FCC Test Report (PART 27)

Report No.:	RF180103E06
FCC ID:	XPY2AGQN1NNN
Test Model:	SARA-R404M
Received Date:	Jan. 03, 2018
Test Date:	Jan. 03 to 05, 2018
Issued Date:	Jan. 26, 2018
Applicant:	u-blox-AG
Address:	Zuercherstrasse 68 8800 Thalwil, Switzerland
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
FCC Registration / Designation Number:	723255 / TW2022

Testing Laboratory
2022

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Release Control Record

Issue No.	Description	Date Issued
RF180103E06	Original release.	Jan. 26, 2018

1 Certificate of Conformity

Product:	LTE CAT-M1 modem
Brand:	u-blox-AG
Test Model:	SARA-R404M
Sample Status:	ENGINEERING SAMPLE
Applicant:	u-blox-AG
Test Date:	Jan. 03 to 05, 2018
Standards:	FCC Part 27 FCC Part 2

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** Jan. 26, 2018

Claire Kuan / Specialist

Approved by : _____ , **Date:** Jan. 26, 2018

May Chen / Manager

2 Summary of Test Results

Applied Standard: FCC Part 27 & Part 2			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50(b)(10)	Radiated Power	PASS	Meet the requirement of limit.
2.1055 27.54	Frequency Stability Stay with the authorized bands of operation	PASS	Meet the requirement of limit.
2.1049 27.53(m)(6)	Occupied Bandwidth	PASS	Meet the requirement of limit.
27.53(g)	Band Edge Measurements	PASS	Meet the requirement of limit.
---	Peak To Average Ratio	PASS	Meet the requirement of limit.
2.1051 27.53(g)	Conducted Spurious Emissions	PASS	Meet the requirement of limit.
2.1053 27.53(g)	Radiated Spurious Emissions	PASS	Meet the requirement of limit. Minimum passing margin is -13.47dB at 1564MHz.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	5.30 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.16 dB
	6GHz ~ 18GHz	4.91 dB
	18GHz ~ 40GHz	5.30 dB

2.2 Test Site and Instruments

For radiated spurious emissions test:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Keysight	N9038A	MY54450088	July 08, 2017	July 07, 2018
Pre-Amplifier(*) EMCI	EMC001340	980142	Jan. 20, 2016	Jan. 19, 2018
Loop Antenna(*) Electro-Metrics	EM-6879	264	Dec. 16, 2016	Dec. 15, 2018
RF Cable	NA	LOOPCAB-001 LOOPCAB-002	Jan. 17, 2017	Jan. 16, 2018
Pre-Amplifier Mini-Circuits	ZFL-1000VH2B	AMP-ZFL-01	Nov. 09, 2017	Nov. 08, 2018
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-406	Nov. 29, 2017	Nov. 28, 2018
RF Cable	8D	966-4-1 966-4-2 966-4-3	Apr. 01, 2017	Mar. 31, 2018
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-4-01	Oct. 03, 2017	Oct. 02, 2018
Horn_Antenna SCHWARZBECK	BBHA 9120D	9120D-783	Dec. 12, 2017	Dec. 11, 2018
Pre-Amplifier EMCI	EMC12630SE	980385	Feb. 02, 2017	Feb. 01, 2018
RF Cable	EMC104-SM-SM-1200 EMC104-SM-SM-2000 EMC104-SM-SM-5000	160923 150318 150321	Feb. 02, 2017 Mar. 29, 2017 Mar. 29, 2017	Feb. 01, 2018 Mar. 28, 2018 Mar. 28, 2018
Pre-Amplifier EMCI	EMC184045SE	980387	Feb. 02, 2017	Feb. 01, 2018
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170608	Dec. 14, 2017	Dec. 13, 2018
RF Cable	SUCOFLEX 102	36432/2 36433/2	Jan. 15, 2017	Jan. 14, 2018
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208410	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP02	NA	NA

Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. *The calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. The test was performed in 966 Chamber No. 4.
4. The CANADA Site Registration No. is 20331-2
5. Loop antenna was used for all emissions below 30 MHz.
6. Tested Date: Jan. 05, 2018

For other test items:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSV40	100964	July 1, 2017	June 30, 2018
Spectrum Analyzer Agilent	E4446A	MY48250254	Nov. 21, 2017	Nov. 20, 2018
Power meter Anritsu	ML2495A	1014008	May 11, 2017	May 10, 2018
Power sensor Anritsu	MA2411B	0917122	May 11, 2017	May 10, 2018
AC Power Source Extech Electronics	6205	1440452	NA	NA
Temperature & Humidity Chamber Giant Force	GTH-150-40-SP-AR	MAA0812-008	Jan. 11, 2017	Jan. 10, 2018
DC Power Supply Topward	6603D	795558	NA	NA
True RMS Clamp Meter FLUKE	325	31130711WS	May 29, 2017	May 28, 2018
ESG Vector signal generator Agilent	E4438C	MY45094468/005 506 602 UK6 UNJ	Nov. 26, 2017	Nov. 25, 2018
ESG Vector signal generator Agilent	E4438C	MY47271330 506 602 UNJ	Oct. 11, 2017	Oct. 10, 2018
Mech Switch Absorptive Mini-Circuits	MSP4TA-18+	0140	Mar. 18, 2017	Mar. 17, 2018
FXD ATTEN Mini-Circuits	BW-S3W2+	MN71981	Mar. 18, 2017	Mar. 17, 2018
Software	ADT_RF Test Software V6.6.5.4	NA	NA	NA

NOTE: 1. The test was performed in Oven room 2.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: Jan. 03, 2018

3 General Information

3.1 General Description of EUT

Product	LTE CAT-M1 modem	
Brand	u-blox-AG	
Test Model	SARA-R404M	
Status of EUT	ENGINEERING SAMPLE	
Power Supply Rating	DC 3.8V from power supply	
Modulation Type	QPSK, 16QAM	
Operating Frequency	LTE Band 13 (Channel Bandwidth 5MHz)	779.5 ~ 784.5 MHz
	LTE Band 13 (Channel Bandwidth 10MHz)	782.0 MHz
Max. ERP Power	LTE Band 13 (Channel Bandwidth 5MHz)	464.5mW(26.67dBm)
	LTE Band 13 (Channel Bandwidth 10MHz)	404.576mW(26.07dBm)
Emission Designator	LTE Band 13 (Channel Bandwidth 5MHz)	QPSK: 1M18G7D
		16QAM: 1M18D7W
	LTE Band 13 (Channel Bandwidth 10MHz)	QPSK: 1M20G7D
		16QAM: 1M18D7W
Antenna Type	Refer to note as below	
Antenna Connector	Refer to user's manual	
Accessory Device	NA	
Data Cable Supplied	NA	

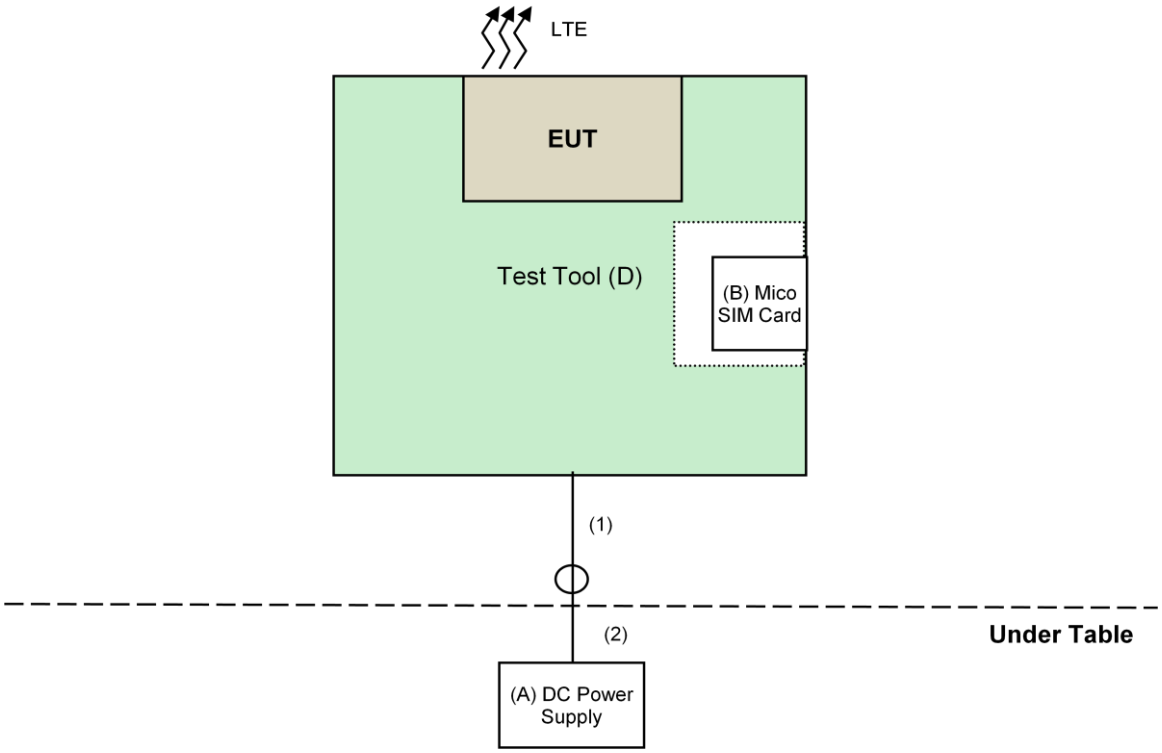
Note:

1. This report is prepared for supplementary report. The difference compared with the original test report design is as the following information:
   - ◆ Antenna trace design change and antenna change.
   - ◆ LTE Cat M1 test mode change for add LTE Cat M1 Bandwidth 5MHz and Bandwidth 10MHz.
2. According to above conditions, all test items need to be performed. And all data were verified to meet the requirements.
3. The antenna provided to the EUT, please refer to the following table:

Gain(dBi) Including cable loss	Frequency range	Antenna Type	Connecter Type	Cable Length
5.2	777-787MHz	Monopole	i-pex(MHF)	84 mm

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or User's Manual.

