DEKRA Testing and Certification, S.A.U.
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C.I.F. A29507456

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
77195RRF.002A3

Test Report
USA FCC Part 24
CANADA RSS-133

(*) 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 24 (10-1-23 Edition). CANADA RSS-133 Issue 6, Jan. 2018 Amendment 1. 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)
Date of issue	2024-06-21
Report template No	FDT08_24 (*) "Data provided by the client"

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

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Competences and guarantees

DEKRA Testing and Certification 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 covers the performed tests in this 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 has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification 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 at the time of performance of the test.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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General conditions

1. This report is only referred to the item that has undergone the test.
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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	☒	☒	☐		
Supplementary information to the ports……:	-						
Rated power supply ..... :	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☒	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 ..... :	☐	Table top equipment					
	☐	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					

	☒ 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
	-	-	-

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)	2023-12-04
Date (finish)	2024-02-26
Date (start)	2024-06-06
Date (finish)	2024-06-06

*Second period of testing to repeat Vmin extreme conditions.

Document history

Report number	Date	Description
77195RRF.002	2024-03-13	First release.
77195RRF.002A1	2024-04-22	Second release. Antenna gain values corrected and EIRP and ERP values recalculated. This test report replaces and cancel 77195RRF.001 test report.
77195RRF.002A2	2024-06-13	Third release. Extreme conditions testing performed to a different minimum voltage. This test report replaces and cancel 77195RRF.002A1 test report.
77195RRF.002A3	2024-06-21	Fourth release. Tests outside ENAC scope are marked. This test report replaces and cancel 77195RRF.002A2 test report.

Environmental conditions

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

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

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

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Rafael Fernández, Carmen Vázquez, Sergio Carrasco, Pablo Redondo, Ireneo Bibang.

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
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 Band 2.

FCC 24 / RSS-133		
Requirement – Test case	**Verdict**	**Remark**
FCC 24.232 / RSS-133 6.4: RF Output Power	P	
FCC 2.1047 / RSS-133 6.2: Modulation characteristics	P	
FCC 24.235 / RSS-133 6.3: Frequency stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 24.238 / RSS-133 6.5: Spurious emissions at antenna terminals	P	
FCC 24.238 / RSS-133 6.5: Spurious emissions at antenna terminals at Block Edges	P	
FCC 24.238 / RSS-133 6.5: Radiated Emissions	P	
Supplementary information and remarks: None.		

Appendix A: Test results for FCC 24 / RSS-133

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TEST CONDITIONS

POWER SUPPLY (*):

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

Type of Power Supply: DC External.

ANTENNA (*):

MIDDLE BAND		ANTENNA TYPE
LTE Cat 1bis Band 2	4.12 dBi	External (Taoglass GSA_8835 (standard reference antenna provided with EVK))

TEST FREQUENCIES:

LTE Cat 1bis Band 2. 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	18607 (1850.7)	18615 (1851.5)	18625 (1852.5)	18650 (1855)	18675 (1857.5)	18700 (1860)
Middle	18900 (1880)	18900 (1880)	18900 (1880)	18900 (1880)	18900 (1880)	18900 (1880)
High	19193 (1909.3)	19185 (1908.5)	19175 (1907.5)	19150 (1905)	19125 (1902.5)	19100 (1900)

RF Output Power

Limits

* FCC § 2.1046 and § 24.232:

Mobile/portable stations are limited to 2 Watts (33 dBm) Effective Isotropic Radiated Power (E.I.R.P.).
The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

* RSS-133 Clause 6.4:

Mobile stations and hand-held portables are limited to 2 watts maximum e.i.r.p. The peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the High 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).

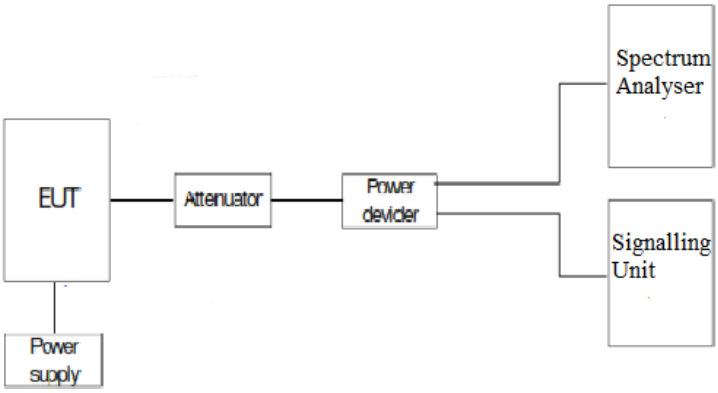
The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

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 2:

Worst-case of RF Power is BW=20 MHz, High Channel, QPSK, RB Size=1, RB Offset=49.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
20	Low 18700	1860	QPSK	1	0	23.02
				1	49	23.12
				1	99	21.89
				50	0	22.06
				50	24	22.12
				50	49	22.2
				100	0	22.07
			16-QAM	1	0	21.91
				1	49	22.15
				1	99	22.28
				25	0	21.06
				25	24	21.2
				25	49	21.39
				100	0	*
	Middle 18900	1880	QPSK	1	0	22.77
				1	49	22.83
				1	99	22.71
				50	0	21.93
				50	24	21.98
				50	49	21.94
				100	0	21.95
			16-QAM	1	0	21.93
				1	49	21.99
				1	99	21.89
				25	0	20.87
				25	24	20.9
				25	49	20.93
				100	0	*
	High 19100	1900	QPSK	1	0	22.82
				1	49	23.17
				1	99	22.71
				50	0	21.96
				50	24	21.46
				50	49	21.96
				100	0	22
			16-QAM	1	0	21.8
				1	49	22.24
				1	99	21.81

				25	0	21.06
				25	24	21.31
				25	49	21
				100	0	*

* Not supported neither RB Size 100 nor 50 for 16QAM.

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	23.12	4.12	27.24	25.09
MIDDLE	22.83	4.12	26.95	24.80
HIGH	23.17	4.12	27.29	25.14
MAX:	23.17		27.29	25.14

BW=20 MHz. 16QAM:

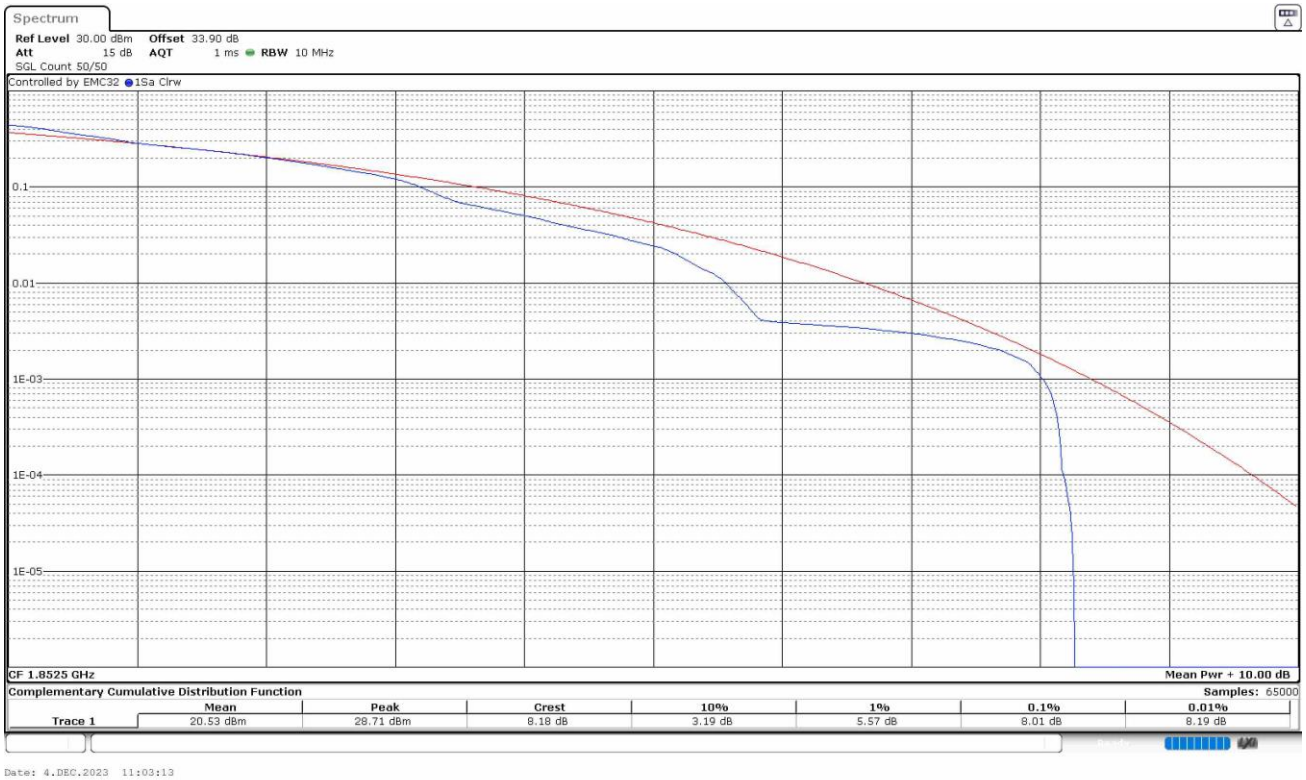
MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.28	4.12	26.40	24.25
MIDDLE	21.99	4.12	26.11	23.96
HIGH	22.24	4.12	26.36	24.21
MAX:	22.28		26.40	24.25

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

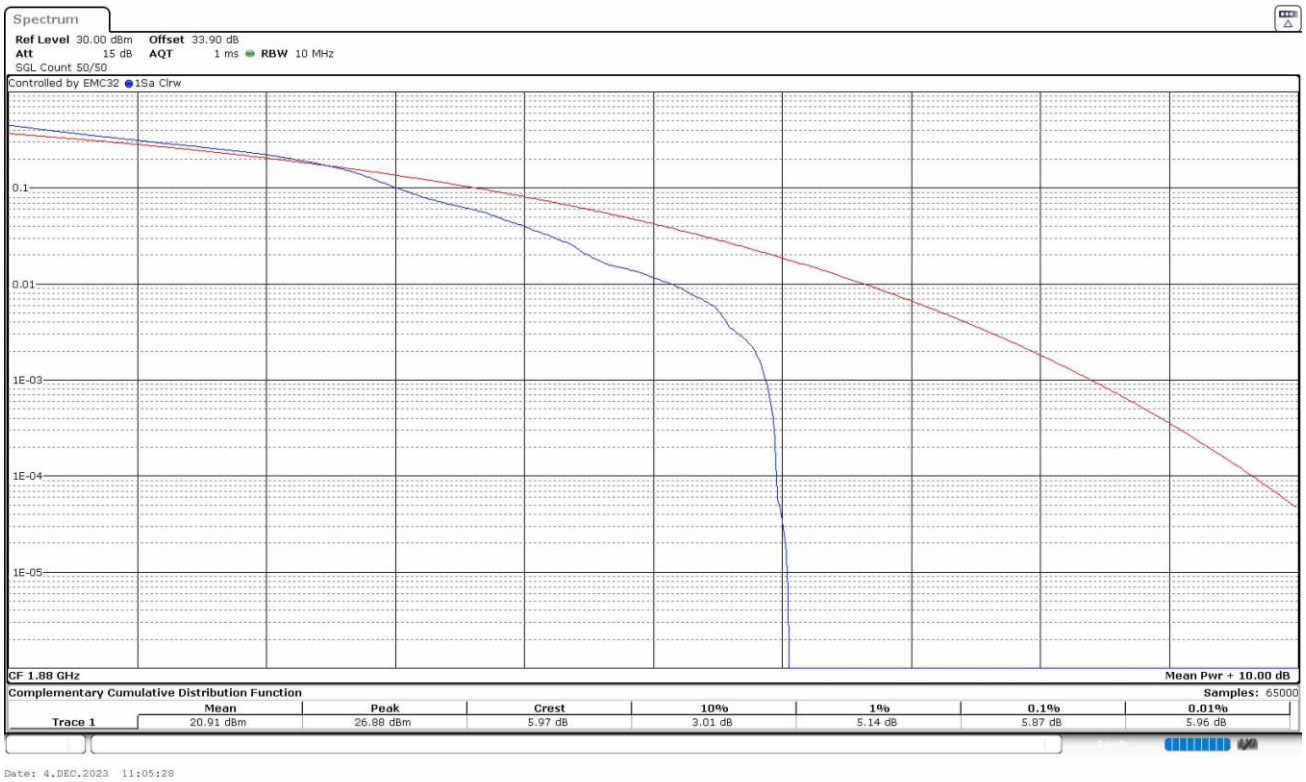
LTE Cat 1bis Band 2:

Worst-case of PAPR is BW=5 MHz, Low Channel, 16QAM, RB Size=1, RB Offset=0.

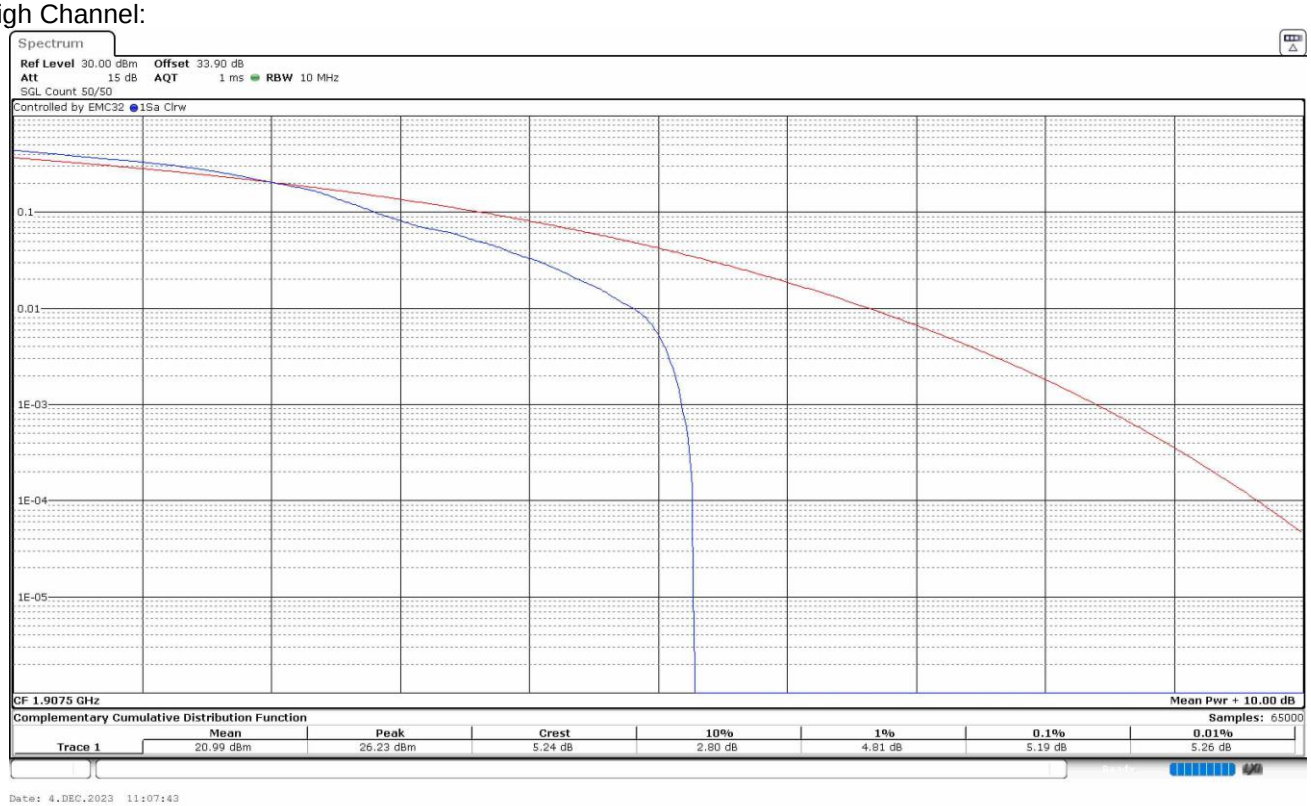
Low Channel:



Middle Channel:



High Channel:



16QAM	Low	Middle	High
PAPR (dB)	8.01	5.87	5.19

Verdict

Pass

Frequency Stability

Limits

* FCC §2.1055 and §24.235. The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

* RSS-133, Clause 6.3. The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations.

