

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
75461RRF.003

Test Report

USA FCC Part 27

CANADA RSS-130, RSS-139

(*) Identification of item tested	LTE Cat 1bis module
(*) Trademark	Sequans Communications
(*) Model and /or type reference	GC02S1-NA2
Other identification of the product	FCC ID: 2AAGMGC02SA IC: 12732A-GC02SA
(*) Features	4G LTE module HW version: Rev1 SW version: LR9.0.1.1-59215
Applicant	SEQUANS COMMUNICATIONS 55 Boulevard Charles de Gaulle, 92700 Colombes, France
Test method requested, standard	USA FCC Part 27 (10-1-21 Edition). CANADA RSS-130 Issue 2, February 2019. CANADA RSS-139 Issue 4 September 2022, Amendment October 2022. CANADA RSS-Gen Issue 5, April 2018. ANSI C63.26-2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Manuel Gómez Galván EMC Consumer & RF Lab. Manager  Firmado digitalmente por 53680346W JOSE MANUEL GOMEZ (C:A29507456) Fecha: 2023.11.09 15:09:55 +01'00'
Date of issue	2023-11-08
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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, Company Number: 4621A, with the appropriate scope of accreditation that covers the performed tests in this report.

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Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample model is GC02S1-NA2. The Calliope 2 GC02S1 modules are based on Sequans's second-generation Calliope 2 silicon and delivers optimized 4G LTE Cat 1 connectivity for IoT, M2M and consumer devices such as wearables and hearables that require voice support and speed higher than LTE-M.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
75461B/005 *	LTE Cat 1bis module	GC02S1-NA2	C2E230509001024	21-07-2023
75461B/008	Antenna Cable	-	-	21-07-2023
75461B/004 **	LTE Cat 1bis module	GC02S1-NA2	C2E230509001008	21-07-2023

Sample S/01 has undergone the following test(s): The conducted tests indicated in Appendix A.

* : Element used in the RF Output Power test of all bands and the other conducted tests, but:

- the Occupied Bandwidth and PAPR tests of LTE Band 66.
- the Spurious Emissions at Antenna Terminals at Block Edges of LTE Band 12.
- the PAPR test in LTE Band 13.

** : Element used in the tests:

- the Occupied Bandwidth and PAPR tests of LTE Band 66.
- the Spurious Emissions at Antenna Terminals at Block Edges of LTE Band 12.
- the PAPR test in LTE Band 13.

- Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
75461B/006	LTE Cat 1bis module	GC02S1-NA2	-	21-07-2023
75461B/001	Antenna	OmniLOG 90200	20200100252	21-07-2023
75461B/012	Antenna Cable	-	-	21-07-2023

Sample S/02 has undergone the following test(s): The radiated tests indicated in Appendix A.

Test sample description

Ports.....:	Port name and description	Cable				
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾	
	USB		☒	☐	☐	
Supplementary information to the ports.....:	-					
Rated power supply :	Voltage and Frequency		Reference poles			
			L1	L2	L3	N

	☐	AC:	☐	☐	☐	☐
	☒	DC: 3.2 to 5.5 V				
Rated Power..... :	-					
Clock frequencies..... :	-					
Other parameters	-					
Software version..... :	LR9.0.1.1-59215					
Hardware version	Rev1					
Dimensions in cm (W x H x D) ... :	21 x 1.8 x 19.5 mm					
Mounting position	☒	Table top equipment				
	☐	Wall/Ceiling mounted equipment				
	☐	Floor standing equipment				
	☐	Hand-held equipment				
	☐	Other:				
Modules/parts..... :	Module/parts of test item		Type	Manufacturer		
	-		-	-		
Accessories (not part of the test item)	Description		Type	Manufacturer		
	USB Cables		USB	-		
	Antennas		Antenna	-		
Documents as provided by the applicant	Description		File name	Issue date		
	-		-	-		

⁽³⁾ Only for Medical Equipment

Identification of the client

SEQUANS COMMUNICATIONS
55 Boulevard Charles de Gaulle, 92700, Colombes, France

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2023-08-16
Date (finish)	2023-10-09

Document history

Report number	Date	Description
75461RRF.003	2023-11-08	First release.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the semi-anechoic chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Antonio Maireles, Sergio Carrasco, Pablo Redondo, Rafael Fernández, Fernando Chito, Francisco López, Carmen Vázquez, Ireneo Bibang.

Used instrumentation:

Control No.	Equipment	Next Calibration
8002	Climatic Chamber BINDER MK 56	2024-03
7794	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2025-04
6157	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2023-10
9229	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-06
6794	Shielded Room ETS LINDGREN S101	N/A
7798	EMC/RF Testing SW ROHDE AND SCHWARZ WMS32	N/A
6791	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A
6792	Shielded Room ETS LINDGREN S101	N/A
6143	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2023-10
7006	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2024-06
6144	RF Preamplifier 40 dB, 10 MHz - 6 GHz BONN ELEKTRONIK BLNA 0160-01N	2024-07
3783	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2023-12
7817	EMI Test Receiver 2 Hz - 44 GHz, ROHDE AND SCHWARZ ESW44	2023-12

Control No.	Equipment	Next Calibration
6667	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	N/A
9227	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-07
7760	Digital Multimeter FLUKE 175	2023-11
4848	EMC/RF Testing SW ROHDE AND SCHWARZ EMC32	N/A

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

LTE Cat 1bis Bands 4, 12, 13, 17, 66.

FCC PART 27 / RSS-130, RSS-139, RSS-Gen PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 27.50 / RSS-130 4.6, RSS-139 5.5: RF Output Power	P	
FCC 2.1047 / RSS-130 4.2, RSS-139 5.3: Modulation Characteristics	P	
FCC 27.54 / RSS-130 4.5, RSS-139 5.4: Frequency Stability	P	
FCC 2.1049 / RSS-130 4.5, RSS-Gen 6.7: Occupied Bandwidth	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Spurious Emissions at Antenna Terminals	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Spurious Emissions at Antenna Terminals at Block Edges	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Radiated Emissions	P	
<u>Supplementary information and remarks:</u> None.		

Appendix A: Test results for FCC 27 / RSS-130, RSS-139, RSS-Gen: LTE Cat 1bis Bands 4, 12, 13, 17, 66

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TEST CONDITIONS

(*): Declared by the Applicant.

POWER SUPPLY (*):

Vnominal: 5 Vdc
Vminimum: 3.2 Vdc
Vmaximum: 5.5 Vdc

Type of Power Supply: DC External.

ANTENNA (*):

Low Bands	Gain (dBi)	Type of Antenna
LTE Cat 1bis Band 12	+2	External (OmniLOG 90200)
LTE Cat 1bis Band 12	+1.1	Internal (FR01-S4-210)
LTE Cat 1bis Band 13	+2	External (OmniLOG 90200)
LTE Cat 1bis Band 13	+1.1	Internal (FR01-S4-210)
LTE Cat 1bis Band 17	+2	External (OmniLOG 90200)
LTE Cat 1bis Band 17	+1.1	Internal (FR01-S4-210)
High Bands	Gain (dBi)	Type of Antenna
LTE Cat 1bis Band 4	+2	External (OmniLOG 90200)
LTE Cat 1bis Band 4	+2.4	Internal (FR01-S4-210)
LTE Cat 1bis Band 66	+2	External (OmniLOG 90200)
LTE Cat 1bis Band 66	+2.4	Internal (FR01-S4-210)

Note: Pre-scan determines that external antenna is the worst case in terms of radiated spurious emissions.

TEST FREQUENCIES:

LTE Cat 1bis Band 4. QPSK and 16QAM:

	Channel per BW=(Frequency, MHz)					
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	19957 (1710.7)	19965 (1711.5)	19975 (1712.5)	20000 (1715.0)	20025 (1717.5)	20050 (1720.0)
Middle	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)
High	20393 (1754.3)	20385 (1753.5)	20375 (1752.5)	20350 (1750.0)	20325 (1747.5)	20300 (1745.0)

NOTE: LTE Cat 1bis Band 4 is completely included in LTE Cat 1bis Band 66, so the channels of LTE Cat 1bis Band 66 were tested to give conformity to the assigned block.

LTE Cat 1bis Band 12. QPSK and 16QAM:

	Channel (Frequency, MHz)			
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz
Low	23017 (699.7)	23025 (700.5)	23035 (701.5)	23060 (704.0)
Middle	23095 (707.5)	23095 (707.5)	23095 (707.5)	23095 (707.5)
High	23173 (715.3)	23165 (714.5)	23155 (713.5)	23130 (711.0)

LTE Cat 1bis Band 13. QPSK and 16QAM:

	Channel (Frequency, MHz)	
	BW = 5 MHz	BW = 10 MHz
Low	23205 (779.5)	
Middle	23230 (782.0)	23230 (782.0)
High	23255 (784.5)	

LTE Cat 1bis Band 17. QPSK and 16QAM:

	Channel (Frequency, MHz)	
	BW = 5 MHz	BW = 10 MHz
Low	23755 (706.5)	23780 (709)
Middle	23790 (710)	23790 (710)
High	23825 (713.5)	23800 (711)

NOTE: LTE Cat 1bis Band 17 is completely included in LTE Cat 1bis Band 12, so the channels of LTE Cat 1bis Band 12 were tested to give conformity to the assigned block.

LTE Cat 1bis Band 66. QPSK and 16QAM:

	Channel per BW=(Frequency, MHz)					
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	131979 (1710.7)	131987 (1711.5)	131997 (1712.5)	132022 (1715.0)	132047 (1717.5)	132072 (1720.0)
Middle	132322 (1745)	132322 (1745)	132322 (1745)	132322 (1745)	132322 (1745)	132322 (1745)
High	132665 (1779.3)	132657 (1778.5)	132647 (1777.5)	132622 (1775)	132597 (1772.5)	132572 (1770)

RF Output Power

Limits

1. LTE Cat 1bis Band 12. FCC §27.50 (c) (10) / RSS-130 Clause 4.6.

FCC §27.50 (c) (10):

Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

RSS-130 Clause 4.6:

4.6.1 General

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the High PAPR during periods of continuous transmission.

4.6.3 Frequency bands 698-756 MHz and 777-787 MHz

The e.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

2. LTE Cat 1bis Band 13. FCC §27.50 (b) (10) / RSS-130 Clause 4.6.

FCC §27.50 (b) (10):

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.

RSS-130 Clause 4.6:

4.6.1 General

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the High PAPR during periods of continuous transmission.

4.6.3 Frequency bands 698-756 MHz and 777-787 MHz

The e.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

3. LTE Cat 1bis Band 66. FCC §27.50 (d) / RSS-139 5.5.

FCC §27.50 (d):

(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.

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

RSS-139 5.5:

The maximum output power of the equipment shall comply with the limits specified below. In the tables, maximum power refers to the equivalent isotropically radiated power (e.i.r.p.) or total radiated power (TRP), measured in terms of average values.

The limits in this RSS are specified for the purpose of certification and may not apply to all deployment scenarios. Consult SRSP-513 and SRSP-519 for more details on the bands 2110-2180 MHz and 2180-2200 MHz respectively.

Table 3: Maximum power of equipment in the band 1710-1780 MHz	
Equipment type	Maximum power
Fixed station and base station	30 dBm e.i.r.p./channel bandwidth
Subscriber equipment	30 dBm e.i.r.p./channel bandwidth

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the highest PAPR during periods of continuous transmission.

Method

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

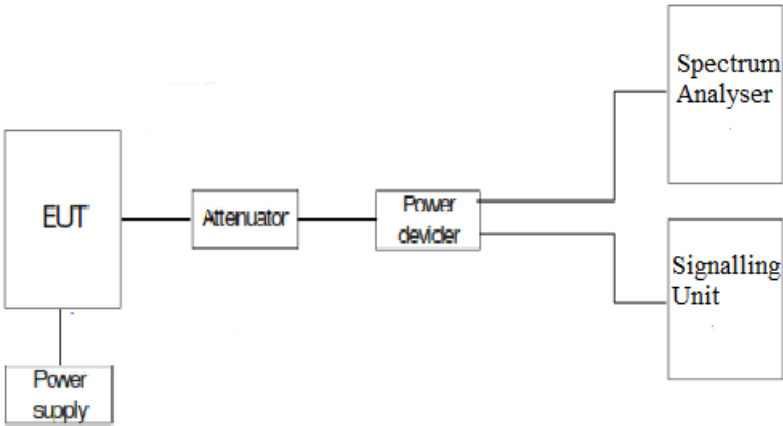
E.R.P. = E.I.R.P. - 2.15 dB

Test Setup

1. CONDUCTED AVERAGE POWER:



2. PEAK-TO-AVERAGE POWER RATIO (PAPR) and Conducted Average power:



Results

1. CONDUCTED AVERAGE POWER:

LTE Cat 1bis Band 12:

Worst-case of RF Power is BW=10 MHz, High Channel, QPSK, RB Size=1, RB Offset=24.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
10	Low 23060	704 MHz	QPSK	1	0	22.31
				1	24	22.19
				1	49	22.3
				25	0	21.14
				25	12	21.12
				25	24	21.24
				50	0	21.21
			16-QAM	1	0	21.43
				1	24	21.31
				1	49	21.44
				25	0	20.05
				25	12	20.03
				25	24	20.17
				50	0	22.06
	Middle 23095	707.5 MHz	QPSK	1	0	22.24
				1	24	22.4
				1	49	22.49
				25	0	21.12
				25	12	21.28
				25	24	21.37
				50	0	21.32
			16-QAM	1	0	21.29
				1	24	21.48
				1	49	21.58
				25	0	20.02
				25	12	20.2
				25	24	20.3
				50	0	22.41
	High 23130	711 MHz	QPSK	1	0	22.68
				1	24	22.93
				1	49	22.19
				25	0	21.65
				25	12	21.75
				25	24	21.44
				50	0	21.28
			16-QAM	1	0	21.59
				1	24	21.94
				1	49	21.24
				25	0	20.51

				25	12	20.63
				25	24	20.29
				50	0	22.49

BW=10 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.31	2	24.31	22.16
MIDDLE	22.49	2	24.49	22.34
HIGH	22.93	2	24.93	22.78
MAX:	22.93		24.93	22.78

BW=10 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.06	2	24.06	21.91
MIDDLE	22.41	2	24.41	22.26
HIGH	22.49	2	24.49	22.34
MAX:	22.49		24.49	22.34

LTE Cat 1bis Band 13:

Worst-case of RF Power is BW=5 MHz, Low Channel, QPSK, RB Size=1, RB Offset=12.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 23205	779.5	QPSK	1	0	22.77
				1	12	23.23
				1	24	23.22
				12	0	21.97
				12	6	22.15
				12	11	22.24
				25	0	22.12
			16-QAM	1	0	21.86
				1	12	22.35
				1	24	22.32
				12	0	20.84
				12	6	20.99
				12	11	21.12
				25	0	21.06
	High 23255	784.5	QPSK	1	0	22.71
				1	12	22.63
				1	24	22.82
				12	0	21.53
				12	6	21.51
				12	11	21.54
				25	0	21.51
			16-QAM	1	0	21.67
				1	12	21.56
				1	24	21.83
				12	0	20.43
				12	6	20.42
				12	11	20.5
				25	0	20.51

BW=5 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	23.23	2	25.23	23.08
HIGH	22.82	2	24.82	22.67
MAX:	23.23		25.23	23.08

BW=5 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.35	2	24.35	22.2
HIGH	21.83	2	23.83	21.68
MAX:	22.35		24.35	22.2

LTE Cat 1bis Band 66:

Worst-case of RF Power is BW=5 MHz, Low Channel, QPSK, RB Size=1, RB Offset=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 131997	1712.5	QPSK	1	0	22.94
				1	12	22.86
				1	24	22.79
				12	0	21.78
				12	6	21.74
				12	11	21.69
				25	0	21.69
			16-QAM	1	0	21.75
				1	12	21.69
				1	24	21.64
				12	0	20.68
				12	6	20.63
				12	11	20.65
				25	0	20.68
	Middle 132322	1745	QPSK	1	0	22.61
				1	12	22.6
				1	24	22.64
				12	0	21.6
				12	6	21.58
				12	11	21.64
				25	0	21.61
			16-QAM	1	0	21.66
				1	12	21.67
				1	24	21.75
				12	0	20.63
				12	6	20.59
				12	11	20.66
				25	0	20.67
	High 132647	1777.5	QPSK	1	0	22.14
				1	12	22.13
				1	24	22.02
				12	0	21.1
				12	6	21.08
				12	11	21.12
				25	0	21.07
			16-QAM	1	0	21.24
				1	12	21.23
				1	24	21.19
				12	0	20.05
				12	6	20.07
				12	11	20.1
				25	0	20.09

BW=5 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.94	2	24.94	22.79
MIDDLE	22.64	2	24.64	22.49
HIGH	22.14	2	24.14	21.99
MAX:	22.94		24.94	22.79

BW=5 MHz. 16QAM:

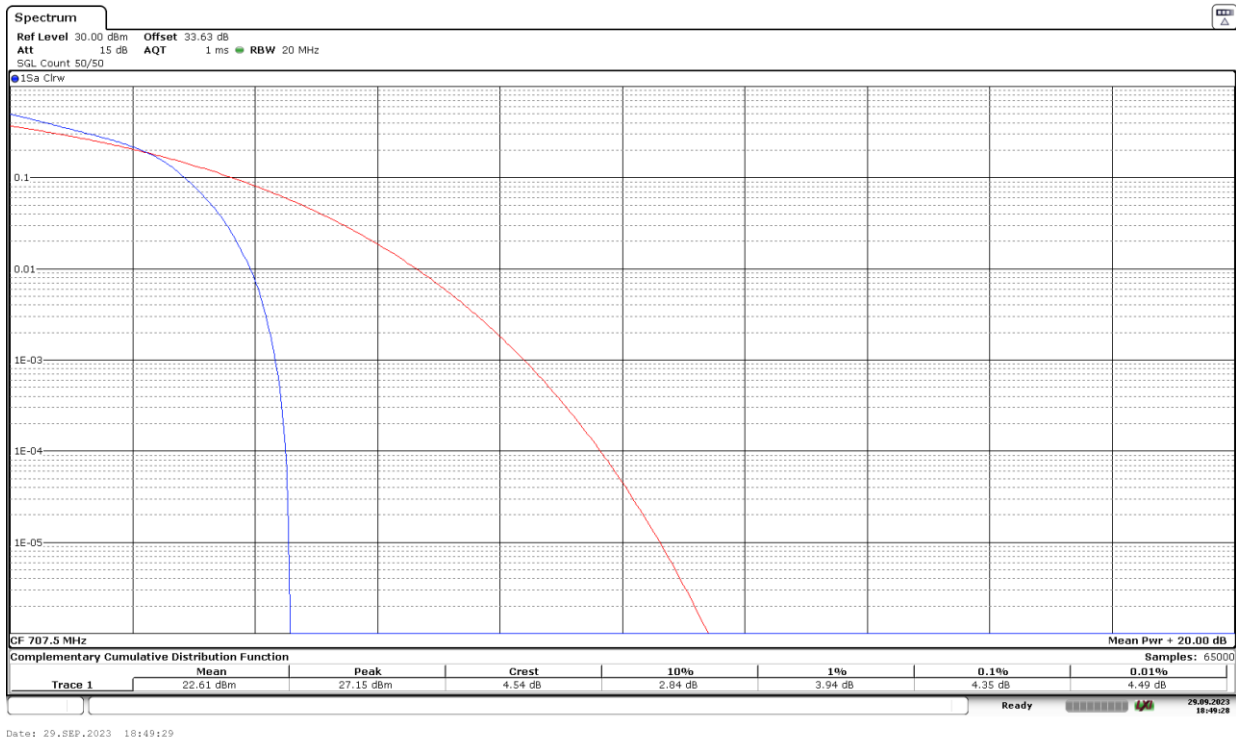
MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	21.75	2	23.75	21.6
MIDDLE	21.75	2	23.75	21.6
HIGH	21.24	2	23.24	21.09
MAX:	21.75		23.75	21.6

2. PEAK-TO-AVERAGE POWER RATIO (PAPR)

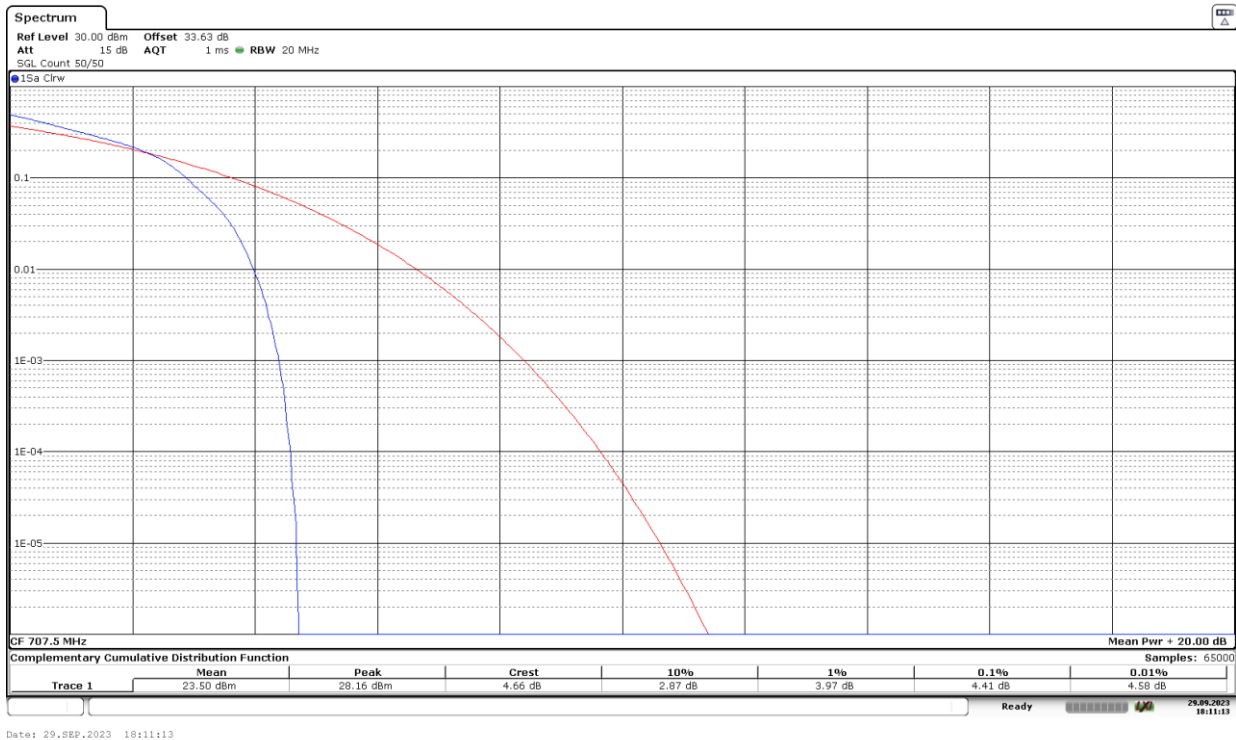
LTE Cat 1bis Band 12:

Worst-case of PAPR is BW=10 MHz, High Channel, 16QAM, RB Size=25, RB Offset=0.

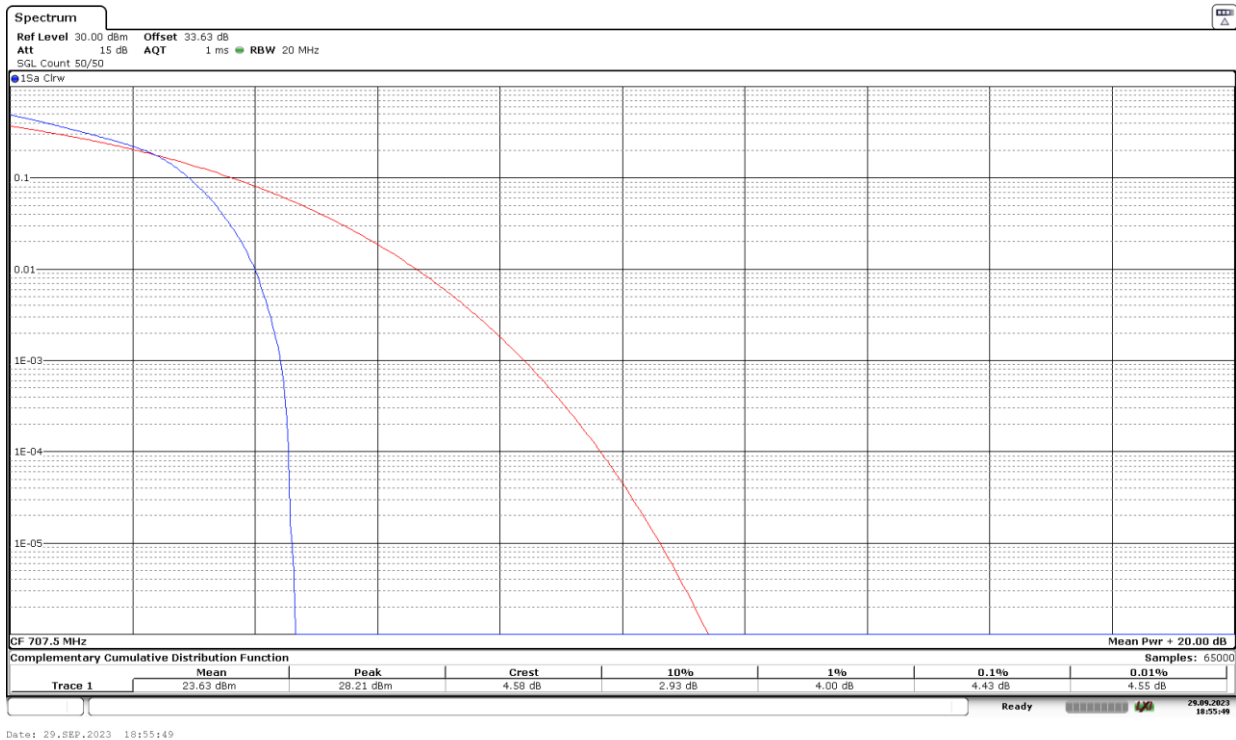
Low Channel:



Middle Channel:



High Channel:



16QAM	Low	Middle	High
PAPR (dB)	4.35	4.41	4.43

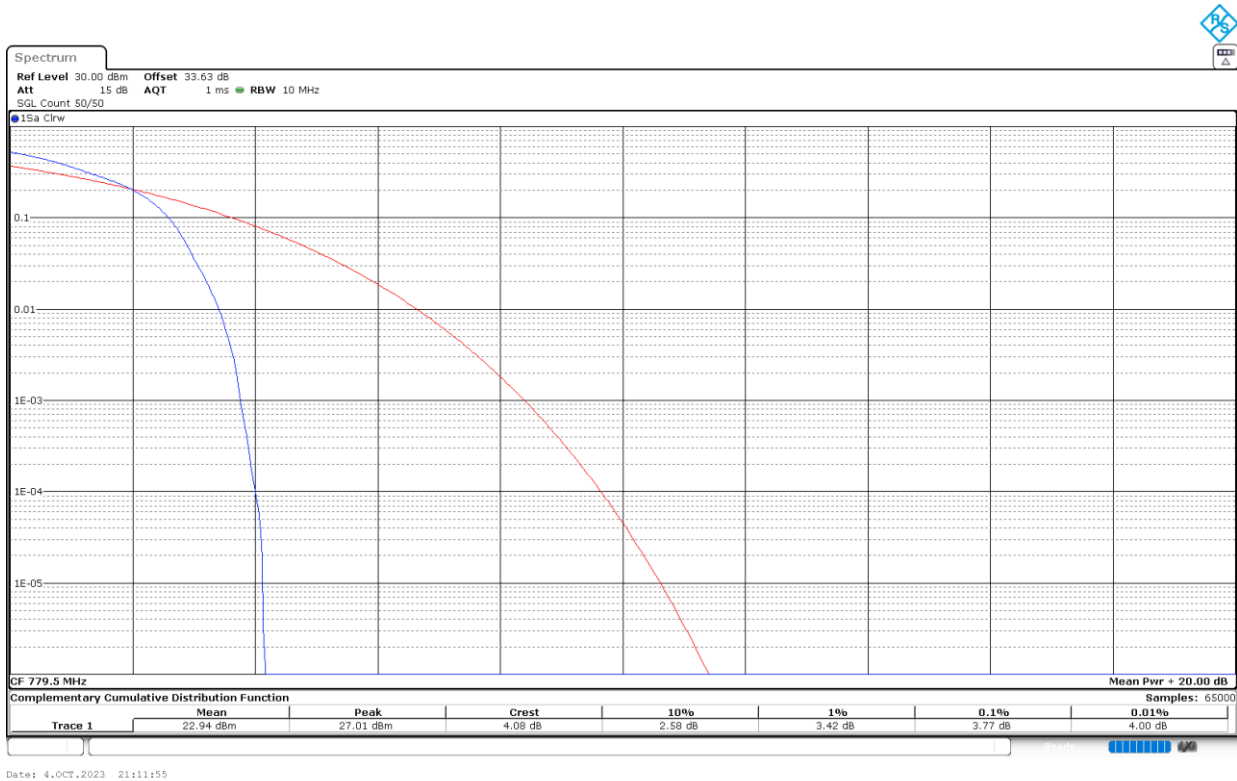
Verdict

Pass

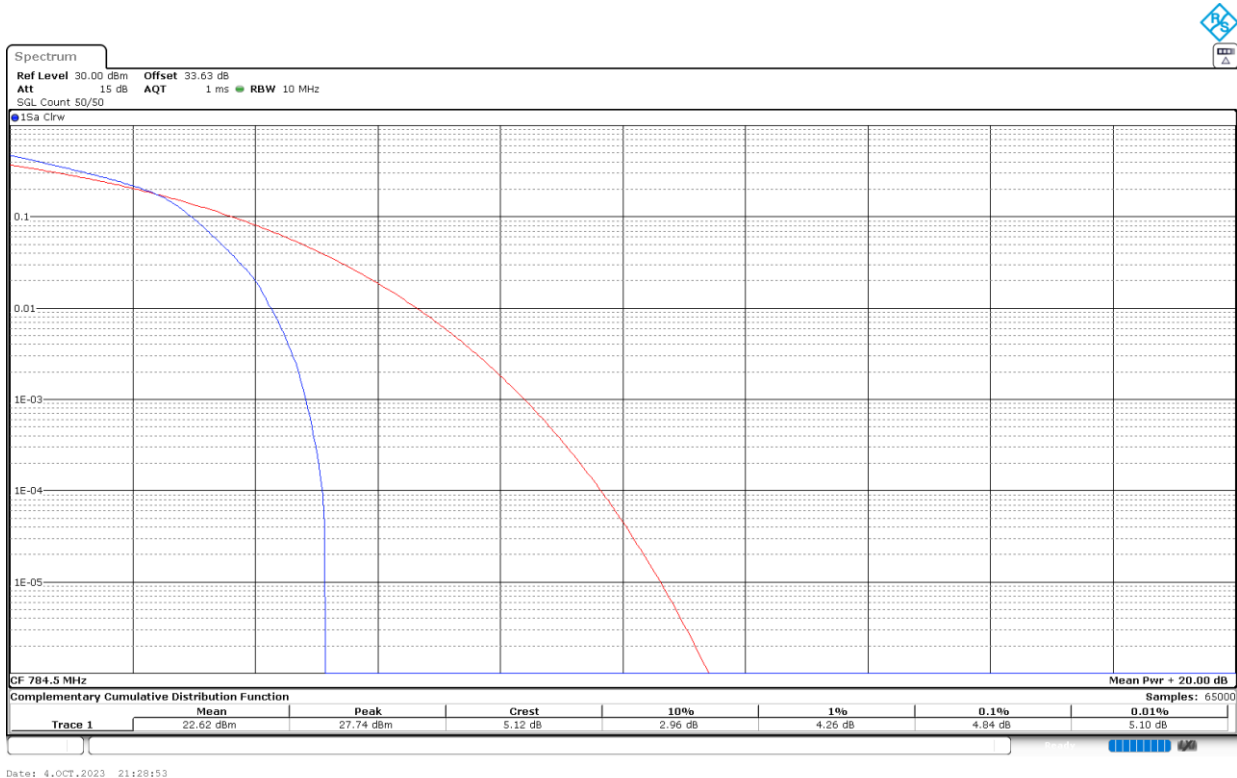
LTE Cat 1bis Band 13:

Worst-case of PAPR is BW= 5 MHz, High Channel, 16QAM, RB Size=12, RB Offset=0.

Low Channel:



High Channel:



16QAM	Low	High
PAPR (dB)	3.77	4.84

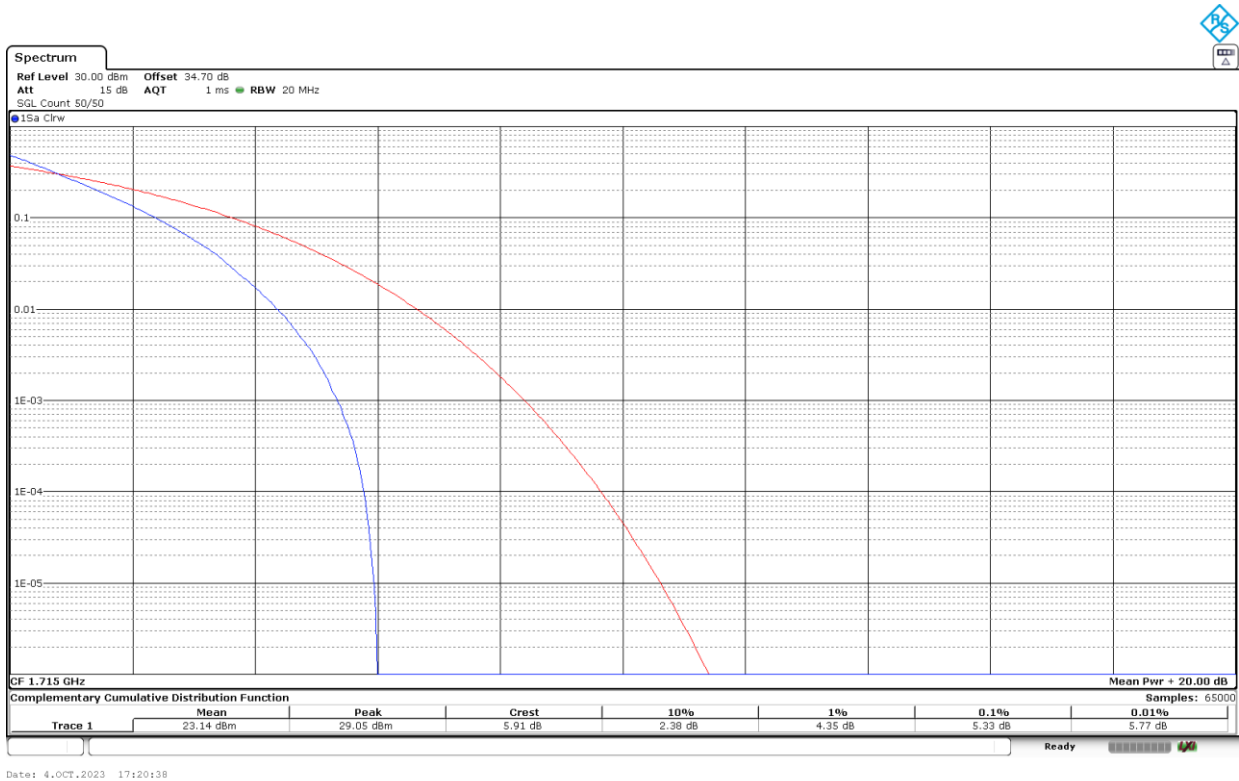
Verdict

Pass

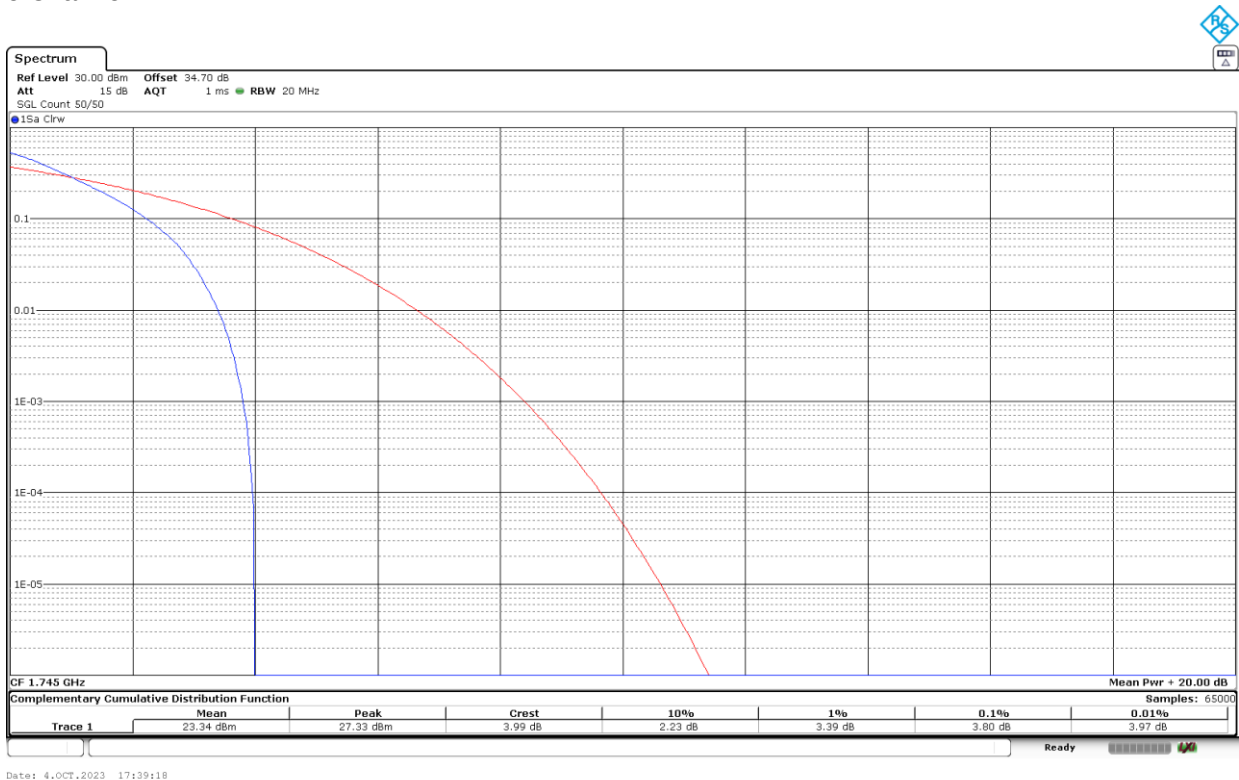
LTE Cat 1bis Band 66:

Worst-case of PAPR is BW= 10 MHz, Low Channel, QPSK, RB Size=50, RB Offset=0.

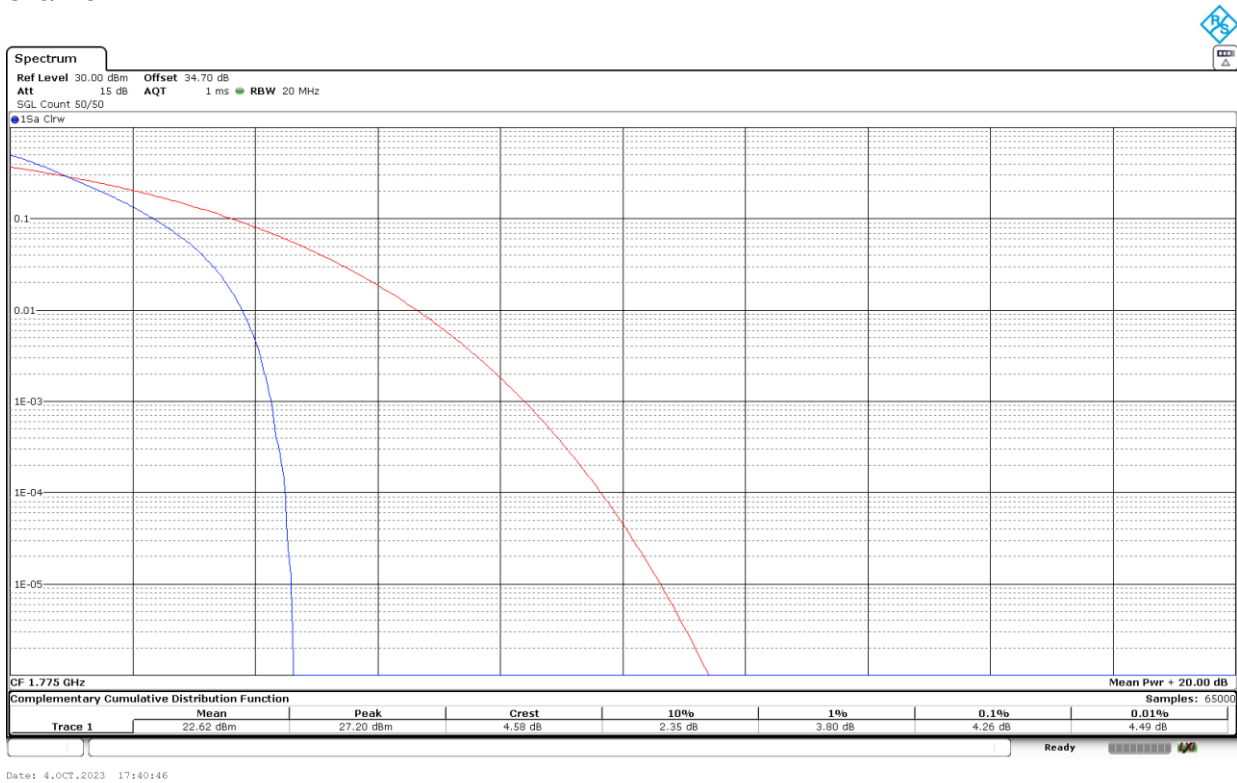
Low Channel:



Middle Channel:



High Channel:



QPSK	Low	Middle	High
PAPR (dB)	5.33	3.80	4.26

Verdict

Pass

Frequency Stability

Limits

1. LTE Cat 1bis Bands 12, 13.

* FCC §27.54: The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

* FCC § 2.1055:

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

(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

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

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

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

* RSS-130, 4.5:

For equipment that is capable of transmitting numerous channels simultaneously for different applications (e.g. LTE and narrowband – Internet of Things (IoT)), the occupied bandwidth shall be the bandwidth representing the sum of the occupied bandwidths of these channels.

The frequency stability shall be sufficient to ensure that the occupied bandwidth remains within each frequency block range when tested at the temperature and supply voltage variations specified in RSS-Gen.

2. LTE Cat 1bis Band 66.

* FCC §27.54: The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

* FCC § 2.1055:

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

(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

- (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
- (c) The frequency stability shall be measured with variation of primary supply voltage as follows:
 - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than 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.
 - (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

* RSS-139, 5.4:

The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block or frequency block group when tested to the temperature and supply voltage variations specified in RSS-Gen.

Method

The frequency tolerance measurements over temperature variations were made over the temperature range of -30°C to +50°C. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to +50°C.

The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set in "Radio Resource Control (RRC) mode" on the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.

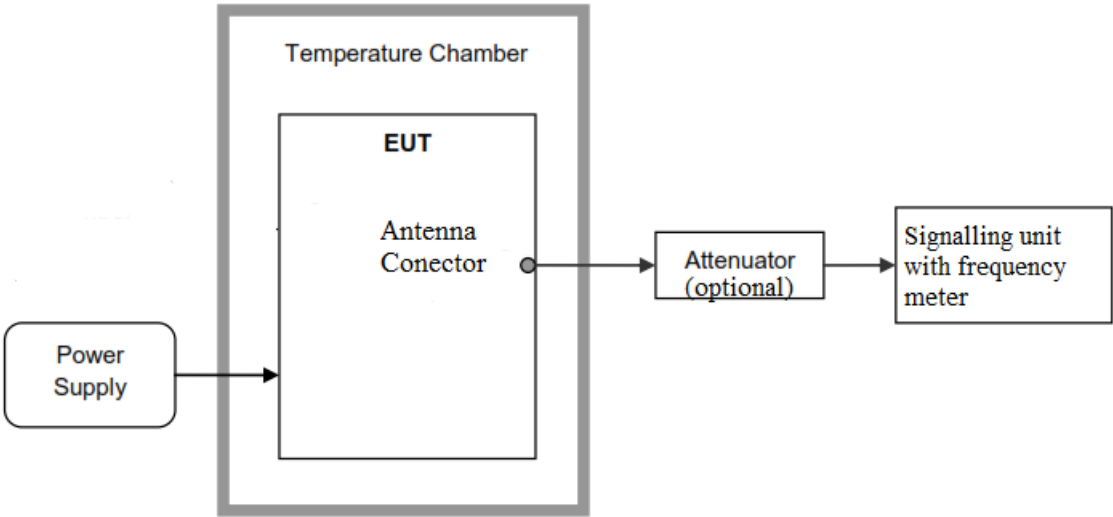
The worst case LTE mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation are identified as fL and fH respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

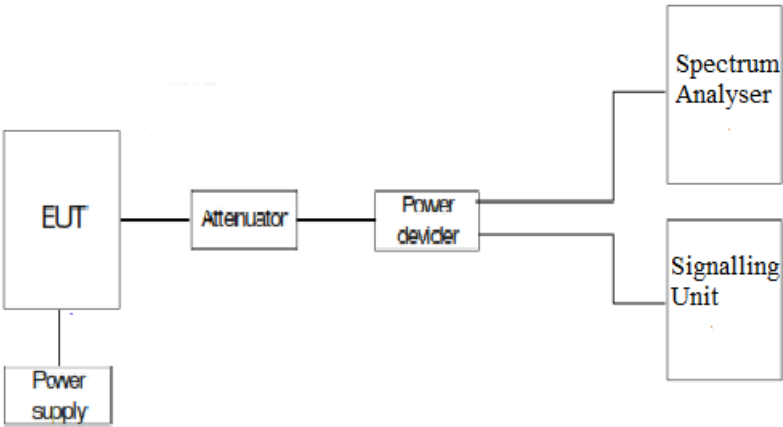
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance:



Reference points f_L and f_H :



Results

1. FREQUENCY TOLERANCE:

- Frequency stability over temperature variations:

LTE Cat 1bis Band 12:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	6.31	0.008918728
+40	4.85	0.006855124
+30	5.4	0.007632509
+20	3.41	0.004819788
+10	2.81	0.003971731
0	3.07	0.004339223
-10	0.99	0.001399293
-20	2.59	0.003660777
-30	2.98	0.004212014

LTE Cat 1bis Band 13:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	3.87	0.004948849
+40	4.22	0.005396419
+30	4.16	0.005319693
+20	2.19	0.002800512
+10	3.56	0.00455243
0	1.81	0.002314578
-10	4.4	0.005626598
-20	5.08	0.006496164
-30	5.2	0.006649616

LTE Cat 1bis Band 66:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-1.92	-0.001100287
+40	-2.15	-0.001232092
+30	2.02	0.001157593
+20	0.4	0.000229226
+10	-0.18	-0.000103152
0	0.71	0.000406877
-10	-0.87	-0.000498567
-20	-1.32	-0.000756447
-30	3.33	0.001908309

- **Frequency stability over voltage variations:**

LTE Cat 1bis Band 12:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	5.5	3.63	0.005130742
Vmin	3.2	4.6	0.006501767

LTE Cat 1bis Band 13:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	5.5	2.08	0.002659847
Vmin	3.2	4.17	0.005332481

LTE Cat 1bis Band 66:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	5.5	-0.2	-0.000114613
Vmin	3.2	-0.1	-5.73066E-05

2. REFERENCE FREQUENCY POINTS f_L AND f_H :

The worst-case frequency offsets added or subtracted per band and bandwidth:

LTE Cat 1bis Band 12: BW=5 MHz. QPSK.

f_L (MHz)	699.0179
f_H (MHz)	715.9907

LTE Cat 1bis Band 13: BW=5 MHz. QPSK.

f_L (MHz)	777.0515
f_H (MHz)	786.9600

LTE Cat 1bis Band 66: BW=5 MHz. QPSK.

f_L (MHz)	1710.0642
f_H (MHz)	1779.8963

The reference frequency points f_L and f_H stay within the authorized blocks for the band above.

Measurement uncertainty (Hz): $<\pm 207.77$

Verdict

PASS

Modulation Characteristics

Limits

1. LTE Cat 1bis Bands 12, 13.

- * FCC §2.1047 Measurements required: Modulation characteristics.
- * RSS-130 4.2: Equipment certified under this standard shall employ digital modulation.

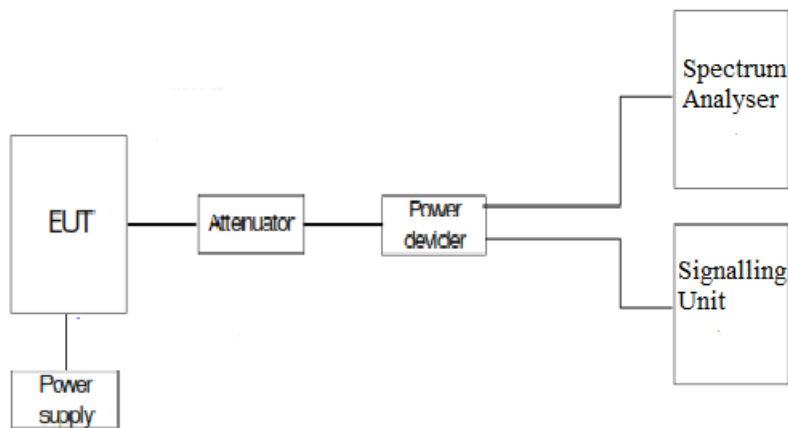
2. LTE Cat 1bis Band 66.

- * FCC §2.1047 Measurements required: Modulation characteristics.
- * RSS-139 5.3: Devices may use any type of modulation technique. The type of modulation shall be documented in the test report.

Method

For LTE the EUT operates with QPSK and 16QAM modulation modes in which the information is digitised and coded into a bit stream. The RF transmission is multiplexed using *Orthogonal Frequency Division Multiplexing (OFDM)* using different possible arrangement of subcarriers (Resource Blocks RB).

Test Setup

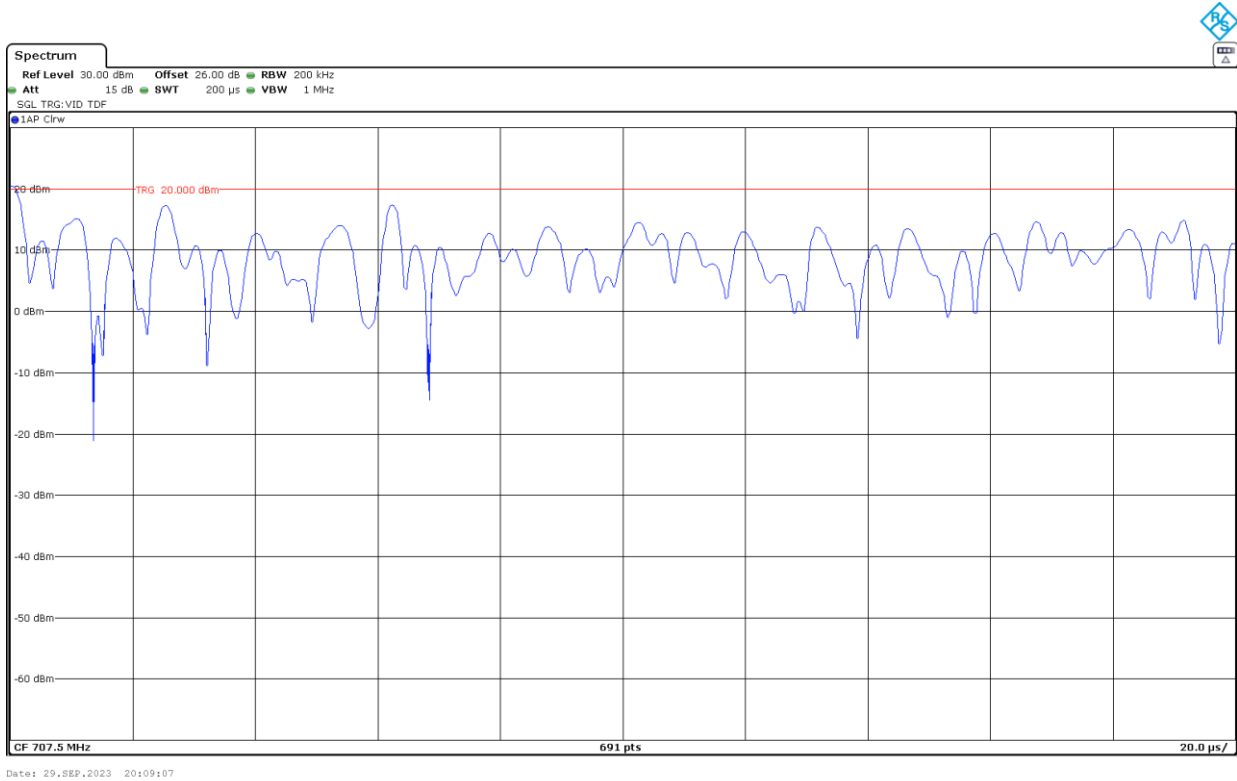


Results

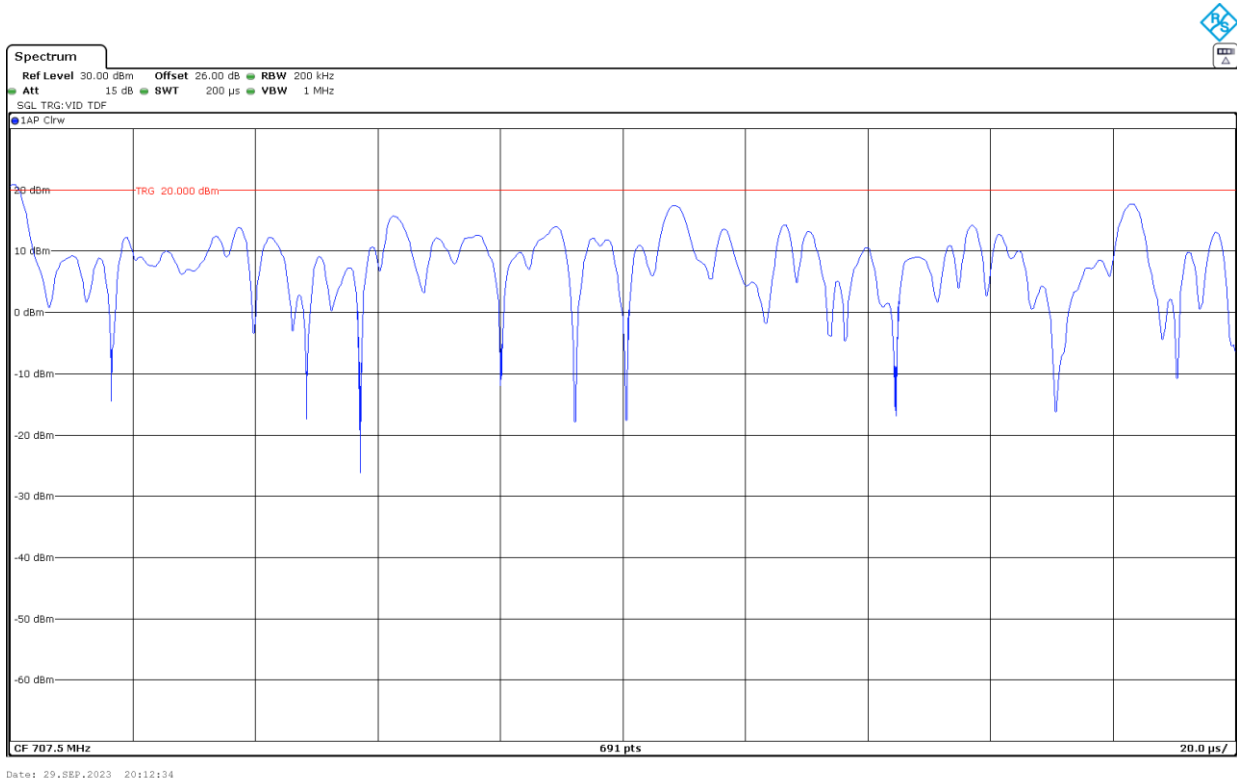
The following plots show the modulation schemes in the EUT.

LTE Cat 1bis Band 12:

QPSK. BW=5 MHz.

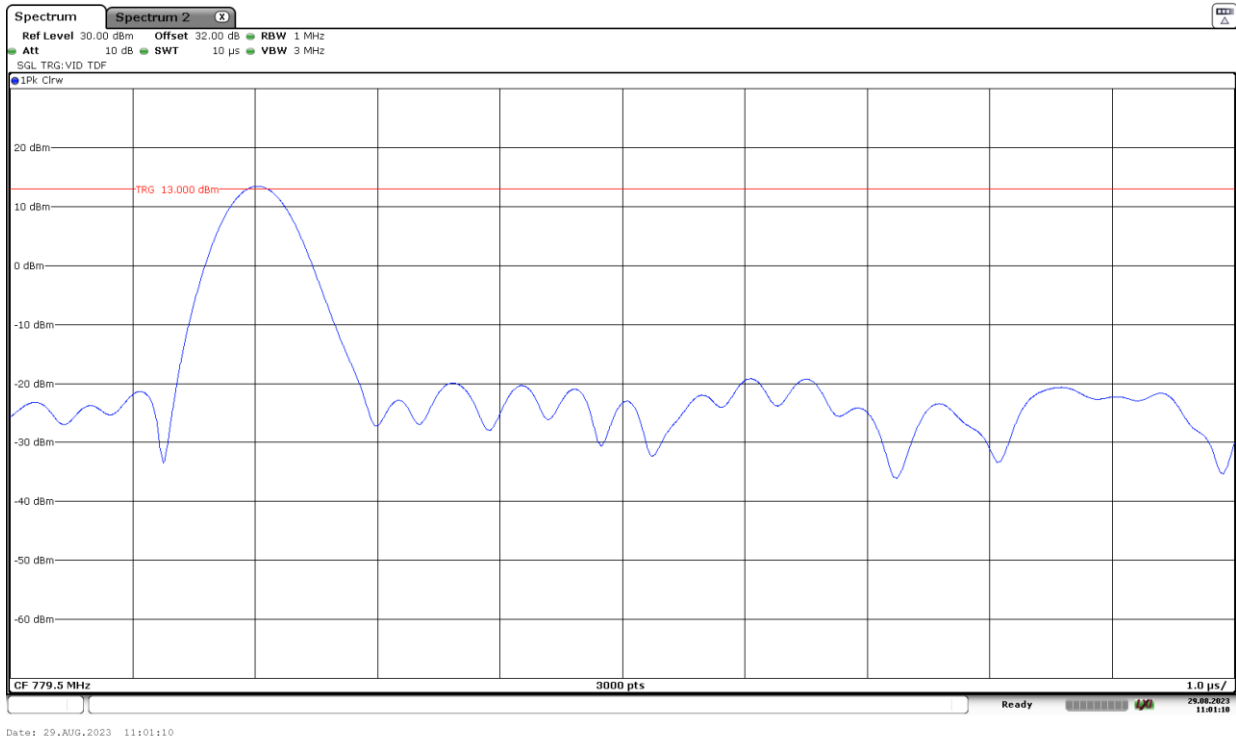


16QAM. BW=5 MHz.

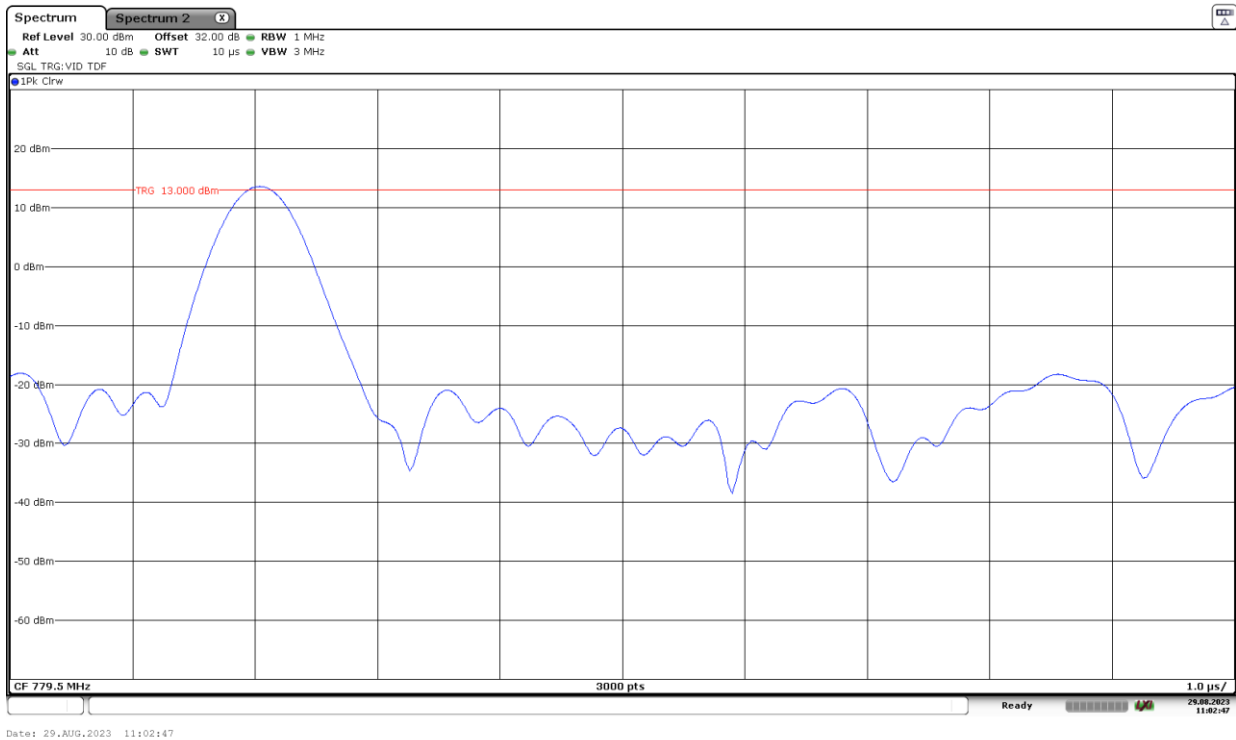


LTE Cat 1bis Band 13:

QPSK. BW=5 MHz.

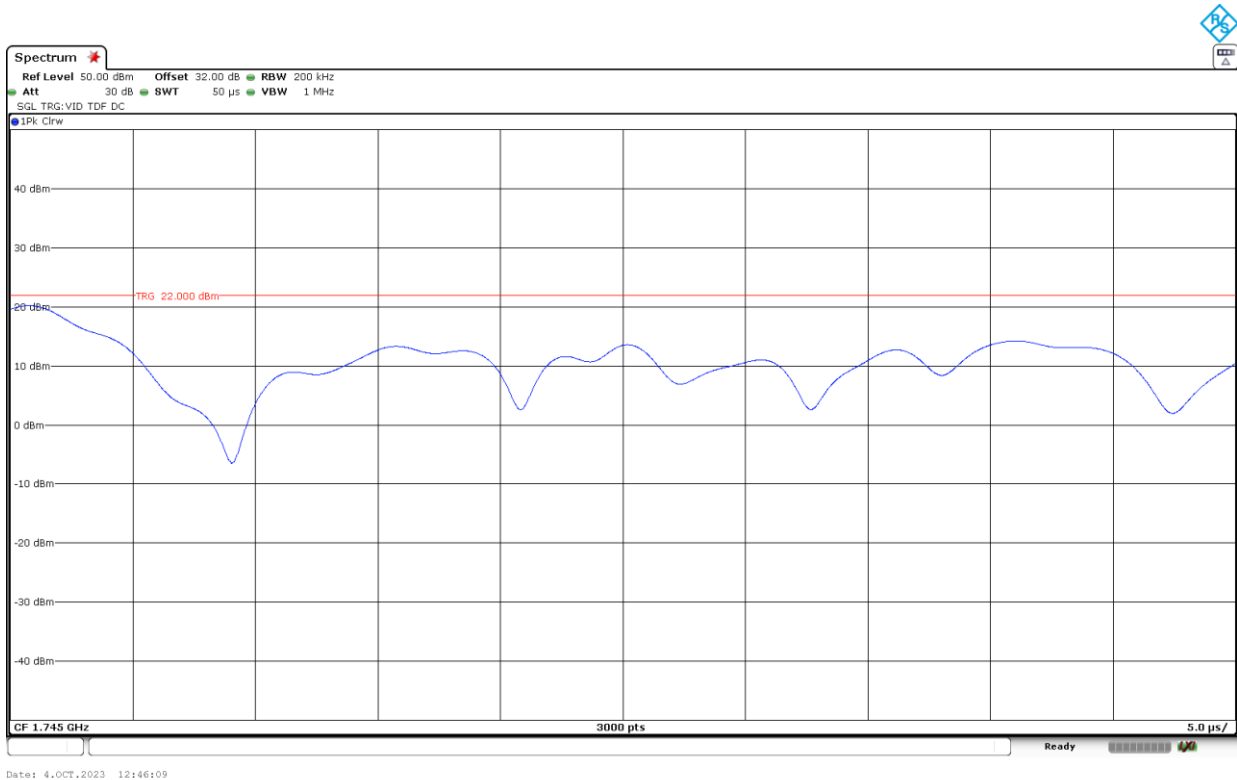


16QAM. BW=5 MHz.

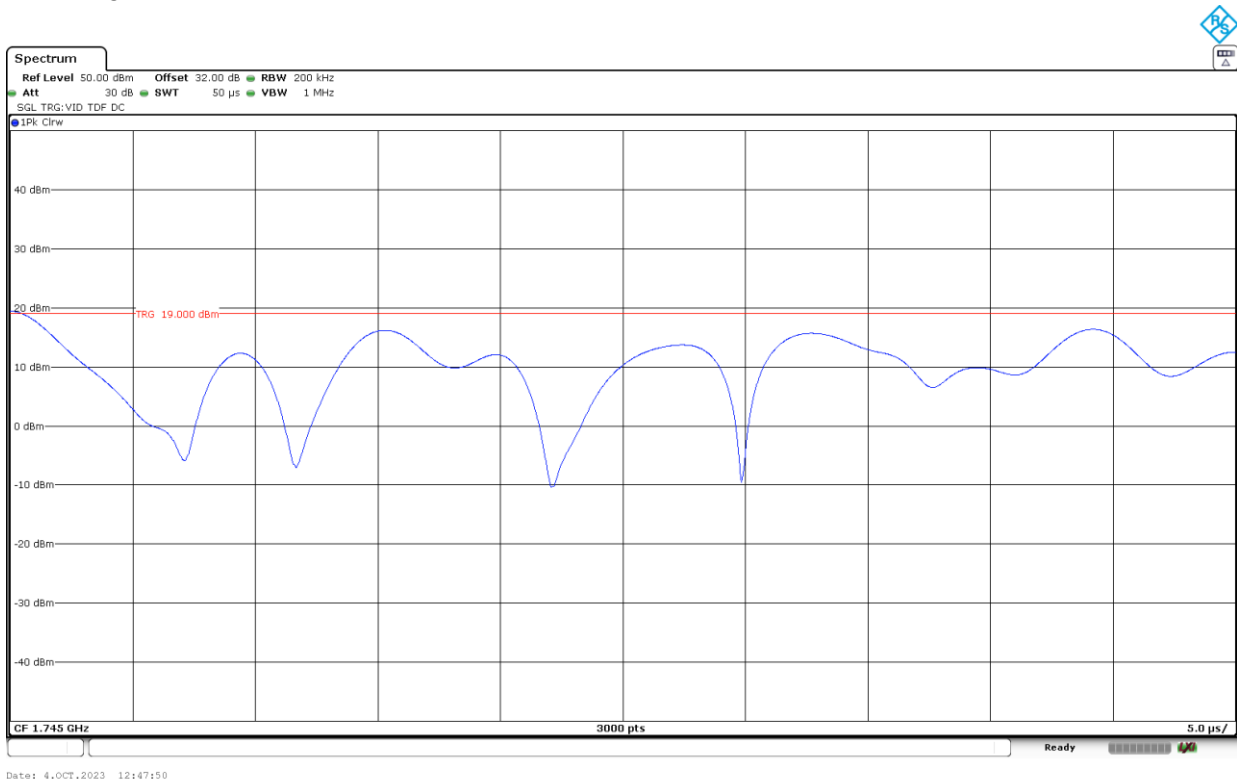


LTE Cat 1bis Band 66:

QPSK. BW=5 MHz.



16QAM. BW=5 MHz.



Occupied Bandwidth

Limits

1. LTE Cat 1bis Bands 12, 13, 66.

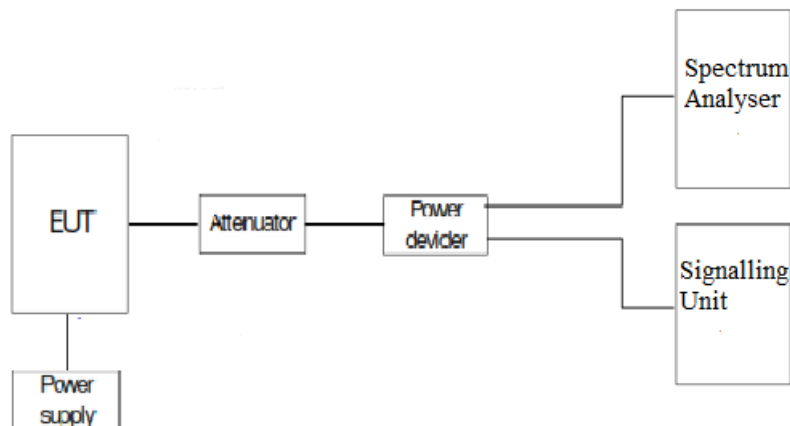
* FCC §2.1049: Measurements required: Occupied bandwidth.

* RSS-Gen 6.7: Occupied bandwidth (or 99% emission bandwidth).

Method

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

Test Setup



Results

The worst case of occupied bandwidth corresponds to Resource Blocks (RB) Size All regardless either the Narrow Band or the Bandwidth selected.

LTE Cat 1bis Band 12:

LTE Cat 1bis Band 12. BW=5 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.573	4.580	4.583
-26 dBc Bandwidth (MHz)	5.676	5.738	5.669
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=5 MHz. 16QAM. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.590	4.593	4.570
-26 dBc Bandwidth (MHz)	5.697	6.901	5.676
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=10 MHz. QPSK. RB Size All.

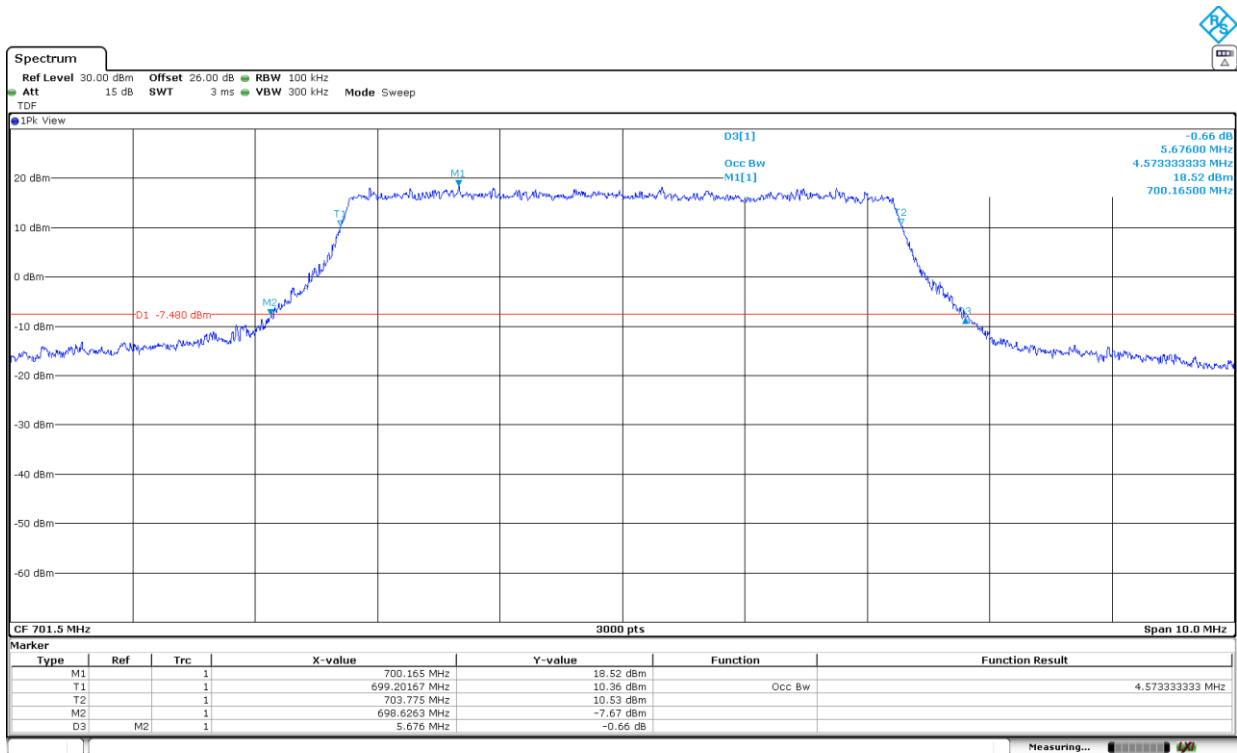
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	9.160	9.160	9.120
-26 dBc Bandwidth (MHz)	12.118	12.097	11.874
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=10 MHz. 16QAM. RB Size All.

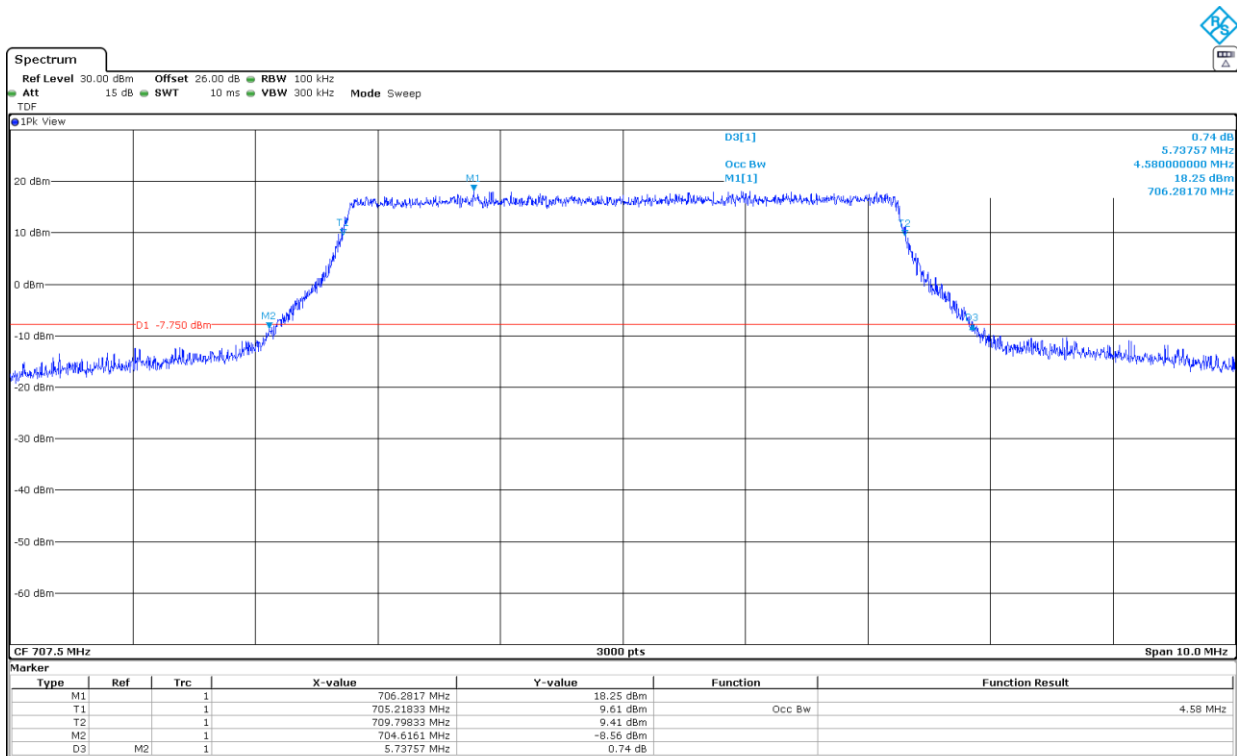
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	5.495	5.460	5.205
-26 dBc Bandwidth (MHz)	10.100	10.279	9.642
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=5 MHz. QPSK. RB Size All.

Low Channel:

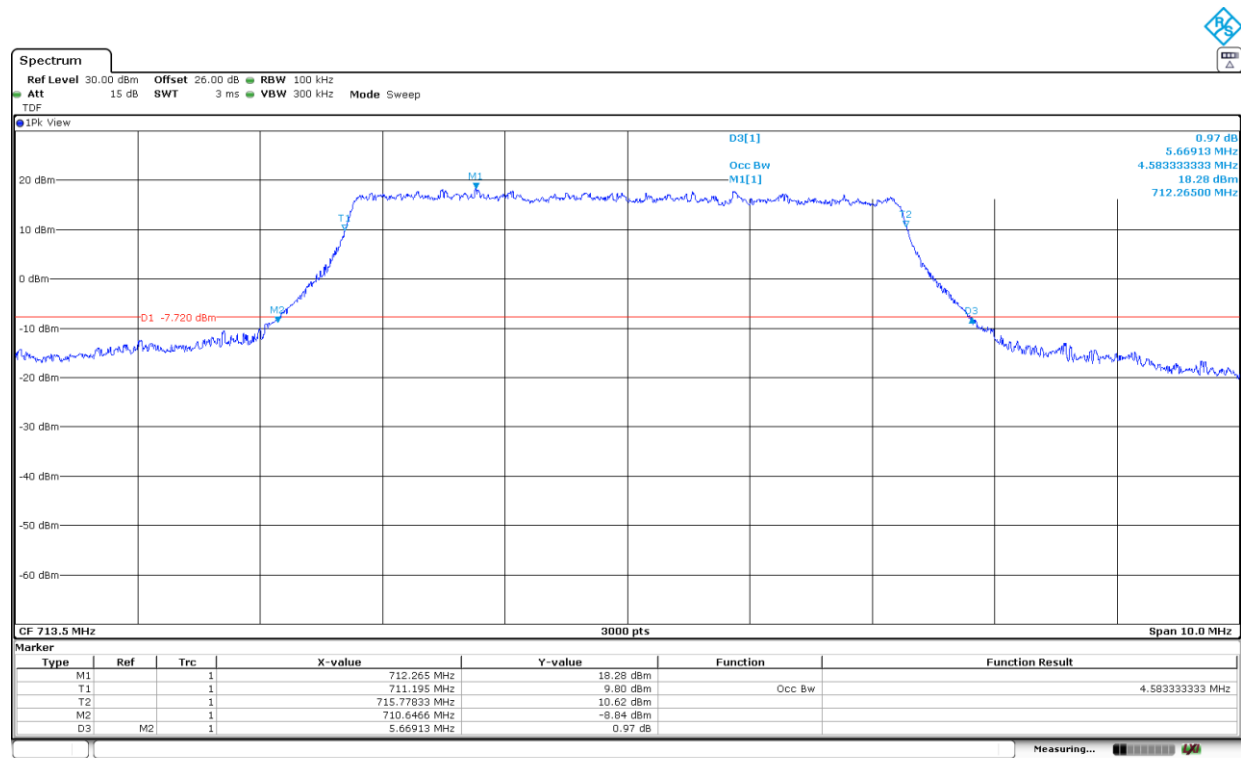


Middle Channel:



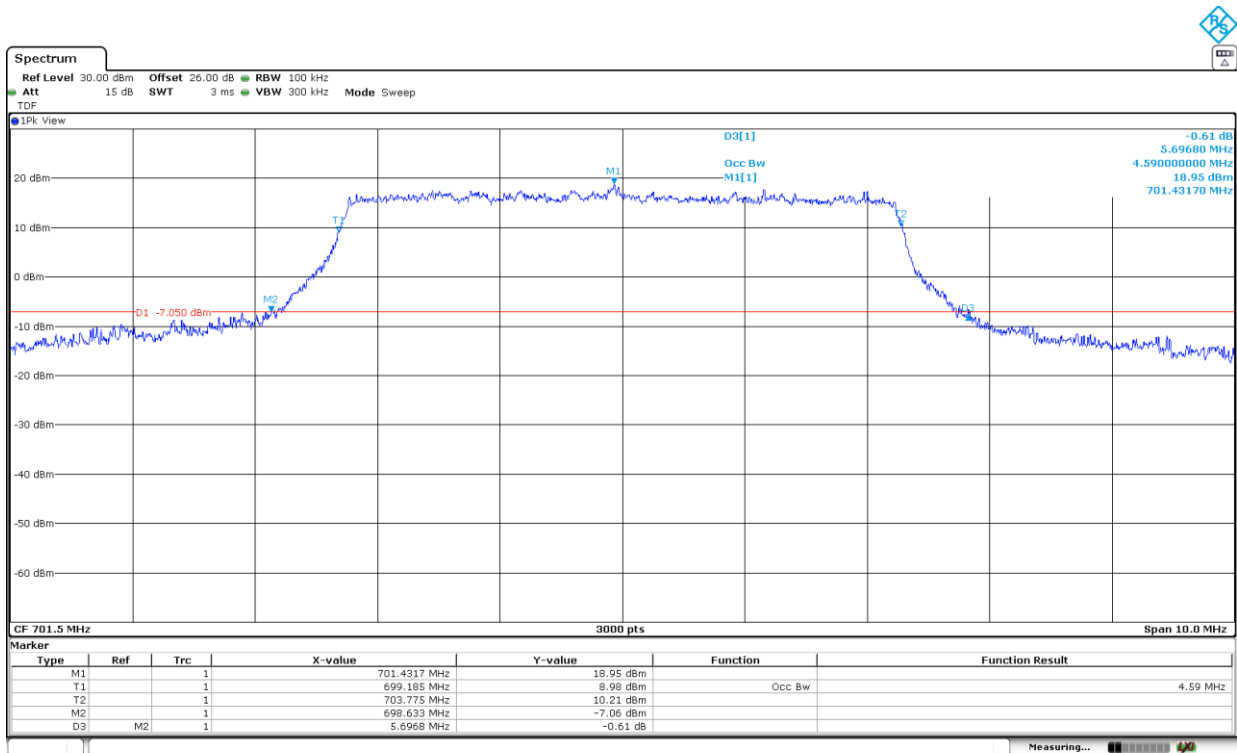
Date: 29.SEP.2023 20:28:38

High Channel:

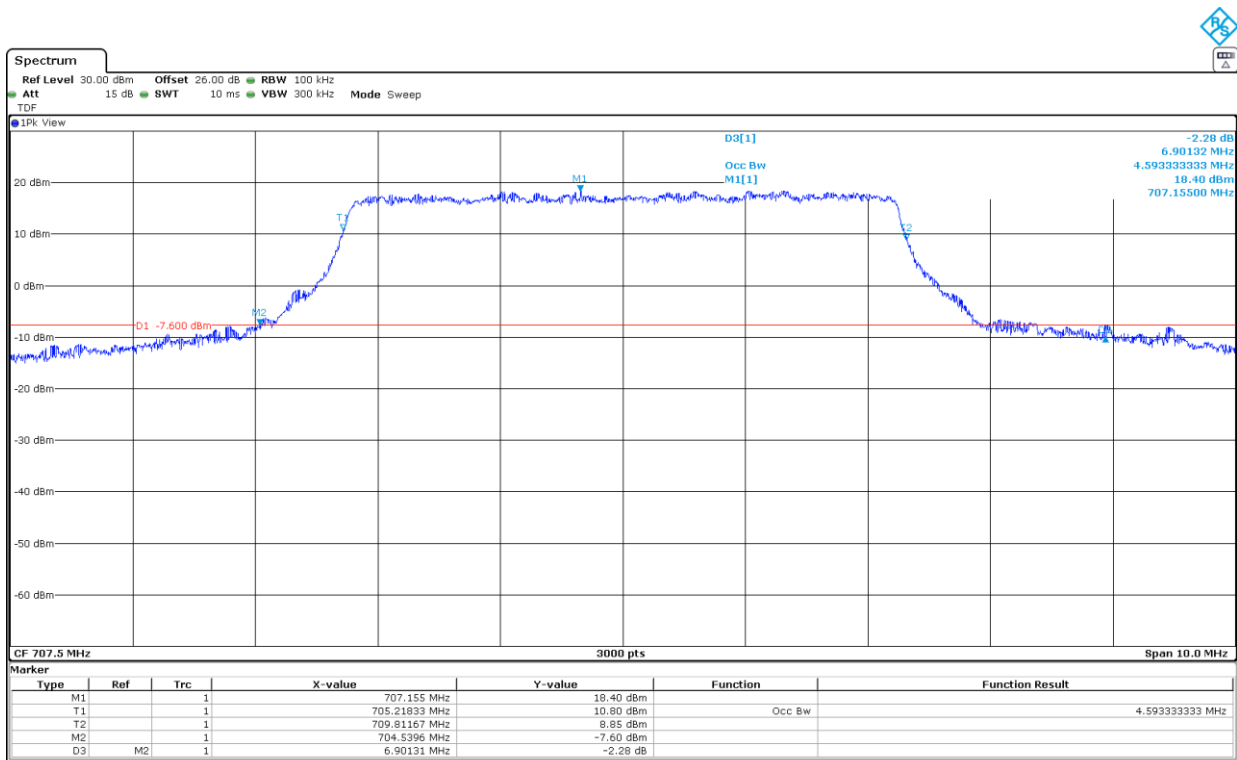


LTE Cat 1bis Band 12. BW=5 MHz. 16QAM. RB Size All.

Low Channel:

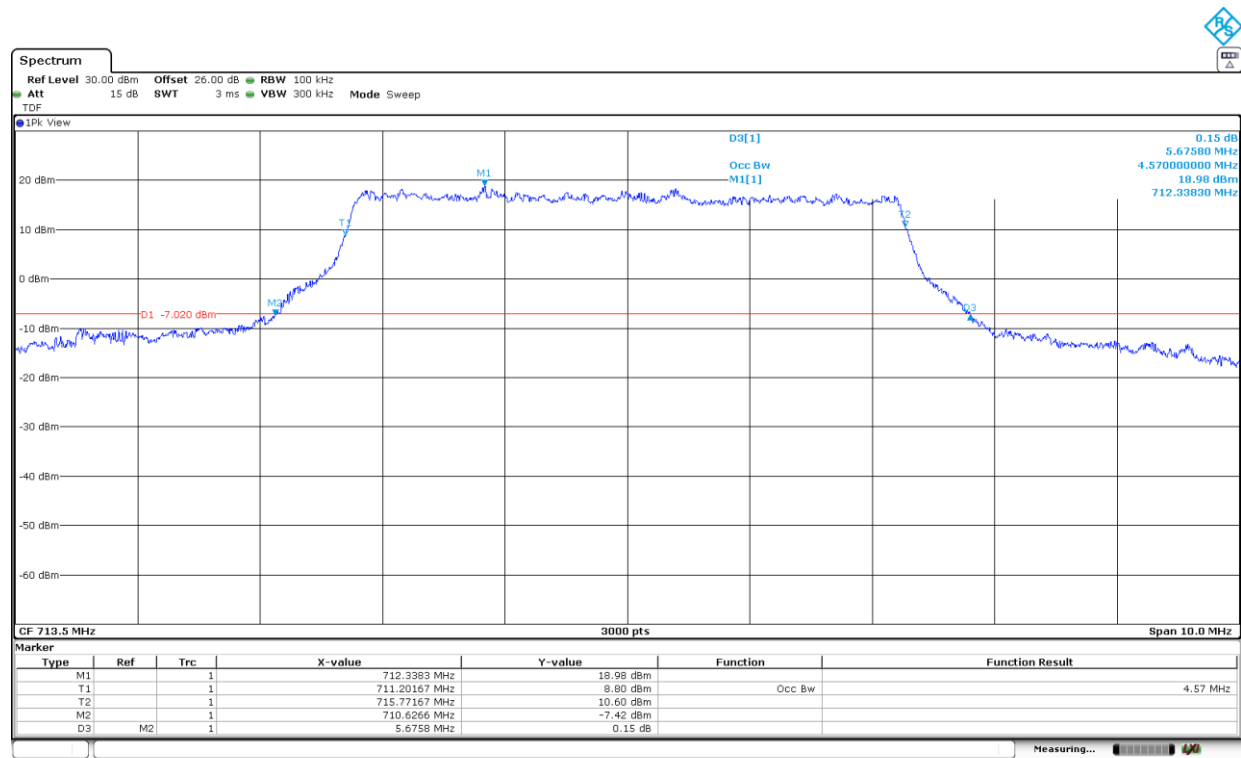


Middle Channel:



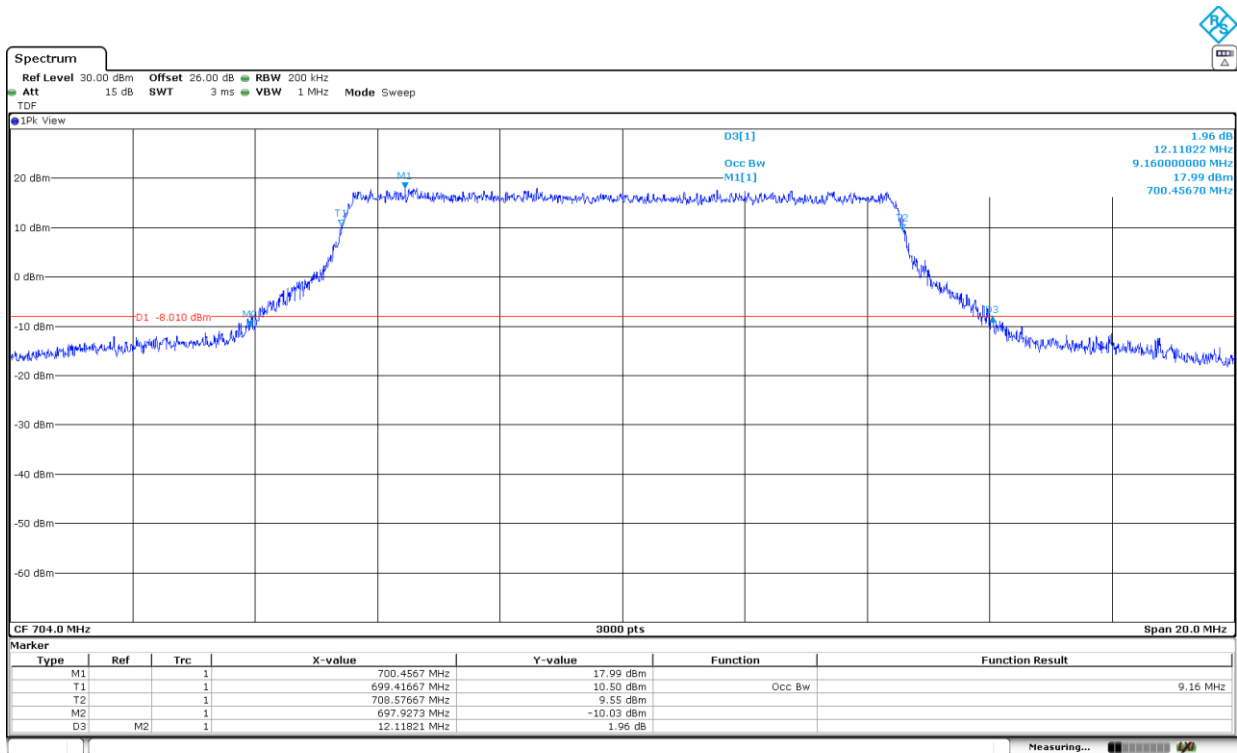
Date: 29.SEP.2023 20:25:29

High Channel:

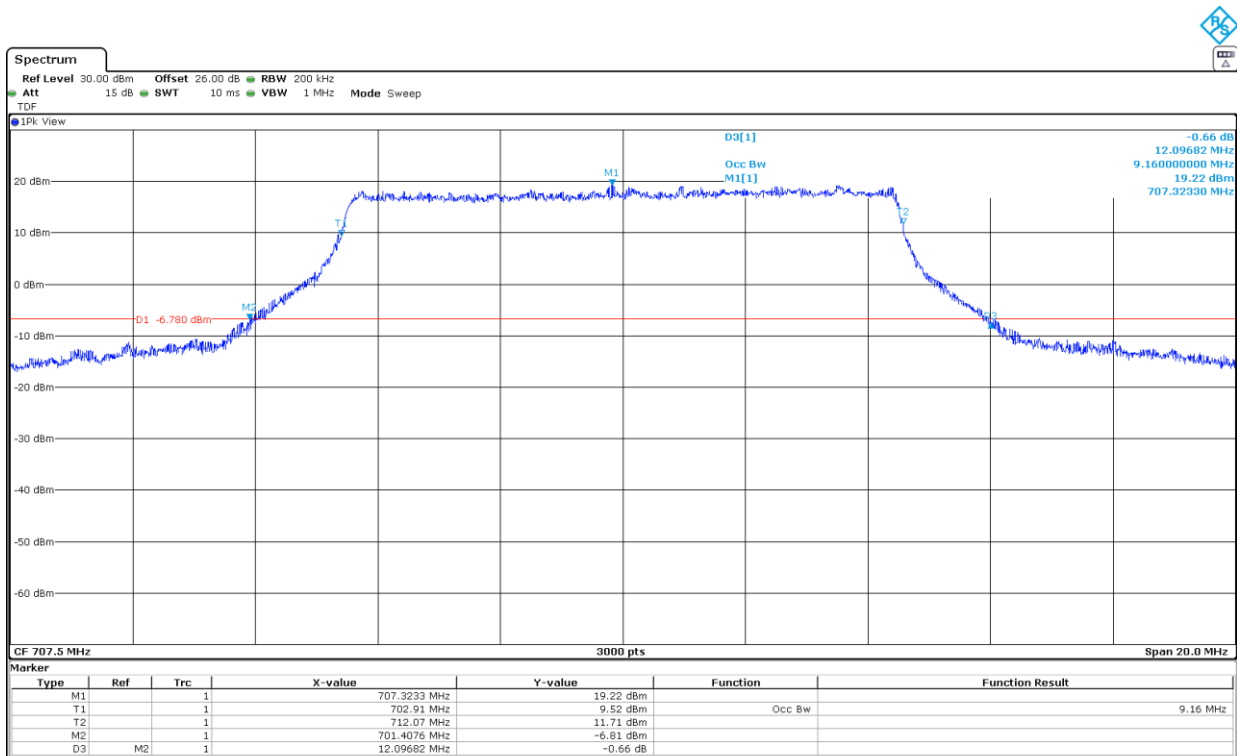


LTE Cat 1bis Band 12. BW=10 MHz. QPSK. RB Size All.

Low Channel:

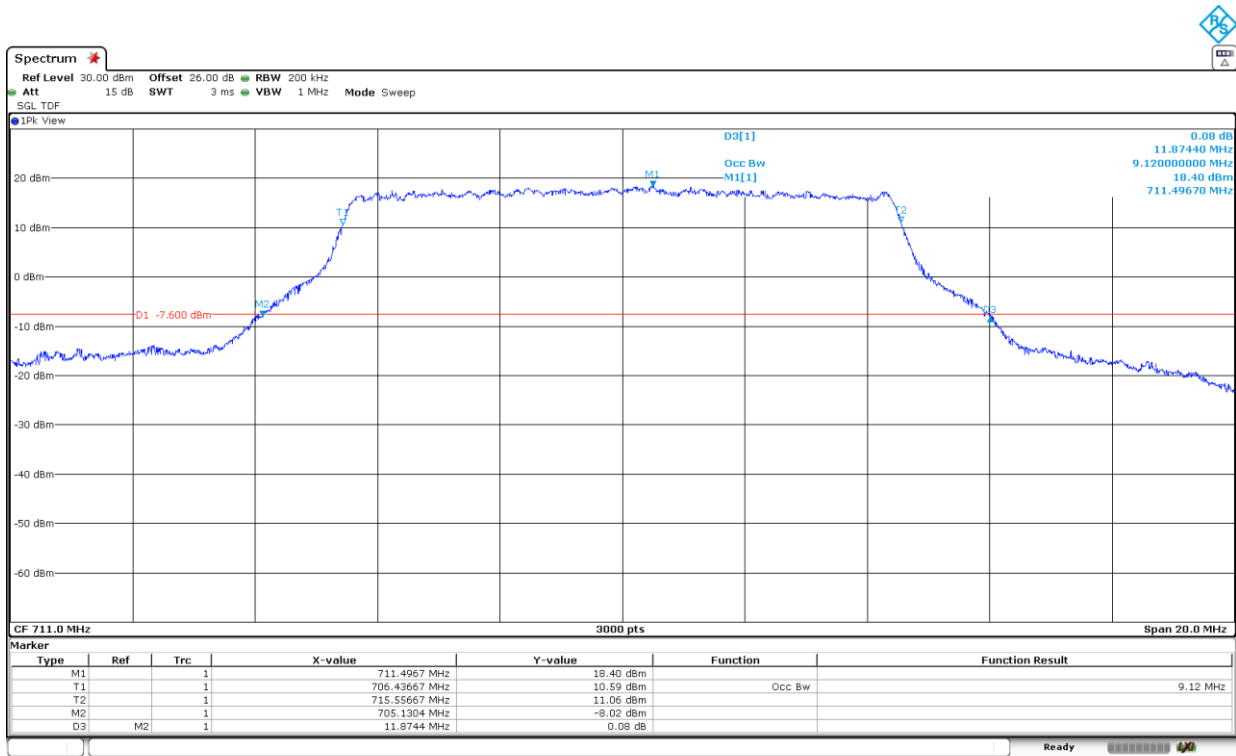


Middle Channel:



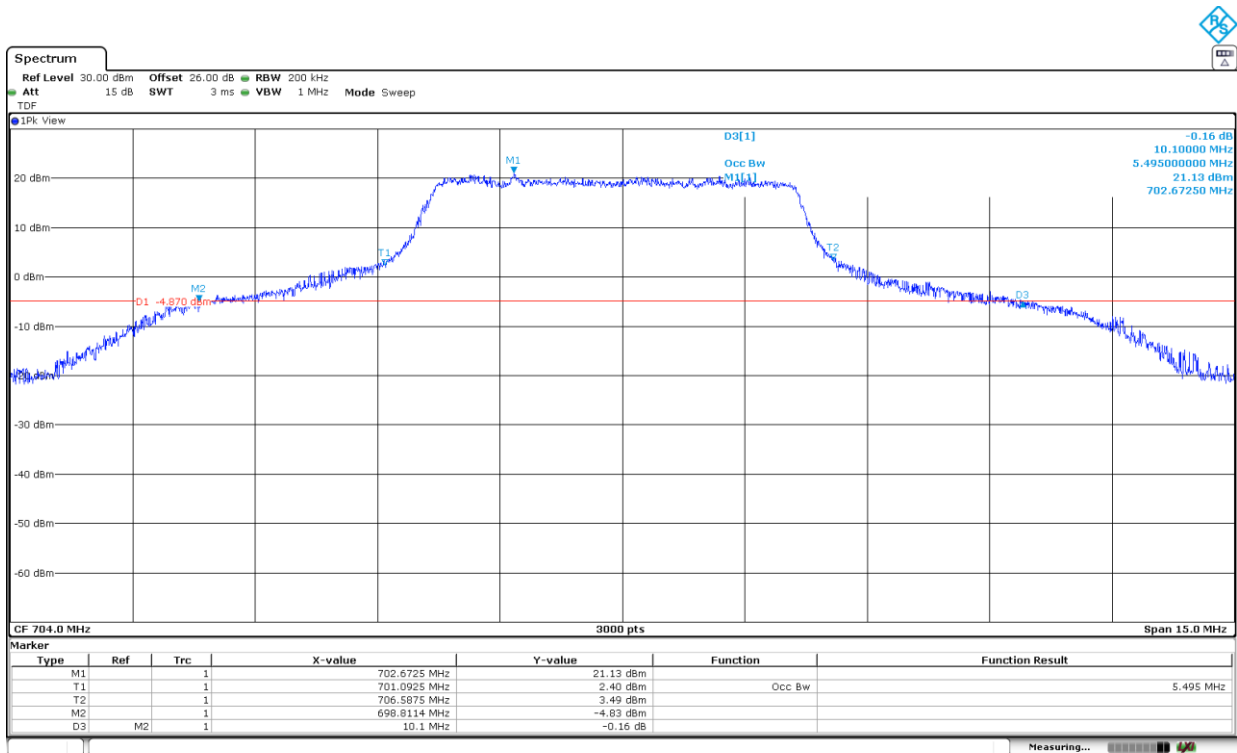
Date: 29.SEP.2023 20:32:51

High Channel:

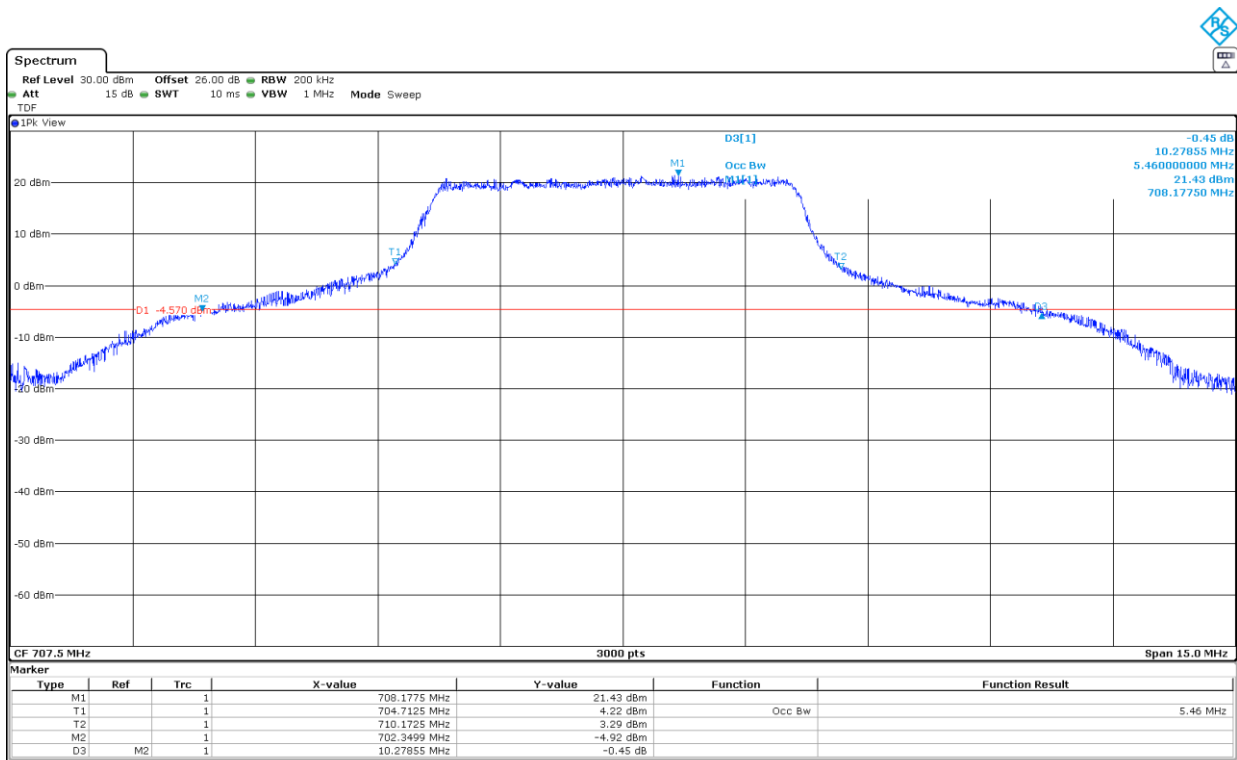


LTE Cat 1bis Band 12. BW=10 MHz. 16QAM. RB Size All.

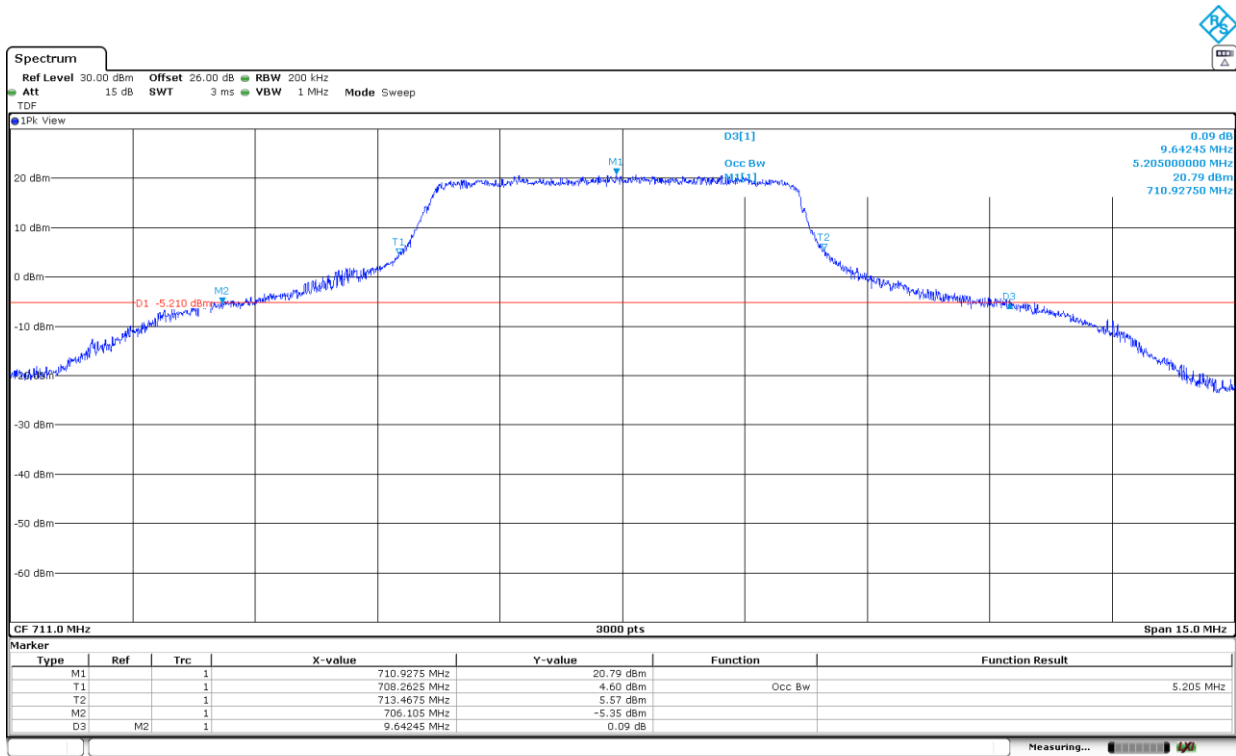
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 13:

LTE Cat 1bis Band 13. BW=5 MHz. QPSK. RB Size All.

Channel	Low	High
99% Occupied Bandwidth (MHz)	4.560	4.570
-26 dBc Bandwidth (MHz)	5.564	5.663
Measurement uncertainty (kHz)	<±3.75	

LTE Cat 1bis Band 13. BW=5 MHz. 16QAM. RB Size All.

Channel	Low	High
99% Occupied Bandwidth (MHz)	4.540	4.570
-26 dBc Bandwidth (MHz)	5.581	5.710
Measurement uncertainty (kHz)	<±3.75	

LTE Cat 1bis Band 13. BW=10 MHz. QPSK. RB Size All.

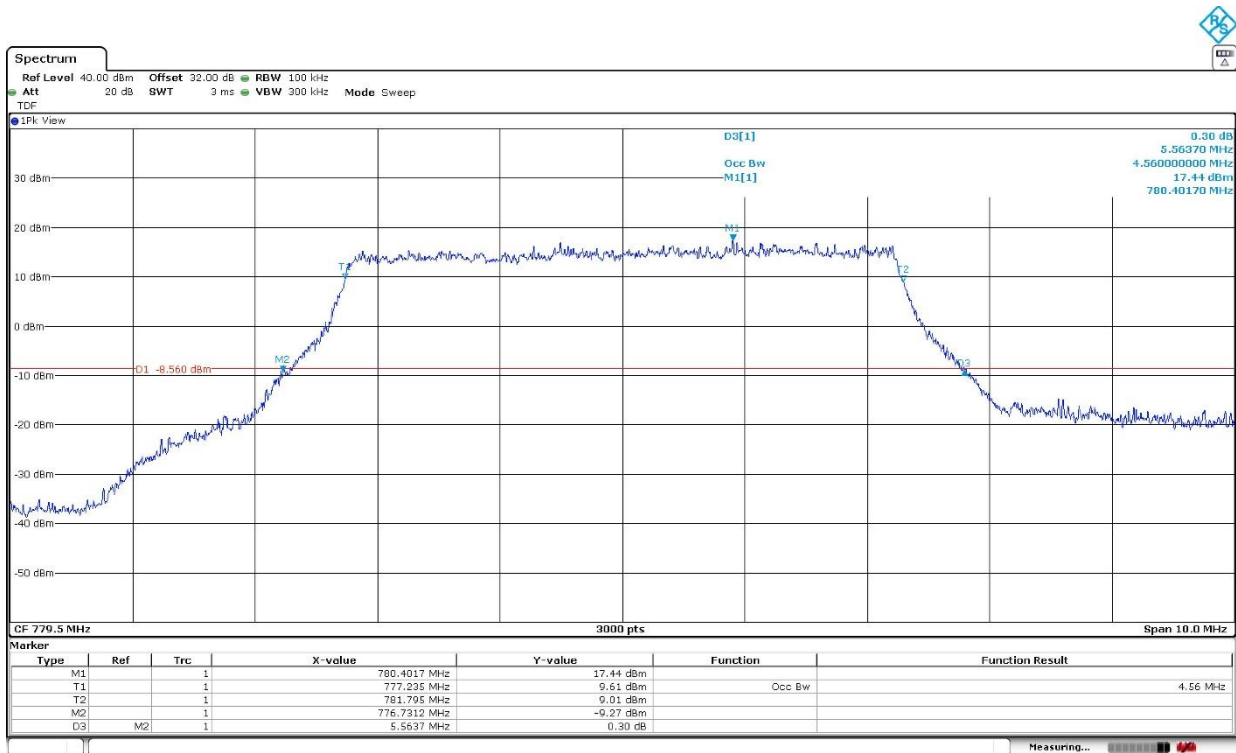
Channel	Middle
99% Occupied Bandwidth (MHz)	9.240
-26 dBc Bandwidth (MHz)	11.803
Measurement uncertainty (kHz)	<±3.75

LTE Cat 1bis Band 13. BW=10 MHz. 16QAM. RB Size All.

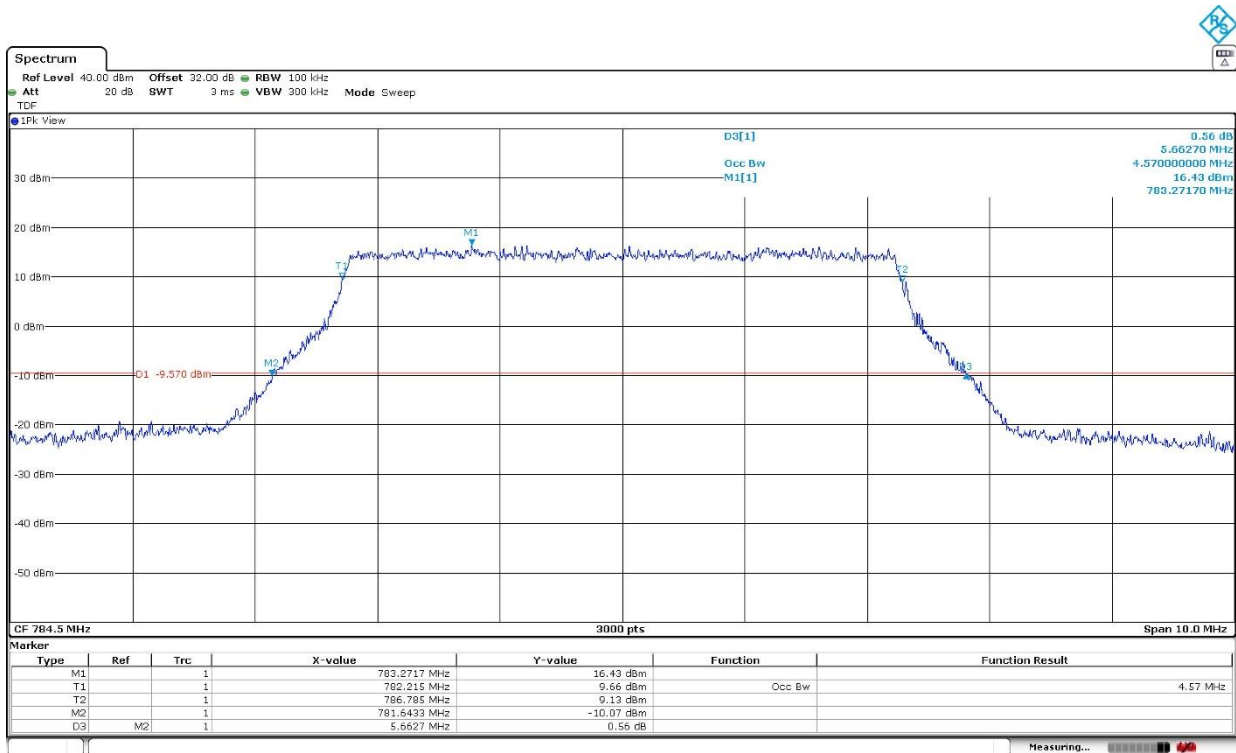
Channel	Middle
99% Occupied Bandwidth (MHz)	6.047
-26 dBc Bandwidth (MHz)	10.850
Measurement uncertainty (kHz)	<±3.75

LTE Cat 1bis Band 13. BW=5 MHz. QPSK. RB Size All.

Low Channel:

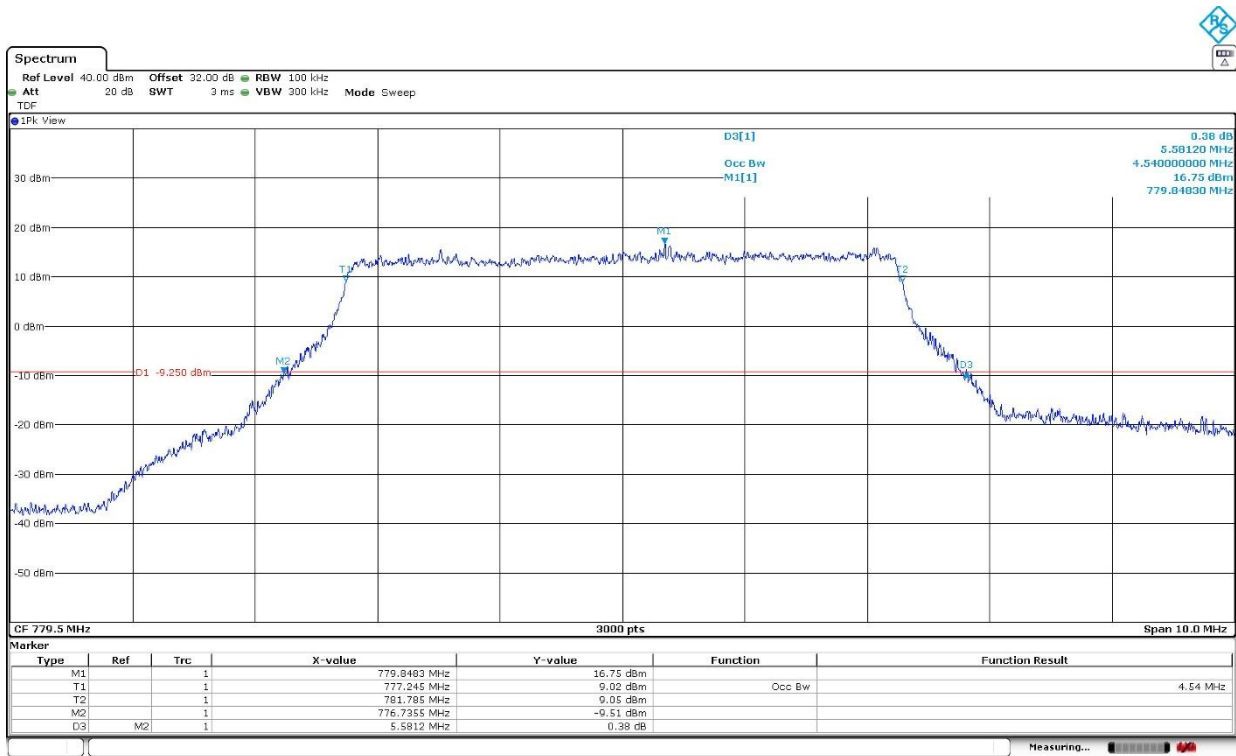


High Channel:

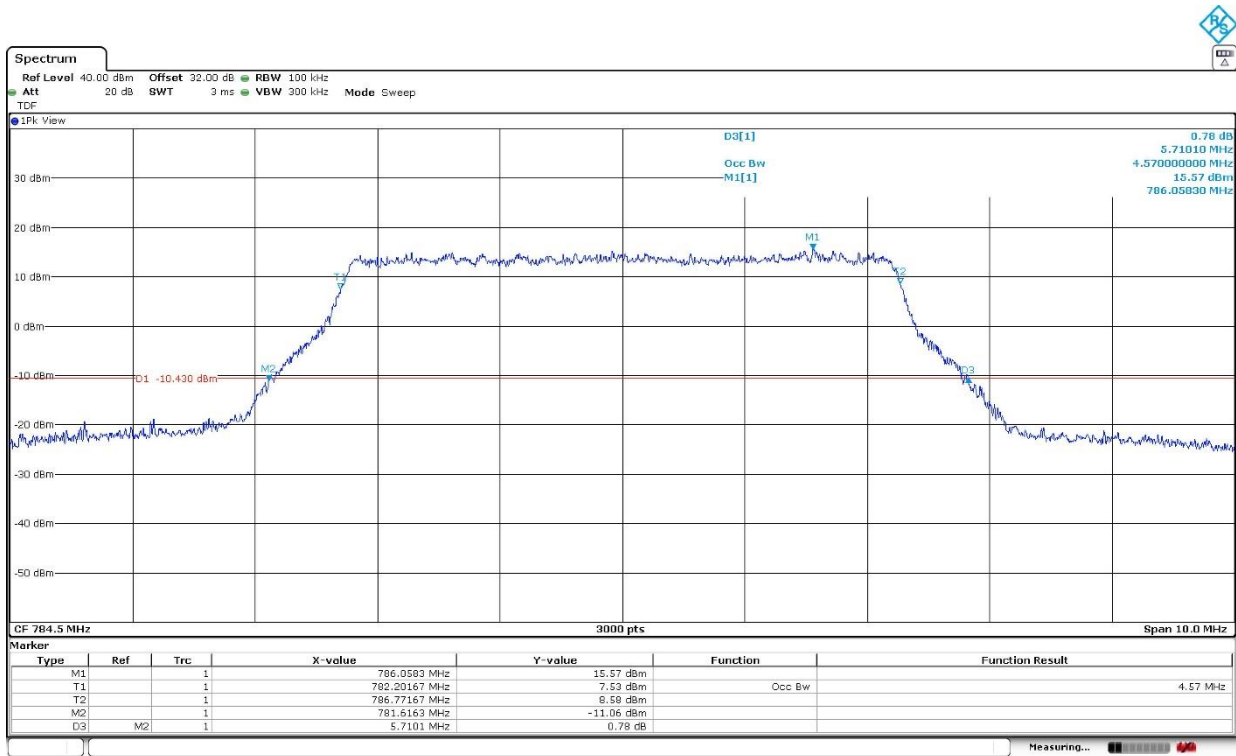


LTE Cat 1bis Band 13. BW=5 MHz. 16QAM. RB Size All.

Low Channel:

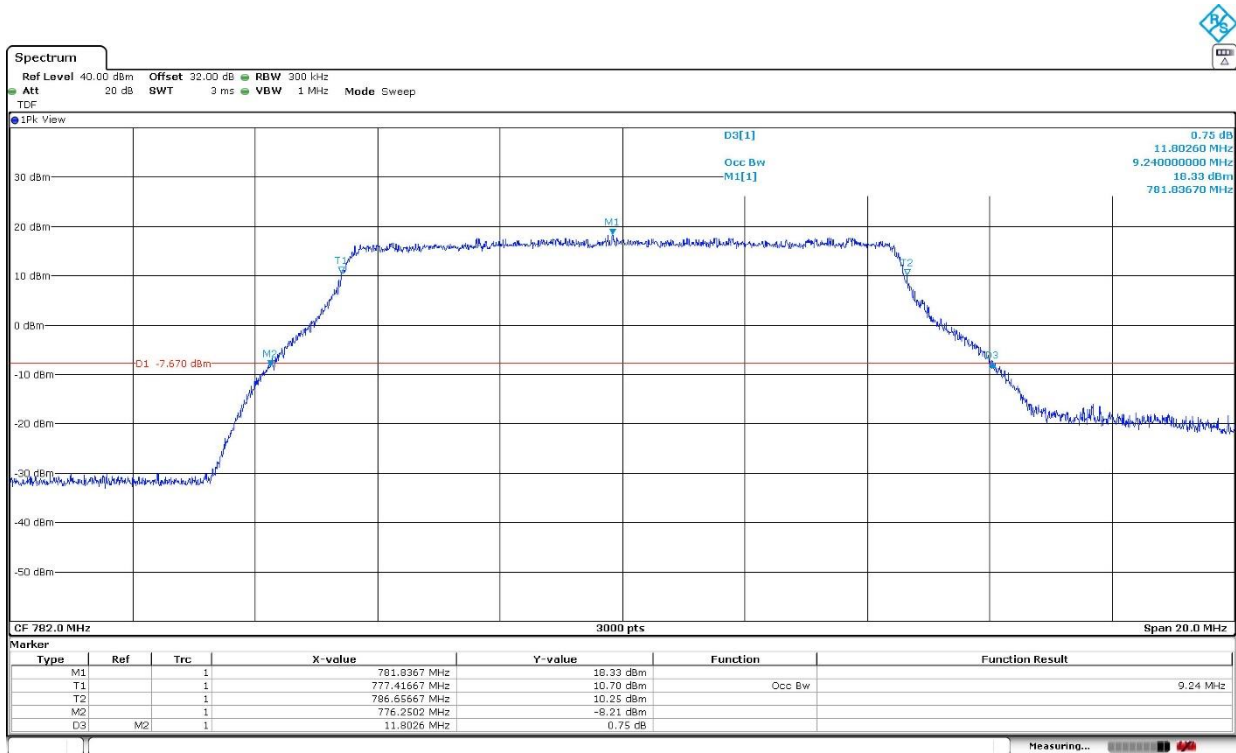


High Channel:



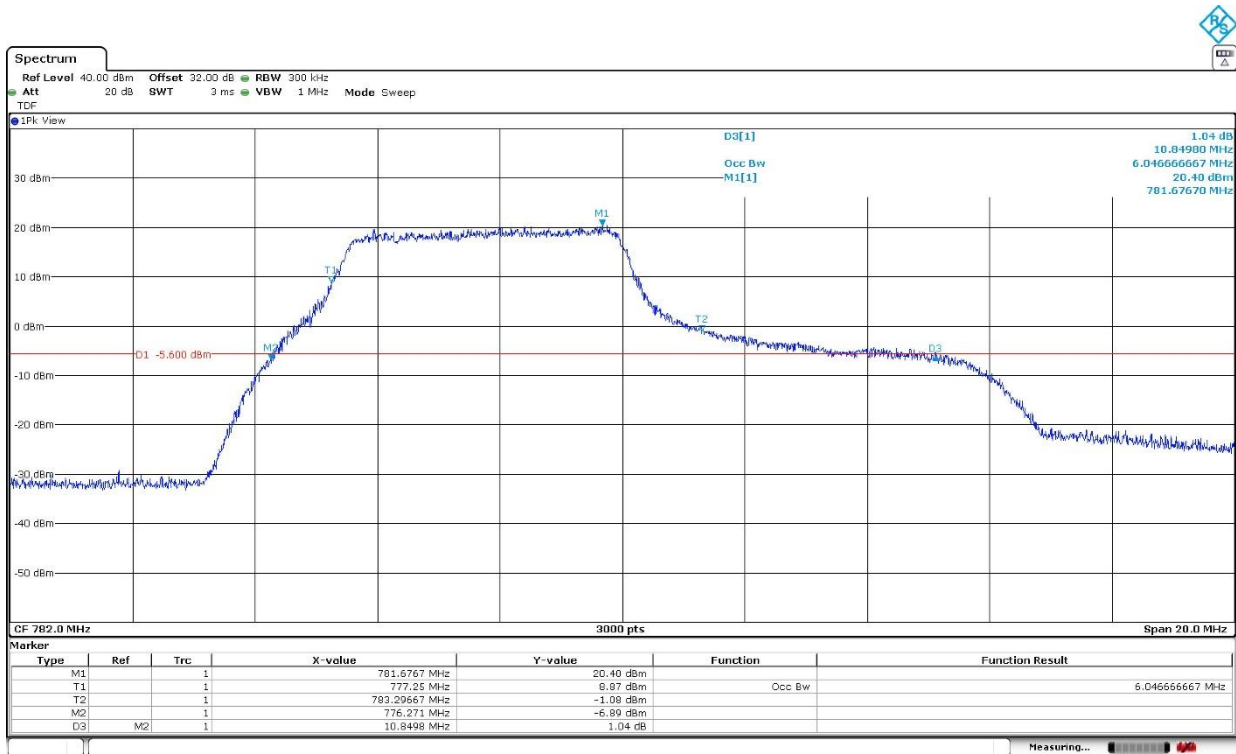
LTE Cat 1bis Band 13. BW=10 MHz. QPSK. RB Size All.

Middle Channel:



LTE Cat 1bis Band 13. BW=10 MHz. 16QAM. RB Size All.

Middle Channel:



LTE Cat 1bis Band 66:

LTE Cat 1bis Band 66. BW=5 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.590	4.610	4.600
-26 dBc Bandwidth (MHz)	5.652	5.779	5.764
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=5 MHz. 16QAM. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.560	4.580	4.570
-26 dBc Bandwidth (MHz)	5.702	5.809	5.665
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=10 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	9.135	9.165	9.120
-26 dBc Bandwidth (MHz)	11.996	12.167	11.948
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=10 MHz. 16QAM. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	5.55	5.55	5.415
-26 dBc Bandwidth (MHz)	10.552	10.831	9.713
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=15 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	13.620	13.650	13.590
-26 dBc Bandwidth (MHz)	15.971	16.297	15.939
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=15 MHz. 16QAM. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	6.060	6.300	6.600
-26 dBc Bandwidth (MHz)	11.089	11.861	11.029
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=20 MHz. QPSK. RB Size All.

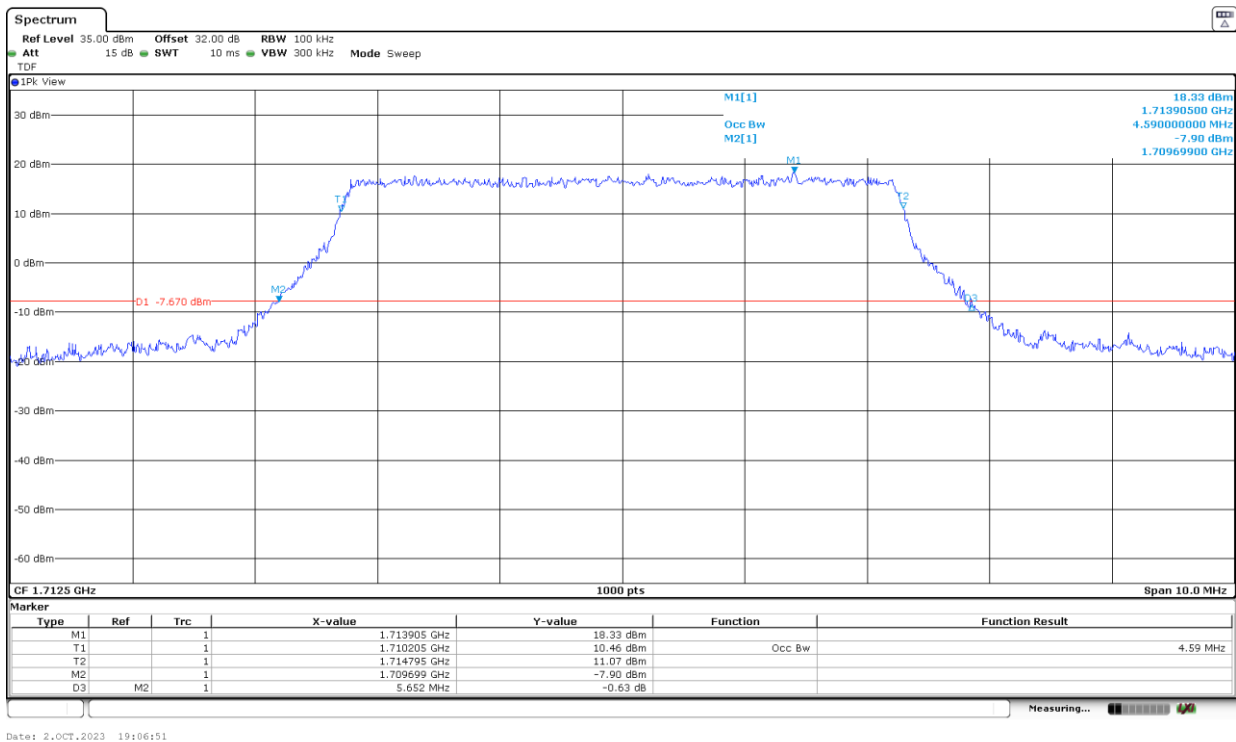
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	18.040	18.080	18.000
-26 dBc Bandwidth (MHz)	20.632	20.832	20.685
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=20 MHz. 16QAM. RB Size All.

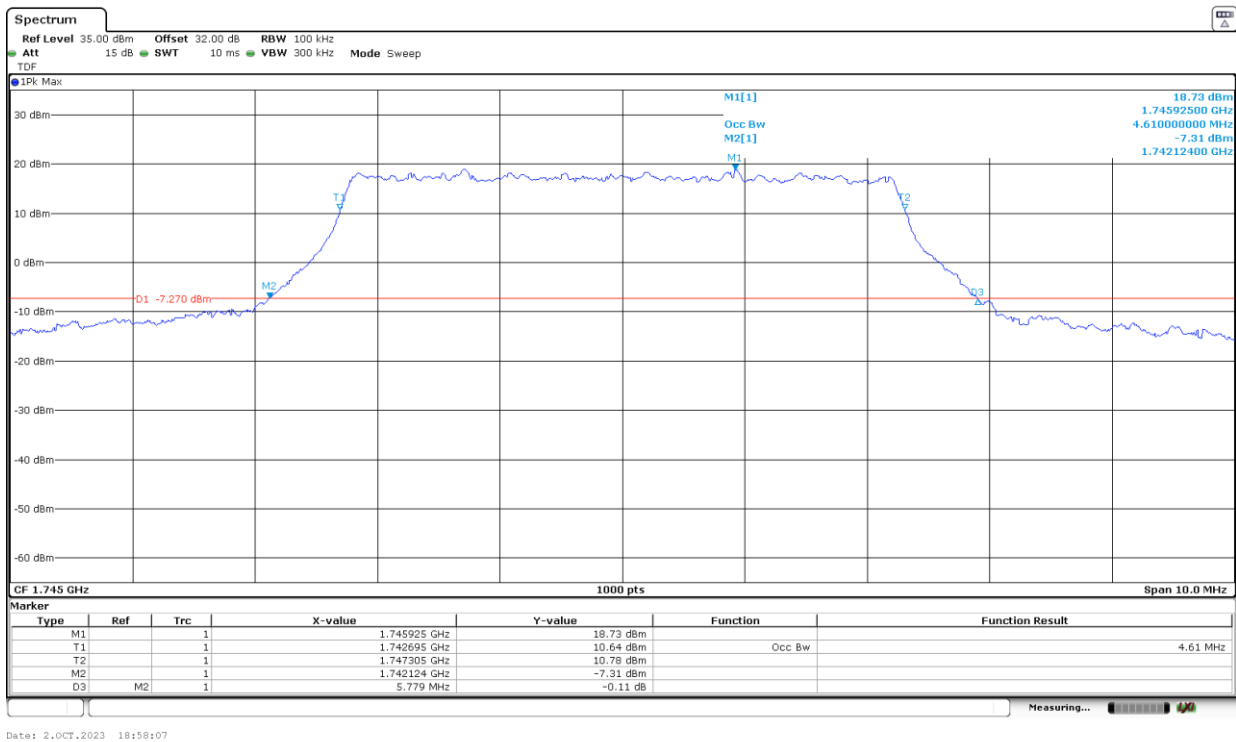
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	6.520	6.640	6.880
-26 dBc Bandwidth (MHz)	11.380	11.705	11.406
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=5 MHz. QPSK. RB Size All.

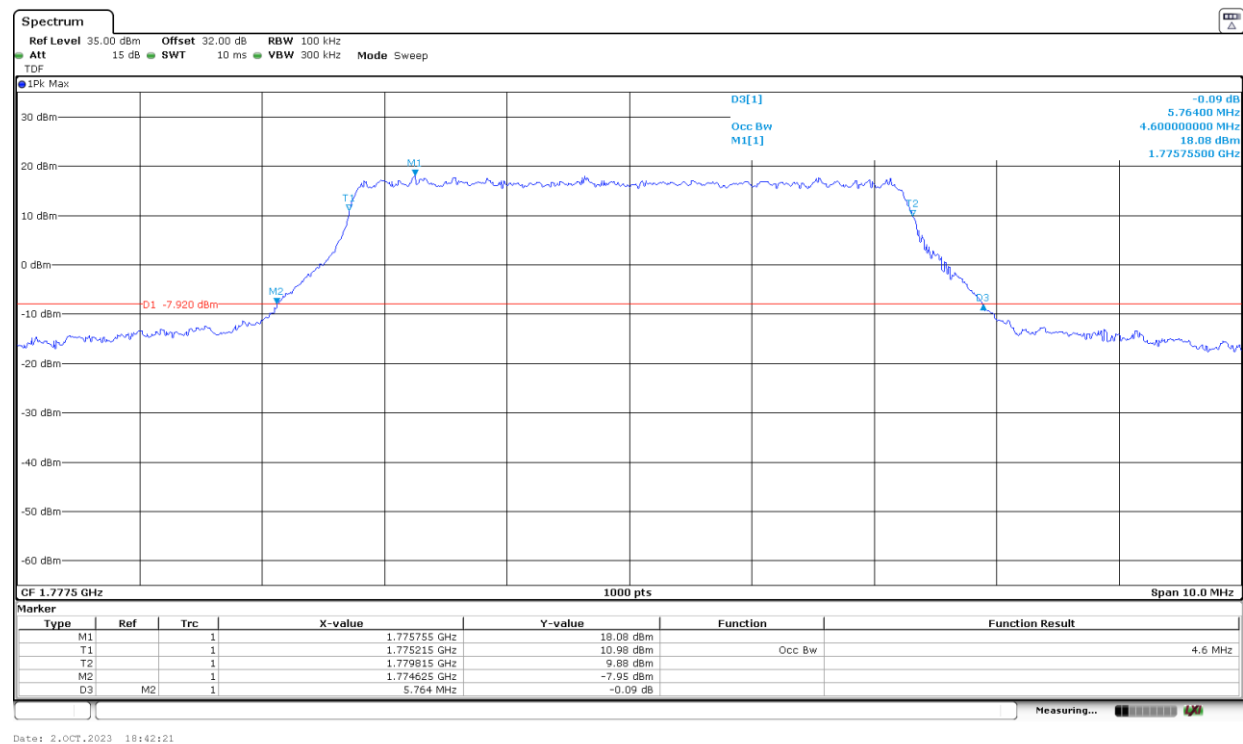
Low Channel:



Middle Channel:

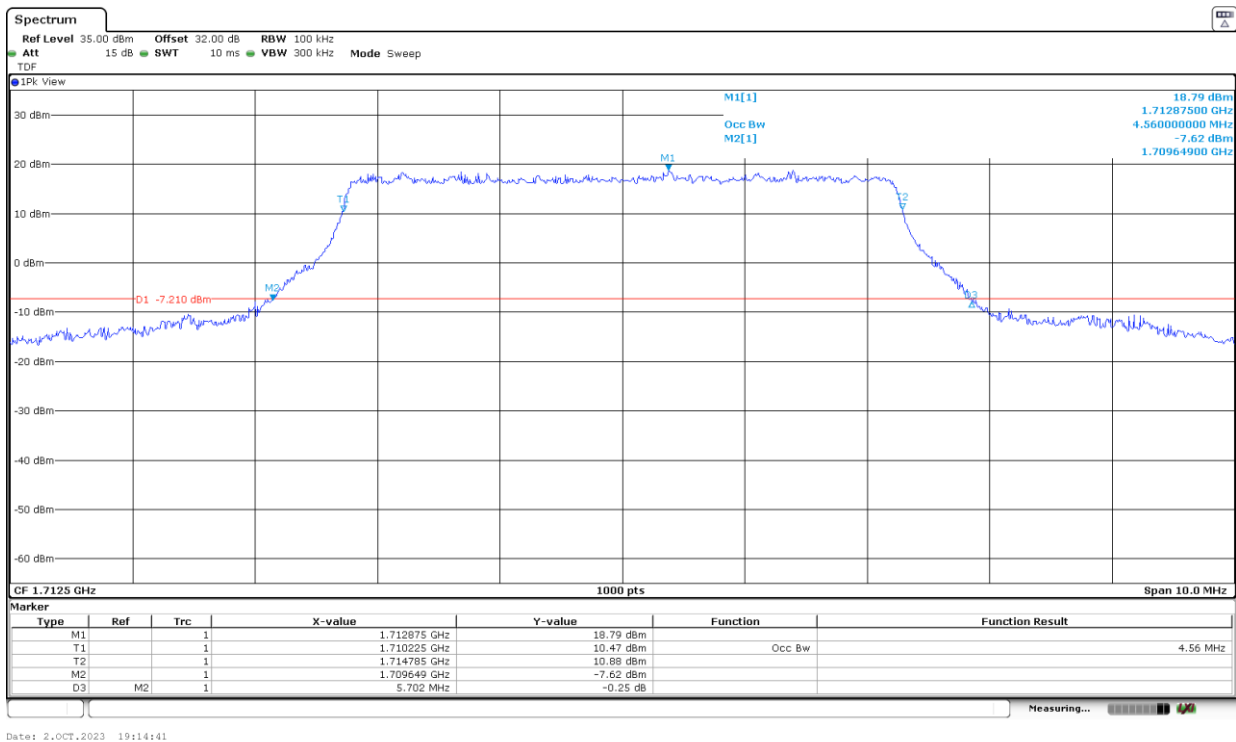


High Channel:

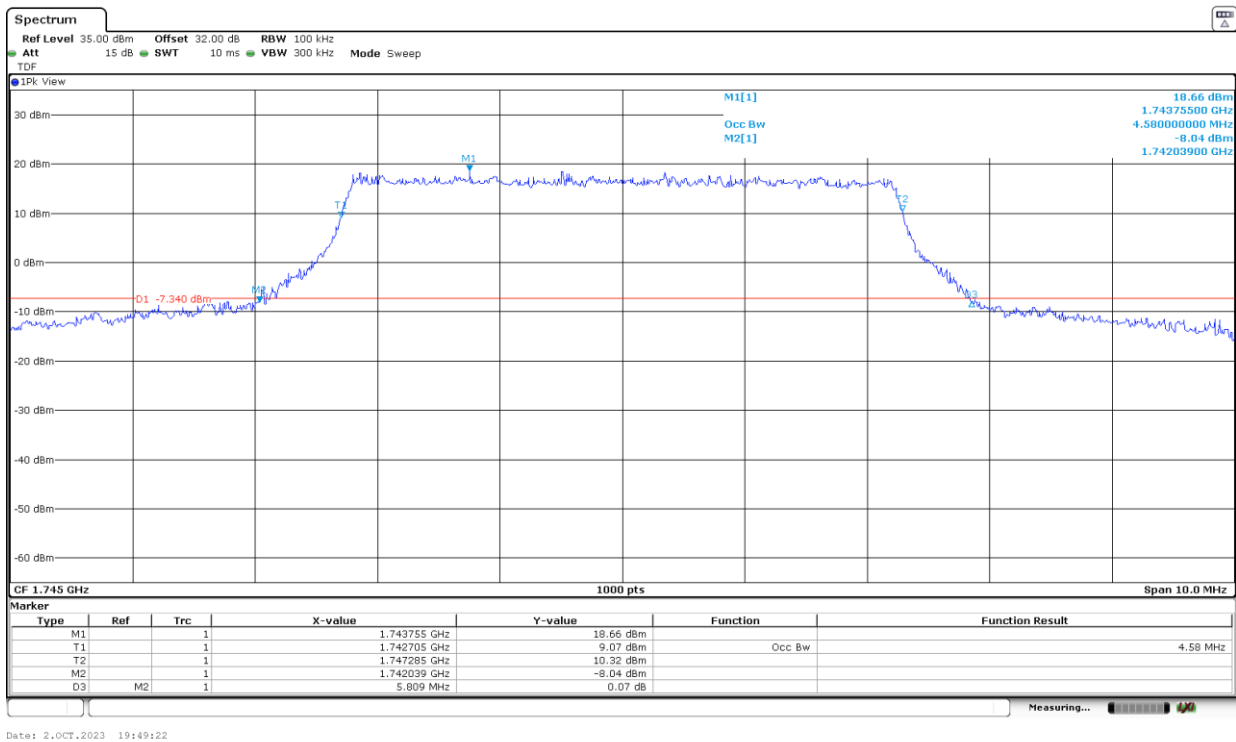


LTE Cat 1bis Band 66. BW=5 MHz. 16QAM. RB Size All.

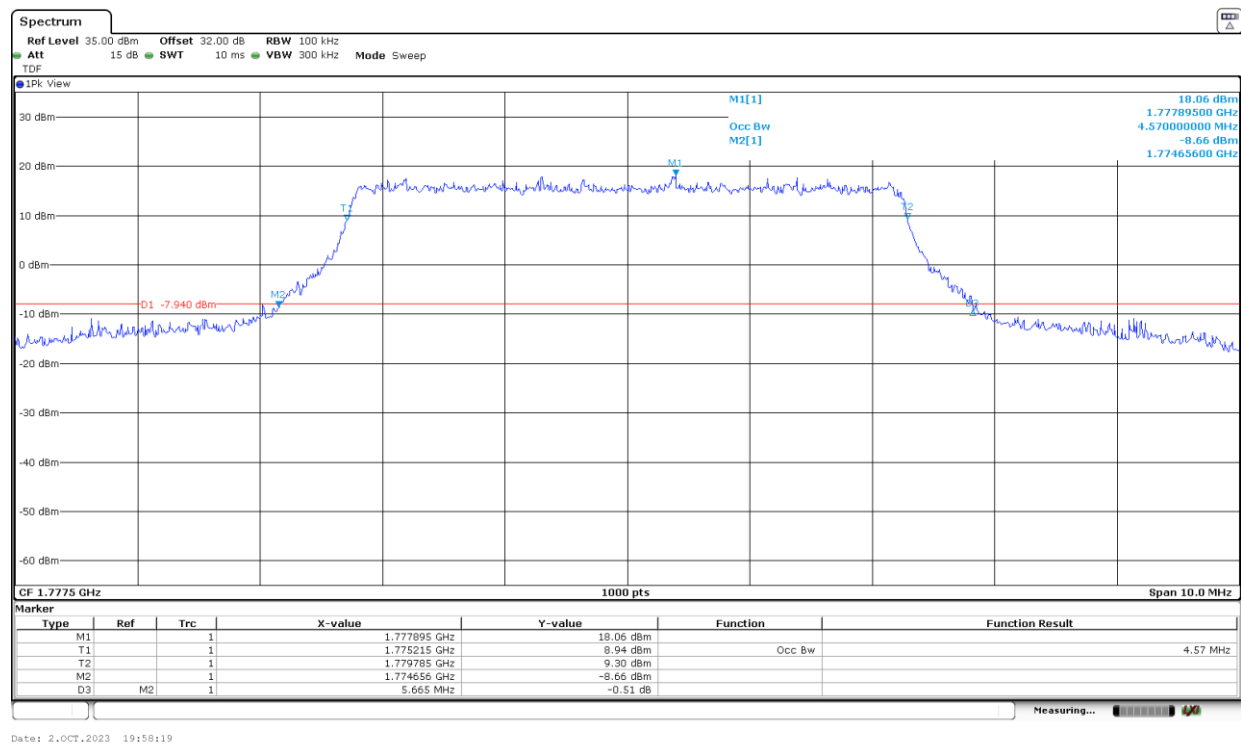
Low Channel:



Middle Channel:

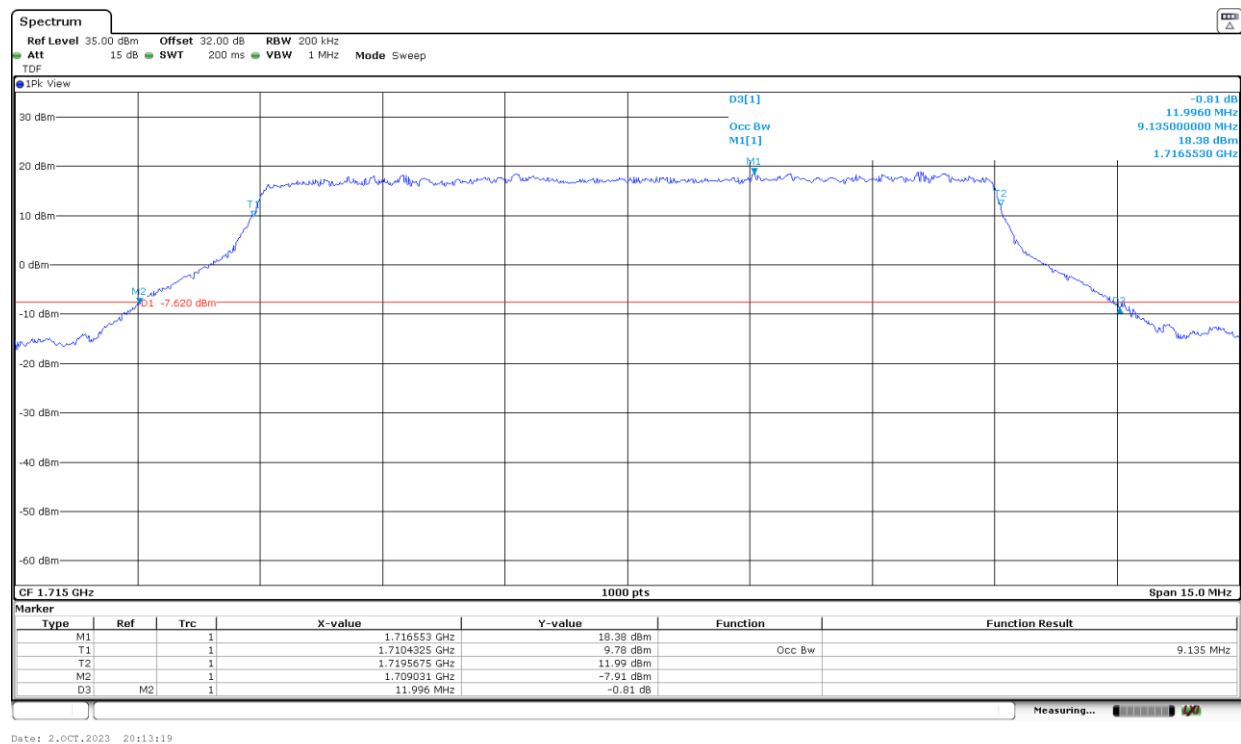


High Channel:

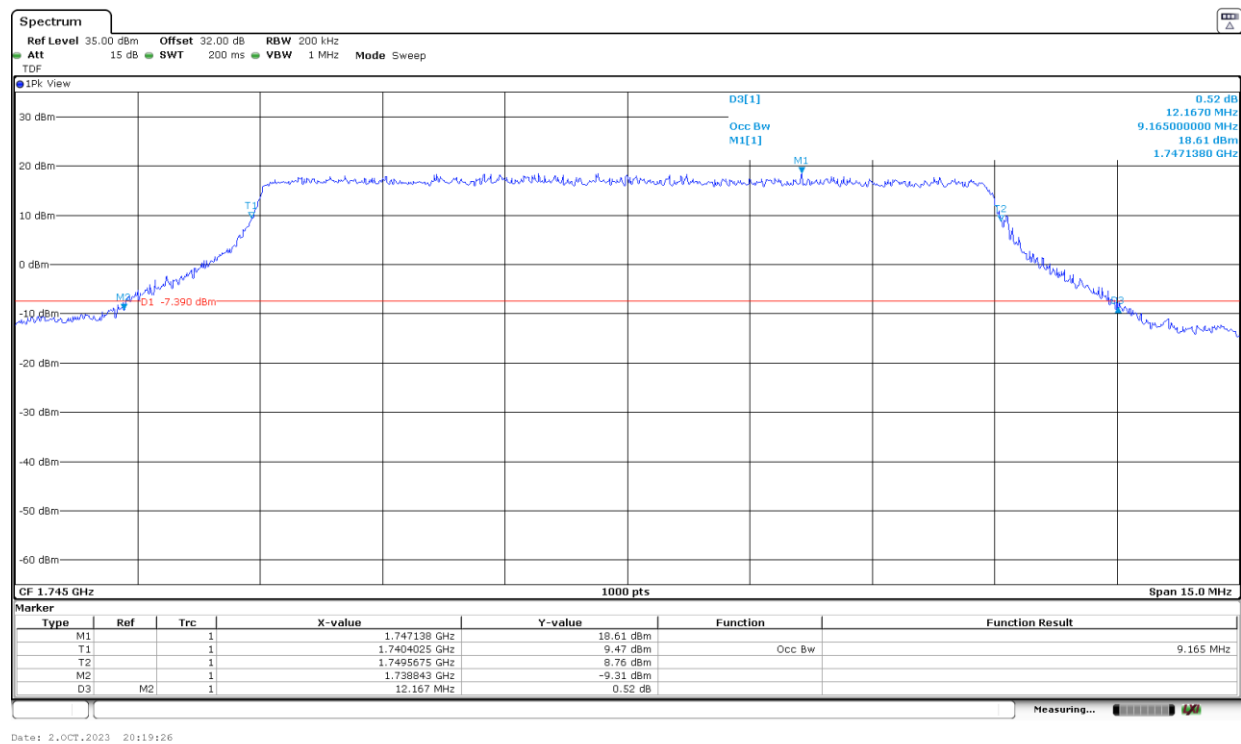


LTE Cat 1bis Band 66. BW=10 MHz. QPSK. RB Size All.

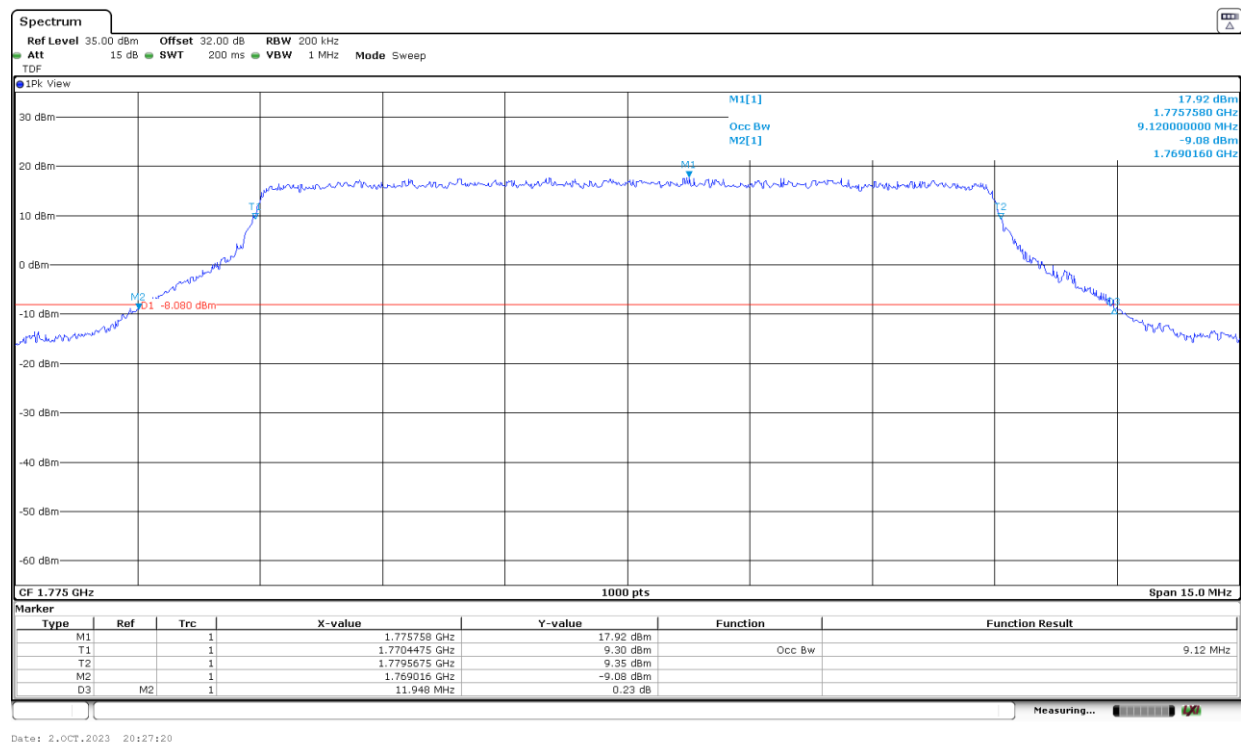
Low Channel:



Middle Channel:

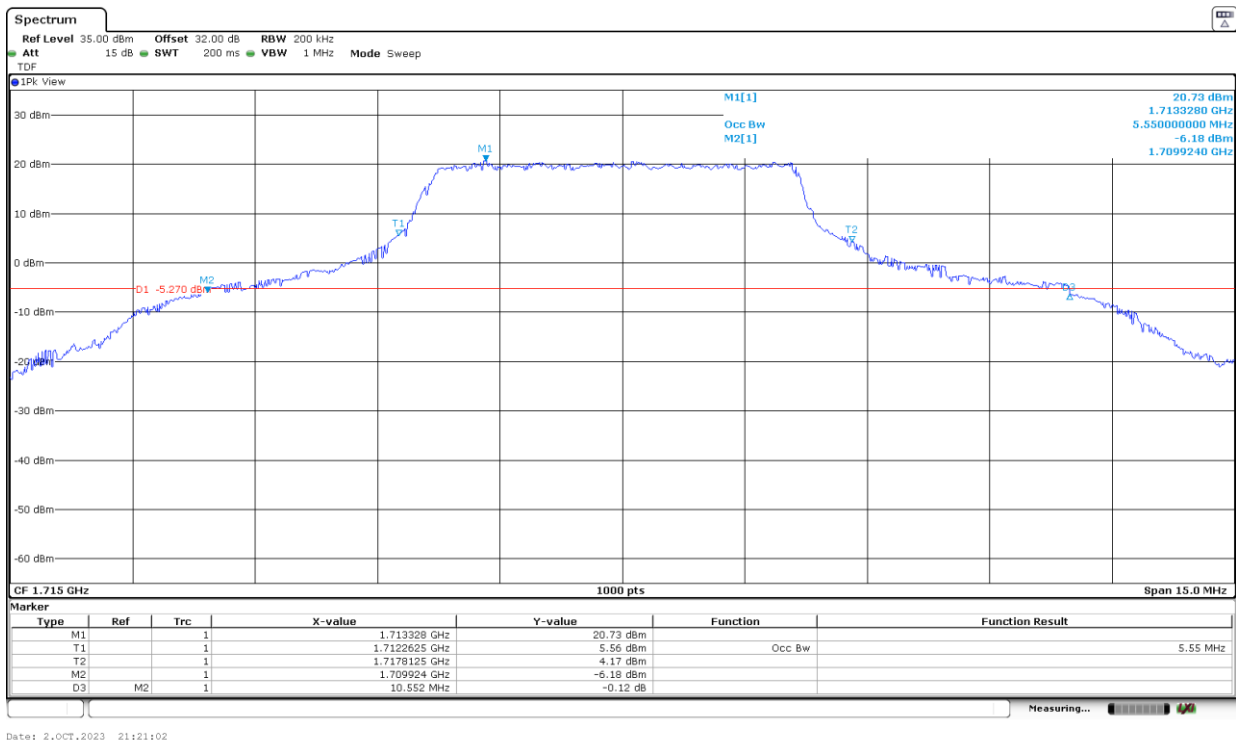


High Channel:

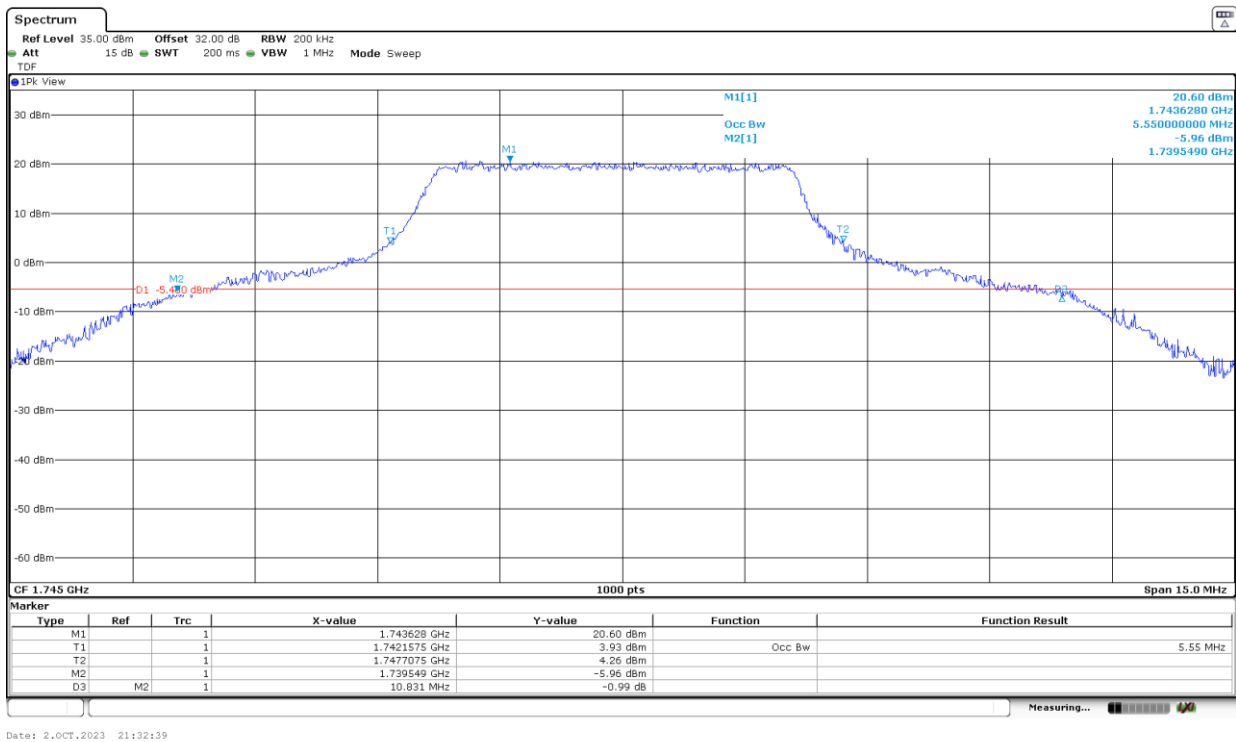


LTE Cat 1bis Band 66. BW=10 MHz. 16QAM. RB Size All.

Low Channel:



Middle Channel:



High Channel:

