

FCC RF Test Report

Test Report Number	WAP-22021511-LC-FCC-IC-BT
FCC ID IC Applicant Applicant Address Product Name Model Name Model Number Date of Receipt Date of Test Report Issue Date Test Standards Test Result	KMH-14H317-NA1 1422A-14H317NA1 Ford Motor Company Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124 Vehicle Telematics Control Unit FNV3-B6-NA U5T-14H317-D 04/05/2022 05/17/2022 – 06/01/2022 06/03/2022 47 CFR Part 15.247 RSS 247 Issue2, February 2017 PASS
	Issued by: Vista Compliance Laboratories 1261 Puerta Del Sol, San Clemente, CA 92673 USA www.vista-compliance.com
 Devin Tai (Test Engineer)	 David Zhang (Technical Manager)
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REVISION HISTORY

Report Number	Version	Description	Issued Date
WAP-22021511-LC-FCC-IC-BT_Classic	01	Initial report	06/03/2022

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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 Telematics Control Unit
Mode Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Family Model Number	N/A
Serial Number	ANHGG22022104741, ANHGG22027104975 (Conducted), ANHGG22022104737, ANHGG21328102795 (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: UL: 1850- 1910MHz; DL: 1930-1990MHz WCDMA Band 4: UL: 1710- 1755MHz. DL: 2110-2155MHz WCDMA Band 5: UL: 824- 849MHz; DL: 869-894MHz LTE Band 2: UL: 1850-1910MHz; DL: 1930-1990MHz LTE Band 4: UL:1710-1755MHz; DL: 2110-2155MHz LTE Band 5: UL:824-849MHz; DL: 869-894MHz LTE Band 7: UL:2500-2570MHz; DL: 2620-2690MHz LTE Band 12: UL:699-716MHz; DL: 729-746MHz LTE Band 13: UL:777-787MHz; DL:746-756MHz LTE Band 17: UL: 704-716MHz; DL: 734-746MHz LTE Band 29: DL: 717-728MHz (UE Receive Only) LTE Band 38: UL: 2570-2620MHz; DL: 2570-2620MHz LTE Band 66: UL:1710-1780MHz; DL: 2110-2200MHz LTE Band 71: UL: 663-698MHz; DL: 617-652MHz 5G NR n2: UL: 1850-1910MHz; DL: 1930-1990MHz 5G NR n5: UL:824-849MHz; DL: 869-894MHz 5G NR n7: UL:2500-2570MHz; DL: 2620-2690MHz 5G NR n41: UL:2496-2690MHz; DL: 2496-2690MHz 5G NR n66: UL:1710-1780MHz; DL: 2110-2200MHz 5G NR n71: UL:663-698MHz; DL: 617-652MHz 5G NR n77-L: UL:3450-3550MHz; DL: 3450-3550MHz 5G NR n77-H: UL:3700-3980MHz; DL: 3700-3980MHz 5G NR n78-L: UL:3450-3550MHz; DL: 3450-3550MHz

	5G NR n78-H: UL: 3700-3800MHz; DL: 3700-3800MHz																													
Type of modulation	BT BDR/EDR: GFSK, $\pi/4$ DQPSK, 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, 64QAM, 256QAM 5G NR: Pi/2-BPSK, QPSK, 16QAM, 64QAM, 256QAM																													
Equipment Class/ Category	DSS, DTS, UNII, PCB																													
Maximum output power	See test result																													
Antenna Information	2 x Internal BT/WLAN PCB trace antenna Peak Gain: - 3.7 dBi @2.4GHz WiFi/Bluetooth, 6.4 dBi @5GHz WiFi																													
	Cellular External antennas: Peak Gain: 6 dBi @ 617 - 960 MHz 8 dBi @ 1710-2200MHz 8.5 dBi @ 2300-2700MHz 9.5 dBi @ 3300-4200MHz 11.0 dBi @ 4400-5000MHz																													
	Antenna connector type: quad mini-Fakra connector																													
	Modem 6 TCU will support 4 vehicle cellular antenna ports. The antenna port mapping is at below table,																													
	<table><tr><td>Antenna</td><td>LB</td><td>MB</td><td>HB</td><td>N77/78/79</td><td>N41</td></tr><tr><td>Antenna1</td><td>DRX</td><td>TX+PRX</td><td>TX+PRX</td><td>TX+PRX</td><td>TX+PRX</td></tr><tr><td>Antenna2</td><td>TX+PRX</td><td>DRX</td><td>DRX</td><td>DRX</td><td>DRX</td></tr><tr><td>Antenna3</td><td>-</td><td>MIMO</td><td>MIMO</td><td>MIMO</td><td>MIMO</td></tr><tr><td>Antenna4</td><td>-</td><td>MIMO</td><td>MIMO</td><td>MIMO</td><td>MIMO</td></tr></table>	Antenna	LB	MB	HB	N77/78/79	N41	Antenna1	DRX	TX+PRX	TX+PRX	TX+PRX	TX+PRX	Antenna2	TX+PRX	DRX	DRX	DRX	DRX	Antenna3	-	MIMO	MIMO	MIMO	MIMO	Antenna4	-	MIMO	MIMO	MIMO
Antenna	LB	MB	HB	N77/78/79	N41																									
Antenna1	DRX	TX+PRX	TX+PRX	TX+PRX	TX+PRX																									
Antenna2	TX+PRX	DRX	DRX	DRX	DRX																									
Antenna3	-	MIMO	MIMO	MIMO	MIMO																									
Antenna4	-	MIMO	MIMO	MIMO	MIMO																									

Note:

1. Antenna 1 and 3 go to the left-side rooftop external antenna (cellular antennas) and antenna 2 and 4 go to the right-side rooftop external antenna (cellular antennas). The cable length between left left-side and right-side rooftop external antenna are more than 20 cm.

2. Antenna 3 and 4 are for 4G-5G MIMO diversity only, no TX.

3. The antenna gain is declared by the manufacturer. Not all antennas support TX. The declared peak gain may have overestimated the TX gain of the single cellular antenna. For ERP/EIRP, radiated power will be measured in case when the calculated ERP/EIRP with declared antenna gain and measured conducted power is high.

4. For Bluetooth/WLAN, EUT has an option to use an external antenna with 10 dBi peak gain in 2.4GHz and 11 dBi gain in 5GHz. This antenna has not been evaluated in current report. However, the conservative 10 dBi gain (2.4GHz) and 11 dBi gain (5GH) are used for power related evaluation in current report.

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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	47 CFR Part 15.247 RSS-247 Issue 2, 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, Inc.
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www.vista-compliance.com

Test Condition	Temperature	Humidity	Atmospheric Pressure
RF Testing	23.2°C	57.5%	996 mbar
Radiated Emission Testing	23.2°C	57.5%	996 mbar

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 BT_Classic and Cellular radio, it's controlled by communication tester to change to different mode.

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

Software	Description
EMISoft Vasona	EMC/RF Spurious emission test software used during testing
Command prompt	Set the BT module communication with CMW500

4.2 EUT test mode

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

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4.3 Supporting Equipment

Description	Manufacturer	Model #	Serial #
AC/DC Adapter	MEAN WELL	GST60A12-P1J	EB74Q81066

5 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.

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 summary and result

7.1 Antenna Requirement

7.1.1 Requirement

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

7.1.2 Result

Analysis:

EUT has internal and optional 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.

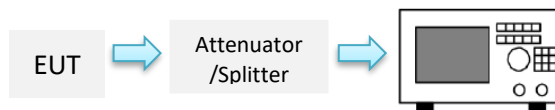
7.2 20 dB Bandwidth

7.2.1 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.

7.2.2 Test setup



7.2.3 Test Procedure

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

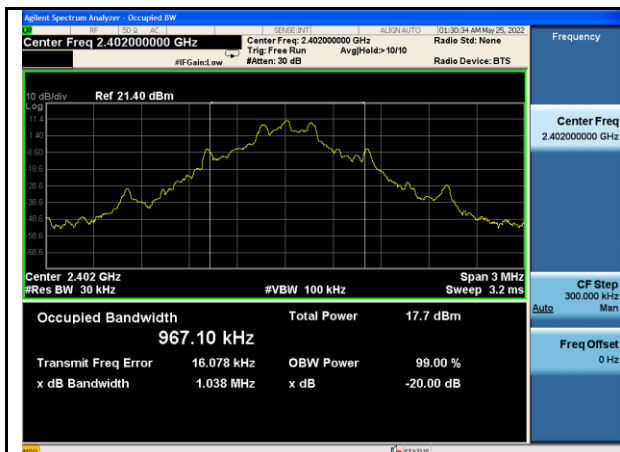
Measurement is made with the occupied bandwidth measurement function incorporated in spectrum analyzer. The following setting are used per ANSI C63.10-2013.

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).

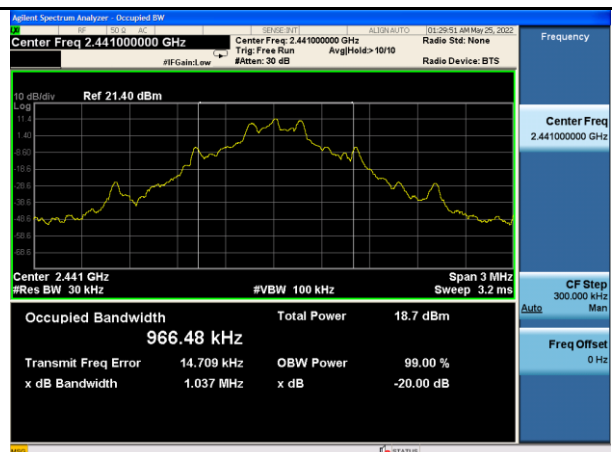
7.2.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Maximum Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	1038	N/A	Pass
BT-GFSK	2441	1Mbps	1037	N/A	Pass
BT-GFSK	2480	1Mbps	1037	N/A	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1284	N/A	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1309	N/A	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1284	N/A	Pass
BT-8DPSK	2402	3Mbps	1296	N/A	Pass
BT-8DPSK	2441	3Mbps	1299	N/A	Pass
BT-8DPSK	2480	3Mbps	1294	N/A	Pass

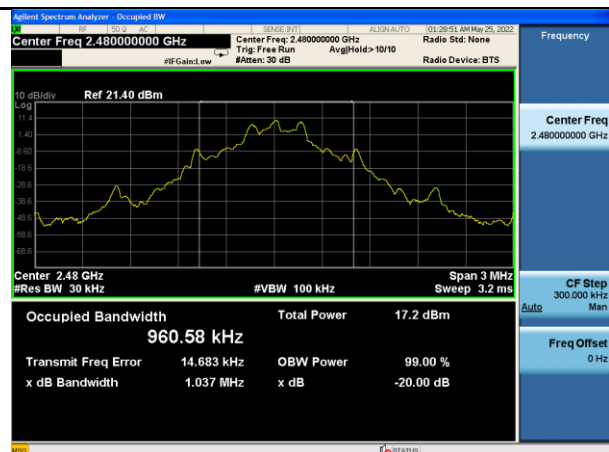
7.2.5 Test Plots



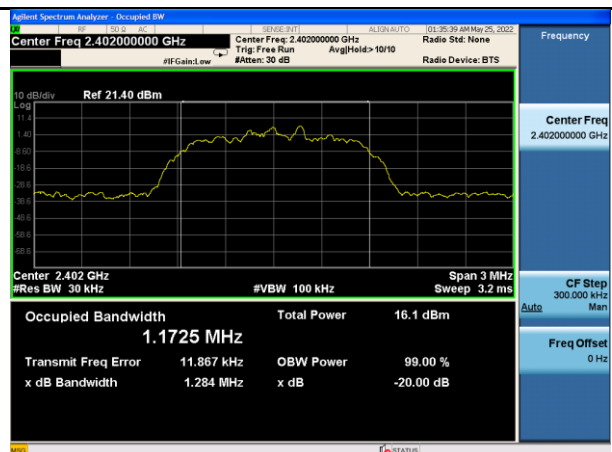
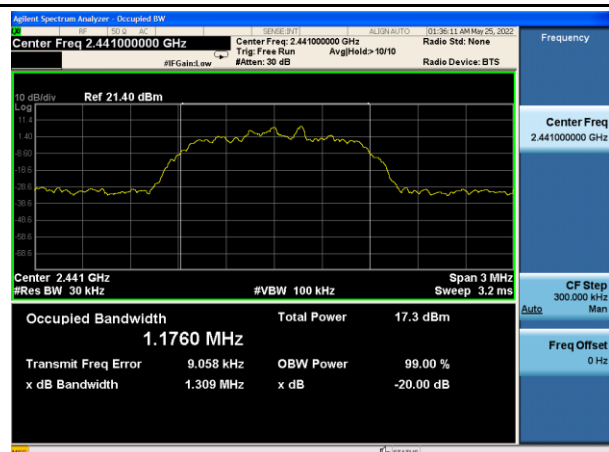
BT-GFSK-20 dB BW-Low



