TEST REPORT

Reference No.	:	WTX22X0704987W-1
FCC ID	:	2A78RKMD-NS
Applicant	:	Kool Brands, LLC.
Address	:	1450 Vassar Street, RENO, NV 89502, USA
Product Name	:	Switch Bluetooth Wireless Controller
Test Model.	:	KMD-NS-1144
Standards	:	FCC Part 15.247
Date of Receipt sample	:	July 16, 2022
Date of Test	:	July 16, 2022 to July 24, 2022
Date of Issue	:	July 24, 2022
Test Result	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:
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Tested by:	Reviewed By:	Approved & Authorized By:
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Report version

Version No.	Date of issue	Description
Rev.00	July 24, 2022	Original
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1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant:	Kool Brands, LLC.
Address of applicant:	1450 Vassar Street, RENO, NV 89502, USA
Manufacturer:	Shenzhen Auzmichain Electronic Co.,Ltd
Address of manufacturer:	3/F, Building 2, YongQi Science&Technology industrial park, Xixiang, BaoAn, Shenzhen, China

General Description of EUT	
Product Name:	Switch Bluetooth Wireless Controller
Brand Name:	KMD
Model No.:	KMD-NS-1144
Adding Model(s):	KMD-NS-1151
Rated Voltage:	DC 5V From USB or DC 3.7V From Battery
Battery Capacity:	600mAh
Power Adapter:	/
Serial Number:	67322ji90
Note: The test data is gathered from a production sample, provided by the manufacturer. The appearance of others models listed in the report is different from main-test model KMD-NS-1144, but the circuit and the electronic construction do not change, declared by the manufacturer.	

Technical Characteristics of EUT	
Bluetooth Version:	V4.2 (BR/EDR mode)
Frequency Range:	2402-2480MHz
RF Output Power:	3.90dBm (Conducted)
Data Rate:	1Mbps, 2Mbps, 3Mbps
Modulation:	GFSK, Pi/4 QDPSK, 8DPSK
Quantity of Channels:	79
Channel Separation:	1MHz
Type of Antenna:	PCB
Antenna Gain:	-1.43dBi

1.2 Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
558074 D01 15.247 Meas Guidance v05r02: Guidance For Compliance Measurements On Digital Transmission System, Frequency Hopping Spread Spectrum System, And Hybrid System Devices Operating Under Section 15.247 Of The Fcc Rules
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013,
The equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted accordingly in reference to the Operating Instructions.

1.4 Test Facility

Address of the test laboratory

Laboratory: Waltek Testing Group (Shenzhen) Co., Ltd.
Address: 1/F., Room 101, Building 1, Hongwei Industrial Park, Liuxian 2nd Road, Block 70 Bao'an District, Shenzhen, Guangdong, China

FCC – Registration No.: 125990

Waltek Testing Group (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintain ed in our files. The Designation Number is CN5010, and Test Firm Registration Number is 125990.

1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List		
Test Mode	Description	Remark
TM1	Low Channel	2402MHz
TM2	Middle Channel	2441MHz
TM3	High Channel	2480MHz
TM4	Hopping	2402-2480MHz

Modulation Configure			
Modulation	Packet	Packet Type	Packet Size
GFSK	DH1	4	27
	DH3	11	183
	DH5	15	339
Pi/4 DQPSK	2DH1	20	54
	2DH3	26	367
	2DH5	30	679
8DPSK	3DH1	24	83
	3DH3	27	552
	3DH5	31	1021
Normal mode: the Bluetooth has been tested on the modulation of GFSK, (Pi/4)DQPSK and 8DPSK, compliance test and record the worst case.			

Test software(Fix the Tx frequency)	**Power level(Testing)**
Name	level
FCC_assist_1.0.1.2	4

Test Condition	
Temperature:	22~25 °C
Relative Humidity:	50~55 %.
ATM Pressure:	1019 mbar

EUT Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Special Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
/	/	/	/

1.6 Measurement Uncertainty

Measurement uncertainty		
Parameter	Conditions	Uncertainty
RF Output Power	Conducted	±0.42dB
Occupied Bandwidth	Conducted	±1.5%
Power Spectral Density	Conducted	±1.8dB
Conducted Spurious Emission	Conducted	±2.17dB
Conducted Emissions	Conducted	9-150kHz ±3.74dB
		0.15-30MHz ±3.34dB
Transmitter Spurious Emissions	Radiated	30-200MHz ±4.52dB
		0.2-1GHz ±5.56dB
		1-6GHz ±3.84dB
		6-18GHz ±3.92dB

1.7 Test Equipment List and Details

No.	Description	Manufacturer	Model	Serial No.	Cal Date	Due. Date
SEMT-1075	Communication Tester	Rohde & Schwarz	CMW500	148650	2022-03-27	2023-03-26
SEMT-1063	GSM Tester	Rohde & Schwarz	CMU200	114403	2022-03-27	2023-03-26
SEMT-1072	Spectrum Analyzer	Agilent	E4407B	MY41440400	2022-03-27	2023-03-26
SEMT-1079	Spectrum Analyzer	Agilent	N9020A	US47140102	2022-03-27	2023-03-26
SEMT-1080	Signal Generator	Agilent	83752A	3610A01453	2022-03-27	2023-03-26
SEMT-1081	Vector Signal Generator	Agilent	N5182A	MY47070202	2022-03-27	2023-03-26
SEMT-1028	Power Divider	Weinschel	1506A	PM204	2022-03-27	2023-03-26
SEMT-1082	Power Divider	RF-Lambda	RFLT4W5M18G	14110400027	2022-03-27	2023-03-26
SEMT-1031	Spectrum Analyzer	Rohde & Schwarz	FSP30	836079/035	2022-03-27	2023-03-26
SEMT-1007	EMI Test Receiver	Rohde & Schwarz	ESVB	825471/005	2022-03-27	2023-03-26
SEMT-1008	Amplifier	Agilent	8447F	3113A06717	2022-04-12	2023-04-11
SEMT-1043	Amplifier	C&D	PAP-1G18	2002	2022-04-12	2023-04-11
SEMT-1069	Loop Antenna	Schwarz beck	FMZB 1516	9773	2021-03-19	2023-03-18
SEMT-1068	Broadband Antenna	Schwarz beck	VULB9163	9163-333	2021-03-19	2023-03-18
SEMT-1042	Horn Antenna	ETS	3117	00086197	2021-03-19	2023-03-18
SEMT-1121	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170582	2021-04-27	2023-04-26
SEMT-1169	Pre-amplifier	Direction Systems Inc.	PAP-2640	14145-14153	2022-04-27	2023-04-26
SEMT-1163	Spectrum Analyzer	Rohde & Schwarz	FSP40	100612	2022-03-27	2023-03-26
SEMT-1166	Power Limiter	Agilent	N9356B	MY45450376	2022-03-27	2023-03-26
SEMT-1076	RF Switcher	Top Precision	RCS03-A2	/	2021-03-19	2023-03-18
SEMT-1096	Power Sensor	Agilent	U2021XA	MY54250019	2022-03-27	2023-03-26
SEMT-C001	Cable	Zheng DI	LL142-07-07-10M(A)	/	/	/
SEMT-C002	Cable	Zheng DI	ZT40-2.92J-2.92J-6M	/	/	/
SEMT-C003	Cable	Zheng DI	ZT40-2.92J-2.92J-2.5M	/	/	/
SEMT-C004	Cable	Zheng DI	2M0RFC	/	/	/
SEMT-C005	Cable	Zheng DI	1M0RFC	/	/	/
SEMT-C006	Cable	Zheng DI	1M0RFC	/	/	/

Software List			
Description	**Manufacturer**	**Model**	**Version**
EMI Test Software (Radiated Emission)*	Farad	EZ-EMC	RA-03A1
EMI Test Software (Conducted Emission)*	Farad	EZ-EMC	RA-03A1

*Remark: indicates software version used in the compliance certification testing.

2. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test Item	Result
§2.1093	RF Exposure	Compliant
§15.203; §15.247(b)(4)(i)	Antenna Requirement	Compliant
§15.205	Restricted Band of Operation	Compliant
§15.207(a)	Conducted Emission	Compliant
§15.209(a)	Radiated Spurious Emissions	Compliant
§15.247(a)(1)(iii)	Quantity of Hopping Channel	Compliant
§15.247(a)(1)	Channel Separation	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell time)	Compliant
§15.247(a)	20dB Bandwidth	Compliant
§15.247(b)(1)	RF Power Output	Compliant
§15.247(d)	Band Edge (Out of Band Emissions)	Compliant
§15.247(a)(1)	Frequency Hopping Sequence	Compliant
§15.247(g), (h)	Frequency Hopping System	Compliant

N/A: not applicable

3. Antenna Requirement

3.1 Standard Applicable

According to FCC Part 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.

3.2 Evaluation Information

This product has a PCB antenna, fulfill the requirement of this section.

4. Frequency Hopping System Requirements

4.1 Standard Applicable

According to FCC Part 15.247(a)(1), 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.

(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.

(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.

4.2 Frequency Hopping System

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

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; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. 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 devices 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 a Bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for 558074 D01 15.247 Meas Guidance v05r02 and FCC Part 15.247 rule.

4.3 EUT Pseudorandom Frequency Hopping Sequence

Pseudorandom Frequency Hopping Sequence Table as below:
Channel: 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.

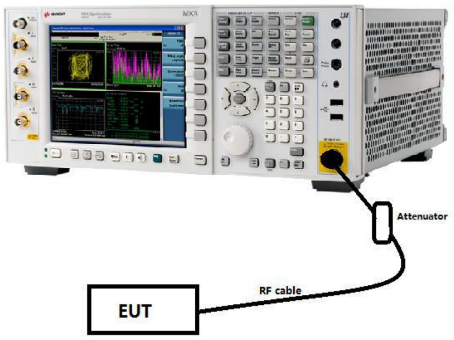
The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

5. Quantity of Hopping Channels and Channel Separation

5.1 Standard Applicable

According to FCC 15.247(a)(1), 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, and frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

5.2 Test Setup Block Diagram



5.3 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013 section 7.8.3, the number of hopping frequencies test method as follows.

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ⩾ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

According to DA 00-705 Section 15.247(a), the EUT shall have its hopping function enabled, the Carrier frequency separation test method as follows:
Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ⩾ 1% of the span
Video (or Average) Bandwidth (VBW) ⩾ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the

adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

5.4 Summary of Test Results/Plots

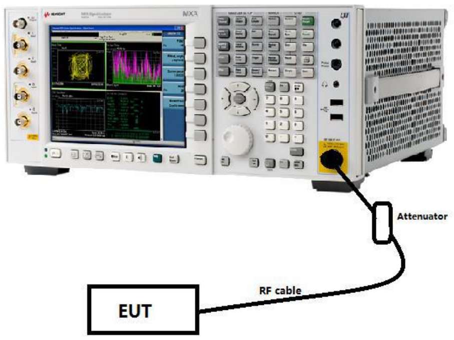
Please refer to Appendix A

6. Dwell Time of Hopping Channel

6.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

6.2 Test Setup Block Diagram



6.3 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013 section 7.8.4, the dwell time of a hopping channel test method as follows.

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: 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.
d) Detector function: Peak.
e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.
Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:
(Number of hops in the period specified in the requirements) =

(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)
The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.
The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

6.4 Summary of Test Results/Plots

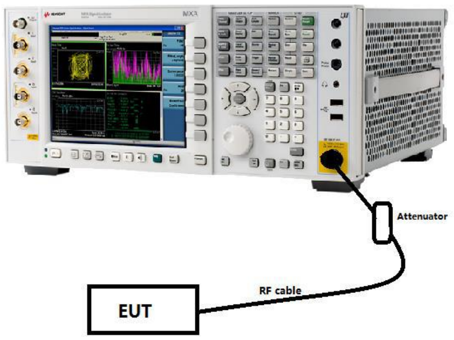
Please refer to Appendix B

7. 20dB Bandwidth

7.1 Standard Applicable

According to 15.247(a) and 15.215(c), 20dB bandwidth is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

7.2 Test Setup Block Diagram



7.3 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013 section 6.9.2, the 20dB bandwidth test method as follows.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize.

Otherwise, the trace from step g) shall be used for step j).
j) 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 in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “−xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
k) 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 labeled. Tabular data may be reported in addition to the plot(s).

7.4 Summary of Test Results/Plots

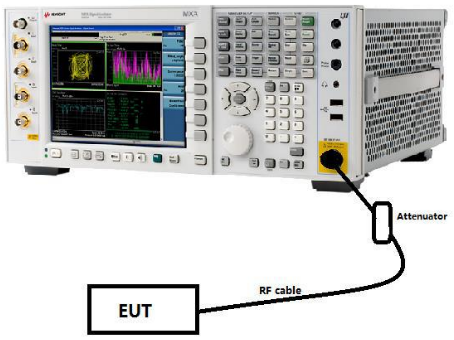
Please refer to Appendix C

8. RF Output Power

8.1 Standard Applicable

According to 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.

8.2 Test Setup Block Diagram



8.3 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013 section 7.8.5, the output power test method as follows.
Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:
a) Use the following spectrum analyzer settings:
   1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
   2) RBW > 20 dB bandwidth of the emission being measured.
   3) VBW ≥ RBW.
   4) Sweep: Auto.
   5) Detector function: Peak.
   6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

8.3 Summary of Test Results/Plots

Please refer to Appendix D

9. Field Strength of Spurious Emissions

9.1 Standard Applicable

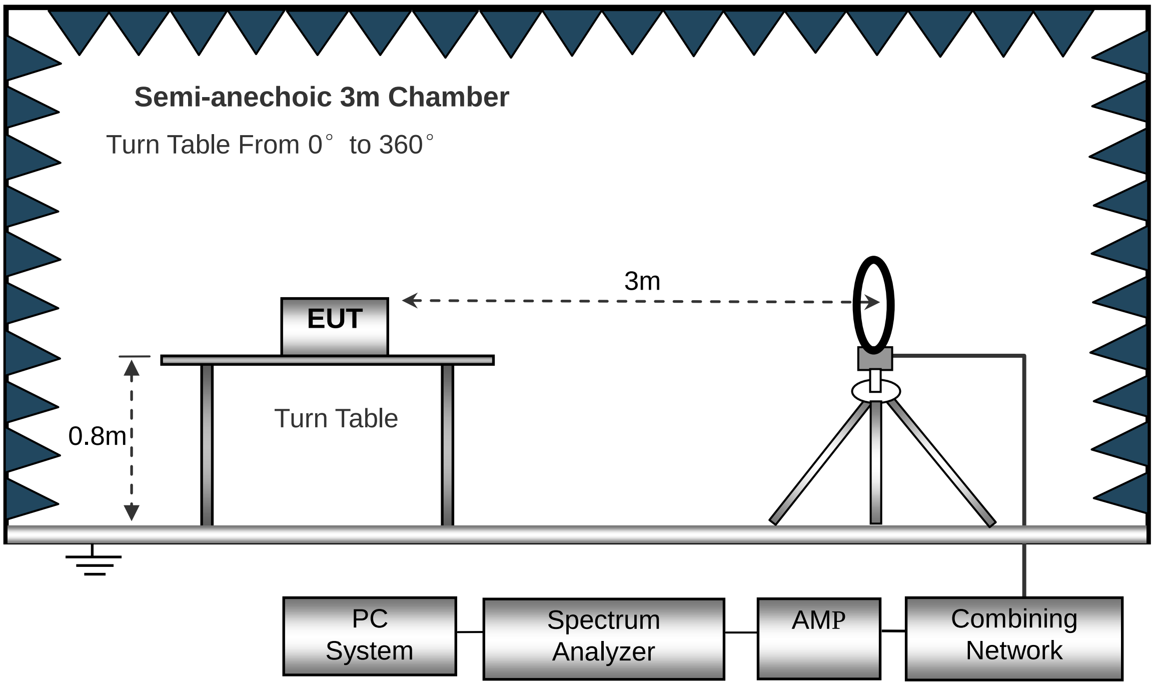
According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) 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).