3.2 Configuration of System under Test



3.2.1 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	DC Power Supply	Topward	6603D	795558	NA	Supplied by client
B.	MiCro SIM Card	NA	NA	NA	NA	Provided by Lab
C.	LTE Simulator	R&S	CMW500	NA	NA	Provided by Lab
D.	Test Tool	WNC	NA	NA	NA	Supplied by client

Note:

1. All power cords of the above support units are non-shielded (1.8m).

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	DC Cable	1	1	No	0	Supplied by client
2.	DC Cable	1	1	No	0	Provided by Lab

3.3 Test Mode Applicability and Tested Channel Detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports
The worst case was found when positioned on X-plane. Following channel(s) was (were) selected for the final test as listed below:

LTE Band 13

TEST ITEM	AVAILABLE CHANNEL	TESTED CHANNEL	CHANNEL BANDWIDTH	MODULATION	RB MODE		
					SIZE	OFFSET	INDEX
ERP	23205 to 23255	23205, 23230, 23255	5MHz	QPSK/16QAM	1	0	0
	23230	23230	10MHz	QPSK/16QAM	1	0	0
Frequency Stability	23230	23230	5MHz	QPSK	1	0	0
	23230	23230	10MHz	QPSK	1	0	0
Band Edge	23205 to 23255	23205	5MHz	QPSK	1	0	0
					6	0	0
		23255			1	5	3
					6	0	3
	23230	23230	10MHz	QPSK	1	0	0
					6	0	0
		23230			1	5	7
					6	0	7
Peak to Average Ratio	23205 to 23255	23205, 23230, 23255	5MHz	QPSK/16QAM	6	0	0
	23230	23230	10MHz	QPSK/16QAM	6	0	0
Occupied Bandwidth	23205 to 23255	23205, 23230, 23255	5MHz	QPSK/16QAM	6	0	0
	23230	23230	10MHz	QPSK/16QAM	6	0	0
Conducted Emission	23205 to 23255	23205, 23230, 23255	5MHz	QPSK	1	0	0
	23230	23230	10MHz	QPSK	1	0	0
Radiated Emission	23205 to 23255	23205, 23230, 23255	5MHz	QPSK	1	0	0
	23230	23230	10MHz	QPSK	1	0	0

NOTE:
All supported modulation types were evaluated.The Worst case of QPSK was selected. Therefore, the Frequency Stability, Band Edge, Condcudeted Emission and Radiated Emission were presented under QPSK mode only.

Test Condition:

Test Item	Environmental Conditions	Input Power (System)	Tested By
ERP	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Frequency Stability	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Occupied Bandwidth	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Band Edge	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Peak to Average Ratio	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Condcudeted Emission	25deg. C, 63%RH	120Vac, 60Hz	Allen Chuang
Radiated Emission Below 1GHz	25deg. C, 66%RH	120Vac, 60Hz	Robert Cheng
Radiated Emission Above 1GHz	23deg. C, 68%RH	120Vac, 60Hz	Robert Cheng

3.4 EUT Operating Conditions

The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency

3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC 47 CFR Part 2

FCC 47 CFR Part 27

KDB 971168 D01 Power Meas License Digital Systems v02r02

ANSI/TIA/EIA-603-E 2016

ANSI 63.26-2015

NOTE: All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Output Power Measurement

4.1.1 Limits of Output Power Measurement

For Portable stations (hand-held devices) operating in the 698-787 MHz band are limited to 3 watts ERP.

4.1.2 Test Procedures

Conducted Power Measurement:

The EUT was set up for the maximum power with LTE link data modulation and link up with simulator. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

EIRP / ERP Measurement:

a. All measurements were done at low, middle and high operational frequency range. RBW ≥OBW and VBW≥3xRBW.
b. Substitution method is used for EIRP measurement. In the semi-anechoic chamber, EUT placed on the 0.8m/1.5m height of Turn Table, rotated the table around 360 degrees to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power. The “Read Value” is the spectrum reading the maximum power value.
c. The substitution horn antenna is substituted for EUT at the same position and signals generator export the CW signal to the substitution antenna via a tx cable. Rotated the Turn Table and moved receiving antenna to find the maximum radiation power. Adjust output power level of S.G to get a Value of spectrum reading equal to “Read Value“ of step b. Record the power level of S.G
d. EIRP = Output power level of S.G – TX cable loss + Antenna gain of substitution horn.
e. ERP power can be calculated form EIRP power by subtracting the gain of dipole, ERP power = EIPR power - 2.15dBi.

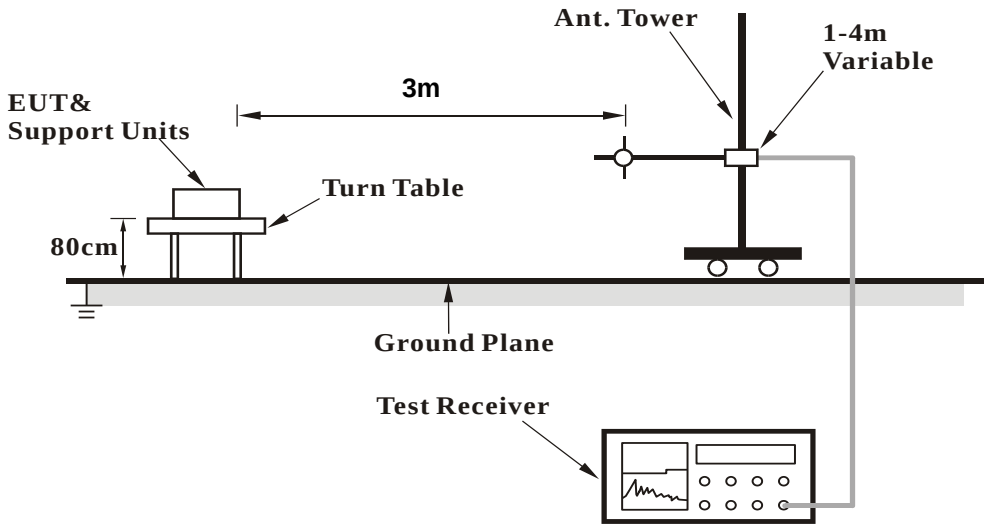
Note: The worst case vertical or horizontal polarization have been investigated and reported in this report

4.1.3 Test Setup

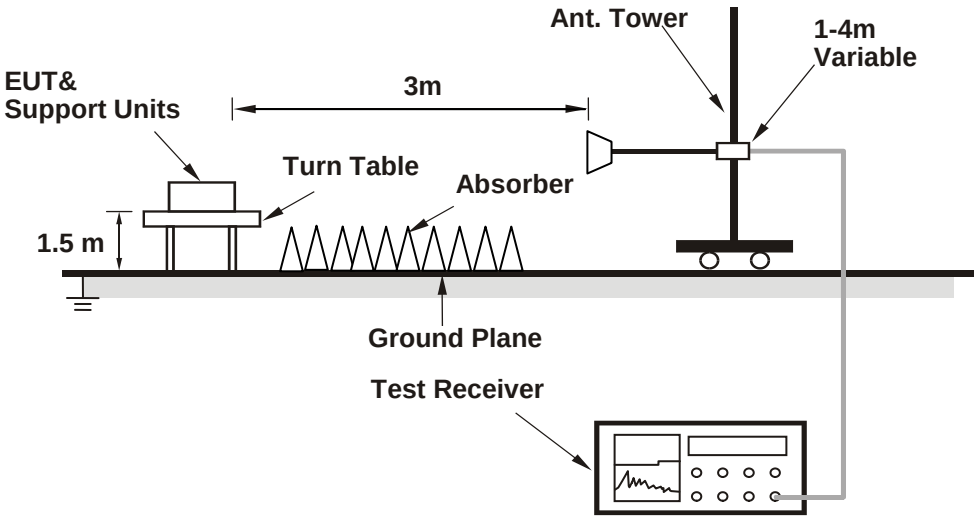
CONDUCTED POWER MEASUREMENT:

ERP/EIRP MEASUREMENT:

For ERP/EIRP below 1GHz



For ERP/EIRP above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.4 Test Results

CONDUCTED OUTPUT POWER (dBm)

Channel Bandwidth: 5MHz

Band / BW	RB Size	RB Offset	RB Index	QPSK			3GPP MPR (dB)
				Low CH 23205	Mid CH 23230	High CH 23255	
				779.5 MHz	782 MHz	784.5 MHz	
13 / 5M	1	0	0	22.71	22.69	22.73	0
	1	5	3	22.51	22.58	22.56	0
	1	0	3	22.47	22.54	22.68	0
	1	5	0	22.53	22.54	22.46	0
	3	0	0	21.34	21.39	21.19	1
	3	3	3	21.41	21.36	21.33	1
	6	0	0	21.37	21.34	21.12	1
	6	0	3	21.35	21.37	21.34	1

Band / BW	RB Size	RB Offset	RB Index	16QAM			3GPP MPR (dB)
				Low CH 23205	Mid CH 23230	High CH 23255	
				779.5 MHz	782 MHz	784.5 MHz	
13 / 5M	1	0	0	22.52	22.51	22.53	0
	1	5	3	21.9	22.19	22.42	0
	1	0	3	22.3	22.29	22.5	0
	1	5	0	22.35	22.32	22.22	0
	3	0	0	21.36	21.28	21.24	1
	3	3	3	21.24	2.3	21.41	1
	6	0	0	21.3	21.26	21.18	1
	6	0	3	21.21	21.26	21.31	1

Channel Bandwidth: 10MHz

Band / BW	RB Size	RB Offset	RB Index	QPSK	3GPP MPR (dB)
				Mid CH 23230	
				782 MHz	
13 / 10M	1	0	0	22.44	0
	1	5	7	22.43	0
	1	0	3	22.33	0
	1	5	4	22.25	0
	4	0	0	22.27	0
	4	2	7	22.39	0
	6	0	0	21.37	1
	6	0	7	21.34	1

Band / BW	RB Size	RB Offset	RB Index	16QAM	3GPP MPR (dB)
				Mid CH 23230	
				782 MHz	
13 / 10M	1	0	0	22.42	0
	1	5	7	22.39	0
	1	0	3	22.26	0
	1	5	4	22.21	0
	4	0	0	22.25	0
	4	2	7	22.16	0
	6	0	0	21.42	1
	6	0	7	21.37	1

ERP POWER

Channel Bandwidth: 5MHz

Channel	Frequency (MHz)	Antenna Polarization	LVL (dBm)	Correction Factor(dB)	ERP(dBm)	ERP(mW)
23205	779.5	H	19.9	6.5	26.47	443.6
23230	782	H	20.0	6.4	26.37	433.5
23255	784.5	H	20.1	6.6	26.67	464.5

Note: The worst case vertical or horizontal polarization have been investigated and find the worst is horizontal.

Channel Bandwidth: 10MHz

Channel	Frequency (MHz)	Antenna Polarization	LVL (dBm)	Correction Factor(dB)	ERP(dBm)	ERP(mW)
23230	782	H	19.14	6.93	26.07	404.576

Note: The worst case vertical or horizontal polarization have been investigated and find the worst is horizontal.

4.2 Frequency Stability Measurement

4.2.1 Limits of Frequency Stabiliity Measurement

According to the FCC part 2.1055 shall be tested the frequency stability. The rule is defined that" The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block." The test extreme voltage is according to the 2.1055(d)(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment and the extreme temperature rule is comply with specification of EUT -30℃ ~ 75℃.

4.2.2 Test Procedure

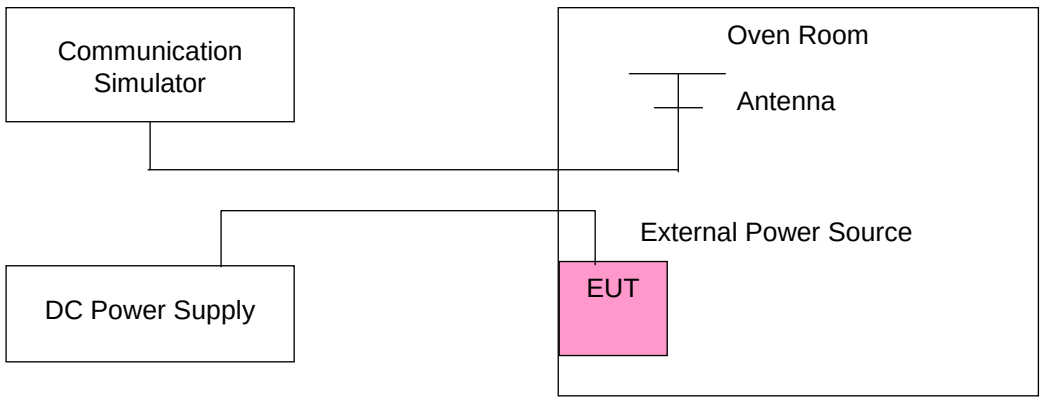
a. Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.

b. EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.

c. The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the ±0.5 ℃ during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

NOTE: The frequency error was recorded frequency error from the communication simulator.

4.2.3 Test Setup



4.2.4 Test Results

LTE Band 13

Voltage (Volts)	Frequency Error (ppm)		Limit (ppm)
	5MHz	10MHz	
3.23	0.002	0.002	2.5
4.37	0.001	0.002	2.5

TEMP. (℃)	Frequency Error (ppm)		Limit (ppm)
	5MHz	10MHz	
75	0.001	0.002	2.5
70	0.002	0.002	2.5
60	0.002	0.001	2.5
50	0.001	0.002	2.5
40	0.001	0.002	2.5
30	0.002	0.002	2.5
20	0.002	0.001	2.5
10	0.002	0.002	2.5
0	0.001	0.001	2.5
-10	0.001	0.001	2.5
-20	0.001	0.002	2.5
-30	0.002	0.002	2.5

4.3 Emission Bandwidth Measurement

4.3.1 Limits of Emission Bandwidth Measurement

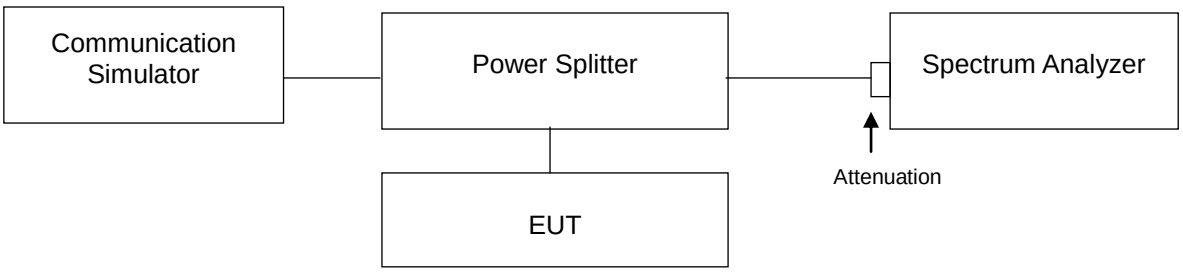
-26dBc Bandwidth
According to FCC 27.53 specified that emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26dB below the transmitter power.

Occupied Bandwidth
The EUT makes a call to the communication simulator. All measurements were done at low, middle and high operational frequency range. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency. Use OBW measurement function of Spectrum analyzer to measure 99 % occupied bandwidth.

4.3.2 Test Procedure

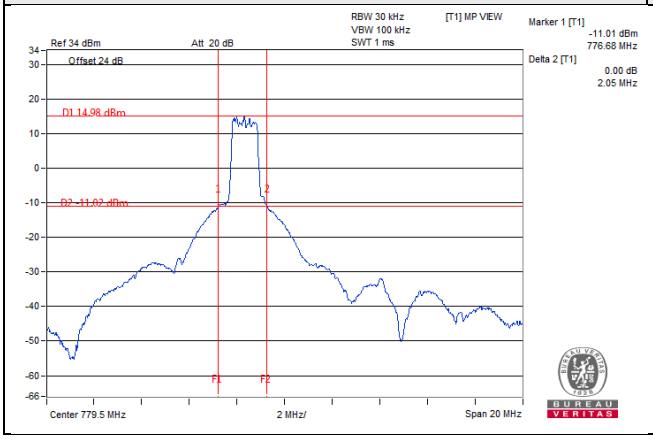
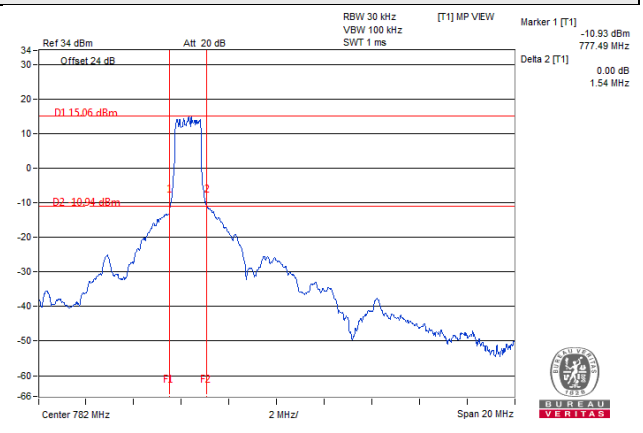
The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW≥1% x OBW and VBW≥3 x VBW.

4.3.3 Test Setup



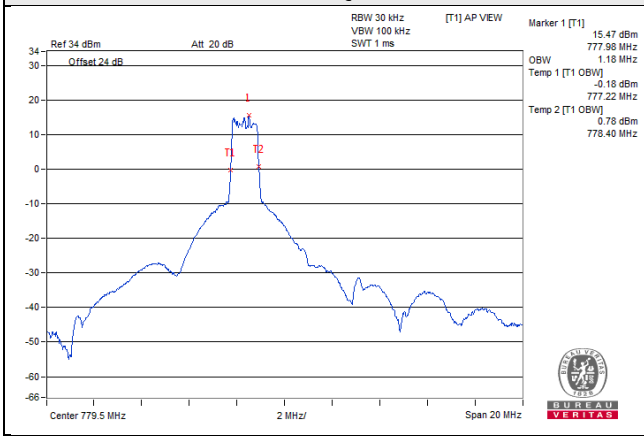
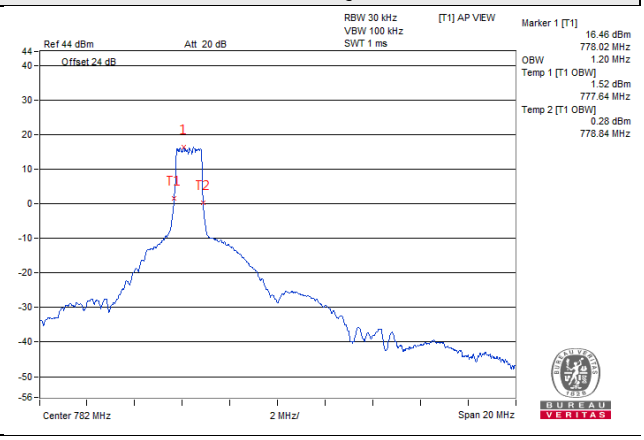
4.3.4 Test Results (-26dBc Bandwidth)

LTE Band 13							
Channel Bandwidth: 5MHz				Channel Bandwidth: 10MHz			
Channel	Frequency (MHz)	-26dB Bandwidth (MHz)		Channel	Frequency (MHz)	-26dB Bandwidth (MHz)	
		QPSK	16QAM			QPSK	16QAM
23205	779.5	2.05	2.04	23230	782	1.54	1.54
23230	782	1.85	1.73				
23255	784.5	1.37	1.52				

Spectrum Plot of Worst Value	
5MHz / QPSK	10MHz / QPSK
	

4.3.5 Test Results (Occupied Bandwidth)

LTE Band 13							
Channel Bandwidth: 5MHz				Channel Bandwidth: 10MHz			
Channel	Frequency (MHz)	Occupied Bandwidth (MHz)		Channel	Frequency (MHz)	Occupied Bandwidth (MHz)	
		QPSK	16QAM			QPSK	16QAM
23205	779.5	1.18	1.18	23230	782	1.20	1.18
23230	782	1.16	1.16				
23255	784.5	1.12	1.14				

Spectrum Plot of Worst Value	
5MHz / QPSK	10MHz / QPSK
	

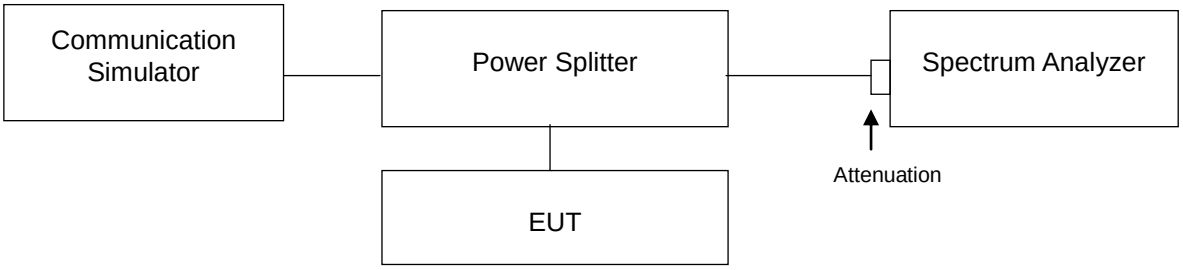
4.4 Channel Edge Measurement

4.4.1 Limits of Channel Edge Measurement

For operations in the 776-787 MHz band, the power of any emission outside a 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, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater.

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

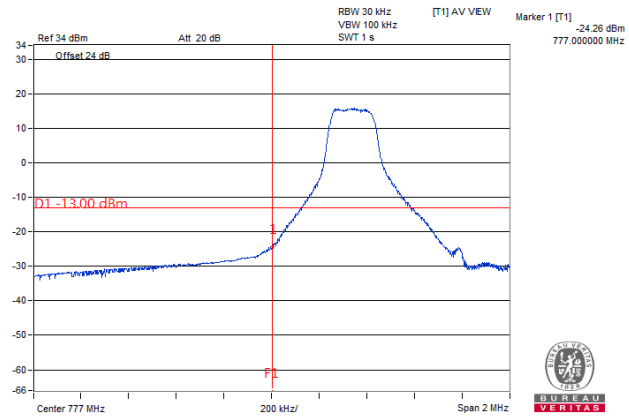
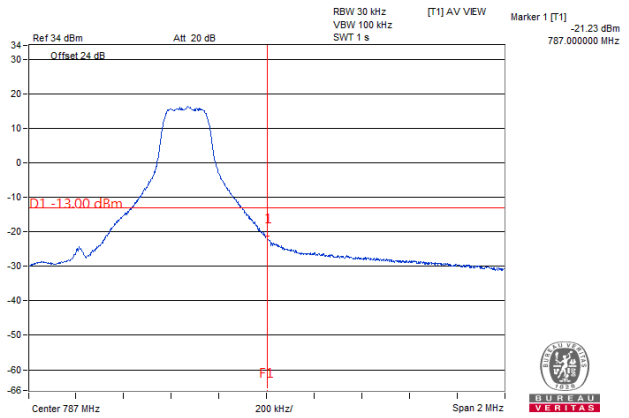
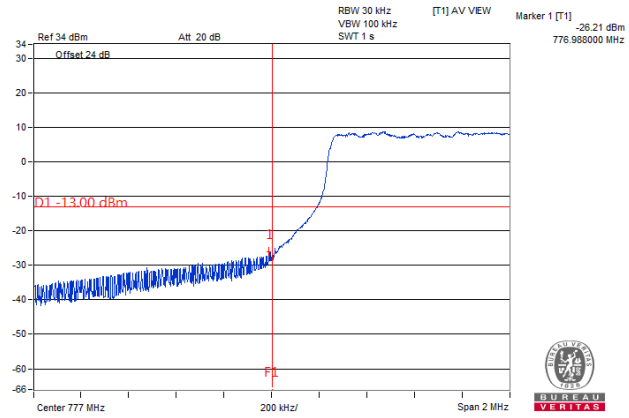
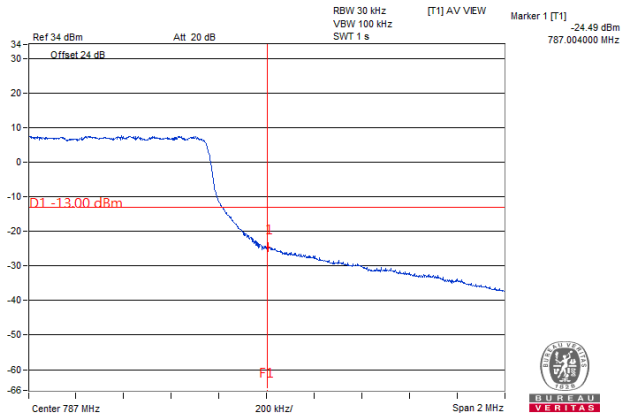
4.4.2 Test Setup



