

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LICENSED TRANSMITTER

Test Report No. : OT-215-RWD-036
Reception No. : 2104001579
Applicant : LG Innotek Co., Ltd.
Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Manufacturer : LG Innotek Co., Ltd.
Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Type of Equipment : Telematics Modem
FCC ID. : YZP-VL3000
Model Name : LTD-VL3000
Serial number : N/A
Total page of Report : 52 pages (including this page)
Date of Incoming : April 20, 2021
Date of issue : May 18, 2021

SUMMARY

The equipment complies with the regulation; **Part 2, Part 27 Subpart C**

This test report only contains the result of a single test of the sample supplied for the examination.

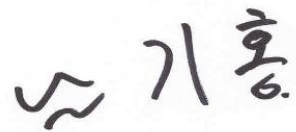
It is not a generally valid assessment of the features of the respective products of the mass-production.



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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-215-RWD-036	May 18, 2021	Class II Permissive Change	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Innotek Co., Ltd.
 Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
 Contact Person : Jeong Inchang / Senior Research Engineer
 Telephone No. : +82-62-950-0332
 FCC ID : YZP-VL3000
 Model Name : LTD-VL3000
 Serial Number : N/A
 Date : May 18, 2021

EQUIPMENT CLASS	PCB-PCS Licensed Transmitter
EQUIPMENT DESCRIPTION	Telematics Modem
THIS REPORT CONCERNS	Class II Permissive Change
MEASUREMENT PROCEDURES	ANSI C63.26:2015, KDB Publication 971168 D01
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC Part 2, Part 27 Subpart C
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
2.1049	Occupied Bandwidth	Met the Limit / PASS
2.1051, 27.53(c)(2), 27.53(f)	Band Edge / Spurious and Harmonic Emissions at Antenna Termianl	Met the Limit / PASS
2.1046	Conducted Output Power	Met the Limit / PASS
27.53(c)(2), KDB Publication 971168 D01	Peak-to-Average Ratio	Met the Limit / PASS
2.1055, 27.54	Frequency stability	Met the Limit / PASS
27.50(b)(10)	Effective Radiated Power	Met the Limit / PASS
2.1053, 27.53(c)(2), 27.53(f)	Radiated Spurious and Harmonic Emissions	Met the Limit / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

-. CLASS II Permissive Change:

The EUT was granted on November 09, 2017 but only following modifications and/or changed items are implemented into the device.

Changed item	Change duplexer of LTE band 2, 13 and CDMA BC1, because of component end of life.
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2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in Part 27 Subpart C.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.26:2015. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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OTC-TRF-RF-001(0)

3. GENERAL INFORMATION

3.1 Product Description

The LG Innotek Co., Ltd., Model LTD-VL3000 (referred to as the EUT in this report) is a Telematics Modem. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Telematics Modem			
OPERATING FREQUENCY	CDMA BC0	TX	824 MHz ~ 849 MHz	
		RX	869 MHz ~ 894 MHz	
	CDMA BC1	TX	1 850 MHz ~ 1 910 MHz	
		RX	1 930 MHz ~ 1 990 MHz	
	LTE Band 2	TX	1 850 MHz ~ 1 910 MHz	
		RX	1 930 MHz ~ 1 990 MHz	
	LTE Band 4	TX	1 710 MHz ~ 1 755 MHz	
		RX	2 110 MHz ~ 2 155 MHz	
	LTE Band 5	TX	824 MHz ~ 849 MHz	
		RX	869 MHz ~ 894 MHz	
	LTE Band 13	TX	777 MHz ~ 787 MHz	
		RX	746 MHz ~ 756 MHz	
	LTE Channel Bandwidth	LTE Band 2	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz	
		LTE Band 4	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz	
LTE Band 5		1.4 MHz, 3 MHz, 5 MHz, 10 MHz		
LTE Band 13		5 MHz, 10 MHz		
Modulation Type	QPSK, 16QAM			

Maximum Output Power	CDMA BC0	22.95 dBm
	CDMA BC1	24.11 dBm
	LTE Band 2	23.13 dBm
	LTE Band 4	23.11 dBm
	LTE Band 5	23.07 dBm
	LTE Band 13	22.77 dBm
Rated Power	CDMA BC0	24 dBm
	CDMA BC1	24 dBm
	LTE Band 2	23 dBm
	LTE Band 4	23 dBm
	LTE Band 5	23 dBm
	LTE Band 13	23 dBm
Antenna Type	Dipole Antenna	
Antenna Gain	CDMA BC0	4.5 dBi
	CDMA BC1	2.0 dBi
	LTE Band 2	2.0 dBi
	LTE Band 4	2.0 dBi
	LTE Band 5	4.5 dBi
	LTE Band 13	4.5 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	19.2 MHz	

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	N/A
Antenna	N/A	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
LTD-VL3000	LG Innotek Co., Ltd.	Telematics Modem	-
GP-4303D	LG Precision Co.,Ltd	DC Power Supply	EUT

5.3 Mode of operation during the test

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	EIRP	Radiated Emission
LTE Band 13	Y-plane	Y-axis

Test Mode : LTE Band 13

Test Item	Channel Bandwidth	Modulation	Mode	Test Channel
Conducted Output Power	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset	779.5 MHz 782.0 MHz 784.5 MHz
			1 RB / 12 RB Offset	
			1 RB / 24 RB Offset	
			12 RB / 0 RB Offset	
			12 RB / 7 RB Offset	
			12 RB / 13 RB Offset	
			25 RB / 0 RB Offset	
	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset	782.0 MHz
			1 RB / 25 RB Offset	
			1 RB / 49 RB Offset	
			25 RB / 0 RB Offset	
			25 RB / 12 RB Offset	
			25 RB / 25 RB Offset	
Effective Radiated Power	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset	779.5 MHz
			1 RB / 12 RB Offset	782.0 MHz
			1 RB / 12 RB Offset	784.5 MHz
	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset	782.0 MHz

Frequency stability	5 MHz	QPSK	25 RB / 0 RB Offset	782.0 MHz
Occupied Bandwidth	5 MHz	QPSK, 16QAM	25 RB / 0 RB Offset	779.5 MHz
				782.0 MHz
				784.5 MHz
	10 MHz	QPSK, 16QAM	50 RB / 0 RB Offset	782.0 MHz
Peak-to-Average Ratio	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 25 RB / 0 RB Offset	779.5 MHz
			1 RB / 12 RB Offset 25 RB / 0 RB Offset	782.0 MHz
			1 RB / 12 RB Offset 25 RB / 0 RB Offset	784.5 MHz
	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 50 RB / 0 RB Offset	782.0 MHz
Band Edge	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 25 RB / 0 RB Offset	779.5 MHz
			1 RB / 24 RB Offset 25 RB / 0 RB Offset	784.5 MHz
	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 50 RB / 0 RB Offset	782.0 MHz
			1 RB / 49 RB Offset 50 RB / 0 RB Offset	
Spurious and Harmonic Emissions at Antenna Terminal & Radiated Spurious and Harmonic Emissions	5 MHz	QPSK (Note 1)	1 RB / 0 RB Offset	779.5 MHz
			1 RB / 12 RB Offset	782.0 MHz
			1 RB / 12 RB Offset	784.5 MHz
	10 MHz	QPSK (Note 1)	1 RB / 0 RB Offset	782.0 MHz

Note 1 : Of all modulation, We have tested modulation of the high Conducted Output Power.

5.4 Frequency List of Low/Middle/High Channels

LTE Band 13 Channel and Frequency List				
Bandwidth	Channel / Frequency	Low	Middle	High
5 MHz	Channel	23205	23230	23255
	Frequency	779.5 MHz	782.0 MHz	784.5 MHz
10 MHz	Channel	-	23230	--
	Frequency	-	782.0 MHz	--

5.5 Configuration of Test System

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.26: 2015 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

6. PRELIMINARY TEST

6.1 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

7. CONDUCTED OUTPUT POWER

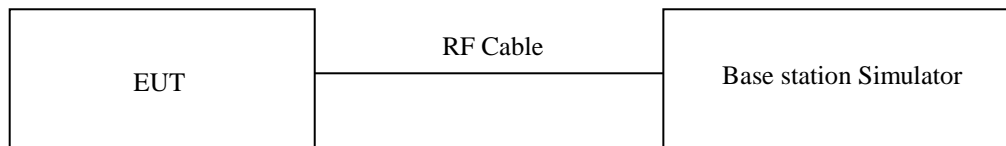
7.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

7.2 Test set-up

Conducted Output Power is tested in accordance with KDB971168 D01 Power Meas License Digital Systems v04, April 9, 2018, Section 5.2.

A base station simulator was used to establish communication with the EUT, and Spectrum analyzer was used for test results. This device was tested under all configurations and the highest power is reported. Conducted Output Powers of EUT are reported below.



7.3 Test Date

April 20, 2021 ~ April 30, 2021

7.4 Test data for Band 13_Bandwidth 5 MHz

-. Test Result : Pass

Conducted Average Output Power (dBm)

RB Size	RB Offset	QPSK			16QAM		
		LOW	MIDDLE	HIGH	LOW	MIDDLE	HIGH
		779.5 MHz	782.0 MHz	784.5 MHz	779.5 MHz	782.0 MHz	784.5 MHz
1	0	22.71	22.67	22.69	21.82	21.61	21.92
1	12	22.63	22.67	22.70	21.56	21.74	21.99
1	24	22.66	22.45	22.67	21.44	21.61	21.60
12	0	21.85	21.67	21.76	20.75	20.61	20.76
12	7	21.80	21.72	21.65	20.83	20.75	20.74
12	13	21.64	21.72	21.51	20.67	20.72	20.40
25	0	21.71	21.68	21.63	20.72	20.69	20.84

7.5 Test data for Band 13_Bandwidth 10 MHz

-. Test Result : Pass

Conducted Average Output Power (dBm)

RB Size	RB Offset	QPSK			16QAM		
		LOW	MIDDLE	HIGH	LOW	MIDDLE	HIGH
			782.0 MHz			782.0 MHz	
1	0		22.77			21.98	
1	25		22.72			22.01	
1	49		22.62			21.69	
25	0		21.63			21.05	
25	12		21.63			21.03	
25	25		21.67			21.03	
50	0		21.65			20.95	

8. EFFECTIVE RADIATED POWER

8.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

8.2 Methods of Measurement

1. The testing follows ANSI C63.26 (2015) Section 5.5.3.
2. 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.
3. 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 2. Record the power level of S.G.
4. EIRP = Output power level of S.G – TX cable loss + Antenna gain of substitution antenna power can be Calculated. E.R.P power = E.I.P.R power - 2.15 dBi.

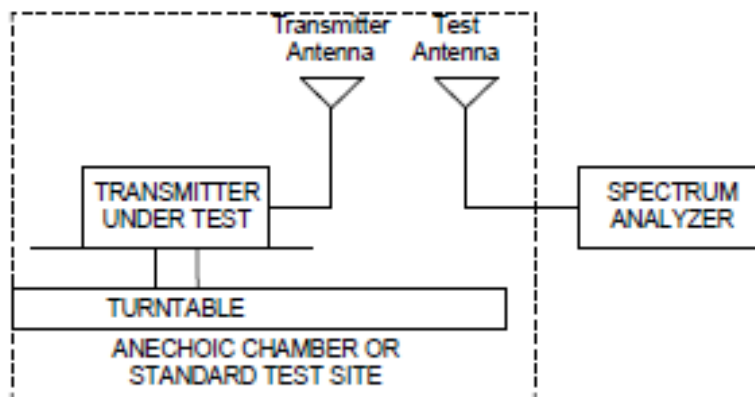
8.3 Limits

Rule Part 27.50(b) (10) specifies that “Portable stations (hand-held devices) transmitting in the 746–757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP”

Limit	3 W (34.77 dBm)
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8.4 Test set-up

The EUT and measurement equipment were set up as shown in the diagram below.



8.5 Test Date

April 20, 2021 ~ April 30, 2021

8.6 Test data for Band 13_Bandwidth 5 MHz

-. Test Result : Pass

Frequency (MHz)	Substituted Level (dBm)	Ant. Pol. (H/V)	Cable Loss (dB)	Ant Gain (dBi)	EIRP (dBm)	Limits (dBm)	Margin (dB)
Test Data for QPSK							
779.5	16.38	H	0.70	7.30	22.98	34.77	11.79
779.5	16.75	V	0.70	7.30	23.35	34.77	11.42
782.0	16.16	H	0.70	7.30	22.76	34.77	12.01
782.0	16.64	V	0.70	7.30	23.24	34.77	11.53
784.5	16.10	H	0.70	7.40	22.80	34.77	11.97
784.5	16.37	V	0.70	7.40	23.07	34.77	11.70
Test Data for 16QAM							
779.5	15.27	H	0.70	7.30	21.87	34.77	12.90
779.5	15.83	V	0.70	7.30	22.43	34.77	12.34
782.0	14.96	H	0.70	7.30	21.56	34.77	13.21
782.0	15.44	V	0.70	7.30	22.04	34.77	12.73
784.5	14.99	H	0.70	7.40	21.69	34.77	13.08
784.5	15.41	V	0.70	7.40	22.11	34.77	12.66

Remark: "H": Horizontal, "V": Vertical

8.7 Test data for Band 13_Bandwidth 10 MHz

-. Test Result : Pass

Frequency (MHz)	Substituted Level (dBm)	Ant. Pol. (H/V)	Cable Loss (dB)	Ant Gain (dBi)	EIRP (dBm)	Limits (dBm)	Margin (dB)
Test Data for QPSK							
782.0	16.41	H	0.70	7.30	23.01	34.77	11.76
782.0	17.18	V	0.70	7.30	23.78	34.77	10.99
Test Data for 16QAM							
782.0	15.54	H	0.70	7.30	22.14	34.77	12.63
782.0	16.32	V	0.70	7.30	22.92	34.77	11.85

Remark: "H": Horizontal, "V": Vertical

9. RADIATED SPURIOUS EMISSIONS

9.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

9.2 Test set-up

Radiated emission measurements are performed in the Semi-Anechoic chamber. The equipment under test is placed on a non-conductive table 3-meters away from the receive antenna in accordance with ANSI C63.26 (2015) Section 5.5.3. The turntable is rotated through 360°, and the receiving antenna scans in order to determine the level of the maximized emission. The level and position of the maximized emission is recorded with the spectrum analyzer using RMS detector.

A vertically polarized half-wave dipole is then substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator and the previously recorded signal was duplicated.

The power is calculated by the following formula;

$$Pd(\text{dBm}) = Pg(\text{dBm}) - \text{cable loss (dB)} + \text{antenna gain (dB)}$$

Where: Pd is the dipole equivalent power and Pg is the generator output power into the substitution antenna.

The maximum EIRP is calculated by adding the forward power to the calibrated source plus its appropriate gain value. These steps are repeated with the receiving antenna in both vertical and horizontal polarization. the difference between the gain of the horn and an isotropic antenna are taken into consideration

Limits

LTE -13 Rule Part 27.53(c)(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.

Part 27.53(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

LTE Band 13 Limit

Limit out of the band 1559-1610 MHz	-13 dBm
Limit in the band 1559-1610 MHz	-40 dBm

Radiated spurious emissions

1. Frequency Range : 9 kHz ~ 10th Harmonics of highest channel fundamental frequency.
2. The EUT was setup to maximum output power. The 100 kHz RBW was used to scan from 30 MHz to 1 GHz.
Also, the 1 MHz RBW was used to scan from 1 GHz to 20 GHz. The high, low and a middle channel were tested for out of band measurements.

9.3 Test Date

April 20, 2021 ~ April 30, 2021

9.4 Test data for Band 13_Bandwidth 5 MHz

-. Detector : RMS

-. Measurement distance : 3 m

-. Result : PASSED

Frequency (MHz)	Substituted Level (dBm)	Ant. Pol. (H/V)	Cable Loss (dB)	Ant Gain (dBi)	Corrected Reading (dBm)	Limits (dBm)	Margin (dB)
Test Data for Low Channel							
1 559.00	-79.53	V	1.40	8.70	-72.23	-40.00	32.23
2 338.50	-77.51	H	1.70	9.80	-69.41	-13.00	56.41
3 118.00	-76.96	H	1.90	11.20	-67.66	-13.00	54.66
3 897.50	-76.72	H	2.10	12.40	-66.42	-13.00	53.42
4 677.00	-74.94	V	2.30	12.60	-64.64	-13.00	51.64
Test Data for Middle Channel							
1 564.00	-79.56	V	1.40	8.70	-72.26	-40.00	32.26
2 346.00	-77.22	H	1.70	9.80	-69.12	-13.00	56.12
3 128.00	-77.03	H	1.90	11.20	-67.73	-13.00	54.73
3 910.00	-76.77	V	2.10	12.40	-66.47	-13.00	53.47
4 692.00	-74.96	V	2.30	12.60	-64.66	-13.00	51.66
Test Data for High Channel							
1 569.00	-79.47	V	1.40	8.70	-72.17	-40.00	32.17
2 353.50	-77.83	H	1.70	9.80	-69.73	-13.00	56.73
3 138.00	-76.88	H	1.90	11.10	-67.68	-13.00	54.68
3 922.50	-77.11	V	2.10	12.40	-66.81	-13.00	53.81
4 707.00	-74.95	V	2.30	12.60	-64.65	-13.00	51.65

Remark: 1. The other Spurious RF Radiated emissions level is no more than noise floor.

2. The worst case was found in QPSK modulation

3. Rule Part 27.53(c)(2) specifies that “ 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) in watts

by at least $43 + 10 \log_{10}(P)$ dB.”

Limit : $34.77 - [43 + 10 \log_{10}(3.00)] = -13$ dBm

“H”: Horizontal, “V”: Vertical

9.5 Test data for Band 13_Bandwidth 10 MHz

- . Detector : RMS
- . Measurement distance : 3 m
- . Result : PASSED

Frequency (MHz)	Substituted Level (dBm)	Ant. Pol. (H/V)	Cable Loss (dB)	Ant Gain (dBi)	Corrected Reading (dBm)	Limits (dBm)	Margin (dB)
Test Data for Low Channel							
1 564.00	-79.56	V	1.40	8.70	-72.26	-40.00	32.26
2 346.00	-77.64	H	1.70	9.80	-69.54	-13.00	56.54
3 128.00	-76.98	H	1.90	11.20	-67.68	-13.00	54.68
3 910.00	-77.11	H	2.10	12.40	-66.81	-13.00	53.81
4 692.00	-74.98	V	2.30	12.60	-64.68	-13.00	51.68

Remark: 1. The other Spurious RF Radiated emissions level is no more than noise floor.
 2. The worst case was found in QPSK modulation
 3. Rule Part 27.53(c)(2) specifies that “ 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) in watts by at least $43 + 10 \log_{10}(P)$ dB.”
 Limit : $34.77 - [43 + 10 \log(3.00)] = -13$ dBm
 “H”: Horizontal, “V”: Vertical

10. PEAK-TO-AVERAGE RATIO

10.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

10.2 Test set-up

Peak to Average Power Ratio is tested in accordance with KDB971168 D01 Power Meas License Digital Systems v04, April 9, 2018, Section 5.7.

- Section 5.7.2 Measurement of peak power in a broadband noise-like signal using CCDF

- a) Set resolution/measurement bandwidth \geq OBW or specified reference bandwidth.
- b) Set the number of counts to a value that stabilizes the measured CCDF curve.
- c) Set the measurement interval as follows:
 - 1) For continuous transmissions, set to the greater of $[10 \times (\text{number of points in sweep}) \times (\text{transmission symbol period})]$ or 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. Set the measurement interval to a time that is less than or equal to the burst duration.
 - 3) If there are several carriers in a single antenna port, the peak power shall be determined for each individual carrier (by disabling the other carriers while measuring the required carrier) and the total peak power calculated from the sum of the individual carrier peak powers.
- d) Record the maximum PAPR level associated with a probability of 0.1%.
- e) The peak power level is calculated from the sum of the PAPR value from step d) to the measured average power.

- Section 5.7.3 Alternate Procedure for PAPR

Some regulatory requirements specify a PAPR limit when the output power limits are specified in terms of average power. If it becomes necessary to provide measurement data to demonstrate compliance to a PAPR limit, then the appropriate procedure from those provided in 5.2.3 shall be utilized to determine the peak power (or peak PSD) and the appropriate procedure from those provided in 5.2.4 shall be used to determine the average power (or average PSD). The data from these measurements is then used in Equation (2) to determine the PAPR of a narrowband CW-like signal. See 5.2.3.4 for guidance on determining the PAPR of a broadband noise-like signal.

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

where

PAPR peak-to-average power ratio, in dB

P_{Pk} measured peak power or peak PSD level, in dBm or dBW

P_{Avg} measured average power or average PSD level, in dBm or dBW

10.3 Test Date

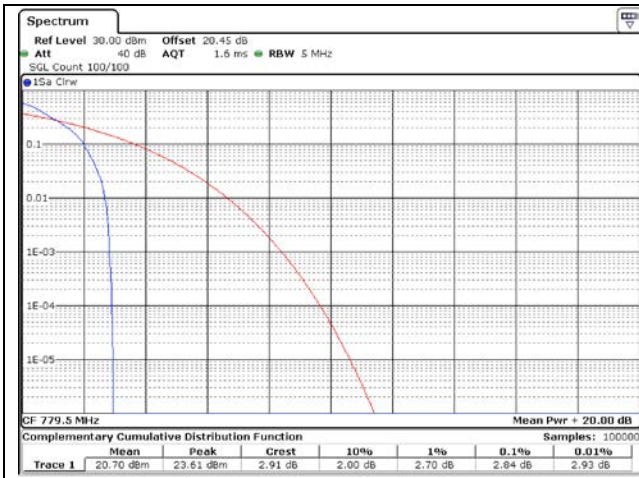
April 20, 2021 ~ April 30, 2021

10.4 Test data for Band 13_Bandwidth 5 MHz

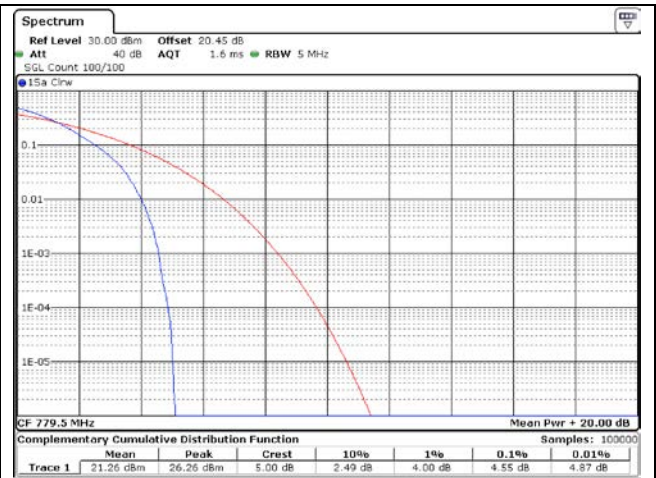
-. Test Result : Pass

Test Mode	Channel	Peak-Average Ratio(PAR) CCDF 0.1 %	Limit (dB)	Result
LTE Band 13 QPSK				
1 RB	23205	2.84	13.00	Pass
	23230	3.83	13.00	Pass
	23255	4.64	13.00	Pass
Full RB	23205	4.55	13.00	Pass
	23230	4.78	13.00	Pass
	23255	5.07	13.00	Pass
LTE Band 13 16QAM				
1 RB	23205	3.91	13.00	Pass
	23230	4.55	13.00	Pass
	23255	5.57	13.00	Pass
Full RB	23205	5.74	13.00	Pass
	23230	5.80	13.00	Pass
	23255	6.06	13.00	Pass

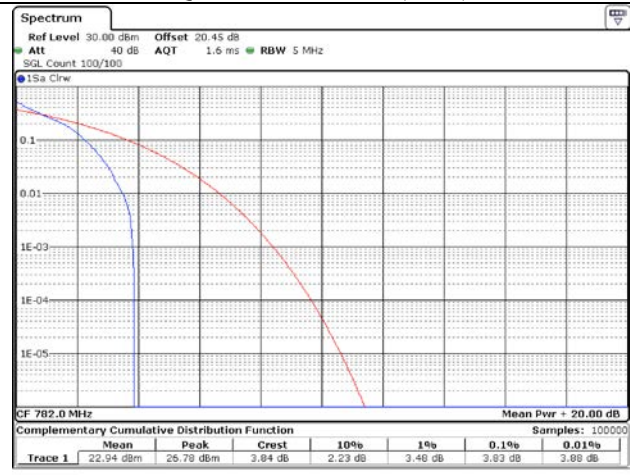
Remark: Measured the using CCDFof spectrum analyzer.



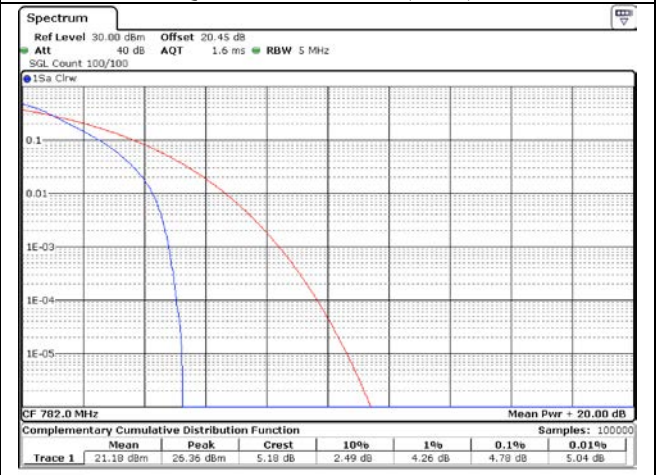
QPSK Low Channel (1 RB)



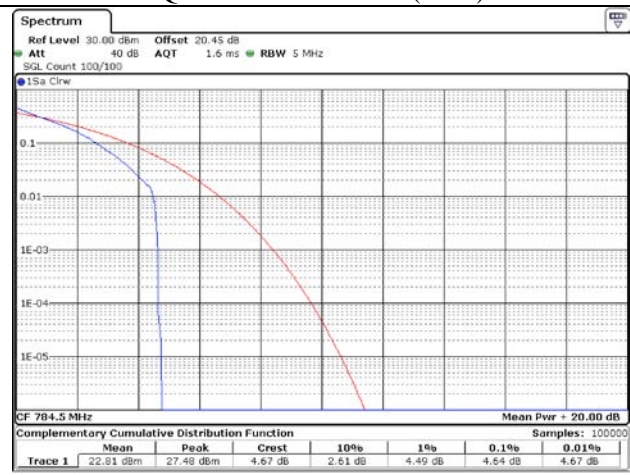
QPSK Low Channel (6 RB)



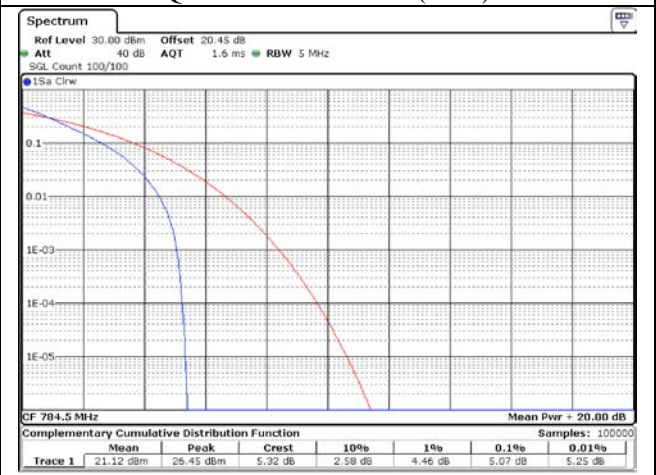
QPSK Middle Channel (1 RB)



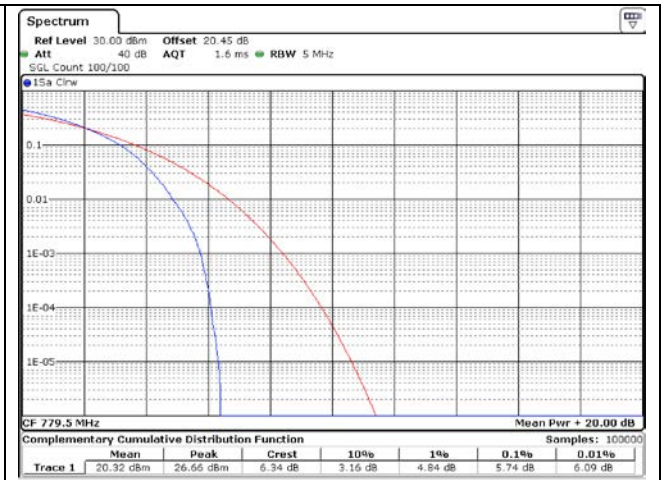
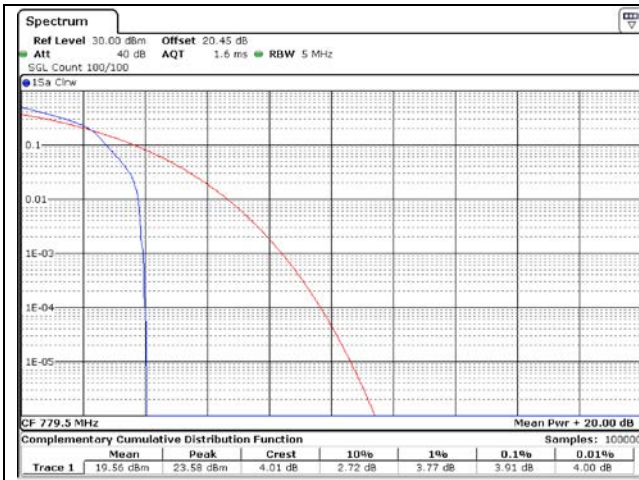
QPSK Middle Channel (6 RB)



QPSK High Channel (1 RB)

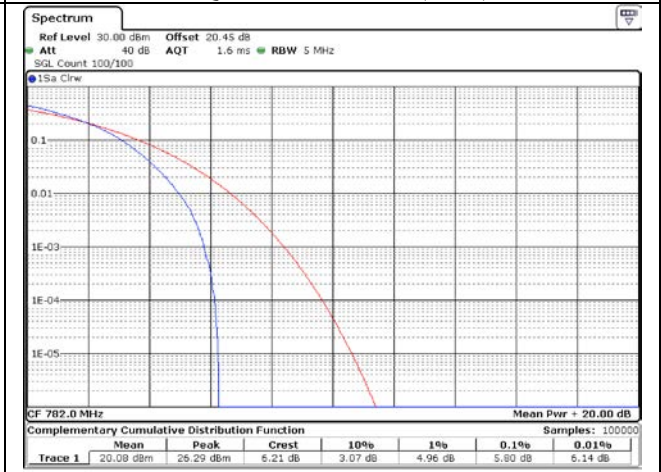
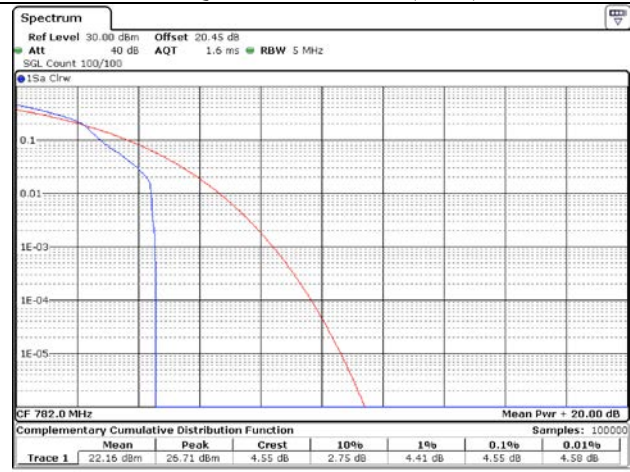


QPSK High Channel (6 RB)



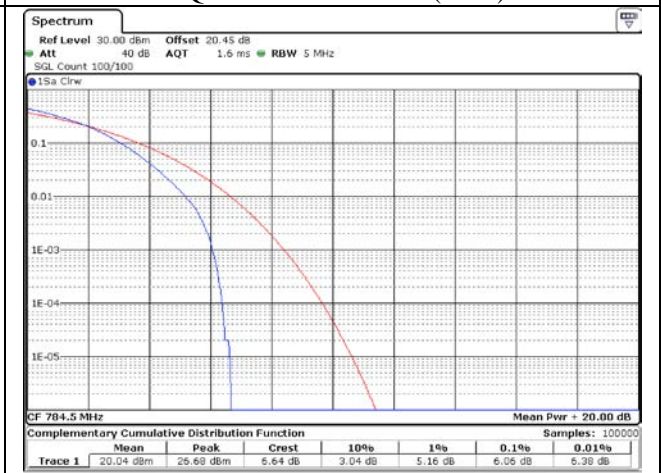
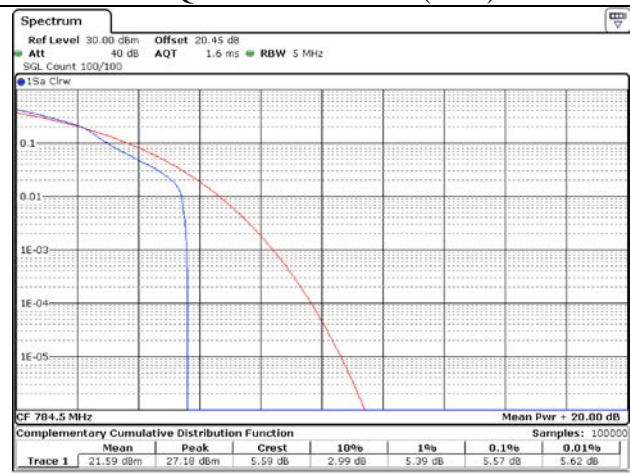
16QAM Low Channel (1 RB)

16QAM Low Channel (6 RB)



16QAM Middle Channel (1 RB)

16QAM Middle Channel (6 RB)



16QAM High Channel (1 RB)

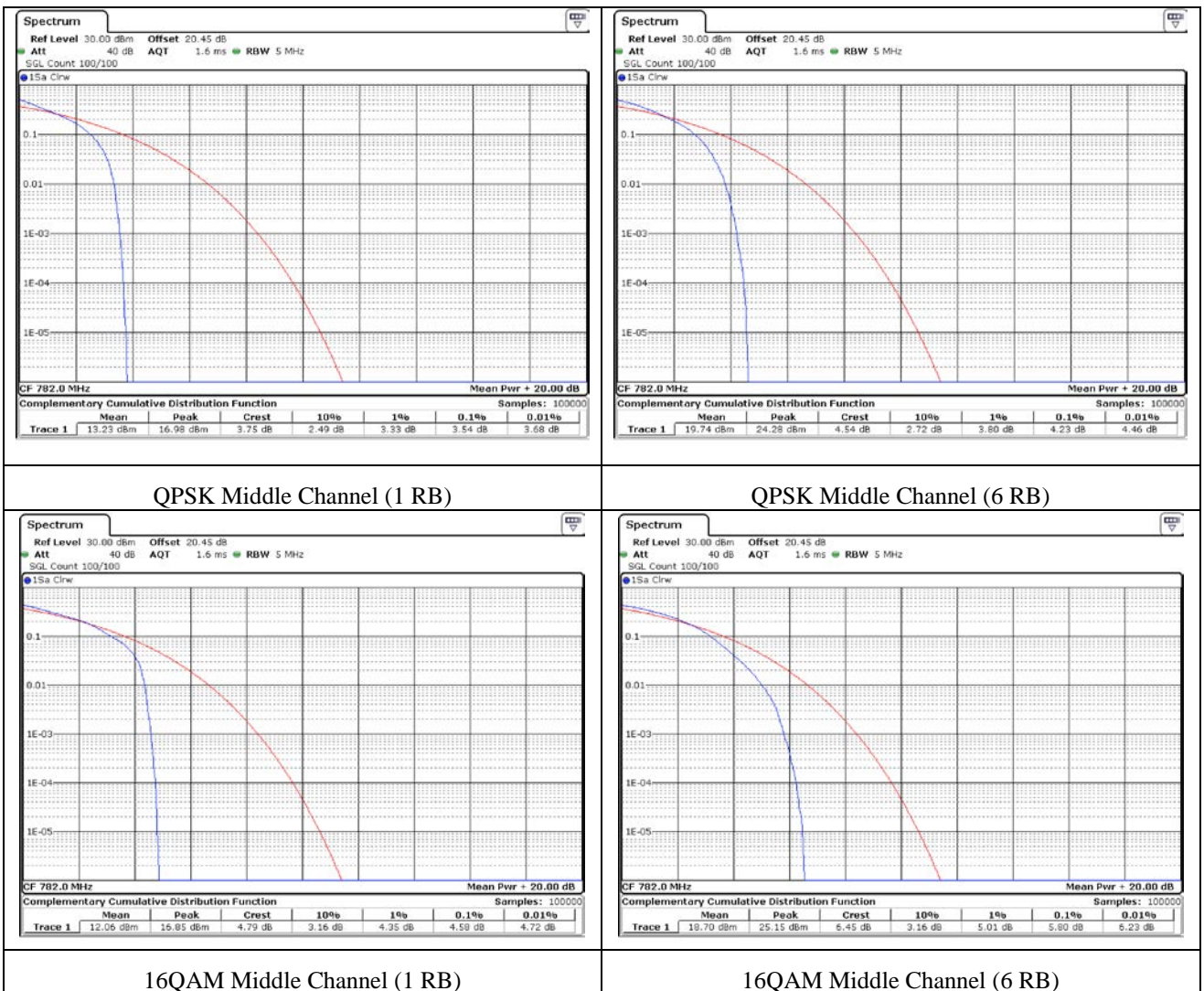
16QAM High Channel (6 RB)

10.5 Test data for Band 13_Bandwidth 10 MHz

-. Test Result : Pass

Test Mode	Channel	Peak-Average Ratio(PAR) CCDF 0.1 %	Limit (dB)	Result
LTE Band 13 QPSK				
1 RB	23230	3.54	13.00	Pass
Full RB	23230	4.23	13.00	Pass
LTE Band 13 16QAM				
1 RB	23230	4.58	13.00	Pass
Full RB	23230	5.80	13.00	Pass

Remark: Measured the using CCDFof spectrum analyzer.



11. OCCUPIED BANDWIDTH

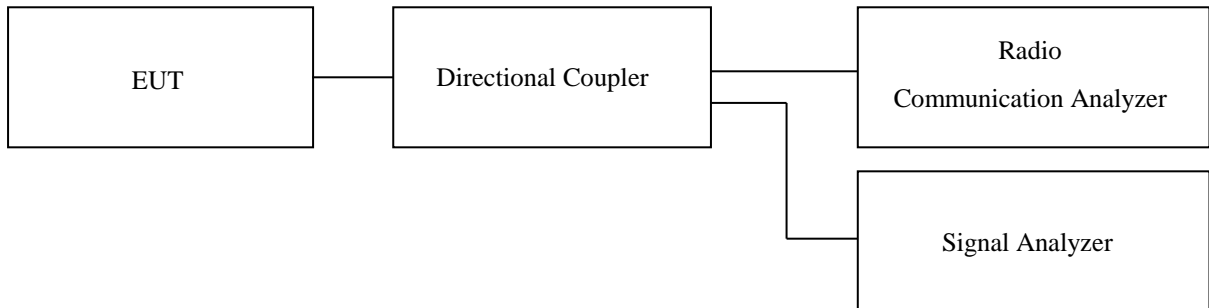
11.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

11.2 Test set-up

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth. When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3×RBW.



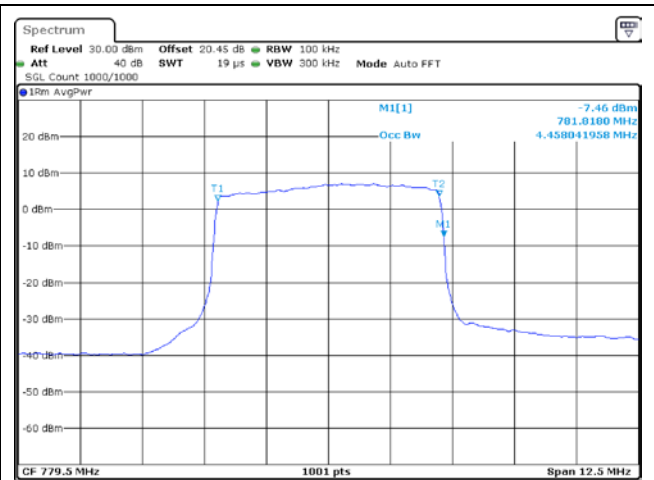
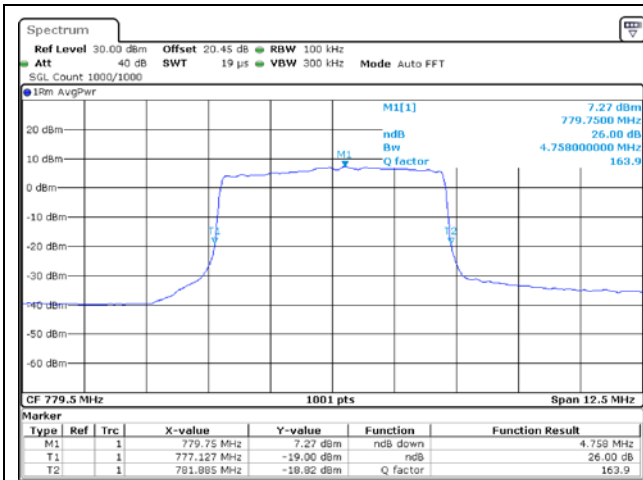
11.3 Test Date

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11.4 Test data for Band 13_Bandwidth 5 MHz

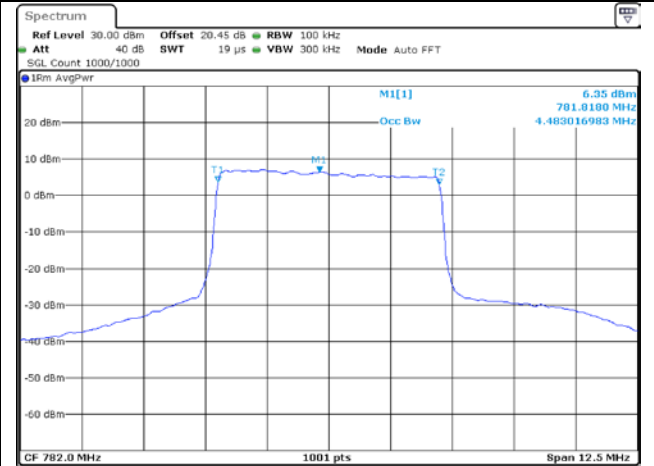
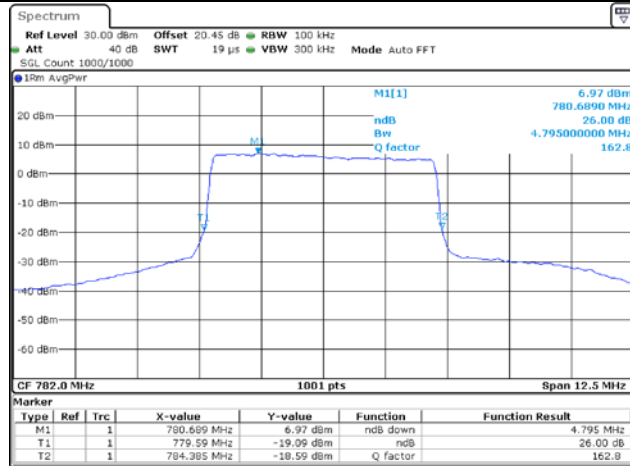
-. Test Result : Pass

Test Mode	Channel	26 dB Bandwidth (MHz)	99 % Occupied Bandwidth (MHz)	Result
QPSK	23205	4.76	4.46	PASS
	23230	4.80	4.48	PASS
	23255	4.83	4.50	PASS
16QAM	23205	4.76	4.46	PASS
	23230	4.78	4.48	PASS
	23255	4.82	4.50	PASS



