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检测
TESTING
CNAS L6791

TEST REPORT

Applicant:	Ugreen Group Limited
Address:	UGREEN Building, Longcheng Industrial Park Longguanxi Road, Longhua, ShenZhen, China
Equipment Type:	Multi-mode Wireless Keyboard
Model Name:	K551
Brand Name:	UGREEN
FCC ID:	2AQI5-K551
Test Standard:	47 CFR Part 15 Subpart C (refer to section 3.1)
Sample Arrival Date:	Mar. 24, 2025
Test Date:	Mar. 26, 2025 - Jun. 03, 2025
Date of Issue:	Jun. 19, 2025

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Julie Zhu **Checked by:** Ye Hongji **Approved by:** Sunny Zou

(Technical Director)

Julie zhu Ye Hongji Sunny Zou

Revision History

Version	Issue Date	Revisions
Rev. 01	Jun. 19, 2025	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Ugreen Group Limited
Address	UGREEN Building, Longcheng Industrial Park Longguanxi Road, Longhua, ShenZhen, China

2.2 Manufacturer Information

Manufacturer	Ugreen Group Limited
Address	UGREEN Building, Longcheng Industrial Park Longguanxi Road, Longhua, ShenZhen, China

2.3 Factory Information

Factory	Shenzhen Loyal Electronics Co., Ltd
Address	101, No.5, the Third Road, Shapu Yangchong Industry Park, Songgang Street, Baoan District, Shenzhen, GuangdongProvince, China

2.4 General Description for Equipment under Test (EUT)

EUT Name	Multi-mode Wireless Keyboard
Model Name Under Test	K551
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	V02
Software Version	0xa0
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

Remark:

- Product Number (P/N) code in the below table, for marketing purpose, will be marked on the marking plate.

65598	65598P	65598X	65598A	65598B	65598C	65598U	65598JP	65598EU	65598UK	65598US	65598KC	KC-65598	65598RU	65598MX	65598DE	65598AB	65598TH
65592	65592P	65592X	65592A	65592B	65592C	65592U	65592JP	65592EU	65592UK	65592US	65592KC	KC-65592	65592RU	65592MX	65592DE	65592AB	65592TH
75045	75045P	75045X	75045A	75045B	75045C	75045U	75045JP	75045EU	75045UK	75045US	75045KC	KC-75045	75045RU	75045MX	75045DE	75045AB	75045TH
75046	75046P	75046X	75046A	75046B	75046C	75046U	75046JP	75046EU	75046UK	75046US	75046KC	KC-75046	75046RU	75046MX	75046DE	75046AB	75046TH
75047	75047P	75047X	75047A	75047B	75047C	75047U	75047JP	75047EU	75047UK	75047US	75047KC	KC-75047	75047RU	75047MX	75047DE	75047AB	75047TH
75048	75048P	75048X	75048A	75048B	75048C	75048U	75048JP	75048EU	75048UK	75048US	75048KC	KC-75048	75048RU	75048MX	75048DE	75048AB	75048TH
75049	75049P	75049X	75049A	75049B	75049C	75049U	75049JP	75049EU	75049UK	75049US	75049KC	KC-75049	75049RU	75049MX	75049DE	75049AB	75049TH
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75147	75147P	75147X	75147A	75147B	75147C	75147U	75147JP	75147EU	75147UK	75147US	75147KC	KC-75147	75147RU	75147MX	75147DE	75147AB	75147TH
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75150	75150P	75150X	75150A	75150B	75150C	75150U	75150JP	75150EU	75150UK	75150US	75150KC	KC-75150	75150RU	75150MX	75150DE	75150AB	75150TH
75151	75151P	75151X	75151A	75151B	75151C	75151U	75151JP	75151EU	75151UK	75151US	75151KC	KC-75151	75151RU	75151MX	75151DE	75151AB	75151TH
85064	85064P	85064X	85064A	85064B	85064C	85064U	85064JP	85064EU	85064UK	85064US	85064KC	KC-85064	85064RU	85064MX	85064DE	85064AB	85064TH
85065	85065P	85065X	85065A	85065B	85065C	85065U	85065JP	85065EU	85065UK	85065US	85065KC	KC-85065	85065RU	85065MX	85065DE	85065AB	85065TH

2.5 Technical Information

Network and Wireless connectivity	Bluetooth (BLE) 2.4G ISM Band

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	DTS
Modulation Type	GFSK
Product Type	☐ Mobile ☒ Portable ☐ Fix Location
Transfer Rate	1 Mbps
Frequency Range	The frequency range used is 2405 MHz – 2470 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of Channel	16
Tested Channel	Low (2405 MHz), Middle (2440 MHz), High (2470 MHz)
Antenna Type	PCB Antenna
Antenna Gain	-2.36 dBi
Adaptive or Non-Adaptive	Non-Adaptive
The Max RF Output power	-13.08 dBm
Antenna System (MIMO Smart Antenna)	N/A

All channel was listed on the following table:

Number	Frequency (MHz)	Number	Frequency (MHz)
1	**2405**	**9**	**2440**
2	2409	10	2445
3	2413	11	2450
4	2417	12	2455
5	2422	13	2460
6	2426	14	2465
7	2430	15	2467
8	2435	**16**	**2470**

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3 ☆	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

3.2 Verdict

No.	Description	FCC Part No.	Channel	Test Result	Verdict
1	Antenna Requirement	15.203	N/A	--	Pass[Note1]
2	Output Power	15.247(b)	Low/Middle/High	5.2.4	Pass
3	Occupied Bandwidth	15.247(a)	Low/Middle/High	5.3.4	Pass
4	Conducted Spurious Emission	15.247(d)	Low/Middle/High	5.4.4	Pass
5	Band Edge(Authorized-band band-edge)	15.247(d)	Low/ High	5.5.4	Pass
6	Conducted Emission	15.207	Low/Middle/High	5.6.4	Pass
7	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	5.7.4	Pass
8	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Low/Middle/High	5.8.4	Pass
9	Power spectral density (PSD)	15.247(e)	Low/Middle/High	5.9.4	Pass
Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.					

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	54% to 63%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+22.3℃ to +24.5℃
Working Voltage of the EUT	NV (Normal Voltage)	3.0V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY46471071	2024.07.04	2025.07.03
Spectrum Analyzer	KEYSIGHT	N9020A	MY50531259	2024.08.01	2025.07.31
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	02460	2024.05.16	2027.05.15
Test Antenna-Horn	A-INFO	LB-180400KF	J211060273	2024.06.15	2027.06.14
Anechoic Chamber	RAINFORD	9m*6m*6m	140	2024.07.28	2027.07.27
Amplifier	COM-MV	LSCX_LNA1-12G-01	7210214	2024.08.01	2025.07.31
Amplifier	COM-MV	XKu_LNA7-18G-01	7210209	2024.08.01	2025.07.31
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2024.08.01	2025.07.31
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2024.01.23	2027.01.22
Amplifier	COM-MV	ZT30-1000M	B2018054558	2024.11.28	2025.11.27
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	130	2024.07.13	2027.07.12
EMI Receiver	Agilent	N9038A	MY55330120	2024.08.01	2025.07.31
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-00867	2025.04.12	2028.04.11
Amplifier	COM-MV	ZT30-1000M	B2017119081	2024.11.28	2025.11.27
Anechoic Chamber	YiHeng	9m*6m*6m	142	2024.07.21	2027.07.20
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2024.08.01	2025.07.31
LISN	SCHWARZBECK	NSLK 8127	8127-687	2024.05.09	2025.05.08
				2025.04.29	2026.04.28
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m*2.8m	112	2025.02.14	2028.02.13

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V19.8.28.435	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT 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.

Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.8℃
Humidity	4%

4.5 Description of Test Setup

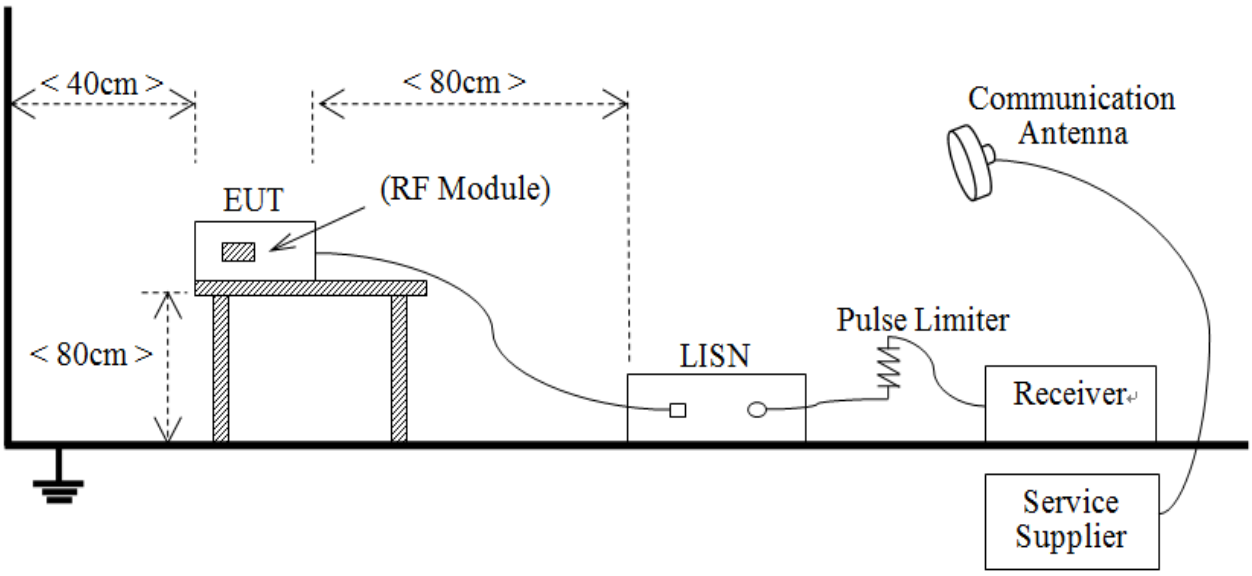
4.5.1. For Antenna Port Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:
Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm

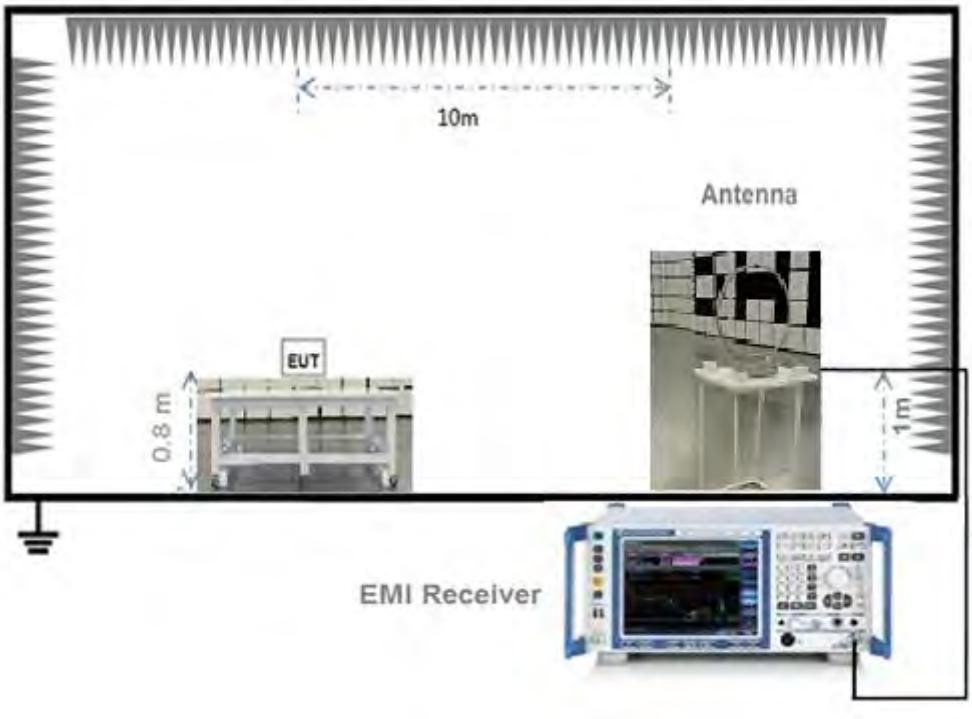
(Diagram 1)

4.5.2. For AC Power Supply Port Test



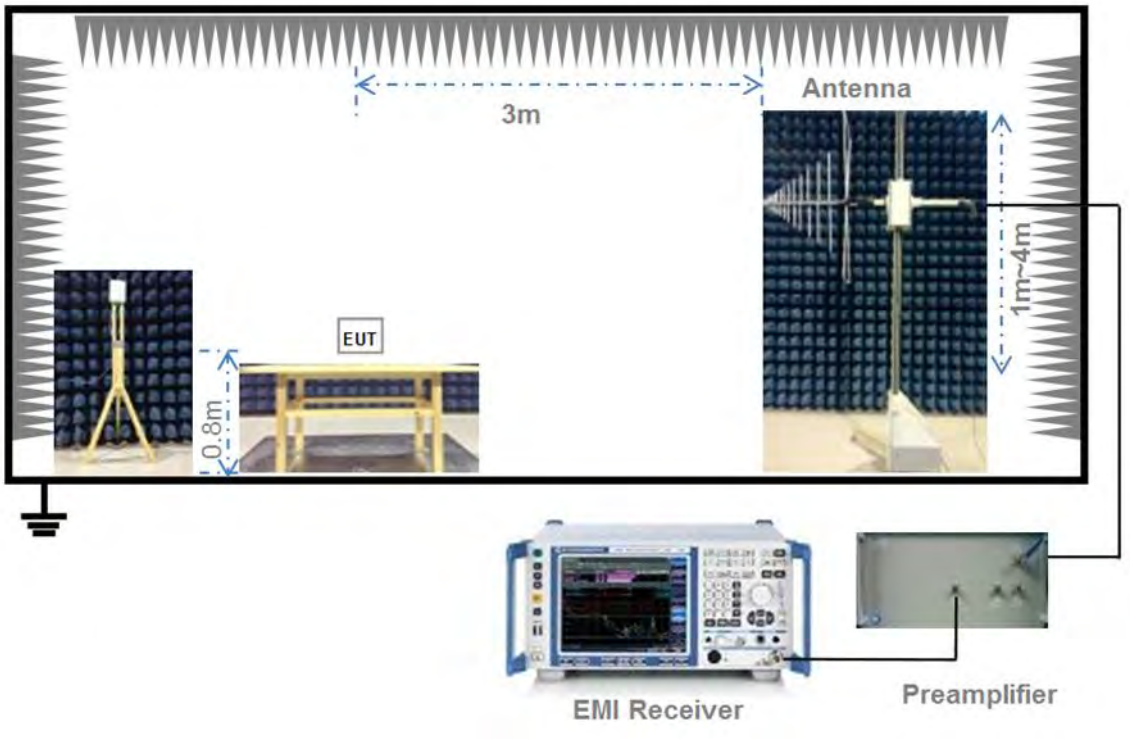
(Diagram 2)

4.5.3. For Radiated Test (Below 30 MHz)



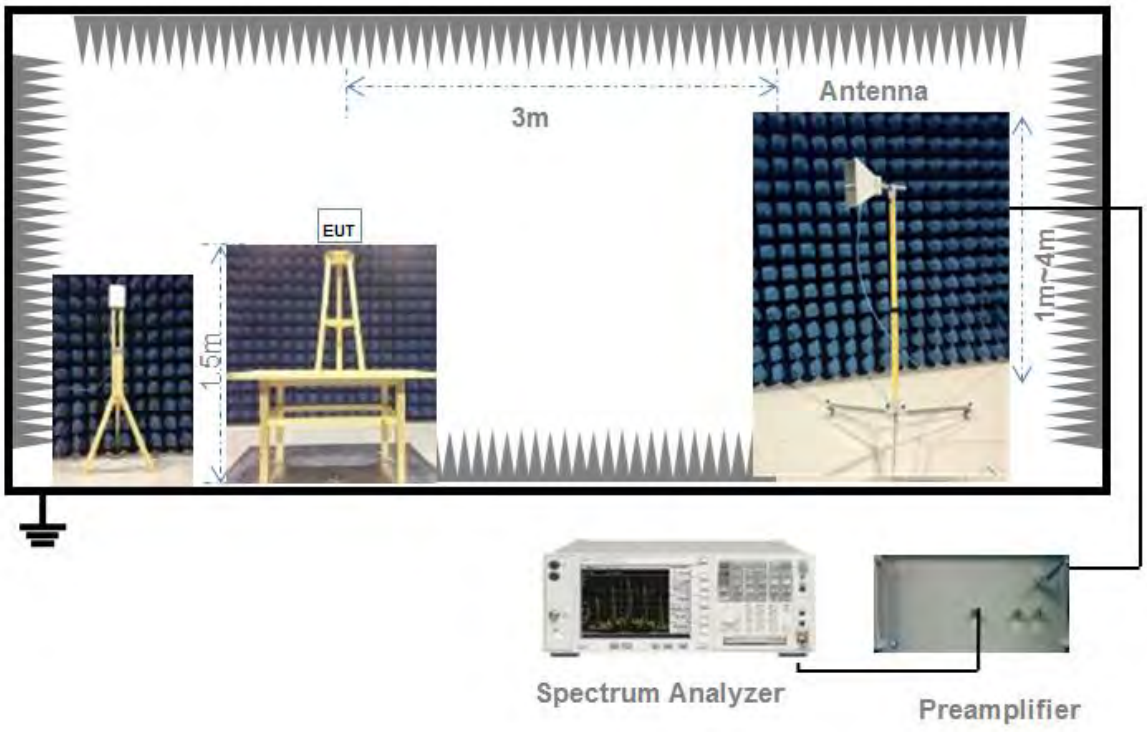
(Diagram 3)

4.5.4. For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5. For Radiated Test (Above 1 GHz)



(Diagram 5)

4.6 Measurement Results Explanation Example

4.6.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

4.6.2 For radiated band edges and spurious emission test:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1. Relevant Standards

FCC §15.203 & 15.247(b)

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 shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2. Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	An embedded-in antenna design is used.

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

5.1.3. Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Output Power

5.2.1. Test Limit

FCC § 15.247(b)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements.

5.2.2. Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.2.3. Test Procedure

a) Maximum peak conducted output power

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

Set the RBW ≥ DTS bandwidth.

Set VBW ≥ 3 x RBW.

Set span ≥ 3 x RBW

Sweep time = auto couple.

Detector = peak.

Trace mode = max hold.

Allow trace to fully stabilize.

Use peak marker function to determine the peak amplitude level.

b) Measurements of duty cycle

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

Set the center frequency of the instrument to the center frequency of the transmission.

Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.

Set VBW ≥ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

5.2.4. Test Result

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	GFSK		dBm	mW	
	dBm	mW			
Low Channel	-13.08	0.05	30	1000	Pass
Middle Channel	-13.16	0.05			Pass
High Channel	-13.27	0.05			Pass

Test Plots

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

5.3 Occupied Bandwidth

5.3.1. Limit

FCC §15.247(a)

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. The 6 dB bandwidth must be greater than 500 kHz.

5.3.2. Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.3.3. Test Procedure

Use the following spectrum analyzer settings:

Set RBW = 100 kHz.

Set the video bandwidth (VBW) ≥ 3 RBW.

Detector = Peak.

Trace mode = max hold.

Sweep = auto couple.

Allow the trace to stabilize.

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.

5.3.4. Test Result

Test Data

Test Mode	GFSK		
Channel	6 dB Bandwidth (kHz)	99% Bandwidth (kHz)	6 dB Bandwidth Limits (kHz)
Low Channel	727.500	1025.400	≥500
Middle Channel	697.500	1002.500	≥500
High Channel	675.000	1006.400	≥500

Test Plots

6 dB Bandwidth

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

99% Bandwidth

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

5.4 Conducted Spurious Emission

5.4.1. Limit

FCC §15.247(d)

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.

5.4.2. Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.4.3. Test Procedure

The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).

c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

The following procedures shall be used to demonstrate compliance to these limits. Note that these procedures can be used in either an antenna-port conducted or radiated test set-up. Radiated tests must conform to the test site requirements and utilize maximization procedures defined herein.

