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FCC ISED RF Test Report

Test Report Number	HME-20071441-LC-FCC-IC-DTS
FCC ID	BYM7001
ISED ID	1860A-7001
Applicant	HM Electronics Inc
Applicant Address	2848 Whiptail Loop, Carlsbad, CA 92010 USA
Product Name	Base Station
Model (s)	7001
Date of Receipt	06/18/2020
Date of Test	06/18/2020 – 10/20/2020
Report Issue Date	10/20/2020
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

Daniel Bruno (Test Technician)

David Zhang (Technical Manager)

REVISION HISTORY

Report Number	Version	Description	Issued Date
HME-20071441-LC-FCC-IC-DTS	01	Initial report	10/20/2020

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1 Test Summary

Test Item	Test Requirement	Test Method	Result
Antenna Requirement	47 CFR Part 15.203 RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
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, Mar 2019	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 15.207 RSS-Gen Issue 5, Mar 2019	ANSI C63.10 (2013)	Pass

2 General Information

2.1 Applicant

Applicant	HM Electronics Inc
Applicant address	2848 Whiptail Loop, Carlsbad, CA 92010 USA
Manufacturer	HM Electronics Inc
Manufacturer Address	2848 Whiptail Loop, Carlsbad, CA 92010 USA

2.2 Product information

Product Name	Base Station
Model Number	7001
Family Models	N/A
Serial Number	F21Z0010
Frequency Band	BLE: 2402-2480MHz NFC: 13.56MHz
Type of modulation	BLE: GFSK NFC: ASK
Equipment Class	DTS, DXX
Antenna Information	BLE: Internal PCB antenna, 3 dBi gain NFC: Internal coil antenna
Clock Frequencies	N/A
Input Power	48VDC Input
Power Adapter Manufacturer/Model	AC/DC Power supply, Model: CP-8072 Input: 100-240VAC, 50-60Hz, 1.2 A Max Output: 48VDC, 1.88A, 90W Max
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	BLE and NFC can transmit simultaneously
Additional Info	N/A

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	23.5°C	58.2%	996 mbar
Radiated Emission Testing	23.5°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.

5 Test Configuration and Operation

5.1 EUT Test Configuration

The EUT is powered by external AC/DC power adaptor. EUT was set to continuous transmission mode during TX testing.

The following software was used for testing.

Software	Description
EMISoft Vasona	EMC/RF Spurious emission test software used during testing
Putty.exe	To set EUT into continuous TX and RX mode under different modulation, data rate and channel, etc.
nRF connect v3.4.1	Set BLE into required transmitter and receiver test mode

5.2 Supporting Equipment

Description	Manufacturer	Model #	Serial #
Laptop	Dell	Latitude E6440	FFF4JC2
Gigabit PoE Switch	BV-Tech	PoE-SW501G	20180300239

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 F-inverted PCB antenna. No standard RF connector is used.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

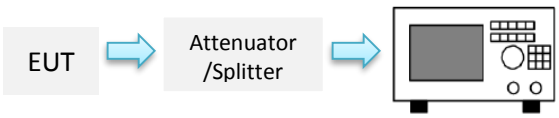
7.2 DTS (6 dB) Bandwidth

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:

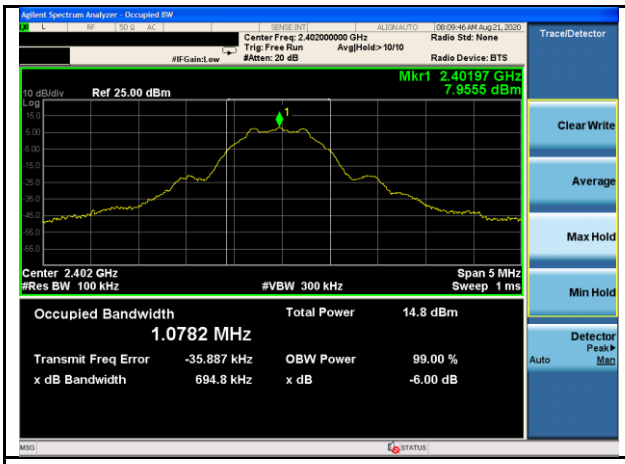
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this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

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.

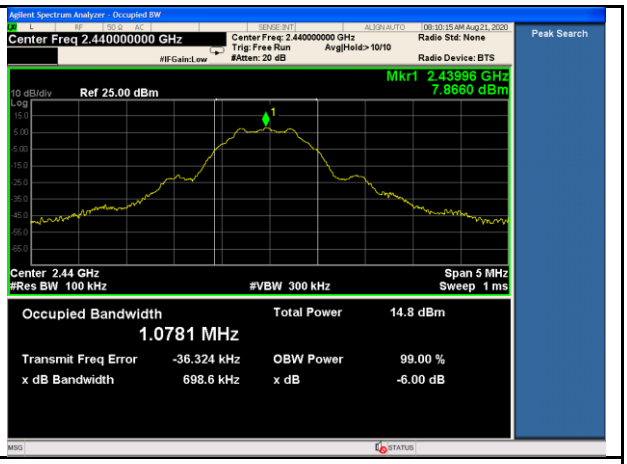
7.2.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Minimum Bandwidth (KHz)	Result
BLE	2402	1Mbps	694.8	500	Pass
BLE	2440	1Mbps	698.6	500	Pass
BLE	2480	1Mbps	709.1	500	Pass
BLE	2402	2Mbps	1158	500	Pass
BLE	2440	2Mbps	1168	500	Pass
BLE	2480	2Mbps	1170	500	Pass

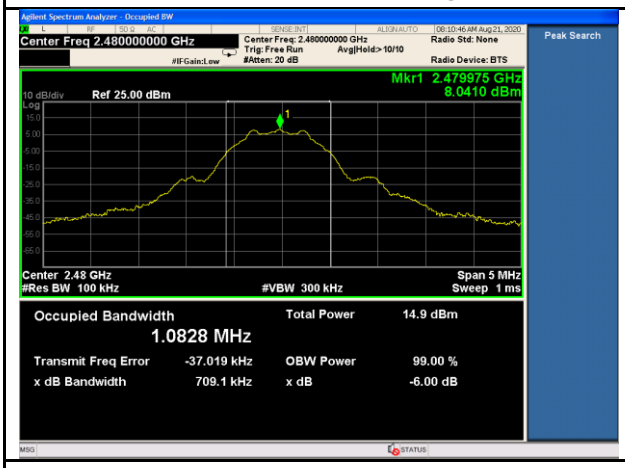
7.2.5 Test Plots



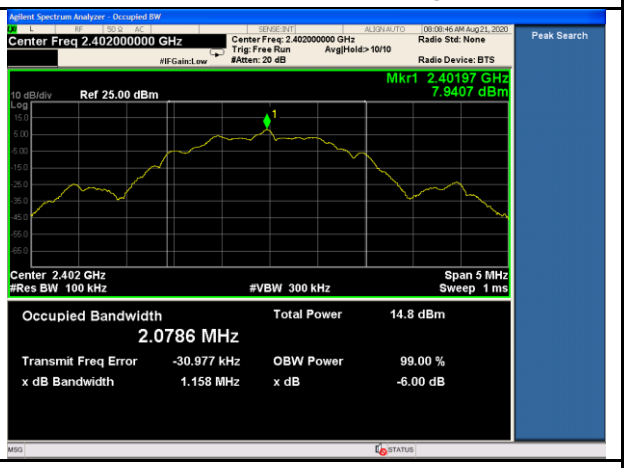
BLE-DTS BW-Low-1Mbps



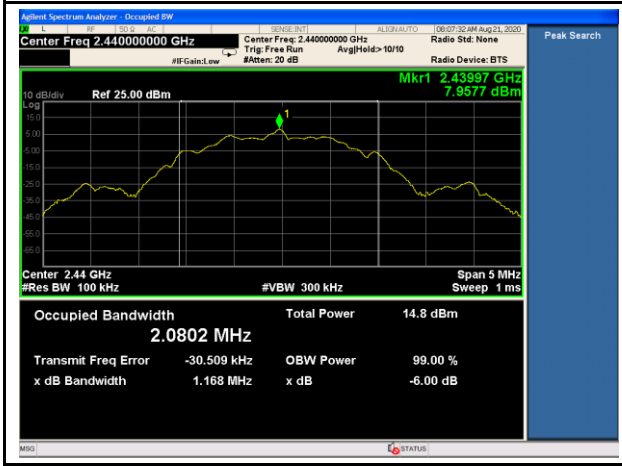
BLE-DTS BW-Mid-1Mbps



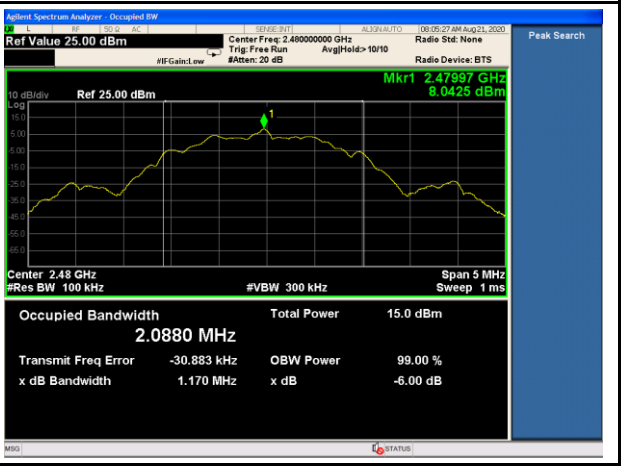
BLE-DTS BW-High-1Mbps



BLE-DTS BW-Low-2Mbps



BLE-DTS BW-Mid-2Mbps



BLE-DTS BW-High-2Mbps

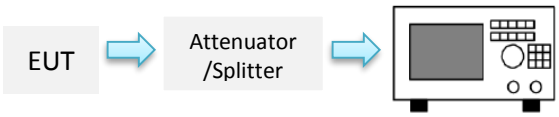
7.3 Occupied Bandwidth (99%)

