

FCC/ISED - TEST REPORT

Report Number : **68.950.23.0533.01** Date of Issue: **June 15, 2023**

Model / HVIN : WOO 4.0

Product Type : WOO 4.0 Sensor

Applicant : WOO Watersports BV

Address : Breelaan 5b 1861GC, Bergen, Netherlands

Manufacturer : WOO Watersports BV

Address : Breelaan 5b 1861GC, Bergen, Netherlands

Test Result : ☒ **Positive** ☐ Negative

Total pages including
Appendices : **47**

Any use for advertising purposes must be granted in writing. This technical report may only be quoted in full. This report is the result of a single examination of the object in question and is not generally applicable evaluation of the quality of other products in regular production. For further details, please see testing and certification regulation, chapter A-3.4.

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2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12 & 13, Zhiheng Wisdomland Business Park, Guankou Erlu,
Nantou, Nanshan District
Shenzhen 518052
P.R. China

Telephone: 86 755 8828 6998

Fax: 86 755 8828 5299

FCC Registration No.: 514049

FCC Designation Number: CA5009

IC Registration No.: 10320A

3 Description of the Equipment Under Test

Product:	WOO 4.0 Sensor
Model no.:	WOO 4.0
Brand name:	WOO Sports
PMN:	WOO 4.0
Hardware Version Identification No. (HVIN)	WOO 4.0
FCC ID:	2BCBY-WOO4
IC:	30746-WOO4
Rating:	3.7VDC rechargeable Li-ion battery or wireless charging 5W powered by 4.0 Charger
RF Transmission Frequency:	2402MHz-2480MHz
No. of Operated Channel:	40
Modulation:	GFSK
Antenna Type:	Ceramic antenna
Antenna 1	Gain: 0.5dBi
Description of the EUT:	The EUT is a Motion Sensor. WOO 4.0 supports BLE_1M and BLE_2M technology. Only Bluetooth Low Energy included in this report.

NOTE:

1. The above EUT's information is declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. The 4.0 Charger is the exclusive charger for the WOO 4.0.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2021 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 5 April 2018 + Amendment 1 (March 2019) + Amendment 2 (February 2021)	General Requirements for Compliance of Radio Apparatus
RSS-247 Issue 2 February 2017	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 Measurement Guidance and ANSI C63.10 (2013).

5 Summary of Test Results

Technical Requirements			
FCC Part 15 Subpart C 10-1-2021 Edition / RSS-247 Issue 2, February 2017/ RSS-Gen Issue 5, April 2018 Amendment 1, March 2019 + Amendment 2, February 2021			
Test Condition		Test Result	Test Site
§15.207 RSS-GEN 8.8	Conducted emission AC power port	Pass	Site 1
§15.247 (b) (3) & RSS-247 5.4(d)	Conducted output power	Pass	Site 1
RSS-247 5.4(d)	Equivalent Isotropic Radiated Power	Pass	Site 1
§15.247(e) RSS-247 5.2(b)	Power spectral density	Pass	Site 1
§15.247(a)(2) RSS-247 5.2(a) & RSS-GEN 6.7	6dB bandwidth	Pass	Site 1
§15.247(a)(1) RSS-247 5.1(b)	20dB Occupied bandwidth	N/A	--
RSS-GEN 6.7	99% Occupied Bandwidth	Pass	Site 1
§15.247(a)(1) RSS-247 5.1(b)	Carrier frequency separation	N/A	--
§15.247(a)(1)(iii) RSS-247 5.1(d)	Number of hopping frequencies	N/A	--
§15.247(a)(1)(iii) RSS-247 5.1(d)	Dwell Time	N/A	--
§15.247(d) RSS-247 5.5	Spurious RF conducted emissions	Pass	Site 1
§15.247(d) RSS-247 5.5	Band edge	Pass	Site 1
§15.247(d) & §15.209 & §15.205 RSS-247 5.5 & RSS-Gen 6.13	Spurious radiated emissions for transmitter	Pass	Site 1
§15.203 RSS-Gen 6.8	Antenna requirement	Pass See note 1	--

Note 1: N/A=Not Applicable.

Note 2: The EUT uses a ceramic antenna, which gain is 0.5dBi. In accordance to §15.203 & RSS-Gen 6.8, it is considered sufficiently to comply with the provisions of this section.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2BCBY-WOO4, IC: 30746-WOO4, complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C rules and RSS-247, RSS-GEN.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: May 29, 2023

Testing Start Date: May 29, 2023

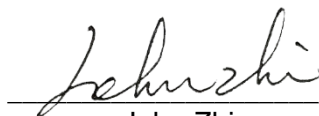
Testing End Date: June 15, 2023

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch -

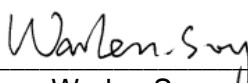
Reviewed by:

Prepared by:

Tested by:



John Zhi
Section Manager



Warlen Song
Project Engineer

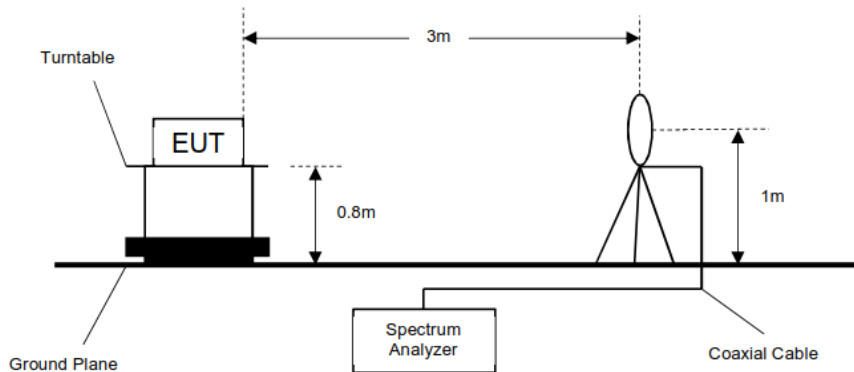


Carry Cai
Test Engineer

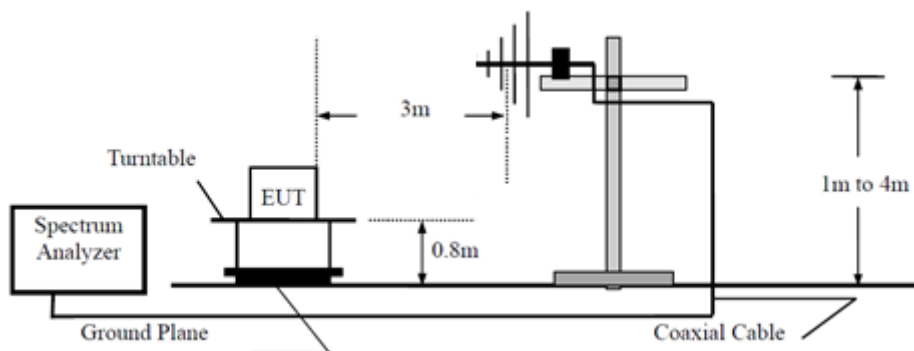
7 Test Setups

7.1 Radiated test setups

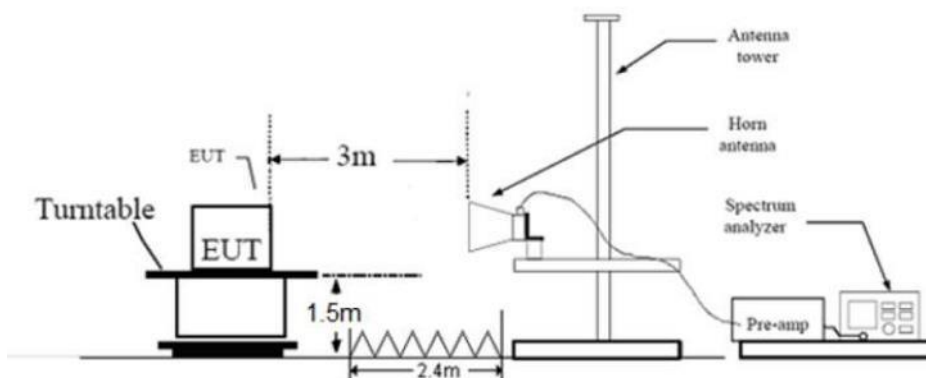
9kHz - 30MHz



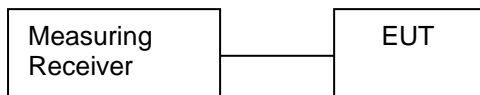
30MHz - 1GHz



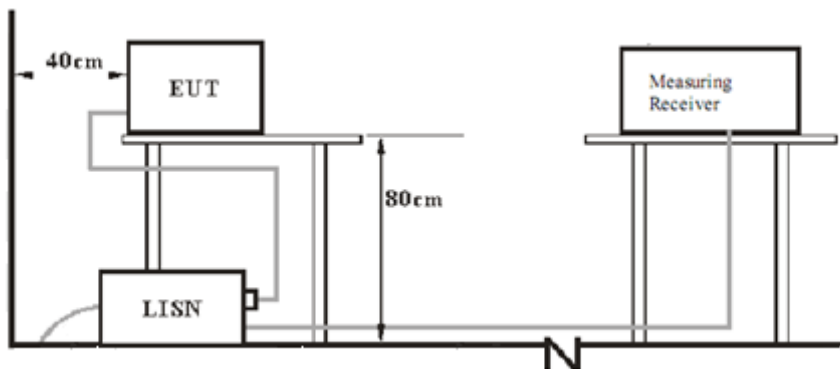
Above 1GHz



7.2 Conducted RF test setups



7.3 AC Power Line Conducted Emission test setups



8 Systems Test Configuration

Auxiliary Equipment Used during Test:

Description	Manufacturer	Model NO.	S/N
Laptop	HP	HP ProBook 455	5CD302CY52
Adaptor	HUAWEI	HW-200325CP2	JH19LBN8V04797
Wireless Charger	WOO Watersports BV	4.0 Charger	---

Test software information:

Test Software Version	nRF Connect	
Modulation	Setting TX Power	Packet Type
GFSK	Default	PRBS9

The system was configured to non-hopping mode, testing channel 0, 19, 39.

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. Both sides of AC line were checked for maximum conducted interference.
6. The frequency range from 150 kHz to 30 MHz was searched.
7. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

Limit

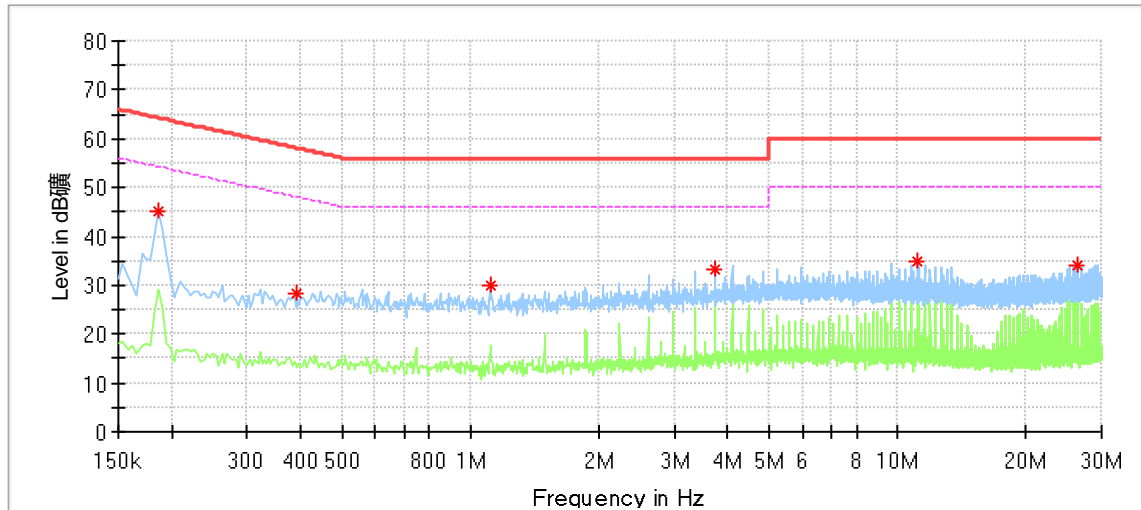
According to §15.207 & RSS-GEN 8.8, conducted emissions limit as below:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

*Decreasing linearly with logarithm of the frequency

Conducted Emission

Product Type : WOO 4.0 Sensor
 M/N : WOO 4.0
 Operating Condition : Charging mode
 Test Specification : Line
 Comment : AC 120V/60Hz



Frequency (MHz)	Max Peak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.186000	44.94	---	64.21	19.28	L1	9.59
0.394000	28.32	---	57.98	29.66	L1	9.62
1.114000	30.11	---	56.00	25.89	L1	9.64
3.726000	33.38	---	56.00	22.62	L1	9.72
11.174000	34.85	---	60.00	25.15	L1	9.93
26.438000	33.87	---	60.00	26.13	L1	10.05

Remark:

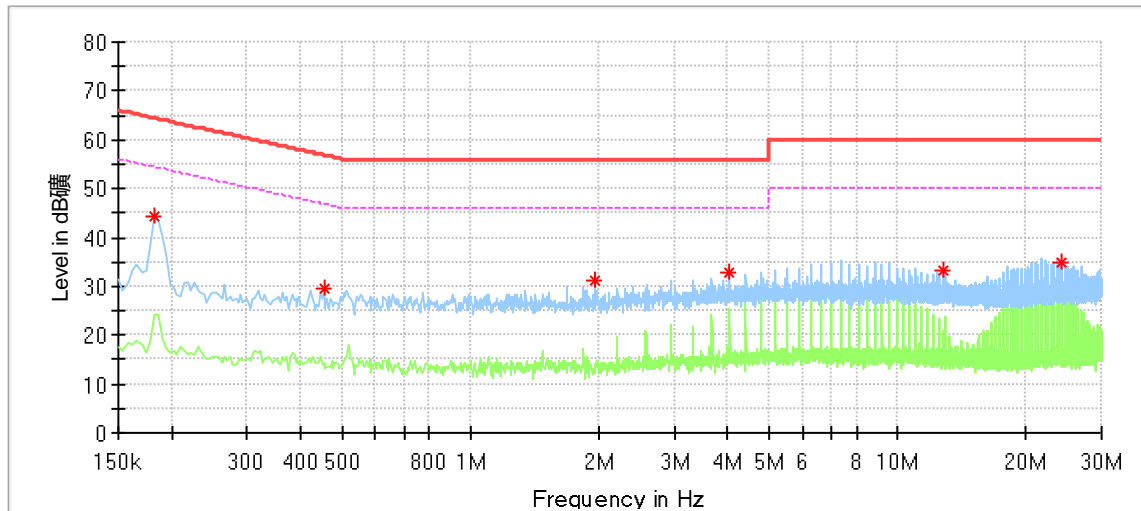
Max Peak=Reading Level + Correction Factor

Correction Factor=Cable Loss + LISN Factor

(The Reading Level is recorded by software which is not shown in the sheet)

Conducted Emission

Product Type : WOO 4.0 Sensor
 M/N : WOO 4.0
 Operating Condition : Charging mode
 Test Specification : Neutral
 Comment : AC 120V/60Hz



Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.182000	44.16	---	64.39	20.23	N	9.58
0.454000	29.53	---	56.80	27.27	N	9.62
1.962000	31.08	---	56.00	24.92	N	9.65
4.046000	32.68	---	56.00	23.32	N	9.73
12.798000	33.07	---	60.00	26.93	N	9.94
24.274000	34.97	---	60.00	25.03	N	10.10

Remark:

Max Peak=Reading Level + Correction Factor

Correction Factor=Cable Loss + LISN Factor

(The Reading Level is recorded by software which is not shown in the sheet)

9.2 Conducted Peak Output Power & EIRP

Test Method

1. The EUT was placed on 0.8m height table, the RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Use the following test receiver settings:
Span = approximately 5 times the 20dB bandwidth, centered on a hopping channel
RBW > the 20dB bandwidth of the emission being measured, VBW ≥ RBW,
Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power and record the results in the test report.
5. Repeat above procedures until all frequencies measured were complete.

Limits

According to §15.247 (b) (3) & RSS-247 5.4(d), conducted output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

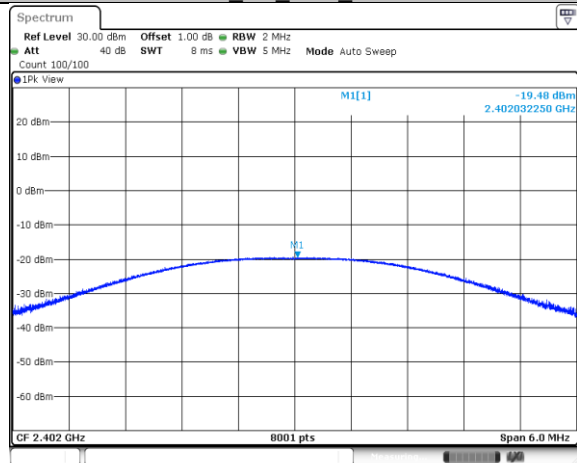
According to & RSS-247 5.4(d), EIRP limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤4	≤36.2

Conducted Peak Output Power & EIRP

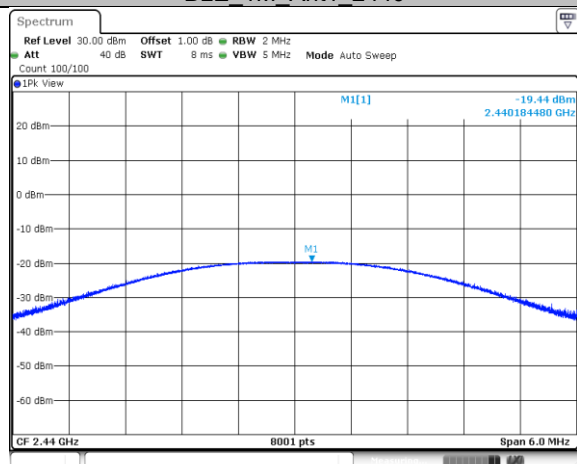
Frequency MHz	Mode	Conducted Peak Output Power dBm	Antenna Gain dBi	EIRP dBm	Result
Bottom channel 2402MHz	LE 1M	-19.48	0.5	-18.98	Pass
Middle channel 2440MHz	LE 1M	-19.44	0.5	-18.94	Pass
Top channel 2480MHz	LE 1M	-18.71	0.5	-18.21	Pass
Bottom channel 2402MHz	LE 2M	-19.47	0.5	-18.97	Pass
Middle channel 2440MHz	LE 2M	-19.69	0.5	-19.19	Pass
Top channel 2480MHz	LE 2M	-18.86	0.5	-18.36	Pass

BLE_1M_Ant1_2402



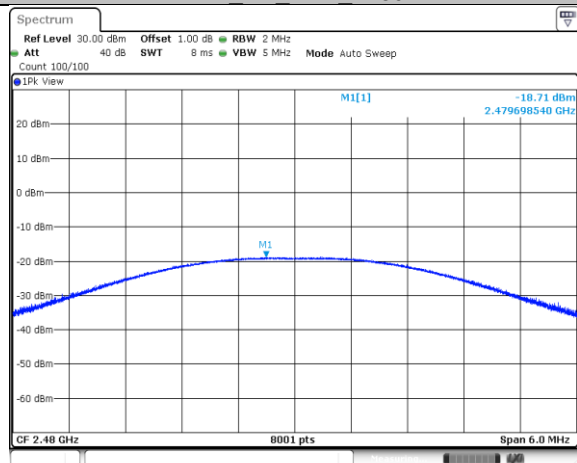
Date: 12 JUN 2023 14:57:16

BLE_1M_Ant1_2440



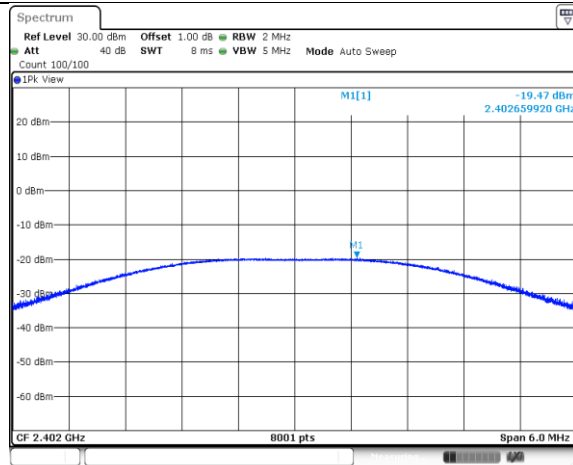
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BLE_1M_Ant1_2480



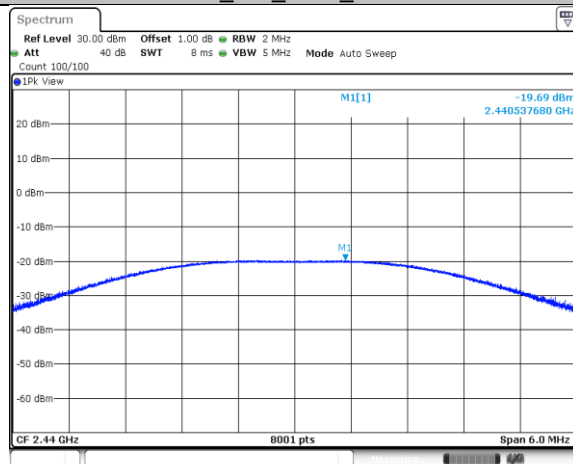
Date: 12 JUN 2023 15:03:37

BLE_2M_Ant1_2402



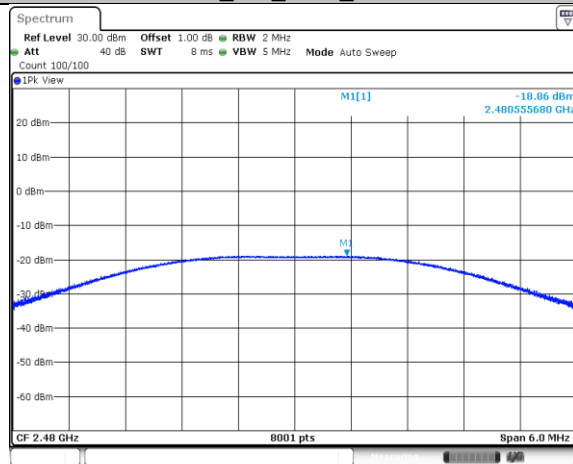
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BLE_2M_Ant1_2440



Date: 12 JUN 2023 16:34:11

BLE_2M_Ant1_2480



Date: 12 JUN 2023 16:37:40

9.3 Power Spectral Density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
4. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW \geq 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
5. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
6. Repeat above procedures until other frequencies measured were completed.

