TEST REPORT

Report No.:	8230EU011906W2
Applicant:	Guangzhou MUNBYN Information Technology Co., Ltd.
Address:	Unit L3A01-4, No. 31-6, Xicha Road, Baiyun District, Guangzhou, China
Product Name:	Thermal Label Printer
Model No.:	FM226 (refer to clause 2.4)
Trademark:	MUNBYN
FCC ID:	2BF4E-FM226
Test Standard(s):	47 CFR Part 15 Subpart C
Date of Receipt:	Jun. 19, 2024
Test Date:	Jun. 19, 2024 – Jul. 19, 2024
Date of Issue:	Jul. 31, 2024

ISSUED BY:

SHENZHEN EU TESTING LABORATORY LIMITED

SHENZHEN EU TESTING LABORATORY LIMITED APPROVED

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2 General Information

2.1 Applicant Information

Applicant	Guangzhou MUNBYN Information Technology Co., Ltd.
Address	Unit L3A01-4, No. 31-6, Xicha Road, Baiyun District, Guangzhou, China

2.2 Manufacturer Information

Manufacturer	Guangzhou MUNBYN Information Technology Co., Ltd.
Address	Unit L3A01-4, No. 31-6, Xicha Road, Baiyun District, Guangzhou, China

2.3 Factory Information

Factory	Guangzhou MUNBYN Information Technology Co., Ltd.
Address	Unit L3A01-4, No. 31-6, Xicha Road, Baiyun District, Guangzhou, China

2.4 General Description of E.U.T.

Product Name	Thermal Label Printer
Model No. Under Test	FM226
List Model No.	FM222, IMP033B, FM226B, FM220
Description of Model differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in model name. (this information provided by the customer)
Rating(s)	Input: 5V⎓ 2A Battery Capacity: 7.4VDC, 2000mAh
Product Type	☐ Mobile ☒ Portable ☐ Fix Location
Test Sample No.	-1/2(Normal Sample), -2/2(Engineering Sample)
Hardware Version	ver:2.02
Software Version	01.01.21
Remark	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 (BDR)

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

Technology	**Bluetooth**
Operation Mode	☒ BDR ☐ EDR ☐ BLE
Modulation Technology	FHSS
Modulation Type	GFSK
Operating Frequency	2402-2480MHz
Transfer Rate	DH5: 1 Mbps
Number of Channel	79
Antenna Type	PCB Antenna
Antenna Gain(Peak)	-0.49 dBi

All channel was listed on the following table:

Channel Number	Freq. (MHz)	Channel Number	Freq. (MHz)	Channel Number	Freq. (MHz)	Channel Number	Freq. (MHz)
0	**2402**	21	2423	42	2444	63	2465
1	2403	22	2424	43	2445	64	2466
2	2404	23	2425	44	2446	65	2467
3	2405	24	2426	45	2447	66	2468
4	2406	25	2427	46	2448	67	2469
5	2407	26	2428	47	2449	68	2470
6	2408	27	2429	48	2450	69	2471
7	2409	28	2430	49	2451	70	2472
8	2410	29	2431	50	2452	71	2473
9	2411	30	2432	51	2453	72	2474
10	2412	31	2433	52	2454	73	2475
11	2413	32	2434	53	2455	74	2476
12	2414	33	2435	54	2456	75	2477
13	2415	34	2436	55	2457	76	2478
14	2416	35	2437	56	2458	77	2479
15	2417	36	2438	57	2459	**78**	**2480**
16	2418	37	2439	58	2460	-	-
17	2419	38	2440	59	2461	-	-
18	2420	**39**	**2441**	60	2462	-	-
19	2421	40	2442	61	2463	-	-
20	2422	41	2443	62	2464	-	-

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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	--
2	Conducted Emission at AC Power Line	15.207	Low/Middle/High	Pass	--
3	20dB Bandwidth	15.215(c)	Low/Middle/High	Pass	--
4	Maximum Conducted Output Power	15.247(b)(1)	Low/Middle/High	Pass	--
5	Carrier Frequency Separation	15.247(a)(1)	Hopping Mode	Pass	--
6	Number of Hopping Frequencies	15.247(a)(1) (iii)	Hopping Mode	Pass	--
7	Time of Occupancy (Dwell time)	15.247(a)(1)(iii)	Hopping Mode	Pass	--
8	Emission in non-restricted frequency bands (Conducted)	15.247(d)	Hopping Mode; Low/Middle/High	Pass	--
9	Band Edge Emissions (Restricted frequency bands)	15.209 15.247(d)	Low/High	Pass	--
10	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	Pass	--

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

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
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	2023/07/31	2024/07/30
Power Sensor	ROHDE&SCHWARZN	NRP18S	ES-052	2024/02/15	2025/02/14

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4.3 Description of Support Unit

No.	Title	Manufacturer	Model No.	Serial No.
1	Adapter	MI	A232-050200U-CN2	--

4.4 Test Mode

No.	Test Modes	Description
TM1	TX-GFSK (Non-Hopping)	Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation.
TM2	TX-GFSK (Hopping)	Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation.

4.5 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%

4.6 Deviation from Standards

None.

4.7 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

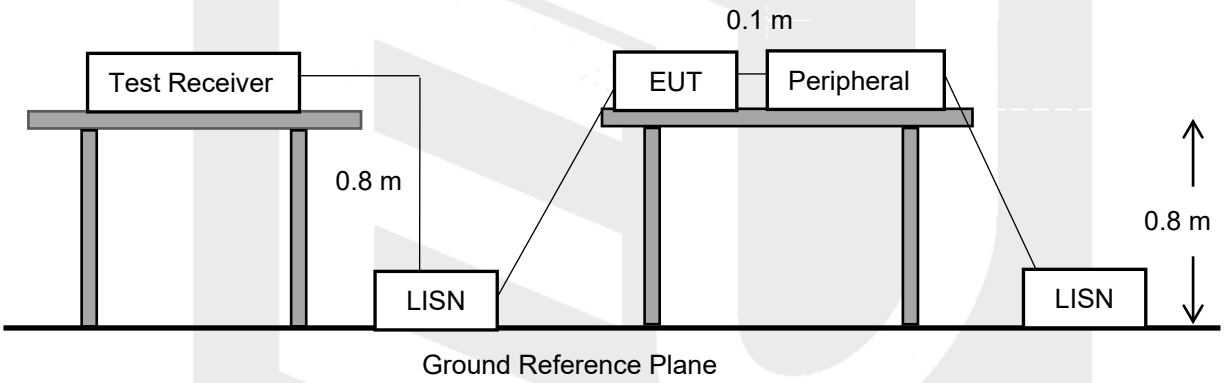
Test Requirement	Except as shown in paragraphs (b)and (c)of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 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