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

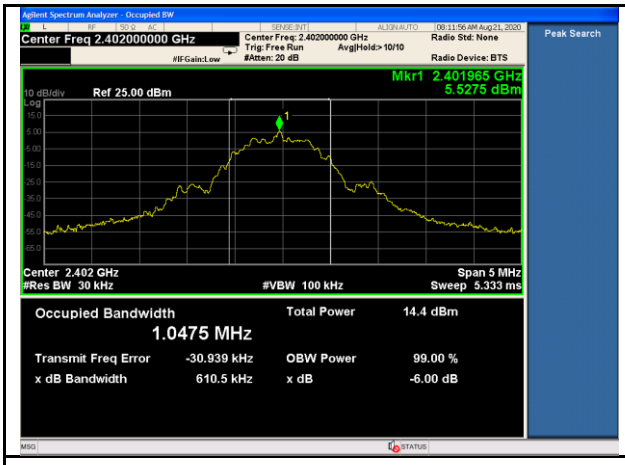
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this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

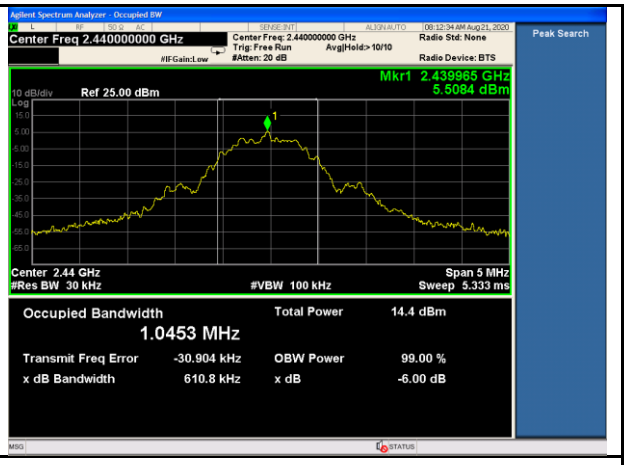
7.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured 99% OBW (KHz)	Limit (KHz)	Result
BLE	2402	1Mbps	1047.5	N/A	Pass
BLE	2440	1Mbps	1045.3	N/A	Pass
BLE	2480	1Mbps	1043.4	N/A	Pass
BLE	2402	2Mbps	2078.6	N/A	Pass
BLE	2440	2Mbps	2080.2	N/A	Pass
BLE	2480	2Mbps	2088.0	N/A	Pass

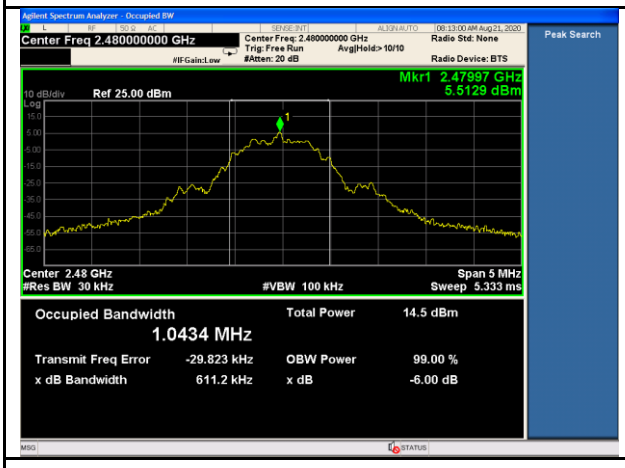
7.3.5 Test Plots



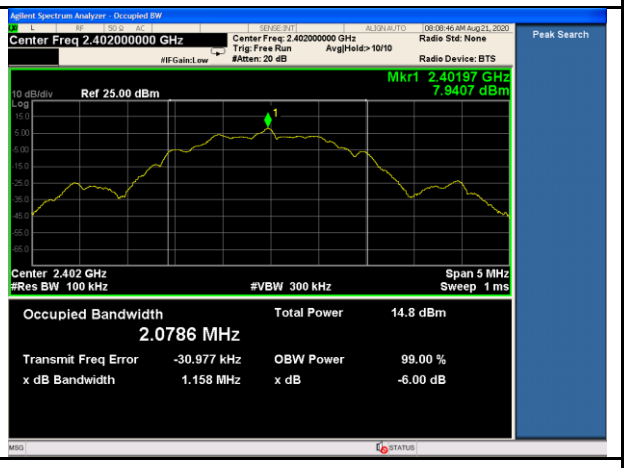
BLE-OBW-Low-1Mpbs



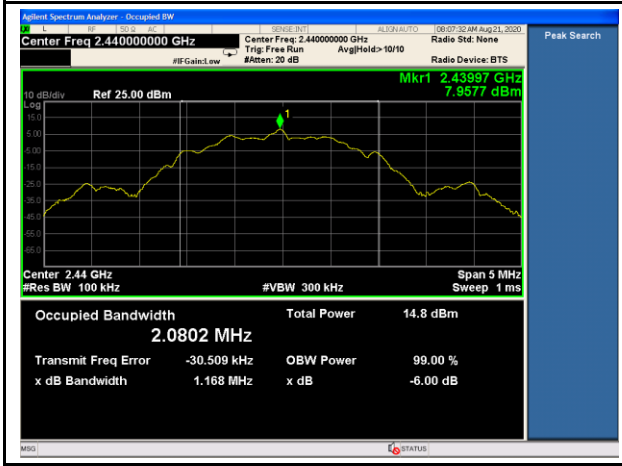
BLE-OBW-Mid-1Mpbs



BLE-OBW-High-1Mpbs



BLE-OBW-Low-2Mpbs



BLE-OBW-Mid-2Mpbs

BLE-OBW-High-2Mpbs

7.4 Maximum Output Power

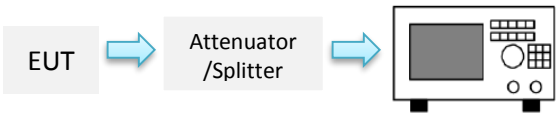
7.4.1 Requirement

§ 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

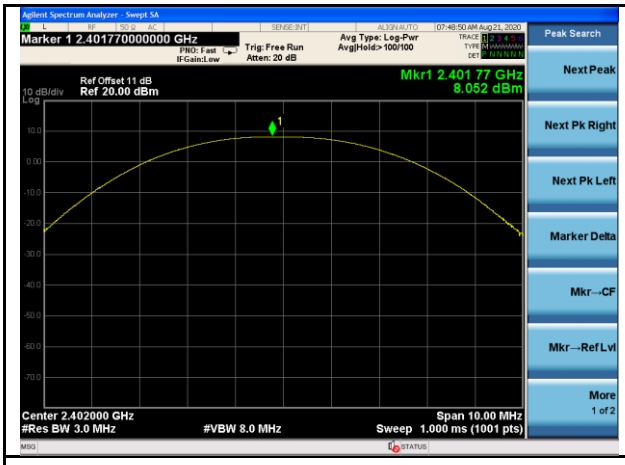
For BLE, power measurement is according to subclause 11.9.1.1 of ANSI C63.10-2013:

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.

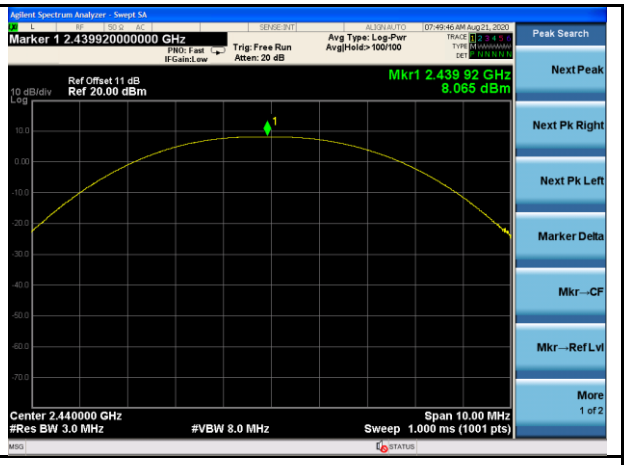
7.4.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Max Output Power (dBm)	Result
BLE	2402	1Mbps	8.052	30	Pass
BLE	2440	1Mbps	8.065	30	Pass
BLE	2480	1Mbps	8.148	30	Pass
BLE	2402	2Mbps	8.064	30	Pass
BLE	2440	2Mbps	8.071	30	Pass
BLE	2480	2Mbps	8.167	30	Pass

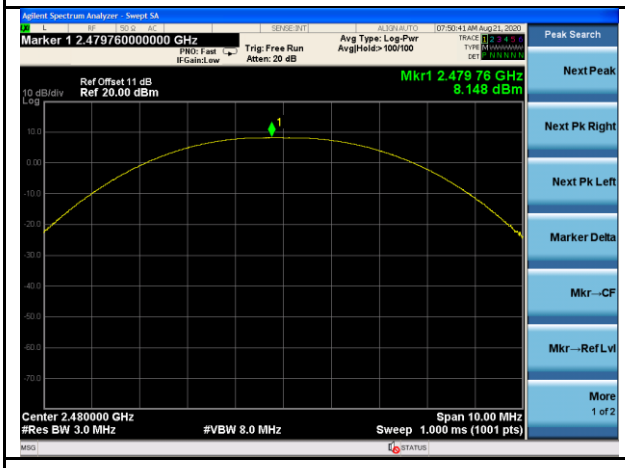
7.4.5 Test Plots



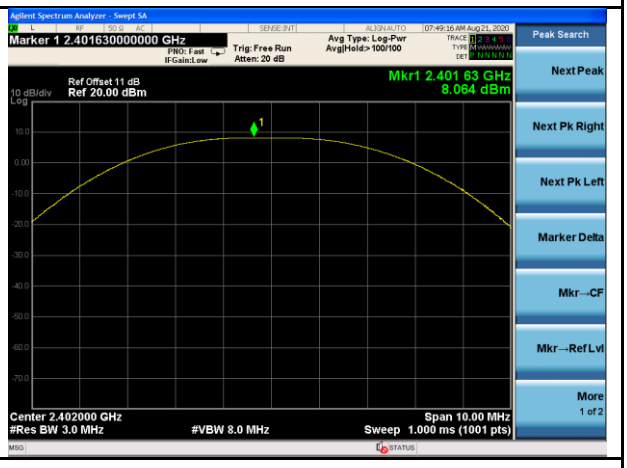
BLE-PWR-Low-1Mbps



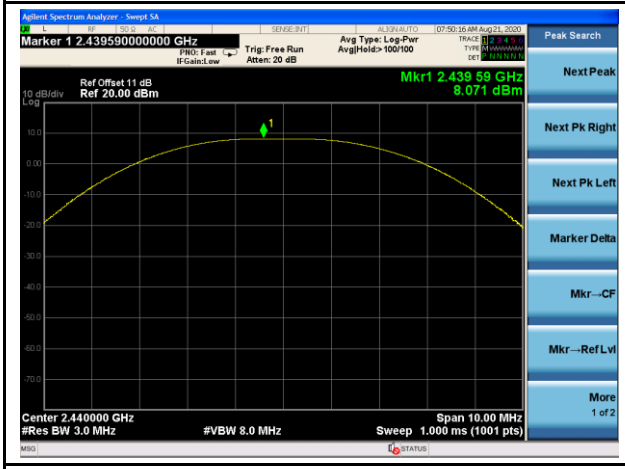
BLE-PWR-Mid-1Mbps



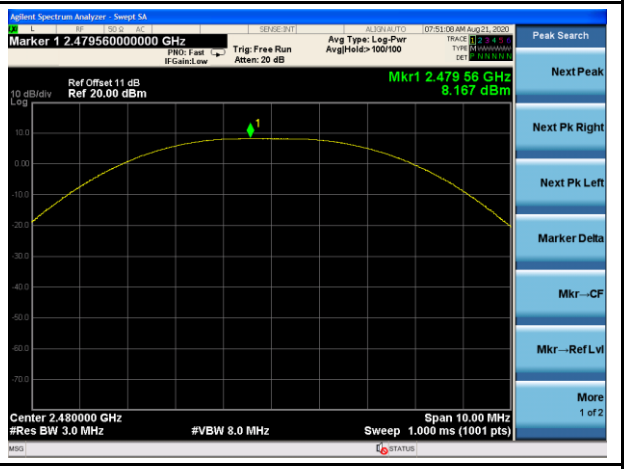
BLE-PWR-High-1Mbps



BLE-PWR-Low-2Mbps



BLE-PWR-Mid-2Mbps



BLE-PWR-High-2Mbps

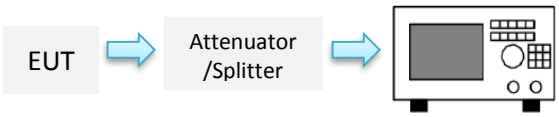
7.5 Power Spectral Density

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

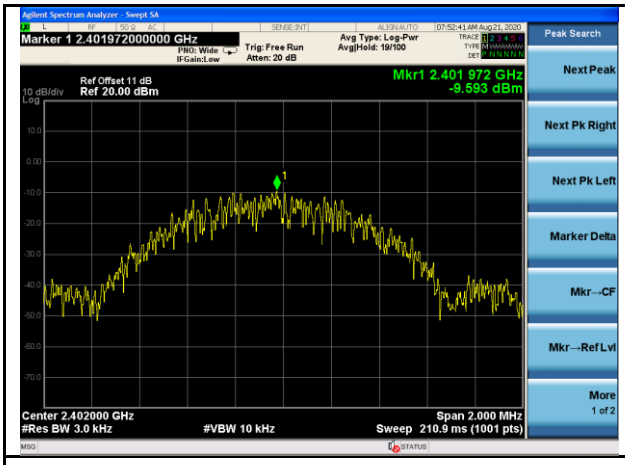
According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

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.

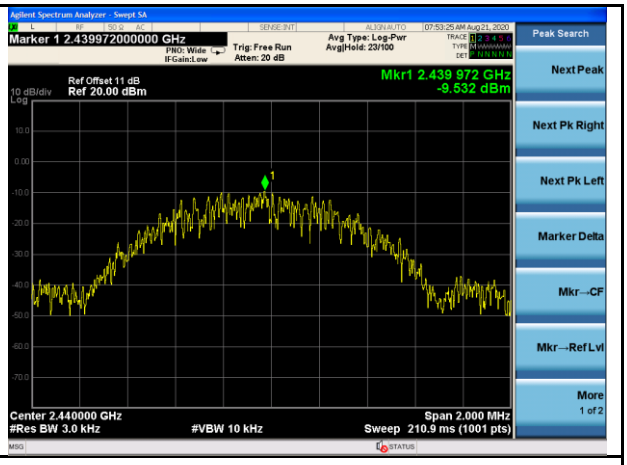
7.5.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured PSD (dBm/3KHz)	Max PSD (dBm/3KHz)	Result
BLE	2402	1Mbps	-9.593	8	Pass
BLE	2440	1Mbps	-9.532	8	Pass
BLE	2480	1Mbps	-9.283	8	Pass
BLE	2402	2Mbps	-10.412	8	Pass
BLE	2440	2Mbps	-10.333	8	Pass
BLE	2480	2Mbps	-10.358	8	Pass

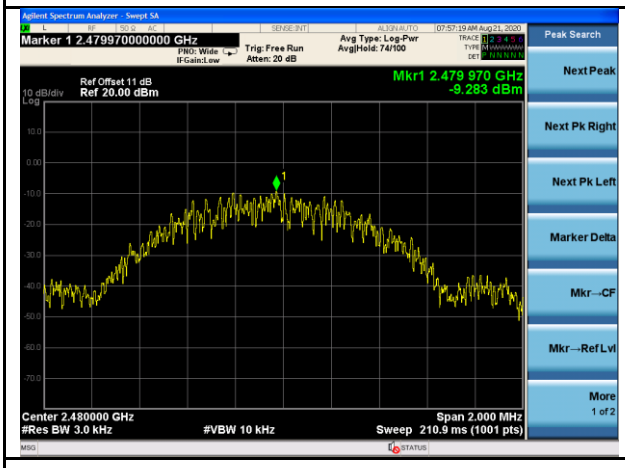
7.5.5 Test Plots



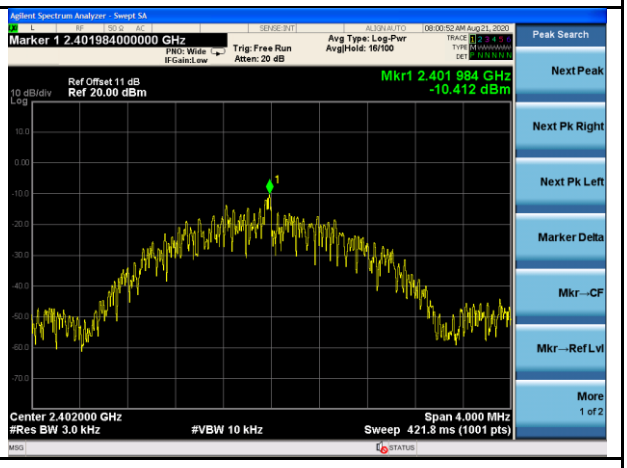
BLE-PSD-Low-1Mbps



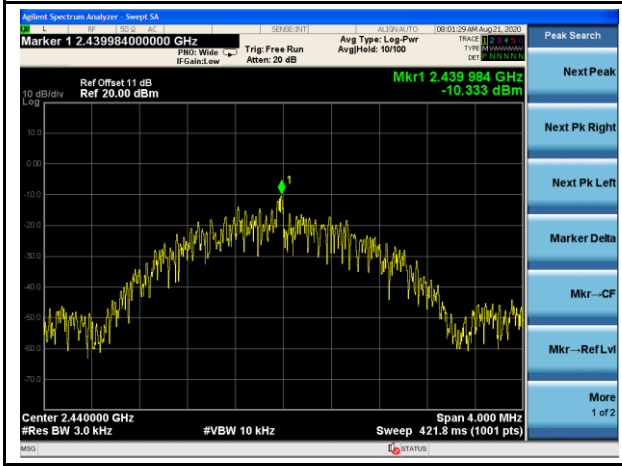
BLE-PSD-Mid-1Mbps



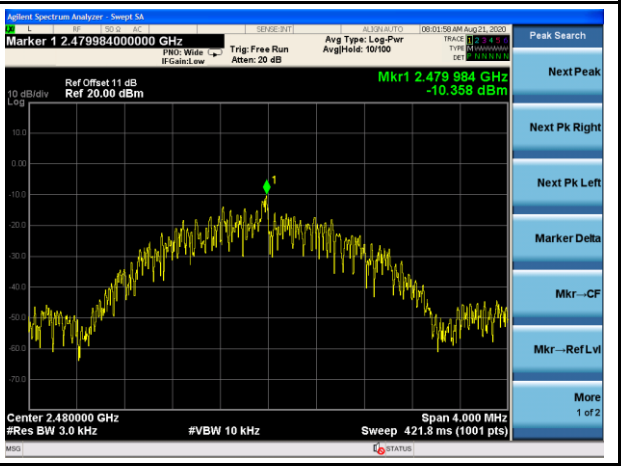
BLE-PSD-High-1Mbps



BLE-PSD-Low-2Mbps



BLE-PSD-Mid-1Mbps



BLE-PSD-High-2Mbps

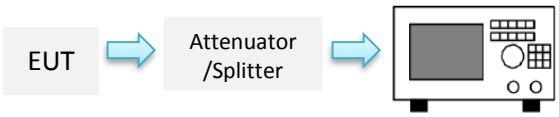
7.6 Conducted Band-Edge Measurement

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

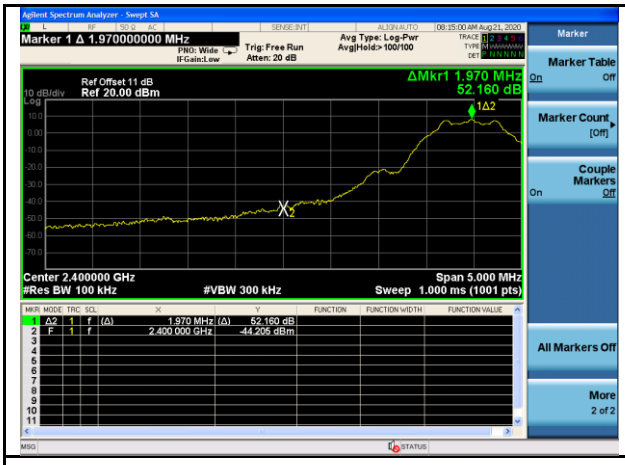
According to section 8.5 Emission level measurement, in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.11.3 in ANSI C63.10-2013:

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

See test plots

7.6.5 Test Plots



BLE-Band Edge-Low-1Mpbs

BLE-Band Edge-High-1Mpbs

BLE-Band Edge-Low-2Mpbs

BLE-Band Edge-High-2Mpbs

BLE-Out of Band Emission-Low-1Mbps

BLE-Out of Band Emission-Mid-1Mbps

BLE-Out of Band Emission-High-1Mbps

BLE-Out of Band Emission-Low-2Mbps

BLE-Out of Band Emission-Mid-2Mbps

BLE-Out of Band Emission-High-2Mbps

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

7.7.1 Requirement

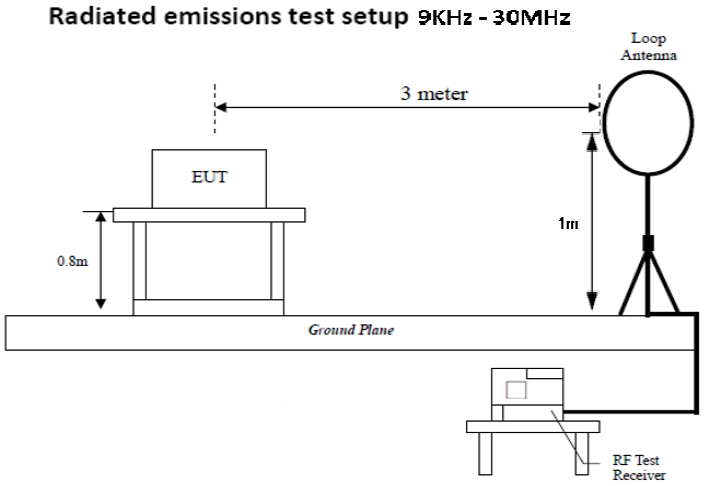
§ 15.247 (d), RSS-247 §5.5

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.

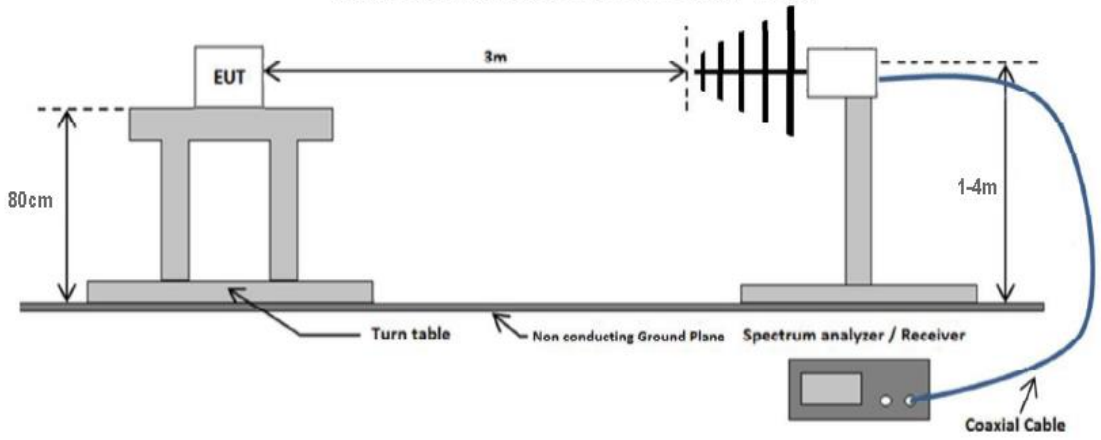
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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

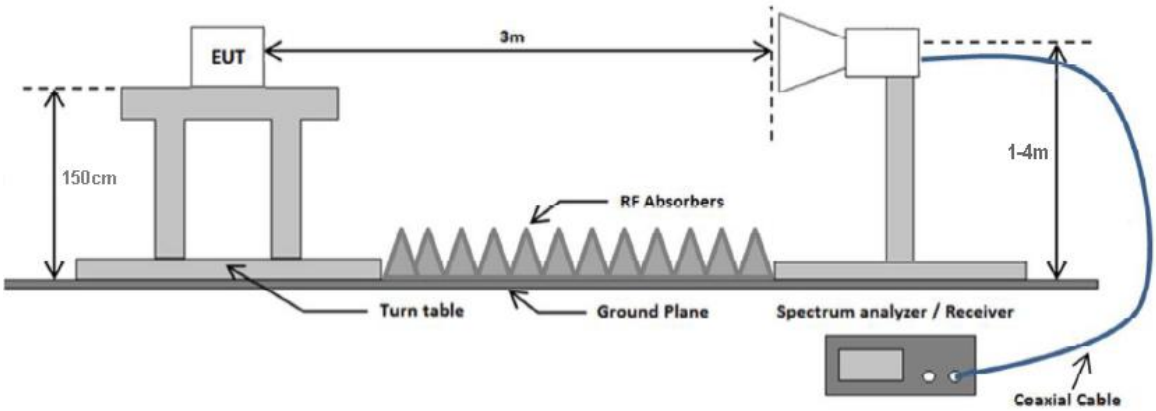
7.7.2 Test Setup



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.

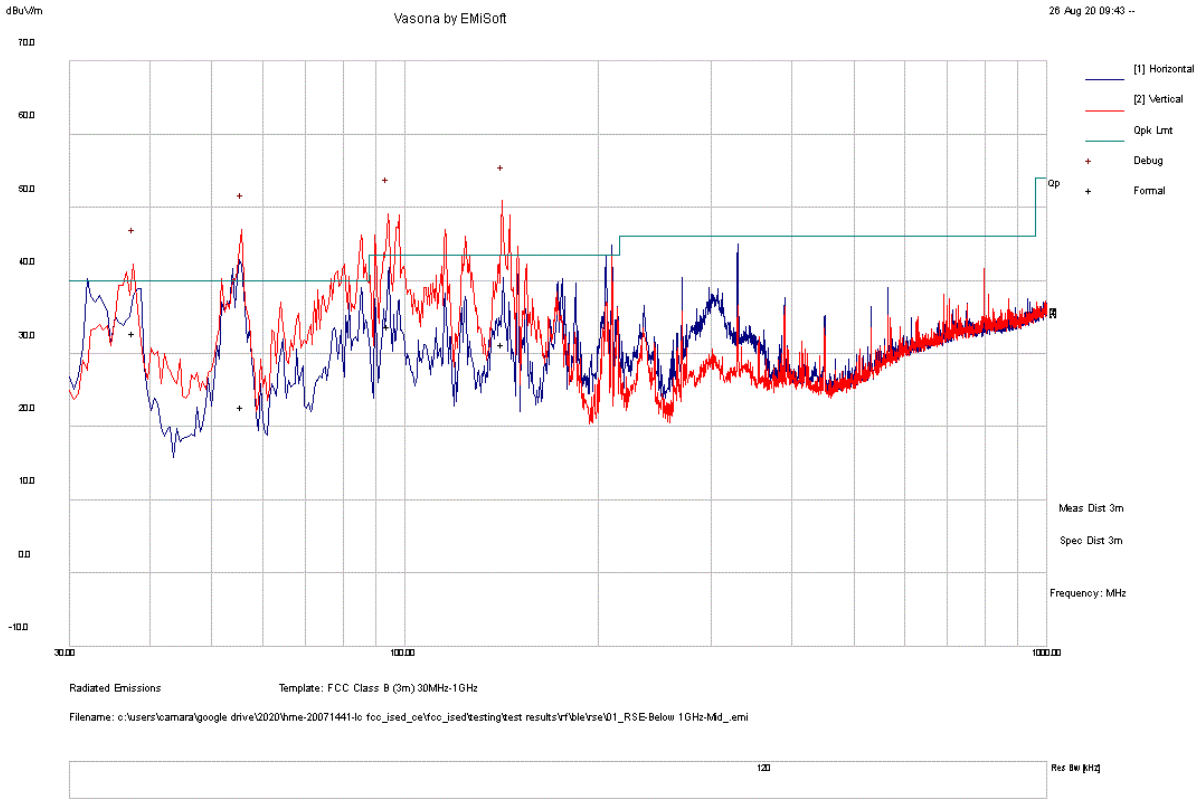
1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting 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 EMISSIONS BELOW 1 GHZ

Test Standard:	15.247, RSS-247	Mode:	Radiated Emission Below 1GHz – BLE mid CH
Frequency Range:	30 MHz - 1 GHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	N/A	Test Result:	Pass