Method

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

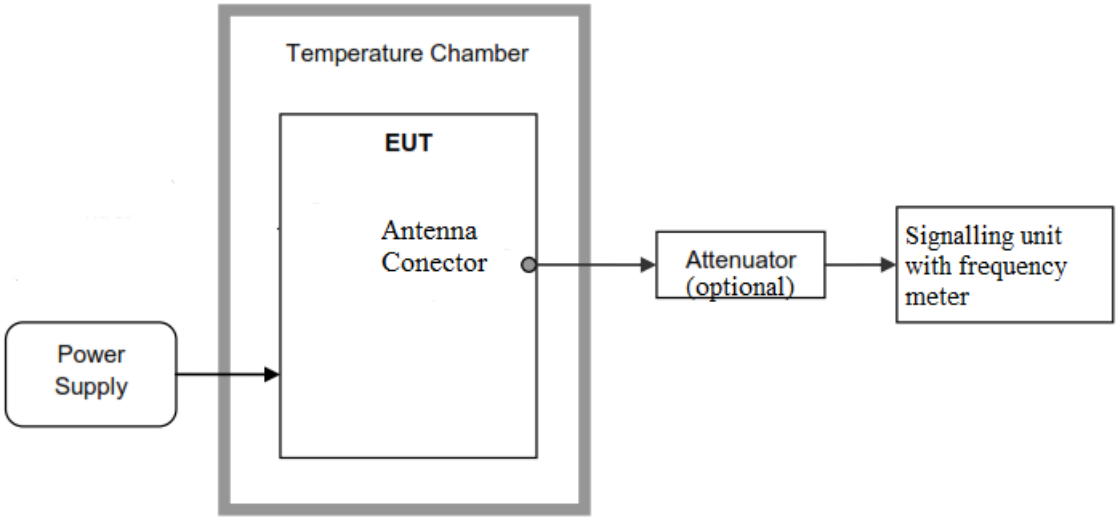
The EUT was set in “Radio Resource Control (RRC) mode” on the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.
The worst case LTE mode for conducted power was used for the test.

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 channels 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.

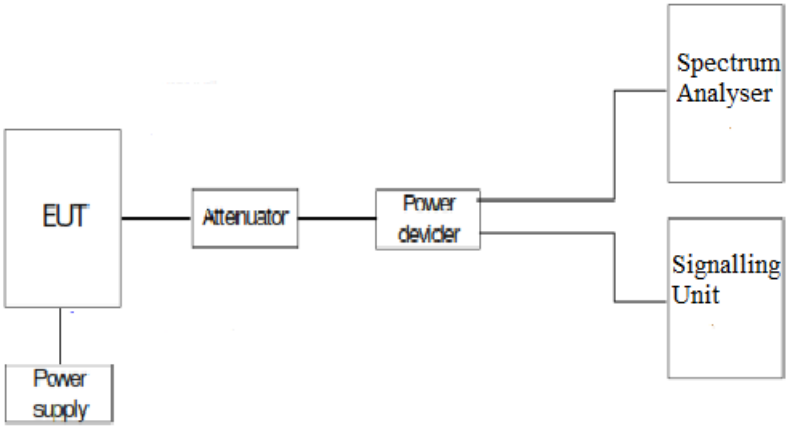
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance:



Reference points *f*L and *f*H:



Results

LTE Cat 1bis Band 2:

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

1. FREQUENCY TOLERANCE:

- **Frequency stability over temperature variations.**

Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
+85 [#]	3.67	0.001952128
+80 [#]	2.7	0.00143617
+70 [#]	2.67	0.001420213
+60 [#]	1.47	0.000781915
+50	2.3	0.001223404
+40	1.97	0.001047872
+30	3.1	0.001648936
+20	1.98	0.001053191
+10	0.8	0.000425532
0	1.2	0.000638298
-10	-1.28	-0.000680851
-20	1.48	0.000787234
-30	0.93	0.000494681
-40 [#]	-1.81	-0.000962766

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	-1.55	-0.000824468
Vmin	3.23	-0.56	-0.000297872

2. REFERENCE FREQUENCY POINTS fL AND fH:

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

*f*L (MHz)	1850.0028
*f*H (MHz)	1909.9924

The reference frequency points fL and fH stay within the authorized blocks for the band above.

Measurement uncertainty (Hz): <±223.94

Verdict

PASS

Modulation Characteristics

Limits

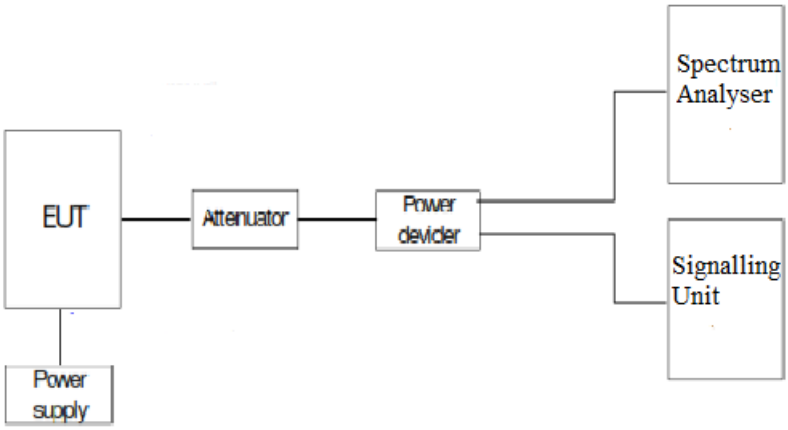
* FCC §2.1047.

* RSS-133. Clause 6.2. Equipment certified under this standard shall use digital modulation.

Method

For LTE the EUT operates with QPSK and 16QAM 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).

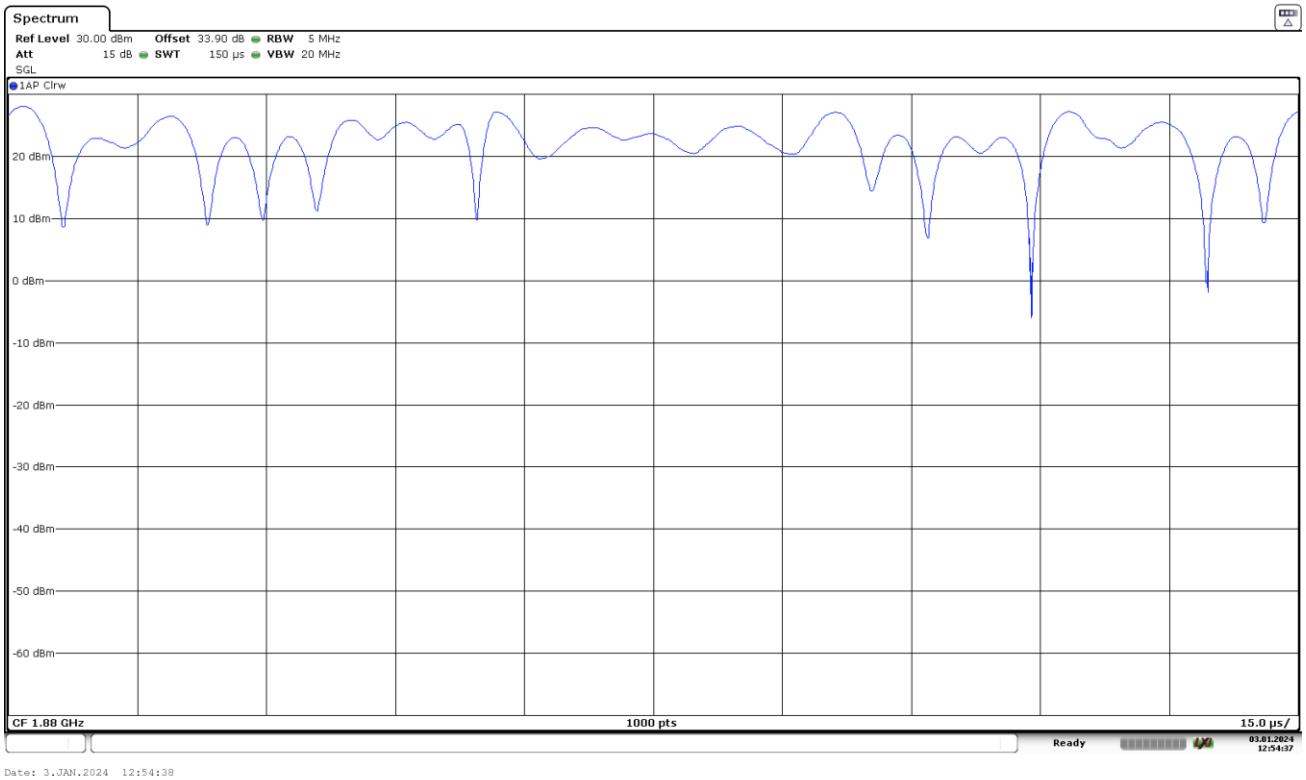
Test Setup



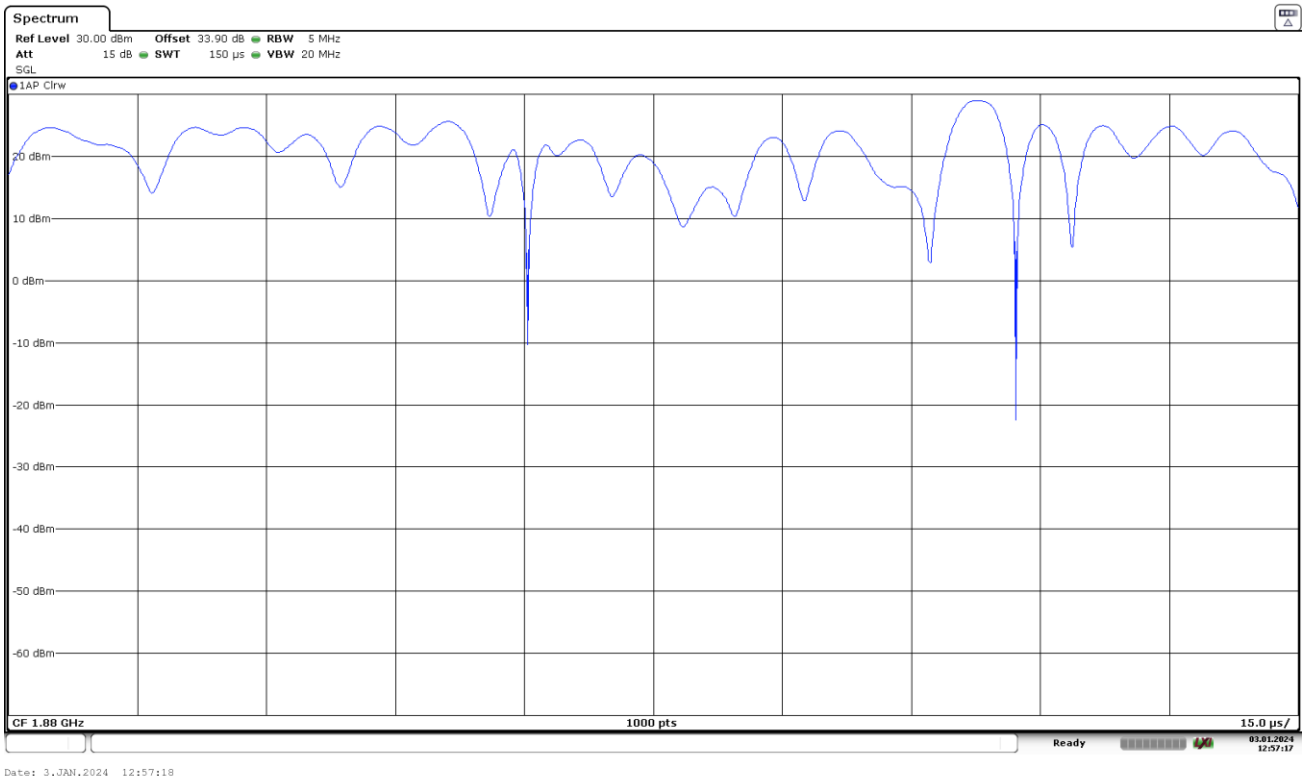
Results

The following plots show the modulation schemes in the EUT.

LTE Cat 1bis Band 2: BW=1.4 MHz. QPSK. RB Size=1. RB Offset=0. Middle Channel.



LTE Cat 1bis Band 25: BW=1.4 MHz. QPSK. RB Size=1. RB Offset=0. Middle Channel.



Occupied Bandwidth

Limits

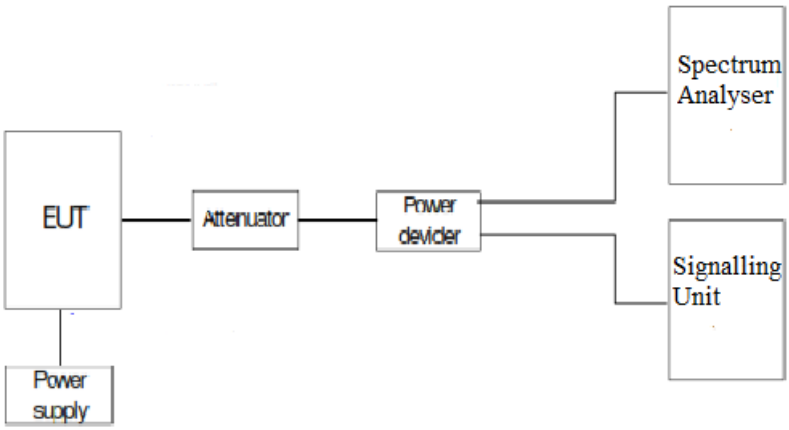
* FCC §2.1049: Measurements required: Occupied bandwidth.

* 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 per modulation is:

<u>LTE Cat 1bis Band 2</u>:

LTE Cat 1bis Band 2. BW=1.4 MHz. QPSK. RB Size=All.

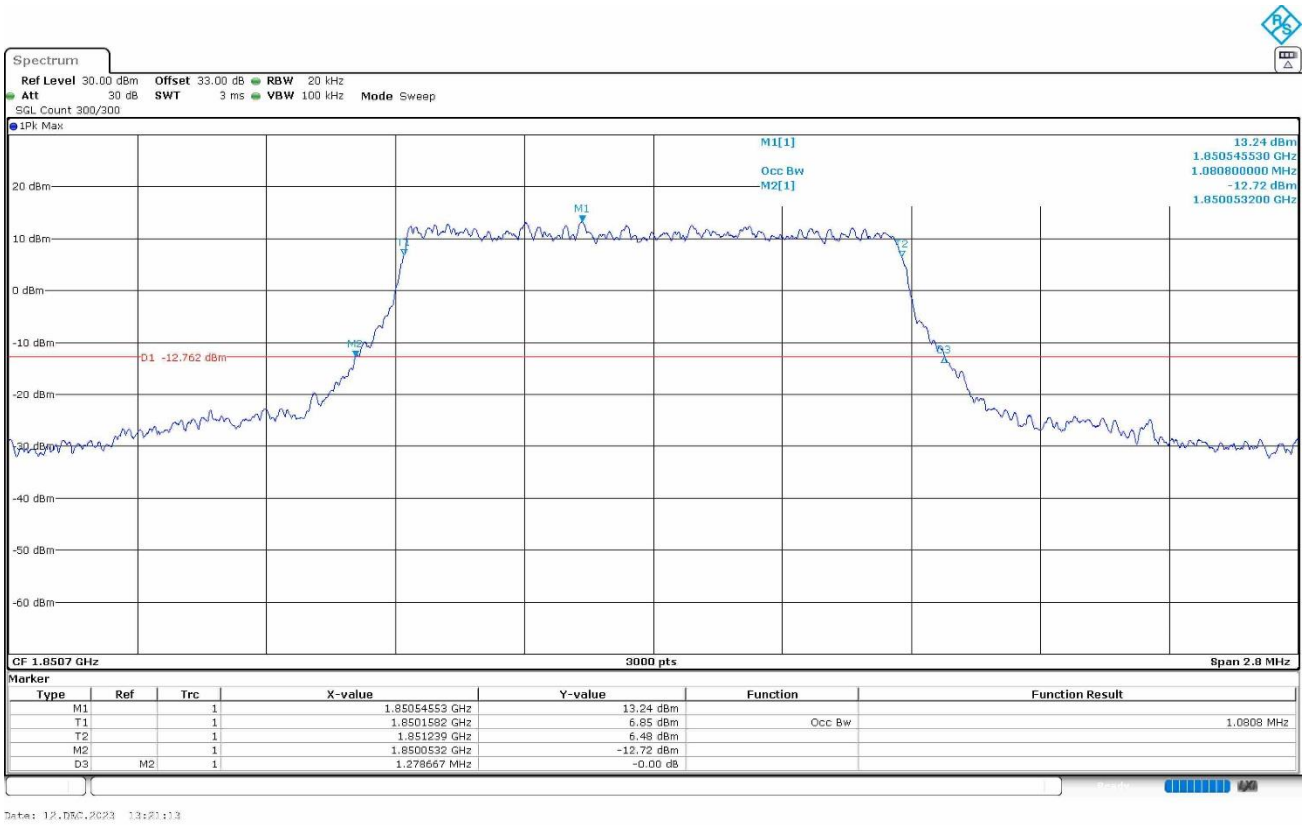
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.081	1.082	1.088
-26 dBc Bandwidth (MHz)	1.279	1.263	1.267
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=1.4 MHz. 16QAM. RB Size=All.

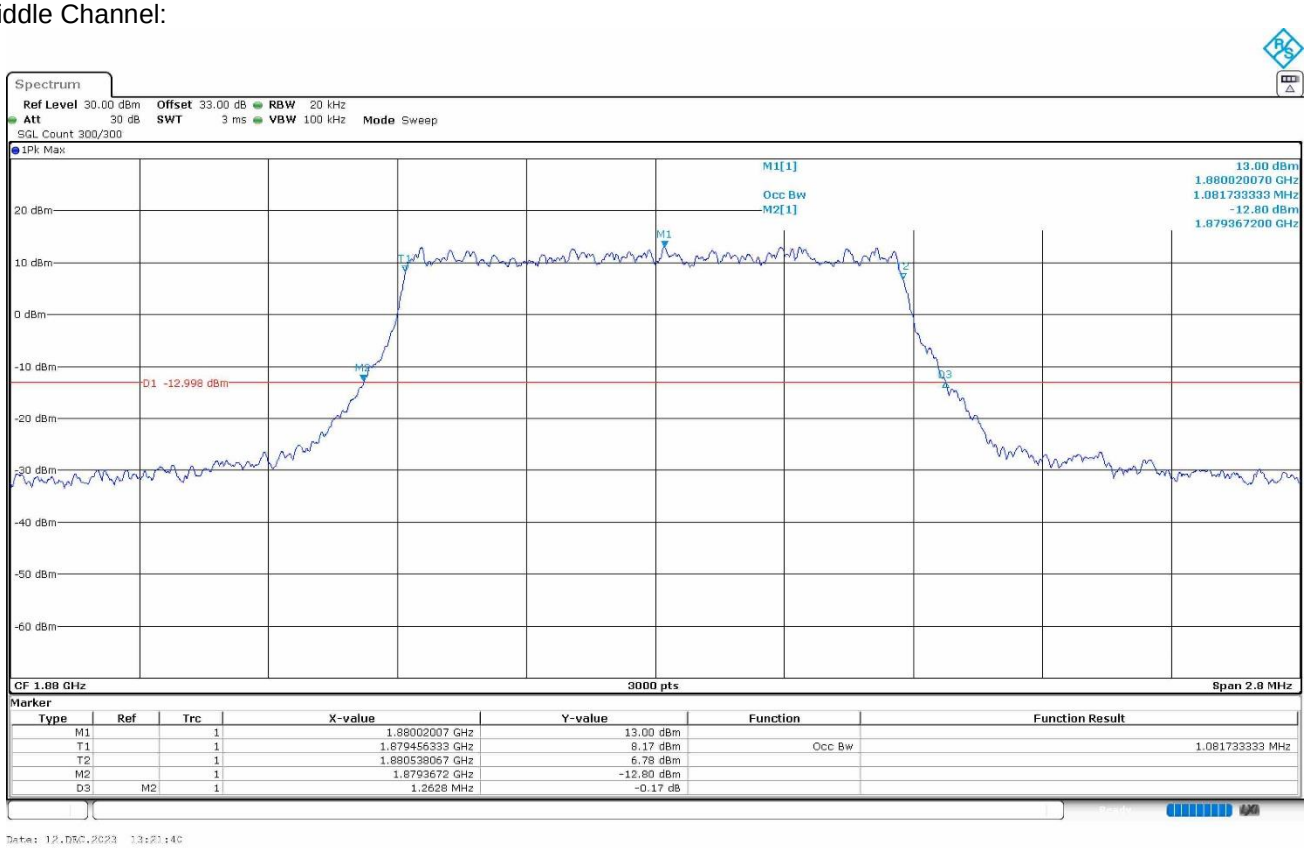
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.085	1.079	1.083
-26 dBc Bandwidth (MHz)	1.261	1.250	1.276
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=1.4 MHz. QPSK. RB Size=All.

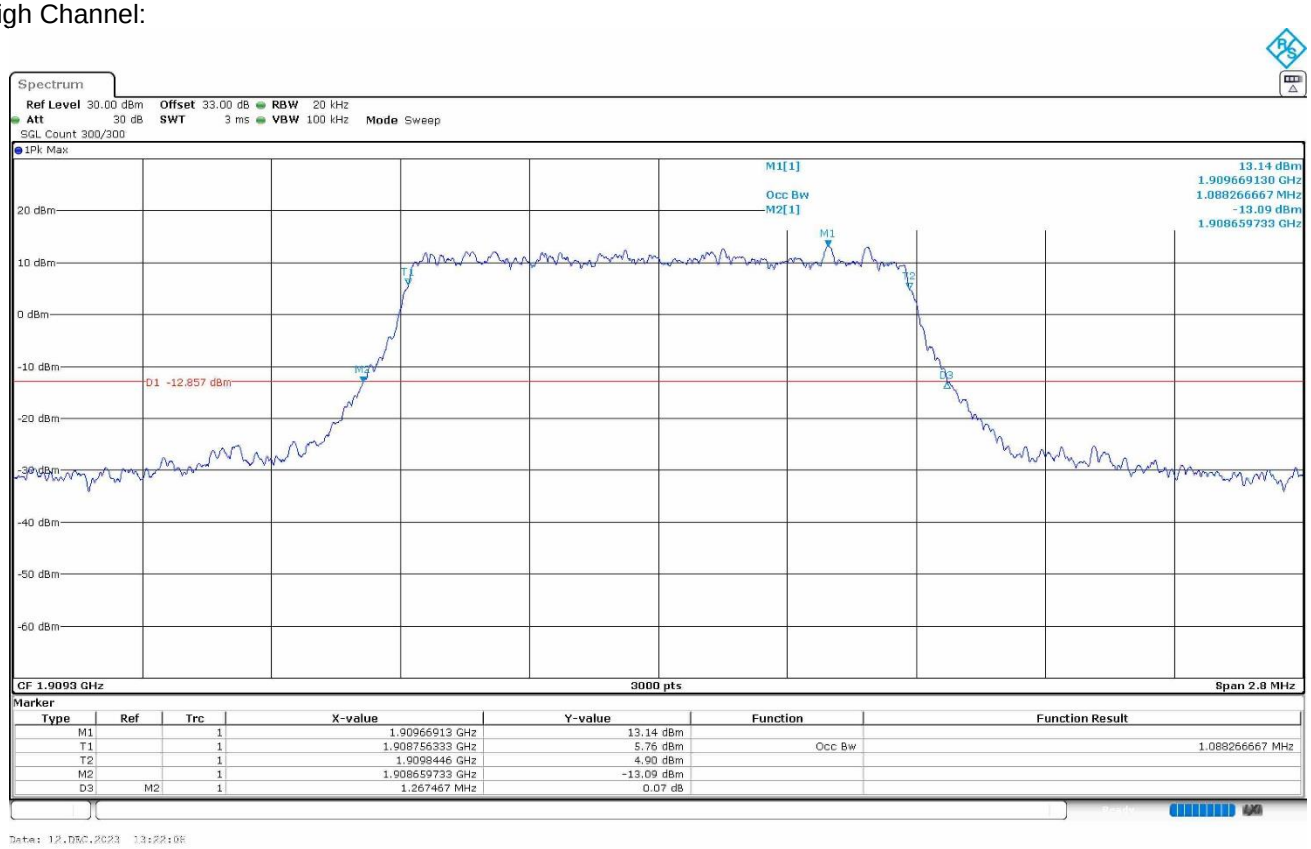
Low Channel:



Middle Channel:

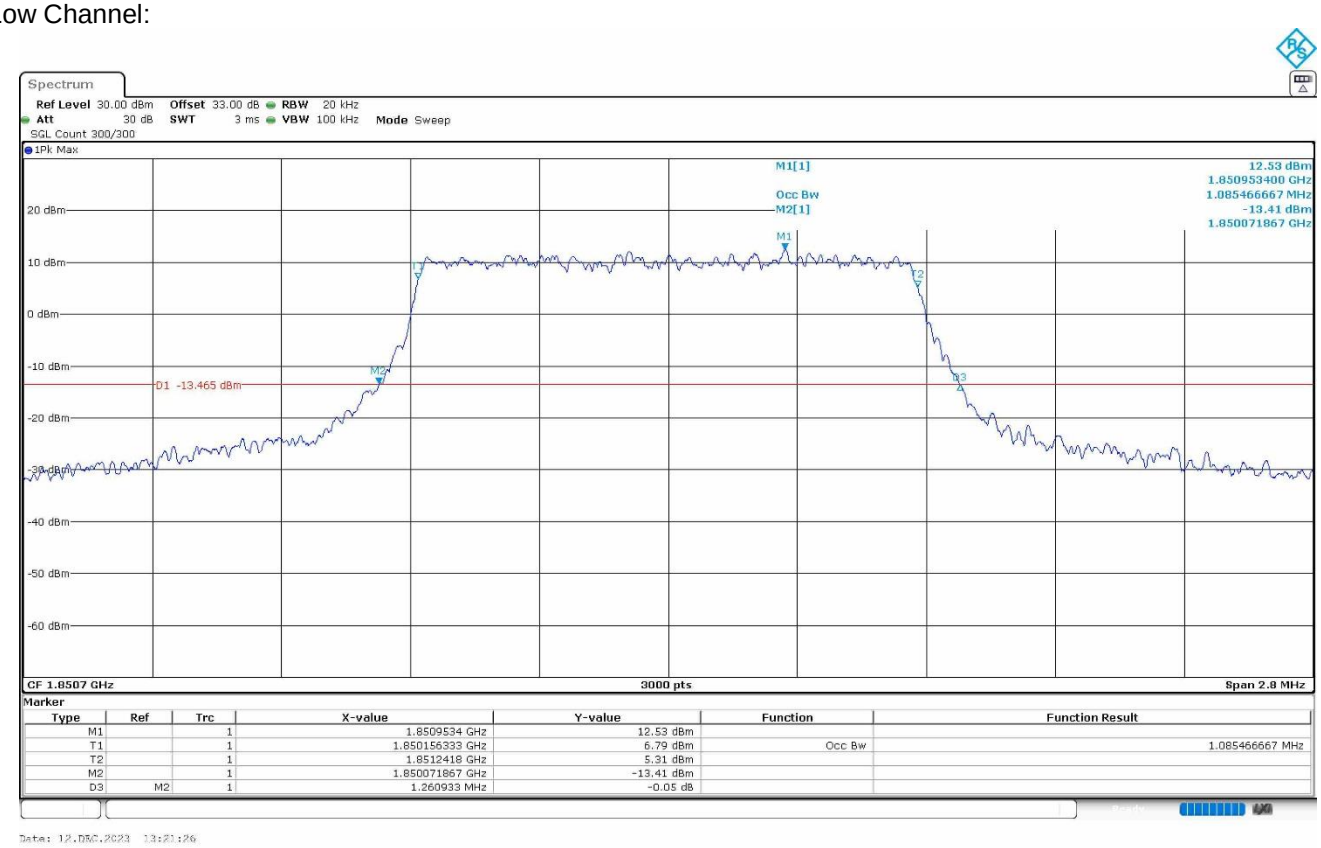


High Channel:

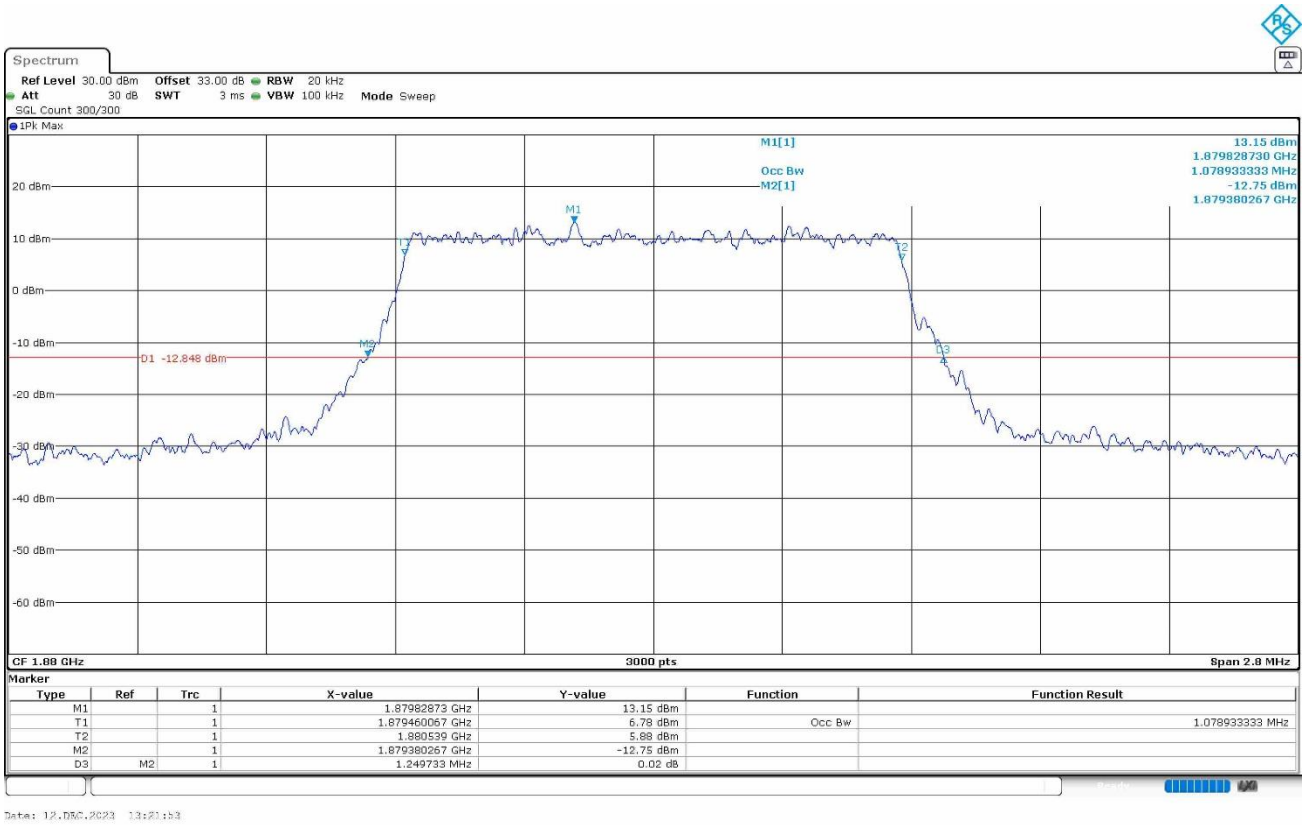


LTE Cat 1bis Band 2. BW=1.4 MHz. 16QAM. RB Size=All.

