

FCC/ISED

RF

TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR

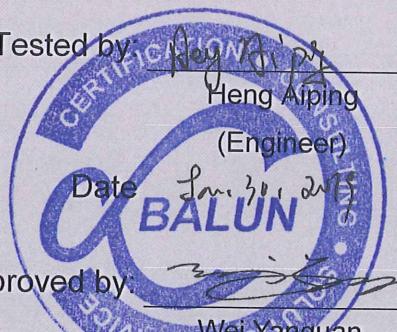
**Leopard CAT M Wireless Communication
Device**

ISSUED TO
M-Labs Technologies, LLC

4740 Von Karman Avenue, Suite 150, Newport Beach, CA 92660



Tested by Heng Aiping
Date Jan. 30, 2019
Approved by Wei Yanquan
Date Jan. 30, 2019



Report No.:	BL-EC18C0431-501
EUT Name:	Leopard CAT M Wireless Communication Device
Model Name:	LP-V001 (refer to section 2.4)
Brand Name:	N/A
Test Standard:	47 CFR Part 2 (10-1-17 Edition) RSS-Gen (Issue 5, April 2018) (Others refer to chapter 3.1)
FCC ID:	2AAQ6LP01V
ISED Number:	20230-LP02
Test Conclusion:	Pass
Test Date:	Dec. 27, 2018 ~ Jan. 30, 2019
Date of Issue:	Jan. 30, 2019

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Revision History

Version	Issue Date	Revisions Content
<u>Rev. 01</u>	Jan. 24, 2019	<u>Initial Issue</u>
<u>Rev. 02</u>	Jan. 30, 2019	<u>Delete LTE-M1 B4 test data and other information; Update the EUT Name and test data for annex A.8&9</u>

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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	<p>The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1.</p> <p>The laboratory is a testing organization accredited by FCC as an accredited testing laboratory. The designation number is CN1196.</p> <p>The laboratory is a testing organization accredited by American Association for Laboratory Accreditation(A2LA) according to ISO/IEC 17025. The accreditation certificate number is 4344.01.</p> <p>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.</p>
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 °C to 35 °C
Ambient Relative Humidity	30 % to 60 %
Ambient Pressure	98 kPa to 102 kPa

1.4 Announce

- (1) The test report reference to the report template version v1.4.
- (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	M-Labs Technologies, LLC
Address	4740 Von Karman Avenue, Suite 150, Newport Beach, CA 92660

2.2 Manufacturer Information

Manufacturer	Asiatelco Technologies Co.
Address	#289 Bisheng Road, Building-8, 3F, Zhangjiang Hi-Tech Park, Pudong, Shanghai, 201204 China

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

EUT Name	Leopard CAT M Wireless Communication Device
Model Name Under Test	LP-V001
Series Model Name	LP-V001, LP-M
Description of Model name differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in model name.
Hardware Version	P2
Software Version	UE5.0.0.0d
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Ancillary Equipment

Note: Not applicable.

2.6 Technical Information

All Network and Wireless connectivity for EUT	4G Network FDD LTE-M1 Band 13 GPS
About the Product	The equipment is CAT M Wireless Communication Device, intended for used with information technology equipment.

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

Operating Bands	FDD LTE-M1 Band 13	
Modulation Type	LTE-M1	QPSK
		16QAM
TX Frequency Range	FDD LTE-M1 Band 13: 777 MHz ~ 787 MHz	
Rx Frequency Range	FDD LTE-M1 Band 13: 746 MHz ~ 756 MHz	
Power Class	FDD LTE-M1 Band 13: 3	
Antenna Type	PIFA Antenna	
Antenna Gain	FDD LTE-M1 Band 13: 0.2 dBi	
The Max RF Output Power (EIRP/ERP)	20.83 dBm	

Note 1: The EUT information are declared by manufacturer. For more detailed features description, please refer to the manufacturer's specifications or user's manual.

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 2 (10-1-17 Edition)	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
2	47 CFR Part 27 (10-1-17 Edition)	Miscellaneous Wireless Communications Services
3	RSS-Gen Issue5 (April 2018)	General Requirements and Information for the Certification of Radio Apparatus
4	RSS-130 Issue1 (October 2013)	Mobile Broadband Services (MBS) Equipment Operating in the Frequency Bands 698-756 MHz and 777-787 MHz
5	ANSI/TIA-603-E-2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
6	KDB 971168 D01 v03r01	Measurement Guidance for Certification of Licensed Digital Transmitters

3.2 Test Verdict

No.	Description	FCC Part No.	ISED Part No.	Test Result	Verdict
1	Conducted RF Output Power	2.1046	RSS-Gen 6.12 RSS-130 4.4	Reporting only (ANNEX A.1)	Pass
2	Effective (Isotropic) Radiated Power	2.1046 27.50	RSS-Gen 6.12 RSS-130 4.4	ANNEX A.1	Pass
3	Peak to Average Radio	2.1046	RSS-130 4.4	ANNEX A.2	Pass
4	Occupied Bandwidth	2.1049 27.53	RSS-Gen 6.7	ANNEX A.3	Pass
5	Frequency Stability	2.1055 27.54	RSS-Gen 6.11 RSS-130 4.3	ANNEX A.4	Pass
6	Spurious Emission at Antenna Terminals	2.1051 27.53	RSS-Gen 6.13 RSS-130 4.6	ANNEX A.5	Pass
7	Band Edge	2.1051 27.53	RSS-130 4.6	ANNEX A.6	Pass
8	Field Strength of Spurious Radiation	2.1053 27.53	RSS-Gen 6.13 RSS-130 4.6	ANNEX A.7	Pass
9	Receiver Spurious Emissions	N/A	RSS-Gen 7	ANNEX A.8	Pass
10	AC Power-line Conducted Emissions	N/A	RSS-Gen 8.8	ANNEX A.9	Pass

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Test Voltage of the EUT	NV (Normal Voltage)	12 V
	LV (Low Voltage)	10 V
	HV (High Voltage)	14 V
Test Temperature of the EUT	NT (Normal Temperature)	+25 °C
	LT (Low Temperature)	-30 °C
	HT (High Temperature)	+50 °C

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Software /Firmware Version	Cal. Date	Cal. Due
Conducted Test System						
Test Software 1	R&S	CMUGo	N/A	V2.0.1	N/A	N/A
Test Software 2	R&S	CMWRun	N/A	V1.8.9	N/A	N/A
Test Software 3	BALUN	BL410R	N/A	V2.1.1.38 4	N/A	N/A
Universal Radio Communication Tester	R&S	CMU 200	119280	V5.13	2018.03.16	2019.03.15
Wideband Radio Communication Tester	R&S	CMW 500	127794	V3.5.137	2018.06.15	2019.06.14
Wideband Radio Communication Tester	R&S	CMW 500	120598	V3.5.137	2018.03.05	2019.03.04
Spectrum Analyzer	R&S	FSV-30	103118	2.30.SP1	2018.06.15	2019.06.14
Spectrum Analyzer	Agilent	E4440A	MY45304434	A.11.21	2018.11.01	2019.10.31
Spectrum Analyzer	Agilent	E4440A	MY46181663	A.11.21	2018.11.01	2019.10.31
Temperature Chamber	AHK	SP20	1412	N/A	2018.06.15	2019.06.14
DC Power Supply	ITECH	IT6863A	6000140106 87210020	N/A	2018.06.14	2019.06.13
Power Sensor	Agilent	E9304A H18	MY41497164	N/A	2018.11.01	2019.10.31
Power Splitter	KMW	DCPD-LDC	1305003215	N/A	N/A	N/A
Attenuator (20 dB)	KMW	ZA-S1-201	110617091	N/A	N/A	N/A
Attenuator (6 dB)	KMW	ZA-S1-61	1305003189	N/A	N/A	N/A

Description	Manufacturer	Model	Serial No.	Software /Firmware Version	Cal. Date	Cal. Due
Radiated Test System						
Test Software	BALUN	BL410_E	N/A	V16.921	N/A	N/A
Test Antenna- Bi-Log (30 MHz-3 GHz)	Schwarzbeck	VULB 9163	9163-624	N/A	2017.07.22	2019.07.21
Test Antenna- Horn(1-18 GHz)	Schwarzbeck	BBHA 9120D	9120D-1600	N/A	2016.07.12	2019.07.11
Test Antenna- Horn(18-40 GHz)	A-INFO	LB- 180400KF	J211060273	N/A	2017.01.06	2020.01.05
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	N/A	2017.02.21	2019.02.20
Shielded Enclosure	ChangNing	CN- 130701	130703	N/A	N/A	N/A
EMI Receiver	KEYSIGHT	N9038A	MY53220118	A.14.16	2018.11.07	2019.11.06
Spectrum Analyzer	R&S	FSV-30	103118	2.30.SP1	2018.06.15	2019.06.14
Wideband Radio Communication Tester	R&S	CMW 500	121551	V3.2.73	2018.05.07	2019.05.06

4.3 Test Configurations

LTE-M1 Band	Bandwidth (MHz)						Modulation Type		RB#			Test Channel		
	1.4	3	5	10	15	20	QPSK	16-QAM	1	Half	Full	LCH	MCH	HCH
Effective (Isotropic) Radiated Power														
13	n	n	v	v	n	n	v	v	v	v	--	v	v	v
Peak to Average Ratio														
13	n	n	--	v	n	n	v	v	v	v	--	v	--	v
Occupied Bandwidth														
13	n	n	v	v	n	n	v	v	--	--	v	v	v	v
Frequency Stability														
13	n	n	--	v	n	n	v	v	--	--	v	--	v	--
Spurious Emission at Antenna Terminals														
13	n	n	v	v	n	n	v	v	v	v	--	v	v	v
Band Edge														
13	n	n	v	v	n	n	v	v	v	v	--	v	v	v
Field Strength of Spurious Radiation														
13	n	n	v	v	n	n	v	--	v	--	--	--	v	--

Note 1: The mark "v" means that this configuration is chosen for testing.
Note 2: The mark "n" means that this bandwidth is not supported.