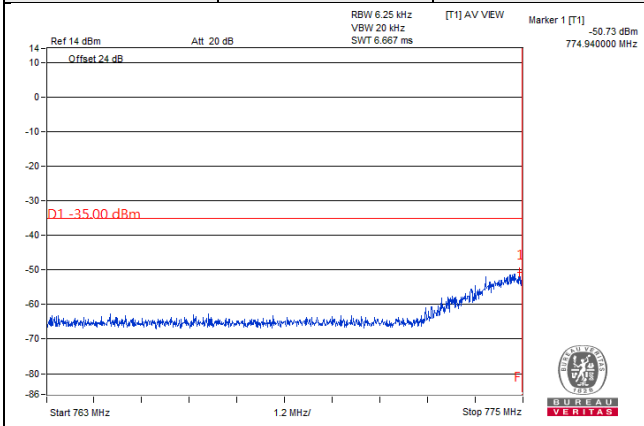
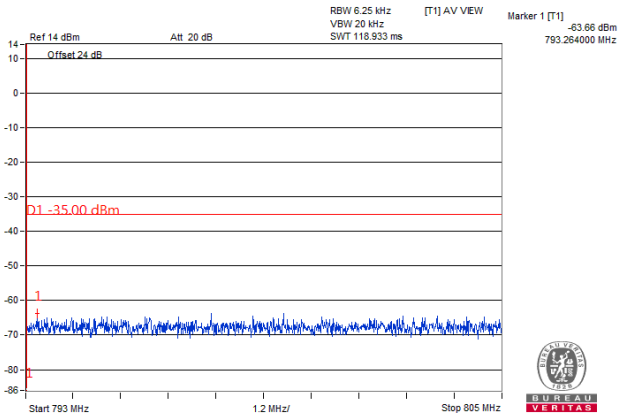
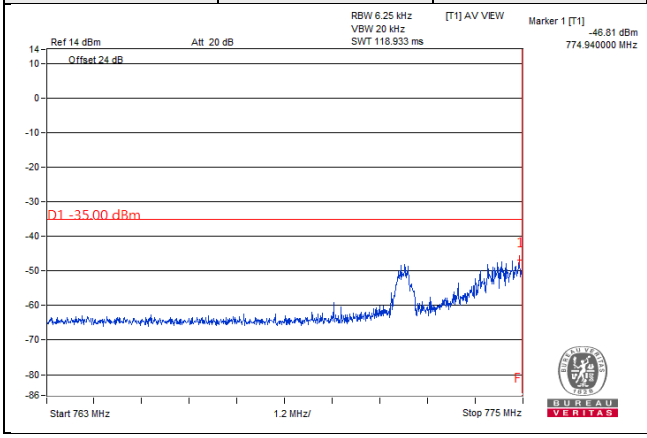
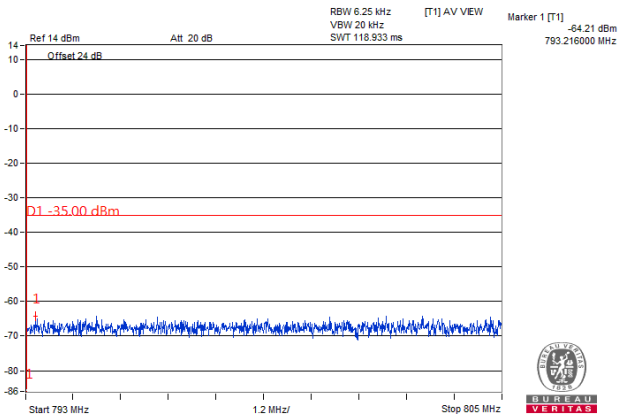
4.4.3 Test Procedures

a. All measurements were done at low and high operational frequency range.
b. The center frequency of spectrum is the band edge frequency and s RB of the spectrum is >1% emission bandwidth and VB of the spectrum is ≧ 3*RB.
c. Record the max trace plot into the test report.

4.4.4 Test Results

Channel Bandwidth: 5MHz					
Channel	23205	1 RB	Channel	23255	1 RB
					
Channel	23205	6 RB	Channel	23255	6 RB
					

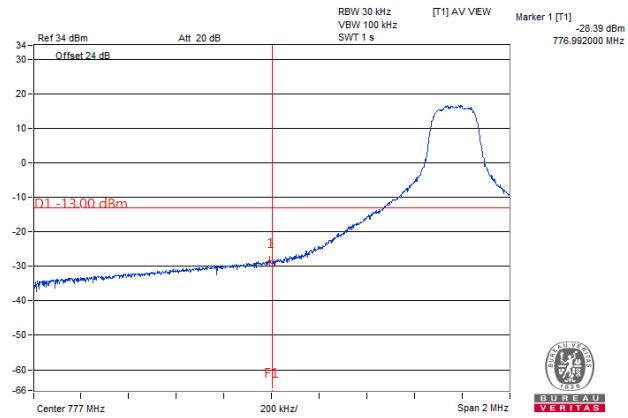
Emission Mask

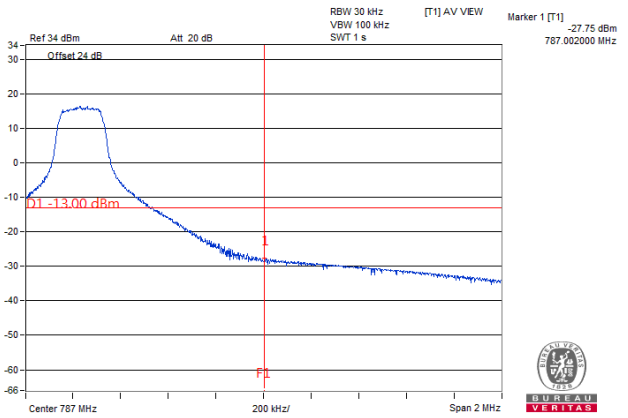
Channel Bandwidth: 5MHz					
Channel	23205	1 RB	Channel	23255	1 RB
					
Channel	23205	6 RB	Channel	23255	6 RB
					

For the 763 - 775 MHz and 793 - 805 MHz band ,the FCC limit is 65+10log(P[watt]) in a 6.25 kHz bandwidth .

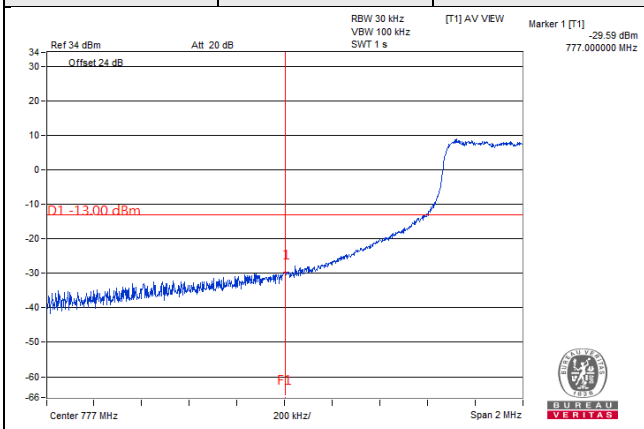
Channel Bandwidth: 10MHz

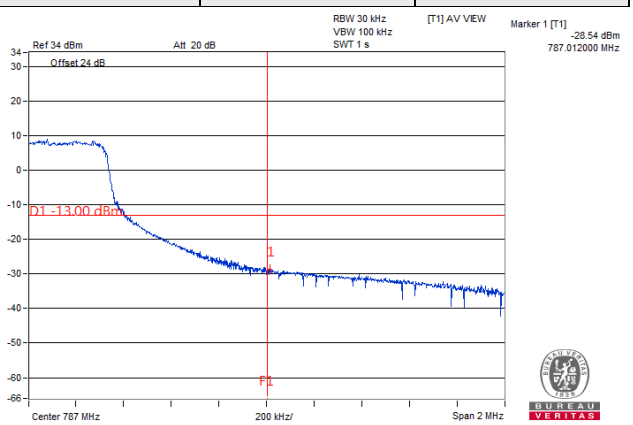
Channel	23230	1 RB	Channel	23230	1 RB





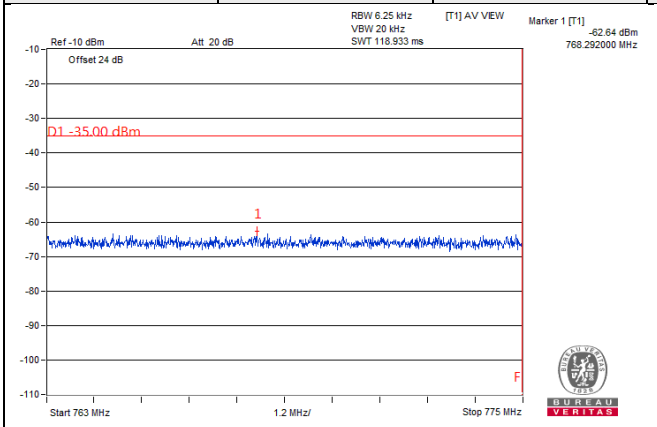
Channel	23230	6 RB	Channel	23230	6 RB

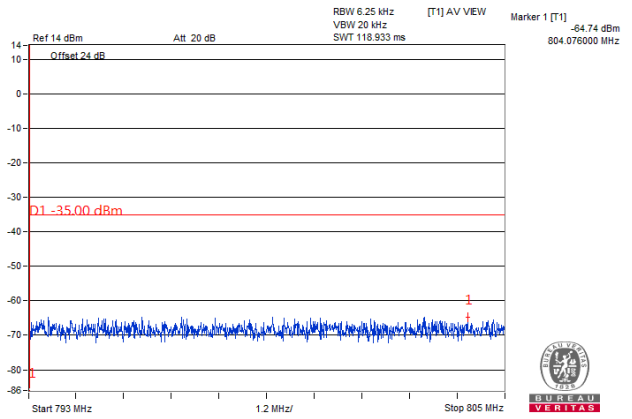




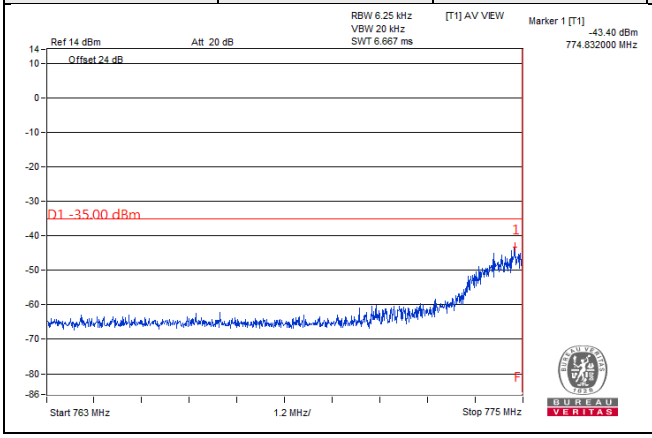
Emission Mask

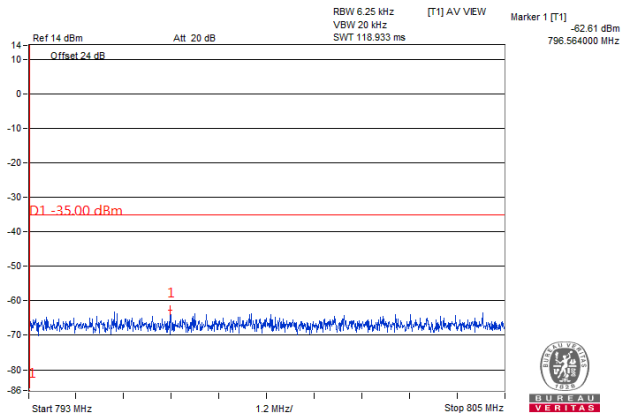
Channel Bandwidth: 10MHz					
Channel	23230	1 RB	Channel	23230	1 RB





Channel	23230	6 RB	Channel	23230	6 RB





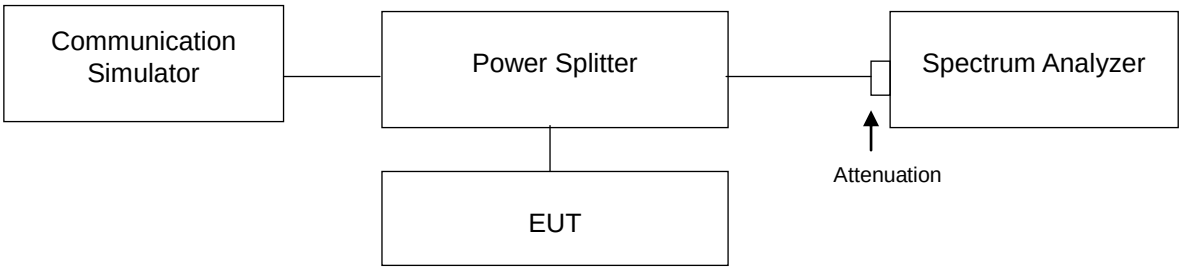
For the 763 - 775 MHz and 793 - 805 MHz band ,the FCC limit is 65+10log(P[watt]) in a 6.25 kHz bandwidth .

4.5 Peak to Average Ratio

4.5.1 Limits of Peak to Average Ratio Measurement

In measuring transmissions in this band using an average power technique, the peak to-average ratio (PAR) of the transmission may not exceed 13 dB.

4.5.2 Test Setup

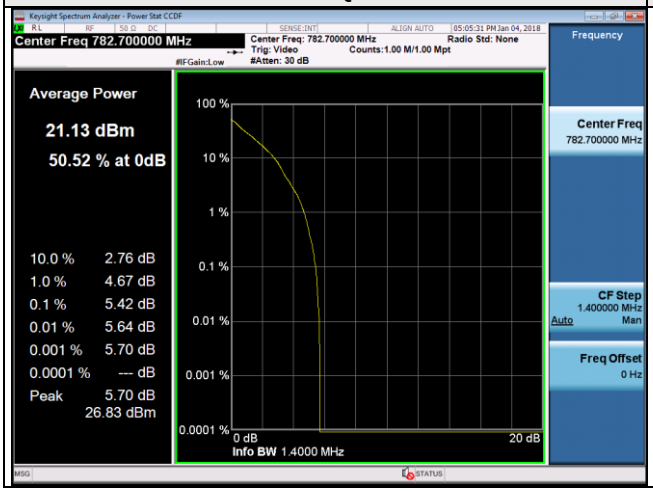
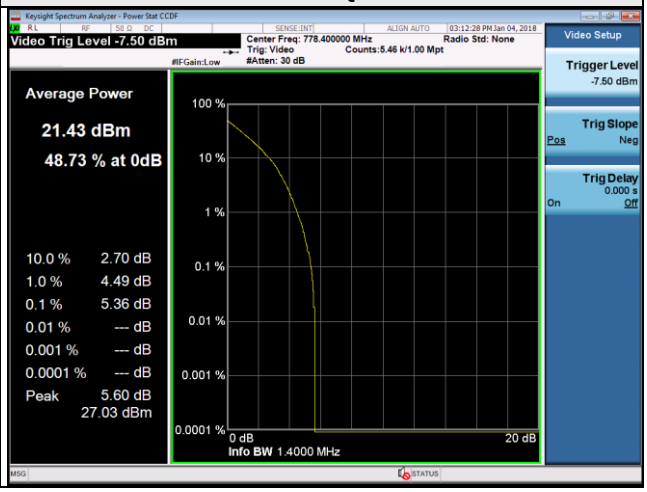


4.5.3 Test Procedures

1. Set resolution/measurement bandwidth ≥ signal's occupied bandwidth;
2. Set the number of counts to a value that stabilizes the measured CCDF curve;
3. Record the maximum PAPR level associated with a probability of 0.1%.

4.5.4 Test Results

LTE Band 13							
Channel Bandwidth: 5MHz				**Channel Bandwidth: 10MHz**			
Channel	Frequency (MHz)	Peak To Average Ratio (dB)		Channel	Frequency (MHz)	Peak To Average Ratio (dB)	
		QPSK	16QAM			QPSK	16QAM
23205	779.5	5.38	5.27	23230	782	5.36	5.02
23230	782	5.19	5.29				
23255	784.5	5.42	5.24				

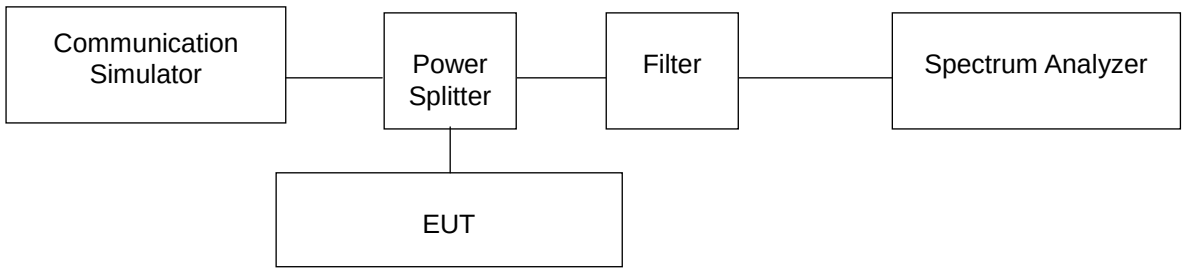
Spectrum Plot of Worst Value	
5MHz / QPSK	10MHz / QPSK
	

4.6 Conducted Spurious Emissions

4.6.1 Limits of Conducted Spurious Emissions Measurement

The power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 +10 log10(P) dB. The limit of emission is equal to -13 dBm.

4.6.2 Test Setup



4.6.3 Test Procedure

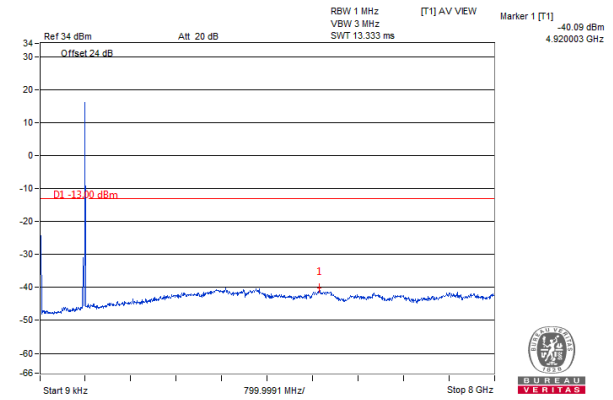
a. All measurements were done at 3 channels: low, middle and high operational frequency range.

b. When the spectrum scanned from 9 kHz to suitable frequency, it shall be connected to the 20dB pad attenuated the carried frequency.

