FCC/ISED TEST REPORT

FOR

Horseware Ireland

IceVibe-CX

Test Model: IceVibe-CX-3

Additional Model NO. : IceVibe-CX-1, IceVibe-CX-2

Prepared for	:	Horseware Ireland
Address	:	Finnabair Business Park , Dundalk , Co Louth , Ireland

Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd
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Date of receipt of test sample	:	February 09, 2018
Number of tested samples	:	1
Sample number	:	Prototype
Date of Test	:	February 09, 2018- March 27, 2018
Date of Report	:	March 27, 2018

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FCC/ISED TEST REPORT
FCC CFR 47 PART 15 C(15.249)/ RSSS-210 Issue 9 / RSS-Gen Issue 4

Report Reference No.	**:**	**LCS180127130AEA**
Date of Issue.....	:	March 27, 2018
Testing Laboratory Name.....	**:**	**Shenzhen LCS Compliance Testing Laboratory Ltd.**
Address.....	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Testing Location/ Procedure	:	Full application of Harmonised standards ■ Partial application of Harmonised standards □ Other standard testing method □
Applicant's Name	**:**	**Horseware Ireland**
Address.....	:	Finnabair Business Park , Dundalk , Co Louth , Ireland
Test Specification		
Standard	:	FCC CFR 47 PART 15 C(15.249) / ANSI C63.10: 2013 RSSS-210 Issue 9 / RSS-Gen Issue 4
Test Report Form No.....	:	LCSEMC-1.0
TRF Originator.....	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF.....	:	Dated 2011-03

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Test Item Description.....	**:**	**IceVibe-CX**
Trade Mark	:	Horseware
Test Model.....	:	IceVibe-CX-3
Ratings.....	:	DC 3.7V by Li-ion Battery (340mAh), Recharge Voltage: DC 5V/1A
Result	**:**	**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Dick Su	Calvin Weng	Gavin Liang
Dick Su/ File administrators	Calvin Weng/ Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS180127130AEA	March 27, 2018 Date of issue

EUT.....	: IceVibe-CX
Test Model.....	: IceVibe-CX-3
Applicant.....	**: Horseware Ireland**
Address.....	: Finnabair Business Park , Dundalk , Co Louth , Ireland
Telephone.....	: /
Fax.....	: /
Manufacturer.....	**: Sentrix Technology Ltd.**
Address.....	: Studio F, 3/F, Centre 600, 82 King Lam Street, Cheung Sha Wan, Kowloon, Hong Kong.
Telephone.....	: /
Fax.....	: /
Factory.....	**: Sentrix Technology Ltd.**
Address.....	: Studio F, 3/F, Centre 600, 82 King Lam Street, Cheung Sha Wan, Kowloon, Hong Kong.
Telephone.....	: /
Fax.....	: /

Test Result	**Positive**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Revision History

Revision	Issue Date	Revisions	Revised By
00	March 27, 2018	Initial Issue	Gavin Liang

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1. GENERAL INFORMATION

1.1 Description of Device (EUT)

EUT	:	IceVibe-CX
Test Model	:	IceVibe-CX-3
Hardware Version	:	PCBA-RC4M-TX-R4 / PCBA-RC4M-RX-R6
Software Version	:	MCUX-RC4M-FX-0FD741
Power Supply	:	DC 3.7V by Li-ion Battery (340mAh), Recharge Voltage: DC 5V/1A
Frequency Range	:	2412MHz, 2429MHz, 2451MHz, 2468MHz
Channel Number	:	4channel
Modulation Type	:	GFSK
Antenna Description	:	Internal Antenna, 0dBi (Max.)

1.2. Support Equipment List

Manufacturer	Description	Model	Serial Number	Certificate
--	--	--	--	--

1.3. External I/O

I/O Port Description	Quantity	Cable
Micro USB	1	--

1.4. Description of Test Facility

FCC Registration Number. is 254912.
Industry Canada Registration Number. is 9642A-1.
ESMD Registration Number. is ARCB0108.
UL Registration Number. is 100571-492.
TUV SUD Registration Number. is SCN1081.
TUV RH Registration Number. is UA 50296516-001
NVLAP Registration Code is 600167-0

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.5. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the LCS quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	3.10dB	(1)
		30MHz~200MHz	2.96dB	(1)
		200MHz~1000MHz	3.10dB	(1)
		1GHz~26.5GHz	4.00dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	1.63dB	(1)
Power disturbance	:	30MHz~300MHz	1.60dB	(1)

(1). This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.7. Description of Test Modes

The EUT operates in the unlicensed ISM band at 2.4GHz. The following operating modes were applied for the related test items.

All test modes were tested, only the result of the worst case was recorded in the report. It was pre-tested on the positioned of each 3 axis. The worst case was found positioned on X-plane.

Mode of Operations	Transmitting Frequency (MHz)
GFSK	2412, 2429, 2451, 2468
For Conducted Emission	
Test Mode	TX Mode
For Radiated Emission	
Test Mode	TX Mode

***Note: Using a temporary antenna connector for the EUT when the conducted measurements are performed.

2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10: 2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd.

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.249 under the FCC Rules Part 15 Subpart C and RSS-Gen, RSS-210 under ISED Rules.

2.3. General Test Procedures

2.3.1 Conducted Emissions

According to the requirements in Section 6.2 of ANSI C63.10: 2013, AC power-line conducted emissions shall be measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table and the turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10: 2013.

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3. Connection Diagram of Test System

3.1. Justification

The system was configured for testing in a continuous transmit condition.

3.2. EUT Exercise Software

Powered on the EUT and press the left and right four buttons for 2 seconds into the fixed frequency mode. Then press the left button to switch the next channel.

3.3. Special Accessories

N/A

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.203	RSS-Gen §8.3	Antenna Requirement	Compliant
§15.207(a)	RSS-Gen §8.8	Power Line Conducted Emissions	Compliant
§15.205(a), §15.209(a), §15.249(a), §15.249(c)	RSS 210 B.10 (b); RSS-Gen § 8.9	Radiated Emissions Measurement	Compliant
§15.249 (d)	RSS210 B.10(b) RSS-Gen § 8.10	Band Edges Measurement	Compliant
§2.1049	RSS-Gen § 6.7	99% and 20 dB Bandwidth	Compliant

5. ANTENNA REQUIREMENT

5.1. Standard Applicable

According to § 15.203 and RSS-Gen, 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.

5.2. Antenna Connected Construction

The antenna used for transmitting is permanently attached and no consideration of replacement. Please see EUT photo for details.

Result: Compliance.

6. Power line conducted emissions

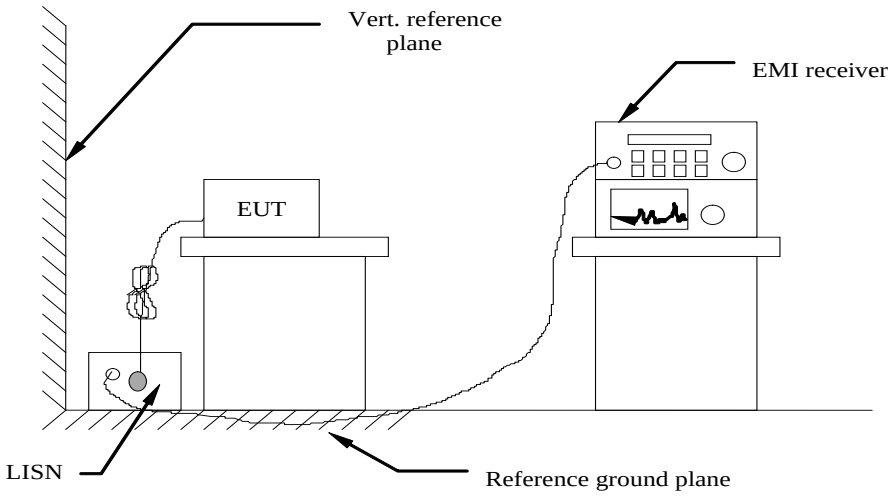
6.1. Standard Applicable

According to §15.207 (a) & RSS-Gen § 8.8: For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

6.2. Block Diagram of Test Setup



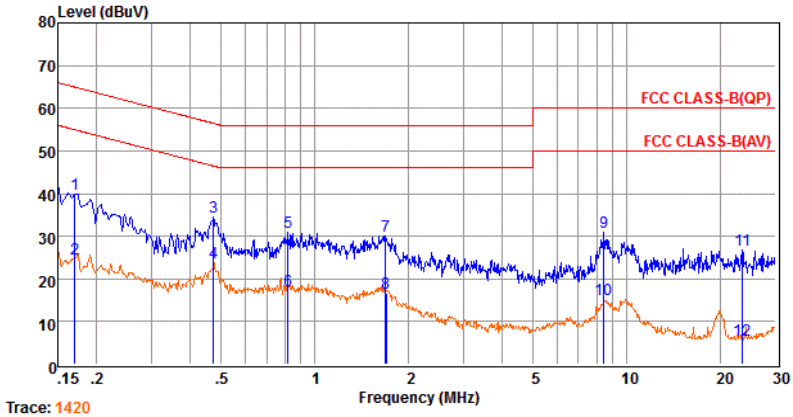
6.3. Test Results

PASS.

The test data please refer to following page.