Reference level measurement:

Establish a reference level by using the following procedure:

Set instrument center frequency to DTS channel center frequency.

Set the span to ≥ 1.5 times the DTS bandwidth.

Set the RBW = 100 kHz.

Set the VBW ≥ 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum PSD level.

Emission level measurement:

Use the following spectrum analyzer settings:

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.

Set the RBW = 100 kHz.

Set the VBW ≥ 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

5.4.4. Test Result

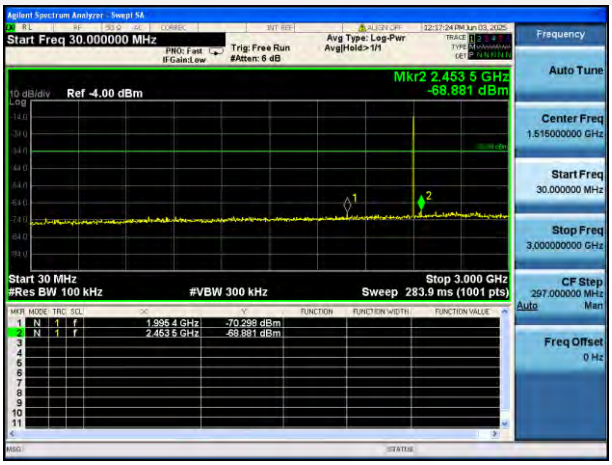
Test Data

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low Channel	-50.67	-13.89	-33.89	Pass
Middle Channel	-50.03	-13.89	-33.89	Pass
High Channel	-47.78	-14.04	-34.04	Pass

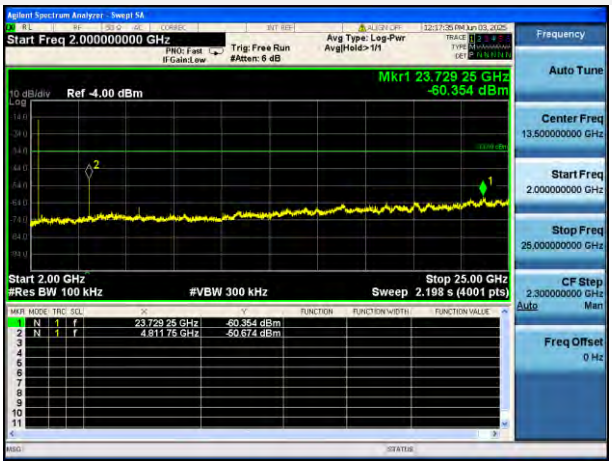
Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL

GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

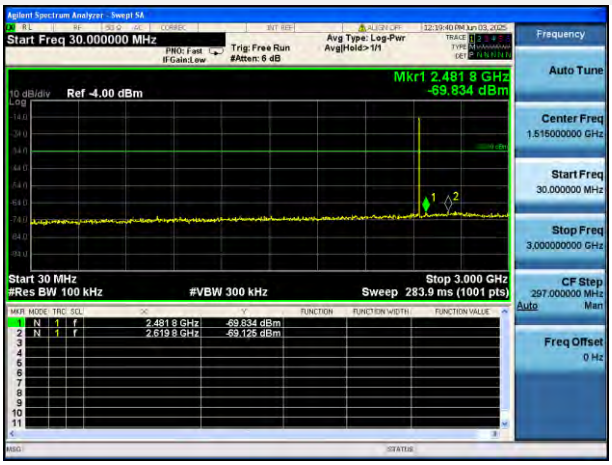


GFSK LOW CHANNEL, SPURIOUS 2 GHz ~ 25 GHz

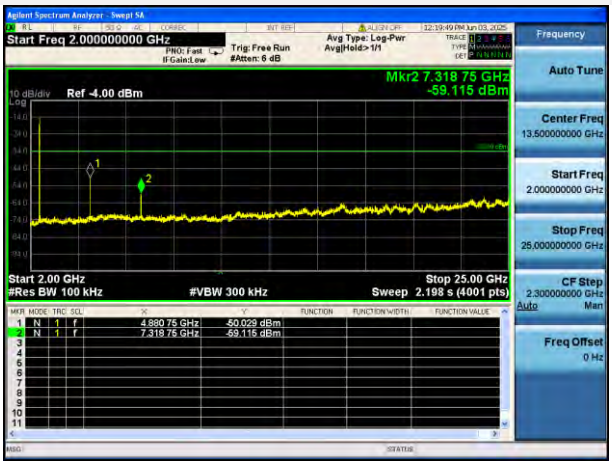


GFSK MIDDLE CHANNEL, CARRIER LEVEL

GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

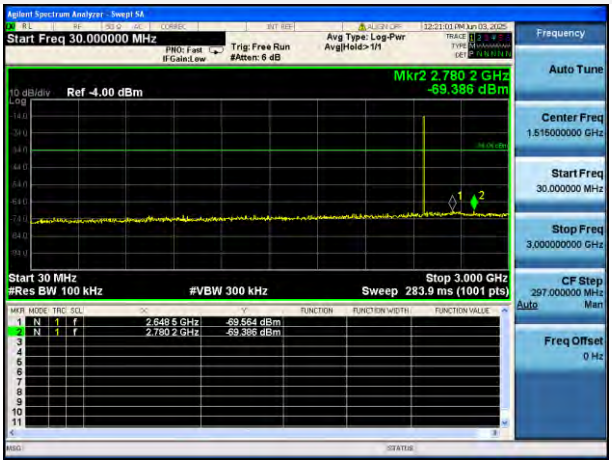


GFSK MIDDLE CHANNEL, SPURIOUS 2 GHz ~ 25 GHz

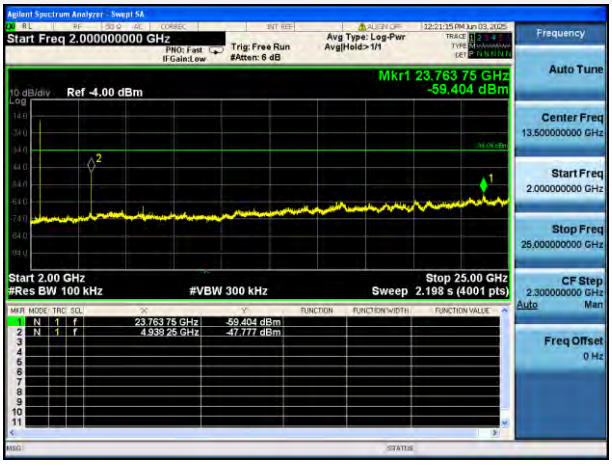


GFSK HIGH CHANNEL, CARRIER LEVEL

GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK HIGH CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



5.5 Band Edge (Authorized-band band-edge)

5.5.1. Limit

FCC §15.247(d)

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.

5.5.2. Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.5.3. Test Procedure

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is utilized, use the procedure described in 13.2.1. Use the procedure described in 13.2.2 when using an average detector and the EUT can be configured to transmit continuously (i.e., duty cycle ≥ 98%). Use the procedure described in 13.2.3 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent). Use the procedure described in 13.2.4 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2 percent).

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used.

Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).

Set span to 2 MHz

RBW = 100 kHz.

VBW ≥ 3 x RBW.

Detector = peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)

Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency (femission) ± 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by femission ± 0.5 MHz.

5.5.4. Test Result

Note: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

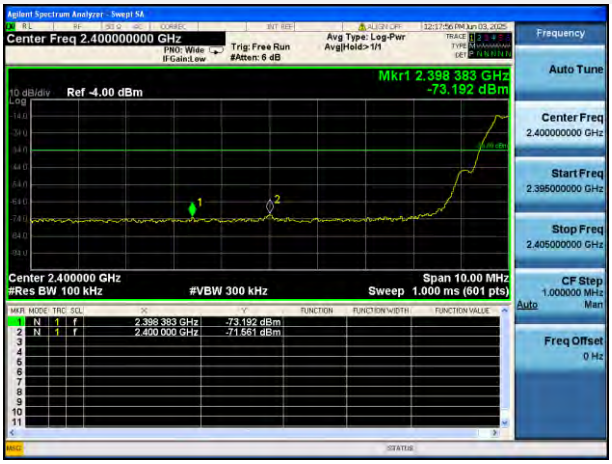
Test Data

GFSK				
Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low Channel	-71.56	-13.89	-33.89	Pass
High Channel	-72.57	-14.04	-34.04	Pass

Test Plots

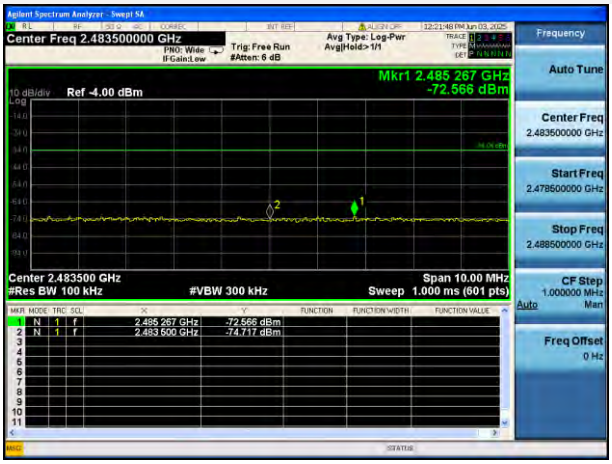
GFSK LOW CHANNEL, CARRIER LEVEL

GFSK LOW CHANNEL, BAND EDGE



GFSK HIGH CHANNEL, CARRIER LEVEL

GFSK HIGH CHANNEL, BAND EDGE



5.6 Conducted Emission

5.6.1. Limit

FCC §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.6.2. Test Setup

See section 4.5.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX A.