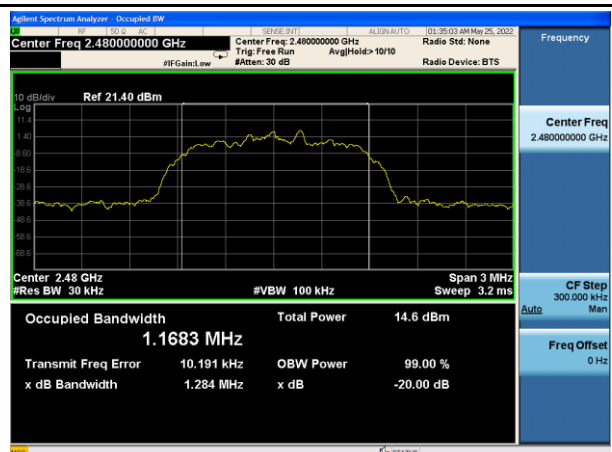
BT-GFSK-20 dB BW-Mid



BT-GFSK-20 dB BW-High

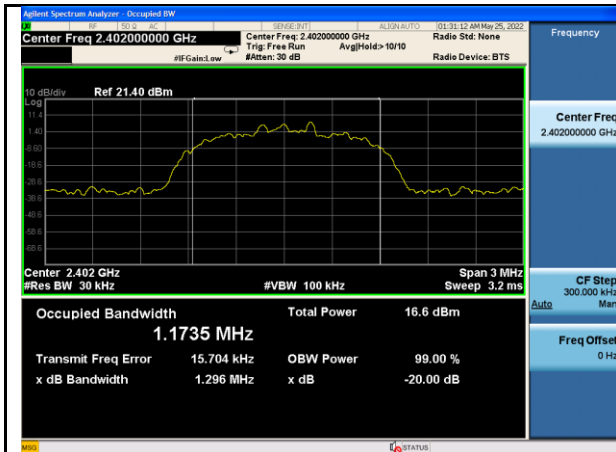
BT- $\pi/4$ DQPSK-20 dB BW-Low

BT- $\pi/4$ DQPSK-20 dB BW-Mid

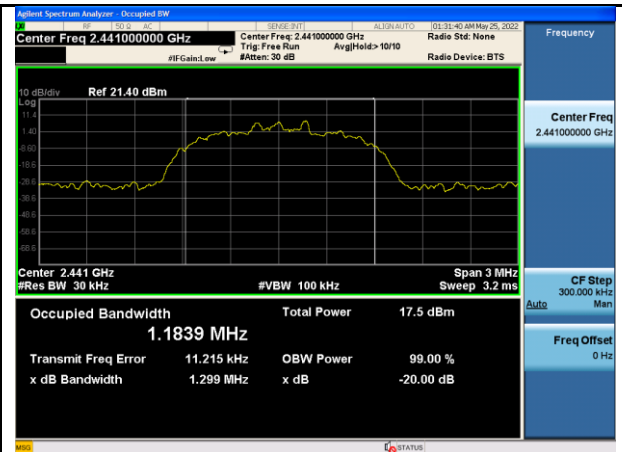


BT- $\pi/4$ DQPSK-20 dB BW-High

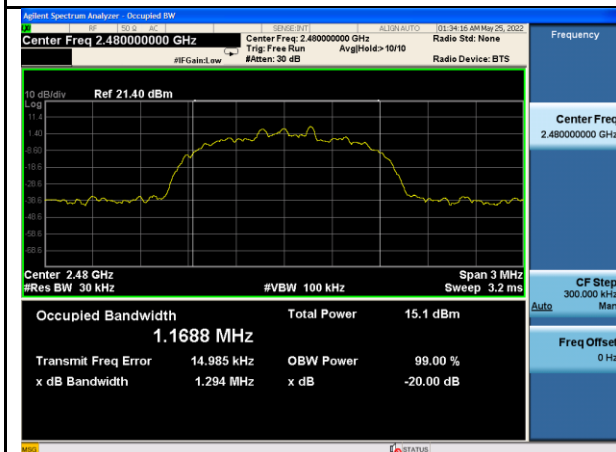
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BT-8DPSK-20 dB BW-Low



BT-8DPSK-20 dB BW-Mid



BT-8DPSK-20 dB BW-High

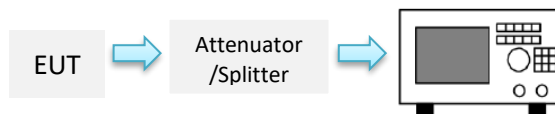
7.3 Occupied Bandwidth (99%)

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

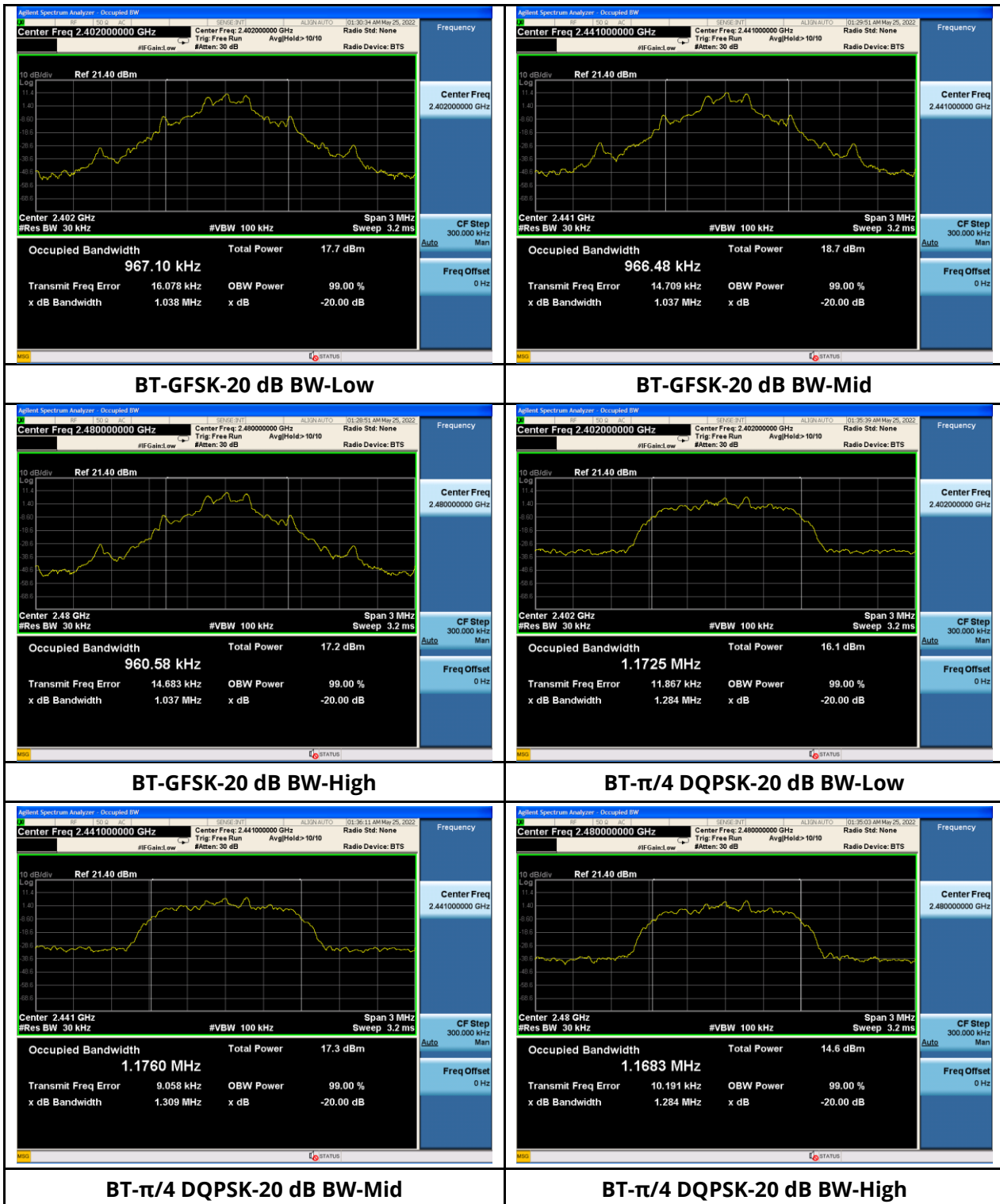
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW $\geq 3 \times$ RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using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

1. Set RBW = 1% to 5% of the actual occupied BW.
2. Set the video bandwidth (VBW) $\geq 3 \times$ 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.

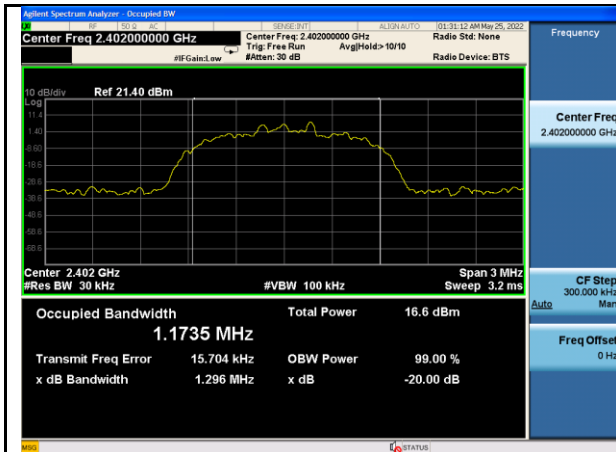
7.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured 99% OBW (KHz)	Limit (KHz)	Result
BT-GFSK	2402	1Mbps	967.10	N/A	Pass
BT-GFSK	2441	1Mbps	966.48	N/A	Pass
BT-GFSK	2480	1Mbps	950.58	N/A	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1172.5	N/A	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1176.0	N/A	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1168.3	N/A	Pass
BT-8DPSK	2402	3Mbps	1173.5	N/A	Pass
BT-8DPSK	2441	3Mbps	1183.9	N/A	Pass
BT-8DPSK	2480	3Mbps	1168.8	N/A	Pass

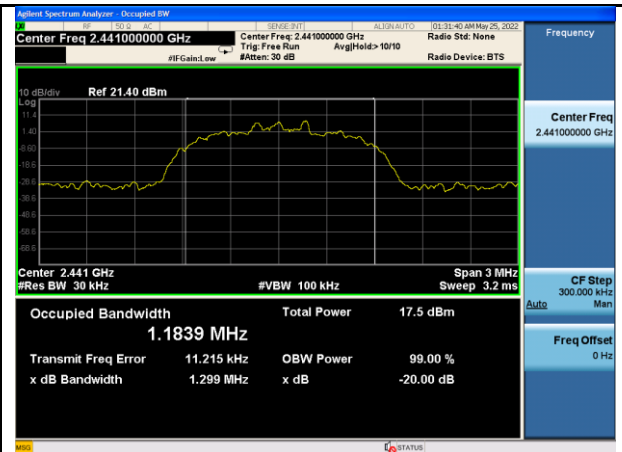
7.3.5 Test Plots



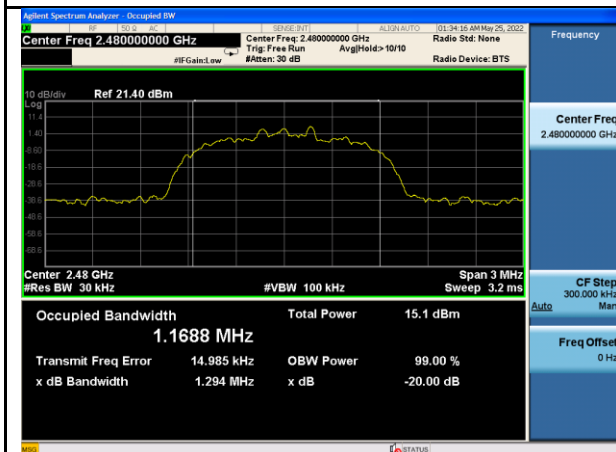
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BT-8DPSK-20 dB BW-Low



BT-8DPSK-20 dB BW-Mid



BT-8DPSK-20 dB BW-High

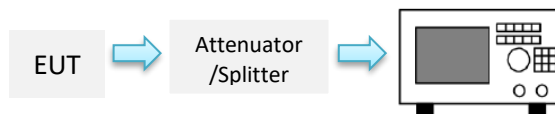
7.4 Number of Hopping Channel

7.4.1 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.

7.4.2 Test setup



7.4.3 Test Procedure

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

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

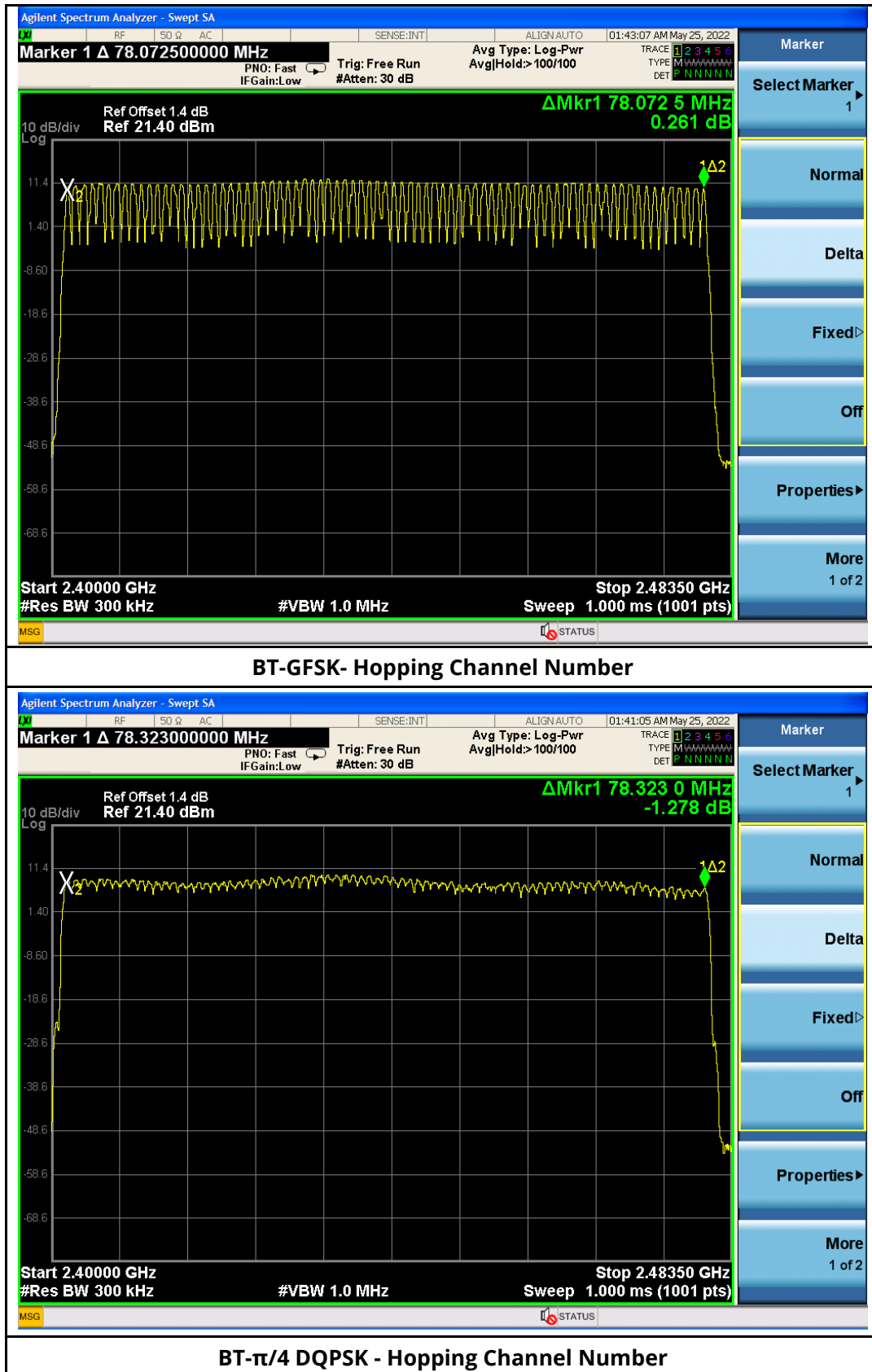
1. Set Span to be the frequency band of operation.
2. Set RBW to less 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW $\geq$ RBW.
4. Sweep: Auto.
5. Detector function: Peak.
6. Trace: Max hold.
7. Allow the trace to stabilize.

7.4.4 Test Result

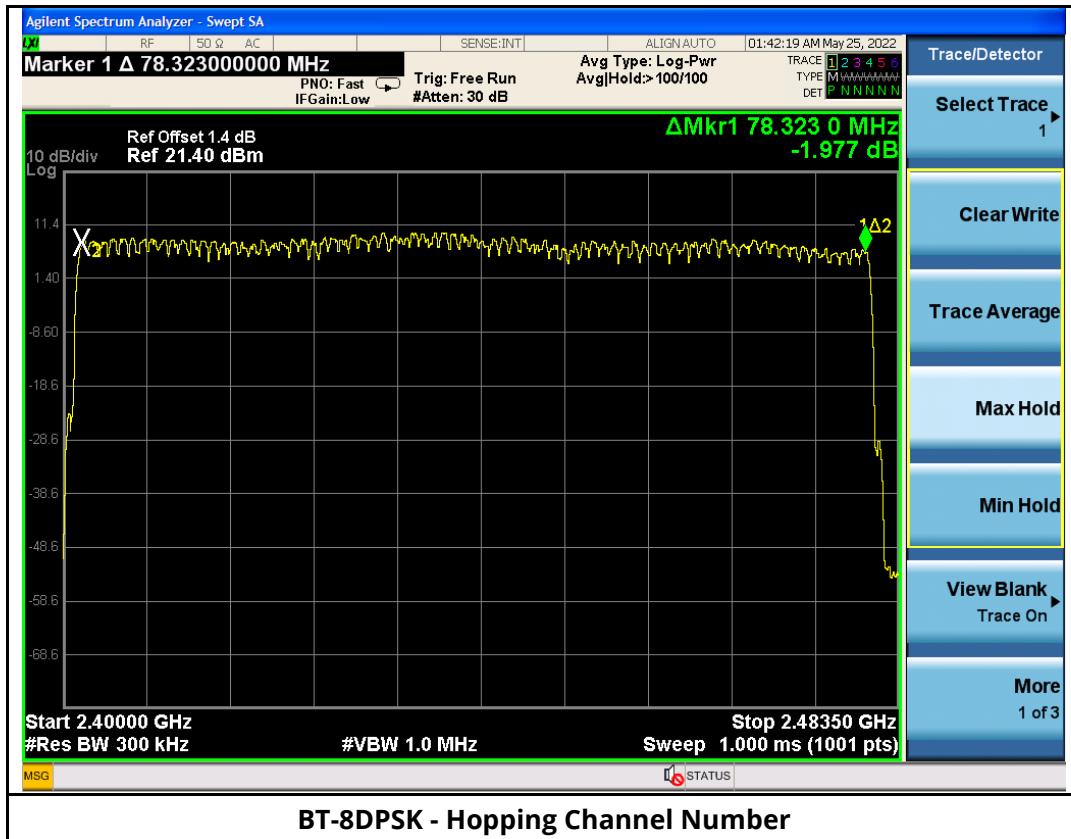
Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Number	Minimum Limit	Result
BT-GFSK	2441	1Mbps	79	15	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	79	15	Pass
BT-8DPSK	2441	3Mbps	79	15	Pass

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7.4.5 Test Plots



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7.5 Maximum Output Power

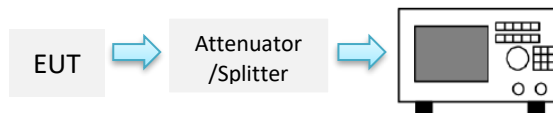
7.5.1 Requirement

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.

7.5.2 Test setup



7.5.3 Test Procedure

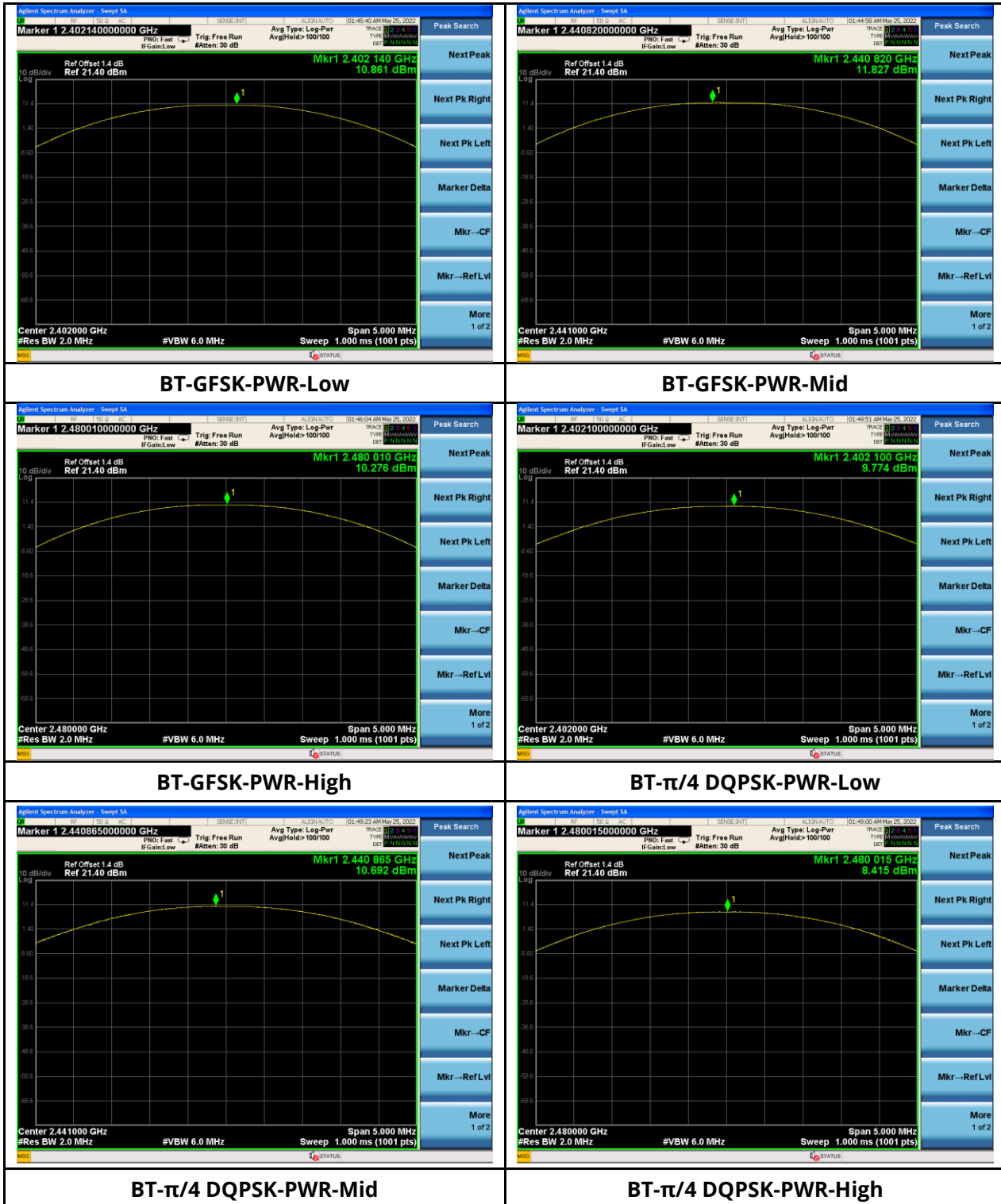
According to section 7.8.5 of ANSI C63.10-2013. The measurement was made with EUT directly connected to spectrum analyzer. The following setting is used.

1. Set the RBW > 20 dB BW
2. Set VBW $\geq$ 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.

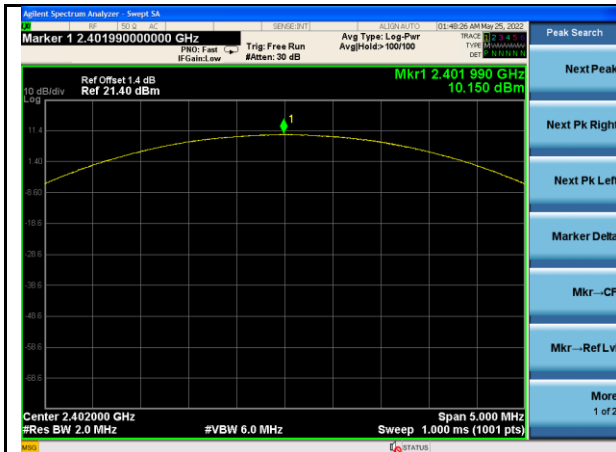
7.5.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Maximum Output Power (dBm)	Result
BT-GFSK	2402	1Mbps	10.861	21	Pass
BT-GFSK	2441	1Mbps	11.827	21	Pass
BT-GFSK	2480	1Mbps	10.276	21	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	9.774	21	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	10.692	21	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	8.415	21	Pass
BT-8DPSK	2402	3Mbps	10.150	21	Pass
BT-8DPSK	2441	3Mbps	11.026	21	Pass
BT-8DPSK	2480	3Mbps	8.871	21	Pass

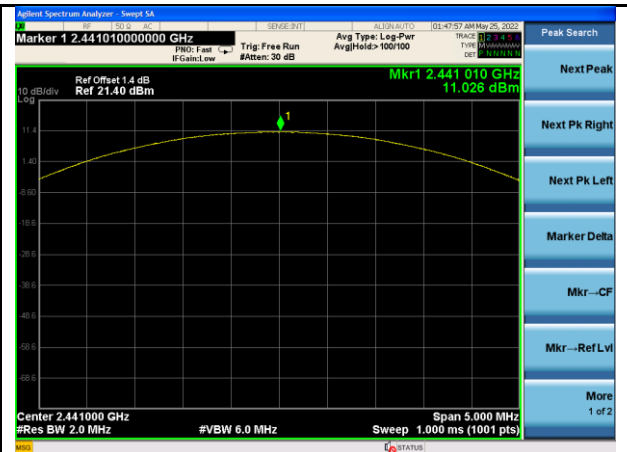
7.5.5 Test Plots



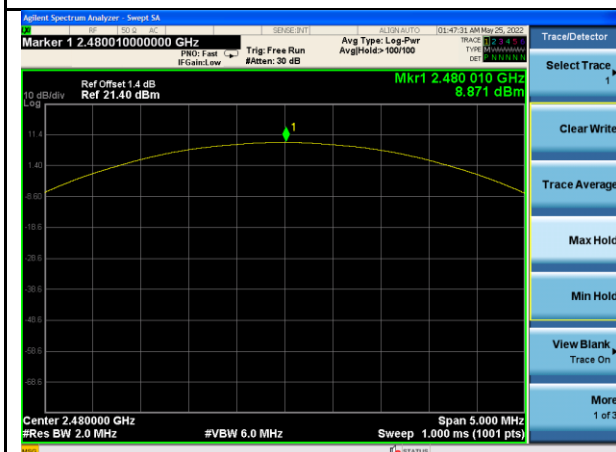
Report# WAP-22021511-LC-FCC-IC-BT



BT-8DPSK-PWR-Low



BT-8DPSK-PWR-Mid



BT-8DPSK-PWR-High

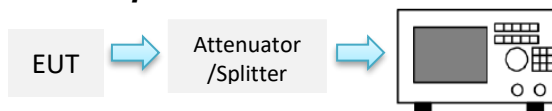
7.6 Channel Separation

7.6.1 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.

7.6.2 Test setup



7.6.3 Test Procedure

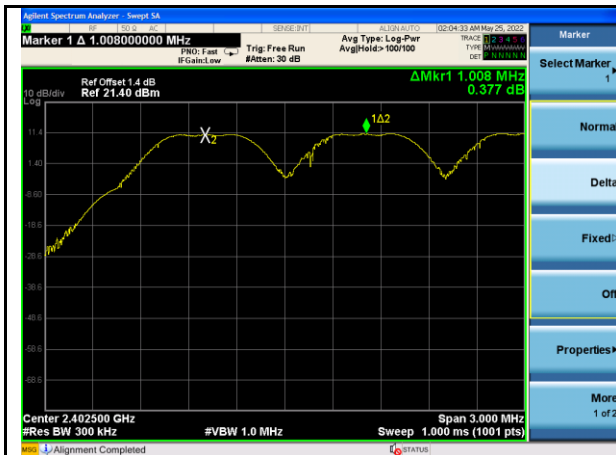
According to section 7.8.2 of ANSI C63.10-2013. The measurement was made with spectrum analyzer. The following setting is used.

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 $\geq$ 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.

7.6.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Separation (KHz)	2/3 of 20 dB Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	1008	672	Pass
BT-GFSK	2441	1Mbps	1005	670	Pass
BT-GFSK	2480	1Mbps	1002	668	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1002	668	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1005	670	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1008	672	Pass
BT-8DPSK	2402	3Mbps	1002	668	Pass
BT-8DPSK	2441	3Mbps	1005	670	Pass
BT-8DPSK	2480	3Mbps	1002	668	Pass

7.6.5 Test Plots



BT-GFSK-Channel Separation-Low



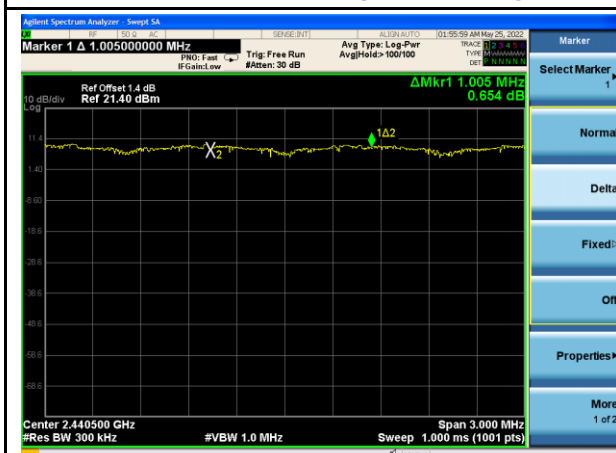
BT-GFSK-Channel Separation-Mid



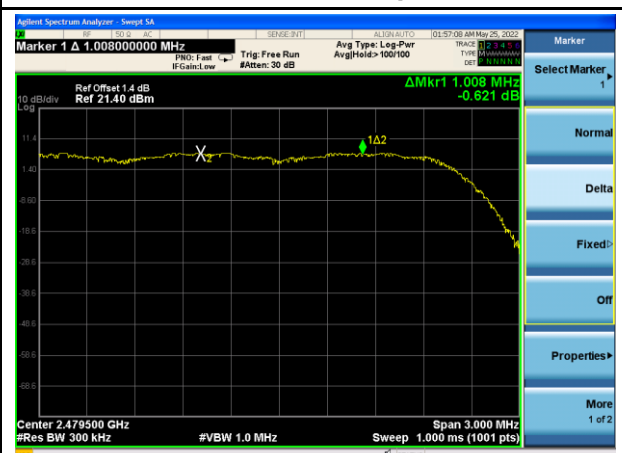
BT-GFSK-Channel Separation-High



BT- $\pi/4$ DQPSK-Channel Separation-Low

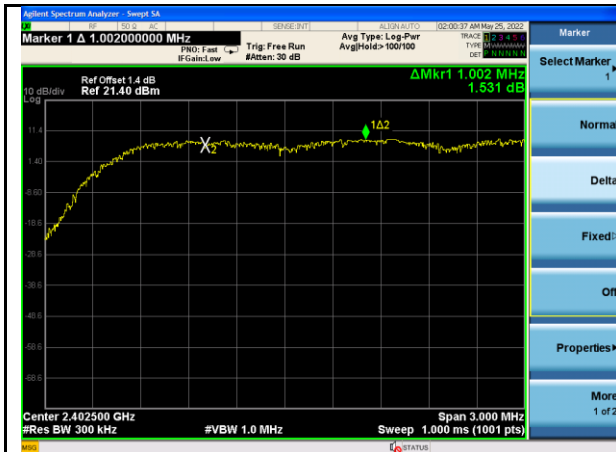


BT- $\pi/4$ DQPSK-Channel Separation-Mid

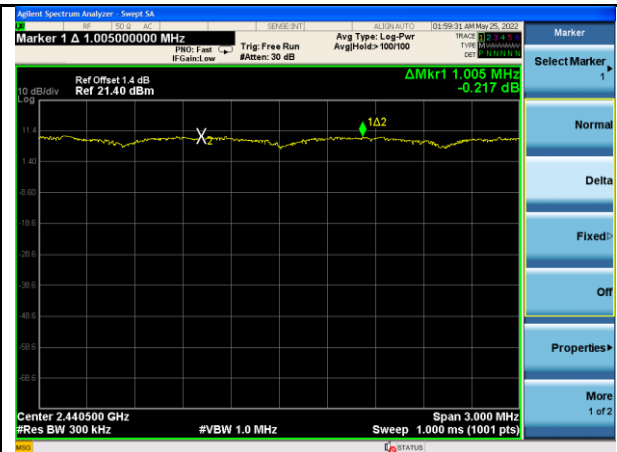


BT- $\pi/4$ DQPSK-Channel Separation-High

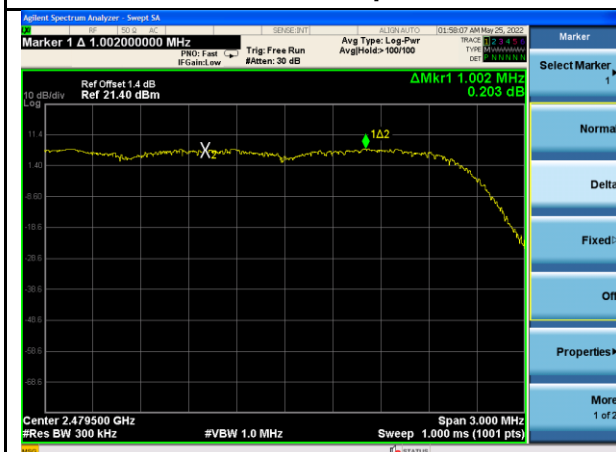
Report# WAP-22021511-LC-FCC-IC-BT



BT-8DPSK-Channel Separation-Low



BT-8DPSK-Channel Separation-Mid



BT-8DPSK-Channel Separation-High

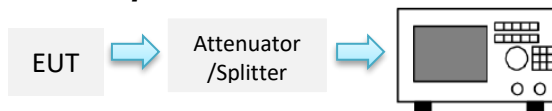
7.7 Time of Occupancy

7.7.1 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.

7.7.2 Test setup



7.7.3 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 $\leq$ channel spacing.
3. VBW $\geq$ 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.

7.7.4 Test Result

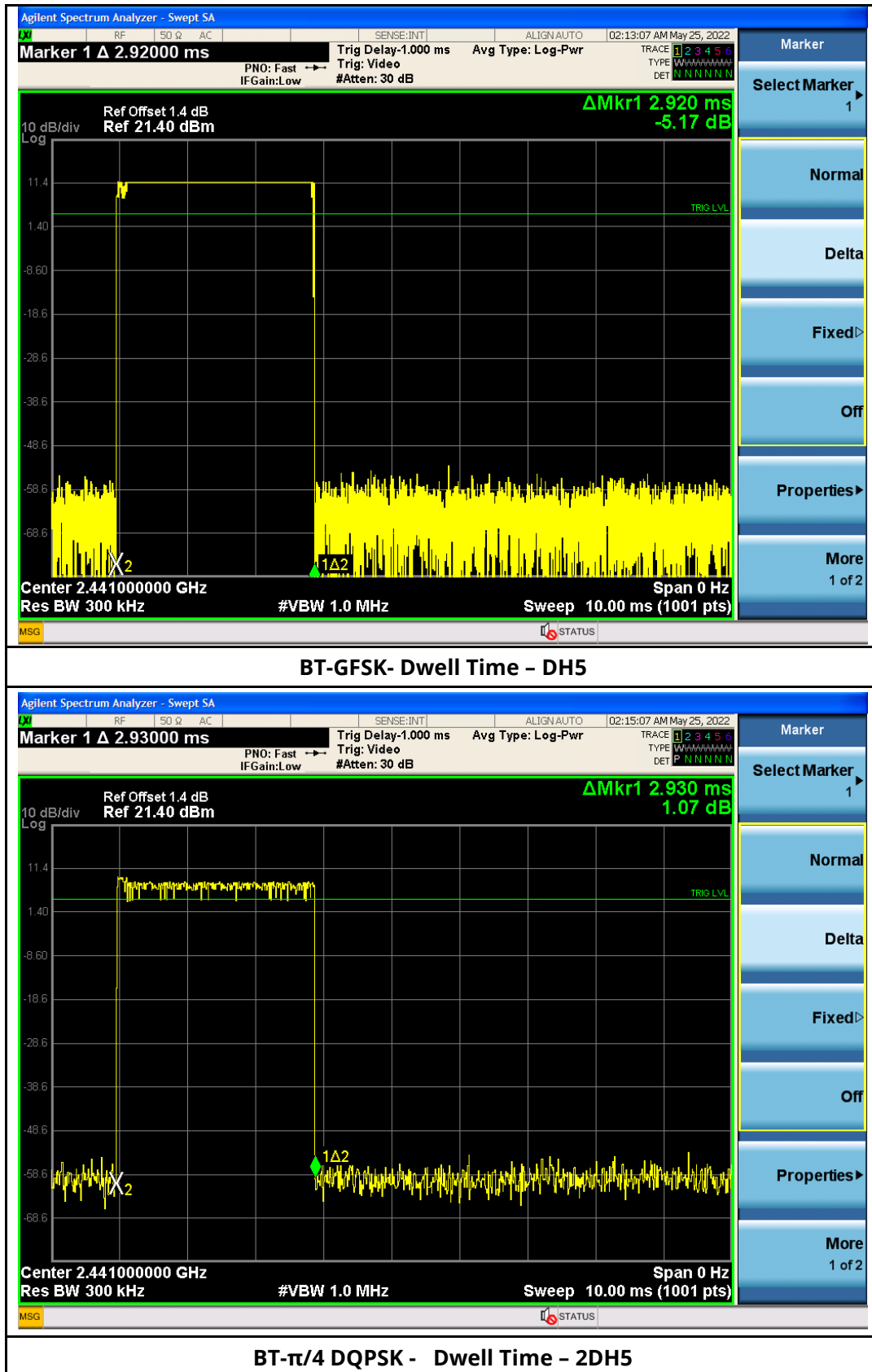
Mode/ Bandwidth	Frequency (MHz)	Data rate	Packet	Burst Width (ms/hop/ch)	Dwell Time (s)	Limit (s)	Result
BT-GFSK	2441	1Mbps	DH5	2.92	0.311	≤0.4	Pass
BT-π/4 DQPSK	2441	2Mbps	2DH5	2.93	0.313	≤0.4	Pass
BT-8DPSK	2441	3Mbps	3DH5	2.94	0.314	≤0.4	Pass

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

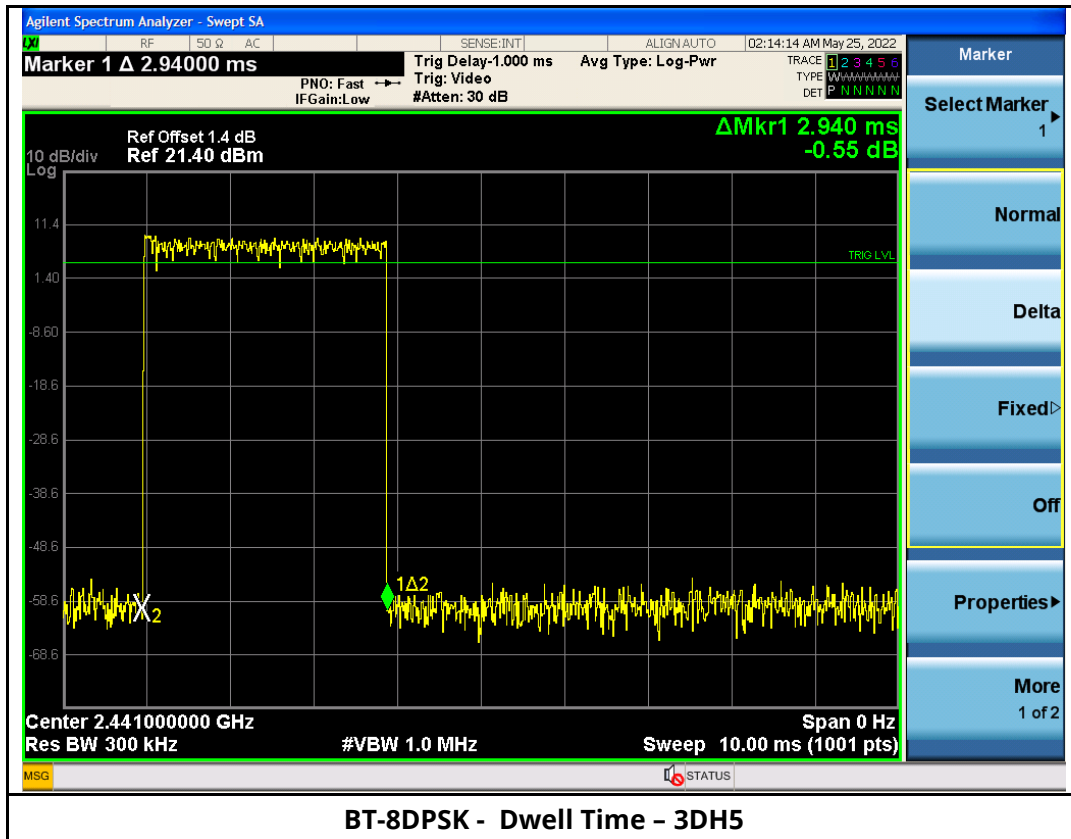
DH5 Dwell time = Burst Width (ms) * (1600/ (6*79)) *31.6

Report# WAP-22021511-LC-FCC-IC-BT

7.7.5 Test Plots



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7.8 Conducted Band-Edge & Unwanted Emissions Measurement

7.8.1 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.

7.8.2 Test setup



7.8.3 Test Procedure

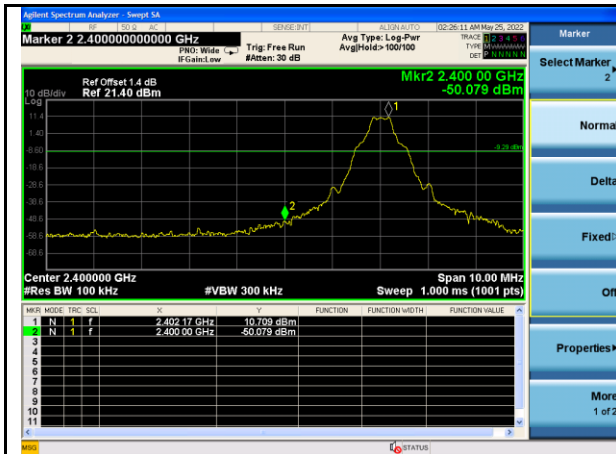
According to section 7.8.8 of ANSI C63.10-2013.

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.

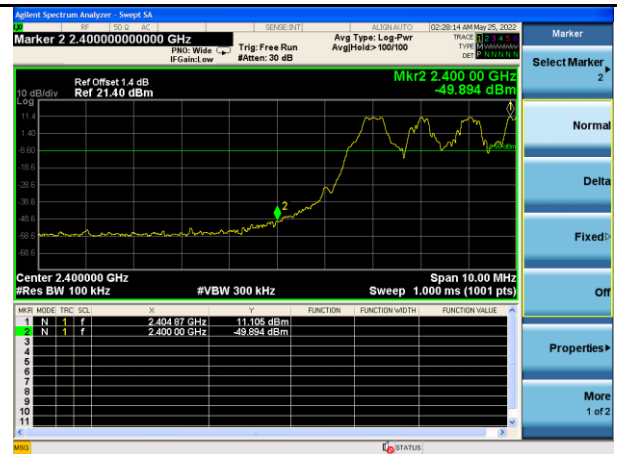
7.8.4 Test Result

See test plots

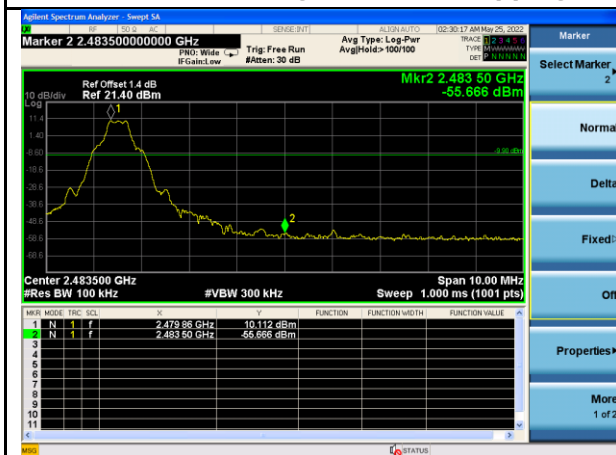
7.8.5 Test plots



BT-GFSK-Band Edge-Low-Non hopping



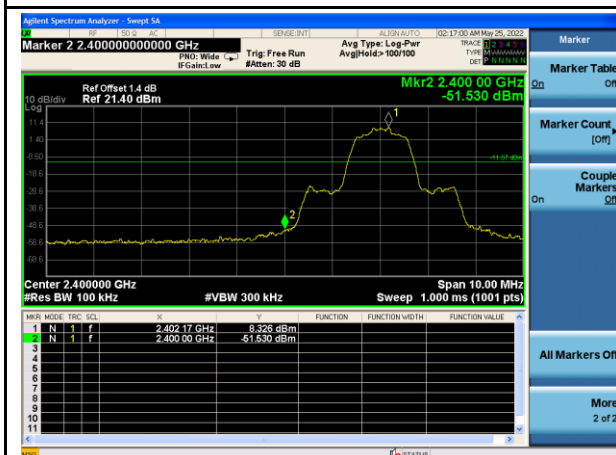
BT-GFSK-Band Edge-Low-Hopping



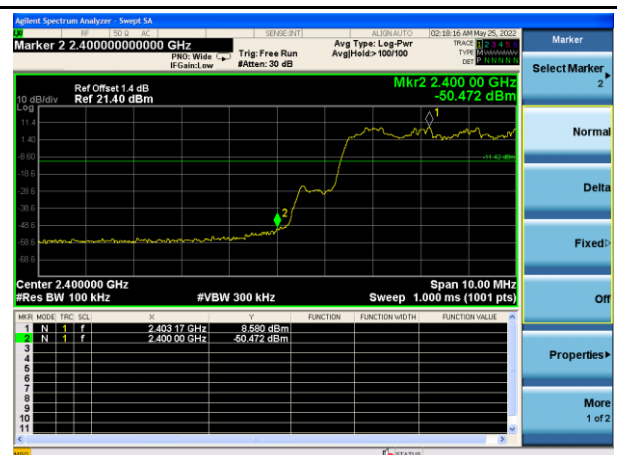
BT-GFSK-Band Edge-High-Non hopping



BT-GFSK-Band Edge-High-Hopping

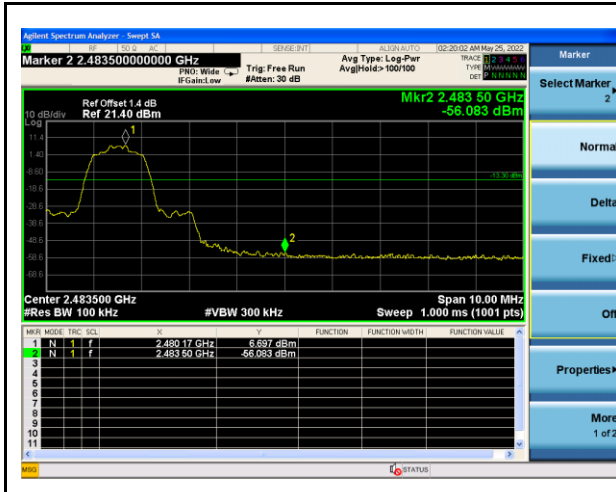


BT- $\pi/4$ DQPSK-Band Edge-Low-Non hopping

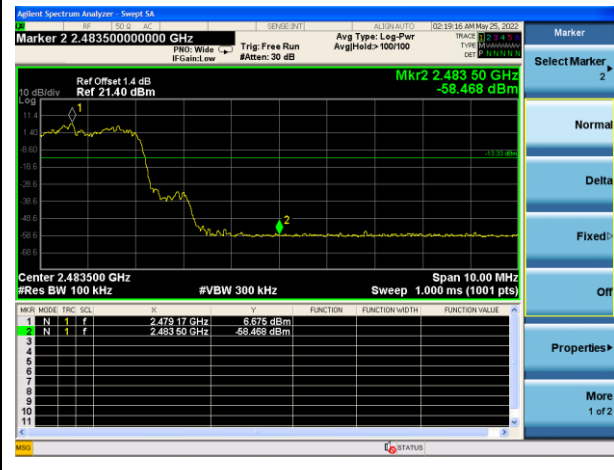


BT- $\pi/4$ DQPSK-Band Edge-Low-Hopping

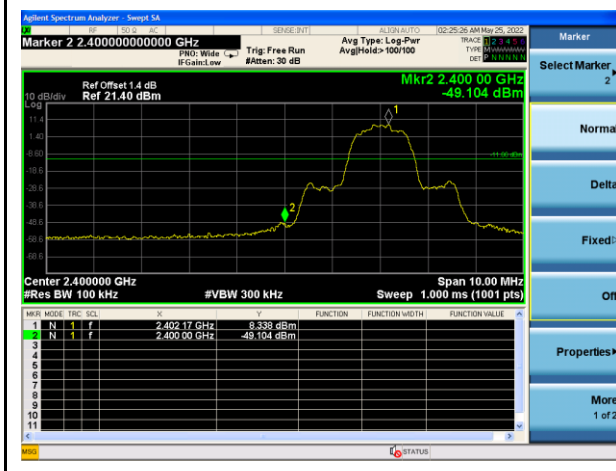
Report# WAP-22021511-LC-FCC-IC-BT



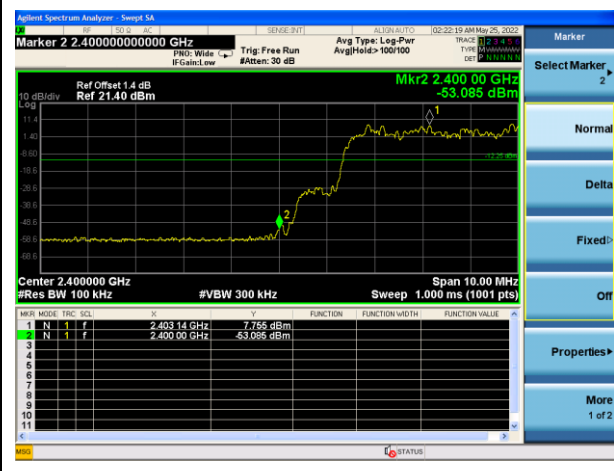
BT- $\pi/4$ DQPSK-Band Edge-High-Non hopping



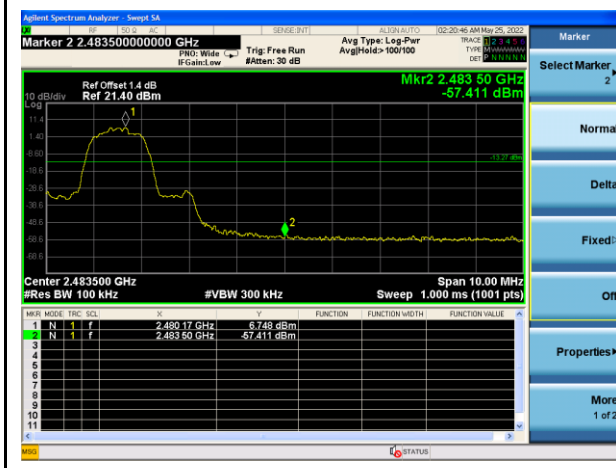
BT- $\pi/4$ DQPSK-Band Edge-High-Hopping



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



BT-8DPSK-Band Edge-Low-Hopping

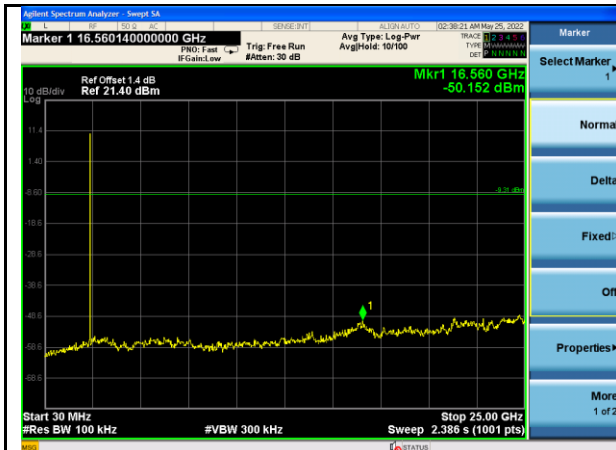


BT-8DPSK-Band Edge-High-Non hopping



BT-8DPSK-Band Edge-High-Hopping

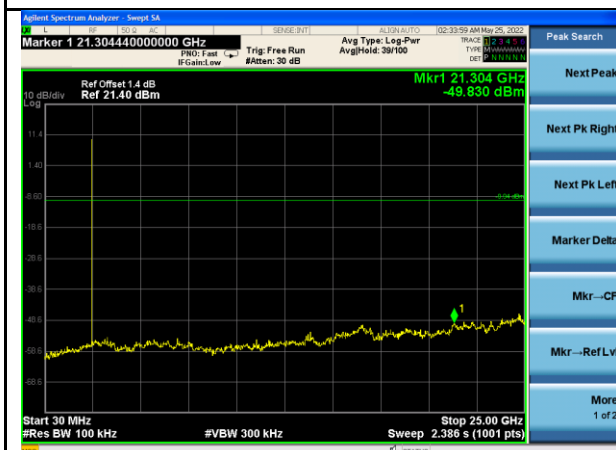
Report# WAP-22021511-LC-FCC-IC-BT



BT-GFSK-CSE-Low



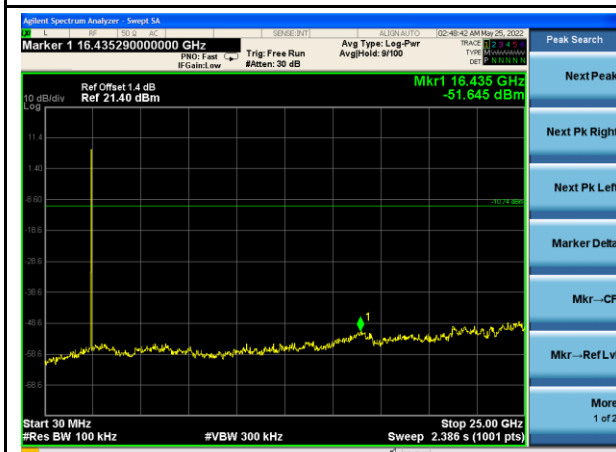
BT-GFSK-CSE-Mid



BT-GFSK-CSE-High



BT- $\pi/4$ DQPSK-CSE-Low



BT- $\pi/4$ DQPSK-CSE-Mid



BT- $\pi/4$ DQPSK-CSE-High

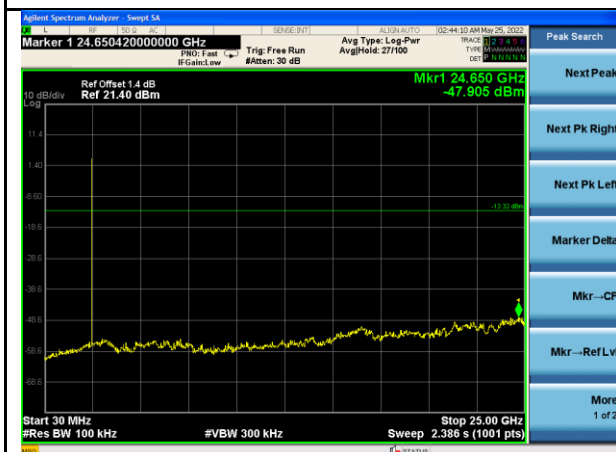
Report# WAP-22021511-LC-FCC-IC-BT



BT-8DPSK-CSE-Low



BT-8DPSK-CSE-Mid



BT-8DPSK-CSE-High

7.9 Frequency Hopping System Requirement

7.9.1 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.

7.9.2 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.

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

7.10.1 Requirement

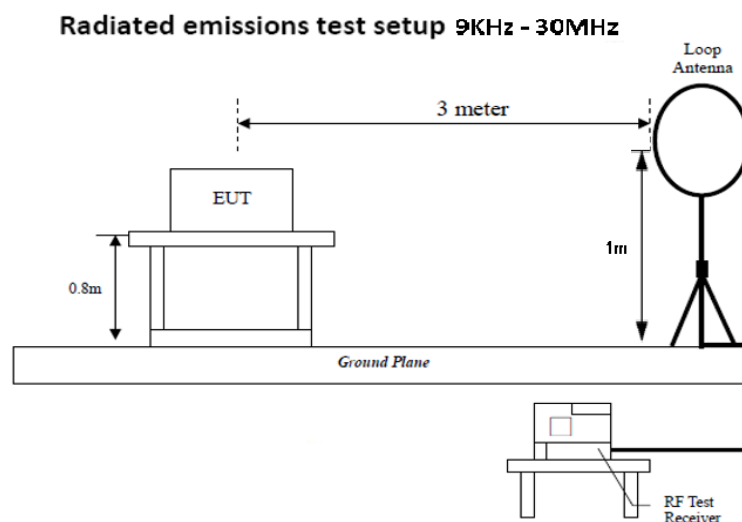
§ 15.247 (d), RSS-247 §5.5

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.

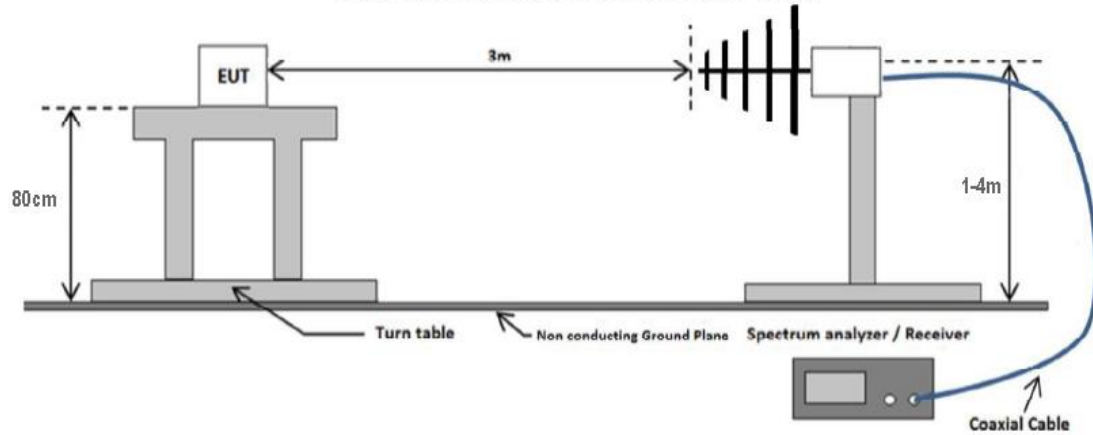
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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

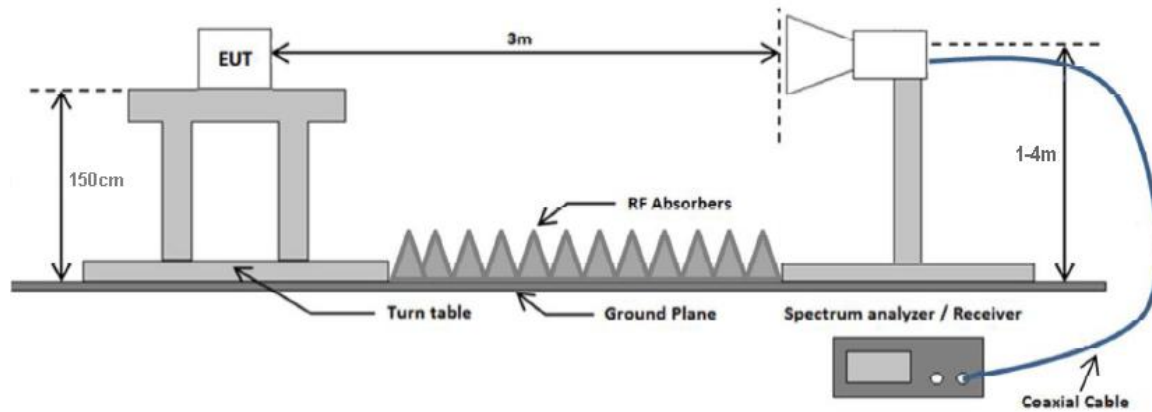
7.10.2 Test setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



7.10.3 **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.

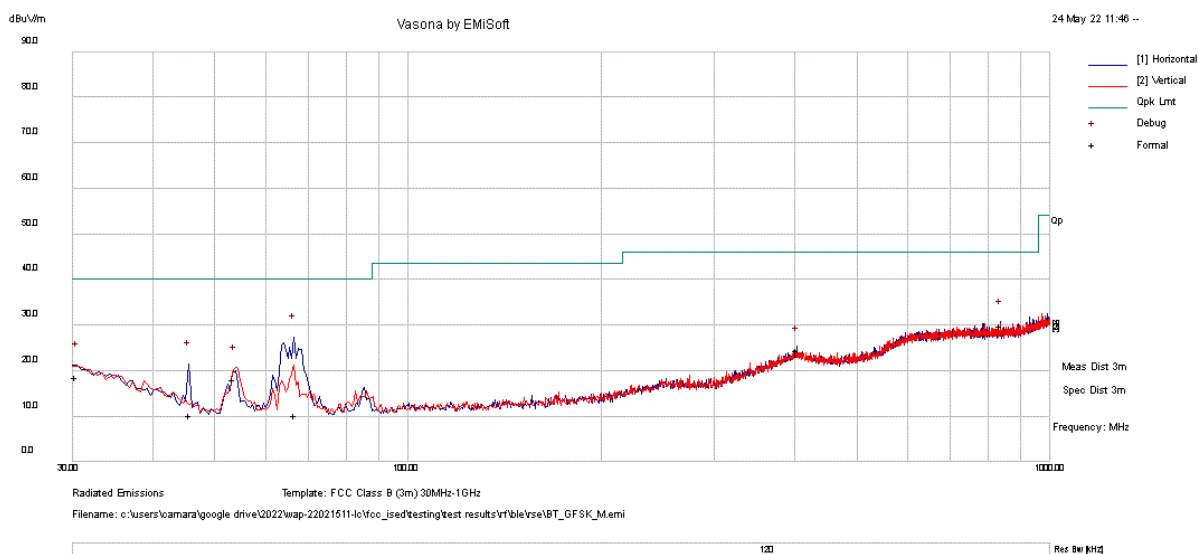
7.10.4 Test Result

Radiated Emission between 9KHz – 30MHz test result

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

RADIATED EMISSIONS BELOW 1 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	GFSK
Frequency Range:	30 MHz - 1 GHz	Test Date:	12/06/2021
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	
1	66.617	27.6	3.1	-20.3	10.4	Quasi Max	H	101	44	40	-29.6	Pass
2	836.933	26.5	7.4	-4	29.9	Quasi Max	V	152	320	46	-16.1	Pass
3	45.757	27.3	2.7	-19.7	10.3	Quasi Max	H	168	143	40	-29.7	Pass
4	30.447	28.1	2.2	-11.8	18.6	Quasi Max	H	259	100	40	-21.4	Pass
5	53.607	36.3	2.9	-20.9	18.3	Quasi Max	V	107	143	40	-21.7	Pass
6	403.38	26.1	6.4	-8	24.4	Quasi Max	H	339	217	46	-21.6	Pass

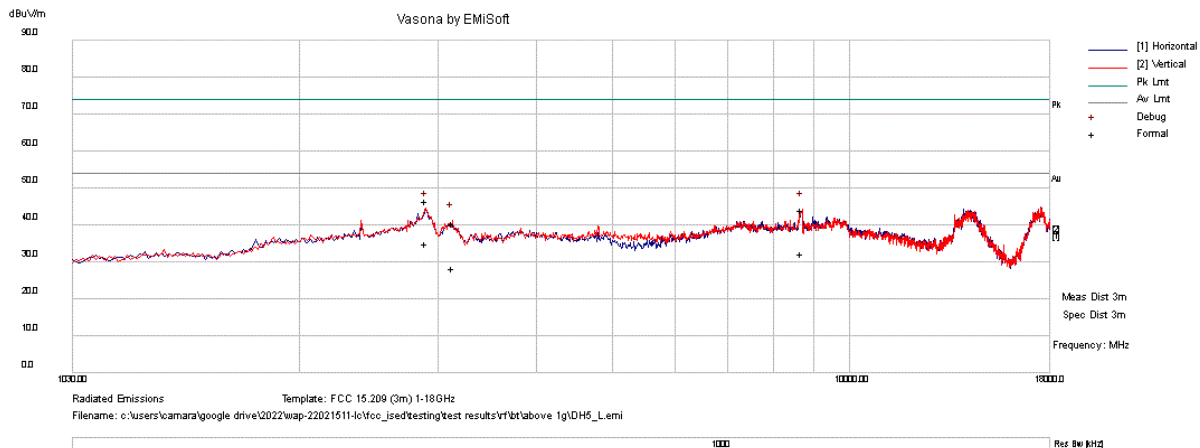
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	GFSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2895.278	20.7	21.9	3.8	46.4	Peak Max	V	100	44	74	-27.7	Pass
2	8707.11	32.1	17.6	-5.7	44	Peak Max	V	163	244	74	-30	Pass
3	3131.433	35.8	7.1	-2.4	40.5	Peak Max	V	370	13	74	-33.5	Pass
4	2895.278	9.4	21.9	3.8	35.1	Average Max	V	100	44	54	-18.9	Pass
5	8707.11	20.4	17.6	-5.7	32.3	Average Max	V	163	244	54	-21.7	Pass
6	3131.433	23.7	7.1	-2.4	28.4	Average Max	V	370	13	54	-25.6	Pass

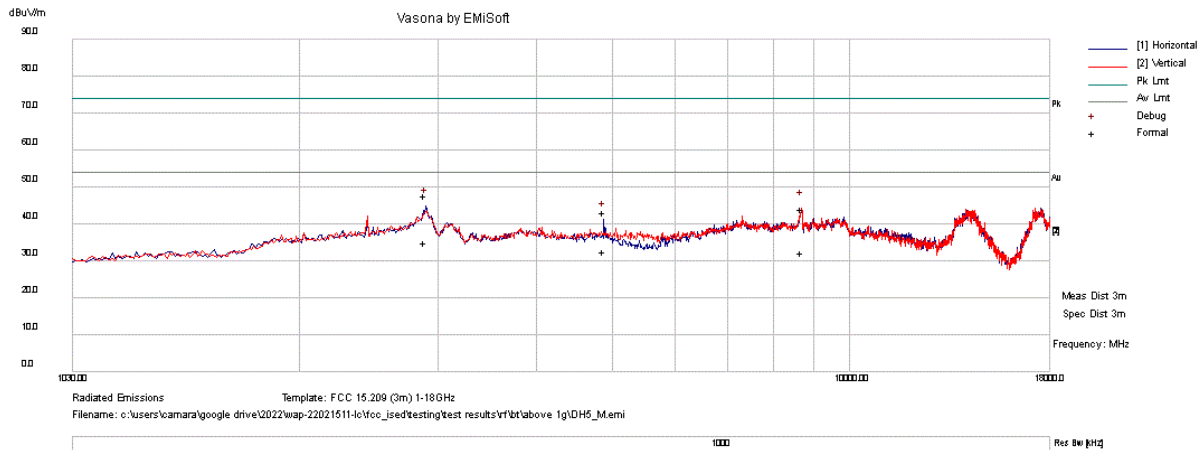
Remarks:

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

Report#	WAP-22021511-LC-FCC-IC-BT
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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	GFSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2894.858	22	21.9	3.8	47.7	Peak Max	H	207	326	74	-26.3	Pass
2	8697.664	31.9	17.8	-5.7	44.1	Peak Max	V	313	128	74	-29.9	Pass
3	4881.916	39.5	9.1	-5.5	43.1	Peak Max	H	226	332	74	-30.9	Pass
4	2894.858	9.3	21.9	3.8	35	Average Max	H	207	326	54	-19	Pass
5	8697.664	20.2	17.8	-5.7	32.3	Average Max	V	313	128	54	-21.7	Pass
6	4881.916	29.1	9.1	-5.5	32.7	Average Max	H	226	332	54	-21.3	Pass

