



# TEST REPORT

No.I23N01610-RF LTE

for

TCL Communication Ltd.

LINKHUB

Model Name: HH40L2

FCC ID: 2ACCJB202

with

Hardware Version: TZ7.823.397

Software Version: HH40L2.1.01

Issued Date: 2023-10-13

**Note:**

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of SAICT.

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## **REPORT HISTORY**

<b>Report Number</b>	<b>Revision</b>	<b>Description</b>	<b>Issue Date</b>
I23N01610-RF LTE	Rev.0	1st edition	2023-10-13

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## **1. SUMMARY OF TEST REPORT**

### **1.1. Test Items**

Description	LINKHUB
Model Name	HH40L2
Brand Name	TCL
Applicant's name	TCL Communication Ltd.
Manufacturer's Name	TCL Communication Ltd.

### **1.2. Test Standards**

FCC Part 2	10-1-21 Edition
FCC Part 22/24	10-1-22 Edition
ANSI C63.26	2015
KDB971168 D01	v03r01

### **1.3. Test Result**

All test items are passed. Please refer to "6 Summary of Test Results" for detail.

### **1.4. Testing Location**

Address: Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China 518000

### **1.5. Project Data**

Testing Start Date: 2023-04-01

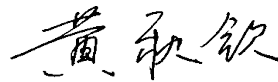
Testing End Date: 2023-10-11

### **1.6. Signature**



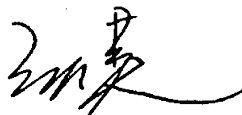
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**Wang Ping**  
**(Prepared this test report)**



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**Huang Qiuqin**  
**(Reviewed this test report)**



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**Zhang Hao**  
**(Approved this test report)**



## **2. CLIENT INFORMATION**

### **2.1. Applicant Information**

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### **2.2. Manufacturer Information**

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Fax: 0086-755-36612000-81722



### **3. EQUIPMENT UNDER TEST (EUT) AND ANCILLARY EQUIPMENT**

#### **(AE)**

#### **3.1. About EUT**

Description	LINKHUB
Model Name	HH40L2
FCC ID	2ACCJB202
Frequency Bands	LTE Bands 5/41
Extreme vol. Limits	6.60V to 15.00V (nominal: 12.00V)
Condition of EUT as received	No abnormality in appearance

Note1: Components list, please refer to documents of the manufacturer; it is also included in the original test record of SAICT.

#### **3.2. Internal Identification of EUT used during the test**

<b>EUT ID*</b>	<b>SN or IMEI</b>	<b>HW Version</b>	<b>SW Version</b>	<b>Date of receipt</b>
UT01aa	355197410026434	TZ7.823.397	HH40L2.1.01	2023-03-27
UT05aa	355197410026798	TZ7.823.397	HH40L2.1.01	2023-03-27

\*EUT ID: is used to identify the test sample in the lab internally.

UT01aa is used for conduction test, UT05aa is used for radiation test.

#### **3.3. Internal Identification of AE used during the test**

<b>AE ID*</b>	<b>Description</b>
AE1	Battery
AE2	Charger

AE1

Model	Z2000
Manufacturer	ShenzhenAerospaceElectronic Co.,Ltd
Capacity	2000mAh
Nominal Voltage	7.4 V

AE2

Model	1-CHUSB102-131
Manufacturer	Huizhou Puan electronics Co.,Ltd

\*AE ID: is used to identify the test sample in the lab internally.

AE: ancillary equipment



#### **4. REFERENCE DOCUMENTS**

The following documents listed in this section are referred for testing.

<b>Reference</b>	<b>Title</b>	<b>Version</b>
FCC Part 2	FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS	10-1-21 Edition
FCC Part 22	PUBLIC MOBILE SERVICES	10-1-22 Edition
FCC Part 27	MISCELLANEOUS WIRELESS COMMUNICATIONS SERVICES	10-1-22 Edition
ANSI C63.26	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services	2015
KDB971168 D01	Power Meas License Digital Systems	v03r01

## 5. LABORATORY ENVIRONMENT

**Shielded room** did not exceed following limits along the RF testing:

Temperature	Min. = 15 °C, Max. = 35 °C
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	0.014MHz-1MHz>60 dB; 1MHz-18000MHz>90 dB
Electrical insulation	>2 MΩ
Ground system resistance	< 4 Ω

**Fully-anechoic chamber** did not exceed following limits along the EMC testing

Temperature	Min. = 15 °C, Max. = 35 °C
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	0.014MHz-1MHz> 60 dB; 1MHz-18000MHz>90 dB
Electrical insulation	> 2MΩ
Ground system resistance	< 4 Ω
Voltage Standing Wave Ratio (VSWR)	≤ 6 dB, from 1 to 18 GHz, 3 m distance
Uniformity of field strength	Between 0 and 6 dB, from 80 to 6000 MHz



## 6. SUMMARY OF TEST RESULTS

Abbreviations used in this clause:		
Verdict Column	P	Pass
	F	Fail
	NA	Not applicable
	NM	Not measured

### LTE band 5

Items	Test Name	Clause in FCC rules	Section in this report	Verdict
1	Output Power	2.1046/22.913	A.1	P
2	Field Strength of Spurious Radiation	2.1053/22.917	A.2	P
3	Frequency Stability	2.1055/22.355	A.3	P
4	Occupied Bandwidth	2.1049/22.917	A.4	P
5	Emission Bandwidth	2.1049/22.917	A.5	P
6	Band Edge Compliance	2.1051/22.917	A.6	P
7	Conducted Spurious Emission	2.1051/22.917	A.7	P
8	Peak-to-Average Power Ratio	KDB971168 D01	A.8	P

### LTE Band 41

Items	Test Name	Clause in FCC rules	Section in this report	Verdict
1	Output Power	2.1046/27.50(h)	A.1	P
2	Field Strength of Spurious Radiation	2.1053/27.53(m)	A.2	P
3	Frequency Stability	2.1055/27.54	A.3	P
4	Occupied Bandwidth	2.1049/27.53(m)	A.4	P
5	Emission Bandwidth	2.1049/27.53(m)	A.5	P
6	Band Edge Compliance	2.1051/27.53(m)	A.6	P
7	Conducted Spurious Emission	2.1051/27.53(m)	A.7	P
8	Peak-to-Average Power Ratio	27.50(a)/ KDB971168 D01	A.8	P



## **7. STATEMENT**

The LINKHUB, HH40L2, manufactured by TCL Communication Ltd. is a variant of T Phone for testing.

According to the declaration, Retested radiated part and reused all other test data from No. I23N00436-RF LTE. For detail information please check the declaration provided by the manufacturer.

Since the information of samples in this report is provided by the client, the laboratory is not responsible for the authenticity of sample information.

This report takes measured values as criterion of test conclusion. The test conclusion meets the limit requirements.

## 8. TEST EQUIPMENTS UTILIZED

NO.	Description	TYPE	Manufacture	series number	Cal Due Date
1	Test Receiver	ESR7	R&S	101676	2023-11-23
2	BiLog Antenna	3142E	ETS-Lindgren	0224831	2024-05-27
3	Horn Antenna	3117	ETS-Lindgren	00066585	2025-03-15
4	Horn Antenna	QSH-SL-18-26-S-20	Q-par	17013	2026-01-30
5	Antenna	BBHA 9120D	Schwarzbeck	1593	2025-10-24
6	Antenna	VUBA 9117	Schwarzbeck	207	2024-07-15
7	Antenna	QWH-SL-18-40-K-SG	Q-par	15979	2026-01-30
8	preamplifier	83017A	Agilent	MY39501110	/
9	Signal Generator	SMB100A	R&S	179725	2023-11-23
10	Fully Anechoic Chamber	FACT3-2.0	ETS-Lindgren	1285	2024-05-29
11	Spectrum Analyzer	FSV40	R&S	101192	2024-01-11
12	Universal Radio Communication Tester	CMU200	R&S	114545	2024-01-11
13	Universal Radio Communication Tester	CMW500	R&S	152499	2024-07-14
14	Universal Radio Communication Tester	CMW500	R&S	129146	2024-04-24
15	Spectrum Analyzer	FSU	R&S	101506	2023-12-13
16	Temperature Chamber	SH-241	ESPEC	92007516	2023-10-15
17	DC Power Supply	U3606A	Agilent Technologies	MY50450012	2023-11-13
18	Spectrum Analyzer	FSW26	R&S	102197	2023-11-24

### Test software

Item	Name	Version
Radiated	EMC32	V10.50.40

## **ANNEX A: MEASUREMENT RESULTS**

### **A.1 OUTPUT POWER**

#### **Reference**

FCC: CFR Part 2.1046, 22.913, 27.50.

#### **A.1.1 Summary**

During the process of testing, the EUT was controlled via Rhode & Schwarz Digital Radio Communication tester (CMW500) to ensure max power transmission and proper modulation.

This result contains peak output power and ERP/EIRP measurements for the EUT.

In all cases, output power is within the specified limits.

#### **A.1.2 Conducted**

##### **A.1.2.1 Method of Measurements**

The EUT was set up for the max output power with pseudo random data modulation.

These measurements were done at 3 frequencies (bottom, middle and top of operational frequency range) for each bandwidth.

##### **A.1.2.2 Measurement result**

#### **LTE band 5**

Bandwidth	RB size/offset	Frequency (MHz)	Power(dBm)	
			QPSK	16QAM
1.4MHz	1 RB high	848.3	22.06	21.19
		836.5	22.41	21.3
		824.7	22.36	20.9
	1 RB low	848.3	22.15	21.6
		836.5	22.57	21.9
		824.7	22.17	21.69
	50% RB mid	848.3	22.12	21.65
		836.5	22.34	22.09
		824.7	22.13	21.73
	100% RB	848.3	21.63	21.62
		836.5	21.84	22.03
		824.7	21.65	21.99
3MHz	1 RB high	847.5	21.8	20.66
		836.5	21.91	20.71
		825.5	22.04	20.42
	1 RB low	847.5	21.95	20.72
		836.5	22.17	20.73
		825.5	21.5	20.51
	50% RB mid	847.5	21.15	21.53
		836.5	21.22	21.81
		825.5	20.95	21.06
	100% RB	847.5	21.12	21.37
		836.5	21.2	21.57
		825.5	20.91	21.62

Bandwidth	RB size/offset	Frequency (MHz)	Power(dBm)	
			QPSK	16QAM
5MHz	1 RB high	846.5	21.63	20.65
		836.5	21.85	20.68
		826.5	21.99	20.6
	1 RB low	846.5	21.7	20.59
		836.5	21.77	20.64
		826.5	21.29	20.52
	50% RB mid	846.5	21.02	21.31
		836.5	21.05	21.46
		826.5	20.98	21.04
	100% RB	846.5	21.1	21.46
		836.5	21.15	21.61
		826.5	21.05	21.67
10MHz	1 RB high	844.0	22.13	20.7
		836.5	22.19	20.87
		829.0	22.56	20.95
	1 RB low	844.0	22.21	20.57
		836.5	22.65	20.65
		829.0	21.75	20.9
	50% RB mid	844.0	20.98	22.03
		836.5	21.11	22.26
		829.0	21.35	21.56
	100% RB	844.0	21.16	21.84
		836.5	21.31	21.99
		829.0	21.44	22.15

Note: Expanded measurement uncertainty is  $U = 0.49\text{dB}$ ,  $k = 1.96$

## LTE band 41

Bandwidth	RB size/offset	Frequency (MHz)	Power(dBm)	
			QPSK	16QAM
5MHz	1 RB high	2687.5	20.09	19.74
		2593.0	20.72	20.59
		2498.5	20.78	20.36
	1 RB low	2687.5	20.39	20.28
		2593.0	20.86	20.57
		2498.5	20.76	20.38
	50% RB mid	2687.5	19.5	18.79
		2593.0	20.05	19.66
		2498.5	20.06	19.67
	100% RB	2687.5	19.63	19.03
		2593.0	20.15	19.71
		2498.5	20.17	19.7
10MHz	1 RB high	2685.0	20.61	20.23
		2593.0	21.42	20.57
		2501.0	21.72	21.09
	1 RB low	2685.0	21.26	20.86
		2593.0	21.26	20.66
		2501.0	21.61	20.88
	50% RB mid	2685.0	19.7	18.99
		2593.0	20.04	19.55
		2501.0	20.03	19.54
	100% RB	2685.0	19.88	19.26
		2593.0	20.23	19.78
		2501.0	20.25	19.75
15MHz	1 RB high	2682.5	20.54	20.08
		2593.0	21.2	20.88
		2503.5	21.79	21.3
	1 RB low	2682.5	21.65	21.01
		2593.0	21.27	21.04
		2503.5	21.34	20.83
	50% RB mid	2682.5	19.87	19.18
		2593.0	20.05	19.53
		2503.5	20.18	19.7



Bandwidth	RB size/offset	Frequency (MHz)	Power(dBm)	
			QPSK	16QAM
	100% RB	2682.5	20.12	19.47
		2593.0	20.29	19.83
		2503.5	20.48	19.99
20MHz	1 RB high	2680.0	20.77	20.37
		2593.0	21.35	21.12
		2506.0	22.5	22.04
	1 RB low	2680.0	21.23	20.98
		2593.0	21.27	21
		2506.0	21.15	20.77
	50% RB mid	2680.0	20.09	19.48
		2593.0	20.09	19.6
		2506.0	20.42	19.94
	100% RB	2680.0	20.4	19.71
		2593.0	20.38	19.89
		2506.0	20.78	20.29

Note: Expanded measurement uncertainty is U = 0.49dB, k = 1.96

### A.1.3 Radiated

#### A.1.3.1 Description

This is the test for the maximum radiated power from the EUT.

Rule Part 27.50(d) specifies “Fixed, mobile, and portable (handheld) stations operating in the 1710–1755 MHz band are limited to 1 watt EIRP”.

Rule Part 27.50(h)(2) specifies “Mobile stations are limited to 2.0 watts EIRP.”.

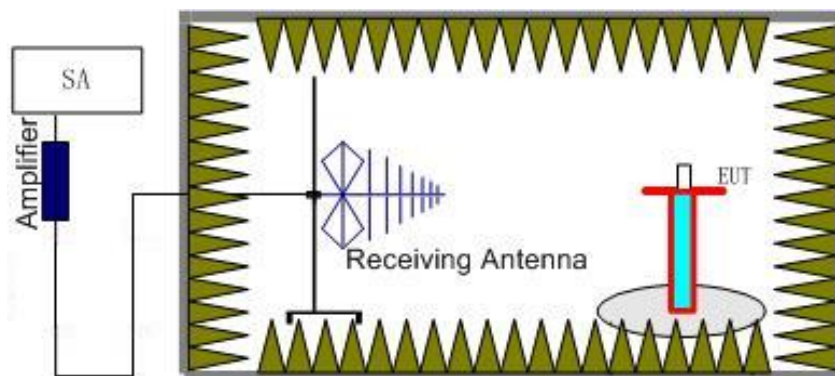
Rule Part 27.50(c) specifies “Portable stations (hand-held de-vices) are limited to 3 watts ERP.”.

Rule Part 27.50(a)(3) specifies “For mobile and portable stations transmitting in the 2305–2315 MHz band or the 2350–2360 MHz band, the average EIRP must not exceed 50 milliwatts within any 1 megahertz of authorized bandwidth, except that for mobile and portable stations compliant with 3GPP LTE standards or another advanced mobile broadband protocol that avoids concentrating energy at the edge of the operating band the average EIRP must not exceed 250 milliwatts within any 5 megahertz of authorized bandwidth but may exceed 50 milliwatts within any 1 megahertz of authorized bandwidth.”

Rule Part 22.913(a) specifies “The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.”

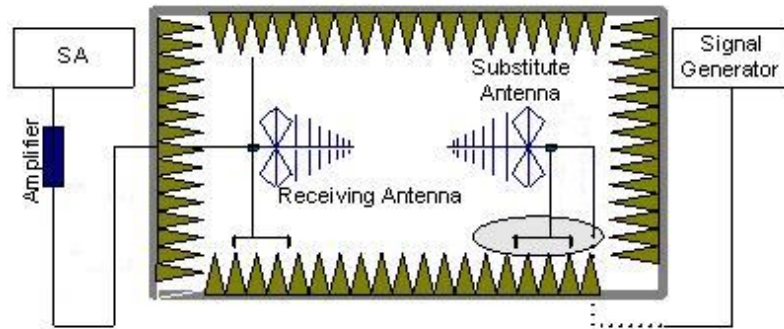
#### A.1.3.2 Method of Measurement

1. For radiated emissions measurements performed at frequencies less than or equal to 1 GHz, EUT was placed on a 80 cm high non-conductive stand at a 3 meter test distance from the receive antenna. For radiated measurements performed at frequencies above 1 GHz, EUT was placed on a 1.5 meter high non-conductive stand at a 3 meter test distance from the receive antenna. Receiving antenna was placed on the antenna mast 3 meters from the EUT. For emission measurements. The receiving antenna shall be varied from 1 m to 4 m in height above the reference ground in a search for the relative positioning that produces the maximum radiated signal level. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all transmit frequencies in three channels (High, Middle, Low) were measured with peak detector.



2. The EUT is then put into continuously transmitting mode at its maximum power level during the test. And the maximum value of the receiver should be recorded as (Pr).
3. The EUT shall be replaced by a substitution antenna. The test setup refers to figure below.





In the chamber, a substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power ( $P_{Mea}$ ) is applied to the input of the substitution antenna and adjusts the level of the signal generator output until the value of the receiver reaches the previously recorded ( $P_r$ ). The power of signal source ( $P_{Mea}$ ) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.

4. An amplifier should be connected to the Signal Source output port. And the cable should be connected between the amplifier and the substitution antenna.

The cable loss ( $P_{cl}$ ), the substitution Antenna Gain(dBi) ( $G_a$ ) and the amplifier Gain ( $P_{Ag}$ ) should be recorded after test.

The measurement results are obtained as described below:

$$\text{Power (EIRP)} = P_{Mea} - P_{Ag} - P_{cl} + G_a$$

5. This value is EIRP since the measurement is calibrated using an antenna of known gain (unit dBi) and known input power.
6. ERP can be calculated from EIRP by subtracting the gain of the dipole,  $ERP = EIRP - 2.15\text{dB}$ .

**A.1.3.3 Measurement result**

**LTE Band 5- ERP Part 22.913(a)**

**Limits:** ≤38.45dBm (7W)

**LTE Band 5\_1.4MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
824.70	-9.32	-33.60	-0.79	2.15	21.34	38.45	V
836.50	-8.23	-33.50	-0.74	2.15	22.38	38.45	V
848.30	-9.37	-33.50	-0.73	2.15	21.25	38.45	V

**LTE Band 5\_3MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
825.50	-9.30	-33.60	-0.84	2.15	21.31	38.45	V
836.50	-8.26	-33.50	-0.74	2.15	22.35	38.45	V
847.50	-9.41	-33.50	-0.73	2.15	21.21	38.45	V

**LTE Band 5\_5MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
826.50	-9.35	-33.60	-0.84	2.15	21.26	38.45	V
836.50	-8.31	-33.50	-0.74	2.15	22.30	38.45	V
846.50	-9.44	-33.50	-0.73	2.15	21.18	38.45	V

**LTE Band 5\_10MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
829.00	-9.38	-33.60	-0.84	2.15	21.23	38.45	V
836.50	-8.37	-33.50	-0.74	2.15	22.24	38.45	V
844.00	-9.45	-33.50	-0.78	2.15	21.12	38.45	V

**LTE Band 5\_1.4MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
824.70	-11.08	-33.60	-0.79	2.15	19.58	38.45	V
836.50	-10.04	-33.50	-0.74	2.15	20.57	38.45	V
848.30	-11.18	-33.50	-0.73	2.15	19.44	38.45	V

**LTE Band 5\_3MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
825.50	-11.07	-33.60	-0.84	2.15	19.54	38.45	V
836.50	-10.09	-33.50	-0.74	2.15	20.52	38.45	V
847.50	-11.20	-33.50	-0.73	2.15	19.42	38.45	V

**LTE Band 5\_5MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
826.50	-11.11	-33.60	-0.84	2.15	19.50	38.45	V
836.50	-10.13	-33.50	-0.74	2.15	20.48	38.45	V
846.50	-11.23	-33.50	-0.73	2.15	19.39	38.45	V

**LTE Band 5\_10MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
829.00	-11.14	-33.60	-0.84	2.15	19.47	38.45	V
836.50	-10.18	-33.50	-0.74	2.15	20.43	38.45	V
844.00	-11.21	-33.50	-0.78	2.15	19.36	38.45	V

**LTE Band 5\_1.4MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
824.70	-12.80	-33.60	-0.79	2.15	17.86	38.45	V
836.50	-11.97	-33.50	-0.74	2.15	18.64	38.45	V
848.30	-12.94	-33.50	-0.73	2.15	17.68	38.45	V

**LTE Band 5\_3MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
825.50	-12.78	-33.60	-0.84	2.15	17.83	38.45	V
836.50	-12.01	-33.50	-0.74	2.15	18.60	38.45	V
847.50	-12.97	-33.50	-0.73	2.15	17.65	38.45	V

**LTE Band 5\_5MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
826.50	-12.82	-33.60	-0.84	2.15	17.79	38.45	V
836.50	-12.05	-33.50	-0.74	2.15	18.56	38.45	V
846.50	-13.01	-33.50	-0.73	2.15	17.61	38.45	V

**LTE Band 5\_10MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Polarization
829.00	-12.86	-33.60	-0.84	2.15	17.75	38.45	V
836.50	-12.08	-33.50	-0.74	2.15	18.53	38.45	V
844.00	-13.00	-33.50	-0.78	2.15	17.57	38.45	V

**LTE Band 41- EIRP Part 27.50(d)(2)****Limits:** ≤33dBm (2W)**LTE Band 41\_5MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2498.50	-16.72	-28.70	10.70	22.68	33.00	H
2593.00	-16.46	-28.60	10.70	22.84	33.00	H
2687.50	-16.64	-28.50	10.70	22.56	33.00	H

**LTE Band 41\_10MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2501.00	-16.75	-28.70	10.70	22.65	33.00	H
2593.00	-16.51	-28.60	10.70	22.79	33.00	H
2685.00	-16.71	-28.50	10.70	22.49	33.00	H

**LTE Band 41\_15MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2503.50	-16.80	-28.70	10.70	22.60	33.00	H
2593.00	-16.54	-28.60	10.70	22.76	33.00	H
2682.50	-16.75	-28.50	10.70	22.45	33.00	H

**LTE Band 41\_20MHz\_QPSK**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2506.00	-16.83	-28.70	10.70	22.57	33.00	H
2593.00	-16.58	-28.60	10.70	22.72	33.00	H
2680.00	-16.77	-28.50	10.70	22.43	33.00	H

**LTE Band 41\_5MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2498.50	-17.54	-28.70	10.70	21.86	33.00	H
2593.00	-17.33	-28.60	10.70	21.97	33.00	H
2687.50	-17.44	-28.50	10.70	21.76	33.00	H

**LTE Band 41\_10MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2501.00	-17.57	-28.70	10.70	21.83	33.00	H
2593.00	-17.38	-28.60	10.70	21.92	33.00	H
2685.00	-17.48	-28.50	10.70	21.72	33.00	H

**LTE Band 41\_15MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2503.50	-17.61	-28.70	10.70	21.79	33.00	H
2593.00	-17.43	-28.60	10.70	21.87	33.00	H
2682.50	-17.53	-28.50	10.70	21.67	33.00	H

**LTE Band 41\_20MHz\_16QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>cl</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2506.00	-17.65	-28.70	10.70	21.75	33.00	H
2593.00	-17.49	-28.60	10.70	21.81	33.00	H
2680.00	-17.57	-28.50	10.70	21.63	33.00	H

**LTE Band 41\_5MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>ci</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2498.50	-18.72	-28.70	10.70	20.68	33.00	H
2593.00	-18.41	-28.60	10.70	20.89	33.00	H
2687.50	-18.58	-28.50	10.70	20.62	33.00	H

**LTE Band 41\_10MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>ci</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2501.00	-18.75	-28.70	10.70	20.65	33.00	H
2593.00	-18.44	-28.60	10.70	20.86	33.00	H
2685.00	-18.61	-28.50	10.70	20.59	33.00	H

**LTE Band 41\_15MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>ci</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2503.50	-18.78	-28.70	10.70	20.62	33.00	H
2593.00	-18.50	-28.60	10.70	20.80	33.00	H
2682.50	-18.64	-28.50	10.70	20.56	33.00	H

**LTE Band 41\_20MHz\_64QAM**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	P <sub>ci</sub> (dB)+ P <sub>Ag</sub> (dB)	Ga Antenna Gain(dBi)	EIRP(dBm)	Limit(dBm)	Polarization
2506.00	-18.82	-28.70	10.70	20.58	33.00	H
2593.00	-18.52	-28.60	10.70	20.78	33.00	H
2680.00	-18.68	-28.50	10.70	20.52	33.00	H

**ANALYZER SETTINGS:**

RBW = VBW = 8MHz for occupied bandwidths equal to or less than 5MHz.

