RADIO TEST REPORT

Report No.:STS2104010W02

Issued for

Shenzhen Zerone Technology Co., Ltd

5th Floor, E Building, No. 9 East Area of Shangxue Industrial Park, Longgang, Shenzhen, China.

Product Name:	GFIVE Neckband Bluetooth Earphone
Brand Name:	GFIVE
Model Name:	GF01
Series Model:	GF01R
FCC ID:	2AZL8-GF01-01R
Test Standard:	FCC Part 15.247

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TEST RESULT CERTIFICATION

Applicant's Name.....:	Shenzhen Zerone Technology Co., Ltd
Address .....:	5th Floor, E Building, No. 9 East Area of Shangxue Industrial Park, Longgang, Shenzhen, China.
Manufacturer's Name .....:	Shenzhen Zerone Technology Co., Ltd
Address .....:	5th Floor, E Building, No. 9 East Area of Shangxue Industrial Park, Longgang, Shenzhen, China.

Product Description

Product Name.....:	GFIVE Neckband Bluetooth Earphone
Brand Name .....:	GFIVE
Model Name .....:	GF01
Series Model.....:	GF01R
Test Standards.....:	FCC Part15.247
Test Procedure .....:	ANSI C63.10-2013

This device described above has been tested by STS, the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
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Date of Test.....:	
Date of receipt of test item .....:	02 Apr. 2021
Date (s) of performance of tests .....:	02 Apr. 2021 ~ 15 Apr. 2021
Date of Issue.....:	15 Apr. 2021
Test Result.....:	**Pass**

Testing Engineer : Chris Chen

(Chris Chen)

Technical Manager : Sean She

(Sean she)

Authorized Signatory : Vita Li

(Vita Li)

Table of Contents

1. SUMMARY OF TEST RESULTS 6

1.1 TEST FACTORY 7

1.2 MEASUREMENT UNCERTAINTY 7

2. GENERAL INFORMATION 8

2.1 GENERAL DESCRIPTION OF THE EUT 8

2.2 DESCRIPTION OF THE TEST MODES 10

2.3 TEST SOFTWARE AND POWER LEVEL 10

2.4 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED 11

2.5 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS 12

2.6 EQUIPMENTS LIST 13

3. EMC EMISSION TEST 15

3.1 CONDUCTED EMISSION MEASUREMENT 15

3.2 TEST PROCEDURE 16

3.3 TEST SETUP 16

3.4 EUT OPERATING CONDITIONS 16

3.5 TEST RESULTS 17

4. RADIATED EMISSION MEASUREMENT 19

4.1 RADIATED EMISSION LIMITS 19

4.2 TEST PROCEDURE 21

4.3 TEST SETUP 22

4.4 EUT OPERATING CONDITIONS 22

4.5 FIELD STRENGTH CALCULATION 22

4.6 TEST RESULTS 24

5. CONDUCTED SPURIOUS & BAND EDGE EMISSION 31

5.1 LIMIT 31

5.2 TEST PROCEDURE 31

5.3 TEST SETUP 31

5.4 EUT OPERATION CONDITIONS 31

5.5 TEST RESULTS 32

6. POWER SPECTRAL DENSITY TEST 36

6.1 LIMIT 36

6.2 TEST PROCEDURE 36

6.3 TEST SETUP 36

Table of Contents

6.4 EUT OPERATION CONDITIONS 36
6.5 TEST RESULTS 37
7. BANDWIDTH TEST 39
7.1 LIMIT 39
7.2 TEST PROCEDURE 39
7.3 TEST SETUP 39
7.4 EUT OPERATION CONDITIONS 39
7.5 TEST RESULTS 40
8. PEAK OUTPUT POWER TEST 42
8.1 LIMIT 42
8.2 TEST PROCEDURE 42
8.3 TEST SETUP 43
8.4 EUT OPERATION CONDITIONS 43
8.5 TEST RESULTS 44
9. ANTENNA REQUIREMENT 45
9.1 STANDARD REQUIREMENT 45
9.2 EUT ANTENNA 45
10. EUT TEST PHOTO 46

Revision History

Rev.	Issue Date	Report NO.	Effect Page	Contents
00	15 Apr. 2021	STS2104010W02	ALL	Initial Issue

1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:
KDB 558074 D01 15.247 Meas Guidance v05r02.

FCC Part 15.247,Subpart C			
Standard Section	Test Item	Judgment	Remark
15.207	Conducted Emission	PASS	--
15.247 (a)(2)	6dB Bandwidth	PASS	--
15.247 (b)(3)	Output Power	PASS	--
15.247 (c)	Radiated Spurious Emission	PASS	--
15.247 (d)	Conducted Spurious & Band Edge Emission	PASS	--
15.247 (e)	Power Spectral Density	PASS	--
15.205	Restricted bands of operation	PASS	--
Part 15.247(d)/part 15.209(a)	Band Edge Emission	PASS	--
15.203	Antenna Requirement	PASS	--

NOTE:

(1) 'N/A' denotes test is not applicable in this Test Report.

(2) All tests are according to ANSI C63.10-2013.

1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD
Add. : A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China
FCC test Firm Registration Number: 625569
IC test Firm Registration Number: 12108A
A2LA Certificate No.: 4338.01

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y** ± **U**, where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**, providing a level of confidence of approximately **95** %.

No.	Item	Uncertainty
1	RF output power, conducted	±0.68dB
2	Unwanted Emissions, conducted	±2.988dB
3	All emissions, radiated 9K-30MHz	±2.84dB
4	All emissions, radiated 30M-1GHz	±4.39dB
5	All emissions, radiated 1G-6GHz	±5.10dB
6	All emissions, radiated>6G	±5.48dB
7	Conducted Emission (9KHz-150KHz)	±2.79dB
8	Conducted Emission (150KHz-30MHz)	±2.80dB

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF THE EUT

Product Name	GFIVE Neckband Bluetooth Earphone
Trade Name	GFIVE
Model Name	GF01
Series Model	GF01R
Model Difference	Only different in model names.
Product Description	The EUT is a GFIVE Neckband Bluetooth Earphone Operation Frequency: 2402~2480 MHz Modulation Type: GFSK Radio Technology: BLE Bluetooth Version: 5.0 Bluetooth Configuration: LE(Support 1M PHY) Number Of Channel: 40 Antenna Designation: Please refer to the Note 3. Antenna Gain (dBi) 0dBi
Channel List	Please refer to the Note 2.
Power Rating	Input: DC 5V
Battery	Rated Voltage:3.7V Charge Limit Voltage:4.2V Capacity: 90mA
Hardware version number	HE05 ProDATE:2020.08.25
Software version number	GF01 EQ1 -6DB_BK3266.P32L.4M__(GF01)__MIC_EQ_MFB.XX_ BUCK_V1.0_20210126_CRC_(98E5).bin
Connecting I/O Port(s)	Please refer to the Note 1.

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User Manual.

2.

Channel List							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	10	2422	20	2442	30	2462
01	2404	11	2424	21	2444	31	2464
02	2406	12	2426	22	2446	32	2466
03	2408	13	2428	23	2448	33	2468
04	2410	14	2430	24	2450	34	2470
05	2412	15	2432	25	2452	35	2472
06	2414	16	2434	26	2454	36	2474
07	2416	17	2436	27	2456	37	2476
08	2418	18	2438	28	2458	38	2478
09	2420	19	2440	29	2460	39	2480

3.

Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	NOTE
1	GFIVE	GF01	PCB	N/A	0dBi	BLE ANT

2.2 DESCRIPTION OF THE TEST MODES

For conducted test items and radiated spurious emissions
Each of these EUT operation mode(s) or test configuration mode(s) mentioned below was evaluated respectively.

Worst Mode	Description	Data/Modulation
Mode 1	TX CH00(2402MHz)	1 Mbps/GFSK
Mode 2	TX CH19(2440MHz)	1 Mbps/GFSK
Mode 3	TX CH39(2480MHz)	1 Mbps/GFSK

Note:

(1) The measurements are performed at all Bit Rate of Transmitter, the worst data was reported.

(2) We tested for all available U.S. voltage and frequencies (For 120V, 50/60Hz and 240V, 50/60Hz) for which the device is capable of operation, and the worst case of 120V/ 60Hz is shown in the report.

(3) The battery is fully-charged during the radiated and RF conducted test.

For AC Conducted Emission

Test Case	
AC Conducted Emission	Mode 4 : Keeping BT TX

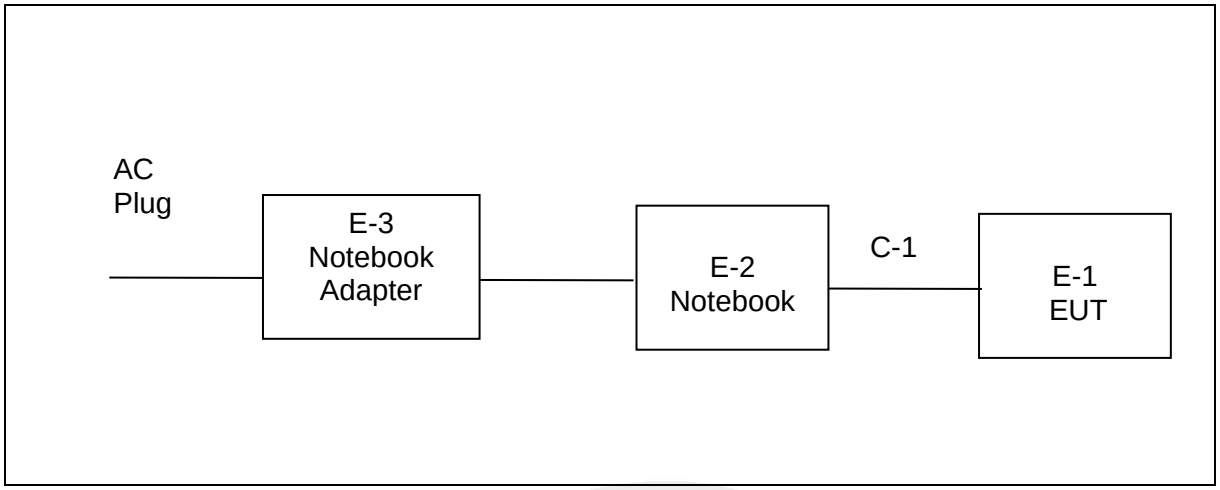
2.3 TEST SOFTWARE AND POWER LEVEL

During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level.

