

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
82302RRF.003

Test Report

USA FCC Part 27

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

(*) Identification of item tested	LTE NB2 module
(*) Trademark	ST87M01
(*) Model and /or type reference	ST87M01
Other identification of the product	FCC ID: S9N-ST87M01 IC: 8976C-ST87M01
(*) Features	LTE NB2, GNSS HW version: MA_641 SW version: M:2.6.0
Applicant	ST Microelectronics SRL Via Camillo Olivetti n. 2 - 20864 Agrate Brianza (MB) - Italy
Test method requested, standard	USA FCC Part 27 (10-1-22 Edition). CANADA RSS-Gen Issue 5, April 2018, Amendment March 2019, Amendment February 2021. CANADA RSS-130 Issue 2, February 2019. CANADA RSS-139 Issue 4 September 2022, Amendment October 2022. ANSI C63.26-2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Manuel Gómez Galván EMC Consumer & RF Lab. Manager 
Date of issue	2025-09-29
Report template No.	FDT08_25 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, Company Number: 4621A, with the appropriate scope of accreditation that covers the performed tests in this report.

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

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Uncertainty

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

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample model ST87M01 is a Module for NB-IOT NB2 and GNSS.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results. The laboratory is not responsible for such information and it is not covered by accreditation.

Usage of samples

Samples undergoing test have been selected by: The client.

Id	Control Number	Description	Model	Serial N°	Date of Reception	Application
S/01	82302_1	Module Circuit Board	ST87M01	-	2025-03-03	Element Under Test
S/01	81088_2	Evaluation board	TEKIT 600- PTCRB0	-	2024-11-12	Auxiliary Element
S/02	82302_2	Module Circuit Board	ST87M01	-	2025-03-03	Element Under Test
S/02	78078_6	Antenna GPS	-	-	2024-02-16	Auxiliary Element
S/02	78078_8	Antenna	-	-	2024-02-16	Auxiliary Element

Notes referenced to samples during the project:

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

Test sample description

Ports.....:	Port name and description	Cable		
		Specified max length [m]	Attached during test	Shielded
	MAIN Antenna		☒	☒
	GNSS Antenna		☐	☐
Supplementary information to the ports.....:	-			
Rated power supply..... :	Voltage and Frequency			
	☒ DC: Min: 2.2V - Nom: 2.5 V - Max: 3V			
Rated Power	-			
Clock frequencies..... :	Reference clocks: 38.4MHz - 32 kHz			
Other parameters	Temperature: -40/+25/+85°C			
Software version	M: 2.6.0			
Hardware version	EVKITST87M01-1 - Version: LA_711			
Dimensions in cm (W x H x D)...	6 * 2* 8			
Mounting position	☒	Table top equipment		
	☐	Wall/Ceiling mounted equipment		
	☐	Floor standing equipment		
	☐	Hand-held equipment		
	☐	Other:		
Modules/parts	Module/parts of test item		Type	Manufacturer
	MA_633_EV_LA_711_#591/IMEI:352825350057562		Module	STMicroelectronic
	MA_633_EV_LA_711_#593/IMEI:352825350057885		Module	STMicroelectronic
	MA_633_EV_LA_711_#600/IMEI:352825350057893		Module	STMicroelectronic
	MA_633_EV_LA_711_#601/IMEI:352825350057653		Module	STMicroelectronic
	MA_633_EV_LA_711_#602/IMEI:352825350057729		Module	STMicroelectronic
Accessories (not part of the test item)..... :	Description		Type	Manufacturer
	-		-	-
Documents as provided by the applicant	Description		File name	Issue date
	EVKITST87M01-1 User Manual		EVKITST87M01	2024-06-18
	ST87MXX UM AT commands description		ST87MXX_UM_	2025-02-18
	DataSheet ST87M01			

Identification of the client

ST Microelectronics
10 Rue de Jouanet. 35700 RENNES. FRANCE

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2024-01-18
Date (finish)	2025-07-10

Document history

Report number	Date	Description
82302RRF.003	2025-09-29	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 semi-anechoic chamber, the following limits were not exceeded during the test:

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Antonio Maireles, Carmen Vázquez, Rafael Fernández, Pablo Redondo.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
7760	Digital Multimeter	175	FLUKE	2024-11
6157	Signal and Spectrum Analyzer 10 Hz - 40 GHz	FSV40	ROHDE AND SCHWARZ	2025-01
9227	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-07
6254	Attenuator 6 dB 2W DC-26.5 GHz	TWSMAG2	TECHNIWAVE	2024-03
6794	Shielded Room	S101	ETS LINDGREN	N/A
8002	TEMPERATURE CHAMBER MK56 BINDER	MK 56	BINDER	2024-04
6668	Signal and Spectrum Analyzer 10 Hz - 40 GHz	FSV40	ROHDE AND SCHWARZ	2024-12
9229	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-06
8849	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2025-10
6791	SEMIANECHOIC ABSORBER LINED	FACT 3 200 STP	ETS LINDGREN	N/A
6792	SHIELDED ROOM	S101	ETS LINDGREN	N/A
6143	Biconical/Log Antenna 30 MHz - 6 GHz	3142E	ETS LINDGREN	2027-01
6021	Attenuator 3 dB, 2W, DC-6GHz	50HN-03	JFW	2025-02
3783	PRE-AMPLIFIER G>30dB 1GHz-18GHz	BLMA 0118-3A	BONN ELEKTRONIK	2025-02
6496	HORN ANTENNA 1-18 GHz	BBHA 9120 D	SCHWARZBECK	2026-12
8856	PRE-AMPLIFIER G>30dB 18-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2025-01
4657	Horn Antenna 18-40 GHz	BBHA 9170	SCHWARZBECK MESS-ELEKTRONIK	2026-06
4848	SOFTWARE FOR EMC/RF TESTING	EMC32	ROHDE AND SCHWARZ	N/A

Testing verdicts

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

Summary

Appendix A: LTE Cat NB2 Bands 4, 12, 13, 66, 85.

FCC PART 27 / RSS-Gen, RSS-130, RSS-139		
Requirement – Test case	Verdict	Remark
FCC 27.50 / RSS-130 4.6, RSS-139 5.5: RF Output Power	P	
FCC 2.1047 / RSS-130 4.2, RSS-139 5.3: Modulation Characteristics	P	
FCC 27.54 / RSS-130 4.5, RSS-139 5.4: Frequency Stability	P	
FCC 2.1049 / RSS-Gen 6.7: Occupied Bandwidth	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Spurious Emissions at Antenna Terminals	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Spurious Emissions at Antenna Terminals at Block Edges	P	
FCC 27.53 / RSS-130 4.7, RSS-139 5.6: Radiated Emissions	P	
<u>Supplementary information and remarks:</u> None.		

Appendix B: Test results for FCC 27 / RSS-130, RSS-139: LTE Cat NB2 Bands 4, 12, 13, 66, 85

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TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

Vnominal: 2.5 Vdc.
 Vminimum: 2.2 Vdc
 Vmaximum: 3 Vdc

Type of Power Supply: Internal DC.

ANTENNA (*):

Low Bands	Gain (dBi)	Type of Antenna
LTE Cat NB2 Band 12	1	External
LTE Cat NB2 Band 13	1	External
LTE Cat NB2 Band 85	1	External
High Bands	Gain (dBi)	Type
LTE Cat NB2 Band 4	4.5	External
LTE Cat NB2 Band 66	4.5	External

TEST FREQUENCIES:

LTE Cat NB2 Band 4. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel. Number (Frequency. MHz)		
Low	Middle	High
19952 (1710.2)*	20175 (1732.5)	20398 (1754.8)*
*The outermost channel which is in compliance with Block edge testing.		

NOTE: LTE Cat NB2 Band 4 is completely included in LTE Cat NB2 Band 66, so the channels of LTE Cat NB2 Band 66 were tested to give conformity to the assigned block.

LTE Cat NB2 Band 12. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel. Number (Frequency. MHz)		
Low	Middle	High
23012 (699.20)*	23095 (707.5)	23179 (715.8)*
*The outermost channel which is in compliance with Block edge testing.		

NOTE: LTE Cat NB2 Band 12 is completely included in LTE Cat NB2 Band 85, so the channels of LTE Cat NB2 Band 85 were tested to give conformity to the assigned block.

LTE Cat NB2 Band 13. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel (Frequency. MHz)		
Low	Middle	High
23182 (777.20)*	23230 (782)	23278 (786.80)*
*The outermost channel which is in compliance with Block edge testing.		

LTE Cat NB2 Band 66. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel (Frequency. MHz)		
Low	Middle	High
131974 (1710.2)	132322 (1745)	132670 (1779.8)
*The outermost channel which is in compliance with Block edge testing.		

LTE Cat NB2 Band 85. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel (Frequency. MHz)		
Low	Middle	High
134004 (698.2)*	134092 (707)	134180 (715.8)*
*The outermost channel which is in compliance with Block edge testing.		

RF Output Power

Limits

1. LTE Cat NB2 Band 13. FCC §27.50 (b) (10) / RSS-130 4.6.

FCC §27.50 (b) (10):

Portable stations (hand-held devices) transmitting in the 746-757 MHz. 776-788 MHz. and 805-806 MHz bands are limited to 3 watts ERP.

RSS-130 4.6:

4.6.1 General

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

4.6.3 Frequency bands 698-756 MHz and 777-787 MHz

The e.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

2. LTE Cat NB2 Band 66. FCC §27.50 (d) / RSS-139 5.5.

FCC §27.50 (d):

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

(5) In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

RSS-139 Clause 5.5:

The maximum output power of the equipment shall comply with the limits specified below. In the tables, maximum power refers to the equivalent isotropically radiated power (e.i.r.p.) or total radiated power (TRP), measured in terms of average values.

The limits in this RSS are specified for the purpose of certification and may not apply to all deployment scenarios. Consult SRSP-513 and SRSP-519 for more details on the bands 2110-2180 MHz and 2180-2200 MHz respectively.

Table 3: Maximum power of equipment in the band 1710-1780 MHz

Equipment type	Maximum power
Fixed station and base station	30 dBm e.i.r.p./channel bandwidth
Subscriber equipment	30 dBm e.i.r.p./channel bandwidth

Table 4: Maximum power of equipment in the band 2110-2180 MHz

Equipment type	Maximum power
Non-AAS fixed station and base station	65 dBm e.i.r.p./MHz
AAS fixed station and base station	46 dBm TRP/MHz
Subscriber equipment	30 dBm e.i.r.p./channel bandwidth

Table 5: Maximum power of equipment in the band 2180-2200 MHz

Equipment type	Maximum power
Non-AAS base station	65 dBm e.i.r.p./MHz
AAS base station	46 dBm TRP/MHz

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

3. LTE Cat NB2 Band 85. FCC §27.50 (c) (10) / RSS-130 4.6.

FCC §27.50 (c) (10):

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

RSS-130 4.6:

4.6.1 General

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

4.6.3 Frequency bands 698-756 MHz and 777-787 MHz

The e.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

Method

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

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

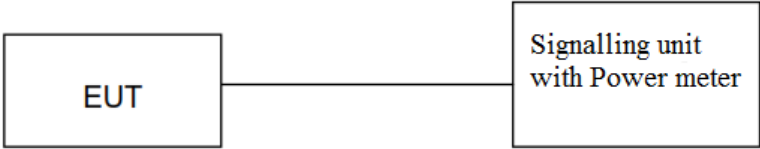
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

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

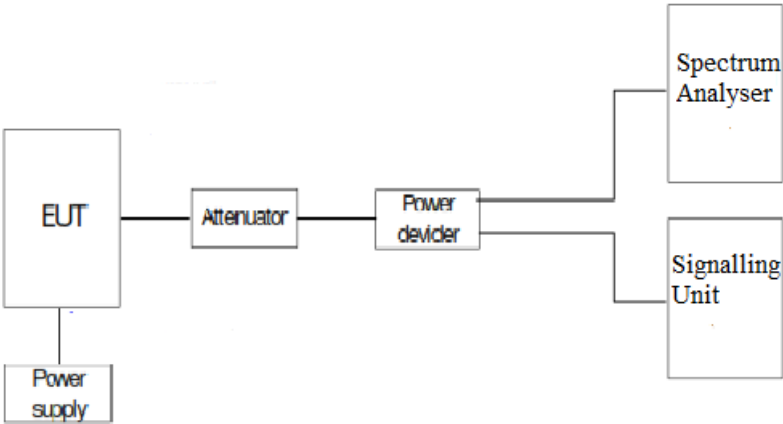
$$\text{E.R.P.} = \text{E.I.R.P.} - 2.15 \text{ dB}$$

Test Setup

1. CONDUCTED AVERAGE POWER:



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



Results

1. CONDUCTED AVERAGE POWER

LTE Cat NB2 Band 13:

CHANNEL	FREQUENCY (MHz)	MODULATION	BW	Tone Number	Tone Offset (Start SubCarrier)	MSC / TBS	AVERAGE POWER (dBm)
Low 23182	777.2 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.05
				1	47	0	22.02
			15 kHz	1	0	0	22.15
				1	11	0	22.24
		Pi/4-QPSK	3.75 kHz	1	0	3	22.05
				1	47	3	22.03
			15 kHz	1	0	3	22.20
				1	11	3	22.32
		QPSK	15 kHz	3	0	5	22.30
				3	6	5	22.41
				6	0	5	21.75
				6	6	5	21.78
High 23278	786.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.35
				1	47	0	22.26
			15 kHz	1	0	0	22.43
				1	11	0	22.53
		Pi/4-QPSK	3.75 kHz	1	0	3	22.32
				1	47	3	22.32
			15 kHz	1	0	3	22.5
				1	11	3	22.62
		QPSK	15 kHz	3	0	5	22.59
				3	6	5	22.71
				6	0	5	22.02
				6	6	5	22.05
				12	0	5	20.52

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22,41	1	23,41	21,26
HIGH	22,71	1	23,71	21,56
MAX:	22,71		23,71	21,56

LTE Cat NB2 Band 66:

CHANNEL	FREQUENCY (MHz)	MODULATION	BW	Tone Number	Tone Offset (Start SubCarrier)	MSC / TBS	AVERAGE POWER (dBm)
Low 131974	1710.2 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.07
				1	47	0	22.17
			15 kHz	1	0	0	22.16
				1	11	0	22.46
		Pi/4-QPSK	3.75 kHz	1	0	3	22.2
				1	47	3	22.23
			15 kHz	1	0	3	22.19
				1	11	3	22.32
		QPSK	15 kHz	3	0	5	22.43
				3	6	5	22.55
				6	0	5	21.67
				6	6	5	21.67
				12	0	5	20.68
Middle 132322	1745 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.03
				1	47	0	22.11
			15 kHz	1	0	0	22.35
				1	11	0	22.41
		Pi/4-QPSK	3.75 kHz	1	0	3	22.21
				1	47	3	22.17
			15 kHz	1	0	3	22.39
				1	11	3	22.64
		QPSK	15 kHz	3	0	5	22.51
				3	6	5	22.64
				6	0	5	21.85
				6	6	5	21.88
				12	0	5	20.72
High 132670	1779.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.06
				1	47	0	22.03
			15 kHz	1	0	0	22.26
				1	11	0	22.41
		Pi/4-QPSK	3.75 kHz	1	0	3	22.14
				1	47	3	22.18
			15 kHz	1	0	3	22.4
				1	11	3	22.53
		QPSK	15 kHz	3	0	5	22.45
				3	6	5	22.57
				6	0	5	21.81
				6	6	5	21.84
				12	0	5	20.67

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22,55	4,5	27,05	24,9
MIDDLE	22,64	4,5	27,14	24,99
HIGH	22,57	4,5	27,07	24,92
MAX:	22,64		27,14	24,99

LTE Cat NB2 Band 85:

CHANNEL	FREQUENCY (MHz)	MODULATION	BW	Tone Number	Tone Offset (Start SubCarrier)	MSC / TBS	AVERAGE POWER (dBm)
Low 134004	698.2 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	21.88
				1	47	0	21.89
			15 kHz	1	0	0	21.44
				1	11	0	21.54
		Pi/4-QPSK	3.75 kHz	1	0	3	21.95
				1	47	3	21.94
			15 kHz	1	0	3	21.51
				1	11	3	21.64
		QPSK	15 kHz	3	0	5	22.31
				3	6	5	22.43
				6	0	5	21.76
				6	6	5	21.79
				12	0	5	20.72
Middle 134092	707 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.27
				1	47	0	22.26
			15 kHz	1	0	0	21.99
				1	11	0	22.14
		Pi/4-QPSK	3.75 kHz	1	0	3	22.34
				1	47	3	22.33
			15 kHz	1	0	3	22.11
				1	11	3	22.24
		QPSK	15 kHz	3	0	5	22.64
				3	6	5	22.75
				6	0	5	22.26
				6	6	5	22.27
				12	0	5	21.23
High 134180	715.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.22
				1	47	0	22.21
			15 kHz	1	0	0	21.91
				1	11	0	22.03
		Pi/4-QPSK	3.75 kHz	1	0	3	22.28
				1	47	3	22.27
			15 kHz	1	0	3	22.02
				1	11	3	22.1
		QPSK	15 kHz	3	0	5	22.51
				3	6	5	22.64
				6	0	5	22.18
				6	6	5	22.18
				12	0	5	21.13

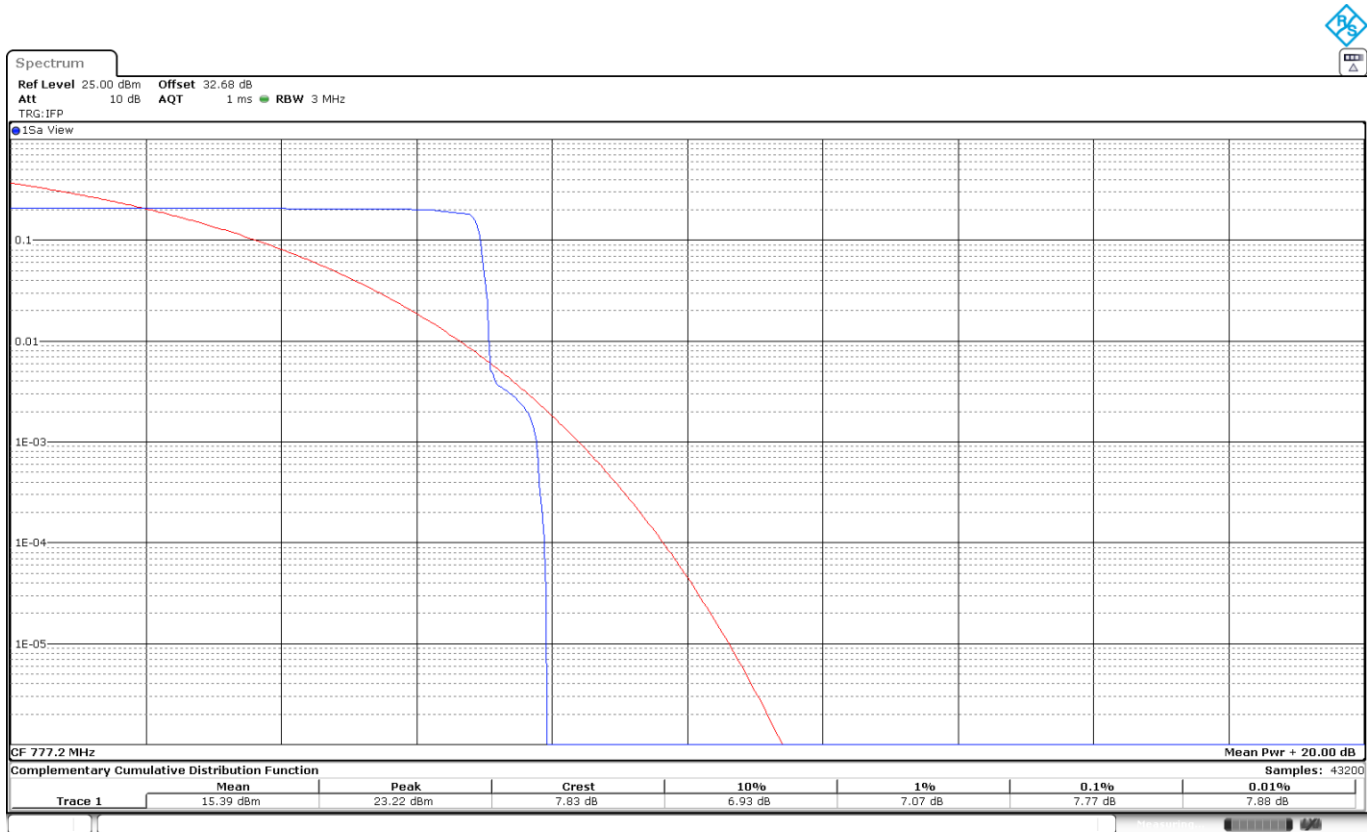
MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.43	1	23,43	21,28
MIDDLE	22.75	1	23,75	21,6
HIGH	22.64	1	23,64	21,49
MAX:	22.75		23,75	21,6