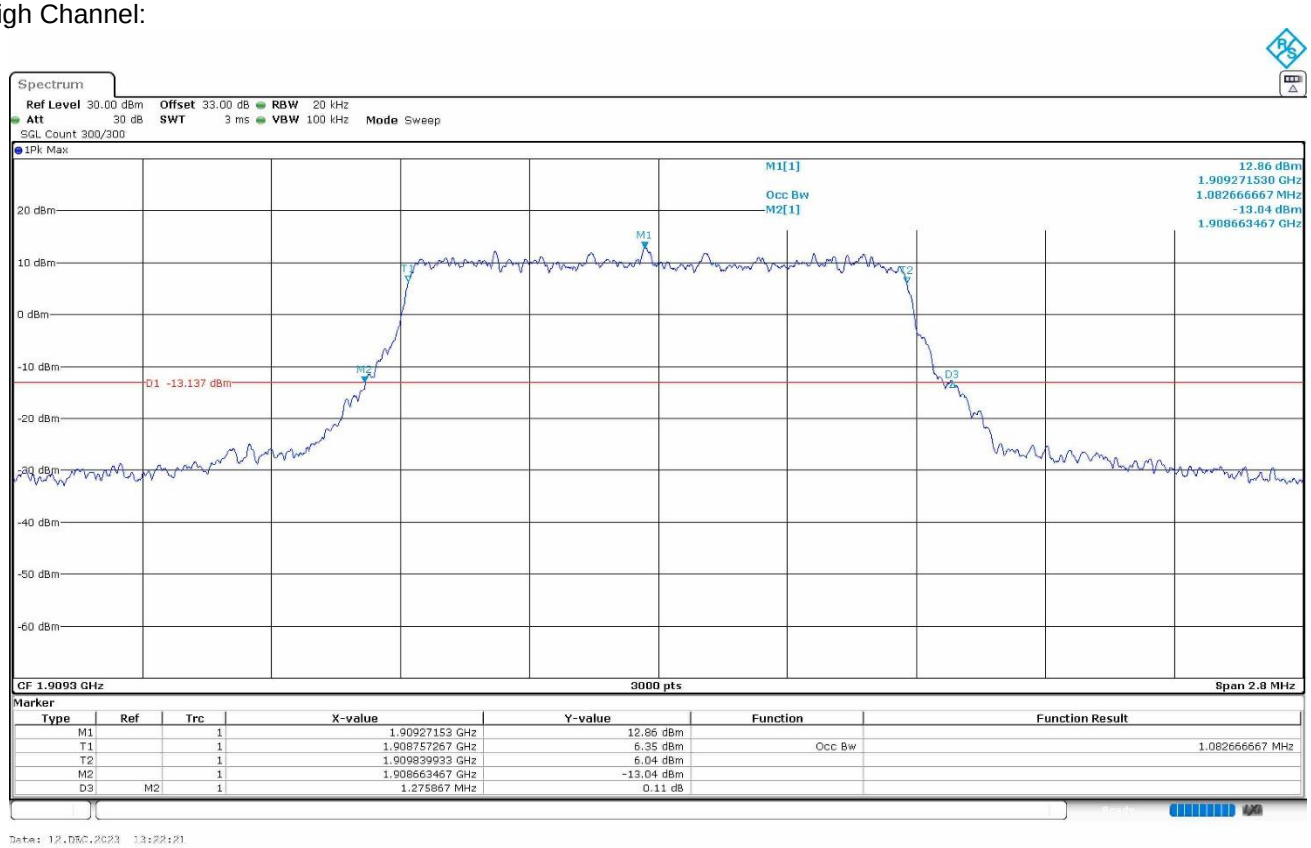
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 2. BW=3 MHz. QPSK. RB Size=All.

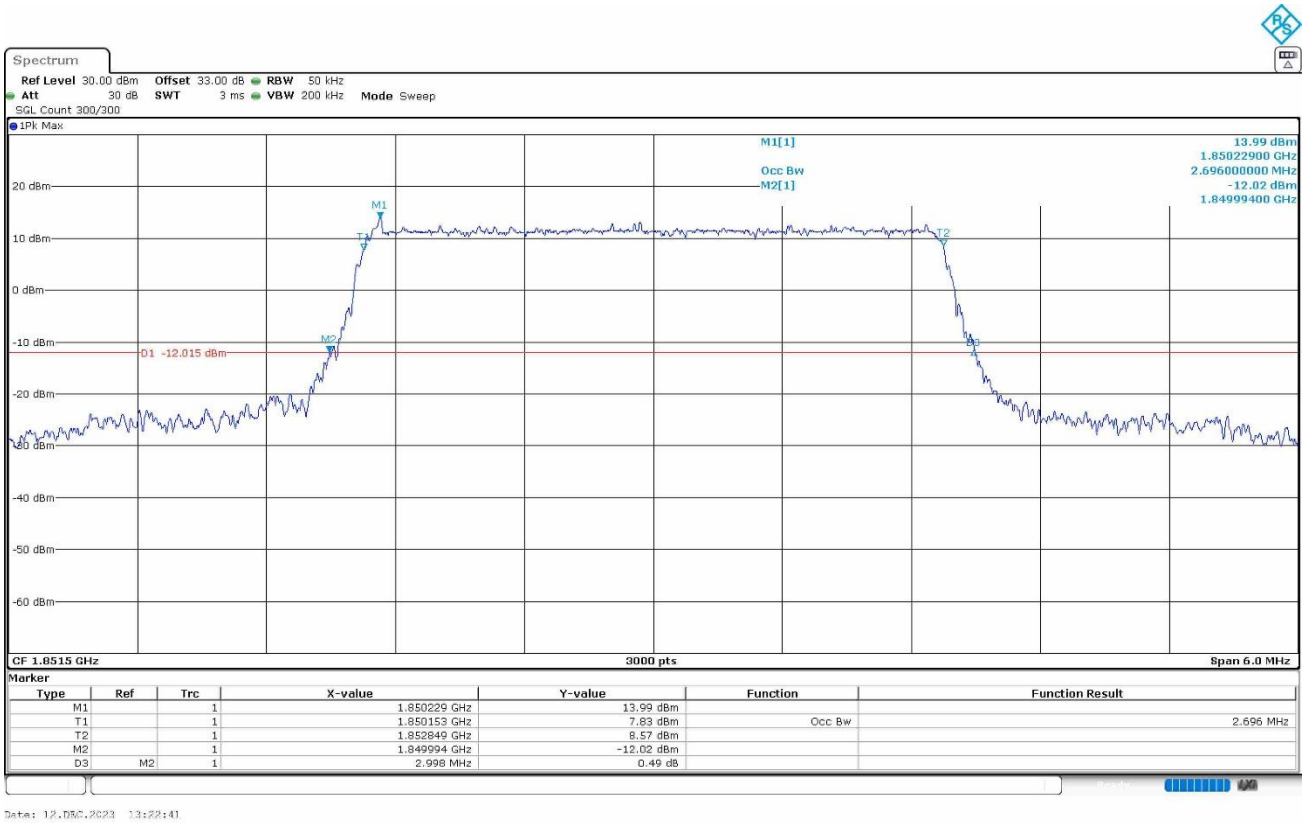
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.696	2.696	2.692
-26 dBc Bandwidth (MHz)	2.988	2.998	2.988
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=3 MHz. 16QAM. RB Size=All.

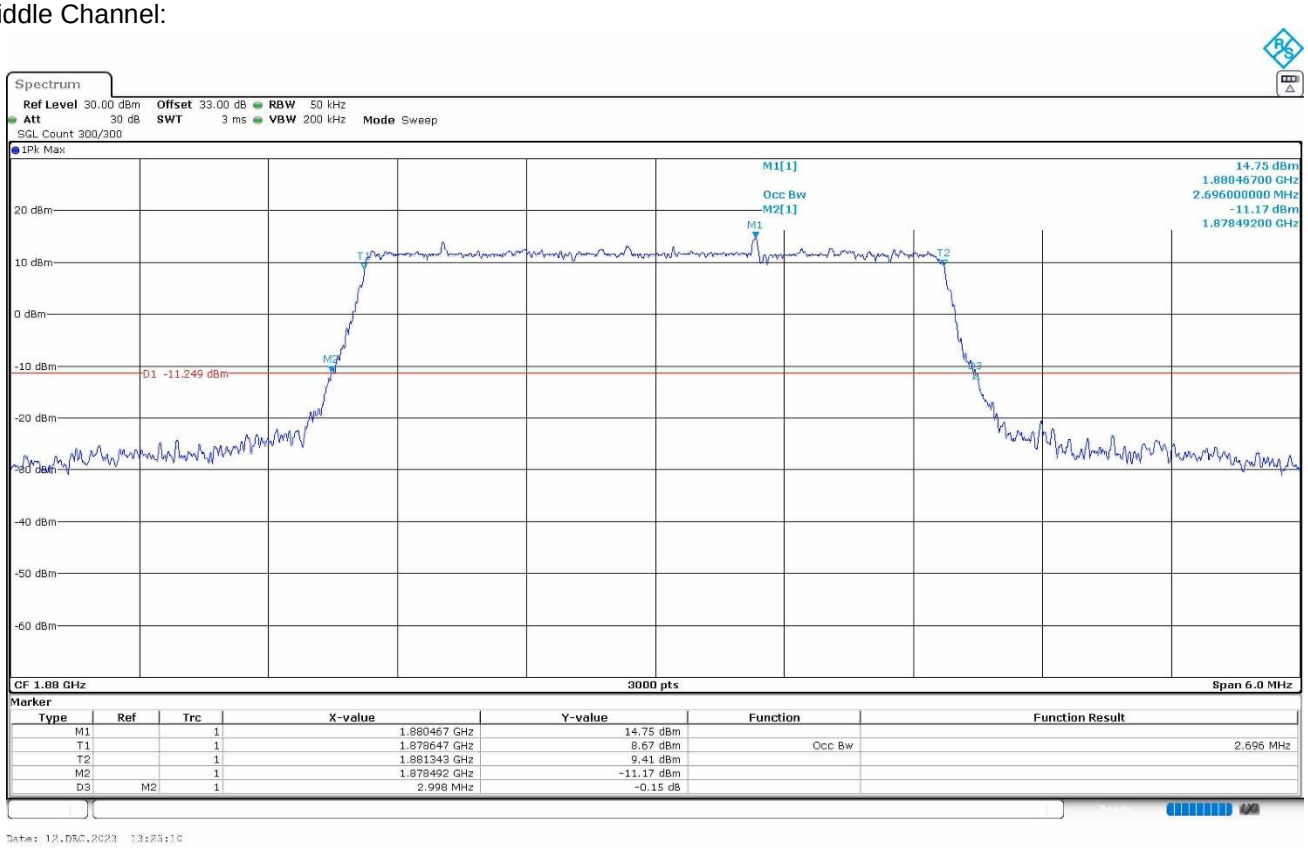
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.684	2.692	2.686
-26 dBc Bandwidth (MHz)	2.986	2.992	2.996
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=3 MHz. QPSK. RB Size=All.

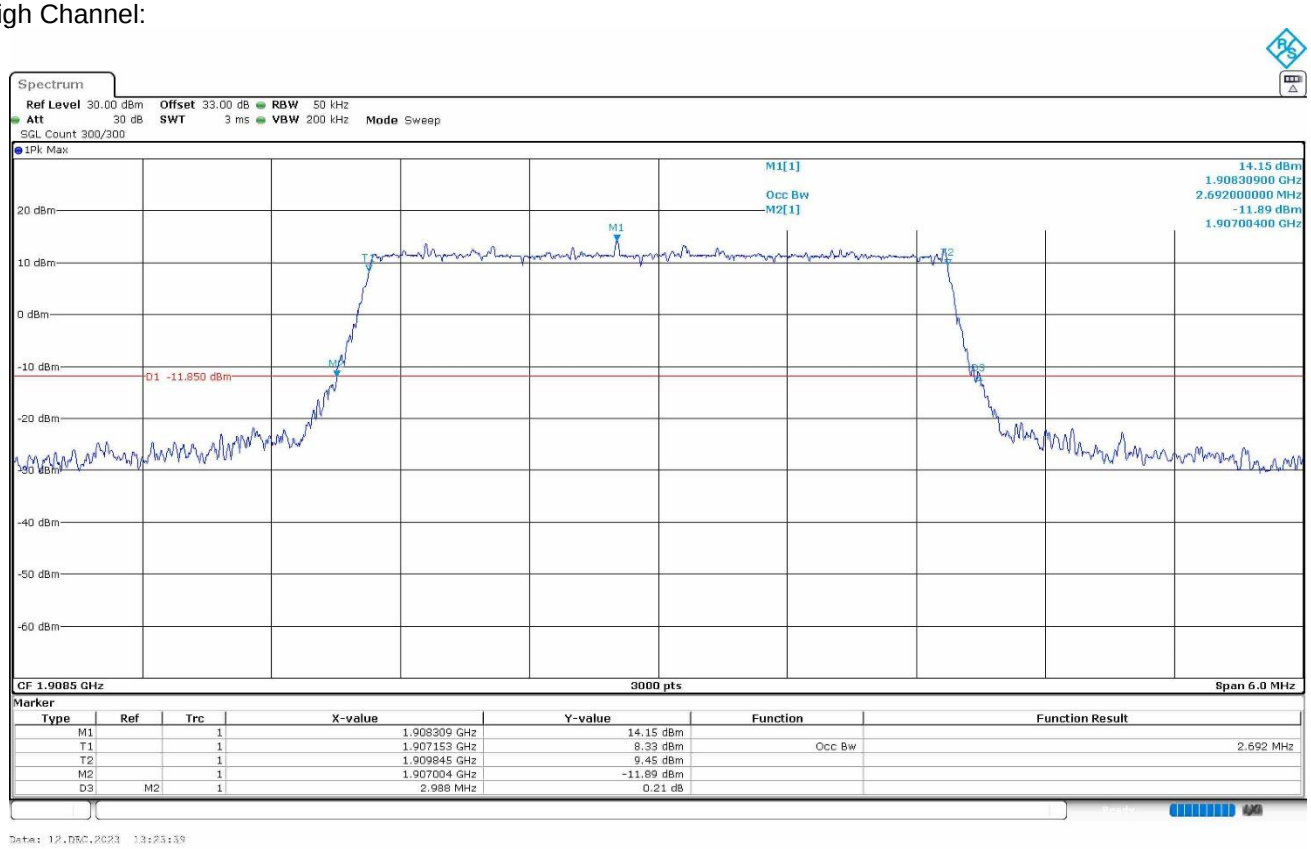
Low Channel:



Middle Channel:

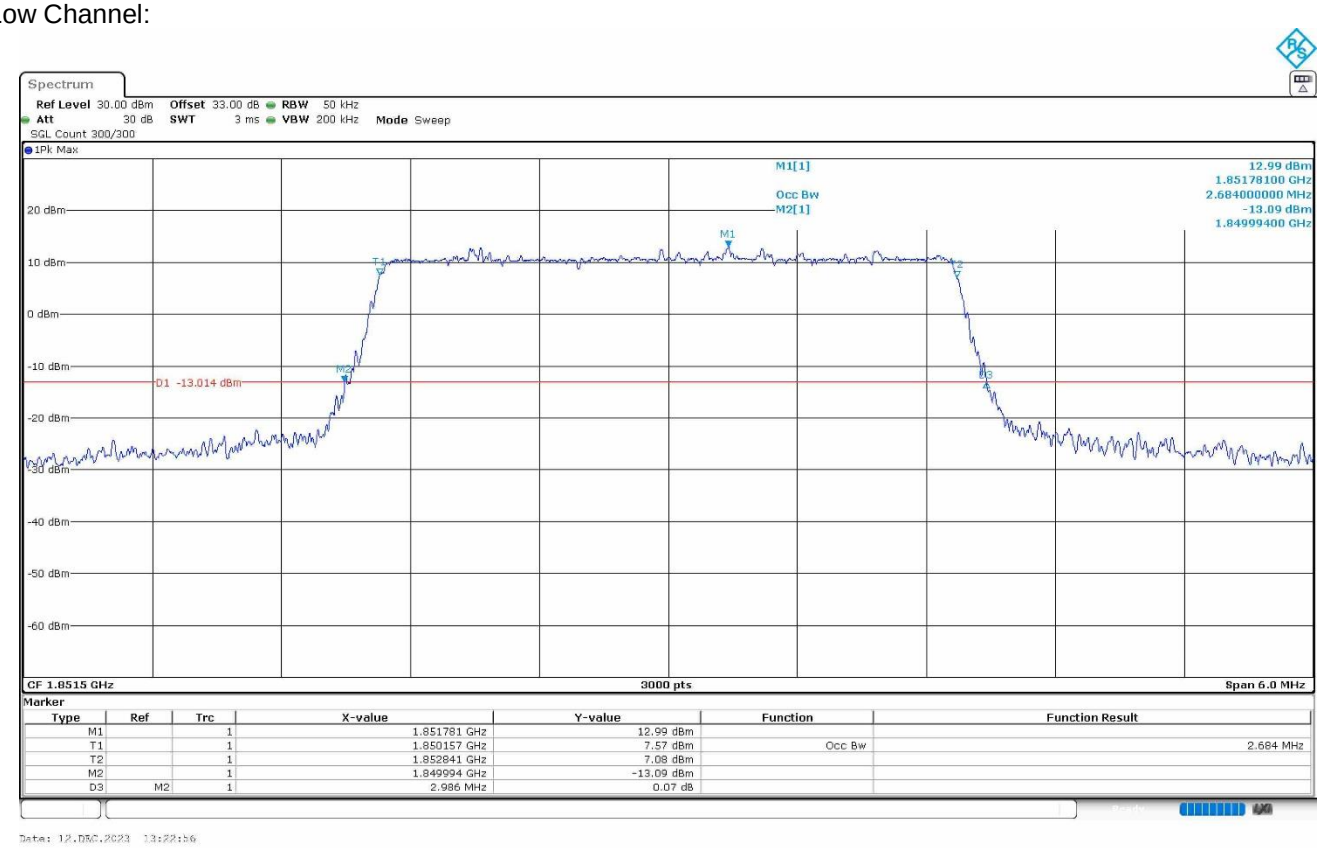


High Channel:

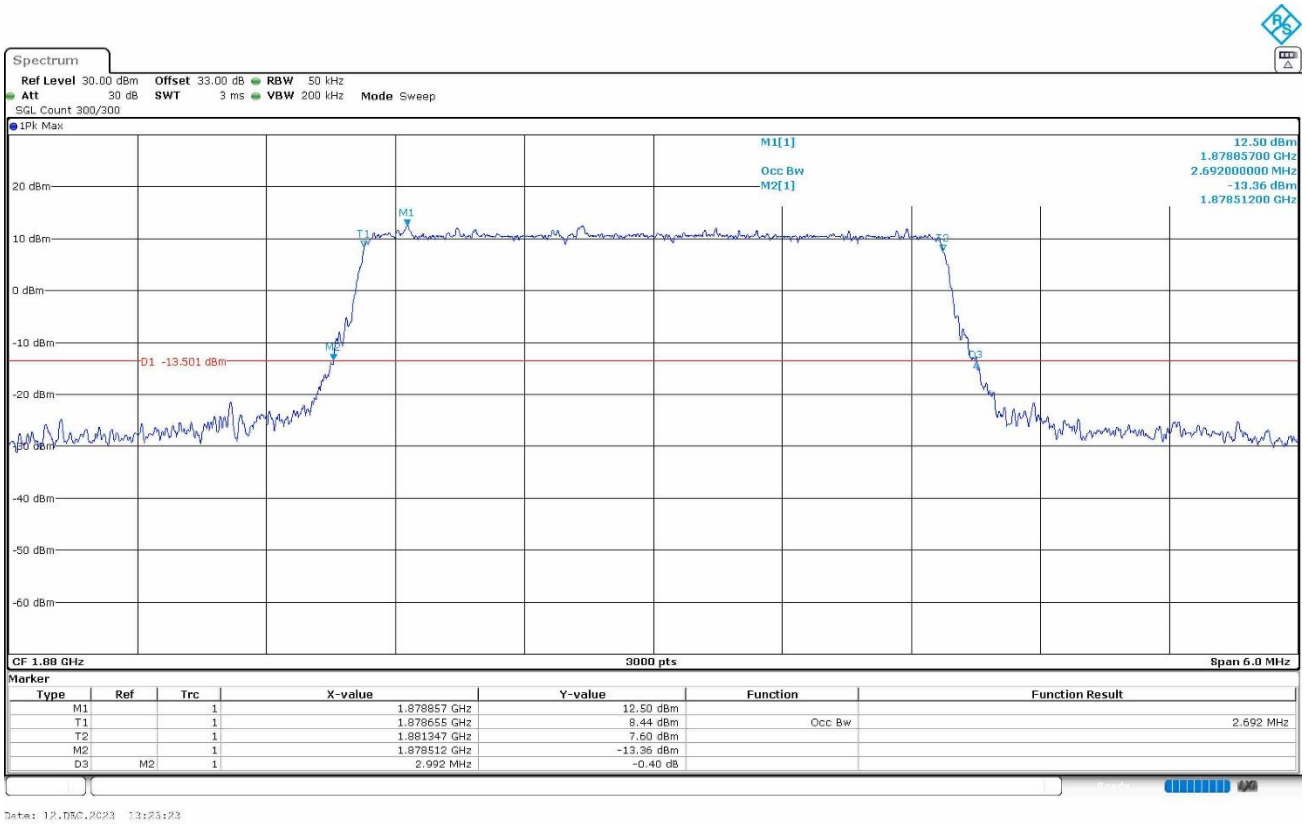


LTE Cat 1bis Band 2. BW=3 MHz. 16QAM. RB Size=All.

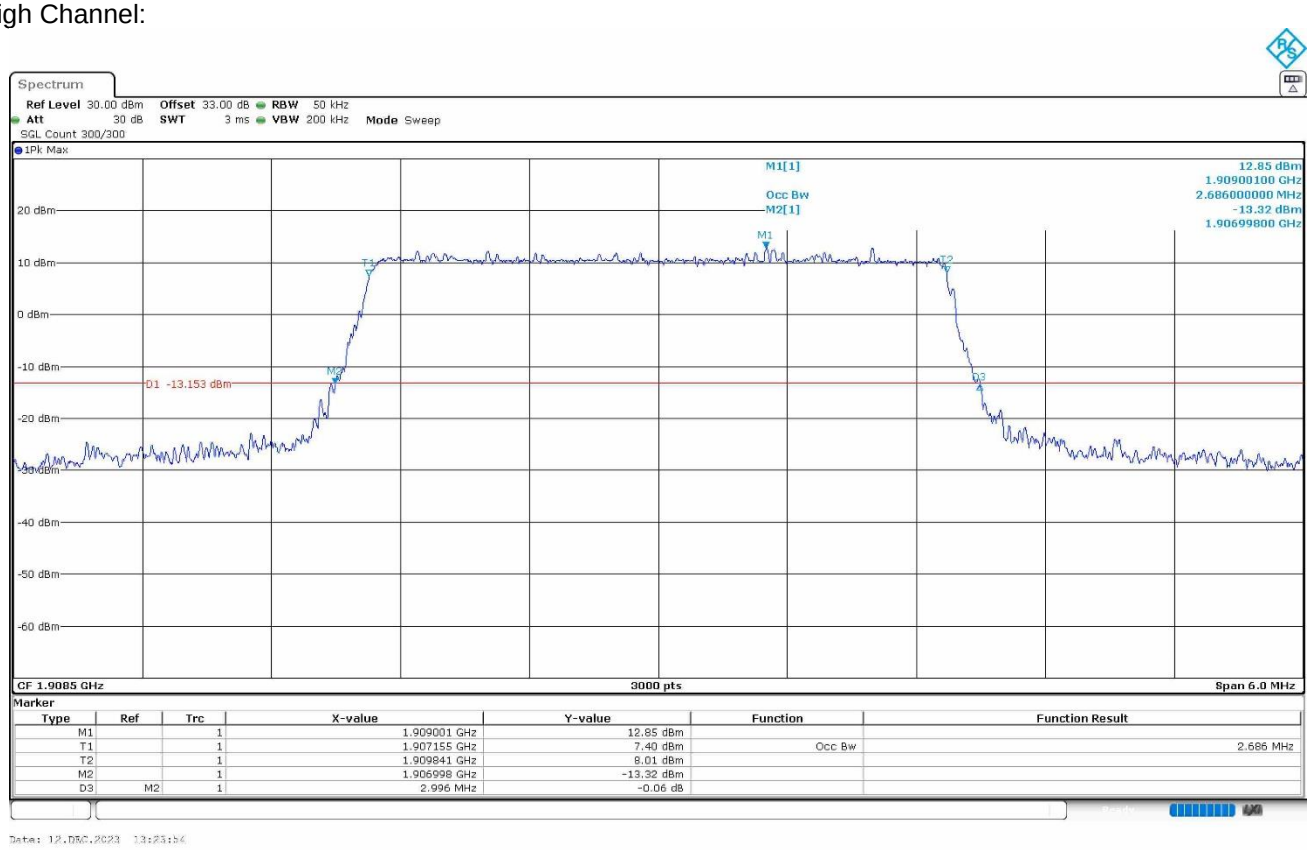
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 2. BW=5 MHz. QPSK. RB Size=All.

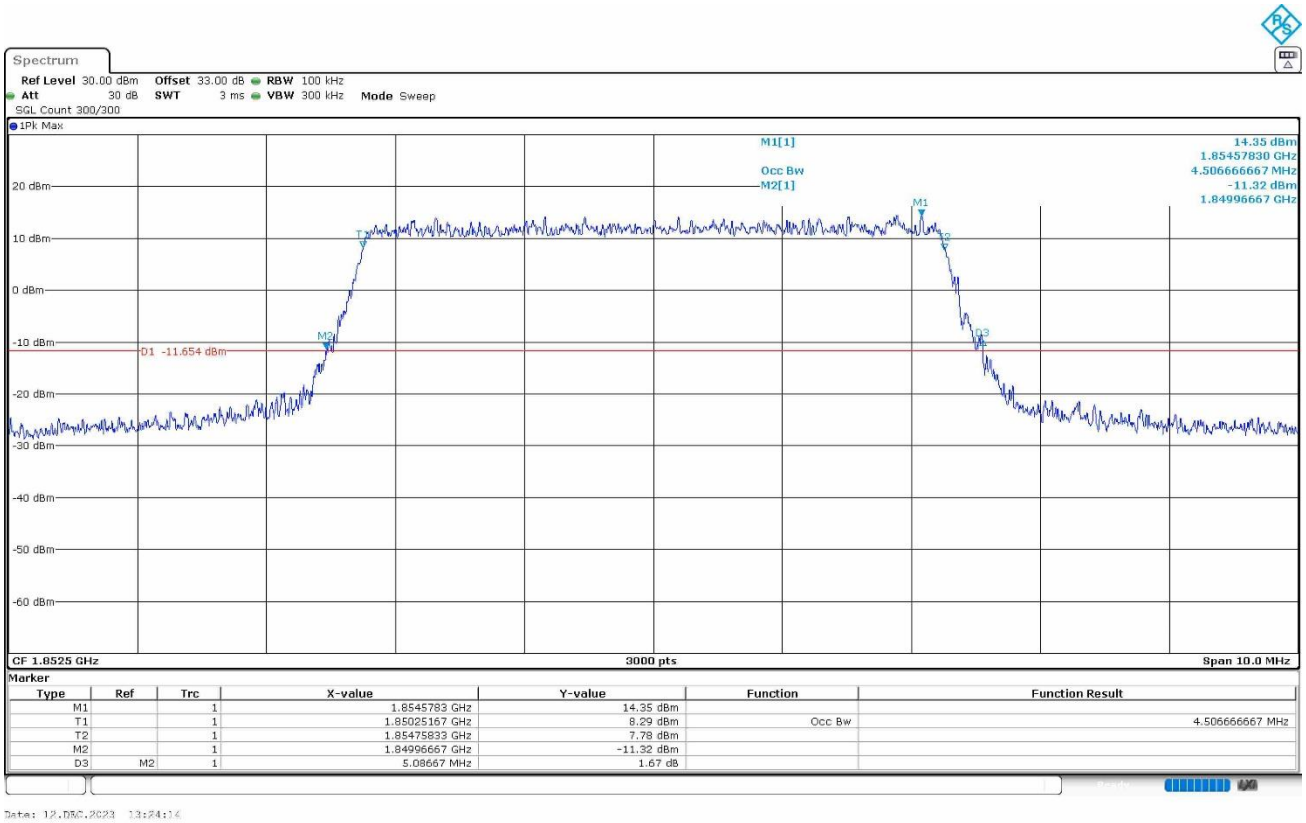
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.506	4.506	4.496
-26 dBc Bandwidth (MHz)	5.087	5.053	5.056
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=5 MHz. 16QAM. RB Size=All.

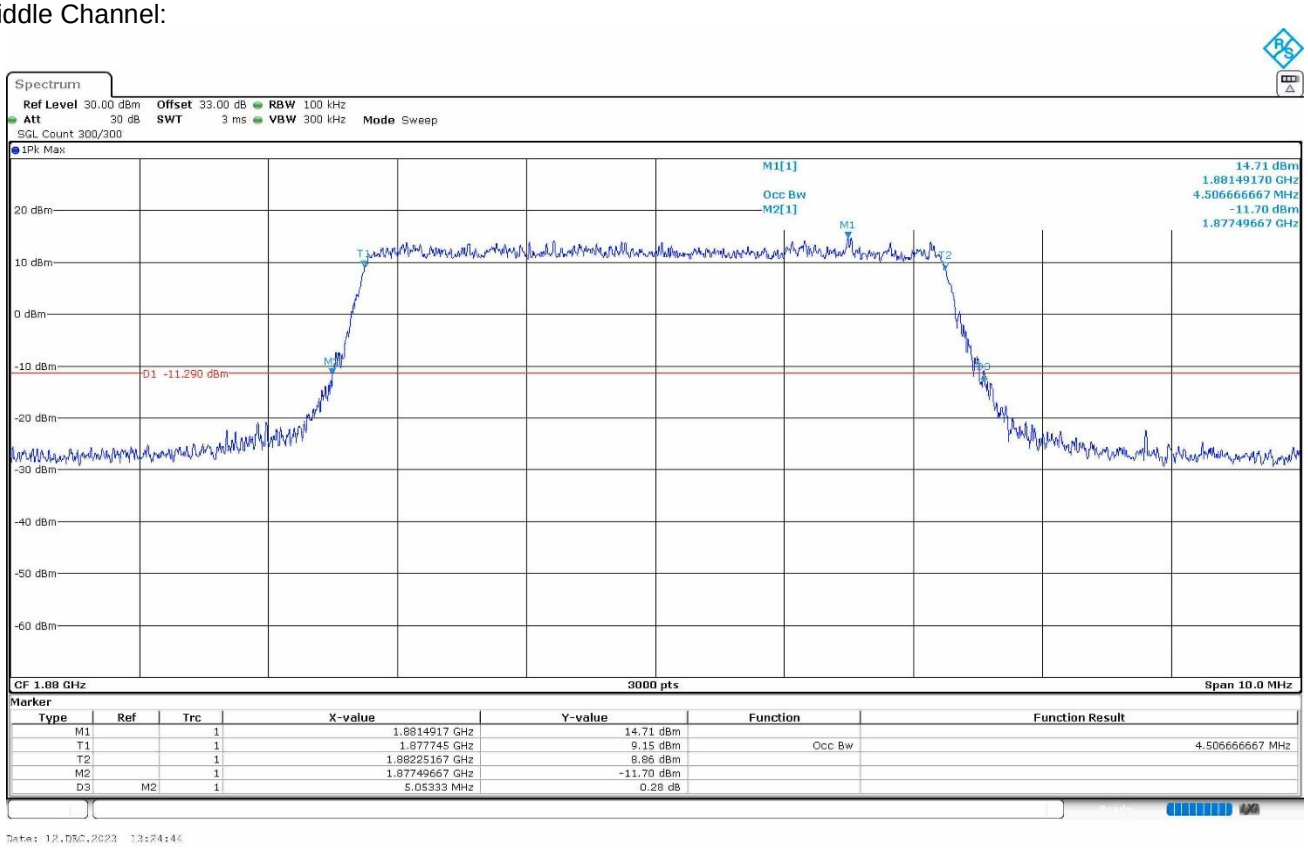
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.503	4.506	4.516
-26 dBc Bandwidth (MHz)	5.053	5.073	5.096
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=5 MHz. QPSK. RB Size=All.

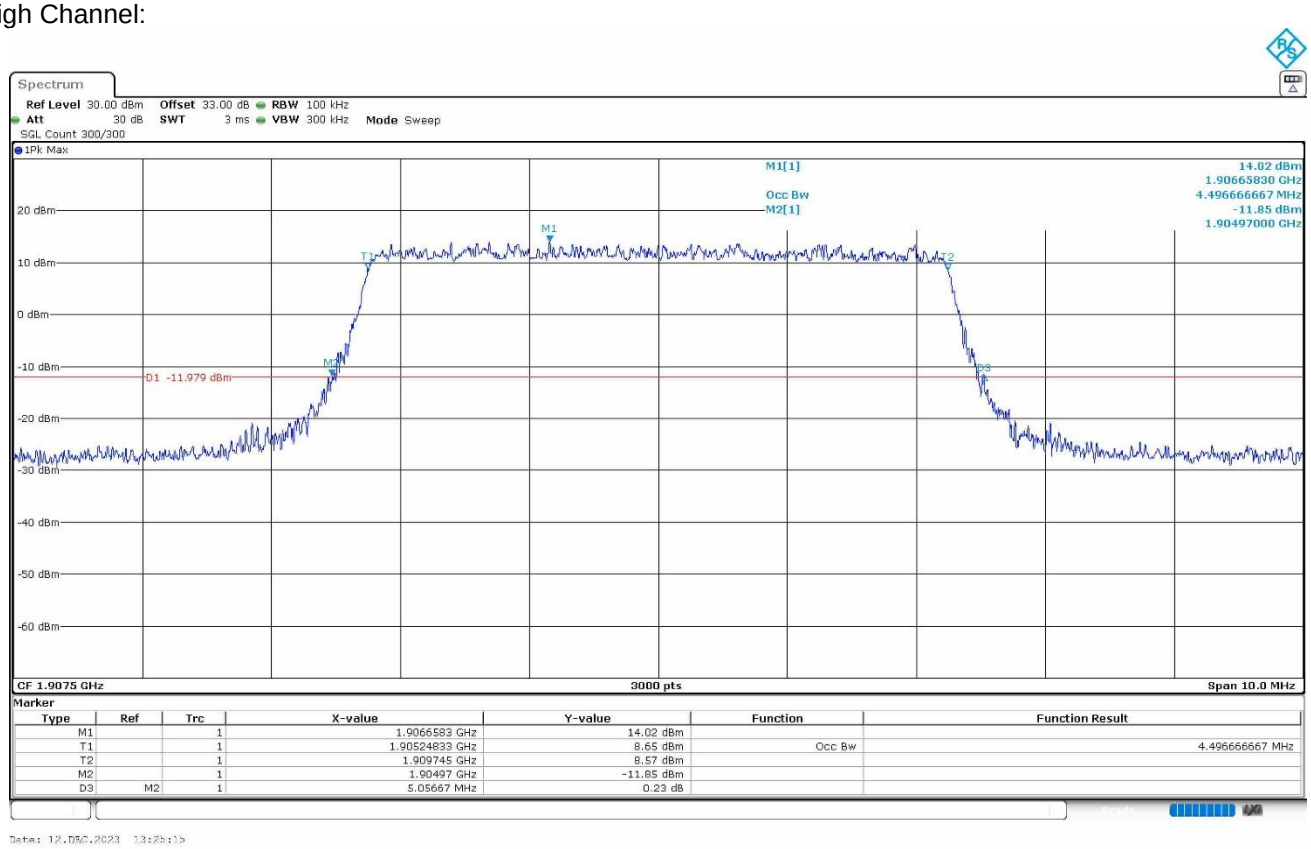
Low Channel:



Middle Channel:

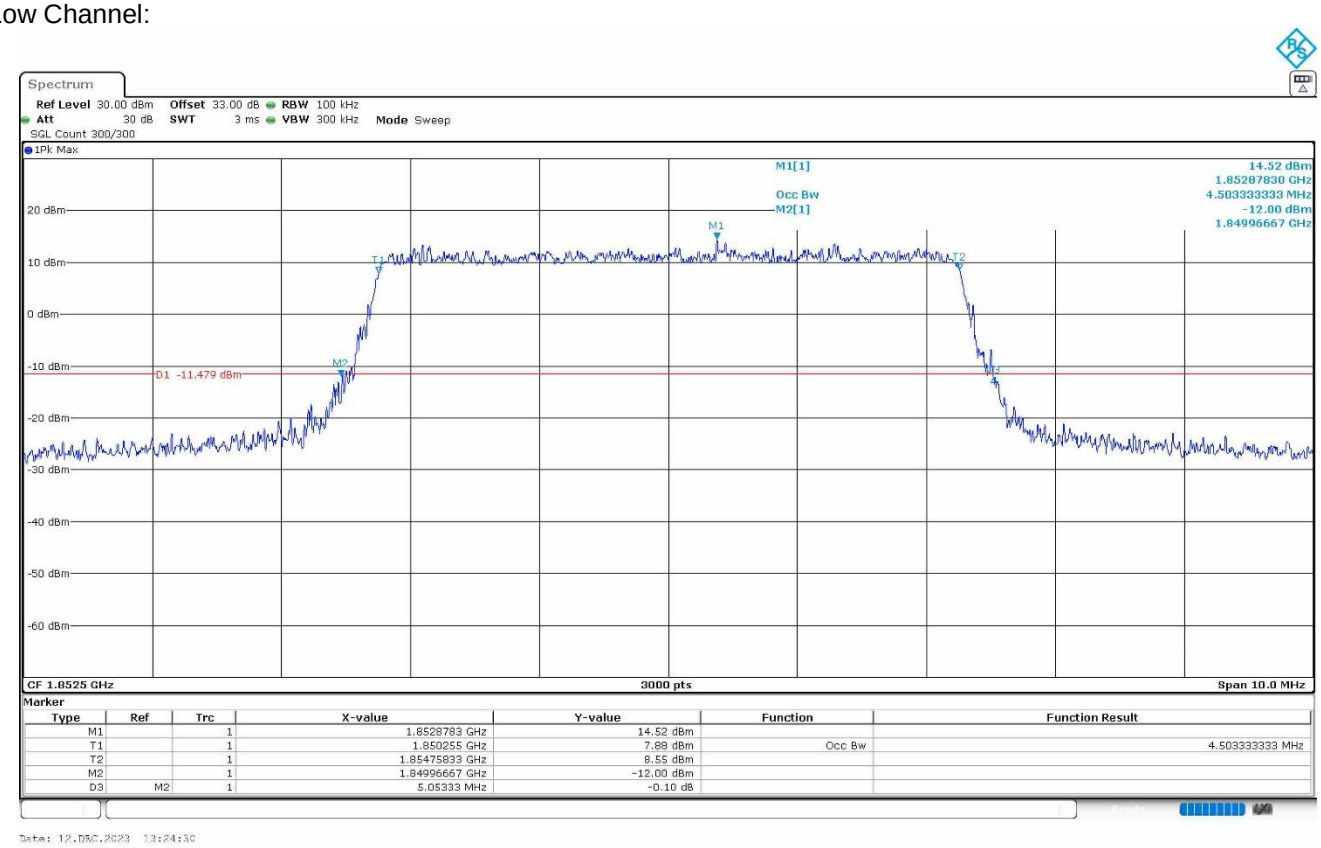


High Channel:

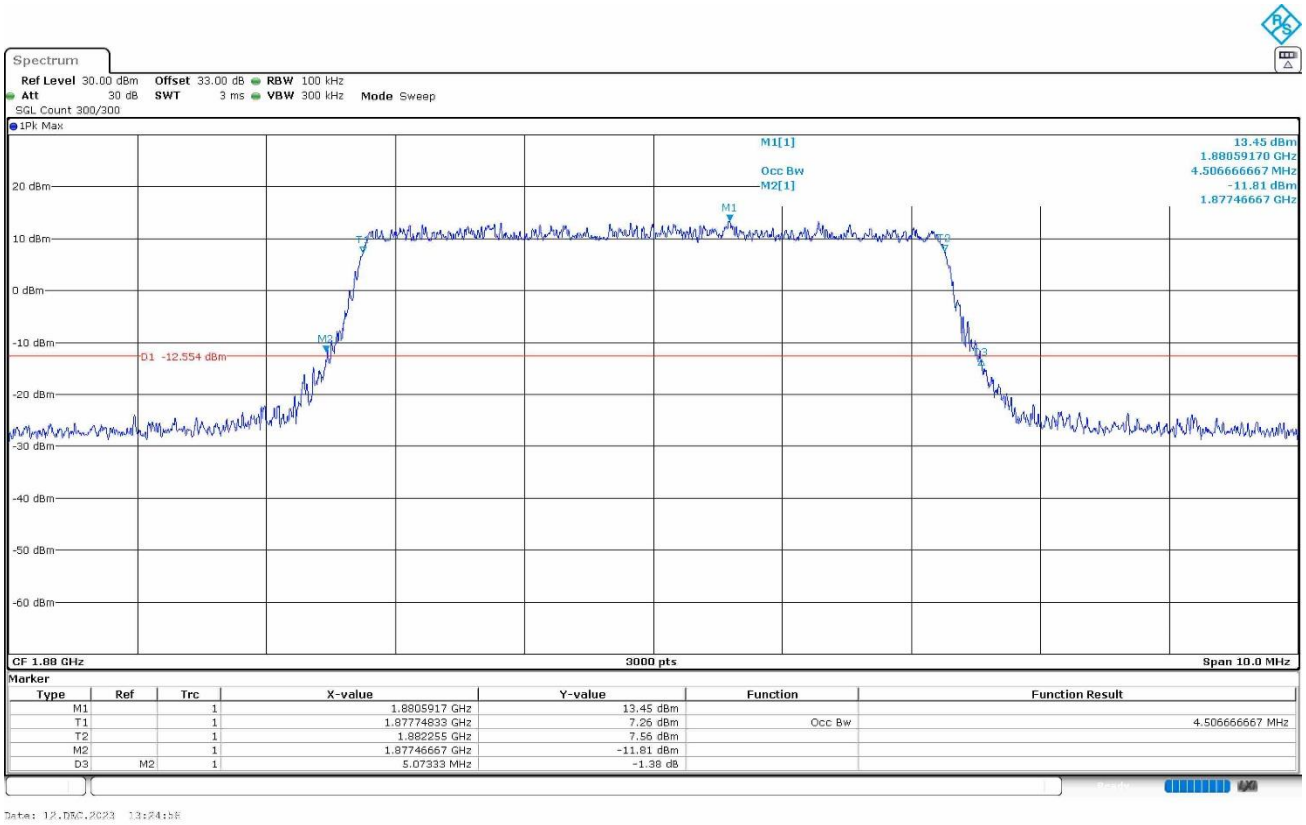


LTE Cat 1bis Band 2. BW=5 MHz. 16QAM. RB Size=All.

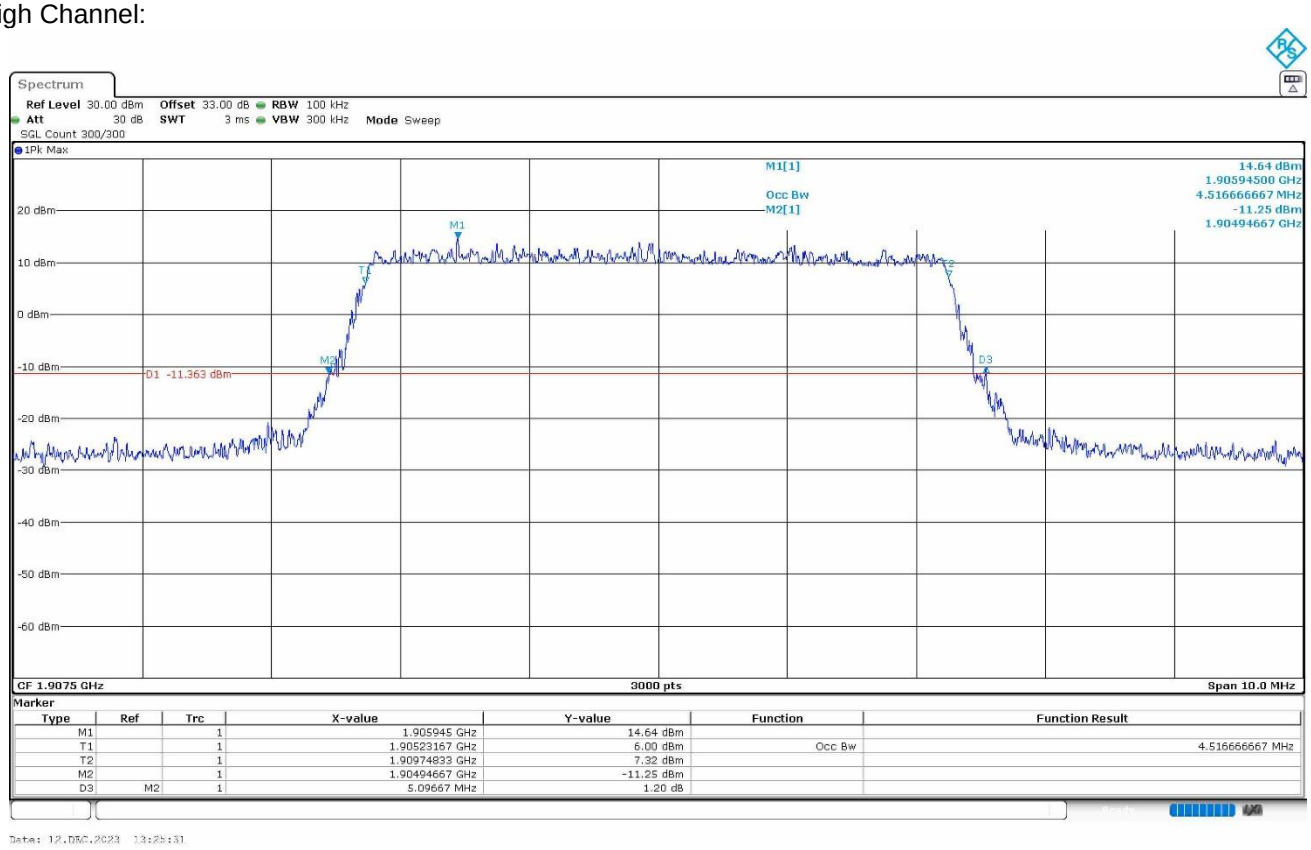
Low Channel:



Middle Channel:



High Channel:



LTE Cat 1bis Band 2. BW=10 MHz. QPSK. RB Size=All.

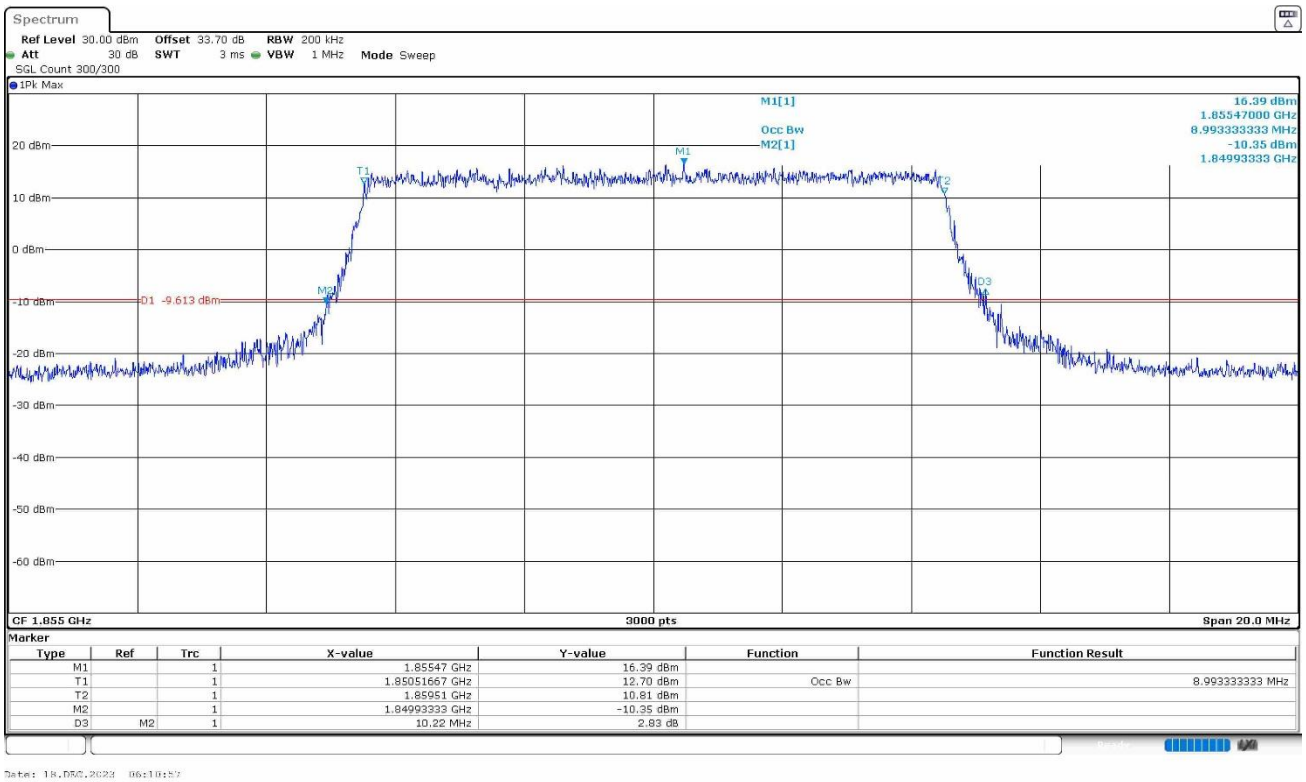
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	8.993	8.967	9.000
-26 dBc Bandwidth (MHz)	10.220	10.120	10.140
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=10 MHz. 16QAM. RB Size=All.

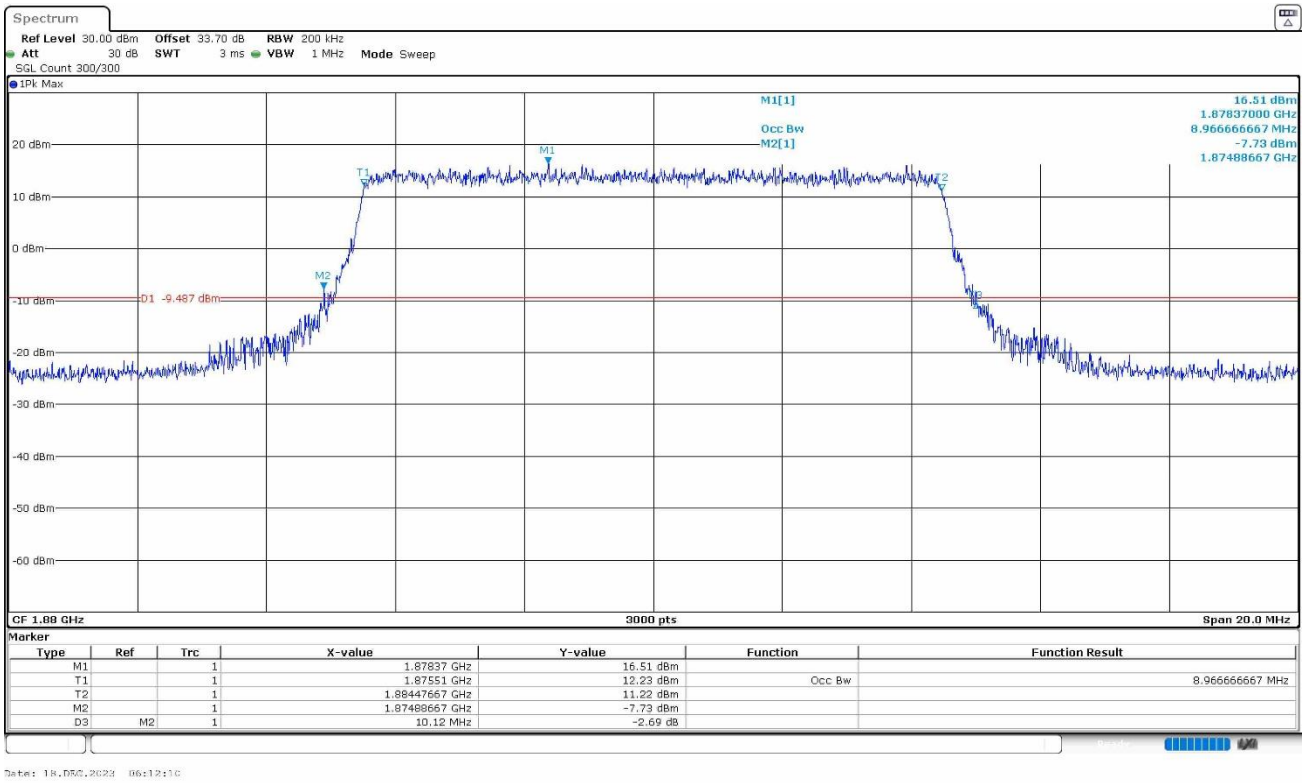
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.633	4.640	4.653
-26 dBc Bandwidth (MHz)	5.893	5.880	5.933
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=10 MHz. QPSK. RB Size=All.

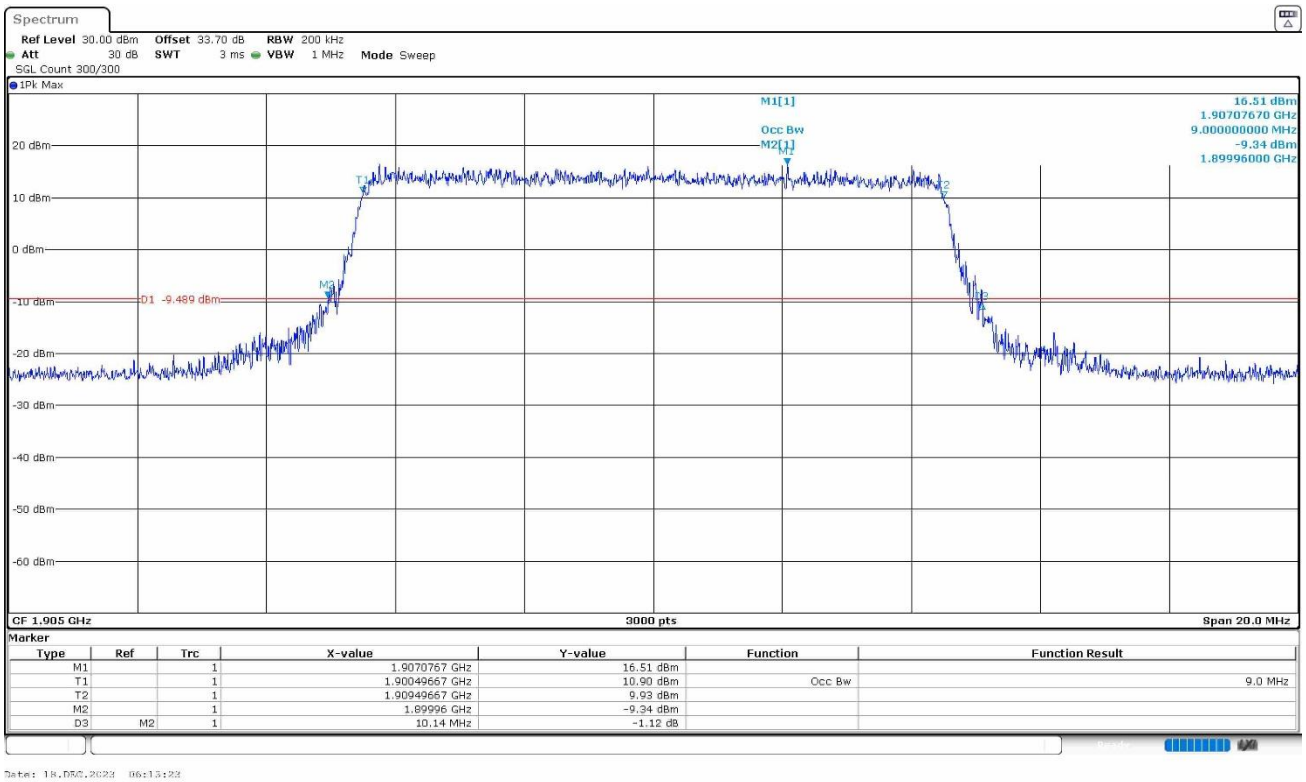
Low Channel:



Middle Channel:

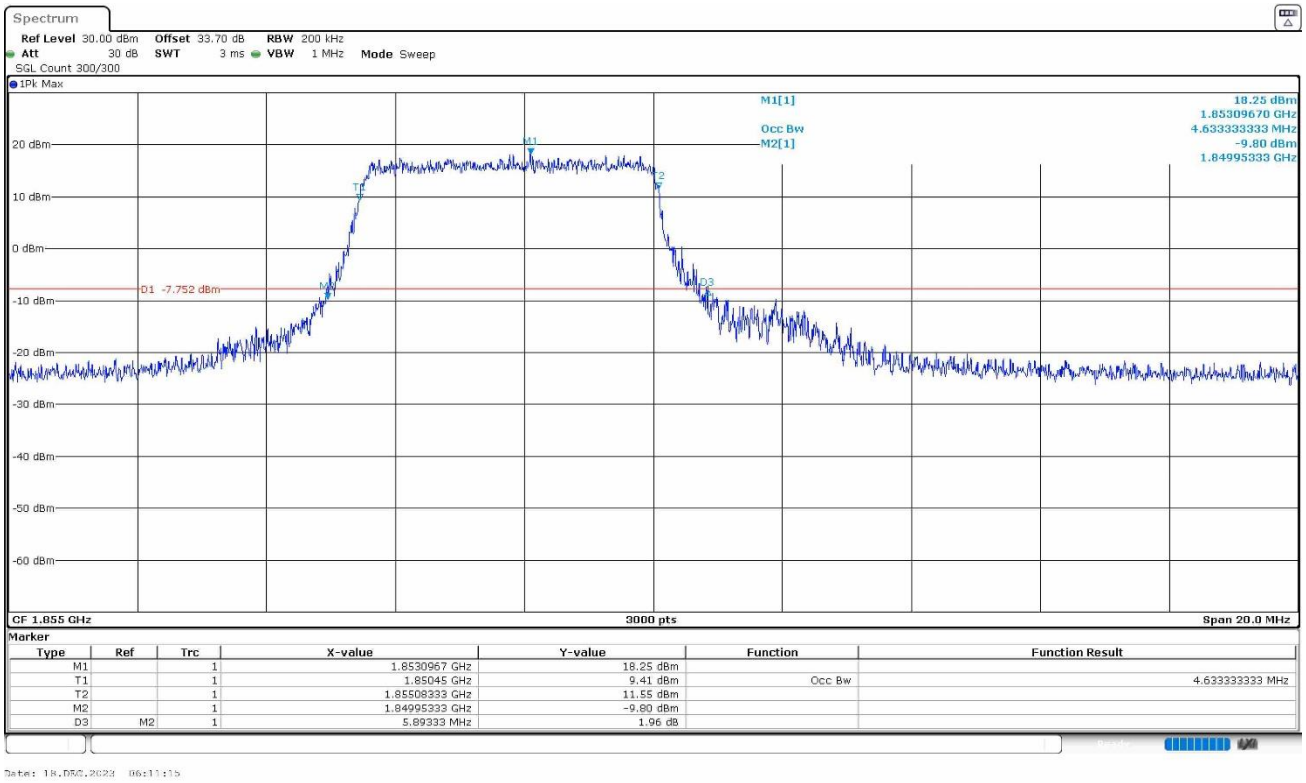


High Channel:

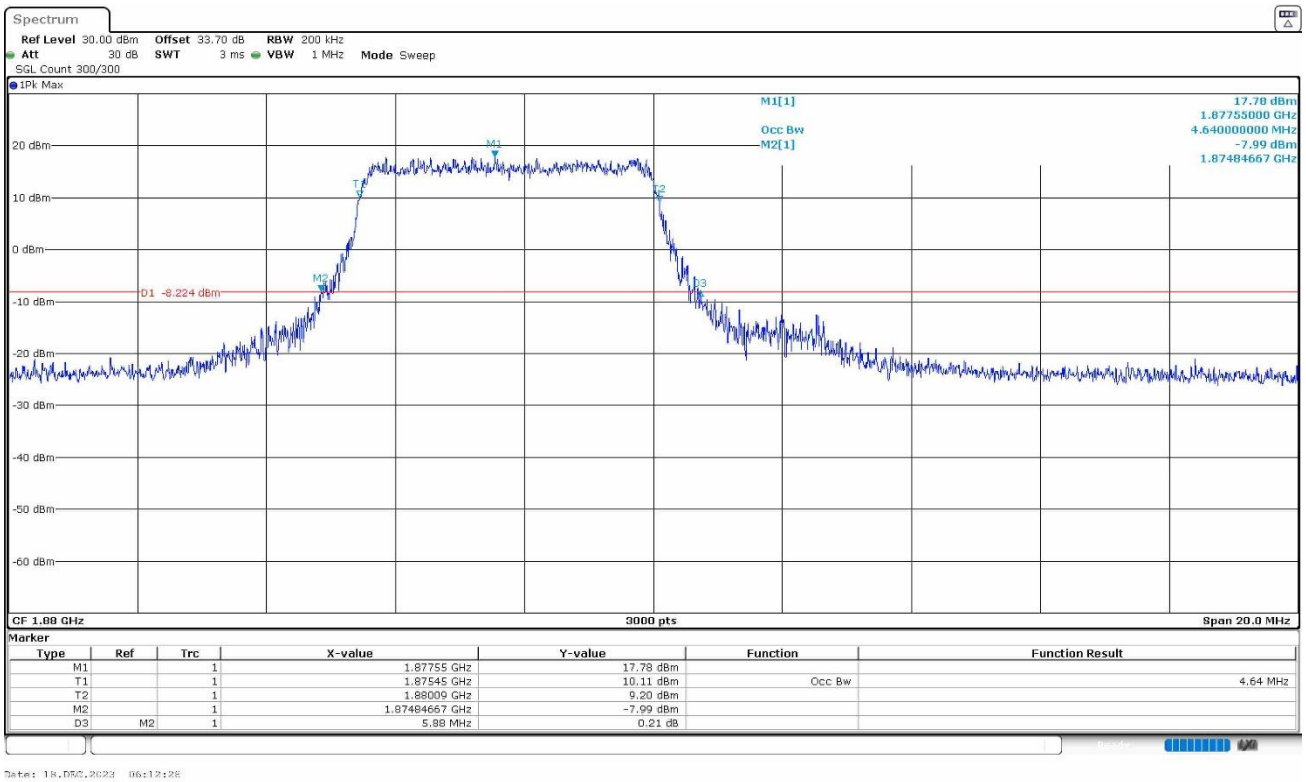


LTE Cat 1bis Band 2. BW=10 MHz. 16QAM. RB Size=All.

