TEST REPORT

Report No.:	8232EU120604W
Applicant:	REDBEAN Corporation
Address:	511, Gasan Terra Tower, 78, Digital-ro 10-gil Geumcheon-gu, Seoul, Republic of Korea
Product Name:	Redbean Pencil H1
Model No.:	H1 (refer to clause 2.4)
Trademark:	Redbean
FCC ID:	2BKJU-H1
Test Standard(s):	47 CFR Part 15 Subpart C
Date of Receipt:	Aug. 06, 2024
Test Date:	Aug. 06, 2024 – Aug. 16, 2024
Date of Issue:	Aug. 26, 2024

ISSUED BY:

SHENZHEN EU TESTING LABORATORY LIMITED

SHENZHEN EU TESTING LABORATORY LIMITED APPROVED

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Revision Record

Report Version	Issued Date	Description	Status
V0	Aug. 26, 2024	Original	Valid

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2 General Information

2.1 Applicant Information

Applicant	REDBEAN Corporation
Address	511, Gasan Terra Tower, 78, Digital-ro 10-gil Geumcheon-gu, Seoul, Republic of Korea

2.2 Manufacturer Information

Manufacturer	REDBEAN Corporation
Address	511, Gasan Terra Tower, 78, Digital-ro 10-gil Geumcheon-gu, Seoul, Republic of Korea

2.3 Factory Information

Factory	Becool Technology (Shenzhen)Co.,Ltd
Address	8F, Building A3, Tianrui Industrial Park No.35 Fuyuan 1st Road Zhancheng Community, Fuhai,Baoan District, Shenzhen, China

2.4 General Description of E.U.T.

Product Name	Redbean Pencil H1
Model No. Under Test	H1
List Model No.	H1-P
Description of Model differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in appearance and model name. (this information provided by the customer)
Rating(s)	Input: 5V⎓120mA / 5V⎓300mA Battery Capacity: 3.7VDC, 70mAh, 0.259Wh
Product Type	☐ Mobile ☒ Portable ☐ Fix Location
Test Sample No.	-1/2(Normal Sample), -2/2(Engineering Sample)
Hardware Version	RDB-H1-2401
Software Version	2.9.9.0
Remark	1) The above information are declared by the applicant, EU-LAB is not responsible for the information accuracy provided by the applicant. 2) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.5 Technical Information of E.U.T.

Network and Wireless Connectivity	Bluetooth Low Energy (BLE)

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

Technology	**Bluetooth**
Operation Mode	☒ BLE
Modulation Type	GFSK
Operating Frequency	2402-2480MHz
Transfer Rate	1 Mbps
Number of Channel	40
Antenna Type	PCB Antenna
Antenna Gain(Peak)	1.9 dBi
Remark	The above information are declared by the applicant, EU-LAB is not responsible for the information accuracy provided by the applicant.

All channels were listed on the following table:

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

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3 Test Summary

3.1 Test Standard

The tests were performed according to following standards:

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	ANSI C63.10-2020	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

Remark:
Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product maybe which result in lowering the emission/immunity should be checked to ensure compliance has been maintained.

3.2 Test Verdict

No.	Description	FCC Part No.	Channel	Verdict	Remark
1	Antenna Requirement	15.203	N/A	Pass	Note [1]
2	Conducted Emission at AC Power Line	15.207	Low/Middle/High	Pass	--
3	Occupied Bandwidth	15.247(a)(2)	Low/Middle/High	Pass	--
4	Maximum Conducted Output Power	15.247(b)(3)	Low/Middle/High	Pass	--
5	Power spectral density (PSD)	15.247(e)	Low/Middle/High	Pass	--
6	Emissions in Non-restricted Frequency Bands (Conducted)	15.247(d)	Low/Middle/High	Pass	--
7	Band Edge Emissions (Restricted frequency bands)	15.209 15.247(d)	Low/High	Pass	--
8	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	Pass	--
Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.					

3.3 Test Laboratory

Test Laboratory	Shenzhen EU Testing Laboratory Limited
Address	101, Building B1, Fuqiao Fourth Area, Qiaotou Community, Fuhai Subdistrict, Baoan District, Shenzhen, Guangdong, China
Designation Number	CN1368
Test Firm Registration Number	952583

4 Test Configuration

4.1 Test Environment

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

Relative Humidity	30% to 60%	
Atmospheric Pressure	86 kPa to 106 kPa	
Temperature	NT (Normal Temperature)	+15℃ to +35℃
Working Voltage of the EUT	NV (Normal Voltage)	AC 120V, 60Hz for adapter 3.7VDC battery inside

4.2 Test Equipment

Conducted Emission at AC power line					
Equipment	**Manufacturer**	**Model No**	**Serial No**	**Cal. Date**	**Cal. Due Date**
L.I.S.N. Artificial Mains Network	Rohde & Schwarz	ENV216	EE-004	2024/01/09	2025/01/08
EMI Test Receiver	Rohde & Schwarz	ESCI	EE-005	2024/01/09	2025/01/08
Test Software	Farad	EZ-EMC	EE-014	N.C.R	N.C.R

Radiated Emission and RF Test					
Equipment	**Manufacturer**	**Model No**	**Serial No**	**Cal Date**	**Cal Due Date**
EMI Test Receiver	ROHDE & SCHWARZ	ESPI	EE-006	2024/01/09	2025/01/08
Bilog Broadband Antenna	SCHWARZBECK	VULB 9163	EE-007	2023/01/14	2026/01/13
Double Ridged Horn Antenna	A-INFOMW	LB-10180-NF	EE-008	2023/01/12	2026/01/11
Pre-amplifier	Agilent	8447D	EE-009	2024/01/09	2025/01/08
Pre-amplifier	Agilent	8449B	EE-010	2024/01/09	2025/01/08
MXA Signal Analyzer	Agilent	N9020A	EE-011	2024/01/09	2025/01/08
MXG RF Vector Signal Generator	Agilent	N5182A	EE-012	2024/01/09	2025/01/08
Test Software	Farad	EZ-EMC	EE-015	N.C.R	N.C.R
MIMO Power Measurement Module	TSTPASS	TSPS 2023R	EE-016	2024/01/09	2025/01/08
RF Test Software	TSTPASS	TS32893 V2.0	EE-017	N.C.R	N.C.R
Antenna Mast	TOP Precision	TPBAM-4	EE-306	N.C.R	N.C.R
Wideband Radio Communication Tester	ROHDE & SCHWARZ	CMW500	EE-402	2024/02/15	2025/02/14
Loop Antenna	TESEQ	HLA6121	EE-403	2024/02/15	2025/02/14
MXG RF Analog Signal Generator	Agilent	N5181A	EE-406	2024/02/15	2025/02/14
DRG Horn Antenna	SCHWARZBECK	BBHA 9170	EE-410	2024/02/15	2025/02/14
Pre-amplifier	SKET	LNPA-1840-50	EE-411	2024/02/15	2025/02/14
Constant Temperature Humidity Chamber	Guangxin	GXP-401	ES-002	2024/07/30	2025/07/29

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4.3 Description of Support Unit

No.	Title	Manufacturer	Model No.	Serial No.
1	Adapter	Apple	A1443	EMC-PJ-001

4.4 Test Mode

No.	Test Modes	Description
TM1	TX-GFSK-1M	Keep the EUT connect to AC power line and works in continuously transmitting mode with GFSK modulation with 1 Mbps rate.
TM2	TX-GFSK-2M	Keep the EUT connect to AC power line and works in continuously transmitting mode with GFSK modulation with 2 Mbps rate.

4.5 Description of Calculation

4.5.1. 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 (dBuV/m) = RA (dBuV) + AF (dB/m) + CL (dB) – AG (dB)

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

4.5.2. Disturbance Calculation

The AC mains conducted disturbance is calculated by adding the 10dB Pulse Limiter and Cable Factor and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

CD (dBuV) = RA (dBuV) + PL (dB) + CL (dB)

Where	CD = Conducted Disturbance	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	PL = 10 dB Pulse Limiter Factor

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4.6 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.

Test Item	Measurement Uncertainty
Conducted Emission	2.64 dB
Occupied Channel Bandwidth	2.8 %
RF output power, conducted	0.68 dB
Power Spectral Density, conducted	1.37 dB
Unwanted Emissions, conducted	1.84 dB
Radiated Emission (30MHz- 1GHz)	Ur = 2.70 dB (Horizontal)
	Ur = 2.70 dB (Vertical)
Radiated Emission (1GHz- 18GHz)	Ur = 3.50 dB (Horizontal)
	Ur = 3.50 dB (Vertical)
Radiated Emission (18GHz- 40GHz)	Ur = 5.15 dB (Horizontal)
	Ur = 5.24 dB (Vertical)
Temperature	0.8°C
Humidity	4%

4.7 Deviation from Standards

None.

4.8 Abnormalities from Standard Condition

None.

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5 Test Items

5.1 Antenna requirement

5.1.1 Test Requirement

Test Requirement	According to FCC §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. 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.

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5.2 Conducted Emission at AC Power Line

5.2.1 Test Requirement

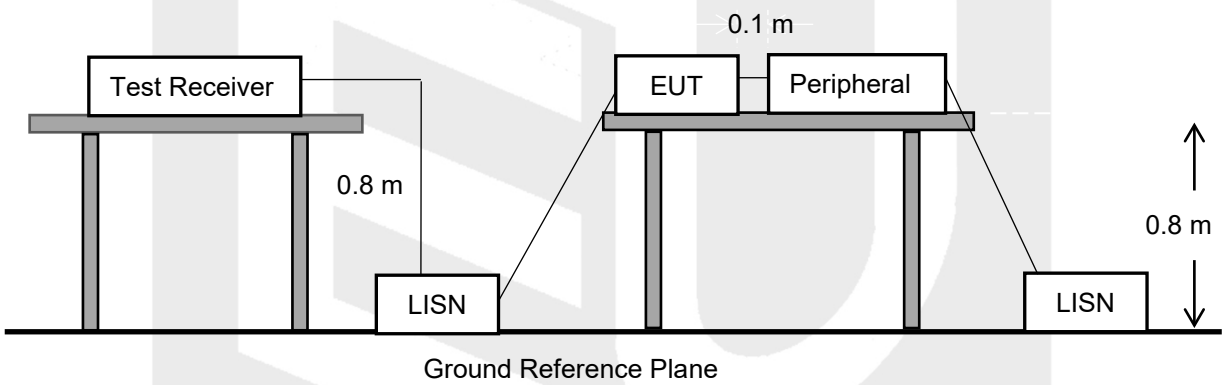
Test Requirement	Except as shown in paragraphs (b)and (c)of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).
Test Limit	

Frequency of emission (MHz)	Conducted limit (dBμV)	
	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 Method	ANSI C63.10-2020 section 6.2

5.2.2 Test Setup Diagram



5.2.3 Test Procedure

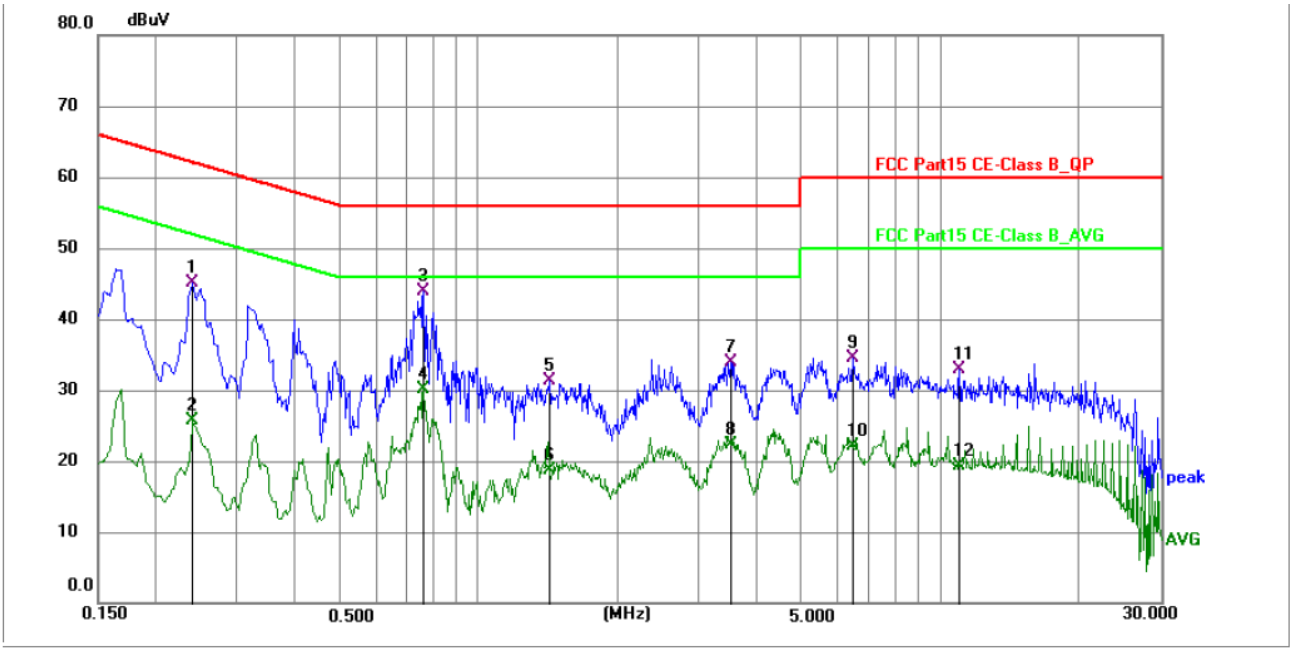
The EUT is put on the plane 0.8 m high above the ground by insulating support and connected to the AC mains through Line Impedance Stability Network (L.I.S.N). This provided a 50ohm coupling impedance for the tested equipment. Both sides of AC line are investigated to find out the maximum conducted emission according to the test standard regulations during conducted emission measurement.
The bandwidth of the field strength meter (R&S Test Receiver ESCI) is set at 9kHz in 150kHz~30MHz.
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.

5.2.4 Test Data

PASS.
Only the worst case data was showed in the report, please to see the following pages.

Conducted Emission Test Data

Test Site:	Shielded Room #1
Test Mode:	TM1/ CH Middle
Comments:	Live Line



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.2400	35.05	9.97	45.02	62.10	-17.08	QP	P	
2	0.2400	15.69	9.97	25.66	52.10	-26.44	AVG	P	
3 *	0.7620	33.79	10.04	43.83	56.00	-12.17	QP	P	
4	0.7620	20.03	10.04	30.07	46.00	-15.93	AVG	P	
5	1.4280	21.20	10.03	31.23	56.00	-24.77	QP	P	
6	1.4280	8.76	10.03	18.79	46.00	-27.21	AVG	P	
7	3.5250	23.84	10.05	33.89	56.00	-22.11	QP	P	
8	3.5250	12.21	10.05	22.26	46.00	-23.74	AVG	P	
9	6.4770	24.47	10.01	34.48	60.00	-25.52	QP	P	
10	6.4770	12.05	10.01	22.06	50.00	-27.94	AVG	P	
11	10.9995	22.87	9.96	32.83	60.00	-27.17	QP	P	
12	10.9995	9.35	9.96	19.31	50.00	-30.69	AVG	P	

Note: Level = Reading + Factor Margin = Level - Limit

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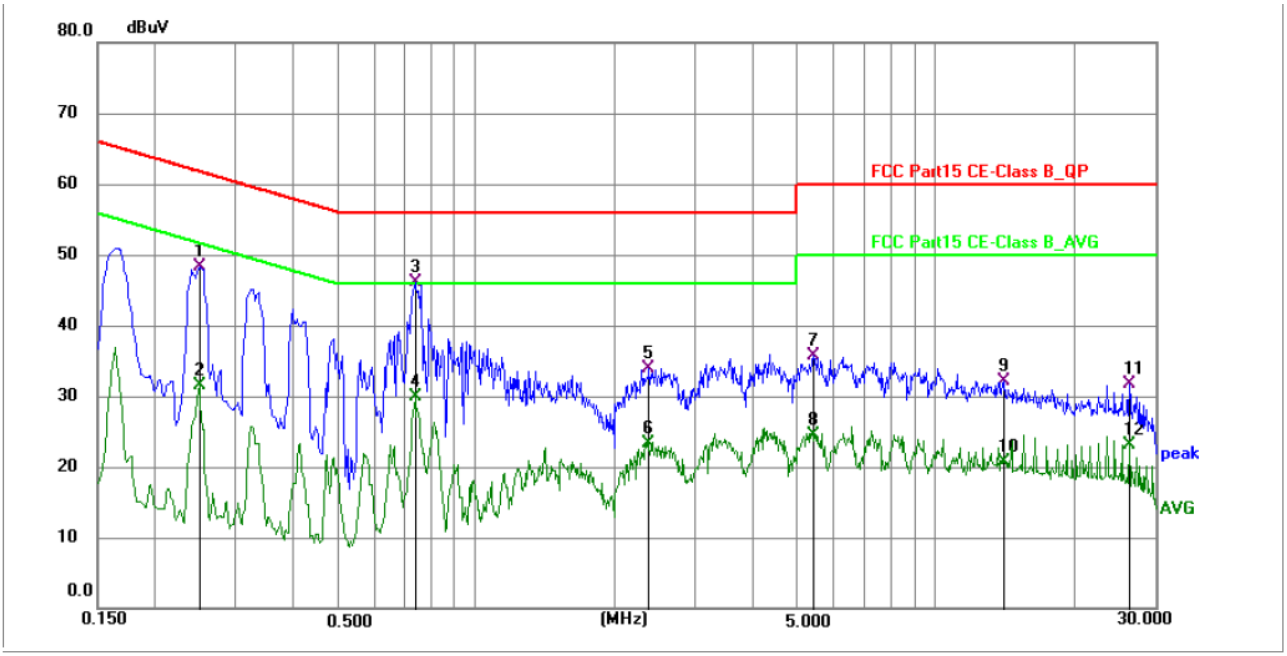
Conducted Emission Test Data

Test Site:	Shielded Room #1
Test Mode:	TM1/ CH Middle
Comments:	Neutral Line



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.2490	38.29	10.00	48.29	61.79	-13.50	QP	P	
2	0.2490	21.47	10.00	31.47	51.79	-20.32	AVG	P	
3 *	0.7350	36.04	10.06	46.10	56.00	-9.90	QP	P	
4	0.7350	19.85	10.06	29.91	46.00	-16.09	AVG	P	
5	2.3775	23.78	10.06	33.84	56.00	-22.16	QP	P	
6	2.3775	13.24	10.06	23.30	46.00	-22.70	AVG	P	
7	5.3970	25.69	10.05	35.74	60.00	-24.26	QP	P	
8	5.3970	14.45	10.05	24.50	50.00	-25.50	AVG	P	
9	14.1225	22.09	9.99	32.08	60.00	-27.92	QP	P	
10	14.1225	10.74	9.99	20.73	50.00	-29.27	AVG	P	
11	26.3625	21.50	10.18	31.68	60.00	-28.32	QP	P	
12	26.3625	12.97	10.18	23.15	50.00	-26.85	AVG	P	

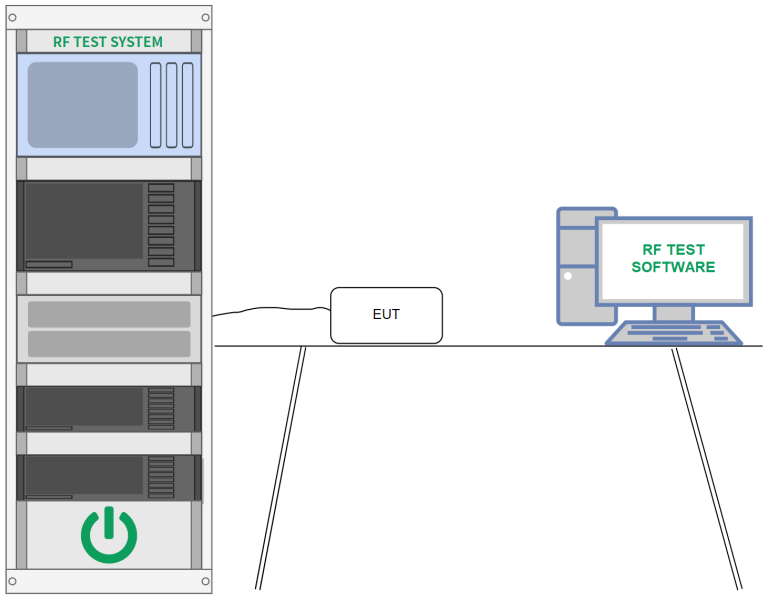
Note: Level = Reading + Factor Margin = Level - Limit

5.3 DTS Bandwidth

5.3.1 Test Requirement

Test Requirement	Systems using digital modulation techniques may operate in the 902-928 MHz, and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
Test Method	ANSI C63.10-2020 section 11.8

5.3.2 Test Setup Diagram



5.3.3 Test Procedure

a) Set RBW = shall be in the range of 1% to 5% of the OBW but not less than 100 kHz.
b) Set the VBW >= [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) 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 Data

PASS.

Please refer to Annex D for details.

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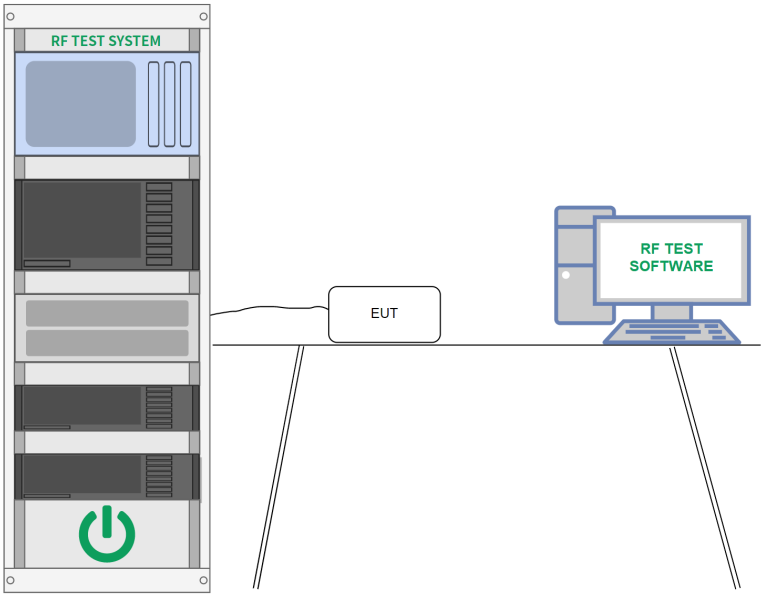
5.4 Maximum Conducted Output Power

5.4.1 Test Requirement

Test Requirement	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. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
Test Method	ANSI C63.10-2020 section 11.9

5.4.2 Test Setup Diagram



5.4.3 Test Procedure

Maximum peak conducted output power

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

Maximum conducted (average) output power (Reporting Only)

a) As an alternative to spectrum analyzer or EMI receiver measurements, measurements may be performed

using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

1) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.

2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.

3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

b) If the transmitter does not transmit continuously, measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.

c) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

d) Adjust the measurement in dBm by adding 10log (1/x), where x is the duty cycle to the measurement result.

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.)

5.4.4 Test Data

PASS.

Please refer to Annex D for details.

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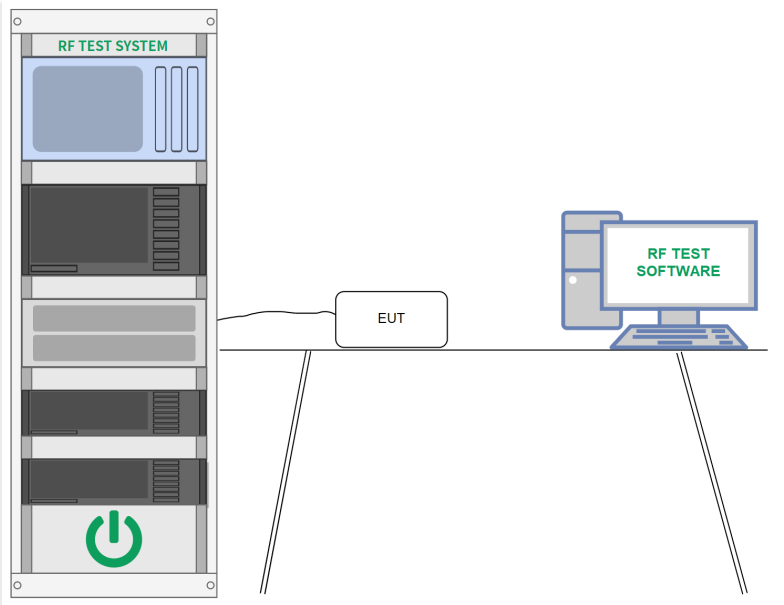
5.5 Power Spectral Density

5.5.1 Test Requirement

Test Requirement	For digitally modulated systems, the power spectral density conducted from the intentional radiator 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 paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.
Test Method	ANSI C63.10-2020 section 11.10

5.5.2 Test Setup Diagram



5.5.3 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.

5.5.4 Test Data

PASS.
Please refer to Annex D for details.

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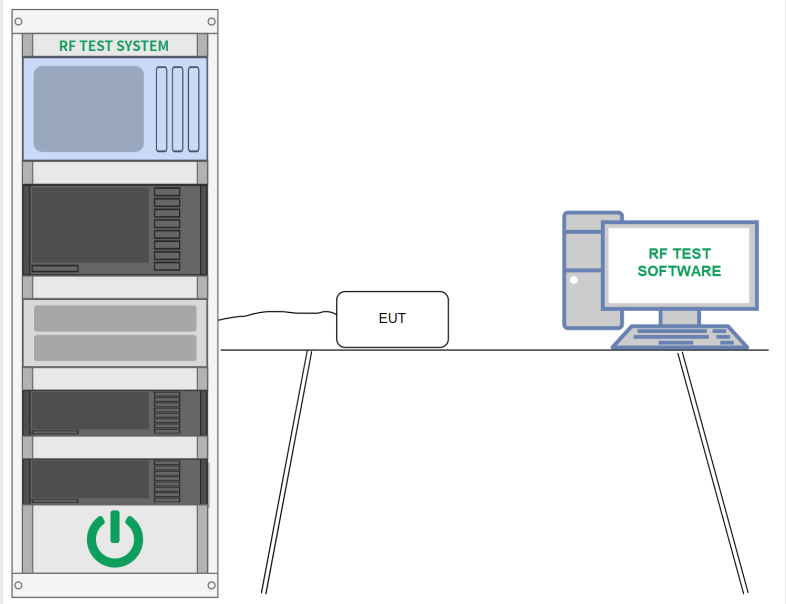
5.6 Emissions in Non-restricted Frequency Bands (Conducted)

5.6.1 Test Requirement

Test Requirement	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.
Test Method	ANSI C63.10-2020 section 11.11

5.6.2 Test Setup Diagram



5.6.3 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.
Standard method(The 99% OBW of the fundamental emission is without 2 MHz of the authorized band):
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 that fall outside of the authorized band of operation.
Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
Attenuation: Auto (at least 10 dB preferred).
Sweep time: Coupled.
Resolution bandwidth: 100 kHz.
Video bandwidth: 300 kHz.
Detector: Peak.
Trace: Max hold.

5.6.4 Test Data

PASS.

Please refer to Annex D for details.

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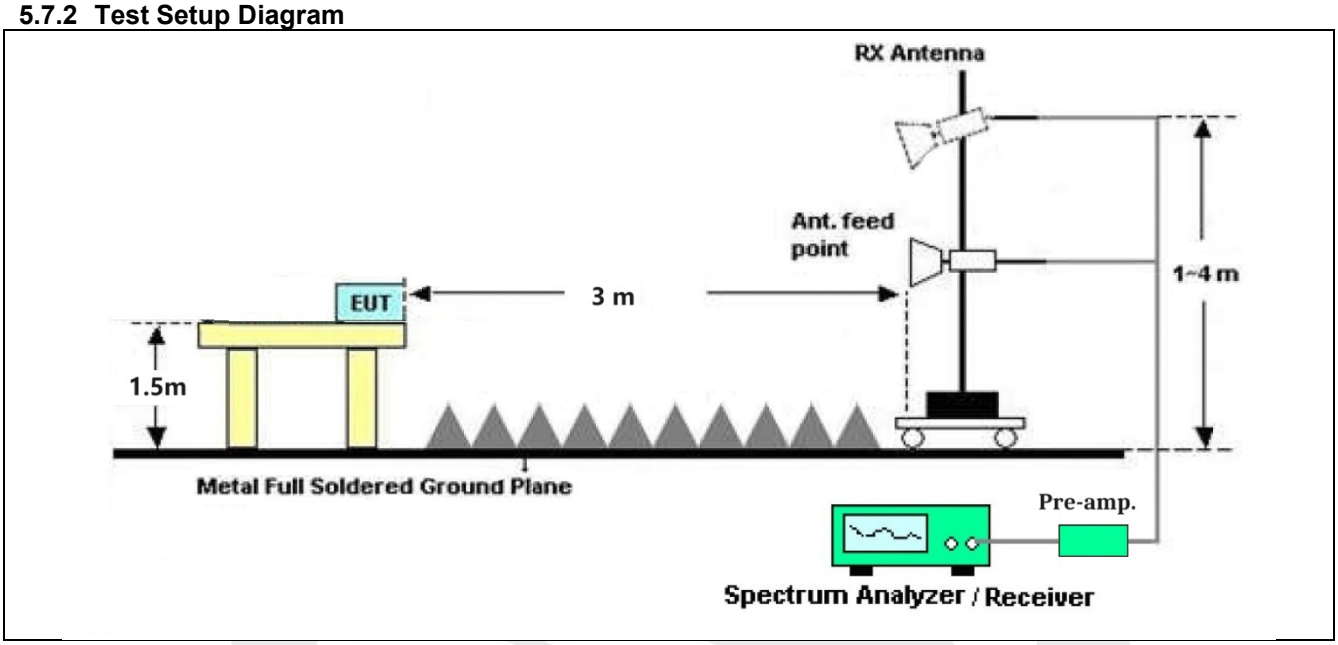
5.7 Band Edge Emissions (Restricted frequency bands)

5.7.1 Test Requirement

<table>
<tr><td>Test Requirement</td><td>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)).</td></tr>
<tr><td>Test Limit</td><td>
<table>
<tr><th>Frequency (MHz)</th><th>Field strength (microvolts/meter)</th><th>Measurement distance (meters)</th></tr>
<tr><td>0.009-0.490</td><td>2400/F(kHz)</td><td>300</td></tr>
<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

Restricted frequency bands:
<table>
<tr><th>MHz</th><th>MHz</th><th>MHz</th><th>GHz</th></tr>
<tr><td>0.090-0.110</td><td>16.42-16.423</td><td>399.9-410</td><td>4.5-5.15</td></tr>
<tr><td>0.495-0.505</td><td>16.69475-16.69525</td><td>608-614</td><td>5.35-5.46</td></tr>
<tr><td>2.1735-2.1905</td><td>16.80425-16.80475</td><td>960-1240</td><td>7.25-7.75</td></tr>
<tr><td>4.125-4.128</td><td>25.5-25.67</td><td>1300-1427</td><td>8.025-8.5</td></tr>
<tr><td>4.17725-4.17775</td><td>37.5-38.25</td><td>1435-1626.5</td><td>9.0-9.2</td></tr>
<tr><td>4.20725-4.20775</td><td>73-74.6</td><td>1645.5-1646.5</td><td>9.3-9.5</td></tr>
<tr><td>6.215-6.218</td><td>74.8-75.2</td><td>1660-1710</td><td>10.6-12.7</td></tr>
<tr><td>6.26775-6.26825</td><td>108-121.94</td><td>1718.8-1722.2</td><td>13.25-13.4</td></tr>
<tr><td>6.31175-6.31225</td><td>123-138</td><td>2200-2300</td><td>14.47-14.5</td></tr>
<tr><td>8.291-8.294</td><td>149.9-150.05</td><td>2310-2390</td><td>15.35-16.2</td></tr>
<tr><td>8.362-8.366</td><td>156.52475-156.52525</td><td>2483.5-2500</td><td>17.7-21.4</td></tr>
<tr><td>8.37625-8.38675</td><td>156.7-156.9</td><td>2690-2900</td><td>22.01-23.12</td></tr>
<tr><td>8.41425-8.41475</td><td>162.0125-167.17</td><td>3260-3267</td><td>23.6-24.0</td></tr>
<tr><td>12.29-12.293</td><td>167.72-173.2</td><td>3332-3339</td><td>31.2-31.8</td></tr>
<tr><td>12.51975-12.52025</td><td>240-285</td><td>3345.8-3358</td><td>36.43-36.5</td></tr>
<tr><td>12.57675-12.57725</td><td>322-335.4</td><td>3600-4400</td><td></td></tr>
<tr><td>13.36-13.41</td><td></td><td></td><td></td></tr>
</table>
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).
</td></tr>
<tr><td>Test Method</td><td>ANSI C63.10-2020 section 6.6.4</td></tr>
</table>

5.7.2 Test Setup Diagram



5.7.3 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.

5.7.4 Test Data

PASS.

Please refer to the following pages.

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Band Edge Emissions (Restricted frequency bands):

Test Mode: TX-GFSK-1M					CH Low: 2402 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
H	2310.00	42.97	-2.81	40.16	74.00	-33.84	PK	PASS
H	2390.00	45.97	-2.69	43.28	74.00	-30.72	PK	PASS
H	**2400.00	61.67	-2.68	58.99	74.00	-15.01	PK	PASS
V	2310.00	43.06	-2.81	40.25	74.00	-33.75	PK	PASS
V	2390.00	47.73	-2.69	45.04	74.00	-28.96	PK	PASS
V	**2400.00	61.62	-2.68	58.94	74.00	-15.06	PK	PASS
H	2310.00	33.51	-2.81	30.70	54.00	-23.30	AV	PASS
H	2390.00	38.14	-2.69	35.45	54.00	-18.55	AV	PASS
H	**2400.00	49.32	-2.68	46.64	54.00	-7.36	AV	PASS
V	2310.00	34.16	-2.81	31.35	54.00	-22.65	AV	PASS
V	2390.00	38.09	-2.69	35.40	54.00	-18.60	AV	PASS
V	**2400.00	49.71	-2.68	47.03	54.00	-6.97	AV	PASS

Test Mode: TX-GFSK-1M					CH High: 2480 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
H	**2483.50	47.49	-2.56	44.93	74.00	-29.07	PK	PASS
H	2500.00	51.93	-2.54	49.39	74.00	-24.61	PK	PASS
V	**2483.50	47.33	-2.56	44.77	74.00	-29.23	PK	PASS
V	2500.00	51.83	-2.54	49.29	74.00	-24.71	PK	PASS
H	**2483.50	36.53	-2.56	33.97	54.00	-20.03	AV	PASS
H	2500.00	41.41	-2.54	38.87	54.00	-15.13	AV	PASS
V	**2483.50	36.17	-2.56	33.61	54.00	-20.39	AV	PASS
V	2500.00	39.69	-2.54	37.15	54.00	-16.85	AV	PASS

1. Emission Level = Reading + Factor, Margin= Emission Level – Limit.

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Band Edge Emissions (Restricted frequency bands):

Test Mode: TX-GFSK-2M					CH Low: 2402 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
H	2310.00	44.50	-2.81	41.69	74.00	-32.31	PK	PASS
H	2390.00	47.16	-2.69	44.47	74.00	-29.53	PK	PASS
H	**2400.00	63.02	-2.68	60.34	74.00	-13.66	PK	PASS
V	2310.00	43.42	-2.81	40.61	74.00	-33.39	PK	PASS
V	2390.00	47.65	-2.69	44.96	74.00	-29.04	PK	PASS
V	**2400.00	63.81	-2.68	61.13	74.00	-12.87	PK	PASS
H	2310.00	34.63	-2.81	31.82	54.00	-22.18	AV	PASS
H	2390.00	34.98	-2.69	32.29	54.00	-21.71	AV	PASS
H	**2400.00	49.18	-2.68	46.50	54.00	-7.50	AV	PASS
V	2310.00	34.16	-2.81	31.35	54.00	-22.65	AV	PASS
V	2390.00	35.20	-2.69	32.51	54.00	-21.49	AV	PASS
V	**2400.00	48.82	-2.68	46.14	54.00	-7.86	AV	PASS

Test Mode: TX-GFSK-2M					CH High: 2480 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
H	**2483.50	48.38	-2.56	45.82	74.00	-28.18	PK	PASS
H	2500.00	52.21	-2.54	49.67	74.00	-24.33	PK	PASS
V	**2483.50	48.19	-2.56	45.63	74.00	-28.37	PK	PASS
V	2500.00	49.30	-2.54	46.76	74.00	-27.24	PK	PASS
H	**2483.50	38.12	-2.56	35.56	54.00	-18.44	AV	PASS
H	2500.00	42.45	-2.54	39.91	54.00	-14.09	AV	PASS
V	**2483.50	38.01	-2.56	35.45	54.00	-18.55	AV	PASS
V	2500.00	38.76	-2.54	36.22	54.00	-17.78	AV	PASS

1. Emission Level = Reading + Factor, Margin= Emission Level – Limit.

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5.8 Radiated Spurious Emission

5.8.1 Test Requirement

<table>
<tr><td>Test Requirement</td><td>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)).</td></tr>
<tr><td>Test Limit</td><td>
<table>
<tr><th>Frequency (MHz)</th><th>Field strength (microvolts/meter)</th><th>Measurement distance (meters)</th></tr>
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<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.
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).
</td></tr>
<tr><td>Test Method</td><td>ANSI C63.10-2020 section 6.6.4</td></tr>
</table>

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5.8.2 Test Setup Diagram

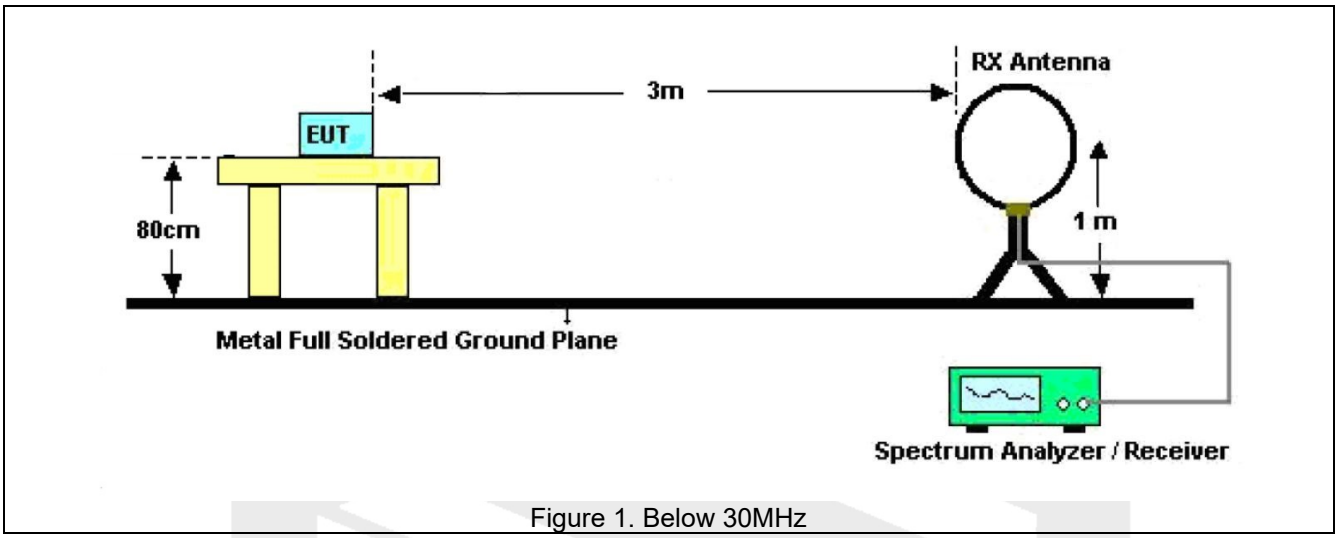

Figure 1. Below 30MHz

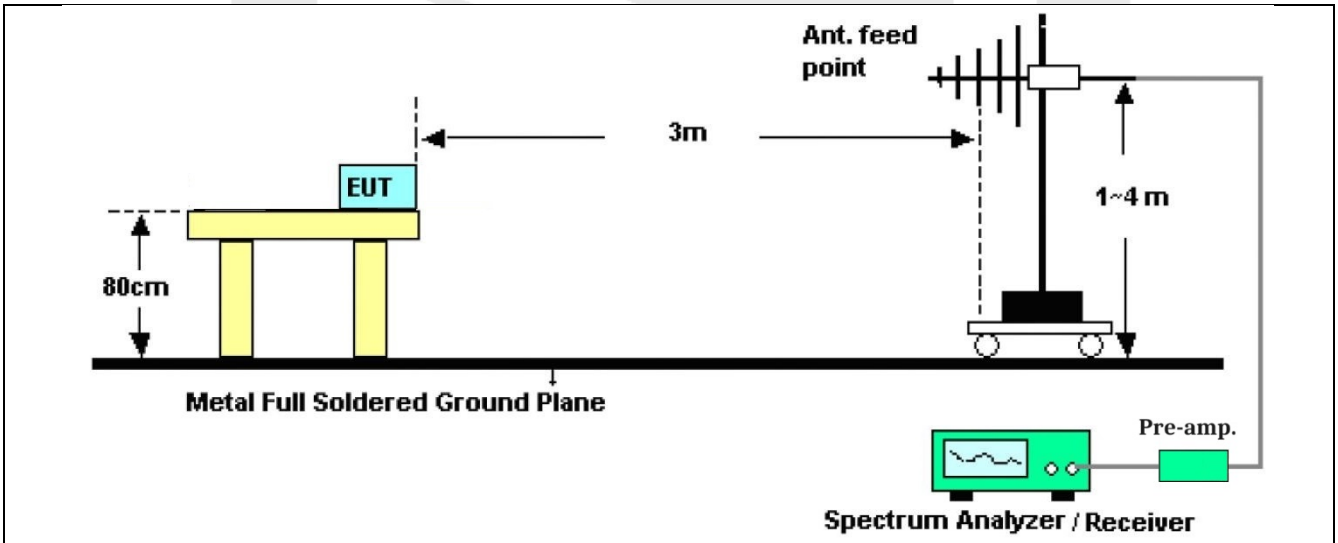

Figure 2. 30MHz to 1GHz

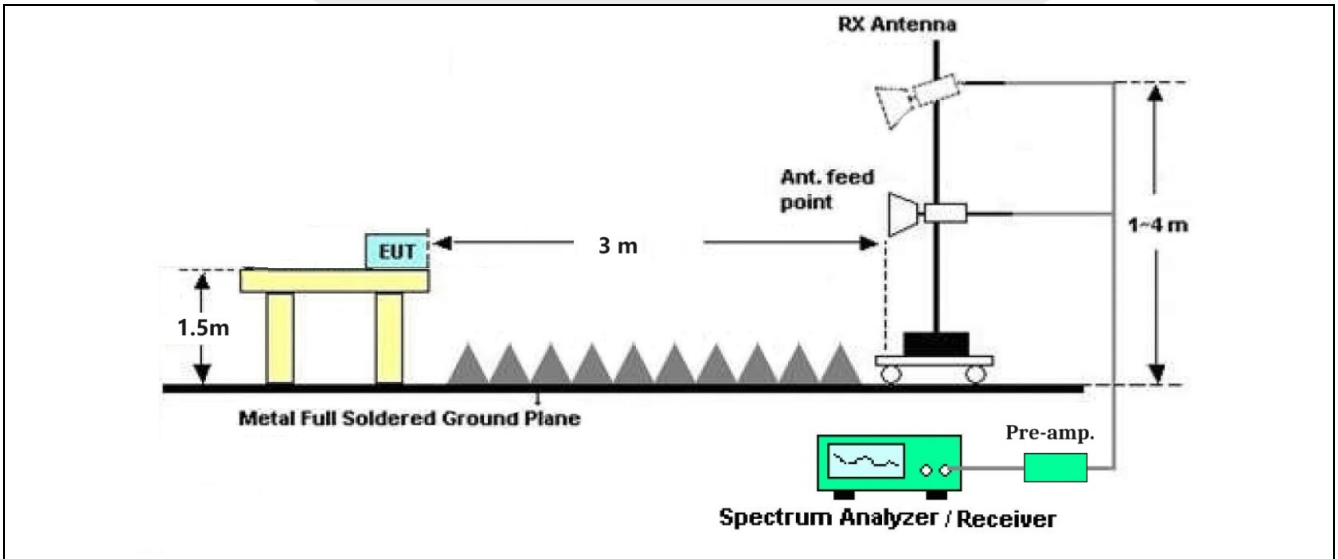

Figure 3. Above 1 GHz

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
For 9kHz to 150kHz, Set the spectrum analyzer as:
RBW = 200Hz, VBW =1kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 150kHz to 30MHz, Set the spectrum analyzer as:
RBW = 9KHz, VBW =30kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 30MHz to 1000MHz, Set the spectrum analyzer as:
RBW = 100kHz, VBW =300kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For above 1GHz, Set the spectrum analyzer as:
RBW =1MHz, VBW =1MHz, Detector= Peak, Trace mode= Max hold, Sweep- auto couple.
RBW =1MHz, VBW =10Hz, Detector= Average, Trace mode= Max hold, Sweep- auto couple.

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.

5.8.4 Test Data

PASS.

Please to see the following pages.
The test results of 9kHz-30MHz was attenuated more than 20dB below the permissible limits, so the results don't record in the report.
For test of 30MHz-1GHz, during the test, pre-scan all test modes, and found the BLE 1M mode with high channel is worse case, the report only record this mode.

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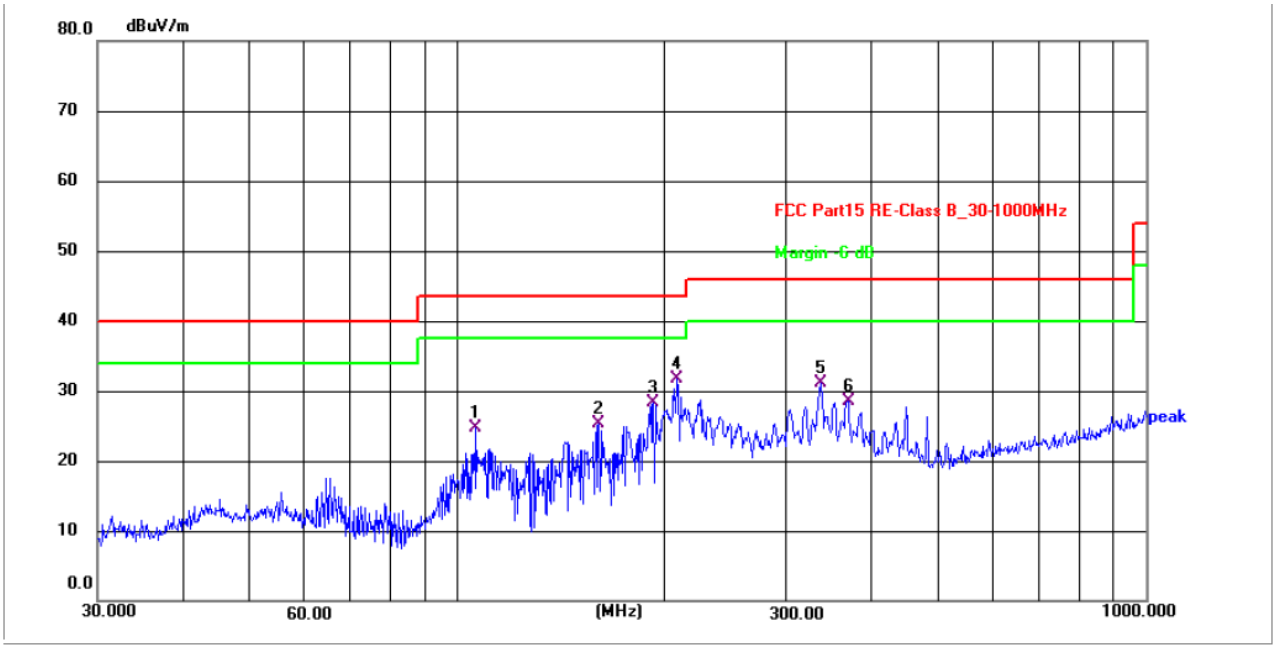
Radiated Emission Test Data (30-1000MHz)

Test Site:	**966 Chamber #1**	**Polarization:**	**Horizontal**
Distance:	**3m**	**Test Mode:**	**TM1/ CH High**



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F	Remark
1	106.3850	40.76	-16.10	24.66	43.50	-18.84	QP	P	
2	160.3456	43.35	-17.95	25.40	43.50	-18.10	QP	P	
3	192.4186	43.85	-15.62	28.23	43.50	-15.27	QP	P	
4 *	208.5803	46.44	-14.77	31.67	43.50	-11.83	QP	P	
5	337.2155	42.36	-11.19	31.17	46.00	-14.83	QP	P	
6	369.4047	39.11	-10.52	28.59	46.00	-17.41	QP	P	

Note: Level = Reading + Factor **Margin = Level - Limit**

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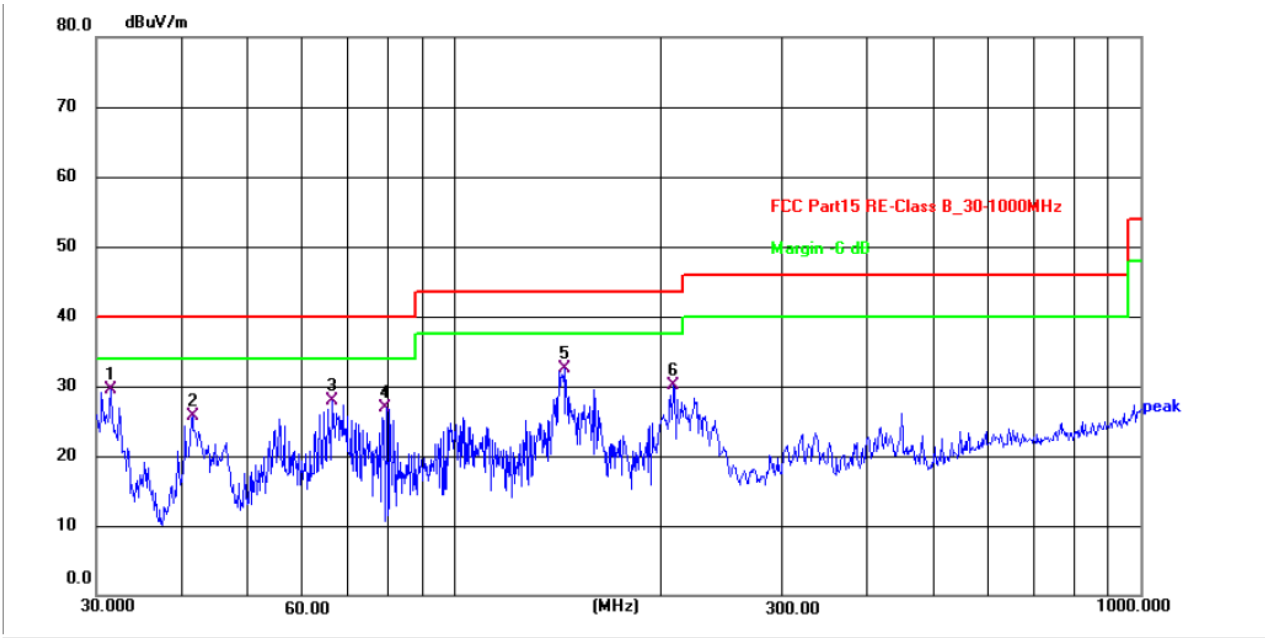
Radiated Emission Test Data (30-1000MHz)

Test Site:	**966 Chamber #1**	**Polarization:**	**Vertical**
Distance:	**3m**	**Test Mode:**	**TM1/ CH High**



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F	Remark
1 *	31.5095	46.42	-16.90	29.52	40.00	-10.48	QP	P	
2	41.4215	40.67	-14.93	25.74	40.00	-14.26	QP	P	
3	66.2662	44.51	-16.64	27.87	40.00	-12.13	QP	P	
4	79.5209	46.56	-19.62	26.94	40.00	-13.06	QP	P	
5	144.3348	50.84	-18.35	32.49	43.50	-11.01	QP	P	
6	208.5803	44.96	-14.80	30.16	43.50	-13.34	QP	P	

Note: Level = Reading + Factor **Margin = Level - Limit**

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Radiated Spurious Emission (1GHz-40GHz)

Test Mode: TX-GFSK-1M					CH Low: 2402 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
V	4804.50	42.01	4.68	46.69	74.00	-27.32	PK	PASS
V	7206.15	35.90	9.84	45.74	74.00	-28.26	PK	PASS
V	9608.40	29.79	13.17	42.96	74.00	-31.05	PK	PASS
V	12010.62	*	*	*	74.00	*	PK	PASS
V	14412.41	*	*	*	74.00	*	PK	PASS
V	16814.09	*	*	*	74.00	*	PK	PASS
H	4804.30	40.23	4.68	44.91	74.00	-29.10	PK	PASS
H	7206.63	35.70	9.84	45.54	74.00	-28.47	PK	PASS
H	9608.52	30.80	13.17	43.97	74.00	-30.03	PK	PASS
H	12010.96	*	*	*	74.00	*	PK	PASS
H	14412.15	*	*	*	74.00	*	PK	PASS
H	16814.13	*	*	*	74.00	*	PK	PASS
V	4804.07	32.47	4.68	37.15	54.00	-16.85	AV	PASS
V	7206.30	22.50	9.84	32.34	54.00	-21.66	AV	PASS
V	9608.42	19.90	13.17	33.07	54.00	-20.94	AV	PASS
V	12010.39	*	*	*	54.00	*	AV	PASS
V	14412.76	*	*	*	54.00	*	AV	PASS
V	16814.91	*	*	*	54.00	*	AV	PASS
H	4804.62	32.20	4.68	36.88	54.00	-17.13	AV	PASS
H	7206.63	24.62	9.84	34.46	54.00	-19.54	AV	PASS
H	9608.52	18.92	13.17	32.09	54.00	-21.91	AV	PASS
H	12010.96	*	*	*	54.00	*	AV	PASS
H	14412.15	*	*	*	54.00	*	AV	PASS
H	16814.13	*	*	*	54.00	*	AV	PASS

Remark:
1. Emission Level = Reading + Factor, Margin= Emission Level – Limit.
2. “*” means the test results were attenuated more than 20dB below the permissible limits, so the results don't record in the report.

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Radiated Spurious Emission (1GHz-40GHz)

Test Mode: TX-GFSK-1M					CH Middle: 2440 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
V	4880.36	42.10	4.92	47.02	74.00	-26.98	PK	PASS
V	7320.06	34.74	9.83	44.57	74.00	-29.43	PK	PASS
V	9760.99	29.82	13.22	43.04	74.00	-30.97	PK	PASS
V	12200.81	*	*	*	74.00	*	PK	PASS
V	14640.49	*	*	*	74.00	*	PK	PASS
V	17080.06	*	*	*	74.00	*	PK	PASS
H	4880.62	40.99	4.92	45.91	74.00	-28.10	PK	PASS
H	7320.87	35.53	9.83	45.36	74.00	-28.64	PK	PASS
H	9760.13	30.80	13.22	44.02	74.00	-29.99	PK	PASS
H	12200.32	*	*	*	74.00	*	PK	PASS
H	14640.17	*	*	*	74.00	*	PK	PASS
H	17080.66	*	*	*	74.00	*	PK	PASS
V	4880.19	32.98	4.92	37.90	54.00	-16.11	AV	PASS
V	7320.32	22.09	9.83	31.92	54.00	-22.09	AV	PASS
V	9760.35	18.01	13.22	31.23	54.00	-22.78	AV	PASS
V	12200.90	*	*	*	54.00	*	AV	PASS
V	14640.88	*	*	*	54.00	*	AV	PASS
V	17080.86	*	*	*	54.00	*	AV	PASS
H	4880.62	30.33	4.92	35.25	54.00	-18.76	AV	PASS
H	7320.87	24.08	9.83	33.91	54.00	-20.10	AV	PASS
H	9760.13	18.22	13.22	31.44	54.00	-22.57	AV	PASS
H	12200.32	*	*	*	54.00	*	AV	PASS
H	14640.17	*	*	*	54.00	*	AV	PASS
H	17080.66	*	*	*	54.00	*	AV	PASS

Remark:
1. Emission Level = Reading + Factor, Margin= Emission Level – Limit.
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Radiated Spurious Emission (1GHz-40GHz)

Test Mode: TX-GFSK-1M					CH High: 2480 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
V	4960.65	41.64	5.17	46.81	74.00	-27.20	PK	PASS
V	7440.51	35.71	9.83	45.54	74.00	-28.47	PK	PASS
V	9920.98	29.87	13.27	43.14	74.00	-30.86	PK	PASS
V	12400.92	*	*	*	74.00	*	PK	PASS
V	14880.99	*	*	*	74.00	*	PK	PASS
V	17360.44	*	*	*	74.00	*	PK	PASS
H	4960.50	41.21	5.17	46.38	74.00	-27.63	PK	PASS
H	7440.33	33.74	9.83	43.57	74.00	-30.43	PK	PASS
H	9920.84	30.29	13.27	43.56	74.00	-30.45	PK	PASS
H	12400.47	*	*	*	74.00	*	PK	PASS
H	14880.88	*	*	*	74.00	*	PK	PASS
H	17360.83	*	*	*	74.00	*	PK	PASS
V	4960.96	32.41	5.17	37.58	54.00	-16.42	AV	PASS
V	7440.49	23.71	9.83	33.54	54.00	-20.47	AV	PASS
V	9920.01	18.77	13.27	32.04	54.00	-21.96	AV	PASS
V	12400.22	*	*	*	54.00	*	AV	PASS
V	14880.77	*	*	*	54.00	*	AV	PASS
V	17360.79	*	*	*	54.00	*	AV	PASS
H	4960.50	30.17	5.17	35.34	54.00	-18.67	AV	PASS
H	7440.33	23.05	9.83	32.88	54.00	-21.12	AV	PASS
H	9920.84	19.14	13.27	32.41	54.00	-21.59	AV	PASS
H	12400.47	*	*	*	54.00	*	AV	PASS
H	14880.88	*	*	*	54.00	*	AV	PASS
H	17360.83	*	*	*	54.00	*	AV	PASS

Remark:
1. Emission Level = Reading + Factor, Margin= Emission Level – Limit.
2. “*” means the test results were attenuated more than 20dB below the permissible limits, so the results don't record in the report.

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ANNEX A TEST SETUP PHOTOS

Please refer to the document “8232EU120604W-AA.PDF”

ANNEX B EXTERNAL PHOTOS

Please refer to the document “8232EU120604W-AB.PDF”

ANNEX C INTERNAL PHOTOS

Please refer to the document “8232EU120604W-AC.PDF”

ANNEX D TEST DATA

Please refer to the document “8232EU120604W-AD.PDF”

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