

TEST REPORT

FCC PART 15 SUBPART C 15.247

Test report On Behalf of SHENZHEN SHENGLAI TECHNOLOGY CO.,LIMITED For Bluetooth Neckband Model No.: NECK-R-FD, NECK-R-BLK, NECK-R-WHT, NECK-R FCC ID: 2AL9B-NECKR

Prepared for : SHENZHEN SHENGLAI TECHNOLOGY CO.,LIMITED ROOM 709,BLOCK B,XINTIAN CENTURY BUSINESS CENTRE, FUMING ROAD,FUTIAN DISTRICT, SHENZHEN, China

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 Date of Test:
 Jun. 01, 2020 ~ Jun. 08, 2020

 Date of Report:
 Jun. 08, 2020

 Report Number:
 HK2005291193-E



TEST RESULT CERTIFICATION

Applicant's name	SHENZHEN SHENGLAI TECHNOLOGY CO., LIMITED
Address:	ROOM 709,BLOCK B,XINTIAN CENTURY BUSINESS CENTRE, FUMING ROAD,FUTIAN DISTRICT, SHENZHEN, China
Manufacture's Name	SHENZHEN SHENGLAI TECHNOLOGY CO., LIMITED
Address:	ROOM 709,BLOCK B,XINTIAN CENTURY BUSINESS CENTRE, FUMING ROAD,FUTIAN DISTRICT, SHENZHEN, China
Product description	
Trade Mark:	Vivitar
Product name:	Bluetooth Neckband
Model and/or type reference :	NECK-R-FD, NECK-R-BLK, NECK-R-WHT, NECK-R
Standards	47 CFR FCC Part 15 Subpart C 15.247

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Date of Test	
Date (s) of performance of tests	Jun. 01, 2020 ~ Jun. 08, 2020
Date of Issue	Jun. 08, 2020
Test Result	Pass

Prepared by:

Grany Qiam Project Engineer

Reviewed by:

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Jason Zhou

Technical Director



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** Modifited History **

Revison	Description	Issued Data	Remark
Revsion 1.0	Initial Test Report Release	Jun. 08, 2020	Jason Zhou



SUMMARY

1.1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

ANSI C63.10:2013 : American National Standard for Testing Unlicensed Wireless Devices

1.2. Test Description

FCC PART 15.247		
FCC Part 15.207	AC Power Conducted Emission	PASS
FCC Part 15.215	20dB Bandwidth& 99% Bandwidth	PASS
FCC Part 15.247(d)	Spurious RF Conducted Emission	PASS
FCC Part 15.247(b)	Maximum Peak Output Power	PASS
FCC Part 15.247 (a) (1)	Pseudorandom Frequency Hopping Sequence	PASS
FCC Part 15.247(a)(1)(iii)	Number of hopping frequency& Time of Occupancy	PASS
FCC Part 15.247(a)(1)	Frequency Separation	PASS
FCC Part 15.205/15.209	Radiated Emissions	PASS
FCC Part 15.247(d)	Band Edge Compliance of RF Emission	PASS



1.3. Test Facility

1.3.1 Address of the test laboratory

Shenzhen HUAK Testing Technology Co., Ltd. Add.:1F, B2 Building, Junfeng Zhongcheng Zhizao Innovation Park,Heping Community, Fuhai Street, Bao'an District, Shenzhen, China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.10 and CISPR 32/EN 55032 requirements.

1.3.2 Laboratory accreditation

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

IC Registration No.: 21210

The 3m alternate test site of Shenzhen HUAK Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 21210 on May 24, 2016.

1.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the Shenzhen HUAK Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Test	Measurement Uncertainty	Notes
Transmitter power conducted	±0.57 dB	(1)
Transmitter power Radiated	±2.20 dB	(1)
Conducted spurious emission 9KHz-40 GHz	±2.20 dB	(1)
Occupied Bandwidth	±0.01ppm	(1)
Radiated Emission 30~1000MHz	±4.10dB	(1)
Radiated Emission Above 1GHz	±4.32dB	(1)
Conducted Disturbance0.15~30MHz	±3.20dB	(1)

Hereafter the best measurement capability for HUAK laboratory is reported:

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.



2. GENERAL INFORMATION

2.1. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	25°C
Relative Humidity:	55 %
Air Pressure:	101 kPa

2.2. General Description of EUT

Product Name:	Bluetooth Neckband
Model/Type reference:	NECK-R-FD
Serial Model:	NECK-R-BLK, NECK-R-WHT, NECK-R
Model Difference:	All model's the function, software and electric circuit are the same, only with a product model named different. Test sample model: NECK-R-FD
Power supply:	DC 3.7V from battery or DC 5V from USB
Version:	Supported EDR
Modulation:	GFSK, π/4DQPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	PCB Antenna
Antenna gain:	-0.58 dBi
Hardware Version:	V1.0
Software Version:	V1.0

Note: For more details, refer to the user's manual of the EUT.

2.3. Description of Test Modes and Test Frequency

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing. There are 79 channels provided to the EUT and Channel 00/39/78 was selected for testing.

Operation Frequency :

Channel	Frequency (MHz)
00	2402
01	2403
:	÷
38	2440
39	2441
40	2442
:	÷
77	2479
78	2480

Note: The line display in grey were the channel selected for testing



Preliminary tests were performed in each mode and packet length of BT, and found worst case as bellow, finally test were conducted at those mode and recorded in this report.

Test Items	Worst case		
Conducted Emissions	DH5 Middle channel		
Radiated Emissions and Band Edge	DH5 low channel		
Maximum Conducted Output Power	DH5/2DH5		
20dB Bandwidth&99% Bandwidth	DH5/2DH5		
Frequency Separation	DH5/2DH5 Middle channel		
Number of hopping frequency	DH5/2DH5		
Time of Occupancy (Dwell Time)	DH1/DH3/DH5 Middle channel 2DH1/2DH3/2DH5 Middle channel		
Out-of-band Emissions	DH5/2DH5		

2.4. Equipments Used during the Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	L.I.S.N. Artificial Mains Network	R&S	ENV216	HKE-002	Dec. 26, 2019	1 Year
2.	Receiver	R&S	ESCI 7	HKE-010	Dec. 26, 2019	1 Year
3.	RF automatic control unit	Tonscend	JS0806-2	HKE-060	Dec. 26, 2019	1 Year
4.	Spectrum analyzer	R&S	FSP40	HKE-025	Dec. 26, 2019	1 Year
5.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 26, 2019	1 Year
6.	Preamplifier	Schwarzbeck	BBV 9743	HKE-006	Dec. 26, 2019	1 Year
7.	EMI Test Receiver	Rohde & Schwarz	ESCI 7	HKE-010	Dec. 26, 2019	1 Year
8.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	HKE-012	Dec. 26, 2019	1 Year
9.	Loop Antenna	Schwarzbeck	FMZB 1519 B	HKE-014	Dec. 26, 2019	1 Year
10.	Horn Antenna	Schewarzbeck	9120D	HKE-013	Dec. 26, 2019	1 Year
11.	Pre-amplifier	EMCI	EMC051845 SE	HKE-015	Dec. 26, 2019	1 Year
12.	Pre-amplifier	Agilent	83051A	HKE-016	Dec. 26, 2019	1 Year
13.	EMI Test Software EZ-EMC	Tonscend	JS1120-B Version	HKE-083	Dec. 26, 2019	N/A
14.	Power Sensor	Agilent	E9300A	HKE-086	Dec. 26, 2019	1 Year
15.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 26, 2019	1 Year
16.	Signal generator	Agilent	N5182A	HKE-029	Dec. 26, 2019	1 Year
17.	Signal Generator	Agilent	83630A	HKE-028	Dec. 26, 2019	1 Year
18.	Shielded room	Shiel Hong	4*3*3	HKE-039	Dec. 27, 2017	3 Year
19.	Power meter	Agilent	E4419B	HKE-085	Dec. 26, 2019	1 Year
20	Horn Antenna	Schewarzbeck	BBHA 9170	HKE-017	Dec. 26, 2019	1 Year

The calibration interval was one year



2.5. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with Section 15.247 of the FCC Part 15, Subpart C Rules ,RSS Gen and RSS 247 Rules.

2.6. Modifications

No modifications were implemented to meet testing criteria.

2.7. DESCRIPTION OF TEST SETUP

Operation of EUT during Conduction and below 1GHz Radiation testing:

AC Plug	Adapter		EUT
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Operation of EUT during Above1GHz Radiation testing:

EUT

Adapter information Model: HW-059200CHQ Input: 100-240V, 50-60Hz, 0.5A Output: 5VDC, 2A

The sample was placed (0.8m below 1GHz, 1.5m above 1GHz) above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. The worst case is X position



TEST CONDITIONS AND RESULTS

2.8. Conducted Emissions Test

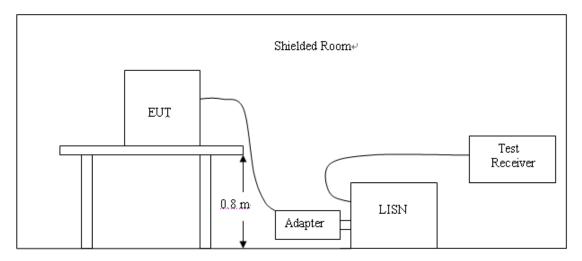
<u>LIMIT</u>

According to FCC CFR Title 47 Part 15 Subpart C Section 15.207 and RSS Gen 8.8, AC Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus as below:

Frequency range (MHz)	Limit (dBuV)				
	Quasi-peak	Average			
0.15-0.5	66 to 56*	56 to 46*			
0.5-5	56	46			
5-30	60	50			

* Decreases with the logarithm of the frequency.

TEST CONFIGURATION



TEST PROCEDURE

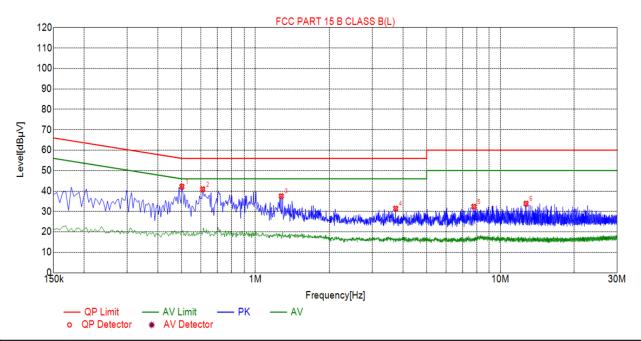
- 1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10:2013.
- 2. Support equipment, if needed, was placed as per ANSI C63.10:2013
- 3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10:2013.
- 4. The adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
- 5. All support equipments received AC power from a second LISN, if any.
- 6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
- 7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
- 8. During the above scans, the emissions were maximized by cable manipulation.



TEST RESULTS

Remark: All modes of GFSK, Pi/4 DQPSK were test at Low, Middle, and High channel; only the worst result of GFSK High Channel was reported as below:

Test Specification: Line



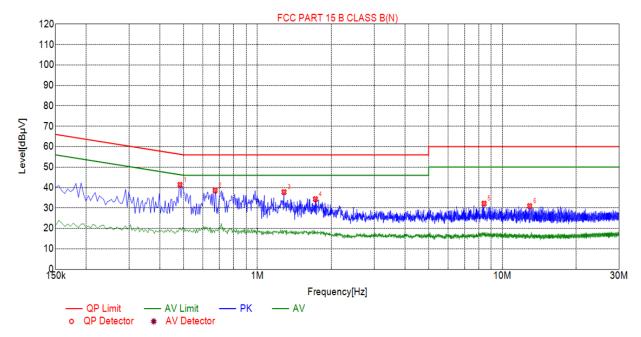
Sus	Suspected List										
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Туре			
1	0.5010	42.17	10.04	56.00	13.83	32.13	PK	L			
2	0.6090	40.89	10.05	56.00	15.11	30.84	PK	L			
3	1.2750	37.50	10.09	56.00	18.50	27.41	PK	L			
4	3.7365	31.43	10.25	56.00	24.57	21.18	PK	L			
5	7.7910	32.37	10.16	60.00	27.63	22.21	PK	L			
6	12.7365	33.85	9.97	60.00	26.15	23.88	PK	L			

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss Level=Test receiver reading + correction factor



Test Specification: Neutral



Sus	Suspected List										
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Туре			
1	0.4830	41.34	10.04	56.29	14.95	31.30	PK	N			
2	0.6720	38.59	10.05	56.00	17.41	28.54	PK	N			
3	1.2840	37.78	10.09	56.00	18.22	27.69	PK	N			
4	1.7250	34.33	10.13	56.00	21.67	24.20	PK	N			
5	8.4210	32.16	10.13	60.00	27.84	22.03	РК	N			
6	12.9300	30.92	9.97	60.00	29.08	20.95	PK	N			

Remark: Margin = Limit – Level Correction factor = Cable lose + LISN insertion loss Level=Test receiver reading + correction factor



2.9. Radiated Emissions and Band Edge

<u>Limit</u>

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

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)

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission

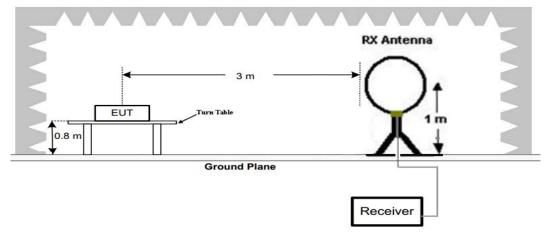
Unwanted emissions that fall into restricted bands shall comply with the limits specified in RSS-Gen; and Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Frequency (MHz)	Distance (Meters)	Radiated (dBµV/m)	Radiated (µV/m)					
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)					
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)					
1.705-30	3	20log(30)+ 40log(30/3)	30					
30-88	3	40.0	100					
88-216	3	43.5	150					
216-960	3	46.0	200					
Above 960	3	54.0	500					

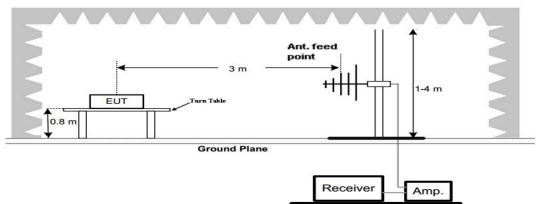
Radiated emission limits

TEST CONFIGURATION

(A) Radiated Emission Test Set-Up, Frequency Below 30MHz

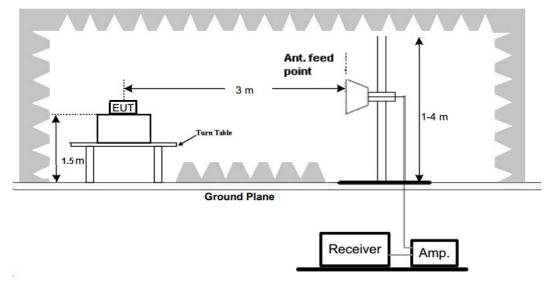






(B) Radiated Emission Test Set-Up, Frequency below 1000MHz

(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



Test Procedure

- The EUT was placed on turn table which is 0.8m above ground plane for below 1GHz test, and on a low permittivity and low loss tangent turn table which is 1.5m above ground plane for above 1GHz test.
- 2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0°C to 360°C to acquire the highest emissions from EUT
- 3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 4. Repeat above procedures until all frequency measurements have been completed.

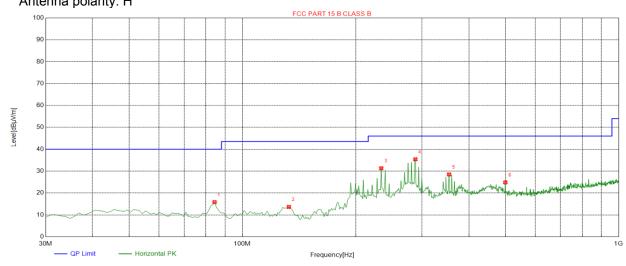
TEST RESULTS

Remark:

- 1. Radiated Emission measured at GFSK, $\pi/4$ DQPSK mode from 9 KHz to 10th harmonic of fundamental and recorded worst case at GFSK DH5 mode.
- 2. There is no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.
- 3. For below 1GHz testing recorded worst at GFSK DH5 low channel.



Below 1GHz Test Results: Antenna polarity: H



_			
	Quenested	Lint	

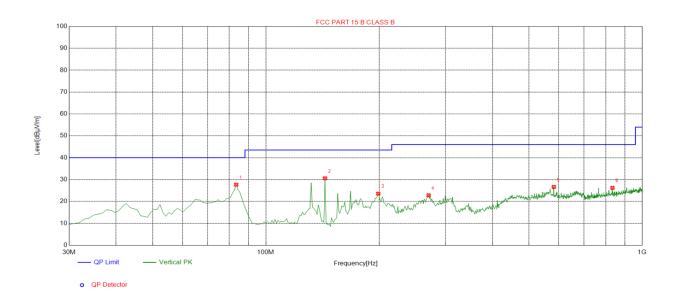
o QP Detector

Suspected List										
Freq.	Factor	Reading	Level	Limit	Margin	Height	Angle	Polarity		
[MHz]	[dB]	[dBµV/m]	[dBµV/m]	[dBµV/m]	[dB]	[cm]	[°]	Folanty		
84.3744	-18.42	34.24	15.82	40.00	24.18	100	26	Horizontal		
132.9229	-18.75	32.38	13.63	43.50	29.87	100	100	Horizontal		
233.9039	-14.14	45.46	31.32	46.00	14.68	100	264	Horizontal		
288.2783	-12.91	48.32	35.41	46.00	10.59	100	264	Horizontal		
354.3043	-11.54	40.02	28.48	46.00	17.52	100	264	Horizontal		
499.9500	-8.30	33.12	24.82	46.00	21.18	100	334	Horizontal		
	[MHz] 84.3744 132.9229 233.9039 288.2783 354.3043	[MHz] [dB] 84.3744 -18.42 132.9229 -18.75 233.9039 -14.14 288.2783 -12.91 354.3043 -11.54	[MHz] [dB] [dBµV/m] 84.3744 -18.42 34.24 132.9229 -18.75 32.38 233.9039 -14.14 45.46 288.2783 -12.91 48.32 354.3043 -11.54 40.02	[MHz][dB][dBµV/m][dBµV/m]84.3744-18.4234.2415.82132.9229-18.7532.3813.63233.9039-14.1445.4631.32288.2783-12.9148.3235.41354.3043-11.5440.0228.48	[MHz][dB][dBµV/m][dBµV/m][dBµV/m]84.3744-18.4234.2415.8240.00132.9229-18.7532.3813.6343.50233.9039-14.1445.4631.3246.00288.2783-12.9148.3235.4146.00354.3043-11.5440.0228.4846.00	[MHz][dB][dBµV/m][dBµV/m][dBµV/m][dBµV/m][dB]84.3744-18.4234.2415.8240.0024.18132.9229-18.7532.3813.6343.5029.87233.9039-14.1445.4631.3246.0014.68288.2783-12.9148.3235.4146.0010.59354.3043-11.5440.0228.4846.0017.52	[MHz] [dB] [dBµV/m] [dBµV/m] [dBµV/m] [dBµV/m] [dB] [cm] 84.3744 -18.42 34.24 15.82 40.00 24.18 100 132.9229 -18.75 32.38 13.63 43.50 29.87 100 233.9039 -14.14 45.46 31.32 46.00 14.68 100 288.2783 -12.91 48.32 35.41 46.00 10.59 100 354.3043 -11.54 40.02 28.48 46.00 17.52 100	[MHz] [dB] [dBµV/m] [dBµV/m] [dBµV/m] [dBµV/m] [dB] [cm] [°] 84.3744 -18.42 34.24 15.82 40.00 24.18 100 26 132.9229 -18.75 32.38 13.63 43.50 29.87 100 100 233.9039 -14.14 45.46 31.32 46.00 14.68 100 264 288.2783 -12.91 48.32 35.41 46.00 10.59 100 264 354.3043 -11.54 40.02 28.48 46.00 17.52 100 264		

Remark: Factor = Cable loss + Antenna factor - Preamplifier; Level = Reading + Factor; Margin = Limit - Level



Antenna polarity: V



Suspe	Suspected List										
NO.	Freq.	Factor	Reading	Level	Limit	Margin	Height	Angle	Delerity		
NO.	[MHz]	[dB]	[dBµV/m]	[dBµV/m]	[dBµV/m]	[dB]	[cm]	[°]	Polarity		
1	83.4034	-18.65	46.31	27.66	40.00	12.34	100	18	Vertical		
2	143.6036	-19.09	49.68	30.59	43.50	12.91	100	18	Vertical		
3	198.9489	-15.16	38.75	23.59	43.50	19.91	100	326	Vertical		
4	270.8008	-13.63	36.47	22.84	46.00	23.16	100	175	Vertical		
5	582.4825	- <mark>6.6</mark> 4	33.29	26.65	46.00	19.35	100	21	Vertical		
6	833.9640	-2.49	28.71	26.22	46.00	19.78	100	290	Vertical		

Remark: Factor = Cable loss + Antenna factor - Preamplifier; Level = Reading + Factor; Margin = Limit - Level

Remark:

(1) Measuring frequencies from 9 KHz to the 1 GHz, Radiated emission test from 9KHz to 30MHz was verified, and no any emission was found except system noise floor.

(2) * denotes emission frequency which appearing within the Restricted Bands specified in

provision of 15.205, then the general radiated emission limits in 15.209 apply.

(3) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz

for measuring above 1 GHz, below 30MHz was 10KHz.



For 1GHz to 25GHz

CH Low (2402MHz) Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type
4804.00	55.45	-3.65	51.80	74.00	-22.20	peak
4804.00	47.66	-3.65	44.01	54.00	-9.99	AVG
7206.00	57.27	-0.95	56.32	74.00	-17.68	peak
7206.00	43.22	-0.95	42.27	54.00	-11.73	AVG
Remark: Facto	or = Antenna Fac	ctor + Cable Lo	oss – Pre-amplifier			

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type
4804.00	57.74	-3.65	54.09	74.00	-19.91	peak
4804.00	46.56	-3.65	42.91	54.00	-11.09	AVG
7206.00	56.48	-0.95	55.53	74.00	-18.47	peak
7206.00	42.77	-0.95	41.82	54.00	-12.18	AVG
Remark: Facto	or = Antenna Fac	ctor + Cable Lo	oss – Pre-amplifier			



CH Middle (2441MHz) Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type
4882.00	57.63	-3.54	54.09	74.00	-19.91	peak
4882.00	48.83	-3.54	45.29	54.00	-8.71	AVG
7323.00	56.28	-0.81	55.47	74.00	-18.53	peak
7323.00	43.33	-0.81	42.52	54.00	-11.48	AVG
Remark: Facto	r = Antenna Fa	ctor + Cable Lo	oss – Pre-amplifier			

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Defector			
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type			
4882.00	57.74	-3.54	54.20	74.00	-19.80	peak			
4882.00	46.88	-3.54	43.34	54.00	-10.66	AVG			
7323.00	55.47	-0.81	54.66	74.00	-19.34	peak			
7323.00	42.31	-0.81	41.50	54.00	-12.50	AVG			
Remark: Facto	Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.								



CH High (2480MHz) Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type
4960.00	55.53	-3.43	52.10	74.00	-21.90	peak
4960.00	46.66	-3.44	43.22	54.00	-10.78	AVG
7440.00	56.74	-0.77	55.97	74.00	-18.03	peak
7440.00	41.44	-0.77	40.67	54.00	-13.33	AVG
Remark: Facto	r = Antenna Fa	ctor + Cable Lo	oss – Pre-amplifier	-		

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Detector Type
4960.00	56.63	-3.43	53.20	74.00	-20.80	peak
4960.00	46.44	-3.44	43.00	54.00	-11.00	AVG
7440.00	56.18	-0.77	55.41	74.00	-18.59	peak
7440.00	42.53	-0.77	41.76	54.00	-12.24	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Remark :

(1) Measuring frequencies from 1 GHz to the 25 GHz $^\circ$

(2) "F" denotes fundamental frequency; "H" denotes spurious frequency. "E" denotes band edge frequency.

(3) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.

(4) The emissions are attenuated more than 20dB below the permissible limits are not recorded in the report.

(5) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz. The resolution bandwidth of test

receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for peak measurement with peak detector at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 10Hz for Average measurement with peak detection at frequency above 1GHz.

(6) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.

(7)All modes of operation were investigated and the worst-case emissions are reported.



Radiated Band Edge Test:

Hopping

Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector		
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре		
2310.00	57.22	-5.81	51.41	74	-22.59	peak		
2310.00	/	-5.81	/	54	1	AVG		
2390.00	55.42	-5.84	49.58	74	-24.42	peak		
2390.00	/	-5.84	/	54	/	AVG		
Remark: Facto	Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.							

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре
2310.00	56.63	-5.81	50.82	74	-23.18	peak
2310.00	/	-5.81	/	54	/	AVG
2390.00	55.44	-5.84	49.6	74	-24.4	peak
2390.00	1	-5.84	/	54	/	AVG
Remark: Facto	or = Antenna Fa	ctor + Cable Lo	ss – Pre-amplifier			



Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector							
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре							
2483.50	57.62	-5.81	51.81	74	-22.19	peak							
2483.50	1	-5.81	/	54	/	AVG							
2500.00	55.74	-6.06	49.68	74	-24.32	peak							
2500.00	1	-6.06	/	54	1	AVG							
Remark: Facto	or = Antenna Fa	ctor + Cable Lo	ss – Pre-amplifier			Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.							

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector						
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре						
2483.50	56.86	-5.81	51.05	74	-22.95	peak						
2483.50	/	-5.81	/	54	1	AVG						
2500.00	54.77	-6.06	48.71	74	-25.29	peak						
2500.00	/	-6.06	/	54	1	AVG						
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.												
Remark: All the	e other emissior	ns not reported	were too low to re	ad and deemed to	o comply with	Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit.						



NO hopping

Operation Mode: TX CH Low (2402MHz) Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре	
2310.00	55.47	-5.81	49.66	74	-24.34	peak	
2310.00	/	-5.81	/	54	/	AVG	
2390.00	54.85	-5.84	49.01	74	-24.99	peak	
2390.00	/	-5.84	/	54	/	AVG	
Remark: Facto	Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре
2310.00	56.44	-5.81	50.63	74	-23.37	peak
2310.00	1	-5.81	1	54	/	AVG
2390.00	55.74	-5.84	49.9	74	-24.1	peak
2390.00	/	-5.84	1	54	/	AVG
Remark: Facto	or = Antenna Fa	ctor + Cable Lo	ss – Pre-amplifier			



Operation Mode: TX CH High (2480MHz) Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector		
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре		
2483.50	57.63	-5.81	51.82	74	-22.18	peak		
2483.50	1	-5.81	/	54	1	AVG		
2500.00	54.77	-6.06	48.71	74	-25.29	peak		
2500.00	1	-6.06	/	54	/	AVG		
Remark: Facto	Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.							

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Туре
2483.50	56.38	-5.81	50.57	74	-23.43	peak
2483.50	/	-5.81	/	54	/	AVG
2500.00	54.44	-6.06	48.38	74	-25.62	peak
2500.00	1	-6.06	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						
Remark: All the	e other emissior	ns not reported	were too low to re	ad and deemed to	o comply with	FCC limit.



2.10. Maximum Peak Conducted Output Power

<u>Limit</u>

Frequency hopping systems 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, 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. 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.

Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

Test Configuration



Test Results

Туре	Channel	Output power (dBm)	Limit (dBm)	Result
	00	-8.79		
GFSK	39	-11.598	21.00	Pass
	78	-12.124		
	00	-9.202		
π/4DQPSK	39	-10.892	21.00	Pass
	78	-11.834		

Note: 1.The test results including the cable lose.



2.11. 20dB Bandwidth

<u>Limit</u>

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW.

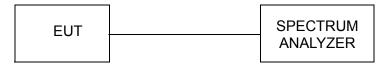
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

RBW=1% to 5% of the OBW VBW=approximately 3 X RBW Detector=Peak Trace Mode: Max Hold

Use the 99% power bandwidth function of the instrument to measure the Occupied Bandwidth and recoded.

Test Configuration

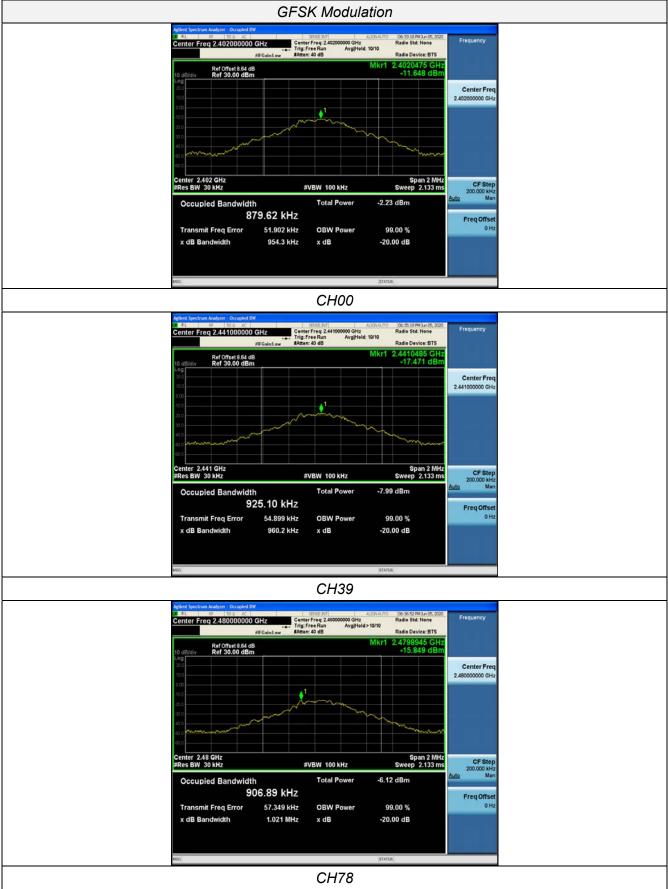


Test Results

Modulation	Channel 20dB bandwidth (MHz)		Result
	CH00	0.9543	
GFSK	CH39	0.9602	
	CH78	1.021	Daga
	CH00	1.371	Pass
π/4DQPSK	CH39	1.391	
	CH78	1.394	



20dB bandwidth







3.5 Frequency Separation

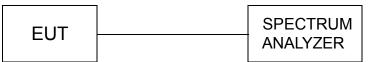
<u>LIMIT</u>

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.

TEST CONFIGURATION



TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result	
GFSK	CH39	1.004	2/3*20dB	Pass	
Gron	CH40	1.004	bandwidth	r a 3 3	
π/4DQPSK	CH39	1.006	2/3*20dB	Pass	
II/4DQF3K	CH40	1.000	bandwidth	Pass	

Note: We have tested all mode at high, middle and low channel, and recorded worst case at middle





2.12. Number of hopping frequency

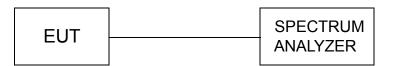
<u>Limit</u>

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz.

Test Configuration



Test Results

Modulation	Number of Hopping Channel	Limit	Result Pass	
GFSK	79	≥15	Daga	
π/4DQPSK	79	210	rass	



GFSK Modulation	
Agilant Synchram Amilyzer Single State GR22 Strill All Strikt TO O72/35 Strikt Strikt O72/35 Strikt O72/35 Strikt Strikt <tho7 35="" strikt<="" th=""> O72/35 Strikt</tho7>	Frequency Auto Tune
	Center Freq 2.441750000 GHz Start Freq
	2.40000000 GHz Stop Freq 2.483500000 GHz
Start 2.40000 GHz Stop 2.48350 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 8.000 ms (100 pts) #Res BW 100 kHz #VBW 300 kHz Sweep 8.000 ms (100 pts) Immunol fill Succession fill	CF Step 8.350000 MHz <u>wto</u> Man Freq Offset 0 Hz
msc status π/4DQPSK Modulation	
Agilent Spectrum Analyzer - Swrgt SA II AL 16 100 0 AC Start Freq 2.40000000000 GHz Trig: Free Run Avg1Hold>100/100 Trie Head Free Run Avg1Hold>100/100 Trie	Frequency
Ref Offset 8,64 dB ΔMkr1 78.406 5 MHz 10 dB/div Ref 10.00 dBm 2.381 dB	Auto Tune
200 100 200 X8 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	Center Freq 2.441750000 GHz
	Start Freq 2.400000000 GHz
800 Start 2.40000 GHz Stop 2.48350 GHz	Stop Freq 2.483500000 GHz CF Step
#Res BW 100 kHz #VBW 300 kHz Sweep 8.000 ms (1001 pts) wr/i MODC TIRC ScL X Y Punction Punction Punction Punction worth P	8.350000 MHz uto Man
3 4 5 6 7 7	Freq Offset 0 Hz
9 10 11 Ko NSO STATUS	



2.13. Time of Occupancy (Dwell Time)

<u>Limit</u>

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

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 3MHz VBW, Span 0Hz.

Test Configuration

FUT	SPECTRUM
LUI	ANALYZER

Test Results

Modulation	Packet	Pulse time (ms)	Dwell time (second)	Limit (second)	Result	
	DH1	0.38	0.122			
GFSK	DH3	1.63	0.261	0.40	Pass	
	DH5	2.88	0.307			
	2-DH1	0.39	0.125			
π/4DQPSK	K 2-DH3 1.64		0.262	0.40	Pass	
	2-DH5	2.88	0.307			

Note:

1. We have tested all mode at high, middle and low channel, and recoreded worst case at middle channel.

Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1, 3-DH1
 Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3
 Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5, 3-DH5









2.14. Out-of-band Emissions

<u>Limit</u>

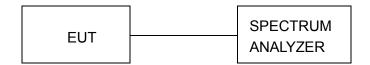
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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 any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector, and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

Test Configuration

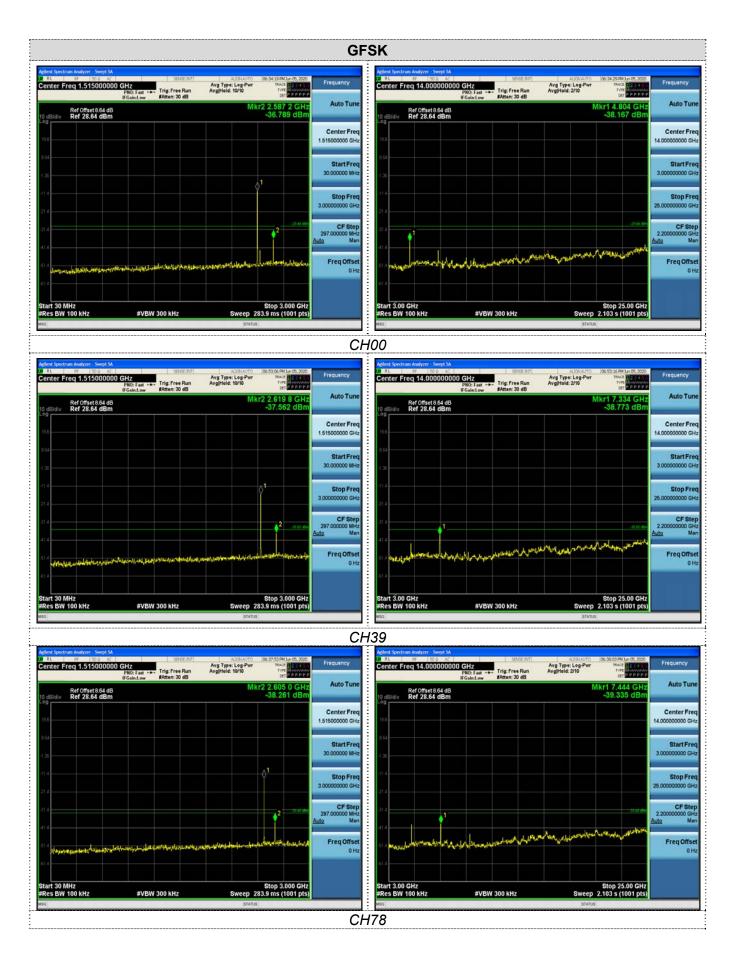


Test Results

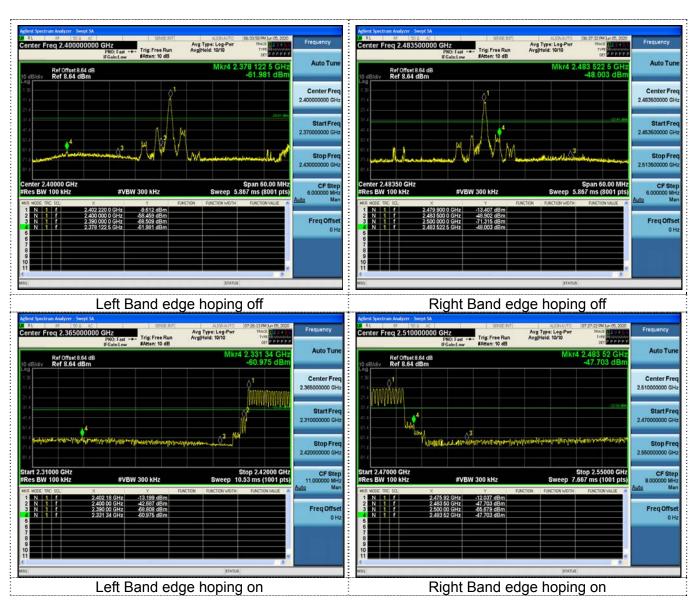
Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

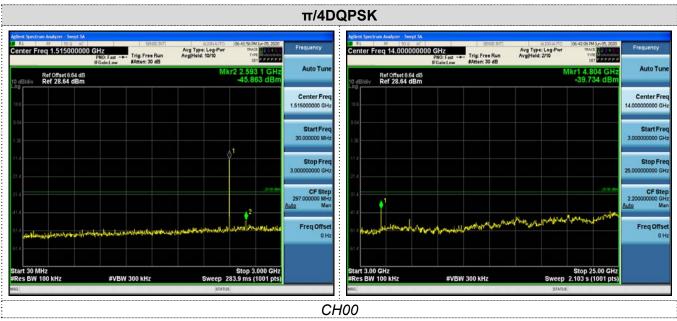
We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5 and 2DH5