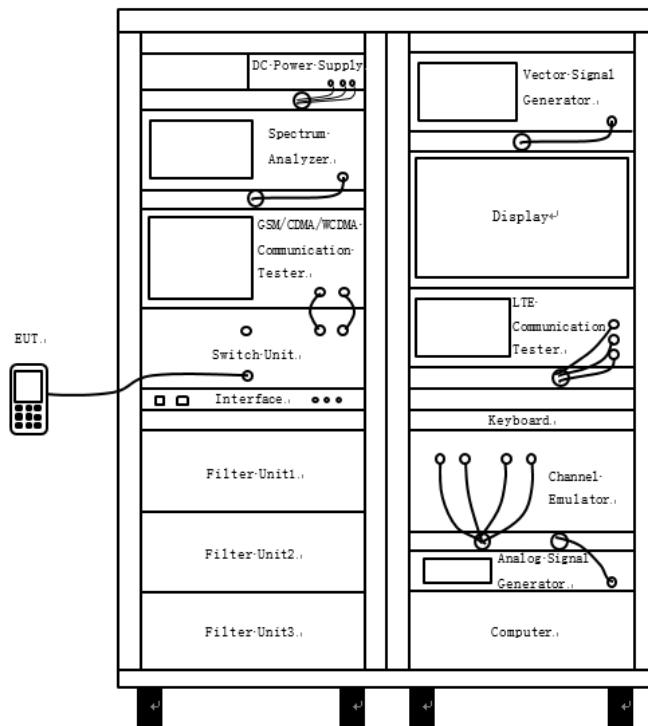
Test Mode	UL Channel	Channel Bandwidth (MHz)	UL Channel No.	UL Frequency (MHz)
LTE-M1 Band 13	Low Range	5	23205	779.5
	Middle Range	5/10	23230	782
	High Range	5	23255	784.5

Test Items	Test Mode	Test Channel		
		LCH	MCH	HCH
Receiver Spurious Emissions	LTE-M1 Band 13	--	v	--
AC Power-line Conducted Emissions	LTE-M1 Band 13	--	v	--

Note 1: The mark "v" means that this configuration is the worst test mode for Receiver Spurious Emissions and AC Power-line Conducted Emissions measurement.

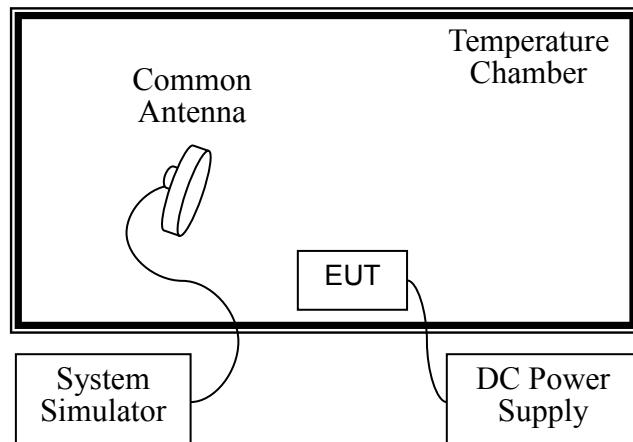
4.4 Test Setup

4.4.1 For Antenna Port Test



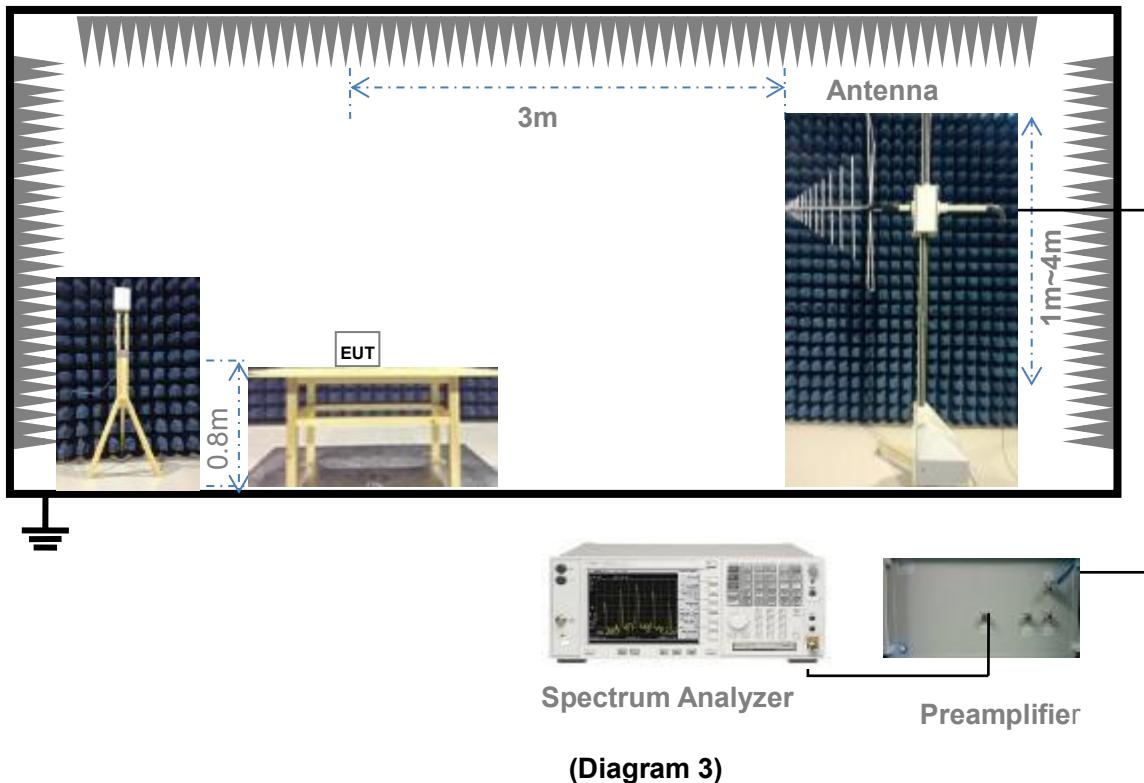
(Diagram 1)

4.4.2 For Frequency Stability Test

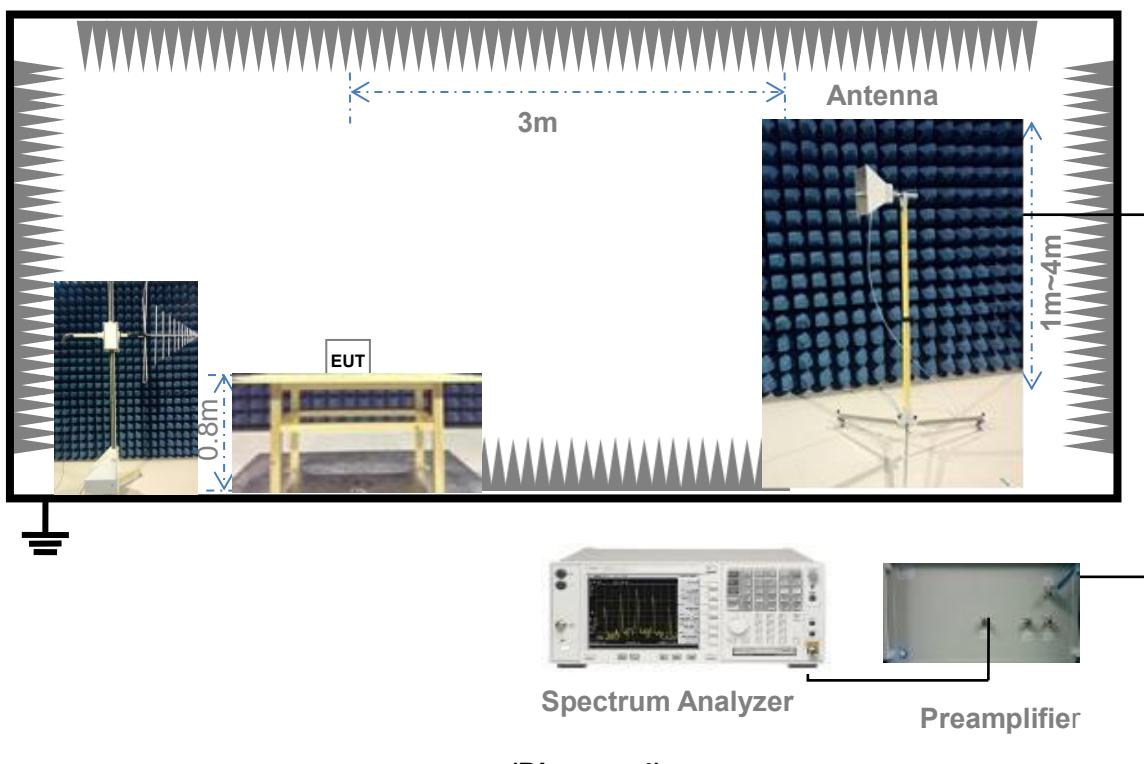


(Diagram 2)

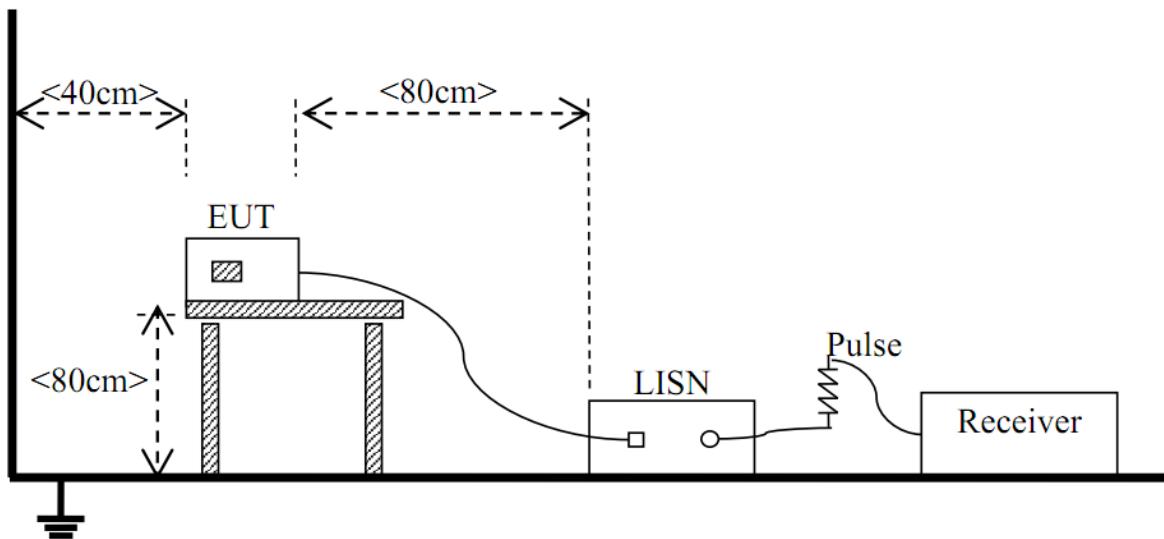
4.4.3 For Radiated Test (30 MHz ~ 1 GHz)



4.4.4 For Radiated Test (Above 1 GHz)



4.4.5 For AC Power-line Conducted Emissions



(Diagram 5)

5 TEST ITEMS

5.1 Transmitter Radiated Power (EIRP/ERP)

5.1.1 Limit

FCC § 2.1046 & 27.50(b)

According to FCC section 27.50(b) (10), portable stations (hand-held devices) transmitting in the 746-757MHz, 776-788MHz, and 805-806MHz bands are limited to 3 watts ERP.

RSS-Gen § 6.12 & RSS-130

According to RSS-130 § 4.4, the e.i.r.p shall not exceed 50 watts for mobile equipment or for outdoor fixed subscriber equipment, nor shall it exceed 5 watts for portable equipment or for indoor fixed subscriber equipment.

5.1.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for conducted test, and the section 4.4.3 and 4.4.4 (Diagram 3, 4) test setup description is used for radiated test. The photo of test setup please refer to ANNEX B.

5.1.3 Test Procedure

Description of the Conducted Output Power Measurement

The EUT is coupled to the SS with attenuator through power splitter; the RF load attached to EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading. A system simulator is used to establish communication with the EUT, and its parameters are set to force the EUT transmitting at maximum output power. The measured power in the radio frequency on the transmitter output terminals shall be reported.

The relevant equation for determining the conducted measured value is:

Conducted Output Power Value (dBm) = Measured Value (dBm) + Path Loss (dB)

where:

Conducted Output Power Value = final conducted measured value in the conducted power test, in dBm;

Measured Value = measured conducted power received by spectrum analyzer or power meter, in dBm;

Path Loss = signal attenuation in the connecting cable between the transmitter and spectrum analyzer or power meter, including external cable loss, in dB;

During the test, the data of Path Loss (dB) is added in the spectrum analyzer or power meter, so Measured Value (dBm) is the final values which contains the data of Path Loss (dB).

For example:

In the conducted output power test, when measured value for GSM850 is 24.7 dBm, and path loss is 8.5 dB, then final conducted output power value is:

$$\text{Conducted Output Power Value (dBm)} = 24.7 \text{ dBm} + 8.5 \text{ dB} = 33.2 \text{ dBm}$$

Description of the Transmitter Radiated Power Measurement

In many cases, the RF output power limits for licensed digital transmission devices is specified in terms of effective radiated power (ERP) or equivalent isotropic radiated power (EIRP). Typically, ERP is specified when the operating frequency is less than or equal to 1 GHz and EIRP is specified when the operating frequency is greater than 1 GHz. Both are determined by adding the transmit antenna gain to the conducted RF output power with the primary difference between the two being that when determining the ERP, the transmit antenna gain is referenced to a dipole antenna (i.e., dBd) whereas when determining the EIRP, the transmit antenna gain is referenced to an isotropic antenna (dBi).

Final measurement calculation as below:

The relevant equation for determining the ERP or EIRP from the conducted RF output power measured using the guidance provided above is:

$$\text{ERP/EIRP} = P_{\text{Meas}} + GT - LC$$

where:

ERP/EIRP = effective or equivalent radiated power, respectively (expressed in the same units as P_{Meas} , typically dBW or dBm);

P_{Meas} = measured transmitter output power or PSD, in dBm or dBW;

GT = gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP);

dBd (ERP)=dBi (EIRP) -2.15 dB

LC = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

For devices utilizing multiple antennas, KDB 662911 provides guidance for determining the effective array transmit antenna gain term to be used in the above equation.

For example:

In the EIRP test, when P_{Meas} value for GSM1900 is 30.2 dBm, LC is 0.6 dB, and GT is -3.4 dB, then final EIRP value is:

$$\text{EIRP for GSM1900} = 30.2 \text{ dBm} - 3.4 \text{ dBi} - 0.6 \text{ dB} = 26.2 \text{ dBm}$$

The relevant equation for determining the ERP/EIRP from the radiated RF output power is:

$$\text{ERP/EIRP (dBm)} = \text{SA Read Value (dBm)} + \text{Correction Factor (dB)}$$

where:

ERP/EIRP = effective or equivalent radiated power, in dBm;

SA Read Value = measured transmitter power received by EMI receiver or spectrum analyzer, in dBm;

Correction Factor = total correction factor including cable loss, in dB;

During the test, the data of Correction Factor (dB) is added in the EMI receiver or spectrum analyzer, so SA Read Value (dBm) is the final values which contains the data of Correction Factor (dB).

For example:

In the ERP test, when SA read value for GSM850 is 21dBm, and correction factor is 8dB, then final ERP value for GSM850 is:

$$\text{ERP (dBm)} = 21\text{dBm} + 8\text{dB} = 29\text{dBm}$$

5.1.4 Test Result

Please refer to ANNEX A.1.

5.2 Peak to Average Ratio

5.2.1 Limit

FCC § 2.1046

RSS-130 § 4.4

In addition, when the transmitter power is measured in terms of average value, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

5.2.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

Here the lowest, middle and highest channels are selected to perform testing to verify the peak-to-average ratio.

According to KDB 971168 D01, there is CCDF procedure for PAPR:

- a) Refer to instrument's analyzer instruction manual for details on how to use the power statistics/CCDF function;
- b) Set resolution/measurement bandwidth \geq signal's occupied bandwidth;
- c) Set the number of counts to a value that stabilizes the measured CCDF curve;
- d) Set the measurement interval as follows:
 - 1) for continuous transmissions, set to 1 ms,
 - 2) for burst transmissions, employ an external trigger that is synchronized with the EUT burst timing sequence, or use the internal burst trigger with a trigger level that allows the burst to stabilize and set the measurement interval to a time that is less than or equal to the burst duration.
- e) Record the maximum PAPR level associated with a probability of 0.1%.

Alternate procedure for PAPR:

Use one of the procedures presented in 4.1 to measure the total peak power and record as P_{Pk} . Use one of the applicable procedures presented 4.2 to measure the total average power and record as P_{Avg} . Both the peak and average power levels must be expressed in the same logarithmic units (e.g., dBm). Determine the PAPR from:

$$\text{PAPR (dB)} = P_{Pk} (\text{dBm}) - P_{Avg} (\text{dBm}).$$

5.2.4 Test Result

Please refer to ANNEX A.2.

5.3 Occupied Bandwidth

5.3.1 Limit

FCC § 2.1049

RSS-Gen § 6.7

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

Many of the individual rule parts specify a relative OBW in lieu of the 99% OBW. In such cases, the OBW is defined as the width of the signal between two points, one below the carrier center frequency and on above the carrier center frequency, outside of which all emissions are attenuated by at least X dB below the transmitter power, where the value of X is typically specified as 26.

5.3.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The following procedure shall be used for measuring power bandwidth.

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (i.e., two to five times the anticipated OBW).
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.
- c) Set the reference level of the instrument as required to keep the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope must be at least $10\log(\text{OBW} / \text{RBW})$ below the reference level.
- d) NOTE—Steps a) through c) may require iteration to adjust within the specified tolerances.
- e) For -26 dB OBW, the dynamic range of the spectrum analyzer at the selected RBW shall be at least 10dB below the target “-X dB down” requirement, e.g. -26 dB OBW, the spectrum analyzer noise floor at the selected RBW shall be 36dB below the reference value.
- f) Set the detection mode to peak, and the trace mode to max hold.
- g) For 99% OBW, use the 99 % power bandwidth function of the spectrum analyzer (if available) and report the measured bandwidth.

If the instrument does not have a 99 % power bandwidth function, the trace data points are to be recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency.

The 99 % power bandwidth is the difference between these two frequencies.

h) For -26 dB OBW, determine the reference value: Set the EUT to transmit a modulated signal. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

Determine the “-X dB down amplitude” as equal to (reference value -X). Alternatively, this calculation can be performed by the analyzer by using the marker-delta function.

Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display such that each marker is at or slightly below “-X dB down amplitude” determined in step g). If a marker is below this “-X dB down amplitude” value it shall be placed as close as possible to this value. The OBW is the positive frequency difference between the two markers.

i) The OBW shall be reported by providing plot(s) of the measuring instrument display. The frequency and amplitude axes and scale shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

j) Change variable modulations, coding, or channel bandwidth settings, then repeat above test procedures.

5.3.4 Test Result

Please refer to ANNEX A.3.

5.4 Frequency Stability

5.4.1 Limit

FCC § 2.1055 & 27.54

RSS-Gen § 6.11 & RSS-130 § 4.3

FCC § 2.1055 & RSS-Gen § 6.11

The frequency stability shall be measured with variation of ambient temperature as follows:

(1) The temperature is varied from -30°C to +50°C.

(2) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10°C through the range.

The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating and point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

FCC § 27.54

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

RSS-130 § 4.3

The frequency offset shall be measured according to the procedure described in RSS-Gen and recorded.

5.4.2 Test Setup

The section 4.4.2 (Diagram 2) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

1. The EUT is placed in a temperature chamber.
2. The temperature is set to 25°C and allowed to stabilize. After sufficient soak time, the transmitting frequency error is measured.
3. The temperature is increased by not more than 10 degrees, allowed to stabilize and soak, and then repeat the frequency error measurement.

4. Repeat procedure 3 until +50°C and -30°C is reached.
5. Change supply voltage, and repeat measurement until extreme voltage is reached.

5.4.4 Test Result

Please refer to ANNEX A.4.

5.5 Spurious Emission at Antenna Terminals

5.5.1 Limit

FCC § 2.1051 & 27.53(c)

RSS-Gen § 6.13 & RSS-130 § 4.6

In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

- (1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $76 + 10 \log (P)$ dB in a 6.25 kHz band segment, for base and fixed stations;
- (4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations;
- (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;

- (6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

RSS-130 § 4.6

The power of any unwanted emissions in any 100kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10\log_{10}P$ (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

5.5.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least $43 + 10 \log(P)$ dB. Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency blocks a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

1. The EUT is coupled to the system simulator and spectrum analyzer; the RF load attached to EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.
2. CMW500 is used to establish communication with the EUT, and its parameters are set to force the EUT transmitting at maximum output power.
3. The RF output of the transmitter is connected to the input of the spectrum analyzer through sufficient attenuation.
4. Spurious emissions are tested with 0.001MHz RBW for frequency less than 150kHz, 0.01MHz RBW for frequency less than 30MHz, 0.1MHz RBW for frequency less than 1GHz, and 1MHz RBW for frequency above 1GHz. And sweep point number are at least 401, referring to following formula.

Sweep point number = Span/RBW

VBW=3*RBW

Detector Mode=mean or average power

5. Record the frequencies and levels of spurious emissions.

5.5.4 Test Result

Please refer to ANNEX A.5.

5.6 Band Edge

5.6.1 Limit

FCC § 2.1051 & 27.53(c)

RSS-130 § 4.6

In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

- (1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $76 + 10 \log (P)$ dB in a 6.25 kHz band segment, for base and fixed stations;
- (4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations;
- (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;

- (6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

RSS-130 § 4.6

The power of any unwanted emissions in any 100kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10\log_{10}P$ (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

In addition to the limit outlined in above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

- (a) The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:
 - (i) $76 + 10 \log_{10} p$ (watts), dB, for base and fixed equipment, and
 - (ii) $65 + 10 \log_{10} p$ (watts), dB, for mobile and portable equipment.
- (b) The e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW/MHz for wideband signal and -80 dBW for discrete emission with bandwidth less than 700 Hz.

5.6.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The EUT, which is powered by the Battery, is coupled to the Spectrum Analyzer (SA) and the System Simulator (SS) with attenuators through the Power Splitter; the RF load attached to the EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading.

1. The EUT is coupled to the system simulator and spectrum analyzer; the RF load attached to EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading.
2. CMW500 is used to establish communication with the EUT, and its parameters are set to force the EUT transmitting at maximum output power.
3. The RF output of the transmitter is connected to the input of the spectrum analyzer through sufficient attenuation.
4. The center of the spectrum analyzer was set to block edge frequency.
5. Band edge are tested with $1\% * cBW$ (RBW), and sweep point number referred to following formula.

$$\text{Sweep point number} = 2 * \text{Span}/\text{RBW}$$

$$\text{VBW} = 3\text{RBW}$$

6. Record the frequencies and levels of spurious emissions.

5.6.4 Test Result

Please refer to ANNEX A.6.

5.7 Field Strength of Spurious Radiation

5.7.1 Limit

FCC § 2.1053 & 27.53(c)

RSS-Gen § 6.13 & RSS-130 § 4.6

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

- (1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $76 + 10 \log (P)$ dB in a 6.25 kHz band segment, for base and fixed stations;
- (4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations;
- (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;

- (6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

RSS-130 § 4.6

The power of any unwanted emissions in any 100kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10\log_{10}P$ (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

5.7.2 Test Setup

The section 4.4.3 and 4.4.4 (Diagram 3, 4) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

1. On a test site, the EUT shall be placed at 80cm height on a turn table, and in the position close to normal use

as declared by the applicant.

2. The test antenna shall be oriented initially for vertical polarization located 3 m from EUT to correspond to the fundamental frequency of the transmitter.
3. The output of the test antenna shall be connected to the measuring receiver and the peak detector is used for the measurement.
4. During the measurement of the EUT, the resolution bandwidth was to 1 MHz and the average bandwidth was set to 1 MHz.
5. The transmitter shall be switched on; the measuring receiver shall be tuned to the frequency of the transmitter under test.

6. The test antenna shall be raised and lowered through the specified range of height until the maximum signal level is detected by the measuring receiver.
7. The transmitter shall be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
8. The test antenna shall be raised and lowered again through the specified range of height until the maximum signal level is detected by the measuring receiver.
9. The maximum signal level detected by the measuring receiver shall be noted.
10. The EUT was replaced by half-wave dipole (824 ~ 849 MHz) or horn antenna (1 850 ~ 1 910 MHz) connected to a signal generator.
11. In necessary, the input attenuator setting on the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.
12. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.
13. The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring received, which is equal to the level noted while the transmitter radiated power was measured, corrected for the change of input attenuator setting of the measuring receiver.
14. The input level to the substitution antenna shall be recorded as power level in dBm, corrected for any change of input attenuator setting of the measuring receiver.
15. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

Final measurement calculation as below:

The relevant equation for determining the ERP/EIRP from the radiated RF output power is:

$$\text{ERP/EIRP (dBm)} = \text{SA Read Value (dBm)} + \text{Correction Factor (dB)}$$

where:

ERP/EIRP = effective or equivalent radiated power, in dBm;

SA Read Value = measured transmitter power received by EMI receiver or spectrum analyzer, in dBm;

Correction Factor = total correction factor including cable loss, in dB;

During the test, the data of Correction Factor (dB) is added in the EMI receiver or spectrum analyzer, so SA Read Value (dBm) is the final values which contains the data of Correction Factor (dB).

For example:

In the ERP test, when SA read value for GSM850 is 21dBm, and correction factor is 8dB, then final ERP value for GSM850 is:

$$\text{ERP (dBm)} = 21\text{dBm} + 8\text{dB} = 29\text{dBm}$$

5.7.4 Test Result

Please refer to ANNEX A.7.

5.8 Receiver Spurious Emissions

5.8.1 Limit

RSS-Gen § 7.3/4

For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz.

As an alternative to CISPR quasi-peak or average measurements, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization, as required, with a measurement bandwidth equal to, or greater than, the applicable CISPR quasi-peak bandwidth or 1 MHz bandwidth, respectively.

Receiver Radiated Limits

Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna ports. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least five times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

Spurious emissions from receivers shall not exceed the radiated emissions limits shown in Table 2 below.

Table 2 –Receiver radiated emissions limits

Frequency (MHz)	Field Strength (μ V/m at 3 metres)
30 - 88	100
88 - 216	150
216 - 960	200
Above 960	500

Receiver Conducted Limits

If the receiver has a detachable antenna of known impedance, an antenna-conducted spurious emissions measurement is permitted as an alternative to radiated measurement. However, the radiated method is preferred.

The antenna-conducted test shall be performed with the antenna disconnected and with the receiver antenna port connected to a measuring instrument having equal input impedance to that specified for the antenna. The RF cable connecting the receiver under test to the measuring instrument shall also have the same impedance to that specified for the receiver's antenna.

The spurious emissions from the receiver at any discrete frequency, measured at the antenna port by the antenna-conducted method, shall not exceed 2 nW in the frequency range 30-1000 MHz and 5 nW above 1 GHz.

5.8.2 Test Setup

The section 4.4.3 and 4.4.4 (Diagram 3, 4) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The test employing the methods of measurement described in the publication referenced in Section 3(b) (ANSI C63.4);

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

An initial pre-scan was performed in the chamber using the EMI Receiver in peak detection mode. Quasi-peak measurements were conducted based on the peak sweep graph. The EUT was measured by Bi-Log antenna with 2 orthogonal polarities.

5.8.4 Test Result

Please refer to ANNEX A.8.

5.9 AC Power-line Conducted Emissions

5.9.1 Limit

RSS-Gen § 8.8

For AC power-line conducted emissions, both quasi-peak and average detectors having the characteristics specified in CAN/CSA-CISPR 16-1-1:15 for the 150 kHz to 30 MHz frequency range shall be employed.

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 3, as measured using a 50 μ H / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 3 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

Table 3 –AC power-line conducted emissions limits

Frequency (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 ^{Note1}	56 to 46 ^{Note1}
0.5 - 5	56	46
5 - 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

5.9.2 Test Setup

The section 4.4.5 (Diagram 5) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The test employing the methods of measurement described in the publication referenced in Section 3(b) (ANSI C63.4);

The EUT is connected to the power mains through a LISN which provides $50 \Omega/50 \mu\text{H}$ of coupling impedance for the measuring instrument. The test frequency range is from 150 kHz to 30 MHz. The maximum conducted interference is searched using Peak (PK), Quasi-peak (QP) and Average (AV) detectors; the emission levels that are 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.

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.

5.9.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULTS

A.1 Transmitter Radiated Power (EIRP/ERP)

LTE-M1 Mode Test Data

Test BW	Test Channel	Test Mode	Test RB (Size#Offsets)	Conducted Output AV Power (dBm)	Antenn a Gain (dBi)	Antenn a Gain (dBd)	ERP (dBm)	ERP (W)	Limit (W)	Verdict
LTE-M1 BAND13										
5 MHz	LCH	QPSK	RB1#0	22.63	0.2	-1.95	20.68	0.117	3.00	Pass
			RB1#5	22.65	0.2	-1.95	20.70	0.117	3.00	Pass
			RB6#0	21.78	0.2	-1.95	19.83	0.096	3.00	Pass
		16-QAM	RB1#0	22.39	0.2	-1.95	20.44	0.111	3.00	Pass
			RB1#5	22.38	0.2	-1.95	20.43	0.110	3.00	Pass
			RB5#0	20.87	0.2	-1.95	18.92	0.078	3.00	Pass
			RB5#1	20.91	0.2	-1.95	18.96	0.079	3.00	Pass
	MCH	QPSK	RB1#0	22.77	0.2	-1.95	20.82	0.121	3.00	Pass
			RB1#5	22.78	0.2	-1.95	20.83	0.121	3.00	Pass
			RB6#0	21.78	0.2	-1.95	19.83	0.096	3.00	Pass
		16-QAM	RB1#0	22.53	0.2	-1.95	20.58	0.114	3.00	Pass
			RB1#5	22.44	0.2	-1.95	20.49	0.112	3.00	Pass
			RB5#0	21.09	0.2	-1.95	19.14	0.082	3.00	Pass
			RB5#1	20.91	0.2	-1.95	18.96	0.079	3.00	Pass
	HCH	QPSK	RB1#0	22.62	0.2	-1.95	20.67	0.117	3.00	Pass
			RB1#5	22.61	0.2	-1.95	20.66	0.116	3.00	Pass
			RB6#0	21.75	0.2	-1.95	19.80	0.095	3.00	Pass
		16-QAM	RB1#0	22.56	0.2	-1.95	20.61	0.115	3.00	Pass
			RB1#5	22.50	0.2	-1.95	20.55	0.114	3.00	Pass
			RB5#0	20.96	0.2	-1.95	19.01	0.080	3.00	Pass
			RB5#1	20.87	0.2	-1.95	18.92	0.078	3.00	Pass
10 MHz	MCH	QPSK	RB1#0	22.61	0.2	-1.95	20.66	0.116	3.00	Pass
			RB1#5	22.60	0.2	-1.95	20.65	0.116	3.00	Pass
			RB6#0	21.82	0.2	-1.95	19.87	0.097	3.00	Pass
		16-QAM	RB1#0	22.32	0.2	-1.95	20.37	0.109	3.00	Pass
			RB1#5	22.29	0.2	-1.95	20.34	0.108	3.00	Pass
			RB5#0	21.66	0.2	-1.95	19.71	0.094	3.00	Pass
			RB5#1	21.63	0.2	-1.95	19.68	0.093	3.00	Pass

A.2 Peak to Average Ratio

Note 1: Test plots please refer to the document “Annex No.: BL-EC18C0431-501 Data Part 1.pdf”.

LTE-M1 Mode Test Data

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Peak to Average Ratio (dB)	Limit (dB)	Refer to Plot ^{Note1}	Verdict	
LTE-M1 Band 13	10 MHz	MCH	QPSK	RB1#0	3.750	13	4.1	Pass	
				RB6#0	3.797	13	4.2	Pass	
	16-QAM		16-QAM	RB1#0	3.891	13	4.3	Pass	
				RB5#1	4.078	13	4.4	Pass	

A.3 Occupied Bandwidth

Note 1: All modes were tested, but only the typical data were reported in this report.

Note 2: Test plots please refer to the document “Annex No.: BL-EC18C0431-501 Data Part 2.pdf”.

LTE-M1 Mode Test Data

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Measured 99% Occupied Bandwidth (MHz)	Measured -26 dB Occupied Bandwidth (MHz)	Refer to Plot ^{Note2}
Band 13	5 MHz	LCH	QPSK	RB6#0	1.108731	1.420712	7.1
			16-QAM	RB5#1	0.968777	1.413462	7.2
		MCH	QPSK	RB6#0	1.110932	1.421834	8.1
			16-QAM	RB5#1	0.970820	1.399998	8.2
		HCH	QPSK	RB6#0	1.115312	1.415618	9.1
			16-QAM	RB5#1	0.975354	1.429921	9.2
	10 MHz	MCH	QPSK	RB6#0	1.111374	1.438599	10.1
			16-QAM	RB5#1	0.961884	1.405854	10.2

A.4 Frequency Stability

LTE-M1 Band 13 QPSK 10 MHz

Test Conditions		Frequency Deviation		Verdict	
Power (VDC)	Temperature (°C)	MCH 782 MHz			
		Value (Hz)	Limits (Hz)		
12	-30	-0.80	±1955	Pass	
	-20	-1.72			
	-10	0.10			
	0	-1.80			
	+10	-1.56			
	+20	-2.99			
	+30	-1.66			
	+40	-3.00			
	+50	-1.27			
	10	+25			
14	+25	-2.80			
	+25	-2.78			

LTE-M1 Band 13 16QAM 10 MHz

Test Conditions		Frequency Deviation		Verdict	
Power (VDC)	Temperature (°C)	MCH 782 MHz			
		Value (Hz)	Limits (Hz)		
12	-30	-19.76	±1955	Pass	
	-20	-29.10			
	-10	-11.17			
	0	-16.69			
	+10	-10.09			
	+20	-10.71			
	+30	-15.08			
	+40	-12.09			
	+50	-13.29			
	10	+25			
14	+25	-25.63			
	+25	14.46			

A.5 Spurious Emission at Antenna Terminals

Note 1: The frequencies of verdict which are marked by "N/A" should be ignored because they are UE carrier frequency.

Note 2: Test plots please refer to the document "Annex No.: BL-EC18C0431-501 Data Part 3.pdf".

LTE-M1 Mode Test Verdict

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot ^{Note2}	Verdict
Band 13	5 MHz	LCH	QPSK	RB1#0	7.1	Pass
			16-QAM	RB1#0	7.2	Pass
		MCH	QPSK	RB1#0	8.1	Pass
			16-QAM	RB1#0	8.2	Pass
		HCH	QPSK	RB1#0	9.1	Pass
			16-QAM	RB1#0	9.2	Pass
	10 MHz	MCH	QPSK	RB1#0	10.1	Pass
			16-QAM	RB1#0	10.2	Pass

A.6 Band Edge

Note 1: Test plots please refer to the document “Annex No.: BL-EC18C0431-501 Data Part 4.pdf”.

LTE-M1 Mode Test Verdict

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot ^{Note1}	Verdict
Band 13	5 MHz	LCH	QPSK	RB1#0	5.1	Pass
				RB6#0	5.2	Pass
			16-QAM	RB1#0	5.3	Pass
				RB5#0	5.4	Pass
		HCH	QPSK	RB1#5	6.1	Pass
				RB6#0	6.2	Pass
			16-QAM	RB1#5	6.3	Pass
				RB5#1	6.4	Pass
	10 MHz	MCH (left)	QPSK	RB1#0	7.1	Pass
				RB6#0	7.2	Pass
			16-QAM	RB1#0	7.3	Pass
				RB5#0	7.4	Pass
		MCH (right)	QPSK	RB1#5	8.1	Pass
				RB6#0	8.2	Pass
			16-QAM	RB1#5	8.3	Pass
				RB5#1	8.4	Pass

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot ^{Note1}	Verdict
Band 13 (Emission Mask)	5 MHz	LCH	QPSK	RB1#0	9.1	Pass
				RB6#0	9.2	Pass
			16-QAM	RB1#0	9.3	Pass
				RB5#0	9.4	Pass
		HCH	QPSK	RB1#5	10.1	Pass
				RB6#0	10.2	Pass
			16-QAM	RB1#5	10.3	Pass
				RB5#1	10.4	Pass
	10 MHz	MCH (left)	QPSK	RB1#0	11.1	Pass
				RB6#0	11.2	Pass
			16-QAM	RB1#0	11.3	Pass
				RB5#0	11.4	Pass
		MCH (right)	QPSK	RB1#5	11.5	Pass
				RB6#0	11.6	Pass
			16-QAM	RB1#5	11.7	Pass
				RB5#1	11.8	Pass

A.7 Field Strength of Spurious Radiation

Note 1: Only the worst data with different transmit bandwidth for LTE-M1 are shown here.

Note 2: The frequencies of verdict which are marked by "N/A" should be ignored because they are UE carrier frequency.

Note 3: Test plots please refer to the document "Annex No.: BL-EC18C0431-501 Data Part 5.pdf".

LTE-M1 Mode Test Verdict

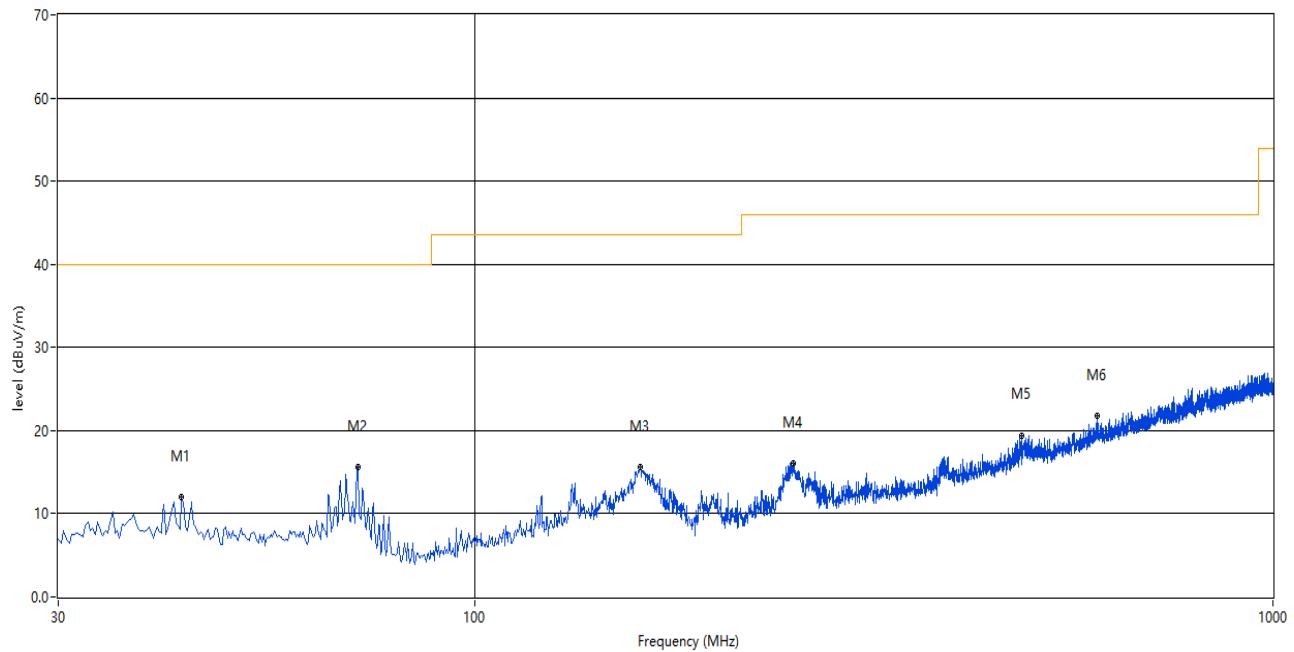
Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot ^{Note3}	Verdict
Band 13	5 MHz	MCH	QPSK	RB1#0	2.1	Pass
	10 MHz	MCH	QPSK	RB1#0	2.2	Pass

A.8 Receiver Spurious Emissions

Note: Only the worst test results were recorded in this report.

30MHz to 1GHz, ANT H

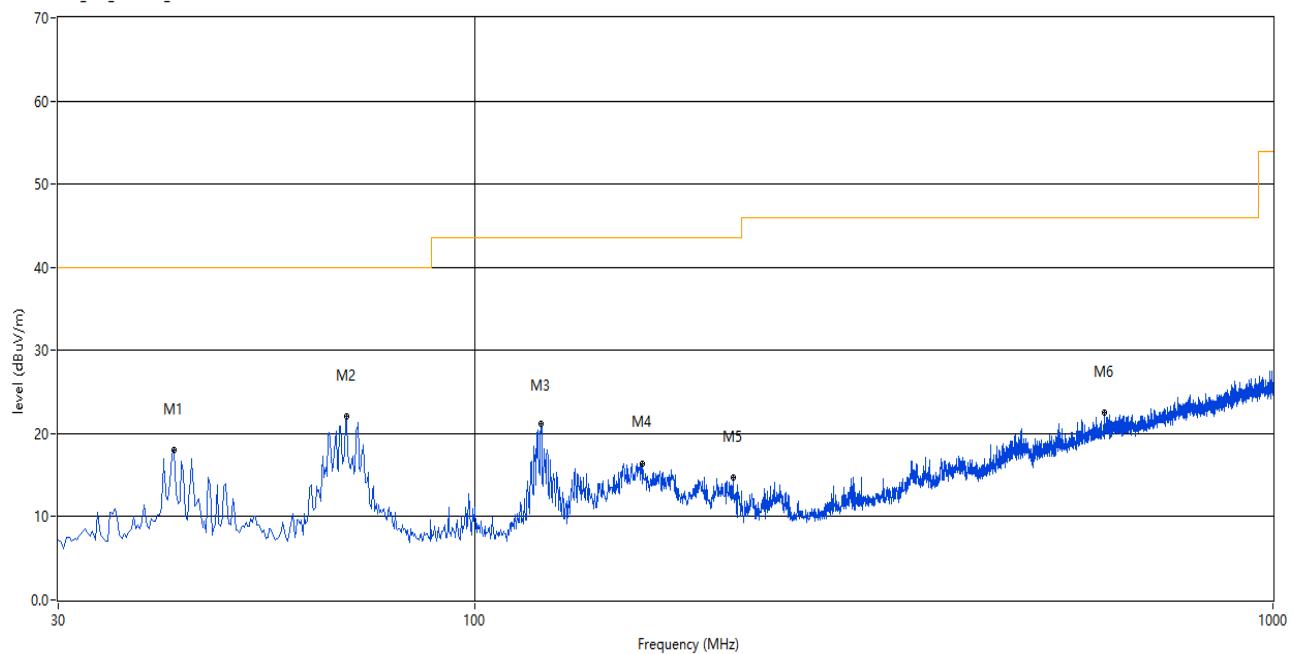
RE Test case_FCC_Part 15B_FCC Part 15B Class B 30MHz-1GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	42.852	12.01	-26.88	40.0	-27.99	Peak	326.00	200	Horizontal	Pass
2	71.225	15.58	-29.68	40.0	-24.42	Peak	358.00	200	Horizontal	Pass
3	160.950	15.56	-24.83	43.5	-27.94	Peak	295.00	200	Horizontal	Pass
4	250.675	16.14	-26.56	46.0	-29.86	Peak	107.00	100	Horizontal	Pass
5	484.203	19.43	-19.32	46.0	-26.57	Peak	141.00	100	Horizontal	Pass
6	602.542	21.81	-16.09	46.0	-24.19	Peak	358.00	200	Horizontal	Pass

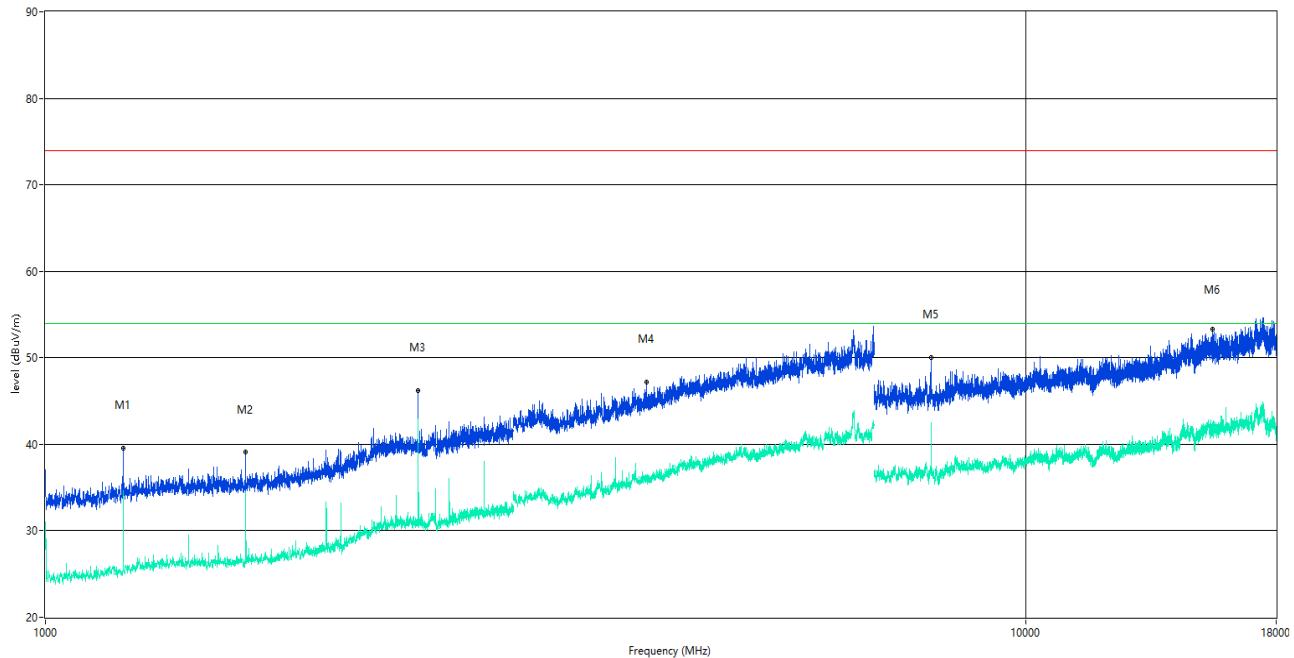
30MHz to 1GHz, ANT V

RE Test case_FCC_Part 15B_FCC Part 15B Class B 30MHz-1GHz



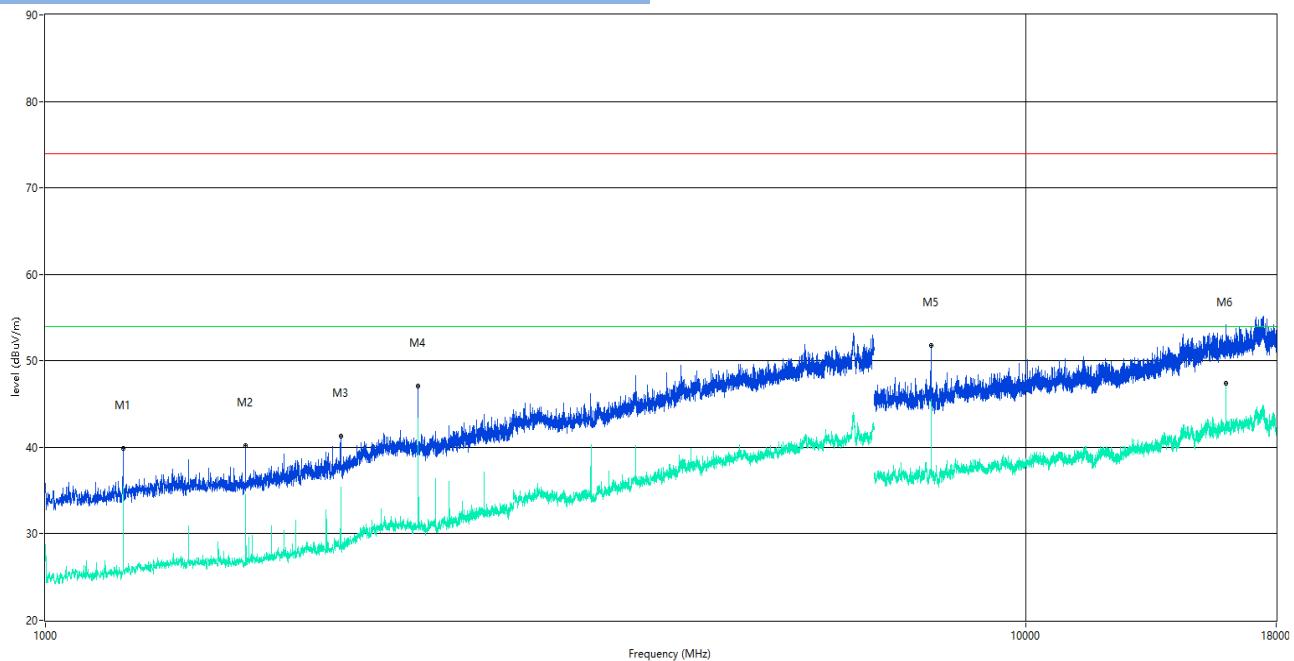
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	41.883	17.99	-26.88	40.0	-22.01	Peak	0.00	100	Vertical	Pass
2	69.043	22.09	-29.27	40.0	-17.91	Peak	0.00	200	vertical	Pass
3	120.936	21.07	-27.27	43.5	-22.43	Peak	0.00	300	vertical	Pass
4	162.163	16.43	-25.06	43.5	-27.07	Peak	0.00	100	vertical	Pass
5	210.663	14.67	-28.47	43.5	-28.83	Peak	0.00	200	vertical	Pass
6	615.153	22.47	-15.70	46.0	-23.53	Peak	0.00	100	vertical	Pass

1GHz to 18GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1**	1200.000	30.80	-17.92	54.0	-23.20	AV	21.00	100	Horizontal	Pass
1	1200.000	39.52	-17.92	74.0	-34.48	Peak	21.00	100	Horizontal	Pass
2**	1600.000	30.99	-17.38	54.0	-23.01	AV	276.00	100	Horizontal	Pass
2	1600.000	39.08	-17.38	74.0	-34.92	Peak	276.00	100	Horizontal	Pass
3**	2400.000	37.83	-12.14	54.0	-16.17	AV	51.00	100	Horizontal	Pass
3	2400.000	46.26	-12.14	74.0	-27.74	Peak	51.00	100	Horizontal	Pass
4**	4100.000	36.14	-5.44	54.0	-17.86	AV	225.00	100	Horizontal	Pass
4	4100.000	47.19	-5.44	74.0	-26.81	Peak	225.00	100	Horizontal	Pass
5**	8000.500	42.54	-1.98	54.0	-11.46	AV	38.00	100	Horizontal	Pass
5	8000.500	50.02	-1.98	74.0	-23.98	Peak	38.00	100	Horizontal	Pass
6**	15514.125	42.16	2.37	54.0	-11.84	AV	87.00	100	Horizontal	Pass
6	15514.125	53.29	2.37	74.0	-20.71	Peak	87.00	100	Horizontal	Pass

1GHz to 18GHz, ANT V



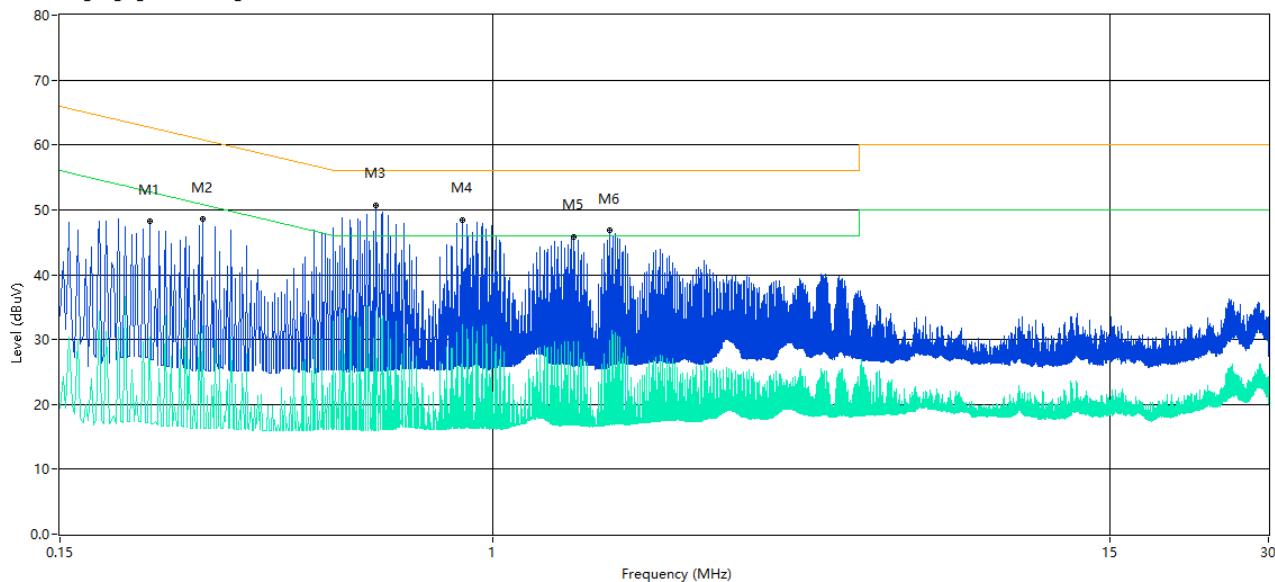
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1**	1200.000	31.65	-17.92	54.0	-22.35	AV	167.00	100	Vertical	Pass
1	1200.000	39.92	-17.92	74.0	-34.08	Peak	167.00	100	vertical	Pass
2**	1600.000	31.33	-17.38	54.0	-22.67	AV	169.00	100	vertical	Pass
2	1600.000	40.17	-17.38	74.0	-33.83	Peak	169.00	100	vertical	Pass
3**	2000.000	31.90	-15.34	54.0	-22.10	AV	360.00	100	vertical	Pass
3	2000.000	41.28	-15.34	74.0	-32.72	Peak	360.00	100	vertical	Pass
4**	2400.000	38.56	-12.14	54.0	-15.44	AV	184.00	100	Vertical	Pass
4	2400.000	47.07	-12.14	74.0	-26.93	Peak	184.00	100	vertical	Pass
5**	7999.063	37.01	-1.97	54.0	-16.99	AV	311.00	100	vertical	Pass
5	7999.063	51.76	-1.97	74.0	-22.24	Peak	311.00	100	vertical	Pass
6**	16001.063	47.37	1.35	54.0	-6.63	AV	49.00	100	vertical	Pass
6	16001.063	51.41	1.35	74.0	-22.59	Peak	49.00	100	vertical	Pass

A.9 AC Power-line Conducted Emissions

Note: Only the worst test results were recorded in this report.

L Phase

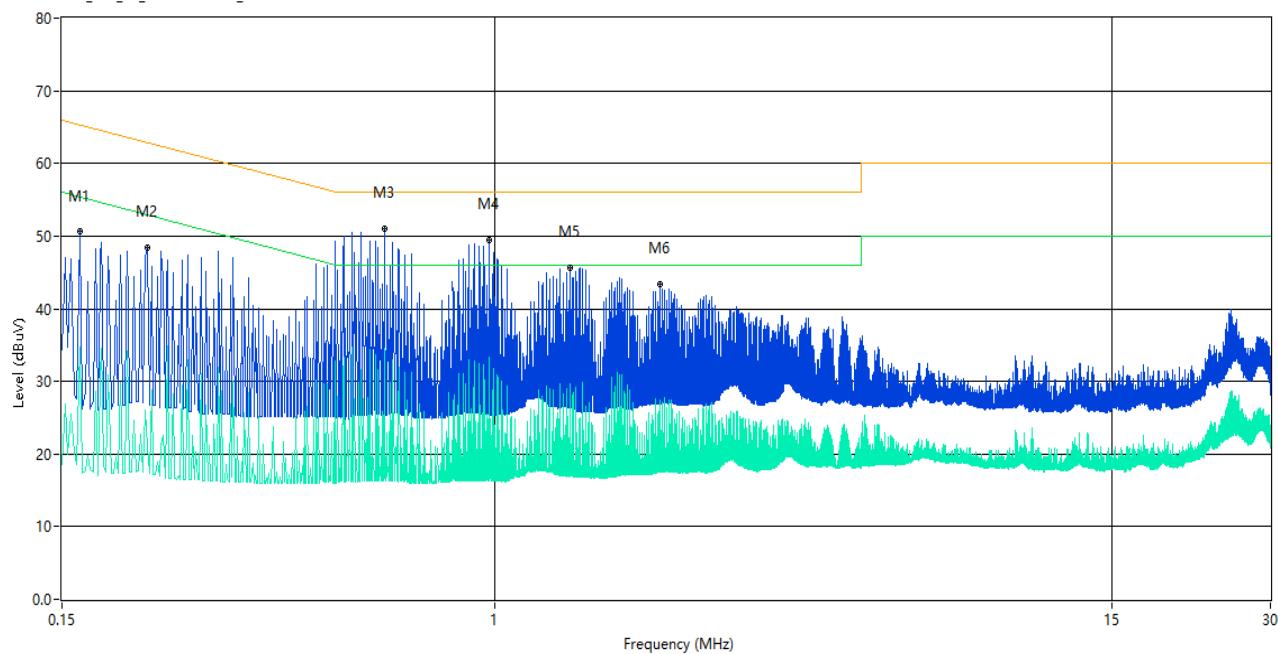
CE Test case_FCC_CE_FCC PART 15B_Class B



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.222	48.3	10.02	62.7	-14.40	Peak	L Line	Pass
1**	0.222	30.4	10.02	52.7	-22.30	AV	L Line	Pass
2	0.280	48.5	10.03	60.8	-12.30	Peak	L Line	Pass
2**	0.280	32.1	10.03	50.8	-18.70	AV	L Line	Pass
3	0.598	50.6	10.02	56.0	-5.40	Peak	L Line	Pass
3**	0.598	34.3	10.02	46.0	-11.70	AV	L Line	Pass
4	0.876	48.4	10.03	56.0	-7.60	Peak	L Line	Pass
4**	0.876	32.4	10.03	46.0	-13.60	AV	L Line	Pass
5	1.430	45.9	10.05	56.0	-10.10	Peak	L Line	Pass
5**	1.430	29.7	10.05	46.0	-16.30	AV	L Line	Pass
6	1.670	46.8	10.06	56.0	-9.20	Peak	L Line	Pass
6**	1.670	30.9	10.06	46.0	-15.10	AV	L Line	Pass

N Phase

CE Test case_FCC_CE_FCC PART 15B_Class B



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.162	50.8	10.01	65.4	-14.60	Peak	N Line	Pass
1**	0.162	34.8	10.01	55.4	-20.60	AV	N Line	Pass
2	0.218	48.5	10.02	62.9	-14.40	Peak	N Line	Pass
2**	0.218	21.0	10.02	52.9	-31.90	AV	N Line	Pass
3	0.616	51.0	10.03	56.0	-5.00	Peak	N Line	Pass
3**	0.616	34.6	10.03	46.0	-11.40	AV	N Line	Pass
4	0.974	49.5	10.03	56.0	-6.50	Peak	N Line	Pass
4**	0.974	33.3	10.03	46.0	-12.70	AV	N Line	Pass
5	1.392	45.6	10.05	56.0	-10.40	Peak	N Line	Pass
5**	1.392	29.8	10.05	46.0	-16.20	AV	N Line	Pass
6	2.066	43.4	10.06	56.0	-12.60	Peak	N Line	Pass
6**	2.066	27.5	10.06	46.0	-18.50	AV	N Line	Pass

ANNEX B TEST SETUP PHOTOS

Please refer to the document "BL-EC18C0431-AR.PDF".

ANNEX C EUT EXTERNAL PHOTOS

Please refer to the document "BL-EC18C0431-AW.PDF".

ANNEX D EUT INTERNAL PHOTOS

Please refer to the document "BL-EC18C0431-AI.PDF".

--END OF REPORT--