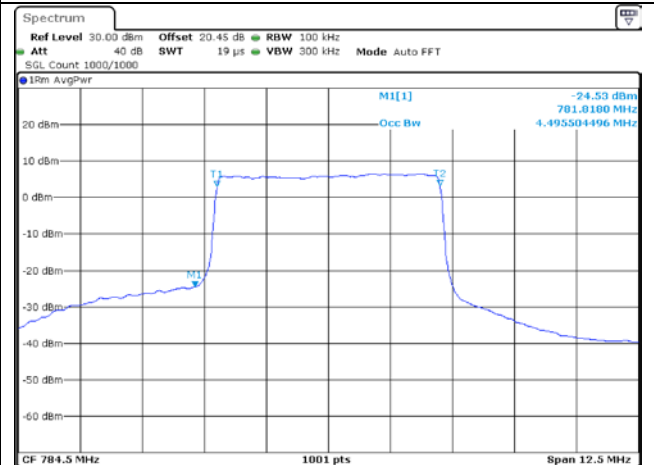
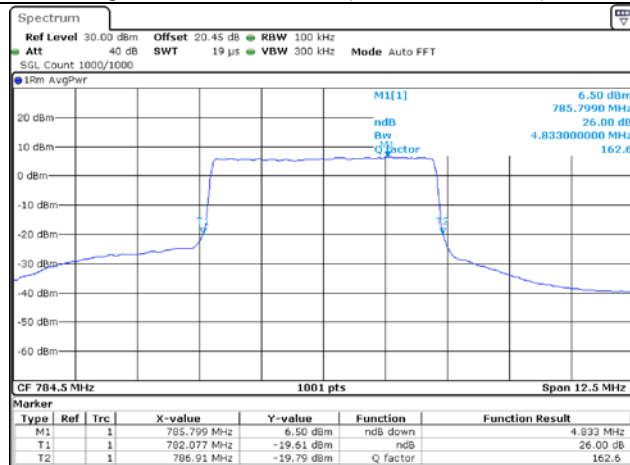
QPSK Low Channel (26 dB Bandwidth)

QPSK Low Channel (99 % Occupied Bandwidth)



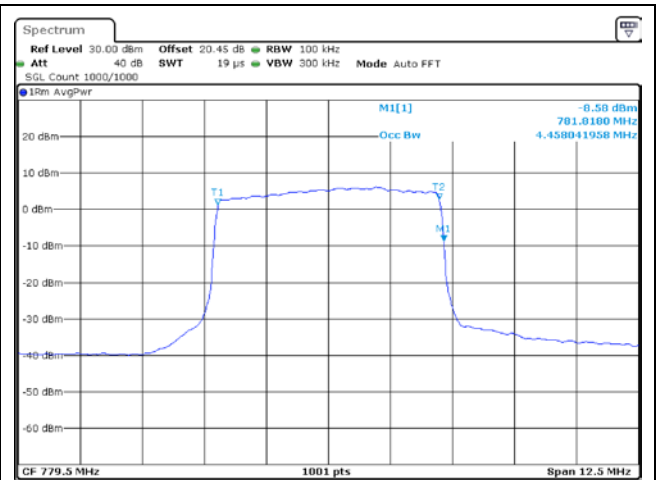
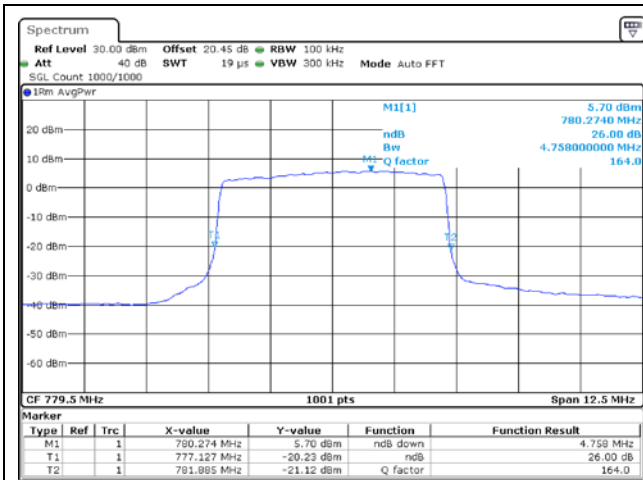
QPSK Middle Channel (26 dB Bandwidth)

QPSK Middle Channel (99 % Occupied Bandwidth)



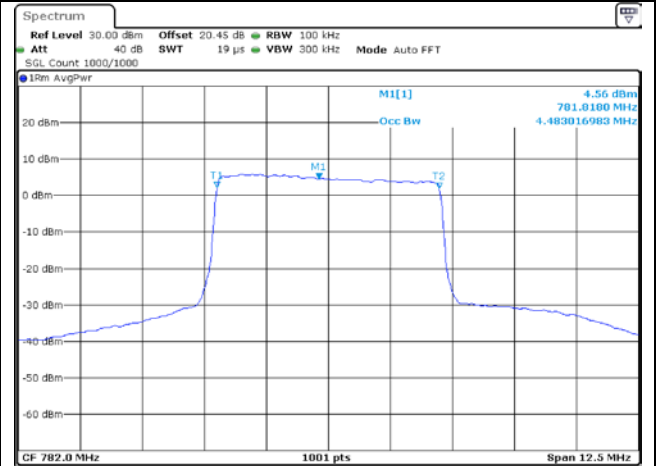
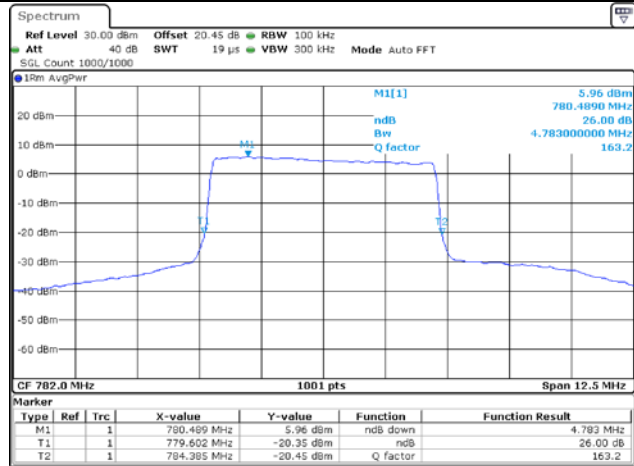
QPSK High Channel (26 dB Bandwidth)

QPSK High Channel (99 % Occupied Bandwidth)



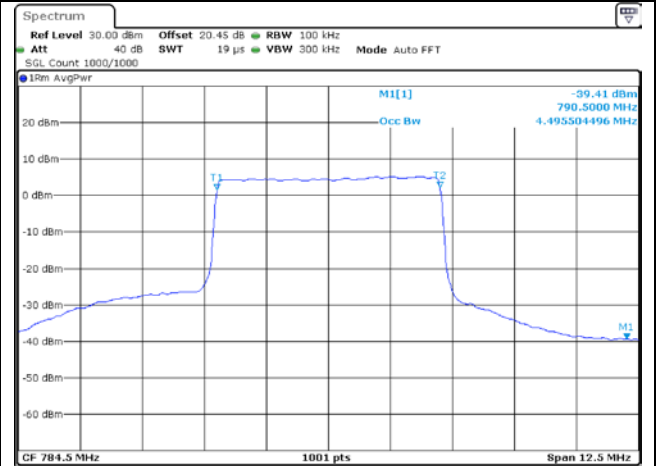
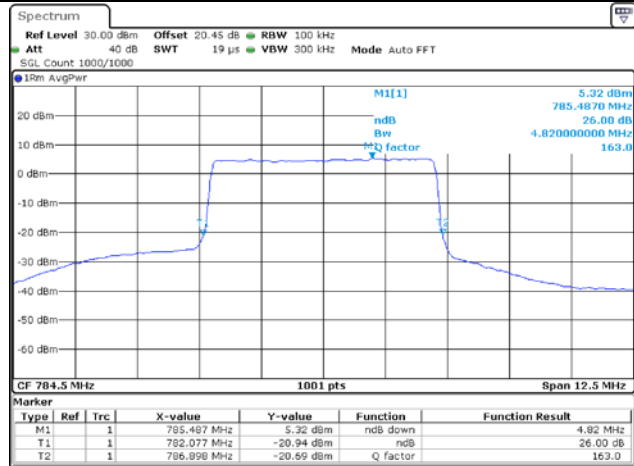
16QAM Low Channel (26 dB Bandwidth)

16QAM Low Channel (99 % Occupied Bandwidth)



16QAM Middle Channel (26 dB Bandwidth)

16QAM Middle Channel (99 % Occupied Bandwidth)



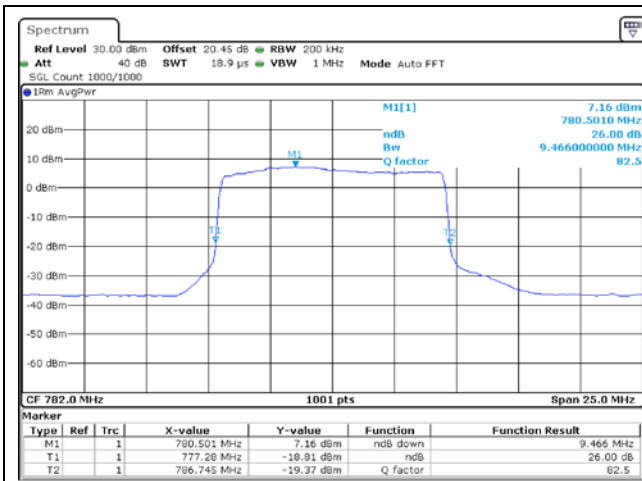
16QAM High Channel (26 dB Bandwidth)

16QAM High Channel (99 % Occupied Bandwidth)

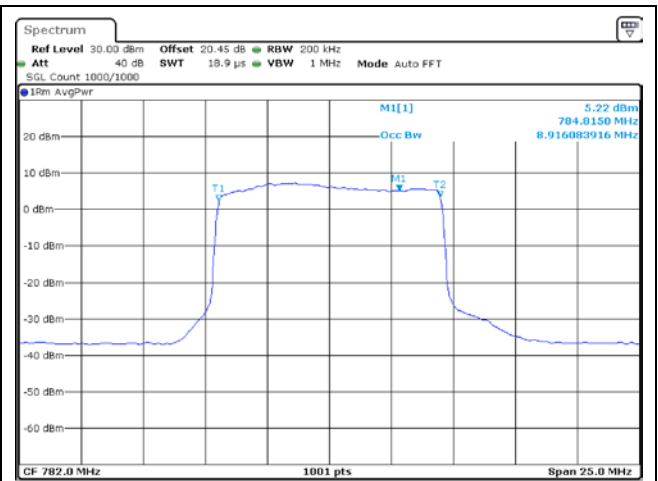
11.5 Test data for Band 13_Bandwidth 10 MHz

-. Test Result : Pass

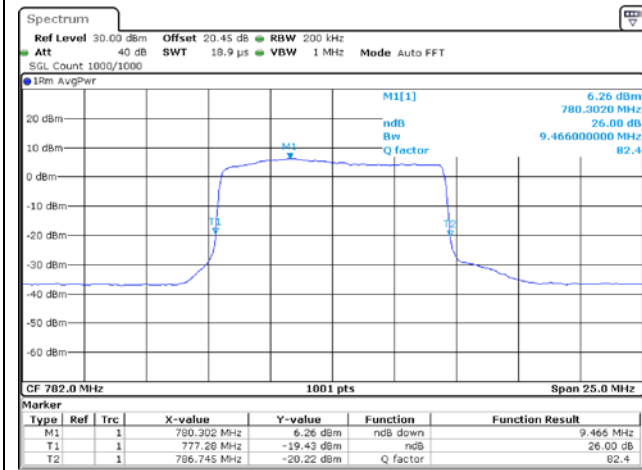
Test Mode	Channel	26 dB Bandwidth (MHz)	99 % Occupied Bandwidth (MHz)	Result
QPSK	23230	9.47	8.92	PASS
16QAM	23230	9.47	8.92	PASS



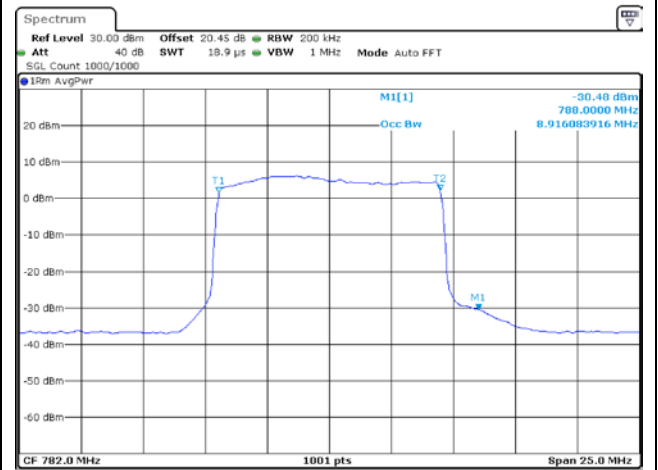
QPSK Middle Channel (26 dB Bandwidth)



QPSK Middle Channel (99 % Occupied Bandwidth)



16QAM Middle Channel (26 dB Bandwidth)



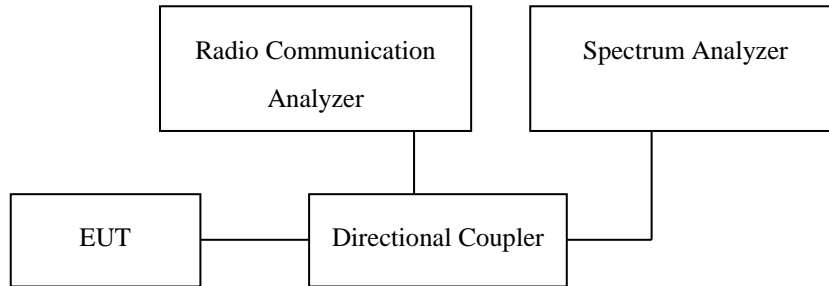
16QAM Middle Channel (99 % Occupied Bandwidth)

12. Conducted Band Edge

12.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

12.2 Test set-up



(Configuration of conducted Emission measurement)

Conducted Spurious Emissions is tested in accordance with KDB971168 D01 Power Meas License Digital Systems v04, April 9, 2018, Section 6.

The EUT makes a call to the communication simulator. The power was measured with R&S Spectrum Analyzer. All measurements were done at 3 channels(low, middle and high operational range.)

The Conducted Spurious Emissions used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

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

12.3 Methods of Measurement

1. All measurements were done at low and high operational frequency range.
2. Set spectrum analyzer with RMS detector.
3. The center frequency of spectrum is the band edge frequency and set RBW of the spectrum is 1 % of the 26 dB bandwidth and VBW of the spectrum is 3 times of RBW.

12.4 Limits

LTE -13 Rule Part 27.53(c)(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.

Part 27.53(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

LTE Band 13 Limit

Limit out of the band 1559-1610 MHz	-13 dBm
Limit in the band 1559-1610 MHz	-40 dBm

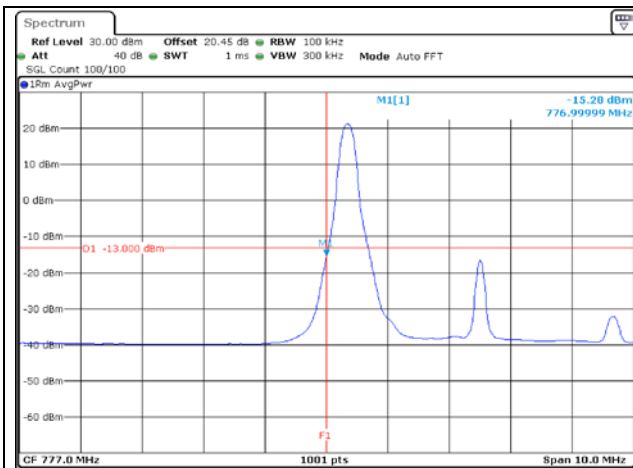
12.5 Test Date

April 20, 2021 ~ April 30, 2021

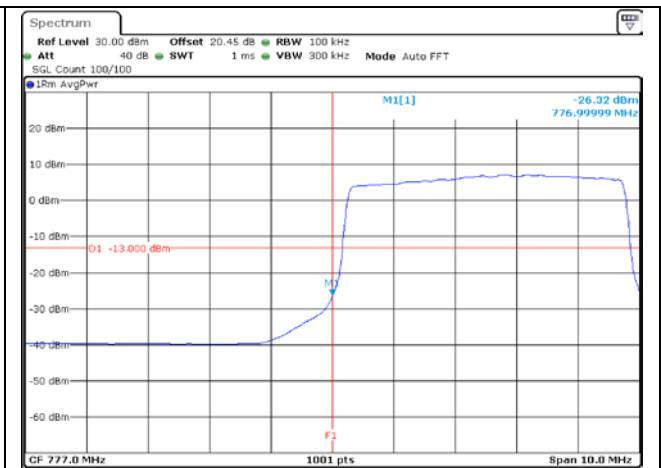
12.6 Test data for Band 13_Bandwidth 5 MHz

-. Test Result : Pass

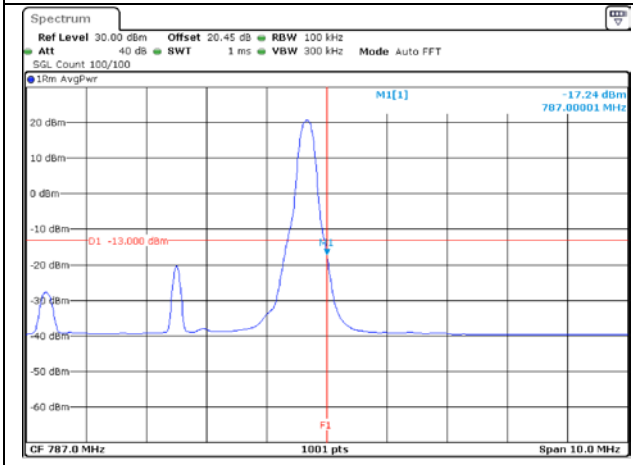
Test Mode	Channel	Edge Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Result
LTE Band 13 QPSK					
1 RB	Low	777	-15.28	-13.00	PASS
	High	787	-17.24	-13.00	PASS
Full RB	Low	777	-26.32	-13.00	PASS
	High	787	-24.77	-13.00	PASS
LTE Band 13 16QAM					
1 RB	Low	777	-16.8	-13.00	PASS
	High	787	-18.79	-13.00	PASS
Full RB	Low	777	-27.88	-13.00	PASS
	High	787	-25.48	-13.00	PASS



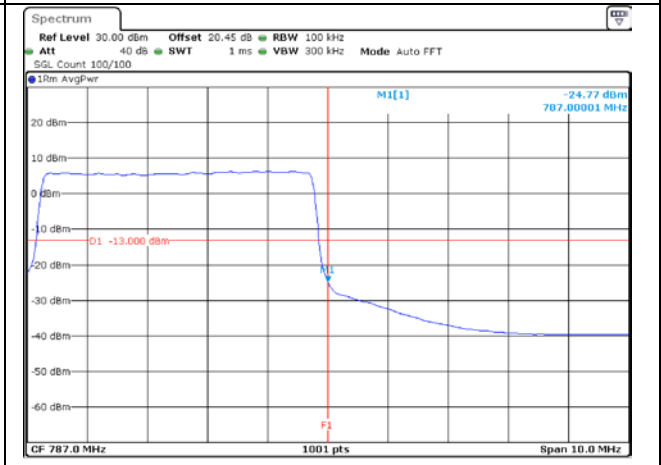
QPSK Low Channel (1 RB)



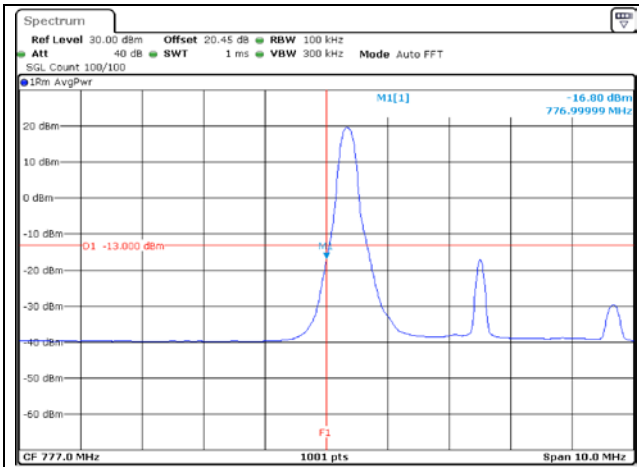
QPSK Low Channel (Full RB)



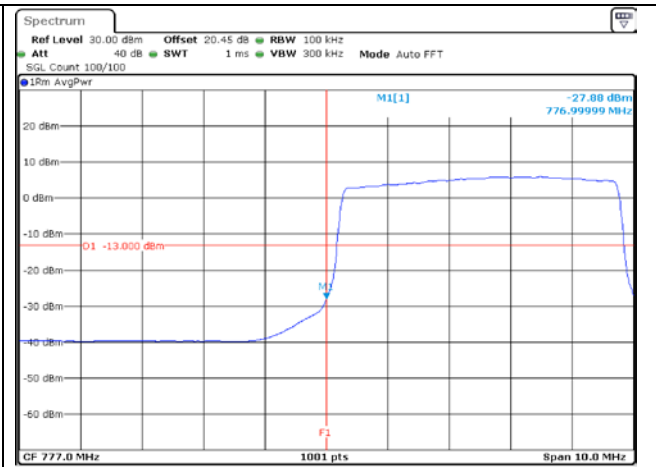
QPSK High Channel (1 RB)



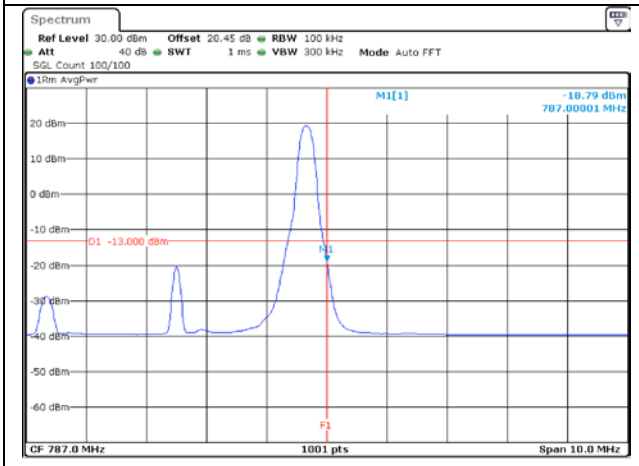
QPSK High Channel (Full RB)



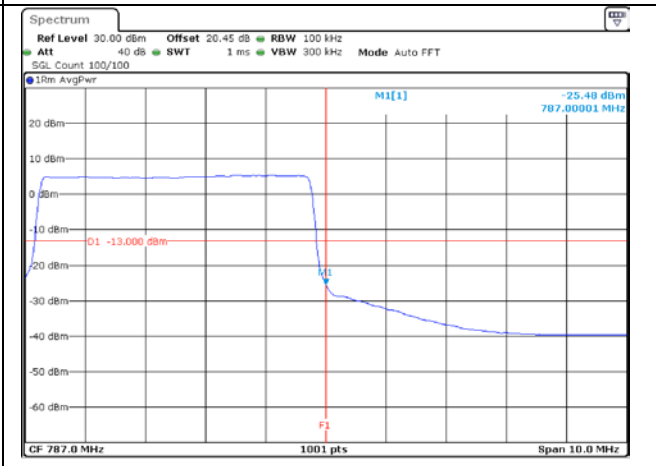
16QAM Low Channel (1 RB)



16QAM Low Channel (Full RB)



16QAM High Channel (1 RB)

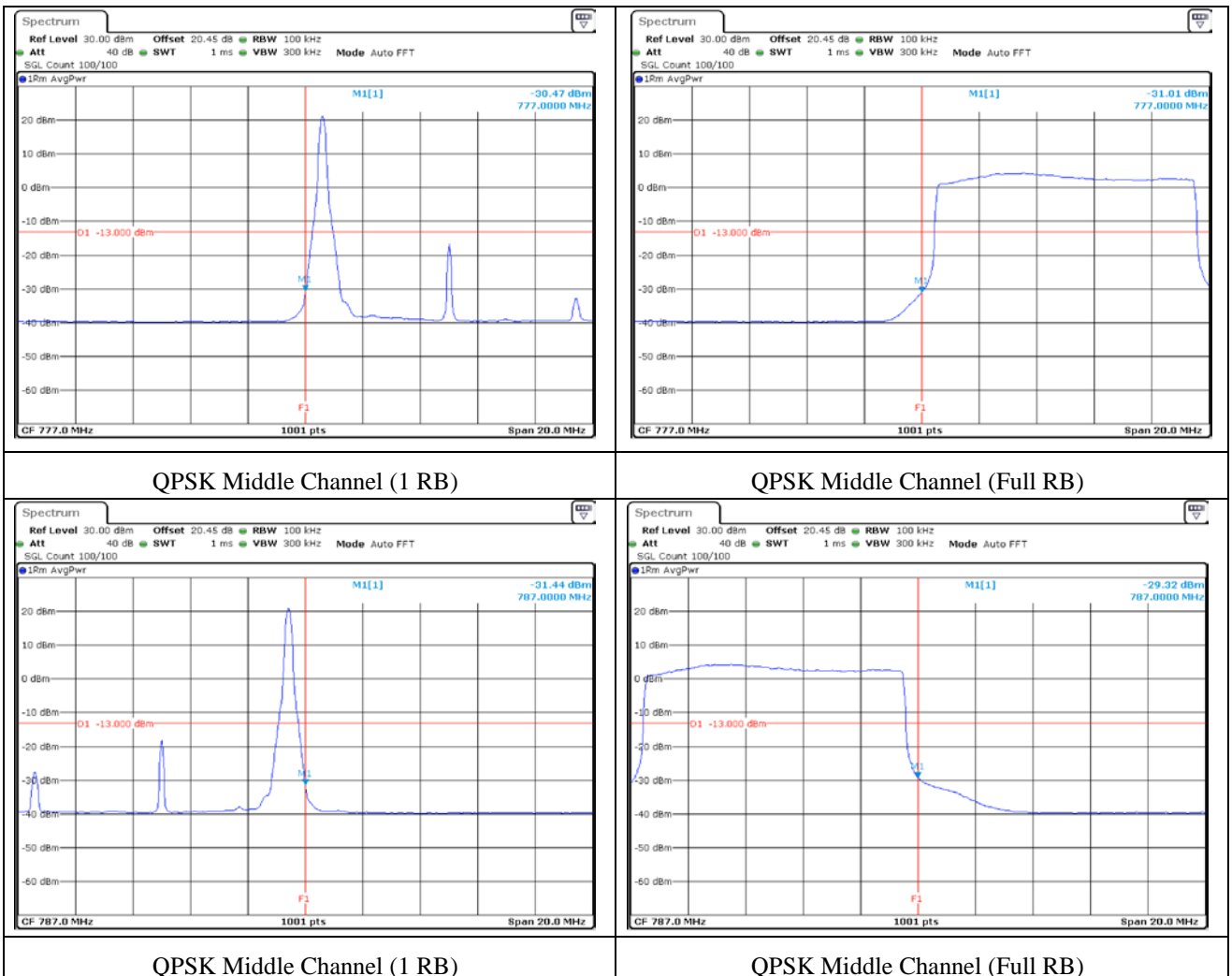


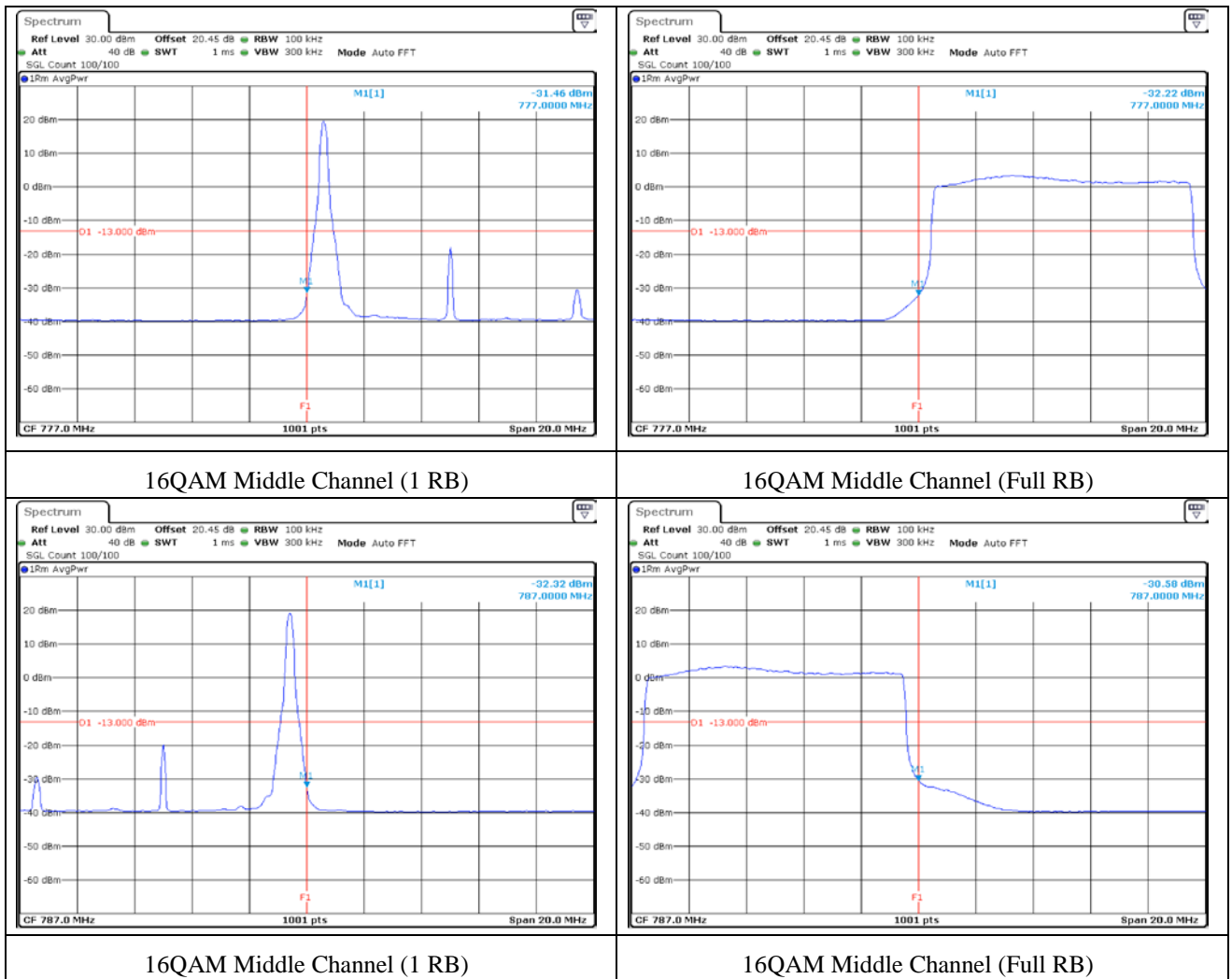
16QAM High Channel (Full RB)

12.7 Test data for Band 13_Bandwidth 10 MHz

-. Test Result : Pass

Test Mode	Channel	Edge Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Result
LTE Band 13 QPSK					
1 RB	Middle	777	-30.47	-13.00	PASS
	Middle	787	-31.44	-13.00	PASS
Full RB	Middle	777	-31.01	-13.00	PASS
	Middle	787	-29.32	-13.00	PASS
LTE Band 13 16QAM					
1 RB	Middle	777	-31.46	-13.00	PASS
	Middle	787	-32.32	-13.00	PASS
Full RB	Middle	777	-32.22	-13.00	PASS
	Middle	787	-30.58	-13.00	PASS



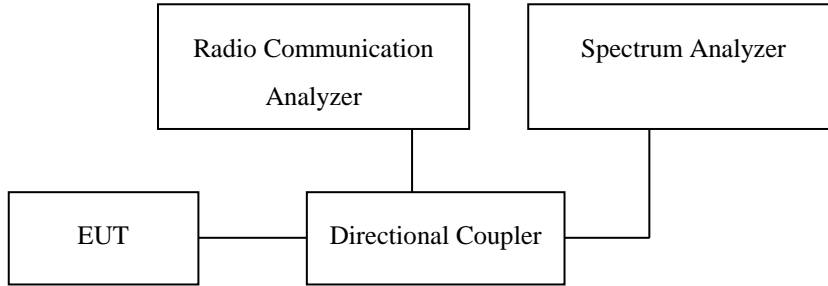


13. Conducted Spurious and Harmonic Emissions at Antenna Termianl

13.1 Operating environment

Temperature : 23 °C
 Relative humidity : 47 % R.H.

13.2 Test set-up



(Configuration of conducted Emission measurement)

Conducted Spurious Emissions is tested in accordance with KDB971168 D01 Power Meas License Digital Systems v04, April 9, 2018, Section 6.

The EUT makes a call to the communication simulator. The power was measured with R&S Spectrum Analyzer. All measurements were done at 3 channels(low, middle and high operational range.)

The Conducted Spurious Emissions used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

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

Conduced spurious emissions

The EUT was setup to maximum output power. The 100 kHz RBW and 300 kHz VBW was used to scan from 30 MHz to 1 GHz. Also, the 1 MHz RBW and 3 MHz VBW was used to scan from 1 GHz to 20 GHz. The high, low and a middle channel were tested for out of band measurements.

13.3 Limits

LTE -13 Rule Part 27.53(c)(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.

Part 27.53(f)For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

LTE Band 13 Limit

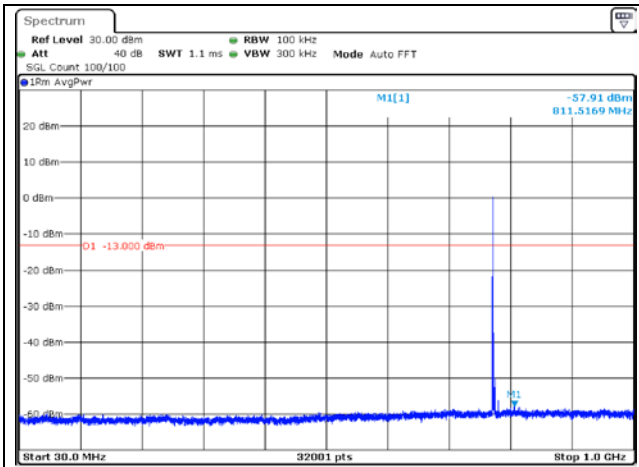
Limit out of the band 1559-1610 MHz	-13 dBm
Limit in the band 1559-1610 MHz	-40 dBm

13.4 Test Date

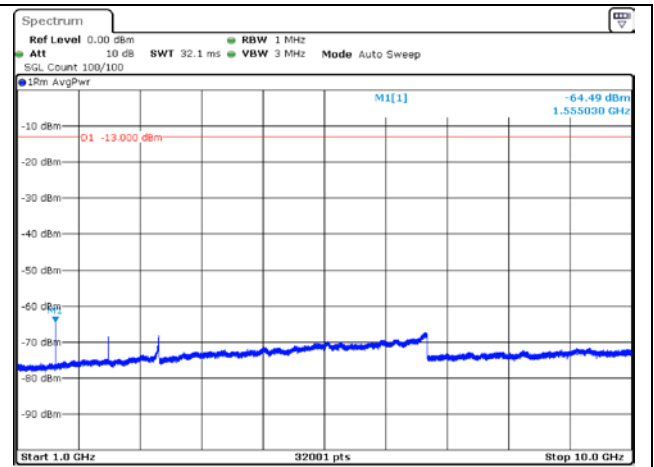
April 20, 2021 ~ April 30, 2021

13.5 Test data for Band 13_Bandwidth 5 MHz

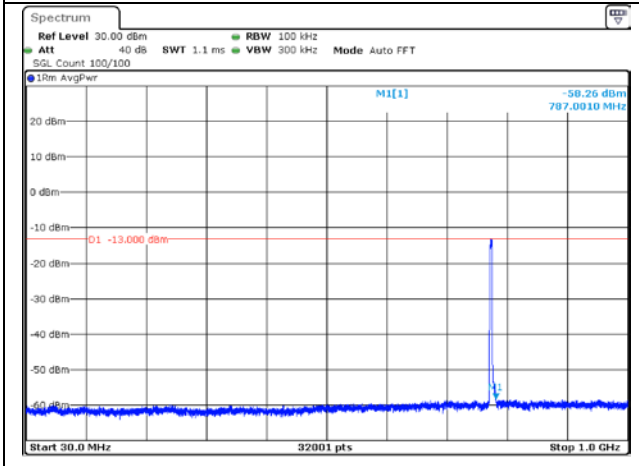
Test Mode	Channel	Frequency Range	Measured Value (dBm)	Cable Loss (dB)	Total Value (dBm)	Limit (dBm)	Result
LTE Band 13 QPSK							
1 RB	Low	30 MHz ~ 1 GHz	-57.91	20.46	-37.45	-13.00	PASS
		1 GHz ~ 20 GHz	-64.49	21.05	-43.44		PASS
	Middle	30 MHz ~ 1 GHz	-58.51	20.65	-37.86		PASS
		1 GHz ~ 20 GHz	-65.55	21.05	-44.50		PASS
	High	30 MHz ~ 1 GHz	-58.05	20.66	-37.39		PASS
		1 GHz ~ 20 GHz	-65.84	21.05	-44.79		PASS
Full RB	Low	30 MHz ~ 1 GHz	-58.26	20.45	-37.81	-13.00	PASS
		1 GHz ~ 20 GHz	-67.33	21.80	-45.53		PASS
	Middle	30 MHz ~ 1 GHz	-51.85	20.45	-31.40		PASS
		1 GHz ~ 20 GHz	-67.25	21.79	-45.46		PASS
	High	30 MHz ~ 1 GHz	-58.19	20.46	-37.73		PASS
		1 GHz ~ 20 GHz	-67.24	21.80	-45.44		PASS
LTE Band 13 16QAM							
1 RB	Low	30 MHz ~ 1 GHz	-58.13	20.46	-37.67	-13.00	PASS
		1 GHz ~ 20 GHz	-66.73	21.05	-45.68		PASS
	Middle	30 MHz ~ 1 GHz	-58.30	20.53	-37.77		PASS
		1 GHz ~ 20 GHz	-66.79	21.05	-45.74		PASS
	High	30 MHz ~ 1 GHz	-58.40	20.66	-37.74		PASS
		1 GHz ~ 20 GHz	-67.27	21.80	-45.47		PASS
Full RB	Low	30 MHz ~ 1 GHz	-58.33	20.66	-37.67	-13.00	PASS
		1 GHz ~ 20 GHz	-67.44	21.80	-45.64		PASS
	Middle	30 MHz ~ 1 GHz	-52.99	20.45	-32.54		PASS
		1 GHz ~ 20 GHz	-67.39	21.79	-45.60		PASS
	High	30 MHz ~ 1 GHz	-58.24	20.46	-37.78		PASS
		1 GHz ~ 20 GHz	-67.23	21.80	-45.43		PASS



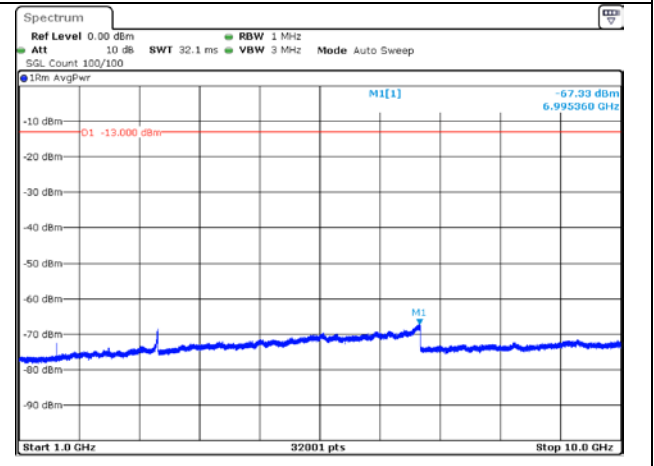
QPSK Low Channel_1G under (1 RB)



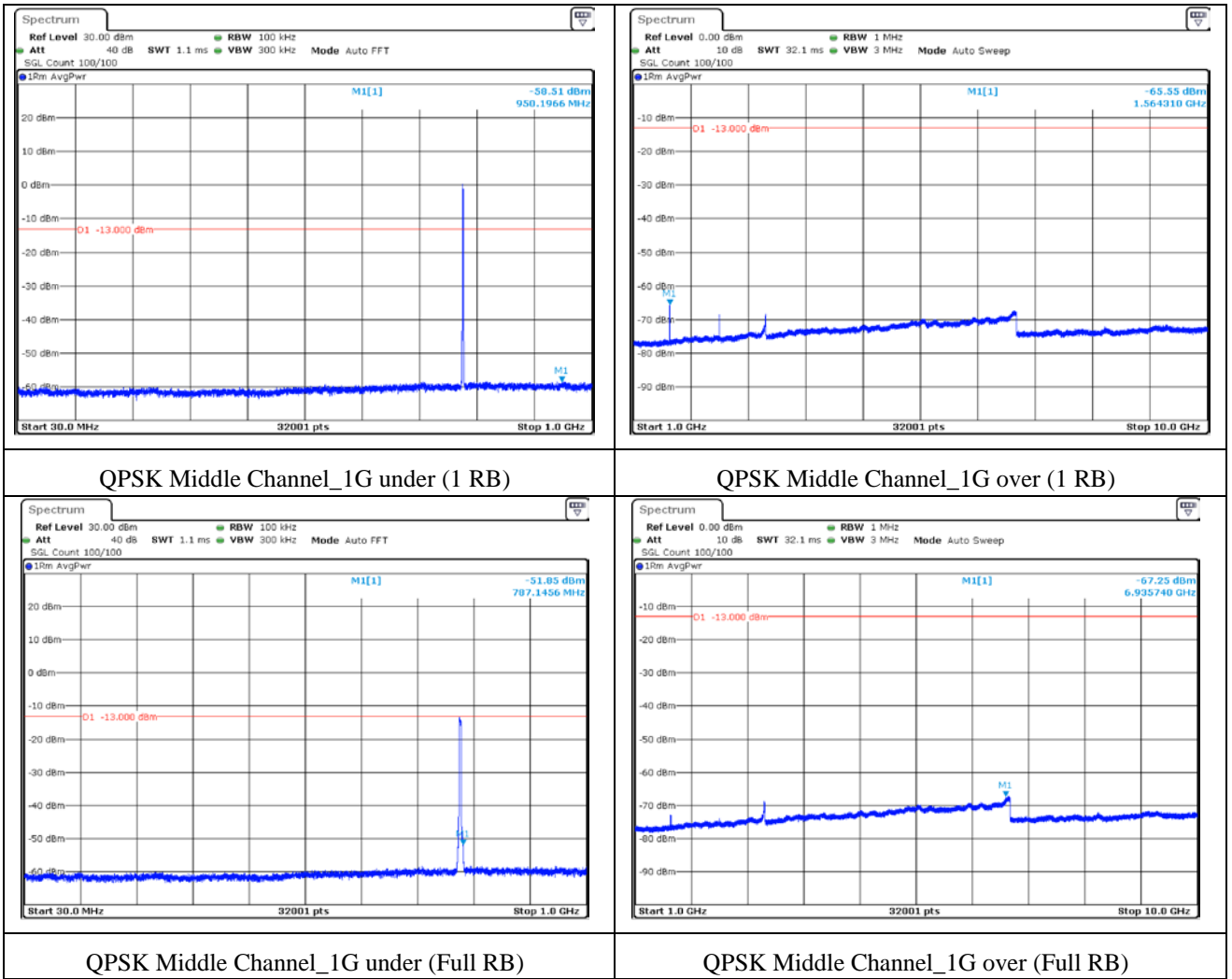
QPSK Low Channel_1G over (1 RB)

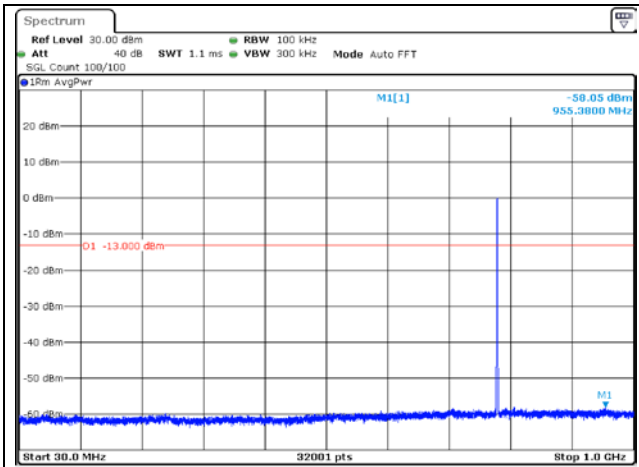


QPSK Low Channel_1G under (Full RB)

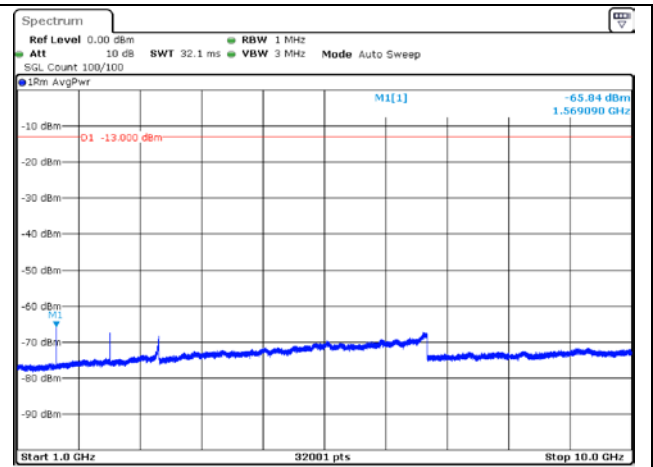


QPSK Low Channel_1G over (Full RB)

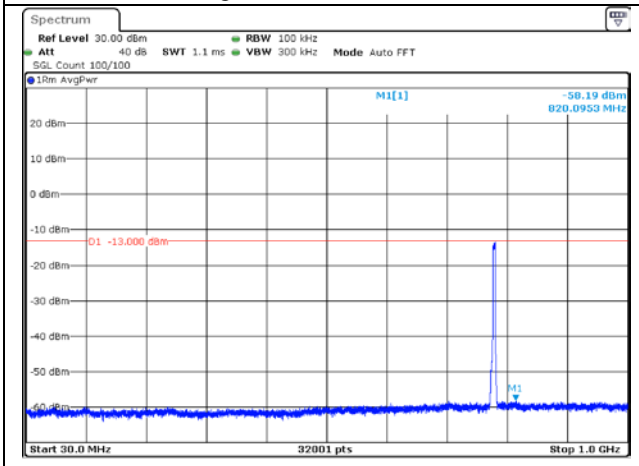




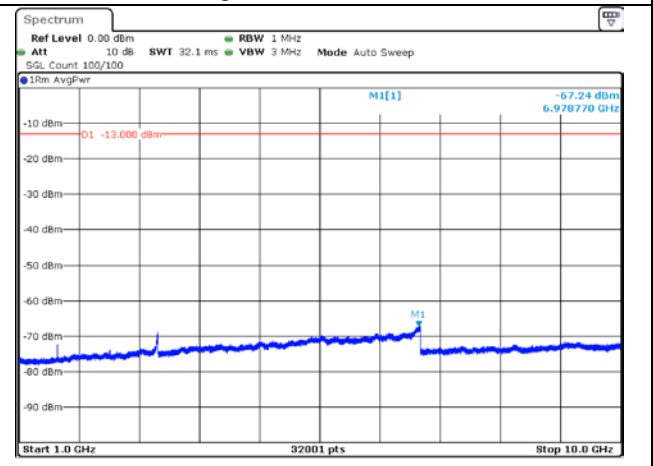
QPSK High Channel_1G under (1 RB)



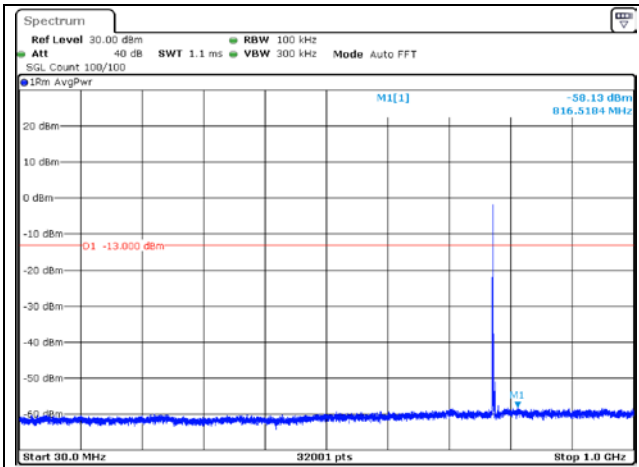
QPSK High Channel_1G over (1 RB)



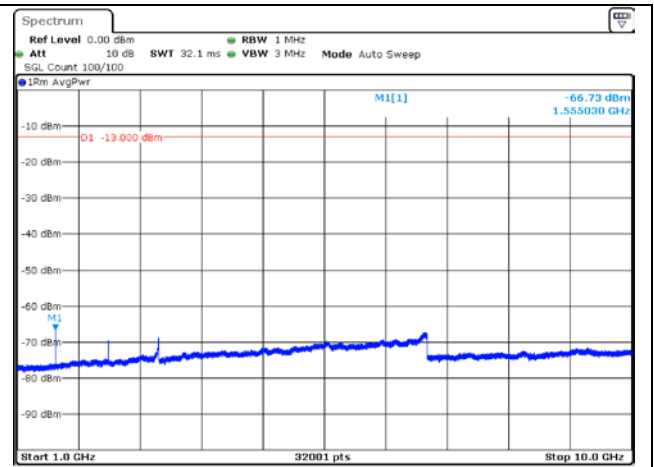
QPSK High Channel_1G under (Full RB)



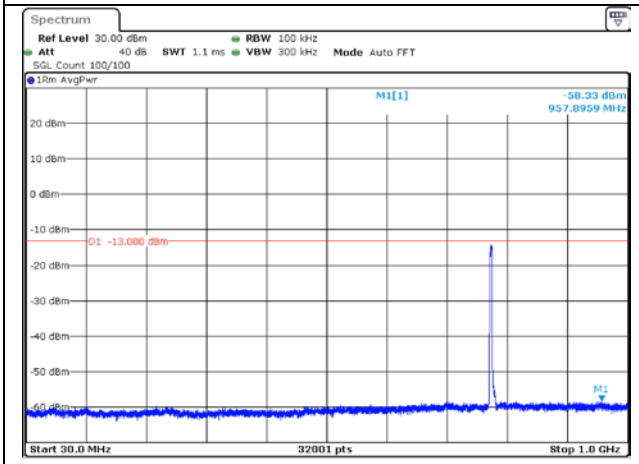
QPSK High Channel_1G over (Full RB)



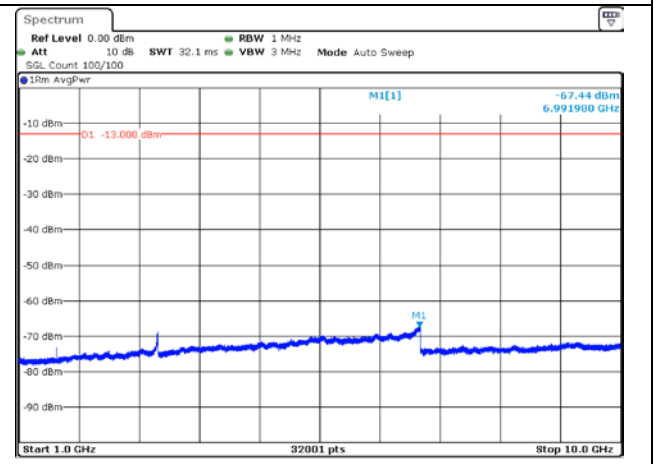
16QAM Low Channel_1G under (1 RB)



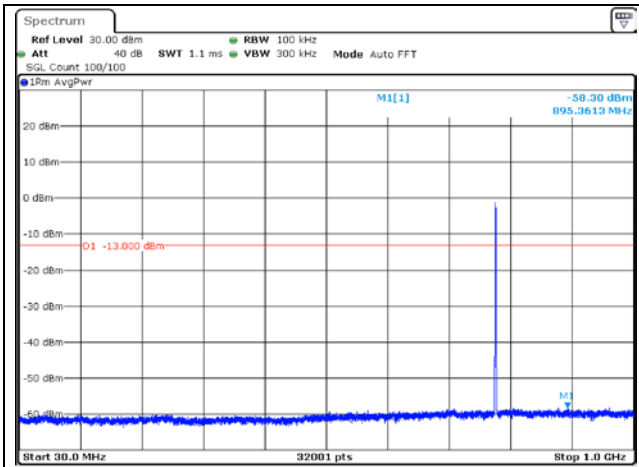
16QAM Low Channel_1G over (1 RB)



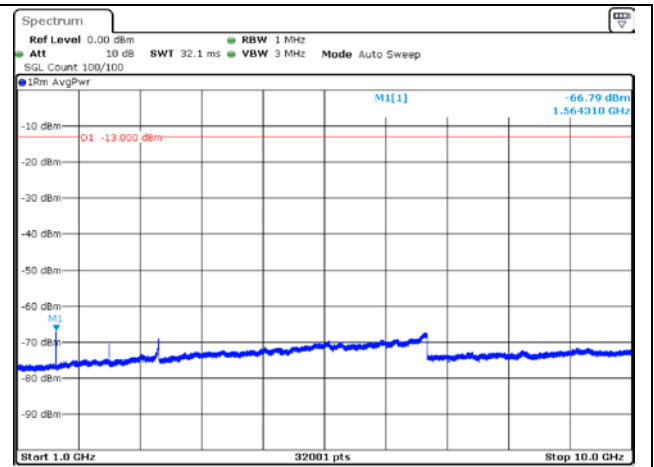
16QAM Low Channel_1G under (Full RB)



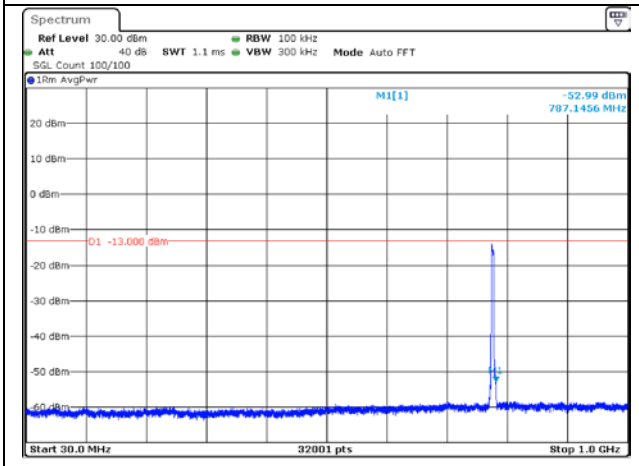
16QAM Low Channel_1G over (Full RB)



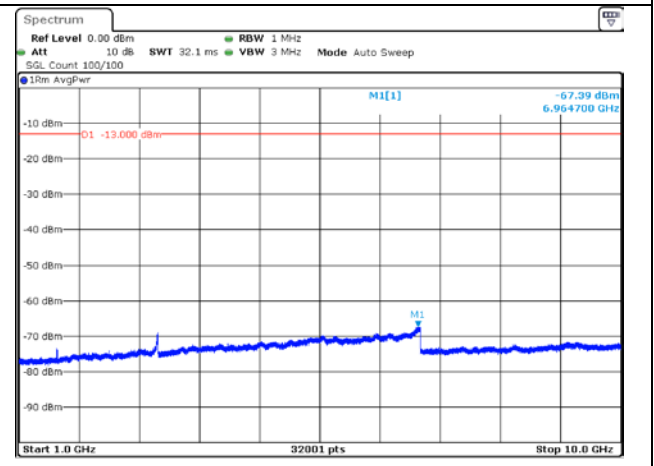
16QAM Middle Channel_1G under (1 RB)



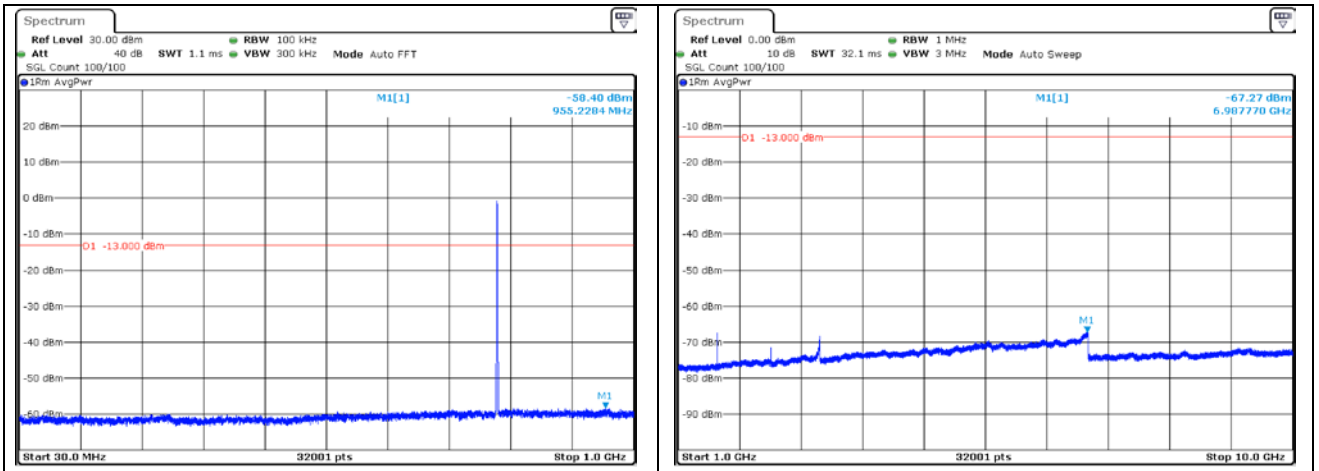
16QAM Middle Channel_1G over (1 RB)



16QAM Middle Channel_1G under (Full RB)

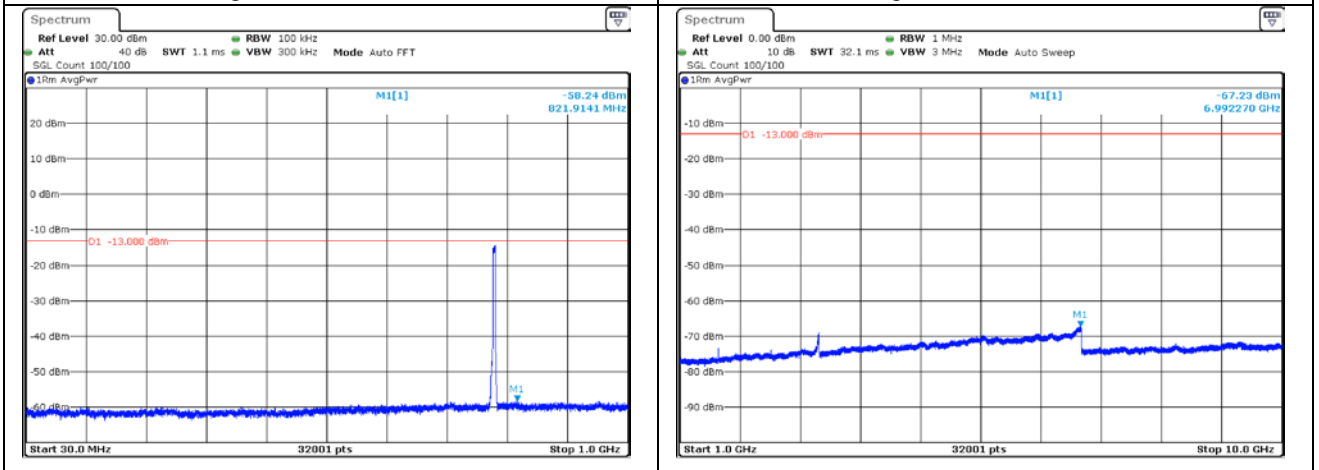


16QAM Middle Channel_1G over (Full RB)



16QAM High Channel_1G under (1 RB)

16QAM High Channel_1G over (1 RB)

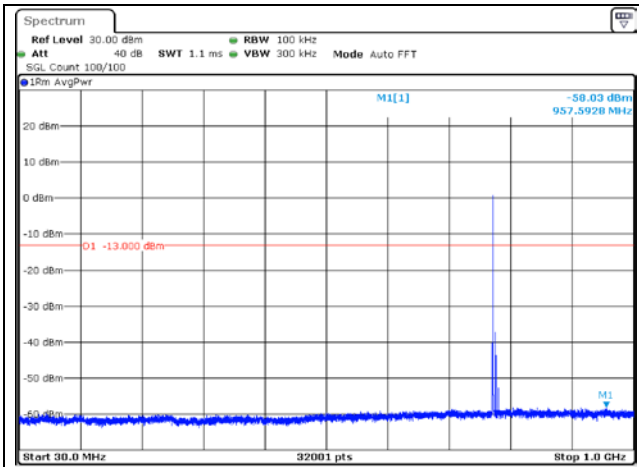


16QAM High Channel_1G under (Full RB)

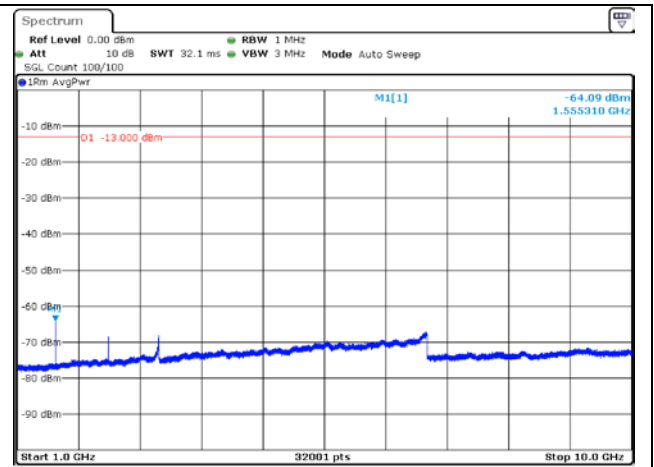
16QAM High Channel_1G over (Full RB)

13.6 Test data for Band 13_Bandwidth 10 MHz

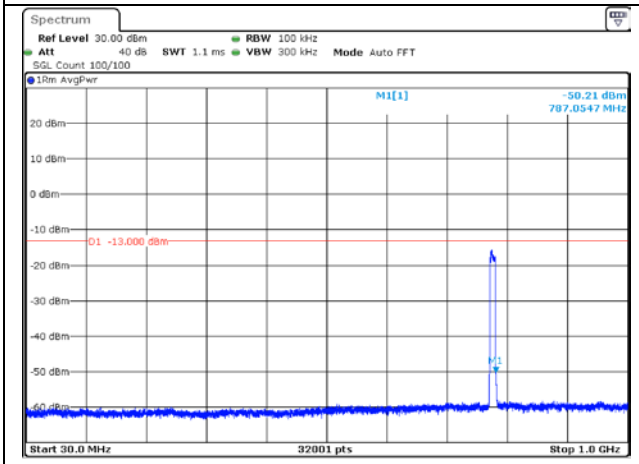
Test Mode	Channel	Frequency Range	Measured Value (dBm)	Cable Loss (dB)	Total Value (dBm)	Limit (dBm)	Result
LTE Band 13 QPSK							
1 RB	Low	30 MHz ~ 1 GHz	-58.03	20.66	-37.37	-13.00	PASS
		1 GHz ~ 20 GHz	-64.09	21.05	-43.04		PASS
Full RB	Low	30 MHz ~ 1 GHz	-50.21	20.45	-29.76	-13.00	PASS
		1 GHz ~ 20 GHz	-67.20	21.80	-45.40		PASS
LTE Band 13 16QAM							
1 RB	Low	30 MHz ~ 1 GHz	-58.35	20.65	-37.70	-13.00	PASS
		1 GHz ~ 20 GHz	-66.91	21.05	-45.86		PASS
Full RB	Low	30 MHz ~ 1 GHz	-51.32	20.45	-30.87	-13.00	PASS
		1 GHz ~ 20 GHz	-67.34	21.79	-45.55		PASS



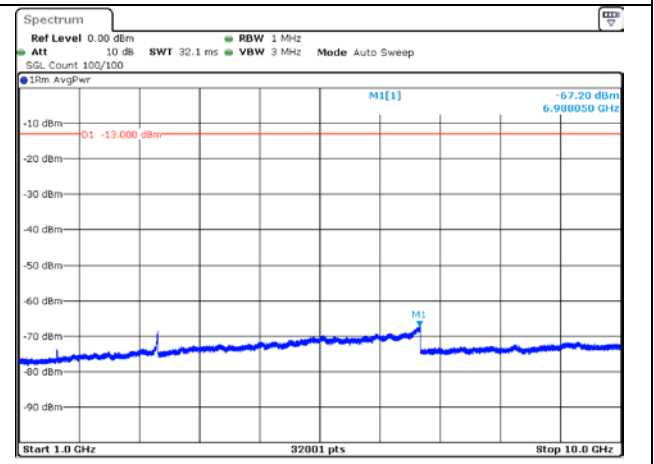
QPSK Low Channel_1G under (1 RB)



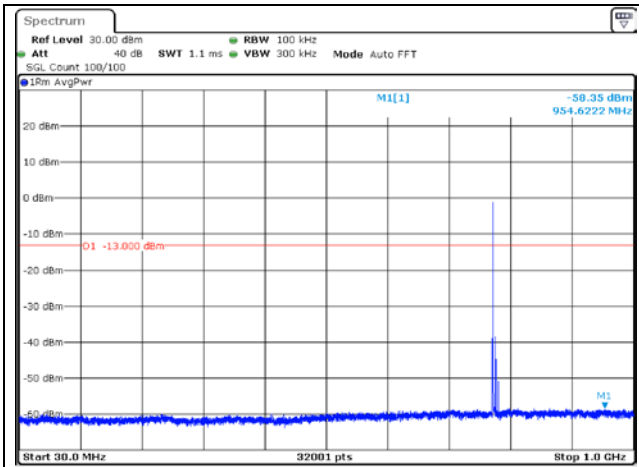
QPSK Low Channel_1G over (1 RB)



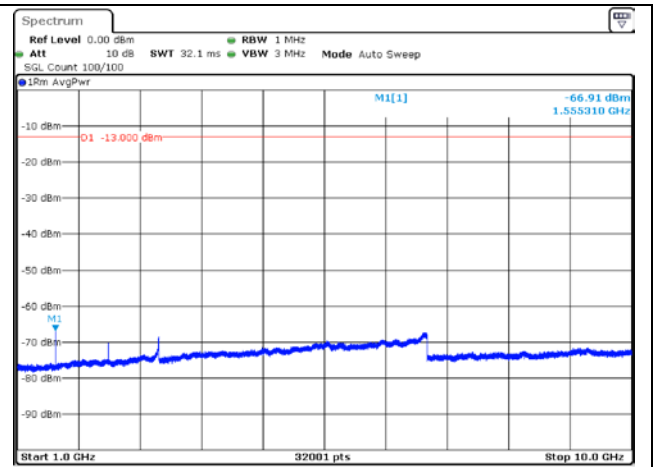
QPSK Low Channel_1G under (Full RB)



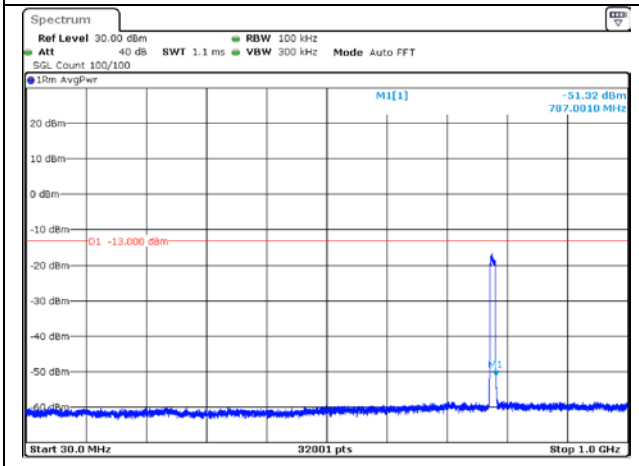
QPSK Low Channel_1G over (Full RB)



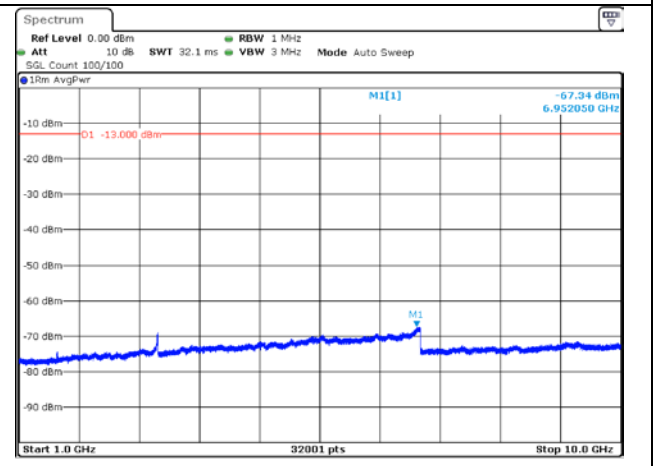
16QAM Low Channel_1G under (1 RB)



16QAM Low Channel_1G over (1 RB)



16QAM Low Channel_1G under (Full RB)



16QAM Low Channel_1G over (Full RB)

14. FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

14.1 Operating environment

Temperature : 23 °C
Relative humidity : 47 % R.H.

14.2 Test set-up

1. Frequency Stability (Voltage Variation)

+20 °C temperature and $\pm 15\%$ supply voltage variations. If a product is specified to operate over a range of input voltage then the -15% variation is applied to the lowermost voltage and the $+15\%$ is applied to the uppermost voltage.

(1) Vary primary supply voltage from $\pm 15\%$ of the nominal value for other than hand carried battery equipment.

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

2. Frequency Stability (Temperature Variation)

Turn EUT off and set chamber temperature to $-30\text{ }^{\circ}\text{C}$ and then allow sufficient time (approximately 20 to 30 minutes after chamber reach the assigned temperature) for EUT to stabilize. Turn ON EUT and measure the EUT operating frequency and then turn off the EUT after the measurement. The temperature in the chamber was raised $10\text{ }^{\circ}\text{C}$ step from $-30\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$. Repeat above method for frequency measurements every $10\text{ }^{\circ}\text{C}$ step and then record all measured frequencies on each temperature step.

14.3 Test Date

April 20, 2021 ~ April 30, 2021

14.4 Test data for Band 13

14.4.1 Test data for Voltage(V)

Temperature(° C)	Power(VDC)	Center Freq.	Measured Freq.	PPM
23	4.0	782 000 000	781 999 996	-0.005 1
	3.9		781 999 995	-0.006 4
	4.1		781 999 996	-0.005 1

14.4.2 Test data for Temperature(° C)

Temperature(° C)	Power(VDC)	Center Freq.	Measured Freq.	PPM
-30	4.0	782 000 000	782 000 005	0.006 4
-20			782 000 006	0.007 7
-10			782 000 004	0.005 1
0			781 999 998	-0.002 6
10			782 000 004	0.005 1
20			782 000 005	0.006 4
30			781 999 998	-0.002 6
40			782 000 015	0.019 2
50			781 999 982	-0.023 0

15. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV30	Rohde & Schwarz	Signal Analyzer	101372	Jul. 15, 2020 (1Y)
CS20-23-436/20	PULSAER MICROWAVE CORPORATION	Broadband Directional Coupler	1147	Jul. 15, 2020 (1Y)
MT8821C	ANRITSU	Radio Communication Analyzer	6261849029	Jul. 15, 2020 (1Y)
E5515C	Agilent	Wireless Connectivity Tester	MY48360785	Feb. 09, 2021 (1Y)
GP-4303D	LG Precision Co.,Ltd	DC Power Supply	5071069	Jan. 06, 2021 (1Y)
PSL-2KP	ESPEC	Environmental Test Chamber	14009407	Feb. 16, 2020 (1Y)
ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 16, 2020 (1Y)
310N	Sonoma Instrument	AMPLIFIER	392756	Oct. 16, 2020 (1Y)
SCU18	Rohde & Schwarz	Signal Conditioning unit	102266	Jul. 15, 2020 (1Y)
HLA 6121	TESEQ	Loop Antenna	50841	Apl. 06, 2020 (2Y)
VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 08, 2020 (2Y)
HLP-2008	TDK RF Solutions	Hybrid Antenna	131316	Feb. 27, 2020 (2Y)
BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1349	Nov. 20, 2020 (1Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2020 (1Y)
HPF 1.5GHz	Rohde & Schwarz	High Pass Filter	N/A	Feb. 08, 2021 (1Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter	N/A	Feb. 08, 2021 (1Y)
MA-4640-XPET	Innco Systems GmbH	Antenna Master	MA4640/652	N/A
DT2000-2t	Innco Systems GmbH	Turn Table	N/A	N/A