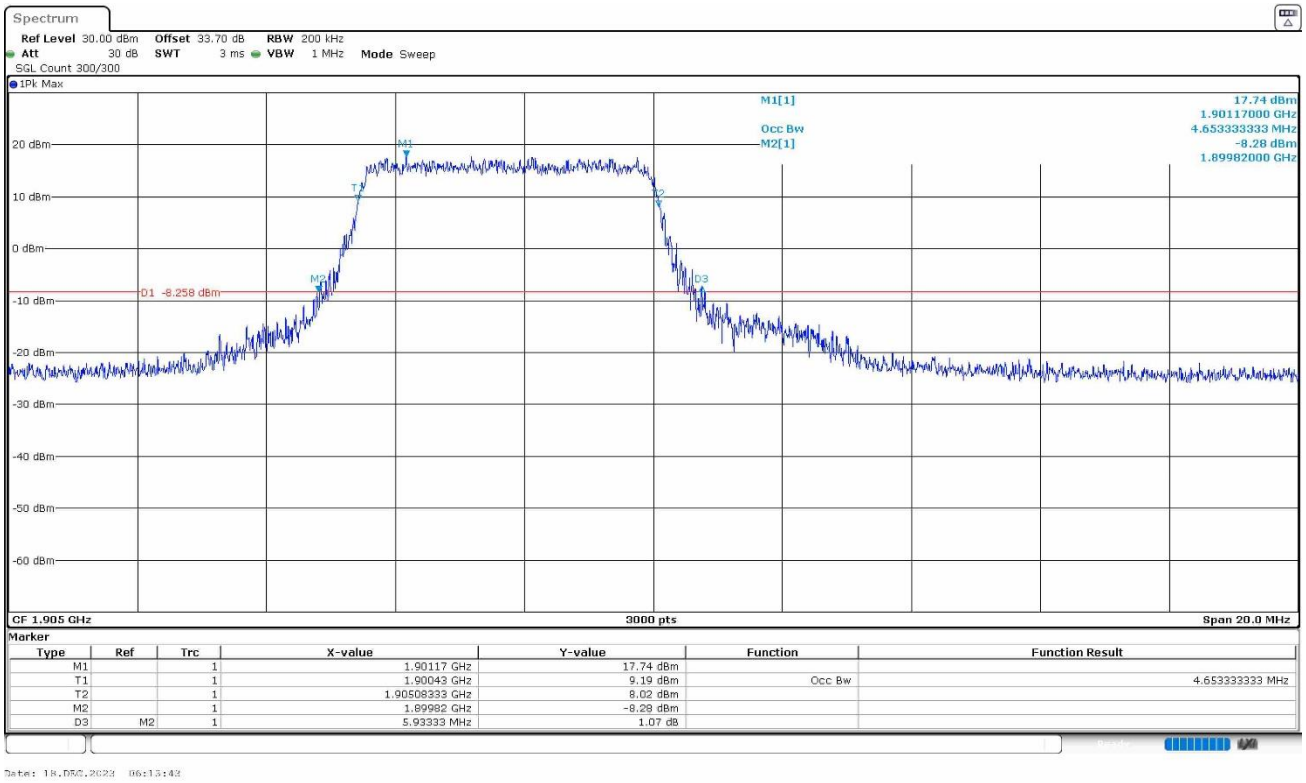
Low Channel:



Middle Channel:



High Channel:



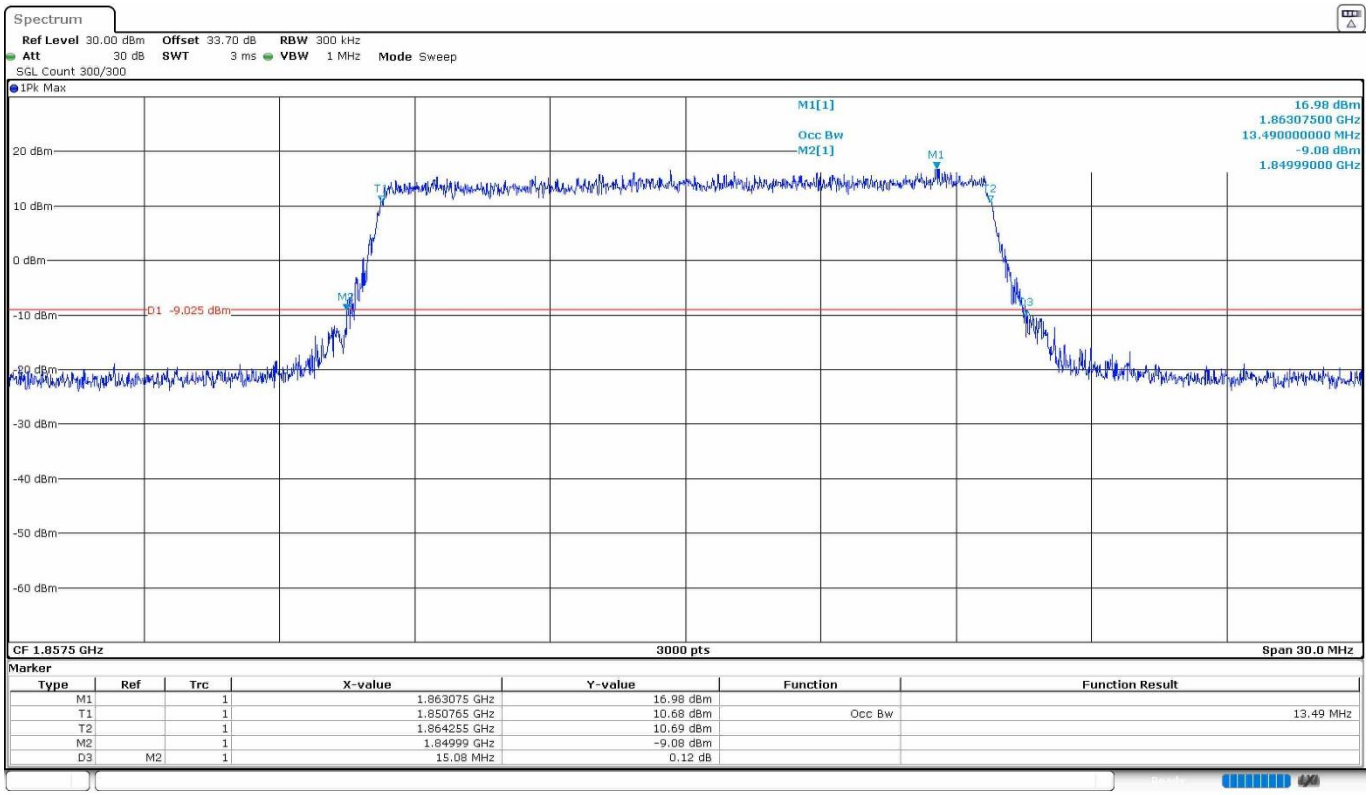
LTE Cat 1bis Band 2. BW=15 MHz. QPSK. RB Size=All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	13.490	13.510	13.490
-26 dBc Bandwidth (MHz)	15.080	15.270	15.320
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=15 MHz. 16QAM. RB Size=All.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.752	4.713	4.704
-26 dBc Bandwidth (MHz)	6.278	6.177	6.112
Measurement uncertainty (kHz)	<±3.75		

LTE Cat 1bis Band 2. BW=15 MHz. QPSK. RB Size=All.
Low Channel:



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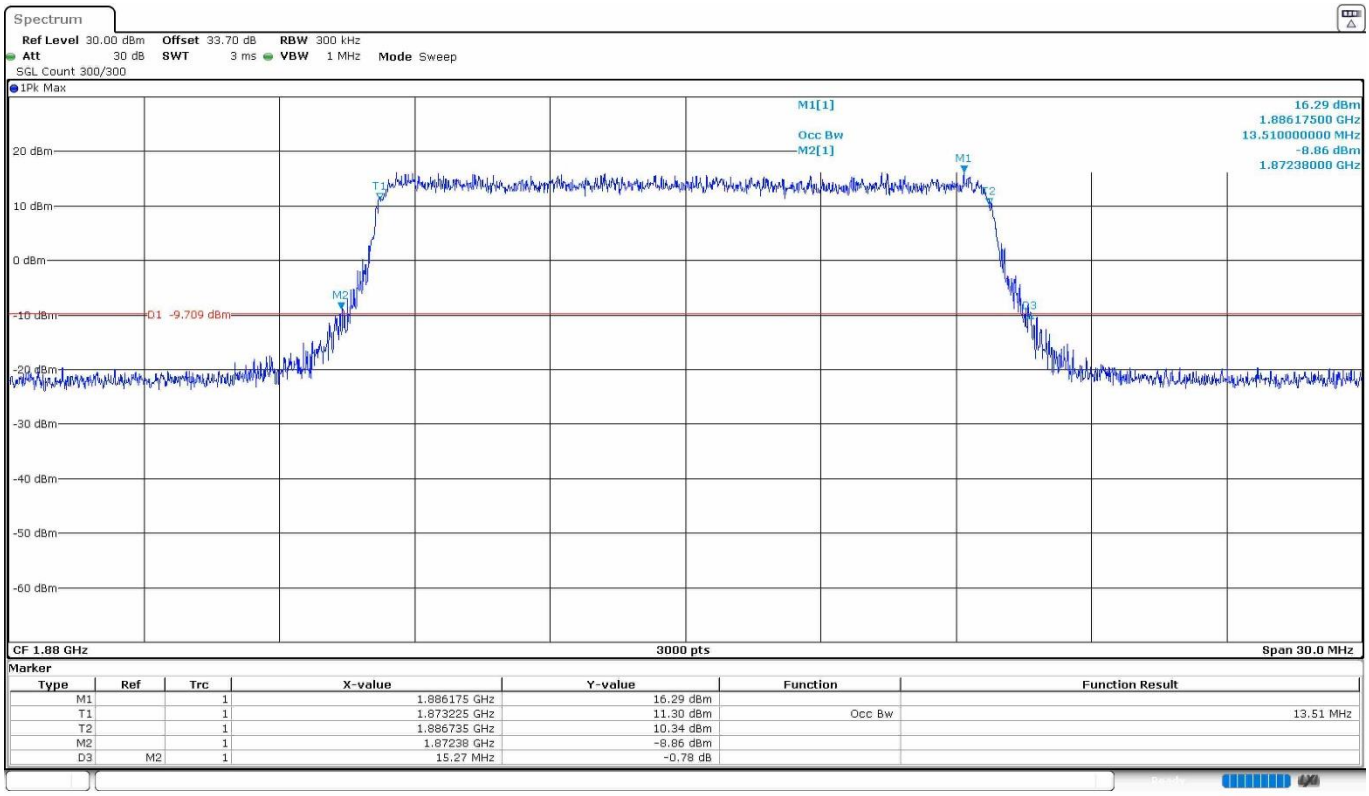
Middle Channel:



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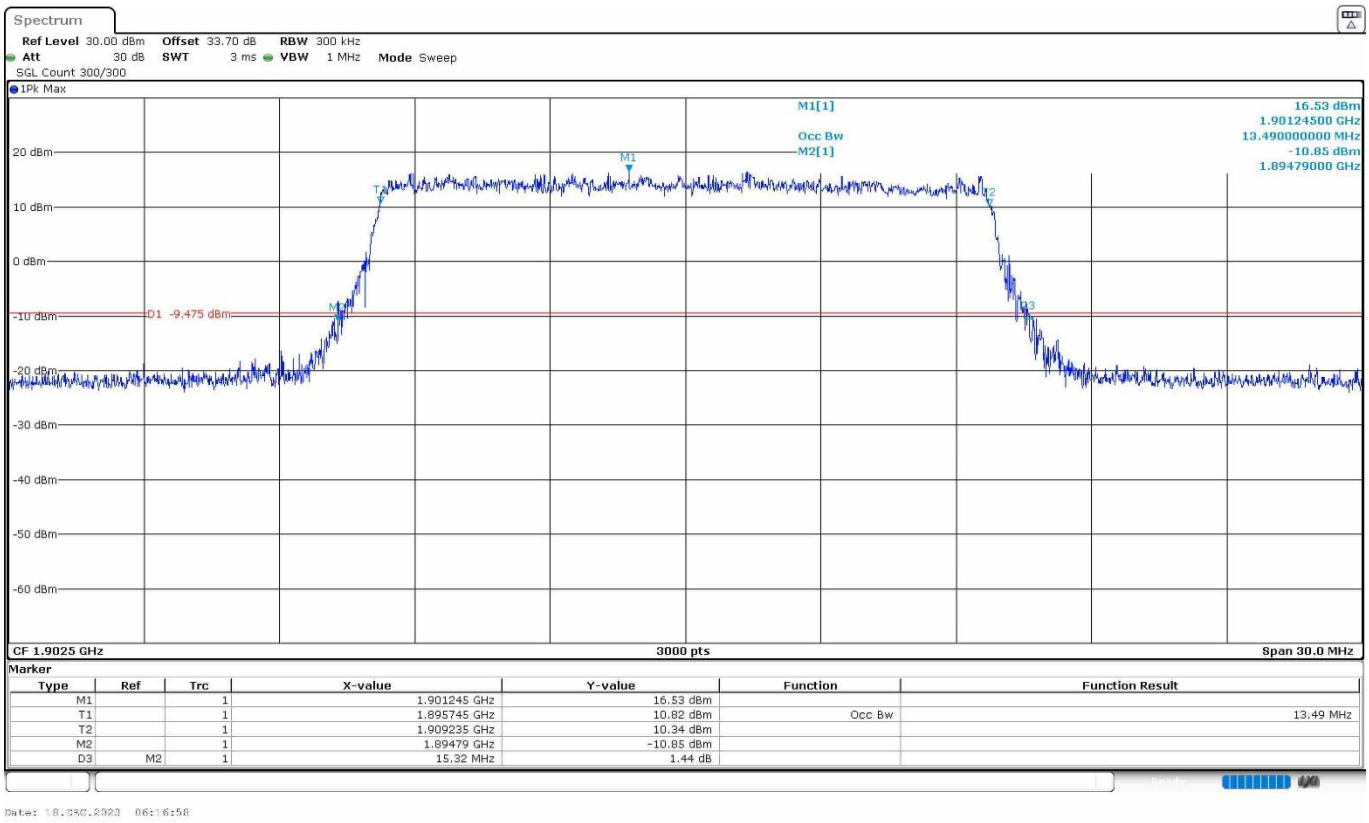
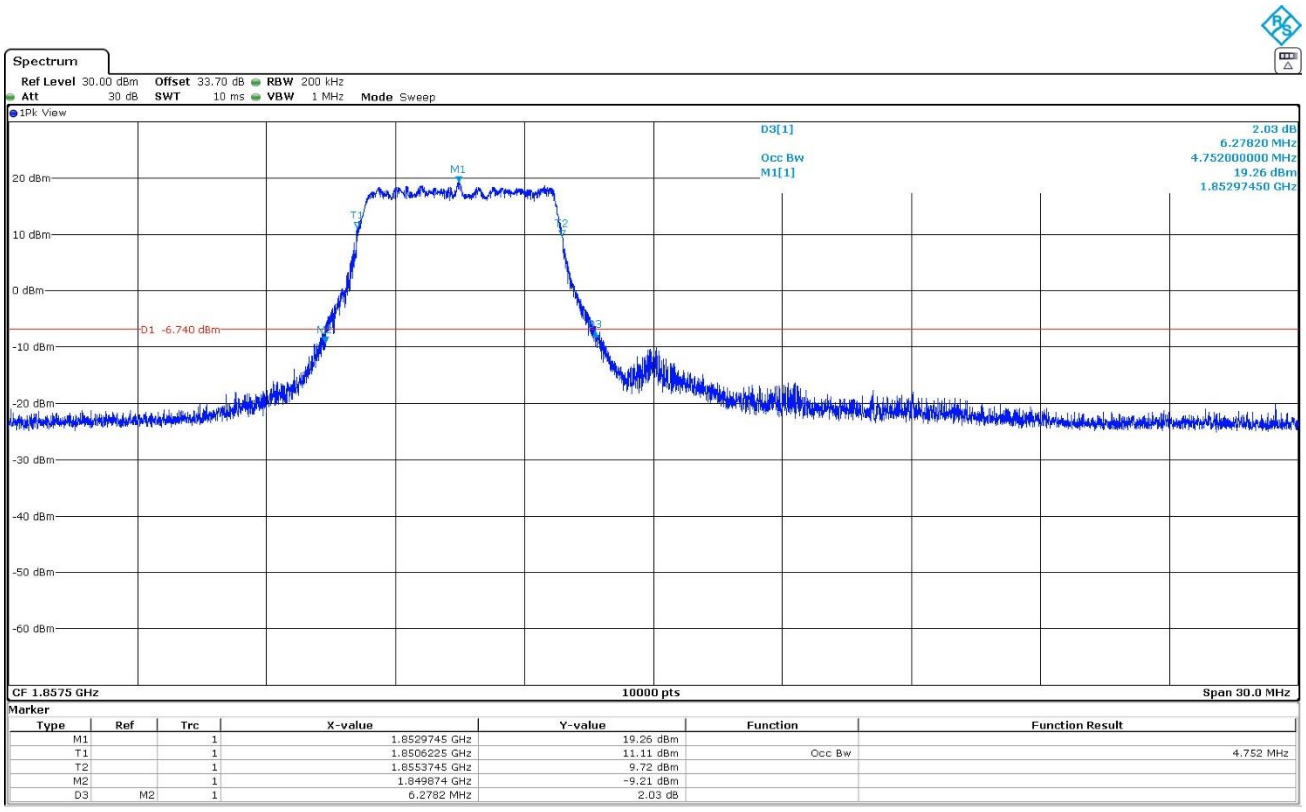
High Channel:



LTE Cat 1bis Band 2. BW=15 MHz. 16QAM. RB Size=All.
Low Channel: