FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No. .....:	**CTA26061701901**	
FCC ID. ..... :	**2A85Y-CERES1**	
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Date of issue .....:	Jul. 09, 2026	
Testing Laboratory Name.....:	**Shenzhen CTA Testing Technology Co., Ltd.**	
Address .....:	Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China	
Applicant's name .....:	**DONGGUAN ESWN TECHNOLOGY CO., LTD**	
Address .....:	Room106, No.15 chukeng Industrial Road, Dongkeng Town, Dongguan City, Guangdong Province, China	
Test specification.....:		
Standard.....:	**FCC Part 15.247**	

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Test item description .....:	**Ceres 1.0 Mechanical Keyboard**
Trade Mark.....:	N/A
Manufacturer .....:	DONGGUAN ESWN TECHNOLOGY CO., LTD
Model/Type reference .....:	Ceres 1.0
Listed Models .....:	N/A
Modulation .....:	GFSK
Frequency .....:	From 2402MHz to 2479MHz
Ratings .....:	Input: 5V⎓1A Battery: 3.7V 4200mAh 15.54Wh
Result .....:	**PASS**

TEST REPORT

Equipment under Test	:	Ceres 1.0 Mechanical Keyboard
Model /Type	:	Ceres 1.0
Applicant	:	**DONGGUAN ESWN TECHNOLOGY CO., LTD**
Address	:	Room106, No.15 chukeng Industrial Road, Dongkeng Town, Dongguan City, Guangdong Province, China
Manufacturer	:	**DONGGUAN ESWN TECHNOLOGY CO., LTD**
Address	:	Room106, No.15 chukeng Industrial Road, Dongkeng Town, Dongguan City, Guangdong Province, China

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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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 C63.10-2020 +Cor. 1-2023+ C63.10a-2024+ Errata to C63.10a-2024: American National Standard for Testing Unlicensed Wireless Devices

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	Jun. 17, 2026
Testing commenced on	:	Jun. 17, 2026
Testing concluded on	:	Jul. 09, 2026

2.2 Product Description

Product description:	Ceres 1.0 Mechanical Keyboard
Model/Type reference:	Ceres 1.0
Power supply:	Input: 5V⎓ 1 A Battery: 3.7V 4200mAh 15.54Wh
Testing sample ID:	CTA260617019-1# (Engineer sample) CTA260617019-2# (Normal sample)
2.4G :	
Modulation:	GFSK
Operation frequency:	2402MHz~2479MHz
Channel number:	78
Channel separation:	1MHz
Antenna type:	PCB Antenna
Antenna gain:	1.58dBi

2.3 Equipment Under Test

Power supply system utilised

Refer to section 2.2

2.4 Short description of the Equipment under Test (EUT)

This is a Ceres 1.0 Mechanical Keyboard.
For more details, refer to the user's manual of the EUT.

Test Software Version	FCC_test_tool V2.4.5		
Frequency	2402 MHz	2440MHz	2479 MHz
GFSK	Default	Default	Default

2.5 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

○ - supplied by the manufacturer
● - supplied by the lab

●	Adapter (Auxiliary test supplied by testing Lab)	Model: EP-TA20CBC Input: AC 100-240V 50/60Hz Output: DC 5V 2A

2.6 EUT operation mode

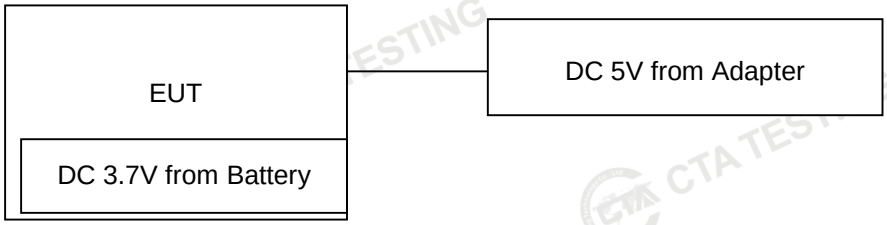
The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing .There are 79 channels provided to the EUT and Channel 00/39/78 were selected to test.

Operation Frequency:

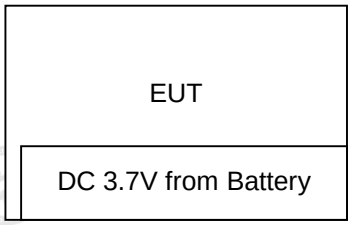
Channel	Frequency (MHz)
00	2402
01	2403
⋮	⋮
38	2440
39	2441
40	2442
⋮	⋮
76	2478
77	2479

2.7 Block Diagram of Test Setup

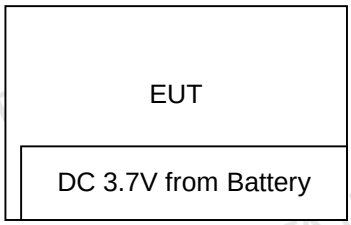
AC Power Conducted Emission



Radiated Emission



RF Conducted



2.8 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.9 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen CTA Testing Technology Co., Ltd.
Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community,Fuhai Street, Bao'an District, Shenzhen, China

3.2 Test Facility

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

FCC-Registration No.: 517856 Designation Number: CN1318
Shenzhen CTA Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA-Lab Cert. No.: 6534.01
Shenzhen CTA Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

3.3 Environmental conditions

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

Temperature:	25 ° C
Humidity:	60 %
Atmospheric pressure:	950-1050mbar

AC Power Conducted Emission:

Temperature:	25 ° C
Humidity:	60 %
Atmospheric pressure:	950-1050mbar

Conducted testing:

Temperature:	25 ° C
Humidity:	60 %
Atmospheric pressure:	950-1050mbar

3.4 Summary of measurement results

Test Specification clause	Test case	Test result
§15.247(a)(1)	Carrier Frequency separation	Compliant
§15.247(a) (1) (iii)	Number of Hopping channels	Compliant
§15.247(a) (1) (iii)	Time of Occupancy (dwell time)	Compliant
§15.247(a)(1)	Spectrum bandwidth of a FHSS system20dB bandwidth	Compliant
§15.247(b)(1)	Maximum output peak power	Compliant
§15.247(d)	Band edge compliance Conducted	Compliant
§15.205	Band edge compliance radiated	Compliant
§15.247(d)	TX spurious emissions conducted	Compliant
§15.247(d)	TX spurious emissions radiated	Compliant
§15.209(a)	TX spurious Emissions radiated Below 1GHz	Compliant
§15.207	AC Power Conducted Emission	Compliant

Remark:
1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report
3. RF Conducted test Offset= cable loss, For conducted spurious emission test, cable loss is the maximum value in the range of test.

3.5 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 TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the Shenzhen CTA 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.
Hereafter the best measurement capability for Shenzhen CTA Testing Technology Co., Ltd. :

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	9KHz~30MHz	3.02 dB	(1)
Radiated Emission	30~1000MHz	4.06 dB	(1)
Radiated Emission	1~18GHz	5.14 dB	(1)
Radiated Emission	18-40GHz	5.38 dB	(1)
Conducted Disturbance	0.15~30MHz	2.14 dB	(1)
Output Peak power	30MHz~18GHz	0.55 dB	(1)
Power spectral density	/	0.57 dB	(1)
Spectrum bandwidth	/	1.1%	(1)
Radiated spurious emission (30MHz-1GHz)	30~1000MHz	4.10 dB	(1)
Radiated spurious emission (1GHz-18GHz)	1~18GHz	4.32 dB	(1)
Radiated spurious emission (18GHz-40GHz)	18-40GHz	5.54 dB	(1)
Time	/	±2%	(1)

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

3.6 Equipments Used during the Test

Item.	Test Equipment	Manufacturer	Model No.	Equipment No.	Calibration Date	Calibration Due Date
AC Conducted Test Equipment						
☒1	LISN	R&S	ENV216	CTA-308	2025/08/04	2026/08/03
☒2	LISN	R&S	ENV216	CTA-314	2025/07/30	2026/07/29
☒3	EMI Test Receiver	R&S	ESPI	CTA-307	2025/07/30	2026/07/29
☒4	CE Cable	SKET	RF Cable (9kHz-30MHz)	CTA-367	2025/07/30	2026/07/29
☒5	Temperature and humidity meter	Chigo	ZG-7020	CTA-327	2025/07/31	2026/07/30
☒6	EMI Test Software	Tonscend	TS®JS32-CE	5.0.0.1	N/A	N/A
RF Radiation Test Equipment						
☒1	EMI Test Receiver	R&S	ESCI	CTA-306	2025/07/30	2026/07/29
☒2	Spectrum analyzer	R&S	FSV40-N	CTA-344	2026/05/16	2027/05/15
☒3	Ultra-Broadband Antenna	Schwarzbeck	VULB9163	CTA-310	2023/10/17	2026/10/16
☒4	Horn Antenna	Schwarzbeck	BBHA 9120D	CTA-309	2023/10/13	2026/10/12
☒5	Loop Antenna	Zhinan	ZN30900C	CTA-311	2023/10/17	2026/10/16
☒6	Horn Antenna	Schwarzbeck	BBHA 9170	CTA-346	2025/05/18	2028/05/17
☒7	Amplifier	Schwarzbeck	BBV9745	CTA-312	2025/07/30	2026/07/29
☒8	Amplifier	Tonscend	TAP-011840	CTA-313	2025/07/30	2026/07/29
☒9	Amplifier	SKET	LNPA 1840G-50	CTA-345	2026/05/16	2027/05/15
☒10	6dB attenuator	Shanghaihuaxiang	GZL-TS5-6-6	CTA-347	2026/05/16	2027/05/15
☒11	RF cable	SKET	RF Cable (9kHz-1GHz)	CTA-360	2025/09/25	2026/09/24
☒12	RF cable	SKET	RF Cable (1GHz-18GHz)	CTA-361	2025/09/25	2026/09/24
☒13	Coaxialcable (1GHz-40GHz)	SKET	RE-04-D	CTA-348	2026/05/16	2027/05/15
☒14	Coaxialcable (1GHz-40GHz)	SKET	RE-04-M	CTA-349	2026/05/16	2027/05/15
☒15	Coaxialcable (1GHz-40GHz)	SKET	RE-04-L	CTA-350	2026/05/16	2027/05/15
☒16	Temperature and humidity meter	Chigo	ZG-7020	CTA-328	2025/07/31	2026/07/30
☒17	2.4GFilter	HX Microwave	HXLBQ-DZA61	CTA-365	2025/07/31	2026/07/30
☐18	5GFilter	CONCEPT	CNF05150M05850Q16A	CTA-366	2025/07/31	2026/07/30
☐19	High-Pass Filter	XingBo	XBLBQ-GTA18	CTA-402	2025/07/30	2026/07/29
☐20	High-Pass Filter	XingBo	XBLBQ-GTA27	CTA-403	2025/07/30	2026/07/29
☐21	High-Pass Filter	XingBo	XBLBQ-GTA10	CTA-364	2025/07/30	2026/07/29
☒22	EMI Test Software	Tonscend	TS®JS32-RE	5.0.0.2	N/A	N/A
RF Conducted Test Equipment						
☒1	Spectrum Analyzer	Agilent	N9020A	CTA-342	2025/07/30	2026/07/29
☐2	Spectrum analyzer	R&S	FSV40-N	CTA-344	2026/05/16	2027/05/15
☒3	RF Coaxial Cable	SKET	RF Cable (9kHz-40GHz)	CTA-368	2025/07/30	2026/07/29
☒4	Temperature and humidity meter	ZG-7020	Chigo	CTA-329	2025/07/31	2026/07/30

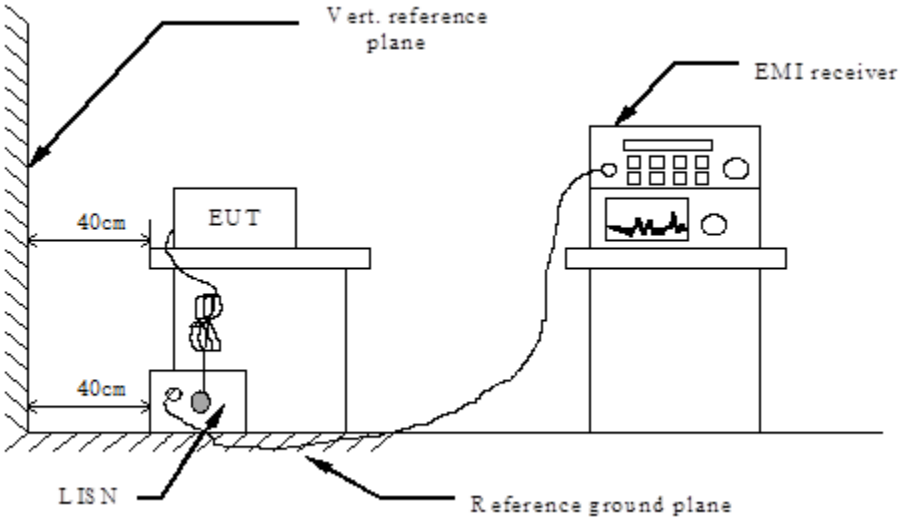
☒5	Programmable Constant Temperature And Humidity Test Chamber	DONGGUAN JINGYU	HT-H-408	CTA-053	2025/07/30	2026/07/29
☐6	Vector Signal generator	Agilent	N5182A	CTA-305	2025/07/30	2026/07/29
☐7	Analog Signal Generator	R&S	E4421B	CTA-304	2025/07/30	2026/07/29
☐8	WIDEBAND RADIO COMMUNICATION TESTER	R&S	CMW500	CTA-302	2025/07/30	2026/07/29
☒9	Automatic control unit	Tonscend	JS0806-2	CTA-351	2025/07/30	2026/07/29
☒10	RF Test Software	Tonscend	TS®JS1120-3	3.1.65	N/A	N/A
☒11	RF Test Software	Tonscend	TS®JS1120	3.1.46	N/A	N/A
☒12	RF Connection Cable	N/A	N/A	1#	Each time	N/A

Note: The automatic control unit integrated Power sensor

4 TEST CONDITIONS AND RESULTS

4.1 AC Power Conducted Emission

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 C63.10-2020.
2 Support equipment, if needed, was placed as per ANSI C63.10-2020
3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2020
4 The EUT received power from adapter, the adapter received AC120V/60Hz and AC 240V/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.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

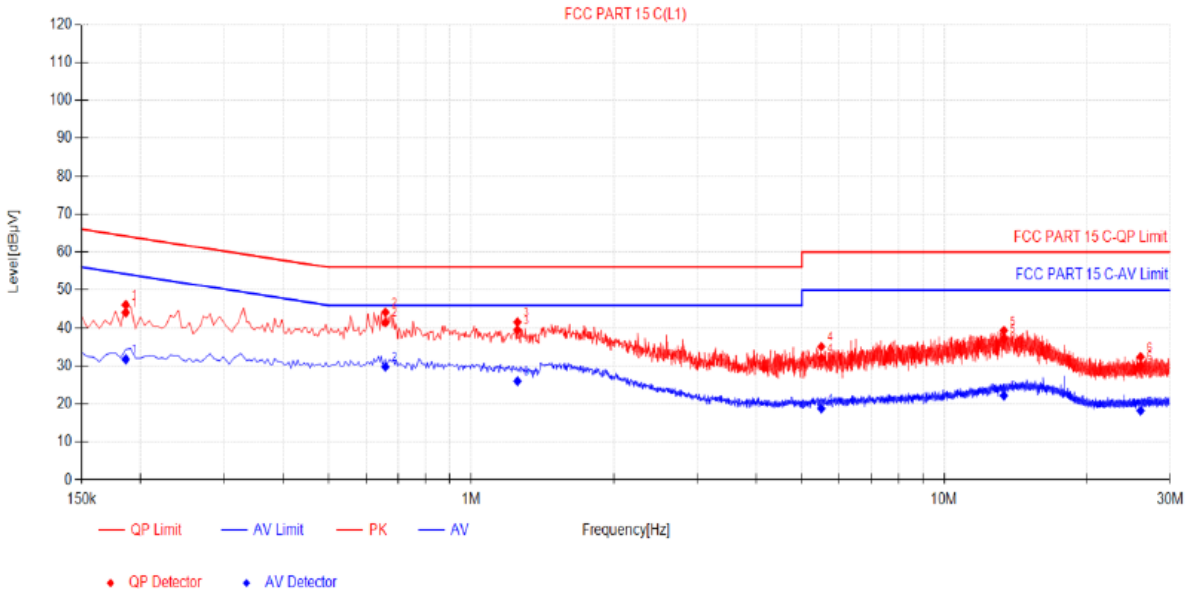
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

TEST RESULTS

Remark:
1. GFSK were test at Low, Middle, and High channel; only the worst result of Low Channel was reported as below:

2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:

Polarization:	L

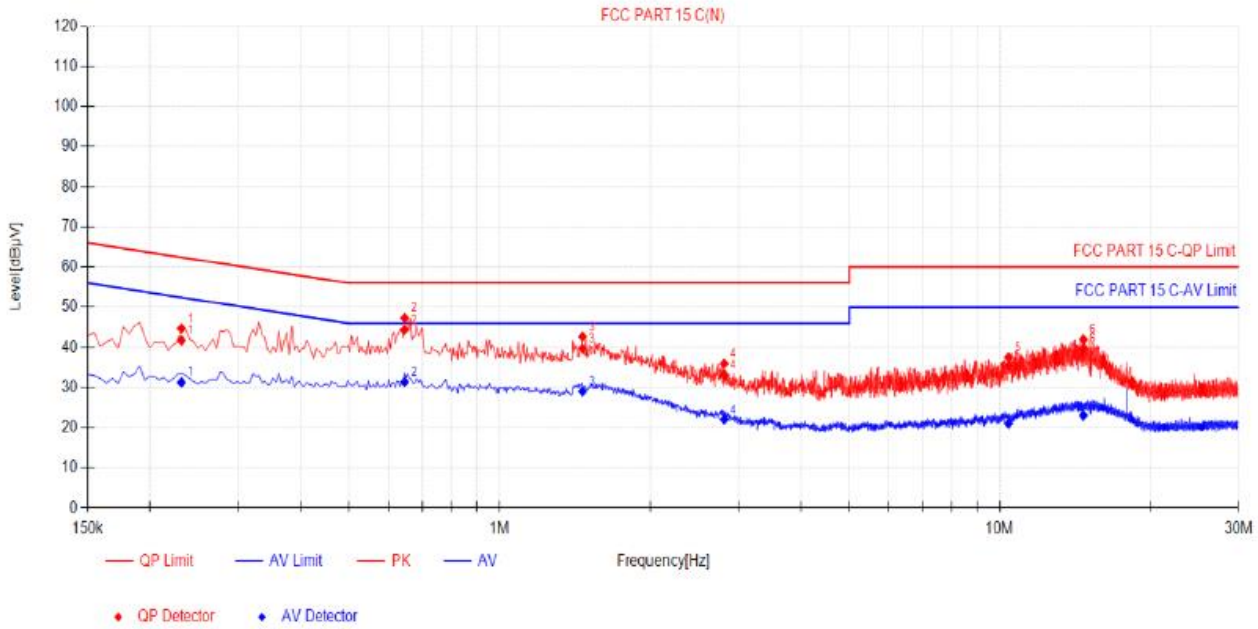


Final Data List

NO.	Freq. [MHz]	Factor [dB]	QP Reading[dBµV]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading [dBµV]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Verdict
1	0.186	9.97	34.10	44.07	64.21	20.14	21.81	31.78	54.21	22.43	PASS
2	0.6585	10.30	31.14	41.44	56.00	14.56	19.43	29.73	46.00	16.27	PASS
3	1.2525	10.44	29.06	39.50	56.00	16.50	15.59	26.03	46.00	19.97	PASS
4	5.496	10.93	21.18	32.11	60.00	27.89	7.83	18.76	50.00	31.24	PASS
5	13.371	12.01	25.22	37.23	60.00	22.77	10.19	22.20	50.00	27.80	PASS
6	25.9845	13.29	16.70	29.99	60.00	30.01	4.89	18.18	50.00	31.82	PASS

Note:1).QP Value (dBµV)= QP Reading (dBµV)+ Factor (dB)
2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)
3). QPMargin(dB) = QP Limit (dBµV) - QP Value (dBµV)
4). AVMargin(dB) = AV Limit (dBµV) - AV Value (dBµV)

Polarization:	N



Final Data List

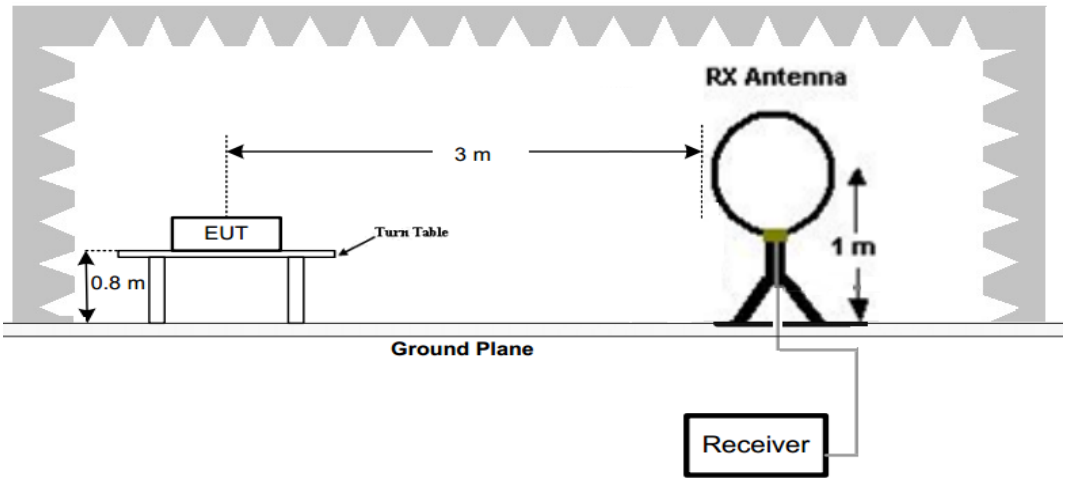
NO.	Freq. [MHz]	Factor [dB]	QP Reading[dBµV]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading [dBµV]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Verdict
1	0.231	9.74	32.03	41.77	62.41	20.64	21.54	31.28	52.41	21.13	PASS
2	0.645	10.27	34.12	44.39	56.00	11.61	21.12	31.39	46.00	14.61	PASS
3	1.464	10.41	29.33	39.74	56.00	16.26	18.59	29.00	46.00	17.00	PASS
4	2.8095	10.59	22.45	33.04	56.00	22.96	11.47	22.06	46.00	23.94	PASS
5	10.41	11.67	23.71	35.38	60.00	24.62	9.35	21.02	50.00	28.98	PASS
6	14.6805	12.29	27.42	39.71	60.00	20.29	10.74	23.03	50.00	26.97	PASS

Note:1).QP Value (dBµV)= QP Reading (dBµV)+ Factor (dB)
2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)
3). QPMargin(dB) = QP Limit (dBµV) - QP Value (dBµV)
4). AVMargin(dB) = AV Limit (dBµV) - AV Value (dBµV)

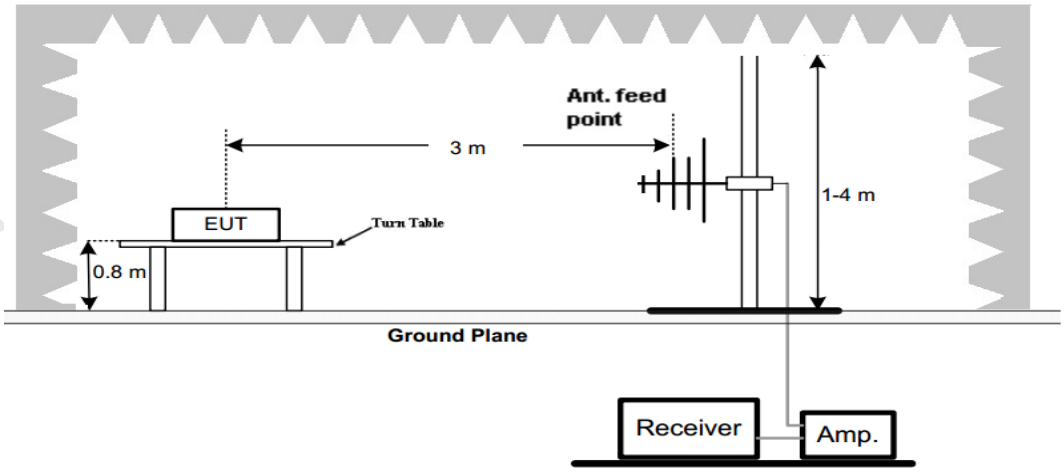
4.2 Radiated Emission

TEST CONFIGURATION

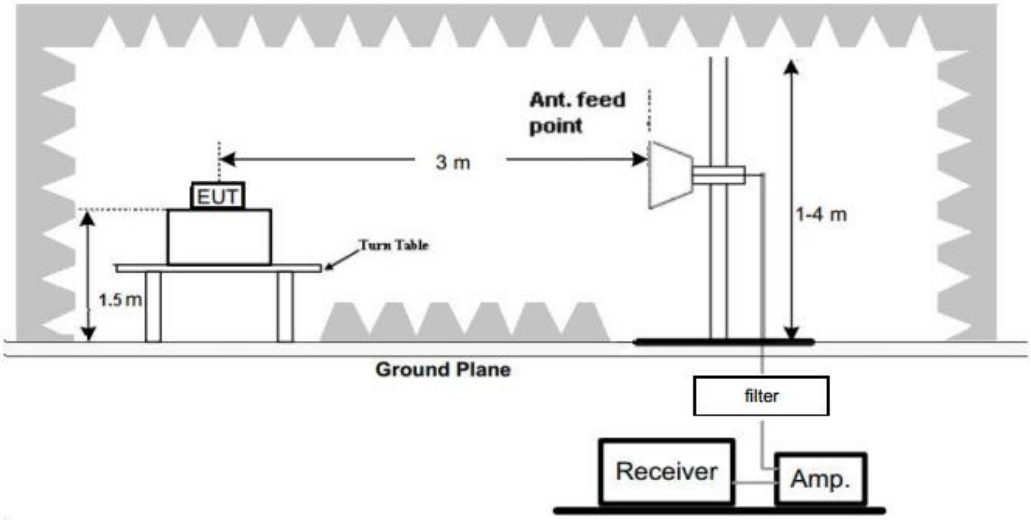
Frequency range 9 KHz – 30MHz

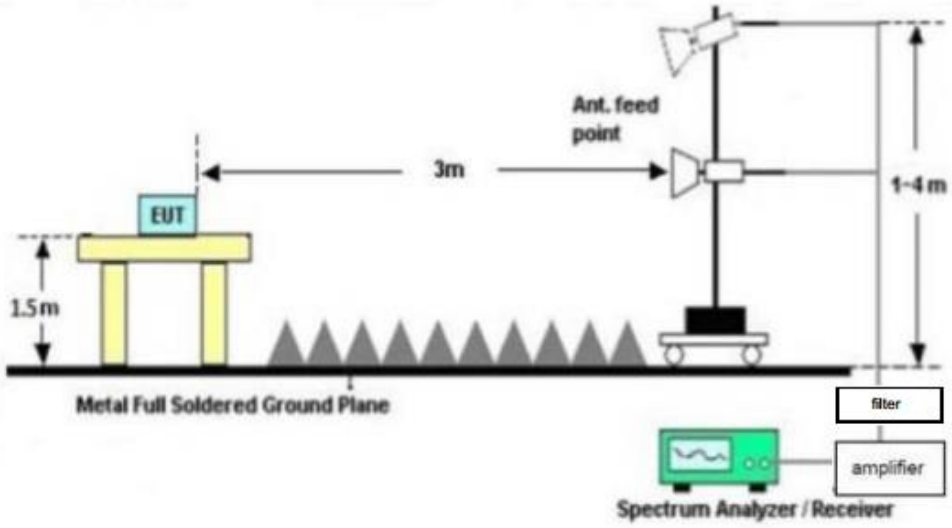


Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz





TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz; the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0° to 360° 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.
5. Radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Anternna	3

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

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	

Transd=AF +CL-AG

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

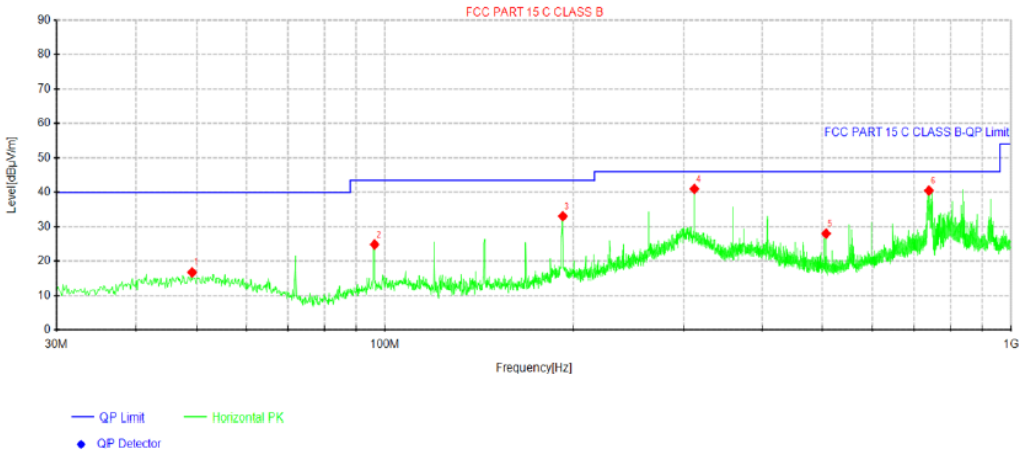
Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

TEST RESULTS

Remark:
1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. We measured Radiated Emission at GFSK mode from 9 KHz to 25GHz.
3. For below 1GHz testing recorded worst at low channel.
4. Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.

For 30MHz-1GHz

Horizontal



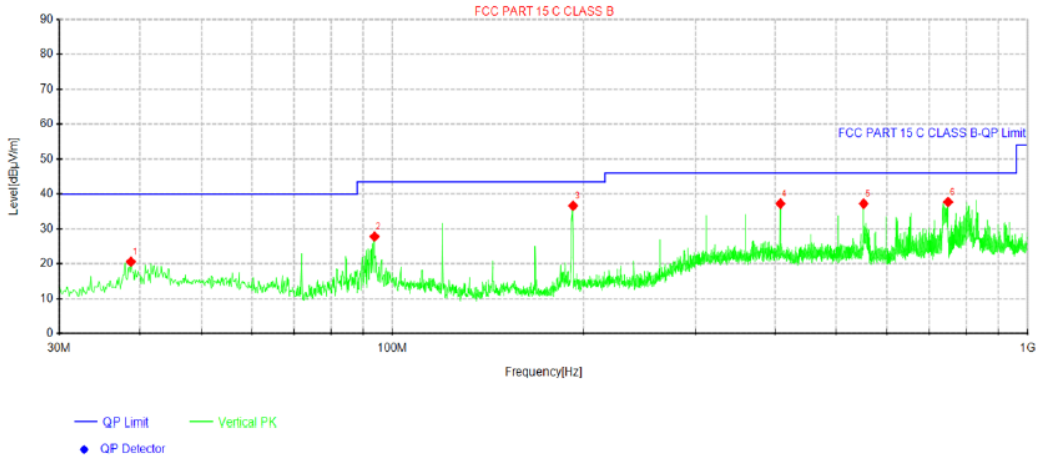
Suspected Data List									
NO.	Freq. [MHz]	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	49.1575	27.24	16.75	-10.49	40.00	23.25	100	1	Horizontal
2	96.2025	38.09	24.83	-13.26	43.50	18.67	100	351	Horizontal
3	192.353	47.12	33.05	-14.07	43.50	10.45	100	124	Horizontal
4	312.027	52.77	41.01	-11.76	46.00	4.99	100	259	Horizontal
5	506.633	36.48	28.02	-8.46	46.00	17.98	100	328	Horizontal
6	739.312	44.50	40.53	-3.97	46.00	5.47	100	214	Horizontal

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)

2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)

3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

Vertical



Suspected Data List

NO.	Freq. [MHz]	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	38.73	32.93	20.59	-12.34	40.00	19.41	100	357	Vertical
2	93.6562	41.42	27.81	-13.61	43.50	15.69	100	316	Vertical
3	192.475	50.67	36.63	-14.04	43.50	6.87	100	278	Vertical
4	408.057	47.22	37.25	-9.97	46.00	8.75	100	326	Vertical
5	551.981	45.23	37.24	-7.99	46.00	8.76	100	21	Vertical
6	749.497	41.57	37.71	-3.86	46.00	8.29	100	145	Vertical

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)

2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)

3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

For 1GHz to 26GHz

GFSK (above 1GHz)

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	48.53	PK	74	25.47	63.31	33.52	5.70	54.00	-14.78
4804.00	39.38	AV	54	14.62	54.16	33.52	5.70	54.00	-14.78
7206.00	43.03	PK	74	30.97	53.46	36.34	6.95	53.72	-10.43
7206.00	33.08	AV	54	20.92	43.51	36.34	6.95	53.72	-10.43

Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	46.55	PK	74	27.45	61.33	33.52	5.70	54.00	-14.78
4804.00	37.29	AV	54	16.71	52.07	33.52	5.70	54.00	-14.78
7206.00	40.51	PK	74	33.49	50.94	36.34	6.95	53.72	-10.43
7206.00	30.31	AV	54	23.69	40.74	36.34	6.95	53.72	-10.43

Frequency(MHz):			2440		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	49.19	PK	74	24.81	63.75	33.76	5.76	54.08	-14.56
4880.00	38.94	AV	54	15.06	53.50	33.76	5.76	54.08	-14.56
7320.00	43.05	PK	74	30.95	53.07	36.66	6.99	53.67	-10.02
7320.00	32.81	AV	54	21.19	42.83	36.66	6.99	53.67	-10.02

Frequency(MHz):			2440		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	47.68	PK	74	26.32	62.24	33.76	5.76	54.08	-14.56
4880.00	37.67	AV	54	16.33	52.23	33.76	5.76	54.08	-14.56
7320.00	41.37	PK	74	32.63	51.39	36.66	6.99	53.67	-10.02
7320.00	31.41	AV	54	22.59	41.43	36.66	6.99	53.67	-10.02

Frequency(MHz):			2479		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4958.00	49.14	PK	74	24.86	63.40	34.08	5.82	54.16	-14.26
4958.00	39.20	AV	54	14.80	53.46	34.08	5.82	54.16	-14.26
7437.00	42.50	PK	74	31.50	52.76	36.32	7.04	53.62	-10.26
7437.00	32.40	AV	54	21.60	42.66	36.32	7.04	53.62	-10.26

Frequency(MHz):			2479		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4958.00	47.56	PK	74	26.44	61.82	34.08	5.82	54.16	-14.26
4958.00	36.91	AV	54	17.09	51.17	34.08	5.82	54.16	-14.26
7437.00	40.39	PK	74	33.61	50.65	36.32	7.04	53.62	-10.26
7437.00	30.33	AV	54	23.67	40.59	36.32	7.04	53.62	-10.26

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. The other emission levels were very low against the limit.

4.3 Maximum Peak Output Power

Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

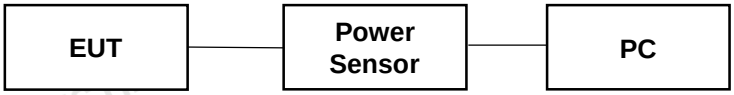
Test Procedure

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

Method PM is Measurement using an RF Peak power sensor. The procedure for this method is as follows:

1. The testing follows the ANSI C63.10 Section 7.8.5
2. The maximum peak conducted output power may be measured using a broadband peak RF power sensor.
3. The power sensor shall have a video bandwidth that is greater than or equal to the 20db bandwidth and shall use a fast-responding diode detector.

Test Configuration



Test Results

Please refer to FCC Appendix RF Test Data for 2.4G

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

4.4 20dB Bandwidth

Limit

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

Test Procedure

The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW. The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW was 1% to 5% of the OBW and VBW shall be at least three times RBW.

a) Span: shall be between two times and five times the OBW.

b) RBW: 1% to 5% of the OBW.

c) Video bandwidth (VBW) ⩾ 3RBW

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max-hold.

g) Allow the trace to stabilize

Test Configuration

Test Results

Please refer to FCC Appendix RF Test Data for 2.4G

4.5 Frequency Separation

LIMIT

According to 15.247(a)(1), 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. 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.
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

TEST PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.

b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

c) Video (or average) bandwidth (VBW) ≥ RBW

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max-hold.

g) Allow the trace to stabilize

TEST CONFIGURATION

TEST RESULTS

Please refer to FCC Appendix RF Test Data for 2.4G
Note:
We have tested all mode at high, middle and low channel, and recorded worst case at middle

4.6 Number of hopping frequency

Limit

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.
The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: The frequency band of operation. Depending on the number of channels the device supports, it could be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ⩾ RBW.
d) Sweep: Auto time.
e) Detector function: Peak.
f) Trace: Max-hold.
g) Allow the trace to stabilize

Test Configuration

Test Results

Please refer to FCC Appendix RF Test Data for 2.4G

4.7 Time of Occupancy (Dwell Time)

Limit

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 VBW⩾RBW, Span 0Hz.

Test Configuration

Test Results

Please refer to FCC Appendix RF Test Data for 2.4G

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

4.8 Out-of-band Emissions

Limit

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.

Test Procedure

The testing follows the ANSI C63.10 Section 6.10.4 and 7.8.7:

- Reference level measurement

Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
RBW = 100kHz
VBW = 300kHz
Detector = Peak
Sweep time = Auto couple
Trace mode = Max hold
Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission.

- Emission level measurement

Span = Wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100kHz
VBW = 300kHz
Detector = Peak
Sweep time = Auto couple
Trace mode = Max hold
Trace was allowed to stabilize
Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this section.

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

Please refer to FCC Appendix RF Test Data for 2.4G

4.9 Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

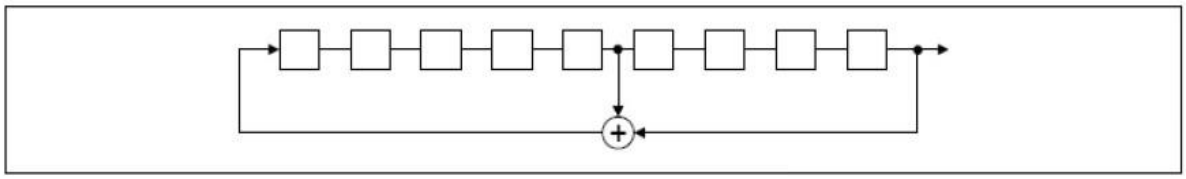
For 47 CFR Part 15C section 15.247 (a) (1) requirement:

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

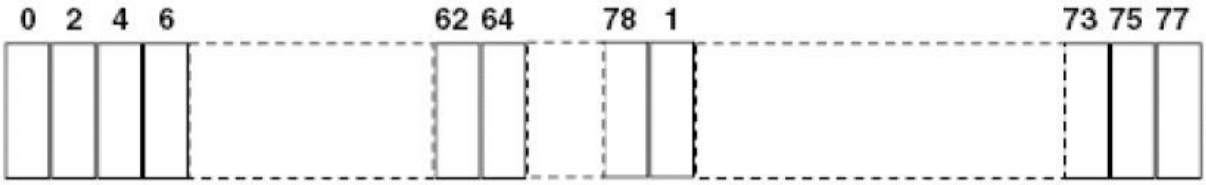
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: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



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.

4.10 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 (c), 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 PCB Antenna maximum gain of antenna was 1.58dBi.

Remark: The antenna gain is provided by the customer, if the data provided by the customer is not accurate, Shenzhen CTA Testing Technology Co., Ltd. does not assume any responsibility.

4.11 On Time and Duty Cycle

Standard Applicable

None; for reporting purpose only.

TEST CONFIGURATION

Test Procedures

1). Set the Centre frequency of the spectrum analyzer to the transmitting frequency;
2). Set the span=0MHz, RBW=8MHz, VBW=8MHz, Sweep time=Auto;
3). Detector = peak;
4). Trace mode = Single hold.

Please refer to FCC Appendix RF Test Data for 2.4G

4.12 Emissions at Restricted Band

Standard Applicable

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 conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies 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 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) (see §15.205(c)).

TEST CONFIGURATION

Test Procedures

According to ANSI C63.10 Field Strength Approach (linear terms):

$$E = EIRP-20 \log d +104.8$$

Where:
E is the electric field strength in dBuV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m
f) Compare the resultant electric field strength level with the applicable regulatory limit.
g) Perform the radiated spurious emission test.

Where all terms are as previously defined.

1). Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2). Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3). Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=3MHz for RMS detector, Max Hold=Average, Trace=100times for AV test.
4). Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5). Repeat above procedures until all measured frequencies were complete.
6). Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7). Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
8). Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

9). For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10). Compare the resultant electric field strength level to the applicable regulatory limit.
11). Perform radiated spurious emission test duress until all measured frequencies were complete.

Test Results

Please refer to FCC Appendix RF Test Data for 2.4G.
Remark:
1). Test results including cable loss;
2). Measured at difference Packet Type for each mode and recorded worst case for each mode.
3). "---"means that the fundamental frequency not for 15.209 limits requirement.
4). Measured at Hopping and Non-Hopping mode, recorded worst at Non-Hopping mode.
5). The other emission levels were very low against the limit.
6). The average measurement was not performed when the peak measured data under the limit of average detection.
7). Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=3MHz/Sweep time=Auto/Detector=RMS, Max Hold=Average, Trace=100times.
8). Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

5 Test Setup Photos of the EUT

Please refer to separated files for Test Setup Photos of the EUT.

6 External and Internal Photos of the EUT

Please refer to separated files for External Photos & Internal Photos of the EUT.

.....End of Report.....