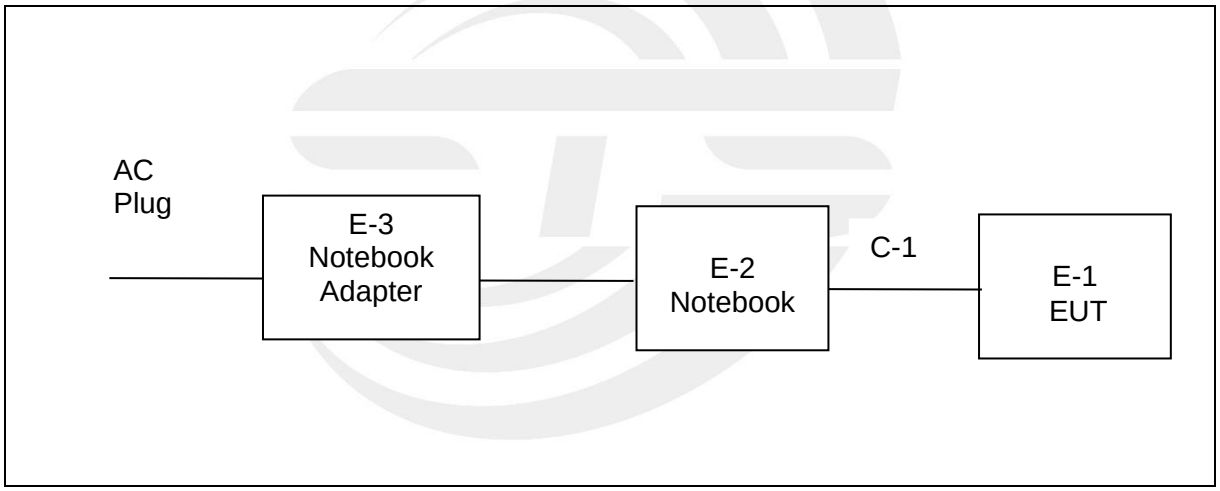
RF Function	Type	Mode Or Modulation type	ANT Gain(dBi)	Power Class	Software For Testing
BLE	BLE	GFSK	0	2	BK32xx RF Test_V1.8.2

2.4 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious Emission Test



Conducted Emission Test



2.5 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Necessary accessories

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
N/A	N/A	N/A	N/A	N/A	N/A

Support units

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
E-3	Notebook Adapter	LENOVO	ADLX45DLC3A	N/A	N/A
E-2	Notebook	LENOVO	ThinkPad E470	N/A	N/A
C-1	USB Cable	N/A	N/A	150cm	N/A

Note:

(1) For detachable type I/O cable should be specified the length in cm in『Length』column.
(2) “YES” is means “with core”; “NO” is means “without core”.

2.6 EQUIPMENTS LIST

Radiation Test equipment

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Test Receiver	R&S	ESCI	101427	2020.10.12	2021.10.11
Signal Analyzer	R&S	FSV 40-N	101823	2020.10.10	2021.10.09
Active loop Antenna	ZHINAN	ZN30900C	16035	2019.07.11	2021.07.10
Bilog Antenna	TESEQ	CBL6111D	34678	2020.10.12	2022.10.11
Horn Antenna	SCHWARZBECK	BBHA 9120D	02014	2019.10.15	2021.10.14
SHF-EHF Horn Antenna (18G-40GHz)	A-INFO	LB-180400-KF	J211020657	2020.10.12	2022.10.11
Pre-Amplifier (0.1M-3GHz)	EM	EM330	060665	2020.10.12	2021.10.11
Pre-Amplifier (1G-18GHz)	SKET	LNPA-01018G-45	SK2018080901	2020.10.12	2021.10.11
Pre-Amplifier (18G-40GHz)	SKET	LNPA-1840-50	SK2018101801	2020.10.10	2021.10.09
Temperature & Humidity	HH660	Mieo	N/A	2020.10.13	2021.10.12
Turn table	EM	SC100_1	60531	N/A	N/A
Antenna mast	EM	SC100	N/A	N/A	N/A
Test SW	FARAD	EZ-EMC(Ver.STSLAB-03A1 RE)			

Conduction Test equipment

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Test Receiver	R&S	ESCI	101427	2020.10.12	2021.10.11
LISN	R&S	ENV216	101242	2020.10.12	2021.10.11
LISN	EMCO	3810/2NM	23625	2020.10.12	2021.10.11
Temperature & Humidity	HH660	Mieo	N/A	2020.10.13	2021.10.12
Test SW	FARAD	EZ-EMC(Ver.STSLAB-03A1 CE)			

RF Connected Test

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Power Sensor	Keysight	U2021XA	MY55520005	2020.10.10	2021.10.09
			MY55520006	2020.10.10	2021.10.09
			MY56120038	2020.10.10	2021.10.09
			MY56280002	2020.10.10	2021.10.09
Signal Analyzer	Agilent	N9020A	MY51110105	2021.03.04	2022.03.03
Temperature & Humidity	HH660	Mieo	N/A	2020.10.13	2021.10.12
Test SW	FARAD	EZ-EMC(Ver.STSLAB-03A1 RE)			

3. EMC EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 POWER LINE CONDUCTED EMISSION LIMITS

The radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table.

FREQUENCY (MHz)	Conducted Emission limit (dBuV)	
	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

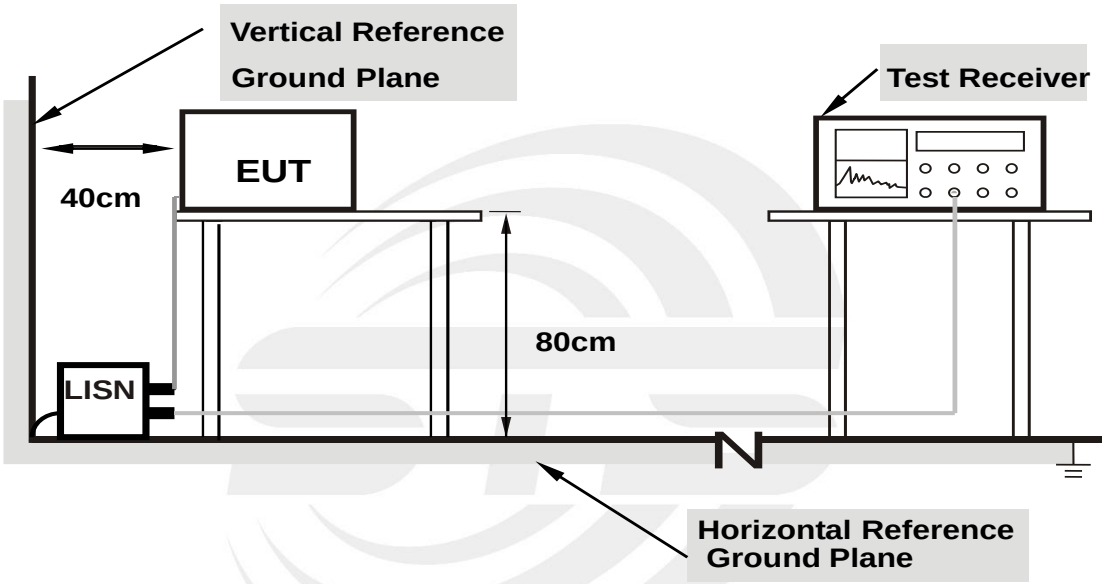
The following table is the setting of the receiver

Receiver Parameters	**Setting**
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

3.2 TEST PROCEDURE

a. The EUT is 0.8 m from the horizontal ground plane and 0.4 m from the vertical ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments are powered from additional LISN(s). The LISN provides 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN is at least 80 cm from the nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.3 TEST SETUP



Note: 1. Support units were connected to second LISN.

2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes support units.

3.4 EUT OPERATING CONDITIONS

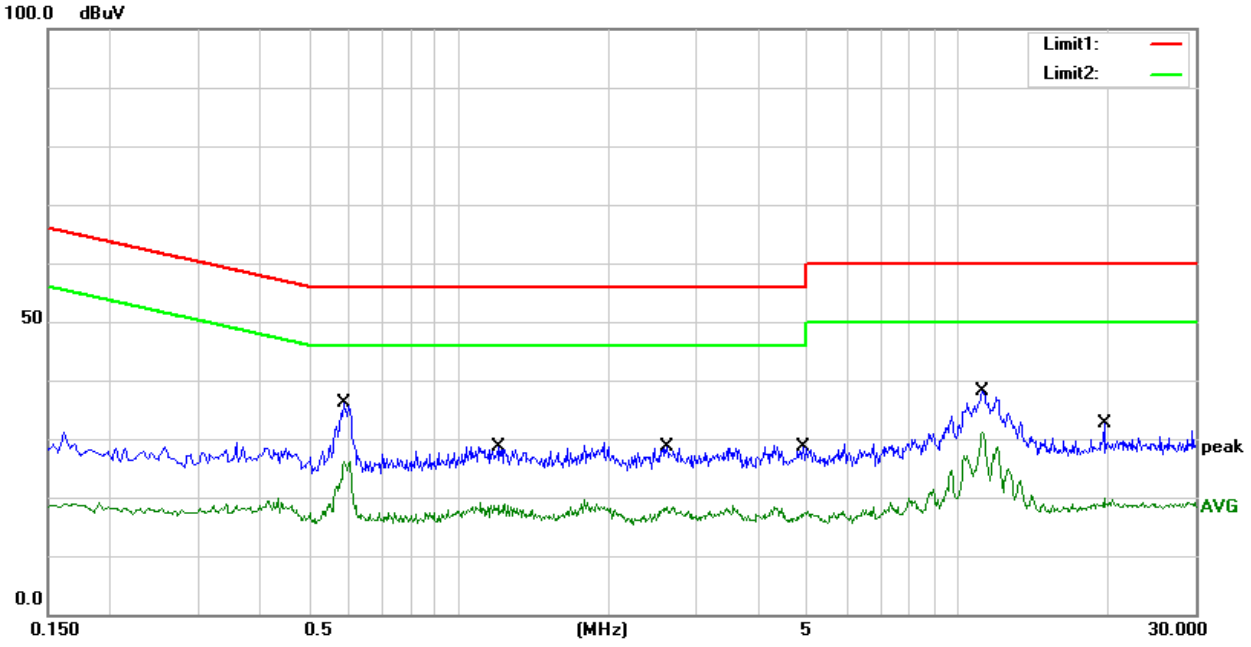
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

3.5 TEST RESULTS

Temperature:	26.8(C)	Relative Humidity:	66%RH
Test Voltage:	AC 120V/60Hz	Phase:	L
Test Mode:	Mode 4		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.5900	15.65	20.36	36.01	56.00	-19.99	QP
2	0.5900	5.73	20.36	26.09	46.00	-19.91	AVG
3	1.1980	8.53	20.15	28.68	56.00	-27.32	QP
4	1.1980	-1.39	20.15	18.76	46.00	-27.24	AVG
5	2.6220	8.59	20.11	28.70	56.00	-27.30	QP
6	2.6220	-1.73	20.11	18.38	46.00	-27.62	AVG
7	4.9020	8.66	20.03	28.69	56.00	-27.31	QP
8	4.9020	-2.52	20.03	17.51	46.00	-28.49	AVG
9	11.2460	18.21	19.89	38.10	60.00	-21.90	QP
10	11.2460	11.14	19.89	31.03	50.00	-18.97	AVG
11	19.6940	11.89	20.62	32.51	60.00	-27.49	QP
12	19.6940	-0.74	20.62	19.88	50.00	-30.12	AVG

