FCC/ISED RF TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

CAT-iq Handset

ISSUED TO
Ooma inc

1880 Embarcadero rd. Palo Alto, CA94303 USA

Tested by: Hu Chao
Hu Chao
(Engineer)
Date Sep. 06, 2017

Approved by:
Liao Jianming
(Technical Director)
Date Sep. 06, 2017

Report No.:	BL-HK1760399-601
EUT Name:	CAT-iq Handset
Model Name:	TELOHS500
Brand Name:	Ooma
Test Standard:	FCC Part 15, subpart D
	RSS-Gen (Issue 4, November 2014)
	RSS-213 (Issue 3, March 2015)
FCC ID:	XFT-TELOHS500
ISED Number:	9769A-TELOHS500
Test conclusion:	Pass
Test Date:	Aug. 10, 2017 ~ Aug. 20, 2017
Date of Issue:	Sep. 06, 2017

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Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100, FAX: +86-755-61824271
Email: info@baluntek.com
www.baluntek.com

Revision History

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Rev. 01	Sep. 06, 2017	Initial Issue

TABLE OF CONTENTS

1 ADMINISTRATIVE DATA (GENERAL INFORMATION) 7

1.1 Identification of the Testing Laboratory 7

1.2 Identification of the Responsible Testing Location 7

1.3 Laboratory Condition 7

1.4 Announce 7

2 PRODUCT INFORMATION 8

2.1 Applicant Information 8

2.2 Manufacturer Information 8

2.3 Factory Information 8

2.4 Ancillary Equipment 9

2.5 Technical Information 9

2.6 General Description for Equipment under Test (EUT) 10

3 SUMMARY OF TEST RESULTS 11

3.1 Test Standards 11

3.2 Verdict 11

4 GENERAL TEST CONFIGURATIONS 13

4.1 Test Environments 13

4.2 Test Equipment List 13

4.3 Measurement Uncertainty 14

4.4 Description of Test Setup 14

4.4.1 For Antenna Port Test 14

4.4.2 For AC Power Supply Port Test 15

4.4.3 For Radiated Test (Below 30 MHz) 15

4.4.4 For Radiated Test (30 MHz-1 GHz) 16

4.4.5 For Radiated Test (Above 1 GHz) 16

4.5 Measurement Results Explanation Example 17

4.5.1 For conducted test items: 17

5 TEST ITEMS 18
5.1 Antenna Requirements 18
5.1.1 Standard Applicable 18
5.1.2 Antenna Anti-Replacement Construction 18
5.1.3 Antenna Gain 18
5.2 Conducted Emission 19
5.2.1 Limit 19
5.2.2 Test Setup 19
5.2.3 Test Procedure 19
5.2.4 Test Result 19
5.3 Peak transmit power 20
5.3.1 Test Limit 20
5.3.2 Test Setup 20
5.3.3 Test Procedure 20
5.3.4 Test Result 20
5.4 Power Spectral density (PSD) 21
5.4.1 Limit 21
5.4.2 Test Setup 21
5.4.3 Test Procedure 21
5.4.4 Test Result 21
5.5 Emission Bandwidth 22
5.5.1 Limit 22
5.5.2 Test Setup 22
5.5.3 Test Procedure 22
5.5.4 Test Result 22
5.6 Emission Inside and Out the sub-band 23
5.6.1 Limit 23
5.6.2 Test Setup 23
5.6.3 Test Procedure 23
5.6.4 Test Result 23
5.7 Carrier Frequency Stability 24
5.7.1 Limit 24
5.7.2 Test Setup 24

5.7.3 Test Procedure....24
5.7.4 Test Result....24
5.8 Frame repetition Stability, period and jitter....25
5.8.1 Requirements....25
5.8.2 Test Setup....25
5.8.3 Test Procedure....25
5.8.4 Test Result....25
5.9 Monitoring the time....26
5.9.1 Limit....26
5.9.2 Test Setup....26
5.9.3 Test Procedure....26
5.9.4 Test Result....26
5.10 Monitoring threshold....27
5.10.1 Limit....27
5.10.2 Test Setup....27
5.10.3 Test Procedure....27
5.10.4 Test Result....27
5.11 Maximum transmit period....28
5.11.1 Limit....28
5.11.2 Test Setup....28
5.11.3 Test Procedure....28
5.11.4 Test Result....28
5.12 Acknowledgment system....29
5.12.1 Limit....29
5.12.2 Test Setup....29
5.12.3 Test Procedure....29
5.12.4 Test Result....29
5.13 Least Interfered Channel, LIC....30
5.13.1 Limit....30
5.13.2 Test Setup....30
5.13.3 Test Procedure....30
5.13.4 Test Result....30
5.14 Random waiting....31

5.14.1 Limit....31
5.14.2 Test Setup....31
5.14.3 Test Procedure....31
5.14.4 Test Result....31
5.15 Monitoring bandwidth and reaction time....32
5.15.1 Limit....32
5.15.2 Test Setup....32
5.15.3 Test Procedure....32
5.15.4 Test Result....32
5.16 Monitoring antenna....33
5.16.1 Limit....33
5.16.2 Test Setup....33
5.16.3 Test Procedure....33
5.16.4 Test Result....33
5.17 Duplex system LBT....34
5.17.1 Limit....34
5.17.2 Test Setup....34
5.17.3 Test Procedure....34
5.17.4 Test Result....34
5.18 Co-located device LBT....35
5.18.1 Limit....35
5.18.2 Test Setup....35
5.18.3 Test Procedure....35
5.18.4 Test Result....35
5.19 Fair access....36
5.19.1 Limit....36
5.19.2 Test Setup....36
5.19.3 Test Result....36
ANNEX A TEST RESULT....37
A.1 Conducted Emissions....37
A.2 Peak transmit power....39
A.3 Power Spectral Density (PSD)....40
A.4 Emission bandwidth....42

A.5 Emission Inside and Out the sub-band 44
A.6 Carrier Frequency Stability 48
A.7 Frame repetition Stability, period and jitter 48
A.8 Monitoring the time 48
A.9 Monitoring threshold 48
A.10 Maximum transmit period 49
A.11 Acknowledgment system 49
A.12 Least Interfered Channel, LIC 50
A.13 Random waiting 50
A.14 Monitoring bandwidth and reaction time 51
A.15 Monitoring antenna 51
A.16 Duplex system LBT 52
A.17 Co-located device LBT 52
A.18 Fair access 52
ANNEX B TEST SETUP PHOTOS 53
ANNEX C EUT EXTERNAL PHOTOS 53
ANNEX D EUT INTERNAL PHOTOS 53

1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

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

1.4 Announce

(1) The test report reference to the report template version v1.0.

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

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

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Ooma inc
Address	1880 Embarcadero rd. Palo Alto, CA94303 USA

2.2 Manufacturer Information

Manufacturer	Shenzhen Guo Wei Electronics Co., Ltd.
Address	No.3038, Luosha Road, Liantang, Luohu District, Shenzhen, Guangdong, China

2.3 Factory Information

Factory	Meizhou Guo Wei Electronics Co., Ltd.
Address	AD1 Section, The Economy Exploitation Area, Meizhou, Guangdong Province, PR, China

2.4 Ancillary Equipment

Ancillary Equipment 1	Battery 1 Note 1	
	Brand Name	HP
	Model No.	HFR-AAA750
	Serial No.	N/A
	Capacitance	750 mAh
	Rated Voltage	1.2 V
	Limit Charge Voltage	1.5 V
	Manufacturer	SHENZHEN HIGHPOWER TECHNOLOGY CO., LTD
Ancillary Equipment 2	Battery 2	
	Brand Name	GP
	Model No.	75AAAHC
	Serial No.	N/A
	Capacitance	750 mAh
	Rated Voltage	1.2 V
	Limit Charge Voltage	1.5 V
	Manufacturer	Dong Guan Chao Ba Batteries Co. Ltd
Ancillary Equipment 3	Adapter 1	
	Brand Name	BLJ
	Model No.	BLJ05W060040P-UA
	Serial No.	N/A
	Rated Input	100-240 V~, 0.2 A, 50/60 Hz
	Rated Output	6 V⎓, 0.4 A
	Manufacturer	Zhongshan Baolijin Electronic Co., Ltd
Ancillary Equipment 4	Adapter 2	
	Brand Name	CSEC
	Model No.	CS3E060040FU
	Serial No.	N/A
	Rated Input	100-240 V~, 0.2 A, 50/60 Hz
	Rated Output	6 V⎓, 0.4 A
	Manufacturer	Chou Sen Electronics (Shenzhen) CO., LTD
Ancillary Equipment 5	Charging Base	

Note 1: The EUT has two Battery, they are same with electrical parameters, but only differ in Manufacturer. The battery of the Manufacturer is SHENZHEN HIGHPOWER TECHNOLOGY CO., LTD as the main for tested in this report.

Note 2: The EUT has two Adapter, they are same with electrical parameters, but only differ in Manufacturer. The adapter of the Manufacturer is Zhongshan Baolijin Electronic CO., LTD as the main for tested in this report.

2.5 Technical Information

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

Frequency Range	1921.536 – 1928.448 MHz
Number of Channels	5 Channels, 5x12 = 60 TDMA Duplex Channels
Modulation Type	GFSK
Number of Antennas	1
Product Type	☒ Mobile ☐ Portable ☐ Fix Location
Antenna Type	Dipole
Antenna Gain	0 dBi
About the Product	This DECT product is a fixed radio termination.

All channel list

Channel number	Channel Frequency	Channel number	Channel Frequency
0	**1921.536**	3	1926.720
1	1923.264	4	**1928.488**
2	**1924.992**	--	--

2.6 General Description for Equipment under Test (EUT)

EUT Type	CAT-iq Handset
Model Name Under Test	TELOHS500
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A
Network and Wireless connectivity	DECT

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart D (10-1-16 Edition)	Miscellaneous Wireless Communications Services
2	RSS-Gen (Issue 4, Nov. 2014)	General Requirements for Compliance of Radio Apparatus
3	RSS-213 (Issue 3 March 2015)	2 GHz Licence-Exempt Personal Communications Services (LE-PCS) Devices
4	ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
5	ANSI C63.17-2013	American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices

3.2 Verdict

No.	Description	FCC PART No.	ISED Part No.	Test Result	Verdict
General Technical Requirements					
1	Antenna Requirement	15.203; 15.317	RSS-GEN 8.3	N/A	Pass[Note 1]
2	Labeling Requirement	15.19(a)(3)	RSP-100 3.1	N/A	Pass[Note 2]
3	Digital Modulation Techniques	15.319 (b)	5.1	N/A	Pass[Note 3]
4	Conducted emission	15.107(a); 15.207(a)	5.4 RSS-GEN 8.8	ANNEX A.1	Pass
5	Peak transmit power	15.319(c)(e), 15.31(e)	5.6 RSS-GEN 8.3	ANNEX A.2	Pass
6	Power spectral density	15.319 (d)	5.7	ANNEX A.3	Pass
7	Emission bandwidth	15.323 (a)	5.5 RSS-GEN 6.6	ANNEX A.4	Pass
8	Emission Inside and Out the sub-band	15.323 (d)	5.8.1; 5.8.2	ANNEX A.5	Pass
9	Carrier Frequency Stability	15.323(f)	5.3	ANNEX A.6	Pass
Specific Requirements for UPCS Device					
10	Frame repetition Stability, period and jitter	15.323(e)	5.2(1)(13)	ANNEX A.7	Pass
11	Monitoring the time	15.323 (c)(1)	5.2(1)	ANNEX A.8	Pass
12	Monitoring threshold	15.323 (c)(2) (9)	5.2(2) (9)	ANNEX A.9	Pass
13	Maximum transmit period	15.323 (c)(3)	5.2(3)	ANNEX A.10	Pass
14	Acknowledgment system	15.323 (c)(4)	5.2(4)	ANNEX A.11	Pass
15	Least Interfered Channel, LIC	15.323 (c)(5)	5.2(5)	ANNEX A.12	Pass
16	Random waiting	15.323 (c)(6)	5.2(6)	ANNEX A.13	Pass

17	Monitoring bandwidth and reaction time	15.323 (c)(7)	5.2(7)	ANNEX A.14	Pass
18	Monitoring antenna	15.323 (c)(8)	5.2(8)	ANNEX A.15	Pass
19	Duplex system LBT	15.323 (c)(10)	5.2(10)	ANNEX A.16	Pass
20	Co-located device LBT	15.323 (c)(11)	5.2(11)	ANNEX A.17	Pass
21	Fair access	15.323 (c)(12)	5.2(12)	ANNEX A.18	Pass
Note [1]: Please refer to section 5.1. Note [2]: Customer declaration .See separate documents showing the label design and the placement of the label on the EUT. Note[3]: The requirement is all transmissions must use only digital modulation techniques. They are made in accordance with ANSI C63.17 sub-clause 6.1.4. Please refer to the technical description or relevant DECT standards for more details.					

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	45% - 55%	
Atmospheric Pressure	100 kPa - 102 kPa	
Temperature	NT (Normal Temperature)	+22℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	3 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-30	103118	2017.06.22	2018.06.21
Switch Unit with OSP-B157	ROHDE&SCHWARZ	OSP120	101270	2017.06.22	2018.06.21
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2016.09.09	2017.09.08
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2017.06.22	2018.06.21
LISN	SCHWARZBECK	NSLK 8127	8127-687	2017.06.22	2018.06.21
Bluetooth Tester	ROHDE&SCHWARZ	CBT	101005	2017.06.22	2018.06.21
Power Splitter	KMW	DCPD-LDC	1305003215	--	--
Power Sensor	ROHDE&SCHWARZ	NRP-Z21	103971	2017.06.22	2018.06.21
Attenuator (20 dB)	KMW	ZA-S1-201	110617091	--	--
DC Power Supply	ROHDE&SCHWARZ	HMP2020	018141664	2017.06.22	2018.06.21
Temperature Chamber	ANGELANTIONI SCIENCE	NTH64-40A	1310	2017.06.22	2018.06.21
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2017.06.22	2018.06.21
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2017.06.22	2018.06.21
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1148	2017.06.22	2018.06.21
Test Antenna-Horn(15-26.5 GHz)	SCHWARZBECK	BBHA 9170	9170-305	2017.06.22	2018.06.21
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2017.02.24	2019.02.23
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60 *7.35m	N/A	2016.08.09	2018.08.08
Shielded Enclosure	ChangNing	CN-130701	130703	--	--
Signal Generator	ROHDE&SCHWARZ	SMB100A	177746	2017.06.22	2018.06.21
Power Amplifier	OPHIR RF	5225F	1037	2017.02.17	2018.02.16
Power Amplifier	OPHIR RF	5273F	1016	2017.02.17	2018.02.16
Directional Coupler	Werlantone	C5982-10	109275	N/A	N/A
Directional Coupler	Werlantone	CHP-273E	S00801z-01	N/A	N/A
Tester	ROHDE&SCHWARZ	CMD60	1050.9008.60	2017.06.22	2018.06.21

4.3 Measurement Uncertainty

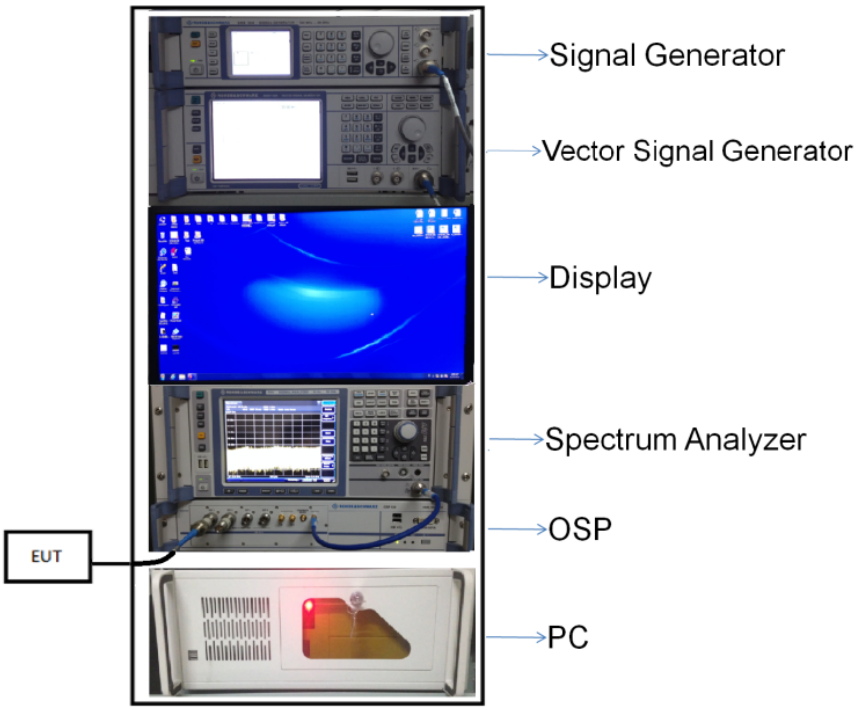
The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

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

Measurement	Value
Occupied Channel Bandwidth	±4%
RF output power, conducted	±1.4 dB
Power Spectral Density, conducted	±2.5 dB
Unwanted Emissions, conducted	±2.8 dB
All emissions, radiated	±5.4 dB
Temperature	±1°C
Humidity	±4%

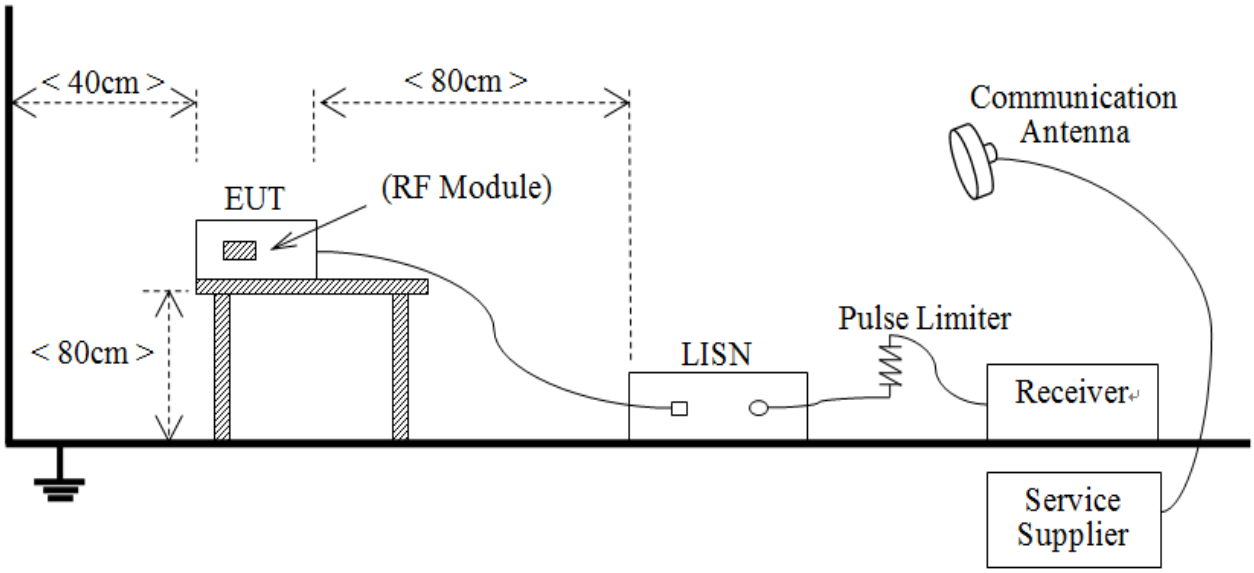
4.4 Description of Test Setup

4.4.1 For Antenna Port Test



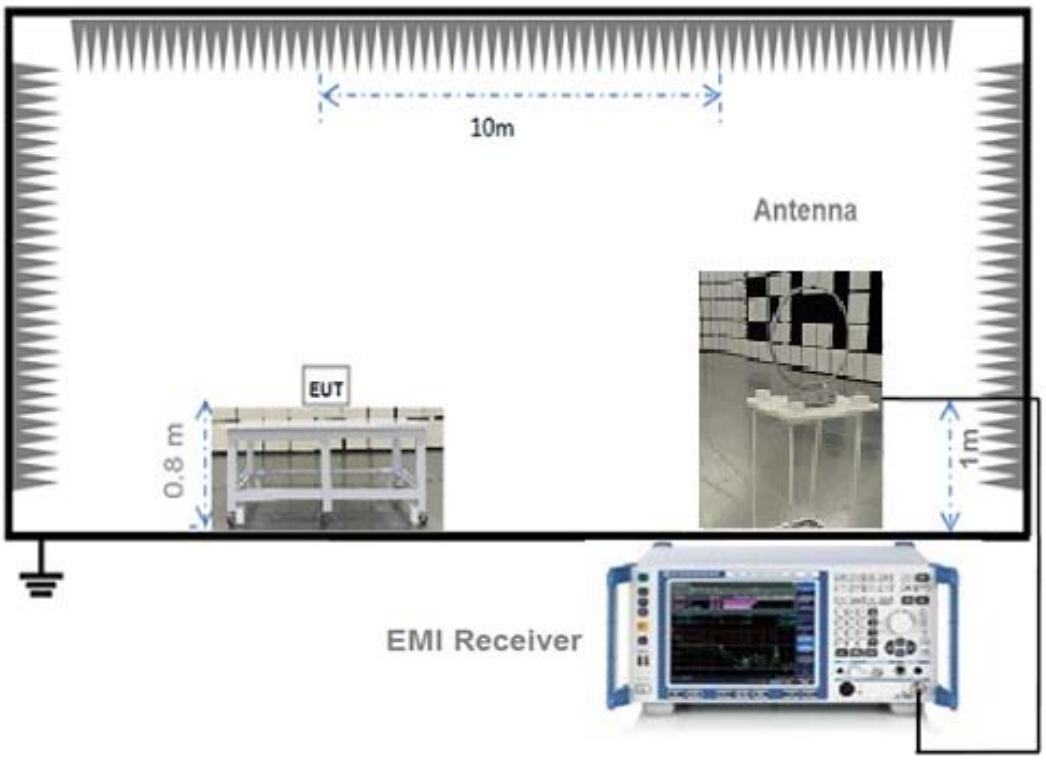
(Diagram 1)

4.4.2 For AC Power Supply Port Test



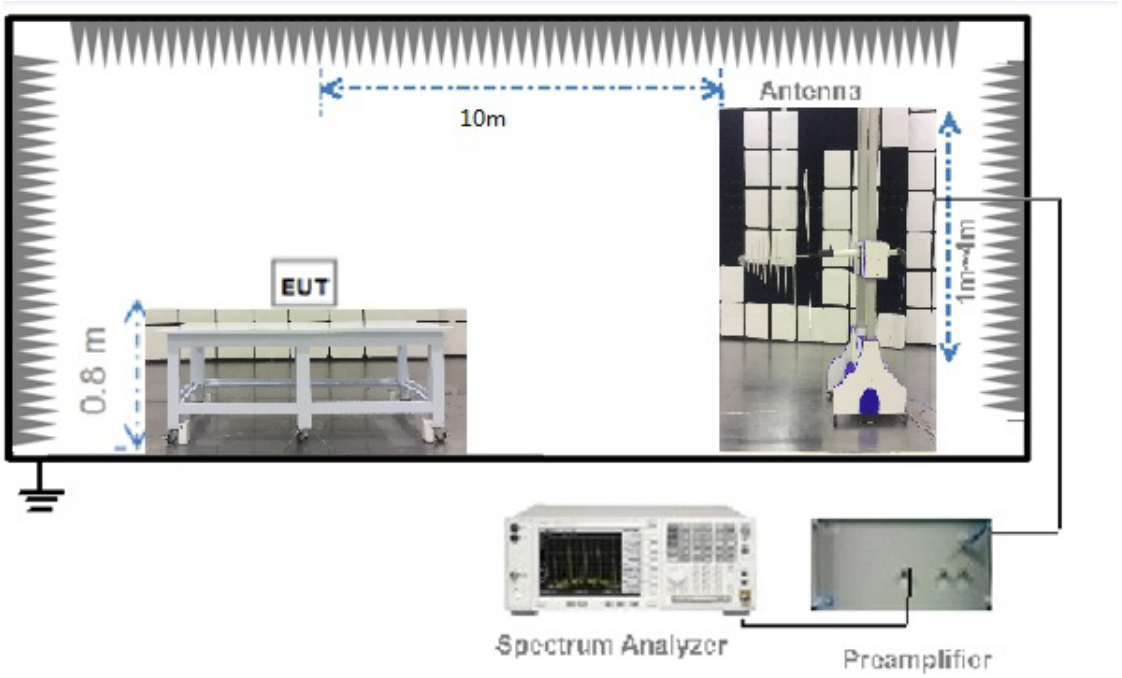
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



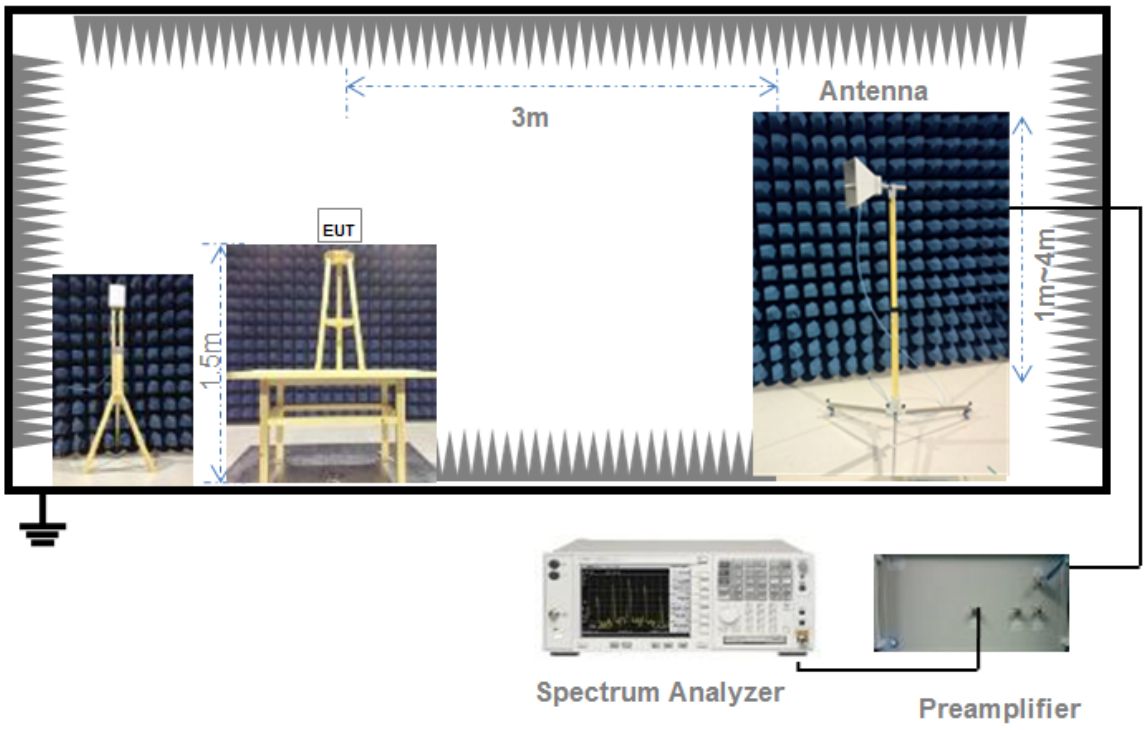
(Diagram 3)

4.4.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.5 Measurement Results Explanation Example

4.5.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Standard Applicable

FCC §15.203 & 15.317

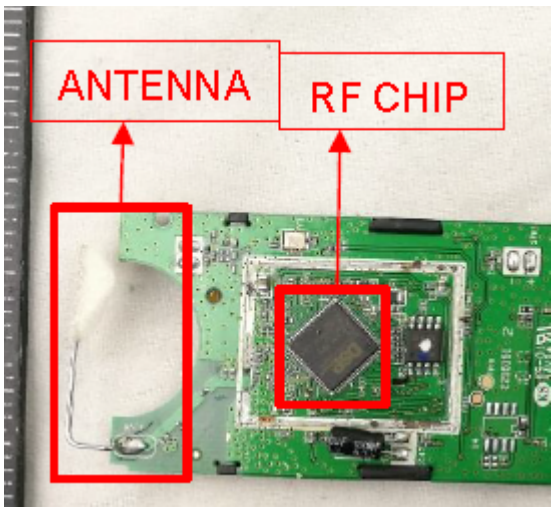
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply 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.

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
Compliance with 15.203, use of a standard antenna jack or electrical connector is prohibited.	The antenna is the unique connector with a wire antenna.

Reference Documents	Item
Photo	

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.

5.2 Conducted Emission

5.2.1 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

5.2.2 Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.2.3 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.

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak transmit power

5.3.1 Test Limit

FCC § 15.319(c)(e); RSS-213, 5.6

Peak transmit power shall not exceed 100 microwatts multiplied by the square root of the emission bandwidth in Hertz.

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3dBi.

5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

Reference to ANSI C63.17, Clause 6.1.2.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Power Spectral density (PSD)

5.4.1 Limit

FCC §15.319(d); RSS-213, 5.7

Power spectral density shall not exceed 3 milliwatts in any 3 kHz bandwidth as measured with a spectrum analyzer having a resolution bandwidth of 3 kHz.

5.4.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

Reference to ANSI C63.17, Clause 6.1.5.

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Emission Bandwidth

5.5.1 Limit

FCC §15.323 (a); RSS-213, 5.5 RSS-GEN, 6.6

The 26 dB and 99% Bandwidth B shall be larger than 50 kHz and less than 2.5 MHz

5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

Reference to ANSI C63.17, Clause 6.1.3.

5.5.4 Test Result

Please refer to ANNEX A.4.

5.6 Emission Inside and Out the sub-band

5.6.1 Limit

FCC §15.323 (d); RSS-213, 5.8

In-Band Emissions:

B < f ≤ 2B: at least 30 dB below max. permitted peak power

2B < f ≤ 3B: at least 50 dB below max. permitted peak power

3B < f ≤ UPCS Band Edge: at least 60 dB below max. permitted peak power

Out-of-Band Emissions:

f ≤ 1.25MHz outside UPCS band: ≤ -9.5dBm

1.25MHz ≤ f ≤ 2.5MHz outside UPCS band: ≤ -29.5 dBm

f ≥ 2.5MHz outside UPCS band: ≤ -39.5 dBm

5.6.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

Reference to ANSI C63.17, Clause 6.1.6.

5.6.4 Test Result

Please refer to ANNEX A.5.

5.7 Carrier Frequency Stability

5.7.1 Limit

FCC §15.323 (f); RSS-213, 5.3

The frequency stability of the carrier frequency of the intentional radiator shall be maintained within ±10 ppm over 1 hour or the interval between channel access monitoring, whichever is shorter. The frequency stability shall be maintained over a temperature variation of −20° to + 50 °C at normal supply voltage, and over a variation in the primary supply voltage of 85 percent to 115 percent of the rated supply voltage at a temperature of 20 °C. For equipment that is capable only of operating from a battery, the frequency stability tests shall be performed using a new battery without any further. Requirement to vary supply voltage.

5.7.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Reference to ANSI C63.17, Clause 6.2.1.

5.7.4 Test Result

Please refer to ANNEX A.6.

5.8 Frame repetition Stability, period and jitter

5.8.1 Requirements

FCC §15.323 (e); RSS-213, 5.2(1) (13)

The frame period (a set of consecutive time slots in which the position of each time slot can be identified by reference to a synchronizing source) of an intentional radiator operating in this band shall be 20 milliseconds or 10 milliseconds/X where X is a positive whole number. Each device that implements time division for the purposes of maintaining a duplex connection on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 50 parts per million (ppm). Each device which further divides access in time in order to support multiple communication links on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 10 ppm. The jitter (time-related, abrupt, spurious variations in the duration of the frame interval) introduced at the two ends of such a communication link shall not exceed 25 microseconds for any two consecutive transmissions. Transmissions shall be continuous in every time and spectrum window during the frame period defined for the device.

5.8.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

Reference to ANSI C63.17, Clause 6.2.2&6.2.3.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Monitoring the time

5.9.1 Limit

FCC §15.323 (c) (1); RSS-213, 5.2(1)

Immediately prior to initiating transmission, devices must monitor the combined time and spectrum windows in which they intend to transmit for a period of at least 10 milliseconds for systems designed to use a 10 milliseconds or shorter frame period or at least 20 milliseconds for systems designed to use a 20 milliseconds frame period.

5.9.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

Reference to ANSI C63.17, Clause 7.3.3.

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Monitoring threshold

5.10.1 Limit

FCC §15.323 (c) (2); RSS-213, 5.2(2)

The monitoring threshold must not be more than 30 dB above the thermal noise power for a bandwidth equivalent to the emission bandwidth used by the device.

FCC §15.323 (c) (9); RSS-213, 5.2(9)

Devices that have a power output lower than the maximum permitted under this subpart may increase their monitoring detection threshold by one decibel for each one decibel that the transmitter power is below the maximum permitted.

5.10.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

Reference to ANSI C63.17, Clause 7.3.1.

5.10.4 Test Result

Please refer to ANNEX A.9.

5.11 Maximum transmit period

5.11.1 Limit

FCC §15.323 (c) (3); RSS-213, 5.2(3)

If no signal above the threshold level is detected, transmission may commence and continue with the same emission bandwidth in the monitored time and spectrum windows without further monitoring. However, occupation of the same combined time and spectrum windows by a device or group of cooperating devices continuously over a period of time longer than 8 hours is not permitted without repeating the access criteria.

5.11.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.11.3 Test Procedure

Reference to ANSI C63.17, Clause 8.2.2.

5.11.4 Test Result

Please refer to ANNEX A.10.

5.12 Acknowledgment system

5.12.1 Limit

FCC §15.323 (c) (4); RSS-213, 5.2(4)

Once access to specific combined time and spectrum windows is obtained an acknowledgment from a system participant must be received by the initiating transmitter within one second or transmission must cease. Periodic acknowledgments must be received at least every 30 seconds or transmission must cease. Channels used exclusively for control and signaling information may transmit continuously for 30 seconds without receiving an acknowledgment, at which time the access criteria must be repeated.

5.12.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.12.3 Test Procedure

Reference to ANSI C63.17, Clause 8.2.

5.12.4 Test Result

Please refer to ANNEX A.11.

5.13 Least Interfered Channel, LIC

5.13.1 Limit

FCC §15.323 (c) (5); RSS-213, 5.2(5)

If access to spectrum is not available as determined by the above, and a minimum of 20 duplex system access channels are defined for the system, the time and spectrum windows with the lowest power level may be accessed. A device utilizing the provisions of this paragraph must have monitored all access channels defined for its system within the last 10 seconds and must verify, within the 20 milliseconds (40 milliseconds for devices designed to use a 20 milliseconds frame period) immediately preceding actual channel access that the detected power of the selected time and spectrum windows is no higher than the previously detected value. The power measurement resolution for this comparison must be accurate to within 6 dB. No device or group of cooperating devices located within 1 meter of each other shall during any frame period occupy more than 6 MHz of aggregate bandwidth, or alternatively, more than one third of the time and spectrum windows defined by the system.

5.13.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.13.3 Test Procedure

Reference to ANSI C63.17, Clause 7.3.2 and 7.3.3.

5.13.4 Test Result

Please refer to ANNEX A.12.

5.14 Random waiting

5.14.1 Limit

FCC §15.323 (c) (6); RSS-213, 5.2(6)

If the selected combined time and spectrum windows are unavailable, the device may either monitor and select different windows or seek to use the same windows after waiting an amount of time, randomly chosen from a uniform random distribution between 10 and 150 milliseconds, commencing when the channel becomes available.

5.14.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.14.3 Test Procedure

Reference to ANSI C63.17, Clause 8.1.3

5.14.4 Test Result

Please refer to ANNEX A.13.

5.15 Monitoring bandwidth and reaction time

5.15.1 Limit

FCC §15.323 (c) (7); RSS-213, 5.2(7)

The monitoring system bandwidth must be equal to or greater than the emission bandwidth of the intended transmission and have a maximum reaction time less than 50xSQRT (1.25/emission bandwidth in MHz) microseconds for signals at the applicable threshold level but shall not be required to be less than 50 microseconds. If a signal is detected that is 6 dB or more above the applicable threshold level, the maximum reaction time shall be 35xSQRT (1.25/emission bandwidth in MHz) microseconds but shall not be required to be less than 35 microseconds.

5.15.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.15.3 Test Procedure

Reference to ANSI C63.17, Clause 7.4 and 7.5.

5.15.4 Test Result

Please refer to ANNEX A.14.

5.16 Monitoring antenna

5.16.1 Limit

FCC §15.323 (c) (8); RSS-213, 5.2(8)

The monitoring system shall use the same antenna used for transmission, or an antenna that yields equivalent reception at that location.

5.16.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.16.3 Test Procedure

Reference to ANSI C63.17, Clause 4.

5.16.4 Test Result

Please refer to ANNEX A.15.

5.17 Duplex system LBT

5.17.1 Limit

FCC §15.323 (c) (10); RSS-213, 5.2(10)

An initiating device may attempt to establish a duplex connection by monitoring both its intended transmit and receive time and spectrum windows. If both the intended transmit and receive time and spectrum windows meet the access criteria, then the initiating device can initiate a transmission in the intended transmit time and spectrum window. If the power detected by the responding device can be decoded as a duplex connection signal from the initiating device, then the responding device may immediately begin transmitting on the receive time and spectrum window monitored by the initiating device.

5.17.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.17.3 Test Procedure

Reference to ANSI C63.17, Clause 8.3.

5.17.4 Test Result

Please refer to ANNEX A.16.

5.18 Co-located device LBT

5.18.1 Limit

FCC §15.323 (c) (11); RSS-213, 5.2(11)

An initiating device that is prevented from monitoring during its intended transmit window due to monitoring system blocking from the transmissions of a collocated (within one meter) transmitter of the same system, may monitor the portions of the time and spectrum windows in which they intend to receive over a period of at least 10 milliseconds. The monitored time and spectrum window must total at least 50 percent of the 10 millisecond frame interval and the monitored spectrum must be within 1.25 MHz of the center frequency of channel(s) already occupied by that device or collocated cooperating devices. If the access criteria is met for the intended receive time and spectrum window under the above conditions, then transmission in the intended transmit window by the initiating device may commence.

5.18.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.18.3 Test Procedure

Reference to ANSI C63.17, Clause 8.4.

5.18.4 Test Result

Please refer to ANNEX A.17.

5.19 Fair access

5.19.1 Limit

FCC §15.323 (c) (12); RSS-213, 5.2(12)

The provisions of (c)(10) or (c)(11) of this section shall not be used to extend the range of spectrum occupied over space or time for the purpose of denying fair access to spectrum to other devices.

5.19.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.19.3 Test Result

Please refer to ANNEX A.18.

ANNEX A TEST RESULT

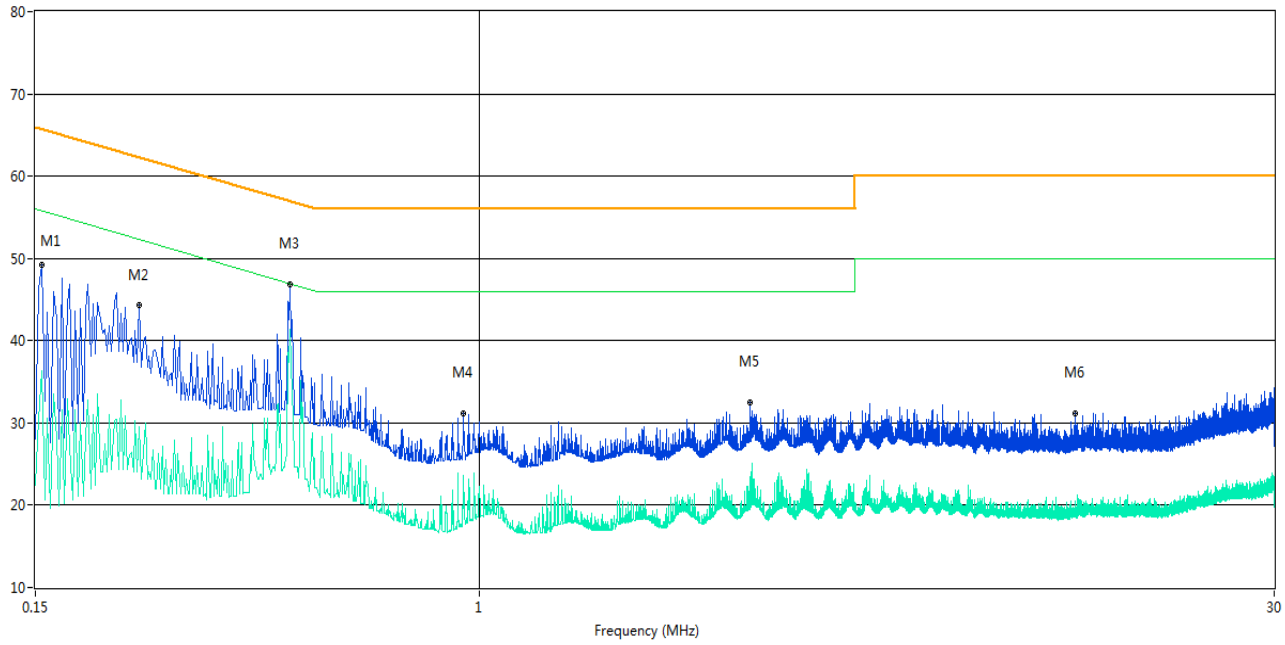
A.1 Conducted Emissions

Note [1]: The EUT is working in the Normal link mode.

Note [2]: 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.

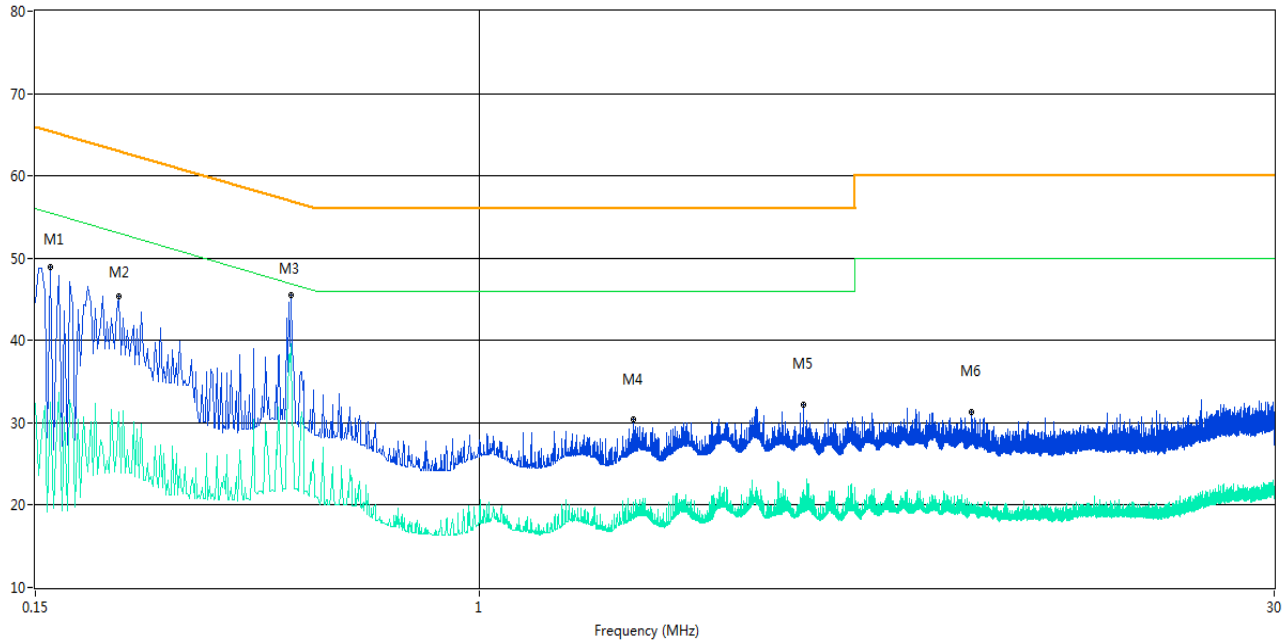
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.154	49.2	9.99	65.8	16.60	Peak	L Line	Pass
1**	0.154	36.3	9.99	55.8	19.50	AV	L Line	Pass
2	0.234	44.3	10.25	62.3	18.00	Peak	L Line	Pass
2**	0.234	29.5	10.25	52.3	22.80	AV	L Line	Pass
3	0.446	46.9	10.01	56.9	10.00	Peak	L Line	Pass
3**	0.446	41.4	10.01	46.9	5.50	AV	L Line	Pass
4	0.936	31.2	10.01	56.0	24.80	Peak	L Line	Pass
4**	0.936	23.6	10.01	46.0	22.40	AV	L Line	Pass
5	3.186	32.4	10.84	56.0	23.60	Peak	L Line	Pass
5**	3.186	23.4	10.84	46.0	22.60	AV	L Line	Pass
6	12.788	31.2	11.29	60.0	28.80	Peak	L Line	Pass
6**	12.788	19.4	11.29	50.0	30.60	AV	L Line	Pass

PHASE N



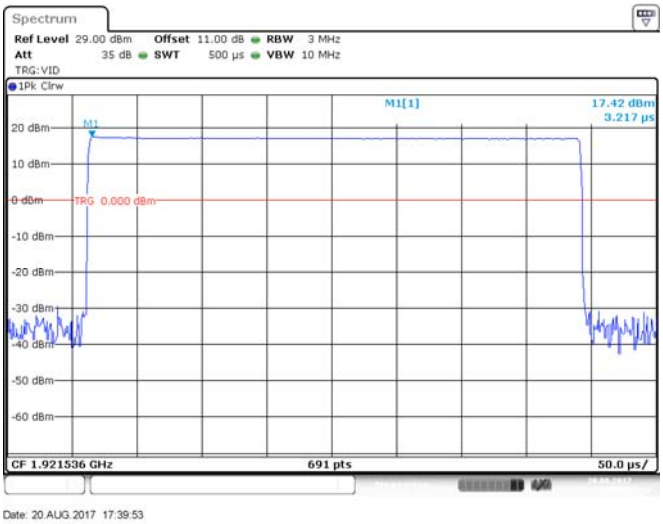
No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.160	48.9	10.29	65.5	16.60	Peak	N Line	Pass
1**	0.160	32.5	10.29	55.5	23.00	AV	N Line	Pass
2	0.214	45.4	10.30	63.0	17.60	Peak	N Line	Pass
2**	0.214	31.2	10.30	53.0	21.80	AV	N Line	Pass
3	0.448	45.5	9.51	56.9	11.40	Peak	N Line	Pass
3**	0.448	39.6	9.51	46.9	7.30	AV	N Line	Pass
4	1.938	30.4	10.29	56.0	25.60	Peak	N Line	Pass
4**	1.938	20.4	10.29	46.0	25.60	AV	N Line	Pass
5	4.012	32.3	10.57	56.0	23.70	Peak	N Line	Pass
5**	4.012	21.7	10.57	46.0	24.30	AV	N Line	Pass
6	8.214	31.3	10.02	60.0	28.70	Peak	N Line	Pass
6**	8.214	20.2	10.02	50.0	29.80	AV	N Line	Pass

A.2 Peak transmit power.

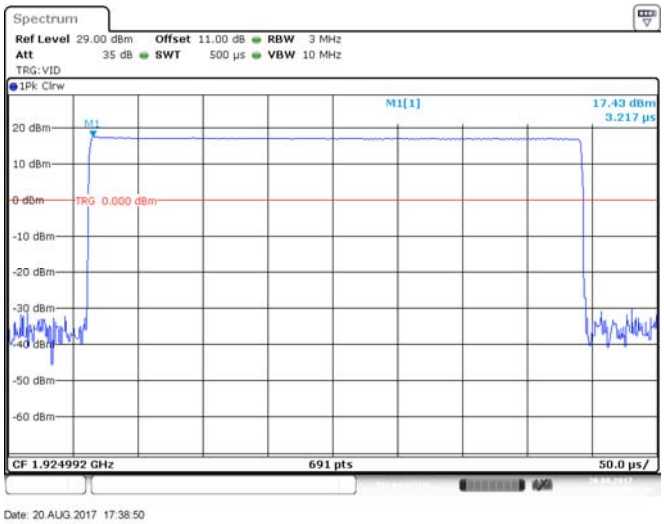
Note: Conducted: 100μW x SQRT (B) where B is the measured Emission Bandwidth in Hz

Frequency (MHz)	Measured Output Peak Power (dBm)	Maximum Antenna Gain (dBi)	Maximum Radiated Output Power Peak (dBm)	Limit (dBm)	Verdict
Low	17.42	0	17.42	20.60	Pass
Middle	17.43	0	17.43	20.60	Pass
High	17.39	0	17.39	20.60	Pass

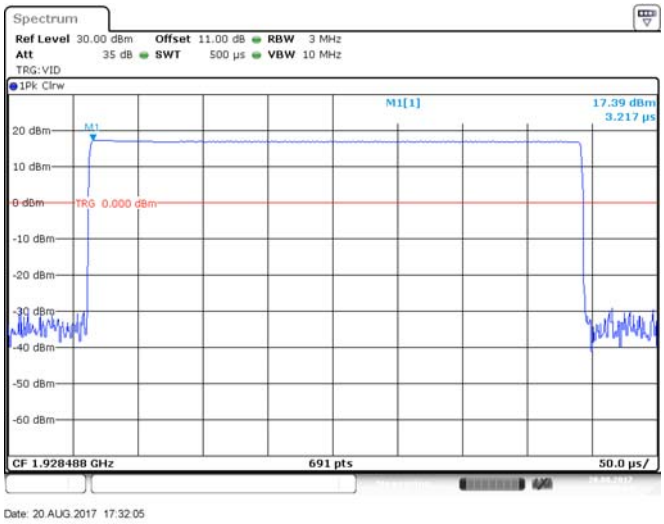
LOW CHANNEL



MIDDLE CHANNEL



HIGH CHANNEL



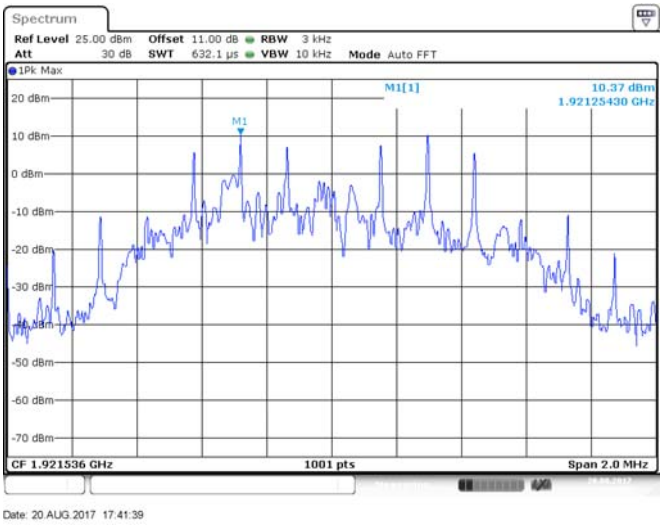
A.3 Power Spectral Density (PSD)

Test Data

Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low	3.63	4.7	Pass
Middle	3.7	4.7	Pass
High	3.03	4.7	Pass

