FCC Test Report

(PART 22)

Report No.: RF180521C04E

FCC ID: 2AAGMGM01QA

Test Model: GM01Q

Received Date: Sep. 06, 2019

Test Date: Sep. 26, 2019 ~ Oct. 01, 2019

Issued Date: Oct. 14, 2019

Applicant: Sequans Communications

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
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FCC Registration / Designation Number: 788550 / TW0003

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Release Control Record

Issue No.	Description	Date Issued
RF180521C04E	Original Release	Oct. 14, 2019

1 Certificate of Conformity

Product: GM01Q EZlinkLTE modules

Brand: SEQUANS COMMUNICATIONS

Test Model: GM01Q

Sample Status: Mass Production

Applicant: Sequans Communications

Test Date: Sep. 26, 2019 ~ Oct. 01, 2019

Standards: FCC Part 22, Subpart H

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 RF characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** Oct. 14, 2019

Rona Chen / Specialist

Approved by : _____ , **Date:** Oct. 14, 2019

Dylan Chiou / Project Engineer

2 Summary of Test Results

Applied Standard: FCC Part 22 & Part 2			
FCC Clause	**Test Item**	**Result**	**Remarks**
2.1046 22.913 (a)	Effective Radiated Power	Pass	Meet the requirement of limit.
2.1047	Modulation Characteristics	Pass	Meet the requirement.
2.1046 22.913 (d)	Peak to Average Ratio	Pass	Meet the requirement of limit.
2.1055 22.355	Frequency Stability	Pass	Meet the requirement of limit.
2.1049	Occupied Bandwidth	Pass	Meet the requirement of limit.
22.917	Band Edge Measurements	Pass	Meet the requirement of limit.
2.1051 22.917	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 22.917	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -11.52 dB at 2487.00 MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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	9 kHz ~ 30 MHz	3.04 dB
	30 MHz ~ 200 MHz	2.93 dB
	200 MHz ~ 1000 MHz	2.95 dB
Radiated Emissions above 1 GHz	1 GHz ~ 18 GHz	2.26 dB
	18 GHz ~ 40 GHz	1.94 dB

2.2 Test Site and Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration
Test Receiver Agilent	N9038A	MY51210203	Mar. 18, 2019	Mar. 17, 2020
Spectrum Analyzer Agilent	N9010A	MY56070348	Sep. 09, 2019	Sep. 08, 2020
Spectrum Analyzer ROHDE & SCHWARZ	FSU43	100115	Jan. 21, 2019	Jan. 20, 2020
Spectrum Analyzer ROHDE & SCHWARZ	FSW26	102023	Oct. 11, 2018	Oct. 10, 2019
HORN Antenna SCHWARZBECK	3115	5619	Nov. 25, 2018	Nov. 24, 2019
HORN Antenna SCHWARZBECK	BBHA 9120 D	9120D-969	Nov. 25, 2018	Nov. 24, 2019
BILOG Antenna SCHWARZBECK	VULB9168	9168-472	Nov. 23, 2018	Nov. 22, 2019
Fixed Attenuator Mini-Circuits	MDCS18N-10	MDCS18N-10-01	Apr. 15, 2019	Apr. 14, 2020
MXG Vector signal generator Agilent	N5182B	MY53052658	May 20, 2019	May 19, 2020
Preamplifier EMCI	EMC 012645	980115	Oct. 12, 2018	Oct. 11, 2019
Preamplifier EMCI	EMC 330H	980112	Oct. 12, 2018	Oct. 11, 2019
RF Coaxial Cable HUBER+SUHNNER	EMC104-SM-SM-800 0&3000	140811+170717	Oct. 12, 2018	Oct. 11, 2019
RF Coaxial Cable HUBER+SUHNNER	SUCOFLEX 104	EMC104-SM-SM-1000(140807)	Oct. 12, 2018	Oct. 11, 2019
RF Coaxial Cable WOKEN	8D-FB	Cable-Ch10-01	Oct. 12, 2018	Oct. 11, 2019
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA
Software BV ADT	E3 6.120103	NA	NA	NA
Antenna Tower MF	MFA-440H	NA	NA	NA
Turn Table MF	MFT-201SS	NA	NA	NA
Antenna Tower &Turn Table Controller MF	MF-7802	NA	NA	NA
LTE Wireless Communication Test Set Keysight	E7515A	MY57270629	Feb. 22, 2019	Feb. 21, 2020
Temperature & Humidity Chamber	GTH-120-40-CP-AR	MAA1306-019	Sep. 06, 2019	Sep. 05, 2020
DC Power Supply Topward	33010D	807748	NA	NA

Note: 1. The calibration interval of the above test instruments is 12 / 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa Chamber 10.

3 General Information

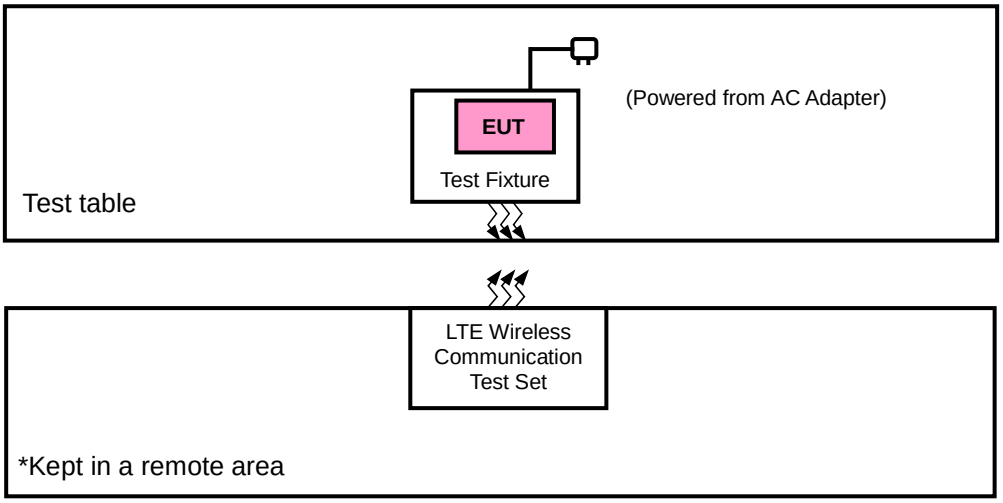
3.1 General Description of EUT

Product	GM01Q EZlinkLTE modules	
Brand	SEQUANS COMMUNICATIONS	
Test Model	GM01Q	
Status of EUT	Mass Production	
Power Supply Rating	5.0 Vdc (adapter) or 3.8 Vdc (form DC power supply)	
Modulation Type	LTE	QPSK, 16QAM
Frequency Range	LTE 5 (Channel Bandwidth: 5 MHz)	826.5 ~ 846.5 MHz
	LTE 5 (Channel Bandwidth: 10 MHz)	829 ~ 844 MHz
Max. ERP Power	LTE 5 (Channel Bandwidth: 5 MHz)	132.74 mW
	LTE 5 (Channel Bandwidth: 10 MHz)	139.00 mW
Emission Designator	LTE 5 (Channel Bandwidth: 5 MHz)	1M10G7D
	LTE 5 (Channel Bandwidth: 10 MHz)	1M09G7D
Antenna Type	Broadband Omni-Directional Antenna with 0.2 dBi gain	
Accessory Device	N/A	
Data Cable Supplied	N/A	

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refers 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.

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 as the table below. Following channel(s) was (were) selected for the final test as listed below:

Band	ERP	Radiated Emission
LTE Band 5	X-plane	X-plane

LTE Band 5

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	ERP	20425 to 20625	20425, 20525, 20625	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		20450 to 20600	20450, 20525, 20600	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
-	Modulation Characteristics	20450 to 20600	20525	10 MHz	QPSK	6 RB / 0 RB Offset
					16QAM	5 RB / 0 RB Offset
-	Frequency Stability	20425 to 20625	20425, 20625	5 MHz	QPSK	1 RB / 0 RB Offset
		20450 to 20600	20450, 20600	10 MHz	QPSK	1 RB / 0 RB Offset
-	Occupied Bandwidth	20425 to 20625	20425, 20525, 20625	5 MHz	QPSK, 16QAM	25 RB / 0 RB Offset
		20450 to 20600	20450, 20525, 20600	10 MHz	QPSK, 16QAM	50 RB / 0 RB Offset
-	Band Edge	20425 to 20625	20425	5 MHz	QPSK	1 RB / 0 RB Offset
						25 RB / 0 RB Offset
			20625	5 MHz	QPSK	1 RB / 24 RB Offset
						25 RB / 0 RB Offset
		20450 to 20600	20450	10 MHz	QPSK	1 RB / 0 RB Offset
						50 RB / 0 RB Offset
			20600	10 MHz	QPSK	1 RB / 49 RB Offset
						50 RB / 0 RB Offset
-	Peak to Average Ratio	20425 to 20625	20425, 20525, 20625	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		20450 to 20600	20450, 20525, 20600	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
-	Conducted Emission	20425 to 20625	20425, 20525, 20625	5 MHz	QPSK	1 RB / 0 RB Offset
		20450 to 20600	20450, 20525, 20600	10 MHz	QPSK	1 RB / 0 RB Offset
-	Radiated Emission	20425 to 20625	20425, 20525, 20625	5 MHz	QPSK	1 RB / 0 RB Offset
		20450 to 20600	20450, 20525, 20600	10 MHz	QPSK	1 RB / 0 RB Offset

Note:

1. This device was tested under all bandwidths, RB configurations and modulations. The worst case was found in QPSK modulation.
2. For radiated emission above 1 GHz, according to 3GPP 36.521 Section 6.6.3.1.4, choose the lowest, 5 MHz & highest channel bandwidth for final test.

Test Condition:

Test Item	Environmental Conditions	Input Power	Tested By
ERP	25 deg. C, 65 % RH	3.8 Vdc	Tim Chen Thomas Wei
Modulation Characteristics	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Frequency Stability	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Occupied Bandwidth	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Band Edge	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Peak to Average Ratio	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Conducted Emission	25 deg. C, 65 % RH	3.8 Vdc	Getaz Yang
Radiated Emission	25 deg. C, 65 % RH	120 Vac, 60 Hz	Tim Chen Thomas Wei

3.4 EUT Operating Conditions

The EUT makes a call to the communication simulator. 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 22
KDB 971168 D01 Power Meas License Digital Systems v03r01
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

Mobile / Portable station are limited to 7 watts e.r.p.

4.1.2 Test Procedures

EIRP / ERP Measurement:

a. All measurements were done at low, middle and high operational frequency range. RBW and VBW is 10 MHz for LTE mode.

b. Substitution method is used for E.I.R.P measurement. In the semi-anechoic chamber, EUT placed on the 0.8 m (below or equal 1 GHz) and/or 1.5 m (above 1 GHz) 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 1 m to 4 m 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.

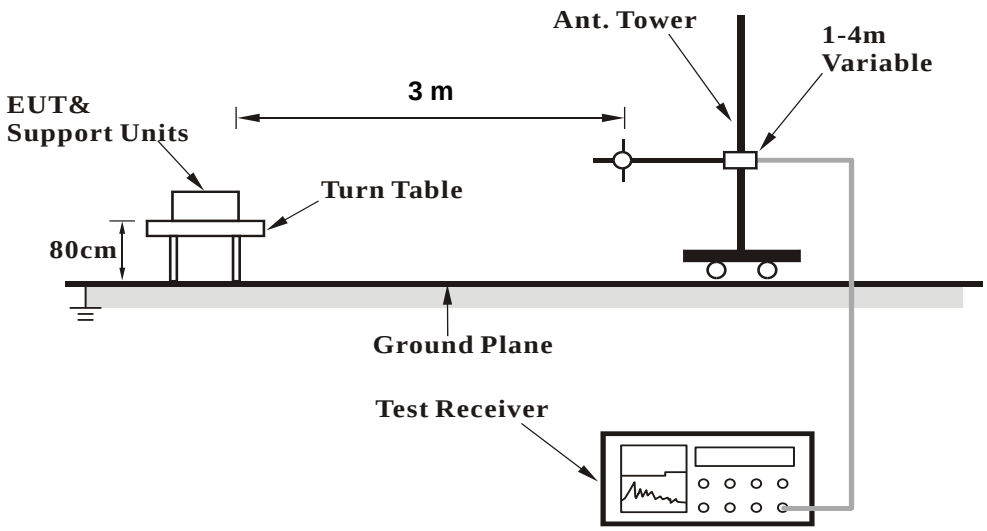
d. EIRP = Output power level of S.G – TX cable loss + Antenna gain of substitution horn. E.R.P power can be calculated form E.I.R.P power by subtracting the gain of dipole, E.R.P power = E.I.R.P power - 2.15 dB.