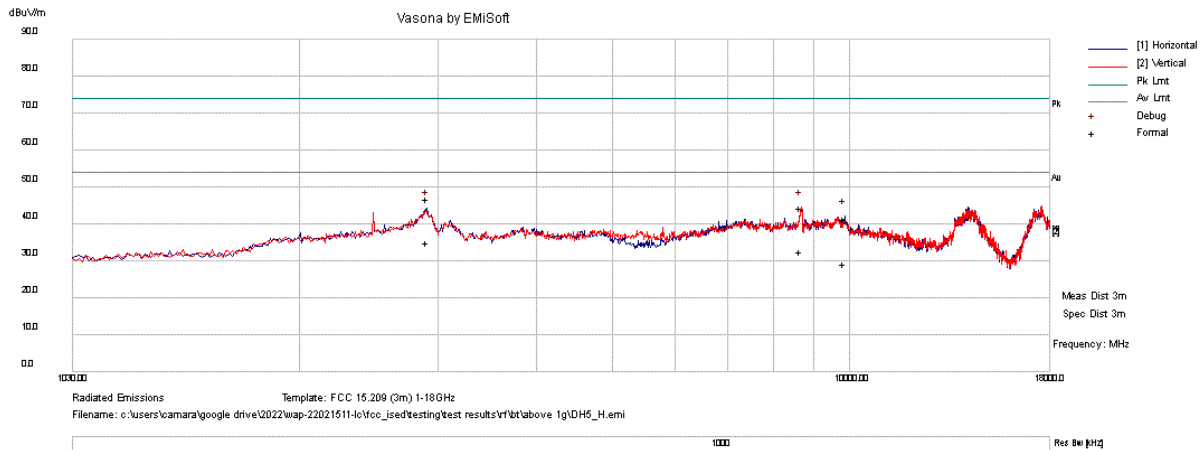
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	GFSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8688.31	32.6	17.4	-5.7	44.3	Peak Max	V	107	0	74	-29.7	Pass
2	2908.259	22.3	20.6	3.9	46.8	Peak Max	H	264	322	74	-27.2	Pass
3	9865.989	32.2	14.4	-5.2	41.4	Peak Max	H	243	222	74	-32.6	Pass
4	8688.31	20.7	17.4	-5.7	32.4	Average Max	V	107	0	54	-21.6	Pass
5	2908.259	10.3	20.6	3.9	34.8	Average Max	H	264	322	54	-19.2	Pass
6	9865.989	19.9	14.4	-5.2	29.1	Average Max	H	243	222	54	-24.9	Pass

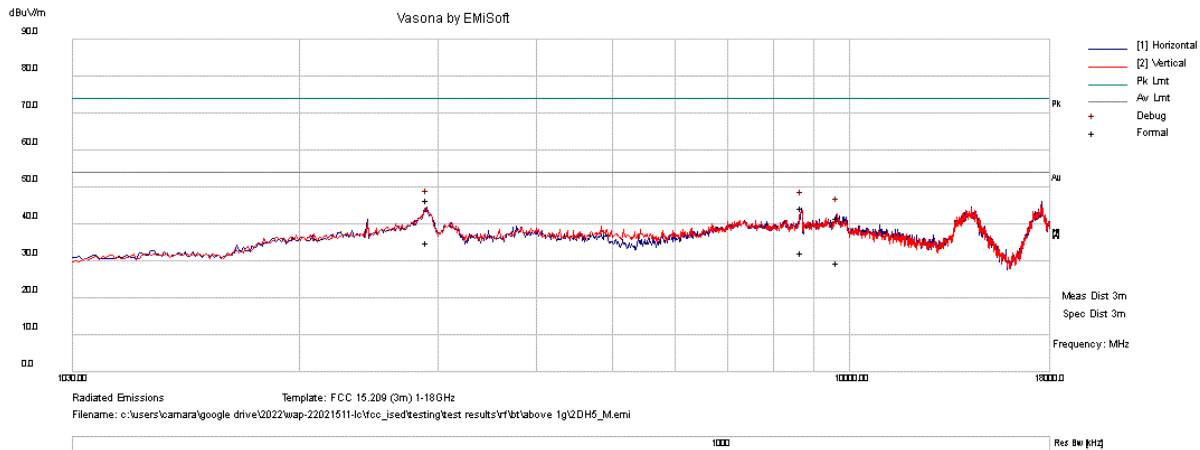
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	$\pi/4$ DQPSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2908.896	22.1	20.5	3.9	46.5	Peak Max	H	254	22	74	-27.5	Pass
2	8697.564	32.1	17.8	-5.7	44.2	Peak Max	H	118	0	74	-29.8	Pass
3	9653.479	32.3	14.4	-5.2	41.6	Peak Max	V	264	46	74	-32.4	Pass
4	2908.896	10.4	20.5	3.9	34.8	Average Max	H	254	22	54	-19.2	Pass
5	8697.564	20.1	17.8	-5.7	32.3	Average Max	H	118	0	54	-21.7	Pass
6	9653.479	20.2	14.4	-5.2	29.4	Average Max	V	264	46	54	-24.6	Pass

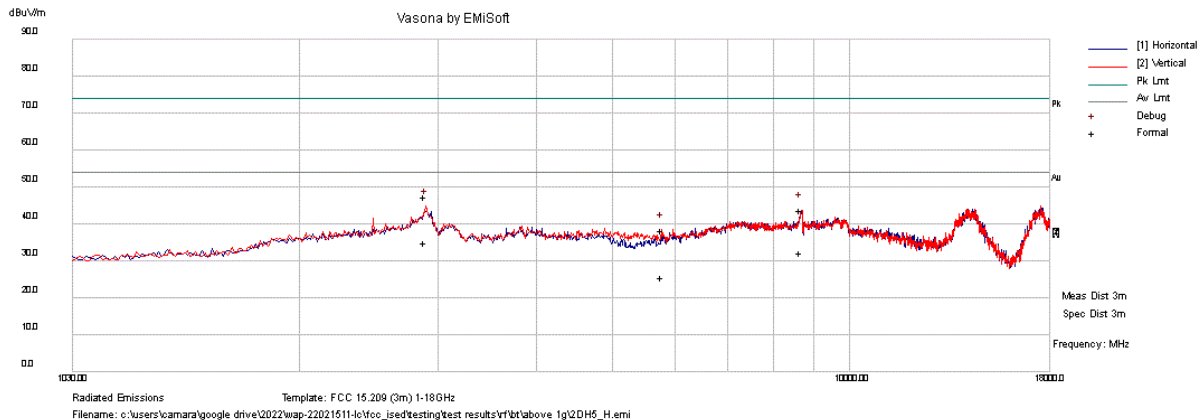
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	$\pi/4$ DQPSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2894.898	21.7	21.9	3.8	47.4	Peak Max	V	244	166	74	-26.6	Pass
2	8688.183	32.1	17.4	-5.7	43.8	Peak Max	V	104	256	74	-30.2	Pass
3	5783.016	38.4	10.2	-10.4	38.3	Peak Max	V	270	23	74	-35.7	Pass
4	2894.898	9.4	21.9	3.8	35.1	Average Max	V	244	166	54	-18.9	Pass
5	8688.183	20.6	17.4	-5.7	32.4	Average Max	V	104	256	54	-21.6	Pass
6	5783.016	25.8	10.2	-10.4	25.6	Average Max	V	270	23	54	-28.4	Pass

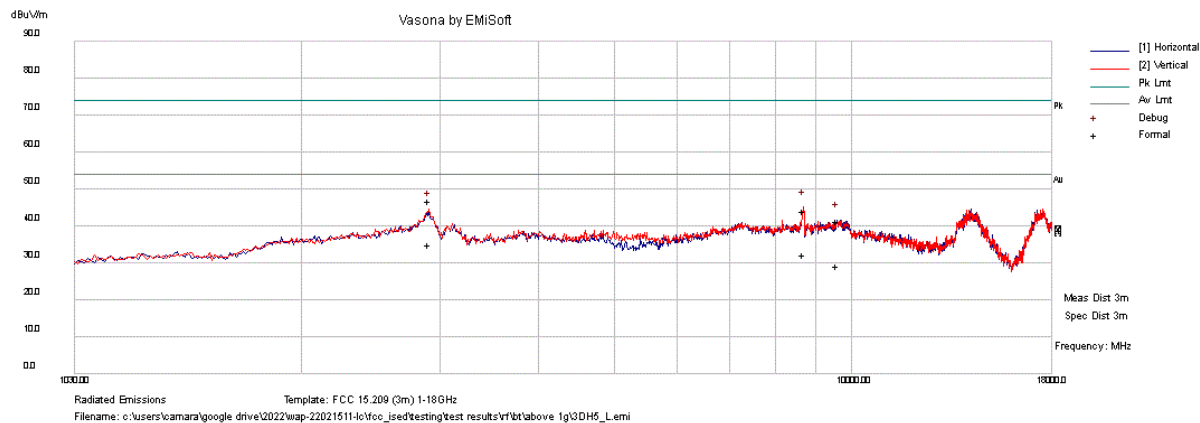
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	8DPSK
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8697.091	31.9	17.8	-5.7	44	Peak Max	V	102	92	74	-30	Pass
2	2907.921	22.4	20.7	3.9	46.9	Peak Max	V	333	154	74	-27.1	Pass
3	9588.594	32.5	14	-5.2	41.4	Peak Max	H	244	297	74	-32.6	Pass
4	8697.091	20.1	17.8	-5.7	32.3	Average Max	V	102	92	54	-21.7	Pass
5	2907.921	10.4	20.7	3.9	35	Average Max	V	333	154	54	-19	Pass
6	9588.594	20.4	14	-5.2	29.2	Average Max	H	244	297	54	-24.8	Pass

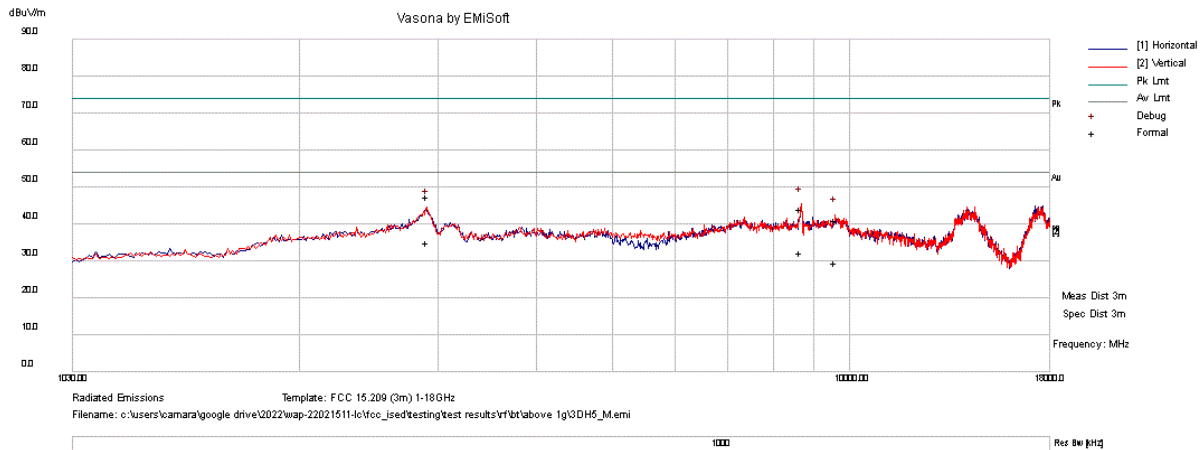
Remarks:

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

Report#	WAP-22021511-LC-FCC-IC-BT
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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	8DPSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8686.39	32.5	17.3	-5.7	44.1	Peak Max	V	268	288	74	-29.9	Pass
2	2908.164	22.9	20.6	3.9	47.4	Peak Max	V	179	0	74	-26.6	Pass
3	9587.791	32.1	14	-5.2	40.9	Peak Max	V	378	19	74	-33.1	Pass
4	8686.39	20.7	17.3	-5.7	32.4	Average Max	V	268	288	54	-21.6	Pass
5	2908.164	10.4	20.6	3.9	34.9	Average Max	V	179	0	54	-19.1	Pass
6	9587.791	20.6	14	-5.2	29.4	Average Max	V	378	19	54	-24.6	Pass

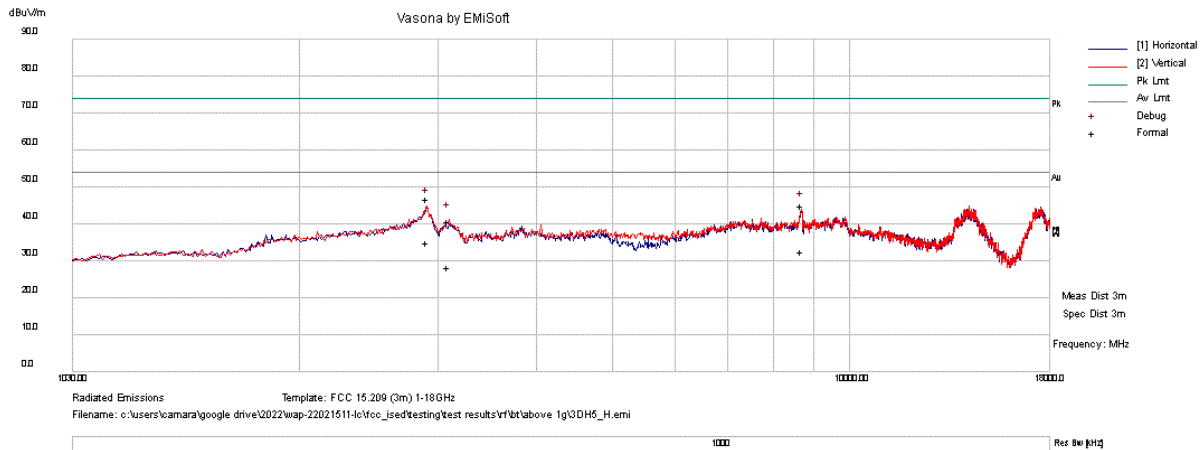
Remarks:

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

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RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	8DPSK
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.659	22.3	20.7	3.9	46.9	Peak Max	V	237	0	74	-27.1	Pass
2	8697.786	32.8	17.8	-5.7	44.9	Peak Max	V	152	255	74	-29.1	Pass
3	3096.459	34.2	7	-0.5	40.7	Peak Max	V	295	248	74	-33.3	Pass
4	2907.659	10.4	20.7	3.9	34.9	Average Max	V	237	0	54	-19.1	Pass
5	8697.786	20.2	17.8	-5.7	32.4	Average Max	V	152	255	54	-21.6	Pass
6	3096.459	21.8	7	-0.5	28.3	Average Max	V	295	248	54	-25.7	Pass

Remarks:

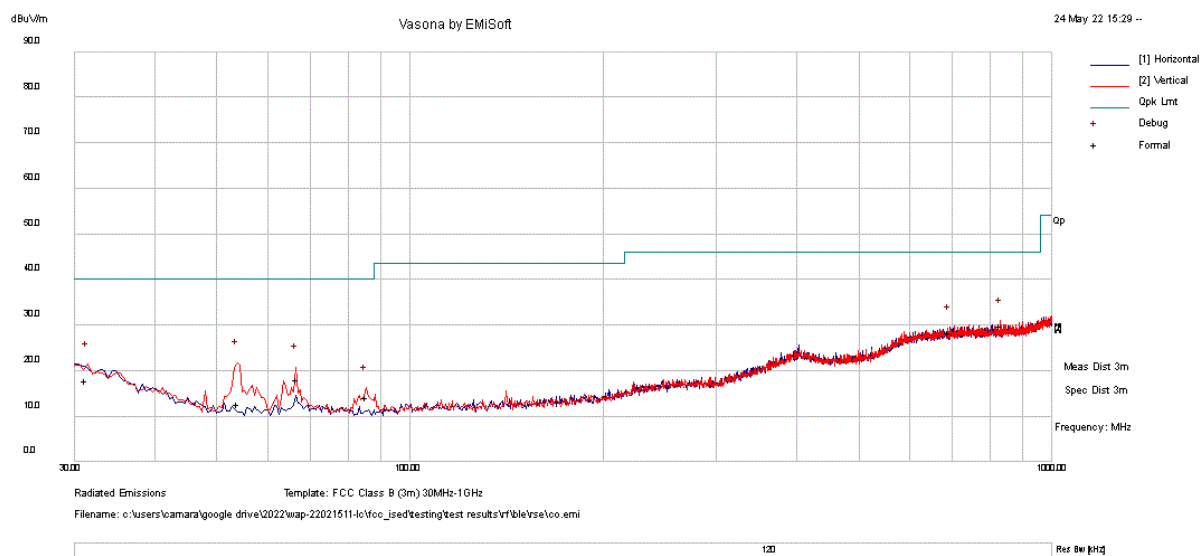
1. Level (dBuV) = Raw (dBuV) + Cable loss(dB) + AF (dB).
2. AF(dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

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BT+WLAN+Cellular co-location

RADIATED EMISSIONS BELOW 1 GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	BT+WLAN+Cellular co-location
Frequency Range:	30 MHz - 1 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid channel	Test Result:	Pass



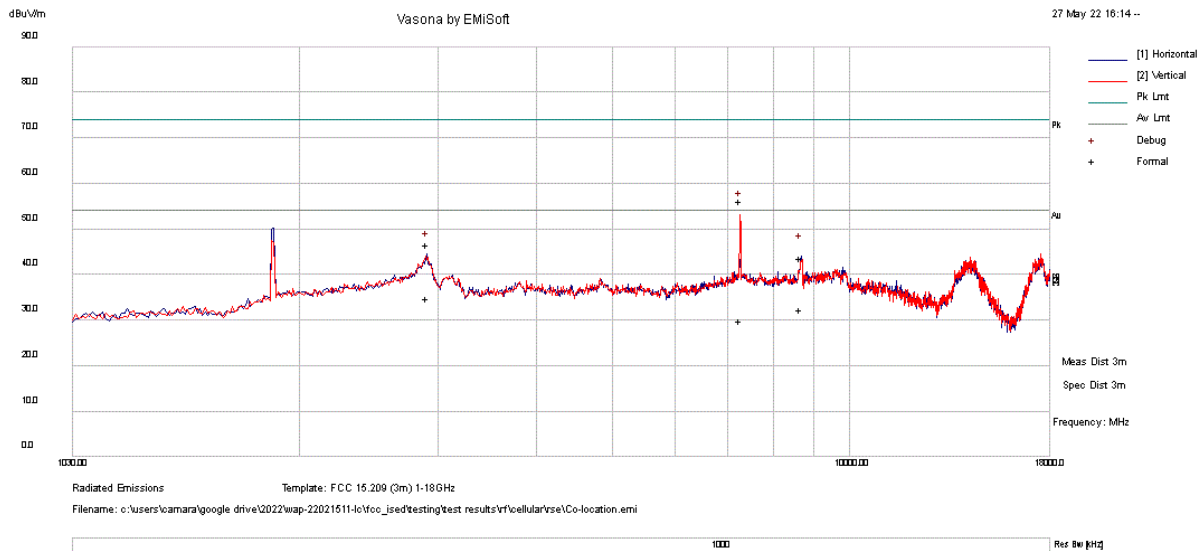
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	
1	831.943	26.6	7.4	-4	29.9	Quasi Max	V	162	40	46	-16.1	Pass
2	692.084	26.7	7.3	-5.4	28.6	Quasi Max	H	113	303	46	-17.4	Pass
3	53.946	30.7	2.9	-20.9	12.7	Quasi Max	V	118	311	40	-27.3	Pass
4	31.328	27.8	2.3	-12.2	17.9	Quasi Max	V	400	227	40	-22.1	Pass
5	66.611	35.3	3.1	-20.3	18.1	Quasi Max	V	102	30	40	-21.9	Pass
6	85.494	31.1	3.4	-20.2	14.3	Quasi Max	V	140	95	40	-25.7	Pass

Remarks:

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

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Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	BT+WLAN+Cellular co-location
Frequency Range:	1 GHz – 18 GHz	Test Date:	05/16/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7267.575	50	11.8	-5.5	56.3	Peak Max	V	122	48	74	-17.7	Pass
2	2909.174	22.3	20.5	3.9	46.6	Peak Max	H	104	0	74	-27.4	Pass
3	8687.05	32.2	17.4	-5.7	43.8	Peak Max	H	370	123	74	-30.2	Pass
4	7267.575	23.6	11.8	-5.5	29.9	Average Max	V	122	48	54	-24.1	Pass
5	2909.174	10.5	20.5	3.9	34.9	Average Max	H	104	0	54	-19.1	Pass
6	8687.05	20.6	17.4	-5.7	32.3	Average Max	H	370	123	54	-21.7	Pass

Remarks:

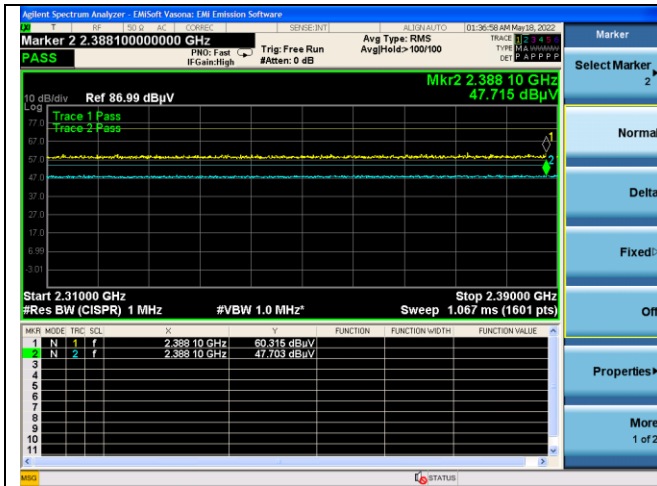
1. Level (dBuV) = Raw (dBuV) + Cable loss(dB) + AF (dB).
2. AF(dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

18GHz – 40GHz test result

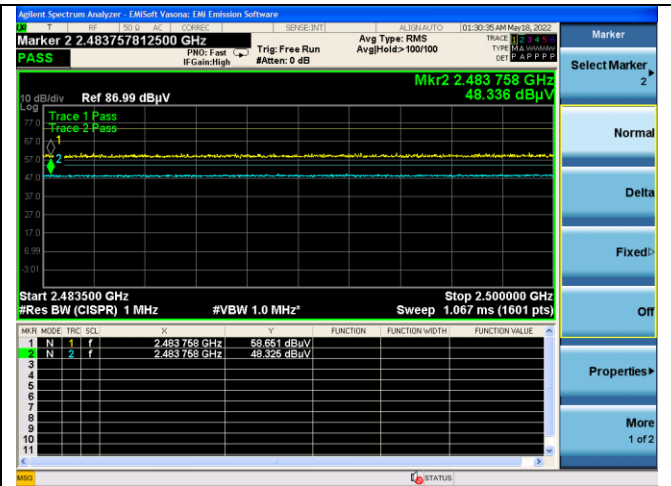
Note: no substantial emission is found other than the noise floor. Different modes have been verified.

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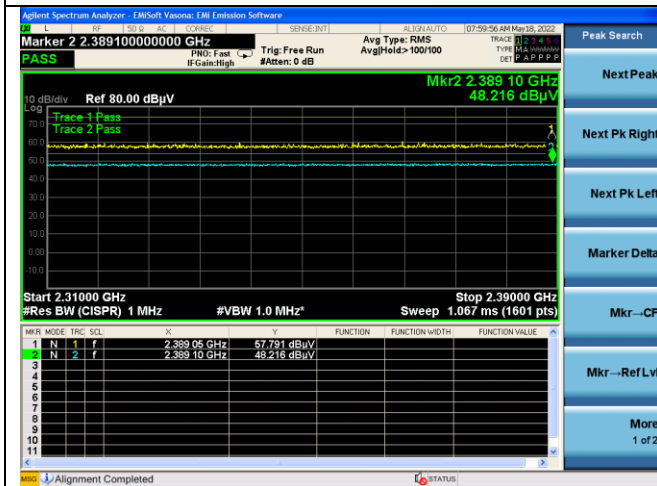
Restricted Band Measurement Plots:



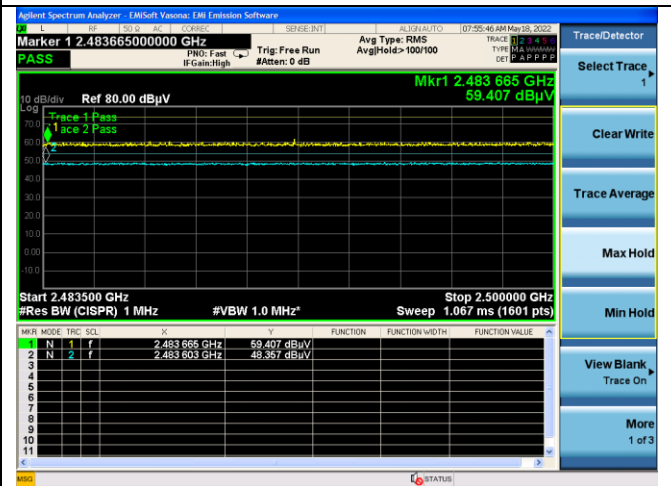
Band Edge - BT BDR Low CH



Band Edge - BT BDR High CH



Band Edge - BT EDR Low CH



Band Edge - BT EDR High CH

8 Test instrument list

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2021	10/18/2022
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/17/2021	06/17/2022
EMC Test Receiver	R&S	ESL6	100230	06/14/2021	06/14/2022
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2021	11/15/2022
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	05/14/2022	05/14/2023
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	06/24/2021	06/24/2022
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2021	07/16/2022
True RMS Multi-meter	UNI-T	UT181A	C173014829	05/05/2022	05/05/2023
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	05/05/2022	05/05/2023
RF Attenuator	Pasternack	PE7005-3	VL061	07/16/2021	07/16/2022
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392- 77150-11	064	07/16/2021	07/16/2022
EM Center Control	ETS-Lindgren	7006-001	160136	N/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	05/16/2022	05/16/2023
RE test cable (below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	07/16/2021	07/16/2022
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	07/16/2021	07/16/2022
RE test cable (>18GHz)	Sucoflex	104	344903/4	07/16/2021	07/16/2022
Pulse limiter	Com-Power	LIT-930A	531727	07/16/2021	07/16/2022
CE test cable #1	FIRST RF	FRF-C-1002- 001	CE-6GHz-01	07/16/2021	07/16/2022
CE test cable#2	FIRST RF	FRF-C-1002- 001	CE-6GHz-02	07/16/2021	07/16/2022
Vector Signal Generator	Keysight	N5182A	US47080548	06/17/2021	06/17/2022
USB RF Power Sensor	ETS-Lindgren	7002-006	SN 00151268	05/15/2022	05/15/2023
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
Wideband Communication	R&S	CMW500	147508	05/10/2022	05/10/2023
Radio Communication Tester	Anritsu	MT8000a	6262261939	02/23/2022	02/23/2023
Temperature/Humidity Chamber	Thermotron	SM-8-8200	40991	09/08/2021	09/08/2022

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