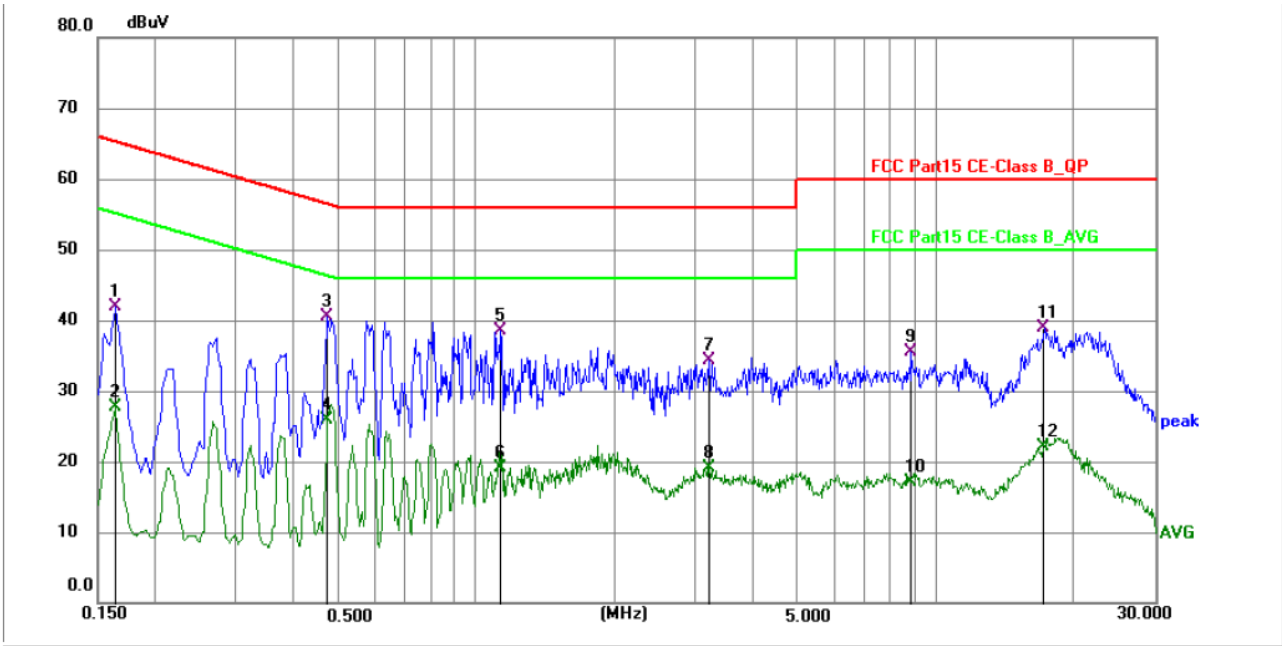
The EUT is put on the plane 0.8 m high above the ground by insulating support and connected to the AC mains through Line Impedance Stability Network (L.I.S.N). This provided a 50ohm coupling impedance for the tested equipment. Both sides of AC line are investigated to find out the maximum conducted emission 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

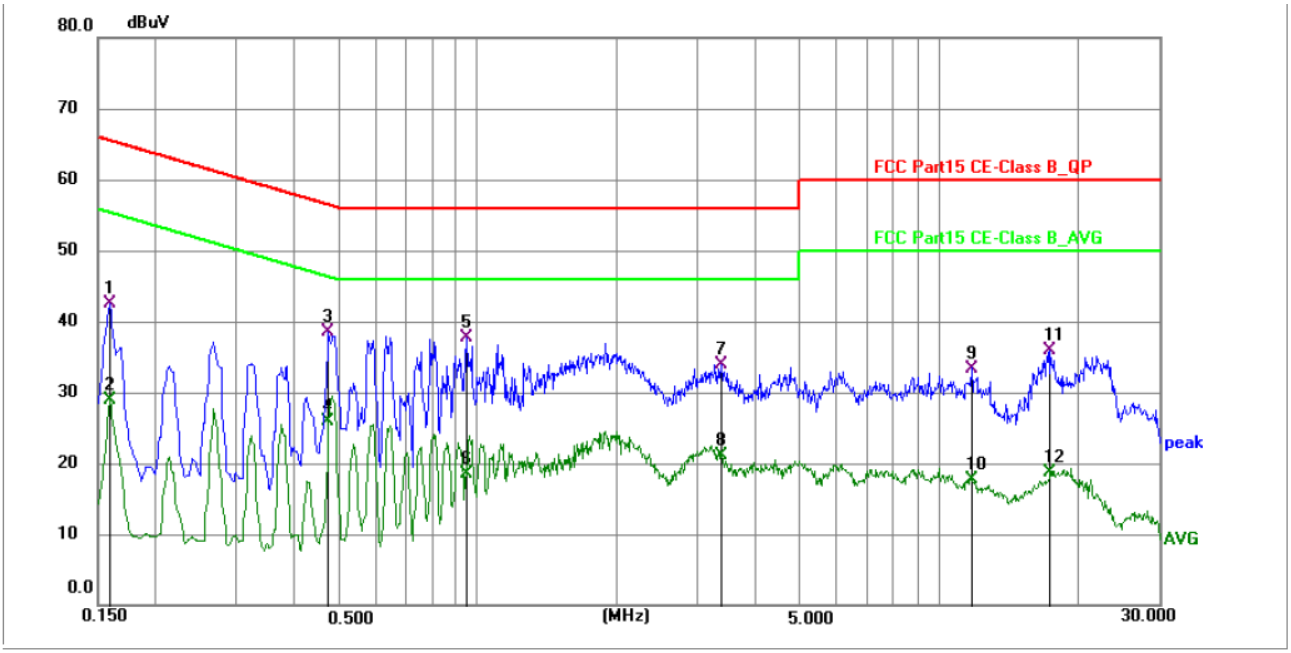


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1635	31.89	9.98	41.87	65.28	-23.41	QP	P	
2	0.1635	17.63	9.98	27.61	55.28	-27.67	AVG	P	
3 *	0.4740	30.46	10.07	40.53	56.44	-15.91	QP	P	
4	0.4740	15.91	10.07	25.98	46.44	-20.46	AVG	P	
5	1.1310	28.45	10.06	38.51	56.00	-17.49	QP	P	
6	1.1310	9.08	10.06	19.14	46.00	-26.86	AVG	P	
7	3.2190	24.30	10.04	34.34	56.00	-21.66	QP	P	
8	3.2190	9.11	10.04	19.15	46.00	-26.85	AVG	P	
9	8.8575	25.48	10.02	35.50	60.00	-24.50	QP	P	
10	8.8575	7.12	10.02	17.14	50.00	-32.86	AVG	P	
11	17.2139	28.86	10.03	38.89	60.00	-21.11	QP	P	
12	17.2139	12.04	10.03	22.07	50.00	-27.93	AVG	P	

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

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	0.1590	32.45	9.98	42.43	65.52	-23.09	QP	P	
2	0.1590	18.95	9.98	28.93	55.52	-26.59	AVG	P	
3 *	0.4740	28.41	10.07	38.48	56.44	-17.96	QP	P	
4	0.4740	15.88	10.07	25.95	46.44	-20.49	AVG	P	
5	0.9465	27.57	10.06	37.63	56.00	-18.37	QP	P	
6	0.9465	8.53	10.06	18.59	46.00	-27.41	AVG	P	
7	3.3765	23.83	10.04	33.87	56.00	-22.13	QP	P	
8	3.3765	11.12	10.04	21.16	46.00	-24.84	AVG	P	
9	11.7465	23.40	10.00	33.40	60.00	-26.60	QP	P	
10	11.7465	7.79	10.00	17.79	50.00	-32.21	AVG	P	
11	17.4345	25.89	10.03	35.92	60.00	-24.08	QP	P	
12	17.4345	8.77	10.03	18.80	50.00	-31.20	AVG	P	

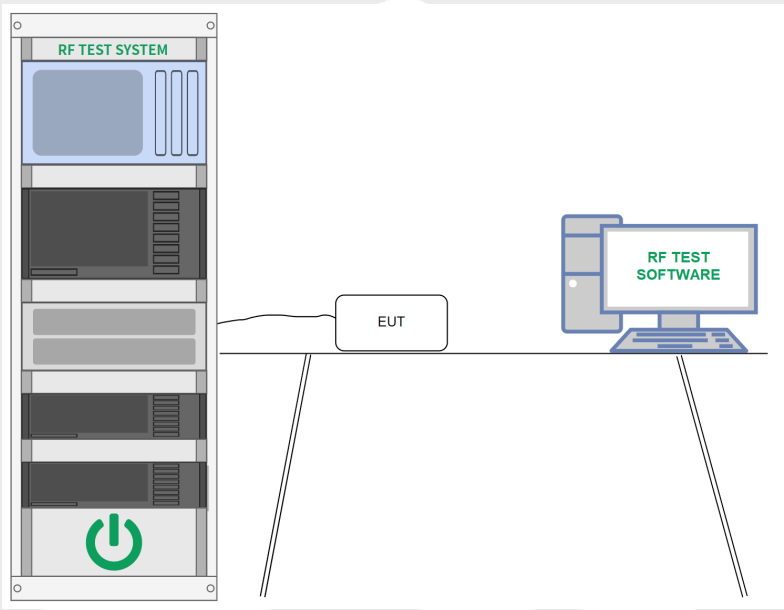
Note: Level = Reading + Factor Margin = Level - Limit

5.3 20dB Bandwidth

5.3.1 Test Requirement

Test Requirement	Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.
Test Method	ANSI C63.10-2020, section 6.9.2

5.3.2 Test Setup Diagram



5.3.3 Test Procedure

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum 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.
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the
reference value.
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "-xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "-xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
k)The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

5.3.4 Test Data

PASS.

Please refer to Annex E for details.

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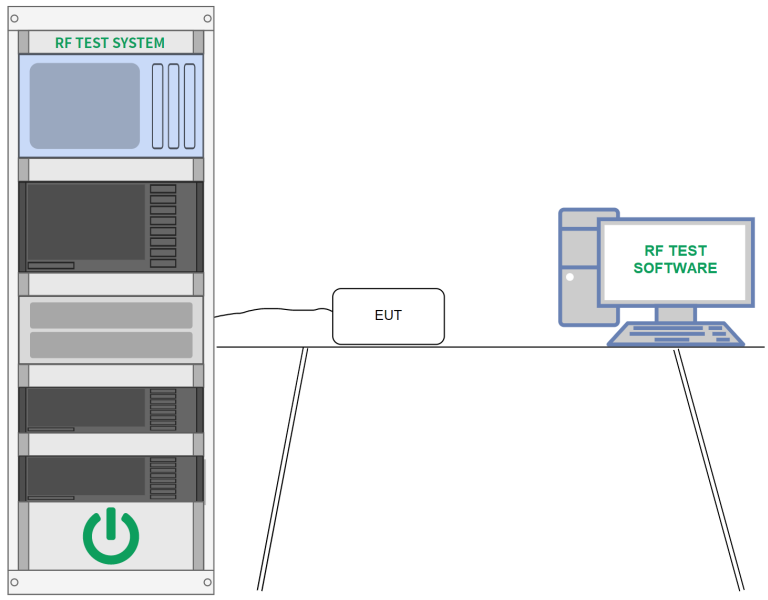
5.4 Maximum Conducted Output Power

5.4.1 Test Requirement

Test Requirement	For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
Test Method	ANSI C63.10-2020, section 7.8.5

5.4.2 Test Setup Diagram



5.4.3 Test Procedure

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW >= RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.

b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

A plot of the test results and setup description shall be included in the test report. NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

5.4.4 Test Data

PASS.

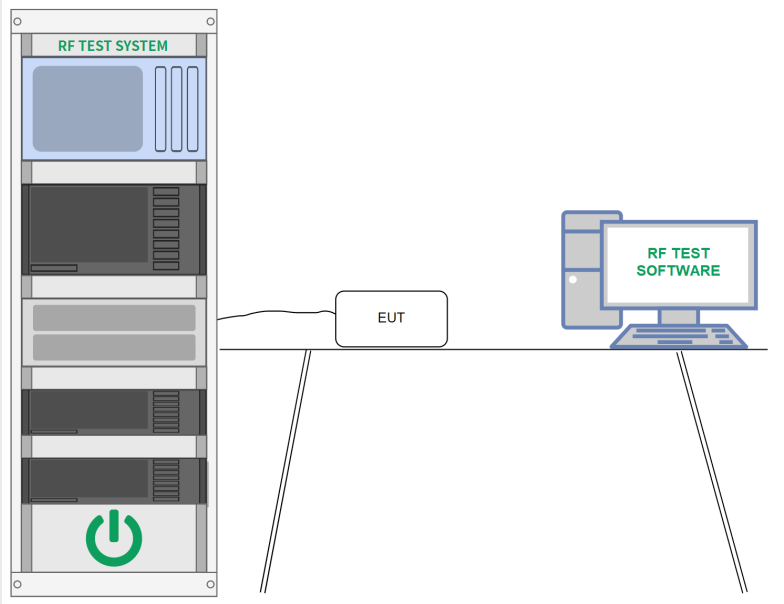
Please refer to Annex E for details.