AC Conducted Emission of power adapter @ AC 120V/60Hz TX-High Channel (worst case)

Line

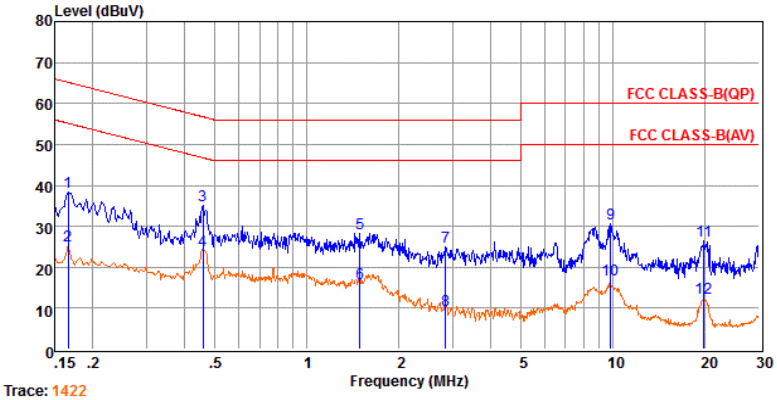


Trace: 1420
Env. Ins: 24*/56%
Pol: LINE

	Freq MHz	Reading dBuV	LISNFac dB	CabLos dB	Aux2Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.17	20.17	9.60	0.02	10.00	39.79	64.94	-25.15	QP
2	0.17	5.20	9.60	0.02	10.00	24.82	54.94	-30.12	Average
3	0.47	14.86	9.62	0.04	10.00	34.52	56.45	-21.93	QP
4	0.47	4.06	9.62	0.04	10.00	23.72	46.45	-22.73	Average
5	0.82	11.36	9.64	0.04	10.00	31.04	56.00	-24.96	QP
6	0.82	-2.34	9.64	0.04	10.00	17.34	46.00	-28.66	Average
7	1.69	10.49	9.64	0.05	10.00	30.18	56.00	-25.82	QP
8	1.69	-2.95	9.64	0.05	10.00	16.74	46.00	-29.26	Average
9	8.46	11.18	9.69	0.08	10.00	30.95	60.00	-29.05	QP
10	8.46	-4.50	9.69	0.08	10.00	15.27	50.00	-34.73	Average
11	23.51	7.03	9.71	0.13	10.00	26.87	60.00	-33.13	QP
12	23.51	-14.30	9.71	0.13	10.00	5.54	50.00	-44.46	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Neutral



Trace: 1422
Env. Ins: 24*/56%
Pol: NEUTRAL

	Freq MHz	Reading dBuV	LISNFac dB	CabLos dB	Aux2Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.17	18.70	9.66	0.02	10.00	38.38	65.16	-26.78	QP
2	0.17	5.52	9.66	0.02	10.00	25.20	55.16	-29.96	Average
3	0.46	15.56	9.62	0.04	10.00	35.22	56.71	-21.49	QP
4	0.46	4.39	9.62	0.04	10.00	24.05	46.71	-22.66	Average
5	1.49	8.59	9.63	0.05	10.00	28.27	56.00	-27.73	QP
6	1.49	-3.48	9.63	0.05	10.00	16.20	46.00	-29.80	Average
7	2.84	5.24	9.64	0.06	10.00	24.94	56.00	-31.06	QP
8	2.84	-10.20	9.64	0.06	10.00	9.50	46.00	-36.50	Average
9	9.81	10.86	9.72	0.08	10.00	30.66	60.00	-29.34	QP
10	9.81	-2.85	9.72	0.08	10.00	16.95	50.00	-33.05	Average
11	19.84	6.61	9.88	0.12	10.00	26.61	60.00	-33.39	QP
12	19.85	-7.54	9.88	0.12	10.00	12.46	50.00	-37.54	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

****Note: Pre-scan all modes and recorded the worst case results in this report (TX-High Channel).*

7. RADIATED EMISSION MEASUREMENT

7.1. Standard Applicable

According to FCC § 15.249: Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) and 15.249 limit in the table below has to be followed.

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

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
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

According to RSS-210 B.10:

The field strength of fundamental and harmonic emissions, measured at 3 m, shall not exceed 50 mV/m and 0.5 mV/m respectively.
The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.
Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

7.2. Instruments Setting

Please refer to equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

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Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

7.3. Test Procedure

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

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3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

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4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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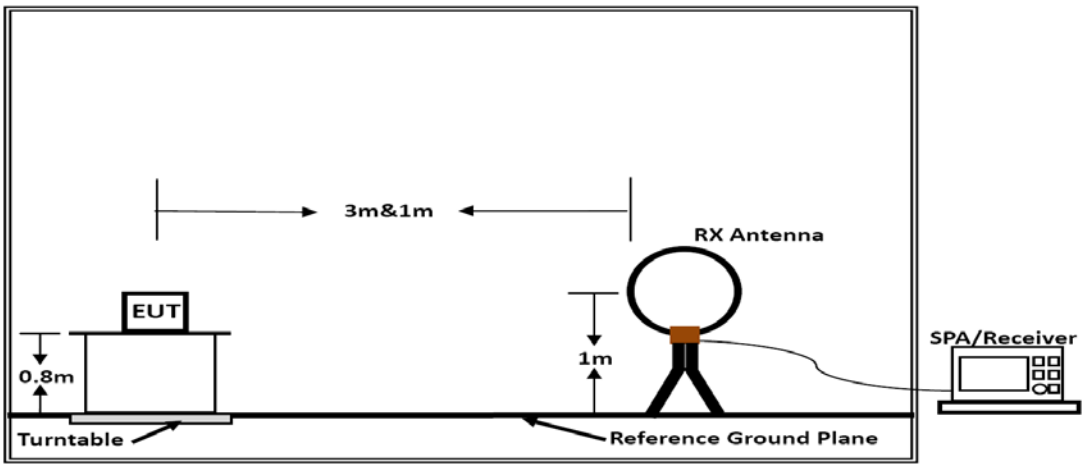
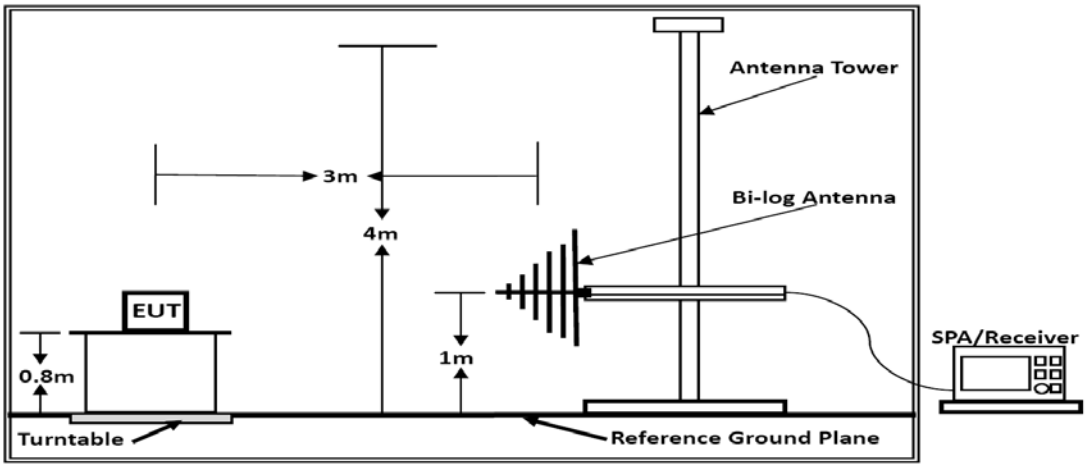
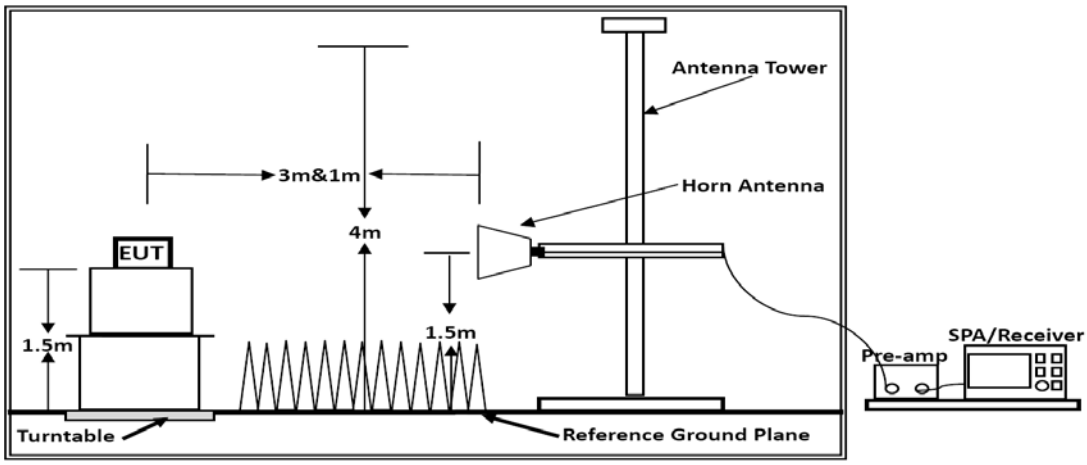
7.4. Block Diagram of Test Setup



Below 30MHz



Below 1GHz



Above 1GHz

7.5 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

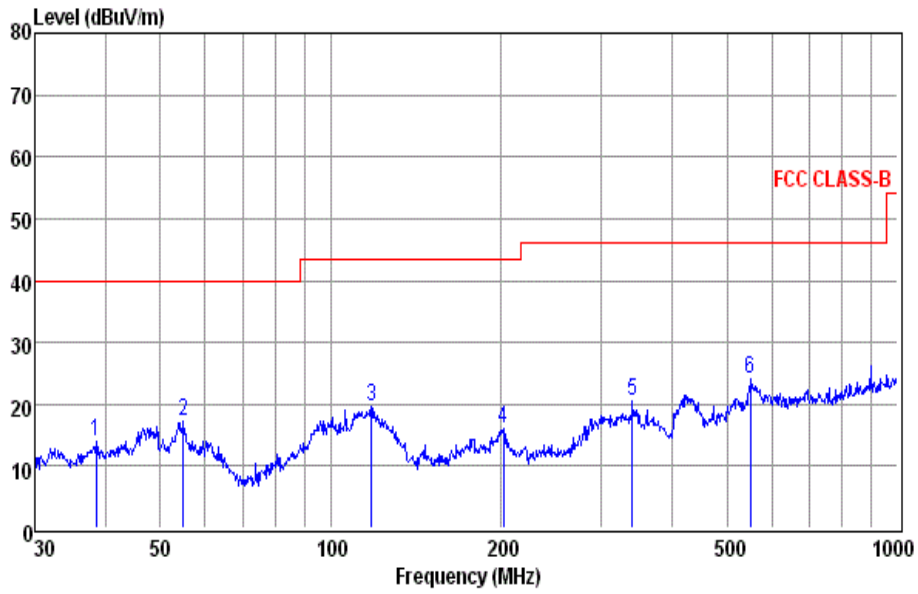
7.6. Test Results of Radiated Emissions (9 KHz~30 MHz)

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:
The amplitude of spurious emissions which are attenuated by more than 20 dB 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.

7.7. Test Results of Radiated Emissions (30 MHz – 1000 MHz)

Vertical

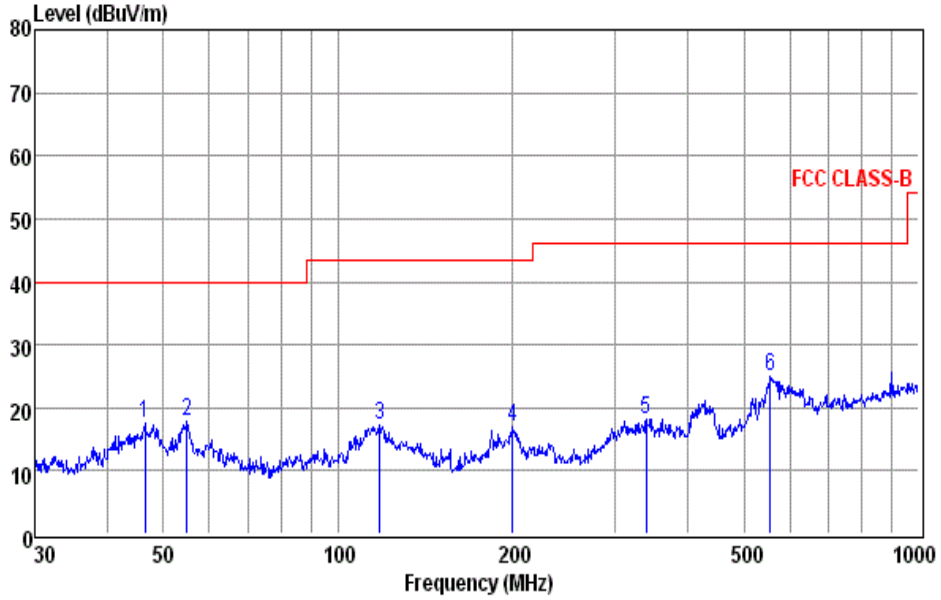


Env./Ins: 24℃/56%
pol: VERTICAL

	Freq MHz	Reading dBuV	CabLos dB	Antfac dB/m	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	38.48	0.53	0.38	13.19	14.10	40.00	-25.90	QP
2	54.83	3.62	0.46	13.03	17.11	40.00	-22.89	QP
3	117.77	8.22	0.64	10.87	19.73	43.50	-23.77	QP
4	201.39	4.65	0.82	10.61	16.08	43.50	-27.42	QP
5	340.78	5.27	1.12	14.13	20.52	46.00	-25.48	QP
6	550.95	5.14	1.39	17.53	24.06	46.00	-21.94	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Horizontal



Env./Ins: 24℃/56%
pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	46.50	3.71	0.35	13.46	17.52	40.00	-22.48	QP
2	54.83	4.45	0.46	13.03	17.94	40.00	-22.06	QP
3	117.77	5.65	0.64	10.87	17.16	43.50	-26.34	QP
4	199.99	5.48	0.84	10.57	16.89	43.50	-26.61	QP
5	339.59	2.86	1.16	14.10	18.12	46.00	-27.88	QP
6	554.83	6.01	1.46	17.61	25.08	46.00	-20.92	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Note:
1). Pre-scan all modes and recorded the worst case results in this report (GFSK (Mid Channel)).
2). Emission level (dBuV/m) = 20 log Emission level (uV/m).
3). Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

7.8. Results for Radiated Emissions (Above 1GHz)

Field Strength of Fundamental (TX-2412MHz)						
Frequency (MHz)	Pol.	Measure Result (PK, dBuV/m)	Measure Result (AVG, dBuV/m)	Peak Limit (dBuV/m)	AVG Limit (dBuV/m)	Result
2412	H	82.83	72.21	114	94	Pass
2412	V	80.11	71.34	114	94	Pass

Freq. MHz	Reading Level dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4824.00	54.88	33.06	35.04	3.94	56.84	74.00	-17.16	Peak	Horizontal
4824.00	37.56	33.06	35.04	3.94	39.52	54.00	-14.48	Average	Horizontal
4824.00	53.01	33.06	35.04	3.94	54.97	74.00	-19.03	Peak	Vertical
4824.00	38.90	33.06	35.04	3.94	40.86	54.00	-13.14	Average	Vertical

Field Strength of Fundamental (TX-2429MHz)						
Frequency (MHz)	Pol.	Measure Result (PK, dBuV/m)	Measure Result (AVG, dBuV/m)	Peak Limit (dBuV/m)	AVG Limit (dBuV/m)	Result
2429	H	84.37	71.17	114	94	Pass
2429	V	79.93	69.80	114	94	Pass

Freq. MHz	Reading Level dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4858.00	53.38	33.06	35.04	3.94	55.34	74.00	-18.66	Peak	Horizontal
4858.00	37.90	33.06	35.04	3.94	39.86	54.00	-14.14	Average	Horizontal
4858.00	52.79	33.06	35.04	3.94	54.75	74.00	-19.25	Peak	Vertical
4858.00	39.46	33.06	35.04	3.94	41.42	54.00	-12.58	Average	Vertical

Field Strength of Fundamental (TX-2468MHz)						
Frequency (MHz)	Pol.	Measure Result (PK, dBuV/m)	Measure Result (AVG, dBuV/m)	Peak Limit (dBuV/m)	AVG Limit (dBuV/m)	Result
2468	H	82.47	73.65	114	94	Pass
2468	V	80.00	69.20	114	94	Pass

Freq. MHz	Reading Level dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4936.00	53.10	33.26	35.14	3.98	55.20	74.00	-18.80	Peak	Horizontal
4936.00	36.45	33.26	35.14	3.98	38.55	54.00	-15.45	Average	Horizontal
4936.00	48.13	33.26	35.14	3.98	50.23	74.00	-23.77	Peak	Vertical
4936.00	42.05	33.26	35.14	3.98	44.15	54.00	-9.85	Average	Vertical

Notes:

1). Measuring frequencies from 9 KHz - 10th harmonic (ex. 26GHz), No emission found between lowest internal used/generated frequency to 30 MHz.

2). Radiated emissions measured in frequency range from 9 KHz - 10th harmonic (ex. 26GHz) were made with an instrument using Peak detector mode.

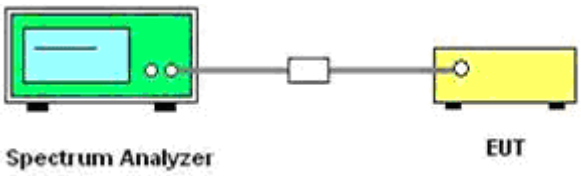
3). 18~25 GHz at least have 20dB margin. No recording in the test report.

7.7. Results for Band edge Testing

7.7.1 Standard Applicable

According to FCC §15.249 (d): Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
According to RSS-210 B.10 (b): Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

7.7.2. Test Setup Layout



7.7.3. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of Spectrum Analyzer.

7.7.4. Test Procedures

According to ANSI C63.10:2013 Field Strength Approach (linear terms):

$eirp = p_t \times g_t = (E \times d)^2/30$

Where:

p_t = transmitter output power in watts,

g_t = numeric gain of the transmitting antenna (unitless),

E = electric field strength in V/m,

d = measurement distance in meters (m).

$erp = eirp/1.64 = (E \times d)^2/(30 \times 1.64)$

Where all terms are as previously defined.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=1/B for Peak detector.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

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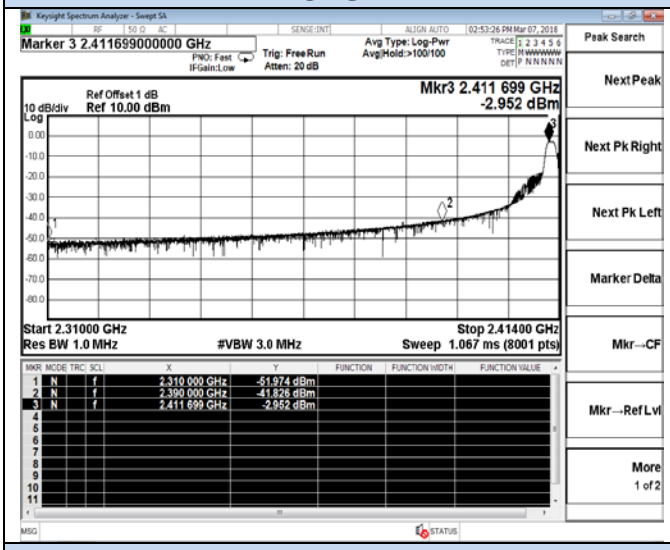
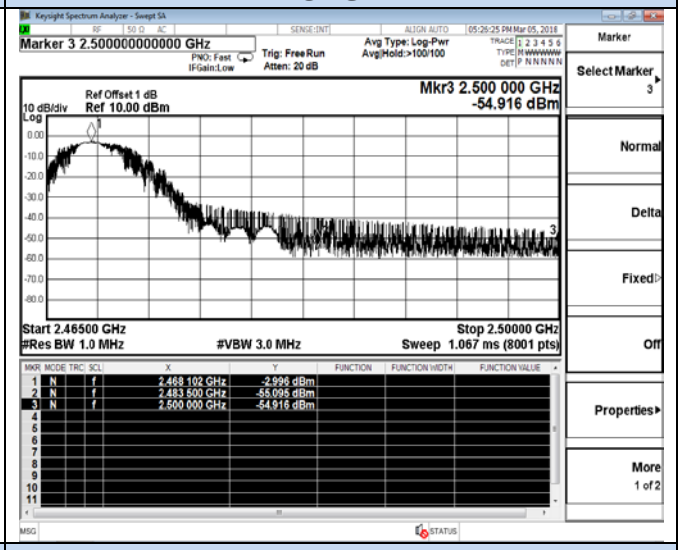
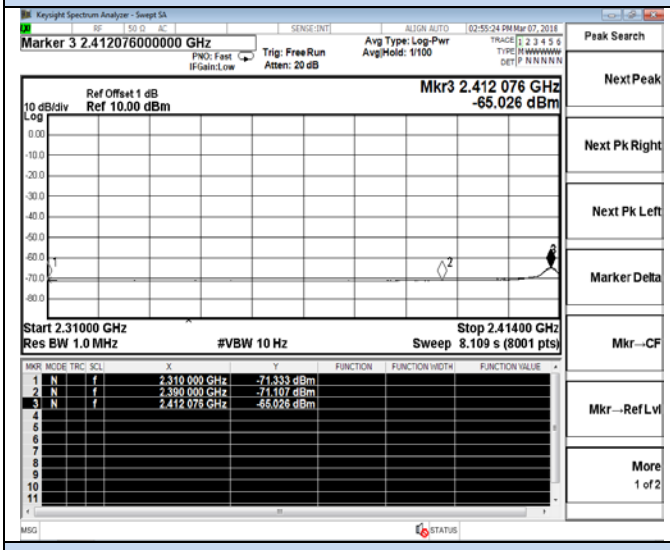
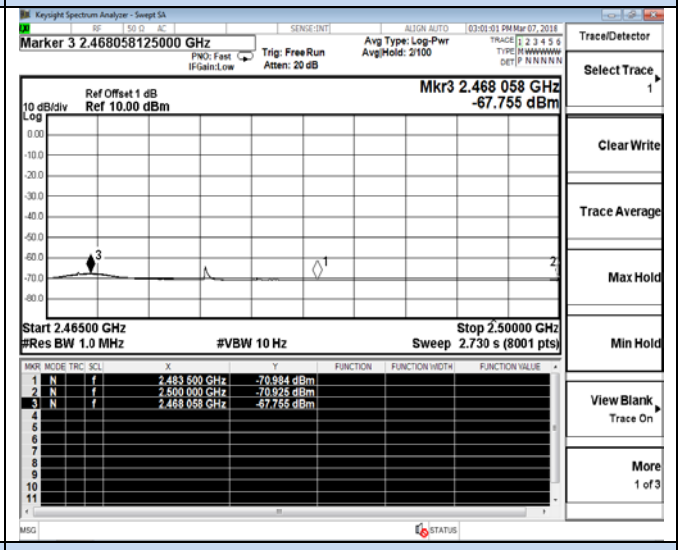
8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10. Compare the resultant electric field strength level to the applicable regulatory limit.
11. Perform radiated spurious emission test duress until all measured frequencies were complete.

7.7.5. Measuring Instruments and Setting

GFSK							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-51.974	2.000	0.000	45.286	Peak	74.00	PASS
2310.000	-71.333	2.000	0.000	25.927	AV	54.00	PASS
2390.000	-41.826	2.000	0.000	55.434	Peak	74.00	PASS
2390.000	-71.107	2.000	0.000	26.153	AV	54.00	PASS
2483.500	-55.095	2.000	0.000	42.165	Peak	74.00	PASS
2483.500	-70.984	2.000	0.000	26.276	AV	54.00	PASS
2500.000	-54.916	2.000	0.000	42.344	Peak	74.00	PASS
2500.000	-70.925	2.000	0.000	26.335	AV	54.00	PASS

Remark:
1. *The other emission levels were very low against the limit.*
2. *The average measurement was not performed when the peak measured data under the limit of average detection.*
3. *Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;*
4. *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.*
5. *Please refer to following test plots;*

Restrict-Band Band-edge measurements for radiated emissions

GFSK	GFSK
	
2412 MHz – Peak	2468 MHz – Peak
	
2412 MHz – Average	2468 MHz – Average

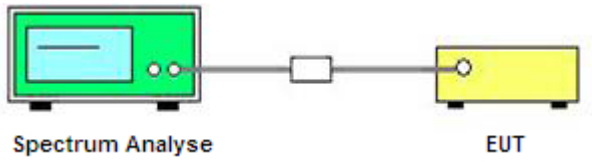
8. 99% Occupied Bandwidth and 20 dB Bandwidth Measurement

8.1. Standard Applicable

According to § 2.1049 and RSS-Gen section 6.7 “The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.”

In some cases, the “x dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

8.2. Block Diagram of Test Setup



8.3. Test Procedure

Use the following spectrum analyzer settings:

Span = 3MHz

RBW = 30KHz

VBW = 100KHz

Sweep = auto

Detector function = peak

Trace = max hold

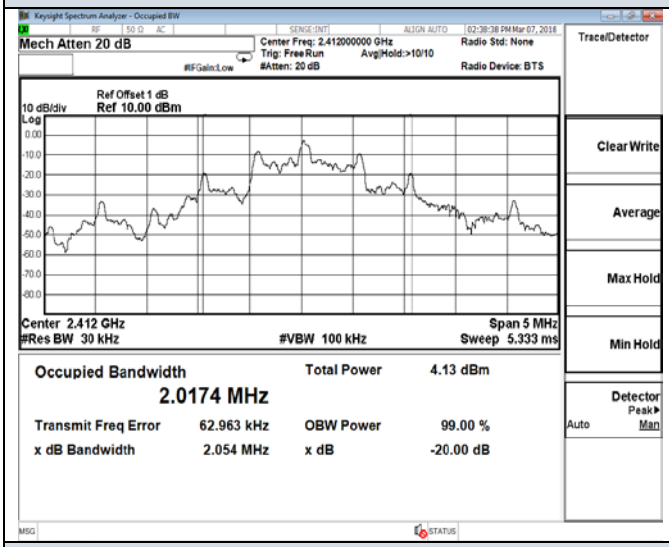
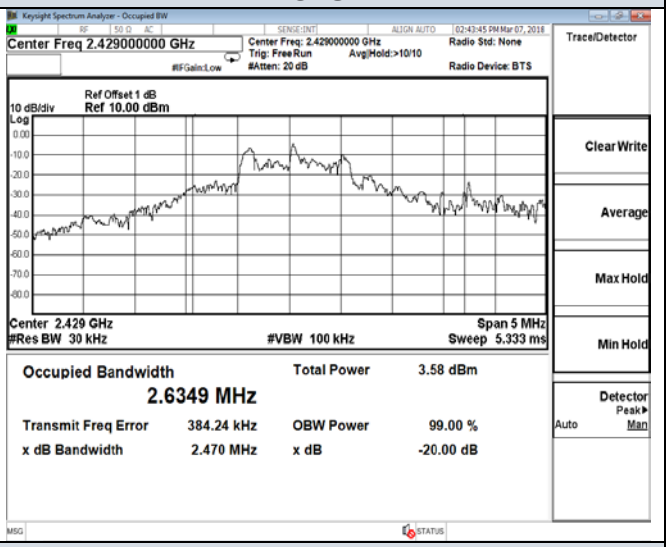
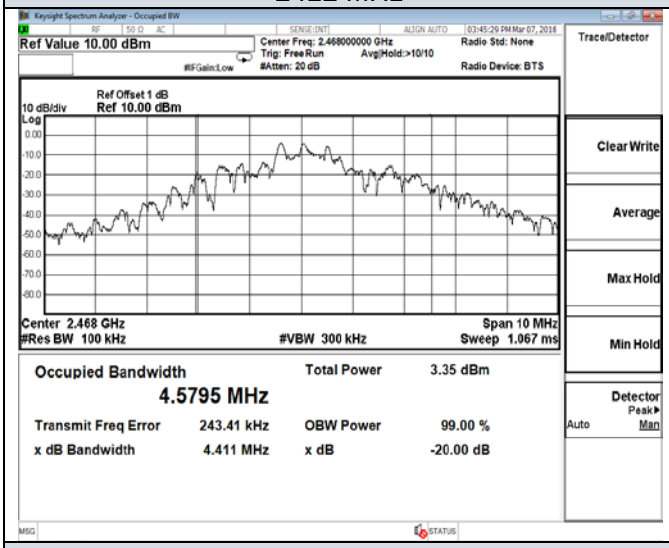
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

8.4. Test Results

Test Result of 99% and 20dB Bandwidth Measurement			
Test Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)	Limit (MHz)
2412	2.054	2.0174	Non-Specified
2429	2.470	2.6349	Non-Specified
2468	4.411	4.5795	Non-Specified

Remark:

1. *Test results including cable loss;*
2. *Please refer following test plots;*

20dB Bandwidth and 99% Bandwidth	
	GFSK
	
2412 MHz	2429 MHz
	
2468 MHz	

9. List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	June 18,2017	June 17,2018
Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	9kHz~40GHz	July 16,2017	July 15,2018
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	June 18,2017	June 17,2018
LISN (Support Unit)	EMCO	3819/2NM	9703-1839	9KHz-30MHz	June 18,2017	June 17,2018
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	June 18,2017	June 17,2018
ISN	SCHAFFNER	ISN ST08	21653	9KHz-30MHz	June 18,2017	June 17,2018
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-40 GHz 3m	June 18,2017	June 17,2018
Amplifier	SCHAFFNER	COA9231A	18667	9kHz-2GHzz	June 18,2017	June 17,2018
Amplifier	Agilent	8449B	3008A02120	1GHz-26.5GHz	July 16,2017	July 15,2018
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	July 16,2017	July 15,2018
Spectrum Analyzer	Agilent	E4407B	MY41440292	9k-26.5GHz	July 16,2017	July 15,2018
MAX Signal Analyzer	Agilent	N9020A	MY50510140	20Hz~26.5GHz	Oct. 27, 2017	Oct. 26, 2018
Loop Antenna	R&S	HFH2-Z2	860004/001	9k-30MHz	June 18,2017	June 17,2018
By-log Antenna	SCHWARZBECK	VULB9163	9163-470	30MHz-1GHz	June 10,2017	June 09,2018
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	June 10,2017	June 09,2018
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	15GHz-40GHz	June 10,2017	June 09,2018
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	June 18,2017	June 17,2018
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz-40GHz	June 18,2017	June 17,2018
Power Meter	R&S	NRVS	100444	DC-40GHz	June 18,2017	June 17,2018
Power Sensor	R&S	NRV-Z51	100458	DC-30GHz	June 18,2017	June 17,2018
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	June 18,2017	June 17,2018
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	June 18,2017	June 17,2018
RF CABLE-2m	JYE Bao	RG142	CB035-2m	20MHz-1GHz	June 18,2017	June 17,2018
Note: All equipment through GRGT EST calibration						

10. TEST SETUP PHOTOGRAPHS

10.1. Photo of Radiated Emissions Measurement

Fig. 1

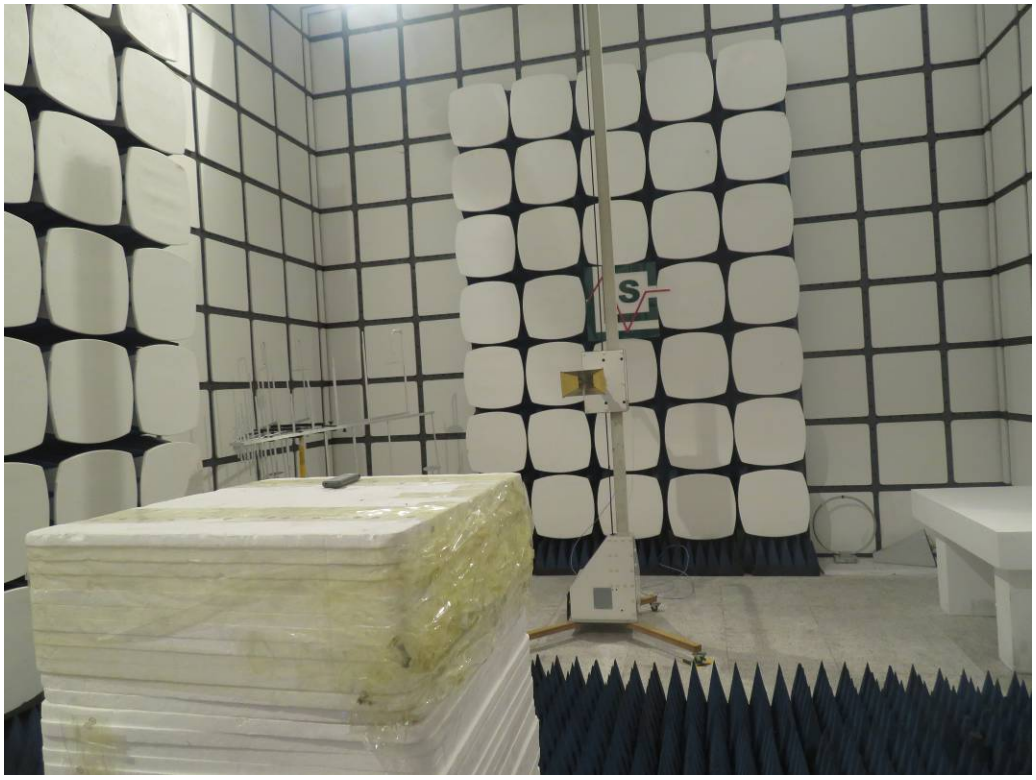


Fig. 2

10.2. Photo of Line Conducted Emissions Measurement

Fig. 3

11. EXTERIOR PHOTOGRAPHS OF THE EUT

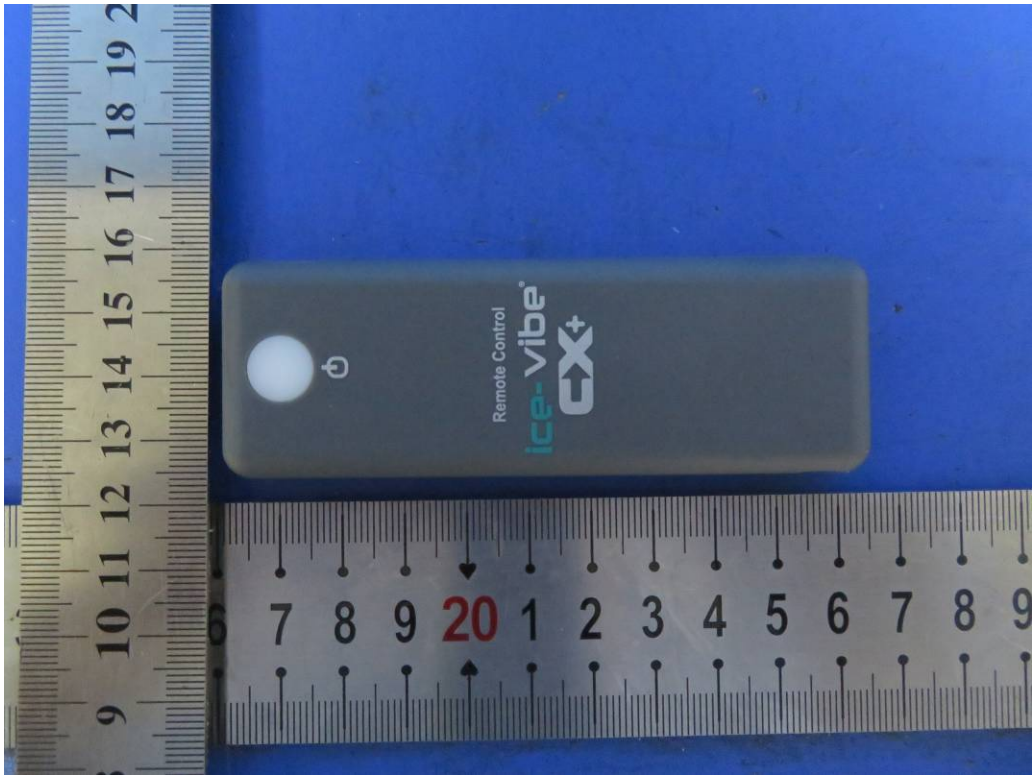


Fig. 1

Fig. 2