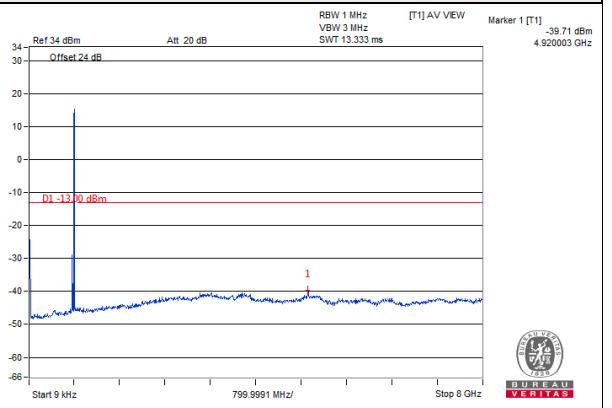
4.6.5 Test Results

Channel Bandwidth: 5MHz					
Channel	Frequency (MHz)	Measurement Value	Margin	Limit	Result
23205	779.5	-40.09	-27.09	-13.00	Pass
23230	782.0	-39.71	-26.71	-13.00	Pass
23255	784.5	-40.94	-27.94	-13.00	Pass

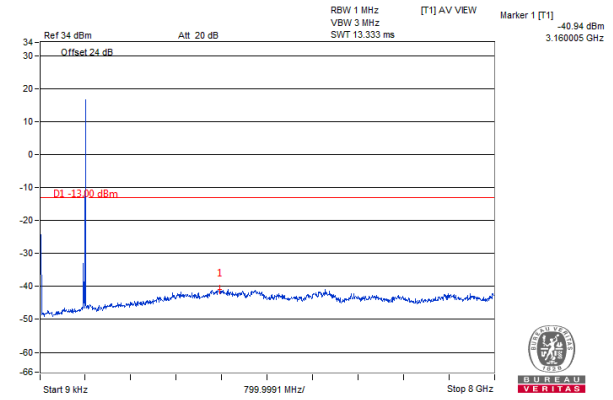
Ch23205



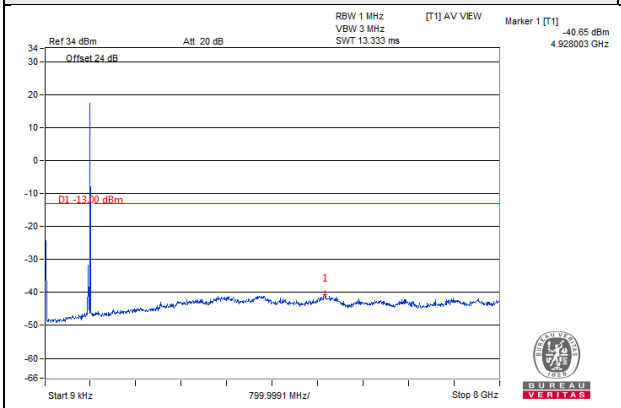
Ch23230



Ch23255



Channel Bandwidth: 10MHz					
Channel	Frequency (MHz)	Measurement Value	Margin	Limit	Result
23230	782.0	-40.65	-27.65	-13.00	Pass

Ch23230	
	

4.7 Radiated Emission Measurement

4.7.1 Limits of Radiated Emission Measurement

The power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 +10 log10(P) dB. The limit of emission is equal to -13 dBm.

4.7.2 Test Procedure

a. The power was measured with R&S Spectrum Analyzer. All measurements were done at 3 channels (low, middle and high channel of operational frequency range.)

b. Substitution method is used for EIRP measurement. In the semi-anechoic chamber, EUT placed on the 0.8m/1.5m height of Turn Table, rotated the table around 360 degrees to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power. The “Read Value” is the spectrum reading the maximum power value.

c. The substitution antenna is substituted for EUT at the same position and signals generator export the CW signal to the substitution antenna via a TX cable. Rotated the Turn Table and moved receiving antenna to find the maximum radiation power. Adjust output power level of S.G to get a Value of spectrum reading equal to “Read Value “ of step b. Record the power level of S.G

d. EIRP = Output power level of S.G – TX cable loss + Antenna gain of substitution antenna.

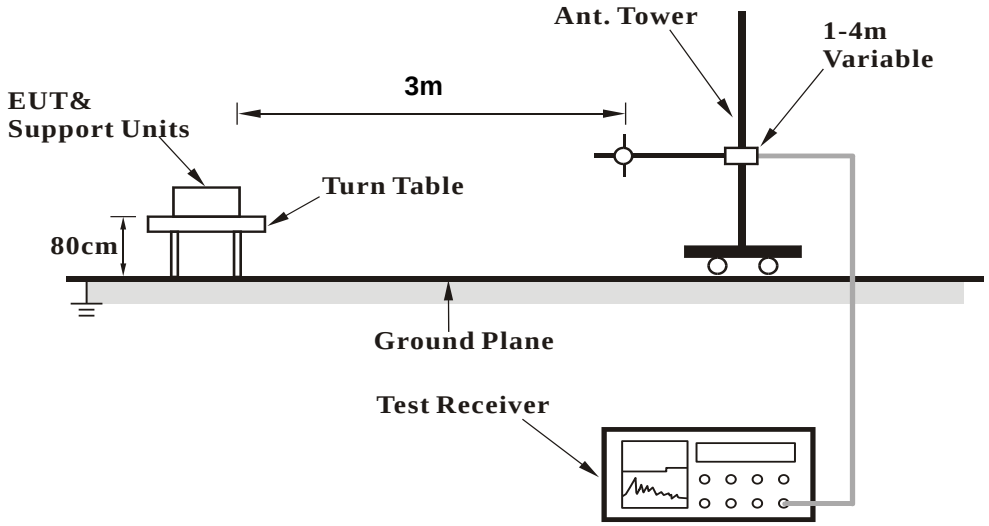
NOTE: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 100kHz/300kHz.

4.7.3 Deviation from Test Standard

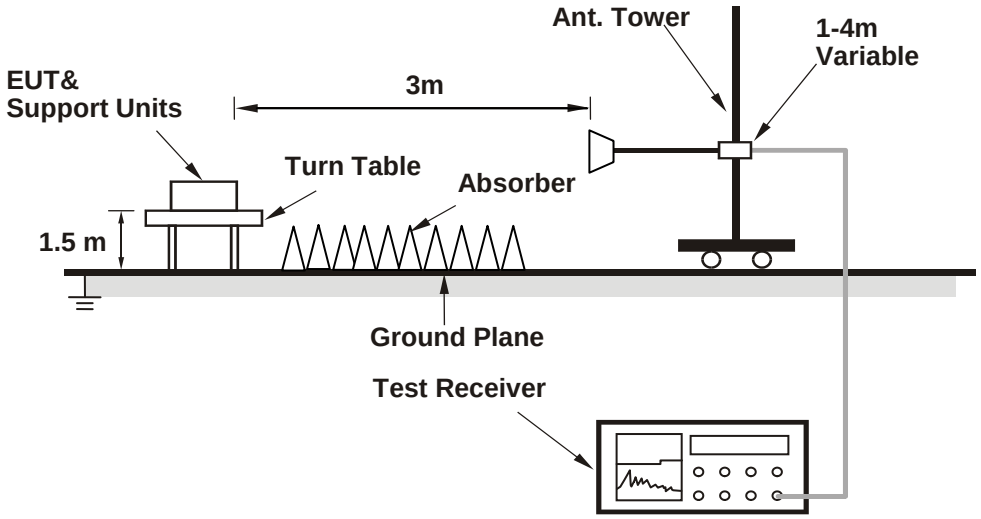
No deviation.

4.7.4 Test Setup

<Frequency Range below 1GHz>



<Frequency Range above 1GHz>



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.7.5 Test Results

Below 1GHz

Channel Bandwidth: 5MHz

Mode	TX channel 23205	Frequency Range	Below 1000 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	77.17	32.85	-59.06	-1.04	-60.11	-13	-47.11
2	128.34	32.85	-62.51	3.84	-58.67	-13	-45.67
3	278.94	33.23	-62.24	3.78	-58.45	-13	-45.45
4	345.38	30.20	-67.49	3.61	-63.88	-13	-50.88
5	521.09	33.20	-63.98	2.84	-61.14	-13	-48.14
6	736.68	27.63	-68.74	1.02	-67.71	-13	-54.71
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	66.84	30.95	-56.68	-4.91	-61.59	-13	-48.59
2	93.27	32.92	-58.88	-1.00	-59.89	-13	-46.89
3	130.75	34.12	-57.23	-1.23	-58.47	-13	-45.47
4	237.72	30.04	-65.32	3.82	-61.50	-13	-48.50
5	508.44	34.94	-60.45	2.81	-57.64	-13	-44.64
6	609.75	38.66	-56.03	1.78	-54.25	-13	-41.25

Remarks:

1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Mode	TX channel 23230	Frequency Range	Below 1000 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	77.03	33.30	-58.61	-1.04	-59.66	-13	-46.66
2	128.33	34.19	-61.17	3.84	-57.33	-13	-44.33
3	278.41	33.24	-62.23	3.78	-58.44	-13	-45.44
4	345.69	30.90	-66.79	3.61	-63.18	-13	-50.18
5	520.68	33.36	-63.82	2.84	-60.98	-13	-47.98
6	736.44	28.76	-67.61	1.02	-66.58	-13	-53.58
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	67.08	31.70	-55.93	-4.91	-60.84	-13	-47.84
2	92.56	33.86	-57.94	-1.00	-58.95	-13	-45.95
3	129.81	35.10	-56.25	-1.23	-57.49	-13	-44.49
4	237.59	30.11	-65.25	3.82	-61.43	-13	-48.43
5	509.38	35.97	-59.42	2.81	-56.61	-13	-43.61
6	608.99	38.89	-55.80	1.78	-54.02	-13	-41.02

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Mode	TX channel 23255	Frequency Range	Below 1000 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	76.49	32.47	-59.44	-1.04	-60.49	-13	-47.49
2	128.57	32.80	-62.56	3.84	-58.72	-13	-45.72
3	277.97	32.12	-63.35	3.78	-59.56	-13	-46.56
4	345.15	29.00	-68.69	3.61	-65.08	-13	-52.08
5	521.09	31.84	-65.34	2.84	-62.50	-13	-49.50
6	737.49	26.90	-69.47	1.02	-68.44	-13	-55.44
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	66.93	29.52	-58.11	-4.91	-63.02	-13	-50.02
2	93.3	31.80	-60.00	-1.00	-61.01	-13	-48.01
3	129.83	32.84	-58.51	-1.23	-59.75	-13	-46.75
4	236.94	29.10	-66.26	3.82	-62.44	-13	-49.44
5	509.32	33.90	-61.49	2.81	-58.68	-13	-45.68
6	609.55	38.63	-56.06	1.78	-54.28	-13	-41.28

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Channel Bandwidth: 10MHz

Mode	TX channel 23230	Frequency Range	Below 1000 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	75.79	33.90	-58.01	-1.04	-59.06	-13	-46.06
2	128.49	35.45	-59.91	3.84	-56.07	-13	-43.07
3	278.13	33.18	-62.29	3.78	-58.50	-13	-45.50
4	345.69	31.78	-65.91	3.61	-62.30	-13	-49.30
5	521.18	34.95	-62.23	2.84	-59.39	-13	-46.39
6	736.29	30.29	-66.08	1.02	-65.05	-13	-52.05
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	67.79	31.10	-56.53	-4.91	-61.44	-13	-48.44
2	92.26	33.87	-57.93	-1.00	-58.94	-13	-45.94
3	127.64	35.27	-56.08	-1.23	-57.32	-13	-44.32
4	238.21	31.21	-64.15	3.82	-60.33	-13	-47.33
5	508.38	34.79	-60.60	2.81	-57.79	-13	-44.79
6	609.14	38.50	-56.19	1.78	-54.41	-13	-41.41

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Above 1GHz

Channel Bandwidth: 5MHz

Mode	TX channel 23205	Frequency Range	Above 1000MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2338.5	33.14	-66.13	6.73	-59.40	-13	-46.40
2	3118	34.74	-67.99	7.30	-60.69	-13	-47.69
3	3897.5	36.92	-67.73	7.59	-60.15	-13	-47.15
4	4677	38.78	-65.64	7.20	-58.44	-13	-45.44
5	5456.5	39.24	-65.67	7.11	-58.56	-13	-45.56
6	6236	39.64	-64.03	5.71	-58.31	-13	-45.31
7	7015.5	43.61	-58.43	4.96	-53.47	-13	-40.47
8	7795	45.2	-57.42	4.29	-53.13	-13	-40.13
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2338.5	34.27	-65.00	6.73	-58.27	-13	-45.27
2	3118	37.39	-65.34	7.30	-58.04	-13	-45.04
3	3897.5	38.43	-66.22	7.59	-58.64	-13	-45.64
4	4677	69.64	-34.78	7.20	-27.58	-13	-14.58
5	5456.5	39.75	-65.16	7.11	-58.05	-13	-45.05
6	6236	39.38	-64.76	6.37	-58.39	-13	-45.39
7	7015.5	43.17	-58.87	4.96	-53.91	-13	-40.91
8	7795	43.74	-58.88	4.29	-54.59	-13	-41.59

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

The EIRP in Frequency Range 1559 - 1610 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1559	42.98	-60.22	6.10	-54.11	-40	-14.11
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1559	39.86	-63.34	6.10	-57.23	-40	-17.23

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Mode	TX channel 23230	Frequency Range	Above 1000MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2346	33.24	-65.99	6.73	-59.26	-13	-46.26
2	3128	34.46	-68.29	7.32	-60.97	-13	-47.97
3	3910	38.47	-66.23	7.58	-58.65	-13	-45.65
4	4692	37.99	-66.42	7.19	-59.23	-13	-46.23
5	5474	38.55	-66.39	7.11	-59.28	-13	-46.28
6	6256	39.46	-64.21	5.71	-58.49	-13	-45.49
7	7038	44.37	-57.70	4.94	-52.76	-13	-39.76
8	7820	44.55	-58.07	4.27	-53.80	-13	-40.80
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2346	35.25	-63.98	6.73	-57.25	-13	-44.25
2	3128	36.19	-66.56	7.32	-59.24	-13	-46.24
3	3910	37.3	-67.40	7.58	-59.82	-13	-46.82
4	4692	67.99	-36.42	7.19	-29.23	-13	-16.23
5	5474	39.11	-65.83	7.11	-58.72	-13	-45.72
6	6256	39.54	-64.60	6.34	-58.26	-13	-45.26
7	7038	42.12	-59.95	4.94	-55.01	-13	-42.01
8	7820	44.45	-58.17	4.27	-53.90	-13	-40.90

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

The EIRP in Frequency Range 1559 - 1610 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	**1564**	**43.59**	**-59.58**	**6.11**	**-53.47**	**-40**	**-13.47**
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1564	41.38	-61.79	6.11	-55.68	-40	-15.68

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Mode	TX channel 23255	Frequency Range	Above 1000MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2353.5	33.60	-65.59	6.72	-58.87	-13	-45.87
2	3138	35.40	-67.36	7.33	-60.03	-13	-47.03
3	3922.5	37.81	-66.94	7.57	-59.36	-13	-46.36
4	4707	38	-66.40	7.18	-59.22	-13	-46.22
5	5491.5	38.5	-66.47	7.12	-59.35	-13	-46.35
6	6276	39.5	-64.17	5.71	-58.45	-13	-45.45
7	7060.5	43.5	-58.59	4.92	-53.67	-13	-40.67
8	7845	45.3	-57.32	4.25	-53.07	-13	-40.07
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2353.5	35	-64.19	6.72	-57.47	-13	-44.47
2	3138	36.8	-65.96	7.33	-58.63	-13	-45.63
3	3922.5	38	-66.75	7.57	-59.17	-13	-46.17
4	4707	68.7	-35.70	7.18	-28.52	-13	-15.52
5	5491.5	38.8	-66.17	7.12	-59.05	-13	-46.05
6	6276	39.9	-64.24	6.31	-57.93	-13	-44.93
7	7060.5	42.8	-59.29	4.92	-54.37	-13	-41.37
8	7845	44.7	-57.92	4.25	-53.67	-13	-40.67

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

The EIRP in Frequency Range 1559 - 1610 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1569	42.70	-60.45	6.12	-54.33	-40	-14.33
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1569	40.5	-62.65	6.12	-56.53	-40	-16.53

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

Channel Bandwidth: 10MHz

Mode	TX channel 23230	Frequency Range	Above 1000MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2346	34.56	-64.67	6.73	-57.94	-13	-44.94
2	3128	34.88	-67.87	7.32	-60.55	-13	-47.55
3	3910	38.26	-66.44	7.58	-58.86	-13	-45.86
4	4692	38.35	-66.06	7.19	-58.87	-13	-45.87
5	5474	39.43	-65.51	7.11	-58.40	-13	-45.40
6	6256	38.68	-64.99	5.71	-59.27	-13	-46.27
7	7038	44.38	-57.69	4.94	-52.75	-13	-39.75
8	7820	44.83	-57.79	4.27	-53.52	-13	-40.52
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm)	Margin (dB)
1	2346	35.3	-63.93	6.73	-57.20	-13	-44.20
2	3128	35.28	-67.47	7.32	-60.15	-13	-47.15
3	3910	37.05	-67.65	7.58	-60.07	-13	-47.07
4	4692	68.28	-36.13	7.19	-28.94	-13	-15.94
5	5474	38.46	-66.48	7.11	-59.37	-13	-46.37
6	6256	39.81	-64.33	6.34	-57.99	-13	-44.99
7	7038	41.21	-60.86	4.94	-55.92	-13	-42.92
8	7820	44.11	-58.51	4.27	-54.24	-13	-41.24

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

The EIRP in Frequency Range 1559 - 1610 MHz

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1564	42.22	-60.95	6.11	-54.84	-40	-14.84
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	Emission Value (dBm)	Limit (dBm/MHz)	Margin (dB)
1	1564	41.45	-61.72	6.11	-55.61	-40	-15.61

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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The address and road map of all our labs can be found in our web site also.

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