Industrial Internet Innovation Center (Shanghai) Co.,Ltd.

FCC BT TEST REPORT

PRODUCT	Multimedia Control System
BRAND	HAVAL
MODEL	IN9.0
APPLICANT	NOBO AUTOMOTIVE TECHNOLOGIES CO., LTD.
FCC ID	2A7V5-IN90-1
ISSUE DATE	September 27, 2022
STANDARD(S)	FCC Part15

Prepared by: ***Tao Lingyan***	**Reviewed by:** ***Yang Fan***	**Approved by:** ***Liu Long***
Signature	***Signature***	***Signature***

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1. Summary of Test Report

1.1 Test Standard(s)

No.	Test Standard(s)	Title	Version
1	FCC Part15	FCC CFR 47, Part 15, Subpart C: 15.205 Restricted bands of operation; 15.209 Radiated emission limits, general requirements; 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz.	2020

1.2 Reference Documents

No.	Title	Title	Version
1	ANSI C63.10	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	2013
2	KDB 558074	Guidance for Performing Compliance Measurements on Frequency Hopping Spread Spectrum systems (DSS) Operating Under §15.247	2019

1.3 Summary of Test Results

Measurement Items	Sub-clause of Part15C	Verdict
Maximum Peak Output Power	15.247(b)	Pass
20dB Occupied Bandwidth	15.247(a)	Pass
99% Occupied Bandwidth	15.247(a)	Pass
Band Edges Compliance	15.247 (d)	Pass
Time Of Occupancy (Dwell Time)	15.247(a)	Pass
Carrier Frequency Separation	15.247(a)	Pass
Number Of Hopping Channels	15.247(a)	Pass
Transmitter Spurious Emission-Conducted	15.247(d)	Pass
Transmitter Spurious Emission-Radiated	15.247,15.209,15.205	Pass
AC Powerline Conducted Emission	15.207	N/A

NOTE:
The IN9.0, manufactured by NOBO AUTOMOTIVE TECHNOLOGIES CO., LTD. is a new product for testing. There are many configurations in this project. We mainly tested the high configuration sample N03&S15 (Main supply) in this report.
Please refer to the " Model Declaration Letter" document for sample configuration information. Sample N03&S15 (Main supply) corresponds to the "Full Testing sample" in the document.
Industrial Internet Innovation Center (Shanghai) Co., Ltd. only performed test cases which identified with Pass/Fail/Inc result in section 1.2.

Industrial Internet Innovation Center (Shanghai) Co., Ltd. has verified that the compliance of the tested device specified in section 4 of this test report is successfully evaluated according to the procedure and test methods as defined in type certification requirement listed in section 1 of this test report.

a. All the test data for each data were verified, but only the worst case was reported.

b.The GFSK, π/4 DQPSK and 8DPSK were set in DH1 for GFSK, 2-DH1 for π/4 DQPSK, 3-DH1 for 8DPSK.

c.The DC and low frequency voltages' measurement uncertainty is ±2%.

1.4 Data Provided by Applicant

No.	Item(s)	Data
1	Antenna gain of EUT	2.34 dBi
Note: The data of 1.3 is provided by the customer may affect the validity of the test results in this report, and the impact and consequences of this shall be undertaken by the customer.		

2. General Information of The Laboratory

2.1 Testing Laboratory

Lab Name	Industrial Internet Innovation Center (Shanghai) Co.,Ltd.
Address	Building 4，No. 766，Jingang Road，Pudong，Shanghai，China
Telephone	021-68866880
FCC Registration No.	958356
FCC Designation No.	CN1177

2.2 Laboratory Environmental Requirements

Temperature	15°C~35°C
Relative Humidity	25%RH~75%RH
Atmospheric Pressure	101kPa

2.3 Project Information

Project Manager	Xu Yuting
Test Date	July 8, 2022 to September 27, 2022

3. General Information of The Customer

3.1 Applicant

Company	NOBO AUTOMOTIVE TECHNOLOGIES CO., LTD.
Address	No. 668, Caihong Road, Zhangjiagang Economic and Technological Development Zone, Suzhou , Jiangsu, P.R. China
Telephone	0512-80616208

3.2 Manufacturer

Company	NOBO AUTOMOTIVE TECHNOLOGIES CO., LTD.
Address	No. 668, Caihong Road, Zhangjiagang Economic and Technological Development Zone, Suzhou , Jiangsu, P.R. China

4. General Information of The Product

4.1 Product Description for Equipment under Test (EUT)

Product	Multimedia Control System
Model	IN9.0
Date of Receipt	July 6,2022/June 28,2022
EUT ID*	N03/S15
SN/IMEI	N/A
Supported Radio Technology and Bands	BT5.1 (2402MHz-2480MHz) 2.4G WLAN 802.11b,g,n,ac (2412MHz-2472MHz) 5G WLAN 802.11a,ac,n (5180 MHz-5240MHz) 5G WLAN 802.11a,ac,n (5745 MHz-5825MHz) GPS (1559MHz to 1610MHz) GLONASS (1559MHz to 1610MHz) BDS (1559MHz to 1610MHz) FM (87.5 MHz to 108 MHz) AM (522-1710KHz)
Hardware Version	AA
Software Version	AA
FCC ID	2A7V5-IN90-1
NOTE：EUT ID is the internal identification code of the laboratory.	

4.2 Description for Auxiliary Equipment (AE)

AE ID*	Description	Model	SN/Remark
AE1	RF Cable	N/A	N/A
NOTE：AE ID is the internal identification code of the laboratory.			

5. Test Configuration Information

5.1 Laboratory Environmental Conditions

5.1.1 Permanent Facilities

Relative Humidity	Min. = 45 %, Max. = 55 %		
Atmospheric Pressure	101kPa		
Temperature	Normal	Minimum	Maximum
	25℃	-40℃	85℃
Working Voltage of EUT	Normal	Minimum	Maximum
	12V	7V	18V

5.2 Test Equipments Utilized

5.2.1 Conducted Test System

No.	Name	Model	S/N	Manufacturer	Cal. Date	Cal. Interval
1	Programmable Power Supply	Keithley 2303	4039070	Starpoint	May 10, 2021	1.5 Years
2	Vector Signal Generator	SMBV100A	257904	R&S	February 21, 2022	1 Year
3	Temperature box	B-TF-107C	BTF107C-201804107	Boyi	May 10, 2021	1.5 Years
4	Spectrum Analyzer	FSQ40	200063	R&S	Novemb er 02,	1 Year
5	USB Wideband Power Senser	U2021XA	MY56410009	Keysight	February 21, 2022	1 Year
6	Simultaneous Sampling DQA	U2531A	TW56183514	Agilent	March 02, 2022	1 Year
7	Vector Signal Generator	SMU200A	104684	R&S	May 10, 2021	1.5 Years
8	Wireless communication comprehensive tester	CMW270	100919	R&S	May 10, 2021	1.5 Years
9	Eagle Test Software	Eagle V3.3	N/A	ECIT	N/A	N/A

5.2.2 Radiated Emission Test System

No.	Name	Model	S/N	Manufacturer	Cal. Date	Cal. Interval
1	Universal Radio Communication Tester	CMU200	123123	R&S	2021/5/10	1.5 year
2	Universal Radio Communication Tester	CMW500	104178	R&S	2021/5/10	1.5 year
3	EMI Test Receiver	ESU40	100307	R&S	2022/2/23	1 year
4	TRILOG Broadband Antenna	VULB9163	VULB9163-515	Schwarzbeck	2022/3/11	1 year
5	Double- ridged Waveguide Antenna	ETS-3117	00135890	ETS	2022/3/9	2 years
6	Horn Antenna	3160-09	LM6321	ETS	2021/2/3	3 years
7	Horn Antenna	3160-10	LM5942	ETS	2021/2/3	3 years
8	Pre-amplifier	SCU08F1	8320024	R&S	2021/5/10	1.5 year
9	Pre-amplifier	SCU18	10155	R&S	2021/5/10	1.5 year
10	Pre-amplifier	SCU26	10025	R&S	2021/5/10	1.5 year
11	Pre-amplifier	SCU40	10020	R&S	2021/5/10	1.5 year
12	2-Line V-Network	ENV216	101380	R&S	44613	1 year
13	EMI Test Receiver	ESCI	101235	R&S	44615	1 year
14	EMI Test software	EMC32 V9.15	N/A	R&S	N/A	N/A
15	EMI Test software	EMC32 V10.35.02	N/A	R&S	N/A	N/A

5.2.3 Test Environment

Shielding Room1 (6.0 meters×3.0 meters×2.7 meters) did not exceed following limits along the conducted RF performance testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	> 100 dB
Ground system resistance	< 0.5 Ω
Temperature	Min. = 15 ℃, Max. = 35 ℃

Control room did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. =30 %, Max. = 60 %

Shielding effectiveness	> 100 dB
Electrical insulation	> 10 kΩ
Ground system resistance	< 0.5 Ω

Fully-anechoic chamber1 (6.9 meters×10.9 meters×5.4 meters) did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. = 25 %, Max. = 75 %
Shielding effectiveness	> 100 dB
Electrical insulation	> 10 kΩ
Ground system resistance	< 0.5 Ω
VSWR	Between 0 and 6 dB, from 1GHz to 18GHz
Site Attenuation Deviation	Between -4 and 4 dB,30MHz to 1GHz

5.3 Measurement Uncertainty

Measurement Items	Range	Confidence Level	Calculated Uncertainty
Peak Output Power-Conducted	2402MHz-2480MHz	95%	0.544dB
Frequency Band Edges-Conducted	2402MHz-2480MHz	95%	0.544dB
Conducted Emission	9KHz-30MHz	95%	0.89dB
Conducted Emission	30MHz-2GHz	95%	0.90dB
Conducted Emission	2GHz-3.6GHz	95%	0.88dB
Conducted Emission	3.6GHz-8GHz	95%	0.96dB
Conducted Emission	8GHz-20GHz	95%	0.94dB
Conducted Emission	20GHz-22GHz	95%	0.88dB
Conducted Emission	22GHz-26GHz	95%	0.86dB
Transmitter Spurious Emission-Radiated	9KHz-30MHz	95%	5.66dB
Transmitter Spurious Emission-Radiated	30MHz-1000MHz	95%	4.98dB
Transmitter Spurious Emission-Radiated	1000MHz -18000MHz	95%	5.06dB
Transmitter Spurious Emission-	18000MHz -40000MHz	95%	5.20dB

Radiated			
Dwell Time	2402MHz-2480MHz	95%	0.218ms
20dB Bandwidth	2402MHz-2480MHz	95%	62.04Hz
AC Power line Conducted Emission	0.15MHz-30MHz	95%	3.66 dB

6. Test Results

6.1 Peak Output Power-Conducted

6.1.1 Measurement Limit

Standard	Limit (dBm)
FCC 47 Part 15.247(b)(3)	<30

6.1.2 Test Condition

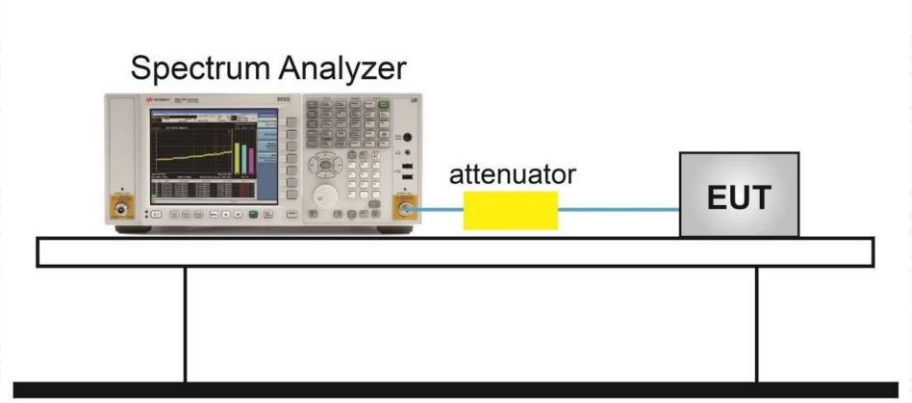
Hopping Mode	RBW	VBW	Span	Sweeptime
Hopping OFF	3MHz	10MHz	9MHz	Auto

6.1.3 Test Procedure

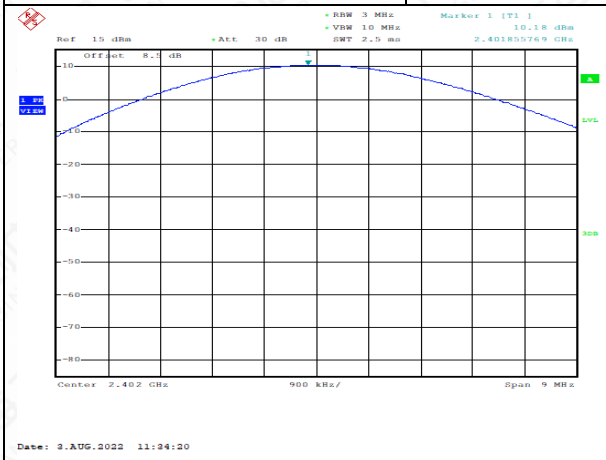
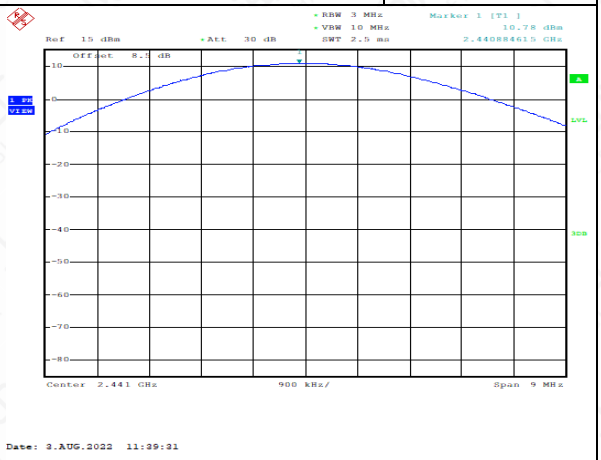
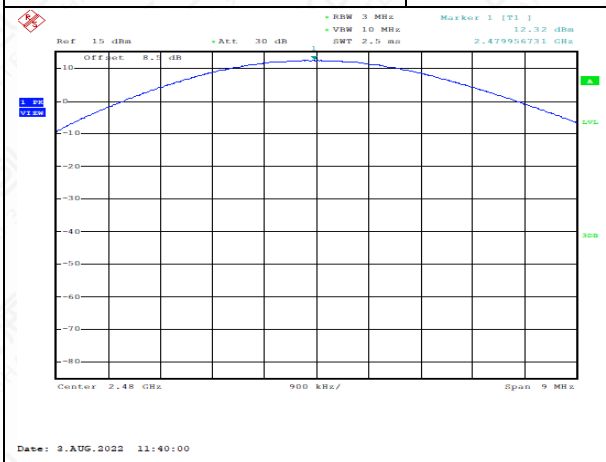
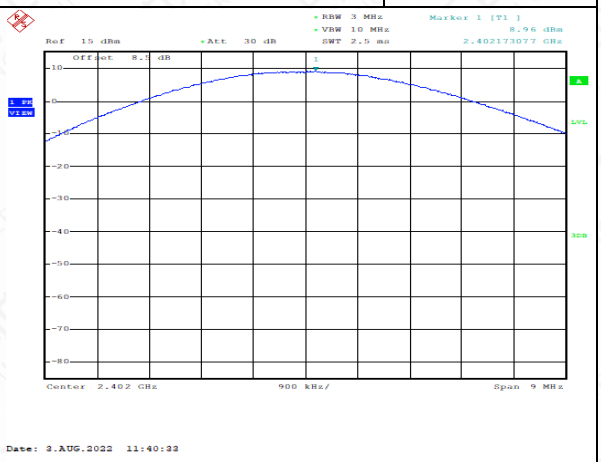
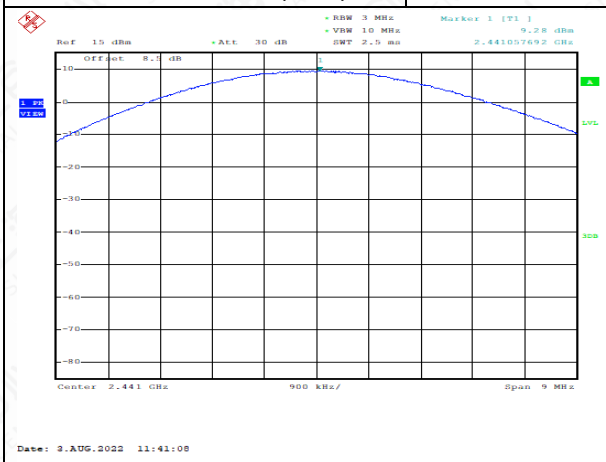
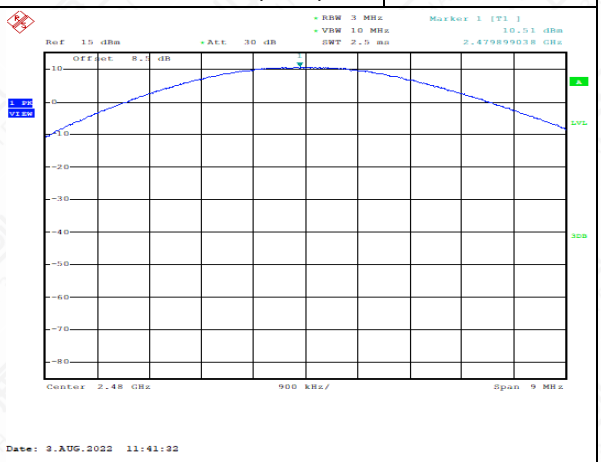
The measurement is according to ANSI C63.10 clause 7.8.5.

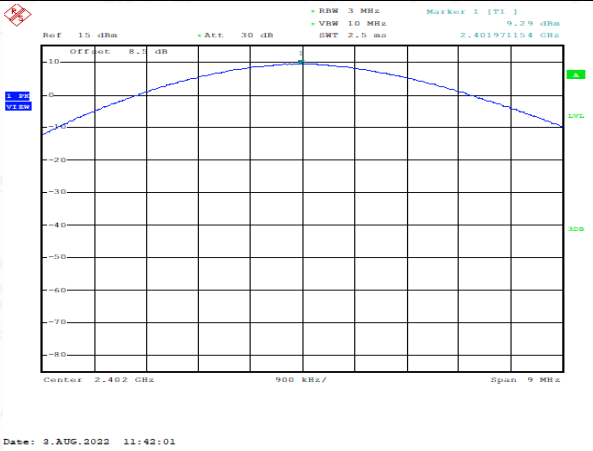
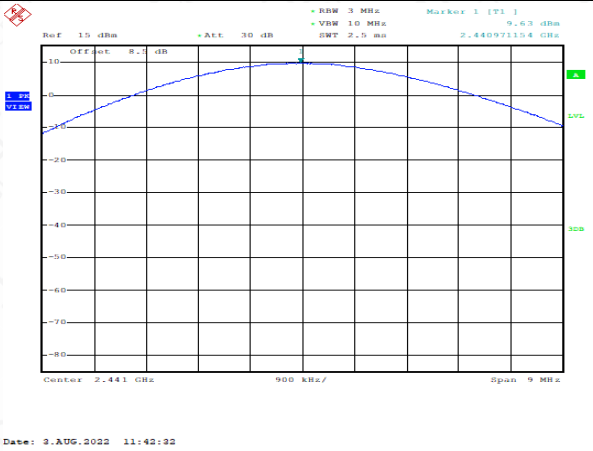
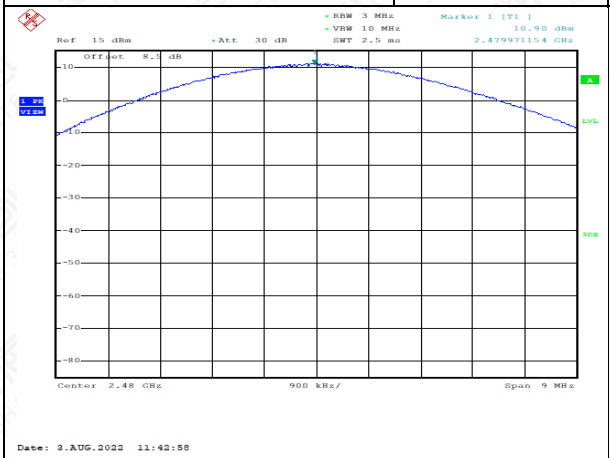
1. The output power of EUT was connected to the spectrum analyzer and CMW 270 by cable and divide. The path loss was compensated to the results for each measurement.
2. Enable EUT transmitter maximum power continuously.
3. Measure the conducted output power and record the results it

6.1.4 Test setup



Measurement Results

Peak Conducted Output Power GFSK, CH0 (dBm)	10.18	Peak Conducted Output Power GFSK, CH39 (dBm)	10.78
			
Peak Conducted Output Power GFSK, CH78 (dBm)	12.32	Peak Conducted Output Power π/4 DQPSK, CH0 (dBm)	8.96
			
Peak Conducted Output Power π /4 DQPSK, CH39 (dBm)	9.28	Peak Conducted Output Power π/4 DQPSK, CH78 (dBm)	10.51
			

Peak Conducted Output Power 8DPSK, CH0 (dBm)	9.29	Peak Conducted Output Power 8DPSK, CH39 (dBm)	9.63
			
Peak Conducted Output Power 8DPSK, CH78 (dBm)	10.90	/	/
		/	

6.2 Frequency Band Edges-Conducted

6.2.1 Measurement Limit

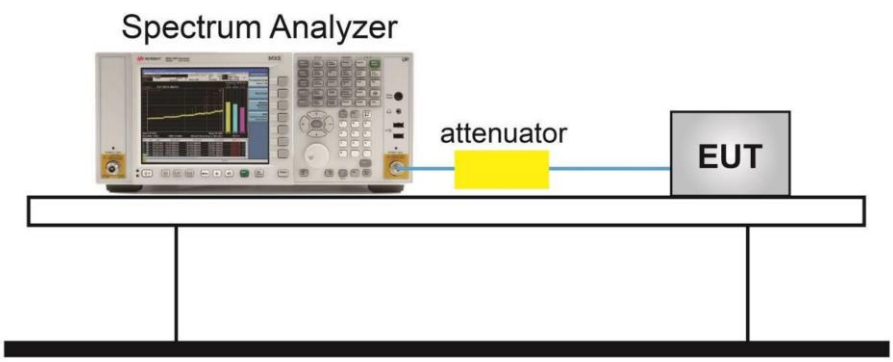
Standard	Limit(dBc)
FCC 47 CFR Part 15.247(d)	>20

6.2.2 Test procedures

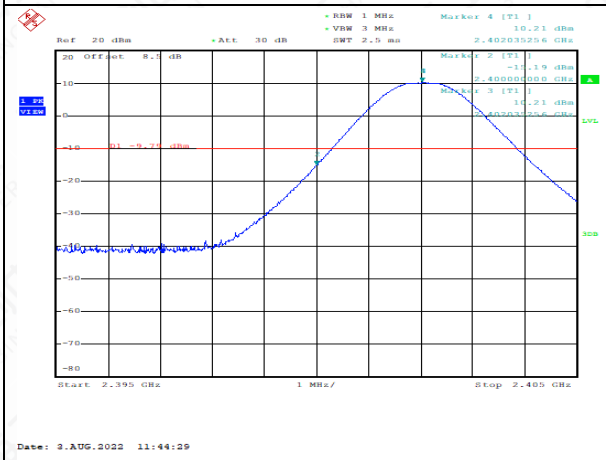
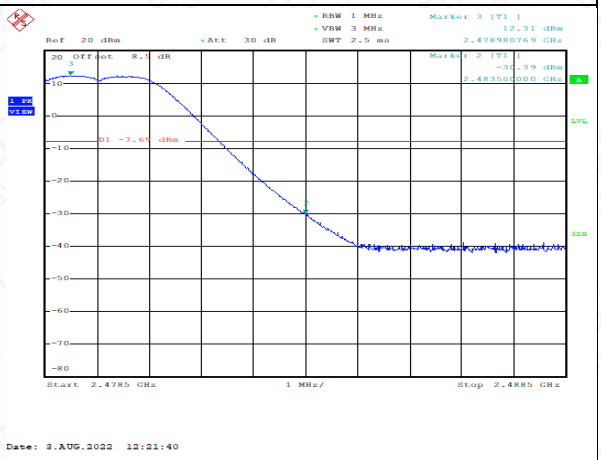
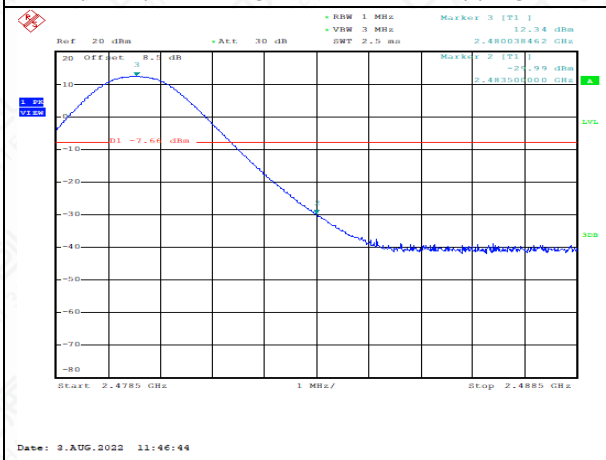
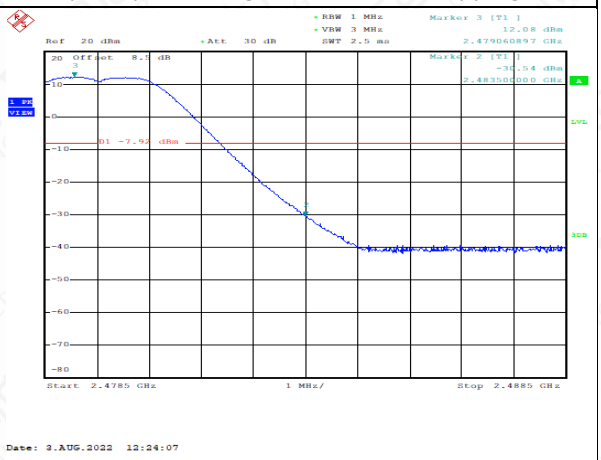
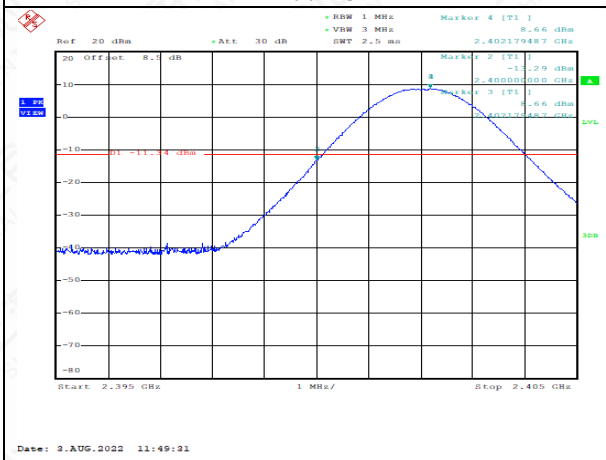
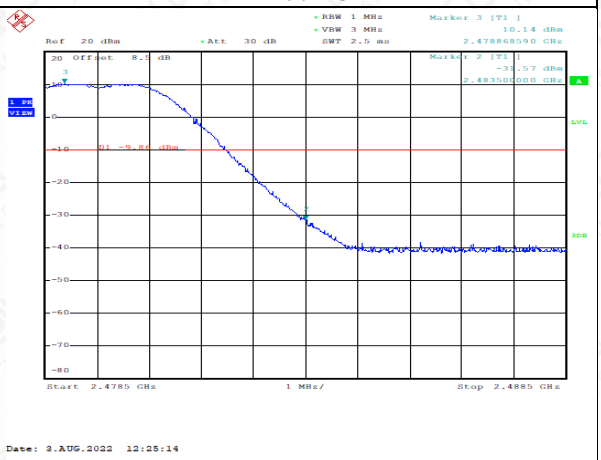
The measurement is according to ANSI C63.10 clause 7.8.6.

1. Connect the EUT to spectrum analyzer.
2. Set RBW=1MHz, VBW=3MHz, span more than 1.5 times channel bandwidth (2MHz).
3. Detector =peak, sweep time=auto couple, trace mode=max hold.Allow sweep to continue until the trace stabilizes.

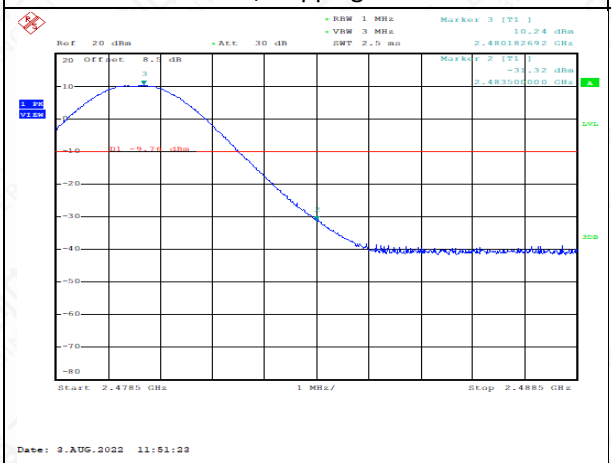
6.2.3 Test setup



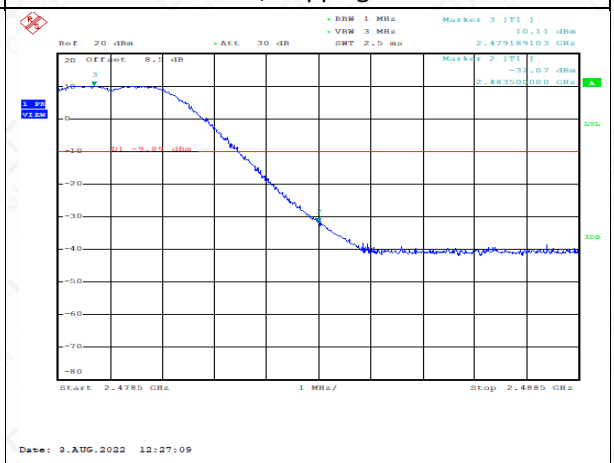
Measurement Result

Frequency Band Edge: GFSK, Ch0, Hopping OFF	Frequency Band Edge: GFSK, Ch0, Hopping ON
	
Frequency Band Edge: GFSK,Ch78, Hopping OFF	Frequency Band Edge: GFSK, Ch78, Hopping ON
	
Frequency Band Edge: π/4 DQPSK, Ch0, Hopping OFF	Frequency Band Edge: π/4 DQPSK, Ch0, Hopping ON
	

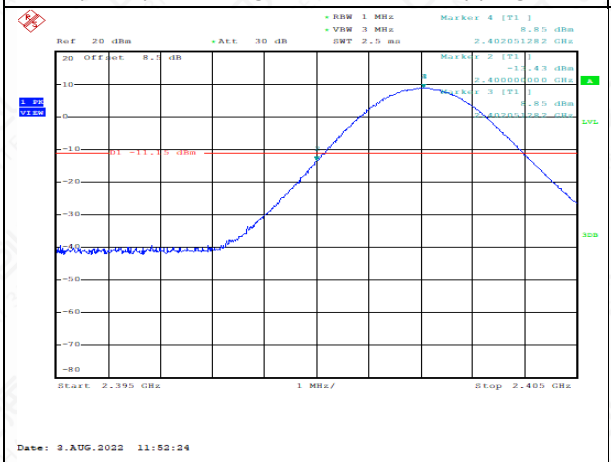
Frequency Band Edge: π/4 DQPSK, Ch78, Hopping OFF



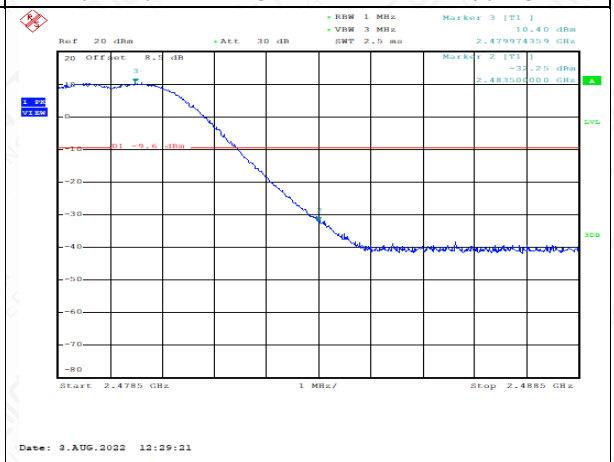
Frequency Band Edge: π/4 DQPSK, Ch78, Hopping ON



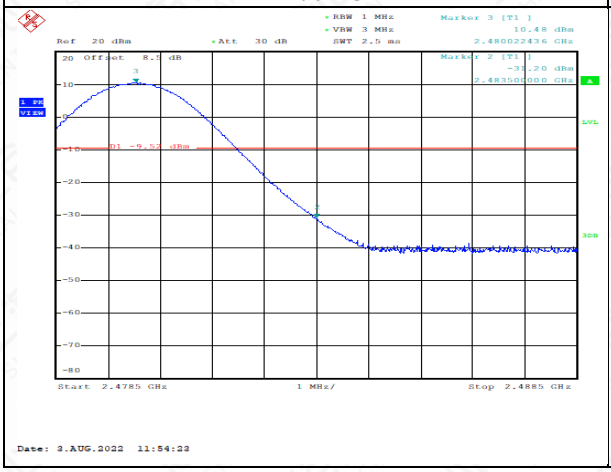
Frequency Band Edge: 8DPSK,Ch0, Hopping OFF



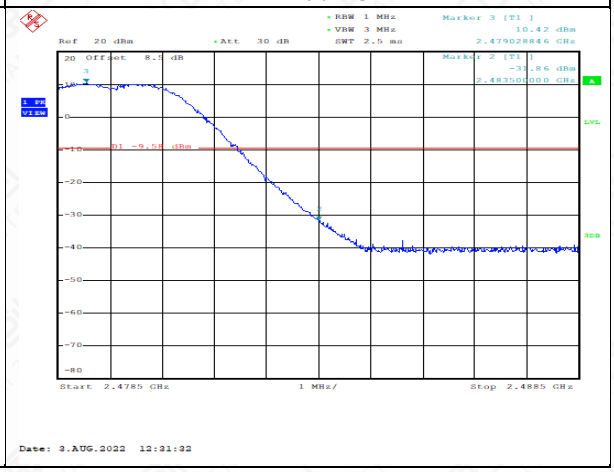
Frequency Band Edge: 8DPSK, Ch0, Hopping ON



Frequency Band Edge:8DPSK, Ch78, Hopping OFF



Frequency Band Edge: 8DPSK, Ch78, Hopping ON



6.3 Conducted Emission

6.3.1 Measurement Limt

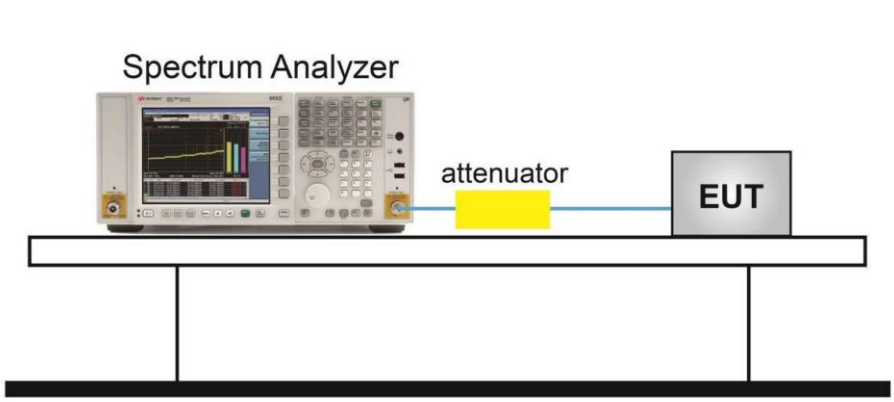
Standard	Limit
FCC 47 CFR Part15.247 (d)	20dB below peak output power in 100KHz

6.3.2 Test procedures

The measurement is according to ANSI C63.10 clause 7.8.8.

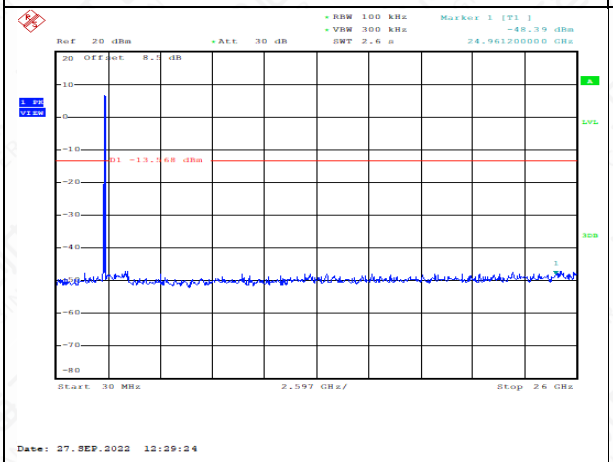
1. Connect the EUT to spectrum analyzer.
2. Set RBW=100kHz, VBW=300kHz.
3. Detector =peak, sweep time=auto couple, trace mode=max hold

6.3.3 Test Setup

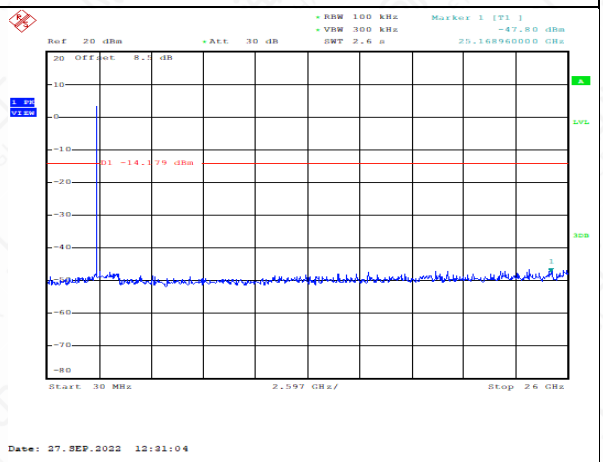


Measurement Results

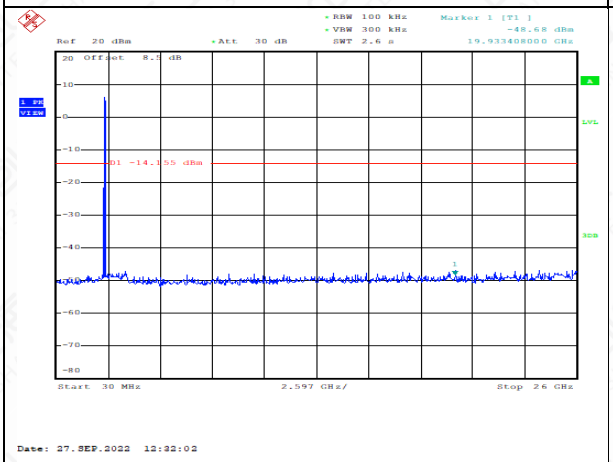
Conducted spurious emission:
GFSK, Ch0, 30MHz~26GHz



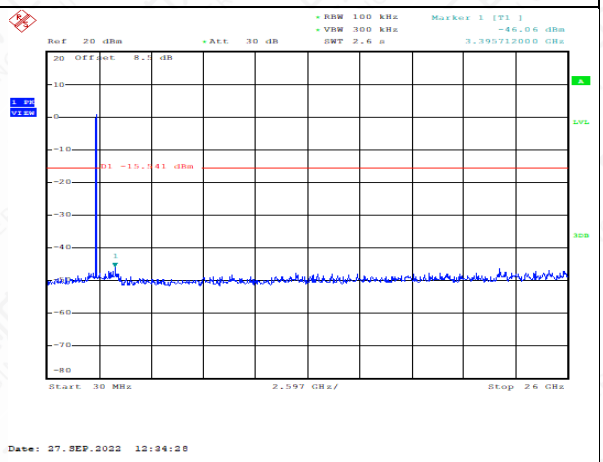
Conducted spurious emission:
GFSK, Ch39, 30MHz~26GHz



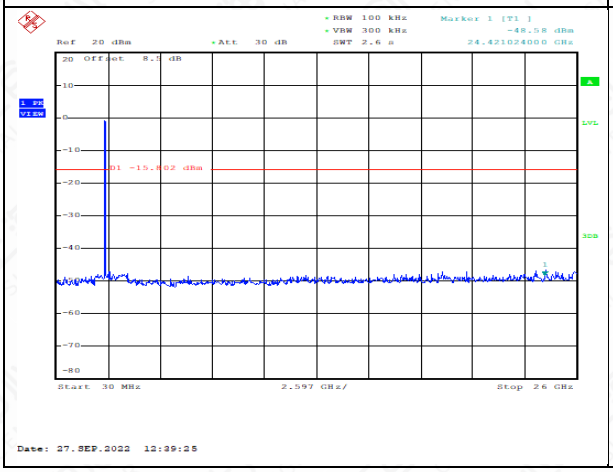
Conducted spurious emission:
GFSK, Ch78, 30MHz~26GHz



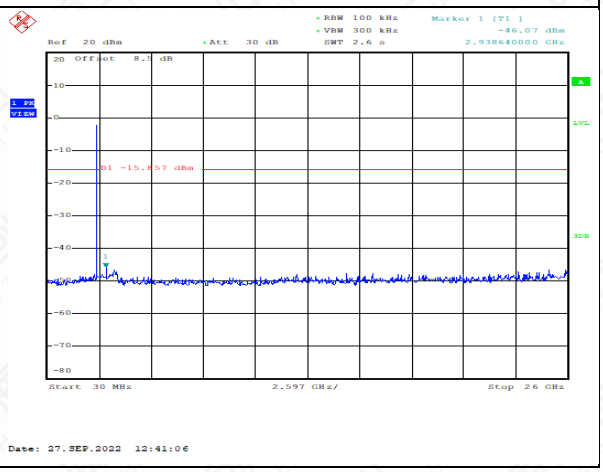
Conducted spurious emission:
π/4 DQPSK, Ch0, 30MHz~26GHz

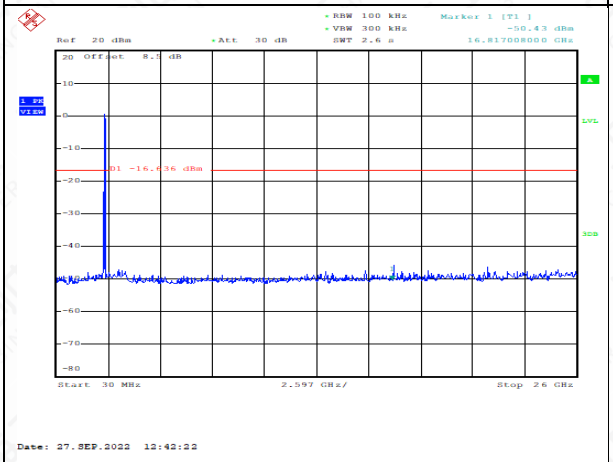
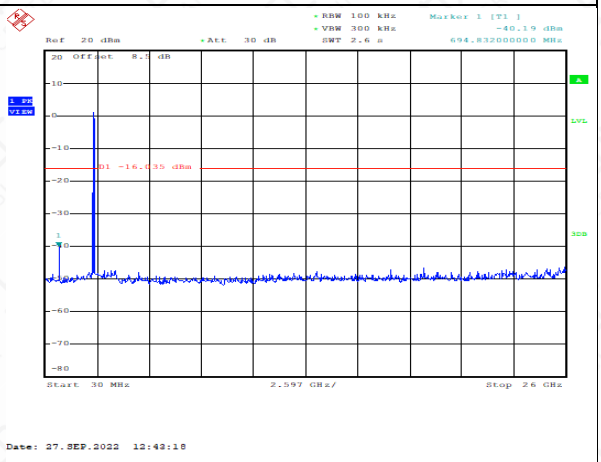
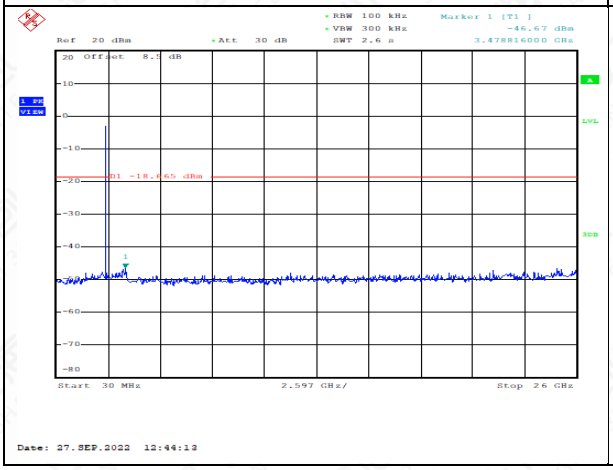


Conducted spurious emission:
π/4 DQPSK, Ch39, 30MHz~26GHz



Conducted spurious emission:
π/4 DQPSK, Ch78, 30MHz~26GHz



Conducted spurious emission: 8DPSK, Ch0, 30MHz~26GHz	Conducted spurious emission: 8DPSK, Ch39, 30MHz~26GHz
	
Conducted spurious emission: 8DPSK, Ch78, 30MHz~26GHz	/
	/

Note: 1. The out-of- limit signal in the picture is the main frequency signal.

2. The test data below 30MHz is more than 20dB lower than the limit value, so it is not provided in the report.

6.4 Radiated Emission

6.4.1 Measurement Limit

Standard	Limit
FCC 47 CFR Part 15.247, 15.205, 15.209	20dB below peak output power

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)).

Limit in restricted band

Frequency of emission (MHz)	Field strength (mV/m)	Field strength (dBuV/m)
0.009~0.49	2400/F (kHz)	129-94
0.49~1.705	24000/F (kHz)	74-63
1.705~30	30	70
30~88	100	40
88~216	150	43.5
216~960	200	46
Above 960	500	54

6.4.2 Test Method

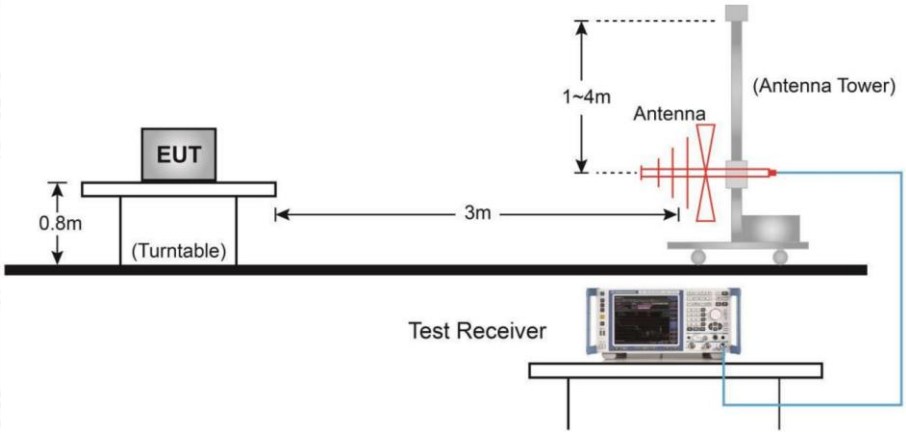
Portable, small, lightweight, or modular devices that may be handheld, worn on the body, or placed on a table during operation shall be positioned on a non-conducting platform, the top of which is 80 cm above the reference ground plane. The preferred area occupied by the EUT arrangement is 1 m by 1.5 m, For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. but it may be larger or smaller to accommodate various sized EUTs. For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop (see also ANSI C63.10-2013 section 6.3.4 and 6.3.5). In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.

The EUT was placed on a non-conductive table. The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and the EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. This maximization process was repeated with the EUT positioned in each of its three orthogonal orientations.

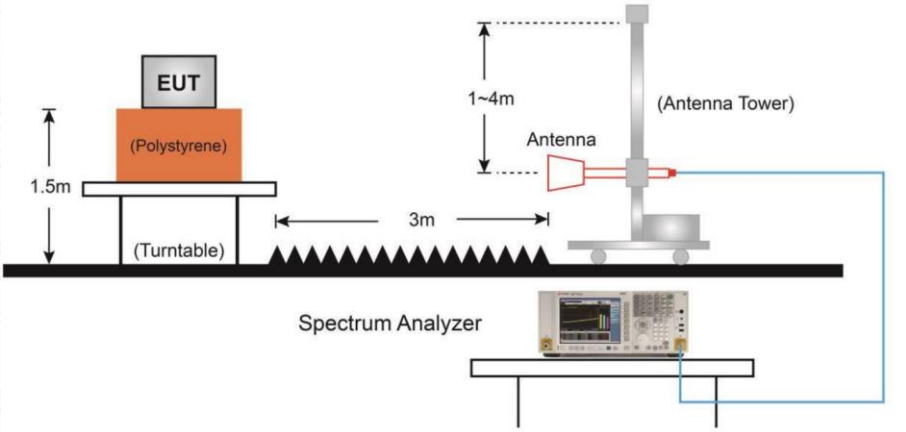
Frequency of emission	RBW/VBW	Sweep Time (s)
0.009~30	9KHz/30KHz	Auto
30~1000	100KHz/300KHz	5
1000~4000	1MHz/3MHz	15
4000~18000	1MHz/3MHz	40
18000~26500	1MHz/3MHz	20

6.4.3 Test Setup

Below 1GHz Test Setup



Above 1GHz Test Setup



Measurement Results

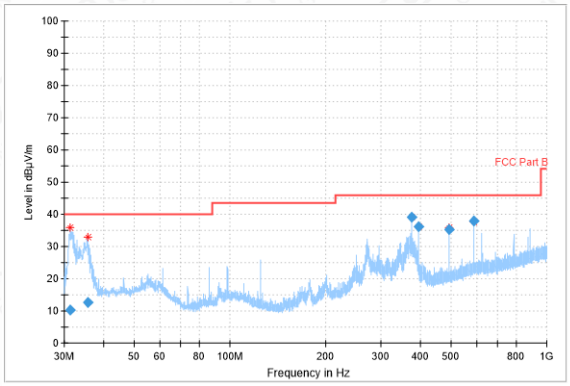
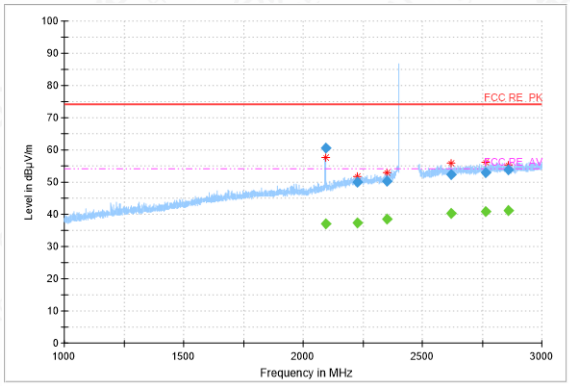
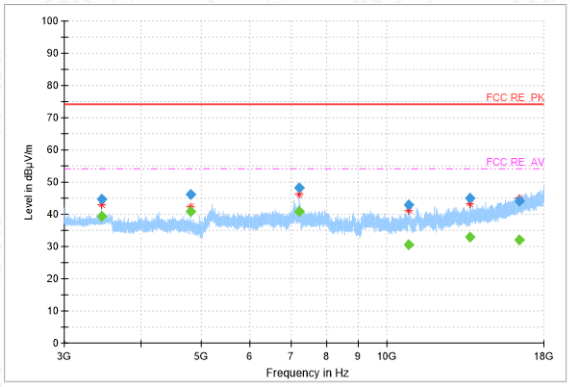
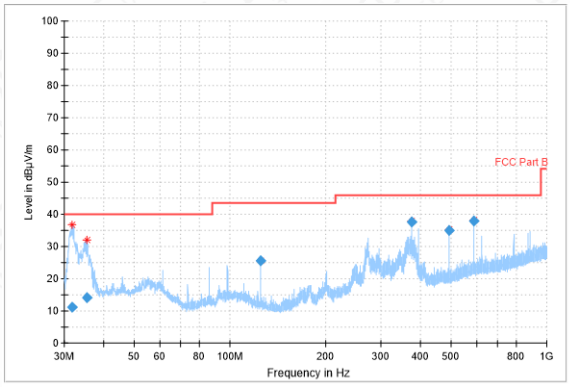
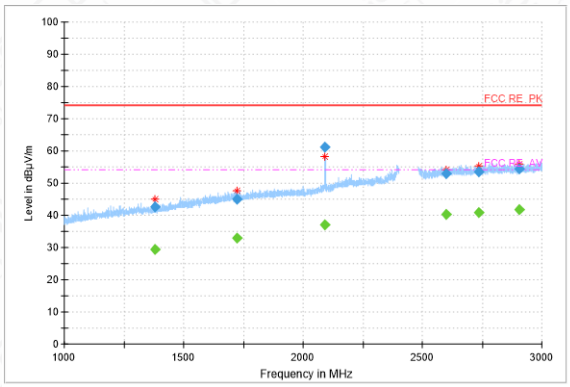
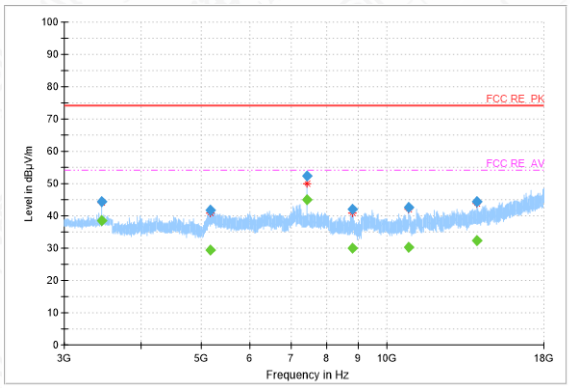
A “reference path loss” is established and ARpi is the attenuation of “reference path loss”, and including the gain of receive antenna, the gain of the preamplifier, the cable loss.

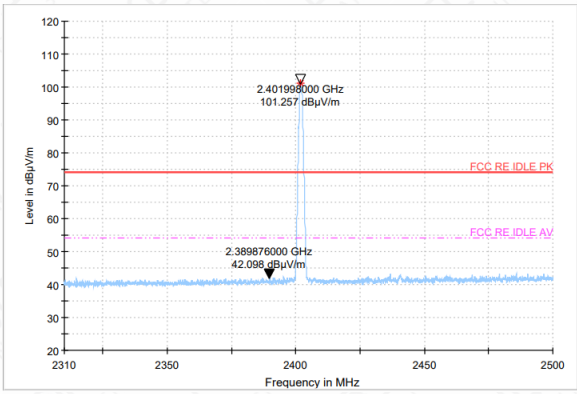
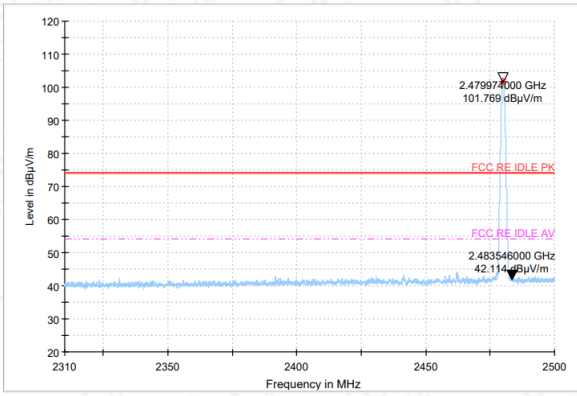
The measurement results are obtained as described below:

ARpi = Cable loss + Antenna Factor-Preamplifier gain

Result=PMea + ARpi

The test data below 30MHz is more than 20dB lower than the limit value, so it is not provided in the report.

Radiated emission: GFSK, Ch0, 30MHz~1GHz	Radiated emission: GFSK, Ch0, 1GHz~3GHz
	
Radiated emission: GFSK, Ch0, 3GHz~18GHz	**Radiated emission: GFSK, Ch78, 30MHz~1GHz**
	
Radiated emission: GFSK, Ch78, 1GHz~3GHz	**Radiated emission: GFSK, Ch78, 3GHz~18GHz**
	

Bandedge (Low): GFSK, low channel	Bandedge (High): GFSK, high channel
	

Note: The out-of- limit signal in the picture is the main frequency signal.

GFSK Ch0 30MHz-1GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
31.3	10.4	-14.3	24.7	V
35.5	12.76	-13.9	26.66	V
375.0	39.13	-8.7	47.83	V
393.2	36.26	-8.3	44.56	H
491.5	35.36	-6.7	42.06	V
589.8	38.01	-3.9	41.91	V

GFSK Ch0 1GHz-3GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
2093.5	60.64	10.8	49.84	V
2227.1	50.08	12.7	37.38	V
2350.7	50.39	13.2	37.19	V
2619.6	52.42	15.7	36.72	V
2764.8	52.83	16.3	36.53	V
2860.3	53.85	16.7	37.15	V

GFSK Ch0 1GHz-3GHz (Average)

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
2093.5	36.98	10.8	26.18	V

GFSK Ch0 3GHz-18GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
3453.7	44.79	-6.7	51.49	V
4804.2	46.31	-4.9	51.21	V
7206.3	48.19	-2	50.19	V
10862.7	42.95	1.1	41.85	V

13676.0	44.97	4	40.97	V
16401.4	44.09	8.1	35.99	V

GFSK Ch78 30MHz-1GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
31.8	11.09	-14.3	25.39	V
35.3	14.25	-14	28.25	V
125.0	25.64	-15.6	41.24	V
375.0	37.71	-8.7	46.41	H
491.5	35.04	-6.7	41.74	H
589.8	37.99	-3.9	41.89	V

GFSK Ch78 1GHz-3GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
1380.0	42.51	4.1	38.41	V
1721.3	45.1	7.8	37.3	V
2092.6	61.3	10.7	50.6	V
2600.7	52.93	15.5	37.43	V
2736.4	53.39	16.1	37.29	V
2906.8	54.29	16.7	37.59	V

GFSK Ch78 1GHz-3GHz(Average)

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
2092.6	37.07	10.7	26.37	V
2906.8	41.64	16.7	24.94	V

GFSK Ch78 3GHz-18GHz

Frequency (MHz)	Result (dBµV/m)	ARpl (dB)	PMea (dBµV/m)	Polarity
3453.8	44.37	-6.7	51.07	V
5172.2	41.78	-1.1	42.88	V
7440.5	52.23	-2.4	54.63	V
8796.0	42.09	-1.5	43.59	V
10860.0	42.72	1.1	41.62	V
14004.3	44.55	4.7	39.85	V

6.5 Time Of Occupancy (Dwell Time)

6.5.1 Measurement Limit

Standard	Limit(ms)
FCC 47 Part 15.247 (a) (1) (iii)	<400

6.5.2 Test procedures

The measurement is according to ANSI C63.10 clause 7.8.4

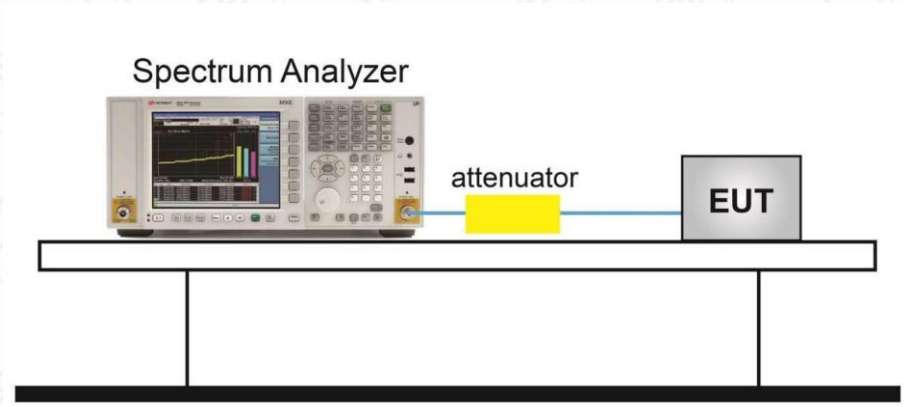
1. Connect the EUT through cable and divide with CMW 270 and spectrum analyzer.
2. Enable the EUT transmit maximum power.
3. Set the spectrum analyzer as step 4 to step 8.
4. Span: Zero span, centered on a hopping channel.
5. RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
6. 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 showtwo successive hops on a channel.
7. Detector function: Peak.
8. Trace: Max hold.
9. Use the marker-delta function, and record it.

Note：For AFH mode, Test Period = 0.4 (second/ channel) x 20 Channel = 8 sec,

For FHSS mode, Test Period = 0.4 (second/ channel) x 79 Channel = 31.6 sec,

So the Time of Occupancy (Dwell Time) of AFH mode= Time of Occupancy (Dwell Time) of FHSS mode / 79 Channel x 20 Channel.

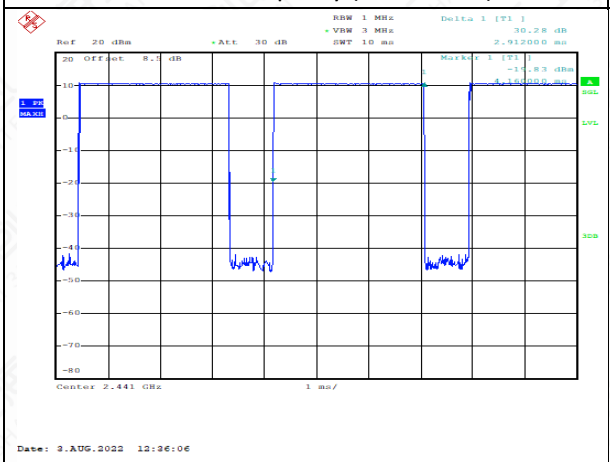
6.5.3 Test Setup



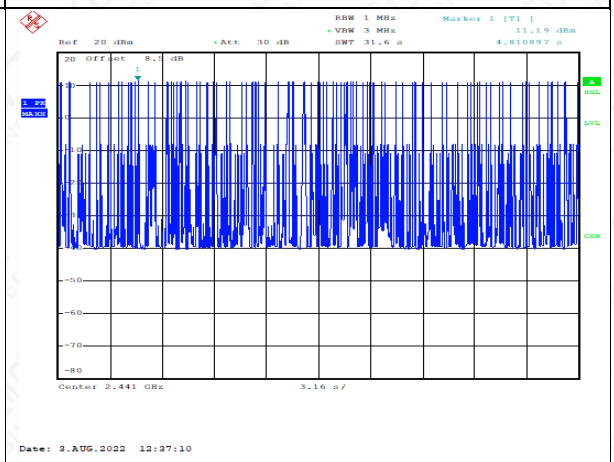
Measurement Result

Modulation type	Frequency (MHz)	Time slot length (ms)	Hop Number	Dwell Time (ms)	Limit (ms)	Conclusion
GFSK DH5	2402-2480	2.90	85	247.52	400	P
π/4 DQPSK 2DH5	2402-2480	2.91	83	240.37	400	P
8DPSK 3DH5	2402-2480	2.90	65	189.28	400	P
Note: Dwell time = time slot length * hop rate						

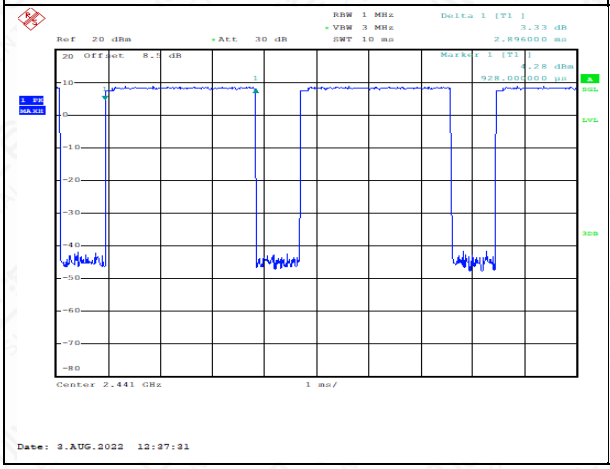
For GFSK, Ch39,Packet DH5
Time of occupancy (Dwell Time)



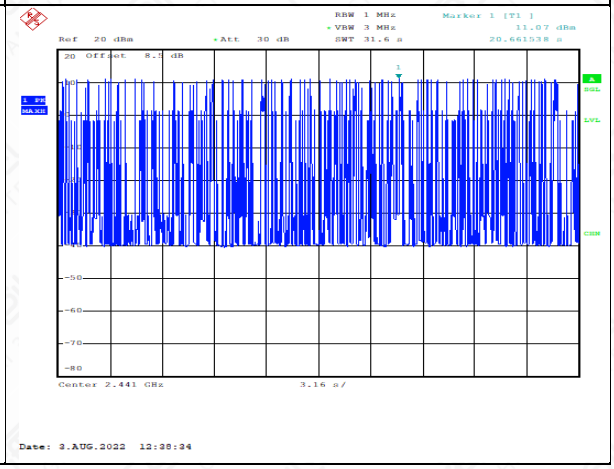
For GFSK, Ch39,Packet DH5
Number of Transmissions Measurement

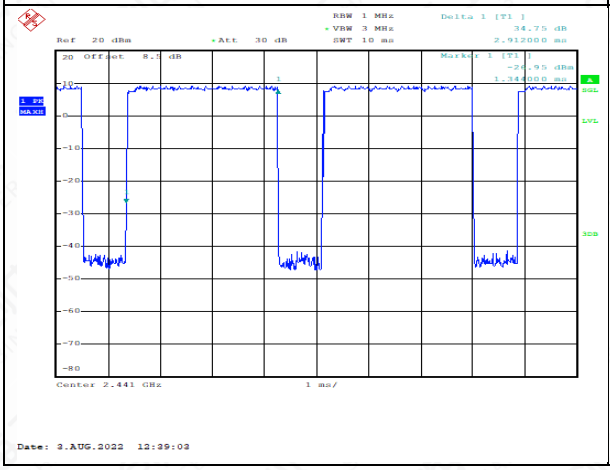
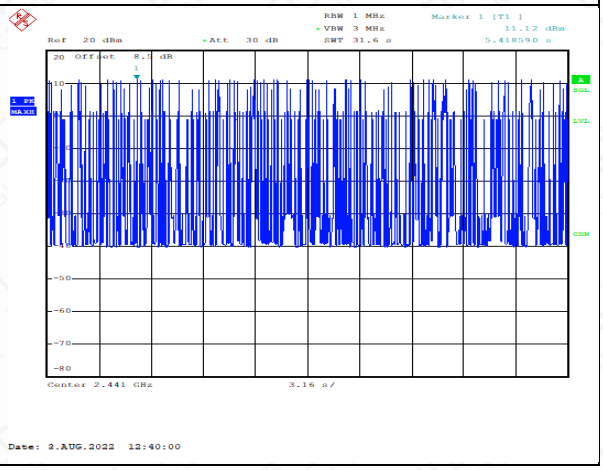


For π/4 DQPSK, Ch39,Packet 2DH5
Time of occupancy (Dwell Time)



For π/4 DQPSK, Ch39,Packet 2DH5
Number of Transmissions Measurement



For 8DPSK, Ch39,Packet 3DH5 Time of occupancy (Dwell Time)	For 8DPSK, Ch39,Packet 3DH5 Number of Transmissions Measurement
	

6.6 20dB Bandwidth

6.6.1 Measurement Limit

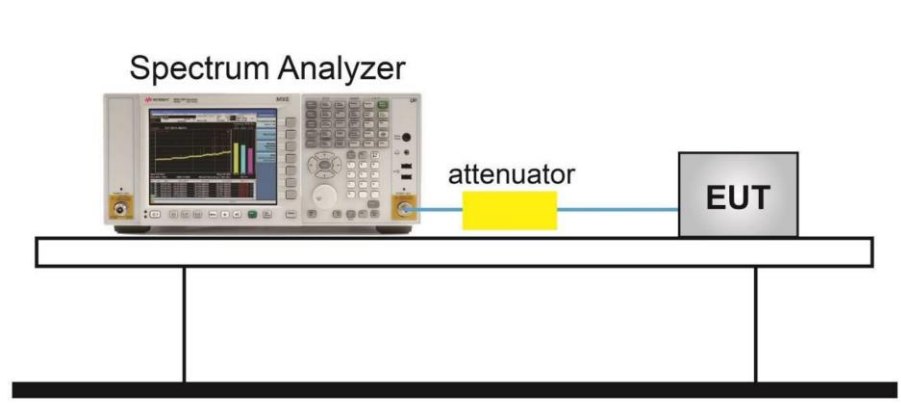
Standard	Limit
FCC 47 Part 15.247(d)	20dB below peak output power in 100KHz bandwidth

6.6.2 Test procedures

The measurement is according to ANSI C63.10 clause 7.8.7

1. Connect the EUT through cable and divide with CMW 270 and spectrum analyzer.
2. Enable the EUT transmit maximum power.
3. Set the spectrum analyzer as step 4 to step 7.
4. Span: two or five times of OBW
5. RBW= 1% to 5% of the OBW; VBW is approximately three times of RBW; Max Hold.
6. Select the max peak, and N DB DOWN=20dB.
7. Record the results.

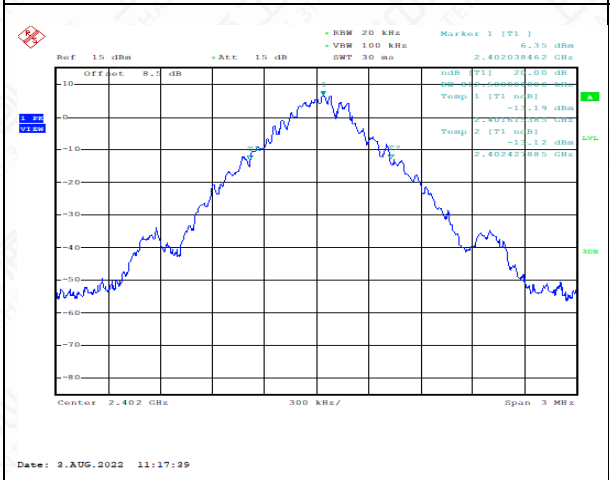
6.6.3 Test Setup



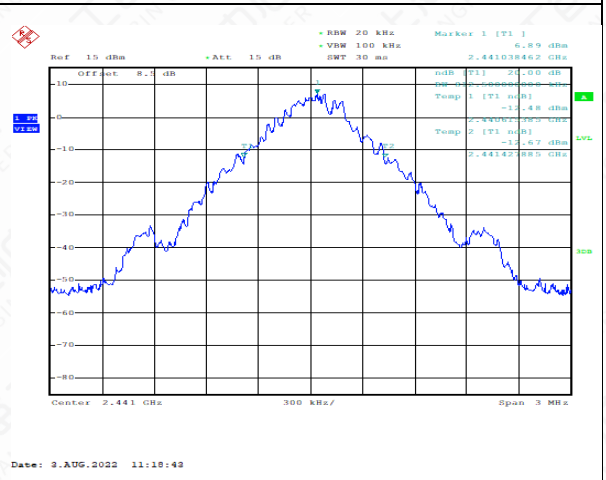
Measurement Result

Modulation type	Frequency (MHz)	20dB Bandwidth (MHz)
GFSK DH5	2402	0.813
	2441	0.813
	2480	0.813
π/4 DQPSK 2DH5	2402	1.269
	2441	1.269
	2480	1.269
8DPSK 3DH5	2402	1.149
	2441	1.139
	2480	1.144

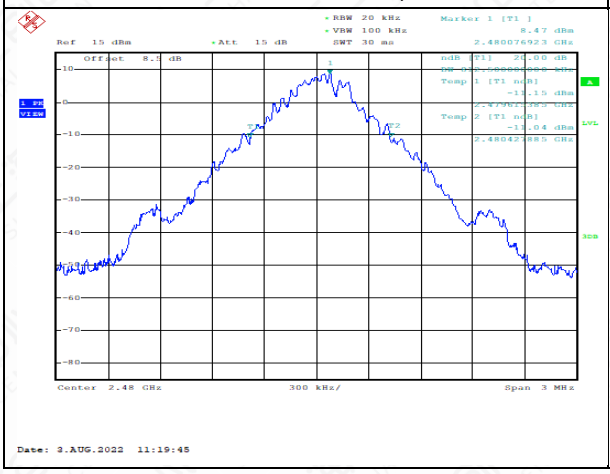
20dB Bandwidth: GFSK, Ch0



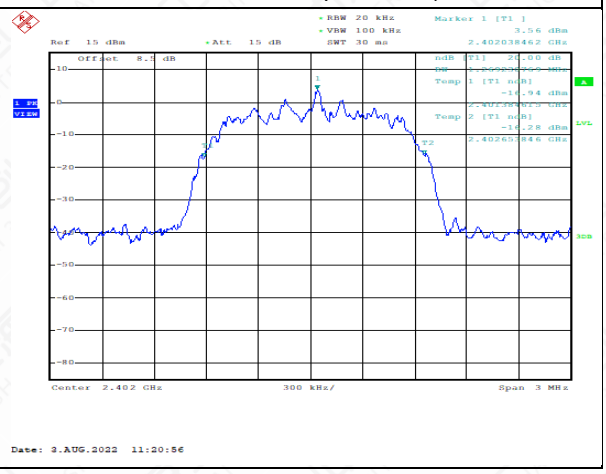
20dB Bandwidth: GFSK, Ch39

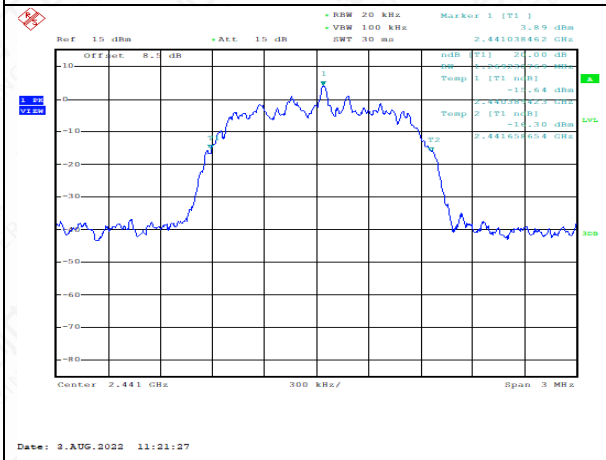
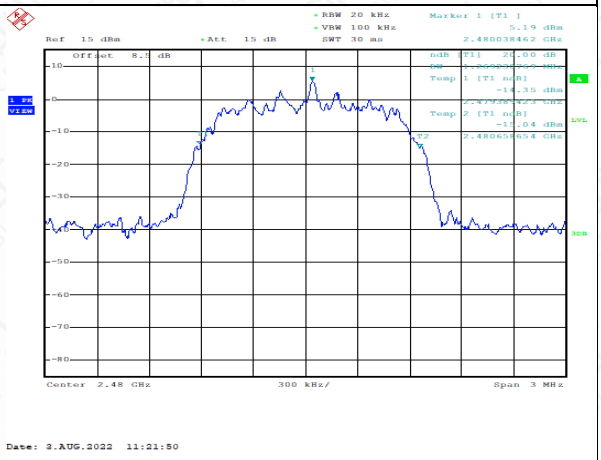
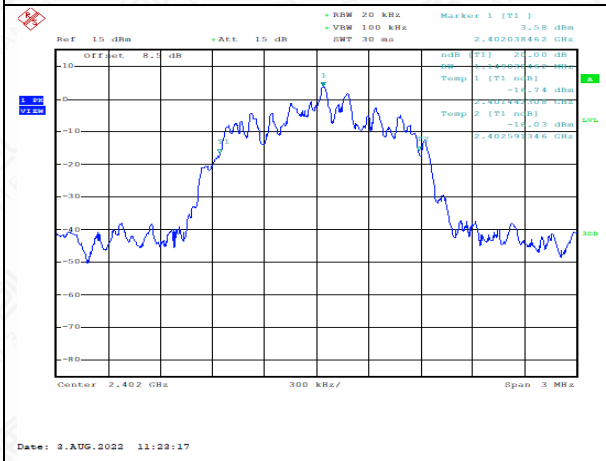
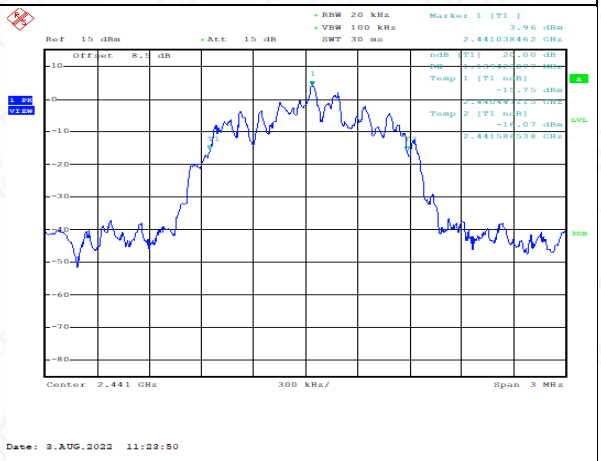
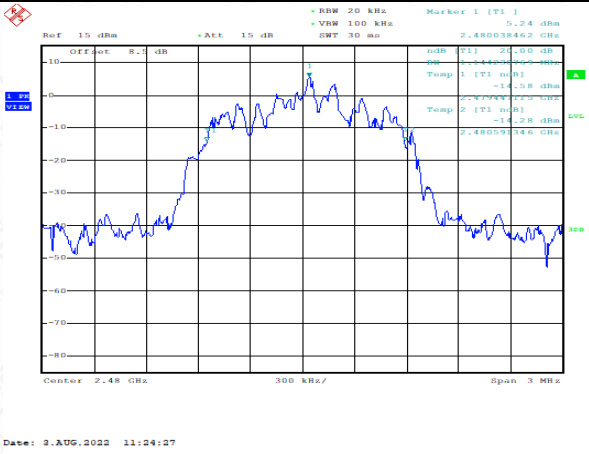


20dB Bandwidth: GFSK, Ch78



20dB Bandwidth: π/4 DQPSK, Ch0



20dB Bandwidth: π/4 DQPSK, Ch39	20dB Bandwidth: π/4 DQPSK, Ch78
	
20dB Bandwidth: 8DPSK, Ch0	20dB Bandwidth: 8DPSK, Ch39
	
20dB Bandwidth: 8DPSK, Ch78	/
	/

6.7 99% Occupied Bandwidth

6.7.1 Measurement Limit

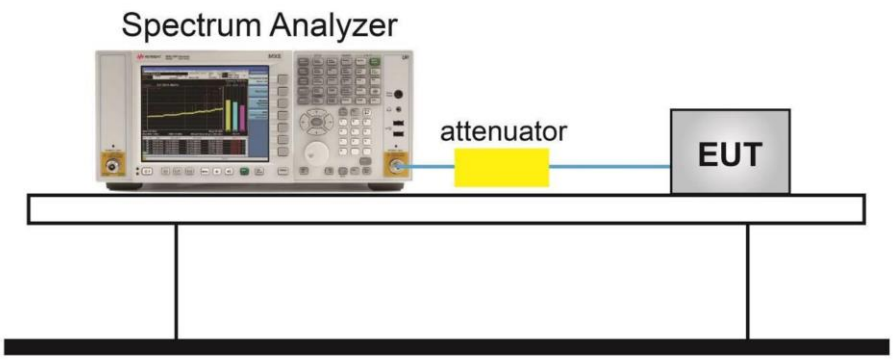
Standard	Limit
N/A	N/A

6.7.2 Test procedures

The measurement is according to ANSI C63.10 clause 6.9.3.

1. The output power of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Enable EUT transmitter maximum power continuously.
3. Set RBW shall be in the range of 1% to 5% of the OBW.
4. Set the VBW ≥ [3 × RBW].
5. Detector = peak.
6. Trace mode = max hold.
7. Sweep = auto couple.
8. Allow the trace to stabilize.
9. The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

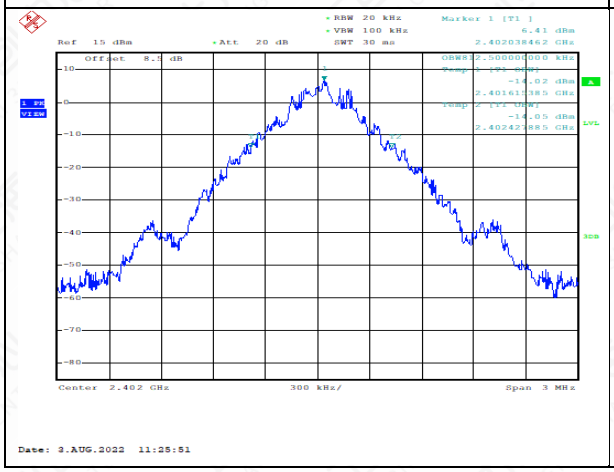
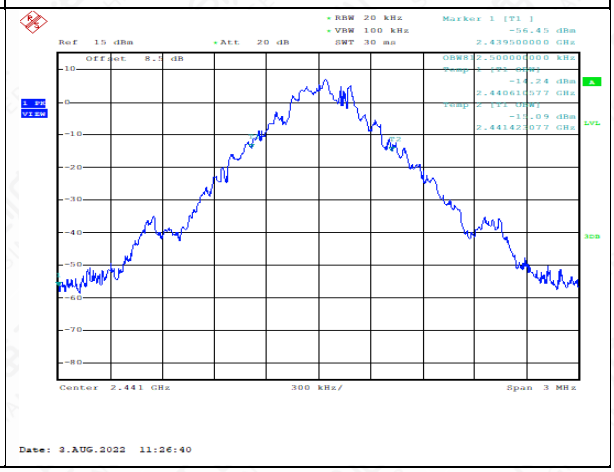
6.7.3 Test setup



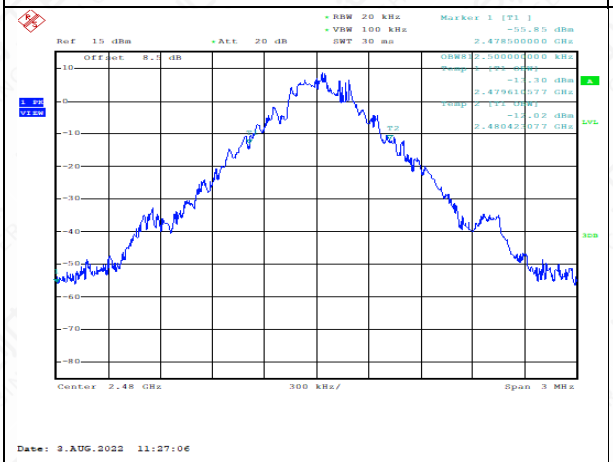
Measurement Result

Modulation type	Channel	99% Bandwidth (MHz)
GFSK DH5	2402	0.813
	2441	0.813
	2480	0.813
π/4 DQPSK 2DH5	2402	1.173
	2441	1.168
	2480	1.168
8DPSK 3DH5	2402	1.197
	2441	1.144
	2480	1.154

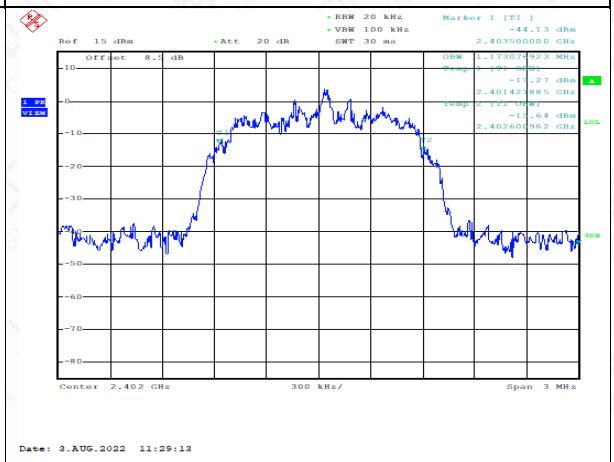
Test graphs as below

99% Bandwidth: GFSK, Ch0	99% Bandwidth: GFSK, Ch39
	

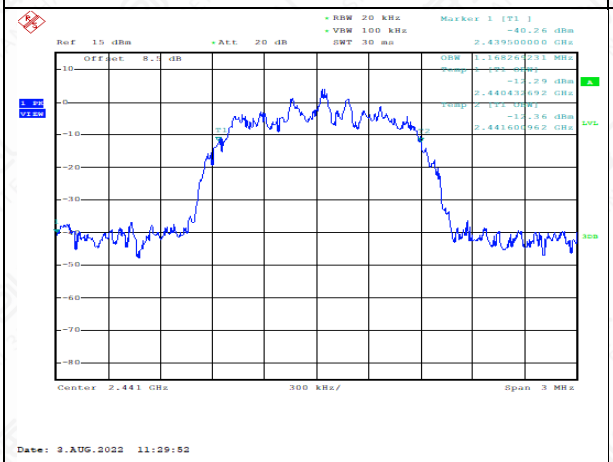
99% Bandwidth: GFSK, Ch78



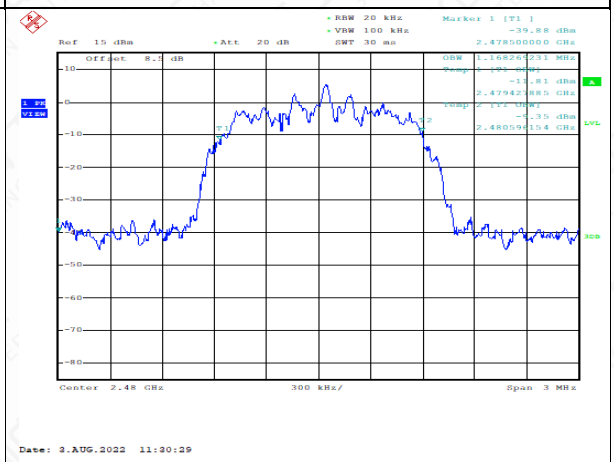
99% Bandwidth: DQPSK, Ch0



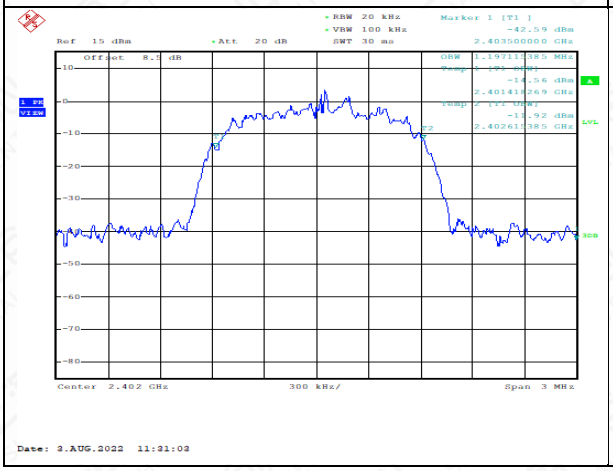
99% Bandwidth: DQPSK, Ch39



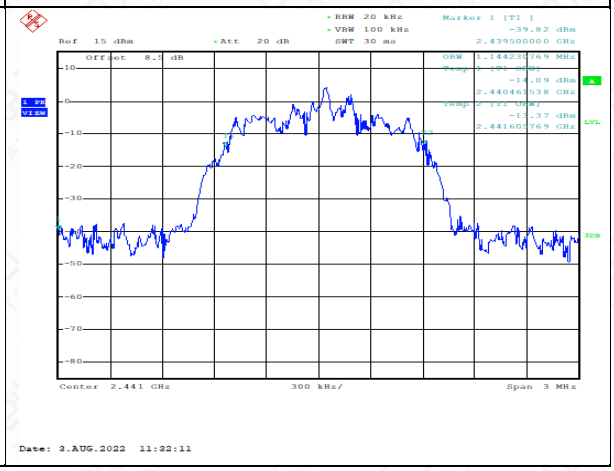
99% Bandwidth: DQPSK, Ch78

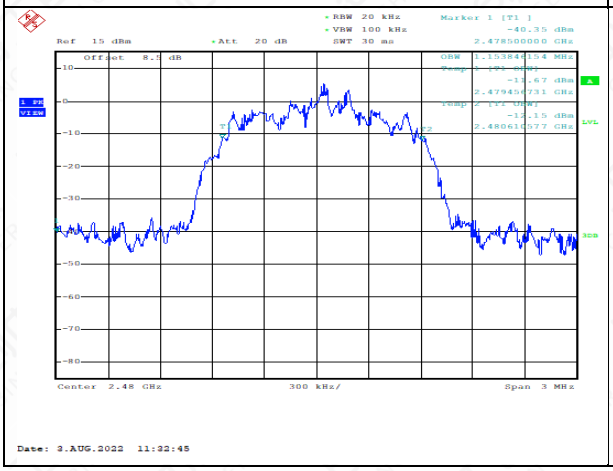


99% Bandwidth: 8DPSK, Ch0



99% Bandwidth: 8DPSK, Ch39



99% Bandwidth: 8DPSK, Ch78	/
	/

6.8 Carrier Frequency Separation

6.8.1 Measurement Limit

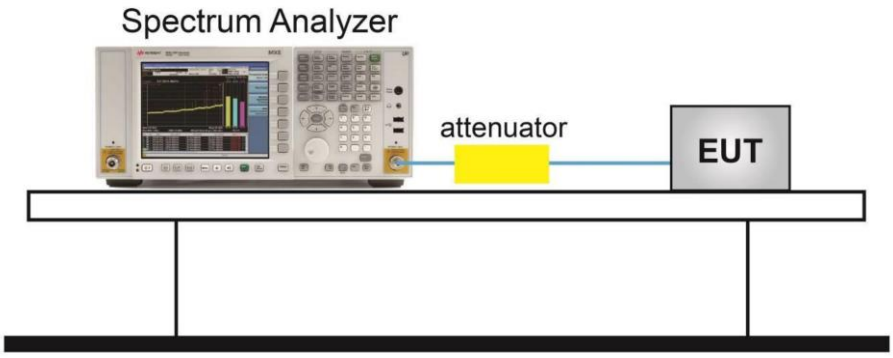
Standard	Limit(KHz)
FCC 47 Part 15.247 (a) (1)	Over 25KHz or (2/3)*20dB bandwidth

6.8.2 Test procedures

The measurement is according to ANSI C63.10 clause 7.8.2.

1. Connect the EUT through cable and divide with CBT32 and spectrum analyzer.
2. Enable the EUT transmit in hopping mode.
3. Span: Wide enough to capture the peaks of two adjacent channels.
4. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
5. Video (or average) bandwidth (VBW) ≥ RBW.
6. Sweep: Auto.
7. Detector function: Peak.
8. Trace: Max hold.
9. Allow the trace to stabilize.S

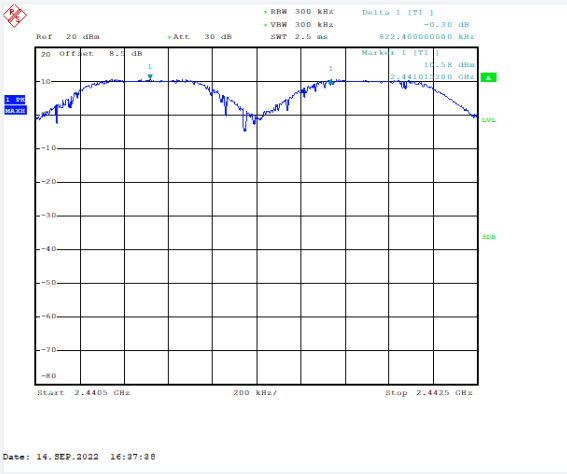
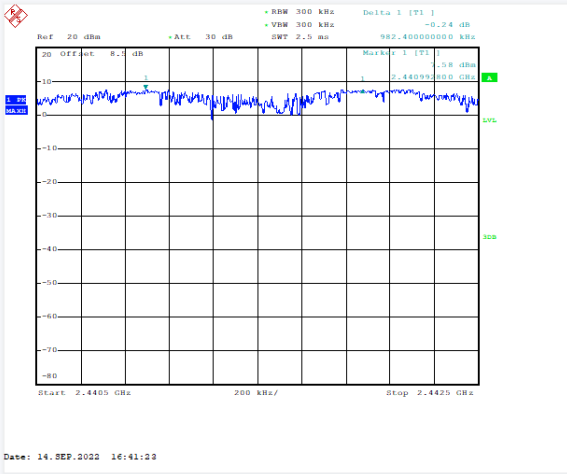
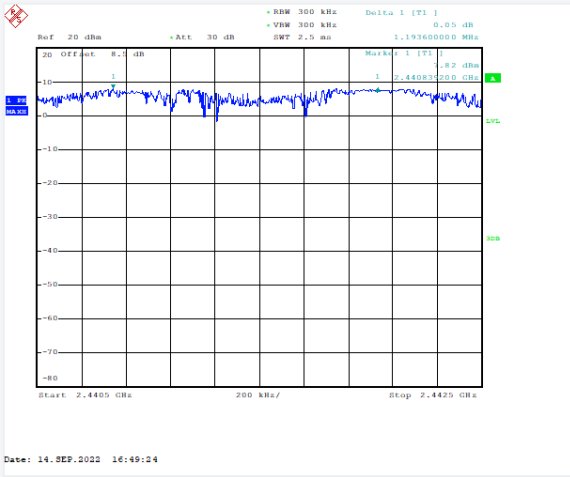
6.8.3 Test Setup



Measurement Result

Modulation type	Frequency (MHz)	Carrier separation measurement (KHz)
GFSK DH5	2441	822.4
π/4 DQPSK 2DH5	2441	982.4

8DPSK 3DH5	2441	1193.6

Carrier separation measurement: GFSK, Ch39	Carrier separation measurement: π/4 DQPSK, Ch39
	
Carrier separation measurement: 8DPSK, Ch39	/
	/

6.9 Number Of Hopping Channels

6.9.1 Measurement Limit

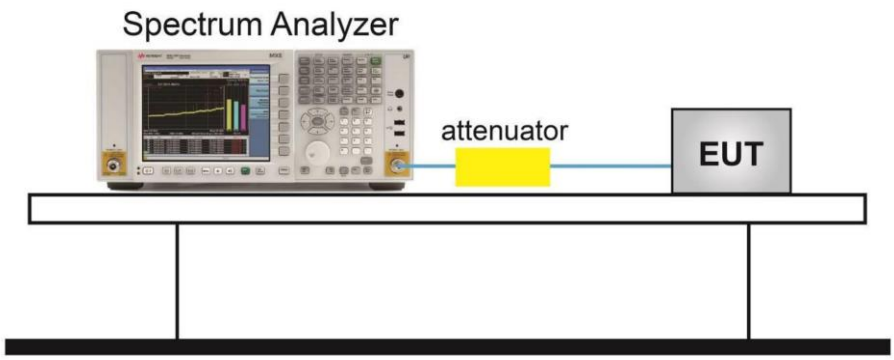
Standard	Limit
FCC 47 CFR Part 15.247 (a)(1)(iii)	At least 15 non-overlapping channels

6.9.2 Test procedure

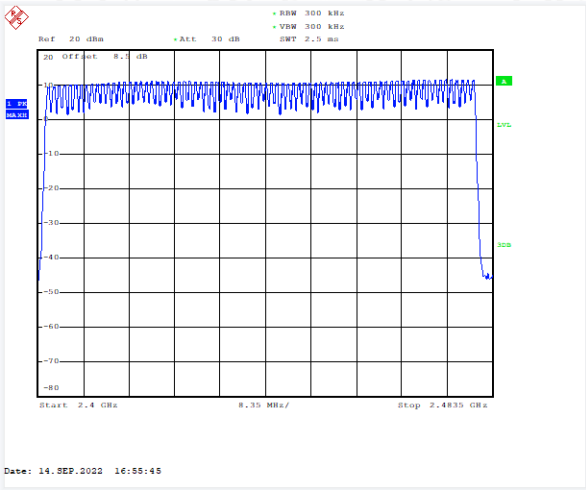
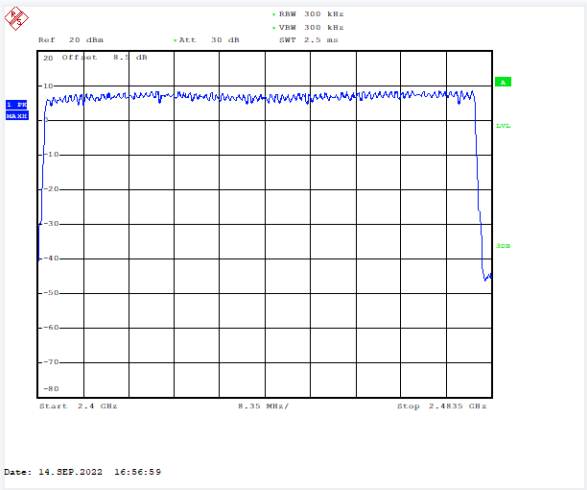
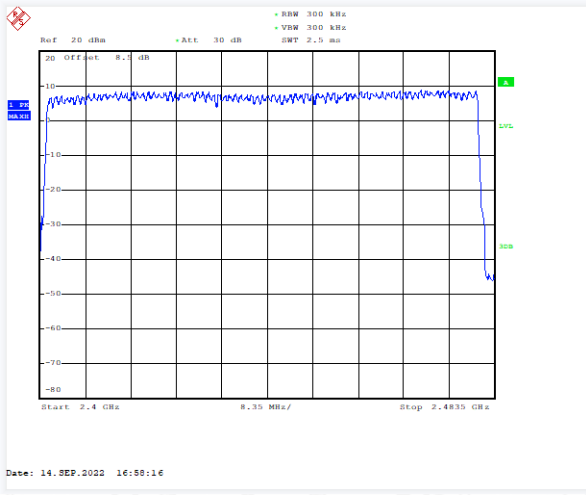
The measurement is according to ANSI C63.10 clause 7.8.3.

1. Connect the EUT through cable and divide with CMW 270 and spectrum analyzer.
2. Enable the EUT transmit in hopping mode.
3. 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.
4. 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.
5. VBW ≥ RBW.
6. Sweep: Auto.
7. Detector function: Peak.
8. Trace: Max hold.
9. Allow the trace to stabilize.
10. Record the test results.

6.9.3 Test Setup



Measurement Result

Number of hopping frequency GFSK Ch0~78:79	Number of hopping frequency π/4 DQPSK Ch0~78:79
	
Number of hopping frequency 8DPSK Ch0~78:79	
	

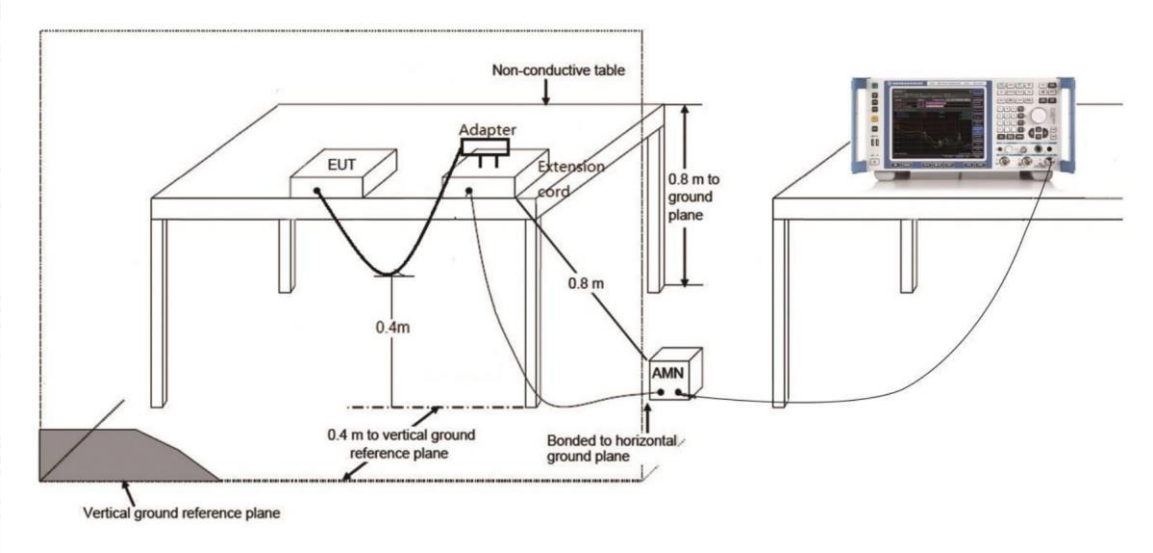
6.10 AC Powerline Conducted Emission

6.10.1 Method of Measurement: ANSI C63.10-2013-clause 6.2

1. The one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT.
2. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are performed.
3. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation.
4. If the EUT is comprised of equipment units that have their own separate ac power connections, e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network, each current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be separately measured. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

If the EUT uses a detachable antenna, these measurements shall be made with a suitable dummy load connected to the antenna output terminals; otherwise, the tests shall be made with the antenna connected and, if adjustable, fully extended. When measuring the ac conducted emissions from a device that operates between 150 kHz and 30 MHz a non-detachable antenna may be replaced with a dummy load for the measurements within the fundamental emission band of the transmitter, but only for those measurements.36 Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency. Diagram or photograph the test setup that was used. See Clause 8 for full reporting requirements.

6.10.2 Test Setup



Measurement Result and limit:

In accordance with the requirements of standard FCC Part 15.207, conducted emission is not applicable.

Annex A: Revised History

Version	Revised Content
V00	Initial

Annex B: Accreditation Certificate

Accredited Laboratory

A2LA has accredited

INDUSTRIAL INTERNET INNOVATION CENTER (SHANGHAI) CO., LTD.

Shanghai, People's Republic of China

for technical competence in the field of

Electrical Testing

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

Presented this 12th day of April 2021.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3682.01
Valid to February 28, 2023

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

END OF REPORT