5.6.3. Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.
Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

5.6.4. Test Result

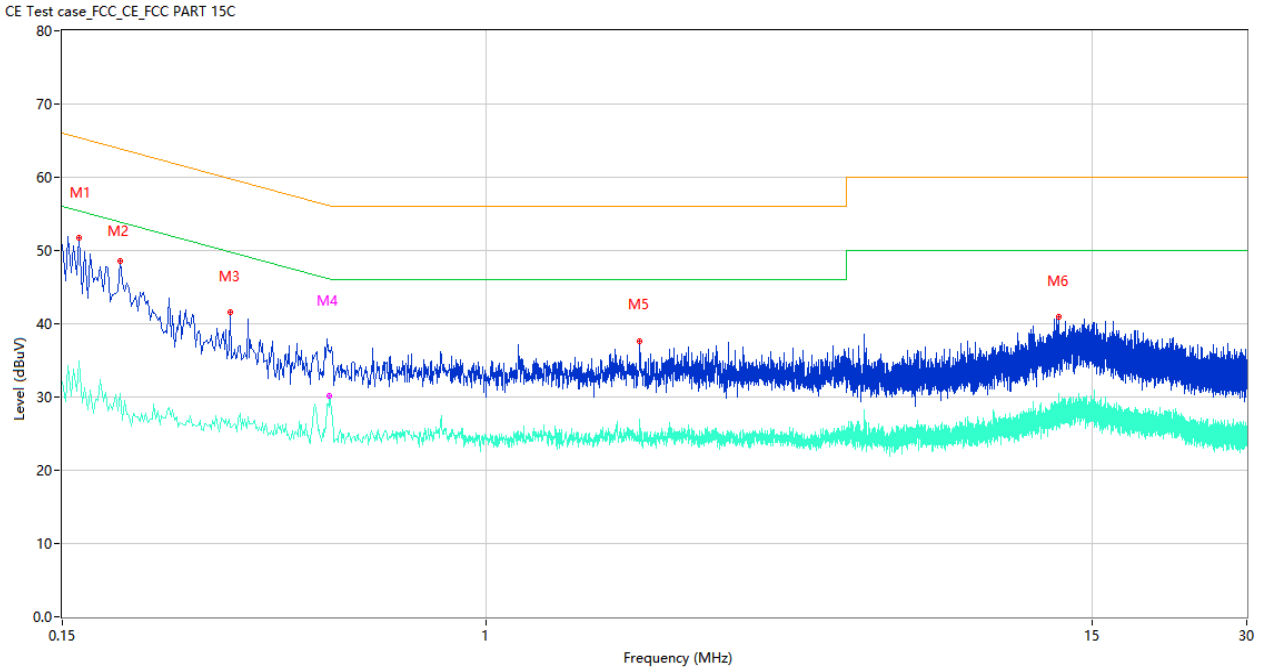
Note [1]: The EUT is working in the Normal link mode.

Note [2]: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (120 VAC, 60 Hz) shown here.

Note [3]: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

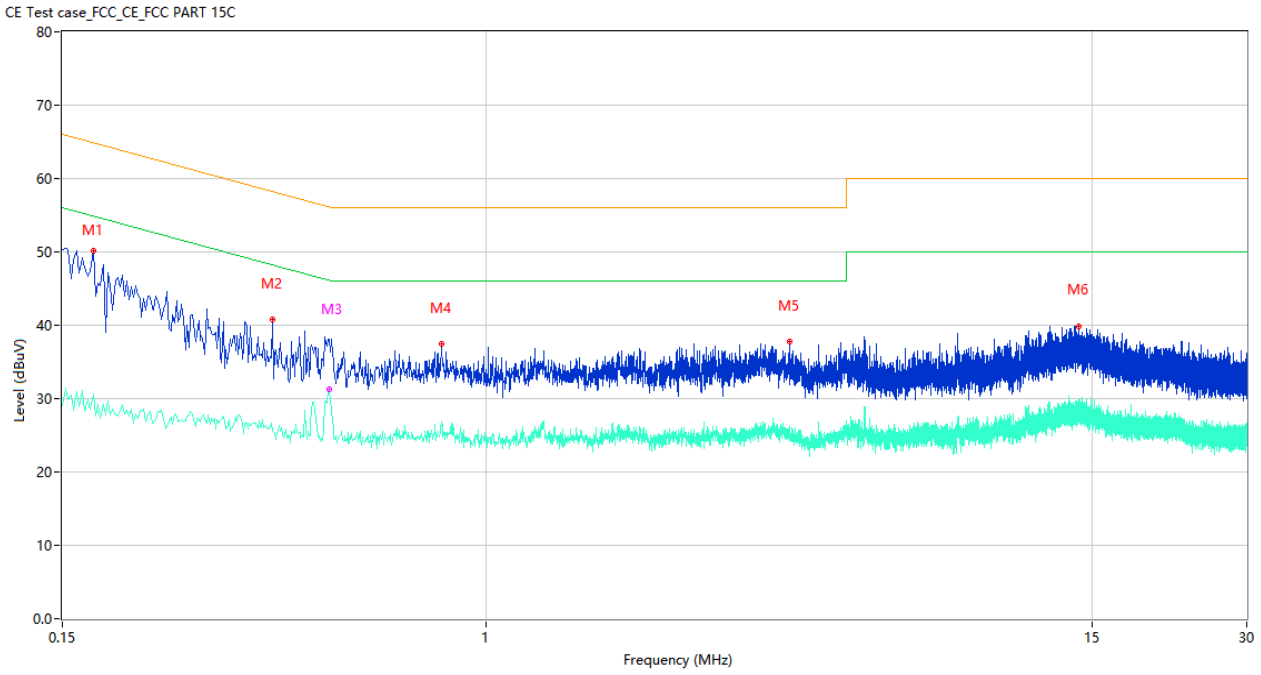
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.162	51.76	9.78	65.36	13.60	Peak	L	Pass
1**	0.162	34.98	9.78	55.36	20.38	AV	L	Pass
2	0.194	48.65	9.77	63.86	15.21	Peak	L	Pass
2**	0.194	30.40	9.77	53.86	23.46	AV	L	Pass
3	0.318	41.52	10.12	59.76	18.24	Peak	L	Pass
3**	0.318	25.95	10.12	49.76	23.81	AV	L	Pass
4	0.496	36.42	9.98	56.07	19.65	Peak	L	Pass
4**	0.496	30.18	9.98	46.07	15.89	AV	L	Pass
5	1.986	37.66	10.20	56.00	18.34	Peak	L	Pass
5**	1.986	26.98	10.20	46.00	19.02	AV	L	Pass
6	12.914	40.89	10.55	60.00	19.11	Peak	L	Pass
6**	12.914	28.32	10.55	50.00	21.68	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.172	50.14	9.78	64.86	14.72	Peak	N	Pass
1**	0.172	30.59	9.78	54.86	24.27	AV	N	Pass
2	0.384	40.72	10.62	58.19	17.47	Peak	N	Pass
2**	0.384	25.49	10.62	48.19	22.70	AV	N	Pass
3	0.494	37.43	9.99	56.10	18.67	Peak	N	Pass
3**	0.494	31.30	9.99	46.10	14.80	AV	N	Pass
4	0.818	37.42	10.56	56.00	18.58	Peak	N	Pass
4**	0.818	26.89	10.56	46.00	19.11	AV	N	Pass
5	3.880	37.77	10.32	56.00	18.23	Peak	N	Pass
5**	3.880	25.10	10.32	46.00	20.90	AV	N	Pass
6	14.170	39.91	10.80	60.00	20.09	Peak	N	Pass
6**	14.170	29.86	10.80	50.00	20.14	AV	N	Pass

5.7 Radiated Spurious Emission

5.7.1. Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
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

Note:

1. Field Strength (dBμV/m) = 20*log[Field Strength (μV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.7.2. Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.7.3. Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated measurements

for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands:

a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)

c) 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).

d) 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).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

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

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure:

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 1.

b) VBW ≥ 3 x RBW.

c) Detector = Peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

a) The EUT shall be configured to operate at the maximum achievable duty cycle.

b) Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.

c) RBW = 1 MHz (unless otherwise specified).

d) VBW ≥ 3 x RBW.

e) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

f) Averaging type = power (i.e., RMS).

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.

2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

g) Sweep time = auto.

h) Perform a trace average of at least 100 traces.

i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

2) If linear voltage averaging mode was used in step f), then the applicable correction factor is 20 log(1/x), where x is the duty cycle.

3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain:

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

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.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test:

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the

Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

5.7.4. Test Result

Note [1]: The symbol of "--" in the table which means not application.

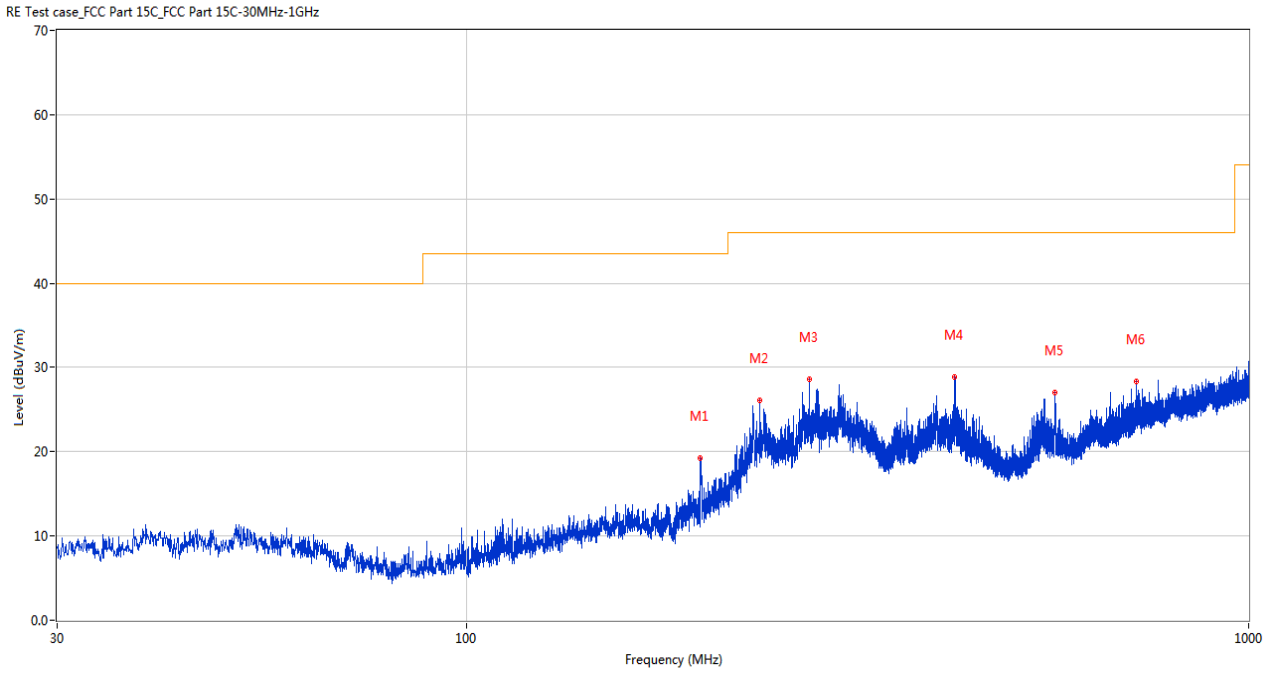
Note [2]: For the test data above 1 GHz, according the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note [3]: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note [4]: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)

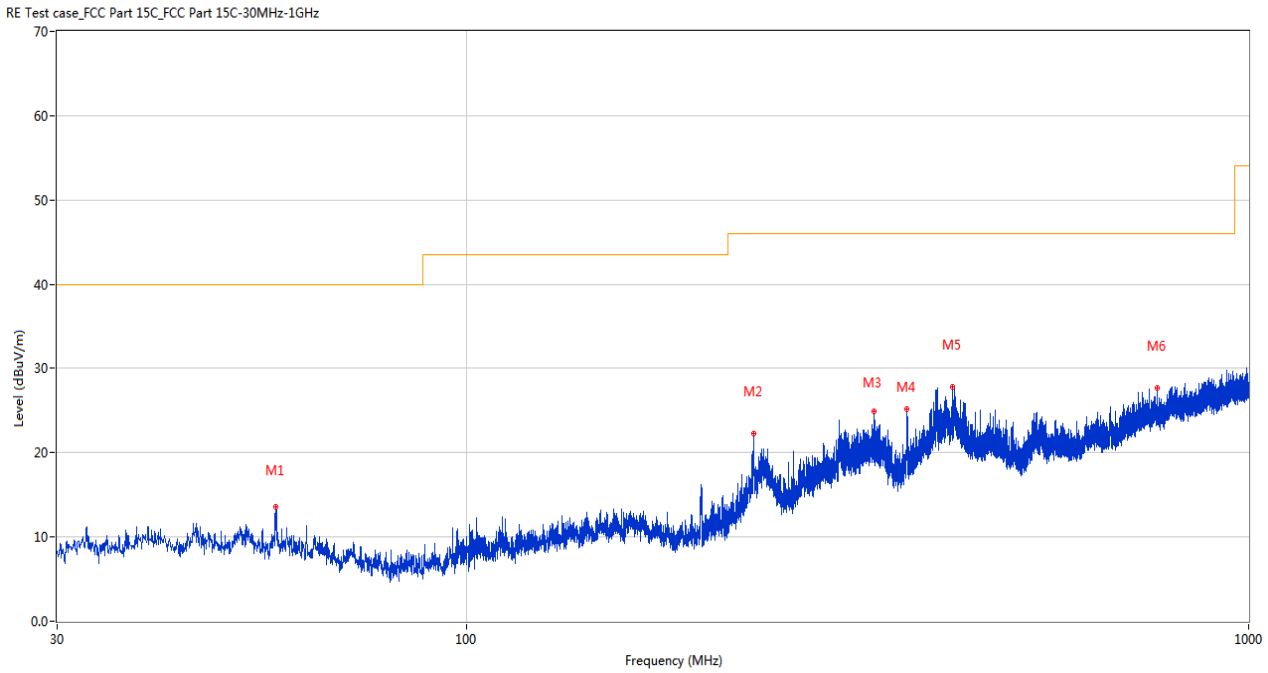
Test Data and Plots

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	199.265	19.24	-28.69	43.5	24.26	Peak	115.00	200	Horizontal	Pass
2	237.483	26.11	-27.60	46.0	19.89	Peak	108.00	100	Horizontal	Pass
3	274.780	28.65	-25.98	46.0	17.35	Peak	83.00	100	Horizontal	Pass
4	421.250	28.94	-20.93	46.0	17.06	Peak	77.00	200	Horizontal	Pass
5	565.246	27.04	-17.34	46.0	18.96	Peak	92.00	100	Horizontal	Pass
6	718.070	28.32	-13.99	46.0	17.68	Peak	95.00	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	57.111	13.52	-26.83	40.0	26.48	Peak	323.00	100	Vertical	Pass
2	233.264	22.34	-27.93	46.0	23.66	Peak	82.00	200	Vertical	Pass
3	331.622	24.88	-23.71	46.0	21.12	Peak	81.00	100	Vertical	Pass
4	365.620	25.23	-22.52	46.0	20.77	Peak	81.00	100	Vertical	Pass
5	418.000	27.82	-21.34	46.0	18.18	Peak	96.00	100	Vertical	Pass
6	764.387	27.68	-12.75	46.0	18.32	Peak	338.00	100	Vertical	Pass

Note [1]: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

Note [2]: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1921.900	54.45	74.0	19.55	Peak	170.00	100	Horizontal	Pass
1**	1921.900	49.62	54.0	4.38	AV	170.00	100	Horizontal	Pass
2	2405.400	84.21	74.0	-10.21	Peak	118.00	150	Horizontal	N/A
2**	2405.400	82.15	54.0	-28.15	AV	118.00	150	Horizontal	N/A
3	4810.000	55.32	74.0	18.68	Peak	92.00	100	Horizontal	Pass
3**	4810.000	53.24	54.0	0.76	AV	92.00	100	Horizontal	N/A
3***	4810.000	52.80	54.0	1.20	AV	92.00	100	Horizontal	Pass
4	7217.000	51.44	74.0	22.56	Peak	92.00	100	Horizontal	Pass
4**	7217.000	49.04	54.0	4.96	AV	92.00	100	Horizontal	Pass
5	12974.175	53.27	74.0	20.73	Peak	70.00	150	Horizontal	Pass
5**	12974.175	44.70	54.0	9.30	AV	70.00	150	Horizontal	Pass
6	16986.225	55.83	74.0	18.17	Peak	209.00	150	Horizontal	Pass
6**	16986.225	46.10	54.0	7.90	AV	209.00	150	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1165.600	45.66	74.0	28.34	Peak	75.00	150	Vertical	Pass
1**	1165.600	34.31	54.0	19.69	AV	75.00	150	Vertical	Pass
2	2405.400	73.23	74.0	0.77	Peak	238.00	150	Vertical	N/A
2**	2405.400	71.63	54.0	-17.63	AV	238.00	150	Vertical	N/A
3	4810.000	52.77	74.0	21.23	Peak	109.00	100	Vertical	Pass
3**	4810.000	49.15	54.0	4.85	AV	109.00	100	Vertical	Pass
4	7216.500	56.16	74.0	17.84	Peak	287.00	100	Vertical	Pass
4**	7216.500	50.86	54.0	3.14	AV	287.00	100	Vertical	Pass
5	12803.550	53.58	74.0	20.42	Peak	283.00	150	Vertical	Pass
5**	12803.550	43.34	54.0	10.66	AV	283.00	150	Vertical	Pass
6	17005.125	55.60	74.0	18.40	Peak	9.00	150	Vertical	Pass
6**	17005.125	46.79	54.0	7.21	AV	9.00	150	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1484.700	44.21	74.0	29.79	Peak	210.00	150	Horizontal	Pass
1**	1484.700	39.84	54.0	14.16	AV	210.00	150	Horizontal	Pass
2	2429.500	85.07	74.0	-11.07	Peak	107.00	150	Horizontal	N/A
2**	2429.500	83.01	54.0	-29.01	AV	107.00	150	Horizontal	N/A
3	4859.500	56.36	74.0	17.64	Peak	114.00	100	Horizontal	Pass
3**	4859.500	53.92	54.0	0.08	AV	114.00	100	Horizontal	N/A
3***	4859.500	53.36	54.0	0.64	AV	114.00	100	Horizontal	Pass
4	7291.750	52.31	74.0	21.69	Peak	289.00	100	Horizontal	Pass
4**	7291.750	48.28	54.0	5.72	AV	289.00	100	Horizontal	Pass
5	12506.800	53.01	74.0	20.99	Peak	337.00	150	Horizontal	Pass
5**	12506.800	43.79	54.0	10.21	AV	337.00	150	Horizontal	Pass
6	16881.225	55.60	74.0	18.40	Peak	318.00	150	Horizontal	Pass
6**	16881.225	47.02	54.0	6.98	AV	318.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1921.900	48.43	74.0	25.57	Peak	216.00	100	Vertical	Pass
1**	1921.900	42.80	54.0	11.20	AV	216.00	100	Vertical	Pass
2	2430.400	75.85	74.0	-1.85	Peak	101.00	100	Vertical	N/A
2**	2430.400	74.18	54.0	-20.18	AV	101.00	100	Vertical	N/A
3	3502.500	55.90	74.0	18.10	Peak	360.00	100	Vertical	Pass
3**	3502.500	52.38	54.0	1.62	AV	360.00	100	Vertical	Pass
4	4861.000	52.43	74.0	21.57	Peak	174.00	100	Vertical	Pass
4**	4861.000	48.06	54.0	5.94	AV	174.00	100	Vertical	Pass
5	7288.750	56.34	74.0	17.66	Peak	311.00	100	Vertical	Pass
5**	7288.750	51.60	54.0	2.40	AV	311.00	100	Vertical	Pass
6	13132.987	54.10	74.0	19.90	Peak	289.00	100	Vertical	Pass
6**	13132.987	44.33	54.0	9.67	AV	289.00	100	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1485.100	43.87	74.0	30.13	Peak	331.00	150	Horizontal	Pass
1**	1485.100	39.27	54.0	14.73	AV	331.00	150	Horizontal	Pass
2	2470.500	84.45	74.0	-10.45	Peak	106.00	150	Horizontal	N/A
2**	2470.500	82.13	54.0	-28.13	AV	106.00	150	Horizontal	N/A
3	4941.250	55.35	74.0	18.65	Peak	113.00	100	Horizontal	Pass
3**	4941.250	53.00	54.0	1.00	AV	113.00	100	Horizontal	Pass
4	7408.750	54.04	74.0	19.96	Peak	269.00	100	Horizontal	Pass
4**	7408.750	50.08	54.0	3.92	AV	269.00	100	Horizontal	Pass
5	12461.200	54.07	74.0	19.93	Peak	90.00	150	Horizontal	Pass
5**	12461.200	43.85	54.0	10.15	AV	90.00	150	Horizontal	Pass
6	14439.975	56.04	74.0	17.96	Peak	147.00	150	Horizontal	Pass
6**	14439.975	45.83	54.0	8.17	AV	147.00	150	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1164.400	48.94	74.0	25.06	Peak	61.00	150	Vertical	Pass
1**	1164.400	41.38	54.0	12.62	AV	61.00	150	Vertical	Pass
2	2470.100	74.42	74.0	-0.42	Peak	95.00	150	Vertical	N/A
2**	2470.100	72.46	54.0	-18.46	AV	95.00	150	Vertical	N/A
3	4939.500	52.03	74.0	21.97	Peak	133.00	100	Vertical	Pass
3**	4939.500	48.30	54.0	5.70	AV	133.00	100	Vertical	Pass
4	7408.750	55.81	74.0	18.19	Peak	311.00	100	Vertical	Pass
4**	7408.750	52.30	54.0	1.70	AV	311.00	100	Vertical	Pass
5	12481.625	54.14	74.0	19.86	Peak	66.00	150	Vertical	Pass
5**	12481.625	43.73	54.0	10.27	AV	66.00	150	Vertical	Pass
6	17012.475	55.79	74.0	18.21	Peak	38.00	150	Vertical	Pass
6**	17012.475	46.46	54.0	7.54	AV	38.00	150	Vertical	Pass

5.8 Band Edge (Restricted-band band-edge)

5.8.1. Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.8.2. Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.8.3. Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

For transmitters operating above 1 GHz repeat the measurement with an average detector.

5.8.4. Test Result

Note [1]: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

Note [2]: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.

Note [3]: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note [4]: The Level (dBuV/m) has been corrected by factor.

Test Data

GFSK LOW CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2325.000	55.53	74.0	18.47	Peak	269.00	150	Horizontal	Pass
1**	2325.000	43.21	54.0	10.79	AV	269.00	150	Horizontal	Pass
2	2389.833	53.39	74.0	20.61	Peak	111.00	150	Horizontal	Pass
2**	2389.833	42.69	54.0	11.31	AV	111.00	150	Horizontal	Pass

GFSK HIGH CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.550	54.16	74.0	19.84	Peak	20.00	150	Horizontal	Pass
1**	2483.550	43.24	54.0	10.76	AV	20.00	150	Horizontal	Pass
2	2487.850	55.84	74.0	18.16	Peak	279.00	150	Horizontal	Pass
2**	2487.850	43.27	54.0	10.73	AV	279.00	150	Horizontal	Pass

5.9 Power Spectral density (PSD)

5.9.1. Limit

FCC §15.247(e)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.9.2. Test Setup

See section 4.5.1 (Diagram 1) for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.9.3. Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.

Set the VBW ≥ 3 RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.9.4. Test Result

Test Data

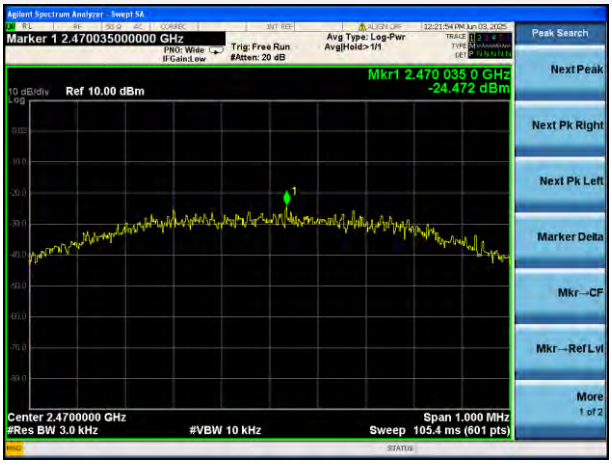
GFSK			
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low Channel	-24.44	8	Pass
Middle Channel	-25.65	8	Pass
High Channel	-24.47	8	Pass

Test Plots

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL

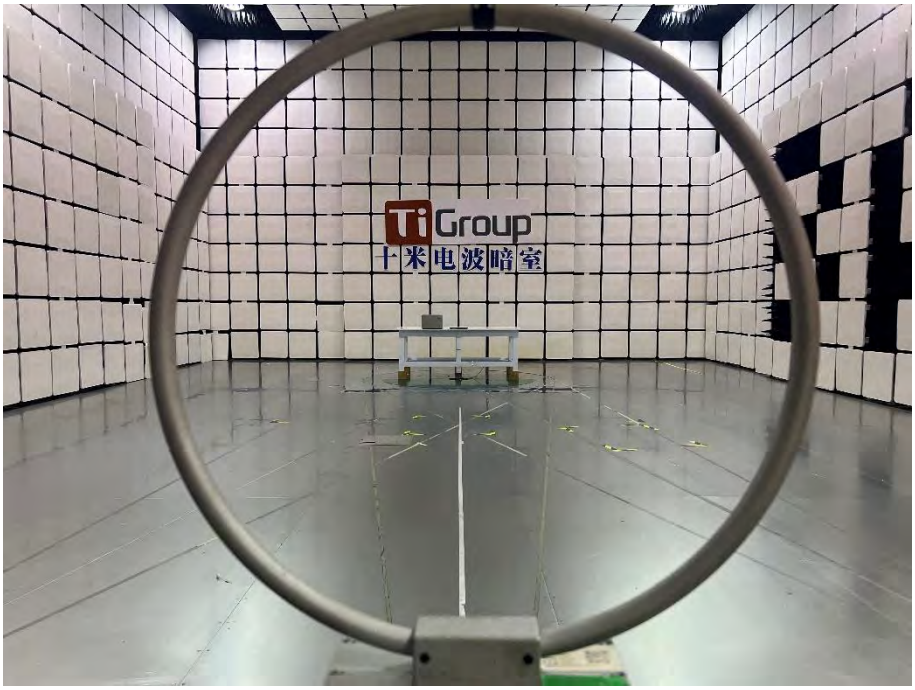
GFSK HIGH CHANNEL



ANNEX A TEST SETUP PHOTOS

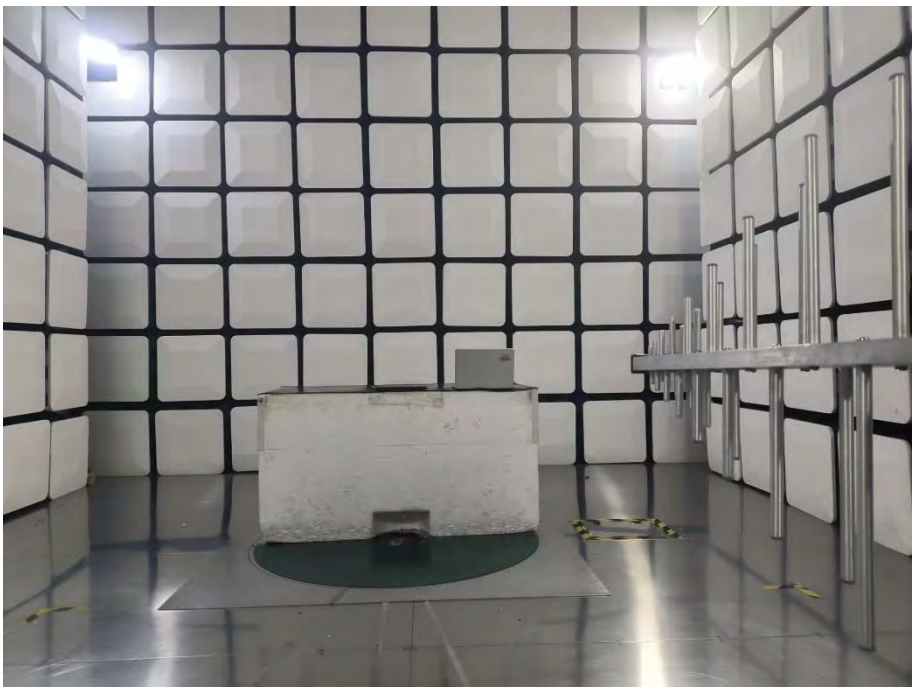
1 Radiated Test Photo

Below 30MHz



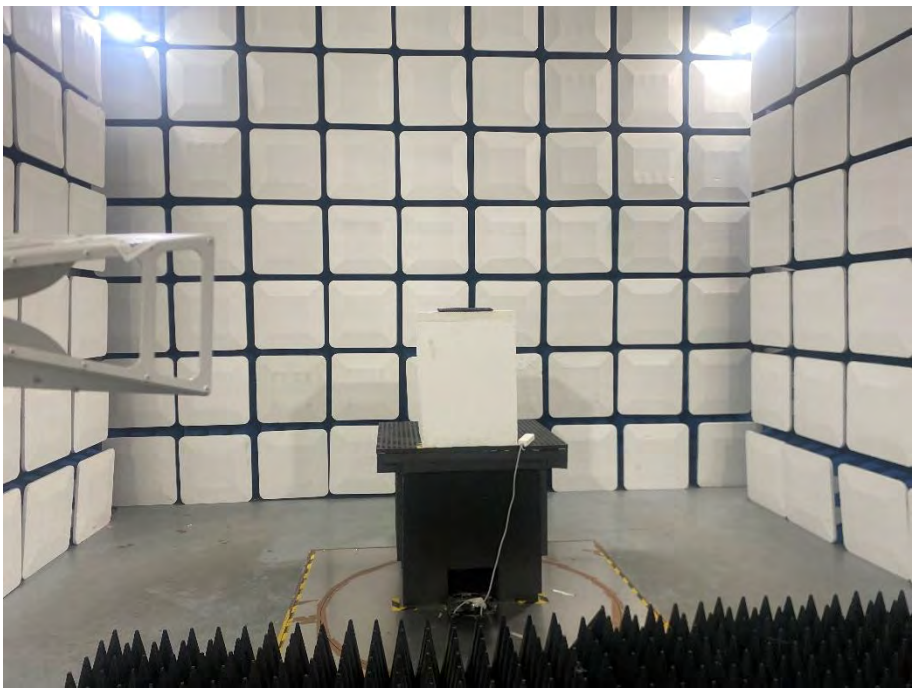
Close-up

30MHz-1GHz

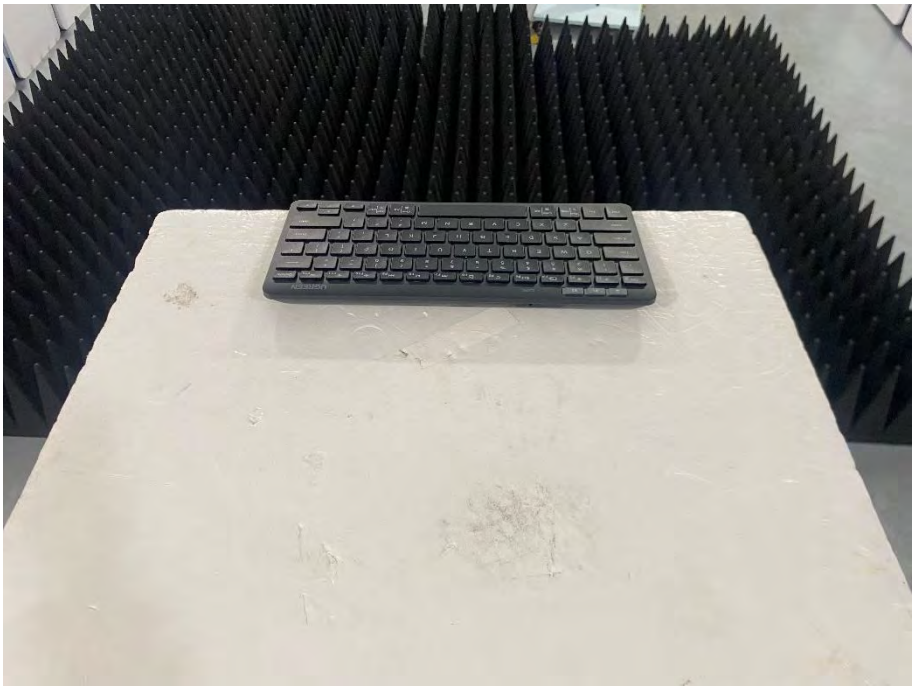


Close-up

Above 1GHz



Close-up

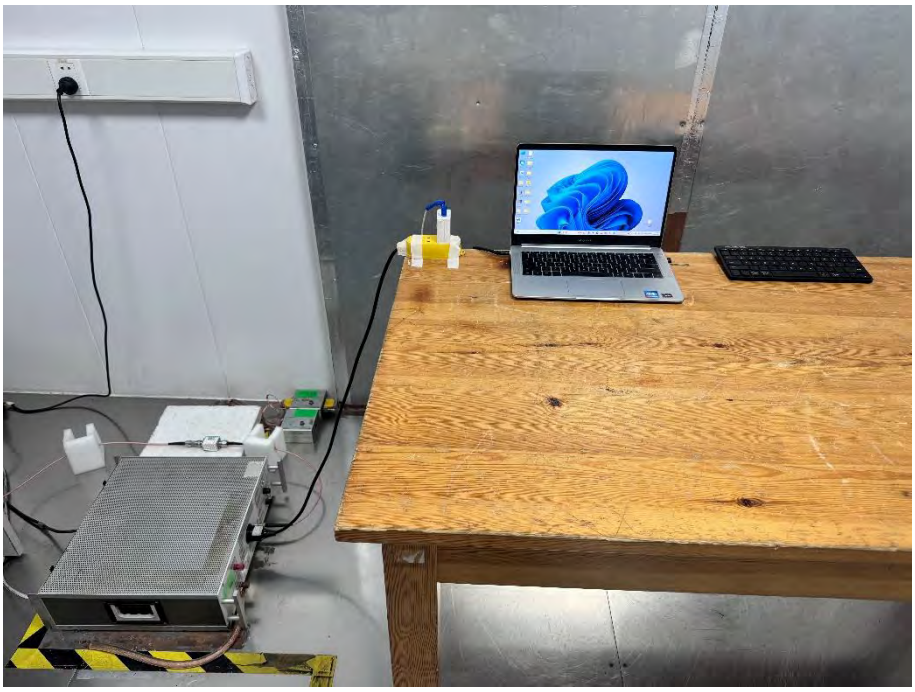


2 Conducted Test Photo

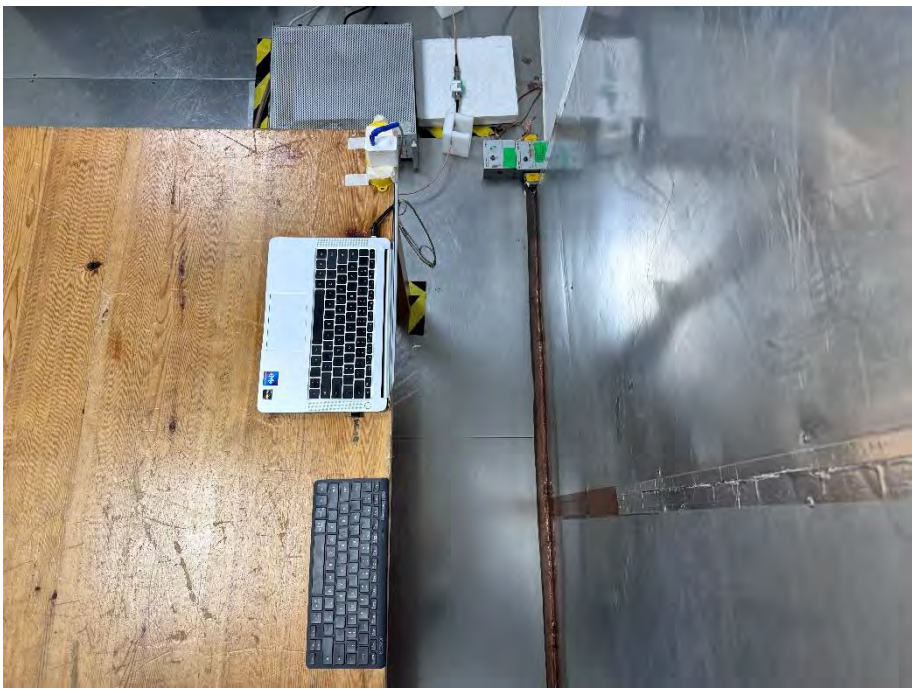
Conducted Test-2.4G ISM Band

3 Conducted Emissions

Test Photo 1

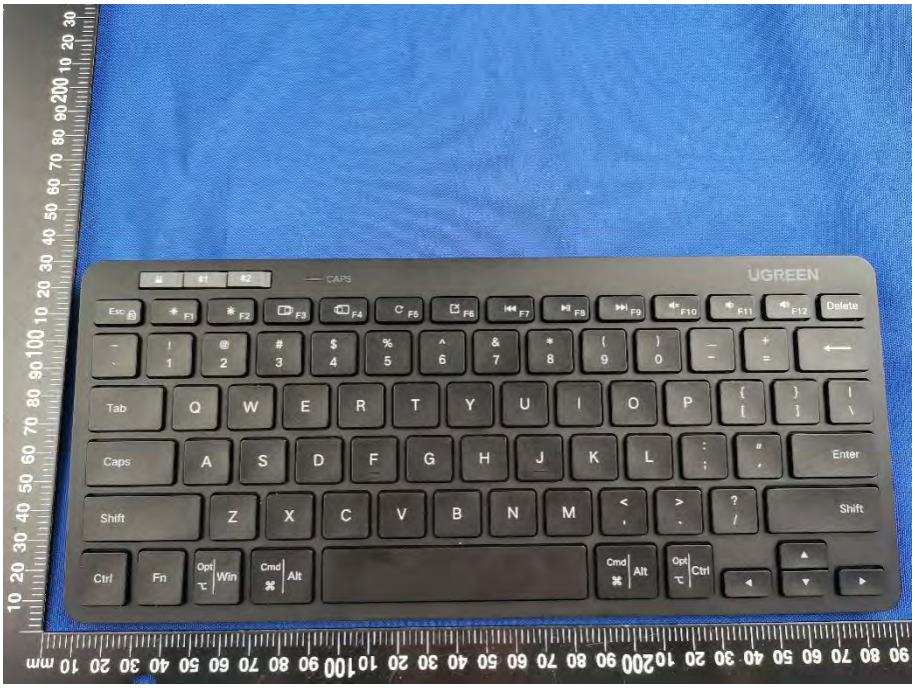


Test Photo 2



ANNEX B EUT EXTERNAL PHOTOS

FRONT VIEW OF EUT



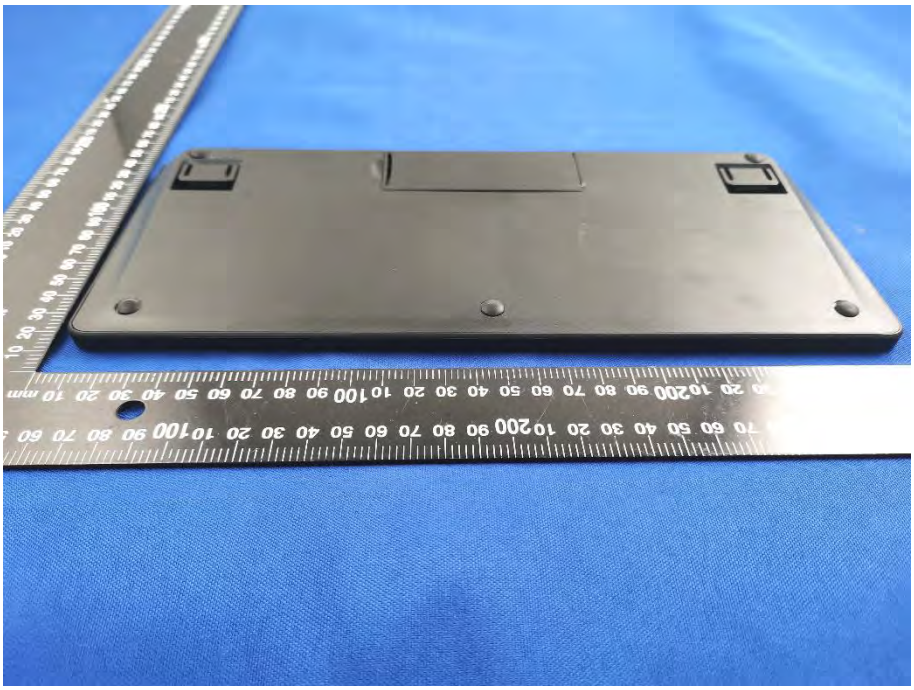
REAR VIEW OF EUT

LEFT VIEW OF EUT

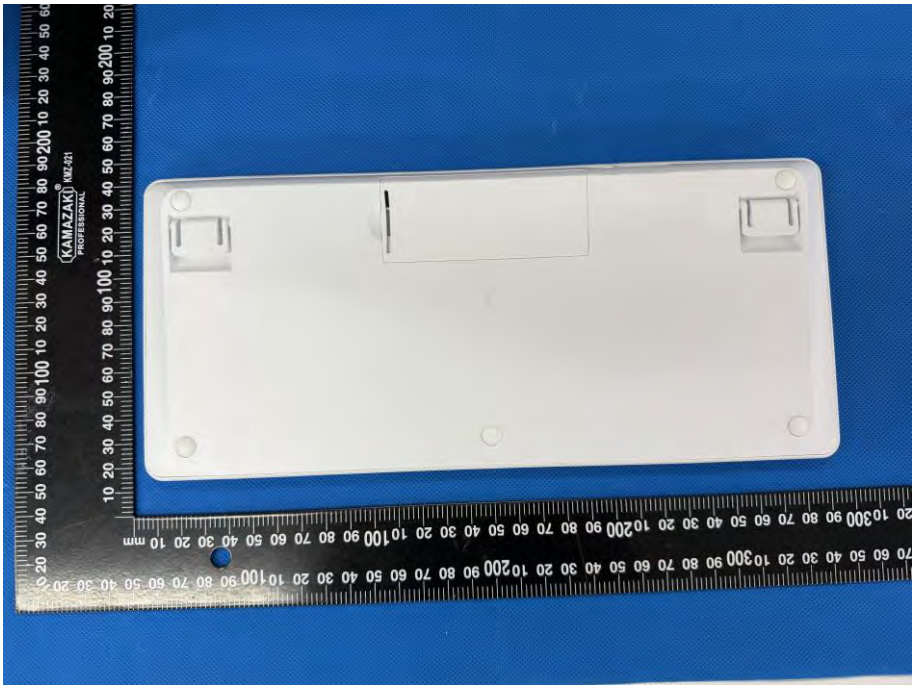
RIGHT VIEW OF EUT

TOP VIEW OF EUT

BOTTOM VIEW OF EUT




UGREEN
CAPS
Delete
Tab
Caps
Enter
Shift
Ctrl
Fn
Win
Alt
Cmd
Opt
KAMAZAKI
PROFESSIONAL


KAMAZAKI
PROFESSIONAL


UGREEN

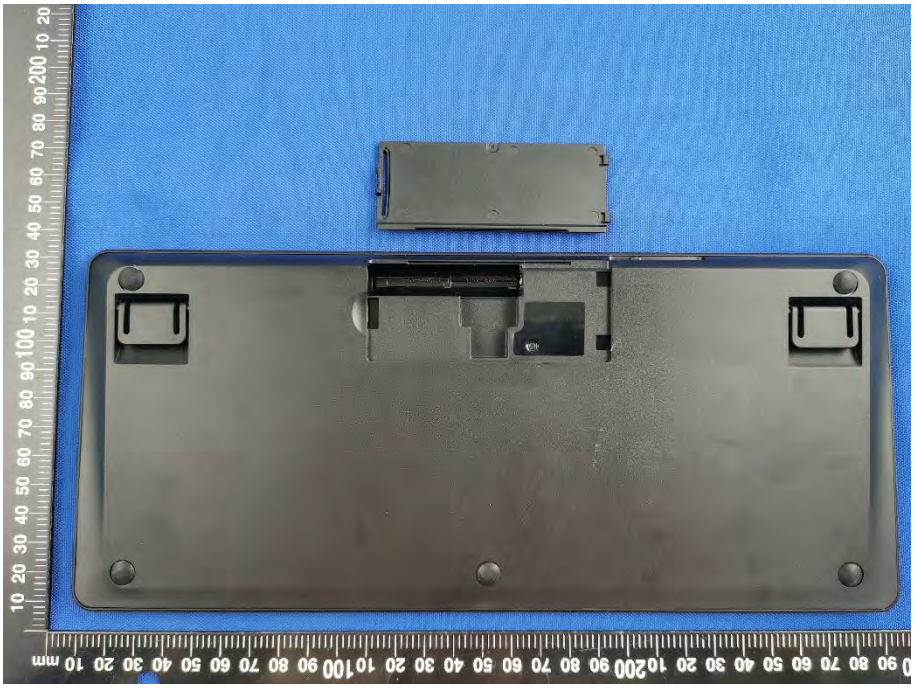
CLOSE-UP

Multi-mode Wireless Keyboard
Model: K551 Input: 3.0V⎓40mA Max Frequency Band: 2400MHz-2483.5MHz
FCC ID: 2AQI5-K551 CAN ICES-003(B) / NMB-003(B) IC: 26850-K551
Manufacturer: Ugreen Group Limited Made in China
Manufacturer Add: Ugreen Building, Longcheng Industrial Park,
Longguanxi Road, Longhua, Shenzhen, China EU REP: Ugreen Group GmbH
EU Add: Prinzenallee 1,40549 Düsseldorf, Germany UK REP: Acumen
International Business Consultancy Limited UK Add: 94 Ock Street, Abingdon,
OX14 5DH, UK This device complies with part 15 of the FCC Rules.
Operation is subject to the following two conditions: (1) This device may not cause harmful interference,
and (2) this device must accept any interference received, including interference that may cause undesired operation.

Accessory-Dongle

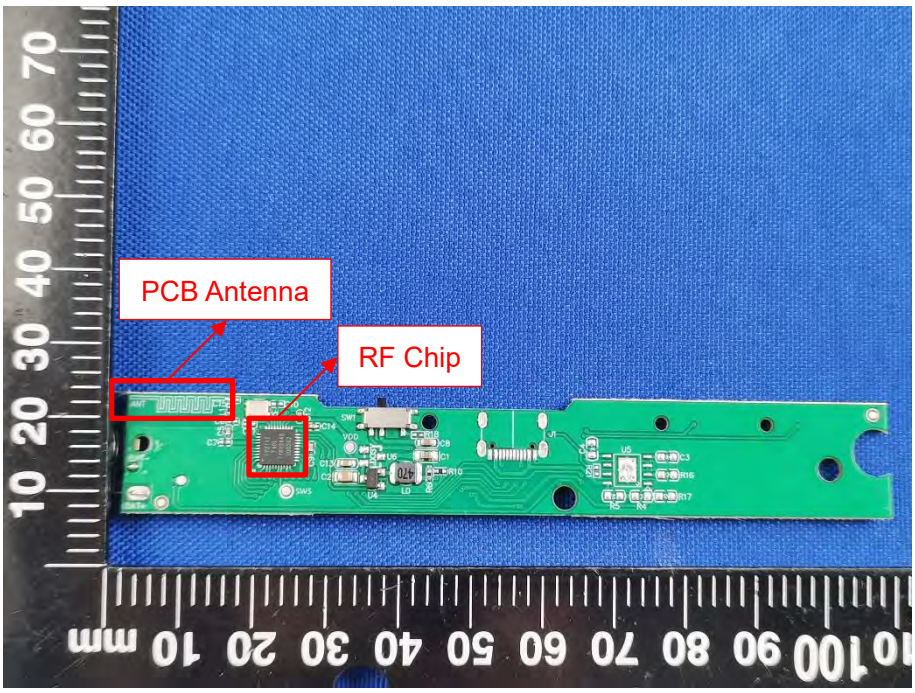
ANNEX C EUT INTERNAL PHOTOS

EUT UNCOVER VIEW 1

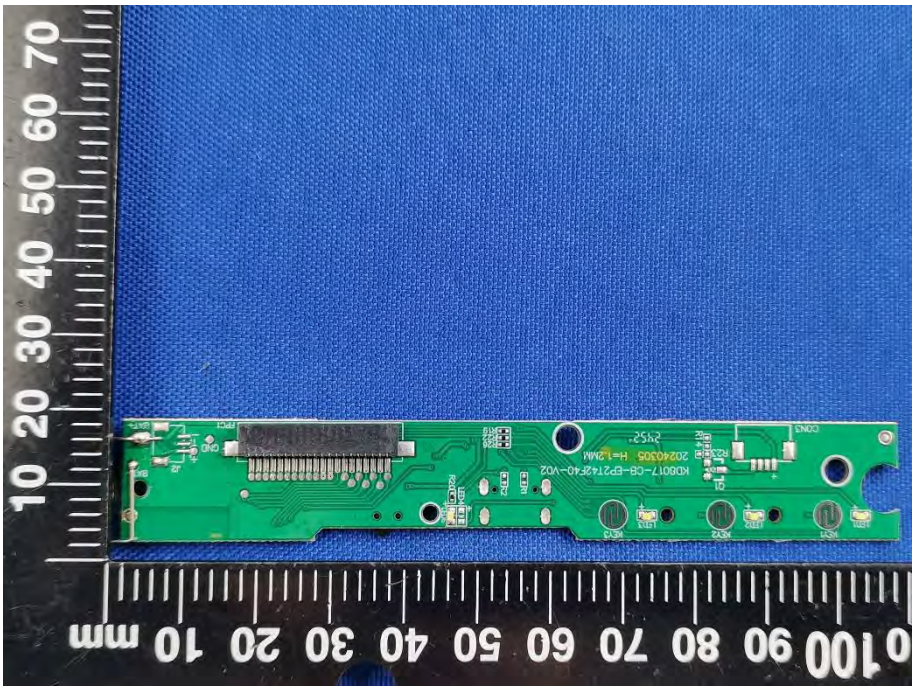


EUT UNCOVER VIEW 2

MAIN BOARD TOP VIEW



MAIN BOARD REAR VIEW



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--END OF REPORT--