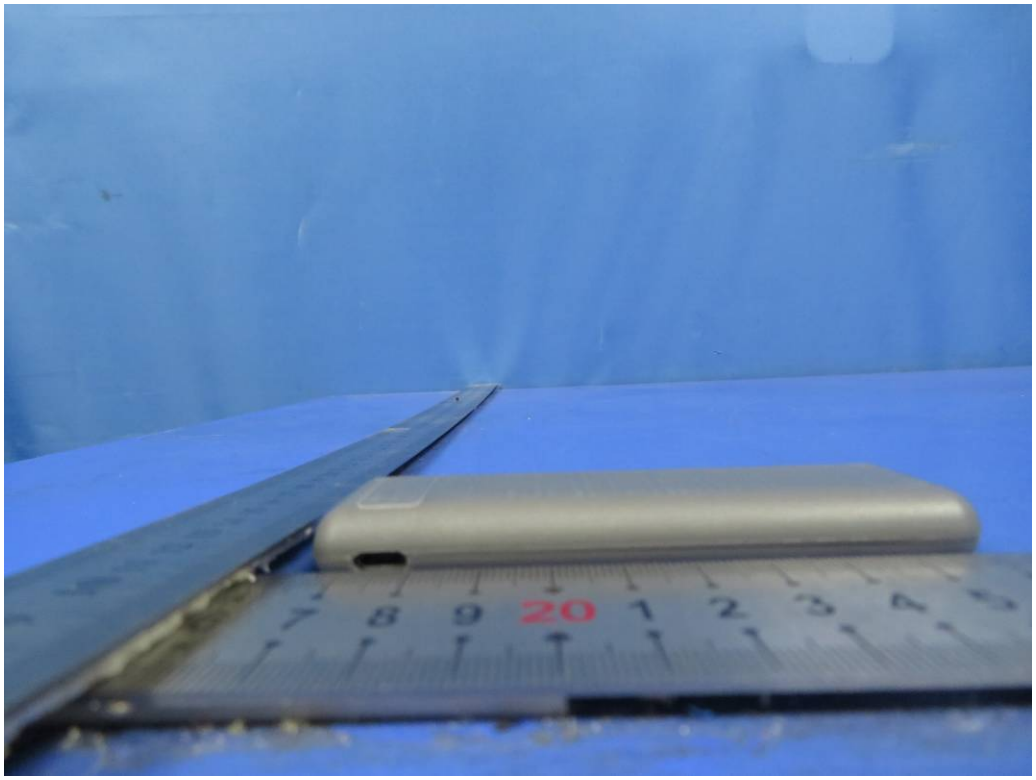


Fig. 3

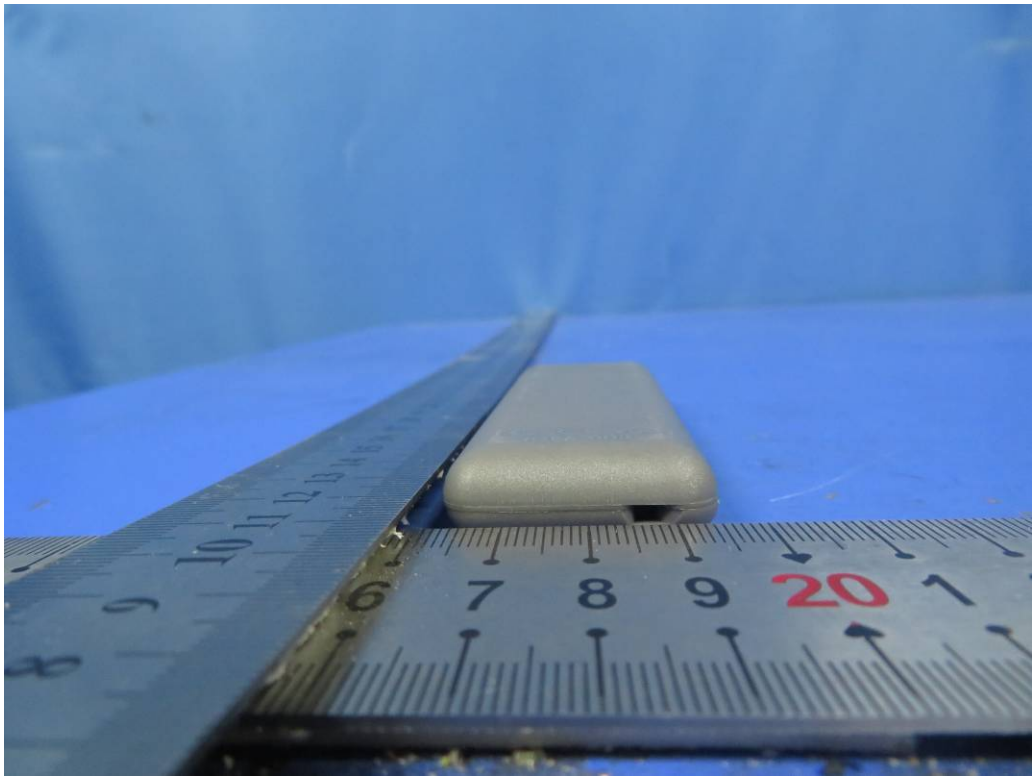


Fig. 4

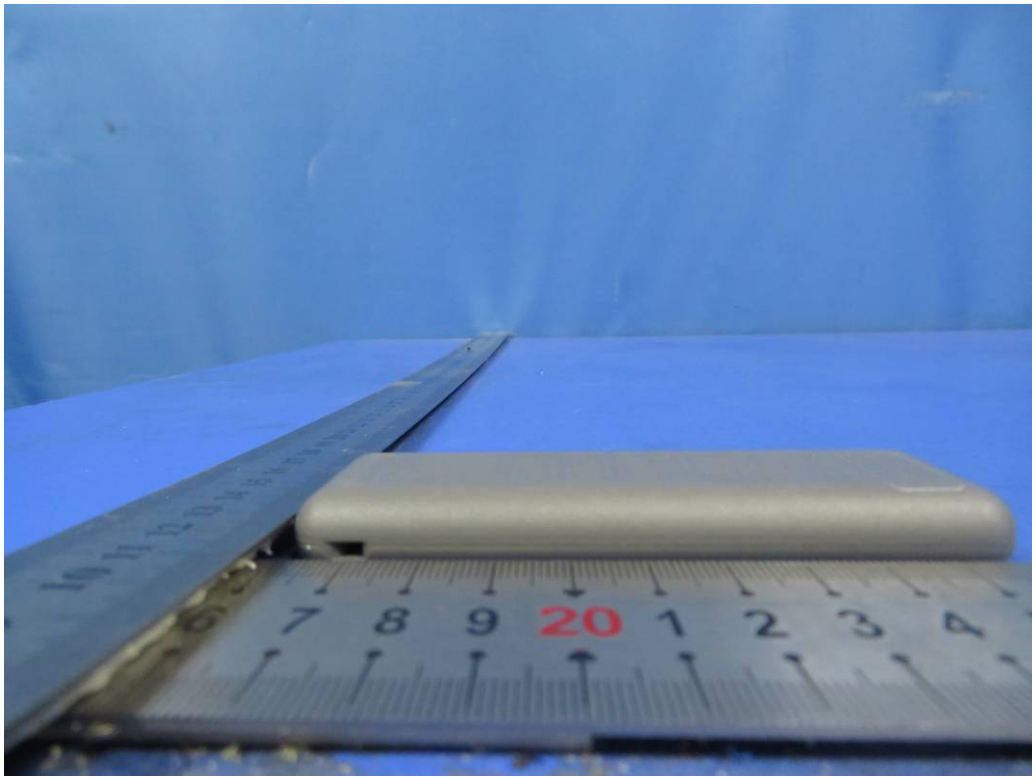


Fig. 5

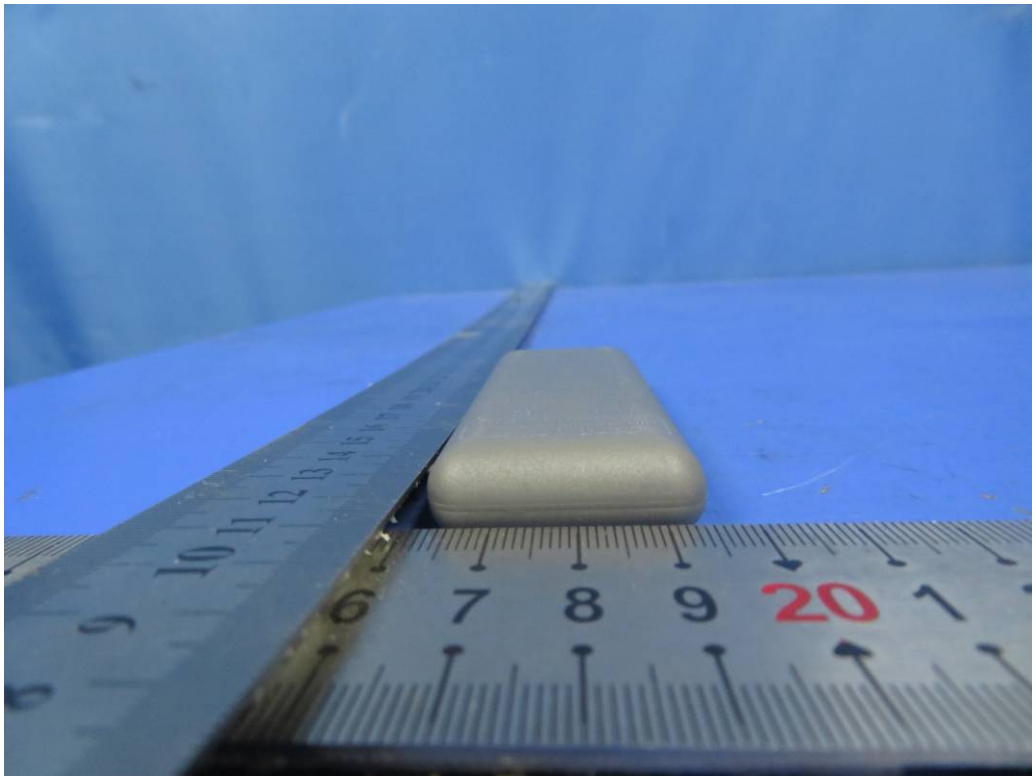


Fig. 6

12. INTERIOR PHOTOGRAPHS OF THE EUT

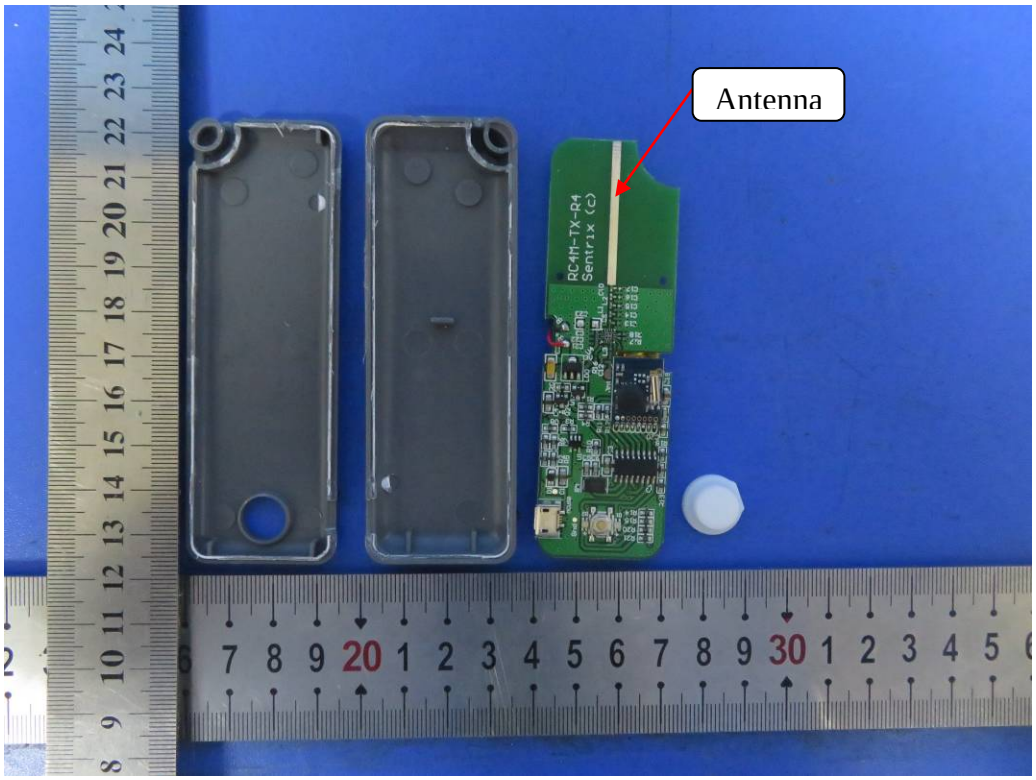


Fig. 7

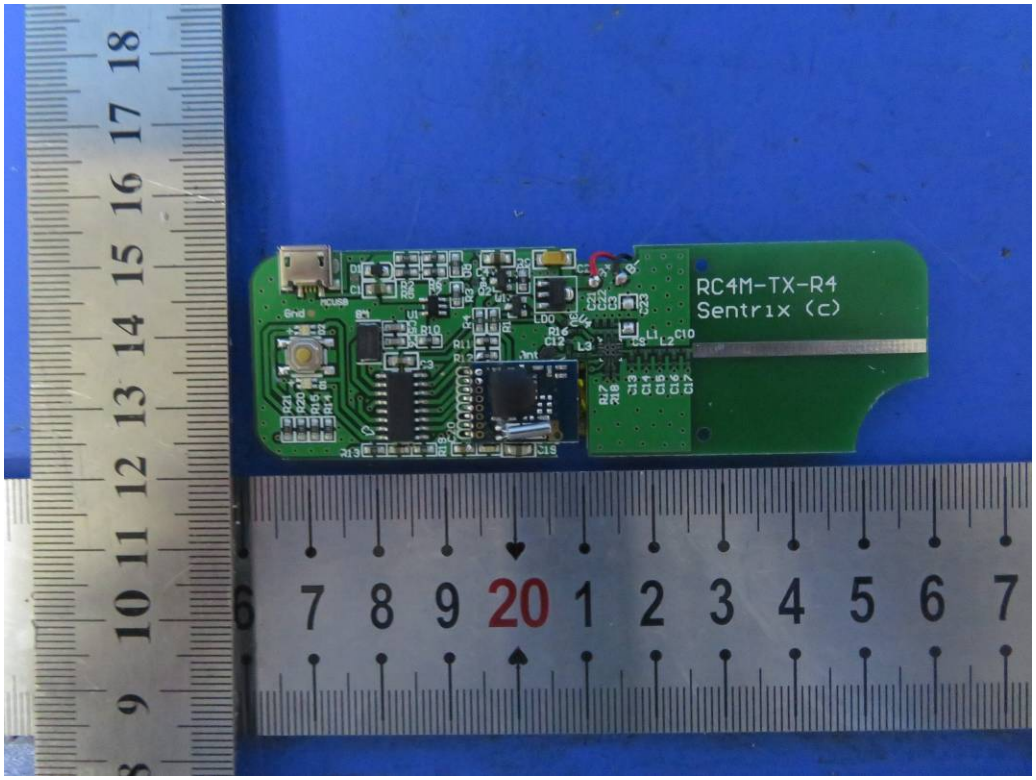


