RF Test Report

For

Applicant Name:	Shenzhen Xinlongwei intelligent Technology Co., LTD
Address:	4 / F, Building E, Xingguang Industrial Park, Shilong Community, Shiyan Street, Baoan District, Shenzhen
EUT Name:	wristband
Brand Name:	N/A
Model Number:	LH10
Series Model Number:	LH8, LH9, LH17, LH18, LH19, LH20, LH21, LH22, LH23, LH25, LH26, LH28, LH29

Issued By

Company Name:	**BTF Testing Lab (Shenzhen) Co., Ltd.**
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Report Number:	BTF230703R00502
Test Standards:	47 CFR Part 15 Subpart C Section 15.247
FCC ID:	2BBTT-LH10
Test Conclusion:	Pass
Test Date:	2023-06-26 to 2023-07-05
Date of Issue:	2023-07-05
Prepared By:	Elma.Kang
	Elma.yang / Project Engineer
Date:	2023-07-05
Approved By:	Ryan.CJ
	Ryan.CJ / EMC Manager
Date:	2023-07-05

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Revision History		
Version	Issue Date	Revisions Content
R_V0	July 05th 2023	Original
Note:	*Once the revision has been made, then previous versions reports are invalid.*	

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1. Introduction

1.1 Identification of Testing Laboratory

Company Name:	BTF Testing Lab (Shenzhen) Co., Ltd.
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Phone Number:	+86-0755-23146130
Fax Number:	+86-0755-23146130

1.2 Identification of the Responsible Testing Location

Test Location:	BTF Testing Lab (Shenzhen) Co., Ltd.
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Description:	All measurement facilities used to collect the measurement data are located at F101,201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
FCC Registration Number:	518915
Designation Number:	CN1330

1.3 Laboratory Condition

Ambient Temperature:	20℃ to 25℃
Ambient Relative Humidity:	45% to 55%
Ambient Pressure:	100 kPa to 102 kPa

1.4 Announcement

(1) The test report reference to the report template version v0.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing, reviewing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

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2. Product Information

2.1 Application Information

Company Name:	Shenzhen Xinlongwei intelligent Technology Co., LTD
Address:	4 / F, Building E, Xingguang Industrial Park, Shilong Community, Shiyan Street, Baoan District, Shenzhen

2.2 Manufacturer Information

Company Name:	Shenzhen Xinlongwei intelligent Technology Co., LTD
Address:	4 / F, Building E, Xingguang Industrial Park, Shilong Community, Shiyan Street, Baoan District, Shenzhen

2.3 Factory Information

Company Name:	Shenzhen Xinlongwei intelligent Technology Co., LTD
Address:	4 / F, Building E, Xingguang Industrial Park, Shilong Community, Shiyan Street, Baoan District, Shenzhen

2.4 General Description of Equipment under Test (EUT)

EUT Name	wristband
Under Test Model Name	LH10
Series Model Name	LH8, LH9, LH17, LH18, LH19, LH20, LH21, LH22, LH23, LH25, LH26, LH28, LH29
Description of Model name differentiation	All the same except model number
Hardware Version	V1.0
Software and Firmware Version	V1.0

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2.5 Technical Information

Modulation Technology	DTS
Modulation Type	GFSK
Product Type	☐Mobile ☒Portable ☐Fixed Location
Transfer Rate	1 Mbps
Frequency Range	The frequency range used is 2402 MHz – 2480 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of Channel	40 (at intervals of 2 MHz)
Tested Channel	0 (2402 MHz), 19 (2440 MHz), 39 (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain#	0.5 dBi
Antenna Impedance	50Ω
Antenna System (MIMO Smart Antenna)	N/A

Note:

#: The antenna gain provided by the applicant, and the laboratory will not be responsible for the accumulated calculation results which covers the information provided by the applicant.

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All channel was listed on the following table:

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
0	**2402**	21	2444
1	2404	22	2446
2	2406	22	2448
3	2408	24	2450
4	2410	25	2452
5	2412	26	2454
6	2414	27	2456
7	2416	28	2458
8	2418	29	2460
9	2420	30	2462
10	2422	31	2464
11	2424	32	2466
12	2426	33	2468
13	2428	34	2470
14	2430	35	2472
15	2432	36	2474
16	2434	37	2476
17	2436	38	2478
18	2438	**39**	**2480**
19	**2440**		
20	2442		

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3. Summary of Test Results

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15 Subpart C Section 15.247	Intentional Radiators
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

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3.2 Summary of Test Result

No.	Description	FCC Part No.	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	N/A	--	Pass	--
2	Peak Output Power	15.247(b)	Low/Middle/High	ANNEX A.1	Pass	--
3	Occupied Bandwidth	15.247(a)	Low/Middle/High	ANNEX A.2	Pass	--
4	Conducted Spurious Emission	15.247(d)	Low/Middle/High	ANNEX A.3	Pass	--
5	Band Edge(Authorized-band band-edge)	15.247(d)	Low/High	ANNEX A.3	Pass	--
6	Conducted Emission	15.207	Low/Middle/High	ANNEX A.4	Pass	--
7	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	ANNEX A.5	Pass	--
8	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Low/High	ANNEX A.6	Pass	--
9	Power spectral density (PSD)	15.247(e)	Low/Middle/High	ANNEX A.7	Pass	--

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3.3 Uncertainty of Test

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2 and TR100 028-1/-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Measurement	Value
Occupied Channel Bandwidth	69 KHz
RF output power, conducted	0.87 dB
Power Spectral Density, conducted	0.69 dB
Unwanted Emissions, conducted	0.94 dB
All emissions, radiated(<1GHz)	4.12 dB
All emissions, radiated(>1GHz)	4.16 dB
Temperature	0.82 °C
Humidity	4.1 %

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4. Test Configuration

4.1 Environment Condition

Environment Parameter	Selected Values During Tests			
	Temperature	Voltage	Relative Humidity	Ambient Pressure
Normal Temperature, Normal Voltage (NTNV)	20°C to 25°C	DC 3.7V from battery	30% to 60%	100 kPa to 102 kPa

4.2 Test Equipment List

Conducted Method Test						
Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due	Use
MXA Signal Analyzer	KEYSIGHT	N9020A	MY50410020	2022.11.24	2023.11.23	☒
WIDEBAND RADIO COMMNUNICATION TESTER	Rohde & Schwarz	CMW500	161997	2022.11.24	2023.11.23	☒
ESG VECTOR SIGNAL GENERATOR	Agilent	E4438C	MY45094854	2022.11.24	2023.11.23	☒
MXG Vector Signal Generator	Agilent	N5182A	MY46240163	2022.11.24	2023.11.23	☒
Adjustable Direct Current Regulated Power Supply	Dongguan Tongmen Electronic Technology Co., LTD	etm-6050c	20211026123	2022.11.25	2023.11.24	☒
Programmable constant temperature and humidity box	ZZCKONG	ZZ-K02A	20210928007	2022.11.24	2023.11.23	☒
RF Control Unit	TST	TST-Full	S01	/	/	☒
RF Test software	TST	V2.0	/	/	/	☒

Radiated Method Test						
Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due	Use
SIGNAL ANALYZER	ROHDE&SCHWARZ	FSQ40	100010	2022.11.24	2023.11.23	☒
EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI7	101032	2022.11.24	2023.11.23	☒
Log periodic antenna	SCHWARZBECK	VULB 9168	01328	2021.11.28	2023.11.27	☒
Horn Antenna	SCHWARZBECK	BBHA9170	01157	2021.11.28	2023.11.27	☒
POSITIONAL CONTROLLER	SKET	PCI-GPIB	/	/	/	☒
RE Cable	REBES Talent	UF2-NMNM-10m	21101570	2022.11.24	2023.11.23	☒
RE Cable	REBES Talent	UF2-NMNM-2.5m	21101573	2022.11.24	2023.11.23	☒
RE Cable	REBES Talent	UF2-NMNM-1m	21101576	2022.11.24	2023.11.23	☒