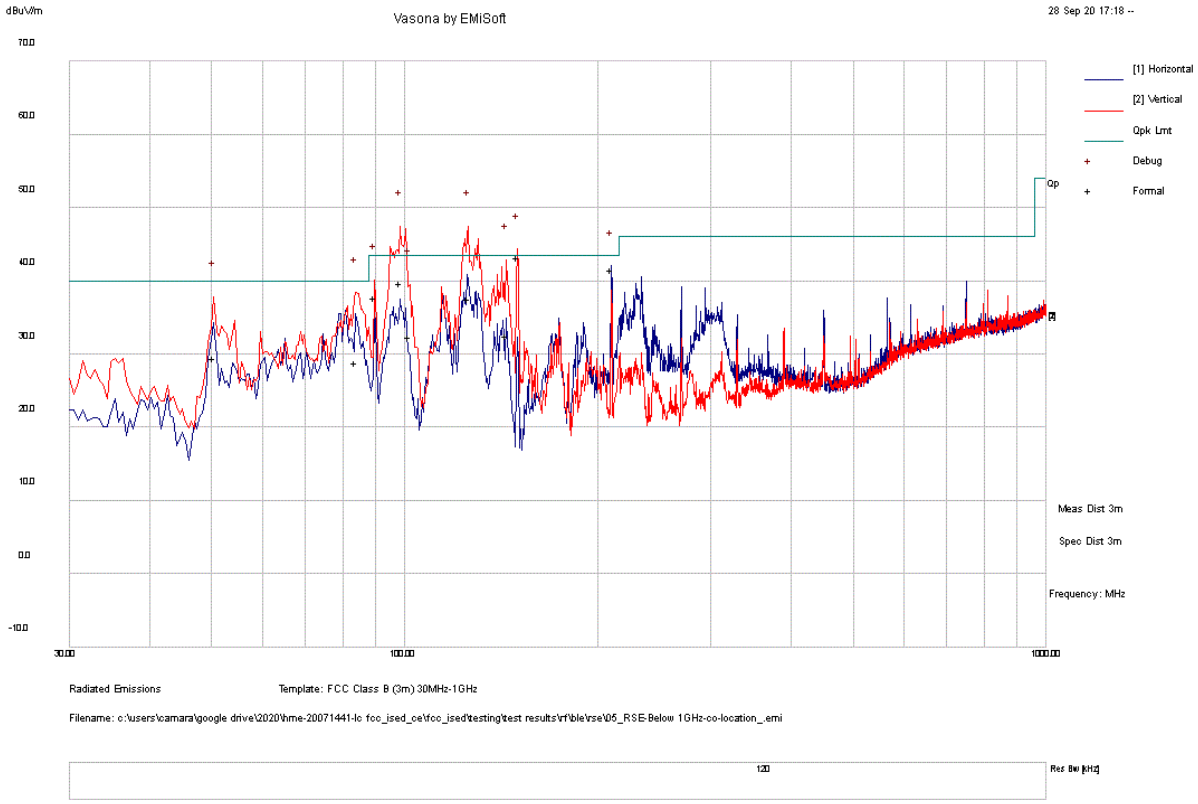
BLE



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
141.57	49.60	4.10	-22.50	31.30	Quasi Max	V	195	202	43.50	-12.20	Pass
55.80	44.90	2.90	-25.10	22.80	Quasi Max	V	138	239	40.00	-17.20	Pass
94.05	54.40	3.50	-24.20	33.70	Quasi Max	V	132	360	43.50	-9.80	Pass
37.75	50.20	2.50	-19.80	32.90	Quasi Max	V	100	279	40.00	-7.10	Pass

Test Standard:	RSS-Gen, RSS-247	Mode:	BLE + NFC co-located
Frequency Range:	30 - 1000 MHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	N/A	Test Result:	Pass

BLE + NFC co-located

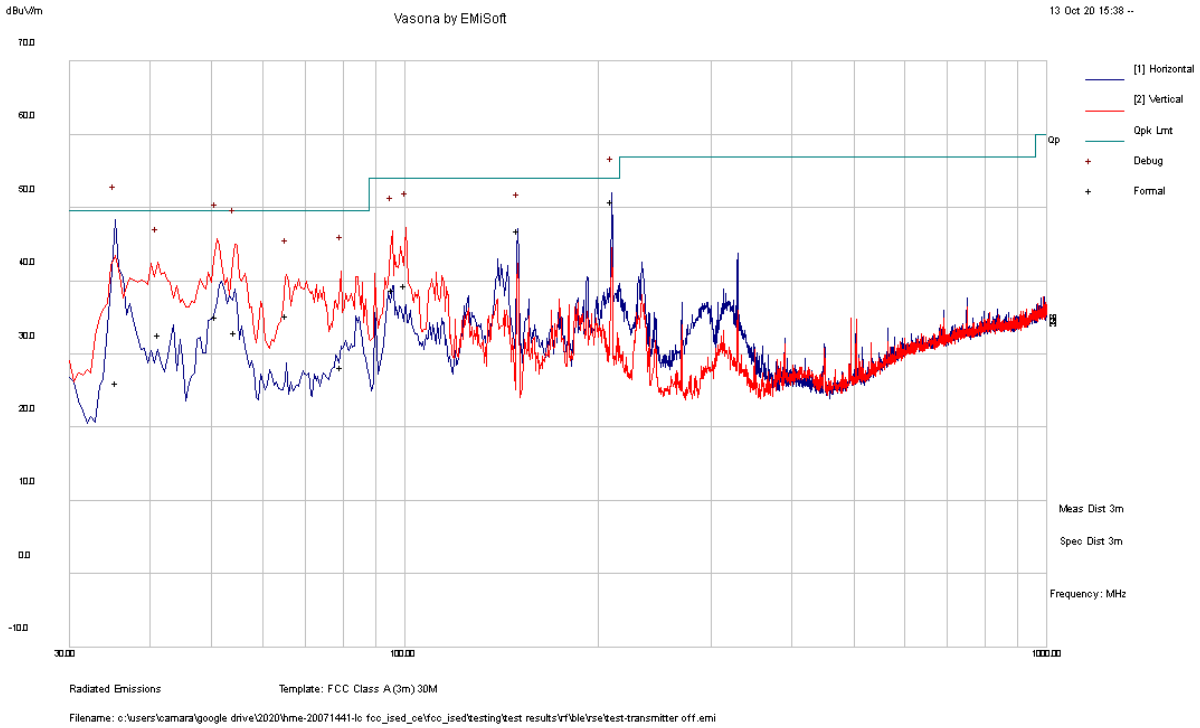


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
98.61	59.90	3.50	-23.70	39.70	Quasi Max	V	108	179	43.50	-3.80	Pass
125.58	56.50	3.90	-22.90	37.60	Quasi Max	V	164	12	43.50	-5.90	Pass
149.95	61.30	4.20	-22.30	43.20	Quasi Max	V	108	0	43.50	-0.30	Pass
144.05	50.90	4.20	-22.40	32.60	Quasi Max	V	100	24	43.50	-10.90	Pass
210.04	57.70	4.80	-20.90	41.60	Quasi Max	H	126	182	43.50	-1.90	Pass
83.78	50.20	3.40	-24.60	28.90	Quasi Max	V	198	248	40.00	-11.10	Pass
50.49	51.60	2.80	-25.00	29.50	Quasi Max	V	151	0	40.00	-10.50	Pass
89.89	58.90	3.40	-24.60	37.80	Quasi Max	V	178	0	43.50	-5.70	Pass
101.58	52.40	3.60	-23.50	32.50	Quasi Max	V	172	355	43.50	-11.00	Pass

Note: The emission at 149.95 MHz and 210.04 MHz with limited margin are from digital circuit, not from RF transmitter. See the data under ITE mode for comparison.

Test Standard:	FCC Part 15B, ICES-003	Mode:	ITE mode (TX off)
Frequency Range:	30 - 1000 MHz	Test Date:	10/20/2020
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	Class A	Test Result:	Pass

ITE mode (Transmitter off)

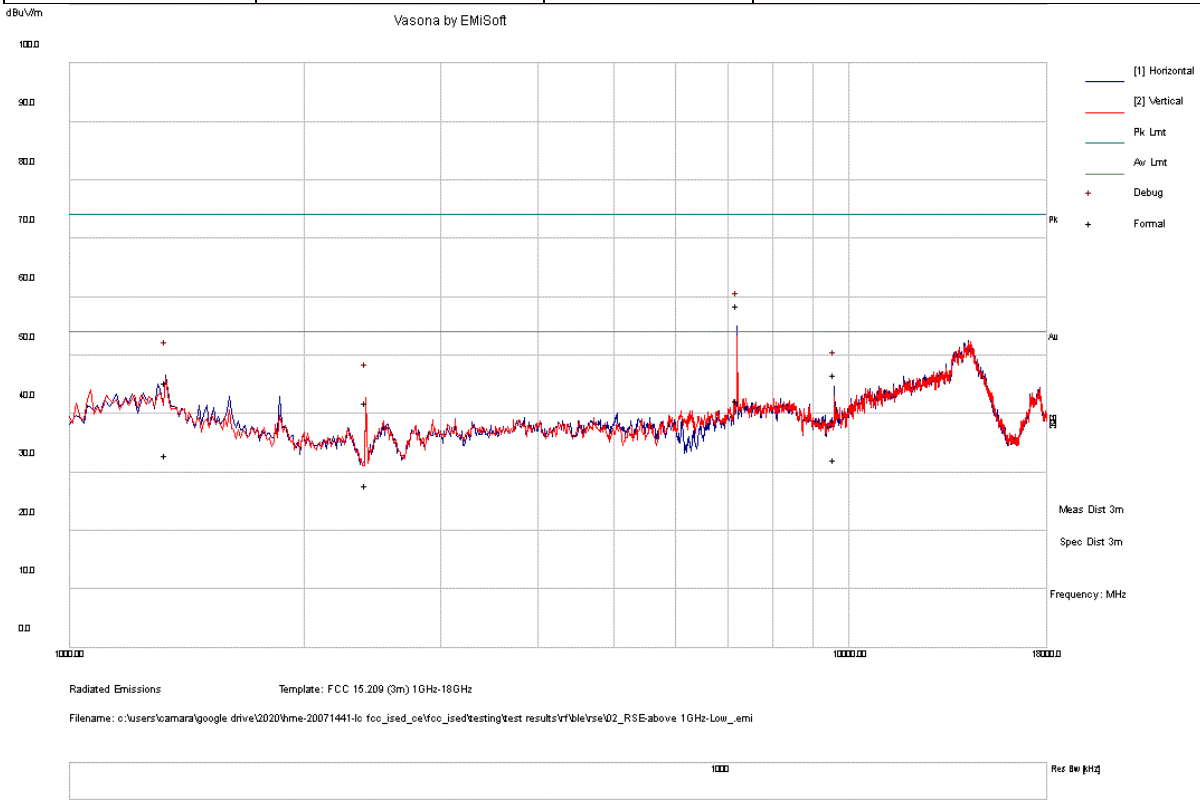


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
209.97	66.98	4.84	-20.95	50.87	Quasi Max	H	100	26	54.00	-3.13	Pass
35.52	42.19	2.41	-18.53	26.07	Quasi Max	H	343	162	49.60	-23.53	Pass
50.87	57.39	2.81	-25.03	35.17	Quasi Max	V	101	1	49.60	-14.43	Pass
54.37	55.19	2.89	-25.09	32.99	Quasi Max	V	286	189	49.60	-16.61	Pass
100.13	59.53	3.57	-23.60	39.50	Quasi Max	V	104	284	54.00	-14.50	Pass
149.96	64.99	4.25	-22.30	46.94	Quasi Max	H	218	6	54.00	-7.06	Pass
95.69	59.26	3.51	-24.01	38.77	Quasi Max	V	127	156	54.00	-15.23	Pass
41.40	51.86	2.58	-21.74	32.70	Quasi Max	V	268	281	49.60	-16.90	Pass
79.48	49.71	3.31	-24.67	28.35	Quasi Max	V	234	152	49.60	-21.25	Pass
65.54	56.83	3.09	-24.62	35.31	Quasi Max	V	113	173	49.60	-14.29	Pass

Note: These data are for comparison purpose only. The emission at around 150 MHz and 210 MHz exist when transmitters are off. Limit here is Class A limit.

