

Test report No:
NIE: 66697RRF.002

Test report

Reference Standard:
USA FCC Part 27
CANADA IC RSS-130, RSS-139

(*) Identification of item tested	LTE Cat-M Cellular communication module
(*) Trademark	Sequans Communications
(*) Model and /or type reference	GM02S
Other identification of the product	HW version: GM02Sv1 SW version: LR8.0.0.1-51281 FCC ID: 2AAGMGM02S IC: 12732A-GM02S IMEI TAC: 01577000
(*) Features	LTE-M, 3GPP LTE Release 13
Applicant	Sequans Communications 55 Boulevard Charles de Gaulle, 92700 Colombes, France
Test method requested, standard	USA FCC Part 27 (10-1-19 Edition). CANADA RSS-130 Issue 2, Feb. 2019. CANADA RSS-139 Issue 3, Jul. 2015. ANSI C63.26: 2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager  RAFAEL LÓPEZ MARTÍN 2020.12.29 14:21:01 +01'00'
Date of issue	2020-12-29
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

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.

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

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

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

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

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification.
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 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 of the model GM02S is a multi-band module supporting cellular LTE-M release 13. It supports HD-FDD.

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
66697B/001	LTE Cat-M Cellular communication module	NETKAR-EVK	58K2050000181	2020/11/30
66697B/006	Antenna	OmniLOG 90200	--	2020/11/30

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
66697B/005	USB Cable	--	--	2020/11/30

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

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

Control N°	Description	Model	Serial N°	Date of reception
66697B/004	LTE Cat-M Cellular communication module	NETKAR-EVK	58K2050000182	2020/11/30

Auxiliary elements used with the Sample S/02:

Control N°	Description	Model	Serial N°	Date of reception
66697B/005	USB Cable	--	--	2020/11/30

Sample S/02 has undergone the following test(s): The 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 ⁽³⁾	
	USB		2	☒	☐	☐	
				☐	☐	☐	
Supplementary information to the ports..... :	N/A						
Rated power supply	Voltage and Frequency			Reference poles			
				L1	L2	L3	N
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 3.3Vdc USB port					
Rated Power	Not provided data						
Clock frequencies.....:	Not provided data						
Other parameters	Not provided data						

Software version	LR8.0.0.1-51281		
Hardware version	GM02Sv1		
Dimensions in cm (W x H x D)	Not provided data		
Mounting position	☒	Table top equipment	
	☐	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☐	Other: Variable equipment	
Modules/parts.....	Module/parts of test item	Type	Manufacturer
	NEKTAR-B-GM02S	Eval Kit	Sequans
	USB Cable		
	External antenna: http://www.aaronia.com/Datasheets/Antennas/Aaronia_Broadband_Antenna_OmnitOG_90200_datasheet.pdf		
Accessories (not part of the test item)	Description	Type	Manufacturer
	N/A		
Documents as provided by the applicant	Description	File name	Issue date
	User Manual	NEKTAR-B_EvalKitUserManual-Rev2	2020-11-20
	AT Commands Reference Manual	GM02S -LR80-ATCommandsRefMan_Rev2	2020-11-13

(3) Only for Medical Equipment

Identification of the client

SEQUANS COMMUNICATIONS

55 Boulevard Charles de Gaulle, 92700 Colombes, France

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-11-30
Date (finish)	2020-12-16

Document history

Report number	Date	Description
66697RRF.002	2020-12-29	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 %

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 %

Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jiménez, Miguel Manuel López and Nicolás Salguero.

Used instrumentation:

Conducted Measurements

	Last Cal. date	Cal. due date
1. Shielded Room ETS LINDGREN S101	N.A.	N.A.
2. Spectrum analyser Rohde & Schwarz FSV40	2020/03	2022/03
3. Signal analyzer Rohde & Schwarz FSQ8	2020/10	2022/10
4. Climatic chamber BINDER MK 56	2020/03	2021/03
5. DC Power Supply Keysight Technologies U8002A	--	--
6. Digital multimeter FLUKE 179	2020/10	2021/10
7. Universal Radio communication Tester R&S CMW50	2020/04	2021/04

Radiated Measurements

	Last Cal. date	Cal. due date
1. Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2. Shielded Room ETS LINDGREN S101	N.A.	N.A.
3. BiconicalLog antenna ETS LINDGREN 3142E	2020/10	2023/10
4. Broadband Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2020/08	2023/08
5. EMI Test Receiver Rohde & Schwarz ESR7	2019/10	2021/10
6. Spectrum analyser Rohde & Schwarz FSV40	2019/10	2021/10
7. RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2020/10	2021/10
8. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04

Testing verdicts

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

Summary

FCC PART 27 / RSS-130, RSS-139 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 27.50 / RSS-130 4.6., RSS-139 6.5.: RF Output Power	P	
FCC 2.1047 / RSS-130 4.1., RSS-139 6.2.: Modulation Characteristics	P	
FCC 27.54 / RSS-130 4.5., RSS-139 6.4.: Frequency Stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 27.53 / RSS-130 4.7., RSS-139 6.6.: Spurious Emissions at Antenna Terminals	P	
FCC 27.53 / RSS-130 4.7., RSS-139 6.6.: Radiated Emissions	P	
<u>Supplementary information and remarks:</u>		
None.		

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TEST CONDITIONS

Power supply (V):

$V_n = 3.3 \text{ Vdc}$

$V_{min} = 2.805 \text{ Vdc}$

$V_{max} = 3.795 \text{ Vdc}$

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

Type of power supply: DC Voltage from USB port.

ANTENNA:

Device with external and internal antennas.

After a preliminary scan, the determined worst case for the Radiated tests is the external antenna.

For the Conducted tests, the gain of the internal antenna is used.

Declared Gain for antennas:

Low band	Gain (dBi)	Antenna type
LTE Band 12	+1.1	Internal
	+0.17	External

Middle band	Gain (dBi)	Antenna type
LTE Band 4	+2.4	Internal
	+2.1	External

TEST FREQUENCIES:

LTE Band 4: QPSK AND 16QAM MODULATIONS.

	Channel per Nominal Bandwidth (Frequency, MHz)			
	BW = 1.4 MHz (*)	BW = 3 MHz (*)	BW = 5 MHz	BW = 10 MHz
Low	23017 (699.7)	23025 (700.5)	23035 (701.5)	23060 (704.0)
Middle	23095 (707.5)	23095 (707.5)	23095 (707.5)	23095 (707.5)
High	23173 (715.3)	23165 (714.5)	23155 (713.5)	23130 (711.0)

(*) The EUT does not support the Nominal Bandwidths 1.4 MHz, 3 MHz.

LTE Band 12. QPSK AND 16QAM MODULATIONS.

	Channel per Nominal Bandwidth (Frequency, MHz)					
	BW = 1.4 MHz (*)	BW = 3 MHz (*)	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	19957 (1710.7)	19965 (1711.5)	19975 (1712.5)	20000 (1715.0)	20025 (1717.5)	20050 (1720.0)
Middle	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)	20175 (1732.5)
High	1754.3 (20393)	20385 (1753.5)	20375 (1752.5)	20350 (1750.0)	20325 (1747.5)	20300 (1745.0)

(*) The EUT does not support the Nominal Bandwidths 1.4 MHz, 3 MHz.

RF Output Power

SPECIFICATION

FCC §27.50 (c) (10):

Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

FCC §27.50 (d) (4) & (5):

(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.

(5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

RSS-130 Clause 4.6:

4.6.1 General

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the High PAPR during periods of continuous transmission.

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

The e.i.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.i.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.i.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.

RSS-139 Clause 6.5:

The equivalent isotropically radiated power (e.i.r.p.) for mobile and portable transmitters shall not exceed one watt. The e.i.r.p. for fixed and base stations in the band 1710-1780 MHz shall not exceed one watt.

Consult SRSP-513 for e.i.r.p. limits on fixed and base stations operating in the band 2110-2180 MHz.

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the 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 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:

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

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

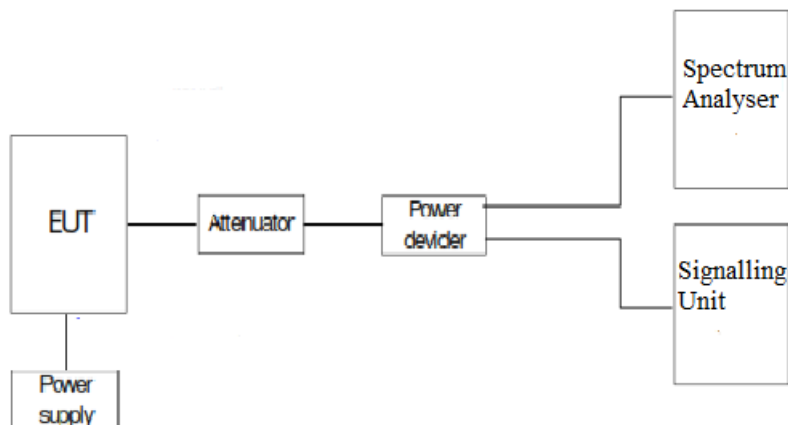
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

1. Conducted average power:



2. Peak-to-average power ratio (PAPR):



RESULTS

1. CONDUCTED AVERAGE POWER:

LTE BAND 4:

Preliminary measurements determined the narrow band = 0 and Nominal Bandwidth of 20 MHz as the worst case. The next results are for the worst-case configuration.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)	PAPR (dB)
20	20050	1720	QPSK	1 6	0 0	21.74 22.15	4.12
			16-QAM	1 5	0 0	21.59 22.03	4.68
	20175	1732.5	QPSK	1 6	0 0	21.34 21.89	4.25
			16-QAM	1 5	0 0	21.23 21.75	4.02
	20300	1745	QPSK	1 6	0 0	21.74 22.23	4.17
			16-QAM	1 5	0 0	21.59 22.2	4.46

LTE BAND 12:

Preliminary measurements determined the narrow band = 0 and Nominal Bandwidth of 5 MHz as the worst case. The next results are for the worst-case configuration.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)	PAPR (dB)
5	23035	701.5	QPSK	1 6	0 0	22.48 22.54	4.28
			16-QAM	1 5	0 0	22.38 21.6	5.16
	23095	707.5	QPSK	1 6	0 0	22.06 22.23	4.04
			16-QAM	1 5	0 0	22.01 21.28	4.94
	23155	713.5	QPSK	1 6	0 0	22.5 22.54	4.34
			16-QAM	1 5	0 0	22.47 21.63	5.13

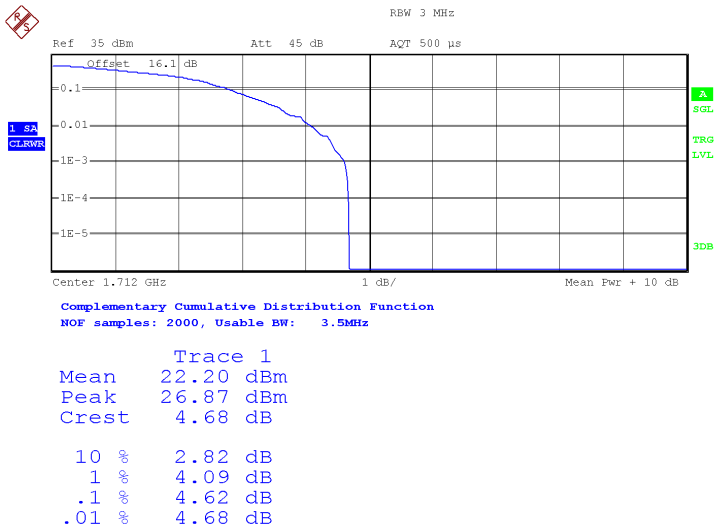
2. PEAK-TO-AVERAGE POWER RATIO (PAPR):

LTE Band 4:

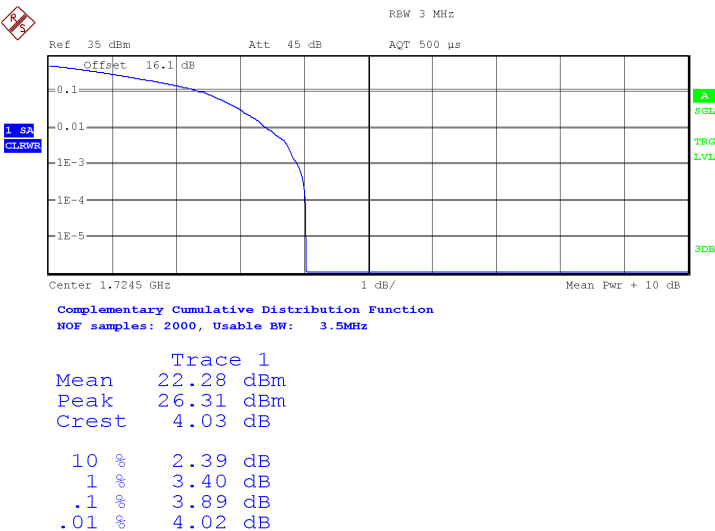
Preliminary measurements determined the narrow band = 0, Nominal Bandwidth of 20 MHz, 16-QAM modulation and 5 RB size offset 0 as the worst case.

The next results are for this worst-case configuration.

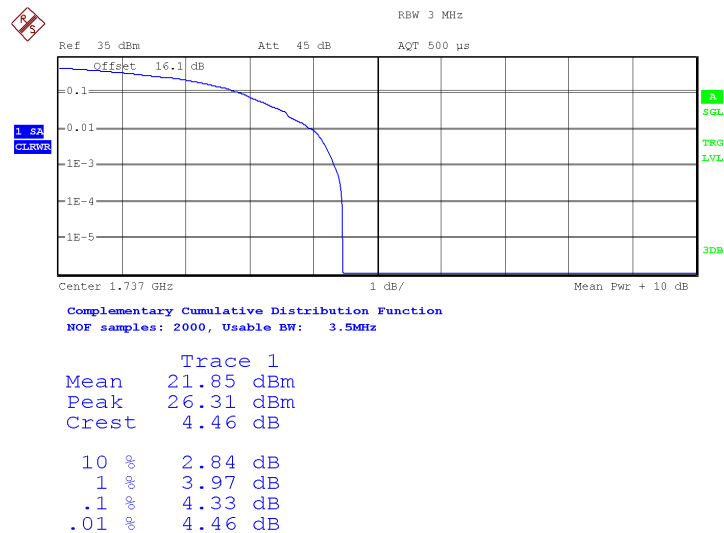
Low Channel:



Middle Channel:



High Channel:

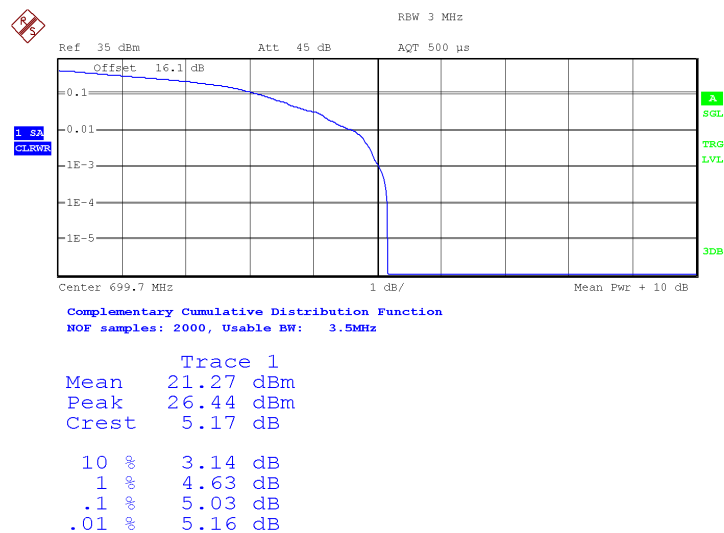


LTE Band 12:

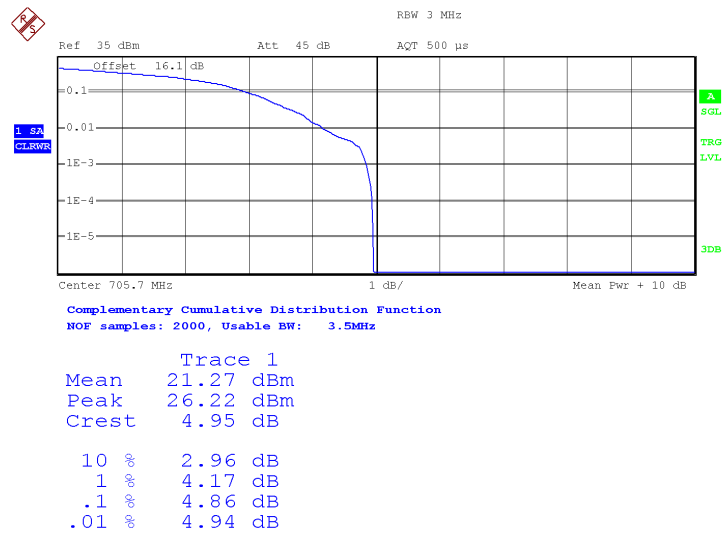
Preliminary measurements determined the narrow band = 0, Nominal Bandwidth of 5 MHz, 16-QAM modulation and 5 RB size offset 0 as the worst case.

The next results are for this worst-case configuration.

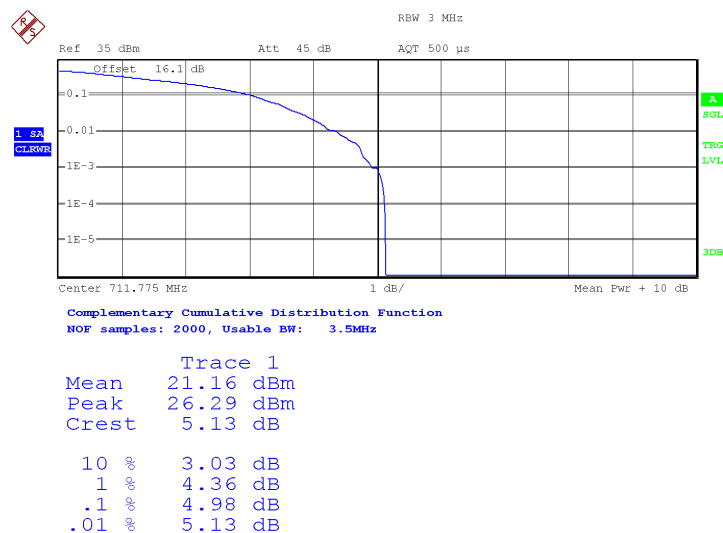
Low Channel:



Middle Channel:



High Channel:



LTE Band 4:

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)	PAPR (dB)
Low	22.15	2.4	24.55	22.4	4.68
Middle	21.89	2.4	24.29	22.14	4.25
High	22.23	2.4	24.63	22.48	4.46
Measurement uncertainty (dB)	<±0.94				

LTE Band 12:

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)	PAPR (dB)
Low	22.54	1.1	23.64	21.49	5.16
Middle	22.23	1.1	23.33	21.18	4.94
High	22.54	1.1	23.64	21.49	5.13
Measurement uncertainty (dB)	<±0.94				

Verdict: PASS

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.

RSS-139 Clause 6.4:

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

METHOD

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

The supply voltage was varied between 85% and 115% of nominal voltage.

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

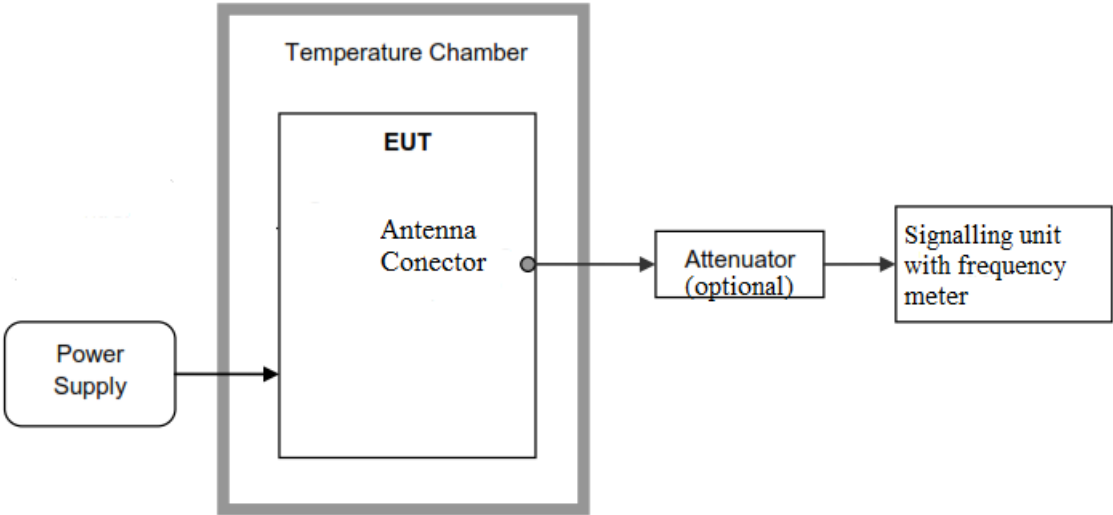
The worst case LTE mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation are identified as fL and fH respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

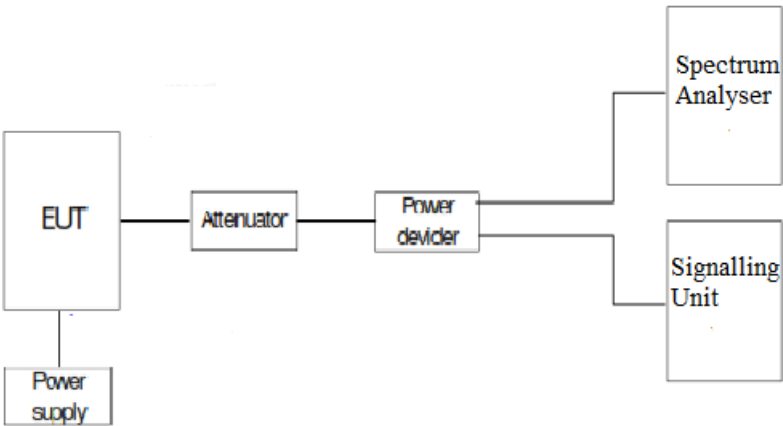
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Frequency tolerance:



Reference points f_L and f_H :



RESULTS

1. FREQUENCY TOLERANCE:

- Frequency stability over temperature variations.

LTE Band 4:

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	1.76	0.001015873
+40	-0.06	-0.000034632
+30	-3.43	-0.001979798
+20	-6.12	-0.003532468
+10	-5.02	-0.002897547
0	-7.94	-0.004582973
-10	-16.02	-0.009246753
-20	-12.13	-0.007001443
-30	-2.33	-0.001344877

LTE Band 12:

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	1.02	0.001441696
+40	3.63	0.005130742
+30	5.78	0.008169611
+20	-0.4	-0.000565371
+10	-5.58	-0.007886926
0	-6.47	-0.009144876
-10	-8.04	-0.011363958
-20	-7.91	-0.011180212
-30	-4.68	-0.006614841

- Frequency stability over voltage variations.

LTE Band 4:

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3.795	-1.36	-0.000784993
Vmin	2.805	-3.6	-0.002077922

LTE Band 12:

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3.795	3.38	0.004777385
Vmin	2.805	-2.47	-0.003491166

2. REFERENCE FREQUENCY POINTS f_L AND f_H :

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

LTE Band 4: QPSK. Nominal bandwidth 5MHz

f_L (MHz)	1710.1240
f_H (MHz)	1754.8790

LTE Band 12: QPSK. Nominal bandwidth 5MHz

f_L (MHz)	699.0038
f_H (MHz)	715.9314

The reference frequency points f_L and f_H stay within the authorized blocks for the band above.

Measurement uncertainty (Hz): $<\pm 206.30$

Verdict: PASS

Modulation Characteristics

SPECIFICATION

FCC §2.1047: Measurements required: Modulation characteristics.

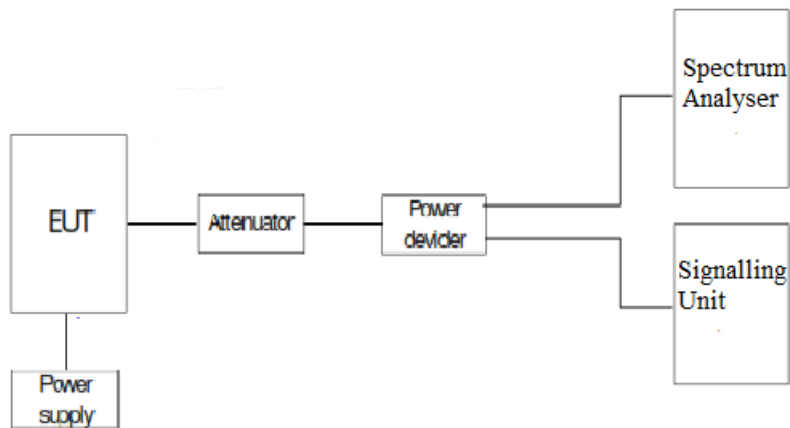
RSS-130 Clause 4.2: Equipment certified under this standard shall employ digital modulation.

RSS-139 Clause 6.2. : The devices may employ any type of modulation techniques. The type of modulation used must be reported.

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

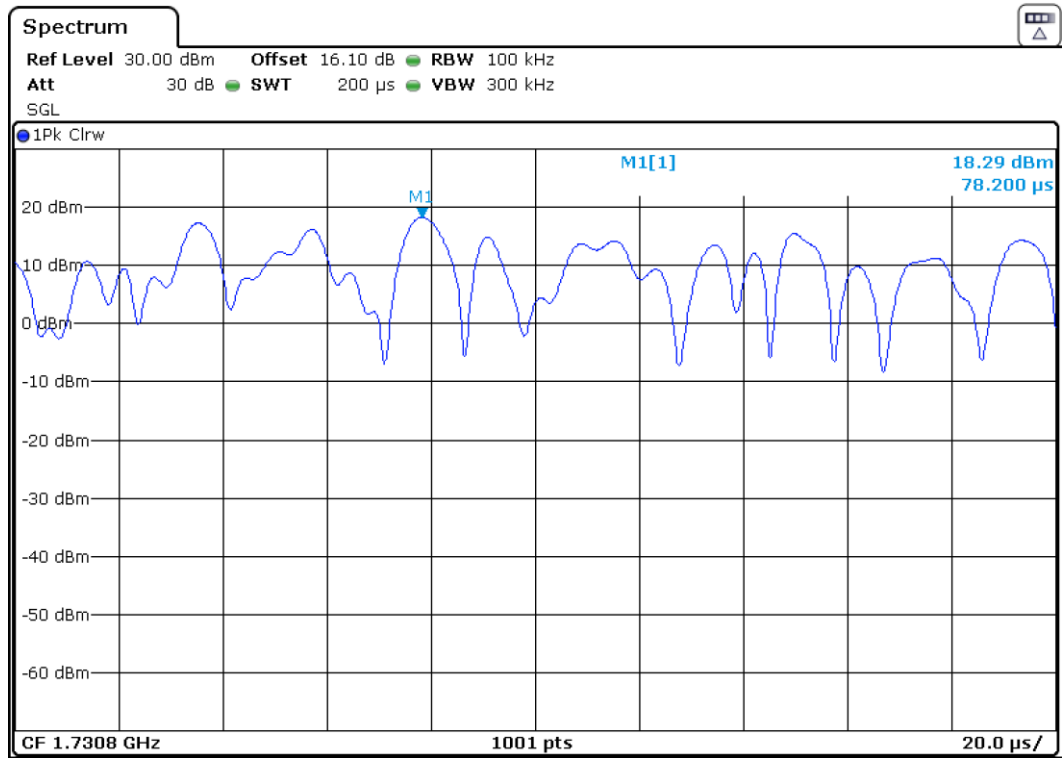


RESULTS

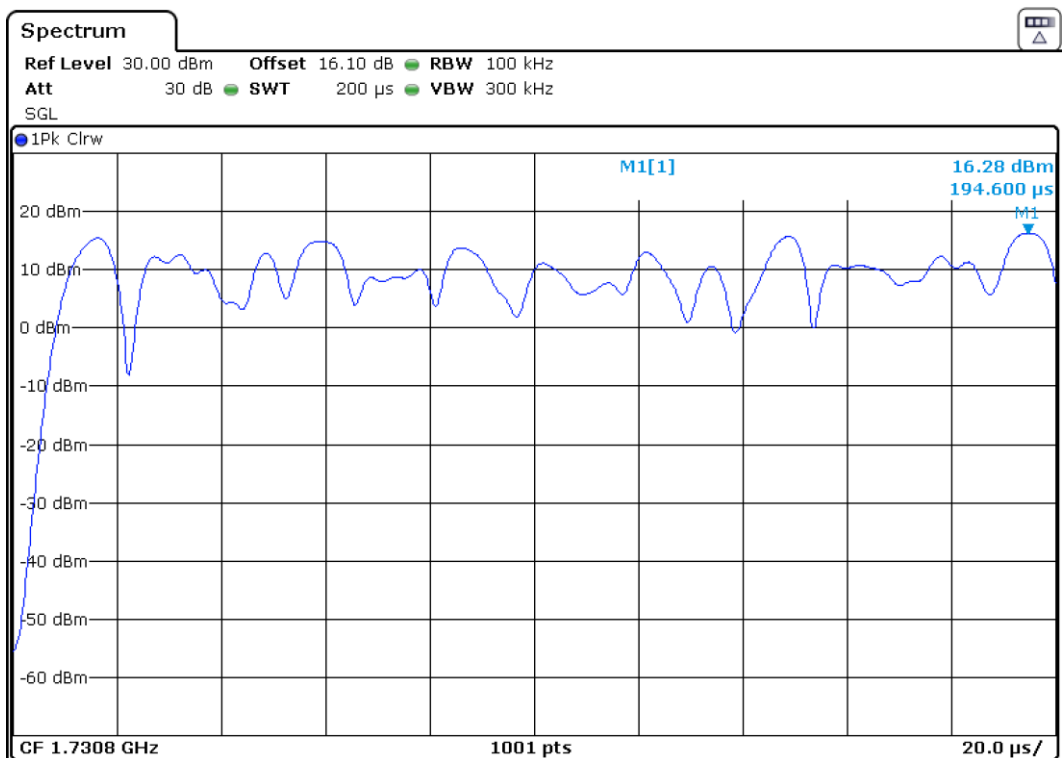
The following plot shows the modulation schemes in the EUT.

LTE Band 4:

QPSK. Nominal Bandwidth 5 MHz

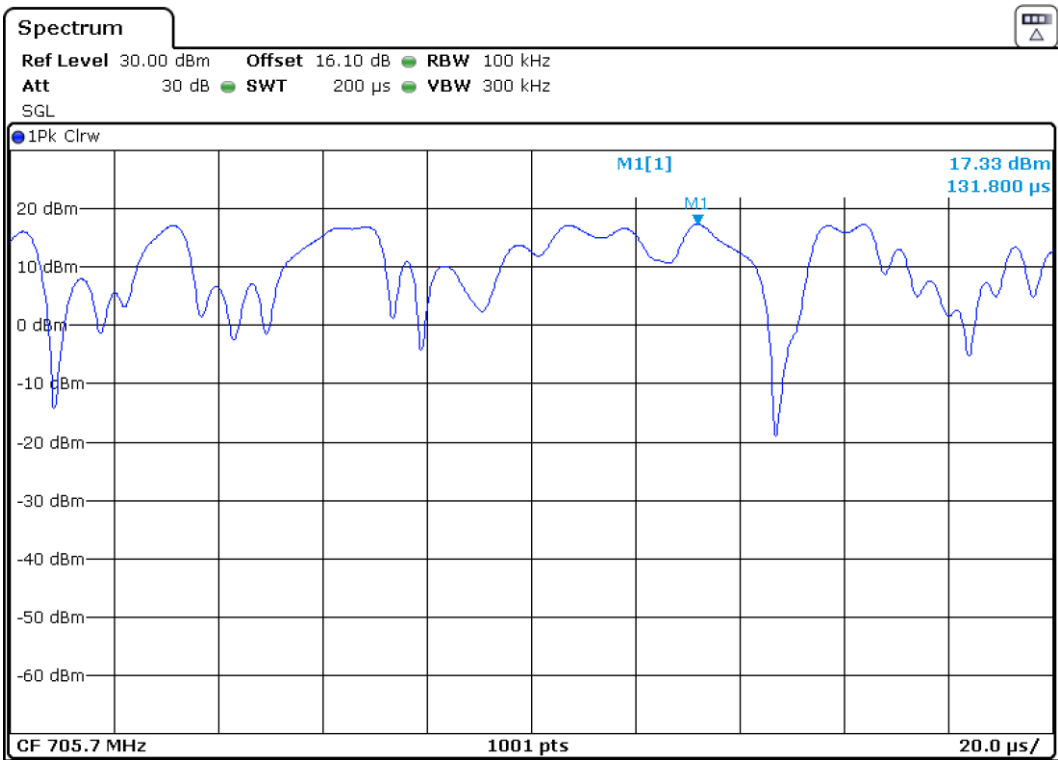


16QAM. Nominal Bandwidth 5 MHz

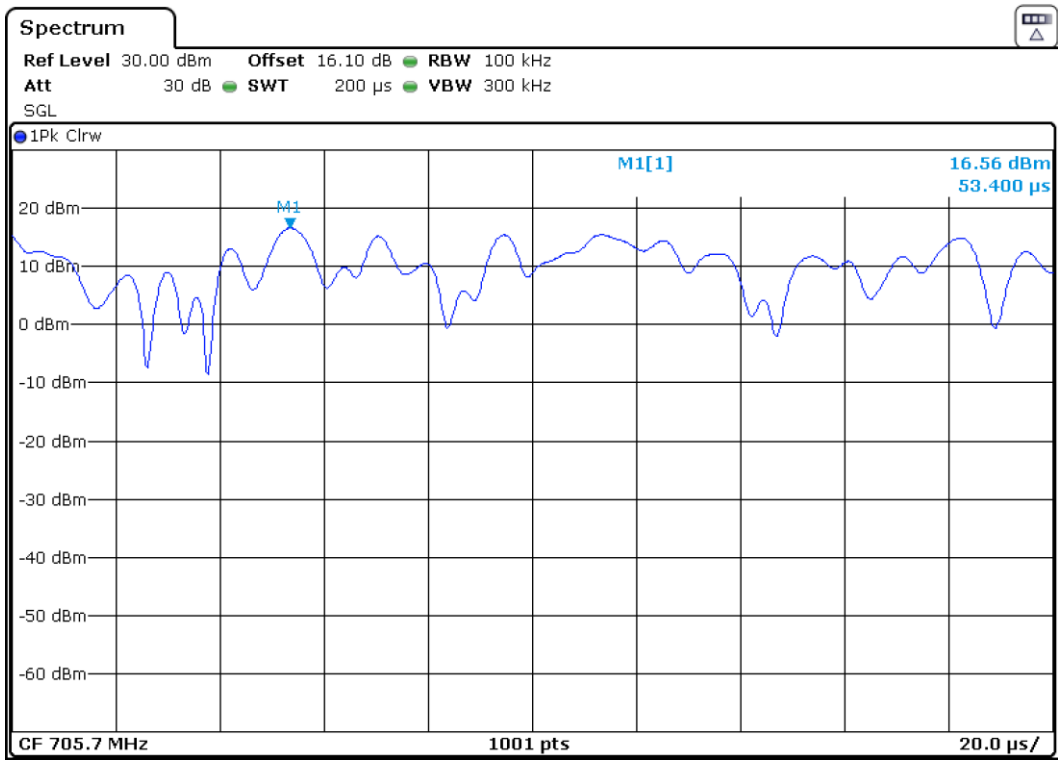


LTE Band 12:

QPSK. Nominal Bandwidth 5 MHz



16QAM. Nominal Bandwidth 5 MHz



Occupied Bandwidth

SPECIFICATION

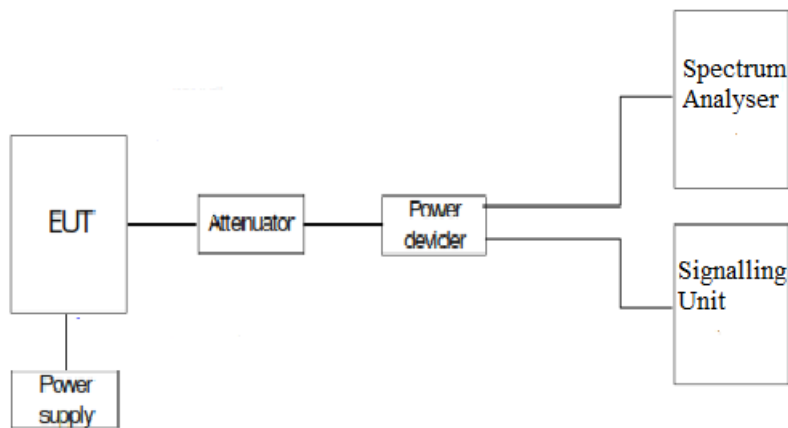
FCC §2.1049: Measurements required: Occupied bandwidth.

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 (see next plots)

The worst case of occupied bandwidth corresponds to all Resource Blocks (RB) offset 0 regardless either the Narrow band position or the Nominal Bandwidth selected.

LTE Band 4:

QPSK. Nominal Bandwidth 5 MHz. Narrow band = 0, Position 1.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.103896104	1.103896104	1.108891109
-26 dBc Bandwidth (MHz)	1.3746	1.4186	1.4458
Measurement uncertainty (kHz)	<±6.35		

16QAM. Nominal Bandwidth 5 MHz. Narrow band = 0, Position 1.

Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	0.944055944	0.959040959	0.939060939
-26 dBc Bandwidth (MHz)	1.3946	1.3536	1.3210
Measurement uncertainty (kHz)	<±6.35		

LTE Band 12:

QPSK. Nominal Bandwidth 5 MHz. Narrow band = 0, Position 1.

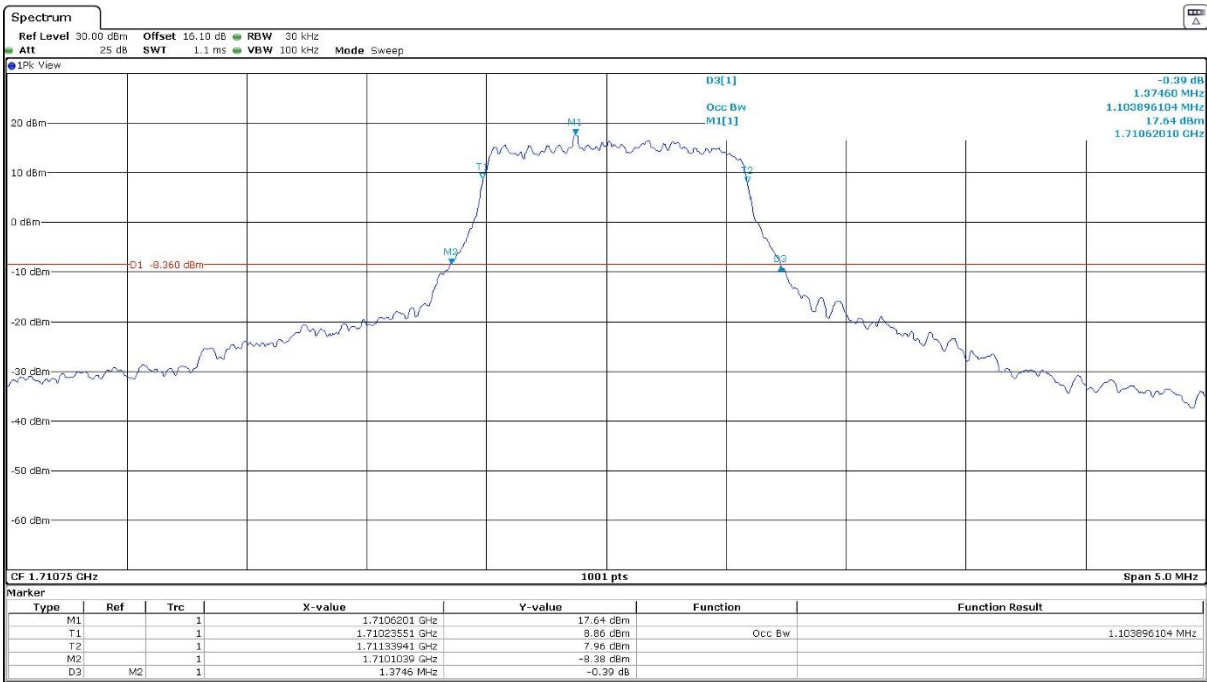
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	1.113886114	1.103896104	1.103896104
-26 dBc Bandwidth (MHz)	1.4291	1.4045	1.3686
Measurement uncertainty (kHz)	<±6.35		

16QAM. Nominal Bandwidth 5 MHz. Narrow band = 0, Position 1.

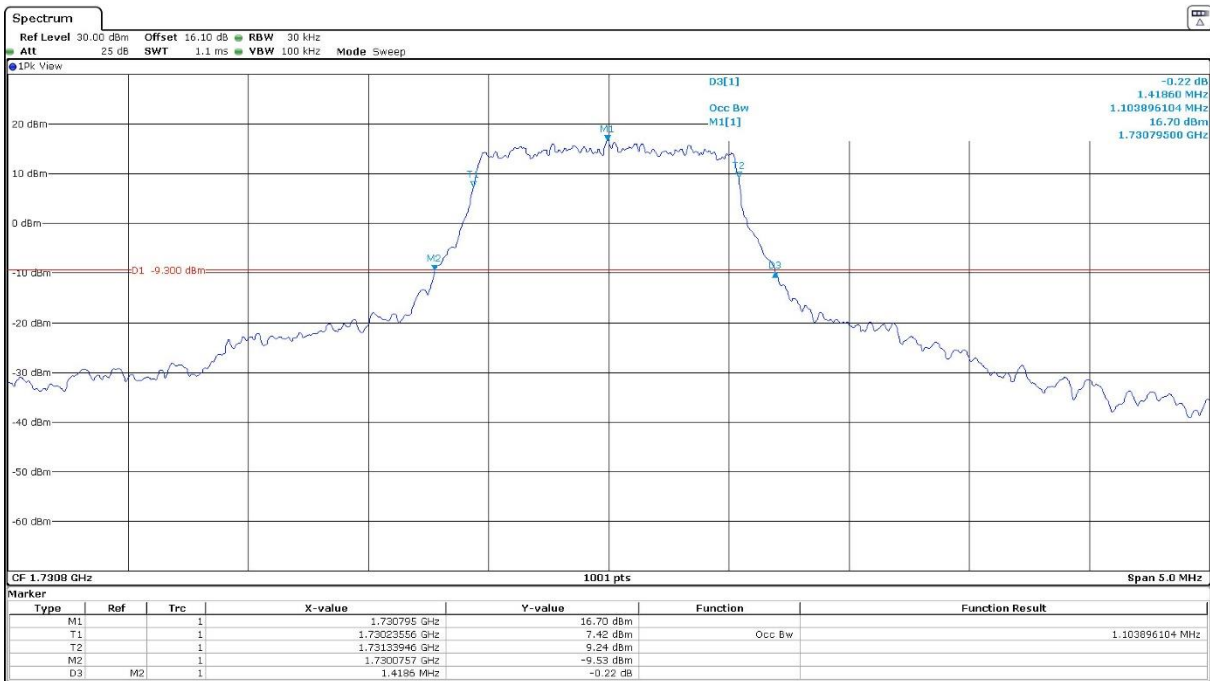
Channel	Low	Middle	High
99% Occupied Bandwidth (MHz)	0.969030969	0.959040959	0.954045954
-26 dBc Bandwidth (MHz)	1.3791	1.3846	1.3736
Measurement uncertainty (kHz)	<±6.35		

LTE Band 4. QPSK. Nominal Bandwidth 5 MHz. Narrow band = 0. Position 1.

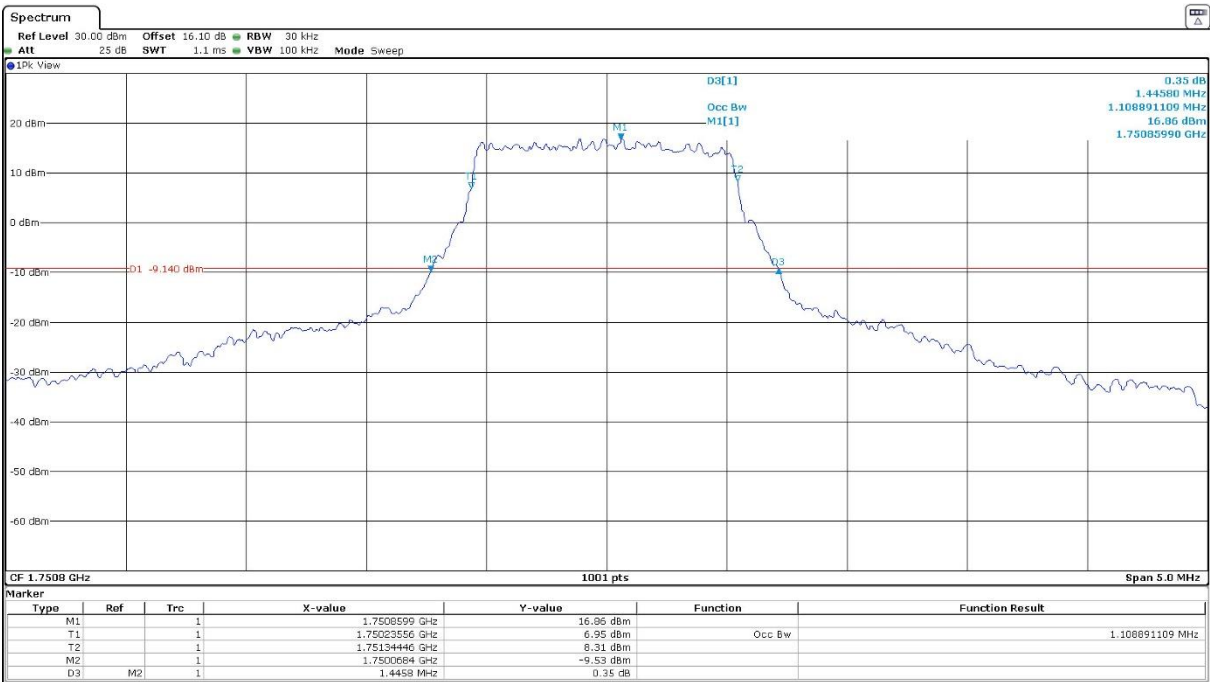
Low Channel:



Middle Channel:

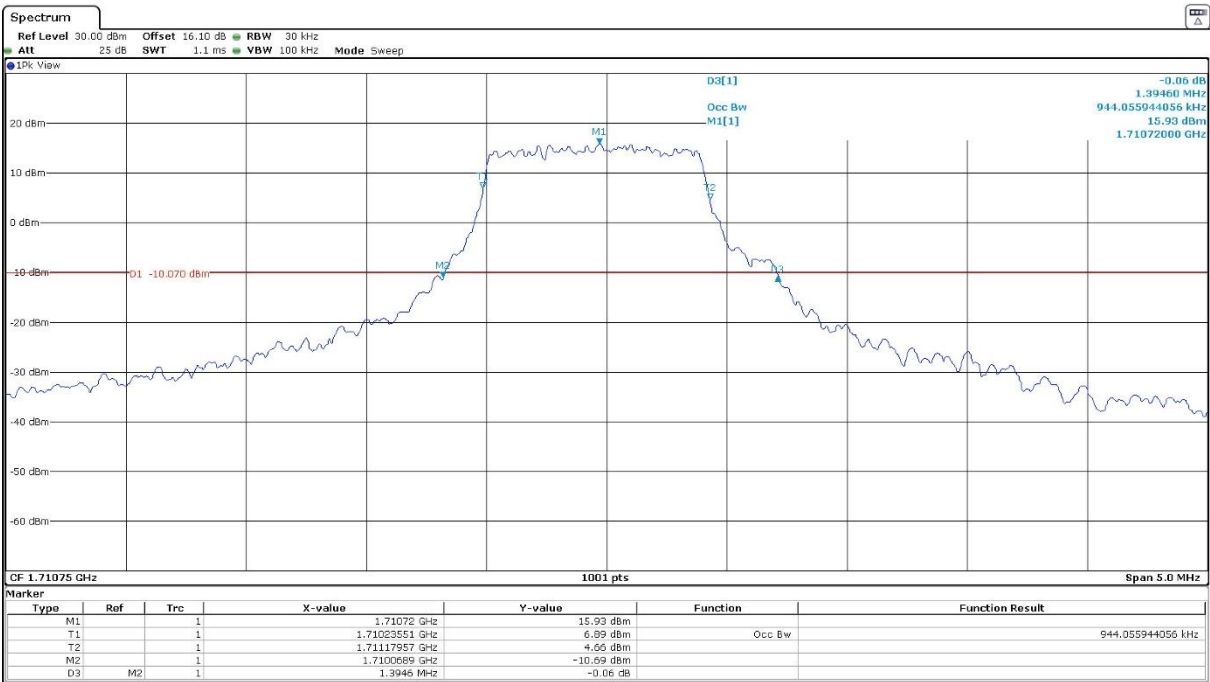


High Channel:

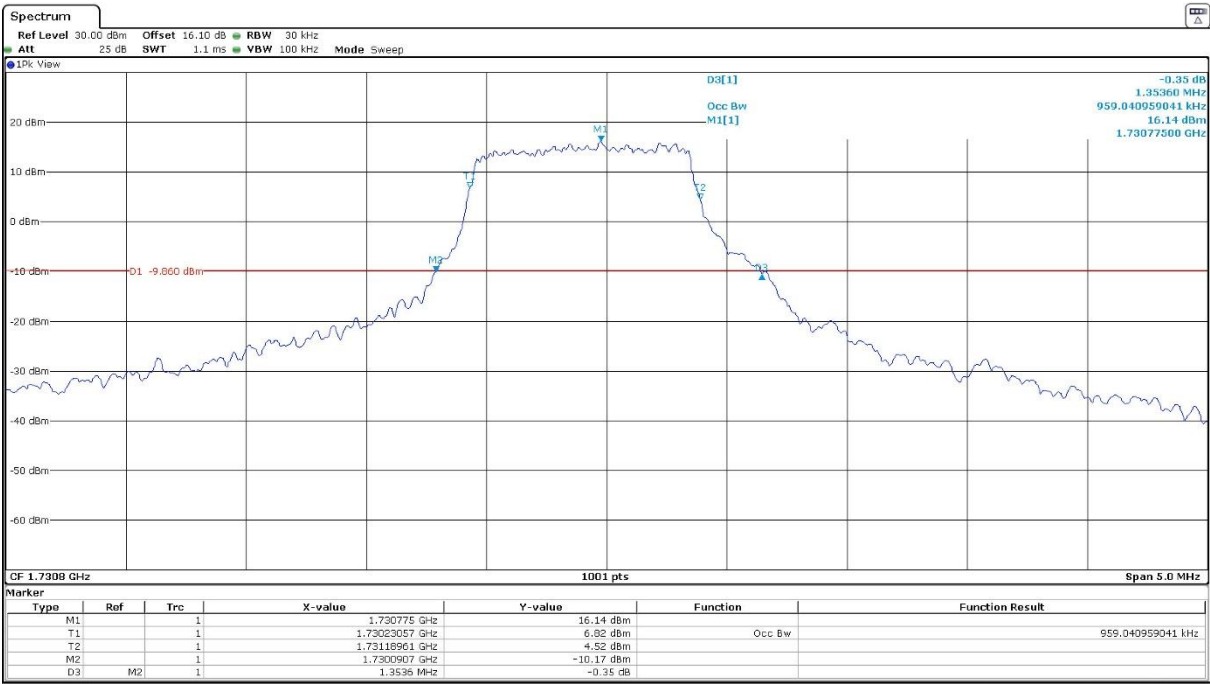


LTE Band 4. 16QAM. Nominal Bandwidth 5 MHz. Narrow band = 0. Position 1.

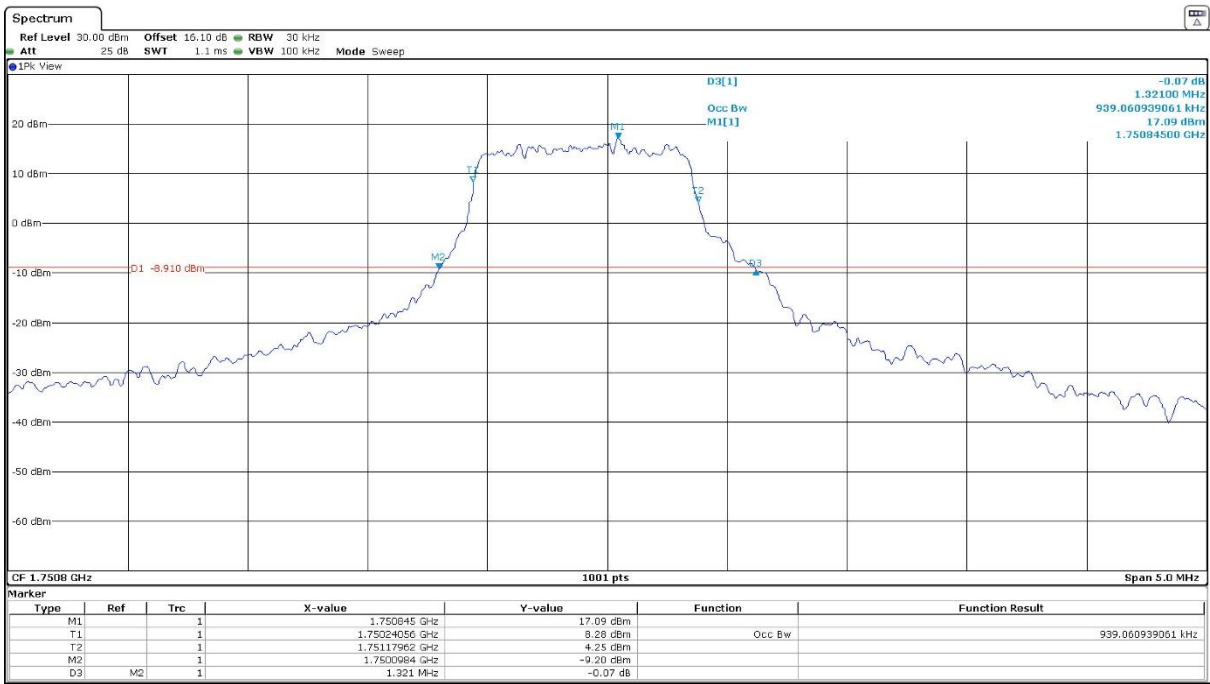
Low Channel:



Middle Channel:

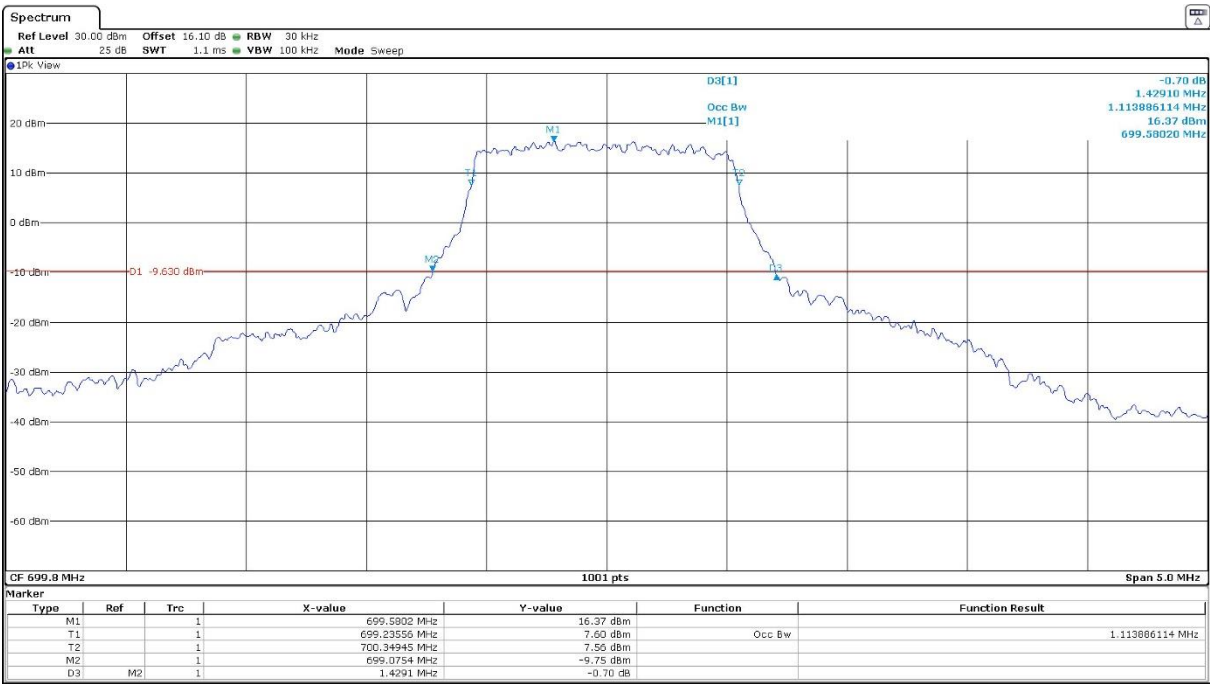


High Channel:

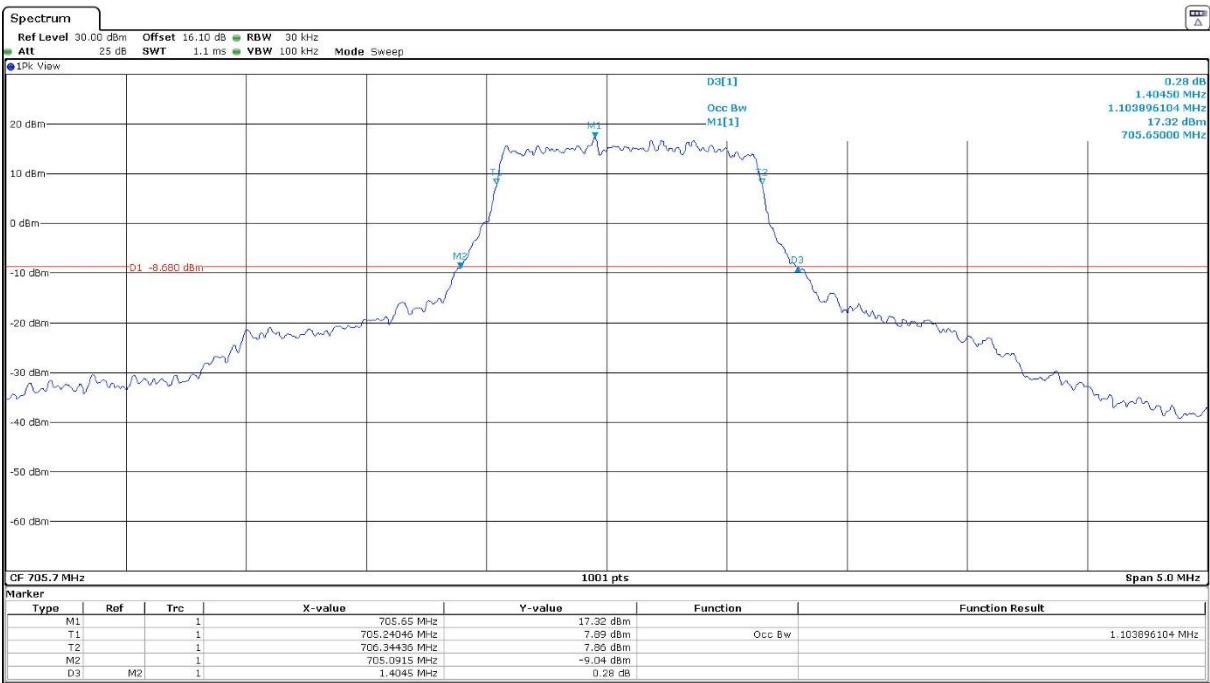


LTE Band 12. QPSK. Nominal Bandwidth 5 MHz. Narrow band = 0. Position 1.

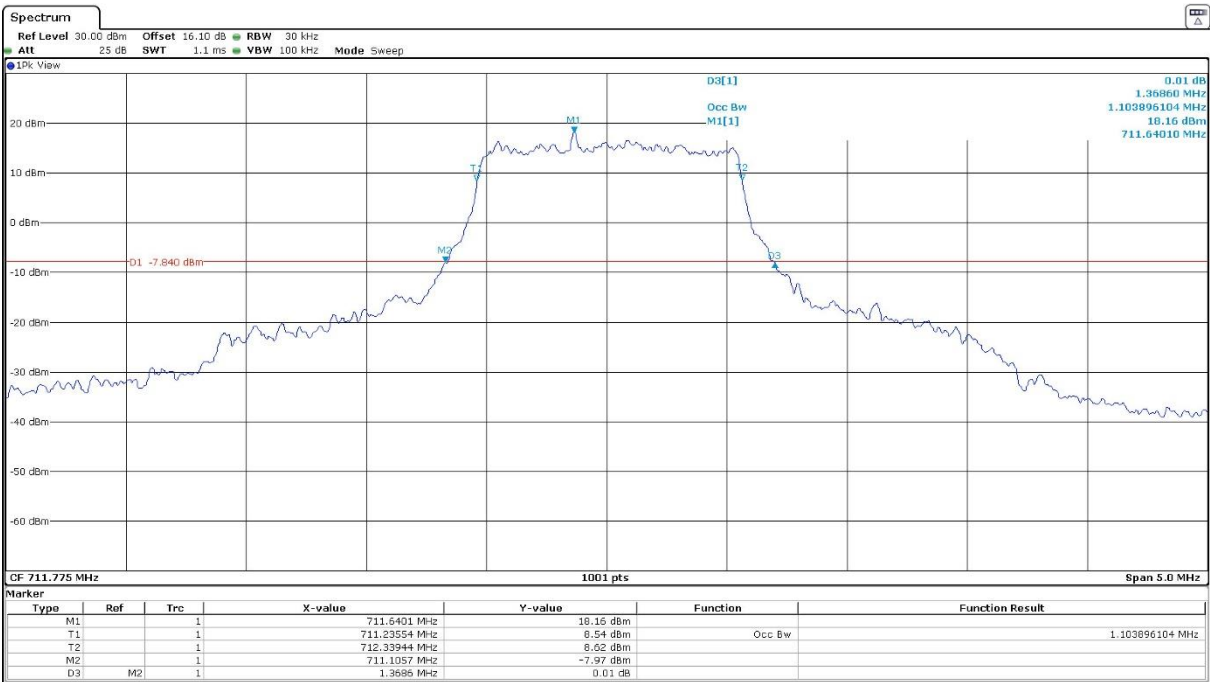
Low Channel:



Middle Channel:

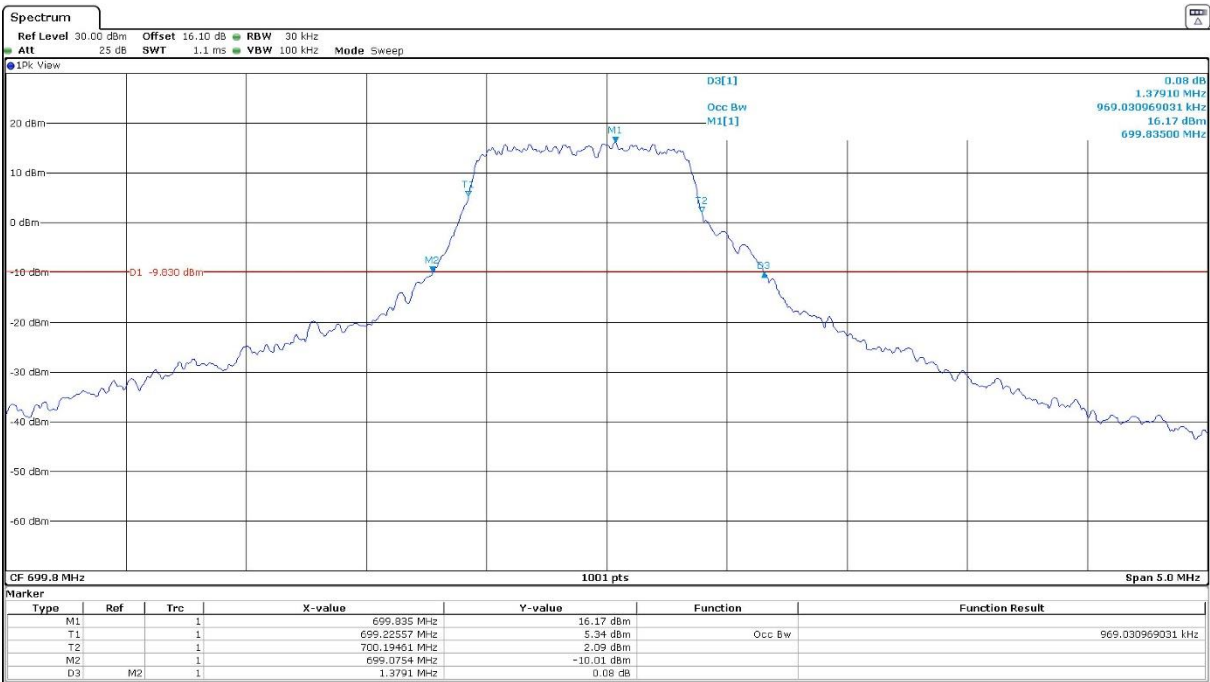


High Channel:

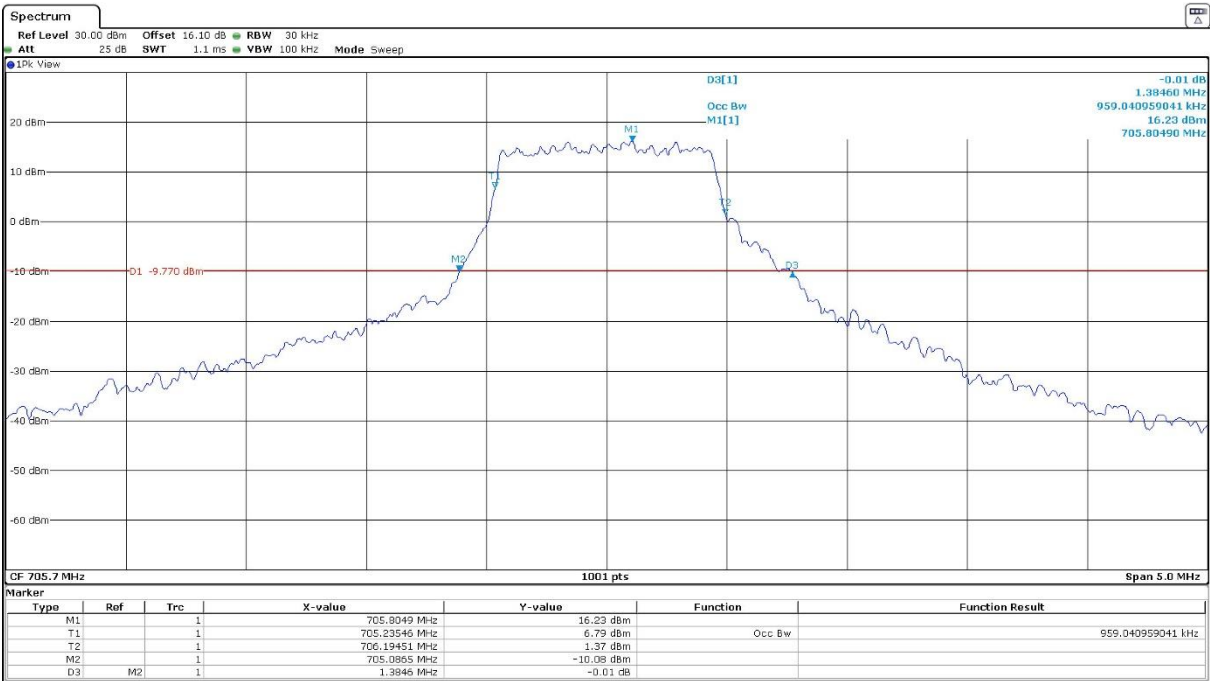


LTE Band 12. 16QAM. Nominal Bandwidth 5 MHz. Narrow band = 0. Position 1.

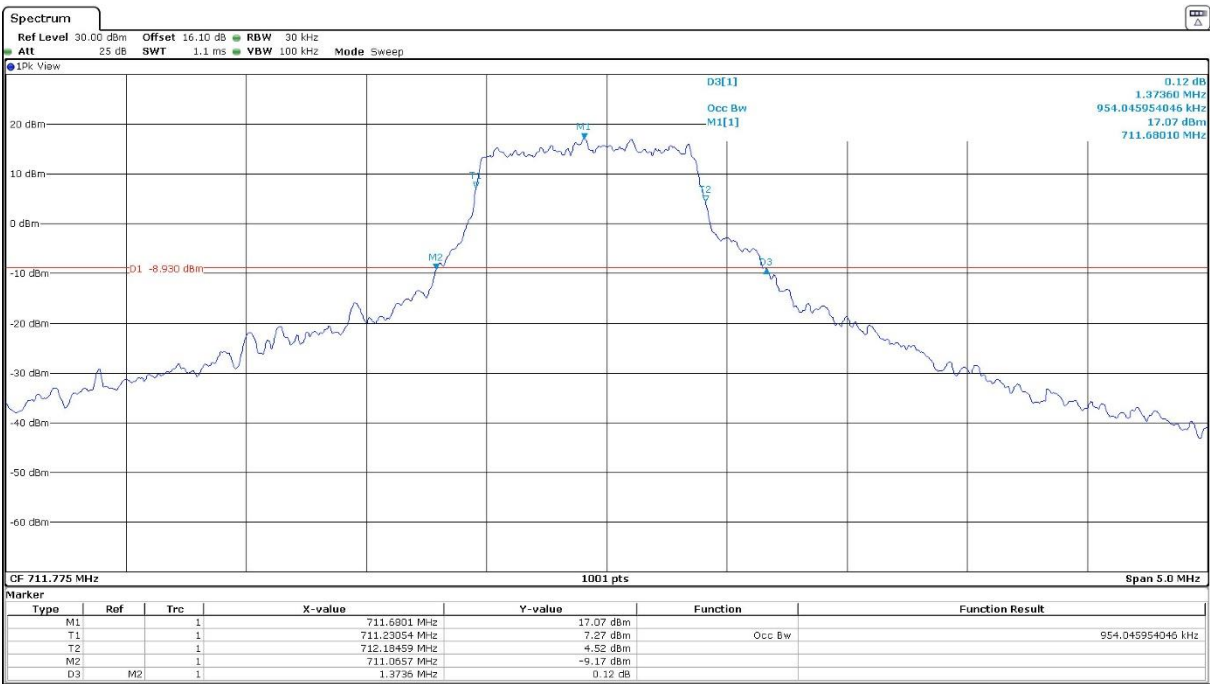
Low Channel:



Middle Channel:



High Channel:



Spurious Emissions at Antenna Terminals

SPECIFICATION

FCC §27.53 (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.

FCC §27.53 (h), RSS-139 Clause 6.6:

According to specification, the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in watts. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

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.

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

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

METHOD

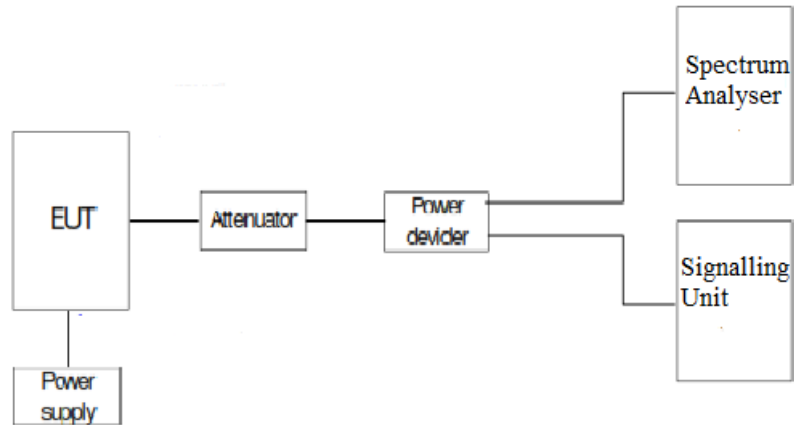
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 18 GHz for LTE Band 4 and 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 (see plots in next pages)

LTE Band 4: QPSK. Nominal Bandwidth 20 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

- Low Channel: Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
2116.509	-24.41
8559.909	-29.6

- Middle Channel: Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
2132.709	-25.11
8623.509	-30.04

- High Channel: Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
2141.709	-23.32
6933.909	-24.6
8682.309	-31.13

LTE Band 12: QPSK. Nominal Bandwidth 5 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

- Low Channel: Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
733.209	-31.99
2098.809	-32.98

- Middle Channel:

Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
739.079	-31.75
2117.469	-28.59

- High Channel:

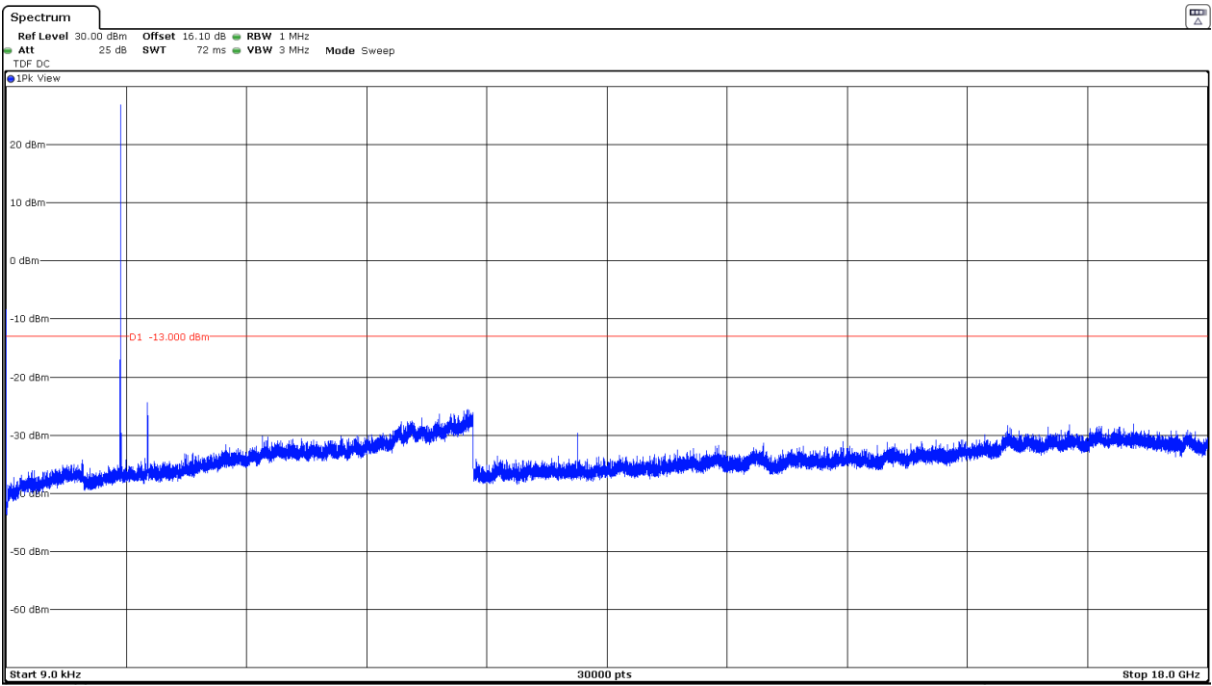
Spurious Frequency (MHz)	Emission Limitations Conducted (dBm)
745.739	-32.18

Measurement uncertainty (dB): $\leq \pm 2.61$

Verdict: PASS

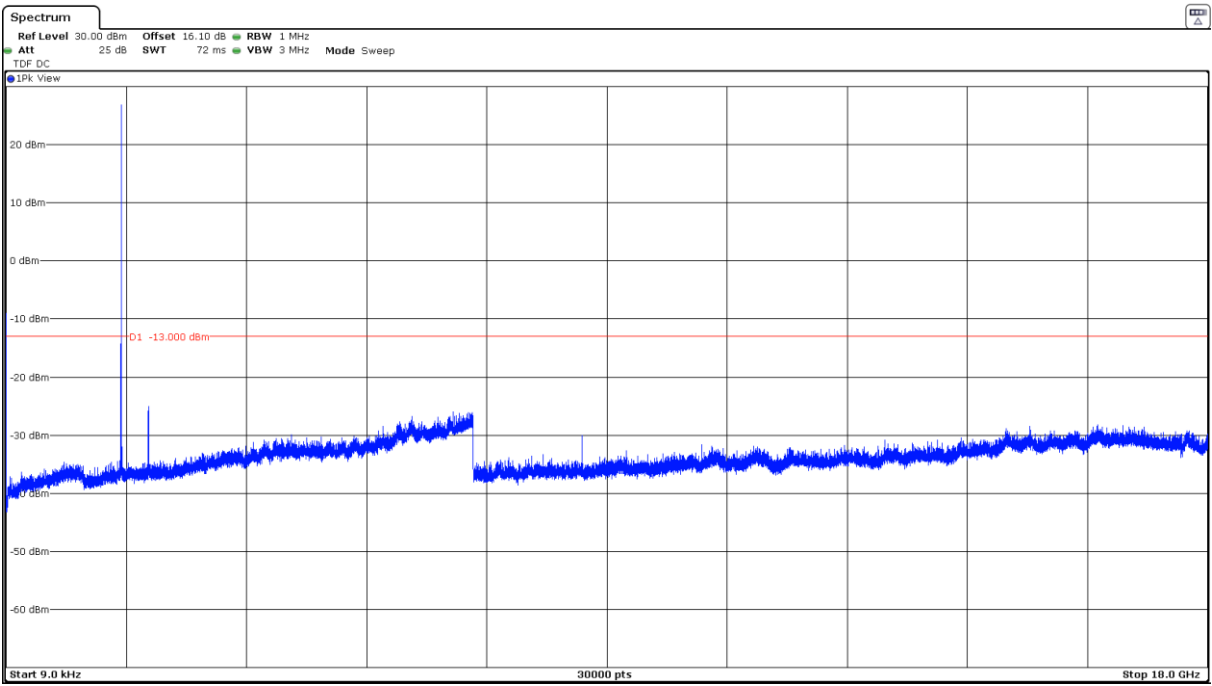
LTE Band 4. QPSK. Nominal Bandwidth 20 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

Low Channel:



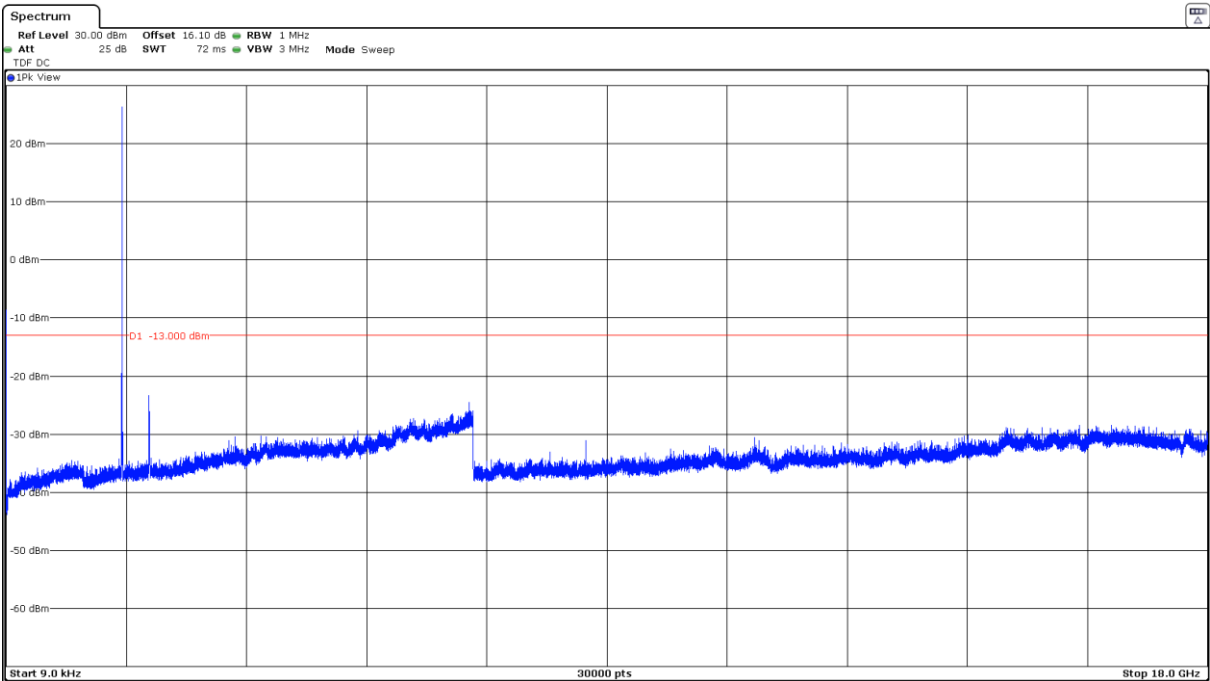
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

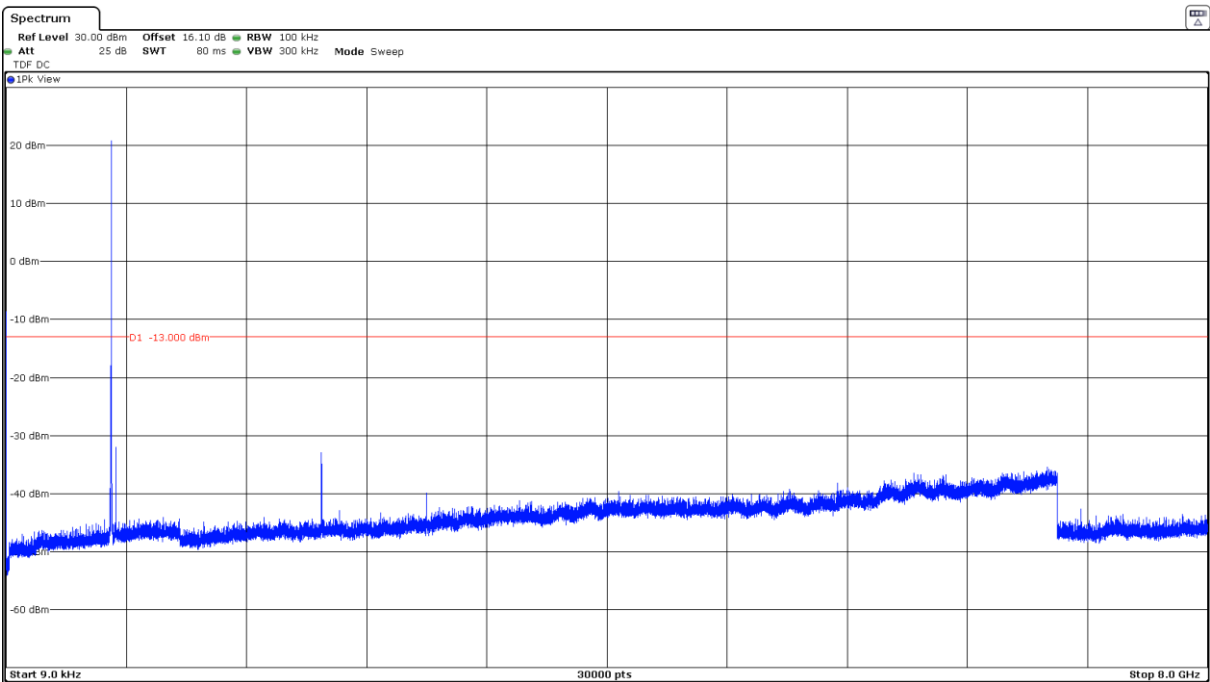
High Channel:



The peak above the limit is the carrier frequency.

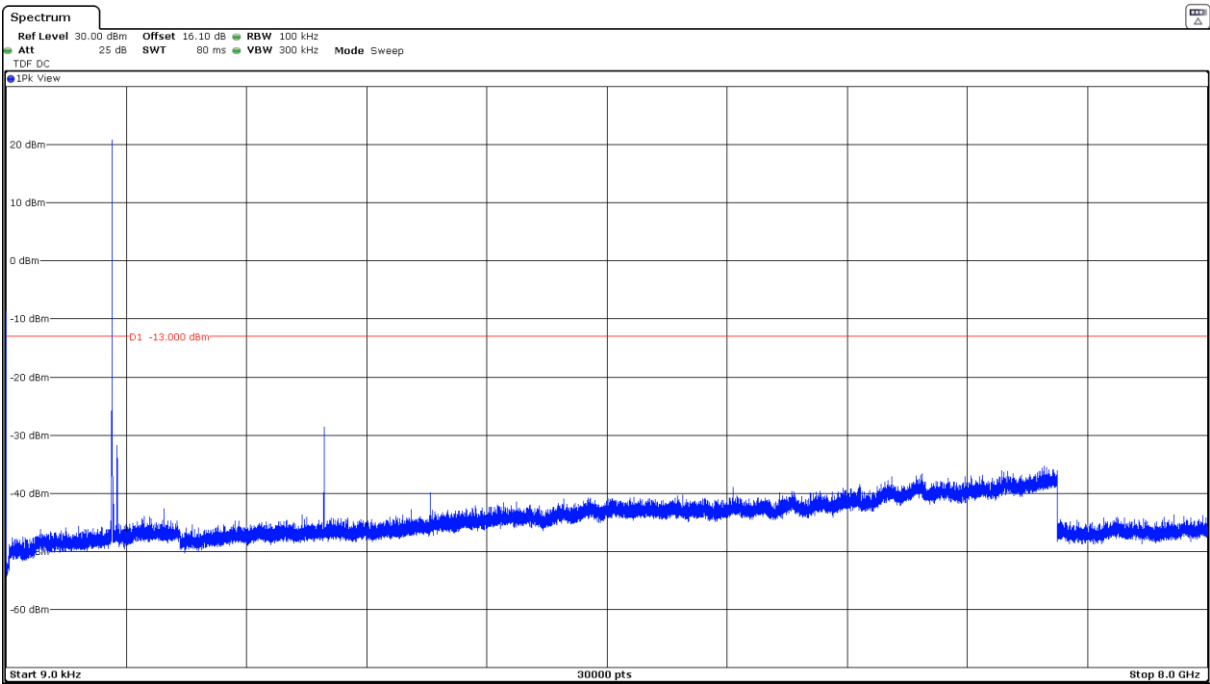
LTE Band 12. QPSK. Nominal Bandwidth 5 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

Low Channel:



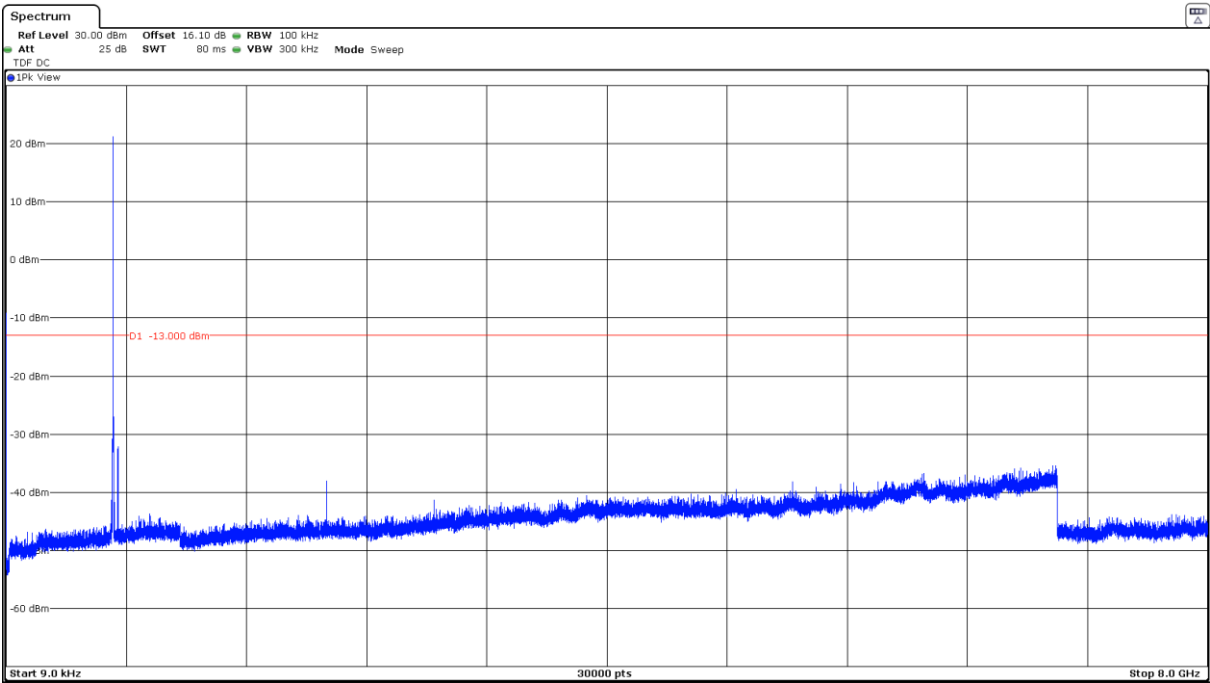
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

High Channel:



The peak above the limit is the carrier frequency.

Spurious Emissions at Antenna Terminals at Block Edges

SPECIFICATION

FCC §27.53 (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.

FCC §27.53 (h):

According to specification, the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in watts. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter 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.

RSS-139 Clause 6.6:

In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10} p$ (watts) dB.

After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10} p$ (watts) dB.

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

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

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.

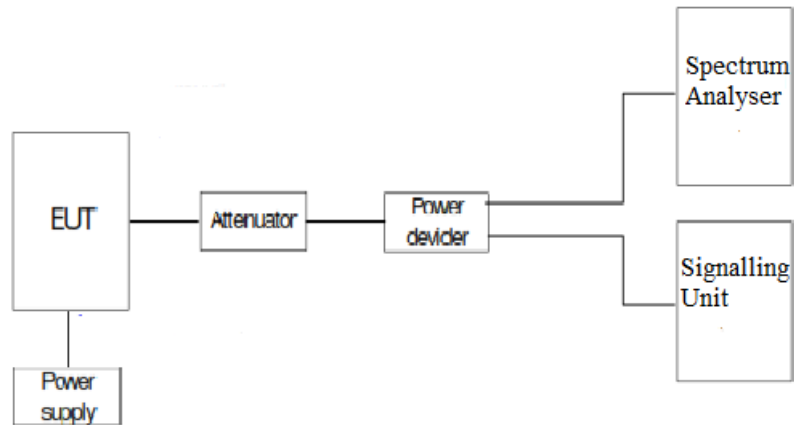
The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

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

For LTE Band 4, as indicated in FCC part 27.53 (h) (3) / RSS-139 Clause 6.6, in the 1 MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

For LTE Band12, as indicated in FCC part 27.53 (g) / RSS-130 Clause 4.7.1, 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 (see plots in next pages)

LTE Band 4:

Preliminary measurements determined the Nominal Bandwidth of 5 MHz, QPSK modulation as the worst case. The next results are for this worst-case configuration.

LTE QPSK MODULATION	RB=1 Offset = 0 BW = 5 MHz Narrow band = 0
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-29.67

LTE QPSK MODULATION	RB = All Offset = 0 BW = 5 MHz Narrow band = 0
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-29.21

LTE QPSK MODULATION	RB = 1 Offset = Max. BW = 5 MHz Narrow band = 3
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-30.98

LTE QPSK MODULATION	RB = All Offset = 0 BW = 5 MHz Narrow band = 3
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-29.73

LTE Band 12:

Preliminary measurements determined the Nominal Bandwidth of 5 MHz, QPSK modulation as the worst case. The next results are for this worst-case configuration.

LTE QPSK MODULATION	RB = 1 Offset = 0 BW = 5 MHz Narrow band = 0
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-34.22

LTE QPSK MODULATION	RB = All Offset = 0 BW = 5 MHz Narrow band = 0
Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm)	-33.29

LTE QPSK MODULATION	RB = 1 Offset = Max. BW = 5 MHz Narrow band = 3
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-18.74

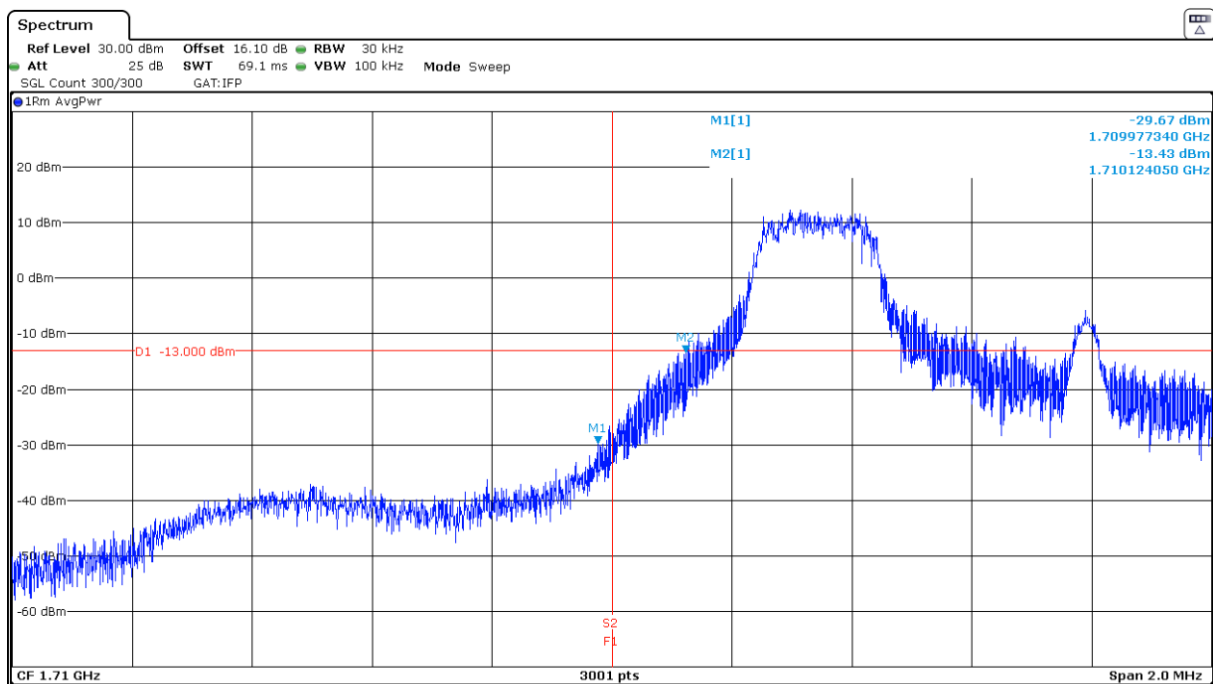
LTE QPSK MODULATION	RB = All Offset = 0 BW = 5 MHz Narrow band = 3
Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm)	-18.58

Measurement uncertainty (dB): $<\pm 2.10$

Verdict: PASS

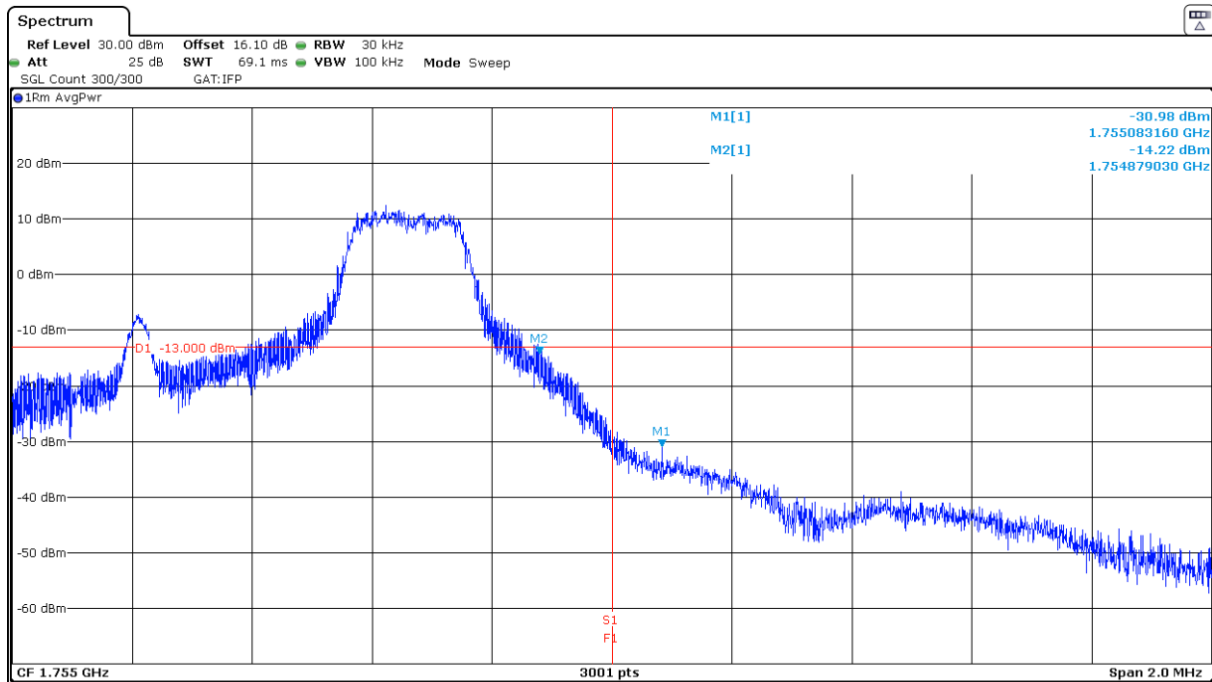
LTE Band 4:

QPSK. Nominal Bandwidth 5 MHz. RB Size 1, RB Offset 0. Narrow band = 0. Lowest Block Edge:



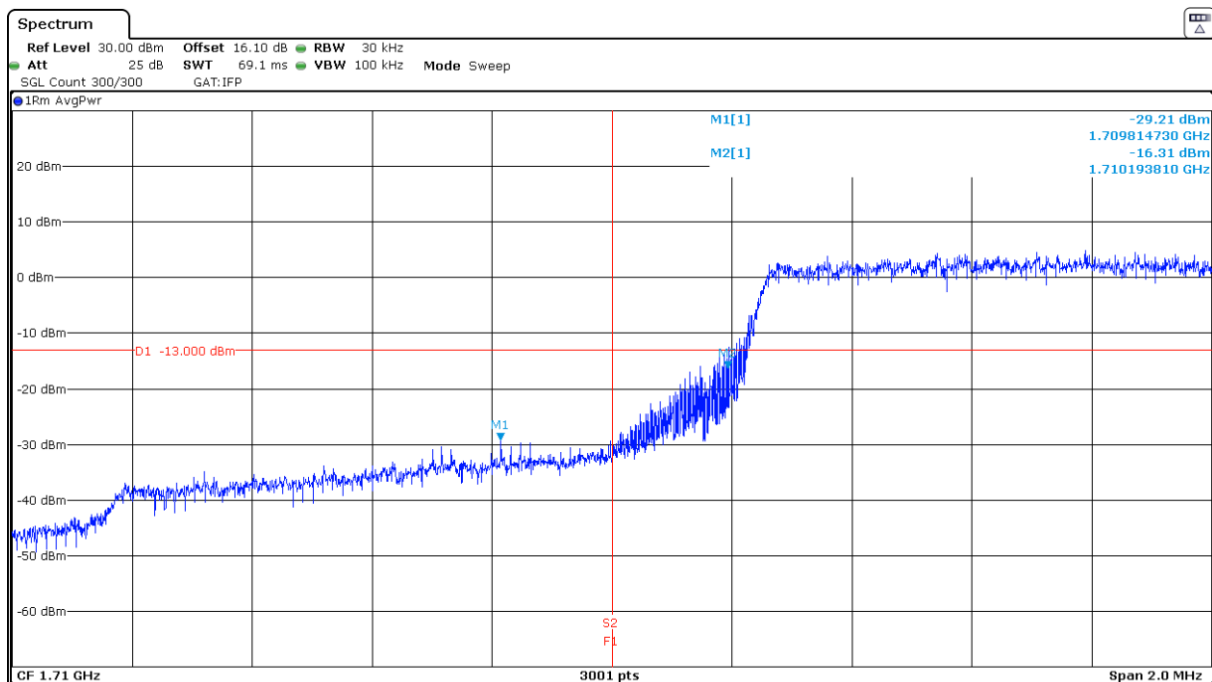
NOTE: The equipment transmits at the maximum output power.

QPSK. Nominal Bandwidth 5 MHz. RB Size 1, RB Offset Max. Narrow band = 3. Highest Block Edge:



NOTE: The equipment transmits at the maximum output power.

QPSK. Nominal Bandwidth 5 MHz. RB Size All, RB Offset 0. Narrow band = 0. Lowest Block Edge:



NOTE: The equipment transmits at the maximum output power.

Spectrum

Ref Level 30.00 dBm Offset 16.10 dB RBW 30 kHz
 Att 25 dB SWT 69.1 ms VBW 100 kHz Mode Sweep
 SGL Count 300/300 GAT:IFP

1Rm AvgPwr

20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm

M1[1] -29.73 dBm
 M2[1] 1.755159950 GHz
 -13.71 dBm
 1.754798750 GHz

D1 -13.000 dBm

M1

S1
F1

CF 1.755 GHz 3001 pts Span 2.0 MHz

LTE Band 12:

Spectrum

Ref Level 30.00 dBm Offset 16.10 dB RBW 100 kHz
 Att 25 dB SWT 20.8 ms VBW 300 kHz Mode Sweep
 SGL Count 300/300 GAT:IFP

1Rm AvgPwr

M1[1] -34.22 dBm
 M2[1] 697.59010 MHz
 -14.06 dBm
 699.00380 MHz

D1 -13.000 dBm

M1

M2

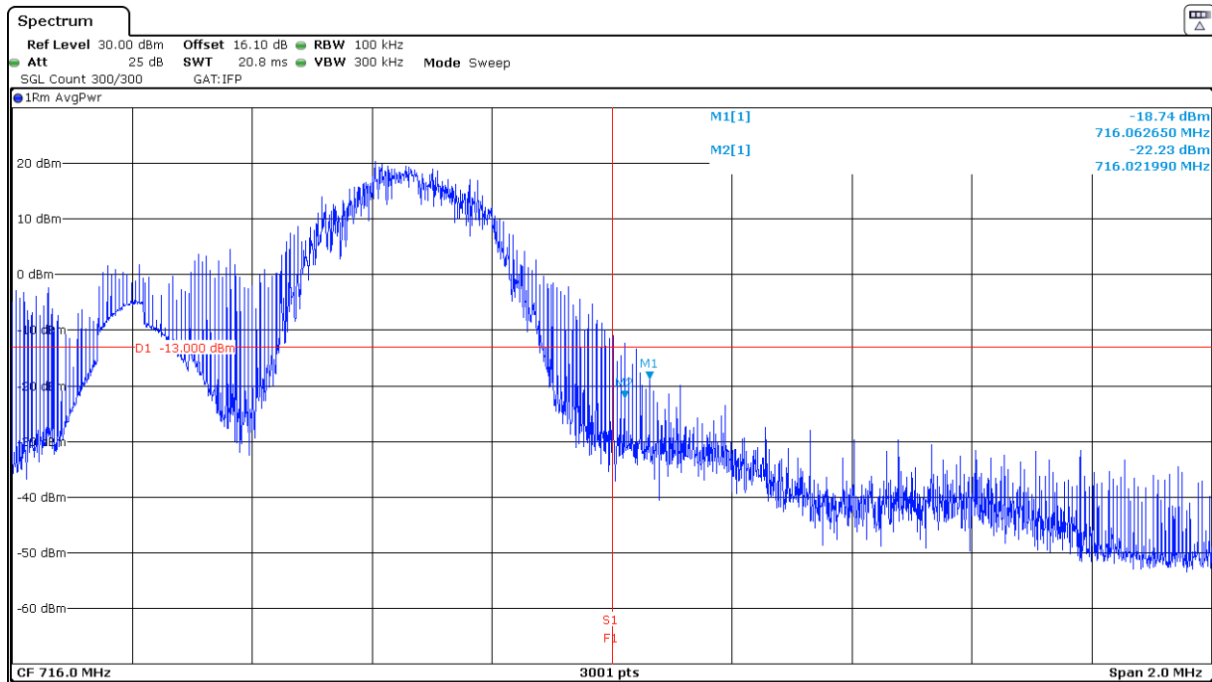
S2

F1

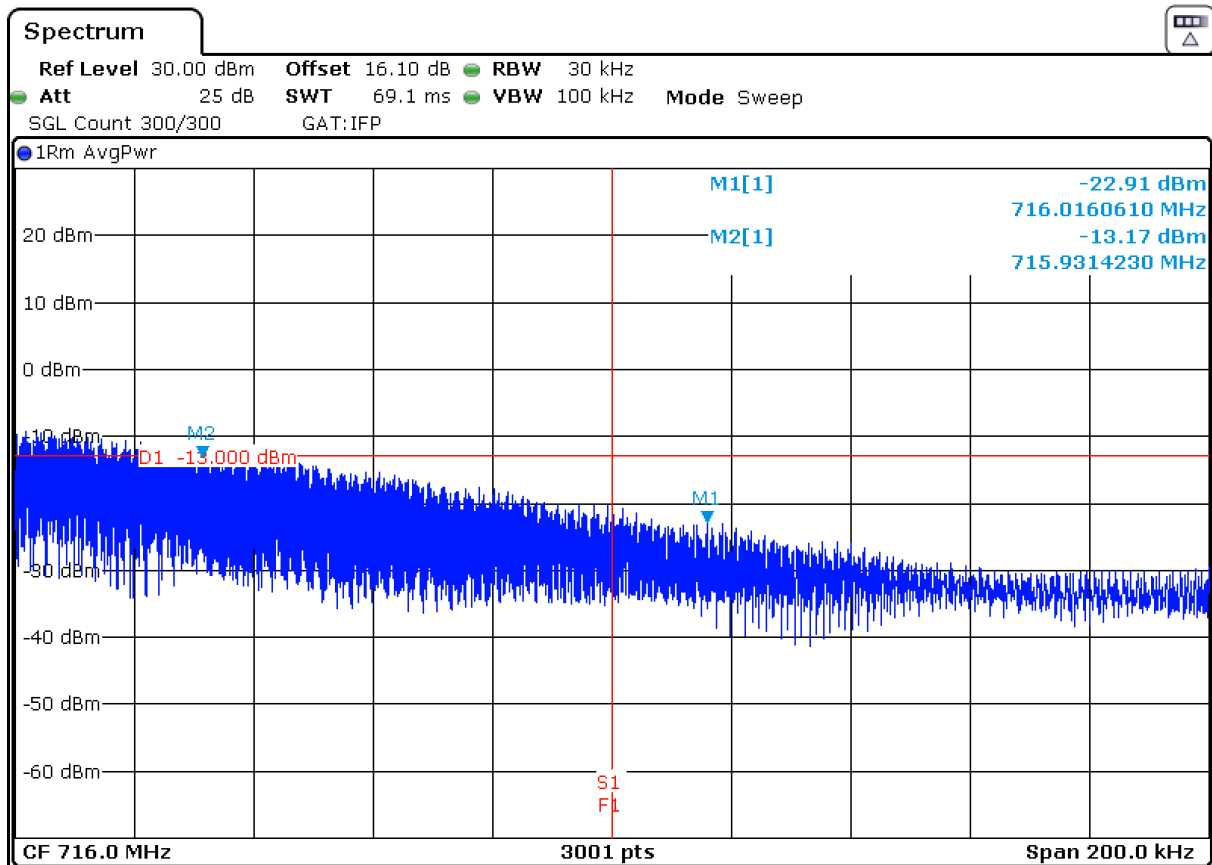
CF 698.0 MHz 3001 pts Span 5.0 MHz

2020-12-29

QPSK. Nominal Bandwidth 5 MHz. RB Size 1, RB Offset Max. Narrow band = 3. Highest Block Edge:

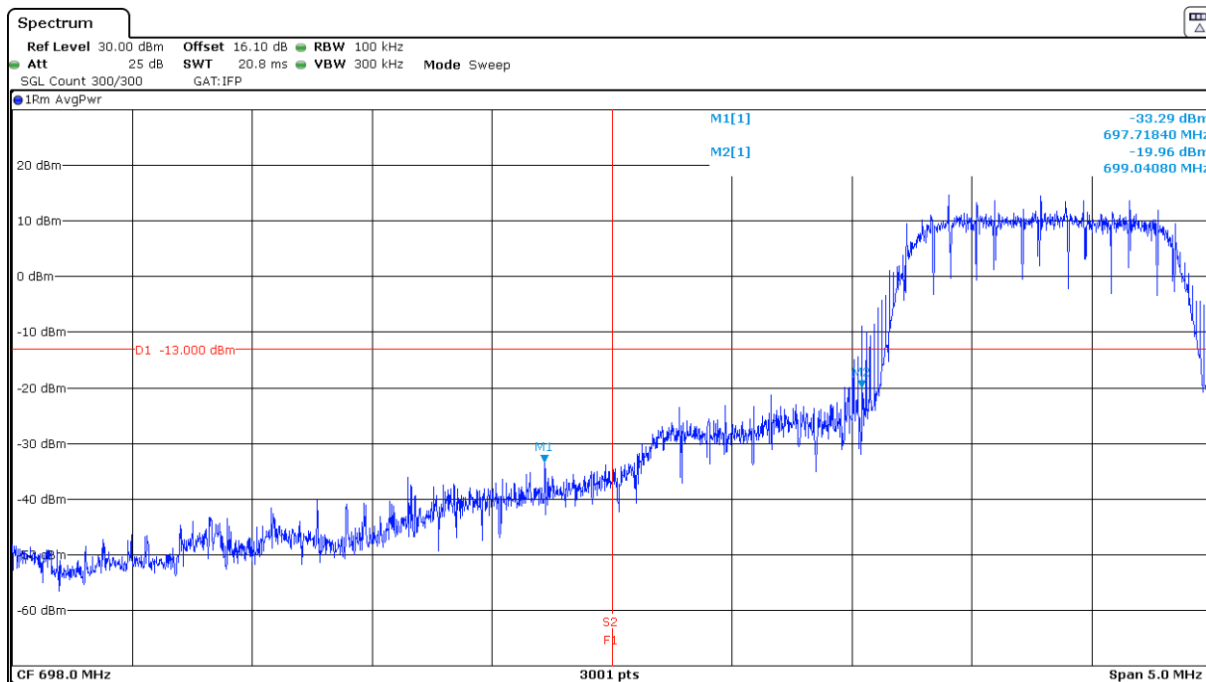


NOTE: The equipment transmits at the maximum output power.



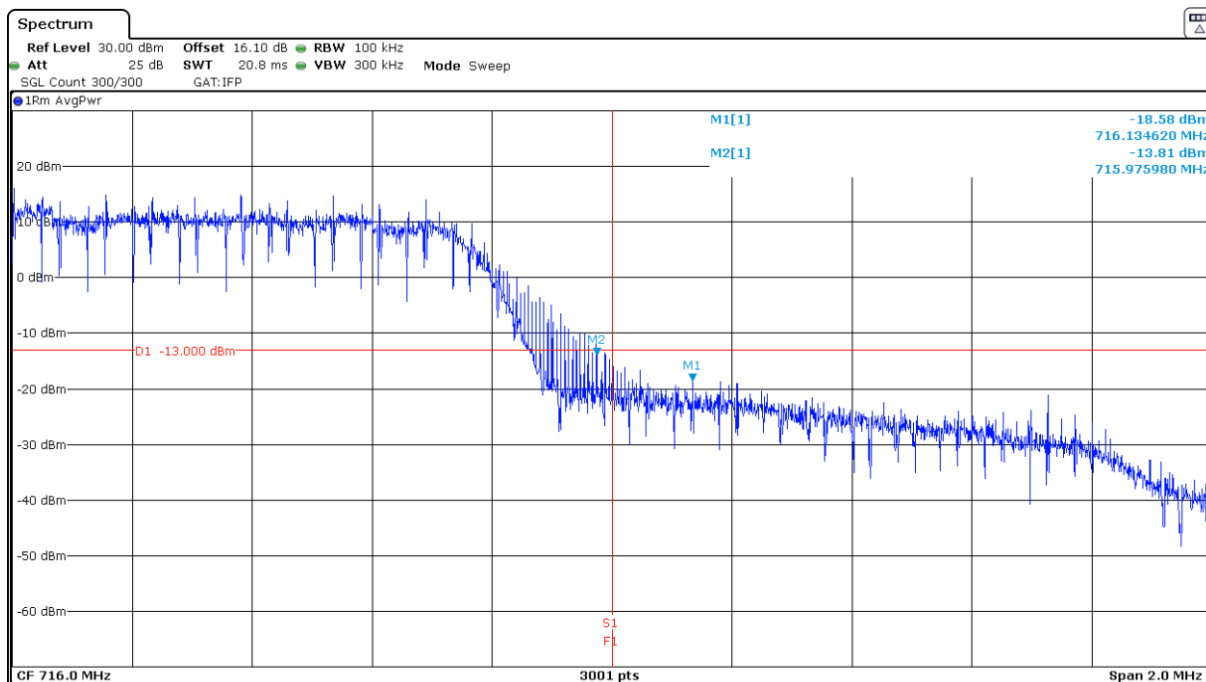
NOTE: Zoom (100kHz) with RBW=30kHz.

QPSK. Nominal Bandwidth 5 MHz. RB Size All, RB Offset 0. Narrow band = 0. Lowest Block Edge:

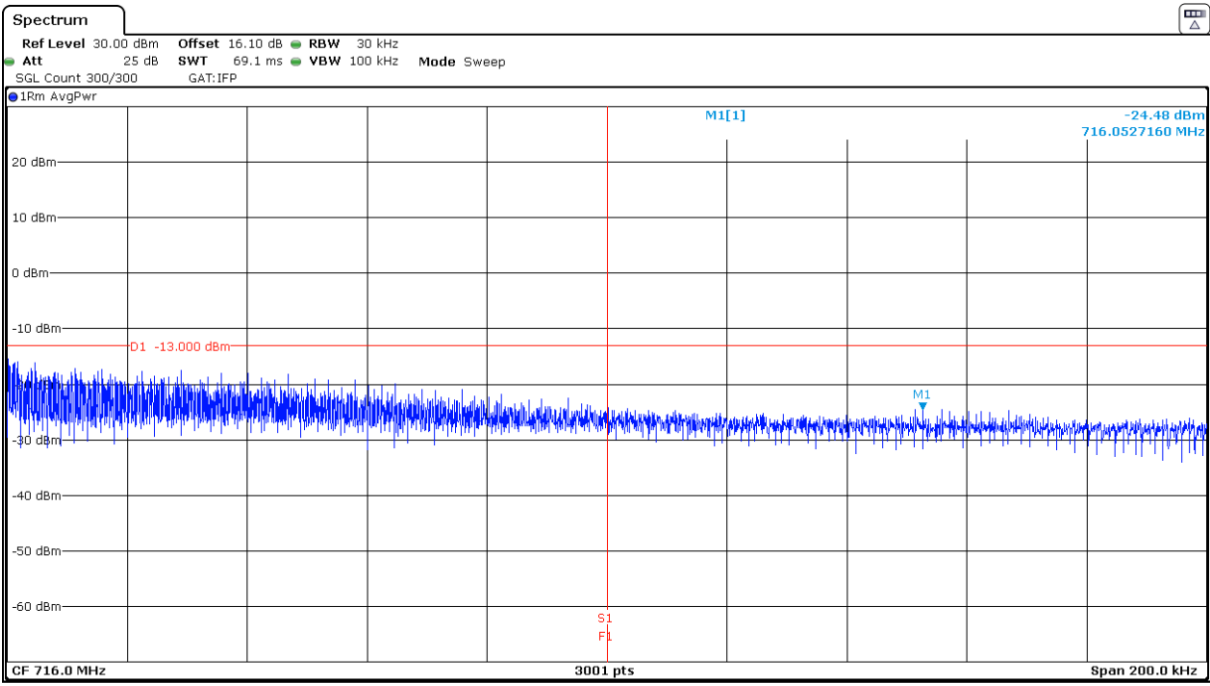


NOTE: The equipment transmits at the maximum output power.

QPSK. Nominal Bandwidth 5 MHz. RB Size All, RB Offset 0. Narrow band = 3. Highest Block Edge:



NOTE: The equipment transmits at the maximum output power.



NOTE: Zoom (100kHz) with RBW=30kHz.

Radiated Emissions

SPECIFICATION

FCC §27.53 (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.

FCC §27.53 (h), RSS-139 Clause 6.6:

According to specification, the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in watts. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

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.

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

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

METHOD

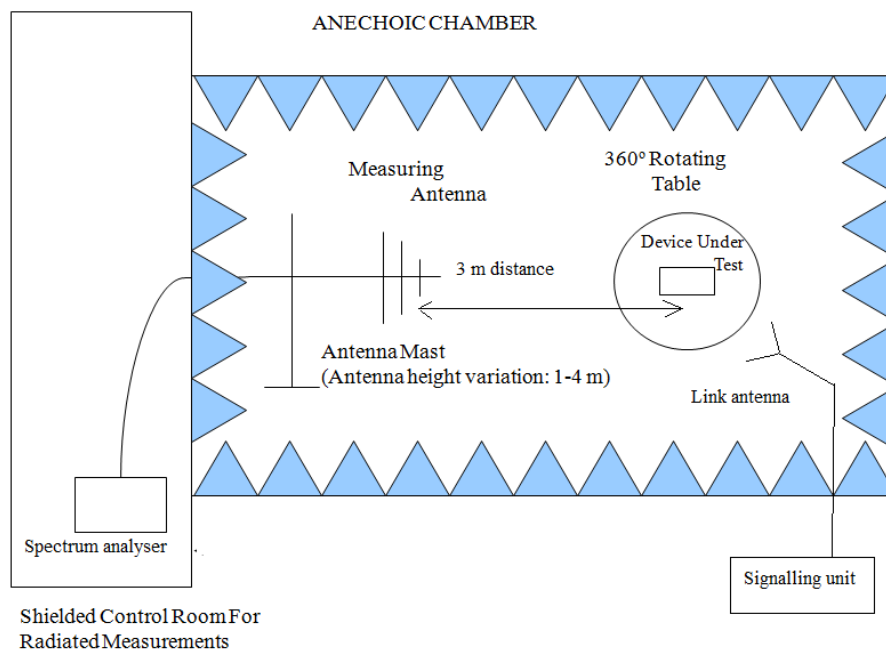
The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.

The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements from 30 MHz up to 18 GHz.

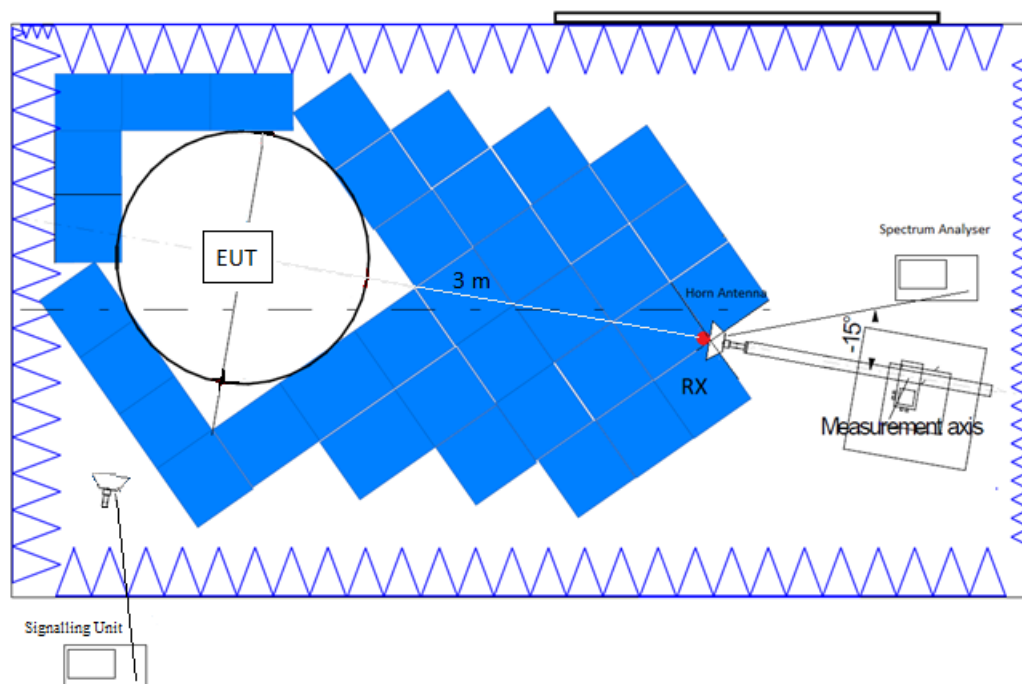
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

TEST SETUP

Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 18 GHz.



RESULTS (see plots in next pages)

LTE Band 4:

Preliminary measurements determined QPSK modulation, Nominal Bandwidth of 20 MHz, RB Size 6, RB Offset 0, Narrow band = 0 as the worst case.

The next results are for this worst-case configuration.

- **Low Channel:**

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 18 GHz

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

- **Middle Channel:**

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 18 GHz

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

- **High Channel:**

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 18 GHz

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

Measurement uncertainty (dB):
 $<\pm 4.89$ for $f \geq 30$ MHz up to 1 GHz
 $<\pm 4.11$ for $f \geq 1$ GHz up to 3 GHz
 $<\pm 5.13$ for $f \geq 3$ GHz up to 18 GHz

Verdict: PASS

LTE Band 12:

Preliminary measurements determined QPSK modulation, Nominal Bandwidth of 5 MHz, RB Size 6, RB Offset 0, Narrow band = 0 as the worst case.

The next results are for this worst-case configuration.

- Low Channel:

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 8 GHz

Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
2.09982	-29.28	H	Peak
2.10005	-27.63	V	Peak

- Middle Channel:

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 8 GHz

Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
2.11335	-25.51	V	Peak

- High Channel:

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 8 GHz

Spurious frequencies at less than 20 dB below the limit:

Spurious Frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
2.14368	-19.17	V	Peak
2.14625	-28.63	H	Peak

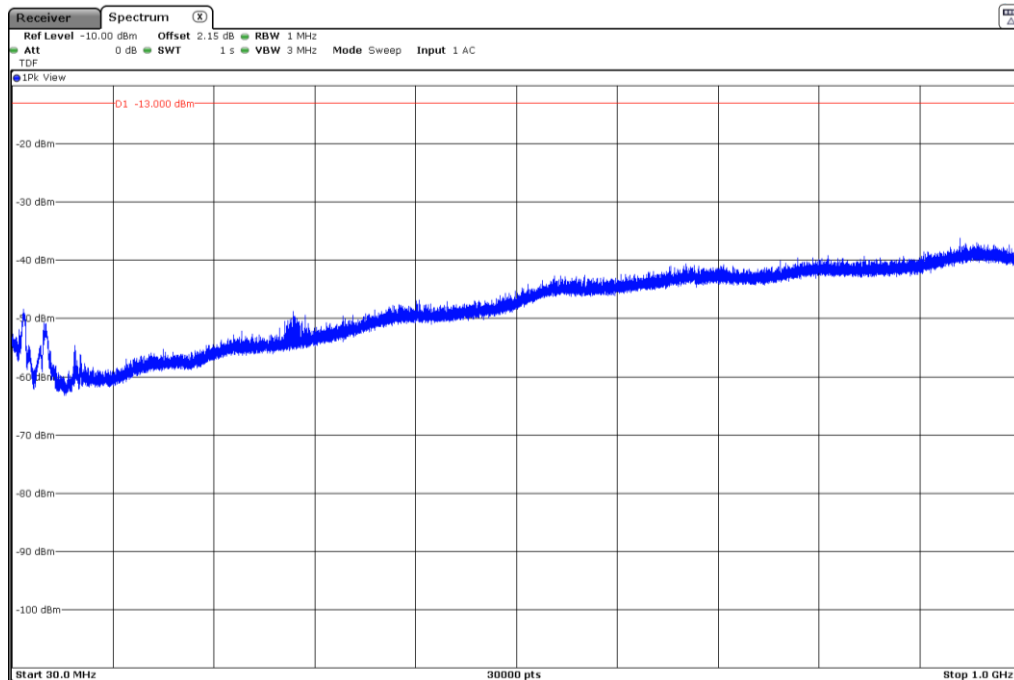
Measurement uncertainty (dB): $<\pm 4.89$ for $f \geq 30$ MHz up to 1 GHz
 $<\pm 5.13$ for $f \geq 1$ GHz up to 8 GHz

Verdict: PASS

LTE Band 4. QPSK. Nominal Bandwidth 20 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

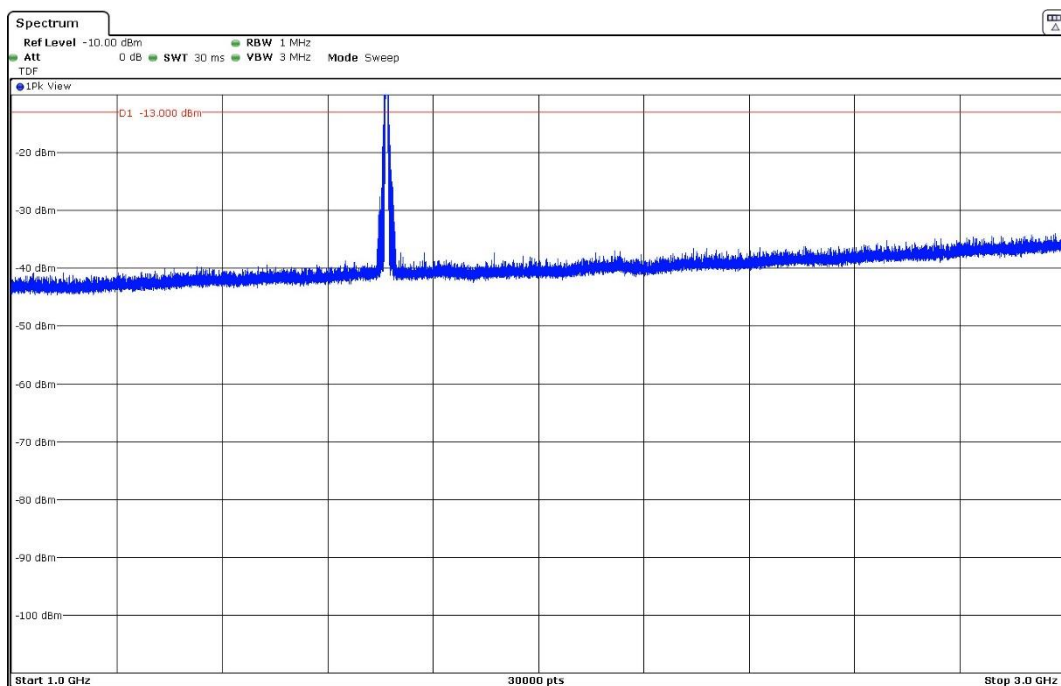
FREQUENCY RANGE 30 MHz - 1 GHz:

This plot is valid for the Low, Middle and High Channels.



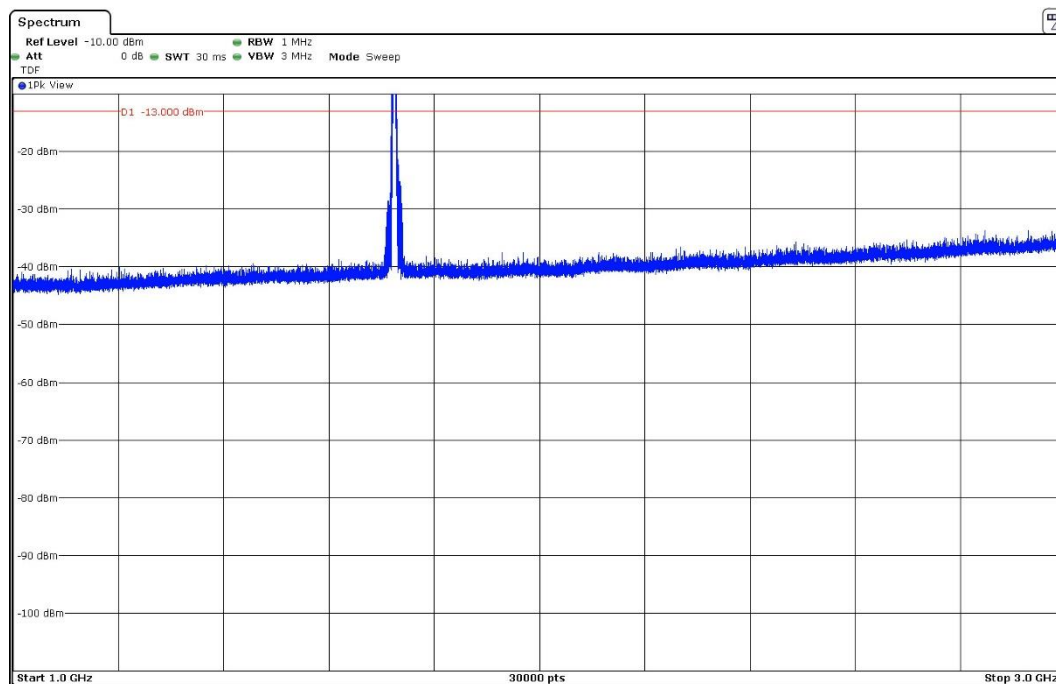
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



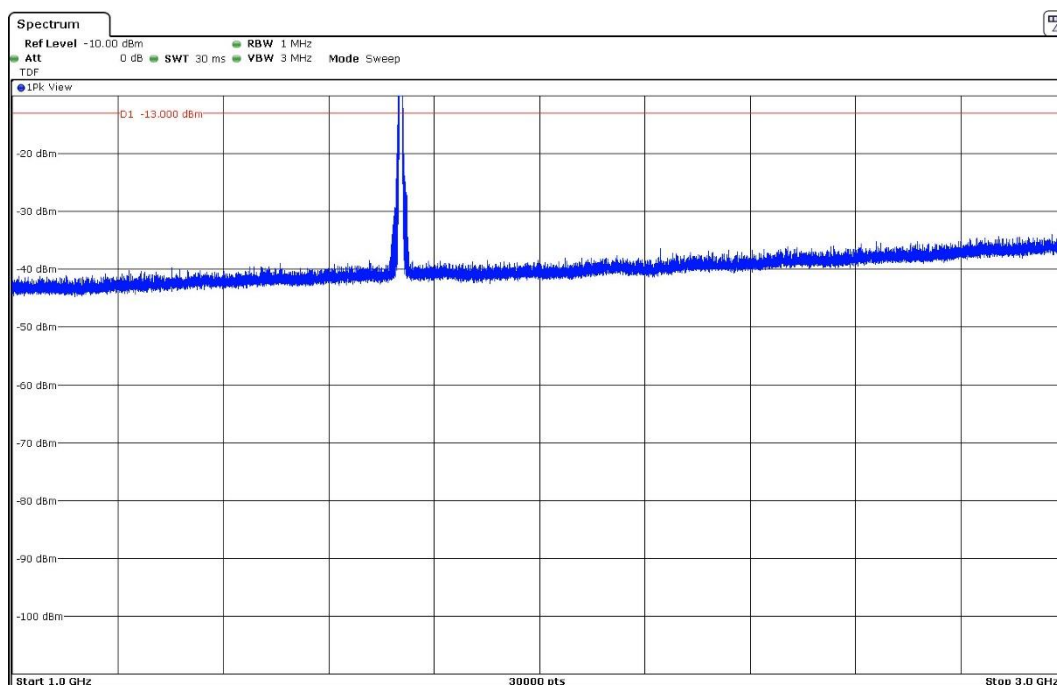
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

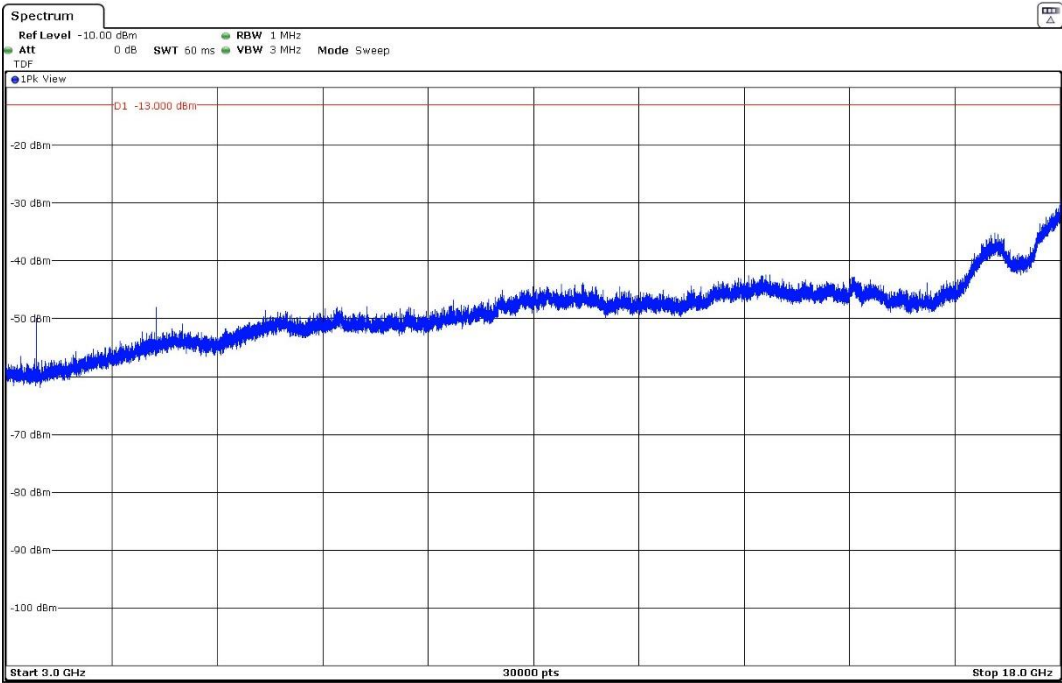
- High Channel:



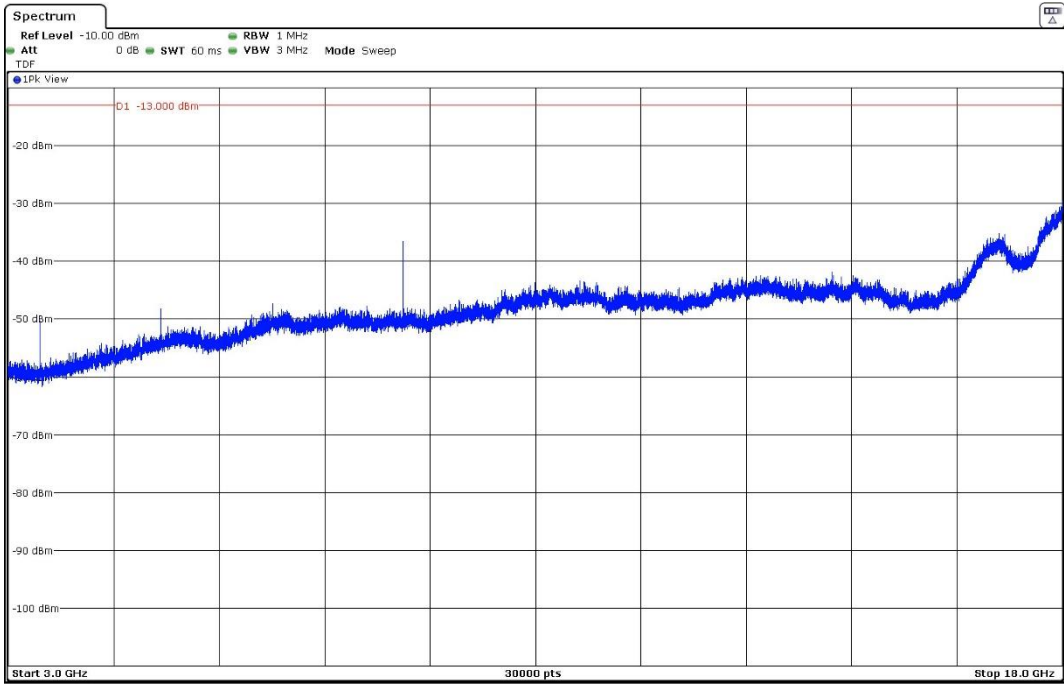
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 18 GHz:

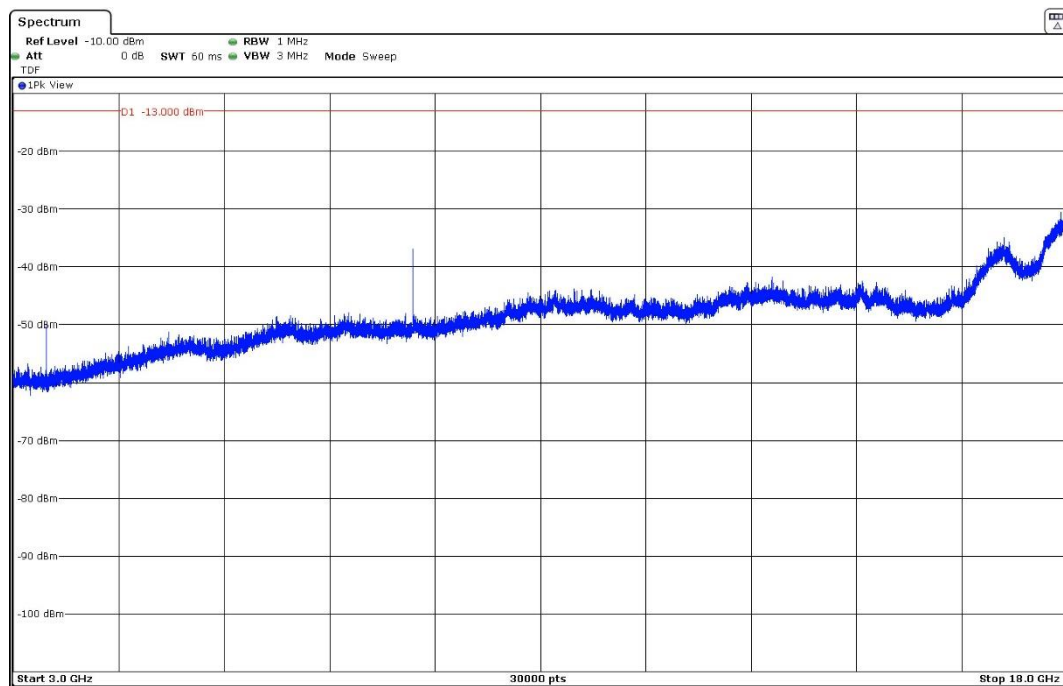
- Low Channel:



- Middle Channel:



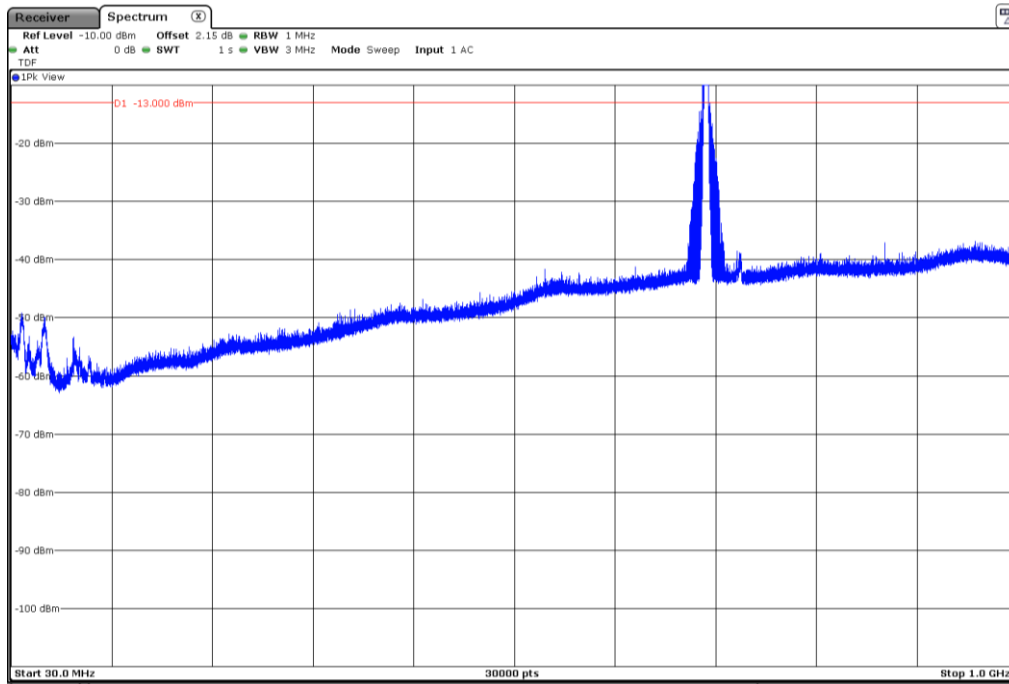
- High Channel:



LTE Band 12. QPSK. Nominal Bandwidth 5 MHz. RB Size 6, RB Offset 0. Narrow band = 0, Position 1.

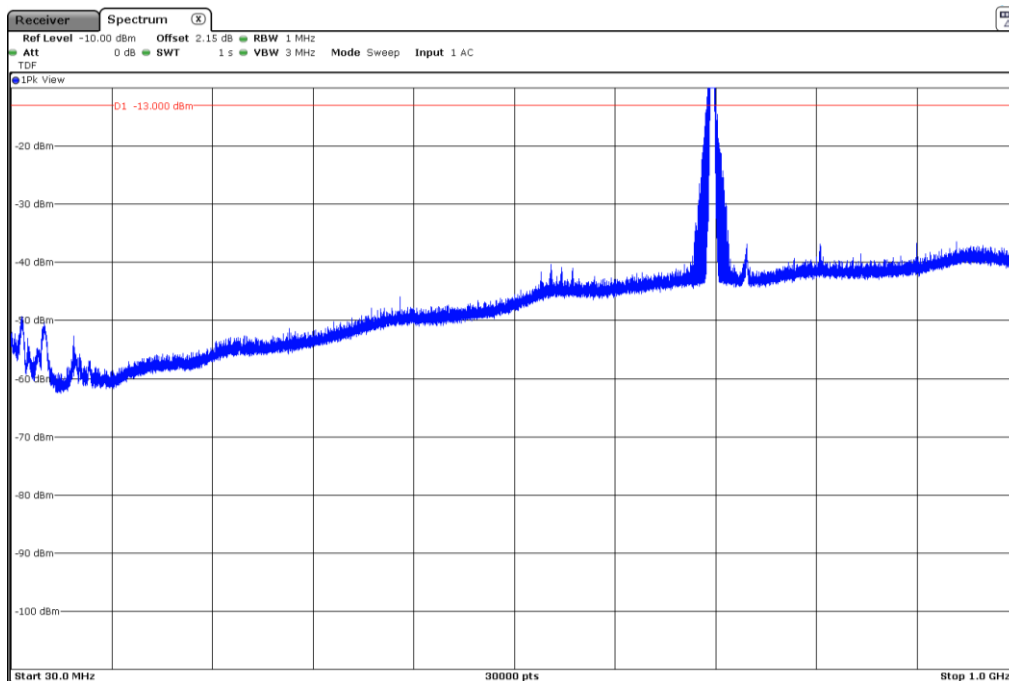
FREQUENCY RANGE 30 MHz - 1 GHz:

- Low Channel:



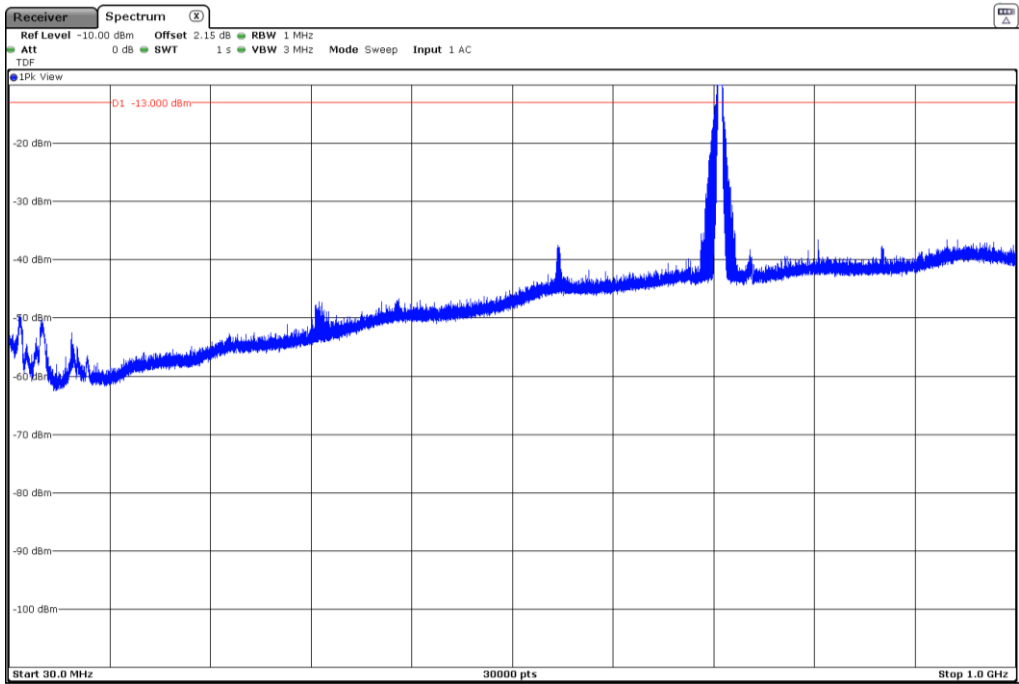
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

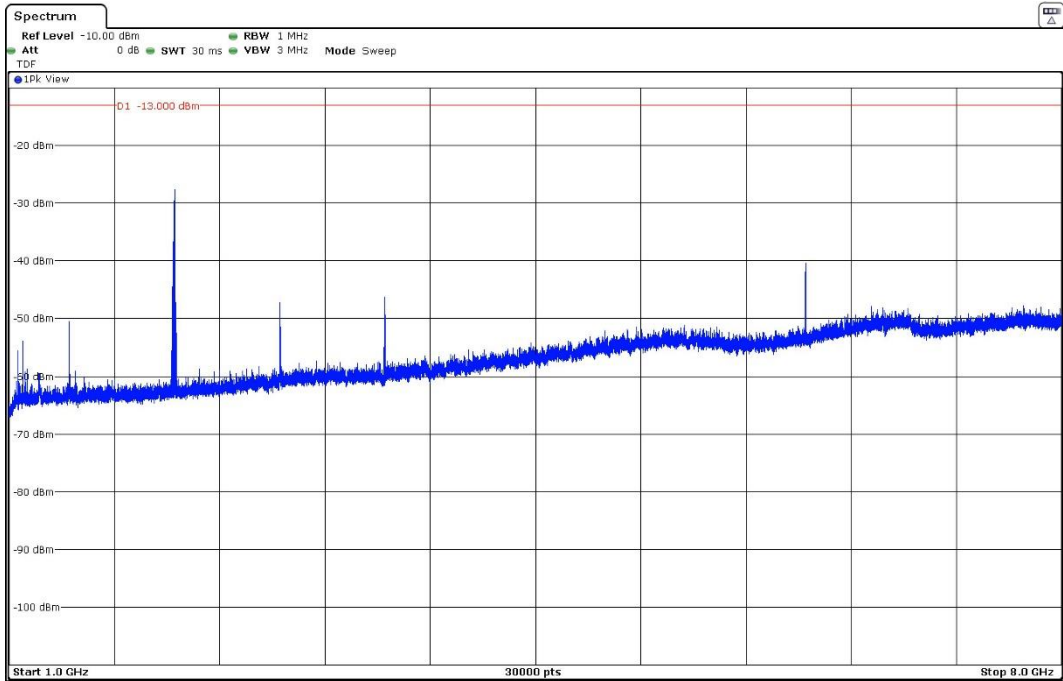
- High Channel:



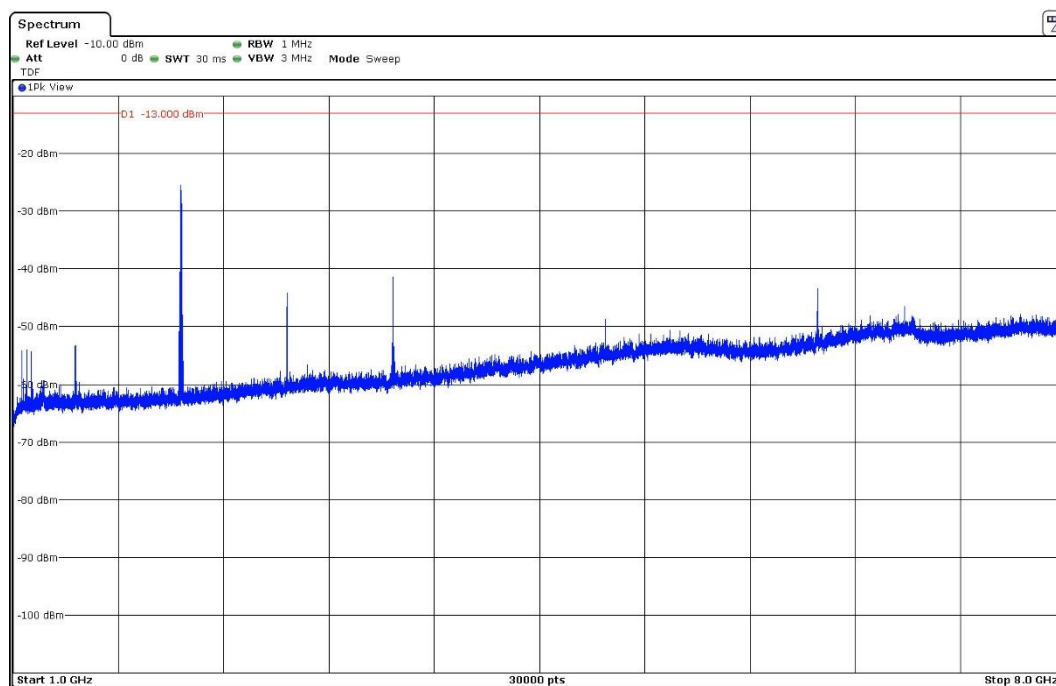
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 1 - 8 GHz:

- Low Channel:



- Middle Channel:



- High Channel:

