

ISED CABid: ES1909
 Lab. Company Number: 4621A

Test Report No:
 77195RRF.003A3

Test Report

USA FCC Part 27

CANADA RSS-130, RSS-139

(*) Identification of item tested	Cat1 bis data only module
(*) Trademark	u-blox
(*) Model and /or type reference	LEXI-R10401D
Other identification of the product	FCC ID: XPYUBX23AD01 IC: 8595A-UBX23AD01
(*) Features	LTE Cat1 bis, Wi-fi Scan / Locate HW version: UBX-437C01 SW version: 01.00.A00.03
Applicant	u-blox AG Zürcherstrasse 68, CH-8800 Thalwil, Switzerland
Test method requested, standard	USA FCC Part 27 (10-1-23 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
Date of issue	2024-06-21
Report template No.	FDT08_24
	(*) "Data provided by the client"



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Competences and guarantees

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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 LEXI-R10401D is a Cat1 bis data only module for industrial IoT applications.

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
77195C/015	Cat1 bis data only module	LEXI-R10401D	-	23-11-2023
77195C/018	USB Cable	-	-	23-11-2023
77195C/025	USB Cable	-	-	23-11-2023

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

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

Control Nº	Description	Model	Serial Nº	Date of reception
77195C/022	Cat1 bis data only module	LEXI-R10401D	-	23-11-2023
77195C/023	GPS Antenna	P1MAM	-	23-11-2023
77195C/024	AC/DC Adaptor	-	-	23-11-2023
77195C/026	Antenna	-	-	23-11-2023

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	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Supplementary information to the ports.....:	-					
Rated power supply	Voltage and Frequency		Reference poles			
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	DC: Min: 3.3, Typical: 3.8, Max: 4.5				
Rated Power..... :	-					
Clock frequencies..... :	26 MHz					
Other parameters..... :	-					
Software version..... :	01.00					
Hardware version..... :	UBX-437C01					
Dimensions in cm (W x H x D) ... :	1.6 x 0.2 x 1.6					
Mounting position..... :	<input type="checkbox"/>	Table top equipment				
	<input type="checkbox"/>	Wall/Ceiling mounted equipment				
	<input type="checkbox"/>	Floor standing equipment				
	<input type="checkbox"/>	Hand-held equipment				

	<input checked="" type="checkbox"/>	Other: Industrial modem component		
Modules/parts..... :	Module/parts of test item	Type	Manufacturer	
	-	-	-	
Accessories (not part of the test item)	Description	Type	Manufacturer	
	Power supply unit	UUX324-1215	Unifive	
	Antenna LTE	GSA.8835	Taoglass	
Documents as provided by the applicant..... :	Description	File name	Issue date	
	-	-	-	

⁽³⁾ Only for Medical Equipment

Identification of the client

u-blox AG
 Zürcherstrasse 68, CH-8800 Thalwil, Switzerland

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2023-11-28
Date (finish)	2024-02-26
Date (start)	2024-06-06
Date (finish)	2024-06-06

*Second period of testing to repeat B12 lower block edge and Vmin extreme conditions.

Document history

Report number	Date	Description
77195RRF.003	2024-03-13	First release.
77195RRF.003A1	2024-04-22	Second release. Antenna gain values corrected and EIRP and ERP values recalculated. This test report replaces and cancel 77195RRF.003 test report.
77195RRF.003A2	2024-06-13	Third release. Minor typos corrected on RF output power test case. Exploration from 698 MHz on B12 lower block edge. Extreme conditions testing performed to a different minimum voltage. This test report replaces and cancel 77195RRF.003A1 test report.
77195RRF.003A3	2024-06-21	Fourth release. Tests outside ENAC scope are marked. This test report replaces and cancel 77195RRF.003A2 test report.

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: Rafael Fernández, Antonio Maireles, Pablo Redondo, Carmen Vázquez, Ireneo Bibang, Sergio Carrasco.

Used instrumentation:

Control No.	Equipment	Next Calibration
08002	Climatic Chamber BINDER MK 56	2025-01
09555	Two-channel power supply, 32V, 10/5A, 188W ROHDE AND SCHWARZ HMP2020	N/A
07794	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2025-04
09227	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-07
02215	Power Divider DC-25 GHz PICOSECOND PULSE LABS 5333-104	2024-07
06791	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A
06792	Shielded Room ETS LINDGREN S101	N/A
07760	Digital Multimeter FLUKE 175	2024-11
04611	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2026-01
06143	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2027-01
03783	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2025-02
06666	EMI Test Receiver 2 Hz - 44 GHz, ROHDE AND SCHWARZ ESW44	2024-03
09229	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-06
07758	Digital Multimeter FLUKE 175	2024-11
06157	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2025-01

Control No.	Equipment	Next Calibration
08856	Pre-Amplifier G>30dB 17-40GHz BONN ELEKTRONIK BLMA 1840-4A	2025-01
04657	Horn Antenna 18-40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2026-06
04848	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, 66, 71.

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-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, 66, 71

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TEST CONDITIONS

(*): Declared by the Applicant.

POWER SUPPLY (*):

Vnominal: 3.8 Vdc
 Vminimum: 3.23 Vdc
 Vmaximum: 4.5 Vdc

Type of Power Supply: DC External (USB).

ANTENNA (*):

Low Bands	Gain (dBi)	Type of Antenna
LTE Cat 1bis Band 12	2.44	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))
LTE Cat 1bis Band 13	2.44	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))
LTE Cat 1bis Band 71	0.95	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))
High Bands	Gain (dBi)	Type of Antenna
LTE Cat 1bis Band 4	4.12	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))
LTE Cat 1bis Band 66	4.12	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))

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 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)

LTE Cat 1bis Band 71. QPSK and 16QAM:

	Channel (Frequency)			
	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	133147 (665.50 MHz)	133172 (668.00 MHz)	133197 (670.50 MHz)	133222 (673.00 MHz)
Middle	133297 (680.50 MHz)	133297 (680.50 MHz)	133297 (680.50 MHz)	133297 (680.50 MHz)
High	133447 (695.50 MHz)	133422 (693.00 MHz)	133397 (690.50 MHz)	133372 (688.00 MHz)

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 Bands 4, 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.

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.

4. LTE Cat-M1 Band 71. 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.

4.6.2 Frequency bands 617-652 MHz and 663-698 MHz

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

For base and fixed equipment other than fixed subscriber equipment, refer to SRSP-518 for the equivalent isotropically radiated power (e.i.r.p.) limits.

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.

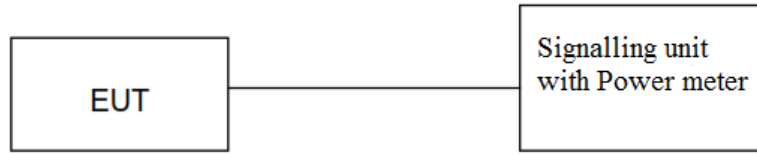
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

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:

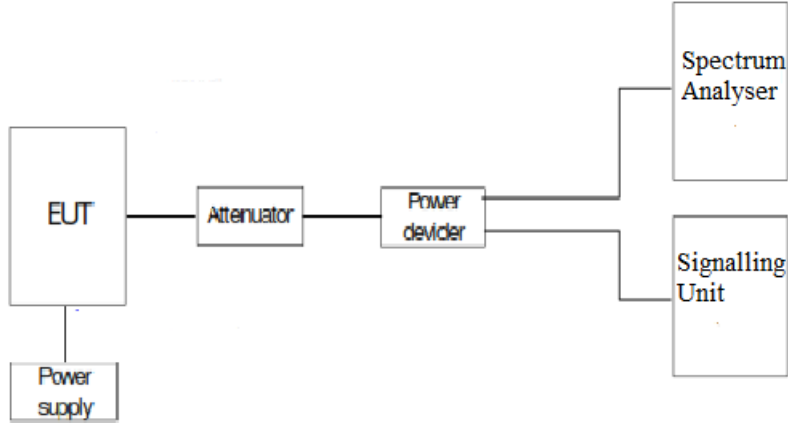
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

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=1.4 MHz, High Channel, QPSK, RB Size=1, RB Offset=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
1.4	Low 23017	699.7 MHz	QPSK	1	0	22.48
				1	2	22.43
				1	5	22.45
				3	0	22.41
				3	1	22.37
				3	2	22.38
			16QAM	6	0	21.59
				1	0	21.86
				1	2	21.83
				1	5	21.83
				3	0	21.65
				3	1	21.62
				3	2	21.61
				6	0	20.82
	Middle 23095	707.5 MHz	QPSK	1	0	23.17
				1	2	23.11
				1	5	22.82
				3	0	23.14
				3	1	23.09
				3	2	23.02
			16QAM	6	0	22.19
				1	0	21.93
				1	2	21.84
				1	5	21.64
				3	0	22.12
				3	1	22.07
				3	2	22
				6	0	21.23
	High 23173	715.3 MHz	QPSK	1	0	23.82
				1	2	23.71
1				5	23.67	
3				0	23.92	
3				1	23.97	
3				2	23.87	
16QAM			6	0	23	
			1	0	23.32	
			1	2	23.26	
			1	5	22.94	

				3	0	23.9
				3	1	23.5
				3	2	22.96
				6	0	22.13

BW=1.4 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.48	2.44	24.92	22.77
MIDDLE	23.17	2.44	25.61	23.46
HIGH	23.82	2.44	26.26	24.11
MAX:	23.82		26.26	24.11

BW=1.4 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	21.86	2.44	24.30	22.15
MIDDLE	22.12	2.44	24.56	22.41
HIGH	23.9	2.44	26.34	24.19
MAX:	23.9		26.34	24.19

LTE Cat 1bis Band 13:

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

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 23205	779.5	QPSK	1	0	22.65
				1	12	22.78
				1	24	23.16
				12	0	21.87
				12	6	21.96
				12	11	22.12
			25	0	22.12	
			16QAM	1	0	22.09
				1	12	22.18
				1	24	22.57
				12	0	21.03
				12	6	21.09
	12	11		21.24		
	High 23255	784.5	QPSK	1	0	23.84
				1	12	23.2
				1	24	23.13
				12	0	22.56
				12	6	22.4
				12	11	22.34
			25	0	22.43	
			16QAM	1	0	22.75
				1	12	22.49
				1	24	22.44
				12	0	21.65
12				6	21.49	
12	11	21.41				
25	0	21.53				

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	23.16	2.44	25.6	23.45
HIGH	23.84	2.44	26.28	24.13
MAX:	23.84		26.28	24.13

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	22.57	2.44	25.01	22.86
HIGH	22.75	2.44	25.19	23.04
MAX:	22.75		25.19	23.04

LTE Cat 1bis Band 66:

Worst-case of RF Power is BW=20 MHz, High Channel, QPSK, RB Size=1, RB Offset=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
20	Low 132072	1720	QPSK	1	0	22.81
				1	49	22.89
				1	99	23.23
				50	0	22.07
				50	24	22.01
				50	49	22.25
			16QAM	100	0	22.11
				1	0	21.97
				1	49	22.14
				1	99	22.33
				25	0	21.2
				25	12	21.2
	Middle 132322	1745	QPSK	25	24	21.15
				1	0	22.96
				1	49	23.04
				1	99	23.23
				50	0	22.08
				50	24	22.15
			16QAM	50	49	22.29
				100	0	22.16
				1	0	22.55
				1	49	22.56
				1	99	22.66
				25	0	21.04
High 132572	1770	QPSK	25	12	21.05	
			25	24	21.08	
			1	0	23.41	
			1	49	23.24	
			1	99	23.31	
			50	0	22.51	
		16QAM	50	24	22.43	
			50	49	22.4	
			100	0	22.49	
			1	0	22.26	
			1	49	22.55	
			1	99	22.52	
25	0	21.6				
25	12	21.61				
25	24	21.54				

BW=20 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	4.12	27.35	25.2
MIDDLE	23.23	4.12	27.35	25.2
HIGH	23.41	4.12	27.53	25.38
MAX:	23.41		27.53	25.38

BW=20 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.33	4.12	26.45	24.3
MIDDLE	22.66	4.12	25.10	22.95
HIGH	22.55	4.12	26.67	24.52
MAX:	22.66		25.10	22.95

LTE Cat 1bis Band 71:

Worst-case of RF Power is BW=15 MHz, High Channel, QPSK, RB Size=1, RB Offset=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
15	Low 133197	670.5	QPSK	1	0	22.95
				1	37	23.29
				1	74	23.12
				36	0	22.52
				36	18	22.6
				36	37	22.32
				75	0	22.44
			16QAM	1	0	21.96
				1	37	22.46
				1	74	22.19
				25	0	21.68
				25	12	21.84
				25	24	21.67
				75	0	*
	Middle 133297	680.5	QPSK	1	0	22.78
				1	37	23.3
				1	74	23.44
				36	0	22.14
				36	18	22.46
				36	37	22.72
				75	0	22.51
			16QAM	1	0	21.68
				1	37	22.2
				1	74	22.28
				25	0	21.21
				25	12	21.35
				25	24	21.52
75				0	*	
High 133397	690.5	QPSK	1	0	23.78	
			1	37	23.2	
			1	74	23.27	
			36	0	22.53	
			36	18	22.3	
			36	37	22.21	
			75	0	22.34	
		16QAM	1	0	22.9	
			1	37	22.42	
			1	74	22.56	
			25	0	21.56	
			25	12	21.43	
			25	24	21.27	
			75	0	*	

* Not supported neither RB Size 75 nor 50 for 16QAM.

BW=15 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	23.29	0.95	24.24	22.09
MIDDLE	23.44	0.95	24.39	22.24
HIGH	23.78	0.95	24.73	22.58
MAX:	23.78		24.73	22.58

BW=15 MHz. 16QAM:

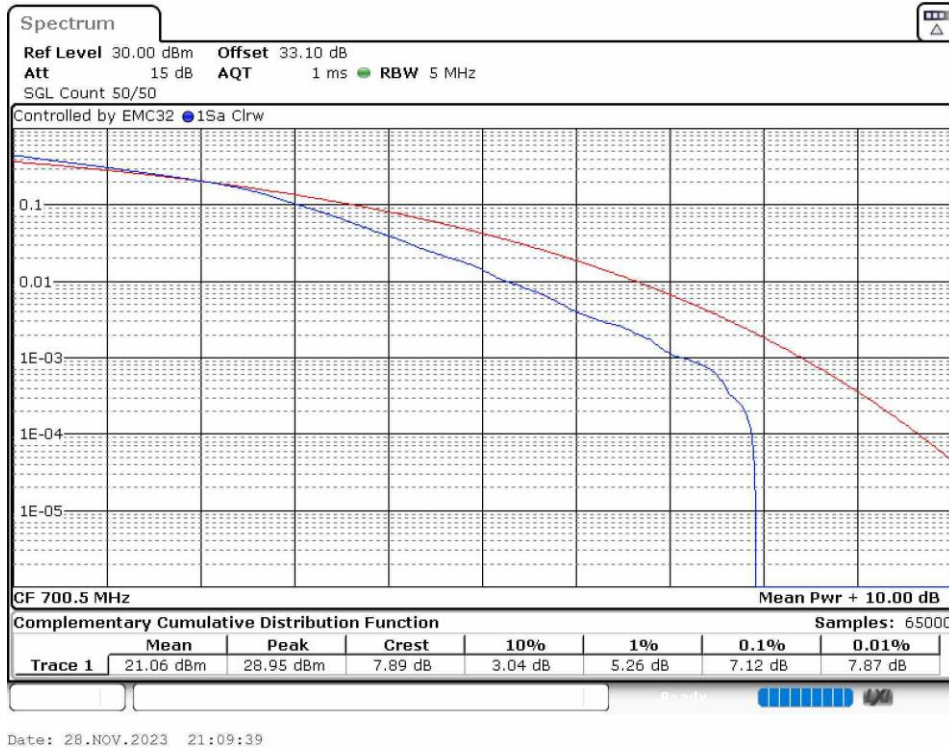
MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.46	0.95	23.41	21.26
MIDDLE	22.28	0.95	23.23	21.08
HIGH	22.9	0.95	23.85	21.70
MAX:	22.9		23.85	21.70

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

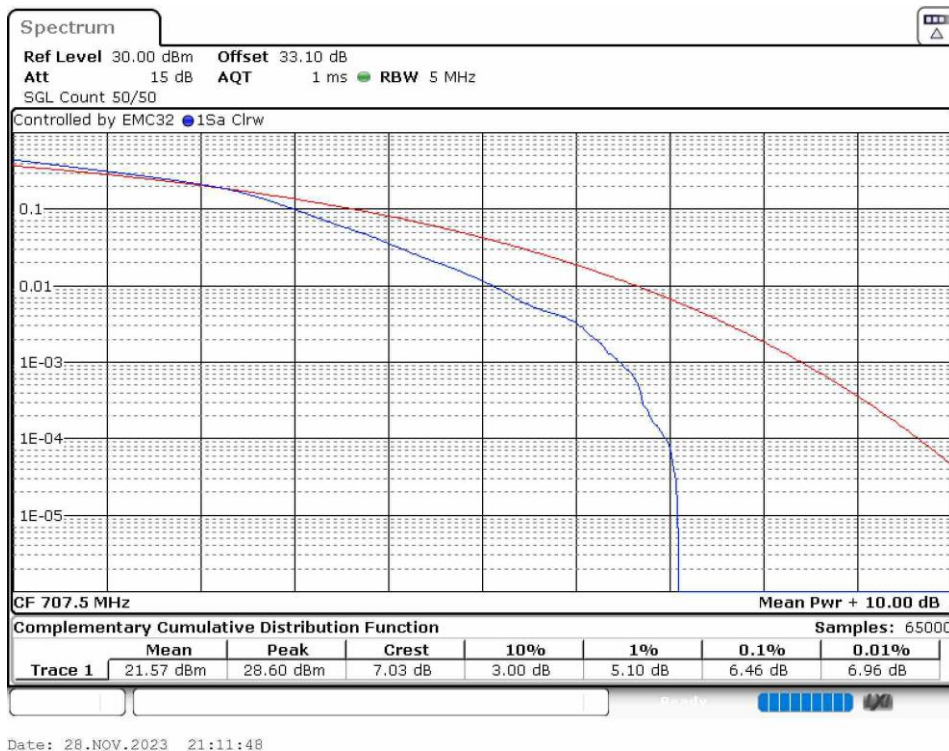
LTE Cat 1bis Band 12:

Worst-case of PAPR is BW=3 MHz, Low Channel, 16QAM, RB Size=8, RB Offset=4.

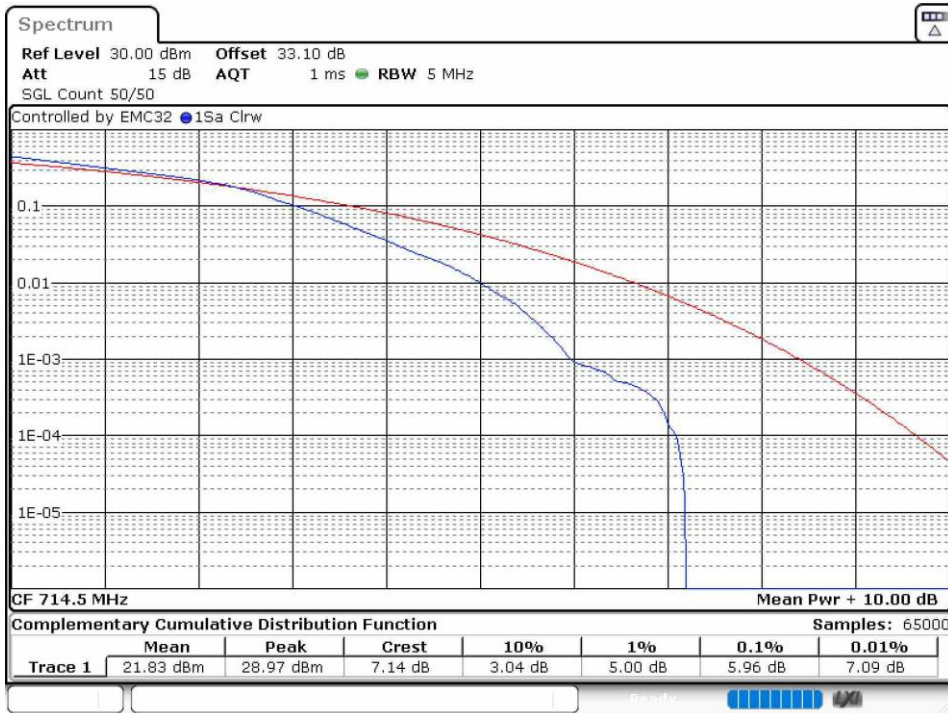
Low Channel:



Middle Channel:



High Channel:



Date: 1.DEC.2023 17:22:34

	Low	Middle	High
16QAM	Low	Middle	High
PAPR (dB)	7.12	6.46	5.96

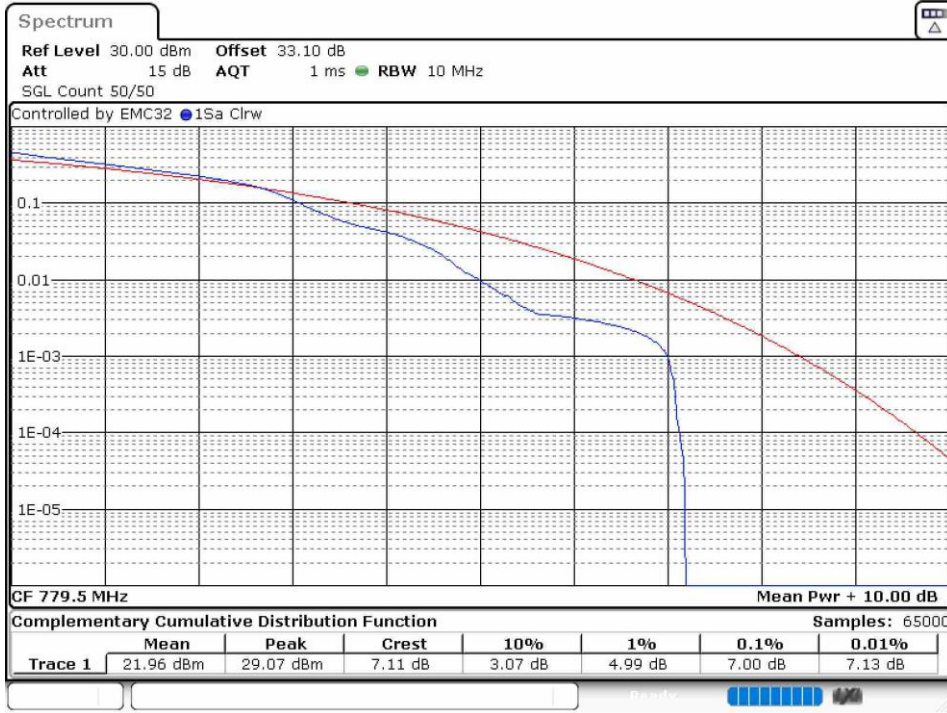
Verdict

Pass

LTE Cat 1bis Band 13:

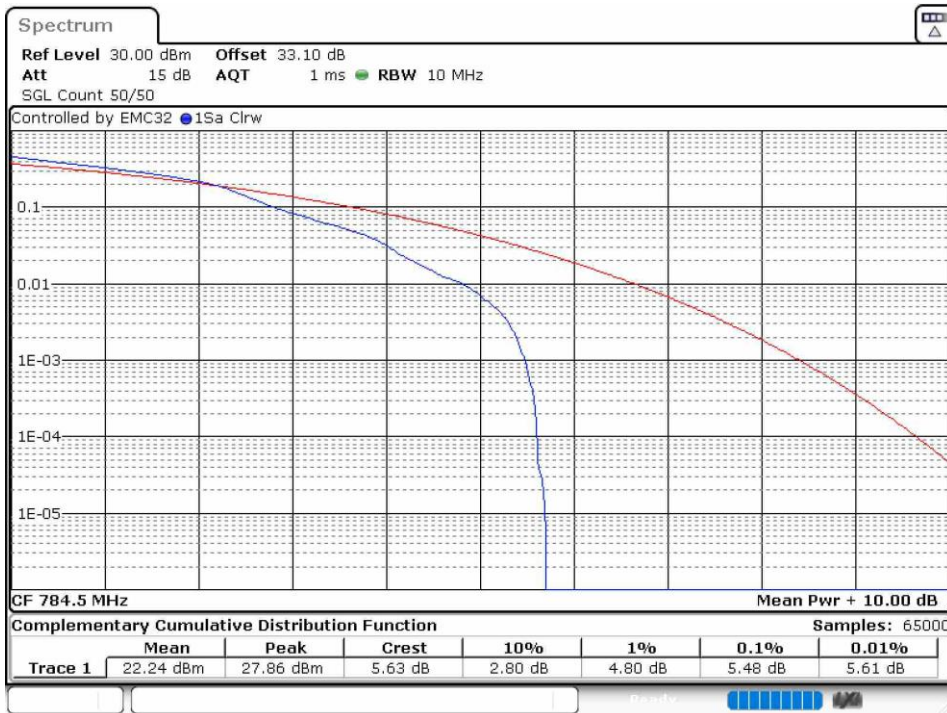
Worst-case of PAPR is BW= 5 MHz, Low Channel, 16QAM, RB Size=1, RB Offset=24.

Low Channel:



Date: 29.NOV.2023 18:29:19

High Channel:



Date: 29.NOV.2023 18:47:27

16QAM	Low	High
PAPR (dB)	7	5.48

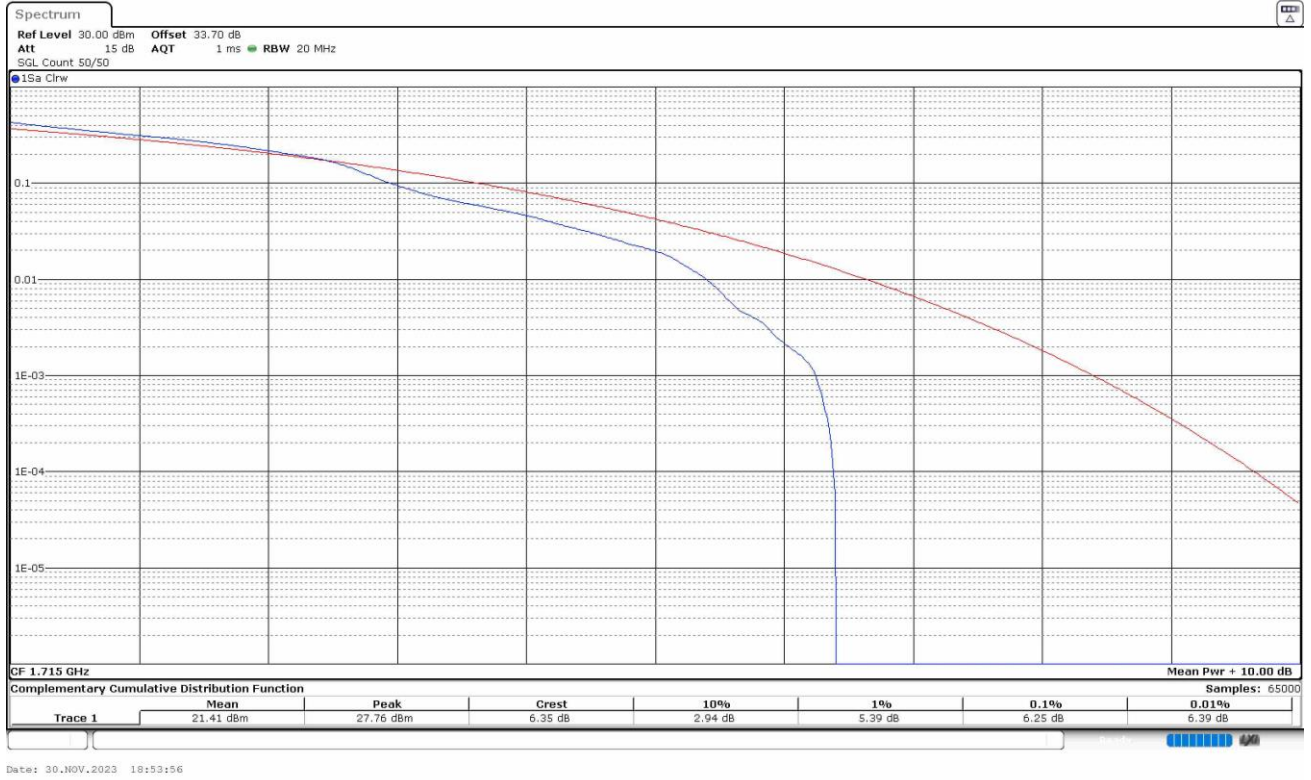
Verdict

Pass

LTE Cat 1bis Band 66:

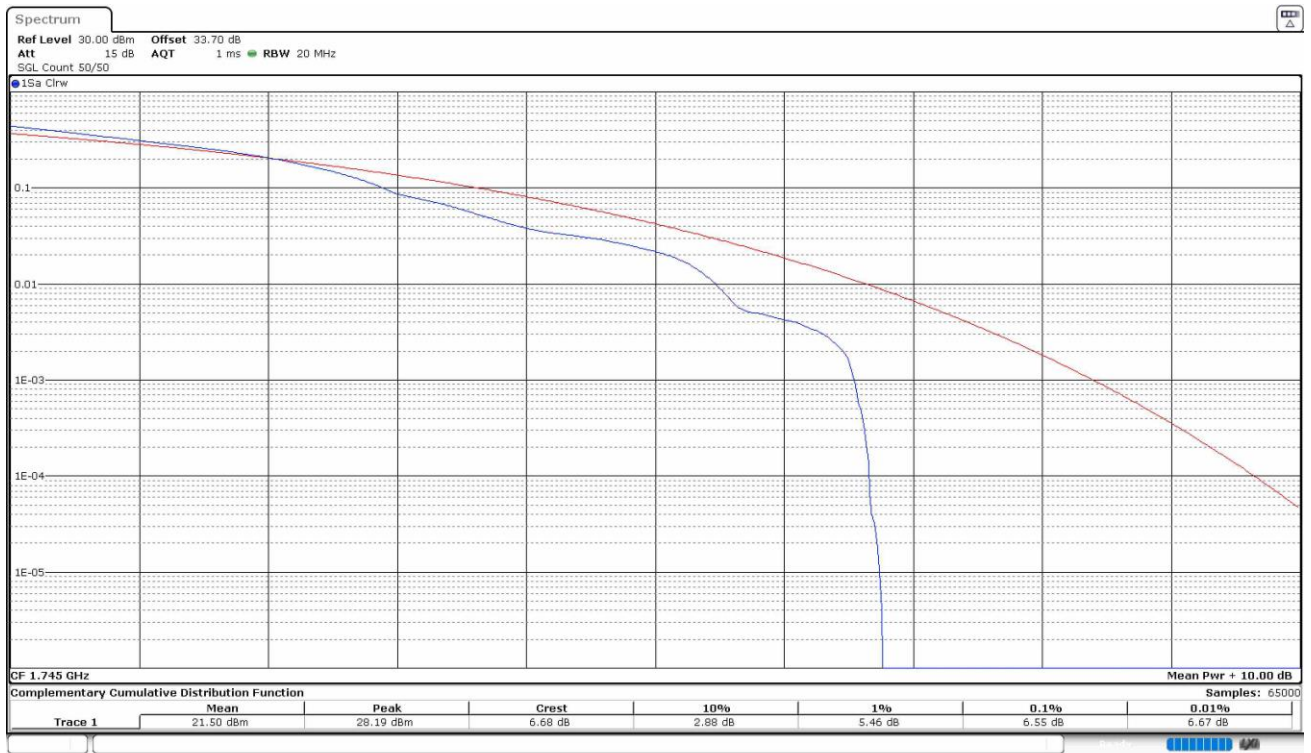
Worst-case of PAPR is BW= 10 MHz, High Channel, 16QAM, RB Size=1, RB Offset=0.

Low Channel:



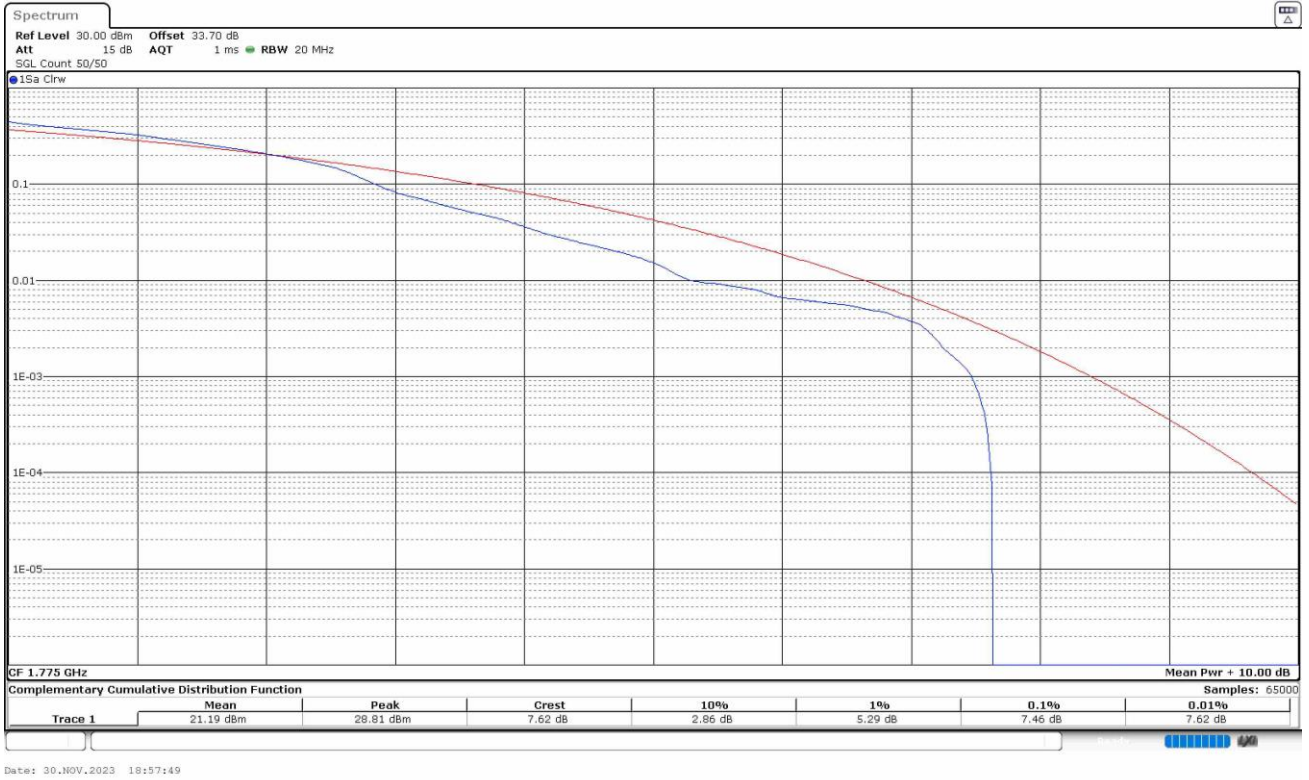
Date: 30.NOV.2023 18:53:56

Middle Channel:



Date: 30.NOV.2023 18:55:52

High Channel:



16QAM	Low	Middle	High
PAPR (dB)	6.25	6.55	7.46

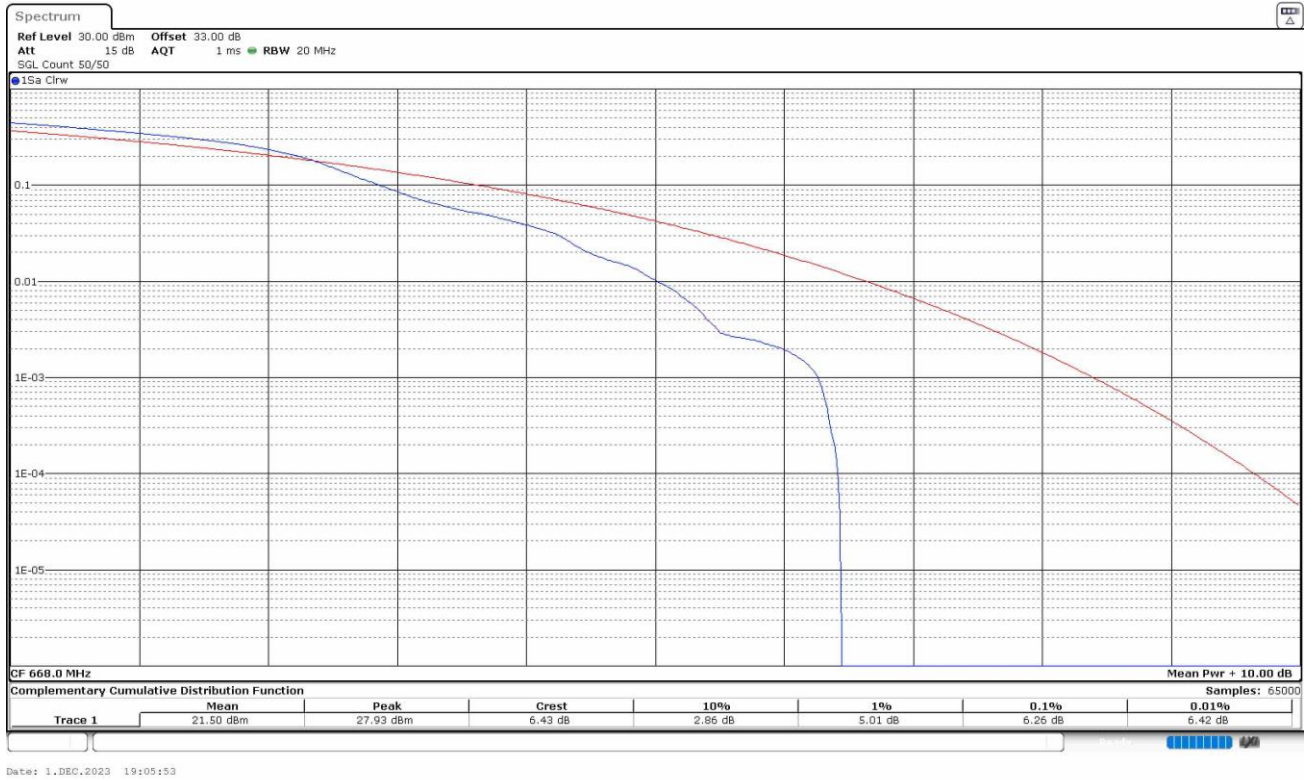
Verdict

Pass

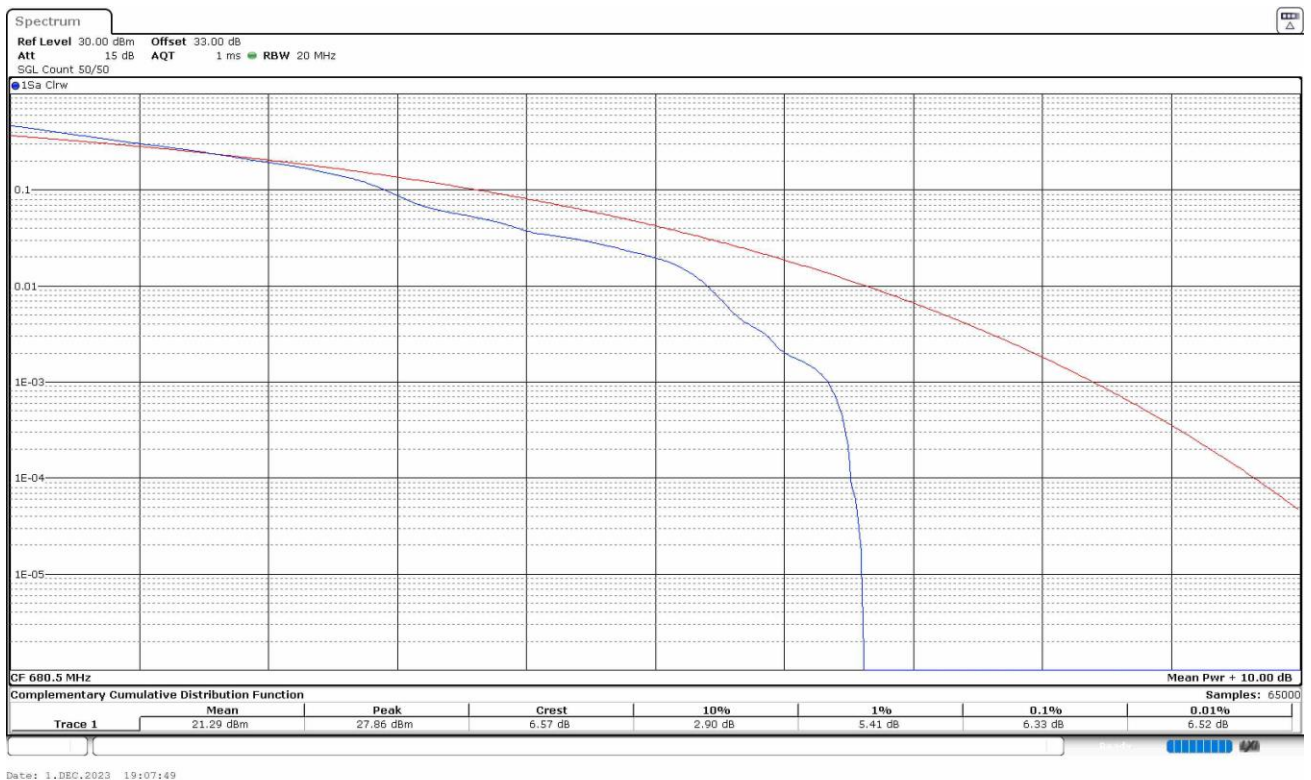
LTE Cat 1bis Band 71:

Worst-case of PAPR is BW= 10 MHz, High Channel, 16QAM, RB Size=1, RB Offset=0.

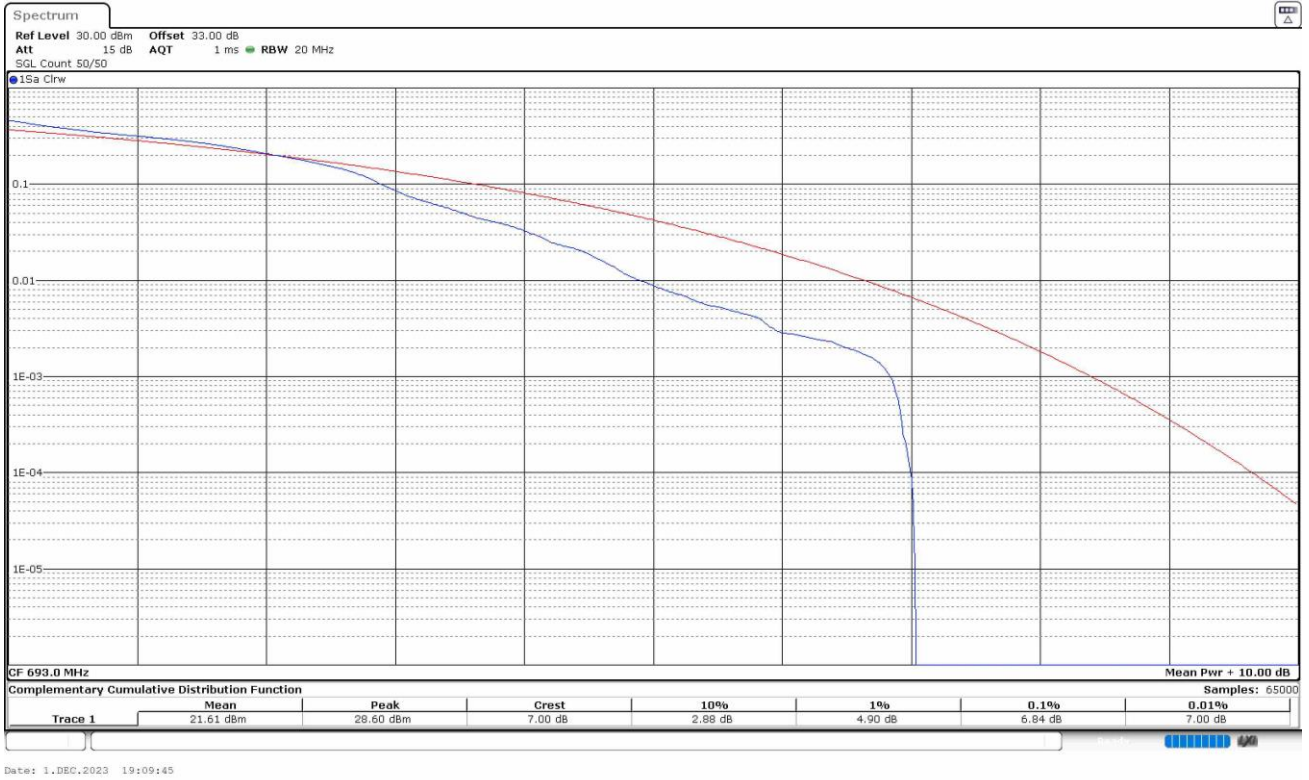
Low Channel:



Middle Channel:



High Channel:



16QAM	Low	Middle	High
PAPR (dB)	6.26	6.33	6.84

Verdict

Pass

Frequency Stability

Limits

1. LTE Cat 1bis Bands 12, 13, 71.

* 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 Bands 4, 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.

Temperature and voltage range of testing has been extended to the maximum and minimum values declared by customer.

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.

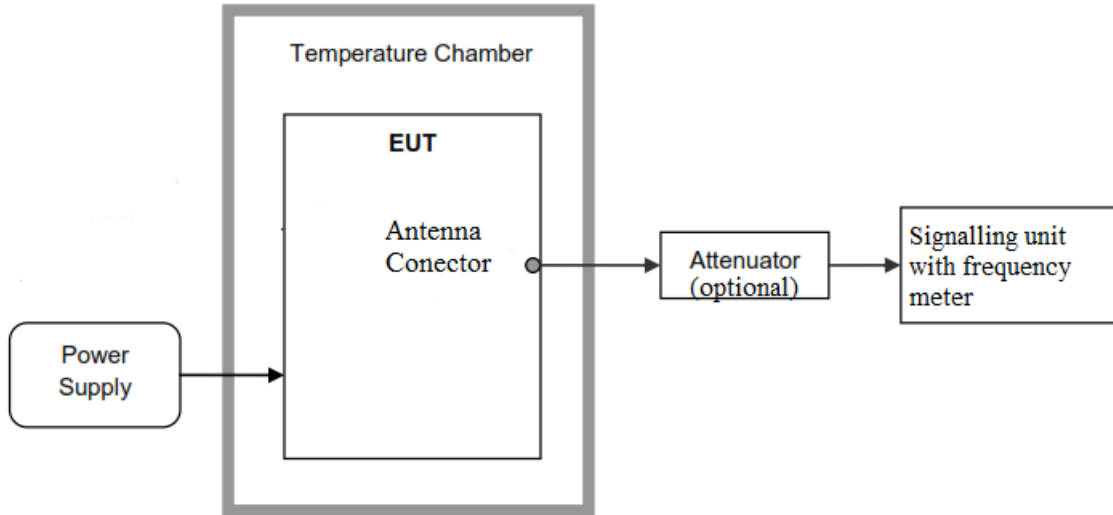
The worst case LTE mode for conducted power was used for the test.

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.

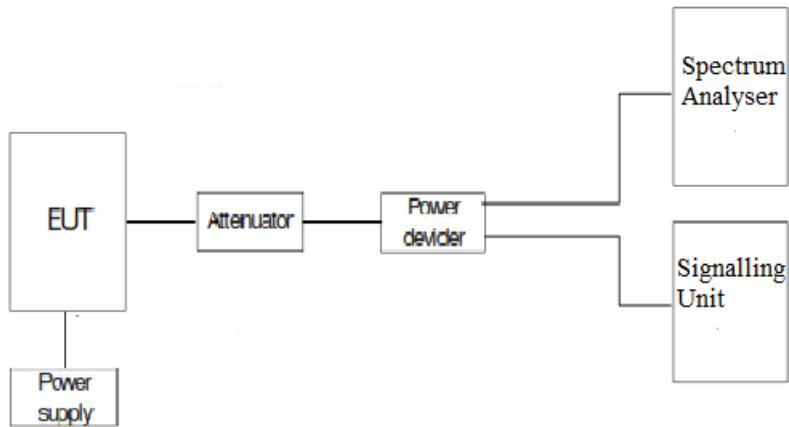
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

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=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.17	0.004480565
+80 [#]	2.37	0.003349823
+70 [#]	2.45	0.003462898
+60 [#]	3.1	0.004381625
+50	1.97	0.002784452
+40	2.63	0.003717314
+30	2.21	0.003123675
+20	-0.82	-0.001159011
+10	0.88	0.001243816
0	-1.45	-0.00204947
-10	-0.35	-0.0004947
-20	-2.02	-0.002855124
-30	-1.52	-0.00214841
-40 [#]	-1.21	-0.001710247

Tests conditions marked with “#” are out of the scope of ENAC accreditation.

LTE Cat 1bis Band 13:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.43	0.004386189
+80 [#]	2.56	0.003273657
+70 [#]	3.12	0.00398977
+60 [#]	2.83	0.003618926
+50	2.39	0.003056266
+40	2.11	0.00269821
+30	1.83	0.002340153
+20	0.89	0.001138107
+10	1.23	0.00157289
0	-0.56	-0.000716113
-10	0.3	0.000383632
-20	1.89	0.00241688
-30	0.54	0.000690537
-40 [#]	-0.56	-0.000716113

Tests conditions marked with “#” are out of the scope of ENAC accreditation.

LTE Cat 1bis Band 66:

The worst case modulation in terms of Frequency Stability is BW=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.26	0.001868195
+80 [#]	2.91	0.001667622
+70 [#]	2.35	0.001346705
+60 [#]	3.21	0.001839542
+50	2.16	0.001237822
+40	1.98	0.00113467
+30	2.1	0.001203438
+20	1.22	0.00069914
+10	0.52	0.000297994
0	-1.27	-0.000727794
-10	0.79	0.000452722
-20	1.82	0.00104298
-30	0.82	0.000469914
-40 [#]	0.04	2.29226E-05

Tests conditions marked with “#” are out of the scope of ENAC accreditation.

LTE Cat 1bis Band 71:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.08	0.004526084
+80 [#]	2.45	0.003600294
+70 [#]	2.92	0.004290963
+60 [#]	3	0.004408523
+50	1.98	0.002909625
+40	2.73	0.004011756
+30	2.01	0.002953711
+20	1.77	0.002601029
+10	-1.01	-0.001484203
0	0.87	0.001278472
-10	1.21	0.001778104
-20	0.65	0.00095518
-30	-0.75	-0.001102131
-40 [#]	0.67	0.00098457

Tests conditions marked with “#” are out of the scope of ENAC accreditation.

- **Frequency stability over voltage variations:**

LTE Cat 1bis Band 12:

The worst case modulation in terms of Frequency Stability is BW=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	-1.46	-0.002063604
Vmin	3.23	-0.26	-0.000367491

LTE Cat 1bis Band 13:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	-2.82	-0.003606138
Vmin	3.23	1.9	0.002429668

LTE Cat 1bis Band 66:

The worst case modulation in terms of Frequency Stability is BW=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	-2.1	-0.001203438
Vmin	3.23	1.12	0.000641834

LTE Cat 1bis Band 71:

The worst case modulation in terms of Frequency Stability is BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	0.12	0.000176341
Vmin	3.23	-1.33	-0.001954445

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=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

f_L (MHz)	699.0166
f_H (MHz)	715.9720

LTE Cat 1bis Band 13: BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

f_L (MHz)	777.0841
f_H (MHz)	786.9175

LTE Cat 1bis Band 66: BW=1.4 MHz, QPSK, RB Size=1, RB Offset=0.

f_L (MHz)	1710.0763
f_H (MHz)	1779.9245

LTE Cat 1bis Band 71: BW=5 MHz, QPSK, RB Size=1, RB Offset=0.

f_L (MHz)	663.0657
f_H (MHz)	697.9259

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, 71.

* 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.

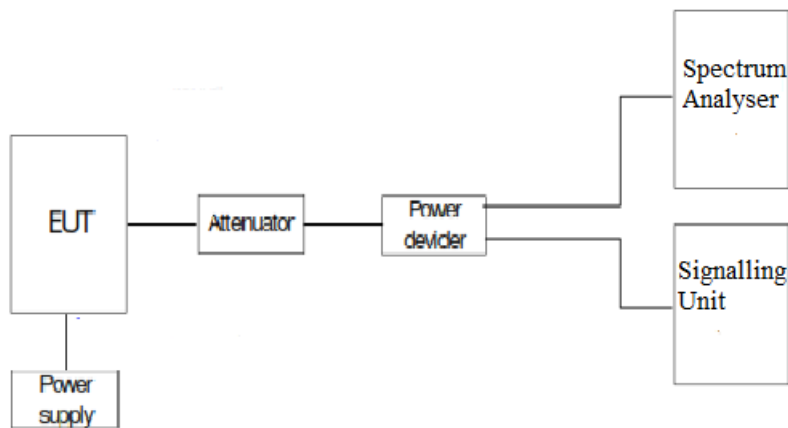
* FCC §2.1047 Measurements required: Modulation characteristics.

* 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

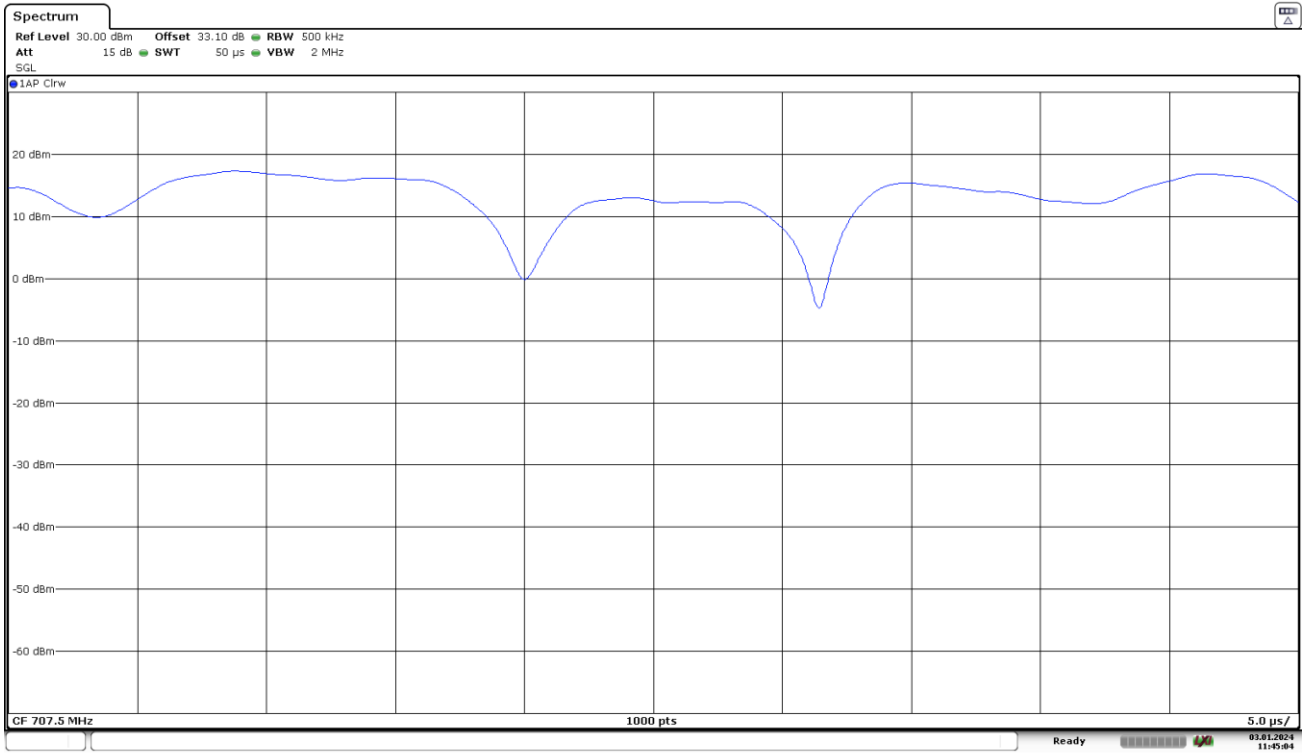


Results

The following plots show the modulation schemes in the EUT.

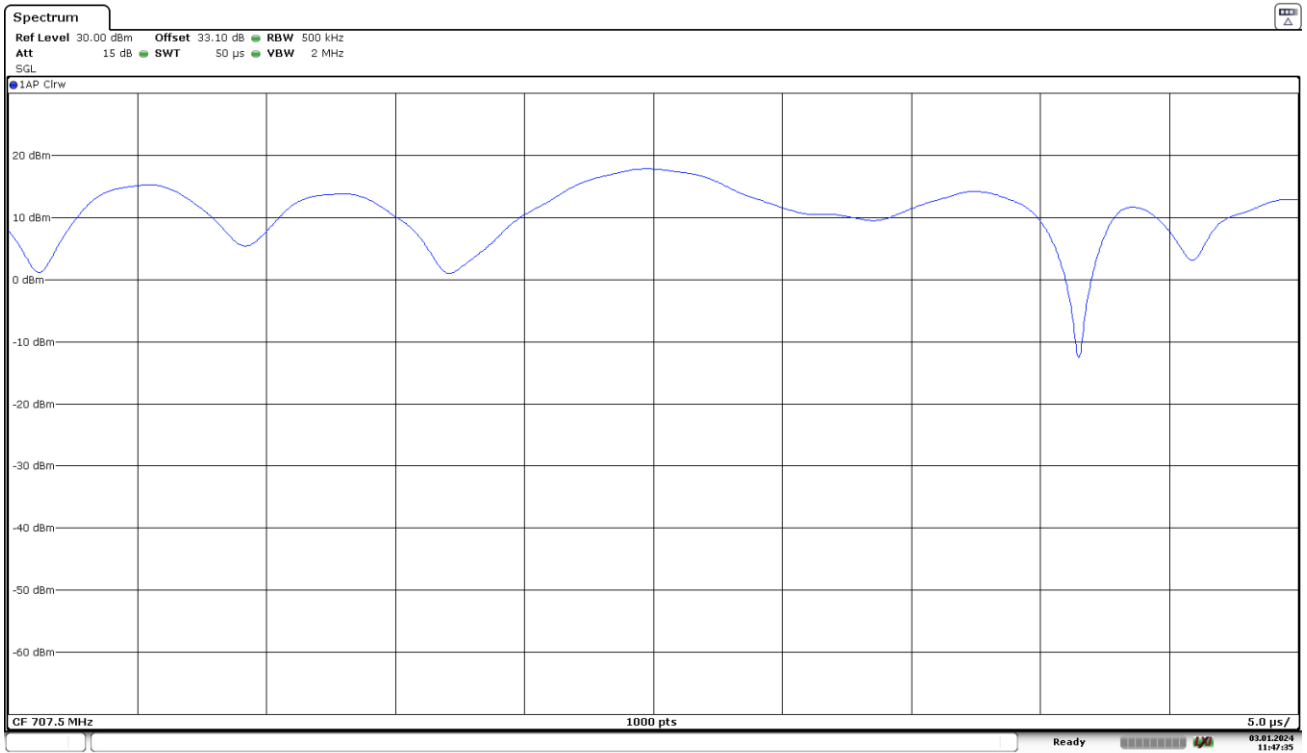
LTE Cat 1bis Band 12:

QPSK. BW=1.4 MHz.



Date: 3.JAN.2024 11:45:04

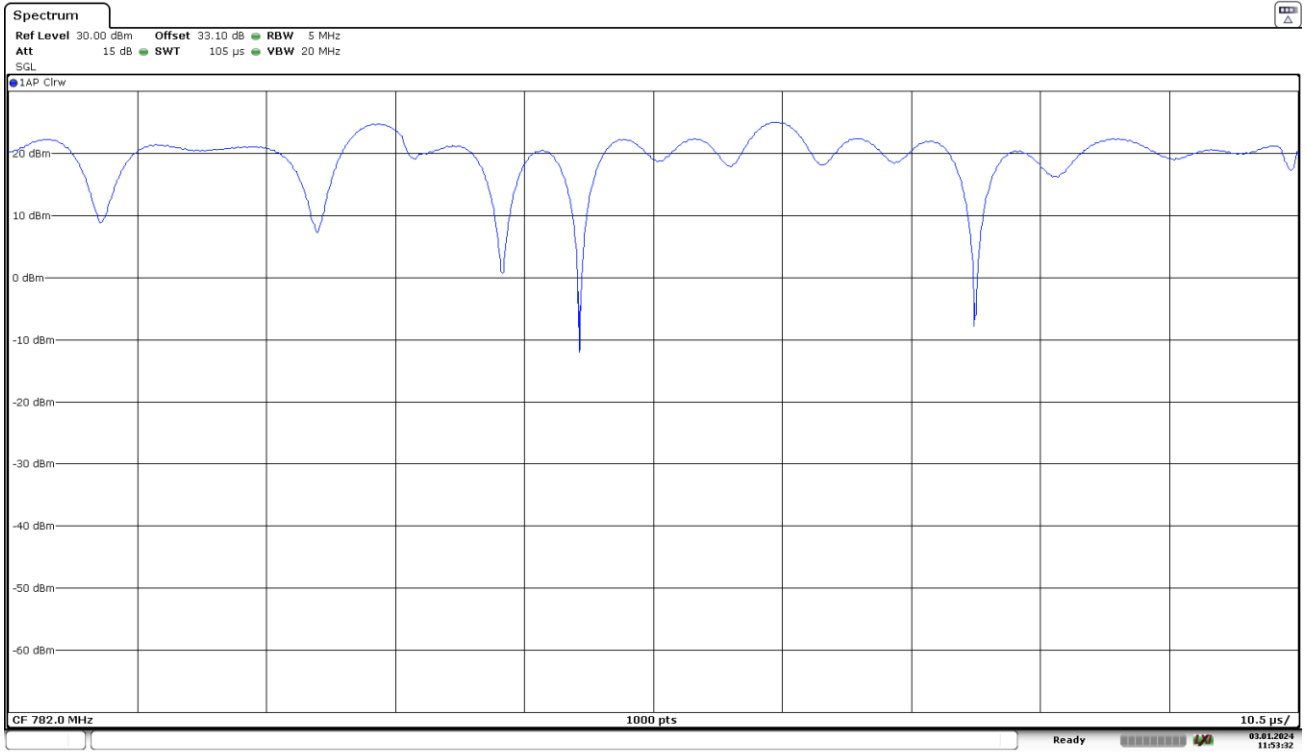
16QAM. BW=1.4 MHz.



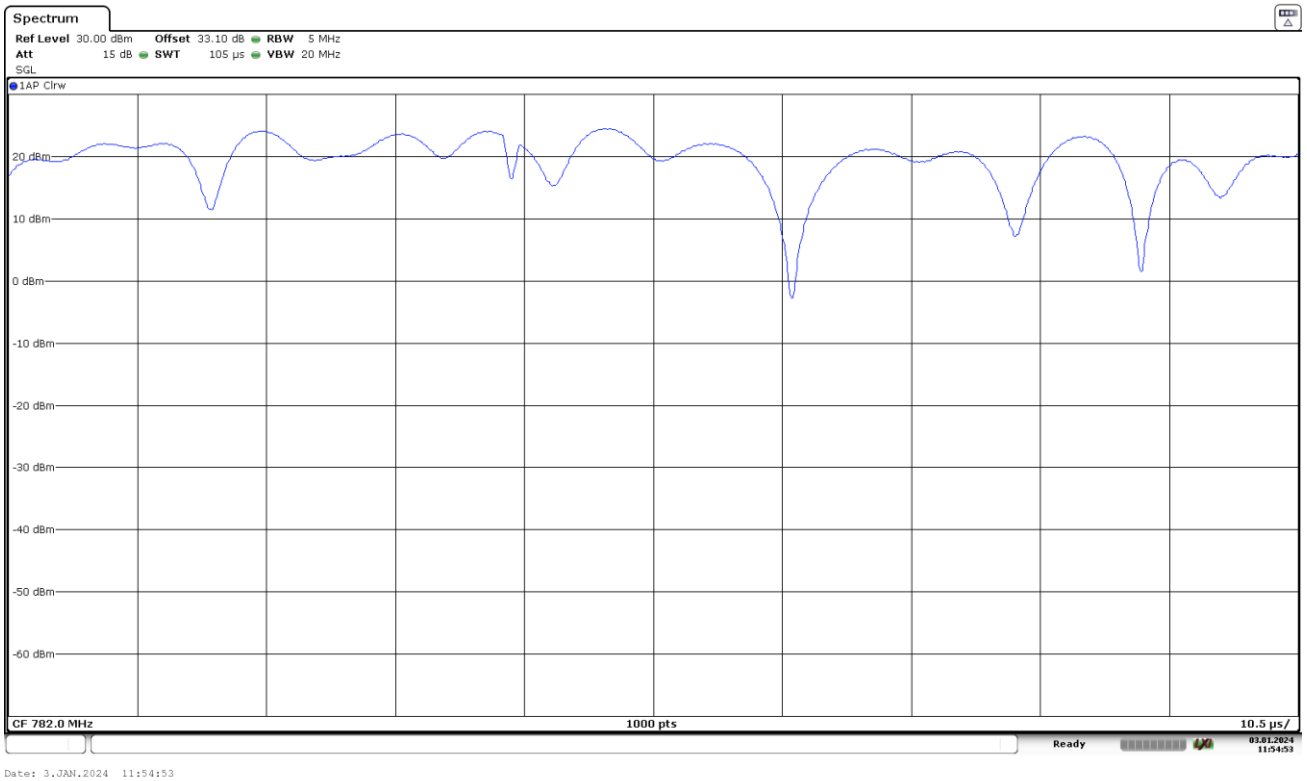
Date: 3.JAN.2024 11:47:35

LTE Cat 1bis Band 13:

QPSK. BW=5 MHz.

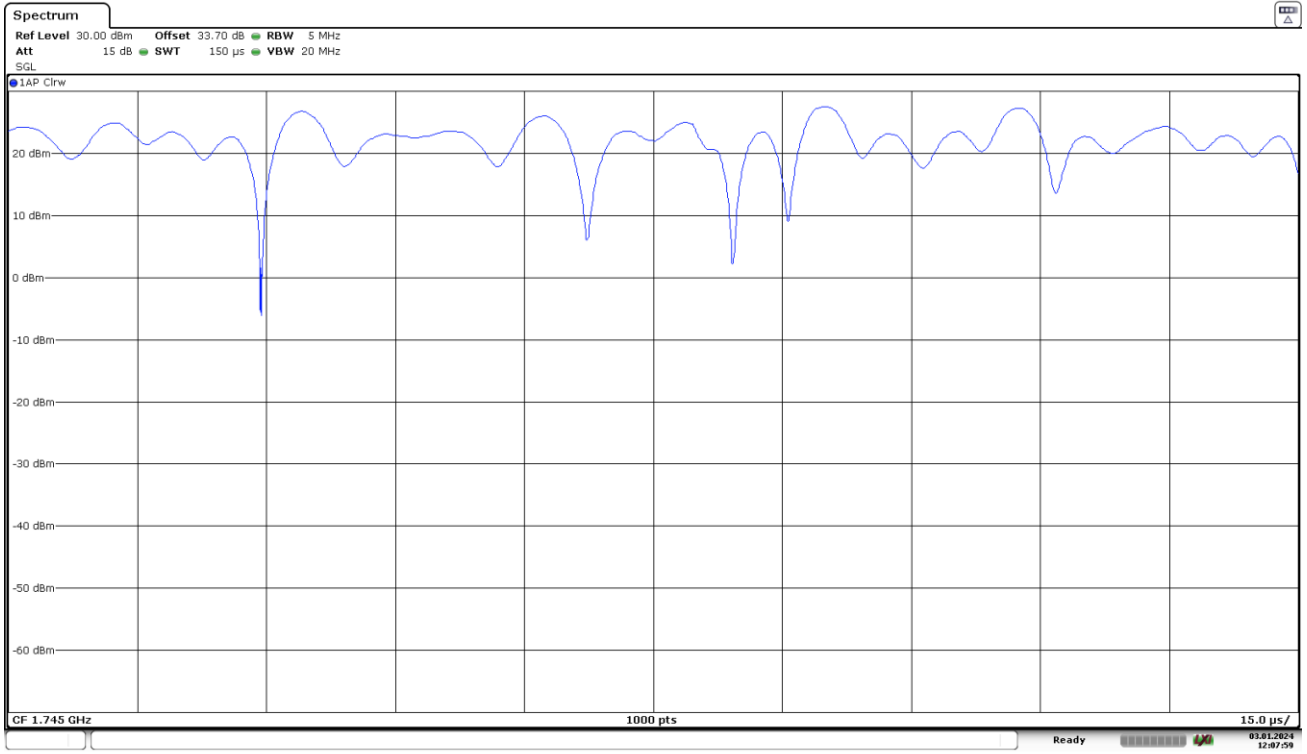


16QAM. BW=5 MHz.

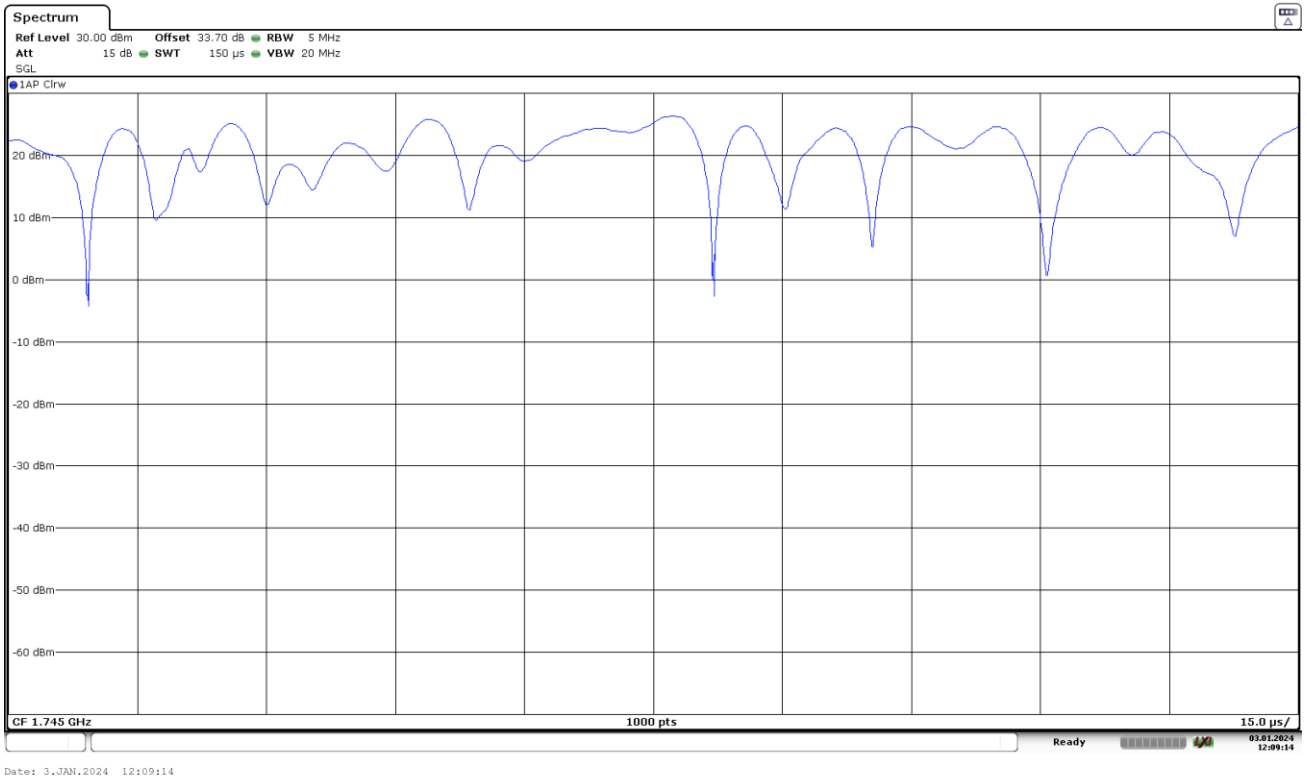


LTE Cat 1bis Band 66:

QPSK. BW=1.4 MHz.

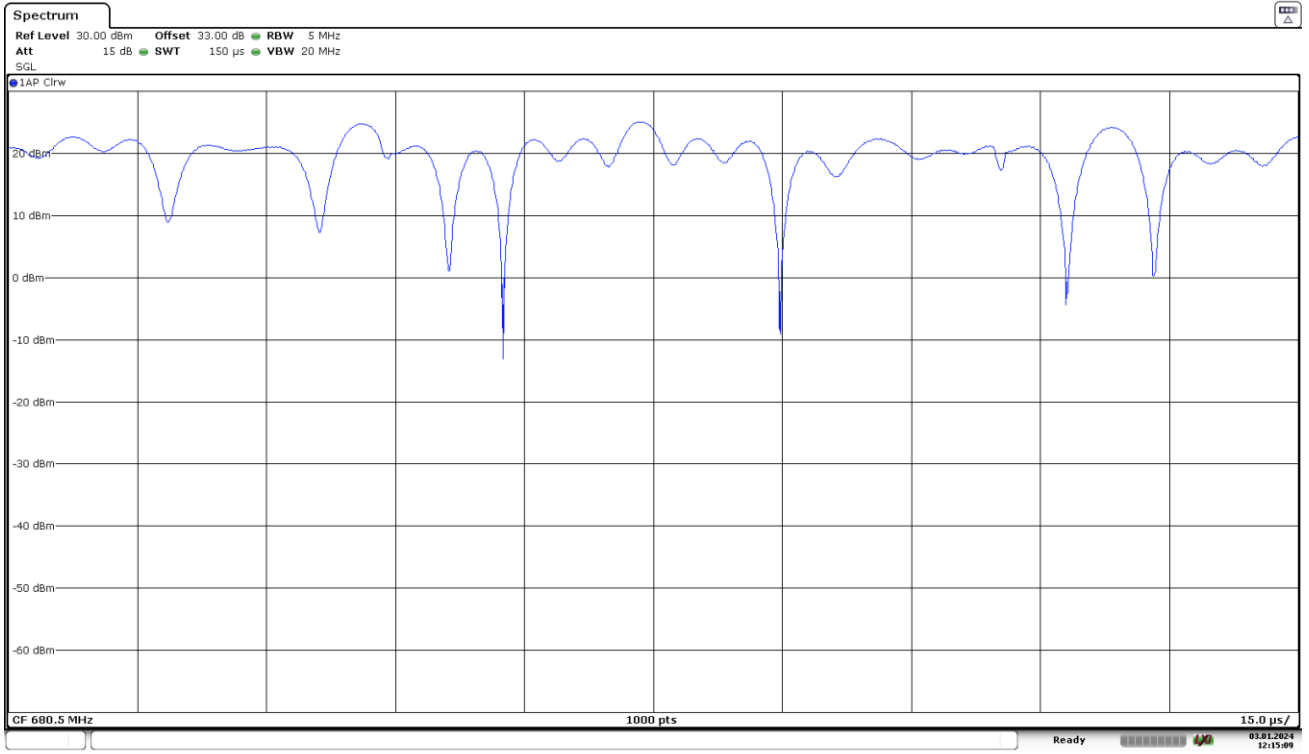


16QAM. BW=1.4 MHz.

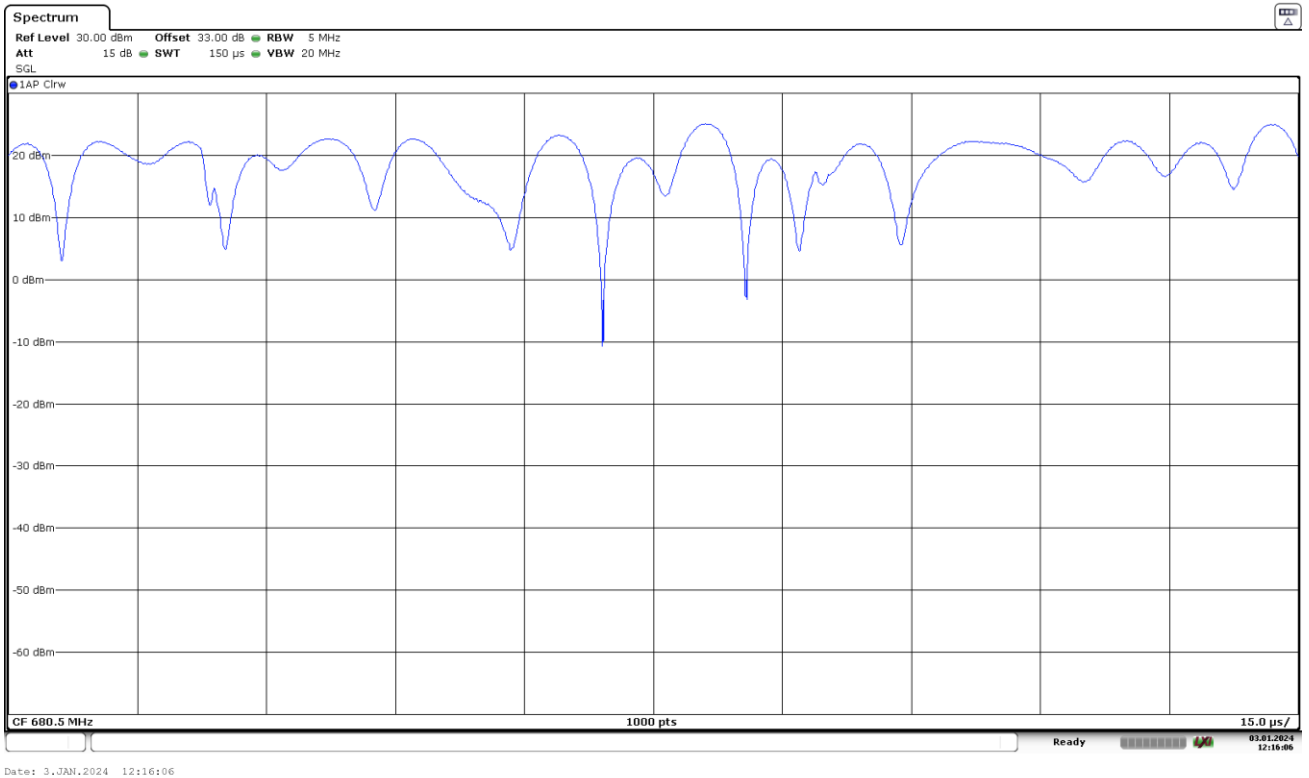


LTE Cat 1bis Band 71:

QPSK. BW=5 MHz.



16QAM. BW=5 MHz.



Occupied Bandwidth

Limits

1. LTE Cat 1bis Bands 12, 13, 66, 71.

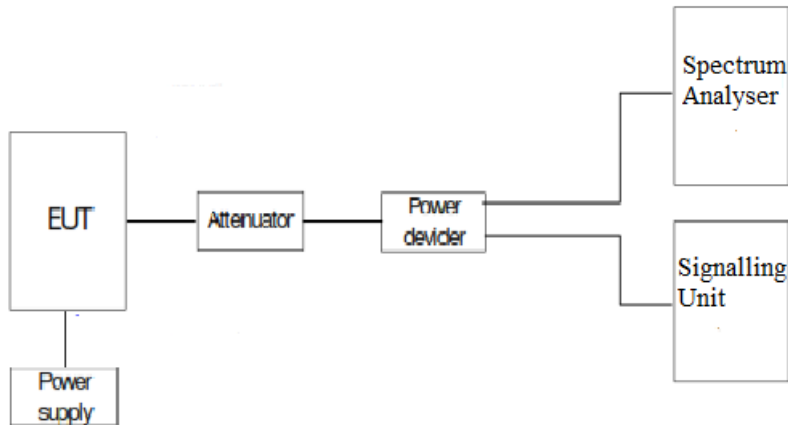
* FCC §2.1049: Measurements required: Occupied bandwidth.

* 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=1.4 MHz. QPSK. RB Size=All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.080	1.081	1.090
-26 dBc Bandwidth (MHz)	1.261	1.255	1.268
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=1.4 MHz. 16QAM. RB Size=All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.084	1.078	1.079
-26 dBc Bandwidth (MHz)	1.279	1.256	1.258
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=3 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.700	2.698	2.690
-26 dBc Bandwidth (MHz)	3.022	2.992	2.974
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=3 MHz. 16QAM. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.690	2.694	2.674
-26 dBc Bandwidth (MHz)	2.994	2.986	2.956
Measurement uncertainty (kHz)	<±3.75		

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

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.523	4.500	4.490
-26 dBc Bandwidth (MHz)	5.110	5.016	4.956
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)	4.513	4.053	4.496
-26 dBc Bandwidth (MHz)	5.050	5.016	5.046
Measurement uncertainty (kHz)	<±3.75		

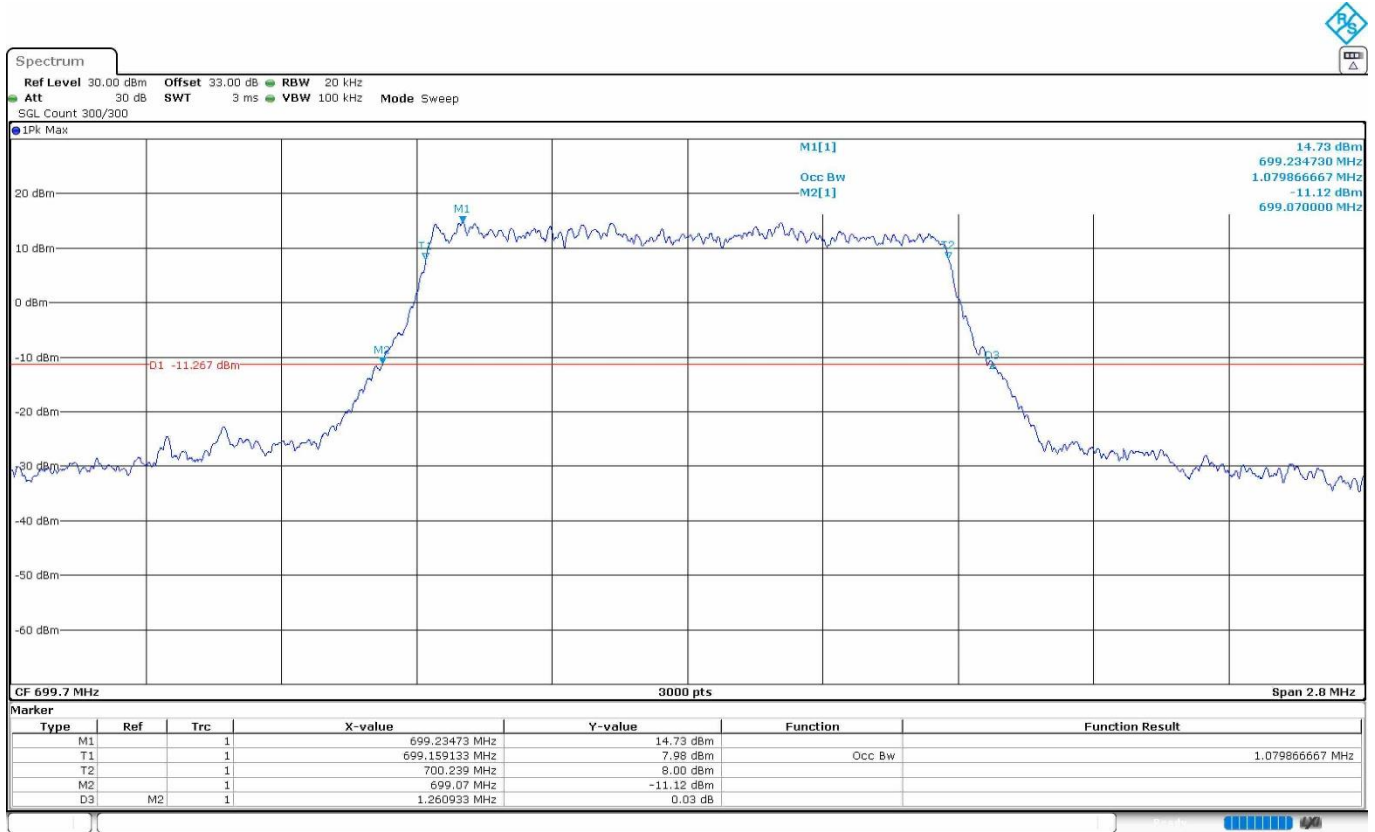
LTE Cat 1bis Band 12. BW=10 MHz. QPSK. RB Size All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	8.967	8.960	9.027
-26 dBc Bandwidth (MHz)	10.060	9.993	10.207
Measurement uncertainty (kHz)	<±3.75		

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

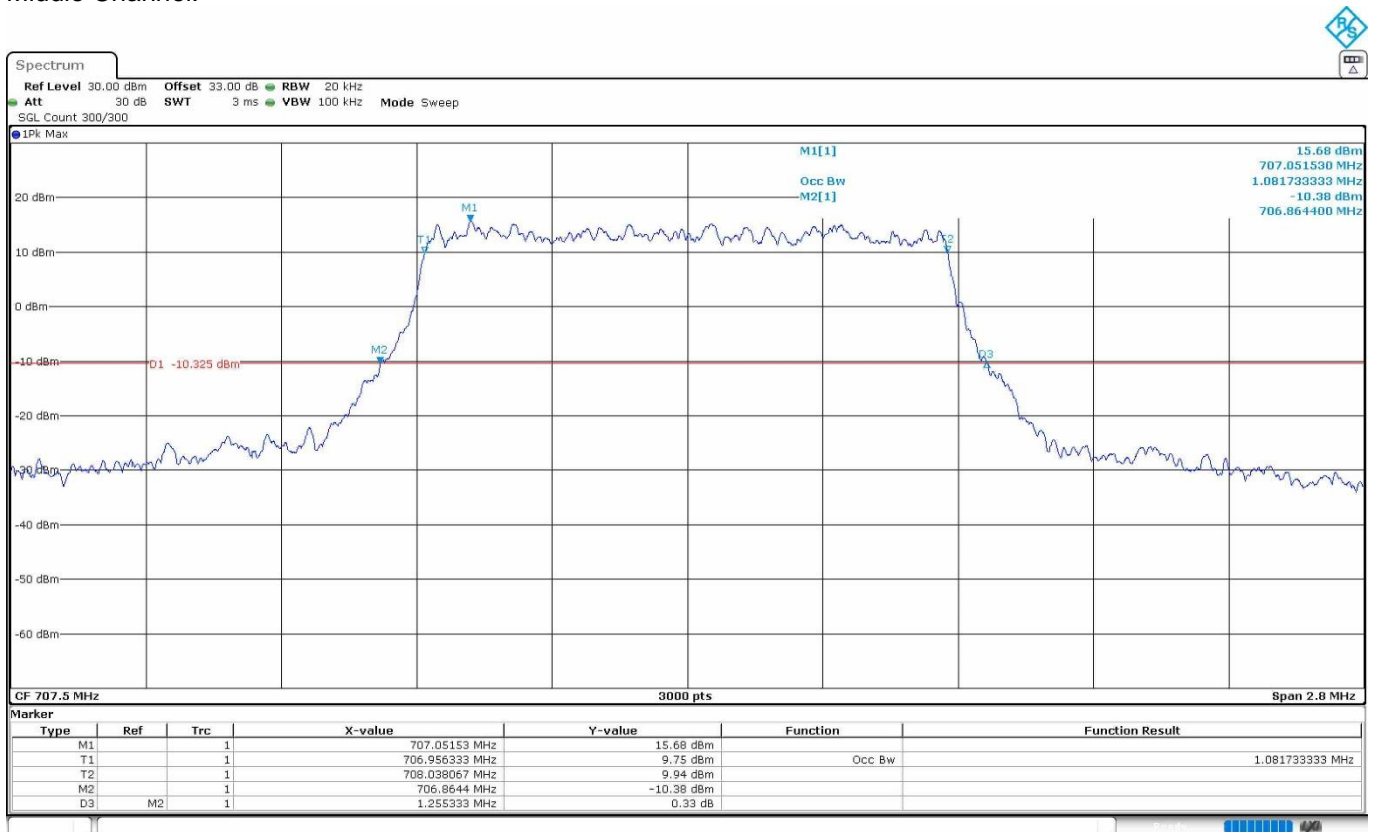
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.666	4.600	4.687
-26 dBc Bandwidth (MHz)	5.860	5.747	5.860
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=1.4 MHz. QPSK. RB Size All.
 Low Channel:



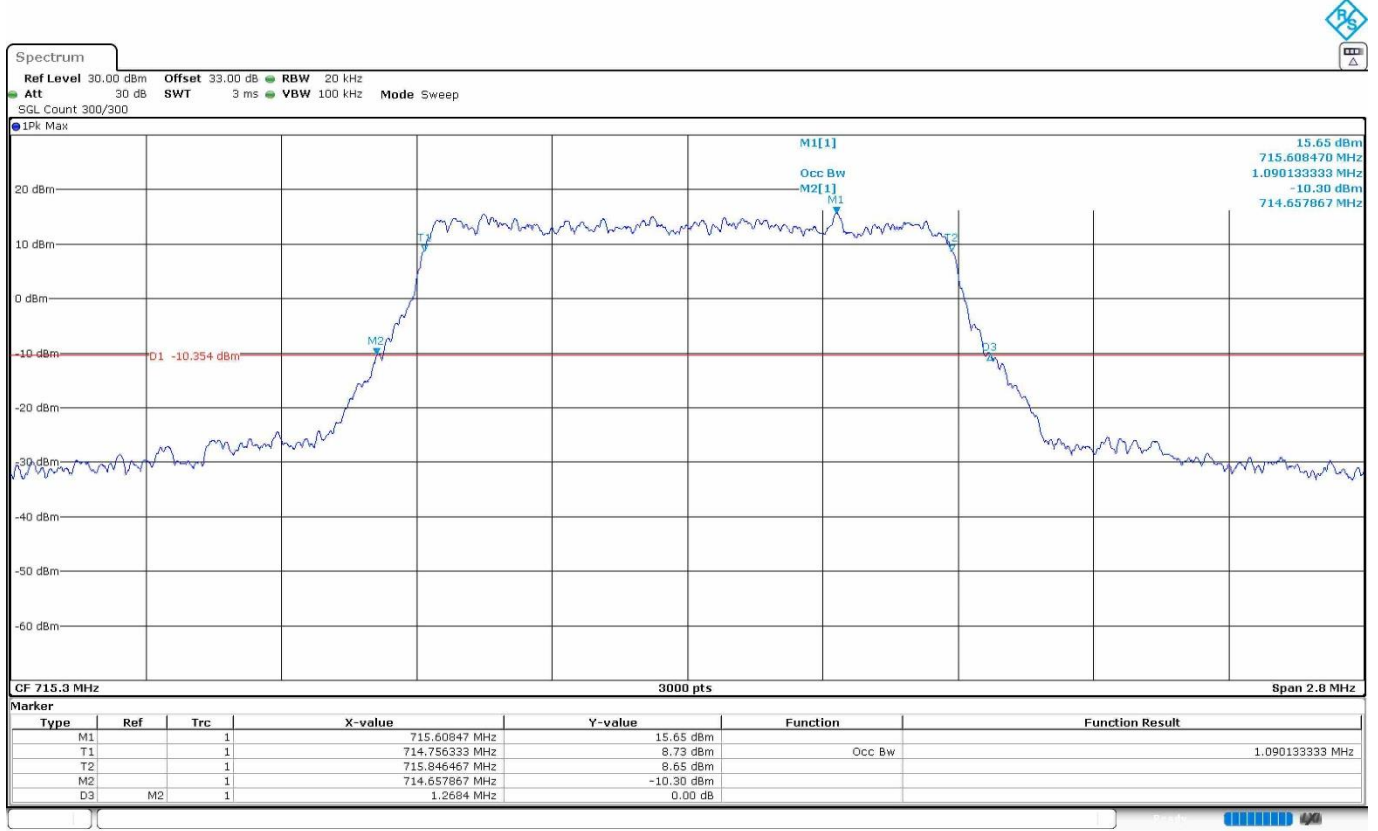
Date: 12.25.2023 13:35:36

Middle Channel:



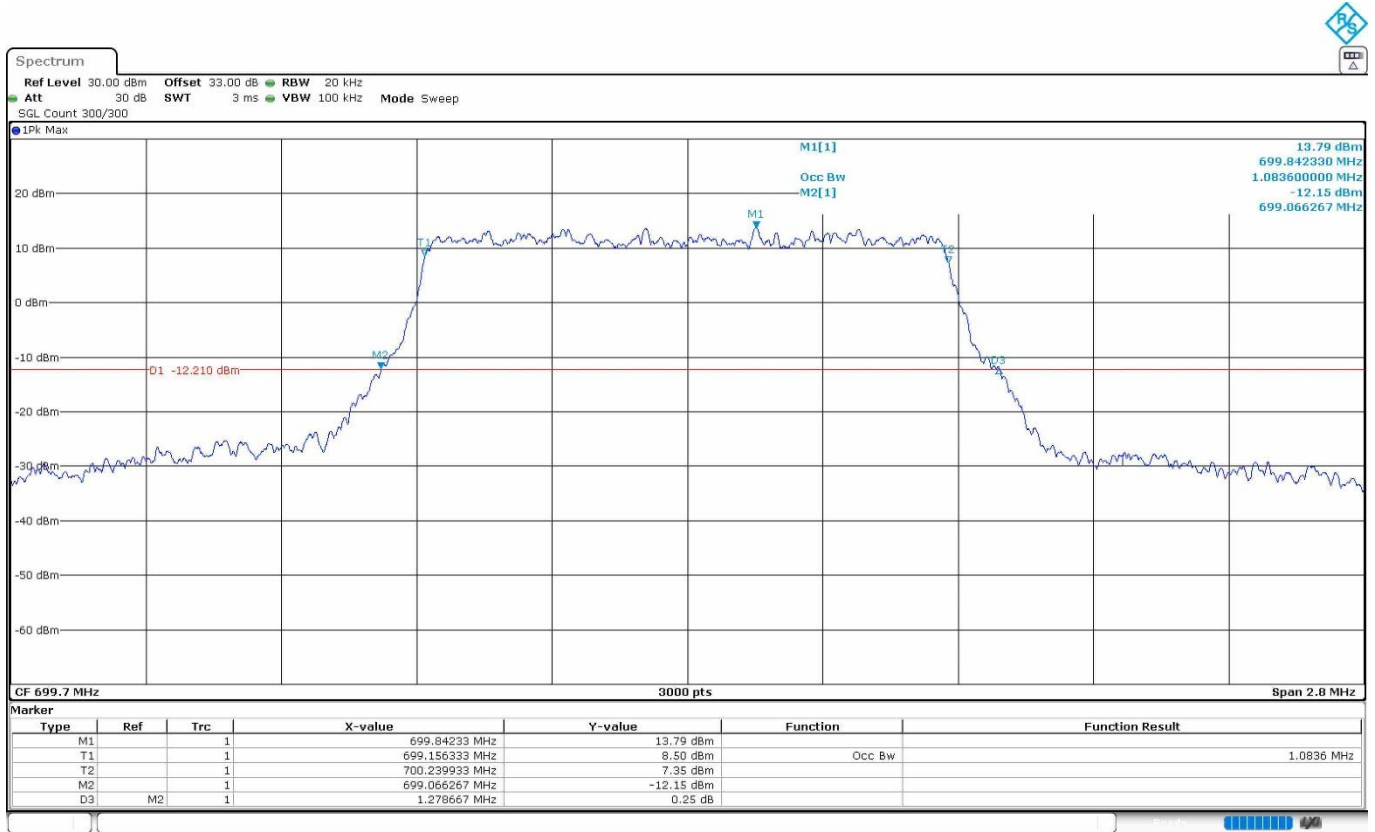
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High Channel:



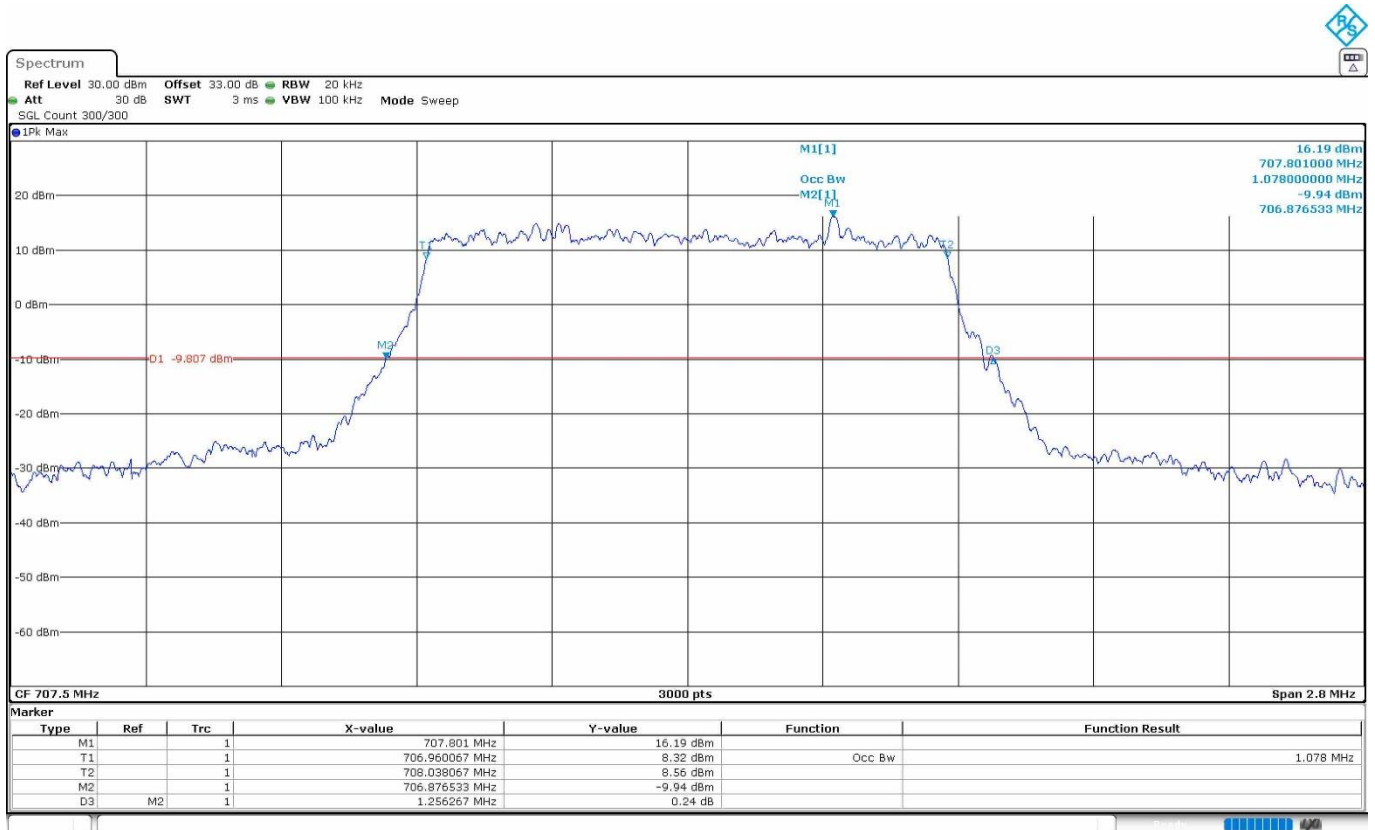
Date: 12.05.2023 13:36:27

LTE Cat 1bis Band 12. BW=1.4 MHz. 16QAM. RB Size All.
 Low Channel:



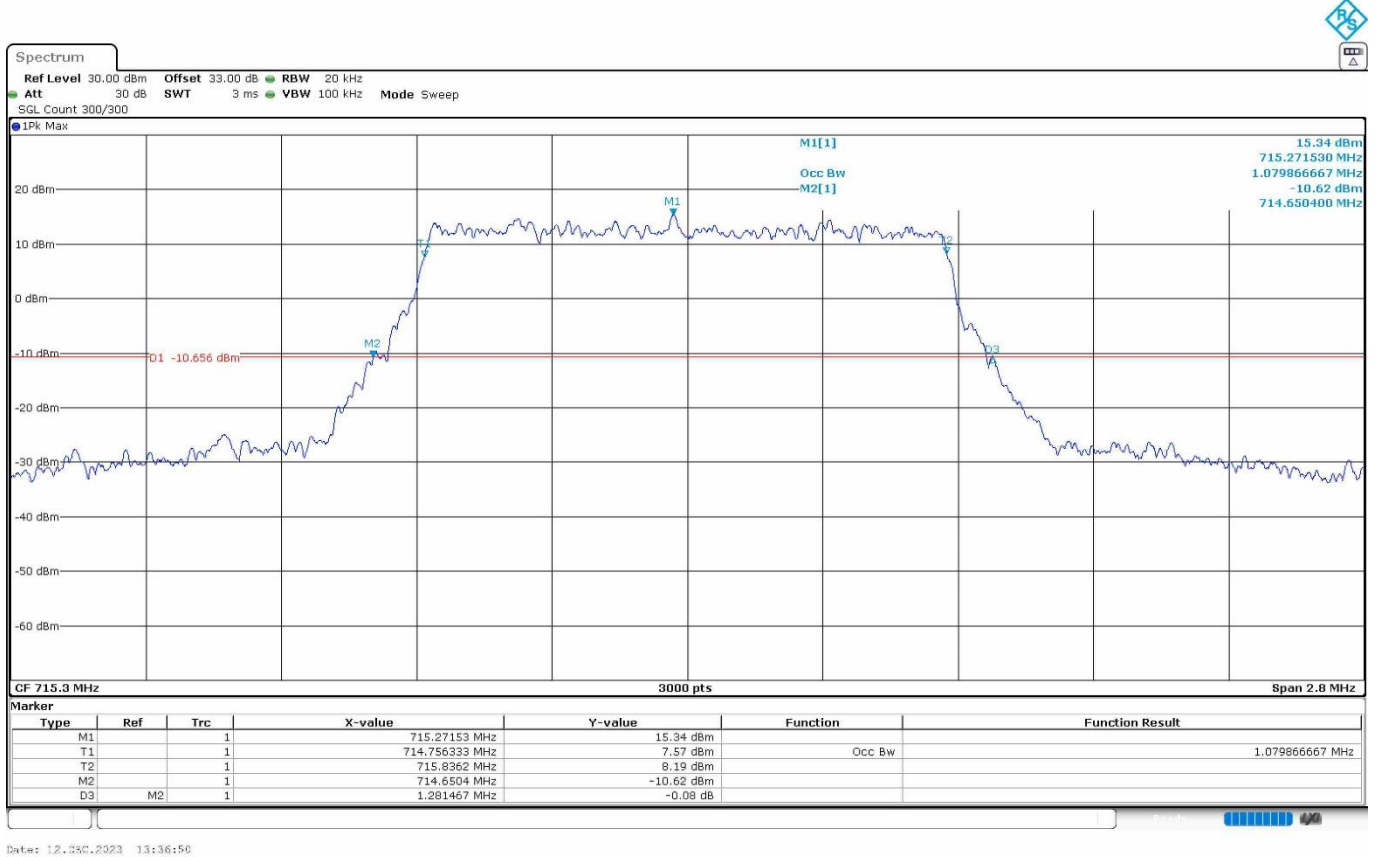
Date: 12.25.2023 13:35:51

Middle Channel:



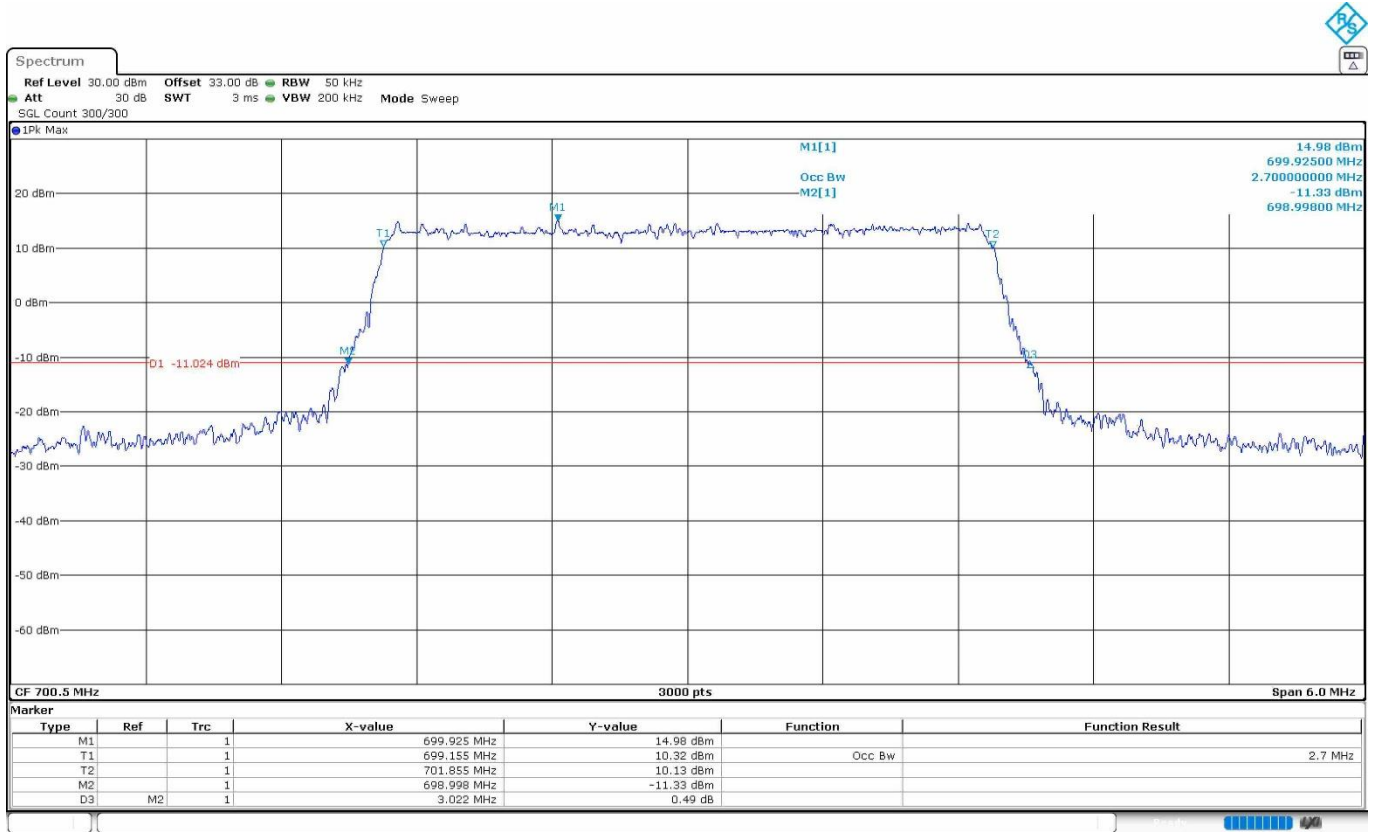
Date: 12.25.2023 13:36:23

High Channel:



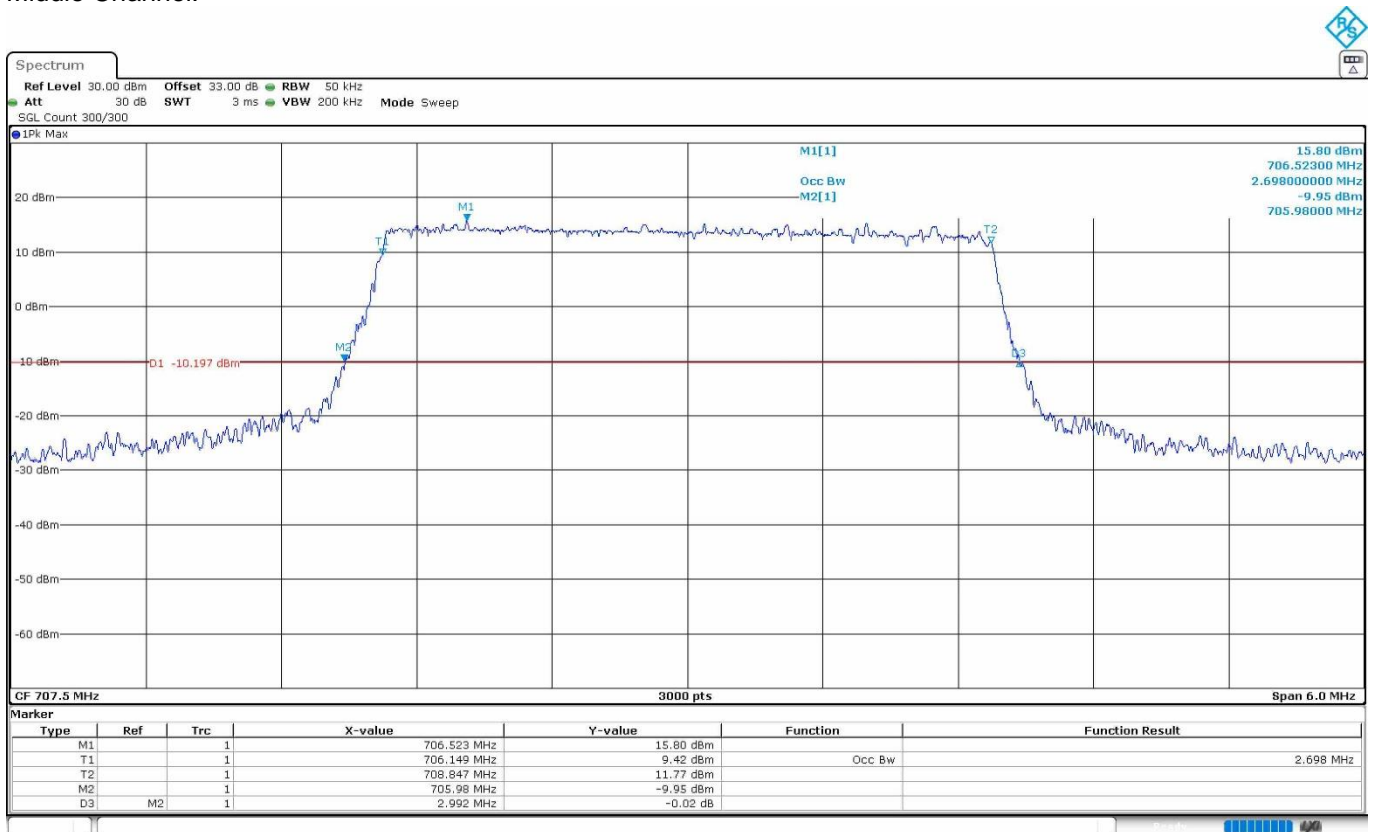
Date: 12.05.2023 13:36:50

LTE Cat 1bis Band 12. BW=3 MHz. QPSK. RB Size All.
 Low Channel:



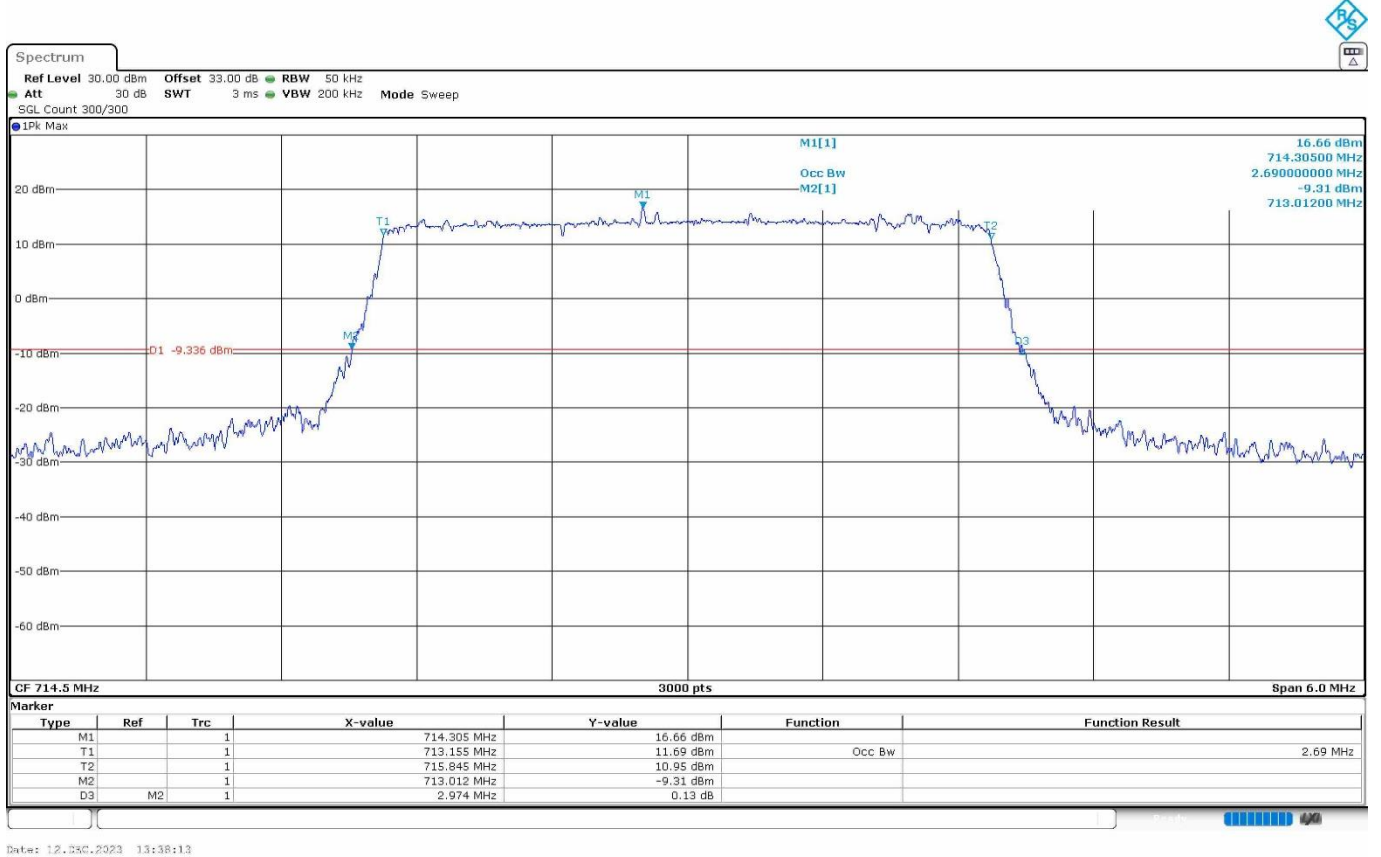
Date: 12.25.2023 13:37:10

Middle Channel:

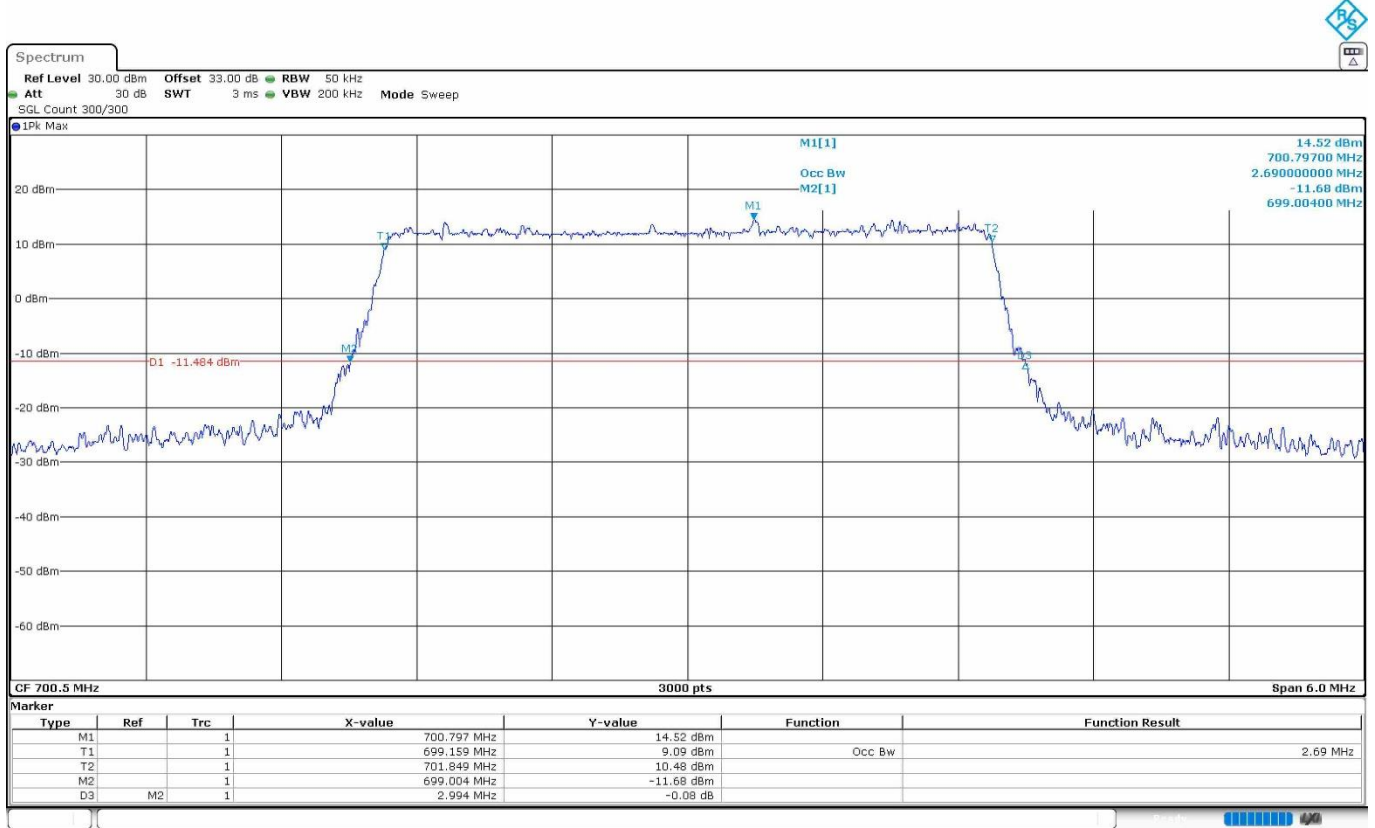


Date: 12.25.2023 13:37:12

High Channel:

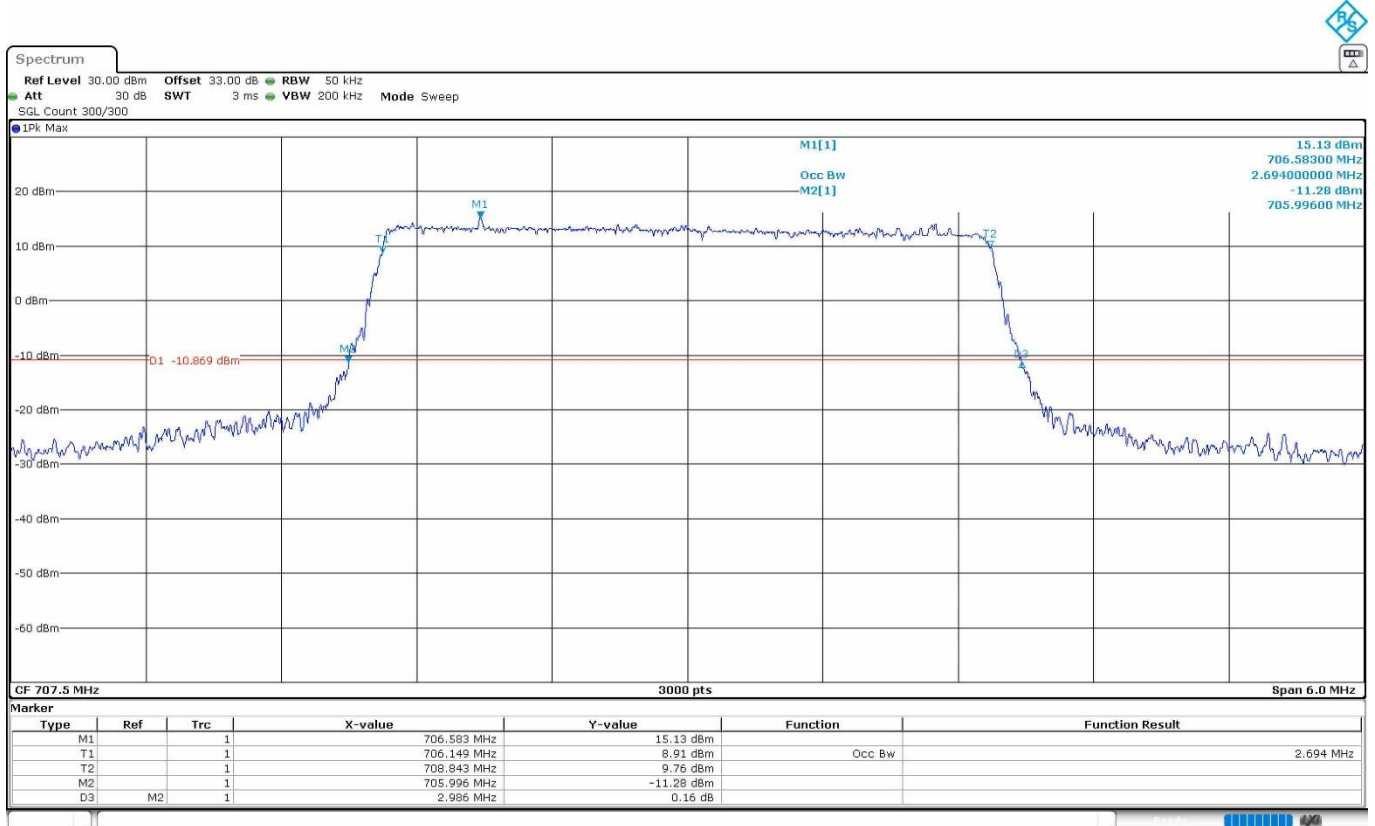


LTE Cat 1bis Band 12. BW=3 MHz. 16QAM. RB Size All.
 Low Channel:



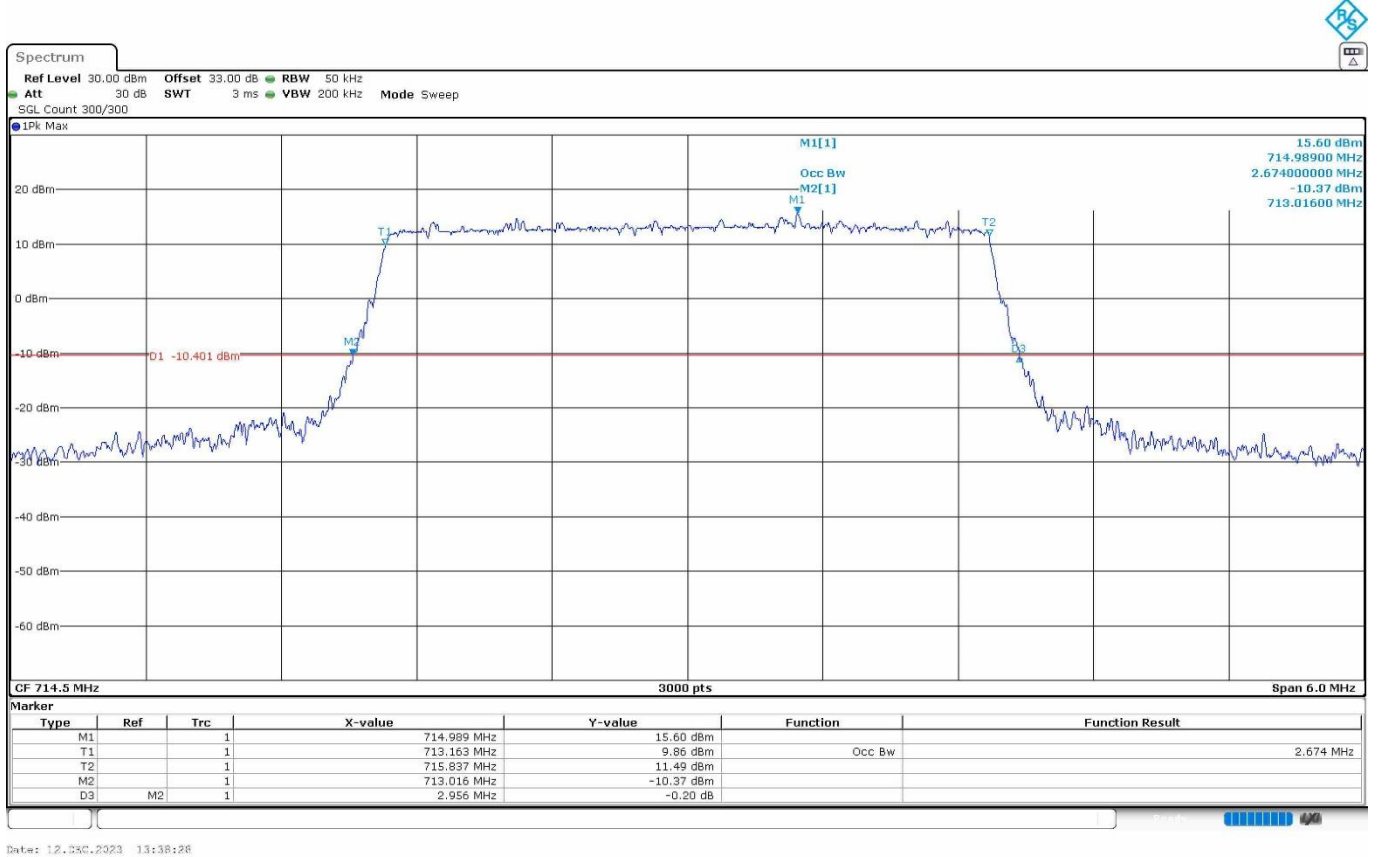
Date: 12.25.2023 13:37:25

Middle Channel:



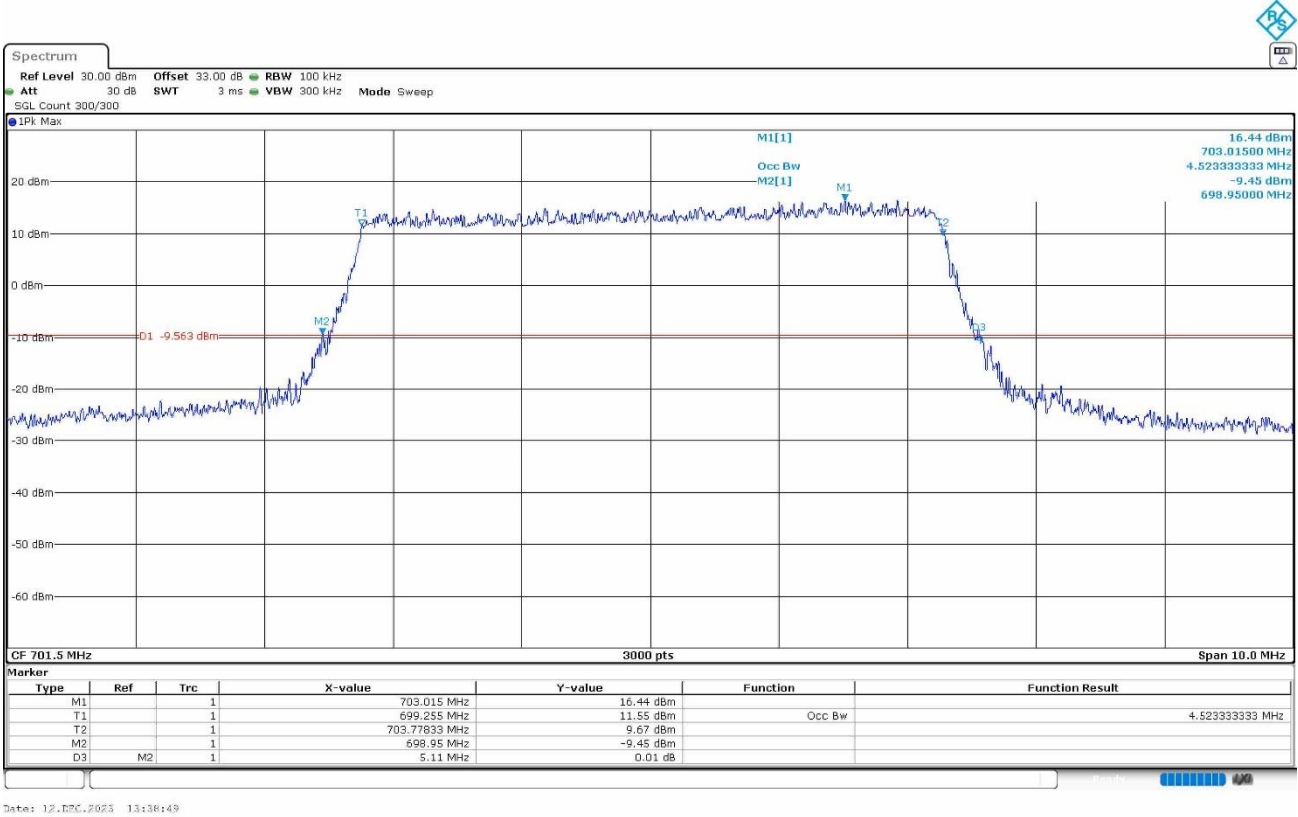
Date: 12.25.2023 13:37:58

High Channel:



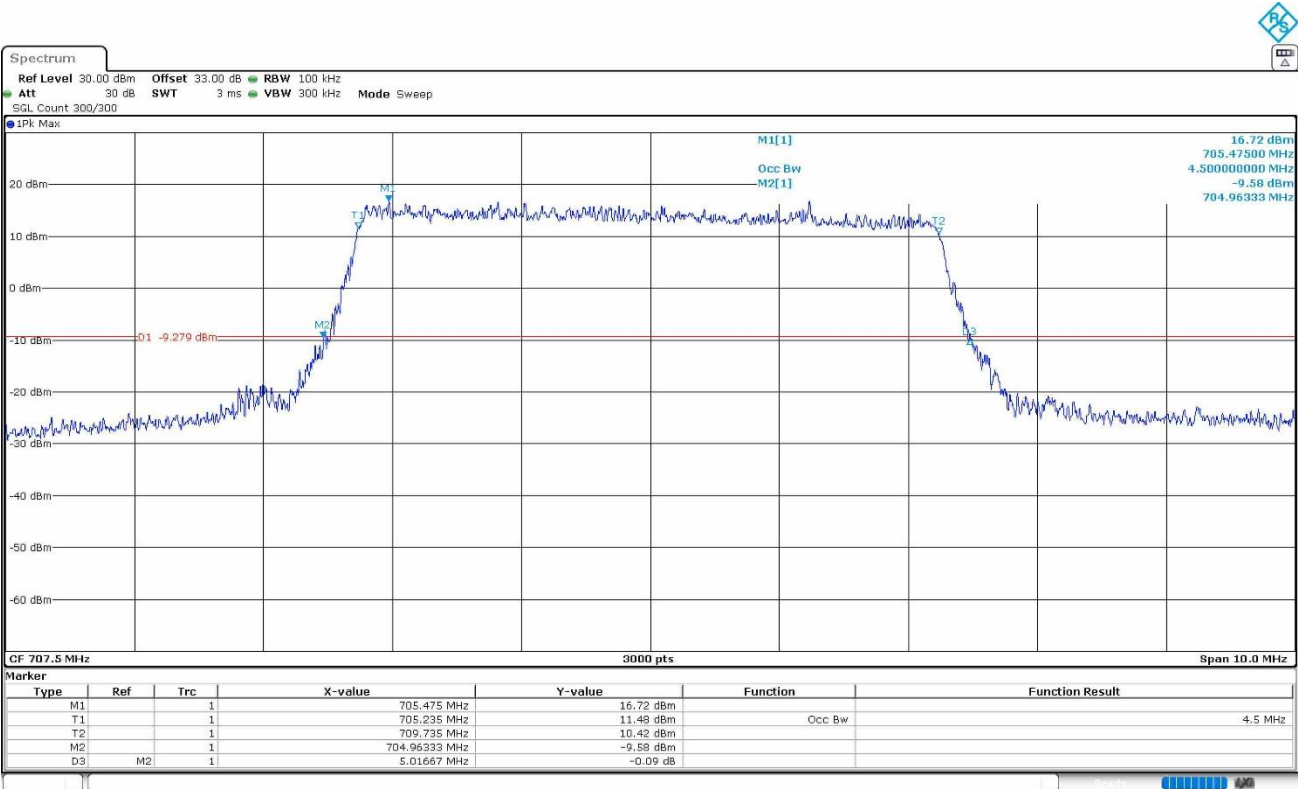
LTE Cat 1bis Band 12. BW=5 MHz. QPSK. RB Size All.

Low Channel:



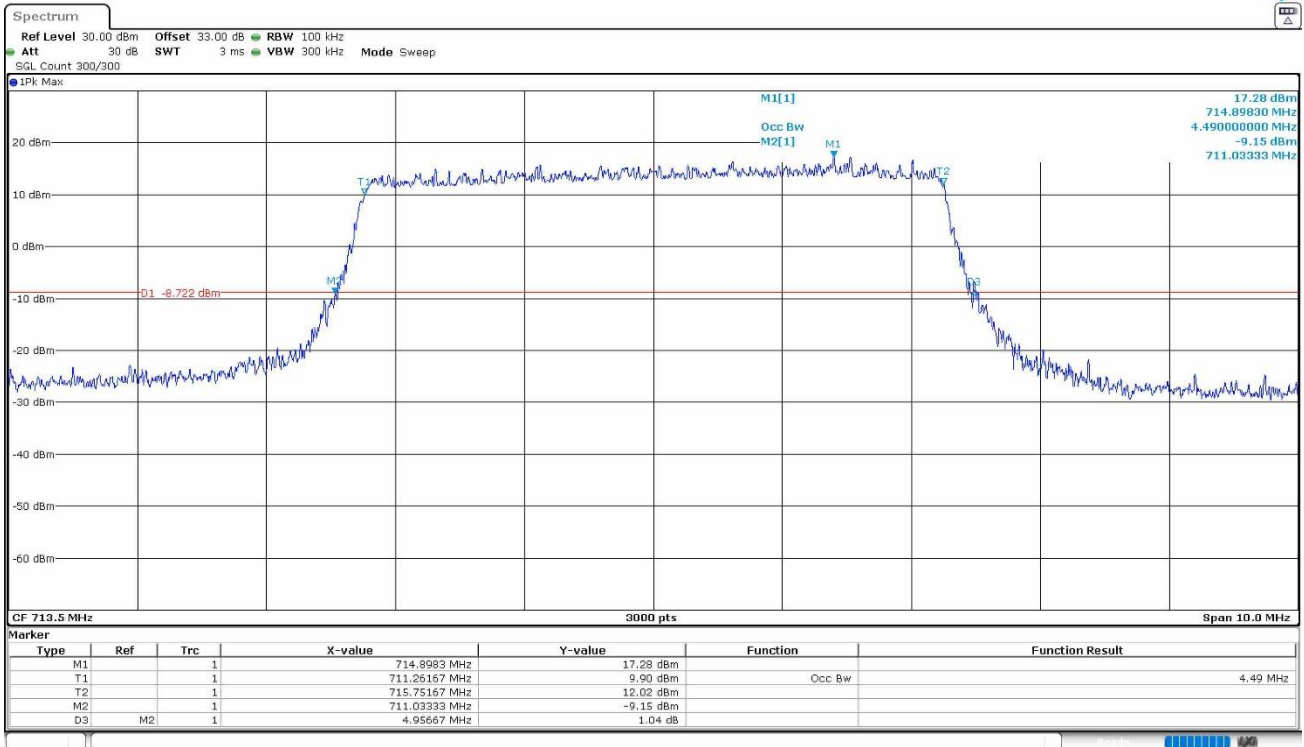
Date: 12.05C.2023 13:38:49

Middle Channel:



Date: 12.05C.2023 13:39:22

High Channel:



Date: 12.05.2023 13:39:53