



TEST REPORT

Product Name: NocFree Split Wireless Keyboard
FCC ID: 2BFHX-NOCFREE
Trademark: NocFree
Model Number: NocFree Lite ANSI, NocFree Lite JIS, NocFree Lite ISO, NocFree Lite+ ANSI, NocFree Lite+ JIS, NocFree Lite+ ISO, NocFree Spark ANSI, NocFree Spark JIS, NocFree Spark ISO, NocFree Lite Num, NocFree Lite+ Num, NocFree Spark Num
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Sample Received Date: Mar. 11, 2024
Sample tested Date: Mar. 11, 2024 to Mar. 18, 2024
Issue Date: Mar. 18, 2024
Report No.: CTB240318005RFX
Test Standards: FCC Part15.247
ANSI C63.10:2013
Test Results: PASS
Remark: This is 2.4GHz radio test report.

Compiled by:

Reviewed by:

Approved by:

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Arron Liu



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Bin Mei / Director

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

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(Note: N/A means not applicable)



1. VERSION

Report No.	Issue Date	Description	Approved
CTB240318005RFX	Mar. 18, 2024	Original	Valid

2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Band edge and RF Conducted Spurious Emissions	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013	PASS
Bandwidth	47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013	PASS
Power Spectral Density	47 CFR Part 15 Subpart C Section 15.247 (e)	ANSI C63.10-2013/ KDB 558074 D01v05r02	PASS
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	/	PASS

Remark:

Test according to ANSI C63.10-2013.

3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Item	Uncertainty
Occupancy bandwidth	54.3kHz
Conducted output power Above 1G	0.9dB
Conducted output power below 1G	0.9dB
Power Spectral Density , Conduction	0.9dB
Conduction spurious emissions	2.0dB
Out of band emission	2.0dB
3m chamber Radiated spurious emission(9K-30MHz)	4.8dB
3m chamber Radiated spurious emission(30MHz-1GHz)	4.6dB
3m chamber Radiated spurious emission(1GHz-18GHz)	5.1dB
3m chamber Radiated spurious emission(18GHz-40GHz)	3.4dB
humidity uncertainty	5.5%
Temperature uncertainty	0.63°C
frequency	1×10 ⁻⁷
Conducted Emission (150KHz-30MHz)	3.2 dB
Radiated Emission(30MHz ~ 1000MHz)	4.8 dB
Radiated Emission(1GHz ~6GHz)	4.9 dB

4. PRODUCT INFORMATION AND TEST SETUP

4.1 Product Information

Model(s):	NocFree Lite ANSI, NocFree Lite JIS, NocFree Lite ISO, NocFree Lite+ ANSI, NocFree Lite+ JIS, NocFree Lite+ ISO, NocFree Spark ANSI, NocFree Spark JIS, NocFree Spark ISO, NocFree Lite Num, NocFree Lite+ Num, NocFree Spark Num
Model Description:	All the model are the same circuit and RF module, only different for model name. Test sample model: NocFree Lite ANSI
Hardware Version:	3.0.1
Software Version:	4.1.1
Operation Frequency:	2403-2471MHz
Max. RF output power:	0.32dBm
Type of Modulation:	GFSK
Antenna installation:	Ceramic Antenna
Antenna Gain:	1.69dBi
Ratings:	DC 5V charging from adapter DC 3.7V by battery

4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1	Laptop	DELL	Vostro 5490	N/A	N/A
2	Adapter	JYIN	JY-05100C	/	/

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

4.4 Channel List

CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)
1	2403	2	2417	3	2430
4	2447	5	2460	6	2471

4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting (GFSK)	2403MHz	2430MHz	2471MHz

4.6 Test Environment

Humidity(%):	54
Atmospheric Pressure(kPa):	101
Normal Voltage(DC):	3.7V
Normal Temperature(°C)	23
Low Temperature(°C)	0
High Temperature(°C)	40

5. TEST FACILITY AND TEST INSTRUMENT USED

5.1 Test Facility

All measurement facilities used to collect the measurement data are located at 1&2F., Building A, No. 26, Xinh Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

5.2 Test Instrument Used

Item	Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	2024.07.05
2	Power Sensor	Agilent	U2021XA	MY56120032	2024.07.05
3	Power Sensor	Agilent	U2021XA	MY56120034	2024.07.05
4	Communication test set	R&S	CMW500	108058	2024.07.05
5	Spectrum Analyzer	KEYSIGHT	N9020A	MY51289897	2024.07.05
6	Signal Generator	Agilent	N5181A	MY50140365	2024.07.05
7	Vector signal generator	Agilent	N5182A	MY47420195	2024.07.05
8	Communication test set	Agilent	E5515C	MY50102567	2024.07.06
9	2.4 GHz Filter	Shenxiang	MSF2400-2483.5MS-1154	20181015001	2024.07.05
10	5 GHz Filter	Shenxiang	MSF5150-5850 MS-1155	20181015001	2024.07.06
11	Filter	Xingbo	XBLBQ-DZA120	190821-1-1	2024.07.06
12	BT&WI-FI Automatic test software	Microwave	MTS8000	Ver. 2.0.0.0	/
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	2024.10.30
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	2024.07.05
15	234G Automatic test software	Microwave	MTS8200	Ver. 2.0.0.0	/
16	966 chamber	C.R.T.	966	/	2024.08.11
17	Receiver	R&S	ESPI	100362	2024.07.05
18	Amplifier	HP	8447E	2945A02747	2024.07.05
19	Amplifier	Agilent	8449B	3008A01838	2024.07.05
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2024.07.08

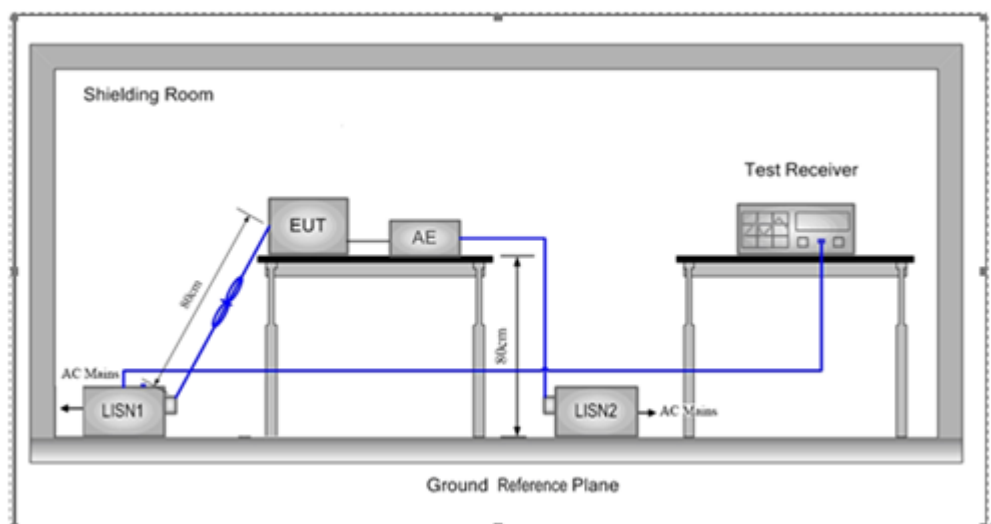
21	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA9120D	01911	2024.07.08
22	EMI test software	Fala	EZ-EMC	FA-03A2 RE	/
23	Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-224	2024.07.08
24	loop antenna	ZHINAN	ZN30900A	GTS534	/
25	40G Horn antenna	A/H/System	SAS-574	588	2024.10.30
26	Amplifier	AEROFLEX	Aeroflex	097	2024.07.05

Continuous disturbance					
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	LISN	ROHDE&SCHWARZ	ESH3-Z5	100318	2024.07.05
2	Pulse limiter	ROHDE&SCHWARZ	ESH3Z2	357881052	2024.07.05
3	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428/003	2024.07.05
4	Coaxial cable	ZDECL	Z302S-NJ-SMA J-12M	18091905	2024.07.05
5	ISN	Schwarzbeck	NTFM8158	183	2024.07.05
6	Communication test set	Agilent	E5515C	MY50102567	2024.07.05
7	Communication test set	R&S	CMW500	108058	2024.07.05
8	EZ-EMC	Frad	EMC-con3A1.1	/	/

Radiated emission					
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	01911	2024.07.08
2	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2024.07.08
3	Amplifier	Agilent	8449B	3008A01838	2024.07.05
4	Amplifier	HP	8447E	2945A02747	2024.07.05
5	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428/003	2024.07.05
6	Coaxial cable	ETS	RFC-SNS-100-NMS-80 NI	/	2024.07.05
7	Coaxial cable	ETS	RFC-SNS-100-NMS-20 NI	/	2024.07.05
8	Coaxial cable	ETS	RFC-SNS-100-SMS-20 NI	/	2024.07.05
9	Coaxial cable	ETS	RFC-NNS-100-NMS-300 NI	/	2024.07.05
10	Communication test set	Agilent	E5515C	MY50102567	2024.07.05
11	Communication test set	R&S	CMW500	108058	2024.07.05
12	EZ-EMC	Frad	EMC-con3A1.1	/	/

6. AC POWER LINE CONDUCTED EMISSION

6.1 Block Diagram Of Test Setup



6.2 Limit

Table 4 – AC power-line conducted emissions limits

Frequency (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 ^{Note 1}	56 to 46 ^{Note 1}
0.5 - 5	56	46
5 - 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

* Decreasing linearly with the logarithm of the frequency

6.3 Test procedure

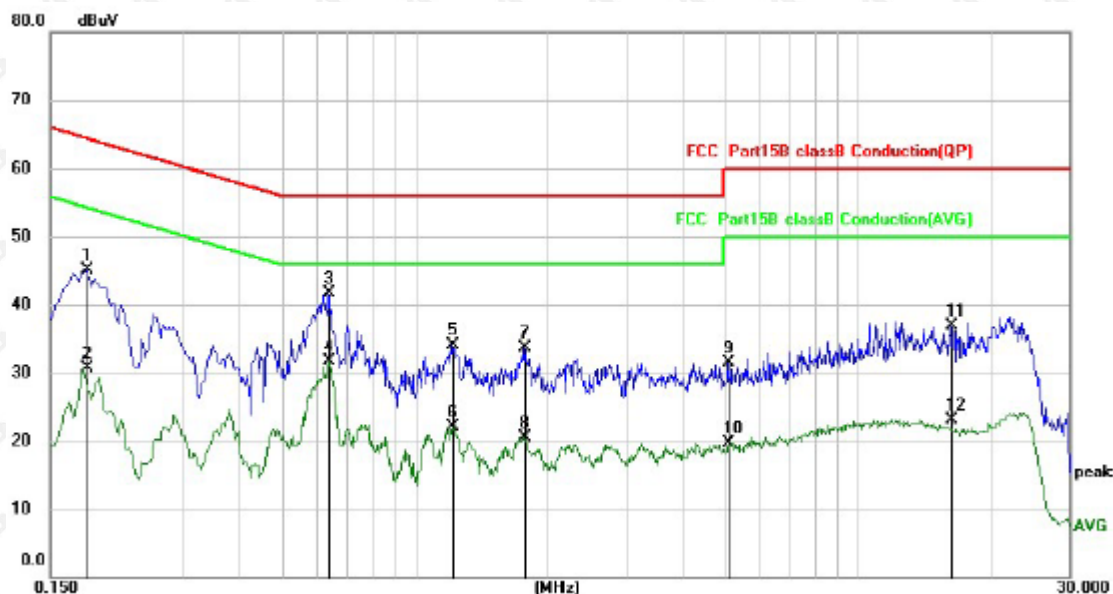
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under

test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.
- 6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- 7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

6.4 Test Result

L: Worst case-GFSK(low channel)

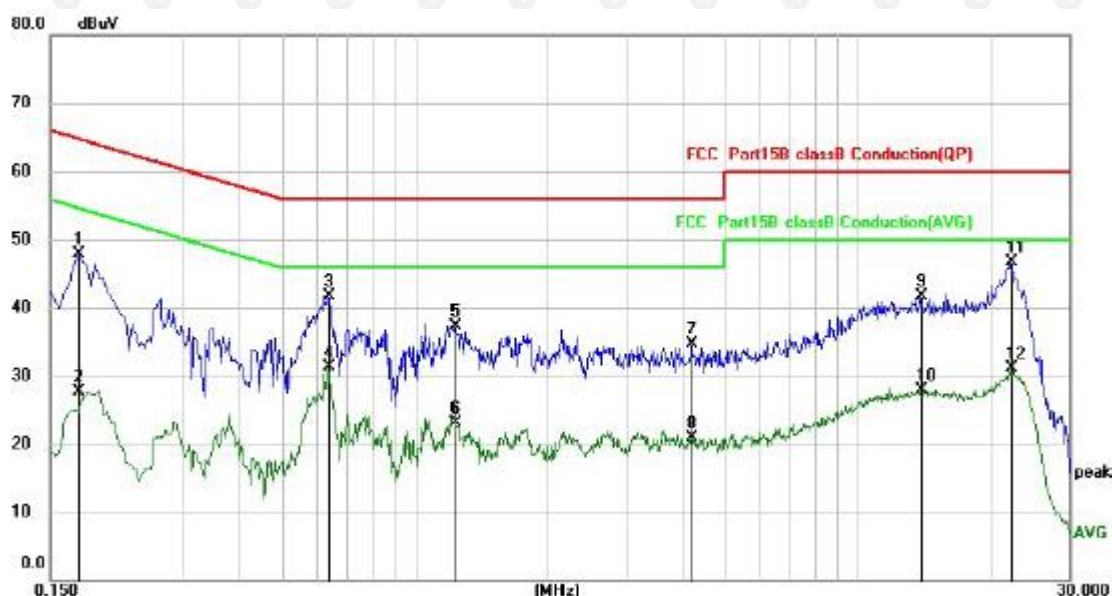


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector
1		0.1819	35.08	9.95	45.03	64.40	-19.37	QP
2		0.1819	20.84	9.95	30.79	54.40	-23.61	AVG
3		0.6380	31.65	10.01	41.66	56.00	-14.34	QP
4	*	0.6380	21.75	10.01	31.76	46.00	-14.24	AVG
5		1.2140	24.12	10.03	34.15	56.00	-21.85	QP
6		1.2140	12.05	10.03	22.08	46.00	-23.92	AVG
7		1.7700	23.71	10.07	33.78	56.00	-22.22	QP
8		1.7700	10.41	10.07	20.48	46.00	-25.52	AVG
9		5.0980	21.05	10.39	31.44	60.00	-28.56	QP
10		5.0980	9.32	10.39	19.71	50.00	-30.29	AVG
11		16.1420	26.19	10.75	36.94	60.00	-23.06	QP
12		16.1420	12.39	10.75	23.14	50.00	-26.86	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

N:



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector
1		0.1740	37.89	9.95	47.84	64.77	-16.93	QP
2		0.1740	17.67	9.95	27.62	54.77	-27.15	AVG
3		0.6380	31.65	10.01	41.66	56.00	-14.34	QP
4		0.6380	21.36	10.01	31.37	46.00	-14.63	AVG
5		1.2340	27.25	10.03	37.28	56.00	-18.72	QP
6		1.2340	13.02	10.03	23.05	46.00	-22.95	AVG
7		4.2140	24.50	10.30	34.80	56.00	-21.20	QP
8		4.2140	10.57	10.30	20.87	46.00	-25.13	AVG
9		13.8820	31.02	10.70	41.72	60.00	-18.28	QP
10		13.8820	17.28	10.70	27.98	50.00	-22.02	AVG
11	*	22.1100	35.85	10.90	46.75	60.00	-13.25	QP
12		22.1100	20.28	10.90	31.18	50.00	-18.82	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

7. RADIATED SPURIOUS EMISSION

7.1 Block Diagram Of Test Setup

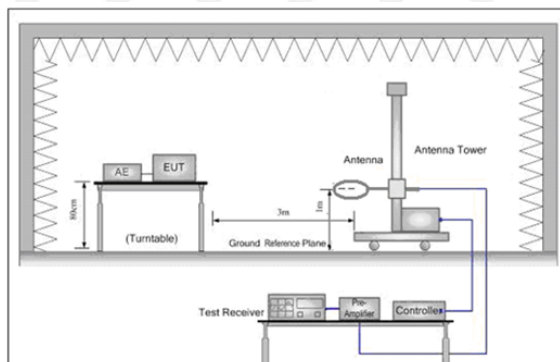


Figure 1. Below 30MHz

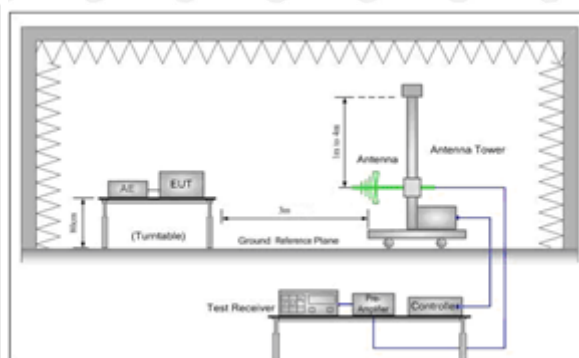
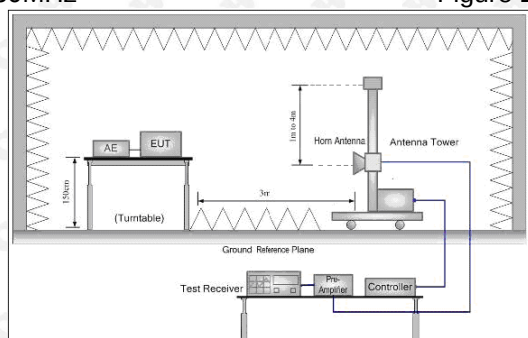


Figure 2. 30MHz to 1GHz



7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

Below 1GHz test procedure as below:

- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

- Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).
- Test the EUT in the lowest channel ,the middle channel ,the Highest channel
- Repeat above procedures until all frequencies measured was complete.
- Full battery is used during test

Receiver set:

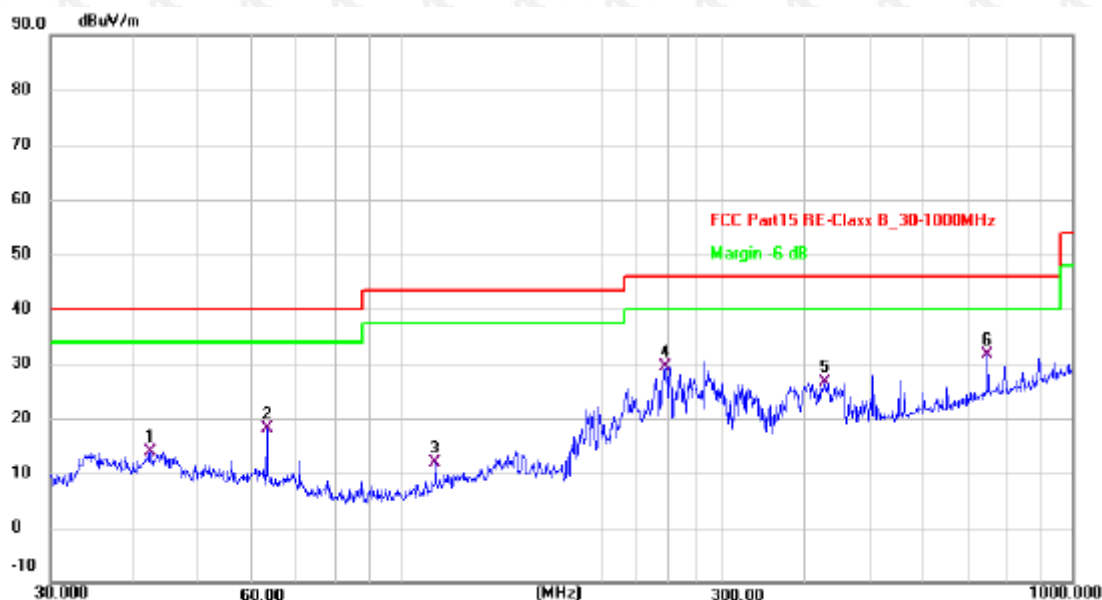
Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30KHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30KHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30KHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30KHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

7.4 Test Result

Below 1GHz Test Results:

Antenna polarity: H

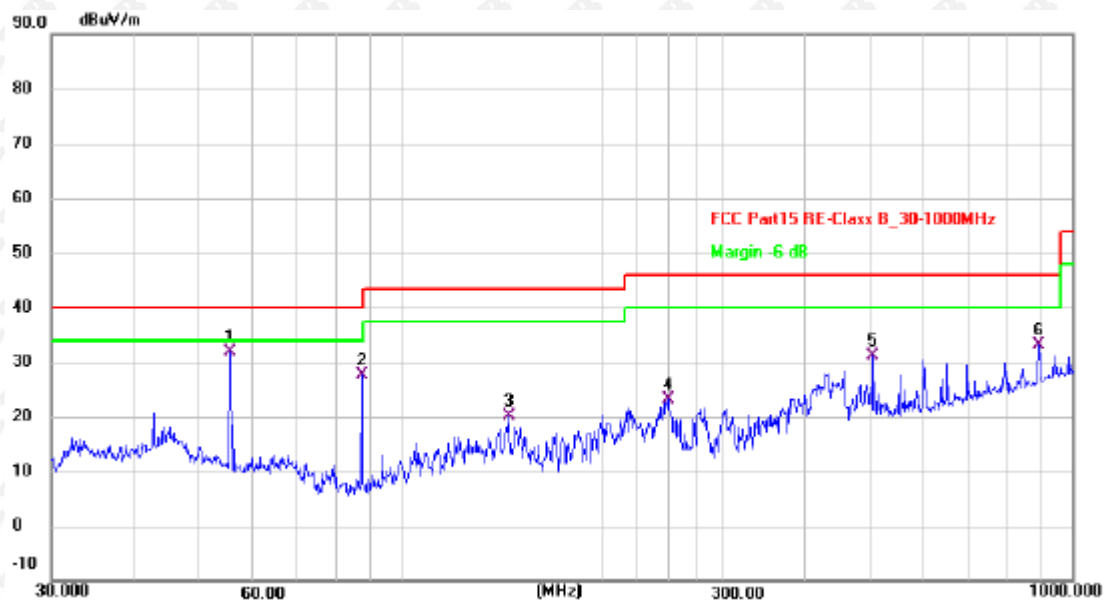
Worst case-GFSK(low channel)



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	42.3022	32.14	-18.21	13.93	40.00	-26.07	QP
2	63.0916	38.68	-20.48	18.20	40.00	-21.80	QP
3	112.5244	32.56	-20.58	11.98	43.50	-31.52	QP
4	248.5519	49.42	-19.92	29.50	46.00	-16.50	QP
5	428.0193	41.25	-14.74	26.51	46.00	-19.49	QP
6 *	747.4825	38.54	-7.01	31.53	46.00	-14.47	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Antenna polarity: V
Worst case-GFSK(low channel)



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	55.4147	48.43	-16.45	31.98	40.00	-8.02	QP
2	87.1117	48.77	-21.20	27.57	40.00	-12.43	QP
3	144.3348	35.92	-15.88	20.04	43.50	-23.46	QP
4	249.4250	39.93	-16.83	23.10	46.00	-22.90	QP
5	504.7062	36.51	-5.44	31.07	46.00	-14.93	QP
6	890.7278	31.31	1.73	33.04	46.00	-12.96	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Above 1 GHz Test Results:

CH Low (2403MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2403	100.19	-5.84	94.35	N/A	N/A	peak
2403	94.08	-5.84	88.24	N/A	N/A	AVG
4806	58.59	-3.64	54.95	74	-19.05	peak
4806	48.08	-3.64	44.44	54	-9.56	AVG
7209	58.89	-0.95	57.94	74	-16.06	peak
7209	49.76	-0.95	48.81	54	-5.19	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2403	100.78	-5.84	94.94	N/A	N/A	peak
2403	92.95	-5.84	87.11	N/A	N/A	AVG
4806	56.33	-3.64	52.69	74	-21.31	peak
4806	47.27	-3.64	43.63	54	-10.37	AVG
7209	59.68	-0.95	58.73	74	-15.27	peak
7209	48.25	-0.95	47.30	54	-6.70	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH Middle (2430MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2430	98.78	-5.71	93.07	N/A	N/A	peak
2430	93.16	-5.71	87.45	N/A	N/A	AVG
4860	55.51	-3.51	52.00	74	-22.00	peak
4860	45.10	-3.51	41.59	54	-12.41	AVG
7290	56.91	-0.82	56.09	74	-17.91	peak
7290	47.19	-0.82	46.37	54	-7.63	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2430	97.89	-5.71	92.18	N/A	N/A	peak
2430	92.03	-5.71	86.32	N/A	N/A	AVG
4860	55.75	-3.51	52.24	74	-21.76	peak
4860	46.67	-3.51	43.16	54	-10.84	AVG
7290	57.96	-0.82	57.14	74	-16.86	peak
7290	47.83	-0.82	47.01	54	-6.99	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH High (2471MHz)
Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2471	98.20	-5.65	92.55	N/A	N/A	peak
2471	91.94	-5.65	86.29	N/A	N/A	AVG
4942	55.04	-3.43	51.61	74	-22.39	peak
4942	47.40	-3.43	43.97	54	-10.03	AVG
7413	57.20	-0.75	56.45	74	-17.55	peak
7413	47.25	-0.75	46.50	54	-7.50	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2471	106.41	-5.65	100.76	N/A	N/A	peak
2471	91.79	-5.65	86.14	N/A	N/A	AVG
4942	55.69	-3.43	52.26	74	-21.74	peak
4942	46.94	-3.43	43.51	54	-10.49	AVG
7413	55.11	-0.75	54.36	74	-19.64	peak
7413	46.24	-0.75	45.49	54	-8.51	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Remark:

- (1) Measuring frequencies from 9KHz to the 25 GHz, The test range is 9K ~10 times the main wave, and other spurious below the limit of 20dB will not be reflected in the report.
- (2). All modes of GFSK were test at Low, Middle, and High channel, only the worst result of GFSK Low Channel was reported for below 1GHz test.
- (3). For GFSK above 1GHz test all modes of GFSK were test at Low, Middle, and High channel, only the worst result of GFSK Low Channel was reported.
- (4). By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, and test data recorded in this report.
- (5). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

Restricted bands around fundamental frequency (Radiated)

Operation Mode: TX CH Low (2403MHz)
Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2310	55.61	-5.81	49.80	74	-24.20	peak
2310	/	-5.81	/	54	/	AVG
2390	54.72	-5.84	48.88	74	-25.12	peak
2390	/	-5.84	/	54	/	AVG
2400	55.45	-5.84	49.61	74	-24.39	peak
2400	/	-5.84	/	54	/	AVG

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2310	55.54	-5.81	49.73	74	-24.27	peak
2310	/	-5.81	/	54	/	AVG
2390	53.43	-5.84	47.59	74	-26.41	peak
2390	/	-5.84	/	54	/	AVG
2400	56.38	-5.84	50.54	74	-23.46	peak
2400	/	-5.84	/	54	/	AVG

When the peak value is smaller than the AVG limit, AVG is not reflected.

Operation Mode: TX CH High (2471MHz)
Horizontal (Worst case)

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2483.50	56.17	-5.65	50.52	74	-23.48	peak
2483.50	/	-5.65	/	54	/	AVG
2500.00	55.60	-5.65	49.95	74	-24.05	peak
2500.00	/	-5.65	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

Vertical:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2483.50	55.40	-5.65	49.75	74	-24.25	peak
2483.50	/	-5.65	/	54	/	AVG
2500.00	56.40	-5.65	50.75	74	-23.25	peak
2500.00	/	-5.65	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						
Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit.						

When the peak value is smaller than the AVG limit, AVG is not reflected.

8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

8.1 Block Diagram Of Test Setup



8.2 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 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)).

8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

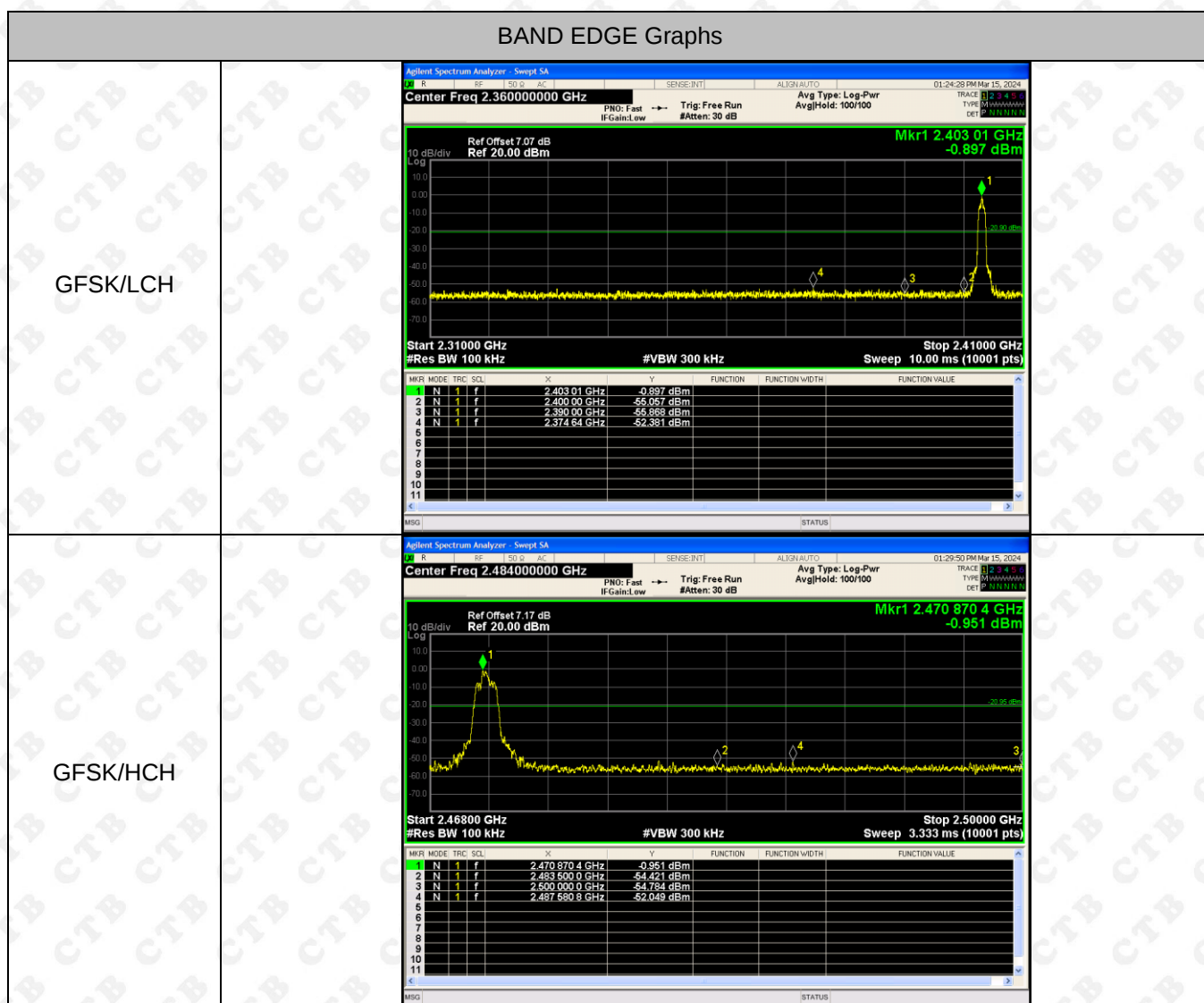
Detector function = peak, Trace = max hold

Above 30MHz:

RBW = 100KHz, VBW = 300KHz, Sweep = auto

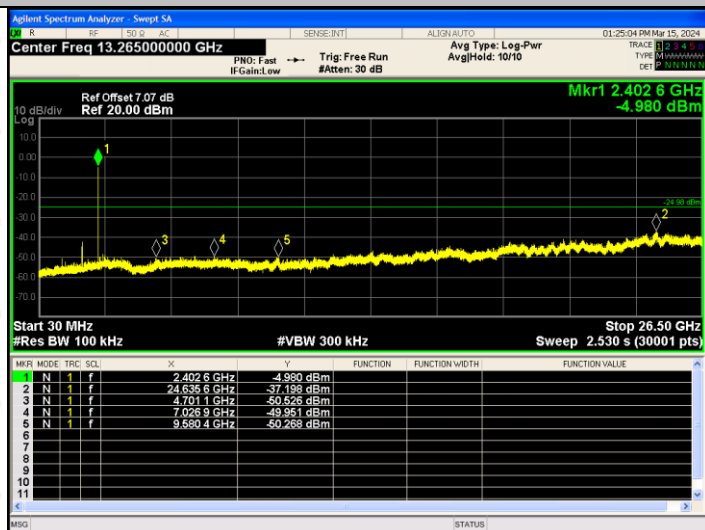
Detector function = peak, Trace = max hold

8.4 Test Result

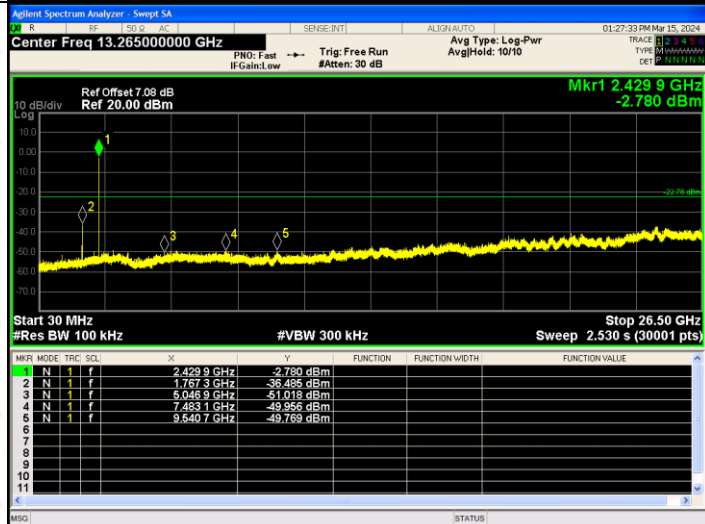


RF Conducted Spurious Emissions Graphs

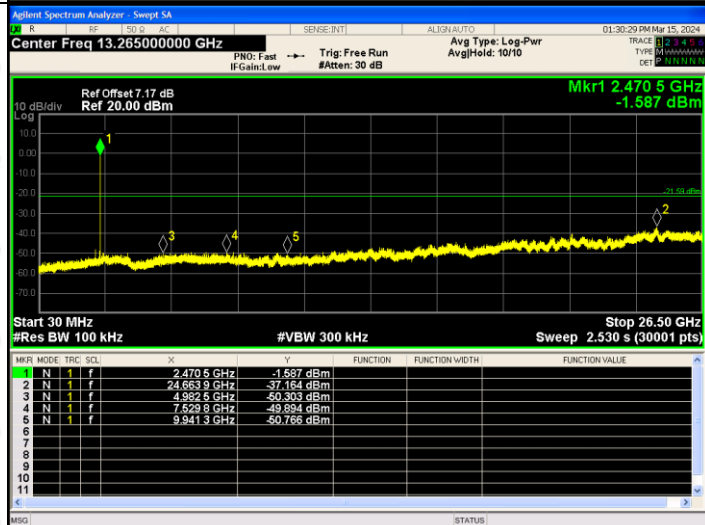
GFSK/LCH



GFSK/MCH



GFSK/HCH



9. COUDUCTED OUTPUT POWER

9.1 Block Diagram Of Test Setup



9.2 Limit

FCC Part15 (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

9.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Channel power measurement.
Sweep = auto; Detector Function = peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

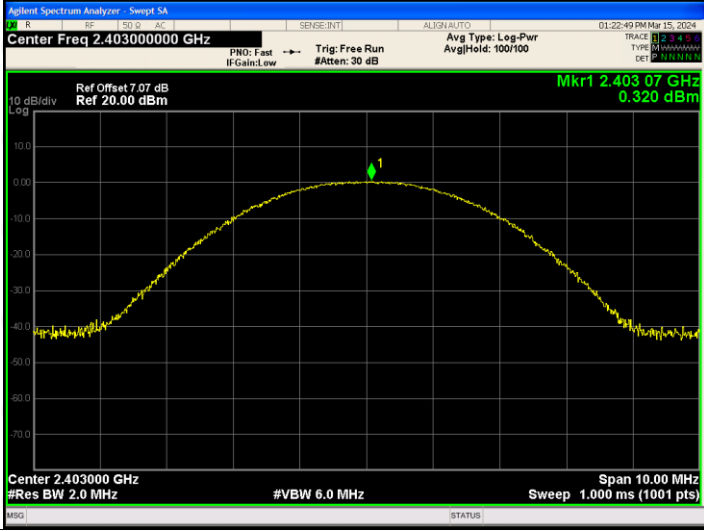
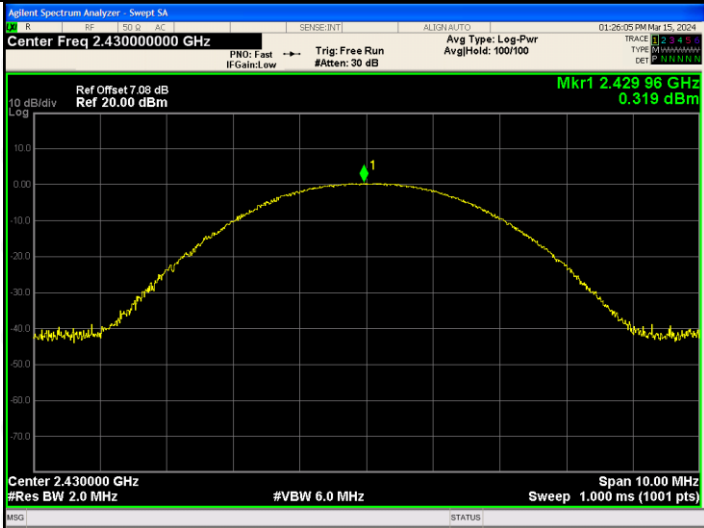
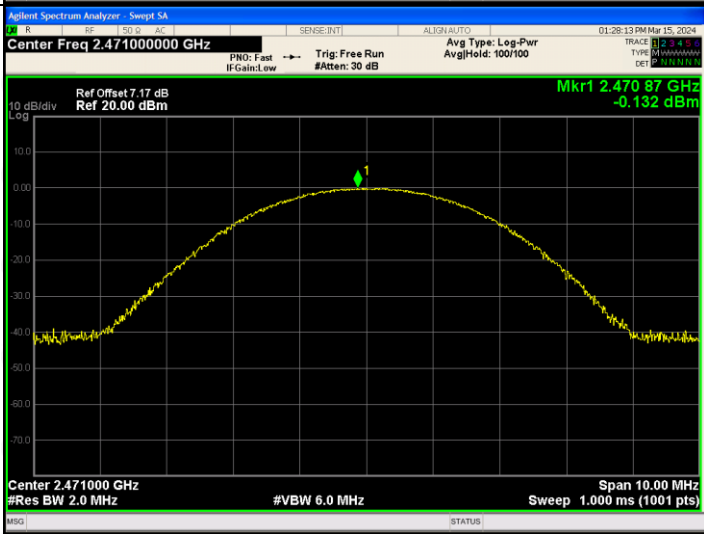
9.4 Test Result

Mode	Channel.	Maximum Output Power [dBm]	Limit[dBm]	Verdict
GFSK	LCH	0.320	30	PASS
	MCH	0.319	30	PASS
	HCH	-0.132	30	PASS

Duty Cycle

Mode	Channel.	Duty Cycle(%)	Correction Factor (dB)
GFSK	LCH	100	0
	MCH	100	0
	HCH	100	0

Test Graph:

GFSK Low channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 2.403000000 GHz Ref Offset 7.07 dB Ref 20.00 dBm Mkr1 2.40307 GHz 0.320 dBm Center 2.403000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)
GFSK Mid channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 2.430000000 GHz Ref Offset 7.08 dB Ref 20.00 dBm Mkr1 2.42996 GHz 0.319 dBm Center 2.430000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)
GFSK High channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 2.471000000 GHz Ref Offset 7.17 dB Ref 20.00 dBm Mkr1 2.47087 GHz -0.132 dBm Center 2.471000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)

10. 6DB OCCUPIED BANDWIDTH

10.1 Block Diagram Of Test Setup



10.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	$\geq 500\text{KHz}$ (6dB bandwidth)	2400-2483.5	PASS

10.3 Test procedure

1. Rem1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. 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 relative to the maximum level measured in the fundamental emission.

10.4 Test Result

Test Mode	Frequency	6dB Bandwidth (MHz)	Limit (KHz)	Result
GFSK	Low channel	0.760	≥ 500	PASS
	Mid channel	0.803	≥ 500	PASS
	High channel	0.802	≥ 500	PASS

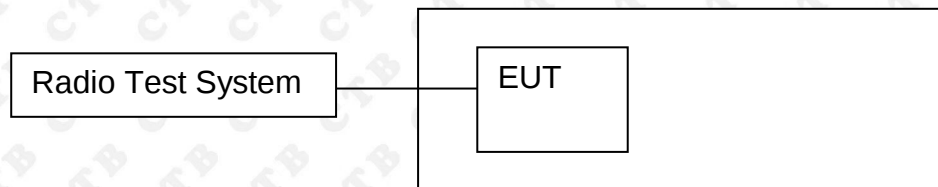
Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

Test Graph:

GFSK Low channel	Agilent Spectrum Analyzer - Occupied BW Center Freq 2.403000000 GHz Center Freq: 2.403000000 GHz Trig: Free Run #Att: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS Ref Offset 7.07 dB Ref 27.07 dBm Mkr3 2.403403 GHz -5.7421 dBm Center 2.403 GHz #Res BW 100 kHz #VBW 300 kHz Span 3 MHz Sweep 1 ms Occupied Bandwidth 1.1940 MHz Total Power 5.16 dBm Transmit Freq Error 23.316 kHz OBW Power 99.00 % x dB Bandwidth 759.8 kHz x dB -6.00 dB
GFSK Mid channel	Agilent Spectrum Analyzer - Occupied BW Center Freq 2.430000000 GHz Center Freq: 2.430000000 GHz Trig: Free Run #Att: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS Ref Offset 7.08 dB Ref 27.08 dBm Mkr3 2.430427 GHz -9.4494 dBm Center 2.43 GHz #Res BW 100 kHz #VBW 300 kHz Span 3 MHz Sweep 1 ms Occupied Bandwidth 1.1910 MHz Total Power 5.02 dBm Transmit Freq Error 24.825 kHz OBW Power 99.00 % x dB Bandwidth 803.4 kHz x dB -6.00 dB
GFSK High channel	Agilent Spectrum Analyzer - Occupied BW Center Freq 2.471000000 GHz Center Freq: 2.471000000 GHz Trig: Free Run #Att: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS Ref Offset 7.17 dB Ref 27.17 dBm Mkr3 2.471421 GHz -8.7901 dBm Center 2.471 GHz #Res BW 100 kHz #VBW 300 kHz Span 3 MHz Sweep 1 ms Occupied Bandwidth 1.1962 MHz Total Power 4.93 dBm Transmit Freq Error 20.570 kHz OBW Power 99.00 % x dB Bandwidth 801.6 kHz x dB -6.00 dB

11. POWER SPECTRAL DENSITY

11.1 Block Diagram Of Test Setup



11.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247	Power Spectral Density	8 dBm (in any 3KHz)	2400-2483.5	PASS

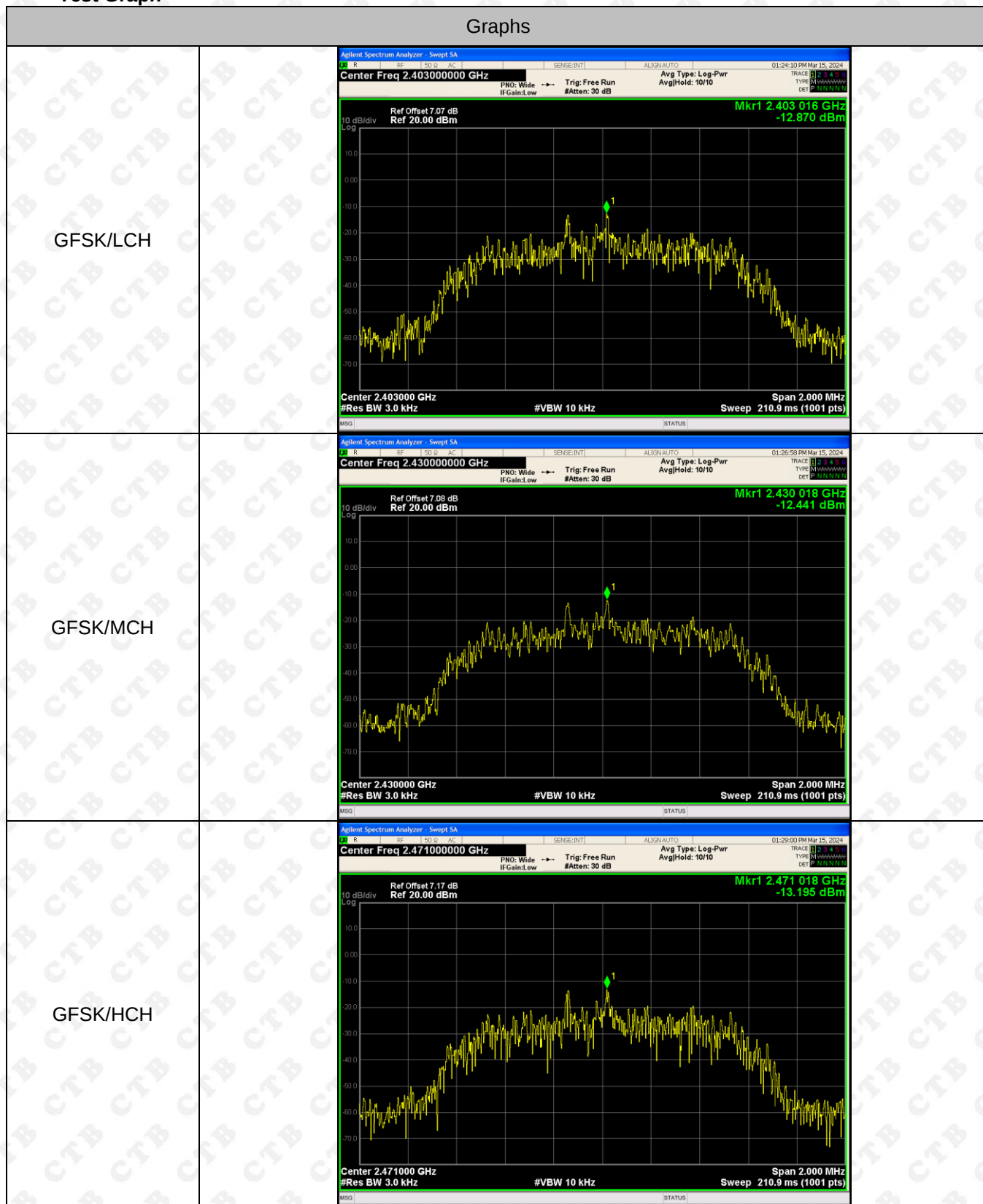
11.3 Test procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
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 within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

11.4 Test Result

Mode	Channel.	Power Spectral Density (dBm/3KHz)	Limit(dBm/3KHz)	Verdict
GFSK	LCH	-12.870	8	PASS
GFSK	MCH	-12.441	8	PASS
GFSK	HCH	-13.195	8	PASS

Test Graph



12. ANTENNA REQUIREMENT

15.203 requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

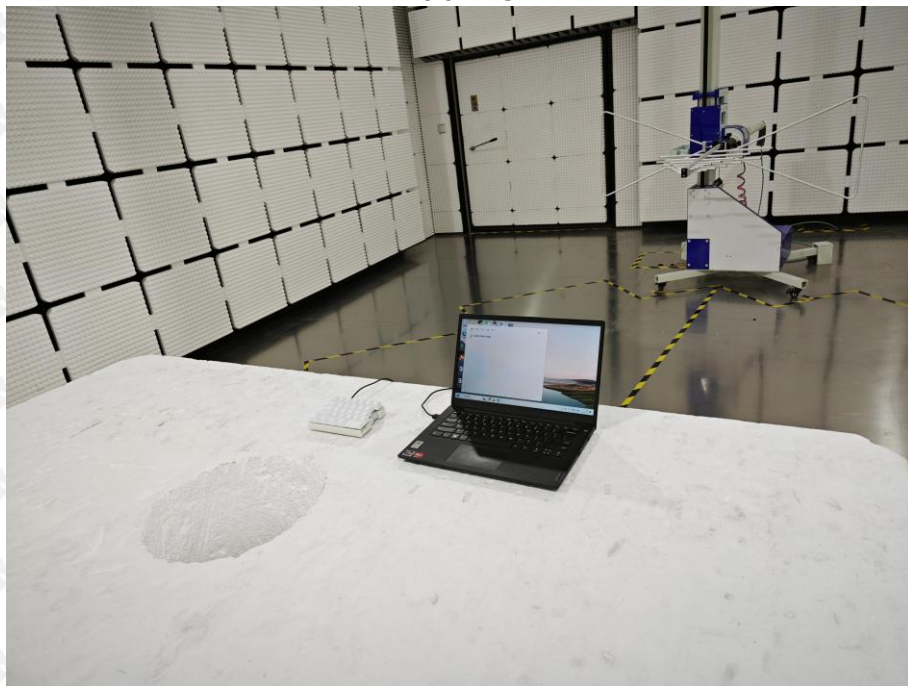
EUT Antenna:

The EUT antenna is Ceramic antenna. The best case gain of the antenna is 1.69dBi.

13. EUT TEST SETUP PHOTOGRAPHS

Radiated Emissions

Below 1G



Above 1G



Conducted emission



***** END OF REPORT *****