S T S LAB

RADIO TEST REPORT

Report No.:STS2007251W04

Issued for

Spark Technology Labs Inc.

680 Davenport Rd., Unit D, Waterloo, ON, Canada N2V 2C3

Product Name:	CH4G Asset Tracker
Brand Name:	CloudHawk
Model Name:	CH4G
Series Model:	N/A
FCC ID:	2AA5OCH4G
IC:	21738-CH4G
Test Standard:	FCC Part 15.247 RSS-247 Issue 2, February 2017

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TEST RESULT CERTIFICATION

Applicant's Name.....: Spark Technology Labs Inc.

Address .....: 680 Davenport Rd., Unit D, Waterloo, ON, Canada N2V 2C3

Manufacture's Name.....: Spark Technology Labs Inc.

Address .....: 680 Davenport Rd., Unit D, Waterloo, ON, Canada N2V 2C3

Product Description

Product Name.....: CH4G Asset Tracker

Brand Name .....: CloudHawk

Model Name .....: CH4G

Series Model.....: N/A

Test Standards.....: FCC Part15.247
RSS-247 Issue 2, February 2017
RSS-Gen Issue 5 ,March 2019

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/IC 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 .....: 16 July 2020

Date (s) of performance of tests .....: 16 July 2020 ~ 30 July 2020

Date of Issue.....: 30 July 2020

Test Result.....: **Pass**

Testing Engineer : Chris Chen
(Chris Chen)

Technical Manager : Sean She
(Sean she)

Authorized Signatory : Vita
(Vita Li)

TESTING • CONSULTING • SOLUTION • CERTIFICATION
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APPROVAL

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Revision History

Rev.	Issue Date	Report NO.	Effect Page	Contents
00	30 July 2020	STS2007251W04	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 RSS-247 Issue 2			
Standard Section	Test Item	Judgment	Remark
15.207 RSS-Gen 8.8	Conducted Emission	N/A	--
15.247 (a)(2) RSS-Gen 6.7 RSS-247 5.2 (a)	6dB&99% Bandwidth	PASS	--
15.247 (b)(3) RSS-247 5.4 (d)	Output Power	PASS	--
15.247 (c) RSS-Gen 8.9 8.10	Radiated Spurious Emission	PASS	--
15.247 (d) RSS-247 5.5 RSS-Gen 8.9 8.10	Conducted Spurious & Band Edge Emission	PASS	--
15.247 (e) RSS-247 5.2 (b)	Power Spectral Density	PASS	--
15.205 RSS-Gen 8.9 8.10	Restricted bands of operation	PASS	--
Part 15.247(d)/part 15.209(a) RSS-247 5.5 RSS-Gen 8.9 8.10	Band Edge Emission	PASS	--
15.203 RSS-Gen 6.8	Antenna Requirement	PASS	--
RSS-Gen 6.11 8.11	Frequency Stability	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 30-1GHz	±6.7dB
4	All emissions, radiated 1G-6GHz	±5.5dB
5	All emissions, radiated>6G	±5.8dB
6	Conducted Emission (9KHz-150KHz)	±3.37dB
7	Conducted Emission (150KHz-30MHz)	±3.83dB

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF THE EUT

Product Name	CH4G Asset Tracker
Trade Name	CloudHawk
Model Name	CH4G
Series Model	N/A
Model Difference	N/A
Product Description	The EUT is a CH4G Asset Tracker 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) -2dBi
Channel List	Please refer to the Note 2.
Power Rating	Input:12~24V DC
Battery	Rated Voltage: 3.7V Charge Limit: 4.2V Capacity: 5200mAh
Hardware version number	Rev. B
Software version number	M0C.400001
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	Frequenc y (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	CloudHawk	CH4G	Internal monopole	N/A	-2dBi	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.

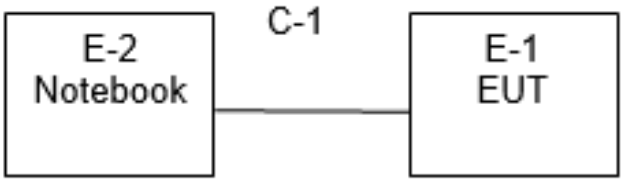
2.3 TEST SOFTWARE AND POWER LEVEL

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	-2	Default	Telit AT Controller

2.4 BLOCK DIGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious 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-2	Notebook	DELL	VOSTRO.3800	N/A	N/A
C-1	USB Cable	N/A	100cm	N/A	N/A

Note:

(1) The support equipment was authorized by Declaration of Confirmation.

(2) For detachable type I/O cable should be specified the length in cm in『Length』column.

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	2019.10.09	2020.10.08
Signal Analyzer	Agilent	N9020A	MY51110105	2020.03.05	2021.03.04
Active loop Antenna	ZHINAN	ZN30900C	16035	2018.03.11	2021.03.10
Bilog Antenna	TESEQ	CBL6111D	34678	2017.11.02	2020.11.01
Horn Antenna	SCHWARZBECK	BBHA 9120D(1201)	9120D-1343	2018.10.19	2021.10.18
SHF-EHF Horn Antenna (18G-40GHz)	A-INFO	LB-180400-KF	J211020657	2018.03.11	2021.03.10
Pre-Amplifier(0.1M-3G Hz)	EM	EM330	060665	2019.10.09	2020.10.08
Pre-Amplifier (1G-18GHz)	SKET	LNPA-01018G-45	SK2018080901	2019.10.12	2020.10.11
Pre-Amplifier (18G-40G)	SKET	LNPA_1840-50	SK2018101801	2019.10.22	2020.10.21
Temperature & Humidity	HH660	Mieo	N/A	2019.10.12	2020.10.11
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)			

RF Connected Test

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
USB RF power sensor	DARE	RPR3006W	15I00041SNO03	2019.10.09	2020.10.08
Signal Analyzer	Agilent	N9020A	MY49100060	2019.10.09	2020.10.08
Temperature & Humidity	HH660	Mieo	N/A	2019.10.12	2020.10.11
Test SW	FARAD	LZ-RF /LzRf-3A3			

3. EMC EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 POWER LINE CONDUCTED EMISSION LIMITS

Operating frequency band. In case the emission fall within the restricted band specified on Part 207(a)&RSS-Gen Issue 5 limit in the table below has to be followed.

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.

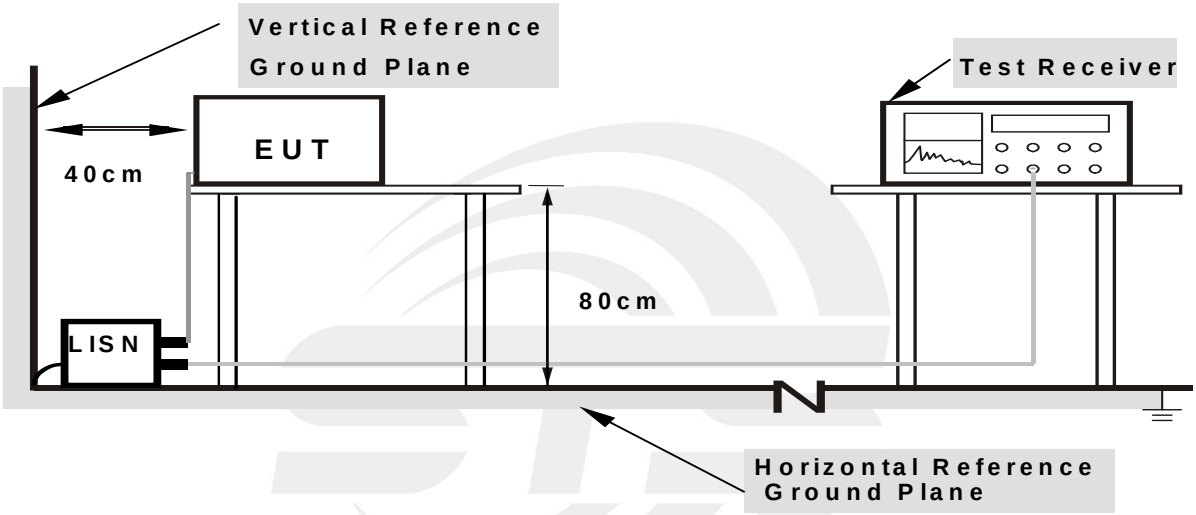
The following table is the setting of the receiver

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 was 0.8 meters from the horizontal ground plane and 0.4 meters from the vertical ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 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 at least 80 cm from 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 from other units and other metal planes

3.4 EUT OPERATING CONDITIONS

Temperature:	25.7(C)	Relative Humidity:	53%RH
Test Voltage:	N/A	Phase:	L/N
Test Mode:	N/A		

Note: The EUT is only power by DC Power, so it is not applicable for this test.

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), RSS-Gen Issue 5 and RSS-247 Issue 2, February 2017 (5.5) 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

FCC:

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			

IC:

FREQUENCY (MHz)	FREQUENCY (MHz)	FREQUENCY (GHz)
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 – 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 – 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 – 8500	
108 – 138		

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

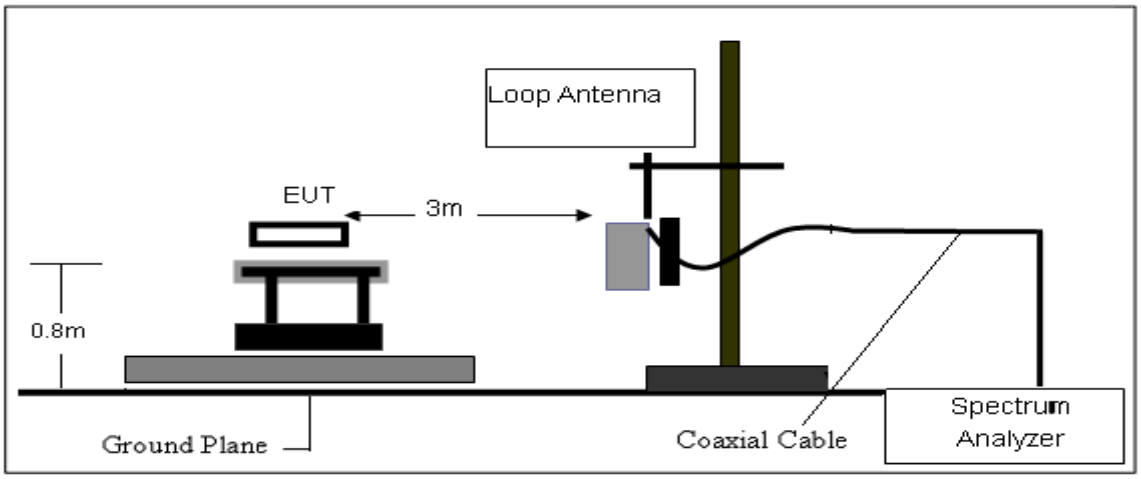
a. The measuring distance of at 3 m shall be used for measurements at frequency 0.009MHz up to 1GHz, and above 1GHz.
b. The EUT was placed on the top of a rotating table 0.8 meters(above 1GHz is 1.5 m) above the ground at a 3 meter anechoic chamber. The table was rotated 360 degrees to determine the 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 polarizations 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 then Quasi Peak detector mode re-measured.
e. If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

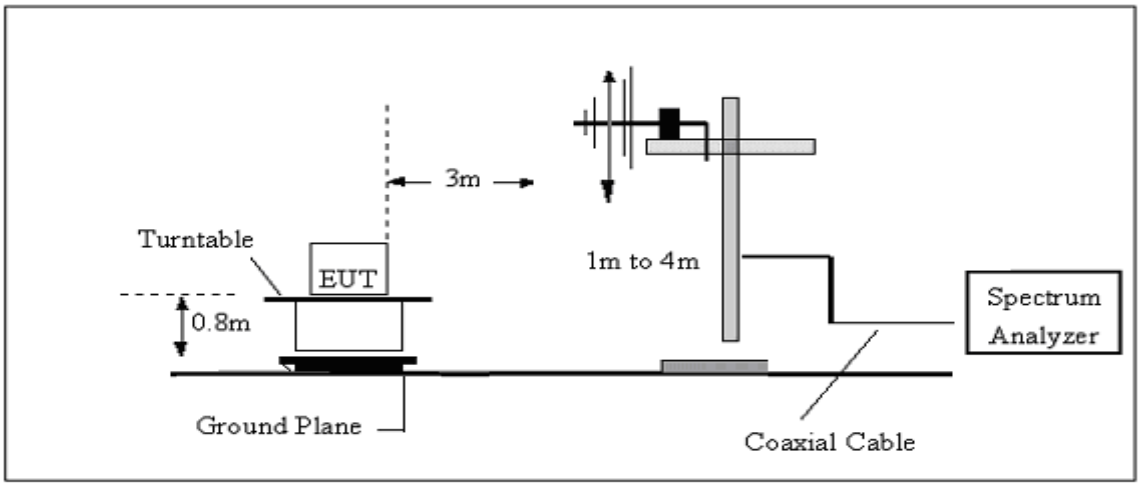
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

4.3 TEST SETUP

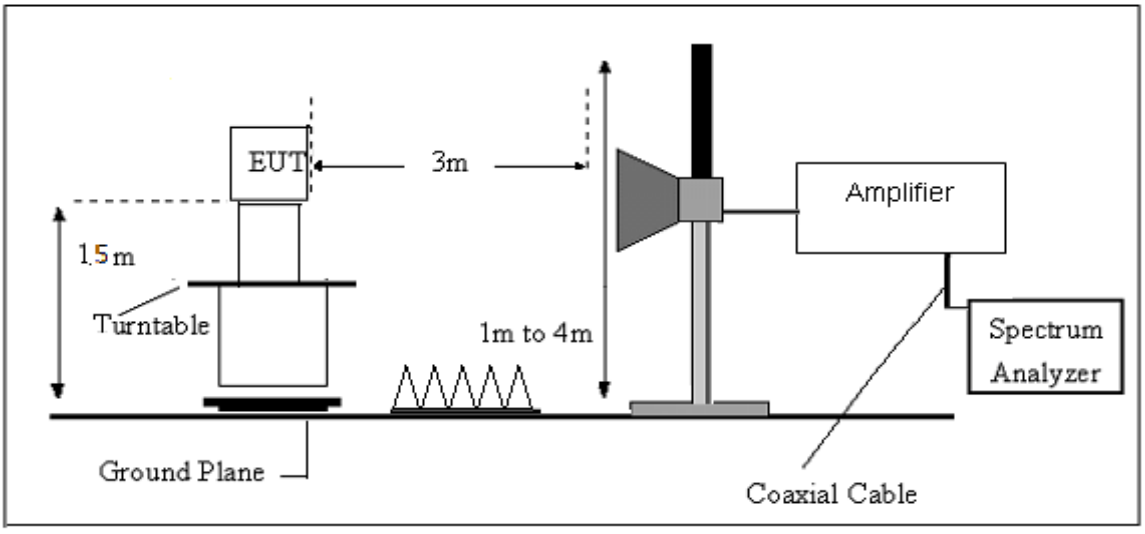
(A) Radiated Emission Test-Up Frequency Below 30MHz



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



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



4.4 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

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:	62%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

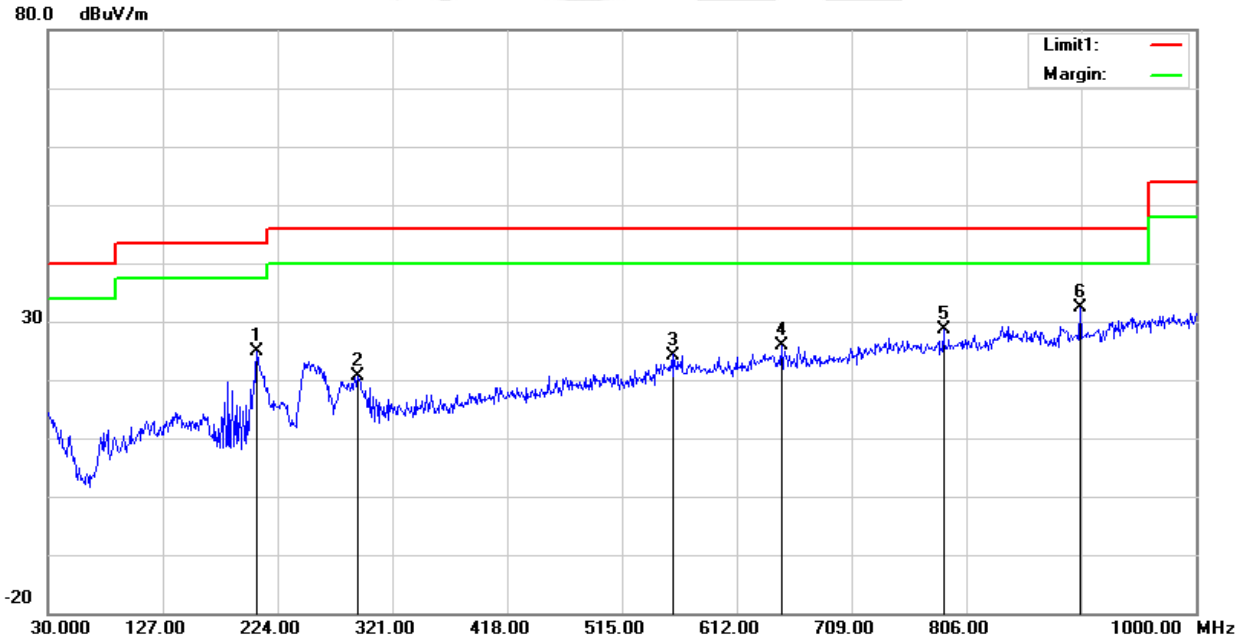
Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits(dBuv) + distance extrapolation factor.

(30MHz -1000MHz)

Temperature:	23.1(C)	Relative Humidity:	62%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	206.5400	45.52	-20.63	24.89	43.50	-18.61	QP
2	291.9000	35.69	-15.09	20.60	46.00	-25.40	QP
3	558.6500	29.77	-5.52	24.25	46.00	-21.75	QP
4	649.8300	30.74	-4.90	25.84	46.00	-20.16	QP
5	786.6000	30.67	-2.05	28.62	46.00	-17.38	QP
6	902.0300	32.75	-0.40	32.35	46.00	-13.65	QP

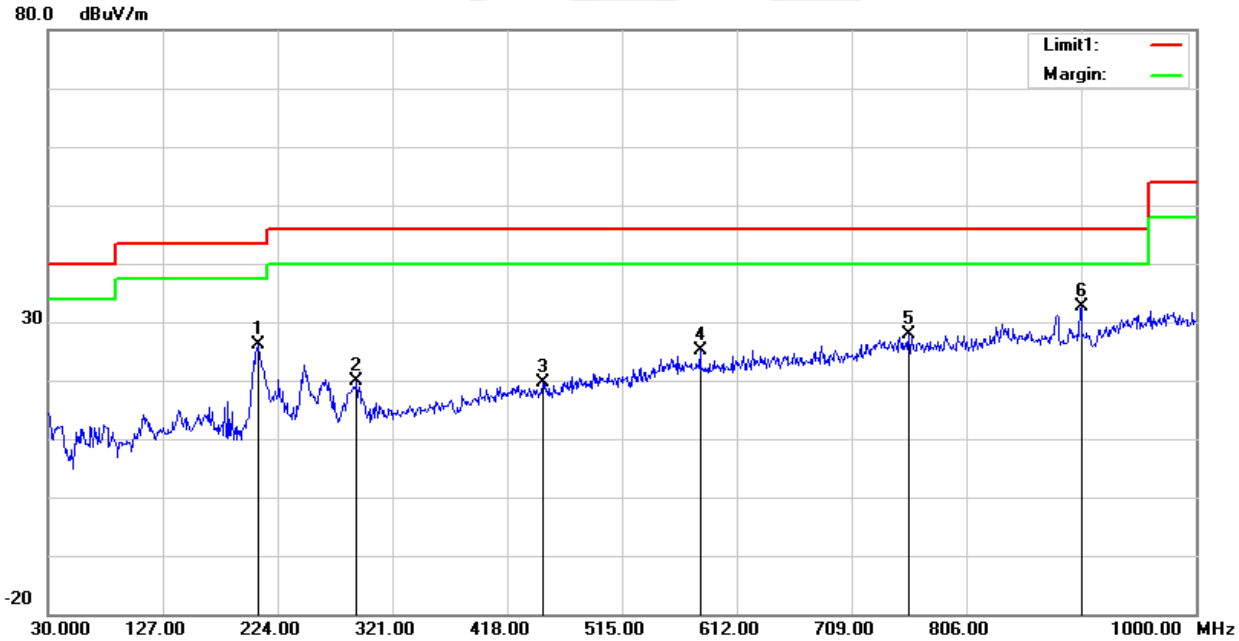
Remark:
1. Margin = Result (Result =Reading + Factor)–Limit



Temperature:	23.1(C)	Relative Humidity:	62%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	207.5100	46.69	-20.54	26.15	43.50	-17.35	QP
2	290.9300	34.95	-15.12	19.83	46.00	-26.17	QP
3	448.0700	29.47	-9.76	19.71	46.00	-26.29	QP
4	580.9600	30.78	-5.76	25.02	46.00	-20.98	QP
5	757.5000	30.05	-2.17	27.88	46.00	-18.12	QP
6	903.0000	32.97	-0.37	32.60	46.00	-13.40	QP

Remark:
1. Margin = Result (Result =Reading + Factor)–Limit



(1GHz-25GHz) Spurious emission Requirements

GFSK

Frequency	Meter Reading	Amplifier	Loss	Antenna Factor	Orrected Factor	Emission Level	Limits	Margin	Detector	Comment
(MHz)	(dBμV)	（dB）	（dB）	（dB/m）	（dB）	(dBμV/m)	(dBμV/m)	(dB)	Type	
Low Channel (2402 MHz)										
3264.88	61.99	44.70	6.70	28.20	-9.80	52.19	74.00	-21.81	PK	Vertical
3264.88	51.45	44.70	6.70	28.20	-9.80	41.65	54.00	-12.35	AV	Vertical
3264.77	61.36	44.70	6.70	28.20	-9.80	51.56	74.00	-22.44	PK	Horizontal
3264.77	49.92	44.70	6.70	28.20	-9.80	40.12	54.00	-13.88	AV	Horizontal
4804.53	58.90	44.20	9.04	31.60	-3.56	55.34	74.00	-18.66	PK	Vertical
4804.53	49.25	44.20	9.04	31.60	-3.56	45.69	54.00	-8.31	AV	Vertical
4804.38	58.31	44.20	9.04	31.60	-3.56	54.75	74.00	-19.25	PK	Horizontal
4804.38	50.41	44.20	9.04	31.60	-3.56	46.85	54.00	-7.15	AV	Horizontal
5359.83	48.76	44.20	9.86	32.00	-2.34	46.42	74.00	-27.58	PK	Vertical
5359.83	39.49	44.20	9.86	32.00	-2.34	37.15	54.00	-16.85	AV	Vertical
5359.59	47.28	44.20	9.86	32.00	-2.34	44.94	74.00	-29.06	PK	Horizontal
5359.59	38.41	44.20	9.86	32.00	-2.34	36.07	54.00	-17.93	AV	Horizontal
7205.80	53.81	43.50	11.40	35.50	3.40	57.21	74.00	-16.79	PK	Vertical
7205.80	43.90	43.50	11.40	35.50	3.40	47.30	54.00	-6.70	AV	Vertical
7205.75	54.56	43.50	11.40	35.50	3.40	57.96	74.00	-16.04	PK	Horizontal
7205.75	44.20	43.50	11.40	35.50	3.40	47.60	54.00	-6.40	AV	Horizontal
Middle Channel (2440 MHz)										
3264.70	61.14	44.70	6.70	28.20	-9.80	51.34	74.00	-22.66	PK	Vertical
3264.70	50.13	44.70	6.70	28.20	-9.80	40.33	54.00	-13.67	AV	Vertical
3264.83	61.09	44.70	6.70	28.20	-9.80	51.29	74.00	-22.71	PK	Horizontal
3264.83	49.96	44.70	6.70	28.20	-9.80	40.16	54.00	-13.84	AV	Horizontal
4880.52	59.25	44.20	9.04	31.60	-3.56	55.69	74.00	-18.31	PK	Vertical
4880.52	49.66	44.20	9.04	31.60	-3.56	46.10	54.00	-7.90	AV	Vertical
4880.46	58.36	44.20	9.04	31.60	-3.56	54.80	74.00	-19.20	PK	Horizontal
4880.46	49.51	44.20	9.04	31.60	-3.56	45.95	54.00	-8.05	AV	Horizontal
5359.66	48.31	44.20	9.86	32.00	-2.34	45.97	74.00	-28.03	PK	Vertical
5359.66	39.93	44.20	9.86	32.00	-2.34	37.59	54.00	-16.41	AV	Vertical
5359.71	47.83	44.20	9.86	32.00	-2.34	45.49	74.00	-28.51	PK	Horizontal
5359.71	38.94	44.20	9.86	32.00	-2.34	36.60	54.00	-17.40	AV	Horizontal
7320.79	54.33	43.50	11.40	35.50	3.40	57.73	74.00	-16.27	PK	Vertical
7320.79	44.42	43.50	11.40	35.50	3.40	47.82	54.00	-6.18	AV	Vertical
7320.81	54.70	43.50	11.40	35.50	3.40	58.10	74.00	-15.90	PK	Horizontal
7320.81	43.96	43.50	11.40	35.50	3.40	47.36	54.00	-6.64	AV	Horizontal

High Channel (2480 MHz)										
3264.86	61.58	44.70	6.70	28.20	-9.80	51.78	74.00	-22.22	PK	Vertical
3264.86	50.24	44.70	6.70	28.20	-9.80	40.44	54.00	-13.56	AV	Vertical
3264.58	60.79	44.70	6.70	28.20	-9.80	50.99	74.00	-23.01	PK	Horizontal
3264.58	50.53	44.70	6.70	28.20	-9.80	40.73	54.00	-13.27	AV	Horizontal
4960.53	58.99	44.20	9.04	31.60	-3.56	55.43	74.00	-18.57	PK	Vertical
4960.53	49.45	44.20	9.04	31.60	-3.56	45.89	54.00	-8.11	AV	Vertical
4960.40	58.29	44.20	9.04	31.60	-3.56	54.73	74.00	-19.27	PK	Horizontal
4960.40	49.98	44.20	9.04	31.60	-3.56	46.42	54.00	-7.58	AV	Horizontal
5359.80	49.15	44.20	9.86	32.00	-2.34	46.81	74.00	-27.19	PK	Vertical
5359.80	40.07	44.20	9.86	32.00	-2.34	37.73	54.00	-16.27	AV	Vertical
5359.63	48.32	44.20	9.86	32.00	-2.34	45.98	74.00	-28.02	PK	Horizontal
5359.63	39.24	44.20	9.86	32.00	-2.34	36.90	54.00	-17.10	AV	Horizontal
7439.81	54.95	43.50	11.40	35.50	3.40	58.35	74.00	-15.65	PK	Vertical
7439.81	44.77	43.50	11.40	35.50	3.40	48.17	54.00	-5.83	AV	Vertical
7439.81	53.97	43.50	11.40	35.50	3.40	57.37	74.00	-16.63	PK	Horizontal
7439.81	43.74	43.50	11.40	35.50	3.40	47.14	54.00	-6.86	AV	Horizontal

Note:

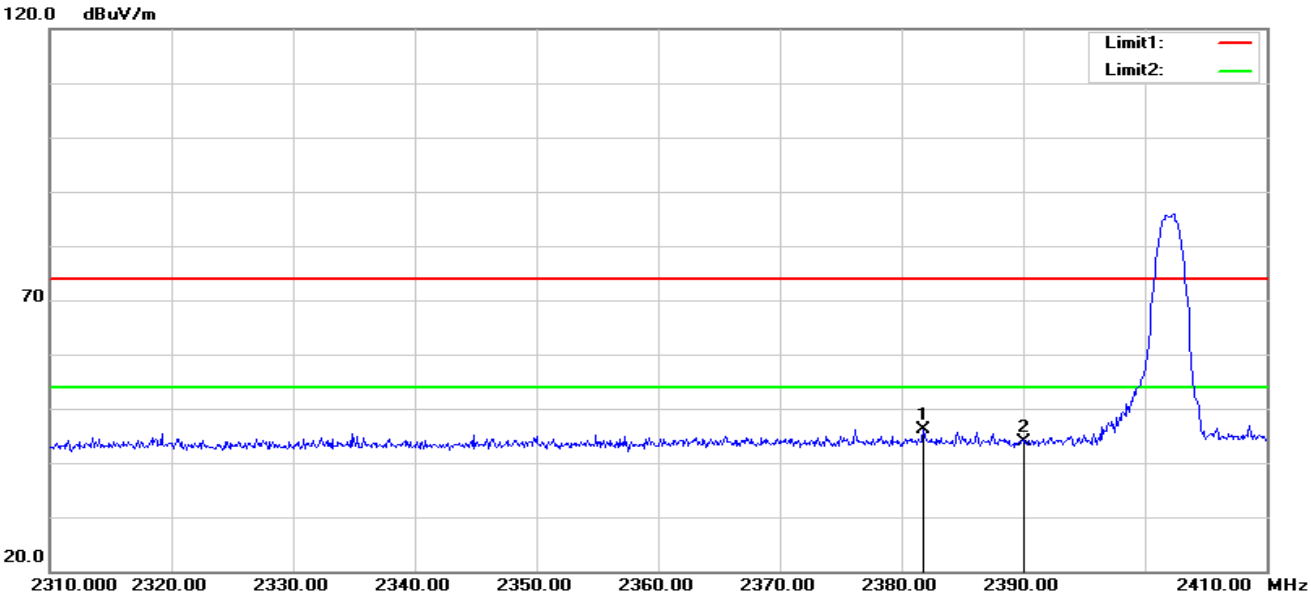
1) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
   Emission Level = Reading + Factor

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)

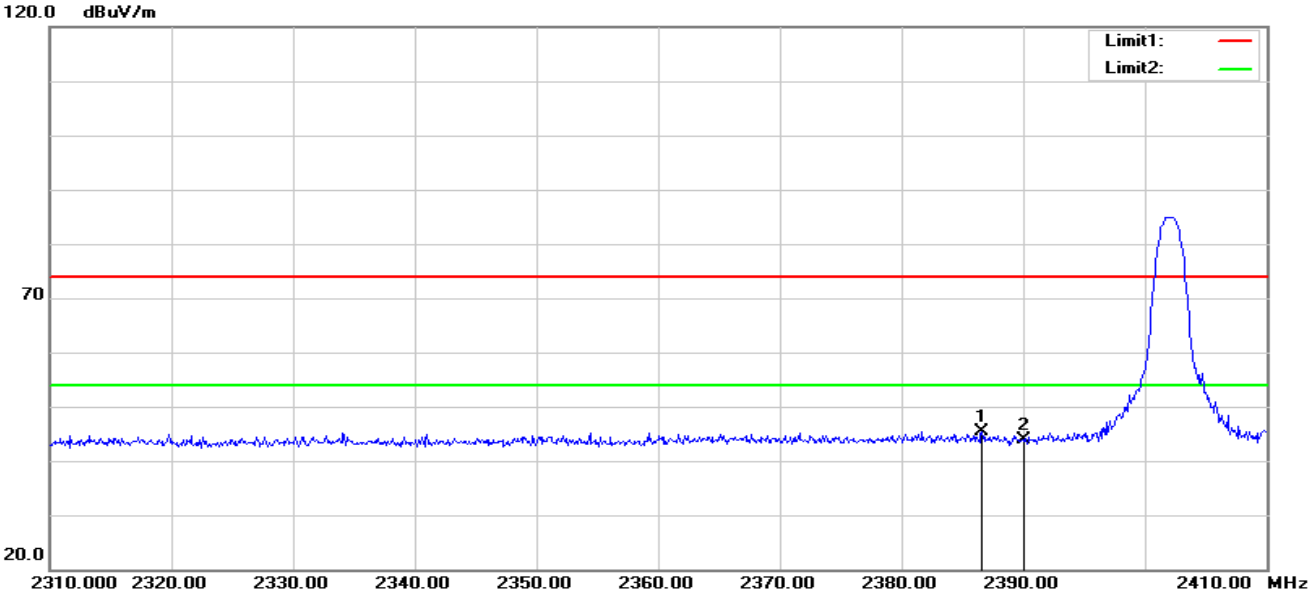
GFSK-Low

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2381.800	41.91	4.22	46.13	74.00	-27.87	peak
2	2390.000	39.60	4.34	43.94	74.00	-30.06	peak

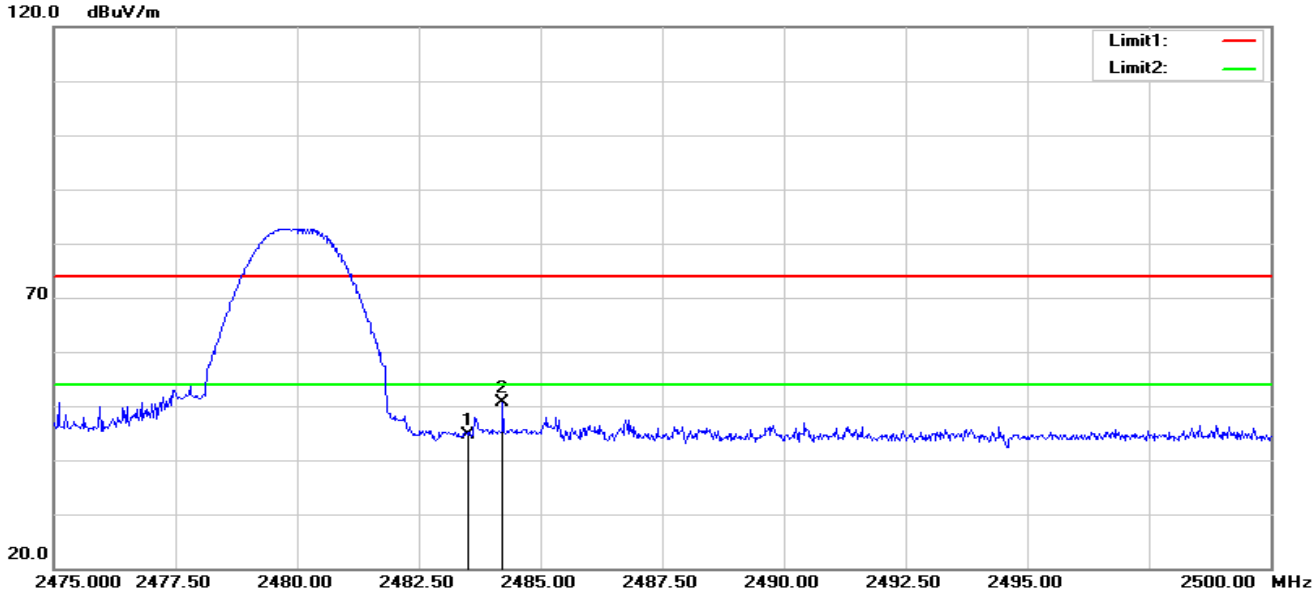
Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2386.600	41.16	4.28	45.44	74.00	-28.56	peak
2	2390.000	39.64	4.34	43.98	74.00	-30.02	peak

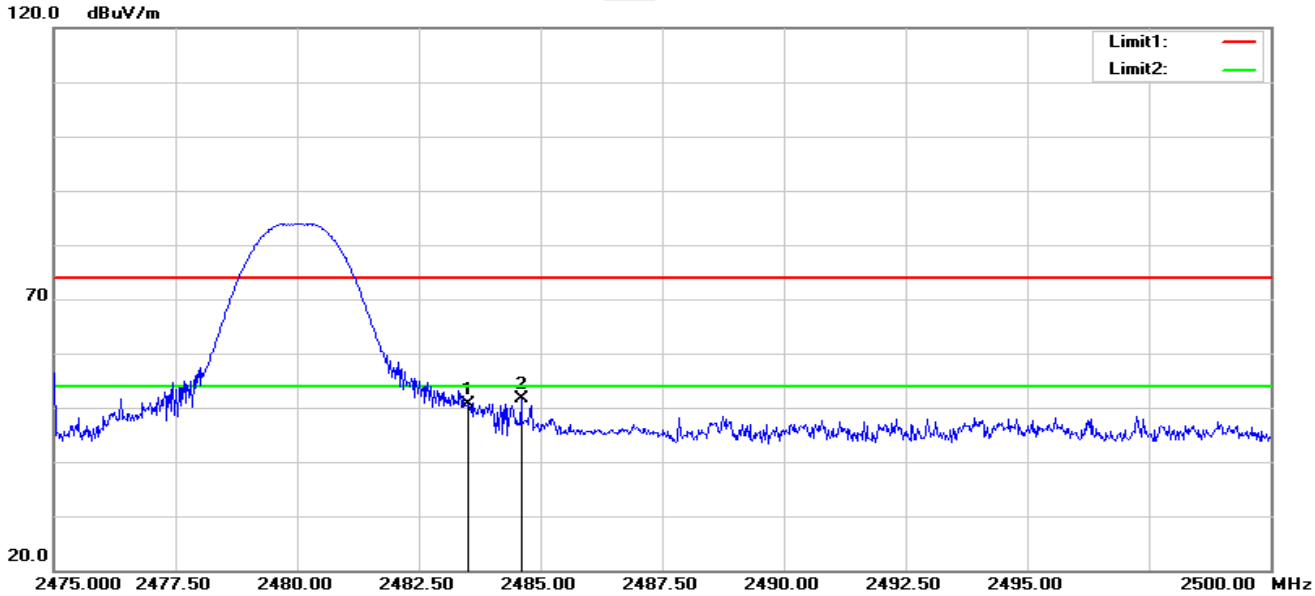
GFSK-High

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2483.500	40.10	4.60	44.70	74.00	-29.30	peak
2	2484.225	46.03	4.61	50.64	74.00	-23.36	peak

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2483.500	46.07	4.60	50.67	74.00	-23.33	peak
2	2484.600	47.06	4.61	51.67	74.00	-22.33	peak

5. CONDUCTED SPURIOUS & BAND EDGE EMISSION

5.1 LIMIT

According to FCC section 15.247(d)&RSS-247 Issue 2, 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

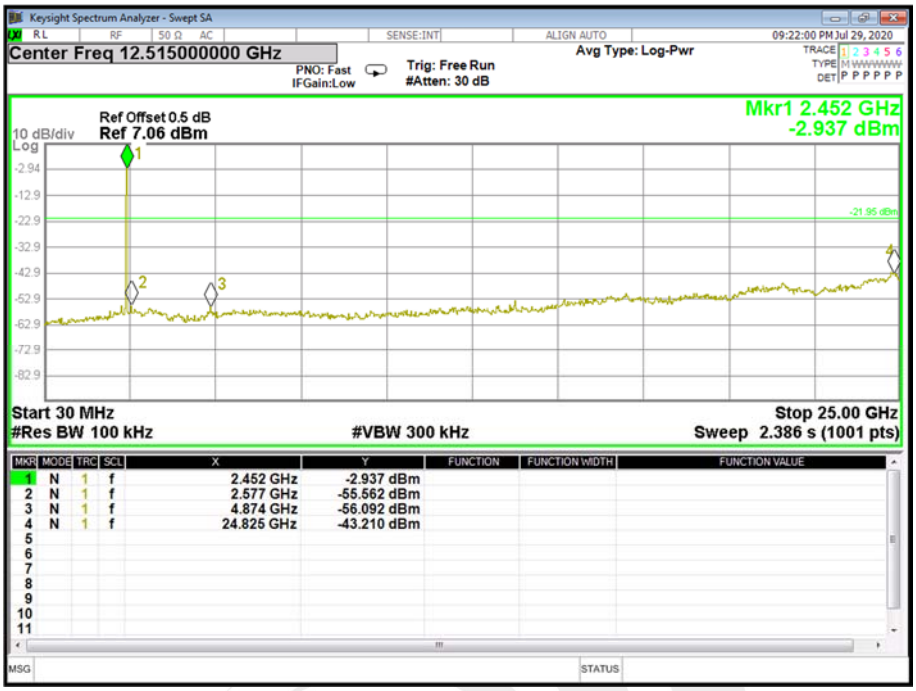
The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

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

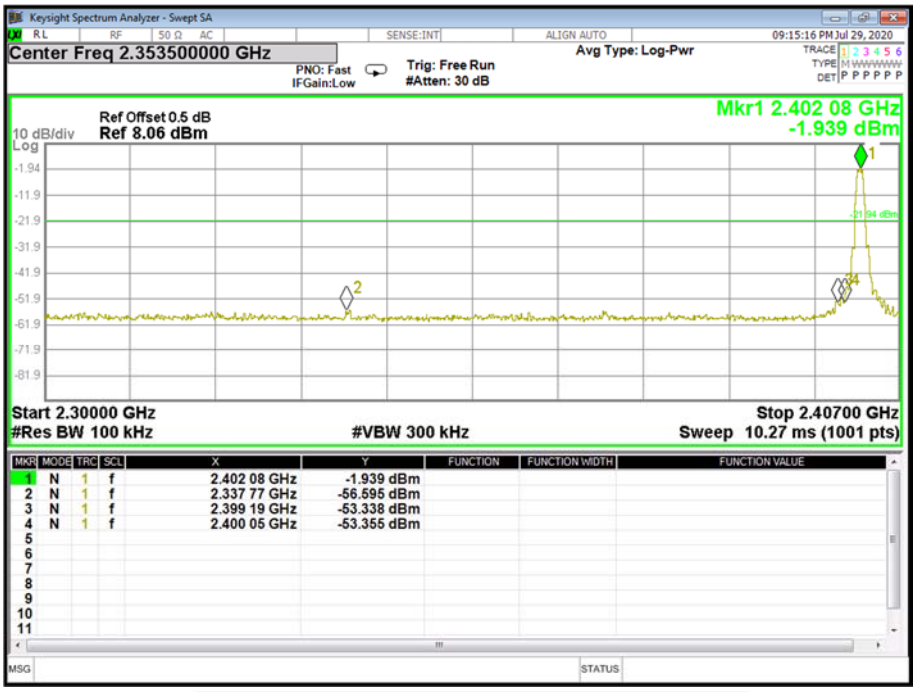

Keysight Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
09:22:00 PM Jul 29, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 7.06 dBm
Mkr1 2.452 GHz
-2.937 dBm
-21.95 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
1 N 1 f 2.452 GHz -2.937 dBm
2 N 1 f 2.577 GHz -55.562 dBm
3 N 1 f 4.874 GHz -56.092 dBm
4 N 1 f 24.825 GHz -43.210 dBm

39 CH

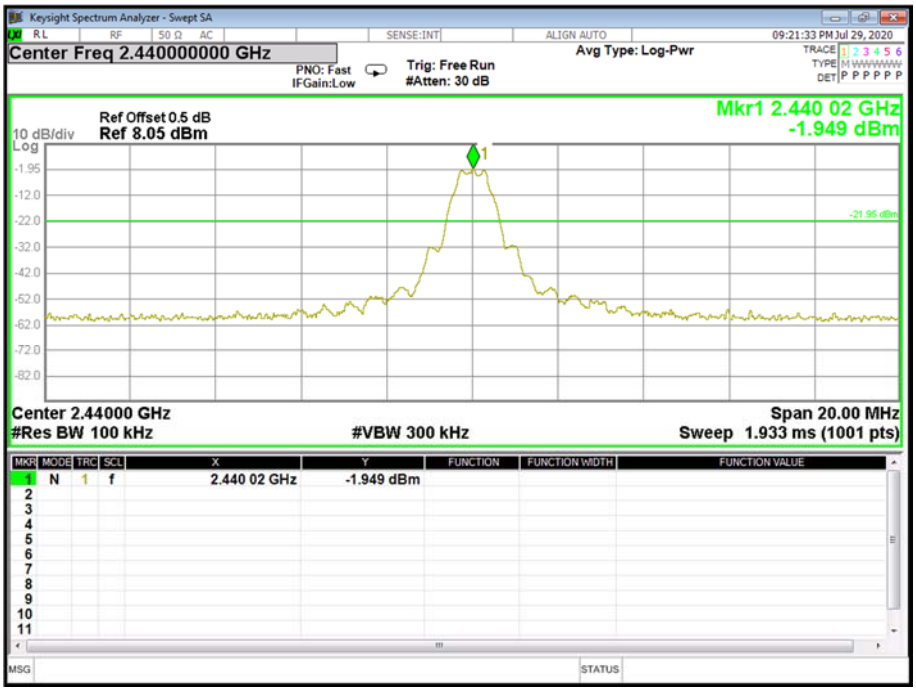
Keysight Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
09:27:57 PM Jul 29, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 4.41 dBm
Mkr1 2.477 GHz
-5.593 dBm
-22.85 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
1 N 1 f 2.477 GHz -5.593 dBm
2 N 1 f 2.602 GHz -54.925 dBm
3 N 1 f 4.949 GHz -55.628 dBm
4 N 1 f 24.800 GHz -41.202 dBm

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

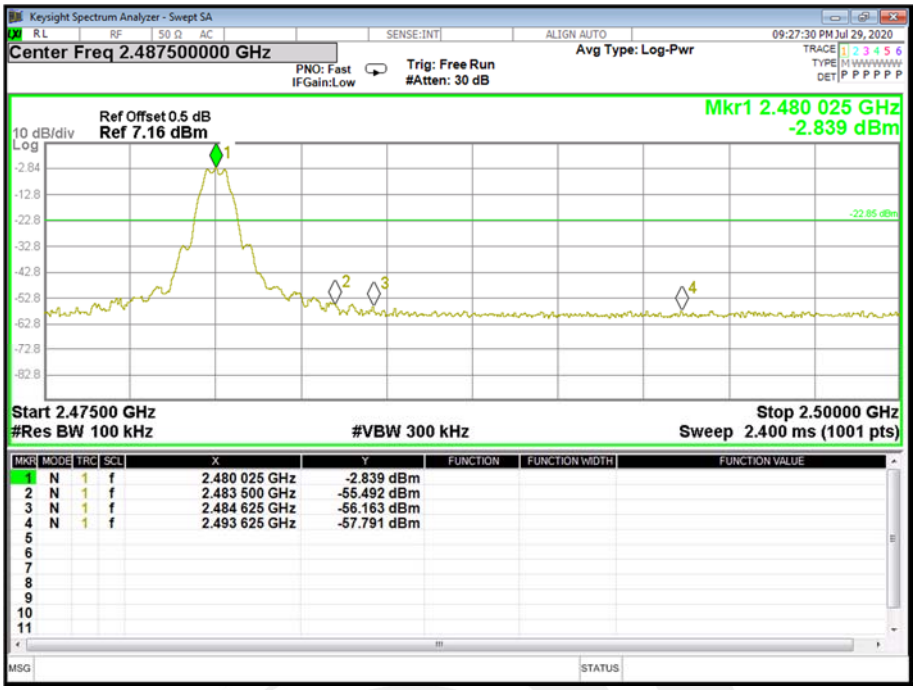
00 CH



19 CH



39 CH


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
09:27:30 PM Jul 29, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 7.16 dBm
Mkr1 2.480 025 GHz
-2.839 dBm
-22.85 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.400 ms (1001 pts)
1 N 1 f 2.480 025 GHz -2.839 dBm
2 N 1 f 2.483 500 GHz -55.492 dBm
3 N 1 f 2.484 625 GHz -56.163 dBm
4 N 1 f 2.493 625 GHz -57.791 dBm

6. POWER SPECTRAL DENSITY TEST

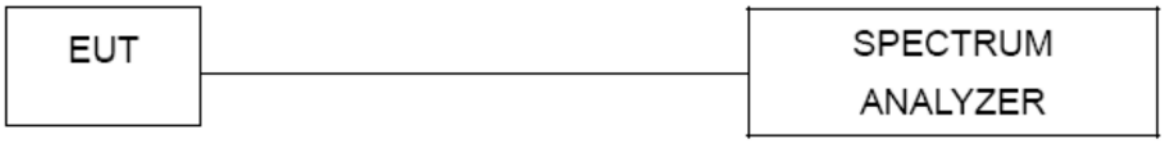
6.1 LIMIT

FCC Part 15.247,Subpart C RSS-247 Issue 2				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(e) RSS-247 Issue 2	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

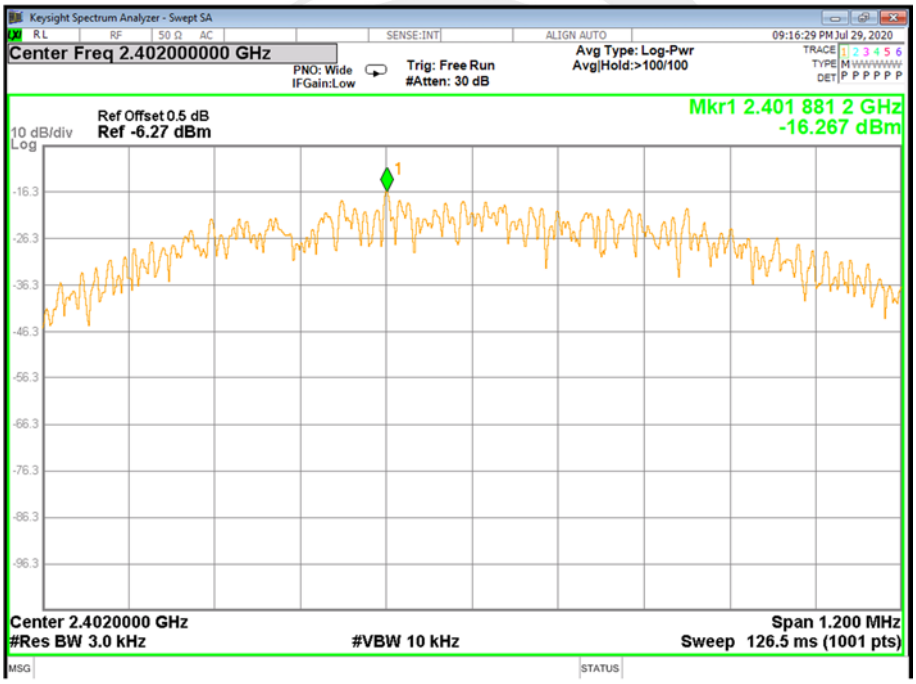
The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

6.5 TEST RESULTS

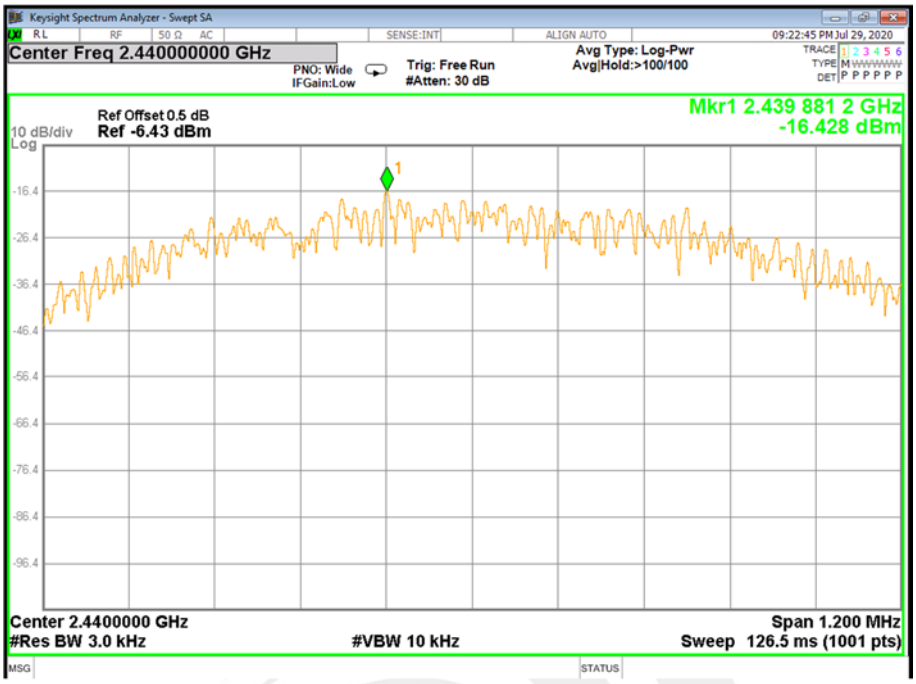
Temperature:	25 ℃	Relative Humidity:	60%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

Frequency	Power Density (dBm/3kHz)	Limit (dBm/3KHz)	Result
2402 MHz	-16.267	≤8	PASS
2440 MHz	-16.428	≤8	PASS
2480 MHz	-17.301	≤8	PASS

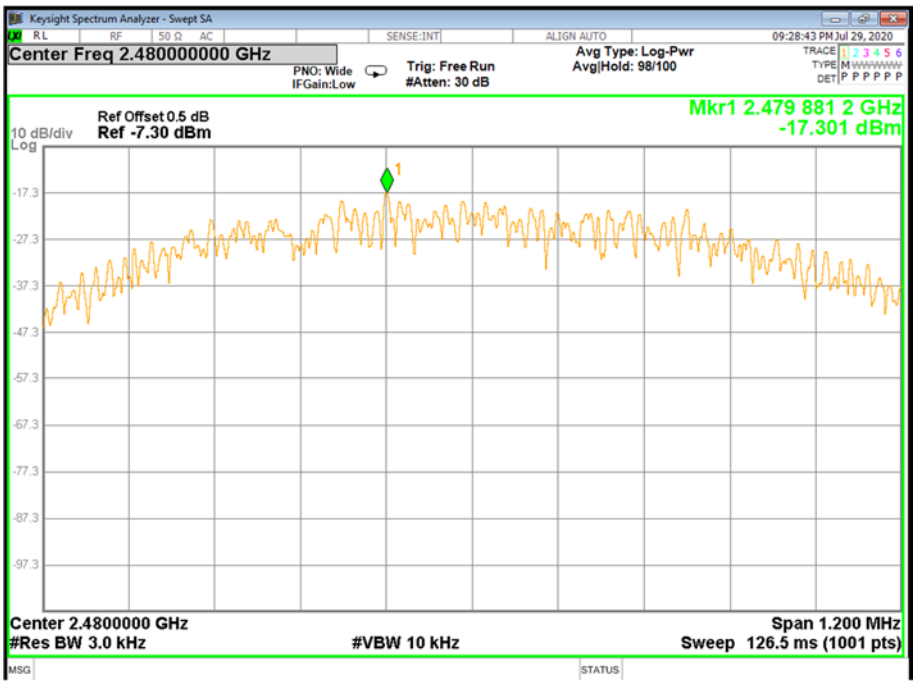
TX CH00



TX CH19



TX CH39



7. BANDWIDTH TEST

7.1 LIMIT

FCC Part 15.247,Subpart C RSS-Gen Clause 6.7				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2) RSS-Gen Clause 6.7	Bandwidth	>= 500KHz (6dB bandwidth)	2400-2483.5	PASS
RSS-Gen Clause 6.7	99% Bandwidth	For reporting purposes only.	2400-2483.5	PASS

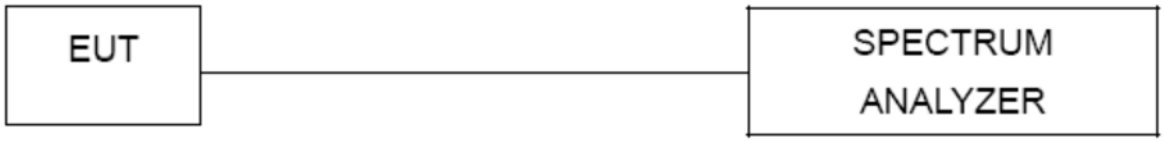
7.2 TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

Center Frequency	The centre frequency of the channel under test
Detector	Peak
RBW	For 6 dB Bandwidth :100KHz For 99% Bandwidth :1% to 5% of the occupied bandwidth
VBW	For 6dB Bandwidth : ≥3 × RBW For 99% Bandwidth : approximately 3×RBW
Trace	Max hold
Sweep	Auto

Allow the trace to stabilize and measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB and 99% relative to the maximum level measured in the fundamental emission.

7.3 TEST SETUP



7.4 EUT OPERATION CONDITIONS

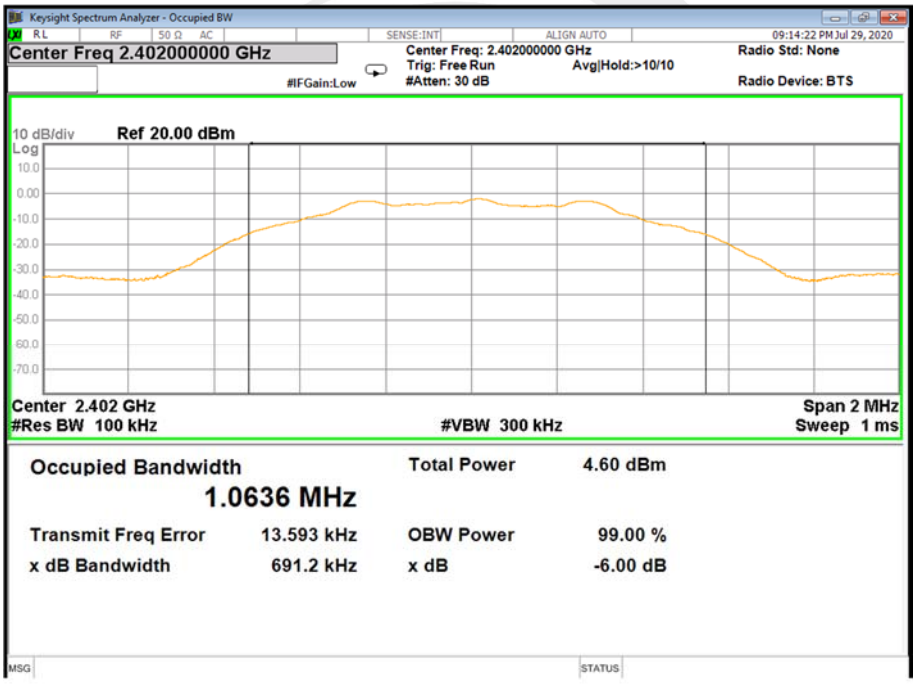
The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

7.5 TEST RESULTS

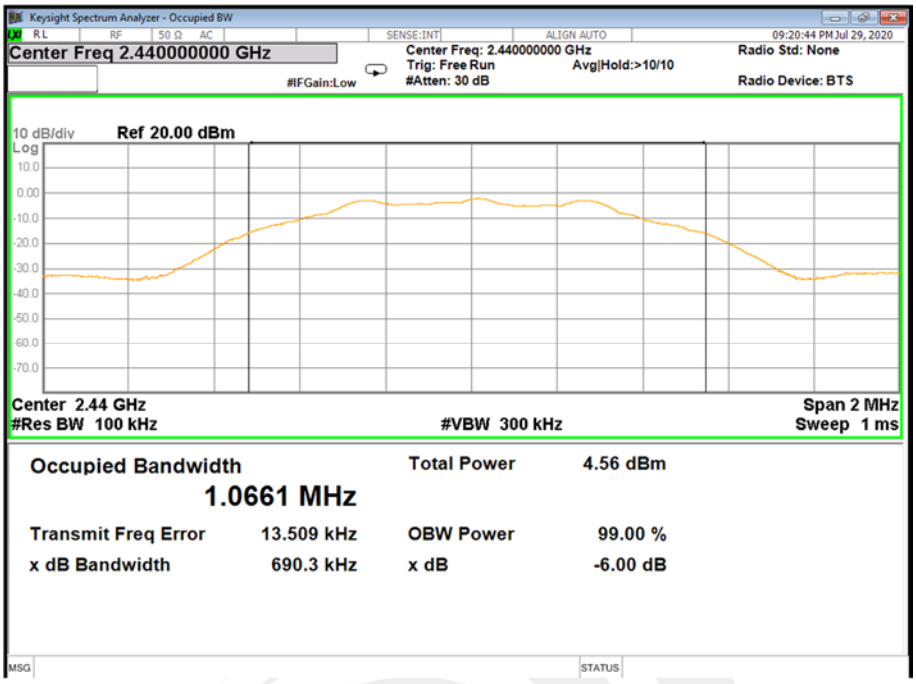
Temperature:	25 ℃	Relative Humidity:	60%
Test Voltage:	DC 3.7V	Test Mode:	TX Mode /CH00, CH19, CH39

Frequency	6dB Bandwidth (KHz)	99% Bandwidth (KHz)	Channel Separation (KHz)	Result
2402 MHz	691.200	1044.900	≥500KHz	PASS
2440 MHz	690.300	1047.300	≥500KHz	PASS
2480 MHz	695.800	1051.200	≥500KHz	PASS

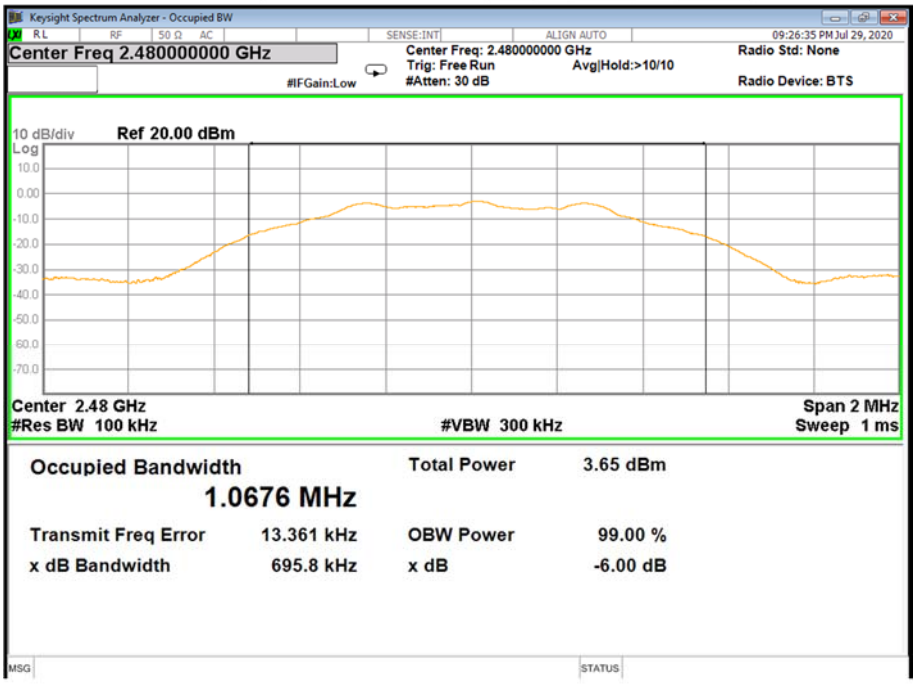
6dB Bandwidth TX CH 00



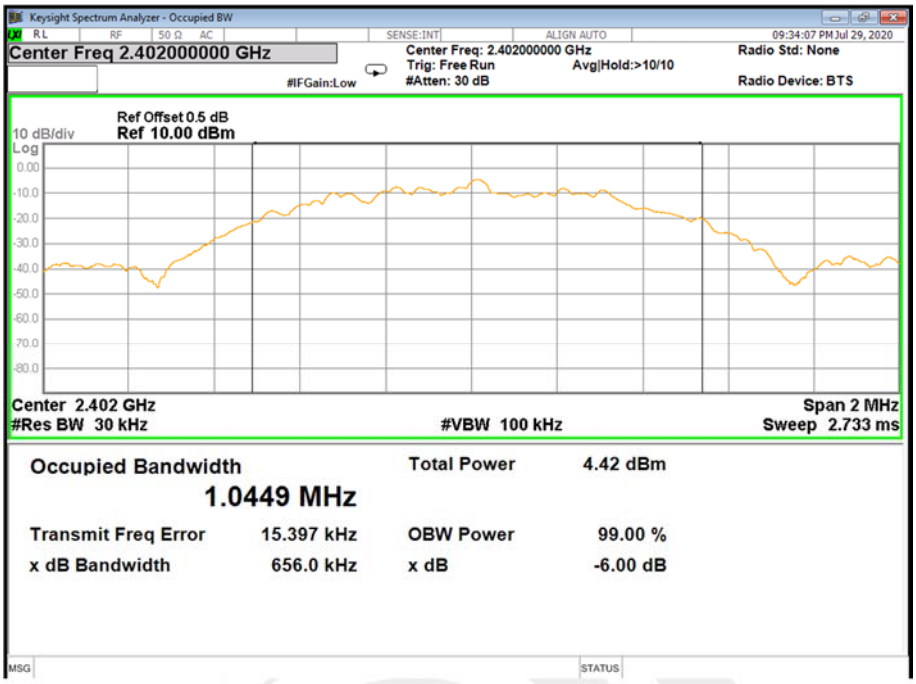
6dB Bandwidth TX CH 19



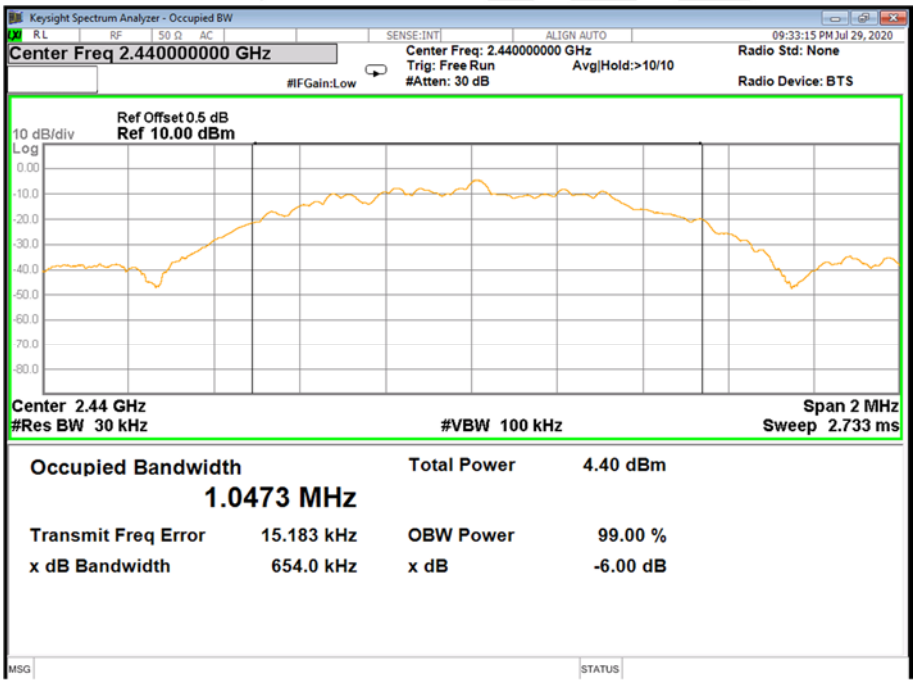
6dB Bandwidth TX CH 39



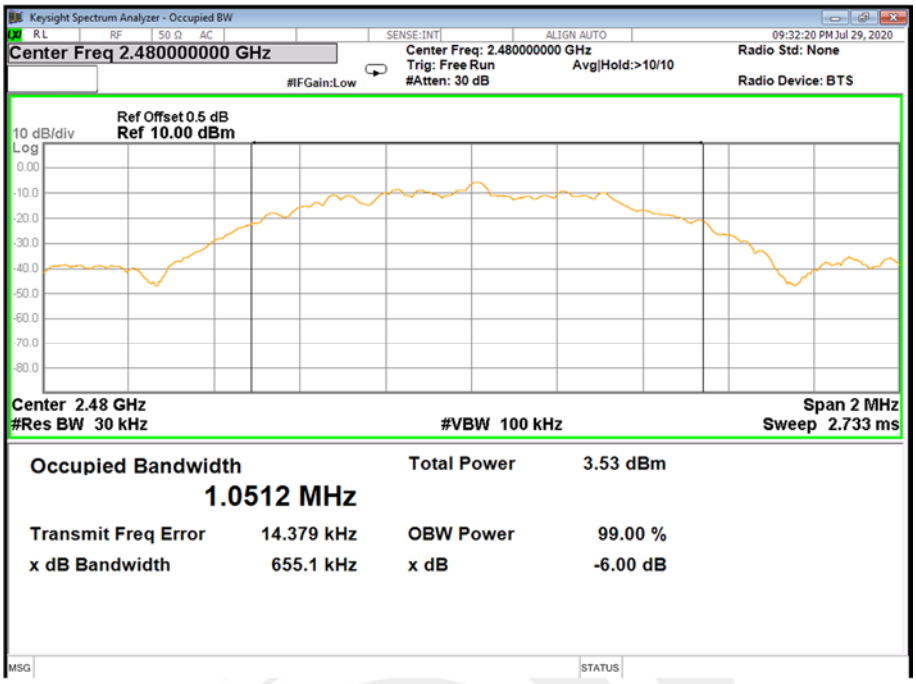
99% Bandwidth TX CH 00



99% Bandwidth TX CH 19



99% Bandwidth TX CH 39



8. PEAK OUTPUT POWER TEST

8.1 LIMIT

FCC Part 15.247,Subpart C RSS-247 Issue 2				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3) RSS 247 Issue 2	Output Power	1 watt or 30dBm	2400-2483.5	PASS
RSS-247	EIRP	4W	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

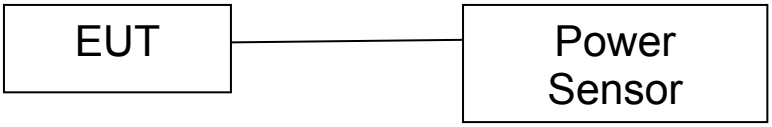
DTS bandwidth:

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

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

8.5 TEST RESULTS

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

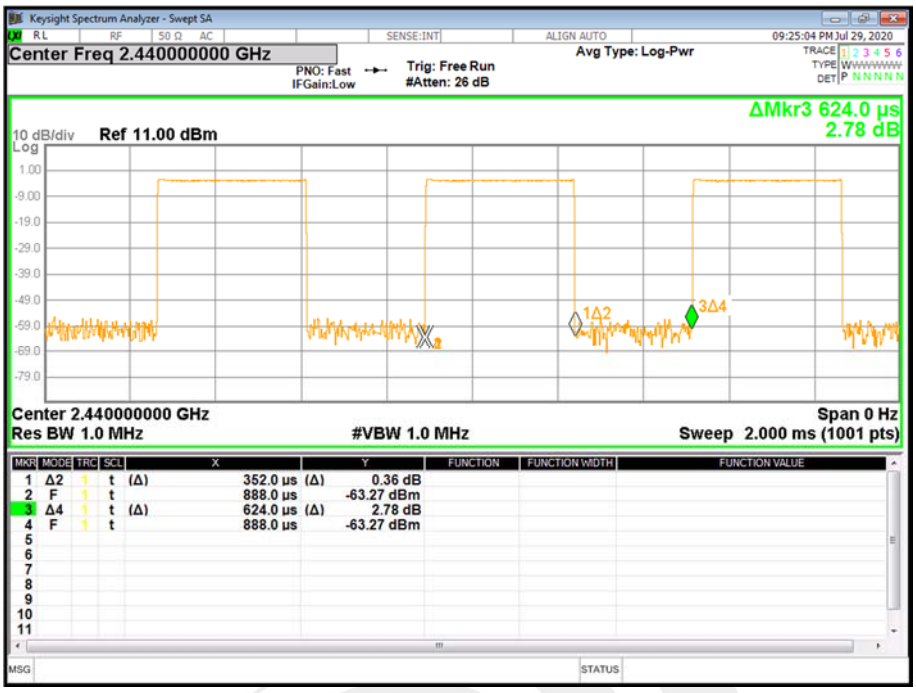
Test Channe	Frequency	Peak Conducted Output Power	Average Conducted Output Power	LIMIT
	(MHz)	(dBm)	(dBm)	dBm
CH0	2402	-0.82	-3.72	30
CH19	2440	-0.97	-3.82	30
CH39	2480	-1.03	-3.89	30

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.

EIRP Power

Test Channe	Frequency	Peak Conducted Output Power	Antenna Gain	EIRP Power	LIMIT
	(MHz)	(dBm)	(dBi)	(dBm)	dBm
CH0	2402	-0.83	-2.00	-2.83	36.02
CH19	2440	-0.97	-2.00	-2.97	36.02
CH39	2480	-1.03	-2.00	-3.03	36.02

Duty cycle



	Ton	Tp	Duty cycle(%)
	0.352	0.624	56.41%

9. ANTENNA REQUIREMENT

9.1 STANDARD REQUIREMENT

15.203&RSS Gen Issue 5 requirement: For intentional device, according to 15.203&RSS Gen Issue 5: 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 Internal monopole Antenna. It comply with the standard requirement.

10. FREQUENCY STABILITY

10.1 LIMITS OF FREQUENCY STABILITY MEASUREMENT

The frequency tolerance of the carrier signal shall be maintained within +/-0.02% of the operating frequency over a temperature variation of -30 degrees to 50 degrees C at normal supply voltage,and for a variation in primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees.

10.2 TEST PROCEDURE

1. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
2. Turn the EUT on and couple its output to spectrum analyzer.
3. Turn the EUT off and set the chamber to the highest temperature specified.
4. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize,turn the EUT on and measure the operating frequency after 2,5,and 10 minutes.
5. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
6. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes.The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

10.3 TEST RESULT

Channel 19 (2440MHz)

Voltage vs. Frequency Stability

Voltage(V)	Measurement Frequency(MHz)
4.255	2440.0051
3.7	2440.0046
3.145	2440.0050
Max.Deviation(MHz)	0.0051
Max.Deviation(ppm)	2.09

Rated working voltage: DC 3.7V

Temperature vs. Frequency Stability

Temperature(℃)	Measurement Frequency(MHz)
-30	2440.0063
-20	2440.0063
-10	2440.0053
0	2440.0058
10	2440.0061
20	2440.0062
30	2440.0063
40	2440.0061
50	2440.0057
Max.Deviation(MHz)	0.0063
Max.Deviation(ppm)	2.58

11. EUT TEST PHOTO

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

※※※※※END OF THE REPORT※※※※※