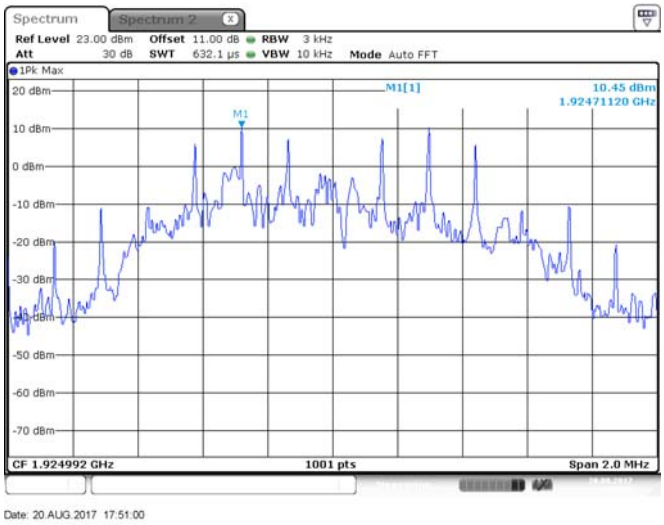
Test plots

LOW CHANNEL

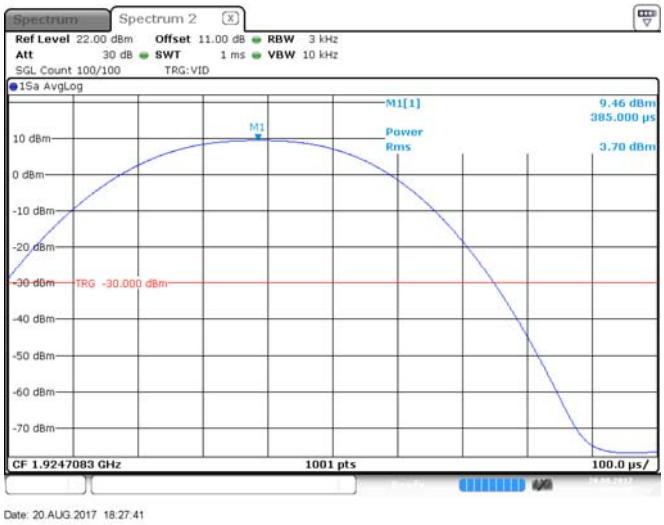


LOW CHANNEL

MIDDLE CHANNEL

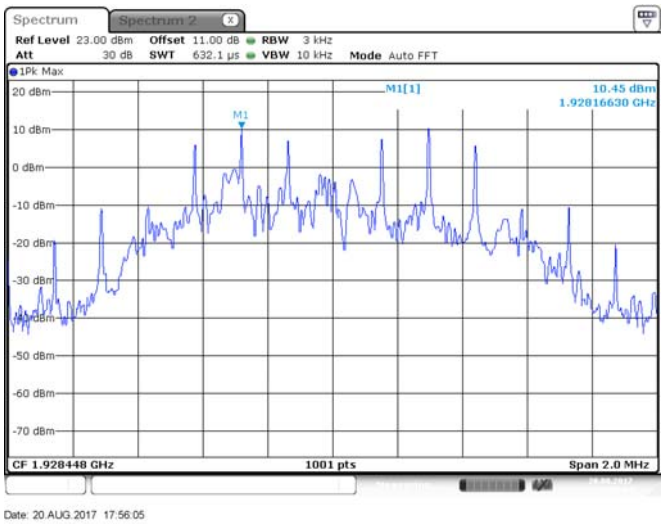


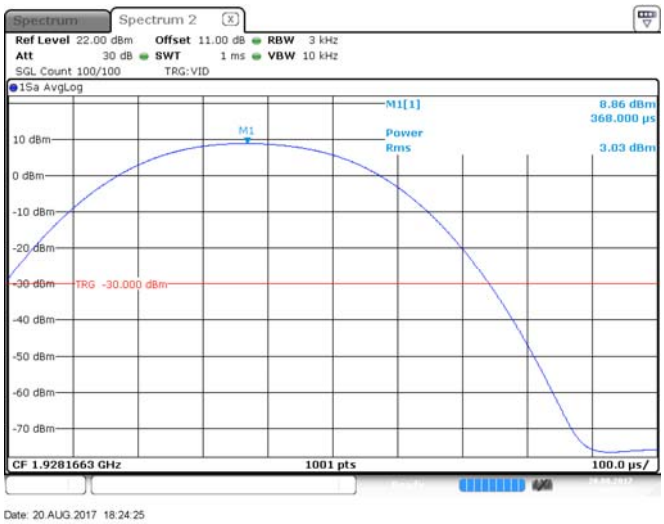
MIDDLE CHANNEL



HIHG CHANNEL

HIHG CHANNEL


Spectrum
Spectrum 2
Ref Level 23.00 dBm Offset 11.00 dB RBW 3 kHz
Att 30 dB SWT 632.1 µs VBW 10 kHz Mode Auto FFT
1Pk Max
M1[1] 10.45 dBm
1.92816630 GHz
M1
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 1.928448 GHz
1001 pts
Span 2.0 MHz
Date: 20.AUG.2017 17:56:05


Spectrum
Spectrum 2
Ref Level 22.00 dBm Offset 11.00 dB RBW 3 kHz
Att 30 dB SWT 1 ms VBW 10 kHz
SGL Count 100/100 TRG:VID
1Sa AvgLog
M1[1] 8.86 dBm
368.000 µs
Power
Rms 3.03 dBm
M1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
TRG -30.000 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 1.9281663 GHz
1001 pts
100.0 µs/
Date: 20.AUG.2017 18:24:25

A.4 Emission bandwidth

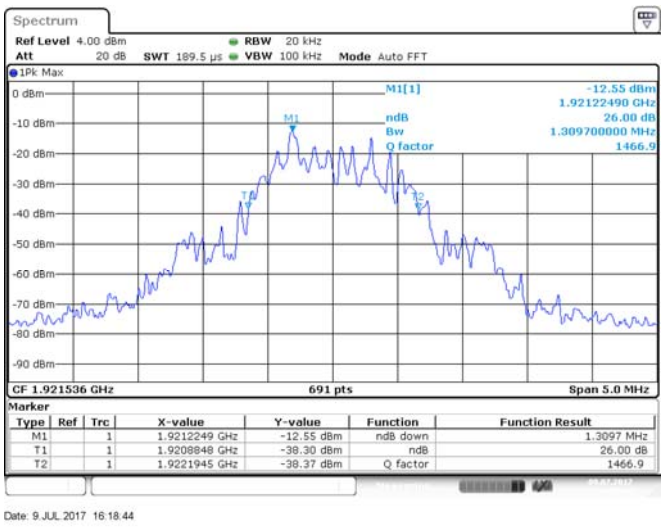
Test Data

Channel	Emission Bandwidth B (MHz)	99% Occupied Bandwidth (MHz)
Low	1.3097	1.1939
Middle	1.3169	1.1939
High	1.3097	1.1201

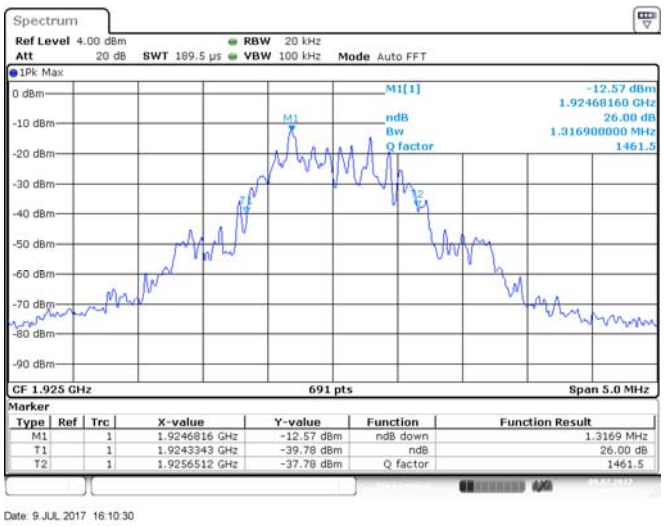
Test plots

Emission Bandwidth B

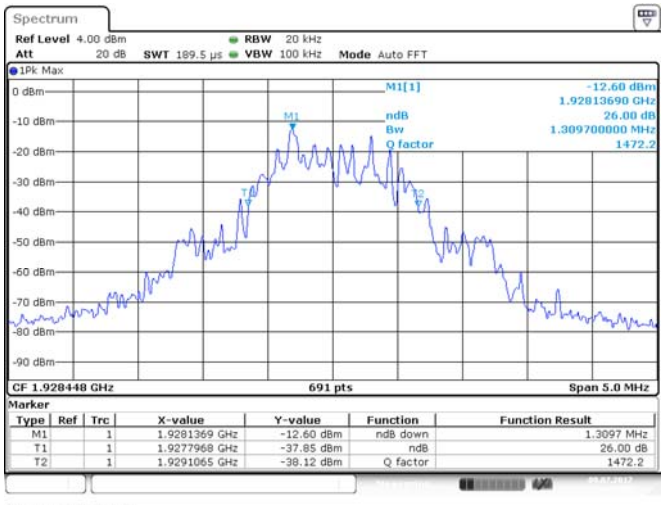
LOW CHANNEL



MIDDLE CHANNEL

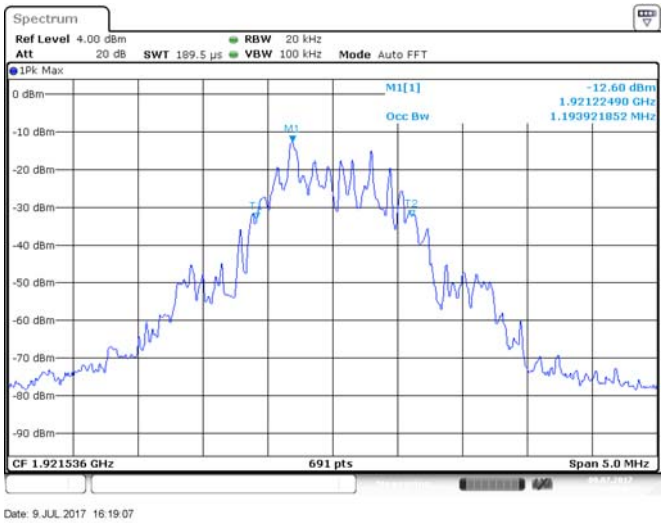


HIHG CHANNEL



99% Occupied Bandwidth (MHz)

LOW CHANNEL



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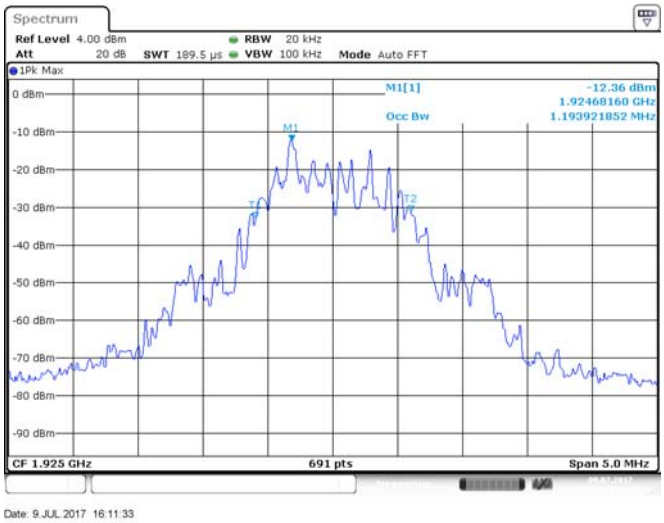
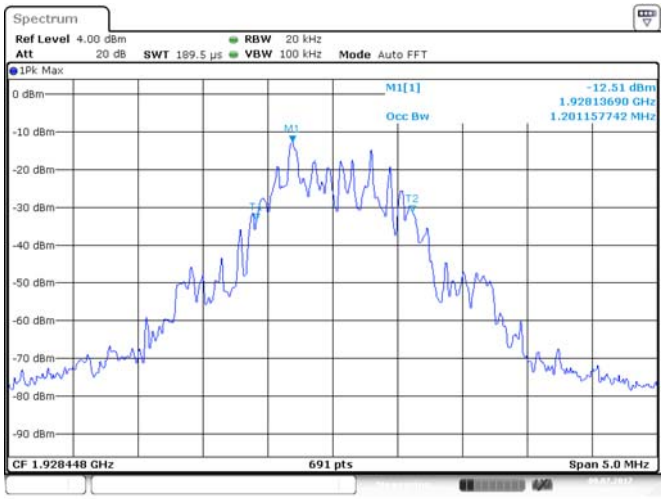
MIDDLE CHANNEL



Date: 9.JUL.2017 16:11:33

HIHG CHANNEL



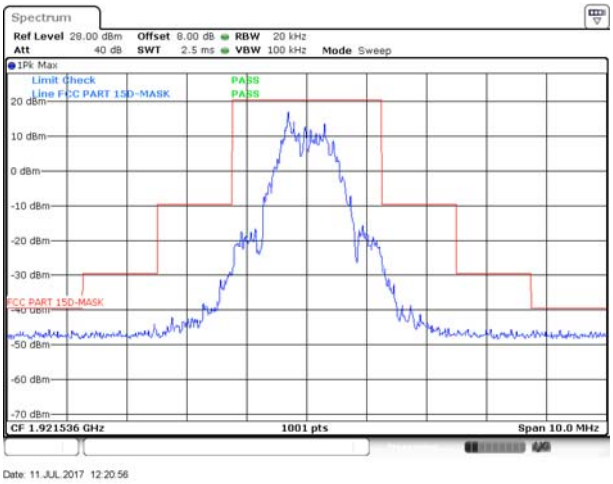
Date: 9.JUL.2017 16:15:24

A.5 Emission Inside and Out the sub-band

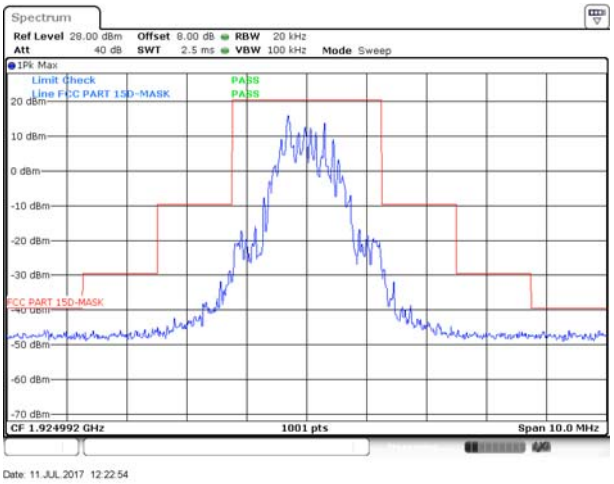
Test Plots

In-band emissions

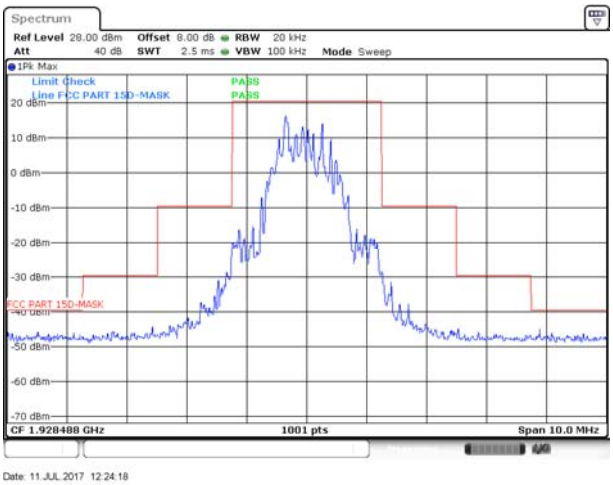
LOW CHANNEL



MIDDLE CHANNEL



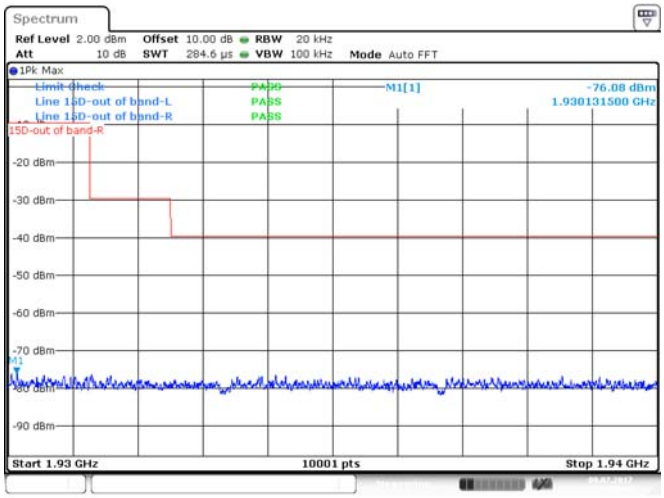
HIGH CHANNEL



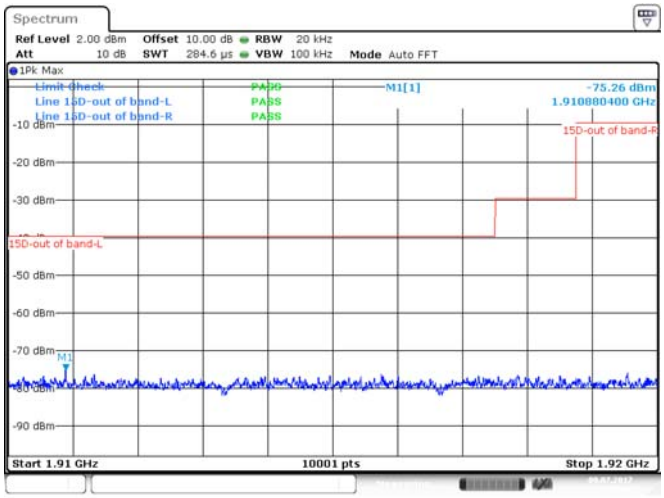
Out of band emissions

Low CHANNEL

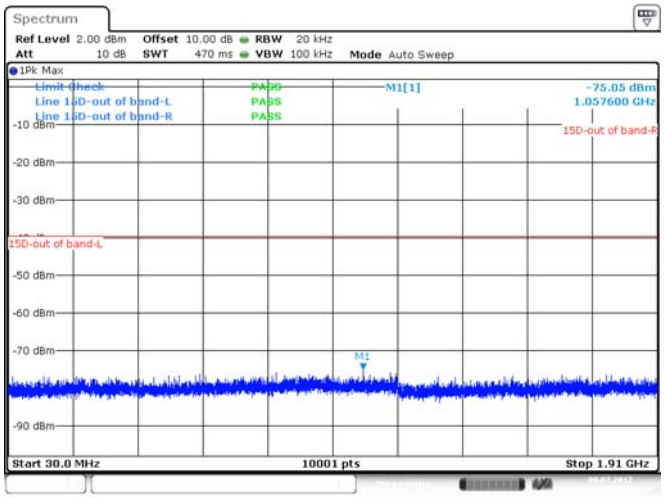
30MHz – 1.94G



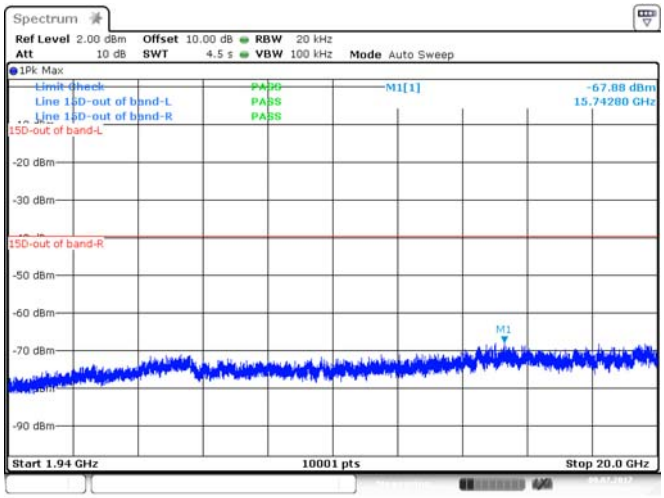
1.91G – 1.92G



1.93G – 1.91G

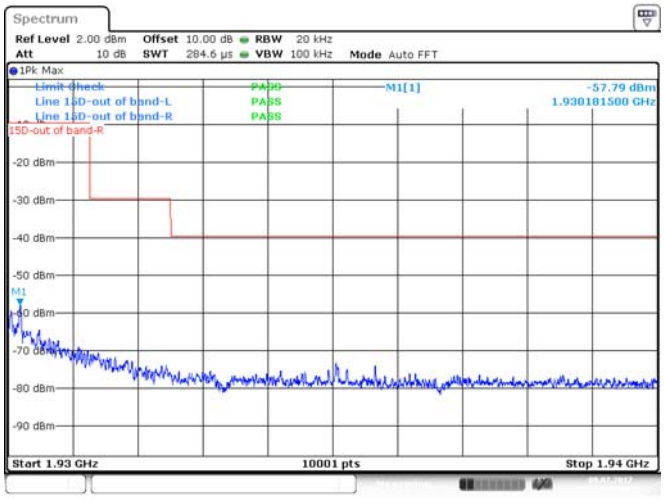


1.94G – 20G



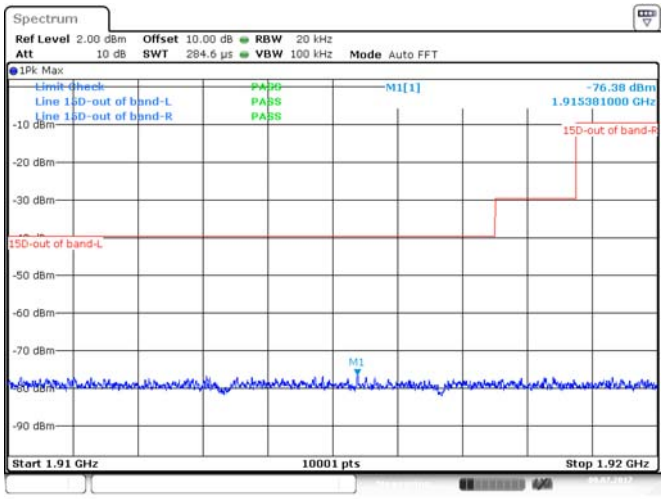
Middle CHANNEL

30MHz – 1.94G



Date: 9.JUL.2017 15:51:03

1.91G – 1.92G



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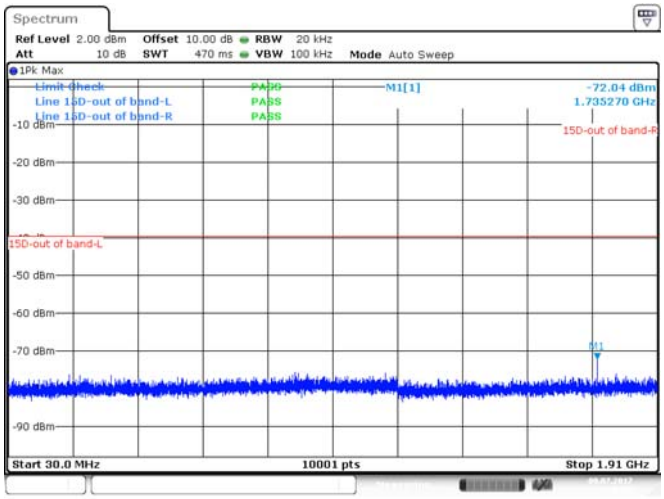
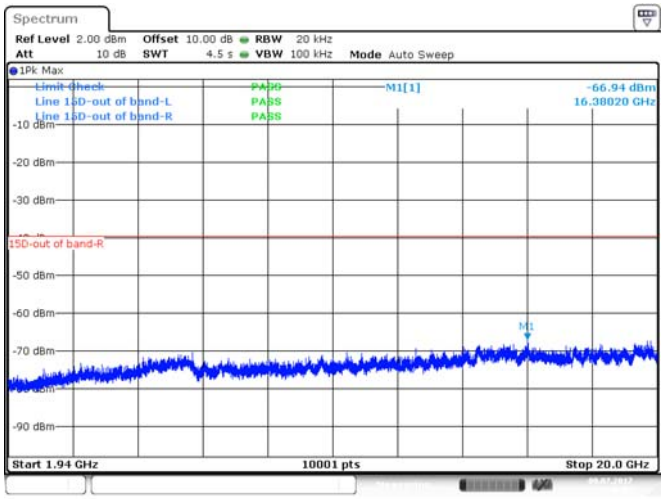
1.93G – 1.91G



Date: 9.JUL.2017 15:49:59

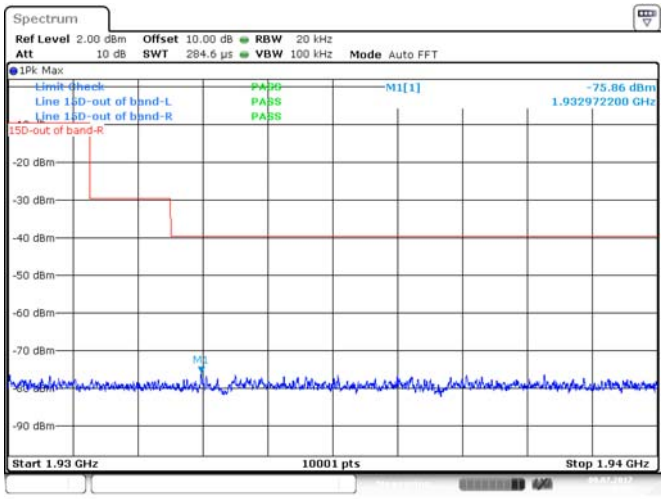
1.94G – 20G



Date: 9.JUL.2017 15:48:03

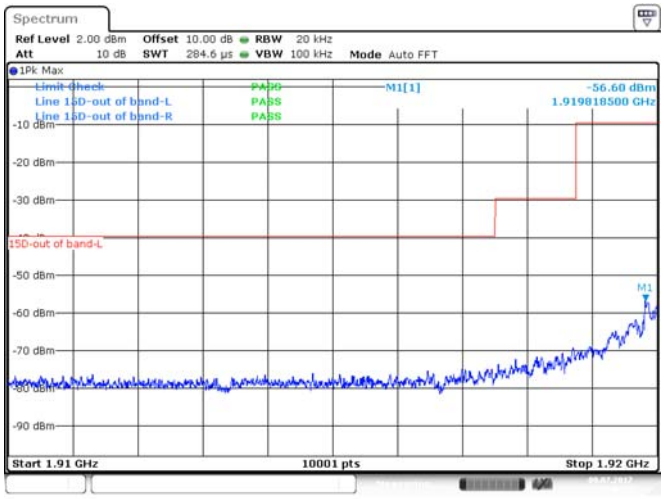
High CHANNEL

30MHz – 1.94G



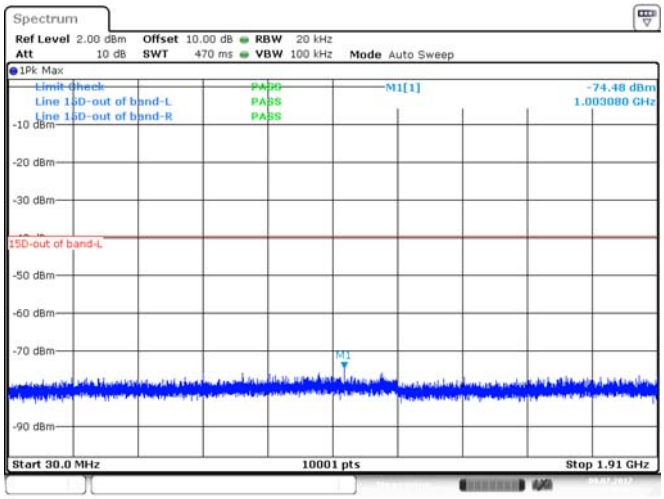
Date: 9.JUL.2017 15:47:21

1.91G – 1.92G



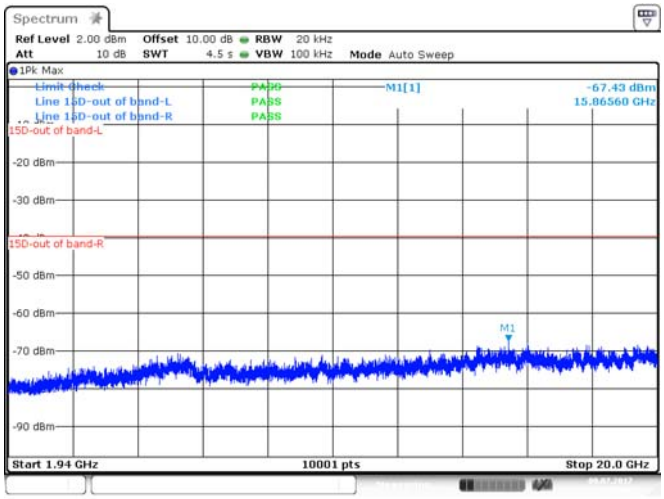
Date: 9.JUL.2017 15:46:32

1.93G – 1.91G



Date: 9.JUL.2017 15:46:02

1.94G – 20G



Date: 9.JUL.2017 15:52:03

A.6 Carrier Frequency Stability

Frequency Stability over Power Supply Voltage at Nominal Temperature

Note: Deviation ppm = ((Mean - Measured Frequency) / Mean) x 106

Voltage	Channel Frequency	Difference	Deviation	Limits	Verdict
Vnom	Middle	3 kHz	1.38 ppm	±10 ppm	Pass
85% of Vnom	Middle	-3 kHz	1.60 ppm	±10 ppm	Pass
115% of Vnom	Middle	4 kHz	1.60 ppm	±10 ppm	Pass

Frequency Stability over Temperature

Temp.	Channel Frequency	Difference	Deviation	Limits	Verdict
Vnom	Middle	3 kHz	1.38 ppm	±10 ppm	Pass
85% of Vnom	Middle	-2 kHz	1.48 ppm	±10 ppm	Pass
115% of Vnom	Middle	5 kHz	1.53 ppm	±10 ppm	Pass

A.7 Frame repetition Stability, period and jitter

The Frame Repetition Stability is measured with the CMD60. The Frame Repetition Stability is 3 times the standard deviation.

Channel	Standard Deviation (ppm)	Frame Repetition (ppm)	The Limit of Frame Repetition Stability (ppm)	Verdict
Middle	0.1	0.3	±10	Pass

Channel	Frame Period (ms)	Max Jitter (µs)	3xStandard Deviation of Jitter (µs)	Limit (µs)		Verdict
				Max Jitter	3 times St.Dev. of Jitter	
Middle	10	0.007	0.006	25	12.5	Pass

Max Jitter = (1/(Frame Period + Pk-Pk)/2) - (1/Frame Period), when Pk-Pk and Frame Period are in Hz.

3 x St. Dev. Jitter 3 x (1/(Frame Period + St. Dev)) - (1/St. Dev)) x 10^6

A.8 Monitoring the time

EUT monitors the combined time and spectrum window prior to initiation of transmission. The observation results as below

Channel Selection	Observation result	Verdict
1. Apply the interference on f1 at level T_U +U_M, and no interference on f2. Initiate transmission and verify the transmission on f2.	EUT transmission on f2	Pass
2. Apply interference on f2 at a level of T_U +U_M, in-band, and immediately remove all interference from f1 and immediately (but not sooner than 20 ms after the interference on f2 is applied) cause the EUT to attempt transmission.	EUT transmission on f1	Pass

A.9 Monitoring threshold

Calculation of Monitoring Threshold Limit:

Lower Threshold:

TL< = 15 logB -184 + 30 - P_{EUT} (dBm)

Upper Threshold:

TU< = 15 logB -184 + 50 - P_{EUT} (dBm)

B is measured Emission Bandwidth in Hz

P_{EUT} is measured Transmitter Power in dBm

The Lower Threshold is applicable for systems which have defined less than 40 duplex system access channels. The Upper Threshold is applicable for systems with more than 40 duplex system access channels and that implements the Least Interfered Channel Procedure (LIC).

Upper Threshold has been removed from FCC 15D but still exists in the current Industry Canada RSS-213.

Test Data:

Monitor Threshold	Measured Level (dBm)	Limit(dBm)	Verdict
Lower threshold	N/A	Lower threshold + 6 dB	N/A[Note]
Upper threshold	N/A	Upper threshold + 6 dB	N/A

Note: For the EUT which support LIC there is no need to measure lower threshold because it is automatically met by LIC procedure

A.10 Maximum transmit period

Test Data:

Test ref. to ANSI C63.17: 2013 clause 8.2.2	Observation result (H)	Limit(H)	Verdict
Transmission duration on same time and frequency window	1	8	Pass

A.11 Acknowledgment system

Test ref. to ANSI C63.17: 2013 clause 8.2.1	Observation result (s)	Limit(s)	Verdict
Initial transmission without acknowledgements	0.68	1	Pass
Transmission time after loss of acknowledgements	10	30	Pass

A.12 Least Interfered Channel, LIC

Calculation of Monitoring Threshold Limit:

Lower Threshold:

TL< = 15 logB -184 + 30 - P_{EUT} (dBm)

B is measured Emission Bandwidth in Hz

P_{EUT} is measured Transmitter Power in dBm

Test Data:

ANSI C63.17 clause 7.3.2 ref.	EUT transmits on	Verdict
f1 TL + 13 dB, *f2* TL + 6 dB	*f2*	Pass
f1 TL + 6 dB, *f2* TL + 13 dB	*f1*	Pass
f1 TL + 7 dB, *f2* TL	*f2*	Pass
f1 TL, *f2* at TL+ 7 dB	*f1*	Pass

A.13 Random waiting

Test Data:

Random Waiting is not implemented in the EUT

Conditions	Transmits Channel	Verdict
Interference applied at operating Channel, f1	*f2*	Pass

A.14 Monitoring bandwidth and reaction time

Monitoring bandwidth:

This test is only required if a dedicated monitoring receiver is used. If the test is not carried out the manufacturer shall declare and provide evidence that the monitoring is made through the radio receiver used for communication.

The test is passed if either the Simple Compliance Test or the More Detailed Test is passed.

During this test the spectrum analyzer is observed visually to see if the EUT transmits or not.

The More Detailed Test must be pass at both the -6dB and -12 dB points if the Simple Compliance Test fails.

Test Data:

Test performed	Observation result	Verdict
Simple Compliance test, at ±30% of B	No transmissions	Pass
More Detailed Test, at -6 dB points	N/A	N/A
More Detailed Test, at -12 dB points	N/A	N/A

Note 1: The tested EUT uses the same receiver for monitoring and communication, this test is therefore not required.

Note 2: The monitoring system bandwidth must be equal to or greater than the emission bandwidth of the intended Transmission.

Reaction time:

By administrative commands and out-of-operating region interference, the EUT is restricted to operate on a single carrier frequency.

Time-synchronized pulsed interference was then applied on the carrier at pulsed levels TU + UM to check that the EUT does not transmit. The level was raised 6 dB for part d) with 35 µs pulses.

The pulses are synchronized with the EUT timeslots and applied cantered within all timeslots.

Test Data:

Test performed	Observation result	Verdict
c) > largest of 50 µs and 50*SQRT(1.25/B)	No transmissions	Pass
d) > largest of 35 µs and 35*SQRT(1.25/B), and with interference level raised 6 dB	No transmissions	Pass

Notes: Since B is larger than 1.25 MHz the test was performed with pulse lengths of 50 µs and 35 µs.

A.15 Monitoring antenna

EUT uses the same antenna used for transmission and monitoring that is in compliance meet above provision.

A.16 Duplex system LBT

Not tested.
The manufacturer declares that this provision is not utilized by the EUT.

A.17 Co-located device LBT

Not appropriate, as the system always monitor both the transmit and receive time/spectrum windows, it is not a co-located device.

A.18 Fair access

Not tested. The tested EUT does not implement this provision. See manufacturer’s declaration.

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-HK1760399-AR.pdf”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-HK1760399-AW.pdf”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-HK1760399-AI.pdf”.

--END OF REPORT--