

# TEST REPORT

**Product Name:** IP Phone  
**Trade Mark:** GRANDSTREAM  
**Model No. / HVIN:** GRP2616  
**Add. Model No. / HVIN:** N/A  
**Report Number:** 190708003RFC-2  
**Test Standards:** FCC 47 CFR Part 15 Subpart C  
RSS-247 Issue 2  
RSS-Gen Issue 5  
**FCC ID:** YZZGRP2616  
**IC:** 11964A-GRP2616  
**Test Result:** PASS  
**Date of Issue:** August 29, 2019

Prepared for:

**Grandstream Networks, Inc.**  
**126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA**

Prepared by:

**Shenzhen UnionTrust Quality and Technology Co., Ltd.**  
**16/F, Block A, Building 6, Baoneng Science and Technology Park,**  
**Qingxiang Road No.1, Longhua New District, Shenzhen, China**

**TEL: +86-755-2823 0888**

**FAX: +86-755-2823 0886**

Prepared by: \_\_\_\_\_

Henry Lu  
Team Leader

Reviewed by: \_\_\_\_\_

Kevin Liang  
Assistant Manager

Approved by: \_\_\_\_\_

Billy Li

Technical Director

Date: August 29, 2019

**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  
Tel: +86-755-28230888 Fax: +86-755-28230886 E-mail: info@uttlab.com

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

## Version

Version No.	Date	Description
V1.0	August 29, 2019	Original



### **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

Tel: +86-755-28230888

Fax: +86-755-28230886

E-mail: [info@uttlab.com](mailto:info@uttlab.com)

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

## CONTENTS

<b>1. GENERAL INFORMATION</b>	<b>4</b>
1.1 CLIENT INFORMATION	4
1.2 EUT INFORMATION	4
1.2.1 GENERAL DESCRIPTION OF EUT	4
1.2.2 DESCRIPTION OF ACCESSORIES	5
1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD	6
1.4 OTHER INFORMATION	6
1.5 DESCRIPTION OF SUPPORT UNITS	6
1.6 TEST LOCATION	7
1.7 TEST FACILITY	7
1.8 DEVIATION FROM STANDARDS	7
1.9 ABNORMALITIES FROM STANDARD CONDITIONS	7
1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER	7
1.11 MEASUREMENT UNCERTAINTY	8
<b>2. TEST SUMMARY</b>	<b>9</b>
<b>3. EQUIPMENT LIST</b>	<b>10</b>
<b>4. TEST CONFIGURATION</b>	<b>11</b>
4.1 ENVIRONMENTAL CONDITIONS FOR TESTING	11
4.1.1 NORMAL OR EXTREME TEST CONDITIONS	11
4.1.2 RECORD OF NORMAL ENVIRONMENT	11
4.2 TEST CHANNELS	11
4.3 EUT TEST STATUS	11
4.4 PRE-SCAN	12
4.4.1 PRE-SCAN UNDER ALL PACKETS AT MIDDLE CHANNEL	12
4.4.2 WORST-CASE DATA PACKETS	12
4.4.3 TESTED CHANNEL DETAIL	12
4.5 TEST SETUP	13
4.5.1 FOR RADIATED EMISSIONS TEST SETUP	13
4.5.2 FOR CONDUCTED EMISSIONS TEST SETUP	14
4.5.3 FOR CONDUCTED RF TEST SETUP	15
4.6 SYSTEM TEST CONFIGURATION	16
4.7 DUTY CYCLE	17
<b>5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION</b>	<b>18</b>
5.1 REFERENCE DOCUMENTS FOR TESTING	18
5.2 ANTENNA REQUIREMENT	18
5.3 CONDUCTED PEAK OUTPUT POWER	19
5.4 20 dB BANDWIDTH & OCCUPIED BANDWIDTH	22
5.5 CARRIER FREQUENCIES SEPARATION	25
5.6 NUMBER OF HOPPING CHANNEL	27
5.7 DWELL TIME	31
5.8 CONDUCTED OUT OF BAND EMISSION	35
5.9 RADIATED SPURIOUS EMISSIONS	40
5.10 BAND EDGE MEASUREMENTS (RADIATED)	44
5.11 CONDUCTED EMISSION	47
<b>APPENDIX 1 PHOTOS OF TEST SETUP</b>	<b>50</b>
<b>APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS</b>	<b>50</b>

## 1. GENERAL INFORMATION

### 1.1 CLIENT INFORMATION

<b>Applicant:</b>	Grandstream Networks, Inc.
<b>Address of Applicant:</b>	126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA
<b>Manufacturer:</b>	Grandstream Networks, Inc.
<b>Address of Manufacturer:</b>	126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA

### 1.2 EUT INFORMATION

#### 1.2.1 General Description of EUT

<b>Product Name:</b>	IP Phone		
<b>Model No. / HVIN:</b>	GRP2616		
<b>Add. Model No. / HVIN:</b>	N/A		
<b>Trade Mark:</b>	GRANDSTREAM		
<b>DUT Stage:</b>	Identical Prototype		
<b>EUT Supports Function:</b>	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
		Bluetooth V4.2	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
<b>Software Version:</b>	0.7.18.50		
<b>Hardware Version:</b>	V1.0		
<b>Sample Received Date:</b>	July 20, 2019		
<b>Sample Tested Date:</b>	July 22, 2019 to August 28, 2019		

## 1.2.2 Description of Accessories

Adapter(1)	
Model No.:	PEA-120100VA
Input:	100-240 V~50/60 Hz 0.3 A
Output:	12.0 V $\equiv$ 1.0 A
AC Cable:	N/A
DC Cable:	2.5 Meter, Unshielded without ferrite

Adapter (2)	
Model No.:	F12L28-120100SPAU
Input:	100-240 V~50/60 Hz 0.3 A
Output:	12.0 V $\equiv$ 1.0 A
AC Cable:	N/A
DC Cable:	2.5 Meter, Unshielded without ferrite

Adapter (3)	
Model No.:	F12US1200100A
Input:	100-240 V~50/60 Hz 0.5 A
Output:	12.0 V $\equiv$ 1.0 A
AC Cable:	N/A
DC Cable:	2.5 Meter, Unshielded without ferrite

Cable (1)	
Description:	Ethernet Cable (RJ45)
Cable Type:	Unshielded without ferrite
Length:	1.5 Meter

Cable (2)	
Description:	Phone Cord (RJ9)
Cable Type:	Unshielded without ferrite
Length:	3.5 Meter

### 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	2400 MHz to 2483.5 MHz
Frequency Range:	2402 MHz to 2480 MHz
Bluetooth Version:	Bluetooth BR + EDR
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:	Dipole Antenna
Antenna Gain:	3.5 dBi
Maximum Peak Power:	8.17 dBm
Normal Test Voltage:	AC 120V/60Hz

### 1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
$f = 2402 + k \text{ MHz}, k = 0, \dots, 78$	
Note:	
f	is the operating frequency (MHz);
k	is the operating channel.

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	B40-80	MP12NEQ6	UnionTrust
Mobile Phone	Apple	A1688	NA	UnionTrust
USB disk	Kingston	DTSE9	N/A	UnionTrust
mouse	DELL	MS111	CN-011D3V-738	UnionTrust
Wireless Home Router	SAGEMCOM	FAST5280	N/A	UnionTrust
Headset	YEEY	VE120-MV	N/A	UnionTrust
Standard POE Power supply	TP-LINK	TL-POE160S	N/A	UnionTrust

## 2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Ethernet Cable	RJ45	1.5 Unshielded without ferrite	UnionTrust
2	Ethernet Cable	RJ45	5.0 Unshielded without ferrite	UnionTrust
3	Ethernet Cable	RJ45	1.5 Unshielded without ferrite	UnionTrust
4	Antenna Cable	SMA	0.15 Meter	UnionTrust

## 1.6 TEST LOCATION

**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 518109  
Telephone: +86 (0) 755 2823 0888  
Fax: +86 (0) 755 2823 0886

## 1.7 TEST FACILITY

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

**CNAS-Lab Code: L9069**

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

**A2LA-Lab Certificate No.: 4312.01**

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**ISED Wireless Device Testing Laboratories**

CAB identifier: CN0032

**FCC Accredited Lab.**

Designation Number: CN1194

Test Firm Registration Number: 259480

## 1.8 DEVIATION FROM STANDARDS

None.

## 1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

## 1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

**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

Tel: +86-755-28230888

Fax: +86-755-28230886

E-mail: info@uttlab.com

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



### 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-150KHz	$\pm 3.8$ dB
2	Conducted emission 150KHz-30MHz	$\pm 3.4$ dB
3	Radiated emission 9KHz-30MHz	$\pm 4.9$ dB
4	Radiated emission 30MHz-1GHz	$\pm 4.7$ dB
5	Radiated emission 1GHz-18GHz	$\pm 5.1$ dB
6	Radiated emission 18GHz-26GHz	$\pm 5.2$ dB
7	Radiated emission 26GHz-40GHz	$\pm 5.2$ 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) RSS-Gen Issue 5, Section 6.8	N/A	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207 RSS-Gen Issue 5, Section 8.8	ANSI C63.10-2013 Section 6.2	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1) RSS-247 Issue 2, Section 5.4(b)	ANSI C63.10-2013 Section 7.8.5	PASS
20 dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1) RSS-247 Issue 2, Section 5.1(a)	ANSI C63.10-2013 Section 6.9.2	PASS
Occupied Bandwidth	RSS-Gen section 6.7	RSS-Gen section 6.7	PASS
Carrier Frequencies Separation	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1) RSS-247 Issue 2, Section 5.1(b)	ANSI C63.10-2013 Section 7.8.2	PASS
Number of Hopping Channel	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1) RSS-247 Issue 2, Section 5.1(d)	ANSI C63.10-2013 Section 7.8.3	PASS
Dwell Time	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1) RSS-247 Issue 2, Section 5.1(d)	ANSI C63.10-2013 Section 7.8.4	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d) RSS-247 Issue 2, Section 5.5	ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8	PASS
Radiated Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209 RSS-Gen Issue 5, Section 6.13/8.9/8.10	ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6	PASS
Band Edge Measurement	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209 RSS-247 Issue 2, Section 5.5	ANSI C63.10-2013 Section 6.10.5	PASS

### 3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
<input checked="" type="checkbox"/>	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Dec. 03, 2018	Dec. 03, 2021
<input checked="" type="checkbox"/>	Receiver	R&S	ESIB26	100114	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	Loop Antenna	ETS-LINDGREN	6502	00202525	Dec. 03, 2018	Dec. 03, 2019
<input checked="" type="checkbox"/>	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Dec. 08, 2018	Dec. 08, 2019
<input checked="" type="checkbox"/>	6dB Attenuator	Talent	RA6A5-N-18	18103001	Dec. 08, 2018	Dec. 08, 2019
<input checked="" type="checkbox"/>	Preamplifier	HP	8447F	2805A02960	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	May 18, 2019	May 18, 2020
<input checked="" type="checkbox"/>	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Jan. 05, 2019	Jan. 05, 2020
<input checked="" type="checkbox"/>	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
<input checked="" type="checkbox"/>	Test Software	Audix	e3	Software Version: 9.160333		

Conducted Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
<input checked="" type="checkbox"/>	Receiver	R&S	ESR7	1316.3003K07-101181-K3	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	LISN	R&S	ESH2-Z5	860014/024	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	Test Software	Audix	e3	Software Version: 9.160323		

Conducted RF test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
<input checked="" type="checkbox"/>	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2018	Nov. 24, 2019
<input checked="" type="checkbox"/>	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 24, 2018	Nov. 24, 2019

## 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	AC 120V/60Hz	20 to 75
<b>Remark:</b> 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	24.2	48	99.8	Bert Xiong
Conducted Peak Output Power	24.9	53	100.0	Hank Wu
20 dB Bandwidth & Occupied Bandwidth				
Carrier Frequencies Separation				
Number of Hopping Channel				
Dwell Time				
Conducted Out of Band Emission	24.6	52	100.0	Andy Lin
Radiated Emissions				
Band Edge Measurement				

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

### Power Setting

Power Setting: not applicable, test used software default power level.

### Test Software

Test software name: putty.exe (Serial port tools);

## 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)	1.84	5.18	5.88	-1.82	1.48	2.18	-1.81	1.47	2.17

### 4.4.2 Worst-case data packets

Type of Modulation	Worst-case data rates
GFSK	1-DH5
$\pi/4$ DQPSK	2-DH5
8DPSK	3-DH5

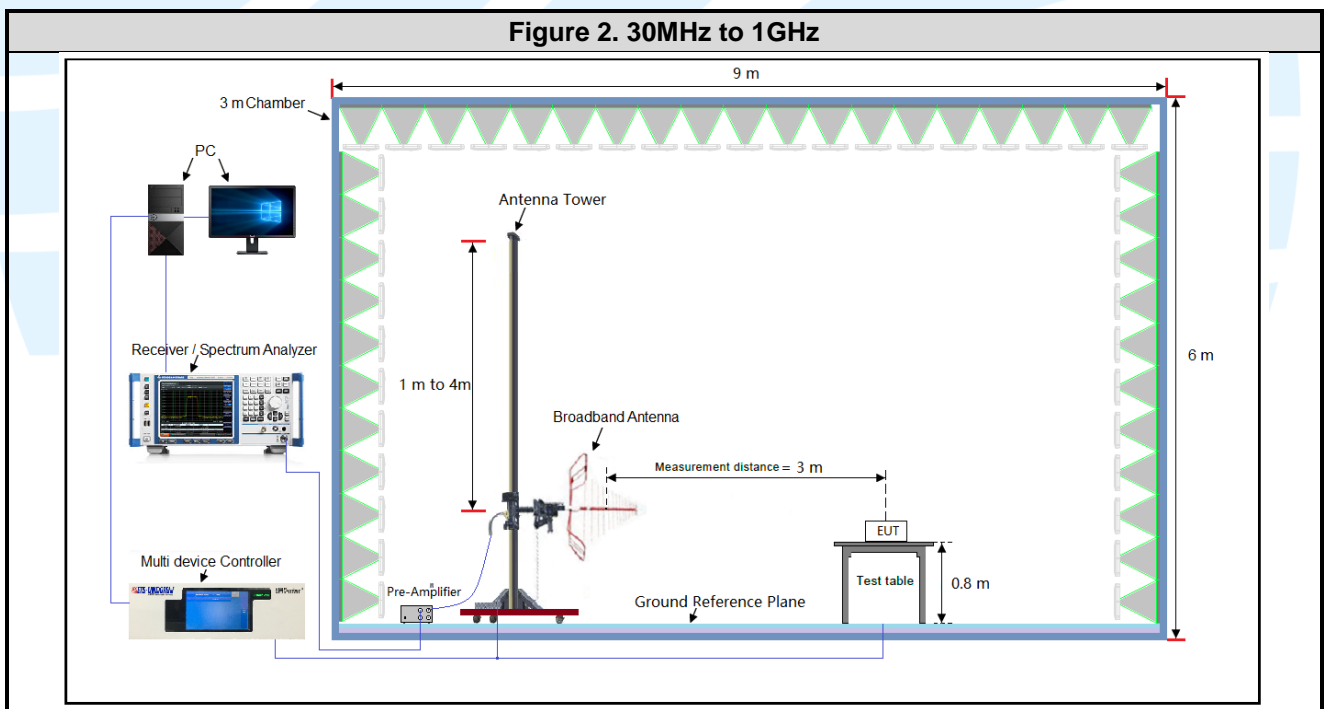
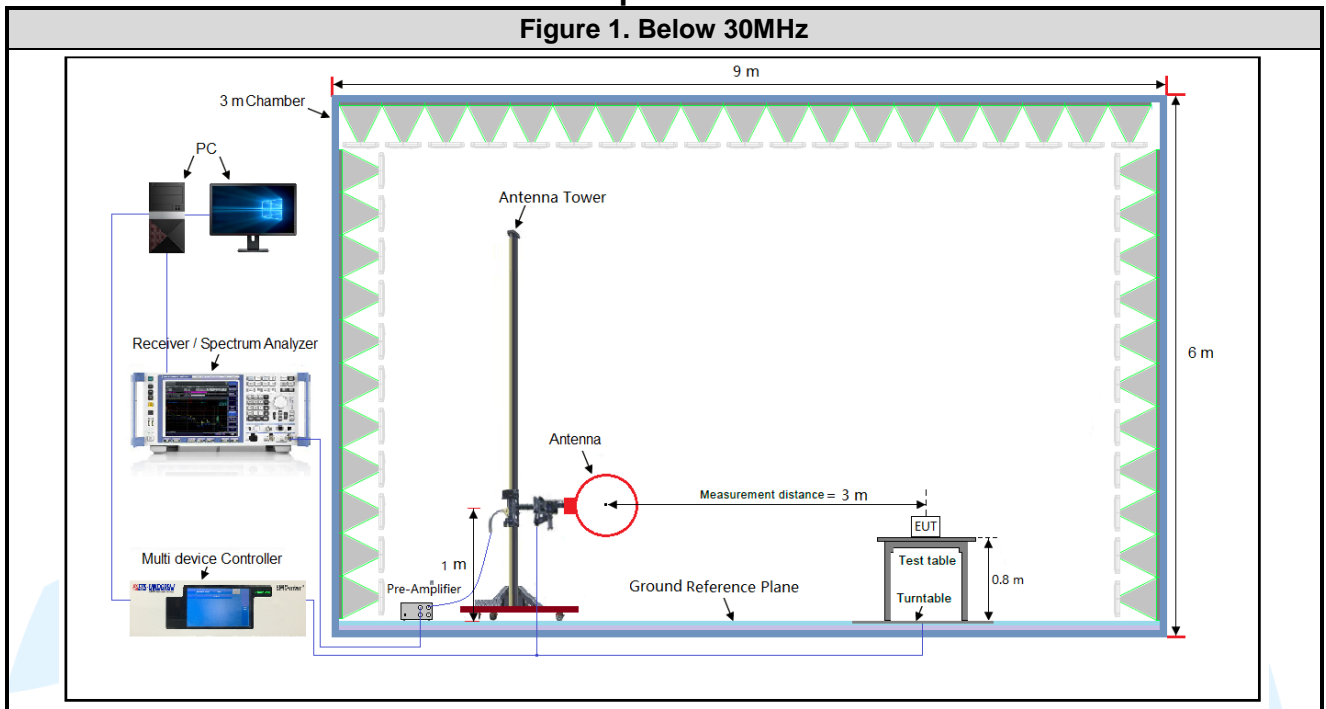
### 4.4.3 Tested channel detail

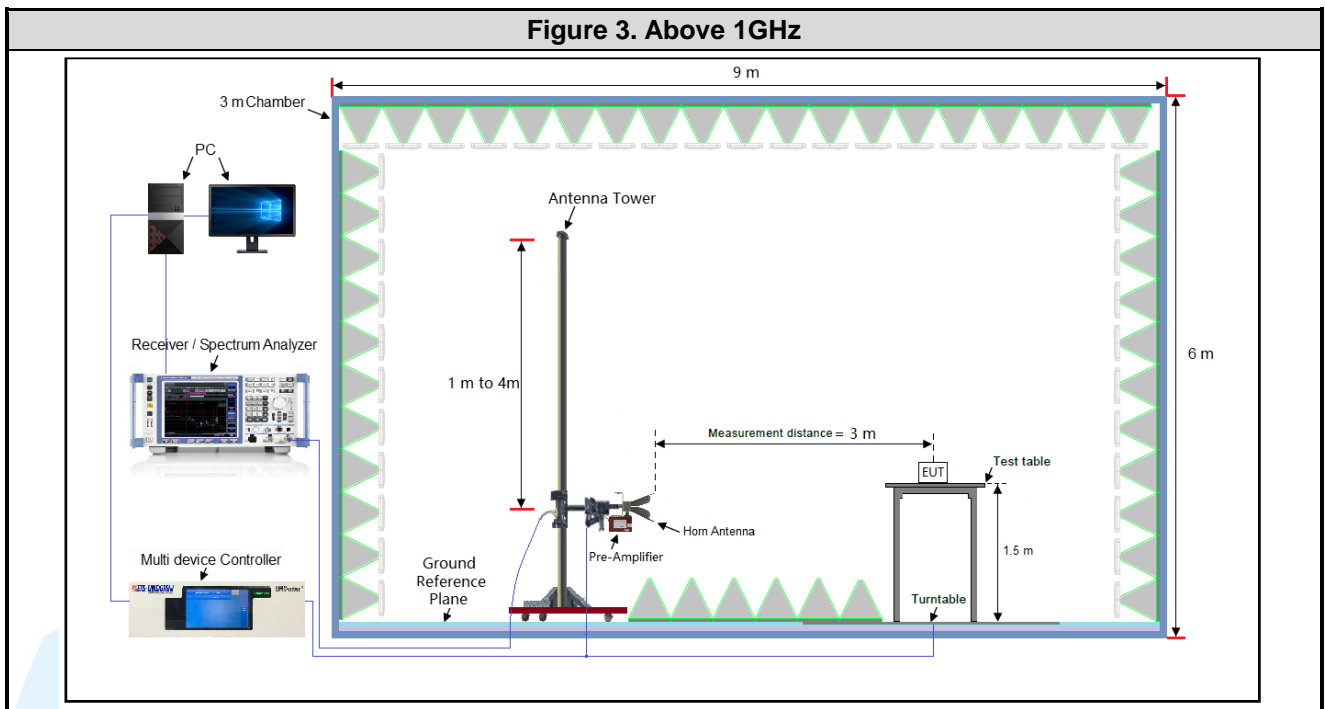
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data packets and antenna ports (if EUT with antenna diversity architecture). Following channel(s) was (were) selected for the final test as listed below.

Type of Modulation	GFSK			$\pi/4$ DQPSK			8DPSK		
Data Packets	1-DH 1	1-DH 3	1-DH 5	2-DH 1	2-DH 3	2-DH 5	3-DH 1	3-DH 3	3-DH 5
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								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20 dB Bandwidth	Channel 0 & 39 & 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Carrier Frequencies Separation	Frequency Hopping Channel 0 to 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Number of Hopping Channel	Frequency Hopping Channel 0 to 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Dwell Time	Channel 39								
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Conducted Out of Band Emission	Channel 0 & 39 & 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Radiated Emissions	Channel 0 & 39 & 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Band Edge Measurements (Radiated)	Channel 0 & 78								
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Remark:									
1. The mark "☑" means is chosen for testing;									
2. The mark "☐" means is not chosen for testing.									

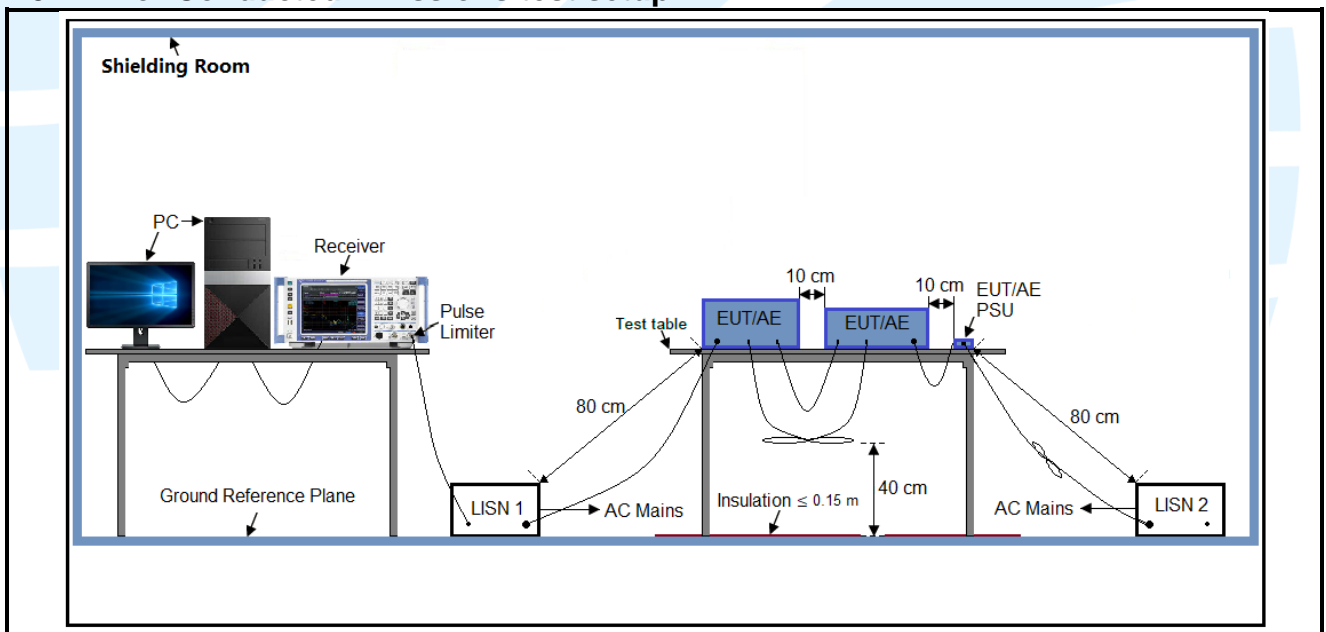
## 4.5 TEST SETUP

### 4.5.1 For Radiated Emissions test setup

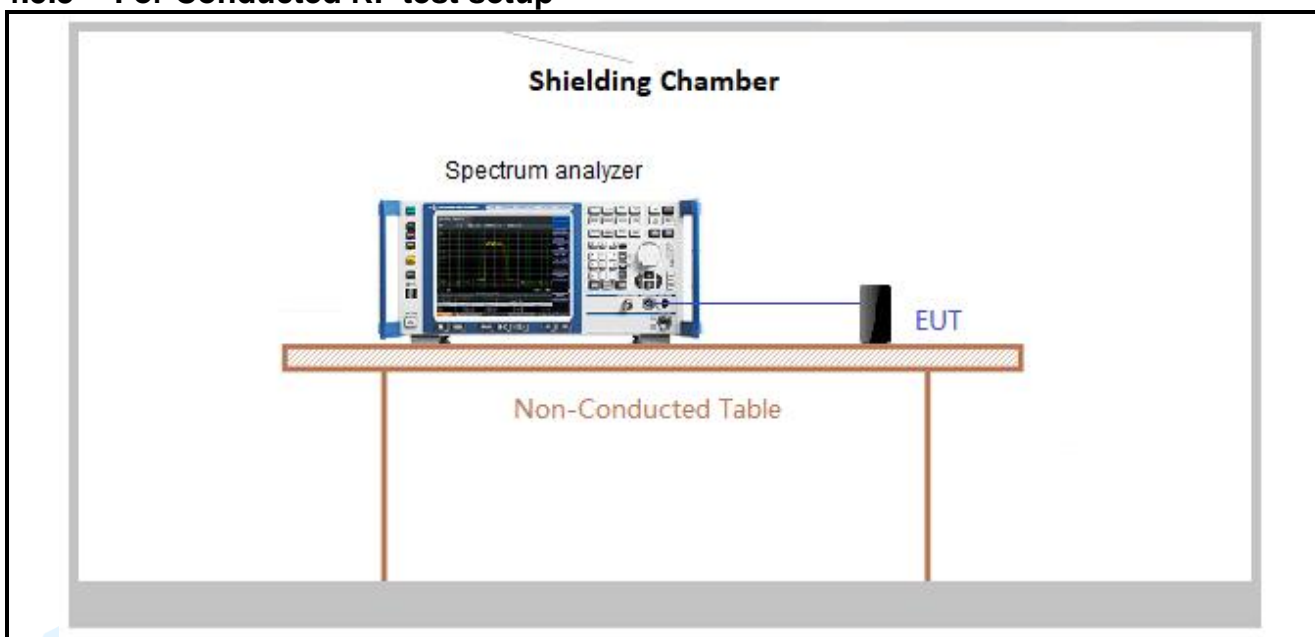




#### 4.5.2 For Conducted Emissions test setup



#### 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 AC 120V/60Hz. 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.

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

**Test Procedure:** ANSI C63.10-2013 Clause 11.6.

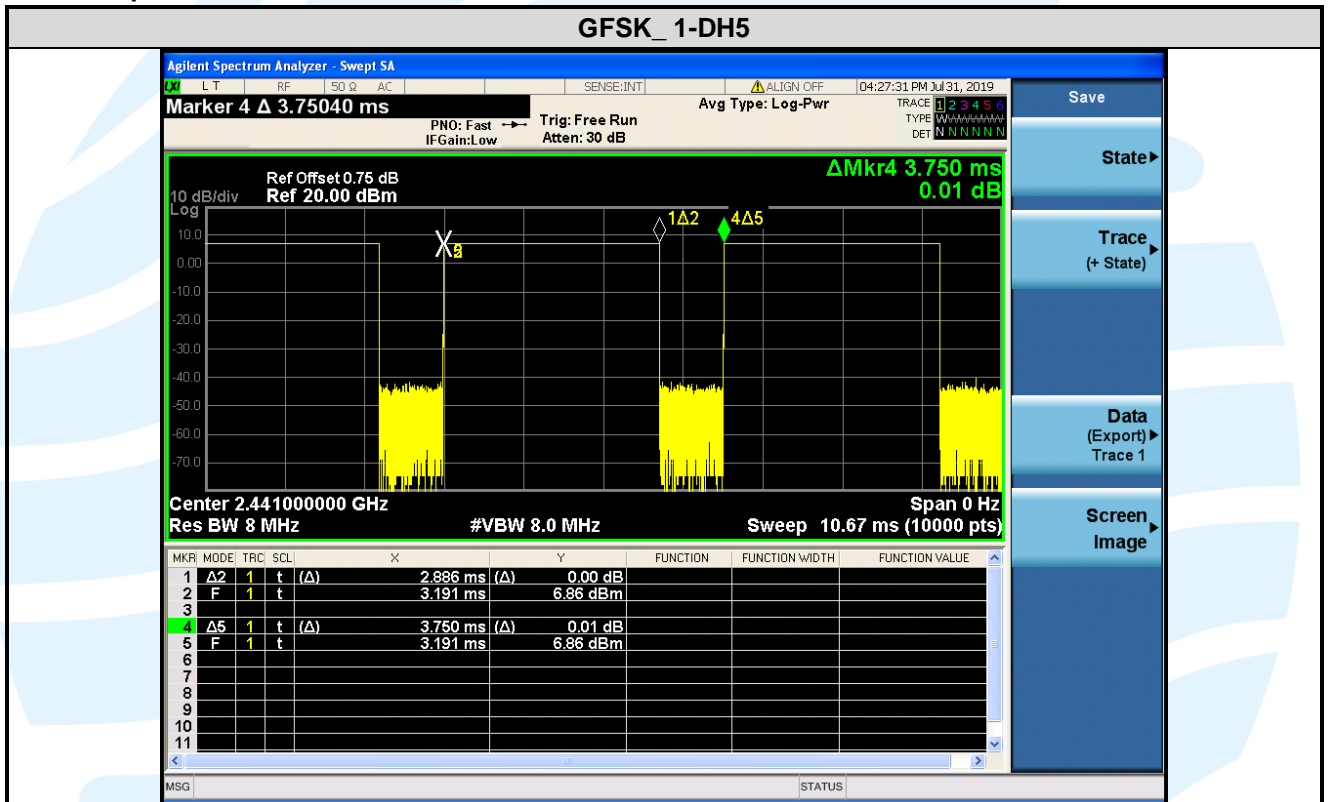
### Test Results

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-DH5	2.886	3.75	0.77	76.96	1.14	0.35	-2.27

### 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	RSS-247 Issue 2	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
4	RSS-Gen Issue 5	General Requirements for Compliance of Radio Apparatus
5	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
6	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules

### 5.2 ANTENNA REQUIREMENT

Standard Requirement
<p><b>15.203 requirement:</b> 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.</p> <p><b>15.247(b) (4) requirement:</b> 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.</p> <p><b>RSS-Gen Issue 5, Section 6.8 requirement:</b> According to RSS-Gen Issue 5, section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.</p>
<p><b>EUT Antenna:</b> Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is 3.5 dBi.</p>

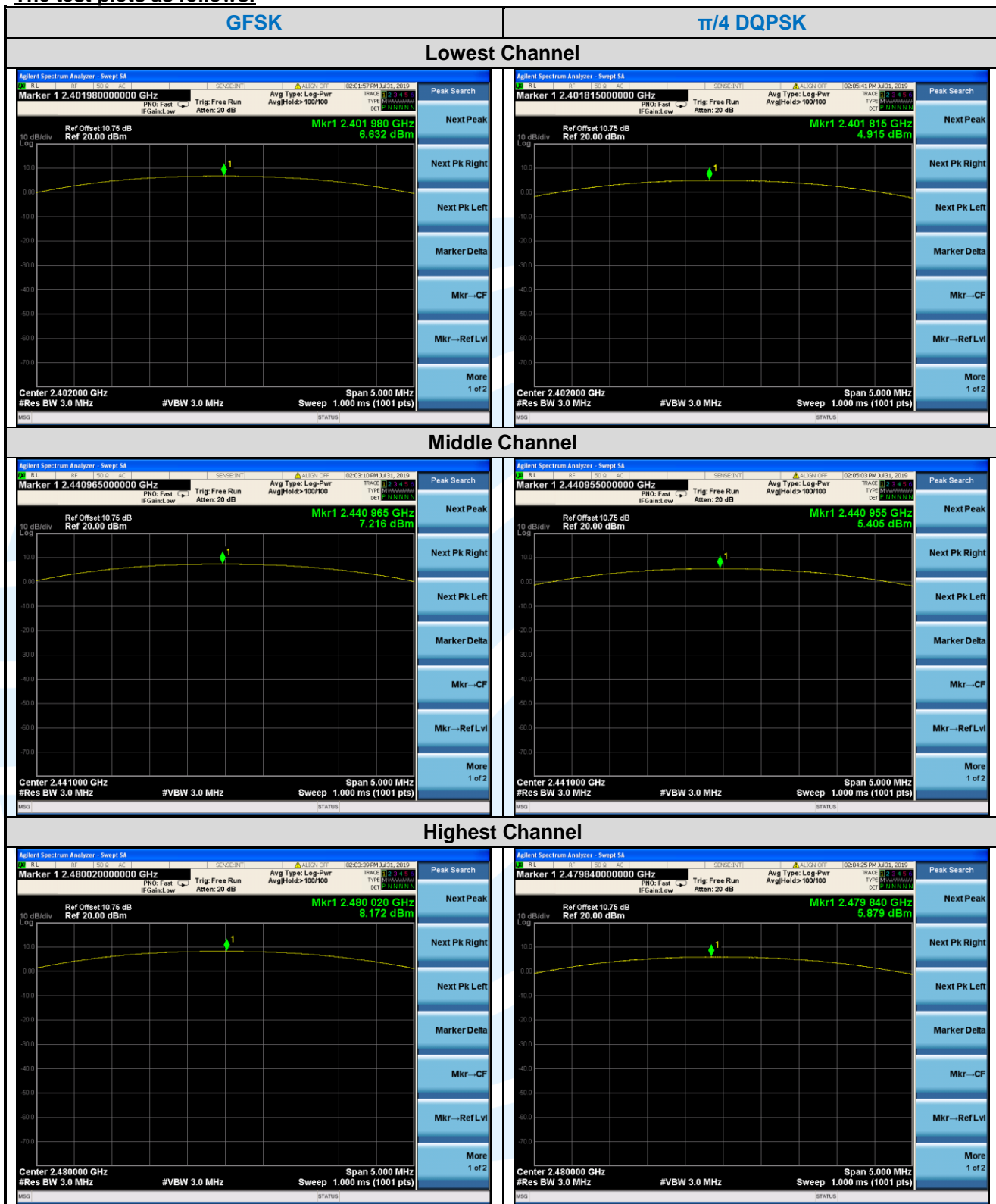
### 5.3 CONDUCTED PEAK OUTPUT POWER

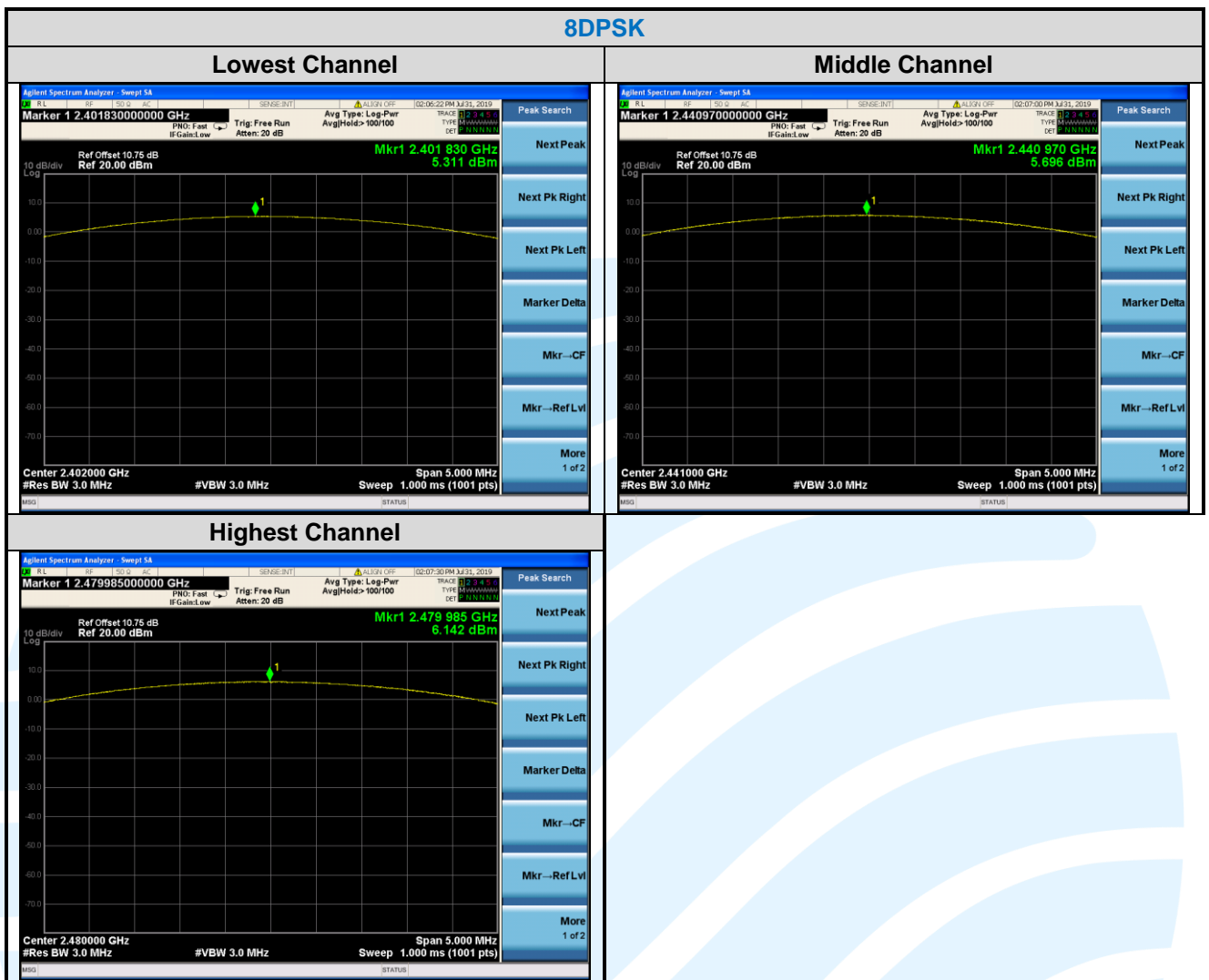
- Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)  
RSS-247 Issue 2, Section 5.4(b)
- Test Method:** ANSI C63.10-2013 Section 7.8.5
- Limit:** For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).  
FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.
- Test Procedure:** Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- a) Use the following spectrum analyzer settings:
    - 1) Span: Approximately 5 x 20 dB bandwidth, centered on a hopping channel.
    - 2) RBW > 20 dB bandwidth of the emission being measured.
    - 3) VBW  $\geq$  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.
- Test Setup:** Refer to section 4.5.3 for details.
- Instruments Used:** Refer to section 3 for details
- Test Results:** Pass

Type of Modulation	Peak Output Power (dBm)			Peak Output Power (mW)		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
GFSK	6.63	7.22	8.17	4.60	5.27	6.56
$\pi/4$ DQPSK	4.92	5.41	5.88	3.10	3.47	3.87
8DPSK	5.31	5.70	6.14	3.40	3.71	4.11

Note: The antenna gain of 3.5 dBi less than 6dBi maximum permission antenna gain value based on 125 mW peak output power limit.

The test plots as follows:





**5.420 DB BANDWIDTH & OCCUPIED BANDWIDTH**

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)  
RSS-247 Issue 2, Section 5.1(a)  
RSS-Gen section 6.7

**Test Method:** ANSI C63.10-2013 Section 6.9.2  
RSS-Gen section 6.7

**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  $\geq 3 \times$  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.

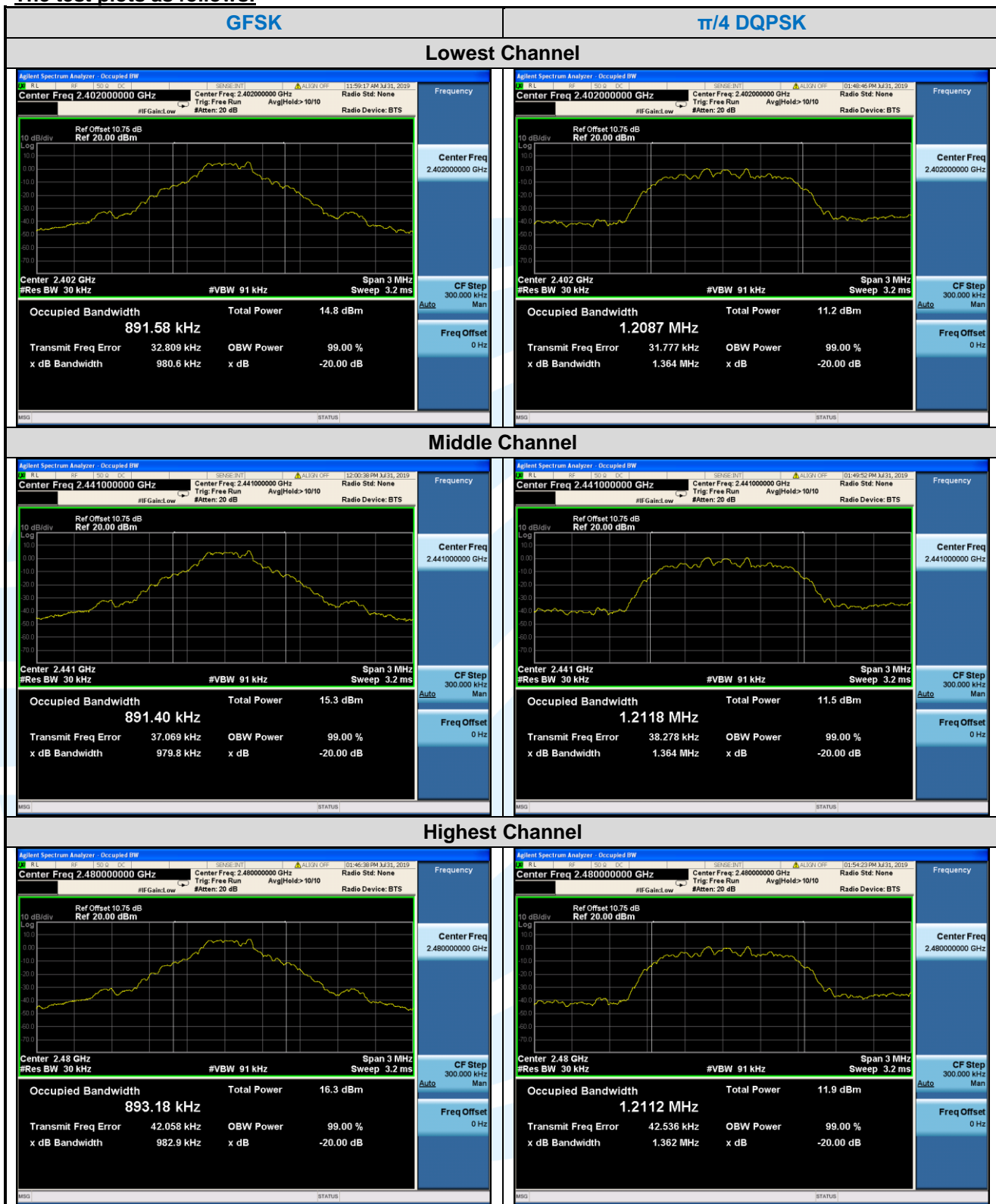
**Instruments Used:** Refer to section 3 for details

**Test Results:** Pass

Type of Modulation	20 dB Bandwidth (MHz)			Occupied Bandwidth (MHz)		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
GFSK	0.981	0.980	0.983	0.8916	0.8914	0.8932
$\pi/4$ DQPSK	1.364	1.364	1.362	1.2087	1.2118	1.2112
8DPSK	1.320	1.318	1.320	1.2086	1.2123	1.2101



The test plots as follows:





## 5.5 CARRIER FREQUENCIES SEPARATION

<b>Test Requirement:</b>	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1) RSS-247 Issue 2, Section 5.1(b)
<b>Test Method:</b>	ANSI C63.10-2013 Section 7.8.2
<b>Limit:</b>	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.
<b>Test Procedure:</b>	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: <ul style="list-style-type: none"><li>a) Span: Wide enough to capture the peaks of two adjacent channels.</li><li>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.</li><li>c) Video (or average) bandwidth (VBW) <math>\geq</math> RBW.</li><li>d) Sweep: Auto.</li><li>e) Detector function: Peak.</li><li>f) Trace: Max hold.</li><li>g) Allow the trace to stabilize.</li><li>h) Use the marker-delta function to determine the separation between the peaks of the adjacent channels.</li></ul> <p>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.</p>
<b>Test Setup:</b>	Refer to section 4.5.3 for details.
<b>Instruments Used:</b>	Refer to section 3 for details
<b>Test Results:</b>	Pass

Type of Modulation	Adjacent Channel Separation (MHz)	Minimum Limit (MHz)
	Channel 39	Channel 39
GFSK	1.000	0.6533
$\pi/4$ DQPSK	1.000	0.9080
8DPSK	1.005	0.8787

Note: The minimum limit is two-third 20 dB bandwidth.