TEST REPORT

Reference No.	:	WTF19F11082751W
FCC ID	:	2AUNV-AI1000
Applicant	:	Great Innovations LLC
Address	:	2301 SW 145th Avenue, 33027, Miramar, Florida, United States of America
Manufacturer	:	FOSHAN SHUNDE MAXCAN ELECTRICAL APPLIANCES CO.,LTD
Address	:	2-10 Road, Technology Zone, Xingtan Industrial Park, Shunde, Foshan, Guangdong
Product Name	:	Bluetooth Humidifier
Model No.	:	MH-902
Standards	:	FCC CFR47 Part 15 Subpart C (Section 15.247): 2018
Date of Receipt sample	:	2019-11-29
Date of Test	:	2019-12-02 to 2019-12-17
Date of Issue	:	2019-12-18
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.

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1 Revision History

Test Report No.	Date of Issue	Description	Status
WTF19F11082751W	2019-12-18	Original	Valid

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3 General Information

3.1 General Description of E.U.T

Product Name ..... : Bluetooth Humidifier

Model No. ..... : MH-902

Model Description ..... : ---

Rated Voltage..... : AC 110-120V, 60Hz, 30W

Battery Capacity ..... : ---

Power Adapter ..... : ---

3.2 Technical Characteristics of EUT

Bluetooth Version..... : V5.0(BR+EDR)

Frequency Range ..... : 2402-2480MHz

RF Output Power ..... : -1.326dBm (Conducted)

Modulation..... : GFSK , π/4 DQPSK

Data Rate ..... : 1Mbps, 2Mbps

Quantity of Channels ..... : 79

Channel Separation..... : 1MHz

Type of Antenna ..... : PCB Printed Antenna

Antenna Gain ..... : -0.58 dBi

Lowest Oscillation..... : 24MHz

3.3 Standards Applicable for Testing

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

3.4 Test Facility

The test facility has a test site registered with the following organizations:

● IC – Registration No.: 21895-1

Waltek Services (Foshan) Co., Ltd. has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration IC number:21895-1, Nov. 14, 2016.

● FCC – Registration No.: 820106

Waltek Services (Foshan) 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 maintained in our files. Registration 820106, August 16, 2018

● FCC – Designation No.: CN5034

Waltek Services (Foshan) 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 maintained in our files. Designation No. CN5034.

● NVLAP – Lab Code: 600191-0

Waltek Services (Foshan) Co., Ltd. EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 600191-0.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

3.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test items: ---

Lab information: ---

3.6 Abnormalities from Standard Conditions

None.

4 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
π/4 DQPSK	2DH1	20	54
	2DH3	26	367
	2DH5	30	679
Normal mode: the Bluetooth has been tested on the modulation of GFSK, π/4 DQPSK, compliance test and record the worst case.			

Test Conditions

Temperature:	22~25℃
Relative Humidity:	50~55%
Atmospheric pressure:	101.9kPa

5 Equipment Used during Test

5.1 Equipment List

Conducted Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal Date**	**Cal Due Date**
1.	EMI Test Receiver	RS	ESCI	101178	2019-01-18	2020-01-17
2.	LISN	RS	ENV216	101215	2019-01-10	2020-01-09
3.	Cable	HUBER+SUHNER	CBL2-NN-3M	223NN322	2019-01-10	2020-01-09
4.	Test Software	FARATRONIC	EZ-EMC CON-03A1	-	-	-
3m Semi-anechoic Chamber for Radiation Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	RS	ESR7	101566	2019-01-18	2020-01-17
2.	EMC Analyzer	Agilent	N9020A	MY48011796	2019-01-26	2020-01-25
3.	Active Loop Antenna	SCHWARZBECK	FMZB1519B	00004	2019-03-10	2020-03-09
4.	Trilog Broadband Antenna	SCHWARZBECK	VULB 9162	9162-117	2019-01-26	2020-01-25
5.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	01561	2019-04-28	2020-04-27
6.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2019-09-18	2021-09-17
7.	Amplifier	Lunar E M	LNA1G18-40	20160501002	2019-04-03	2020-04-02
8.	Coaxial Cable (below 1GHz)	H+S	CBL3-NN-12+3 m	214NN320	2019-01-10	2020-01-09
9.	Coaxial Cable (above 1GHz)	Times-Micorwave	CBL5-NN	-	2019-01-10	2020-01-09
10.	Test Software	FARATRONIC	EZ-EMC RA-03A1-1	-	-	-
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	Spectrum Analyzer	Agilent	N9020A	MY48011796	2019-01-26	2020-01-25
2.	Spectrum Analyzer	R&S	FSP40	100501	2019-11-13	2020-11-12
3.	Vector Signal Generator	Agilent	N5182A	MY50141533	2019-03-03	2020-03-02
4.	Analog Signal Generator	Agilent	N5181A	MY48180720	2019-01-26	2020-01-26
5.	Environmental Chamber	KSON	THS-D4C-100	5244K	2019-01-26	2020-01-26
6.	RF Control Unit	CHANGCHUANG	JS0806-2	-	2019-04-10	2020-04-09

5.2 Special Accessories and Auxiliary Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.
1.	/	/	/	/

5.3 Measurement Uncertainty

Parameter	Uncertainty
RF Output Power	±0.95dB
Occupied Bandwidth	±1.5%
Conducted Spurious Emission	±2.7dB
Conducted Emission	±2.7dB
Transmitter Spurious Emission	±3.8dB (for 25MHz-1GHz)
	±5.0dB (for 1GHz-18GHz)

6 Summary of Test Result

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

Remark:

Pass Test item meets the requirement

Fail Test item does not meet the requirement

N/A Test case does not apply to the test object

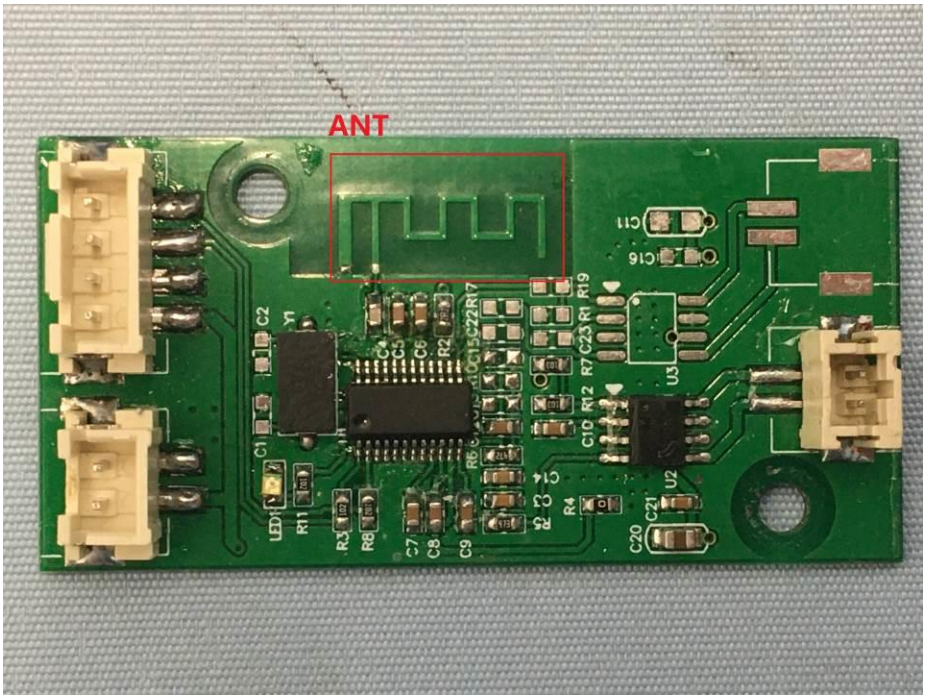
6.1 Antenna Requirement

6.1.1 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.

6.1.2 Evaluation Information

The EUT has an PCB Printed Antenna, the gain is 0dBi, fulfil the requirement of this section.



6.2 Frequency Hopping System Requirements

6.2.1 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 hop sets 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.

6.2.2 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 2480MHz) in the range 2,400-2,483.5MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless 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.

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

6.3 Conducted Emission

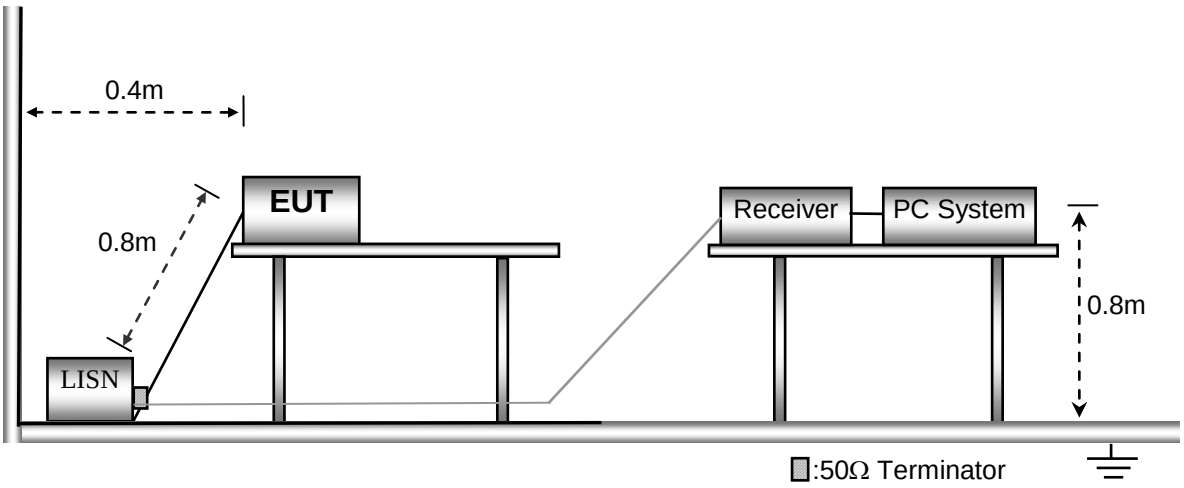
6.3.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013measurement procedure. The specification used was with the FCC Part 15.207Limit.

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.

6.3.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10:2013.



6.3.3 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

6.3.4 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

6.3.5 Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF(Voltage Division Facotr), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Measurement=Reading Level+Correct Factor

Correct Facotor=LISN VDF+Cable Loss

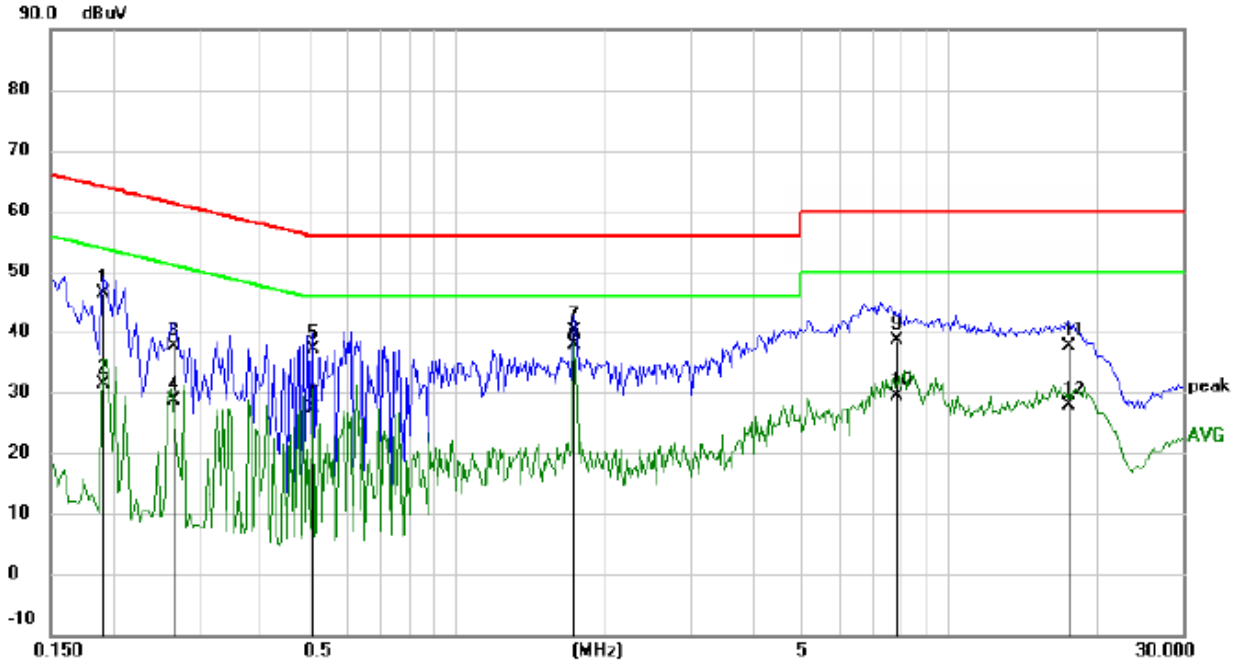
The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin=Limit-Measurement

6.3.6 Test Result

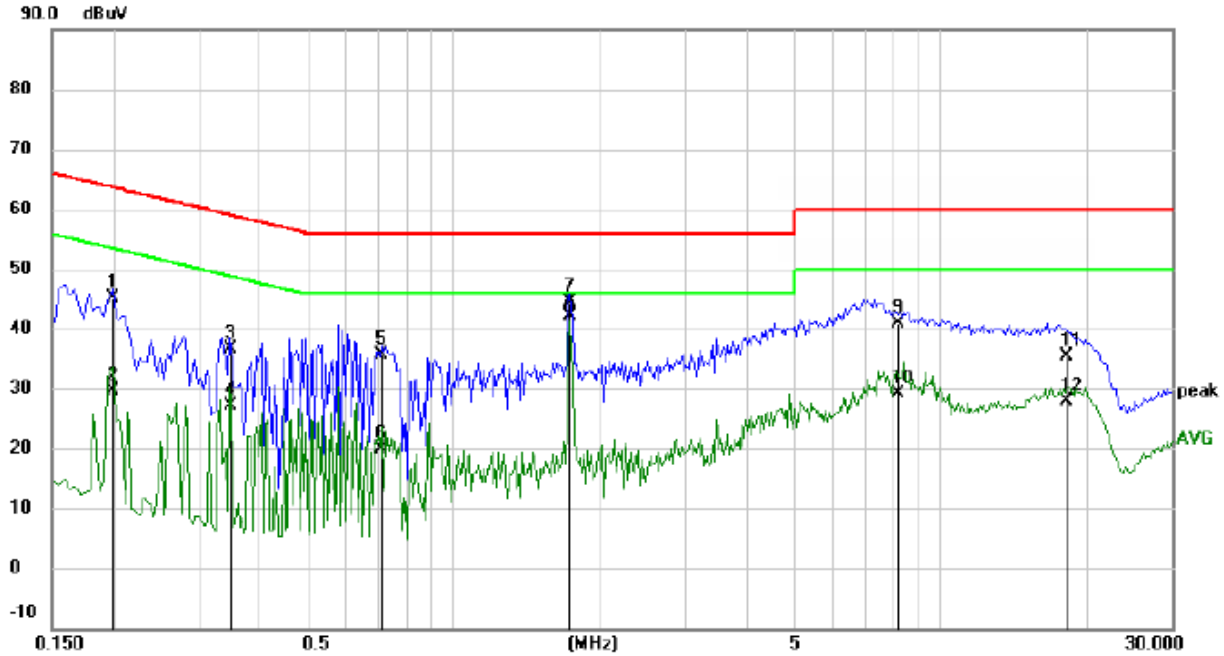
An initial pre-scan was performed on the live and neutral lines.

Test Mode Communication **Test Voltage** AC 120V/60Hz **Phase** Live



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1900	36.82	9.59	46.41	64.04	-17.63	QP	
2		0.1900	21.83	9.59	31.42	54.04	-22.62	AVG	
3		0.2660	27.95	9.59	37.54	61.24	-23.70	QP	
4		0.2660	19.08	9.59	28.67	51.24	-22.57	AVG	
5		0.5100	27.64	9.59	37.23	56.00	-18.77	QP	
6		0.5100	17.84	9.59	27.43	46.00	-18.57	AVG	
7		1.7340	30.55	9.62	40.17	56.00	-15.83	QP	
8	*	1.7340	28.15	9.62	37.77	46.00	-8.23	AVG	
9		7.8580	28.76	9.77	38.53	60.00	-21.47	QP	
10		7.8580	19.62	9.77	29.39	50.00	-20.61	AVG	
11		17.5180	27.77	9.97	37.74	60.00	-22.26	QP	
12		17.5180	17.93	9.97	27.90	50.00	-22.10	AVG	

Test Mode Communication **Test Voltage** AC 120V/60Hz **Phase** Neutral



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1980	35.35	9.66	45.01	63.69	-18.68	QP	
2		0.1980	20.02	9.66	29.68	53.69	-24.01	AVG	
3		0.3460	27.01	9.68	36.69	59.06	-22.37	QP	
4		0.3460	17.40	9.68	27.08	49.06	-21.98	AVG	
5		0.7100	26.02	9.69	35.71	56.00	-20.29	QP	
6		0.7100	10.30	9.69	19.99	46.00	-26.01	AVG	
7		1.7340	34.68	9.71	44.39	56.00	-11.61	QP	
8	*	1.7340	32.35	9.71	42.06	46.00	-3.94	AVG	
9		8.1300	31.06	9.92	40.98	60.00	-19.02	QP	
10		8.1300	19.33	9.92	29.25	50.00	-20.75	AVG	
11		18.2660	25.31	10.18	35.49	60.00	-24.51	QP	
12		18.2660	17.77	10.18	27.95	50.00	-22.05	AVG	

6.4 Radiated Spurious Emissions

6.4.1 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.

6.4.2 Test Procedure

1) The EUT is placed on a turntable, which is 0.8m(Below 1G) 1.5m(above 1G)above ground plane.

2) The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

3) EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

4) Maximum procedure was performed on the six highest emissions to ensure EUT compliance.

5) And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

6) Repeat above procedures until the measurements for all frequencies are complete.

7) The radiation measurements are tested under 3-axes(X, Y, Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the Z position. So the data shown was the Z position only.

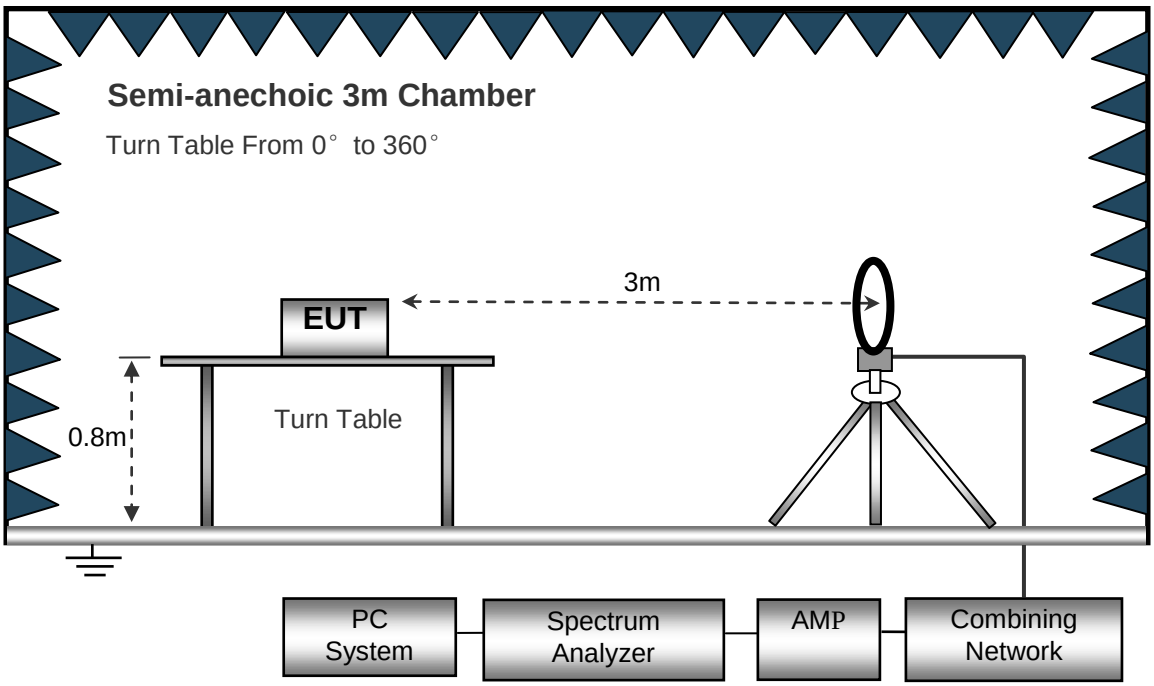
6.4.3 Test Setup

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.

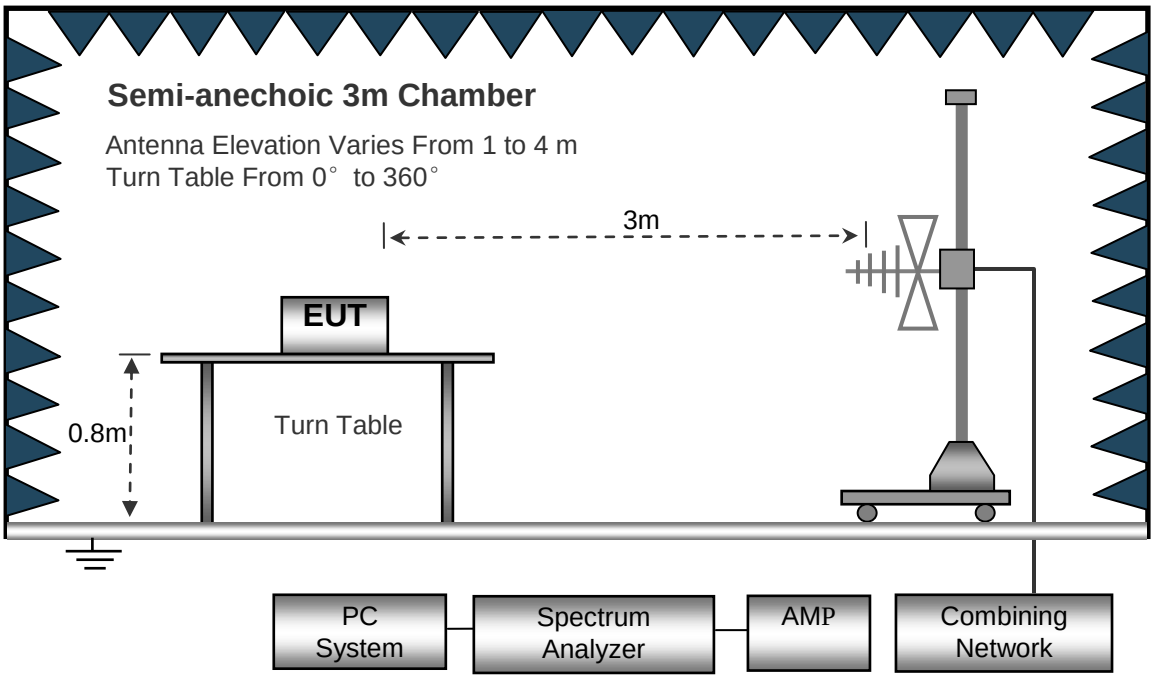
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

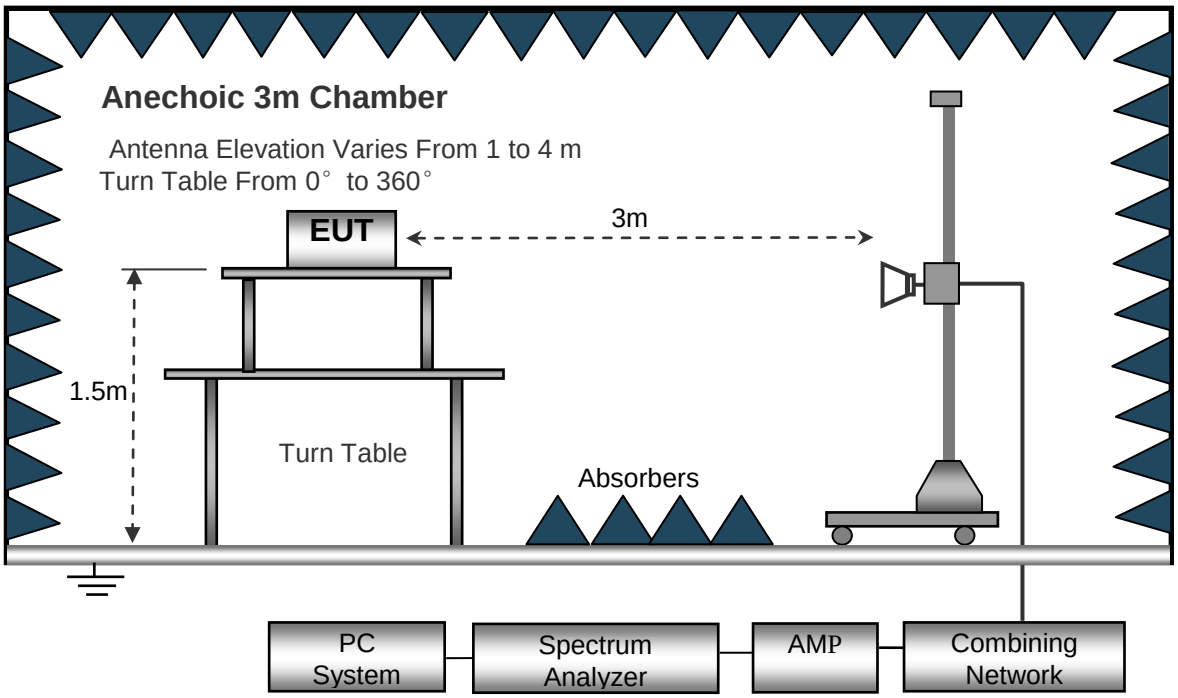
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



6.4.4 Spectrum Analyzer Setup

9KHz-30MHz	30MHz-1GHz	Above 1GHz
RBW=10kHz	RBW=120kHz	RBW=1MHz
VBW=30kHz	VBW=300kHz	VBW=3MHz(Peak), 10MHz(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

6.4.5 Corrected Amplitude & Margin Calculation

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

Corr. Ampl. = Indicated Reading + Corr. Factor

Corr.Factor=Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

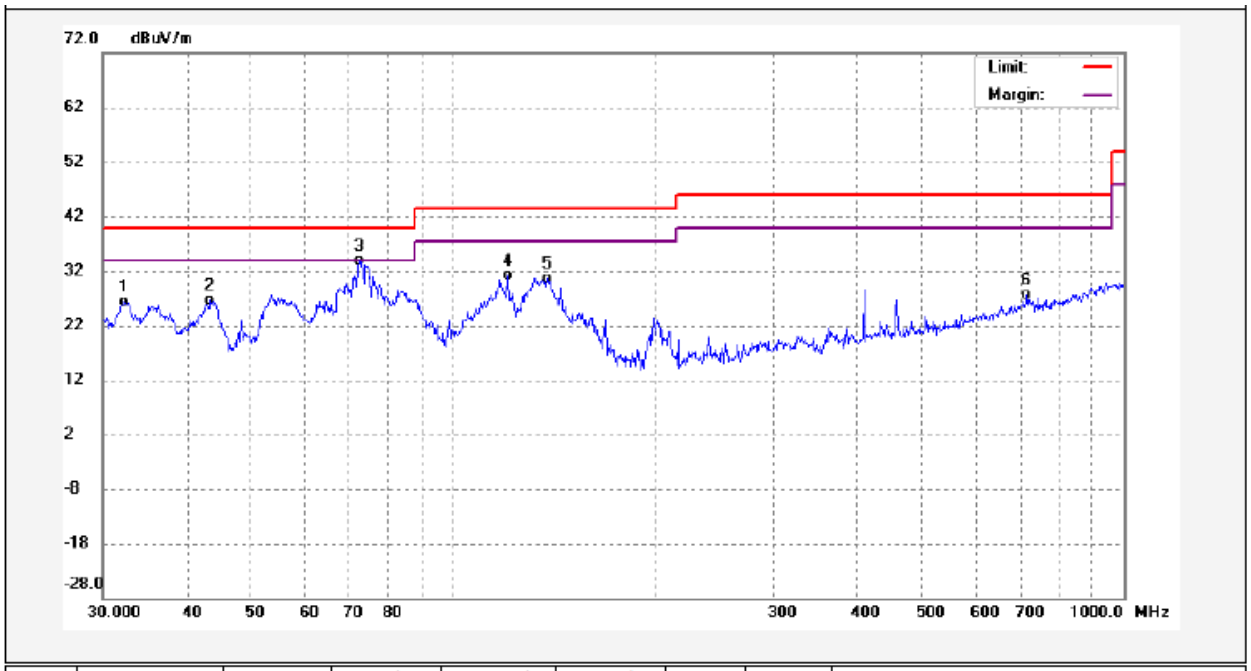
6.4.6 Test Result

Test Frequency: 9 kHz~30 MHz

The measurements were more than 20 dB below the limit and not reported.

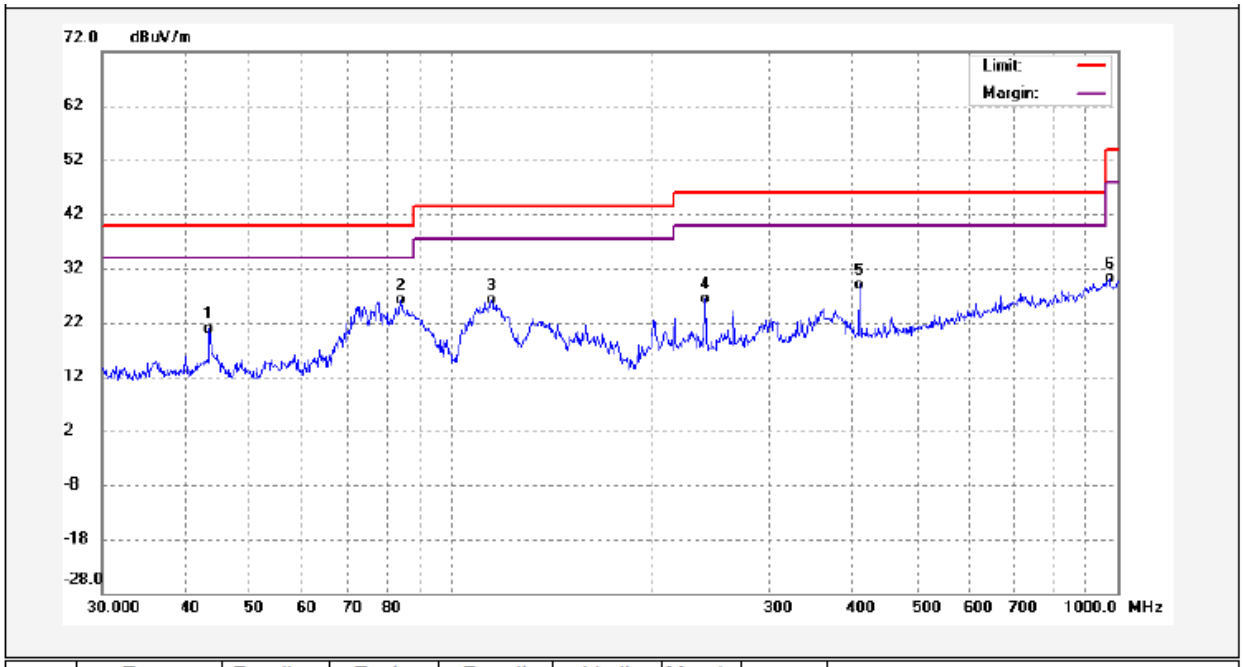
Test Frequency: 30MHz ~ 1GHz (worst case)

Test Channel GFSK Low Channel **Polarization** Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	32.2925	14.28	12.18	26.46	40.00	-13.54	QP	
2	43.3534	11.91	14.60	26.51	40.00	-13.49	QP	
3	72.3376	24.29	9.51	33.80	40.00	-6.20	QP	
4	120.2766	21.21	9.87	31.08	43.50	-12.42	QP	
5	137.9028	20.73	10.02	30.75	43.50	-12.75	QP	
6	716.6820	2.68	24.89	27.57	46.00	-18.43	QP	

Test Channel GFSK Low Channel **Polarization** Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	43.3534	5.87	15.10	20.97	40.00	-19.03	QP	
2	84.1100	16.49	9.58	26.07	40.00	-13.93	QP	
3	114.9169	15.48	10.64	26.12	43.50	-17.38	QP	
4	240.8304	11.11	15.19	26.30	46.00	-19.70	QP	
5	410.3825	10.06	18.94	29.00	46.00	-17.00	QP	
6	972.3374	2.40	27.62	30.02	54.00	-23.98	QP	

Test Frequency: 1GHz~18GHz

Frequency (MHz)	Reading (dBμV/m)	Detector	Polar (H/V)	Corrected Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low Channel-2402MHz							
4804	51.03	PK	H	-6.71	44.32	74	-29.68
4804	25.24	AV	H	-6.71	18.53	54	-35.47
7206	48.94	PK	H	-1.46	47.48	74	-26.52
7206	26.45	AV	H	-1.46	24.99	54	-29.01
4804	57.10	PK	V	-6.71	50.39	74	-23.61
4804	29.53	AV	V	-6.71	22.82	54	-31.18
7206	49.05	PK	V	-1.46	47.59	74	-26.41
7206	23.51	AV	V	-1.46	22.05	54	-31.95
Middle Channel-2441MHz							
4882	52.63	PK	H	-6.50	46.13	74	-27.87
4882	23.76	AV	H	-6.50	17.26	54	-36.74
7323	43.75	PK	H	-1.12	42.63	74	-31.37
7323	20.41	AV	H	-1.12	19.29	54	-34.71
4882	53.29	PK	V	-6.50	46.79	74	-27.21
4882	26.87	AV	V	-6.50	20.37	54	-33.63
7323	48.73	PK	V	-1.12	47.61	74	-26.39
7323	25.42	AV	V	-1.12	24.30	54	-29.70
High Channel-2480MHz							
4960	47.62	PK	H	-6.29	41.33	74	-32.67
4960	24.99	AV	H	-6.29	18.70	54	-35.30
7440	45.84	PK	H	-0.80	45.04	74	-28.96
7440	19.39	AV	H	-0.80	18.59	54	-35.41
4960	51.66	PK	V	-6.29	45.37	74	-28.63
4960	29.91	AV	V	-6.29	23.62	54	-30.38
7440	50.64	PK	V	-0.80	49.84	74	-24.16
7440	23.85	AV	V	-0.80	23.05	54	-30.95

Test Frequency: 18GHz~25GHz

The measurements were more than 20 dB below the limit and not reported.

6.5 Number of Hopping Channel and Channel Separation

6.5.1 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.

6.5.2 Test Procedure

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

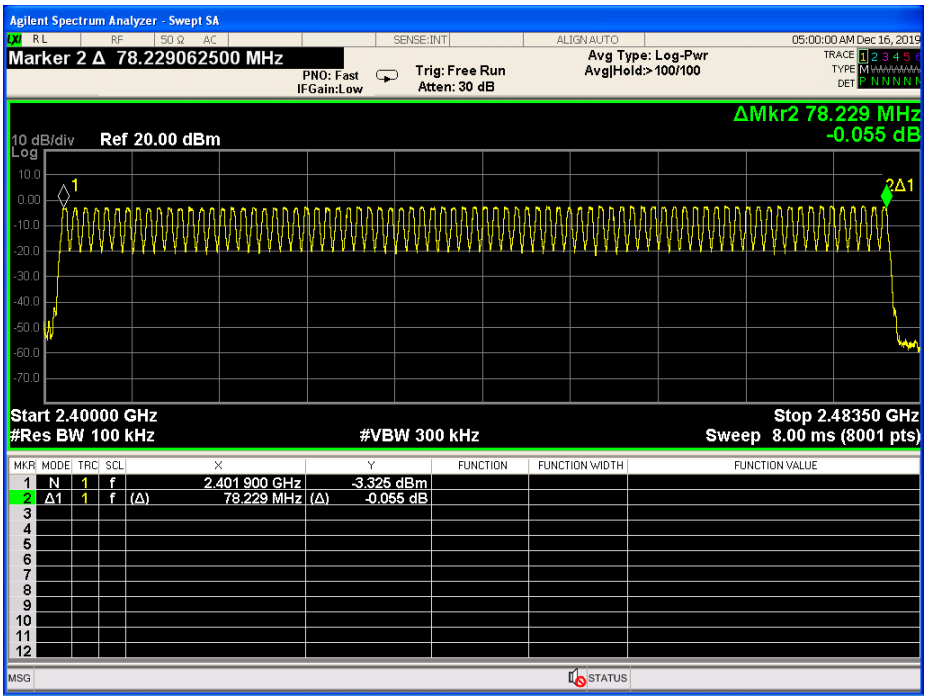
a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW 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 KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013 section 7.8.2, the EUT shall have its hopping function enabled, the Carrier frequency separation test method as follows:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) 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.
c) Video (or average) bandwidth (VBW) ⩾ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.
Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

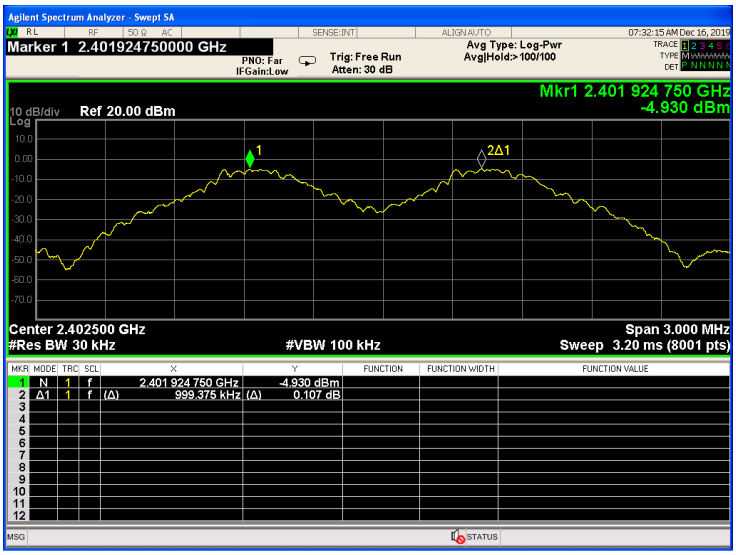
6.5.3 Test Result

79 Hopping Channels

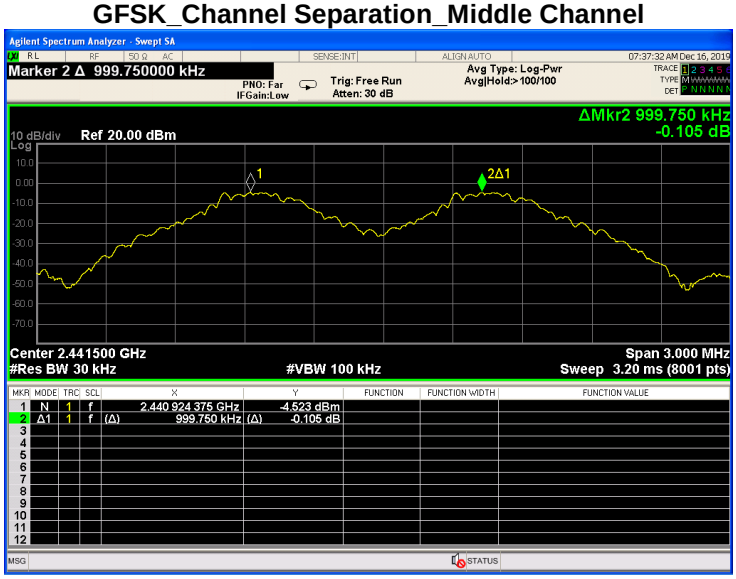


Modulation	Test Channel	Carrier Frequency Separation (kHz)	Result
GFSK	Low	999.375	Pass
	Middle	999.750	Pass
	High	999.750	Pass
π/4 DQPSK	Low	999.750	Pass
	Middle	999.750	Pass
	High	999.750	Pass

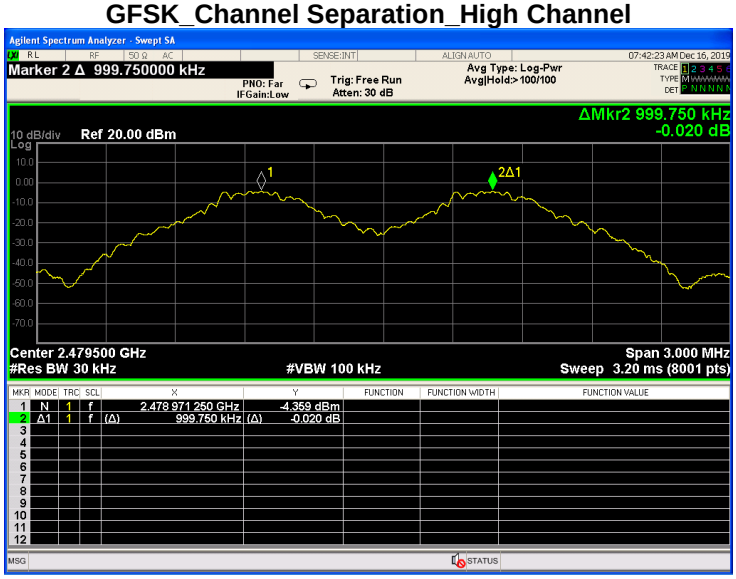
GFSK_Channel Separation_Low Channel



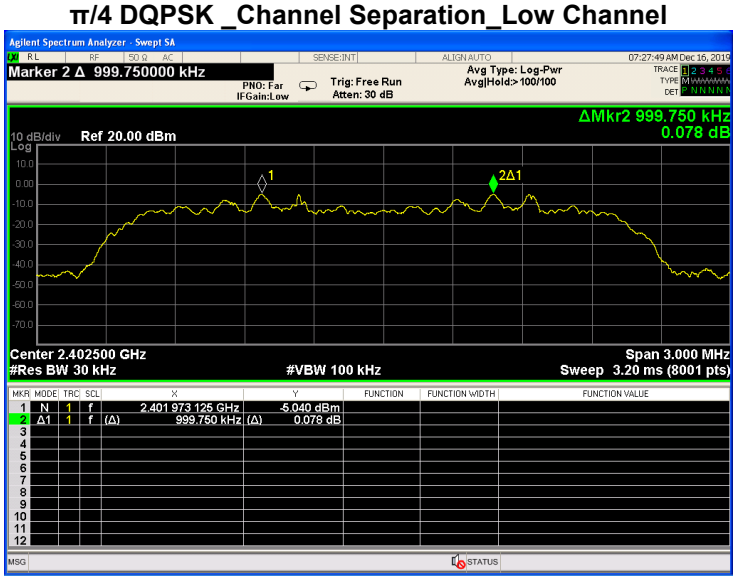
GFSK_Channel Separation_Middle Channel



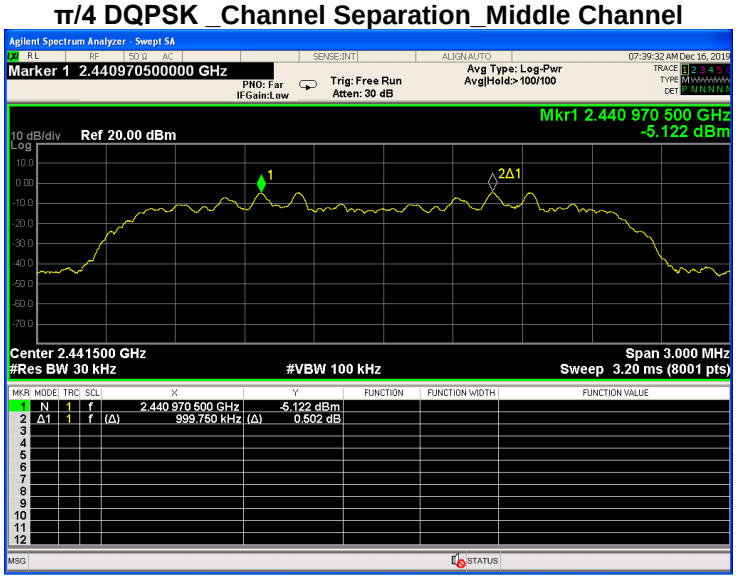
GFSK_Channel Separation_High Channel



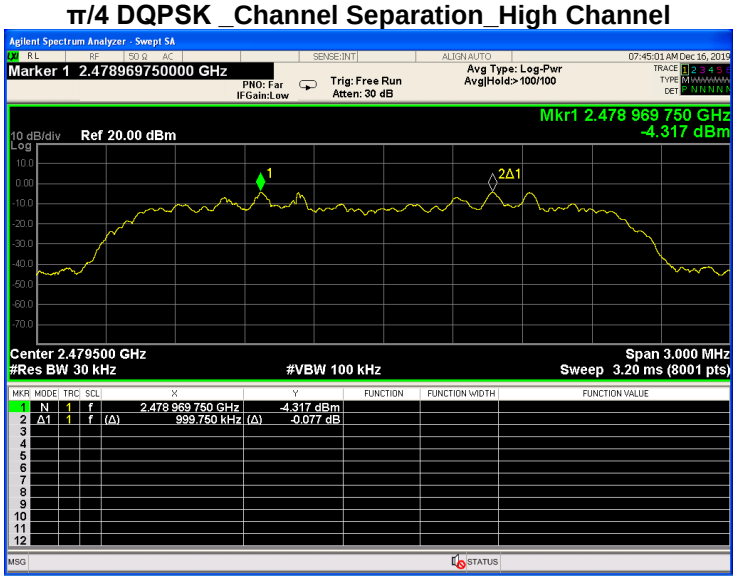
π/4 DQPSK _Channel Separation_Low Channel



π/4 DQPSK _Channel Separation_Middle Channel



π/4 DQPSK _Channel Separation_High Channel



6.6 Time of occupancy (Dwell Time)

6.6.1 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.

6.6.2 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.

6.6.3 Test Result

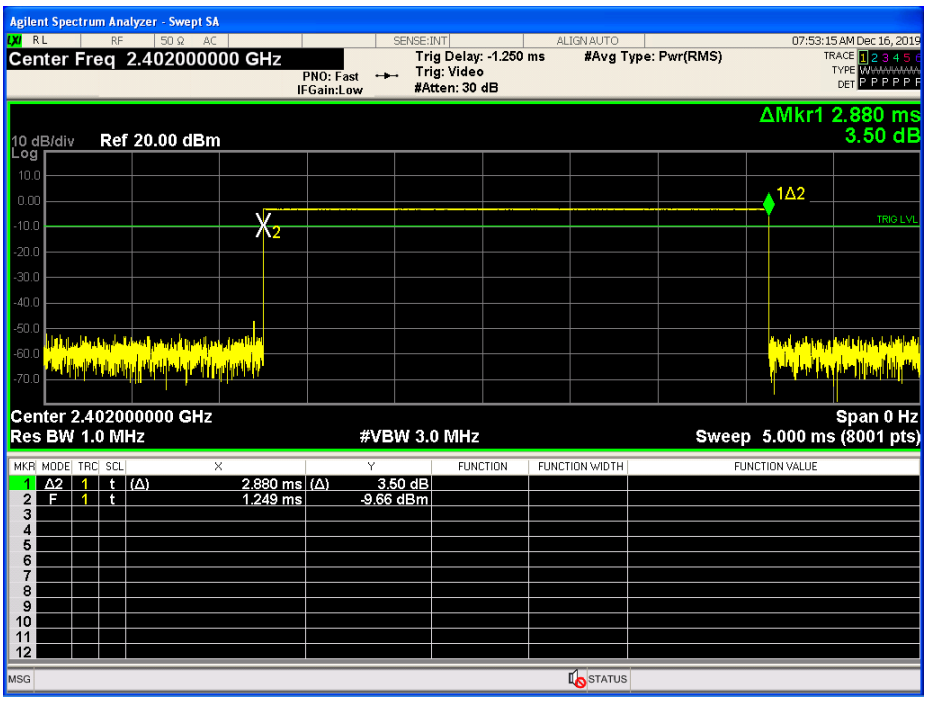
The dwell time within a period in data mode is independent from the packet type (packet length).

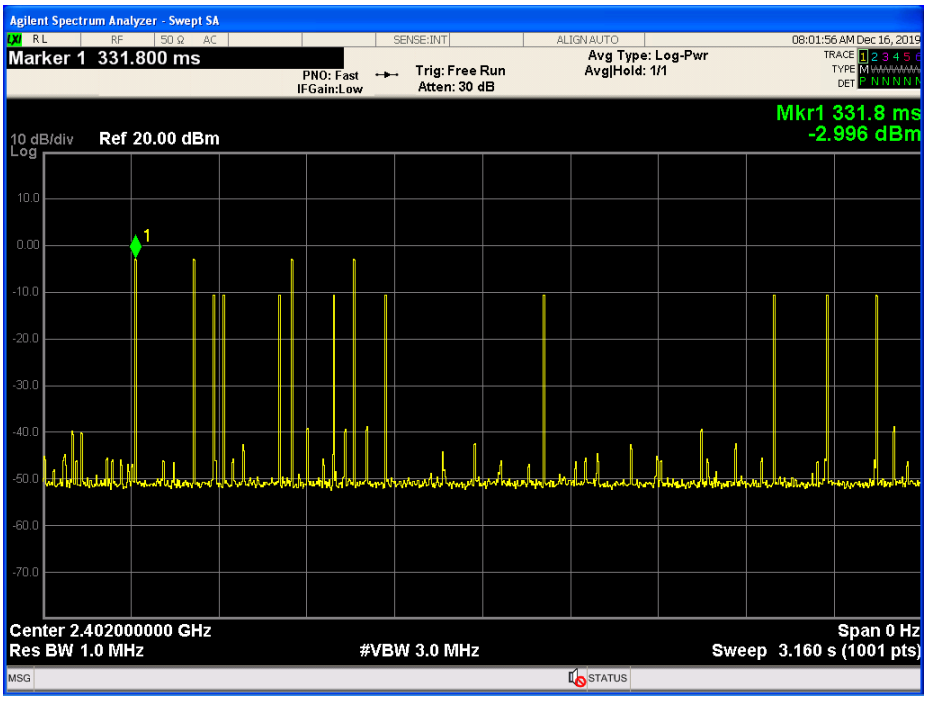
Test data is corrected with the worst case, which the packet length is DH5.

The test period: T = 0.4 Second * 79 Channel = 31.6 s

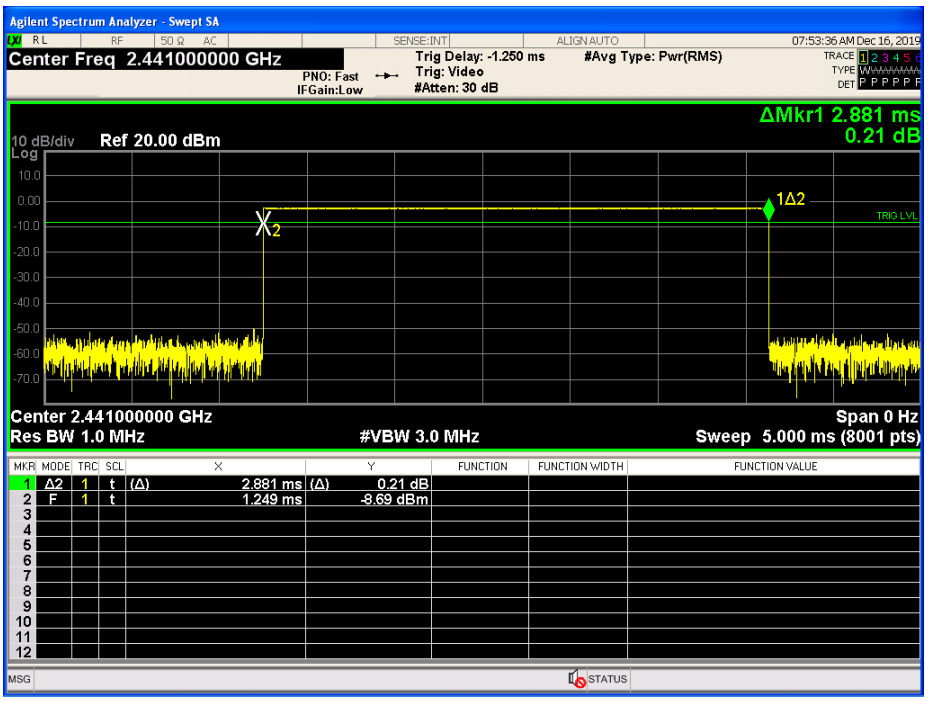
Mode	Test Frequency	Packet Type	Transmission Time(ms)	Number	Dwell Time(ms)	Limit ms
GFSK	Low Channel	DH5	1.249	40	49.96	400
	Middle Channel	DH5	1.249	80	99.92	400
	High Channel	DH5	1.249	70	87.43	400
π/4DQPSK	Low Channel	2DH5	1.249	80	99.92	400
	Middle Channel	2DH5	1.249	40	49.96	400
	High Channel	2DH5	1.249	60	74.94	400

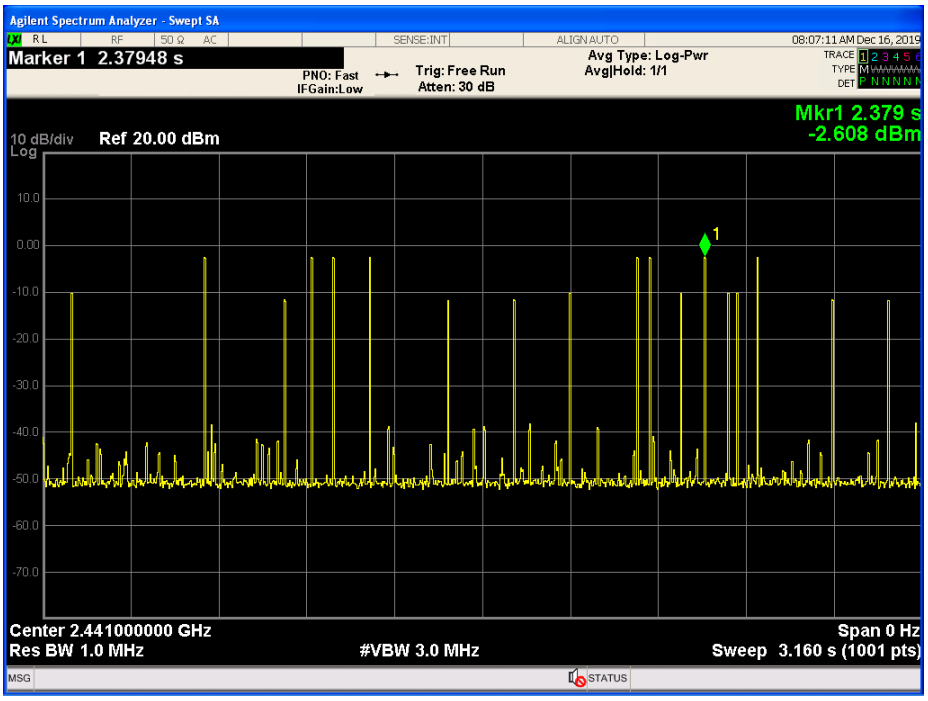
DH5_Low Channel



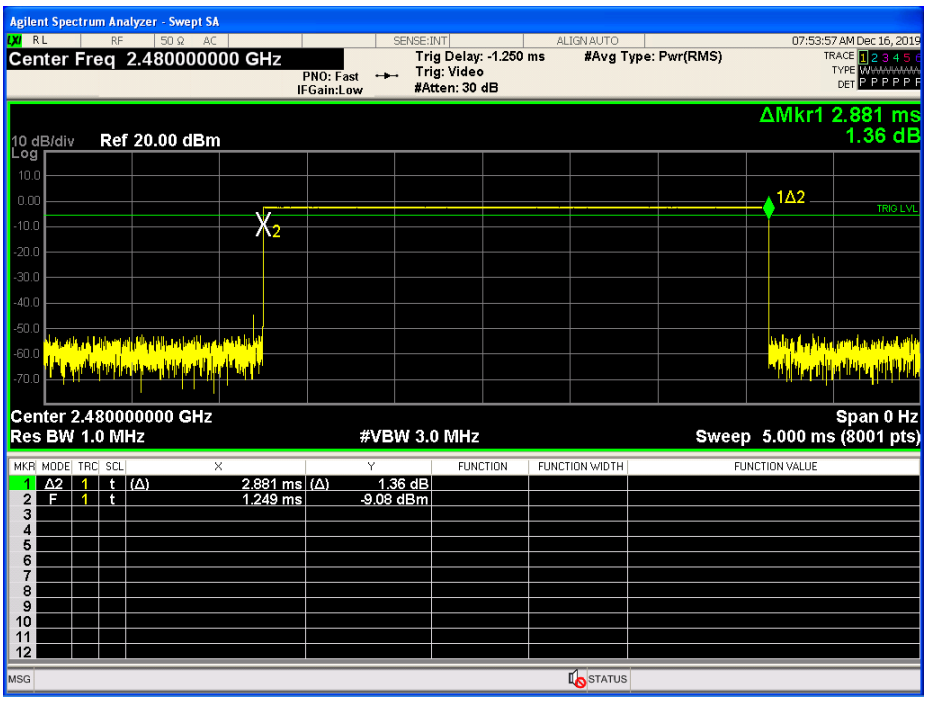


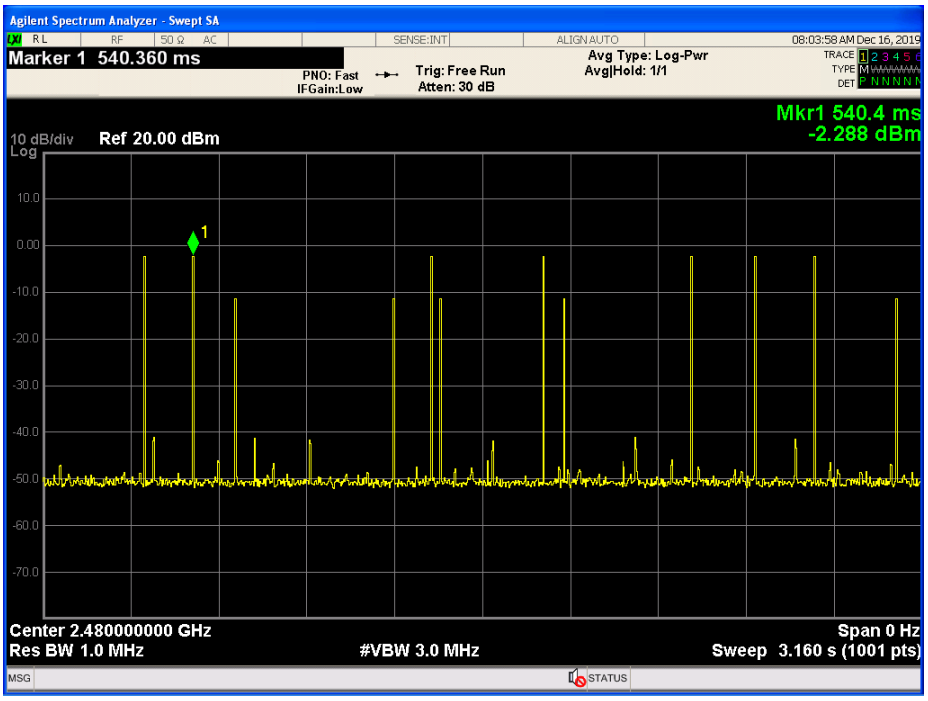
DH5_Middle Channel



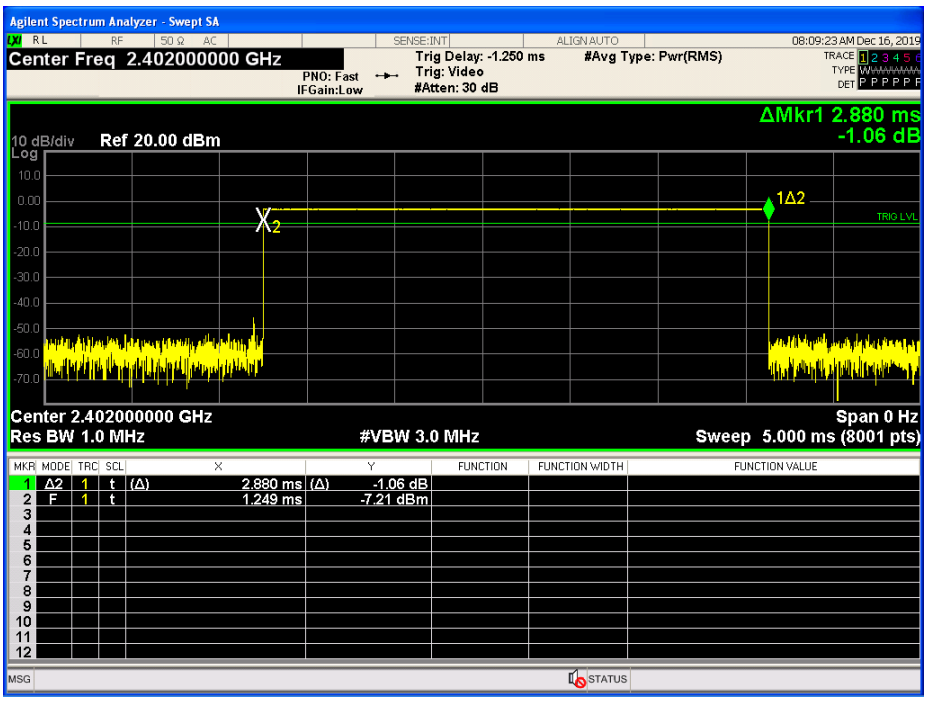


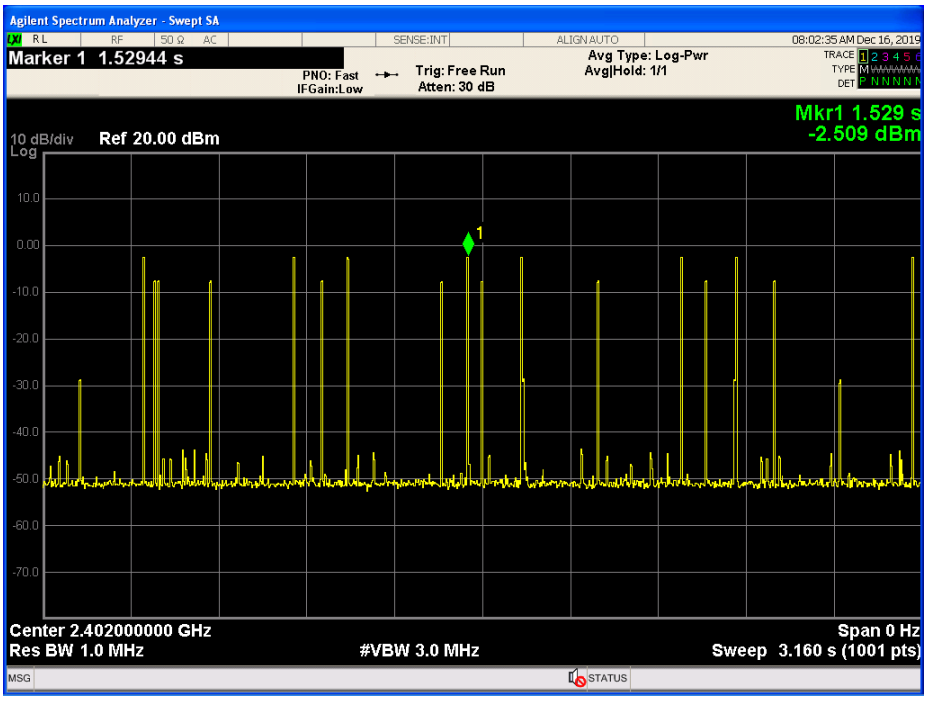
DH5_High Channel



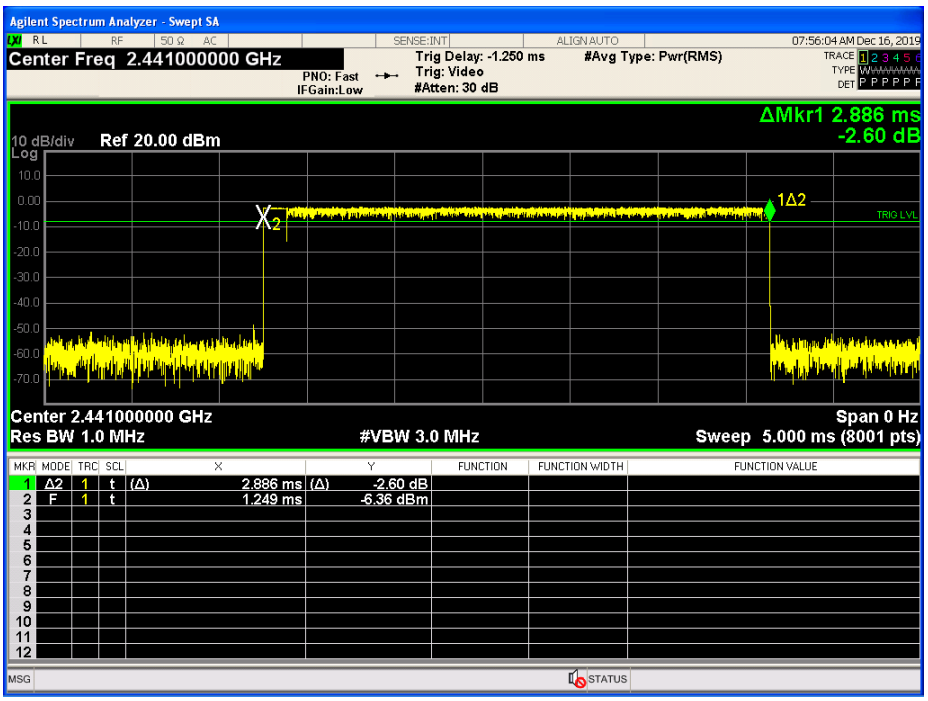


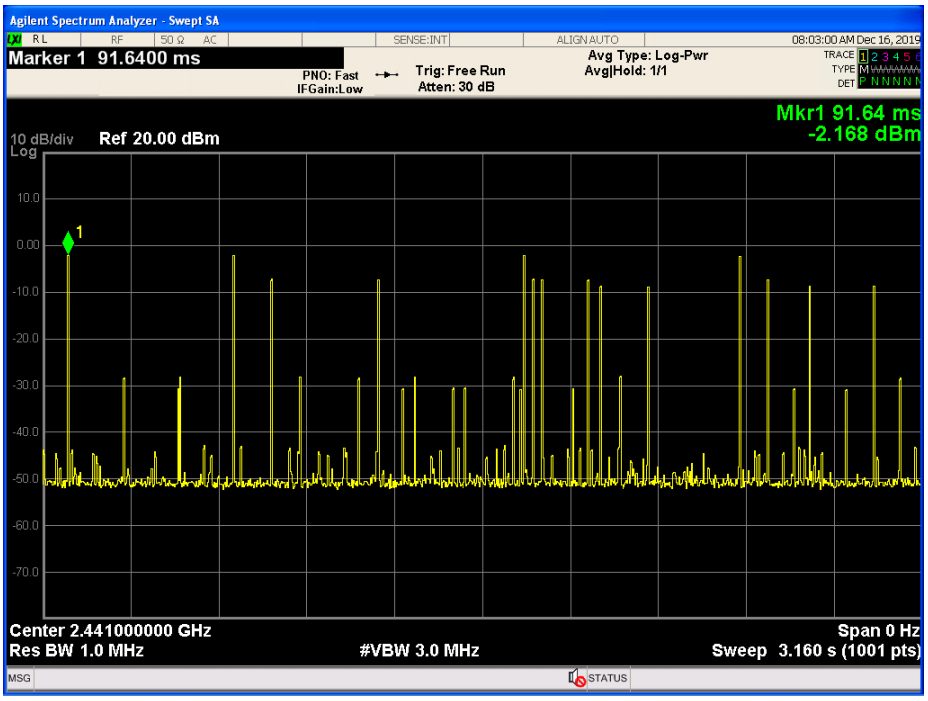
2DH5_Low Channel



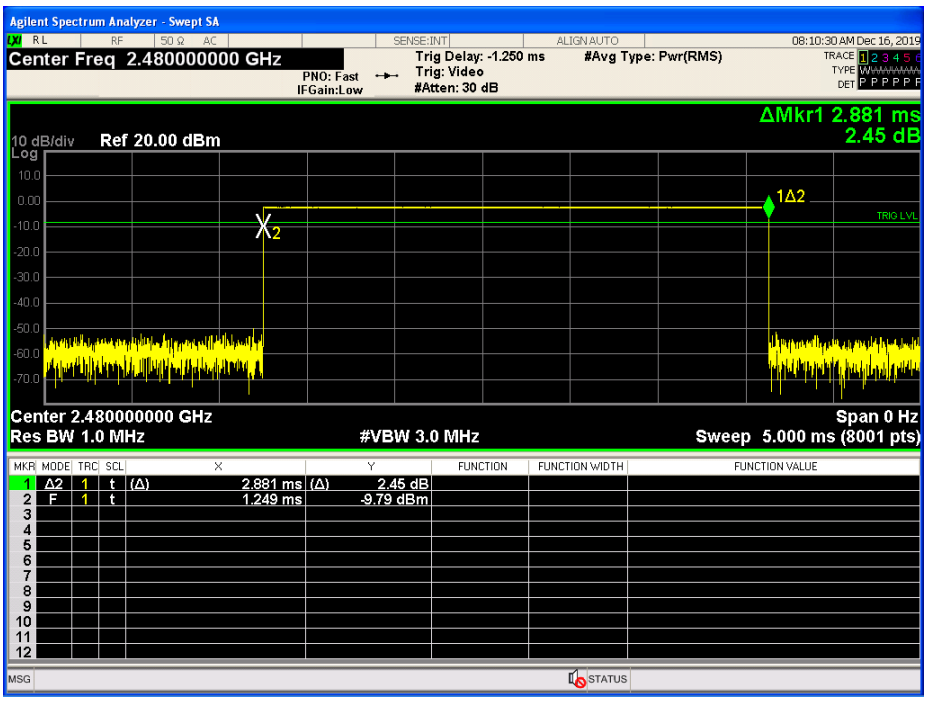


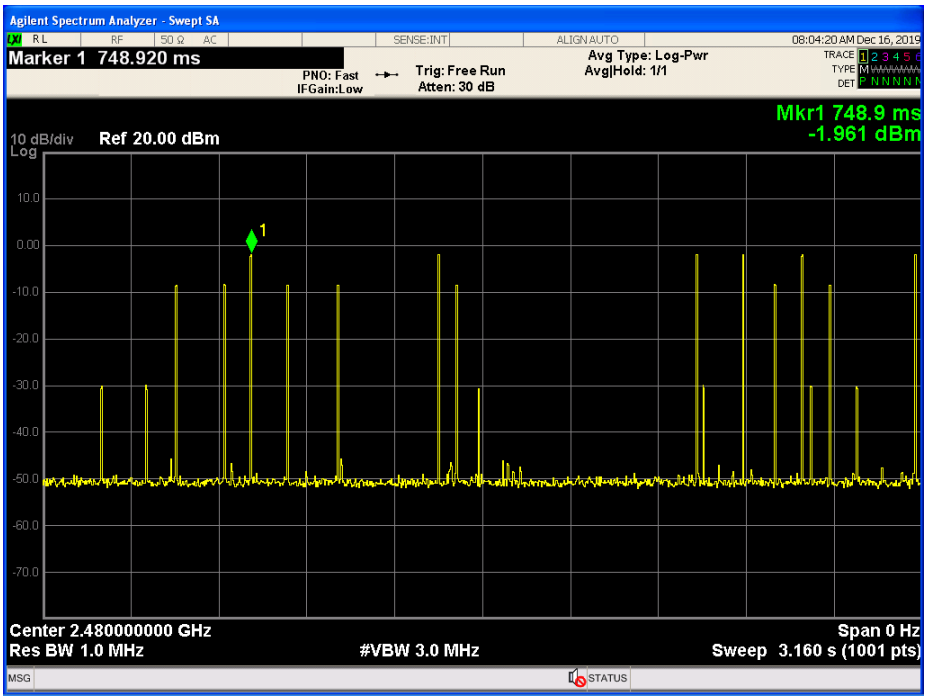
2DH5_Middle Channel





2DH5_High Channel





6.7 20 dB Bandwidth Measurement

6.7.1 Standard Applicable

According to 15.247(a)and 15.215(c),20dB bandwidthis 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.

6.7.2 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013section 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).

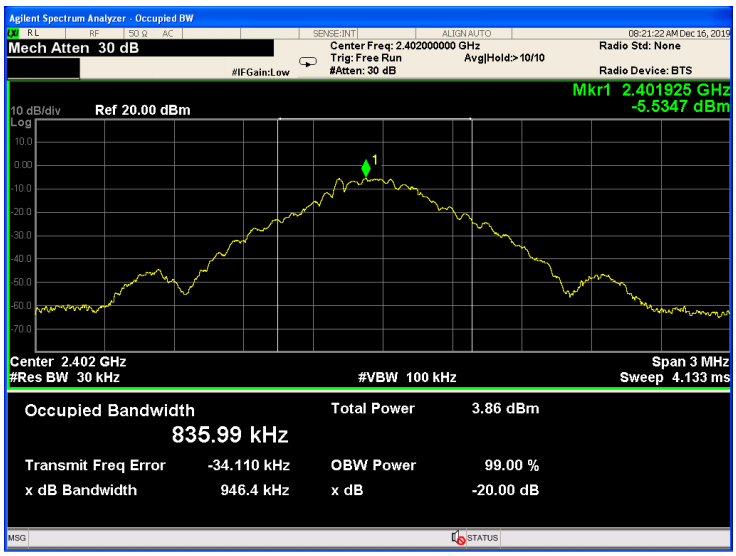
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “−xx dB down amplitude” determined in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be 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 labelled. Tabular data maybe reported in addition to the plot(s).

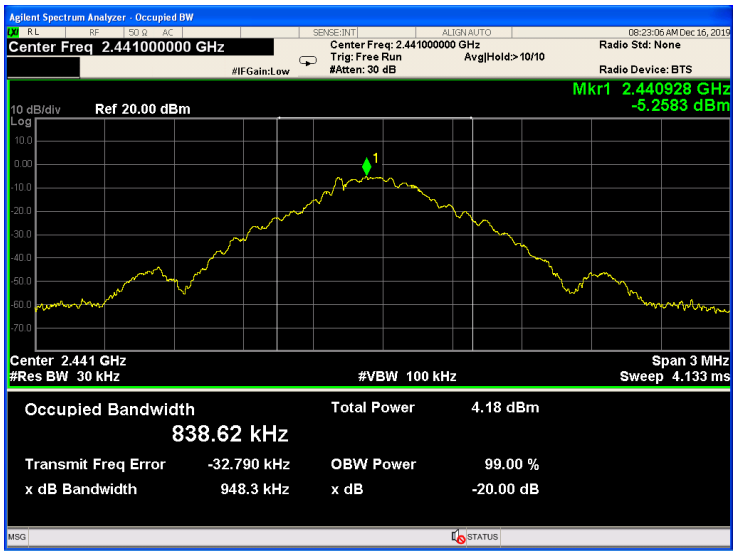
6.7.3 Test Result

Modulation	Test Channel	20dB Bandwidth (kHz)	Result
GFSK	Low	946.4	Pass
	Middle	948.3	Pass
	High	946.4	Pass
π/4 DQPSK	Low	1308.0	Pass
	Middle	1308.0	Pass
	High	1307.0	Pass

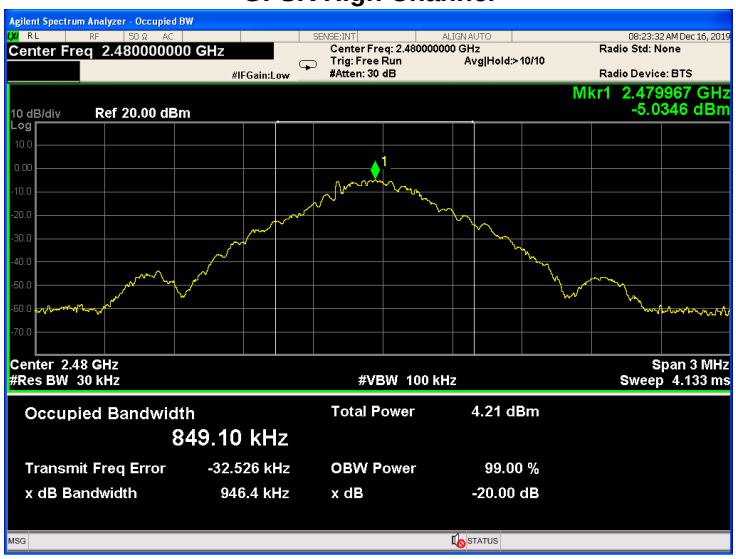
GFSK Low Channel



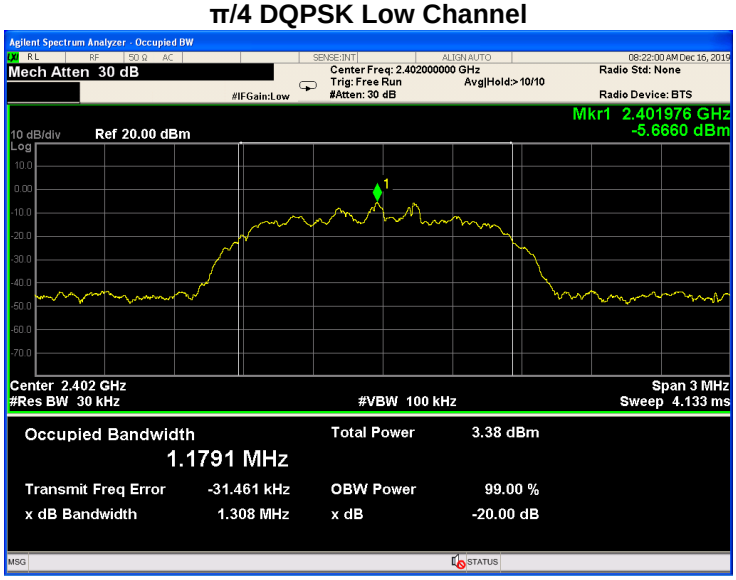
GFSK Middle Channel



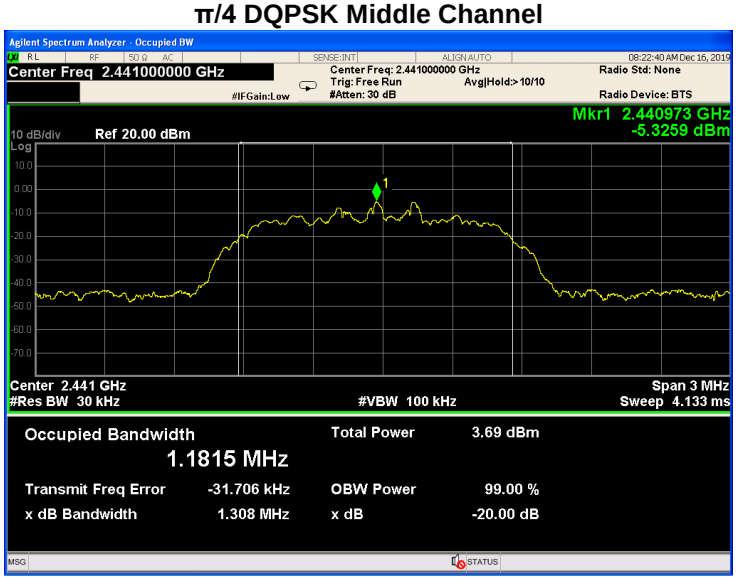
GFSK High Channel



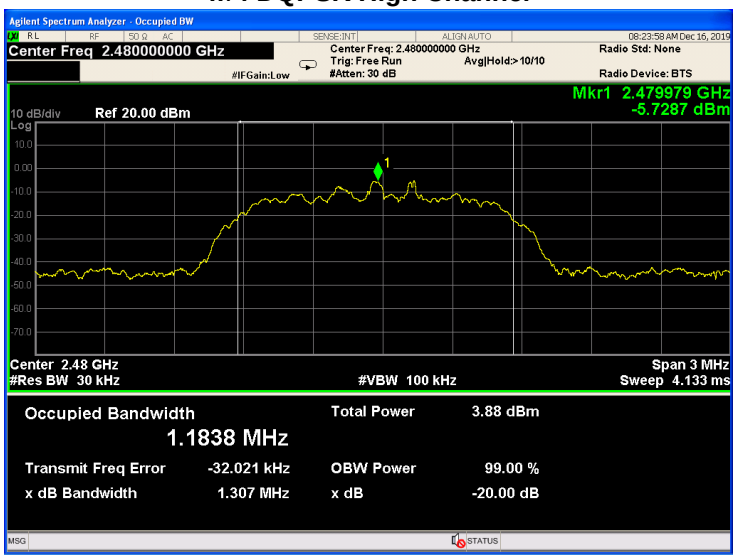
π/4 DQPSK Low Channel



π/4 DQPSK Middle Channel



π/4 DQPSK High Channel



6.8 RF Output Power

6.8.1 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.

6.8.2 Test Procedure

According to KDB 558074 D01 v05r02 Subclause 9 and ANSI C63.10-2013section 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.

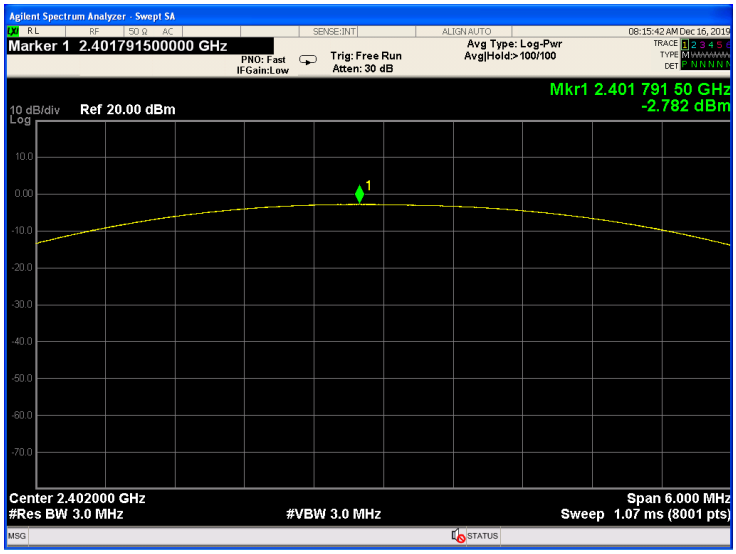
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

e) A plot of the test results and setup description shall be included in the test report.

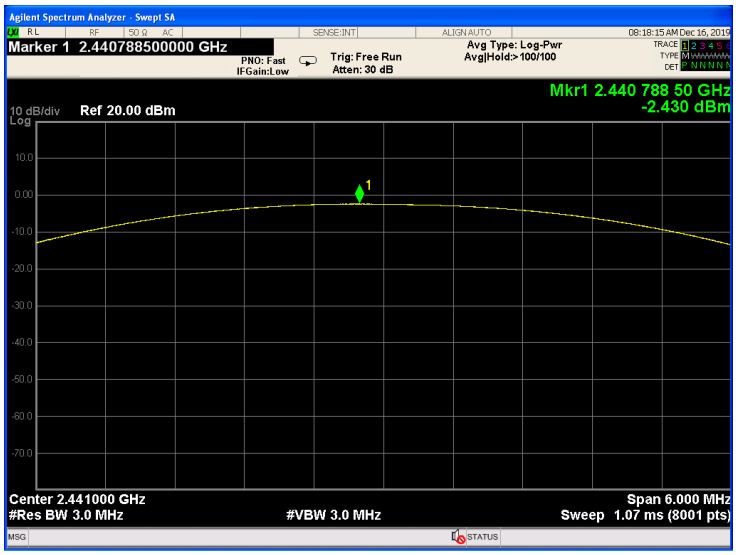
6.8.3 Test Result

Modulation	Test Channel	Output Power (dBm)	Output Power (mW)	Limit (mW)	Result
GFSK	Low	-2.782	0.527	1000	Pass
	Middle	-2.430	0.571	1000	Pass
	High	-2.160	0.608	1000	Pass
π/4 DQPSK	Low	-2.046	0.624	1000	Pass
	Middle	-1.392	0.726	1000	Pass
	High	-1.326	0.737	1000	Pass

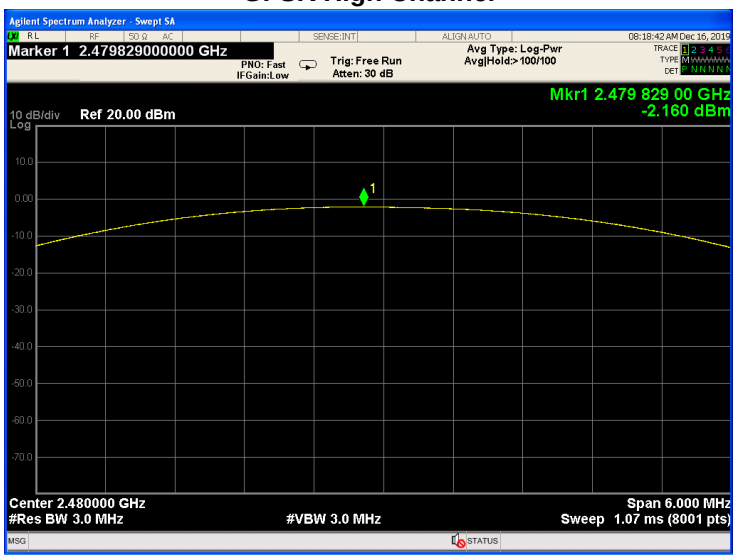
GFSK Low Channel



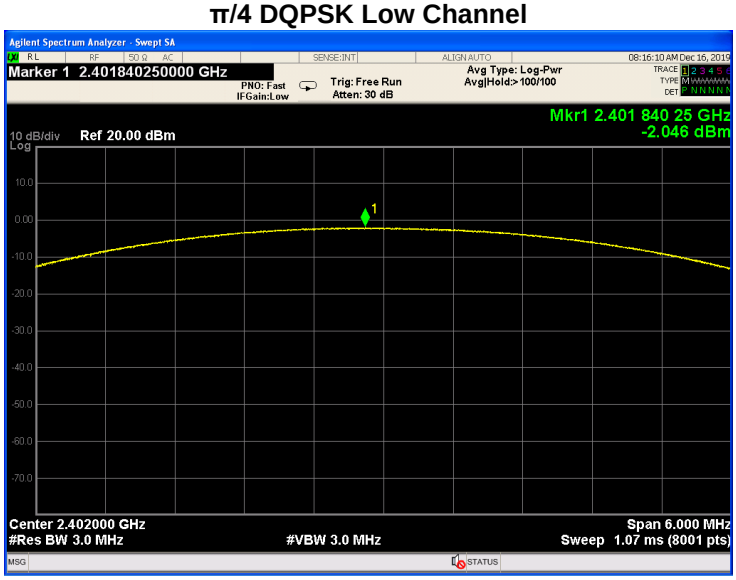
GFSK Middle Channel



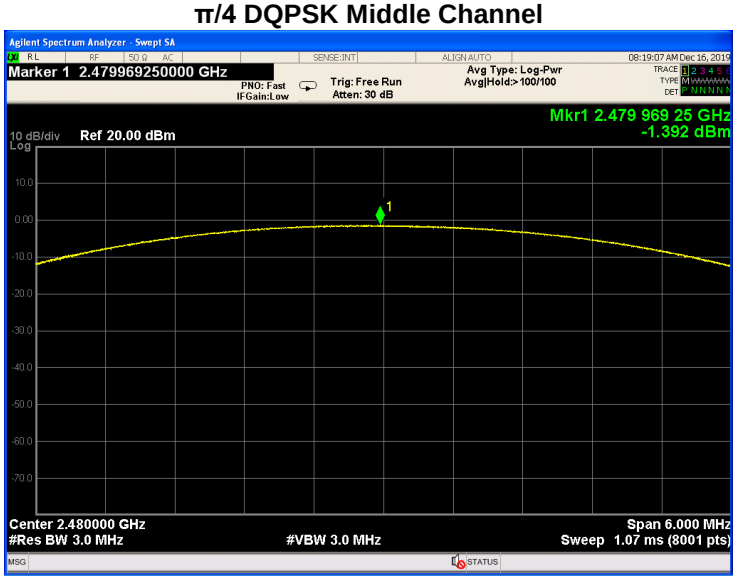
GFSK High Channel



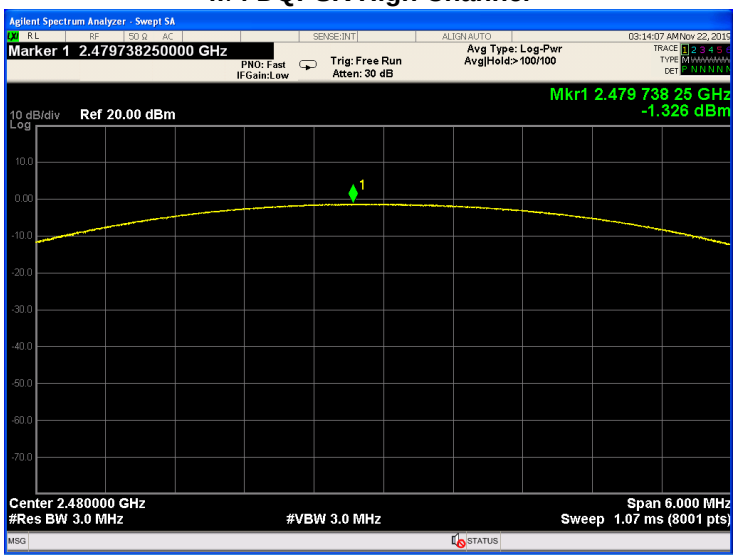
π/4 DQPSK Low Channel



π/4 DQPSK Middle Channel



π/4 DQPSK High Channel



6.9 Band edge (Out of Band Emissions)

6.9.1 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).

6.9.2 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.

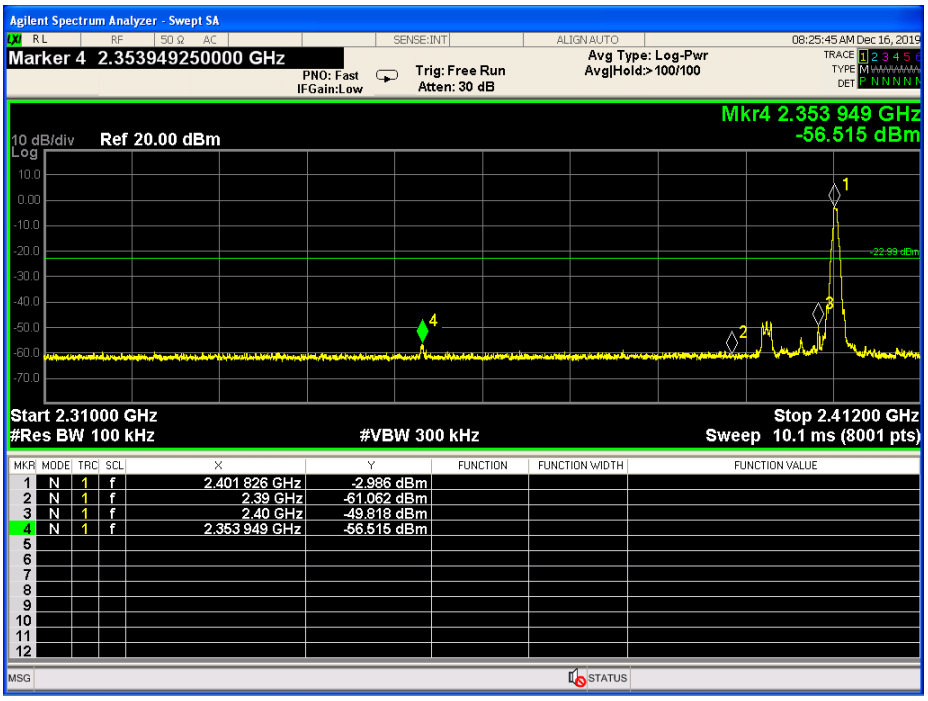
g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
h) Repeat 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 labelled. 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.

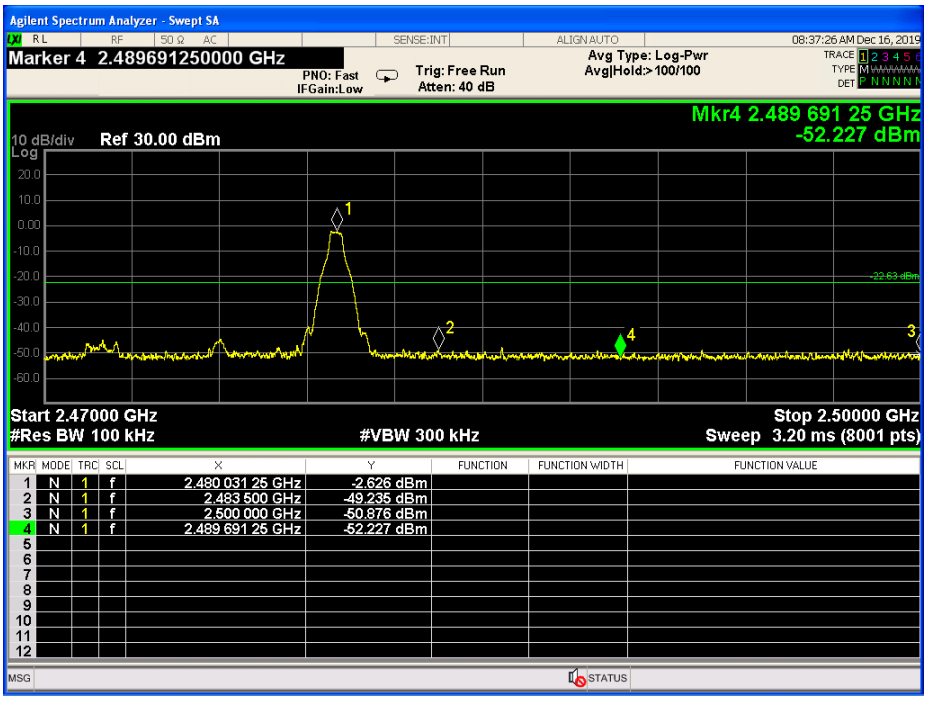
According to ANSI C63.10-2013 section 7.8.8, Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers.
Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between 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.

6.9.3 Test Result

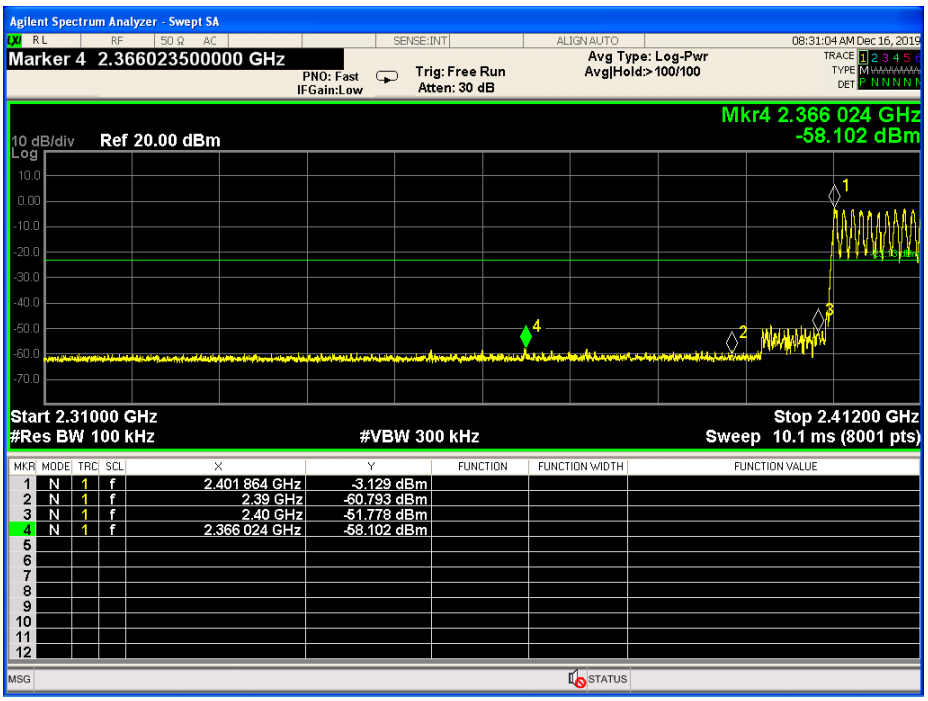
GFSK Transmitting Band edge-left side



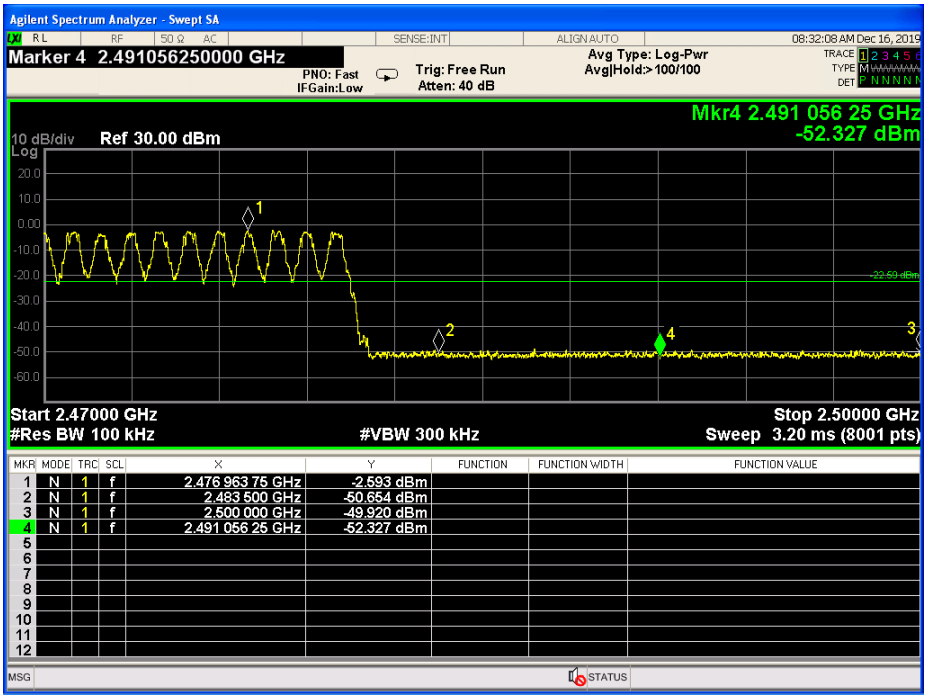
GFSK Transmitting Band edge-right side



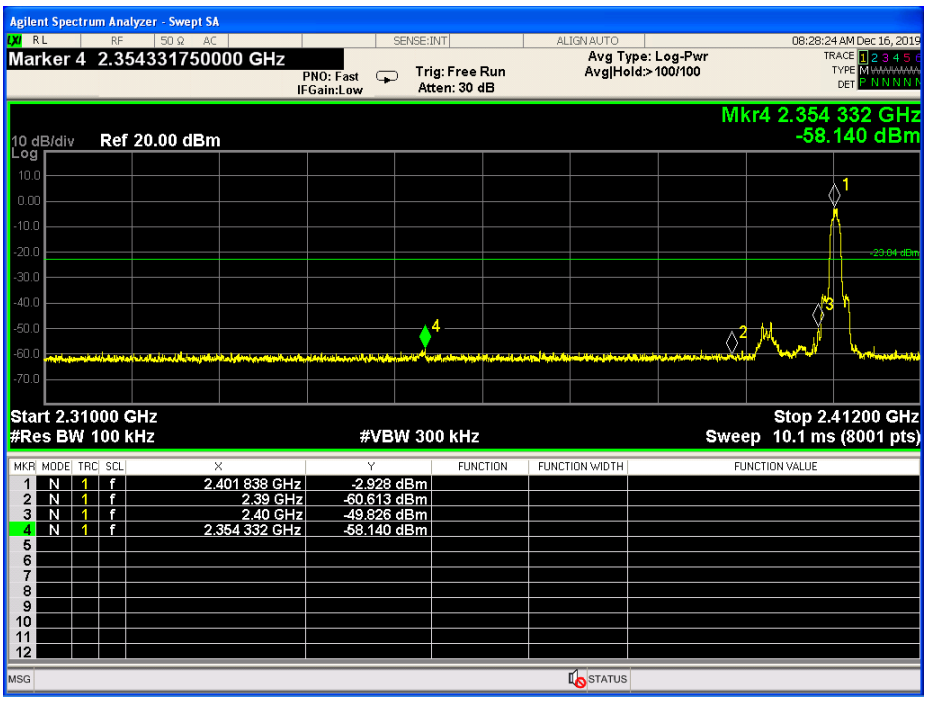
GFSK Hopping Band edge-left side



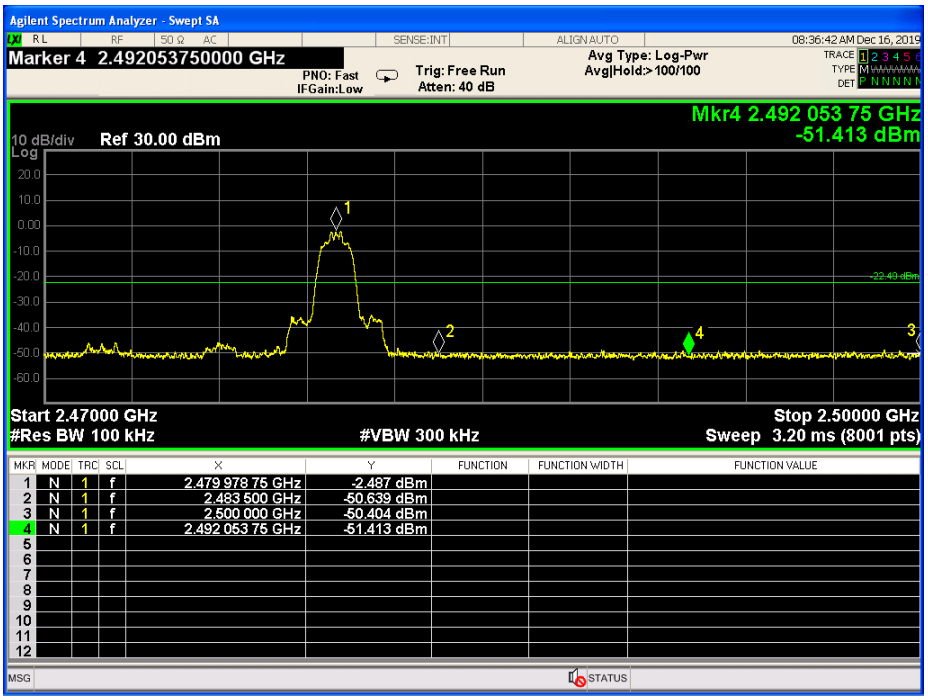
GFSK Hopping Band edge-right side



π/4 DQPSK Transmitting Band edge-left side



π/4 DQPSK Transmitting Band edge-right side



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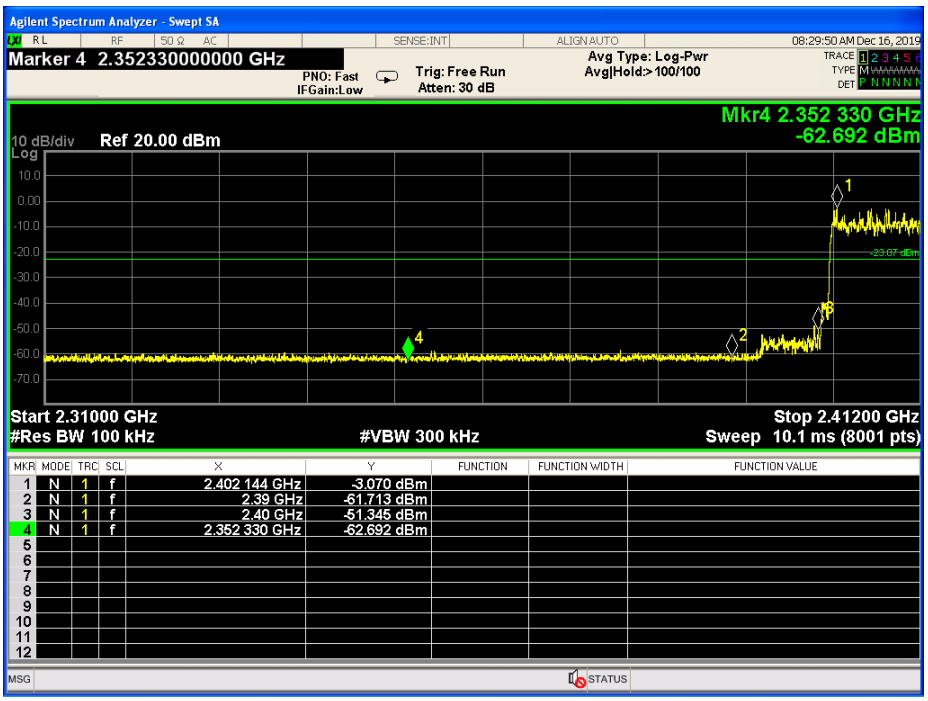
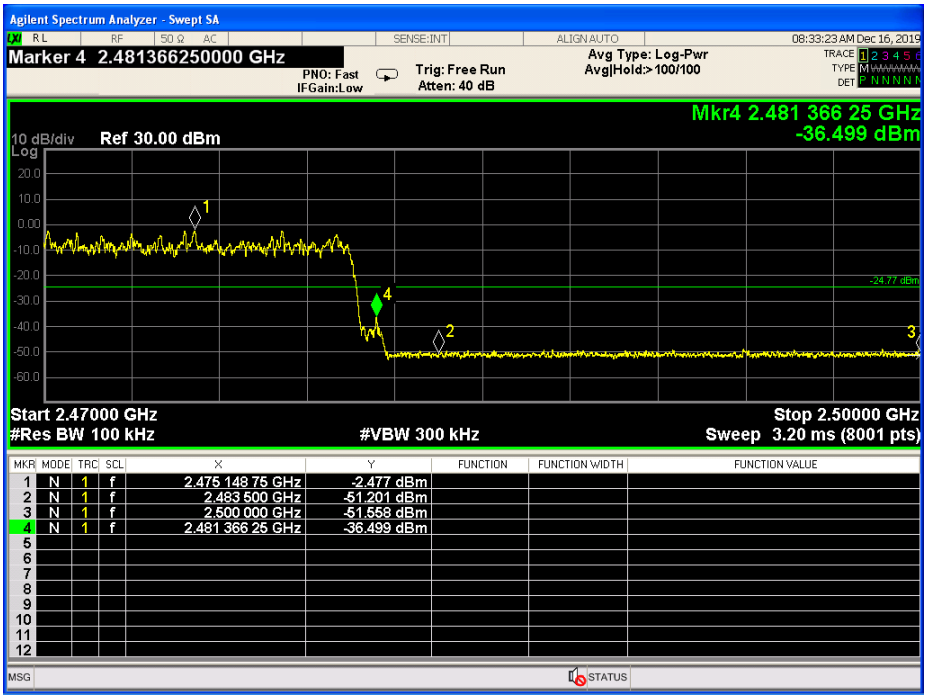


π/4 DQPSK Hopping Band edge-right side



7 RF Exposure

Test Requirement	:	FCC Part 1.1307
Test Method	:	FCC Part2.1093 & KDB 447498 D01 General RF Exposure Guidance v06

7.1 Requirements

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

As noted in §2.1091(b) a mobile device is defined as “a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.” According to §2.1091(c) the limits to be used for evaluation are defined in §1.1310.

As specified in §1.1310(d)(2) at operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 of §1.1310(e) may be used.

Table 1 below shows the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

7.2 The procedures / limit

(A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm^2)	Averaging Time $\|E\|^2$,$\|H\|^2$or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm^2)	Averaging Time $\|E\|^2$,$\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

7.3 MPE Calculation Method

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = output power to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

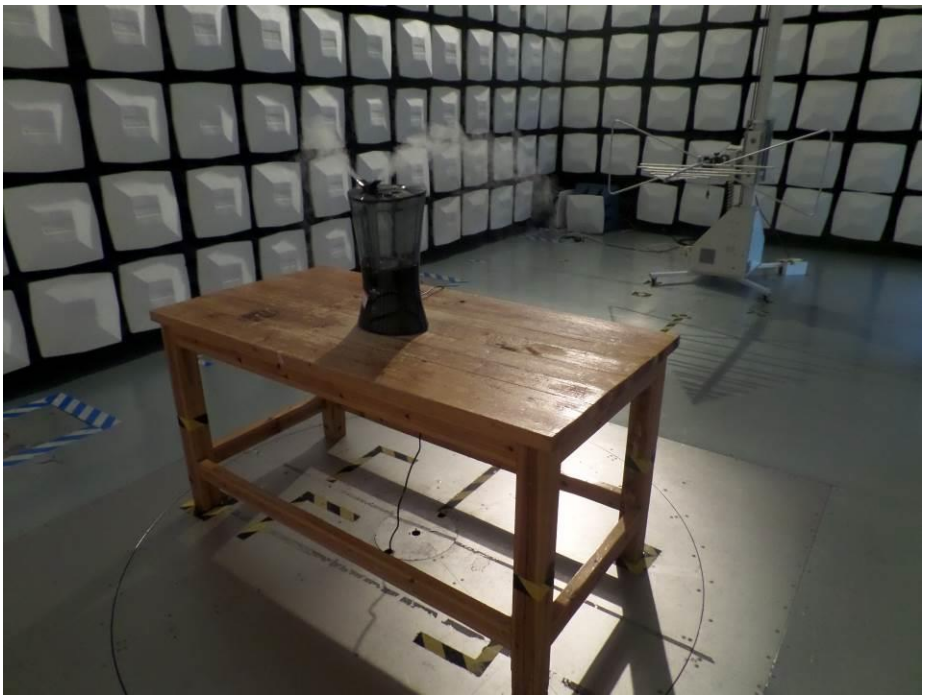
From the peak EUT RF output power, the minimum mobile separation distance, R=20cm, as well as the gain of the used antenna, the RF power density can be obtained

Separation distance (mm)	Channel Frequency (MHz)	Rated Power (dBm)	Rated Power (mW)	Pd (mW/cm2)	Limit Pd (mW/cm2)
>200	2480	-1.326	0.737	0.073	1.0

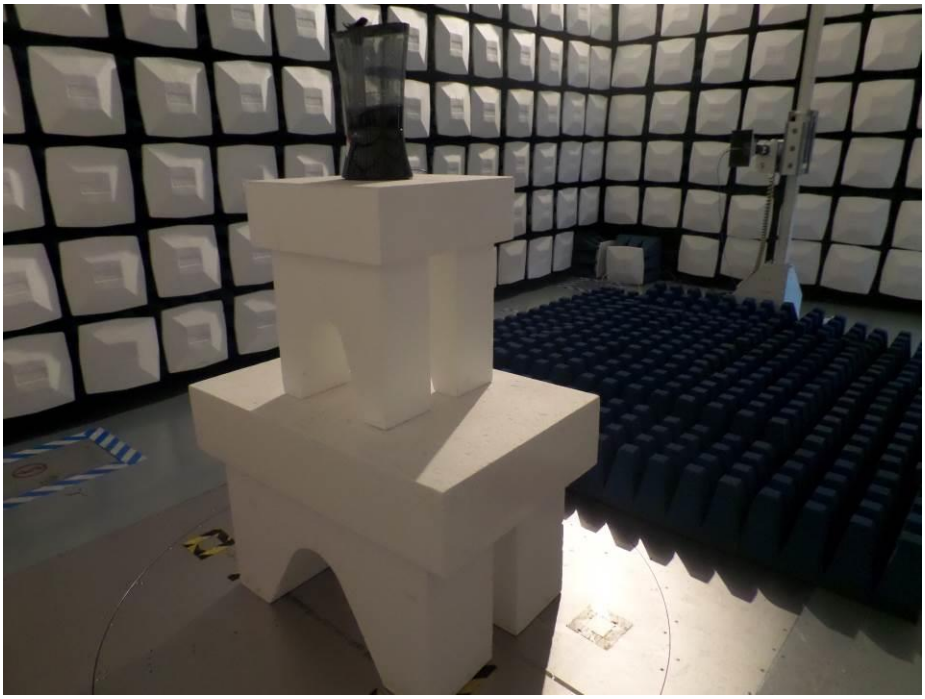
8 Photographs Test Setup

8.1 Photographs - Radiated Emission Test Setup

30MHz-1GHz



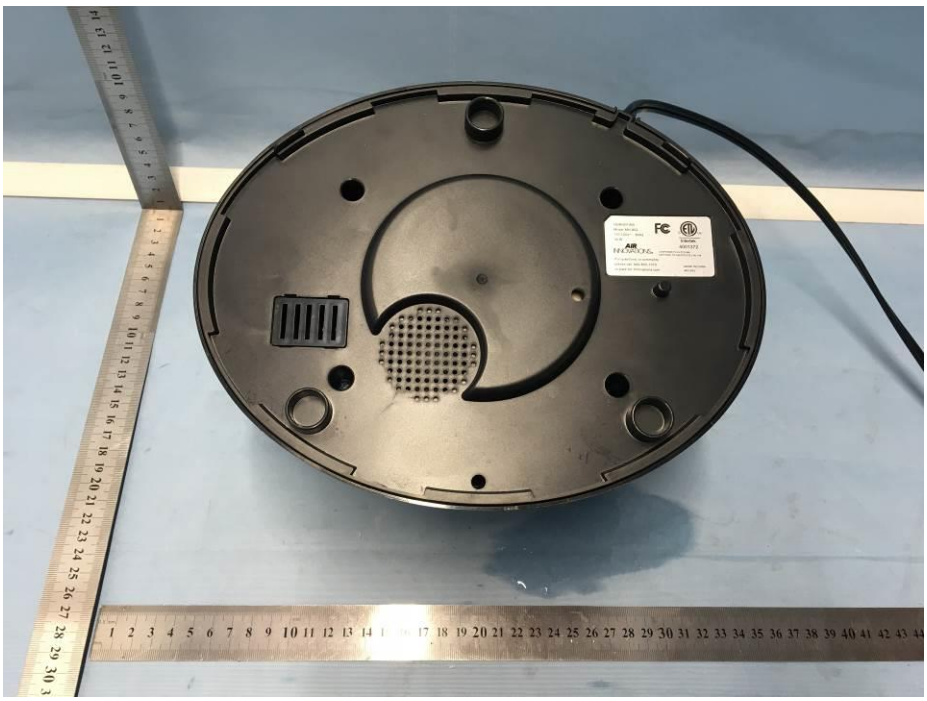
Above 1GHz



8.2 Photographs – Conducted Emission Test Setup

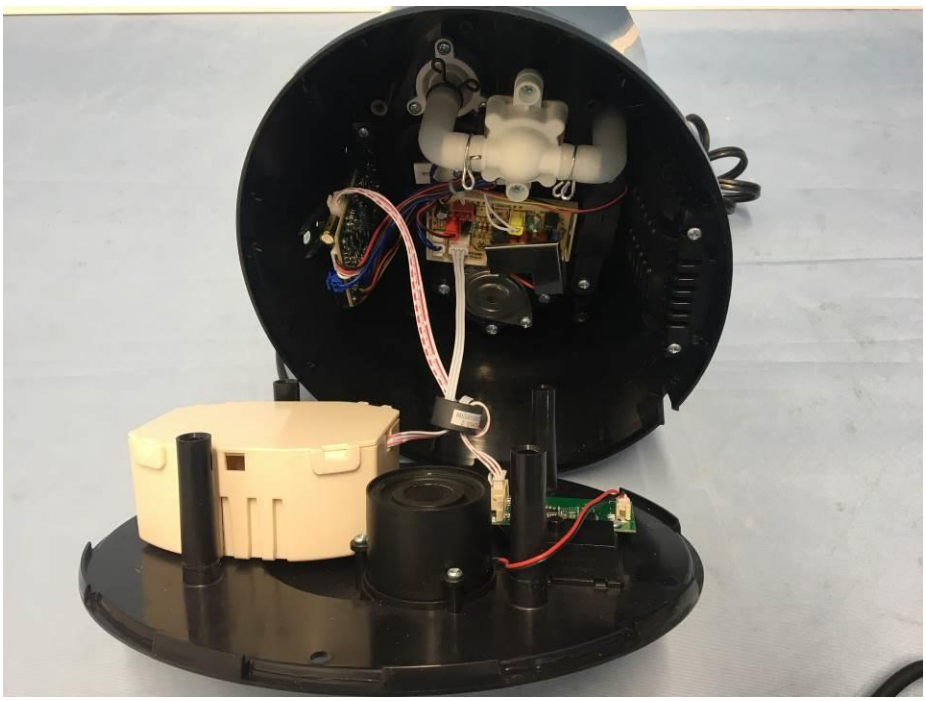
9 Photographs - Constructional Details

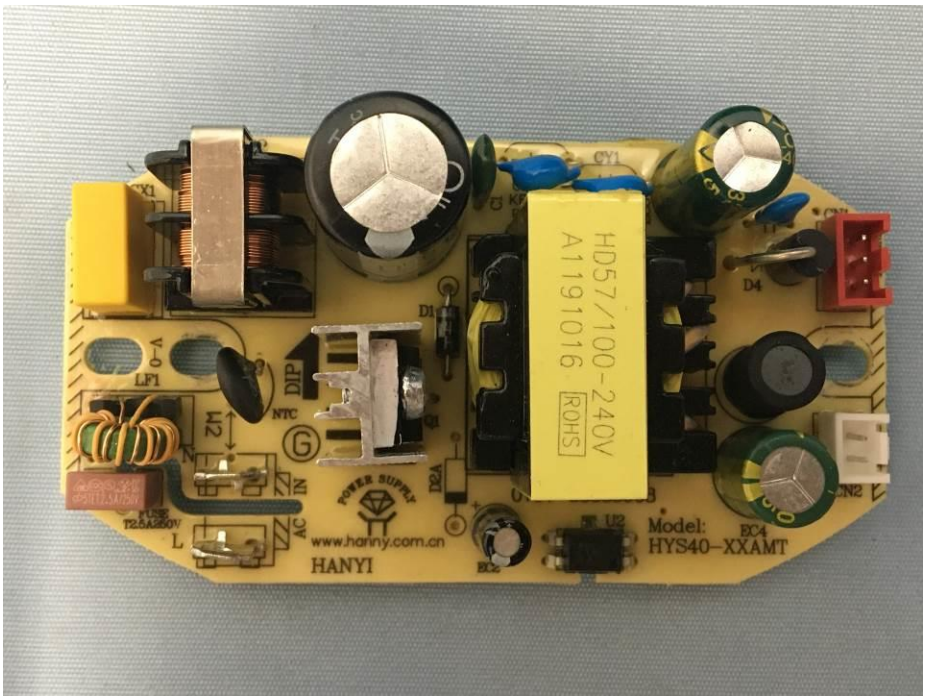
9.1 EUT - External View

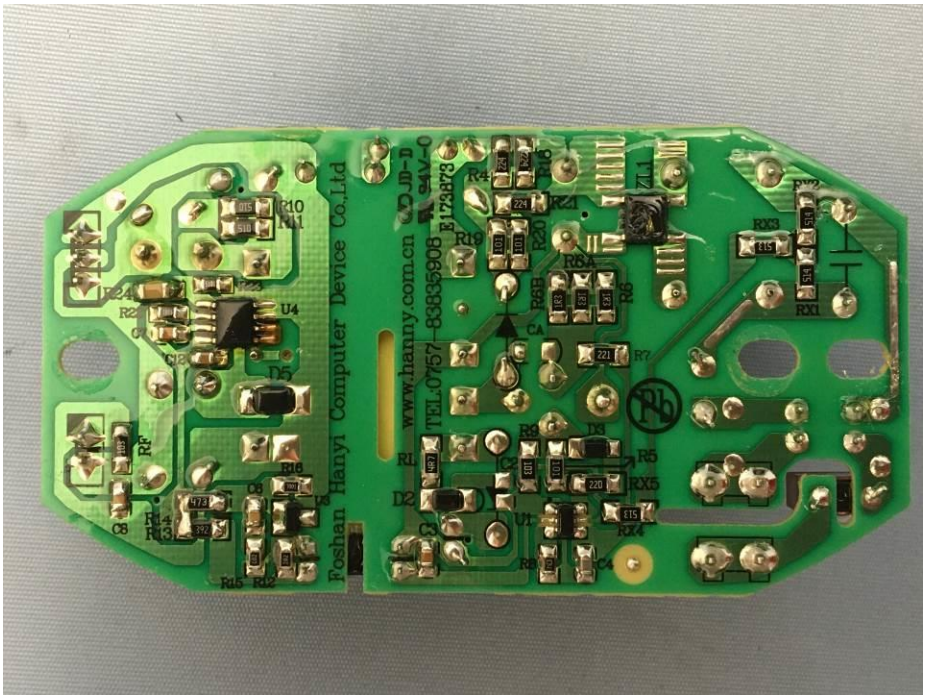


AIR
INNOVATIONS

9.2 EUT - Internal View



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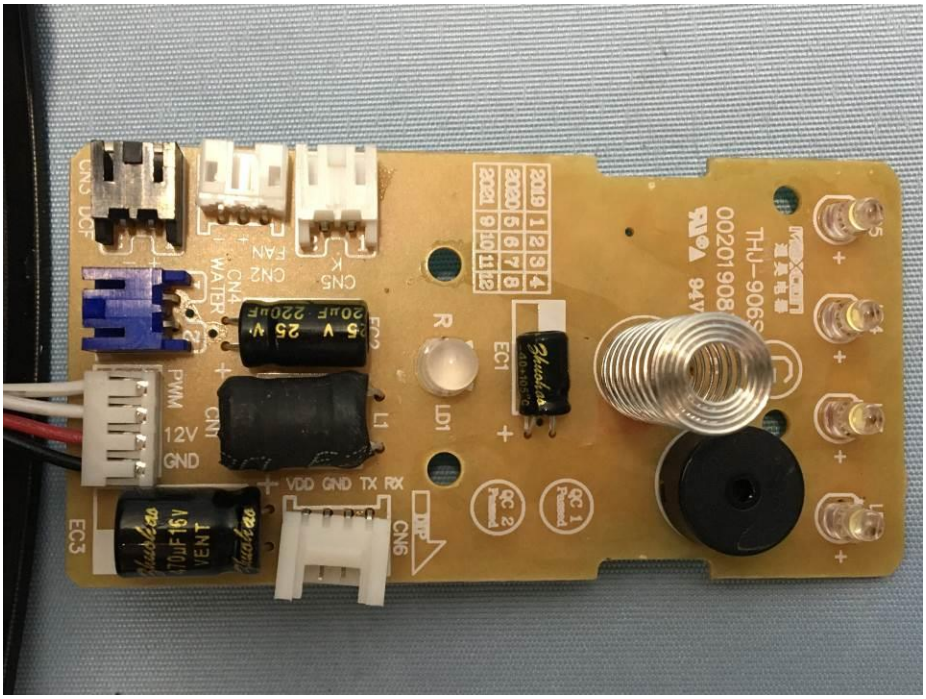
www.hanny.com.cn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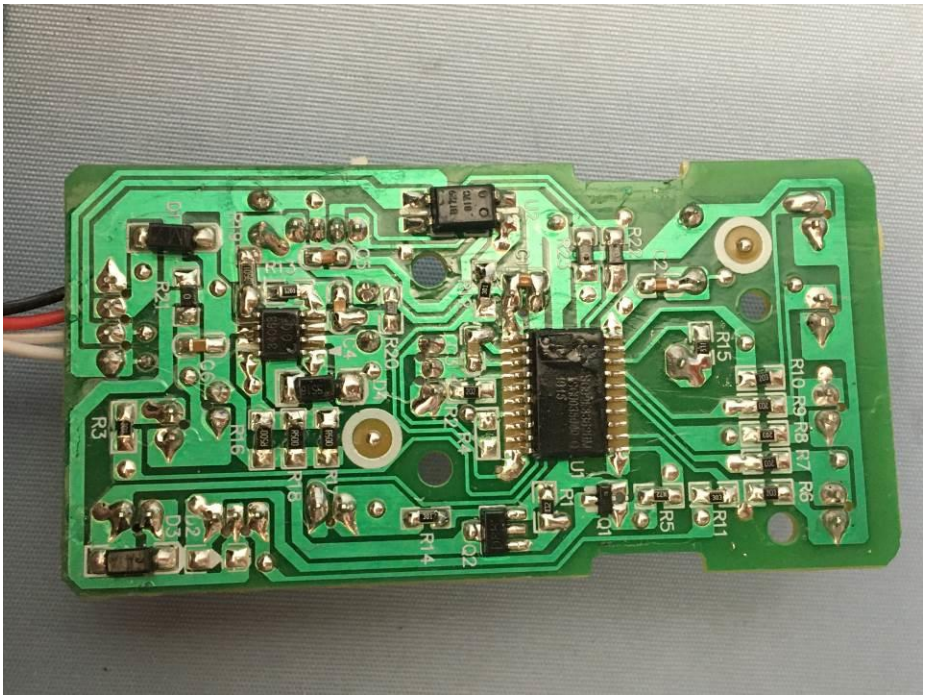
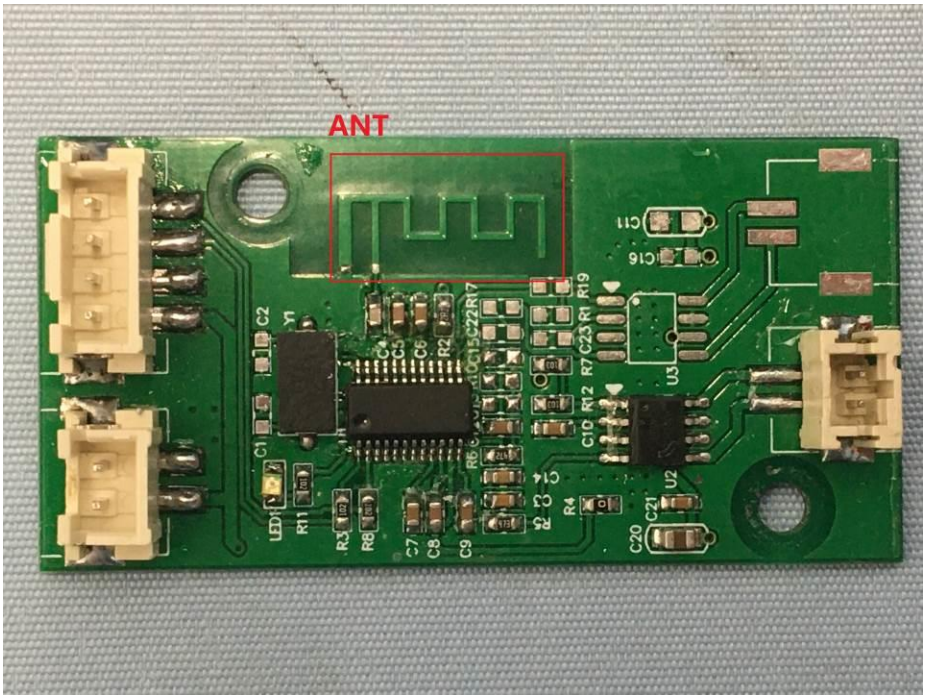
GND
VDD GND TX RX
EC1
EC3
LD1
CN6

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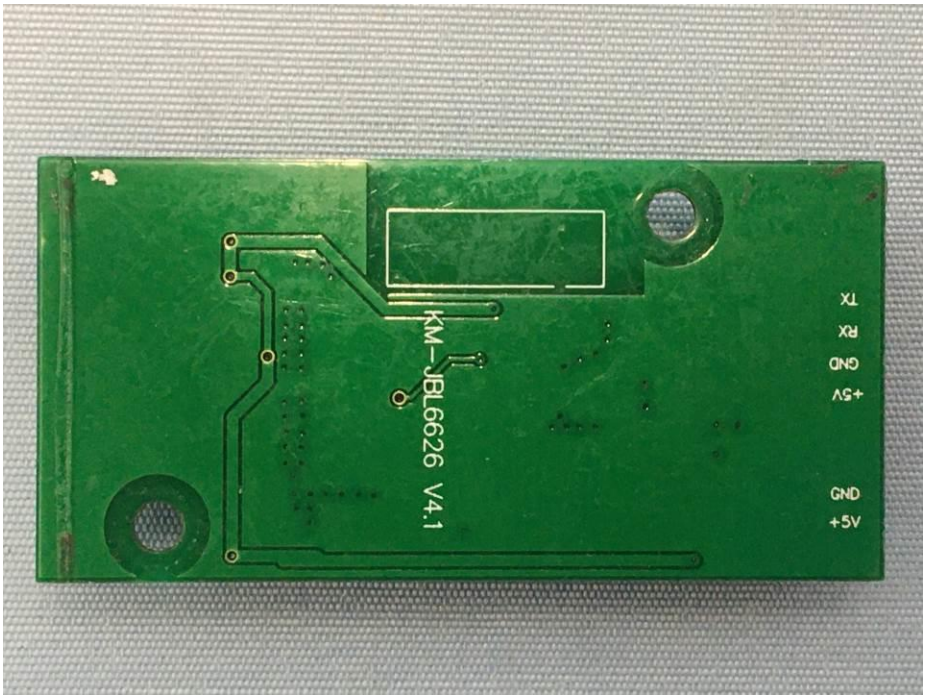
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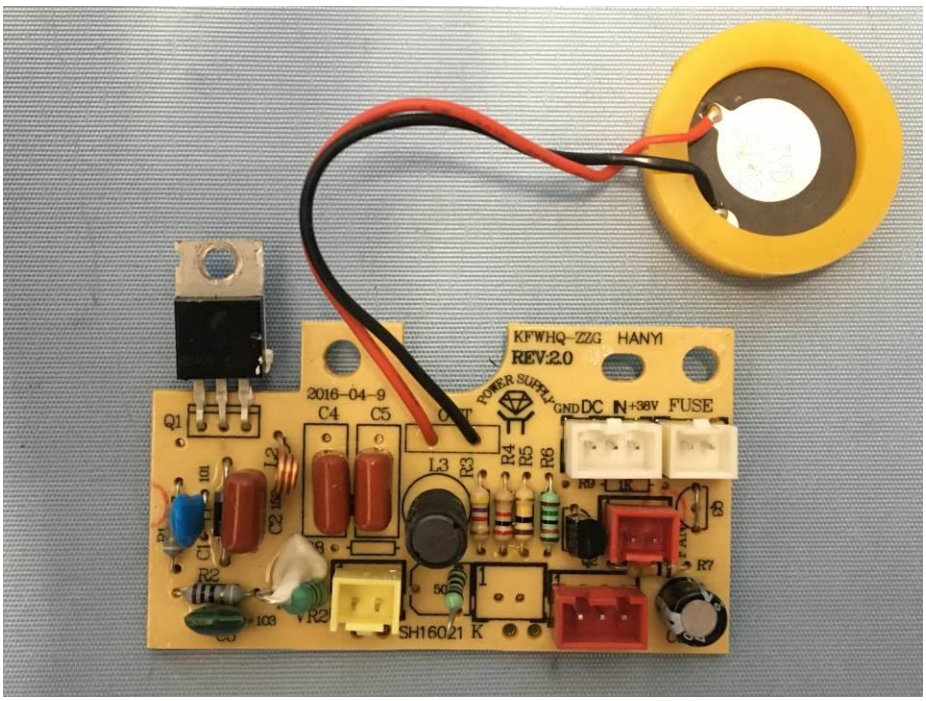
RX
GND
+5V
GND
+5V


KFWHQ-ZZG HANYI
REV:2.0
2016-04-9
C4
C5
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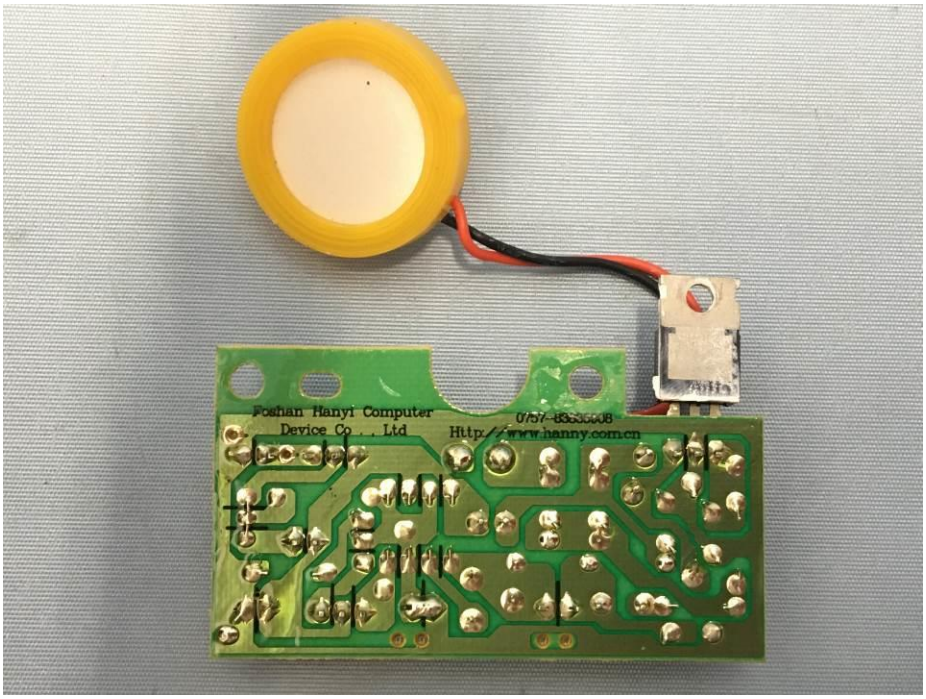
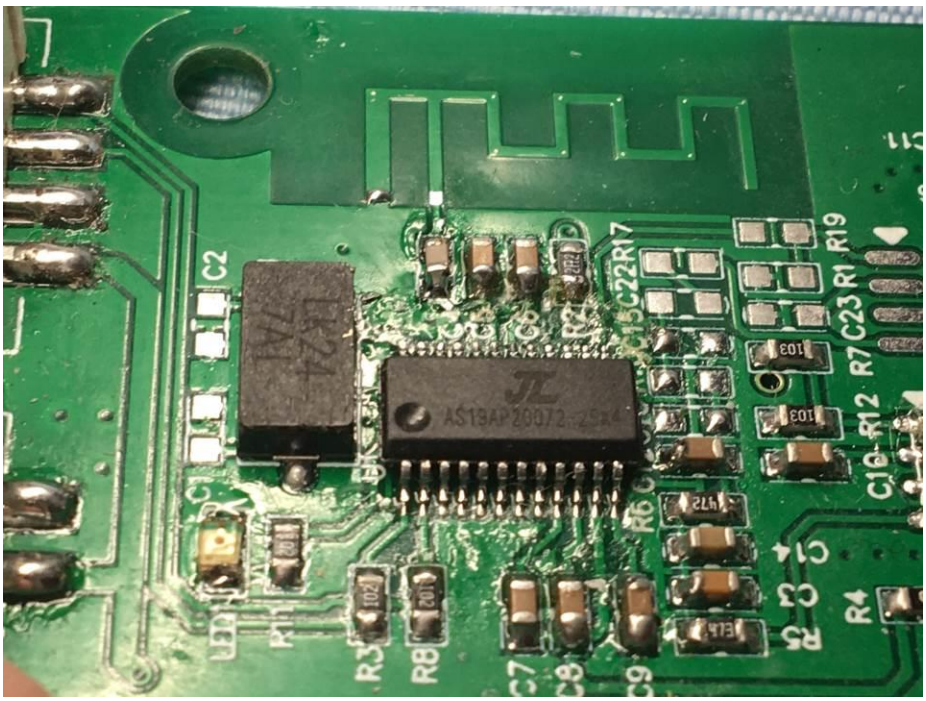
R7
R2
SH16021 K





======End of Report======