FCC/ISED DSS RF TEST REPORT

Test Report Number……	**WAP-19091821-LC-FCC-IC-DSS**
Applicant……	**Ford Motor Company**
Applicant Address……	**Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124**
Product Name……	Vehicle Telematics Control Unit
Model Number……	FB5-TCU-NA
Family Product/Model……	N/A
FCC ID……	KMH-14H074-NA1
ISED ID……	1422A-14H074NA1
Date of EUT received……	09/27/2019
Date of Test……	09/27/2019 – 11/25/2019
Report Issue Date……	12/02/2019
Test Standards……	**47CFR Part 15.247** **RSS-247 Issue2: Feb 2017**
Test Result……	Pass

Issued By:

Vista Laboratories

1261 Puerta Del Sol, San Clemente, CA 92673 USA

www.vista-compliance.com

Tested by:	**Approved By:**
Bruce Li	
Bruce Li/Test Engineer	**David Zhang/Technical Manager**

Laboratory Introduction

Vista Labs is an A2LA accredited 17025 compliant regulatory compliance testing laboratories (Cert. number: 4848-01) strategically located in Orange County, providing services in the electrical and telecommunication industries. Vista labs is also recognized testing facility for Australia (ACMA), Chinese Taipei (BSMI), Chinese Taipei (NCC), Hong Kong (OFCA), Israel (MOC), Korea (RRA), Singapore (IMDA), Vietnam (MIC), etc.

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As your partner, Vista investigates appropriate test standards, develops test plans, performs troubleshooting & failure analysis, reviews documentation, and provides test reports for a complete compliance testing and certification package.

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San Clemente, CA

for technical competence in the field of

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This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 21st day of June 2018.

President and CEO
For the Accreditation Council
Certificate Number 4848.01
Valid to July 31, 2020

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

17025 Product Testing Accreditation Certificate

Accredited Product Certification Body

A2LA has accredited

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San Clemente, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 *Requirements for bodies certifying products, processes and services*. This product certification body also meets the A2LA R308 – Specific Requirements – ISO-IEC 17065 – Telecommunication Certification Body Accreditation Program and R322 – Specific Requirements – Notified Body Accreditation Requirements. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 1st day of October 2018.

President and CEO
For the Accreditation Council
Certificate Number 4848.02
Valid to July 31, 2020

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

17065 Product Certification Accreditation Certificate

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REVISION HISTORY

Revision	Issue Date	Description	Note
Original	12/02/2019	Original release	N/A

1 General Information

1.1 Applicant

Applicant:	Ford Motor Company
Applicant address:	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Manufacturer:	Ford Motor Company
Manufacturer Address:	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124

1.2 Product information

Product Name	Vehicle Infotainment System
Model Number	FB5-TCU-NA
Family Model Number	N/A
Serial Number	ENMHF19050112411, ENMHF19050112546 (Conducted), ENMHF19050112536, ENMHF19050112440 (Radiated)
Frequency Band	BT BDR/EDR: 2402-2480MHz BLE: 2402-2480MHz 802.11b/g/n-20MHz: 2412-2462MHz 802.11n-40MHz: 2422-2452MHz 802.11a/n-20MHz: 5500-5580MHz, 5660-5720, 5725-5825MHz 802.11n-40MHz: 5510-5550MHz, 5630-5710, 5755-5795MHz 802.11ac: 5530, 5690MHz, 5775MHz WCDMA Band 2: 1852.4- 1907.6MHz WCDMA Band 4: 1712.4- 1752.6MHz WCDMA Band 5: 826.4- 846.6MHz LTE Band 2: 1850.7-1909.3MHz LTE Band 4: 1710.7-1754.3MHz LTE Band 5: 824.7-848.3MHz LTE Band 12: 699.7-713.5MHz LTE Band 17: 706.5-784.5 MHz LTE Band 66: 1710.7-1779.3MHz
Type of modulation	BT BDR/EDR: GFSK, π/4DQPSK, 8DPSK BLE: GFSK 802.11b: DSSS (CCK, DQPSK, DBPSK) 802.11g: OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM) 802.11a/n/ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) WCDMA: QPSK LTE: QPSK, 16QAM
Equipment Class/ Category	DSS, DTS, UNII, PCB

Maximum output power	See test result
Antenna Information	**Internal PCB trace antenna** Peak Gain: - Antenna1: 3.40 dBi @2.4GHz WiFi/Bluetooth, 8.00 dBi @5GHz WiFi - Antenna2: 3.39 dBi @2.4GHz WiFi/Bluetooth, 6.17 dBi @5GHz WiFi **External Antenna** Peak Gain: - Antenna3: 9.74 dBi @2.4GHz WiFi/Bluetooth **Cellular main and diversity antennas:** Peak Gain: 4.32 dBi @ 698-850MHz 5.53 dBi @ 1700-1910MHz For 2.4GHz Wi-Fi, it has total 3 antennas that can transmit simultaneously (Internal antenna 1 &2, and external antenna). For 5GHz Wi-Fi, it has total 2 antennas that can transmit simultaneously (Internal antenna 1 &2). The directional gain is calculated per KDB 662911 D01 Multiple Transmitter Output v02r01, Directional Gain: - 12.59 dBi @2.4GHz - 10.143 dBi @5GHz
Clock Frequencies	N/A
Port/Connectors	CAN bus
Input Power	Vehicle Battery powered: 12VDC
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	BT/BLE, WLAN and cellular radio can transmit simultaneously
Additional Info	N/A

1.3 Test standard and method

Test standard	47CFR Part 15.247 RSS-247 Issue2: Feb 2017
Test method	ANSI C63.10: 2013 558074 D01 15.247 Meas Guidance v05r02

1.4 Test Purpose and statement

The purpose of this test report is intended to demonstrate the compliance of product listed in section 1.2, received from company listed in section 1.1, to the requirements of standard and method listed in section 1.3. Based on our test results, we conclude that the product tested complies with the requirements of the standards indicated.

2 Test site information

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

Test condition	Test Engineer	Test Environment	Test Date
RF conducted	Bruce Li	23.5°C / 58.2%/996 mbar	09/27/2019–11/25/2019
Radiated	Bruce Li	23.5°C / 58.2%/996 mbar	09/27/2019–11/25/2019

3 Modification of EUT

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

4 Test configuration and operation

4.1 EUT test configuration

EUT is powered by external DC power supply for testing purpose. EUT's RF antenna port is connected to spectrum analyzer through RF test cable for measurement. The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc. For Cellular radio, it's controlled by communication tester to change to different mode.

4.2 EUT test mode

Radio	Channel	Frequency (MHz)
BT BDR/EDR	0	2402
BT BDR/EDR	39	2441
BT BDR/EDR	78	2480

4.3 Supporting Equipment

Index	Description	Model	S/N	Brand	Remark
1	AC/DC Adapter	GST60A12-P1J	EB74Q81066	MEAN WELL	-

4.4 EUT setup diagram

4.5 EUT operation

The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc. For Cellular radio, it's controlled by communication tester to change to different mode.

4.6 Test software

Index	Description	Remark
1	Qualcomm QRCT ver 4.0.00138.0	Set Wi-Fi radio to different test mode
2	Window command prompt	Set BDR/EDR and BLE to different test mode
3	EMISoft Vasona 6.0049	EMC/Spurious emission test software used during testing

5 EUT and test setup pictures

See associated filing

6 Test Summary

FCC Rules	ISED Rules	Test Item	Section	Verdict
§15.203	N/A	Antenna Requirement	8.1	Pass
§15.207 (a)	RSS-Gen §8.8	AC Power Line Conducted Emissions	N/A	N/A 1)
§15.247 (a)(1)	RSS-247 §5.1, b)	20 dB Bandwidth	8.2	Pass
-	RSS-Gen §6.7	Occupied Bandwidth	8.3	Pass
§15.247 (a)(1)	RSS-247 §5.1, d)	Number of Hopping Channel	8.4	Pass
§15.247(b)(2)	RSS-247 §5.4, b)	Conducted Maximum Output Power	8.5	Pass
§15.247 (a)(1)	RSS-247 §5.1, b)	Chanel Separation	8.6	Pass
§15.247 (a)(1)	RSS-247 §5.1, d)	Time of Occupancy	8.7	Pass
§15.247(d)	RSS-247 §5.5	Conducted Band-Edge & Unwanted Emissions	8.8	Pass
§15.247 (a)(1), §15.247 (g), §15.247 (h)	RSS-247 §5.1, a)	Frequency Hopping System Requirement	8.9	Pass
§15.205, §15.209, §15.247(d)	RSS-247 §5.5	Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	8.10	Pass

Note1: EUT is powered by Vehicle mains. It does not connect to public AC mains. This item is not applicable.

7 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

8 Test summary and result

8.1 Antenna Requirement

8.1.1 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.

8.1.2 Result

Analysis:

EUT has internal and external antennas.

- For Internal antennas, they're PCB trace antennas. No standard RF connector or coupling is used.
- For External antennas, they're connected using non-standard coupling port. No standard RF connector or coupling is used.

Conclusion:

EUT complies with antenna requirement in § 15.203.

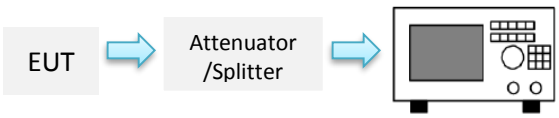
8.2 20 dB Bandwidth

8.2.1 Requirement

Per § 15.247 (a) (1) (i), RSS-247 §5.1, b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.2.2 Test setup



8.2.3 Test Procedure

According to section 6.9.2, in ANSI C63.10-2013:

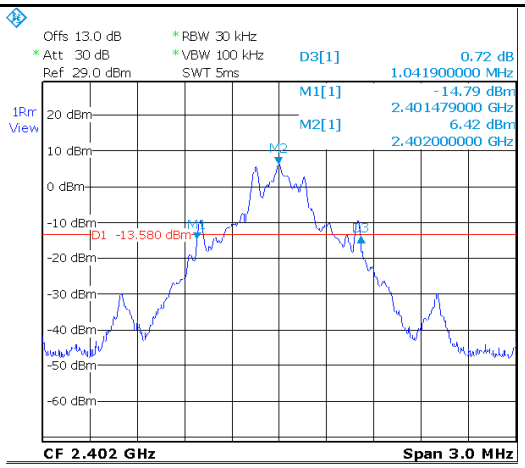
Measurement is made with the occupied bandwidth measurement function incorporated in spectrum analyzer. The following setting are used per ANSI C63.10-2013.

1. Set Center Frequency = Nominal EUT channel center frequency.
2. Set Span to be between two times and five times of the OBW.
3. RBW shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times RBW.
4. Set detection mode to peak and trace mode to max hold.
5. Use the occupied bandwidth measurement function to place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "-xx dB down amplitude" determined.
6. The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

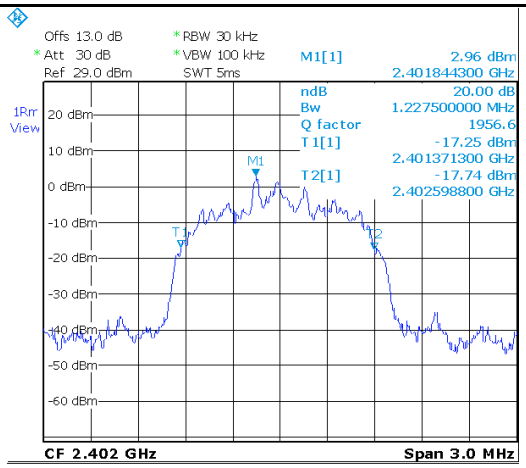
8.2.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Maximum Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	1041.9	N/A	Pass
BT-GFSK	2441	1Mbps	1041.9	N/A	Pass
BT-GFSK	2480	1Mbps	1041.9	N/A	Pass
BT-π/4 DQPSK	2402	2Mbps	1227.5	N/A	Pass
BT-π/4 DQPSK	2441	2Mbps	1233.5	N/A	Pass
BT-π/4 DQPSK	2480	2Mbps	1239.5	N/A	Pass
BT-8DPSK	2402	3Mbps	1227.5	N/A	Pass
BT-8DPSK	2441	3Mbps	1233.5	N/A	Pass
BT-8DPSK	2480	3Mbps	1233.5	N/A	Pass

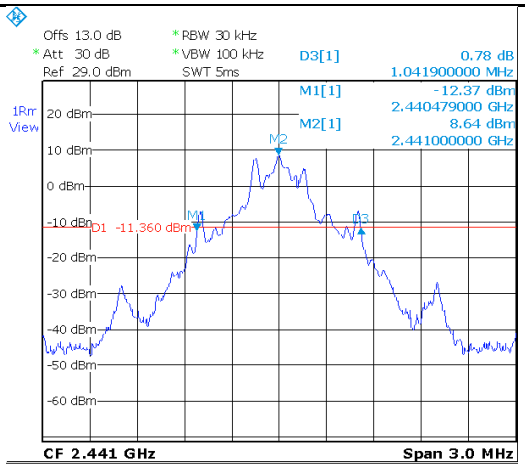
8.2.5 Test Plots



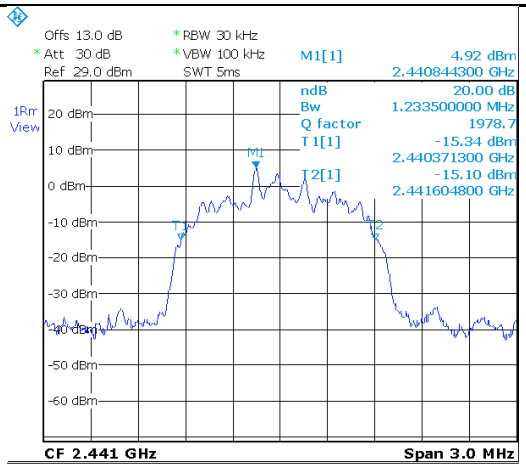
BT-GFSK-20 dB BW-Low



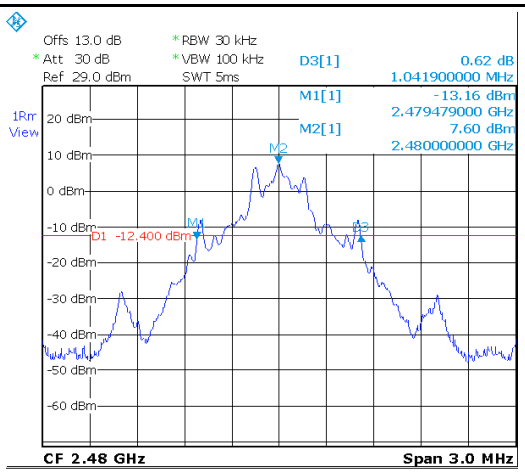
BT-π/4 DQPSK-20 dB BW-Low



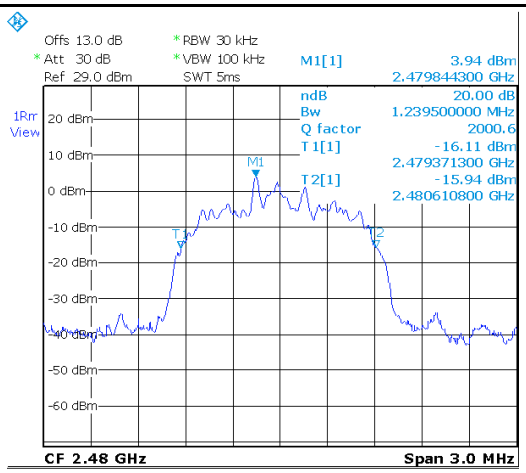
BT-GFSK-20 dB BW-Mid



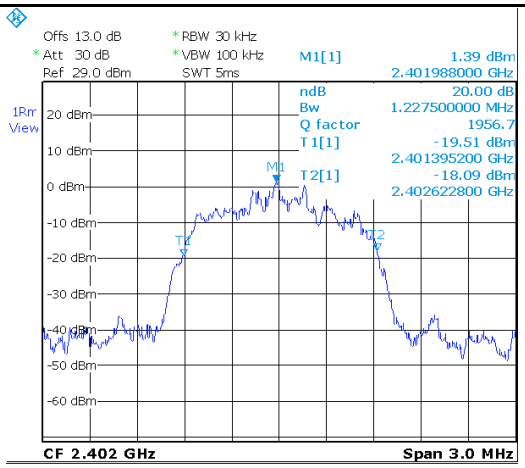
BT-π/4 DQPSK-20 dB BW-Mid



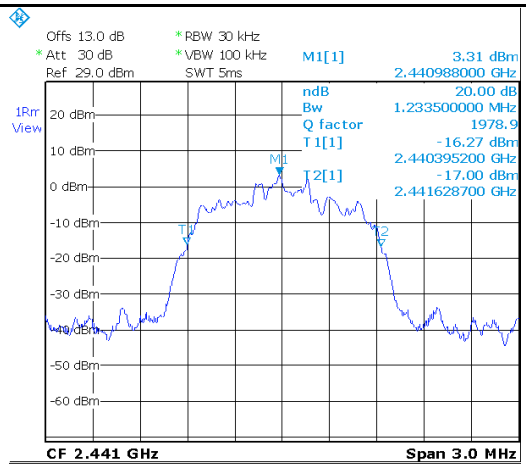
BT-GFSK-20 dB BW-High



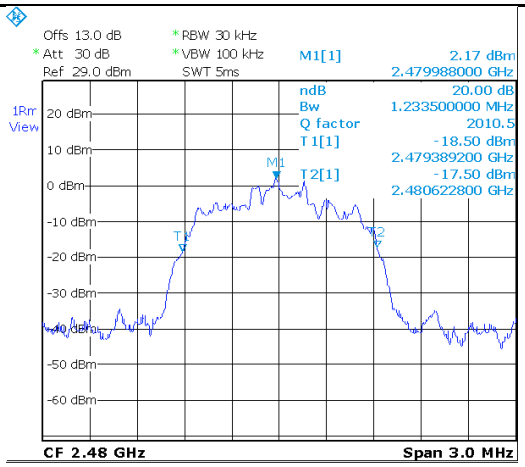
BT-π/4 DQPSK-20 dB BW-High



BT-8DPSK-20 dB BW-Low



BT-8DPSK-20 dB BW-Mid



BT-8DPSK-20 dB BW-High

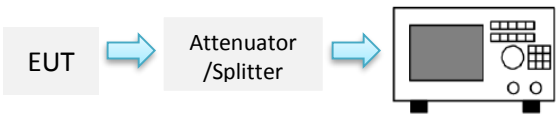
8.3 Occupied Bandwidth (99%)

8.3.1 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.

8.3.2 Test setup



8.3.3 Test Procedure

According to section RSS-Gen §6.7

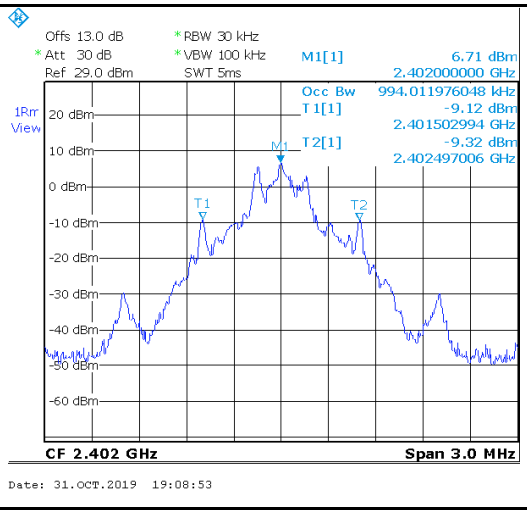
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this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

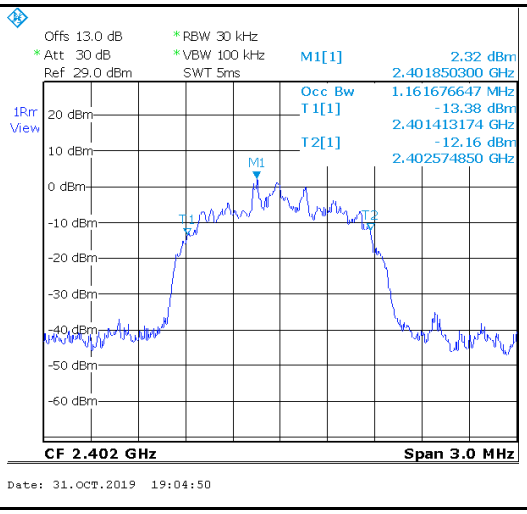
8.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured 99% OBW (KHz)	Limit (KHz)	Result
BT-GFSK	2402	1Mbps	994	N/A	Pass
BT-GFSK	2441	1Mbps	994	N/A	Pass
BT-GFSK	2480	1Mbps	994	N/A	Pass
BT-π/4 DQPSK	2402	2Mbps	1161.7	N/A	Pass
BT-π/4 DQPSK	2441	2Mbps	1161.7	N/A	Pass
BT-π/4 DQPSK	2480	2Mbps	1161.7	N/A	Pass
BT-8DPSK	2402	3Mbps	1155.7	N/A	Pass
BT-8DPSK	2441	3Mbps	1149.7	N/A	Pass
BT-8DPSK	2480	3Mbps	1155.7	N/A	Pass

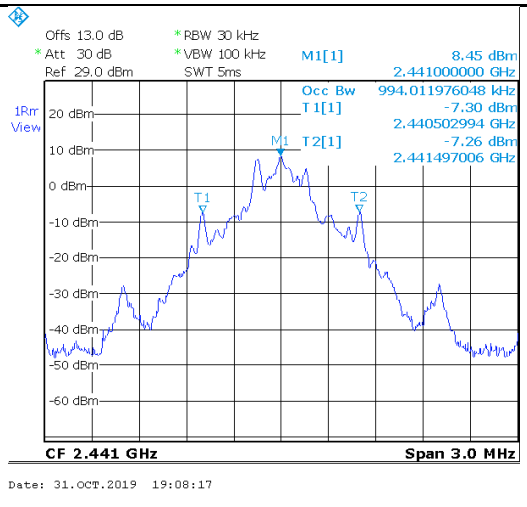
8.3.5 Test Plots



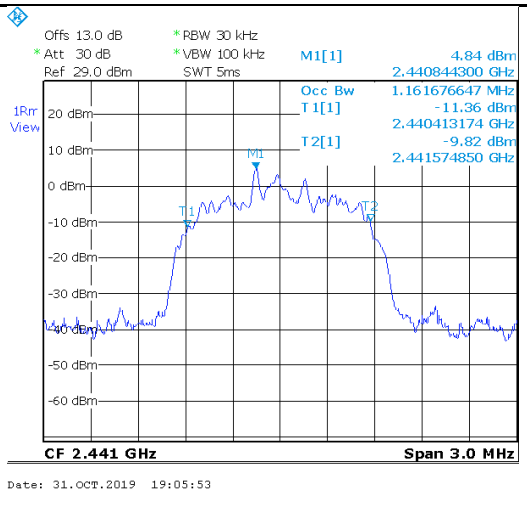
BT-GFSK-20 dB BW-Low



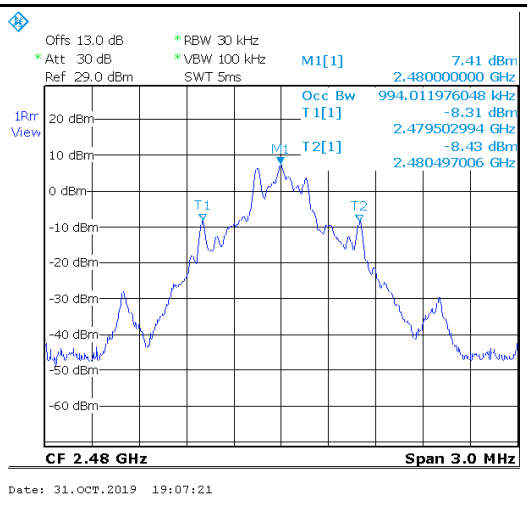
BT-π/4 DQPSK-20 dB BW-Low



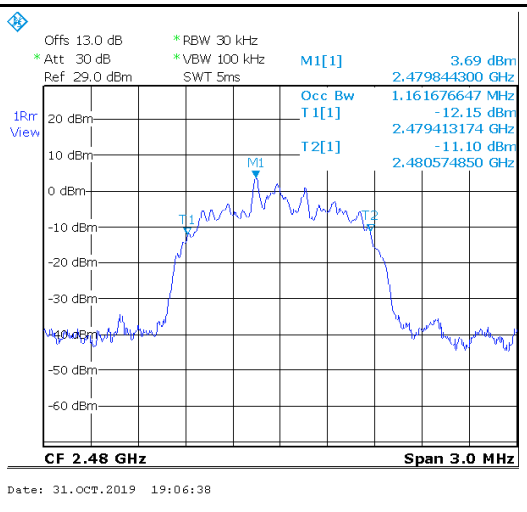
BT-GFSK-OBW-Mid



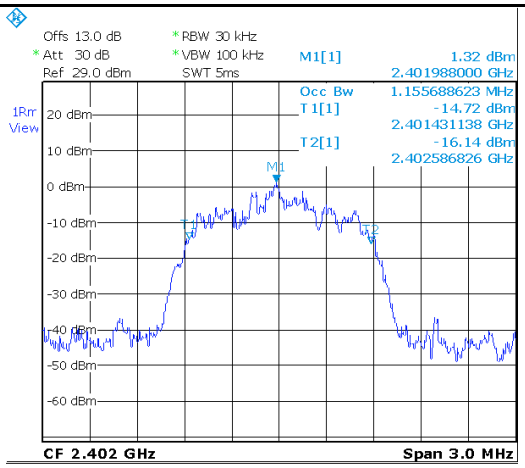
BT-π/4 DQPSK-OBW-Mid



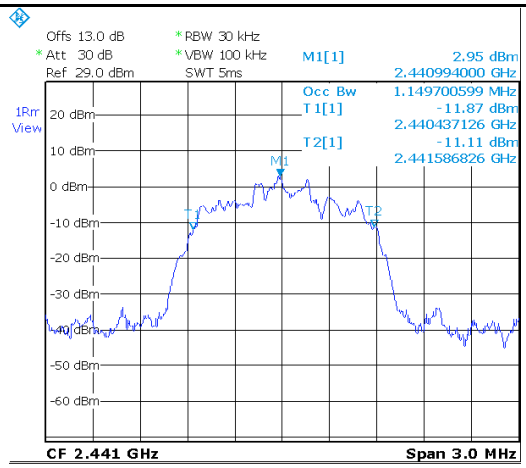
BT-GFSK-OBW-High



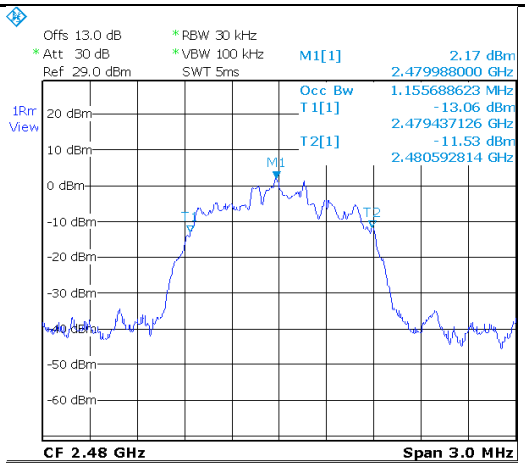
BT-π/4 DQPSK-OBW-High



BT-8DPSK-OBW-Low



BT-8DPSK-OBW-Mid



BT-8DPSK-OBW-High

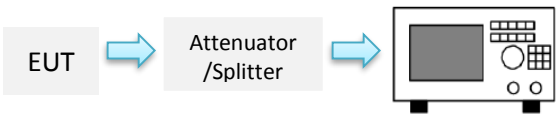
8.4 Number of Hopping Channel

8.4.1 Requirement

Per § 15.247 (a) (1) (iii), RSS-247 §5.1, d)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.4.2 Test setup



8.4.3 Test Procedure

According to section 7.8.3, in ANSI C63.10-2013:

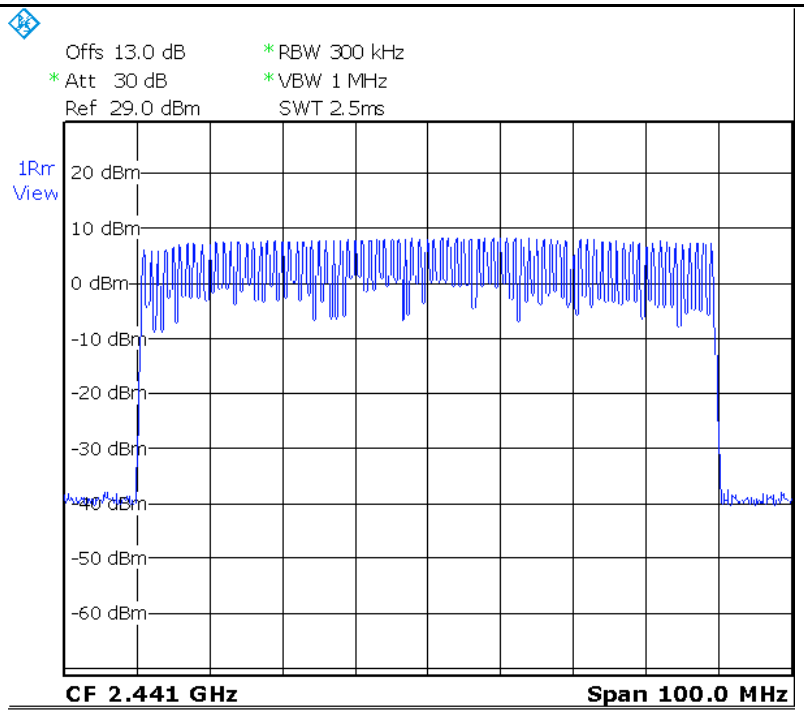
Measurement is made with spectrum analyzer. The following setting is used.

1. Set Span to be the frequency band of operation.
2. Set RBW to less 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW ≥ RBW.
4. Sweep: Auto.
5. Detector function: Peak.
6. Trace: Max hold.
7. Allow the trace to stabilize.

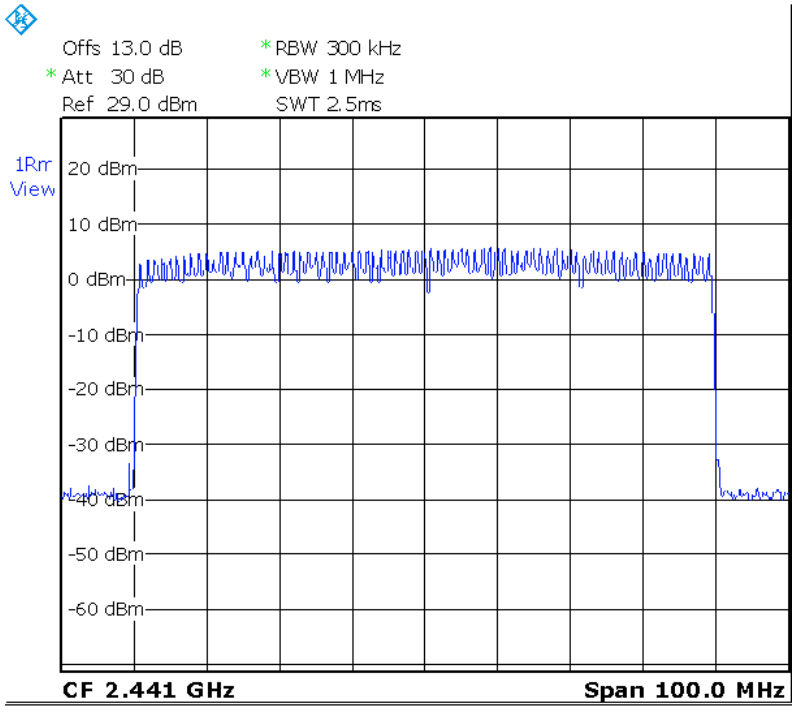
8.4.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Number	Minimum Limit	Result
BT-GFSK	2441	1Mbps	79	15	Pass
BT-π/4 DQPSK	2441	2Mbps	79	15	Pass
BT-8DPSK	2441	3Mbps	79	15	Pass

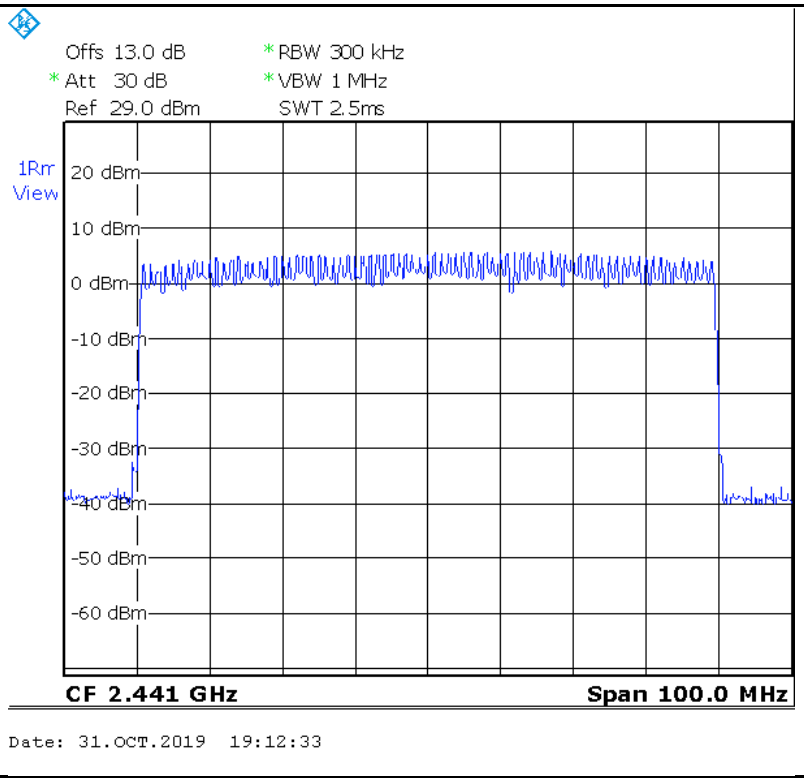
8.4.5 Test Plots



BT-GFSK- Hopping Channel Number



BT-π/4 DQPSK - Hopping Channel Number



BT-8DPSK - Hopping Channel Number

8.5 Maximum Output Power

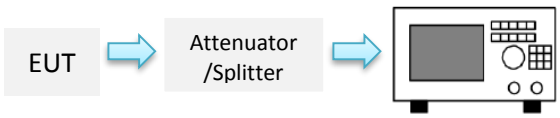
8.5.1 Requirement

Per § 15.247 (a)(1), RSS-247 §5.4, b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Per § 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

8.5.2 Test setup



8.5.3 Test Procedure

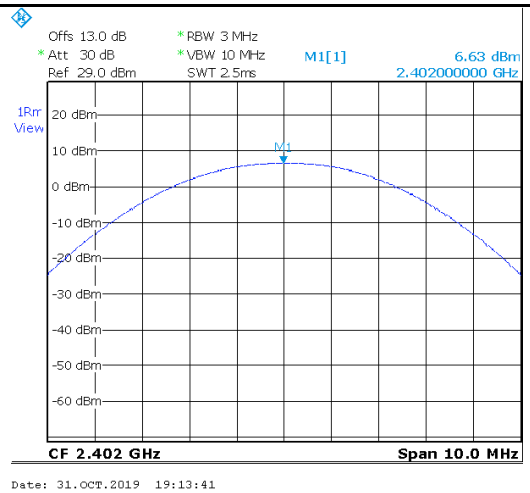
According to section 7.8.5 of ANSI C63.10-2013. The measurement was made with EUT directly connected to spectrum analyzer. The following setting is used.

1. Set the RBW > 20 dB BW
2. Set VBW ≥ RBW.
3. Set span to approximately five times the 20 dB bandwidth, centered on a hopping channel.
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.

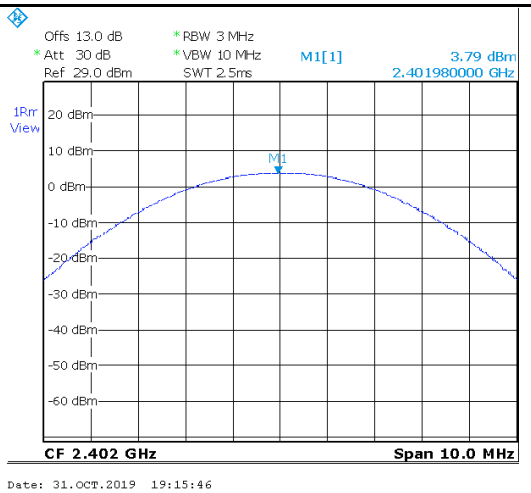
8.5.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Maximum Output Power (dBm)	Result
BT-GFSK	2402	1Mbps	6.63	21	Pass
BT-GFSK	2440	1Mbps	8.68	21	Pass
BT-GFSK	2480	1Mbps	7.62	21	Pass
BT-π/4 DQPSK	2402	2Mbps	3.79	21	Pass
BT-π/4 DQPSK	2440	2Mbps	5.99	21	Pass
BT-π/4 DQPSK	2480	2Mbps	4.86	21	Pass
BT-8DPSK	2402	3Mbps	3.78	21	Pass
BT-8DPSK	2440	3Mbps	5.97	21	Pass
BT-8DPSK	2480	3Mbps	4.85	21	Pass

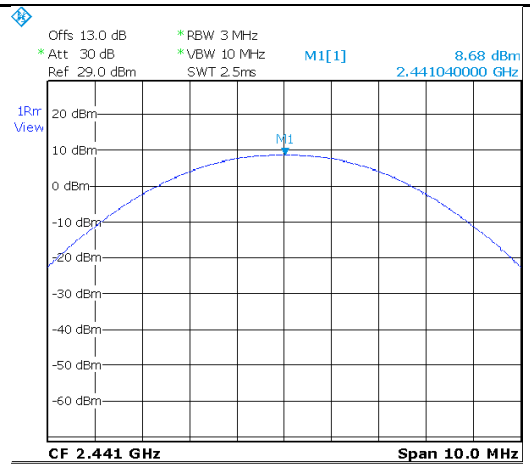
8.5.5 Test Plots



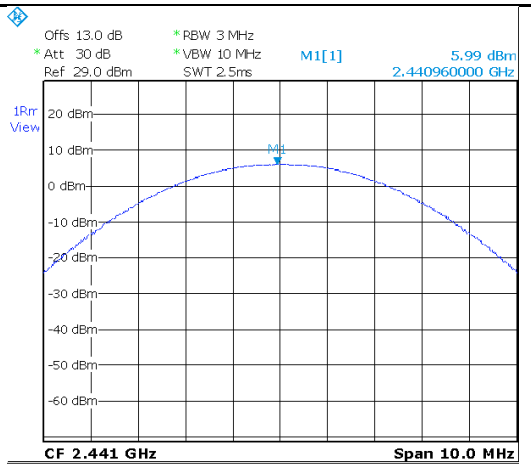
BT-GFSK-PWR-Low



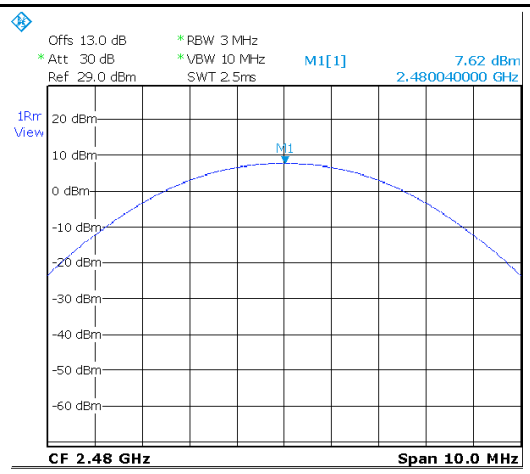
BT-π/4 DQPSK-PWR-Low



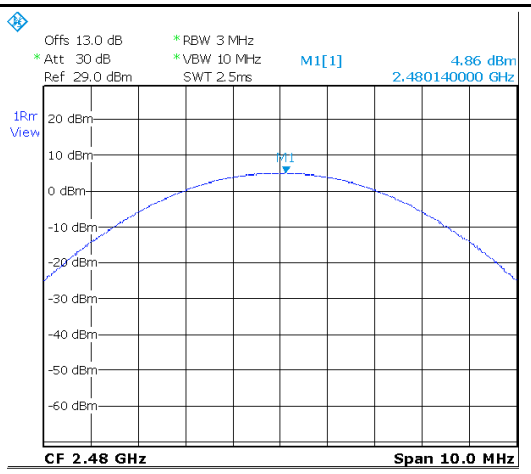
BT-GFSK-PWR-Mid



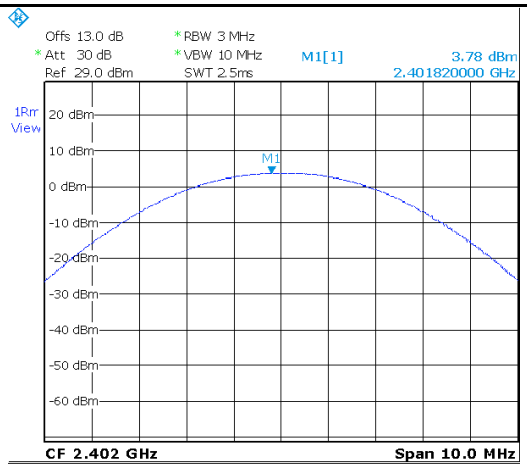
BT-π/4 DQPSK-PWR-Mid



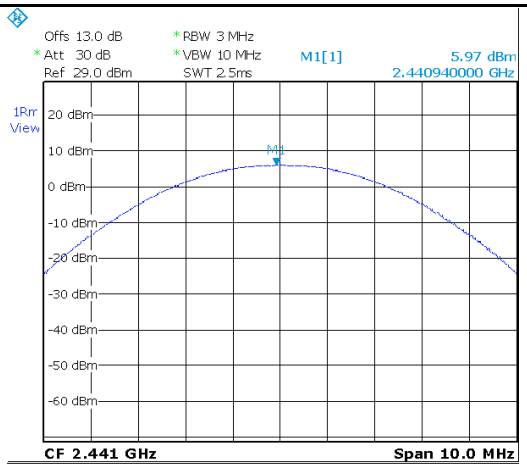
BT-GFSK-PWR-High



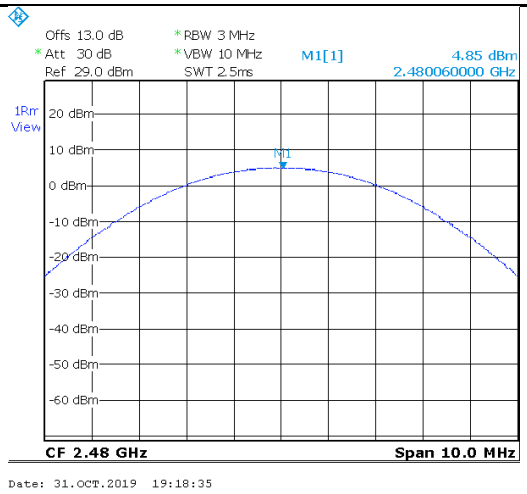
BT-π/4 DQPSK-PWR-High



BT-8DPSK-PWR-Low



BT-8DPSK-PWR-Mid



BT-8DPSK-PWR-High

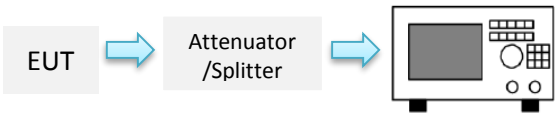
8.6 Channel Separation

8.6.1 Requirement

Per § 15.247 (a) (1), RSS-247 §5.1, b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.6.2 Test setup



8.6.3 Test Procedure

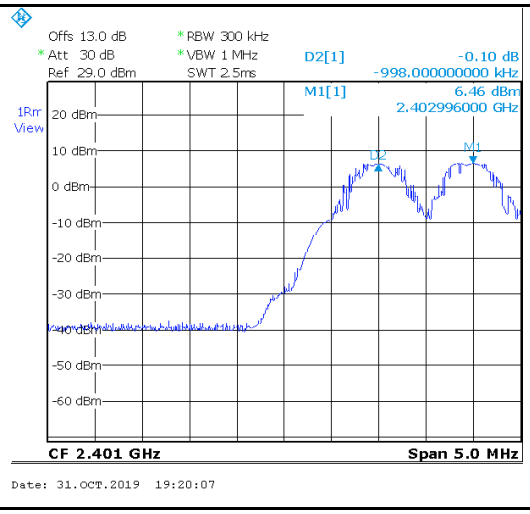
According to section 7.8.2 of ANSI C63.10-2013. The measurement was made with spectrum analyzer. The following setting is used.

1. Set Span to wide enough to capture the peaks of two adjacent channels.
2. RBW: Start with the RBW set to approximately 30% of the channel spacing
3. VBW ≥ 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 separation between the peaks of adjacent channels.

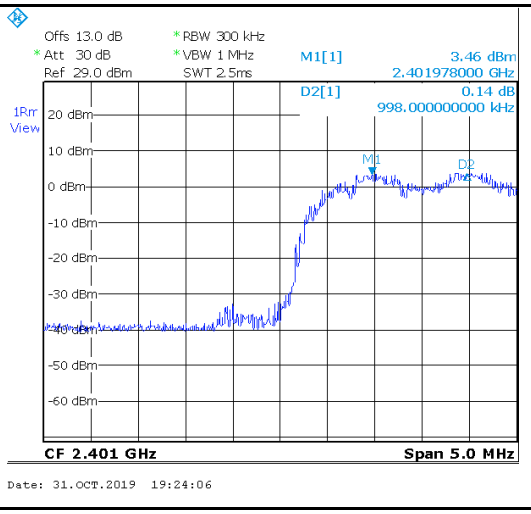
8.6.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Separation (KHz)	2/3 of 20 dB Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	998	694.6	Pass
BT-GFSK	2441	1Mbps	998	694.6	Pass
BT-GFSK	2480	1Mbps	998	694.6	Pass
BT-π/4 DQPSK	2402	2Mbps	998	818.3	Pass
BT-π/4 DQPSK	2441	2Mbps	1068	822.3	Pass
BT-π/4 DQPSK	2480	2Mbps	1078	826.3	Pass
BT-8DPSK	2402	3Mbps	1028	818.3	Pass
BT-8DPSK	2441	3Mbps	1008	822.3	Pass
BT-8DPSK	2480	3Mbps	1078	822.3	Pass

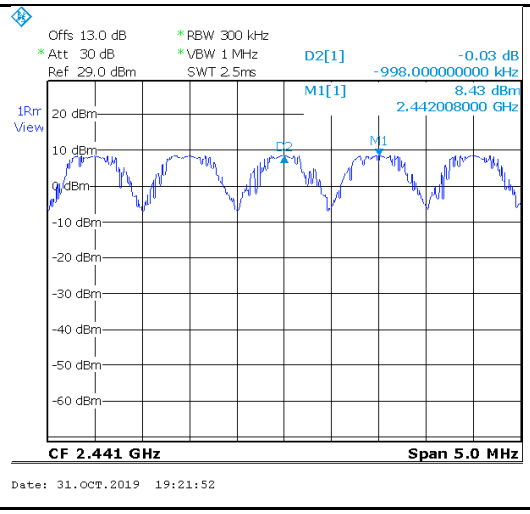
8.6.5 Test Plots



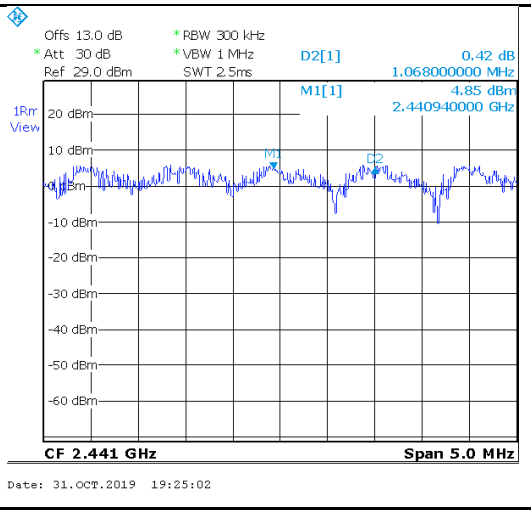
BT-GFSK-Channel Separation-Low



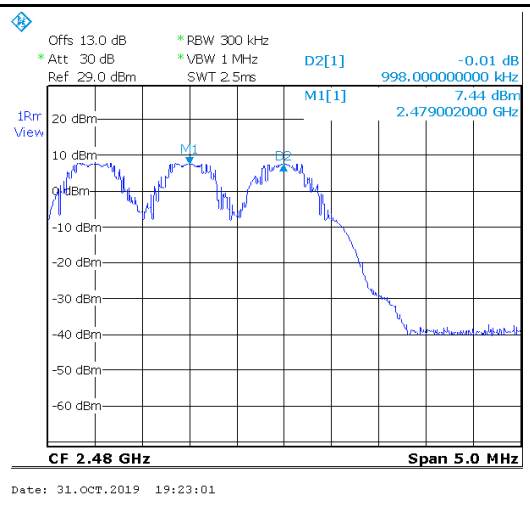
BT-π/4 DQPSK-Channel Separation-Low



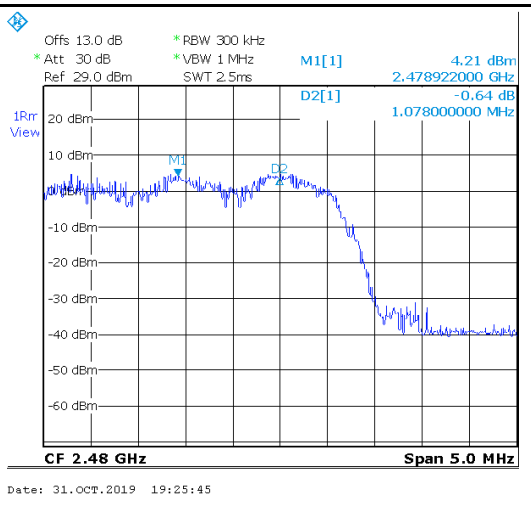
BT-GFSK-Channel Separation-Mid



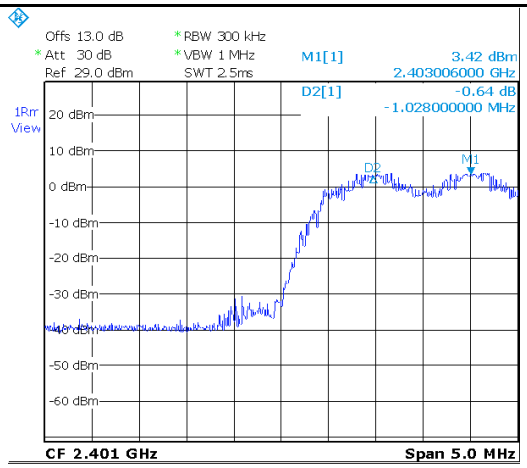
BT-π/4 DQPSK-Channel Separation-Mid



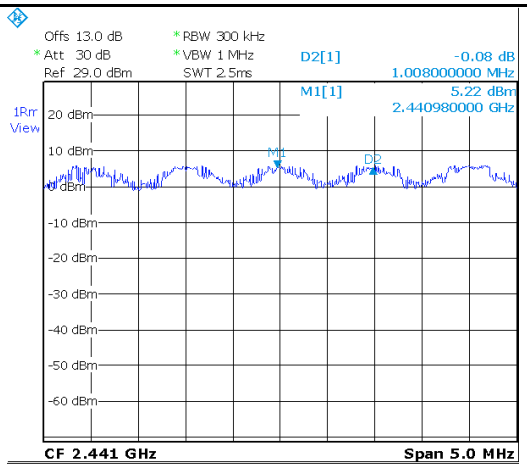
BT-GFSK-Channel Separation-High



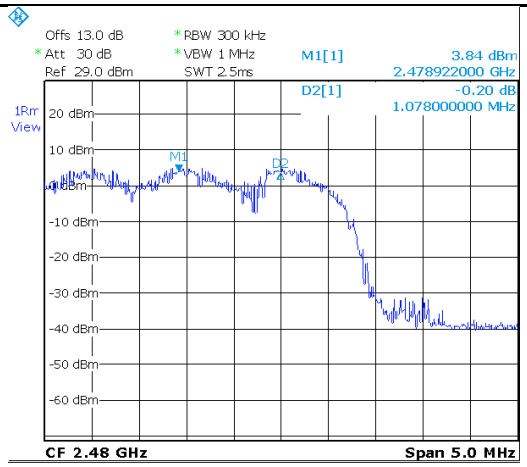
BT-π/4 DQPSK-Channel Separation-High



BT-8DPSK-Channel Separation-Low



BT-8DPSK-Channel Separation-Mid



BT-8DPSK-Channel Separation-High

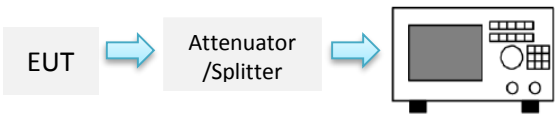
8.7 Time of Occupancy

8.7.1 Requirement

Per § 15.247 (a) (1) (iii), RSS-247 §5.1, d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.7.2 Test setup



8.7.3 Test Procedure

According to section 7.8.4 of ANSI C63.10-2013. The measurement was made with spectrum analyzer. The following setting is used.

1. Set Span to zero, centered on a hopping channel.
2. RBW shall be ≤ channel spacing.
3. VBW ≥ RBW.
5. Detector = peak.
6. Sweep time = auto couple. As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the marker-delta function to determine the transmit time per hop.

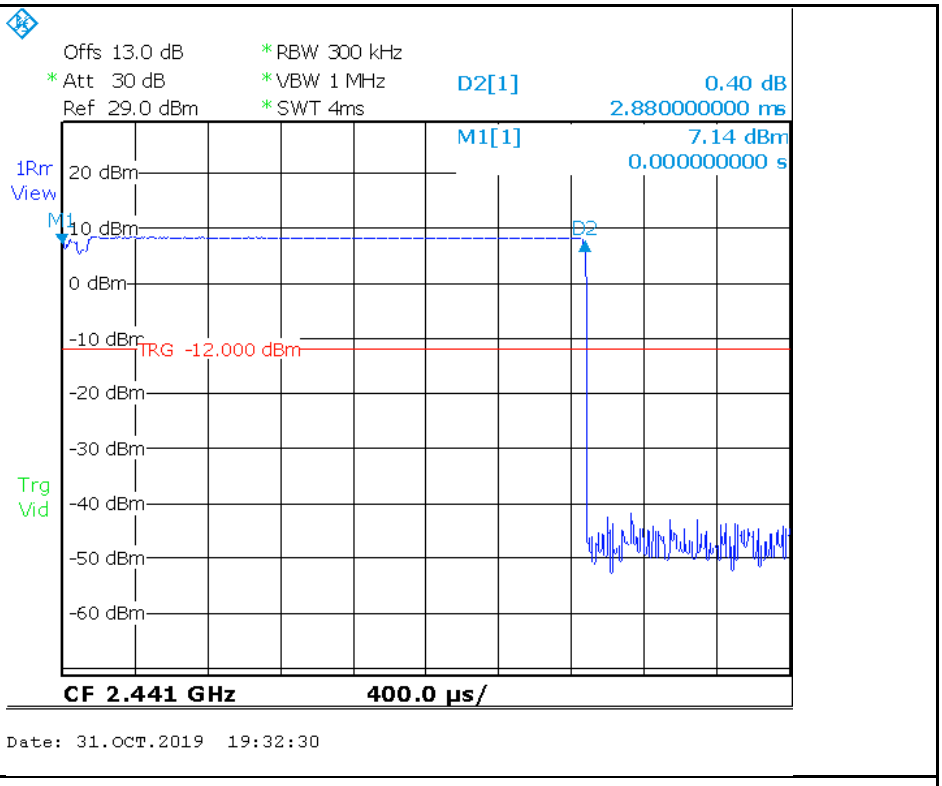
8.7.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Packet	Burst Width (ms/hop/ch)	Dwell Time (s)	Limit (s)	Result
BT-GFSK	2402	1Mbps	DH5	2.88	0.3072	≤0.4	Pass
BT-π/4 DQPSK	2402	1Mbps	2DH5	2.88	0.3072	≤0.4	Pass
BT-8DPSK	2402	1Mbps	3DH5	2.88	0.3072	≤0.4	Pass

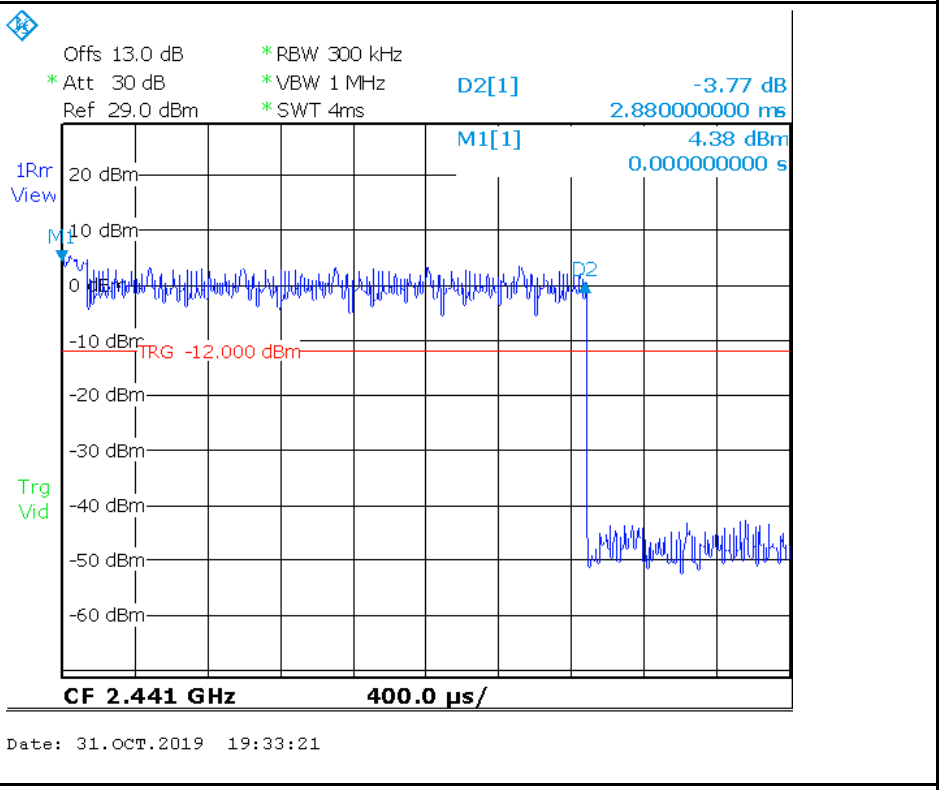
The test period: T=0.4 second / channel * 79 channels = 31.6 s

DH5 Dwell time = Burst Width (ms) * (1600/ (6*79)) *31.6

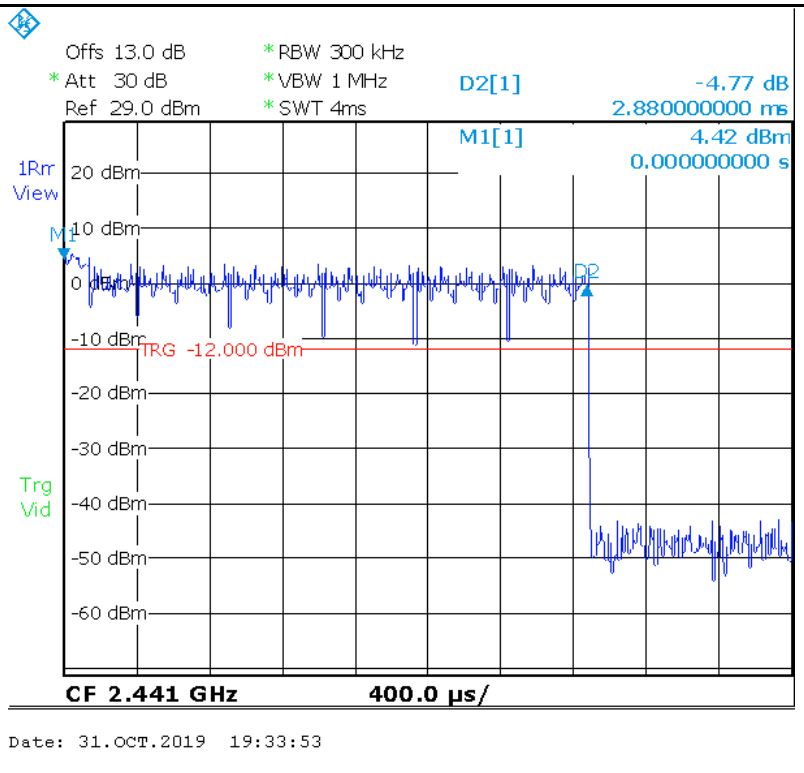
8.7.5 Test Plots



BT-GFSK- Dwell Time – DH5



BT-π/4 DQPSK - Dwell Time – 2DH5



BT-8DPSK - Dwell Time – 3DH5

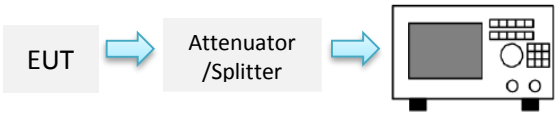
8.8 Conducted Band-Edge & Unwanted Emissions Measurement

8.8.1 Requirement

Per § 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.

8.8.2 Test setup



8.8.3 Test Procedure

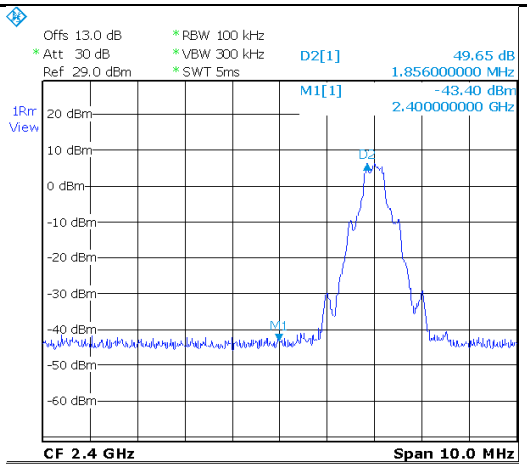
According to section 7.8.8 of ANSI C63.10-2013.

Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered. The following setting is used.

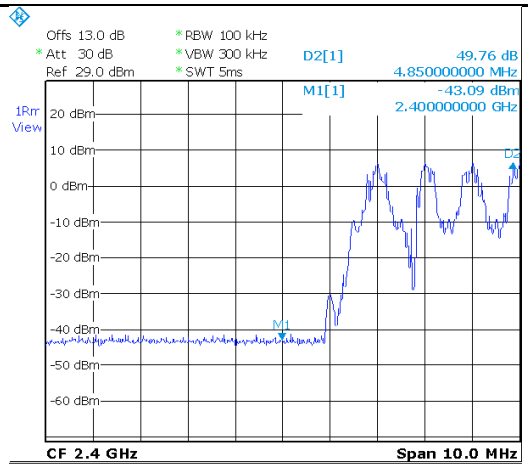
8.8.4 Test Result

See test plots

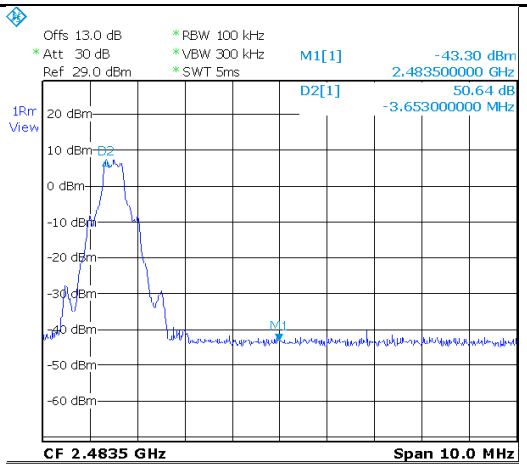
8.8.5 Test Plots



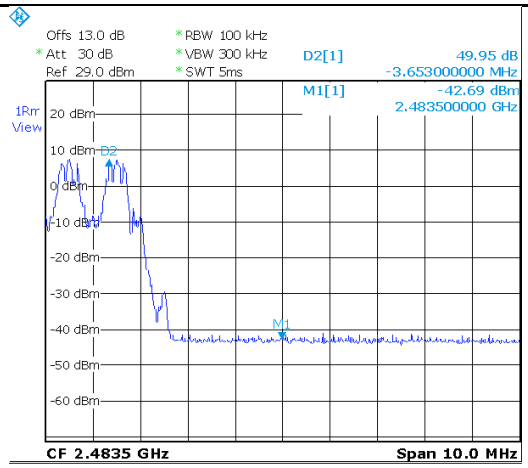
BT-GFSK-Band Edge-Low-Non hopping



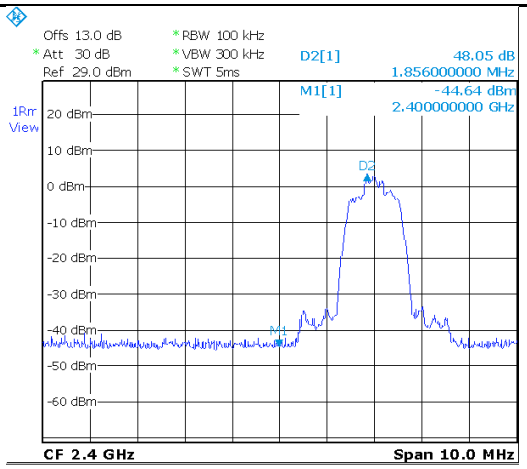
BT-GFSK-Band Edge-Low-Hopping



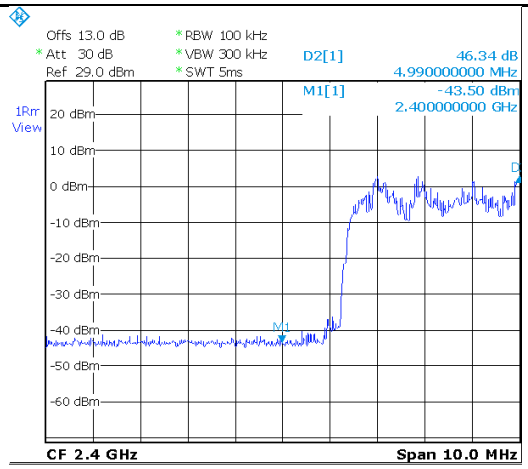
BT-GFSK-Band Edge-High-Non hopping



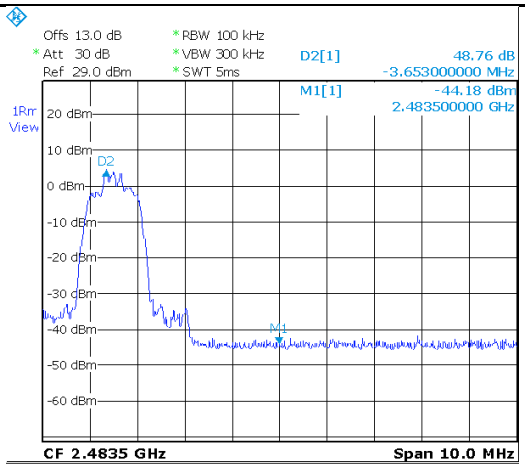
BT-GFSK-Band Edge-High-Hopping



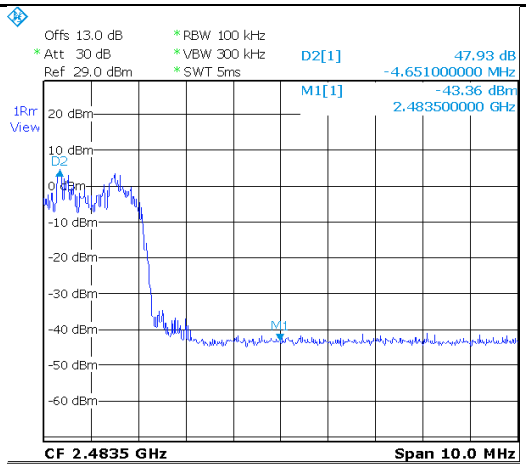
BT-π/4 DQPSK-Band Edge-Low-Non hopping



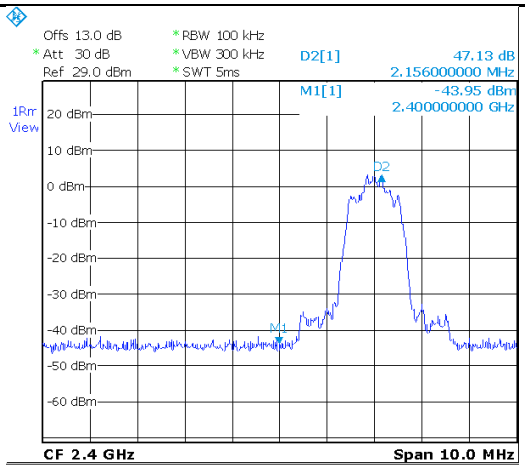
BT-π/4 DQPSK-Band Edge-Low-Hopping



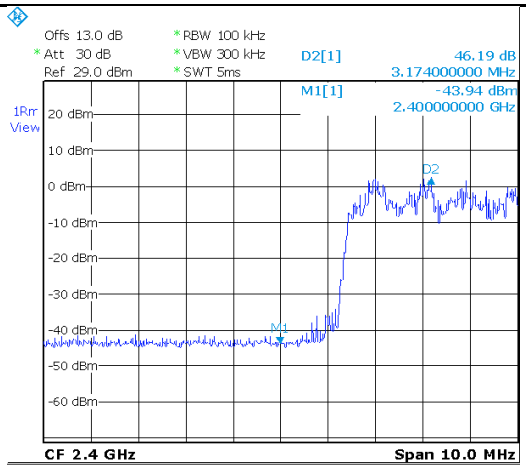
BT-π/4 DQPSK-Band Edge-High-Non hopping



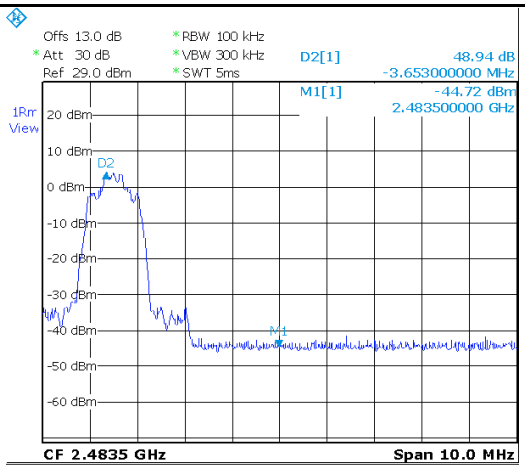
BT-π/4 DQPSK-Band Edge-High-Hopping



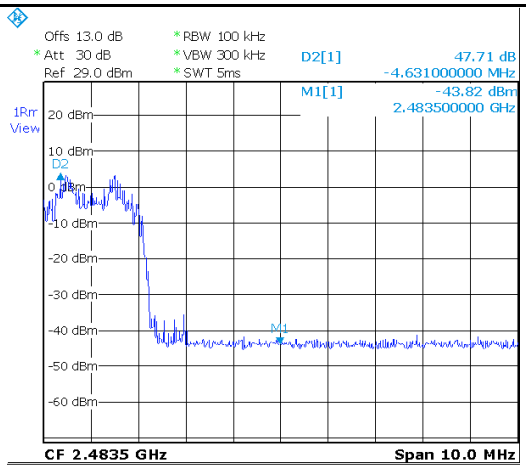
BT-8DPSK-Band Edge-Low-Non hopping



BT-8DPSK-Band Edge-Low-Hopping



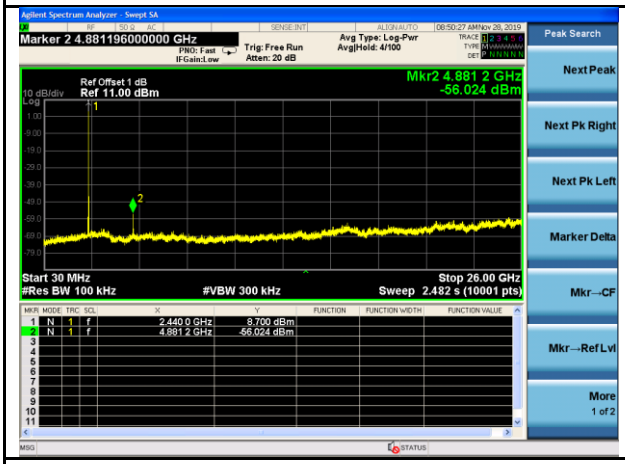
BT-8DPSK-Band Edge-High-Non hopping



BT-8DPSK-Band Edge-High-Hopping

BT-GFSK-CSE-Low

BT-π/4 DQPSK-CSE-Low



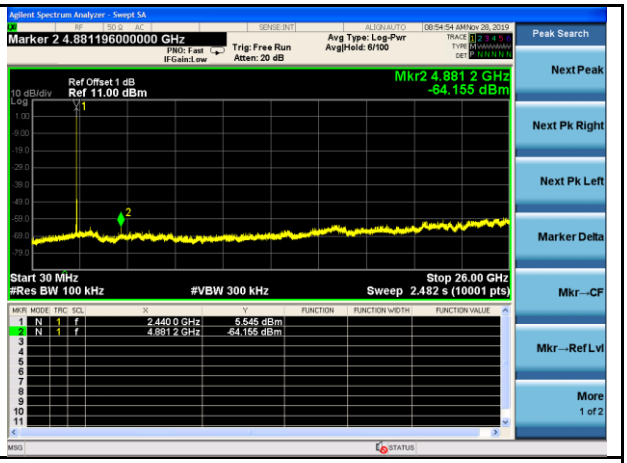
BT-GFSK-CSE-Mid

BT-π/4 DQPSK-CSE-Mid

BT-GFSK-CSE-High

BT-π/4 DQPSK-CSE-High

BT-8DPSK-CSE-Low



BT-8DPSK-CSE-Mid

BT-8DPSK-CSE-High

8.9 Frequency Hopping System Requirement

8.9.1 Requirement

Per § 15.247 (a) (1), RSS-247 §5.1, a)

the system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Per § 15.247 (g), frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Per § 15.247 (h), the incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

8.9.2 Result

Analysis:

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centered from 2402 to 2480MHz) in the range 2,400-2,483.5MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless device are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad

channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with an Bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for DA 00-705 and FCC Part 15.247 rule.

An example of Pseudorandom Frequency Hopping Sequence Table as below:

08, 24, 40, 56, 40, 56, 72, 09, 01, 09, 33, 41, 33, 41, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 42, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 55, 71, 08, 24, 08, 24, 40, 56, 40, 48, 72, 01, 72, 01, 25, 33, 12, 28, 44, 60, 42, 58, 74, 11, 05, 13, 37, 45 etc.

The system receiver has input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

Conclusion:

EUT complies with frequency hopping system requirement in § 15.247.

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

8.10.1 Requirement

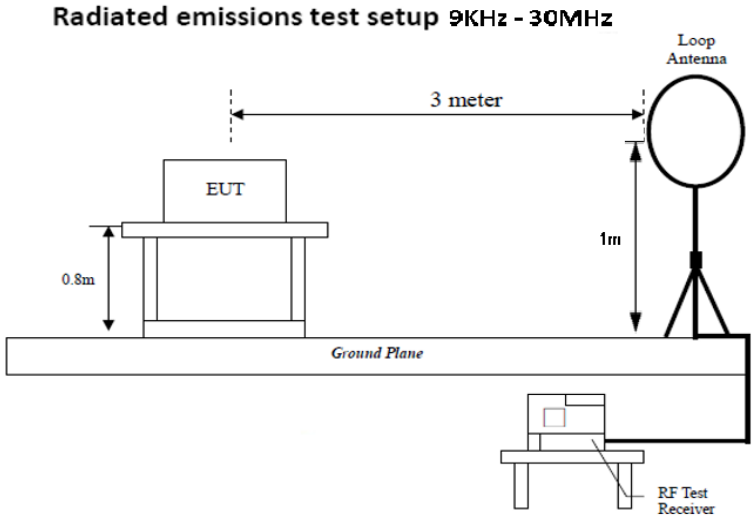
§ 15.247 (d), RSS-247 §5.5

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.

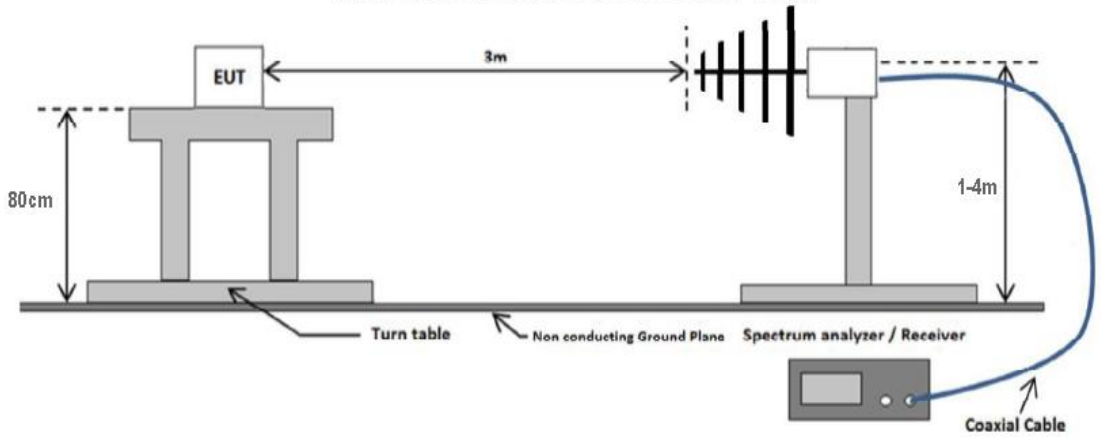
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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

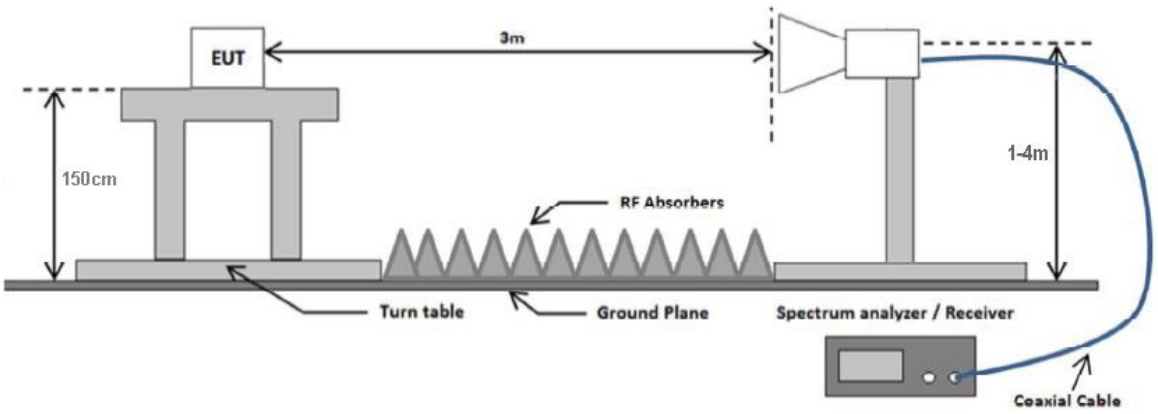
8.10.2 Test setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



8.10.3 ***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.

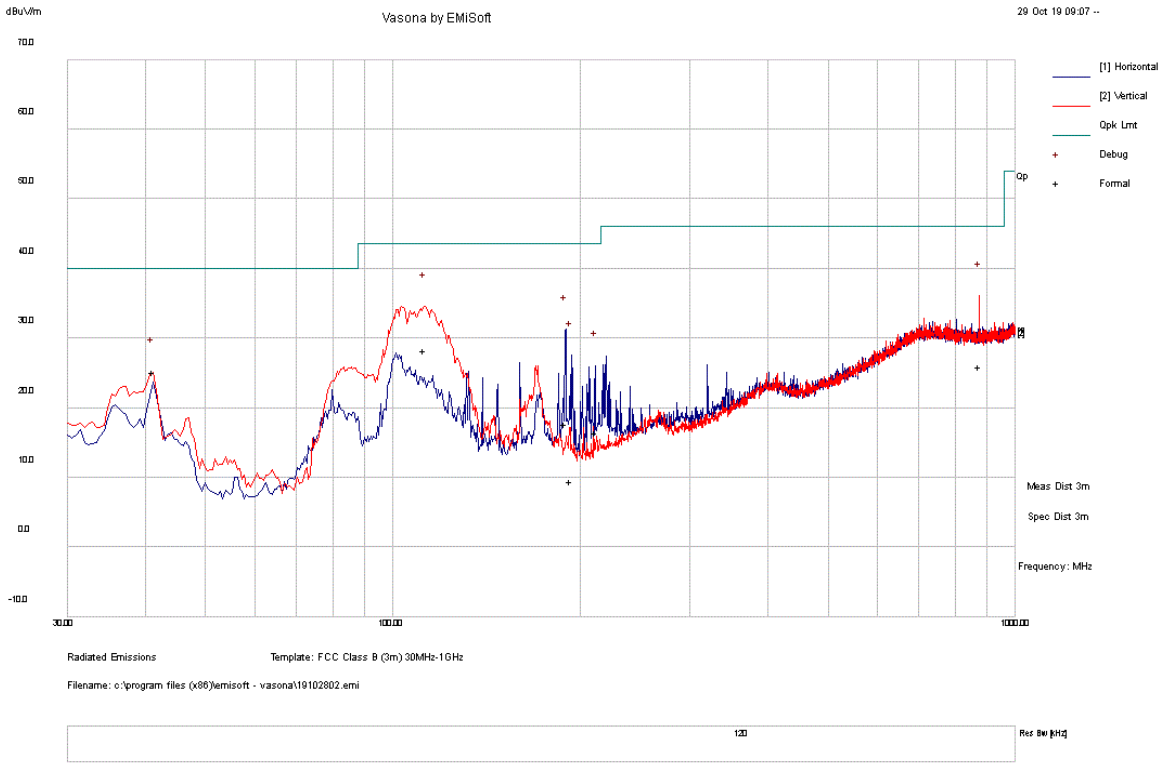
1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting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

8.10.4 Test Result

RADIATED EMISSIONS < 1 GHZ

Test Standard:	15.209, 15.247	Mode:	BT EDR 2480 MHz
Frequency Range:	30 - 1000 MHz	Test Date:	10/28/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

BT EDR 2480 MHz

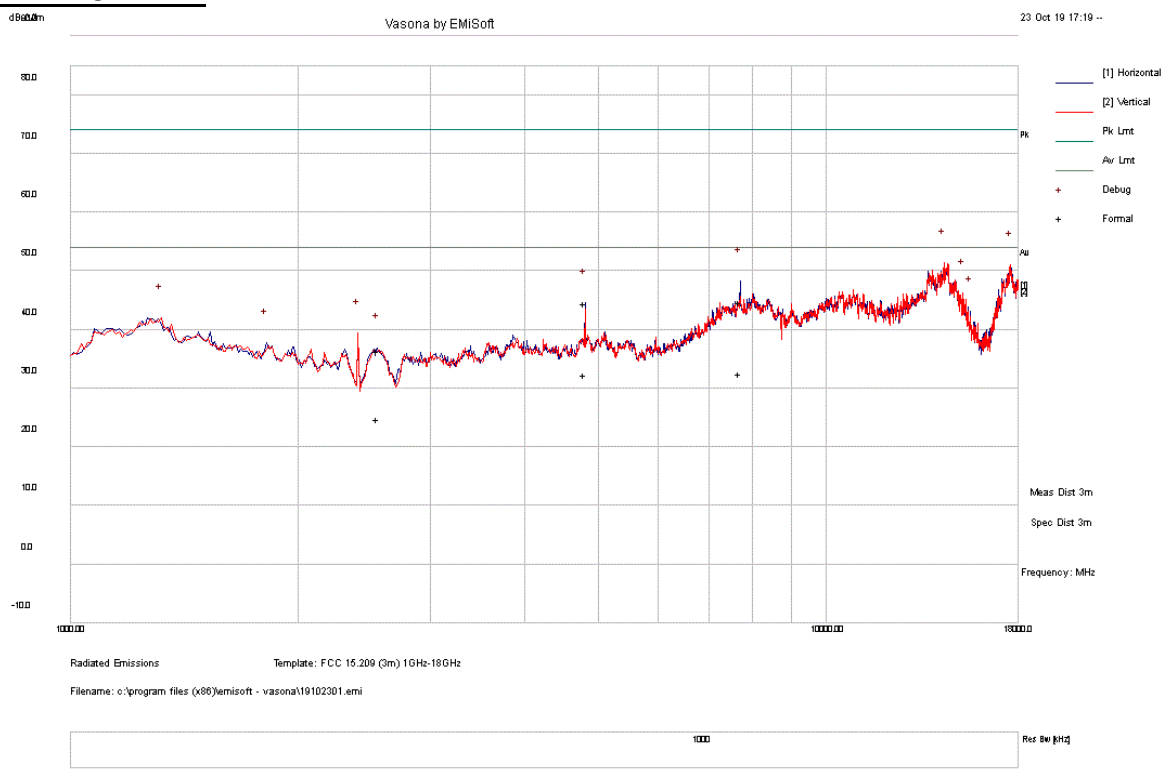


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
112.39	47.83	3.76	-23.35	28.23	Quasi Max	V	175	138	43.50	-15.27	Pass
875.34	25.48	7.52	-7.12	25.89	Quasi Max	V	400	H	46.00	-20.11	Pass
189.67	35.04	4.64	-21.94	17.75	Quasi Max	H	158	337	43.50	-25.75	Pass
41.19	43.76	2.58	-21.08	25.25	Quasi Max	V	148	285	40.00	-14.75	Pass
193.45	26.66	4.67	-21.89	9.45	Quasi Max	H	171	43	43.50	-34.05	Pass
211.47	32.79	4.86	-21.17	16.49	Quasi Max	H	123	94	43.50	-27.01	Pass

RADIATED EMISSIONS > 1 GHZ

Test Standard:	15.209, 15.247	Mode:	BLE 2402 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

BLE 2402 MHz

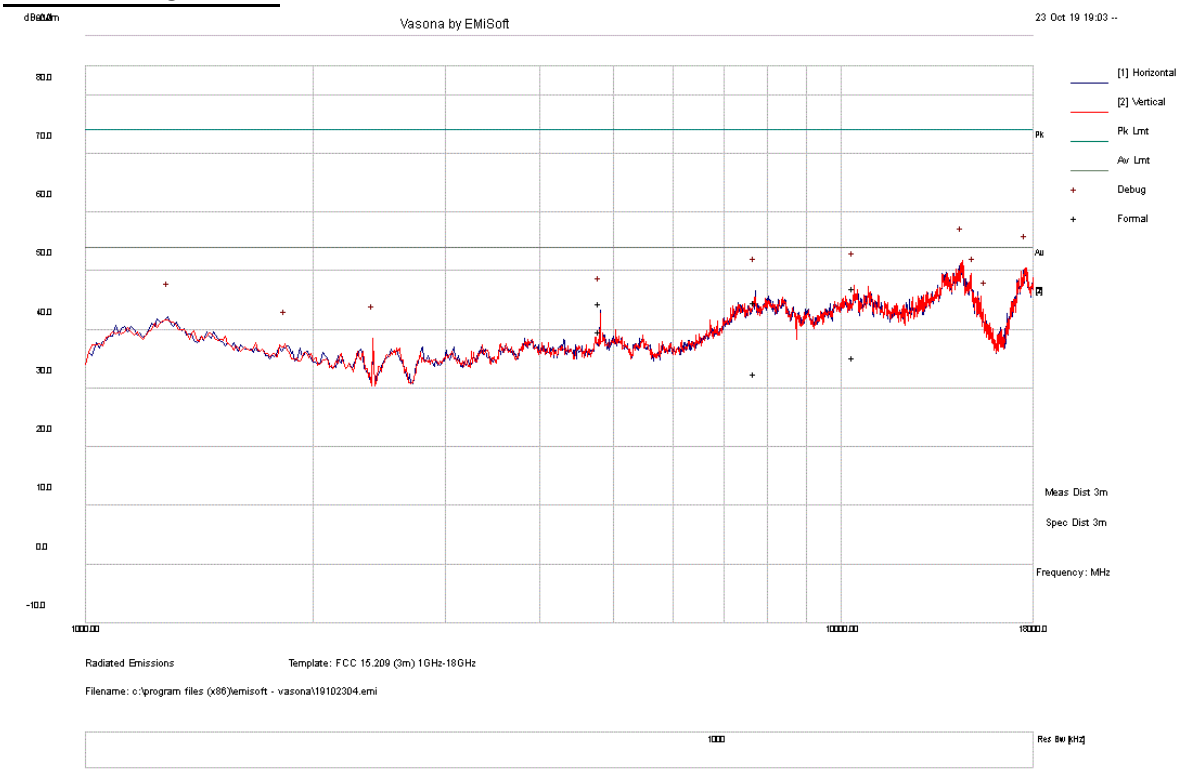


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
7703.86	30.72	21.12	-7.21	44.63	Peak Max	H	220	156	74.00	-29.37	Pass
4803.35	40.60	17.35	-13.43	44.52	Peak Max	H	126	160	74.00	-29.48	Pass
2552.13	43.13	14.87	-21.55	36.46	Peak Max	H	152	132	74.00	-37.54	Pass
7703.86	18.64	21.12	-7.21	32.55	Average Max	H	220	156	54.00	-21.46	Pass
4803.35	28.40	17.35	-13.43	32.32	Average Max	H	126	160	54.00	-21.68	Pass
2552.13	31.37	14.87	-21.55	24.69	Average Max	H	152	132	54.00	-29.31	Pass

RADIATED EMISSIONS > 1 GHZ

Test Standard:	15.209, 15.247	Mode:	BT BDR 2402 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

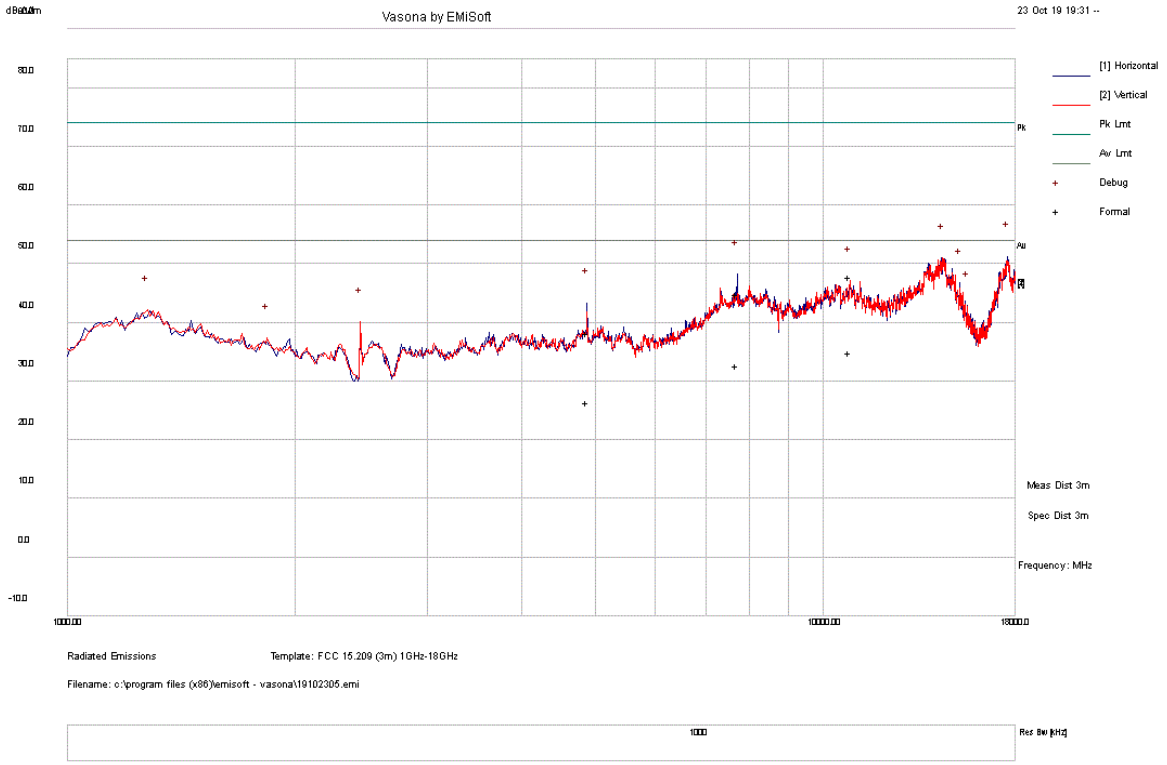
BT BDR 2402 MHz



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
10413.6	27.57	23.00	-3.55	47.02	Peak Max	V	159	46	74.00	-26.98	Pass
7704.9	30.80	21.12	-7.20	44.72	Peak Max	H	235	104	74.00	-29.28	Pass
4804.02	40.63	17.35	-13.43	44.55	Peak Max	H	110	5	74.00	-29.45	Pass
10413.6	15.76	23.00	-3.55	35.21	Average Max	V	159	46	54.00	-18.79	Pass
7704.9	18.68	21.12	-7.20	32.59	Average Max	H	235	104	54.00	-21.41	Pass
4804.02	35.84	17.35	-13.43	39.76	Average Max	H	110	5	54.00	-14.24	Pass

Test Standard:	15.209, 15.247	Mode:	BT BDR 2441 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

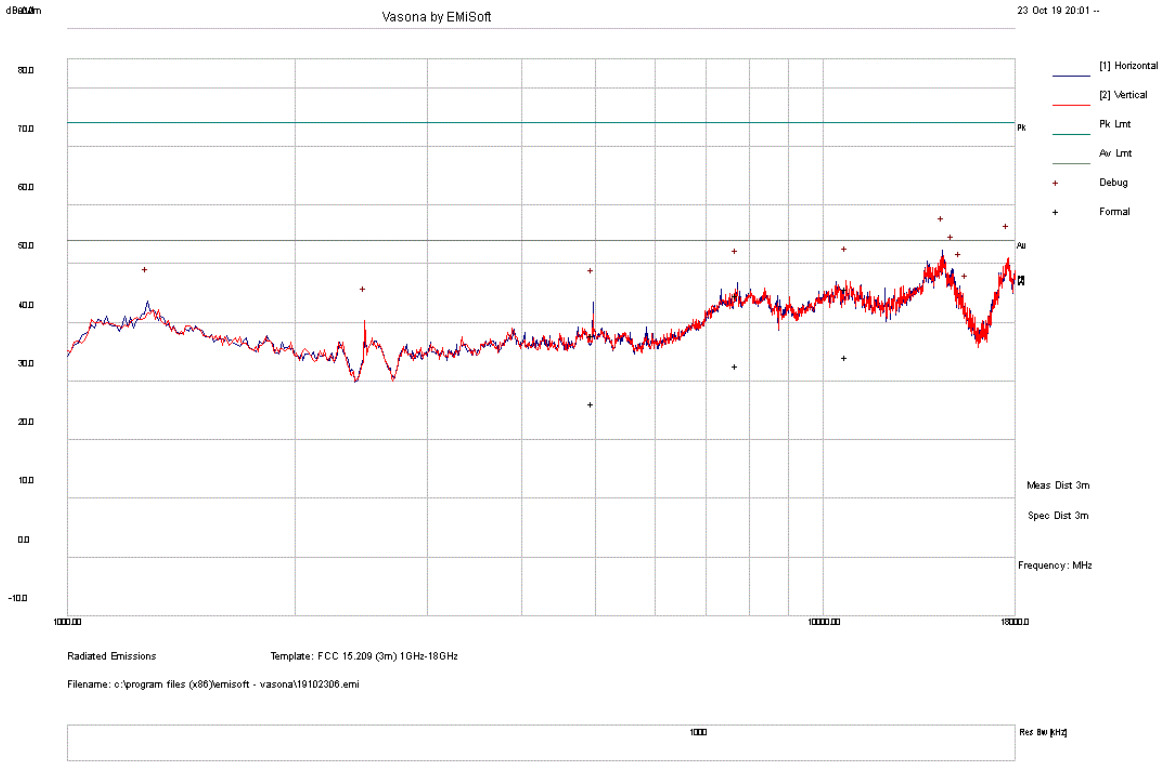
BT BDR 2441 MHz



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
7705.49	30.89	21.12	-7.20	44.81	Peak Max	H	370	14	74.00	-29.19	Pass
10861.93	27.50	23.66	-3.31	47.85	Peak Max	V	400	255	74.00	-26.15	Pass
4878.89	34.22	17.37	-13.27	38.32	Peak Max	H	202	292	74.00	-35.68	Pass
7705.49	18.75	21.12	-7.20	32.66	Average Max	H	370	14	54.00	-21.34	Pass
10861.93	14.49	23.66	-3.31	34.84	Average Max	V	400	255	54.00	-19.16	Pass
4878.89	22.41	17.37	-13.27	26.51	Average Max	H	202	292	54.00	-27.49	Pass

Test Standard:	15.209, 15.247	Mode:	BT BDR 2480 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

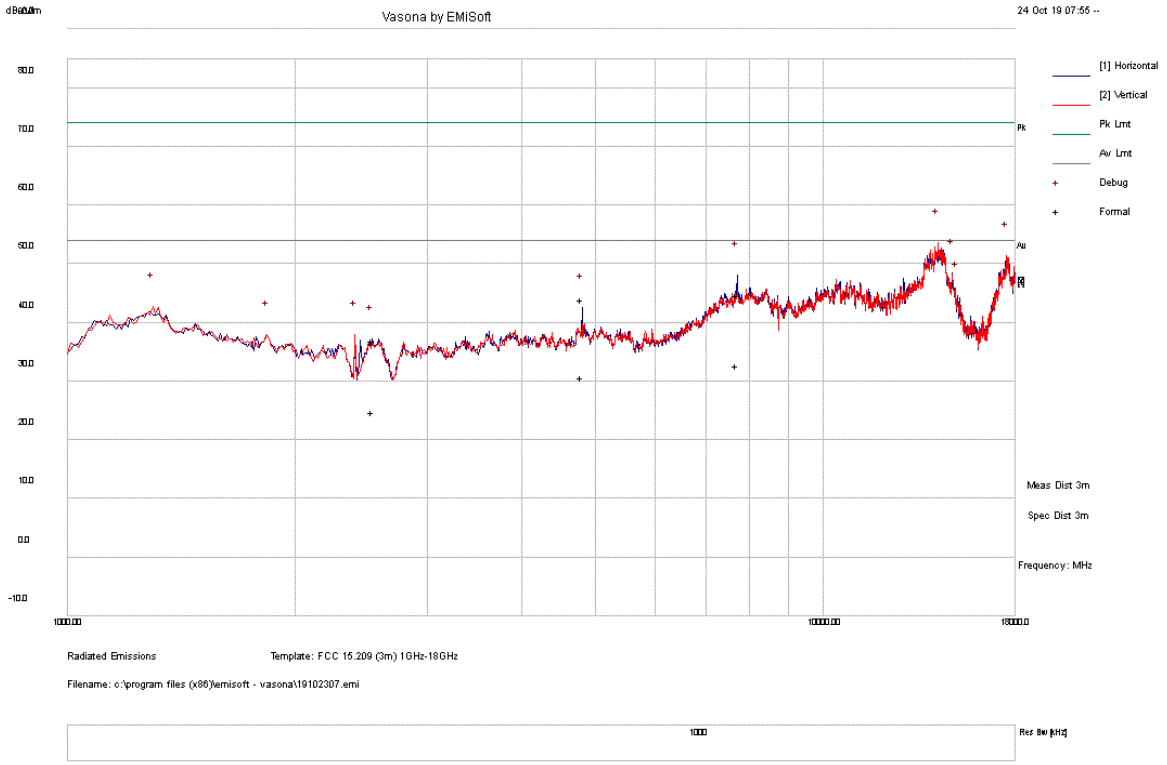
BT BDR 2480 MHz



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
10744.85	25.87	23.49	-3.57	45.79	Peak Max	V	137	7	74.00	-28.22	Pass
7705.91	30.82	21.12	-7.20	44.74	Peak Max	H	374	147	74.00	-29.27	Pass
4965.05	33.62	17.39	-13.22	37.79	Peak Max	H	358	0	74.00	-36.21	Pass
10744.85	14.25	23.49	-3.57	34.17	Average Max	V	137	7	54.00	-19.83	Pass
7705.91	18.77	21.12	-7.20	32.68	Average Max	H	374	147	54.00	-21.32	Pass
4965.05	22.06	17.39	-13.22	26.24	Average Max	H	358	0	54.00	-27.77	Pass

Test Standard:	15.209, 15.247	Mode:	BT EDR 2402 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

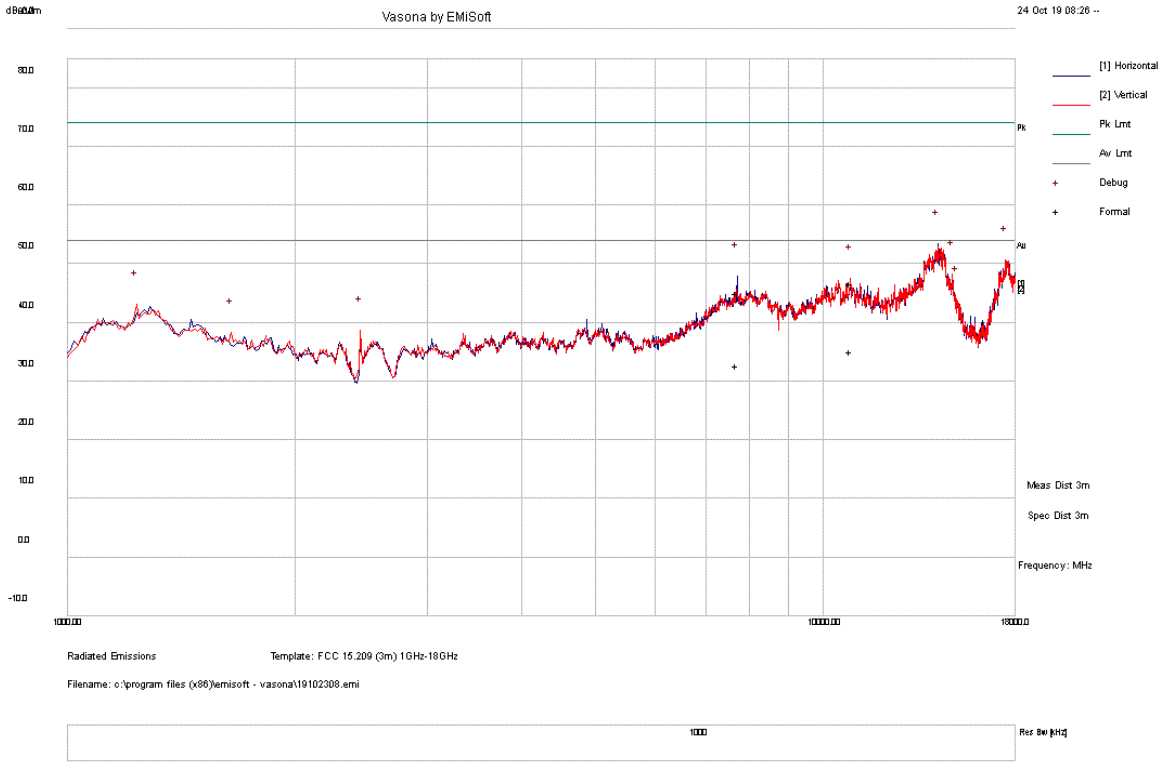
BT EDR 2402 MHz



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
7706.02	30.84	21.12	-7.20	44.76	Peak Max	H	198	67	74.00	-29.24	Pass
4803.91	39.99	17.35	-13.43	43.91	Peak Max	H	173	150	74.00	-30.09	Pass
2530.54	43.67	14.85	-21.66	36.86	Peak Max	H	385	74	74.00	-37.14	Pass
7706.02	18.85	21.12	-7.20	32.77	Average Max	H	198	67	54.00	-21.23	Pass
4803.91	26.69	17.35	-13.43	30.61	Average Max	H	173	150	54.00	-23.39	Pass
2530.54	31.53	14.85	-21.66	24.72	Average Max	H	385	74	54.00	-29.28	Pass

Test Standard:	15.209, 15.247	Mode:	BT EDR 2441 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

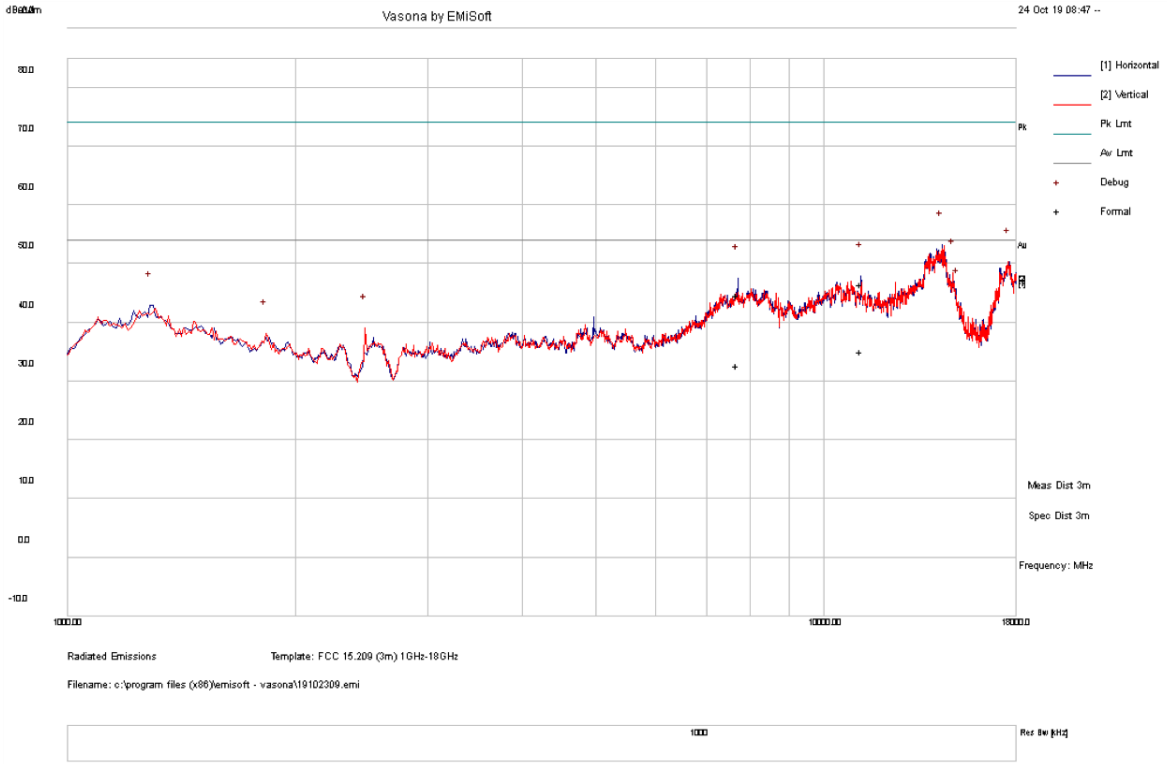
BT EDR 2441 MHz



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
7702.52	31.15	21.11	-7.21	45.06	Peak Max	H	288	114	74.00	-28.94	Pass
10893.56	26.25	23.71	-3.22	46.74	Peak Max	V	135	114	74.00	-27.26	Pass
7702.52	18.89	21.11	-7.21	32.79	Average Max	H	288	114	54.00	-21.21	Pass
10893.56	14.58	23.71	-3.22	35.07	Average Max	V	135	114	54.00	-18.93	Pass

Test Standard:	15.209, 15.247	Mode:	BT EDR 2480 MHz
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

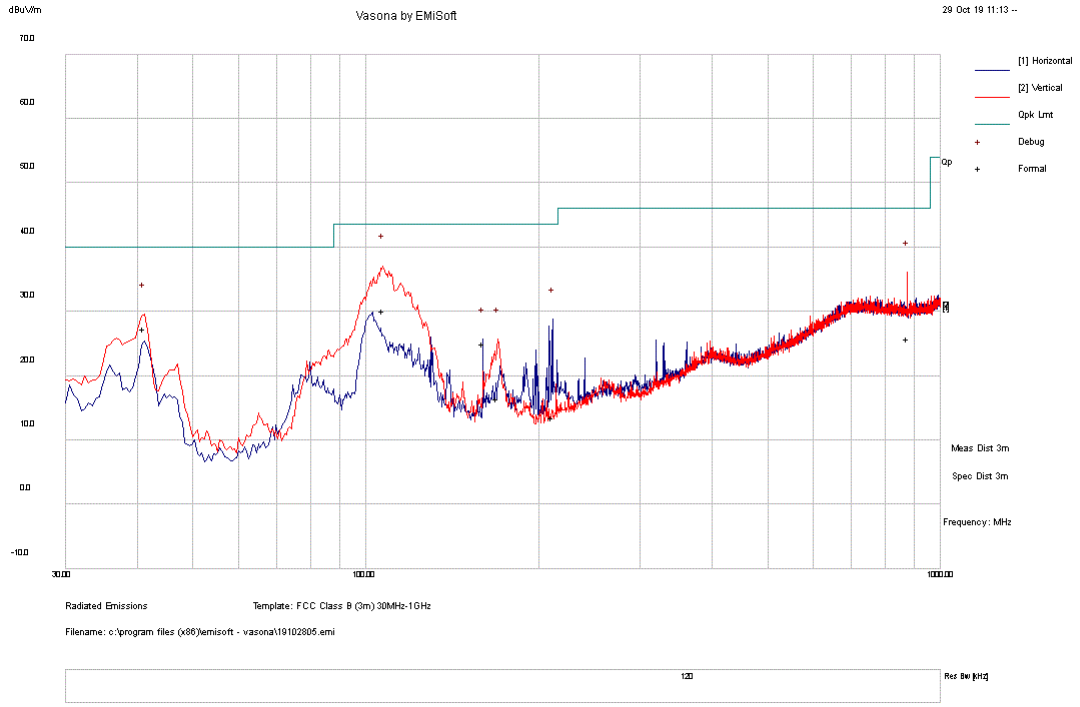
BT EDR 2480 MHz



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
11219.75	25.09	24.26	-2.86	46.48	Peak Max	H	148	328	74.00	-27.52	Pass
7705.81	30.69	21.12	-7.20	44.60	Peak Max	H	187	77	74.00	-29.40	Pass
11219.75	13.69	24.26	-2.86	35.09	Average Max	H	148	328	54.00	-18.91	Pass
7705.81	18.80	21.12	-7.20	32.72	Average Max	H	187	77	54.00	-21.28	Pass

Test Standard:	15.209, 15.247	Mode:	BT+WLAN+Cellular co-location
Frequency Range:	30 - 1000 MHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

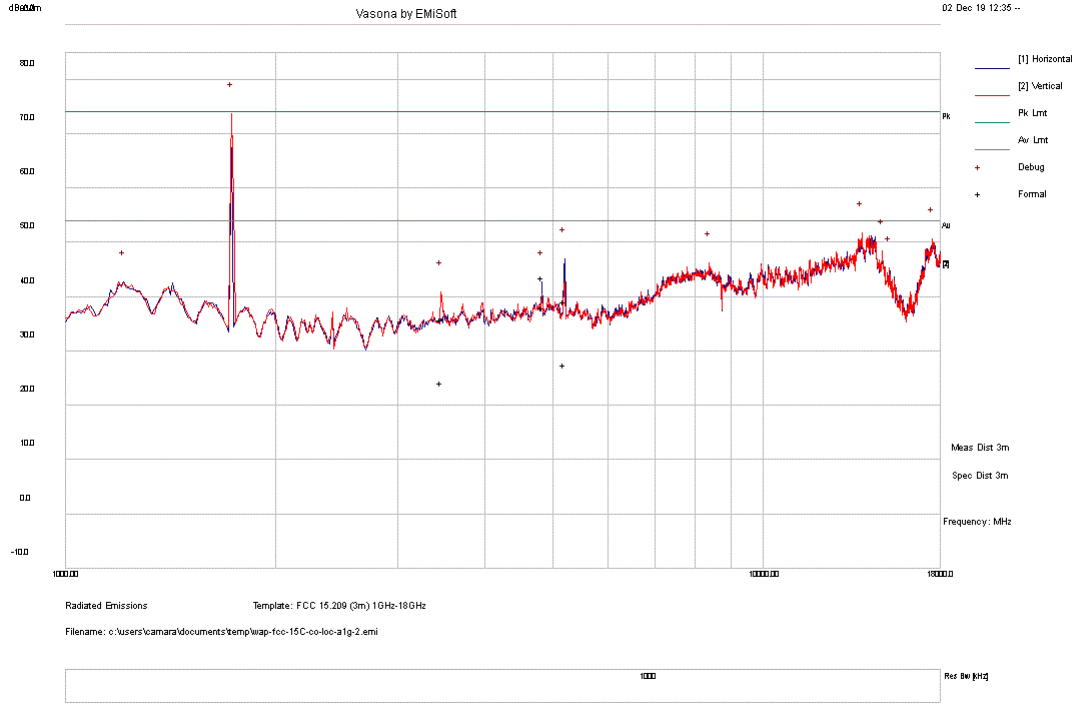
BT+WLAN+Cellular co-location



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
107.28	50.04	3.68	-23.49	30.23	Quasi Max	V	149	87	43.50	-13.27	Pass
875.27	25.41	7.52	-7.12	25.81	Quasi Max	V	163	144	46.00	-20.19	Pass
41.01	45.73	2.57	-20.99	27.31	Quasi Max	V	100	308	40.00	-12.69	Pass
211.26	29.79	4.86	-21.18	13.46	Quasi Max	H	103	84	43.50	-30.04	Pass
169.48	34.27	4.45	-22.22	16.51	Quasi Max	V	141	344	43.50	-26.99	Pass
160.0	43.08	4.35	-22.36	25.08	Quasi Max	H	206	174	43.50	-18.42	Pass

Test Standard:	15.209, 15.247	Mode:	BT+WLAN+Cellular co-location
Frequency Range:	1 - 18 GHz	Test Date:	10/22/2019 - 10/23/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Bruce Li
Remark:	N/A	Test Result:	Pass

BT+WLAN+Cellular co-location

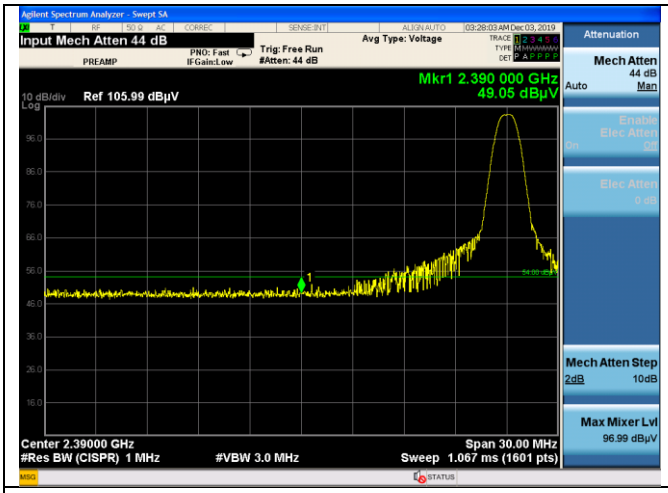


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
5199.20	34.4	17.5	-12.6	39.2	Peak Max	V	356	129	74	-34.8	Pass
4824.13	39.7	17.4	-13.4	43.7	Peak Max	V	101	156	74	-30.3	Pass
3456.57	38.1	15.8	-18.1	35.9	Peak Max	V	278	111	74	-38.1	Pass
5199.20	22.8	17.5	-12.6	27.6	Average Max	V	356	129	54	-26.4	Pass
4824.13	34.1	17.4	-13.4	38.1	Average Max	V	101	156	54	-15.9	Pass
3456.57	26.5	15.8	-18.1	24.2	Average Max	V	278	111	54	-29.8	Pass

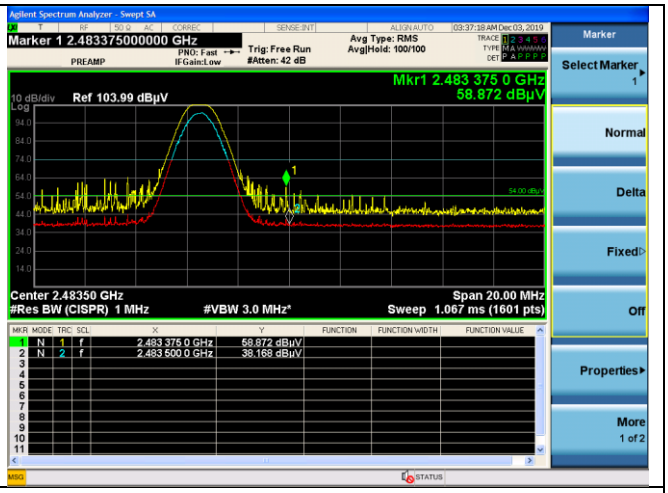
18GHz – 40GHz test result

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

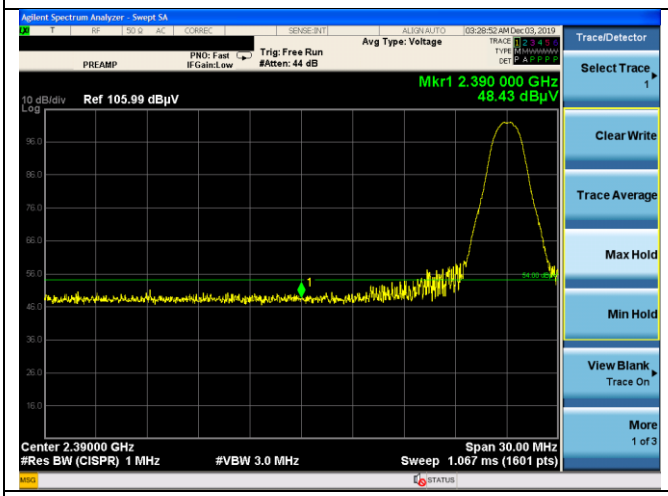
Restricted Band Measurement Plots:



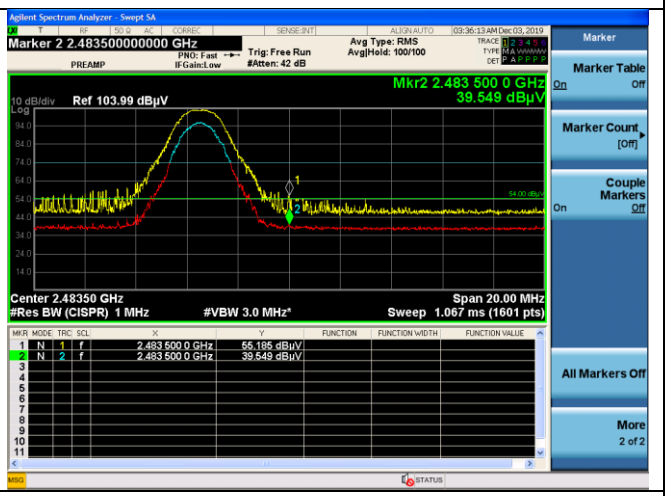
Band Edge - BT BDR Low CH



Band Edge - BT BDR High CH



Band Edge - BT EDR Low CH



Band Edge - BT EDR High CH

9 Test instrument list

Equipment	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	5/11/2019	5/11/2020
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	5/4/2019	5/4/2020
EMC Test Receiver	R&S	ESL6	100230	5/7/2019	5/7/2020
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	5/4/2019	5/4/2020
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2019	11/15/2020
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	5/2/2019	5/2/2020
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	5/2/2019	5/2/2020
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	5/10/2019	5/10/2020
True RMS Multi-meter	UNI-T	UT181A	C173014829	5/10/2019	5/10/2020
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	5/9/2019	5/9/2020
RF Attenuator	Pasternack	PE7005-3	VL061	5/10/2019	5/10/2020
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	5/10/2019	5/10/2020
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	5/9/2019	5/9/2020
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	5/10/2019	5/10/2020
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	5/10/2019	5/10/2020
RE test cable (>18GHz)	Sucoflex	104	344903/4	5/10/2019	5/10/2020
Pulse limiter	Com-Power	LIT-930A	531727	5/15/2019	5/15/2020
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	5/10/2019	5/10/2020
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	5/9/2019	5/9/2020
Wideband Communication	R&S	CMW500	147508	5/8/2019	5/8/2020