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

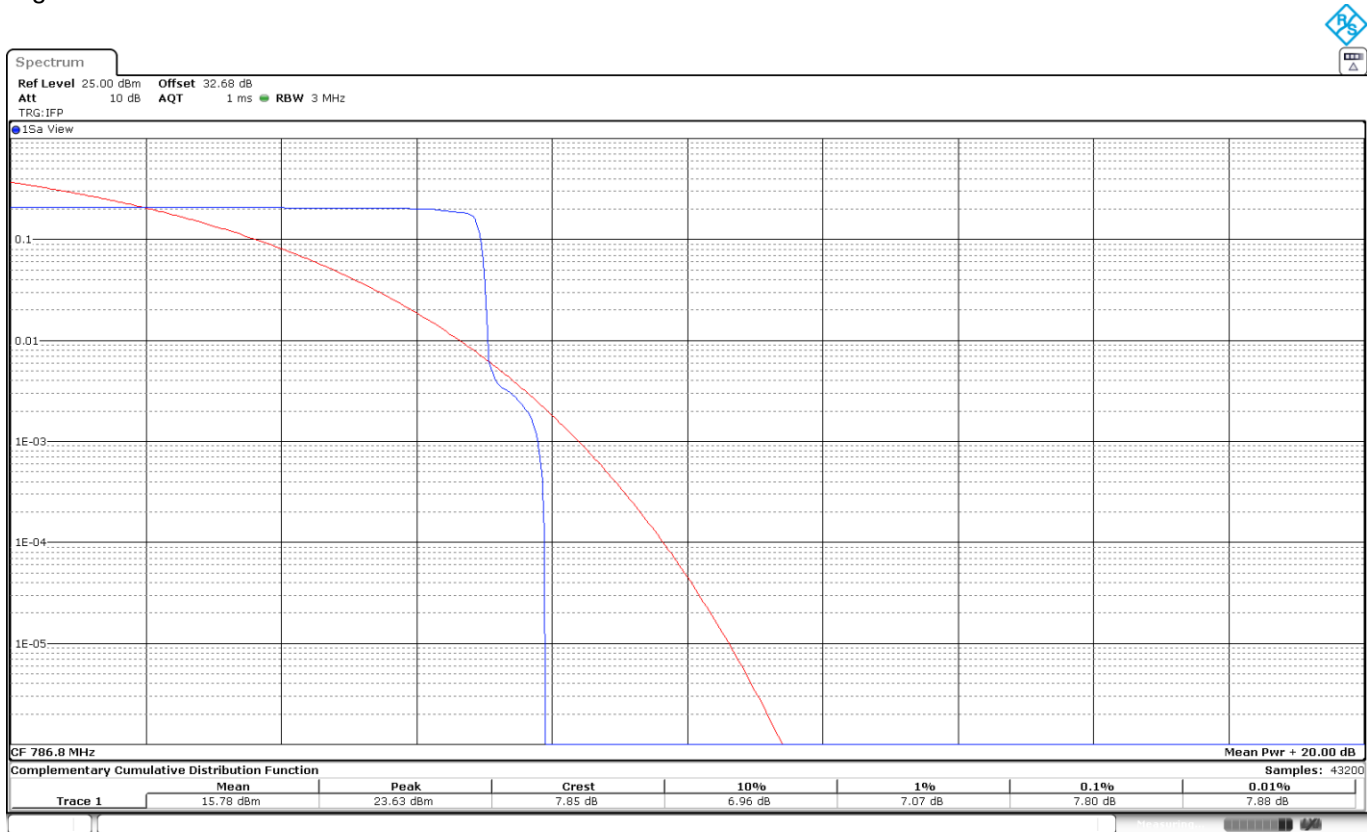
LTE Cat NB2 Band 13:

Worst-case of PAPR is High Channel. Pi/4-QPSK. BW=15 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.

Low Channel:



High Channel:



QPSK	Low	High
PAPR (dB)	7.77	7.8

Measurement uncertainty (dB) <±1.11

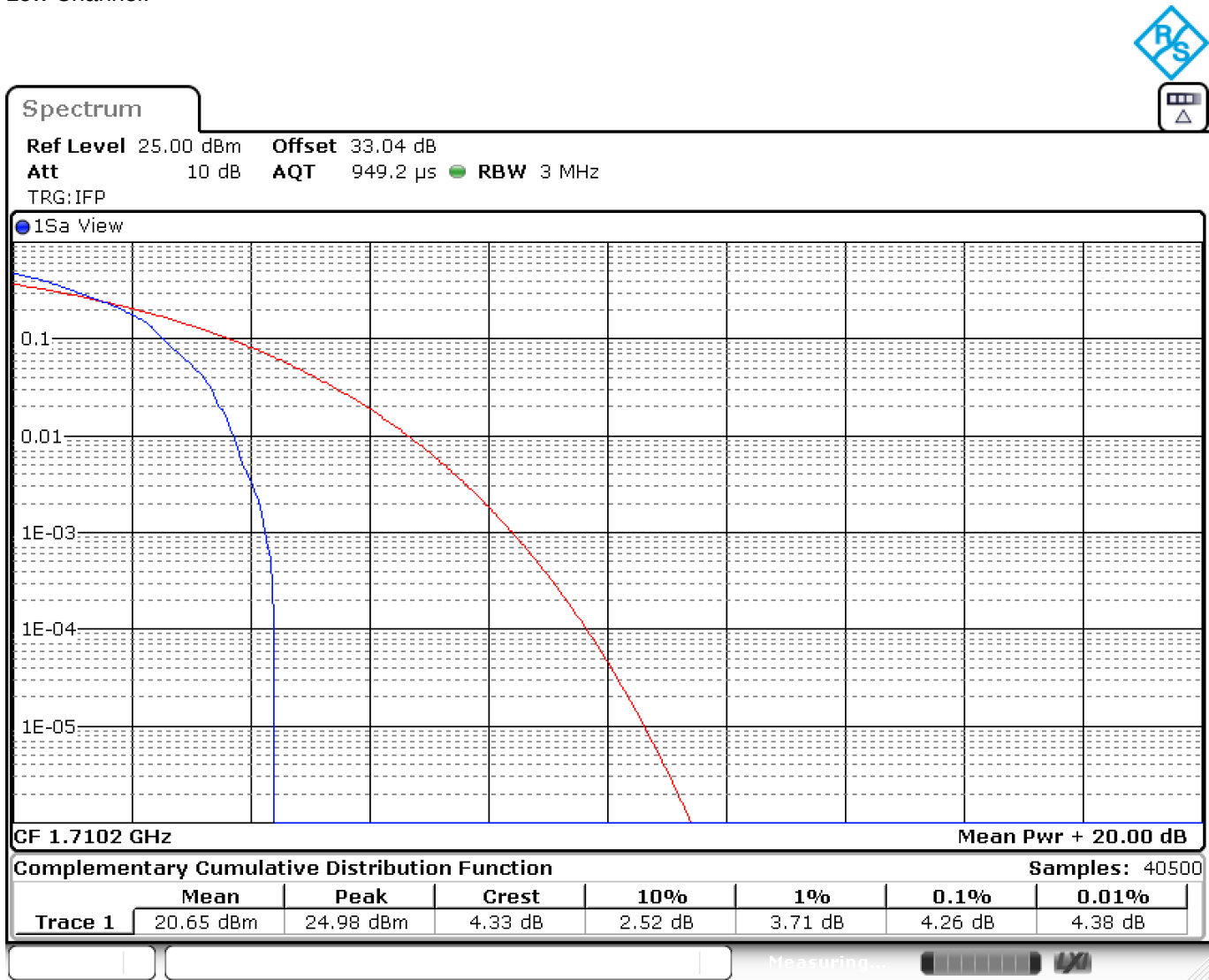
Verdict

Pass

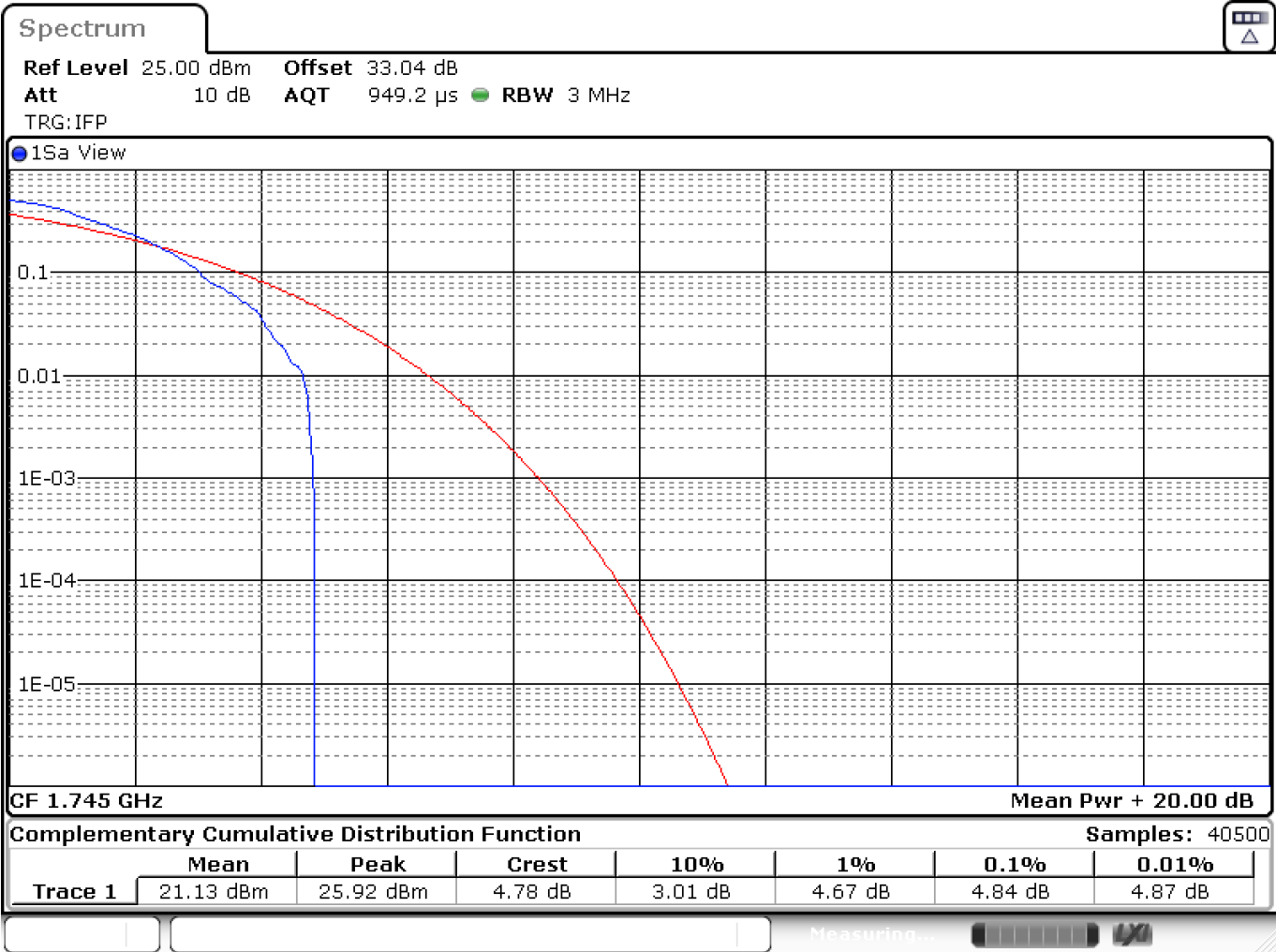
LTE Cat NB2 Band 66:

Worst-case of PAPR is Middle Channel. QPSK. BW=15 kHz. Tone Number=6. Tone Offset=0. MSC/TBS=5.

