

Test report No:  
 NIE: 61457RRF.005

# Test report

Reference Standard:  
 USA FCC Part 27  
 CANADA RSS-130

(*) Identification of item tested	Data Logger
(*) Trademark	Danlaw
(*) Model and /or type reference	DL970
Other identification of the product	HW Version: 2.0 SW Version: 1.4.0.0 FCC ID: 2AD9I-DL970 IC: 20087-DL970
(*) Features	LTE, 3G, GPS, WLAN, Bluetooth (BLE)
Applicant	DANLAW INC 41211 Vincenti Court, Novi, Michigan 48375, USA
Test method requested, standard	USA FCC Part 27 (10-1-18 Edition). CANADA RSS-130 Issue 2, Feb. 2019. ANSI C63.26-2015. ANSI/TIA-603-E: 2016. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Jose Carlos Luque RF Lab. Supervisor
Date of issue	2019-10-28
Report template No	FDT08_22 (*) "Data provided by the client"

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## Competences and guarantees

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DEKRA Testing and Certification S.A.U. is a testing laboratory competent to carry out the tests described in this report.

DEKRA Testing and Certification is a 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 with appropriate scope of accreditation that include testing performed in this test 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

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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

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

## Data provided by the client

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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 of DL970 consists of a Data Logger developed to provide companies with an easy to install, wireless communication device for monitoring and logging vehicle network message data.

The Danlaw Data Logger provides:

- Support for all major passenger car & light truck protocols.
- Simple plug-n-go via the vehicle's OBDII connector.
- OBD Vehicle Data logging with real-time data stamp.
- LTE & 3G communication.
- Support for FTP, TCP/IP data transfer.
- Firmware Over-The-Air (FOTA) Re-flash.
- Rugged, compact field-hardened design.
- No external antenna connections needed.
- Completely self-contained.

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

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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
61457C/003	Data Logger	DL970	5337	2019/07/23

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

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

Control N°	Description	Model	Serial N°	Date of reception
61457C/001	Data Logger	DL970	--	2019/06/20

Sample S/02 has undergone the following test(s): All conducted 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 <sup>(3)</sup>		
	USB connector; access virtual COM port	1.70	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Supplementary information to the ports..... :	-						
Rated power supply .....	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	DC: $V_{nom} = 12\text{ V}$ ; $V_{low} = 9\text{ V}$ ; $V_{high} = 15\text{ V}$					
Rated Power .....	-						
Clock frequencies..... :	-						
Other parameters .....	-						
Software version .....	1.4.0.0						
Hardware version .....	2.0						
Dimensions in cm (W x H x D) .....	4.75 x 4.4 x 2.3						
Mounting position .....	<input checked="" type="checkbox"/>	Other: Vehicle					
Modules/parts..... :	Module/parts of test item		Type	Manufacturer			
	WLAN/BLT module		QCA9377	Qualcomm			
	3G/LTE/GPS module		MDM9207	Qualcomm			
Accessories (not part of the test item) .....	Description		Type	Manufacturer			
	-						
Documents as provided by the applicant..... :	Description		File name	Issue date			
	PICS						
	User Manual						
	Instruction for testing						

## Identification of the client

DANLAW INC  
41211 Vincenti Court, Novi, Michigan 48375, USA

## Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2019-08-12
Date (finish)	2019-09-27

## Document history

Report number	Date	Description
61457RRF.005	2019-10-28	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 semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

## Remarks and comments

The tests have been performed by the technical personnel: José Alberto Aranda, Miguel Ángel Torres, Verónica García, Ignacio Cabra, Jaime Barranquero, Jesús García, Cristina Calle, José Manuel Jiménez.

Used instrumentation:

### Conducted Measurements

		Last Calibration	Due Calibration
1.	Chamber HERAEUS VMT 04/35	2018/06	2020/06
2.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/05	2020/05
3.	Signal Analyzer 20 Hz to 8 GHz ROHDE AND SCHWARZ FSQ8	2018/08	2020/08
4.	DC Power Supply 40V/40A Rohde & Schwarz NGPE40	2018/02	2021/02
5.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2019/09	2021/09
6.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2018/10	2020/10
7.	Spectrum analyser Agilent PSA E4440A	2017/10	2019/10

### Radiated Measurements

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/05	2020/05
3.	EMI Test Receiver ROHDE AND SCHWARZ ESR7	2018/10	2020/10
4.	Biconical/Log Antenna ETS LINDGREN 3142E	2017/04	2020/04
5.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2018/02	2020/02
6.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2019/04	2020/04
7.	Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2016/11	2019/11
8.	DC Power Supply Keysight Technologies U8002A	---	---
9.	Digital multimeter FLUKE 179	2019/06	2020/06

## Testing verdicts

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

## Summary

FCC PART 27 / RSS-130 PARAGRAPH		
Requirement – Test case	Verdict	Remark
Clause 27.50 / RSS-130 Clause 4.6: RF output power	P	
Clause 2.1047 / RSS-130 Clause 4.1: Modulation characteristics	P	
Clause 27.54 / RSS-130 Clause 4.5: Frequency stability	P	
Clause 2.1049: Occupied Bandwidth	P	
Clause 27.53 / RSS-130 Clause 4.7: Spurious emissions at antenna terminals	P	
Clause 27.53 / RSS-130 Clause 4.7: Radiated emissions	P	
<u>Supplementary information and remarks:</u>		
None.		



## Appendix A: Test results for FCC PART 27 / RSS-130

## INDEX

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## TEST CONDITIONS

### POWER SUPPLY (V):

Vn: 12 Vdc  
 Vmin: 9 Vdc (\*)  
 Vmax: 15 Vdc (\*)

Type of Power Supply: External power supply (car battery).

The subscripts 'n', 'min' and 'max' indicate voltage test conditions (nominal, minimum and maximum respectively), as declared by the applicant.

### ANTENNA:

LOW Bands		ANTENNA TYPE
LTE Band 12	+2.36 dBi	Internal (embedded in the plastics of the device)

### TEST FREQUENCIES:

#### LTE Band 12. QPSK AND 16QAM MODULATION:

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

Note: LTE Category 1 device, so for BW=10 MHz the 16QAM modulation does not support transmission in RB=All.

## RF Output Power

### SPECIFICATION:

#### FCC §27.50 (c) (10):

(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 highest PAPR during periods of continuous transmission.

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

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

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

##### 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.

For base and fixed equipment other than fixed subscriber equipment, refer to SRSP-518 for the e.i.r.p. limits.

**METHOD:**

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

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:

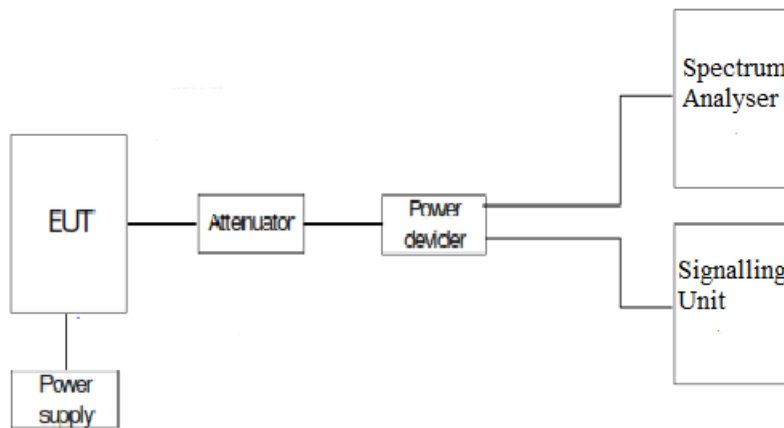
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

**TEST SETUP:**

1. CONDUCTED AVERAGE POWER:



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



**RESULTS:**

**1. AVERAGE POWER:**

LTE Band 12:

LTE Band 12. QPSK MODULATION. Bandwidth = 1.4 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.72	22.63	21.81
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	24.08	24.99	24.17
Maximum effective radiated power E.R.P. (dBm)	21.93	22.84	22.02
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 5.

(\*): Preliminary measurements determined PAPR of 16QAM as the worst case.

LTE Band 12. 16QAM MODULATION. Bandwidth = 1.4 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.62	21.38	20.86
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	23.98	23.74	23.22
Maximum effective radiated power E.R.P. (dBm)	21.83	21.59	21.07
PAPR (dB)	5.77	5.58	5.21
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 1. RB Offset: 0.  
 Worst case PAPR: Modulation 16QAM. RB Size: 6. RB Offset: 0.

LTE Band 12. QPSK MODULATION. Bandwidth = 3 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.94	22.68	21.96
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	24.30	25.04	24.32
Maximum effective radiated power E.R.P. (dBm)	22.15	22.89	22.17
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 7.

(\*): Preliminary measurements determined PAPR of 16QAM as the worst case.

LTE Band 12. 16QAM MODULATION. Bandwidth = 3 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.41	21.55	20.95
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	23.77	23.91	23.31
Maximum effective radiated power E.R.P. (dBm)	21.62	21.76	21.16
PAPR (dB)	5.74	5.88	5.58
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER: Modulation 16QAM. RB Size: 1. RB Offset: 14.  
 Worst case PAPR: Modulation 16QAM. RB Size: 15. RB Offset: 0.

LTE Band 12. QPSK MODULATION. Bandwidth = 5 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	22.21	22.59	21.82
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	24.57	24.95	24.18
Maximum effective radiated power E.R.P. (dBm)	22.42	22.80	22.03
PAPR (dB)	(*)	(*)	(*)
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER: Modulation QPSK. RB Size: 1. RB Offset: 12.

(\*): Preliminary measurements determined PAPR of 16QAM as the worst case.

LTE Band 12. 16QAM MODULATION. Bandwidth = 5 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.19	21.21	21.12
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	23.55	23.57	23.48
Maximum effective radiated power E.R.P. (dBm)	21.4	21.42	21.33
PAPR (dB)	5.56	5.67	5.64
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER:  
 Worst case PAPR:

Modulation 16QAM. RB Size: 1. RB Offset: 12.  
 Modulation 16QAM. RB Size: 25. RB Offset: 0.

LTE Band 12. QPSK MODULATION. Bandwidth = 10 MHz.

Channel	Lowest	Middle	Highest
Maximum declared antenna gain (dBi)	2.36	2.36	2.36
Measured maximum average power (dBm) at antenna port	21.90	22.85	22.01
Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	24.26	25.21	24.37
Maximum effective radiated power E.R.P. (dBm)	22.11	23.06	22.22
PAPR (dB)	4.78	5.02	4.84
Measurement uncertainty (dB)	<±0.66		

Worst case AVERAGE POWER:  
 Worst case PAPR:

Modulation QPSK. RB Size: 1. RB Offset: 49.  
 Modulation QPSK. RB Size: 50. RB Offset: 0.

(\*): Not supported the modulation 16QAM.

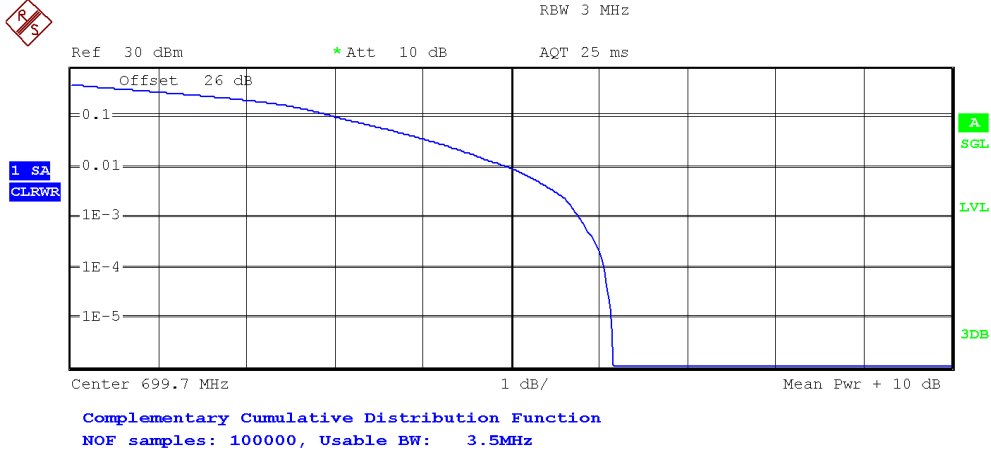


## 2. PEAK-TO-AVERAGE POWER RATIO (PAPR):

LTE Band 12.

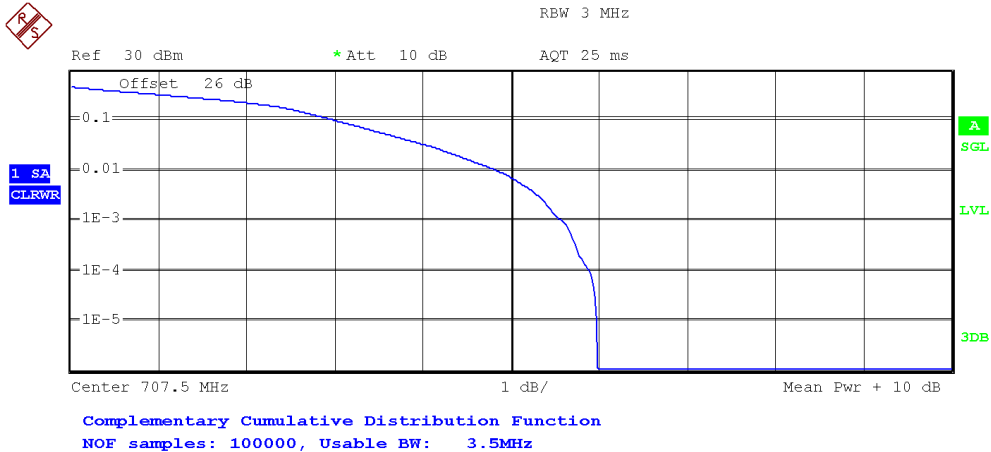
Bandwidth = 1.4 MHz. Modulation 16 QAM. RB Size: 6. RB Offset: 0.

Lowest Channel:



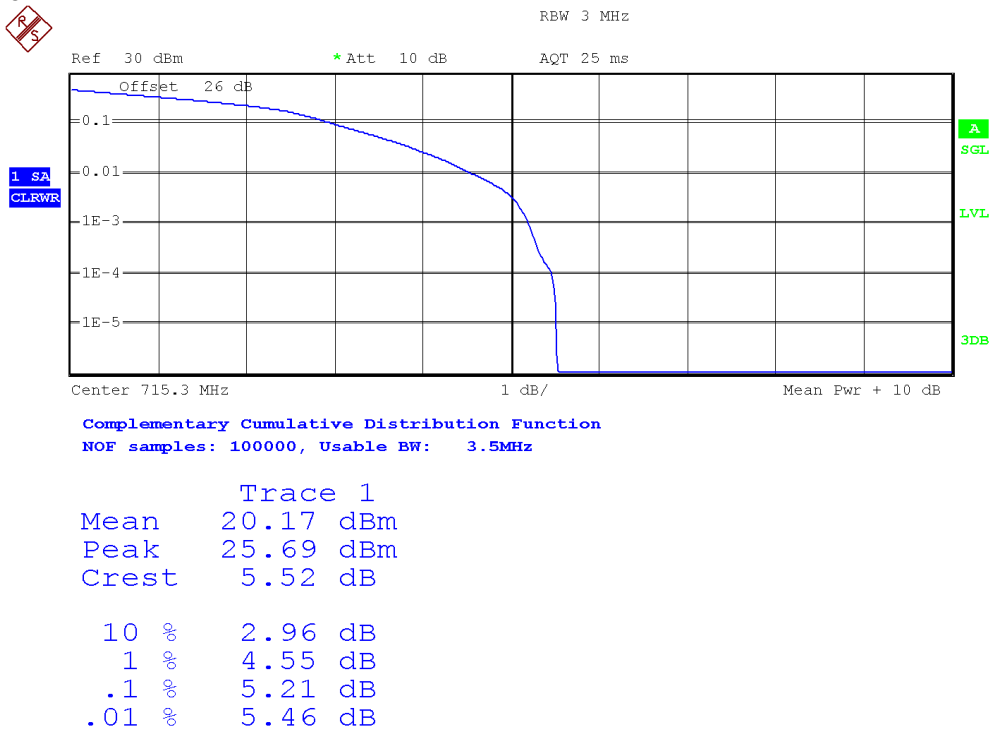
Trace 1	
Mean	20.18 dBm
Peak	26.33 dBm
Crest	6.15 dB
10 %	3.03 dB
1 %	4.97 dB
.1 %	5.77 dB
.01 %	6.06 dB

Middle Channel:



Trace 1	
Mean	20.50 dBm
Peak	26.47 dBm
Crest	5.98 dB
10 %	3.00 dB
1 %	4.84 dB
.1 %	5.58 dB
.01 %	5.88 dB

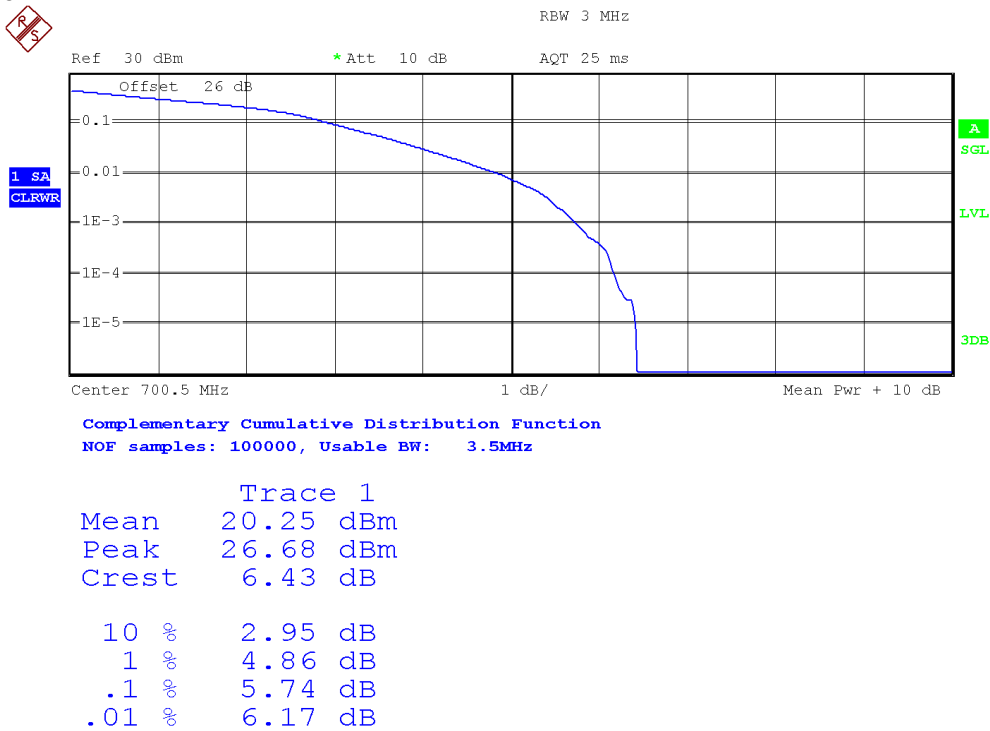
Highest Channel:



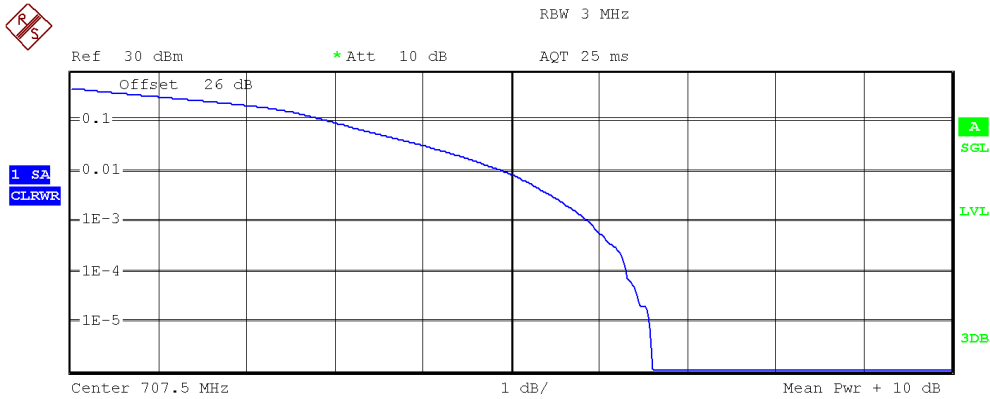
LTE Band 12.

Bandwidth = 3 MHz. Modulation 16 QAM. RB Size: 15. RB Offset: 0.

Lowest Channel:



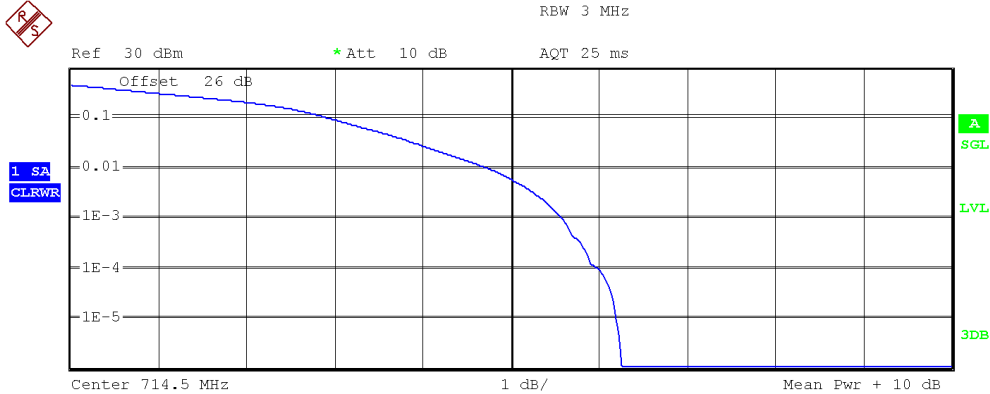
Middle Channel:



Center 707.5 MHz 1 dB/ Mean Pwr + 10 dB  
 Complementary Cumulative Distribution Function  
 NOF samples: 100000, Usable BW: 3.5MHz

	Trace 1
Mean	20.29 dBm
Peak	26.90 dBm
Crest	6.60 dB
10 %	2.93 dB
1 %	4.92 dB
.1 %	5.88 dB
.01 %	6.31 dB

Highest Channel:



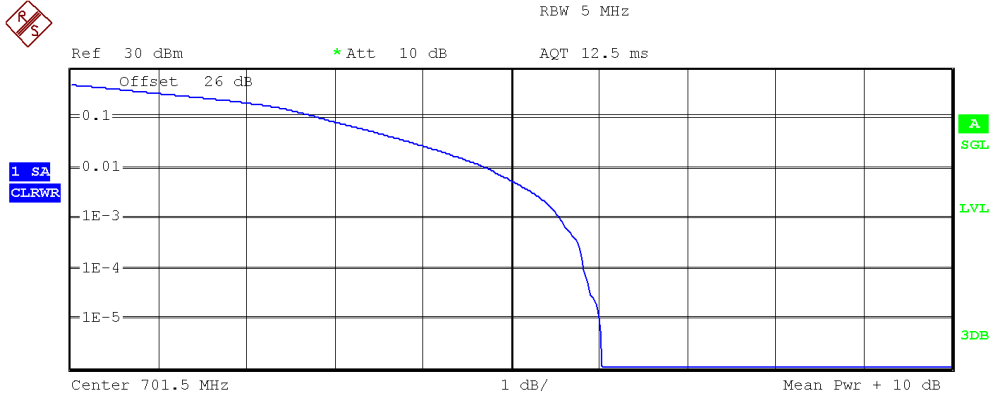
Center 714.5 MHz 1 dB/ Mean Pwr + 10 dB  
 Complementary Cumulative Distribution Function  
 NOF samples: 100000, Usable BW: 3.5MHz

	Trace 1
Mean	20.35 dBm
Peak	26.61 dBm
Crest	6.26 dB
10 %	2.92 dB
1 %	4.73 dB
.1 %	5.58 dB
.01 %	5.98 dB

LTE Band 12.

Bandwidth = 5 MHz. Modulation 16 QAM. RB Size: 25. RB Offset: 0.

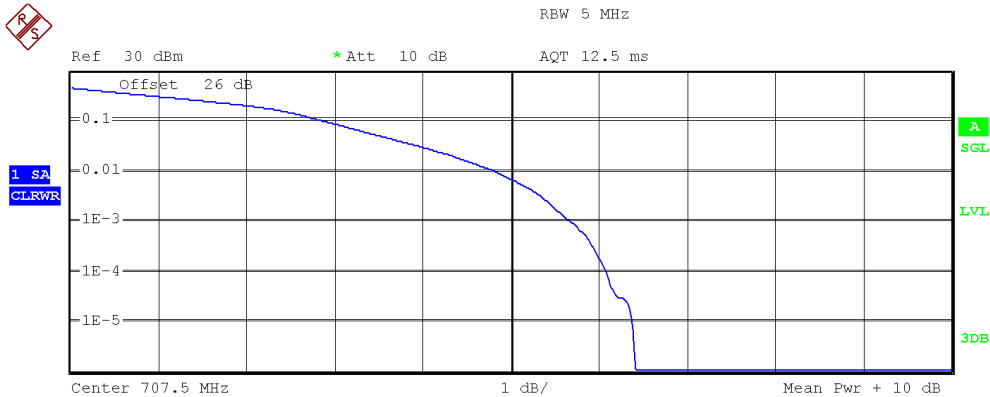
Lowest Channel:



Complementary Cumulative Distribution Function  
 NOF samples: 100000, Usable BW: 7.1MHz

	Trace 1
Mean	20.37 dBm
Peak	26.40 dBm
Crest	6.04 dB
10 %	2.84 dB
1 %	4.73 dB
.1 %	5.56 dB
.01 %	5.83 dB

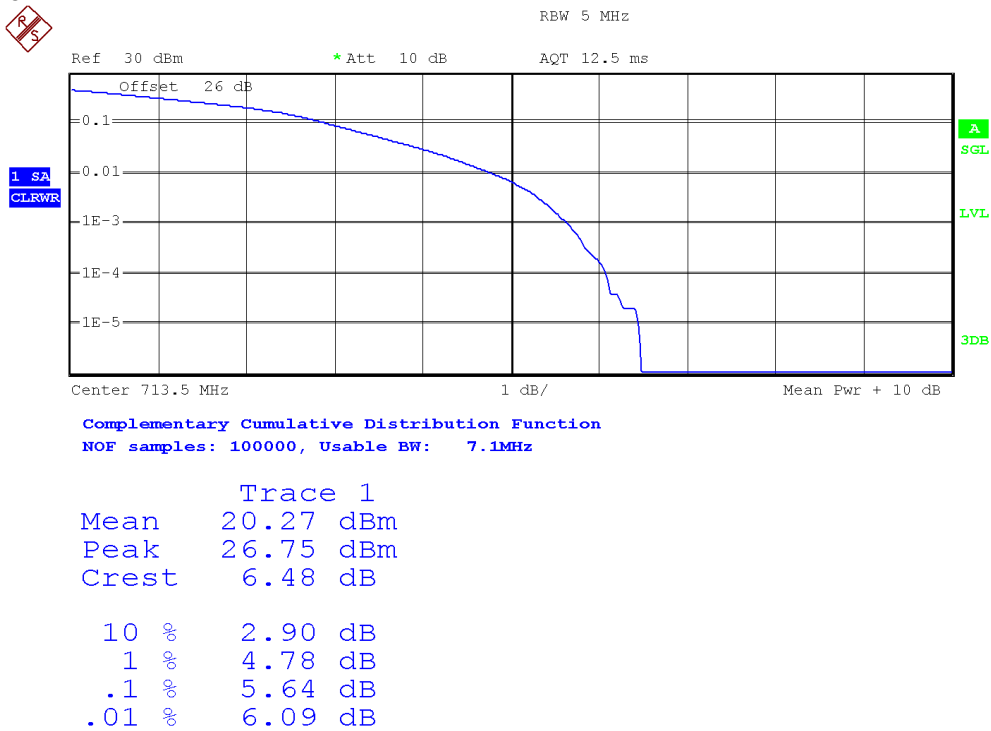
Middle Channel:



Complementary Cumulative Distribution Function  
 NOF samples: 100000, Usable BW: 7.1MHz

	Trace 1
Mean	20.42 dBm
Peak	26.83 dBm
Crest	6.41 dB
10 %	2.87 dB
1 %	4.82 dB
.1 %	5.67 dB
.01 %	6.09 dB

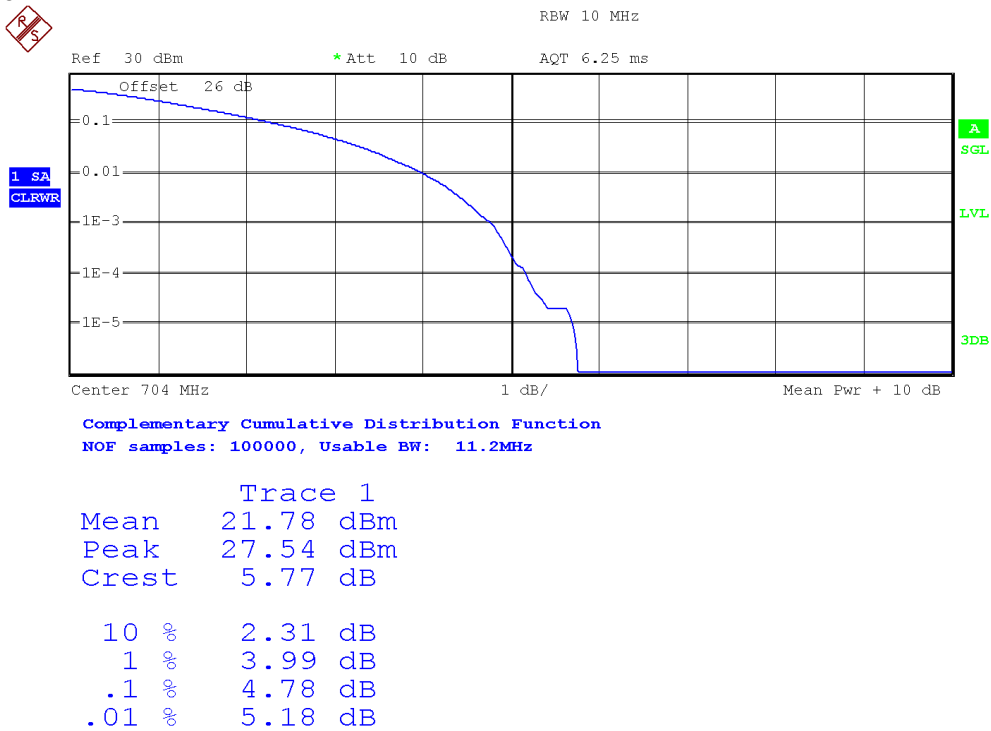
Highest Channel:



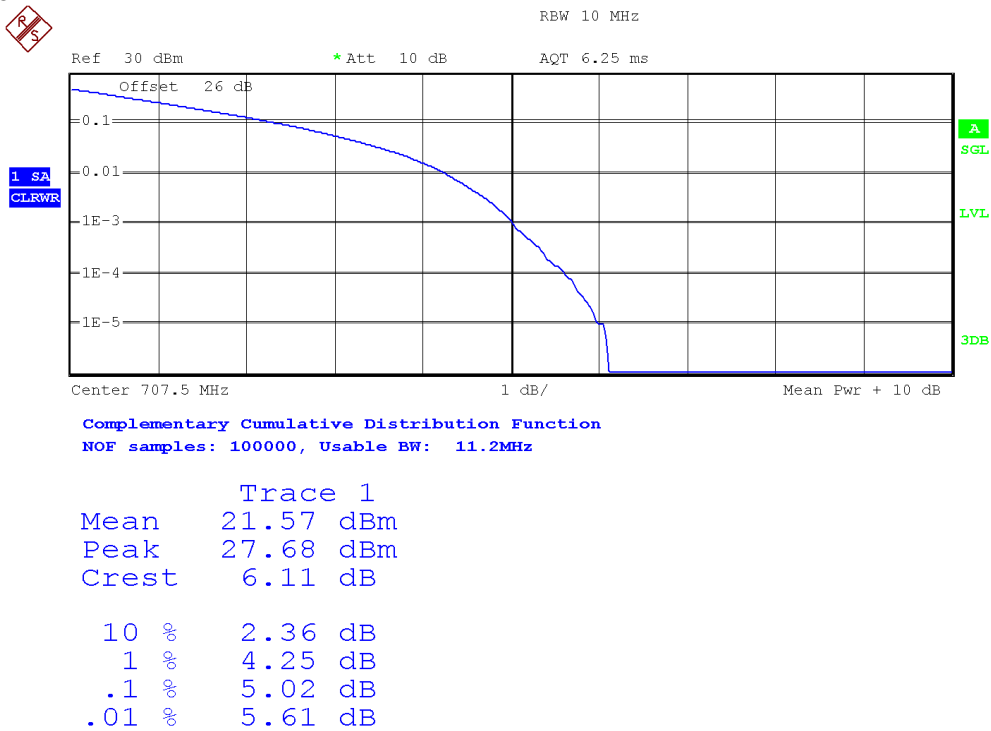
LTE Band 12.

Bandwidth = 10 MHz. Modulation QPSK. RB Size: 50. RB Offset: 0.

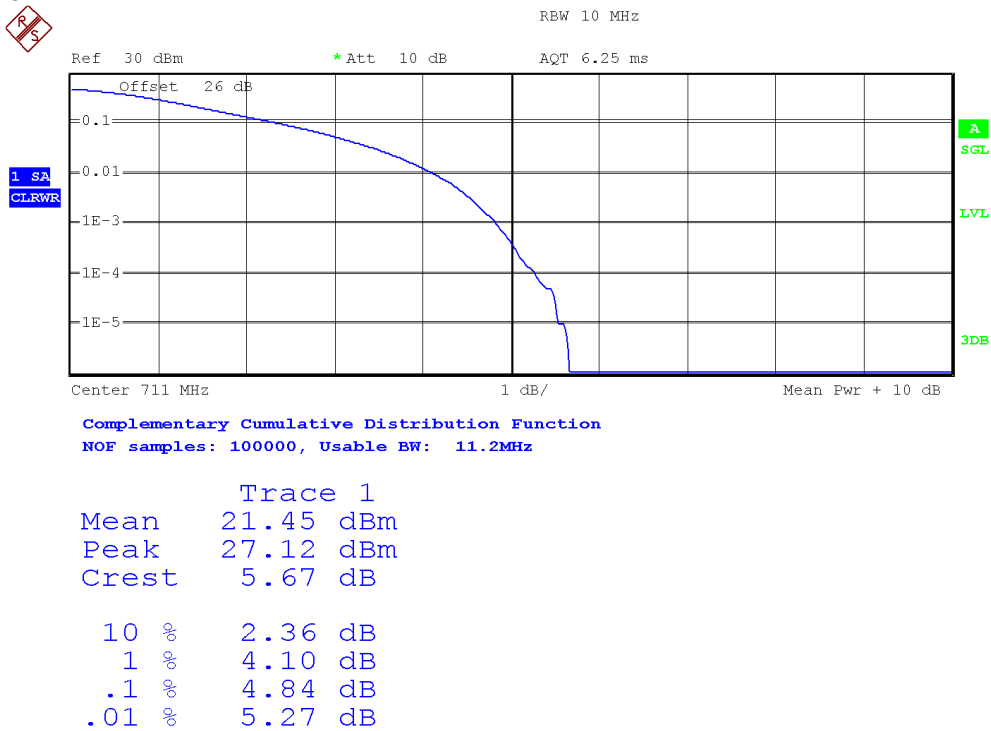
Lowest Channel:



Middle Channel:



Highest Channel:



## Modulation Characteristics

### SPECIFICATION:

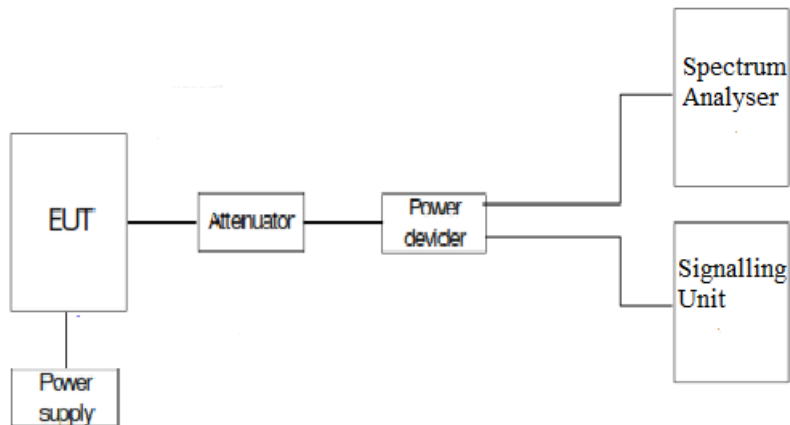
FCC §2.1047: Measurements required: Modulation characteristics.

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

### 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).

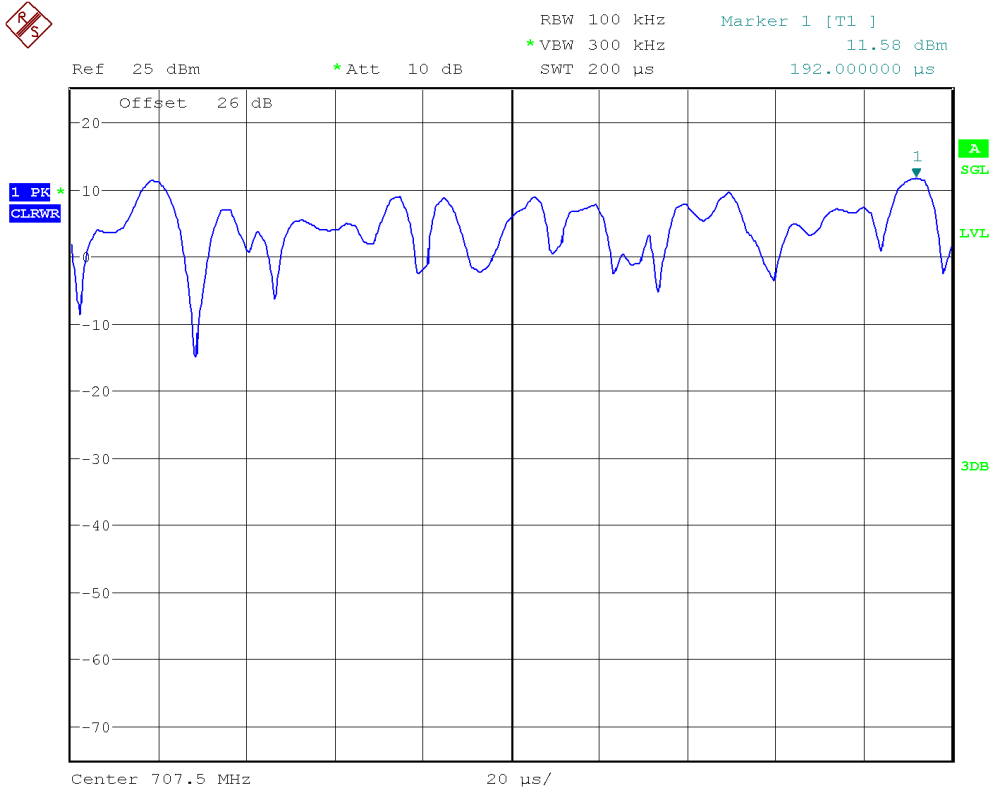
### TEST SETUP:



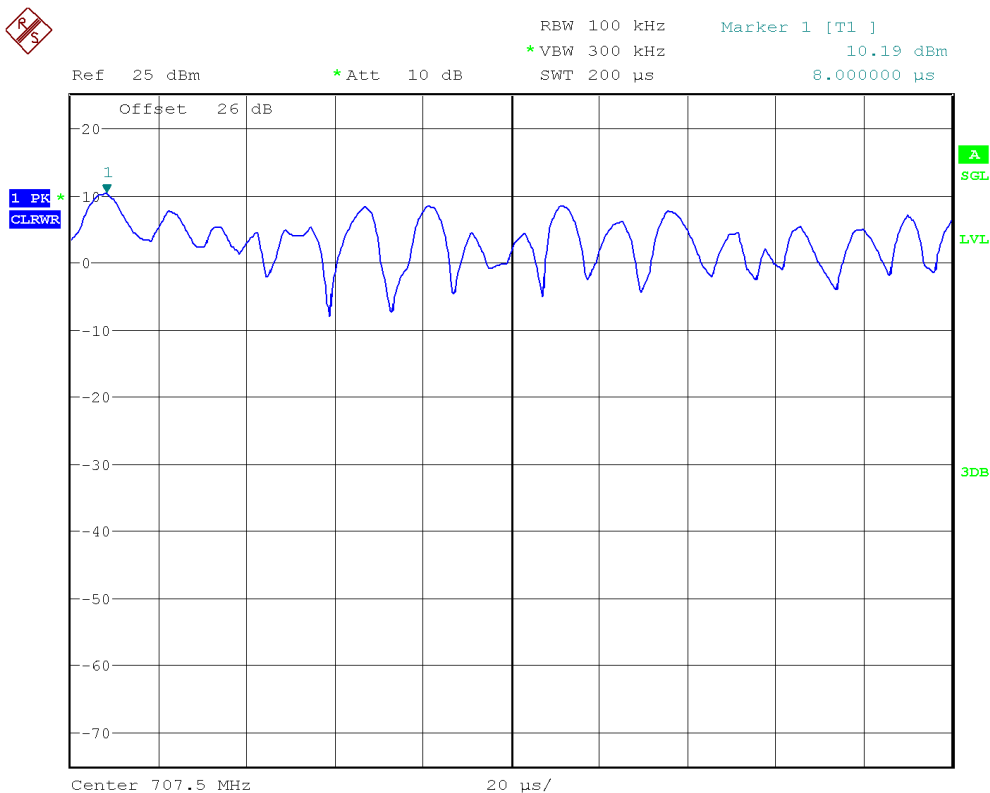
**RESULTS:**

The following plots show the modulation schemes in the EUT.

**LTE Band 12. QPSK MODULATION. BW = 5 MHz.**



**LTE Band 12. 16QAM MODULATION. BW = 5 MHz.**





## Frequency Stability

### SPECIFICATION:

#### 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:

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

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

### METHOD:

The frequency tolerance measurements over temperature variations were made over the temperature range of  $-30^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . The EUT was placed inside a climatic chamber and the temperature was raised hourly in  $10^{\circ}\text{C}$  steps from  $-30^{\circ}\text{C}$  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” in 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.

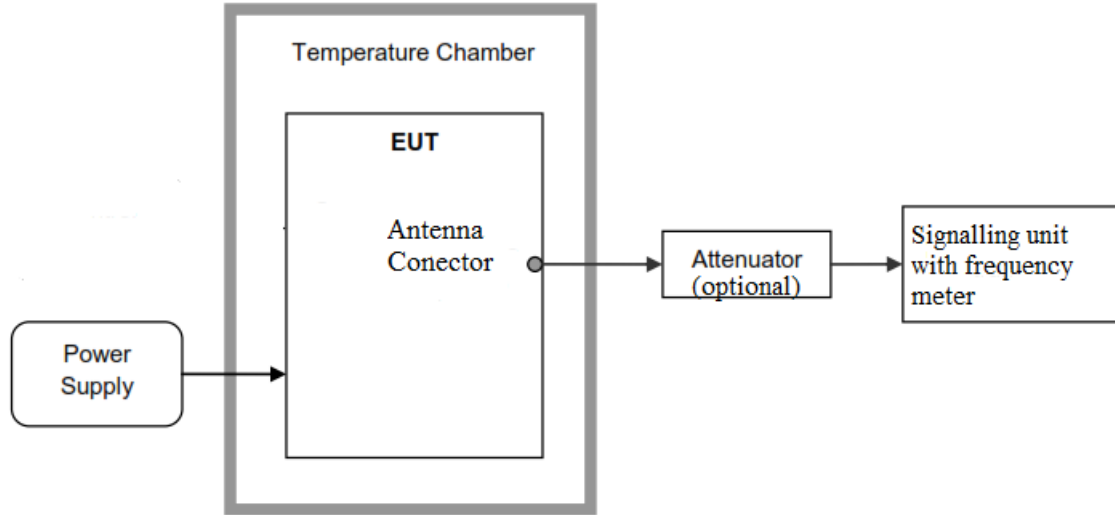
The worst case LTE mode for conducted power was used for the test.

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.

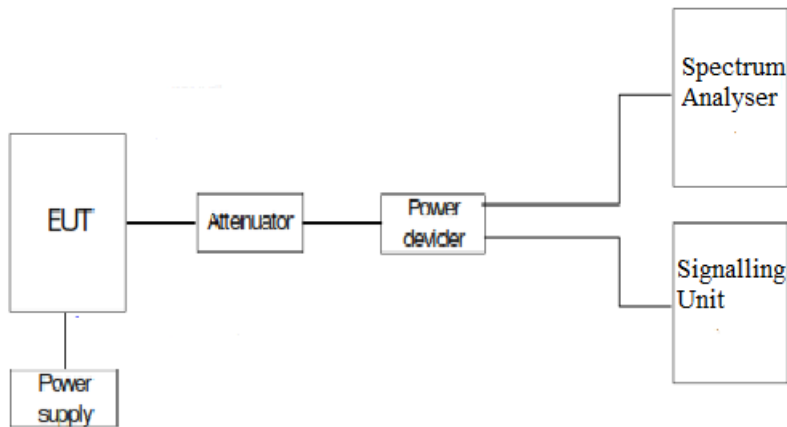
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP:

1. Frequency Tolerance:



2. Reference Frequency Points  $f_L$  and  $f_H$ :



**RESULTS:**

**1. Frequency Tolerance:**

- Frequency Stability over Temperature Variations:**

LTE Band 12. QPSK MODULATION. BW = 10 MHz.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-0.59	-0.000833922
+40	-0.75	-0.001060071
+30	-0.42	-0.00059364
+20	-0.4	-0.000565371
+10	0.69	0.000975265
0	-0.14	-0.00019788
-10	0.49	0.00069258
-20	0.49	0.00069258
-30	0.29	0.000409894

- Frequency Stability over Voltage Variations.**

LTE Band 12. QPSK MODULATION. BW = 10 MHz.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	15	-0.62	-0.000876325
Vmin(*)	9	-0.44	-0.000621908

(\*): Operating end point specified by the manufacturer.

**2. Reference Frequency Points fL and fH:**

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

LTE Band 12:

	LTE QPSK MODULATION. BW = 10 MHz
fL (MHz)	698.98580
fH (MHz)	715.96777

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

Verdict: PASS

## Occupied Bandwidth

### SPECIFICATION:

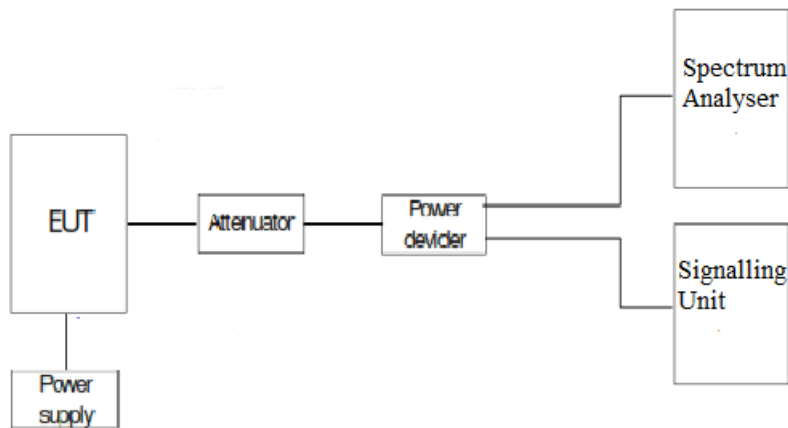
FCC §2.1049: Measurements required: Occupied bandwidth.

RSS-Gen Clause 6.7: Occupied bandwidth (or 99% emission bandwidth) and x dB 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:**

**LTE Band:** The worst case of Occupied Bandwidth corresponds to all Resource Blocks (RB) with Offset 0, regardless the nominal bandwidth selected.

**LTE Band 12:**

LTE Band 12. QPSK MODULATION. BW = 1.4 MHz.

	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	1100.40	1106.00	1111.60
-26 dBc bandwidth (kHz)	1330.00	1335.60	1332.80
Measurement uncertainty (kHz)	<±4.67		

LTE Band 12. 16QAM MODULATION. BW = 1.4 MHz.

	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	1094.80	1106.00	1097.60
-26 dBc bandwidth (kHz)	1310.40	1330.00	1327.20
Measurement uncertainty (kHz)	<±4.67		

LTE Band 12. QPSK MODULATION. BW = 3 MHz.

	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	2736.00	2748.00	2730.00
-26 dBc bandwidth (kHz)	3074.20	3078.00	3078.00
Measurement uncertainty (kHz)	<±10		

LTE Band 12. 16QAM MODULATION. BW = 3 MHz.

	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	2736.00	2742.00	2718.00
-26 dBc bandwidth (kHz)	3054.00	3072.00	3072.00
Measurement uncertainty (kHz)	<±10		

LTE Band 12. QPSK MODULATION. BW = 5 MHz.

	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	4500.00	4520.00	4540.00
-26 dBc bandwidth (kHz)	4984.00	4994.00	5064.00
Measurement uncertainty (kHz)	<±16.67		

LTE Band 12. 16QAM MODULATION. BW = 5 MHz.

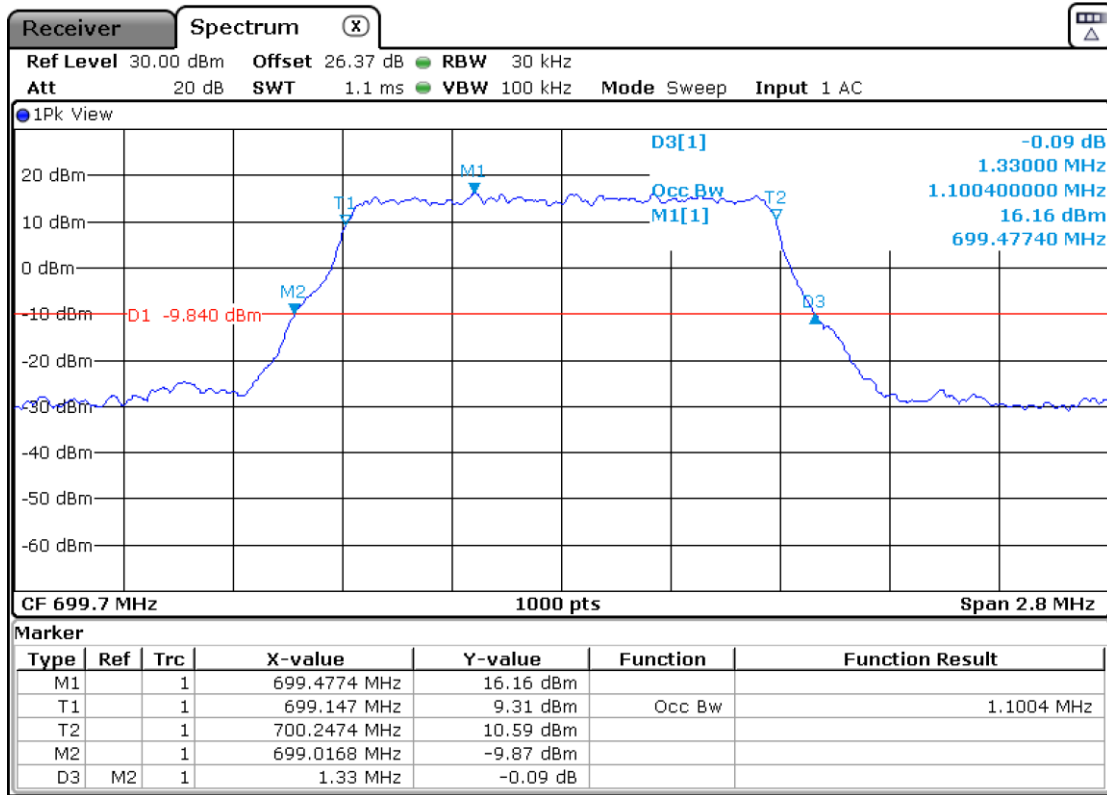
	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	4490.00	4520.00	4510.00
-26 dBc bandwidth (kHz)	4950.00	5020.00	5044.00
Measurement uncertainty (kHz)	<±16.67		

LTE Band 12. QPSK MODULATION. BW = 10 MHz.

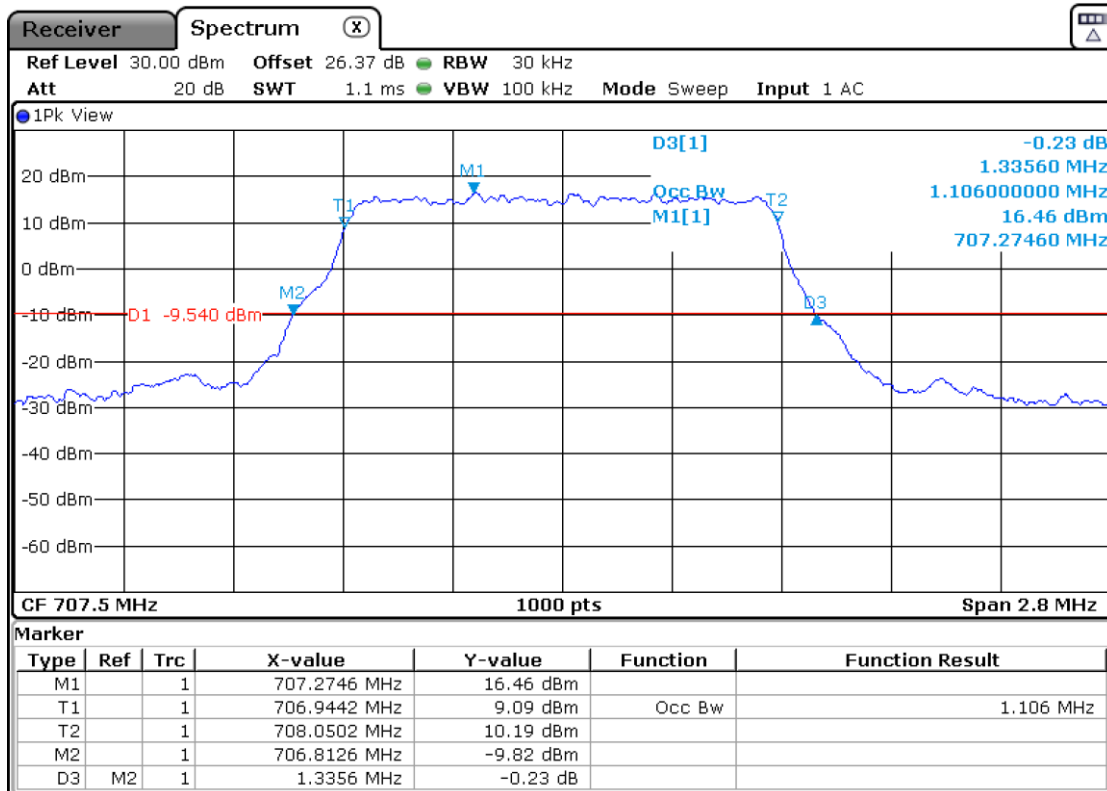
	Lowest Channel	Middle Channel	Highest Channel
99% Occupied bandwidth (kHz)	8920.00	8960.00	8920.00
-26 dBc bandwidth (kHz)	9710.00	9810.00	9750.00
Measurement uncertainty (kHz)	<±33.33		

**LTE Band 12. QPSK MODULATION. BW = 1.4 MHz.**

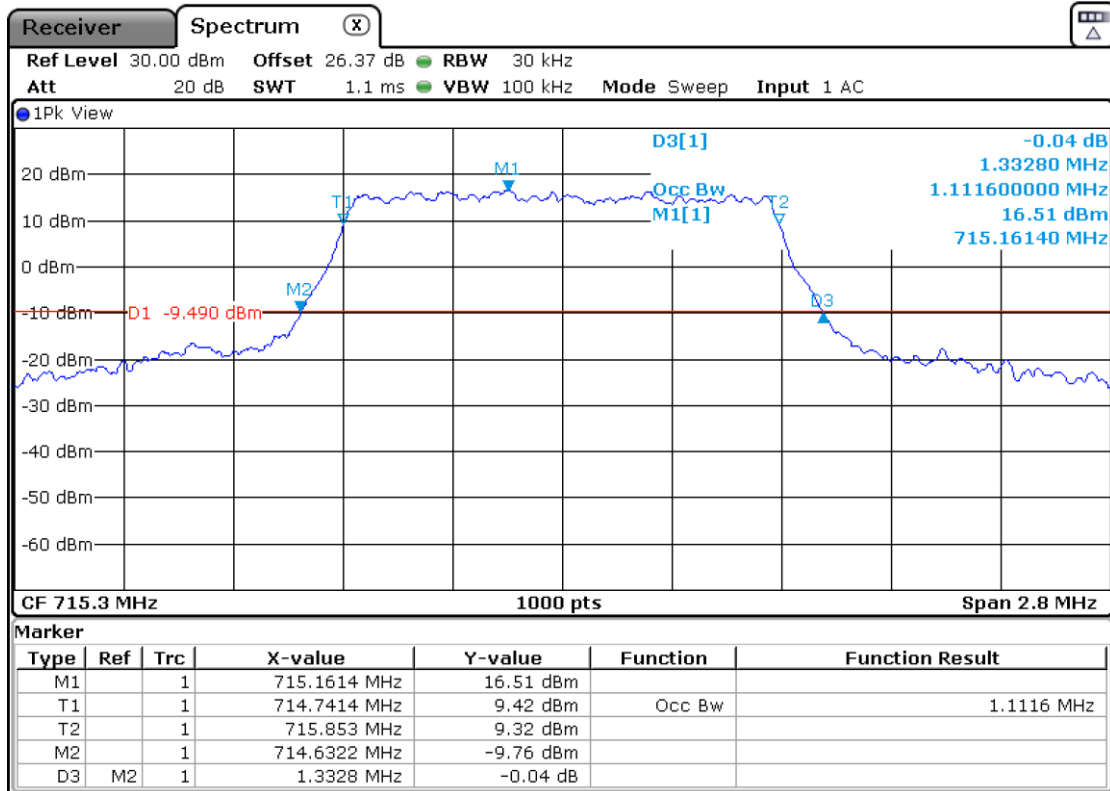
Lowest Channel:



Middle Channel:

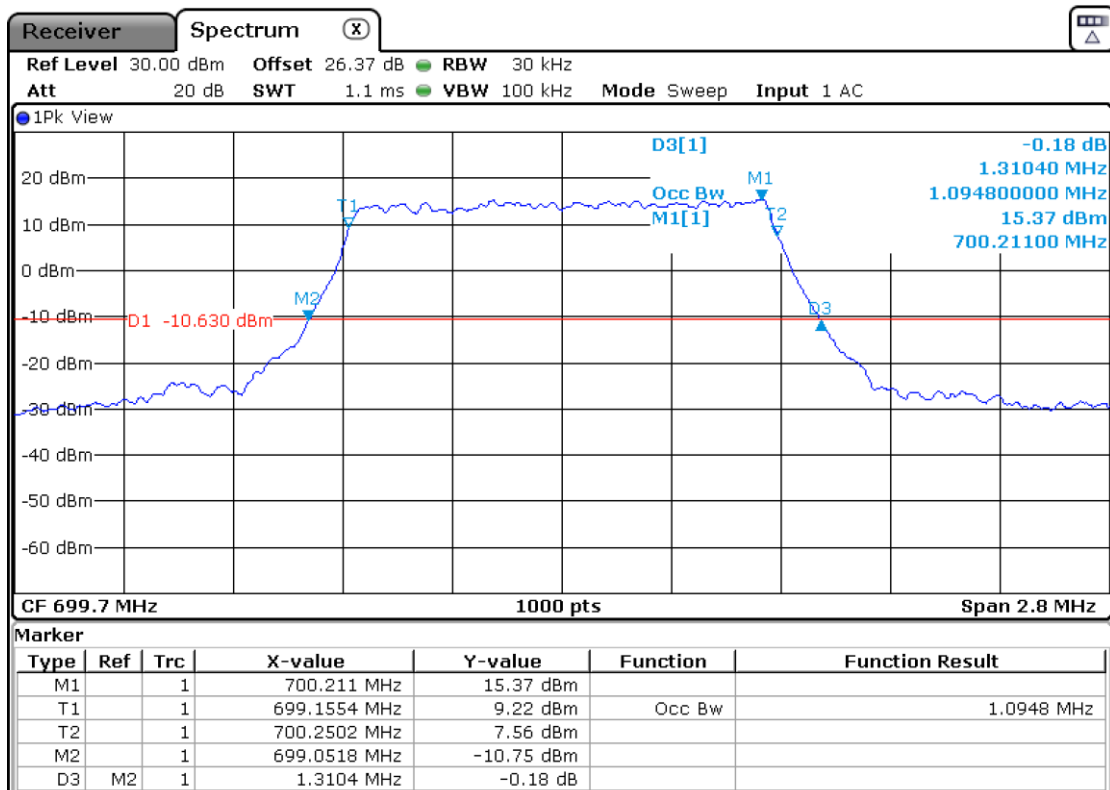


Highest Channel:



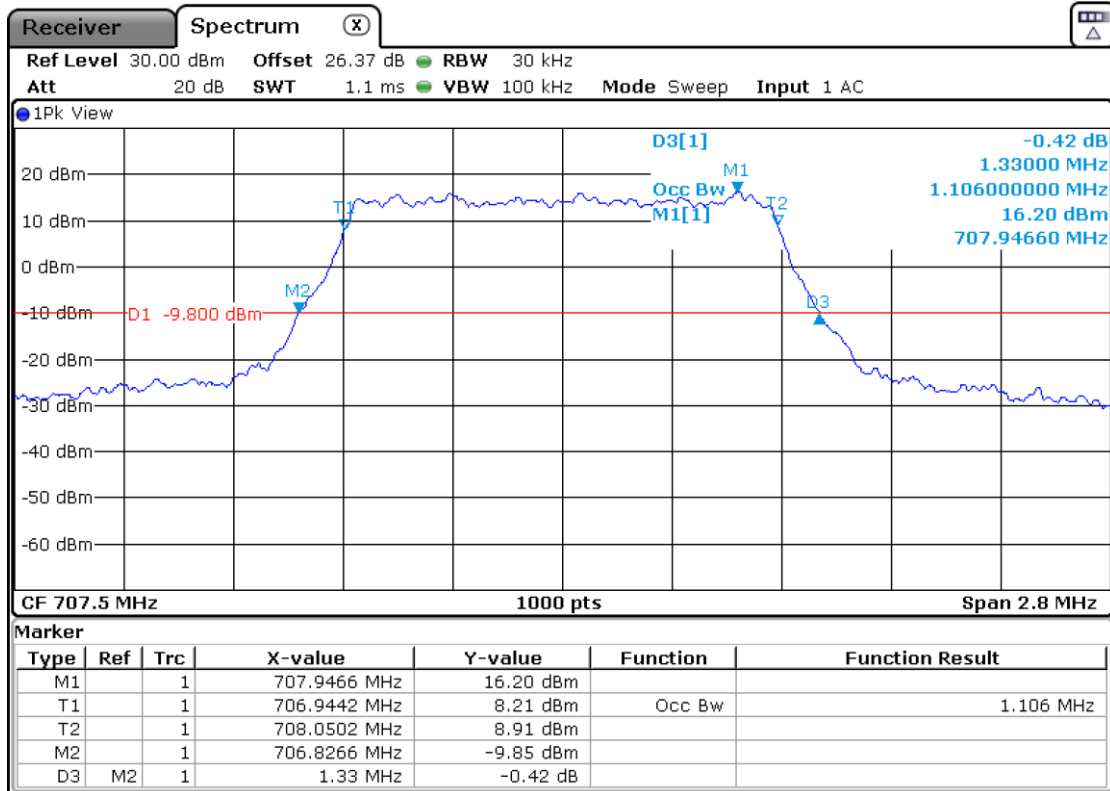
LTE Band 12. 16QAM MODULATION. BW = 1.4 MHz.

Lowest Channel:

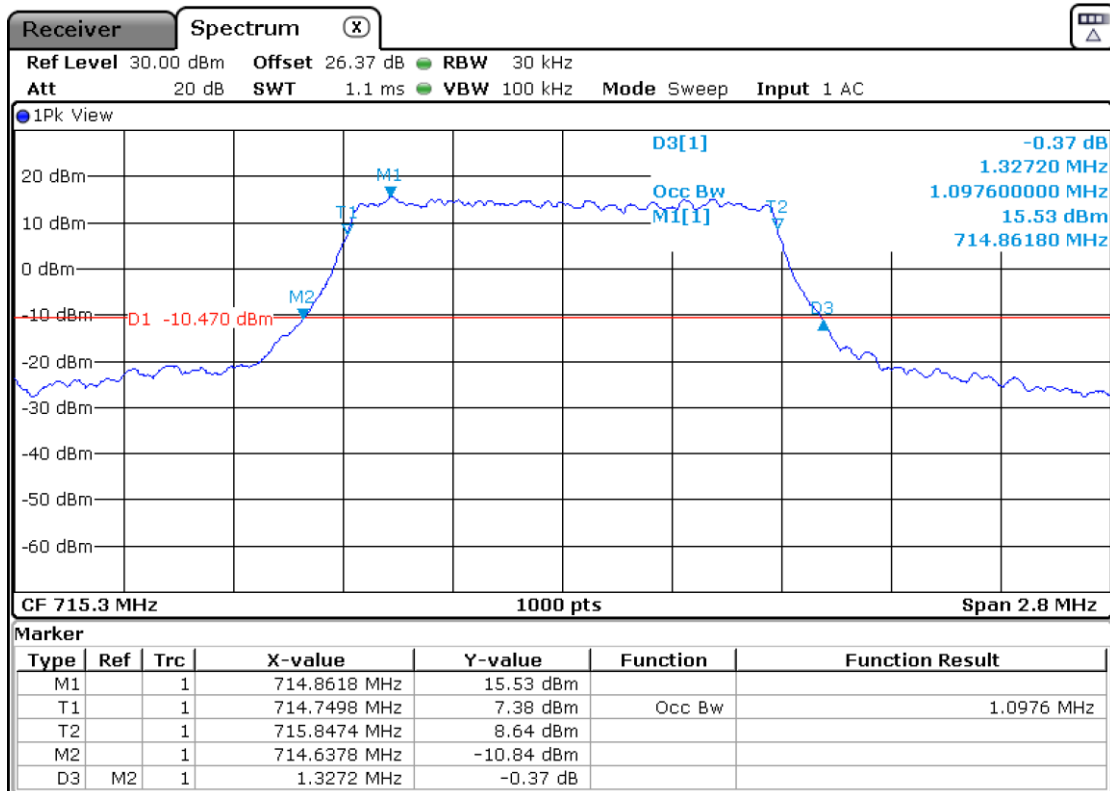




Middle Channel:

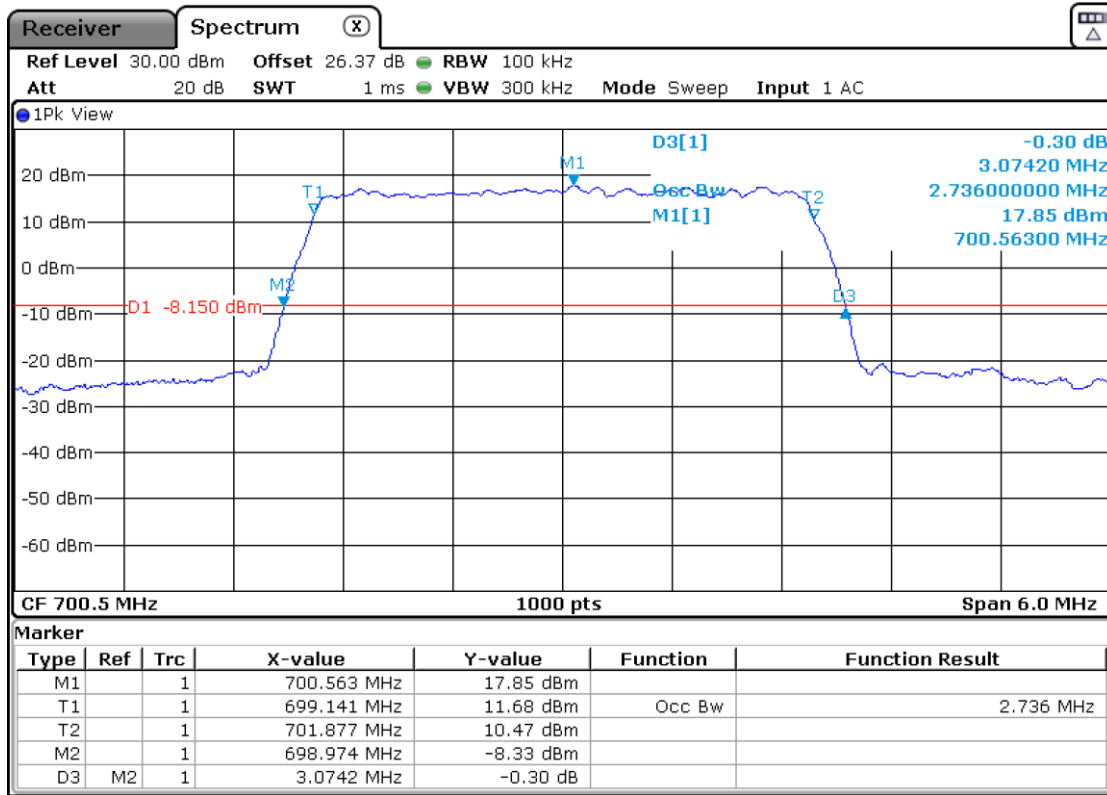


Highest Channel:

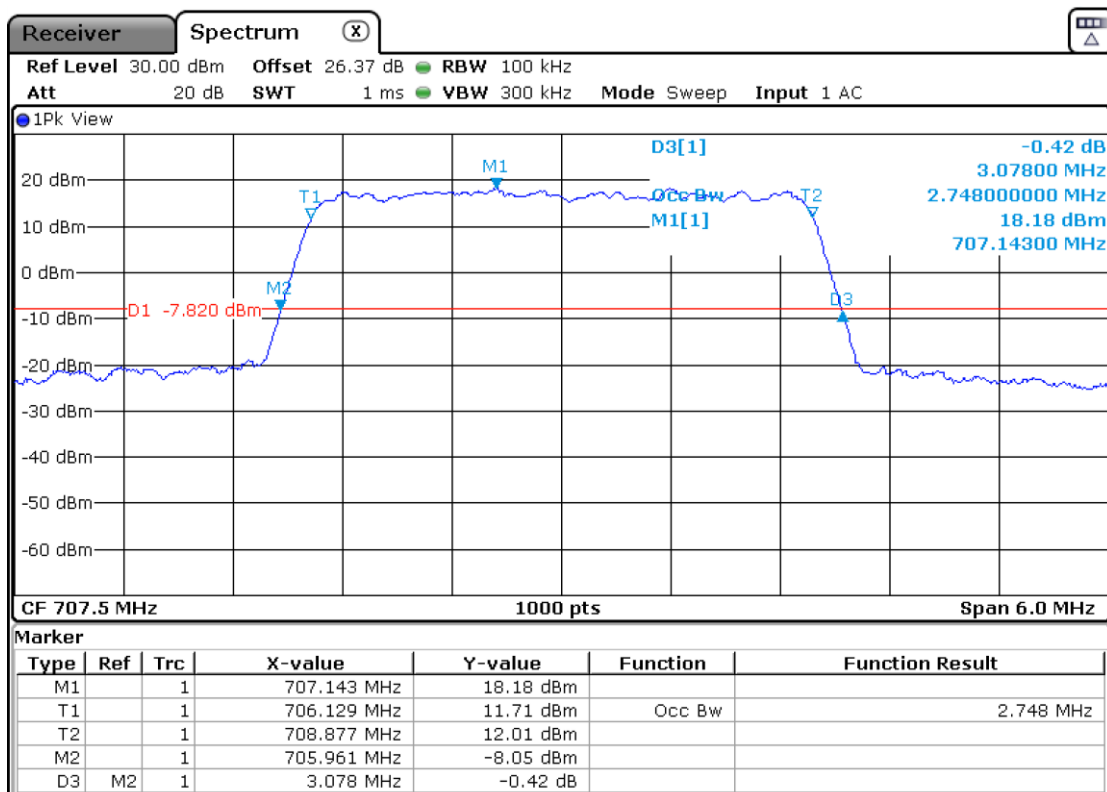


**LTE Band 12. QPSK MODULATION. BW = 3 MHz.**

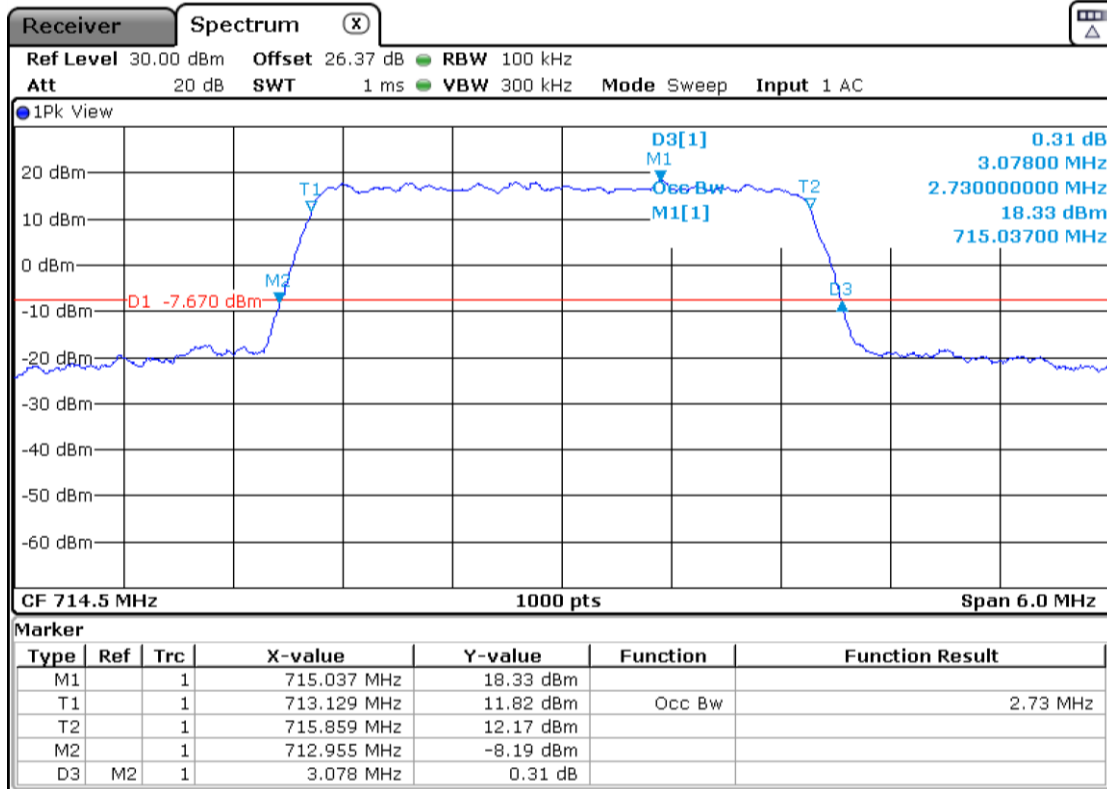
Lowest Channel:



Middle Channel:

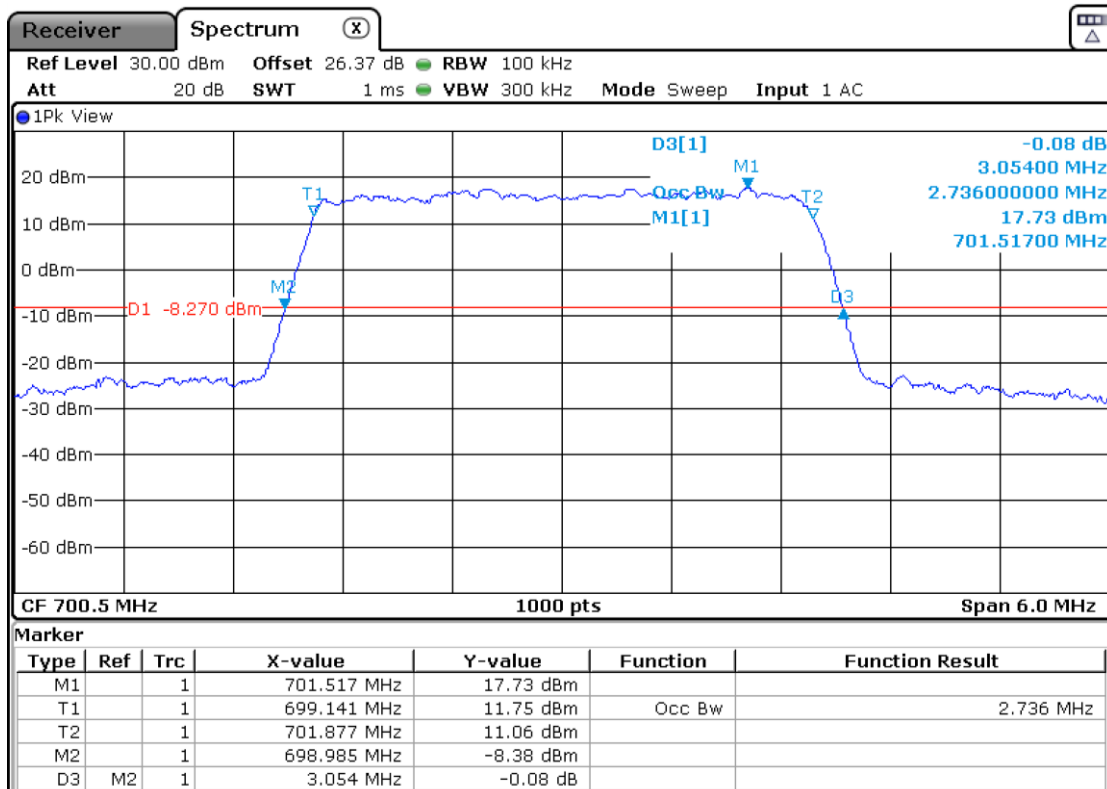


Highest Channel:

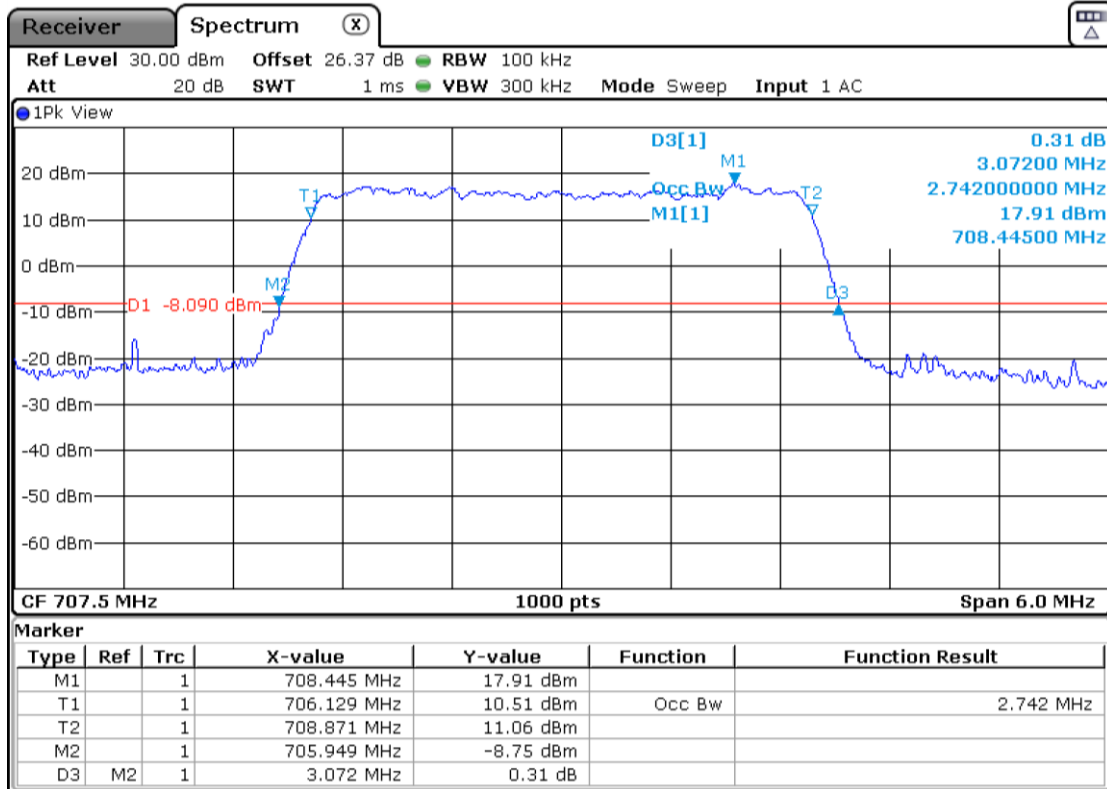


LTE Band 12. 16QAM MODULATION. BW = 3 MHz.

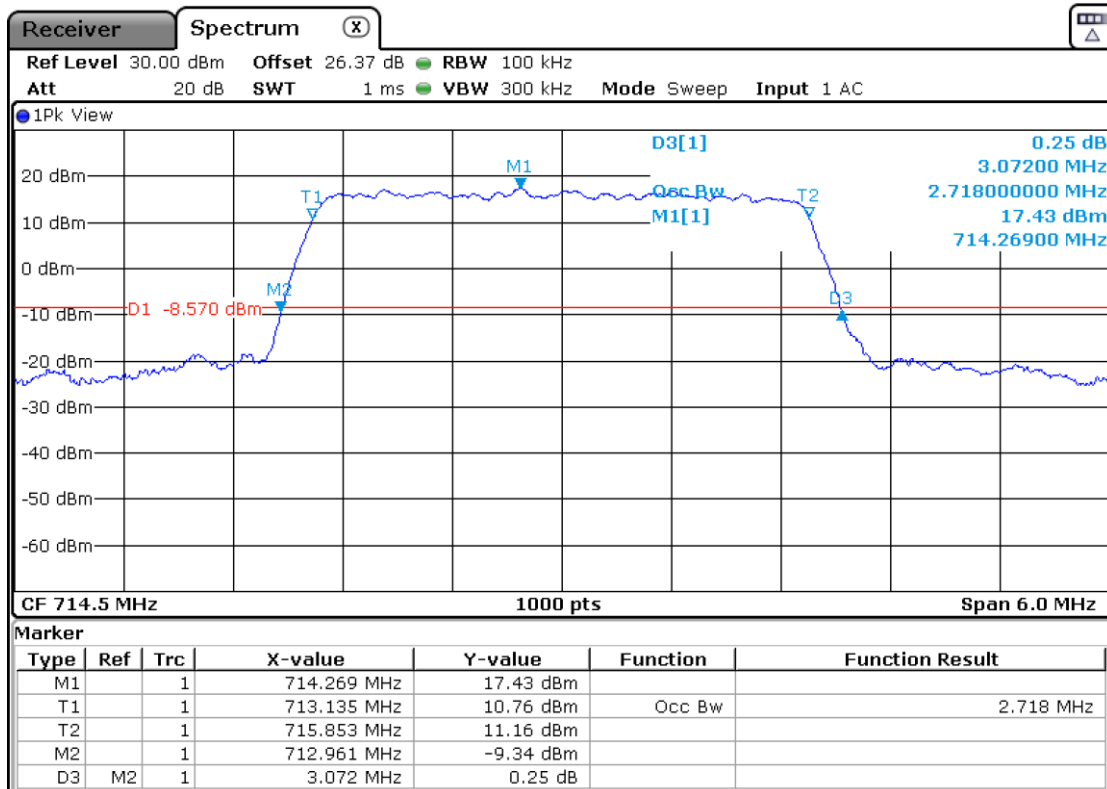
Lowest Channel:



Middle Channel:

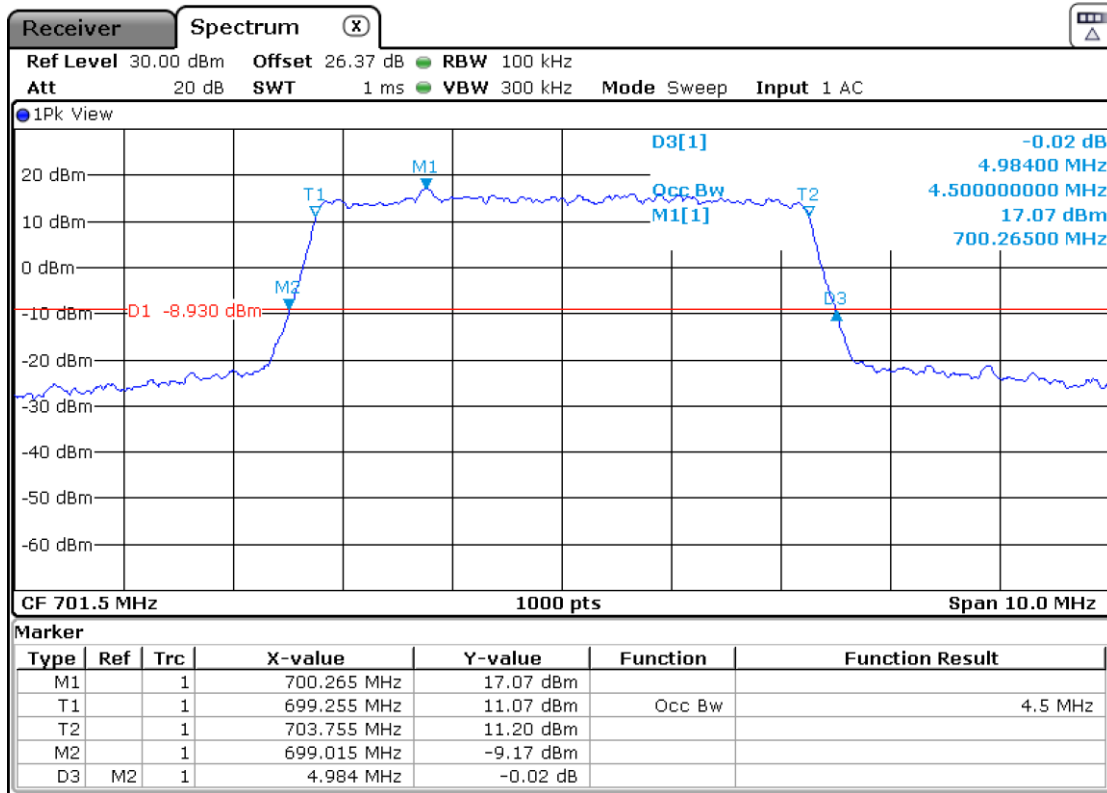


Highest Channel:

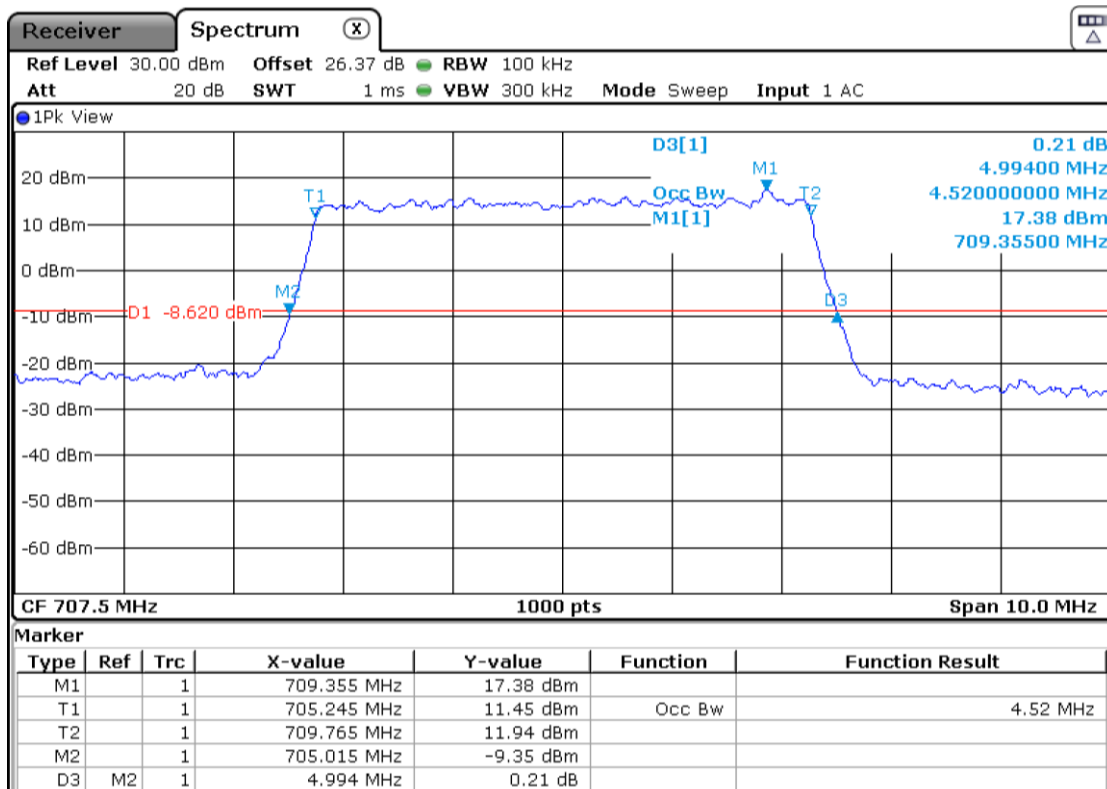


LTE Band 12. QPSK MODULATION. BW = 5 MHz.

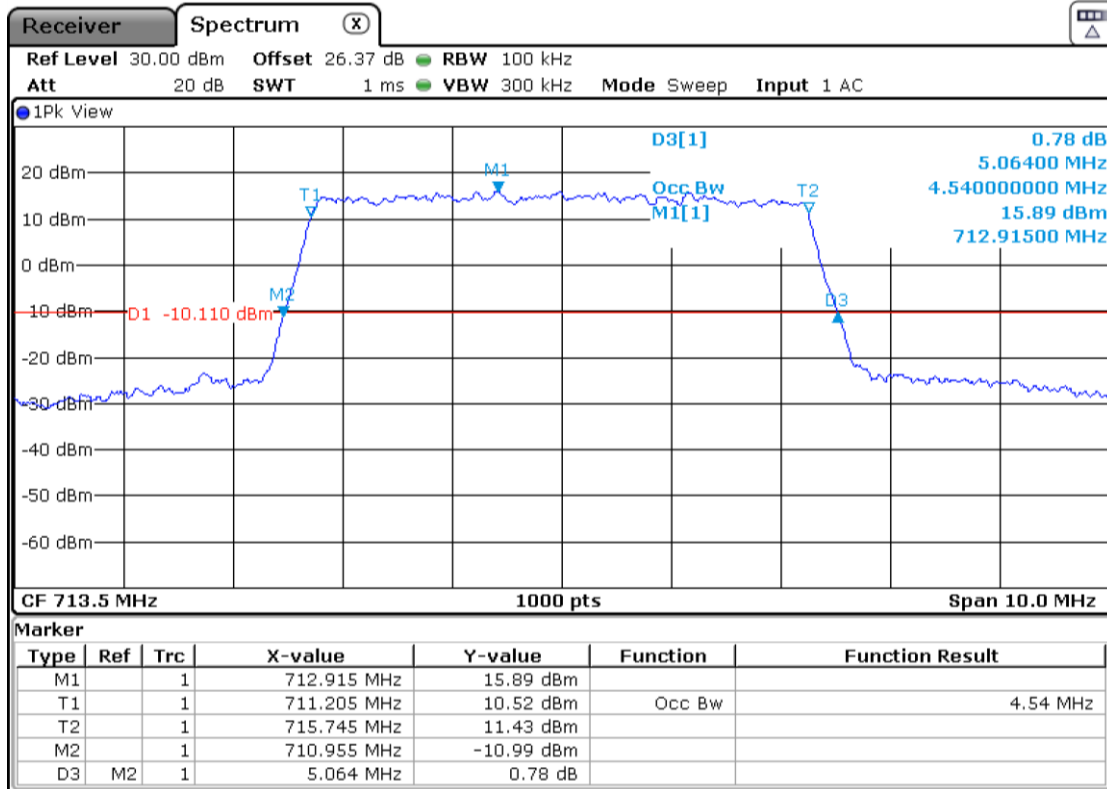
Lowest Channel:



Middle Channel:

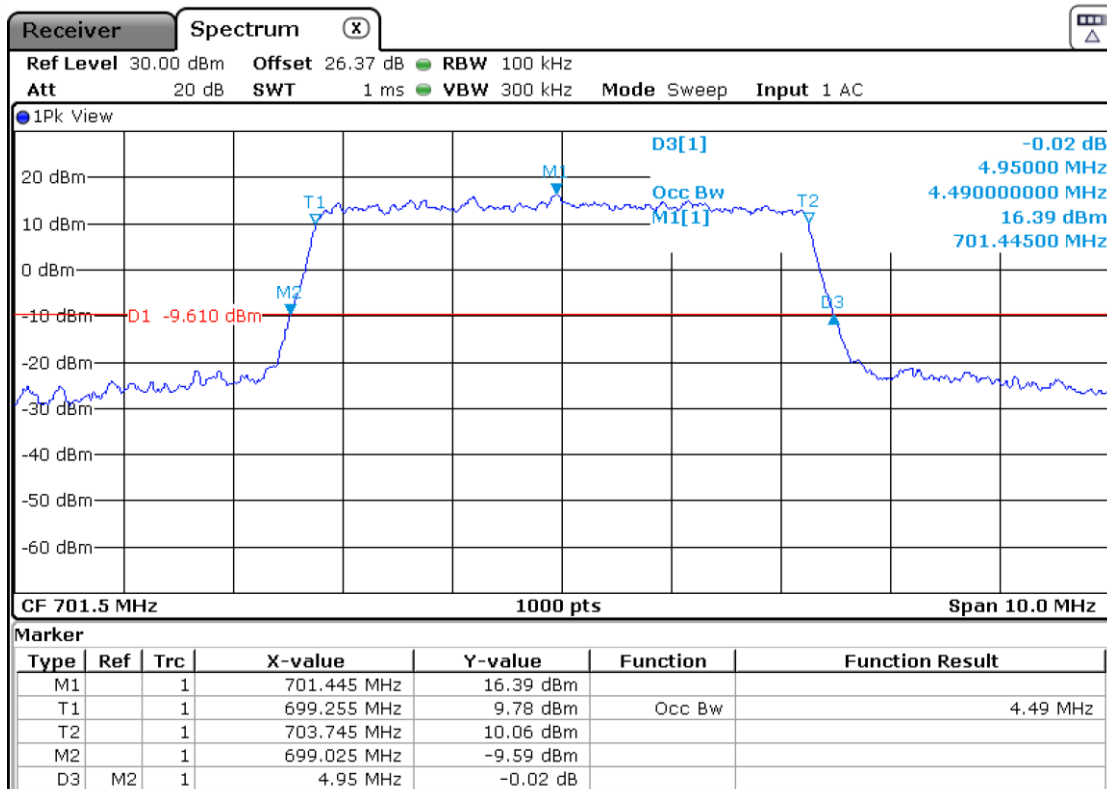


Highest Channel:

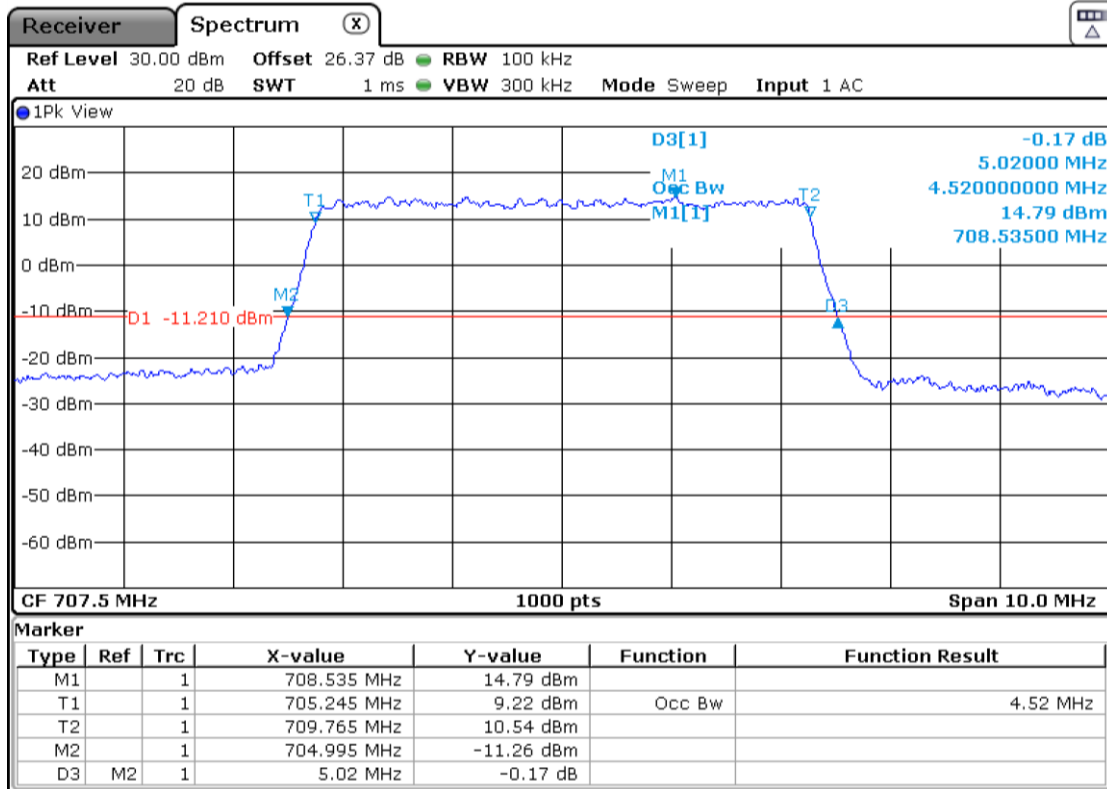


LTE Band 12. 16QAM MODULATION. BW = 5 MHz.

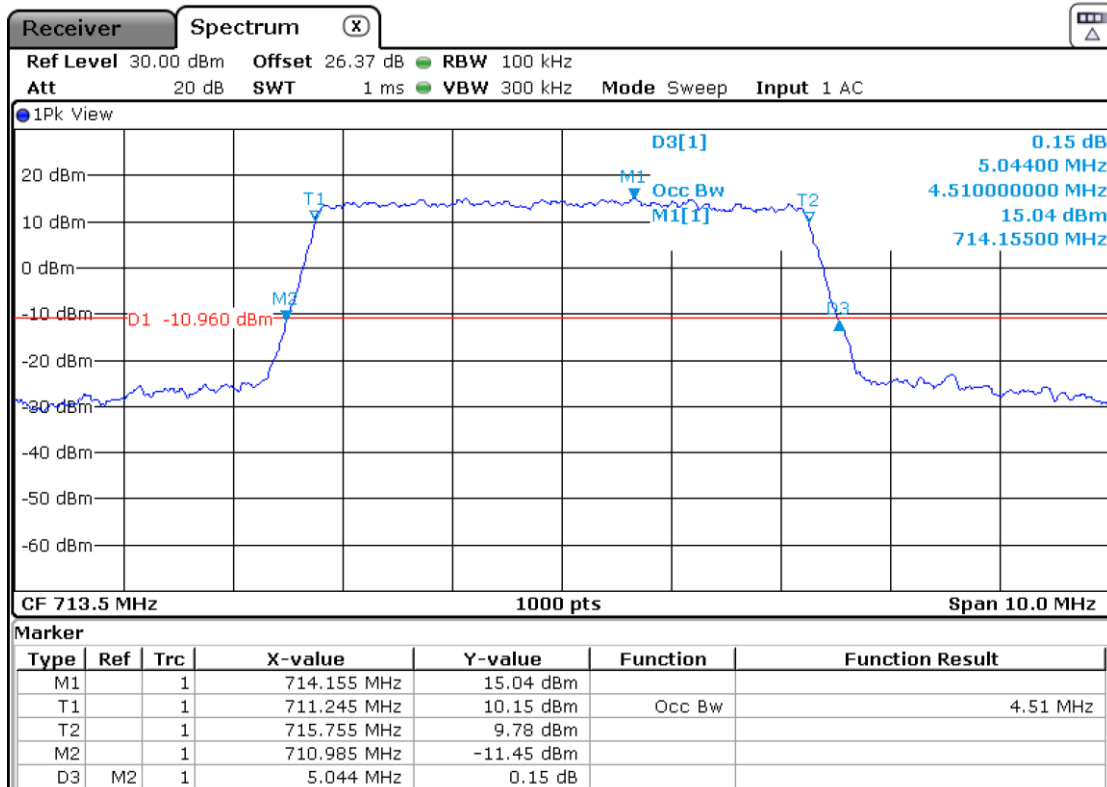
Lowest Channel:



Middle Channel:

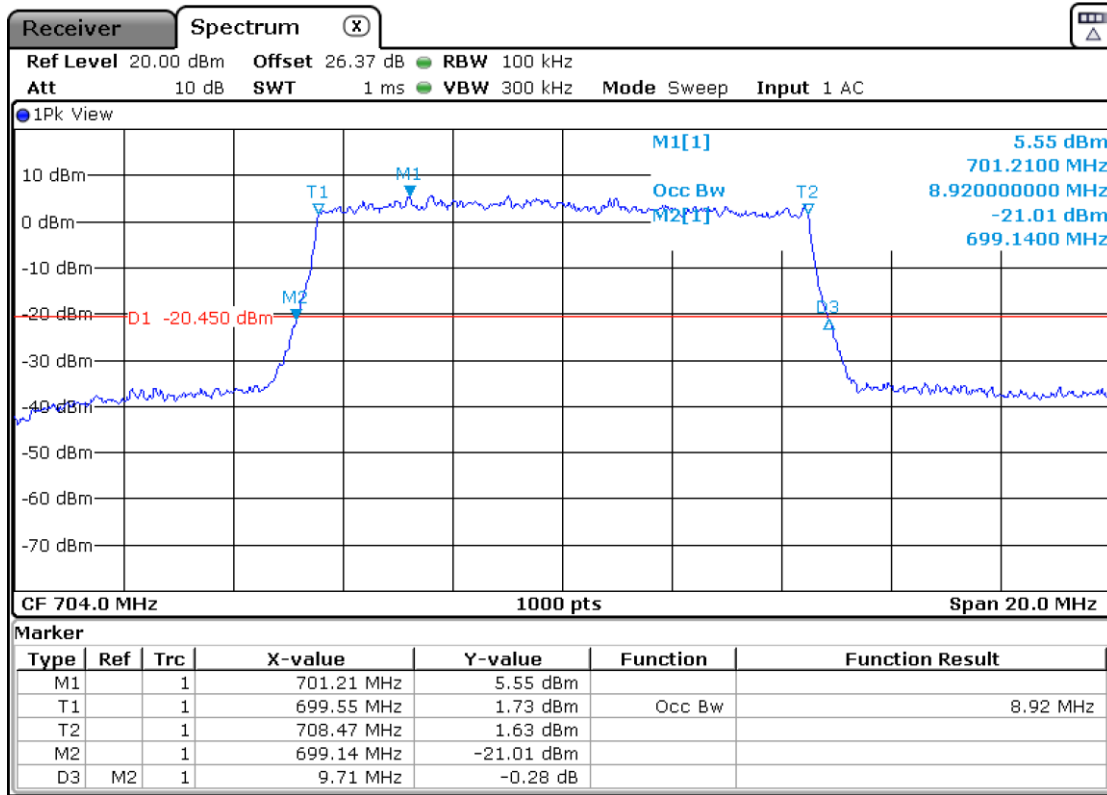


Highest Channel:

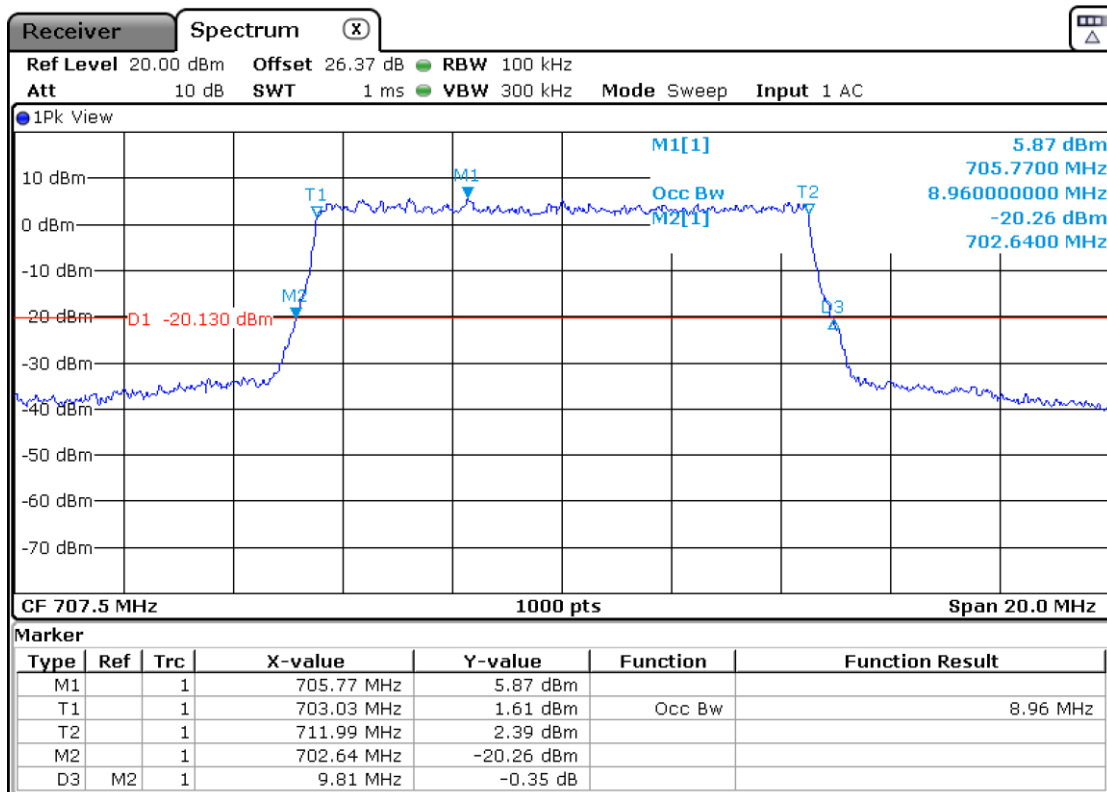


**LTE Band 12. QPSK MODULATION. BW = 10 MHz.**

Lowest Channel:

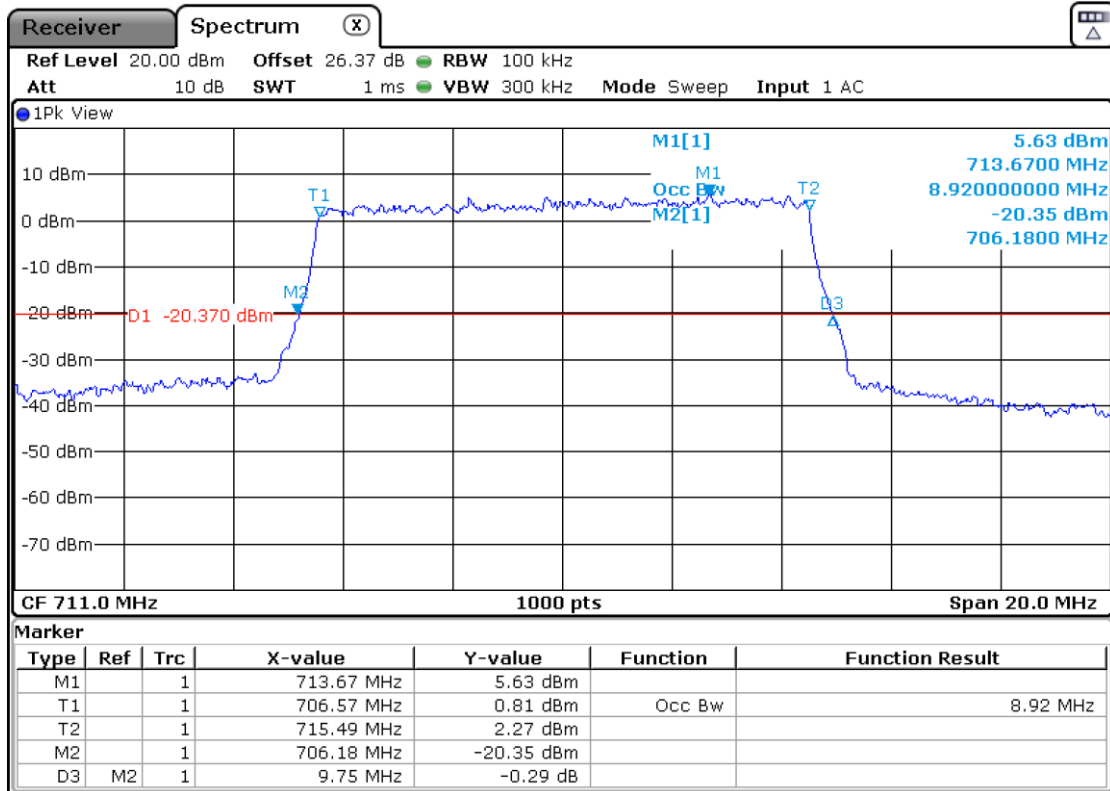


Middle Channel:





Highest Channel:



## Spurious emissions at antenna terminals

### SPECIFICATION:

FCC §27.53 (g):

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130 Clause 4.7.1:

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

### METHOD:

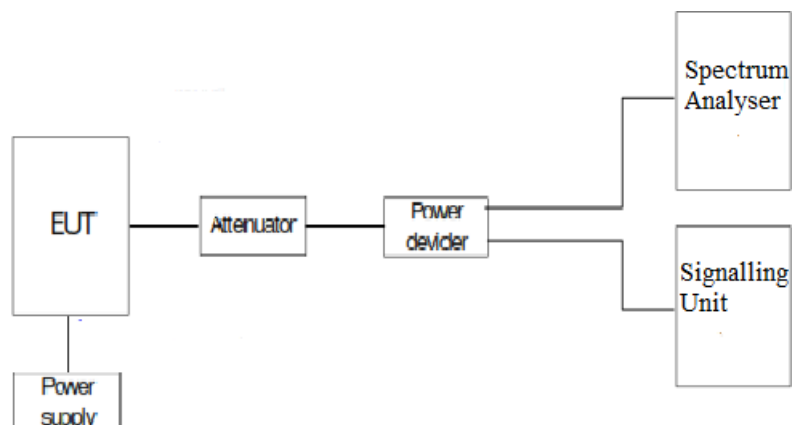
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 8 GHz for LTE Band 12.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of Resource Blocks and modulation which is the worst case for conducted power was used.

### TEST SETUP:



RESULTS:

**LTE BAND:** Test performed on the worst-case modulation and worst RB and worst Offset for all the nominal BW of each LTE band.

LTE Band 12. QPSK MODULATION. BW = 1.4 MHz.

- Lowest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Middle Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Highest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.

LTE Band 12. QPSK MODULATION. BW = 3 MHz.

- Lowest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Middle Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Highest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.

LTE Band 12. QPSK MODULATION. BW = 5 MHz.

- Lowest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Middle Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Highest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.

LTE Band 12. QPSK MODULATION. BW = 10 MHz.

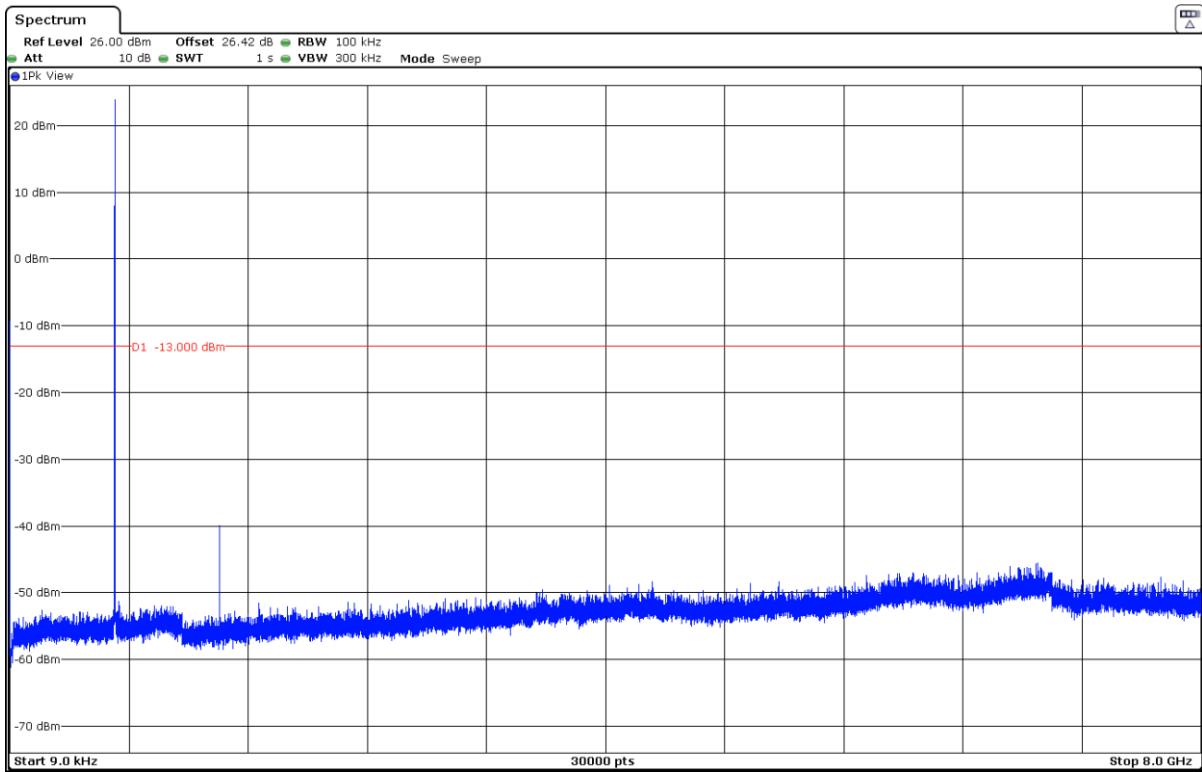
- Lowest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Middle Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.
- Highest Channel:  
No spurious frequencies detected at less than 20 dB below the limit in all the range.

Measurement uncertainty (dB)	<±2.03
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Verdict: PASS

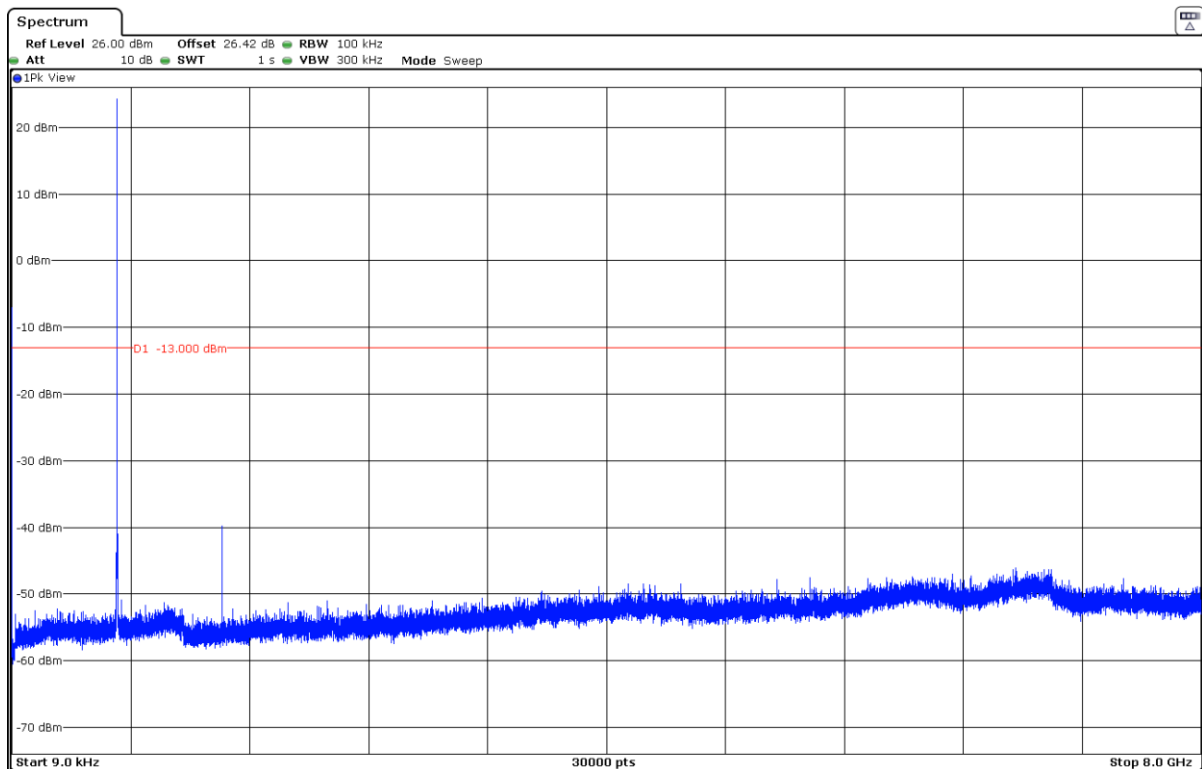
LTE Band 12. QPSK MODULATION. BW = 1.4 MHz.

Lowest Channel:



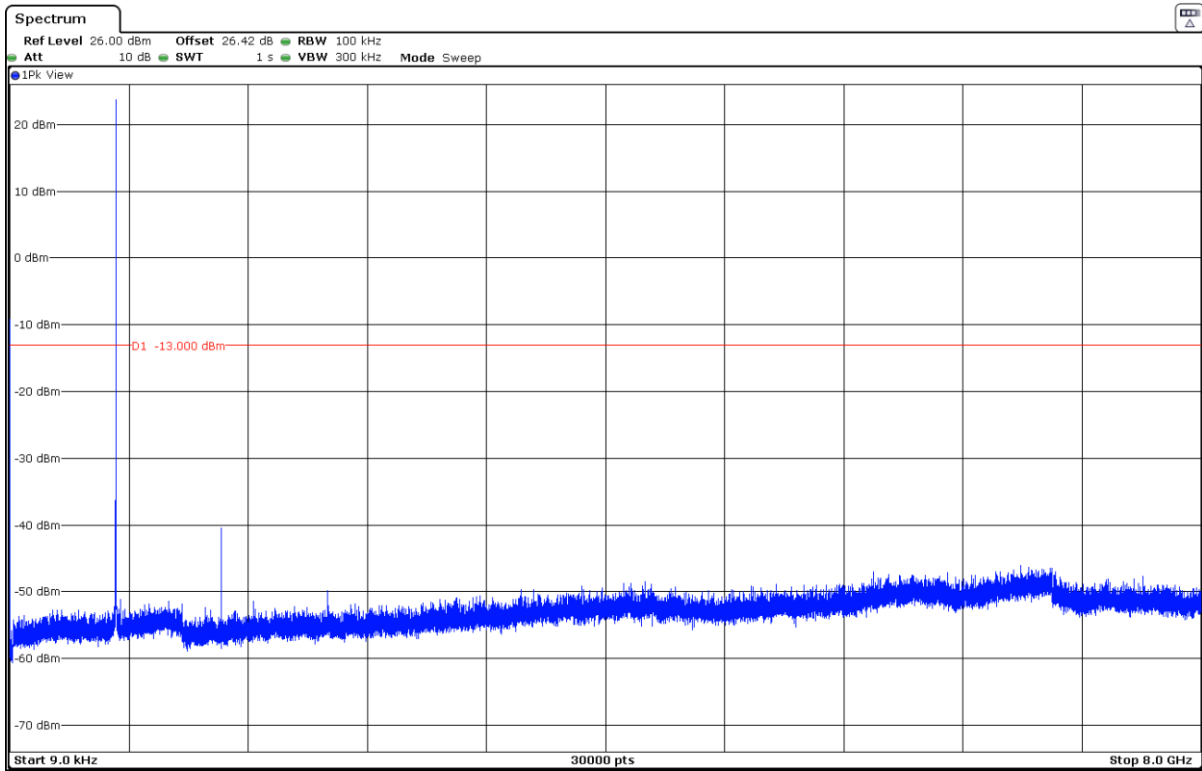
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

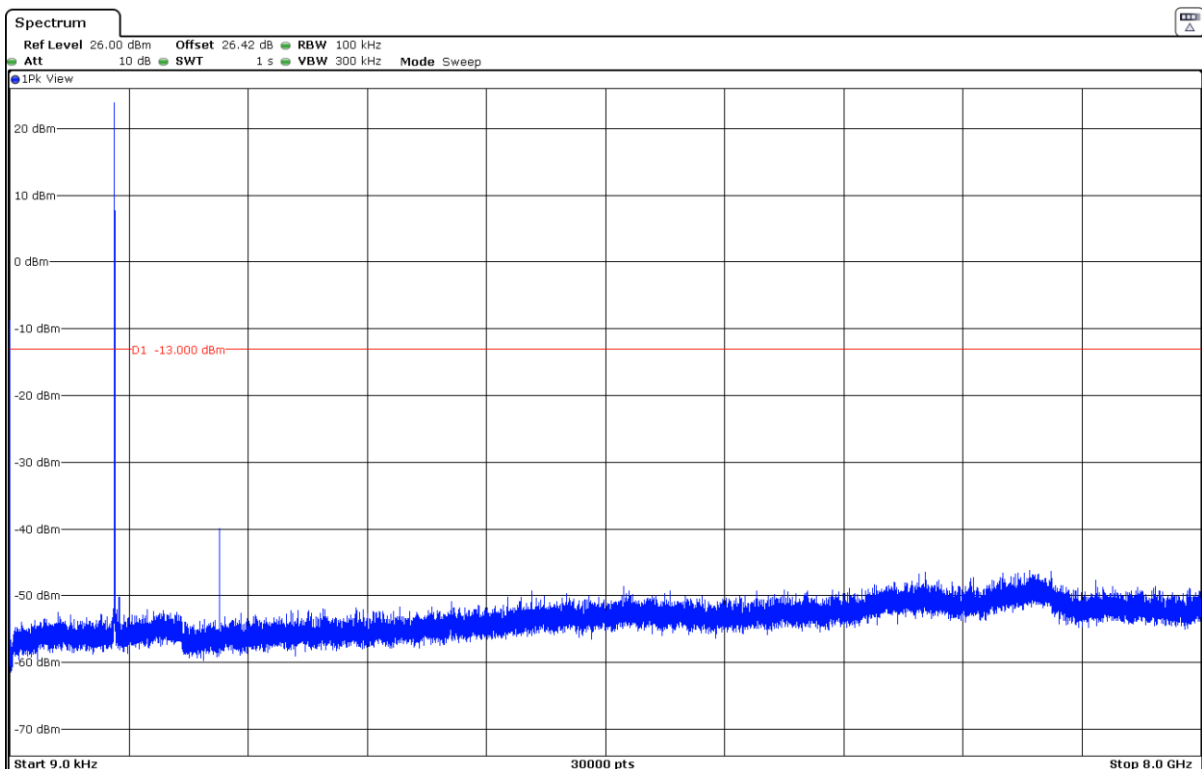
Highest Channel:



The peak above the limit is the carrier frequency.

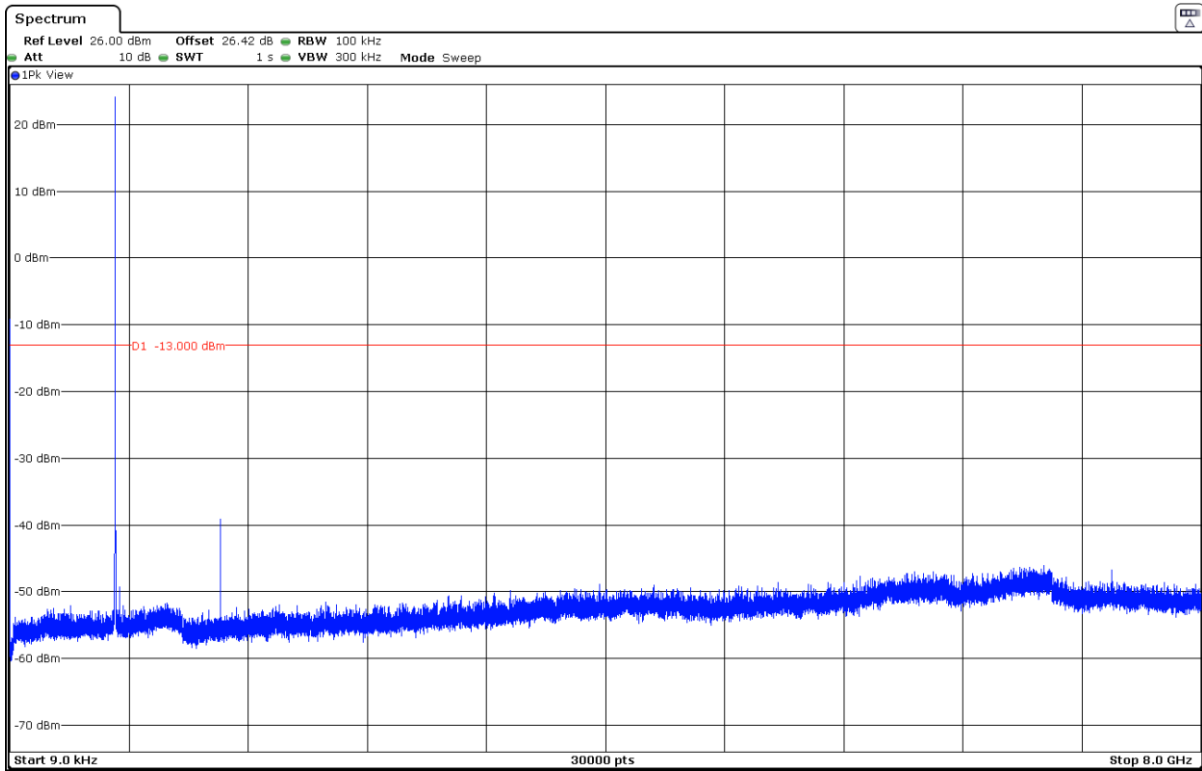
LTE Band 12. QPSK MODULATION. BW = 3 MHz.

Lowest Channel:



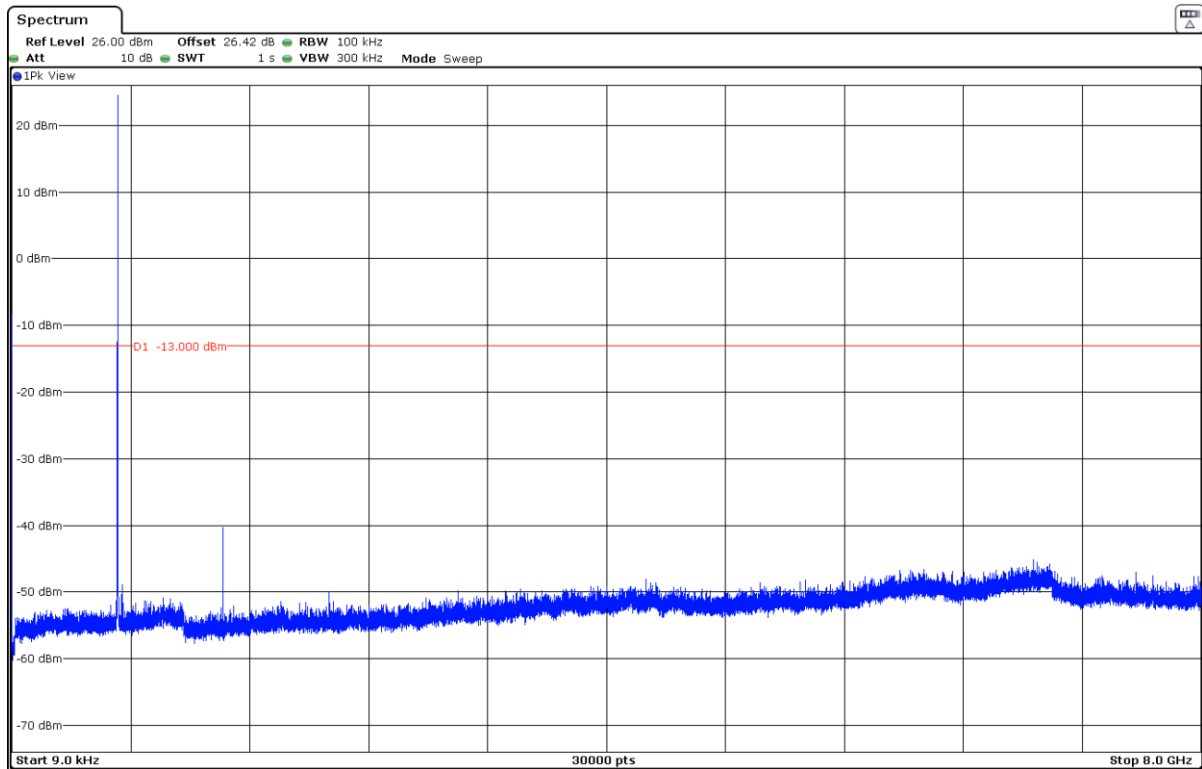
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

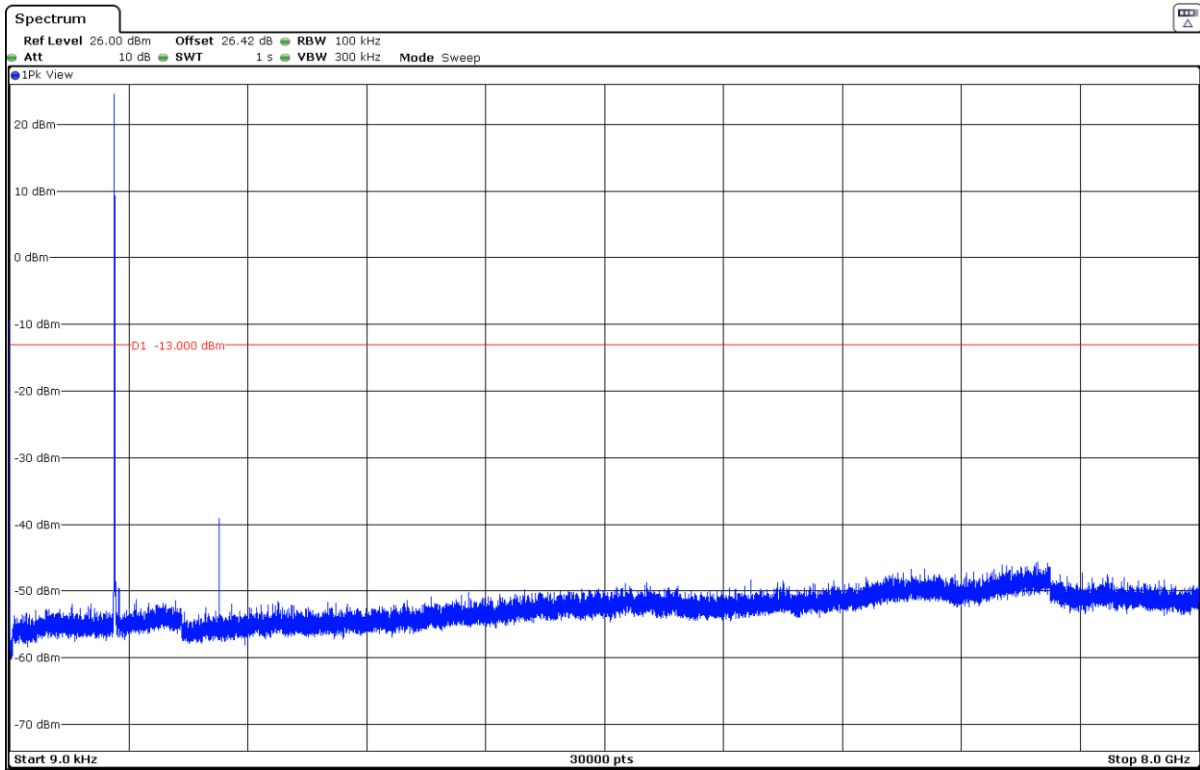
Highest Channel:



The peak above the limit is the carrier frequency.

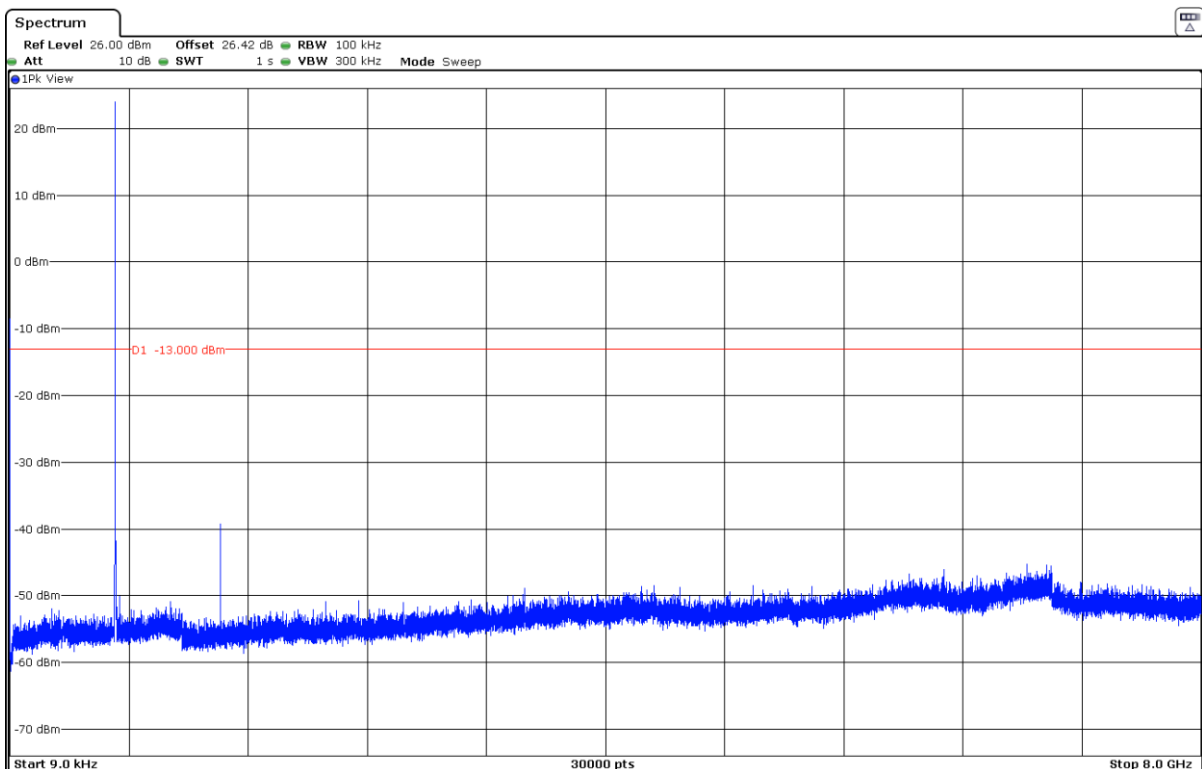
LTE Band 12. QPSK MODULATION. BW = 5 MHz.

Lowest Channel:



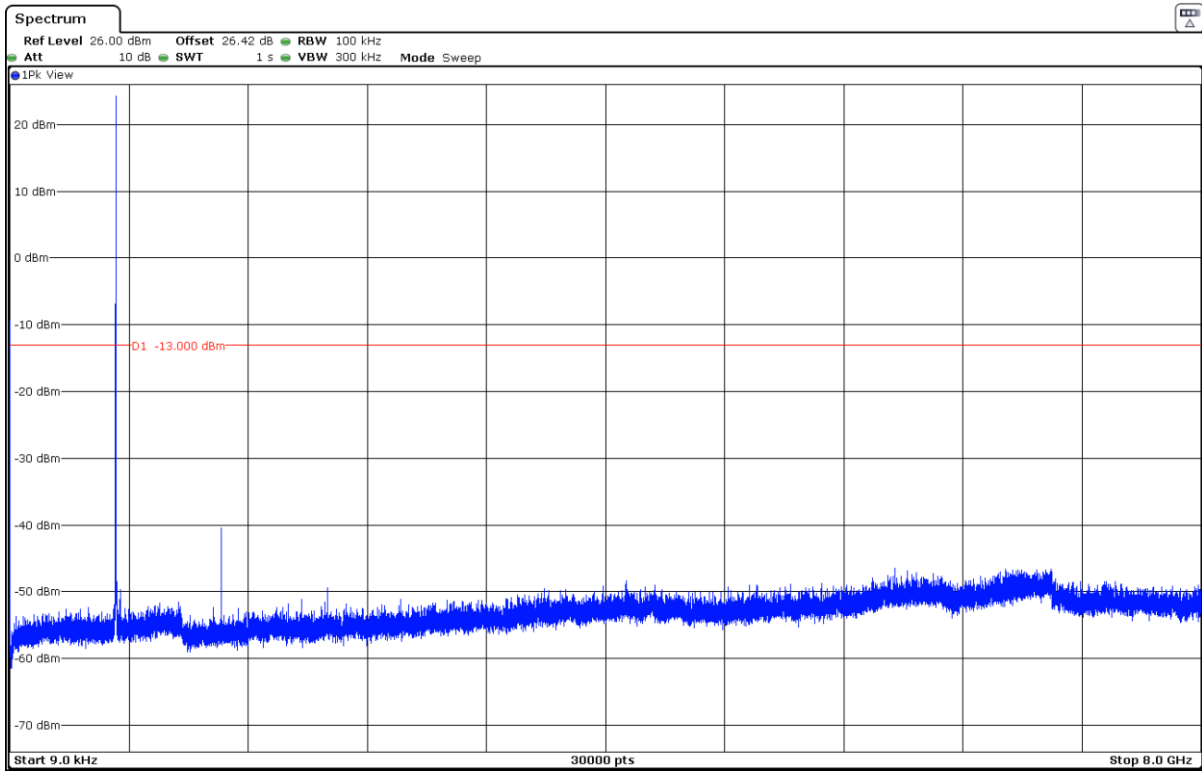
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

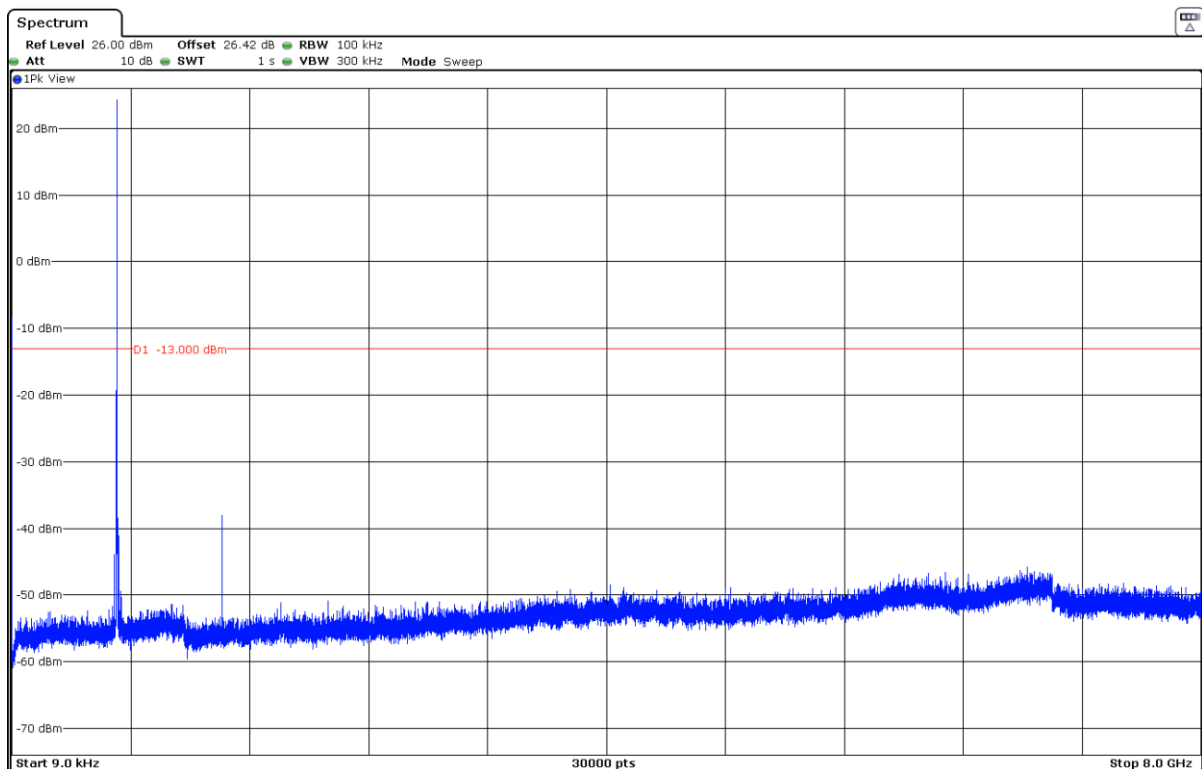
Highest Channel:



The peak above the limit is the carrier frequency.

LTE Band 12. QPSK MODULATION. BW = 10 MHz.

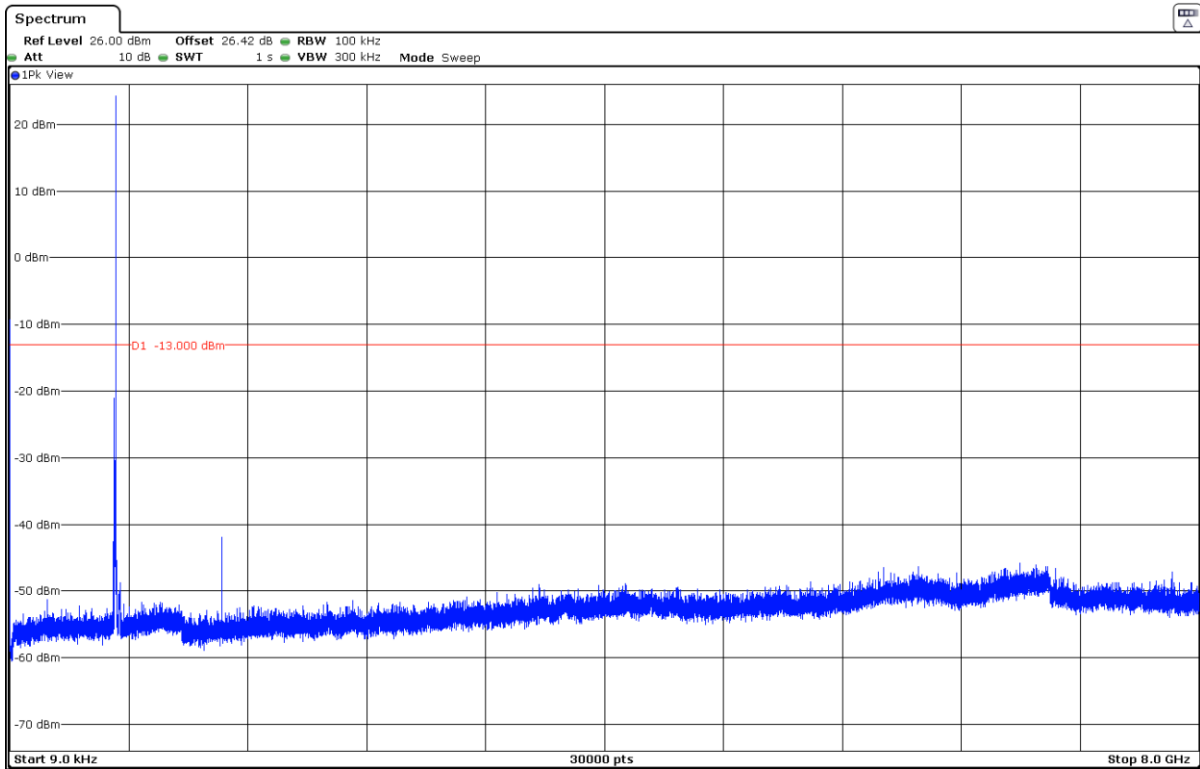
Lowest Channel:



The peak above the limit is the carrier frequency.

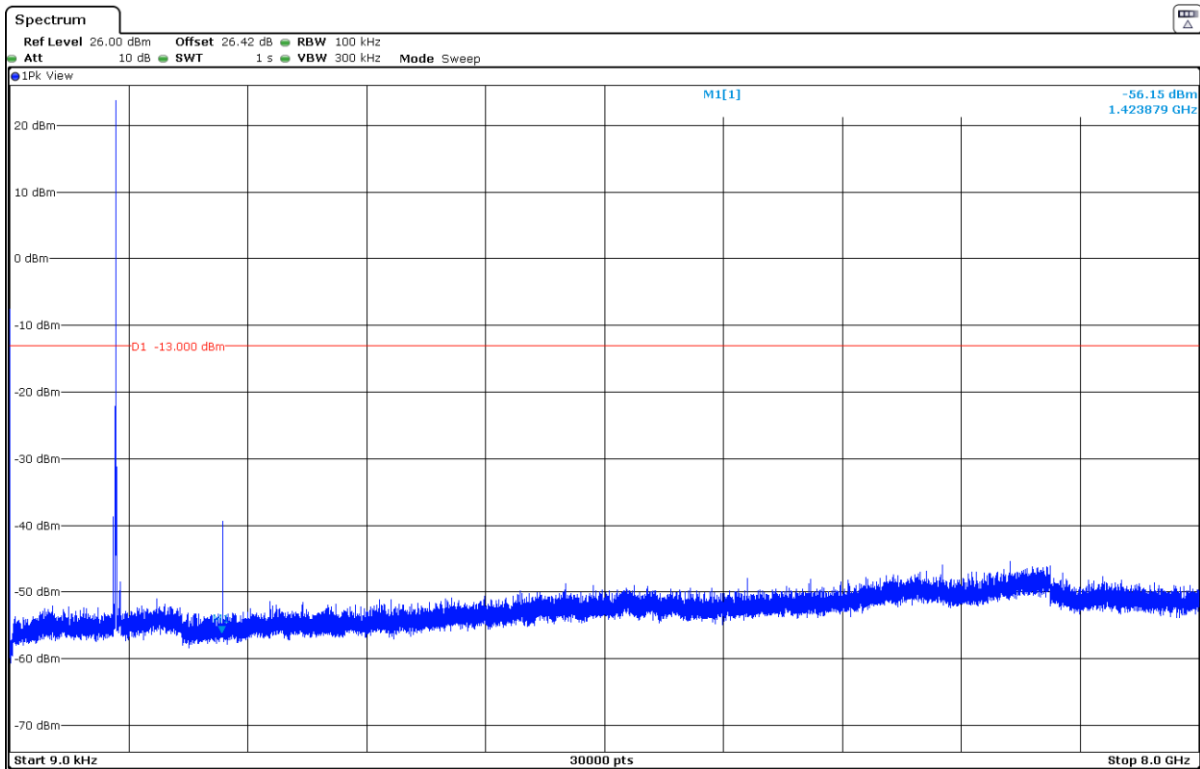


Middle Channel:



The peak above the limit is the carrier frequency.

Highest Channel:



The peak above the limit is the carrier frequency.

## Spurious emissions at antenna terminals at Block Edges

### SPECIFICATION:

FCC §27.53 (g):

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130 Clause 4.7.1:

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

### METHOD:

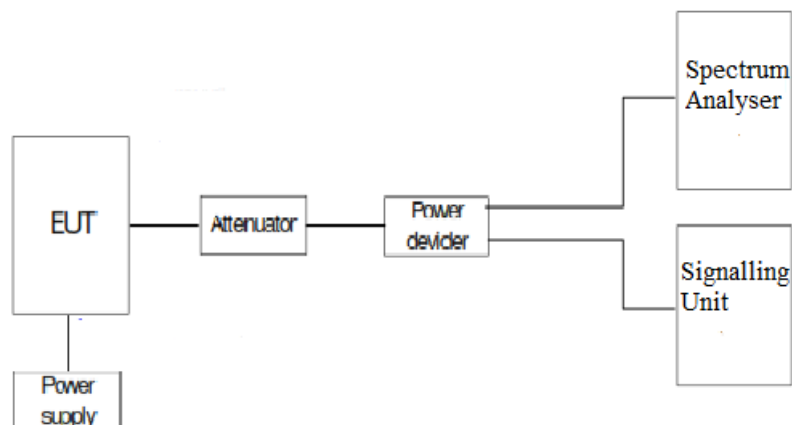
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 Ohm attenuator and a power splitter.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of modulation which is the worst case for conducted power was used.

For LTE Band 12 , as indicated in FCC part 27.53 (g), in the 100 kHz bands immediately outside and adjacent to the licensee's frequency block or band, a resolution bandwidth of 30 kHz may be employed.

### TEST SETUP:



**RESULTS:**

LTE Band 12.

LTE QPSK MODULATION:	RB=1, Offset=0, BW=1.4 MHz	RB=1 , Offset =0, BW = 3 MHz	RB=1, Offset=0, BW=5 MHz	RB=1 , Offset =0, BW = 10 MHz
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-47.35	-46.89	-48.13	-47.85

LTE QPSK MODULATION:	RB=All, Offset=0, BW=1.4 MHz	RB=All, Offset=0, BW = 3 MHz	RB=All, Offset=0, BW=5 MHz	RB=All, Offset=0, BW = 10 MHz
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-39.63	-34.32	-34.95	-38.15

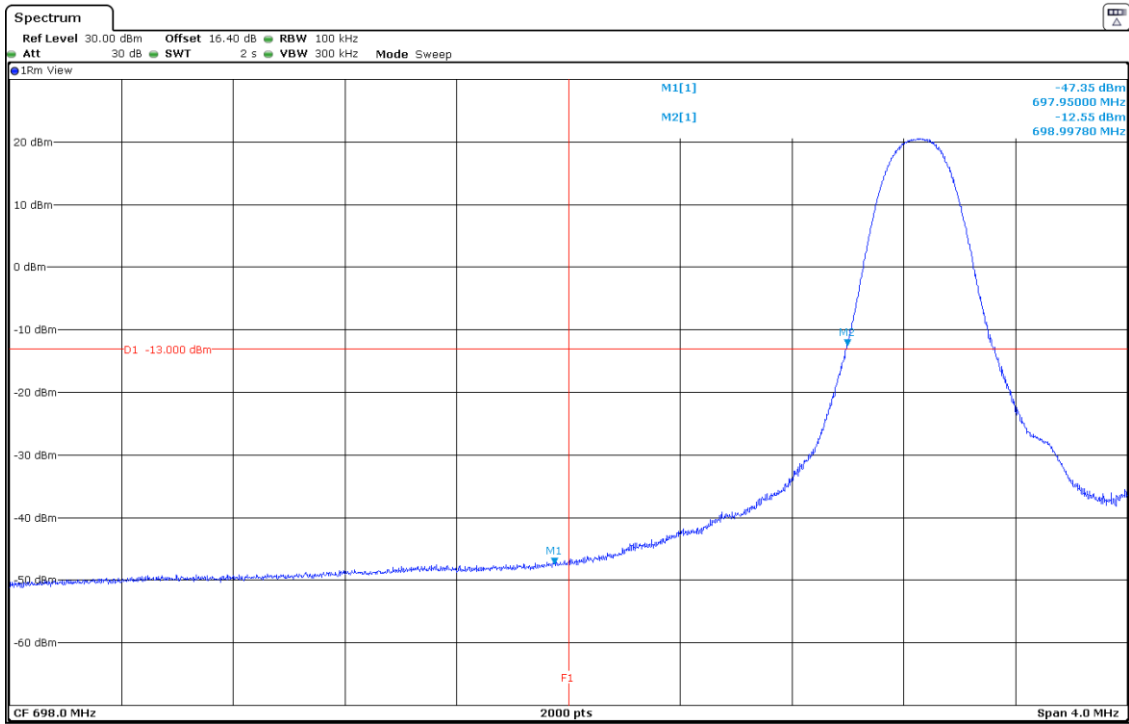
LTE QPSK MODULATION:	RB=1, Offset=Max, BW=1.4 MHz	RB=1 , Offset =Max, BW = 3 MHz	RB=1, Offset =Max, BW=5 MHz	RB=1 , Offset =Max, BW = 10 MHz
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-27.51	-28.05	-22.29	-35.98

LTE QPSK MODULATION:	RB=All, Offset=0, BW=1.4 MHz	RB=All, Offset=0, BW = 3 MHz	RB=All, Offset=0, BW=5 MHz	RB=All, Offset=0, BW = 10 MHz
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-21.25	-25.44	-28.78	-33.41

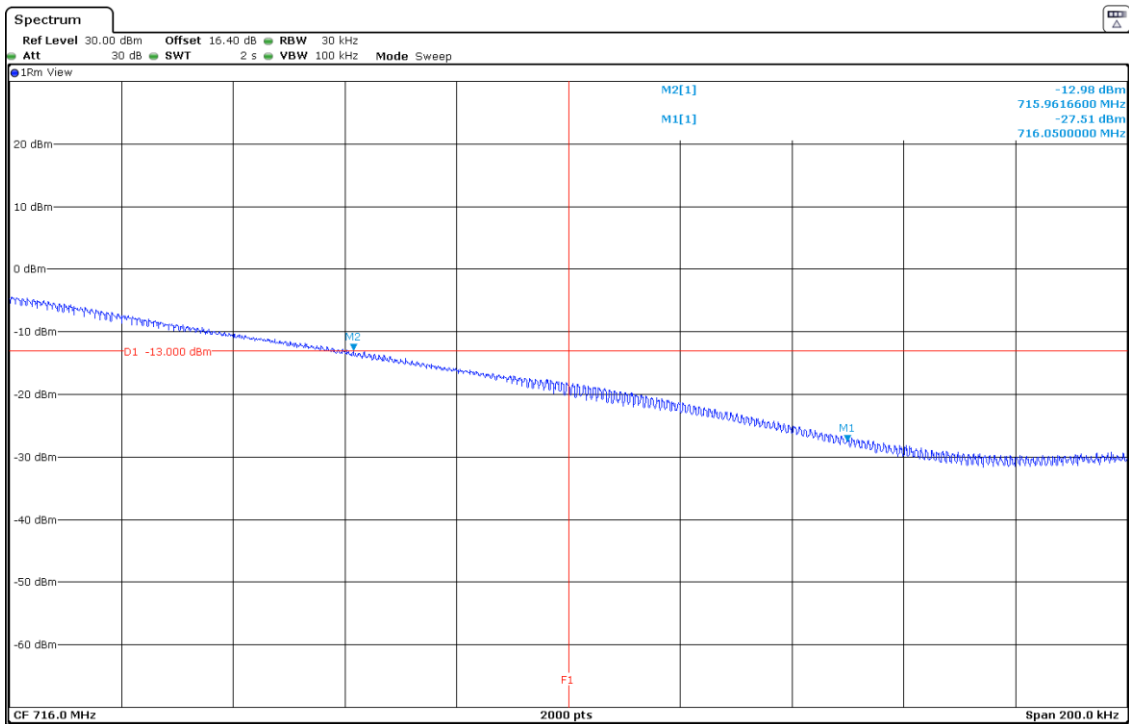
Measurement uncertainty:  $\leq \pm 2.03$  dB

Verdict: PASS

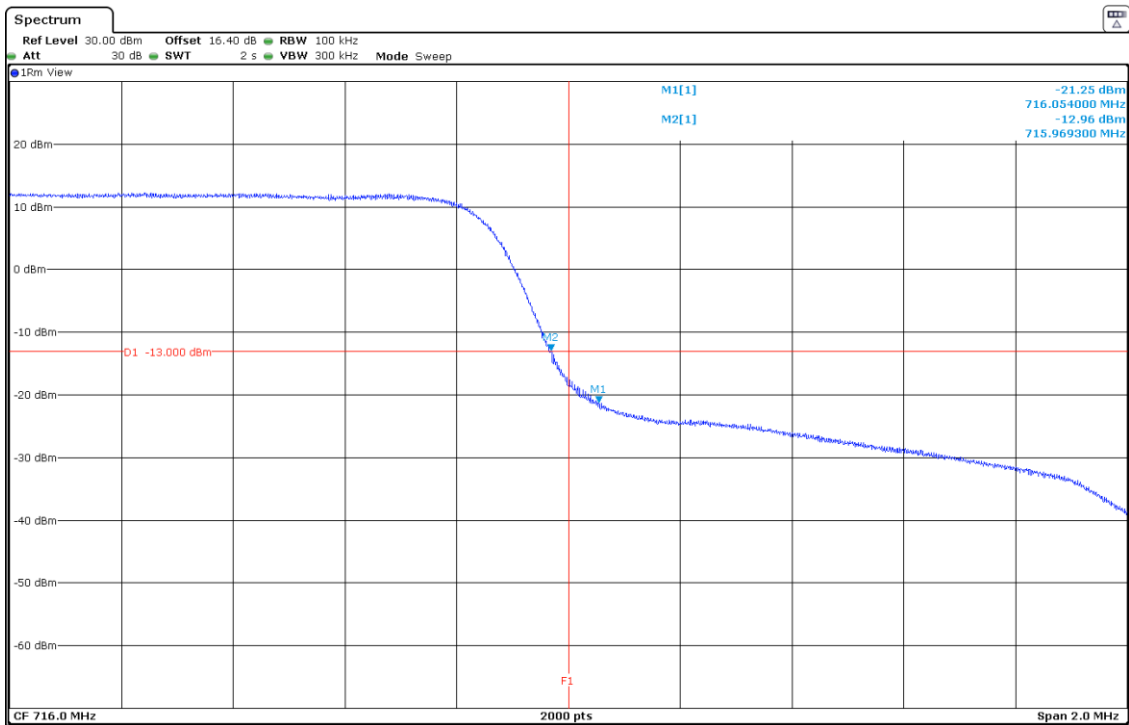
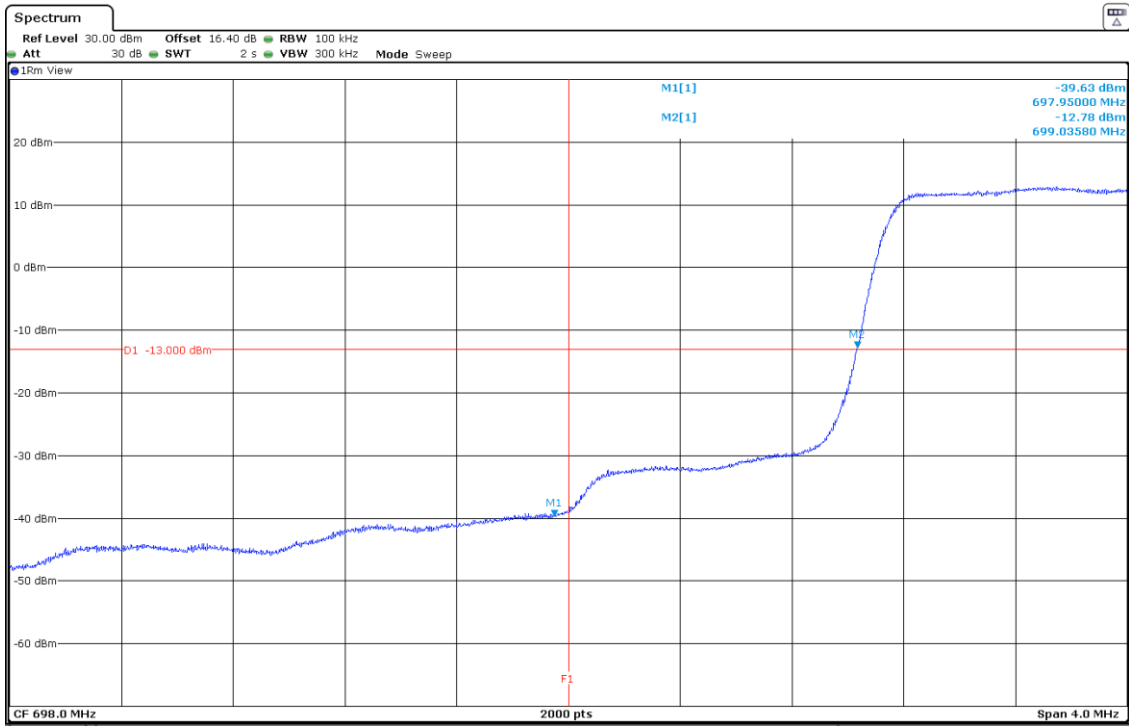
LTE Band 12. QPSK MODULATION. BW=1.4 MHz. RB=1. Offset=0. Lowest Block Edge:



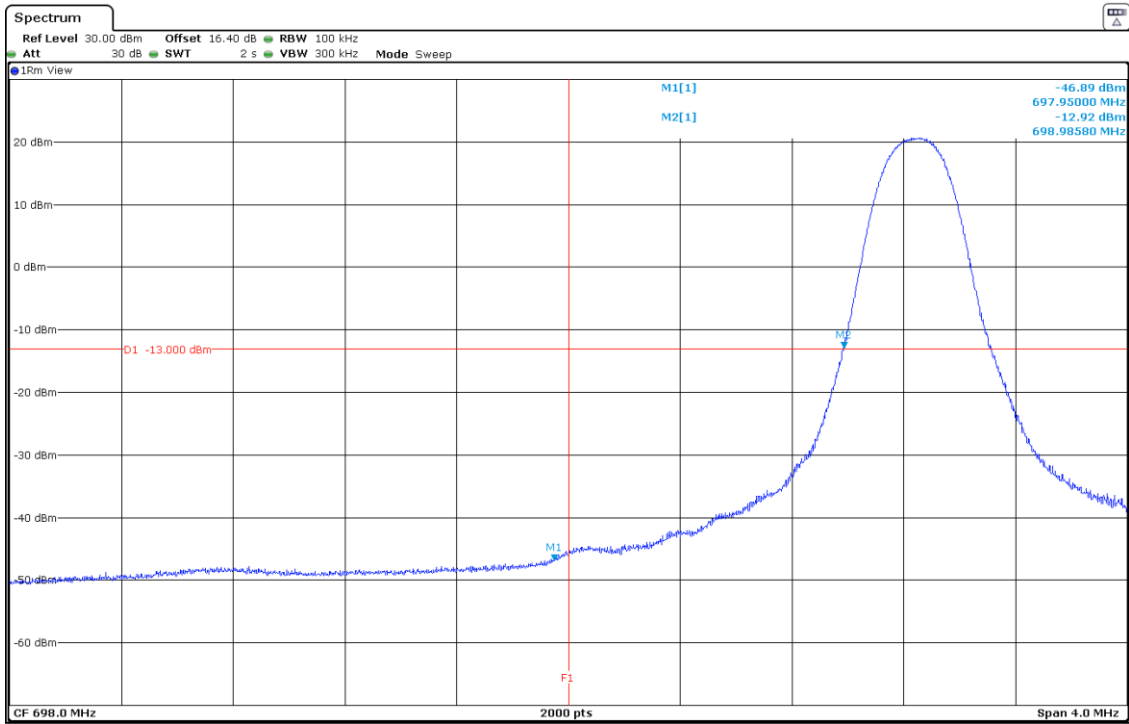
LTE Band 12. QPSK MODULATION. BW=1.4 MHz. RB=1. Offset=Max. Highest Block Edge:



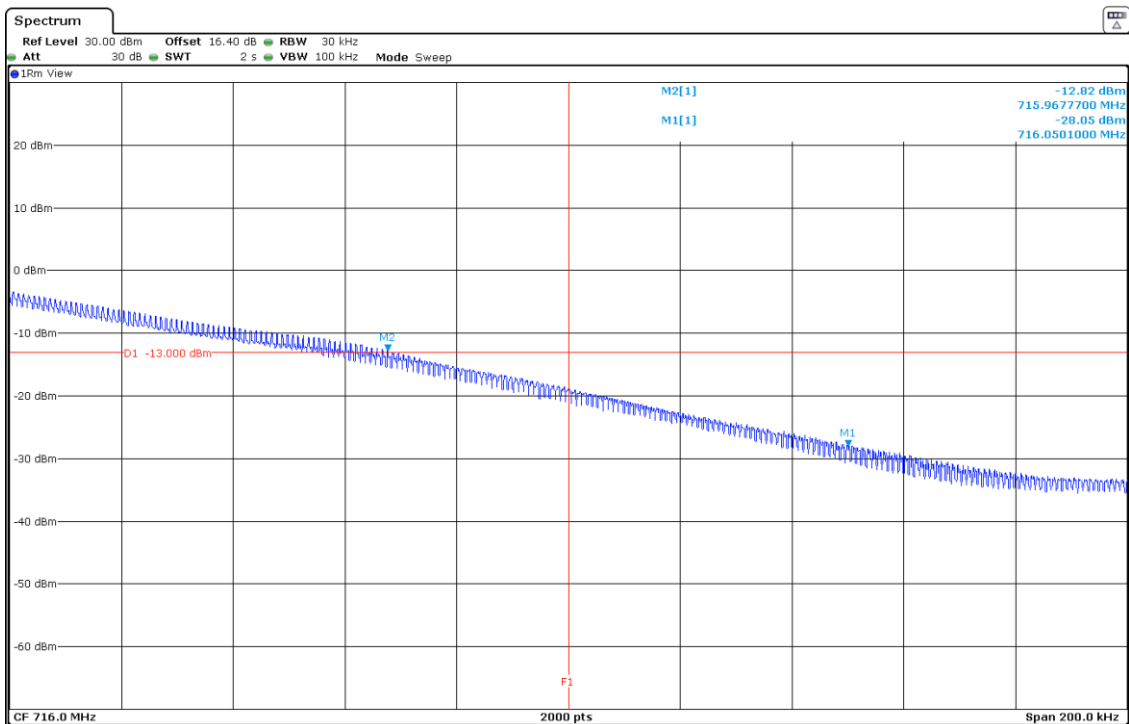
**LTE Band 12. QPSK MODULATION. BW=1.4 MHz. RB=All. Offset=0. Lowest and Highest Block Edges:**



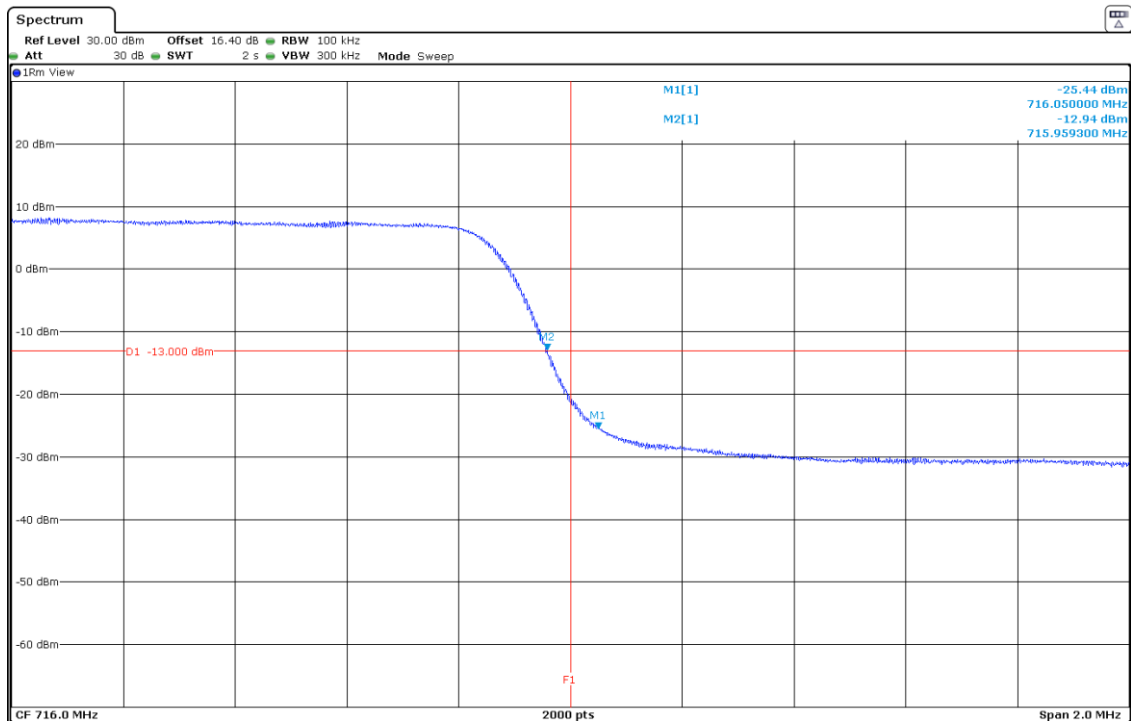
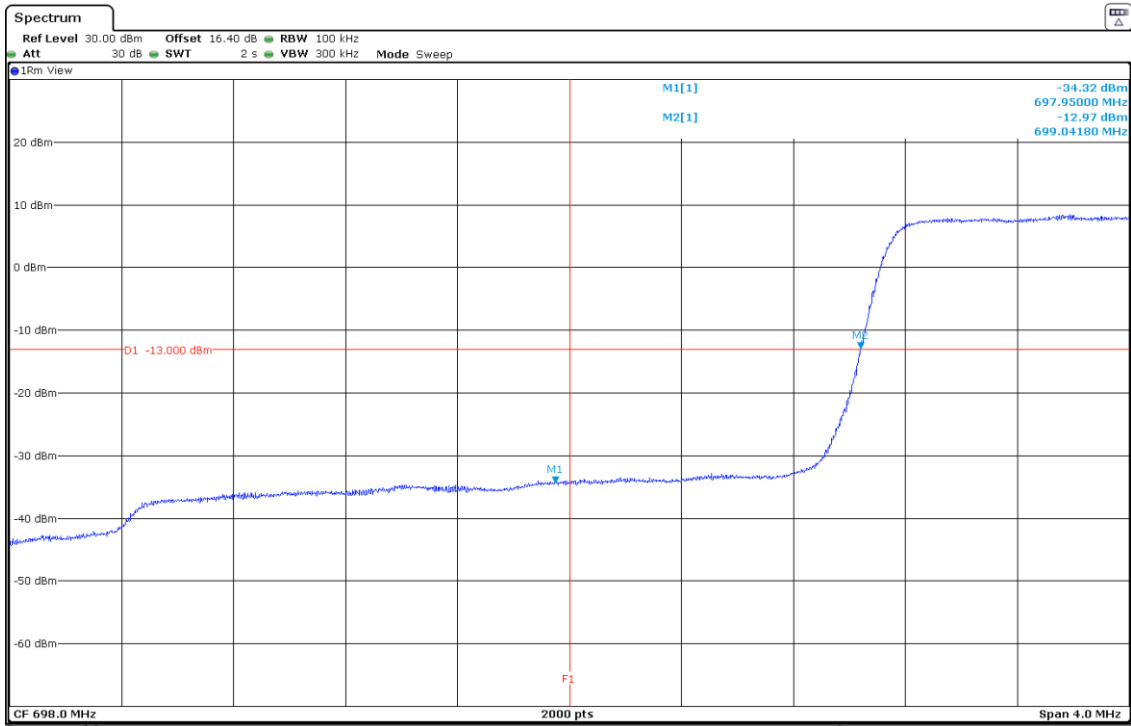
LTE Band 12. QPSK MODULATION. BW=3 MHz. RB=1. Offset=0. Lowest Block Edge:



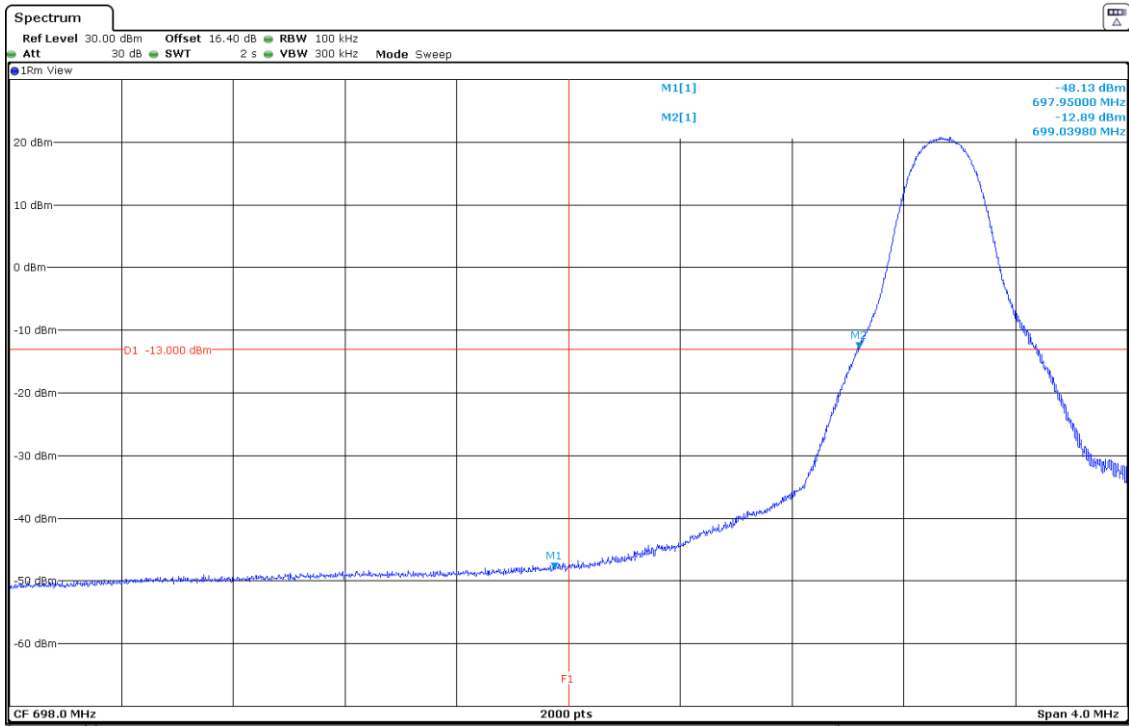
LTE Band 12. QPSK MODULATION. BW=3 MHz. RB=1. Offset=Max. Highest Block Edge:



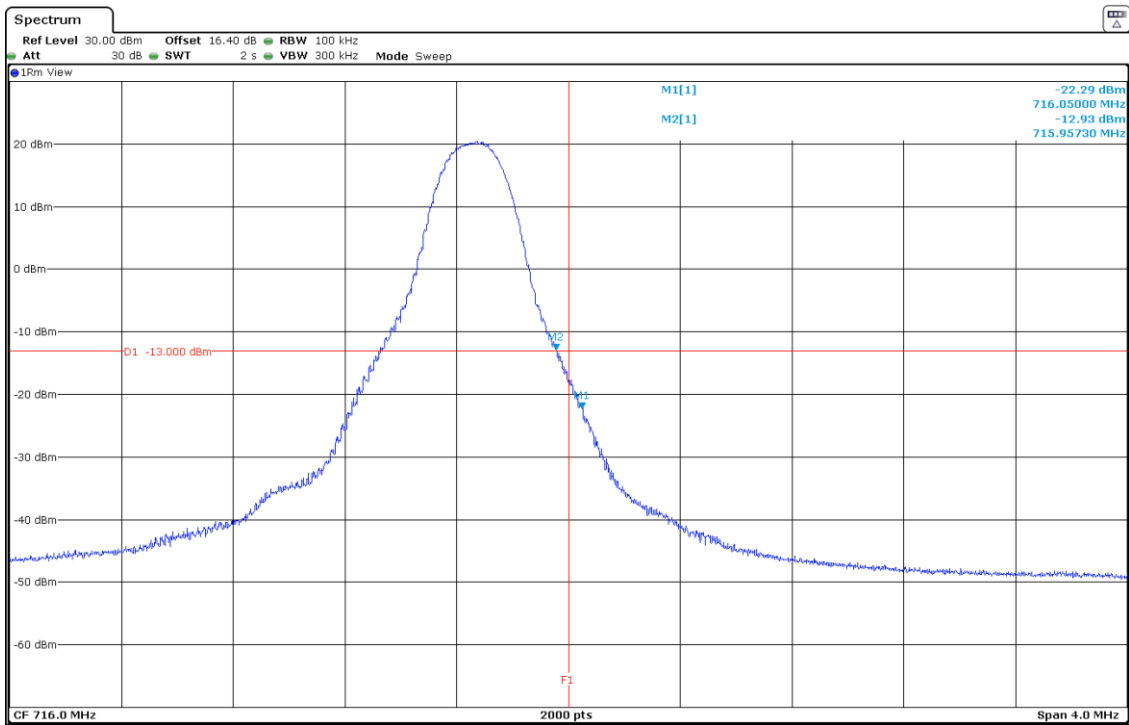
LTE Band 12. QPSK MODULATION. BW=3 MHz. RB=All. Offset=0. Lowest and Highest Block Edges:



**LTE Band 12. QPSK MODULATION. BW=5 MHz. RB=1. Offset=0. Lowest Block Edge:**

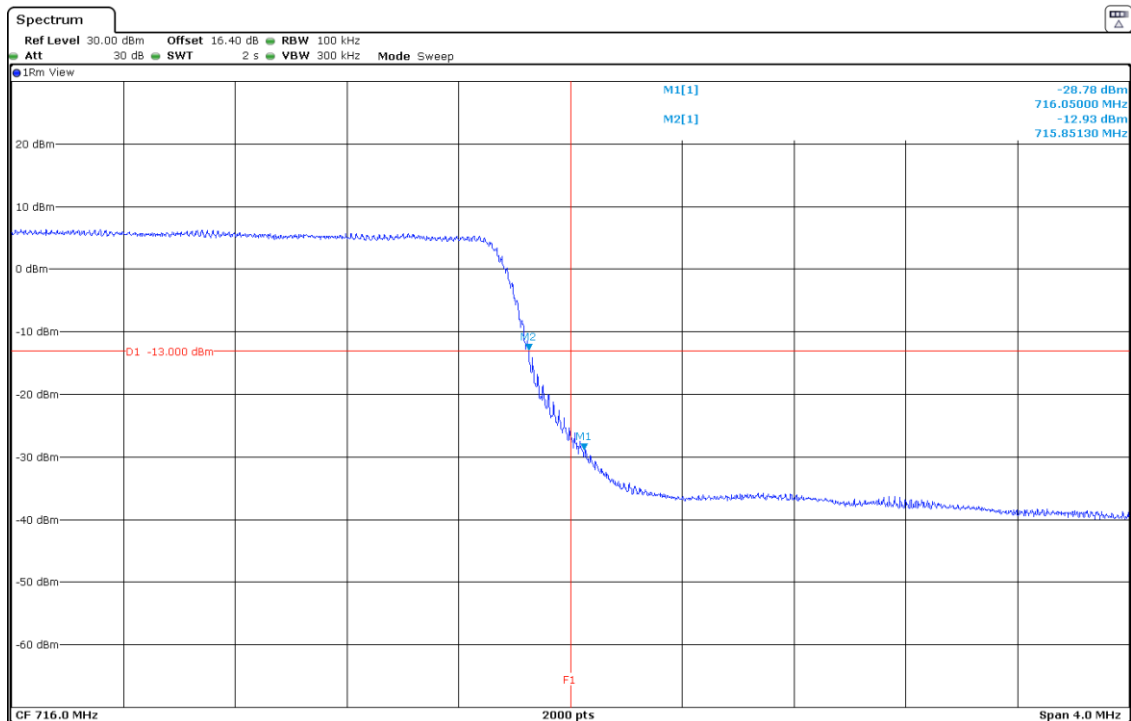
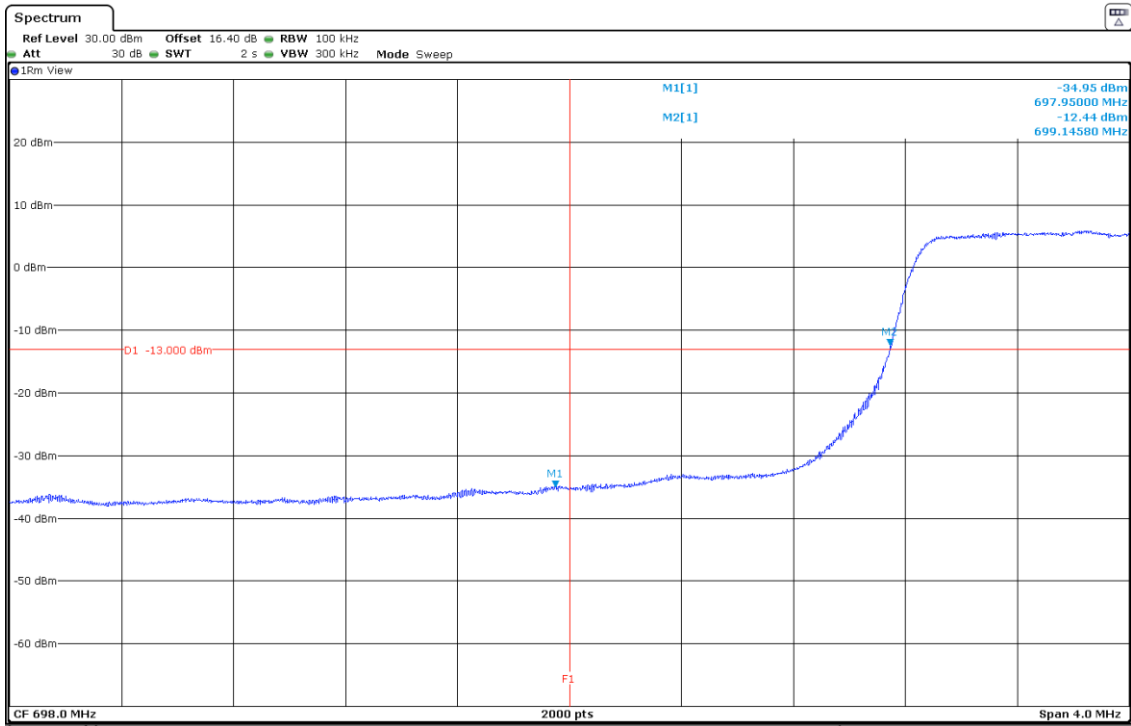


**LTE Band 12. QPSK MODULATION. BW=5 MHz. RB=1. Offset=Max. Highest Block Edge:**

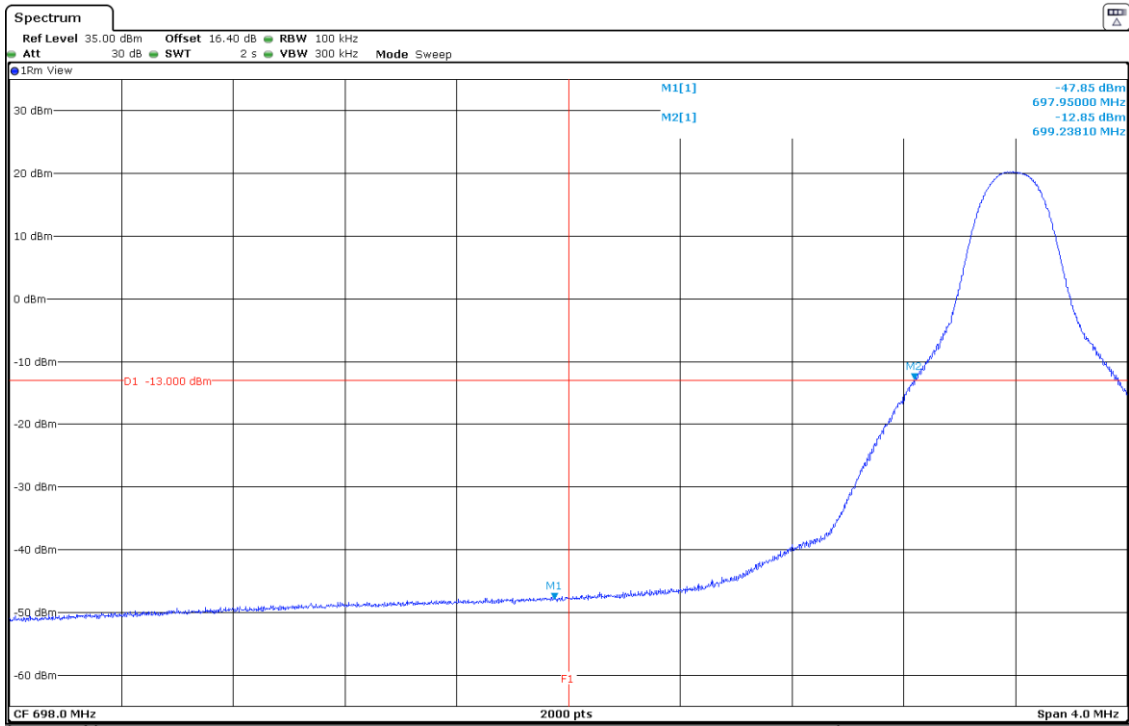




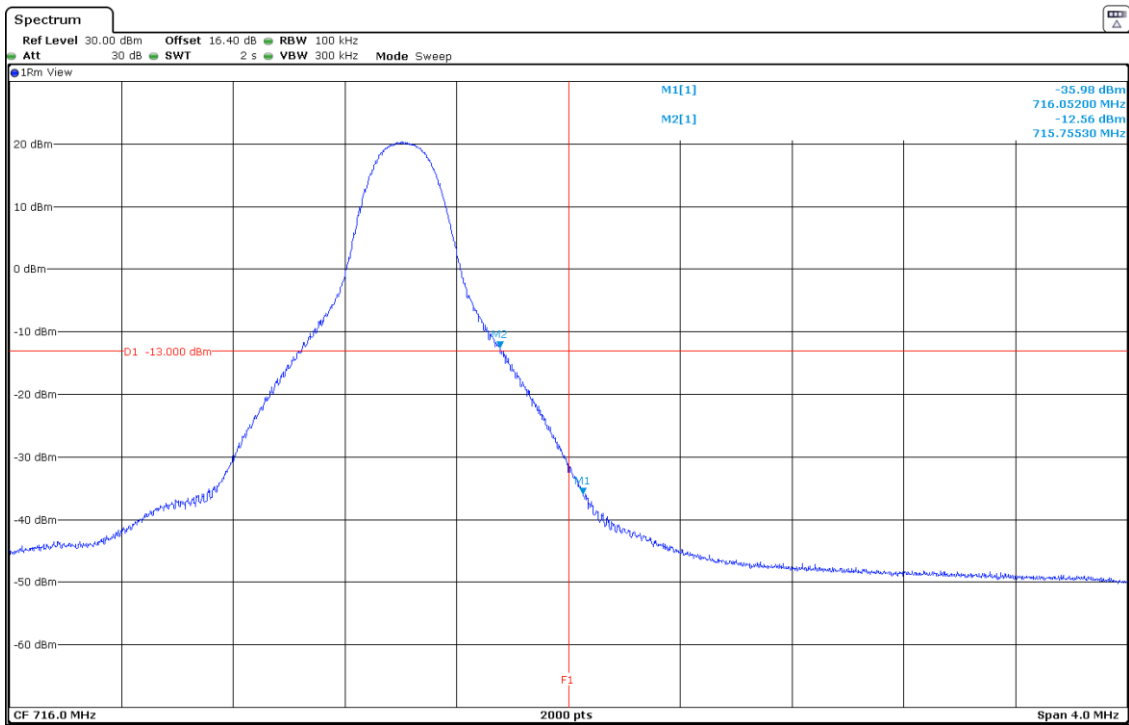
LTE Band 12. QPSK MODULATION. BW=5 MHz. RB=All. Offset=0. Lowest and Highest Block Edges:



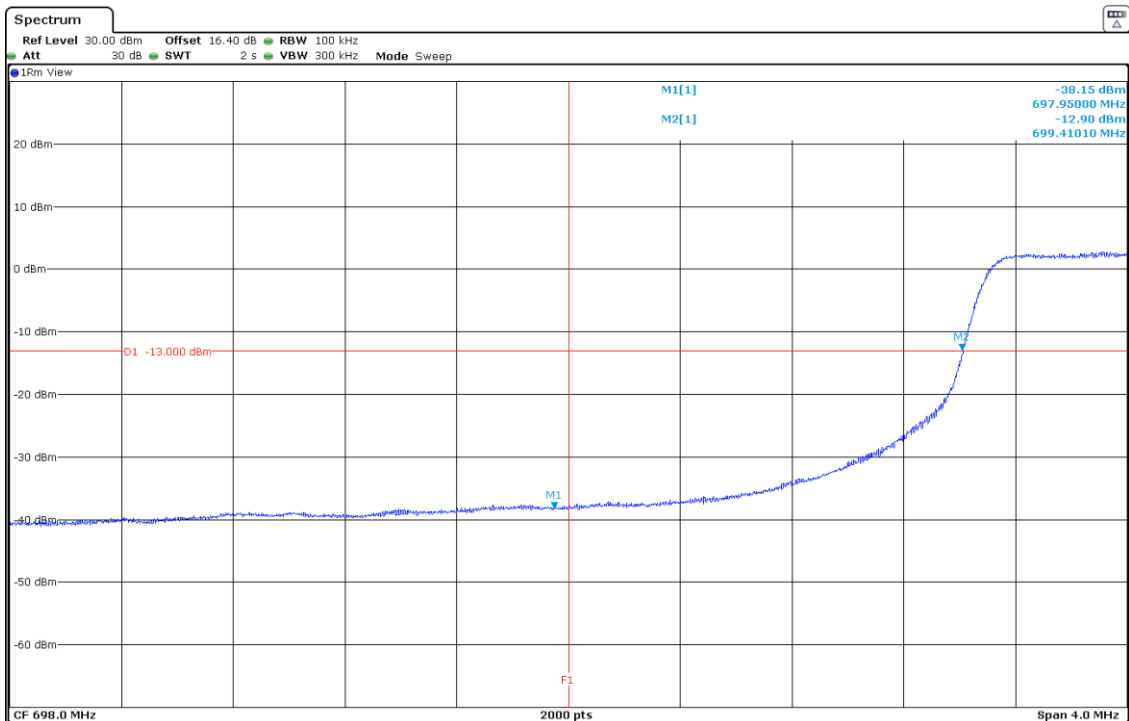
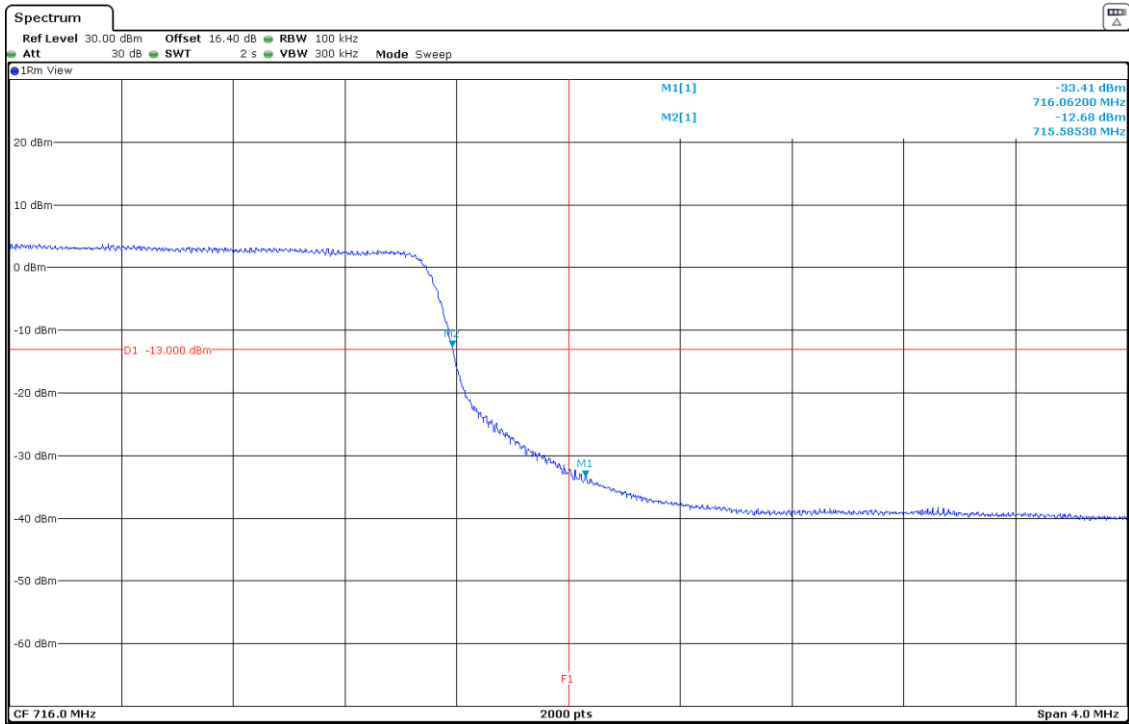
**LTE Band 12. QPSK MODULATION. BW=10 MHz. RB=1. Offset=0. Lowest Block Edge:**



**LTE Band 12. QPSK MODULATION. BW=10 MHz. RB=1. Offset=Max. Highest Block Edge:**



**LTE Band 12. QPSK MODULATION. BW=10 MHz. RB=All. Offset=0. Lowest and Highest Block Edges:**



## Radiated emissions

### SPECIFICATION:

FCC §27.53 (g):

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130 Clause 4.7.1:

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

LTE Band 12 MEASUREMENT LIMIT:

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $43+10 \log (P_o)$ , and the level in dBm relative  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mwatts}) - 30] = -13 \text{ dBm}$$

### METHOD:

The measurement was performed with the EUT inside an anechoic chamber.

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.

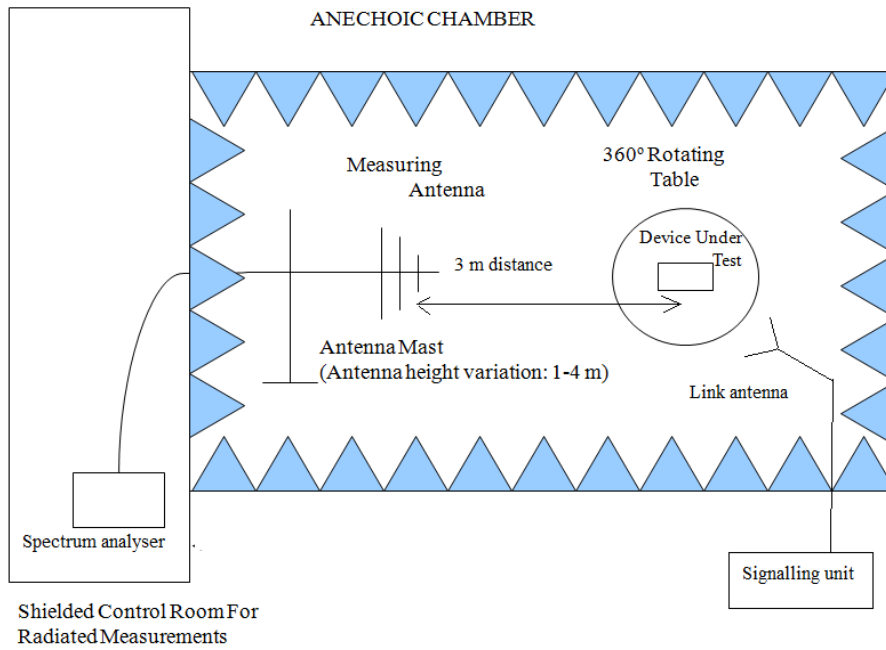
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

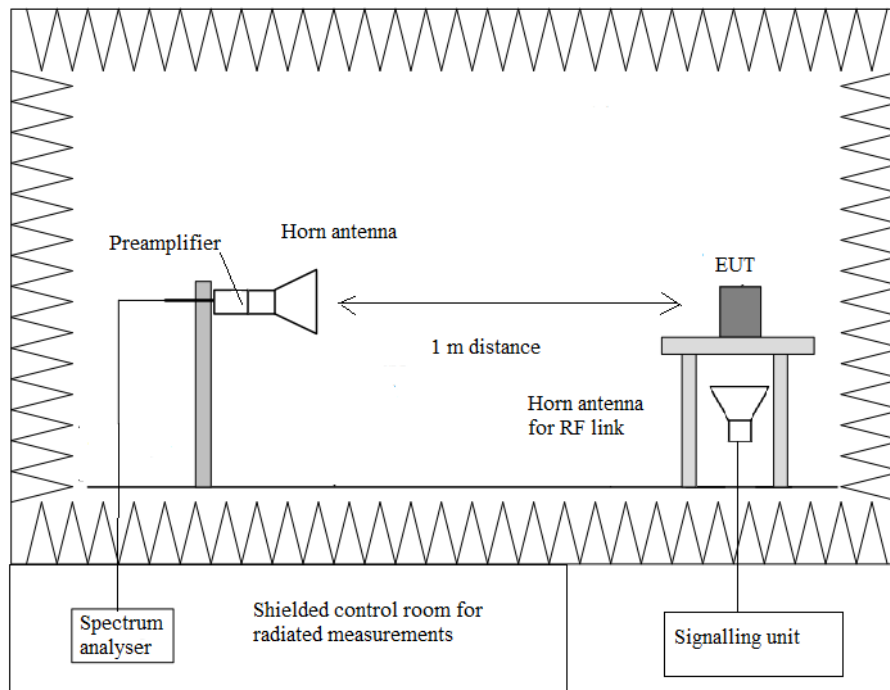
Each detected emission at less than 20 dB respect to the limit is substituted by the Substitution method in accordance with the ANSI/TIA-603-E: 2016.

**TEST SETUP:**

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS:

**LTE Band 12:**

QPSK and 16QAM Modulations:

A preliminary scan determined the QPSK modulation, BW=10 MHz, RB=1, Offset=49 as the worst case.

**- Lowest Channel:**

**Frequency range 30 MHz - 1 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

**Frequency range 1 - 8 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

**- Middle Channel:**

**Frequency range 30 MHz - 1 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

**Frequency range 1 - 8 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

**- Highest Channel:**

**Frequency range 30 MHz - 1 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

**Frequency range 1 - 8 GHz**

No spurious frequencies detected at less than 20 dB below the limit.

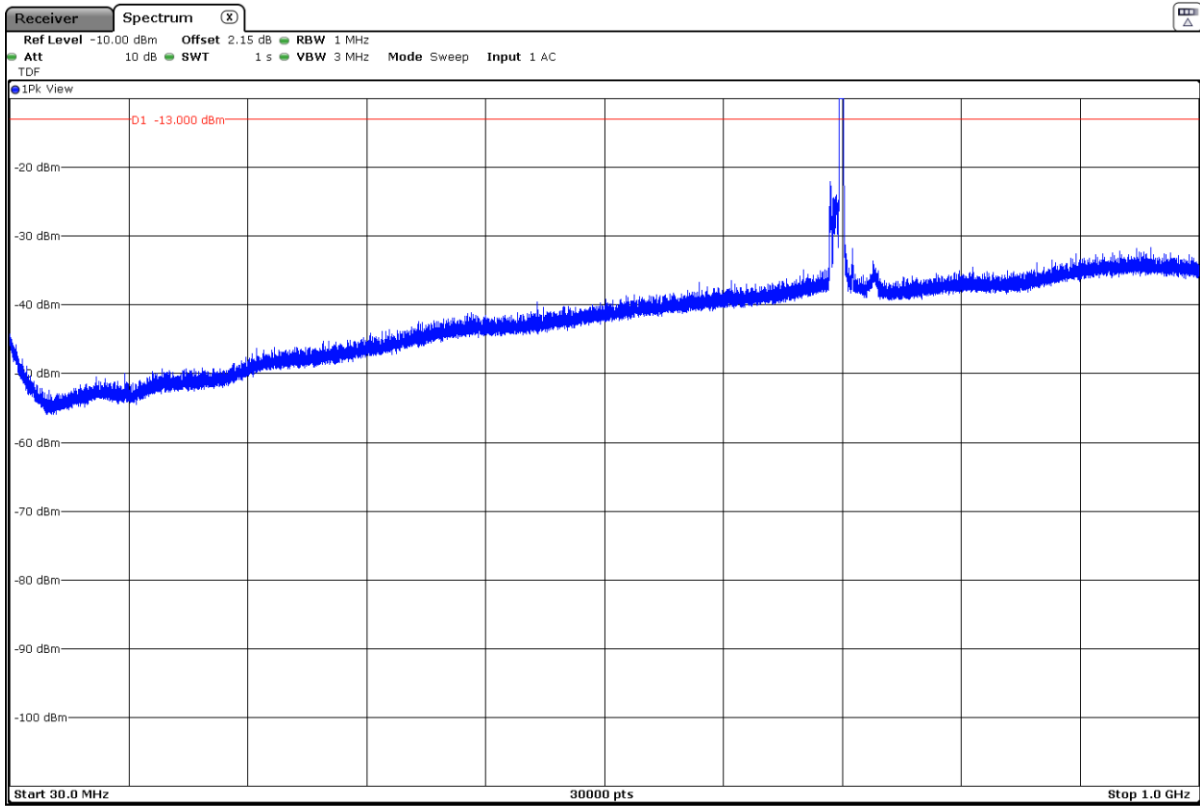
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 8 GHz
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Verdict: PASS

### FREQUENCY RANGE 30 MHz - 1 GHz

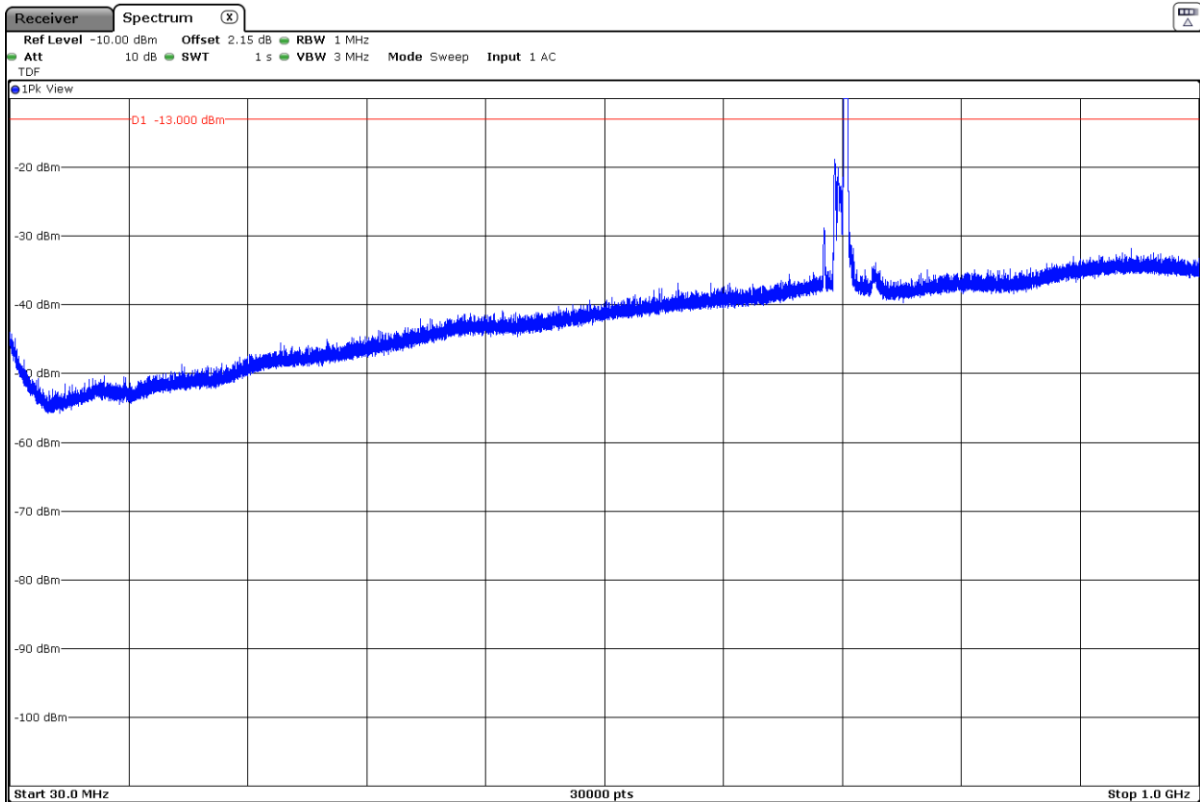
### QPSK MODULATION

- Lowest Channel:



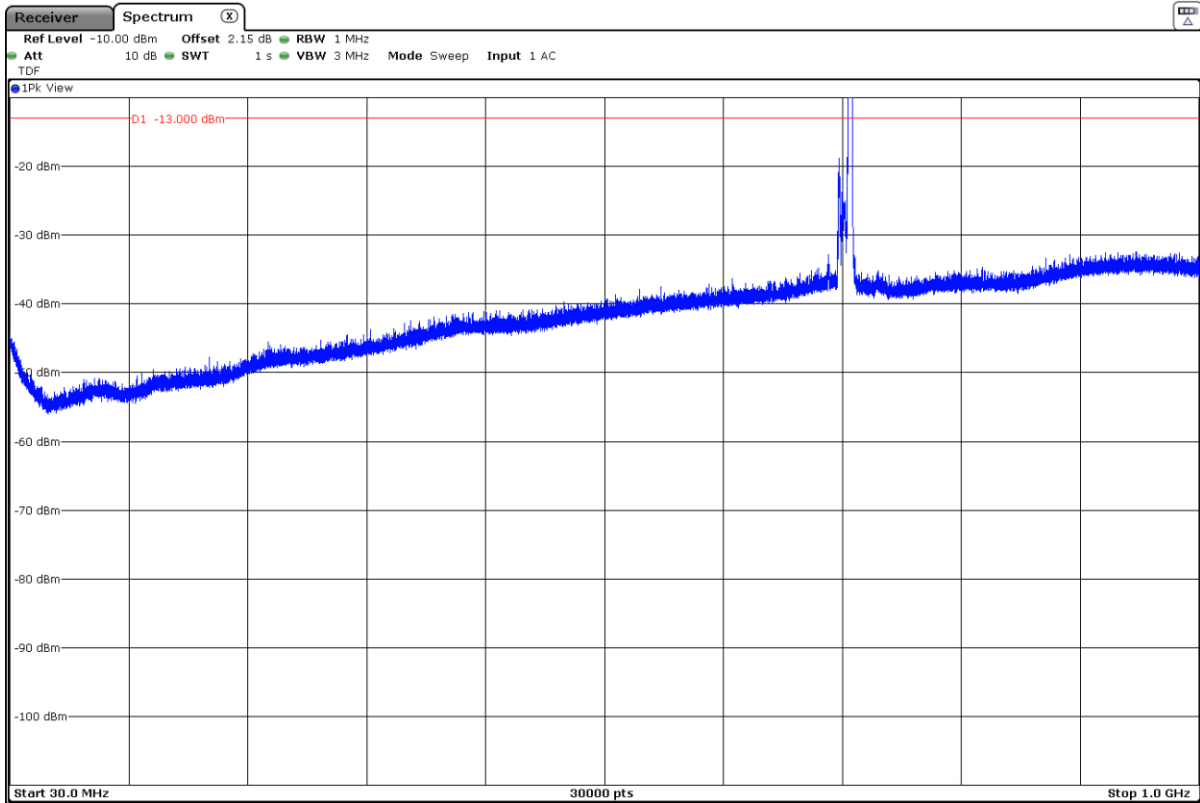
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

- Highest Channel:



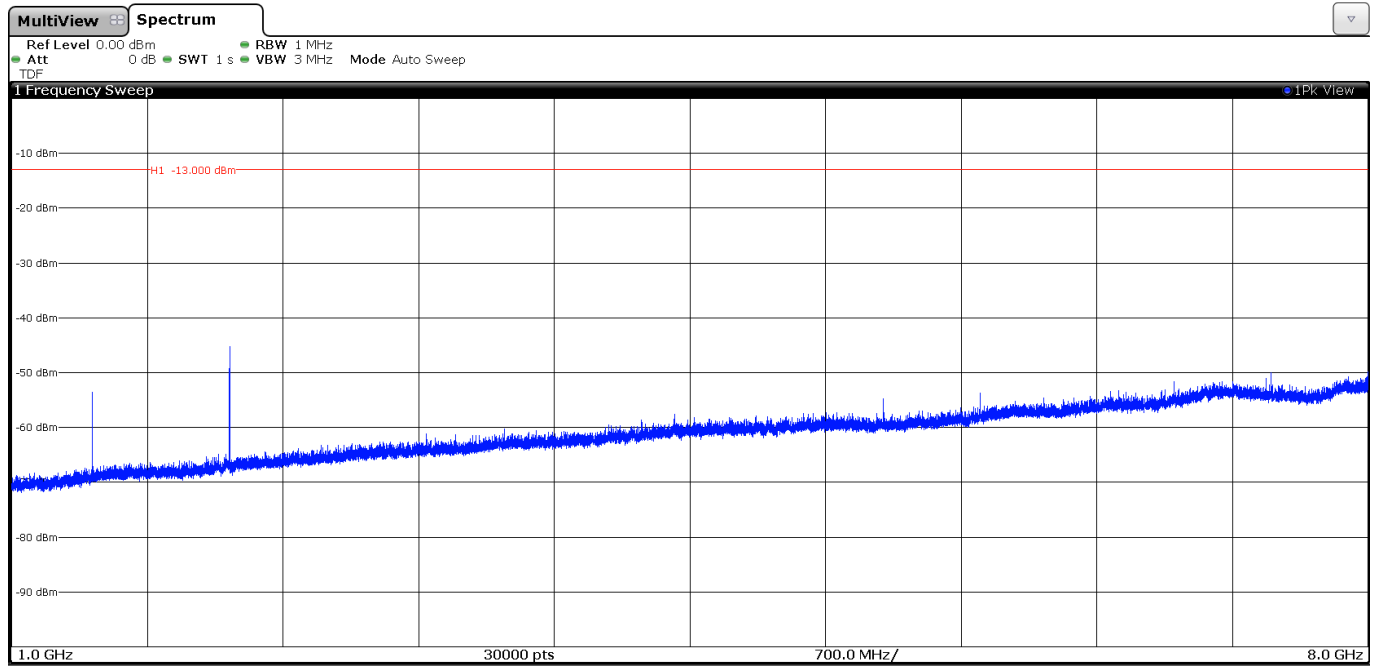
The peak above the limit is the carrier frequency.



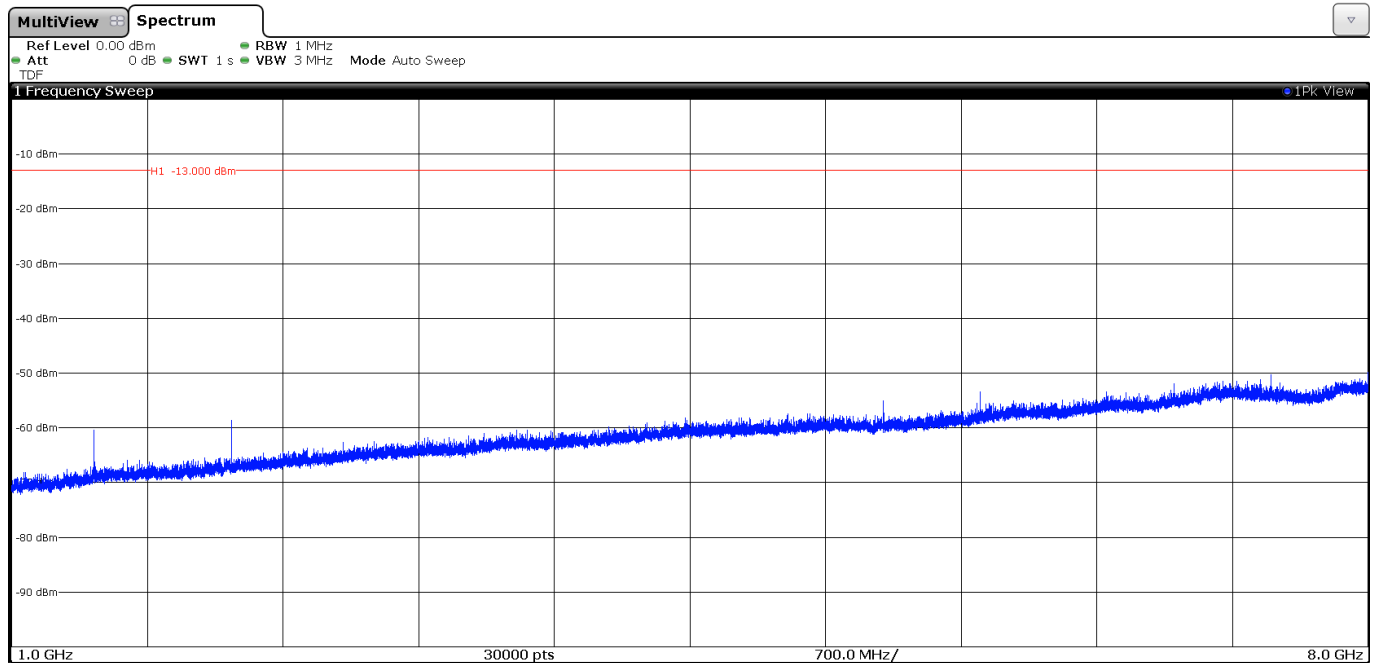
### FREQUENCY RANGE 1 - 8 GHz

### QPSK MODULATION

- Lowest Channel:



- Middle Channel:



- Highest Channel:

