

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
85372RRF.003

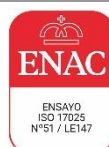
Test Report

USA FCC Part 27

CANADA RSS-Gen, RSS-130, RSS-139

(*) Identification of item tested	LTE Cat1-bis module
(*) Trademark	Sequans Communications
(*) Model and /or type reference	GC02S1-WW
Other identification of the product	FCC ID: 2AAGMGC02SW IC: 12732A-GC02SW
(*) Features	LTE Category CAT1_BIS HW version: Rev1 SW version: LR9.0.5.1-63892
Applicant	Sequans Communications 55 Boulevard Charles de Gaulle, 92700 Colombes. FRANCE
Test method requested, standard	USA FCC Part 27 (10-1-23 Edition). CANADA RSS-Gen Issue 5, April 2018, Amendment March 2019, Amendment February 2021. CANADA RSS-130 Issue 2, February 2019. CANADA RSS-139 Issue 4 September 2022, Amendment October 2022. 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	2026-03-10
Report template No.	FDT08_27 (*) "Data provided by the client"

Firmado digitalmente por 53680346W JOSE MANUEL GOMEZ (C:A29507456)



Index

Competences and guarantees 3

General conditions 3

Uncertainty 3

Data provided by the client.....3

Usage of samples 3

Test sample description 4

Identification of the client.....6

Testing period and place.....6

Document history 6

Environmental conditions 6

Remarks and comments 7

Testing verdicts.....7

Summary 8

Appendix A: Test results for FCC 27 / RSS-130, RSS-139: LTE Cat 1bis Bands 4, 12, 13, 17, 669

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

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.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document. **IMPORTANT:** No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification S.A.U.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

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 consists of: 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 speeds 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. The laboratory is not responsible for such information and it is not covered by accreditation.

Usage of samples

Samples undergoing test have been selected by: The client.

Id	Control Number	Description	Model	Serial N°	Date of Reception	Application
S/01	85370/002	LTE Cat1-bis module	GC02S1-WW	-	2025-12-11	Element Under Test
S/01	85370/011	LTE Cat1-bis module	GC02S1-WW	-	2026-01-09	Element Under Test
S/02	85370/002	LTE Cat1-bis module	GC02S1-WW	-	2025-12-11	Element Under Test
S/02	85370/005	SMA Cable	-	-	2025-12-11	Auxiliary Element
S/02	85370/010	LTE Cat1-bis module	GC02S1-WW	-	2026-01-09	Element Under Test
S/02	85370/012	SMA Cable	-	-	2026-01-09	Auxiliary Element

Notes referenced to samples during the project:

Id	Type
S/01	Radiated tests
S/02	Conducted tests

Test sample description

Ports..... :	Port name and description	Cable										
		Specified max length [m]	Attached during test	Shielded								
	USB	-	X	-								
	UART	-	X	-								
Supplementary information to the ports..... :	-											
Rated power supply :	Voltage and Frequency		Reference poles									
			L1	L2	L3	N	PE					
	AC:											
	DC: 3.3 to 4.5 V											
Rated Power..... :	-											
Clock frequencies..... :	-											
Other parameters :	-											
Software version..... :												
Hardware version :												
Dimensions in cm (W x H x D) ... :	21 x 19.5 x 1.8 mm											
Mounting position :	X	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							
	-		-		-							

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. C/ Severo Ochoa, 6 - Parque Tecnológico de Andalucía; 29590, Málaga, Spain
Date (start)	2025-12-16
Date (finish)	2026-01-29

Document history

Report number	Date	Description
85372RRF.003	2026-03-10	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: Carmen Vázquez.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
06791	SEMIANECHOIC ABSORBER LINED CHAMBER IV	FACT 3 200 STP	ETS LINDGREN	N/A
06792	SHIELDED ROOM	S101	ETS LINDGREN	N/A
06609	TEMPERATURE AND HUMIDITY PROBE	HWg-STE	HW GROUP	2026-04-21
06615	TEMPERATURE AND HUMIDITY PROBE	HWg-STE	HW GROUP	2026-04-24
06158	SIGNAL AND SPECTRUM ANALYZER 10 Hz - 40 GHz	FSV40	ROHDE AND SCHWARZ	2026-02-05
08849	WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE AND SCHWARZ	2026-03-31
06043	POWER DIVIDER, DC-26 GHz	5333	TEKTRONIX	N/A
06165	EMI TEST RECEIVER 9 kHz-7 GHz	ESR	ROHDE AND SCHWARZ	2025-12-27
04578	HYBRID BILOG ANTENNA 30 MHz - 6 GHz	3142E	ETS LINDGREN	2026-06-01
07692	ATTENUATOR 3 dB, 2 W, DC, 18 GHz	TWTS2G	TECHNIWAVE	2026-02-03
08835	SIGNAL AND SPECTRUM ANALYZER 2 Hz - 50 GHz	FSW50	ROHDE AND SCHWARZ	2027-04-15
05705	PRE-AMPLIFIER G>40dB, 1-18 GHz	BLMA 0118-1M	BONN ELEKTRONIK	2026-07-23
04611	HORN ANTENNA 1-18 GHz	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	2026-01-16
04716	SIGNAL AND SPECTRUM ANALYZER 2 Hz - 50 GHz	FSW50	ROHDE AND SCHWARZ	2026-08-02
10573	PRE-AMPLIFIER G>46dB 18-40 GHz	BLMA 1840-5G	BONN ELEKTRONIK	2026-03-07
04657	HORN ANTENNA 18-40 GHz	BBHA 9170	SCHWARZBECK MESS-ELEKTRONIK	2026-06-12
04848	SOFTWARE FOR EMC/RF TESTING	EMC32	ROHDE AND SCHWARZ	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-Gen, RSS-130, RSS-139			
Requirement – Test case	Verdict	Remark	Location
FCC 27.50 / RSS-130 4.6, RSS-139 5.5: RF Output Power	P	-	DEKRA TESTING AND CERTIFICATION S.A.U. C/ Severo Ochoa, 6 - Parque Tecnológico de Andalucía; 29590, Málaga, Spain
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: LTE Cat 1bis Bands 4, 12, 13, 17, 66

INDEX

TEST CONDITIONS 11

RF Output Power 13

Frequency Stability 28

Modulation Characteristics 34

Occupied Bandwidth 38

Spurious Emissions at Antenna Terminals 68

Spurious Emissions at Antenna Terminals at Block Edges 79

Radiated Emissions 92

TEST CONDITIONS

(*): Declared by the Applicant.

POWER SUPPLY (*):

Vnominal: 3.8 Vdc
Vminimum: 3.3 Vdc
Vmaximum: 4.5 Vdc
Type of Power Supply: USB.

ANTENNA (*):

Bands	Gain (dBi)	Type of Antenna
LTE 4	+2.4	TRIO mXTEND™ (NN03-310)
LTE 12	+2.4	TRIO mXTEND™ (NN03-310)
LTE 13	+2.4	TRIO mXTEND™ (NN03-310)
LTE 17	+2.4	TRIO mXTEND™ (NN03-310)
LTE 66	+2.4	TRIO mXTEND™ (NN03-310)

TEST FREQUENCIES:

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

	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 modulations:

	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 modulations:

	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 modulations:

	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, 17. 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 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

Table 4: Maximum power of equipment in the band 2110-2180 MHz	
Equipment type	Maximum power
Non-AAS fixed station and base station	65 dBm e.i.r.p./MHz
AAS fixed station and base station	46 dBm TRP/MHz
Subscriber equipment	30 dBm e.i.r.p./channel bandwidth

Table 5: Maximum power of equipment in the band 2180-2200 MHz	
Equipment type	Maximum power
Non-AAS base station	65 dBm e.i.r.p./MHz
AAS base station	46 dBm TRP/MHz

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:

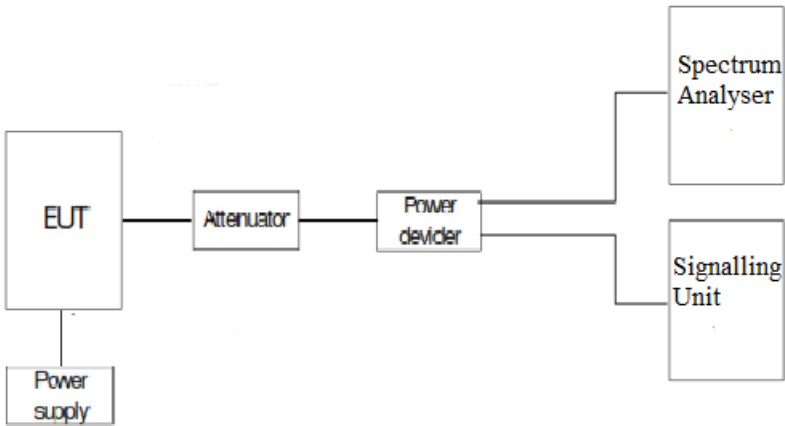
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

Test Setup

1. CONDUCTED AVERAGE POWER:



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



Results

1. CONDUCTED AVERAGE POWER:

LTE Cat 1bis Band 12:

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 23035	701.5	QPSK	1	0	22.88
				1	12	23.05
				1	24	22.96
				12	0	22.09
				12	6	22.08
				12	11	22.17
				25	0	22.11
			16-QAM	1	0	22.14
				1	12	22.32
				1	24	22.17
				12	0	21.09
				12	6	21.09
				12	11	21.17
				25	0	21.09
	Middle 23095	707.5	QPSK	1	0	23
				1	12	22.99
				1	24	22.96
				12	0	22.13
				12	6	22
				12	11	21.97
				25	0	22.12
			16-QAM	1	0	22.36
				1	12	22.28
				1	24	22.21
				12	0	21.12
				12	6	21.01
				12	11	21.01
				25	0	21.11
	High 23155	713.5	QPSK	1	0	22.83
				1	12	23.02
				1	24	22.89
				12	0	22.05
				12	6	22.1
				12	11	22.21
				25	0	22.11
			16-QAM	1	0	22.03
				1	12	22.32
				1	24	22.26
				12	0	21.13
				12	6	21.16
				12	11	21.28
				25	0	21.1

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	23.05	2.4	25.45	23.3
MIDDLE	23	2.4	25.4	23.25
HIGH	23.02	2.4	25.42	23.27
MAX:	23.05		23.05	23.3

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	22.32	2.4	24.72	22.57
MIDDLE	22.36	2.4	24.76	22.61
HIGH	22.32	2.4	24.72	22.57
MAX:	22.36		24.76	22.61

LTE Cat 1bis Band 13:

Worst-case of RF Power is BW=5 MHz. High Channel. QPSK. RB Size=1. RB Offset=24.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 23205	779.5	QPSK	1	0	22.86
				1	12	22.98
				1	24	22.9
				12	0	21.96
				12	6	22.01
				12	11	22.11
				25	0	22.01
			16-QAM	1	0	22.1
				1	12	22.28
				1	24	22.57
				12	0	20.92
				12	6	21.05
				12	11	21.12
				25	0	20.97
	Middle 23230	782	QPSK	1	0	N/A
				1	12	N/A
				1	24	N/A
				12	0	N/A
				12	6	N/A
				12	11	N/A
				25	0	N/A
			16-QAM	1	0	N/A
				1	12	N/A
				1	24	N/A
				12	0	N/A
				12	6	N/A
				12	11	N/A
				25	0	N/A
	High 23255	784.5	QPSK	1	0	22.78
				1	12	22.89
				1	24	23.08
				12	0	21.98
				12	6	21.9
				12	11	21.95
				25	0	21.97
			16-QAM	1	0	22.15
				1	12	22.25
				1	24	22.84
				12	0	20.99
				12	6	20.91
				12	11	20.98
				25	0	20.97

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	22.98	2.4	25.38	23.23
HIGH	23.08	2.4	25.48	23.33
MAX:	23.08		25.48	23.33

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	2.4	24.97	22.82
HIGH	22.84	2.4	25.24	23.09
MAX:	22.84		25.24	23.09

LTE Cat 1bis Band 66:

Worst-case of RF Power is BW=15 MHz. Middle Channel. QPSK. RB Size=1. RB Offset=37.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
15	Low 132047	1717.5	QPSK	1	0	23.1
				1	37	23.12
				1	74	22.5
				36	0	22.22
				36	18	22.18
				36	37	22.07
				75	0	22.23
			16-QAM	1	0	21.89
				1	37	22.38
				1	74	21.77
				25	0	21.15
				25	25	21.2
				25	50	21.03
				75	0	
	Middle 132322	1745	QPSK	1	0	22.68
				1	37	23.26
				1	74	23.16
				25	0	21.74
				25	25	22.03
				25	50	22.32
				75	0	21.71
			16-QAM	1	0	21.89
				1	37	22.45
				1	74	22.15
				25	0	20.75
				25	25	21.15
				25	50	21.24
				75	0	
	High 132597	1772.5	QPSK	1	0	22.58
				1	37	23.25
				1	74	22.88
				25	0	22.05
				25	25	22.05
				25	50	22.18
				75	0	21.41
			16-QAM	1	0	21.46
				1	37	22.54
				1	74	22.18
				25	0	20.97
				25	25	21.25
				25	50	21.31
				75	0	

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	23.12	2.4	25.52	23.37
MIDDLE	23.26	2.4	25.66	23.51
HIGH	23.25	2.4	25.65	23.5
MAX:	23.26		25.66	23.51

BW=15 MHz. 16QAM:

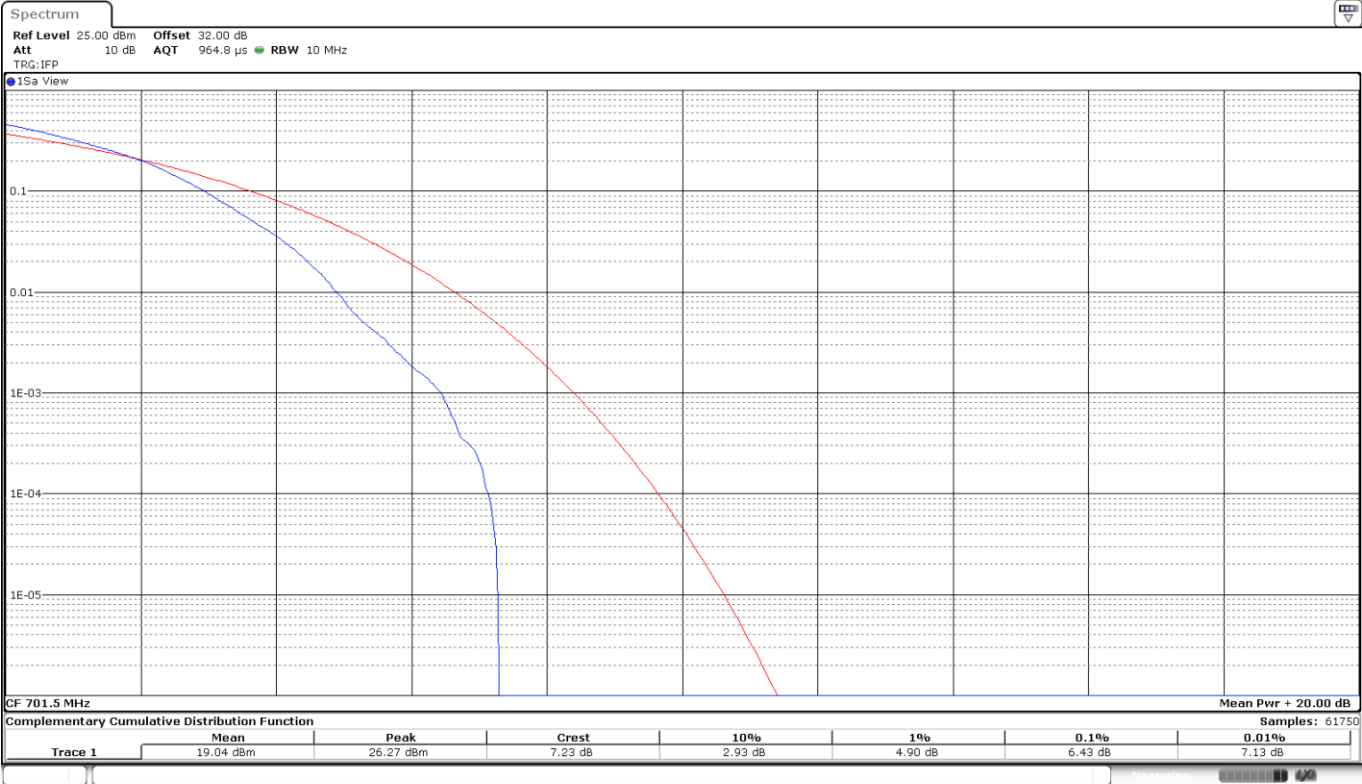
MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.38	2.4	24.78	22.63
MIDDLE	22.45	2.4	24.85	22.7
HIGH	22.54	2.4	24.94	22.79
MAX:	22.54		24.94	22.79

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

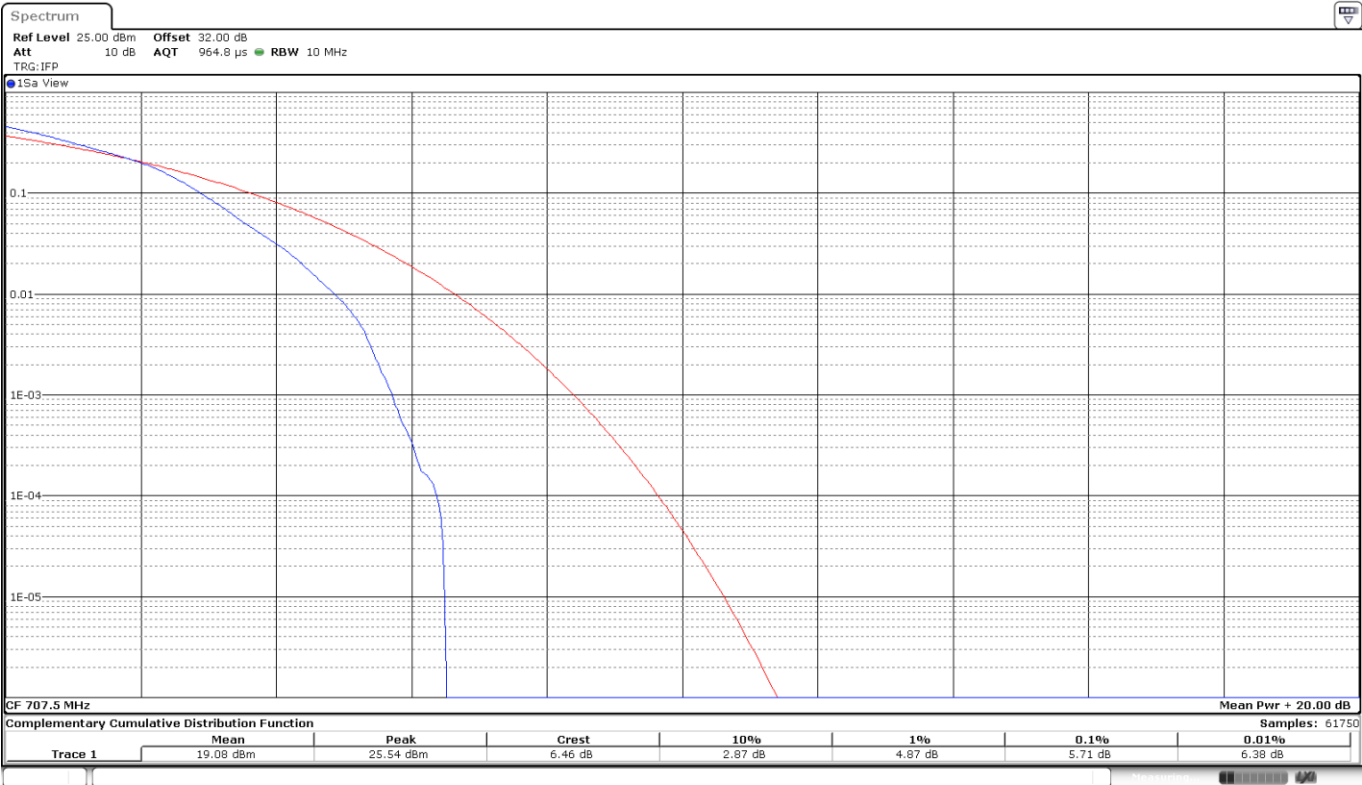
LTE Cat 1bis Band 12:

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

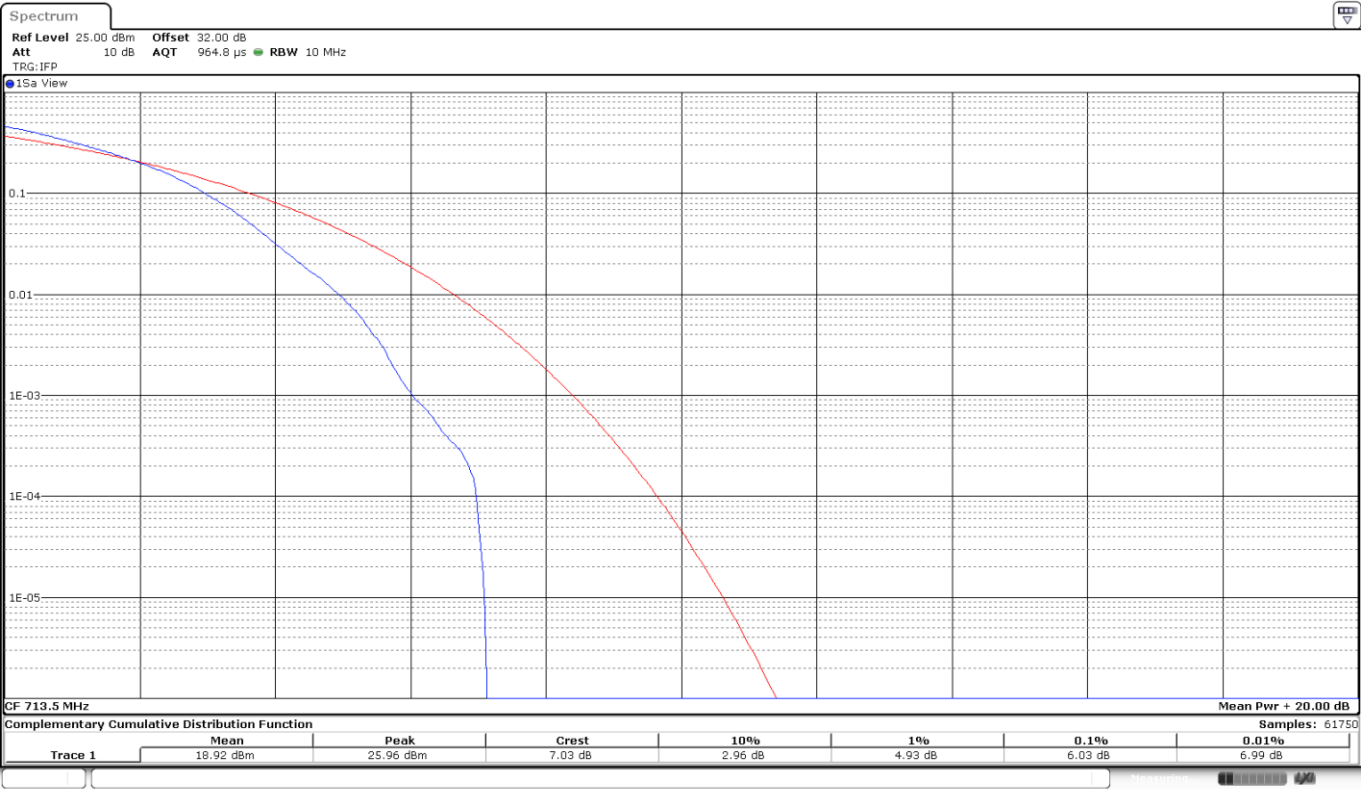
Low Channel:



Middle Channel:



High Channel:



16QAM	Low	Middle	High
PAPR (dB)	6.43	6.06	6.29

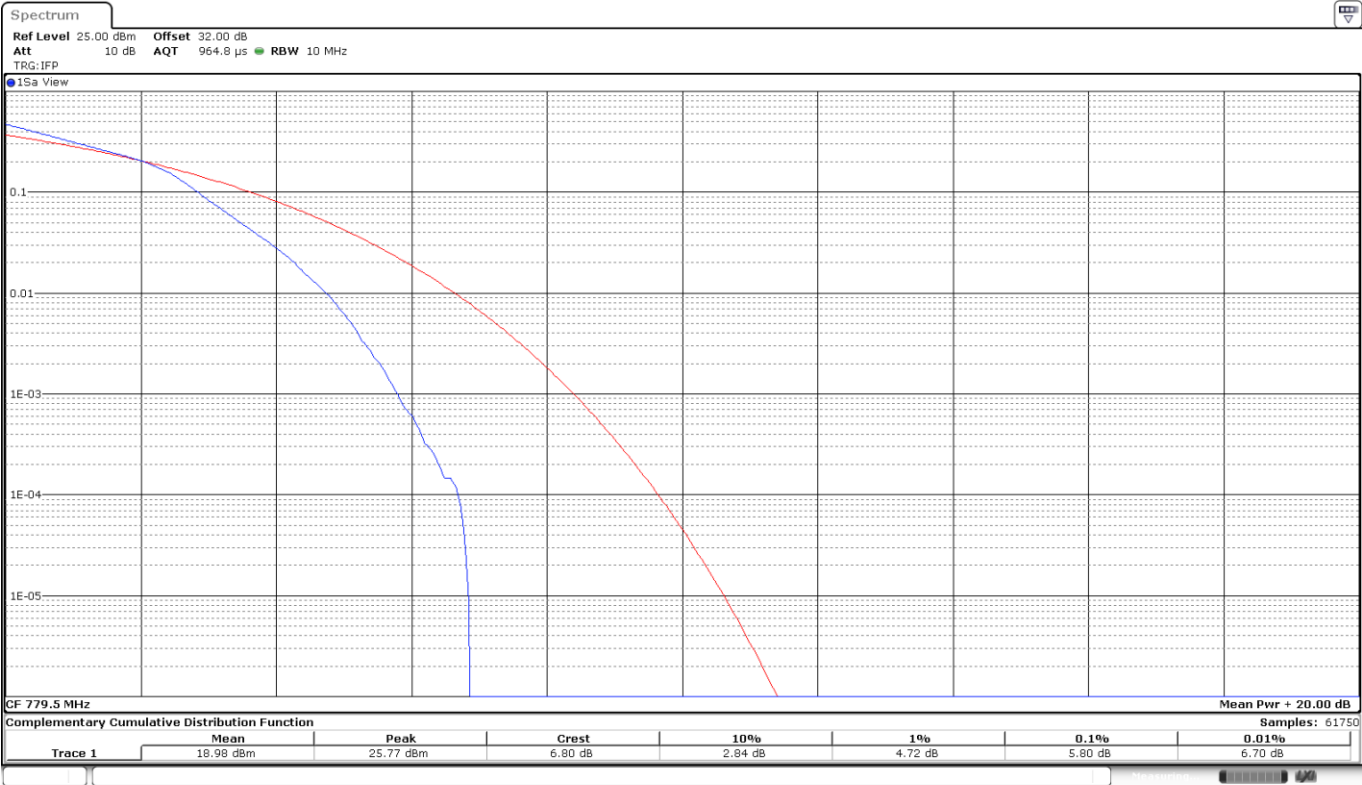
Verdict

Pass

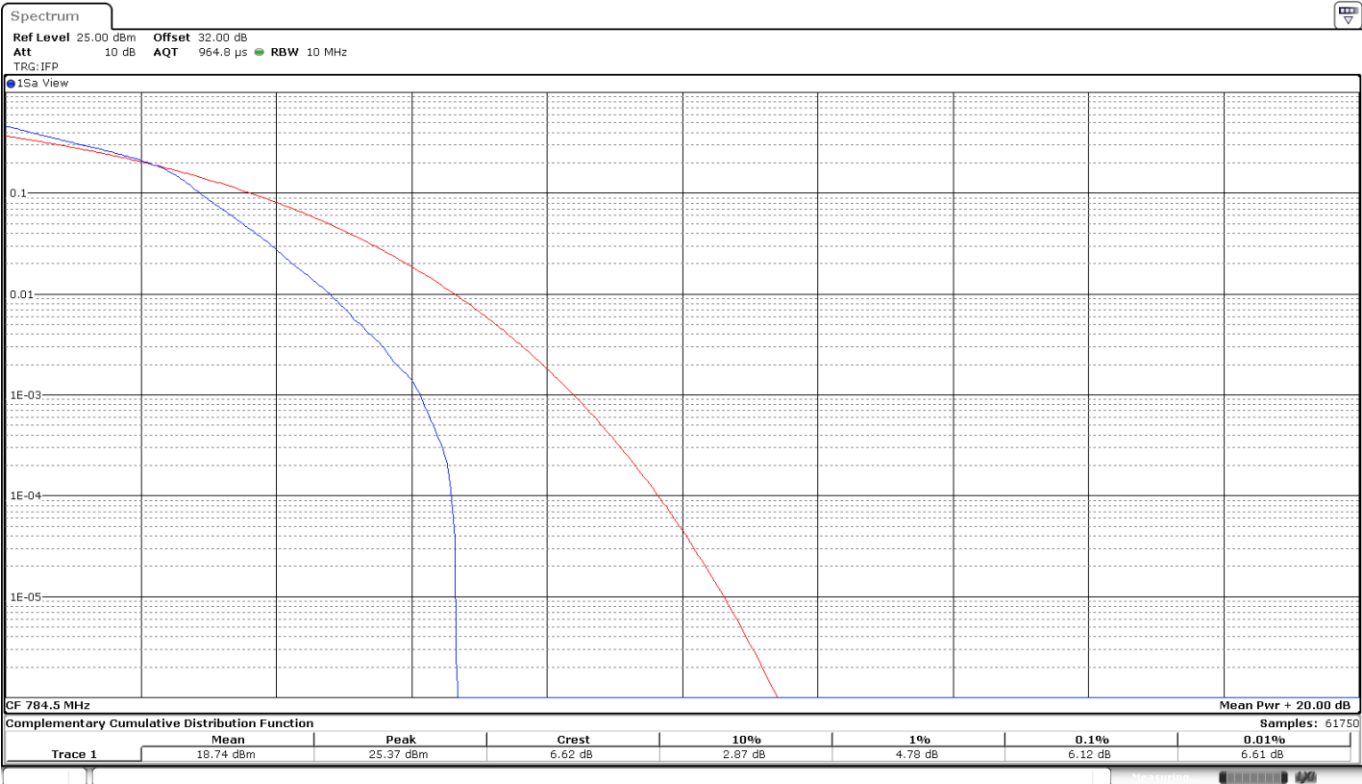
LTE Cat 1bis Band 13:

Worst-case of PAPR is BW= 5 MHz. High Channel. 16QAM. RB Size=12. RB Offset=6.

Low Channel:



High Channel:

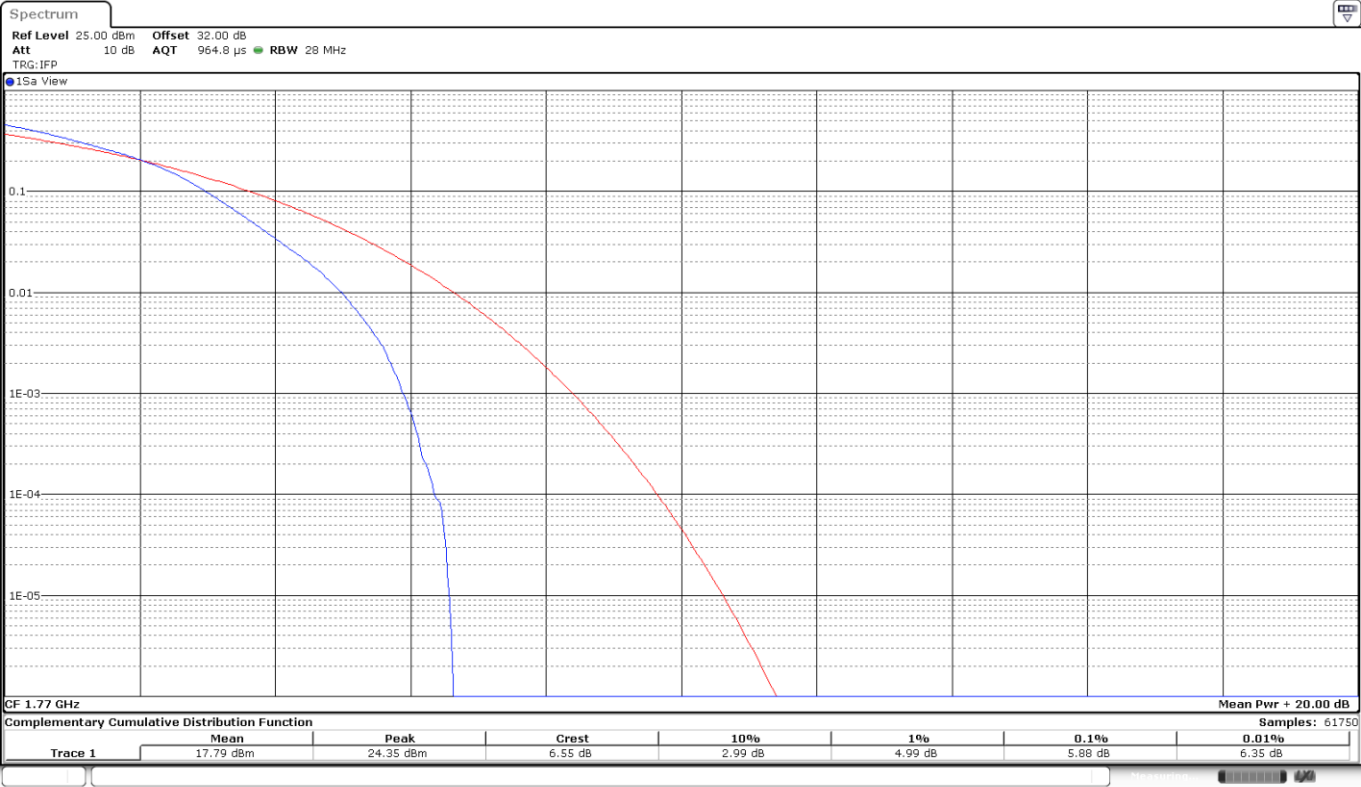


16QAM	Low	High
PAPR (dB)	5.86	6.12

Verdict

Pass

High Channel:



16QAM	Low	Middle	High
PAPR (dB)	6.72	6.55	6.35

Verdict

Pass

Frequency Stability

Limits

* FCC §27.54 & §2.1055. The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

* RSS-130. Clause 4.5 & 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 $+50^{\circ}\text{C}$. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to $+50^{\circ}\text{C}$.

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.

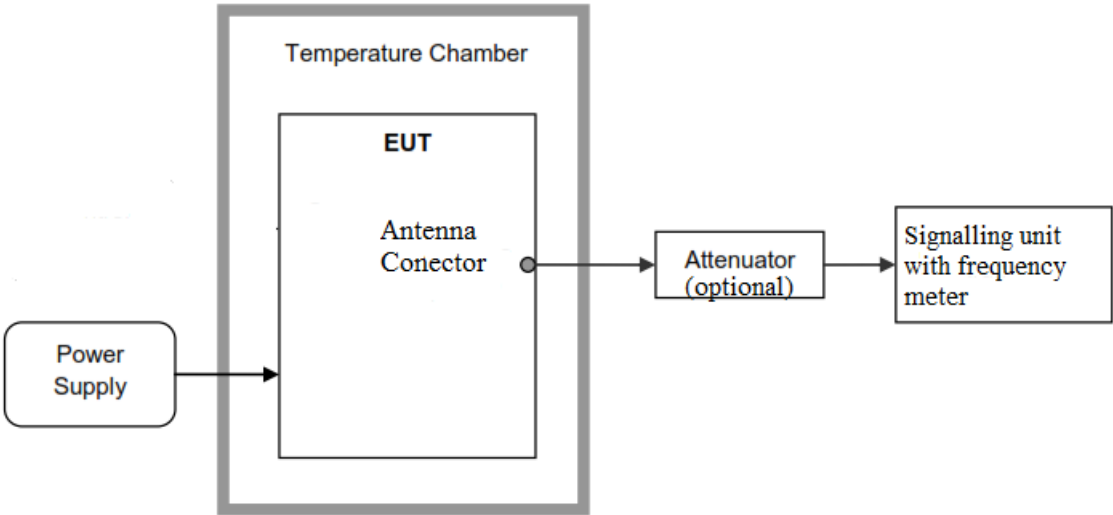
The worst case LTE mode for conducted power was used for the test.

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.

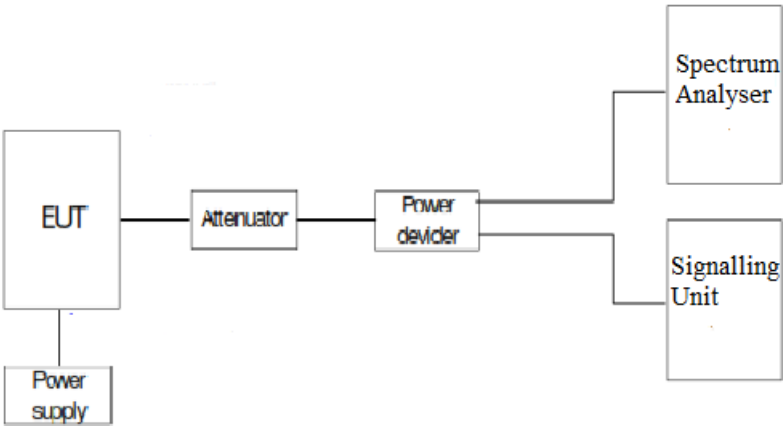
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance:



Reference points f_L and f_H :



Results

1. FREQUENCY TOLERANCE:

LTE Cat 1bis Band 12:

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

- Frequency stability over temperature variations:

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	-1.44	-0.002035336
+80 [#]	2.47	0.003491166
+70 [#]	-3.85	-0.005441696
+60 [#]	3.12	0.004409894
+50	-2.96	-0.004183746
+40	2.78	0.003929329
+30	-4.33	-0.006120141
+20	3.89	0.005498233
+10	-2.54	-0.003590106
0	2.65	0.003745583
-10	-3.12	-0.004409894
-20	4	0.00565371
-30	-2.87	-0.004056537
-40 [#]	3.21	0.004537102

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

- Frequency stability over voltage variations:

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	3.41	0.004819788
Vmin	3.3	-4.28	-0.00604947

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.

- **Frequency stability over temperature variations:**

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	1.96	0.002506394
+80 [#]	3.67	0.004693095
+70 [#]	-2.58	-0.003299233
+60 [#]	4.12	0.005268542
+50	-3.74	-0.004782609
+40	2.95	0.003772379
+30	-4	-0.00511509
+20	3.21	0.004104859
+10	-2.89	-0.003695652
0	4.87	0.006227621
-10	-3.33	-0.004258312
-20	2.46	0.00314578
-30	-2.77	-0.003542199
-40 [#]	4.56	0.005831202

- **Frequency stability over voltage variations:**

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	3.54	0.004526854
Vmin	3.3	-2.96	-0.003785166

LTE Cat 1bis Band 66:

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

- **Frequency stability over temperature variations:**

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.57	0.002045845
+80 [#]	-4.89	-0.002802292
+70 [#]	5.12	0.002934097
+60 [#]	-2.34	-0.001340974
+50	4.76	0.002727794
+40	-5.21	-0.002985673
+30	2.85	0.001633238
+20	-6.1	-0.003495702
+10	3.98	0.002280802
0	-3.47	-0.001988539
-10	5.12	0.002934097
-20	-2.65	-0.001518625
-30	4.32	0.002475645
-40 [#]	-3.78	-0.002166189

- **Frequency stability over voltage variations:**

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.5	4.21	0.002412607
Vmin	3.3	-3.28	-0.001879656

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)	699.097096
f_H (MHz)	715.908104

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

f_L (MHz)	777.092395
f_H (MHz)	786.898705

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

f_L (MHz)	1710.148844
f_H (MHz)	1779.849156

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

FCC §2.1047.

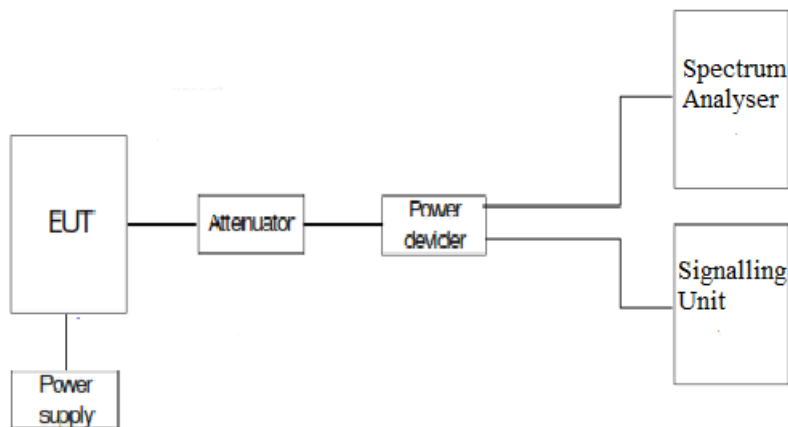
RSS-130. 4.2: Equipment certified under this standard shall employ digital modulation.

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

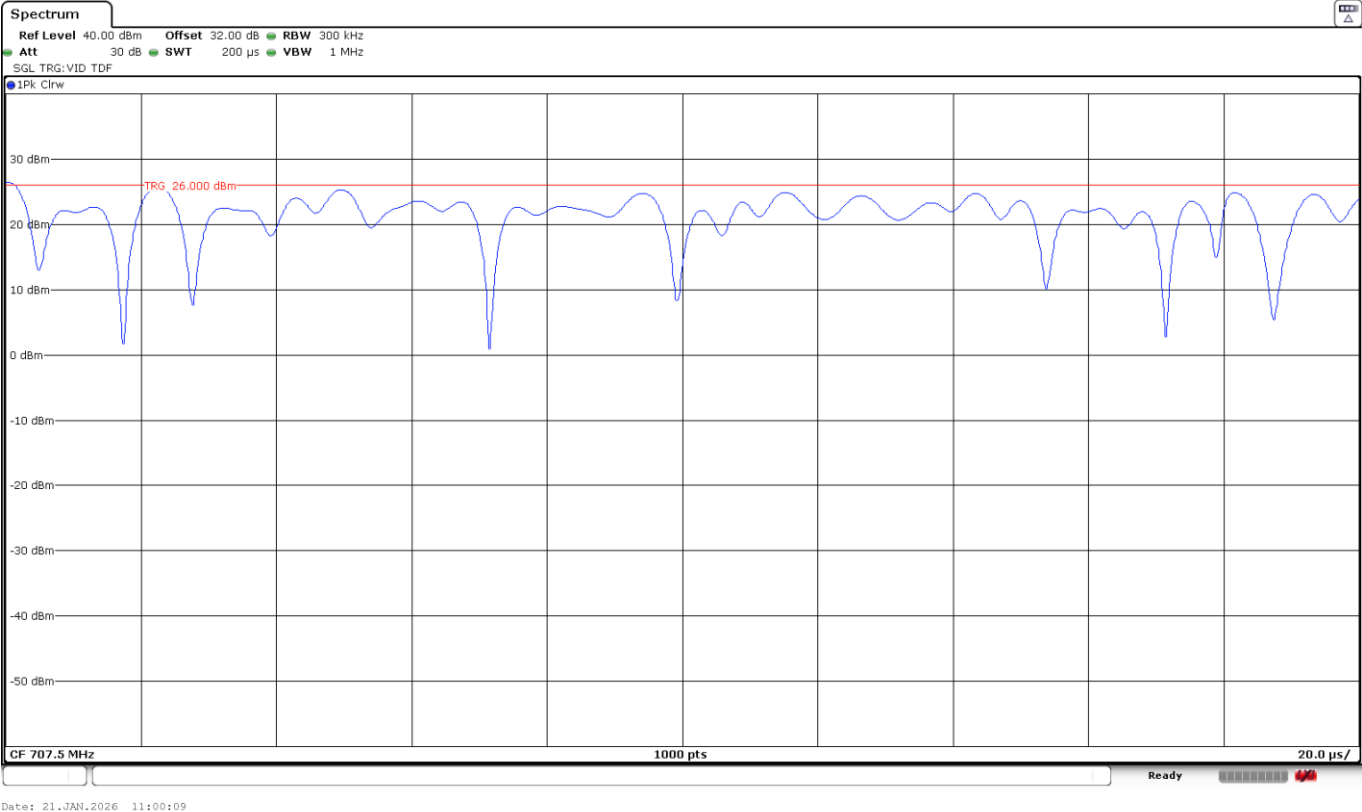


Results

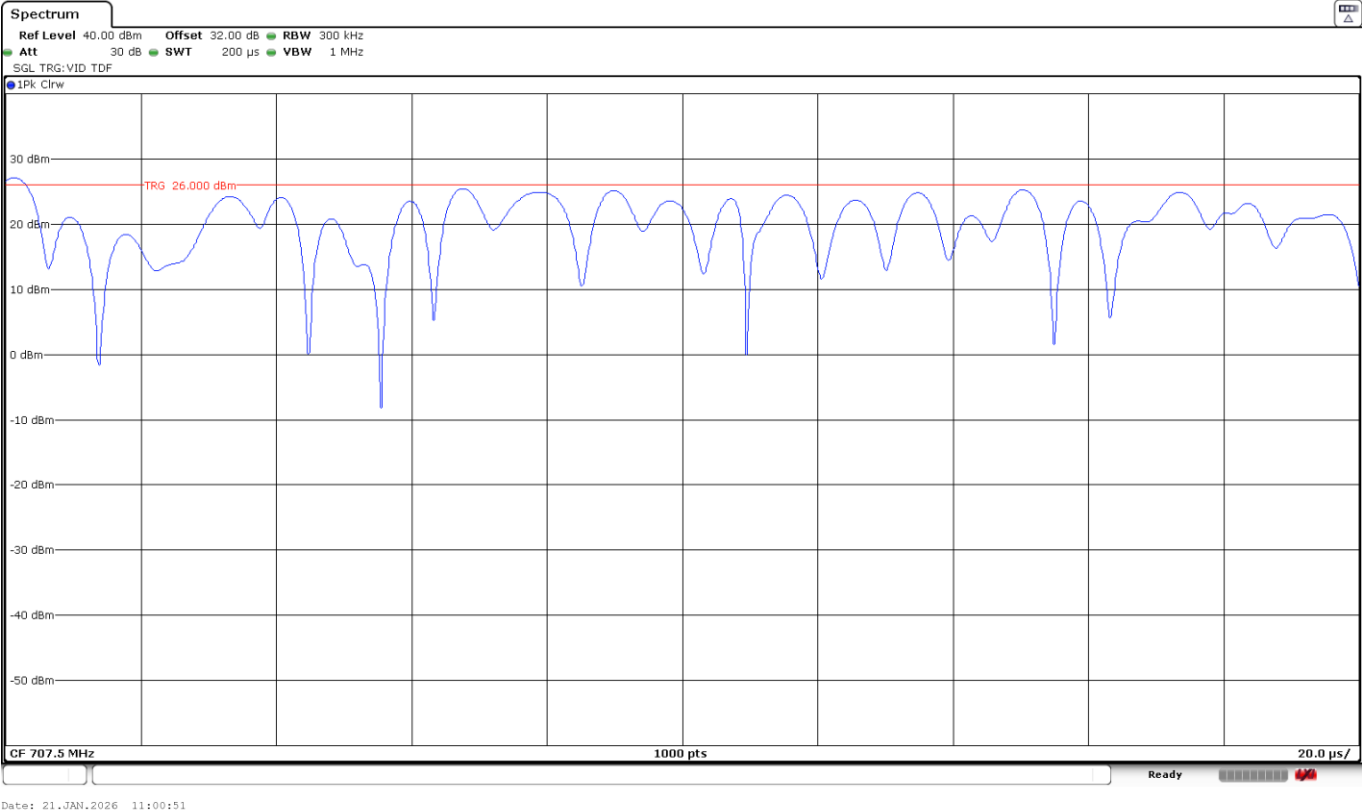
The following plots show the modulation schemes in the EUT.

LTE Cat 1bis Band 12:

QPSK. BW=5 MHz.

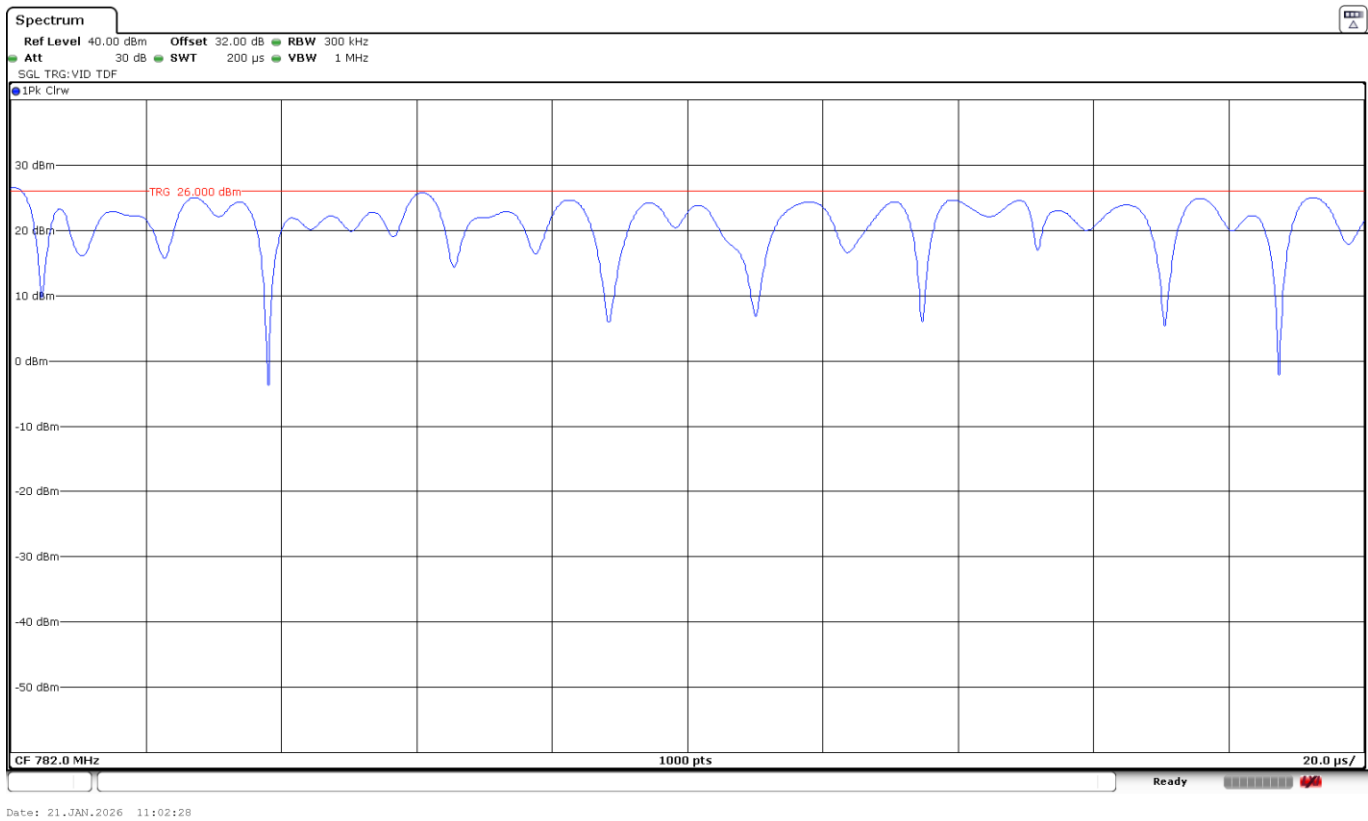


16QAM. BW=5 MHz.

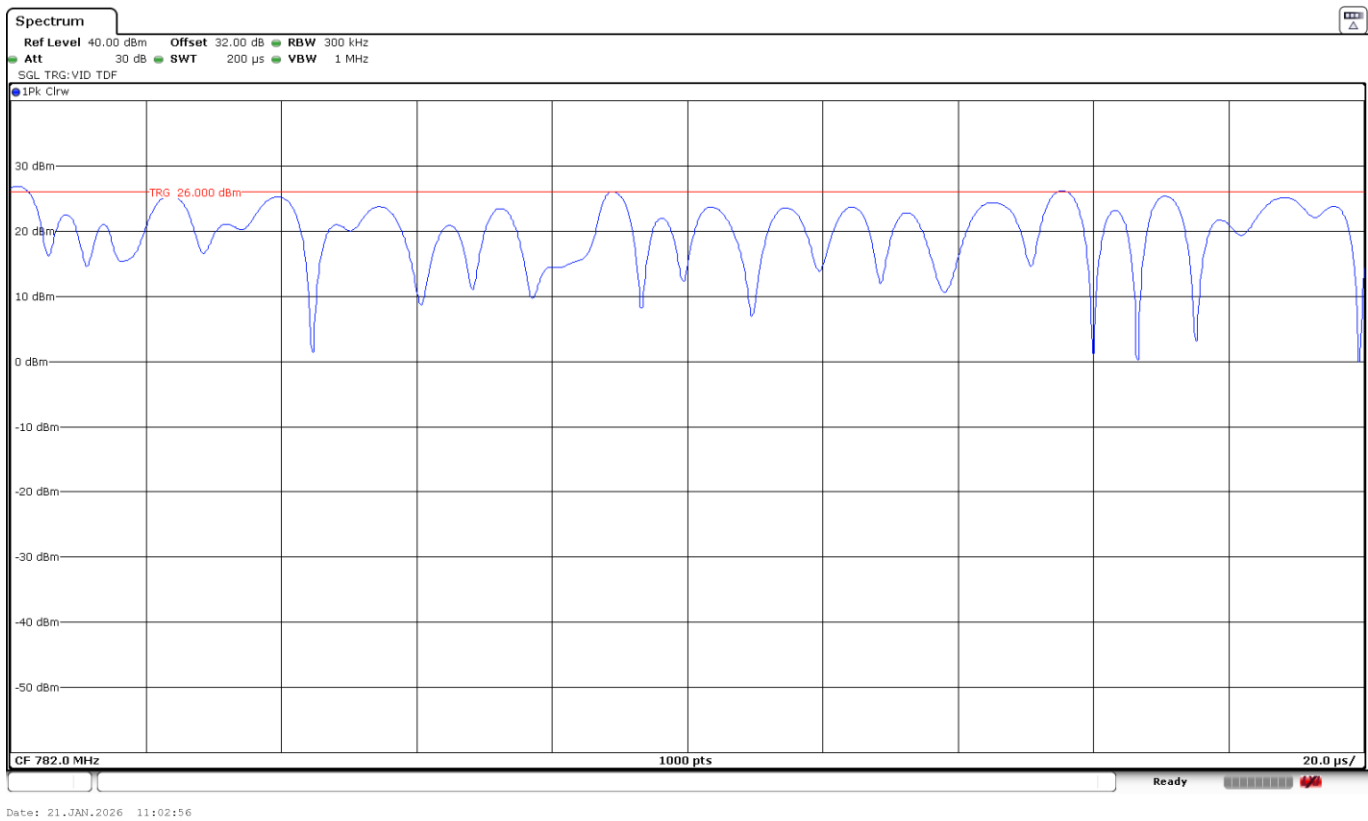


LTE Cat 1bis Band 13:

QPSK. BW=5 MHz.

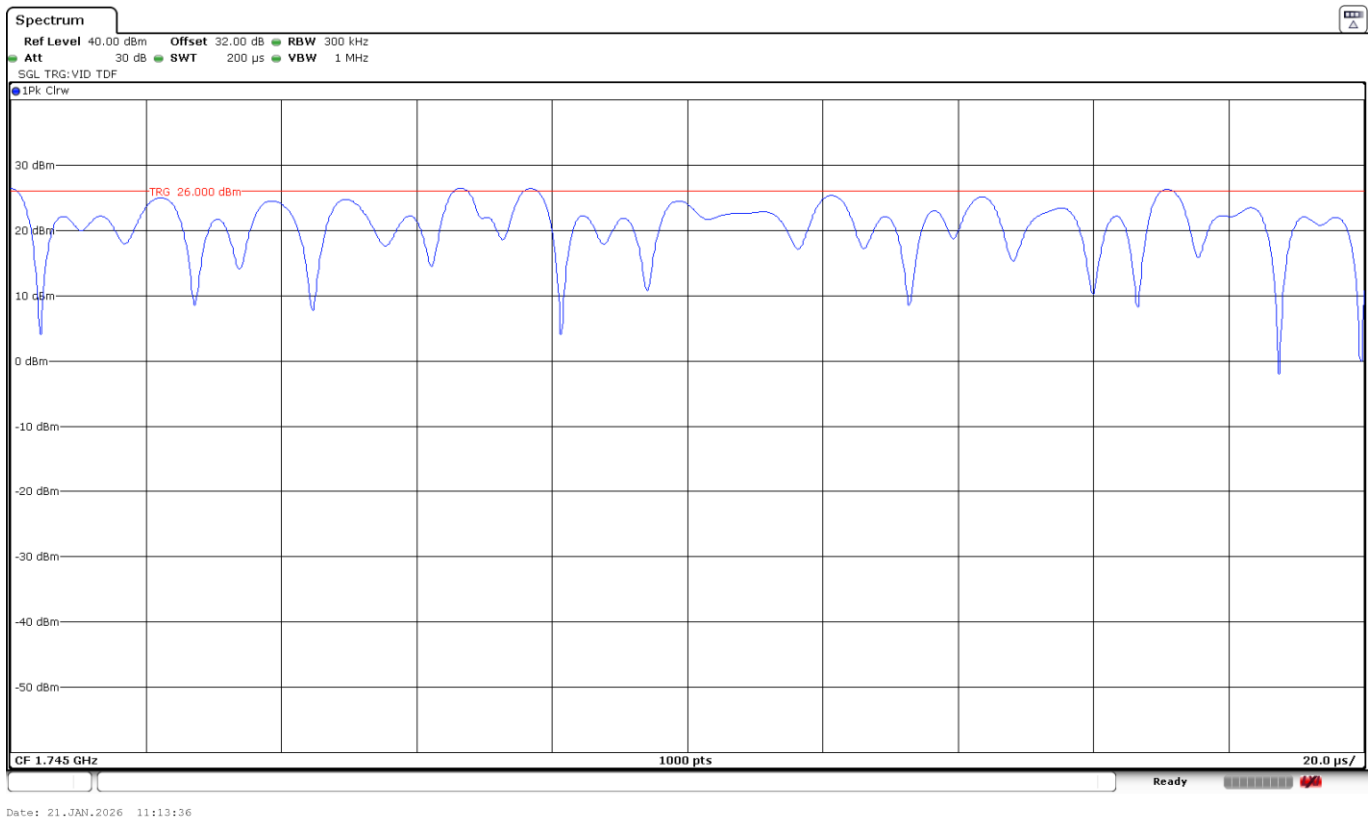


16QAM. BW=5 MHz.

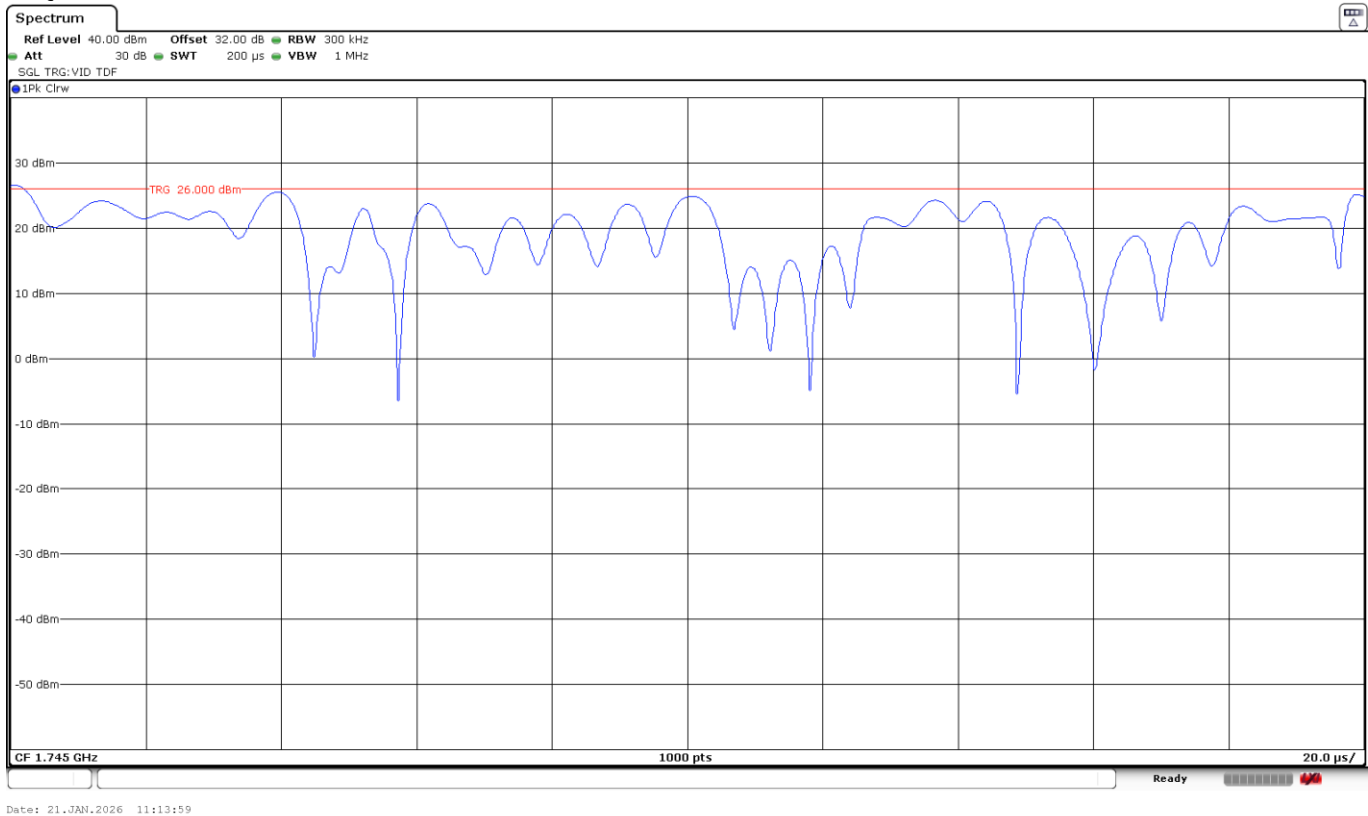


LTE Cat 1bis Band 66:

QPSK. BW=5 MHz.



16QAM. BW=5 MHz.



Occupied Bandwidth

Limits

FCC §2.1049: Measurements required: Occupied bandwidth.

RSS-Gen 6.7. The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

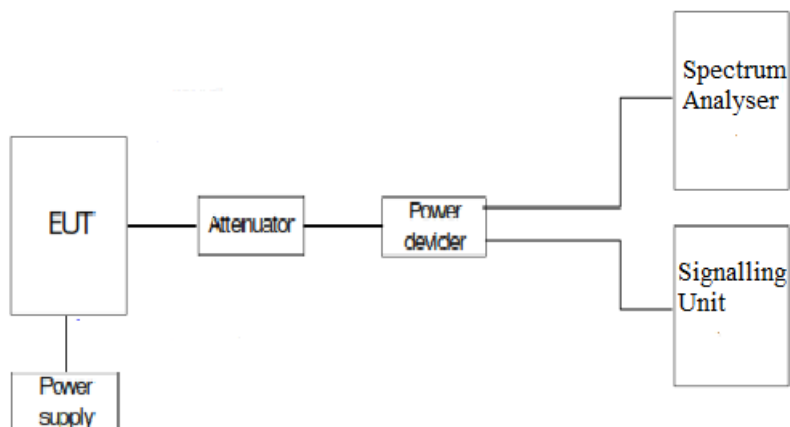
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 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 all Resource Blocks (RB) offset 0 regardless the Bandwidth selected.

LTE Cat 1bis Band 12:

LTE Cat 1bis Band 12. BW=5 MHz. QPSK. RB Size 6.

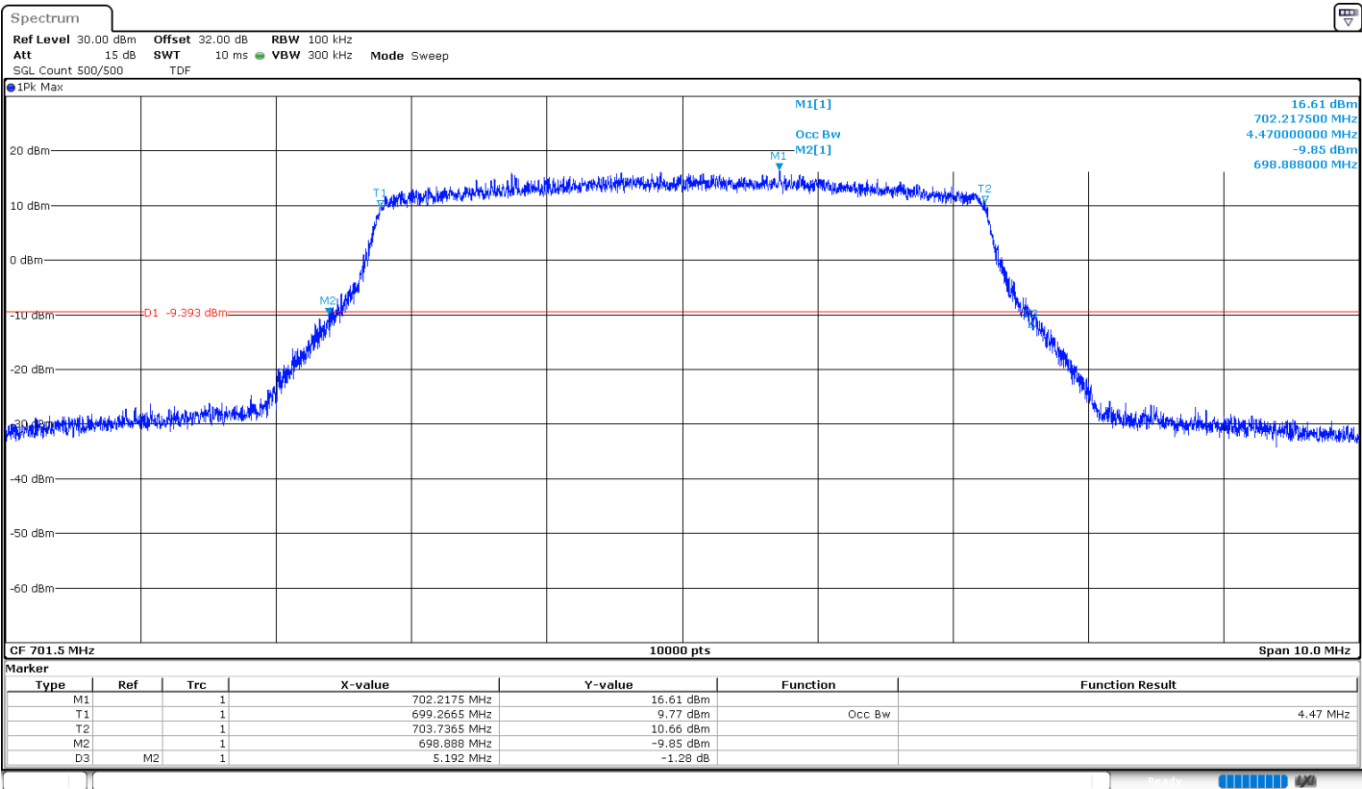
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.470	4.470	4.465
-26 dBc Bandwidth (MHz)	5.192	5.193	5.139
Measurement uncertainty (kHz)	<±3.75		

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

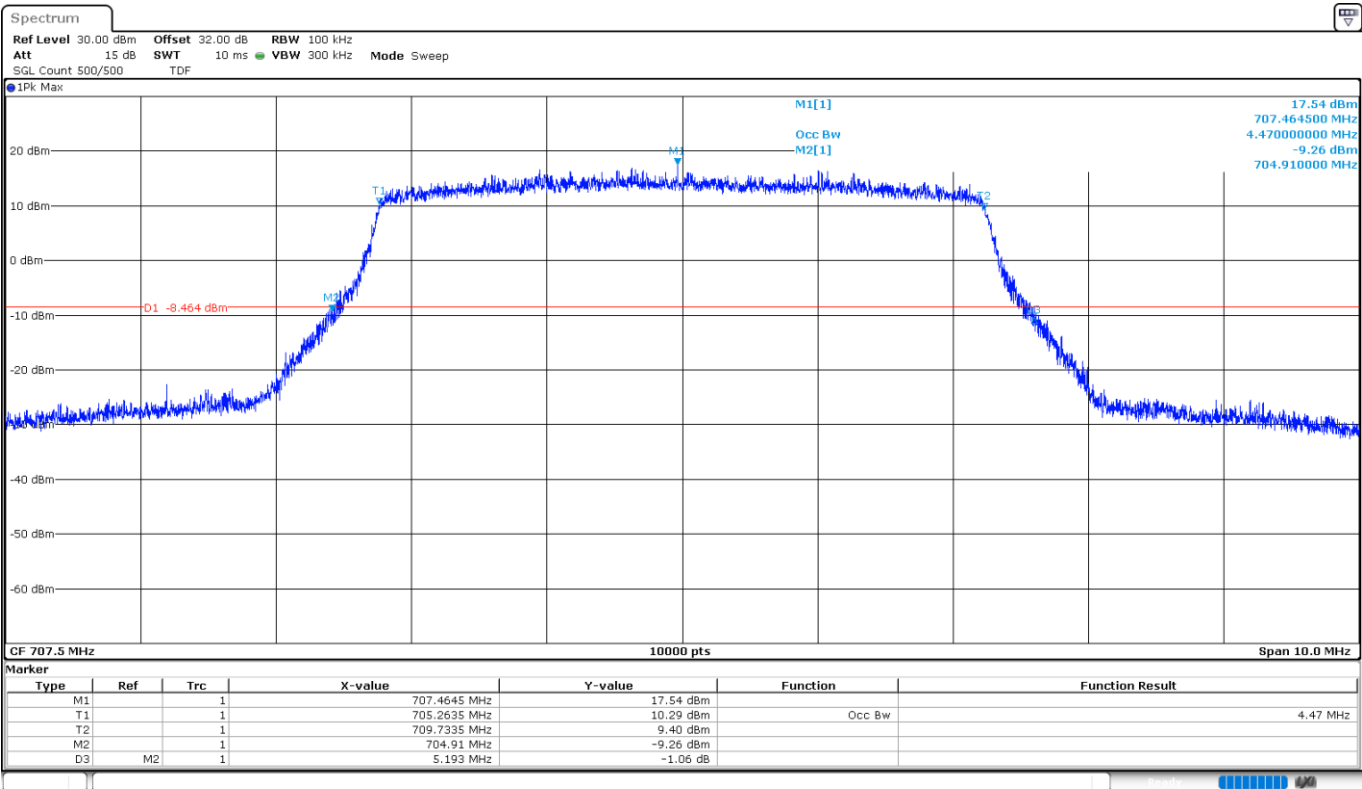
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.463	4.466	4.466
-26 dBc Bandwidth (MHz)	5.165	5.244	5.181
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=5 MHz. QPSK. RB Size 6.

