RF Test Report

For

Applicant Name:	**Zewox GmbH**
Address:	Oststr.159, 47057 Duisburg, Germany
EUT Name:	Electric Heated Insoles
Brand Name:	N/A
Model Number:	HI616BLU
Series Model Number:	Refer to section 2

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:	BTF230718R01301
Test Standards:	47 CFR Part 15 Subpart C Section 15.249 RSS-210 Issue 10, Amendment 1, April 2020 RSS-Gen Issue 5, Amendment 2, February, 2021
FCC ID:	2BCGT-HI616BLU
IC:	31191-HI616BLU
Test Conclusion:	Pass
Test Date:	2023-07-11 to 2023-07-20
Date of Issue:	2023-07-20

Prepared By:	Elma.yang / Project Engineer
Date:	2023-07-20
Approved By:	Ryan.CJ / EMC Manager
Date:	2023-07-20

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Revision History		
Version	Issue Date	Revisions Content
R_V0	2023-07-20	Original
Note:	*Once the revision has been made, then previous versions reports are invalid.*	

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BTF Testing Lab (Shenzhen) Co., Ltd.
F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China

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
IC Registered No.:	27844
CAB ID.:	CN0135

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:	Zewox GmbH
Address:	Oststr.159, 47057 Duisburg, Germany

2.2 Manufacturer Information

Company Name:	Changzhou Ructerm Technology Co.,LTD.
Address:	No.12 Fenghuang South Road, Hutang Town, Wujin District, Changzhou, China

2.3 Factory Information

Company Name:	Changzhou Ructerm Technology Co.,LTD.
Address:	No.12 Fenghuang South Road, Hutang Town, Wujin District, Changzhou, China

2.4 General Description of Equipment under Test (EUT)

EUT Name	Electric Heated Insoles
Under Test Model Name	HI616BLU
Series number	230002
Description of Model name differentiation	N/A
Hardware Version	1.0
Software and Firmware Version	1.0

2.5 Technical Information

Modulation Type	GFSK
Operation Frequency	2402~2480MHz
Number of Channel	40 Channels
Antenna Type	Internal Antenna
Antenna Gain	3.3dBi
Channel list	Please see next page
Power Supply	DC 8.4V from adapter DC 7.4V from battery
Adapter	Manuafactor:Guangdong ABT industrial Co., Ltd. Model:ABT020084CUS

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	Input: AC 100-240V 50/60Hz 1.5A Output: DC 8.4V 2.0A 16.8W Series Number: 230032

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

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3. Summary of Test Results

3.1 Test Standards

No.	Identity
1	47 CFR Part 15 Subpart C Section 15.249 RSS-210 Issue 10, Amendment 1, April 2020 RSS-Gen Issue 5, Amendment 2, February, 2021
2	ANSI C63.10-2013

3.2 Summary of Test Result

No.	Description	FCC Part No.	Test Result	Test By	Verdict	Remark
1	Antenna Requirement	15.203 RSS-Gen Section 6.8	--		Pass	--
2	20dB&99% Bandwidth	15.215 RSS-210 RSS-Gen Section 6.7	ANNEX A.1		Pass	--
3	Band Edge Emission	RSS-210 Section B.10 FCC Part15.249(d)	ANNEX A.2		Pass	--
4	Conducted Emission	15.207 RSS-Gen Section 8.8	ANNEX A.3		Pass	--
5	Fundamental &Radiated Spurious Emission Measurement	RSS-210 RSS-Gen Section 8.9 FCC Part15.205(a), FCC Part15.209(a) FCC Part15.249(a), FCC Part15.249(c)	ANNEX A.4		Pass	--

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
Conducted Emission Test	2.56dB
Occupied Channel Bandwidth	69 KHz
All emissions, radiated(<1GHz)	4.12 dB
All emissions, radiated(>1GHz)	4.89dB
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 7.4V 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	☒

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	☒
Coaxial cable Multiflex 141	Schwarzbeck	N/SMA 0.5m	517386	2023.3.24	2024.3.23	☒

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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
Heated insole	Changzhou Ructerm Technology Co.,LTD.	HI616BLU	230025			☒

4.4 Table Of Parameters Of Test Software Setting

During testing, channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the end product.

Test software Version	Test program:FCC TEST3.1		
Frequency	2402 MHz	2440 MHz	2480 MHz
Power Setting of Softwave	0	0	0

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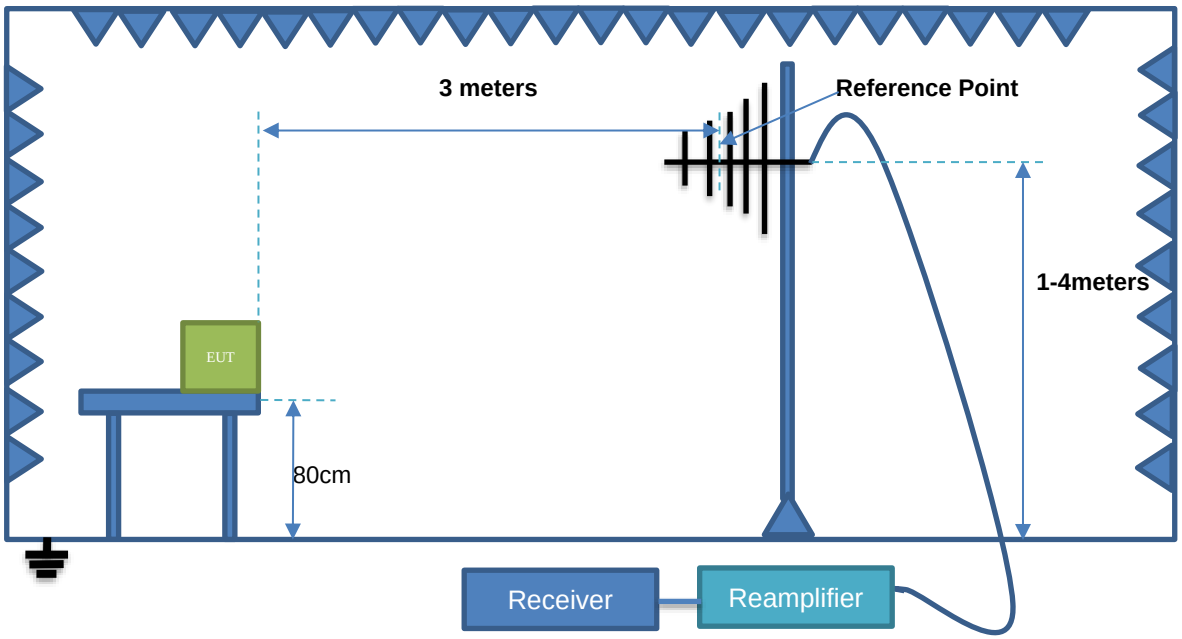
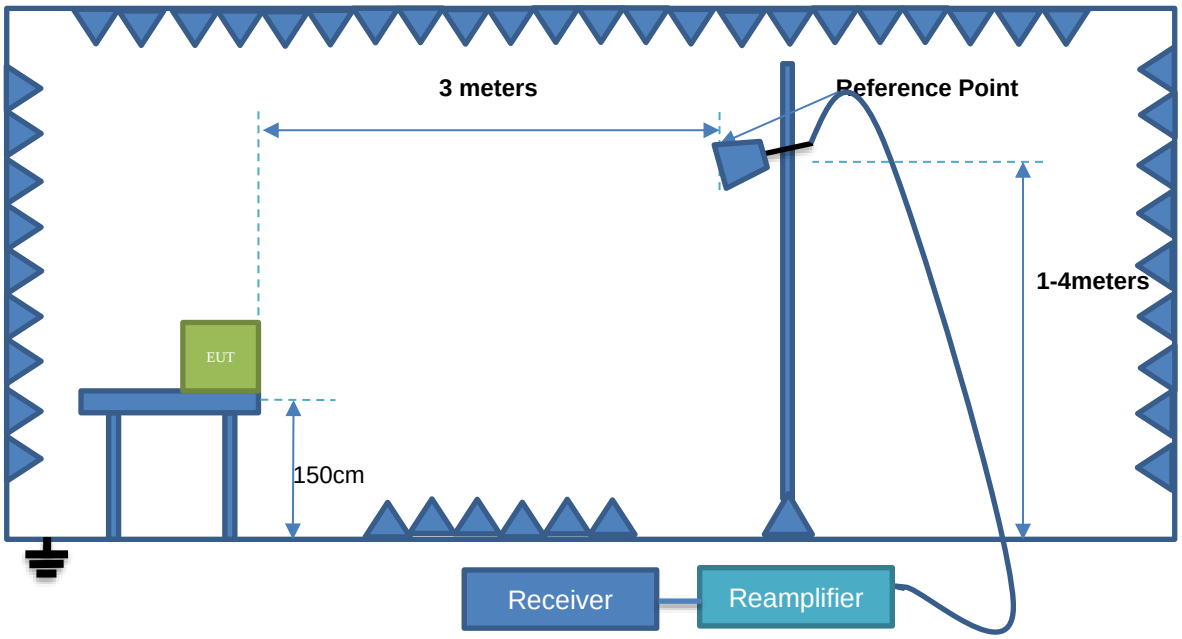
1.1 Test Setup

Test Setup 1

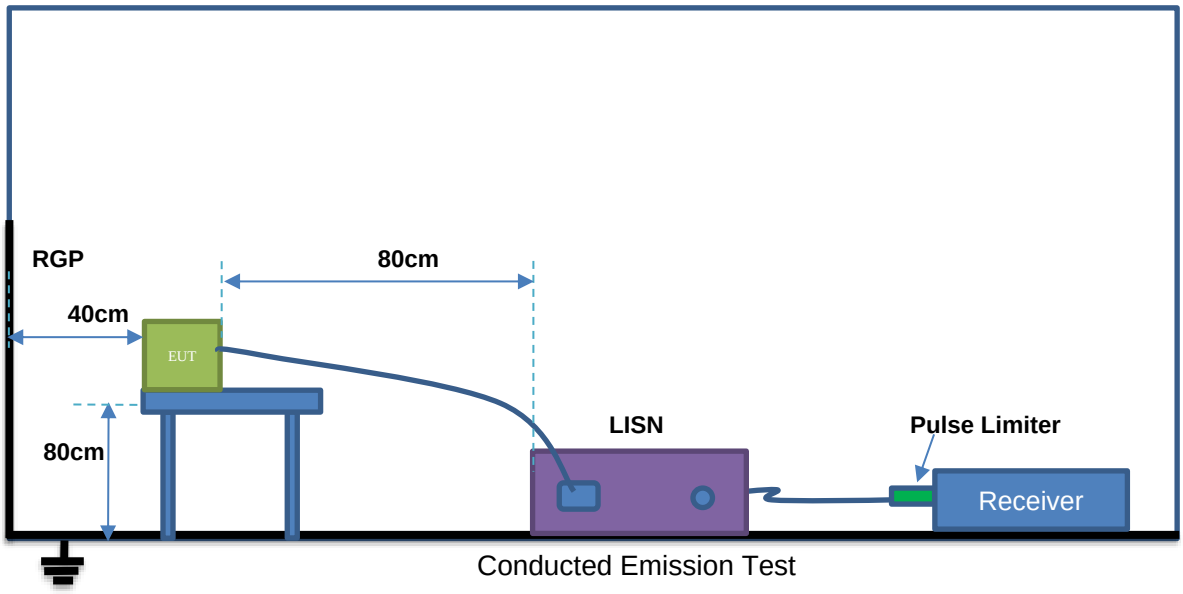


Radiation Test (30MHz – 1GHz)



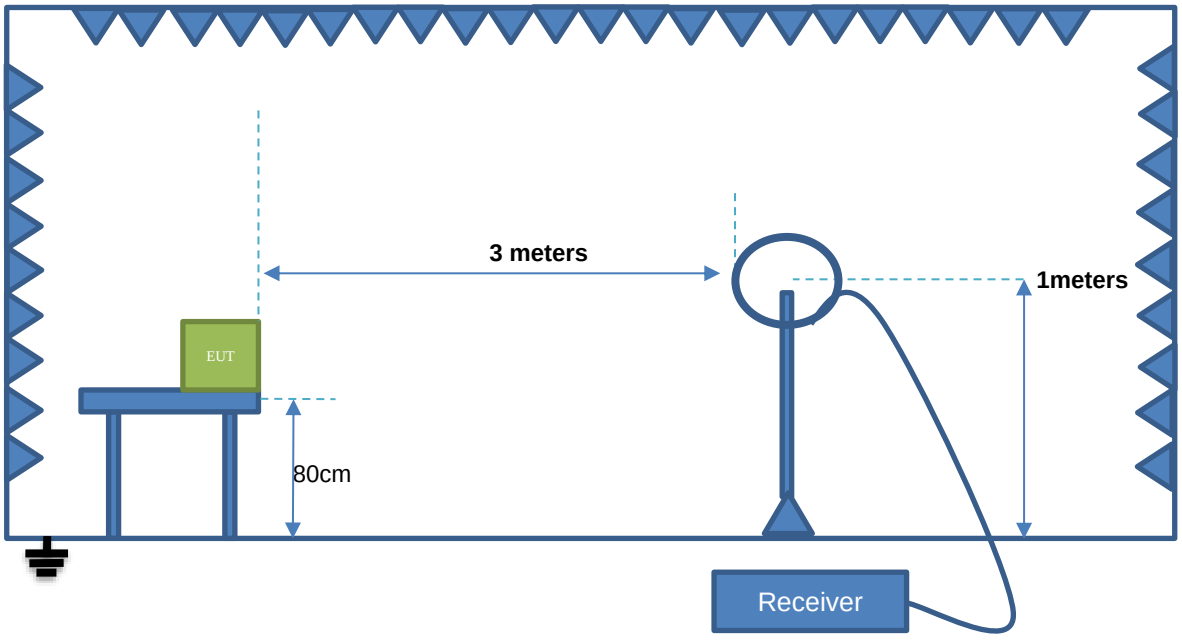
Radiation Test (Above 1GHz)

Test Setup 2



Conducted Emission Test

Test Setup 3



Radiation Test (9k - 30MHz)

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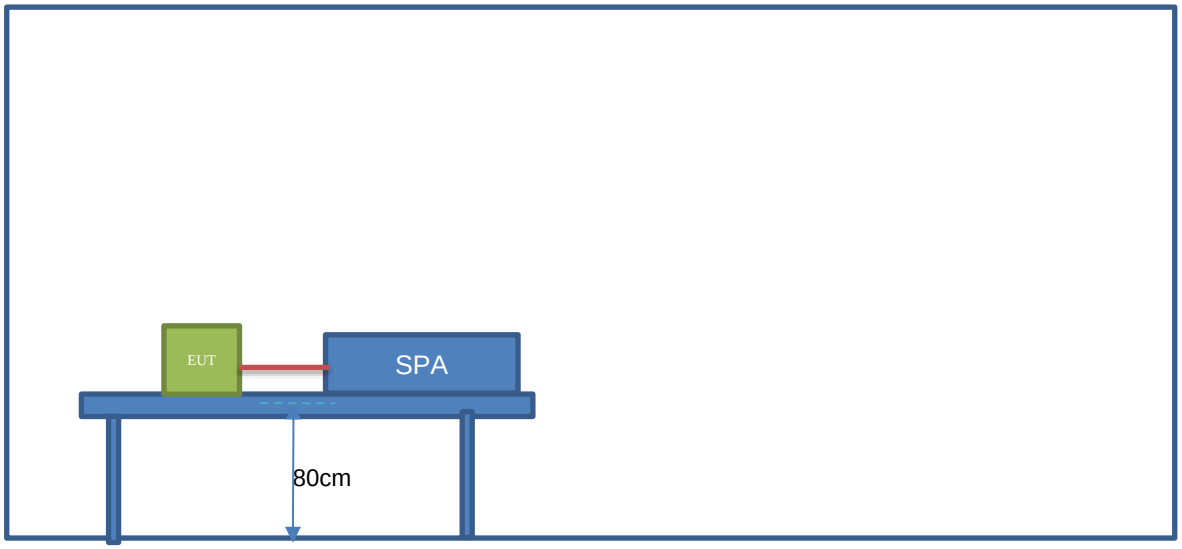
Test Setup 4



1.2 Test Modes

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Pretest Mode	Description	
Mode 1	CH00	GFSK
Mode 2	CH19	
Mode 3	CH39	
Mode 4	Link Mode	

For Conducted & Radiated Emission		
Final Test Mode	Description	
Mode 1	CH00	GFSK
Mode 2	CH19	
Mode 3	CH39	
Mode 4	Link Mode	
Mode 5	Charging Mode	

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2. Test Items

2.1 Antenna Requirements

2.1.1 Relevant Standards

FCC §15.203; RSS-Gen Section 6.8

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.

2.1.2 Antenna Anti-Replacement Construction

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

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

2.2 20dB &99%Bandwidth

2.2.1 Limit

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.215 through 15.257 RSS-Gen Section 6.7 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. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

2.2.2 Test Setup

See section 4.4 for test setup 4. The photo of test setup please refer to ANNEX B

2.2.3 Test Procedure

a) The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.

b) Set to the maximum power setting and enable the EUT transmit continuously.

c) Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel,

RBW ≥ 1% of the 20 dB bandwidth, VBW ≥ RBW,

Sweep = auto, Detector function = peak, Trace = max hold.

d) Measure and record the results in the test report.

2.2.4 Test Result

Please refer to ANNEX A.1

2.3 Fundamental &Radiated Spurious Emission Measurement

2.3.1 Limit

FCC Part15 C Section 15.209 and 15.205, RSS-210, RSS-Gen Section 8.9

FREQUENCY (MHz)	Limit (dBuV/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

2.3.2 Test Setup

See section 4.4 for test setup 3. The photo of test setup please refer to ANNEX B

2.3.3 Test Procedure

a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
g. Test the EUT in the lowest channel,the Highest channel

Note:

Both horizontal and vertical antenna polarities were tested
and performed pretest to three orthogonal axis. The worst case emissions were reported

2.3.4 Test Result

Please refer to ANNEX A.2

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2.4 Conducted Emission

2.4.1 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

2.4.2 Test Setup

See section 4.4 for test setup 2. The photo of test setup please refer to ANNEX B

2.4.3 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.

2.4.4 Test Result

Please refer to ANNEX A.3

NOTE:

Margin = Limit – Level,
Correct Factor = Cable lose + LISN insertion loss, Level= Reading + Correct factor

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2.5 Radiated Spurious Emission

2.5.1 Limit

FCC §15.209&15.225, RSS-210, RSS-Gen Section 8.9

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).

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902 - 928 MHz	50	500
2400 - 2483.5 MHz	50	500
5725 - 5875 MHz	50	500
24.0 - 24.25 GHz	250	2500

2.5.2 Test Setup

See section 4.4 for test setup 1 and 3. The photo of test setup please refer to ANNEX B

2.5.3 Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to

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

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands:
a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)
c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$E = EIRP – 20\log D + 104.8$

where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm D = specified measurement distance in meters.
f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.
As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.
Peak power measurement procedure:

Peak emission levels are measured by setting the instrument as follows:
a)RBW = as specified in Table 1.
b)VBW ≥ 3 x RBW.
c)Detector = Peak.
d)Sweep time = auto.
e)Trace mode = max hold.
f)Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).
Table 1—RBW as a function of frequency

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

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

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

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:
a) The EUT shall be configured to operate at the maximum achievable duty cycle.
b) Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.
c) RBW = 1 MHz (unless otherwise specified).
d) VBW ≥ 3 x RBW.
e) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
f) Averaging type = power (i.e., RMS).
1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
g) Sweep time = auto.
h) Perform a trace average of at least 100 traces.
i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x),

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where x is the duty cycle.
2) If linear voltage averaging mode was used in step f), then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

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

Determining the applicable transmit antenna gain:

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).
Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test:

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.
For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.
The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only

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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

2.5.4 Test Result

Please refer to ANNEX A.4

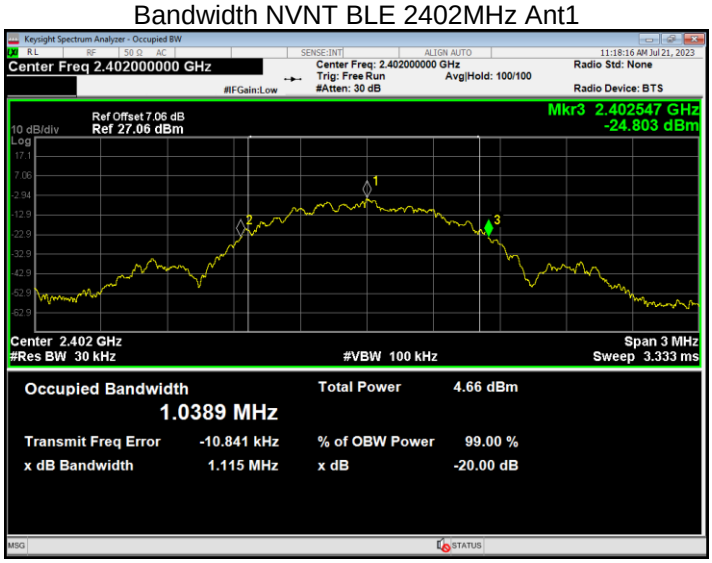
NOTE:
1. Results (dBuV) = Reading (dBuV) + Factor (dB)
The reading level is calculated by software which is not shown in the sheet
2. Factor = Insertion loss + Cable loss
3. Over limit = Results – Limit.