Limit

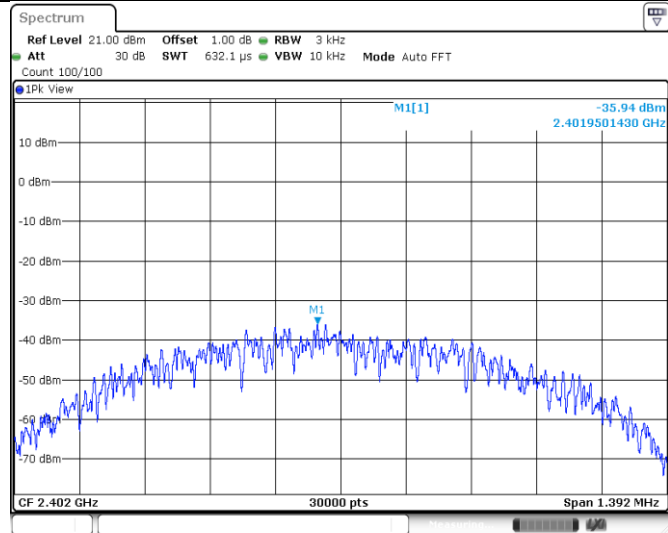
Limit [dBm]

≤ 8

Test result

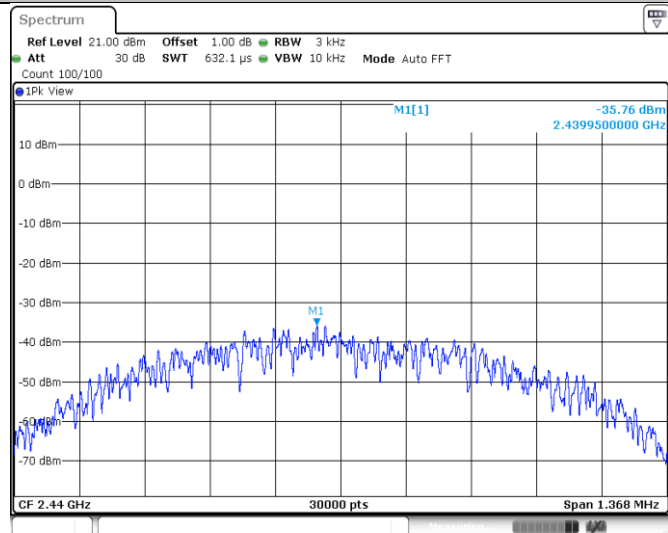
Frequency MHz	Mode	Power spectral density dBm/3kHz	Result
Bottom channel 2402MHz	LE 1M	-35.94	Pass
Middle channel 2440MHz	LE 1M	-35.76	Pass
Top channel 2480MHz	LE 1M	-35.33	Pass
Bottom channel 2402MHz	LE 2M	-38.47	Pass
Middle channel 2440MHz	LE 2M	-38.15	Pass
Top channel 2480MHz	LE 2M	-37.48	Pass

BLE_1M_Ant1_2402



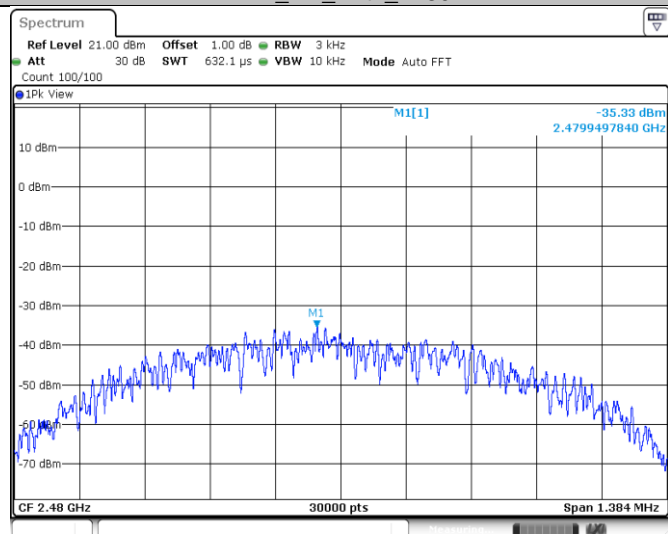
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BLE_1M_Ant1_2440



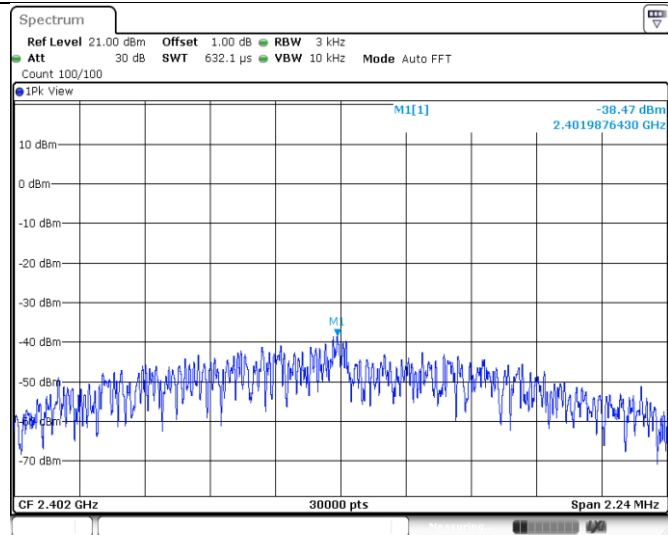
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BLE_1M_Ant1_2480



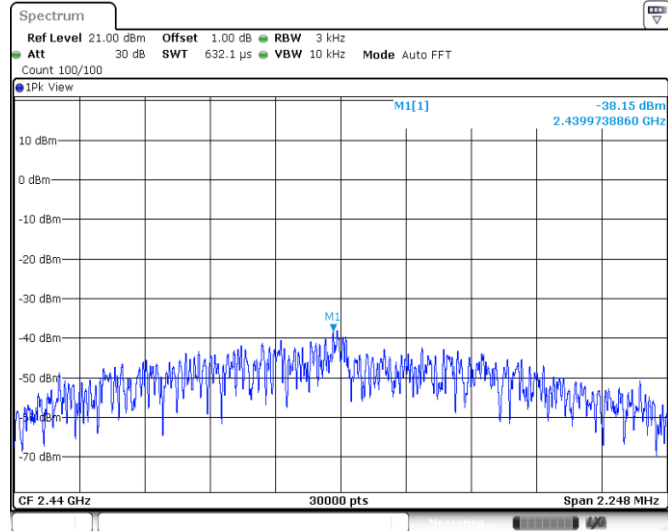
Date: 12 JUN 2023 15:03:42

BLE_2M_Ant1_2402



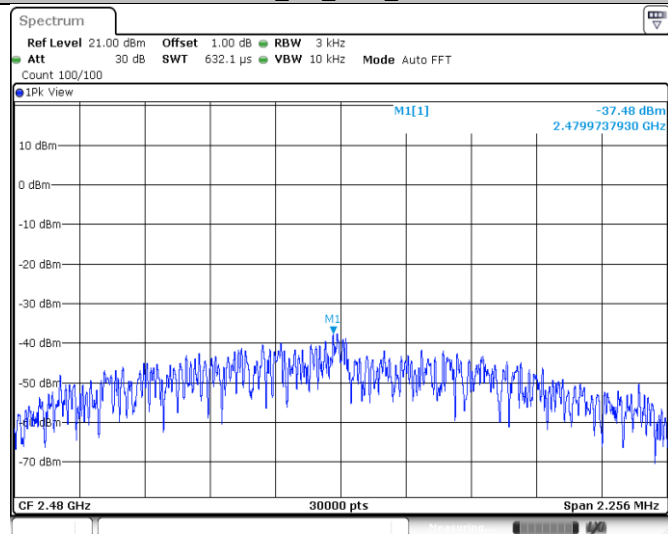
Date: 12 JUN 2023 16:31:08

BLE_2M_Ant1_2440



Date: 12 JUN 2023 16:34:16

BLE_2M_Ant1_2480



Date: 12 JUN 2023 16:37:46

9.4 6 dB Bandwidth

Test Method

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
RBW=100KHz, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Use the automatic bandwidth measurement capability of an instrument, use the X dB bandwidth mode with X set to 6 dB.
5. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Limit

Limit [kHz]

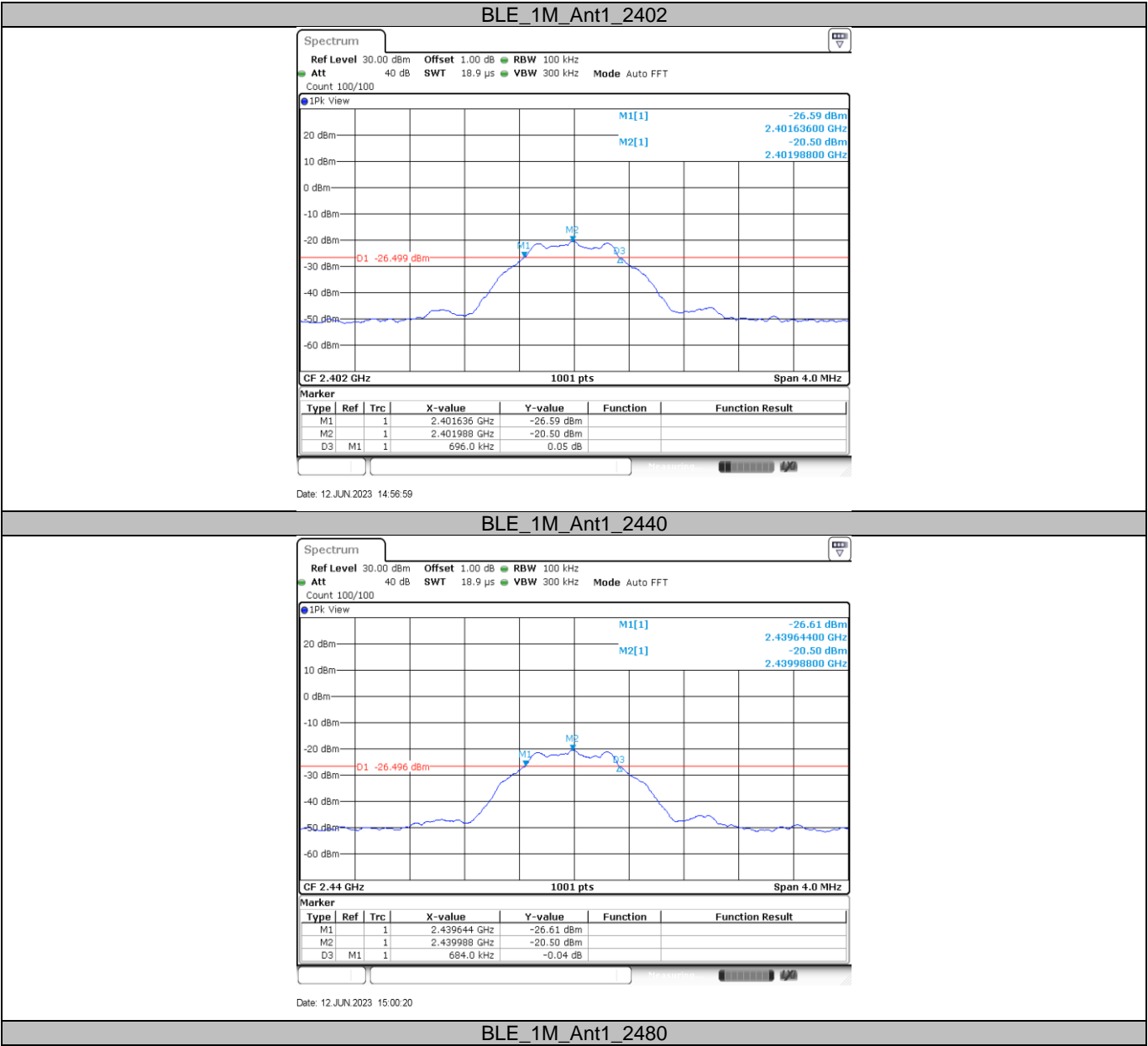
≥500

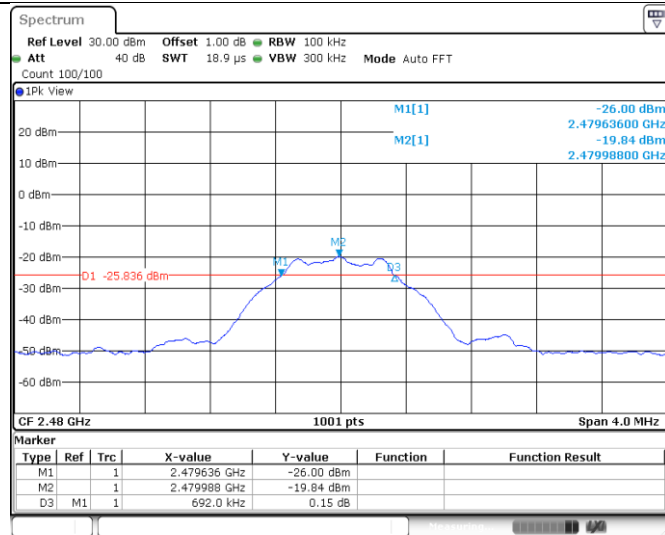
Test result

Frequency MHz	Mode	6dB bandwidth MHz	Result
Bottom channel 2402MHz	LE 1M	0.696	Pass
Middle channel 2440MHz	LE 1M	0.684	Pass
Top channel 2480MHz	LE 1M	0.692	Pass
Bottom channel 2402MHz	LE 2M	1.120	Pass
Middle channel 2440MHz	LE 2M	1.124	Pass
Top channel 2480MHz	LE 2M	1.128	Pass