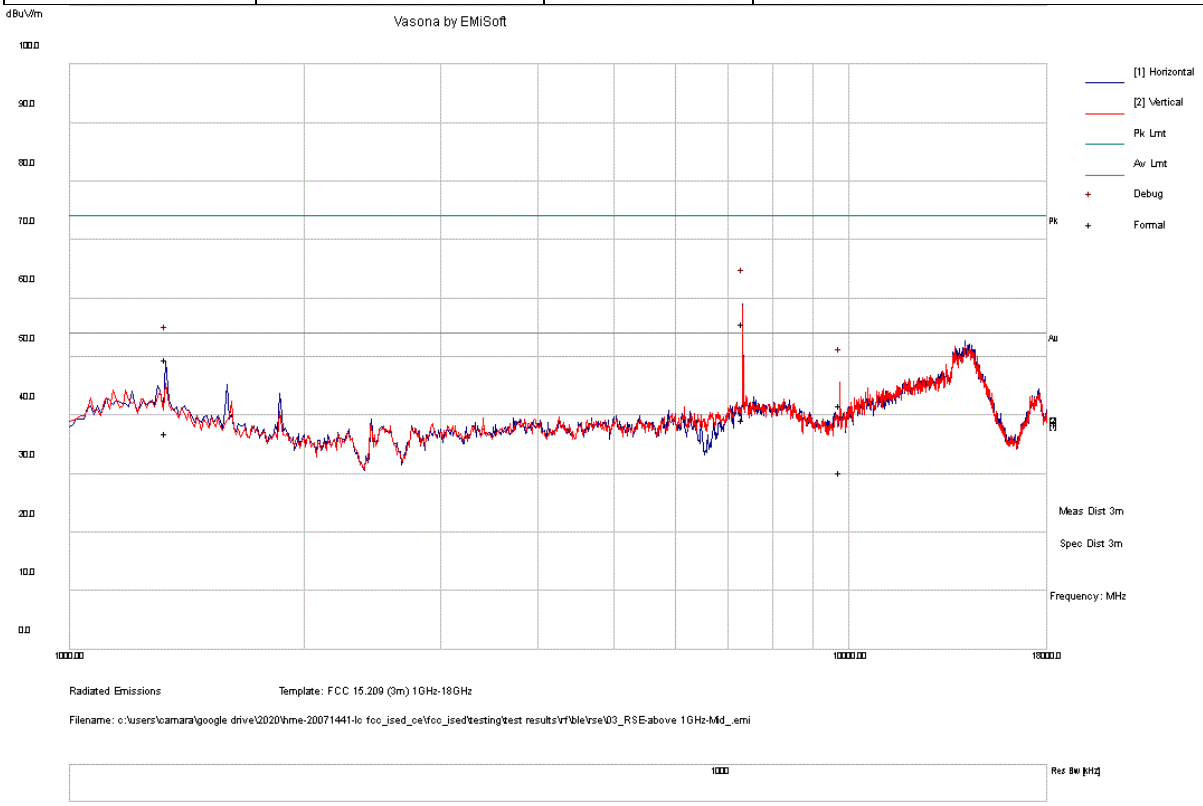
RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	15.247, RSS-247	Mode:	Radiated Emission RF Above 1GHz - BLE Low
Frequency Range:	1 GHz – 18GHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	N/A	Test Result:	Pass



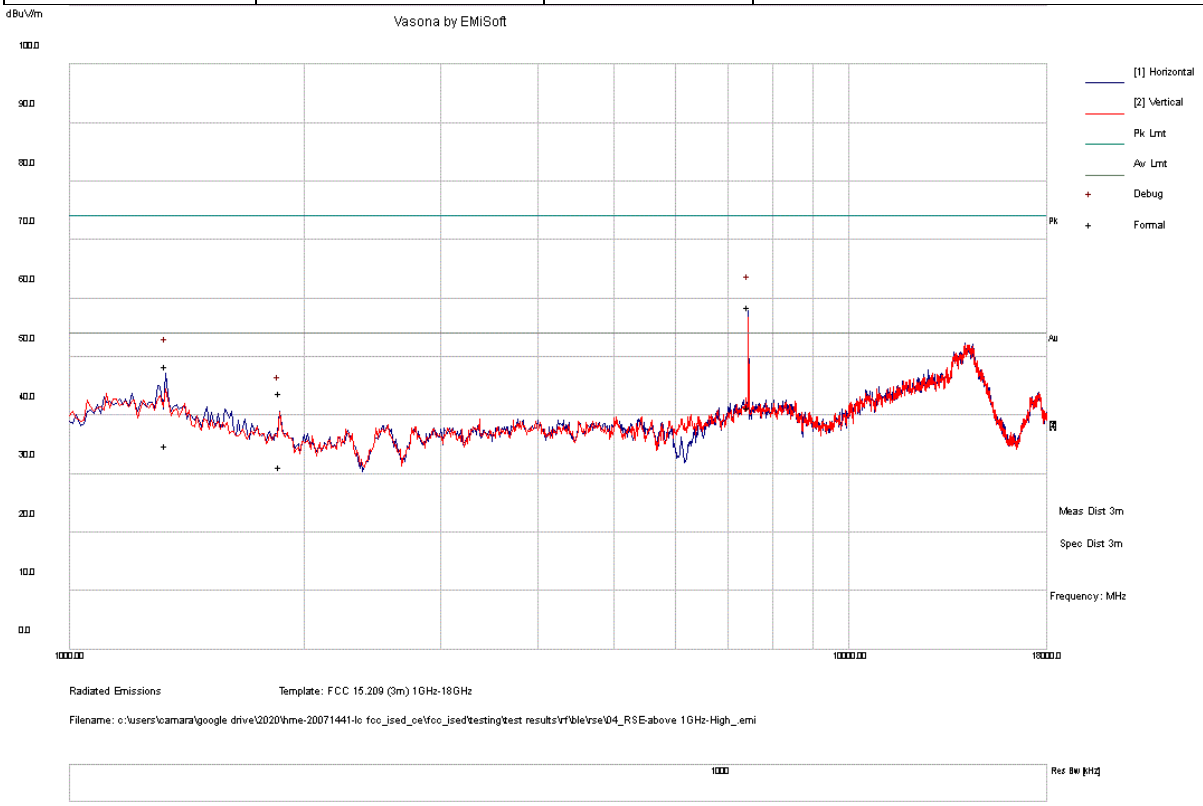
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
7205.14	36.80	20.50	1.20	58.50	Peak Max	H	120	337	74.00	-15.50	Pass
1331.04	37.40	14.60	-6.60	45.40	Peak Max	H	153	116	74.00	-28.60	Pass
9607.53	24.20	21.90	0.60	46.70	Peak Max	H	100	24	74.00	-27.30	Pass
7205.14	20.70	20.50	1.20	42.30	Average Max	H	120	337	54.00	-11.70	Pass
1331.04	25.10	14.60	-6.60	33	Average Max	H	153	116	54.00	-21.00	Pass
9607.53	9.70	21.90	0.60	32.2	Average Max	H	100	24	54.00	-21.80	Pass

Test Standard:	15.247, RSS-247	Mode:	Radiated Emission RF Above 1GHz - BLE Mid
Frequency Range:	1 GHz – 18GHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Daniel Bruno
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
7320.64	33.80	20.70	1.20	55.70	Peak Max	H	102	46	74.00	-18.30	Pass
1330.02	41.60	14.60	-6.60	49.60	Peak Max	H	208	5	74.00	-24.40	Pass
9754.04	18.80	22.10	0.80	41.70	Peak Max	V	302	222	74.00	-32.30	Pass
7320.64	17.50	20.70	1.20	39.30	Average Max	H	102	46	54.00	-14.70	Pass
1330.02	28.90	14.60	-6.60	36.9	Average Max	H	208	5	54.00	-17.10	Pass
9754.04	7.40	22.10	0.80	30.2	Average Max	V	302	222	54.00	-23.80	Pass