ANNEX A Test Results

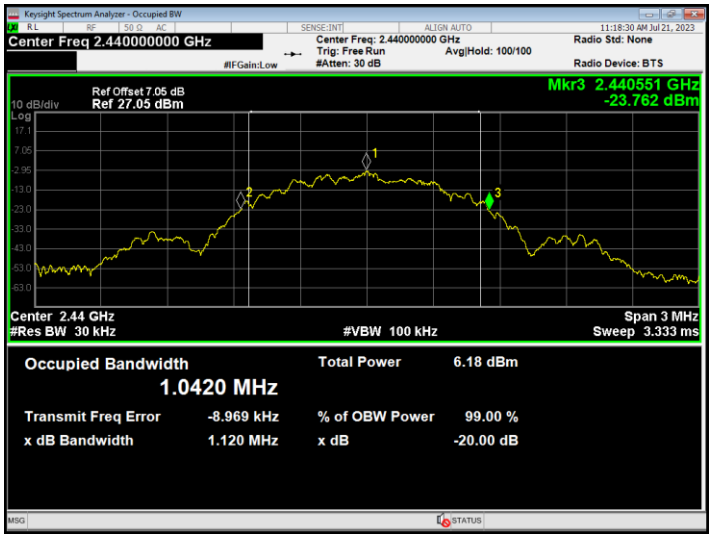
A.1 20dB Bandwidth

Mode	Frequency (MHz)	Antenna	-20 dB Bandwidth (MHz)	99% Bandwidth (MHz)	Verdict
BLE	2402	Ant1	1.115	1.039	Pass
BLE	2440	Ant1	1.120	1.042	Pass
BLE	2480	Ant1	1.122	1.048	Pass

Bandwidth NVNT BLE 2402MHz Ant1



Bandwidth NVNT BLE 2440MHz Ant1



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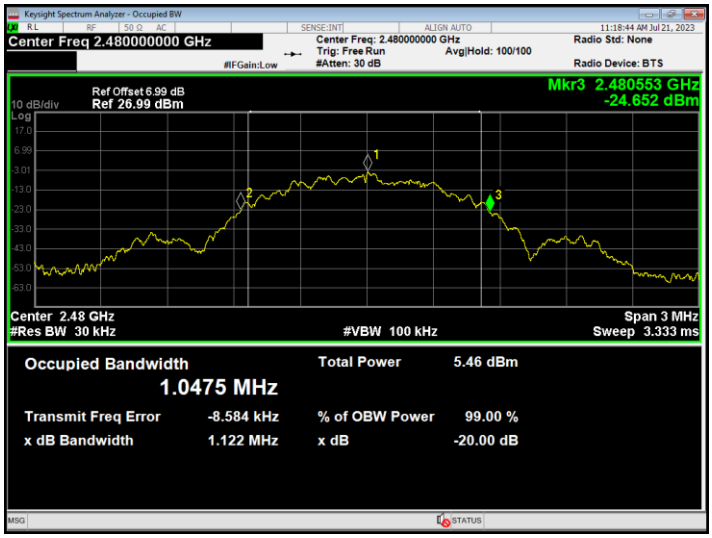
Bandwidth NVNT BLE 2480MHz Ant1



A.2 RADIATED BAND EMISSION MEASUREMENT

GFSK

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
operation frequency:2402									
V	2390.00	76.27	52.12	2.73	27.38	54.26	74	-19.74	PK
V	2390.00	64.95	52.12	2.73	27.38	42.94	54	-11.06	AV
V	2400.00	75.76	52.16	2.78	27.41	53.79	74	-20.21	PK
V	2400.00	64.03	52.16	2.78	27.41	42.06	54	-11.94	AV
H	2390.00	75.89	52.12	2.73	27.38	53.88	74	-20.12	PK
H	2390.00	65.11	52.12	2.73	27.38	43.10	54	-10.90	AV
H	2400.00	75.84	52.16	2.78	27.41	53.87	74	-20.13	PK
H	2400.00	65.11	52.16	2.78	27.41	43.14	54	-10.86	AV

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
operation frequency:2480									
V	2483.50	76.68	52.23	2.86	27.44	54.75	74	-19.25	PK
V	2483.50	65.30	52.23	2.86	27.44	43.37	54	-10.63	AV
V	2500.00	76.16	52.26	2.88	27.49	54.27	74	-19.73	PK
V	2500.00	64.37	52.26	2.88	27.49	42.48	54	-11.52	AV
H	2483.50	76.29	52.23	2.86	27.44	54.36	74	-19.64	PK
H	2483.50	65.45	52.23	2.86	27.44	43.52	54	-10.48	AV
H	2500.00	76.24	52.26	2.88	27.49	54.35	74	-19.65	PK
H	2500.00	65.45	52.26	2.88	27.49	43.56	54	-10.44	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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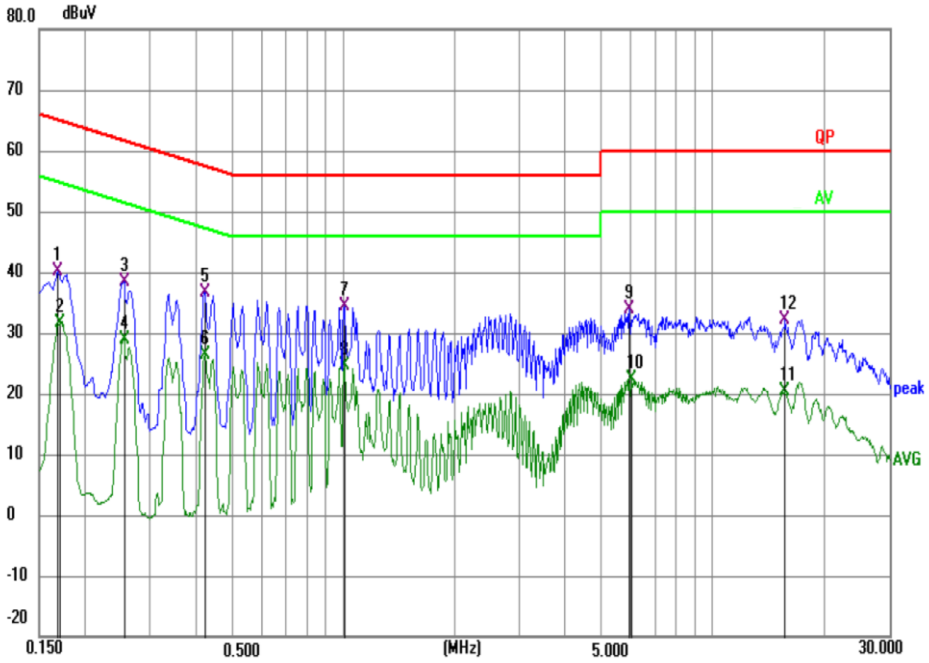
A.3 Conducted Emission

Temperature:	25 ℃	Relative Humidity:	54%
Pressure:	1010hPa	Phase :	L
Test Voltage :	AC 120V/60Hz	Test Mode:	Mode 5



Remark:
Margin = Limit – Level, Correct Factor = Cable lose + LISN insertion loss, Level= Reading + Correct factor

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.168000	30.05	10.13	40.18	65.06	-24.88	QP	P	
2	0.171100	21.52	10.06	31.58	54.91	-23.33	AVG	P	
3	0.253500	29.03	9.32	38.35	61.64	-23.29	QP	P	
4	0.253500	19.58	9.32	28.90	51.64	-22.74	AVG	P	
5 *	0.420000	27.50	9.15	36.65	57.45	-20.80	QP	P	
6	0.420000	17.33	9.15	26.48	47.45	-20.97	AVG	P	
7	1.004000	25.17	9.28	34.45	56.00	-21.55	QP	P	
8	1.004000	15.33	9.28	24.61	46.00	-21.39	AVG	P	
9	5.932500	24.13	9.70	33.83	60.00	-26.17	QP	P	
10	6.027000	12.63	9.71	22.34	50.00	-27.66	AVG	P	
11	15.576000	10.18	10.16	20.34	50.00	-29.66	AVG	P	
12	15.652400	21.96	10.17	32.13	60.00	-27.87	QP	P	

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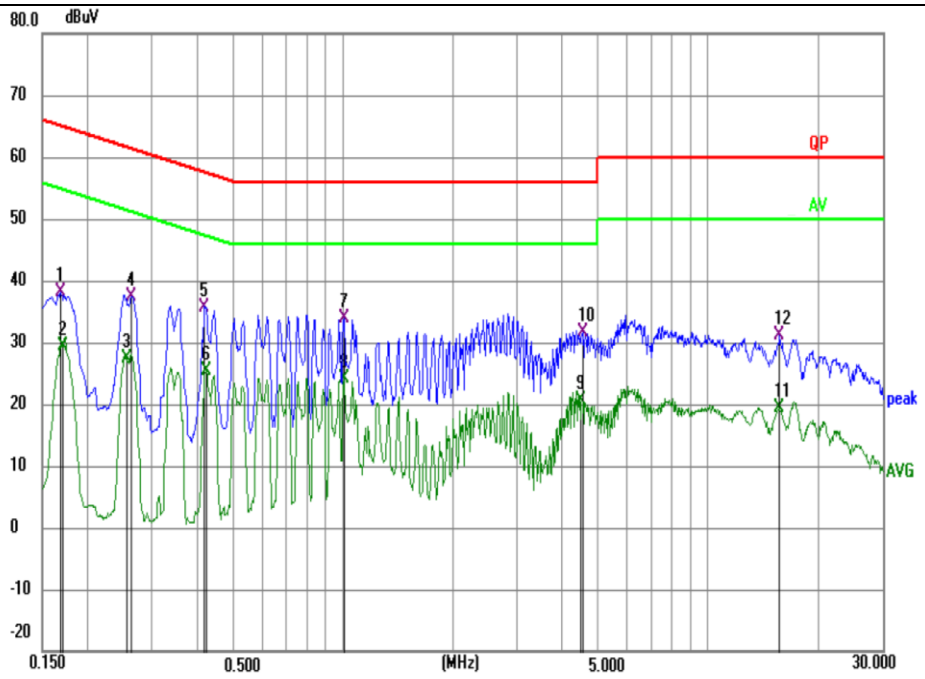
Temperature:	25 ℃	Relative Humidity:	54%
Pressure:	1010hPa	Phase :	N
Test Voltage :	AC 120V/60Hz	Test Mode:	Mode 5



Remark:
Margin = Limit – Level, Correct Factor = Cable lose + LISN insertion loss, Level= Reading + Correct factor

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.168000	28.05	10.13	38.18	65.06	-26.88	QP	P	
2	0.170300	19.34	10.08	29.42	54.95	-25.53	AVG	P	
3	0.253500	18.08	9.32	27.40	51.64	-24.24	AVG	P	
4	0.262500	28.24	9.25	37.49	61.35	-23.86	QP	P	
5 *	0.415300	26.60	9.15	35.75	57.54	-21.79	QP	P	
6	0.420000	16.33	9.15	25.48	47.45	-21.97	AVG	P	
7	1.004000	24.67	9.28	33.95	56.00	-22.05	QP	P	
8	1.004000	14.83	9.28	24.11	46.00	-21.89	AVG	P	
9	4.514700	10.94	9.65	20.59	46.00	-25.41	AVG	P	
10	4.528500	21.97	9.65	31.62	56.00	-24.38	QP	P	
11	15.576000	9.18	10.16	19.34	50.00	-30.66	AVG	P	
12	15.652400	20.96	10.17	31.13	60.00	-28.87	QP	P	

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A.4 Radiated Spurious Emission

9KHz – 30MHz

Temperature:	20℃	Relative Humidtity:	48%
Pressure:	1010 hPa	Test Voltage :	DC 7.4V
Test Mode :	Mode 4	Polarization :	--

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	PASS
--	--	--	--	PASS

NOTE:

The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits(dBuv) + distance extrapolation factor.

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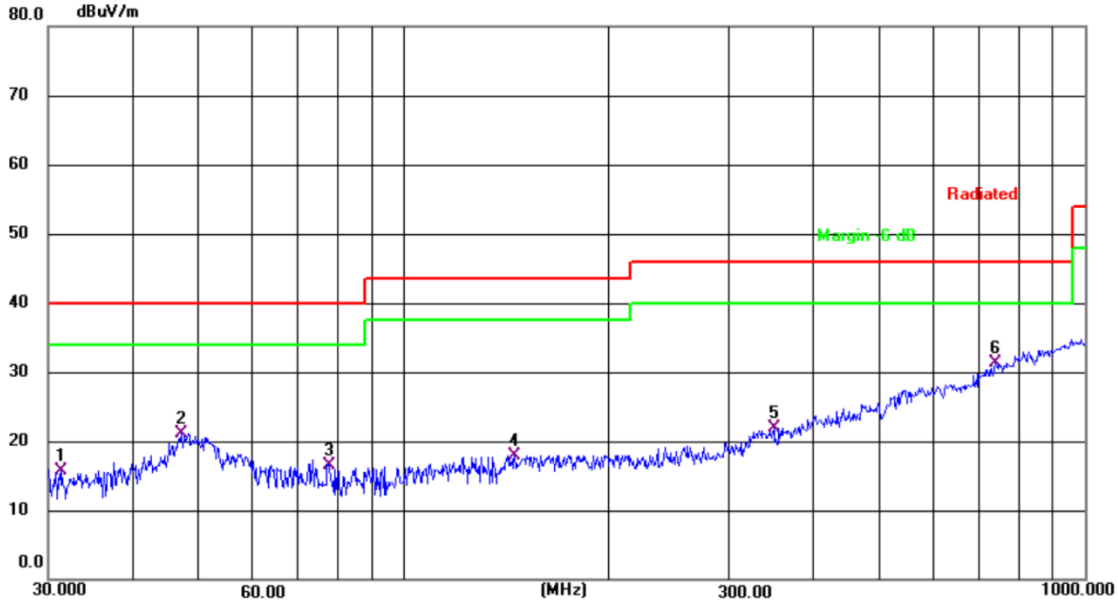
30MHz – 1GHz

Temperature:	26℃	Relative Humidity:	54%
Pressure:	1010 hPa	Polarization :	Horizontal
Test Voltage :	DC 7.4V		
Test Mode :	Mode 4		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		31.3992	30.34	-14.69	15.65	40.00	-24.35	QP
2		47.1597	32.85	-11.80	21.05	40.00	-18.95	QP
3		77.5926	33.69	-17.13	16.56	40.00	-23.44	QP
4		145.3505	34.24	-16.24	18.00	43.50	-25.50	QP
5		349.2500	31.21	-9.22	21.99	46.00	-24.01	QP
6	*	739.6603	33.79	-2.48	31.31	46.00	-14.69	QP

Remark:
Correct Factor = Cable loss + Antenna factor – Preamplifier;
Level = Reading Level + Correct Factor; Margin = Level - Limit;

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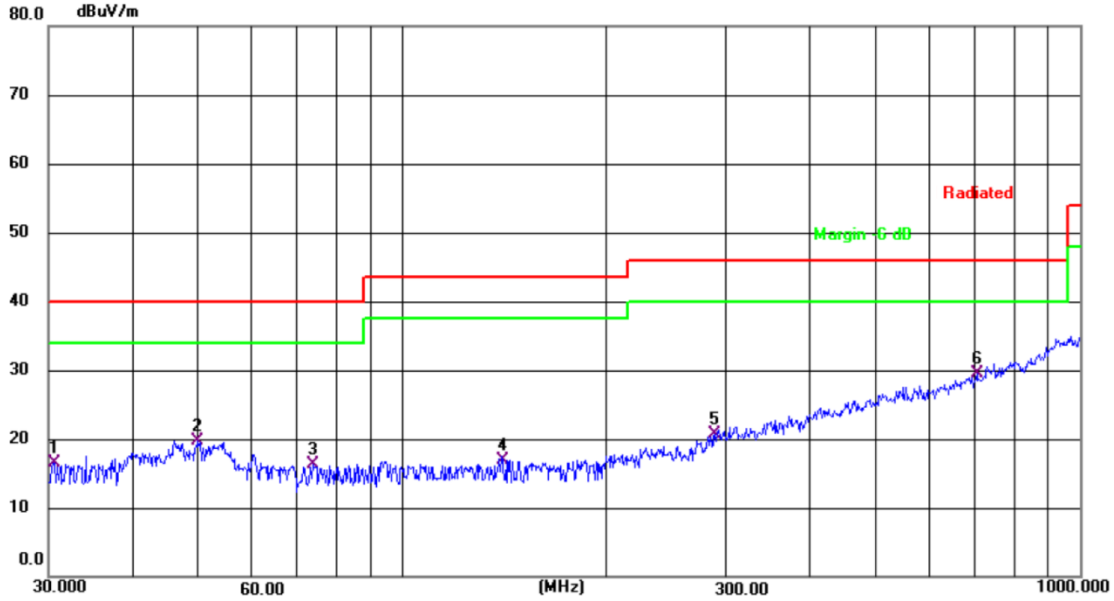
Temperature:	26℃	Relative Humidity:	54%
Pressure:	1010 hPa	Polarization :	Vertical
Test Voltage :	DC 7.4V		
Test Mode :	Mode 4		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		30.6371	31.45	-14.86	16.59	40.00	-23.41	QP
2		49.8813	31.05	-11.41	19.64	40.00	-20.36	QP
3		73.6170	32.74	-16.40	16.34	40.00	-23.66	QP
4		140.3420	33.06	-16.09	16.97	43.50	-26.53	QP
5		289.0020	31.03	-10.33	20.70	46.00	-25.30	QP
6	*	704.2259	32.36	-2.94	29.42	46.00	-16.58	QP

Remark:
Correct Factor = Cable loss + Antenna factor – Preamplifier;
Level = Reading Level + Correct Factor; Margin = Level - Limit;

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1GHz – 25GHz
GFSK

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
operation frequency:2402									
V	2402.00	113.25	52.16	2.78	27.41	91.28	114	-22.72	PK
V	2402.00	103.20	52.16	2.78	27.41	81.23	94	-12.77	AV
V	4804.00	77.57	51.74	3.08	31.25	60.16	74	-13.84	PK
V	4804.00	60.15	51.74	3.08	31.25	42.74	54	-11.26	AV
V	16128.00	54.28	51.56	7.36	41.57	51.65	74	-22.35	PK
H	2402.00	112.68	52.16	2.78	27.41	90.71	114	-23.29	PK
H	2402.00	105.15	52.16	2.78	27.41	83.18	94	-10.82	AV
H	4804.00	76.69	51.74	3.08	31.25	59.28	74	-14.72	PK
H	4804.00	59.39	51.74	3.08	31.25	41.98	54	-12.02	AV
H	16128.00	55.37	51.56	7.36	41.57	52.74	74	-21.26	PK
operation frequency:2440									
V	2440.00	112.55	52.11	2.82	27.47	90.73	114	-23.27	PK
V	2440.00	105.17	52.11	2.82	27.47	83.35	94	-10.65	AV
V	4880.00	77.65	51.77	3.03	31.34	60.25	74	-13.75	PK
V	4880.00	60.24	51.77	3.03	31.34	42.84	54	-11.16	AV
V	16128.00	54.18	51.56	7.36	41.57	51.55	74	-22.45	PK
H	2440.00	112.88	52.11	2.82	27.47	91.06	114	-22.94	PK
H	2440.00	104.28	52.11	2.82	27.47	82.46	94	-11.54	AV
H	4880.00	76.20	51.77	3.03	31.34	58.80	74	-15.20	PK
H	4880.00	59.59	51.77	3.03	31.34	42.19	54	-11.81	AV
H	16128.00	55.87	51.56	7.36	41.57	53.24	74	-20.76	PK
operation frequency:2480									
V	2480.00	113.36	52.23	2.86	27.44	91.43	114	-22.57	PK
V	2480.00	106.40	52.23	2.86	27.44	84.47	94	-9.53	AV
V	4960.00	78.28	51.69	3.05	31.39	61.03	74	-12.97	PK
V	4960.00	60.96	51.69	3.05	31.39	43.71	54	-10.29	AV
V	16128.00	54.57	51.56	7.36	41.57	51.94	74	-22.06	PK
H	2480.00	113.19	52.23	2.86	27.44	91.26	114	-22.74	PK
H	2480.00	105.86	52.23	2.86	27.44	83.93	94	-10.07	AV
H	4960.00	77.37	51.69	3.05	31.39	60.12	74	-13.88	PK
H	4960.00	59.89	51.69	3.05	31.39	42.64	54	-11.36	AV
H	16128.00	54.37	51.56	7.36	41.57	51.74	74	-22.26	PK

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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ANNEX B TEST SETUP PHOTOS

Please see setup photos file.

ANNEX C EUT EXTERNAL PHOTOS

ANNEX D EUT INTERNAL PHOTOS

Please see internal photos file.

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