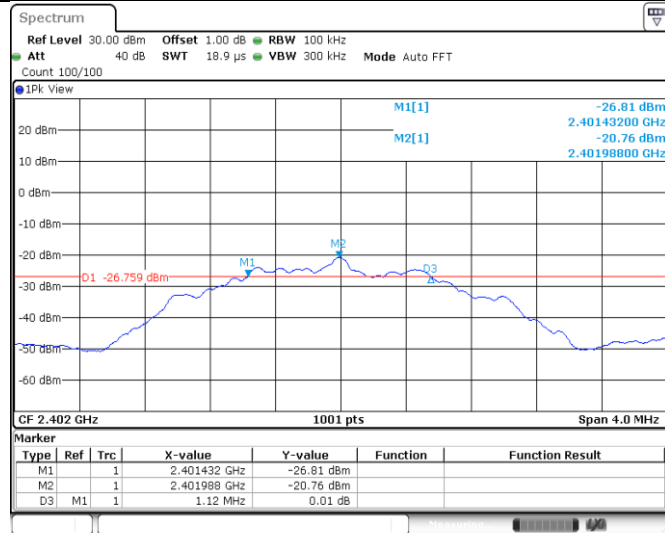
Test Graphs





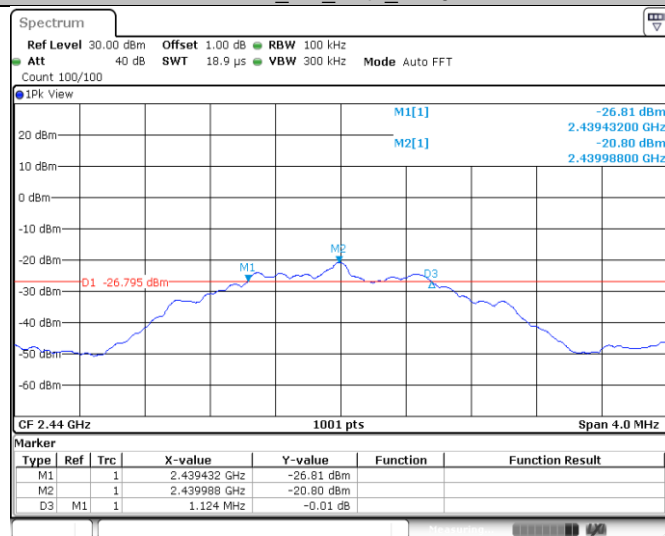
Date: 12 JUN 2023 15:03:19

BLE_2M_Ant1_2402



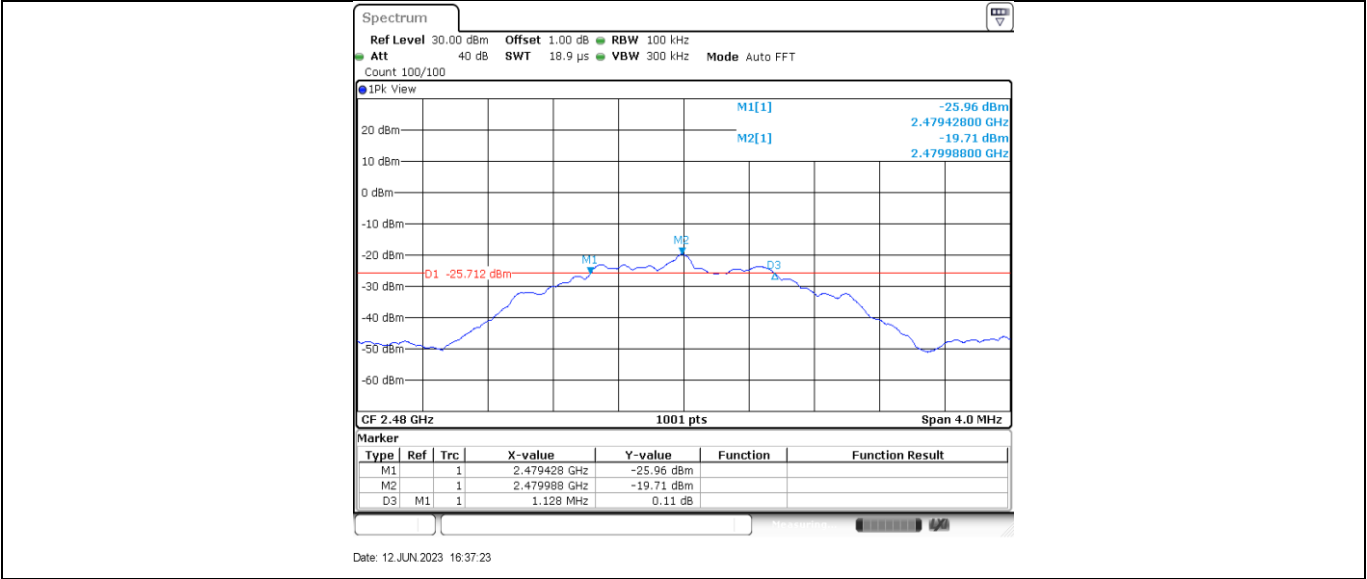
Date: 12 JUN 2023 16:30:45

BLE_2M_Ant1_2440



Date: 12 JUN 2023 16:33:54

BLE_2M_Ant1_2480



9.5 99% bandwidth

Test Method

1. Connect EUT test port to spectrum analyzer.
2. Use the following spectrum analyzer settings:
RBW=1% to 5% of the actual occupied, VBW \geq 3RBW, Sweep = auto,
Detector function = peak, Trace = max hold
3. Use the occupied bandwidth measurement capability of test receiver.
4. Allow the trace to stabilize, record the occupied bandwidth value.

Limit

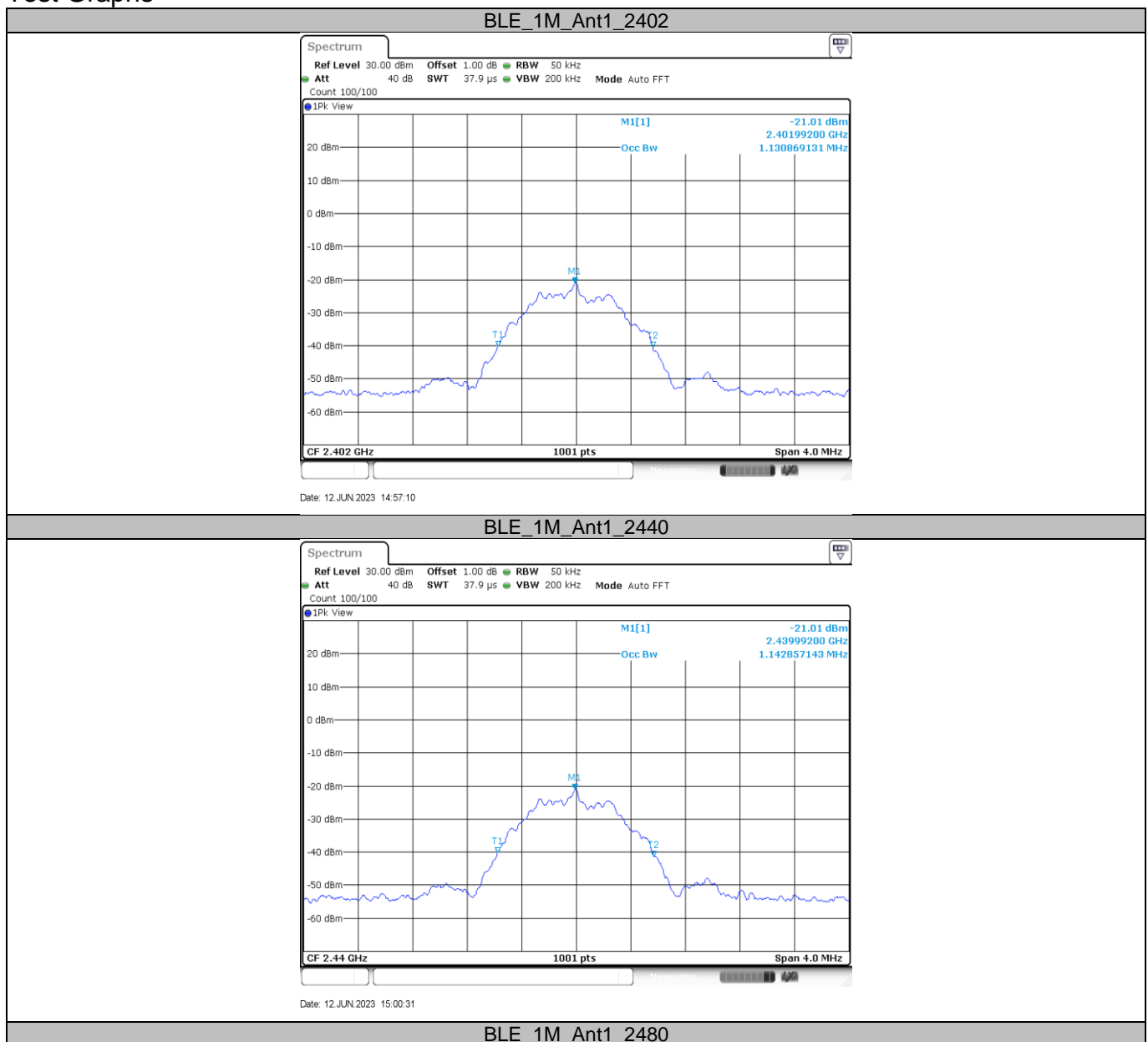
Limit [kHz]

--

Test result

Frequency MHz	Mode	99% bandwidth MHz	Result
Bottom channel 2402MHz	LE 1M	1.131	Pass
Middle channel 2440MHz	LE 1M	1.143	Pass
Top channel 2480MHz	LE 1M	1.135	Pass
Bottom channel 2402MHz	LE 2M	2.198	Pass
Middle channel 2440MHz	LE 2M	2.226	Pass
Top channel 2480MHz	LE 2M	2.186	Pass

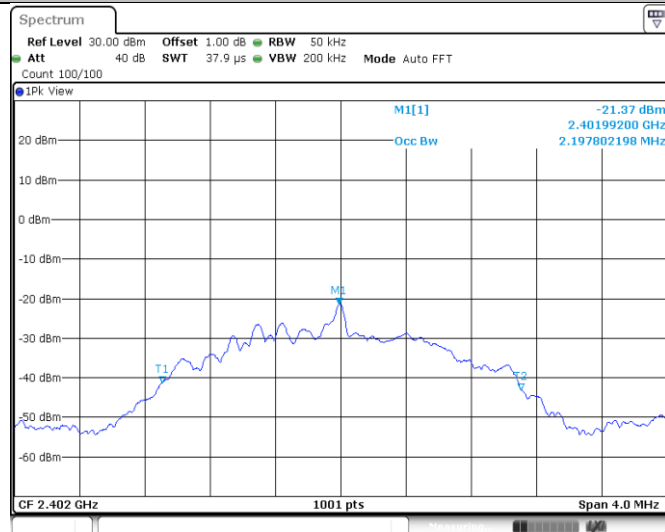
Test Graphs





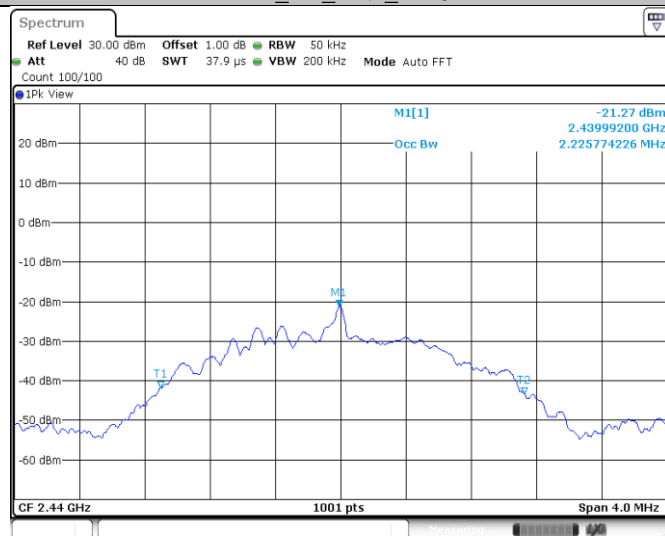
Date: 12 JUN 2023 15:03:30

BLE_2M_Ant1_2402



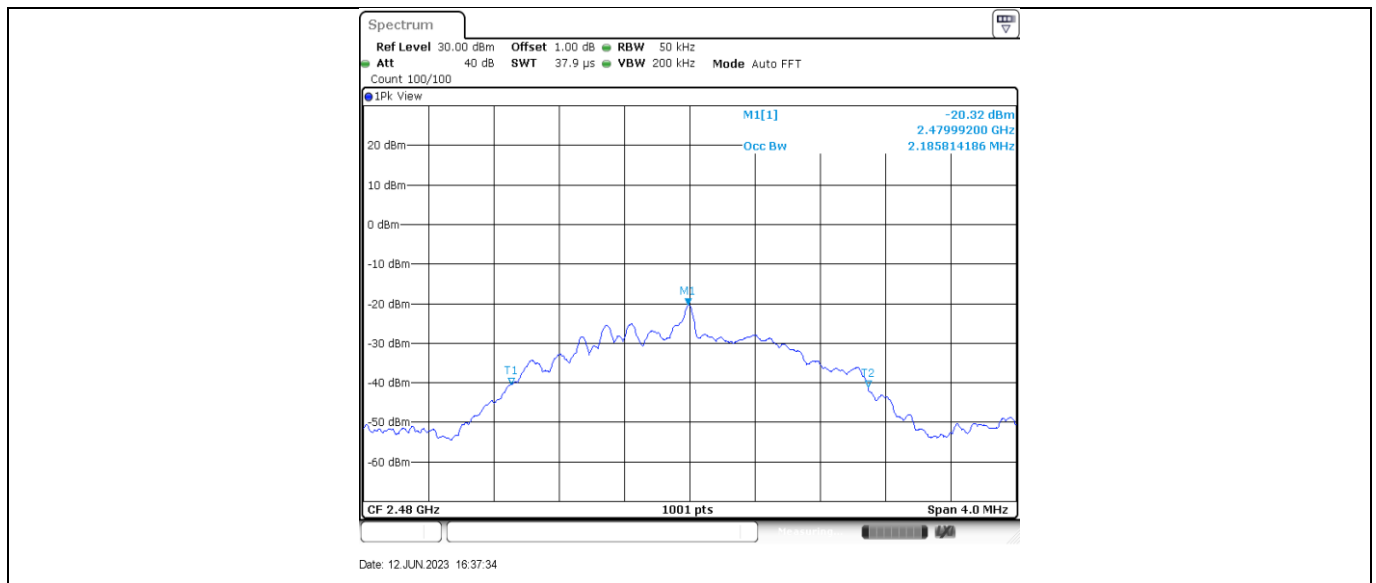
Date: 12 JUN 2023 16:30:56

BLE_2M_Ant1_2440



Date: 12 JUN 2023 16:34:05

BLE_2M_Ant1_2480



9.6 Spurious RF Conducted Emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW \geq 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
5. The level displayed must comply with the limit specified in this Section. Submit these plots.
6. Repeat above procedures until all frequencies measured were complete.

Limit

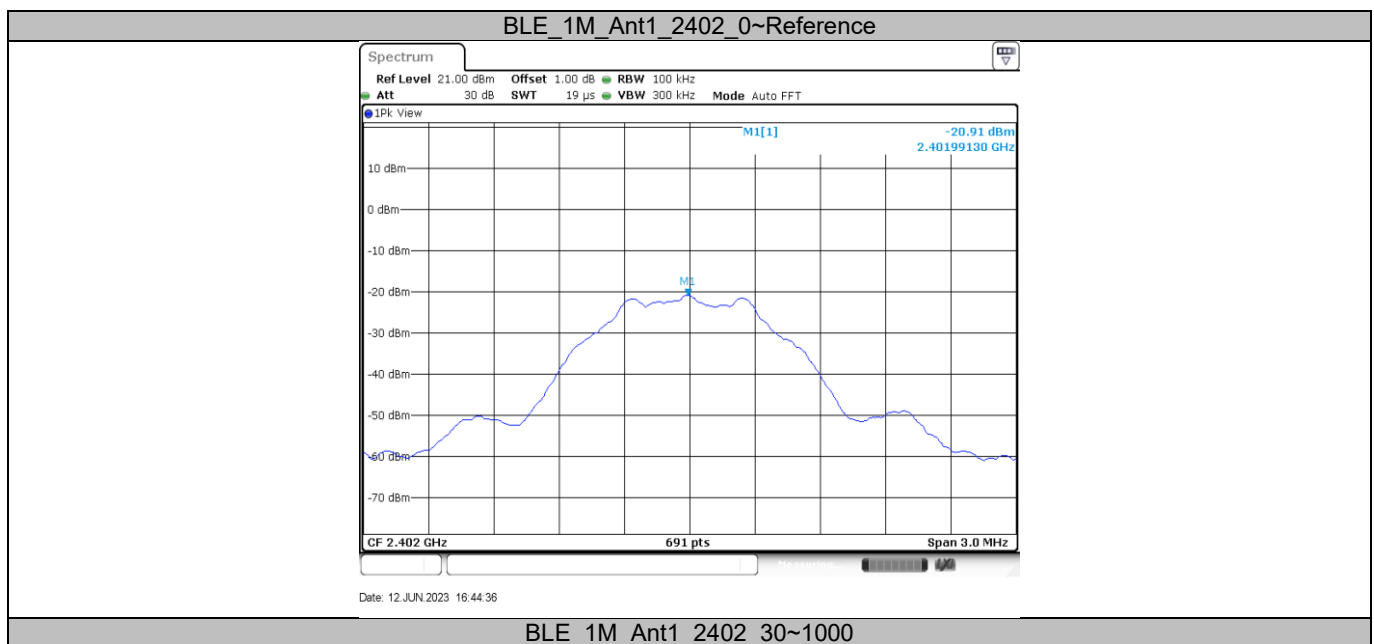
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that 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 § 15.247(b)(3) and RSS 247 section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB.

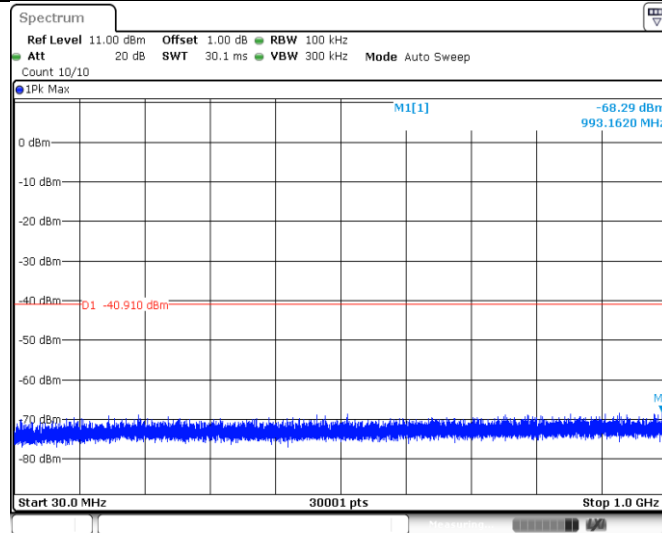
Frequency Range MHz	Limit (dBc)
30-25000	-20

Spurious RF conducted emissions

Test Mode	Antenna	Channel (MHz)	Frequency Range (MHz)	Reference Level	Result (dBm)	Limit (dBm)	Verdict
BLE_1M	Ant1	2402	Reference	-20.91	-20.91	---	PASS
			30~1000	30~1000	-68.29	<=-40.91	PASS
			1000~26500	1000~26500	-52.67	<=-40.91	PASS
		2440	Reference	-20.69	-20.69	---	PASS
			30~1000	30~1000	-68.15	<=-40.69	PASS
			1000~26500	1000~26500	-52.49	<=-40.69	PASS
		2480	Reference	-19.99	-19.99	---	PASS
			30~1000	30~1000	-67.61	<=-39.99	PASS
			1000~26500	1000~26500	-52.56	<=-39.99	PASS
BLE_2M	Ant1	2402	Reference	-20.96	-20.96	---	PASS
			30~1000	30~1000	-68.47	<=-40.96	PASS
			1000~26500	1000~26500	-52.59	<=-40.96	PASS
		2440	Reference	-20.73	-20.73	---	PASS
			30~1000	30~1000	-68.52	<=-40.73	PASS
			1000~26500	1000~26500	-52.72	<=-40.73	PASS
		2480	Reference	-19.99	-19.99	---	PASS
			30~1000	30~1000	-68	<=-39.99	PASS
			1000~26500	1000~26500	-52.13	<=-39.99	PASS

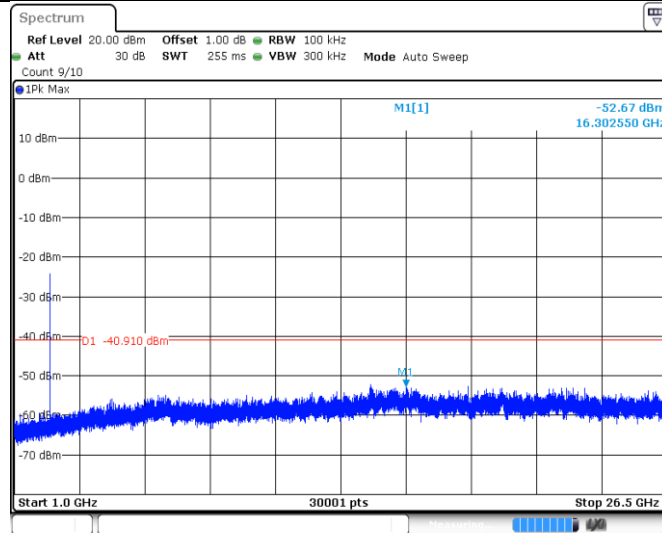
Remark: The emissions exceed limit is fundamental signal.





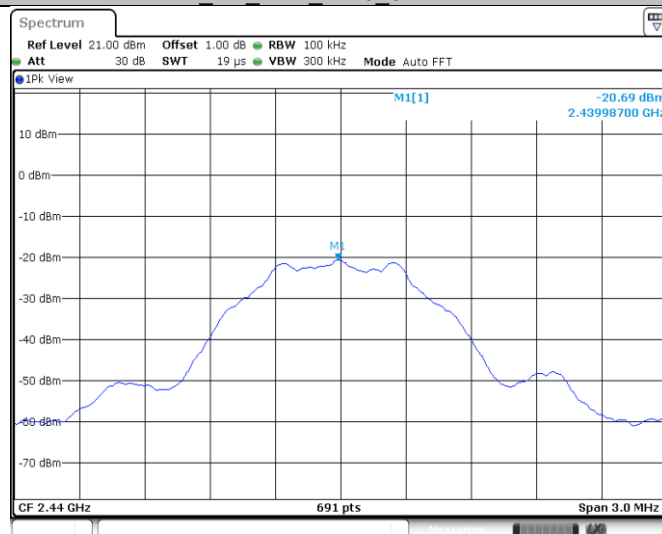
Date: 12 JUN 2023 16:44:42

BLE 1M Ant1 2402 1000~26500



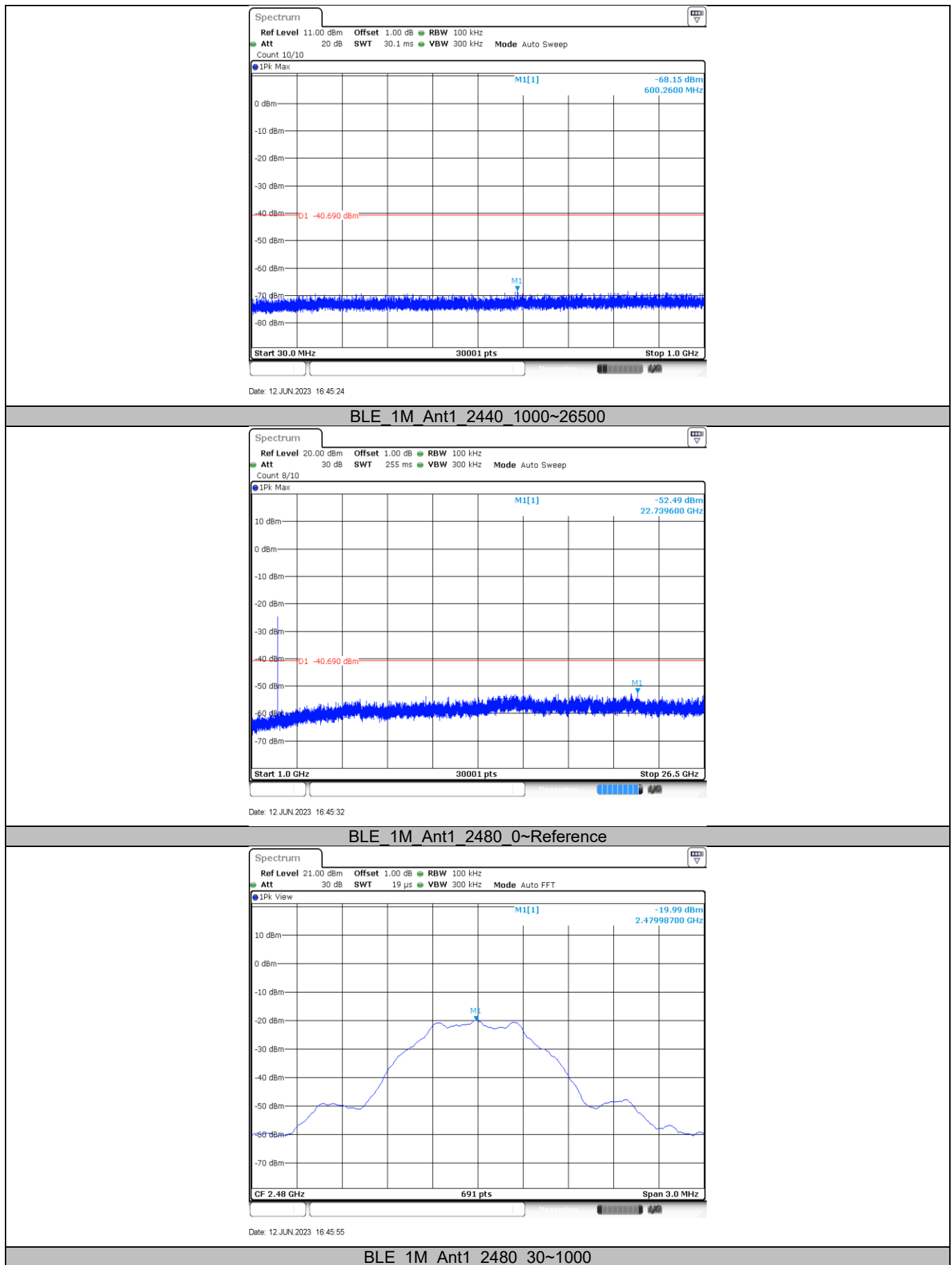
Date: 12 JUN 2023 16:44:50

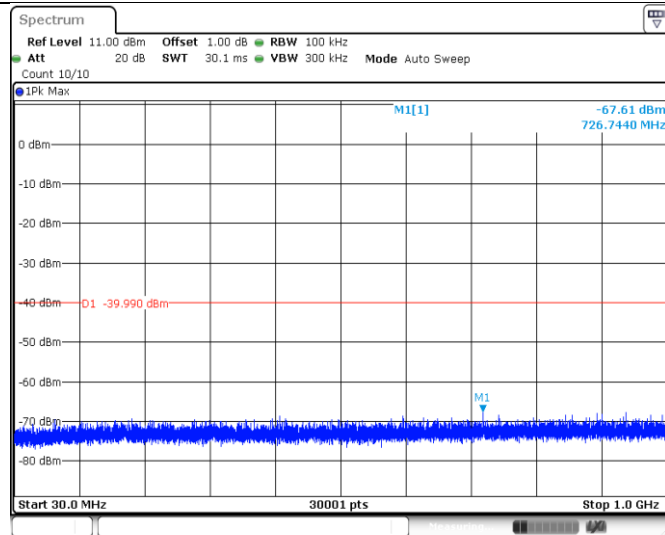
BLE 1M Ant1 2440 0~Reference



Date: 12 JUN 2023 16:45:18

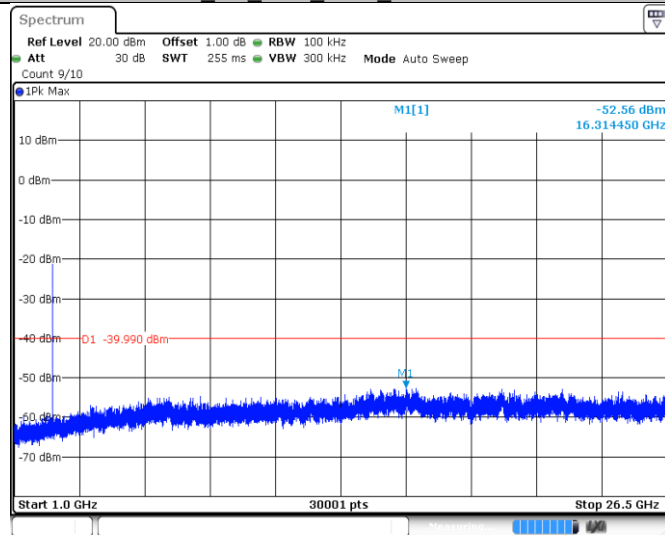
BLE 1M Ant1 2440 30~1000





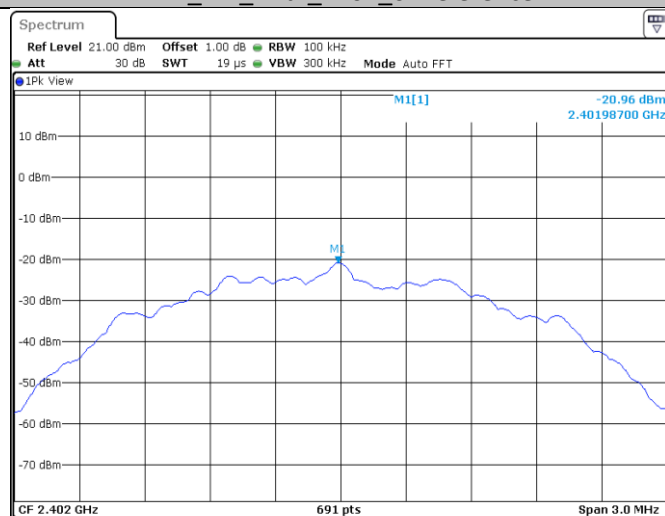
Date: 12 JUN 2023 16:46:01

BLE_1M_Ant1_2480_1000~26500



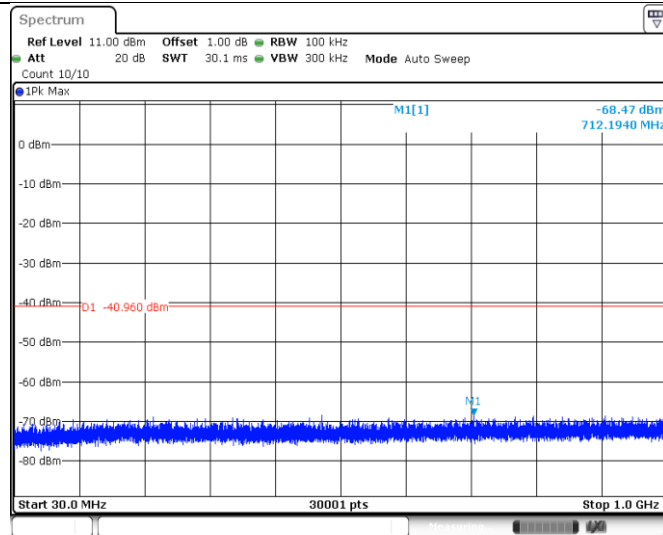
Date: 12 JUN 2023 16:46:09

BLE_2M_Ant1_2402_0~Reference



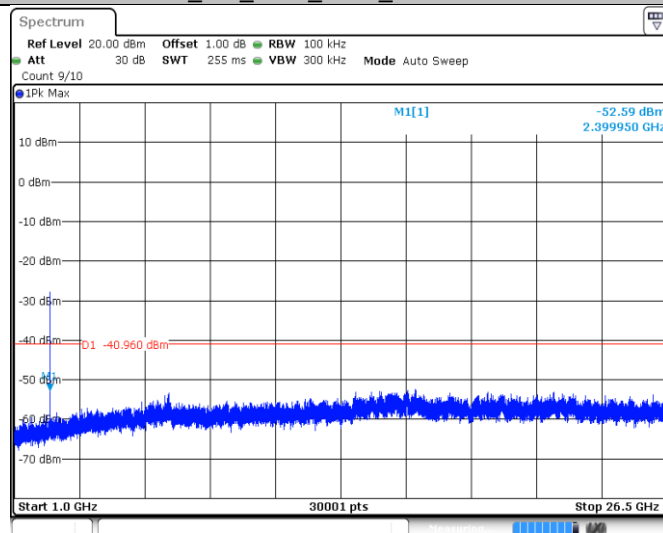
Date: 12 JUN 2023 16:38:34

BLE_2M_Ant1_2402_30~1000



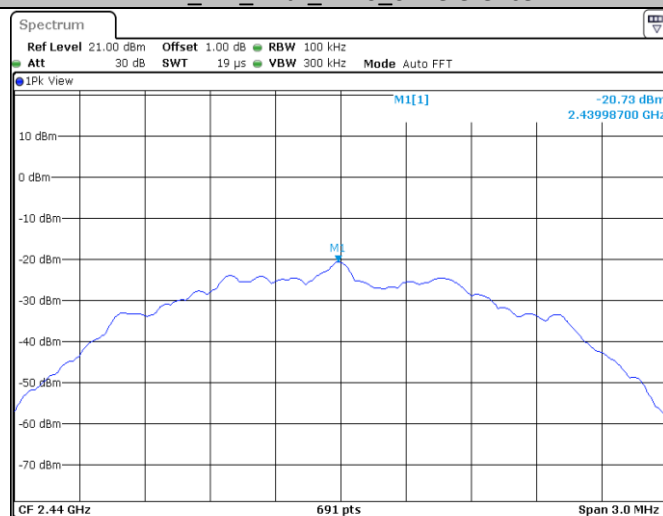
Date: 12 JUN 2023 16:38:41

BLE_2M_Ant1_2402_1000~26500



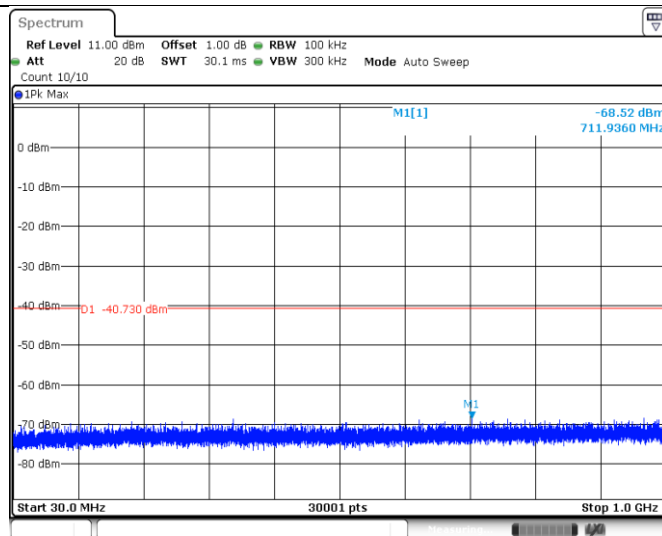
Date: 12 JUN 2023 16:38:48

BLE_2M_Ant1_2440_0~Reference



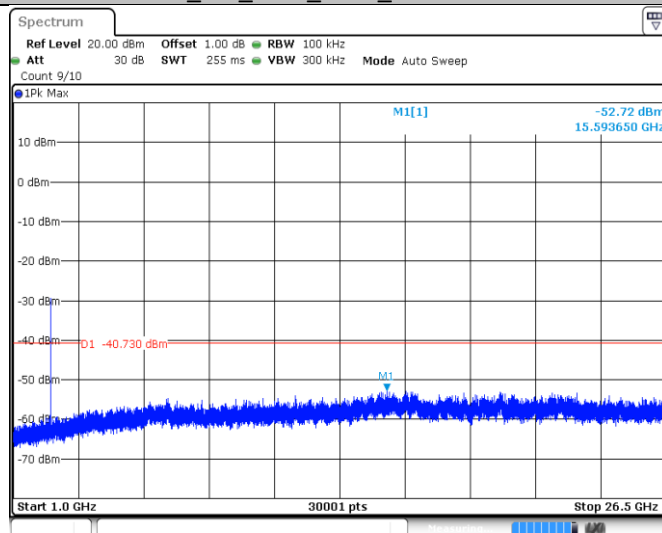
Date: 12 JUN 2023 16:39:21

BLE_2M_Ant1_2440_30~1000



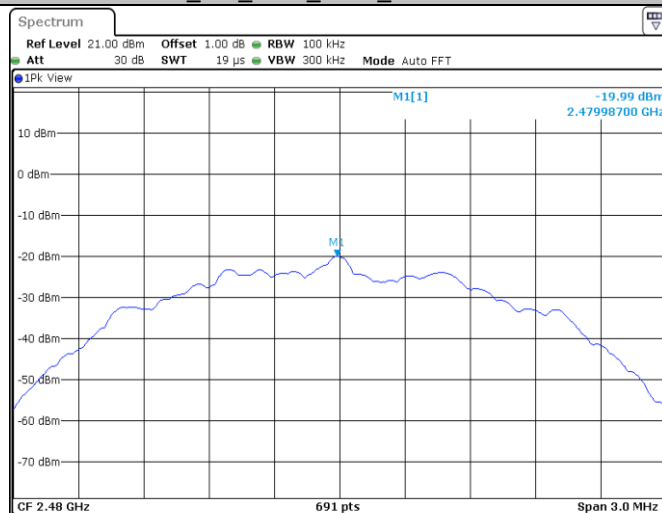
Date: 12 JUN 2023 16:39:27

BLE_2M_Ant1_2440_1000~26500



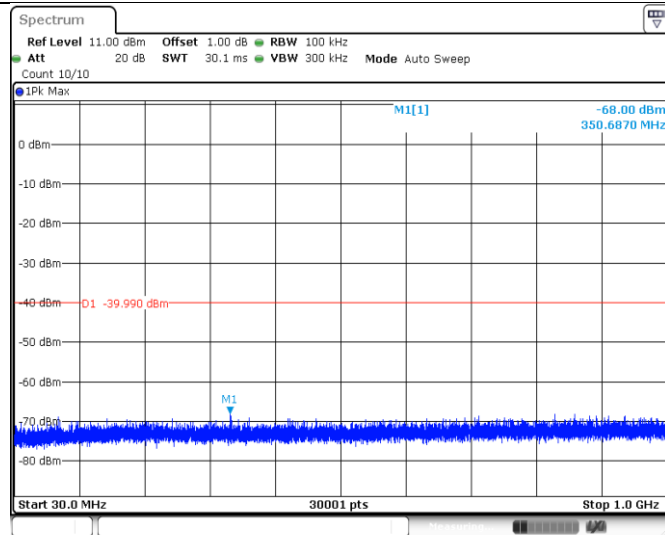
Date: 12 JUN 2023 16:39:35

BLE_2M_Ant1_2480_0~Reference



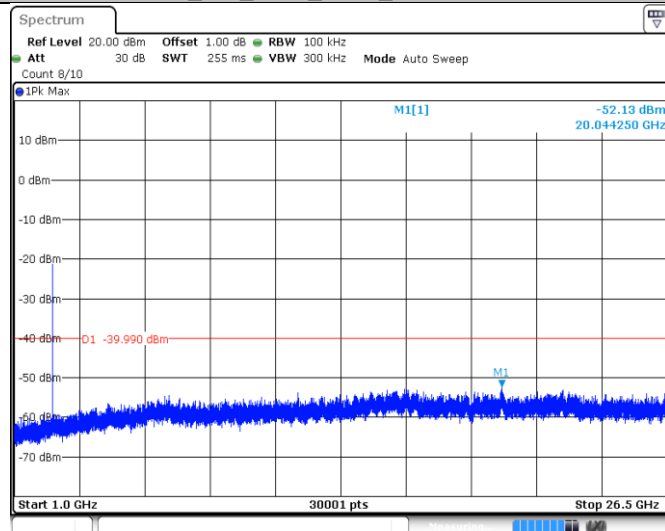
Date: 12 JUN 2023 16:39:58

BLE_2M_Ant1_2480_30~1000



Date: 12 JUN 2023 16:40:04

BLE_2M_Ant1_2480_1000~26500



Date: 12 JUN 2023 16:40:12

9.7 Band Edge

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW \geq 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize, use the peak and delta measurement to record the result.
5. The level displayed must comply with the limit specified in this Section.
6. Repeat above procedures until all frequencies measured were complete and submit all the plots.

Limit:

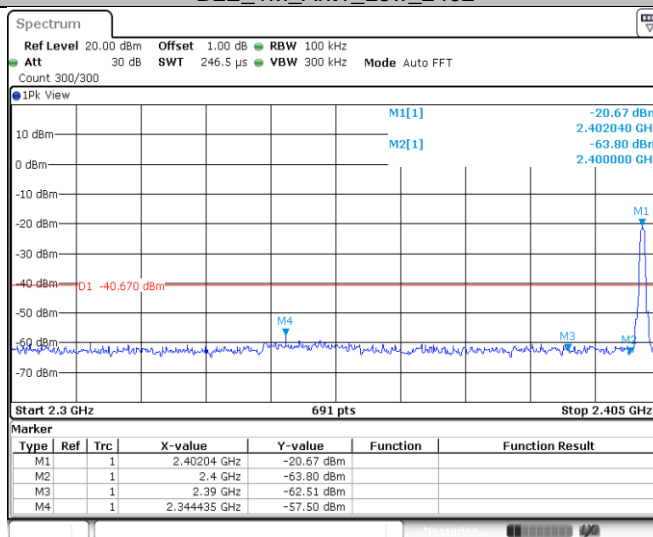
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that 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 § 15.247(b)(3) and RSS-247 section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB.

Frequency Range MHz	Limit (dBc)
30-25000	-20

Band edge testing

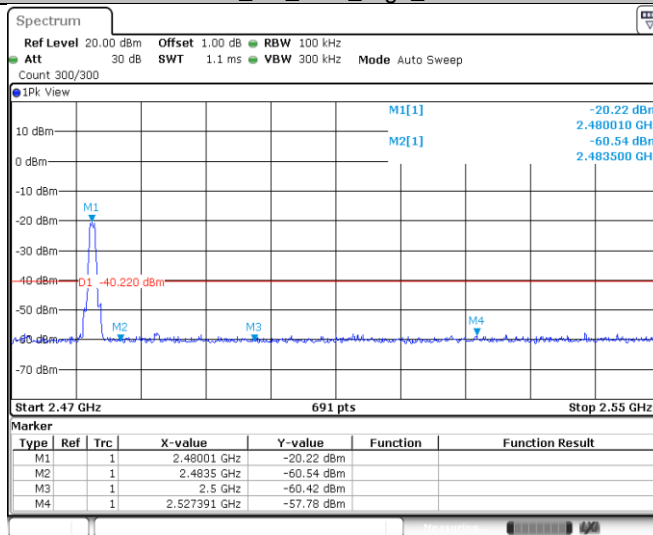
Test Mode	Antenna	Channel	Channel (MHz)	Reference Level (dBm)	Result (dBm)	Limit (dBm)	Verdict
BLE_1M	Ant1	Low	2402	-20.67	-57.5	<=-40.67	PASS
		High	2480	-20.22	-57.78	<=-40.22	PASS
BLE_2M	Ant1	Low	2402	-21.04	-51.4	<=-41.04	PASS
		High	2480	-20.15	-57.85	<=-40.15	PASS

BLE_1M_Ant1_Low_2402



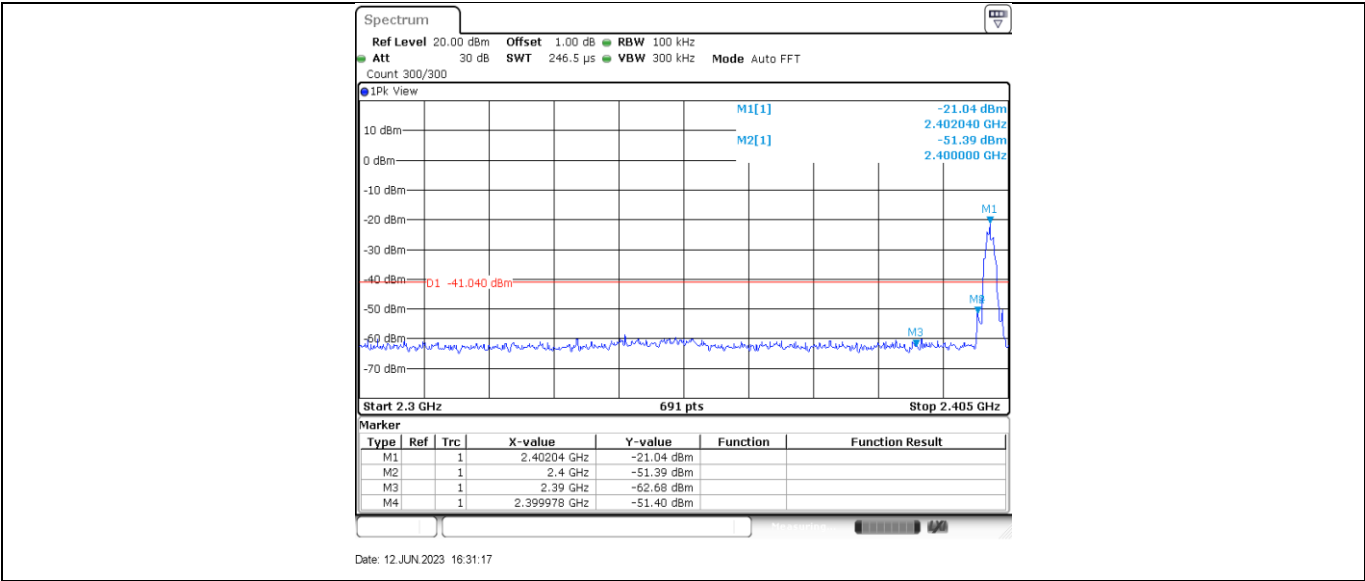
Date: 12 JUN 2023 14:57:31

BLE_1M_Ant1_High_2480

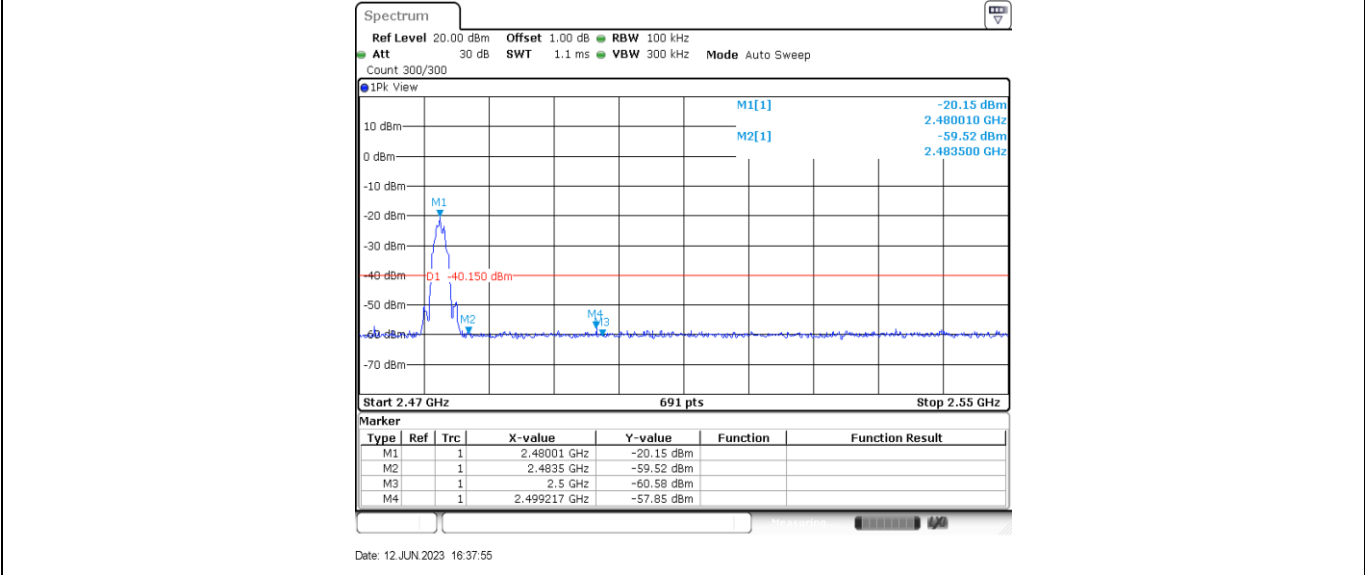


Date: 12 JUN 2023 15:03:51

BLE_2M_Ant1_Low_2402



BLE 2M_Ant1_High_2480



9.8 Spurious Radiated Emissions for Transmitter

Test Method

- 1: The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
- 3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 5: Use the following spectrum analyzer settings According to C63.10:

For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious
 RBW = 100kHz to 120kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious
 RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1000 MHz

- a) RBW = 1MHz.
- b) VBW \ [3 × RBW].
- c) Detector = RMS (power averaging), if [span / (# of points in sweep)] \ RBW / 2. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
- e) Sweep time = auto.
- f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
- g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
 - 2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty

cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that 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 § 15.247(b)(3) and RSS 247 section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in § 15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a) and RSS-Gen section 8.9, must also comply with the radiated emission limits specified in § 15.209(a) and RSS-Gen section 8.10.

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:

Test data_30MHz to 1000MHz

Frequency Band	Frequency MHz	Emission Level dB μ V/m	Polarization	Limit dB μ V/m	Detector	Margin dB μ V/m	Correct factor (dB/m)	Result
30-1000MHz	48.369375	24.10	H	40.00	QP	15.90	20.92	Pass
	94.747500	21.56	H	43.50	QP	21.94	17.83	Pass
	252.008750	24.44	H	46.00	QP	21.56	20.47	Pass
	476.260625	29.77	H	46.00	QP	16.23	25.37	Pass
	591.326875	33.23	H	46.00	QP	12.77	27.75	Pass
	907.486250	38.42	H	46.00	QP	7.58	32.33	Pass
	Other Frequencies	--	H	--	QP	--	--	Pass
	48.551250	23.61	V	40.00	QP	16.39	20.96	Pass
	108.266875	22.12	V	43.50	QP	21.38	18.40	Pass
	200.477500	23.19	V	43.50	QP	20.31	18.67	Pass
	428.185000	29.29	V	46.00	QP	16.71	24.57	Pass
	615.334375	33.83	V	46.00	QP	12.17	28.08	Pass
	924.521875	39.08	V	46.00	QP	6.92	32.41	Pass
	Other Frequencies	--	V	--	QP	--	--	Pass

BLE_1M of low channel 2402MHz

Frequency Band	Frequency MHz	Emission Level dB μ V/m	Polarization	Limit dB μ V/m	Detector	Margin dB μ V/m	Correct factor (dB/m)	Result
1000-25000MHz	2011.500000	41.96	H	74.00	PK	32.04	-6.17	Pass
	3732.000000	47.96	H	74.00	PK	26.04	2.03	Pass
	7205.000000	42.83	H	74.00	PK	31.17	8.91	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1864.500000	43.67	V	74.00	PK	30.33	-7.43	Pass
	3166.500000	44.53	V	74.00	PK	29.47	-0.33	Pass
	7480.000000	40.08	V	74.00	PK	33.92	9.14	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

BLE_1M of Middle channel 2440MHz

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB/m)	Result
1000-25000MHz	1927.500000	41.90	H	74.00	PK	32.10	-6.92	Pass
	3139.500000	44.10	H	74.00	PK	29.90	-0.37	Pass
	8006.000000	42.13	H	74.00	PK	31.87	10.13	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1743.000000	42.02	V	74.00	PK	31.98	-8.47	Pass
	3932.500000	46.49	V	74.00	PK	27.51	2.76	Pass
	6331.000000	39.62	V	74.00	PK	34.38	7.61	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

BLE_1M of high channel 2480MHz

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB/m)	Result
1000-25000MHz	1350.000000	35.62	H	74.00	PK	38.38	-10.86	Pass
	4447.500000	48.44	H	74.00	PK	25.56	4.48	Pass
	9972.000000	41.95	H	74.00	PK	32.05	12.58	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1885.000000	45.86	V	74.00	PK	28.14	-7.25	Pass
	3212.000000	44.49	V	74.00	PK	29.51	-0.42	Pass
	7553.500000	41.10	V	74.00	PK	32.90	9.56	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

BLE_2M of low channel 2402MHz

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB/m)	Result
1000-25000MHz	2021.500000	37.86	H	74.00	PK	36.14	-6.17	Pass
	3553.500000	44.75	H	74.00	PK	29.25	0.97	Pass
	7168.500000	42.37	H	74.00	PK	31.63	8.73	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1481.500000	35.54	V	74.00	PK	38.46	-9.85	Pass
	3148.000000	43.42	V	74.00	PK	30.58	-0.33	Pass
	8185.000000	40.76	V	74.00	PK	33.24	10.51	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

BLE_2M of Middle channel 2440MHz

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB/m)	Result
1000-25000MHz	1489.000000	34.47	H	74.00	PK	39.53	-9.78	Pass
	3026.000000	41.63	H	74.00	PK	32.37	-1.39	Pass
	8398.500000	40.75	H	74.00	PK	33.25	10.82	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1963.500000	38.97	V	74.00	PK	35.03	-6.65	Pass
	3061.500000	43.01	V	74.00	PK	30.99	-0.88	Pass
	8025.000000	40.35	V	74.00	PK	33.65	10.19	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

BLE_2M of high channel 2480MHz

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB/m)	Result
1000-25000MHz	1805.000000	36.80	H	74.00	PK	37.20	-7.90	Pass
	3078.500000	43.09	H	74.00	PK	30.91	-1.04	Pass
	8102.500000	40.19	H	74.00	PK	33.81	10.40	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1705.500000	35.60	V	74.00	PK	38.40	-8.64	Pass
	3155.500000	44.38	V	74.00	PK	29.62	-0.32	Pass
	8357.000000	41.10	V	74.00	PK	32.90	10.85	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

Remark:

- (1) Data of measurement within frequency ranges 9kHz-30MHz and 18-26GHz are the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report,
- (2) Level= Reading Level + Correction Factor
- (3) Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
Below 1GHz: Corrector factor = Antenna Factor + Cable Loss
(The Reading Level is recorded by software which is not shown in the sheet)

10 Test Equipment List

List of Test Instruments

Radiated Emission 1# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 7	68-4-74-19-001	102176	2024-5-20
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	68-4-80-14-002	707	2023-7-12
Loop Antenna	Rohde & Schwarz	HFH2-Z2	68-4-80-14-006	100398	2023-8-17
Pre-amplifier	Rohde & Schwarz	SCU 18	68-4-29-14-001	102230	2024-5-19
Attenuator	Mini-circuits	UNAT-6+	68-4-81-21-001	15542	2024-5-19
3m Semi-anechoic chamber	TDK	SAC-3 #1	68-4-90-14-001	----	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-14-001-A10	Version10.35.0 2	N/A

Radiated Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 26	68-4-74-14-002	101269	2024-5-20
Wave Guide Antenna	ETS	3117	68-4-80-19-001	00218954	2024-4-26
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-001	100745	2024-5-19
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-002	100746	2024-5-19
Sideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	68-4-80-14-008	12827	2023-7-12
Pre-amplifier	Rohde & Schwarz	SCU 40A	68-4-29-14-002	100432	2023-7-27
Attenuator	Mini-circuits	UNAT-6+	68-4-81-21-002	15542	2024-5-19
3m Semi-anechoic chamber	TDK	SAC-3 #2	68-4-90-19-006	----	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-19-006-A01	Version10.35.0 2	N/A

Conducted Emission Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 3	68-4-74-14-001	101782	2024-5-20
LISN	Rohde & Schwarz	ENV432	68-4-87-16-001	101318	2024-5-20
Test software	Rohde & Schwarz	EMC32	68-4-90-14-003-A10	Version9.15.00	N/A
Shielding Room	TDK	CSR #1	68-4-90-19-004	----	2025-10-15

Conducted RF Test System

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	68-4-74-14-004	101030	2024-5-19
RF Switch Module	Rohde & Schwarz	OSP120/OSP-B157W	68-4-93-14-003	101226/100929	2024-5-20
Power Splitter	Weinschel	1580	68-4-85-14-001	SC319	2024-5-20
10dB Attenuator	Weinschel	4M-10	68-4-81-14-003	43152	2024-5-19
10dB Attenuator	R&S	DNF	68-4-81-14-004	DNF-001	2024-5-19
10dB Attenuator	R&S	DNF	68-4-81-14-005	DNF-002	2024-5-19
10dB Attenuator	R&S	DNF	68-4-81-14-006	DNF-003	2024-5-19
10dB Attenuator	R&S	DNF	68-4-81-14-007	DNF-004	2024-5-19
Test software	Tonscend	System for BT/WIFI	68-4-74-14-006-A13	Version 2.6.77.0518	N/A
Shielding Room	TDK	TS8997	68-4-90-19-003	----	2025-10-15

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Conducted Emission 150kHz-30MHz (for test using AMN ENV432 or ENV4200)	3.57dB
Uncertainty for Radiated Emission in 3m chamber 9kHz-30MHz	4.70dB
Uncertainty for Radiated Emission in new 3m chamber 30MHz-1000MHz	Horizontal: 4.59dB; Vertical: 4.75dB
Uncertainty for Radiated Emission in new 3m 1000MHz-18000MHz	Horizontal: 5.08dB; Vertical: 5.09dB;
Uncertainty for Radiated Emission 18000MHz-40000MHz	Horizontal: 4.52dB; Vertical: 4.51dB
Uncertainty for Conducted RF test	RF Power Conducted: 1.31dB Frequency test involved: 0.6×10^{-8} or 1%

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2021, clause 4.4.3 and 4.5.1.

THE END