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

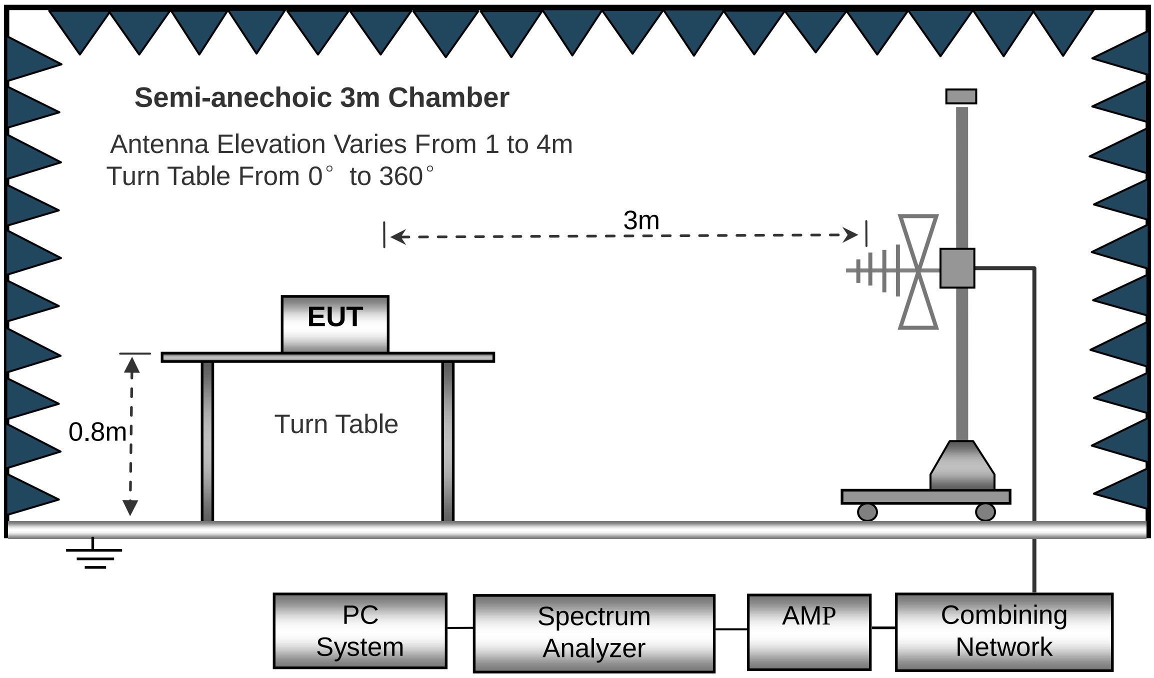
9.2 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

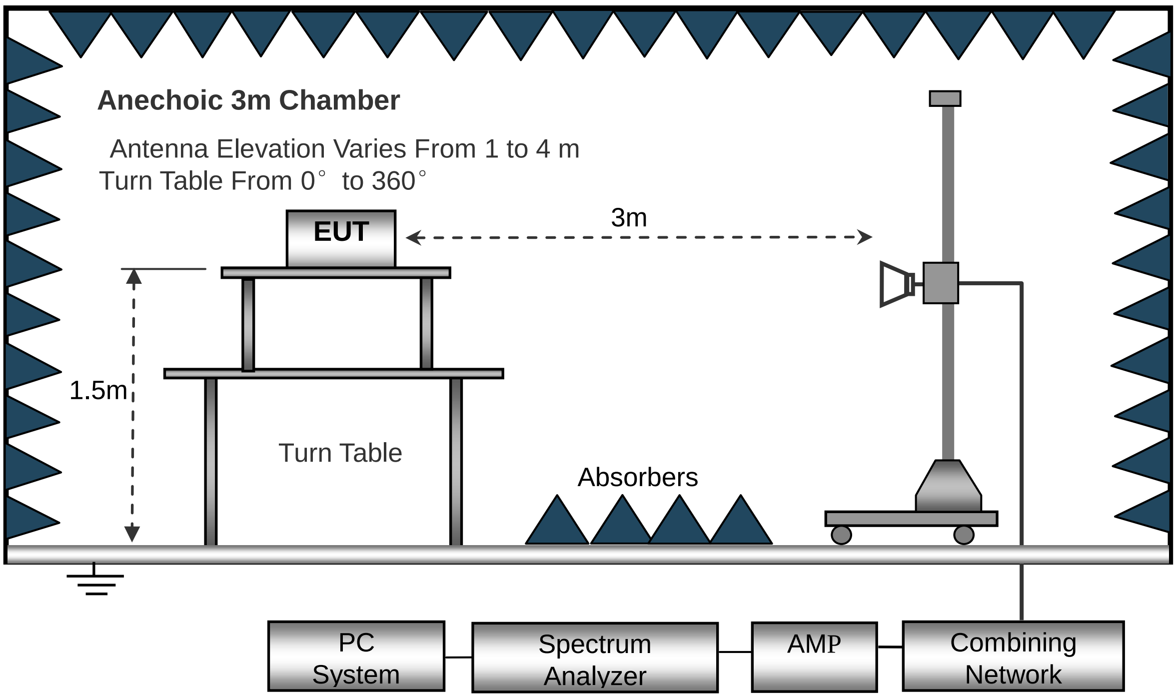
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30MHz to 1GHz.



The test setup for emission measurement above 1GHz.



Frequency :9kHz-30MHz	Frequency :30MHz-1GHz	Frequency :Above 1GHz
RBW=10KHz,	RBW=120KHz,	RBW=1MHz,
VBW =30KHz	VBW=300KHz	VBW=3MHz(Peak), 10Hz(AV)
Sweep time= Auto	Sweep time= Auto	Sweep time= Auto
Trace = max hold	Trace = max hold	Trace = max hold
Detector function = peak	Detector function = peak, QP	Detector function = peak, AV

9.3 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Result = Indicated Reading + Correct
Correct =Ant. Factor + Cable Loss – Ampl. Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dBμV means the emission is 6dBμV below the maximum limit. The equation for margin calculation is as follows:

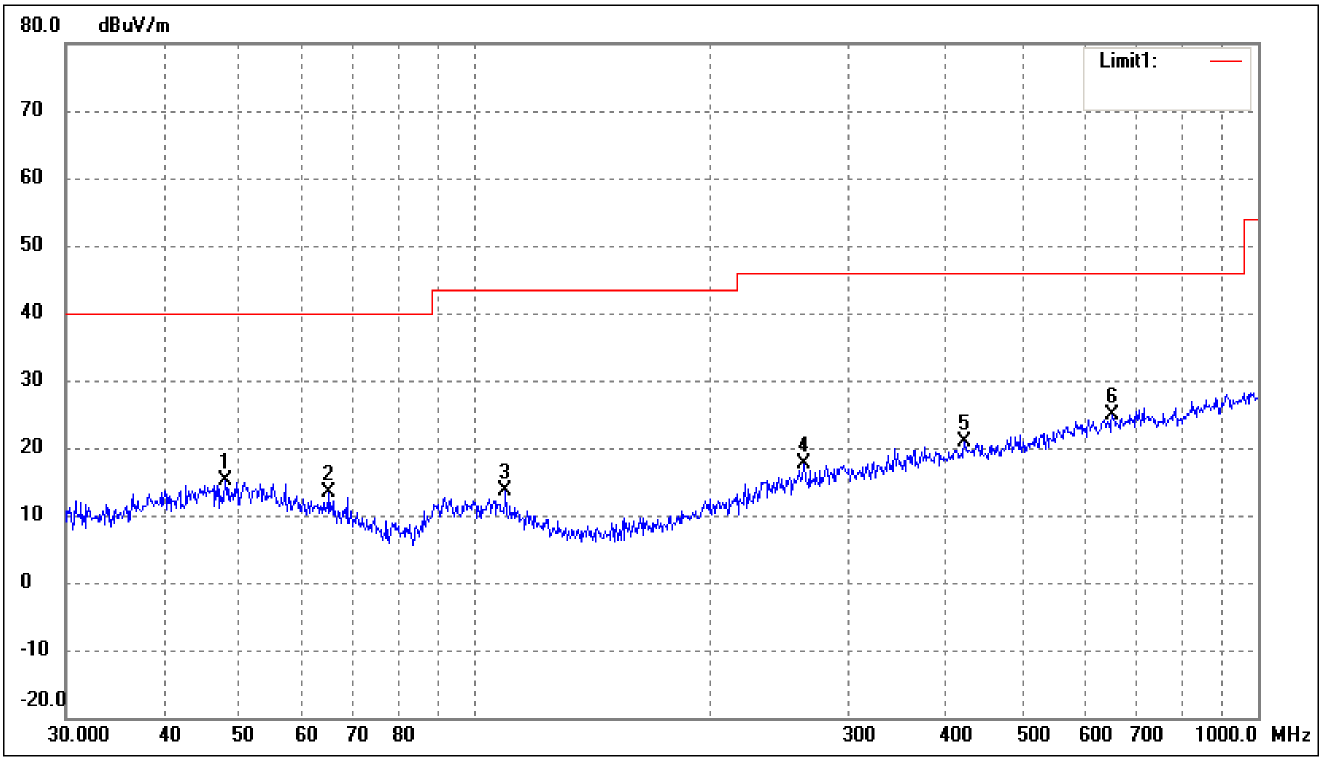
Margin = Result – FCC Part 15 Limit

9.4 Summary of Test Results/Plots

Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.
All test modes (different data rate and different modulation) are performed, but only the worst case (GFSK) is recorded in this report.

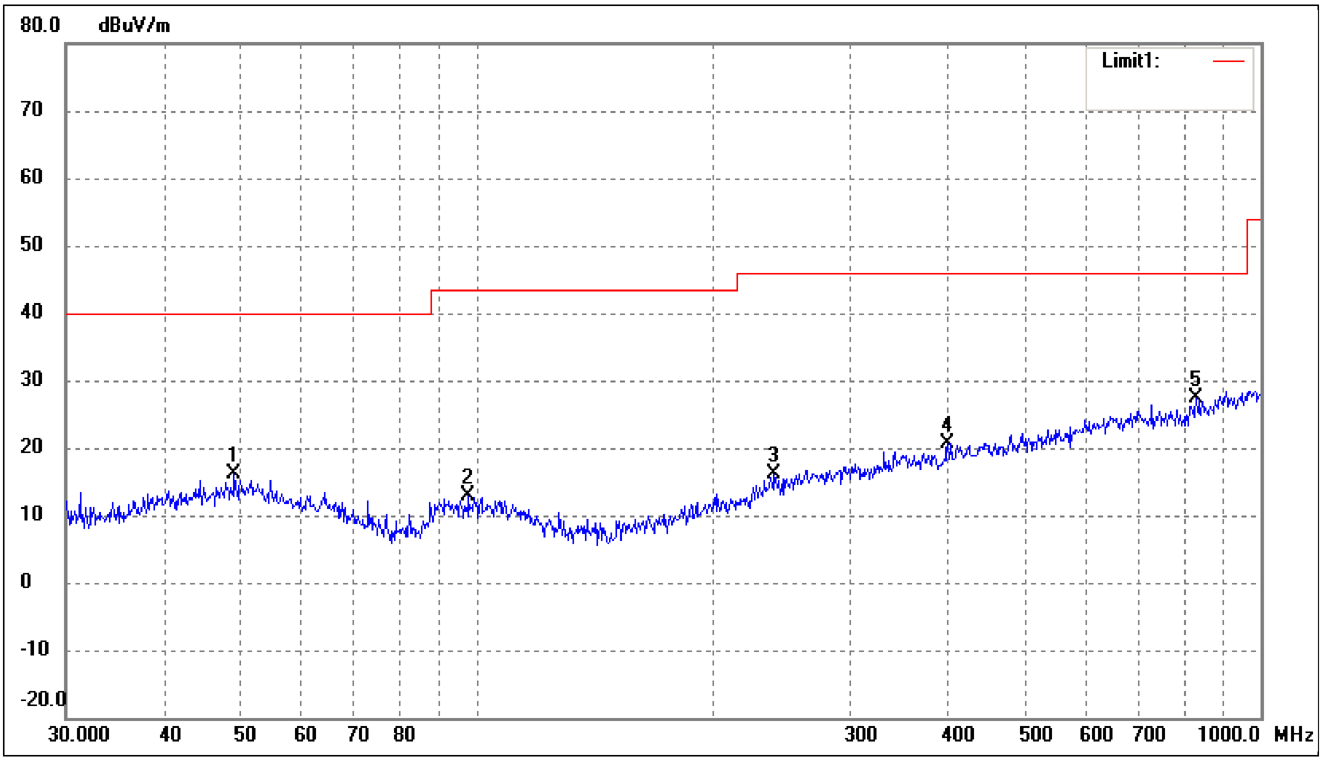
➢ Spurious Emissions Below 1GHz

Test Channel	Low	Polarity:	Horizontal



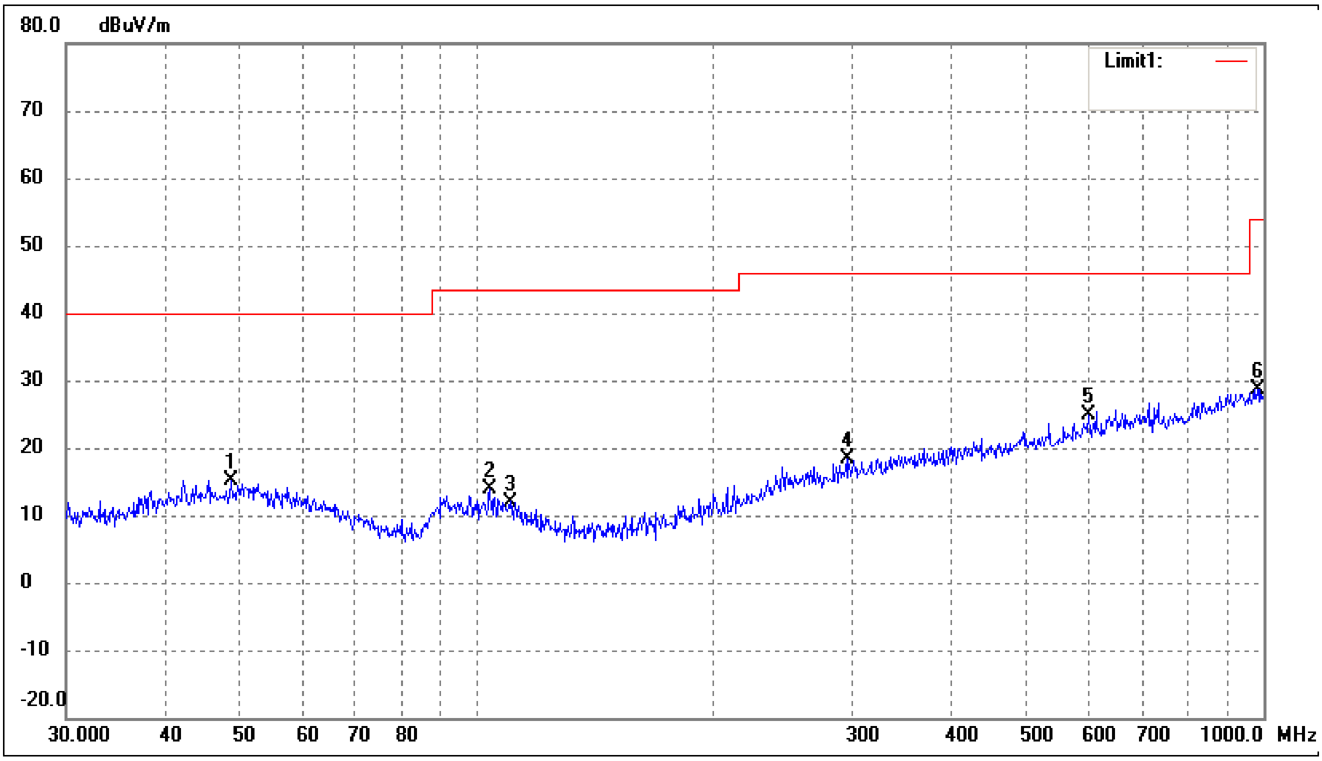
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	47.9940	26.76	-11.66	15.10	40.00	-24.90	355	100	peak
2	65.1145	27.37	-14.04	13.33	40.00	-26.67	98	100	peak
3	109.4116	27.43	-13.80	13.63	43.50	-29.87	134	100	peak
4	262.8955	26.73	-9.11	17.62	46.00	-28.38	117	100	peak
5	422.0577	27.08	-6.27	20.81	46.00	-25.19	194	100	peak
6	651.9417	27.34	-2.49	24.85	46.00	-21.15	178	100	peak

Test Channel	Low	Polarity:	Vertical



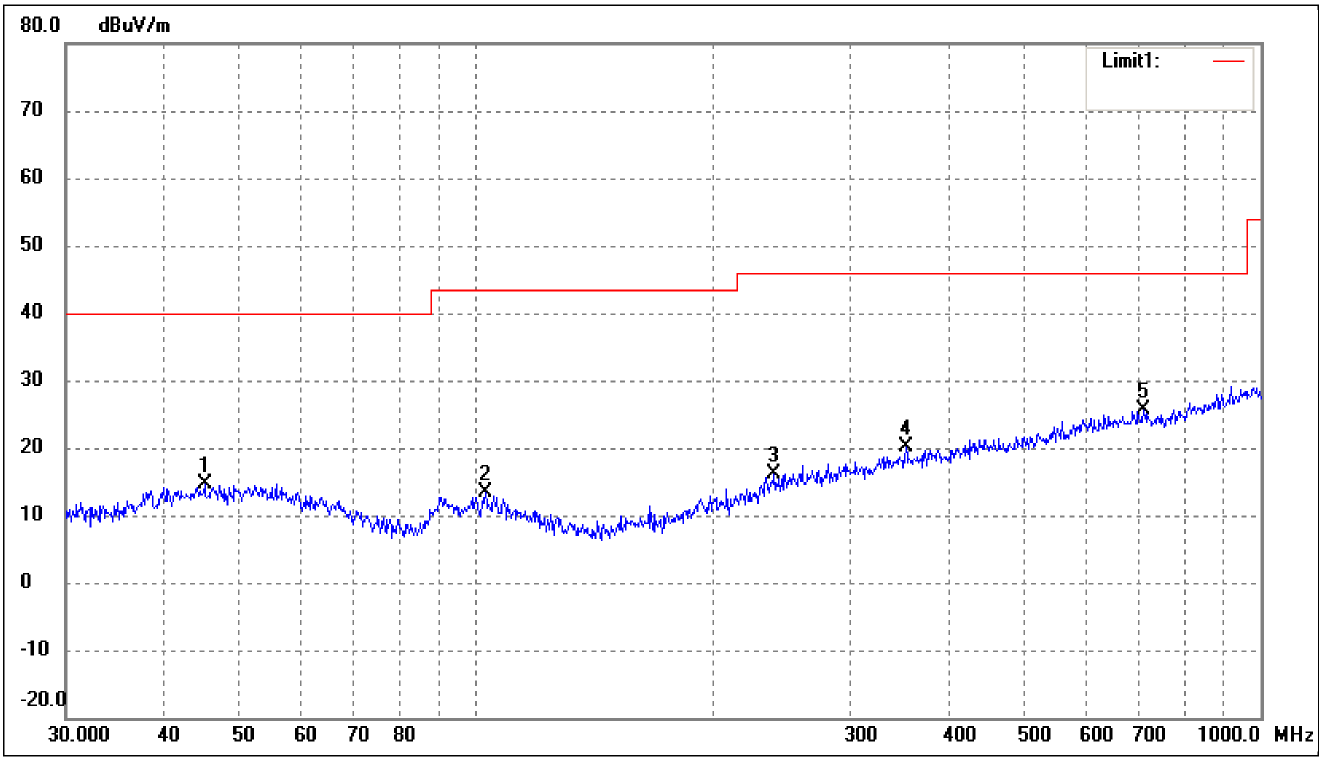
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	49.1866	27.69	-11.63	16.06	40.00	-23.94	262	100	peak
2	97.7983	26.94	-14.06	12.88	43.50	-30.62	91	100	peak
3	239.9874	26.07	-9.98	16.09	46.00	-29.91	190	100	peak
4	399.0302	27.49	-6.79	20.70	46.00	-25.30	121	100	peak
5	827.4934	27.59	-0.29	27.30	46.00	-18.70	325	100	peak

Test Channel	Middle	Polarity:	Horizontal



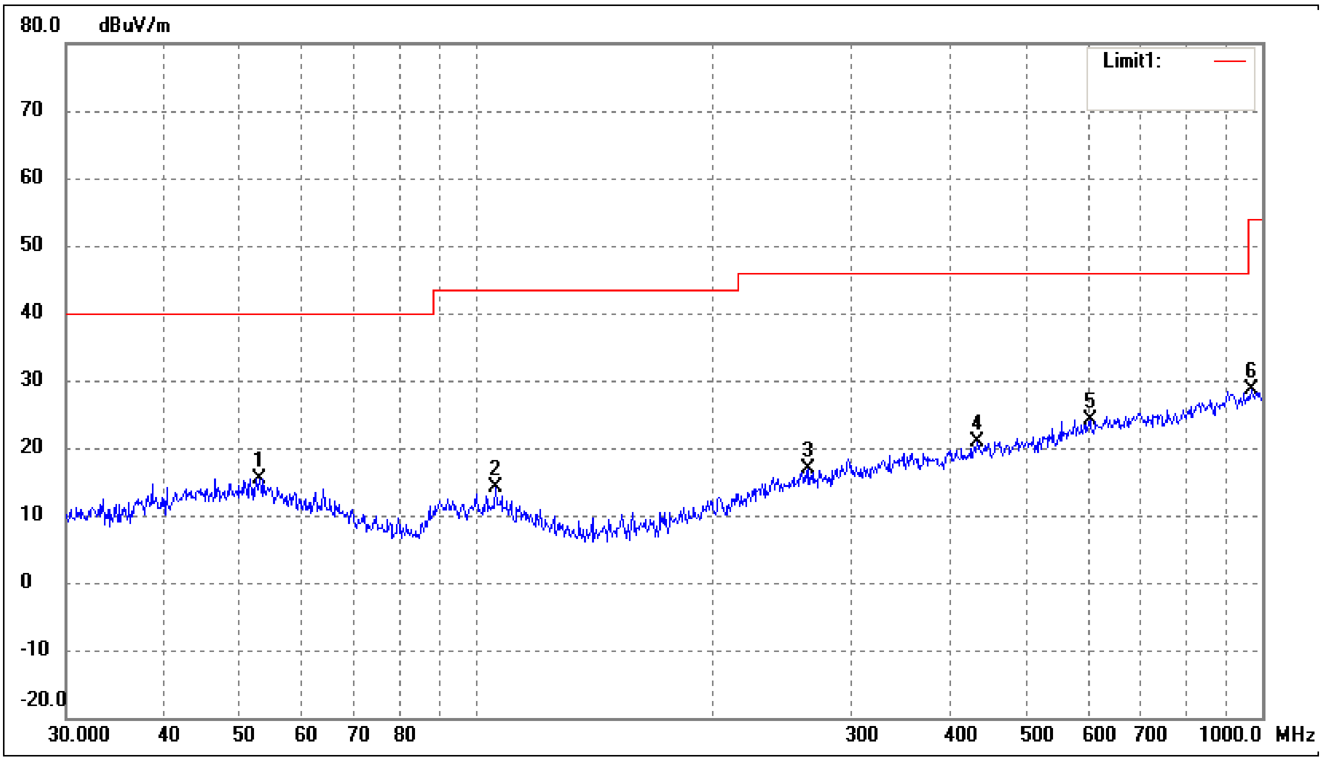
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	48.6719	26.83	-11.64	15.19	40.00	-24.81	79	100	peak
2	103.8055	27.32	-13.48	13.84	43.50	-29.66	260	100	peak
3	110.1816	25.90	-13.90	12.00	43.50	-31.50	76	100	peak
4	295.1469	26.62	-8.17	18.45	46.00	-27.55	166	100	peak
5	599.3213	28.17	-3.33	24.84	46.00	-21.16	248	100	peak
6	982.6200	26.50	2.23	28.73	54.00	-25.27	130	100	peak

Test Channel	Middle	Polarity:	Vertical



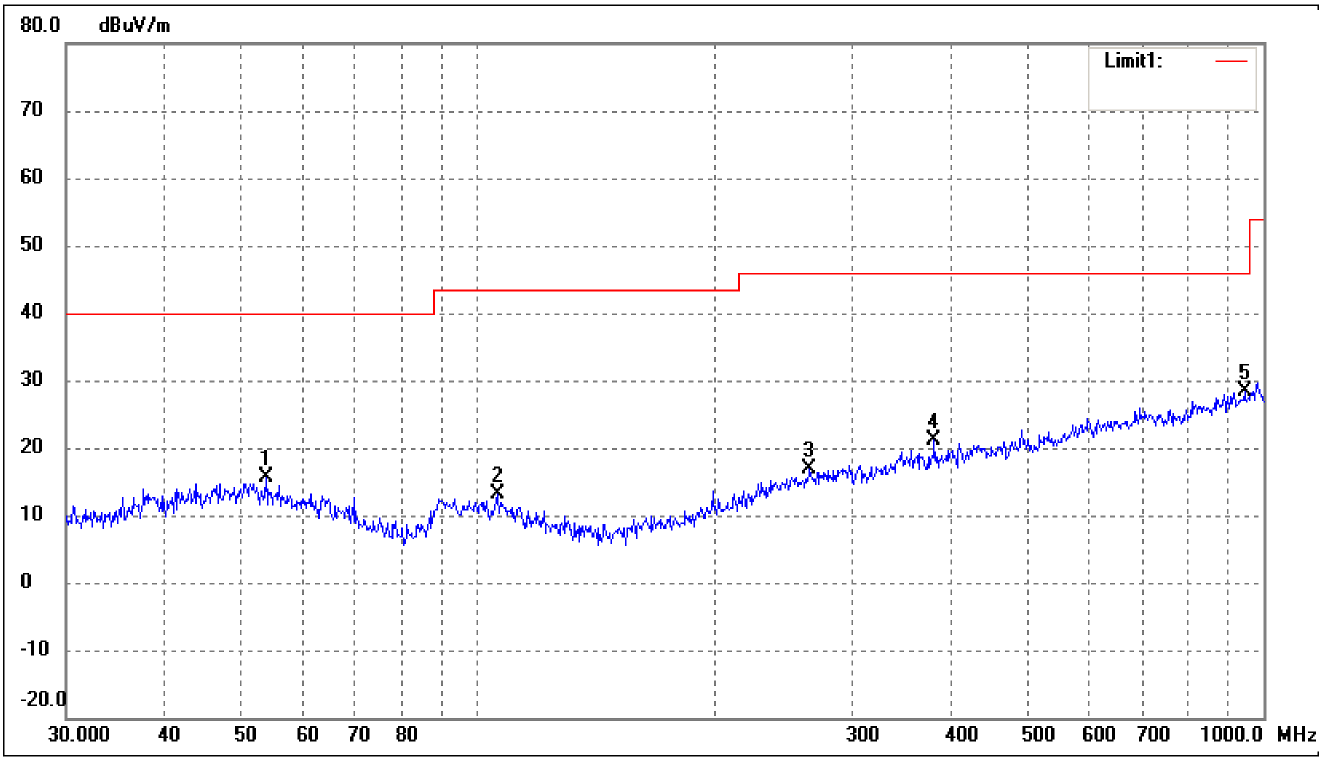
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	45.0583	26.65	-11.93	14.72	40.00	-25.28	314	100	peak
2	102.7192	27.03	-13.57	13.46	43.50	-30.04	131	100	peak
3	239.9874	26.12	-9.98	16.14	46.00	-29.86	80	100	peak
4	352.9434	26.97	-6.96	20.01	46.00	-25.99	212	100	peak
5	709.1823	27.40	-1.83	25.57	46.00	-20.43	126	100	peak

Test Channel	High	Polarity:	Horizontal



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	52.9453	27.21	-11.72	15.49	40.00	-24.51	178	100	peak
2	105.6415	27.62	-13.44	14.18	43.50	-29.32	190	100	peak
3	264.7457	25.85	-8.95	16.90	46.00	-29.10	141	100	peak
4	434.0651	27.02	-6.07	20.95	46.00	-25.05	93	100	peak
5	603.5392	27.49	-3.28	24.21	46.00	-21.79	339	100	peak
6	968.9338	26.67	1.86	28.53	54.00	-25.47	132	100	peak

Test Channel	High	Polarity:	Vertical



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	53.8818	27.59	-11.85	15.74	40.00	-24.26	60	100	peak
2	106.0126	26.60	-13.48	13.12	43.50	-30.38	146	100	peak
3	264.7457	25.77	-8.95	16.82	46.00	-29.18	147	100	peak
4	381.2487	27.97	-6.93	21.04	46.00	-24.96	113	100	peak
5	945.4399	26.80	1.47	28.27	46.00	-17.73	242	100	peak

➢ Spurious Emissions Above 1GHz

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2402MHz							
4804	62.25	-3.59	58.66	74	-15.34	H	PK
4804	48.45	-3.59	44.86	54	-9.14	H	AV
7206	57.78	-0.52	57.26	74	-16.74	H	PK
7206	40.93	-0.52	40.41	54	-13.59	H	AV
4804	67.51	-3.59	63.92	74	-10.08	V	PK
4804	50.21	-3.59	46.62	54	-7.38	V	AV
7206	60.67	-0.52	60.15	74	-13.85	V	PK
7206	48.43	-0.52	47.91	54	-6.09	V	AV
Middle Channel-2441MHz							
4882	58.67	-3.49	55.18	74	-18.82	H	PK
4882	43.59	-3.49	40.10	54	-13.90	H	AV
7323	62.83	-0.47	62.36	74	-11.64	H	PK
7323	40.87	-0.47	40.40	54	-13.60	H	AV
4882	65.64	-3.49	62.15	74	-11.85	V	PK
4882	49.28	-3.49	45.79	54	-8.21	V	AV
7323	65.37	-0.47	64.90	74	-9.10	V	PK
7323	46.43	-0.47	45.96	54	-8.04	V	AV
High Channel-2480MHz							
4960	54.12	-3.41	50.71	74	-23.29	H	PK
4960	46.61	-3.41	43.20	54	-10.80	H	AV
7440	60.03	-0.42	59.61	74	-14.39	H	PK
7440	42.66	-0.42	42.24	54	-11.76	H	AV
4960	60.73	-3.41	57.32	74	-16.68	V	PK
4960	47.28	-3.41	43.87	54	-10.13	V	AV
7440	60.30	-0.42	59.88	74	-14.12	V	PK
7440	45.83	-0.42	45.41	54	-8.59	V	AV

Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

11. Out of Band Emissions

11.1 Standard Applicable

According to §15.247 (d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) 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).

11.2 Test Procedure

According to ANSI C63.10-2013 section 7.8.6, the Band-edge measurements for RF conducted emissions test method as follows.

a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).
b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3.
d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6, and orient the EUT and measurement antenna positions to produce the highest emission level.
e) Perform the test as follows:

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
3) Attenuation: Auto (at least 10 dB preferred).
4) Sweep time: Coupled.
5) Resolution bandwidth: 100 kHz.
6) Video bandwidth: 300 kHz.
7) Detector: Peak.
8) Trace: Max hold.

f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.

g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
h) Repeat step c) through step e) for every applicable modulation.
i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).
j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

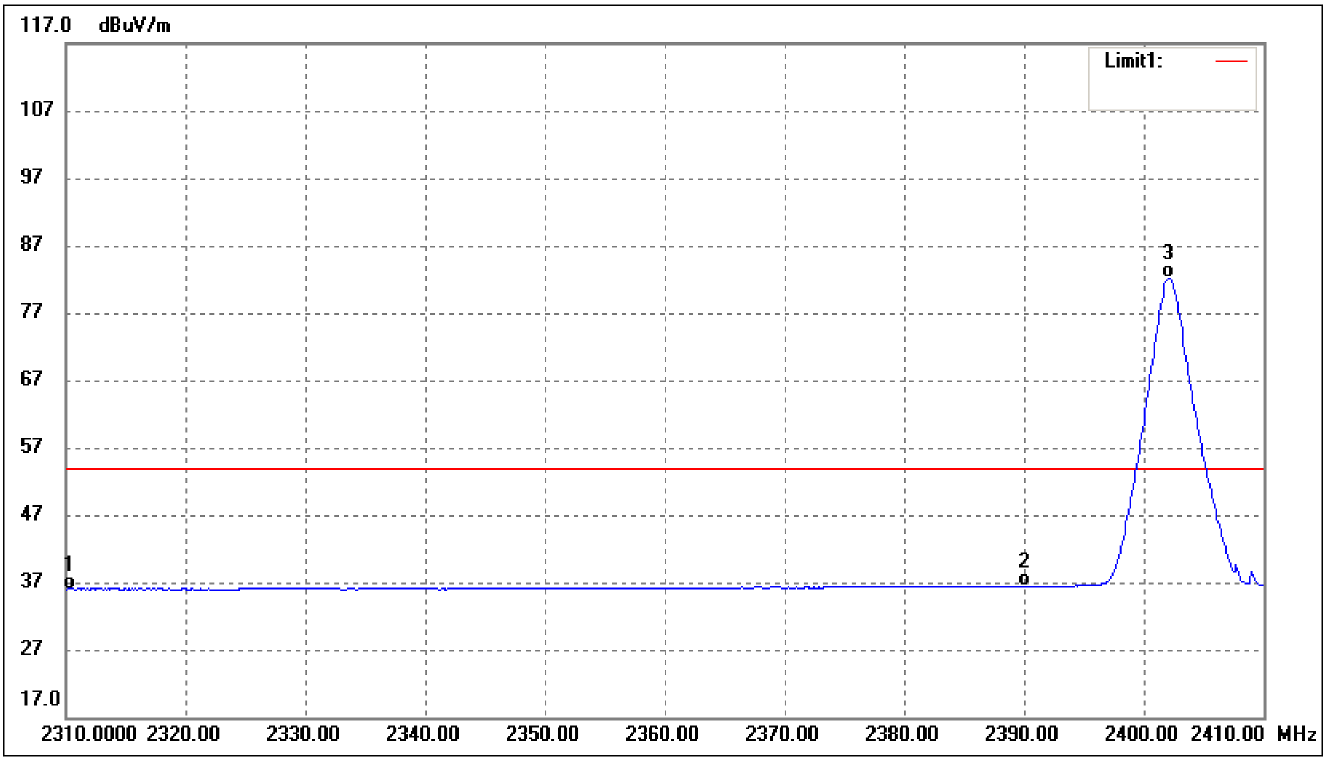
Restricted-band band-edge test method please refers to ANSI C63.10-2013 section 6.10.5. The emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement KDB publication number: 913591 may be used for the radiated band-edge measurements.

According to ANSI C63.10-2013 section 7.8.8, Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers.
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.

11.3 Summary of Test Results/Plots

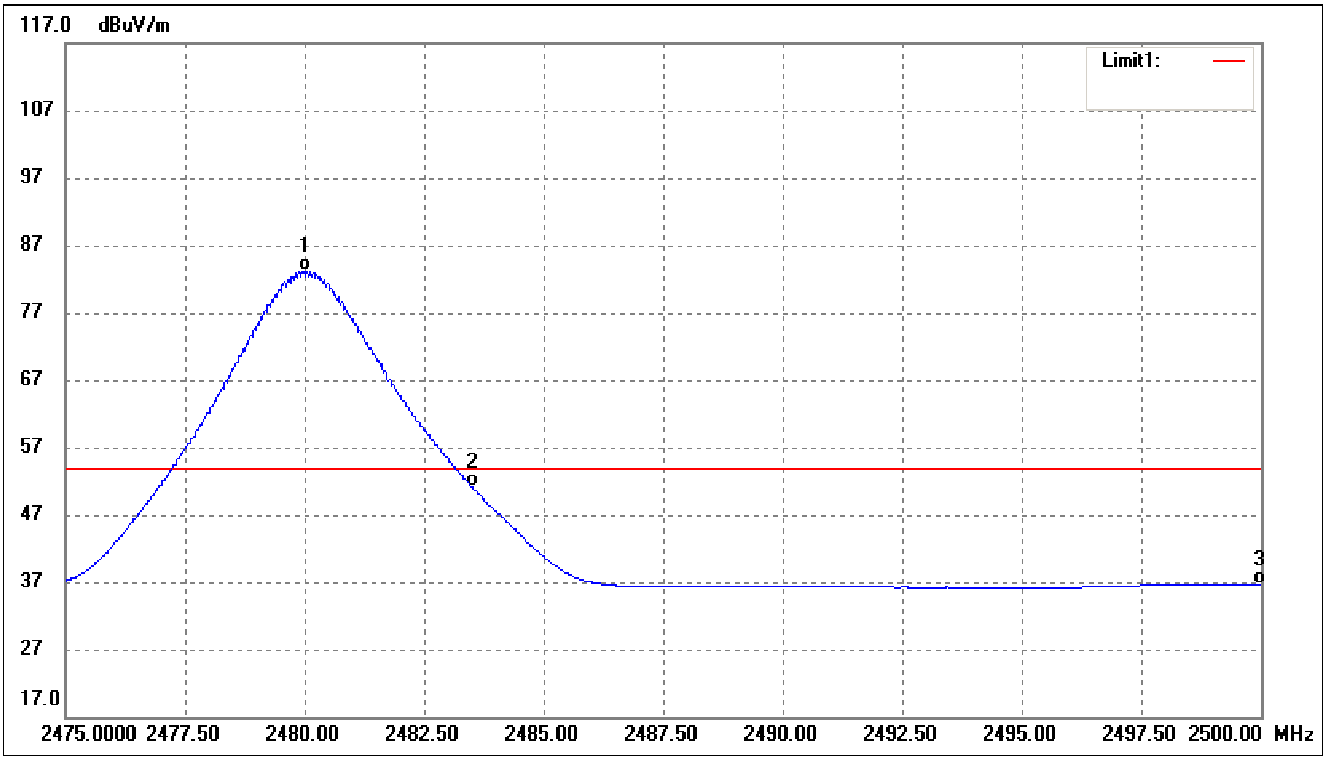
Note: All test modes (different data rate and different modulation) are performed, but only the worst case（GFSK）is recorded in this report.

Test Channel	Low	Polarity:	Vertical(worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	Factor(dB)	(dBuV/m)	(dBuV/m)	(dB)	
1	2310.000	43.76	-7.78	35.98	54.00	-18.02	Average Detector
	2310.000	56.42	-7.78	48.64	74.00	-25.36	Peak Detector
2	2390.000	43.74	-7.32	36.42	54.00	-17.58	Average Detector
	2390.000	56.83	-7.32	49.51	74.00	-24.49	Peak Detector
3	2402.100	89.44	-7.25	82.19	/	/	Average Detector
	2402.200	104.57	-7.25	97.32	/	/	Peak Detector

Test Channel	High	Polarity:	Vertical(worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	Factor(dB)	(dBuV/m)	(dBuV/m)	(dB)	
1	2480.025	90.01	-6.79	83.22	/	/	Average Detector
	2480.150	105.06	-6.78	98.28	/	/	Peak Detector
2	2483.500	57.98	-6.77	51.21	54.00	-2.79	Average Detector
	2483.500	66.10	-6.77	59.33	74.00	-14.67	Peak Detector
3	2500.000	43.23	-6.67	36.56	54.00	-17.44	Average Detector
	2500.000	55.22	-6.67	48.55	74.00	-25.45	Peak Detector

- Conducted test

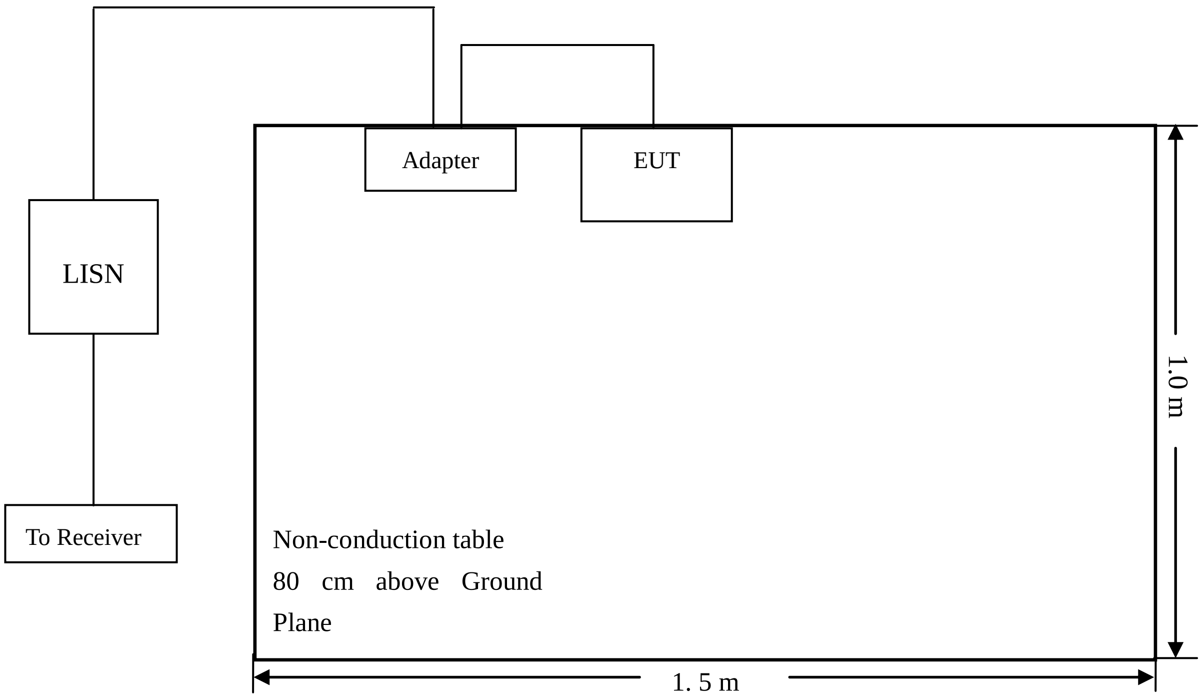
Please refer to Appendix E

12. Conducted Emissions

12.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

12.2 Basic Test Setup Block Diagram



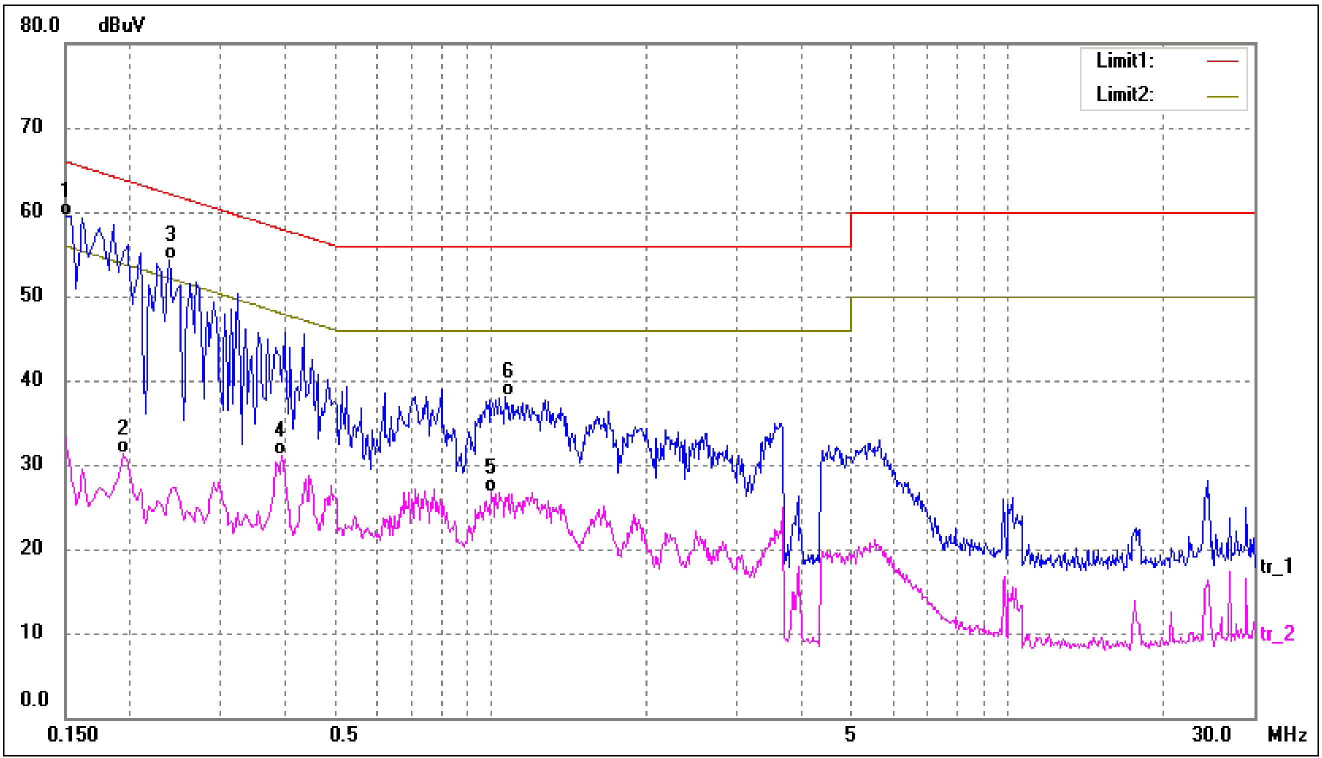
12.3 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency .... 150 kHz
Stop Frequency .... 30 MHz
Sweep Speed .... Auto
IF Bandwidth.. 10 kHz
Quasi-Peak Adapter Bandwidth .... 9 kHz
Quasi-Peak Adapter Mode .... Normal

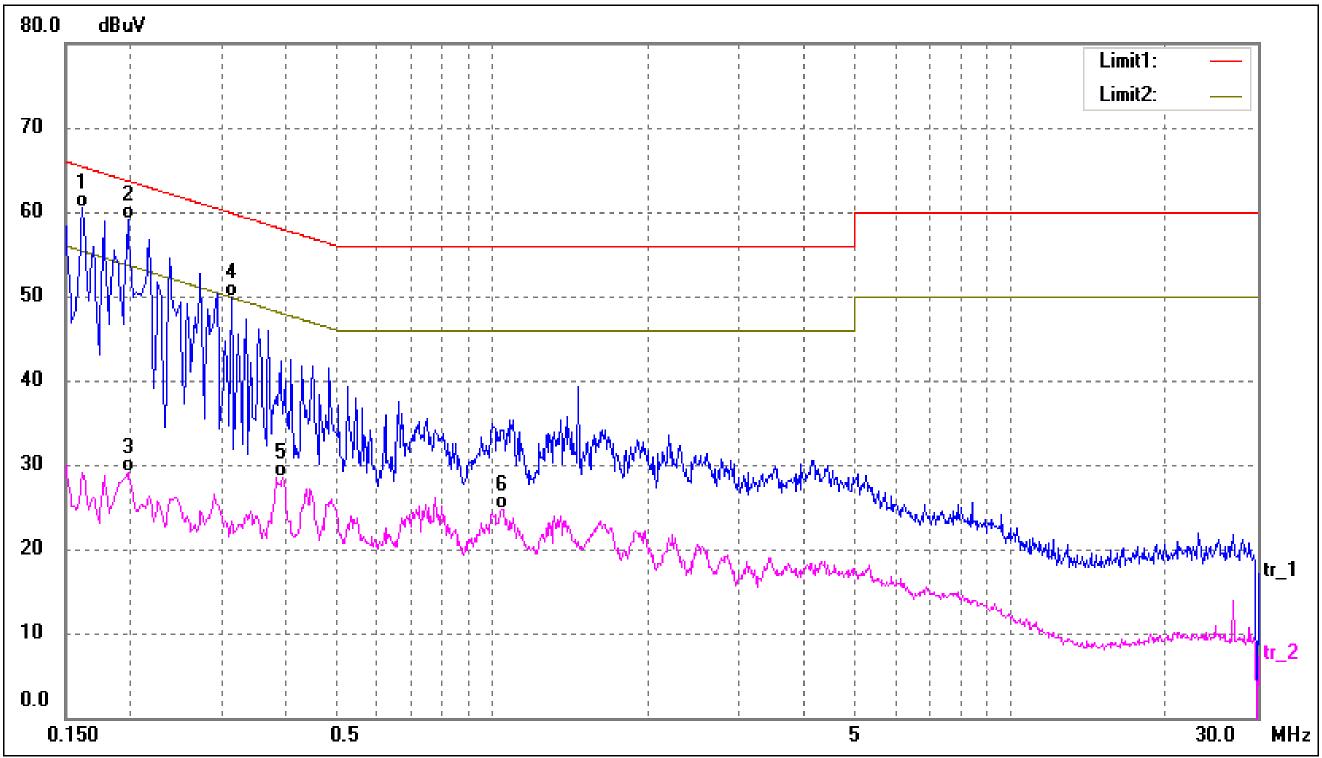
12.4 Summary of Test Results/Plots

Test Mode	Communication	AC120V 60Hz	Polarity:	Neutral



No.	Frequency	Reading	Correct	Result	Limit	Margin	Detector
	(MHz)	(dBuV)	(dB/m)	(dBuV)	(dBuV)	(dB)	
1*	0.1500	49.40	10.10	59.50	66.00	-6.50	QP
2	0.1940	21.09	10.12	31.21	53.86	-22.65	AVG
3	0.2380	44.13	10.15	54.28	62.17	-7.89	QP
4	0.3940	20.91	10.25	31.16	47.98	-16.82	AVG
5	1.0020	16.22	10.50	26.72	46.00	-19.28	AVG
6	1.0660	27.63	10.51	38.14	56.00	-17.86	QP

Test Mode	Communication	AC120V 60Hz	Polarity:	Line



No.	Frequency	Reading	Correct	Result	Limit	Margin	Detector
	(MHz)	(dBuV)	(dB/m)	(dBuV)	(dBuV)	(dB)	
1	0.1620	50.49	10.10	60.59	65.36	-4.77	QP
2*	0.1980	48.92	10.12	59.04	63.69	-4.65	QP
3	0.1980	18.97	10.12	29.09	53.69	-24.60	AVG
4	0.3140	39.68	10.20	49.88	59.86	-9.98	QP
5	0.3940	18.27	10.25	28.52	47.98	-19.46	AVG
6	1.0460	14.16	10.51	24.67	46.00	-21.33	AVG

APPENDIX SUMMARY

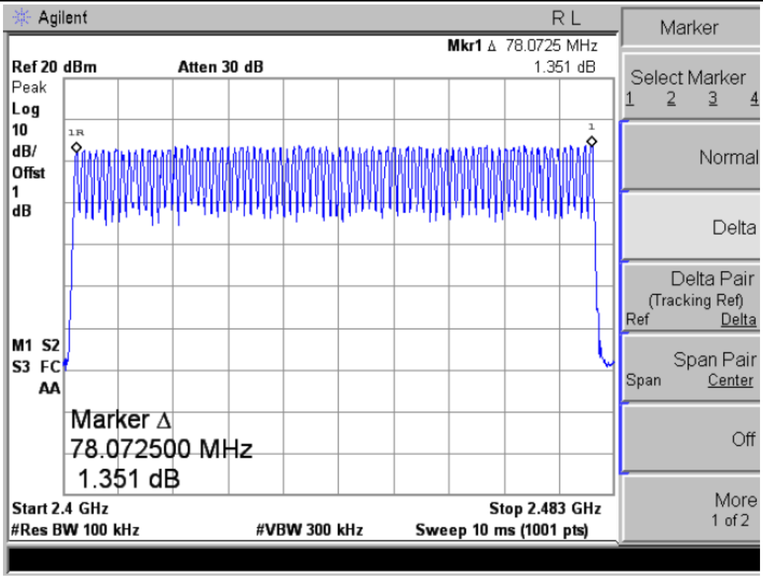
Project No.	WTX22X0704987W-1	Test Engineer	Tom Wang
Start date	2022/07/16	Finish date	2022/07/24
Temperature	28℃	Humidity	47%
RF specifications	BT-BR/EDR		

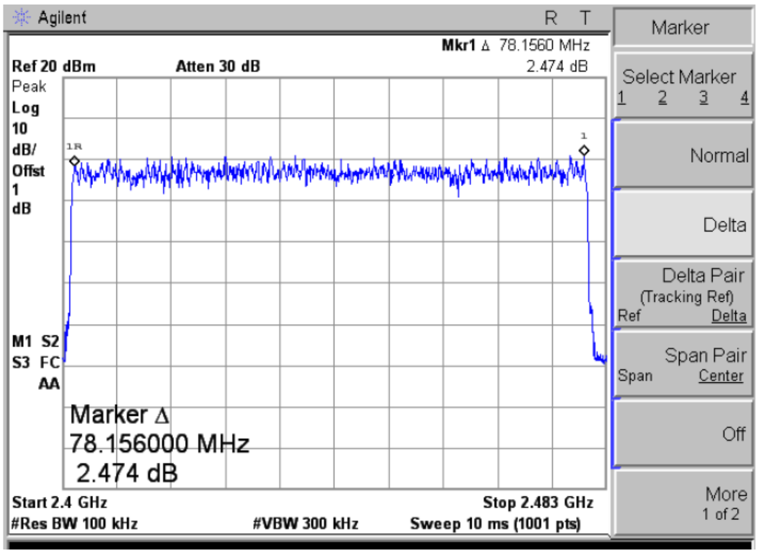
APPENDIX	Description of Test Item	Result
A	Hopping Channels and Channel Separation	Compliant
B	Dwell Time of Hopping Channel	Compliant
C	20dB Bandwidth	Compliant
D	RF Output Power	Compliant
E	Conducted Out of Band Emissions	Compliant

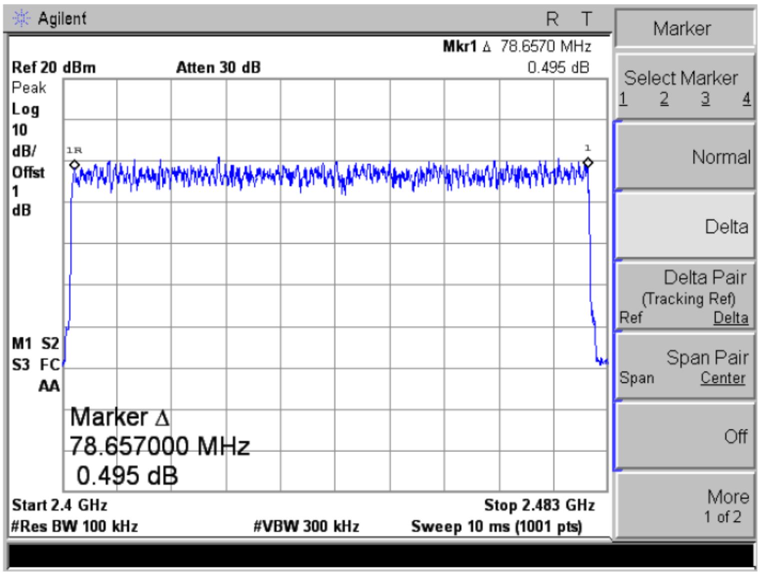
APPENDIX A

Hopping Channels Number			
Mode	Test Result	Limit	Result
GFSK	79	⩾75	Pass
π /4 DQPSK	79	⩾75	Pass
8DPSK	79	⩾75	Pass

GFSK	
π /4 DQPSK	
8DPSK	

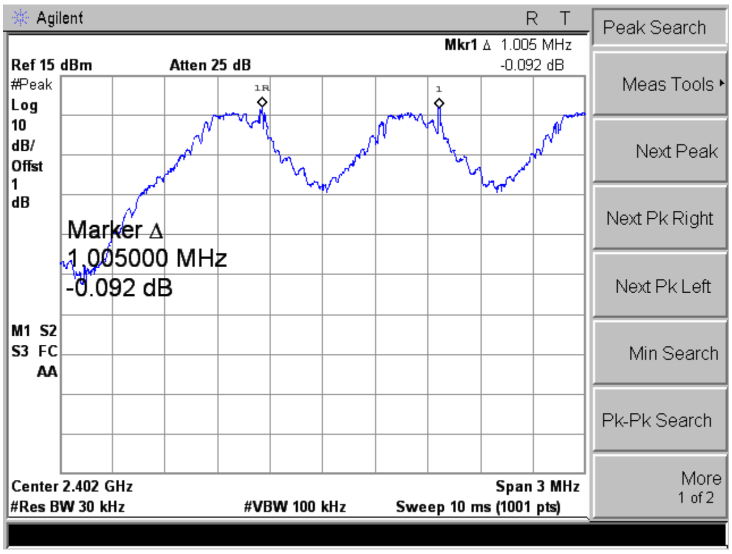
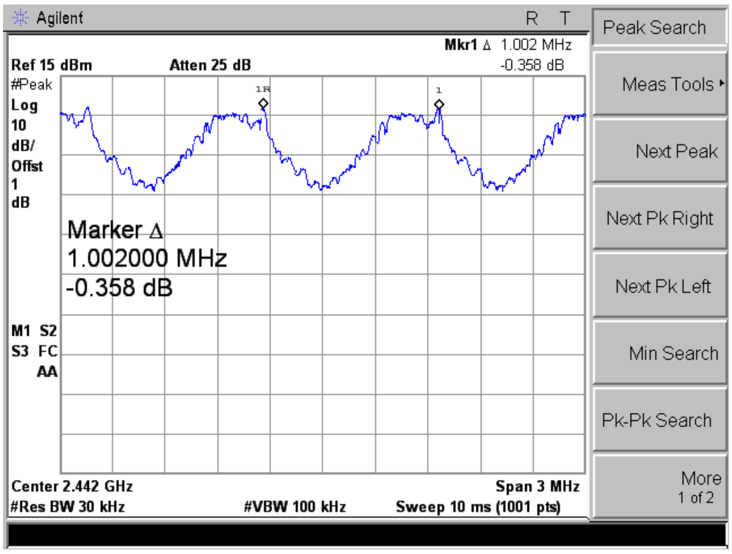
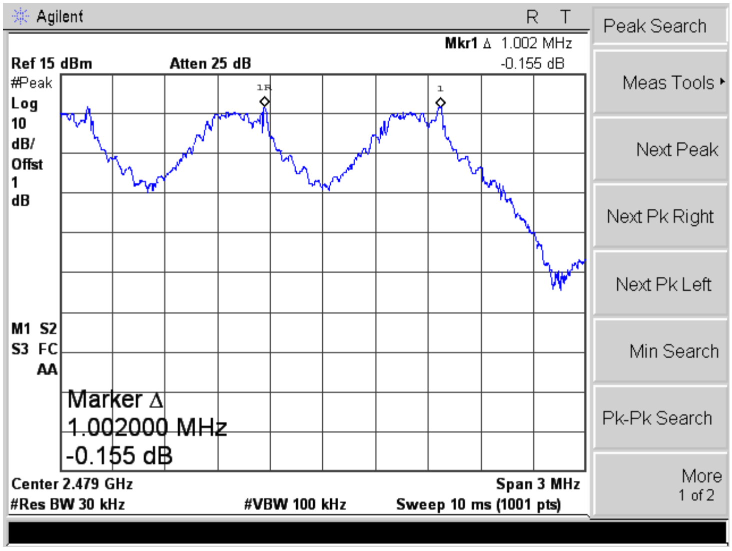


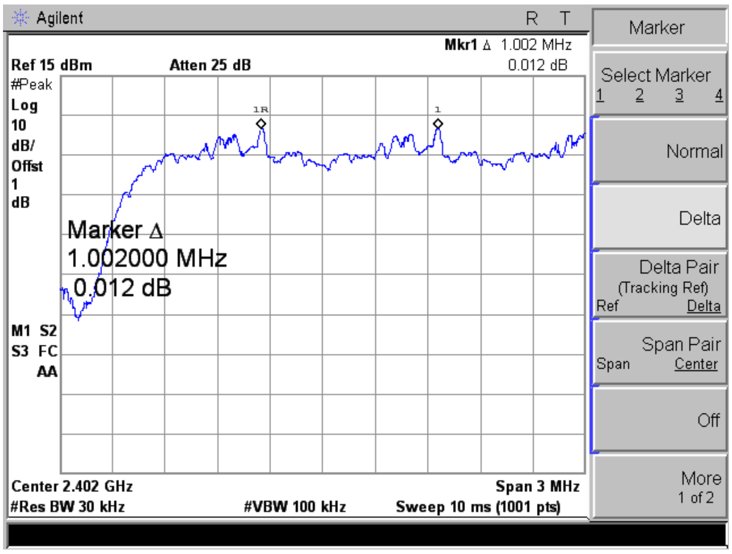
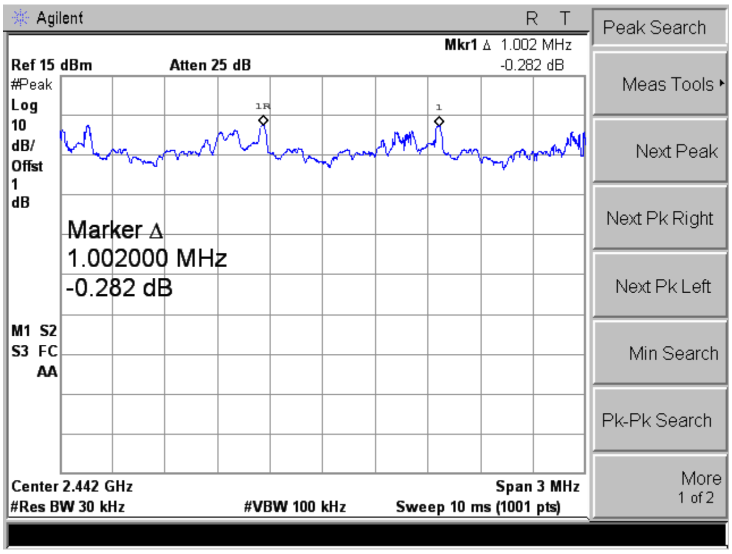
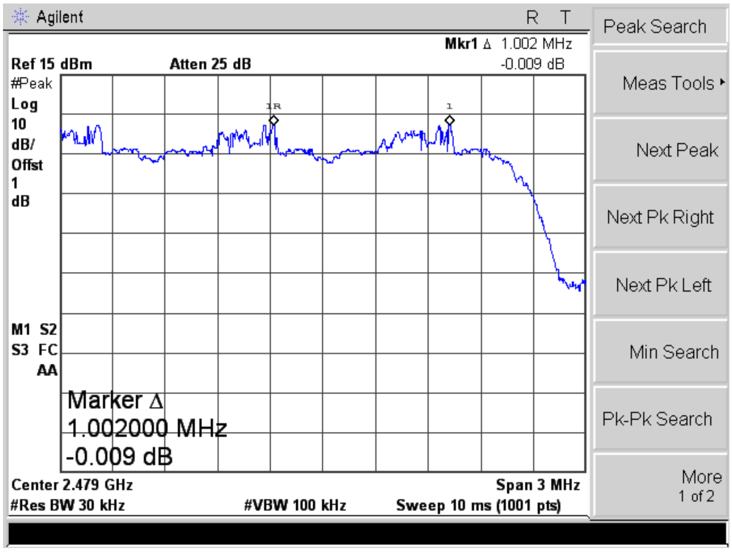




Channel Separation			
Mode	Channel	Carrier Frequencies Separation (kHz)	Result
GFSK	Low	1005.0	Pass
	Middle	1002.0	Pass
	High	1002.0	Pass
8DPSK	Low	1002.0	Pass
	Middle	1002.0	Pass
	High	1002.0	Pass

Note: Test data is corrected with the worse case (GFSK, 8DPSK).

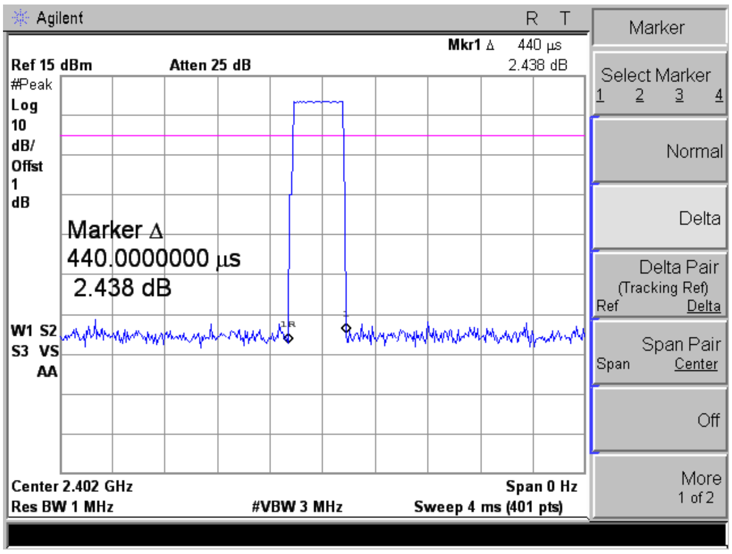
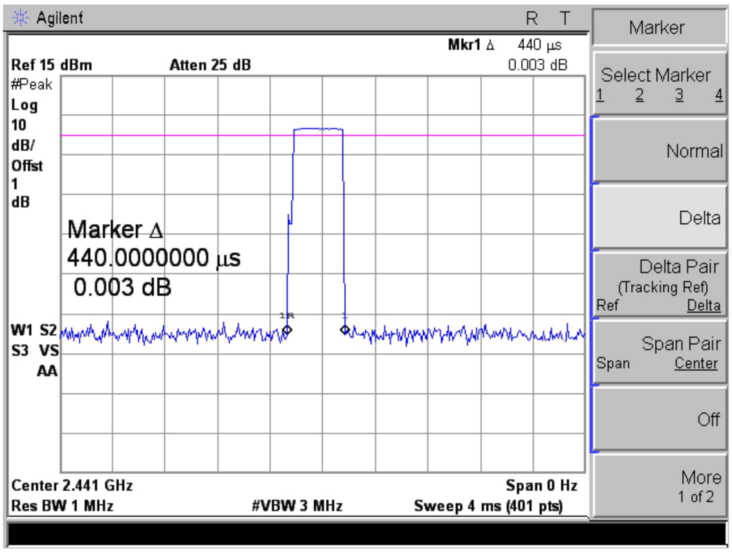
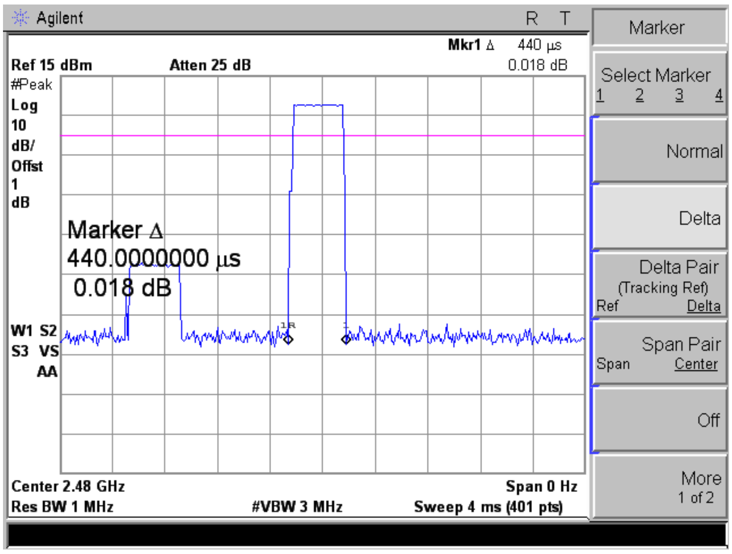
GFSK Low Channel	
GFSK Middle Channel	
GFSK High Channel	

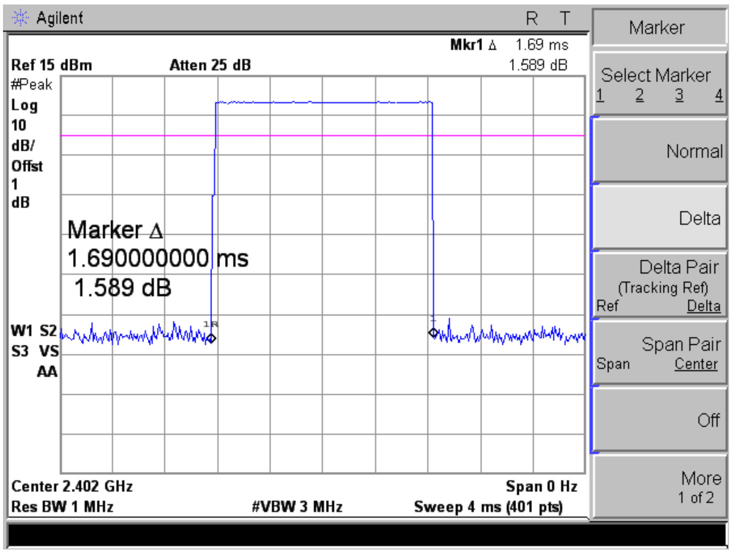
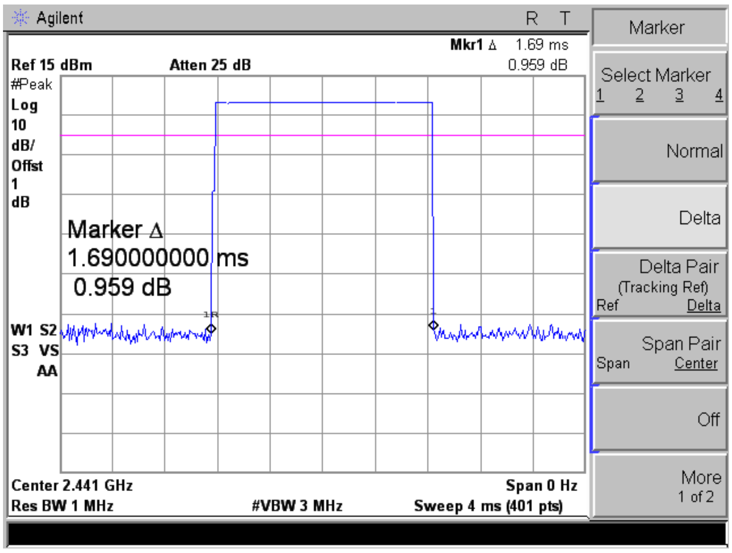
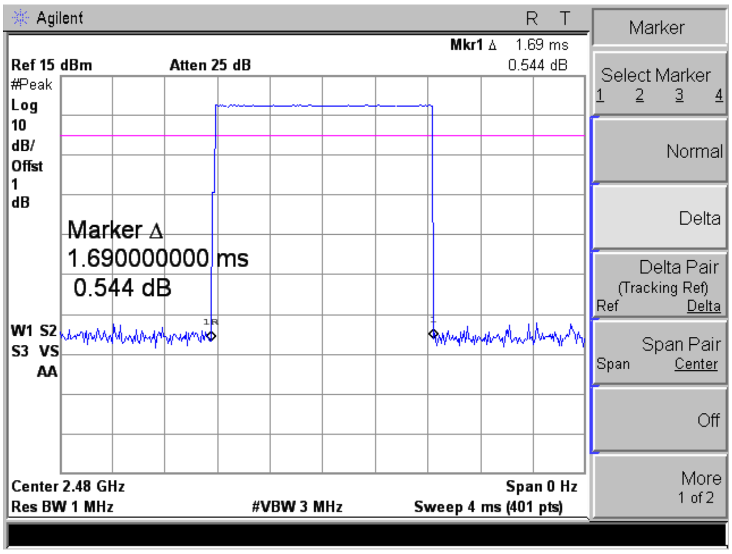
8DPSK Low Channel	
8DPSK Middle Channel	
8DPSK High Channel	

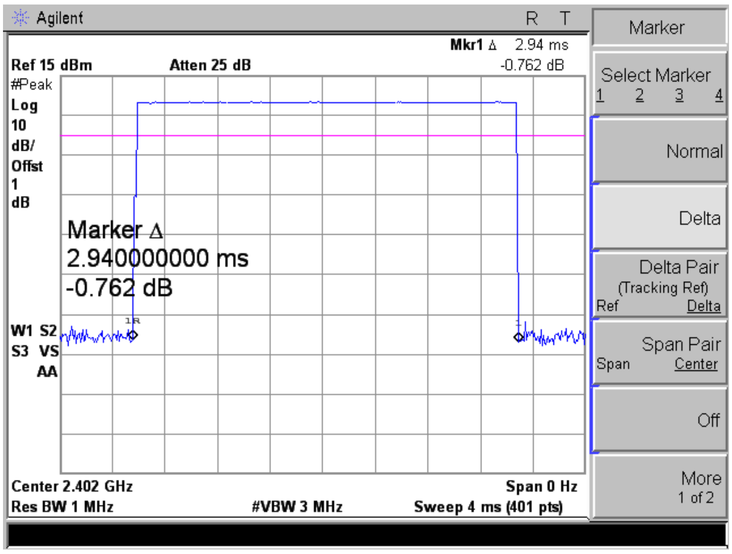
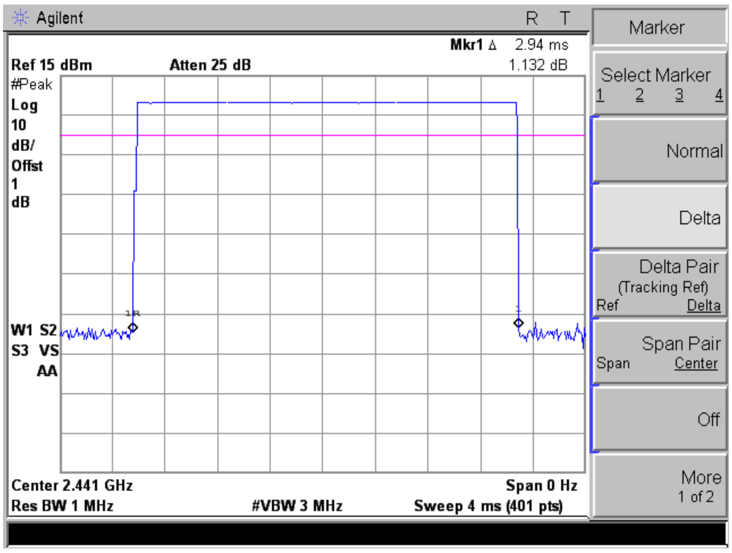
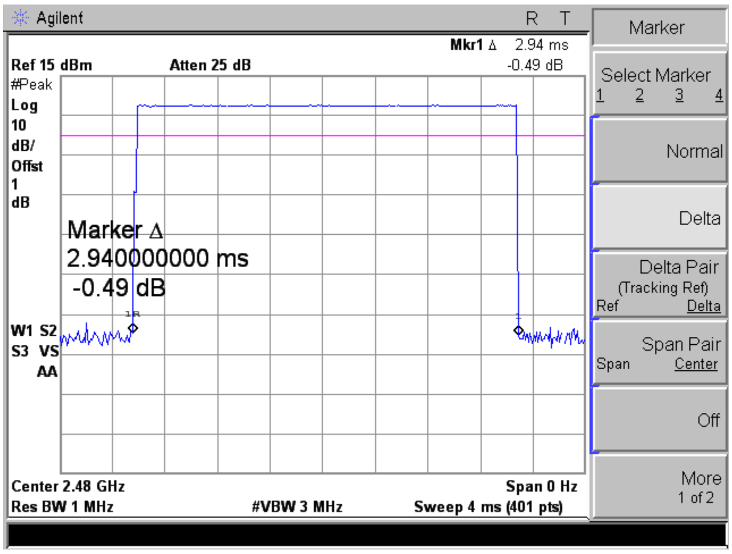
APPENDIX B

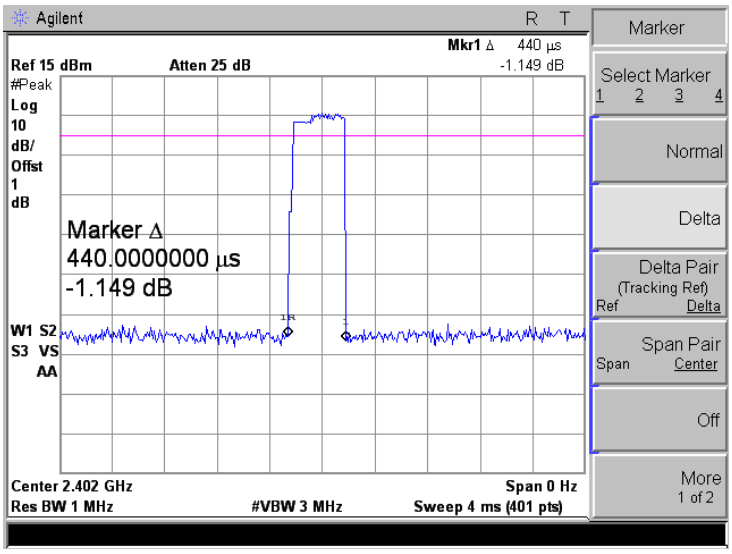
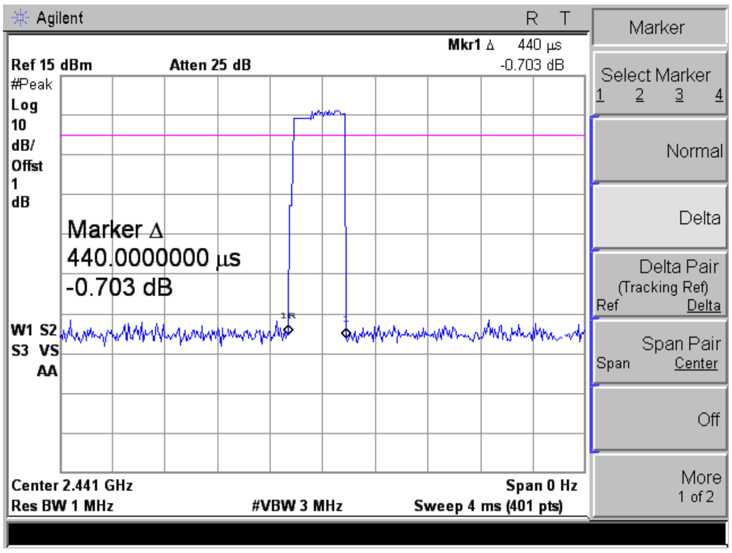
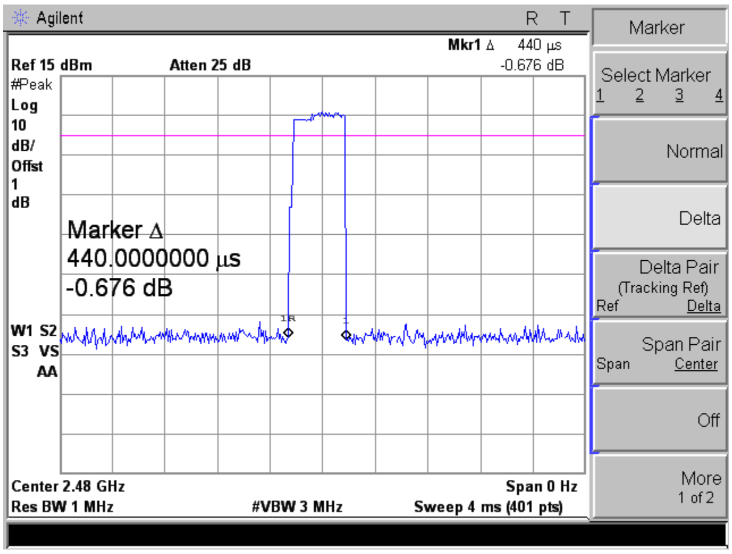
Dwell Time of Hopping Channel					
Modulation	Test Channel	Packet	Time Slot Length	Dwell Time	Limit
			ms	ms	ms
GFSK	Low	DH1	0.44	140.80	400
		DH3	1.69	270.40	400
		DH5	2.94	313.60	400
	Middle	DH1	0.44	140.80	400
		DH3	1.69	270.40	400
		DH5	2.94	313.60	400
	High	DH1	0.44	140.80	400
		DH3	1.69	270.40	400
		DH5	2.94	313.60	400
8DPSK	Low	3DH1	0.44	140.80	400
		3DH3	1.69	270.40	400
		3DH5	2.95	314.67	400
	Middle	3DH1	0.44	140.80	400
		3DH3	1.69	270.40	400
		3DH5	2.95	314.67	400
	High	3DH1	0.44	140.80	400
		3DH3	1.69	270.40	400
		3DH5	2.95	314.67	400

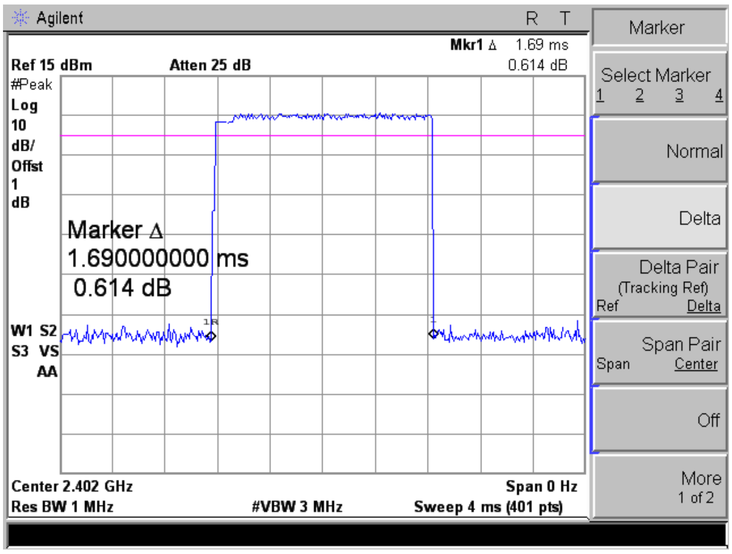
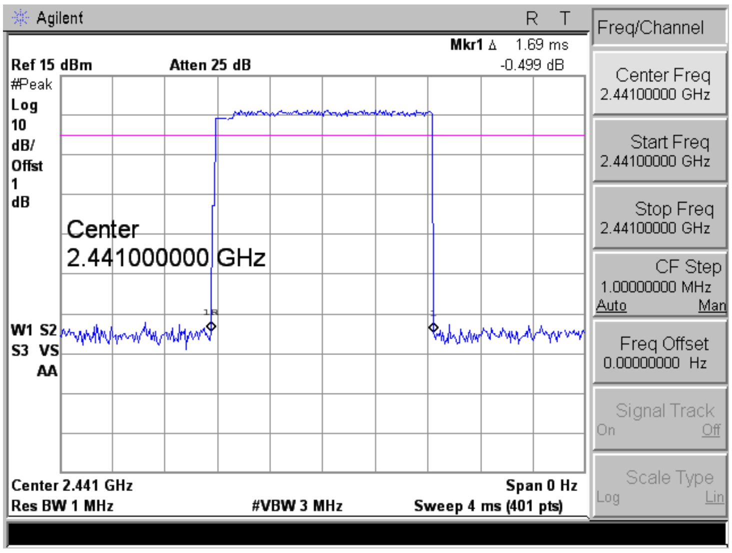
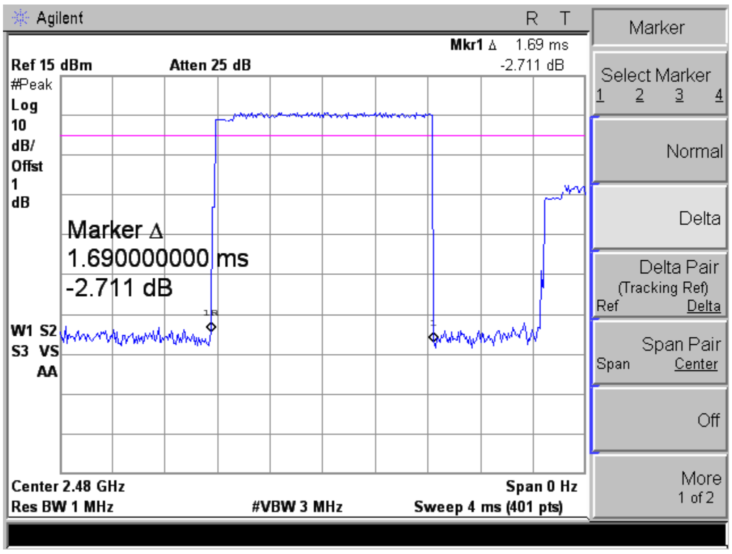
The dwell time within a period in data mode is independent from the packet type (packet length).
Test data is corrected with the worse case(GFSK, 8DPSK), which the packet length is DH1, DH3, and DH5.
The test period: T = 0.4 Second * 79 Channel = 31.6 s
Dwell time = time slot length * (Hopping rate / Number of hopping channels) * Period
Dwell time=Pulse time (ms) ×(1600 ÷2 ÷79) ×31.6 Second for DH1, 2-DH1, 3-DH1
Dwell time=Pulse time (ms) ×(1600 ÷4 ÷79) ×31.6 Second for DH3, 2-DH3, 3-DH3
Dwell time=Pulse time (ms) ×(1600 ÷6 ÷79) ×31.6 Second for DH5, 2-DH5, 3-DH5

DH1	
Low Channel	
Middle Channel	
High Channel	

DH3	
Low Channel	
Middle Channel	
High Channel	

DH5	
Low Channel	
Middle Channel	
High Channel	

3DH1	
Low Channel	
Middle Channel	
High Channel	

3DH3	
Low Channel	
Middle Channel	
High Channel	

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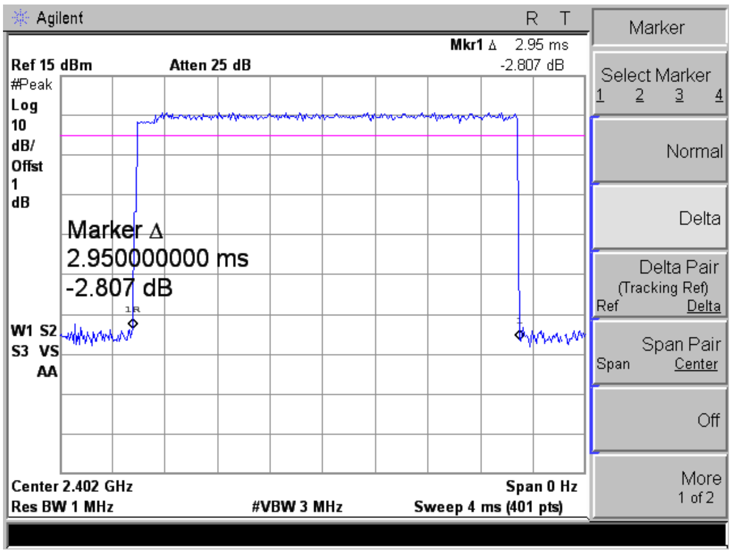
<tr><td>Low Channel</td><td>
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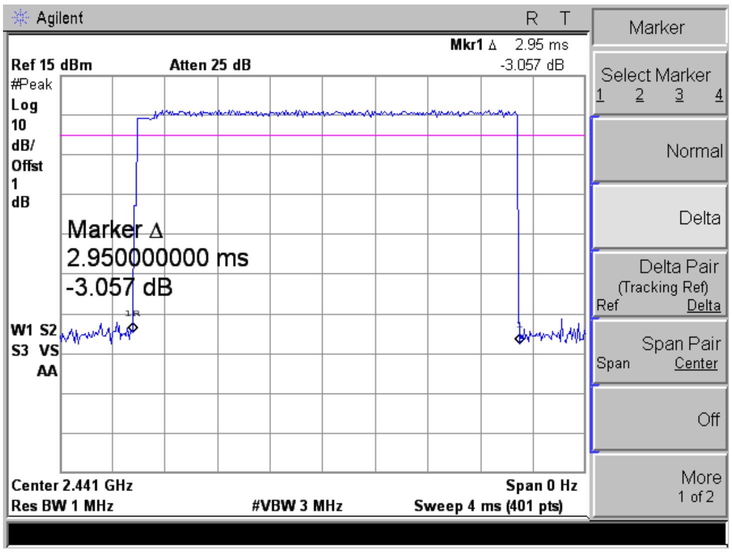
<tr><td>Middle Channel</td><td>
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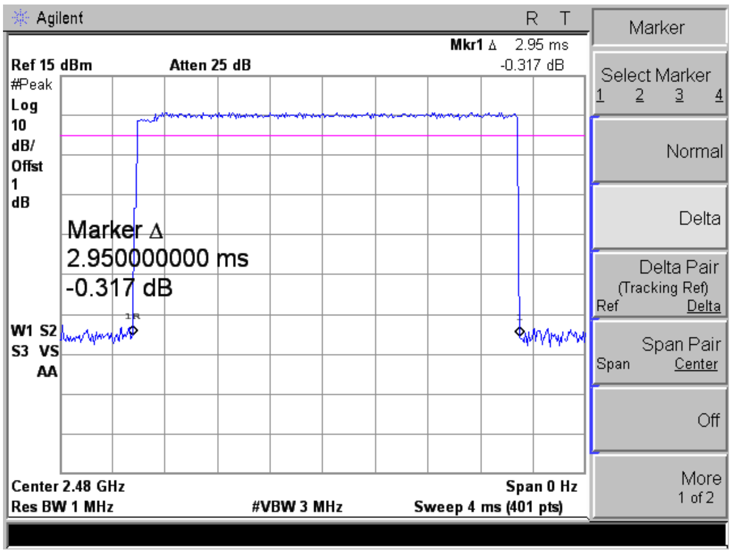
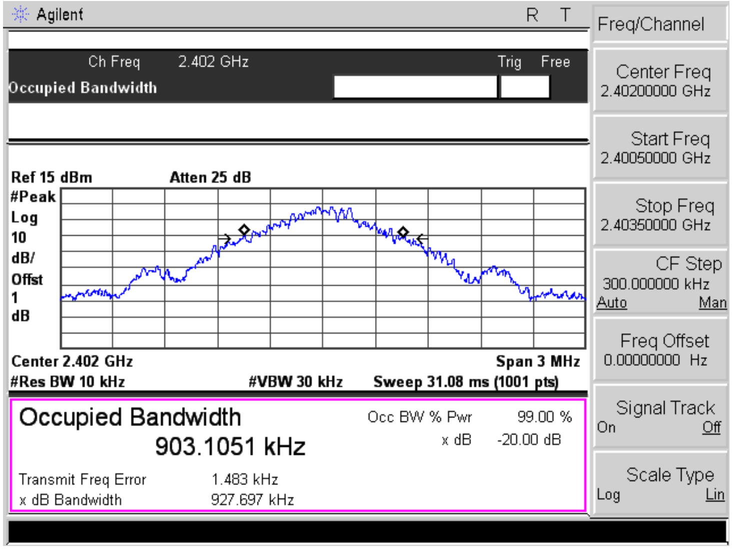
<tr><td>High Channel</td><td>
</td></tr>
</table>

APPENDIX C

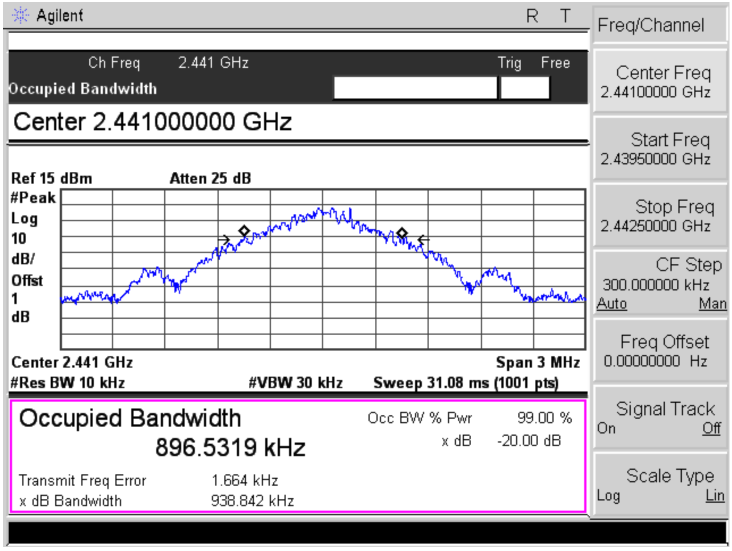
20 dB Bandwidth			
Test Mode	Test Channel MHz	20 dB Bandwidth kHz	Result
GFSK	2402	927.697	Pass
	2441	938.842	Pass
	2480	932.616	Pass
Pi/4 QDPSK	2402	1360.000	Pass
	2441	1351.000	Pass
	2480	1351.000	Pass
8DPSK	2402	1328.000	Pass
	2441	1309.000	Pass
	2480	1315.000	Pass

GFSK

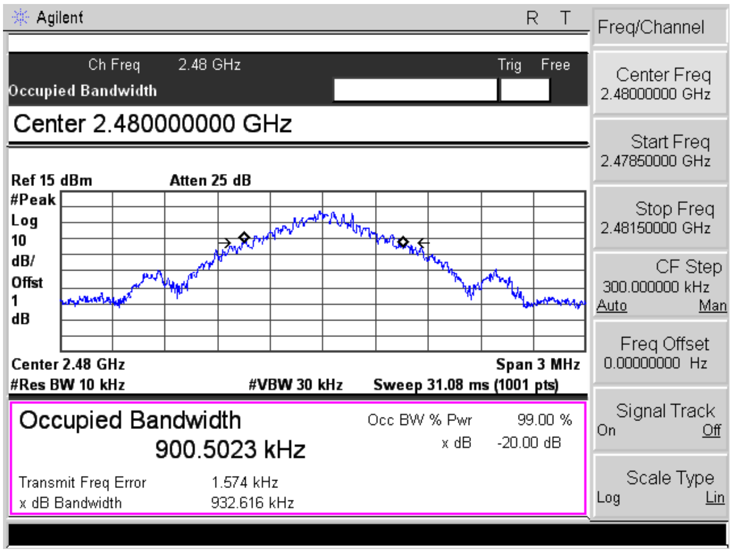
Low Channel

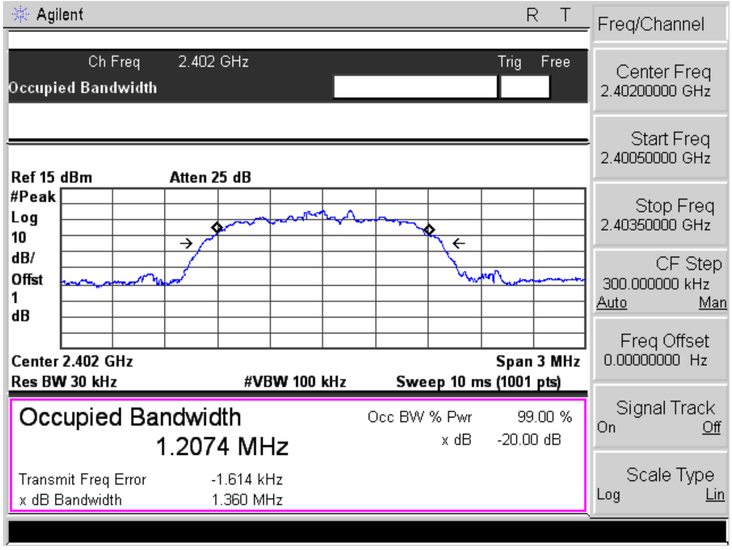


Middle Channel



High Channel



<table>
<tr><th colspan="2">Pi/4 QDPSK</th></tr>
<tr><td>Low Channel</td><td>
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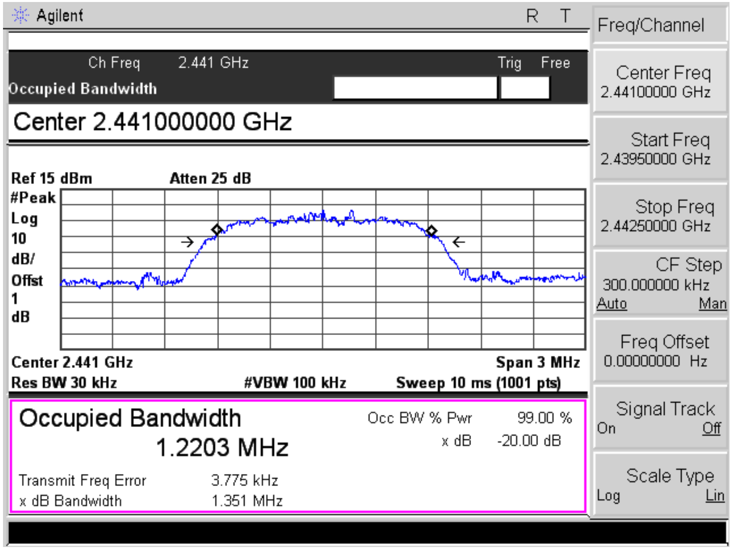
<tr><td>Middle Channel</td><td>
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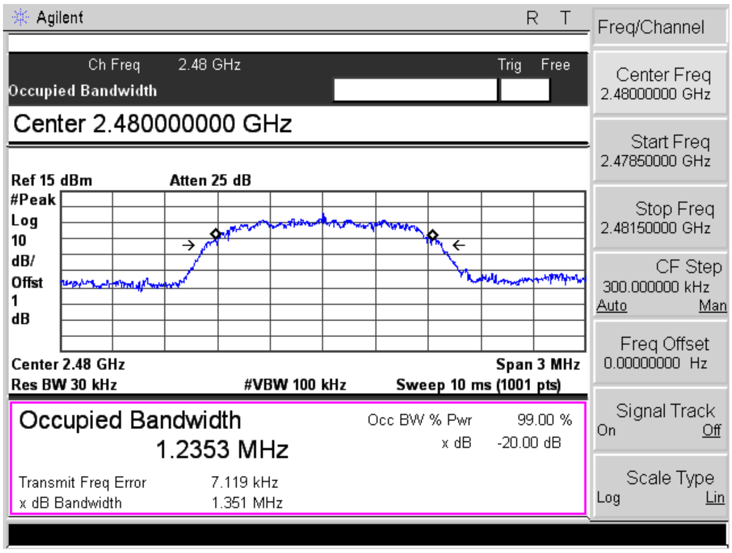
<tr><td>High Channel</td><td>
</td></tr>
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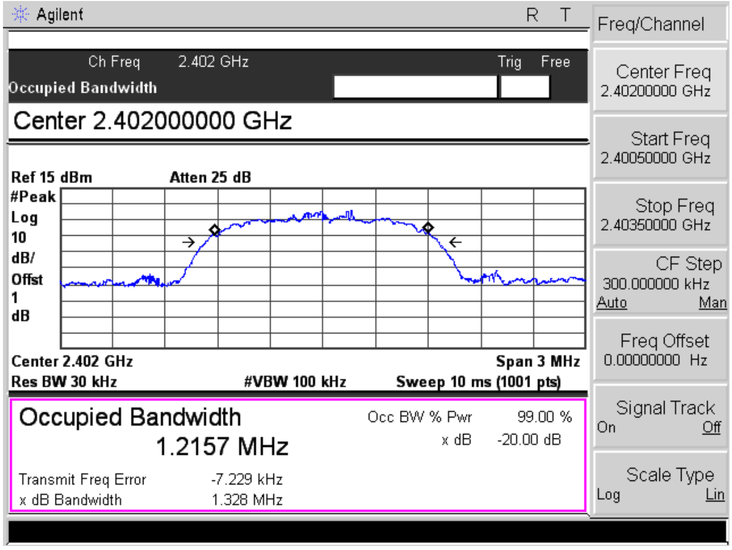
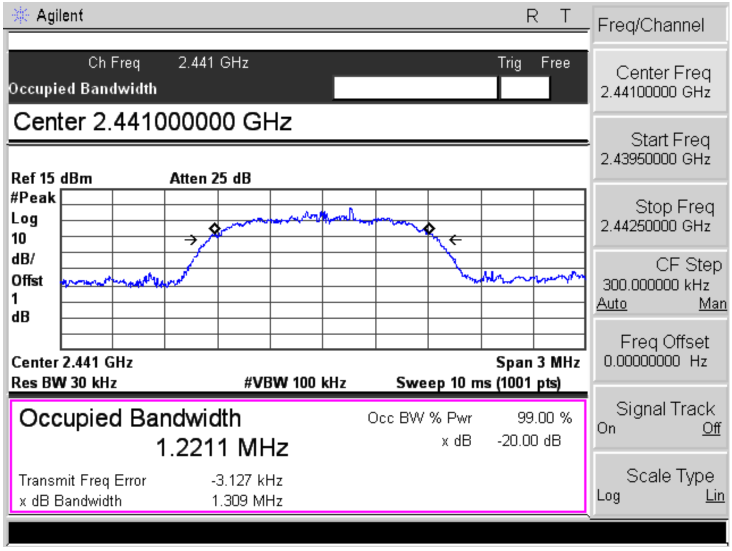
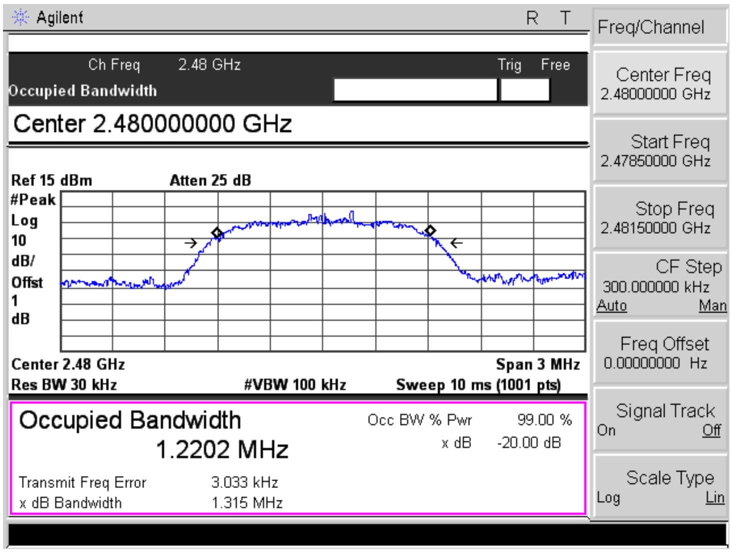
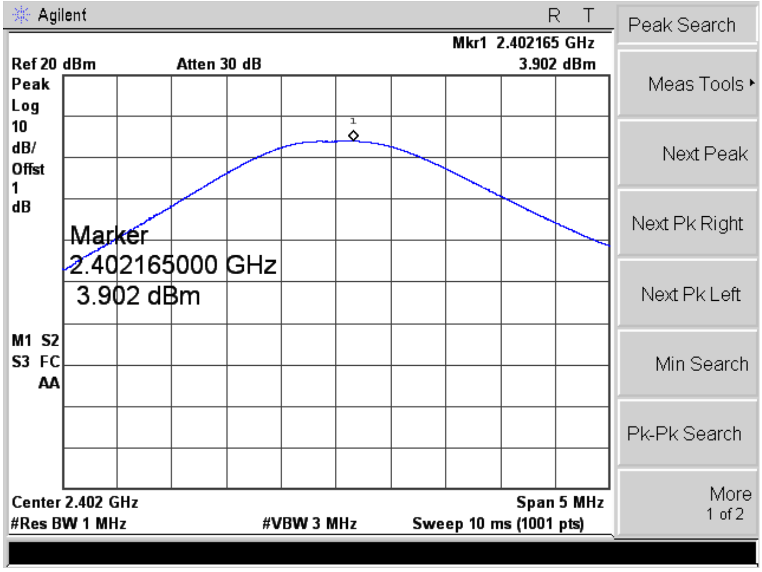
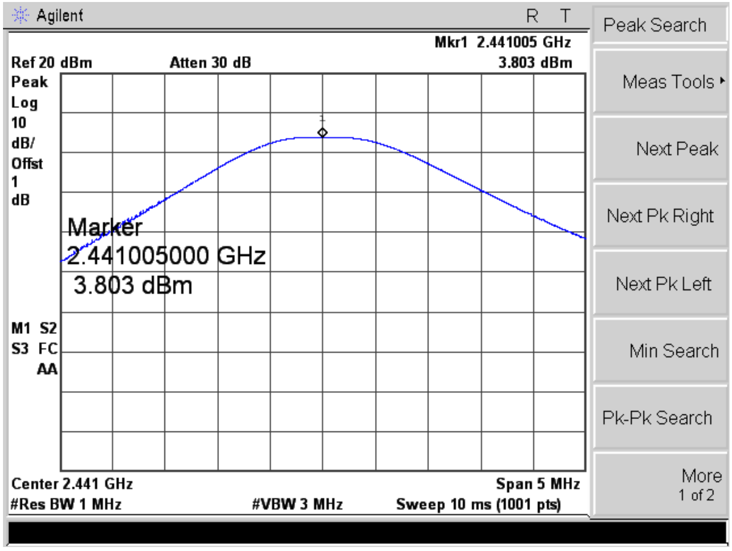
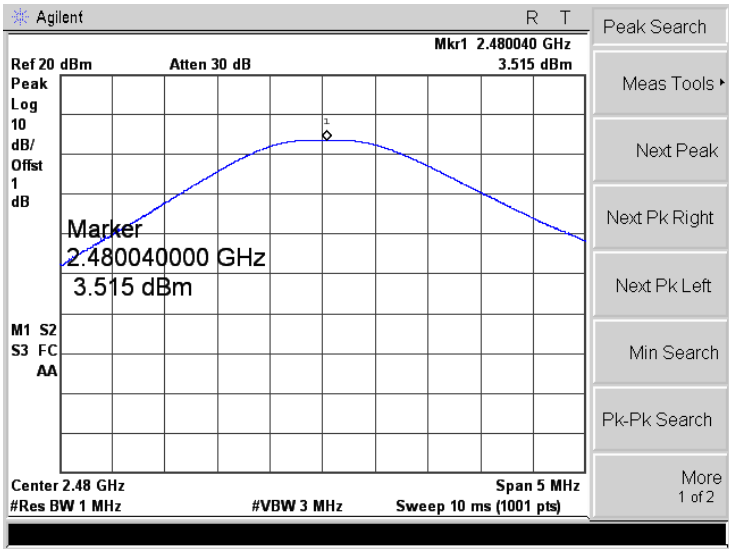
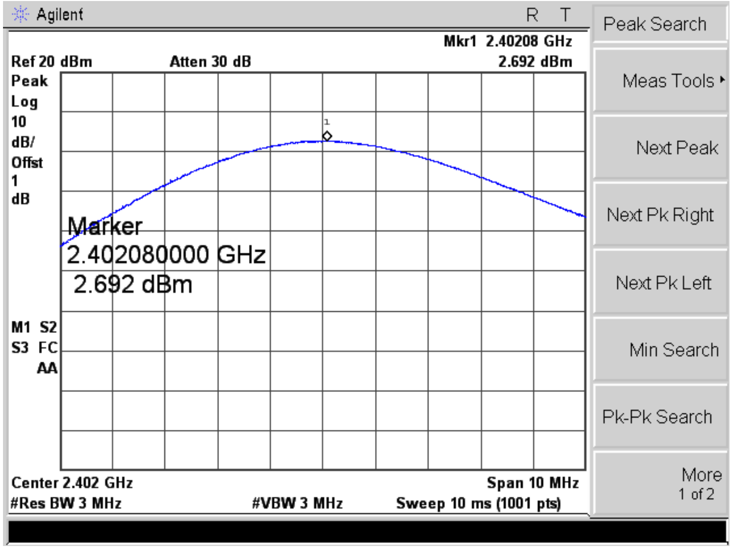
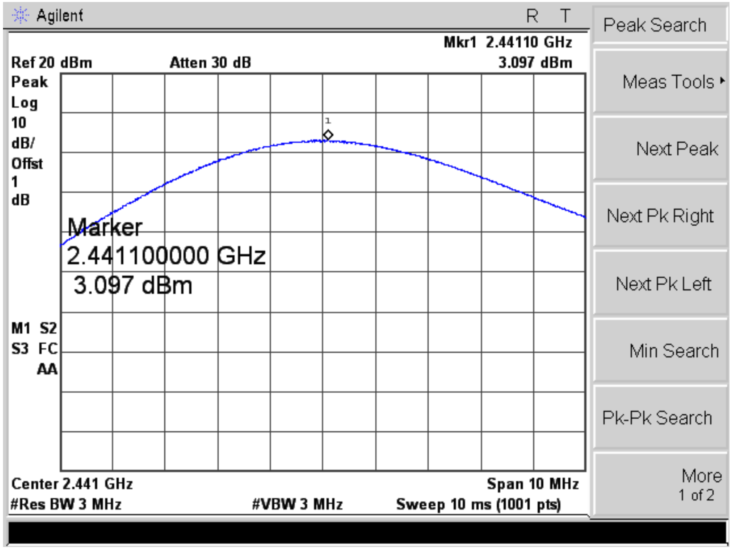
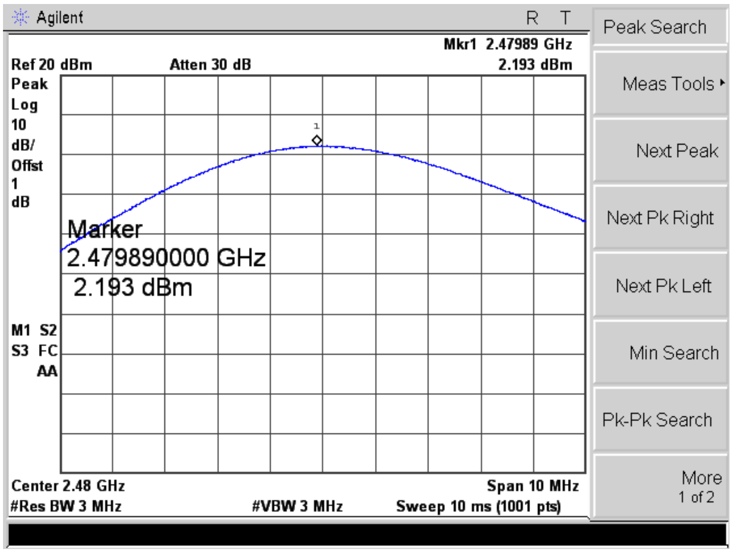
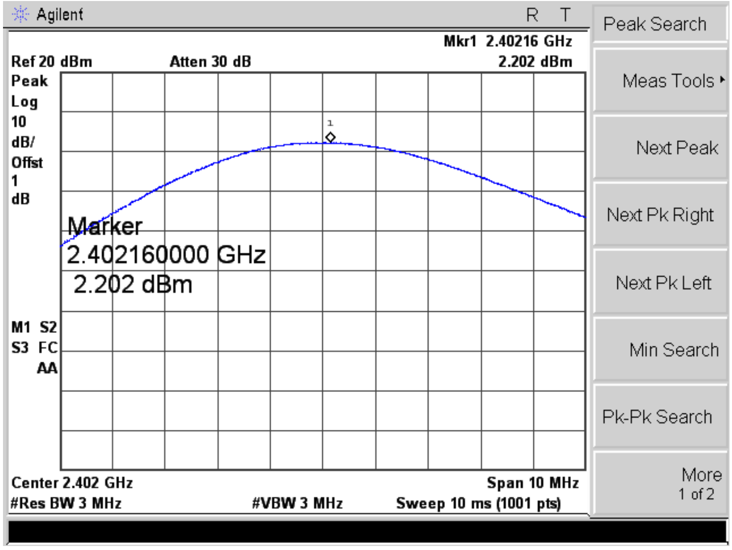
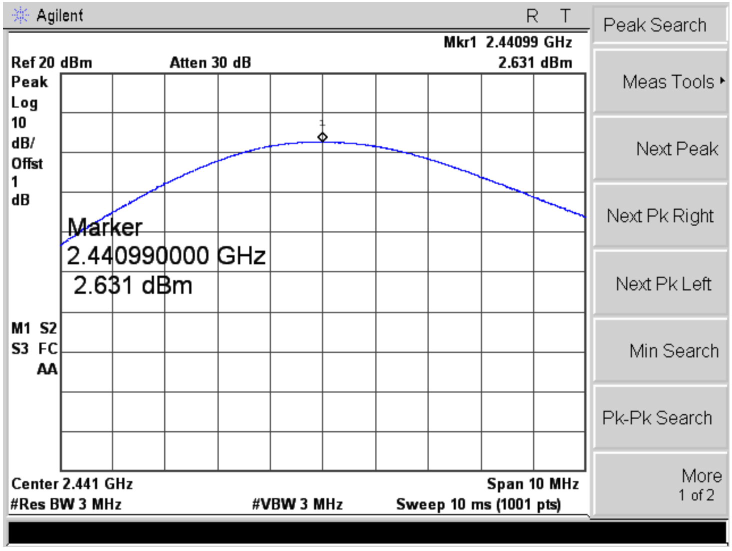
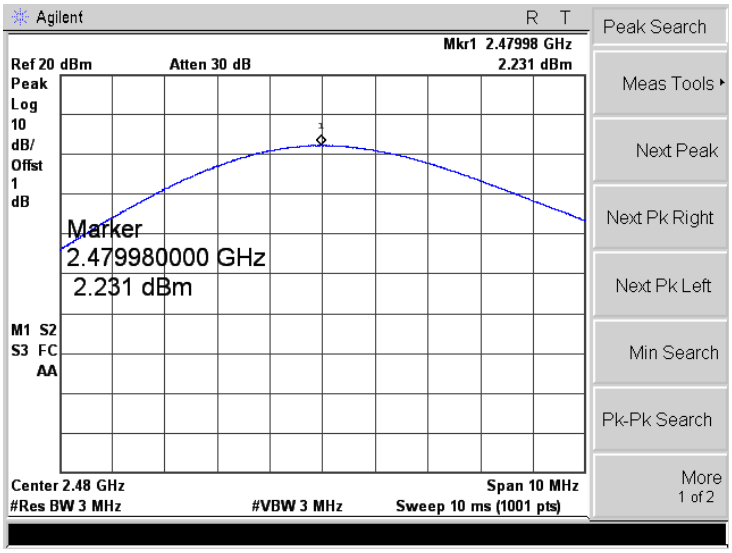
8DPSK	
Low Channel	
Middle Channel	
High Channel	

APPENDIX D

Output power				
Modulation type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	Low	3.90	30	Pass
	Middle	3.80		
	High	3.52		
π/4DQPSK	Low	2.69	30	Pass
	Middle	3.10		
	High	2.20		
8DPSK	Low	2.20	30	Pass
	Middle	2.63		
	High	2.23		

GFSK	
Low Channel	
Middle Channel	
High Channel	

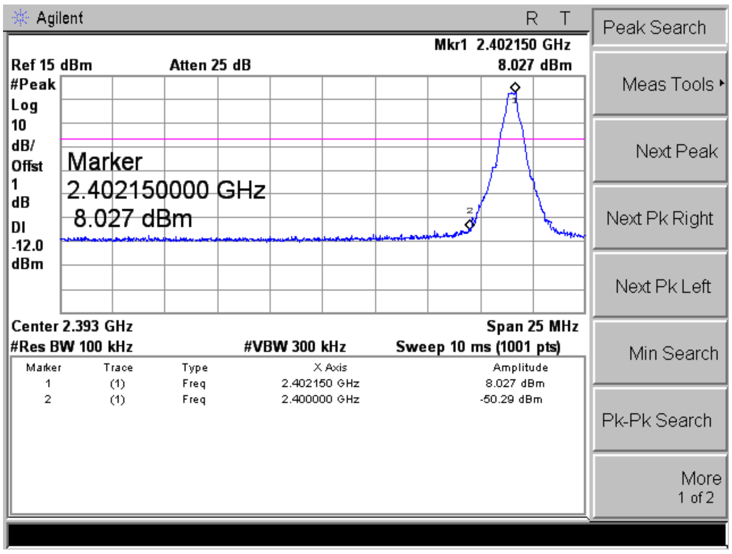
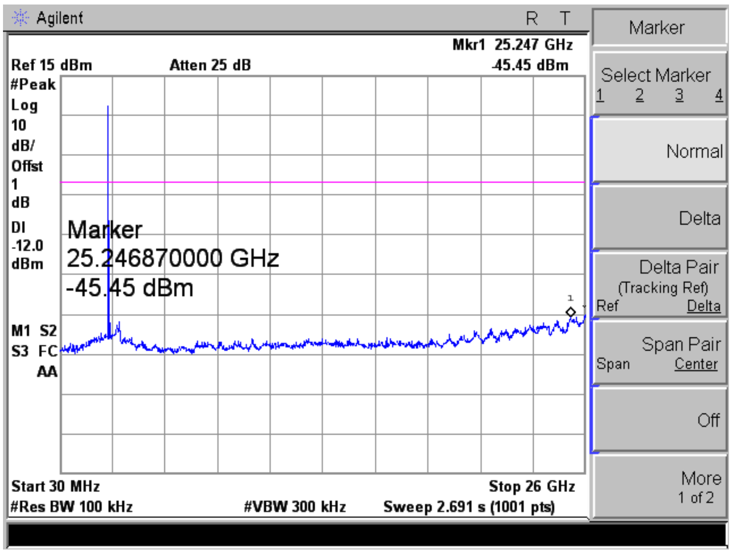
Pi/4 QDPSK	
Low Channel	
Middle Channel	
High Channel	

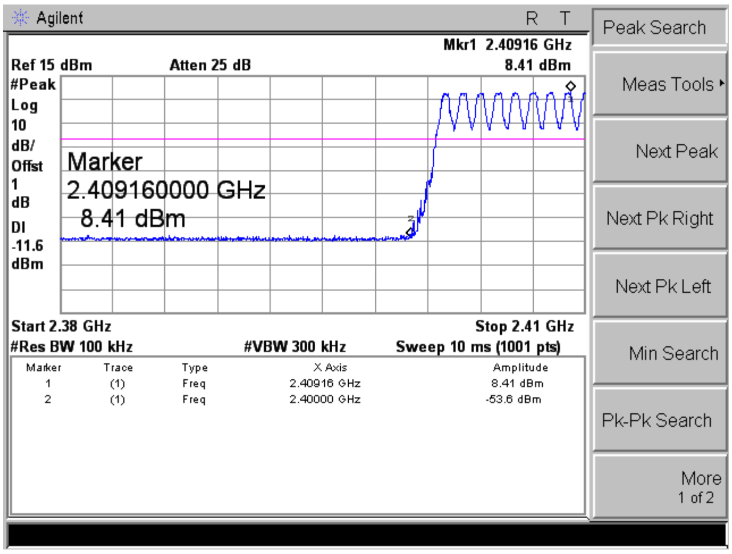
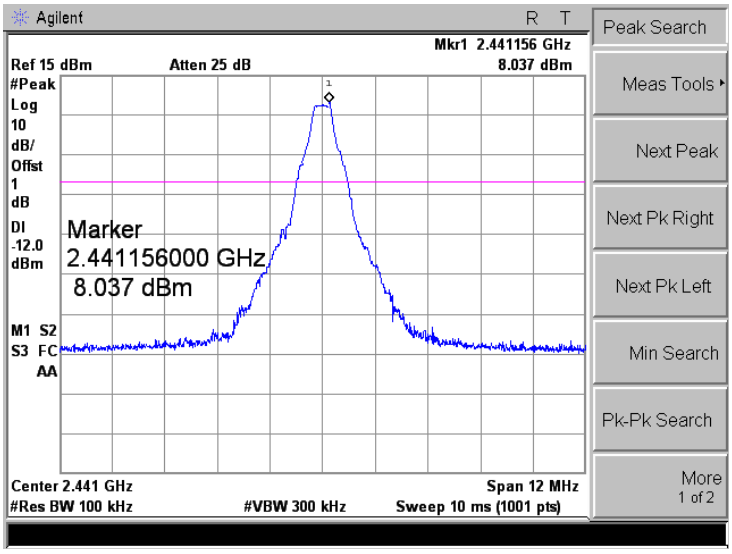
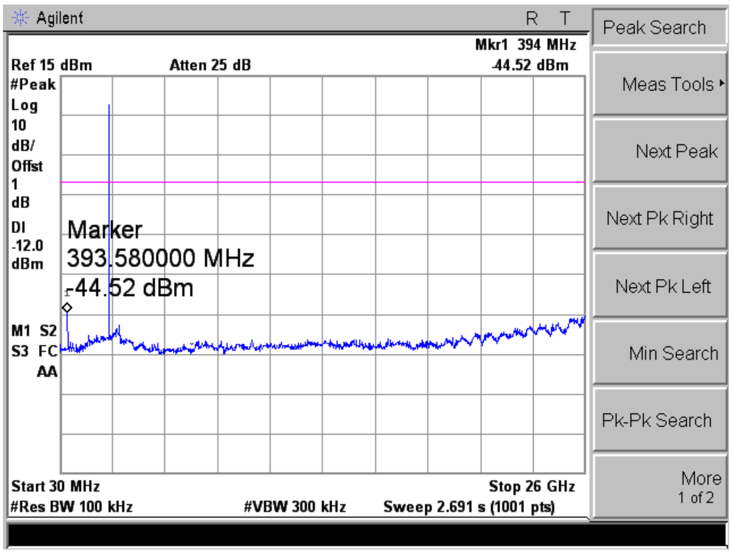
8DPSK	
Low Channel	
Middle Channel	
High Channel	

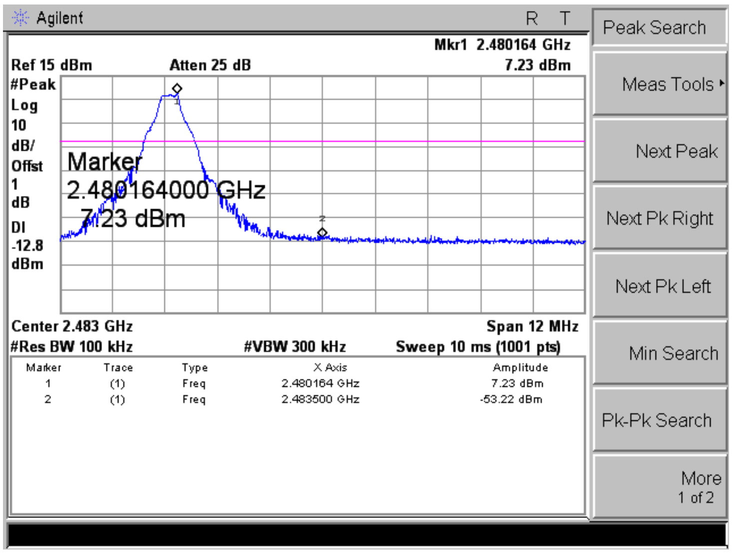
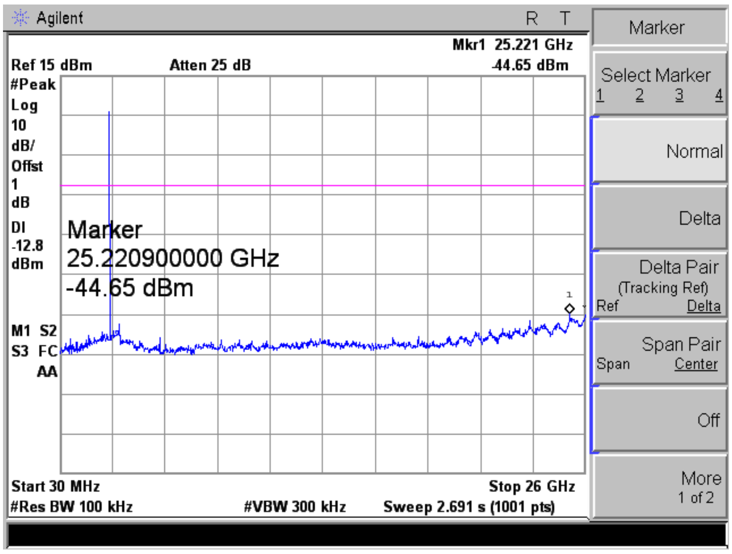
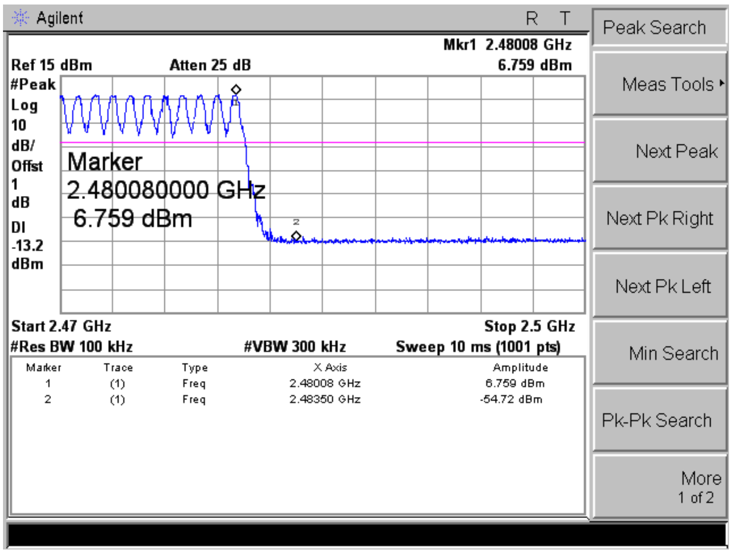
APPENDIX E

Conducted Out of Band Emissions

Note: All test modes (different data rate and different modulation) are performed, but only the worst case（DH1） is recorded in this report.

Worst mode DH1	
Low channel	
	

	
Worst mode DH1	
Middle channel	
	

Worst mode DH1	
High channel	
	
	

APPENDIX PHOTOGRAPHS

Please refer to “ANNEX”

******* END OF REPORT *******