RBW = VBW = 20MHz for occupied bandwidths equal to or greater than 10MHz.

Note: The maximum value of expanded measurement uncertainty for this test item is  $U = 2.87\text{dB}(30\text{MHz}-3\text{GHz})/3.35\text{dB}(3\text{GHz}-18\text{GHz})/2.68\text{dB}(18\text{GHz}-40\text{GHz})$ ,  $k = 2$

**Note: Both of Vertical and Horizontal polarizations are evaluated, but only the worst case is recorded in this report.**

## A.2 FIELD STRENGTH OF SPURIOUS RADIATION

### Reference

FCC: CFR 2.1053, 22.917, 27.53.

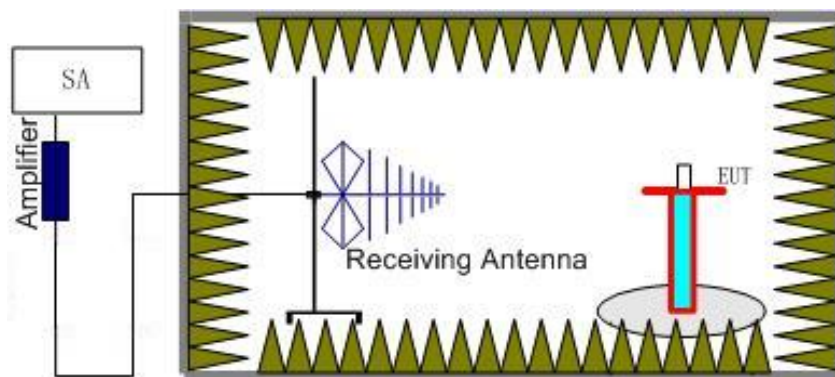
### A.2.1 Measurement Method

This measurement is carried out in fully-anechoic chamber FAC-3.

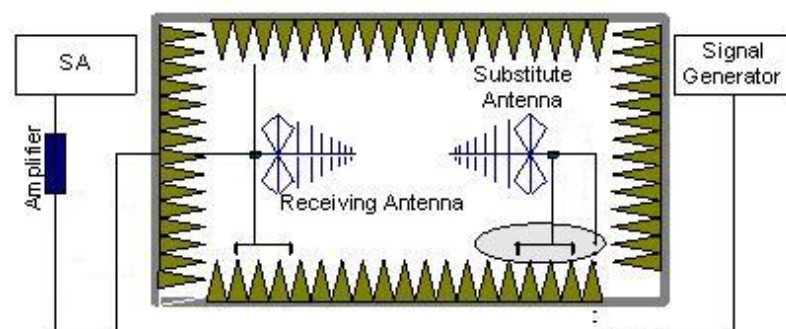
The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier. The resolution bandwidth is set 1MHz as outlined in Part 22.917, 27.53(h). The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the all LTE Bands

### The procedure of radiated spurious emissions is as follows:

1. For radiated emissions measurements performed at frequencies less than or equal to 1 GHz, EUT was placed on a 80 cm high non-conductive stand at a 3 meter test distance from the receive antenna. For radiated measurements performed at frequencies above 1 GHz, EUT was placed on a 1.5 meter high non-conductive stand at a 3 meter test distance from the receive antenna. Receiving antenna was placed on the antenna mast 3 meters from the EUT. For emission measurements. The receiving antenna shall be varied from 1 m to 4 m in height above the reference ground in a search for the relative positioning that produces the maximum radiated signal level. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all transmit frequencies in three channels (High, Middle, Low) were measured with peak detector.



2. The EUT is then put into continuously transmitting mode at its maximum power level during the test. And the maximum value of the receiver should be recorded as (Pr).
3. The EUT shall be replaced by a substitution antenna. The test setup refers to figure below.





In the chamber, a substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power ( $P_{Mea}$ ) is applied to the input of the substitution antenna and adjusts the level of the signal generator output until the value of the receiver reaches the previously recorded ( $P_r$ ). The power of signal source ( $P_{Mea}$ ) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.

4. The Path loss ( $P_{pl}$ ) between the Signal Source with the Substitution Antenna and the Substitution Antenna Gain(dBi) ( $G_a$ ) should be recorded after test.

An amplifier should be connected in for the test.

The Path loss ( $P_{pl}$ ) is the summation of the cable loss and the gain of the amplifier.

The measurement results are obtained as described below:

$$\text{Power (EIRP)} = P_{Mea} - P_{pl} + G_a$$

5. This value is EIRP since the measurement is calibrated using an antenna of known gain (unit: dBi) and known input power.
6. ERP can be calculated from EIRP by subtracting the gain of the dipole,  $ERP = EIRP - 2.15\text{dB}$ .

#### **A.2.2 Measurement Results**

Radiated emissions measurements were made only at the upper, middle, and lower carrier frequencies of the test LTE Bands. It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the test LTE Bands. into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

Only worst case result is given below.

**LTE Band 5, 1.4MHz, QPSK, Channel 20407**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
1648.33	-49.01	0.80	8.10	-43.86	-13.00	V
2472.50	-50.91	0.90	9.80	-44.16	-13.00	V
8478.00	-51.45	1.80	11.30	-44.10	-13.00	H
9299.50	-50.85	2.00	11.60	-43.40	-13.00	H
9425.00	-51.56	2.10	11.60	-44.21	-13.00	H
9472.75	-50.77	2.10	11.60	-43.42	-13.00	V

**LTE Band 5, 1.4MHz, QPSK, Channel 20525**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
1671.25	-44.20	0.80	8.10	-39.05	-13.00	H
2507.92	-47.22	0.90	10.70	-39.57	-13.00	H
9227.75	-51.07	2.10	11.60	-43.72	-13.00	H
9304.00	-50.15	2.00	11.60	-42.70	-13.00	H
9425.75	-51.34	2.10	11.60	-43.99	-13.00	H
9476.00	-51.39	2.10	11.60	-44.04	-13.00	V

**LTE Band 5, 1.4MHz, QPSK, Channel 20643**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
2543.75	-48.62	0.90	10.70	-40.97	-13.00	H
7888.50	-51.50	1.70	11.30	-44.05	-13.00	H
8636.50	-52.11	2.00	12.00	-44.26	-13.00	H
9099.00	-51.51	2.20	11.60	-44.26	-13.00	H
9223.25	-51.11	2.10	11.60	-43.76	-13.00	H
9302.25	-50.11	2.00	11.60	-42.66	-13.00	H

**LTE Band 5, 1.4MHz, 16QAM, Channel 20407**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
1648.33	-49.82	0.80	8.10	-44.67	-13.00	H
8417.25	-51.76	1.80	11.30	-44.41	-13.00	H
9225.75	-50.78	2.10	11.60	-43.43	-13.00	H
9302.00	-50.67	2.00	11.60	-43.22	-13.00	H
9425.00	-51.41	2.10	11.60	-44.06	-13.00	H
9476.00	-51.06	2.10	11.60	-43.71	-13.00	V

**LTE Band 5, 1.4MHz, 16QAM, Channel 20525**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
8435.75	-51.42	1.80	11.30	-44.07	-13.00	H
9153.25	-51.73	2.10	11.60	-44.38	-13.00	H
9226.75	-51.17	2.10	11.60	-43.82	-13.00	H
9307.50	-51.50	2.00	11.60	-44.05	-13.00	H
9362.75	-52.04	2.00	11.60	-44.59	-13.00	V
9474.25	-50.83	2.10	11.60	-43.48	-13.00	V

**LTE Band 5, 1.4MHz, 16QAM, Channel 20643**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
8475.00	-52.17	1.80	11.30	-44.82	-13.00	H
9103.00	-51.80	2.20	11.60	-44.55	-13.00	H
9227.25	-51.29	2.10	11.60	-43.94	-13.00	H
9301.50	-51.42	2.00	11.60	-43.97	-13.00	H
9477.75	-50.69	2.10	11.60	-43.34	-13.00	V
9720.50	-51.44	2.20	11.20	-44.59	-13.00	H

**LTE Band 5, 1.4MHz, 64QAM, Channel 20407**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
7187.25	-52.54	1.80	12.00	-44.49	-13.00	H
9151.25	-52.00	2.10	11.60	-44.65	-13.00	H
9227.00	-51.19	2.10	11.60	-43.84	-13.00	H
9300.75	-50.88	2.00	11.60	-43.43	-13.00	H
9425.00	-51.48	2.10	11.60	-44.13	-13.00	H
9473.00	-50.80	2.10	11.60	-43.45	-13.00	V

**LTE Band 5, 1.4MHz, 64QAM, Channel 20525**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
8719.00	-52.51	2.00	12.00	-44.66	-13.00	H
9103.75	-52.34	2.20	11.60	-45.09	-13.00	H
9221.75	-51.13	2.10	11.60	-43.78	-13.00	H
9305.50	-51.37	2.00	11.60	-43.92	-13.00	H
9368.00	-52.01	2.00	11.60	-44.56	-13.00	V
9475.50	-51.53	2.10	11.60	-44.18	-13.00	V

**LTE Band 5, 1.4MHz, 64QAM, Channel 20643**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit (dBm)	Polarization
2543.33	-50.95	0.90	10.70	-43.30	-13.00	H
8899.25	-51.90	1.90	12.00	-43.95	-13.00	H
9225.25	-51.42	2.10	11.60	-44.07	-13.00	H
9299.75	-50.11	2.00	11.60	-42.66	-13.00	H
9441.25	-51.82	2.10	11.60	-44.47	-13.00	H
9472.50	-51.34	2.10	11.60	-43.99	-13.00	V

**LTE Band 41, 5MHz, QPSK, Channel 39675**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
4992.86	-40.92	1.30	12.50	-29.72	-25.00	V
7489.00	-39.19	1.90	12.00	-29.09	-25.00	V
16961.50	-48.64	2.90	16.50	-35.04	-25.00	H
17413.00	-46.46	2.90	14.50	-34.86	-25.00	H
17583.50	-44.30	3.30	12.80	-34.80	-25.00	H
17830.00	-43.71	3.60	12.80	-34.51	-25.00	H

**LTE Band 41, 5MHz, QPSK, Channel 40620**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
5181.90	-38.99	1.60	12.50	-28.09	-25.00	V
16986.50	-47.46	2.90	16.50	-33.86	-25.00	H
17143.00	-47.09	2.90	14.50	-35.49	-25.00	H
17501.00	-44.34	2.90	12.80	-34.44	-25.00	H
17547.00	-44.12	2.90	12.80	-34.22	-25.00	H
17839.50	-43.51	3.60	12.80	-34.31	-25.00	H

**LTE Band 41, 5MHz, QPSK, Channel 41565**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
8056.50	-39.02	2.00	11.30	-29.72	-25.00	V
16952.00	-47.78	2.90	16.50	-34.18	-25.00	H
17369.00	-46.19	3.20	14.50	-34.89	-25.00	H
17480.50	-46.76	2.90	14.50	-35.16	-25.00	H
17574.00	-43.58	3.30	12.80	-34.08	-25.00	H
17818.50	-43.92	3.60	12.80	-34.72	-25.00	H

**LTE Band 41, 5MHz, 16QAM, Channel 39675**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
4992.86	-41.32	1.30	12.50	-30.12	-25.00	V
7488.50	-41.82	1.90	12.00	-31.72	-25.00	V
17346.00	-45.96	3.20	14.50	-34.66	-25.00	H
17456.00	-46.67	2.90	14.50	-35.07	-25.00	H
17594.00	-44.13	3.30	12.80	-34.63	-25.00	H
17827.00	-43.30	3.60	12.80	-34.10	-25.00	H

**LTE Band 41, 5MHz, 16QAM, Channel 40620**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
5182.38	-40.35	1.60	12.50	-29.45	-25.00	V
16939.00	-48.01	2.90	16.50	-34.41	-25.00	H
17294.00	-46.47	3.20	14.50	-35.17	-25.00	H
17447.00	-46.34	2.90	14.50	-34.74	-25.00	H
17578.00	-44.31	3.30	12.80	-34.81	-25.00	H
17832.00	-43.91	3.60	12.80	-34.71	-25.00	H

**LTE Band 41, 5MHz, 16QAM, Channel 41565**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
5370.95	-41.09	1.30	12.50	-29.89	-25.00	V
16960.00	-48.50	2.90	16.50	-34.90	-25.00	H
17353.50	-46.05	3.20	14.50	-34.75	-25.00	H
17409.00	-46.44	2.90	14.50	-34.84	-25.00	H
17590.50	-44.26	3.30	12.80	-34.76	-25.00	H
17775.00	-43.63	3.60	12.80	-34.43	-25.00	H

**LTE Band 41, 5MHz, 64QAM, Channel 39675**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
7488.50	-44.12	1.90	12.00	-34.02	-25.00	H
17212.50	-46.11	2.90	14.50	-34.51	-25.00	H
17320.00	-45.67	3.20	14.50	-34.37	-25.00	H
17517.50	-45.30	2.90	12.80	-35.40	-25.00	H
17589.00	-44.00	3.30	12.80	-34.50	-25.00	H
17771.50	-43.92	3.60	12.80	-34.72	-25.00	H

**LTE Band 41, 5MHz, 64QAM, Channel 40620**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
5181.43	-40.95	1.60	12.50	-30.05	-25.00	V
7772.00	-40.59	1.80	11.30	-31.09	-25.00	V
16971.00	-48.48	2.90	16.50	-34.88	-25.00	H
17517.50	-43.99	2.90	12.80	-34.09	-25.00	H
17590.50	-44.28	3.30	12.80	-34.78	-25.00	H
17838.50	-43.82	3.60	12.80	-34.62	-25.00	H

**LTE Band 41, 5MHz, 64QAM, Channel 41565**

Frequency(MHz)	P <sub>Mea</sub> (dBm)	Path Loss	Antenna Gain	Peak EIRP(dBm)	Limit (dBm)	Polarization
5370.48	-41.45	1.30	12.50	-30.25	-25.00	V
17006.00	-46.36	2.90	14.50	-34.76	-25.00	H
17301.50	-45.77	3.20	14.50	-34.47	-25.00	H
17507.00	-44.01	2.90	12.80	-34.11	-25.00	H
17526.00	-44.57	2.90	12.80	-34.67	-25.00	H
17821.50	-43.79	3.60	12.80	-34.59	-25.00	H

Note: The maximum value of expanded measurement uncertainty for this test item is  $U = 2.87\text{dB}(30\text{MHz}-3\text{GHz})/3.35\text{dB}(3\text{GHz}-18\text{GHz})/2.68\text{dB}(18\text{GHz}-40\text{GHz})$ ,  $k = 2$



### **A.3 FREQUENCY STABILITY**

#### **Reference**

FCC: CFR Part 2.1055, 22.355, 27.54.

#### **A.3.1 Method of Measurement**

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the EUT in a "call mode". This is accomplished with the use of R&S CMW500.

1. Measure the carrier frequency at room temperature.
2. Subject the EUT to overnight soak at -30°C.
3. With the EUT, powered via nominal voltage, connected to the CMW500 and in a simulated call on mid channel of all bands, measure the carrier frequency. These measurements should be made within 2 minutes of Powering up the EUT, to prevent significant self-warming.
4. Repeat the above measurements at 10°C increments from -30°C to +50°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with nominal voltage. Vary supply voltage from minimum voltage to maximum voltage, in 0.1Volt increments remeasuring carrier frequency at each voltage. Pause at nominal voltage for 1.5 hours unpowered, to allow any self-heating to stabilize, before continuing.
6. Subject the EUT to overnight soak at +50°C.
7. With the EUT, powered via nominal voltage, connected to the CMW500 and in a simulated call on the center channel, measure the carrier frequency. These measurements should be made within 2 minutes of Powering up the EUT, to prevent significant self-warming.
8. Repeat the above measurements at 10°C increments from -30°C to +50°C. Allow at least 1 1/2 hours at each temperature, unpowered, before making measurements.
9. At all temperature levels hold the temperature to +/- 0.5°C during the measurement procedure.

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block. As this transceiver is considered "Hand carried, battery powered equipment" Section 2.1055(d)(2) applies. This requires that the lower voltage for frequency stability testing be specified by the manufacturer. This transceiver is specified to operate with an input voltage of the lower, higher and nominal voltage. Operation above or below these voltage limits is prohibited by transceiver software in order to prevent improper operation as well as to protect components from overstress.



**A.3.2 Measurement results**
**LTE Band 5, 5MHz bandwidth (worst case of all bandwidths)**
**Frequency Error vs Temperature**

Temperature(°C)	Voltage(V)	FL(MHz)	FH(MHz)	Offset(Hz)	Frequency error(ppm)
50	12.00	824.360	848.670		
40				-1.02	0.0012
30				-0.47	0.0006
20				-3.09	0.0037
10				-3.19	0.0038
0				-3.79	0.0045
-10				-3.88	0.0046
-20				-5.65	0.0068
-30				-4.64	0.0055

**Frequency Error vs Voltage**

Voltage(V)	Temperature(°C)	FL(MHz)	FH(MHz)	Offset(Hz)	Frequency error(ppm)
6.60	20	824.360	848.670	-6.37	0.0076
15.00				-6.58	0.0079

 Expanded measurement uncertainty is 10 Hz,  $k = 2$ 
**LTE band 41, 20MHz bandwidth QPSK(worst case of all bandwidths)**
**Frequency Error vs Temperature**

Temperature(°C)	Voltage(V)	FL(MHz)	FH(MHz)	Offset(Hz)	Frequency error(ppm)
20	12.00	2496.560	2689.340		
50				2.89	0.0011
40				2.07	0.0008
30				1.89	0.0007
10				0.12	0.0000
0				1.66	0.0006
-10				4.15	0.0016
-20				-2.29	0.0009
-30				1.03	0.0004

**Frequency Error vs Voltage**

Voltage(V)	Temperature(°C)	FL(MHz)	FH(MHz)	Offset(Hz)	Frequency error(ppm)
6.60	20	2496.560	2689.340	2.83	0.0011
15.00				-0.54	0.0002

 Expanded measurement uncertainty is 10 Hz,  $k = 2$

## **A.4 OCCUPIED BANDWIDTH**

### **Reference**

FCC: CFR Part 2.1049, 22.917, 27.53.

### **A.4.1 Occupied Bandwidth Results**

Occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the US Cellular/PCS frequency bands. The table below lists the measured 99% BW. Spectrum analyzer plots are included on the following pages.

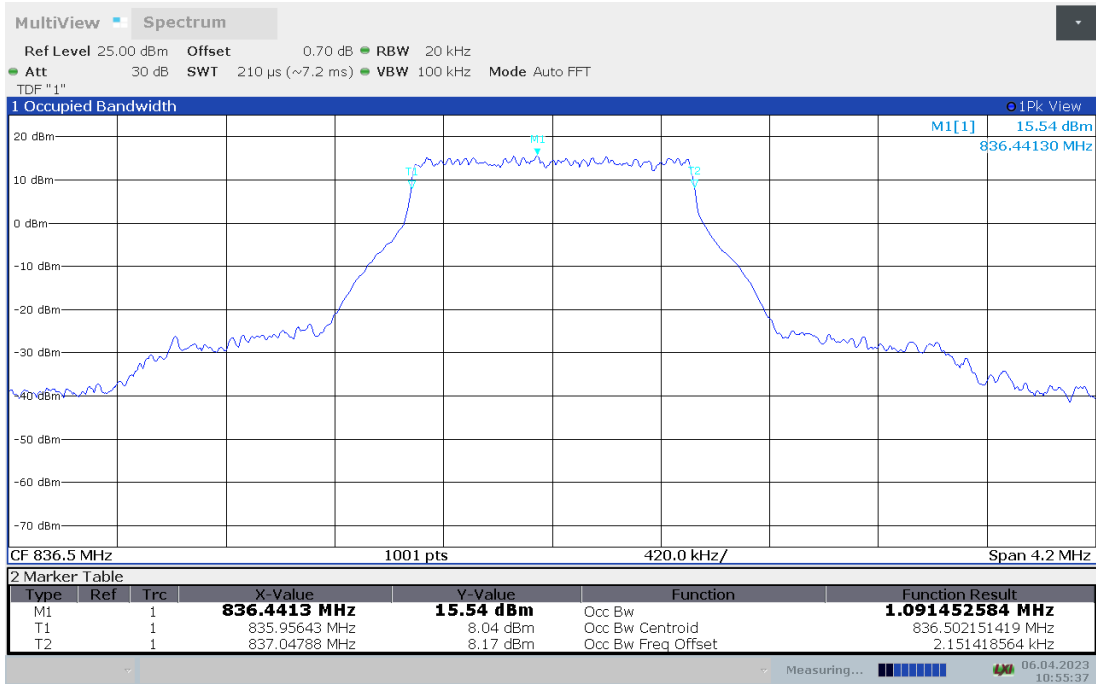
- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (i.e., two to five times the OBW).
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.
- c) Set the reference level of the instrument as required to keep the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope must be at least  $10\log(\text{OBW} / \text{RBW})$  below the reference level.
- d) Set the detection mode to peak, and the trace mode to max hold.
- e) Use the 99 % power bandwidth function of the spectrum analyzer and report the measured bandwidth.



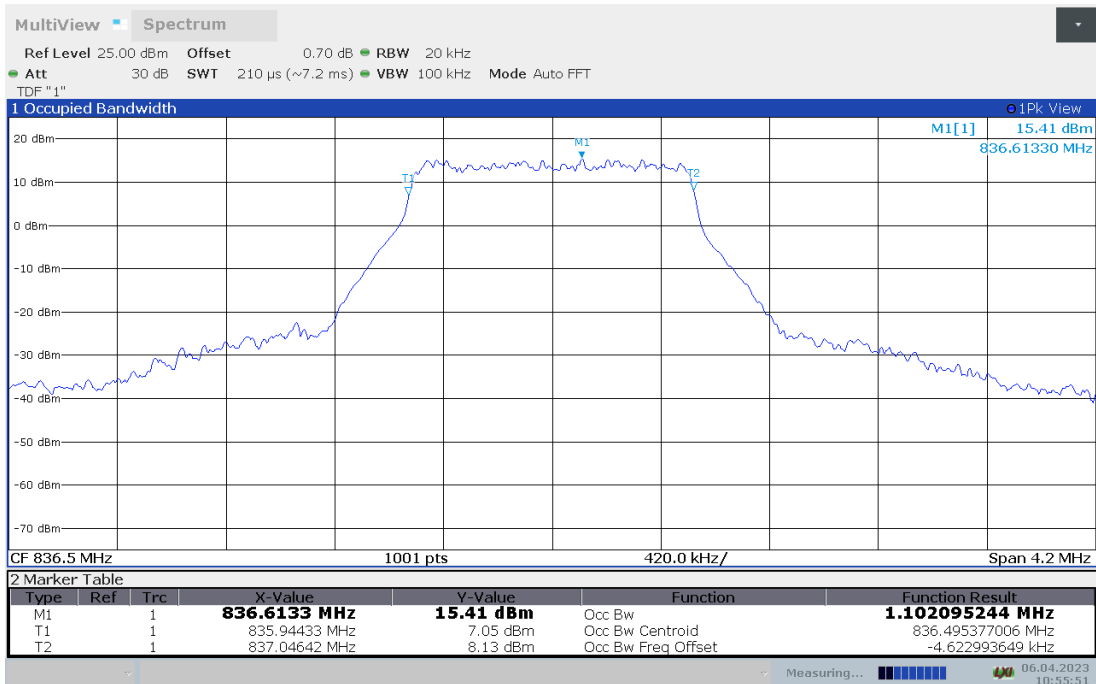
**LTE band 5,1.4MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
836.5	1.091	1.102

**LTE band 5 , 1.4MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 5 , 1.4MHz Bandwidth, MID, 16QAM (99% BW)**

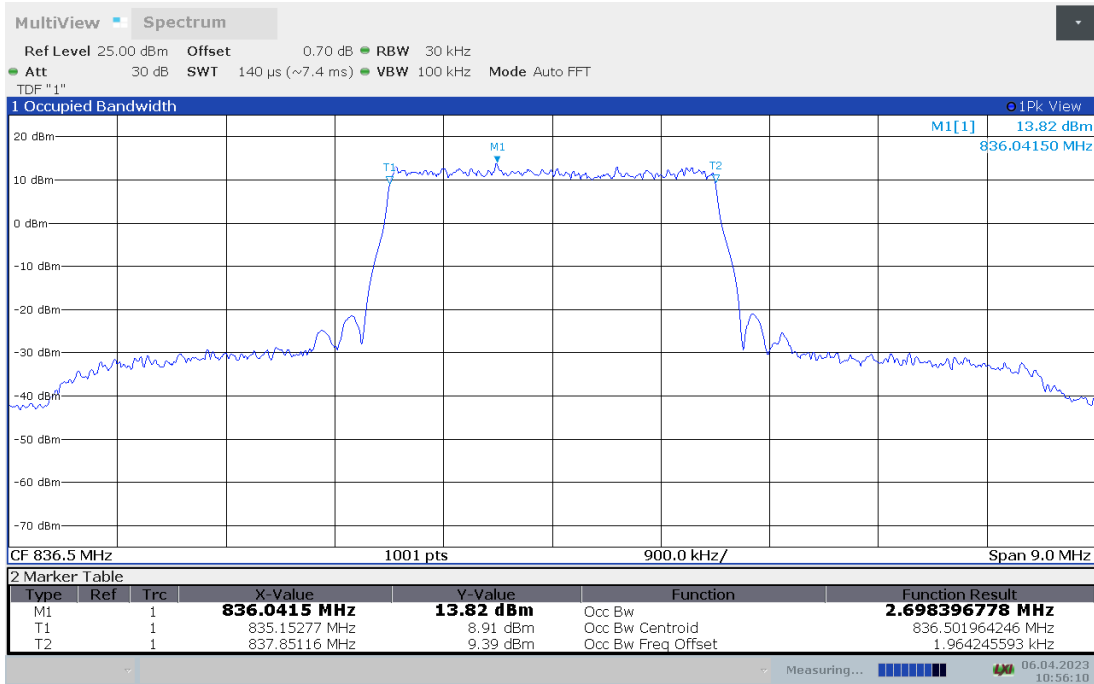




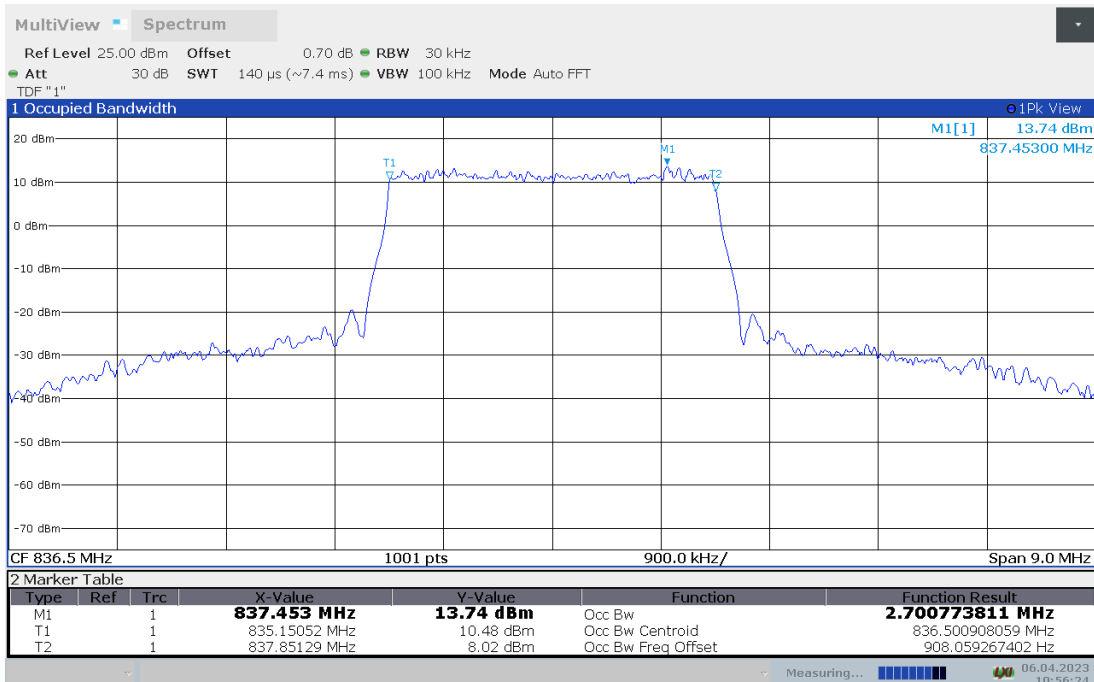
**LTE band 5,3MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
836.5	2.698	2.701

**LTE band 5 , 3MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 5 , 3MHz Bandwidth, MID, 16QAM (99% BW)**

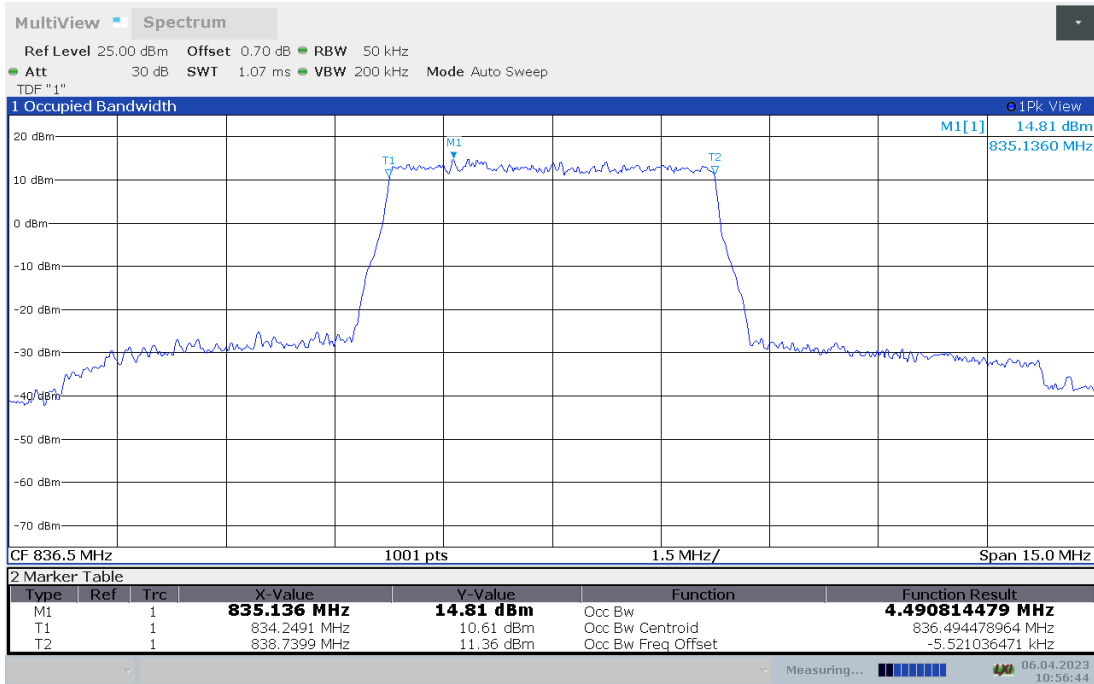




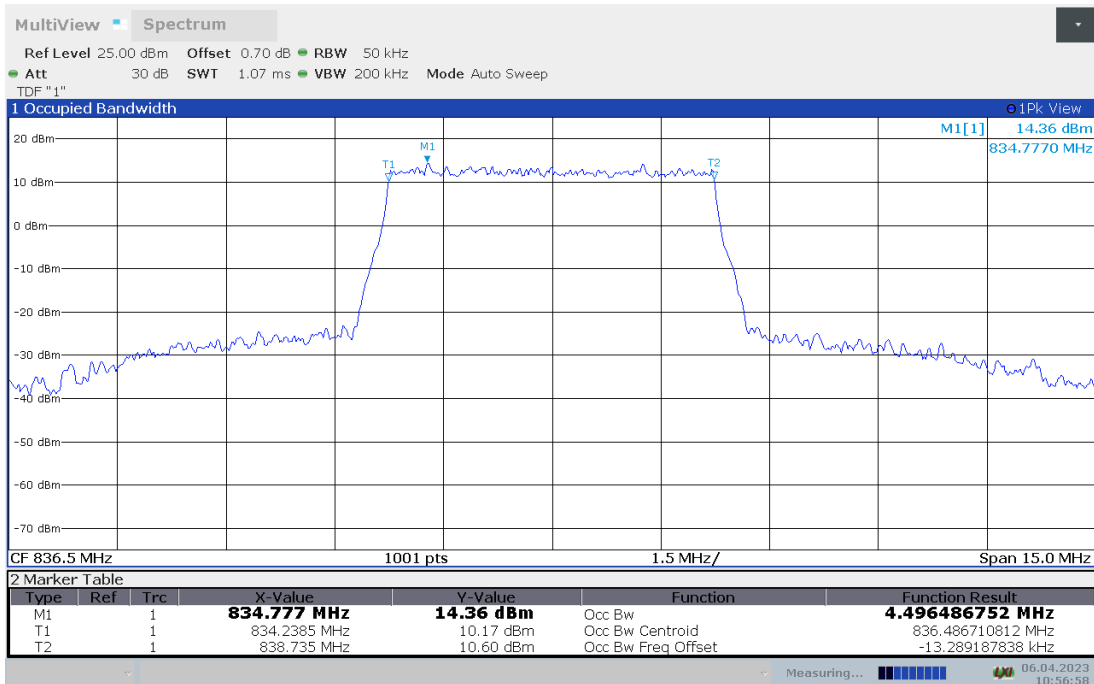
**LTE band 5,5MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
836.5	4.491	4.496

**LTE band 5 , 5MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 5 , 5MHz Bandwidth, MID, 16QAM (99% BW)**

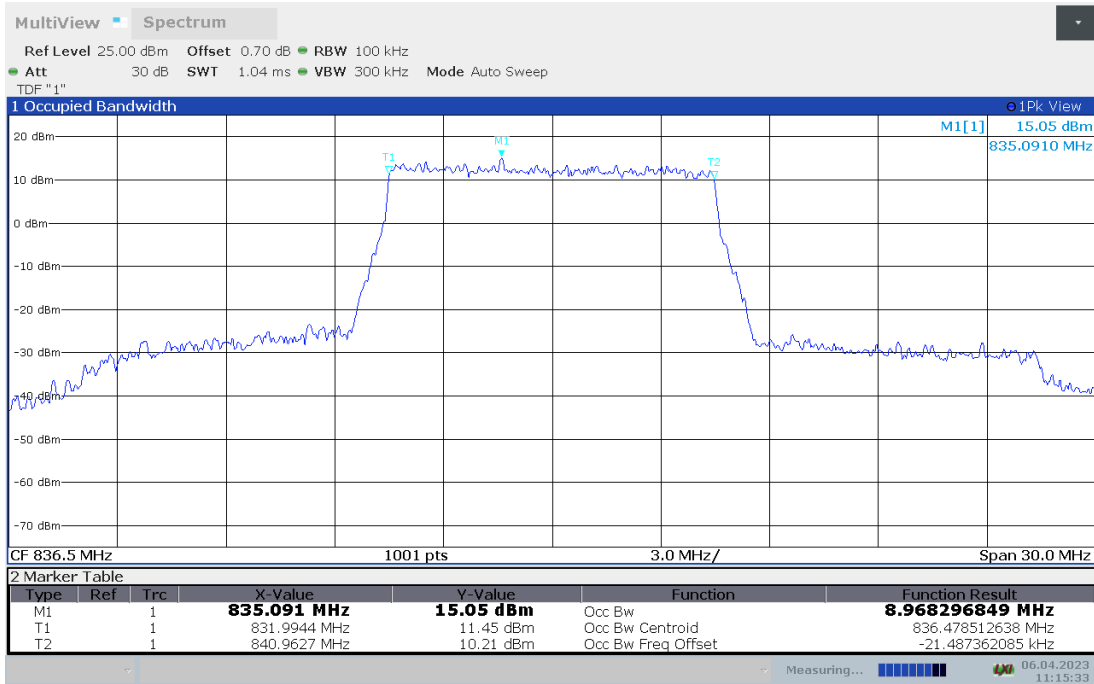




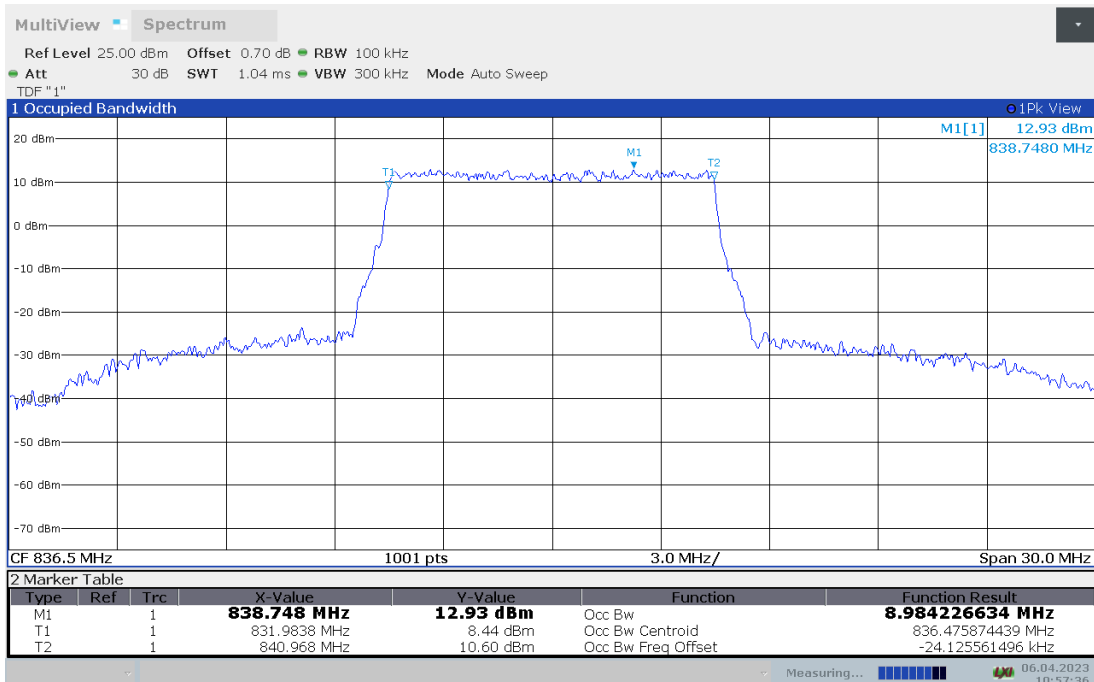
**LTE band 5,10MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
836.5	8.968	8.984

**LTE band 5 , 10MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 5 , 10MHz Bandwidth, MID, 16QAM (99% BW)**

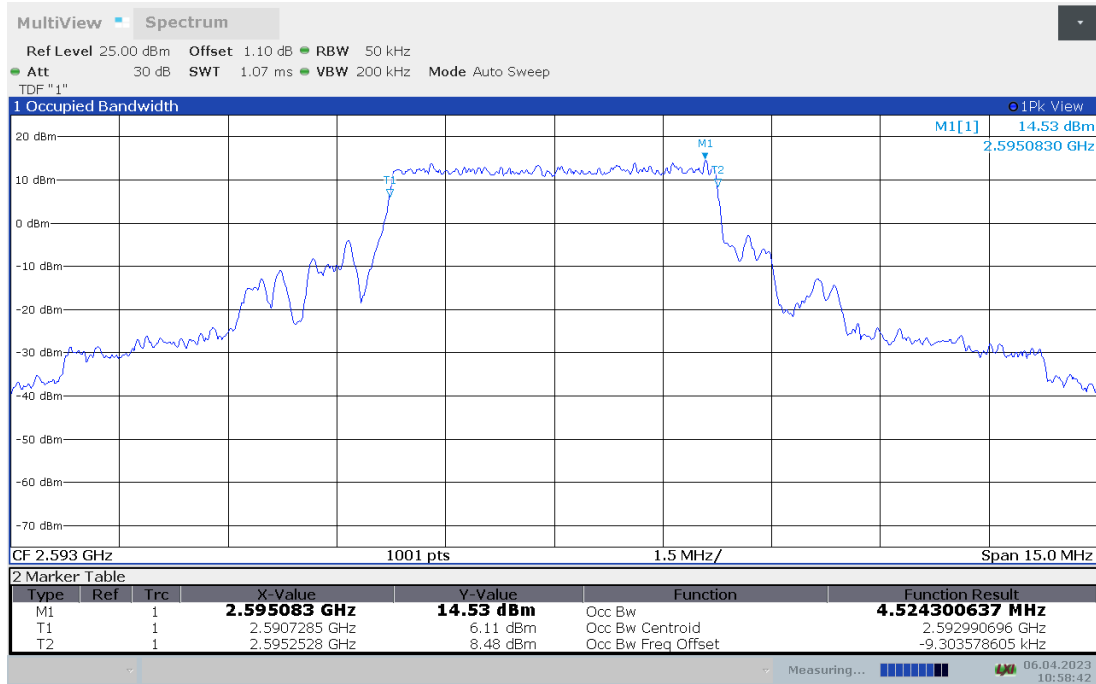




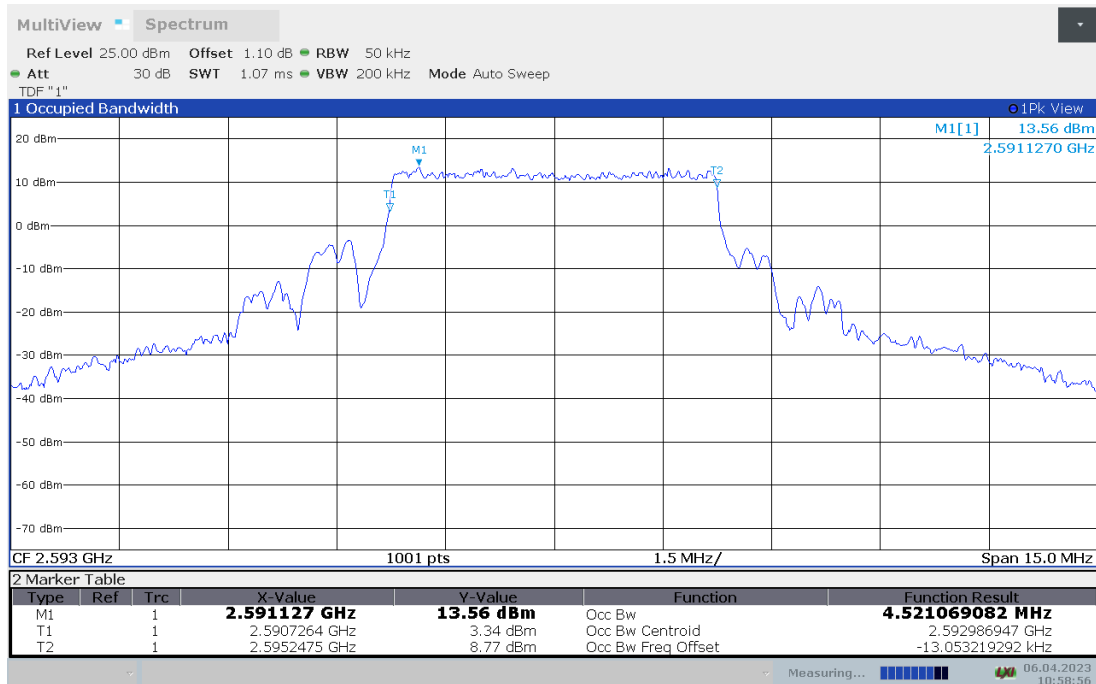
**LTE band 41,5MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
2593	4.524	4.521

**LTE band 41 , 5MHz Bandwidth, MID, QPSK (99% BW)**



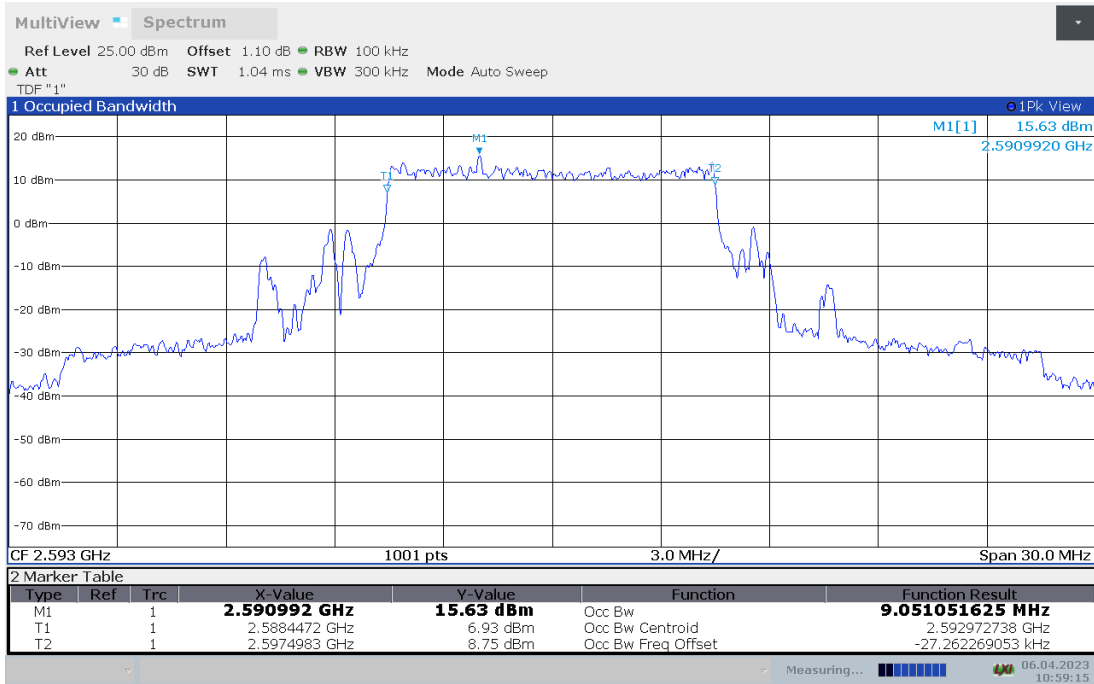
**LTE band 41 , 5MHz Bandwidth, MID, 16QAM (99% BW)**



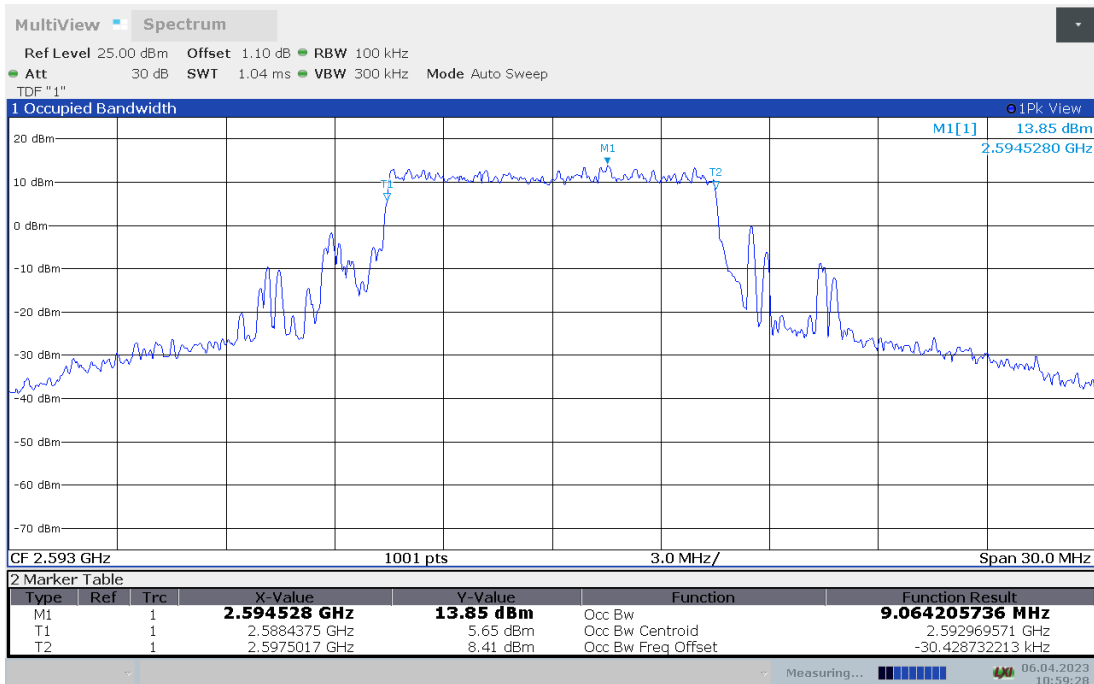
**LTE band 41,10MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
2593	9.051	9.064

**LTE band 41 , 10MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 41 , 10MHz Bandwidth, MID, 16QAM (99% BW)**



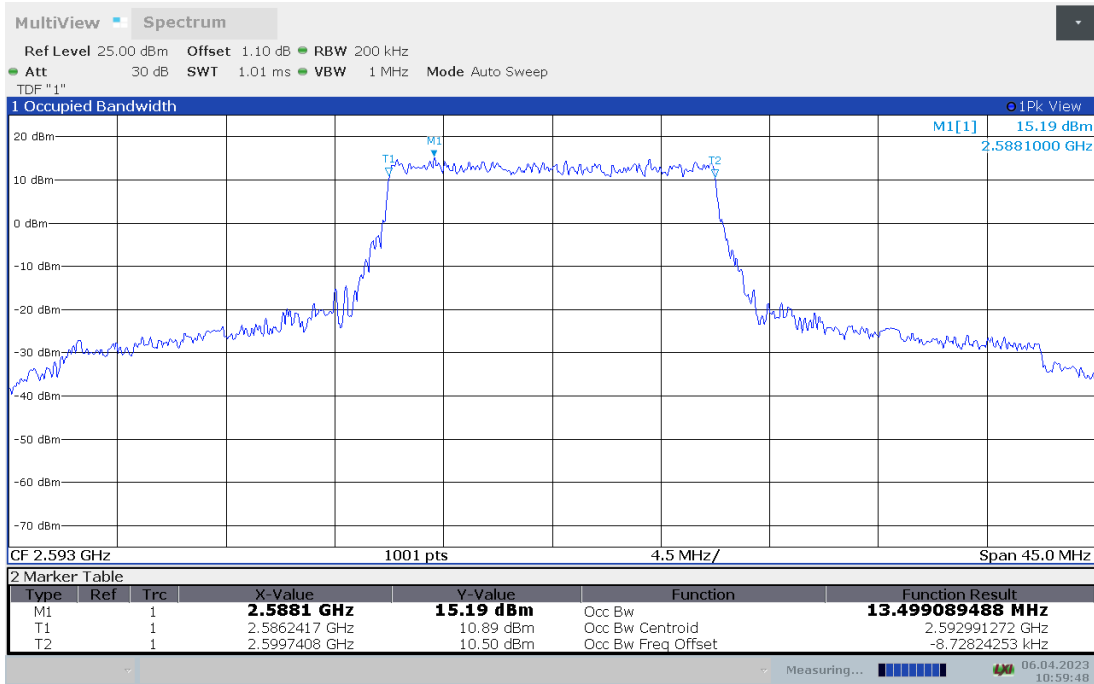




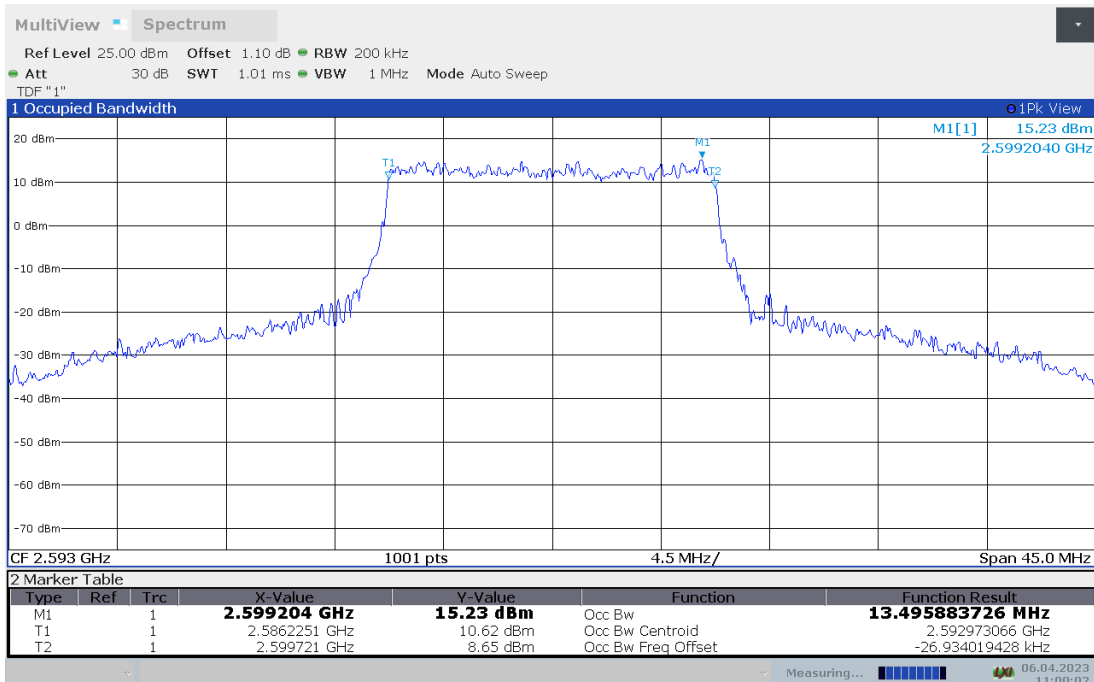
**LTE band 41,15MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
2593	13.499	13.496

**LTE band 41 , 15MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 41 , 15MHz Bandwidth, MID, 16QAM (99% BW)**

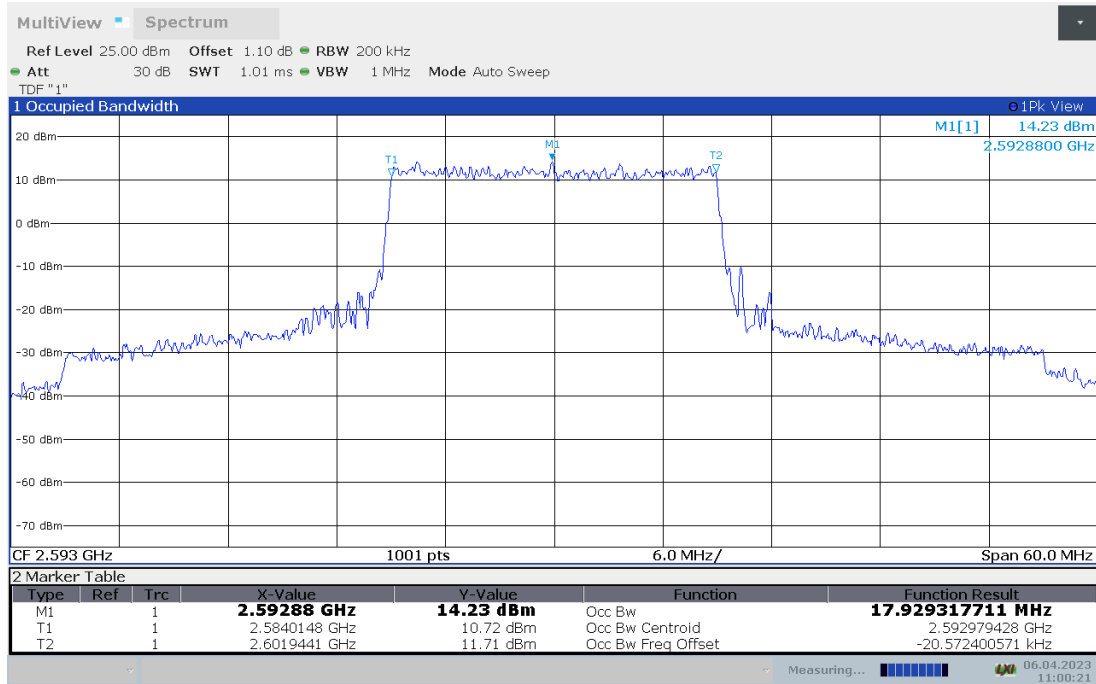




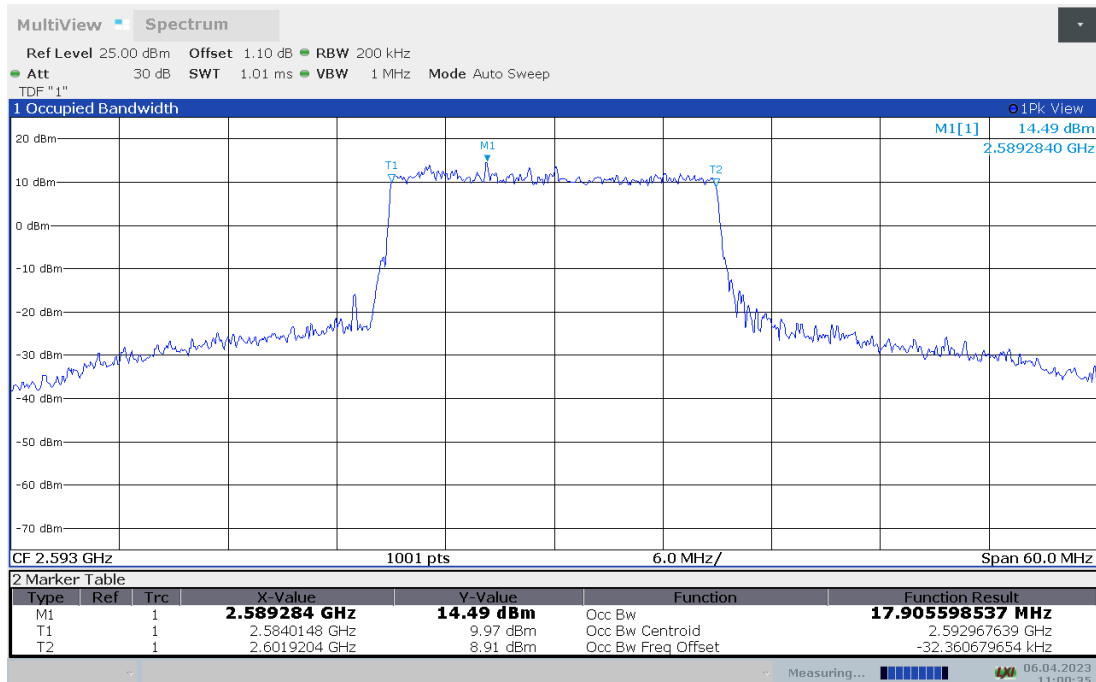
**LTE band 41,20MHz(99%)**

Frequency (MHz)	Occupied Bandwidth (99%)(MHz)	
	QPSK	16QAM
2593	17.929	17.906

**LTE band 41 , 20MHz Bandwidth, MID, QPSK (99% BW)**



**LTE band 41 , 20MHz Bandwidth, MID, 16QAM (99% BW)**



Note: Expanded measurement uncertainty is  $U = 3428 \text{ Hz}$ ,  $k = 2$



## **A.5 EMISSION BANDWIDTH**

### **Reference**

FCC: CFR Part 2.1049, 22.917, 27.53.

### **A.5.1 Measurement Procedure**

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

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (i.e., two to five times the OBW).
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.
- c) Set the reference level of the instrument as required to keep the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope must be at least  $10\log(\text{OBW} / \text{RBW})$  below the reference level.
- d) Set the detection mode to peak, and the trace mode to max hold.
- e) Use the 26dB bandwidth function of the spectrum analyzer and report the measured bandwidth.

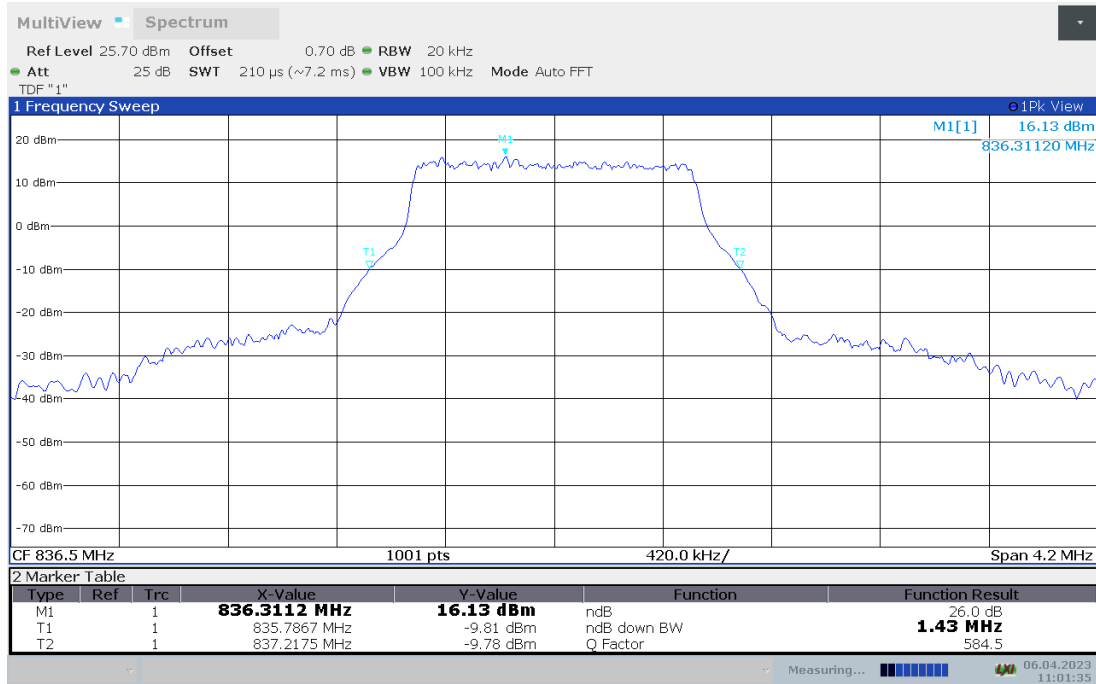
### **A.5.2 Emission Bandwidth Results**

Similar to conducted emissions; Emission bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies. Table below lists the measured -26dBc BW. Spectrum analyzer plots are included on the following pages.

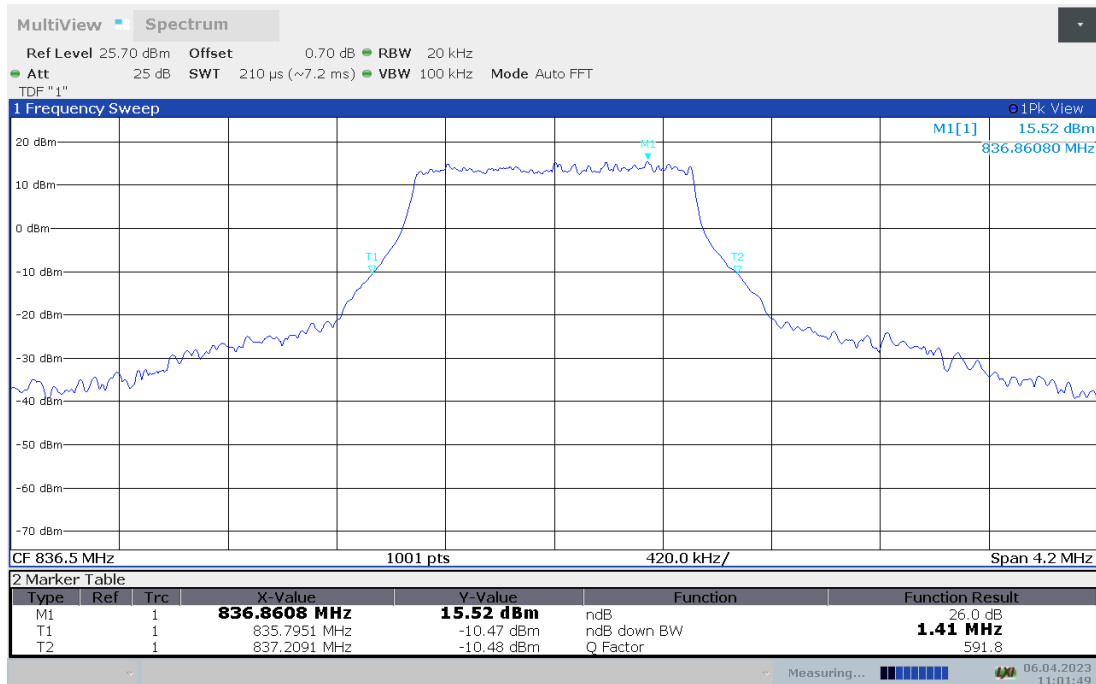
**LTE band 5,1.4MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
836.5	1.431	1.414

**LTE band 5 , 1.4MHz Bandwidth, MID, QPSK (-26dBc BW)**



**LTE band 5 , 1.4MHz Bandwidth, MID, 16QAM (-26dBc BW)**

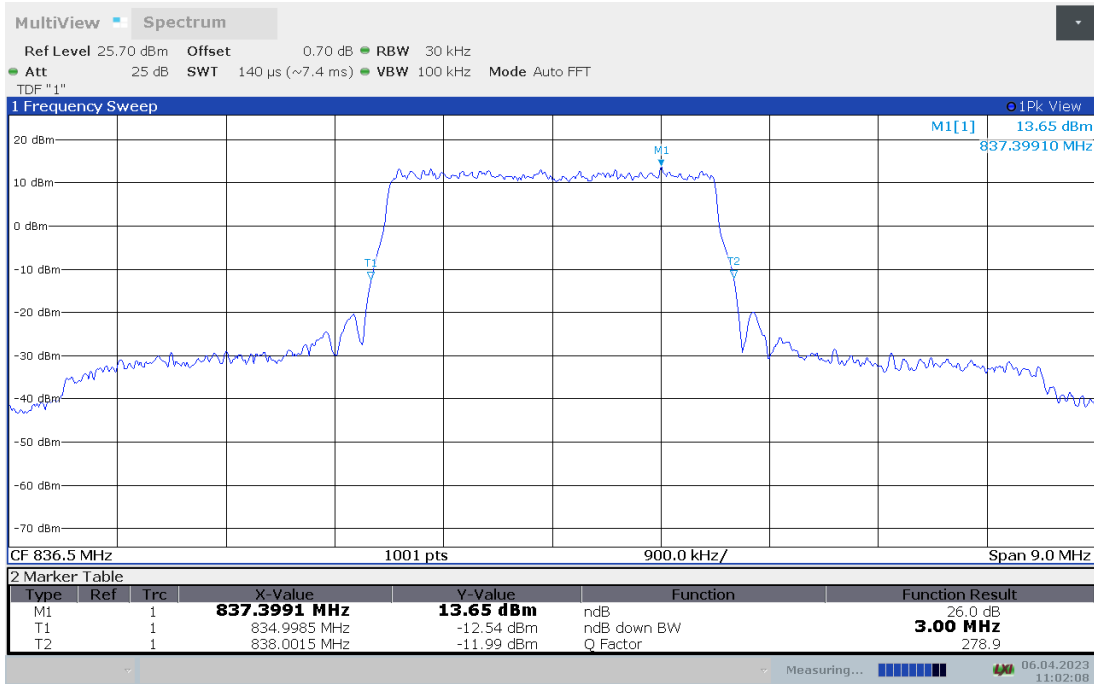




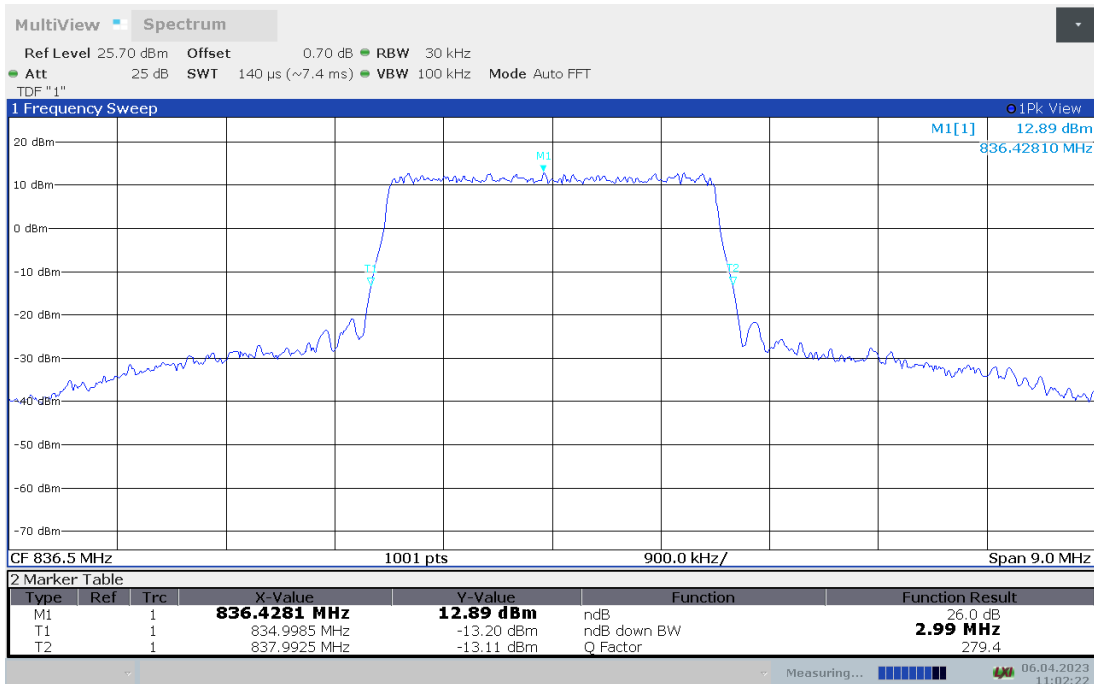
**LTE band 5,3MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
836.5	3.003	2.994

**LTE band 5 , 3MHz Bandwidth, MID, QPSK (-26dBc BW)**



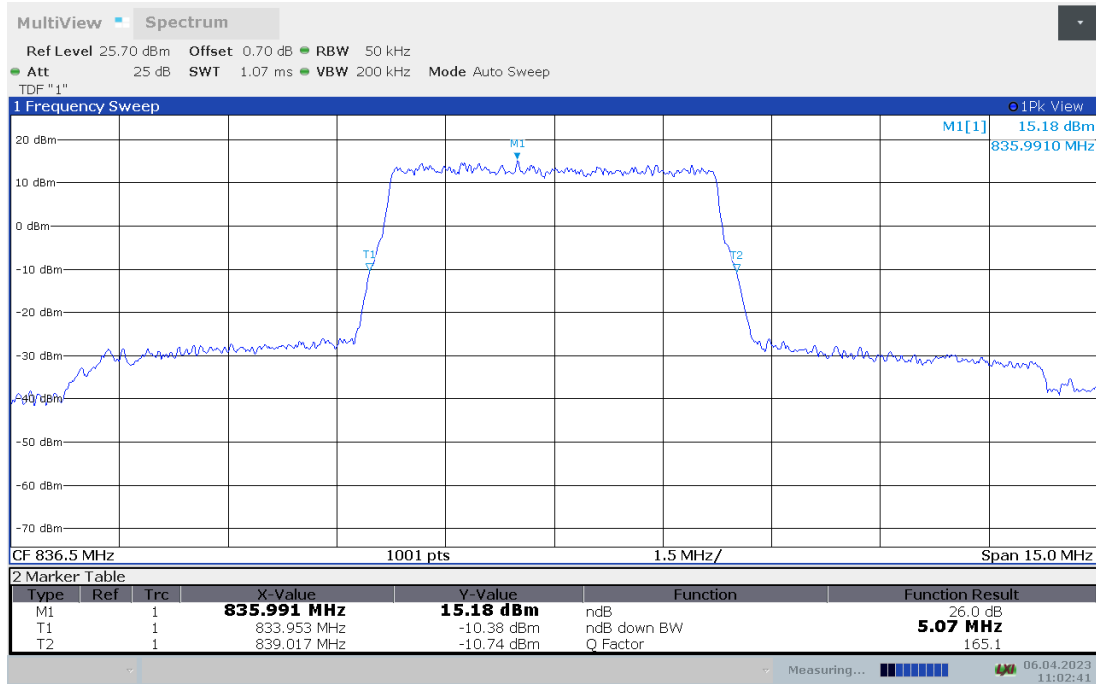
**LTE band 5 , 3MHz Bandwidth, MID, 16QAM (-26dBc BW)**



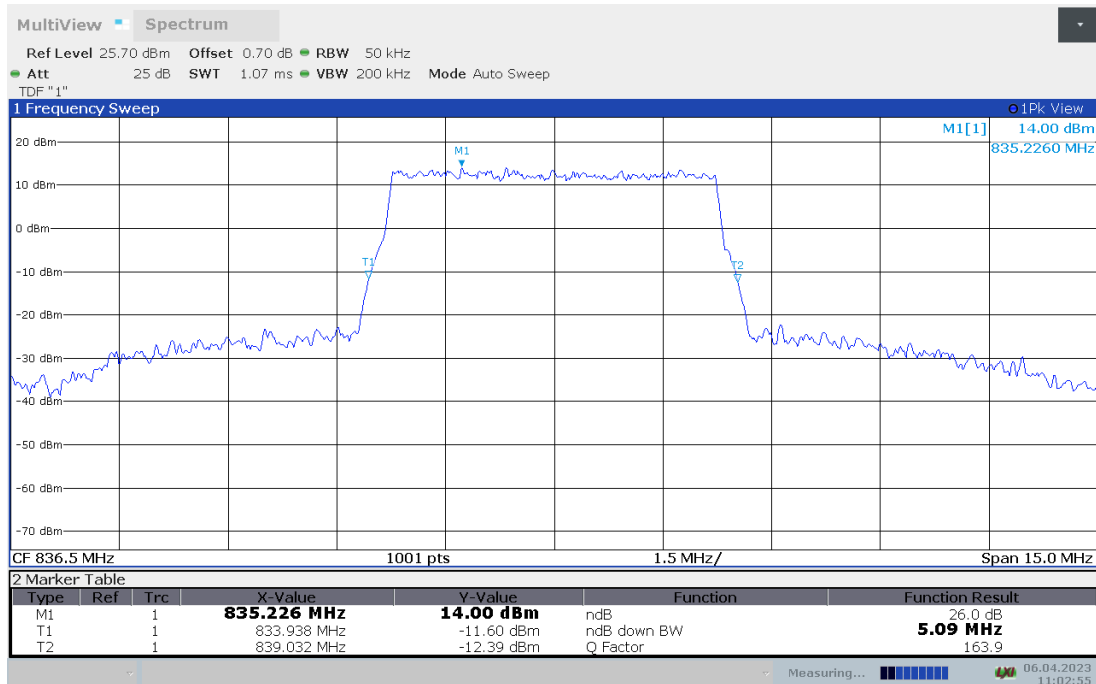
**LTE band 5,5MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
836.5	5.065	5.095

**LTE band 5 , 5MHz Bandwidth, MID, QPSK (-26dBc BW)**



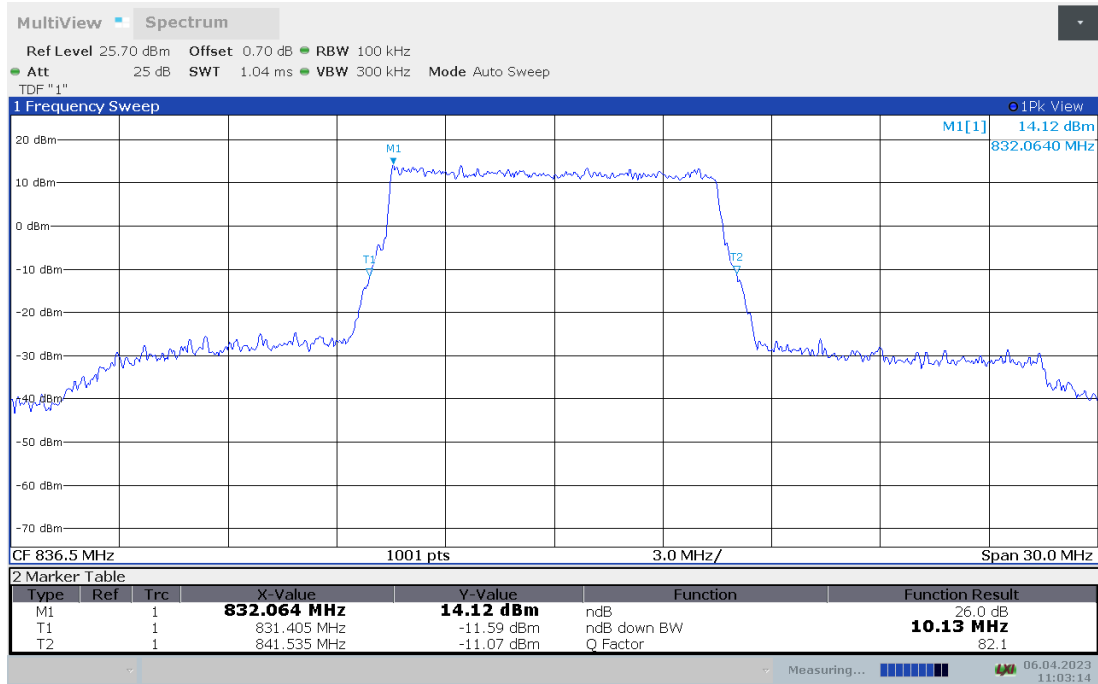
**LTE band 5 , 5MHz Bandwidth, MID, 16QAM (-26dBc BW)**



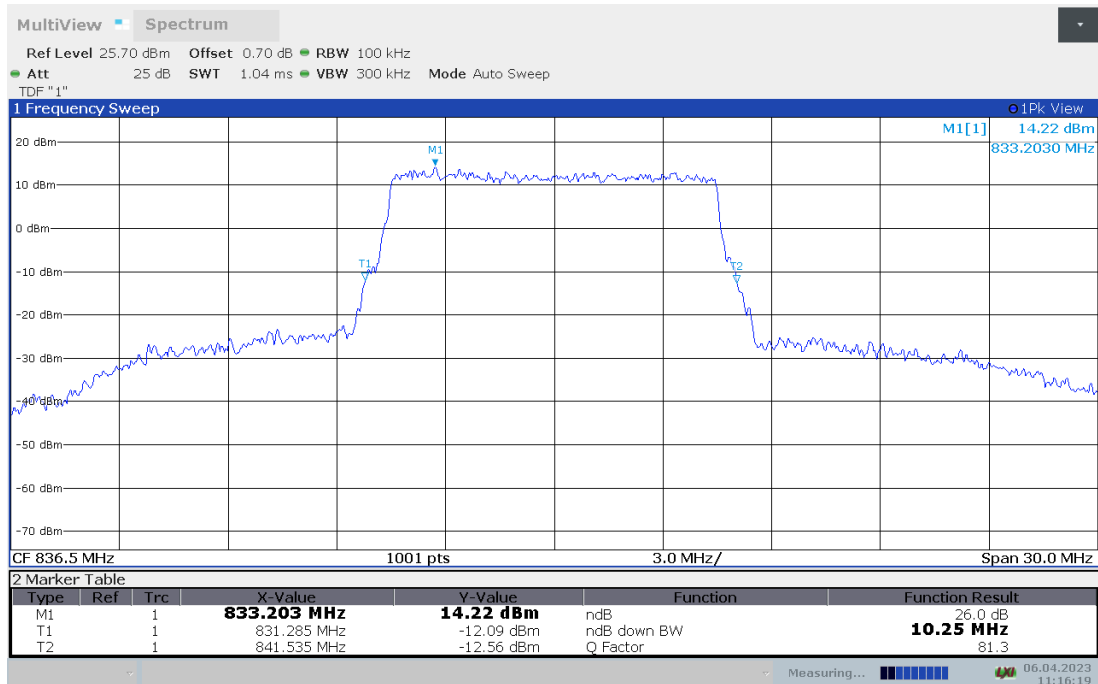
**LTE band 5,10MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
836.5	10.130	10.250

**LTE band 5 , 10MHz Bandwidth, MID, QPSK (-26dBc BW)**



**LTE band 5 , 10MHz Bandwidth, MID, 16QAM (-26dBc BW)**



**LTE band 41,5MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
2593	5.095	5.350

**LTE band 41 , 5MHz Bandwidth, MID, QPSK (-26dBc BW)**



**LTE band 41 , 5MHz Bandwidth, MID, 16QAM (-26dBc BW)**

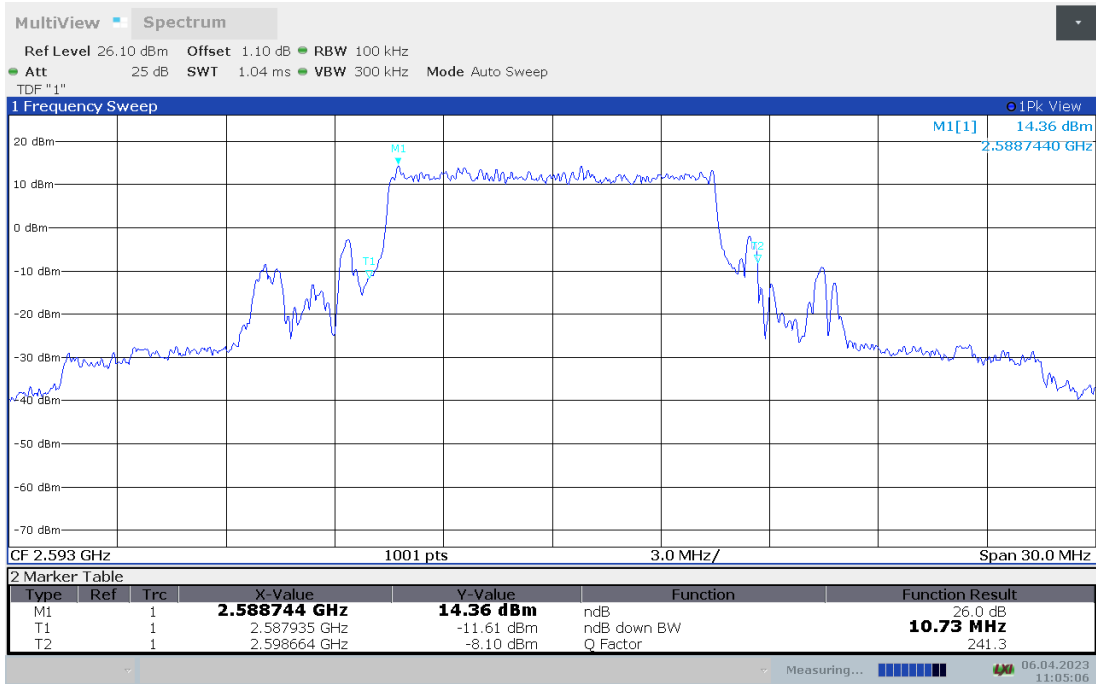




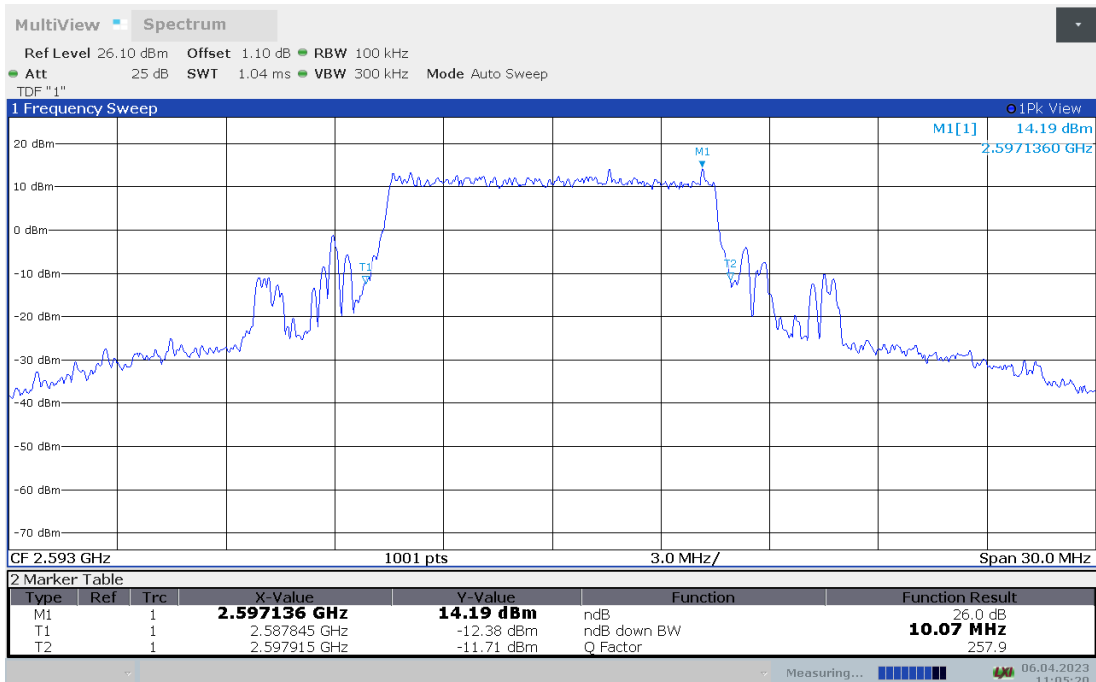
**LTE band 41,10MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
2593	10.729	10.070

**LTE band 41 , 10MHz Bandwidth, MID, QPSK (-26dBc BW)**



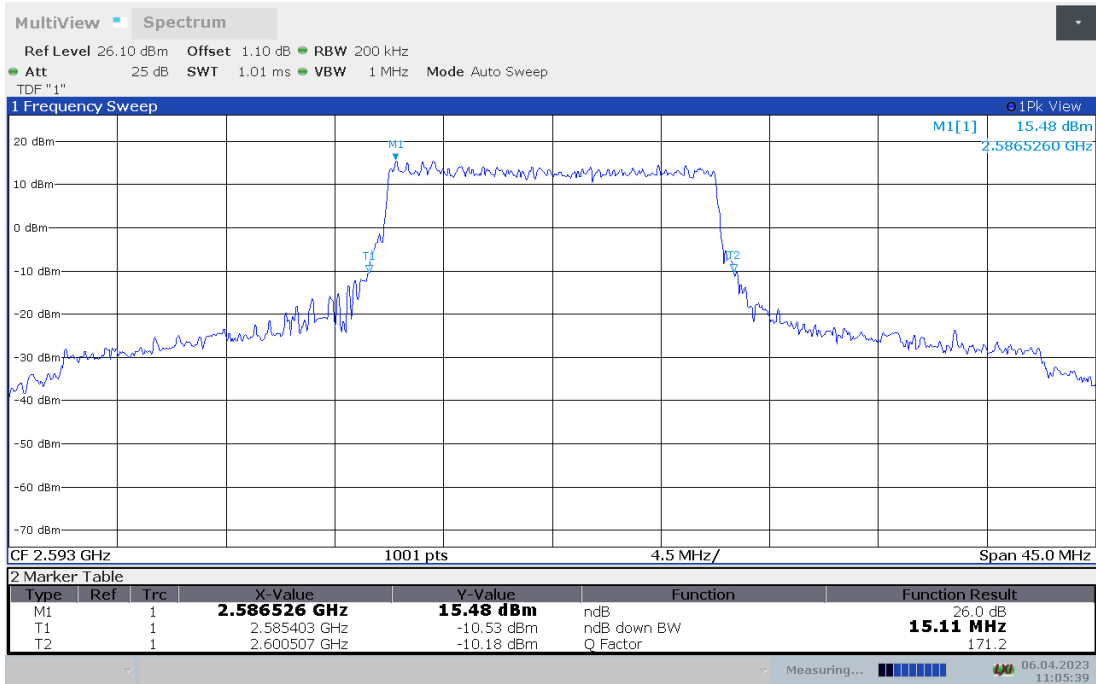
**LTE band 41 , 10MHz Bandwidth, MID, 16QAM (-26dBc BW)**



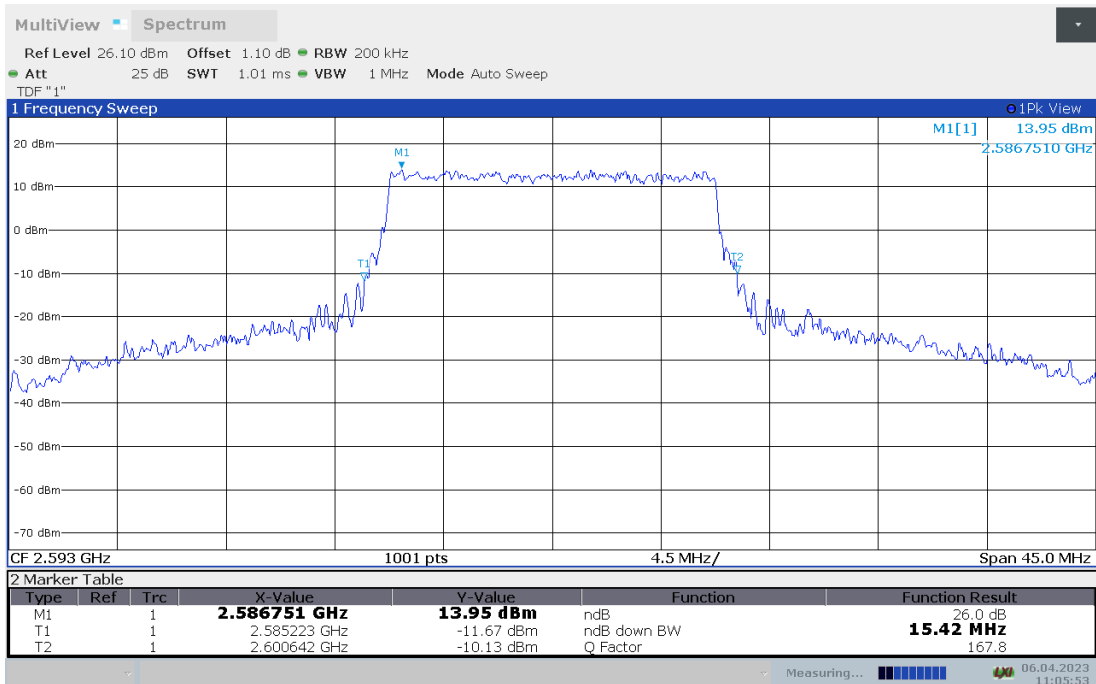
**LTE band 41,15MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
2593	15.105	15.420

**LTE band 41 , 15MHz Bandwidth, MID, QPSK (-26dBc BW)**



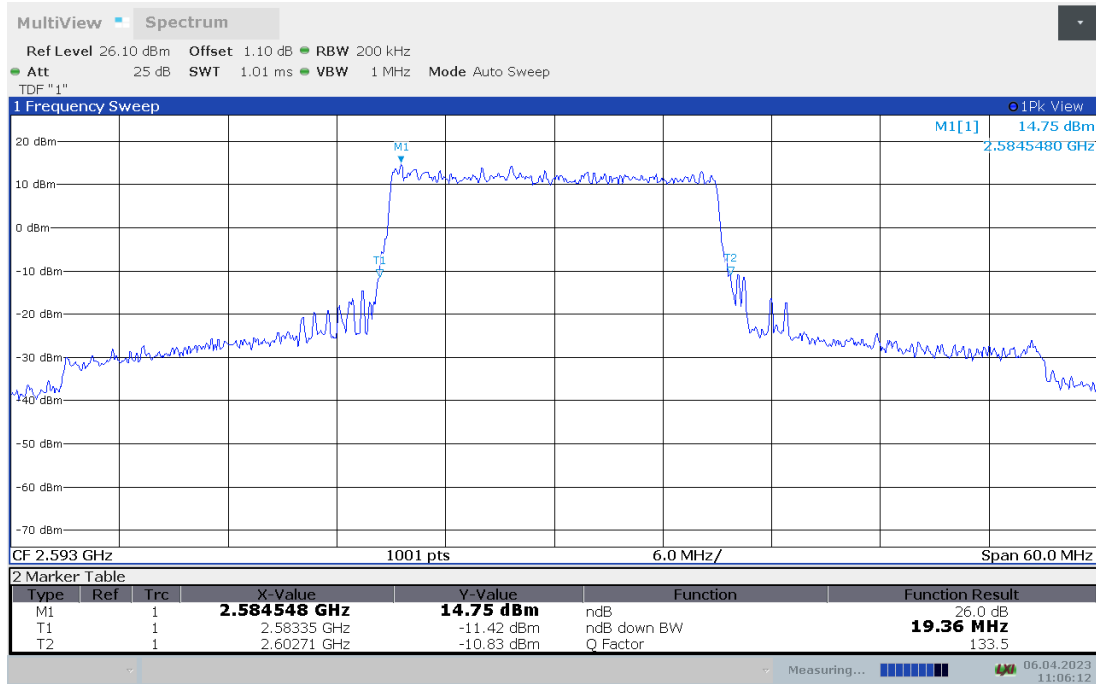
**LTE band 41 , 15MHz Bandwidth, MID, 16QAM (-26dBc BW)**



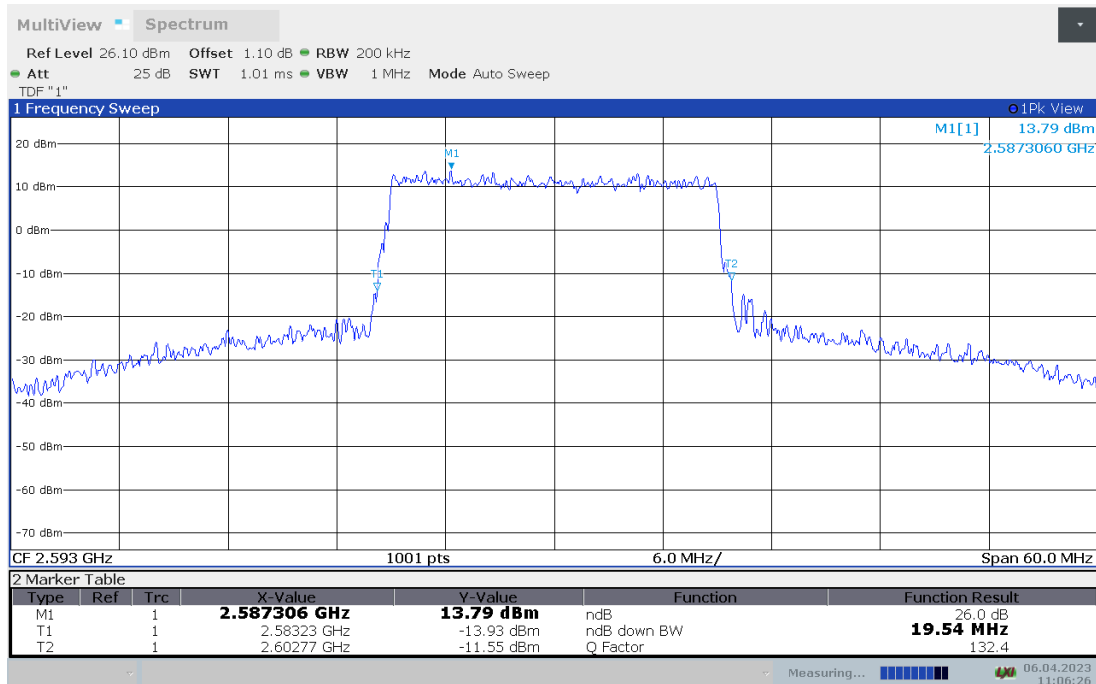
**LTE band 41,20MHz(-26dBc)**

Frequency(MHz)	Emission Bandwidth (-26dBc)(MHz)	
	QPSK	16QAM
2593	19.361	19.540

**LTE band 41 , 20MHz Bandwidth, MID, QPSK (-26dBc BW)**



**LTE band 41 , 20MHz Bandwidth, MID, 16QAM (-26dBc BW)**



Note: Expanded measurement uncertainty is  $U = 3428 \text{ Hz}$ ,  $k = 2$

## **A.6 BAND EDGE COMPLIANCE**

### **Reference**

FCC: CFR Part 2.1051, 22.917, 27.53.

### **A.6.1 Measurement limit**

Part 22.917 For operations in the 824–849MHz band, the FCC limit is  $43 + 10 \log (P)$  dB below the transmitter power(P) in a 100kHz bandwidth. However, in the 1MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Part 27.53(h) specify that 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.

Part 27.53(m) specifies for mobile digital stations, the attenuation factor shall be not less than  $40 + 10 \log (P)$  dB on all frequencies between the channel edge and 5 megahertz from the channel edge,  $43 + 10 \log (P)$  dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and  $55 + 10 \log (P)$  dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that  $43 + 10 \log (P)$  dB on all frequencies between 2490.5 MHz and 2496 MHz and  $55 + 10 \log (P)$  dB at or below 2490.5MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

Part 27.53(g) states for operations in the 600 MHz band and the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

### **A.6.2 Measurement Procedure**

The testing follows ANSI C63.26

- a) The EUT was connected to spectrum analyzer and system simulator via a power divider.
- b) The band edges of low and high channels for the highest RF powers were measured.
- c) Set RBW  $\geq$  1% EBW in the 1MHz band immediately outside and adjacent to the band edge.
- d) Set spectrum analyzer with RMS detector.
- e) The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
- f) Checked that all the results comply with the emission limit line.

### **A.6.3 Measurement result**

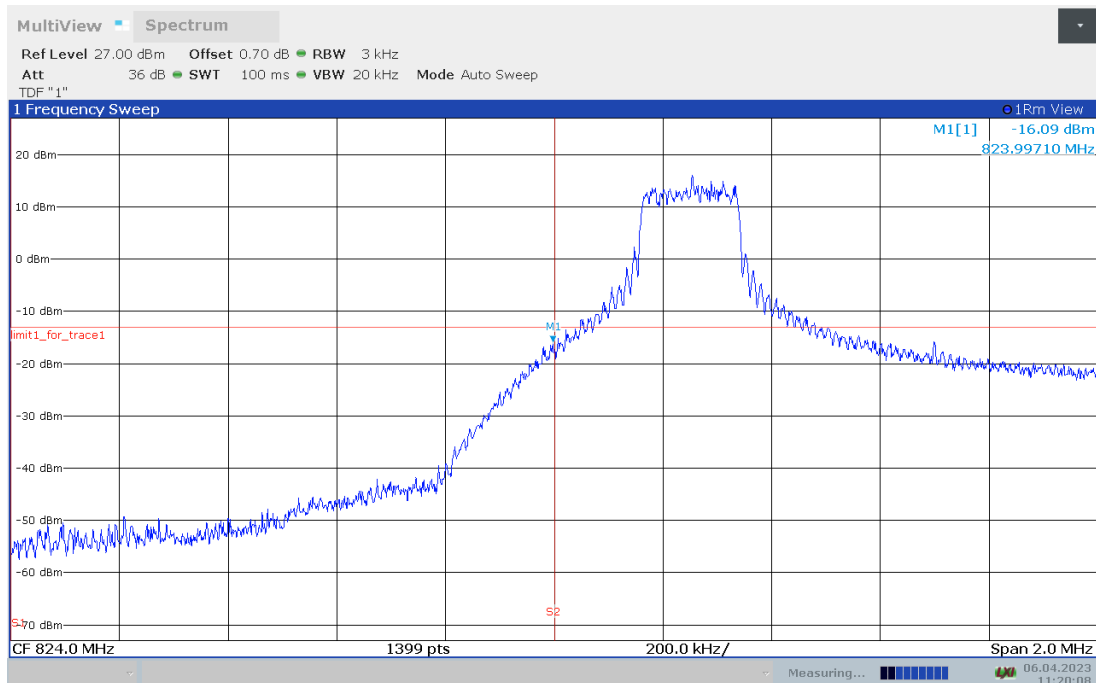
**Only worst case result is given below**

LTE band 5

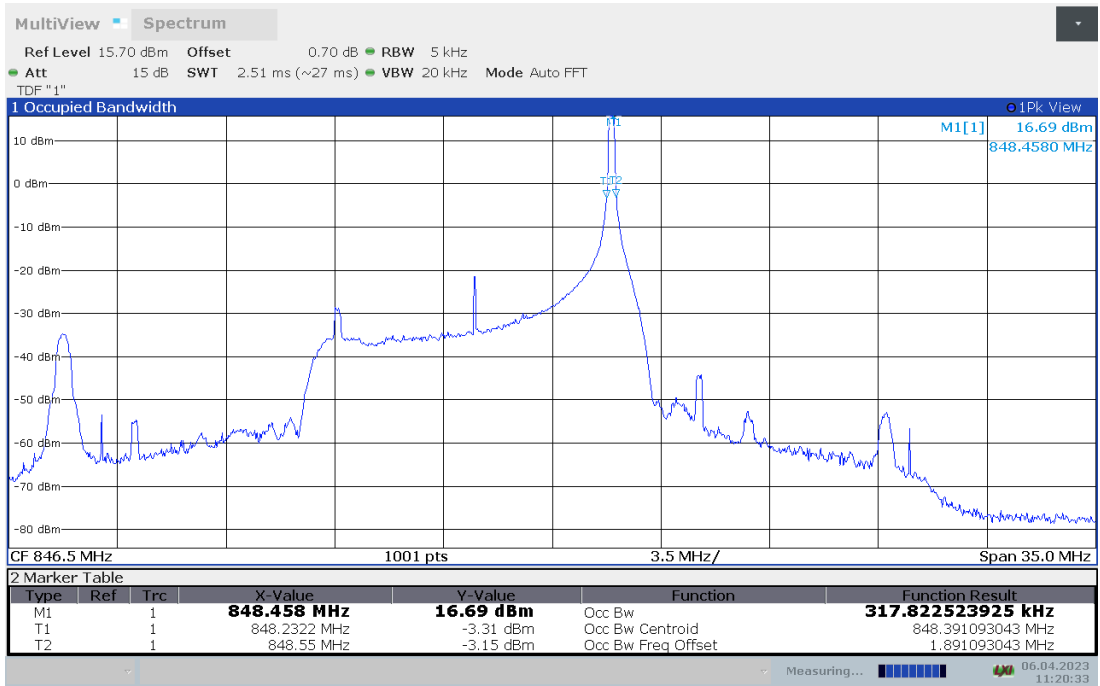
OBW: 1RB-LOW\_offset



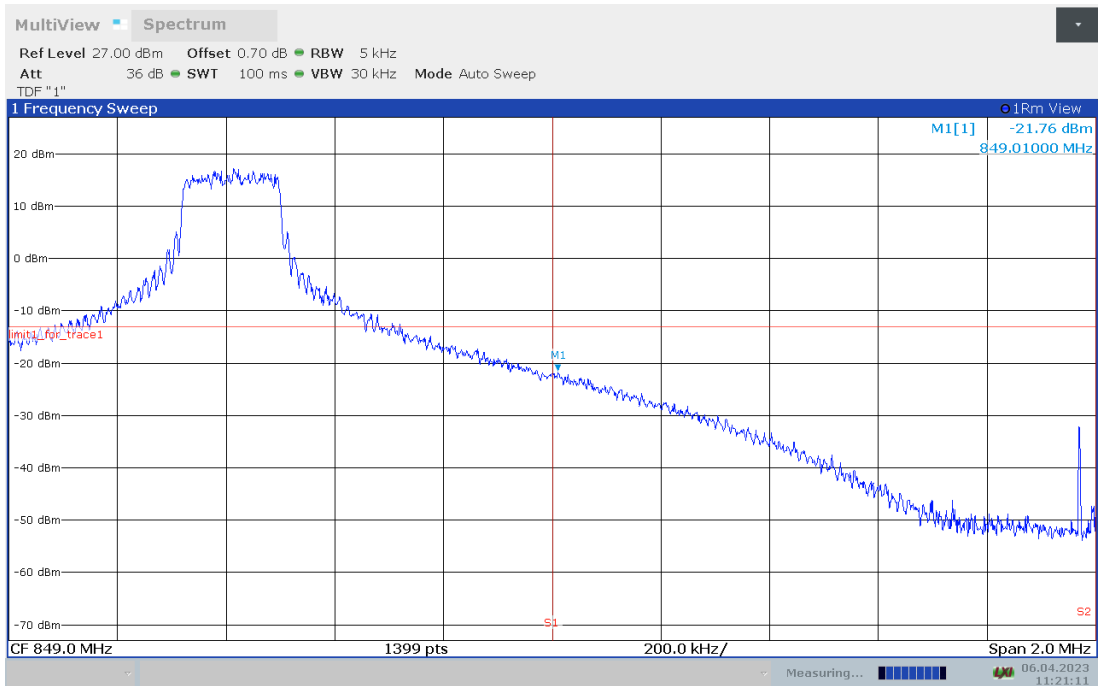
LOW BAND EDGE BLOCK-1RB-LOW\_offset



**OBW: 1RB-HIGH\_offset**

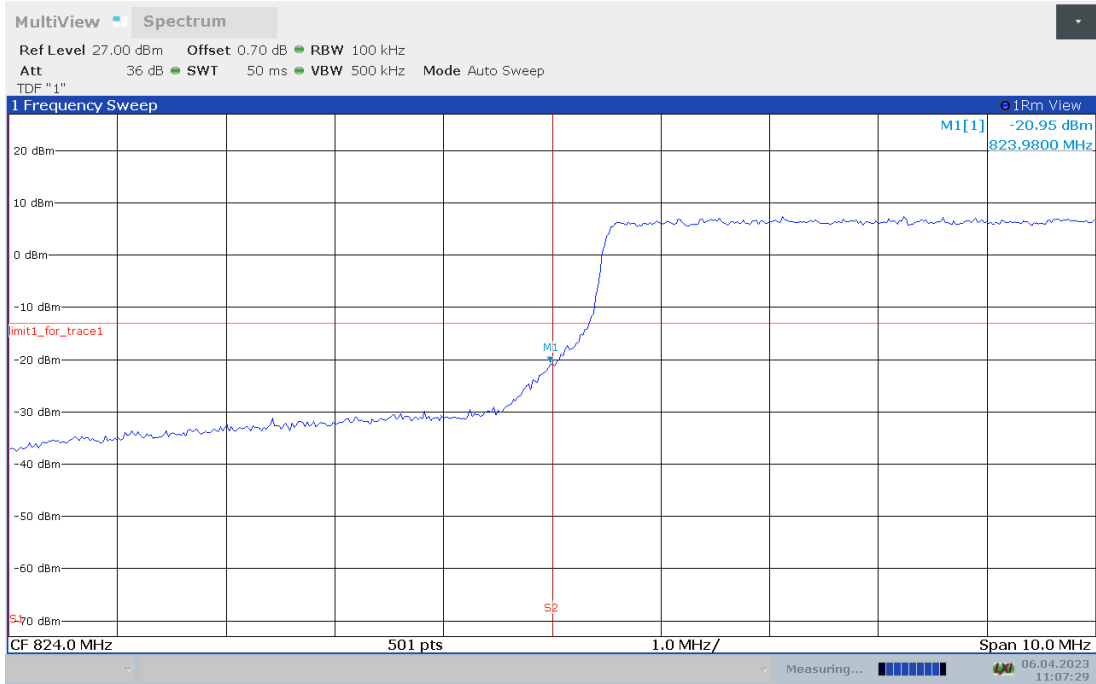


**HIGH BAND EDGE BLOCK-1RB-HIGH\_offset**

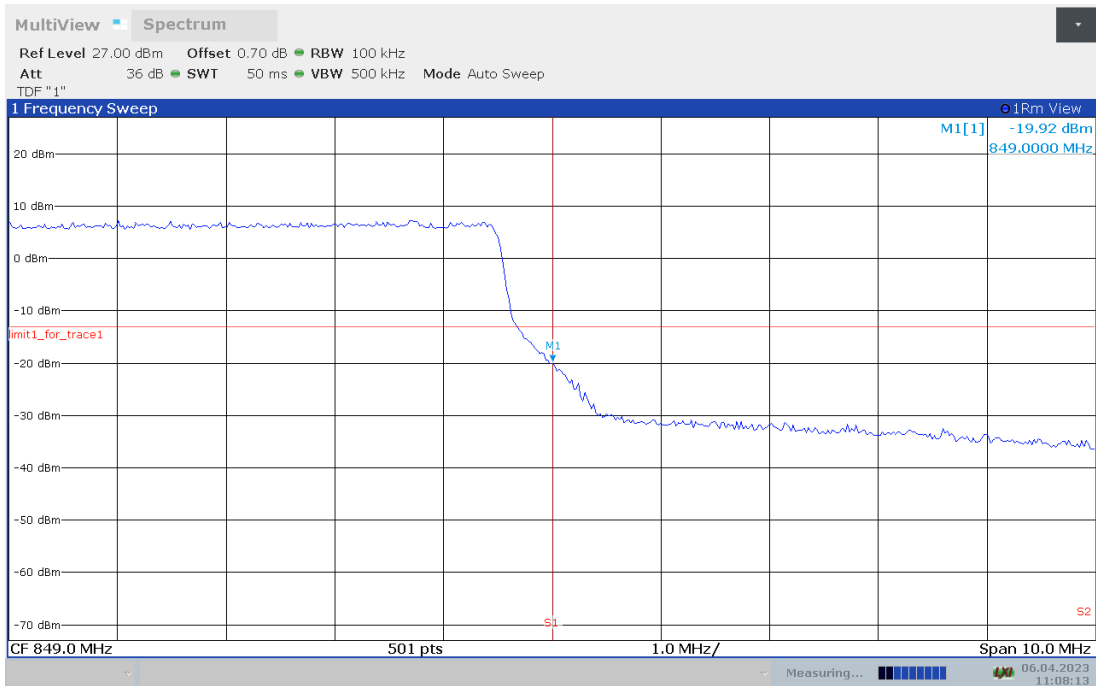




### LOW BAND EDGE BLOCK-10M-100%RB



### HIGH BAND EDGE BLOCK-10M-100%RB

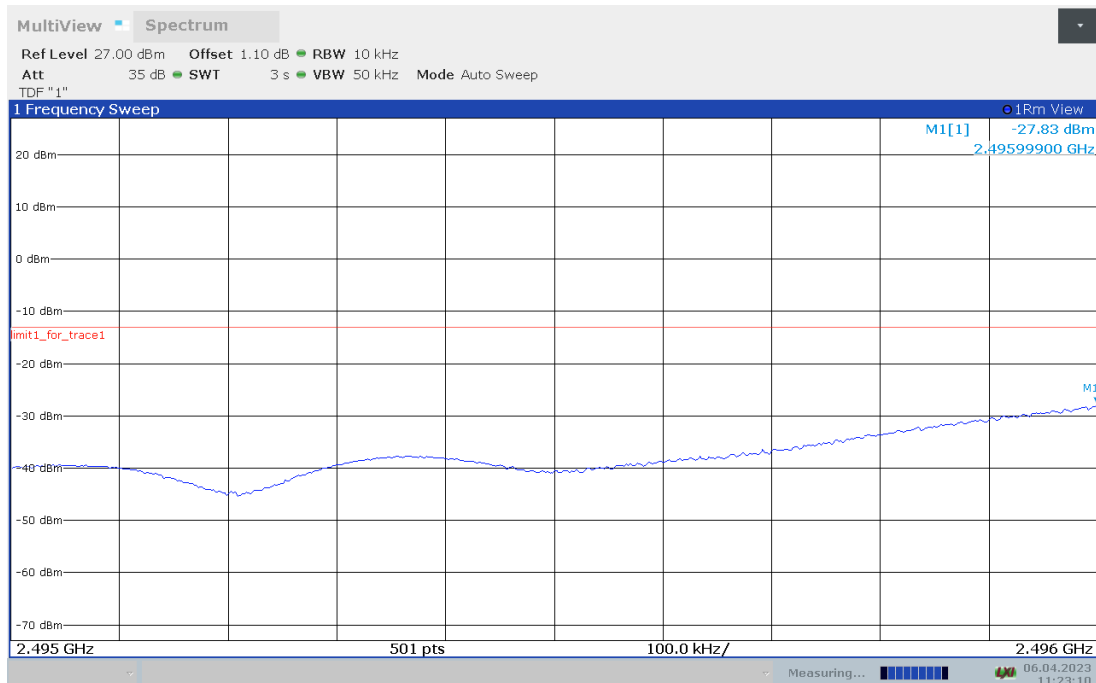


LTE band 41

OBW: 1RB-LOW\_offset

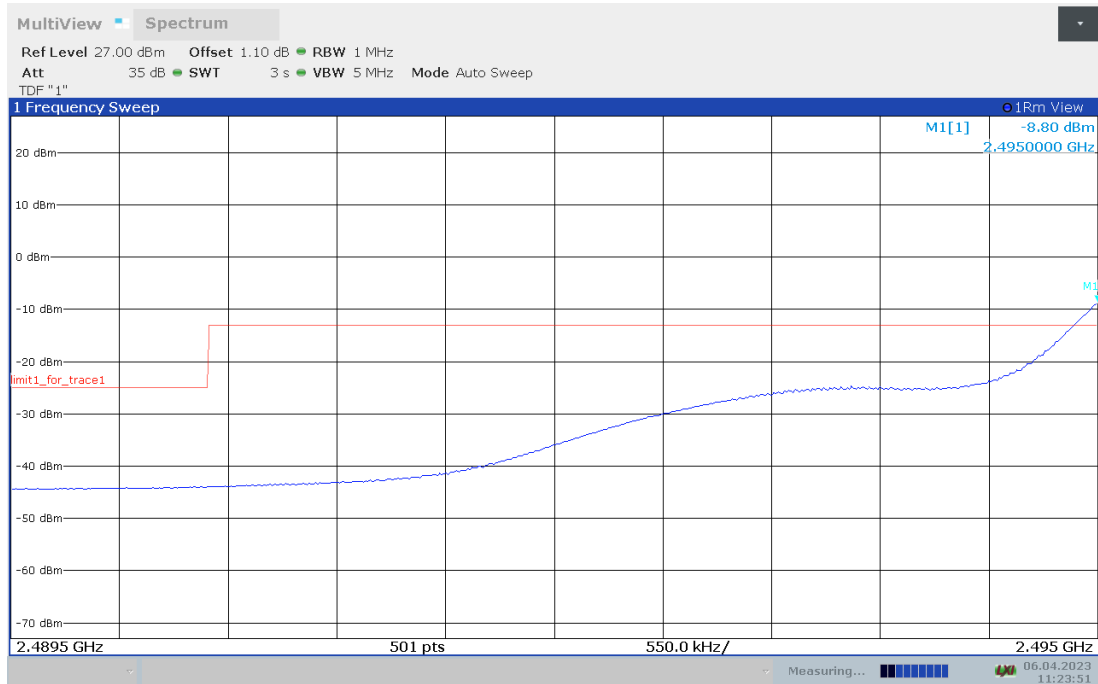


LOW BAND EDGE BLOCK-1RB-LOW\_offset

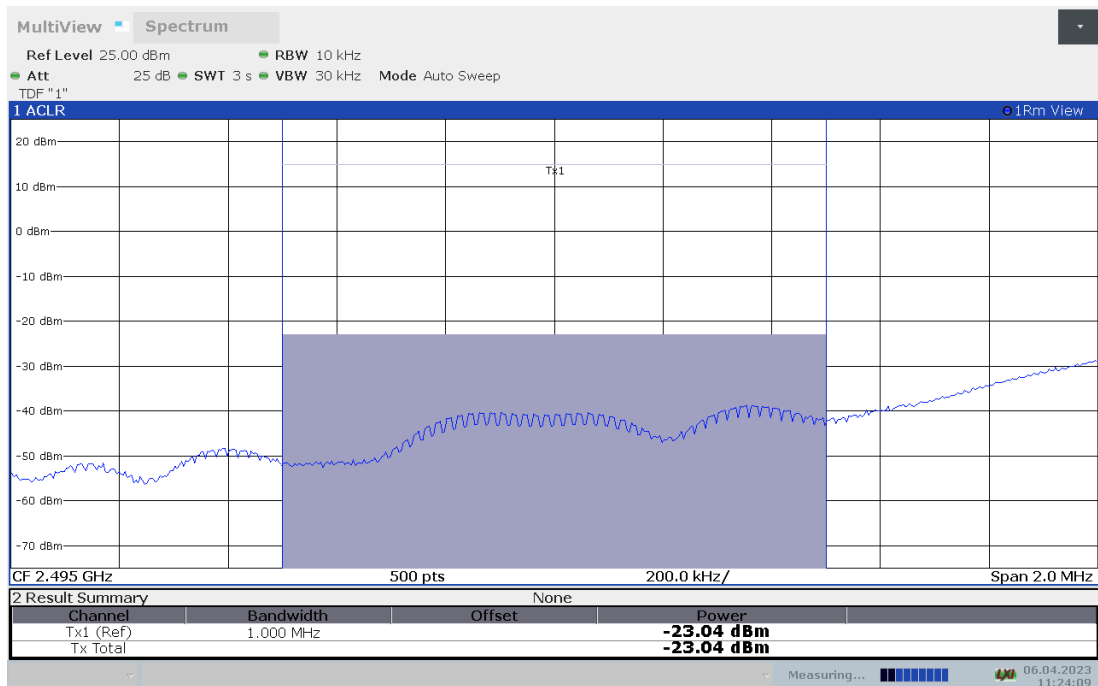




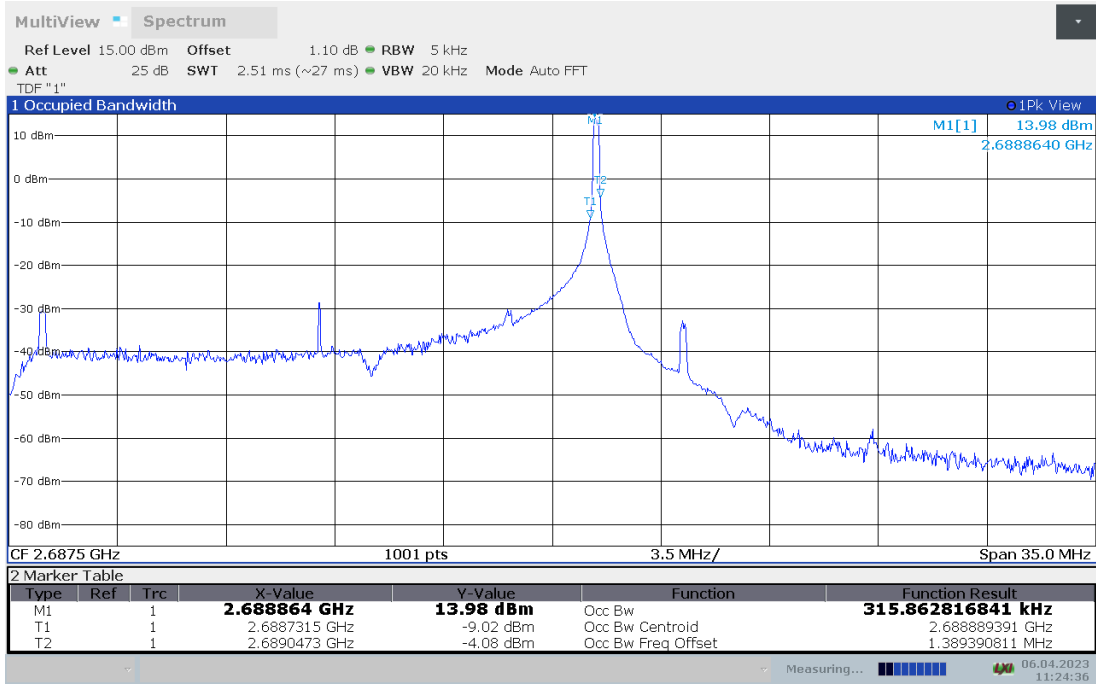
### LOW BAND EDGE BLOCK-1RB-LOW\_offset



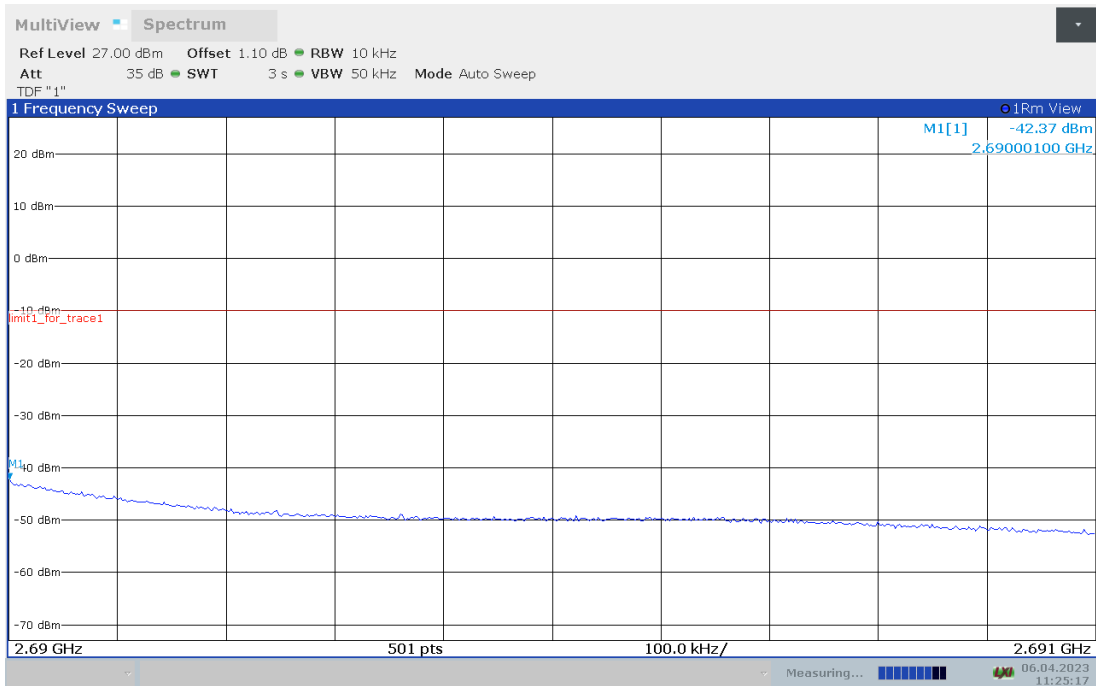
### Channel power



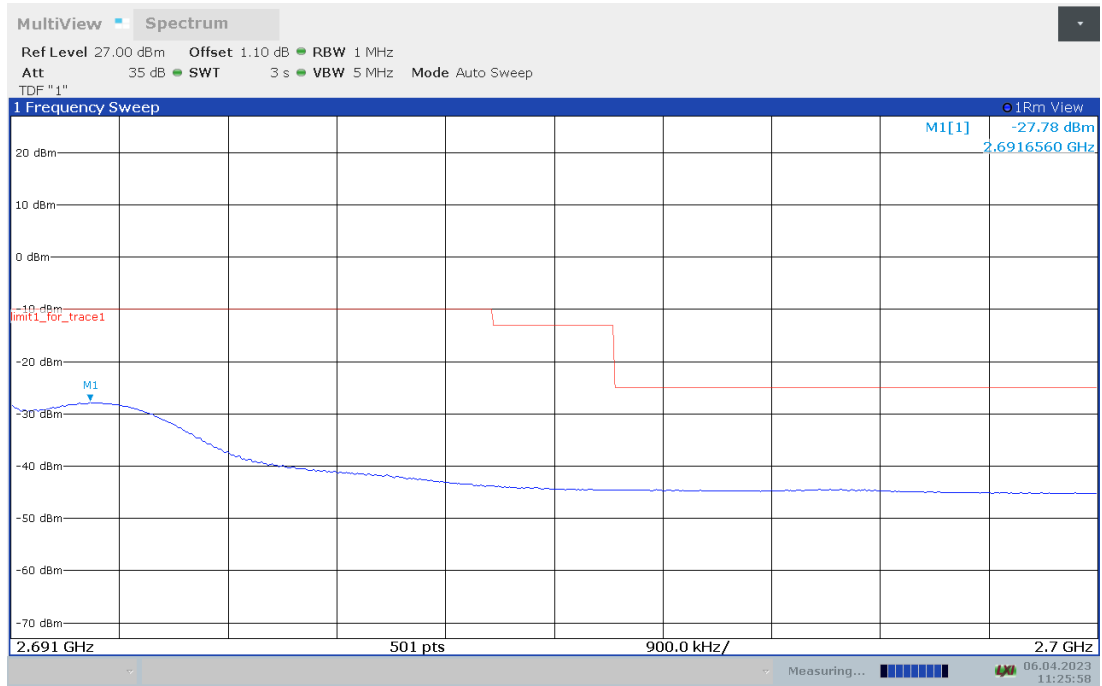
**OBW: 1RB-HIGH\_offset**



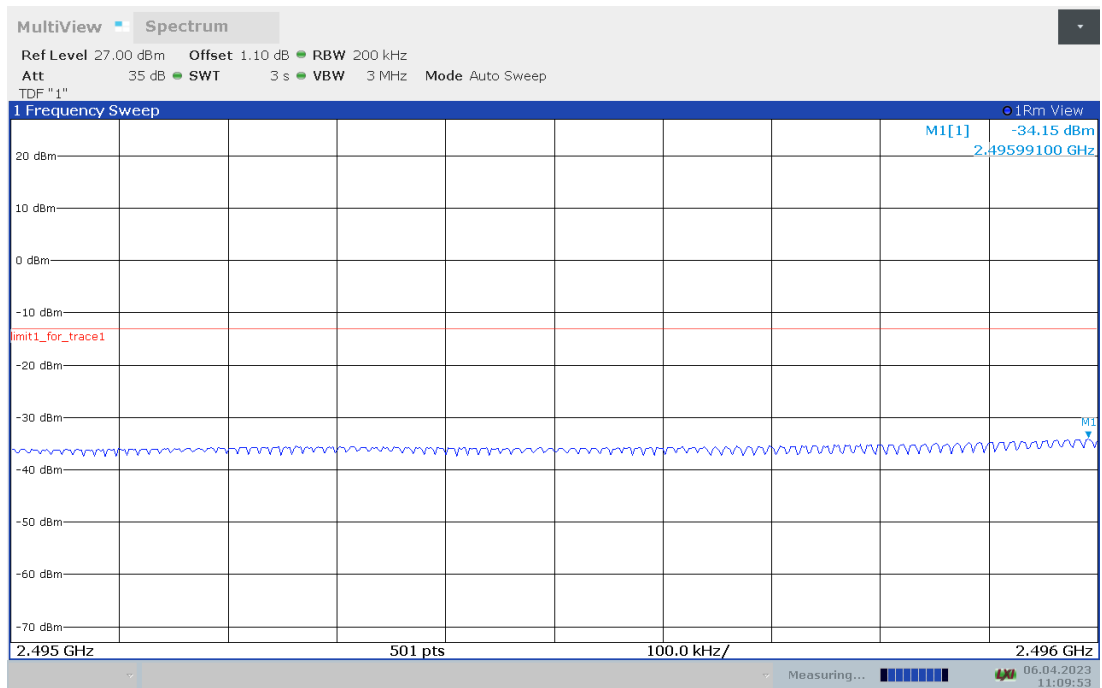
**HIGH BAND EDGE BLOCK-1RB-HIGH\_offset**



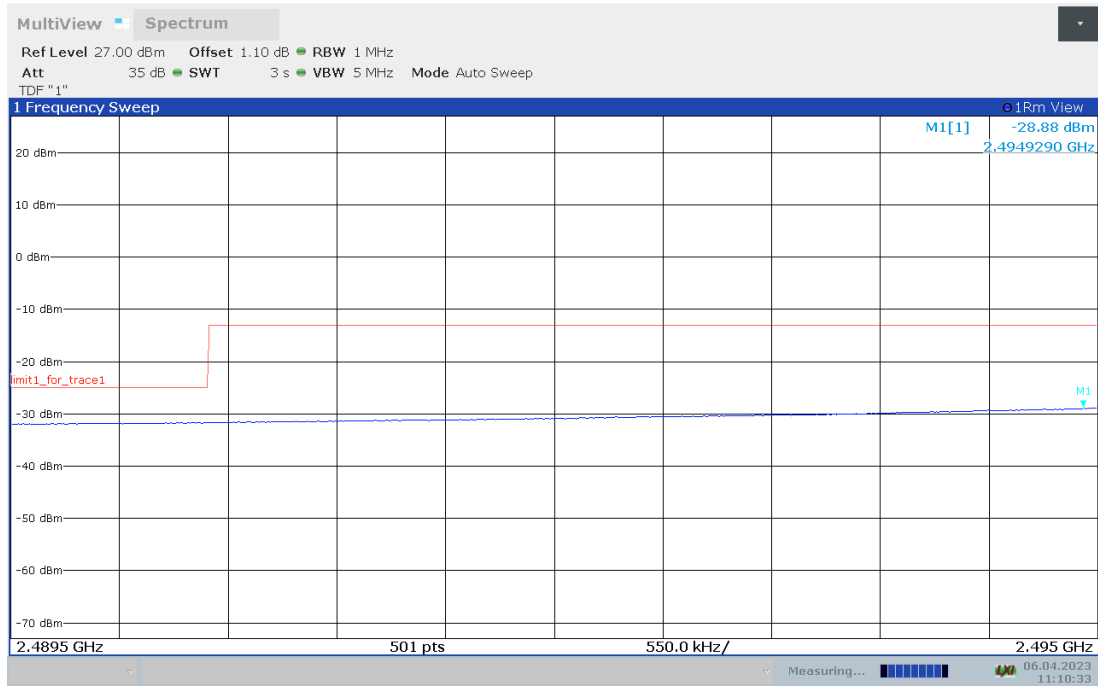
### HIGH BAND EDGE BLOCK-1RB-HIGH\_offset



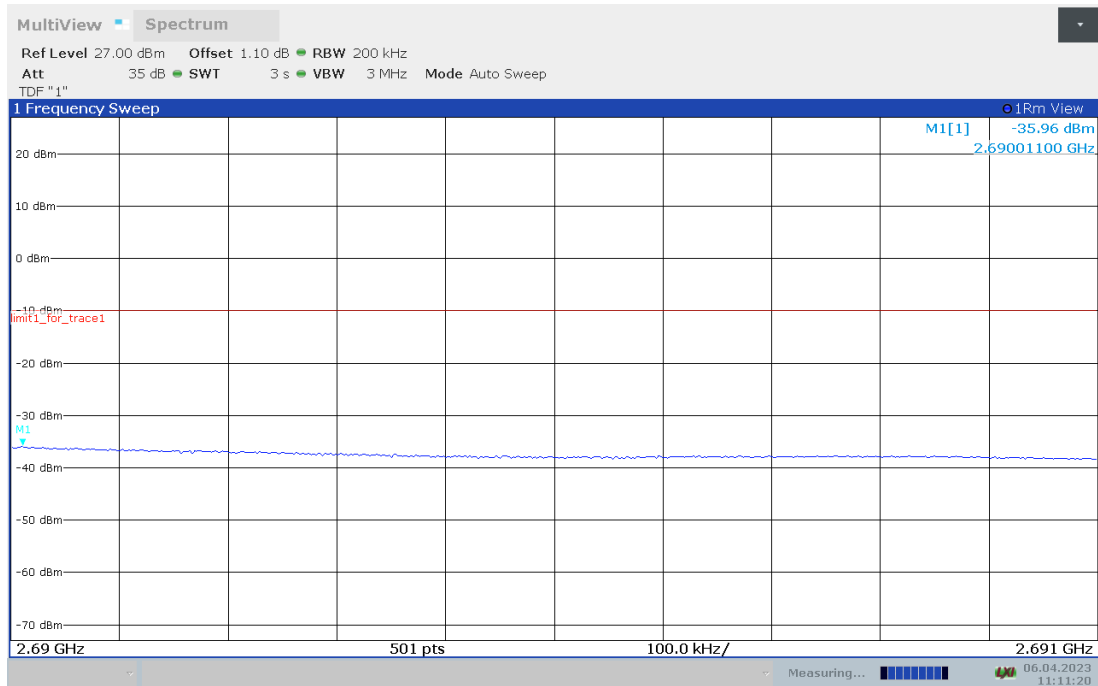
### LOW BAND EDGE BLOCK-20M-100%RB



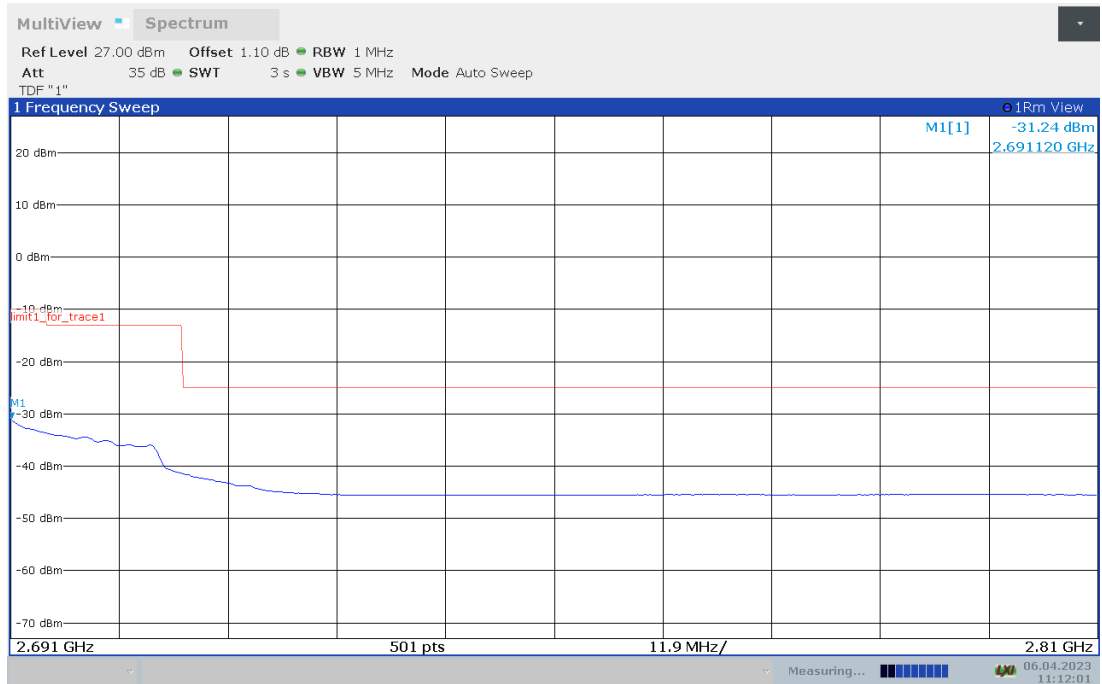
**LOW BAND EDGE BLOCK-20M-100%RB**



**HIGH BAND EDGE BLOCK-20M-100%RB**



**HIGH BAND EDGE BLOCK-20M-100%RB**



Note: Expanded measurement uncertainty is  $U = 0.49 \text{ dB}(100\text{KHz}-2\text{GHz})/1.21\text{dB}(2\text{GHz}-26.5\text{GHz}), k = 1.96$

## **A.7 CONDUCTED SPURIOUS EMISSION**

### **Reference**

FCC: CFR Part 2.1051, 22.917, 27.53.

### **A.7.1 Measurement Method**

The following steps outline the procedure used to measure the conducted emissions from the EUT.

1. Determine frequency range for measurements: From CFR 2.1051 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 13 MHz to 9 GHz, data taken from 10 MHz to 25 GHz.
2. Determine EUT transmit frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.
3. The number of sweep points of spectrum analyzer is set to 30001 which is greater than span/RBW.

### **A. 7.2 Measurement Limit**

Part 22.917 and Part 27.53(h) specify that 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 specification that emissions shall be attenuated below the transmitter power (P) by at least  $43 + 10 \log(P)$  dB, translates in the relevant power range (1 to 0.001 W) to -13 dBm. At 1 W the specified minimum attenuation becomes 43 dB and relative to a 30 dBm (1 W) carrier becomes a limit of -13 dBm. At 0.001 W (0 dBm) the minimum attenuation is 13 dB, which again yields a limit of -13 dBm. In this way a translation of the specification from relative to absolute terms is carried out.

Part 27.53(m)(4) specifies for mobile digital stations, the attenuation factor shall be not less than  $40 + 10 \log(P)$  dB on all frequencies between the channel edge and 5 megahertz from the channel edge,  $43 + 10 \log(P)$  dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and  $55 + 10 \log(P)$  dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less than  $43 + 10 \log(P)$  dB on all frequencies between 2490.5 MHz and 2496 MHz and  $55 + 10 \log(P)$  dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

Part 27.53(a) states for mobile and portable stations operating in the 2305–2315 MHz and 2350–2360 MHz bands: By a factor of not less than:  $43 + 10 \log(P)$  dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, not less than  $55 + 10 \log(P)$  dB on all frequencies between 2320 and 2324 MHz and on all frequencies between 2341 and 2345 MHz, not less than  $61 + 10 \log(P)$  dB on all frequencies between 2324 and 2328 MHz and on all frequencies between 2337 and 2341 MHz, and not less than  $67 + 10 \log(P)$  dB on all frequencies between 2328 and 2337 MHz; By a factor of not less than  $43 + 10 \log(P)$  dB on all frequencies between 2300 and 2305 MHz,  $55 + 10 \log(P)$  dB on all frequencies between 2296 and 2300 MHz,  $61 + 10 \log(P)$  dB on all frequencies

between 2292 and 2296 MHz,  $67 + 10 \log (P)$  dB on all frequencies between 2288 and 2292 MHz, and  $70 + 10 \log (P)$  dB below 2288 MHz; By a factor of not less than  $43 + 10 \log (P)$  dB on all frequencies between 2360 and 2365 MHz, and not less than  $70 + 10 \log (P)$  dB above 2365 MHz.

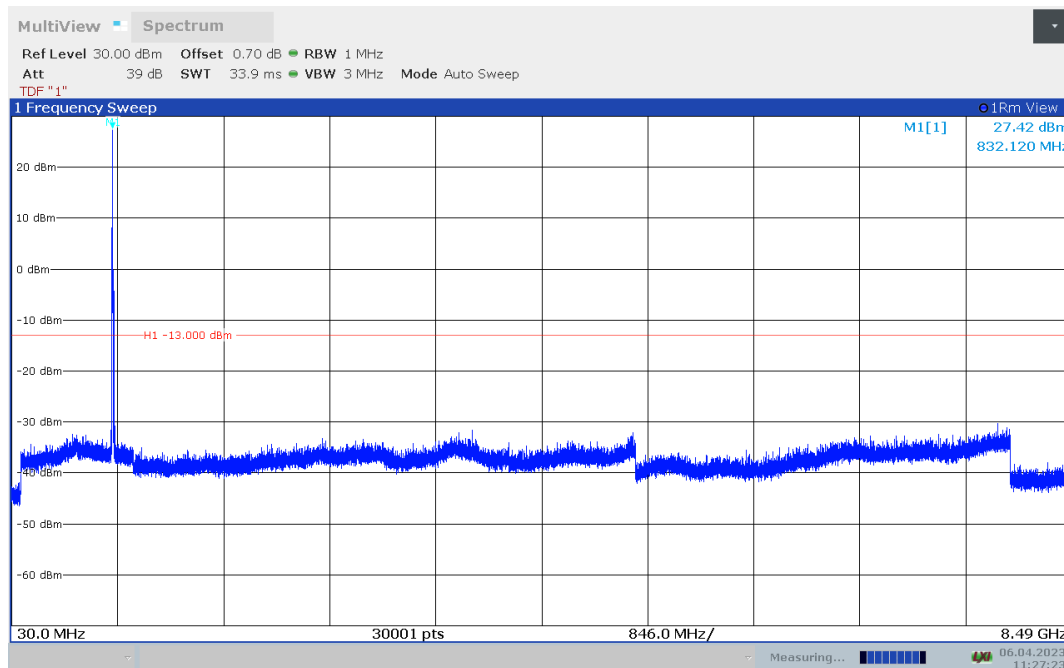
**A. 7.3 Measurement result**

Only worst case result is given below

**LTE band 5 10MHz QPSK: 30MHz – 8.49GHz**

Spurious emission limit  $-25\text{dBm}$ .

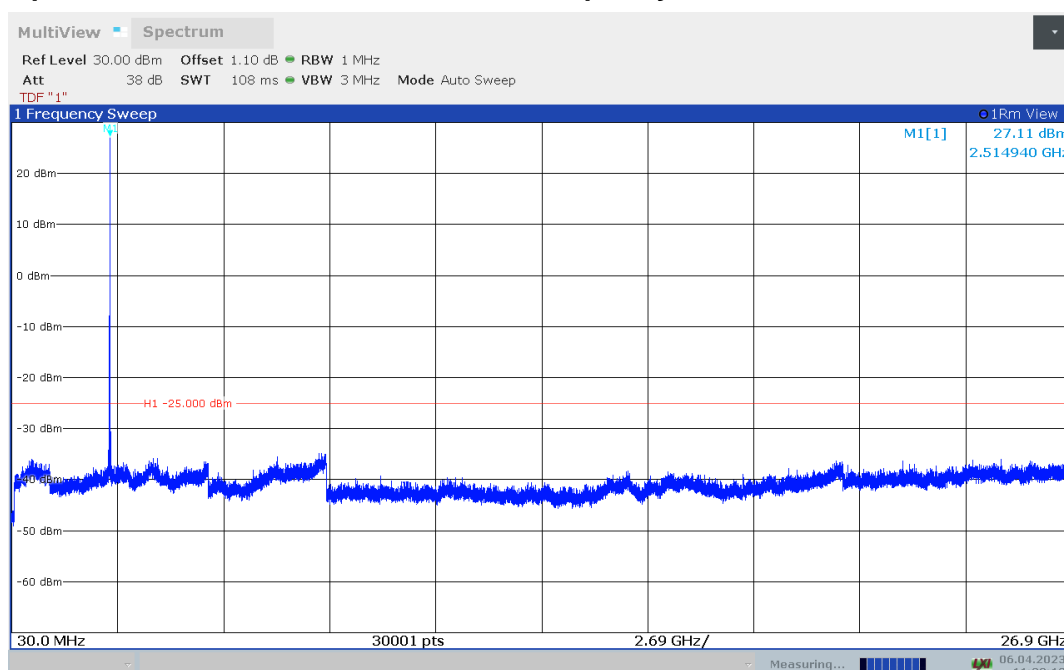
**NOTE: peak above the limit line is the carrier frequency.**



**LTE band 41: 30MHz – 26.9GHz**

Spurious emission limit  $-25\text{dBm}$ .

**NOTE: peak above the limit line is the carrier frequency.**



## **A.8 PEAK-TO-AVERAGE POWER RATIO**

### **Reference**

FCC: CFR Part 27.50(d), KDB971168 D01(5.7).

The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13dB. The PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that PAPR will not exceed 13 dB for more than 0.1 percent of the time or other Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

- a) Refer to instrument's analyzer instruction manual for details on how to use the power statistics/CCDF function;
- b) Set resolution/measurement bandwidth  $\geq$  signal's occupied bandwidth;
- c) Set the number of counts to a value that stabilizes the measured CCDF curve;
- d) Set the measurement interval to 1ms.
- e) Record the maximum PAPR level associated with a probability of 0.1%

### **A.8.1 Measurement limit**

not exceed 13dB

### **A.8.2 Measurement results**

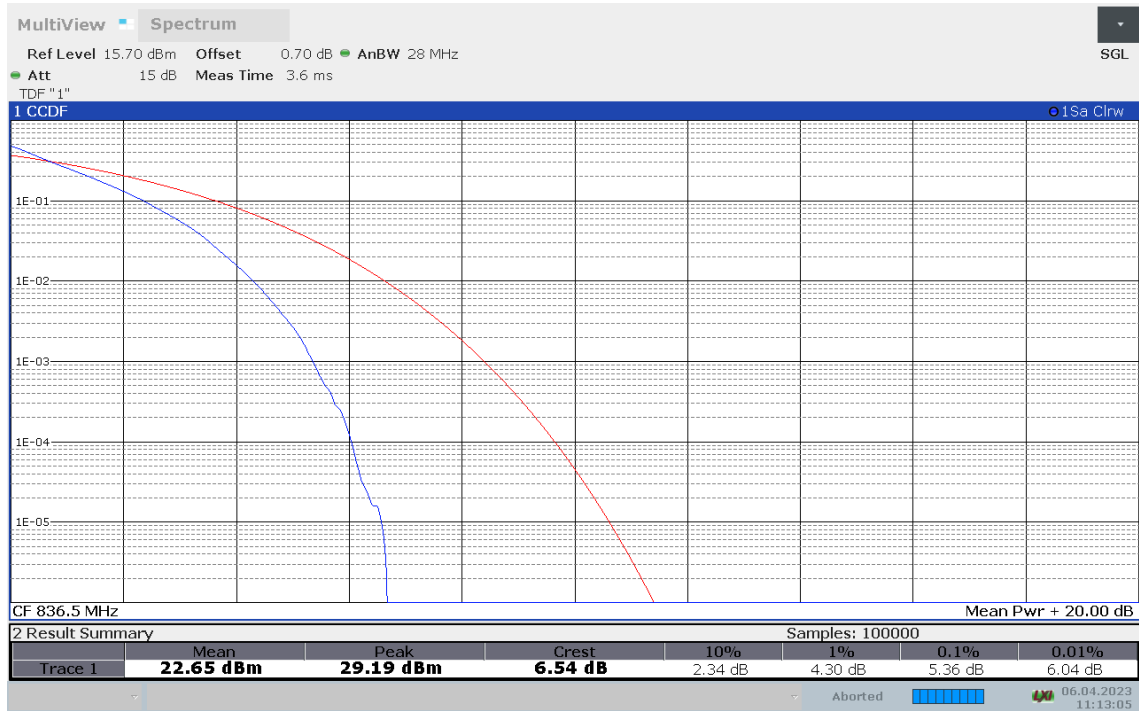
**Only worst case result is given below**



LTE band 5

Frequency(MHz)	Bandwidth(MHz)	PAPR(dB)	
		QPSK	16QAM
826.5	10	5.36	5.98

LTE band 5, 10MHz Bandwidth, QPSK (PAPR)



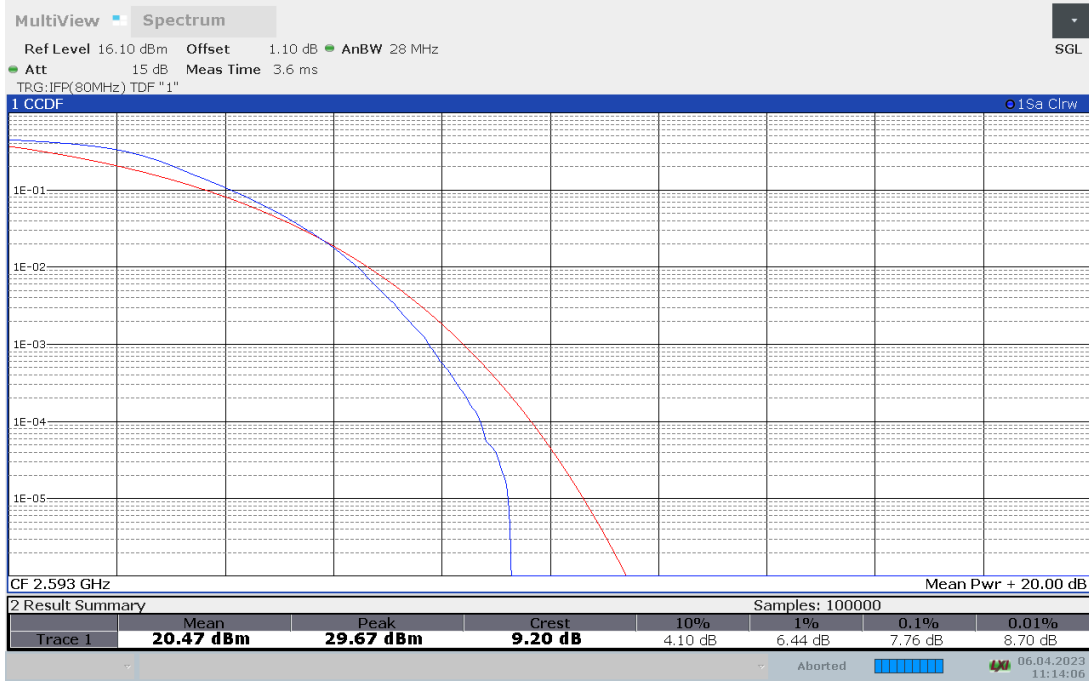
LTE band 5, 10MHz Bandwidth, 16QAM (PAPR)



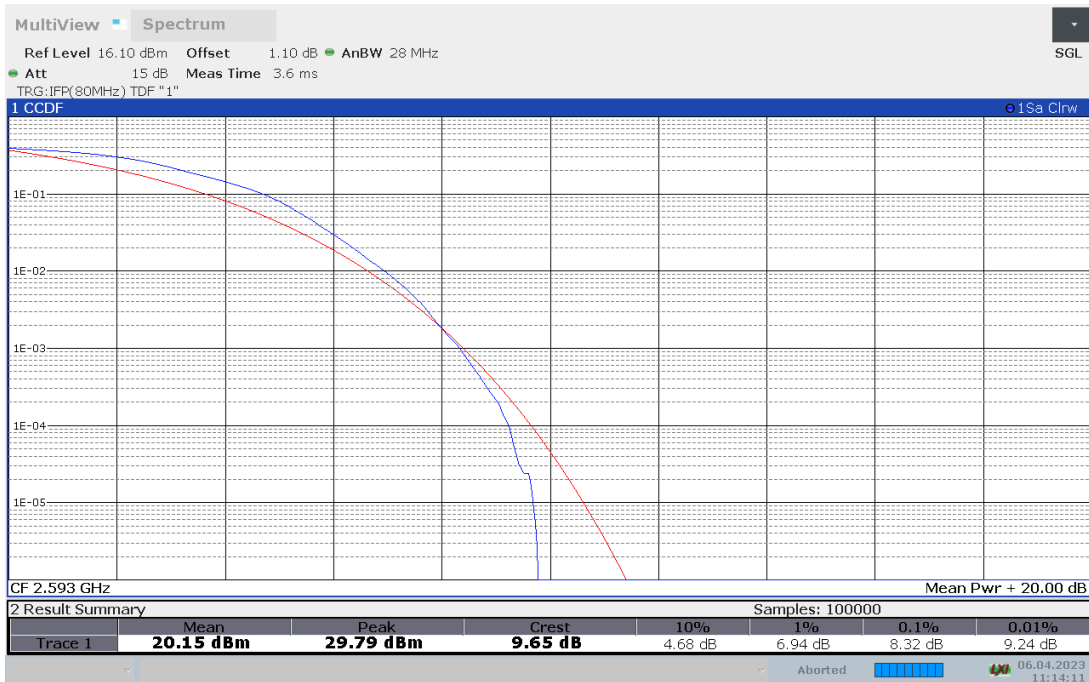
**LTE band 41**

Frequency(MHz)	Bandwidth(MHz)	PAPR(dB)	
		QPSK	16QAM
2593.0	20	7.76	8.32

**LTE band 41, 20MHz Bandwidth, QPSK (PAPR)**



**LTE band 41, 20MHz Bandwidth, 16QAM (PAPR)**



Note: Expanded measurement uncertainty is  $U = 0.48, k = 2$

\*\*\*END OF REPORT\*\*\*