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FCC RF Test Report

Test Report Number	HID-21050342-LC-FCC-IC-RF-BLE
FCC ID	JQ6-SECONNECT
IC	2236B-SECONNECT
Applicant	HID Global Corporation
Applicant Address	611 Center Ridge Drive, Austin, TX, 78753, USA
Product Name	HID® iCLASS SE® Connectivity Module
Model (s)	BT/WIFIE
Date of Receipt	11/23/2021
Date of Test	11/29/2021- 04/14/2022
Report Issue Date	06/07/2022
Test Standards	47 CFR Part 15.247 RSS 247 Issue2, February 2017 RSS-Gen Issue 5, Mar 2019
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)

David Zhang (Technical Manager)

REVISION HISTORY

Report Number	Version	Description	Issued Date
HID-21050342-LC-FCC-IC-RF-BLE	01	Initial report	06/07/2022

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DTS (6 dB) Channel Bandwidth	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Occupied Bandwidth	RSS-Gen Issue 5, Mar 2019	RSS-Gen Issue 5, Feb 2021	Pass
Conducted Maximum Output Power	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Power Spectral Density	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Conducted Band-Edge & Unwanted Emissions	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
AC Power Line Conducted Emissions	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass

2 General Information

2.1 Applicant

Applicant	HID Global Corporation
Applicant address	611 Center Ridge Drive, Austin, TX, 78753, USA
Manufacturer	HID Global Corporation
Manufacturer Address	611 Center Ridge Drive, Austin, TX, 78753, USA

2.2 Product information

Product Name	HID® iCLASS SE® Connectivity Module
Model Number	BT/WIFIE
Family Models	N/A
Serial Number	210119 0028
Frequency Band	BLE: 2402-2480MHz 2.4G: 2412-2462MHz 5G: U-NII-1: 5150-5250MHz U-NII-2A: 5250-5350MHz U-NII-2C: 5470-5725MHz U-NII-3: 5725-5850MHz
Type of modulation	BT_LE: GFSK 2.4G: CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM 5G: 64QAM, 16QAM, QPSK, BPSK
Equipment Class	DTS
Antenna Information	Chip Antenna Antenna Gain: BLE:0.5dBi 2.4G: 1.0dBi 5G: 2.6dBi
Clock Frequencies	N/A
Input Power	DC 3.0V (EUT obtains power from the reader it works with)
Power Adapter Manufacturer/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Additional Info	Test sample has u.FL connector for direct RF conducted measurement

2.3 Test standard and method

Test standard	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017
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	23.2°C	57.5%	996 mbar
Radiated Emission Testing	23.2°C	57.5%	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.

EUT test sample has u.FL connector for direct RF conducted measurement.
It also has a soldered 3.5mm TRS jack connector to connect to laptop with USB to UART cable for programming purpose, to set EUT into test mode.

5 Test Configuration and Operation

5.1 EUT Test Configuration

The EUT is mounted onto an iCLASS SE® Readers to support testing. EUT is set to different transmission modes in terms of radio mode bandwidth, power level, test channel, etc.

For Radiated Emission testing, a 12VDC battery is used as power source to minimize the ambient noise; for other testing, a 12VDC power supply provided by manufacturer is used as a power source representative for the reader that supplier power to EUT.

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
FieldON.exe	To set BLE into RF test mode
Putty	Realtek Bluetooth tool, Set the module at different mode, channel, bandwidth, etc.

5.2 Supporting Equipment

Description	Manufacturer	Model #	Serial #	Remark
Laptop	Dell	Inspiron 15 3000 series	72YPMJ2	Provided by client
iCLASS SE® Readers	HID Global Corporation	RK40	N/A	Provided by client
DC Power supply	WERKER	WK12V1000	MRG05	Provided by client
12VDC Battery	EverStart	VP-26	2111282188	Provided by lab
USB to UART cable	FTDI Chip	TTL-232R-3V3-AJ	N/A	Provided by client
USB to UART cable	FTDI Chip	TTL-232R-3V3	N/A	Provided by client

Description	Qty	Length (m)	Shielding (Y/N)	Core(s)	Remark
/	/	/	/	/	/

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 a chip antenna which is soldered onto the main board. The antenna gain is 0.5 dBi. This meets the requirement of permanent attachment.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

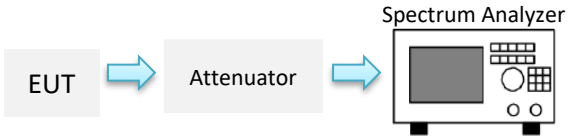
7.2 DTS (6 dB) Bandwidth

7.2.1 Requirement

§ 15.247 (a)(2), RSS-247 §5.2

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.

7.2.2 Test Setup



7.2.3 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:

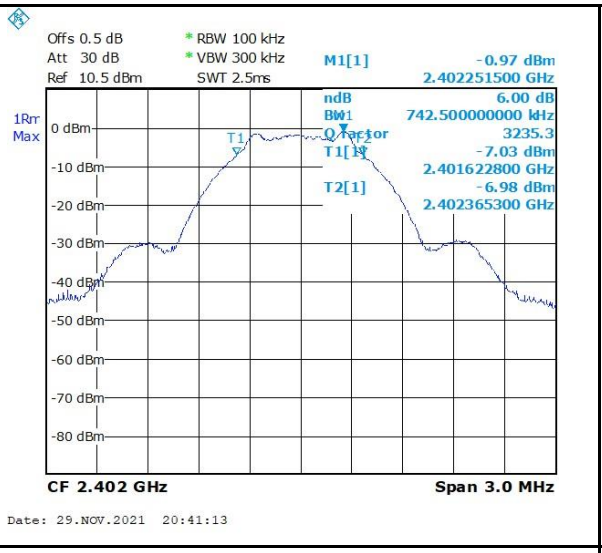
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this 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) ≥ 3 x 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.

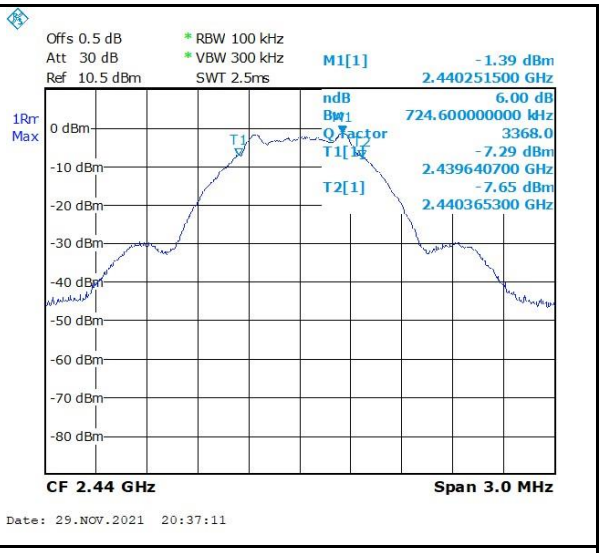
7.2.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured Bandwidth (KHz)	Minimum Bandwidth (KHz)	Result
BLE	1Mbps	2402	742.5	500	Pass
		2440	724.6	500	Pass
		2480	772.5	500	Pass
	2Mbps	2402	1238	500	Pass
		2440	1168	500	Pass
		2480	1148	500	Pass

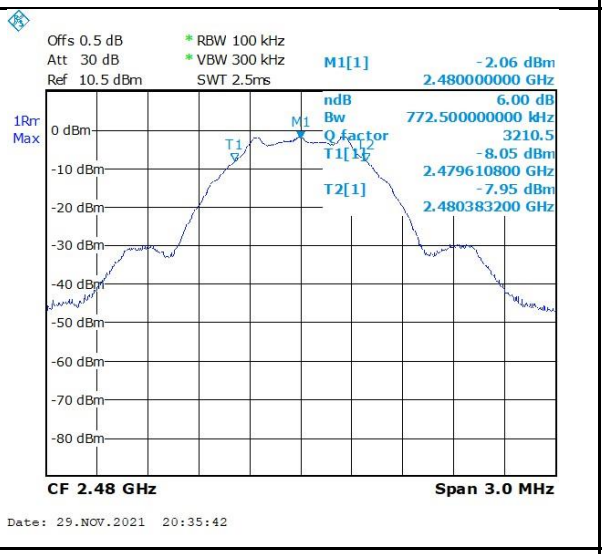
7.2.5 Test Plots



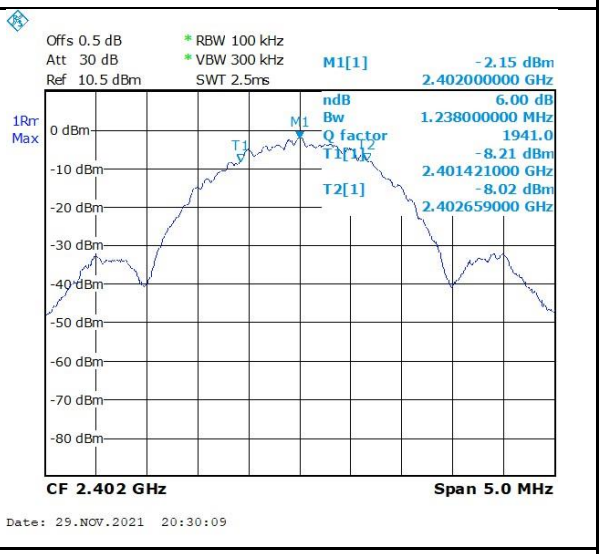
BLE-DTS BW-Low-1Mbps



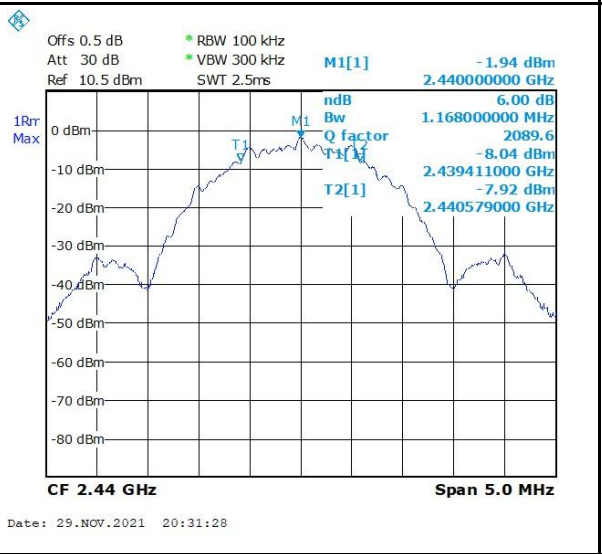
BLE-DTS BW-Mid-1Mbps



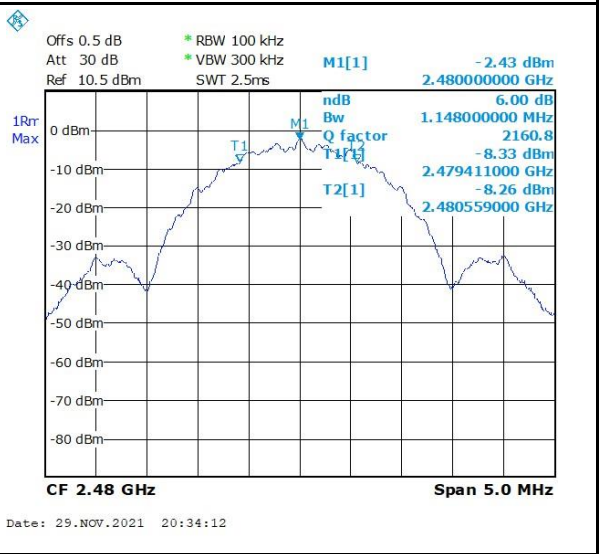
BLE-DTS BW-High-1Mbps



BLE-DTS BW-Low-2Mbps



BLE-DTS BW-Mid-2Mbps



BLE-DTS BW-High-2Mbps

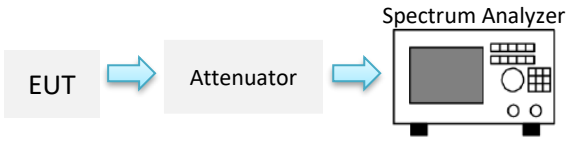
7.3 Occupied Bandwidth (99%)

7.3.1 Requirement

RSS-Gen §6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

7.3.2 Test Setup



7.3.3 Test Procedure

According to section RSS-Gen §6.7

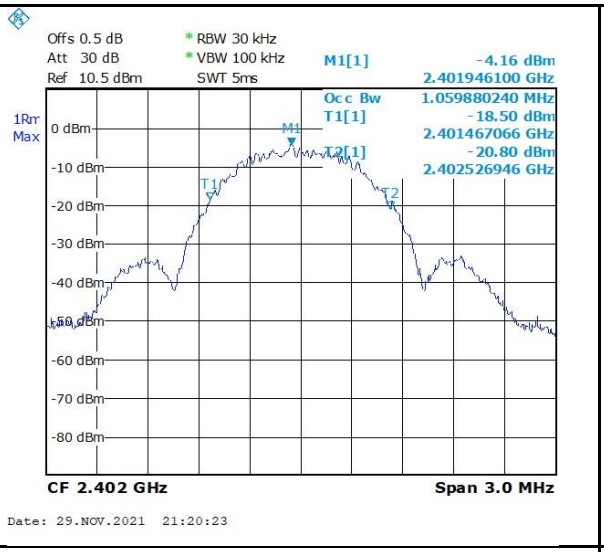
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this 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 = 1% to 5% of the actual occupied BW.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Span = large enough to capture all products of the modulation process
7. Allow the trace to stabilize.
8. Use automatic bandwidth measurement capability on instrument to obtain BW result.

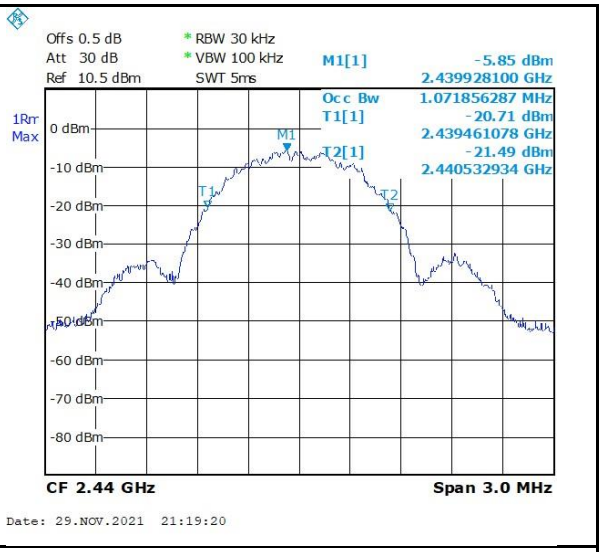
7.3.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured 99% OBW (KHz)	Limit (KHz)	Result
BLE	1Mbps	2402	1059.88	N/A	N/A
		2440	1071.86	N/A	N/A
		2480	1071.86	N/A	N/A
	2Mbps	2402	2075.85	N/A	N/A
		2440	2075.85	N/A	N/A
		2480	2075.85	N/A	N/A

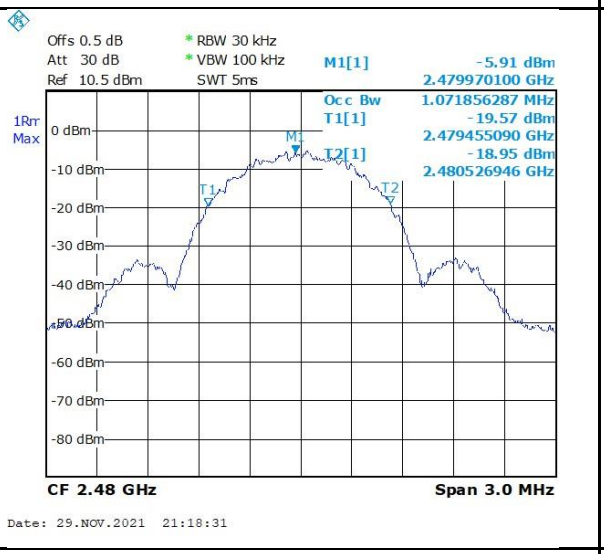
7.3.5 Test Plots



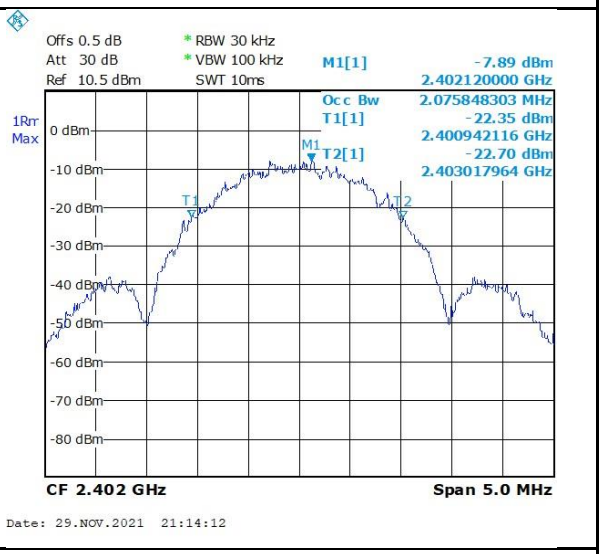
BLE-OBW-Low-1Mpbs



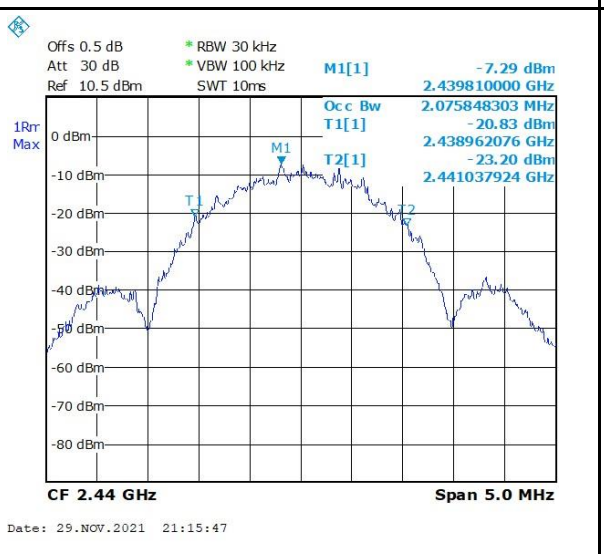
BLE-OBW-Mid-1Mpbs



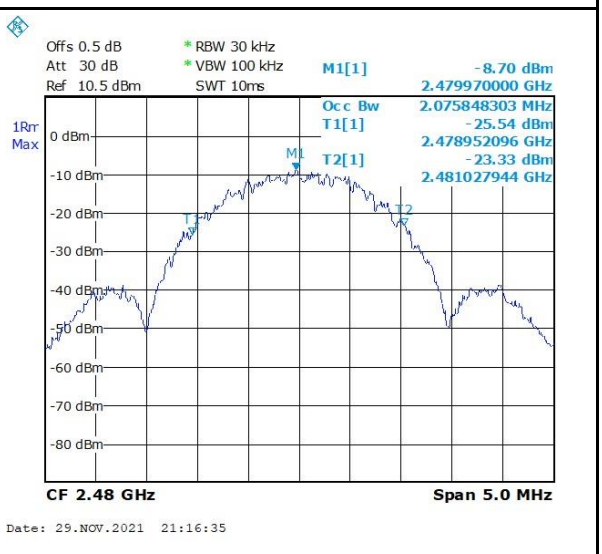
BLE-OBW-Mid-1Mpbs



BLE-OBW-Low-2Mpbs



BLE-OBW-Mid-2Mpbs



BLE-OBW-High-2Mpbs

7.4 Maximum Output Power

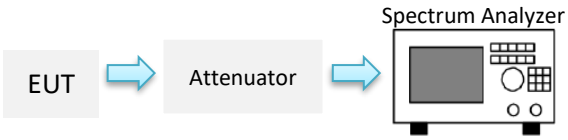
7.4.1 Requirement

§ 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

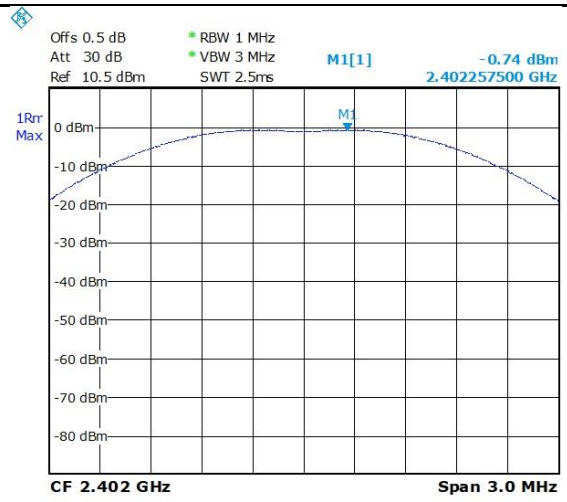
For BLE, power measurement is according to subclause 11.9.1.1 of ANSI C63.10-2013:

1. Set the RBW ≥ DTS bandwidth
2. Set VBW ≥ 3 X RBW.
2. Set SPAN ≥ 3 X 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.

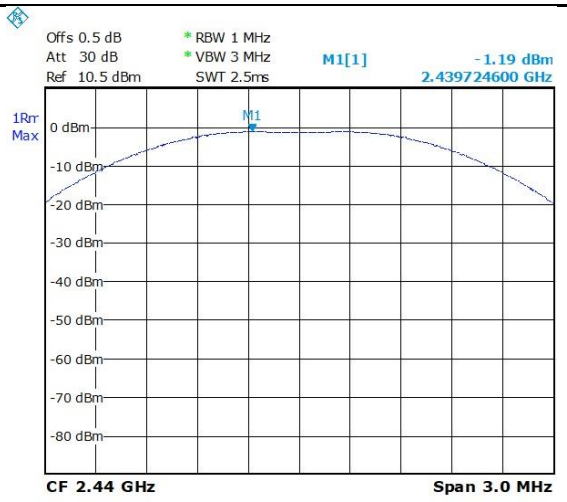
7.4.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured Output Power (dBm)	Max Output Power (dBm)	Result
BLE	1Mbps	2402	-0.74	30	Pass
		2440	-1.19	30	Pass
		2480	-1.29	30	Pass
	2Mbps	2402	-0.74	30	Pass
		2440	-1.21	30	Pass
		2480	-1.29	30	Pass

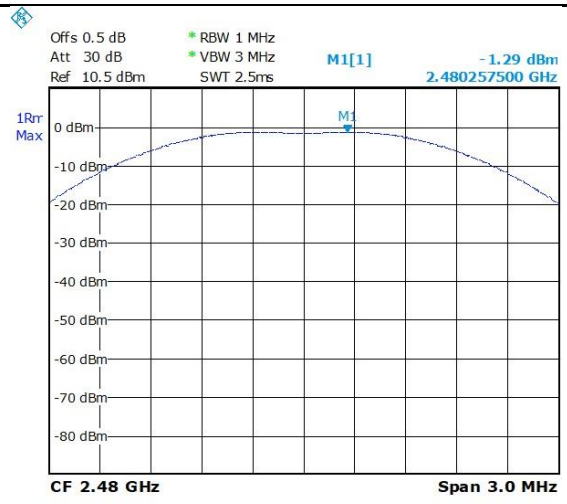
7.4.5 Test Plots



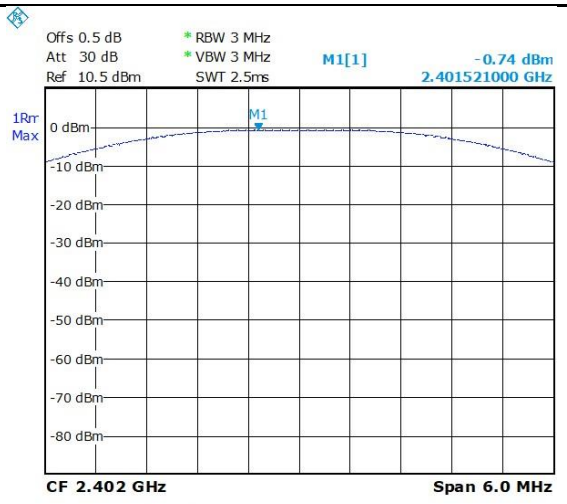
BLE-Power-Low-1Mbps



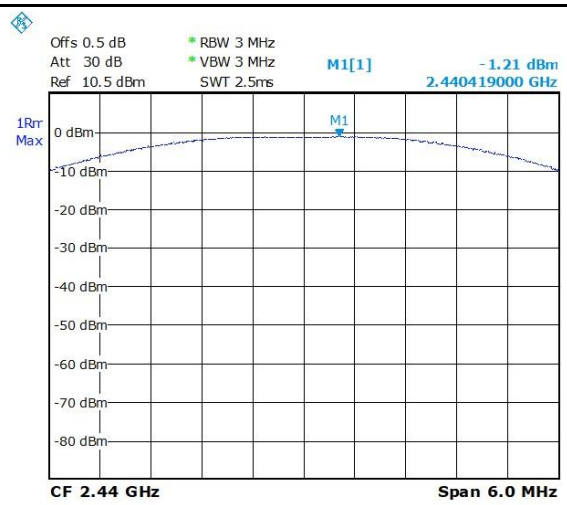
BLE-Power-Mid-1Mbps



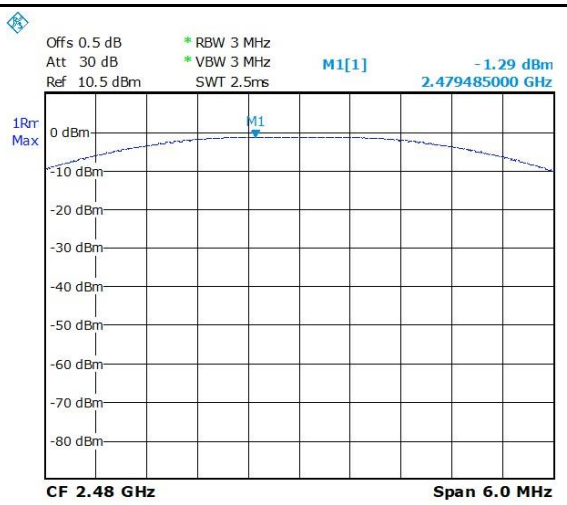
BLE-Power-High-1Mbps



BLE-Power-Low-2Mbps



BLE-Power-Mid-2Mbps



BLE-Power-High-2Mbps

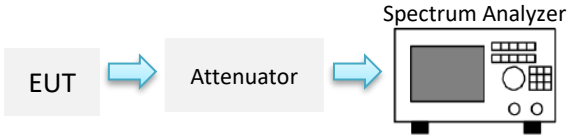
7.5 Power Spectral Density

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

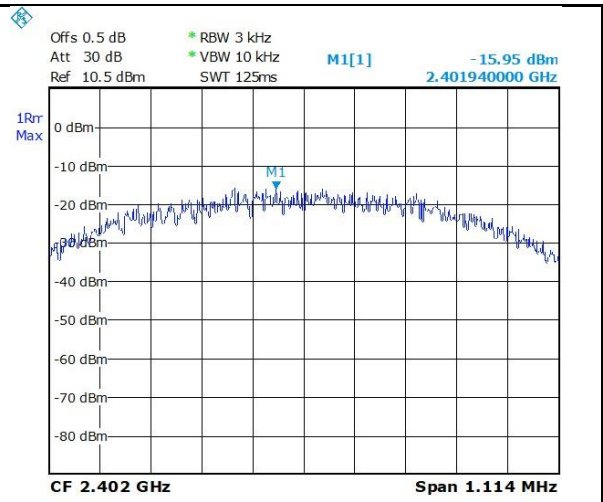
According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

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 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x 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.

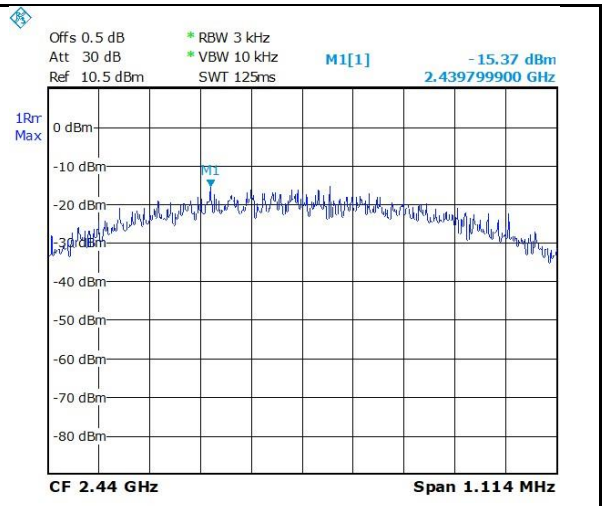
7.5.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured PSD (dBm/3KHz)	Max PSD (dBm/3KHz)	Result
BLE	1Mbps	2402	-15.95	8	Pass
		2440	-15.37	8	Pass
		2480	-15.52	8	Pass
	2Mbps	2402	-18.53	8	Pass
		2440	-18.55	8	Pass
		2480	-19.89	8	Pass

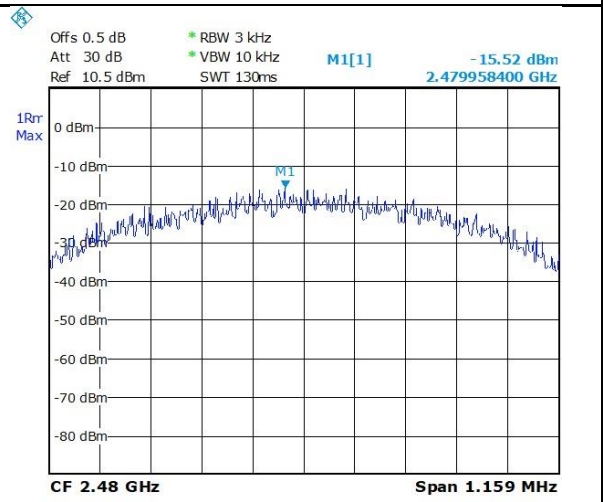
7.5.5 Test Plots



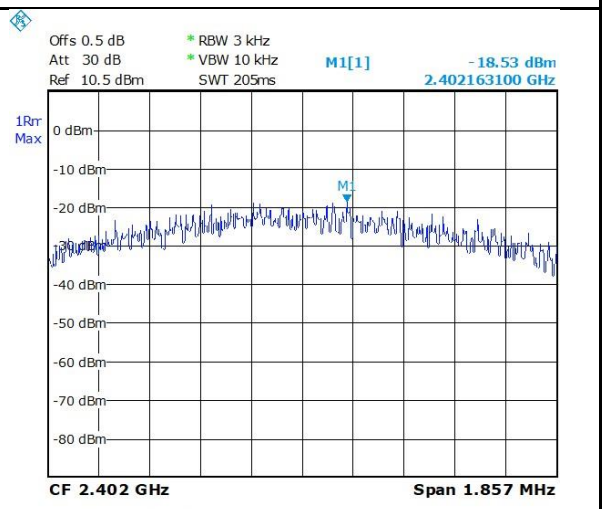
BLE-PSD-Low-1Mbps



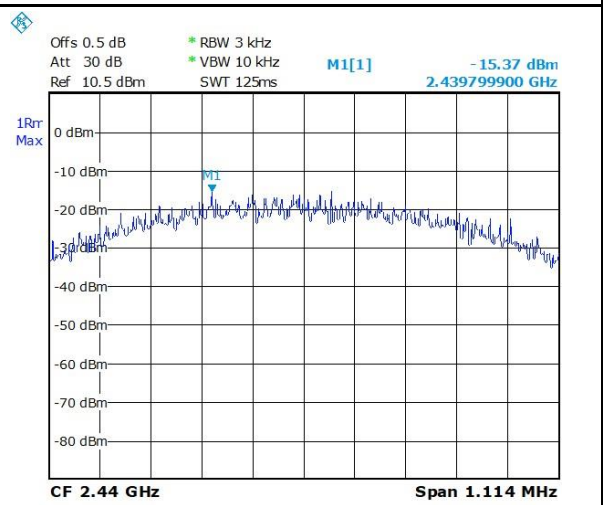
BLE-PSD-Mid-1Mbps



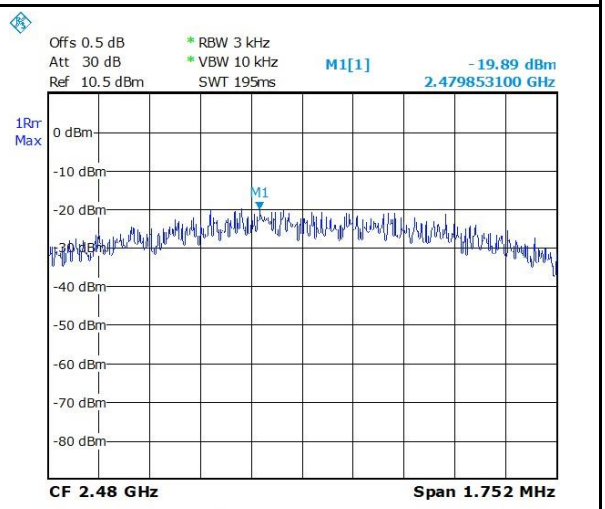
BLE-PSD-High-1Mbps



BLE-PSD-Low-2Mbps



BLE-PSD-Mid-2Mbps



BLE-PSD-High-2Mbps

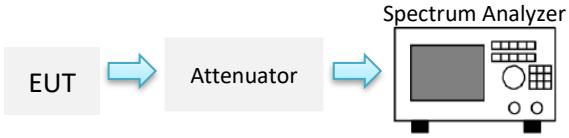
7.6 Conducted Band-Edge & Unwanted Emissions

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



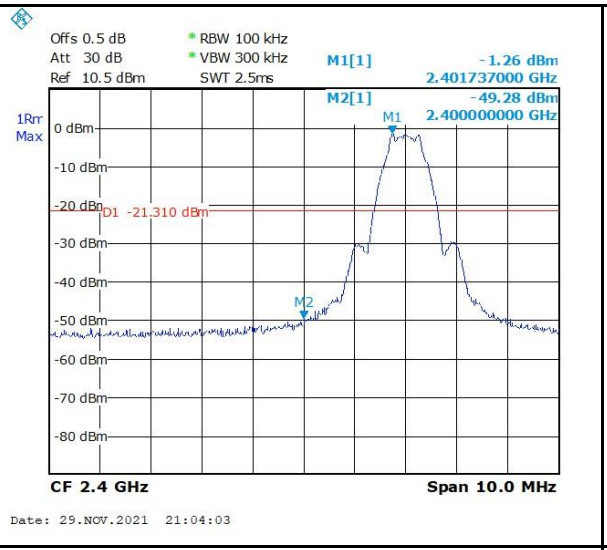
7.6.3 Test Procedure

According to ANSI C63.10-2013 clause 11.13

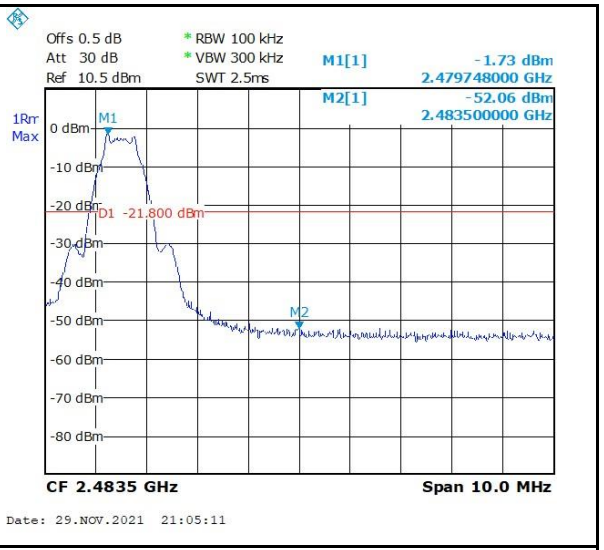
1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW=100 KHZ, VBW=300 KHZ, Peak Detector. Unwanted Emissions 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

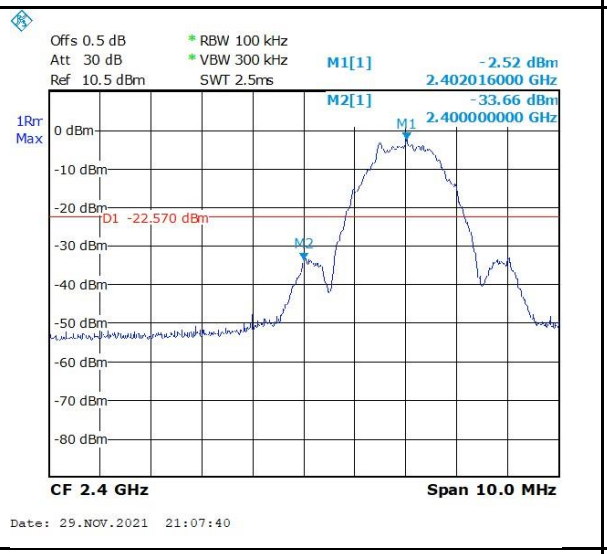
Conducted Band edge



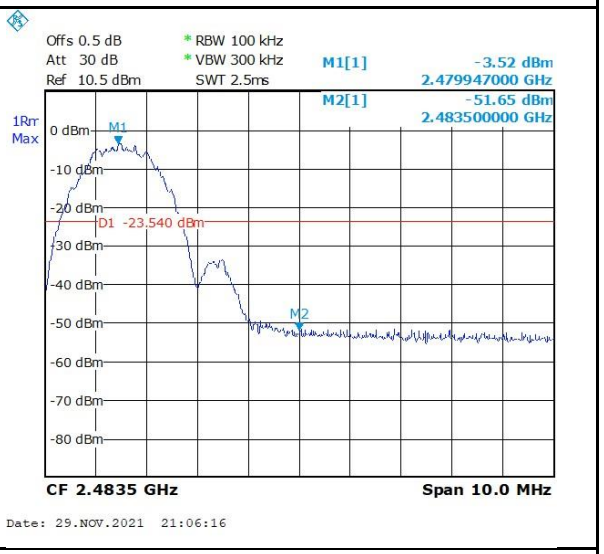
BLE-Band Edge-Low CH-1Mbps



BLE-Band Edge -High CH -1Mbps



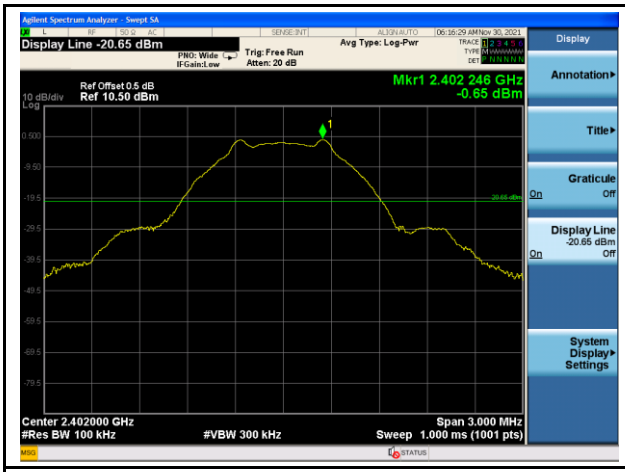
BLE-Band Edge-Low CH-2Mbps



BLE-Band Edge -High CH-2Mbps

Conducted Spurious emission

Mode	Data rate	Test Frequency (MHz)	Ref level (dBm)	Emission Frequency (MHz)	Emission Level (dBm)	Limit (dBm) Δ-20dBc	Result
BLE	1Mbps	2422	-0.65	4799	-53.59	-20.65	Pass
		2440	-0.70	4874	-52.91	-20.70	Pass
		2480	-0.99	4949	-52.43	-20.99	Pass



BLE-CSE-Low-REF-1Mbps

BLE-CSE-Low-1Mbps

BLE-CSE-Mid-REF-1Mbps

BLE-CSE-Mid-1Mbps

BLE-CSE-High-REF-1Mbps

BLE-CSE-High-1Mbps

Mode	Data rate	Test Frequency (MHz)	Ref level (dBm)	Emission Frequency (MHz)	Emission Level (dBm)	Limit (dBm) Δ-20dBc	Result
BLE	2Mbps	2402	-1.96	4799	-54.93	-21.96	Pass
		2440	-1.49	4874	-54.63	-21.49	Pass
		2480	-1.63	4949	-55.01	-21.63	Pass

BLE-CSE-Low-REF-2Mbps

BLE-CSE-Low-2Mbps

BLE-CSE-Mid-REF-2Mbps

BLE-CSE-Mid-2Mbps

BLE-CSE-High-REF-2Mbps

BLE-CSE-High-2Mbps

7.7 Radiated Spurious Emissions into Restricted Frequency Bands

7.7.1 Requirement

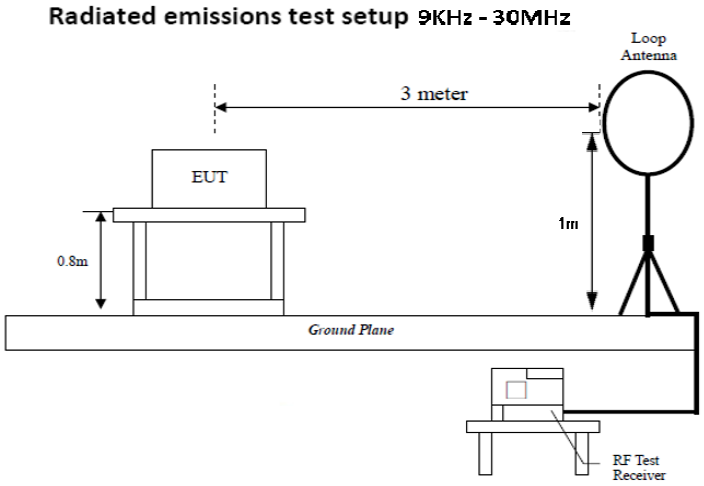
§ 15.247 (d), RSS-247 §5.5

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.

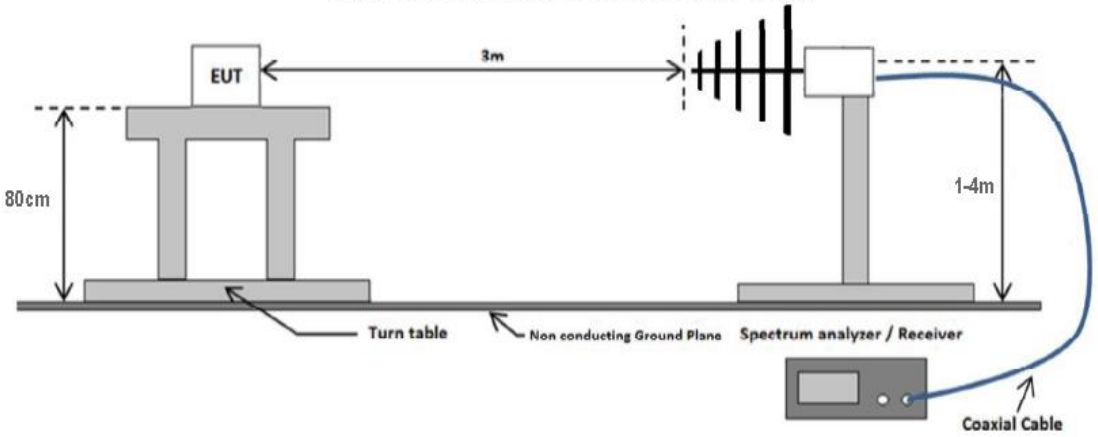
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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

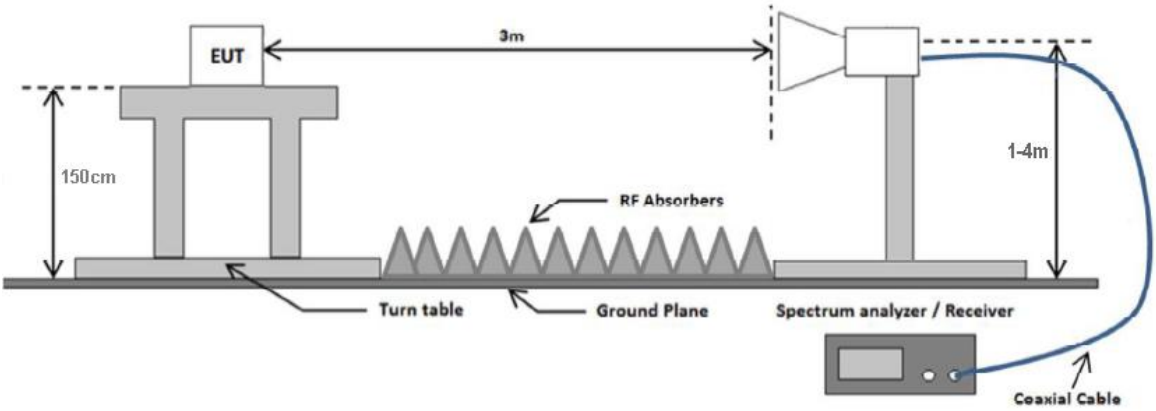
7.7.2 Test Setup



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 C63.10-2013 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.

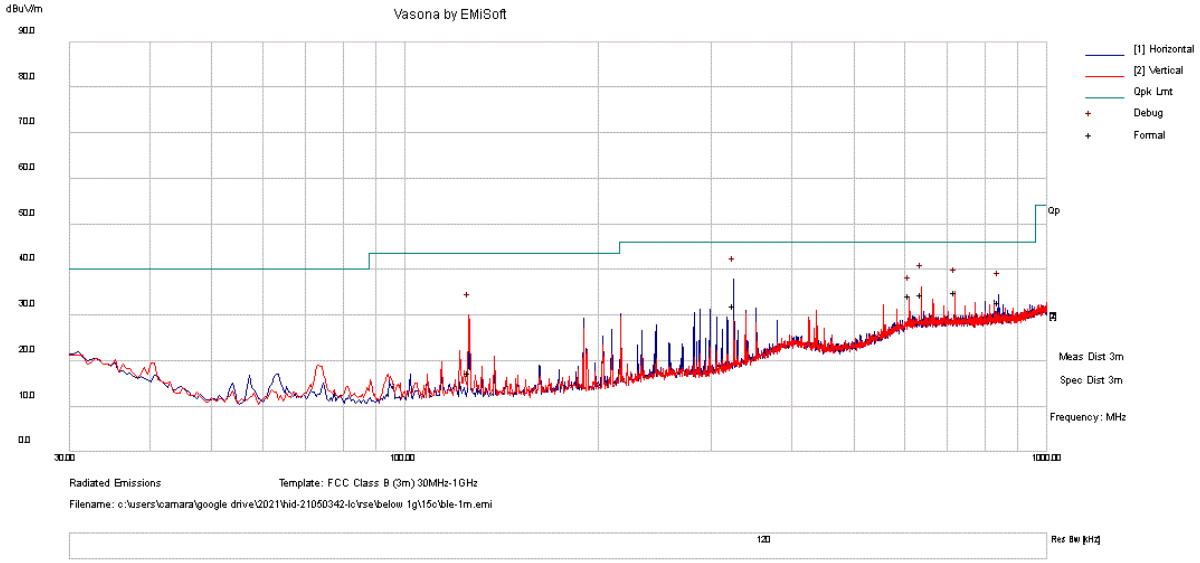
7.7.4 Test Result

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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_1Mbps
Frequency Range:	30 MHz - 1 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid channel	Test Result:	Pass



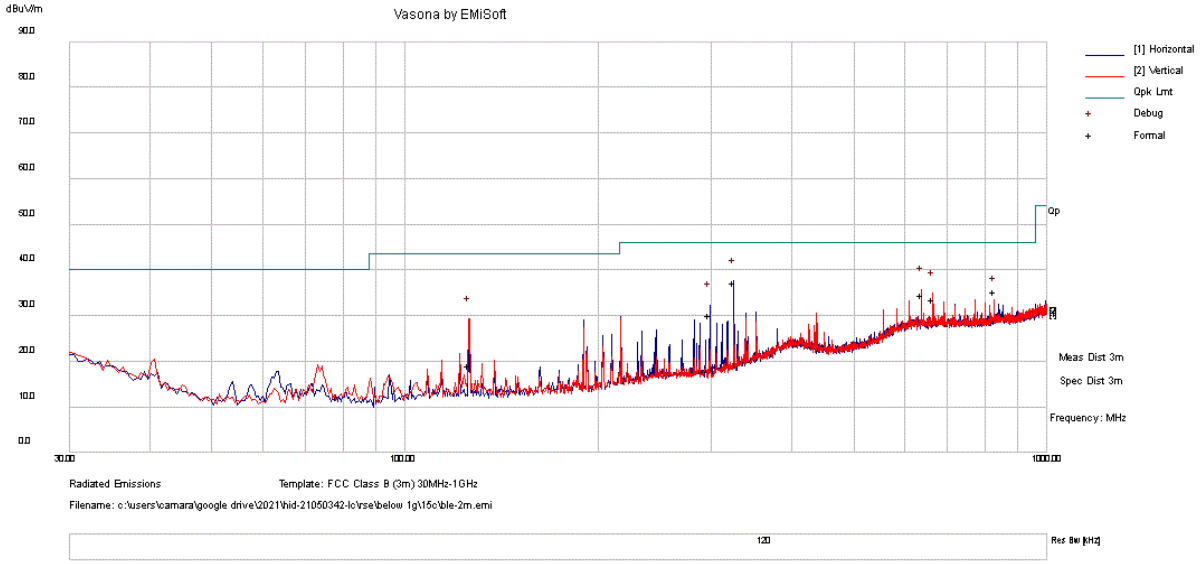
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	325.452	38.9	5.9	-12.5	32.3	QP Max	H	306	3	46	-13.7	Pass
2	637.357	32.6	7.2	-5.1	34.7	QP Max	V	100	360	46	-11.3	Pass
3	718.711	32.9	7.3	-5.2	35.1	QP Max	V	162	18	46	-10.9	Pass
4	840.787	29.4	7.4	-4	32.8	QP Max	H	117	15	46	-13.2	Pass
5	610.246	32.1	7.2	-5	34.3	QP Max	V	0	341	46	-11.7	Pass
6	125.77	31.7	3.9	-18.4	17.3	QP Max	V	152	46	43.5	-26.2	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 BELOW 1 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	BLE_2Mbps
Frequency Range:	30 MHz - 1 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid channel	Test Result:	Pass



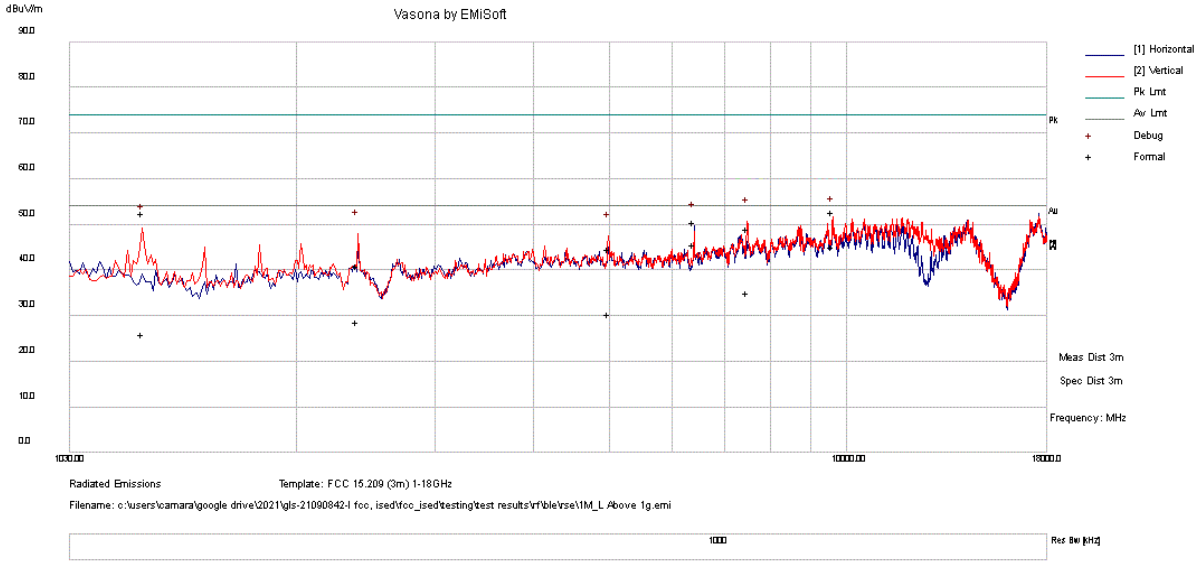
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	325.456	43.9	5.9	-12.5	37.2	QP Max	H	101	110	46	-8.8	Pass
2	637.365	32.4	7.2	-5.1	34.5	QP Max	V	203	5	46	-11.5	Pass
3	664.491	31.6	7.3	-5.2	33.7	QP Max	V	254	2	46	-12.3	Pass
4	827.227	32	7.3	-4.1	35.3	QP Max	V	116	350	46	-10.7	Pass
5	298.323	38.9	5.7	-14.2	30.3	QP Max	H	120	91	46	-15.7	Pass
6	125.783	33.6	3.9	-18.4	19.2	QP Max	V	108	1	43.5	-24.3	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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_1Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



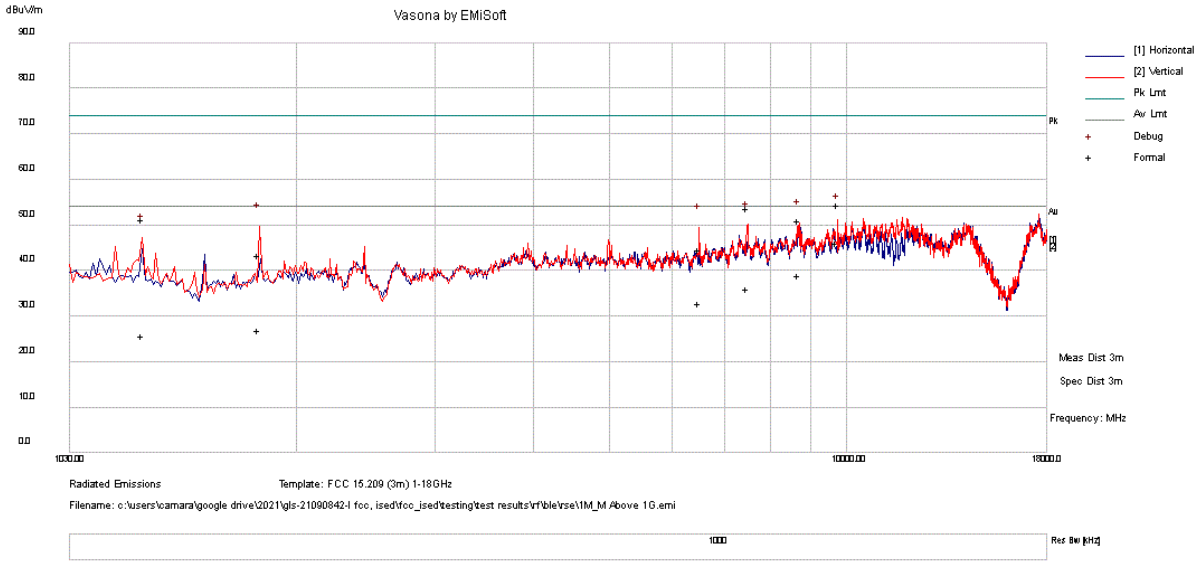
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7488.289	32.7	11.9	4.5	49.1	Peak Max	V	173	31	74	-24.9	Pass
2	9608.462	32.8	14.1	5.9	52.8	Peak Max	V	124	23	74	-21.2	Pass
3	6405.382	35.4	10.9	4.4	50.7	Peak Max	H	112	139	74	-23.3	Pass
4	1274.887	54.2	4.5	-6	52.7	Peak Max	V	198	271	74	-21.3	Pass
5	2389.055	38.7	6.3	-4.1	40.9	Peak Max	V	144	142	74	-33.1	Pass
6	4987.74	32.9	9.1	2.7	44.7	Peak Max	V	109	91	74	-29.3	Pass
7	7488.289	18.6	11.9	4.5	35	Average Max	V	173	31	54	-19	Pass
8	9608.462	25.3	14.1	5.9	45.3	Average Max	V	124	23	54	-8.7	Pass
9	6405.382	30.5	10.9	4.4	45.8	Average Max	H	112	139	54	-8.2	Pass
10	1274.887	27.5	4.5	-6	26	Average Max	V	198	271	54	-28	Pass
11	2389.055	26.5	6.3	-4.1	28.7	Average Max	V	144	142	54	-25.3	Pass
12	4987.74	18.6	9.1	2.7	30.4	Average Max	V	109	91	54	-23.6	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)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	BLE_1Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



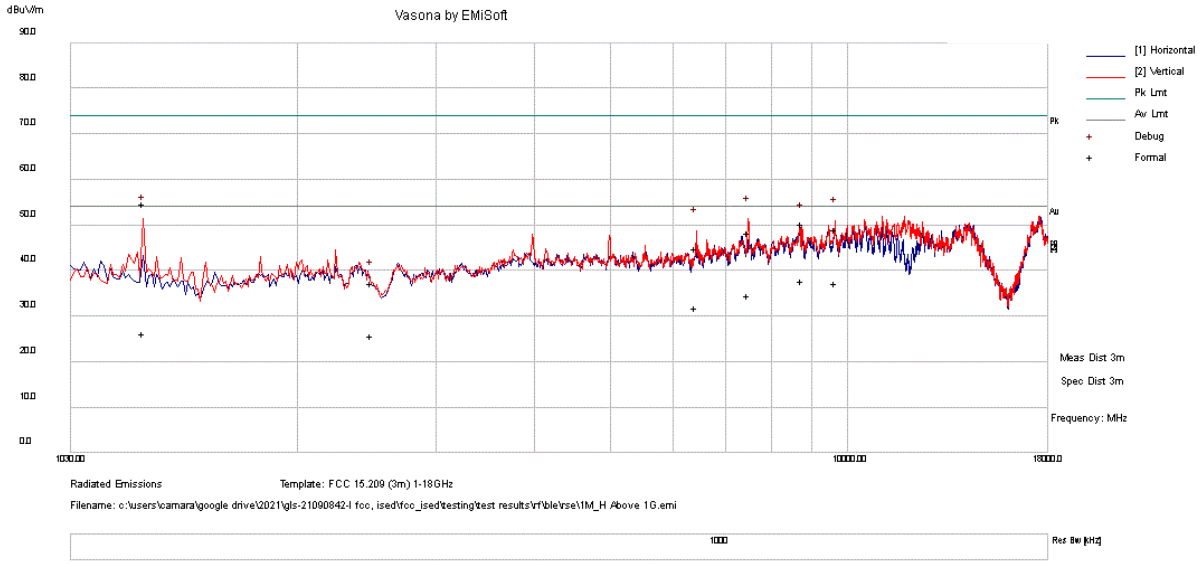
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7498.428	40.3	11.9	4.4	56.6	Peak Max	V	121	109	74	-17.4	Pass
2	9760.093	34.4	14.3	5.8	54.5	Peak Max	V	109	33	74	-19.5	Pass
3	8707.622	28.5	17.6	5.1	51.2	Peak Max	V	292	138	74	-22.8	Pass
4	1794.122	43.4	5.4	-5.4	43.4	Peak Max	V	138	28	74	-30.6	Pass
5	6504.661	28.9	10.9	4.8	44.6	Peak Max	V	212	353	74	-29.4	Pass
6	1275.23	52.8	4.5	-6	51.3	Peak Max	V	102	338	74	-22.7	Pass
7	7498.428	19.9	11.9	4.4	36.2	Average Max	V	121	109	54	-17.8	Pass
8	9760.093	25.3	14.3	5.8	45.4	Average Max	V	109	33	54	-8.6	Pass
9	8707.622	16.3	17.6	5.1	39	Average Max	V	292	138	54	-15	Pass
10	1794.122	27.3	5.4	-5.4	27.3	Average Max	V	138	28	54	-26.7	Pass
11	6504.661	17.2	10.9	4.8	32.9	Average Max	V	212	353	54	-21.1	Pass
12	1275.23	27.1	4.5	-6	25.6	Average Max	V	102	338	54	-28.4	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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_1Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



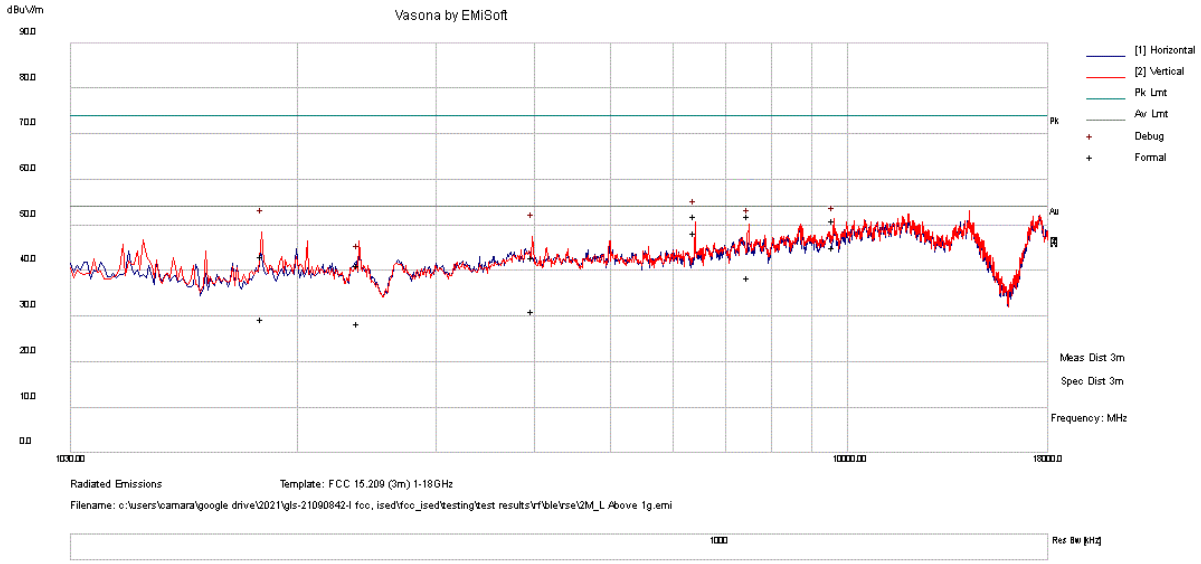
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7489.133	31.6	11.9	4.5	48	Peak Max	V	133	33	74	-26	Pass
2	9651.626	28.5	14.4	6	48.9	Peak Max	V	123	232	74	-25.1	Pass
3	1275.55	55.7	4.5	-6	54.2	Peak Max	V	101	145	74	-19.8	Pass
4	8762.621	29.3	15.3	5.9	50.5	Peak Max	V	234	45	74	-23.5	Pass
5	6428.122	29.2	10.9	4.5	44.6	Peak Max	V	145	230	74	-29.4	Pass
6	2483.931	34.7	6.3	-4.5	36.5	Peak Max	V	357	123	74	-37.5	Pass
7	7489.133	18.4	11.9	4.5	34.8	Average Max	V	133	33	54	-19.2	Pass
8	9651.626	16.9	14.4	6	37.3	Average Max	V	123	232	54	-16.7	Pass
9	1275.55	27.9	4.5	-6	26.4	Average Max	V	101	145	54	-27.6	Pass
10	8762.621	16.8	15.3	5.9	38	Average Max	V	234	45	54	-16	Pass
11	6428.122	16.6	10.9	4.5	32	Average Max	V	145	230	54	-22	Pass
12	2483.931	23.9	6.3	-4.5	25.7	Average Max	V	357	123	54	-28.3	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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_2Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



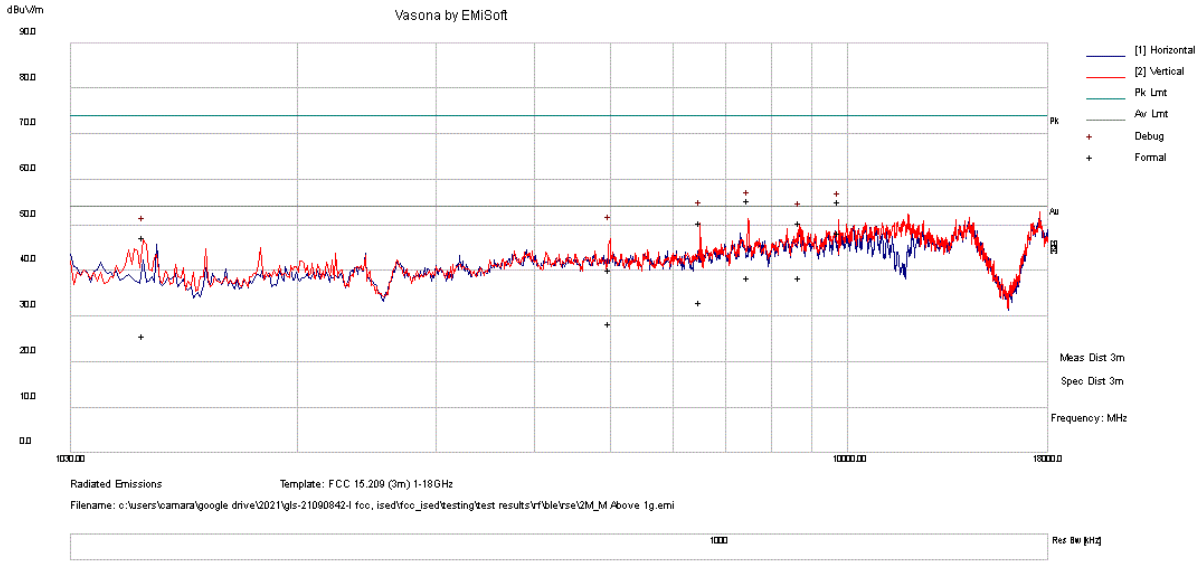
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7489.121	4.09	11.9	4.5	20.49	Peak Max	V	233	21	74	-53.51	Pass
2	9608.444	33.2	14.1	5.9	53.2	Peak Max	V	231	182	74	-20.8	Pass
3	6405.422	34.6	10.9	4.4	49.9	Peak Max	V	145	222	74	-24.1	Pass
4	1802.33	43.2	5.4	-5.3	43.3	Peak Max	V	134	90	74	-30.7	Pass
5	3980.442	33.4	8	1.9	43.3	Peak Max	V	195	331	74	-30.7	Pass
6	2390.42	38.9	6.3	-4.1	41.1	Peak Max	V	255	238	74	-32.9	Pass
7	7489.121	22.1	11.9	4.5	38.5	Average Max	V	233	21	54	-15.5	Pass
8	9608.444	23.5	14.1	5.9	43.5	Average Max	V	231	182	54	-10.5	Pass
9	6405.422	30.1	10.9	4.4	45.4	Average Max	V	145	222	54	-8.6	Pass
10	1802.33	29.5	5.4	-5.3	29.6	Average Max	V	134	90	54	-24.4	Pass
11	3980.442	21.4	8	1.9	31.3	Average Max	V	195	331	54	-22.7	Pass
12	2390.42	26.3	6.3	-4.1	28.5	Average Max	V	255	238	54	-25.5	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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_2Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



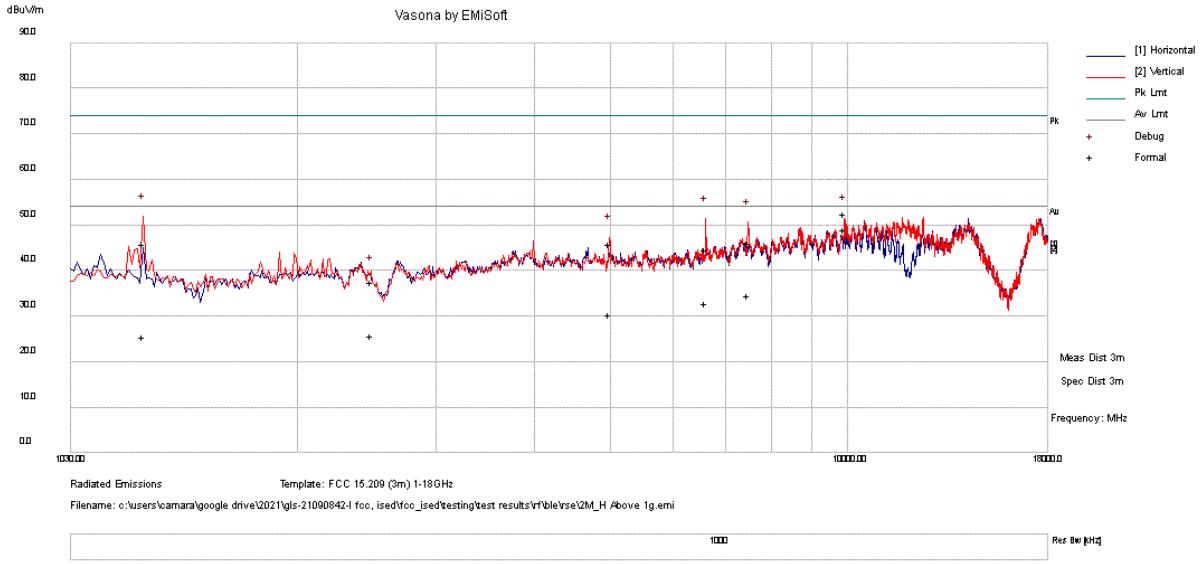
No.	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7488.852	41.5	11.9	4.5	57.9	Peak Max	V	132	183	74	-16.1	Pass
2	9759.93	32.4	14.3	5.8	52.5	Peak Max	V	232	219	74	-21.5	Pass
3	6504.682	33.5	10.9	4.8	49.2	Peak Max	V	244	216	74	-24.8	Pass
4	8698.0521	27.9	17.9	5	50.8	Peak Max	V	230	134	74	-23.2	Pass
5	4997.53	28.8	9.1	2.6	40.5	Peak Max	V	232	205	74	-33.5	Pass
6	1275.14	48.1	4.5	-6	46.6	Peak Max	V	266	30	74	-27.4	Pass
7	7488.852	22.1	11.9	4.5	38.5	Average Max	V	132	183	54	-15.5	Pass
8	9759.93	27.4	14.3	5.8	47.5	Average Max	V	232	219	54	-6.5	Pass
9	6504.682	17.4	10.9	4.8	33.1	Average Max	V	244	216	54	-20.9	Pass
10	8698.0521	15.7	17.9	5	38.6	Average Max	V	230	134	54	-15.4	Pass
11	4997.53	16.8	9.1	2.6	28.5	Average Max	V	232	205	54	-25.5	Pass
12	1275.14	27.3	4.5	-6	25.8	Average Max	V	266	30	54	-28.2	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:	FCC15.247, 15.209, RSS-247	Mode:	BLE_2Mbps
Frequency Range:	1 GHz – 18 GHz	Test Date:	04/06/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	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	9919.924	30.4	14.7	7.4	52.5	Peak Max	V	102	123	74	-21.5	Pass
2	7490.33	29.6	11.9	4.5	46	Peak Max	V	322	223	74	-28	Pass
3	1275.533	47.2	4.5	-6	45.7	Peak Max	V	122	140	74	-28.3	Pass
4	6610.524	29.3	11.2	4.2	44.7	Peak Max	V	129	123	74	-29.3	Pass
5	4987.644	33.8	9.1	2.7	45.6	Peak Max	V	192	90	74	-28.4	Pass
6	2483.743	35.7	6.3	-4.5	37.5	Peak Max	V	290	123	74	-36.5	Pass
7	9919.924	25.7	14.7	7.4	47.8	Average Max	V	102	123	54	-6.2	Pass
8	7490.33	18.1	11.9	4.5	34.5	Average Max	V	322	223	54	-19.5	Pass
9	1275.533	27.1	4.5	-6	25.6	Average Max	V	122	140	54	-28.4	Pass
10	6610.524	17.5	11.2	4.2	32.9	Average Max	V	129	123	54	-21.1	Pass
11	4987.644	18.5	9.1	2.7	30.3	Average Max	V	192	90	54	-23.7	Pass
12	2483.743	24.1	6.3	-4.5	25.9	Average Max	V	290	123	54	-28.1	Pass

Remarks:

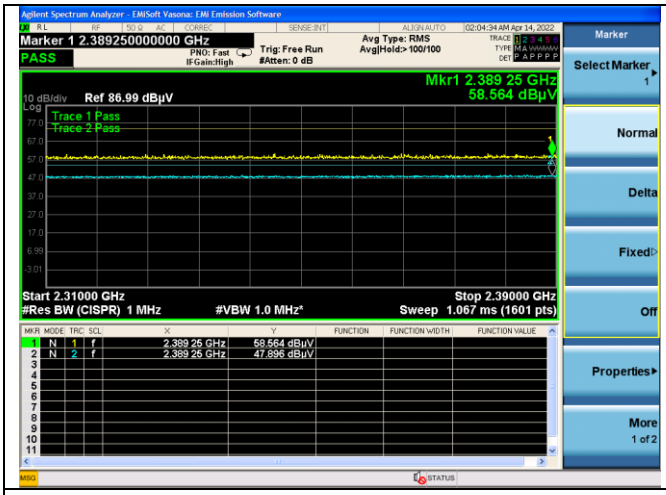
1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Radiated Emission between 18GHz – 40GHz test result

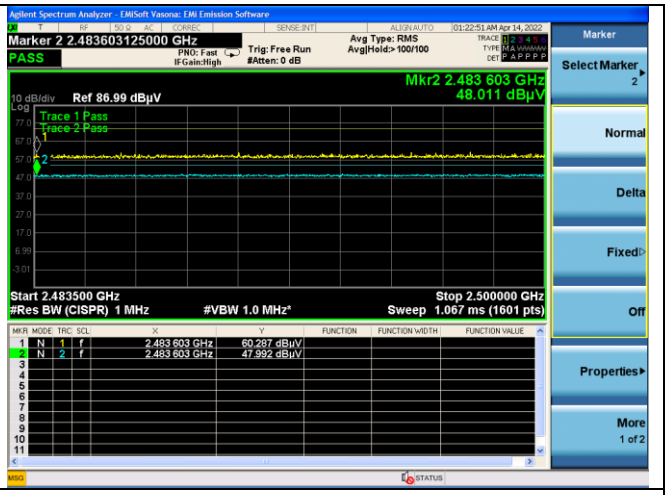
Note: no substantial emission is found other than the noise floor. Different modes have been verified.

Restricted Band Measurement Result

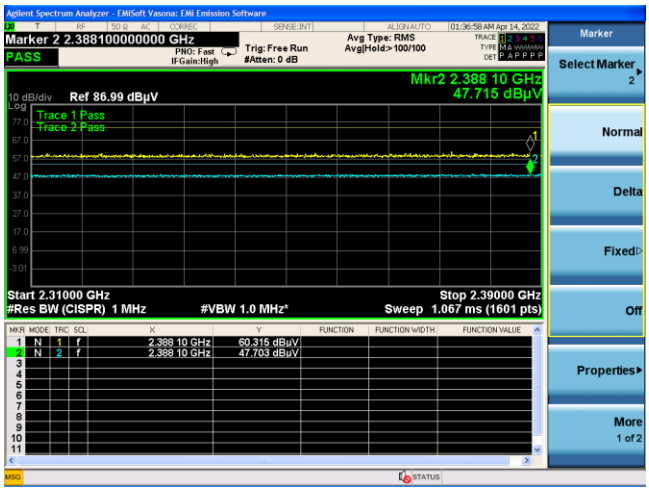
Data Rate	Frequency MHz	Level dBuV/m	Measurement Type	Limit dBuV/m	Margin dB	Pass/Fail
1Mbps	2389.25	58.564	Peak Max	74	-15.436	Pass
	2483.603	60.287	Peak Max	74	-13.713	Pass
	2389.25	47.896	Average Max	54	-6.104	Pass
	2483.603	47.992	Average Max	54	-6.008	Pass
2Mbps	2388.10	60.315	Peak Max	74	-13.685	Pass
	2483.758	58.651	Peak Max	74	-15.349	Pass
	2388.10	47.703	Average Max	54	-6.297	Pass
	2483.758	48.325	Average Max	54	-5.675	Pass



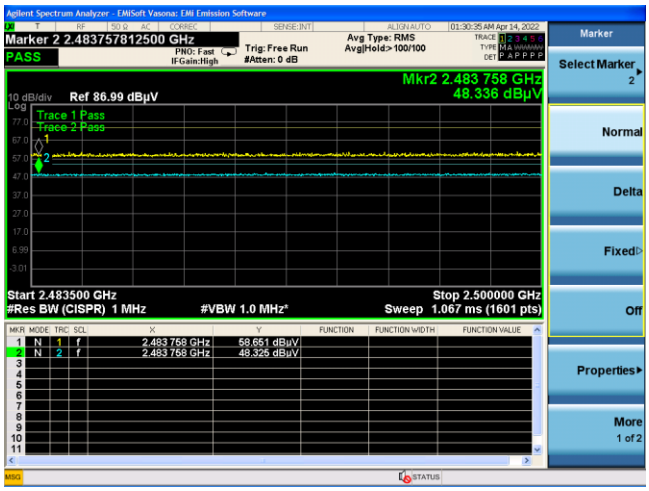
BLE – Low CH-1Mpbs



BLE – High CH-1Mpbs



BLE – Low CH-2Mpbs



BLE – High CH-2Mpbs

7.8 Conducted Emissions

7.8.1 Requirement

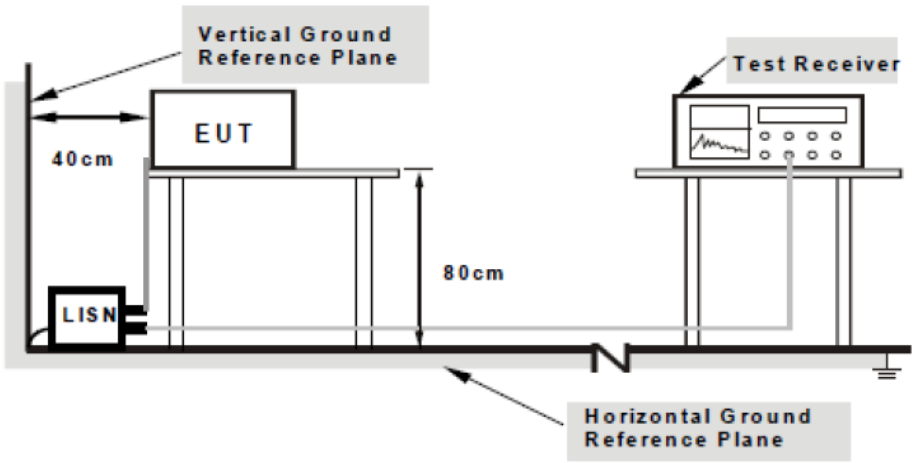
Per § 15.207 (a), RSS Gen 8.8

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 μH/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.			

7.8.2 Test setup



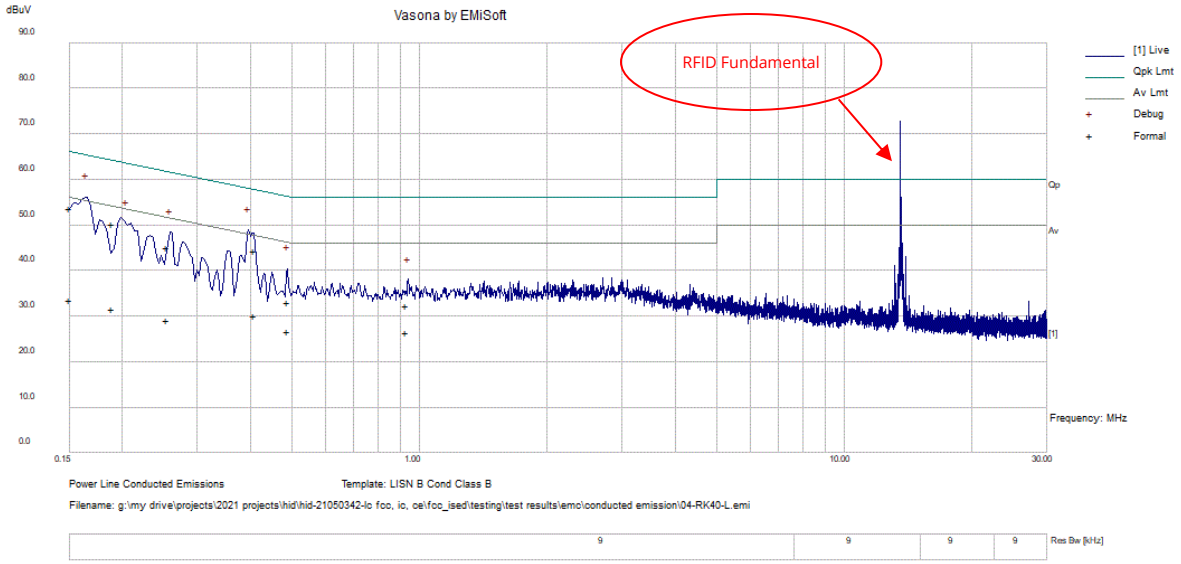
Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

7.8.3 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 50Ω/50μH 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. The LISN bonded to the reference ground plane used has a direct current (dc) resistance of less than 2.5 mΩ.
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 Live / 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.

7.8.4 Test Result

Test Standard:	Part 15.207, RSS Gen 8.8	Mode:	TX Mode
Frequency Range:	0.15-30MHz	Test Date:	03/14/2022
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Line 120VAC, 60Hz	Test Result:	Pass

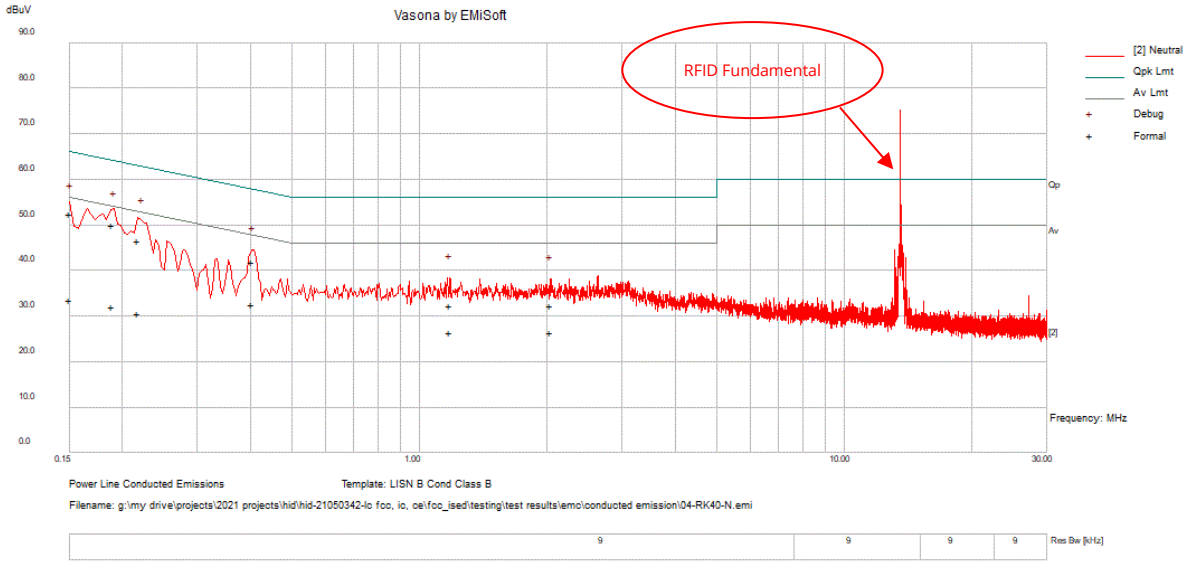


No.	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.409	34.3	10.1	0.1	44.5	Quasi Peak	Live	57.7	-13.2	Pass
2	0.15	43.5	10.1	0.2	53.8	Quasi Peak	Live	66	-12.2	Pass
3	0.254	35	10.1	0.2	45.3	Quasi Peak	Live	61.6	-16.3	Pass
4	0.19	40.1	10.1	0.2	50.4	Quasi Peak	Live	64	-13.6	Pass
5	0.489	23	10.1	0.1	33.2	Quasi Peak	Live	56.2	-23	Pass
6	0.933	22.2	10.1	0.1	32.4	Quasi Peak	Live	56	-23.6	Pass
7	0.409	20	10.1	0.1	30.2	Average	Live	47.7	-17.5	Pass
8	0.15	23.4	10.1	0.2	33.7	Average	Live	56	-22.3	Pass
9	0.254	19	10.1	0.2	29.3	Average	Live	51.6	-22.3	Pass
10	0.19	21.5	10.1	0.2	31.8	Average	Live	54	-22.2	Pass
11	0.489	16.5	10.1	0.1	26.7	Average	Live	46.2	-19.5	Pass
12	0.933	16.2	10.1	0.1	26.4	Average	Live	46	-19.6	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.
5. RFID fundamental signal comes from the integrated 13.56MHz RFID in the support equipment iCLASS SE® Readers that this module obtains power from.

Test Standard:	Part 15.207, RSS Gen 8.8	Mode:	TX Mode
Frequency Range:	0.15-30MHz	Test Date:	03/14/2022
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Neutral 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	0.189	39.9	10.1	0.2	50.2	Quasi Peak	Neutral	64.1	-13.9	Pass
2	0.15	42.2	10.1	0.2	52.5	Quasi Peak	Neutral	66	-13.5	Pass
3	0.218	36.3	10.1	0.2	46.6	Quasi Peak	Neutral	62.9	-16.3	Pass
4	0.403	31.9	10.1	0.1	42.1	Quasi Peak	Neutral	57.8	-15.7	Pass
5	1.182	22.2	10.2	0.1	32.5	Quasi Peak	Neutral	56	-23.5	Pass
6	2.03	22.1	10.2	0.1	32.4	Quasi Peak	Neutral	56	-23.6	Pass
7	0.189	22	10.1	0.2	32.3	Average	Neutral	54.1	-21.8	Pass
8	0.15	23.3	10.1	0.2	33.6	Average	Neutral	56	-22.4	Pass
9	0.218	20.4	10.1	0.2	30.7	Average	Neutral	52.9	-22.2	Pass
10	0.403	22.5	10.1	0.1	32.7	Average	Neutral	47.8	-15.1	Pass
11	1.182	16.3	10.2	0.1	26.6	Average	Neutral	46	-19.4	Pass
12	2.03	16.2	10.2	0.1	26.5	Average	Neutral	46	-19.5	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.
5. RFID fundamental signal comes from the integrated 13.56MHz RFID in the support equipment iCLASS SE® Readers that this module obtains power from.

8 EUT and Test Setup Photos

Refer to FCC/ISED exhibits

9 Test Instrument List

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2020	10/18/2022
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A1)	N/A1)
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/17/2021	06/17/2022
EMC Test Receiver	R&S	ESL6	100230	06/14/2021	06/14/2022
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	05/04/2021	05/04/2022
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2021	11/15/2022
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	05/14/2021	05/14/2022
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	06/24/2021	06/24/2022
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2021	07/16/2022
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	05/15/2021	05/15/2022
RF Attenuator	Pasternack	PE7005-3	VL061	07/16/2021	07/16/2022
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	07/16/2021	07/16/2022
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	05/16/2021	05/16/2022
RE test cable (below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	07/16/2021	07/16/2022
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	07/16/2021	07/16/2022
RE test cable (>18GHz)	Sucoflex	104	344903/4	07/16/2021	07/16/2022
Pulse limiter	Com-Power	LIT-930A	531727	07/16/2021	07/16/2022
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	07/16/2021	07/16/2022
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	07/16/2021	07/16/2022
Agilent Signal Generator	MXG N5182A	N5182A	US47080548	6/17/2021	6/17/2022
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL052	N/A1)	N/A1)
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL053	N/A1)	N/A1)
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL054	N/A1)	N/A1)
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL055	N/A1)	N/A1)

Note:

1) This equipment is not for measurement purpose and only require functional verification. Calibration is not required.

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