Vista Labs
TEST • CERTIFY • COMPLY

Phone: +1 (949) 393-1123
Web: www.vista-compliance.com
Email: info@vista-compliance.com

FCC ISED RF Test Report

Test Report Number	HID-21012642-LC-FCC-IC-BEEKSLR
FCC ID	SL6-BEEKSLR001
ISED ID	24824-BEEKSLR001
Applicant	HID Global Corporation
Applicant Address	611 Center Ridge Drive, Austin, TX, 78753, USA
Product Name	BEEKS (TM) Long Range Beacon
Model (s)	BEEKSLR001
Date of Receipt	08/10/2021
Date of Test	08/10/2021- 08/20/2021
Report Issue Date	08/24/2021
Test Standards	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017
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-21012642-LC-FCC-IC-BEEKSLR	01	Initial report	08/24/2021

TABLE OF CONTENTS

1 Test Summary

Test Item	Test Requirement	Test Method	Result
Antenna Requirement	47 CFR Part 15.247	N/A	Pass
AC Power Line Conducted Emissions	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	N/A 1)
Occupied Bandwidth	RSS-Gen issue 5 amendment 2, Feb 2021	ANSI C63.10-2013 RSS-Gen issue 5 amendment 2, Feb 2021	Pass 2)
DTS (6 dB) Channel Bandwidth	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Conducted Maximum Output Power	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Power Spectral Density	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass
Conducted Band-Edge & Unwanted Emissions	47 CFR Part 15.247 RSS-247 Issue 2, Feb 2017	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 RSS-247 Issue 2, Feb 2017	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02	Pass

Note

1) EUT is powered by internal battery only. There isn't any connection to public AC mains. This test item is not applicable.
2) The occupied bandwidth is required per ISED RSS-Gen only.

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	BEEKS (TM) Long Range Beacon
Model Number	BEEKSLR001
Family Models	N/A
Serial Number	#1 (Radiated sample) #4 (Conducted sample)
Test Sample Number	HID-21012642-LC-S11 (Radiated) HID-21012642-LC-S15 (Conducted)
Frequency Band	2402-2480MHz
Type of modulation	GFSK
Equipment Class	DTS
Antenna Information	Internal PCB Antenna, 1.77 dBi max gain
Clock Frequencies	N/A
Input Power	3.6VDC Lithium Battery, 2400mAh
Power Adapter Manufacturer/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	V450
Simultaneous Transmission	N/A
Additional Info	1. The product is stationary, within a freezer/ refrigerator, so it is NOT within 20 cm of human during operation. 2. The product's typical application is long range beacon. It has limitation on transmission duty cycle and size of data bytes. The duty cycle of the BLE transmit function is limited to a maximum of 2.08%. The BLE radio firmware limits the periodic frequency of transmissions to a maximum of once every 20 ms, and the operational firmware limits the maximum data payload to 37 bytes which results in a transmit burst duration of 416 µs. In any 100 ms period, the transmit function is no greater than 2080 µs (2.080 ms).

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	22.7°C	58.2%	996 mbar
Radiated Emission Testing	22.7°C	58.2%	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. The sample with S/N 4 is modified with an RF connector in place of the antenna, and both samples had serial communication wires to externally control operation.

5 Test Configuration and Operation

5.1 EUT Test Configuration

EUT is powered by three 3.6VDC non rechargeable Lithium batteries. EUT was set to continuous transmission mode during TX testing and was set to continuous receiver mode during RX testing.

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
dmtest rev1	To set EUT into continuous TX and RX mode under different modulation, data rate and channel, etc.

5.2 EUT transmission duty cycle and correction factor

§ 15.35 (c) allows that when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.

EUT's application is long range beacon. It has limitation on transmission duty cycle and size of data bytes. The duty cycle of the BLE transmit function is limited to a maximum of 2.08%. The BLE radio firmware limits the periodic frequency of transmissions to a maximum of once every 20 ms, and the operational firmware limits the maximum data payload to 37 bytes which results in a transmit burst duration of 416 µs. In any 100 ms period, the transmit function is no greater than 2080 µs (2.080 ms).

Calculation

- BLE data rate: 1Mbit/s
- Maximum data payload: 37 bytes
- Maximum periodic frequency: once every 20 mS
- Maximum transmit burst duration: 416 uS
- Calculated max duty cycle in 100 mS is 416 uS x (100 mS / 20 mS) / 100 mS = 0.0208
- Corresponding FCC duty cycle correction factor is 20 * Log 10 (0.0208) = -33.64 dB

5.3 Supporting Equipment

Description	Manufacturer	Model #	Serial #
Laptop	Dell	G1H5102	P29G003

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 uses internal PCB antenna that is not removable. No standard RF connector is used.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

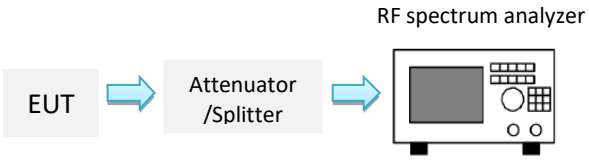
7.2 DTS (6 dB) Bandwidth

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:

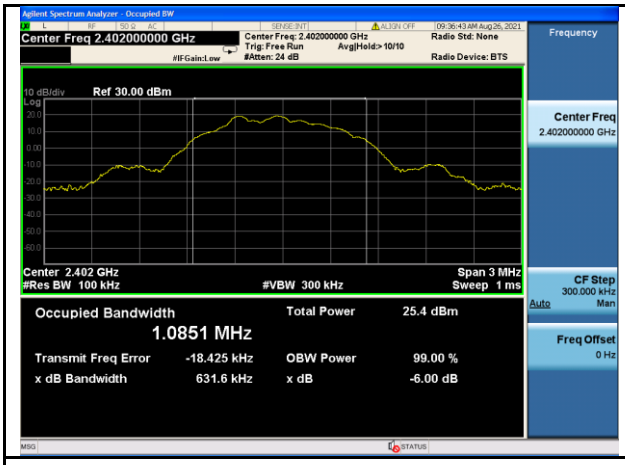
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this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

The measurement instrument is a spectrum analzyer.

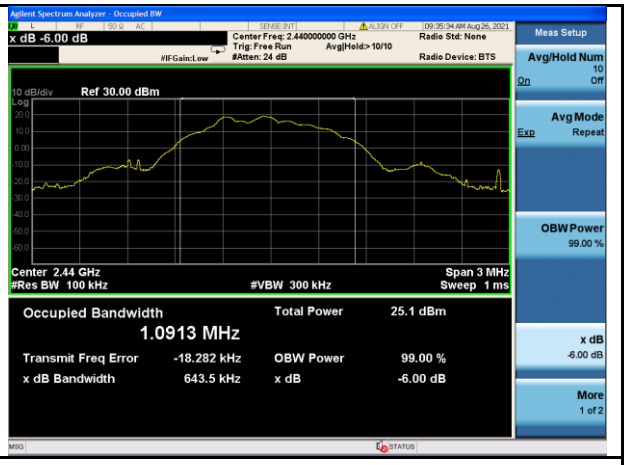
1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Use automatic bandwidth measurement capability on instrument to obtain BW result.

7.2.4 Test Result

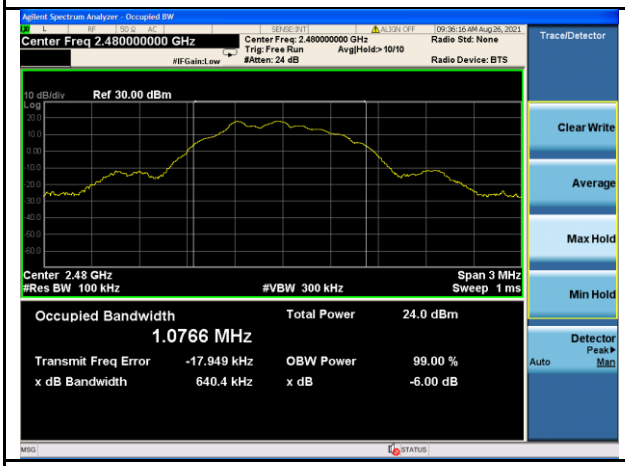
Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Minimum Bandwidth (KHz)	Result
BLE	2402	1Mbps	631.6	500	Pass
BLE	2440	1Mbps	643.5	500	Pass
BLE	2480	1Mbps	640.4	500	Pass



BLE-DTS BW-Low-1Mbps



BLE-DTS BW-Mid-1Mbps



BLE-DTS BW-High-1Mbps

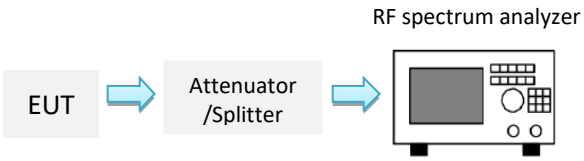
7.3 Occupied Bandwidth (99%)

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.

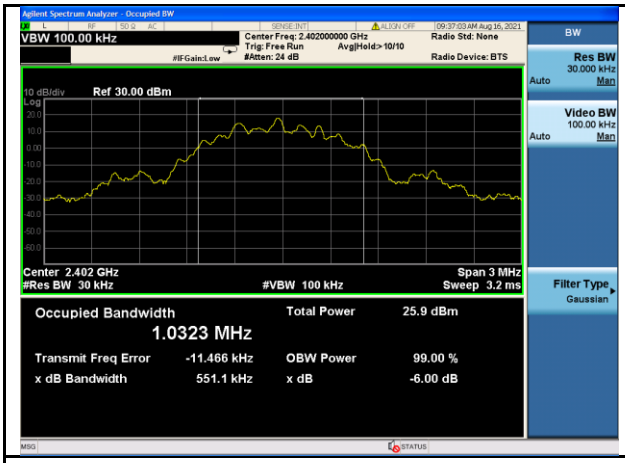
The measurement instrument is a spectrum analzyer.

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.

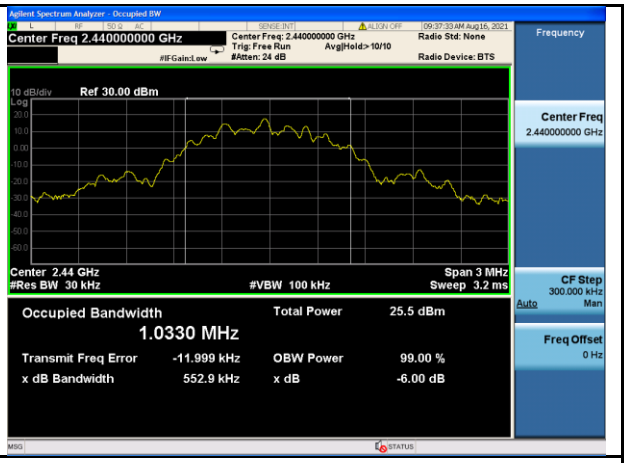
7.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured 99% OBW (KHz)	Limit (KHz)	Result
BLE	2402	1Mbps	1032.3	N/A	Pass
BLE	2440	1Mbps	1033.0	N/A	Pass
BLE	2480	1Mbps	1028.6	N/A	Pass

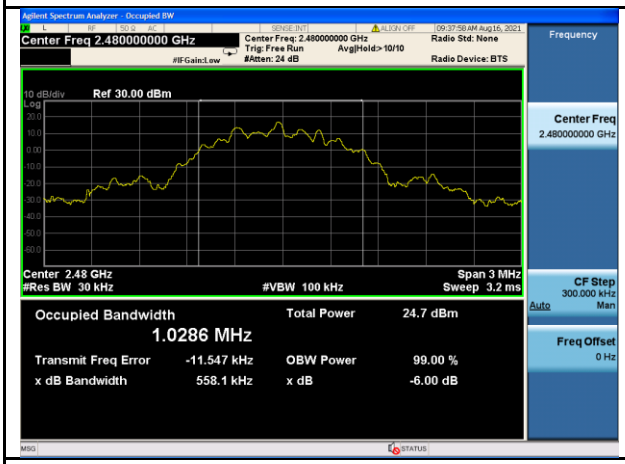
7.3.5 Test Plots



BLE-OBW-Low-1Mpbs



BLE-OBW-Mid-1Mpbs



BLE-OBW-High-1Mpbs

7.4 Maximum Output Power

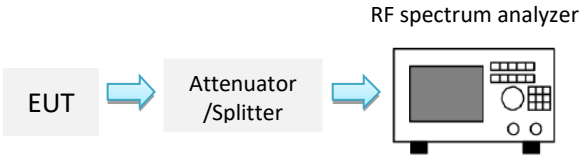
7.4.1 Requirement

§ 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

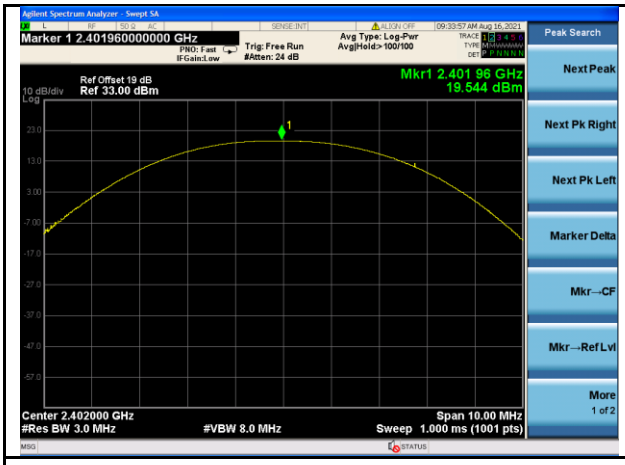
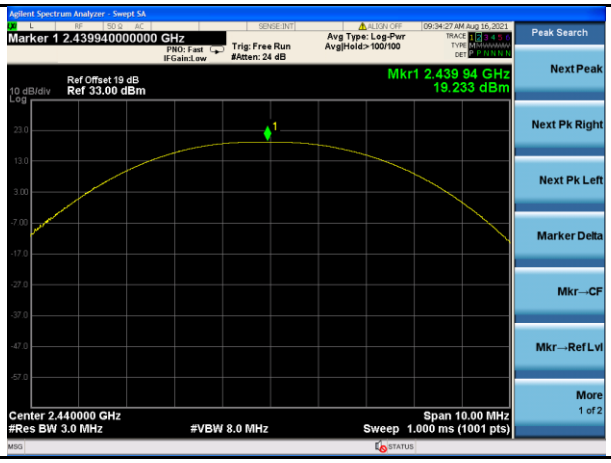
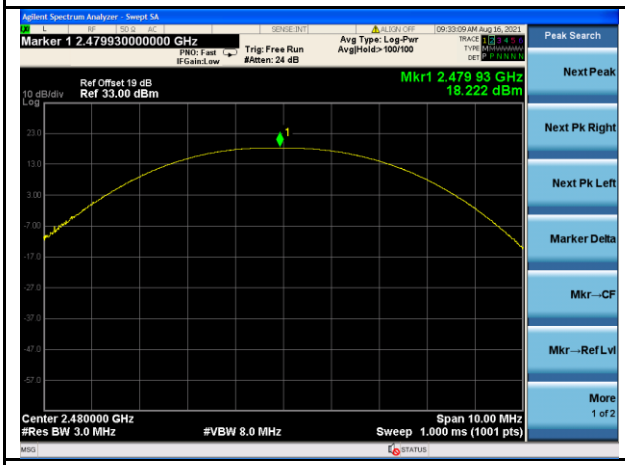
For BLE, power measurement is according to subclause 11.9.1.1 of ANSI C63.10-2013:

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/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Max Output Power (dBm)	Result
BLE	2402	1Mbps	19.544	30	Pass
BLE	2440	1Mbps	19.233	30	Pass
BLE	2480	1Mbps	18.222	30	Pass

7.4.5 Test Plots

<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>BLE-Power-Low-1Mpbs</td><td>BLE-Power-Mid-1Mpbs</td></tr>
<tr><td> 
</td><td></td></tr>
<tr><td>BLE-Power-High-1Mpbs</td><td></td></tr>
</table>

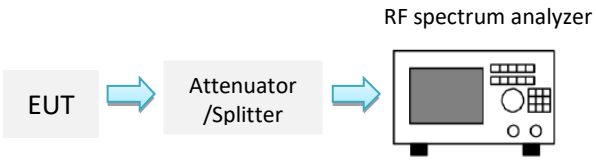
7.5 Power Spectral Density

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

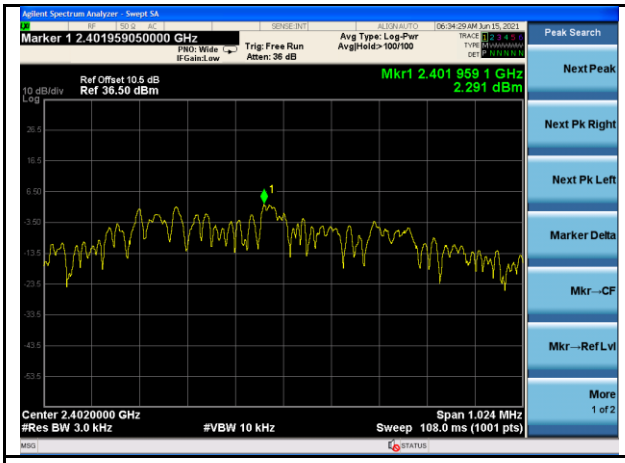
According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

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

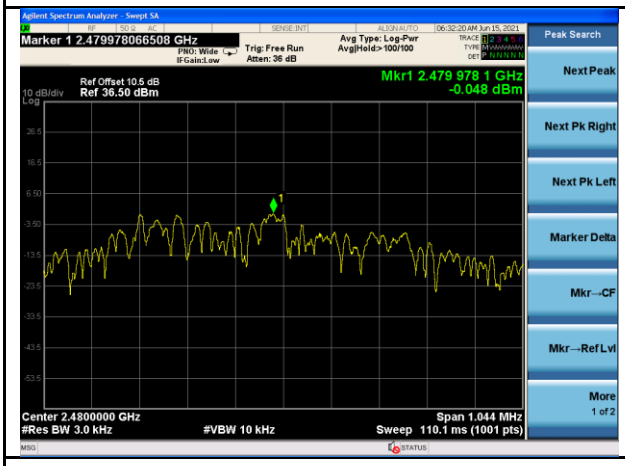
Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured PSD (dBm/3KHz)	Max PSD (dBm/3KHz)	Result
BLE	2402	1Mbps	2.291	8	Pass
BLE	2440	1Mbps	1.138	8	Pass
BLE	2480	1Mbps	-0.048	8	Pass

7.5.5 Test Plots



BLE-PSD-Low-1Mbps

BLE-PSD-Mid-1Mbps



BLE-PSD-High-1Mbps

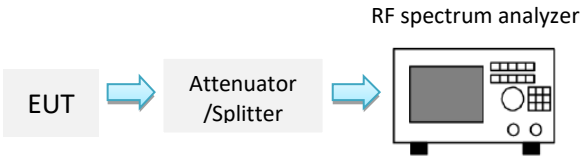
7.6 Conducted Band-Edge Measurement

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.

7.6.2 Test Setup



7.6.3 Test Procedure

According to section 8.5 Emission level measurement, in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.11.3 in ANSI C63.10-2013:

1. Set the centre frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.
3. Set the VBW ≥ 3 X RBW.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

7.6.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Band Edge to Fundamental (dBc)	Limit (dBc)	Result
BLE	2402	1Mbps	-45.128	-20	Pass
BLE	2480	1Mbps	-53.460	-20	Pass

7.6.5 Test Plots

	
BLE-Conducted Band Edge-Low-1Mpbs	**BLE- Conducted Band Edge-High-1Mpbs**

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

7.7.1 Requirement

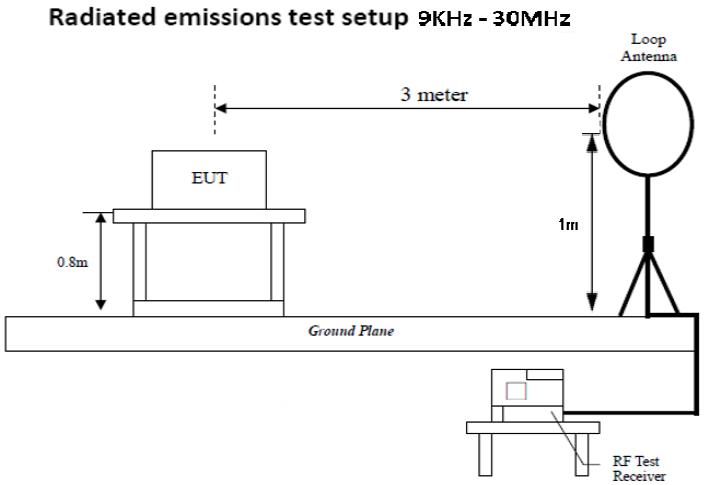
§ 15.247 (d), RSS-247 §5.5

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.

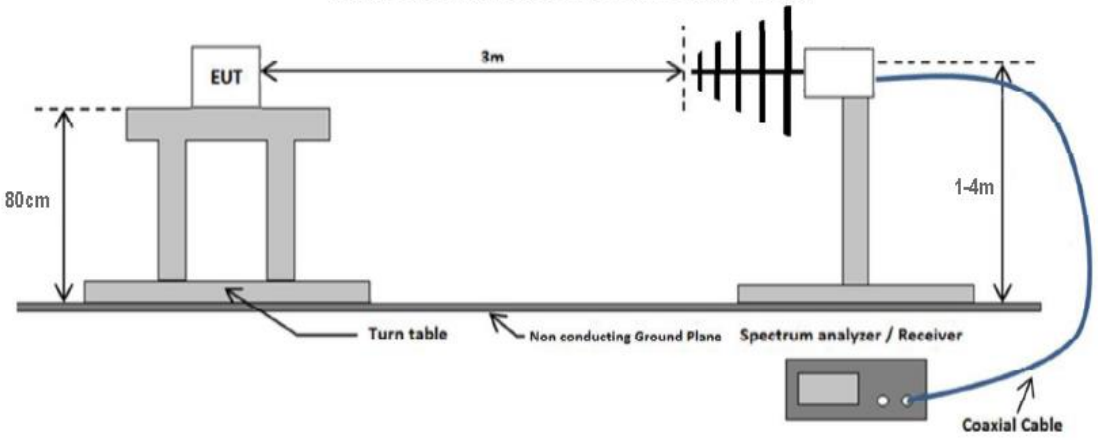
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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

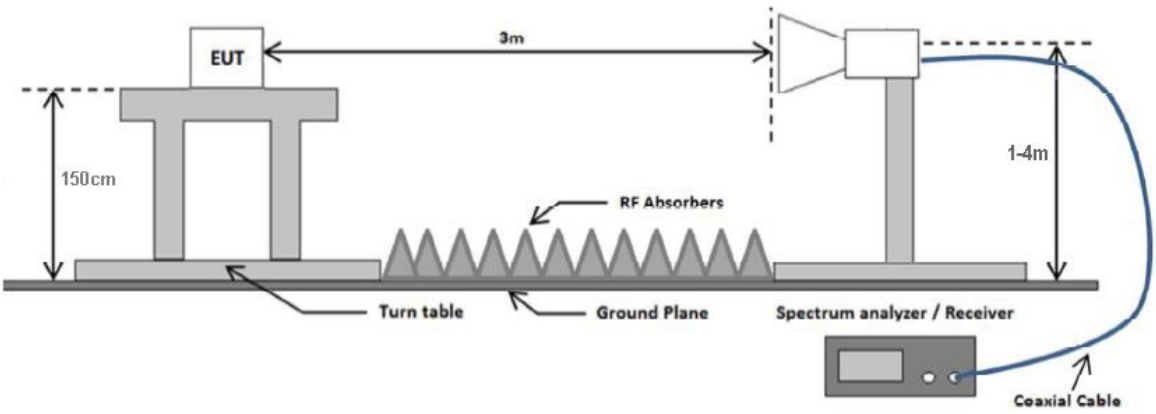
7.7.2 Test Setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



7.7.3 Test Procedure

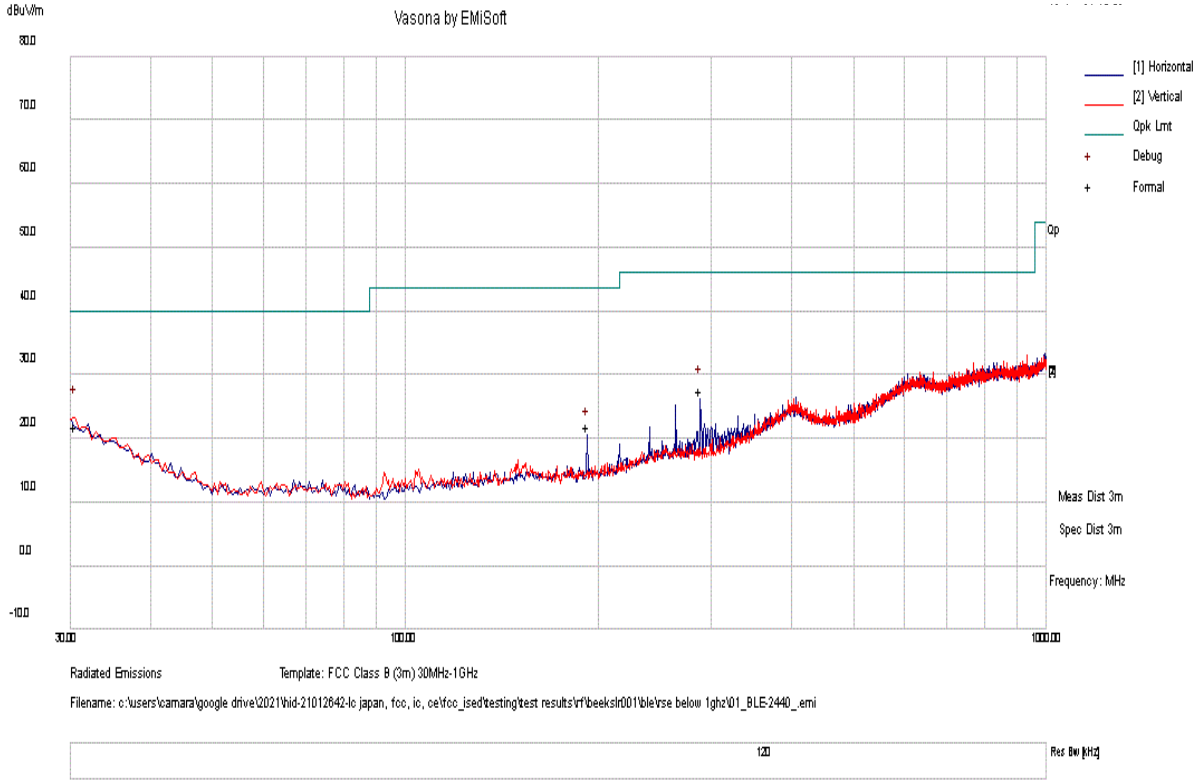
According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C63.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was 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. For the average value, the average can be determined by the applicable duty cycle correction factor if the emission type is pulsed per 15.35 (c).
7. Steps 2 and 6 were repeated for the next frequency point, until all selected frequency points were measured.

7.7.4 Test Result

RADIATED EMISSIONS BELOW 1 GHZ

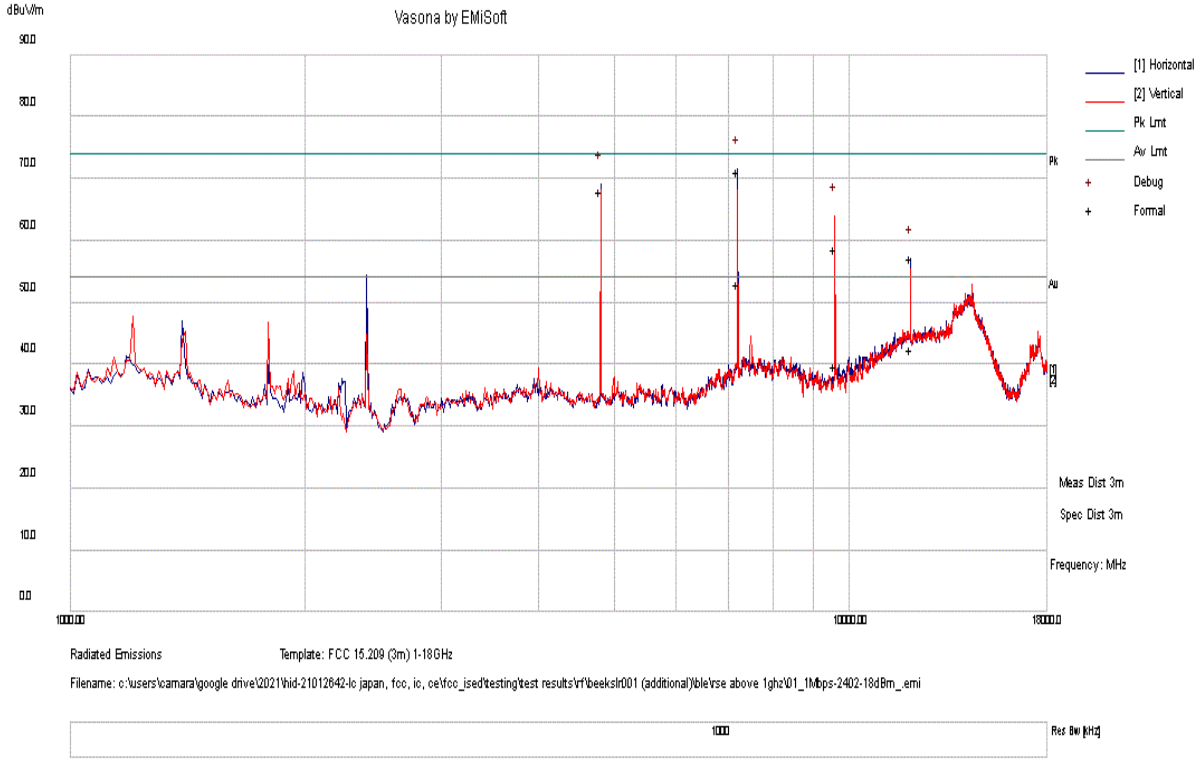
Test Standard:	15.247, RSS-247, RSS-247	Mode:	Radiated Emission Below 1GHz – BLE mid CH
Frequency Range:	30 MHz - 1 GHz	Test Date:	08/10/2021
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
30.582	31.50	2.2	-11.8	21.9	Quasi Max	V	398.00	0	40	-18.1	Pass
287.997	36.20	5.6	-14.3	27.5	Quasi Max	H	100.00	350	46	-18.5	Pass
192.004	34.40	4.7	-17.1	21.9	Quasi Max	H	146.00	352	43.5	-21.6	Pass

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	15.247, RSS-247, RSS-247	Mode:	Radiated Emission RF Above 1GHz - BLE Low
Frequency Range:	1 GHz - 18 GHz	Test Date:	08/10/2021
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass

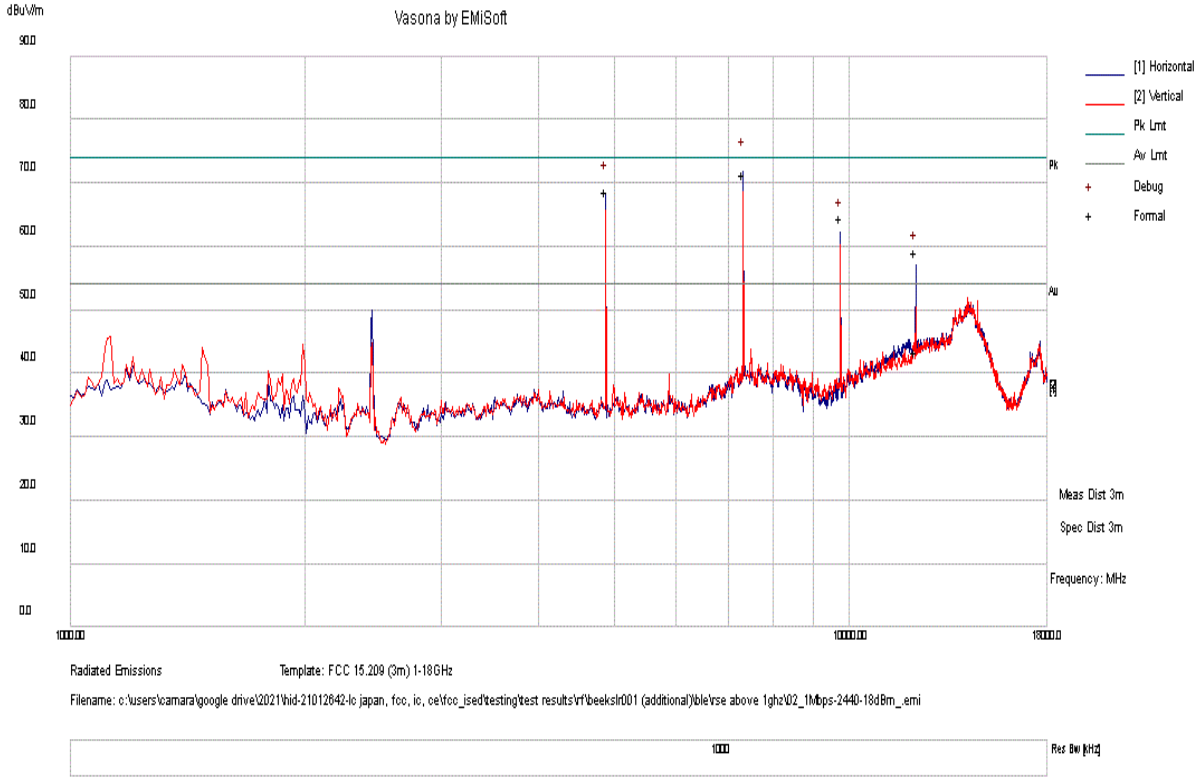


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
7206.00	49.50	20.50	1.20	71.20	Peak Max	H	131	254	74	-2.80	Pass
4804.00	52.90	17.40	-2.20	68.00	Peak Max	H	100	19	74	-6.00	Pass
9608.00	36.10	21.90	0.60	58.60	Peak Max	V	121	202	74	-15.40	Pass
12010.00	27.60	25.60	4.00	57.20	Peak Max	H	170	26	74	-16.80	Pass
7206.00	-	-	-	37.56	Average Max	H	131	254	54	-16.44	Pass
4804.00	-	-	-	34.36	Average Max	H	100	19	54	-19.64	Pass
9608.00	-	-	-	24.96	Average Max	V	121	202	54	-29.04	Pass
12010.00	-	-	-	23.56	Average Max	H	170	26	54	-30.44	Pass

Note:

1. These emissions are BLE fundamental's harmonics and has the same signal characteristics as the fundamental including the transmission duty cycle. The duty cycle correction factor is applicable for determining the average value.
2. The worst-case calculated duty cycle correction factor is -33.64 dB. See the additional info in section 5.2, General information.
3. Average Max Level = Peak Max Level - Duty Cycle Correction Factor

Test Standard:	15.209, 15.247	Mode:	Radiated Emission RF Above 1GHz - BLE Mid
Frequency Range:	1 GHz - 18 GHz	Test Date:	08/10/2021
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass

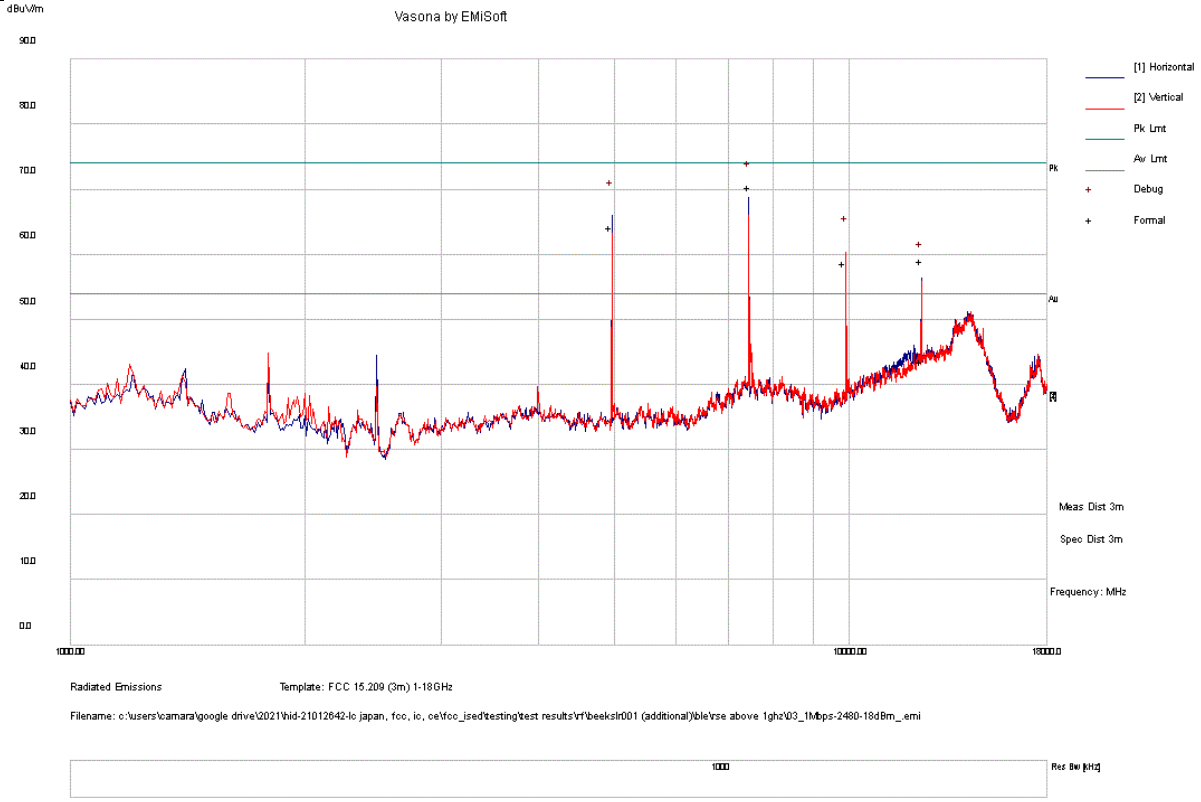


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
7320.00	49.60	20.70	1.20	71.50	Peak Max	H	125	185	74	-2.50	Pass
4880.00	53.60	17.40	-2.20	68.80	Peak Max	H	110	98	74	-5.20	Pass
9760.00	18.20	22.10	0.80	41.10	Peak Max	H	329	33	74	-32.90	Pass
12200.00	29.70	25.60	3.90	59.20	Peak Max	H	113	156	74	-14.80	Pass
7320.00	-	-	-	37.86	Average Max	H	125	185	54	-16.14	Pass
4880.00	-	-	-	35.16	Average Max	H	110	98	54	-18.84	Pass
9760.00	-	-	-	7.46	Average Max	H	329	33	54	-46.54	Pass
12200.00	-	-	-	25.56	Average Max	H	113	156	54	-28.44	Pass

Note:

1. These emissions are BLE fundamental's harmonics and has the same signal characteristics as the fundamental including the transmission duty cycle. The duty cycle correction factor is applicable for determining the average value.
2. The worst-case calculated duty cycle correction factor is -33.64 dB. See the additional info in section 5.2, General information.
3. Average Max Level = Peak Max Level - Duty Cycle Correction Factor

Test Standard:	15.247	Mode:	Radiated Emission RF Above 1GHz - BLE High
Frequency Range:	1 GHz - 12.75 GHz	Test Date:	08/10/2021
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
7440.00	48.50	20.90	1.00	70.30	Peak Max	H	127	157	74	-3.70	Pass
4960.00	37.20	17.40	-2.20	52.40	Peak Max	H	211	192	74	-21.60	Pass
9920.00	18.40	22.30	0.90	41.60	Peak Max	V	223	276	74	-32.40	Pass
12400.00	29.40	25.50	4.10	59.00	Peak Max	H	122	210	74	-15.00	Pass
7440.00	-	-	-	36.66	Average Max	H	127	157	54	-17.34	Pass
4960.00	-	-	-	18.76	Average Max	H	211	192	54	-35.24	Pass
9920.00	-	-	-	7.96	Average Max	V	223	276	54	-46.04	Pass
12400.00	-	-	-	25.36	Average Max	H	122	210	54	-28.64	Pass

Note:

1. These emissions are BLE fundamental's harmonics and has the same signal characteristics as the fundamental including the transmission duty cycle. The duty cycle correction factor is applicable for determining the average value.
2. The worst-case calculated duty cycle correction factor is -33.64 dB. See the additional info in section 5.2, General information.
3. Average Max Level = Peak Max Level - Duty Cycle Correction Factor

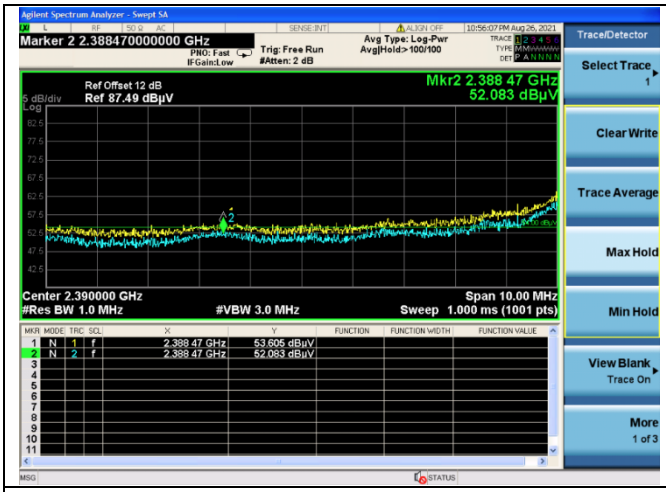
Radiated Emission between 9KHz – 30MHz test result

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

Radiated Emission between 18GHz – 25GHz test result

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

Restricted Band Measurement Result



BLE-Radiated Band Edge-Low-1Mpbs (Peak & Average)

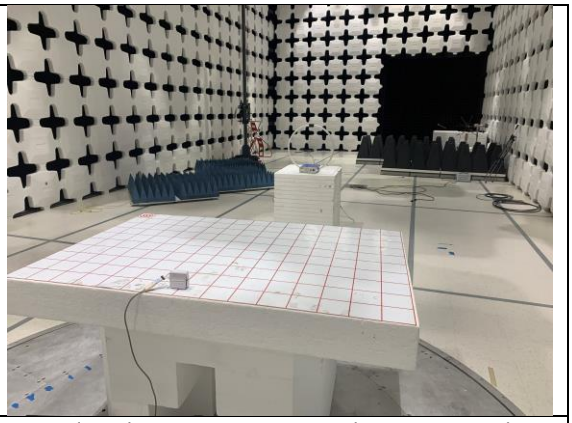
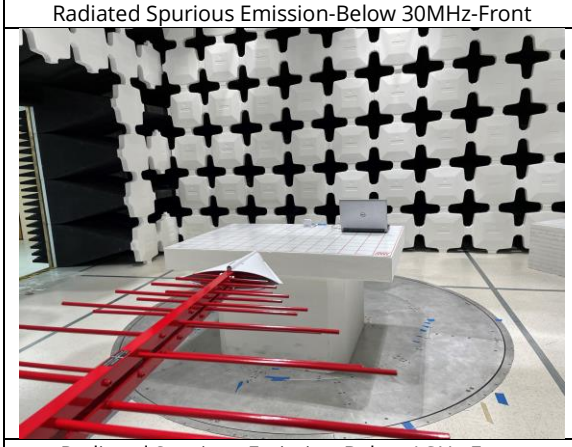
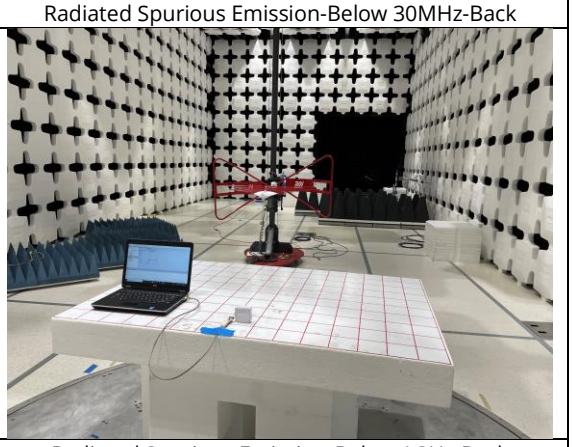
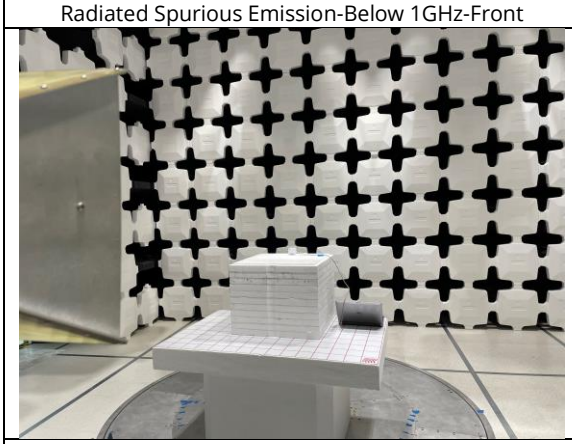
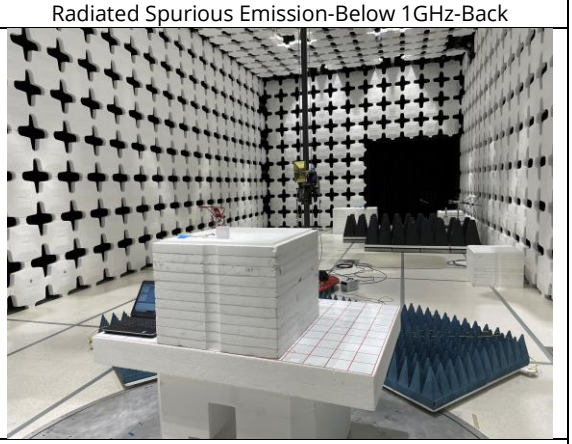
BLE- Radiated Band Edge-High-1Mpbs (Peak)

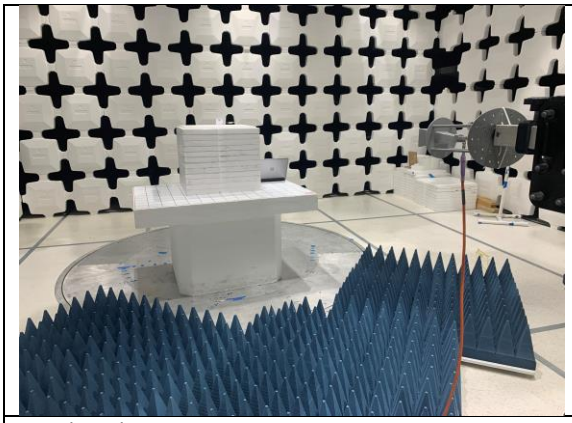
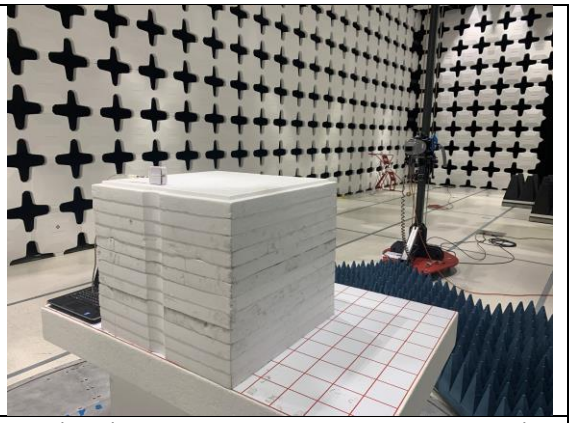
Frequency MHz	Level dBuV/m	Measurement Type	Limit dBuV/m	Margin dB	Pass/Fail
2388.47	53.605	Peak Max	74	-20.395	Pass
2483.50	73.149	Peak Max	74	-0.851	Pass
2388.47	52.083	Average Max	54	-1.917	Pass
2483.50	39.509	Average Max	54	-14.491	Pass

Note:

1. The band edge emissions are BLE fundamental's harmonics and has the same signal characteristics as the fundamental including the transmission duty cycle. The duty cycle correction factor is applicable for determining the average value.
2. The worst-case calculated duty cycle correction factor is -33.64 dB. See the additional info in section 5.2, General information.
3. Average Max Level = Peak Max Level - Duty Cycle Correction Factor
4. For the radiated band edge at 2390MHz, the yellow trace is peak trace and the blue trace is average trace. The emission at this frequency may be the noise floor but can't be further reduced due to limitation of instrument dynamic range set to accommodate the fundamental emission. The average value is measured. The emission level at 2488.47 MHz is marked since it's higher than at 2390MHz.
5. For the radiated band edge at 2483.5MHz, the emission at this frequency is associated with the fundamental at 2480MHz and the average value is calculated.

8 Test Setup Photos

	
Radiated Spurious Emission-Below 30MHz-Front	Radiated Spurious Emission-Below 30MHz-Back
	
Radiated Spurious Emission-Below 1GHz-Front	Radiated Spurious Emission-Below 1GHz-Back
	
Radiated Spurious Emission- 1GHz to 18GHz-Front	Radiated Spurious Emission- 1GHz to 18GHz-Back

	
Radiated Spurious Emission- 18GHz to 25GHz-Front	Radiated Spurious Emission- 18GHz to 25GHz-Back

9 Test Instrument List

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2019	10/18/2021
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	6/17/2021	6/17/2022
EMC Test Receiver	R&S	ESL6	100230	6/14/2021	6/14/2022
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	5/4/2021	5/4/2022
LISN (9KHz – 30MHz)	Com-Power	LI-550C	20140050	01/29/2021	01/29/2022
LISN (9KHz – 30MHz)	Com-Power	LI-550C	20140051	01/29/2021	01/29/2022
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2019	11/15/2021
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	5/14/2021	5/14/2022
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	6/24/2021	6/24/2022
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	7/16/2020	7/16/2022
True RMS Multi-meter	UNI-T	UT181A	C173014829	5/5/2021	5/5/2022
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	5/15/2021	5/15/2022
RF Attenuator	Pasternack	PE7005-3	VL061	7/16/2020	7/16/2022
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	7/16/2020	7/16/2022
EM Center Control	ETS-Lindgren	7006-001	160136	N/A	N/A
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A	N/A
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A	N/A
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	5/16/2021	5/16/2022
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	7/16/2020	7/16/2022
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	7/16/2020	7/16/2022
RE test cable (>18GHz)	Sucoflex	104	344903/4	7/16/2020	7/16/2022
Pulse limiter	Com-Power	LIT-930A	531727	7/16/2020	7/16/2022
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	7/16/2020	7/16/2022
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	7/16/2020	7/16/2022
Vector Signal Generator	Keysight	N5182A	US47080548	6/17/2021	6/17/2022
RF Power Amplifier (80-1000MHz)	Ophir	5226FE	1013/1815	N/A	N/A
RF Power Amplifier (700-6000MHz)	Ophir	5293FE	1063/1815	N/A	N/A
Horn Antenna (1-18GHz)	FT-RF	HA-07M18G-NF	180010HA	5/14/2021	5/14/2022
Wideband Communication Tester	Rohde & Schwarz	CMW500	147508	5/8/2019	5/8/2022
Biconical Antenna	ETS-Lindgren	3110C	114366	11/15/2019	11/15/2021
Log Periodic Antenna	ETS-Lindgren	3148B	148038	11/15/2019	11/15/2021