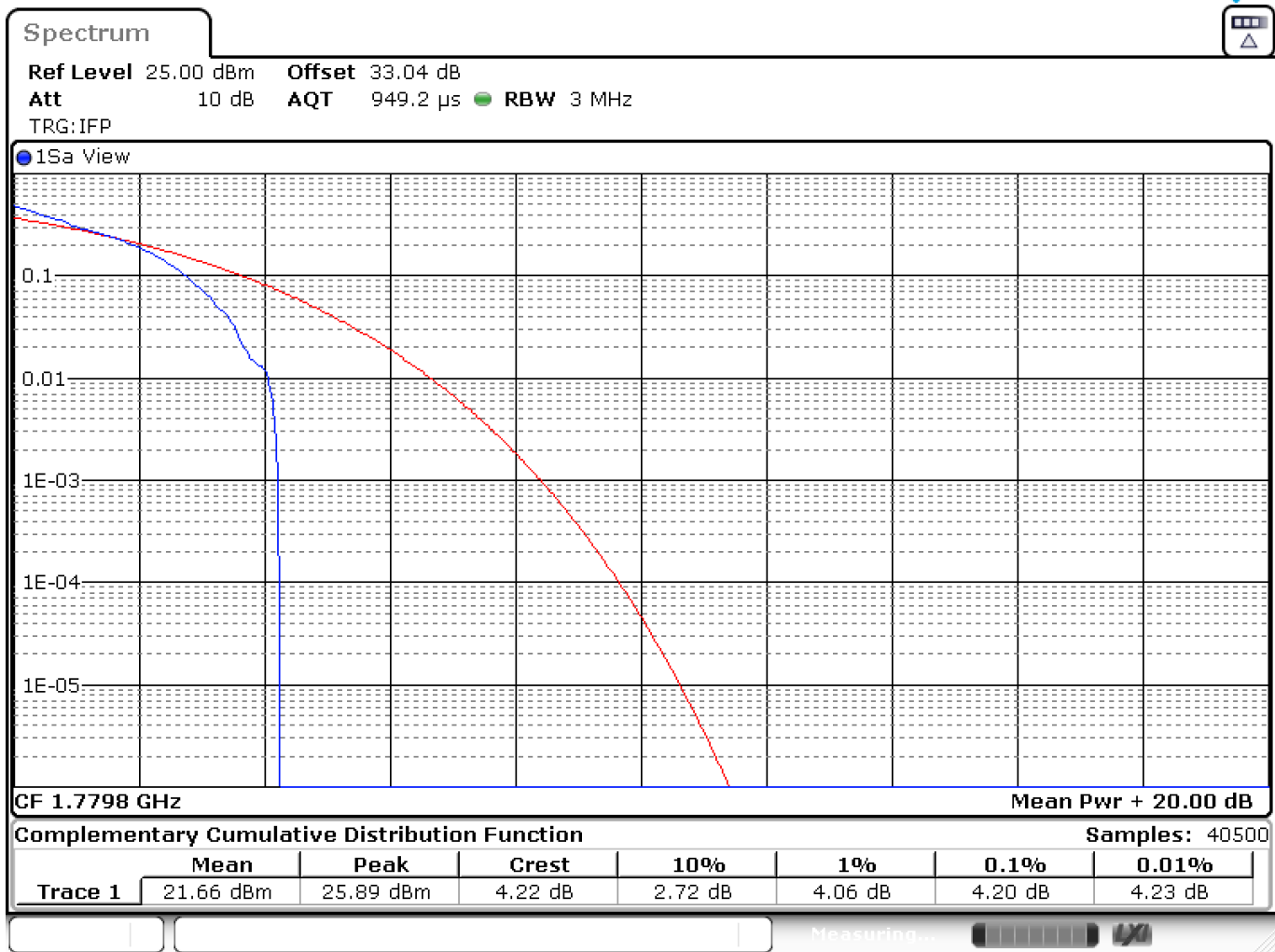
Low Channel:



Middle Channel:



High Channel:



QPSK	Low	Middle	High
PAPR (dB)	4.26	4.84	4.2

Measurement uncertainty (dB) <±1.11

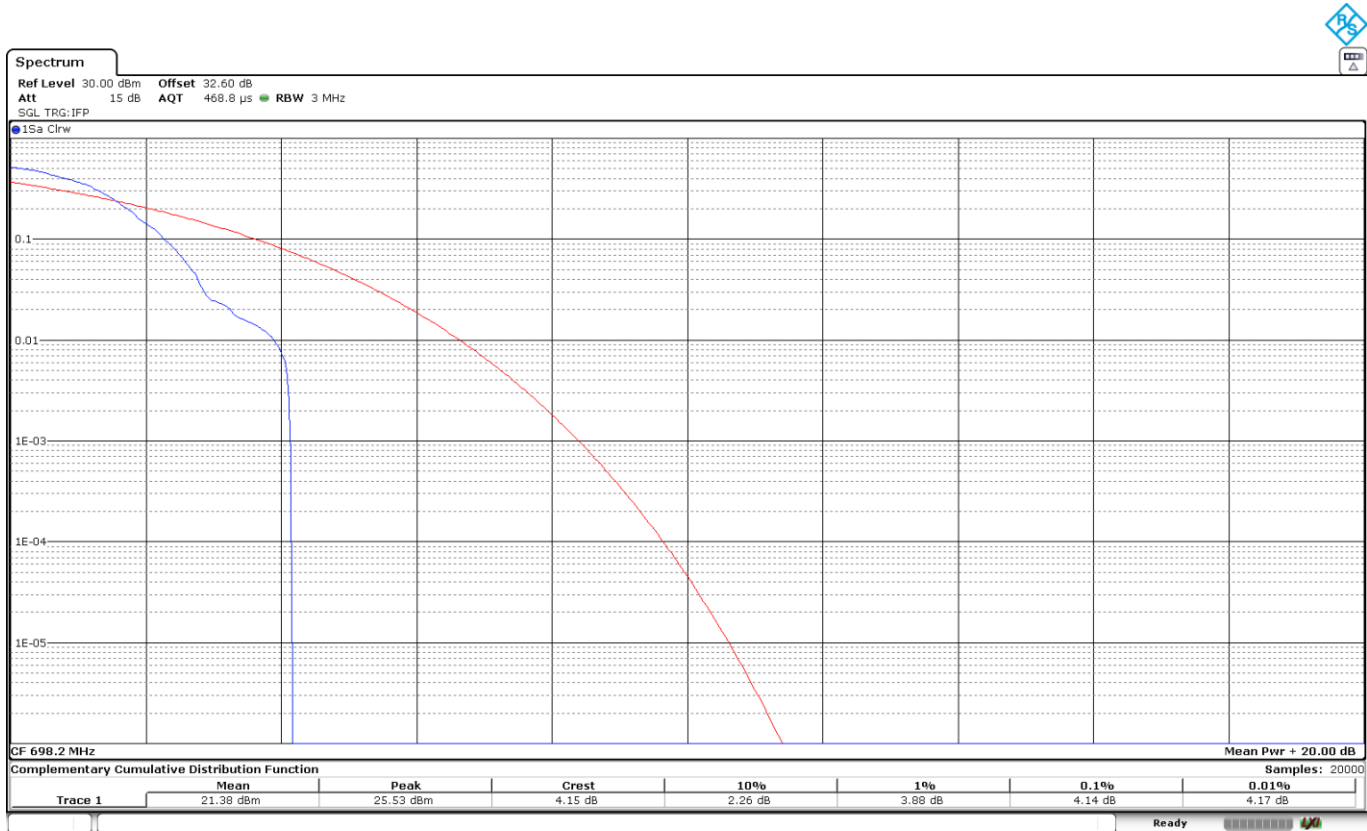
Verdict

Pass

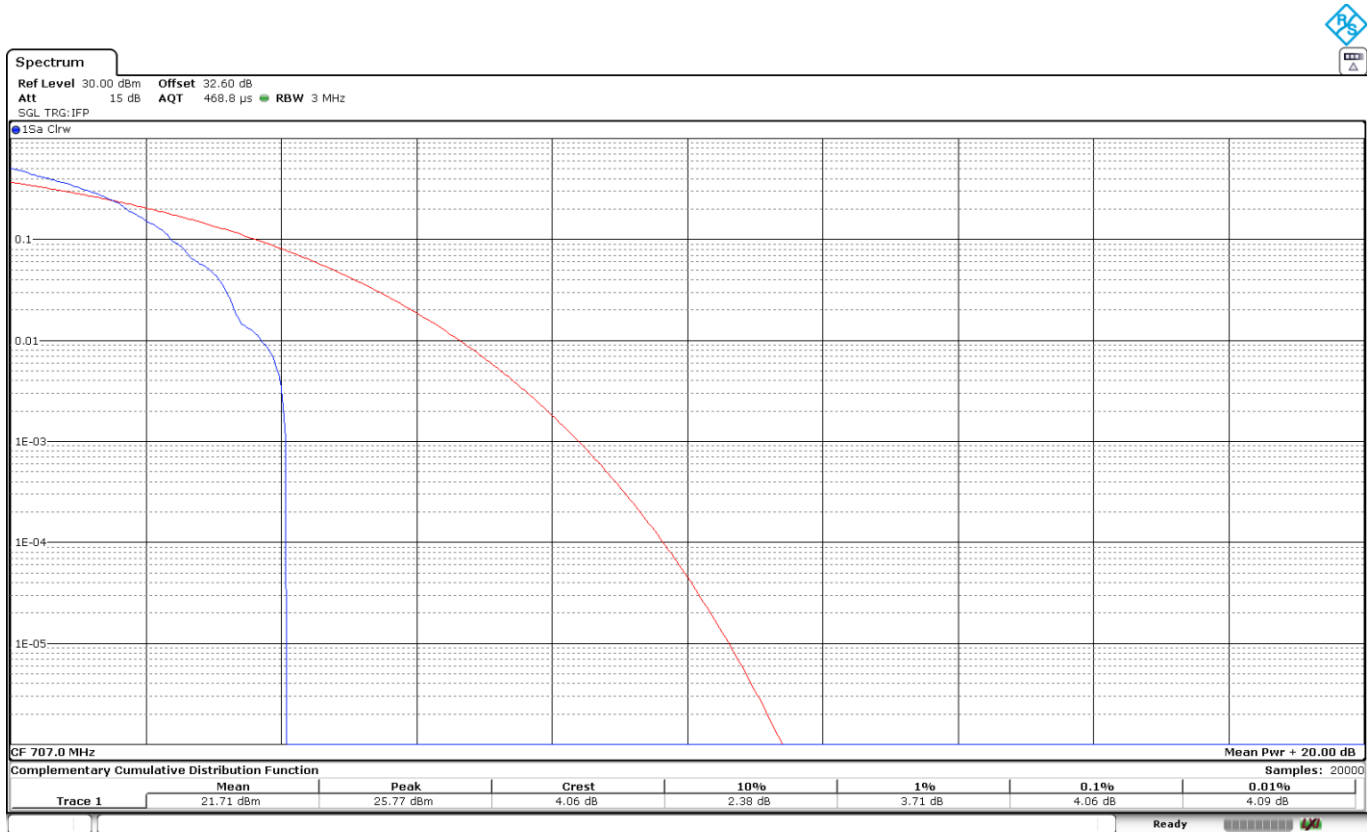
LTE Cat NB2 Band 85:

Worst-case of PAPR is Low Channel. QPSK. BW=15 kHz. Tone Number=6. Tone Offset=0. MSC/TBS=5.

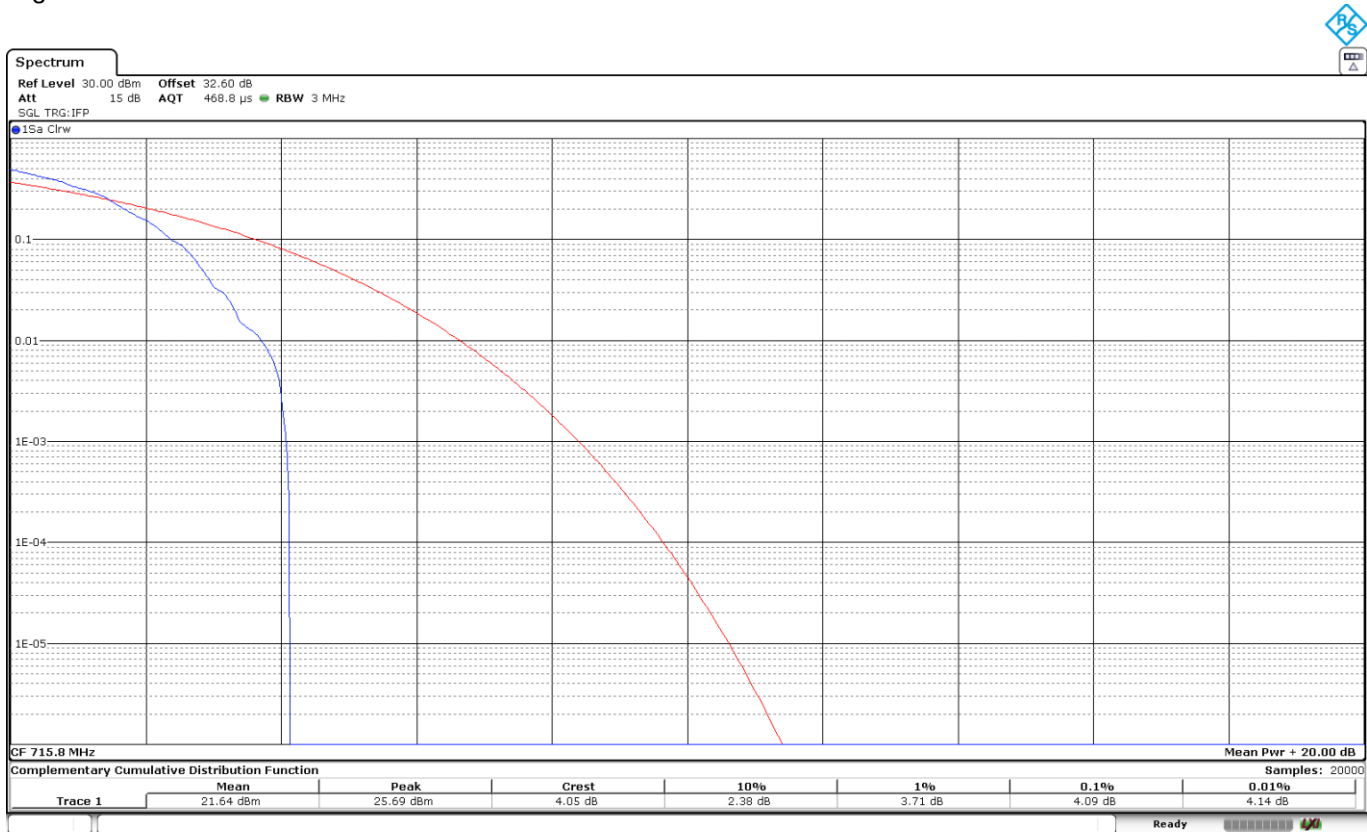
Low Channel:



Middle Channel:



High Channel:



QPSK	Low	Middle	High
PAPR (dB)	4.14	4.06	4.09

Measurement uncertainty (dB) <±1.11

Verdict

Pass

Frequency Stability

Limits

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

* RSS-130. Clause 4.5 & RSS-139. 5.4. The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block or frequency block group when tested to the temperature and supply voltage variations specified in RSS-Gen.

Method

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

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

Temperature and voltage range of testing has been extended to the maximum and minimum values declared by customer.

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

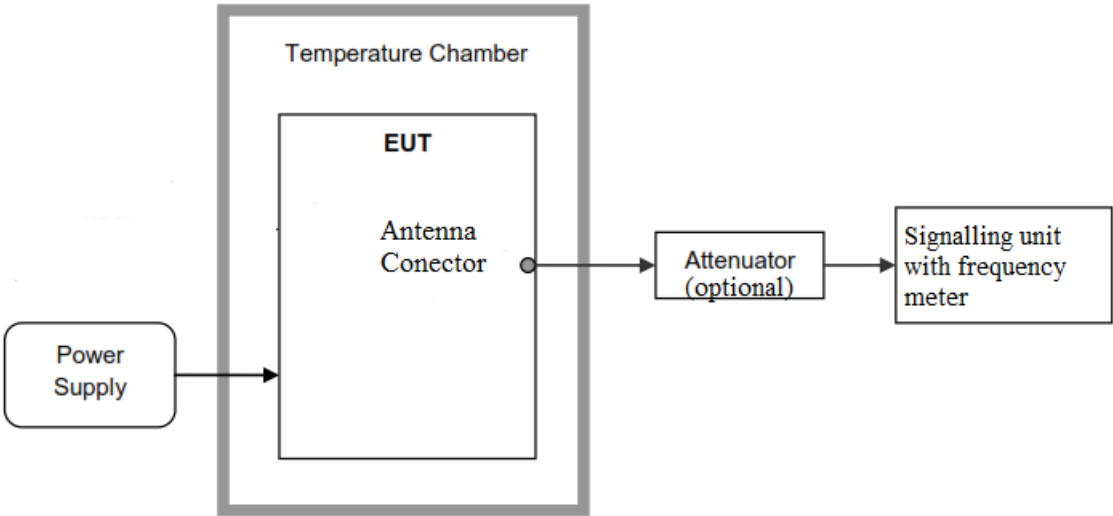
The worst case LTE mode for conducted power was used for the test.

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

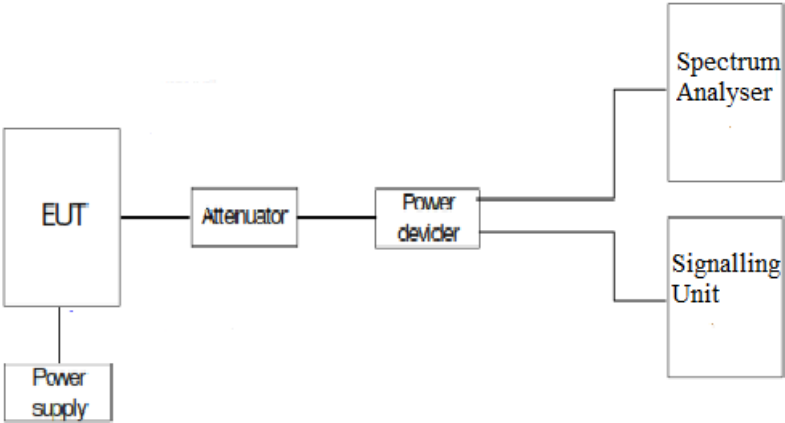
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance.



Reference points f_L and f_H .



Results

1. FREQUENCY TOLERANCE:

- Frequency stability over temperature variations:

LTE Cat NB2 Band 13:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85	-9.81	-0.012544757
+80	-8.72	-0.011150895
+70	-7.44	-0.009514066
+60	-9.92	-0.012685422
+50	4.01	0.005127877
+40	-4.11	-0.005255754
+30	2.18	0.002787724
+20	-2.7	-0.003452685
+10	1.73	0.002212276
0	3.33	0.004258312
-10	-3.34	-0.0042711
-20	-5.55	-0.007097187
-30	-7.62	-0.009744246
-40	-5.59	-0.007148338

LTE Cat NB2 Band 66:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85	34.56	0.019805158
+80	28.02	0.016057307
+70	26.61	0.015249284
+60	42.29	0.024234957
+50	32.11	0.018401146
+40	27.68	0.015862464
+30	24.46	0.014017192
+20	29.23	0.016750716
+10	29.67	0.017002865
0	33.06	0.018945559
-10	33.16	0.019002865
-20	21.4	0.01226361
-30	25.43	0.014573066
-40	28.07	0.01608596

LTE Cat NB2 Band 85:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+85	3.55	0.005021216
+80	3.04	0.004299859
+70	2.75	0.003889675
+60	3.53	0.004992928
+50	-3.38	-0.004780764
+40	1.53	0.002164074
+30	-4.56	-0.006449788
+20	-2.56	-0.003620934
+10	-2.53	-0.003578501
0	1.46	0.002065064
-10	2.06	0.00291372
-20	2.78	0.003932107
-30	2.34	0.00330976
-40	3.12	0.004413013

- **Frequency stability over voltage variations:**

LTE Cat NB2 Band 13:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3	-3.49	-0.004462916
Vmin	2.2	-8.54	-0.010920716

LTE Cat NB2 Band 66:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3	26.64	0.015266476
Vmin	2.2	22.99	0.013174785

LTE Cat NB2 Band 85:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3	0.86	0.001216407
Vmin	2.2	2.62	0.003705799

2. REFERENCE FREQUENCY POINTS f_L AND f_H :

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

LTE Cat NB2 Band 13:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

f_L (MHz)	777.000321
f_H (MHz)	786.999696

LTE Cat NB2 Band 66:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

f_L (MHz)	1710.033400
f_H (MHz)	1779.933000

LTE Cat NB2 Band 85:

The worst case modulation in terms of Frequency Stability is QPSK. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

f_L (MHz)	698.0395
f_H (MHz)	715.9690

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

Measurement uncertainty (Hz): $<\pm 211.77$

Verdict

PASS

Modulation Characteristics

Limits

FCC §2.1047.

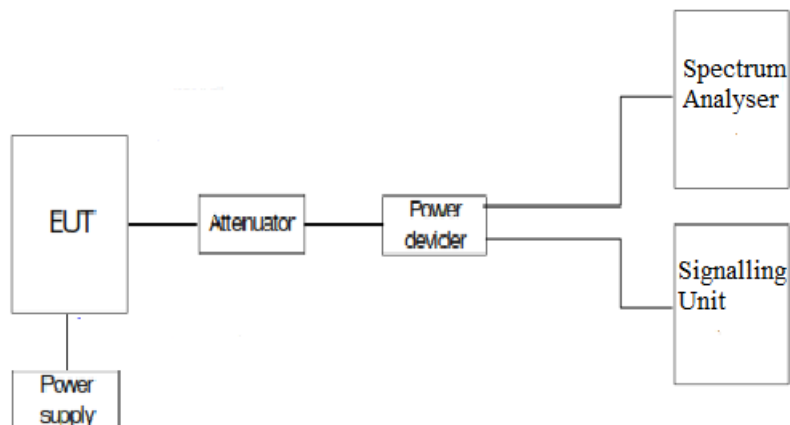
RSS-130. Clause 4.2: Equipment certified under this standard shall employ digital modulation.

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 NB2 the EUT operates with $\pi/2$ -BPSK, $\pi/4$ -QPSK and QPSK modulations in which the information is digitized and coded into a bit stream.

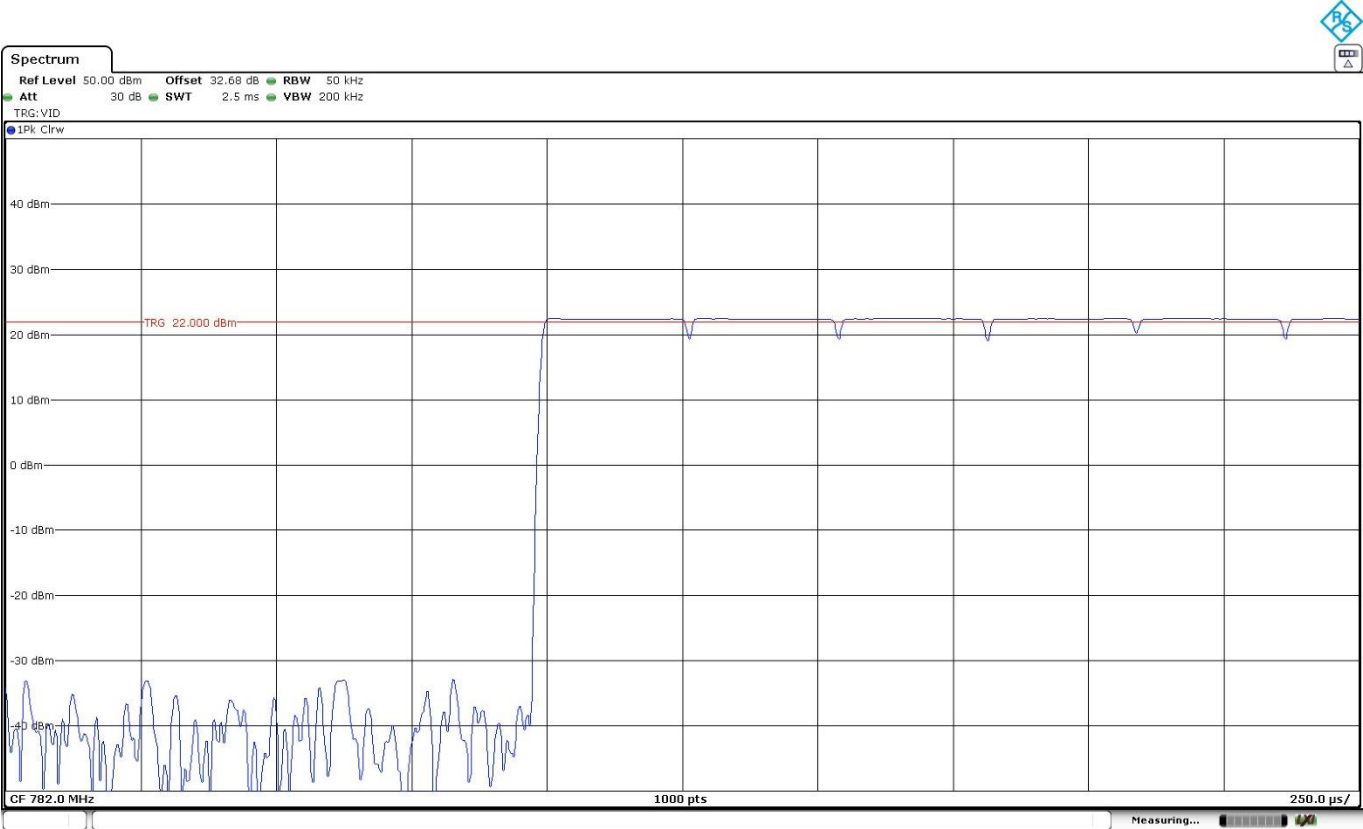
Test Setup



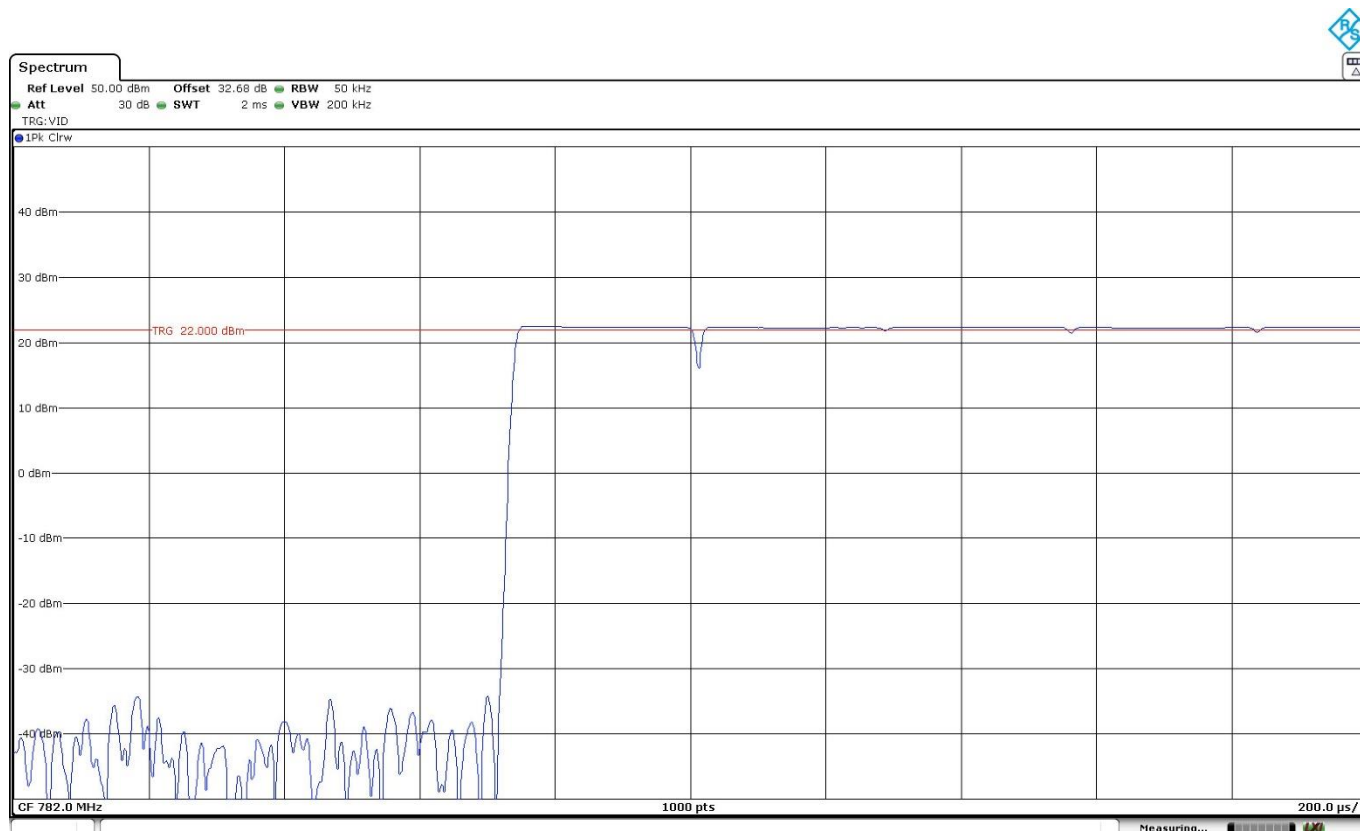
Results

The following plot shows the modulation schemes in the EUT.

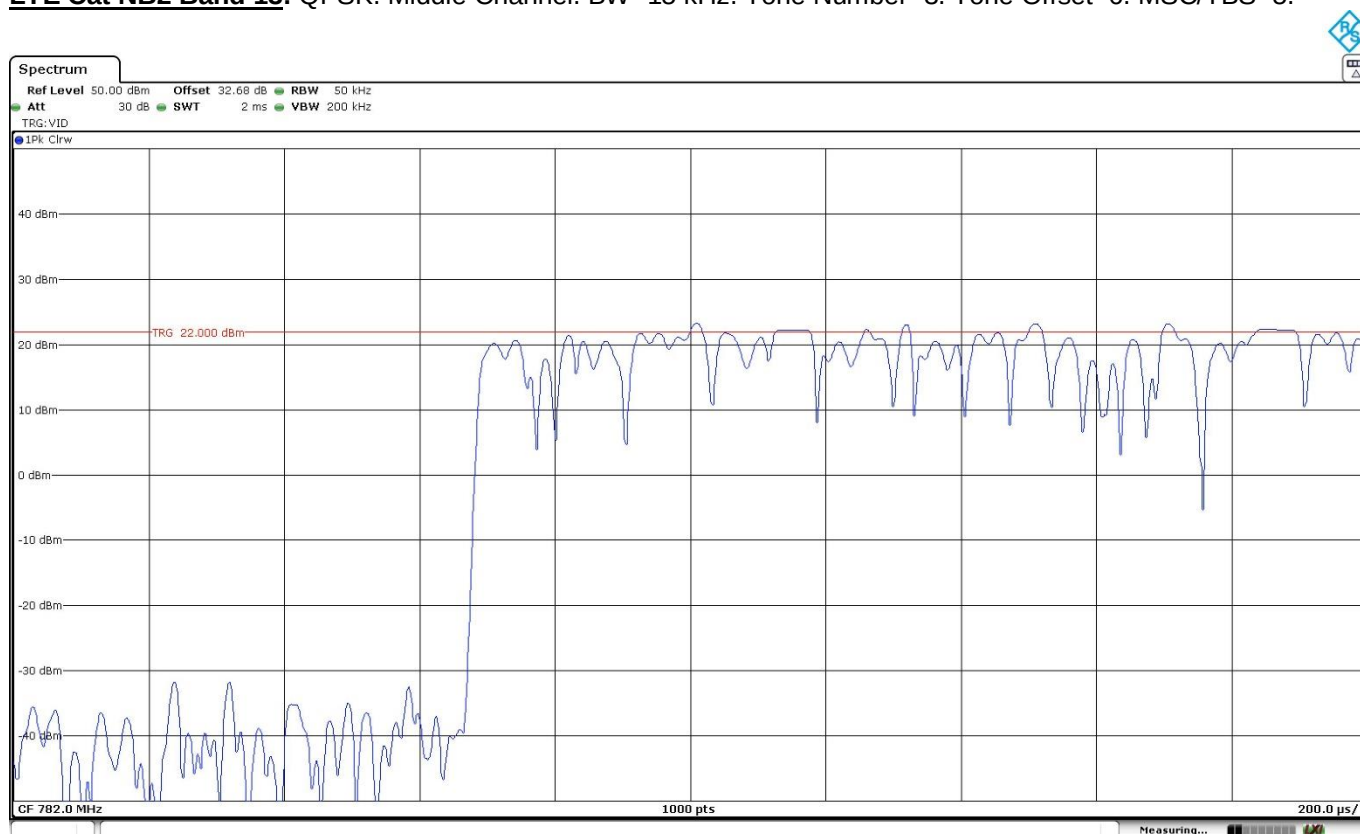
LTE Cat NB2 Band 13: Pi/2-BPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=0.



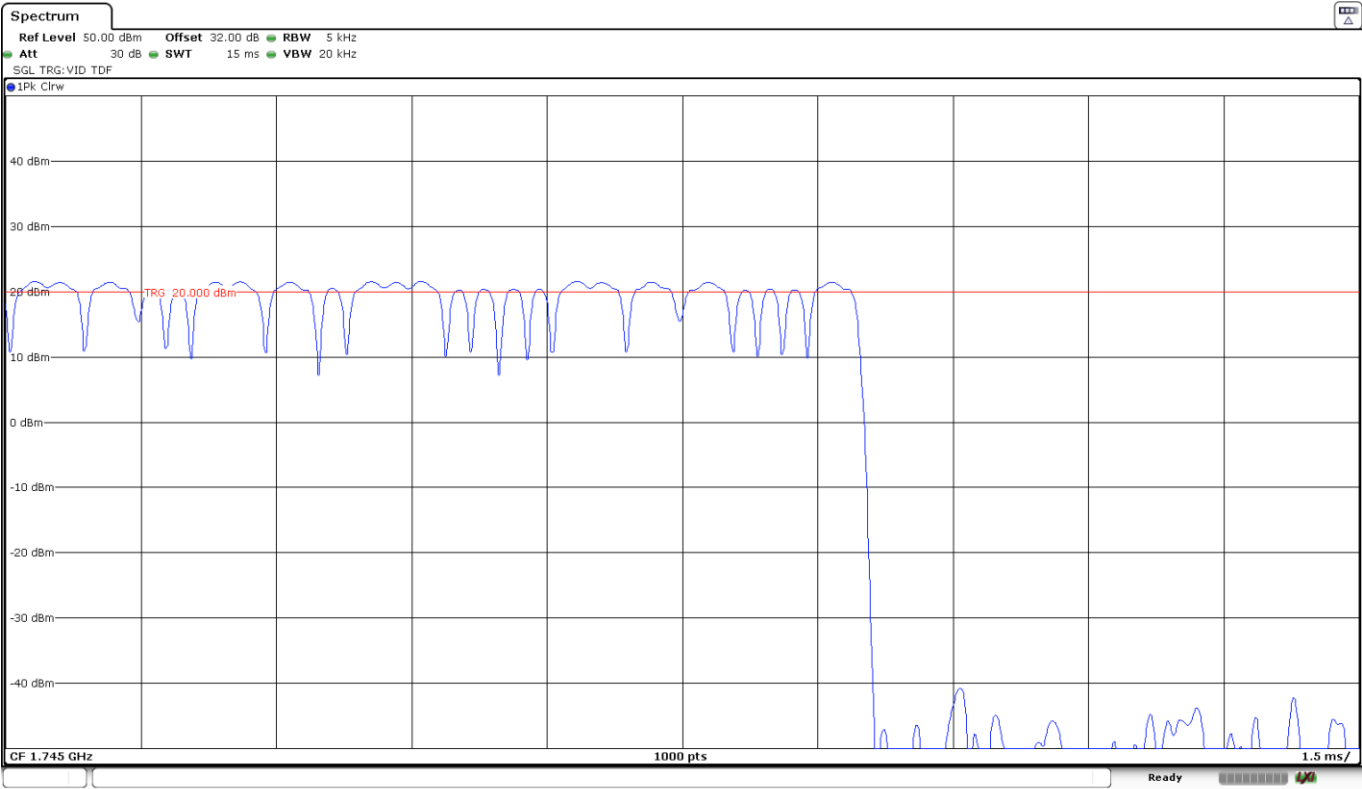
LTE Cat NB2 Band 13: Pi/4-QPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=3.



LTE Cat NB2 Band 13: QPSK. Middle Channel. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.

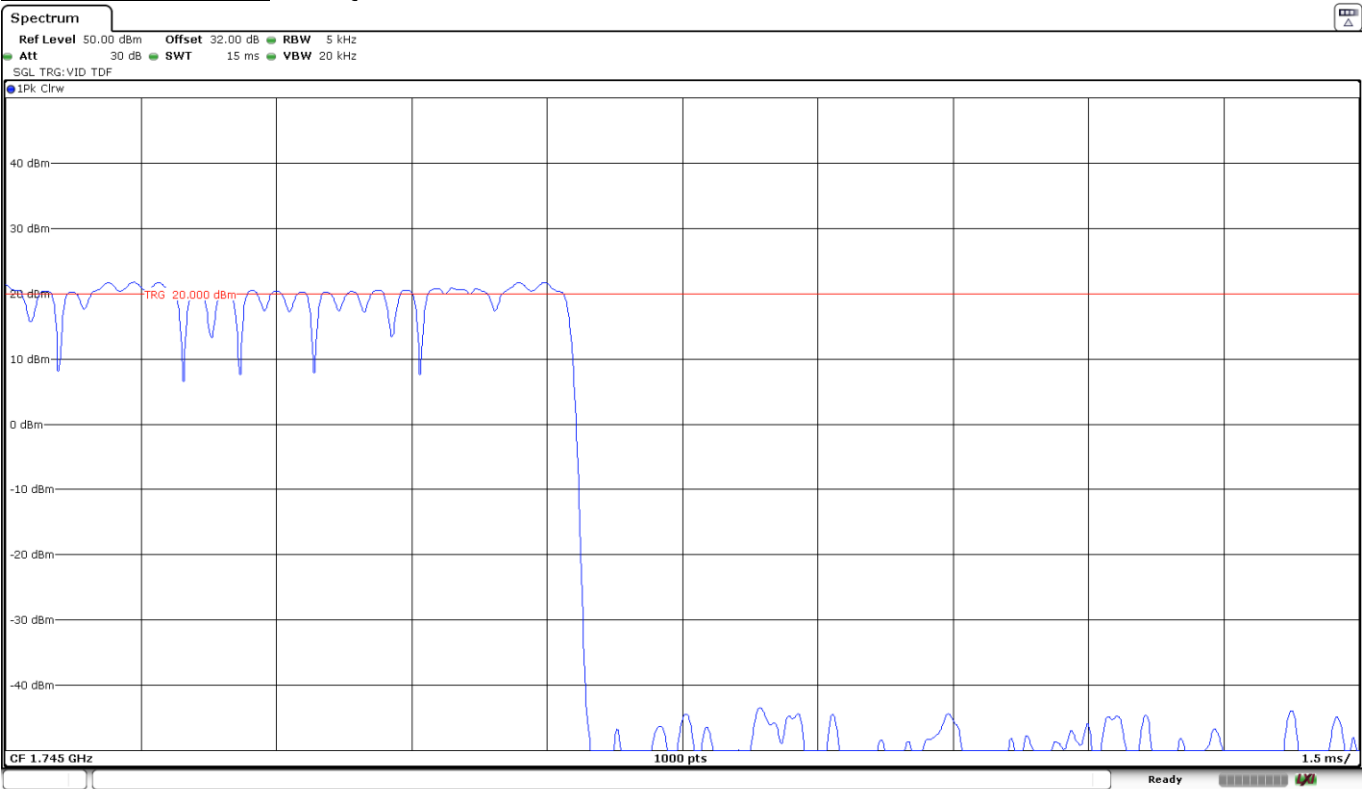


LTE Cat NB2 Band 66: Pi/2-BPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=0.



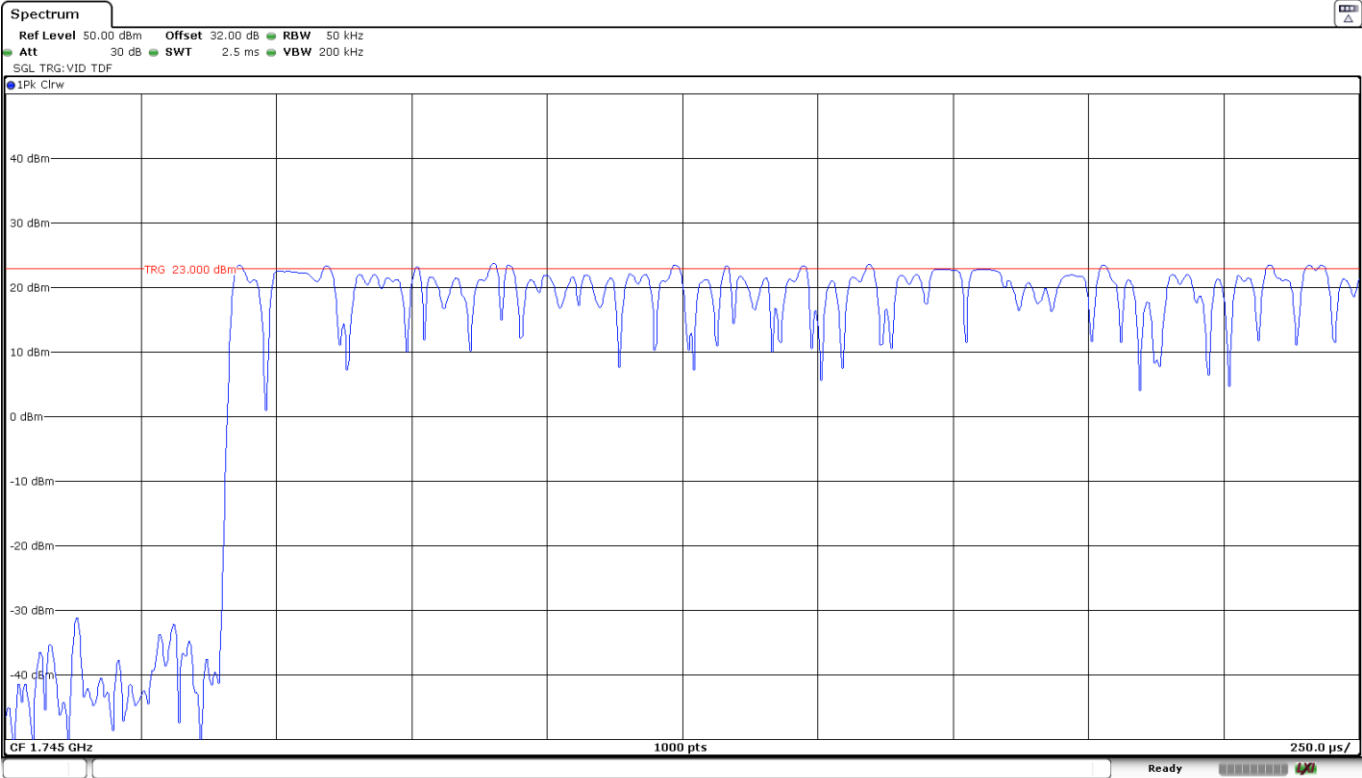
Date: 21.MAR.2025 03:26:41

LTE Cat NB2 Band 66: Pi/4-QPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=3.



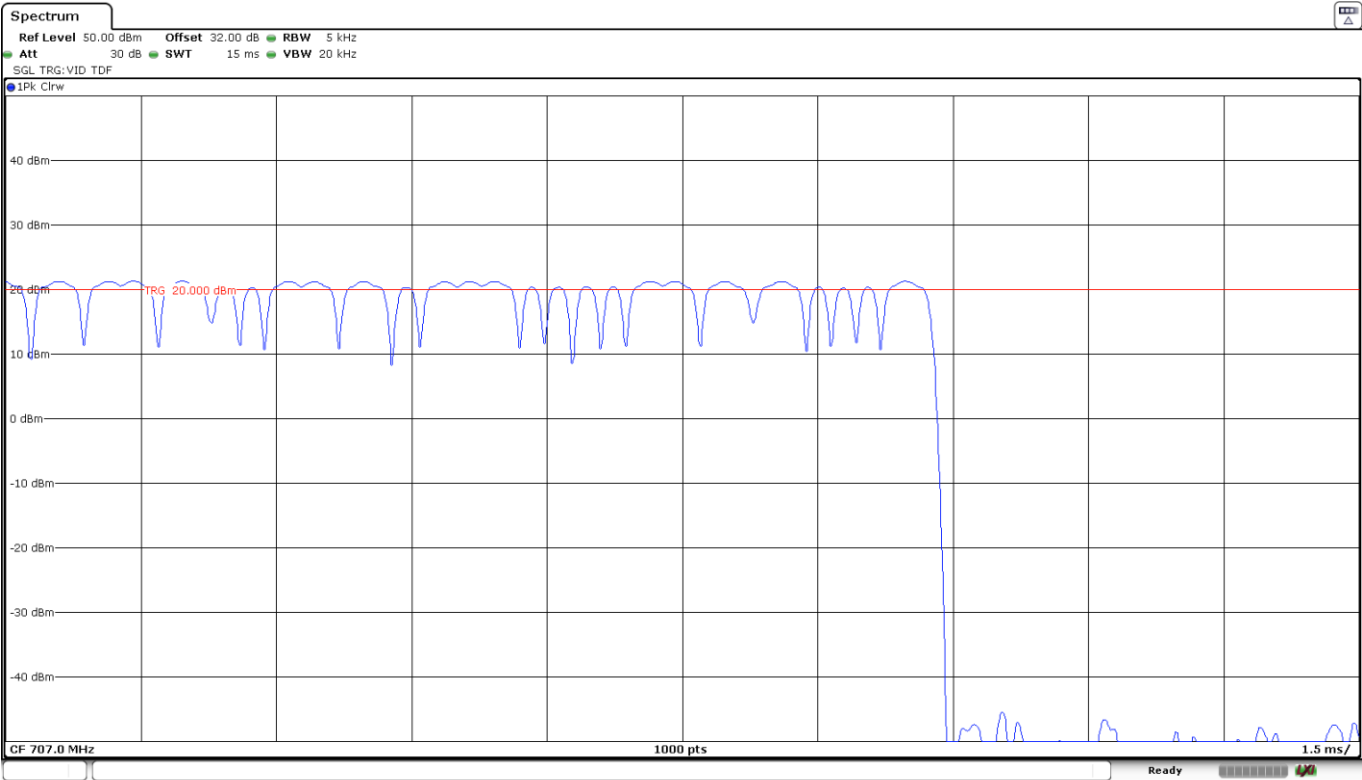
Date: 21.MAR.2025 03:27:17

LTE Cat NB2 Band 66: QPSK. Middle Channel. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.



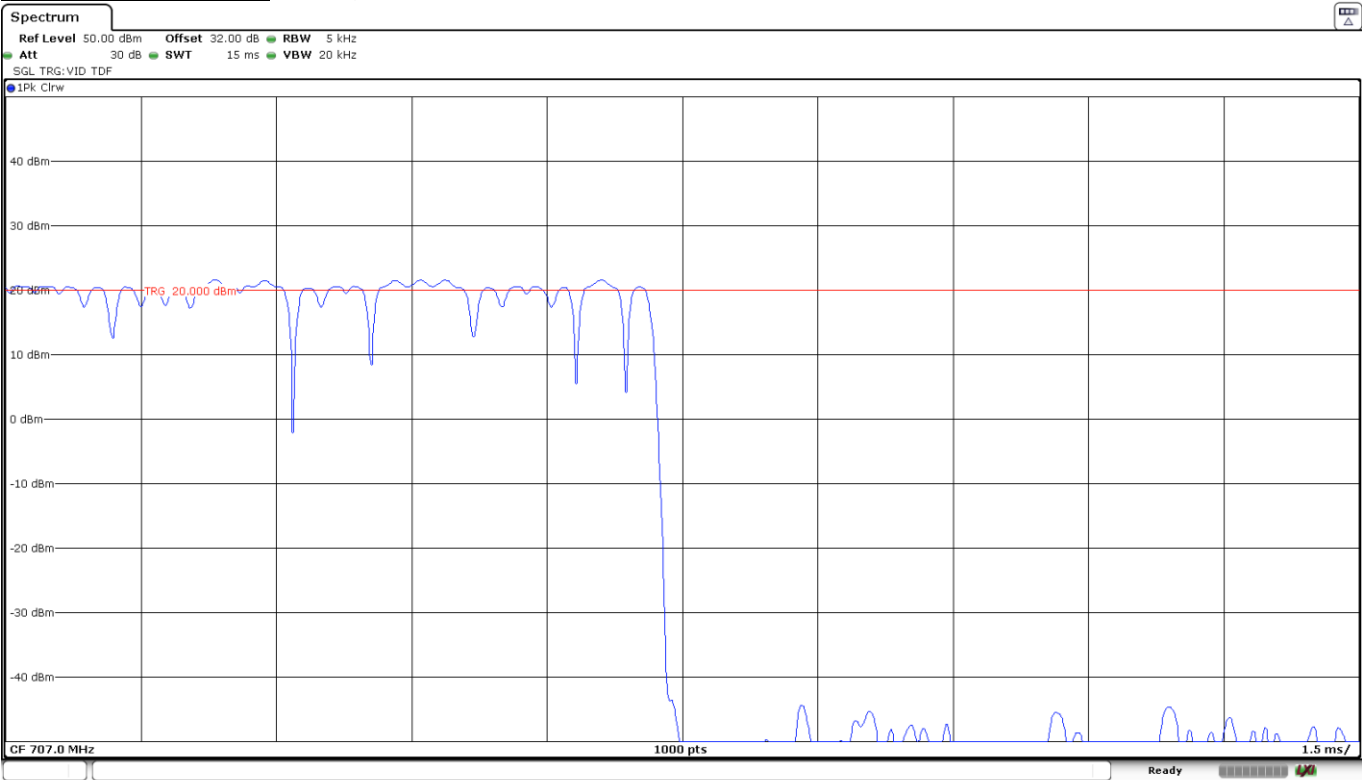
Date: 21.MAR.2025 03:29:13

LTE Cat NB2 Band 85: Pi/2-BPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=0.



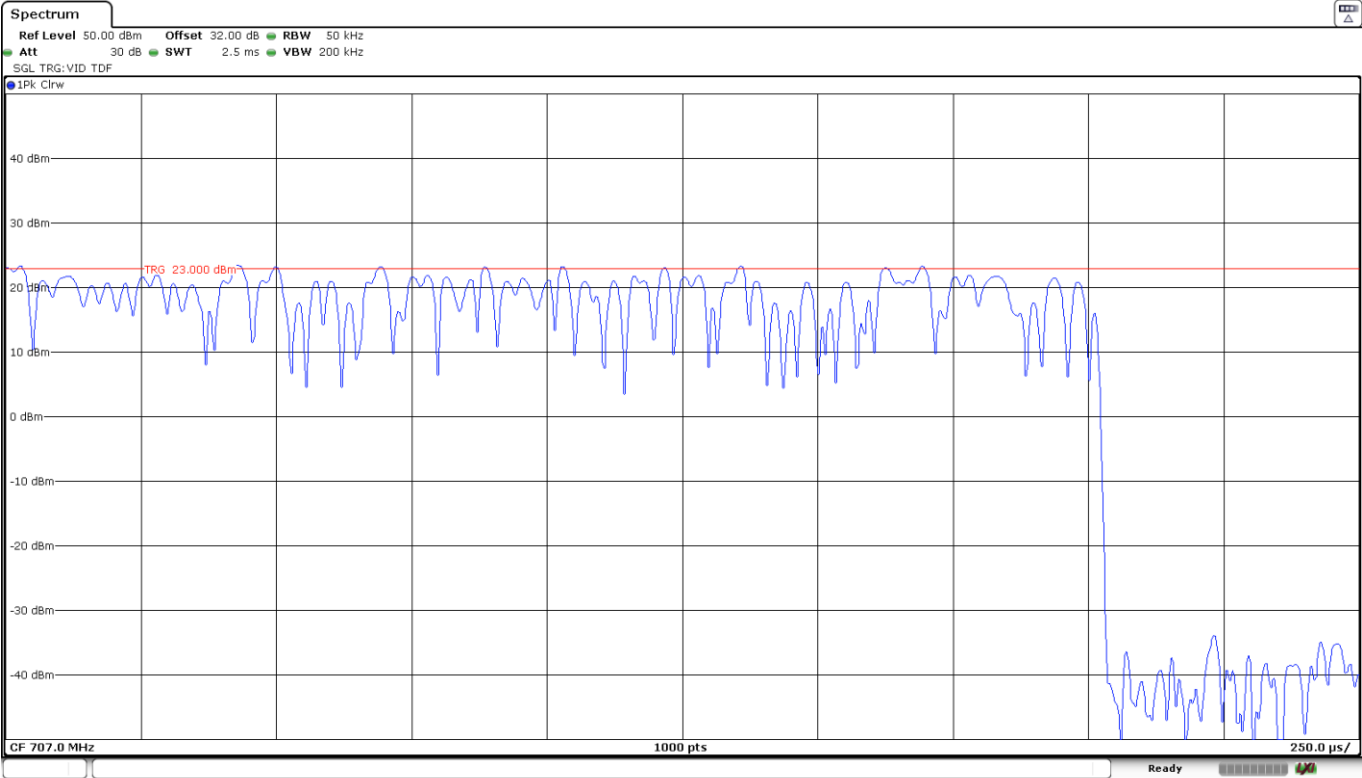
Date: 21.MAR.2025 03:39:45

LTE Cat NB2 Band 85: Pi/4-QPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=24. MSC/TBS=3.



Date: 21.MAR.2025 03:40:52

LTE Cat NB2 Band 85: QPSK. Middle Channel. BW=15 kHz. Tone Number=3. Tone Offset=6. MSC/TBS=5.



Date: 21.MAR.2025 03:33:13

Occupied Bandwidth

Limits

FCC §2.1049. Measurements required: Occupied bandwidth.

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

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

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

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

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

Method

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.