Agilent Spectrum Analyzer - Swept SA R RL RF 50.9 AC SENSE: 2017	410144/70 06:53:47 PM Jan 05, 2020	Con RL		T ALX914UTO 06-53:57 PM 3m 05, 2020 Ava Tune: Log-Per 1945 0 D20 100	Frequency
Center Freq 1.515000000 GHz PN0: Fast + Trig: Free Run IFGain:Low #Atten: 30 dB	Avg Type: Log-Pwr Avg[Hold: 10/10 Tvre DET P.P.P.P	Center	Freq 14.000000000 GHz PN0: Fast ++- Trig: Free Run IFGain:Lew #Atten: 30 dB		
Ref Offset 8.64 dB	Mkr2 2.619 8 GHz -40.531 dBm	Auto Tune	Ref Offset 8.64 dB Ref 28.64 dBm	Mkr1 24.670 GHz -40.158 dBm	Auto Tu
		Center Freq			Center Fr
18.5		1.515000000 GHz			4.000000000 G
164		StartFreq			Start Fr
а Т		30.000000 MHz			3.000000000 G
11.4	01	Stop Freq			Stop Fr
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61.47		61.4			
Start 30 MHz	Stop 3.000 GHz			Stop 25.00 GHz	
#Res BW 100 kHz #VBW 300 kHz	Sweep 283.9 ms (1001 pts) status	#Res BV	V 100 kHz #VBW 300 kHz	Sweep 2.103 s (1001 pts)	
		CH39			
Agilent Spectrum Analyzer - Swept SA			strum Analyzer - Swept SA		
Center Freq 1.515000000 GHz PN0: Fast +++ Trig: Free Run	ALIGNAUTO 06:45:40 PM Jun 05, 2020 Avg Type: Log-Pwr TRACE 0 2014 Avg[Hold: 10/10 TVFE		Freq 14.00000000 GHz PN0: Fast +++ Trig: Free Run	Avg Type: Log-Pwr TRACE RED 4 97	Frequency
PRO: Fast PRO: Fast #GainLow Ref Offset 8.64 dB	Mkr2 2.593 1 GHz	Auto Tune	IFGain:Low #Atten: 30 dB Ref Offset 8.64 dB	Mkr1 4.958 GHz	Auto Tu
to dB/div Ref 28.64 dBm	-44.428 dBm	10 dB/div Log	Ref 28.64 dBm	-36.796 dBm	
18.5		Center Freq 1.51500000 GHz 185			Center Fr 4.000000000 G
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1 33		30.000000 MHz -1.35			3.000000000 G
1) 4		Stop Freq			Stop Fr
21.4	Y	3.00000000 GHz			5.00000000 G
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Start 30 MHz	Stop 3.000 GHz	Start 3.0 #Res BV	10 GHZ V 100 kHz #VBW 300 kHz	Stop 25.00 GHz Sweep 2.103 s (1001 pts)	
#Res BW 100 kHz #VBW 300 kHz	Sweep 283.9 ms (1001 pts)				
#Res BW 100 kHz #VBW 300 kHz	Sweep 283.9 ms (1001 pts)			ETATUS	
80	Sweep 283.9 ms (1001 pts)	CH78		BTATUS	
nso Agliest Spectrum Analyzer - Swipt SA R III Social Accil Spectrum Color Accil Contern Error 2 ADDODODOD CH-	Sweep 283.9 ms (1001 pts)	Agilent Spec	trust Analyzer - Swept SA IF 150 0 4C SINCE AT Free 2 483500000 GHz	TI I JUSUUTO 100-45-10 PM to 05-200	Frequency
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Ref SD (200 m) Trig: Free Run (200 m) <thtrig: free="" run<br="">(200 m) Trig: Free Run (200 m)</thtrig:>	Sweep 283.9 ms (1001 pts)	Adject Sec Center Freq 2.40000000 GHz Center 10 dB/dv Center Freq 2.40000000 GHz 11 0 dB/dv Start Freq 2.37000000 GHz 11 0 dB/dv Start Freq 2.45000000 GHz 11 0 dB/dv CF Step 6.000000 GHz 11 0 dB/dv Freq Offset 0 Hz 11 0 dB/dv Freq Offset 0 Hz 10 0 Hz	IF 100 6 AC L SPEER Freq 2.483500000 GHz PICO Fast ->> Trig: Free Run Fatter: 10 dB Ref Offset 8.64 dB Trig: Free Run Fatter: 10 dB Trig: Free Run Fatter: 10 dB Ref Offset 8.64 dB Image: Comparison of the set of the se	Avg179:LcsPwr Avg179:LcsPwr Avg179:LcsPwr Mkr4 2.493 537 5 GHz 47.972 dB Span 60.00 MHz Sweep 5.867 ms (8001 pts)	Auto Tu Center Fr 2.45350000 0 Start Fr 2.513500000 0 Stop Fr 6.00000 M M Freq Offs







2.15. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

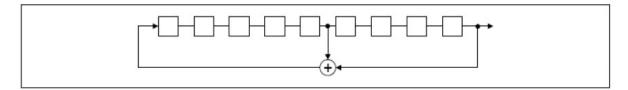
For 47 CFR Part 15C section 15.247 (a) (1):

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping 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. 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 hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence Requirement

The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of pseudorandom frequency hopping sequence as follows:

0	2	4	6	62	64	78	1	73	75 77
								 T	
								1	
				L				\$ <u></u>	

Each frequency used equally one the average by each transmitter.

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



2.16. ANTENNA REQUIREMENT

Standard Applicable

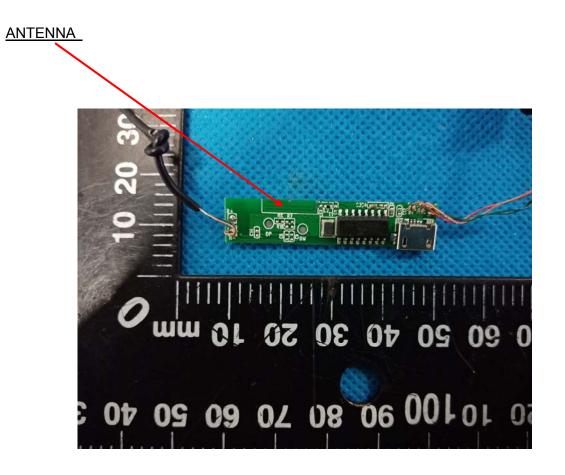
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247, if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Refer to statement below for compliance.

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

Antenna Connected Construction

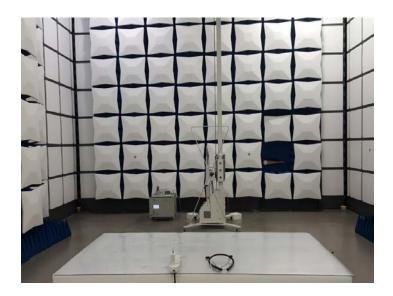
The antenna used in this product is a PCB Antenna which permanently attached. It conforms to the standard requirements. The directional gains of antenna used for transmitting is -0.58 dBi.

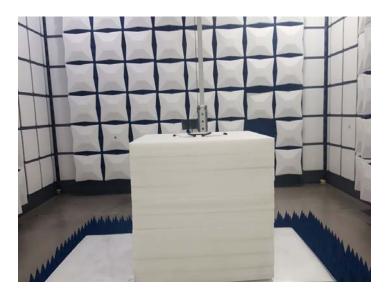




3. Test Setup Photos of the EUT









4. PHOTOS OF THE EUT

Reference to the report: ANNEX A of external photos and ANNEX B of internal photos

-----End of test report------