Conducted Power Measurement:

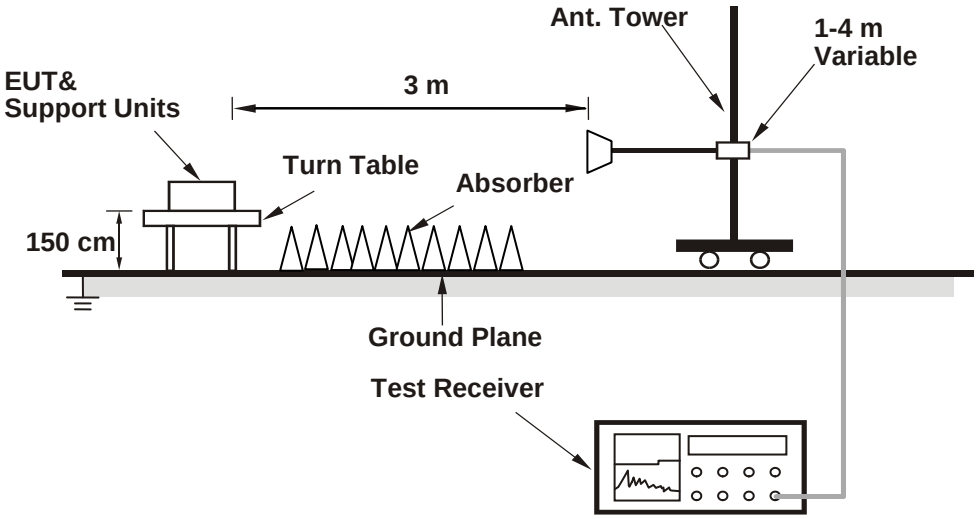
The EUT was set up for the maximum power with LTE link data modulation and link up with simulator. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

4.1.3 Test Setup

EIRP / ERP Measurement:
<Radiated Emission below or equal 1 GHz>



<Radiated Emission above 1 GHz>



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

Conducted Power Measurement:

4.1.4 Test Results

Conducted Output Power (dBm)

LTE Band 5

BW (MHz): 5										
Test Frequency ID	N_{UL}	Frequency of Uplink [MHz]	N_{DL}	Frequency of Downlink [MHz]	Test Configuration Initial of Power				EUT	
					Modulation	RB Size	RB Offset	Narrowband Index	Cell power (dBm/15kHz)	Power (dBm)
Low Range	20425	826.5	2425	871.5	QPSK	1	0	0	-85	23.78
					QPSK	1	5	0	-85	23.77
					QPSK	1	0	1	-85	23.70
					QPSK	1	5	1	-85	23.75
					QPSK	1	0	3	-85	23.75
					QPSK	1	5	3	-85	23.72
					QPSK	3	0	0	-85	22.97
					QPSK	3	3	3	-85	22.94
					QPSK	6	0	0	-85	22.99
					QPSK	6	0	1	-85	22.97
					QPSK	6	0	3	-85	22.94
					16QAM	1	0	0	-85	23.68
					16QAM	1	5	0	-85	23.67
					16QAM	1	0	1	-85	23.67
					16QAM	1	5	1	-85	23.66
					16QAM	1	0	3	-85	23.61
					16QAM	1	5	3	-85	23.56
					16QAM	3	0	0	-85	23.10
					16QAM	3	3	3	-85	23.08
					16QAM	5	0	0	-85	22.24
					16QAM	5	0	1	-85	22.17
					16QAM	5	0	3	-85	22.20
Mid Range	20525	836.5	2525	881.5	QPSK	1	0	0	-85	23.49
					QPSK	1	5	0	-85	23.46
					QPSK	1	0	1	-85	23.42
					QPSK	1	5	1	-85	23.43
					QPSK	1	0	3	-85	23.44
					QPSK	1	5	3	-85	23.45
					QPSK	3	0	0	-85	22.88
					QPSK	3	3	3	-85	22.81
					QPSK	6	0	0	-85	22.83
					QPSK	6	0	1	-85	22.81
					QPSK	6	0	3	-85	22.83
					16QAM	1	0	0	-85	23.42
					16QAM	1	5	0	-85	23.40
					16QAM	1	0	1	-85	23.38
					16QAM	1	5	1	-85	23.39
					16QAM	1	0	3	-85	23.41
					16QAM	1	5	3	-85	23.38
					16QAM	3	0	0	-85	22.81
					16QAM	3	3	3	-85	22.97
					16QAM	5	0	0	-85	22.11
					16QAM	5	0	1	-85	22.12
					16QAM	5	0	3	-85	22.03

Test Frequency ID	N_{UL}	Frequency of Uplink [MHz]	N_{DL}	Frequency of Downlink [MHz]	Test Configuration Initial of Power				EUT	
					Modulation	RB Size	RB Offset	Narrowband Index	Cell power (dBm/15kHz)	Power (dBm)
High Range	20625	846.5	2625	891.5	QPSK	1	0	0	-85	23.34
					QPSK	1	5	0	-85	23.31
					QPSK	1	0	1	-85	23.32
					QPSK	1	5	1	-85	23.31
					QPSK	1	0	3	-85	23.33
					QPSK	1	5	3	-85	23.32
					QPSK	3	0	0	-85	22.78
					QPSK	3	3	3	-85	22.77
					QPSK	6	0	0	-85	22.71
					QPSK	6	0	1	-85	22.72
					QPSK	6	0	3	-85	22.74
					16QAM	1	0	0	-85	23.31
					16QAM	1	5	0	-85	23.29
					16QAM	1	0	1	-85	23.28
					16QAM	1	5	1	-85	23.29
					16QAM	1	0	3	-85	23.30
					16QAM	1	5	3	-85	23.27
					16QAM	3	0	0	-85	22.65
					16QAM	3	3	3	-85	22.61
					16QAM	5	0	0	-85	22.02
					16QAM	5	0	1	-85	22.01
					16QAM	5	0	3	-85	21.98

BW (MHz): 10										
Test Frequency ID	N_{UL}	Frequency of Uplink [MHz]	N_{DL}	Frequency of Downlink [MHz]	Test Configuration Initial of Power				EUT	
					Modulation	RB Size	RB Offset	Narrowband Index	Cell power (dBm/15kHz)	Power (dBm)
Low Range	20450	829	2450	874	QPSK	1	0	0	-85	23.81
					QPSK	1	5	0	-85	23.75
					QPSK	1	0	3	-85	23.77
					QPSK	1	5	3	-85	23.78
					QPSK	1	0	7	-85	23.71
					QPSK	1	5	7	-85	23.70
					QPSK	4	0	0	-85	23.74
					QPSK	4	2	7	-85	23.70
					QPSK	6	0	0	-85	22.91
					QPSK	6	0	7	-85	22.82
					16QAM	1	0	0	-85	23.72
					16QAM	1	5	0	-85	23.73
					16QAM	1	0	3	-85	23.74
					16QAM	1	5	3	-85	23.74
					16QAM	1	0	7	-85	23.71
					16QAM	1	5	7	-85	23.69
					16QAM	4	2	0	-85	22.78
					16QAM	4	2	7	-85	22.74
					16QAM	5	0	0	-85	22.80
					16QAM	5	0	7	-85	22.86
Mid Range	20525	836.5	2525	881.5	QPSK	1	0	0	-85	23.66
					QPSK	1	5	0	-85	23.63
					QPSK	1	0	3	-85	23.53
					QPSK	1	5	3	-85	23.58
					QPSK	1	0	7	-85	23.45
					QPSK	1	5	7	-85	23.41
					QPSK	4	0	0	-85	23.56
					QPSK	4	2	7	-85	22.62
					QPSK	6	0	0	-85	22.75
					QPSK	6	0	7	-85	22.67
					16QAM	1	0	0	-85	23.60
					16QAM	1	5	0	-85	23.57
					16QAM	1	0	3	-85	23.55
					16QAM	1	5	3	-85	23.51
					16QAM	1	0	7	-85	23.59
					16QAM	1	5	7	-85	23.56
					16QAM	4	2	0	-85	22.79
					16QAM	4	2	7	-85	22.63
					16QAM	5	0	0	-85	22.91
					16QAM	5	0	7	-85	22.63
High Range	20600	844	2600	889	QPSK	1	0	0	-85	23.65
					QPSK	1	5	0	-85	23.56
					QPSK	1	5	7	-85	23.31
					QPSK	1	0	3	-85	23.47
					QPSK	1	5	3	-85	23.43
					QPSK	1	0	7	-85	23.39
					QPSK	4	0	0	-85	23.60
					QPSK	4	2	7	-85	23.38
					QPSK	6	0	0	-85	22.71
					QPSK	6	0	7	-85	22.53
					16QAM	1	0	0	-85	23.62
					16QAM	1	5	0	-85	23.53
					16QAM	1	0	3	-85	23.60
					16QAM	1	5	3	-85	23.50
					16QAM	1	0	7	-85	23.49
					16QAM	1	5	7	-85	23.46
					16QAM	4	2	0	-85	22.65
					16QAM	4	2	7	-85	22.53
					16QAM	5	0	0	-85	22.73
					16QAM	5	0	7	-85	22.51

ERP Power (dBm)

LTE Band 5							
Channel Bandwidth: 5 MHz / QPSK							
Plane	**Channel**	**Frequency (MHz)**	**Reading (dBm)**	**Correction Factor (dB)**	**ERP (dBm)**	**ERP (mW)**	**Polarization (H/V)**
X	20425	826.5	-9.24	32.62	21.23	132.74	H
	20525	836.5	-9.21	32.52	21.16	130.62	
	20625	846.5	-9.44	32.65	21.06	127.64	
	20425	826.5	-15.84	32.76	14.77	29.99	V
	20525	836.5	-15.63	32.39	14.61	28.91	
	20625	846.5	-15.85	32.54	14.54	28.44	
Channel Bandwidth: 5 MHz / 16QAM							
X	20425	826.5	-10.28	32.62	20.19	104.47	H
	20525	836.5	-10.30	32.52	20.07	101.62	
	20625	846.5	-10.69	32.65	19.81	95.72	
	20425	826.5	-16.88	32.76	13.73	23.60	V
	20525	836.5	-16.77	32.39	13.47	22.23	
	20625	846.5	-17.00	32.54	13.39	21.83	

Note: ERP (dBm) = Reading (dBm) + Correction Factor (dB) – 2.15

LTE Band 5							
Channel Bandwidth: 10 MHz / QPSK							
Plane	**Channel**	**Frequency (MHz)**	**Reading (dBm)**	**Correction Factor (dB)**	**ERP (dBm)**	**ERP (mW)**	**Polarization (H/V)**
X	20450	829.0	-9.04	32.62	21.43	139.00	H
	20525	836.5	-9.01	32.52	21.36	136.77	
	20600	844.0	-9.22	32.65	21.28	134.28	
	20450	829.0	-15.51	32.76	15.10	32.36	V
	20525	836.5	-15.32	32.39	14.92	31.05	
	20600	844.0	-15.55	32.54	14.84	30.48	
Channel Bandwidth: 10 MHz / 16QAM							
X	20425	826.5	-10.02	32.62	20.45	110.92	H
	20525	836.5	-10.02	32.52	20.35	108.39	
	20625	846.5	-10.46	32.65	20.04	100.93	
	20425	826.5	-16.55	32.76	14.06	25.47	V
	20525	836.5	-16.55	32.39	13.69	23.39	
	20625	846.5	-16.74	32.54	13.65	23.17	

Note: ERP (dBm) = Reading (dBm) + Correction Factor (dB) – 2.15

4.2 Modulation Characteristics Measurement

4.2.1 Limits of Modulation Characteristics

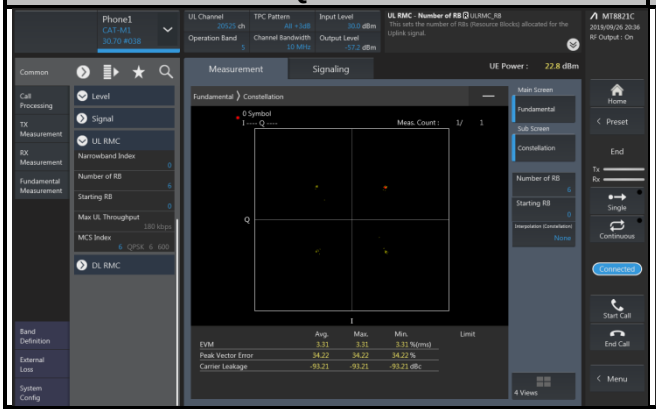
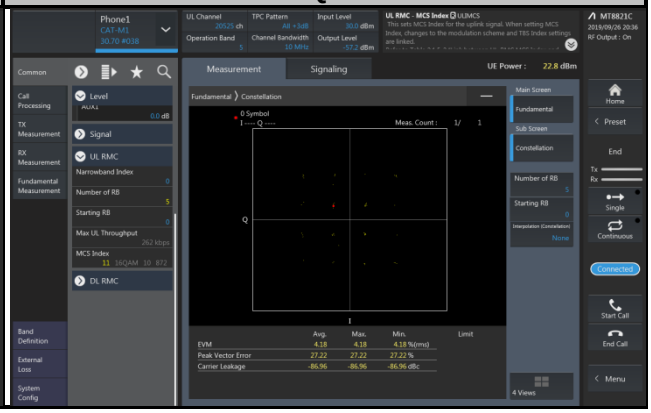
N/A

4.2.2 Test Setup

4.2.3 Test Procedure

Connect the EUT to Communication Simulator via the antenna connector. The frequency band is set as EUT supported Modulation and Channels, the EUT output is matched with 50 ohm load, the waveform quality and constellation of the EUT was tested.

4.2.4 Test Results

Spectrum Plot of Measurement	
LTE Band 5	
Channel 20525	
QPSK	16QAM
	

4.3 Frequency Stability Measurement

4.3.1 Limits of Frequency Stability Measurement

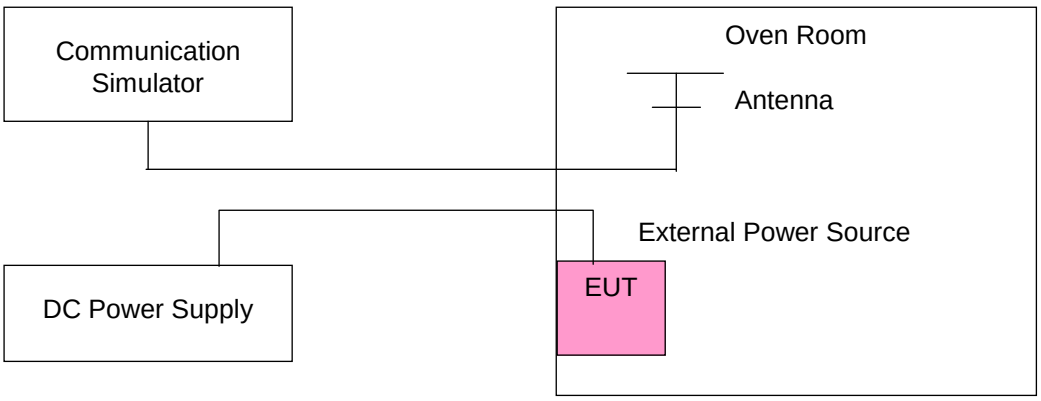
1.5 ppm is for base and fixed station. 2.5 ppm is for mobile station.

4.3.2 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.

4.3.3 Test Setup



4.3.4 Test Results

Frequency Error vs. Voltage

Voltage (Volts)	LTE Band 5				Limit (ppm)
	Channel Bandwidth: 5 MHz				
	Low Channel		High Channel		
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
3.8	826.500004	0.004	846.500002	0.002	2.5
3.6	826.500004	0.004	846.500001	0.001	2.5
4.35	826.500001	0.001	846.500003	0.004	2.5

Note: The applicant defined the normal working voltage of the battery is from 3.6 Vdc to 4.35 Vdc.

Frequency Error vs. Temperature

Temp. (℃)	LTE Band 5				Limit (ppm)
	Channel Bandwidth: 5 MHz				
	Low Channel		High Channel		
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
-30	826.500001	0.002	846.500001	0.001	2.5
-20	826.500002	0.002	846.500004	0.004	2.5
-10	826.500001	0.001	846.500002	0.002	2.5
0	826.500003	0.003	846.500002	0.002	2.5
10	826.500001	0.002	846.500003	0.003	2.5
20	826.499997	-0.004	846.499998	-0.003	2.5
30	826.499996	-0.005	846.499998	-0.003	2.5
40	826.499999	-0.002	846.499996	-0.005	2.5
50	826.499997	-0.004	846.499996	-0.004	2.5
60	824.699999	-0.002	848.299997	-0.003	2.5
70	824.699998	-0.003	848.299998	-0.002	2.5
80	824.699998	-0.003	848.299999	-0.001	2.5
85	826.499996	-0.005	846.499997	-0.003	2.5

Frequency Error vs. Voltage

Voltage (Volts)	LTE Band 5				Limit (ppm)
	Channel Bandwidth: 10 MHz				
	Low Channel		High Channel		
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
3.8	829.000003	0.003	844.000001	0.001	2.5
3.6	829.000002	0.002	844.000003	0.003	2.5
4.35	829.000003	0.004	844.000004	0.005	2.5

Note: The applicant defined the normal working voltage of the battery is from 3.6 Vdc to 4.35 Vdc.

Frequency Error vs. Temperature

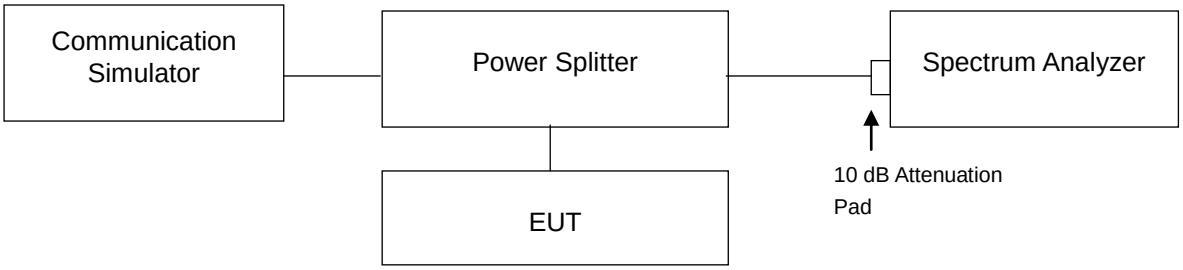
Temp. (℃)	LTE Band 5				Limit (ppm)
	Channel Bandwidth: 10 MHz				
	Low Channel		High Channel		
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
-30	829.000002	0.002	844.000003	0.003	2.5
-20	829.000003	0.003	844.000002	0.002	2.5
-10	829.000003	0.003	844.000003	0.004	2.5
0	829.000002	0.003	844.000004	0.005	2.5
10	829.000003	0.004	844.000003	0.003	2.5
20	828.999996	-0.005	843.999999	-0.002	2.5
30	828.999996	-0.004	843.999997	-0.003	2.5
40	828.999998	-0.002	843.999997	-0.004	2.5
50	828.999999	-0.001	843.999997	-0.004	2.5
60	824.699996	-0.004	848.299999	-0.002	2.5
70	824.699999	-0.002	848.299996	-0.005	2.5
80	824.699996	-0.005	848.299998	-0.002	2.5
85	828.999998	-0.003	843.999999	-0.001	2.5

4.4 Occupied Bandwidth Measurement

4.4.1 Test Procedure

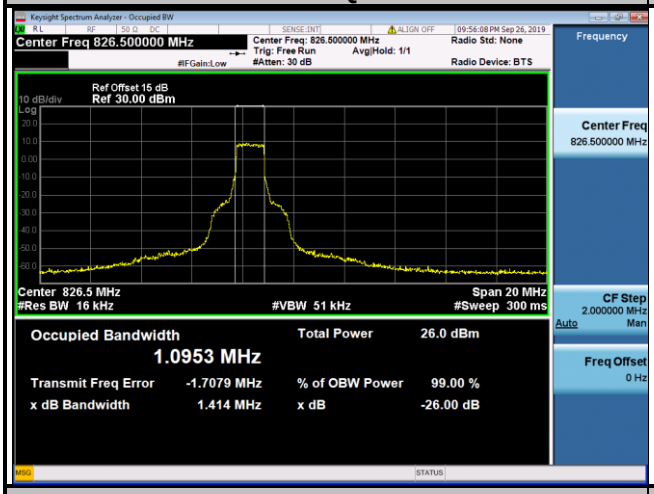
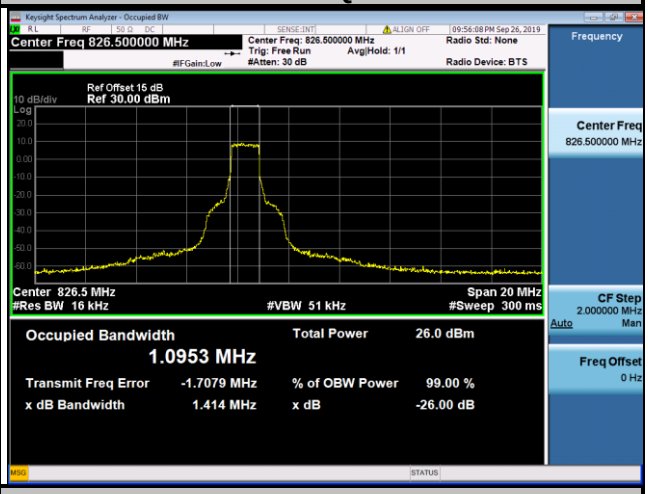
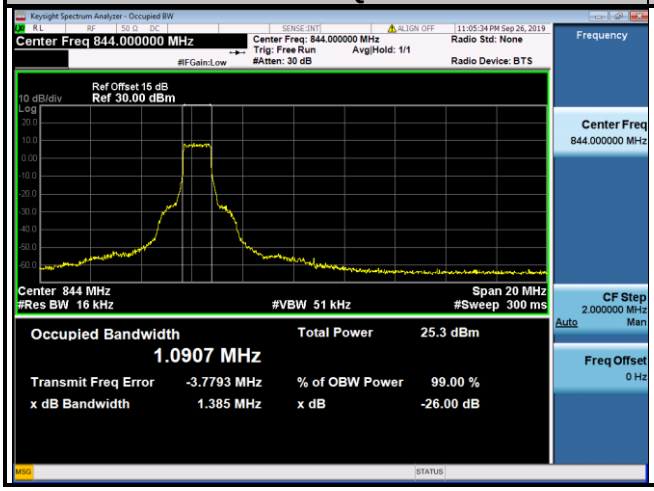
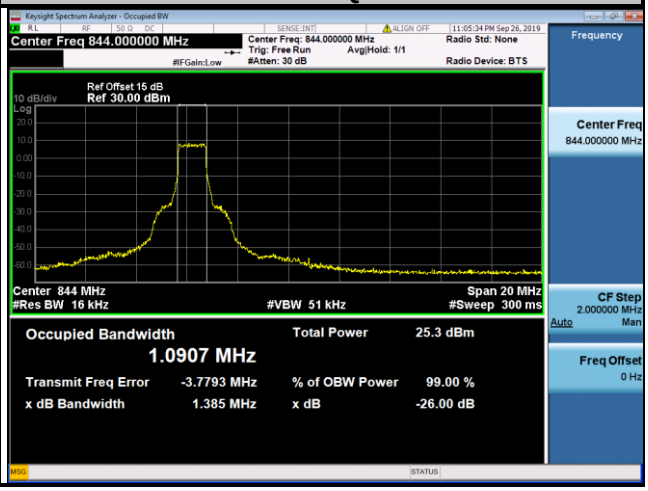
The EUT makes a call to the communication simulator. All measurements were done at low, middle and high operational frequency range. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency. Use OBW measurement function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

4.4.2 Test Setup



4.4.3 Test Result

LTE Band 5					
Channel Bandwidth: 5 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
20425	826.5	1.0953	0.9248	1.414	1.302
20525	836.5	1.0855	0.9136	1.369	1.316
20625	846.5	1.0850	0.9170	1.362	1.248
Channel Bandwidth: 10 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
20450	829.0	1.0872	0.9141	1.372	1.294
20525	836.5	1.0878	0.9135	1.382	1.287
20600	844.0	1.0907	0.9161	1.385	1.367

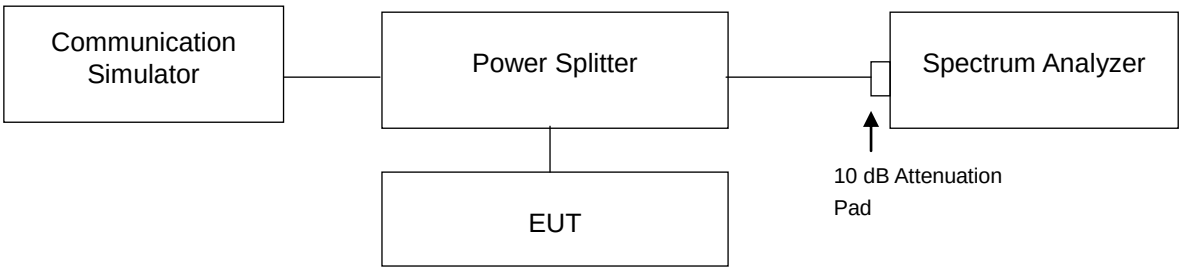
Spectrum Plot of Worst Value	
99 % Occupied Bandwidth	26 dB Bandwidth
5 MHz / QPSK	5 MHz / QPSK
	
10 MHz / QPSK	10 MHz / QPSK
	

4.5 Band Edge Measurement

4.5.1 Limits of Band Edge Measurement

Power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB. 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.

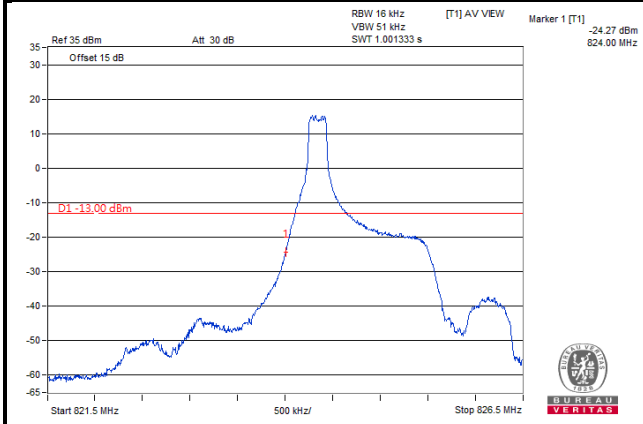
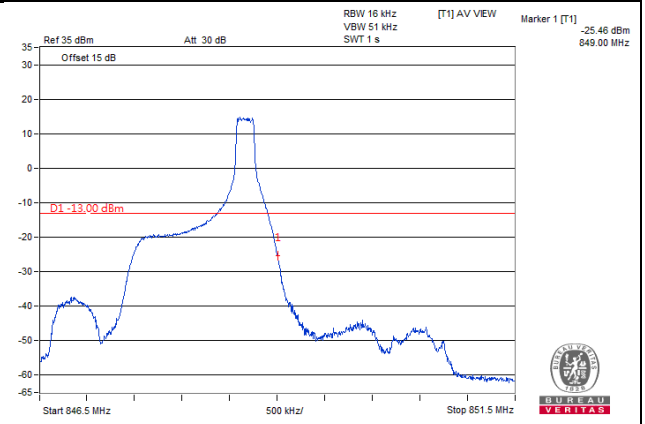
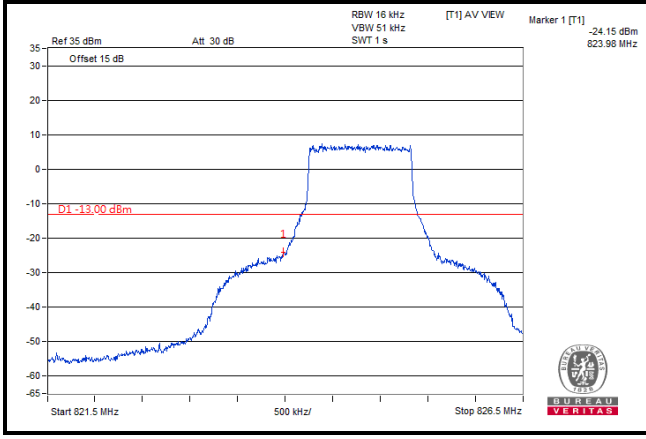
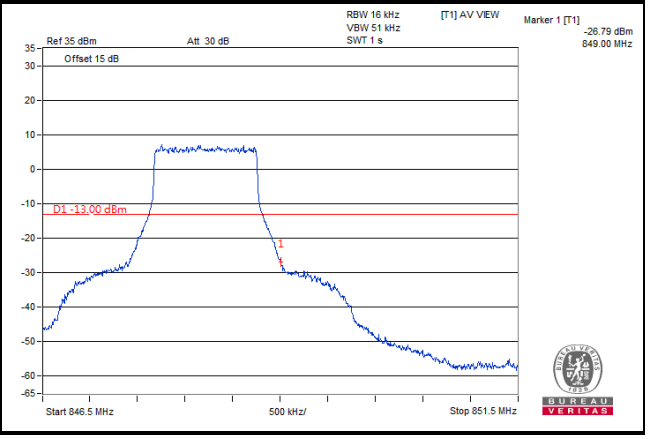
4.5.2 Test Setup

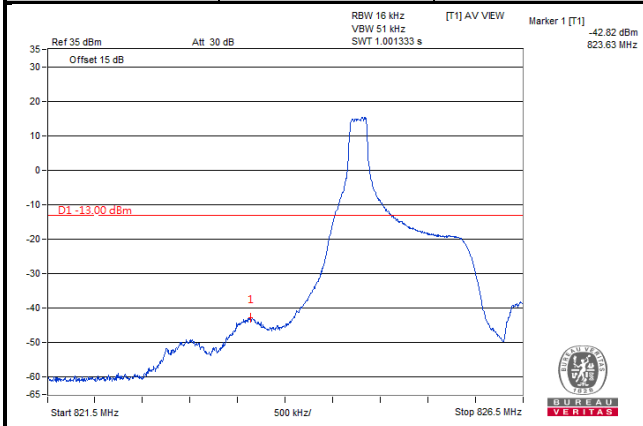
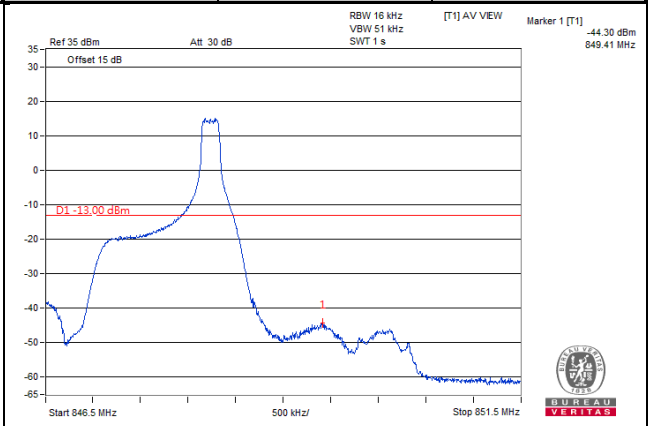
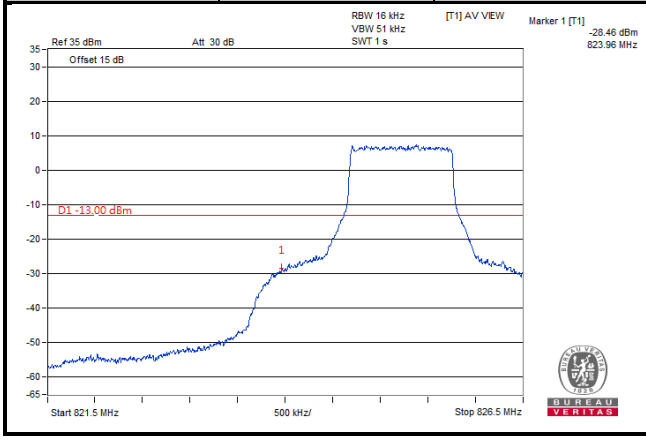
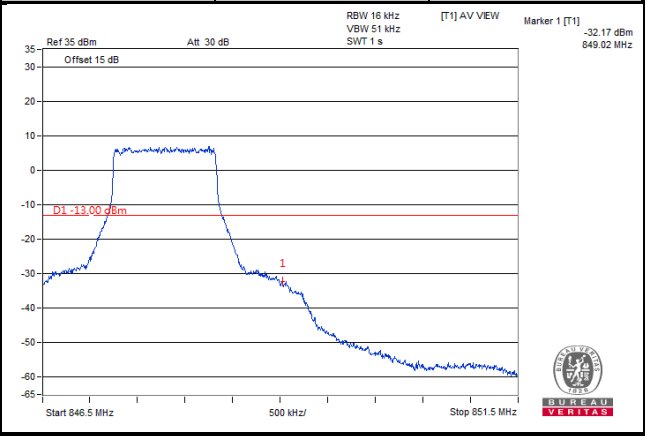


4.5.3 Test Procedures

a. All measurements were done at low and high operational frequency range.
b. The center frequency of spectrum is the band edge frequency and span is 1 MHz. RB of the spectrum is 62 kHz and VB of the spectrum is 200 kHz (LTE Bandwidth 5 MHz).
c. The center frequency of spectrum is the band edge frequency and span is 1 MHz. RB of the spectrum is 100 kHz and VB of the spectrum is 300 kHz (LTE Bandwidth 10 MHz).
d. Record the max trace plot into the test report.

4.5.4 Test Results

LTE Band 5					
Channel Bandwidth: 5 MHz					
Channel	20425	1 RB	Channel	20625	1 RB
					
Channel	20425	25 RB	Channel	20625	25 RB
					

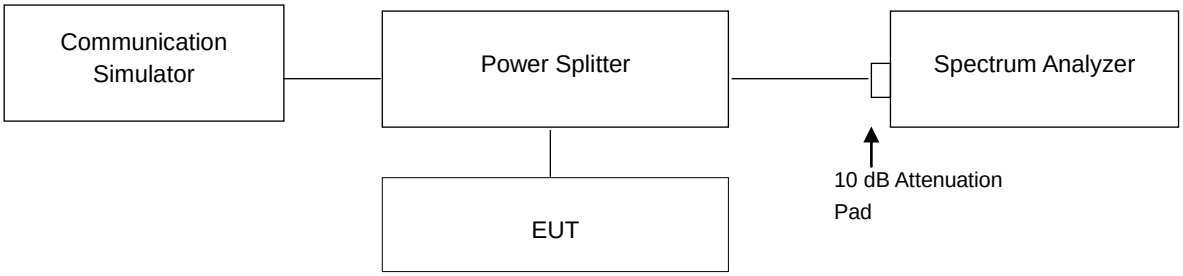
LTE Band 5					
Channel Bandwidth: 10 MHz					
Channel	20450	1 RB	Channel	20600	1 RB
					
Channel	20450	50 RB	Channel	20600	50 RB
					

4.6 Peak to Average Ratio

4.6.1 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.

4.6.2 Test Setup

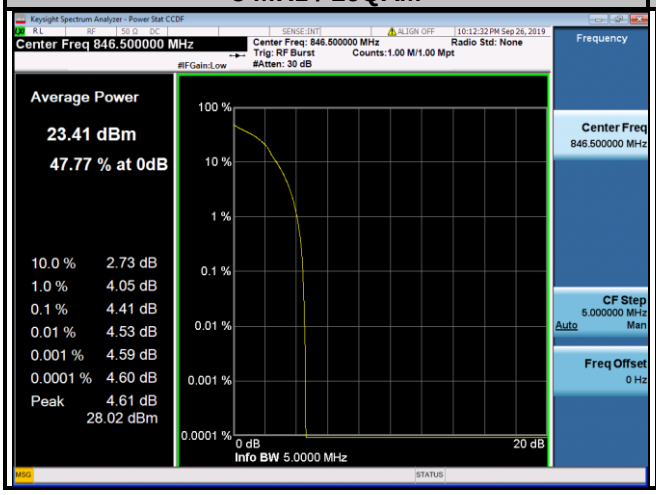
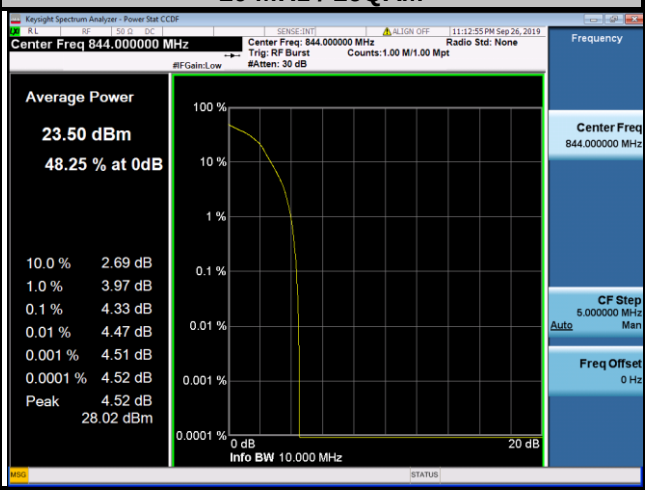


4.6.3 Test Procedures

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 %.

4.6.4 Test Results

LTE Band 5							
Channel Bandwidth: 5 MHz				Channel Bandwidth: 10 MHz			
Channel	Frequency (MHz)	Peak to Average Ratio (dB)		Channel	Frequency (MHz)	Peak to Average Ratio (dB)	
		QPSK	16QAM			QPSK	16QAM
20425	826.5	3.77	4.21	20450	829.0	3.71	4.20
20525	836.5	3.97	4.23	20525	836.5	3.93	4.20
20625	846.5	3.99	4.41	20600	844.0	3.95	4.33

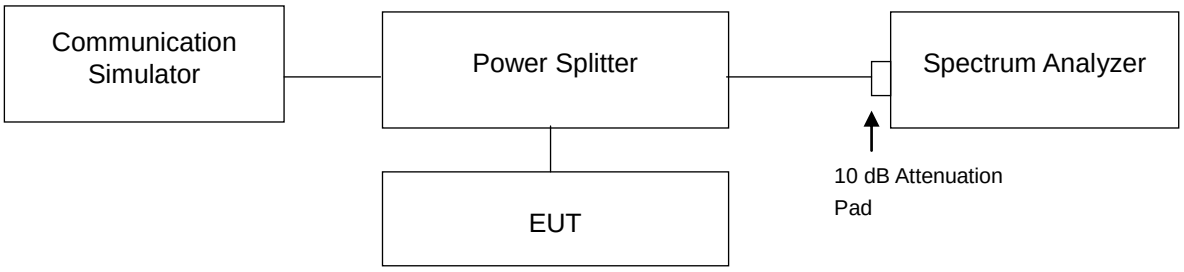
Spectrum Plot of Worst Value	
5 MHz / 16QAM	10 MHz / 16QAM
	

4.7 Conducted Spurious Emissions

4.7.1 Limits of Conducted Spurious Emissions Measurement

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB. The emission limit equal to -13 dBm.

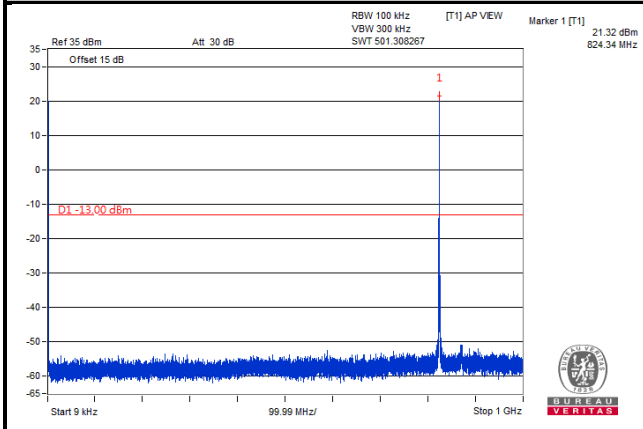
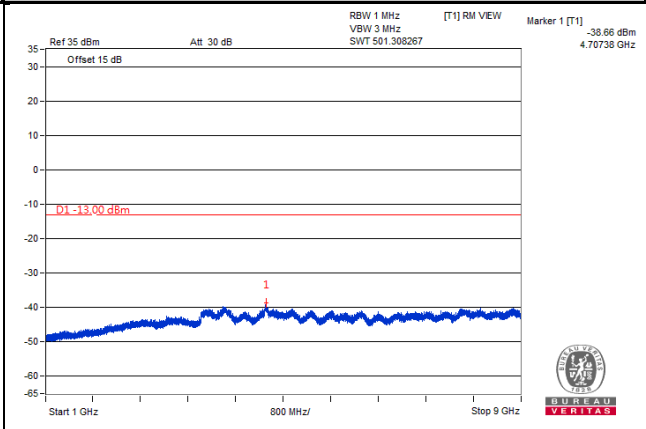
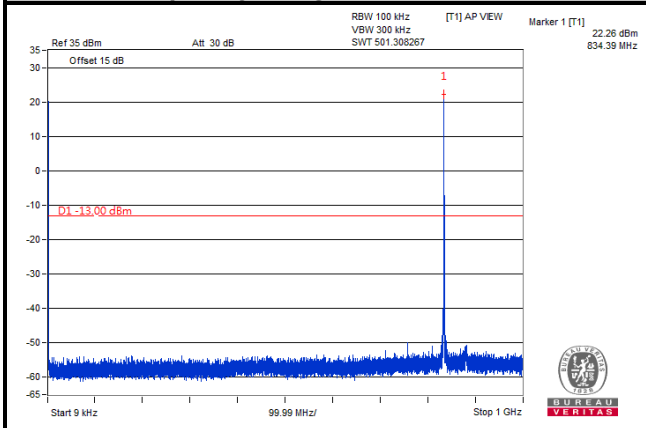
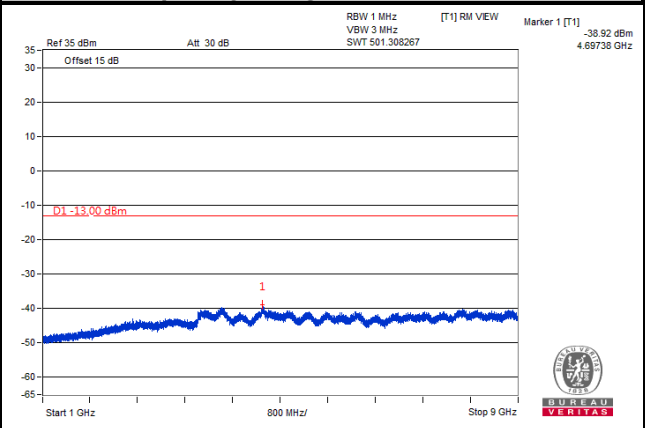
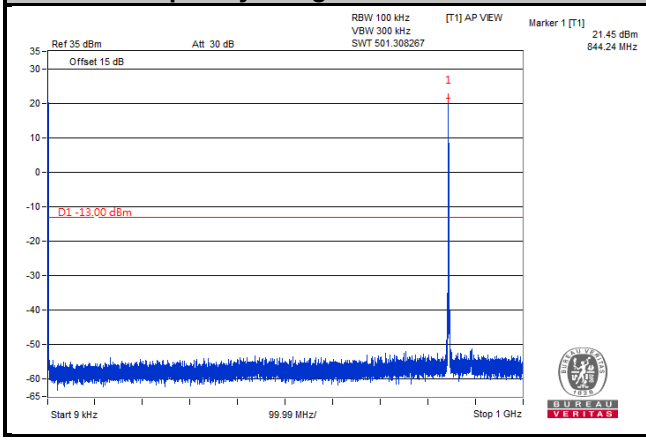
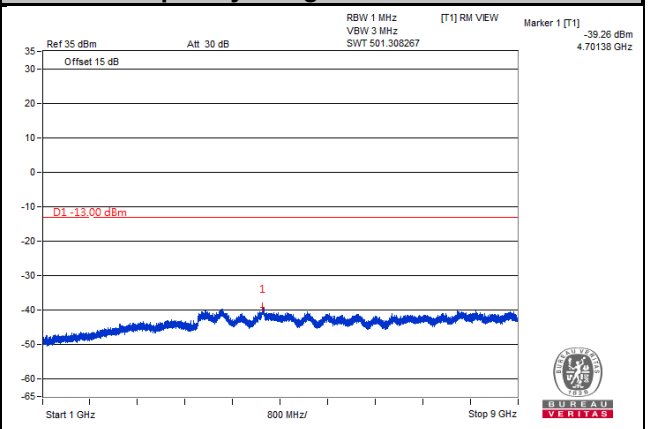
4.7.2 Test Setup



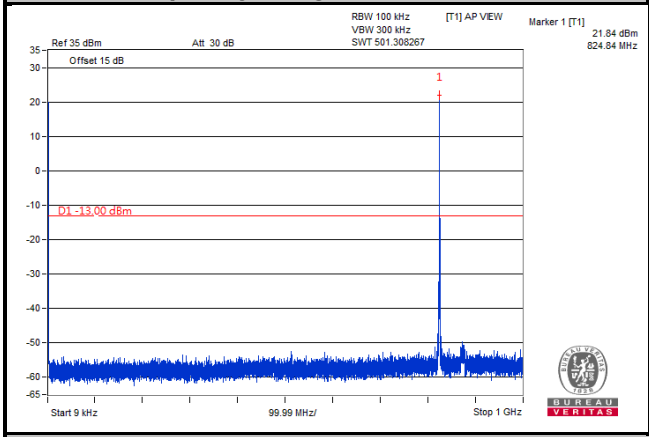
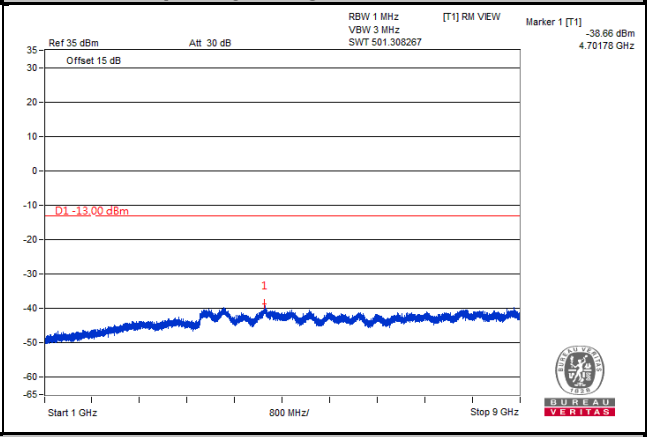
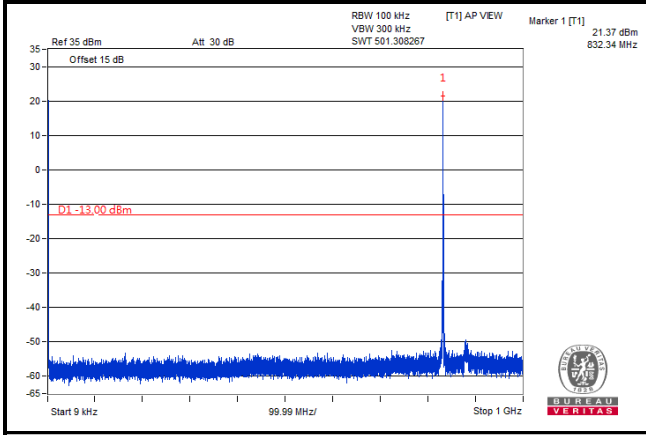
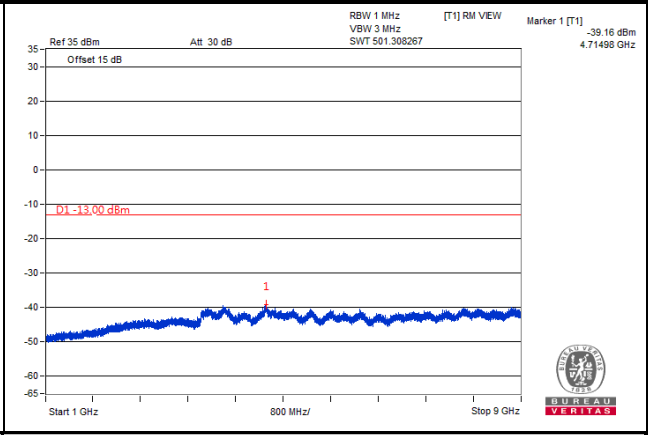
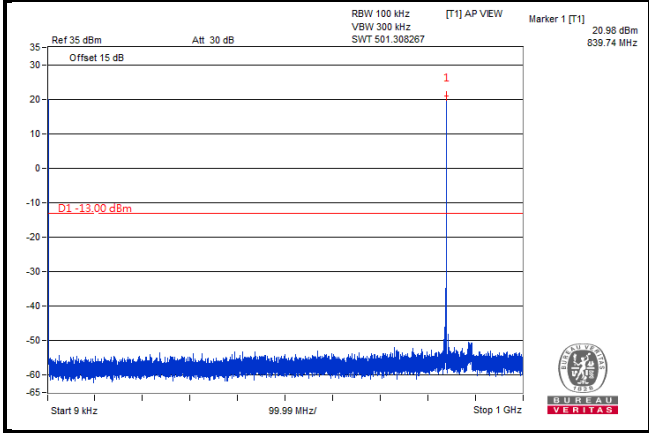
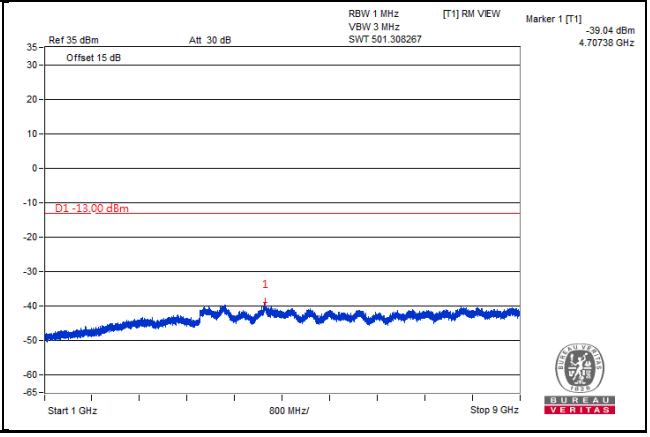
4.7.3 Test Procedure

a. The EUT makes a phone call to the communication simulator. All measurements were done at low, middle and high operational frequency range.
b. Measuring frequency range is from 9 kHz to 1 GHz. 10 dB attenuation pad is connected with spectrum. RBW = 100 kHz and VBW = 300 kHz is used for conducted emission measurement.
c. Measuring frequency range is from 1 GHz to 9 GHz. 10 dB attenuation pad is connected with spectrum. RBW = 1 MHz and VBW = 3 MHz is used for conducted emission measurement.

4.7.4 Test Results

LTE Band 5	
Channel Bandwidth: 5 MHz	
Channel 20425	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	
Channel 20525	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	
Channel 20625	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	

Note: The signal over the limit in 9 kHz is from spectrum analyzer.

LTE Band 5	
Channel Bandwidth: 10 MHz	
Channel 20450	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	
Channel 20525	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	
Channel 20600	
Frequency Range: 9 kHz ~ 1 GHz	Frequency Range: 1 GHz ~ 9 GHz
	

Note: The signal over the limit in 9 kHz is from spectrum analyzer.

4.8 Radiated Emission Measurement

4.8.1 Limits of Radiated Emission Measurement

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB. The emission limit is equal to -13 dBm.

4.8.2 Test Procedure

a. Substitution method is used for E.I.R.P measurement. In the semi-anechoic chamber, EUT placed on the 0.8 m (below or equal 1 GHz) and/or 1.5 m (above 1 GHz) 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 1 m to 4 m to find the maximum polar radiated power. The "Read Value" is the spectrum reading the maximum power value.
b. 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 a. Record the power level of S.G
c. EIRP = Output power level of S.G – TX cable loss + Antenna gain of substitution horn.
d. E.R.P power can be calculated form E.I.R.P power by subtracting the gain of dipole, E.R.P power = E.I.R.P power - 2.15 dB.

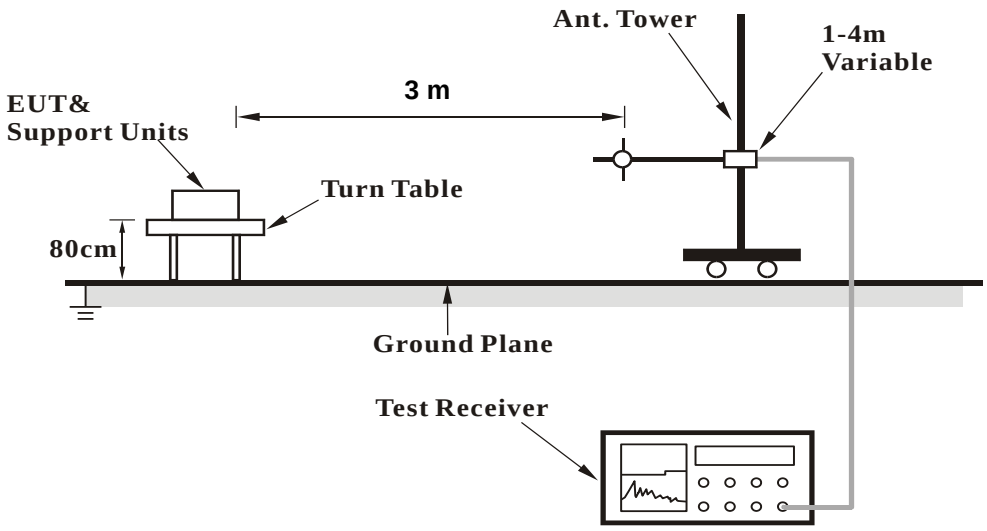
NOTE: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz/3 MHz.

4.8.3 Deviation from Test Standard

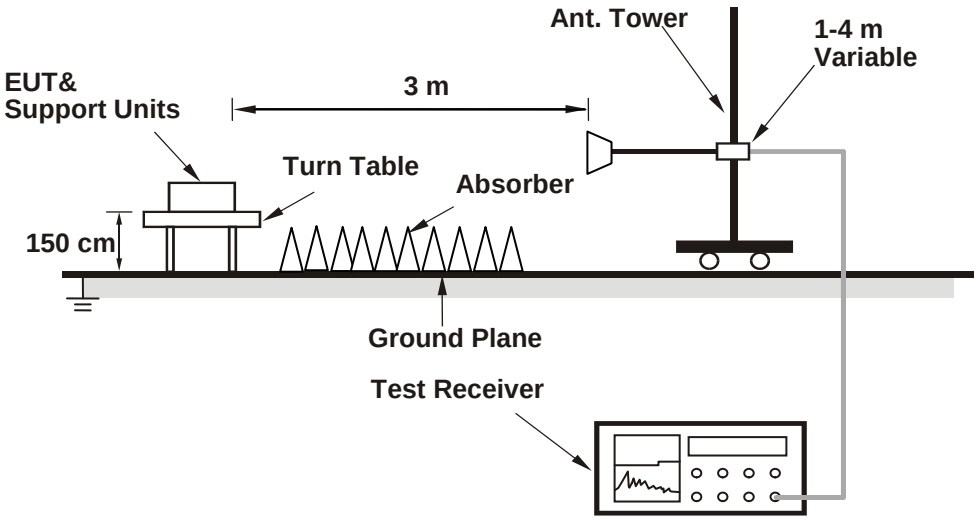
No deviation.

4.8.4 Test Setup

<Radiated Emission below or equal 1 GHz>



<Radiated Emission above 1 GHz>



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

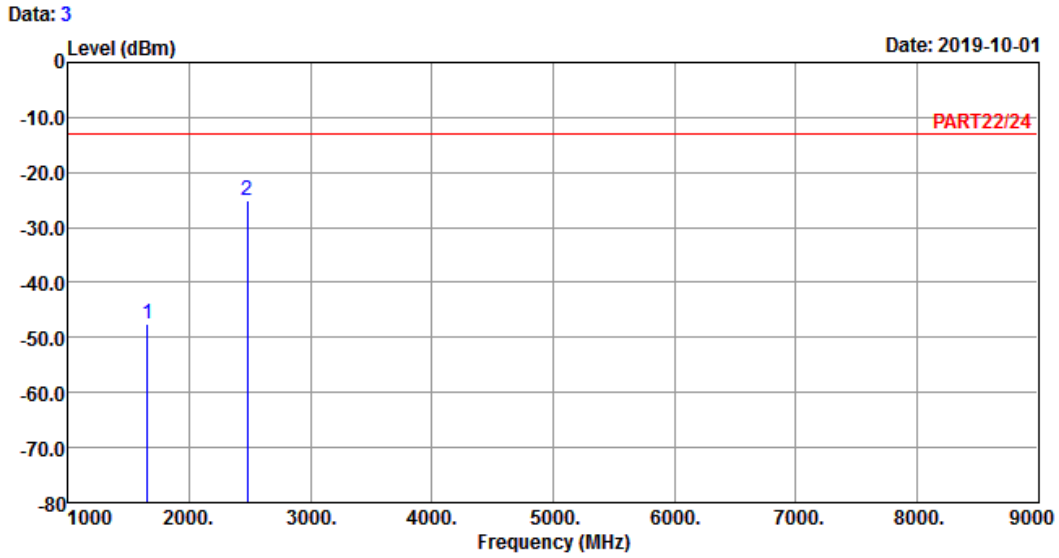
4.8.5 Test Results

LTE Band 5

Channel Bandwidth: 5 MHz / QPSK

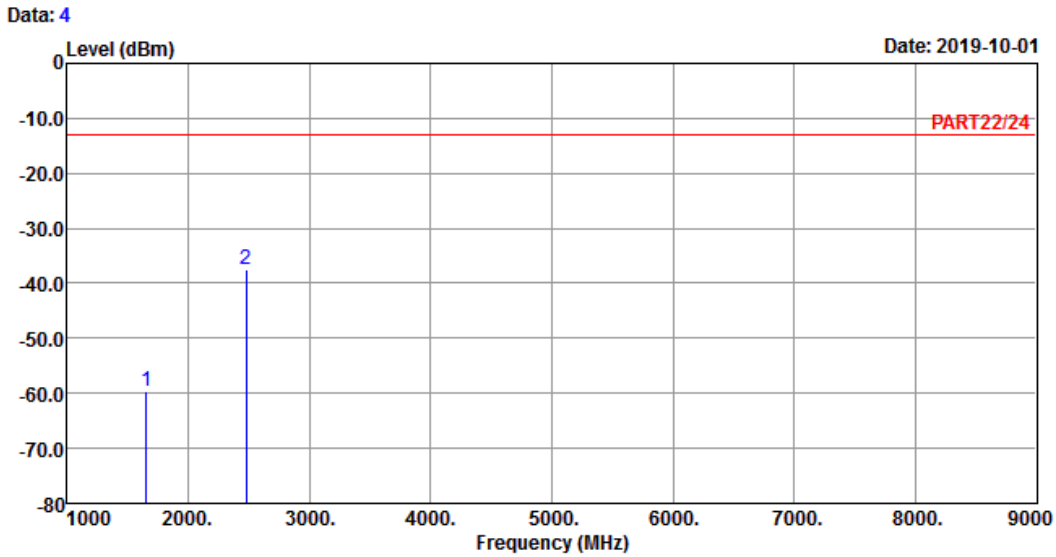
Low Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_5M Link_L-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1653.00	-47.46	-33.69	-13.00	-13.77	-34.46	Peak
2 pp	2479.50	-24.99	-14.96	-13.00	-10.03	-11.99	Peak

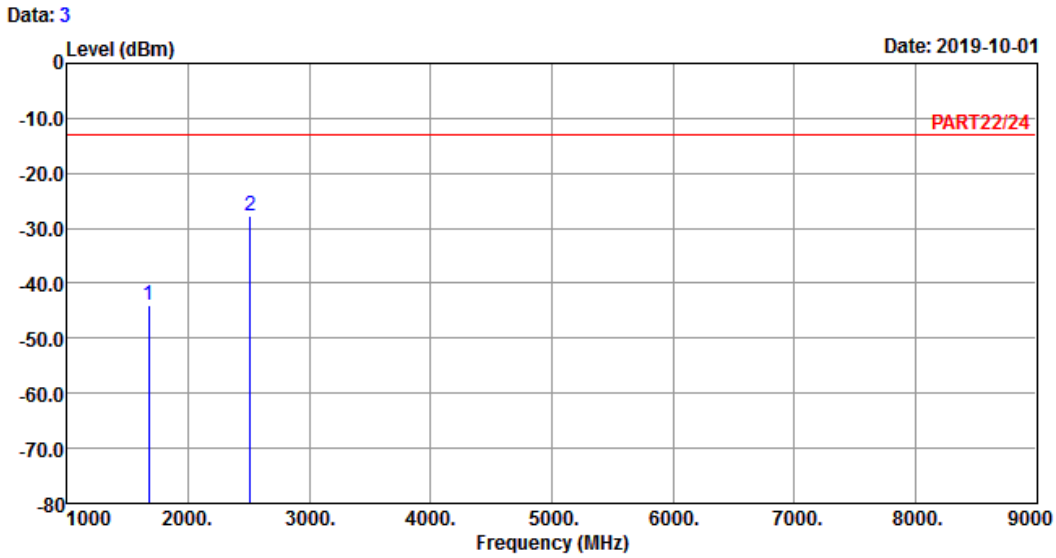


Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_5M Link_L-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1653.00	-59.57	-45.80	-13.00	-13.77	-46.57	Peak
2 pp	2479.50	-37.47	-27.44	-13.00	-10.03	-24.47	Peak

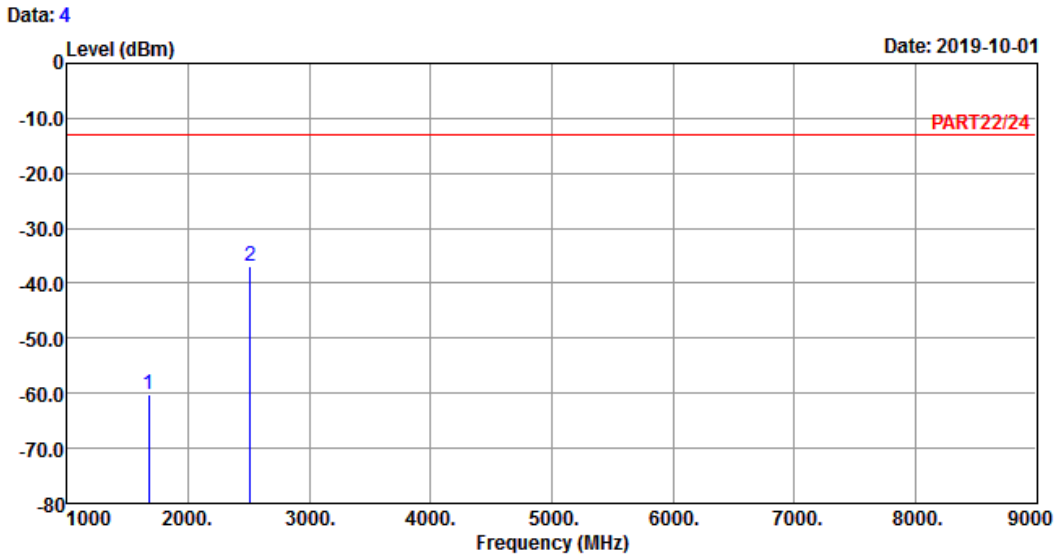
Middle Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_5M Link_M-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1673.00	-43.91	-30.01	-13.00	-13.90	-30.91	Peak
2 pp	2509.50	-27.73	-17.65	-13.00	-10.08	-14.73	Peak

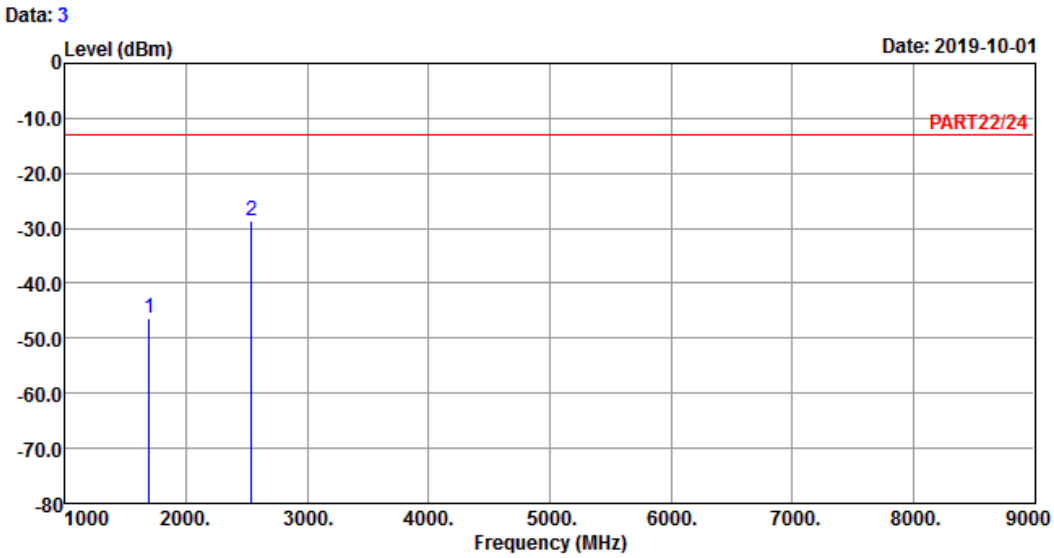


Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_5M Link_M-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1673.00	-60.13	-46.23	-13.00	-13.90	-47.13	Peak
2 pp	2509.50	-36.96	-26.88	-13.00	-10.08	-23.96	Peak

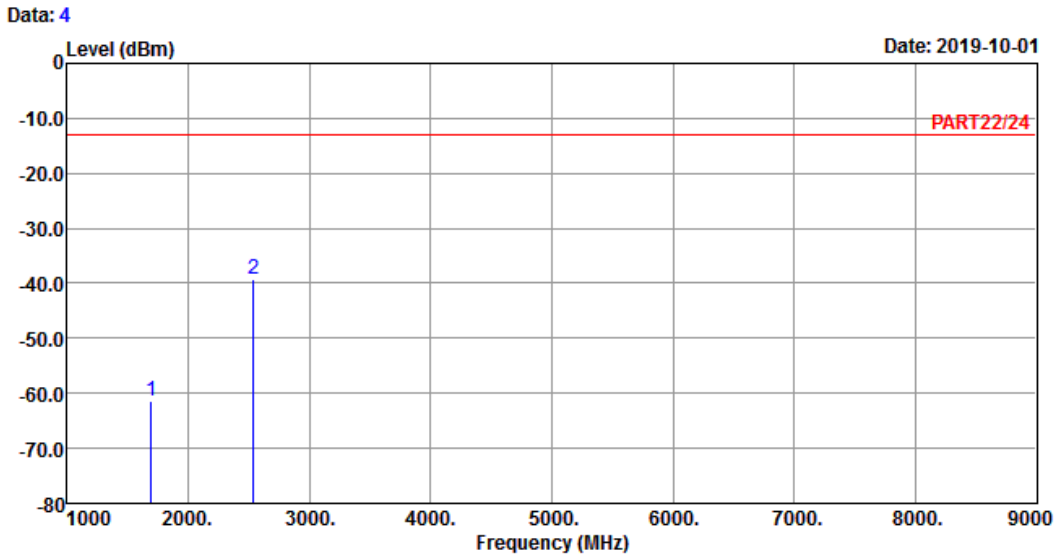
High Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_5M Link_H-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1693.00	-46.40	-32.38	-13.00	-14.02	-33.40	Peak
2 pp	2539.50	-28.63	-18.57	-13.00	-10.06	-15.63	Peak

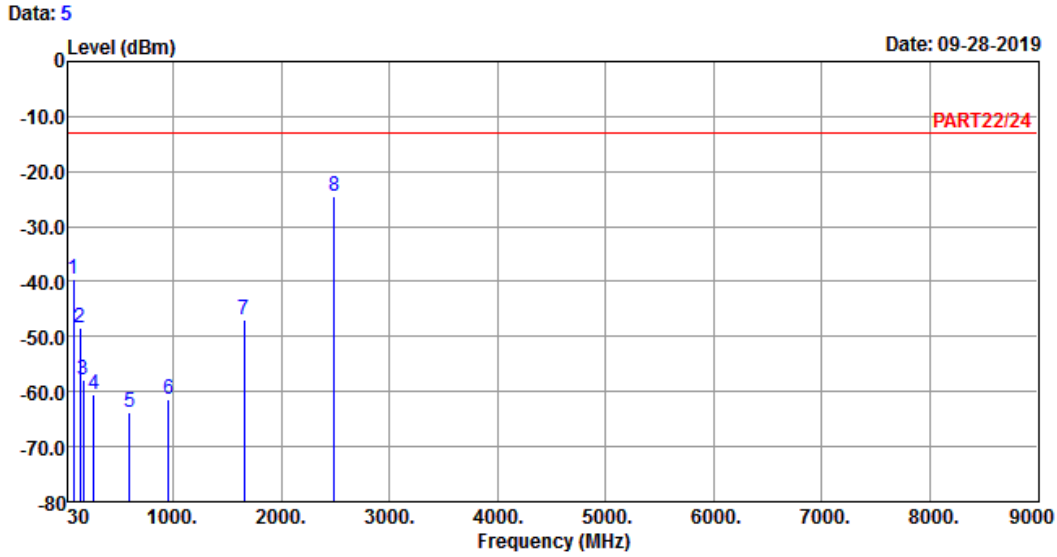


Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_5M Link_H-CH
Tested by: tim-chen

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1693.00	-61.33	-47.31	-13.00	-14.02	-48.33	Peak
2 pp	2539.50	-39.20	-29.14	-13.00	-10.06	-26.20	Peak

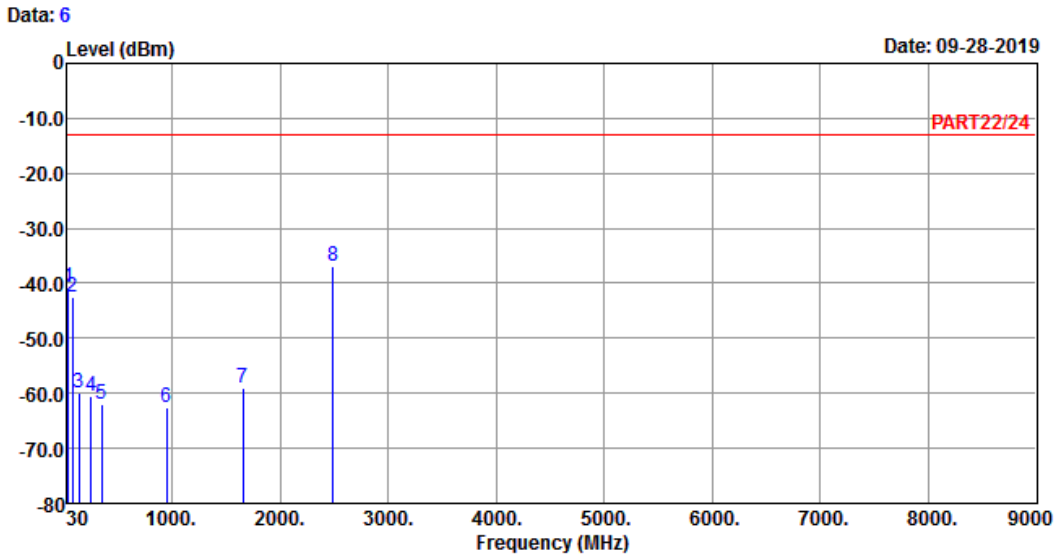
Channel Bandwidth: 10 MHz / QPSK
Low Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_10M Link_L-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	76.56	-39.69	-29.71	-13.00	-9.98	-26.69	Peak
2	136.70	-48.35	-39.69	-13.00	-8.66	-35.35	Peak
3	170.65	-57.88	-52.18	-13.00	-5.70	-44.88	Peak
4	266.68	-60.41	-54.08	-13.00	-6.33	-47.41	Peak
5	595.51	-63.62	-62.67	-13.00	-0.95	-50.62	Peak
6	959.26	-61.48	-63.62	-13.00	2.14	-48.48	Peak
7	1658.00	-47.00	-33.20	-13.00	-13.80	-34.00	Peak
8 pp	2487.00	-24.52	-14.47	-13.00	-10.05	-11.52	Peak

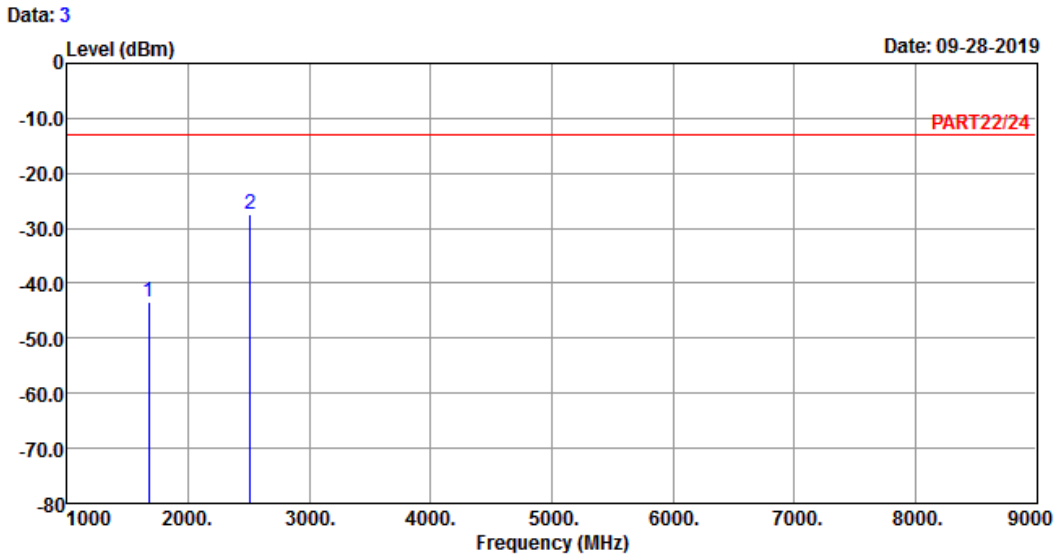


Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_10M Link_L-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	40.67	-40.82	-40.94	-13.00	0.12	-27.82	Peak
2	75.59	-42.47	-32.72	-13.00	-9.75	-29.47	Peak
3	136.70	-59.82	-51.16	-13.00	-8.66	-46.82	Peak
4	251.16	-60.38	-54.37	-13.00	-6.01	-47.38	Peak
5	346.22	-62.10	-55.80	-13.00	-6.30	-49.10	Peak
6	952.47	-62.68	-64.58	-13.00	1.90	-49.68	Peak
7	1658.00	-59.05	-45.25	-13.00	-13.80	-46.05	Peak
8 pp	2487.00	-36.97	-26.92	-13.00	-10.05	-23.97	Peak

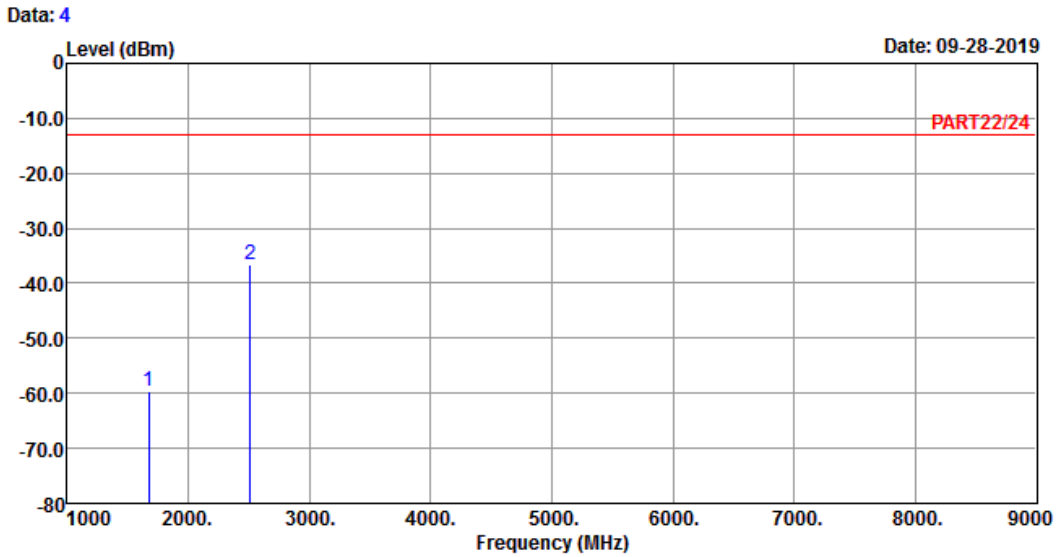
Middle Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_10M Link_M-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1673.00	-43.45	-29.55	-13.00	-13.90	-30.45	Peak
2 pp	2509.50	-27.33	-17.25	-13.00	-10.08	-14.33	Peak

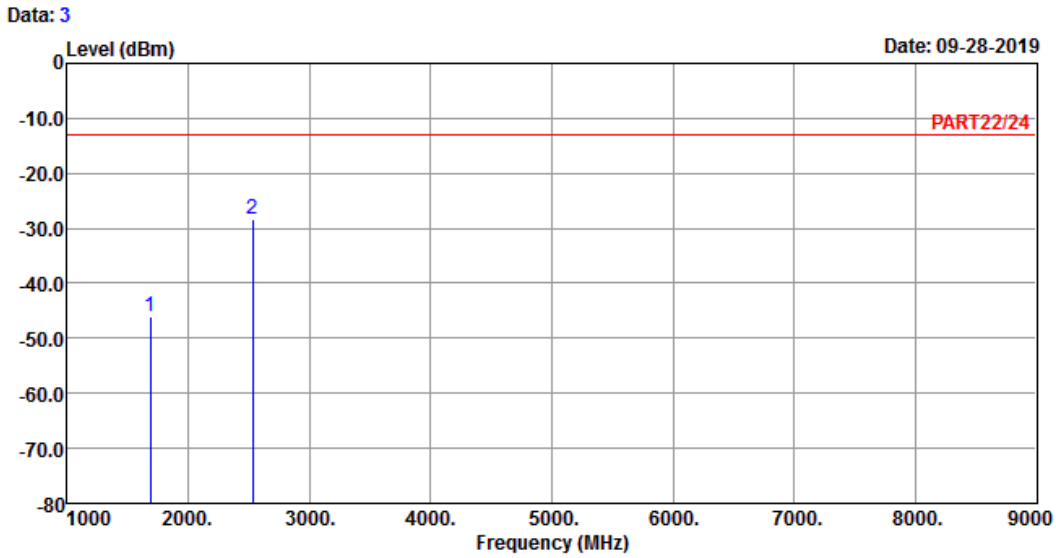


Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_10M Link_M-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1673.00	-59.77	-45.87	-13.00	-13.90	-46.77	Peak
2 pp	2509.50	-36.47	-26.39	-13.00	-10.08	-23.47	Peak

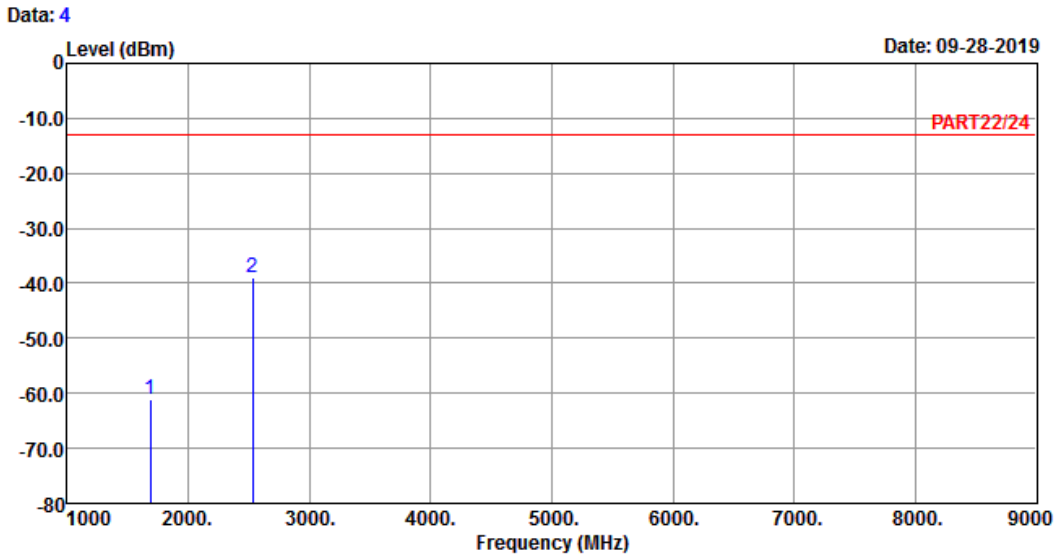
High Channel

Bureau Veritas Consumer Products Services Ltd.,Taoyuan Branch



Site : 966 Chamber 5
Condition: PART22/24 HORIZONTAL
Remak : Cat-M1 Band 5 QPSK_10M Link_H-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1688.00	-46.15	-32.16	-13.00	-13.99	-33.15	Peak
2 pp	2532.00	-28.20	-18.13	-13.00	-10.07	-15.20	Peak



Site : 966 Chamber 5
Condition: PART22/24 VERTICAL
Remak : Cat-M1 Band 5 QPSK_10M Link_H-CH
Tested by: Thomas Wei

	Freq	Level	Read Level	Limit Line	Factor	Over Limit	Remark
	MHz	dBm	dBm	dBm	dB	dB	
1	1688.00	-61.01	-47.02	-13.00	-13.99	-48.01	Peak
2 pp	2532.00	-38.88	-28.81	-13.00	-10.07	-25.88	Peak

5 Pictures of Test Arrangements

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

Appendix – Information of 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 FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

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

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab
Tel: 886-3-3183232
Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

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

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