5.5 Carrier Frequency Separation

5.5.1 Test Requirement

Test Requirement	Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
Test Method	ANSI C63.10-2020, section 7.8.2

5.5.2 Test Setup Diagram



5.5.3 Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.
Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

5.5.4 Test Data

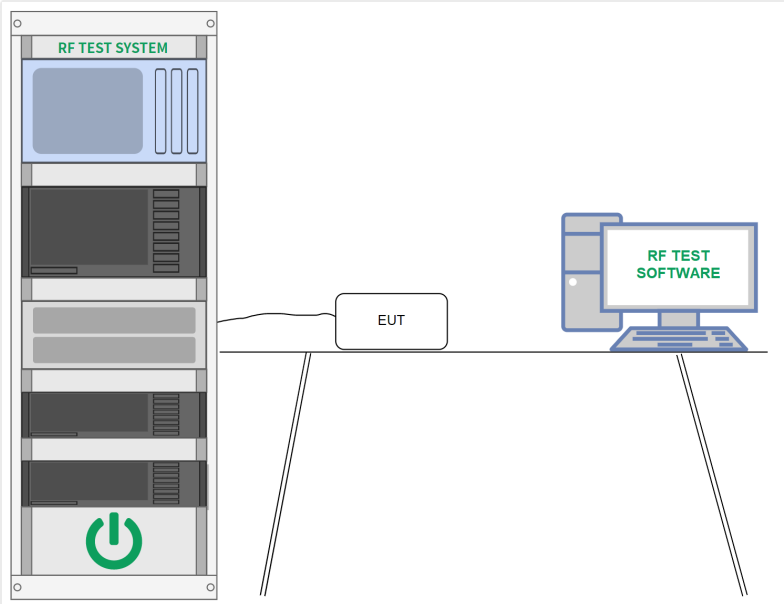
PASS.
Please refer to Annex E for details.

5.6 Number of Hopping Frequencies

5.6.1 Test Requirement

Test Requirement	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied bythe number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method	ANSI C63.10-2020, section 7.8.3

5.6.2 Test Setup Diagram



5.6.3 Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.
It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

5.6.4 Test Data

PASS.

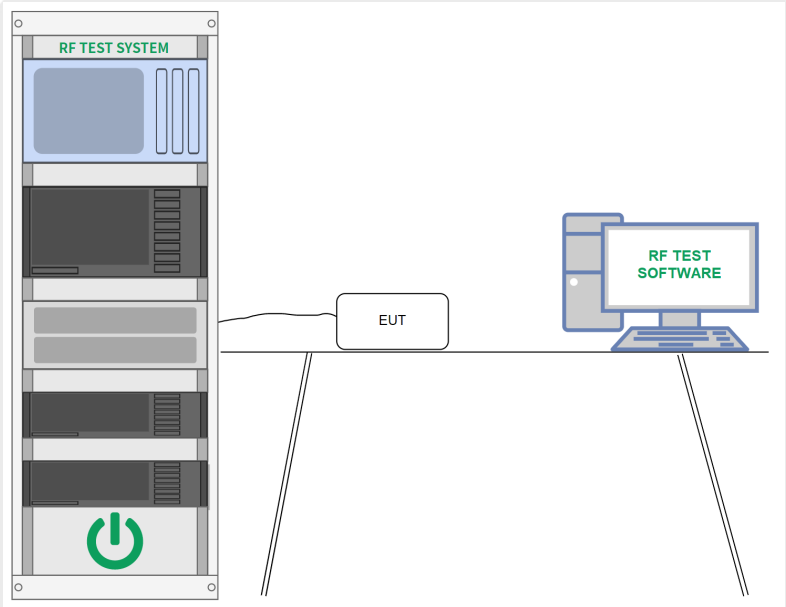
Please refer to Annex E for details.

5.7 Time of Occupancy (Dwell Time)

5.7.1 Test Requirement

Test Requirement	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method	ANSI C63.10-2020, section 7.8.4

5.7.2 Test Setup Diagram



5.7.3 Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Zero span, centered on a hopping channel.
b) RBW shall be <= channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.
Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.
Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:
(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)
The average time of occupancy is calculated from the transmit time per hop multiplied by the number of

hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

5.7.4 Test Data

PASS.

Please refer to Annex E for details.

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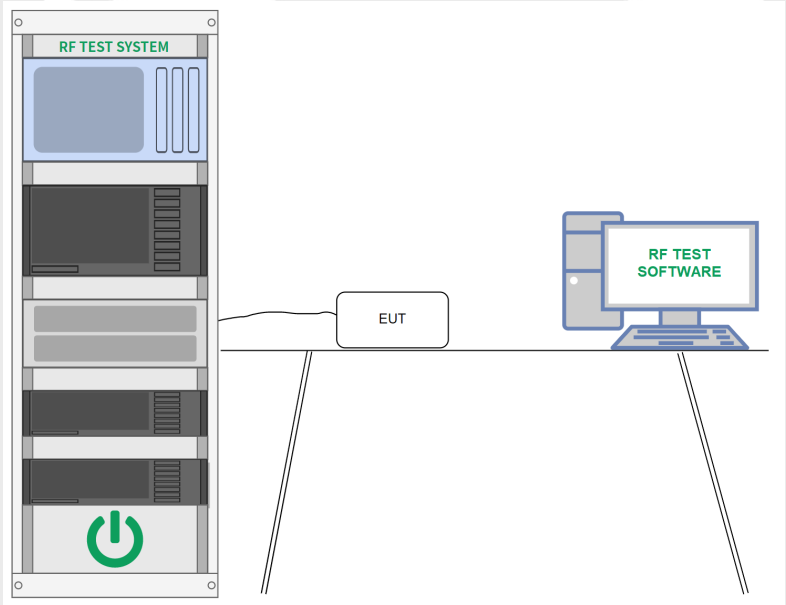
5.8 Emissions in Non-restricted Frequency Bands (Conducted)

5.8.1 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

5.8.2 Test Setup Diagram



5.8.3 Test Procedure

Conducted spurious emissions shall be measured for the transmit frequency and at the maximum transmit powers.
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW = 300 kHz
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.8.4 Test Data

PASS.
Please refer to Annex E for details.

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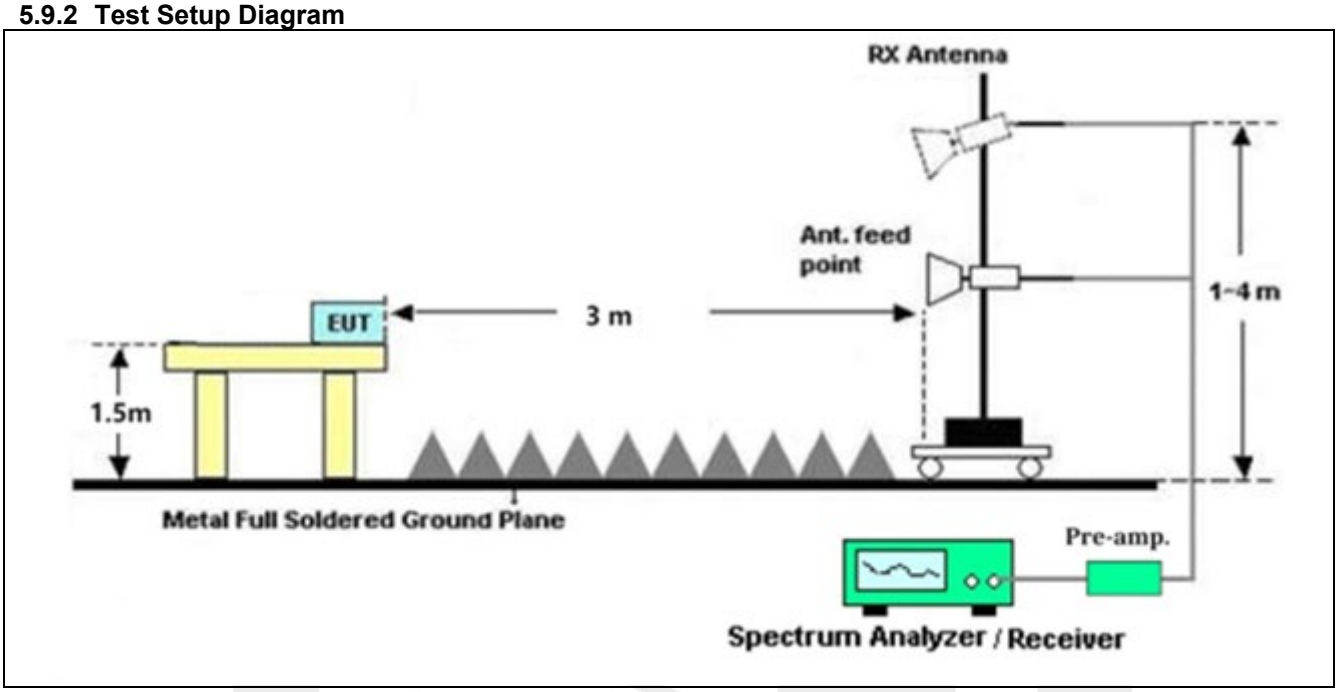
5.9 Band Edge Emissions (Restricted frequency bands)

5.9.1 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>

5.9.2 Test Setup Diagram



5.9.3 Test Procedure

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. All test modes are verified.
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
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold.

5.9.4 Test Data

PASS.

Please refer to the following pages.

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Band Edge Emissions (Restricted frequency bands):

Test Mode: GFSK					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	46.28	-2.81	43.47	74.00	-30.53	PK	PASS
H	2390.00	50.24	-2.69	47.55	74.00	-26.45	PK	PASS
H	**2400.00	62.71	-2.68	60.03	74.00	-13.97	PK	PASS
V	2310.00	45.61	-2.81	42.80	74.00	-31.20	PK	PASS
V	2390.00	48.11	-2.69	45.42	74.00	-28.58	PK	PASS
V	**2400.00	64.68	-2.68	62.00	74.00	-12.00	PK	PASS
H	2310.00	35.10	-2.81	32.29	54.00	-21.71	AV	PASS
H	2390.00	36.71	-2.69	34.02	54.00	-19.98	AV	PASS
H	**2400.00	47.89	-2.68	45.21	54.00	-8.79	AV	PASS
V	2310.00	35.45	-2.81	32.64	54.00	-21.36	AV	PASS
V	2390.00	37.42	-2.69	34.73	54.00	-19.27	AV	PASS
V	**2400.00	49.87	-2.68	47.19	54.00	-6.81	AV	PASS

Test Mode: GFSK					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	47.61	-2.56	45.05	74.00	-28.95	PK	PASS
H	2500.00	49.25	-2.54	46.71	74.00	-27.29	PK	PASS
V	**2483.50	47.73	-2.56	45.17	74.00	-28.83	PK	PASS
V	2500.00	50.41	-2.54	47.87	74.00	-26.13	PK	PASS
H	**2483.50	37.16	-2.56	34.60	54.00	-19.40	AV	PASS
H	2500.00	40.20	-2.54	37.66	54.00	-16.34	AV	PASS
V	**2483.50	40.43	-2.56	37.87	54.00	-16.13	AV	PASS
V	2500.00	40.00	-2.54	37.46	54.00	-16.54	AV	PASS

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

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5.10 Radiated Spurious Emission

5.10.1 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.
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
Radiated emissions tests</td></tr>
</table>

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5.10.2Test Setup Diagram

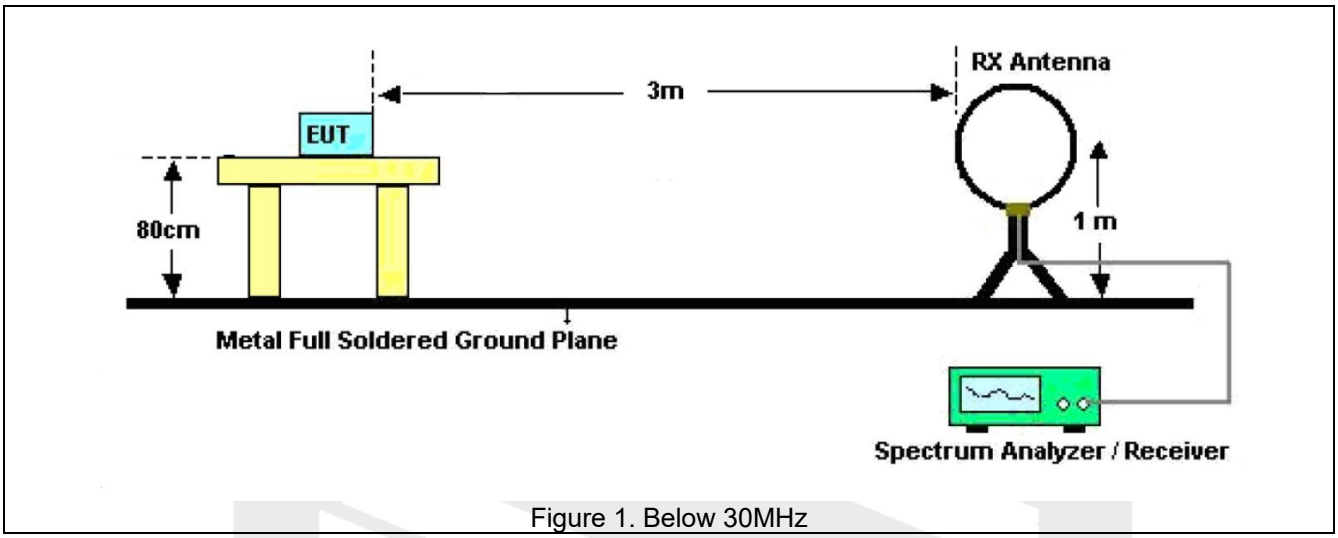

Figure 1. Below 30MHz

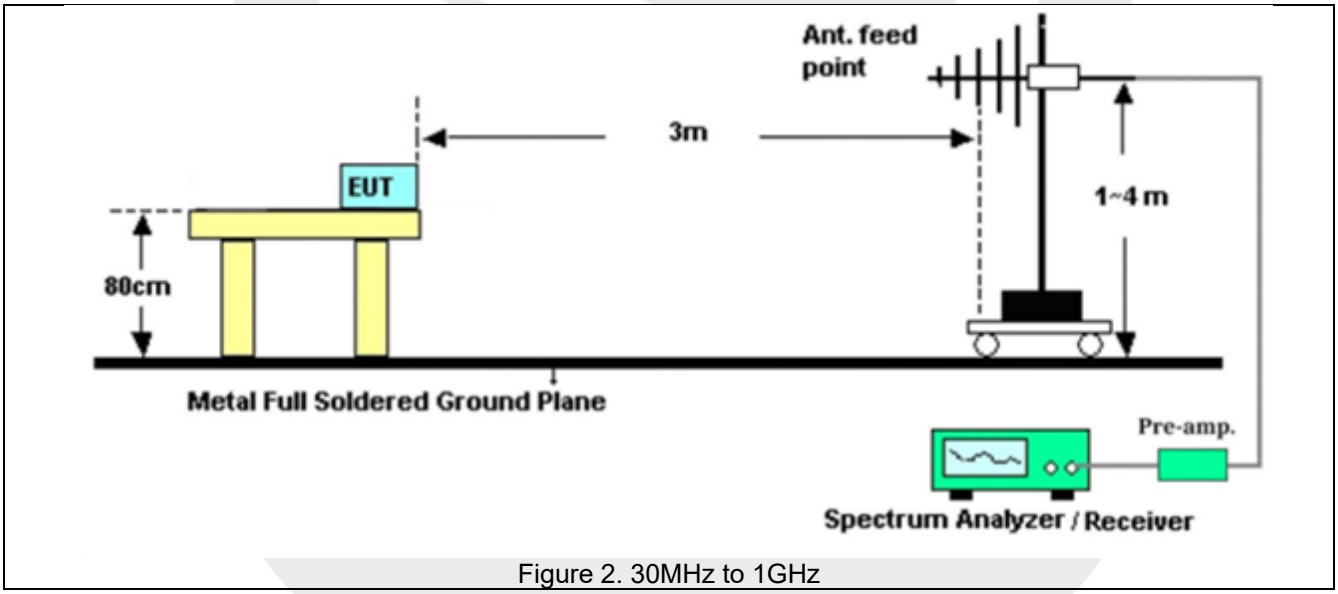

Figure 2. 30MHz to 1GHz

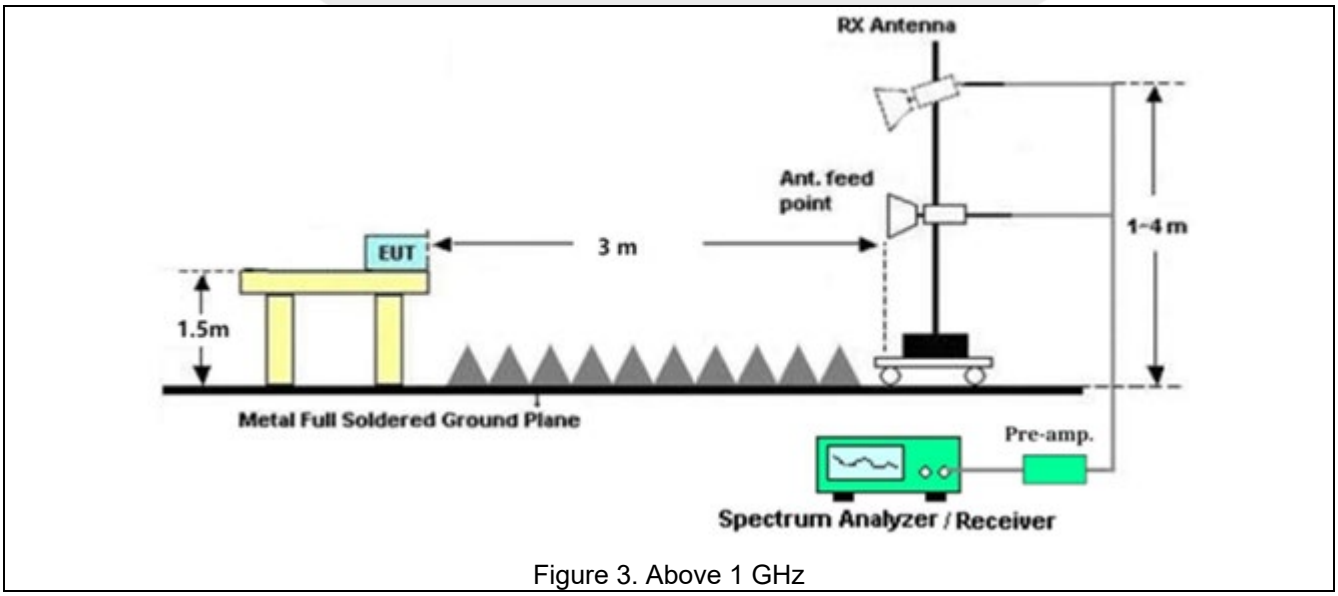

Figure 3. Above 1 GHz

5.10.3Test 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.
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.

5.10.4Test Data

PASS.

The test results of 9kHz-30MHz was attenuated more than 20dB below the permissible limits, so the results don't record in the report.
During the test, for 30MHz to 1000MHz, pre-scan the all modulation, and found the GFSK modulation Middle channel which is the worst case, only the worst case is recorded in the report.

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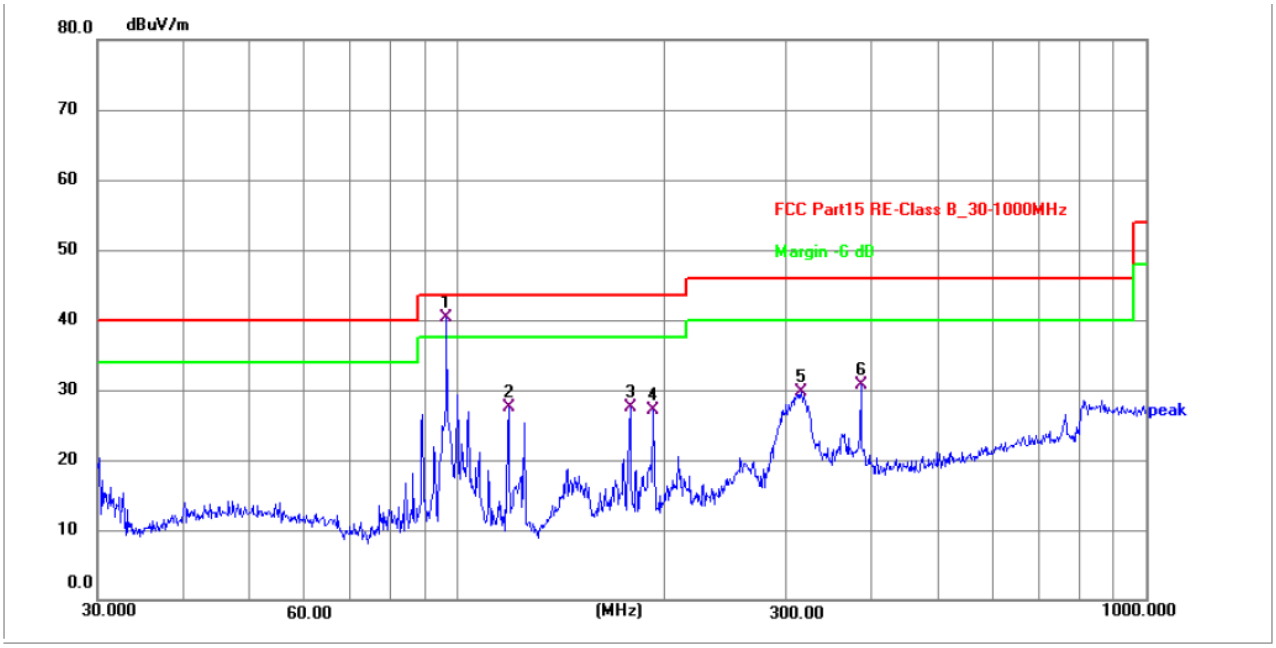
Radiated Emission Test Data (30-1000MHz)

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

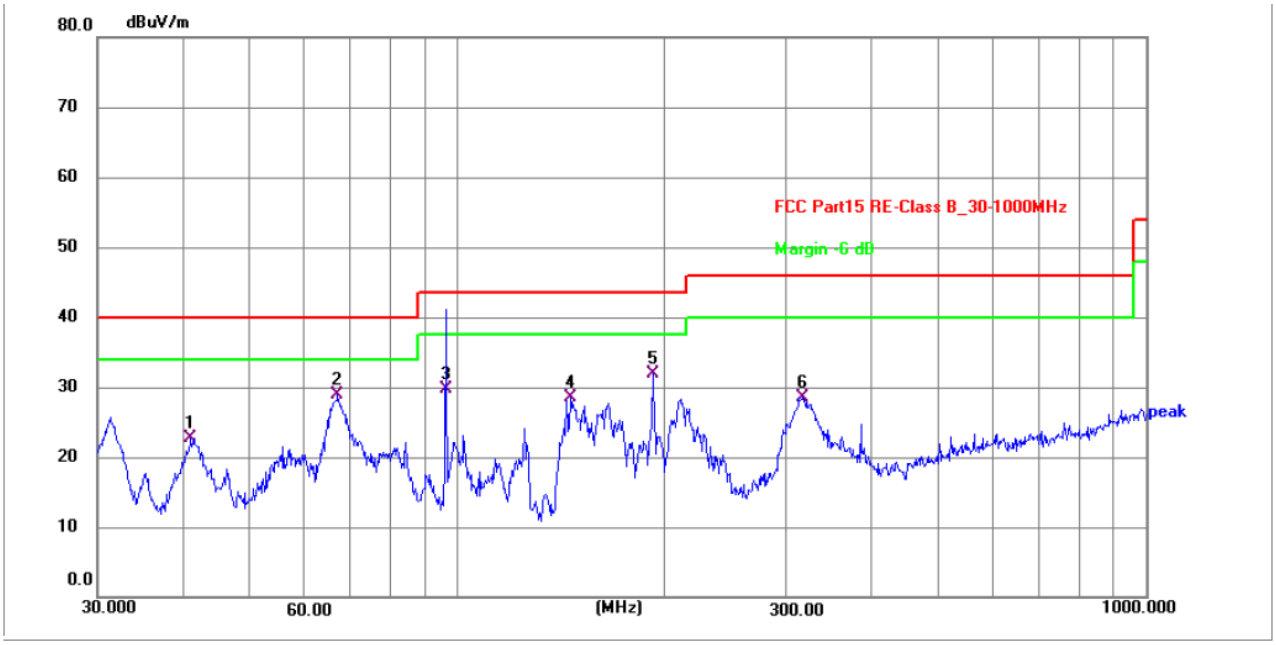


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F	Remark
1 *	96.4362	56.66	-16.43	40.23	43.50	-3.27	QP	P	
2	118.6014	44.26	-16.84	27.42	43.50	-16.08	QP	P	
3	178.1327	44.17	-16.65	27.52	43.50	-15.98	QP	P	
4	192.4186	42.69	-15.62	27.07	43.50	-16.43	QP	P	
5	315.4808	41.38	-11.66	29.72	46.00	-16.28	QP	P	
6	385.2805	40.90	-10.21	30.69	46.00	-15.31	QP	P	

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

Radiated Emission Test Data (30-1000MHz)

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



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F	Remark
1	40.9881	37.76	-15.01	22.75	40.00	-17.25	QP	P	
2 *	66.9669	45.73	-16.90	28.83	40.00	-11.17	QP	P	
3	96.0986	46.20	-16.50	29.70	43.50	-13.80	QP	P	
4	145.8611	46.90	-18.45	28.45	43.50	-15.05	QP	P	
5	192.4186	47.58	-15.62	31.96	43.50	-11.54	QP	P	
6	317.7011	40.14	-11.58	28.56	46.00	-17.44	QP	P	

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

Radiated Spurious Emission (1GHz-25GHz)

Test Mode: GFSK					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	4804.87	42.99	4.68	47.67	74.00	-26.33	PK	PASS
V	7206.40	34.22	9.84	44.06	74.00	-29.94	PK	PASS
V	9608.06	30.52	13.17	43.69	74.00	-30.32	PK	PASS
V	12010.81	*	*	*	74.00	*	PK	PASS
V	14412.29	*	*	*	74.00	*	PK	PASS
V	16814.71	*	*	*	74.00	*	PK	PASS
H	4804.48	41.58	4.68	46.26	74.00	-27.74	PK	PASS
H	7206.69	33.81	9.84	43.65	74.00	-30.35	PK	PASS
H	9608.42	29.20	13.17	42.37	74.00	-31.64	PK	PASS
H	12010.51	*	*	*	74.00	*	PK	PASS
H	14412.92	*	*	*	74.00	*	PK	PASS
H	16814.26	*	*	*	74.00	*	PK	PASS
V	4804.89	30.49	4.68	35.17	54.00	-18.84	AV	PASS
V	7206.44	23.20	9.84	33.04	54.00	-20.97	AV	PASS
V	9608.86	17.87	13.17	31.04	54.00	-22.97	AV	PASS
V	12010.32	*	*	*	54.00	*	AV	PASS
V	14412.38	*	*	*	54.00	*	AV	PASS
V	16814.81	*	*	*	54.00	*	AV	PASS
H	4804.58	30.23	4.68	34.91	54.00	-19.10	AV	PASS
H	7206.69	24.54	9.84	34.38	54.00	-19.62	AV	PASS
H	9608.42	18.96	13.17	32.13	54.00	-21.88	AV	PASS
H	12010.51	*	*	*	54.00	*	AV	PASS
H	14412.92	*	*	*	54.00	*	AV	PASS
H	16814.26	*	*	*	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-25GHz)

Test Mode: GFSK					CH Middle: 2441 MHz			
Pol.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type	Result
V	4882.94	42.18	4.92	47.10	74.00	-26.91	PK	PASS
V	7323.04	33.36	9.83	43.19	74.00	-30.81	PK	PASS
V	9764.44	29.17	13.22	42.39	74.00	-31.61	PK	PASS
V	12205.05	*	*	*	74.00	*	PK	PASS
V	14646.40	*	*	*	74.00	*	PK	PASS
V	17087.42	*	*	*	74.00	*	PK	PASS
H	4882.22	42.94	4.92	47.86	74.00	-26.15	PK	PASS
H	7323.49	35.62	9.83	45.45	74.00	-28.56	PK	PASS
H	9764.92	30.72	13.22	43.94	74.00	-30.06	PK	PASS
H	12205.45	*	*	*	74.00	*	PK	PASS
H	14646.98	*	*	*	74.00	*	PK	PASS
H	17087.93	*	*	*	74.00	*	PK	PASS
V	4882.23	32.74	4.92	37.66	54.00	-16.35	AV	PASS
V	7323.88	22.32	9.83	32.15	54.00	-21.86	AV	PASS
V	9764.53	17.66	13.22	30.88	54.00	-23.12	AV	PASS
V	12205.38	*	*	*	54.00	*	AV	PASS
V	14646.56	*	*	*	54.00	*	AV	PASS
V	17087.06	*	*	*	54.00	*	AV	PASS
H	4882.22	31.54	4.92	36.46	54.00	-17.55	AV	PASS
H	7323.49	24.71	9.83	34.54	54.00	-19.47	AV	PASS
H	9764.92	17.96	13.22	31.18	54.00	-22.82	AV	PASS
H	12205.45	*	*	*	54.00	*	AV	PASS
H	14646.98	*	*	*	54.00	*	AV	PASS
H	17087.93	*	*	*	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.

Radiated Spurious Emission (1GHz-25GHz)

Test Mode: GFSK					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	4960.43	41.14	5.17	46.31	74.00	-27.69	PK	PASS
V	7440.72	33.94	9.83	43.77	74.00	-30.24	PK	PASS
V	9920.73	29.71	13.27	42.98	74.00	-31.03	PK	PASS
V	12400.97	*	*	*	74.00	*	PK	PASS
V	14880.18	*	*	*	74.00	*	PK	PASS
V	17360.74	*	*	*	74.00	*	PK	PASS
H	4960.60	41.74	5.17	46.91	74.00	-27.09	PK	PASS
H	7440.39	33.17	9.83	43.00	74.00	-31.00	PK	PASS
H	9920.84	30.07	13.27	43.34	74.00	-30.66	PK	PASS
H	12400.23	*	*	*	74.00	*	PK	PASS
H	14880.90	*	*	*	74.00	*	PK	PASS
H	17360.44	*	*	*	74.00	*	PK	PASS
V	4961.00	30.24	5.17	35.41	54.00	-18.59	AV	PASS
V	7440.35	23.46	9.83	33.29	54.00	-20.71	AV	PASS
V	9920.65	18.07	13.27	31.34	54.00	-22.67	AV	PASS
V	12400.10	*	*	*	54.00	*	AV	PASS
V	14880.73	*	*	*	54.00	*	AV	PASS
V	17360.96	*	*	*	54.00	*	AV	PASS
H	4960.60	31.85	5.17	37.02	54.00	-16.98	AV	PASS
H	7440.39	23.80	9.83	33.63	54.00	-20.38	AV	PASS
H	9920.84	17.98	13.27	31.25	54.00	-22.75	AV	PASS
H	12400.23	*	*	*	54.00	*	AV	PASS
H	14880.90	*	*	*	54.00	*	AV	PASS
H	17360.44	*	*	*	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 “8230EU011906W-AA.PDF”

ANNEX B EXTERNAL PHOTOS

Please refer to the document “8230EU011906W-AB.PDF”

ANNEX C INTERNAL PHOTOS

Please refer to the document “8230EU011906W-AC.PDF”

ANNEX D TEST DATA

Please refer to the document “8230EU011906W-AE.PDF”

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