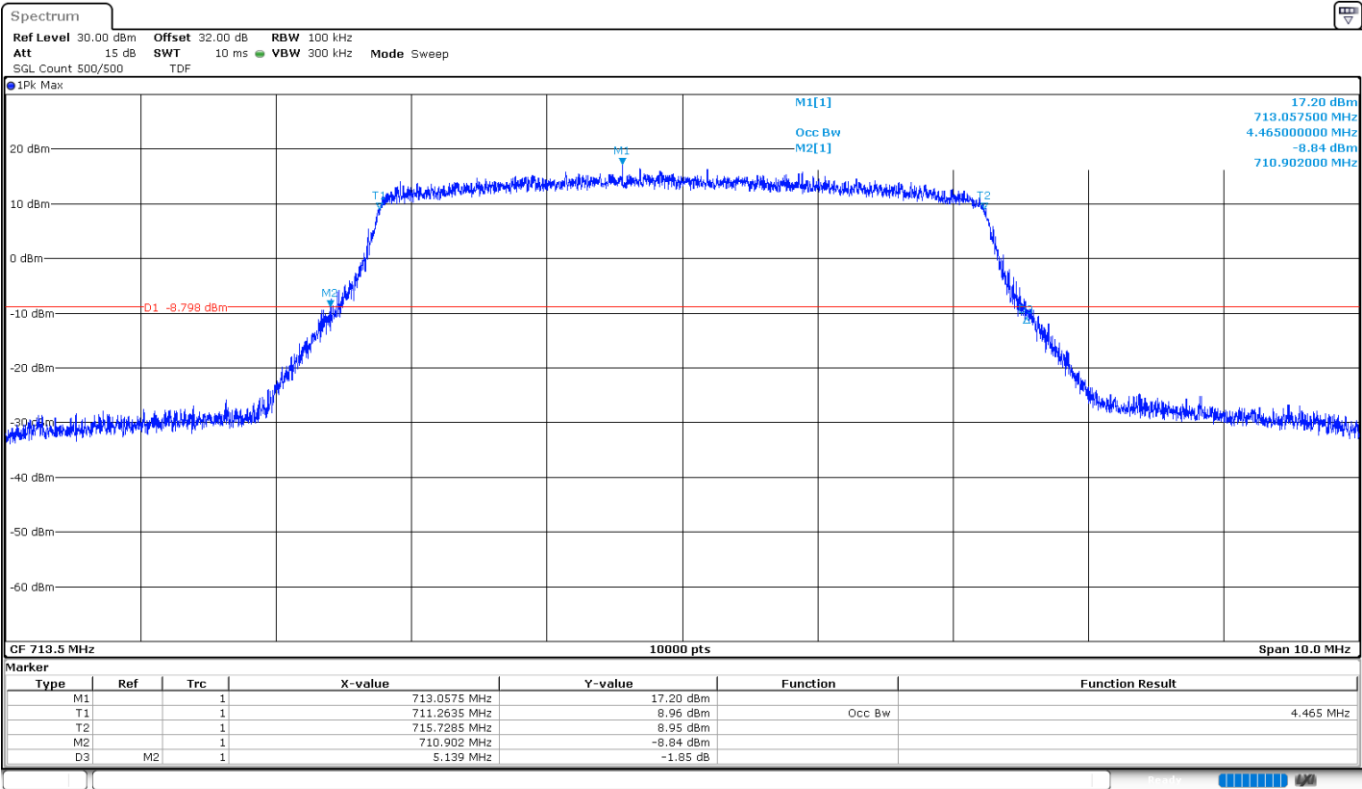
Low Channel:



Middle Channel:

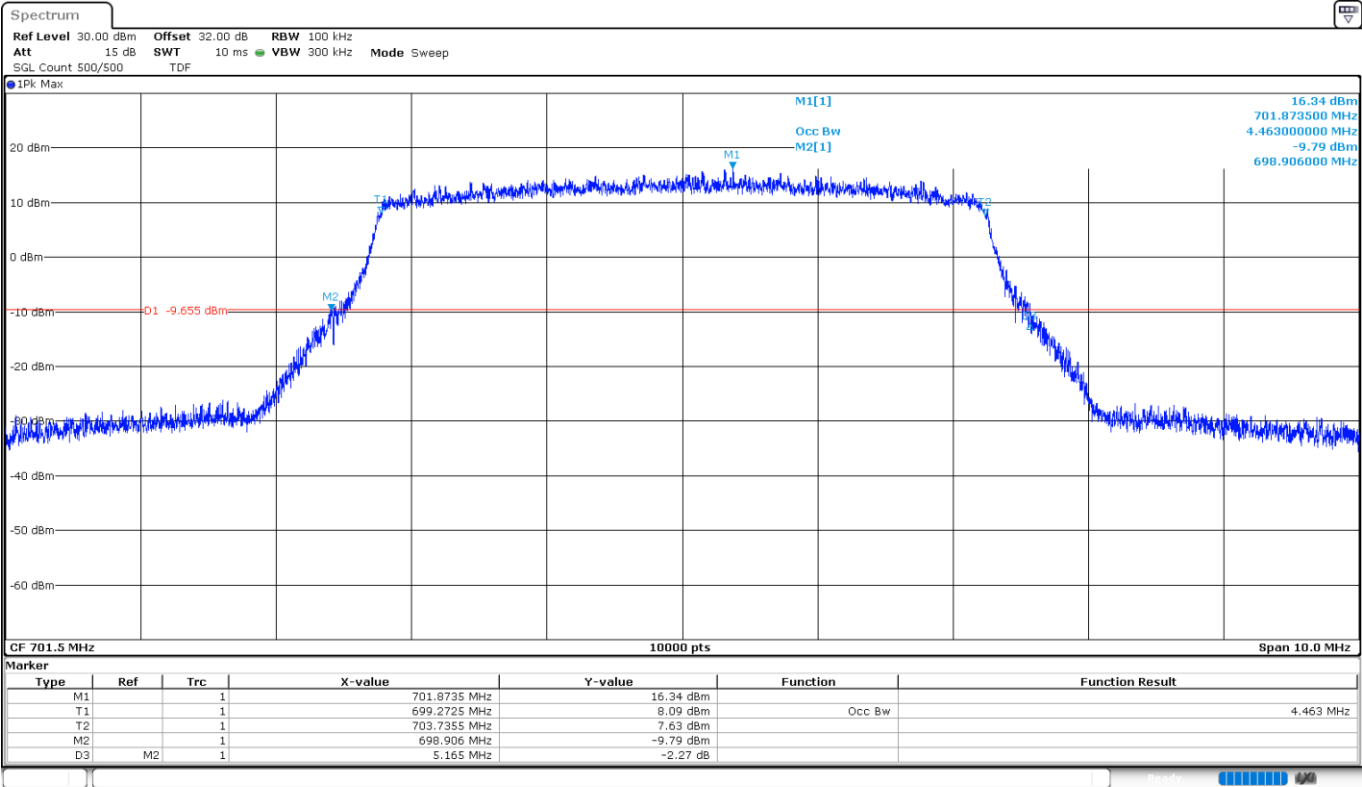


High Channel:

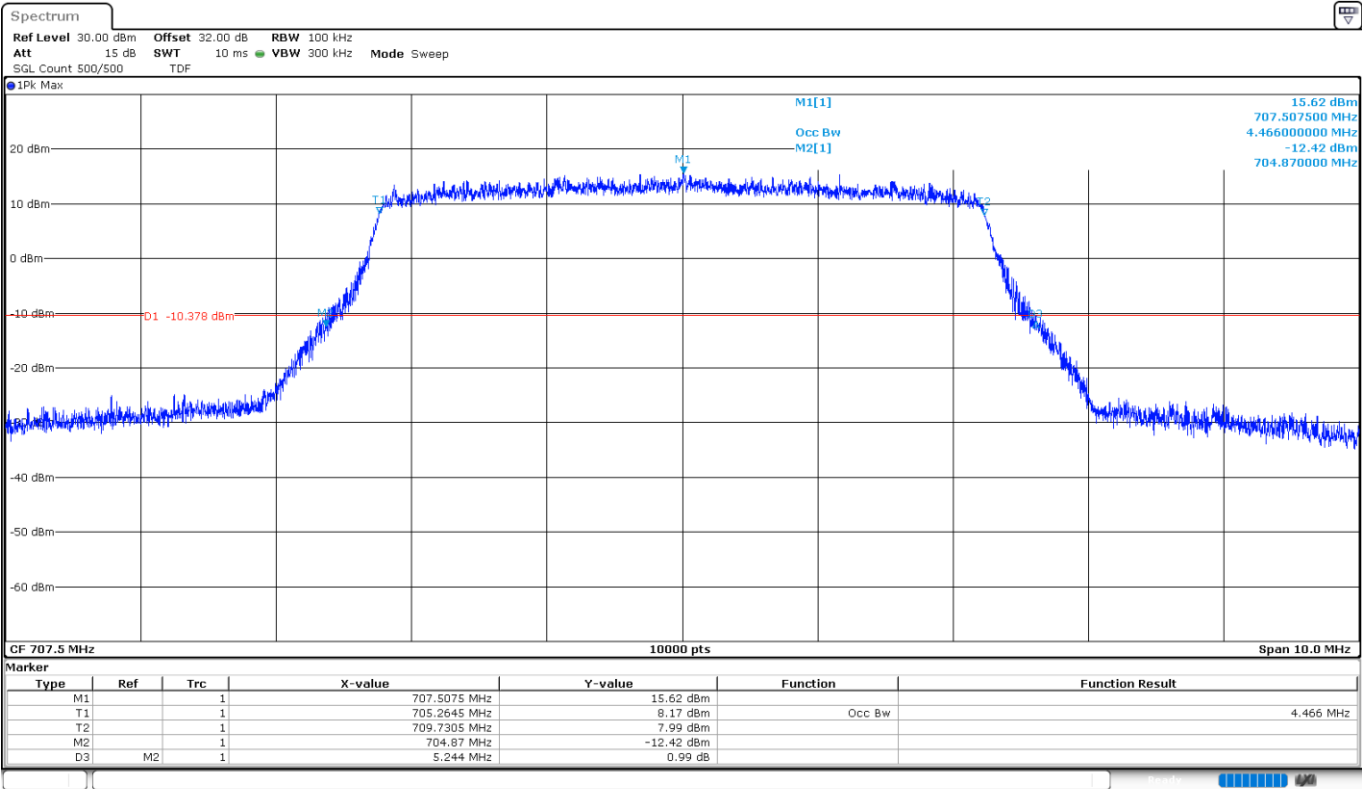


LTE Cat 1bis Band 12. BW=5 MHz. 16QAM. RB Size 5.

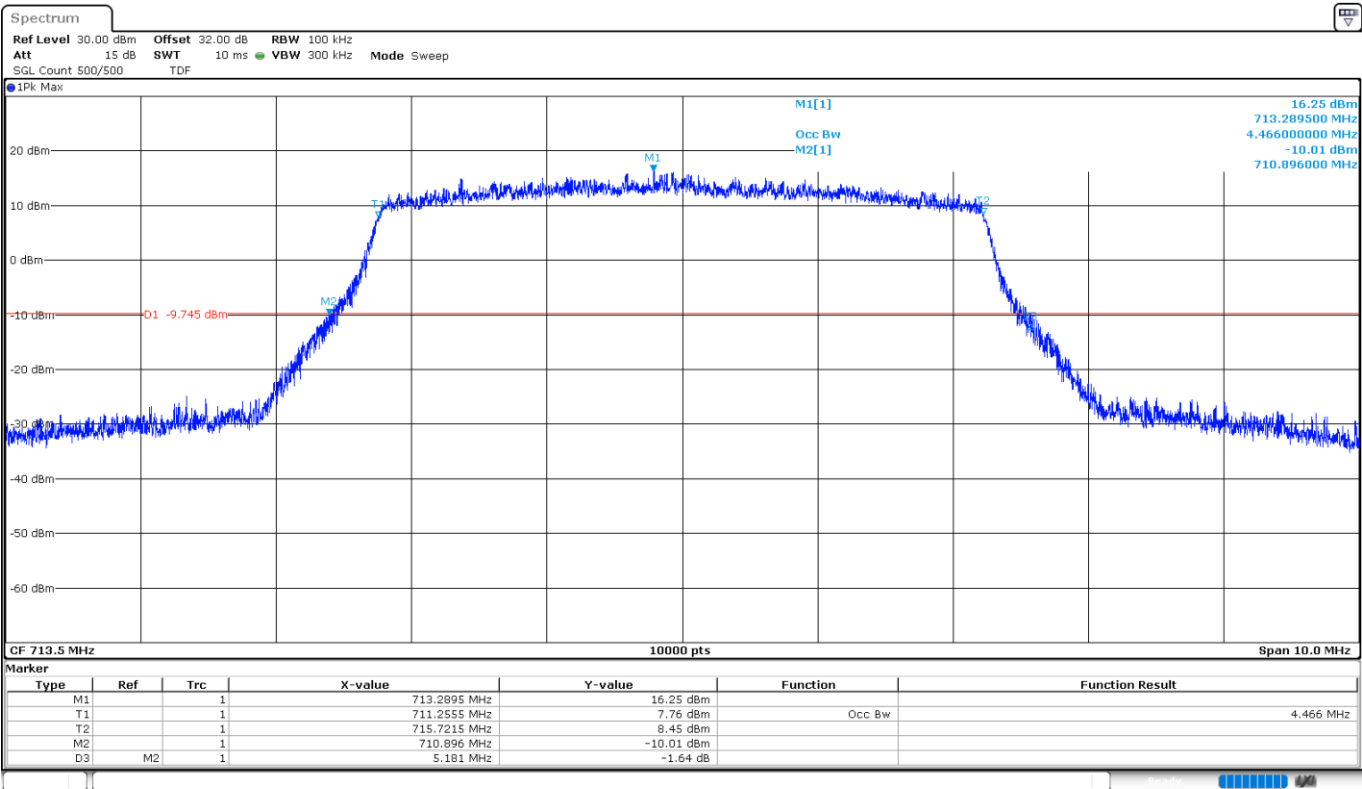
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 12. BW=10 MHz. QPSK. RB Size 6.

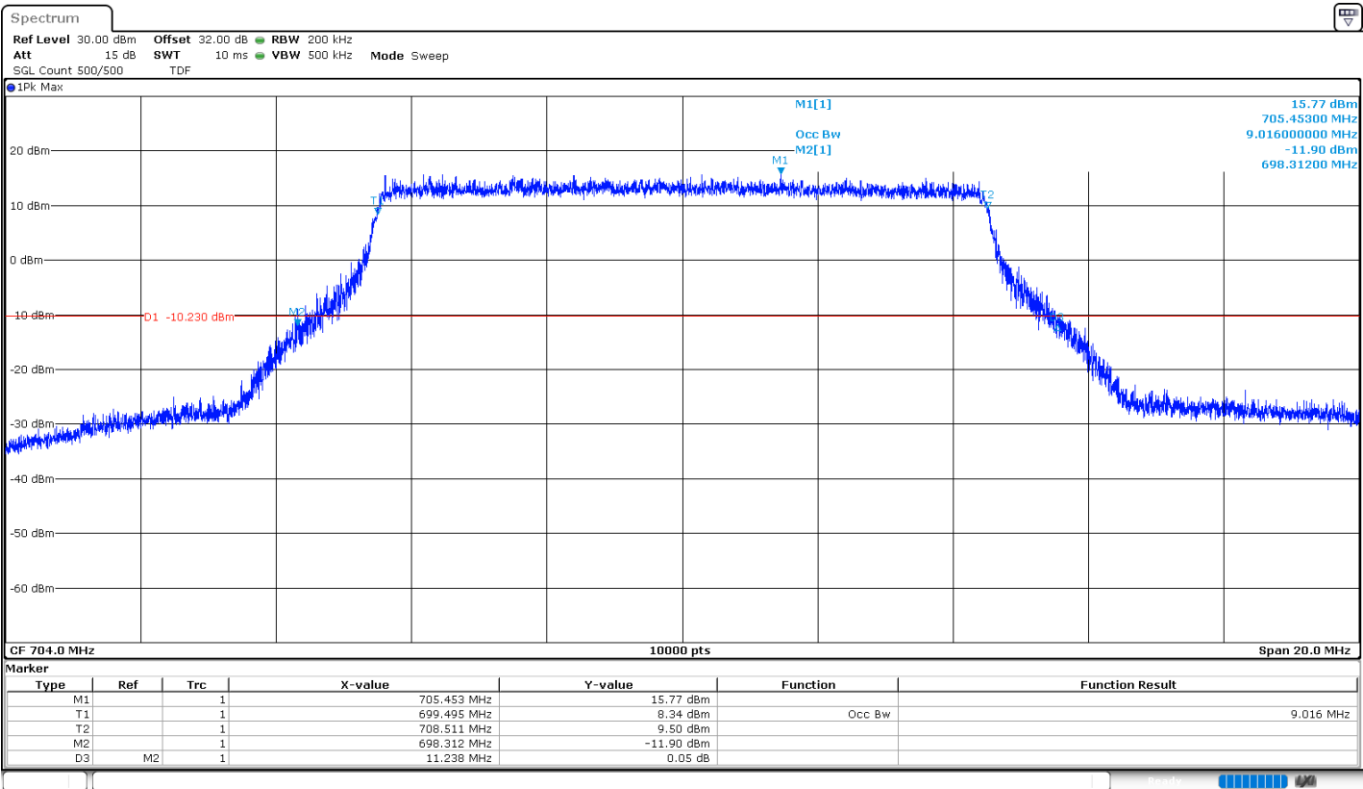
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	9.016	9.042	9.020
-26 dBc Bandwidth (MHz)	11.238	11.100	11.238
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=10 MHz. 16QAM. RB Size 5.

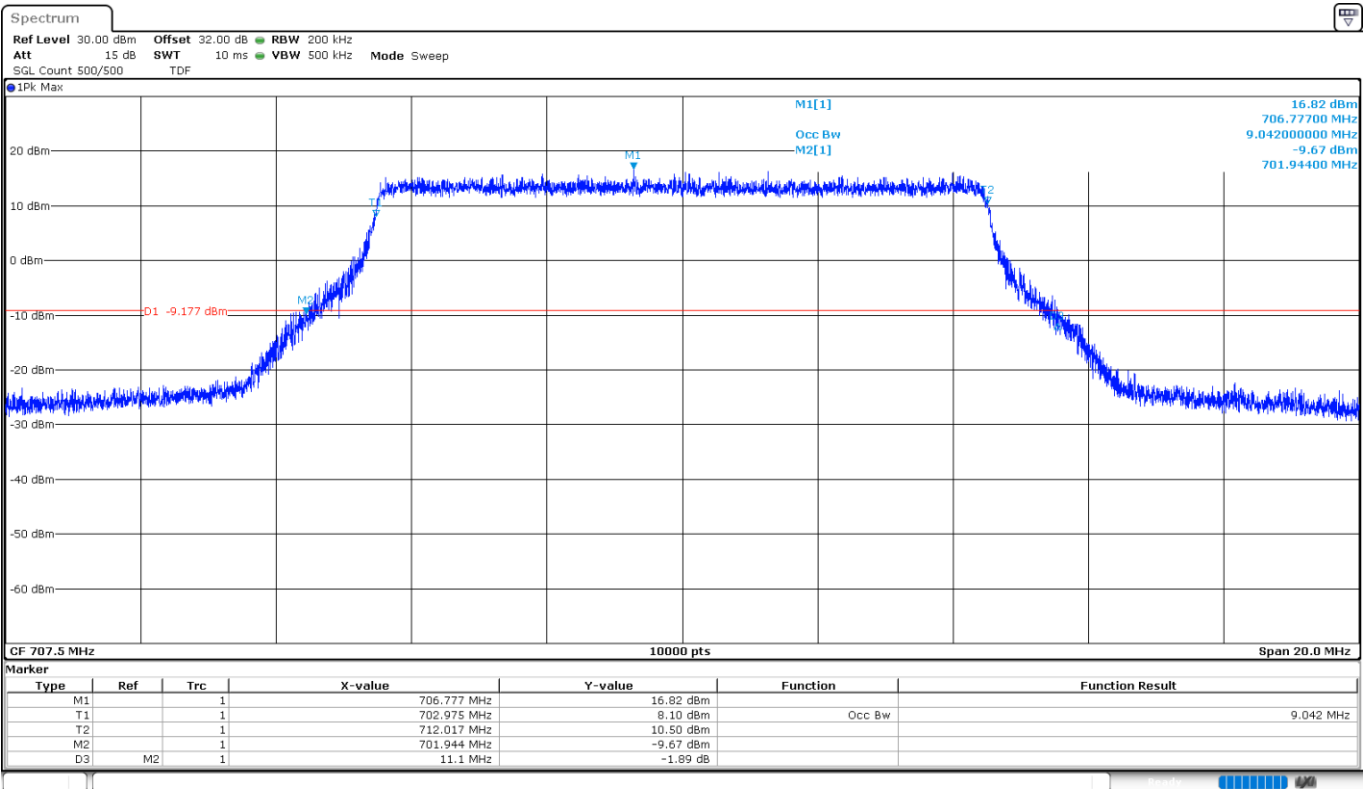
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.646	4.620	4.614
-26 dBc Bandwidth (MHz)	7.066	6.782	6.616
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 12. BW=10 MHz. QPSK. RB Size 6.

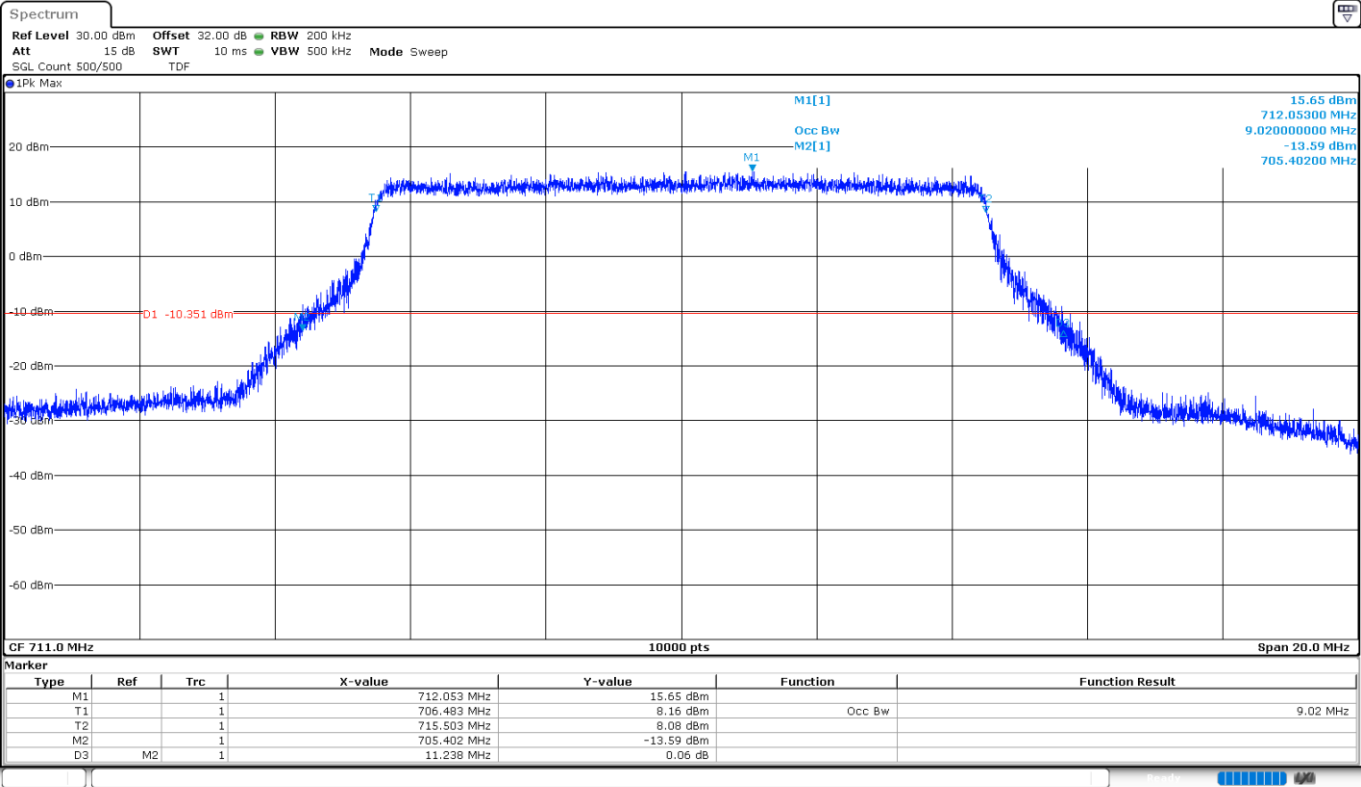
Low Channel:



Middle Channel:

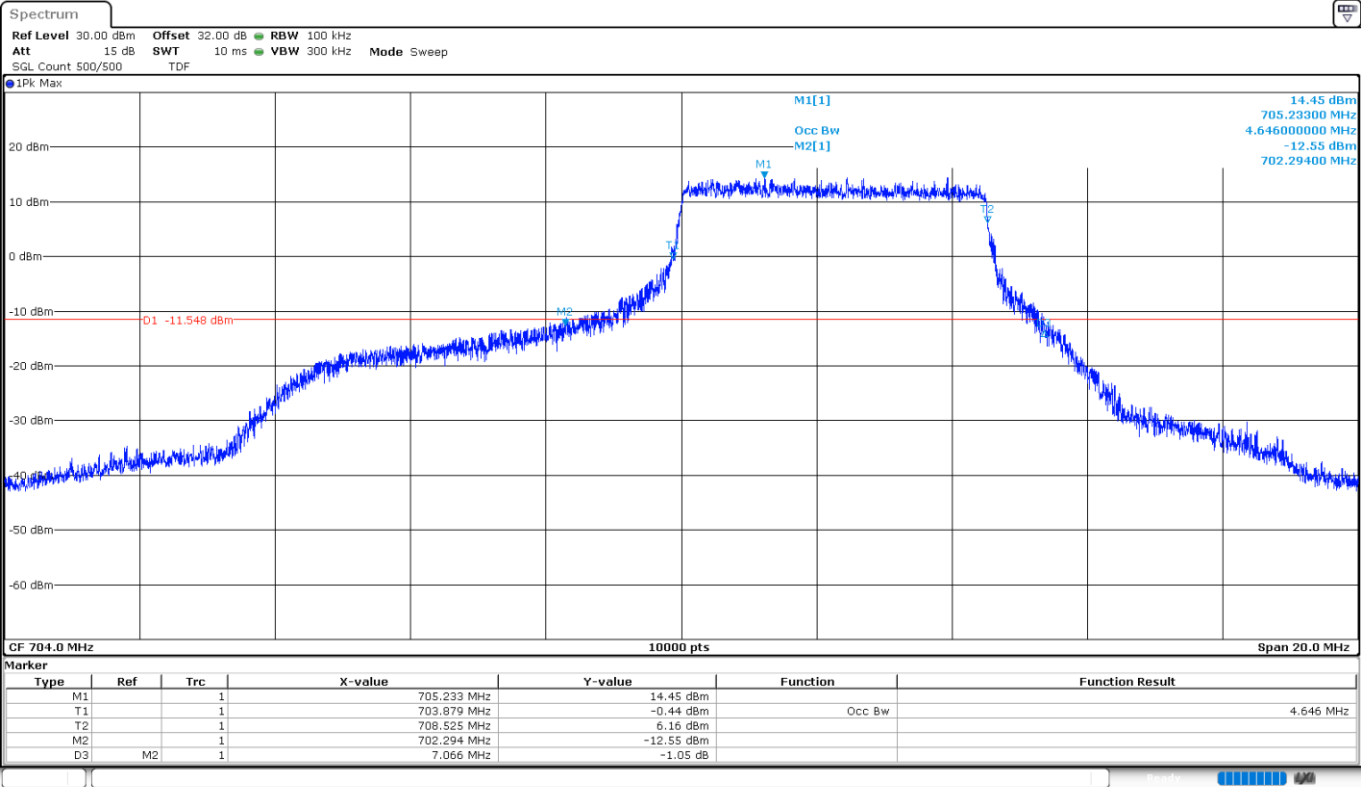


High Channel:

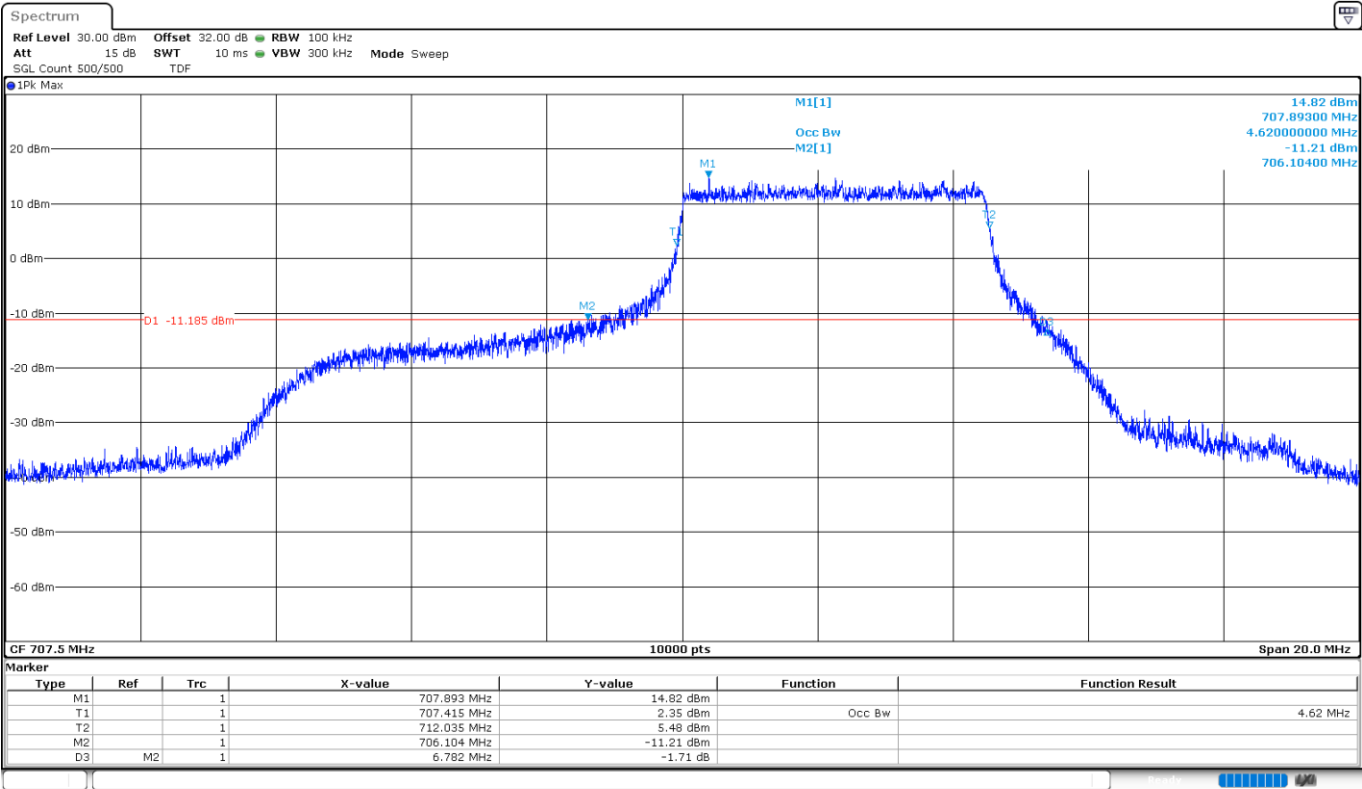


LTE Cat 1bis Band 12. BW=10 MHz. 16QAM. RB Size 5.

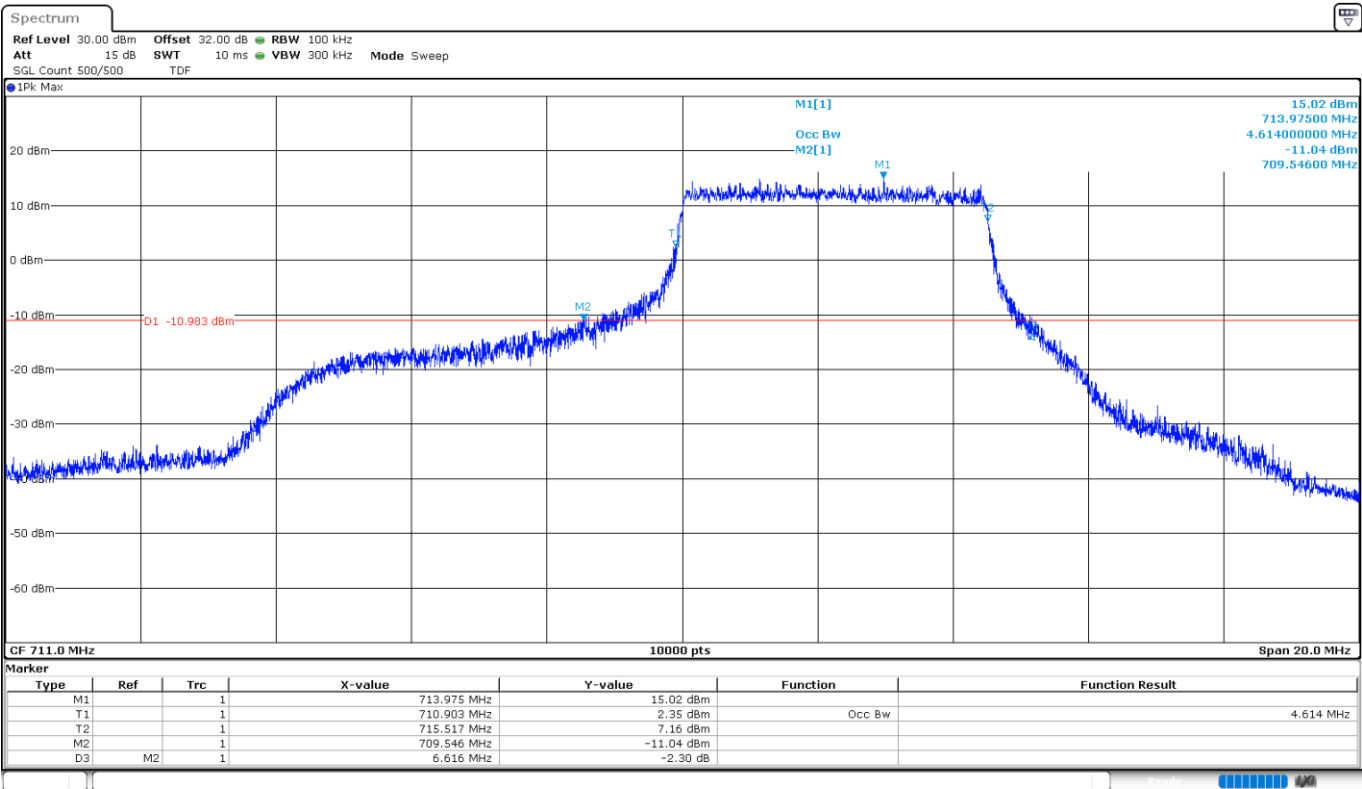
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 13:

LTE Cat 1bis Band 13. BW=5 MHz. QPSK. RB Size 6.

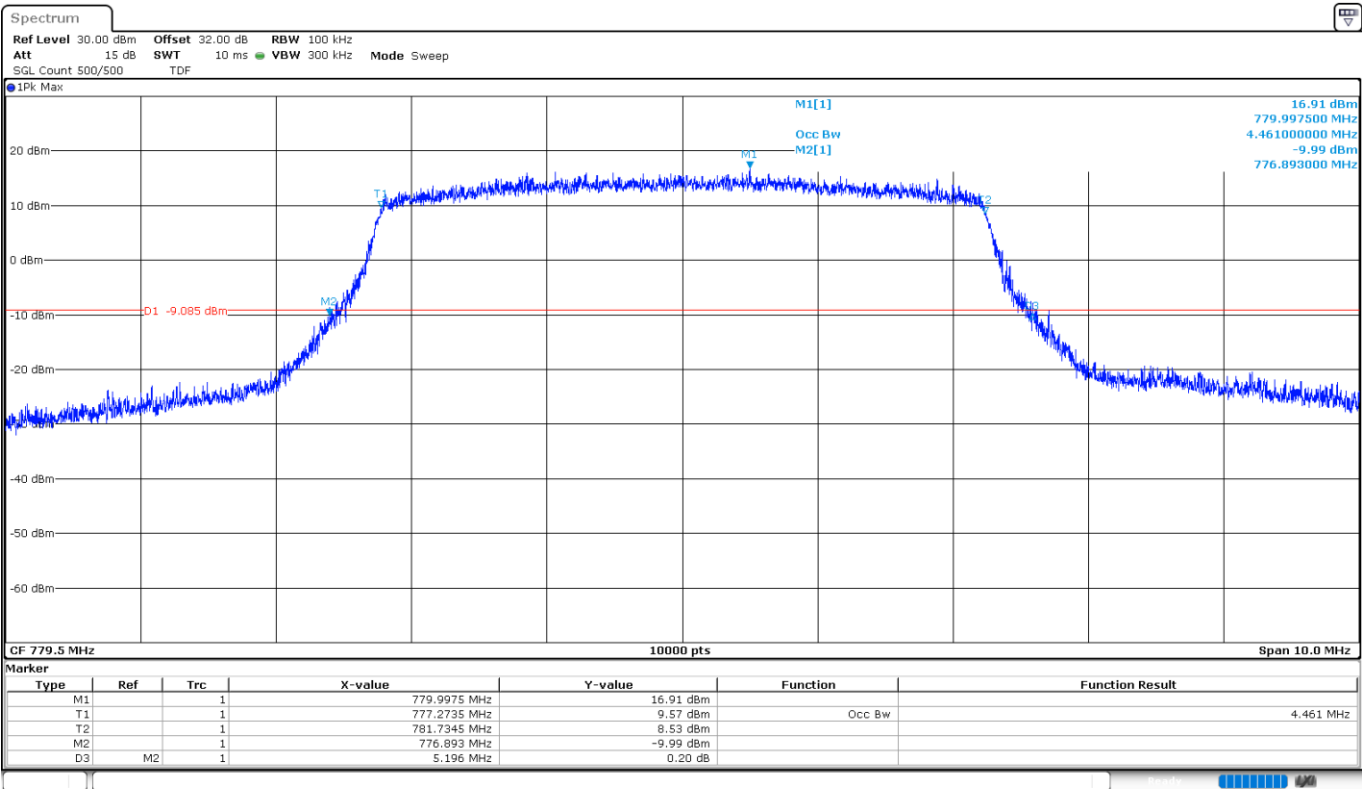
Channel	Low	High
99% Occupied Bandwidth (MHz)	4.461	4.479
-26 dBc Bandwidth (MHz)	5.196	5.196
Measurement uncertainty (kHz)	<±3.75	

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

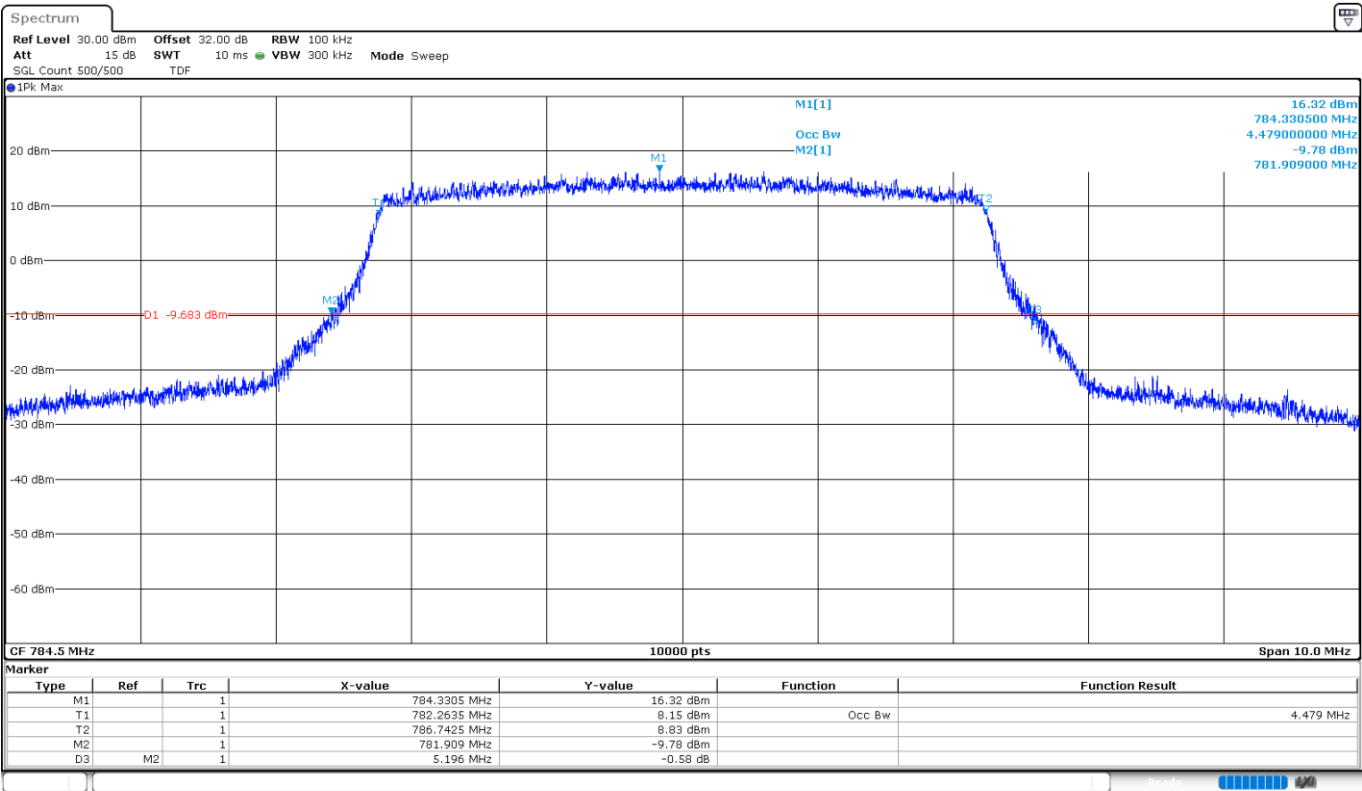
Channel	Low	High
99% Occupied Bandwidth (MHz)	4.469	4.465
-26 dBc Bandwidth (MHz)	5.146	5.233
Measurement uncertainty (kHz)	<±3.75	

LTE Cat 1bis Band 13. BW=5 MHz. QPSK. RB Size 6.

Low Channel:

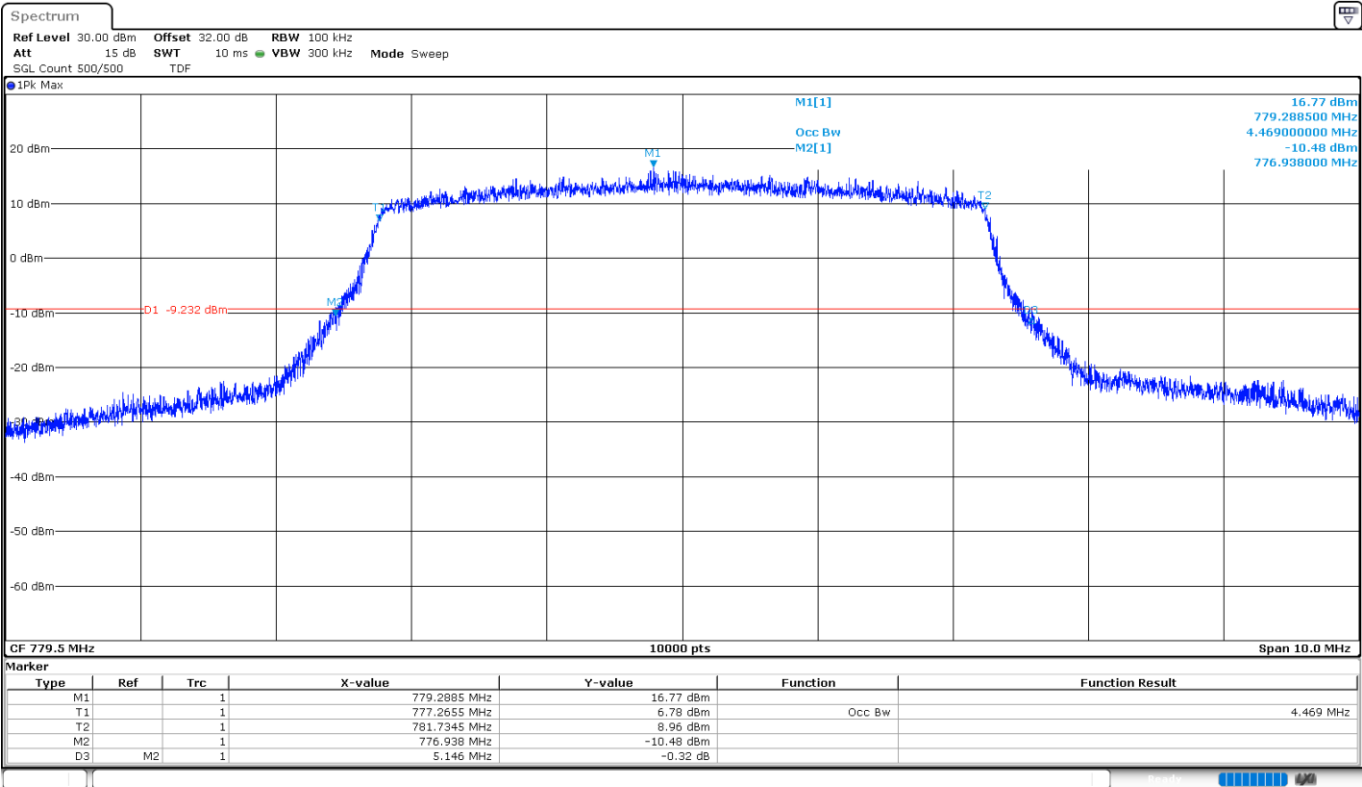


High Channel:

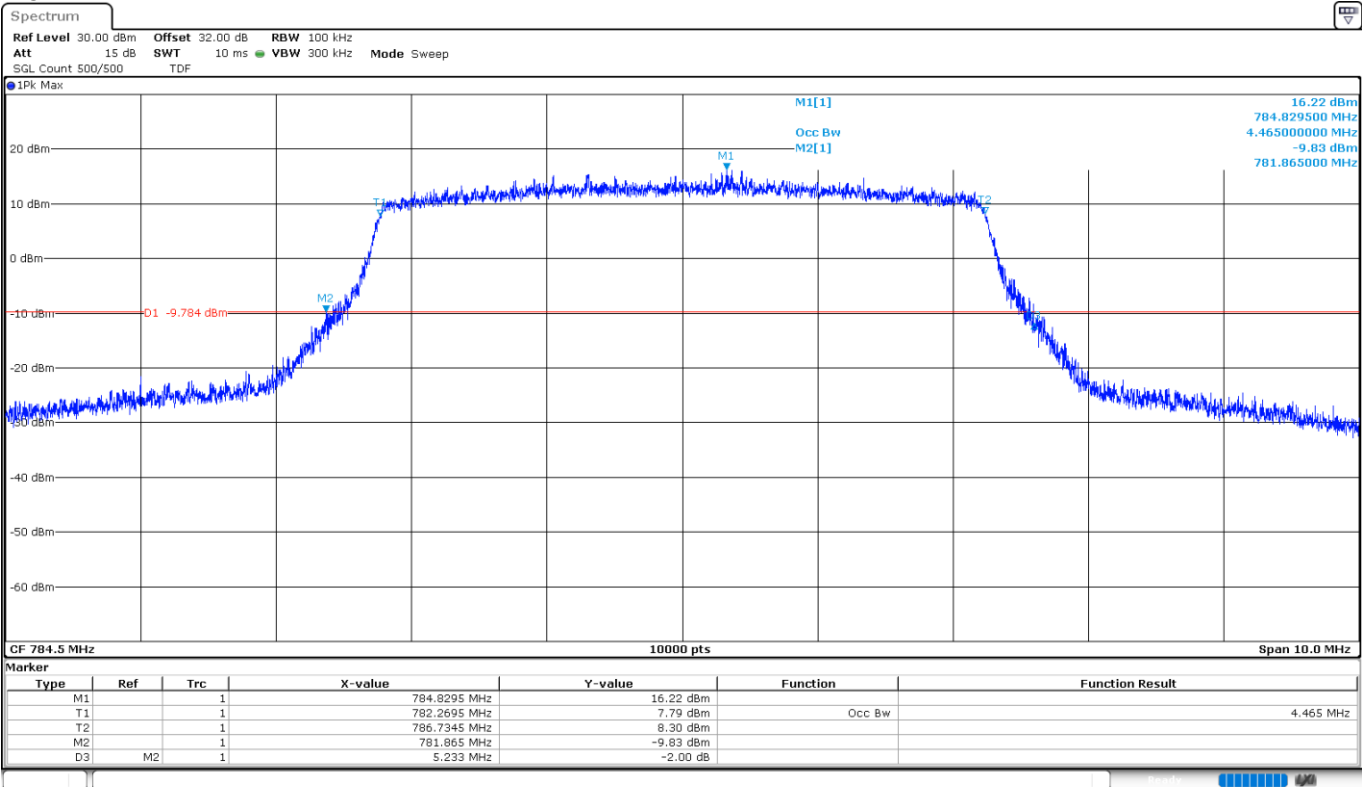


LTE Cat 1bis Band 13. BW=5 MHz. 16QAM. RB Size 5.

Low Channel:



High Channel:



LTE Cat 1bis Band 13. BW=10 MHz. QPSK. RB Size 6.

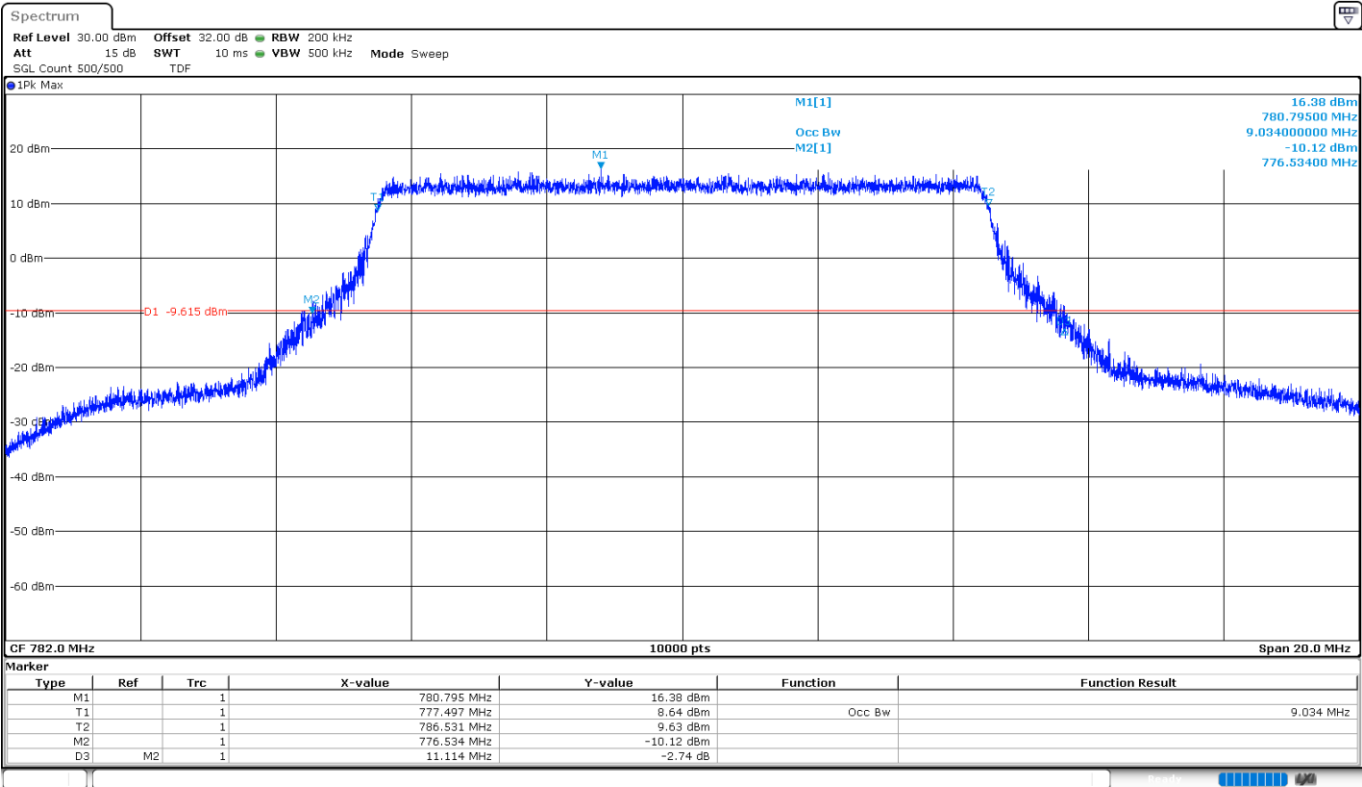
Channel	Middle
99% Occupied Bandwidth (MHz)	9.034
-26 dBc Bandwidth (MHz)	11.114
Measurement uncertainty (kHz)	<±3.75

LTE Cat 1bis Band 13. BW=10 MHz. 16QAM. RB Size 5.

Channel	Middle
99% Occupied Bandwidth (MHz)	4.650
-26 dBc Bandwidth (MHz)	6.774
Measurement uncertainty (kHz)	<±3.75

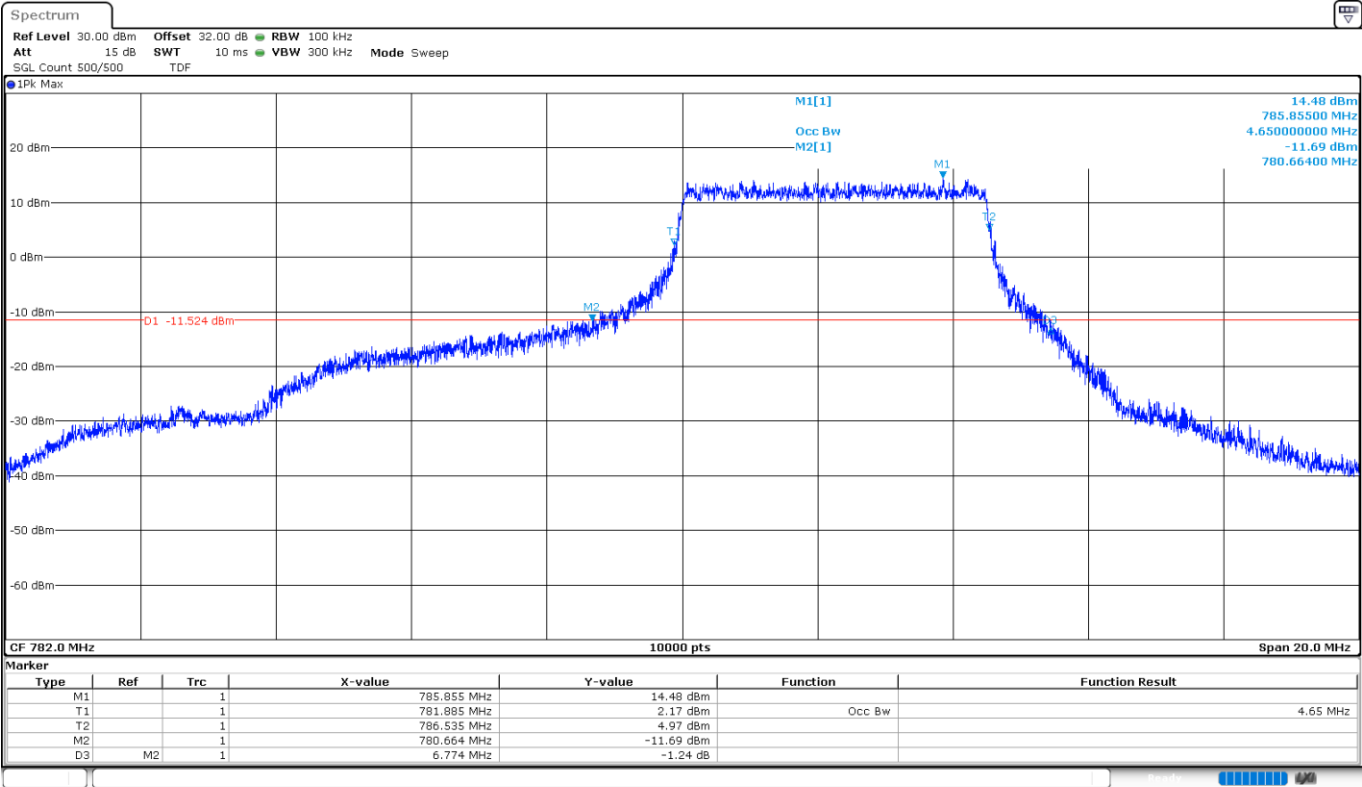
LTE Cat 1bis Band 13. BW=10 MHz. QPSK. RB Size 6.

Middle Channel:



LTE Cat 1bis Band 13. BW=10 MHz. 16QAM. RB Size 5.

Middle Channel:



LTE Cat 1bis Band 66:

LTE Cat 1bis Band 66. BW=5 MHz. QPSK. RB Size 6.

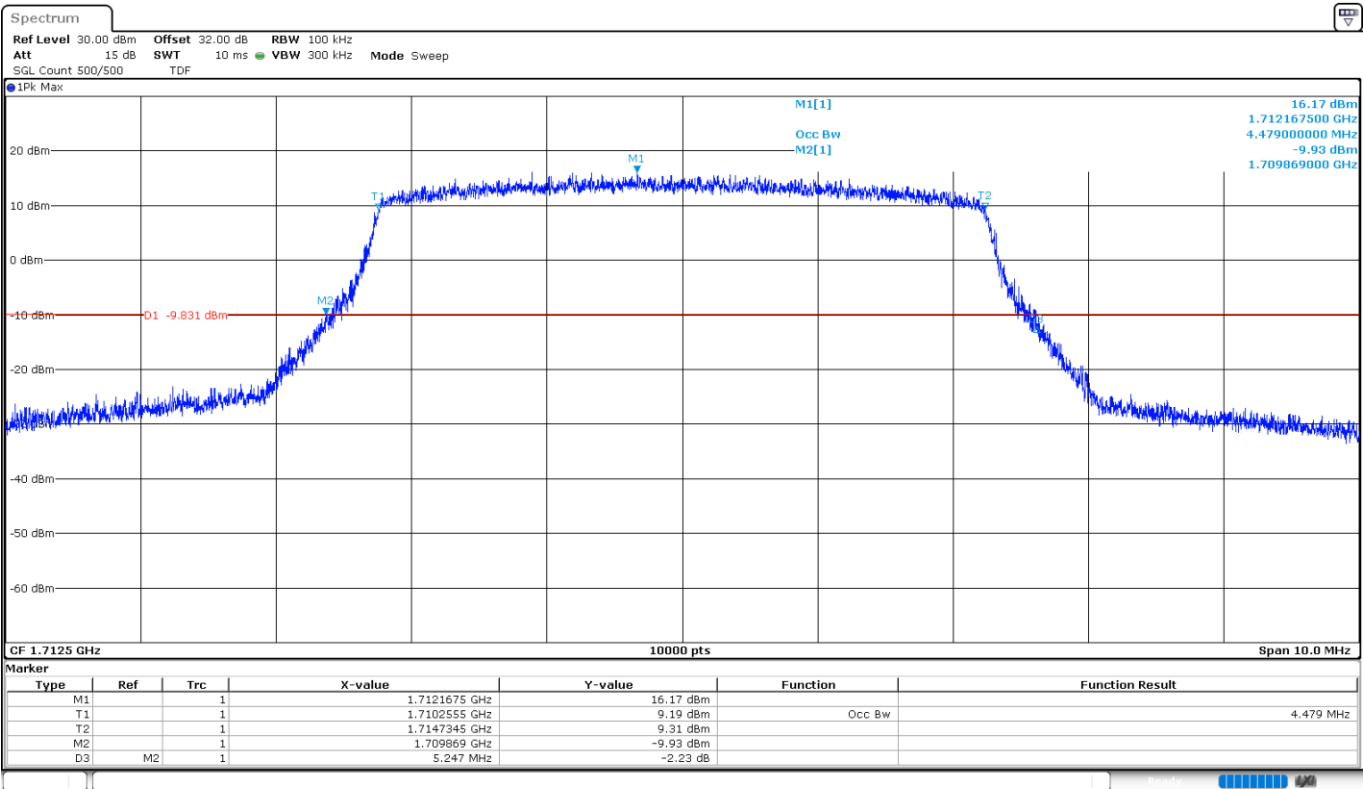
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.479	4.473	4.475
-26 dBc Bandwidth (MHz)	5.247	5.246	5.305
Measurement uncertainty (kHz)	<±3.75		

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

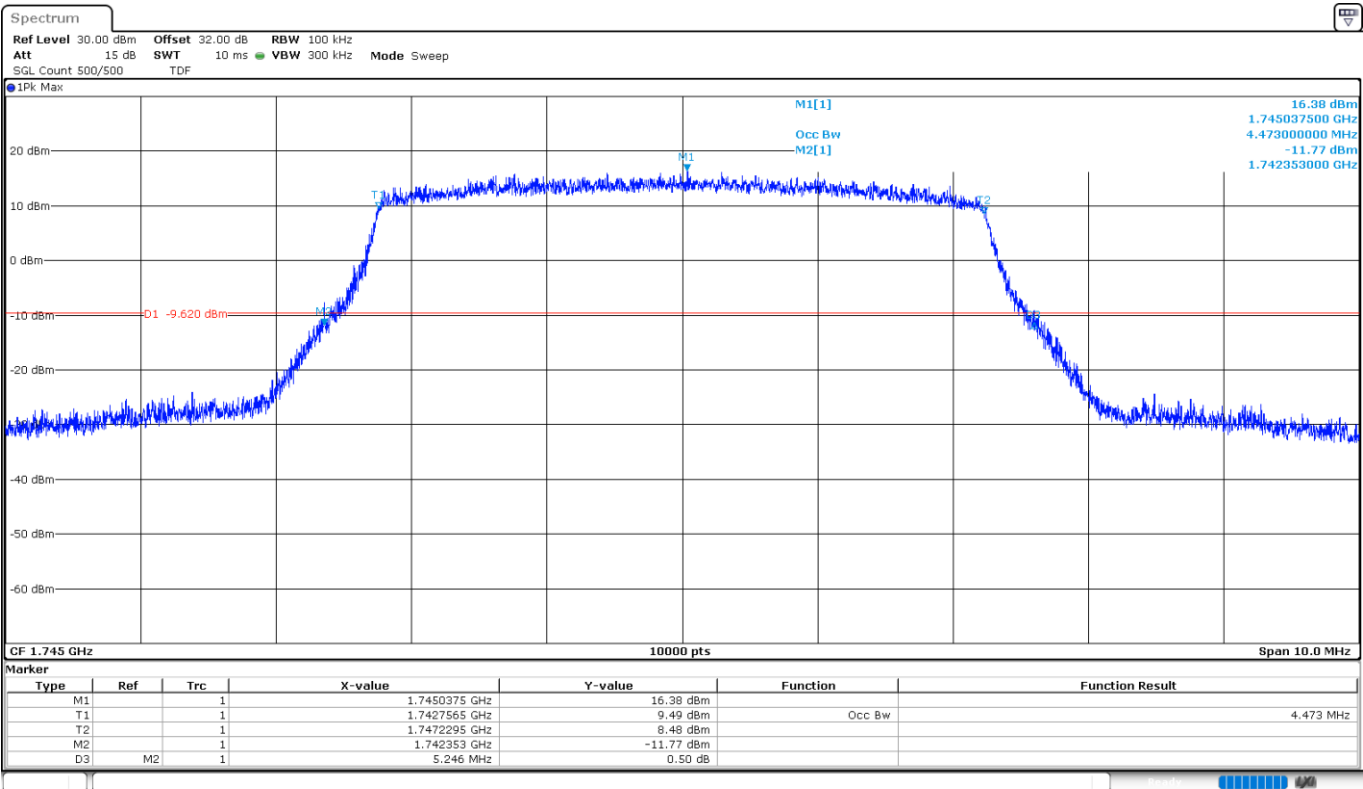
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.466	4.469	4.469
-26 dBc Bandwidth (MHz)	5.238	5.160	5.147
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=5 MHz. QPSK. RB Size 6.

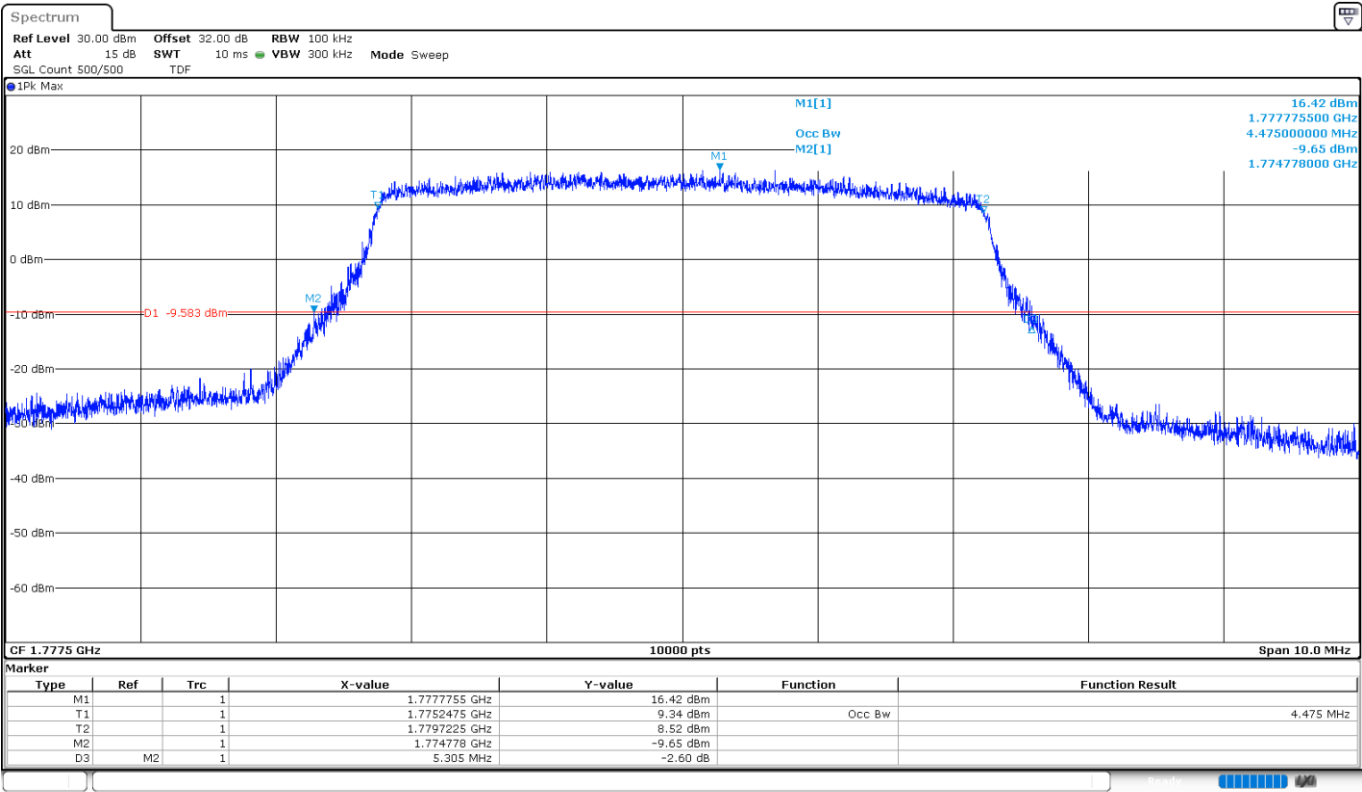
Low Channel:



Middle Channel:

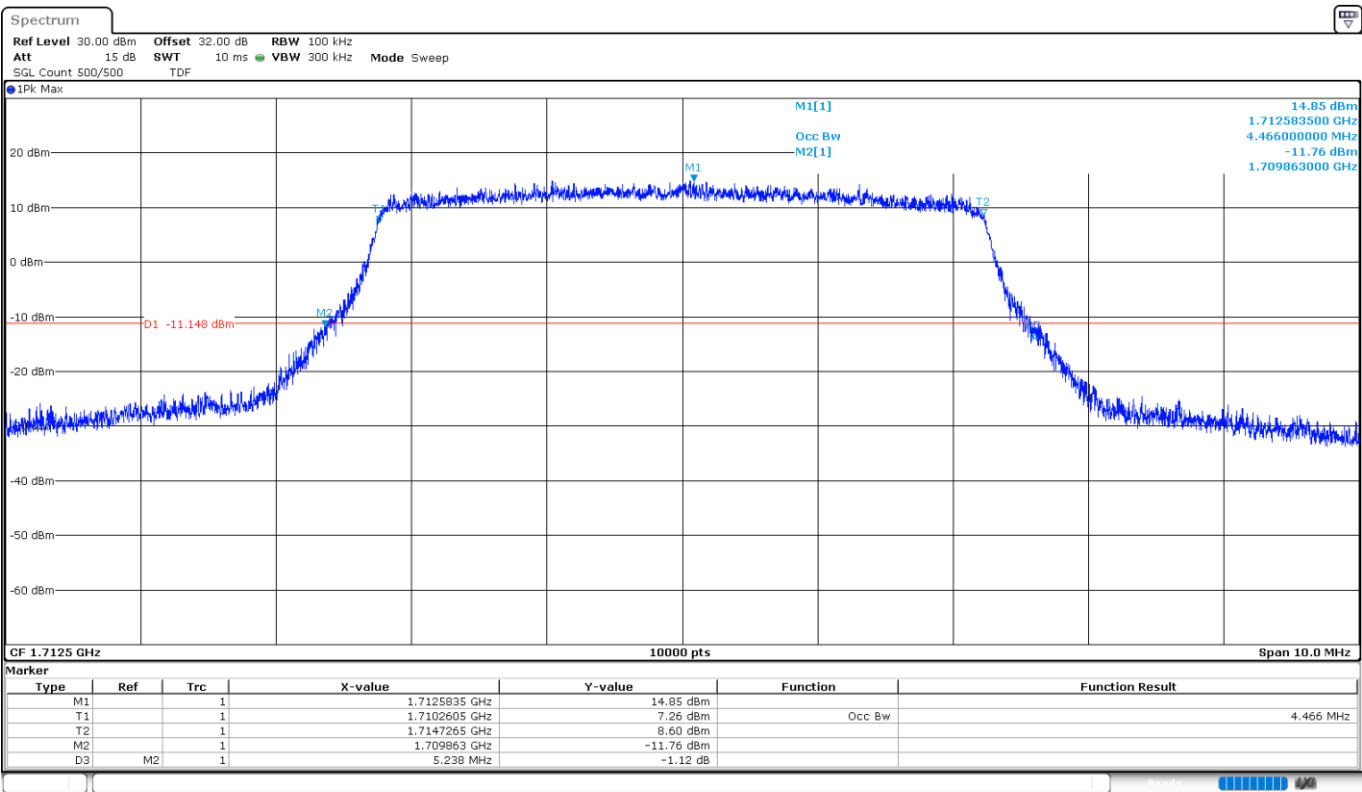


High Channel:

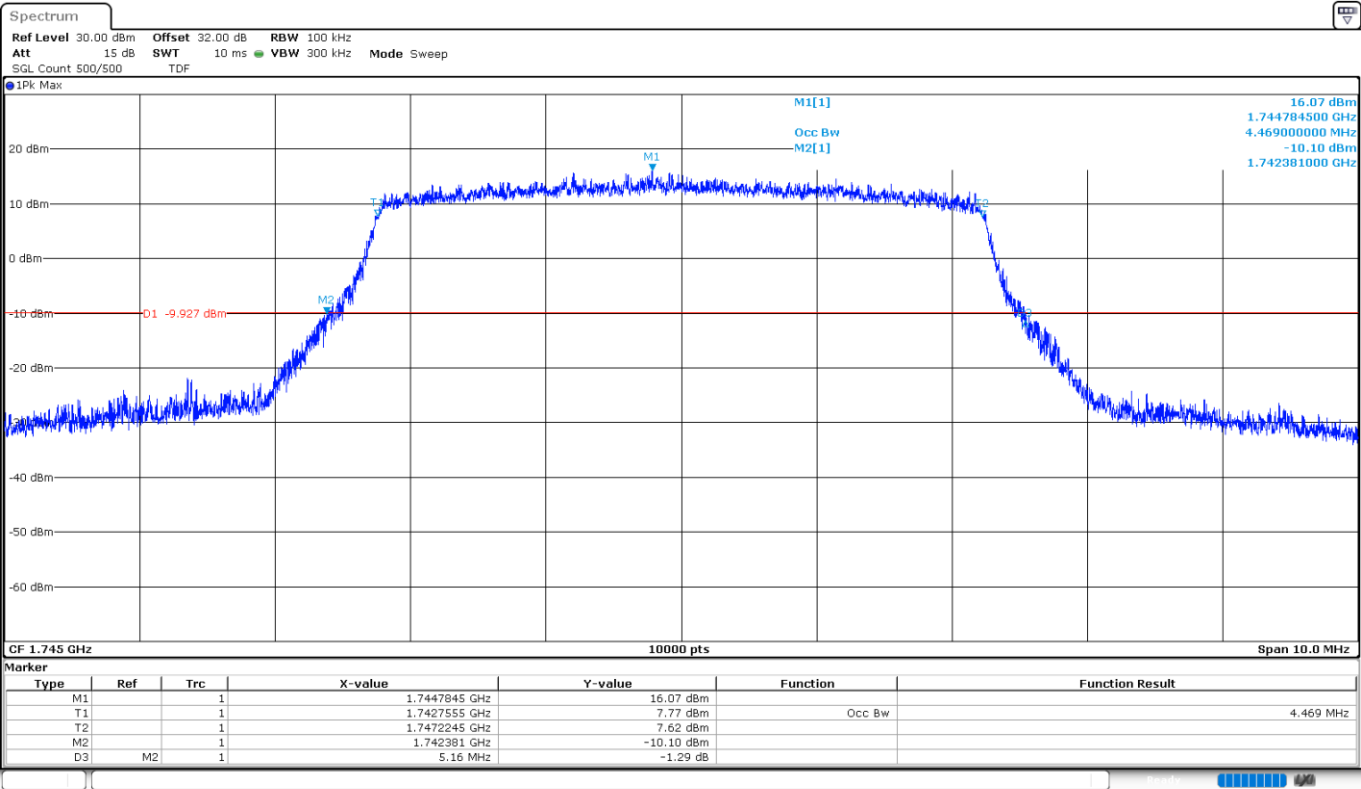


LTE Cat 1bis Band 66. BW=5 MHz. 16QAM. RB Size 5.

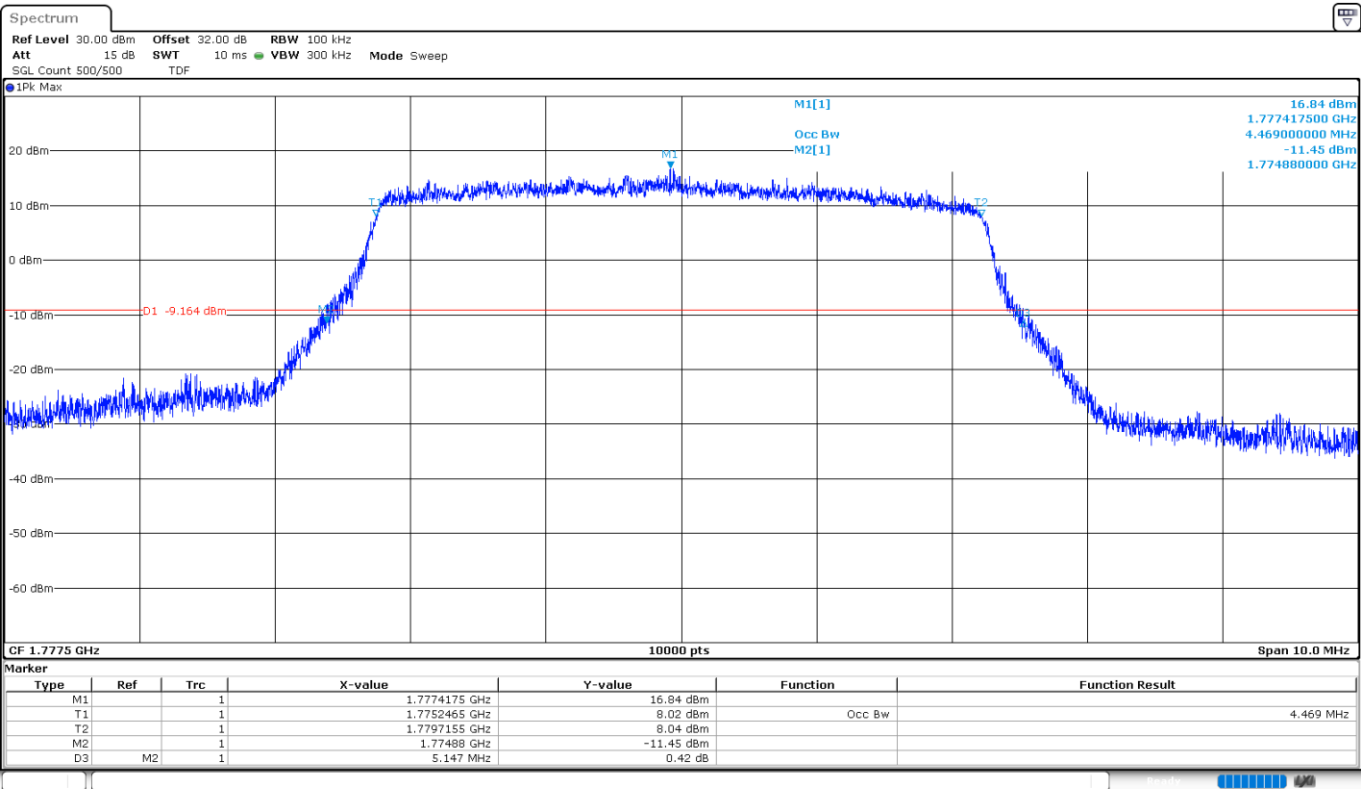
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 66. BW=10 MHz. QPSK. RB Size 6.

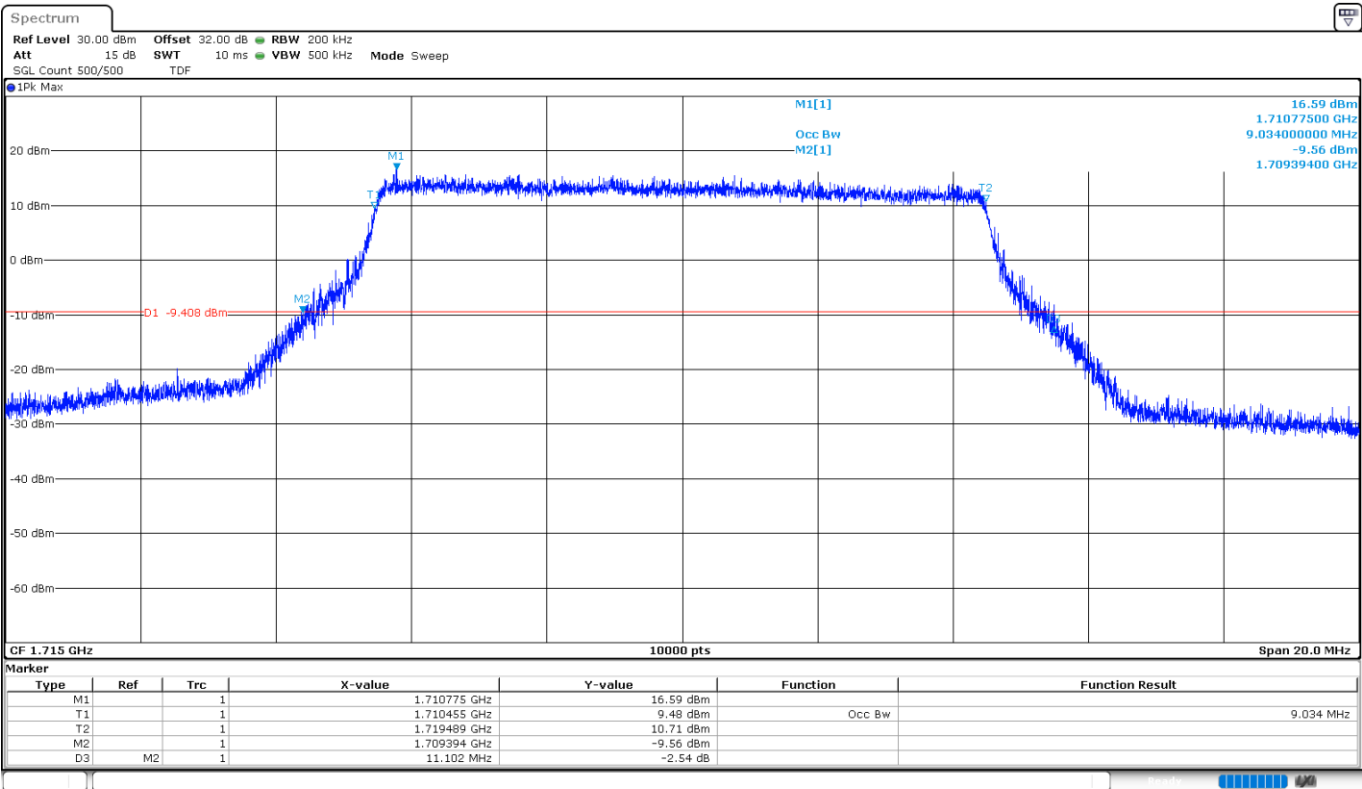
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	9.034	9.010	9.006
-26 dBc Bandwidth (MHz)	11.102	11.196	11.112
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=10 MHz. 16QAM. RB Size 5.

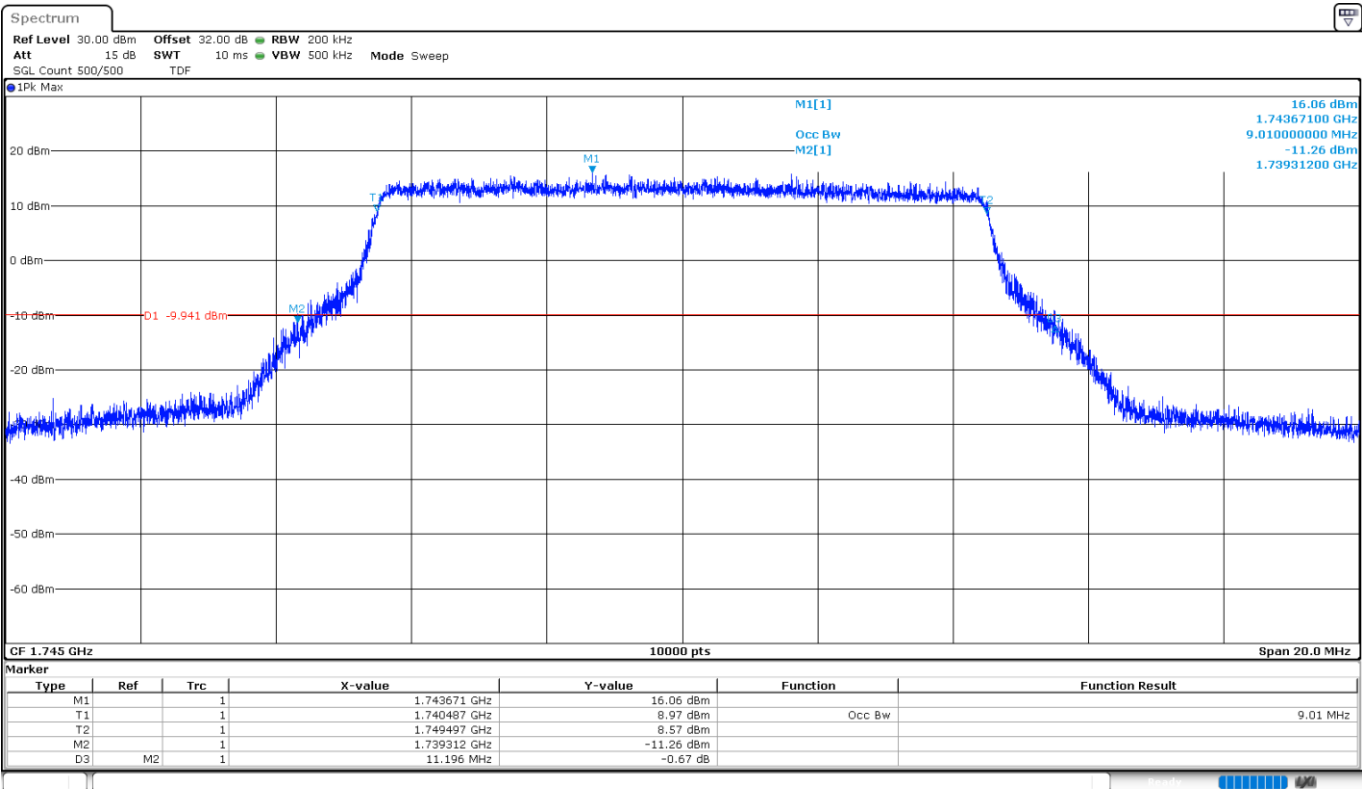
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.702	4.674	4.728
-26 dBc Bandwidth (MHz)	6.582	6.850	6.858
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=10 MHz. QPSK. RB Size 6.

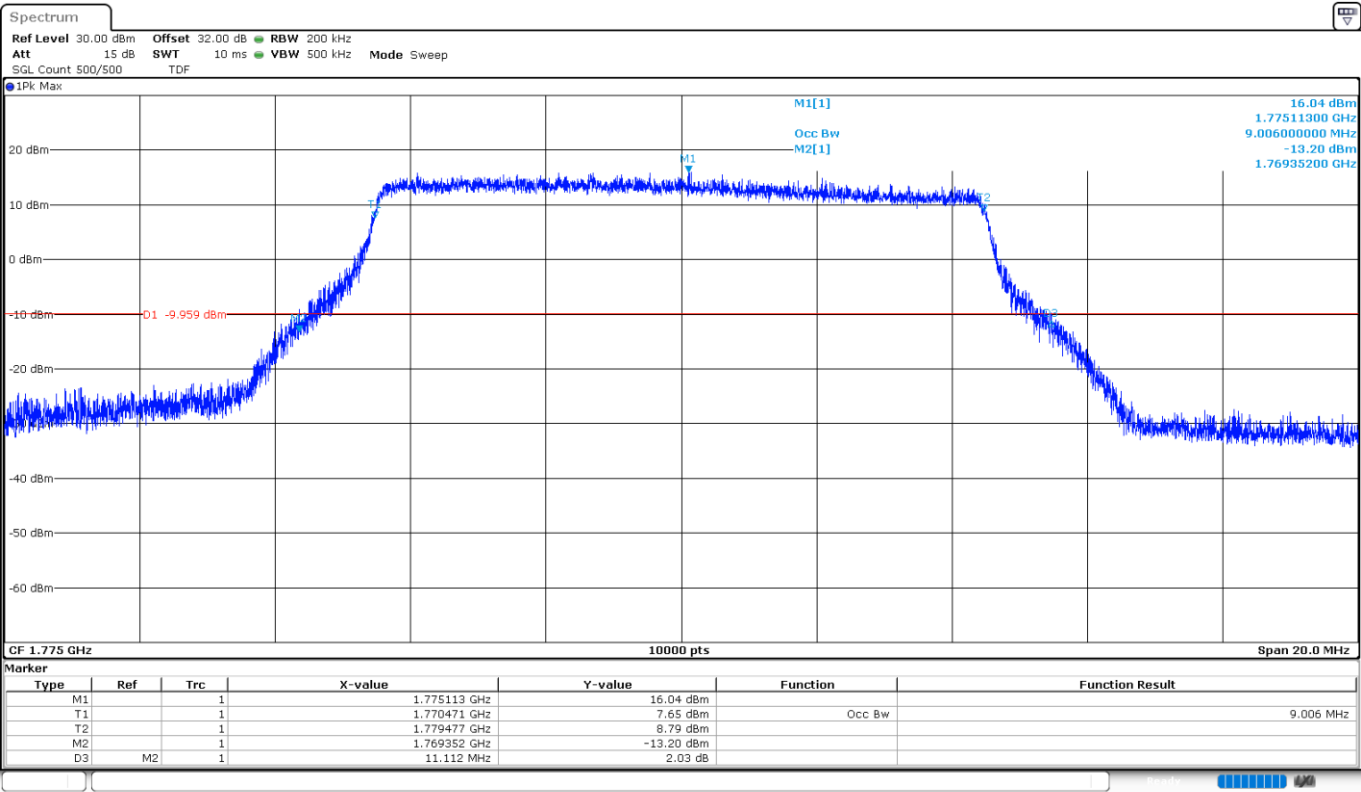
Low Channel:



Middle Channel:

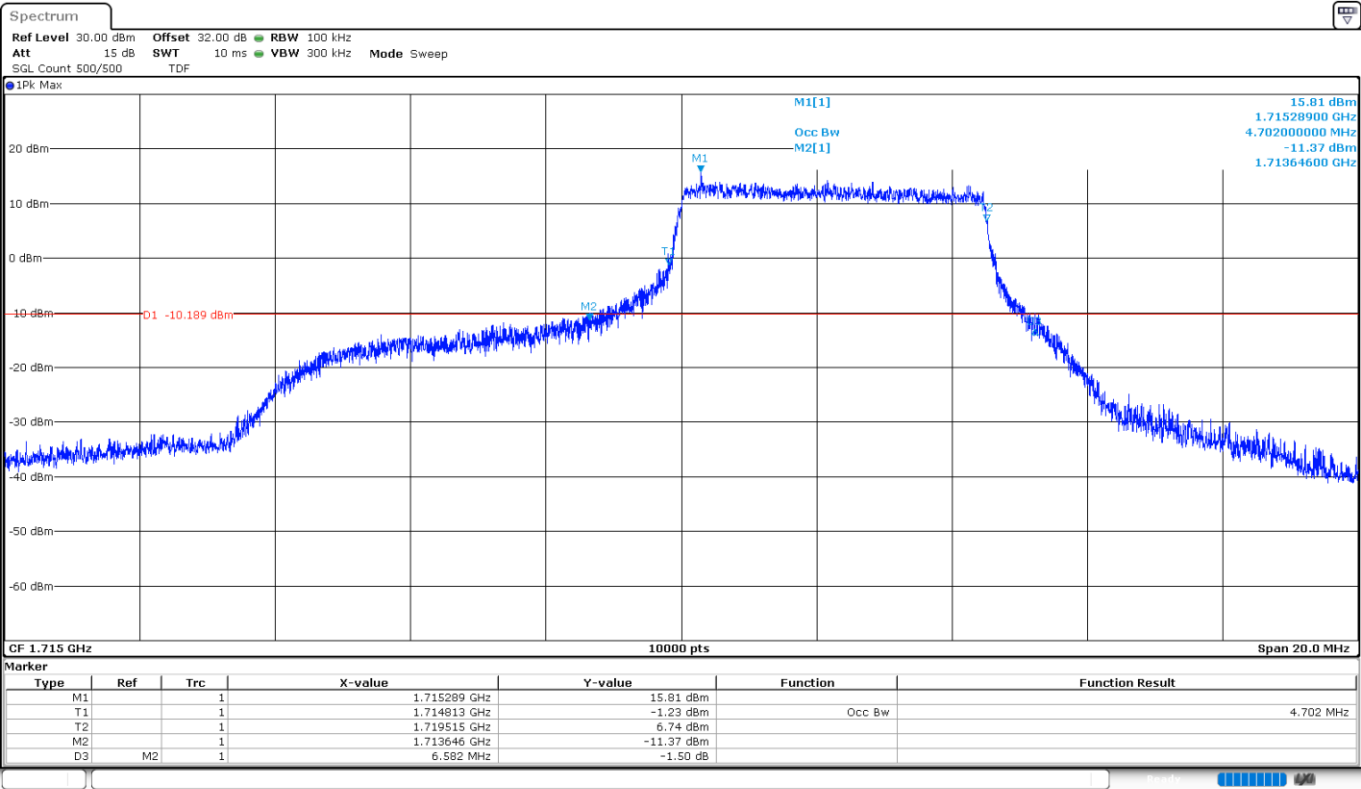


High Channel:

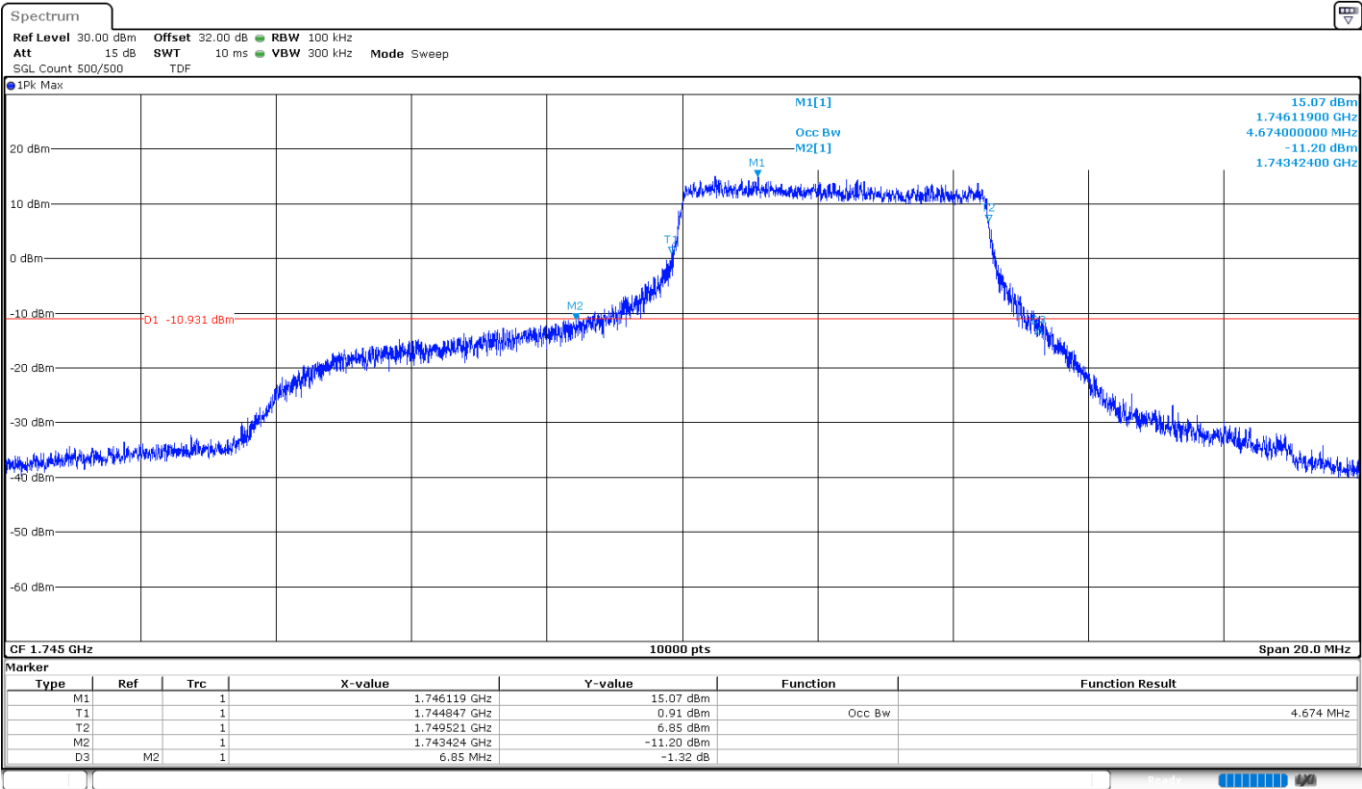


LTE Cat 1bis Band 66. BW=10 MHz. 16QAM. RB Size 5.

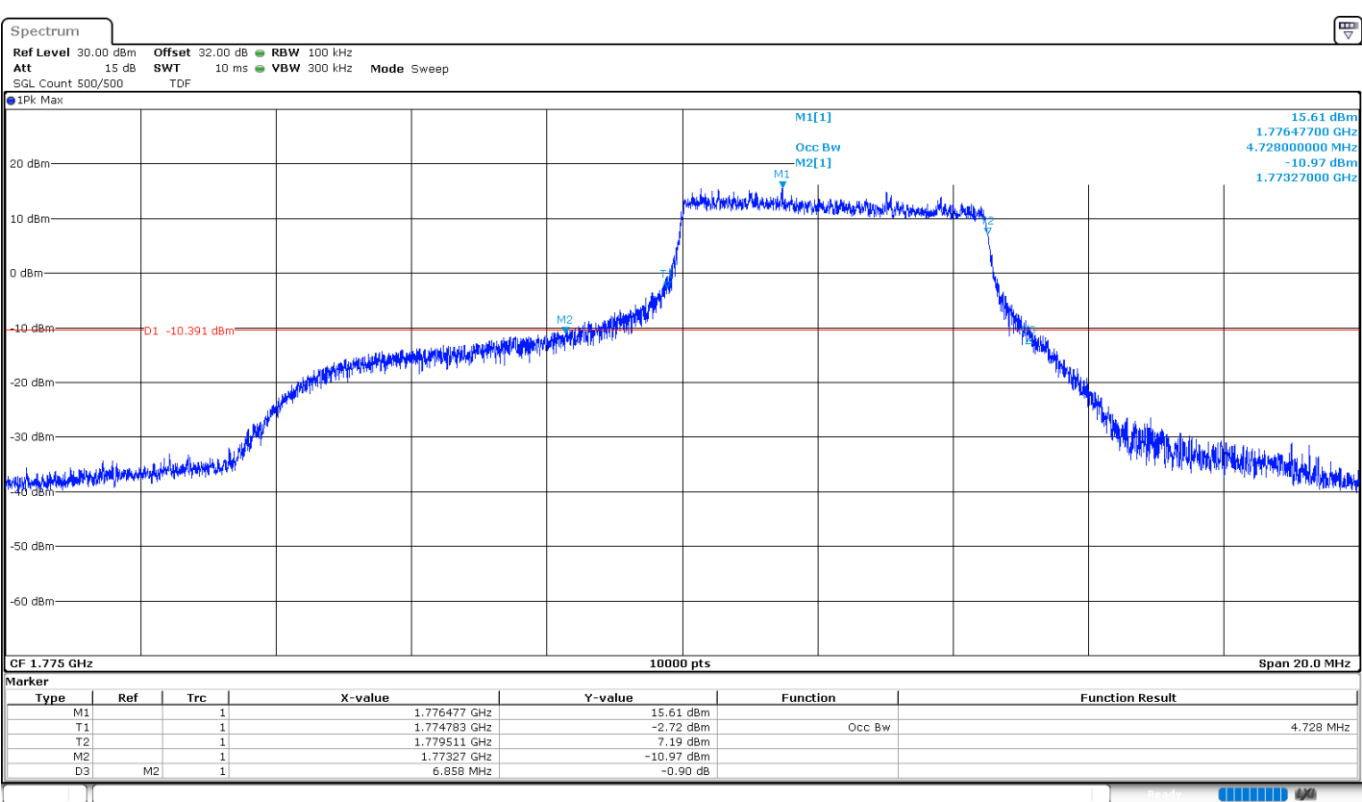
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 66. BW=15 MHz. QPSK. RB Size 6.

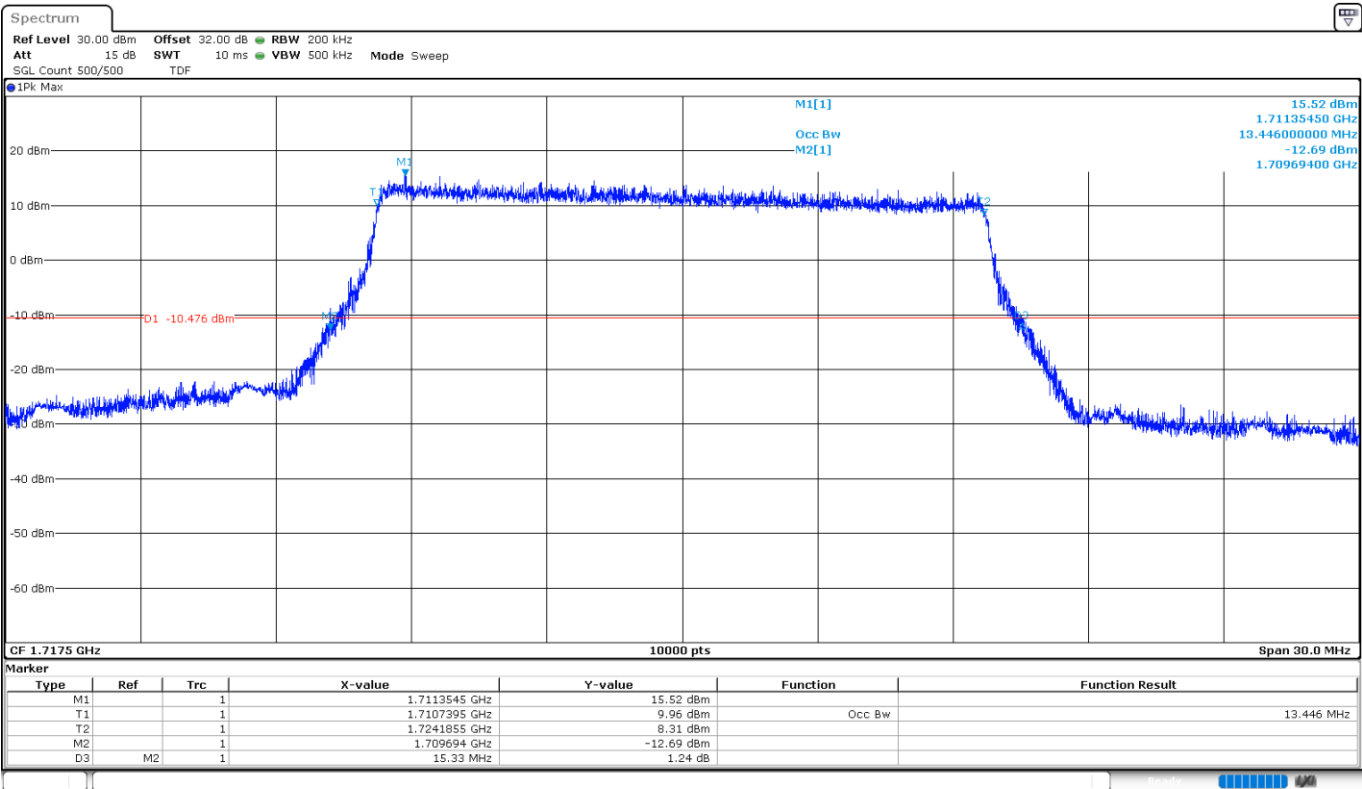
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	13.446	13.419	13.404
-26 dBc Bandwidth (MHz)	15.330	15.021	15.402
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=15 MHz. 16QAM. RB Size 5.

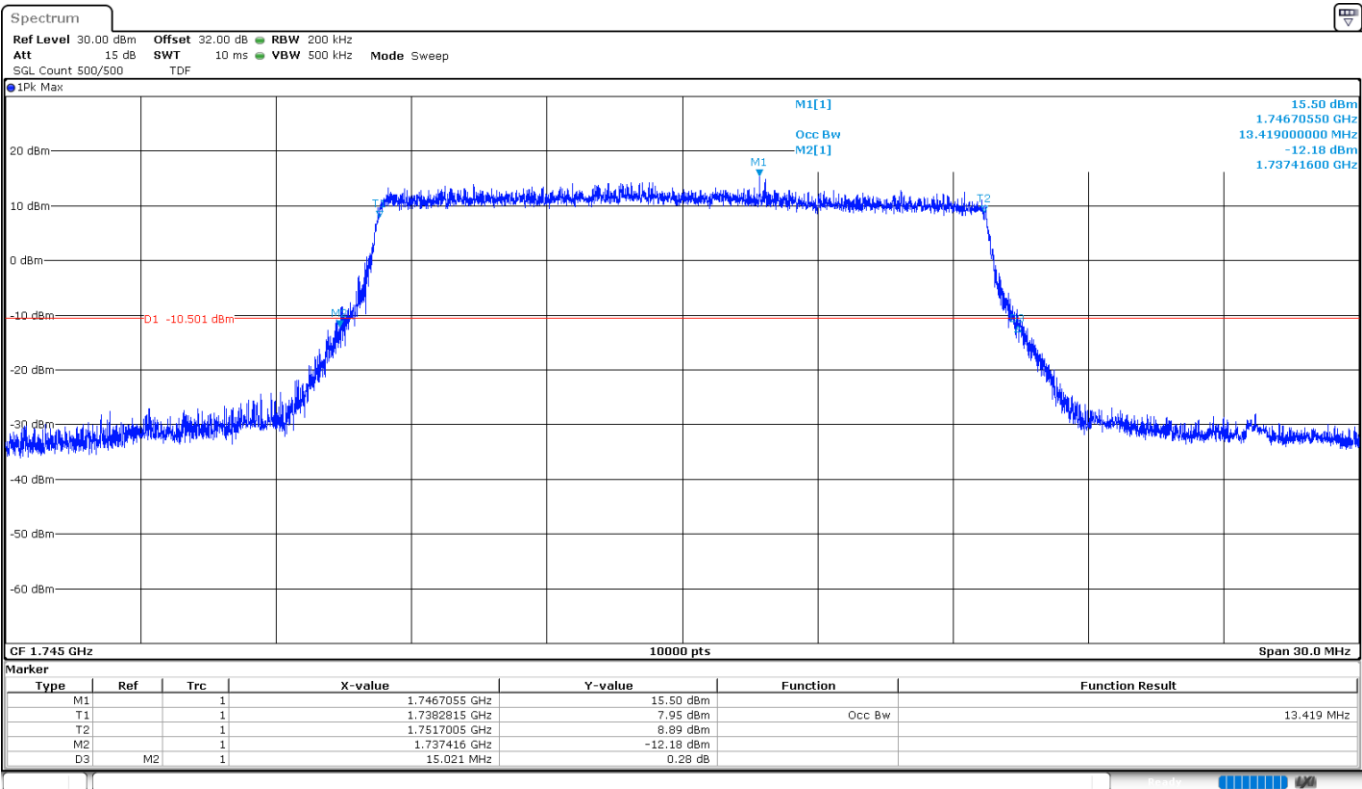
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.626	4.692	4.755
-26 dBc Bandwidth (MHz)	6.687	6.663	7.371
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=15 MHz. QPSK. RB Size 6.

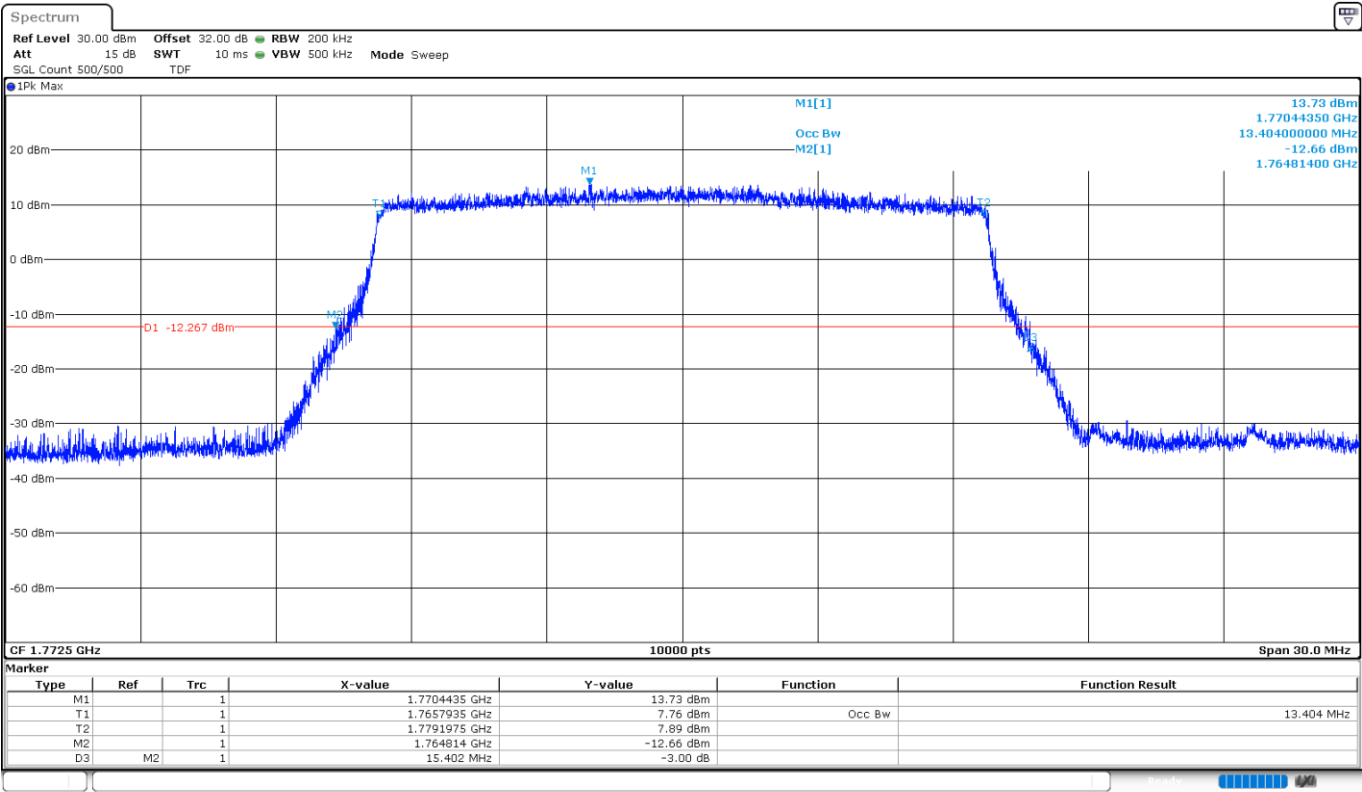
Low Channel:



Middle Channel:

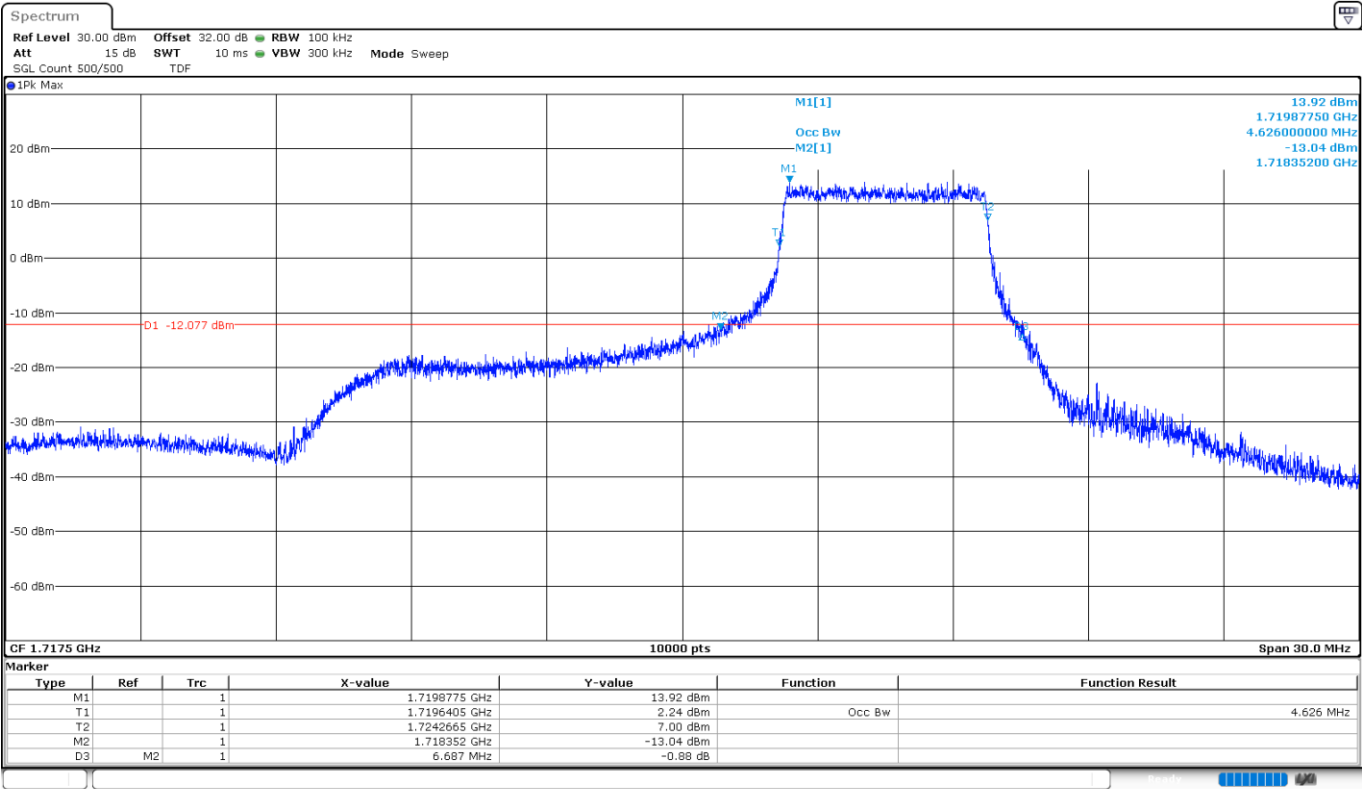


High Channel:

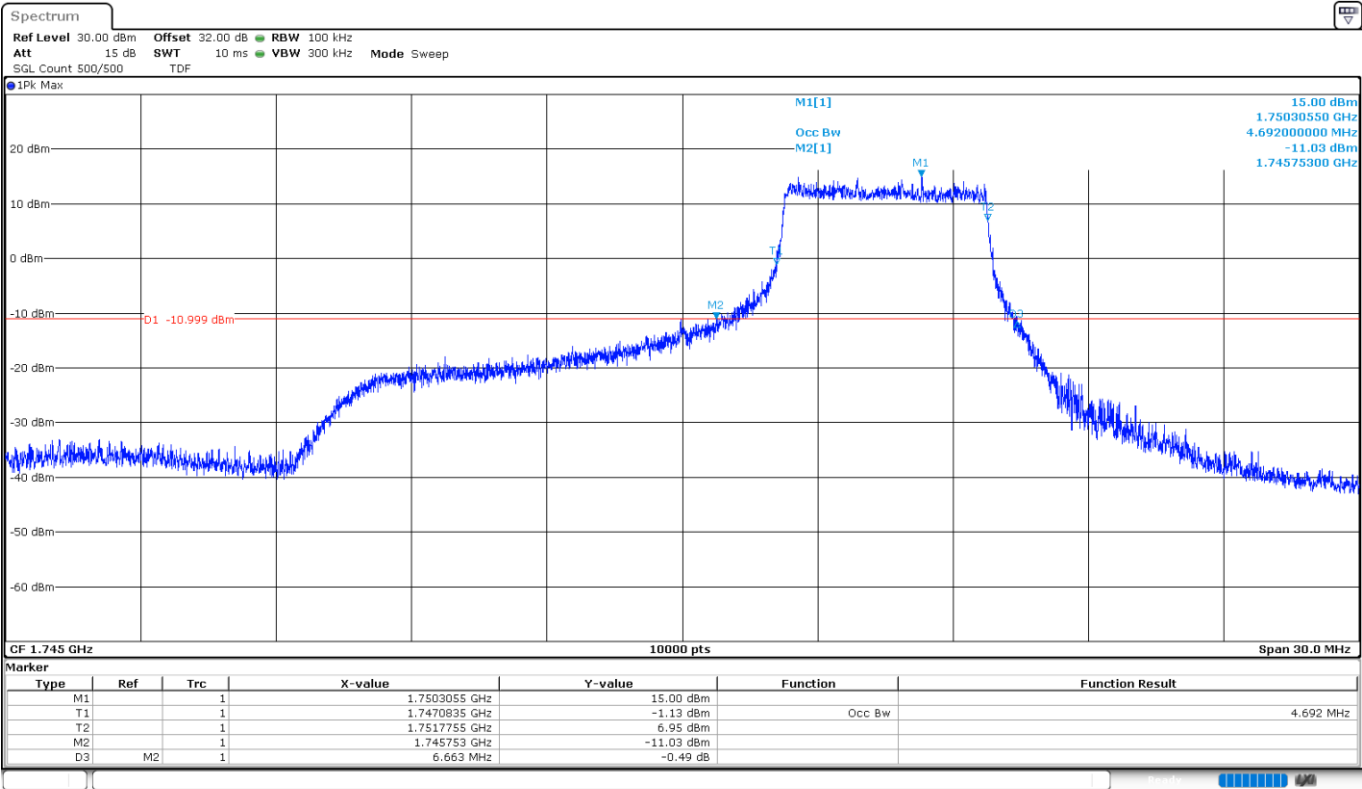


LTE Cat 1bis Band 66. BW=15 MHz. 16QAM. RB Size 5.

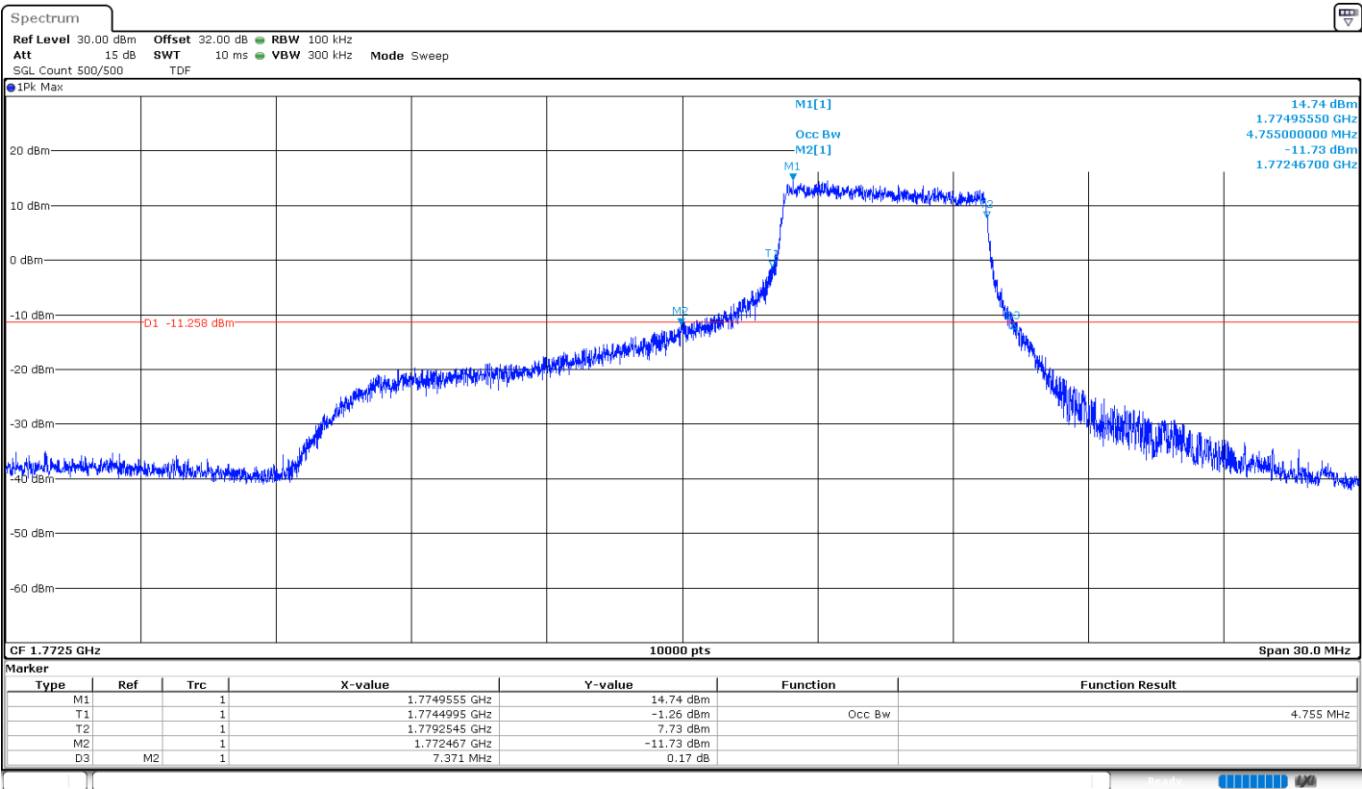
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 66. BW=20 MHz. QPSK. RB Size 6.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	17.944	17.852	17.840
-26 dBc Bandwidth (MHz)	20.104	19.888	19.832
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 66. BW=20 MHz. 16QAM. RB Size 5.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.648	4.816	4.724
-26 dBc Bandwidth (MHz)	6.476	6.756	6.716
Measurement uncertainty (kHz)	<±3.75		