

FCC RF Test Report

Test Report Number SUB-23071961-LC-FCC-DTS

FCC ID 2AS4H-BLINC2

Applicant Subeca, Inc.

Applicant Address 4514 Cole Avenue Suite 600, Dallas, TX 75205

Product Name Subeca BLINC

Model (s) BLINC

Date of Receipt 08/15/2023

Date of Test 08/15/2023- 08/21/2023

Report Issue Date 02/27/2024

Test Standards 47 CFR Part 15.247

Test Result PASS



Issued by:

Vista Compliance Laboratories

1261 Puerta Del Sol, San Clemente, CA 92673 USA

www.vista-compliance.com



Devin Tai (Test Engineer)



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REVISION HISTORY

Report Number	Version	Description	Issued Date
SUB-23071961-LC-FCC-DTS	01	Initial report	02/27/2024

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1 Test Summary

Test Item	Test Requirement	Test Method	Result
Antenna Requirement	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
AC Power Line Conducted Emissions	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Occupied Bandwidth	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
DTS (6 dB) Channel Bandwidth	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Conducted Maximum Output Power	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Power Spectral Density	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Conducted Band-Edge & Unwanted Emissions	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	47 CFR Part 15.247	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass

2 General Information

2.1 Applicant

Applicant	Subeca, Inc.
Applicant address	4514 Cole Avenue Suite 600, Dallas, TX 75205
Manufacturer	Subeca, Inc.
Manufacturer Address	4514 Cole Avenue Suite 600, Dallas, TX 75205

2.2 Product information

Product Name	Subeca BLINC
Product Description	Subeca BLINC
Model Number	BLINC
Family Models	N/A
Serial Number	N/A
Frequency Band	BLE: 2402-2480MHz LoRA: 902.3-914.9MHz
Type of modulation	GFSK (BLE), LoRA
Equipment Class	DTS, DSS
Antenna Information	FPC Antenna: WPANT10148-S1A (BLE antenna), peak gain: 2 dBi WPANT10144-S2A (LoRA antenna), peak gain: -1 dBi WPANT10129-S1A (LoRA antenna), peak gain: 2 dBi
Clock Frequencies	N/A
Input Power	DC 3.7V
Power Adapter Manufacturer/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	BLE and LoRa can transmit simultaneously
Additional Info	N/A

2.3 Test standard and method

Test standard	47 CFR Part 15.247
Test method	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02

3 Test Site Information

Lab performing tests	Vista Laboratories, Inc.
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www.vista-compliance.com

Test Condition	Temperature	Humidity	Atmospheric Pressure
RF Testing	23.5°C	55.1%	996 mbar
Radiated Emission Testing	23.5°C	55.1%	996 mbar

4 Modification of EUT / Deviations from Standards

The EUT is an engineering test sample loaded with RF testing firmware specifically designed to support the RF TX/RX measurement in different aspects.

5 Test Configuration and Operation

5.1 EUT Test Configuration

The EUT is mounted onto a development board to support testing. EUT is set to different transmission mode in terms of radio mode bandwidth, power level, test channel, etc.

The following software was used for testing and to monitor EUT performance

Software	Description
EMISoft Vasona	EMC/RF Spurious emission test software used during testing

5.2 Supporting Equipment

Description	Manufacturer	Model #	Serial #
Development board	Subeca	PCB-00017	N/A
Power adapter	GNARBOX	KYTW40P01	N/A

6 Uncertainty of Measurement

Test item	Measurement Uncertainty (dB)
RF Output Power (Conducted)	±1.2 dB
Power Spectral Density	±0.9 dB
Unwanted Emission (conducted)	±2.6 dB
Occupied Channel Bandwidth	±5 %
Radiated Emission (9KHz-30MHz)	±3.5 dB
Radiated Emission (30MHz-1GHz)	±4.6 dB
Radiated Emission (1-18GHz)	±4.9 dB
Radiated Emission (18-40GHz)	±3.5 dB

7 Test Results

7.1 Antenna Requirement

7.1.1 Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

7.1.2 Result

Analysis:

- EUT has two removable FPC antennas which connect to the main board through unique U.FL RF connectors. One for BLE and one for LoRa.
- Both main board and antenna are equipped with U.FL connector. No standard RF connector is used.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

7.2 Conducted Emissions

7.2.1 Requirement

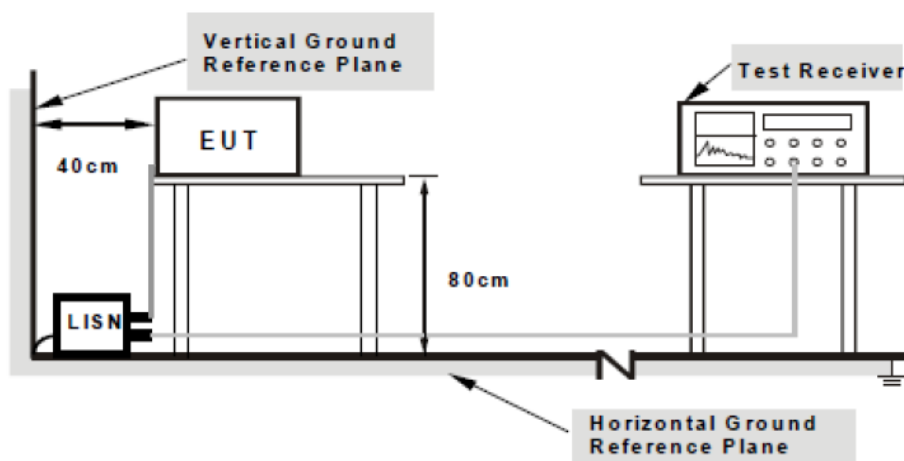
Per § 15.207 (a), an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Limits for Conducted Emissions at the Mains Ports

Section	Frequency ranges (MHz)	Limit (dBuV)	
		QP	Average
Class B devices	0.15 - 0.5	66 - 56	56 - 46
	0.5 - 5	56	46
	5 - 30	60	50

NOTE 1 The lower limit shall apply at the transition frequencies.

7.2.2 Test setup



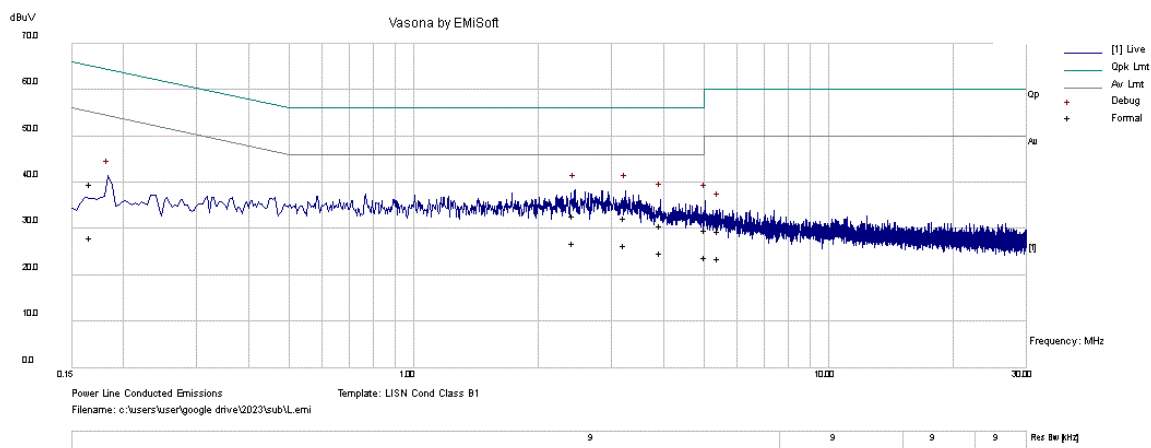
Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

7.2.3 Test Procedure

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50 Ω /50 μ H EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment was powered separately from another main supply.
5. The EUT was switched on and allowed to warm up to its normal operating condition.
6. A scan was made on the NEUTRAL line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.
7. High peaks, relative to the limit line, were then selected.
8. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, both Quasi-peak and Average measurements were made
9. All possible modes of operation were investigated. Only the worst case emissions were measured and reported. All other emissions were relatively insignificant.

7.2.4 Test Result

Test Standard:	Part 15.207	Mode:	TX, Live
Frequency Range:	0.15-30MHz	Test Date:	08/21/2023
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Class B, 120VAC, 60Hz	Test Result:	Pass

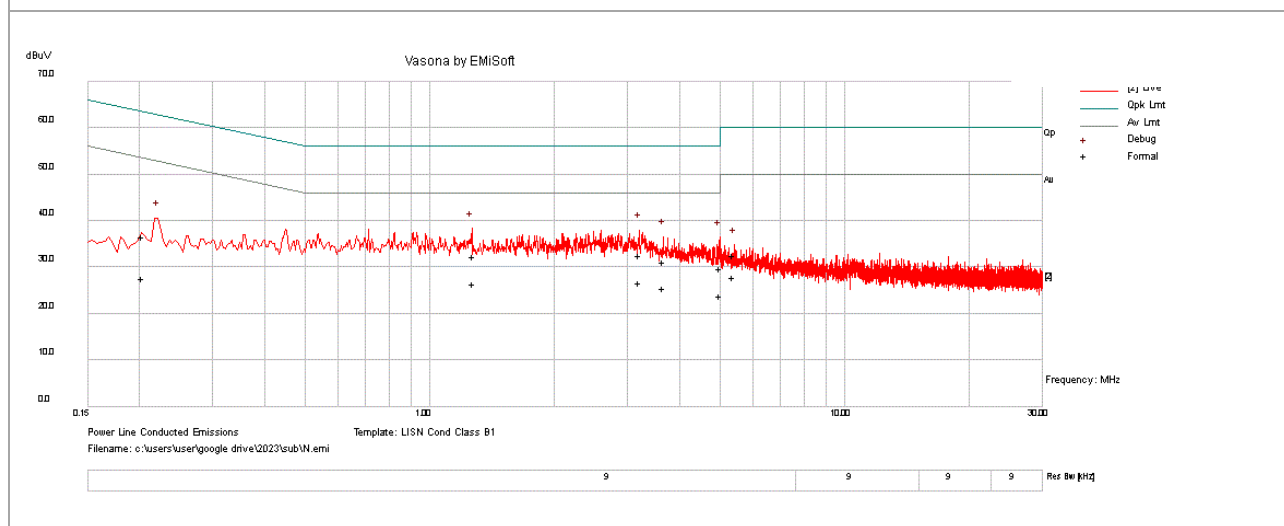


No.	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	2.432	22.4	10.2	0.1	32.7	Quasi Peak	Live	56	-23.3	Pass
2	3.223	22.1	10.3	0.1	32.5	Quasi Peak	Live	56	-23.5	Pass
3	3.95	20.3	10.3	0.1	30.7	Quasi Peak	Live	56	-25.3	Pass
4	0.166	29.5	10.1	0.2	39.8	Quasi Peak	Live	65.1	-25.3	Pass
5	5.046	19.3	10.4	0.1	29.8	Quasi Peak	Live	60	-30.2	Pass
6	5.439	18.9	10.4	0.1	29.4	Quasi Peak	Live	60	-30.6	Pass
7	2.432	16.5	10.2	0.1	26.8	Average	Live	46	-19.2	Pass
8	3.223	16.2	10.3	0.1	26.6	Average	Live	46	-19.4	Pass
9	3.95	14.4	10.3	0.1	24.8	Average	Live	46	-21.2	Pass
10	0.166	17.8	10.1	0.2	28.1	Average	Live	55.1	-27	Pass
11	5.046	13.4	10.4	0.1	23.9	Average	Live	50	-26.1	Pass
12	5.439	13.1	10.4	0.1	23.6	Average	Live	50	-26.4	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Factor = Inert loss of LISN
3. Margin value = Emission level - Limit value
4. Emission Level = Raw Value + Cable loss + Factors Value.

Test Standard:	Part 15.207	Mode:	TX, Neutral
Frequency Range:	0.15-30MHz	Test Date:	08/21/2023
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Class B, 120VAC, 60Hz	Test Result:	Pass



No.	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	1.274	22	10.2	0.1	32.3	Quasi Peak	Neutral	56	-23.7	Pass
2	3.207	22.2	10.3	0.1	32.6	Quasi Peak	Neutral	56	-23.4	Pass
3	3.656	20.9	10.3	0.1	31.3	Quasi Peak	Neutral	56	-24.7	Pass
4	0.204	26.3	10.1	0.2	36.6	Quasi Peak	Neutral	63.4	-26.8	Pass
5	5.018	19.3	10.4	0.1	29.8	Quasi Peak	Neutral	60	-30.2	Pass
6	5.414	22	10.4	0.2	32.6	Quasi Peak	Neutral	60	-27.4	Pass
7	1.274	16.2	10.2	0.1	26.5	Average	Neutral	46	-19.5	Pass
8	3.207	16.3	10.3	0.1	26.7	Average	Neutral	46	-19.3	Pass
9	3.656	15	10.3	0.1	25.4	Average	Neutral	46	-20.6	Pass
10	0.204	17.5	10.1	0.2	27.8	Average	Neutral	53.4	-25.6	Pass
11	5.018	13.5	10.4	0.1	24	Average	Neutral	50	-26	Pass
12	5.414	17.3	10.4	0.2	27.9	Average	Neutral	50	-22.1	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Factor = Inert loss of LISN
3. Margin value = Emission level - Limit value
4. Emission Level = Raw Value + Cable loss + Factors Value.

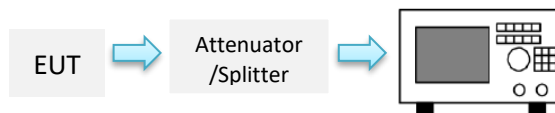
7.3 DTS (6 dB) Bandwidth

7.3.1 Requirement

§ 15.247 (a)(2)

Systems using digital modulation techniques may operate in the 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz bands. The minimum 6 dB bandwidth shall be at least 500 KHz.

7.3.2 Test Setup



7.3.3 Test Procedure

According to section 8.2, option 2, in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.8 of ANSI C63.10-2013:

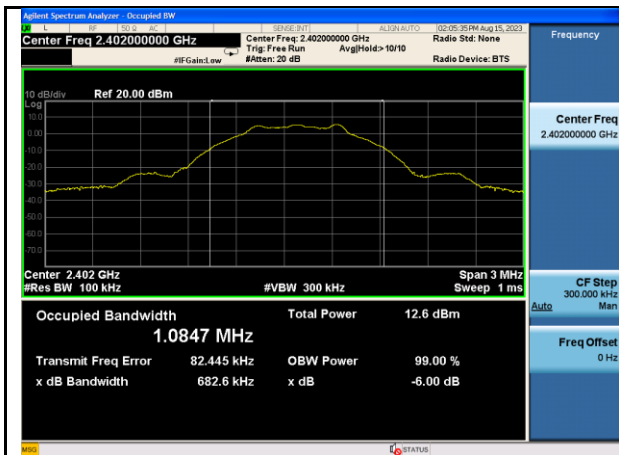
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW $\geq 3 \times$ RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Use automatic bandwidth measurement capability on instrument to obtain BW result.

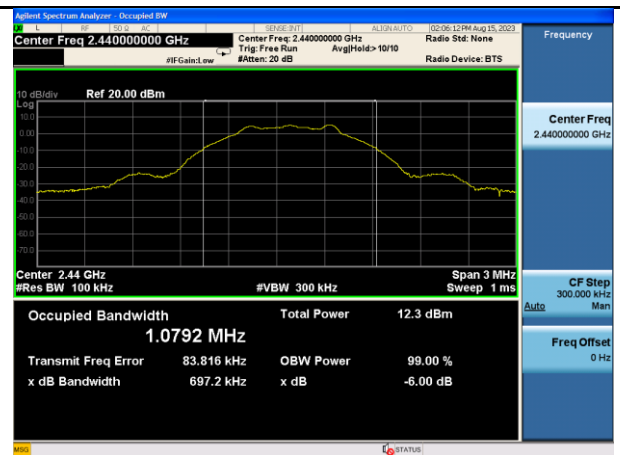
7.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Minimum Bandwidth (KHz)	Result
BLE	2402	1Mbps	682.6	500	Pass
	2440		697.2	500	Pass
	2480		706.4	500	Pass
	2402	2Mbps	1219	500	Pass
	2440		1174	500	Pass
	2480		1156	500	Pass

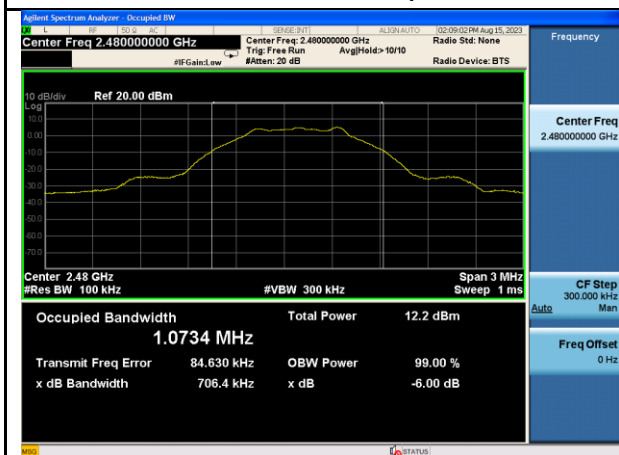
7.3.5 Test Plots



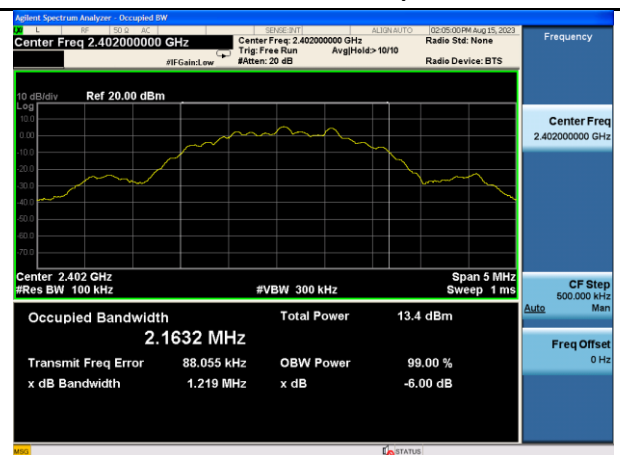
DTS BW-Low-1Mbps



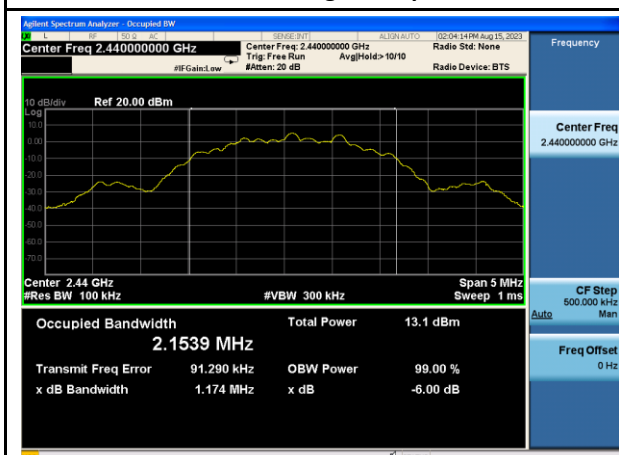
DTS BW-Mid-1Mbps



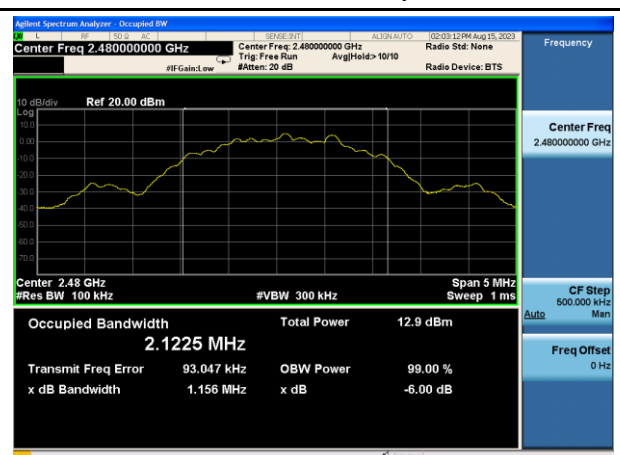
DTS BW-High-1Mbps



DTS BW-Low-2Mbps



DTS BW-Mid-2Mbps



DTS BW-High-2Mbps

7.4 Maximum Output Power

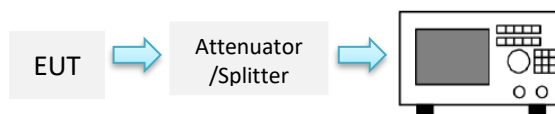
7.4.1 Requirement

§ 15.247 (b)(3), RSS-247 §5.4

or systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: the maximum output power is 1 Watt.

If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.4.2 Test Setup



7.4.3 Test Procedure

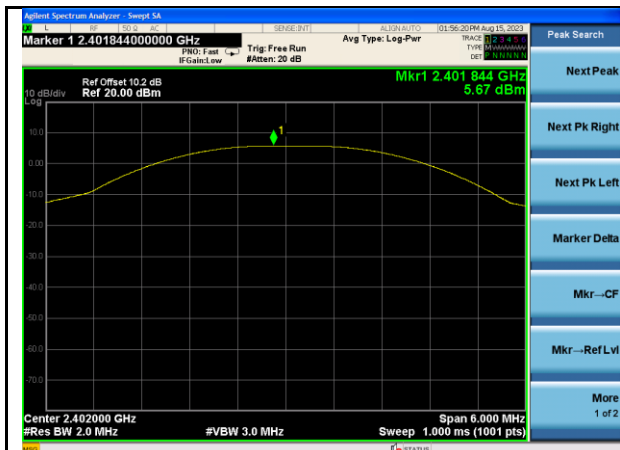
For BLE, power measurement is according to subclause 11.9.1.1 of ANSI C63.10-2013:

1. Set the RBW $\geq$ DTS bandwidth
2. Set VBW $\geq 3 \times$ RBW.
2. Set SPAN $\geq 3 \times$ RBW.
3. Sweep time = auto couple.
4. Detector = peak.
5. Trace mode = max hold
6. Allow trace to fully stabilize.
7. Use peak marker function to determine the peak amplitude level.

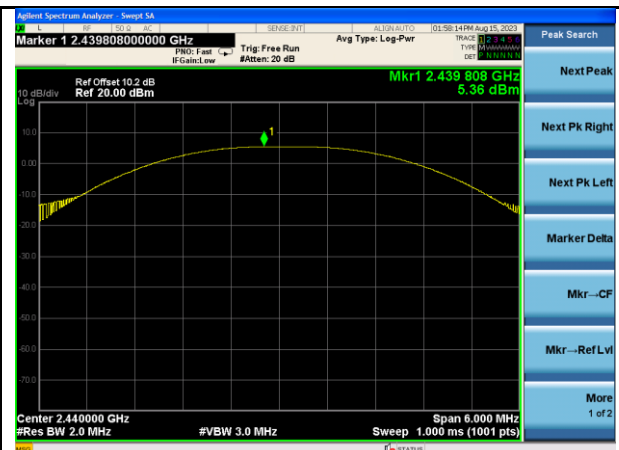
7.4.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Max Output Power (dBm)	Result
BLE	2402	1Mbps	5.67	30	Pass
	2440		5.36	30	Pass
	2480		5.14	30	Pass
	2402	2Mbps	5.65	30	Pass
	2440		5.37	30	Pass
	2480		5.14	30	Pass

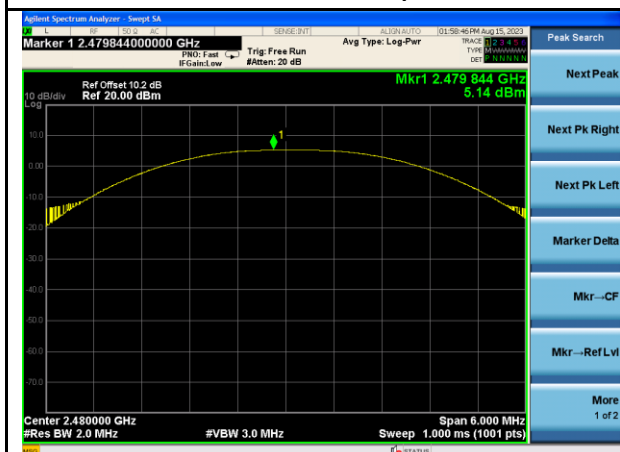
7.4.5 Test Plots



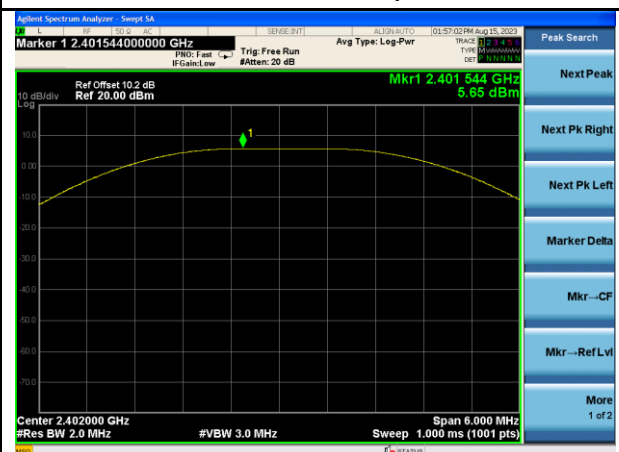
Power-Low-1Mbps



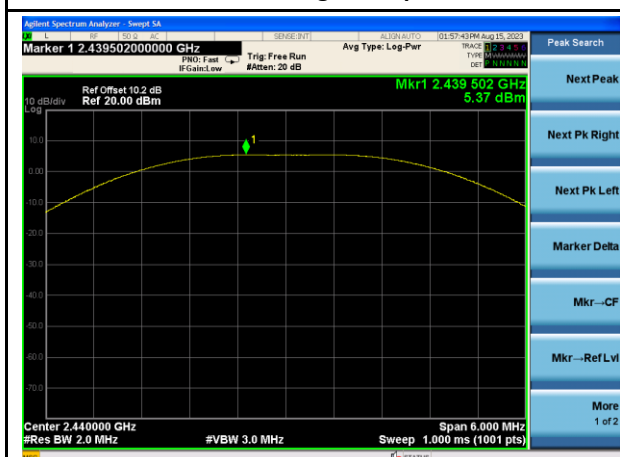
Power-Mid-1Mbps



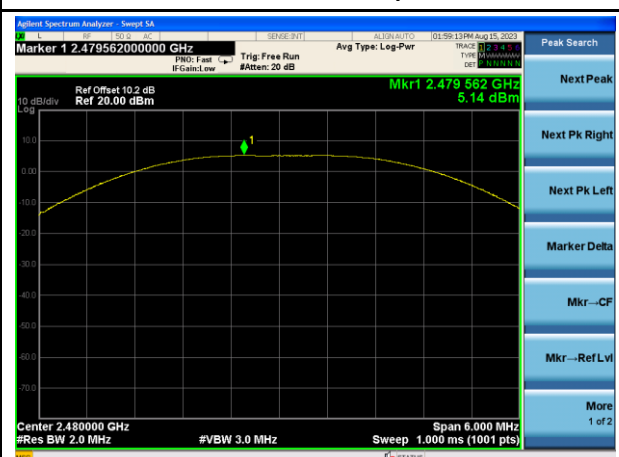
Power-High-1Mbps



Power-Low-2Mbps



Power-Mid-2Mbps



Power-Low-3Mbps

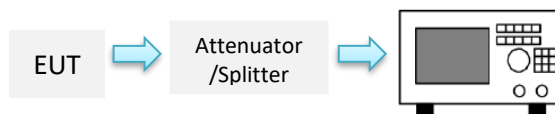
7.5 Power Spectral Density

7.5.1 Requirement

§ 15.247 (e), RSS-247 §5.2

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power is used to determine the power spectral density.

7.5.2 Test Setup



7.5.3 Test Procedure

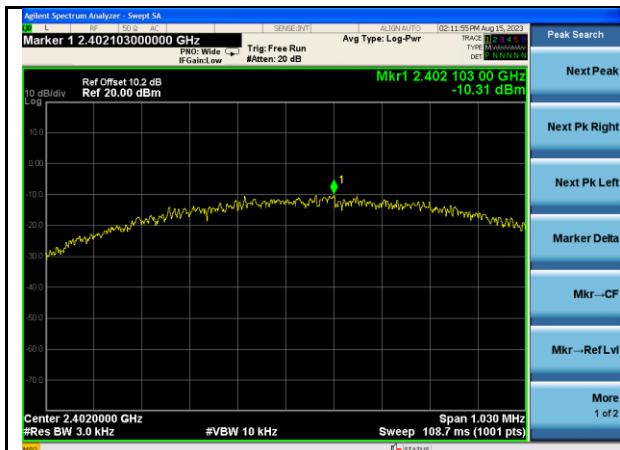
According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

1. Set analyser centre frequency to DTS channel centre frequency.
2. Set the span to 1.5 X DTS bandwidth.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

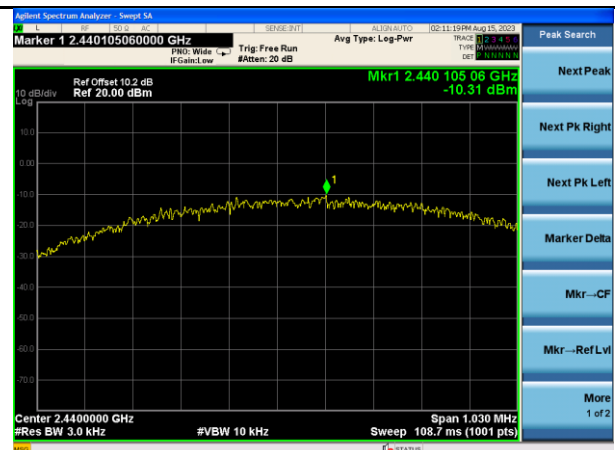
7.5.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured PSD (dBm/3KHz)	Max PSD (dBm/3KHz)	Result
BLE	2402	1Mbps	-10.31	8	Pass
	2440		-10.31	8	Pass
	2480		-10.63	8	Pass
	2402	2Mbps	-12.35	8	Pass
	2440		-12.51	8	Pass
	2480		-12.88	8	Pass

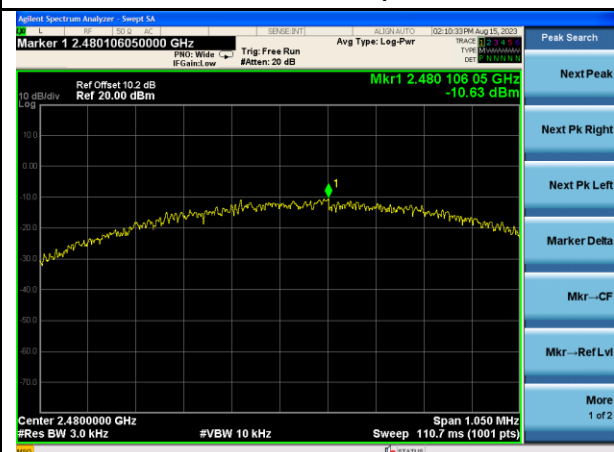
7.5.5 Test Plots



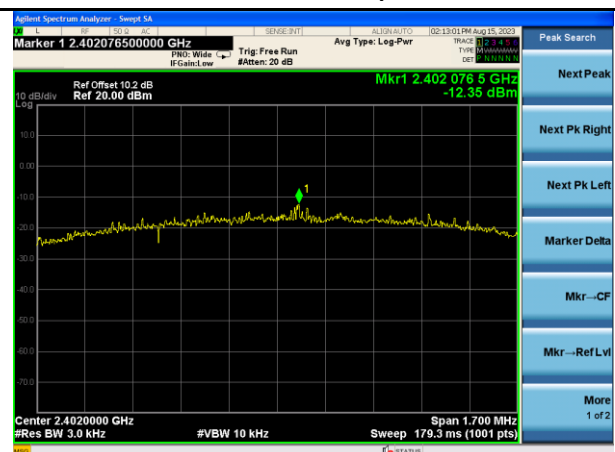
PSD-Low-1Mbps



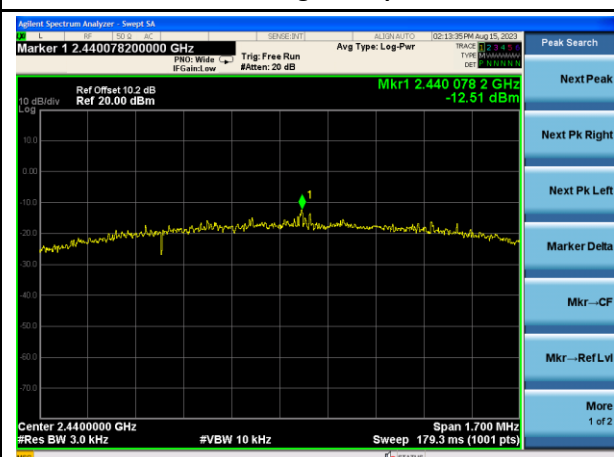
PSD-Mid-1Mbps



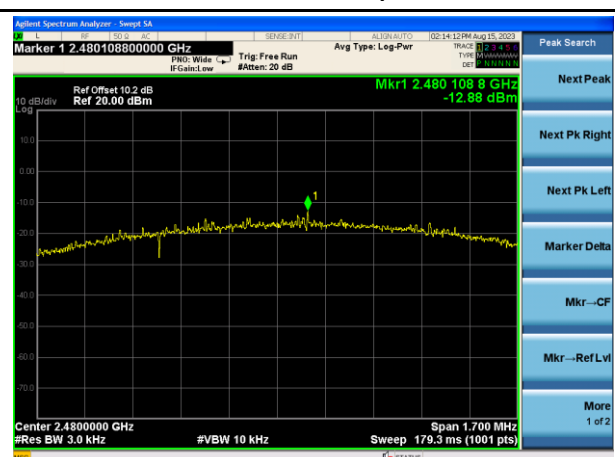
PSD-High-1Mbps



PSD-Low-2Mbps



PSD-Mid-2Mbps



PSD-High-2Mbps

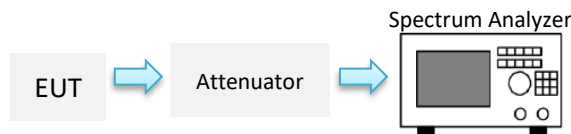
7.6 Conducted Band-Edge & Unwanted Emissions

7.6.1 Requirement

§ 15.247 (d), RSS-247 §5.5

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.

7.6.2 Test Setup



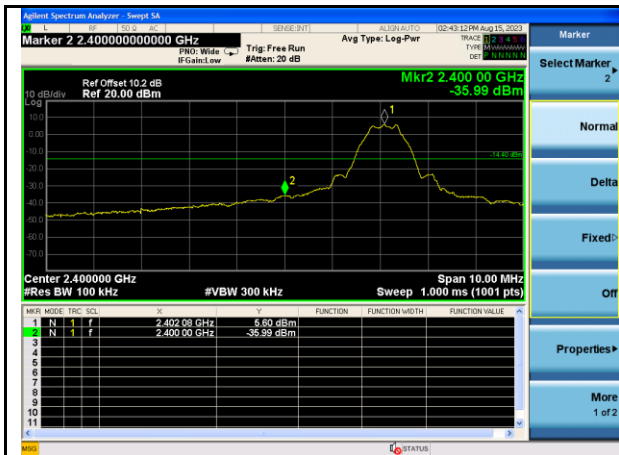
7.6.3 Test Procedure

According to ANSI C63.10-2013 clause 11.13

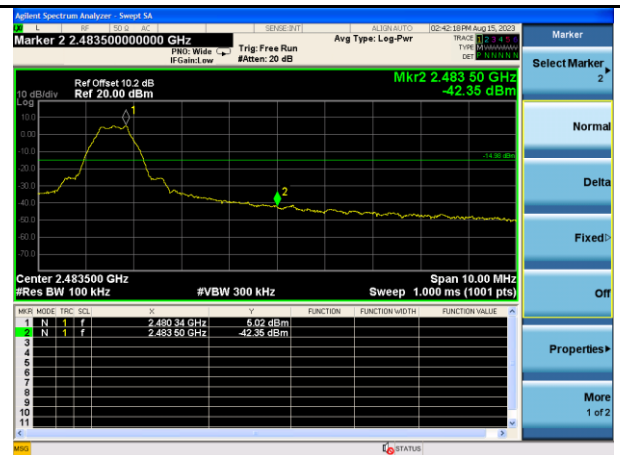
1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW=100 KHZ, VBW=300 KHZ, Peak Detector. Unwanted Emissions measured in any 100 khz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 db relative to the maximum in-band peak PSD level in 100 KHZ when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 db instead of 20 db per 15.247(d).
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete and record the results in the test report.

7.6.4 Test Result

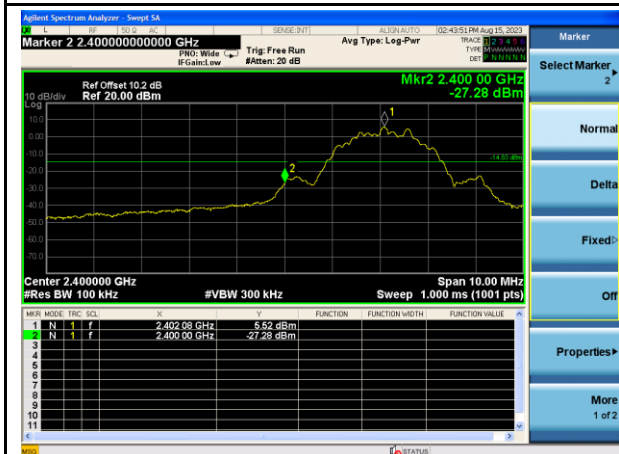
Conducted Band edge



Band Edge-Low CH-1Mbps



Band Edge-High CH -1Mbps

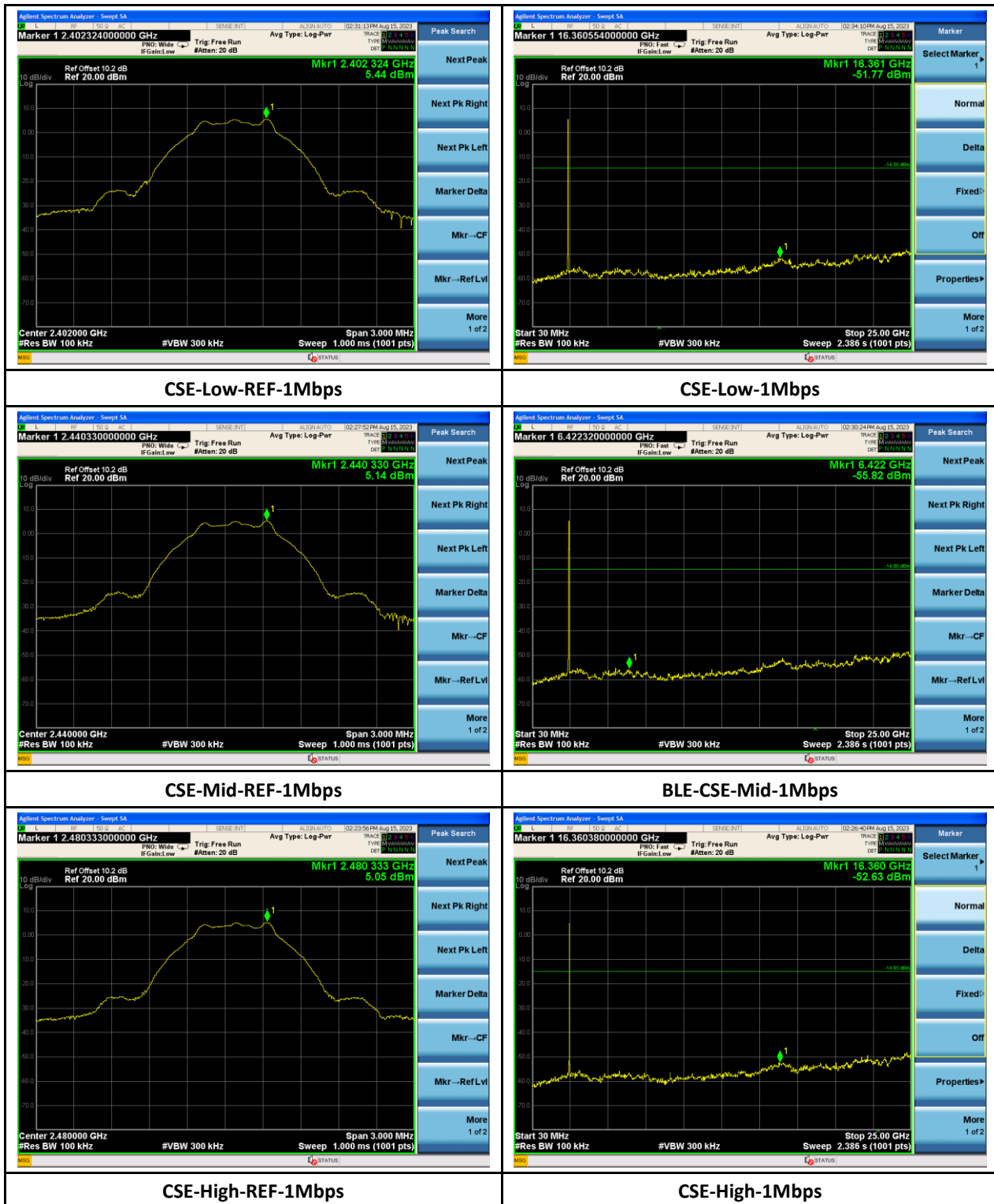


Band Edge-Low CH-2Mbps



Band Edge-High CH -2Mbps

Conducted Spurious emission

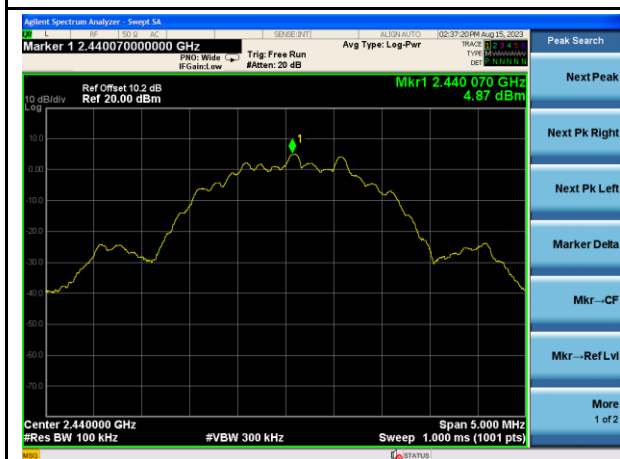




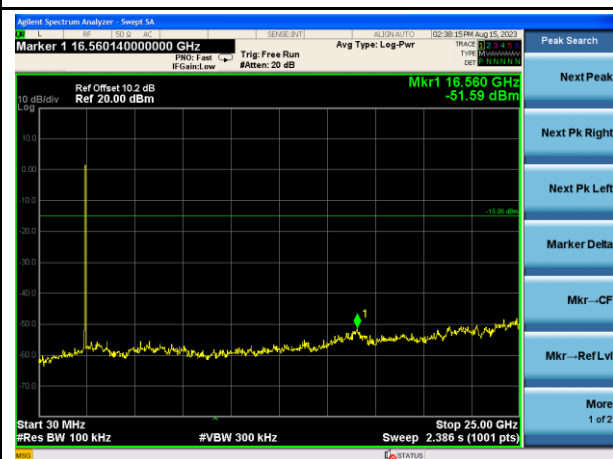
CSE-Low-REF-2Mbps



CSE-Low-2Mbps



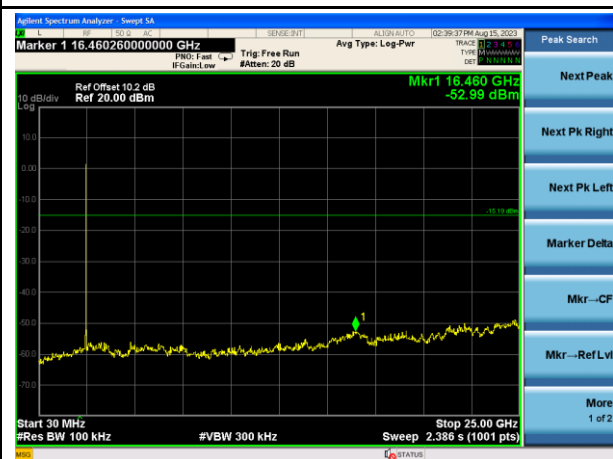
CSE-Mid-REF-2Mbps



BLE-CSE-Mid-2Mbps



CSE-High-REF-2Mbps



CSE-High-2Mbps

7.7 Radiated Band-Edge & Spurious Emissions into Restricted Frequency Bands

7.7.1 Requirement

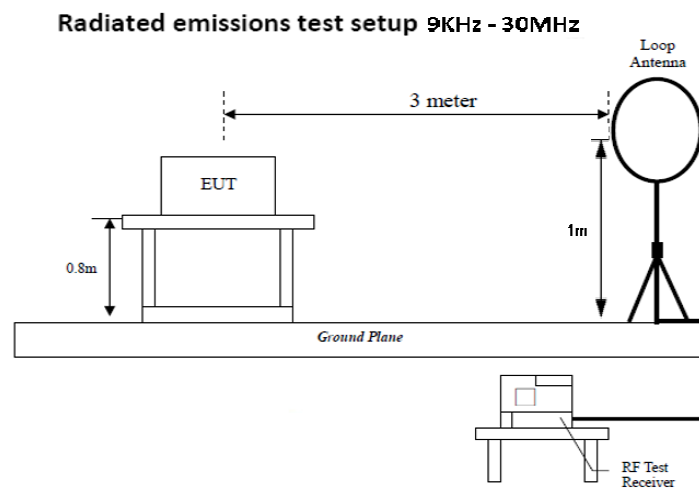
§ 15.247 (d), RSS-247 §5.5

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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

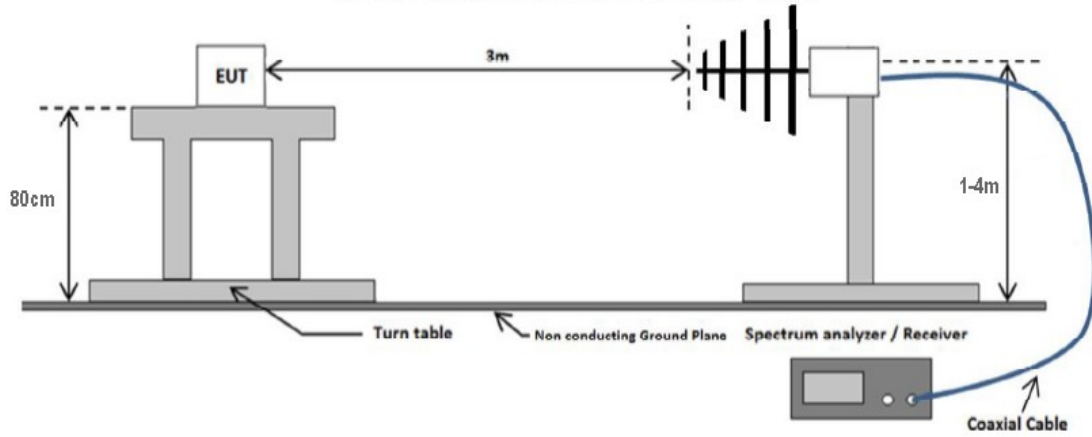
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency Range (MHZ)	Field Strength (µV/m)
0.009~0.490	2400/F(KHz)
0.490~1.705	24000/F(KHz)
1.705~30.0	30
30 – 88	100
88 – 216	150
216 960	200
Above 960	500

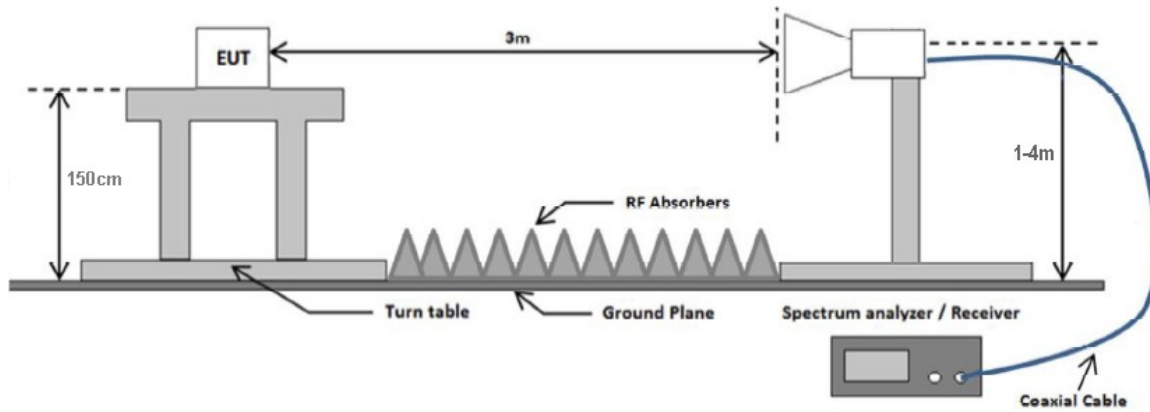
7.7.2 Test Setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



7.7.3 Test Procedure

According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C62.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
 - a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
 - b. The EUT was then rotated to the direction that gave the maximum emission.
 - c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

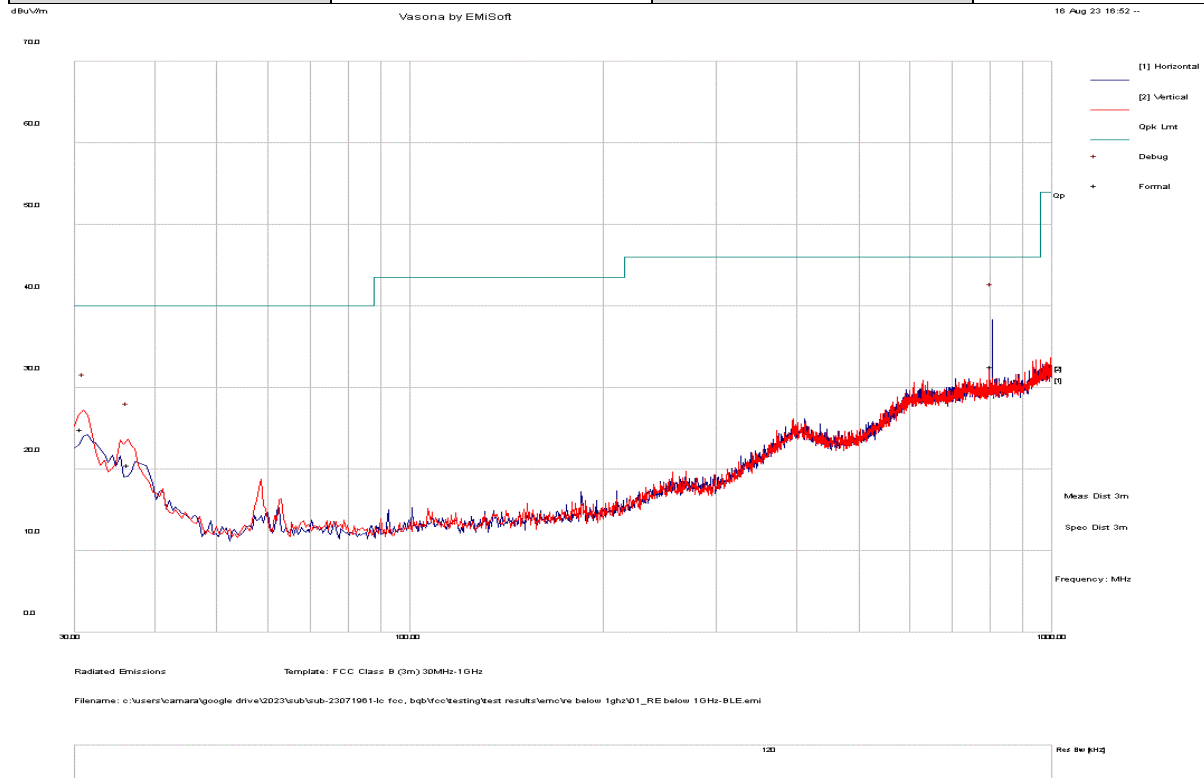
7.7.4 Test Result

Radiated Emission between 9KHz – 30MHz test result

Note: no substantial emission is found other than the noise floor. Different modes have been verified.

RADIATED EMISSIONS BELOW 1 GHZ

Test Standard:	15.247, 15.209	Mode:	BLE+Lora Transmit mode
Frequency Range:	30 MHz - 1 GHz	Test Date:	08/16/2023
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



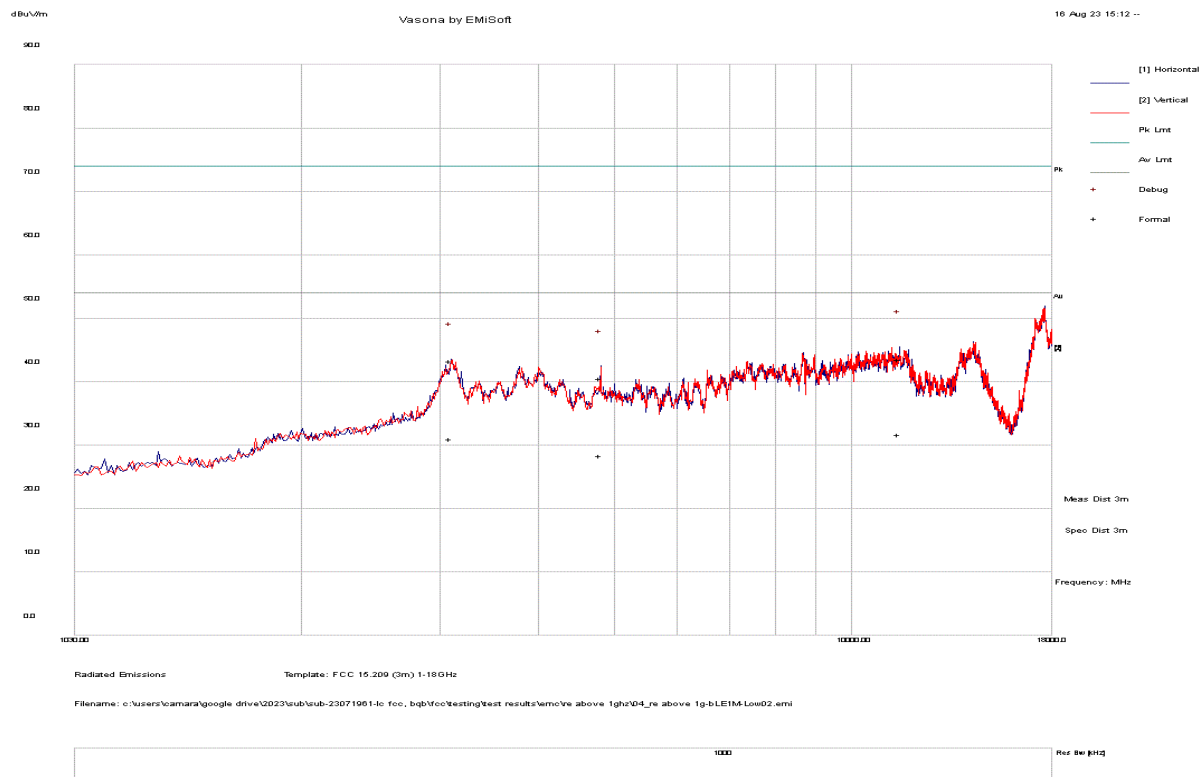
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	806.708	29.5	7.3	-4.2	32.6	Quasi Max	H	193	314	46	-13.4	Pass
2	30.75	34.6	2.3	-11.9	25	Quasi Max	V	370	142	40	-15	Pass
3	36.422	33.2	2.4	-15.1	20.5	Quasi Max	V	132	266	40	-19.5	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	15.247, 15.209	Mode:	BLE+LoRa Low CH
Frequency Range:	1 GHz - 18 GHz	Test Date:	08/16/2023
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



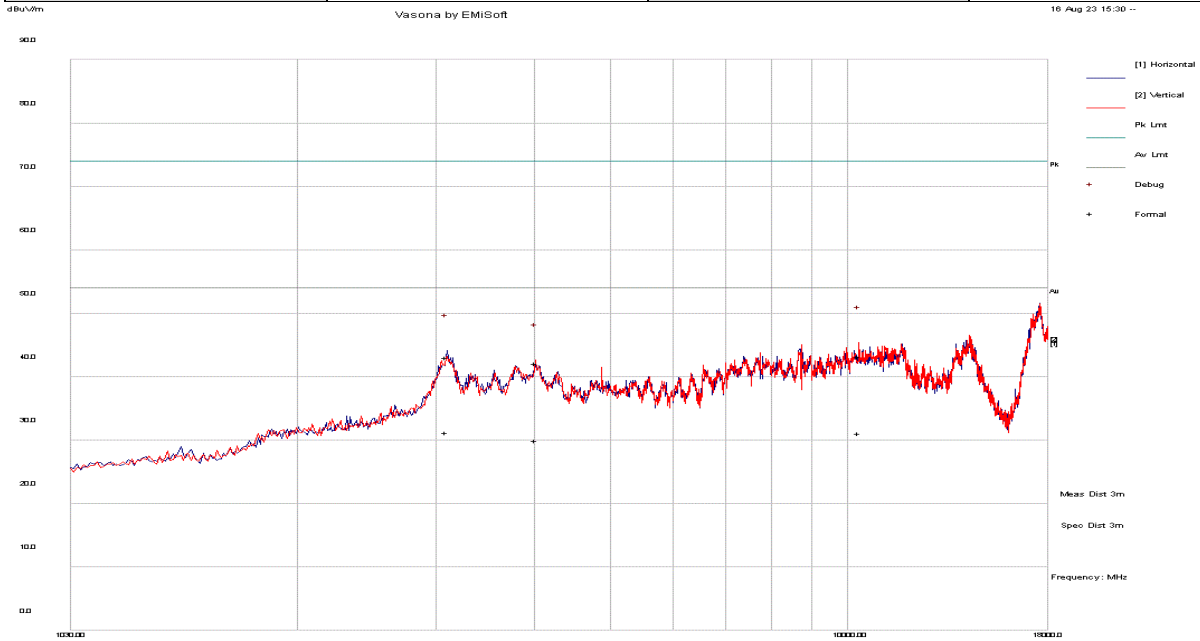
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	11507.513	30.4	17.8	-4.6	43.6	Peak Max	H	115	230	74	-30.4	Pass
2	3096.941	36.1	7.7	-0.5	43.3	Peak Max	H	252	219	74	-30.7	Pass
3	4805.23	36	9.1	-4.5	40.6	Peak Max	H	108	88	74	-33.4	Pass
4	11507.513	18.6	17.8	-4.6	31.8	Average Max	H	115	230	54	-22.2	Pass
5	3096.941	23.9	7.7	-0.5	31.1	Average Max	H	252	219	54	-22.9	Pass
6	4805.23	23.8	9.1	-4.5	28.4	Average Max	H	108	88	54	-25.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Report# SUB-23071961-LC-FCC-DTS

Test Standard:	15.247, 15.209	Mode:	BLE+LoRa Mid CH
Frequency Range:	1 GHz – 18 GHz	Test Date:	08/16/2023
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



Radiated Emissions Template: FCC 15.209 (3m) 1-18GHz
Filename: c:\users\camara\google drive\2023\sub\sub-23071961-lc-fcc-bqb\fcc\testing\test results\emo\ve above 1ghz\05_re above 1g-bLE1M4Mid.emi

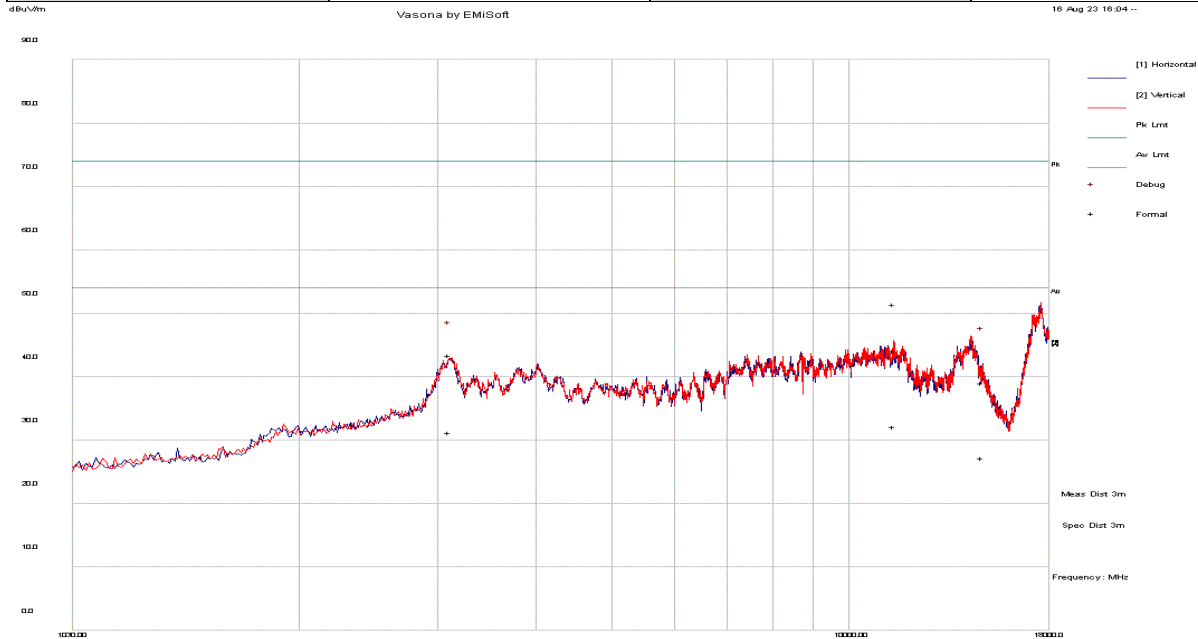
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	10351.491	31.5	16.8	-5.1	43.2	Peak Max	V	255	64	74	-30.8	Pass
2	3099.321	36	7.7	-0.7	43	Peak Max	H	126	190	74	-31	Pass
3	4020.088	26.9	9.9	5.3	42.1	Peak Max	V	275	158	74	-31.9	Pass
4	10351.491	19.5	16.8	-5.1	31.2	Average Max	V	255	64	54	-22.8	Pass
5	3099.321	24.2	7.7	-0.7	31.2	Average Max	H	126	190	54	-22.8	Pass
6	4020.088	14.8	9.9	5.3	30	Average Max	V	275	158	54	-24	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Report# SUB-23071961-LC-FCC-DTS

Test Standard:	15.247, 15.209	Mode:	BLE+LoRa High CH
Frequency Range:	1 GHz – 18 GHz	Test Date:	08/16/2023
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



Radiated Emissions Template: FCC 15.209 (3m) 1-18GHz
 Filename: c:\users\camara\google drive\2023\sub\sub-23071961-lc-fcc-bqb\fcc\testing\test results\emc\ve above 1ghz\06_re above 1g-bLE1M4high.eml

No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	11403.485	31.2	17.7	-4.8	44.1	Peak Max	V	105	318	74	-29.9	Pass
2	3109.028	36.9	7.7	-1.2	43.4	Peak Max	V	112	149	74	-30.6	Pass
3	14798.285	25.4	16.2	-2.5	39.1	Peak Max	H	216	100	74	-34.9	Pass
4	11403.485	19.3	17.7	-4.8	32.2	Average Max	V	105	318	54	-21.8	Pass
5	3109.028	24.7	7.7	-1.2	31.2	Average Max	V	112	149	54	-22.8	Pass
6	14798.285	13.5	16.2	-2.5	27.2	Average Max	H	216	100	54	-26.8	Pass

Remarks:

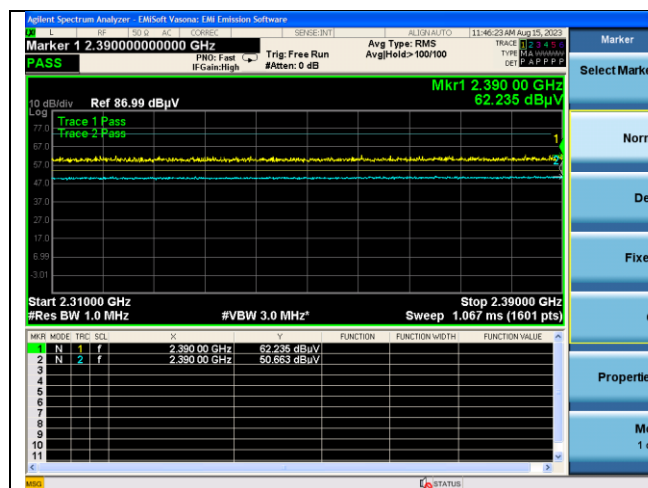
1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Radiated Emission between 18GHz – 40GHz test result

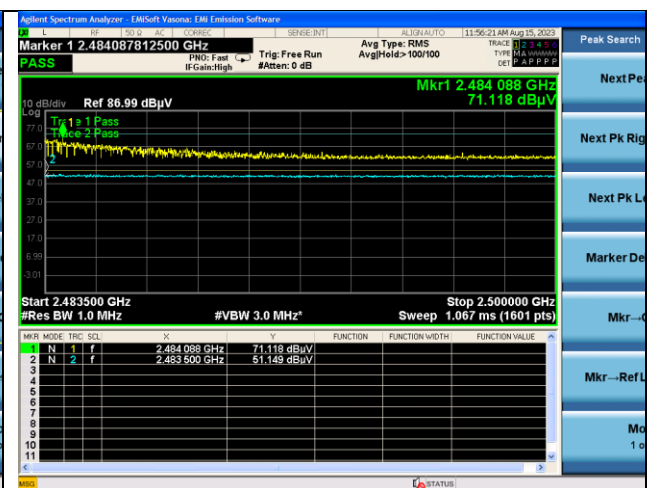
Note: no substantial emission is found other than the noise floor. Different modes have been verified.

Restricted Band Measurement Result

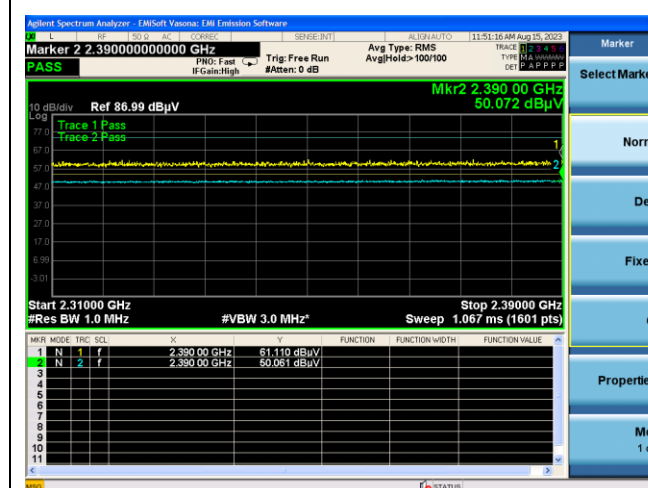
Data Rate	Frequency (MHz)	Level (dBuV/m)	Measurement Type	Limit (dBuV/m)	Margin (dB)	Pass/Fail
1Mbps	2390	62.24	Peak Max	74	-11.77	Pass
	2483.5	71.12	Peak Max	74	-2.88	Pass
	2390	50.66	Average Max	54	-3.34	Pass
	2483.5	51.14	Average Max	54	-2.86	Pass
2Mbps	2390	61.11	Peak Max	74	-12.89	Pass
	2483.5	73.29	Peak Max	74	-0.71	Pass
	2390	50.06	Average Max	54	-3.94	Pass
	2483.5	52.22	Average Max	54	-1.78	Pass



BLE - Low CH-1Mbps



BLE - High CH-1Mbps



BLE - Low CH-2Mbps



BLE - High CH-2Mbps

8 EUT and Test Setup Photos

See FCC exhibits

9 Test Instrument List

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2022	10/18/2023
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A1)	N/A1)
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/09/2023	06/09/2024
EMC Test Receiver	R&S	ESL6	100230	06/07/2023	06/07/2024
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	07/12/2023	07/12/2024
Bi-Log Antenna	ETS-Lindgren	3142E	217921	07/19/2023	07/19/2024
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	07/21/2023	07/21/2024
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	07/21/2023	07/21/2024
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2023	07/16/2024
True RMS Multi-meter	UNI-T	UT181A	C173014829	06/07/2023	06/07/2024
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	06/07/2023	06/07/2024
RF Attenuator	Pasternack	PE7005-3	VL061	N/A2)	N/A2)
EM Center Control	ETS-Lindgren	7006-001	160136	N/A1)	N/A1)
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A1)	N/A1)
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A1)	N/A1)
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	06/09/2023	06/09/2024
RE test cable (below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	07/16/2023	07/16/2024
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	07/16/2023	07/16/2024
RE test cable (>18GHz)	Sucoflex	104	344903/4	07/16/2023	07/16/2024
Pulse limiter	Com-Power	LIT-930A	531727	07/16/2023	07/16/2024
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	07/16/2023	07/16/2024
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	07/16/2023	07/16/2024

Note:

- 1) This equipment is not for measurement purposes and only require functional verification. Calibration is not required.
- 2) This equipment is part of test system that to be calibrated as a system. It's verified together with the test system prior to testing.

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