

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
75462RRF.002

Test Report

USA FCC Part 24

CANADA RSS-133

(*) Identification of item tested	LTE Cat-4
(*) Trademark	Sequans Communications
(*) Model and /or type reference	CA410
Other identification of the product	FCC ID: 2AAGMCA410A IC: 12732A-CA410A
(*) Features	LTE Cat-4 HW version: V1 SW version: LR4.1.6.0-CBRSA-59334
Applicant	SEQUANS COMMUNICATIONS 55 Boulevard Charles de Gaulle, 92700 Colombes, France
Test method requested, standard	USA FCC Part 24 (10-1-21 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 
Date of issue	2023-10-24
Report template No	FDT08_24 (*) "Data provided by the client"

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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.

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.

DEKRA Testing and Certification 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.

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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.
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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 CA410 is ideal for adding LTE connectivity to electronics devices for industrial Internet of Things (IoT), Machine-to-Machine (M2M) and broadband consumer applications. CA410 is compliant with CBRS networks operating on LTE band 48 in USA, with US B8 – known as Anterix band - and with other US MNO bands: bands 2/4/5/12/13/66 as well as Firstnet LTE band 14 and band 26 used in private networks.

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 N°	Description	Model	Serial N°	Date of reception
75462C/012 *	LTE Cat-4	CA410-EVK	FOX-23-26-0658	25-07-2023
75462C/017	USB Cable	-	-	25-07-2023
75462C/022 **	LTE Cat-4	CA410-EVK	FOX-23-26-0647	20-09-2023

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

* : Used for al the conducted tests but the PAPR test.

** : Used for the PAPR test.

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

Control N°	Description	Model	Serial N°	Date of reception
75462C/014	LTE Cat-4	CA410-EVK	FOX-23-26-0647	25-07-2023
75462C/007	Antenna	-	-	25-07-2023
75462C/008	Antenna	-	-	25-07-2023

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

Test sample description

Ports.....:	Port name and description		Cable			
			Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾
	USB		-	☒	☐	☐
Supplementary information to the ports.....:	-					
Rated power supply	Voltage and Frequency			Reference poles		
	☐	AC:	☐	☐	☐	☐
	☒	DC: 3.2V Min, 3.3V Typ, 4.6V Max				
Rated Power.....:	-					
Clock frequencies.....:	-					
Other parameters	-					
Software version.....:	-					
Hardware version	-					

Dimensions in cm (W x H x D) ... :	-		
Mounting position	☒	Table top equipment	
	☐	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☐	Other:	
Modules/parts.....	Module/parts of test item	Type	Manufacturer
	-	-	-
Accessories (not part of the test item)	Description	Type	Manufacturer
	USB Cable	USB	-
	Antenna	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

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2023-08-01
Date (finish)	2023-09-21

Document history

Report number	Date	Description
75462RRF.002	2023-10-24	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: Ireneo Bibang, Rafael Fernández, Carmen Vázquez, Francisco López.

Used instrumentation:

Control No.	Equipment	Next Calibration
8002	Climatic Chamber BINDER MK 56	2024-03
6157	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2023-10
9229	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-06
6794	Shielded Room ETS LINDGREN S101	N/A
7798	EMC/RF Testing SW ROHDE AND SCHWARZ WMS32	N/A
6791	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A
6792	Shielded Room ETS LINDGREN S101	N/A
6143	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2023-10
4612	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2024-07
3783	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2023-12
6142	RF Preamplifier, G>38dB, 30MHz-6GHz BONN ELEKTRONIK BLNA 0360-01N	2024-06
7817	EMI Test Receiver 2 Hz - 44 GHz, ROHDE AND SCHWARZ ESW44	2023-12
6667	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2024-06
4848	EMC/RF Testing SW ROHDE AND SCHWARZ EMC32	N/A

Testing verdicts

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

Summary

Appendix A: LTE Cat-4 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	
<u>Supplementary information and remarks:</u> None.		

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

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TEST CONDITIONS

POWER SUPPLY (*):

Vnominal: 3.2 Vdc
Vminimum: 3.3 Vdc
Vmaximum: 4.6 Vdc

Type of Power Supply: DC External.

ANTENNA (*):

MIDDLE BAND		ANTENNA TYPE
LTE Cat-4 Band 2	+0.5 dBi	External (reference 2JW1183-C952B)

TEST FREQUENCIES:

LTE Cat-4 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.

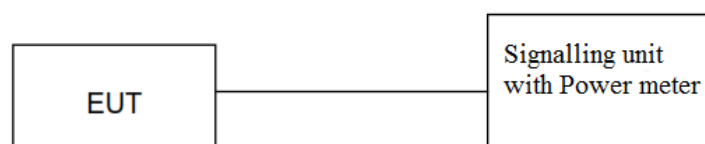
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

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:

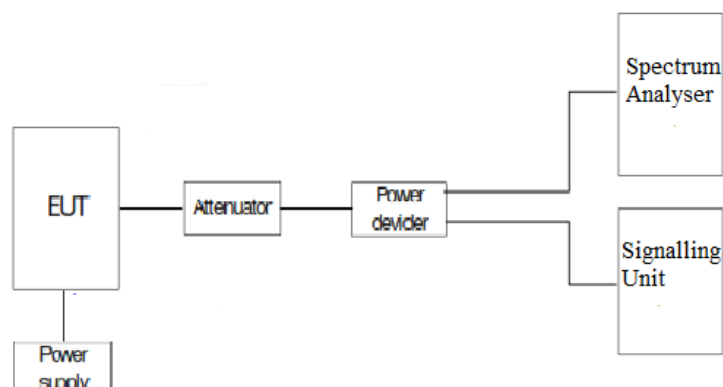
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

Test Setup

1. CONDUCTED AVERAGE POWER:



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



Results

1. CONDUCTED AVERAGE POWER:

LTE Cat-4 Band 2:

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

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
10	Low 18650	1855	QPSK	1	0	22.91
				1	24	23.59
				1	49	22.73
				25	0	22.24
				25	12	22.41
				25	24	22.12
				50	0	22.17
			16-QAM	1	0	22.19
				1	24	22.72
				1	49	22.02
				25	0	21.29
				25	12	21.42
				25	24	21.13
	Middle 18900	1880	QPSK	1	0	23.18
				1	24	23.66
				1	49	22.88
				25	0	22.54
				25	12	22.69
				25	24	22.49
				50	0	22.58
			16-QAM	1	0	22.45
				1	24	23.07
				1	49	22.21
				25	0	21.63
				25	12	21.7
				25	24	21.6
	High 19150	1905	QPSK	1	0	23.24
				1	24	23.98
				1	49	23.11
				25	0	22.52
				25	12	22.95
				25	24	22.91
				50	0	22.8
			16-QAM	1	0	22.19
				1	24	23
				1	49	22.16
				25	0	21.6

				25	12	21.95
				25	24	22.06
				50	0	21.96

BW=10 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)
LOW	23.51	0.5	24.01
MIDDLE	23.68	0.5	24.18
HIGH	23.74	0.5	24.24
MAX:	23.74		24.24

BW=10 MHz. 16QAM:

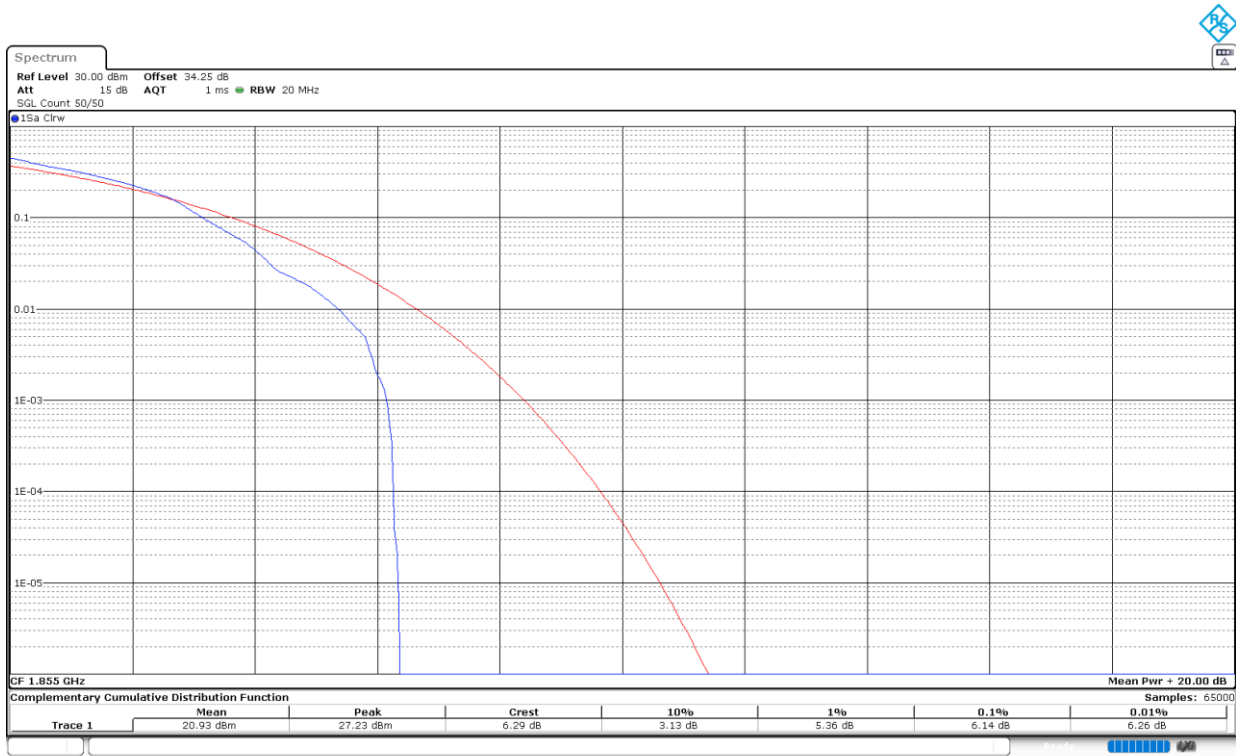
MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)
LOW	22.75	0.5	23.25
MIDDLE	22.77	0.5	23.27
HIGH	22.93	0.5	23.43
MAX:	22.93		23.43

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

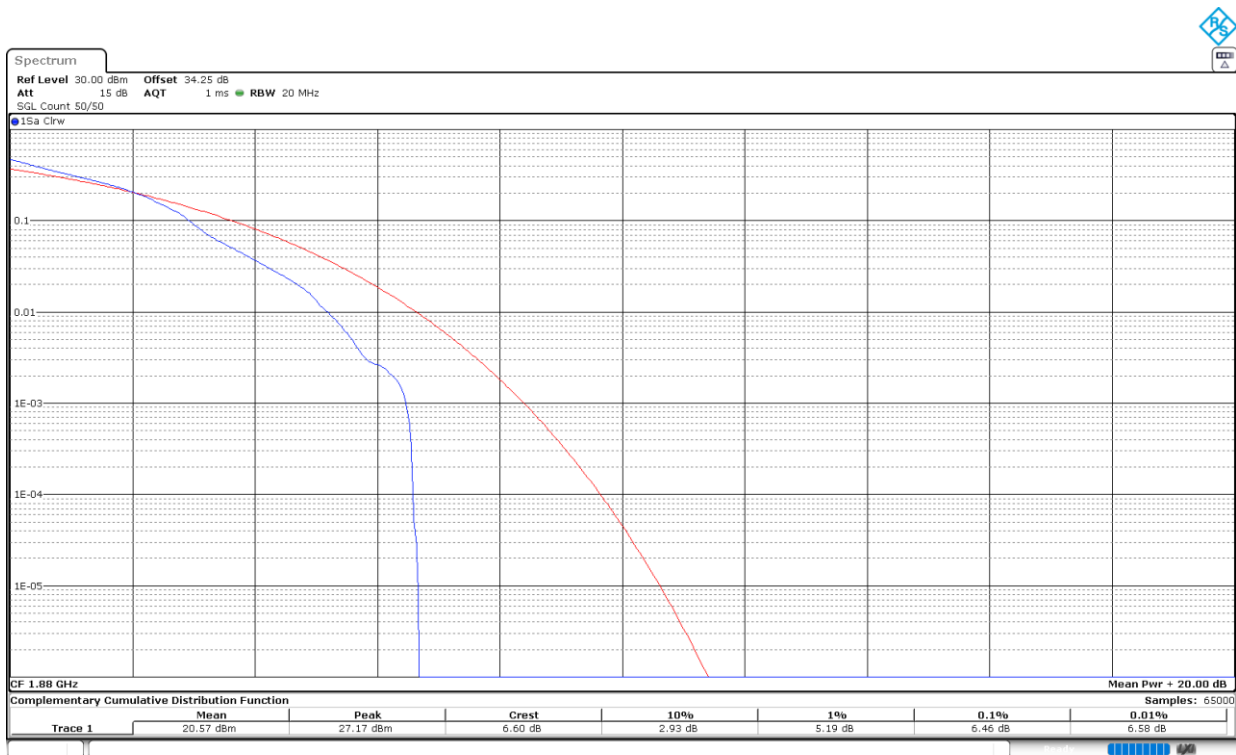
LTE Cat-4 Band 2:

Worst-case of PAPR is BW=10 MHz, Middle Channel, 16QAM, RB Size=1, RB Offset=49.

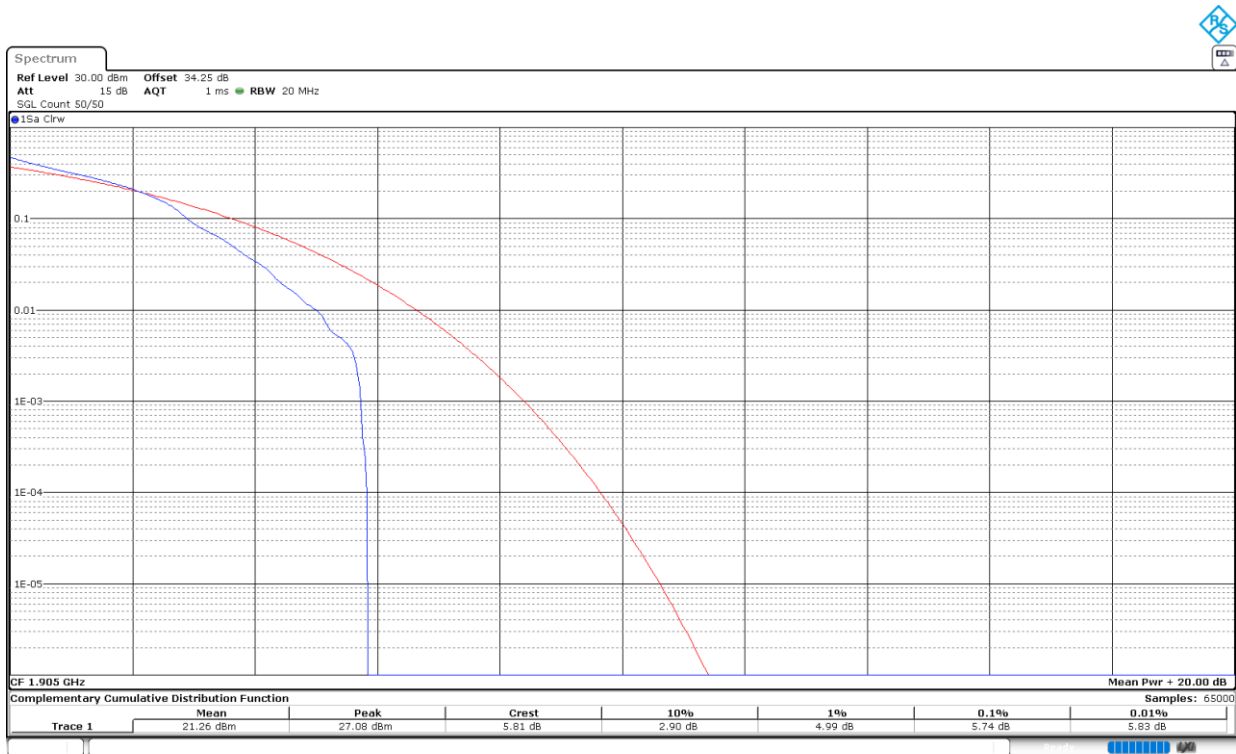
Low Channel:



Middle Channel:



High Channel:



16QAM	Low	Middle	High
PAPR (dB)	6.14	6.46	5.74

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 -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.

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.

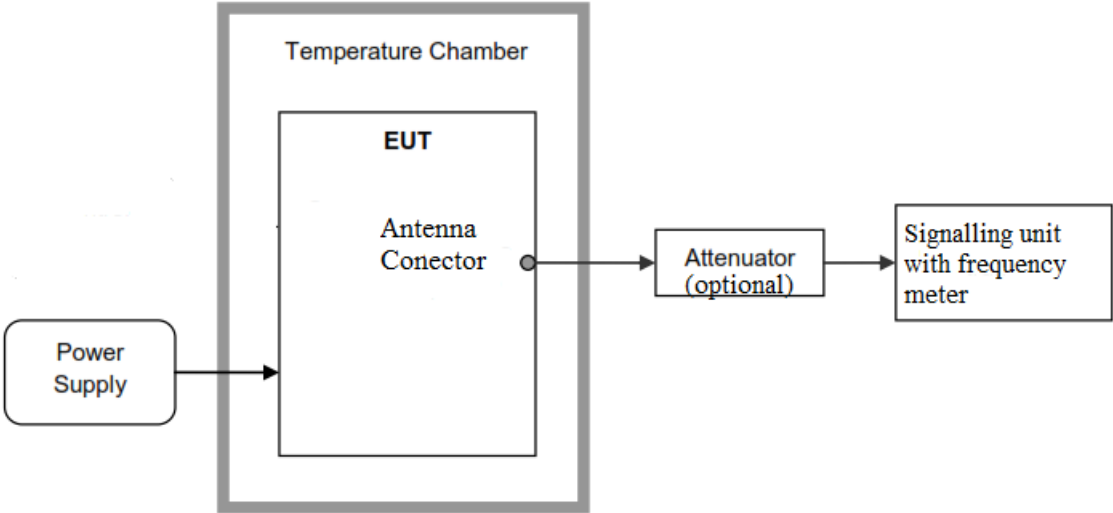
The worst case LTE mode for conducted power was used for the test.

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.

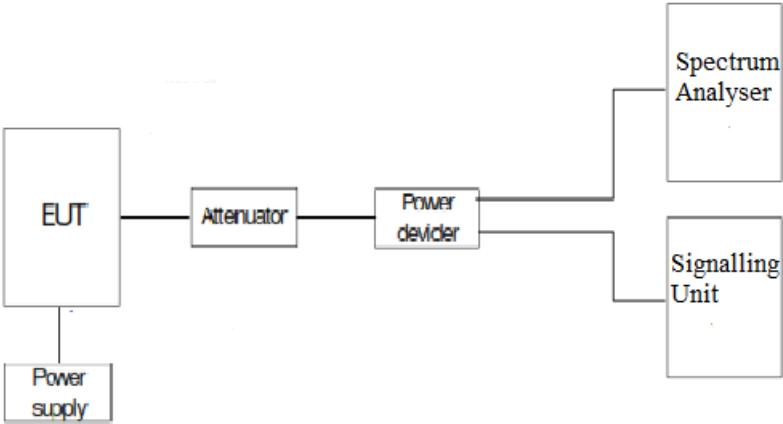
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance:



Reference points f_L and f_H :



Results

LTE Cat-4 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 (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+65	-3,41	-0,00181383
+60	-4,88	-0,002595745
+50	4.96	0.002638298
+40	7.61	0.004047872
+30	3.23	0.001718085
+20	4.03	0.002143617
+10	3.98	0.002117021
0	4.09	0.002175532
-10	3.81	0.002026596
-20	4.09	0.002175532
-30	7.47	0.003973404
-40	-1,19	-0,000632979

- Frequency stability over voltage variations.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.6	4,57	0,002430851
Vmin	3.2	-1,66	-0,000882979

2. REFERENCE FREQUENCY POINTS fL AND fH:

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

fL (MHz)	1850.0413
fH (MHz)	1909.9494

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

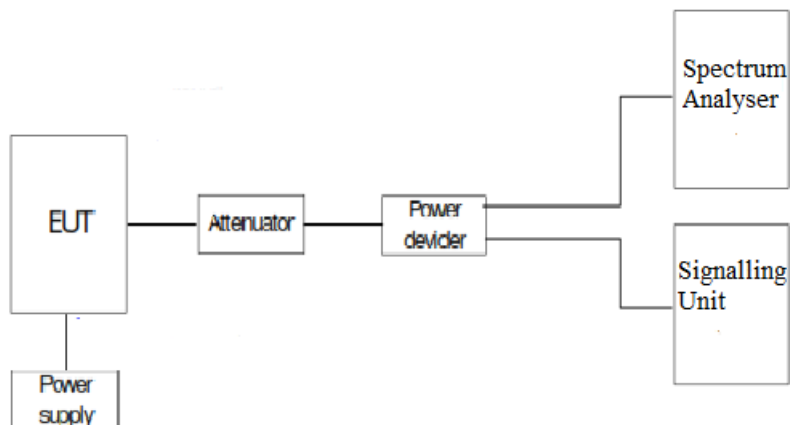
FCC §2.1047.

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).

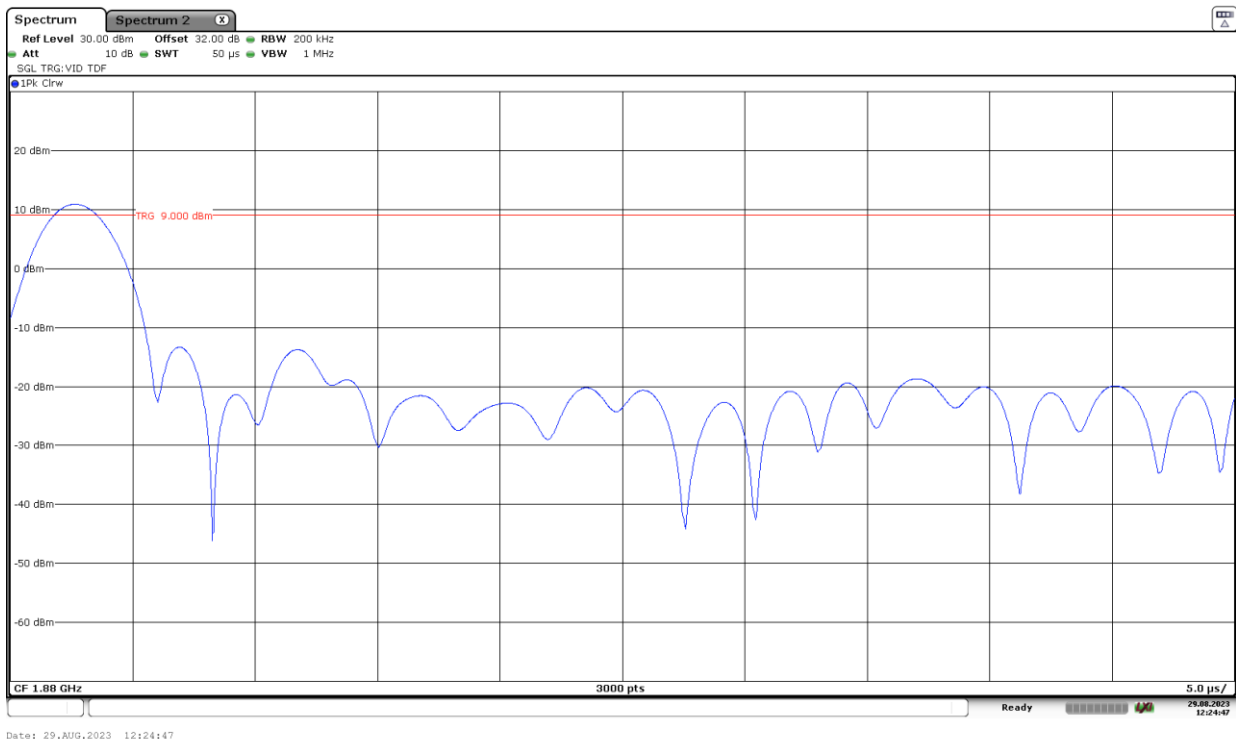
Test Setup



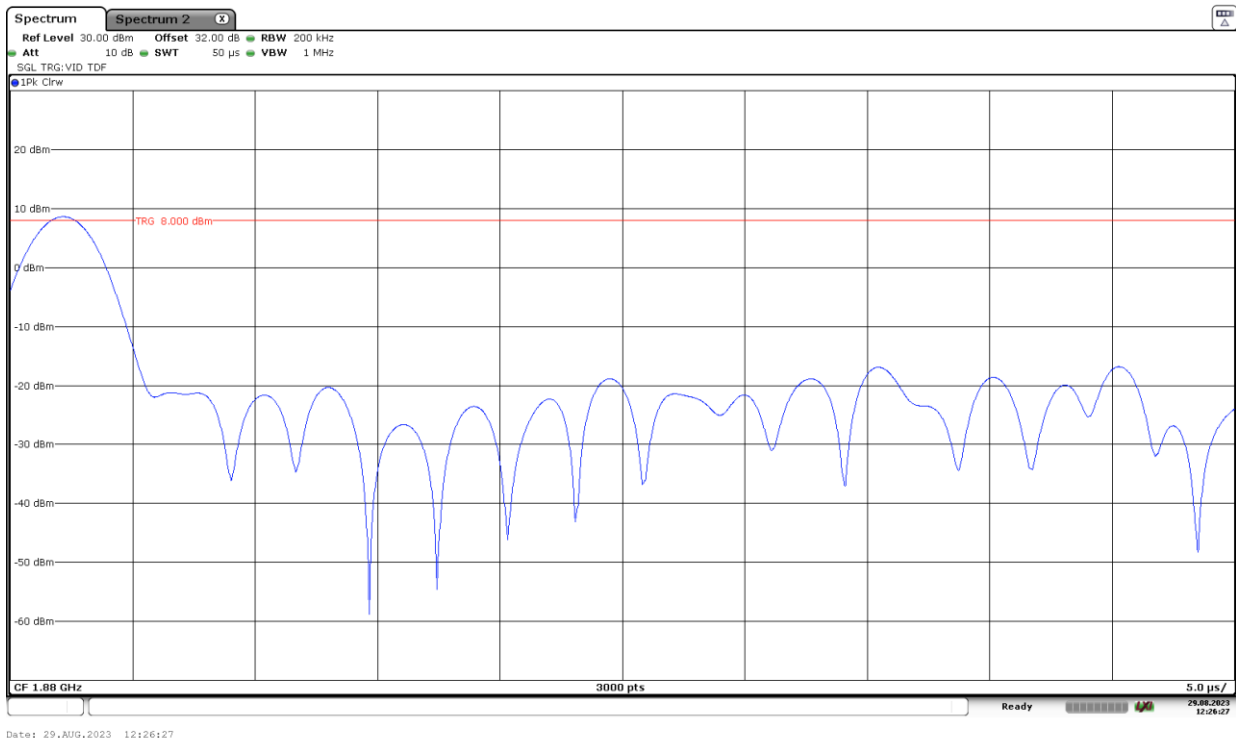
Results

The following plots show the modulation schemes in the EUT.

LTE Cat-4 Band 2: BW=1.4 MHz. QPSK.



LTE Cat-4 Band 2: BW=1.4 MHz. 16QAM.



Occupied Bandwidth

Limits

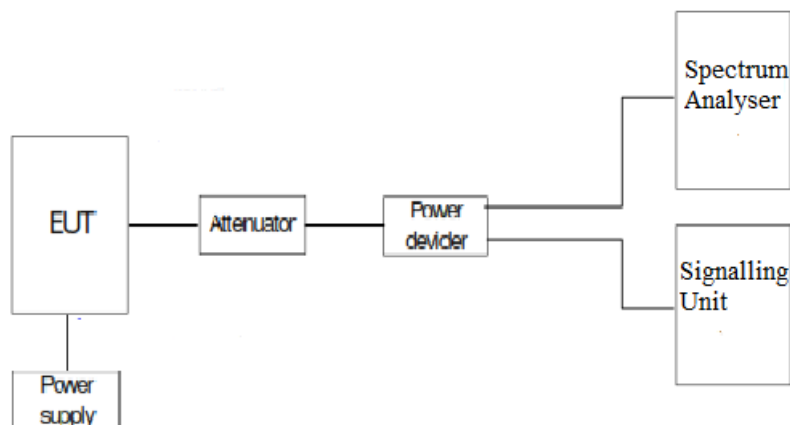
FCC §2.1049. Measurements required: Occupied bandwidth.

RSS-Gen, Clause 6.7.

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 Block (RB) Size All and Offset 0 regardless the nominal bandwidth selected.

LTE Cat-4 Band 2:

LTE Cat-4 Band 2. BW=1.4 MHz. QPSK. RB Size=All. RB Offset=0.

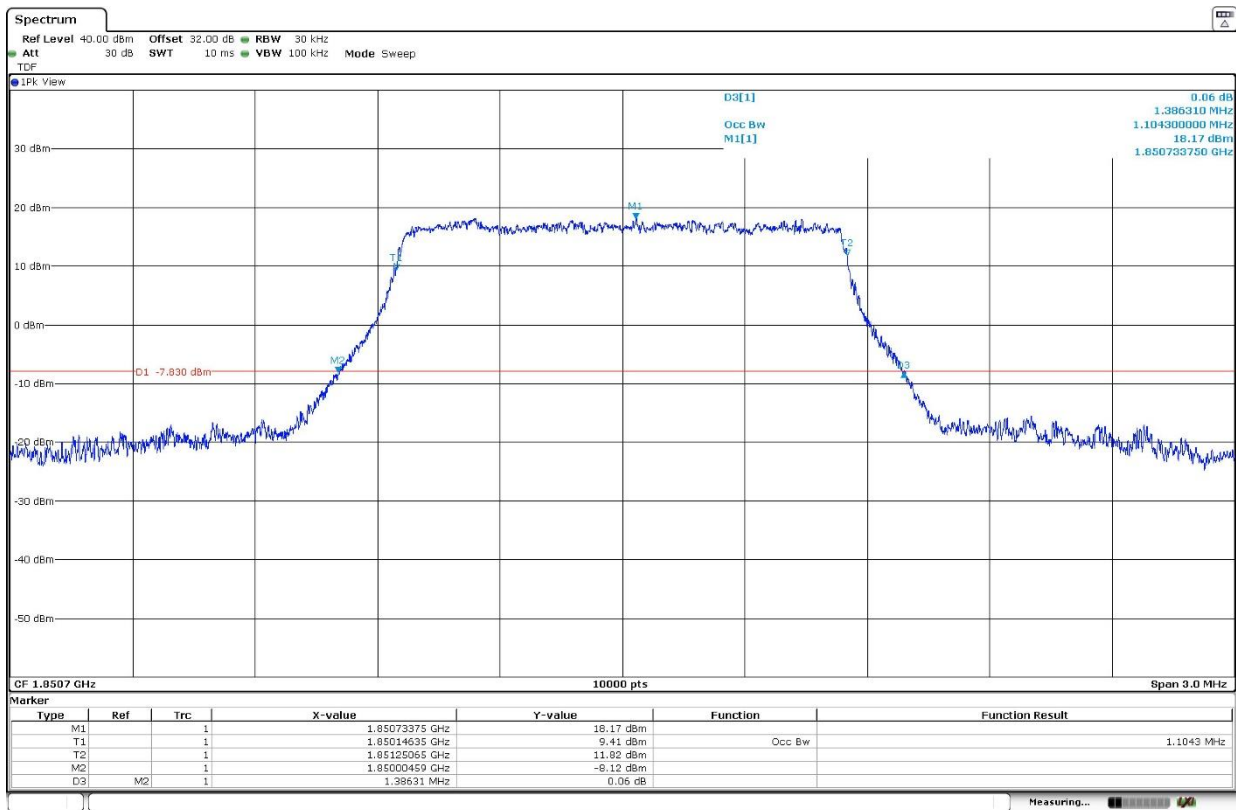
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.104	1.106	1.104
-26 dBc Bandwidth (MHz)	1.386	1.387	1.387
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=1.4 MHz. 16QAM. RB Size=All. RB Offset=0.

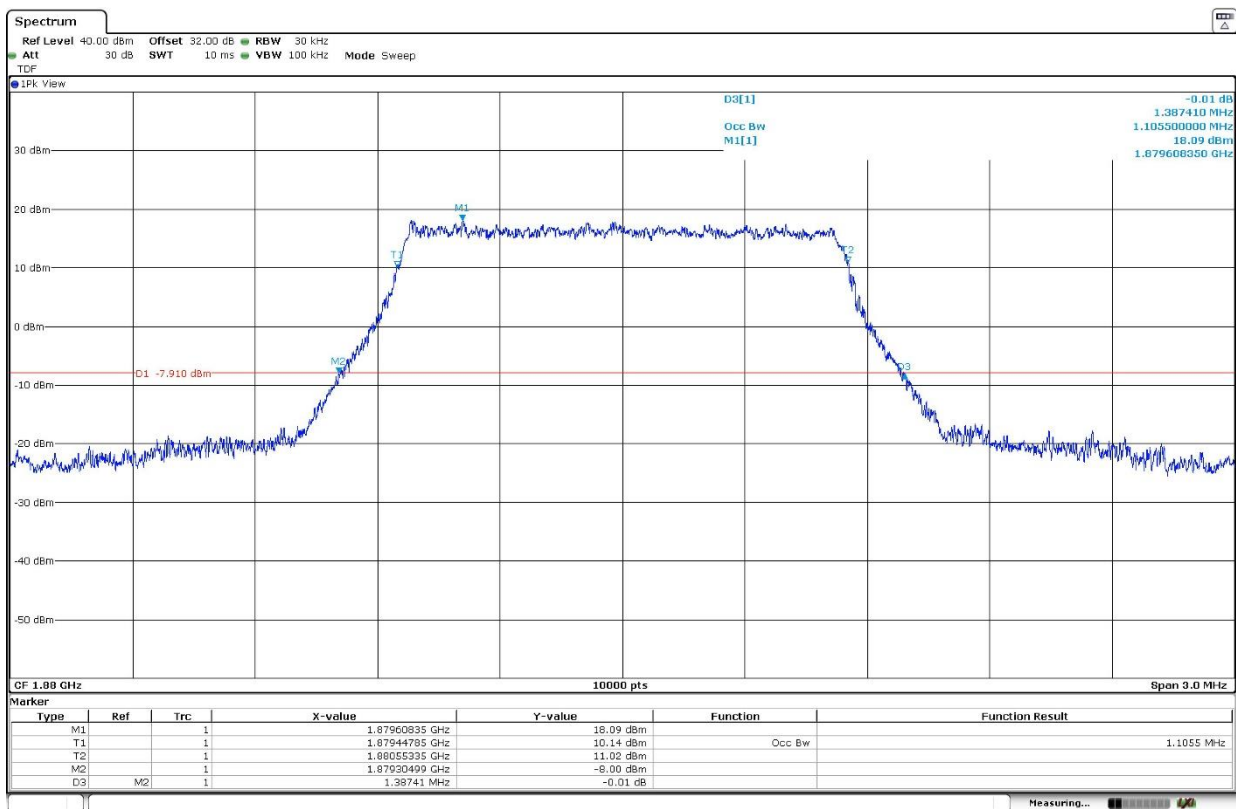
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.109	1.102	1.103
-26 dBc Bandwidth (MHz)	1.391	1.372	1.368
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=1.4 MHz. QPSK. RB Size=All.

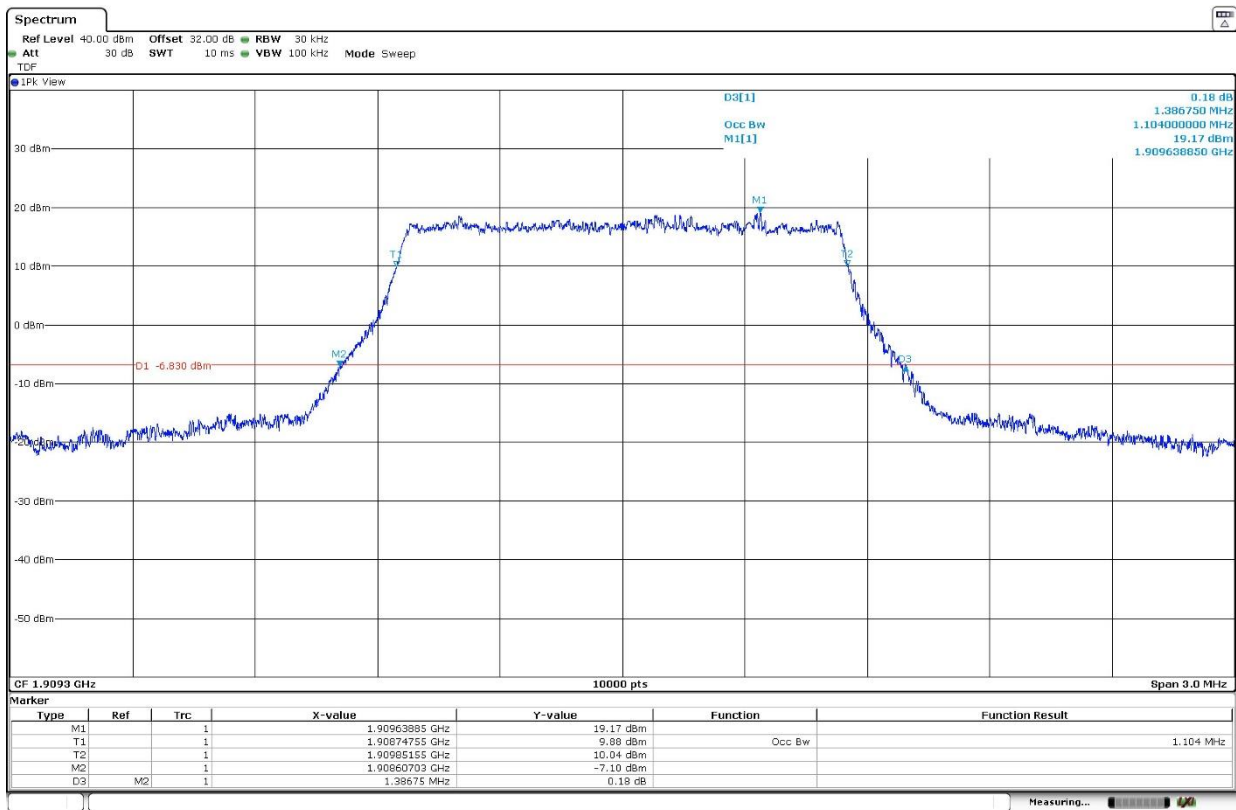
Low Channel:



Middle Channel:

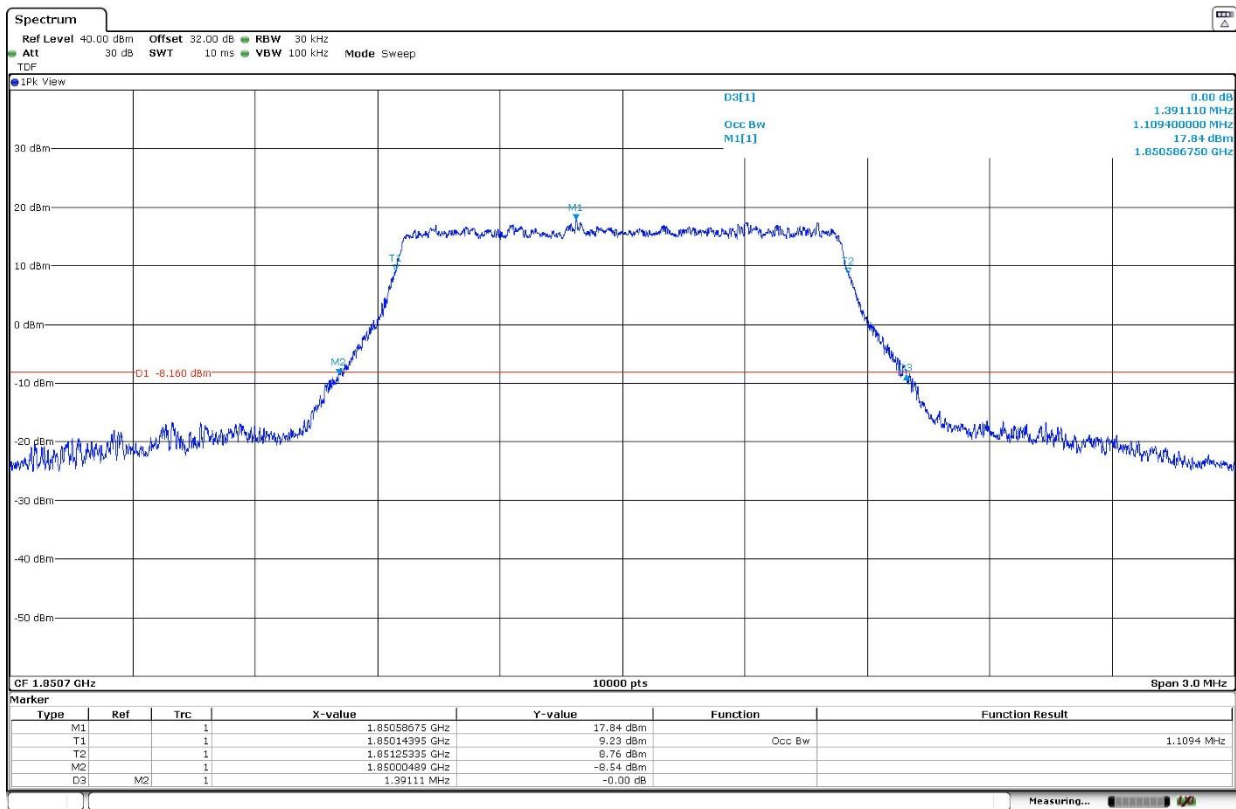


High Channel:

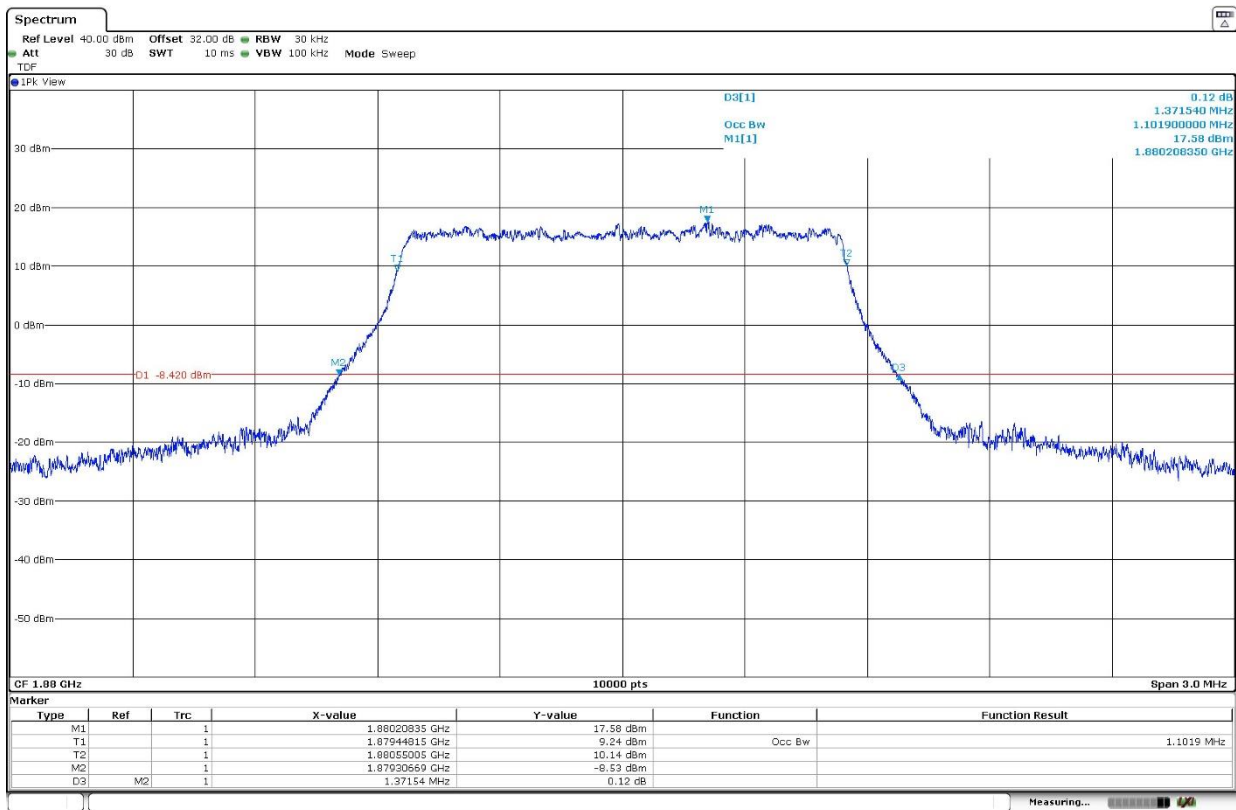


LTE Cat-4 Band 2. BW=1.4 MHz. 16QAM. RB Size=All.

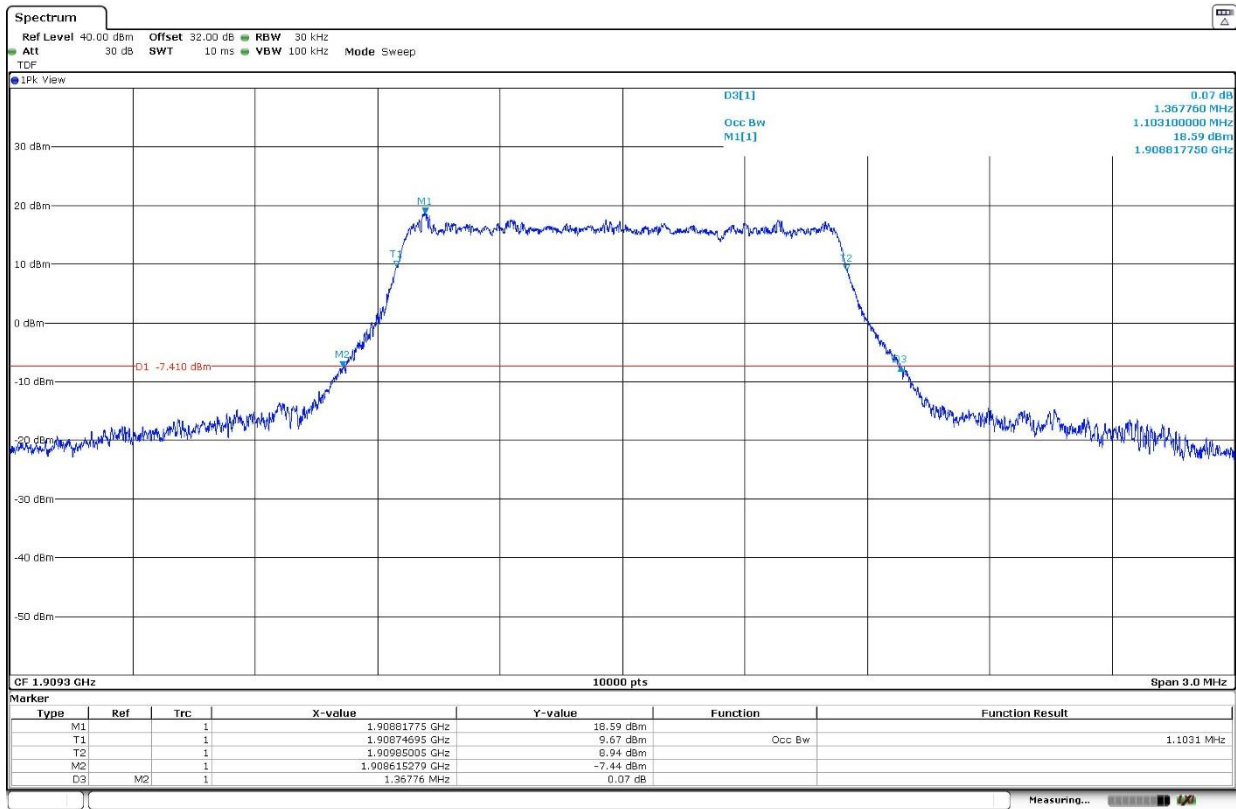
Low Channel:



Middle Channel:



High Channel:



LTE Cat-4 Band 2. BW=3 MHz. QPSK. RB Size=All. RB Offset=0.

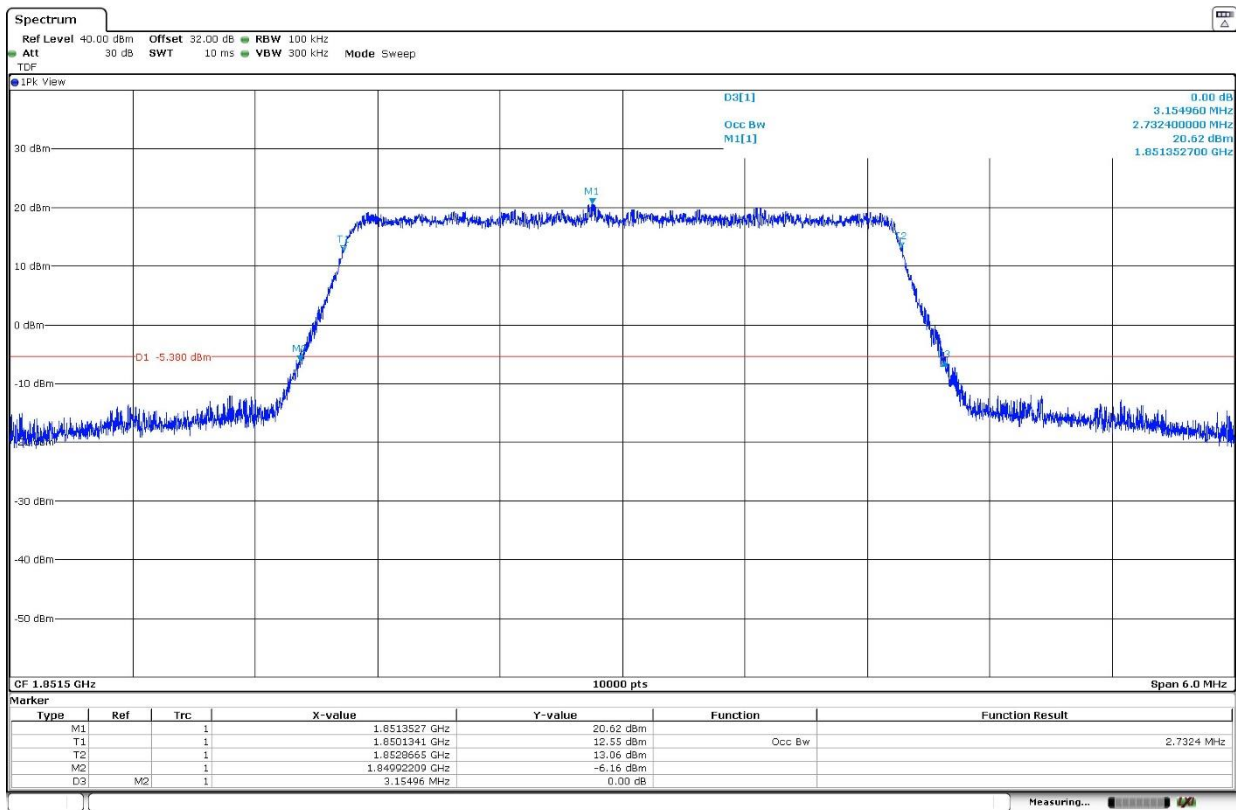
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.732	2.739	2.738
-26 dBc Bandwidth (MHz)	3.155	3.196	3.177
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=3 MHz. 16QAM. RB Size=All. RB Offset=0.

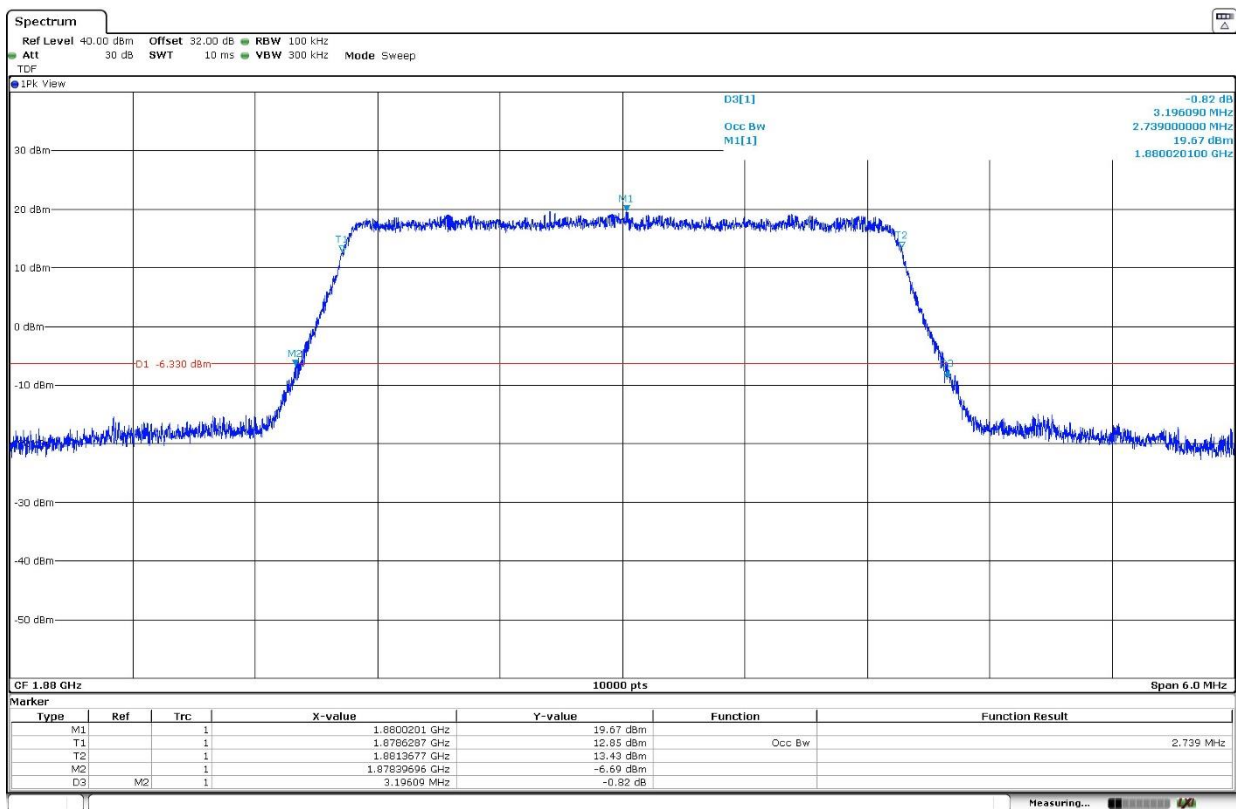
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	2.735	2.744	2.738
-26 dBc Bandwidth (MHz)	3.170	3.178	3.173
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=3 MHz. QPSK. RB Size=All.

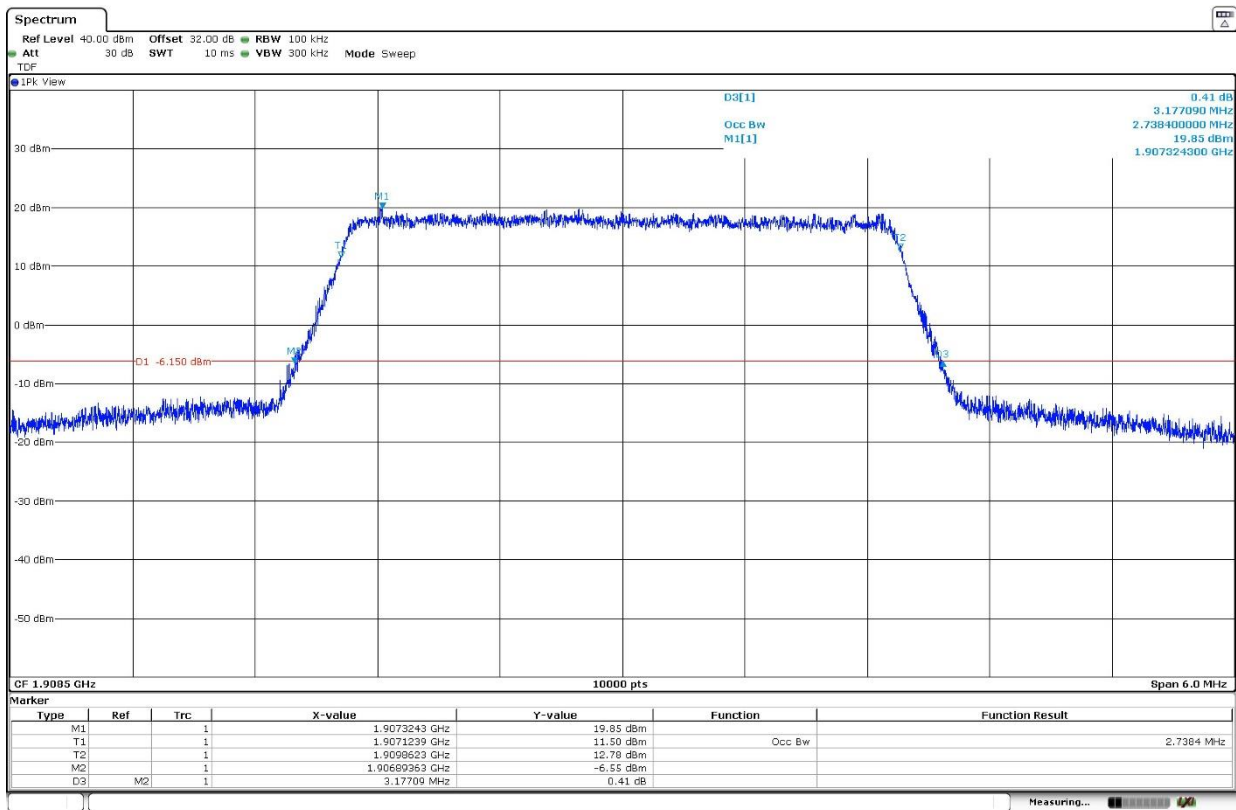
Low Channel:



Middle Channel:

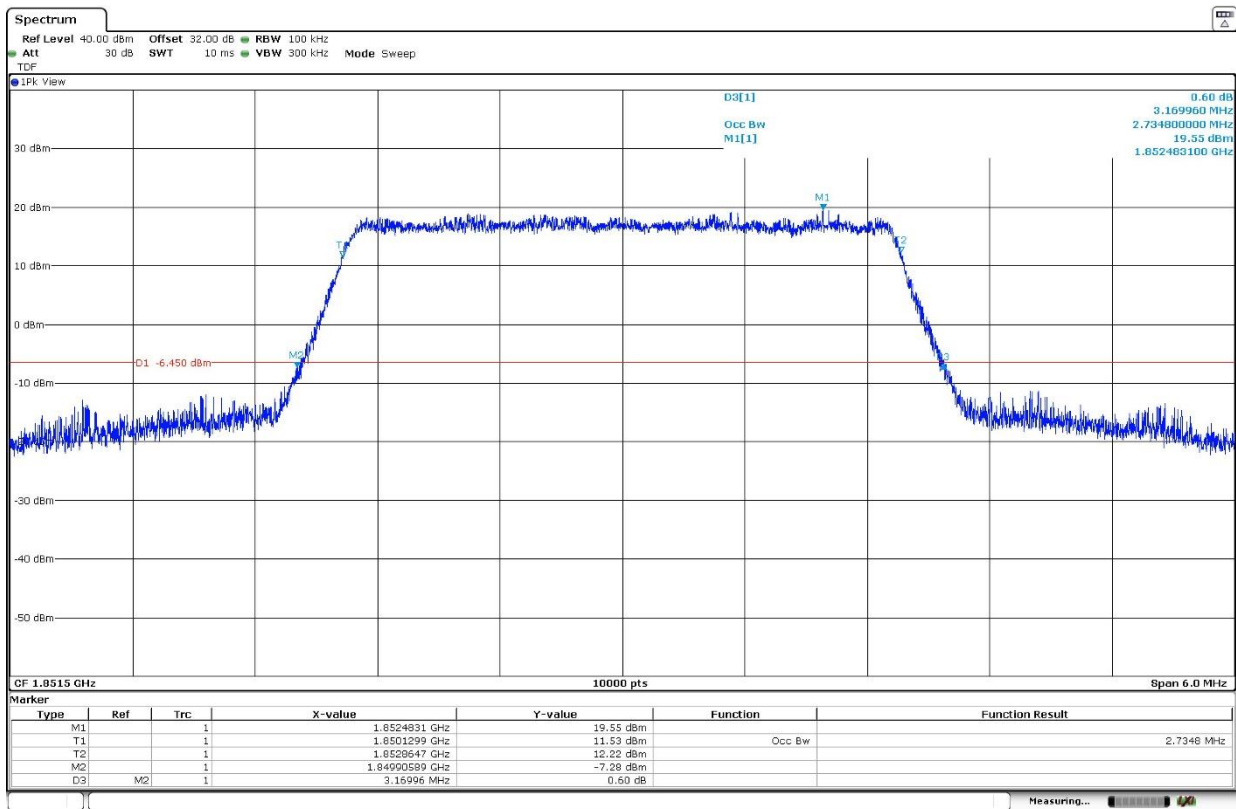


High Channel:

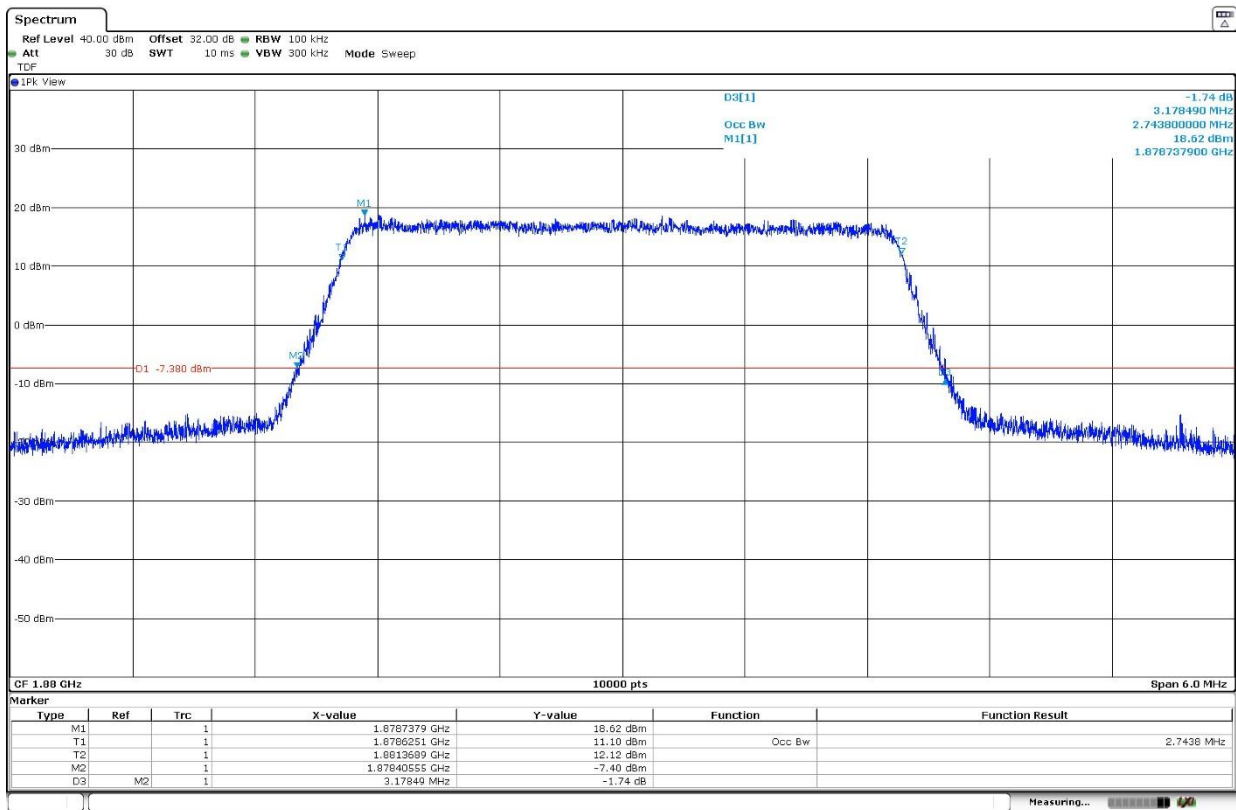


LTE Cat-4 Band 2. BW=3 MHz. 16QAM. RB Size=All.

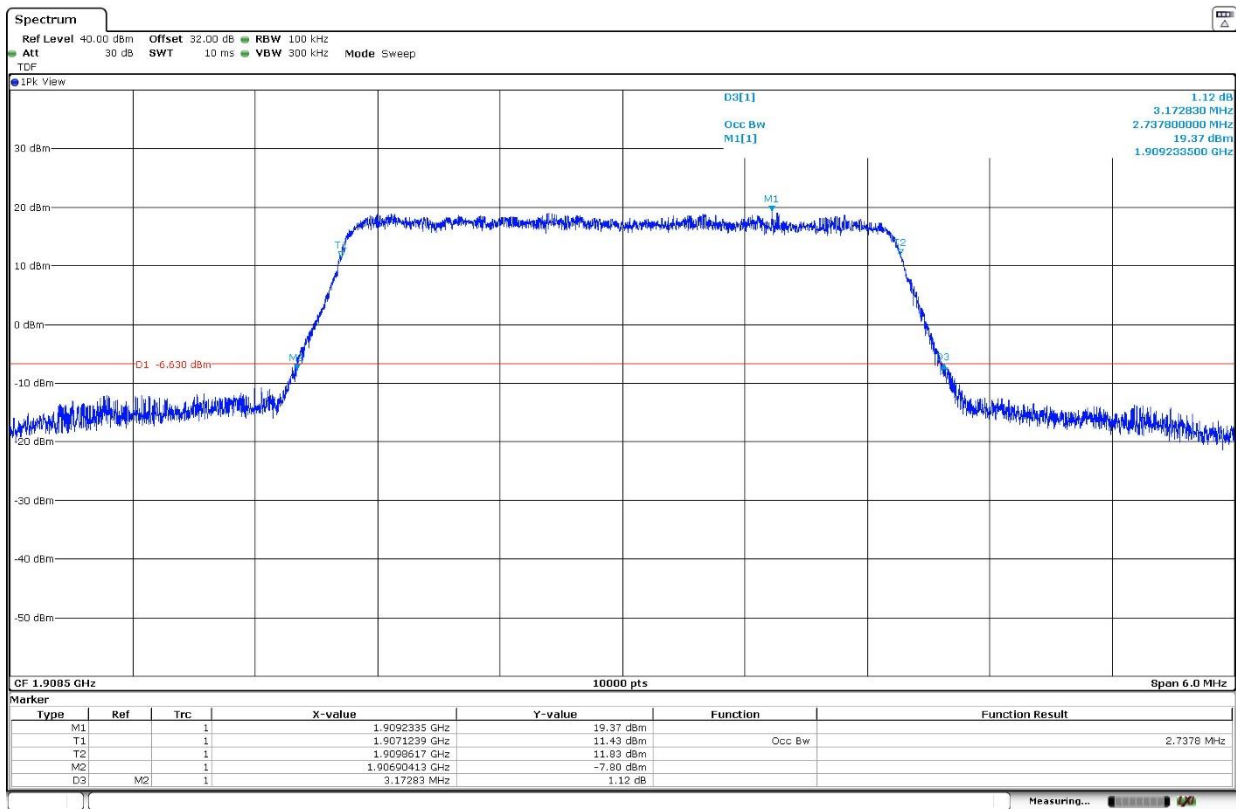
Low Channel:



Middle Channel:



High Channel:



LTE Cat-4 Band 2. BW=5 MHz. QPSK. RB Size=All. RB Offset=0.

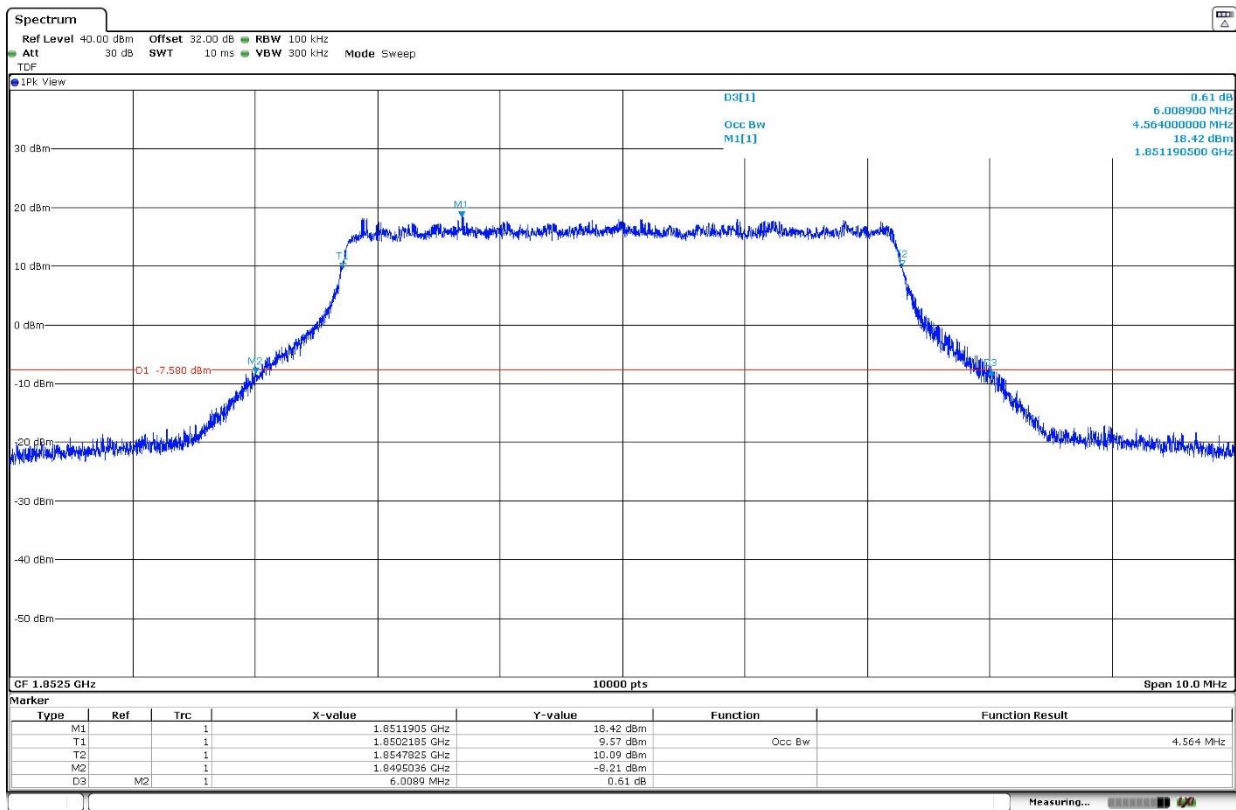
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.564	4.569	4.568
-26 dBc Bandwidth (MHz)	6.009	5.907	5.991
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=5 MHz. 16QAM. RB Size=All. RB Offset=0.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	4.565	4.572	4.585
-26 dBc Bandwidth (MHz)	6.057	5.958	6.027
Measurement uncertainty (kHz)	<±3.75		

LTE Cat-4 Band 2. BW=5 MHz. QPSK. RB Size=All.

Low Channel:



Middle Channel:

