

FCC TEST REPORT

Product Name: Bluetooth speaker
Trade Mark: N/A
Model No.: CBT
Report Number: 170509014RFC-1
Test Standards: FCC 47 CFR Part 15 Subpart C
FCC ID: 2AMCB-CBT
Test Result: PASS
Date of Issue: June 20, 2017

Prepared for:

China World Connection (HK) Co., Ltd.
5/F B, Meijiamei Industrial Park, Zhangqi Rd, Daping, Guanlan,
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Date: June 20, 2017


Version

Version No.	Date	Description
V1.0	June 20, 2017	Original



CONTENTS

1. GENERAL INFORMATION	4
1.1 CLIENT INFORMATION	4
1.2 EUT INFORMATION	4
1.2.1 GENERAL DESCRIPTION OF EUT	4
1.2.2 DESCRIPTION OF ACCESSORIES	4
1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD	5
1.4 OTHER INFORMATION	5
1.5 DESCRIPTION OF SUPPORT UNITS	6
1.6 TEST LOCATION	6
1.7 TEST FACILITY	6
1.8 DEVIATION FROM STANDARDS	6
1.9 ABNORMALITIES FROM STANDARD CONDITIONS	6
1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER	6
1.11 MEASUREMENT UNCERTAINTY	6
2. TEST SUMMARY	8
3. EQUIPMENT LIST	9
4. TEST CONFIGURATION	10
4.1 ENVIRONMENTAL CONDITIONS FOR TESTING	10
4.1.1 NORMAL OR EXTREME TEST CONDITIONS	10
4.1.2 RECORD OF NORMAL ENVIRONMENT	10
4.2 TEST CHANNELS	10
4.3 EUT TEST STATUS	10
4.4 PRE-SCAN	11
4.4.1 PRE-SCAN UNDER ALL PACKETS AT MIDDLE CHANNEL	11
4.4.2 WORST-CASE DATA PACKETS	11
4.4.3 TESTED CHANNEL DETAIL	11
4.5 TEST SETUP	12
4.5.1 FOR RADIATED EMISSIONS TEST SETUP	12
4.5.2 FOR CONDUCTED EMISSIONS TEST SETUP	12
4.5.3 FOR CONDUCTED RF TEST SETUP	13
4.6 SYSTEM TEST CONFIGURATION	13
4.7 DUTY CYCLE	14
5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION	15
5.1 REFERENCE DOCUMENTS FOR TESTING	15
5.2 ANTENNA REQUIREMENT	15
5.3 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE	16
5.4 CONDUCTED PEAK OUTPUT POWER	17
5.5 20 dB BANDWIDTH	18
5.6 CARRIER FREQUENCIES SEPARATION	21
5.7 NUMBER OF HOPPING CHANNEL	24
5.8 DWELL TIME	26
5.9 CONDUCTED OUT OF BAND EMISSION	33
5.10 RADIATED SPURIOUS EMISSIONS	37
5.11 BAND EDGE MEASUREMENTS (RADIATED)	46
5.12 CONDUCTED EMISSION	48
APPENDIX 1 PHOTOGRAPHS OF TEST SETUP	51
APPENDIX 2 PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS	51

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	China World Connection (HK) Co., Ltd.
Address of Applicant:	5/F B, Meijiamei industrial Park, Zhangqi Rd, Daping, Guanlan, Longhua, Shenzhen, China
Manufacturer:	Shenzhen CWC Industrial Co., Ltd.
Address of Manufacturer:	5/F B, Meijiamei industrial Park, Zhangqi Rd, Daping, Guanlan, Longhua, Shenzhen, China

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	Bluetooth speaker	
Model No.:	CBT	
Add. Model No.:	CBT-XXX ("X" can be 0-9, A-Z, or blank for custom code)	
Trade Mark:	N/A	
DUT Stage:	Identical Prototype	
EUT Supports Function:	2.4 GHz ISM Band:	Bluetooth: V4.2
Software Version:	085	
Hardware Version:	1.3	
Sample Received Date:	May 10, 2017	
Sample Tested Date:	May 10, 2017 to June 16, 2017	
Note: ALL models are the same except for decorative enclosure.		

1.2.2 Description of Accessories

Battery	
Trade Mark:	N/A
Model No.:	801525-230mAh
Battery Type:	Lithium-ion Polymer Rechargeable Battery
Rated Voltage:	3.7 Vdc
Limited Charge Voltage:	4.2 Vdc
Rated Capacity:	230 mAh
Manufacturer:	Shenzhen Theurgy Technology Co., Ltd

Cable(1)	
Trade Mark:	N/A
Model No.:	N/A
Description:	USB Changing Cable
Cable Type:	Unshielded without ferrite
Length:	0.54 Meter

Cable(2)	
Trade Mark:	N/A
Model No.:	N/A
Description:	AUX Cable
Cable Type:	Unshielded without ferrite
Length:	0.53 Meter

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Range:	2400 MHz to 2483.5 MHz
Bluetooth Version:	Bluetooth V4.2
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Type of Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Number of Channels:	79
Channel Separation:	1 MHz
Hopping Channel Type:	Adaptive Frequency Hopping Systems
Antenna Type:	Integral Antenna
Antenna Gain:	1.2 dBi
Maximum Peak Power:	-1.51 dBm
Normal Test Voltage:	3.7 Vdc

1.4 OTHER INFORMATION

Operation Frequency Each of Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402 MHz	20	2422 MHz	40	2442 MHz	60	2462 MHz
1	2403 MHz	21	2423 MHz	41	2443 MHz	61	2463 MHz
2	2404 MHz	22	2424 MHz	42	2444 MHz	62	2464 MHz
3	2405 MHz	23	2425 MHz	43	2445 MHz	63	2465 MHz
4	2406 MHz	24	2426 MHz	44	2446 MHz	64	2466 MHz
5	2407 MHz	25	2427 MHz	45	2447 MHz	65	2467 MHz
6	2408 MHz	26	2428 MHz	46	2448 MHz	66	2468 MHz
7	2409 MHz	27	2429 MHz	47	2449 MHz	67	2469 MHz
8	2410 MHz	28	2430 MHz	48	2450 MHz	68	2470 MHz
9	2411 MHz	29	2431 MHz	49	2451 MHz	69	2471 MHz
10	2412 MHz	30	2432 MHz	50	2452 MHz	70	2472 MHz
11	2413 MHz	31	2433 MHz	51	2453 MHz	71	2473 MHz
12	2414 MHz	32	2434 MHz	52	2454 MHz	72	2474 MHz
13	2415 MHz	33	2435 MHz	53	2455 MHz	73	2475 MHz
14	2416 MHz	34	2436 MHz	54	2456 MHz	74	2476 MHz
15	2417 MHz	35	2437 MHz	55	2457 MHz	75	2477 MHz
16	2418 MHz	36	2438 MHz	56	2458 MHz	76	2478 MHz
17	2419 MHz	37	2439 MHz	57	2459 MHz	77	2479 MHz
18	2420 MHz	38	2440 MHz	58	2460 MHz	78	2480 MHz
19	2421 MHz	39	2441 MHz	59	2461 MHz	N/A	

Modulation Configure			
Modulation	Packet	Packet Type	Packet Size
GFSK	1-DH1	4	27
	1-DH3	11	183
	1-DH5	15	339
$\pi/4$ DQPSK	2-DH1	20	54
	2-DH3	26	367
	2-DH5	30	679
8DPSK	3-DH1	24	83

	3-DH3	27	552
	3-DH5	31	1021

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	Lenovo	E450	SL10G10780	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.30 Meter	UnionTrust

1.6 TEST LOCATION

All tests were sub-contracted.

Compliance Certification Services (Shenzhen) Inc.

Address: No.10-1 Mingkeda Logistics Park, No.18 Huanguan South RD. Guan lan Town, Baoan Distr, Shenzhen, Guangdong, China.

Telephone: +86 (0) 755 28055000 Fax: +86 (0) 755 29055221

1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

Compliance Certification Services (Shenzhen) Inc.

FCC Registration Number is 441872.

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-30MHz	± 3.6836 dB

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China

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[Http://www.uttlab.com](http://www.uttlab.com)

2	Radiated emission 30MHz-200MHz	± 3.6880 dB
3	Radiated emission 200MHz-1000MHz	± 3.6695 dB
4	Radiated emission 1GHz-8GHz	± 5.1782 dB
5	Radiated emission 8GHz-18GHz	± 5.2173 dB



2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	Test Requirement	Test Method	Result
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)	ANSI C63.10-2013	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)	ANSI C63.10-2013	PASS
20 dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Carrier Frequencies Separation	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Number of Hopping Channel	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)	ANSI C63.10-2013	PASS
Dwell Time	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Pseudorandom Frequency Hopping Sequence	FCC 47 CFR Part 15 Subpart C Section 15.247(a)(1)(g)(h)	ANSI C63.10-2013	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d)	ANSI C63.10-2013	PASS
Radiated Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Band Edge Measurement	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Note: 1) N/A: In this whole report not application. 2) This EUT is charged from USB port to the battery.			

3. EQUIPMENT LIST

Radiated Emission Test Equipment List 966(2)						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	PSA Series Spectrum Analyzer	Agilent	E4446A	US44300399	Feb. 17, 2017	Feb. 16, 2018
☒	High Noise Amplifier	Agilent	8449B	3008A01838	Feb. 11, 2017	Feb. 10, 2018
☒	Bilog Antenna	SCHAFFNER	CBL6143	5082	Feb. 12, 2017	Feb. 11, 2018
☒	Horn Antenna	SCHWARZBEC K	BBHA9120	D286	Feb. 12, 2017	Feb. 11, 2018
☒	Board-Band Horn Antenna	Schwarzbeck	BBHA 9170	9170-497	Feb. 11, 2017	Feb. 10, 2018
☒	Turn Table	N/A	N/A	N/A	N.C.R	N.C.R
☒	Controller	Sunol Sciences	SC104V	022310-1	N.C.R	N.C.R
☒	Controller	CT	N/A	N/A	N.C.R	N.C.R
☒	Antenna Tower	SUNOL	TLT2	N/A	N.C.R	N.C.R
☒	Temp. / Humidity Meter	Anymetre	JR913	N/A	Feb. 15, 2017	Feb. 14, 2018
☒	RF Cable	REBES	N/A	N/A	N.C.R	N.C.R
☒	RF Cable	REBES	N/A	N/A	N.C.R	N.C.R
☒	Test S/W	FARAD	LZ-RF / CCS-SZ-3A2			

Conducted Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	EMI TEST RECEIVER	ROHDE&SCHW ARZ	ESCI	100783	Feb. 11, 2017	Feb. 10, 2018
☒	LISN(EUT)	ROHDE&SCHW ARZ	ENV216	101543-WX	Feb. 11, 2017	Feb. 10, 2018
☒	LISN	EMCO	3825/2	8901-1459	Feb. 12, 2017	Feb. 11, 2018
☒	RF Cable	REBES	N/A	N/A	N.C.R	N.C.R
☒	Temp. / Humidity Meter	VICTOR	HTC-1	N/A	Feb. 15, 2017	Feb. 14, 2018
☒	Test S/W	FARAD	EZ-EMC/ CCS-3A1-CE			

Conducted RF test						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	PSA Series Spectrum Analyzer	Agilent	E4446A	US44300399	Feb. 17, 2017	Feb. 16, 2018
☒	Power Meter	Anritsu	ML2495A	1204003	Feb. 21, 2017	Feb. 20, 2018
☒	Power Sensor	Anritsu	MA2411B	1126150	Feb. 21, 2017	Feb. 20, 2018

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage (V)	Relative Humidity (%)
NT/NV	+15 to +35	3.7	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment

Test Item	Temperature (°C)	Relative Humidity (%)	Pressure (Kpa)	Tested by
AC Power Line Conducted Emission	26	51	101.0	Tiny You
Conducted Peak Output Power	23	53	101.2	Tiny You
20 dB Bandwidth	23	53	101.2	Tiny You
Carrier Frequencies Separation	23	53	101.2	Tiny You
Number of Hopping Channel	23	53	101.2	Tiny You
Dwell Time	23	53	101.2	Tiny You
Pseudorandom Frequency Hopping Sequence	23	53	101.2	Tiny You
Conducted Out of Band Emission	23	53	101.2	Tiny You
Radiated Emissions	23	53	101.2	Tiny You
Band Edge Measurement	23	53	101.2	Tiny You

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
GFSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz
$\pi/4$ DQPSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz
8DPSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz

4.3 EUT TEST STATUS

Type of Modulation	Tx/Rx Function	Description
GFSK/ $\pi/4$ DQPSK/ 8DPSK	1Tx/1Rx	1. Keep the EUT in continuously transmitting with Modulation test single 2. Keep the EUT in continuously transmitting with Modulation test Hopping Frequency.

4.4 PRE-SCAN

4.4.1 Pre-scan under all packets at middle channel

Conducted Average Power (dBm) for packets									
Type of Modulation	GFSK			$\pi/4$ DQPSK			8DPSK		
Packets	1-DH1	1-DH3	1-DH5	2-DH1	2-DH3	2-DH5	3-DH1	3-DH3	3-DH5
Power (dBm)	-4.56	-4.62	-4.78	-2.81	-2.83	-2.87	-2.81	-2.86	-2.91

4.4.2 Worst-case data packets

Type of Modulation	Worst-case data rates
GFSK	1-DH1
$\pi/4$ DQPSK	2-DH1
8DPSK	3-DH1

4.4.3 Tested channel detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data packets and antenna ports (if EUT with antenna diversity architecture). Following channel(s) was (were) selected for the final test as listed below.

Type of Modulation	GFSK			$\pi/4$ DQPSK			8DPSK		
Data Packets	1-DH1	1-DH3	1-DH5	2-DH1	2-DH3	2-DH5	3-DH1	3-DH3	3-DH5
Available Channel	0 to 78								
Test Item	Test channel and choose of data packets								
AC Power Line Conducted Emission	Frequency Hopping Channel 0 to 78								
	Link								
Conducted Peak Output Power	Channel 0 & 39 & 78								
	☒	☐	☐	☒	☐	☐	☒	☐	☐
20 dB Bandwidth	Channel 0 & 39 & 78								
	☐	☐	☒	☐	☐	☒	☐	☐	☒
Carrier Frequencies Separation	Frequency Hopping Channel 0 to 78								
	☒	☐	☐	☒	☐	☐	☒	☐	☐
Number of Hopping Channel	Frequency Hopping Channel 0 to 78								
	☒	☐	☐	☐	☐	☐	☒	☐	☐
Dwell Time	Channel 0 & 39 & 78								
	☒	☒	☒	☐	☐	☐	☒	☒	☒
Pseudorandom Frequency Hopping Sequence	Frequency Hopping Channel 0 to 78								
	☒	☐	☐	☐	☐	☐	☒	☐	☐
Conducted Out of Band Emission	Channel 0 & 39 & 78								
	☒	☐	☐	☐	☐	☐	☒	☐	☐
Radiated Emissions	Channel 0 & 39 & 78								
	☒	☐	☐	☐	☐	☐	☐	☐	☐
Band Edge Measurements (Radiated)	Channel 0 & 78								
	☒	☐	☐	☐	☐	☐	☐	☐	☐
Remark:									
1. The mark " ☒ " means is chosen for testing;									
2. The mark " ☐ " means is not chosen for testing.									

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

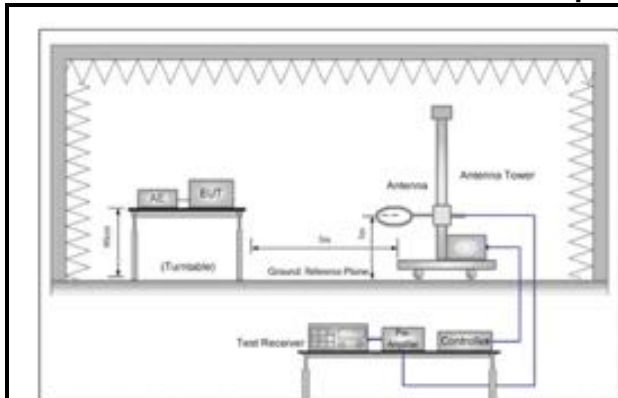


Figure 1. Below 30MHz

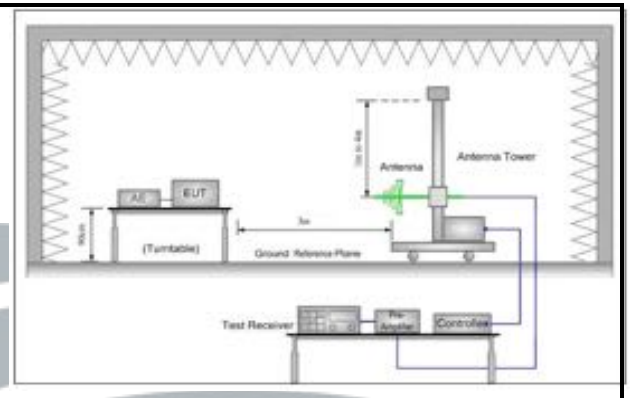


Figure 2. 30MHz to 1GHz

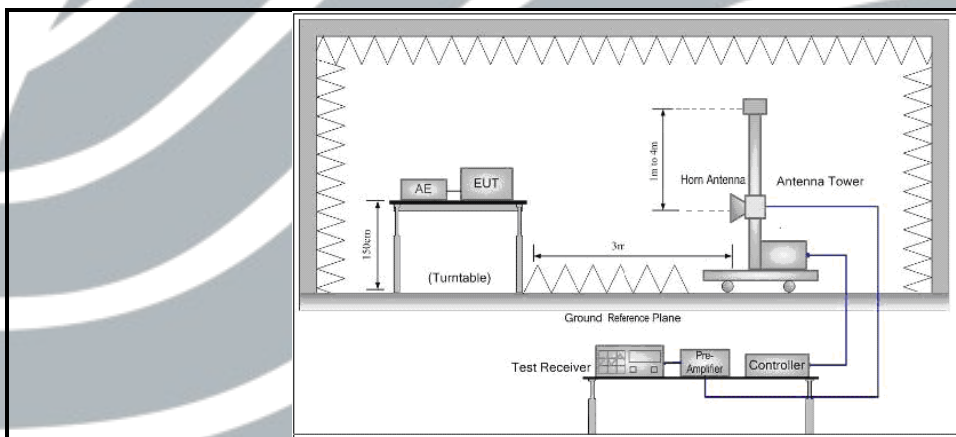
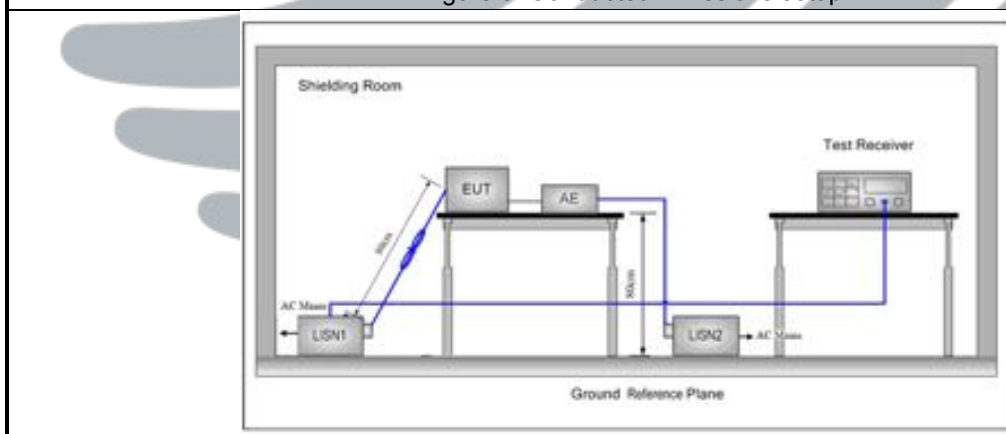


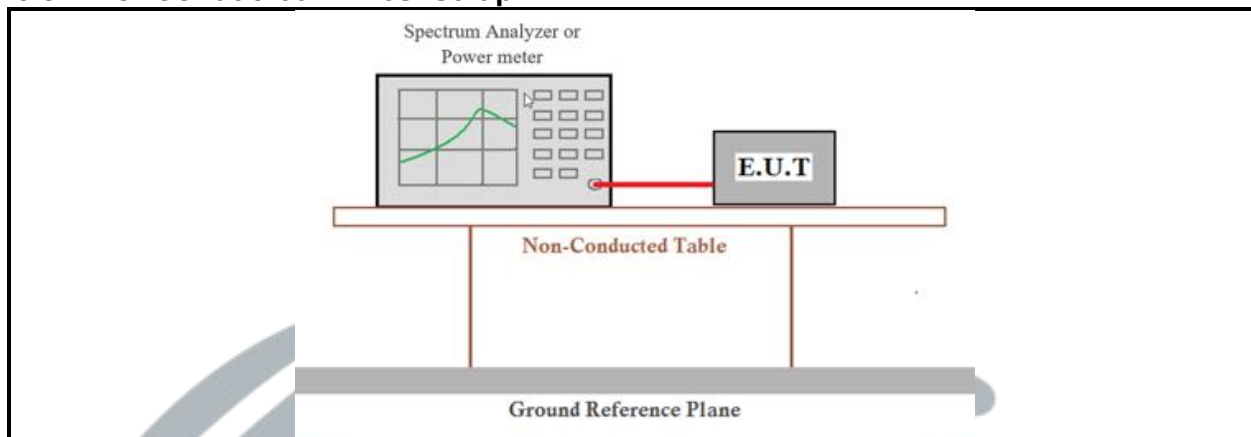
Figure 3. Above 1GHz

4.5.2 For Conducted Emissions test setup

Figure 3. Conducted Emissions setup



4.5.3 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by a 3.7Vdc rechargeable Li-on battery. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency	Mode	Antenna Port	Worst-case axis positioning
Above 1GHz	1TX	Chain 0	X axis

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

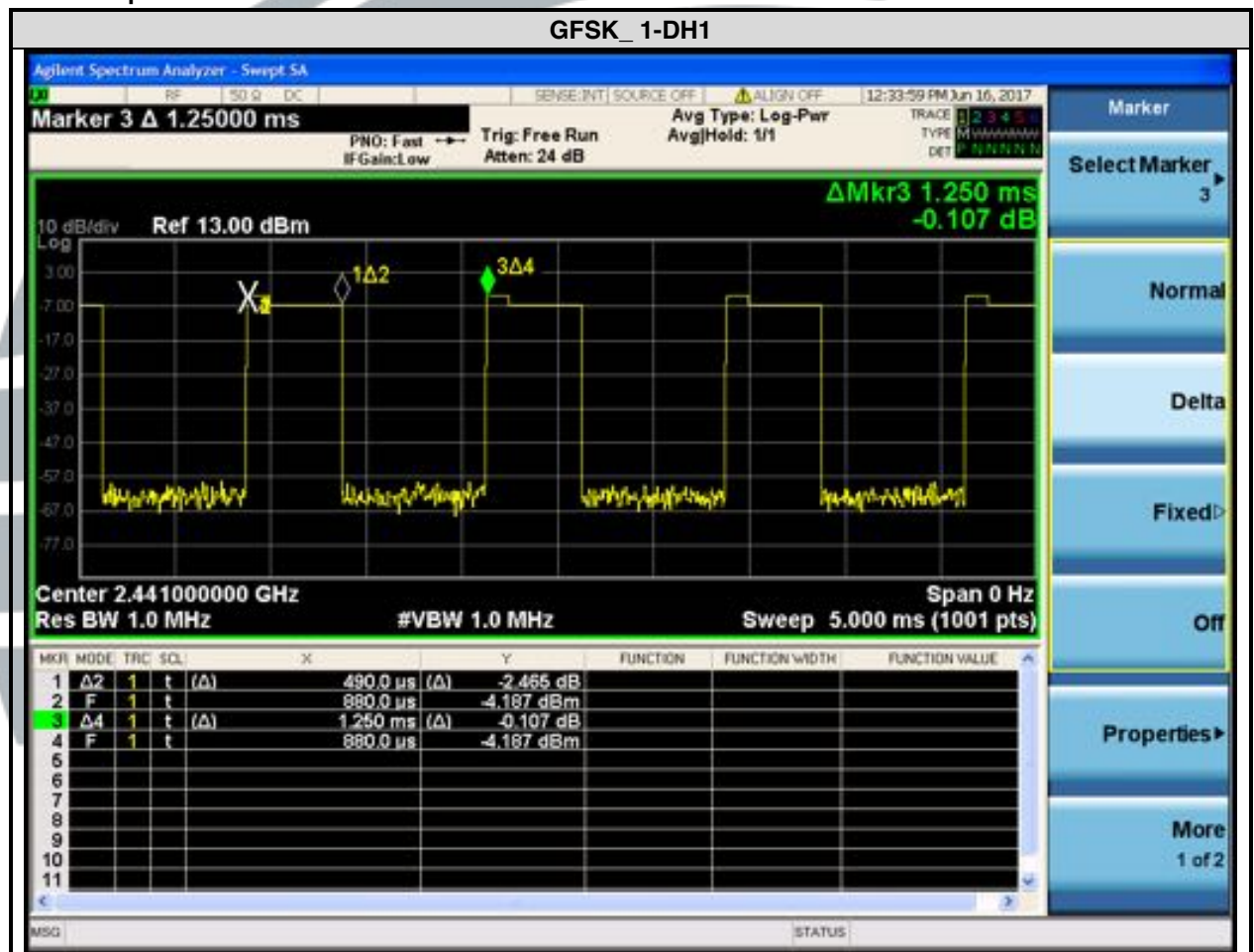
4.7 DUTY CYCLE

Type of Modulation	Packets	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
GFSK	1-DH1	0.49	1.25	0.39	39.20	4.07	2.04	-8.13

Remark:

- 1) Duty cycle= On Time/ Period;
- 2) Duty Cycle factor = $10 * \log(1/ \text{Duty cycle})$;
- 3) Average factor = $20 \log_{10} \text{Duty Cycle}$.

The test plot as follows



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: 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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. EUT Antenna: Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is 1.2 dBi.

5.3 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(b)(g)(h)

Test Method: ANSI C63.10-2013

Frequency Hopping System:

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

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

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

EUT Pseudorandom Frequency Hopping Sequence:

Pseudorandom Frequency Hopping Sequence Table as below:

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

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

5.4 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)

Test Method: ANSI C63.10-2013

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

Test Procedure: a) Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
b) Measure out each test modes' peak or average output power, record the power level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Type of Modulation	Peak Output Power (dBm)			Peak Output Power (mW)		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
GFSK	-3.54	-3.93	-4.21	0.44	0.40	0.38
$\pi/4$ DQPSK	-1.53	-1.87	-2.13	0.70	0.65	0.61
8DPSK	-1.51	-1.85	-2.12	0.71	0.65	0.61

Note: The antenna gain of 1.2 dBi less than 6dBi maximum permission antenna gain value based on 1 watt peak output power limit.

5.520 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: ANSI C63.10-2013

Limit: None; for reporting purposes only.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

- a) Span = approximately 2 to 5 times the OBW, centered on a hopping channel
- b) RBW = 1% to 5% of the OBW
- c) VBW = approximately 3 times RBW
- d) Sweep = auto;
- e) Detector function = peak
- f) Trace = max hold
- g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Type of Modulation	20 dB Bandwidth (MHz)			99% Bandwidth (MHz)		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
GFSK	1.048	1.061	1.065	0.99278	0.99170	0.98786
$\pi/4$ DQPSK	1.082	1.101	1.109	1.0931	1.0956	1.0943
8DPSK	1.095	1.099	1.108	1.0743	1.0677	1.0663

The test plots as follows:



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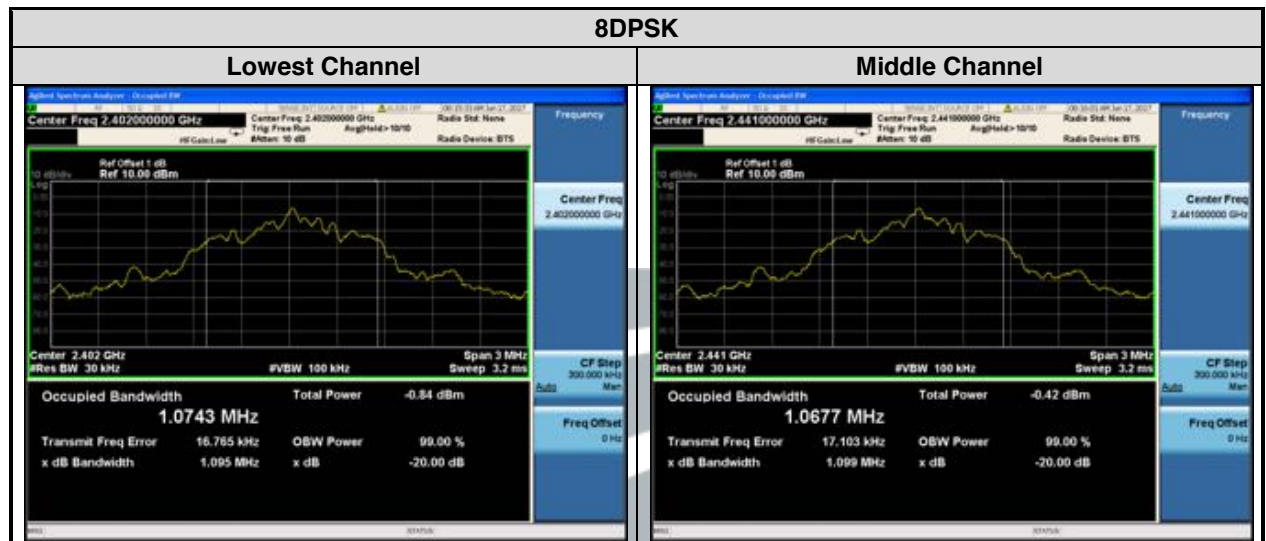
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5.6 CARRIER FREQUENCIES SEPARATION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: ANSI C63.10-2013

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

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

- Set span = wide enough to capture the peaks of two adjacent channels
- 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
- Video (or Average) Bandwidth (VBW) $\geq$ RBW
- Sweep = auto;
- Detector function = peak;
- Trace = max hold
- Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

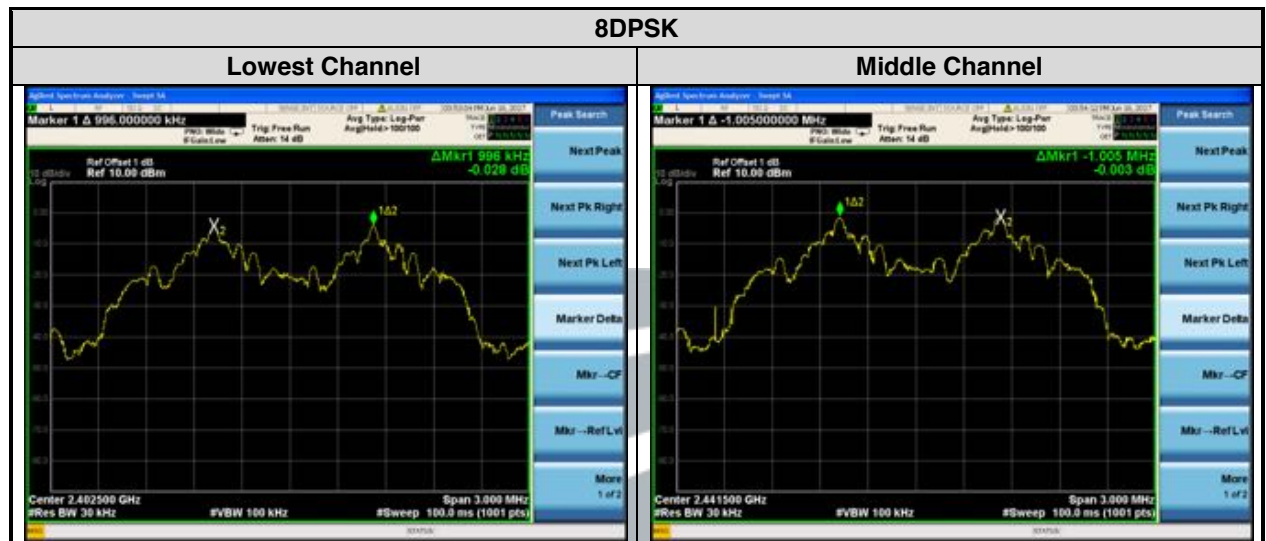
Test Results: Pass

Test Data:

Type of Modulation	Adjacent Channel Separation (MHz)			Minimum Limit (MHz)		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
GFSK	1.005	1.002	1.032	0.699	0.707	0.734
$\pi/4$ DQPSK	1.002	1.002	1.002	0.721	0.710	0.739
8DPSK	0.996	1.005	0.996	0.730	0.733	0.739
Note: The minimum limit is two-third 20 dB bandwidth.						

The test plots as follows:





5.7 NUMBER OF HOPPING CHANNEL

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(b)(1)

Test Method: ANSI C63.10-2013

Limit: Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

- a) Span = the frequency band of operation
- 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 $\geq$ RBW
- d) Sweep = auto
- e) Detector function = peak
- f) Trace mode = max hold
- g) Allow the trace to stabilize, observed the band of 2400MHz to 2483.5MHz, than count it out the number of channels for comparing with the FCC rules.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

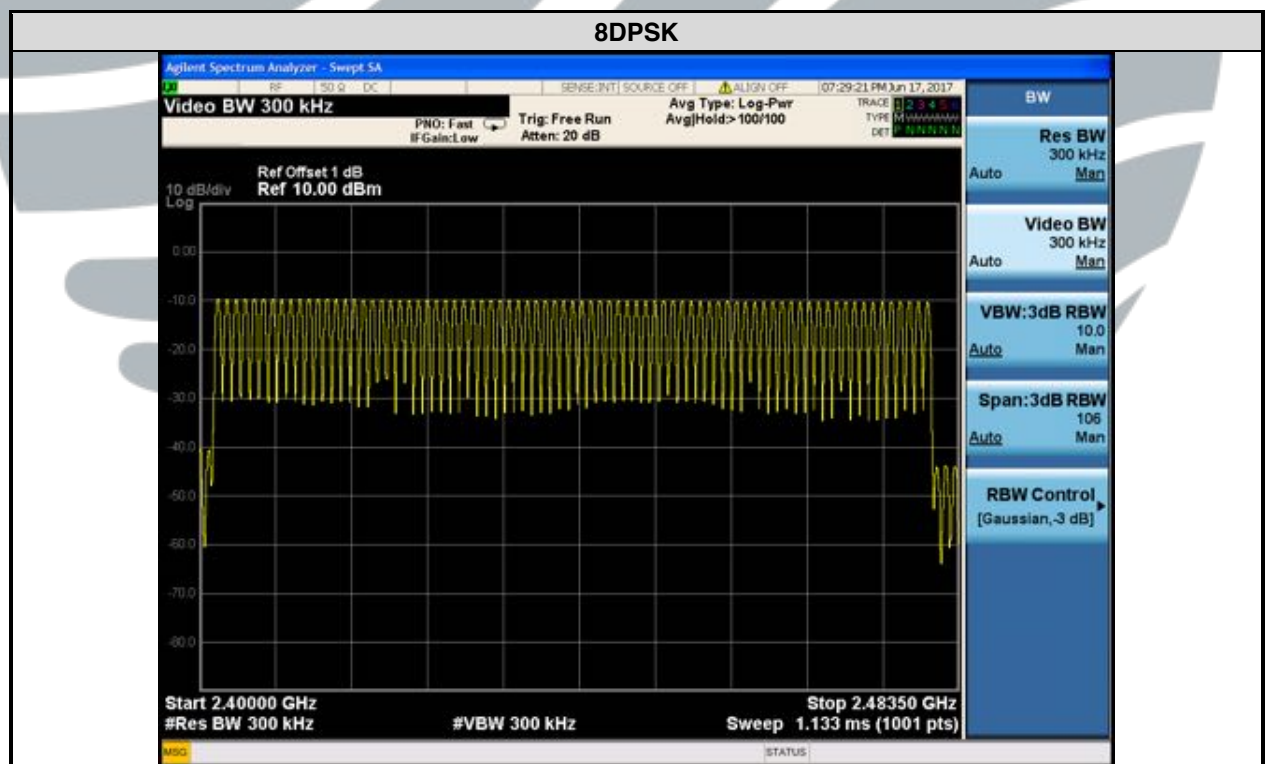
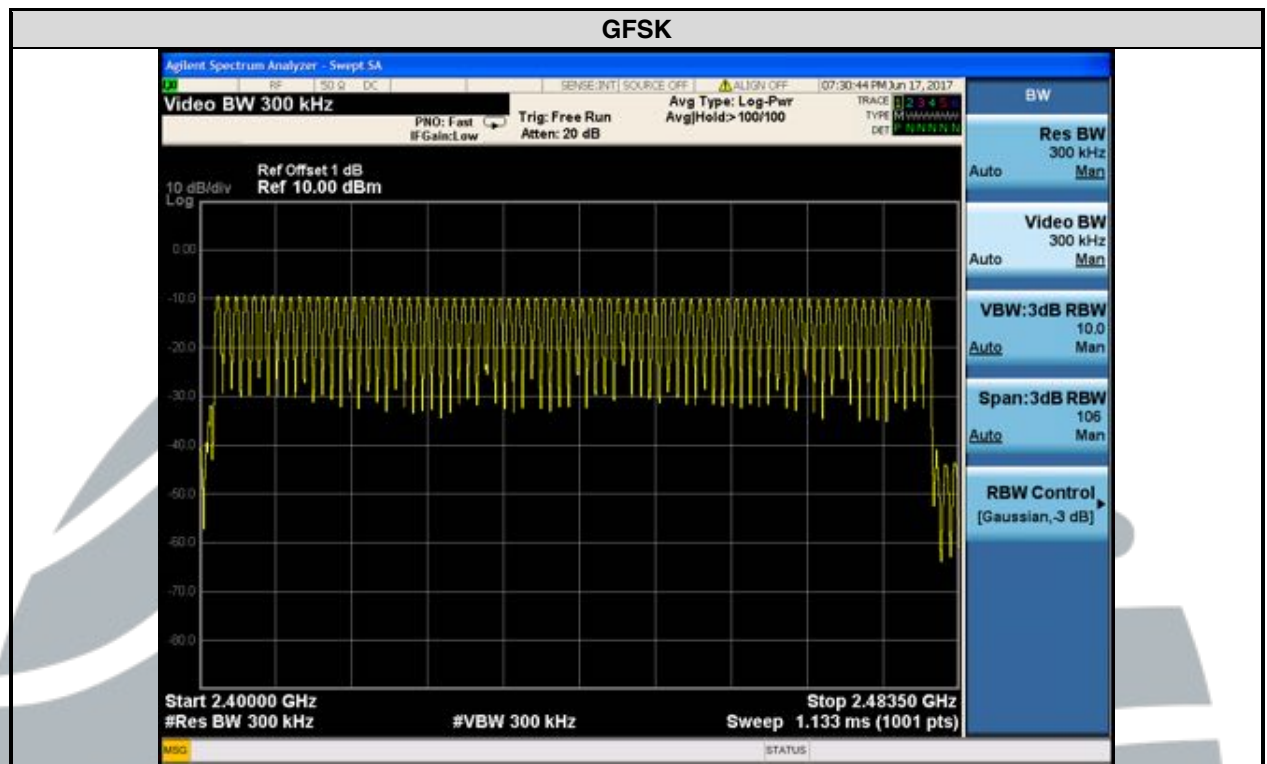
Test Mode: Hopping Frequencies Transmitter mode

Test Results: Pass

Test Data:

Type of Modulation	Number of Hopping Channel
GFSK	79
8DPSK	79

The test plots as follows:



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5.8 DWELL TIME

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(a)(1)

Test Method: ANSI C63.10-2013

Limit: 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.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

- Span = zero span, centered on a hopping channel
- RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1/T$, where T is the expected dwell time per channel.
- VBW $\geq$ RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold
- Use the marker-delta function to determine the dwell time

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

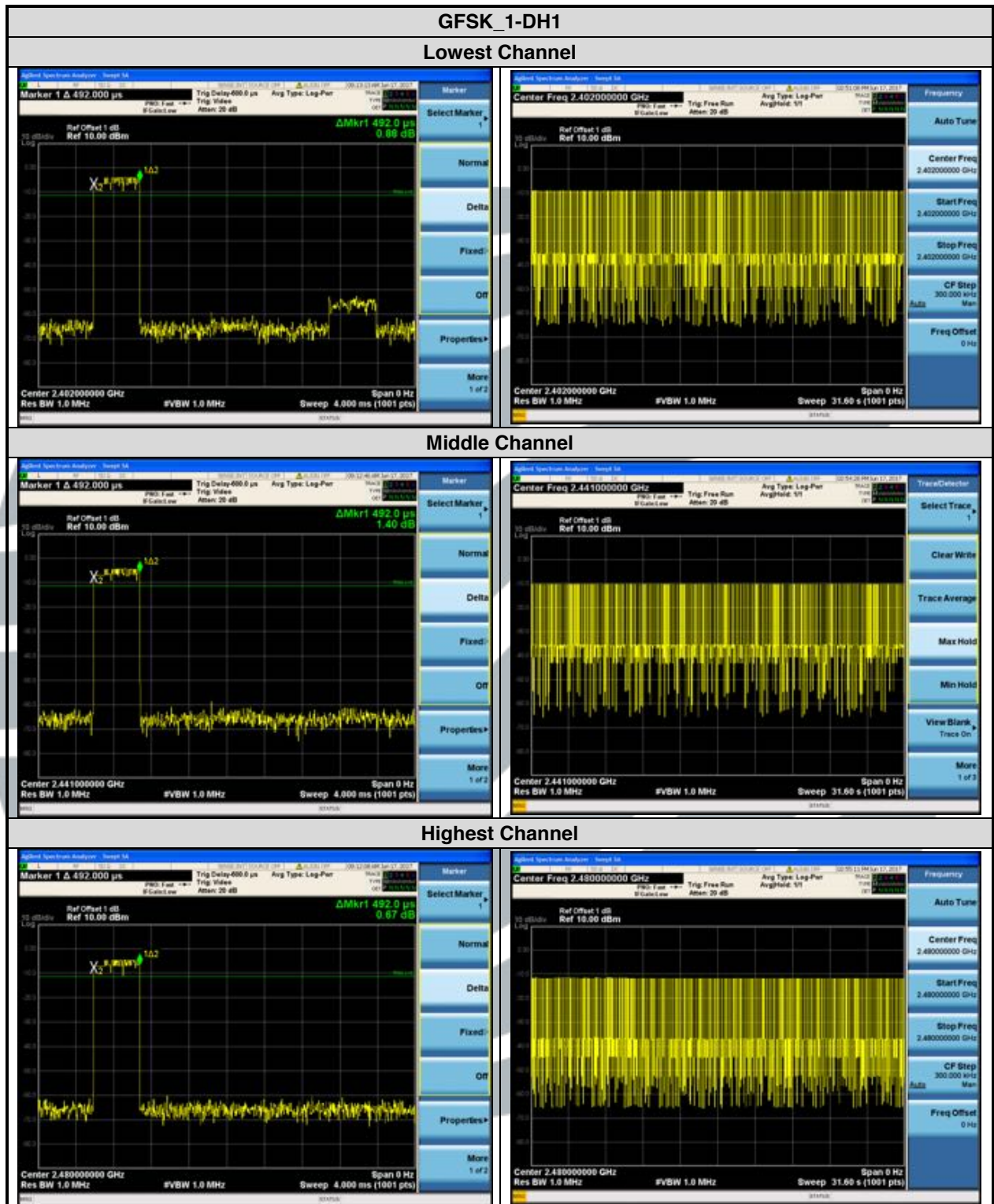
Test Mode: Hopping Frequencies Transmitter mode

Test Results: Pass

Test Data:

Type of Modulation	Test Frequency	Packet	Time Slot Length	Dwell Time	Limit
			ms	ms	ms
GFSK	2402MHz	1-DH1	0.492	157.44	< 400
		1-DH3	1.748	279.68	< 400
		1-DH5	2.996	323.57	< 400
	2441MHz	1-DH1	0.492	157.44	< 400
		1-DH3	1.748	279.68	< 400
		1-DH5	2.996	319.57	< 400
	2480MHz	1-DH1	0.492	157.44	< 400
		1-DH3	1.748	279.68	< 400
		1-DH5	2.996	299.60	< 400
8DPSK	2402MHz	3-DH1	0.500	160.00	< 400
		3-DH3	1.752	280.32	< 400
		3-DH5	3.004	375.50	< 400
	2441MHz	3-DH1	0.504	161.28	< 400
		3-DH3	1.752	280.32	< 400
		3-DH5	3.004	372.50	< 400
	2480MHz	3-DH1	0.504	161.28	< 400
		3-DH3	1.756	280.96	< 400
		3-DH5	3.004	369.49	< 400

The test plots as follows:



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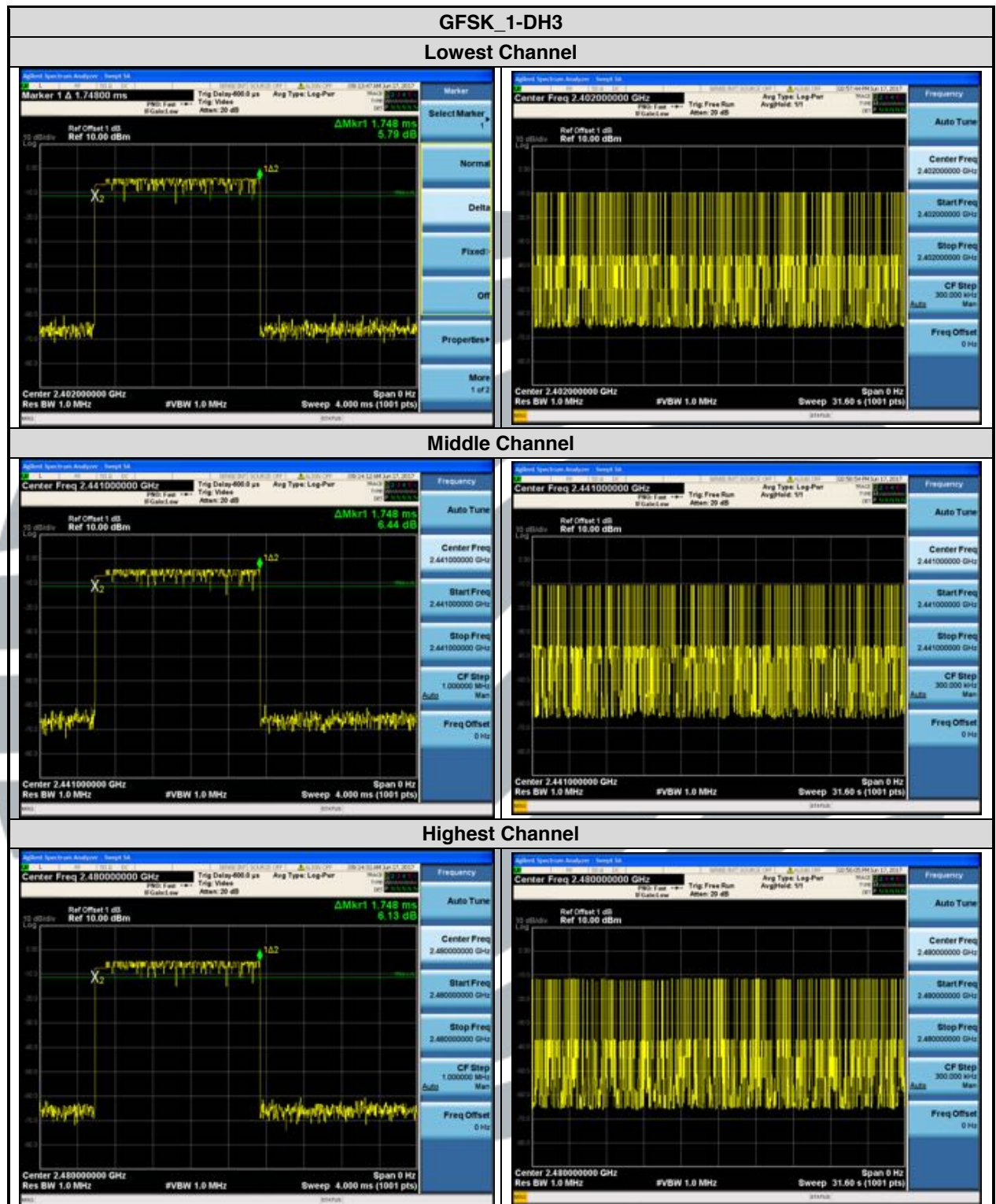
Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China

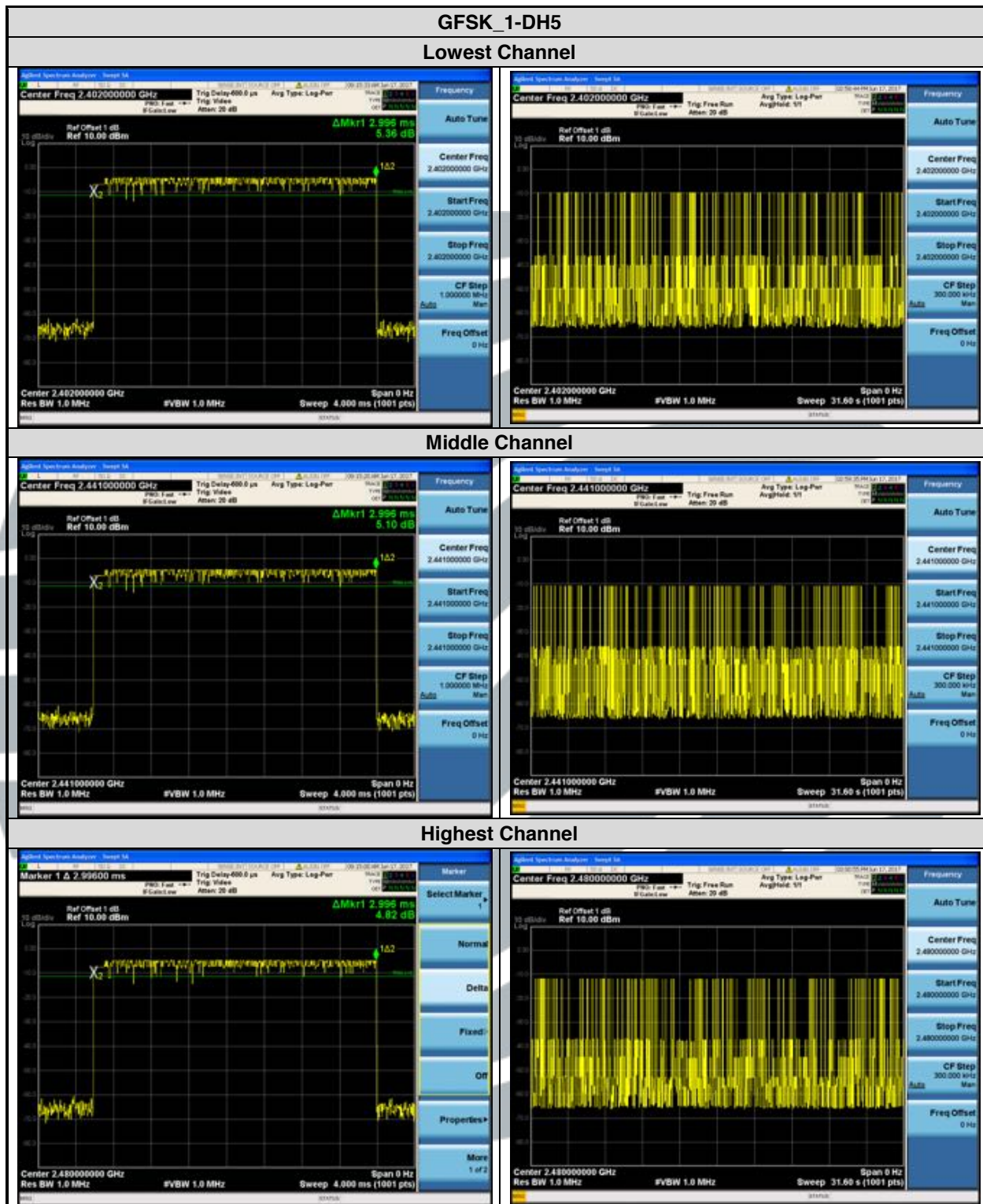
Tel: +86-755-28230888

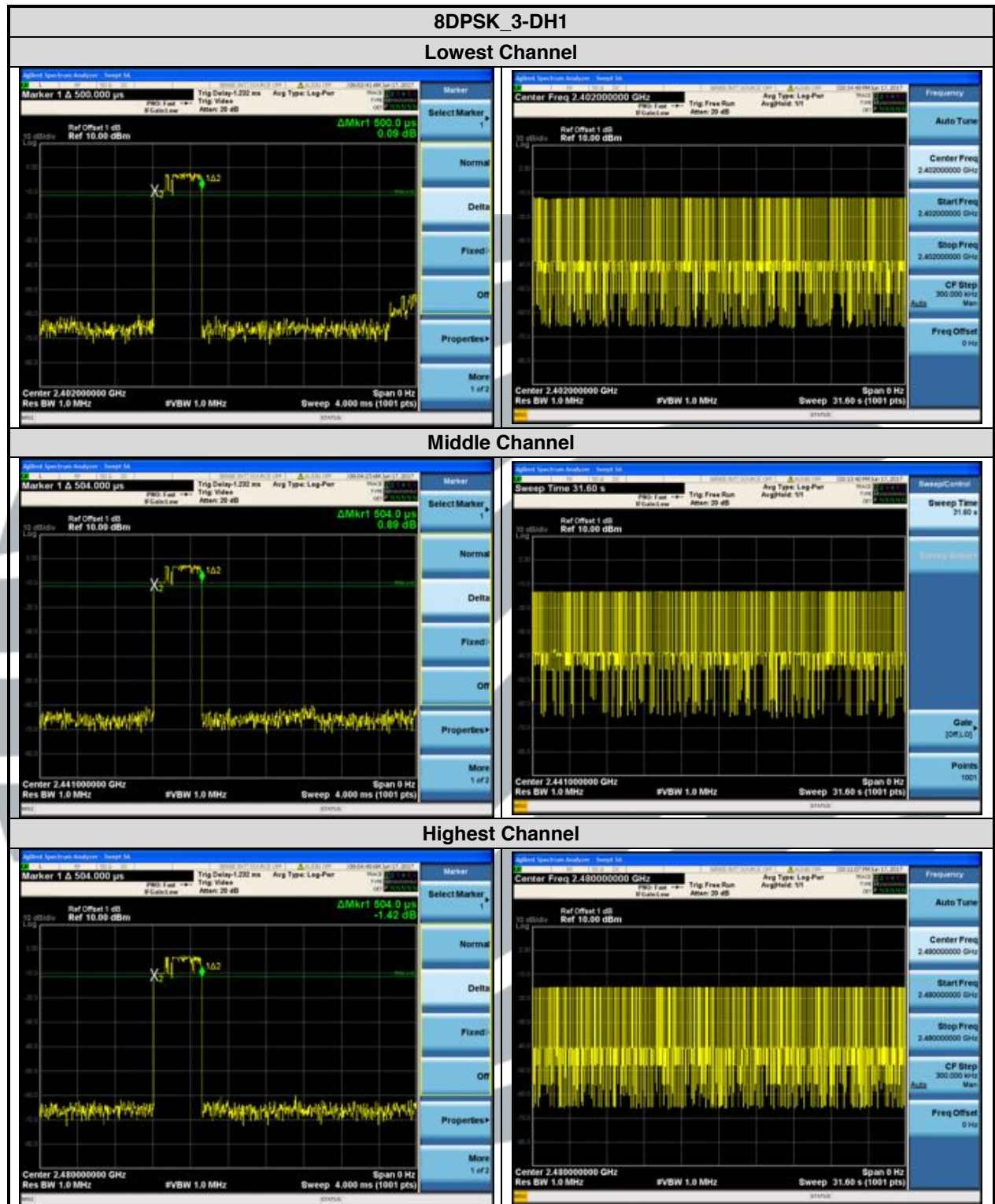
Fax: +86-755-28230886

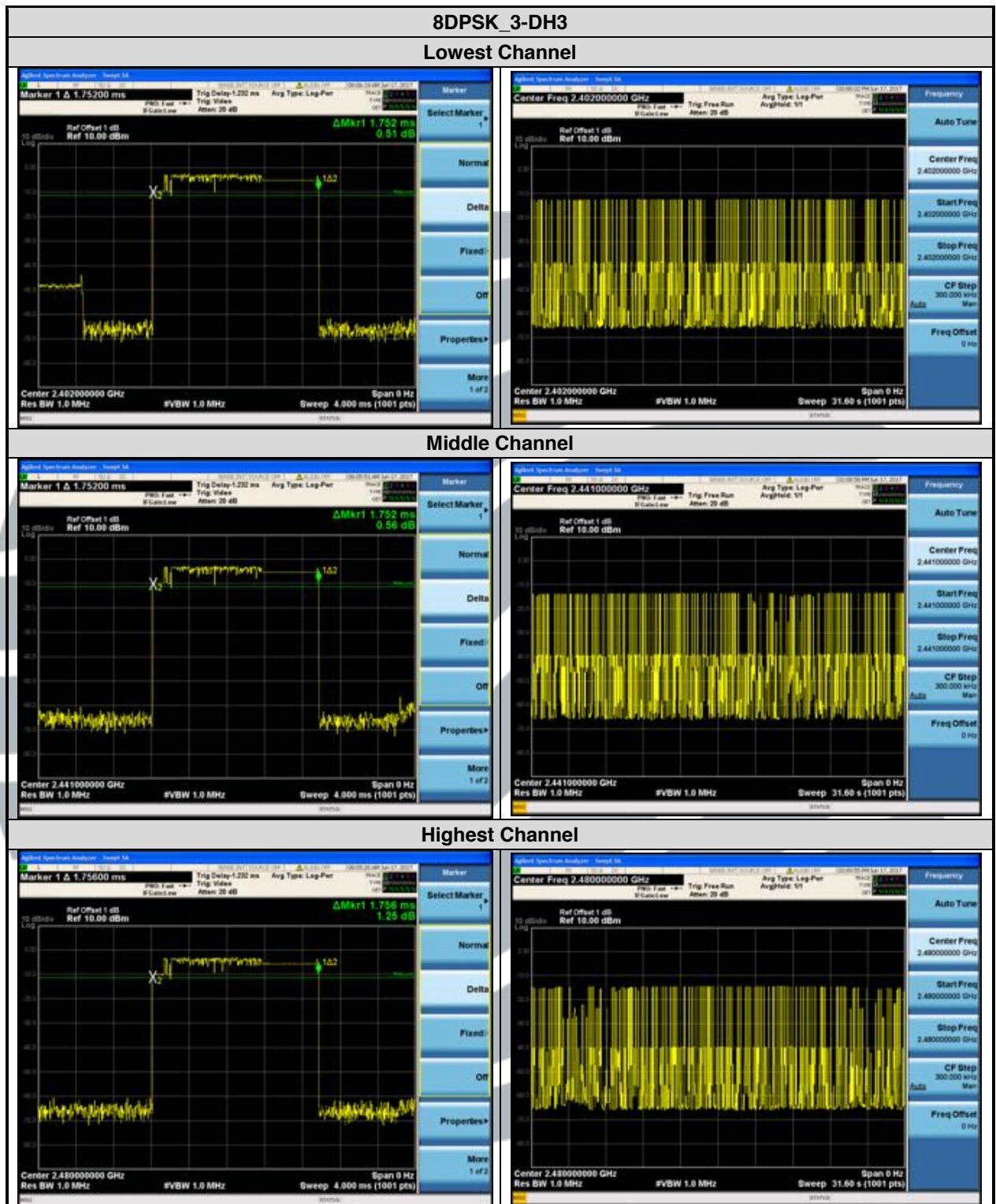
E-mail: info@uttlab.com

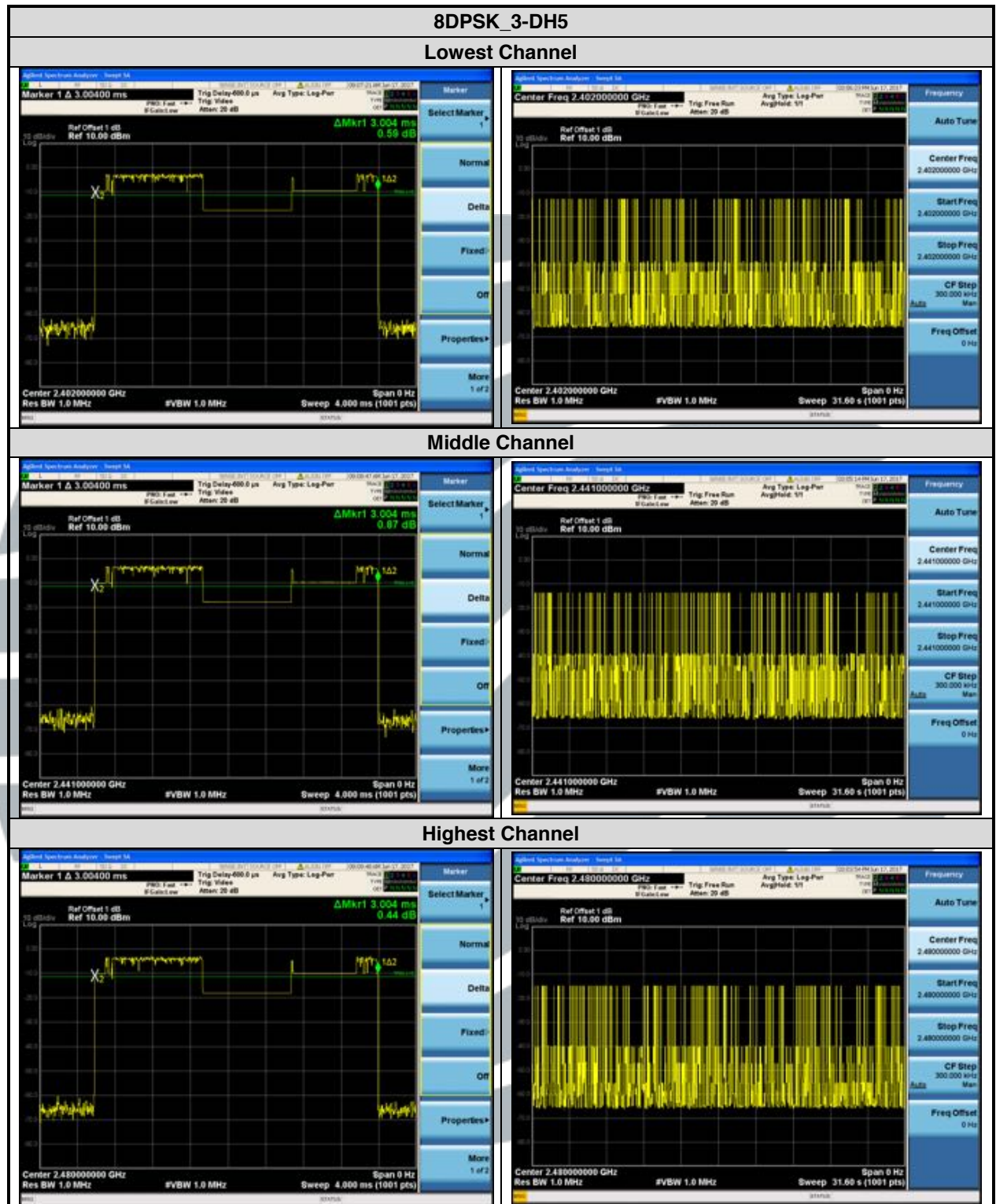
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5.9 CONDUCTED OUT OF BAND EMISSION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(d)

Test Method: ANSI C63.10-2013

Limit: In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

- Suitable frequency span
- RBW = 100 KHz
- VBW = 300 KHz
- Sweep = Coupled
- Detector function = peak
- Trace = max hold
- The band edges was measured and recorded.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

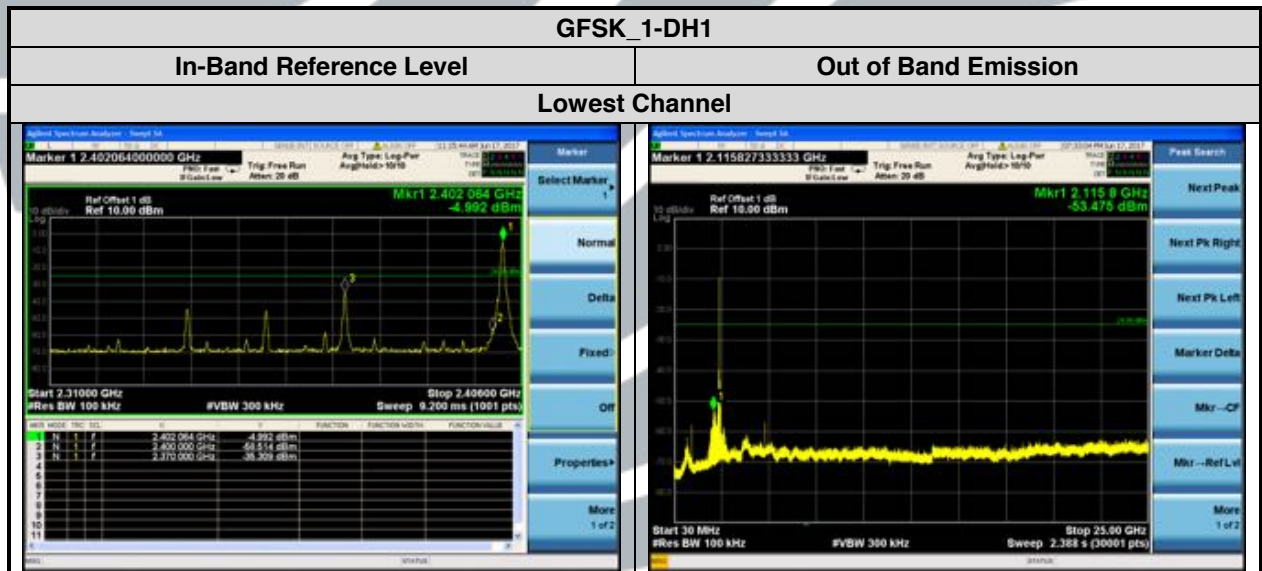
Instruments Used: Refer to section 3 for details

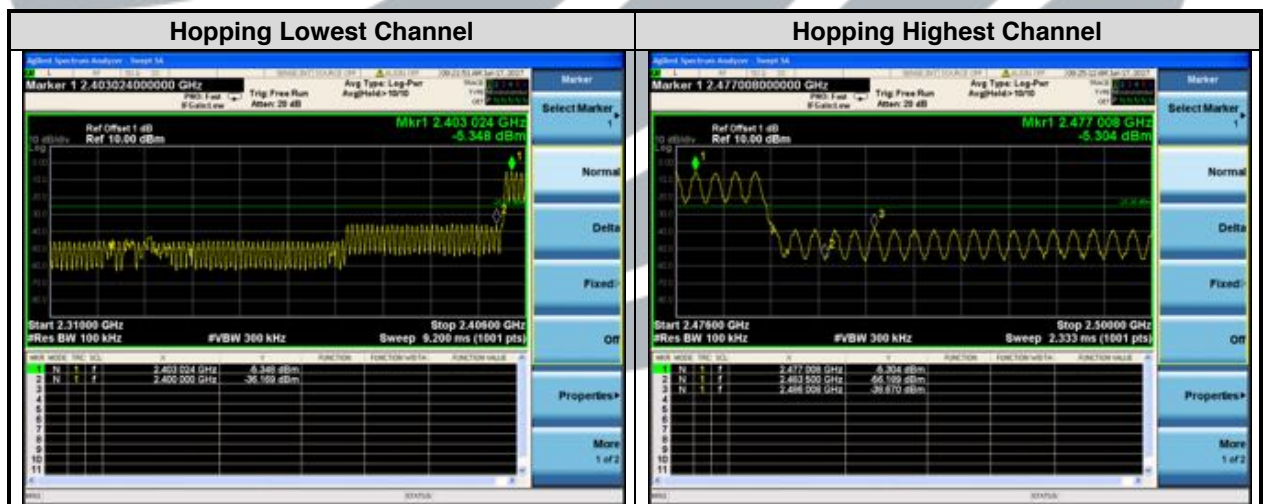
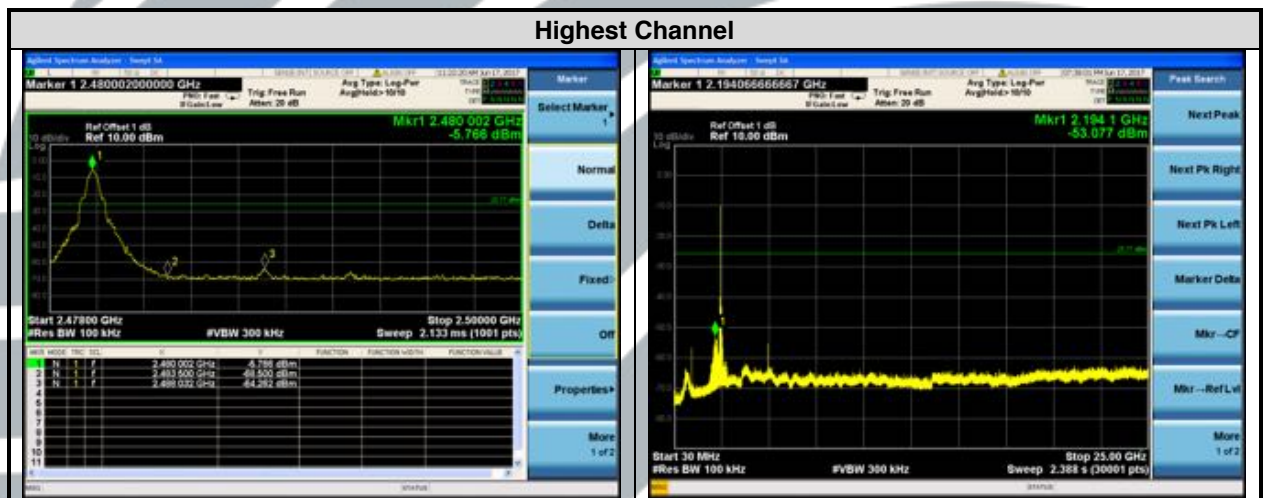
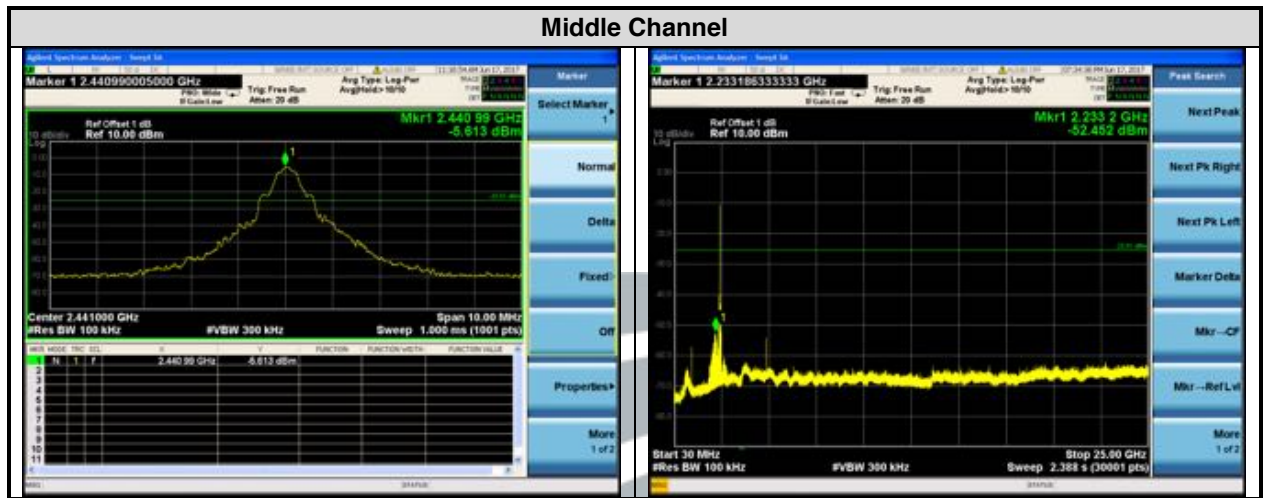
Test Mode: Hopping Frequencies Transmitter mode

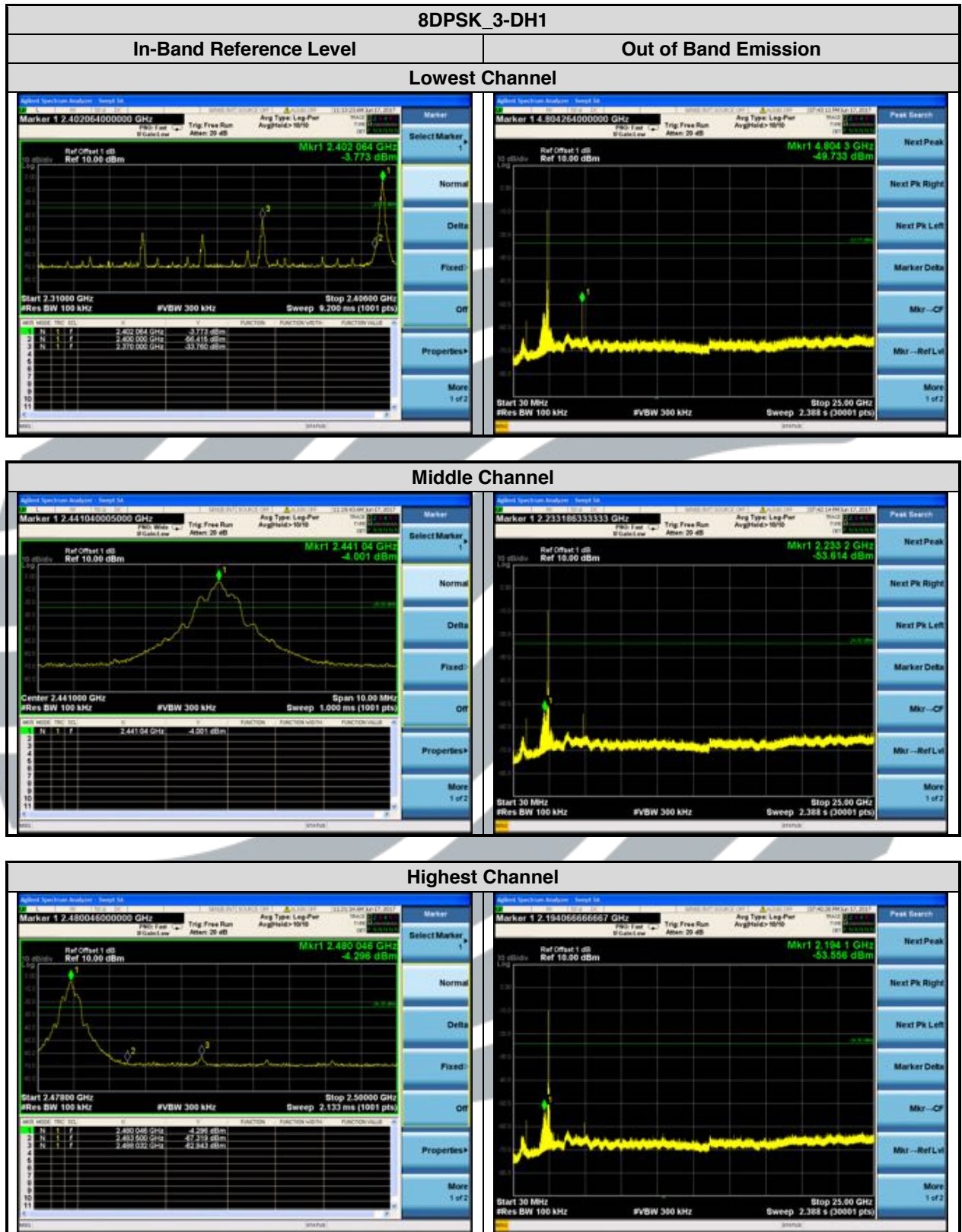
Test Results: Pass

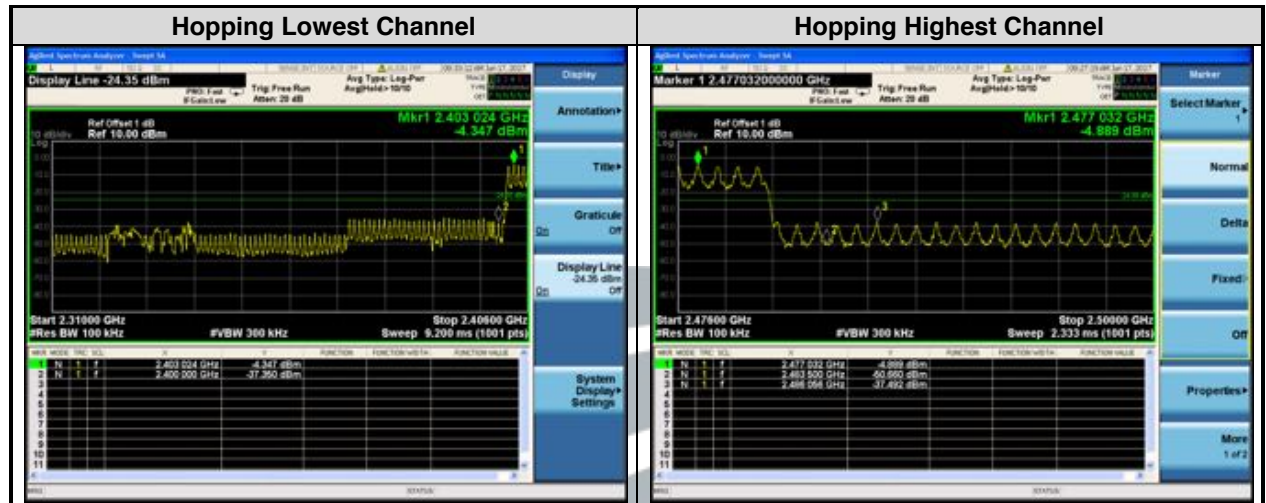
Test Data:

The test plots as follows:









5.10 RADIATED SPURIOUS EMISSIONS

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: ANSI C63.10-2013

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009 MHz-0.090 MHz	Peak	10 kHz	30 KHz	Peak
0.009 MHz-0.090 MHz	Average	10 kHz	30 KHz	Average
0.090 MHz-0.110 MHz	Quasi-peak	10 kHz	30 KHz	Quasi-peak
0.110 MHz-0.490 MHz	Peak	10 kHz	30 KHz	Peak
0.110 MHz-0.490 MHz	Average	10 kHz	30 KHz	Average
0.490 MHz -30 MHz	Quasi-peak	10 kHz	30 kHz	Quasi-peak
30 MHz-1 GHz	Quasi-peak	100 kHz	300 KHz	Quasi-peak
Above 1 GHz	Peak	1 MHz	3 MHz	Peak
	Peak	1 MHz	10 Hz	Average

Limits:

Spurious Emissions

Frequency	Field strength (microvolt/meter)	Limit (dB μ V/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Remark:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

1. From 30 MHz to 1GHz test procedure as below:
 - 1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
 - 2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
 - 3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
 - 4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
 - 5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

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- 6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2. Above 1GHz test procedure as below:

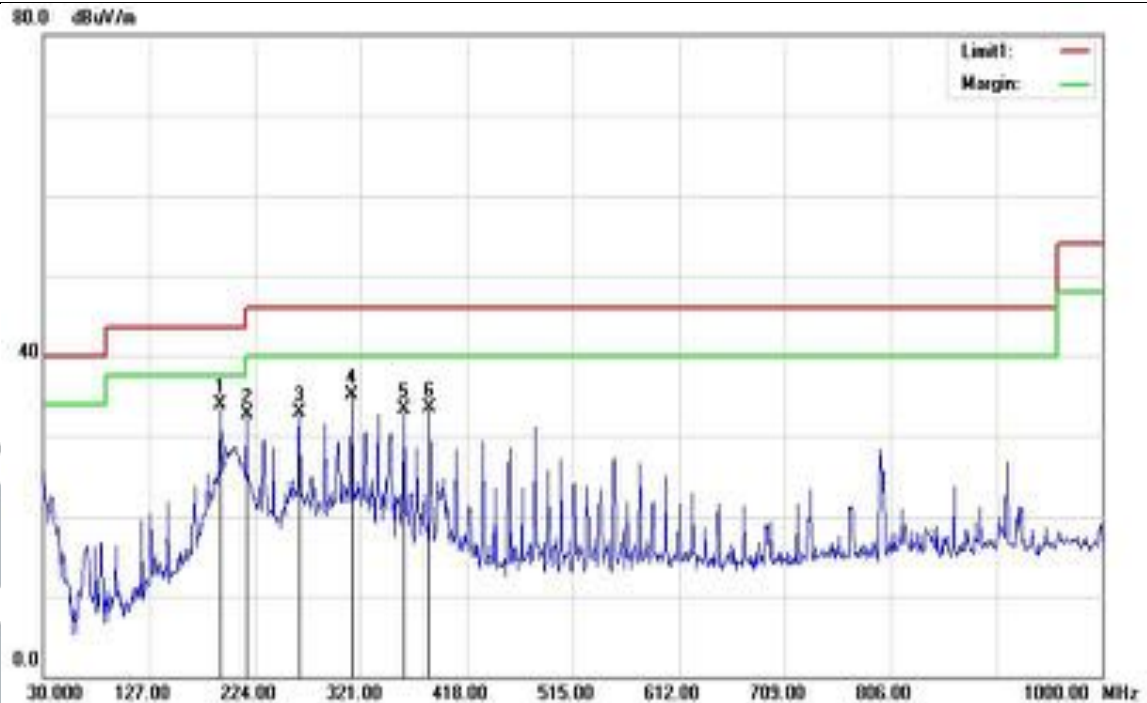
- 1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).
- 2) Test the EUT in the lowest channel ,middle channel, the Highest channel
- 3) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is worse case.
- 4) Repeat above procedures until all frequencies measured was complete.

Equipment Used: Refer to section 3 for details.

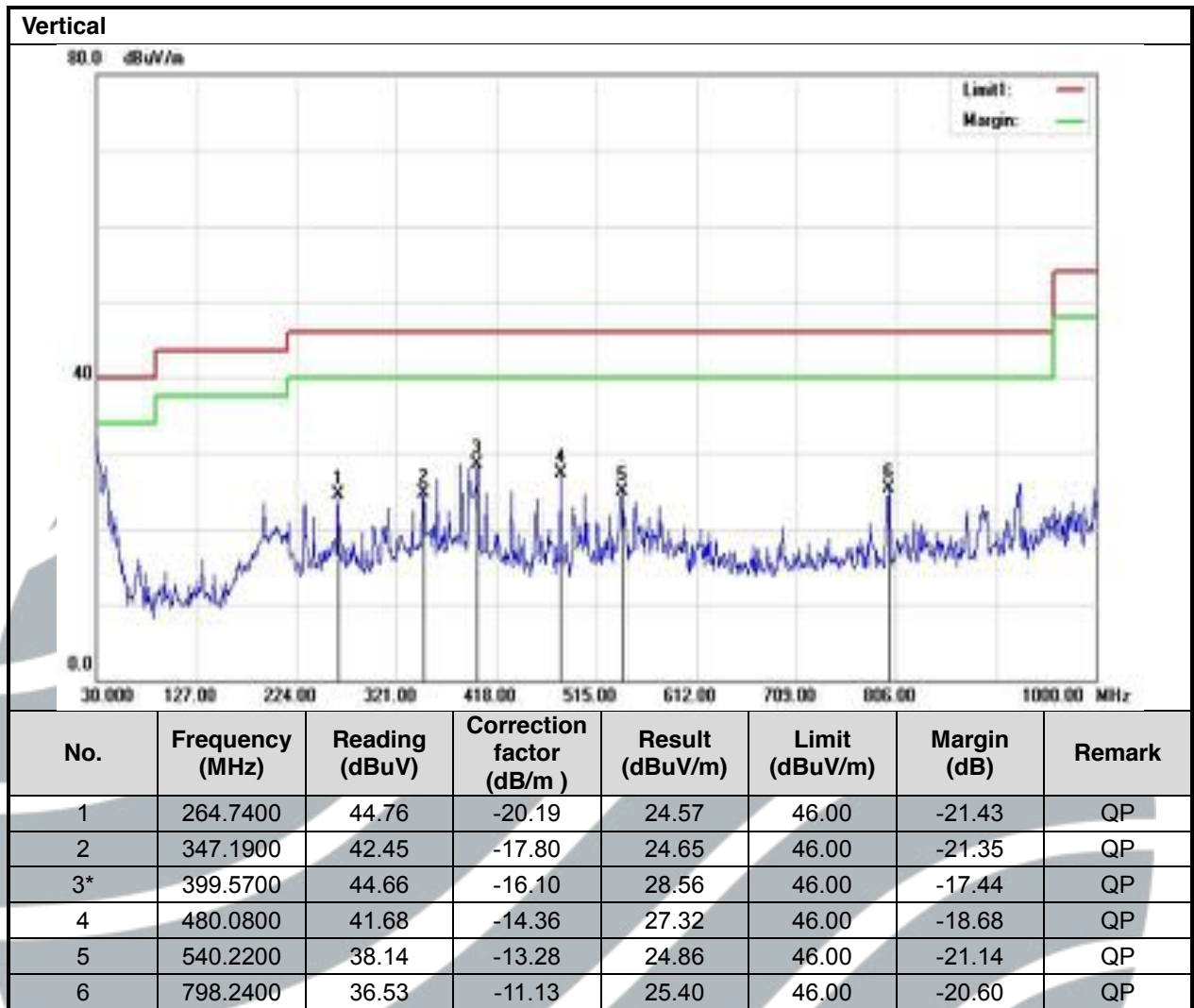
Test Result: Pass

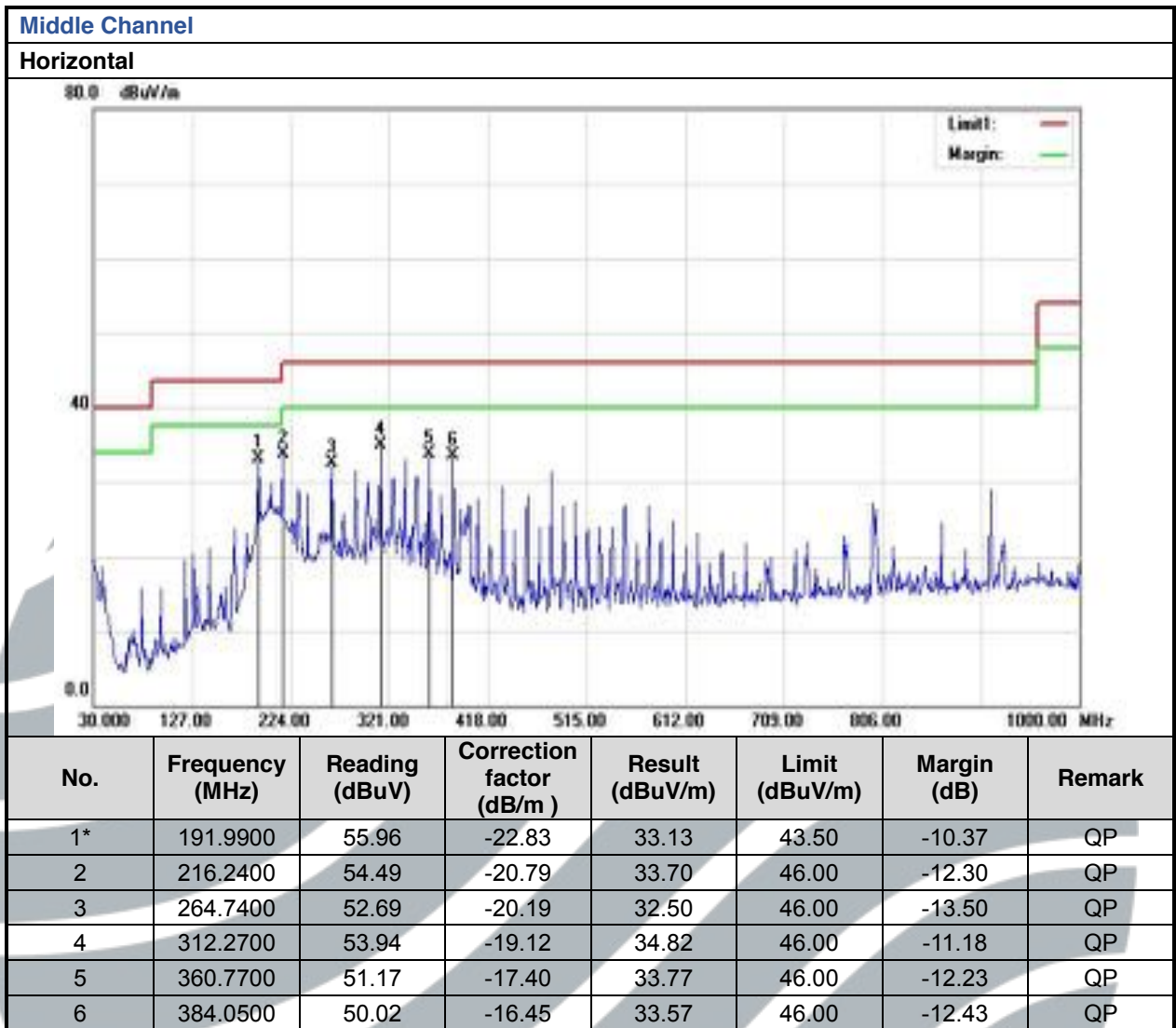
The measurement data as follows:

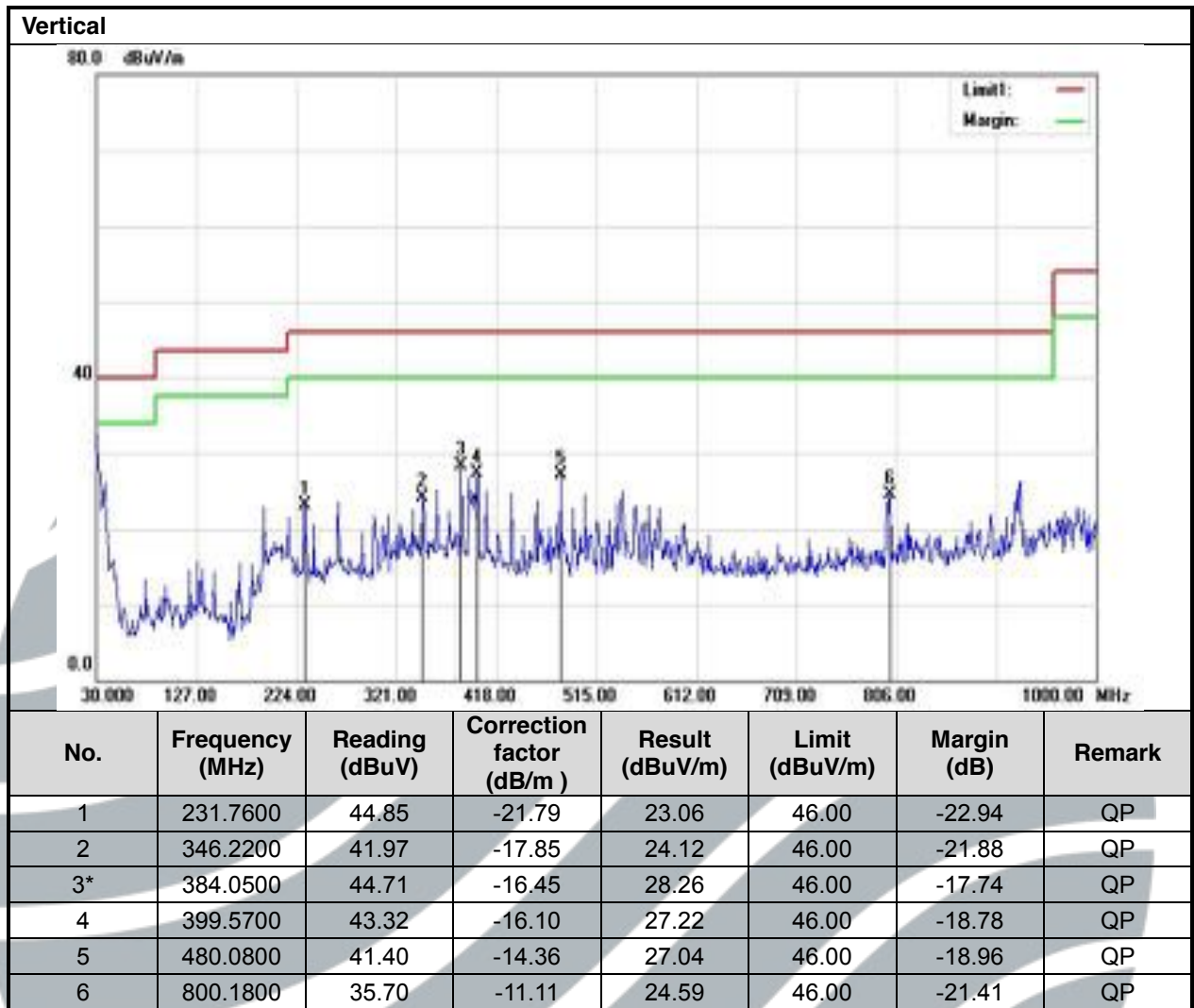
Radiated Emission Test Data (9 KHz ~ 30 MHz):
The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

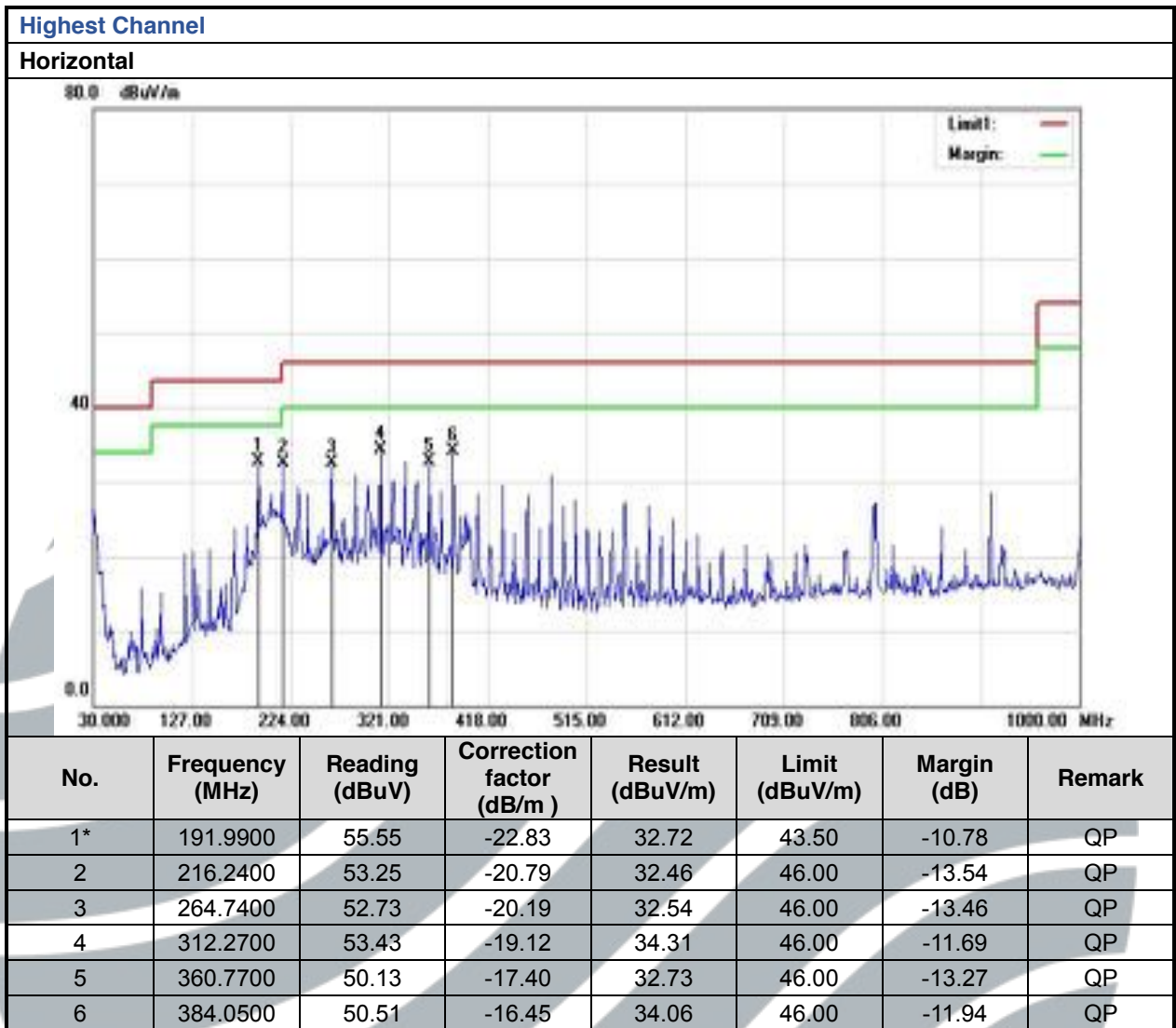
Radiated Emission Test Data (30 MHz ~ 1 GHz):
Lowest Channel
Horizontal


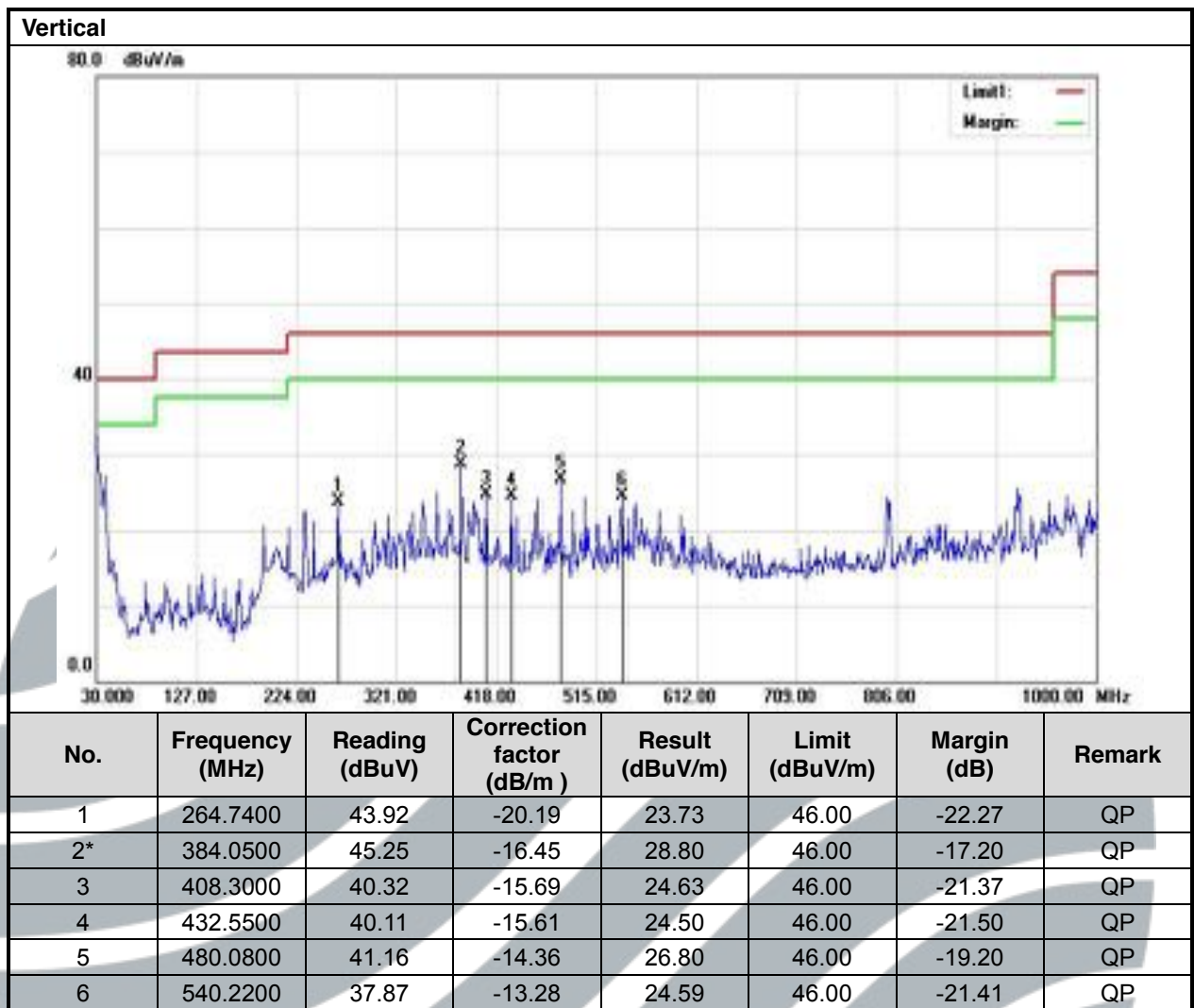
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	191.9900	56.74	-22.83	33.91	43.50	-9.59	QP
2	216.2400	53.47	-20.79	32.68	46.00	-13.32	QP
3	264.7400	53.09	-20.19	32.90	46.00	-13.10	QP
4	312.2700	54.13	-19.12	35.01	46.00	-10.99	QP
5	360.7700	50.71	-17.40	33.31	46.00	-12.69	QP
6	384.0500	50.04	-16.45	33.59	46.00	-12.41	QP











Radiated Emission Test Data (Above 1GHz):
Lowest Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polaxis	Remark
1	4804.00	50.34	74.00	23.66	Peak	Horizontal
2	7206.00	49.17	74.00	24.83	Peak	Horizontal
3	4804.00	44.90	74.00	29.10	Peak	Vertical
4	7206.00	47.15	74.00	26.85	Peak	Vertical

Middle Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polaxis	Remark
1	4882.00	50.62	74.00	23.38	Peak	Horizontal
2	7323.00	49.83	74.00	24.17	Peak	Horizontal
3	4882.00	45.33	74.00	28.67	Peak	Vertical
4	7323.00	47.09	74.00	26.91	Peak	Vertical

Highest Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polaxis	Remark
1	4960.00	53.31	74.00	20.69	Peak	Horizontal
2	7440.00	48.76	74.00	25.24	Peak	Horizontal
3	4960.00	51.18	74.00	22.82	Peak	Vertical
4	7440.00	50.02	74.00	23.98	Peak	Vertical

Note:

- 1) Above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.
- 2) Since peak data above 1 GHz are lower the average limit, so the average data are pass, no need for testing.

5.11 BAND EDGE MEASUREMENTS (RADIATED)

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: ANSI C63.10-2013

Limits:

Radiated emissions which fall in the restricted bands, as defined in section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a).

Frequency	Limit (dB μ V/m @3m)	Remark
30 MHz-88 MHz	40.0	Quasi-peak Value
88 MHz-216 MHz	43.5	Quasi-peak Value
216 MHz-960 MHz	46.0	Quasi-peak Value
960 MHz-1 GHz	54.0	Quasi-peak Value
Above 1 GHz	54.0	Average Value
	74.0	Peak Value

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

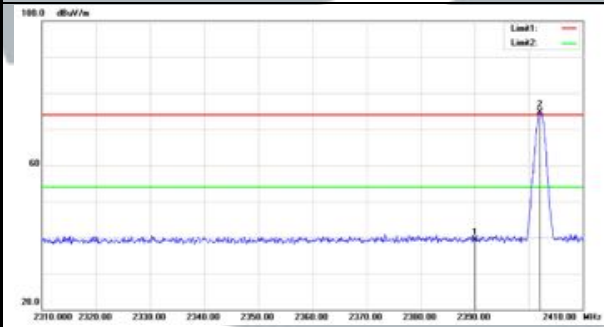
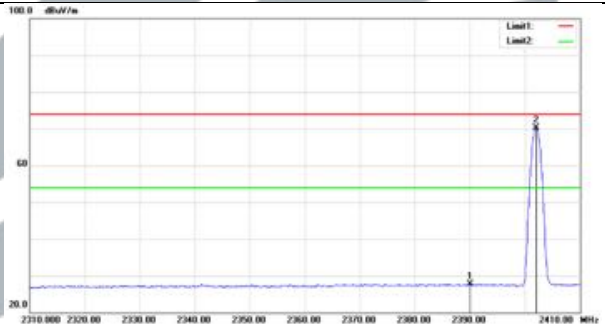
Radiated band edge measurements at 2390 MHz and 2483.5 MHz were made with the unit transmitting in the low end of the channel range and the high end closest to the restricted bands respectively. The emissions were made on the 966 Semi-Chamber. Use (resolution bandwidth (RBW) = 1 MHz, video bandwidth (VBW) = 3 MHz for peak levels and RBW = 1 MHz and VBW = 10 Hz or 1/T for average levels).

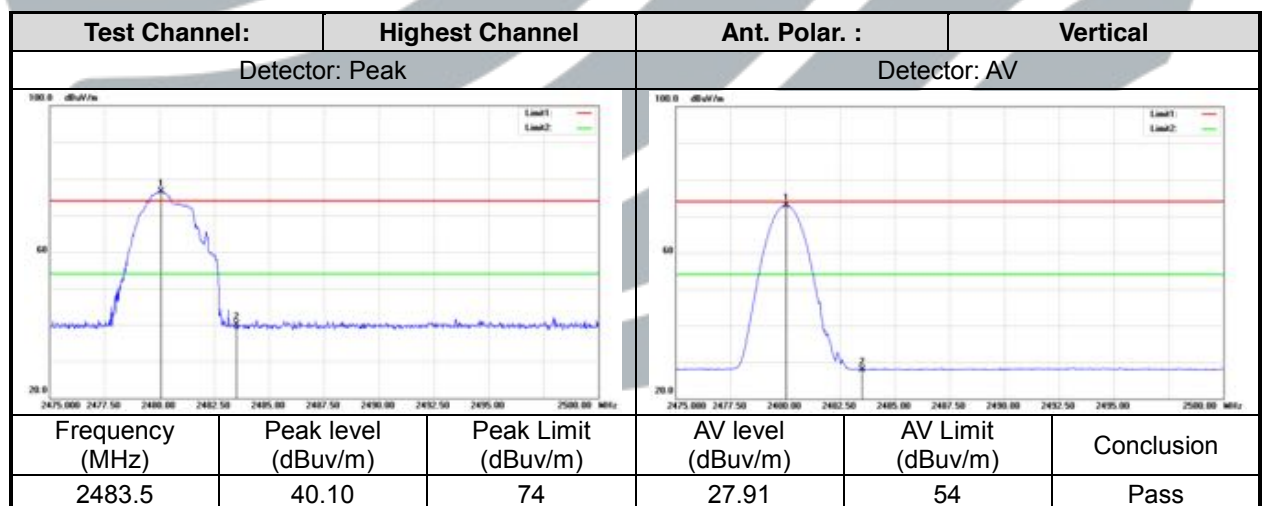
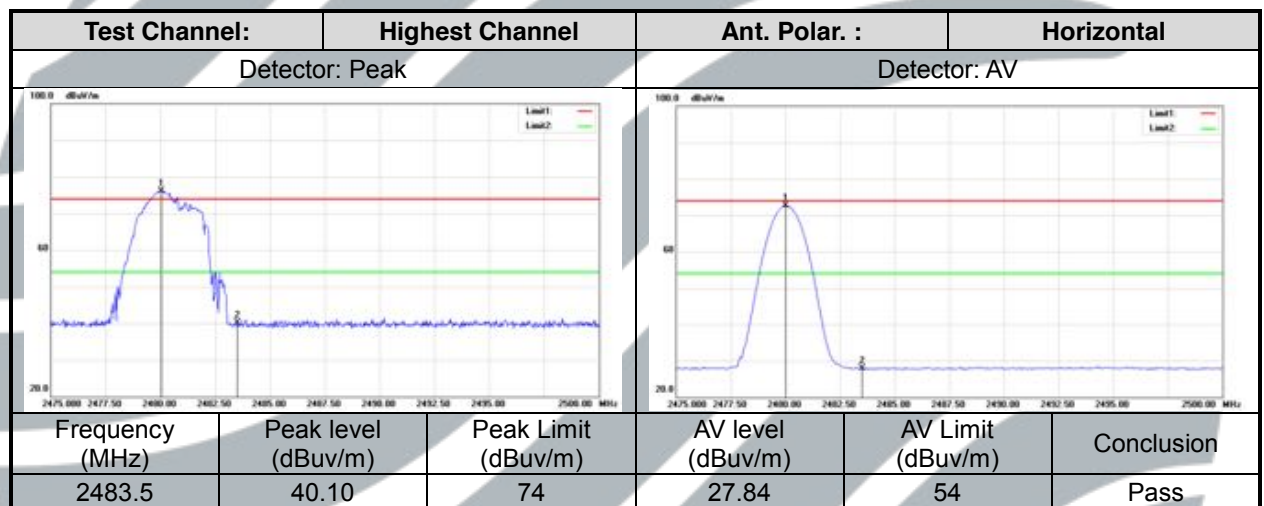
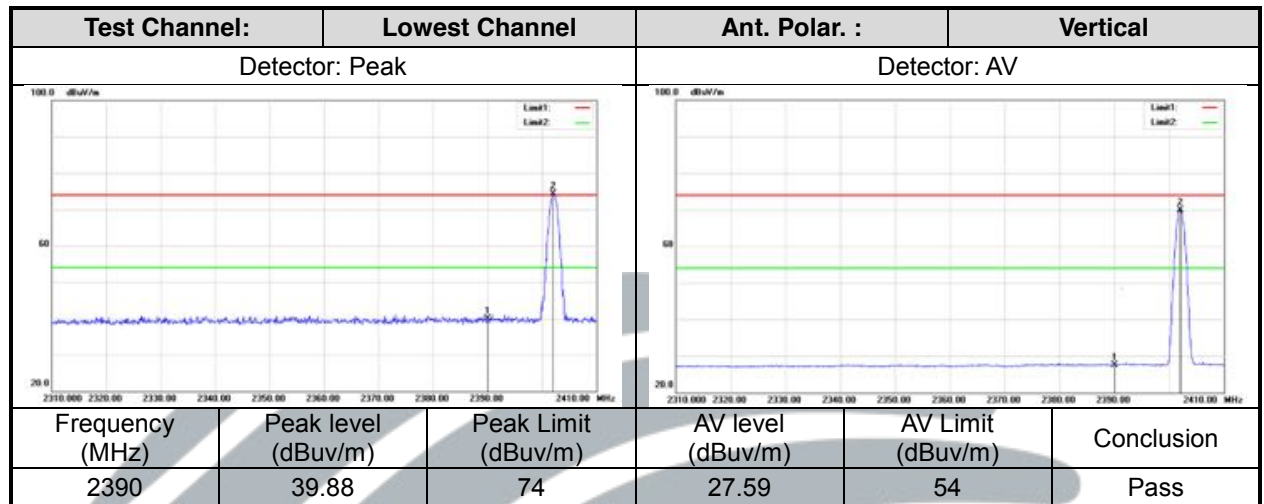
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

The measurement data as follows:

Test Channel:		Lowest Channel		Ant. Polar. :	Horizontal
Detector: Peak			Detector: AV		
					
Frequency (MHz)	Peak level (dBuV/m)	Peak Limit (dBuV/m)	AV level (dBuV/m)	AV Limit (dBuV/m)	Conclusion
2390	39.26	74	27.68	54	Pass



5.12 CONDUCTED EMISSION

Test Requirement: 47 CFR Part 15C Section 15.207

Test Method: ANSI C63.10-2013

Limits:

Frequency range (MHz)	Limits (dB(μV))	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50

Remark:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 to 0.50 MHz.

Test Setup: Refer to section 4.5.2 for details.

Test Procedures:

Test frequency range :150KHz-30MHz

- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The unit under test was connected to AC power source through a LISN (Line Impedance Stabilization Network) which provides a $50\Omega/50\mu\text{H} + 5\Omega$ linear impedance.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane.
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN and the EUT.
- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

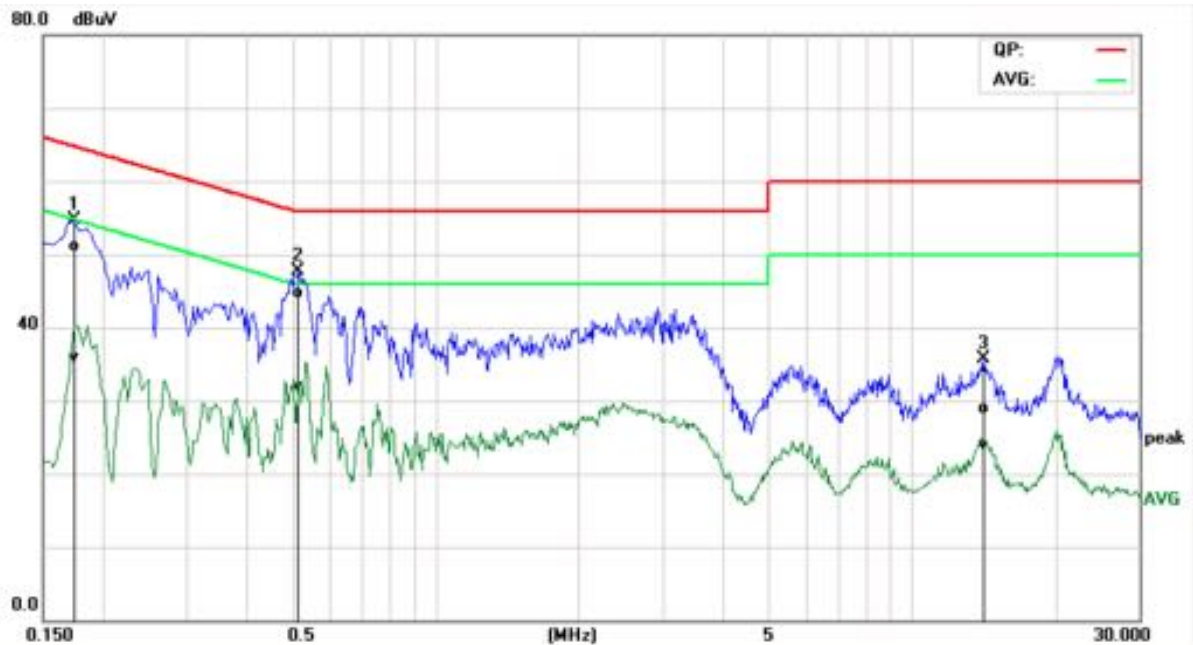
Equipment Used: Refer to section 3 for details.

Test Result: Pass

The measurement data as follows:

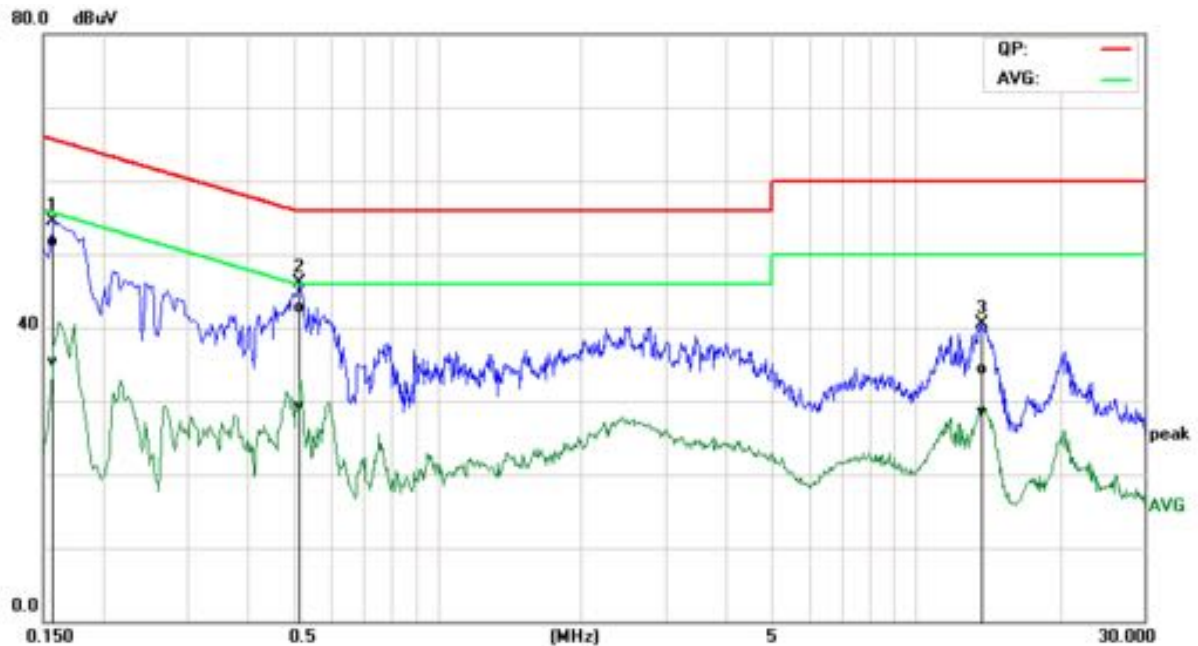
GFSK_lowest channel

Live Line



No.	Frequency (MHz)	QuasiPeak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	QuasiPeak result (dBuV)	Average result (dBuV)	QuasiPeak limit (dBuV)	Average limit (dBuV)	QuasiPeak margin (dB)	Average margin (dB)	Remark
1P	0.1740	31.57	16.27	19.63	51.20	35.90	64.76	54.77	-13.56	-18.87	Pass
2*	0.5180	25.16	12.36	19.54	44.70	31.90	56.00	46.00	-11.30	-14.10	Pass
3P	14.1700	8.97	3.97	20.03	29.00	24.00	60.00	50.00	-31.00	-26.00	Pass

Neutral Line



No.	Frequency (MHz)	QuasiPeak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	QuasiPeak result (dBuV)	Average result (dBuV)	QuasiPeak limit (dBuV)	Average limit (dBuV)	QuasiPeak margin (dB)	Average margin (dB)	Remark
1P	0.1580	32.18	15.88	19.52	51.70	35.40	65.56	55.57	-13.86	-20.17	Pass
2*	0.5140	23.16	9.76	19.54	42.70	29.30	56.00	46.00	-13.30	-16.70	Pass
3P	13.7100	14.36	8.46	20.04	34.40	28.50	60.00	50.00	-25.60	-21.50	Pass

Remark:

1. An initial pre-scan was performed on the Phase and neutral lines with peak detector. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

APPENDIX 1 PHOTOGRAPHS OF TEST SETUP

See test photographs attached in Appendix 1 for the actual connections between Product and support equipment.

APPENDIX 2 PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photographs.

*** End of Report ***

The test report is effective only with both signature and specialized stamp. The result(s) shown in this report refer only to the sample(s) tested. Without written approval of UnionTrust, this report can't be reproduced except in full.