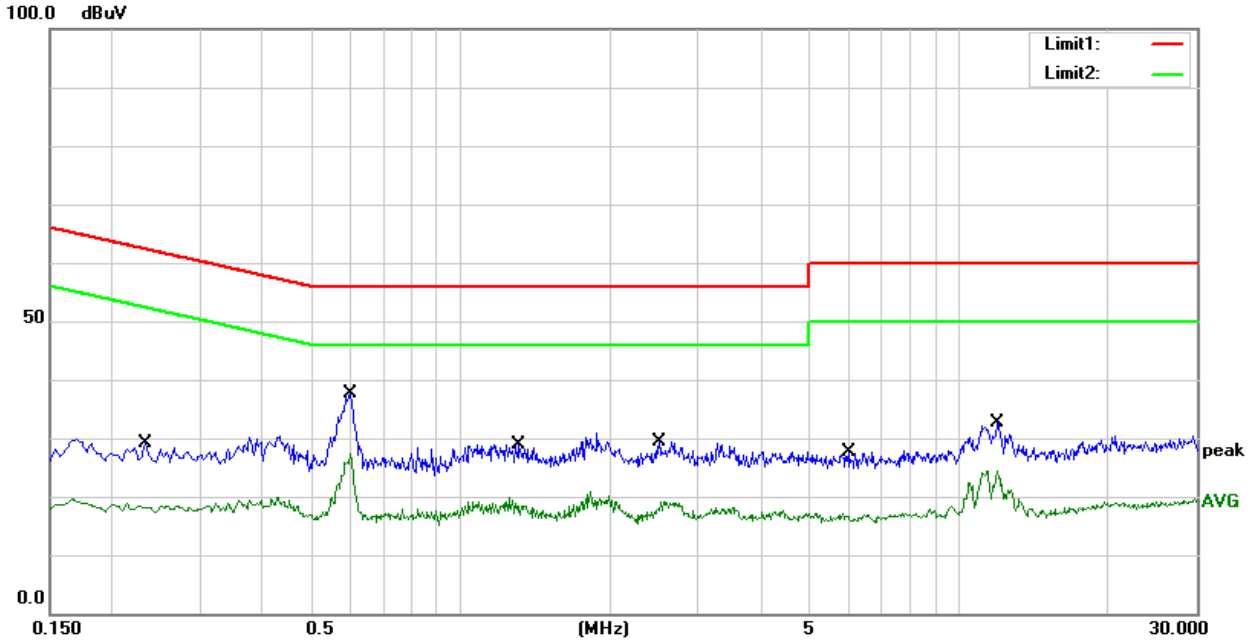
Remark:
1. All readings are Quasi-Peak and Average values
2. Margin = Result (Result =Reading + Factor)–Limit
3. Factor=LISN factor+Cable loss+Limiter (10dB)



Temperature:	26.8(C)	Relative Humidity:	66%RH
Test Voltage:	AC 120V/60Hz	Phase:	N
Test Mode:	Mode 4		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.2340	8.67	20.48	29.15	62.31	-33.16	QP
2	0.2340	-2.27	20.48	18.21	52.31	-34.10	AVG
3	0.6020	17.30	20.35	37.65	56.00	-18.35	QP
4	0.6020	7.07	20.35	27.42	46.00	-18.58	AVG
5	1.3100	8.76	20.16	28.92	56.00	-27.08	QP
6	1.3100	-1.73	20.16	18.43	46.00	-27.57	AVG
7	2.5100	9.34	20.12	29.46	56.00	-26.54	QP
8	2.5100	-1.11	20.12	19.01	46.00	-26.99	AVG
9	6.0180	7.76	19.93	27.69	60.00	-32.31	QP
10	6.0180	-3.26	19.93	16.67	50.00	-33.33	AVG
11	11.9900	12.65	19.90	32.55	60.00	-27.45	QP
12	11.9900	4.56	19.90	24.46	50.00	-25.54	AVG

Remark:
1. All readings are Quasi-Peak and Average values
2. Margin = Result (Result =Reading + Factor)–Limit
3. Factor=LISN factor+Cable loss+Limiter (10dB)



4. RADIATED EMISSION MEASUREMENT

4.1 RADIATED EMISSION LIMITS

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the Restricted band specified on Part15.205(a)&209(a) limit in the table and according to ANSI C63.10-2013 below has to be followed.

LIMITS OF RADIATED EMISSION MEASUREMENT (Frequency Range 9kHz-1000MHz)

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

FREQUENCY (MHz)	(dBuV/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

LIMITS OF RESTRICTED FREQUENCY BANDS

FREQUENCY (MHz)	FREQUENCY (MHz)	FREQUENCY (MHz)	FREQUENCY (GHz)
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

For Radiated Emission

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/QP/AV
Start Frequency	9 KHz/150KHz(Peak/QP/AV)
Stop Frequency	150KHz/30MHz(Peak/QP/AV)
RB / VB (emission in restricted band)	200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz); 200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz)

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/QP
Start Frequency	30 MHz(Peak/QP)
Stop Frequency	1000 MHz (Peak/QP)
RB / VB (emission in restricted band)	120 KHz / 300 KHz

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/AV
Start Frequency	1000 MHz(Peak/AV)
Stop Frequency	10th carrier hamonic(Peak/AV)
RB / VB (emission in restricted band)	1 MHz / 3 MHz(Peak) 1 MHz/1/T MHz(AVG)

For Restricted band

Spectrum Parameter	Setting
Detector	Peak/AV
Start/Stop Frequency	Lower Band Edge: 2310 to 2410 MHz Upper Band Edge: 2475 to 2500 MHz
RB / VB	1 MHz / 3 MHz(Peak) 1 MHz/1/T MHz(AVG)

Receiver Parameter	Setting
Start ~ Stop Frequency	9kHz~90kHz / RB 200Hz for PK & AV
Start ~ Stop Frequency	90kHz~110kHz / RB 200Hz for QP
Start ~ Stop Frequency	110kHz~490kHz / RB 200Hz for PK & AV
Start ~ Stop Frequency	490kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

4.2 TEST PROCEDURE

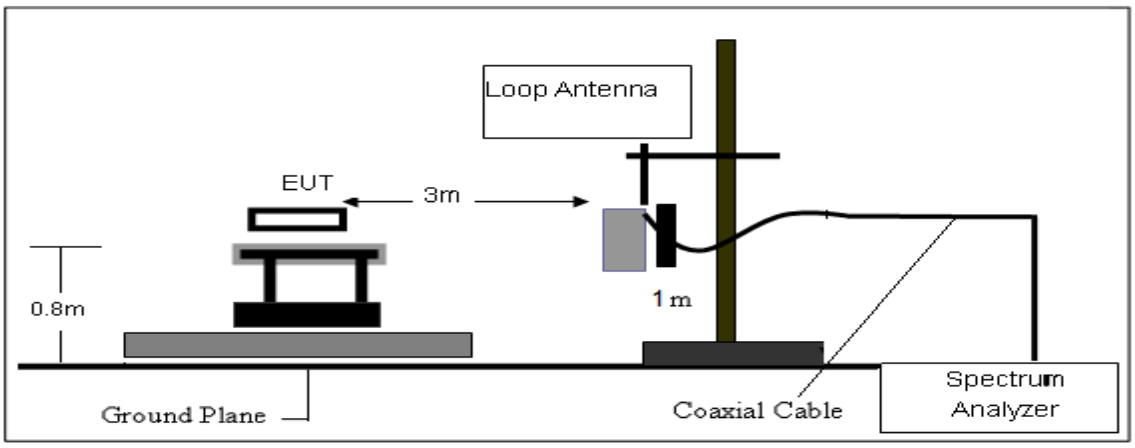
a. The measuring distance at 3 m shall be used for measurements at frequency 0.009MHz up to 1GHz, and above 1GHz.
b. The EUT was placed on the top of a rotating table 0.8 m (above 1GHz is 1.5 m) above the ground at a 3 m anechoic chamber test site. The table was rotated 360 degree to determine the position of the highest radiation.
c. The height of the equipment shall be 0.8 m (above 1GHz is 1.5 m); the height of the test antenna shall vary between 1 m to 4 m. Horizontal and vertical polarization of the antenna are set to make the measurement.
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and QuasiPeak detector mode will be re-measured.
e. If the Peak Mode measured value is compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and no additional QP Mode measurement was performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

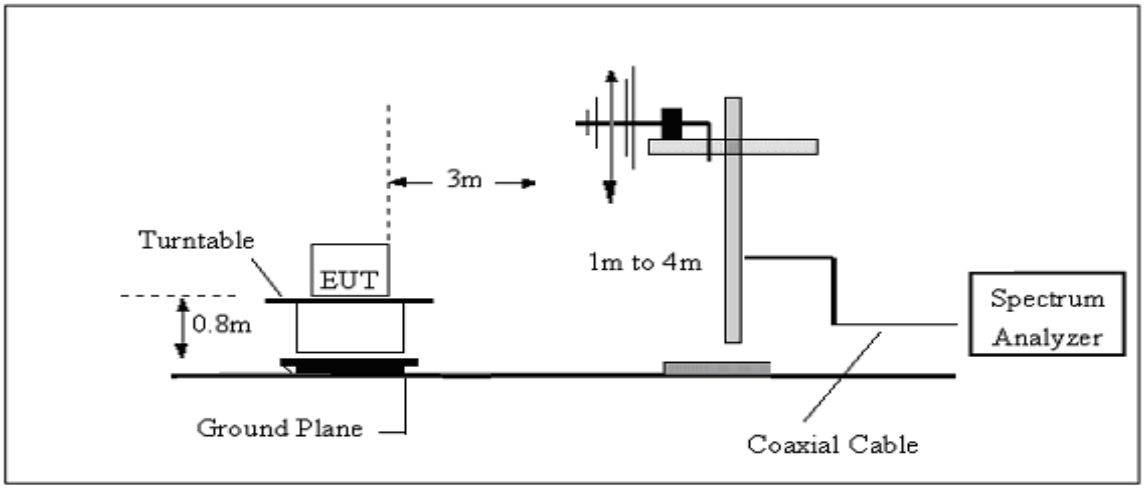
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

4.3 TEST SETUP

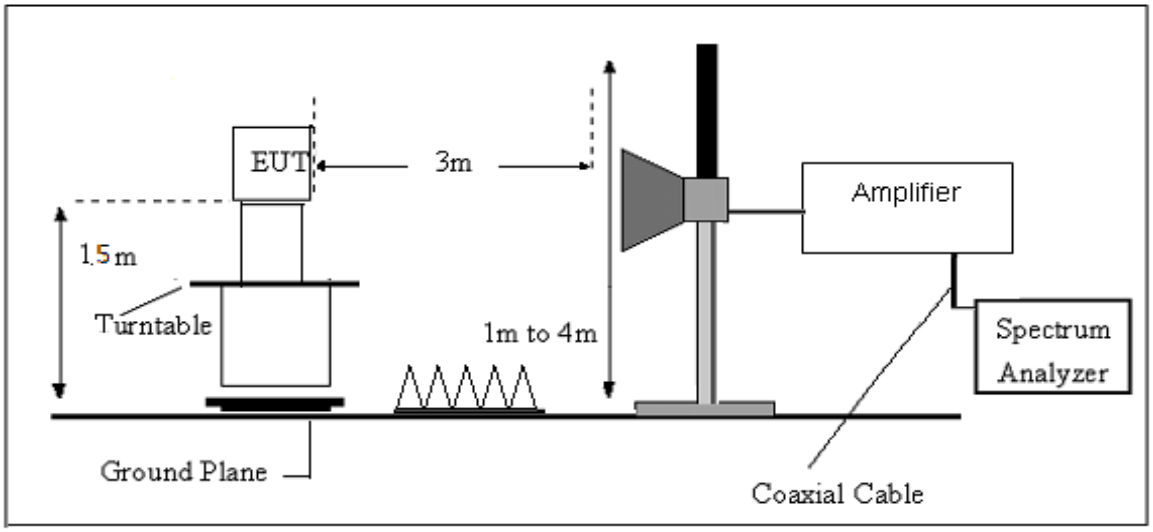
(A) Radiated Emission Test-Up Frequency Below 30MHz



(B) Radiated Emission Test-Up Frequency 30MHz~1GHz



(C) Radiated Emission Test-Up Frequency Above 1GHz



4.4 EUT OPERATING CONDITIONS

Please refer to section 3.4 of this report.

4.5 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF + CL - AG
Where
FS = Field Strength
CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude
AG = Amplifier Gain
AF = Antenna Factor
For example

Frequency	FS	RA	AF	CL	AG	Factor
(MHz)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(dB)	(dB)
300	40	58.1	12.2	1.6	31.9	-18.1

Factor=AF+CL-AG

4.6 TEST RESULTS

(Between 9KHz – 30 MHz)

Temperature:	23.1(C)	Relative Humidtity:	60%RH
Test Voltage:	DC 3.7V	Polarization:	--
Test Mode:	TX Mode		

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	PASS
--	--	--	--	PASS

Note:

The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Distance extrapolation factor =40 log (specific distance/test distance)(dB);

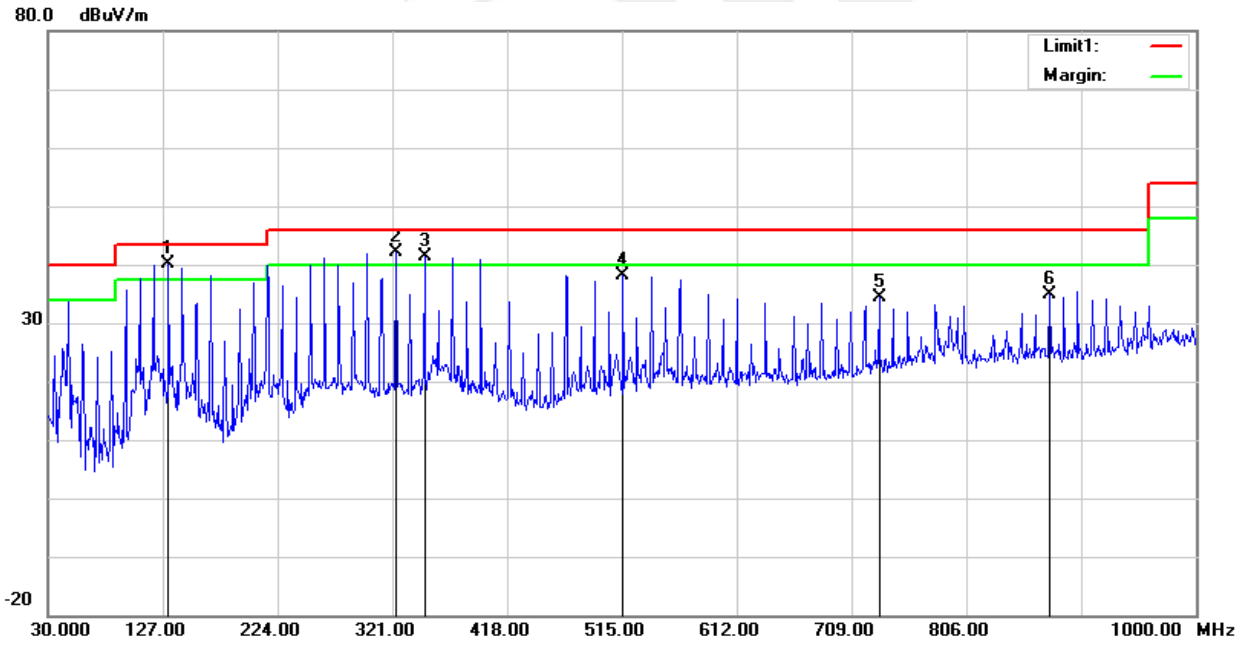
Limit line = specific limits(dBuv) + distance extrapolation factor.

(30MHz -1000MHz)

Temperature:	23.1(C)	Relative Humidity:	60%RH
Test Voltage:	DC 3.7V	Phase:	Horizontal
Test Mode:	Mode 1/2/3 (Mode 1 worst mode)		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	131.8500	58.29	-18.20	40.09	43.50	-3.41	QP
2	323.9100	56.11	-13.88	42.23	46.00	-3.77	QP
3	348.1600	54.62	-13.13	41.49	46.00	-4.51	QP
4	515.9700	46.02	-7.87	38.15	46.00	-7.85	QP
5	732.2800	36.74	-2.39	34.35	46.00	-11.65	QP
6	875.8400	35.43	-0.61	34.82	46.00	-11.18	QP

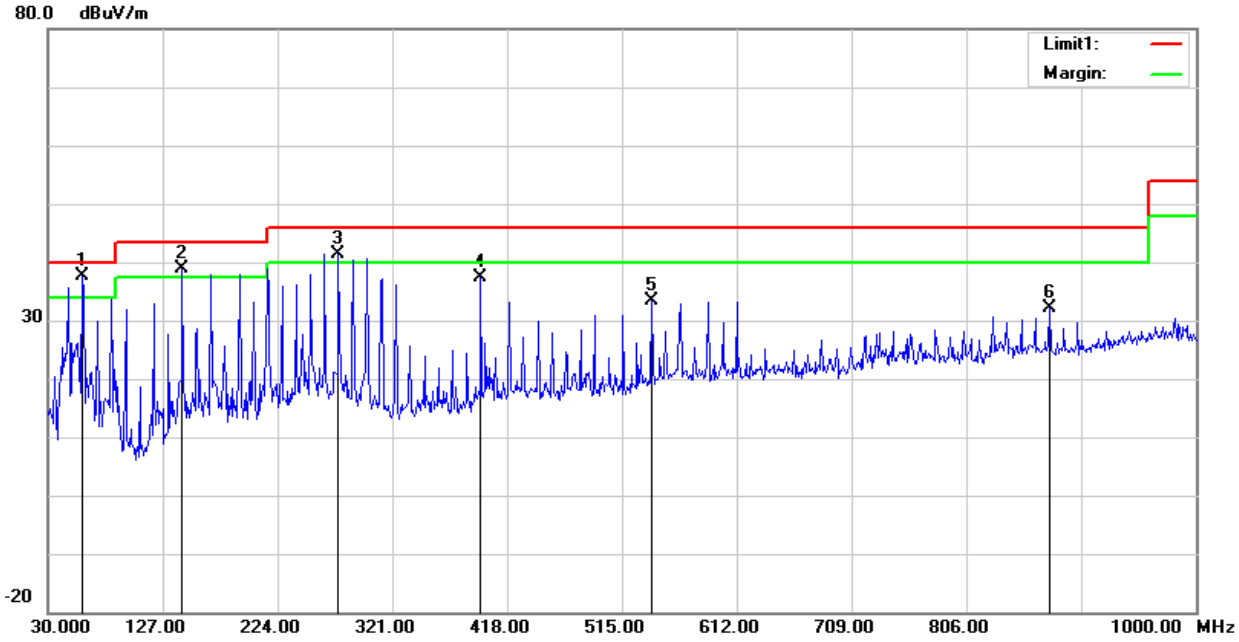
Remark:
1. Margin = Result (Result =Reading + Factor)–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



Temperature:	23.1(C)	Relative Humidity:	60%RH
Test Voltage:	DC 3.7V	Phase:	Vertical
Test Mode:	Mode 1/2/3 (Mode 1 worst mode)		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	59.1000	63.30	-25.73	37.57	40.00	-2.43	QP
2	143.4900	57.06	-18.23	38.83	43.50	-4.67	QP
3	275.4100	56.95	-15.46	41.49	46.00	-4.51	QP
4	395.6900	48.67	-11.34	37.33	46.00	-8.67	QP
5	540.2200	40.11	-6.84	33.27	46.00	-12.73	QP
6	876.8100	32.86	-0.62	32.24	46.00	-13.76	QP

Remark:
1. Margin = Result (Result =Reading + Factor)–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



(1GHz-25GHz) Spurious emission Requirements

GFSK

Frequency	Meter Reading	Amplifier	Loss	Antenna Factor	Corrected Factor	Emission Level	Limits	Margin	Detector	Comment
(MHz)	(dBμV)	(dB)	(dB)	(dB/m)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	Type	
Low Channel (GFSK/2402 MHz)										
3264.73	62.29	44.70	6.70	28.20	-9.80	52.49	74.00	-21.51	PK	Vertical
3264.73	50.57	44.70	6.70	28.20	-9.80	40.77	54.00	-13.23	AV	Vertical
3264.64	61.62	44.70	6.70	28.20	-9.80	51.82	74.00	-22.18	PK	Horizontal
3264.64	50.43	44.70	6.70	28.20	-9.80	40.63	54.00	-13.37	AV	Horizontal
4804.48	58.15	44.20	9.04	31.60	-3.56	54.59	74.00	-19.41	PK	Vertical
4804.48	49.23	44.20	9.04	31.60	-3.56	45.67	54.00	-8.33	AV	Vertical
4804.59	59.43	44.20	9.04	31.60	-3.56	55.87	74.00	-18.13	PK	Horizontal
4804.59	49.77	44.20	9.04	31.60	-3.56	46.21	54.00	-7.79	AV	Horizontal
5359.83	48.81	44.20	9.86	32.00	-2.34	46.47	74.00	-27.53	PK	Vertical
5359.83	39.95	44.20	9.86	32.00	-2.34	37.61	54.00	-16.39	AV	Vertical
5359.68	47.95	44.20	9.86	32.00	-2.34	45.61	74.00	-28.39	PK	Horizontal
5359.68	39.15	44.20	9.86	32.00	-2.34	36.81	54.00	-17.19	AV	Horizontal
7205.74	53.94	43.50	11.40	35.50	3.40	57.34	74.00	-16.66	PK	Vertical
7205.74	44.68	43.50	11.40	35.50	3.40	48.08	54.00	-5.92	AV	Vertical
7205.87	54.72	43.50	11.40	35.50	3.40	58.12	74.00	-15.88	PK	Horizontal
7205.87	44.08	43.50	11.40	35.50	3.40	47.48	54.00	-6.52	AV	Horizontal
Middle Channel (GFSK/2440 MHz)										
3262.96	61.47	44.70	6.70	28.20	-9.80	51.67	74.00	-22.33	PK	Vertical
3262.96	50.54	44.70	6.70	28.20	-9.80	40.74	54.00	-13.26	AV	Vertical
3263.20	61.29	44.70	6.70	28.20	-9.80	51.49	74.00	-22.51	PK	Horizontal
3263.20	50.62	44.70	6.70	28.20	-9.80	40.82	54.00	-13.18	AV	Horizontal
4880.05	59.45	44.20	9.04	31.60	-3.56	55.89	74.00	-18.11	PK	Vertical
4880.05	50.51	44.20	9.04	31.60	-3.56	46.95	54.00	-7.05	AV	Vertical
4879.96	59.48	44.20	9.04	31.60	-3.56	55.92	74.00	-18.08	PK	Horizontal
4879.96	50.02	44.20	9.04	31.60	-3.56	46.46	54.00	-7.54	AV	Horizontal
5357.16	49.13	44.20	9.86	32.00	-2.34	46.79	74.00	-27.21	PK	Vertical
5357.16	39.03	44.20	9.86	32.00	-2.34	36.69	54.00	-17.31	AV	Vertical
5357.39	47.76	44.20	9.86	32.00	-2.34	45.42	74.00	-28.58	PK	Horizontal
5357.17	39.23	44.20	9.86	32.00	-2.34	36.89	54.00	-17.11	AV	Horizontal
7320.85	54.43	43.50	11.40	35.50	3.40	57.83	74.00	-16.17	PK	Vertical
7320.85	43.95	43.50	11.40	35.50	3.40	47.35	54.00	-6.65	AV	Vertical
7320.35	54.44	43.50	11.40	35.50	3.40	57.84	74.00	-16.16	PK	Horizontal
7320.35	44.68	43.50	11.40	35.50	3.40	48.08	54.00	-5.92	AV	Horizontal

High Channel (GFSK/2480 MHz)										
3264.70	61.71	44.70	6.70	28.20	-9.80	51.91	74.00	-22.09	PK	Vertical
3264.70	50.32	44.70	6.70	28.20	-9.80	40.52	54.00	-13.48	AV	Vertical
3264.70	60.96	44.70	6.70	28.20	-9.80	51.16	74.00	-22.84	PK	Horizontal
3264.70	51.00	44.70	6.70	28.20	-9.80	41.20	54.00	-12.80	AV	Horizontal
4960.49	58.98	44.20	9.04	31.60	-3.56	55.42	74.00	-18.58	PK	Vertical
4960.49	49.37	44.20	9.04	31.60	-3.56	45.81	54.00	-8.19	AV	Vertical
4960.40	59.43	44.20	9.04	31.60	-3.56	55.87	74.00	-18.13	PK	Horizontal
4960.40	49.19	44.20	9.04	31.60	-3.56	45.63	54.00	-8.37	AV	Horizontal
5359.77	48.22	44.20	9.86	32.00	-2.34	45.88	74.00	-28.12	PK	Vertical
5359.77	39.45	44.20	9.86	32.00	-2.34	37.11	54.00	-16.89	AV	Vertical
5359.71	48.05	44.20	9.86	32.00	-2.34	45.71	74.00	-28.29	PK	Horizontal
5359.71	39.42	44.20	9.86	32.00	-2.34	37.08	54.00	-16.92	AV	Horizontal
7439.84	53.83	43.50	11.40	35.50	3.40	57.23	74.00	-16.77	PK	Vertical
7439.84	44.94	43.50	11.40	35.50	3.40	48.34	54.00	-5.66	AV	Vertical
7439.67	54.40	43.50	11.40	35.50	3.40	57.80	74.00	-16.20	PK	Horizontal
7439.67	44.96	43.50	11.40	35.50	3.40	48.36	54.00	-5.64	AV	Horizontal

Note:

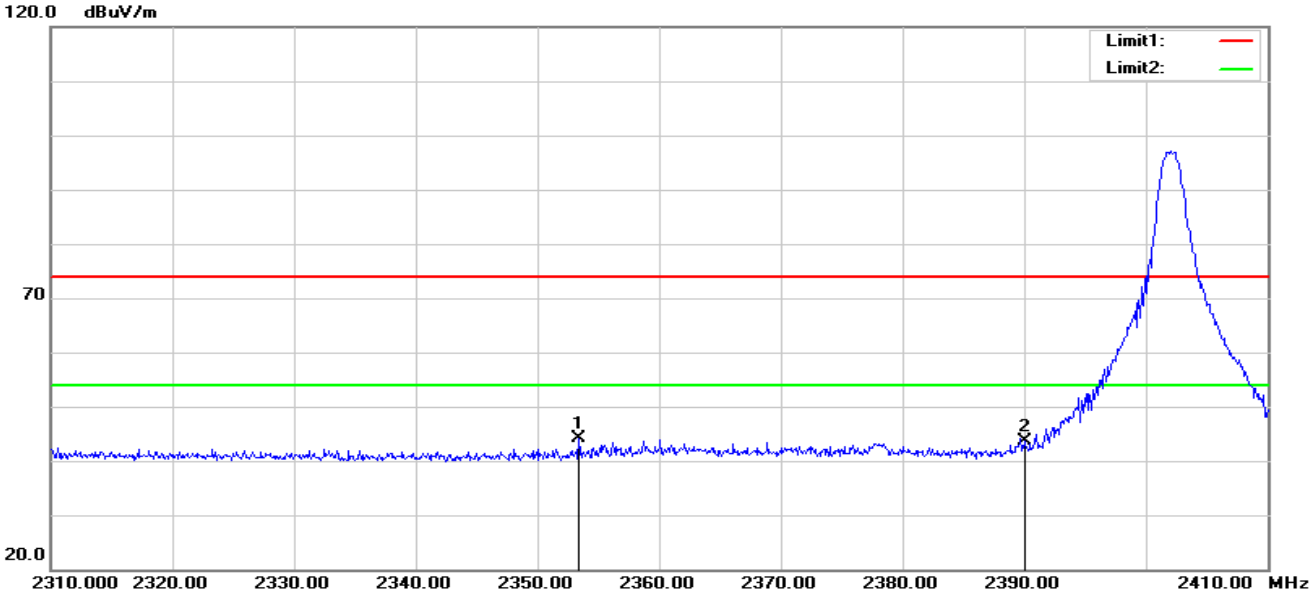
1) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
   Emission Level = Reading + Factor

2) The frequency emission of peak points that did not show above the forms are at least 20dB below the limit, the frequency emission is mainly from the environment noise.

4.6 TEST RESULTS (Restricted Bands Requirements)

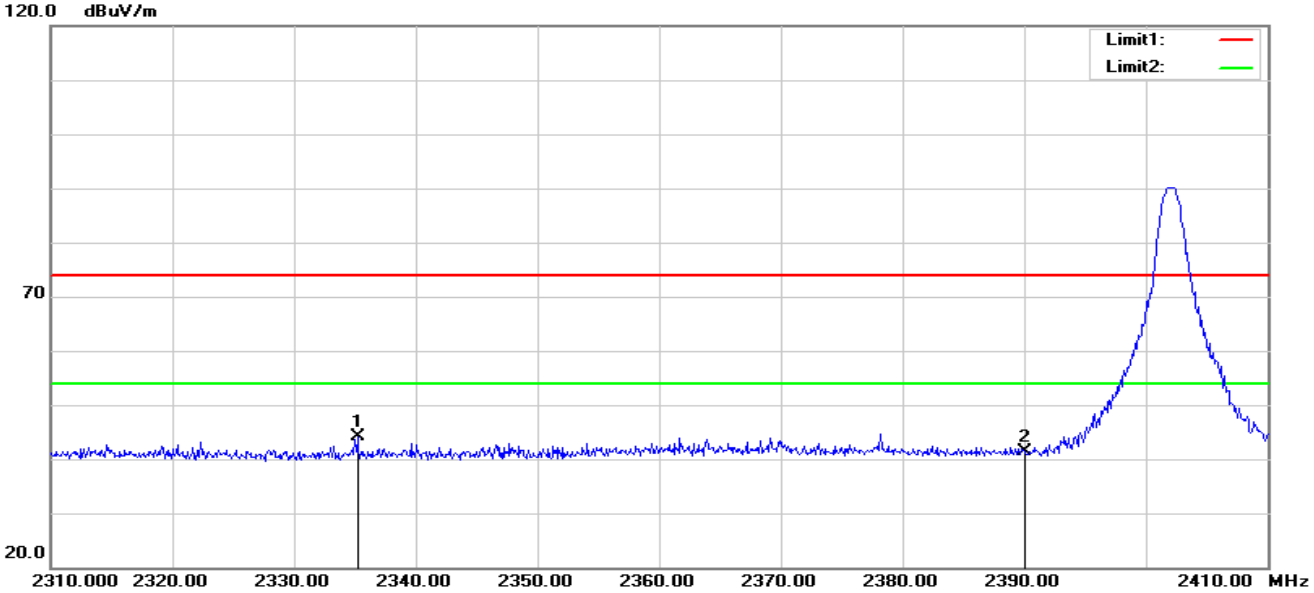
GFSK-Low

Horizontal



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
1	2353.400	40.23	3.79	44.02	74.00	-29.98	peak
2	2390.000	39.39	4.34	43.73	74.00	-30.27	peak

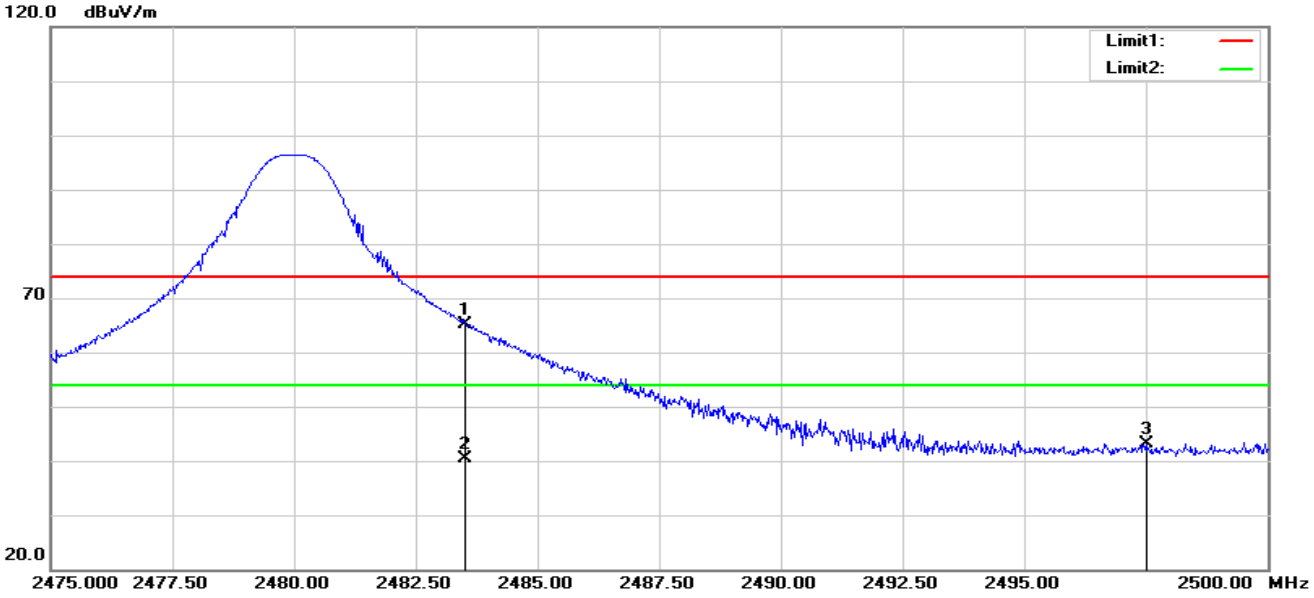
Vertical



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
1	2335.200	40.38	3.66	44.04	74.00	-29.96	peak
2	2390.000	37.10	4.34	41.44	74.00	-32.56	peak

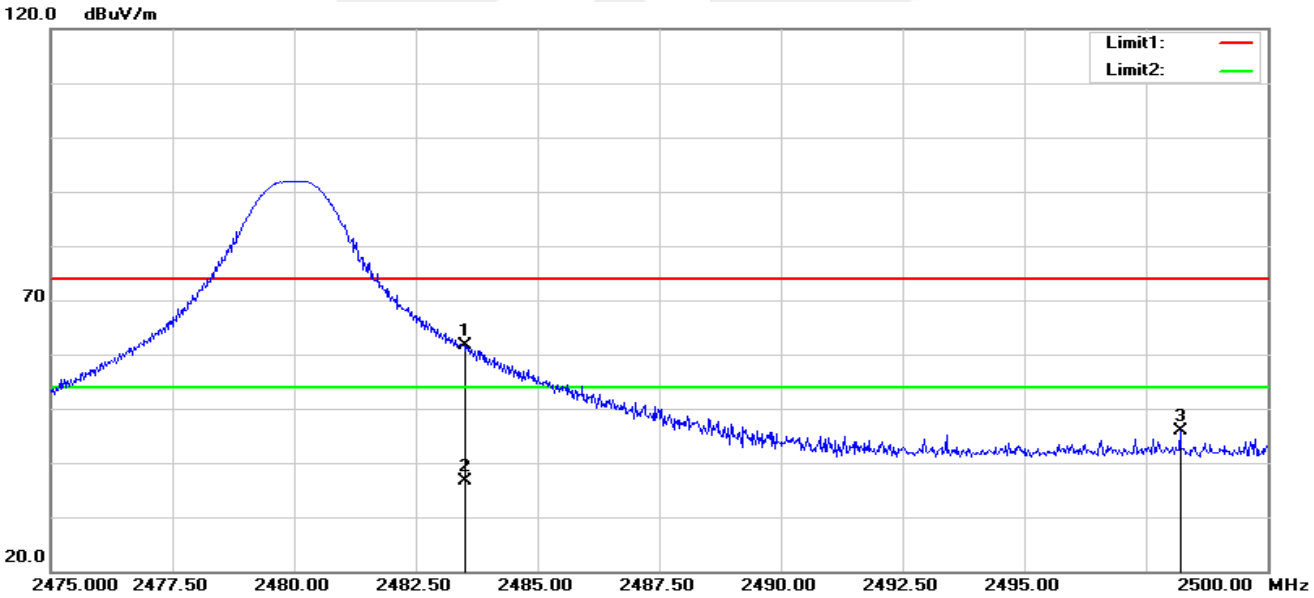
GFSK-High

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2483.500	60.46	4.60	65.06	74.00	-8.94	peak
2	2483.500	35.70	4.60	40.30	54.00	-13.70	AVG
3	2497.500	38.48	4.64	43.12	74.00	-30.88	peak

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2483.500	57.03	4.60	61.63	74.00	-12.37	peak
2	2483.500	31.95	4.60	36.55	54.00	-17.45	AVG
3	2498.200	41.18	4.64	45.82	74.00	-28.18	peak

5. CONDUCTED SPURIOUS & BAND EDGE EMISSION

5.1 LIMIT

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

5.2 TEST PROCEDURE

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	30 MHz to 10th carrier harmonic
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

For Band edge

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	Lower Band Edge: 2300 – 2407 MHz Upper Band Edge: 2475 – 2500 MHz
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

5.3 TEST SETUP

The EUT which is powered by the Battery, is connected to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading. Make the measurement with the spectrum analyzer's resolution bandwidth(RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW.

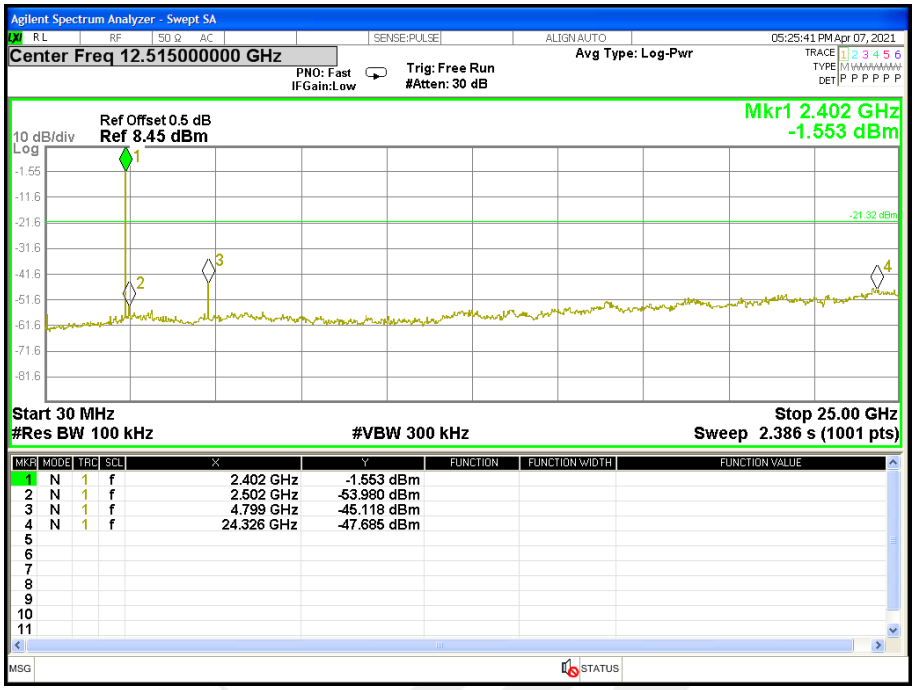
5.4 EUT OPERATION CONDITIONS

Please refer to section 3.4 of this report.

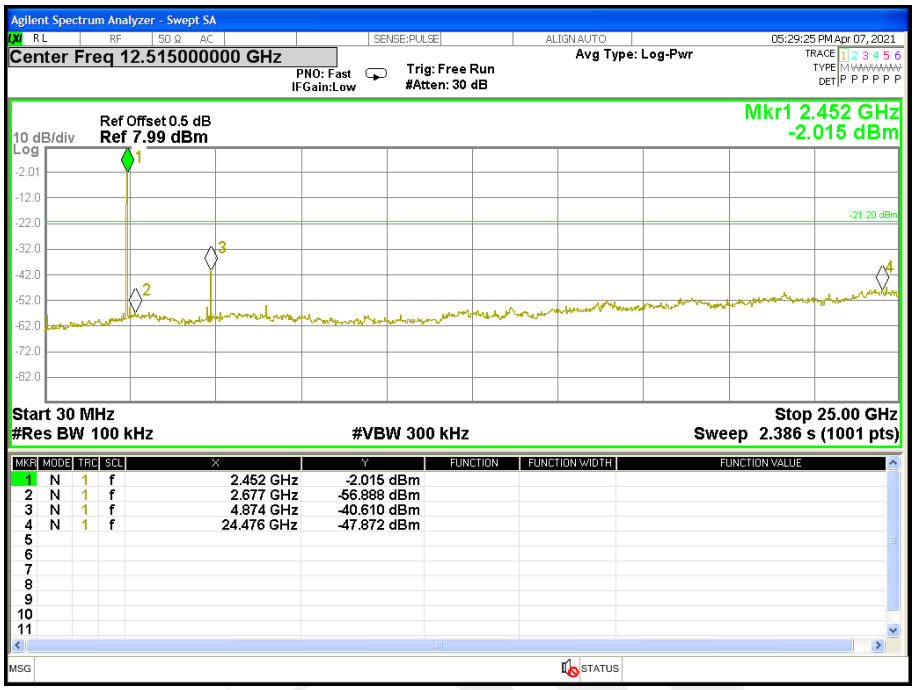
5.5 TEST RESULTS

Temperature:	25 ℃	Relative Humidity:	50%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

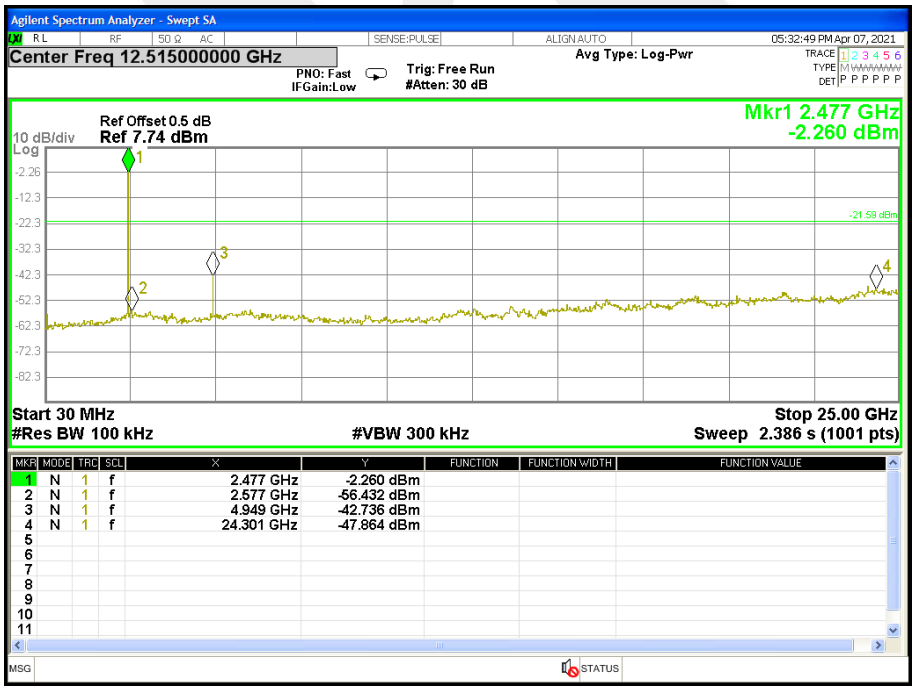
00 CH



19 CH

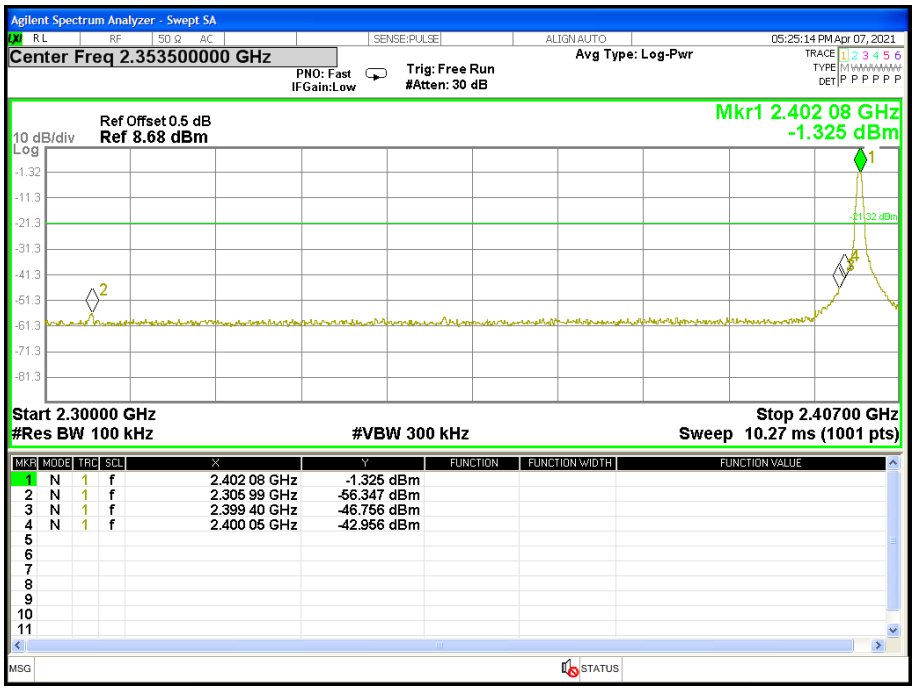

Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:29:25 PM Apr 07, 2021
Ref Offset 0.5 dB
10 dB/div
Ref 7.99 dBm
Mkr1 2.452 GHz
-2.015 dBm
-21.20 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
1 N 1 f 2.452 GHz -2.015 dBm
2 N 1 f 2.677 GHz -56.888 dBm
3 N 1 f 4.874 GHz -40.610 dBm
4 N 1 f 24.476 GHz -47.872 dBm

39 CH

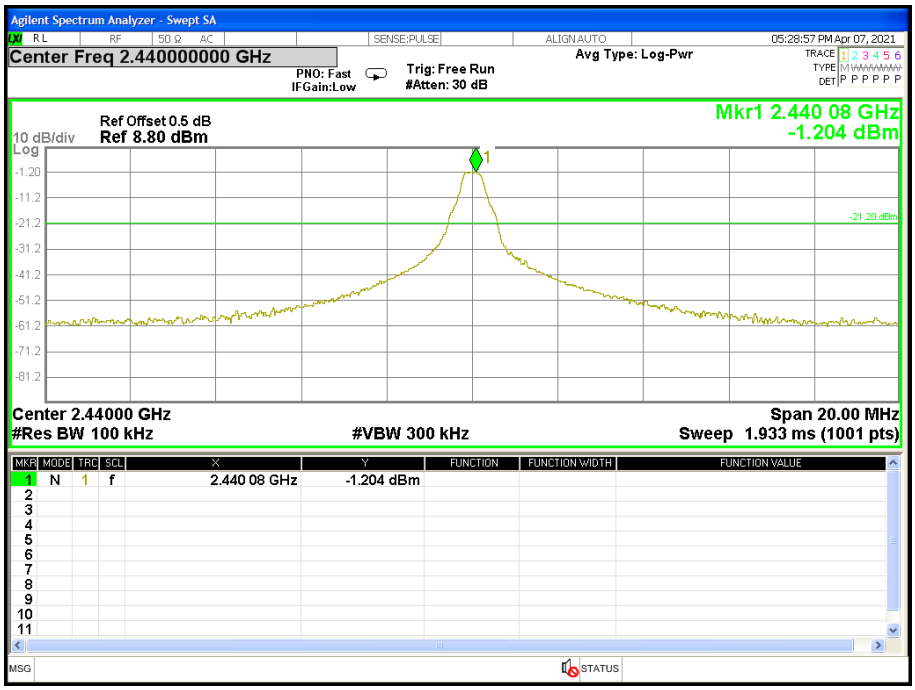

Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:32:49 PM Apr 07, 2021
Ref Offset 0.5 dB
10 dB/div
Ref 7.74 dBm
Mkr1 2.477 GHz
-2.260 dBm
-21.59 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
1 N 1 f 2.477 GHz -2.260 dBm
2 N 1 f 2.577 GHz -56.432 dBm
3 N 1 f 4.949 GHz -42.736 dBm
4 N 1 f 24.301 GHz -47.864 dBm

For Band edge(it's also the reference level for conducted spurious emission)

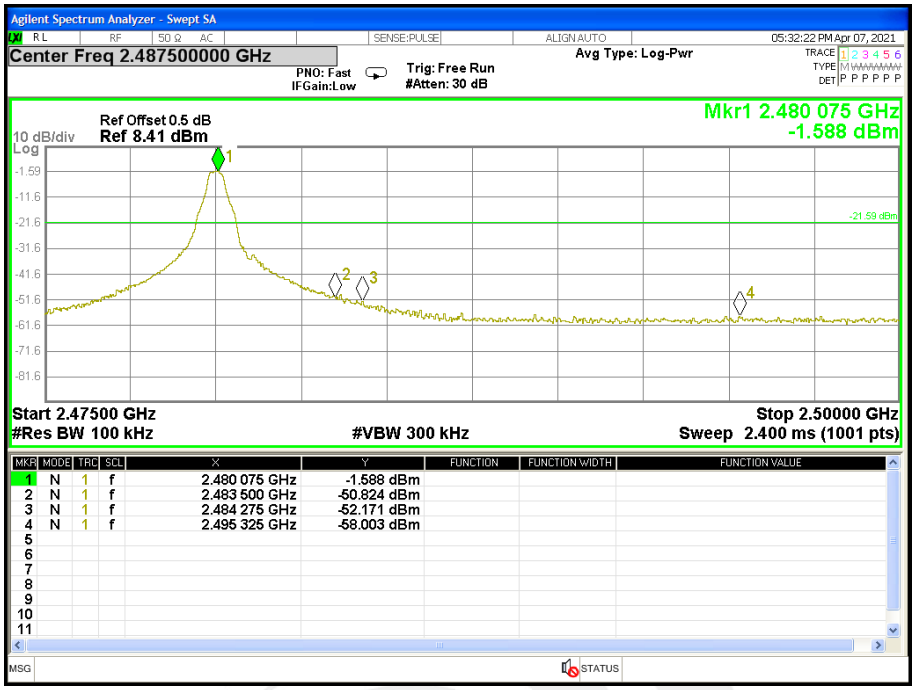
00 CH



19 CH



39 CH


Agilent Spectrum Analyzer - Swept SA
RL
RF
50 Ω AC
SENSE:PULSE
ALIGN AUTO
05:32:22 PM Apr 07, 2021
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M
DET P P P P P
Ref Offset 0.5 dB
10 dB/div
Log
Ref 8.41 dBm
Mkr1 2.480 075 GHz
-1.588 dBm
-1.59
-11.6
-21.6
-31.6
-41.6
-51.6
-61.6
-71.6
-81.6
-21.59 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.400 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.480 075 GHz -1.588 dBm
2 N 1 f 2.483 500 GHz -50.824 dBm
3 N 1 f 2.484 275 GHz -52.171 dBm
4 N 1 f 2.495 325 GHz -58.003 dBm
MSG
STATUS

6. POWER SPECTRAL DENSITY TEST

6.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(e)	Power Spectral Density	≤8 dBm (RBW≥3KHz)	2400-2483.5	PASS

6.2 TEST PROCEDURE

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW to: 100 kHz ≥ RBW ≥ 3 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.3 TEST SETUP

6.4 EUT OPERATION CONDITIONS

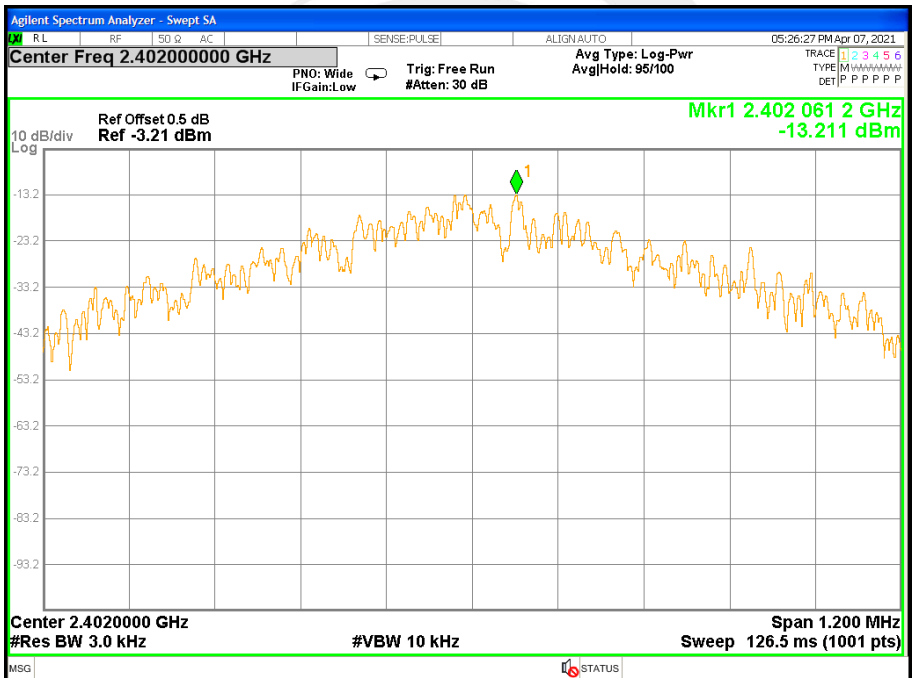
Please refer to section 3.4 of this report.

6.5 TEST RESULTS

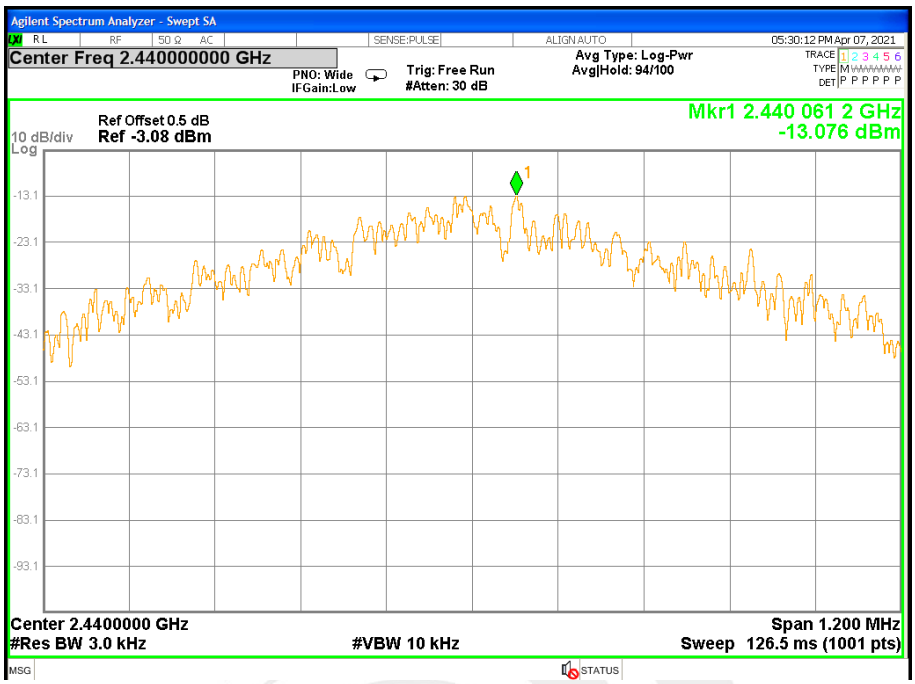
Temperature:	25 ℃	Relative Humidity:	60%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

Frequency	Power Density (dBm/3kHz)	Limit (dBm/3KHz)	Result
2402 MHz	-13.211	≤8	PASS
2440 MHz	-13.076	≤8	PASS
2480 MHz	-13.589	≤8	PASS

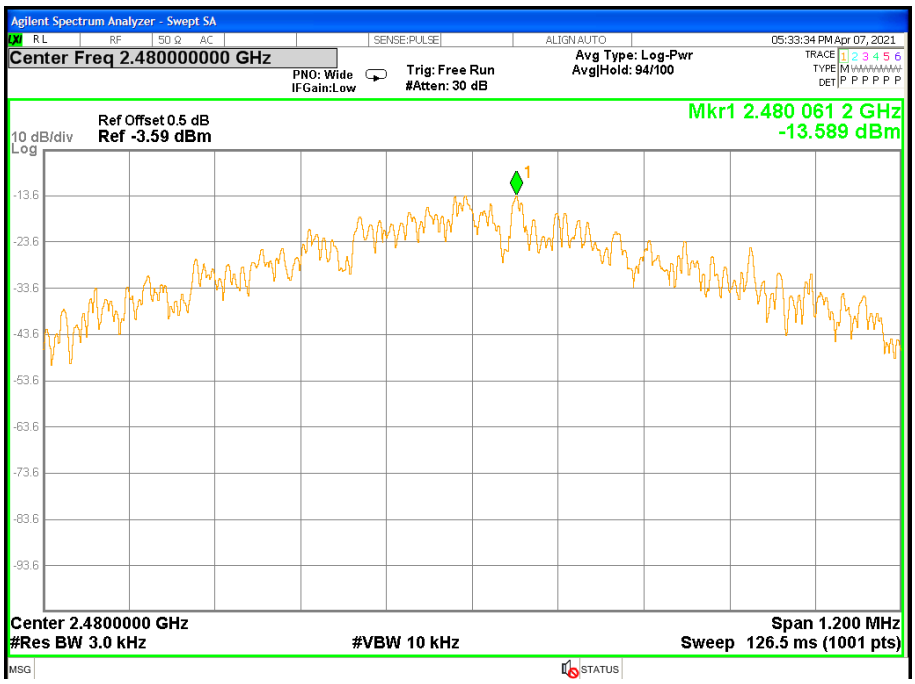
TX CH00



TX CH19



TX CH39



7. BANDWIDTH TEST

7.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	>= 500KHz (6dB bandwidth)	2400-2483.5	PASS

7.2 TEST PROCEDURE

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW≥3RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be≥6 dB.

7.3 TEST SETUP

7.4 EUT OPERATION CONDITIONS

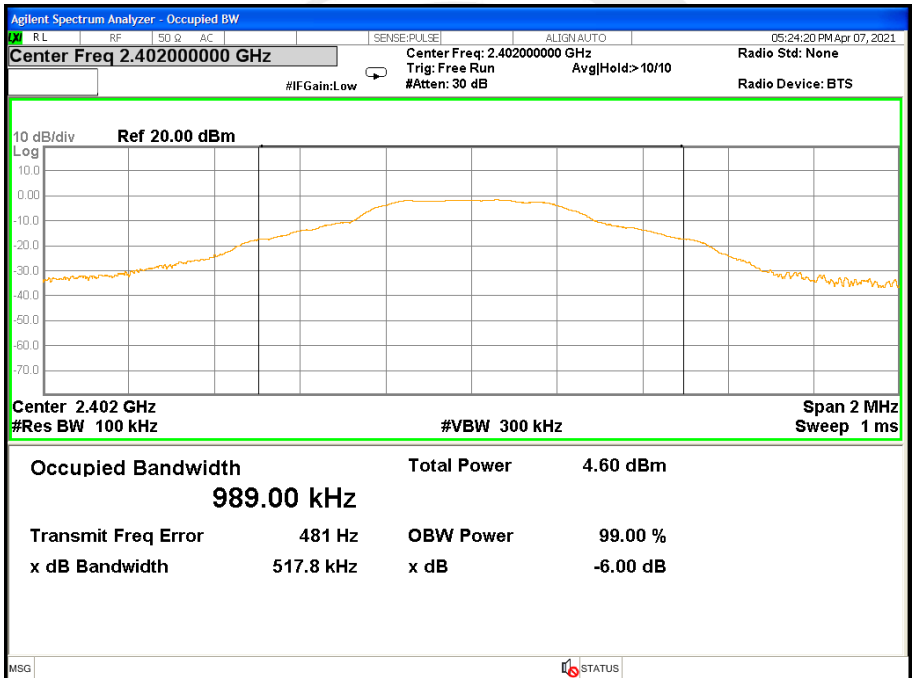
Please refer to section 3.4 of this report.

7.5 TEST RESULTS

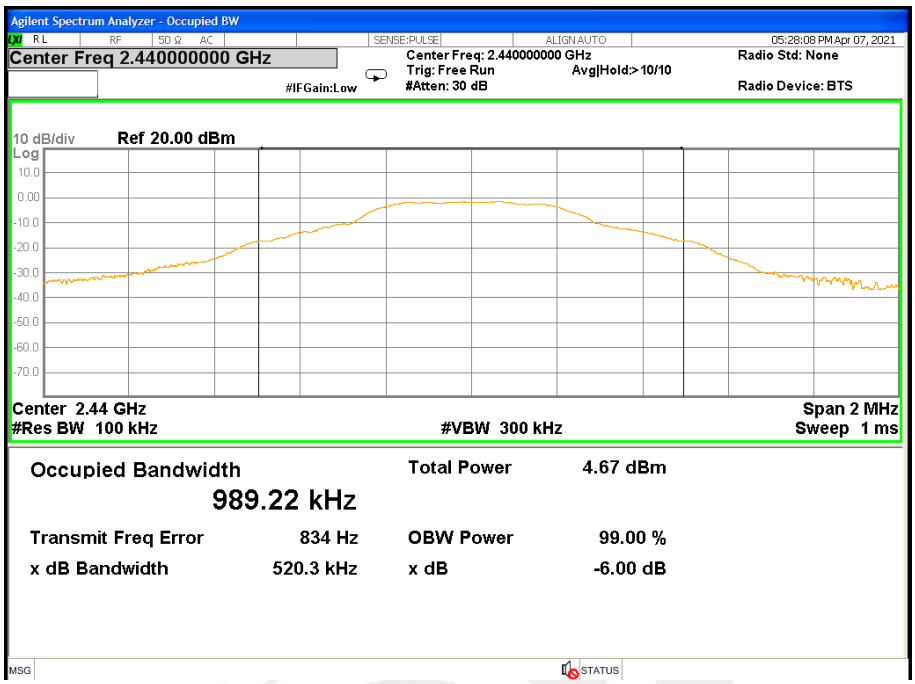
Temperature:	25 ℃	Relative Humidity:	60%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

Frequency	6dB Bandwidth (KHz)	Limit (KHz)	Result
2402 MHz	517.800	≥500KHz	PASS
2440 MHz	520.300	≥500KHz	PASS
2480 MHz	516.700	≥500KHz	PASS

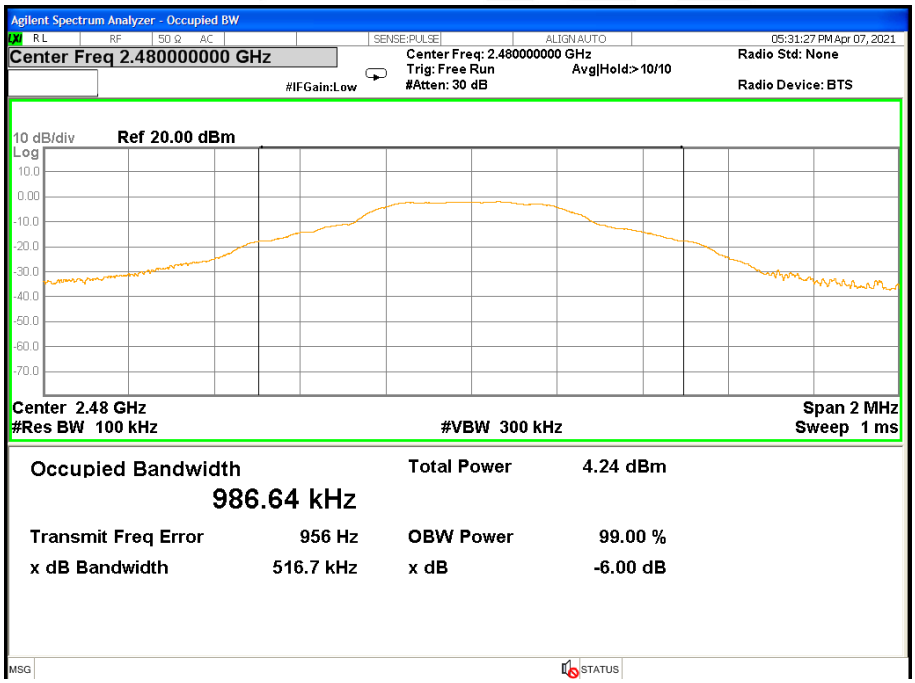
TX CH 00



TX CH 19



TX CH 39



8. PEAK OUTPUT POWER TEST

8.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3)	Output Power	1 watt or 30dBm	2400-2483.5	PASS

8.2 TEST PROCEDURE

One of the following procedures may be used to determine the maximum peak conducted output power of a DTS EUT.

RBW ≥ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

Integrated band power method:

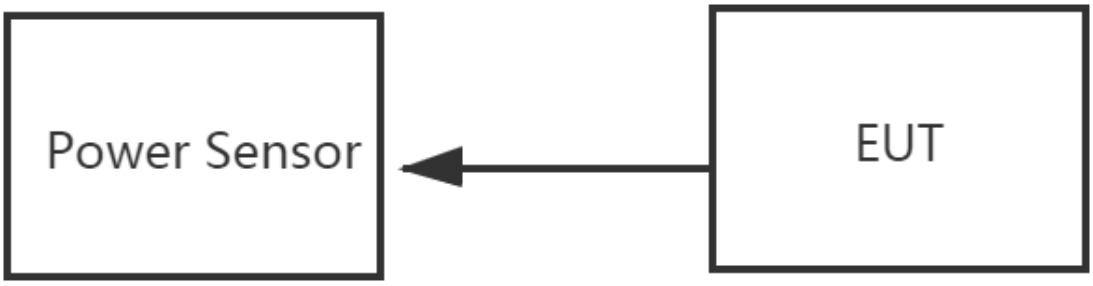
The following procedure can be used when the maximum available RBW of the instrument is less than the
DTS bandwidth:

a) Set the RBW = 1 MHz.
b) Set the VBW ≥ [3 × RBW].
c) Set the span ≥ [1.5 × DTS bandwidth].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select the peak detector). If the instrument does not have a band power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS channel bandwidth.

PKPM1 Peak power meter method:

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

8.3 TEST SETUP



8.4 EUT OPERATION CONDITIONS

Please refer to section 3.4 of this report.

8.5 TEST RESULTS

Temperature:	25 ℃	Relative Humidity:	60%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

Test Channe	Frequency	Peak Conducted Output Power	Average Conducted Output Power	LIMIT
	(MHz)	(dBm)	(dBm)	dBm
CH0	2402	-0.15	-2.93	30
CH19	2440	-0.24	-3.04	30
CH39	2480	-0.57	-3.23	30

Note: Our power sensor test AVG power has no duty cycle display. The power sensor measures AVG power is Burst power. The software has considered the factor of the duty cycle factor, so it is unnecessary to add it again.

Duty cycle

Ton	Tp	Duty cycle(%)	Duty factor(dB)
0.416	0.646	64.40%	1.91

9. ANTENNA REQUIREMENT

9.1 STANDARD REQUIREMENT

15.203 requirement: For intentional device, according to 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.

9.2 EUT ANTENNA

The EUT antenna is PCB Antenna. It comply with the standard requirement.

10. EUT TEST PHOTO

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

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