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Coaxial cable Multiflex 141	Schwarzbeck	N/SMA 0.5m	517386	2023.3.24	2024.3.23	☒
RE Cable	Talent Microwave	A40-2.92M2.92 M-14M	22080539	2022.11.24	2023.11.23	☒
RE Cable	Talent Microwave	A81-SMAMNM-14M	22080538	2022.11.24	2023.11.23	☒
Preamplifier	SCHWARZBECK	BBV9744	00246	2022.11.24	2023.11.23	☒
Horn Antenna	Schwarzbeck	BBHA9120D	2597	2022.5.22	2024.5.21	☒
Broadband Preamplilifier	Schwarzbeck	BBV9718D	00008	2023.3.24	2024.3.23	☒

Conducted disturbance Test						
Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due	Use
EMI Receiver	ROHDE&SCHWARZ	ESCI3	101422	2022.11.24	2023.11.23	☒
V-LISN	SCHWARZBECK	NSLK 8127	01073	2022.11.24	2023.11.23	☒
LISN	AFJ	LS16/110VAC	16010020076	2022.11.24	2023.11.23	☒
Coaxial Switcher	SCHWARZBECK	CX210	CX210	2022.11.24	2023.11.23	☒
Pulse Limiter	SCHWARZBECK	VTSD 9561-F	00953	2022.11.24	2023.11.23	☒
EZ_EMC	Frad	EMC-CON 3A1.1+	/	/	/	☒

4.3 Test Auxiliary Equipment

Description	Manufacturer	Model	Serial No.	Length	Description	Use
						☒

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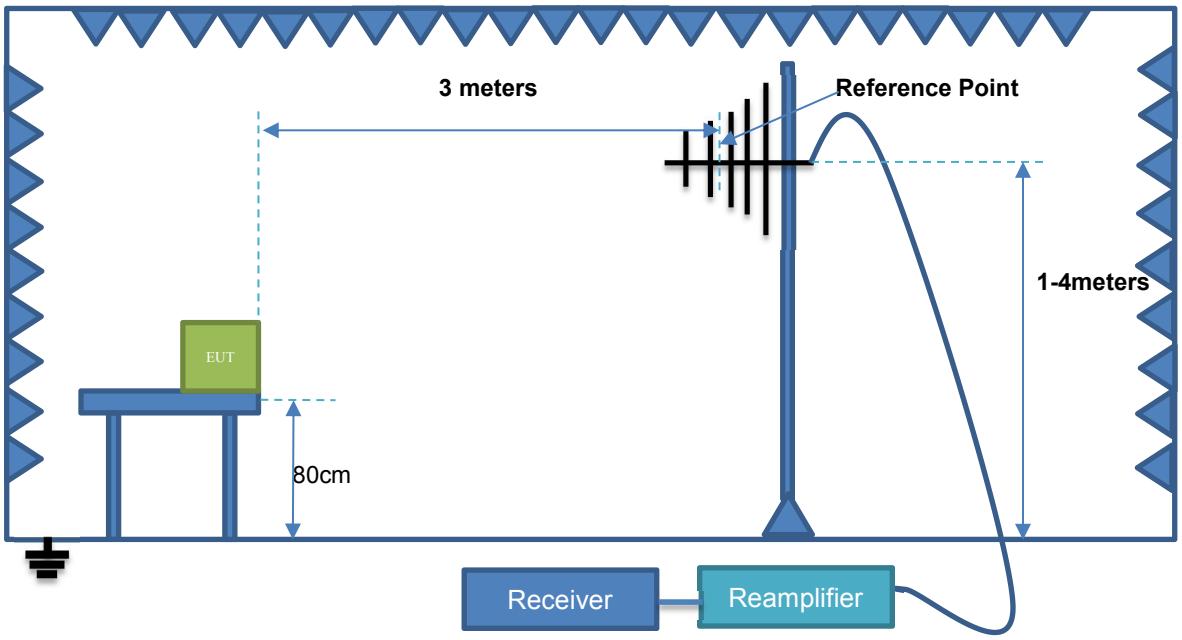
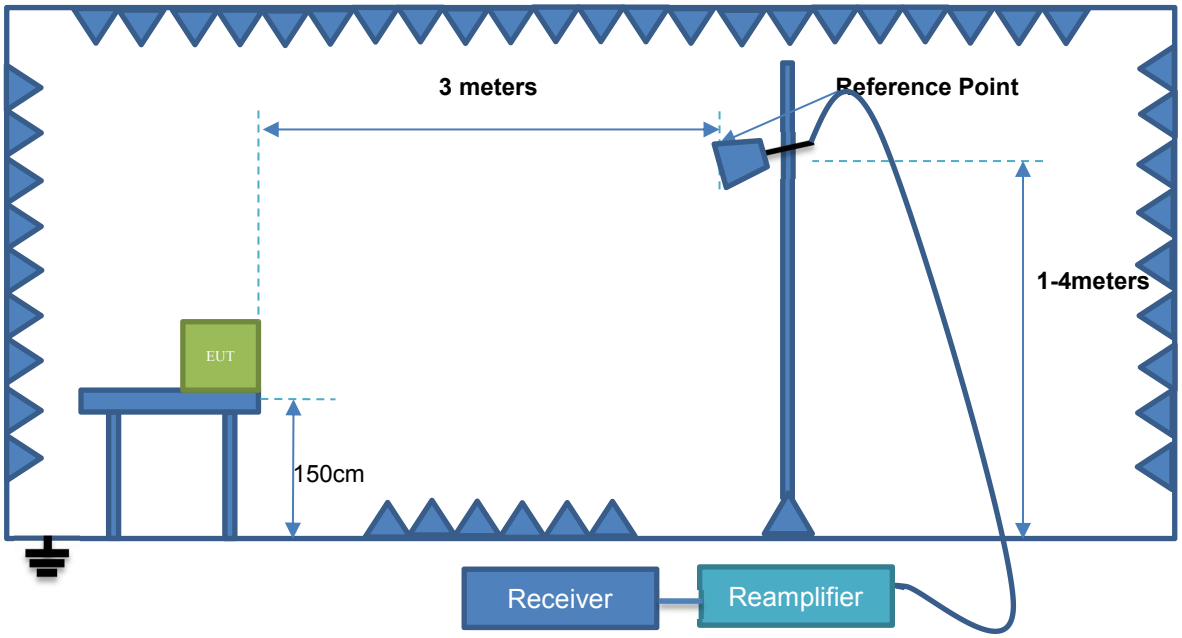
4.4 Test Setup

Test Setup 1



Radiation Test (30MHz – 1GHz)



Radiation Test (Above 1GHz)

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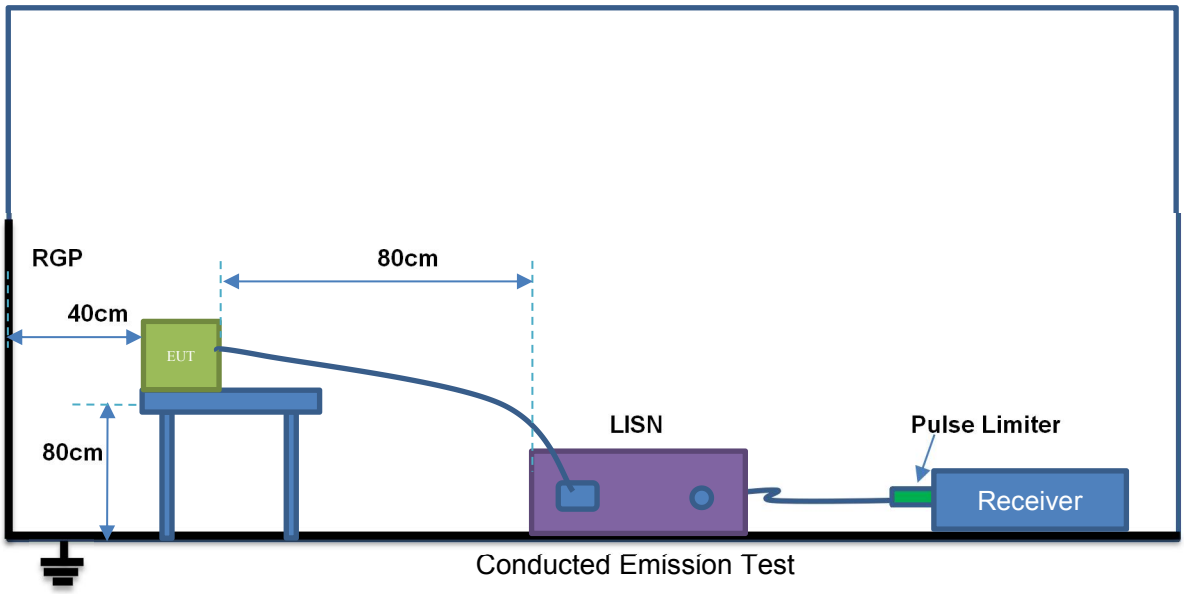
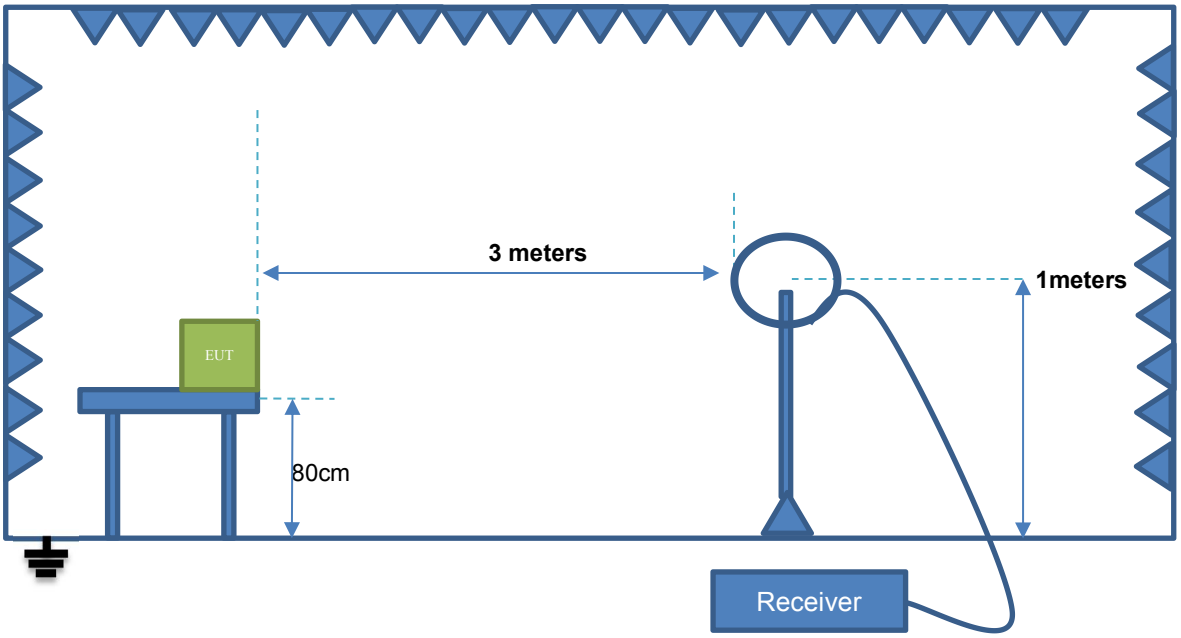
Test Setup 2



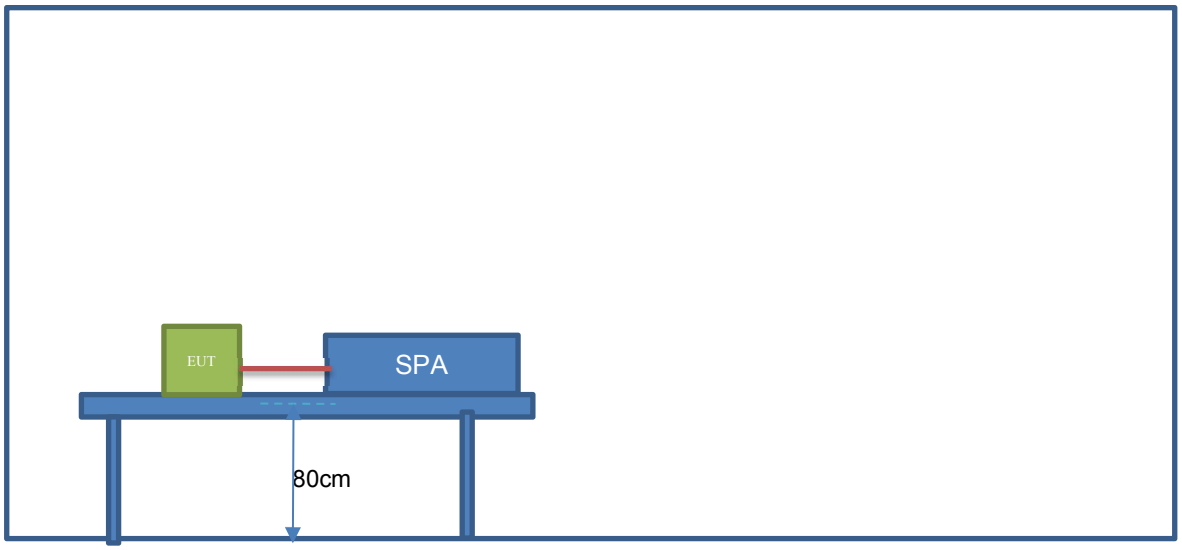
Conducted Emission Test

Test Setup 3



Radiation Test (9k - 30MHz)

Test Setup 4



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5. Test Items

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203; RSS-247, 5.4(f)

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

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 Output Power

5.2.1 Limit

FCC § 15.247(b) ; RSS-247, 5.4(d)

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

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.)

5.2.3 Test Result

Please refer to ANNEX A.1

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5.3 Emission Bandwidth

5.3.1 Limit

FCC §15.247(a) ; RSS-GEN, 6.7; RSS-247, 5.2 (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 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

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

Please refer to ANNEX A.2

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5.4 Conducted Spurious Emission

5.4.1 Limit

FCC §15.247(d) ; RSS-247, 5.5

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 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

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.

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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

Please refer to ANNEX A.3

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5.5 Band Edge (Authorized-band band-edge)

5.5.1 Limit

FCC §15.247(d) ; RSS-GEN, 8.9, RSS-247, 5.5

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 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

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

Please refer to ANNEX A.3

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5.6 Conducted Emission

5.6.1 Limit

FCC §15.207; RSS-GEN, 8.8

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 for test setup description for setup 2. The photo of test setup please refer to ANNEX B

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

Please refer to ANNEX A.4

NOTE:

1. Results (dBuV) = Reading (dBuV) + Factor (dB)

The reading level is calculated by software which is not shown in the sheet

2. Factor = Insertion loss + Cable loss
3. Over limit = Results – Limit.

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5.7 Radiated Spurious Emission

5.7.1 Limit

FCC §15.209&15.247(d) ; RSS-247, 5.5

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 for test setup description for setup 1 and 3. The photo of test setup please refer to ANNEX B

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

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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.

<u>Quasi-Peak measurement procedure</u>

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

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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

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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:

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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

Please refer to ANNEX A.5

NOTE:
1. Results (dBuV) = Reading (dBuV) + Factor (dB)
The reading level is calculated by software which is not shown in the sheet
2. Factor = Insertion loss + Cable loss
3. Over limit = Results – Limit.

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5.8 Band Edge (Restricted-band-edge)

5.8.1 Limit

FCC §15.209&15.247(d) ; RSS-247, 5.5

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 for test setup description for antenna port. The photo of test setup please refer to ANNEX B

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.

5.8.4 Test Result

Please refer to ANNEX A.6

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5.9 Power Spectral Density

5.9.1 Limit

FCC §15.209&15.247(e) ; RSS-247, 5.2 (b)

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 for test setup description for antenna port. The photo of test setup please refer to ANNEX B

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

Please refer to ANNEX A.7

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ANNEX A Test Results

A.1 Output Power

Temperature:	26℃	Relative Humidity:	54%
Test Mode :	GFSK	Test Voltage :	DC 3.7V

Test channel	Peak Output Power (dBm)	Limit(dBm)	Result
Lowest	1.207	30.00	Pass
Middle	2.679		
Highest	2.016		

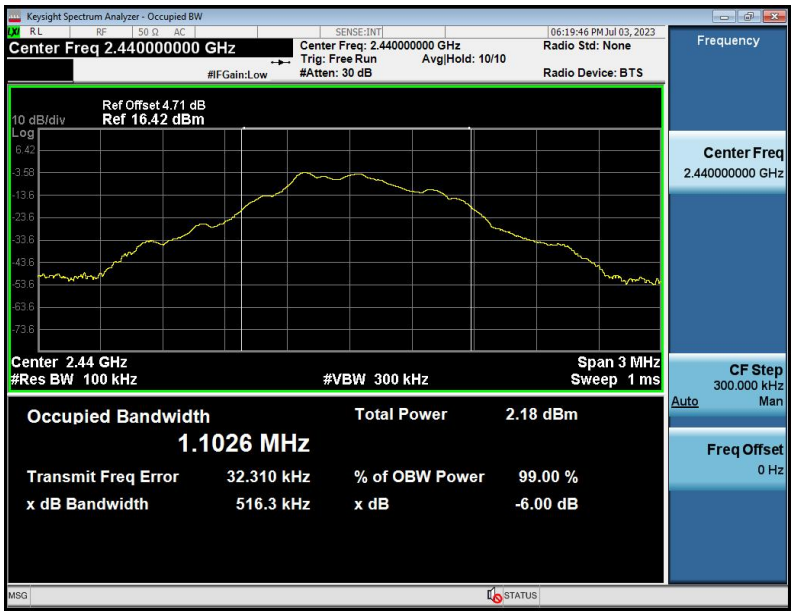
A.2 Occupied Bandwidth .

Temperature:	26℃	Relative Humidity:	54%
Test Mode :	GFSK	Test Voltage :	DC 3V

Test channel	Channel Bandwidth (KHz)	Limit(KHz)	Result
Lowest	509.2	>500	Pass
Middle	516.3		
Highest	526.6		

CH 01

CH20



CH40

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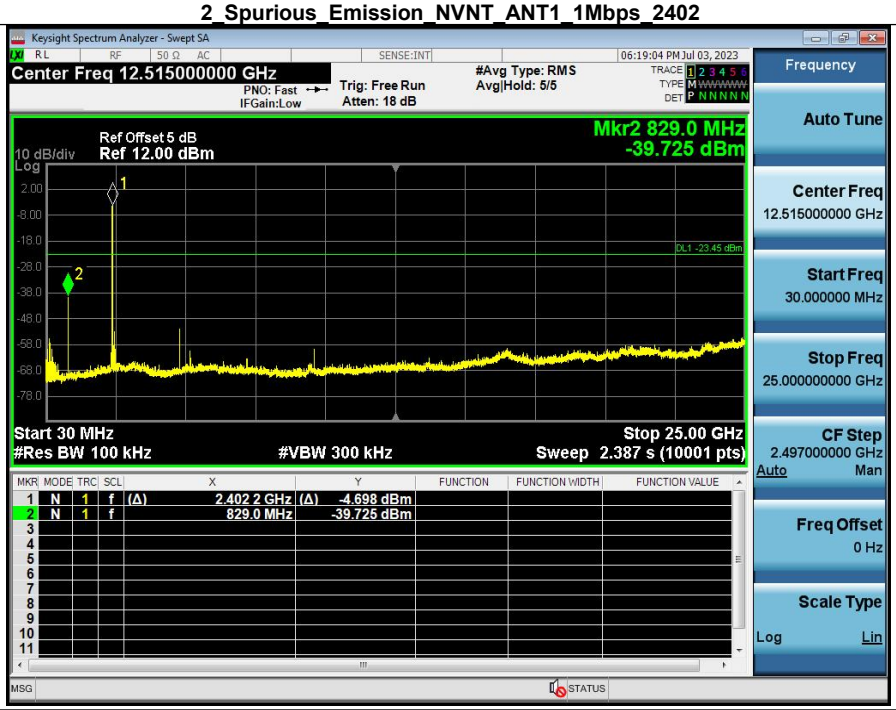
A.3 Conducted Spurious Emissions & Band Edge (Authorized-band band-edge)

1_Reference_Level_NVNT_ANT1_1Mbps_2402

2_Spurious_Emission_NVNT_ANT1_1Mbps_2402



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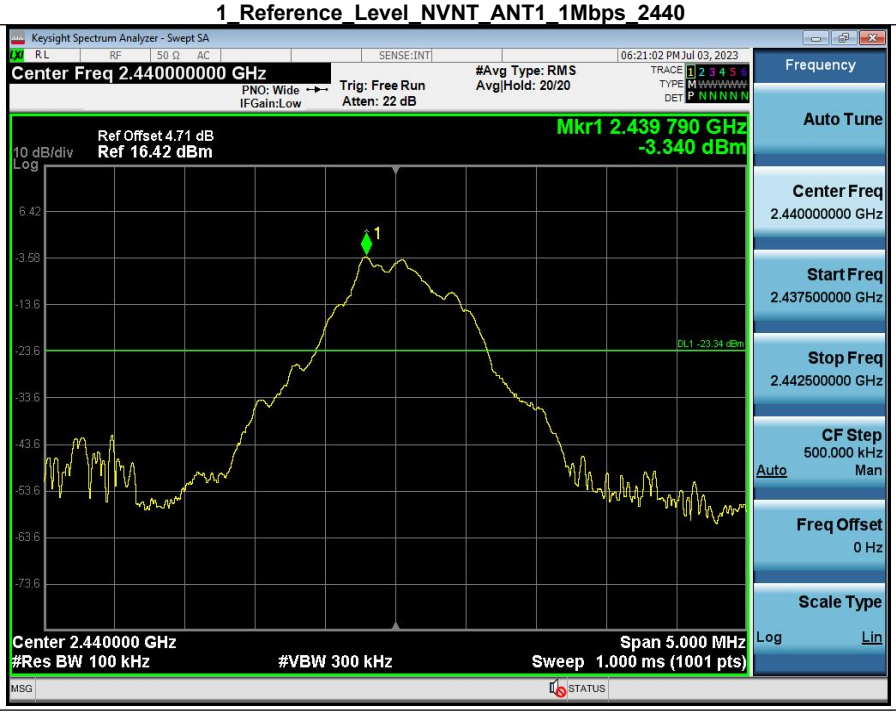
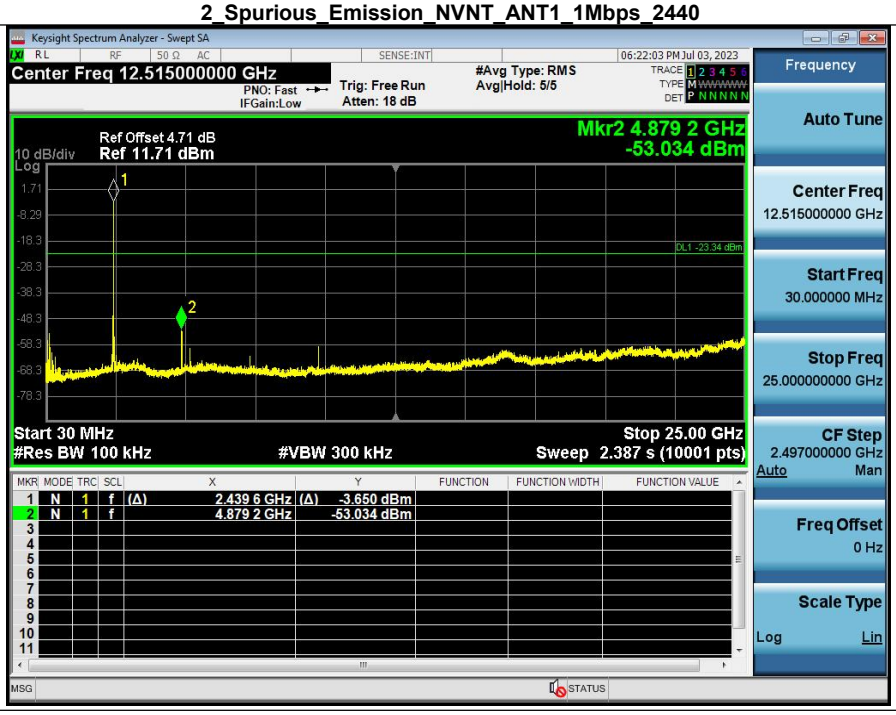
1_Reference_Level_NVNT_ANT1_1Mbps_2440



2_Spurious_Emission_NVNT_ANT1_1Mbps_2440



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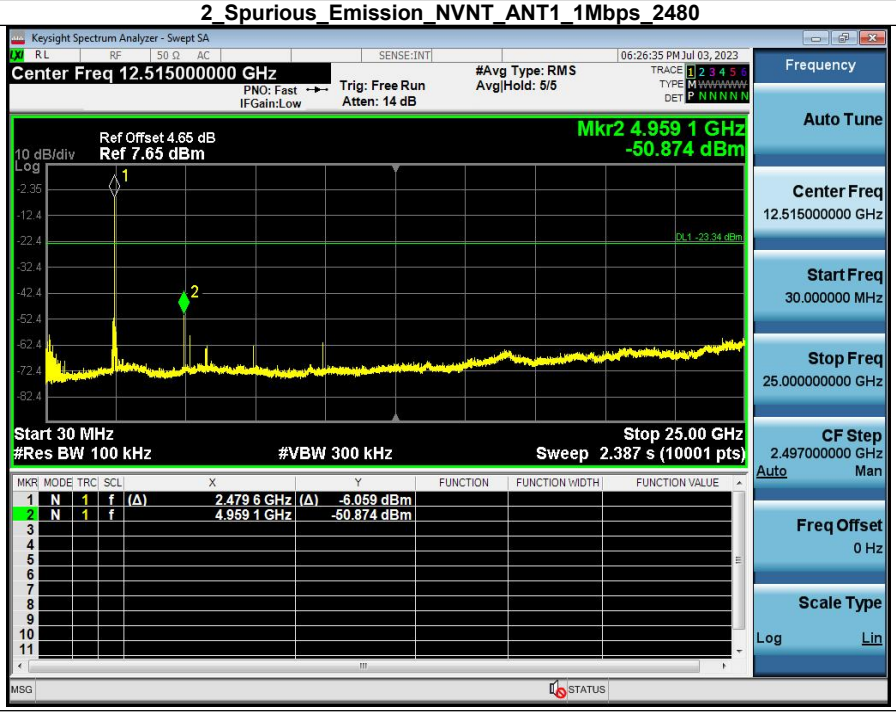
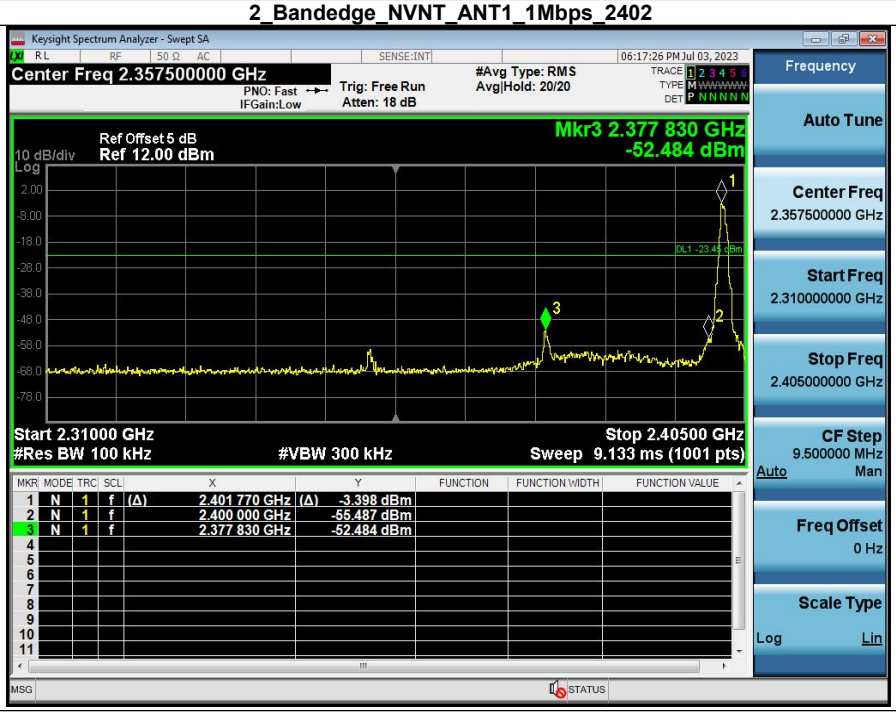
1_Reference_Level_NVNT_ANT1_1Mbps_2480

2_Spurious_Emission_NVNT_ANT1_1Mbps_2480



1_Reference_Level_NVNT_ANT1_1Mbps_2402

2_Bandedge_NVNT_ANT1_1Mbps_2402



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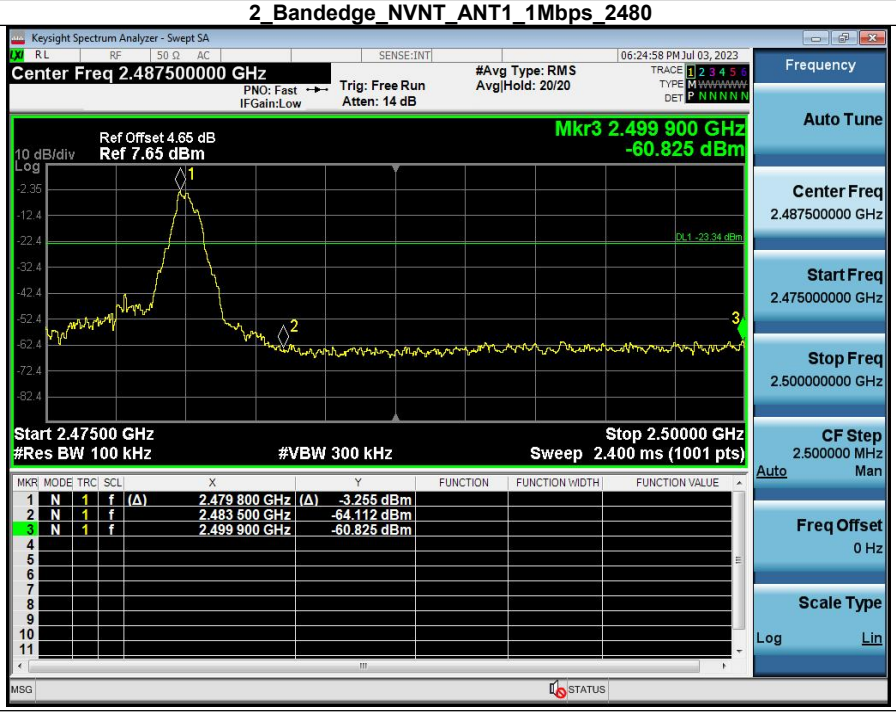
1_Reference_Level_NVNT_ANT1_1Mbps_2480

2_Bandedge_NVNT_ANT1_1Mbps_2480



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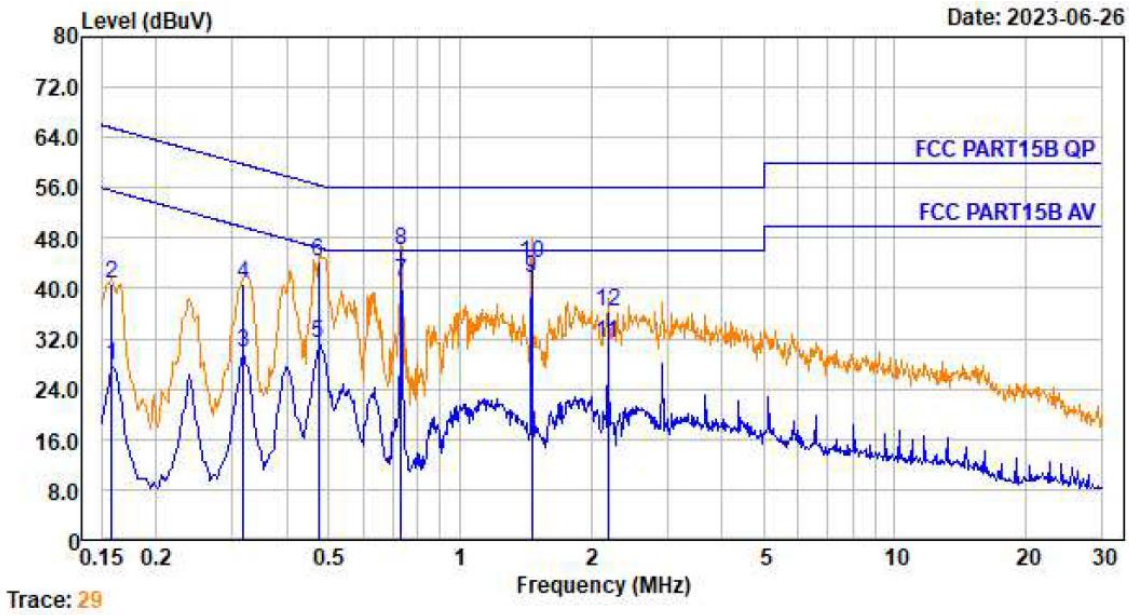
A.4 Conducted Emission

Note 1: 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.

Test Data and plots.

PHASE L



No.	Freq MHz	Cable Loss dB	LISN Factor dB/m	Receiver Reading dBuV	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	0.158	0.00	9.54	18.24	27.78	55.56	-27.78	Average
2.	0.158	0.00	9.54	31.21	40.75	65.56	-24.81	QP
3.	0.318	0.01	9.56	20.23	29.80	49.75	-19.95	Average
4.	0.318	0.01	9.56	31.25	40.82	59.75	-18.93	QP
5.	0.474	0.01	9.57	21.63	31.21	46.45	-15.24	Average
6.	0.474	0.01	9.57	34.62	44.20	56.45	-12.25	QP
7.	0.731	0.02	9.58	31.33	40.93	46.00	-5.07	Average
8.	0.731	0.02	9.58	36.32	45.92	56.00	-10.08	QP
9.	1.464	0.03	9.58	32.08	41.69	46.00	-4.31	Average
10.	1.464	0.03	9.58	34.50	44.11	56.00	-11.89	QP
11.	2.190	0.05	9.58	21.75	31.38	46.00	-14.62	Average
12.	2.190	0.05	9.58	26.74	36.37	56.00	-19.63	QP

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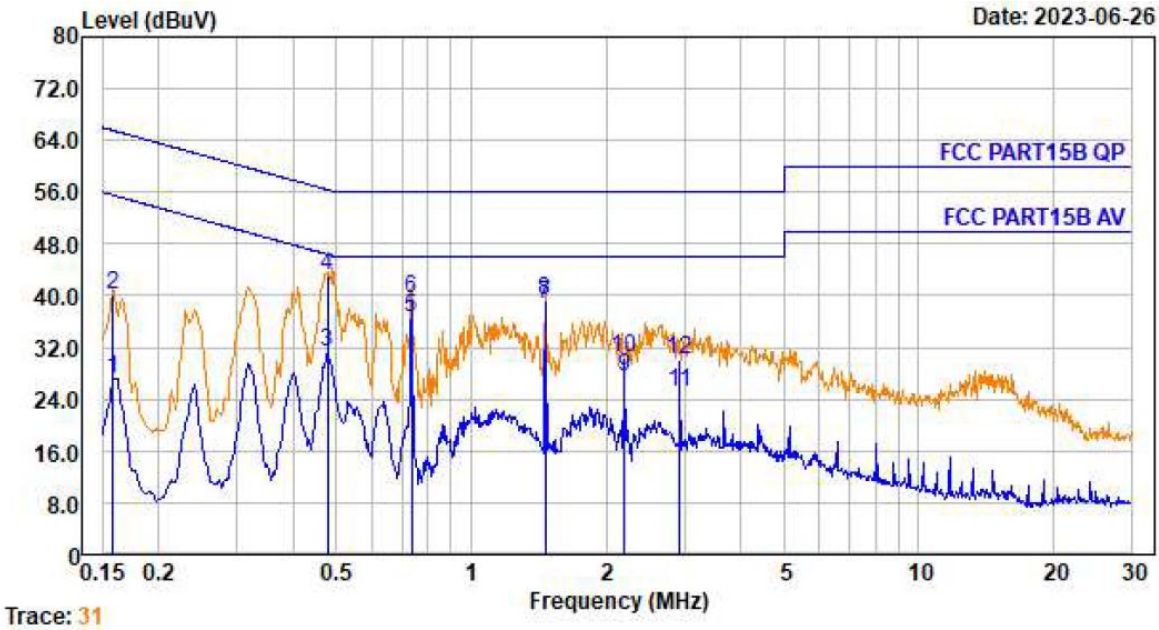
PHASE N



No.	Freq MHz	Cable Loss dB	LISN Factor dB/m	Receiver Reading dBuV	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	0.158	0.00	9.53	17.74	27.27	55.56	-28.29	Average
2.	0.158	0.00	9.53	30.73	40.26	65.56	-25.30	QP
3.	0.479	0.01	9.58	21.57	31.16	46.36	-15.20	Average
4.	0.479	0.01	9.58	33.50	43.09	56.36	-13.27	QP
5.	0.735	0.02	9.58	27.09	36.69	46.00	-9.31	Average
6.	0.735	0.02	9.58	30.10	39.70	56.00	-16.30	QP
7.	1.464	0.03	9.58	29.01	38.62	46.00	-7.38	Average
8.	1.464	0.03	9.58	29.70	39.31	56.00	-16.69	QP
9.	2.201	0.05	9.58	17.79	27.42	46.00	-18.58	Average
10.	2.201	0.05	9.58	20.78	30.41	56.00	-25.59	QP
11.	2.931	0.06	9.60	15.56	25.22	46.00	-20.78	Average
12.	2.931	0.06	9.60	20.58	30.24	56.00	-25.76	QP

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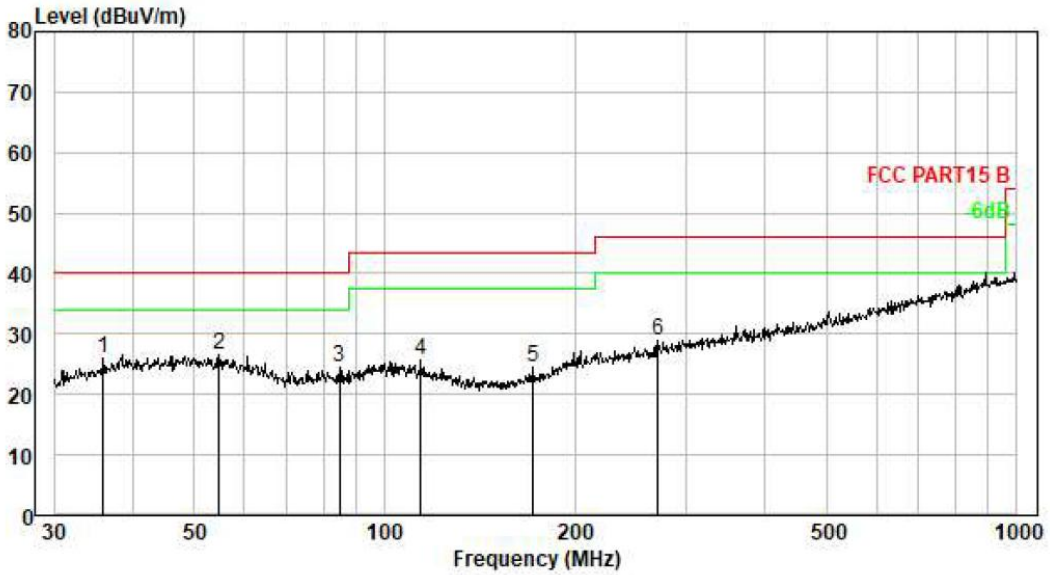
A.5 Radiated Spurious Emission

Note 1: The symbol of "--" in the table which means not application.
Note 2: For the test data above 1 GHz, according the ANSI C63.10-2013, 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 3: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.
Note 4: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)
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.

(30 MHz ~ 1GHz Harmonic)

30 MHz to 1 GHz, ANT Vertical



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Receiver Reading dBμV	Emission Level dBμV/m	Limit dBμV/m	Over Limit dB	Remark
1	35.875	0.31	11.40	14.35	26.06	40.00	-13.94	QP
2	54.643	0.46	12.21	13.93	26.60	40.00	-13.40	QP
3	84.999	0.63	9.80	13.98	24.41	40.00	-15.59	QP
4	114.114	0.76	10.82	14.05	25.63	43.50	-17.87	QP
5	171.995	0.98	9.40	14.05	24.43	43.50	-19.07	QP
6	270.375	1.22	13.56	14.26	29.04	46.00	-16.96	QP

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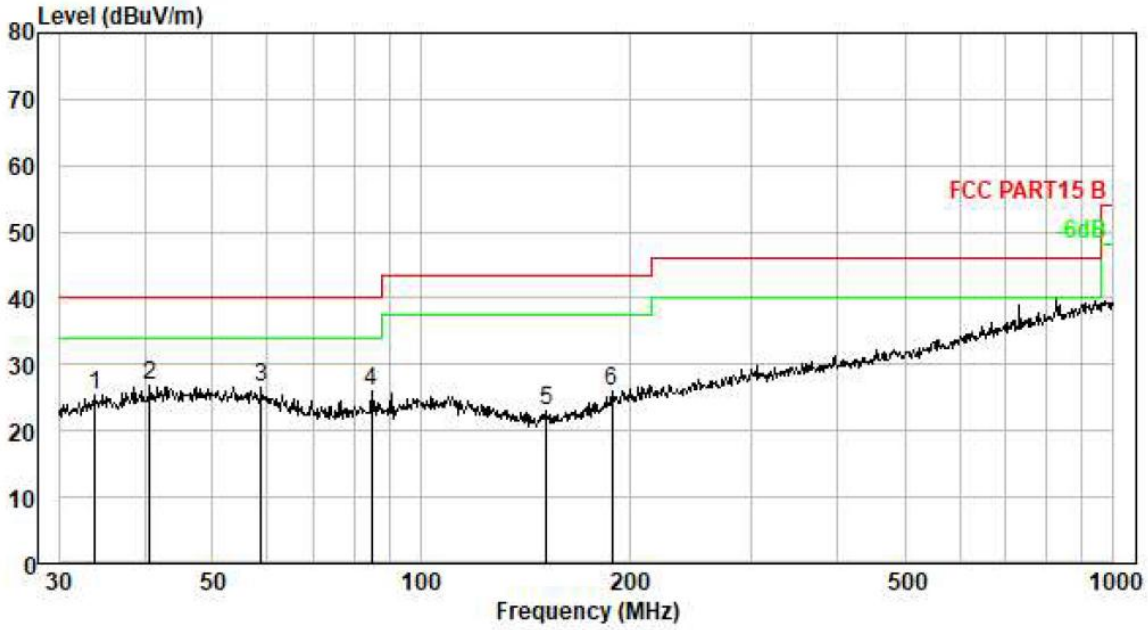
30 MHz to 1 GHz, ANT Horizontor



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Receiver Reading dBμV	Emission Level dBμV/m	Limit dBμV/m	Over Limit dB	Remark
1	33.799	0.28	10.80	14.38	25.46	40.00	-14.54	QP
2	40.559	0.35	12.51	13.90	26.76	40.00	-13.24	QP
3	58.819	0.49	11.81	14.27	26.57	40.00	-13.43	QP
4	84.999	0.63	9.80	15.54	25.97	40.00	-14.03	QP
5	151.597	0.91	8.38	13.61	22.90	43.50	-20.60	QP
6	189.074	1.03	10.98	14.00	26.01	43.50	-17.49	QP

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(1 GHz ~ 25 GHz)

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
Low Channel:2402MHz									
V	4804.00	51.33	30.55	5.77	24.66	51.21	74.00	-22.79	Pk
V	4804.00	39.57	30.55	5.77	24.66	39.45	54.00	-14.55	AV
V	7206.00	48.01	30.33	6.32	24.55	48.55	74.00	-25.45	Pk
V	7206.00	41.16	30.33	6.32	24.55	41.70	54.00	-12.30	AV
V	9608.00	48.47	30.85	7.45	24.69	49.76	74.00	-24.24	Pk
V	9608.00	41.30	30.85	7.45	24.69	42.59	54.00	-11.41	AV
V	12010.00	48.75	31.02	8.99	25.57	52.29	74.00	-21.71	Pk
V	12010.00	38.91	31.02	8.99	25.57	42.45	54.00	-11.55	AV
H	4804.00	51.32	30.55	5.77	24.66	51.20	74.00	-22.80	Pk
H	4804.00	40.16	30.55	5.77	24.66	40.04	54.00	-13.96	AV
H	7206.00	50.11	30.33	6.32	24.55	50.65	74.00	-23.35	Pk
H	7206.00	41.56	30.33	6.32	24.55	42.10	54.00	-11.90	AV
H	9608.00	49.61	30.85	7.45	24.69	50.90	74.00	-23.10	Pk
H	9608.00	41.01	30.85	7.45	24.69	42.30	54.00	-11.70	AV
H	12010.00	49.77	31.02	8.99	25.57	53.31	74.00	-20.69	Pk
H	12010.00	40.34	31.02	8.99	25.57	43.88	54.00	-10.12	AV

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
Middle Channel:2440MHz									
V	4880.00	48.78	30.55	5.77	24.66	48.66	74.00	-25.34	Pk
V	4880.00	39.59	30.55	5.77	24.66	39.47	54.00	-14.53	AV
V	7320.00	46.84	30.33	6.32	24.55	47.38	74.00	-26.62	Pk
V	7320.00	40.41	30.33	6.32	24.55	40.95	54.00	-13.05	AV
V	9760.00	46.81	30.85	7.45	24.69	48.10	74.00	-25.90	Pk
V	9760.00	39.48	30.85	7.45	24.69	40.77	54.00	-13.23	AV
V	12200.00	47.21	31.02	8.99	25.57	50.75	74.00	-23.25	Pk
V	12200.00	38.15	31.02	8.99	25.57	41.69	54.00	-12.31	AV
H	4880.00	49.27	30.55	5.77	24.66	49.15	74.00	-24.85	Pk
H	4880.00	39.99	30.55	5.77	24.66	39.87	54.00	-14.13	AV
H	7320.00	48.57	30.33	6.32	24.55	49.11	74.00	-24.89	Pk
H	7320.00	39.01	30.33	6.32	24.55	39.55	54.00	-14.45	AV
H	9760.00	49.22	30.85	7.45	24.69	50.51	74.00	-23.49	Pk
H	9760.00	40.30	30.85	7.45	24.69	41.59	54.00	-12.41	AV
H	12200.00	48.66	31.02	8.99	25.57	52.20	74.00	-21.80	Pk
H	12200.00	37.87	31.02	8.99	25.57	41.41	54.00	-12.59	AV

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Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
High Channel:2480MHz									
V	4960.00	49.19	30.55	5.77	24.66	49.07	74.00	-24.93	Pk
V	4960.00	38.90	30.55	5.77	24.66	38.78	54.00	-15.22	AV
V	7440.00	46.81	30.33	6.32	24.55	47.35	74.00	-26.65	Pk
V	7440.00	40.68	30.33	6.32	24.55	41.22	54.00	-12.78	AV
V	9920.00	47.21	30.85	7.45	24.69	48.50	74.00	-25.50	Pk
V	9920.00	39.80	30.85	7.45	24.69	41.09	54.00	-12.91	AV
V	12400.00	46.15	31.02	8.99	25.57	49.69	74.00	-24.31	Pk
V	12400.00	37.72	31.02	8.99	25.57	41.26	54.00	-12.74	AV
H	4960.00	49.59	30.55	5.77	24.66	49.47	74.00	-24.53	Pk
H	4960.00	41.22	30.55	5.77	24.66	41.10	54.00	-12.90	AV
H	7440.00	48.41	30.33	6.32	24.55	48.95	74.00	-25.05	Pk
H	7440.00	40.03	30.33	6.32	24.55	40.57	54.00	-13.43	AV
H	9920.00	48.16	30.85	7.45	24.69	49.45	74.00	-24.55	Pk
H	9920.00	39.80	30.85	7.45	24.69	41.09	54.00	-12.91	AV
H	12400.00	49.27	31.02	8.99	25.57	52.81	74.00	-21.19	Pk
H	12400.00	38.15	31.02	8.99	25.57	41.69	54.00	-12.31	AV

Remark:
1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier,
   Margin= Emission Level - Limit
2. If peak below the average limit, the average emission was no test.
3. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

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A.6 Band Edge (Restricted-band-edge)

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.

	Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Detector Type	Result
GFSK	Low Channel: 2402MHz									
	H	2390.00	55.44	30.22	4.85	23.98	54.05	74.00	PK	PASS
	H	2390.00	47.30	30.22	4.85	23.98	45.91	54.00	AV	PASS
	H	2400.00	56.93	30.22	4.85	23.98	55.54	74.00	PK	PASS
	H	2400.00	48.12	30.22	4.85	23.98	46.73	54.00	AV	PASS
	V	2390.00	56.98	30.22	4.85	23.98	55.59	74.00	PK	PASS
	V	2390.00	46.52	30.22	4.85	23.98	45.13	54.00	AV	PASS
	V	2400.00	58.53	30.22	4.85	23.98	57.14	74.00	PK	PASS
	V	2400.00	46.49	30.22	4.85	23.98	45.10	54.00	AV	PASS
	High Channel: 2480MHz									
	H	2483.50	54.04	30.22	4.85	23.98	52.65	74.00	PK	PASS
	H	2483.50	45.98	30.22	4.85	23.98	44.59	54.00	AV	PASS
	H	2500.00	58.53	30.22	4.85	23.98	57.14	74.00	PK	PASS
	H	2500.00	46.34	30.22	4.85	23.98	44.95	54.00	AV	PASS
	V	2483.50	56.32	30.22	4.85	23.98	54.93	74.00	PK	PASS
	V	2483.50	47.57	30.22	4.85	23.98	46.18	54.00	AV	PASS
	V	2500.00	55.15	30.22	4.85	23.98	53.76	74.00	PK	PASS
	V	2500.00	46.44	30.22	4.85	23.98	45.05	54.00	AV	PASS

Remark:
1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier, Margin= Emission Level - Limit

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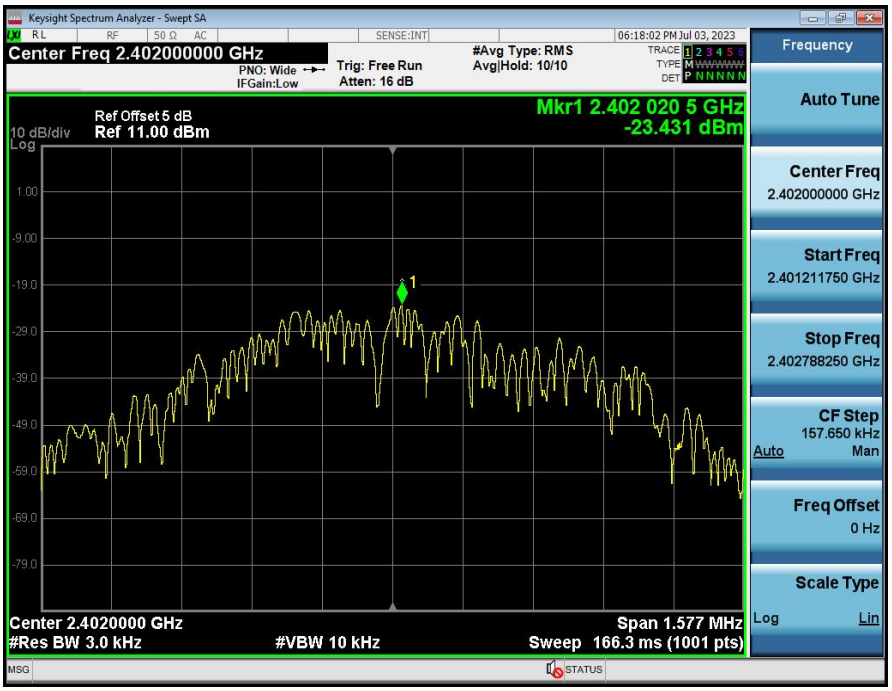
A.7 Power Spectral Density

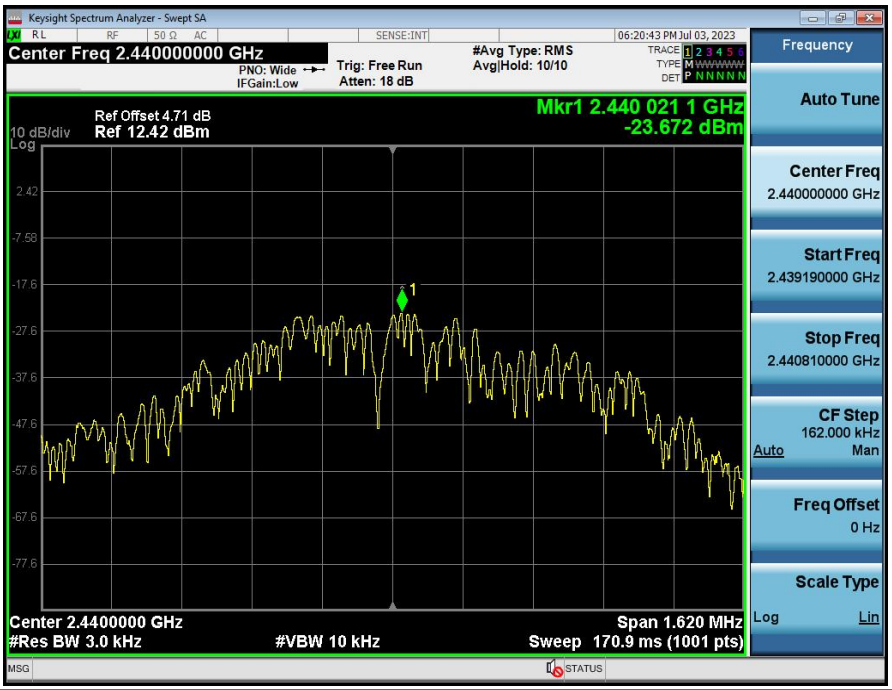
Temperature:	26℃	Relative Humidity:	54%
Test Mode :	GFSK	Test Voltage :	DC 3V

Frequency	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402 MHz	-23.431	8	PASS
2440 MHz	-23.672	8	PASS
2480 MHz	-24.030	8	PASS

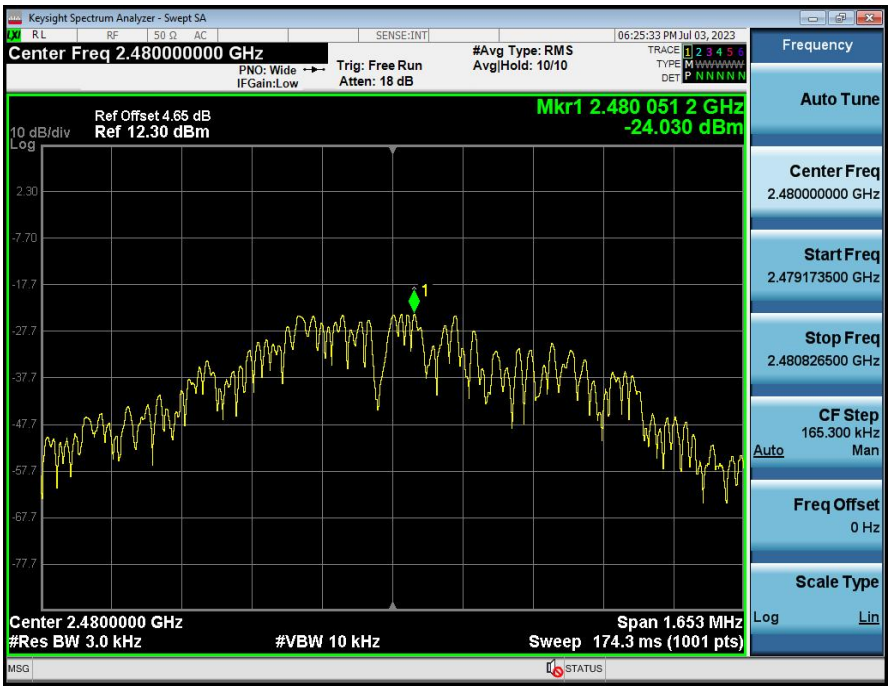
CH01



CH20



CH40



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ANNEX B TEST SETUP PHOTOS

Please see the attachment for the test setup photos.

ANNEX C EUT EXTERNAL PHOTOS

Please see the attachment for the External photos.

ANNEX D EUT INTERNAL PHOTOS

Please see the attachment for the Internal photos.

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