Fig. 8

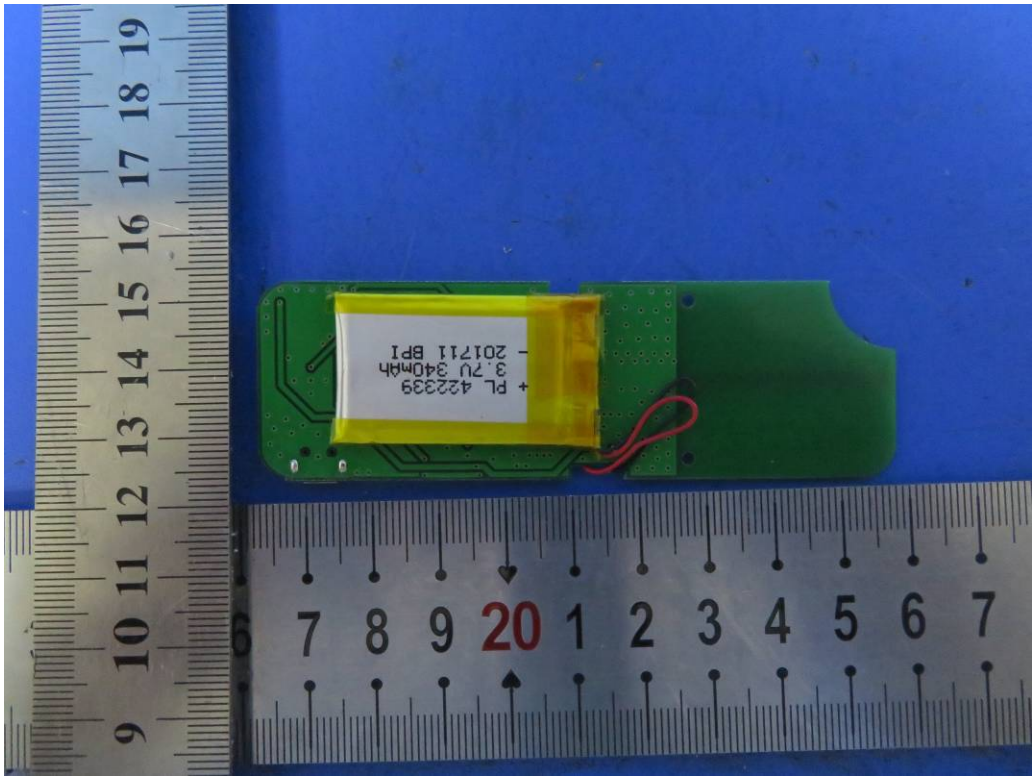


Fig. 9

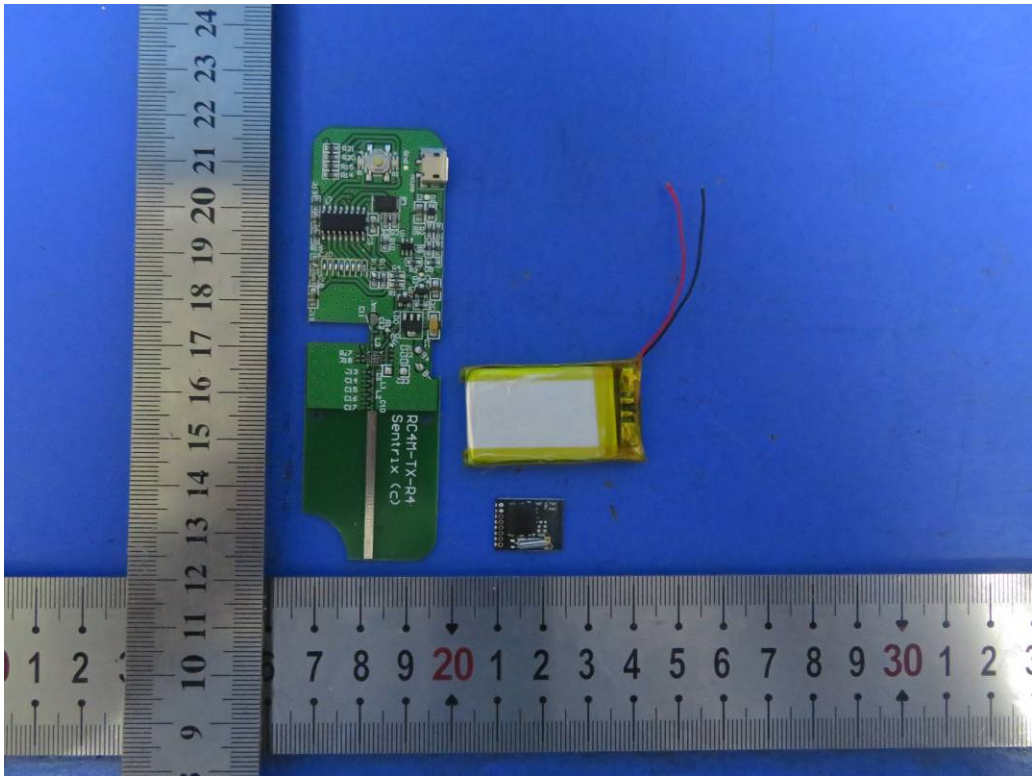


Fig. 10

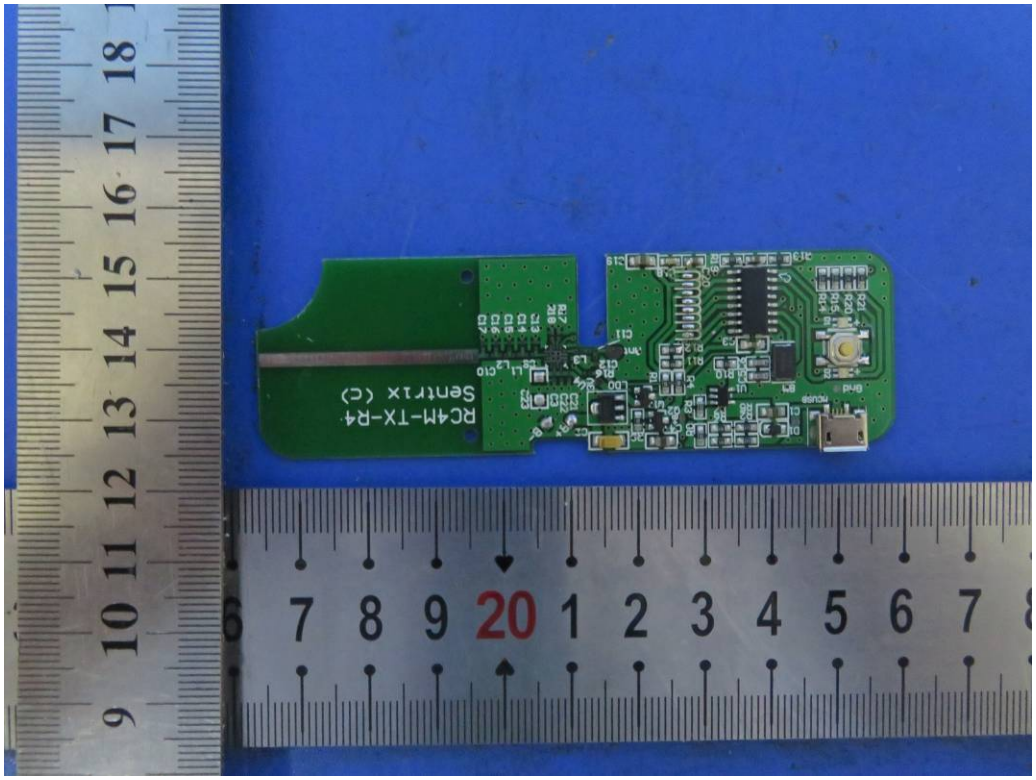


Fig. 11

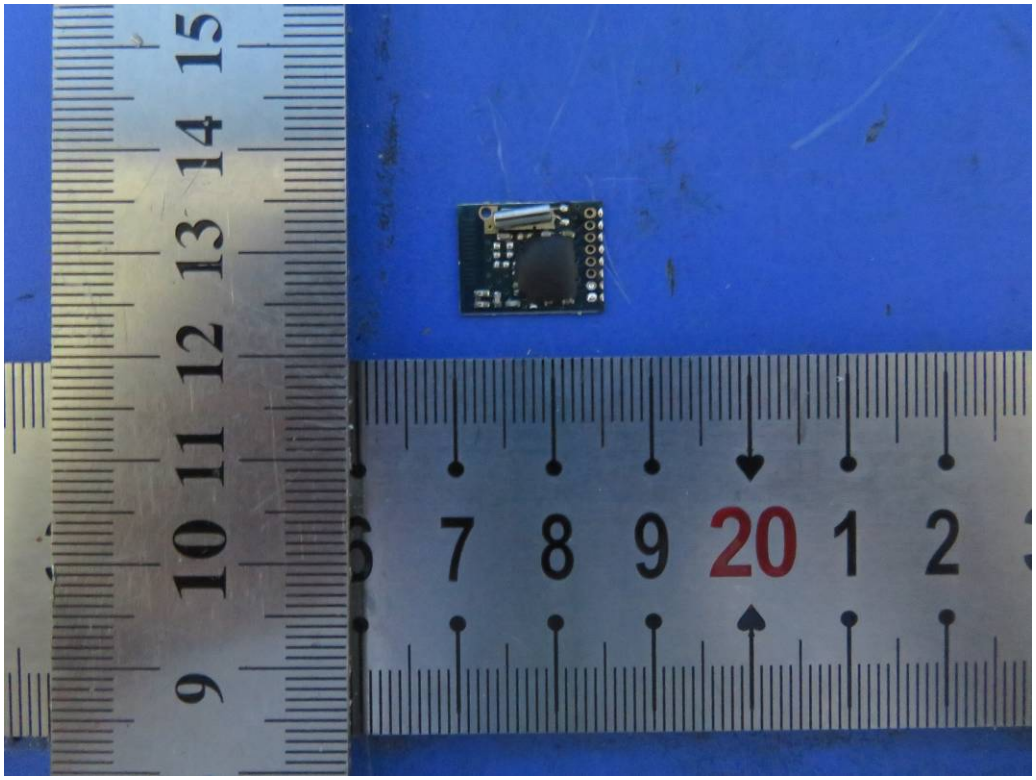


Fig. 12

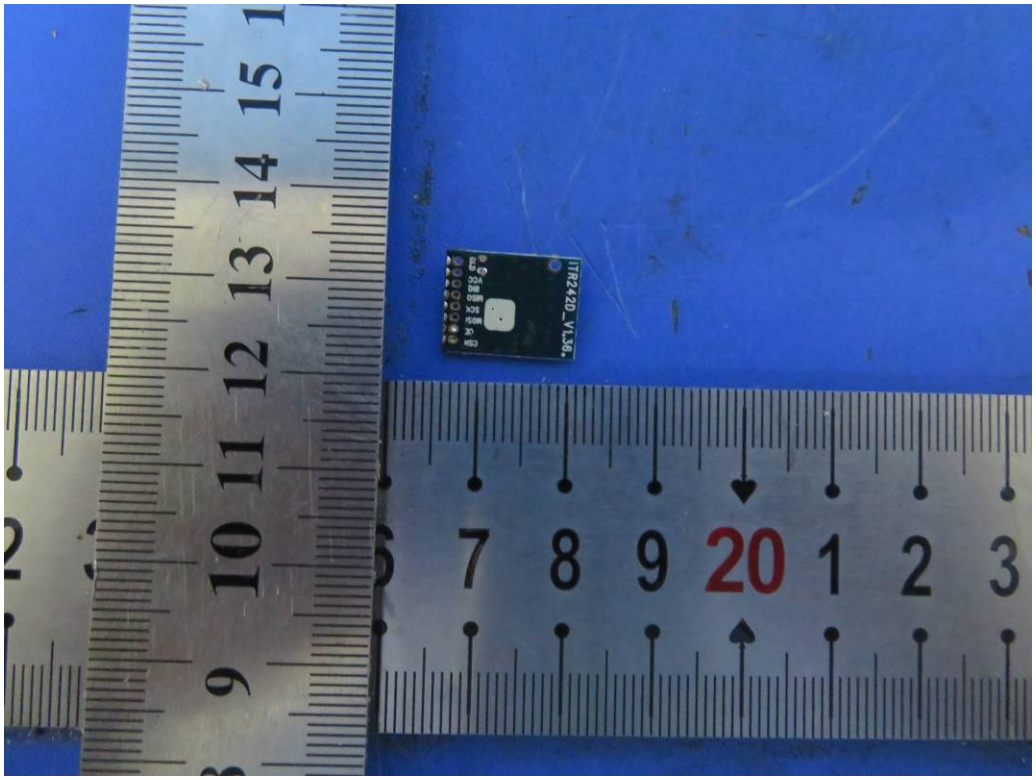


Fig. 13

----------THE END OF TEST REPORT----------