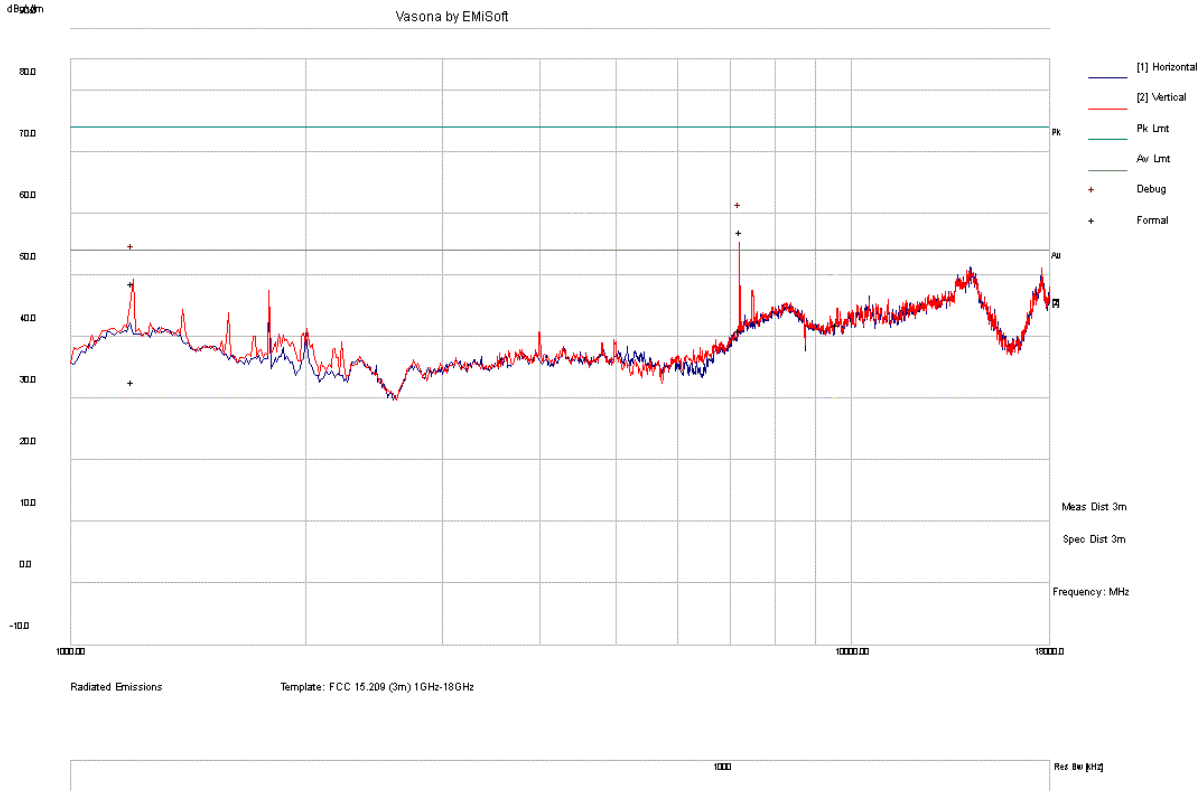
Test Standard:	15.247, RSS-247	Mode:	Radiated Emission RF Above 1GHz - BLE High
Frequency Range:	1 GHz – 18GHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	N/A	Test Result:	Pass



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
7440.66	36.60	20.90	1.00	58.50	Peak Max	H	125	306	74.00	-15.50	Pass
1329.36	40.40	14.60	-6.60	48.40	Peak Max	H	177	71	74.00	-25.60	Pass
1861.16	38.20	14.40	-8.70	43.90	Peak Max	H	253	76	74.00	-30.10	Pass
7440.66	19.50	20.90	1.00	41.40	Average Max	H	125	306	54.00	-12.60	Pass
1329.36	26.90	14.60	-6.60	34.9	Average Max	H	177	71	54.00	-19.10	Pass
1861.16	25.60	14.40	-8.70	31.3	Average Max	H	253	76	54.00	-22.70	Pass

Test Standard:	RSS-Gen, RSS-247	Mode:	BLE+NFC co-located
Frequency Range:	1 - 18 GHz	Test Date:	08/26/2020
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Daniel Bruno
Remark:	N/A	Test Result:	Pass

BLE+NFC co-located



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
7203.27	28.90	20.40	-8.40	41.00	Peak Max	V	348	160	74.00	-33.00	Pass
1200.08	53.70	14.30	-19.20	48.80	Peak Max	V	273	334	74.00	-25.20	Pass
7203.27	17.10	20.40	-8.40	29.20	Average Max	V	348	160	54.00	-24.80	Pass
1200.08	37.60	14.30	-19.20	32.70	Average Max	V	273	334	54.00	-21.30	Pass

Note: the highest emission is fundamental emission.

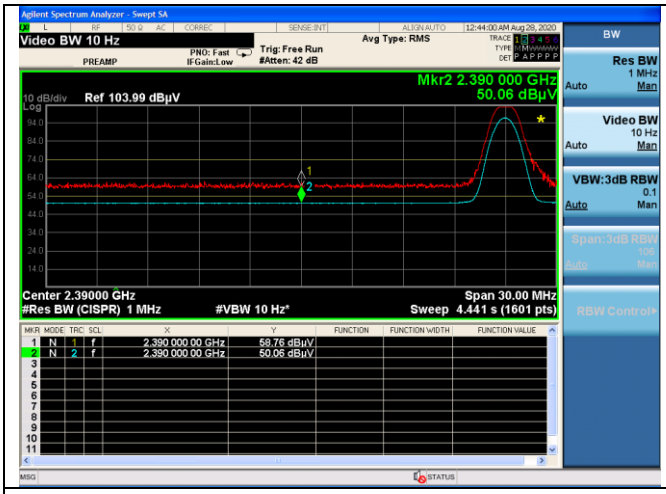
Radiated Emission between 9KHz – 30MHz test result

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

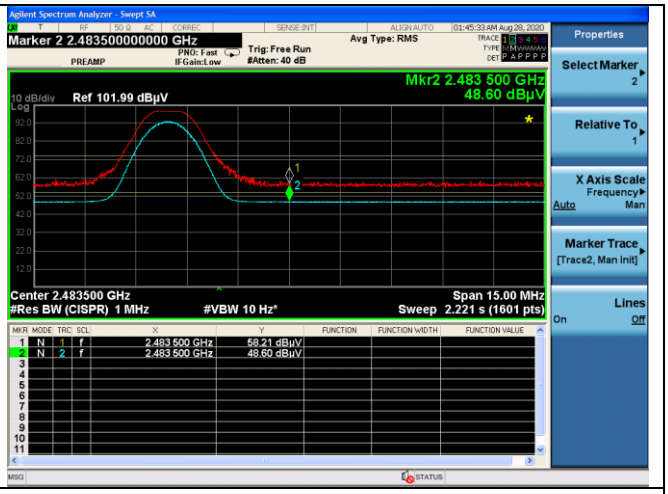
Radiated Emission between 18GHz – 40GHz test result

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

Restricted Band Measurement Result



BLE – Low CH-1Mpbs



BLE – High CH-1Mpbs

BLE – Low CH-2Mpbs

BLE – High CH-2Mpbs

7.8 Conducted Emissions

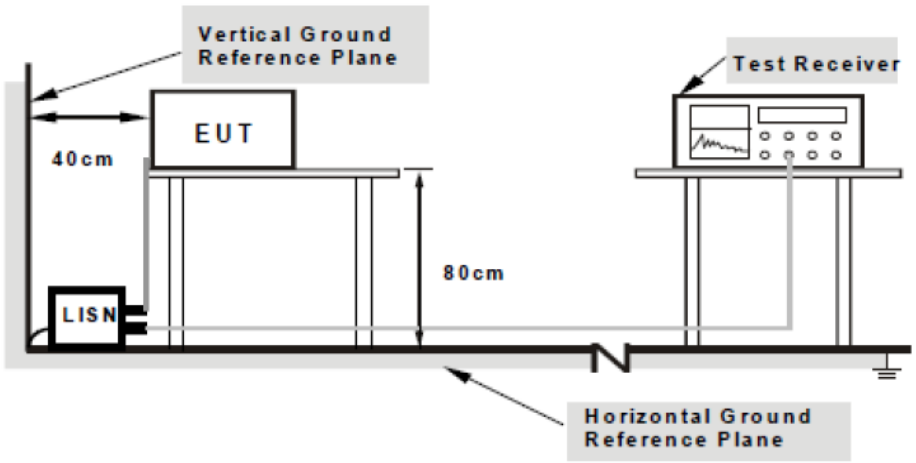
7.8.1 Requirement

Per § 15.207 (a), 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.

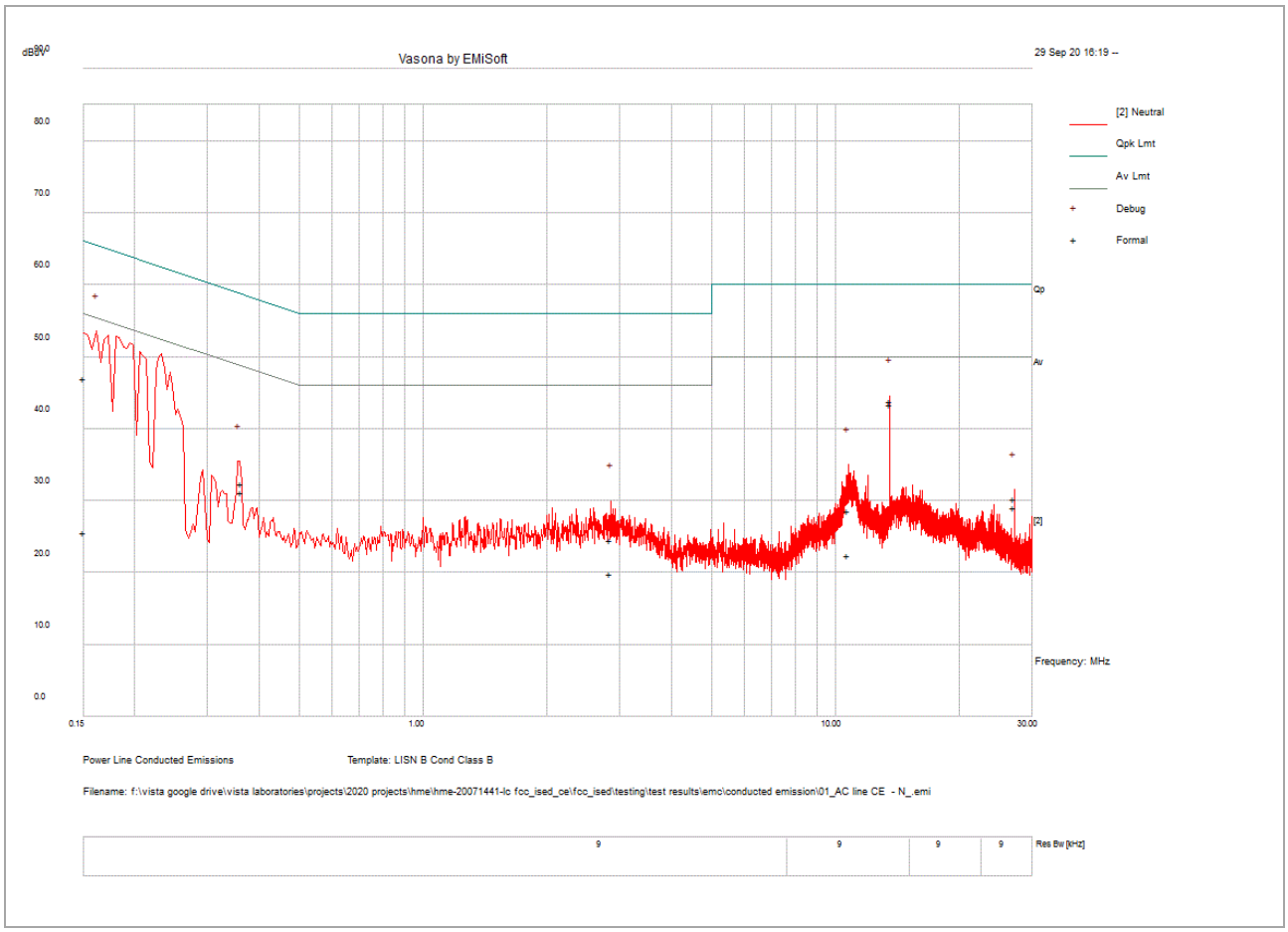
7.8.3 Test Procedure

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.
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.

7.8.4 Test Result

Live Line

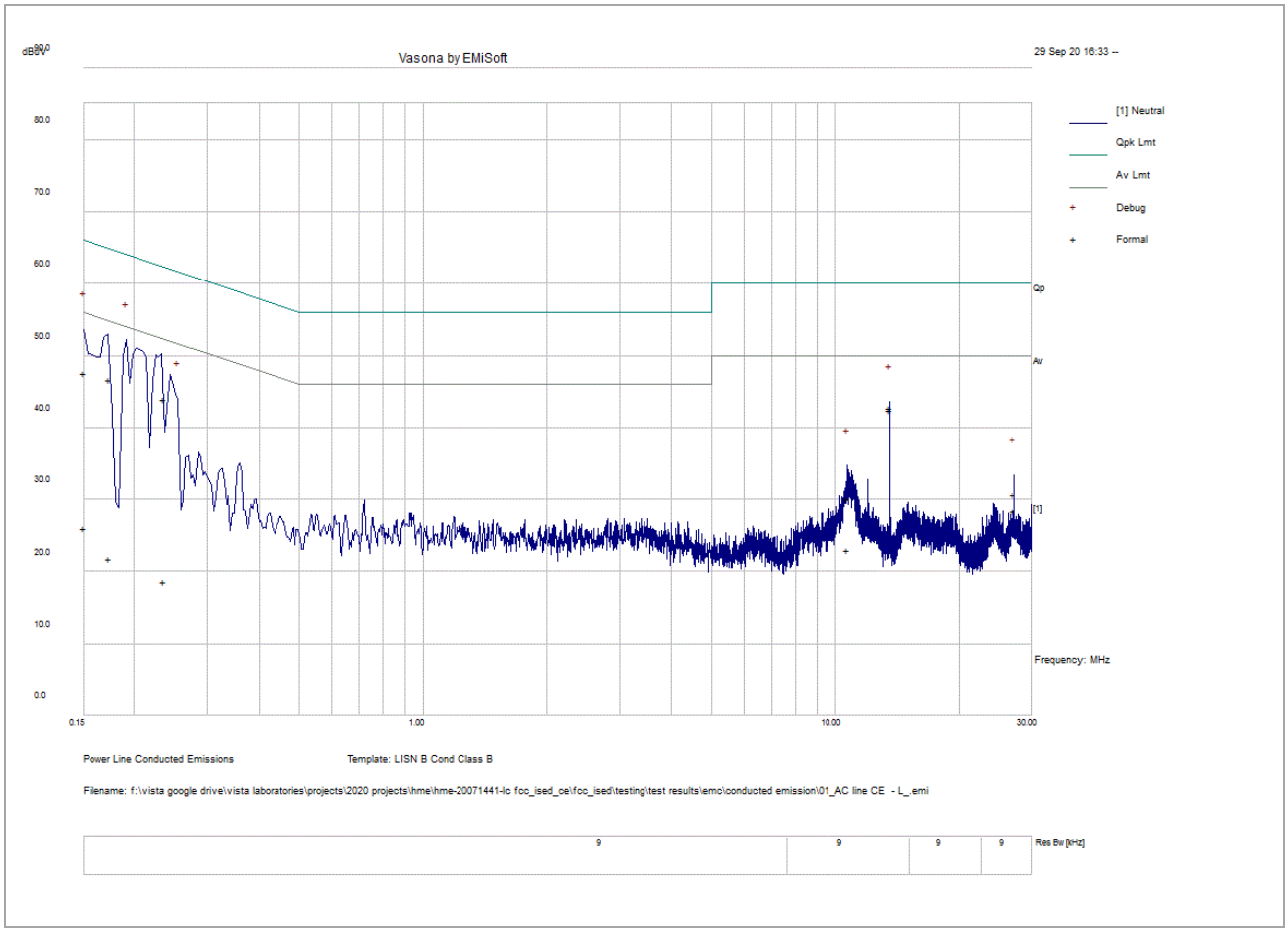
Test Standard:	Part 15.207, RSS-Gen	Mode:	Normal
Frequency Range:	0.15-30MHz	Test Date:	08/14/2020
Antenna Type/Polarity:	N/A	Test Personnel:	Daniel Bruno
Remark:	Class B, 120VAC, 60Hz	Test Result:	Pass



Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
0.150	37.00	10.10	0.00	47.100	Quasi Peak	Live	66.00	-18.90	Pass
13.559	32.80	10.60	0.40	43.800	Quasi Peak	Live	60.00	-16.20	Pass
0.361	21.80	10.10	0.50	32.400	Quasi Peak	Live	58.70	-26.30	Pass
10.736	17.50	10.60	0.60	28.600	Quasi Peak	Live	60.00	-31.40	Pass
2.844	14.10	10.30	0.20	24.600	Quasi Peak	Live	56.00	-31.40	Pass
27.119	18.00	10.90	1.50	30.400	Quasi Peak	Live	60.00	-29.60	Pass
0.150	15.60	10.10	0.00	25.600	Average	Live	56.00	-30.40	Pass
13.559	32.50	10.60	0.40	43.500	Average	Live	50.00	-6.50	Pass
0.361	20.50	10.10	0.50	31.200	Average	Live	48.70	-17.50	Pass
10.736	11.40	10.60	0.60	22.500	Average	Live	50.00	-27.50	Pass
2.844	9.40	10.30	0.20	19.900	Average	Live	46.00	-26.10	Pass
27.119	16.80	10.90	1.50	29.200	Average	Live	50.00	-20.80	Pass

Neutral Line

Test Standard:	Part 15.207, RSS-Gen	Mode:	Normal
Frequency Range:	0.15-30MHz	Test Date:	08/14/2020
Antenna Type/Polarity:	N/A	Test Personnel:	Daniel Bruno
Remark:	Class B, 120VAC, 60Hz	Test Result:	Pass



Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
0.173	36.60	10.10	0.10	46.70	Quasi Peak	Neutral	64.80	-18.10	Pass
0.150	37.60	10.10	0.00	47.70	Quasi Peak	Neutral	66.00	-18.30	Pass
13.559	31.70	10.60	0.40	42.80	Quasi Peak	Neutral	60.00	-17.20	Pass
0.236	34.00	10.10	-0.10	44.00	Quasi Peak	Neutral	62.20	-18.30	Pass
10.726	19.00	10.60	0.60	30.10	Quasi Peak	Neutral	60.00	-29.90	Pass
27.117	18.40	10.90	1.50	30.80	Quasi Peak	Neutral	60.00	-29.20	Pass
0.173	11.70	10.10	0.10	21.90	Average	Neutral	54.80	-32.90	Pass
0.150	16.10	10.10	0.00	26.20	Average	Neutral	56.00	-29.80	Pass
13.559	31.60	10.60	0.40	42.60	Average	Neutral	50.00	-7.40	Pass
0.236	8.70	10.10	-0.10	18.60	Average	Neutral	52.20	-33.60	Pass
10.726	11.90	10.60	0.60	23.00	Average	Neutral	50.00	-27.00	Pass
27.117	16.20	10.90	1.50	28.50	Average	Neutral	50.00	-21.50	Pass

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	10/18/19	10/18/20
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	6/17/20	6/17/21
EMC Test Receiver	R&S	ESL6	100230	6/14/20	6/14/21
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	5/4/20	5/4/21
LISN (9KHz – 30MHz)	Com-Power	LI-550C	20140050	01/29/2020	01/29/2021
LISN (9KHz – 30MHz)	Com-Power	LI-550C	20140051	01/29/2020	01/29/2021
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2019	11/15/2020
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	5/14/2020	5/14/2021
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	6/24/20	6/24/21
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	7/16/2020	7/16/2021
True RMS Multi-meter	UNI-T	UT181A	C173014829	5/5/2020	5/5/2021
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	5/15/2020	5/15/2021
RF Attenuator	Pasternack	PE7005-3	VL061	7/16/2020	7/16/2021
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	7/16/2020	7/16/2021
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	5/16/20	5/16/21
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	7/16/2020	7/16/2021
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	7/16/2020	7/16/2021
RE test cable (>18GHz)	Sucoflex	104	344903/4	7/16/2020	7/16/2021
Pulse limiter	Com-Power	LIT-930A	531727	7/16/2020	7/16/2021
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	7/16/2020	7/16/2021
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	7/16/2020	7/16/2021
Vector Signal Generator	Keysight	N5182A	US47080548	6/17/20	6/17/21
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	N/A	N/A