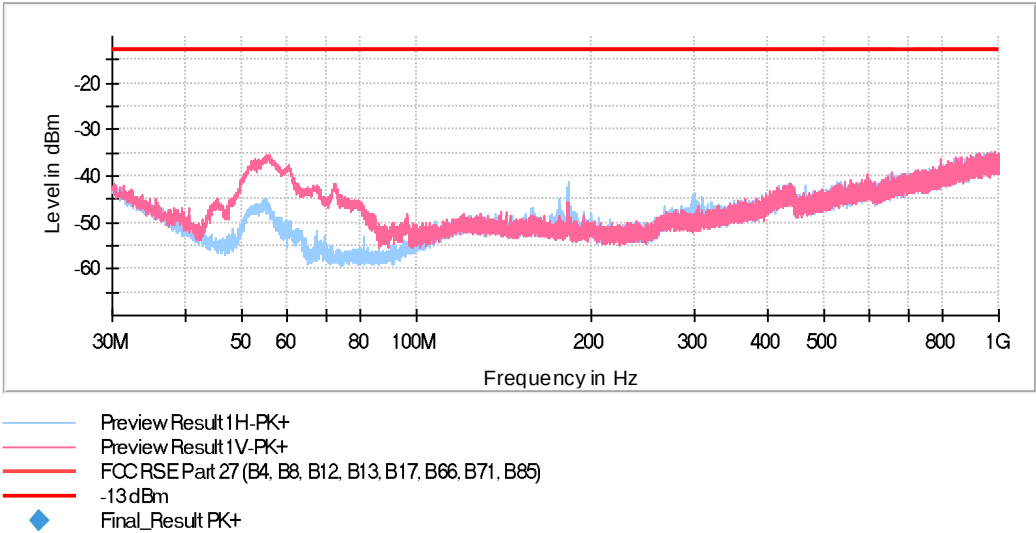


Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	30.312 kHz	PK+	1 MHz	Coupled	0 dB
1 GHz - 3 GHz	62.5 kHz	PK+	1 MHz	1 s	0 dB
3 GHz - 17 GHz	437.5 kHz	PK+	1 MHz	1 s	0 dB
17 GHz - 18 GHz	31.25 kHz	PK+	1 MHz	1 s	0 dB

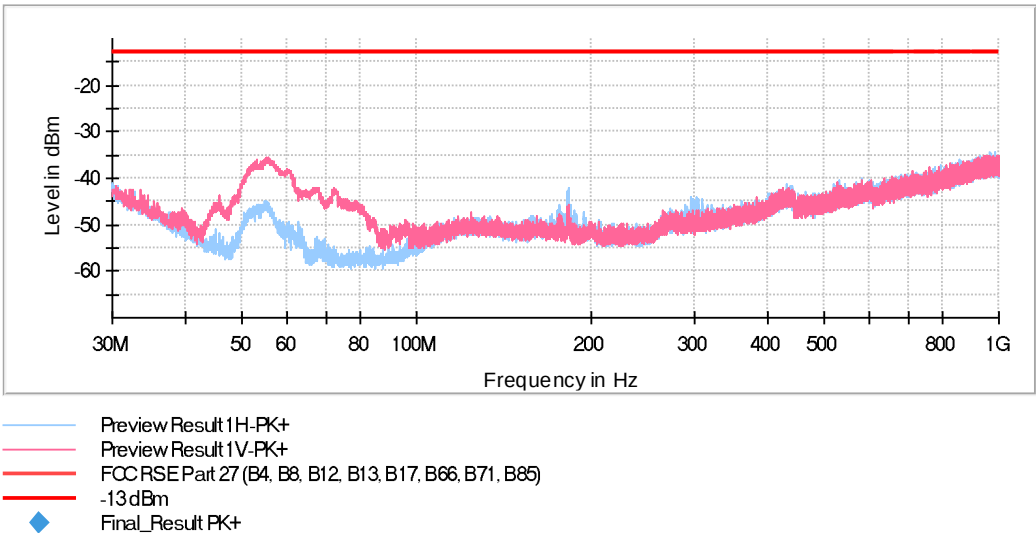
LTE Cat-M1 Band 66:

FREQUENCY RANGE 30 MHz - 1 GHz:

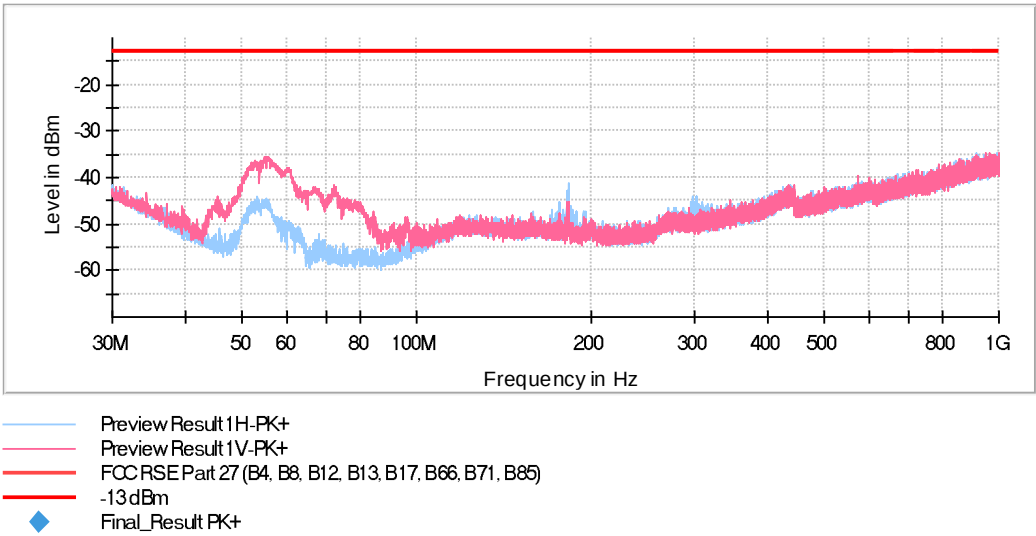
- LOW CHANNEL:



- MIDDLE CHANNEL:

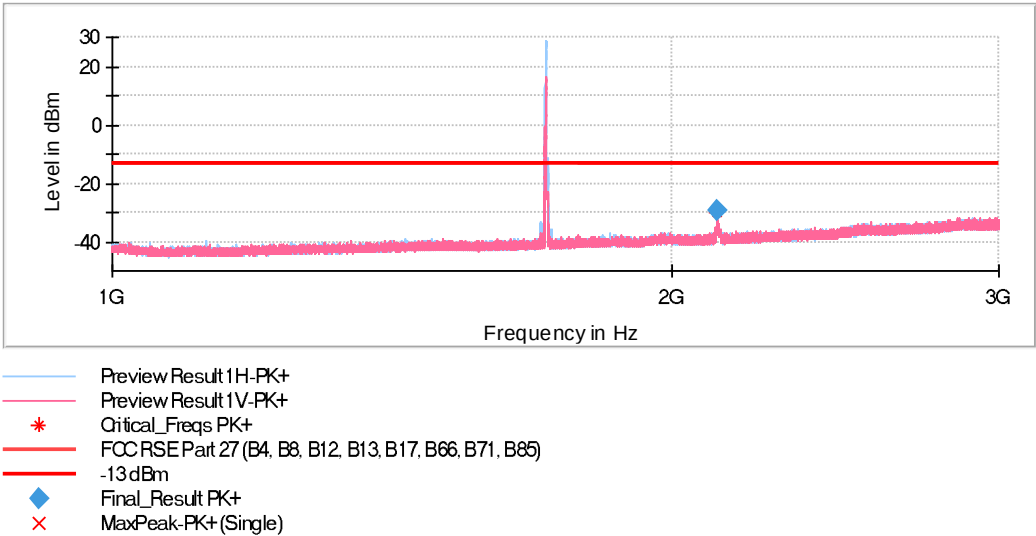


- HIGH CHANNEL:



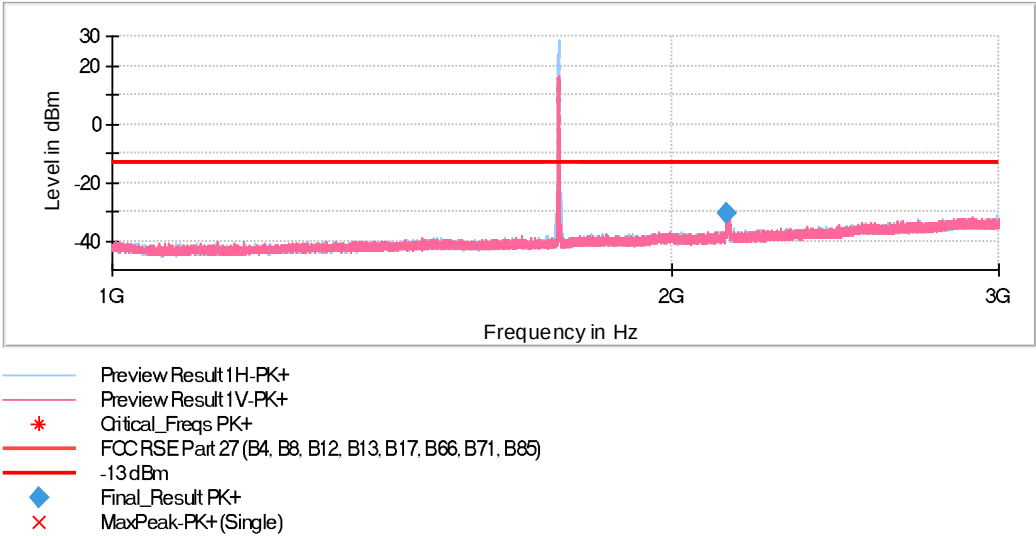
FREQUENCY RANGE 1 - 3 GHz:

- LOW CHANNEL:



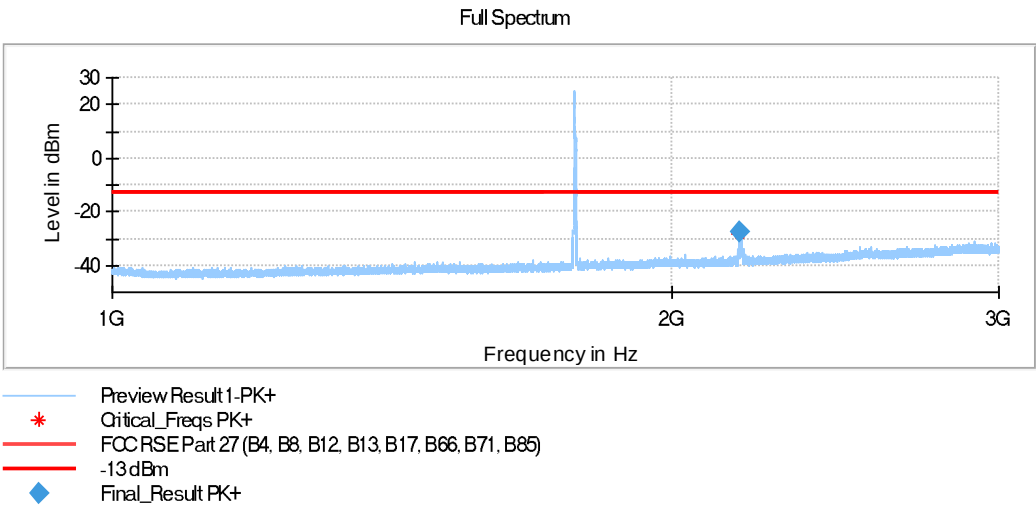
The higher peak is the carrier frequency.

- MIDDLE CHANNEL:



The higher peak is the carrier frequency.

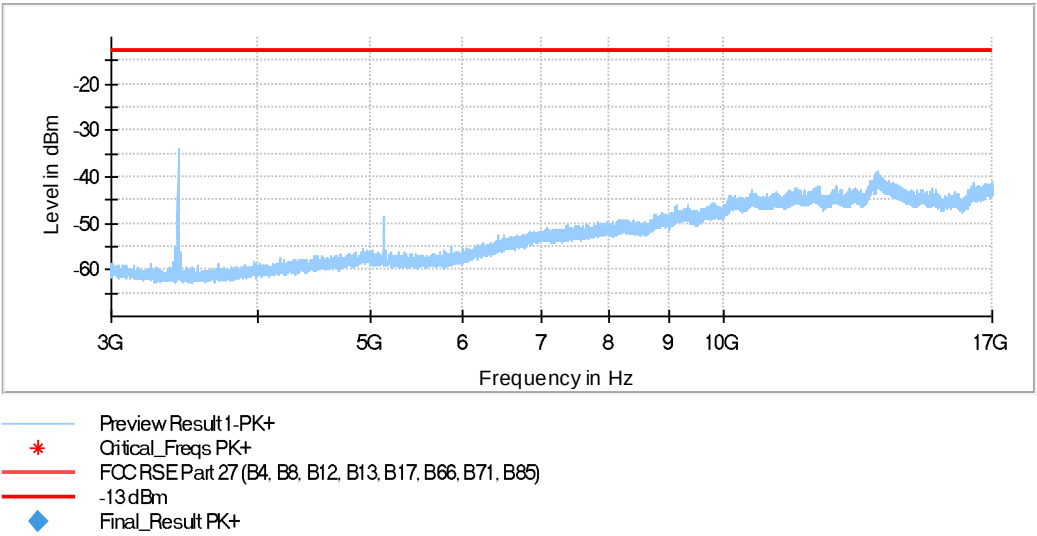
- HIGH CHANNEL:



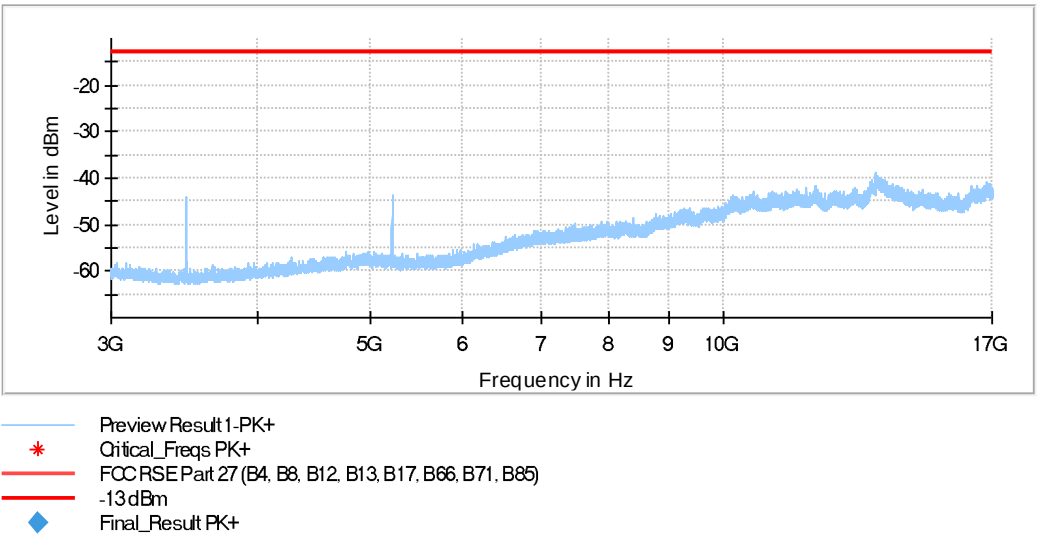
The higher peak is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

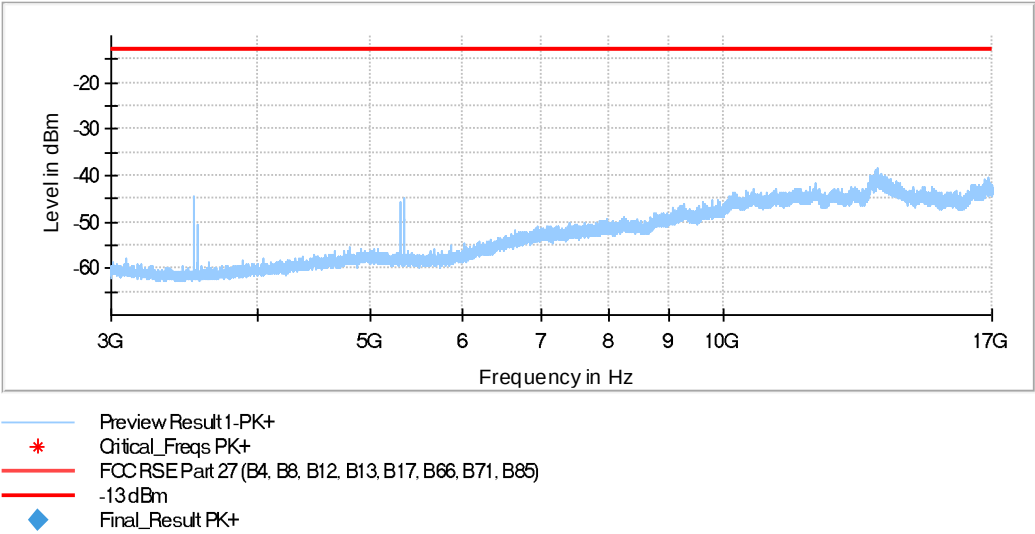
- LOW CHANNEL:



- MIDDLE CHANNEL:

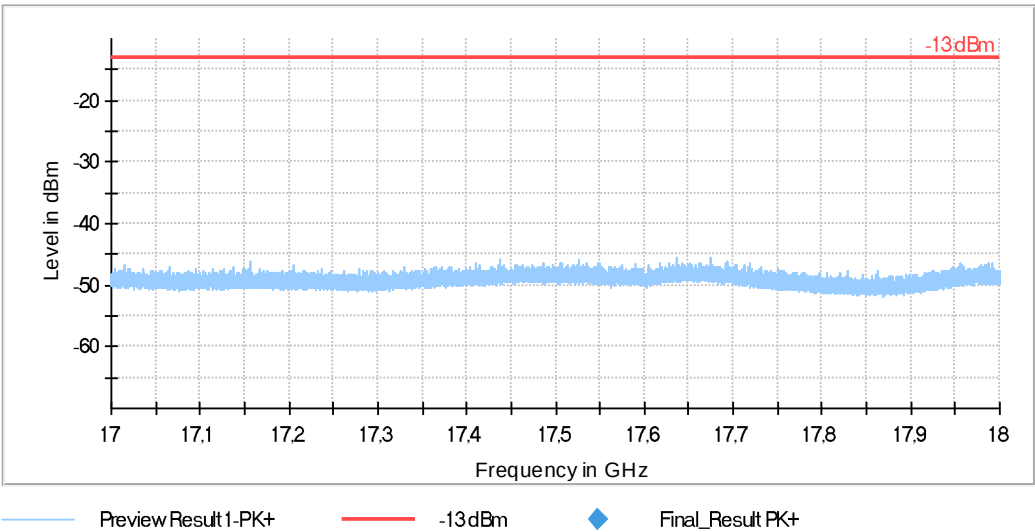


- HIGH CHANNEL:

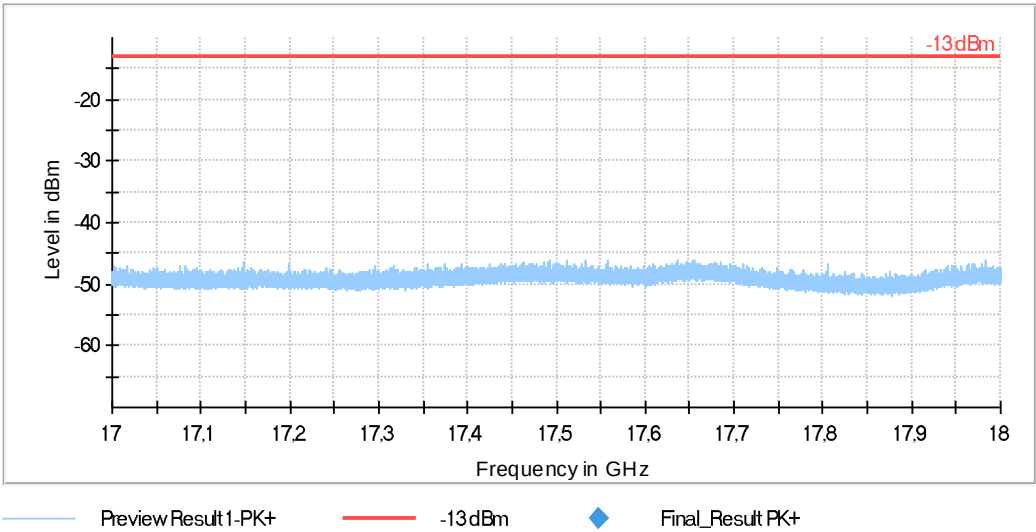


FREQUENCY RANGE 17 - 18 GHz:

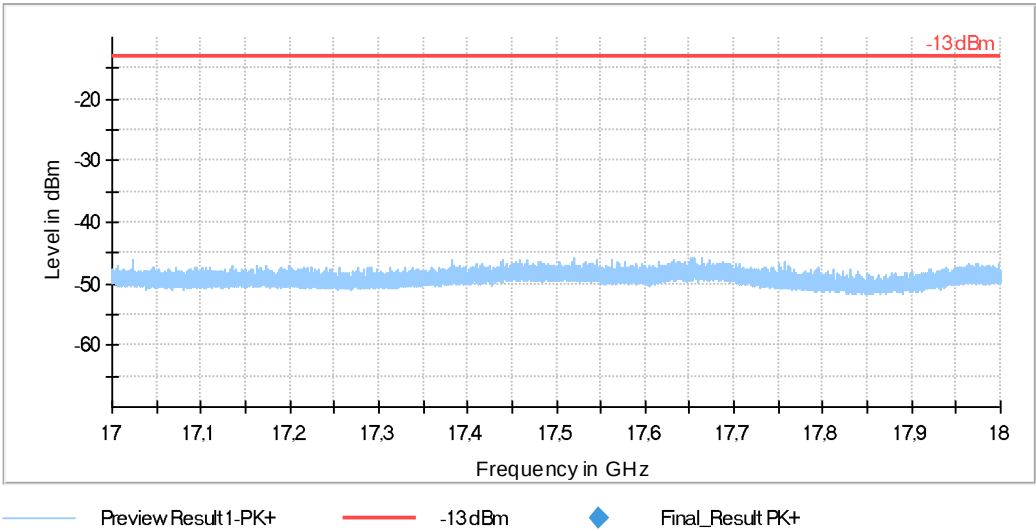
- LOW CHANNEL:



- MIDDLE CHANNEL:



- HIGH CHANNEL:



LTE Cat-M1 Band 85:

A preliminary scan determined the QPSK. BW=5 MHz. RB Size=1. RB Offset=2. Narrowband=1 as the worst case. The next results are for this worst-case configuration.

Frequency range 30 MHz - 1 GHz:

- LOW CHANNEL:

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

- MIDDLE CHANNEL:

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

- HIGH CHANNEL:

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

Frequency range 1 - 8 GHz:

- LOW CHANNEL:

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

- MIDDLE CHANNEL:

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

- HIGH CHANNEL:

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

Measurement uncertainty (dB) $< \pm 5.35$ for $f < 1$ GHz
 $< \pm 4.32$ for $f \geq 1$ GHz up to 8 GHz

Verdict

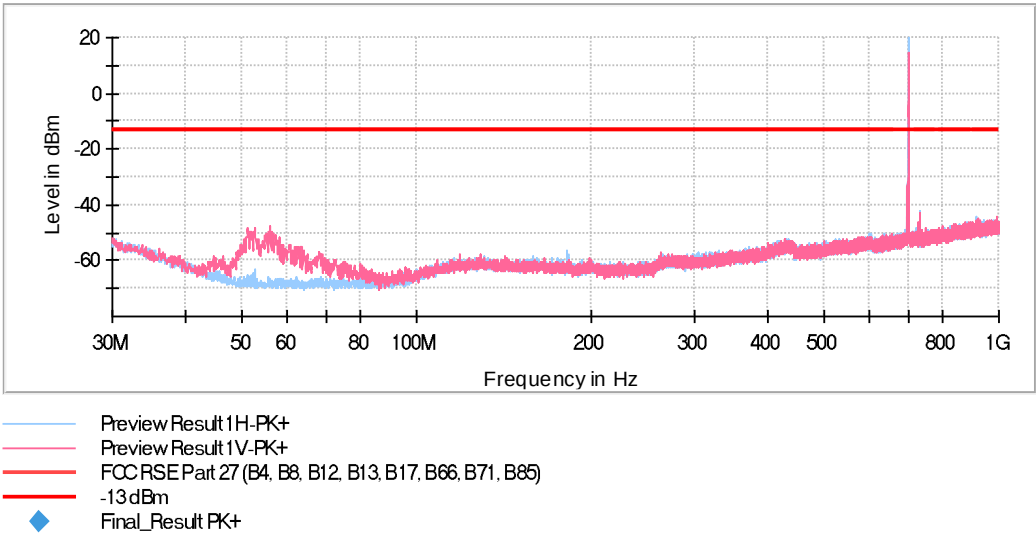
Pass

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	30.312 kHz	PK+	100 kHz	Coupled	0 dB
1 GHz - 8.5 GHz	234.375 kHz	PK+	100 kHz	1 s	0 dB

LTE Cat-M1 Band 85:

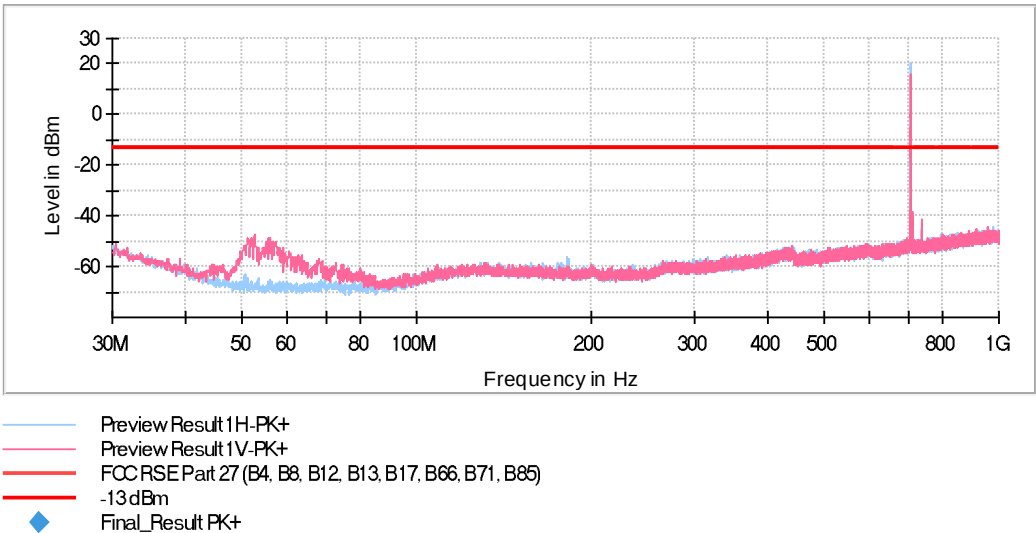
FREQUENCY RANGE 30 MHz - 1 GHz:

- LOW CHANNEL:



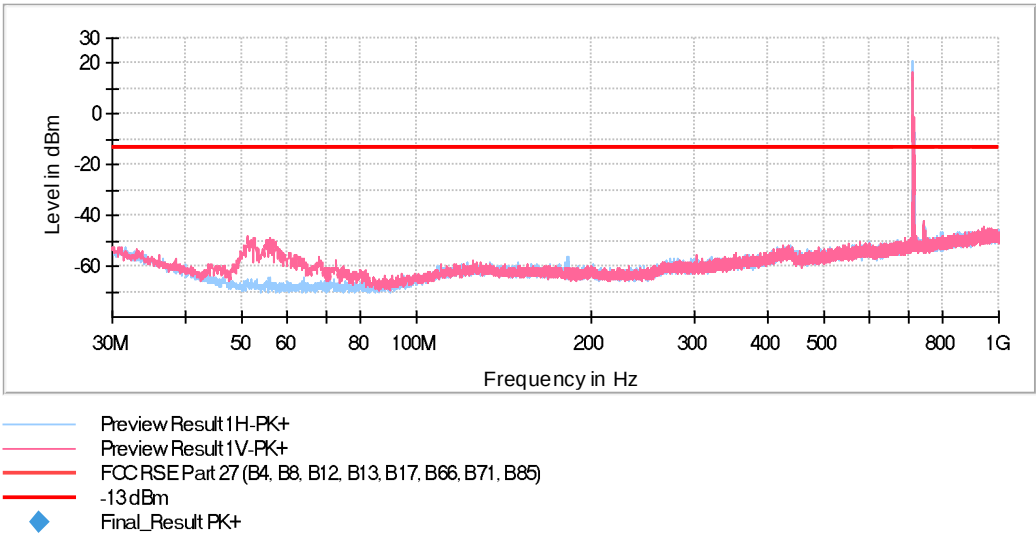
The peak above the limit is the LTE Cat-M1 Band 85 carrier frequency.

- MIDDLE CHANNEL:



The peak above the limit is the LTE Cat-M1 Band 85 carrier frequency.

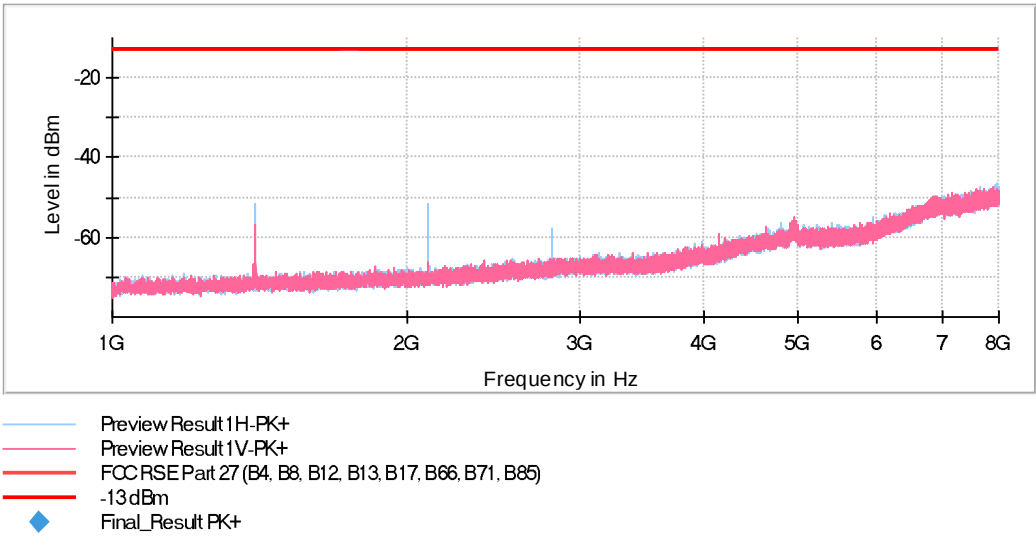
- HIGH CHANNEL:



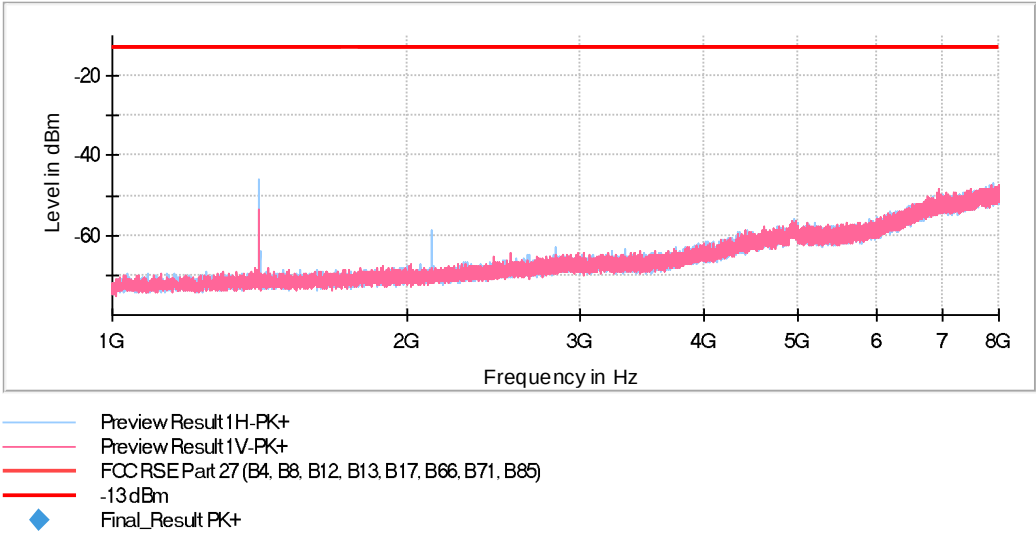
The peak above the limit is the LTE Cat-M1 Band 85 carrier frequency.

FREQUENCY RANGE 1 GHz - 8 GHz

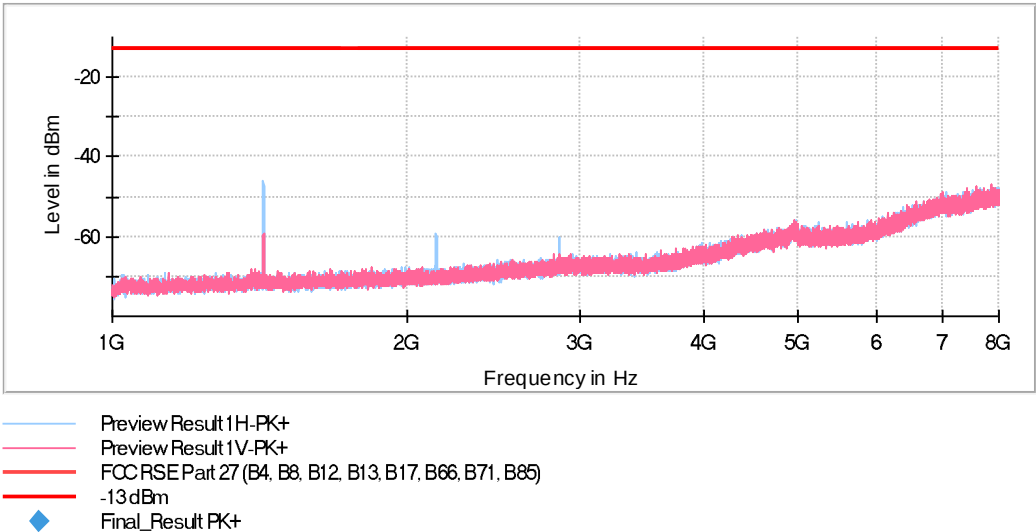
- LOW CHANNEL:



- MIDDLE CHANNEL:



- HIGH CHANNEL:



Appendix B: Test results for FCC 27 / RSS-130. RSS-139: LTE Cat NB1 Bands 4, 8, 12, 13, 17, 66, 85

INDEX

TEST CONDITIONS114

RF Output Power117

Frequency Stability126

Modulation Characteristics141

Occupied Bandwidth144

Spurious emissions at antenna terminals157

Spurious emissions at antenna terminals at Block Edges210

Radiated emissions.....227

TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

Vnormal: 3.8 Vdc.
Vminimum: 3 Vdc
Vmaximum: 5 Vdc
Type of Power Supply: Internal DC.

ANTENNA (*):

Low Bands	Gain (dBi)	Type of Antenna
LTE NB1 8	+2.70	SMD
LTE NB1 12	+1.56	SMD
LTE NB1 13	+1.56	SMD
LTE NB1 17	+1.56	SMD
LTE NB1 85	+1.56	SMD
High Bands	Gain (dBi)	Type
LTE NB1 4	+3.0	SMD
LTE NB1 66	+3.0	SMD

TEST FREQUENCIES:

LTE Cat NB1 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 NB1 Band 4 is completely included in LTE Cat NB1 Band 66, so the channels of LTE Cat NB1 Band 66 were tested to give conformity to the assigned block.

LTE Cat NB1 Band 8. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel (Frequency. MHz)		
Low	Middle	High
21628 (897.80)*	21640 (899)	21652 (900.20)*
*The outermost channel which is in compliance with Block edge testing.		

LTE Cat NB1 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 NB1 Band 12 is completely included in LTE Cat NB1 Band 85, so the channels of LTE Cat NB1 Band 85 were tested to give conformity to the assigned block.

LTE Cat NB1 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 NB1 Band 17. Pi/2-BPSK. Pi/4-QPSK. QPSK modulations:

Channel. Number (Frequency. MHz)		
Low	Middle	High
23732 (704.20)*	23790 (710)	23848 (715.80)*
*The outermost channel which is in compliance with Block edge testing.		

NOTE: LTE Cat NB1 Band 17 is completely included in LTE Cat NB1 Band 85, so the channels of LTE Cat NB1 Band 85 were tested to give conformity to the assigned block.

LTE Cat NB1 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 NB1 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 NB1 Band 8. FCC §27.1507 (a) & (d).

FCC §27.1507 (a) & (d):

(a) *Maximum ERP.* The power limits specified in this section are applicable to operations in areas more than 110 km (68.4 miles) from the U.S./Mexico border and 140 km (87 miles) from the U.S./Canada border.

(3) *Mobile, control and auxiliary test stations.* Mobile, control and auxiliary test stations must not exceed 10 watts ERP.

(4) *Portable stations.* Portable stations must not exceed 3 watts ERP.

(d) *PAR limit.* The peak-to-average ratio (PAR) of the transmission must not exceed 13 dB.

2. LTE Cat NB1 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.

3. LTE Cat NB1 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.

4. LTE Cat NB1 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.

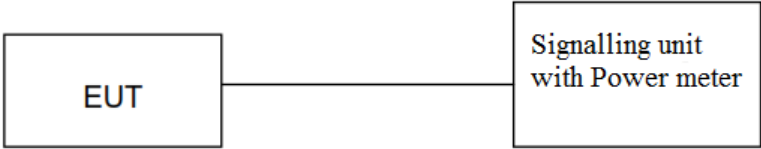
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

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:

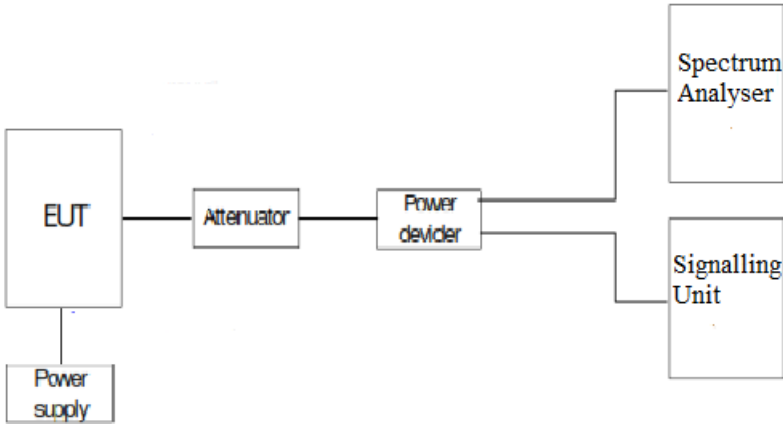
$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

Test Setup

1. CONDUCTED AVERAGE POWER:



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



Results

1. CONDUCTED AVERAGE POWER

LTE Cat NB1 Band 8:

Worst-case of RF Power is Low Channel. Pi/4-QPSK. BW=15 kHz. Tone Number=1. Tone Offset=11. MSC/TBS=3.

CHANNEL	FREQUENCY (MHz)	MODULATION	BW	Tone Number	Tone Offset (Start SubCarrier)	MSC / TBS	AVERAGE POWER (dBm)
Low 21627	897.7 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.31
				1	47	0	22.23
			15 kHz	1	0	0	22.29
				1	11	0	22.27
		Pi/4-QPSK	3.75 kHz	1	0	3	22.14
				1	47	3	22.27
			15 kHz	1	0	3	22.29
				1	11	3	22.32
		QPSK	15 kHz	3	0	5	22.13
				3	9	5	22.11
				6	0	5	21.31
				6	6	5	21.34
High 21653	900.3 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.28
				1	47	0	22.2
			15 kHz	1	0	0	22.27
				1	11	0	22.22
		Pi/4-QPSK	3.75 kHz	1	0	3	22.2
				1	47	3	22.18
			15 kHz	1	0	3	22.24
				1	11	3	22.25
		QPSK	15 kHz	3	0	5	22.09
				3	9	5	22.08
				6	0	5	21.27
				6	6	5	21.32
				12	0	5	20.26

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG. EIRP (dBm)	RAD. POWER AVG. ERP (dBm)
LOW	22.32	2.70	25.02	22.87
HIGH	22.28	2.70	24.98	22.83
MAX:	22.32		25.02	22.87

LTE Cat NB1 Band 13:

Worst-case of RF Power is Low Channel. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.

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	22.16
				1	47	0	22.2
			15 kHz	1	0	0	22.15
				1	11	0	22.25
		Pi/4-QPSK	3.75 kHz	1	0	3	22.27
				1	47	3	22.18
			15 kHz	1	0	3	22.19
				1	11	3	22.17
		QPSK	15 kHz	3	0	5	22.19
				3	6	5	22.11
				6	0	5	21.15
				6	6	5	21.26
High 23278	786.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	21.17
				1	47	0	22.12
			15 kHz	1	0	0	22.05
				1	11	0	22.17
		Pi/4-QPSK	3.75 kHz	1	0	3	22.17
				1	47	3	21.93
			15 kHz	1	0	3	22.13
				1	11	3	22.12
		QPSK	15 kHz	3	0	5	22.04
				3	6	5	22.01
				6	0	5	20.8
				6	6	5	20.92
				12	0	5	20.06

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.27	+1.56	23.83	21.68
HIGH	22.17	+1.56	23.73	21.58
MAX:	22.27		23.83	21.68

LTE Cat NB1 Band 66:

Worst-case of RF Power is Low Channel. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.

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	22.48
				1	47	0	22.42
			15 kHz	1	0	0	22.54
				1	11	0	22.52
		Pi/4-QPSK	3.75 kHz	1	0	3	22.48
				1	47	3	22.42
			15 kHz	1	0	3	22.52
				1	11	3	22.52
		QPSK	15 kHz	3	0	5	22.24
				3	6	5	22.45
				6	0	5	21.68
				6	6	5	21.5
				12	0	5	20.64
Middle 132322	1745 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.34
				1	47	0	22.31
			15 kHz	1	0	0	22.41
				1	11	0	22.39
		Pi/4-QPSK	3.75 kHz	1	0	3	22.4
				1	47	3	22.33
			15 kHz	1	0	3	22.43
				1	11	3	22.4
		QPSK	15 kHz	3	0	5	22.22
				3	6	5	22.29
				6	0	5	21.13
				6	6	5	21.38
				12	0	5	20.26
High 132670	1779.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.35
				1	47	0	22.22
			15 kHz	1	0	0	22.38
				1	11	0	22.33
		Pi/4-QPSK	3.75 kHz	1	0	3	22.32
				1	47	3	22.27
			15 kHz	1	0	3	22.29
				1	11	3	22.31
		QPSK	15 kHz	3	0	5	22.02
				3	6	5	22.29
				6	0	5	21.15
				6	6	5	21.14
				12	0	5	20.36

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.54	+3.00	25.54	23.39
MIDDLE	22.43	+3.00	25.43	23.28
HIGH	22.38	+3.00	25.38	23.23
MAX:	22.54		25.54	23.39

LTE Cat NB1 Band 85:

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

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	22.09
				1	47	0	22.09
			15 kHz	1	0	0	22.1
				1	11	0	22.06
		Pi/4-QPSK	3.75 kHz	1	0	3	22.07
				1	47	3	22.09
			15 kHz	1	0	3	22.16
				1	11	3	22.08
		QPSK	15 kHz	3	0	5	22.07
				3	9	5	21.97
				6	0	5	21.08
				6	6	5	21.21
				12	0	5	20.14
Middle 134092	707 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	21.99
				1	47	0	21.94
			15 kHz	1	0	0	22.04
				1	11	0	22.11
		Pi/4-QPSK	3.75 kHz	1	0	3	22.01
				1	47	3	21.93
			15 kHz	1	0	3	22.13
				1	11	3	22.07
		QPSK	15 kHz	3	0	5	21.64
				3	9	5	21.77
				6	0	5	21.05
				6	6	5	20.9
				12	0	5	19.91
High 134180	715.8 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	21.97
				1	47	0	22
			15 kHz	1	0	0	22.11
				1	11	0	22.07
		Pi/4-QPSK	3.75 kHz	1	0	3	22.1
				1	47	3	22.02
			15 kHz	1	0	3	22.08
				1	11	3	22.08
		QPSK	15 kHz	3	0	5	21.82
				3	9	5	21.84
				6	0	5	20.87
				6	6	5	20.72
				12	0	5	20.01

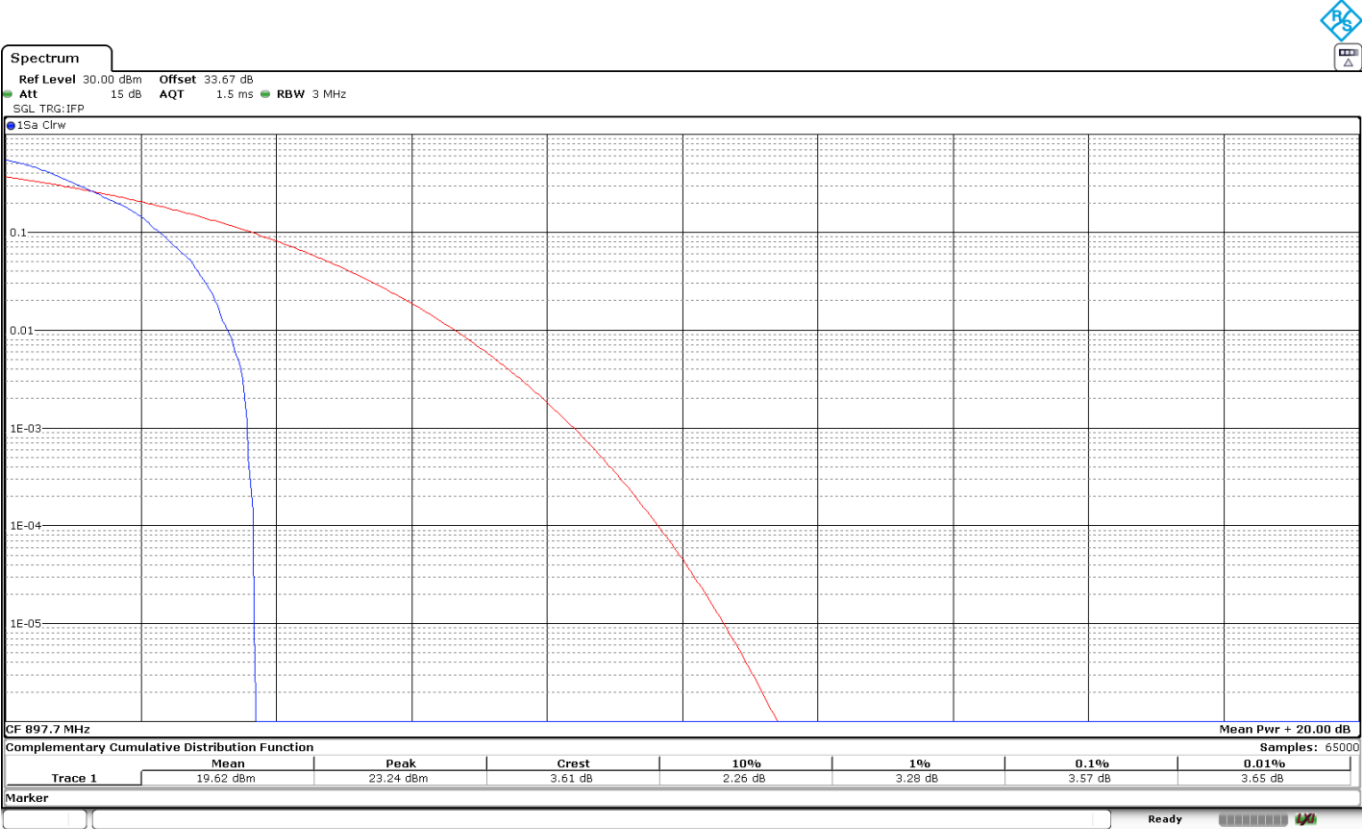
MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOW	22.16	+1.56	23.72	21.57
MIDDLE	22.13	+1.56	23.69	21.54
HIGH	22.11	+1.56	23.67	21.52
MAX:	22.16		23.72	21.57

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

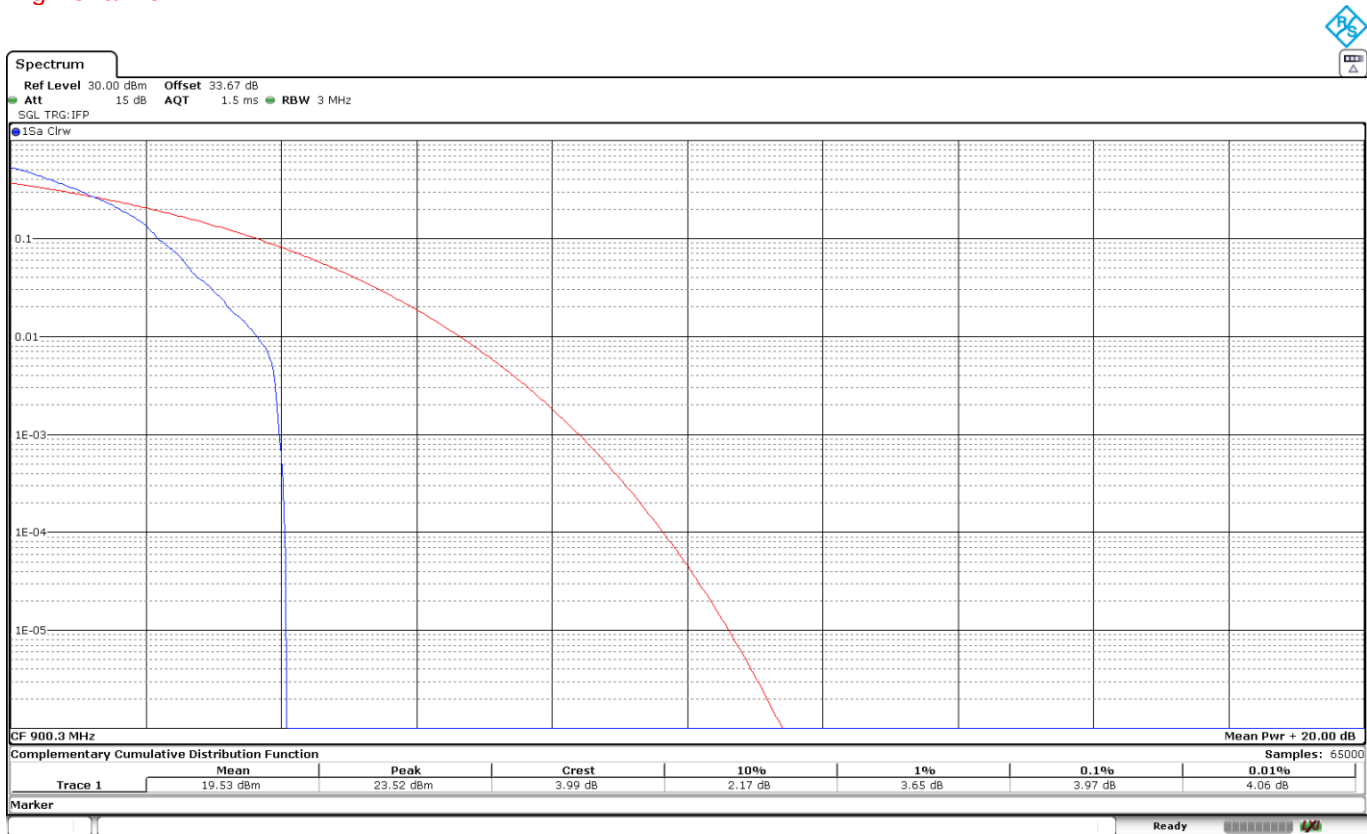
LTE Cat NB1 Band 8:

Worst-case of PAPR is High Channel. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

Low Channel:



High Channel:



QPSK	Low	High
PAPR (dB)	3.57	3.97

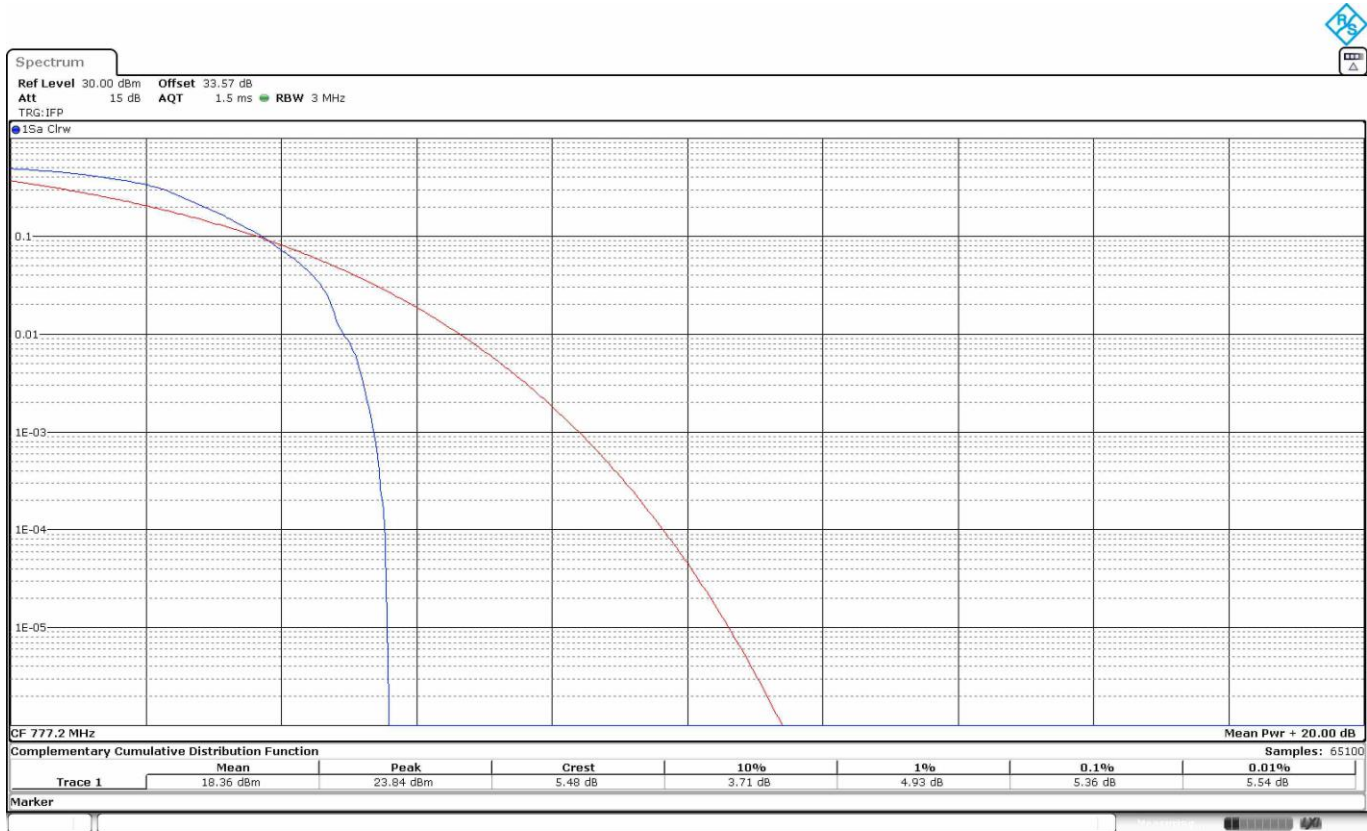
Verdict

Pass

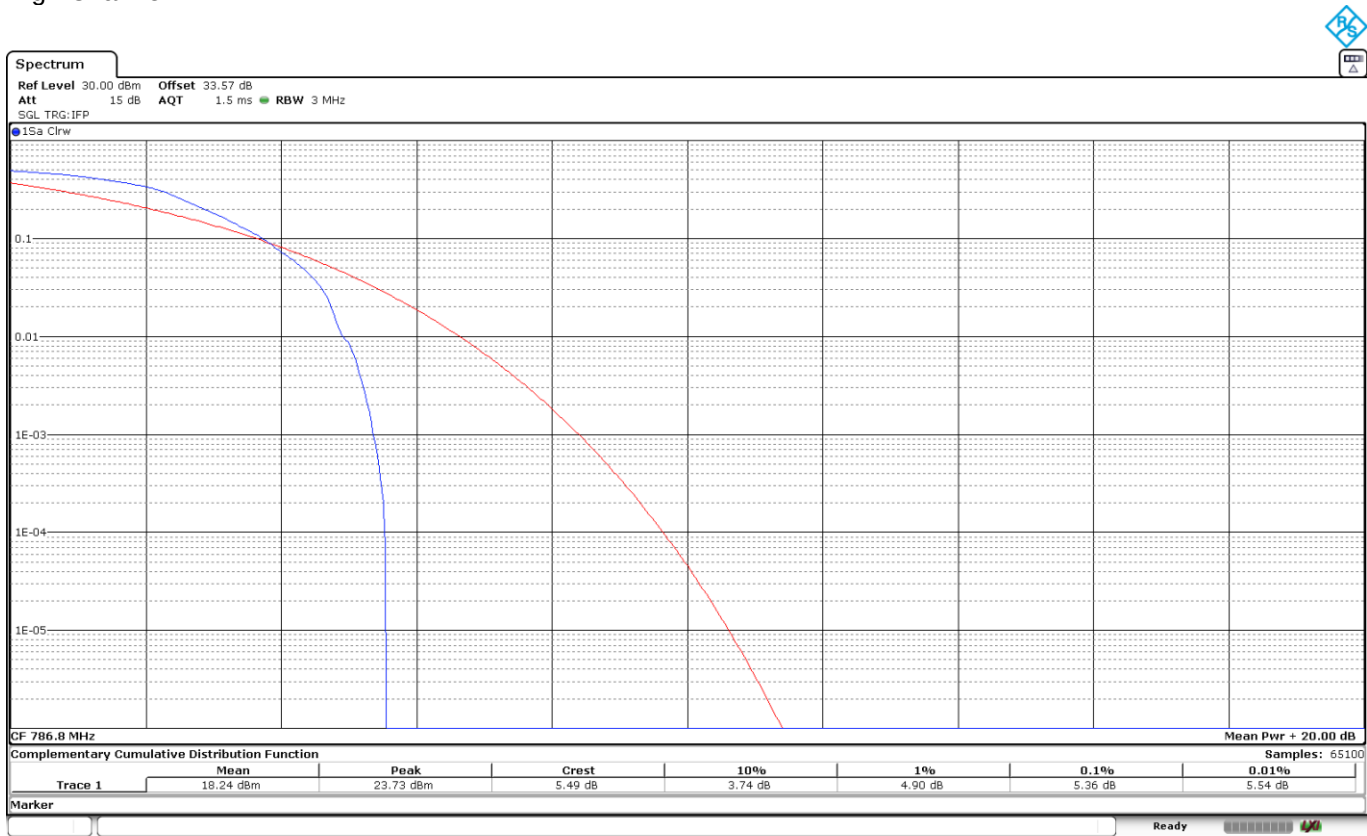
LTE Cat NB1 Band 13:

Worst-case of PAPR is Low Channel. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

Low Channel:



High Channel:



QPSK	Low	High
PAPR (dB)	5.36	5.36

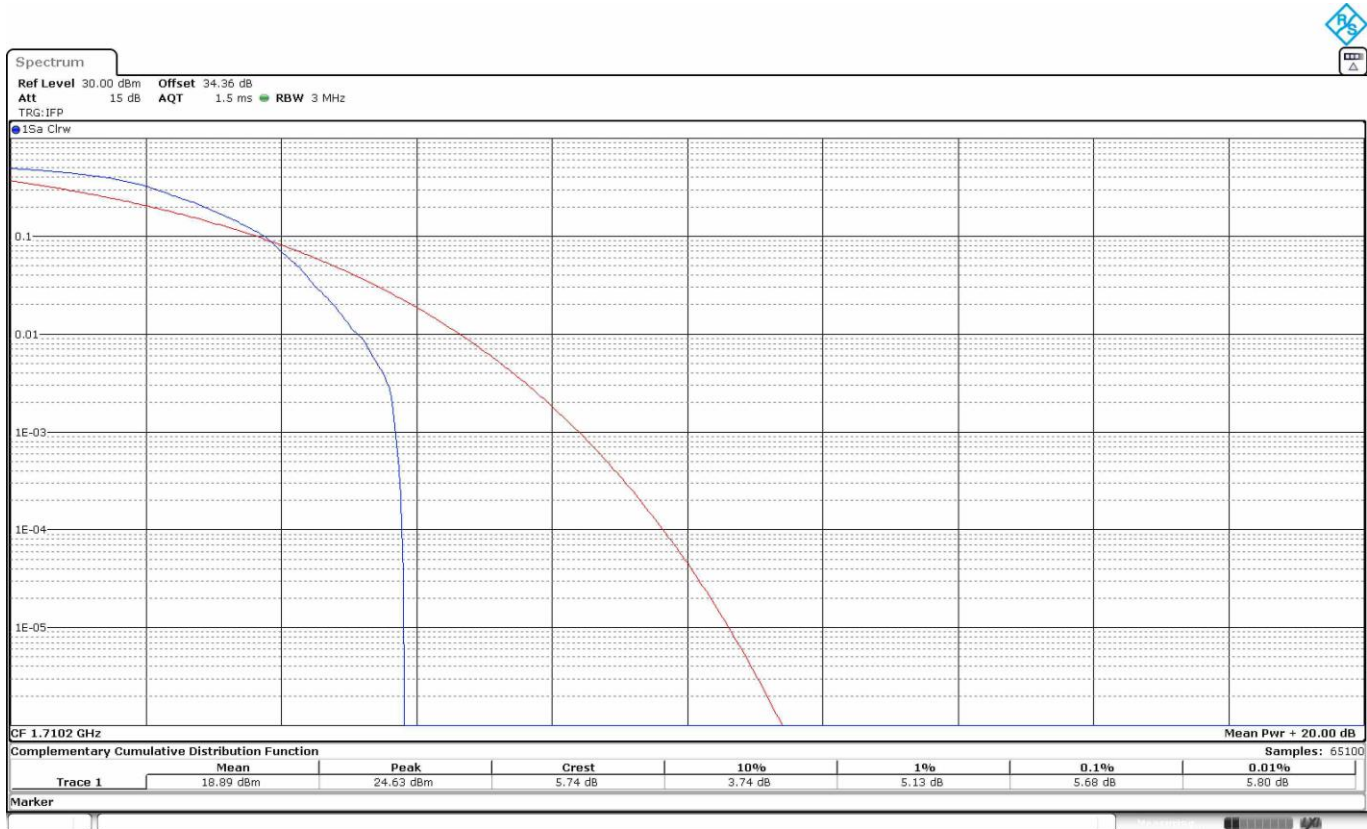
Verdict

Pass

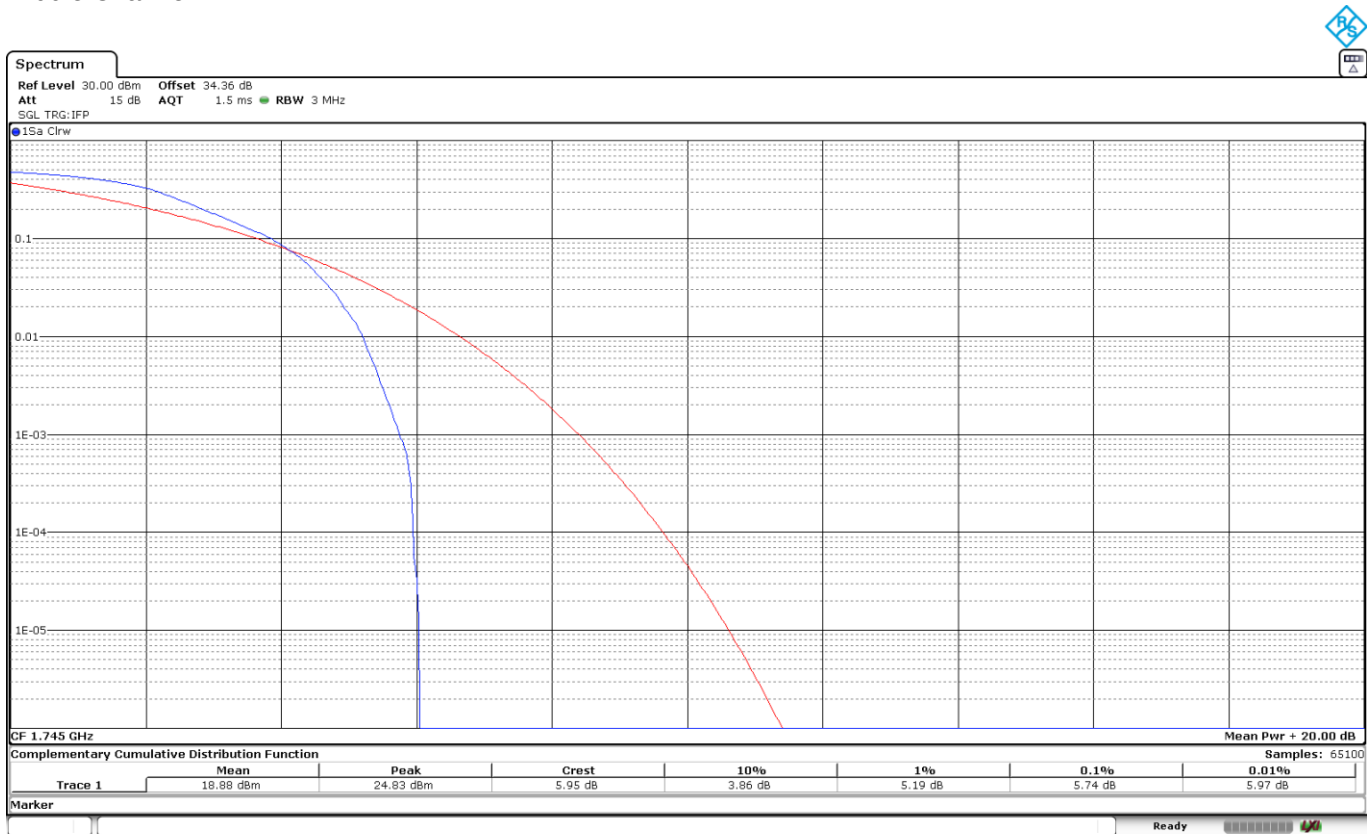
LTE Cat NB1 Band 66:

Worst-case of PAPR is High Channel. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

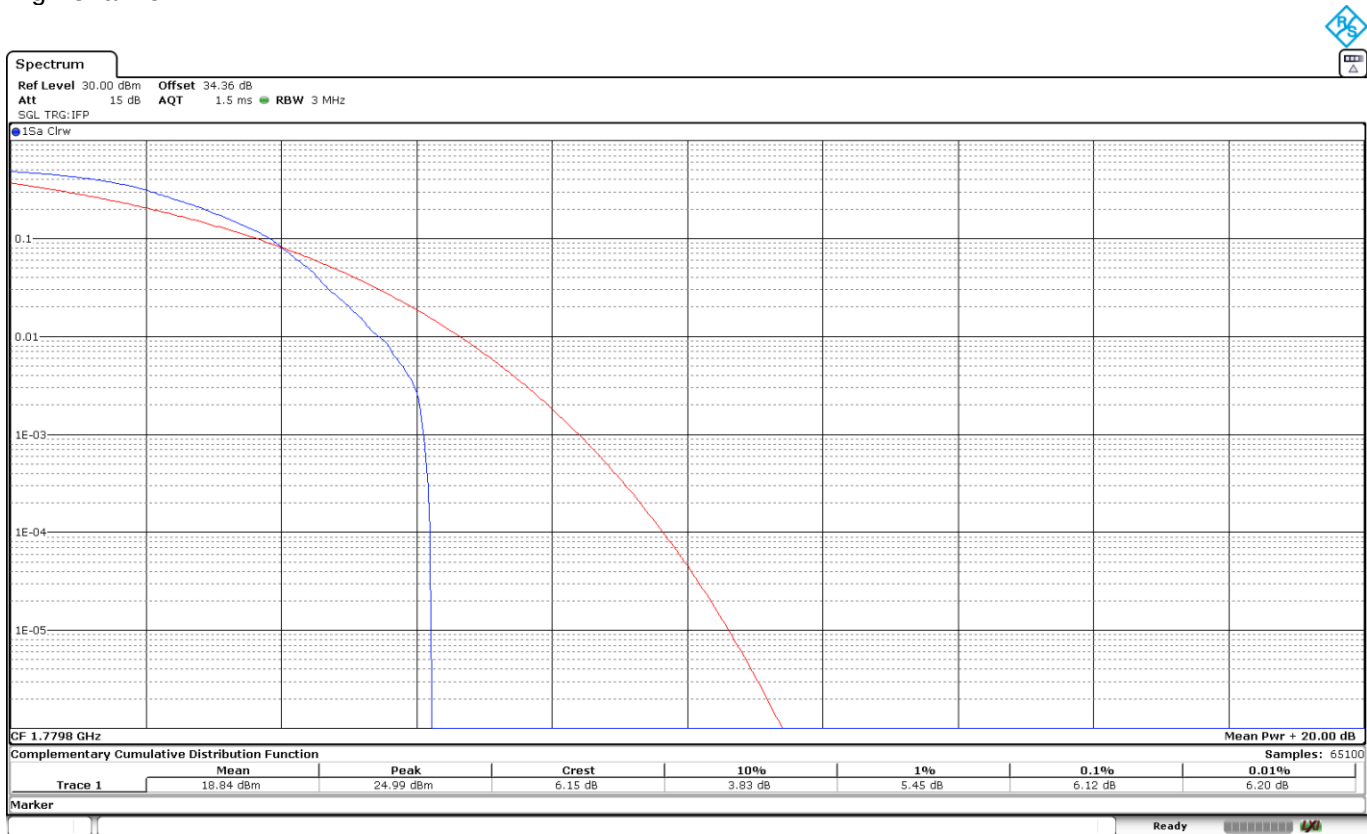
Low Channel:



Middle Channel:



High Channel:



QPSK	Low	Middle	High
PAPR (dB)	5.68	5.74	6.12

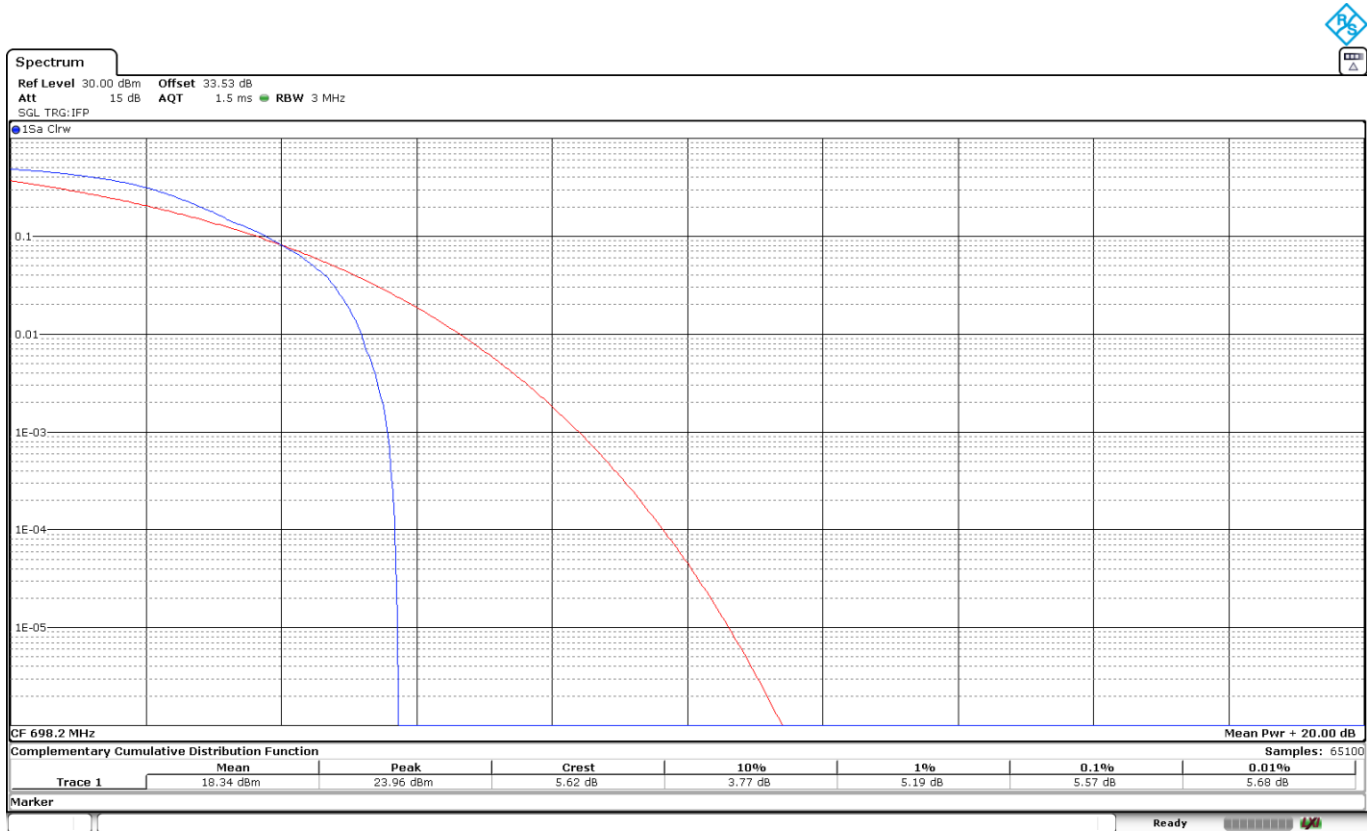
Verdict

Pass

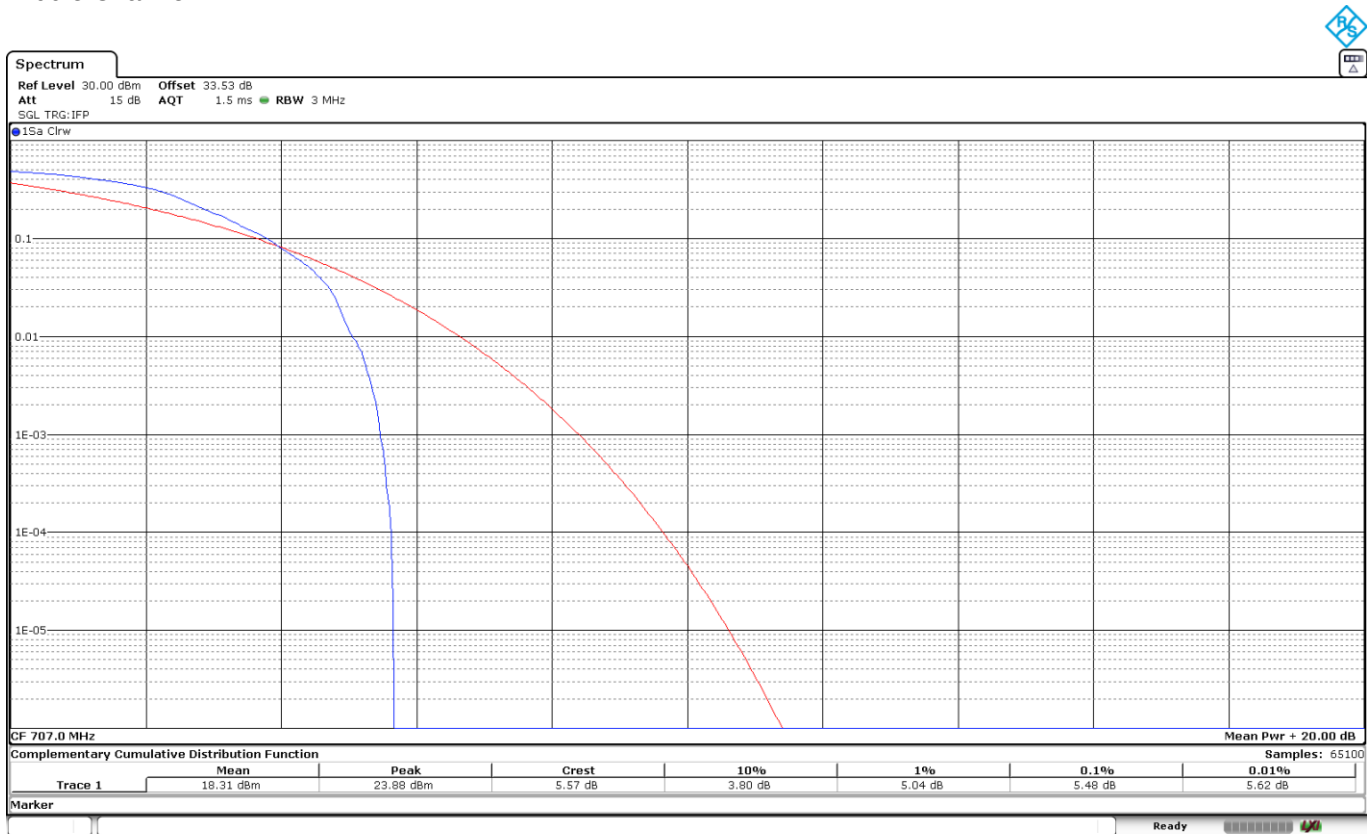
LTE Cat NB1 Band 85:

Worst-case of PAPR is Low Channel. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

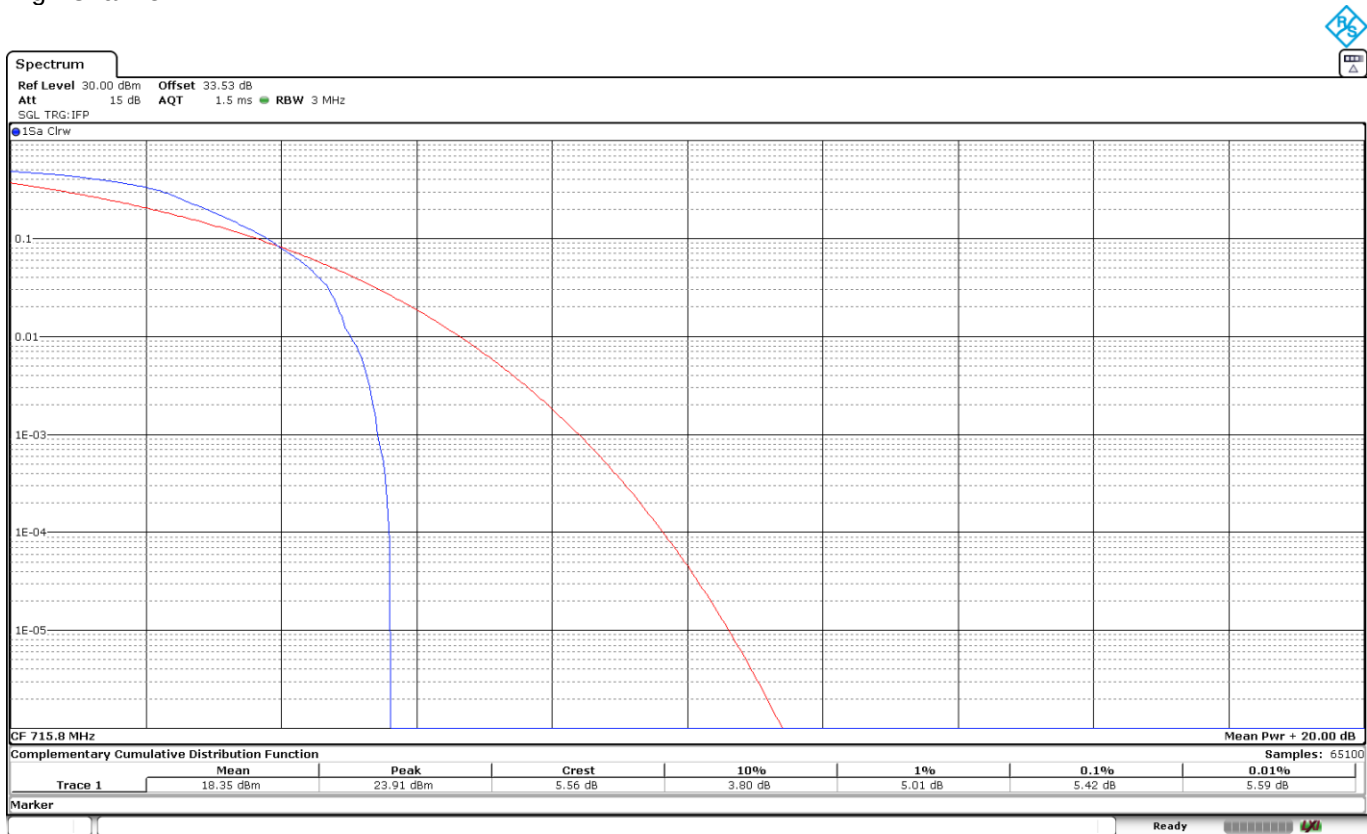
Low Channel:



Middle Channel:



High Channel:



QPSK	Low	Middle	High
PAPR (dB)	5.57	5.48	5.42

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.

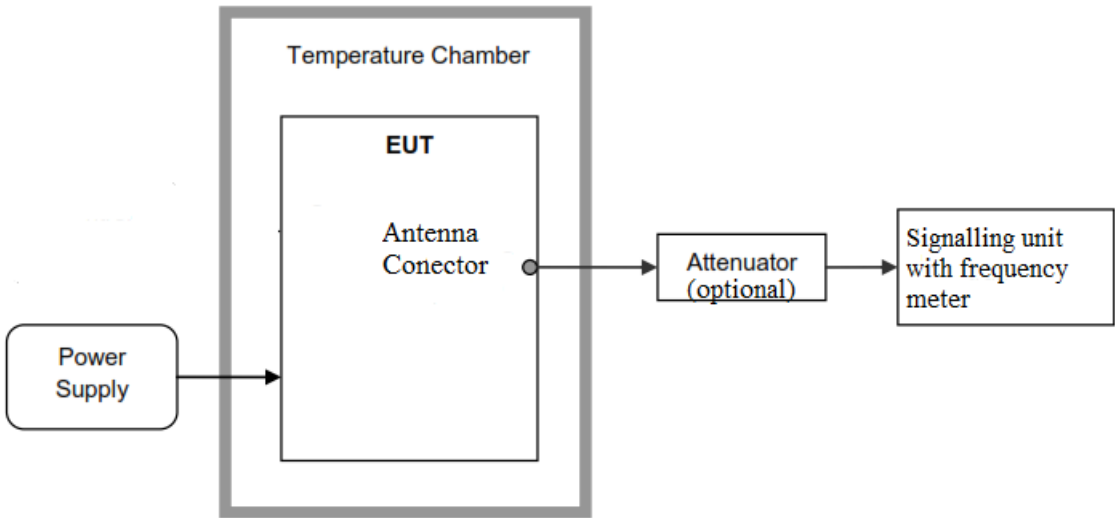
The worst case LTE mode for conducted power was used for the test.

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.

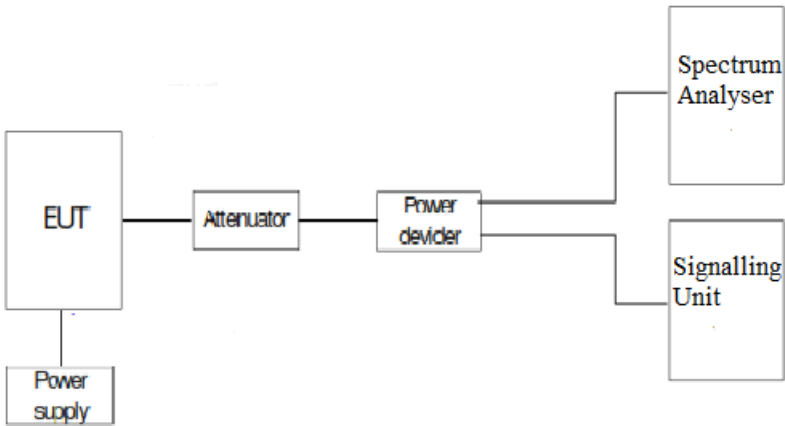
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

Frequency tolerance.



Reference points f_L and f_H .



Results

1. FREQUENCY TOLERANCE:

- Frequency stability over temperature variations:

LTE Cat NB1 Band 8:

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	23.56	0.026206897
+80	19.51	0.021701891
+70	-13.19	-0.014671858
+60	-27.32	-0.030389321
+50	16	0.017797553
+40	-6.56	-0.007296997
+30	-7.03	-0.0078198
+20	15.69	0.017452725
+10	15.41	0.017141268
0	14.84	0.01650723
-10	18.25	0.020300334
-20	20.24	0.022513904
-30	19.02	0.021156841
-40	21.04	0.023403782

LTE Cat NB1 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	5.11	0.006534527
+80	-4.02	-0.005140665
+70	-0.07	-8.95141E-05
+60	-9.66	-0.012352941
+50	-12.93	-0.016534527
+40	14.41	0.01842711
+30	-10.03	-0.012826087
+20	-17.35	-0.022186701
+10	6.45	0.008248082
0	10.31	0.013184143
-10	-13.8	-0.017647059
-20	-5.94	-0.007595908
-30	-13.59	-0.017378517
-40	23.55	0.03011509

LTE Cat NB1 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	13.92	0.007977077
+80	13.65	0.00782235
+70	16.45	0.009426934
+60	8.04	0.00460745
+50	9.78	0.005604585
+40	2.55	0.001461318
+30	13.98	0.008011461
+20	1.53	0.000876791
+10	1.23	0.000704871
0	2.57	0.001472779
-10	2.05	0.001174785
-20	-0.47	-0.000269341
-30	9.41	0.00539255
-40	20.36	0.011667622

LTE Cat NB1 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	0.79	0.001117397
+80	21.2	0.029985856
+70	-1.65	-0.002333805
+60	-17.24	-0.024384724
+50	-5.78	-0.008175389
+40	15.41	0.021796322
+30	-1.77	-0.002503536
+20	-14.46	-0.020452617
+10	-0.56	-0.000792079
0	-5.54	-0.007835926
-10	-11.77	-0.016647808
-20	-4.25	-0.006011315
-30	-14.02	-0.019830269
-40	21.86	0.030919378

- **Frequency stability over voltage variations:**

LTE Cat NB1 Band 8:

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	5.5	2.78	0.003092325
Vmin	3	4.23	0.004705228

LTE Cat NB1 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	5.5	-8.65	-0.011061381
Vmin	3	6.05	0.007736573

LTE Cat NB1 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	5.5	-2.47	-0.001415473
Vmin	3	-10.29	-0.005896848

LTE Cat NB1 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	5.5	-3.26	-0.004611033
Vmin	3	-5.25	-0.007425743

2. REFERENCE FREQUENCY POINTS f_L AND f_H :

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

LTE Cat NB1 Band 4:

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)	1710.0241
f_H (MHz)	1754.9775

LTE Cat NB1 Band 8:

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)	897.5345
f_H (MHz)	900.4667

LTE Cat NB1 Band 12:

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)	699.0061
f_H (MHz)	715.9952

LTE Cat NB1 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)	777.0093
f_H (MHz)	786.9901

LTE Cat NB1 Band 17:

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)	704.0024
f_H (MHz)	715.9952

LTE Cat NB1 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)	1710.0241
f_H (MHz)	1779.9787

LTE Cat NB1 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.

fL (MHz)	698.0094
fH (MHz)	715.9952

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

Measurement uncertainty (Hz): <±211.77

Verdict

PASS

Modulation Characteristics

Limits

FCC §2.1047.

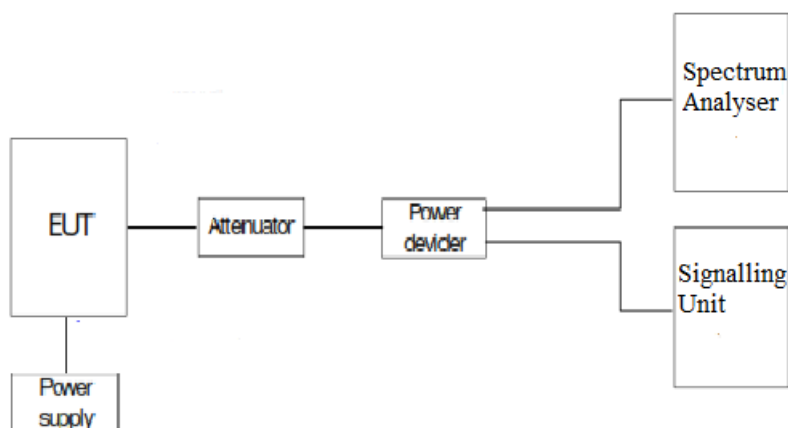
RSS-130. Clause 4.2: Equipment certified under this standard shall employ digital modulation.

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 NB1 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.

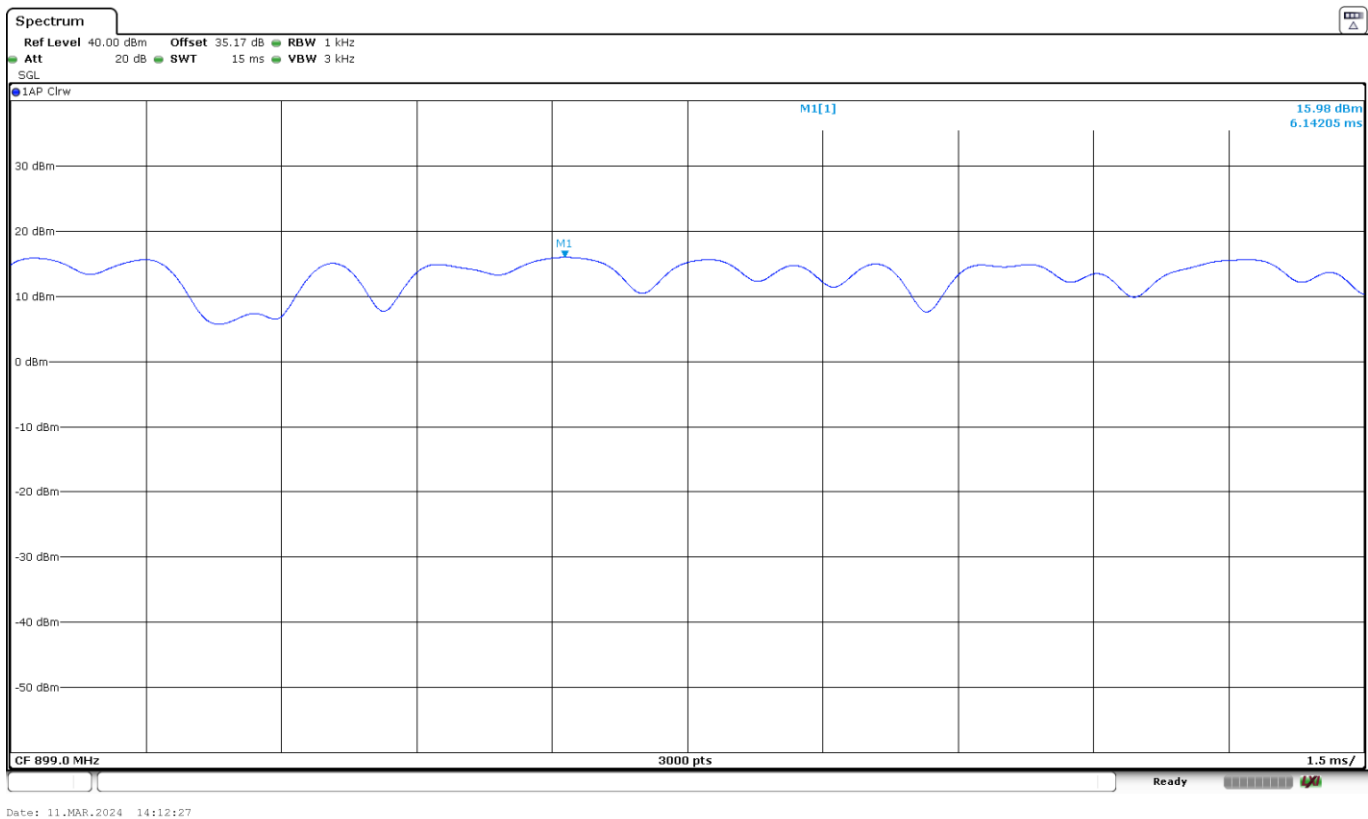
Test Setup



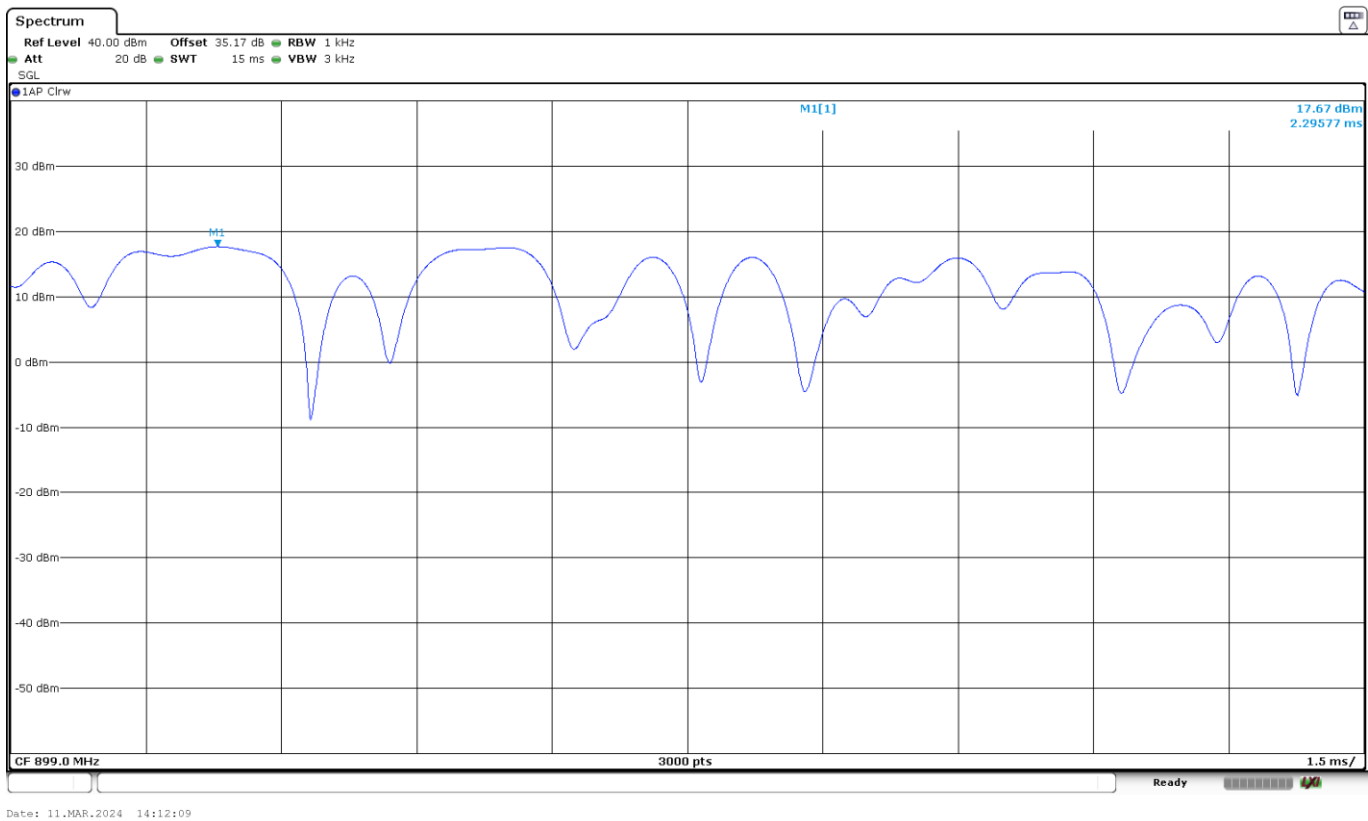
Results

The following plot shows the modulation schemes in the EUT.

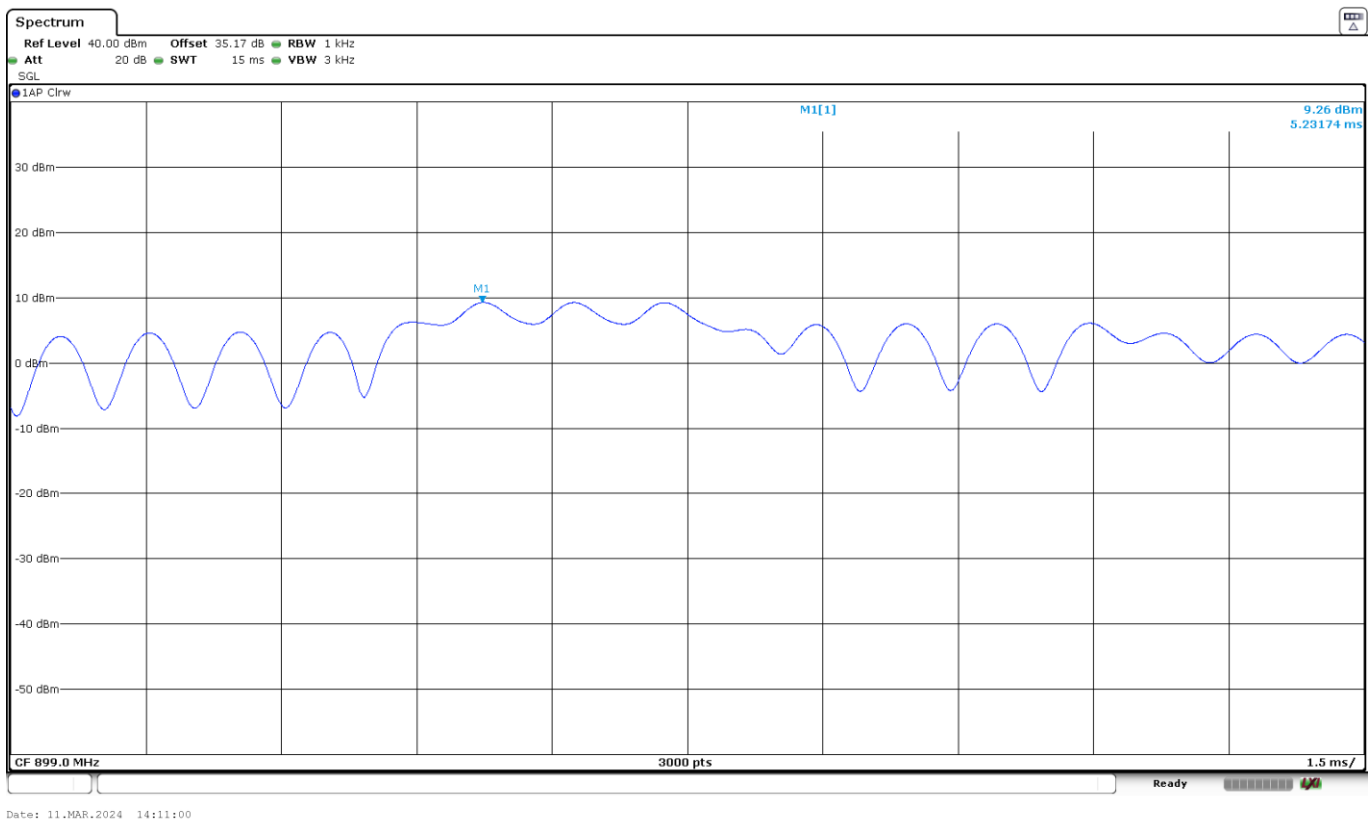
LTE Cat NB1 Band 8: Pi/2-BPSK. Low Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.



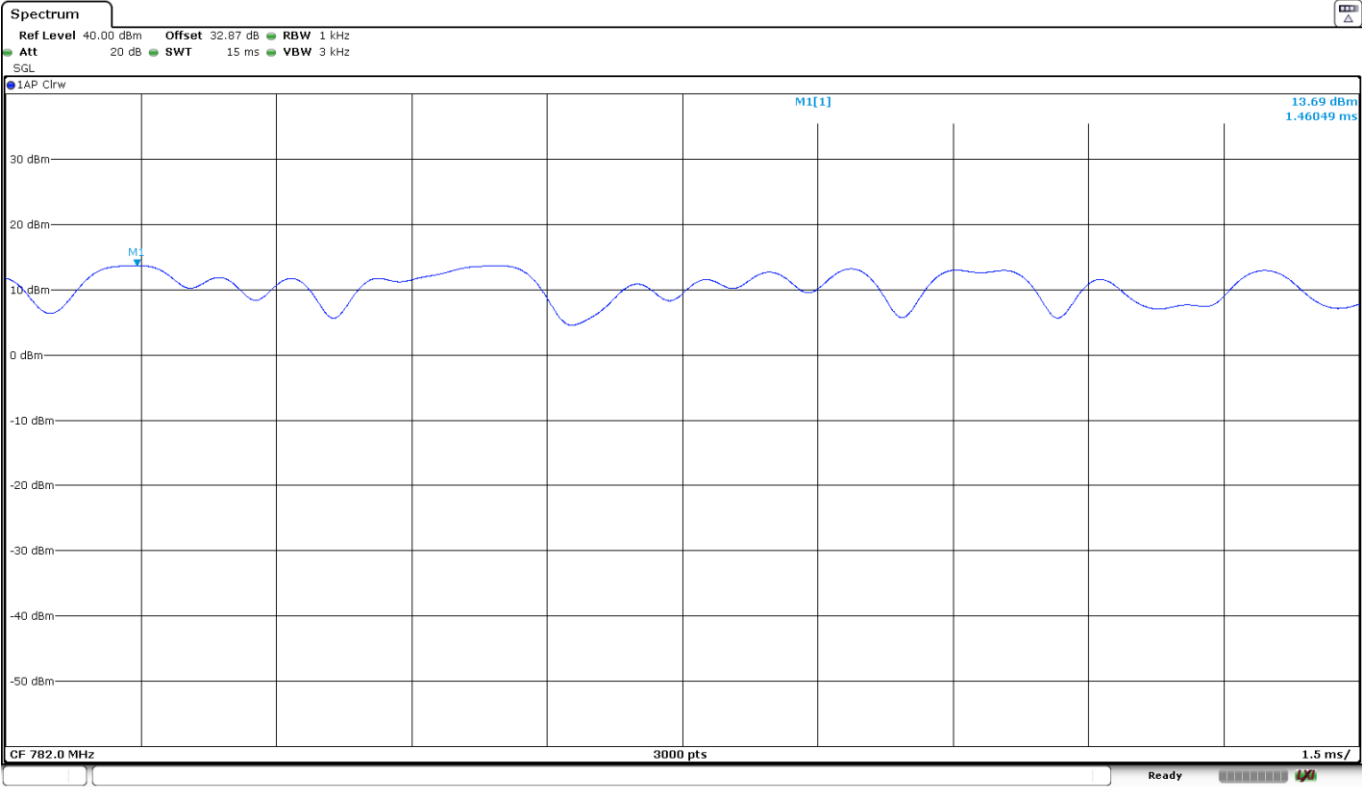
LTE Cat NB1 Band 8: Pi/4-QPSK. Low Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.



LTE Cat NB1 Band 8: QPSK. Low Channel. BW=15 kHz. Tone Number=3. Tone Offset=0. MSC/TBS=5.

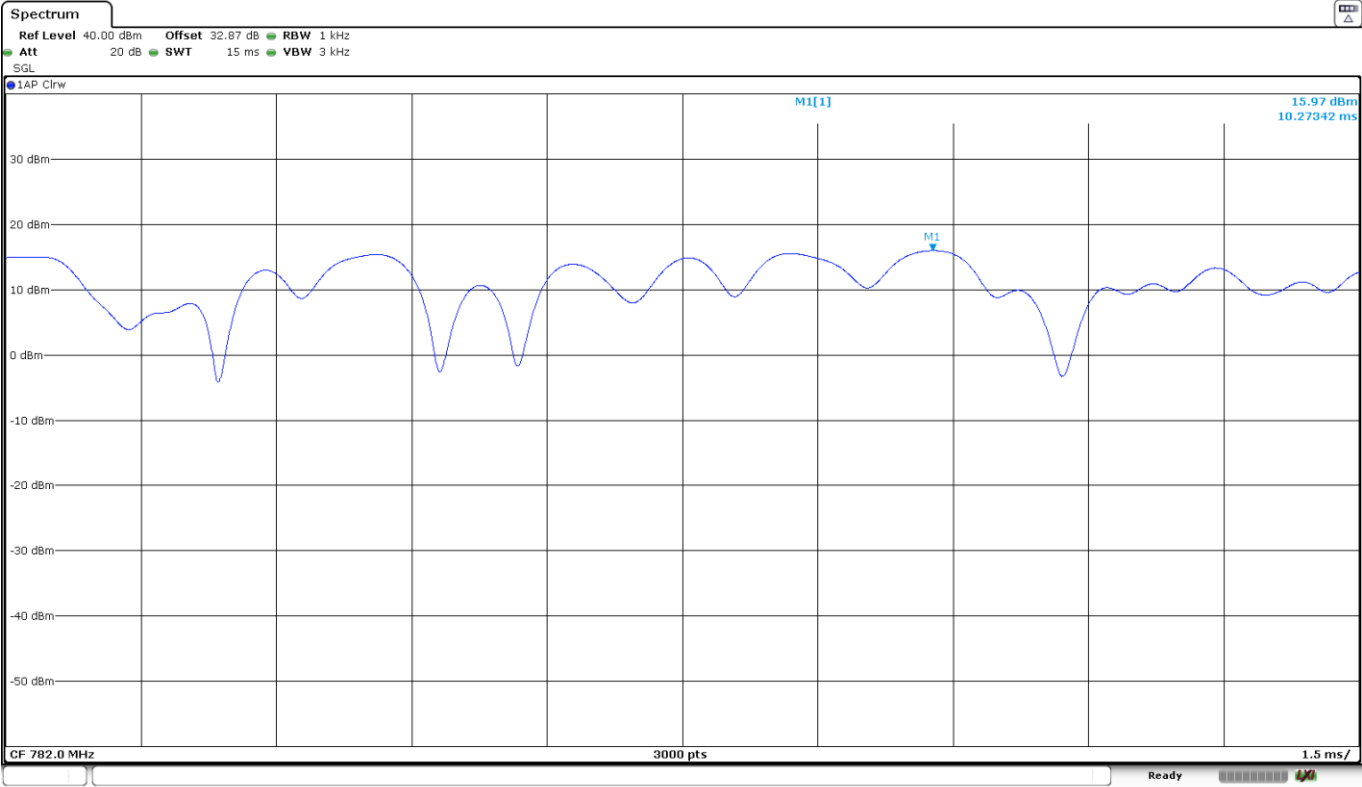


LTE Cat NB1 Band 13: Pi/2-BPSK. Low Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.



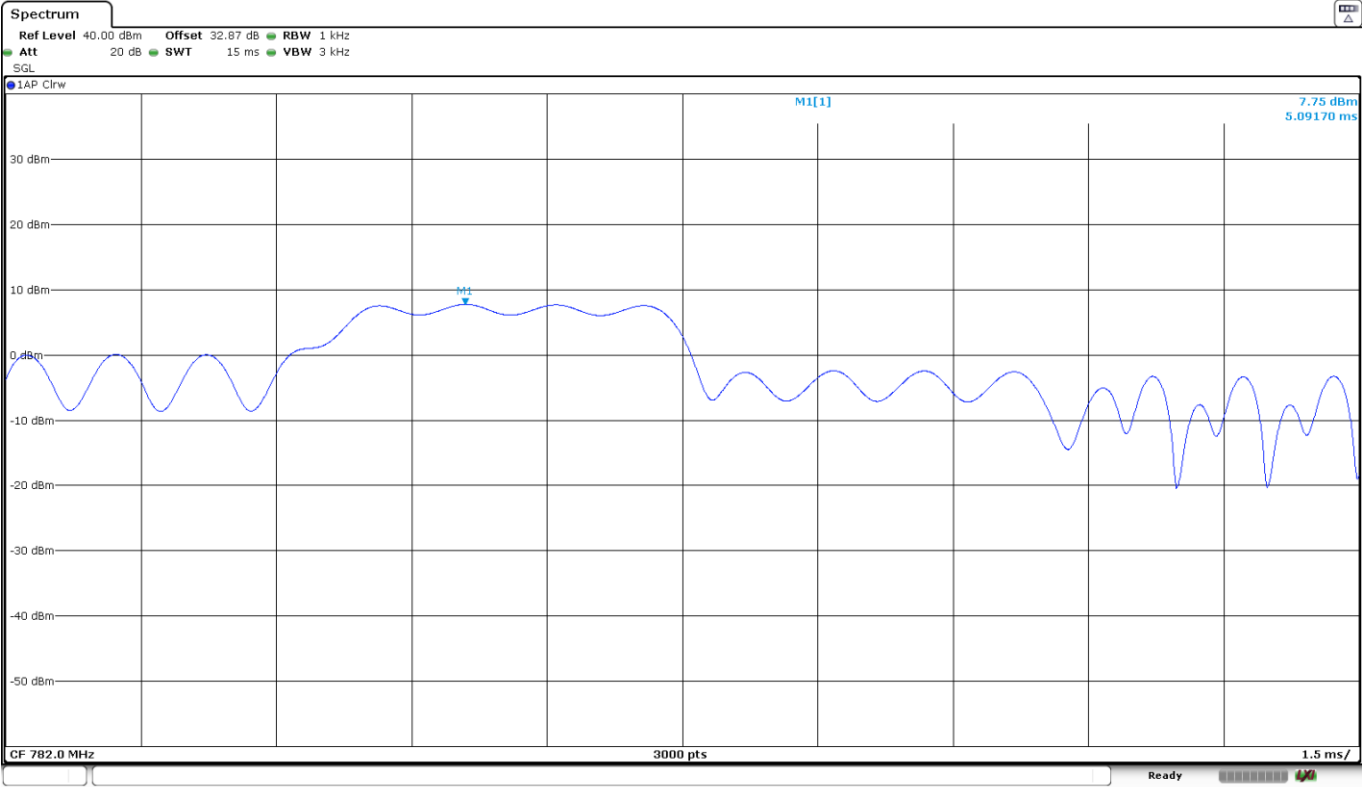
Date: 11.MAR.2024 12:54:39

LTE Cat NB1 Band 13: Pi/4-QPSK. Low Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.



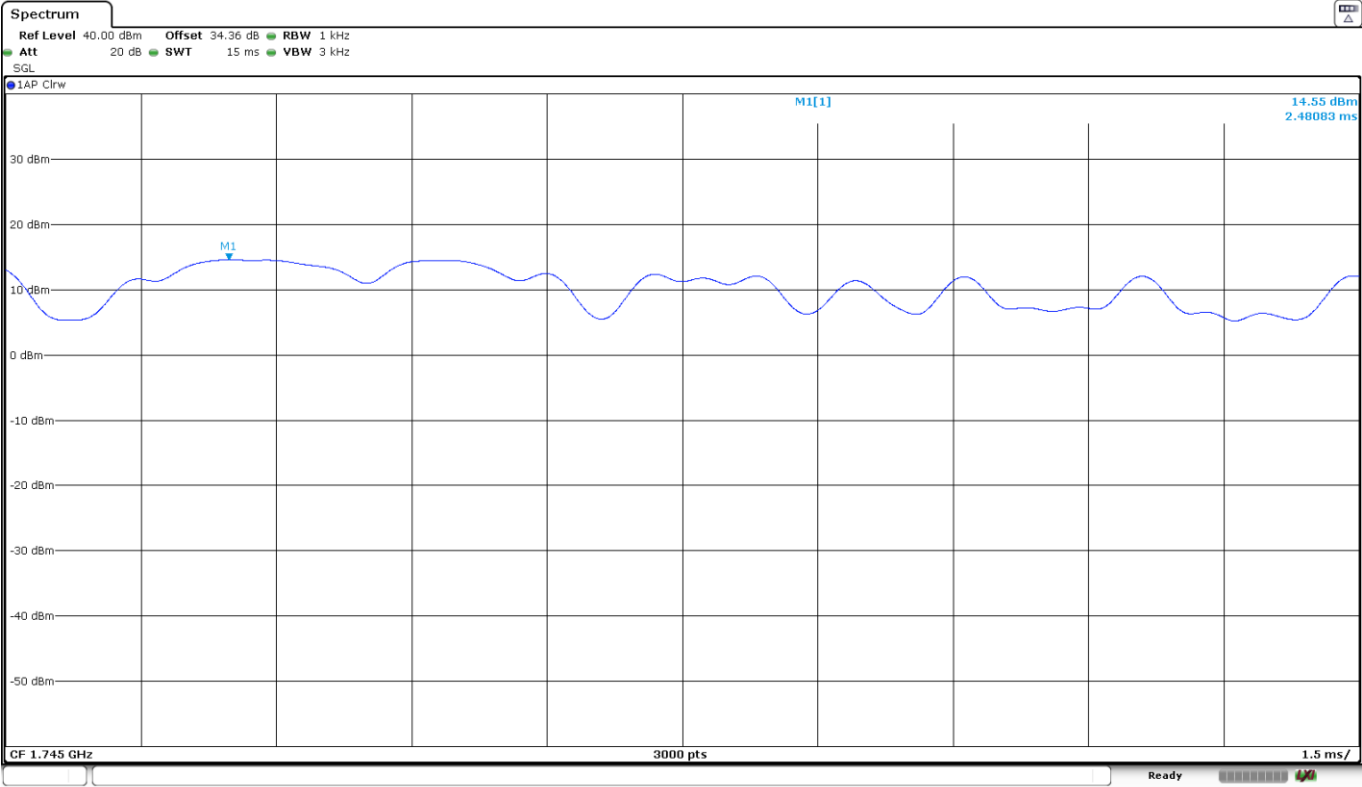
Date: 11.MAR.2024 12:54:24

LTE Cat NB1 Band 13: QPSK. Low Channel. BW=15 kHz. Tone Number=3. Tone Offset=0. MSC/TBS=5.



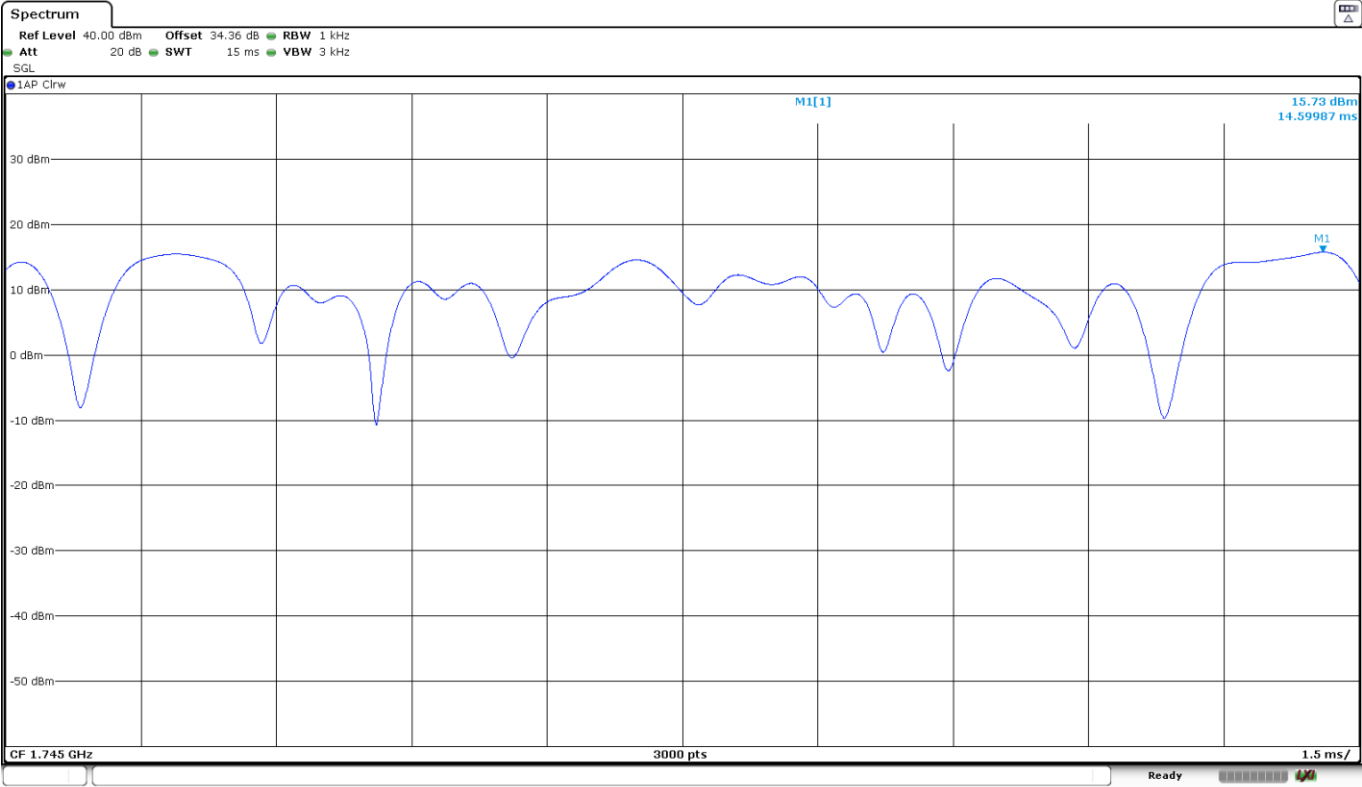
Date: 11.MAR.2024 12:53:43

LTE Cat NB1 Band 66: Pi/2-BPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.



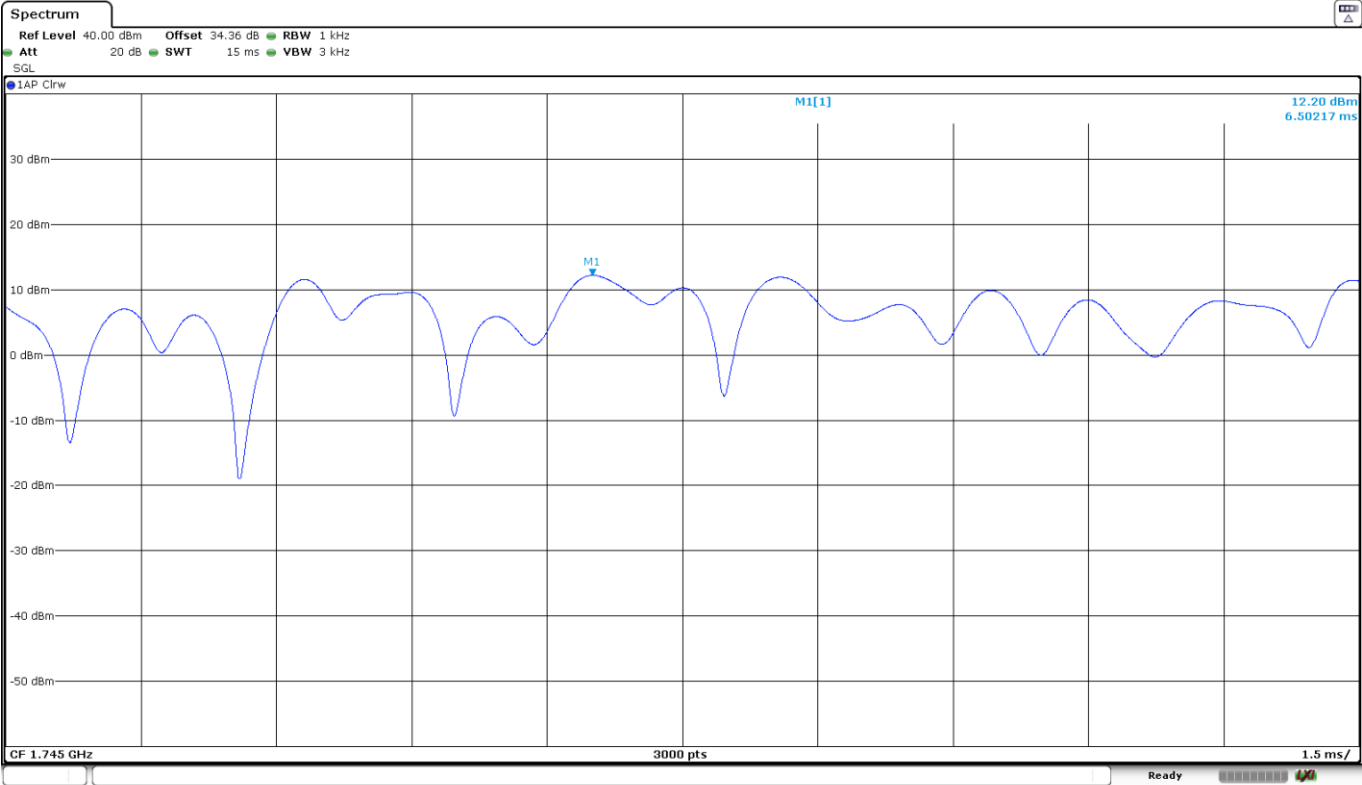
Date: 11.MAR.2024 13:14:12

LTE Cat NB1 Band 66: Pi/4-QPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.



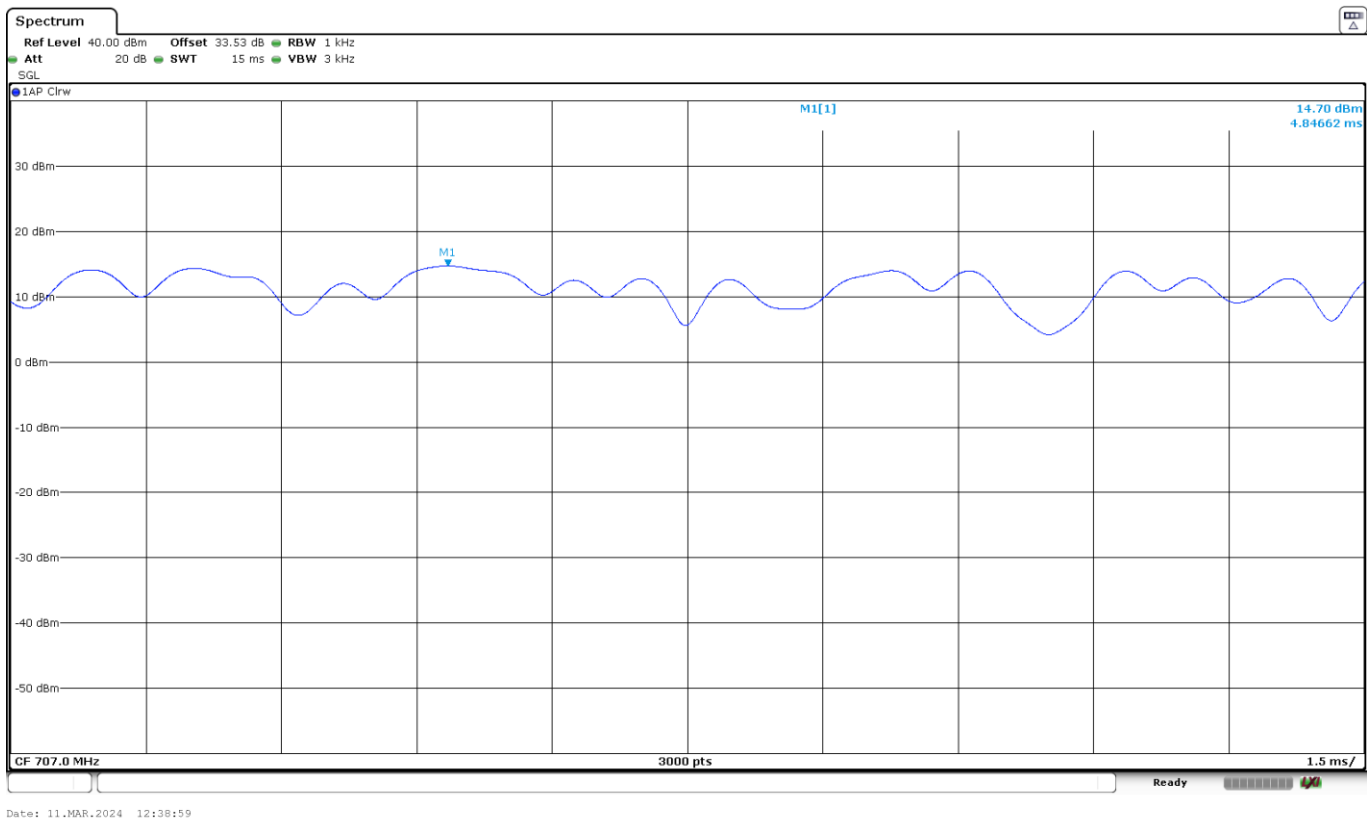
Date: 11.MAR.2024 13:15:04

LTE Cat NB1 Band 66: QPSK. Middle Channel. BW=15 kHz. Tone Number=3. Tone Offset=0. MSC/TBS=5.

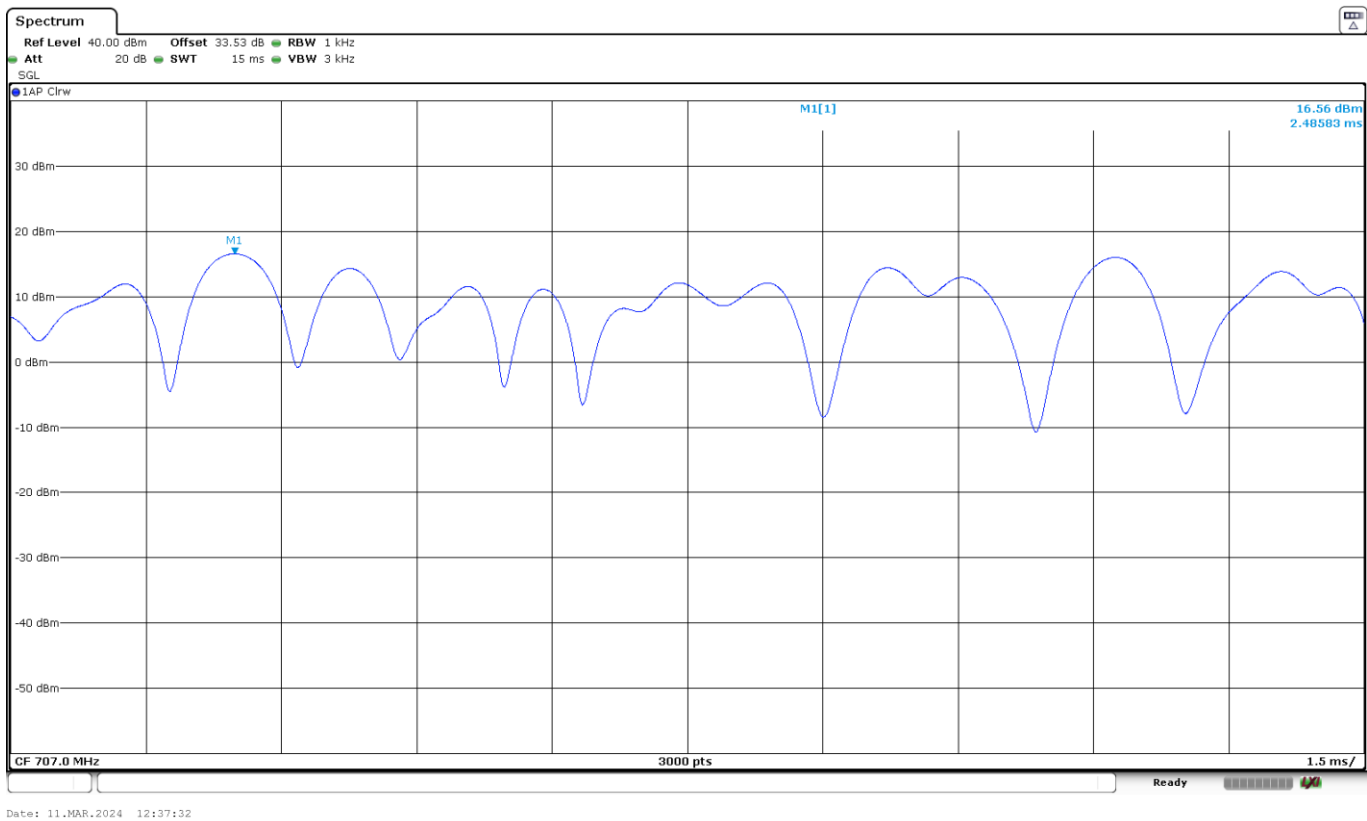


Date: 11.MAR.2024 13:16:47

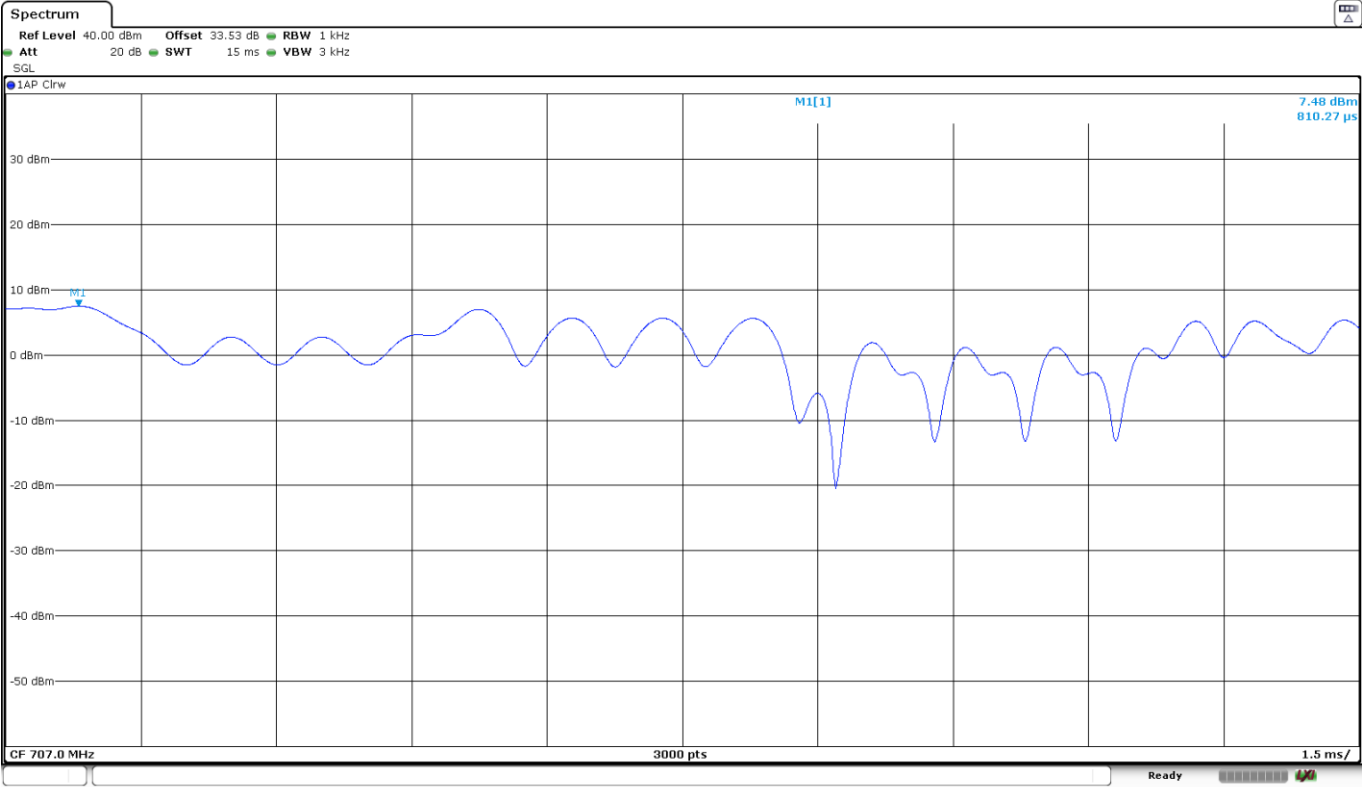
LTE Cat NB1 Band 85: Pi/2-BPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.



LTE Cat NB1 Band 85: Pi/4-QPSK. Middle Channel. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=3.



LTE Cat NB1 Band 85: QPSK. Middle Channel. BW=15 kHz. Tone Number=3. Tone Offset=0. MSC/TBS=5.



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.

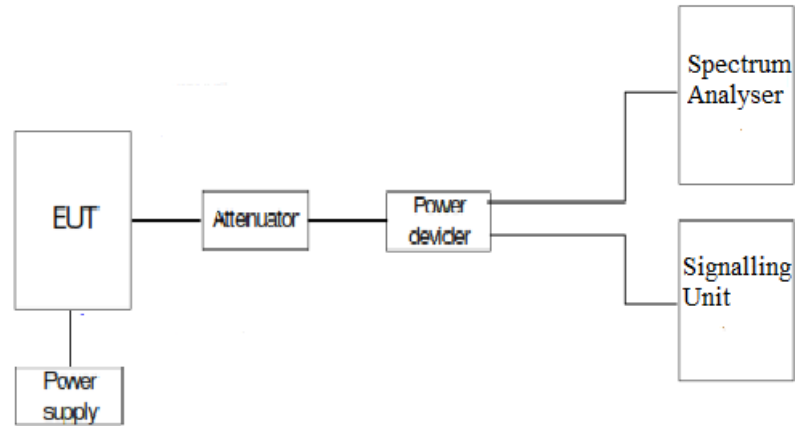
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

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.

Test Setup



Results

The worst case of occupied bandwidth corresponds to the following ones.

LTE Cat NB1 Band 8:

LTE Cat NB1 Band 8. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

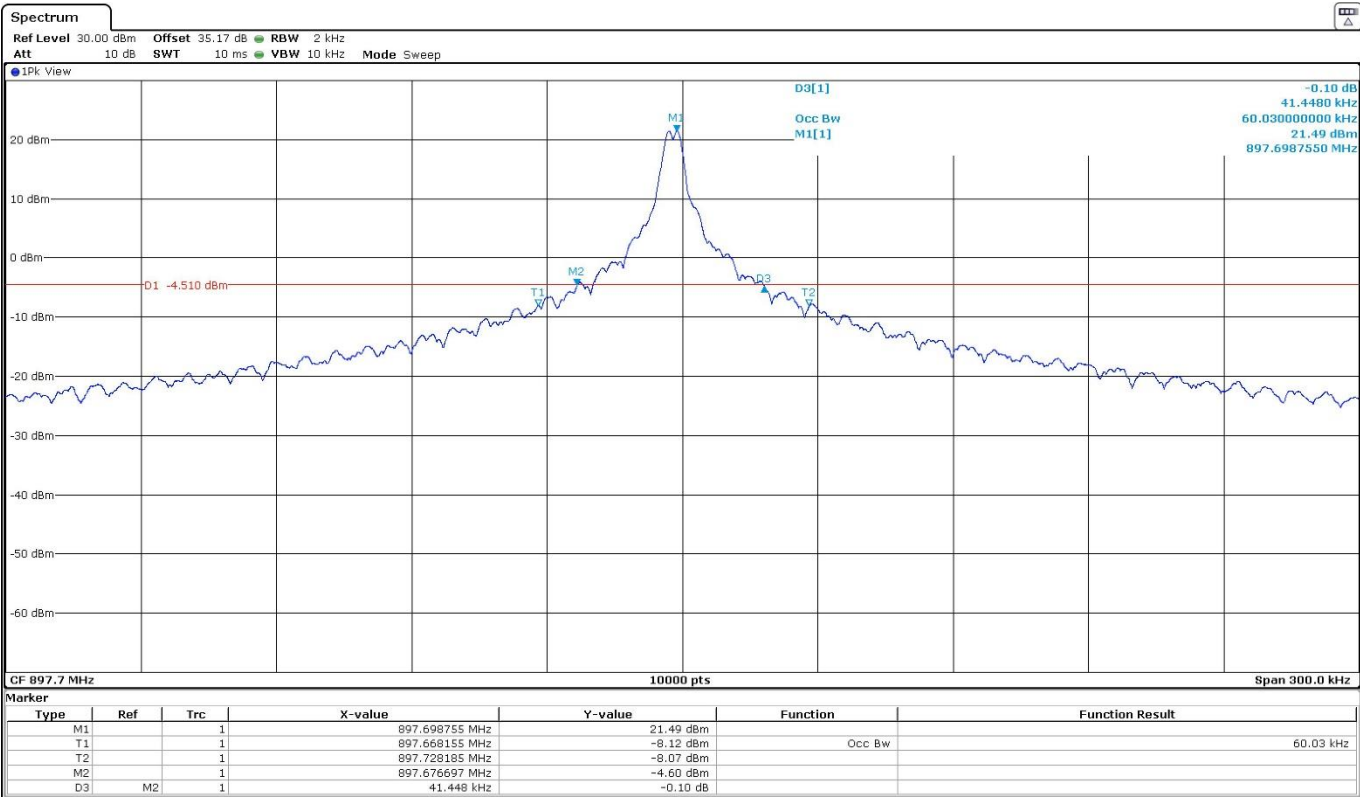
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	60.03000	59.82000
-26 dBc Bandwidth (kHz)	41.44800	41.19800
Measurement uncertainty (kHz)	<±0.35	

LTE Cat NB1 Band 8. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

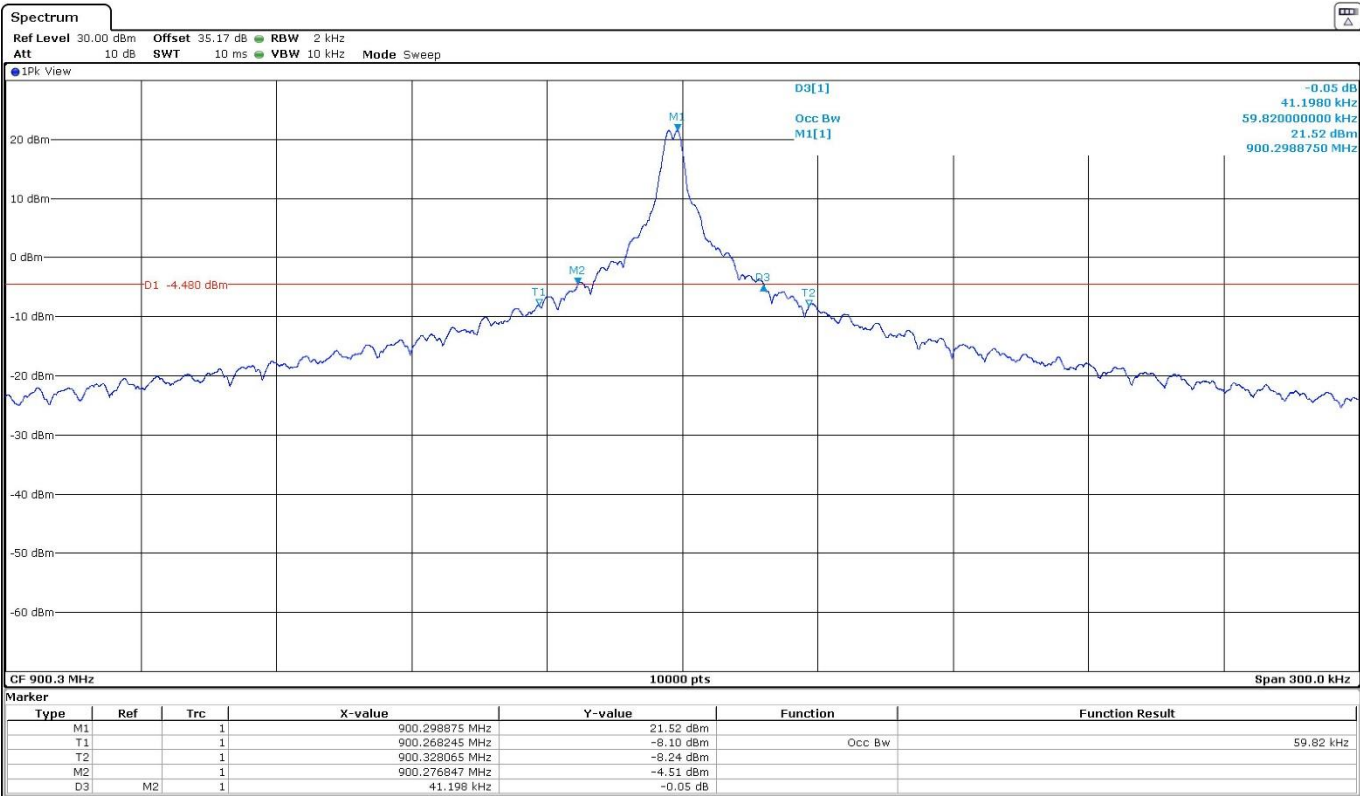
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	63.90000	63.45000
-26 dBc Bandwidth (kHz)	41.89800	41.85800
Measurement uncertainty (kHz)	<±0.35	

LTE Cat NB1 Band 8. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

Low Channel:

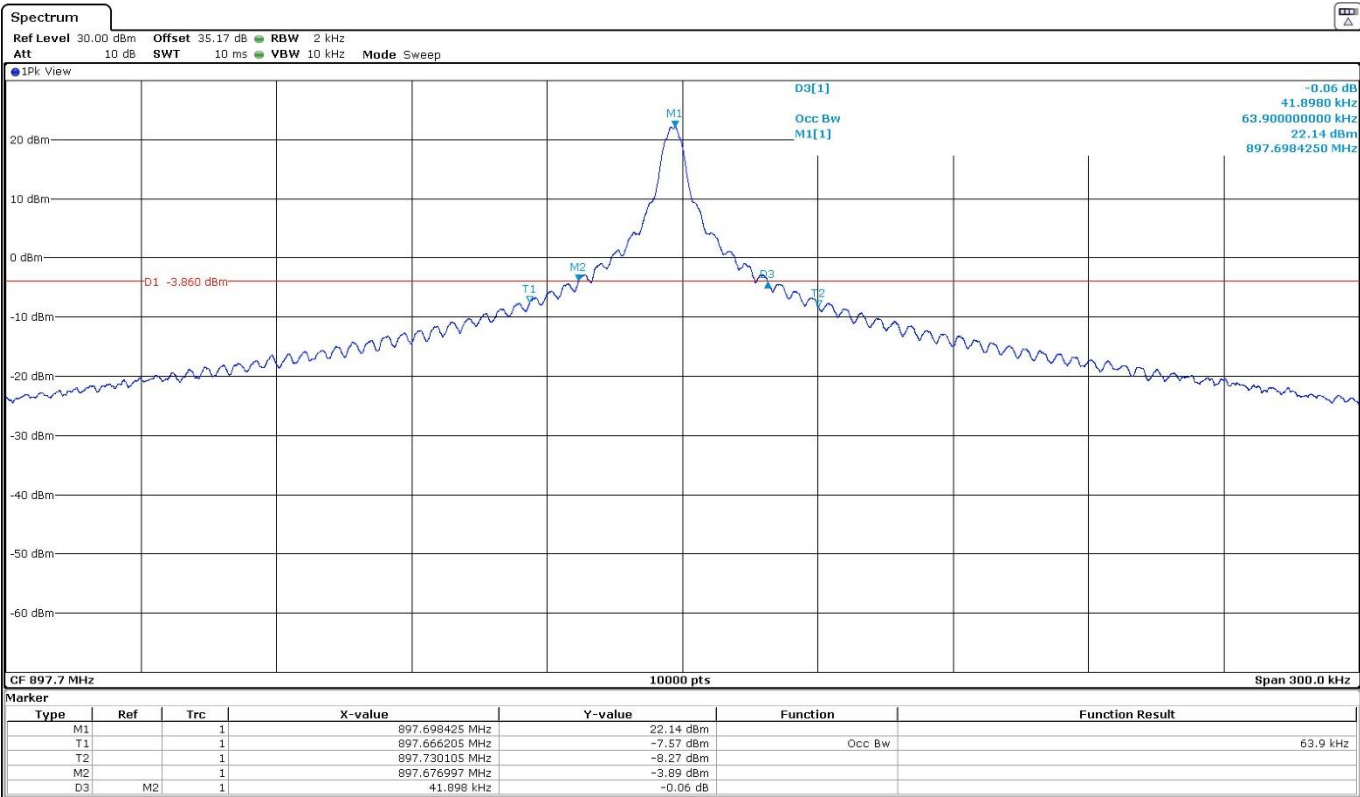


High Channel:

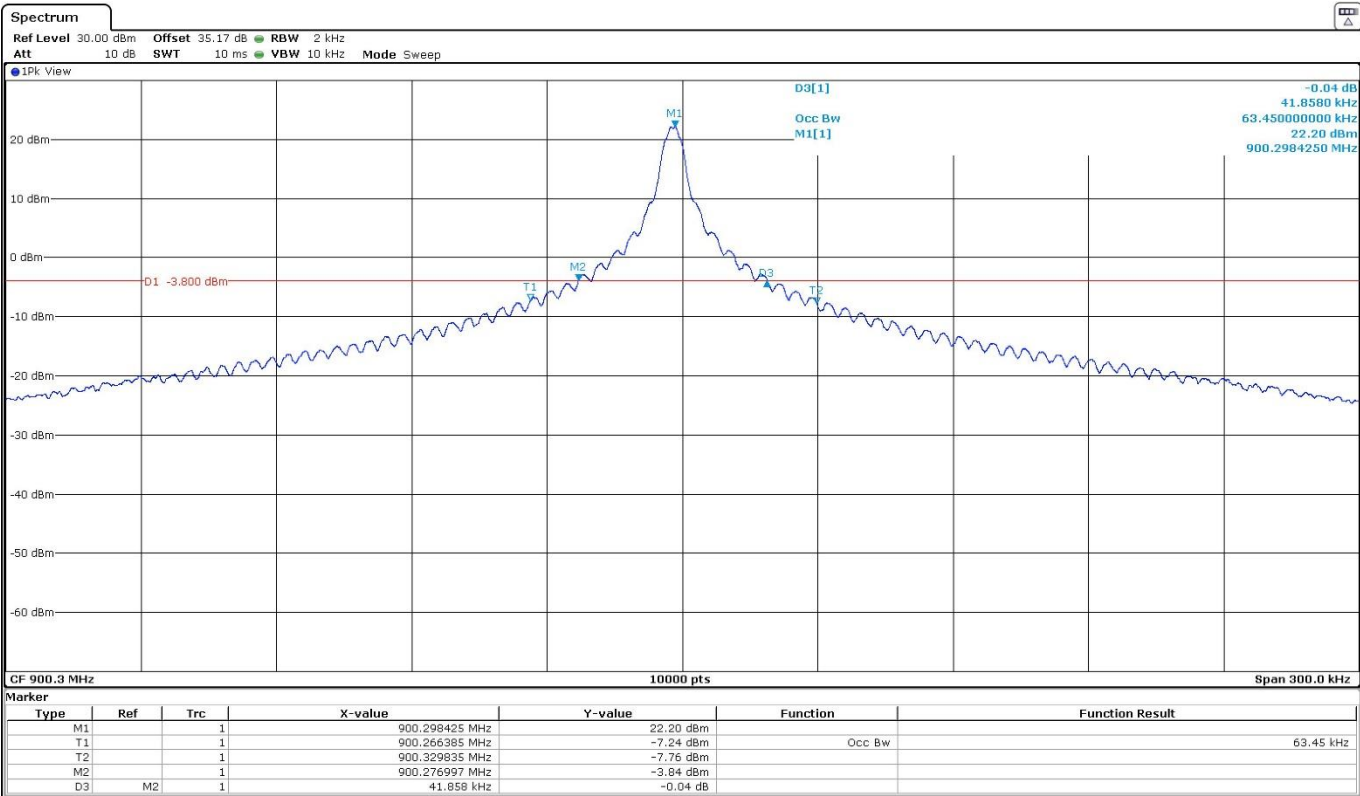


LTE Cat NB1 Band 8. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

Low Channel:



High Channel:



LTE Cat NB1 Band 8. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.

	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	125.82000	125.73000
-26 dBc Bandwidth (kHz)	123.33900	123.32800
Measurement uncertainty (kHz)	<±0.58	

LTE Cat NB1 Band 8. Pi/4-QPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=3.

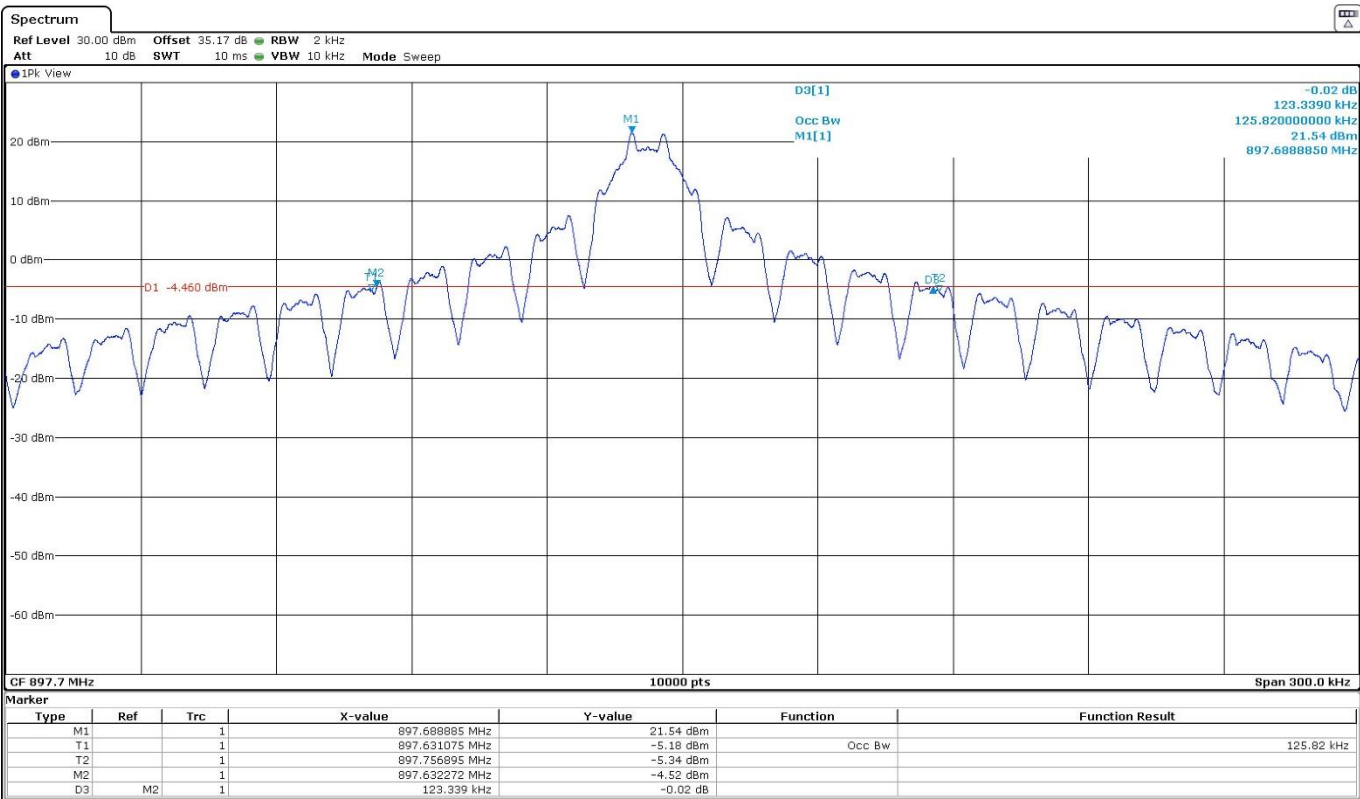
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	139.70000	140.25000
-26 dBc Bandwidth (kHz)	144.22500	153.40100
Measurement uncertainty (kHz)	<±0.58	

LTE Cat NB1 Band 8. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

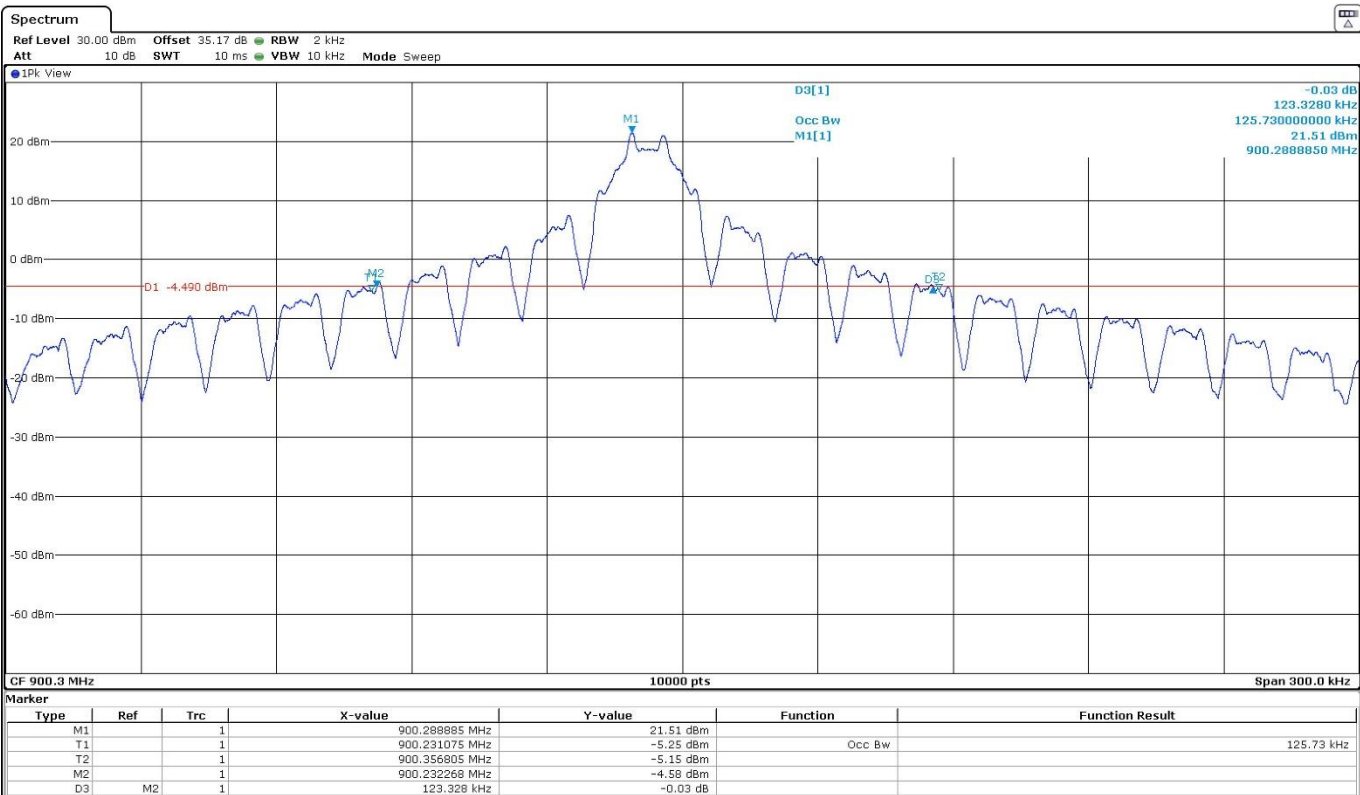
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	189.05000	188.60000
-26 dBc Bandwidth (kHz)	309.14500	309.83900
Measurement uncertainty (kHz)	<±0.58	

LTE Cat NB1 Band 8. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.

Low Channel:

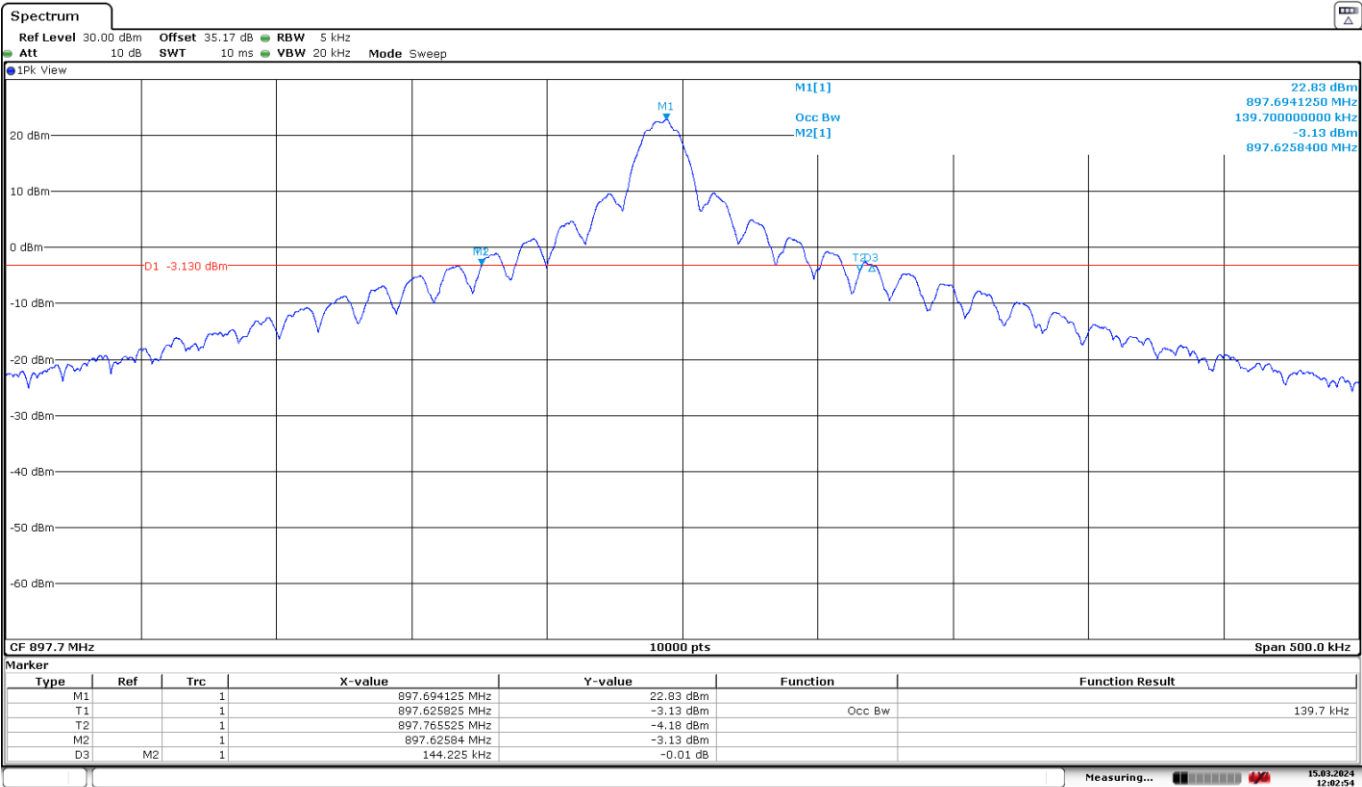


High Channel:



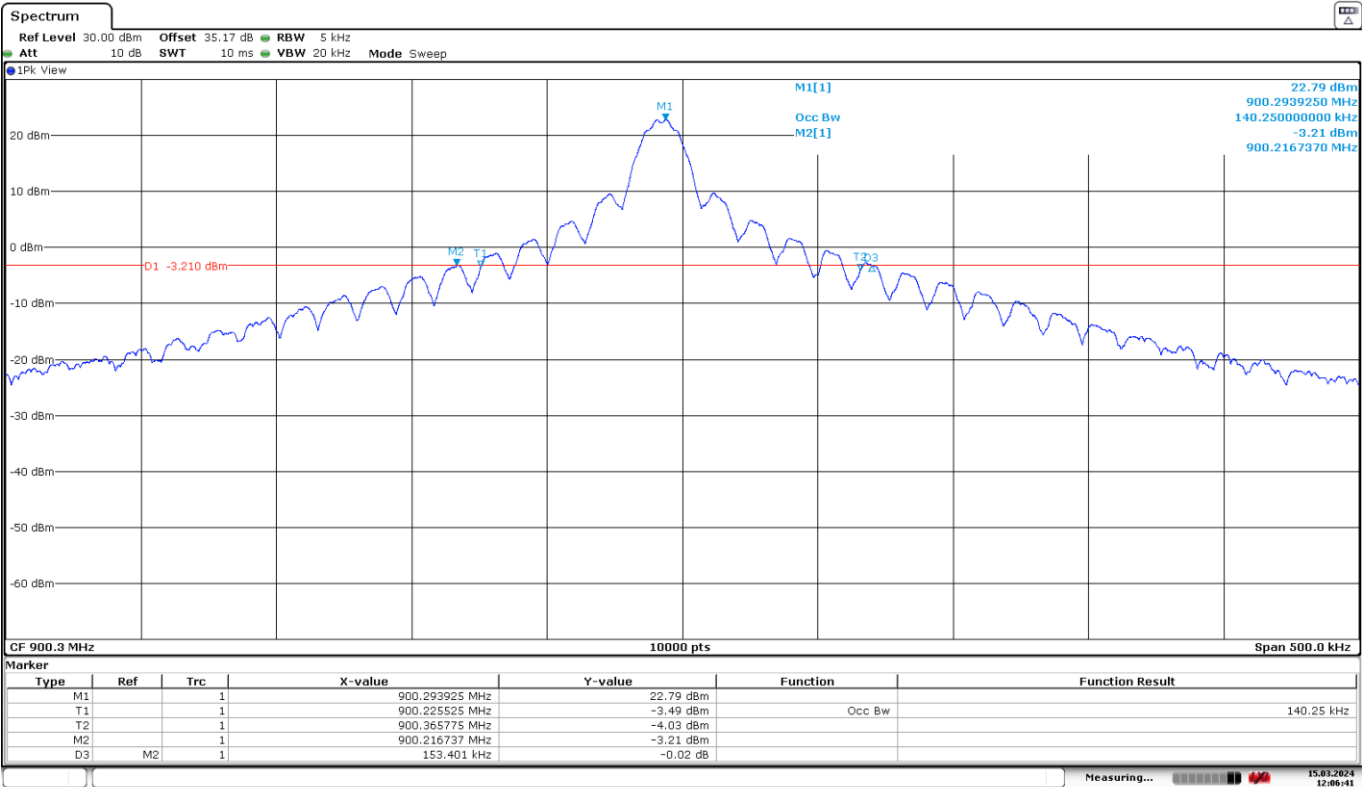
LTE Cat NB1 Band 8. Pi/4-QPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=3.

Low Channel:



Date: 15.MAR.2024 12:02:54

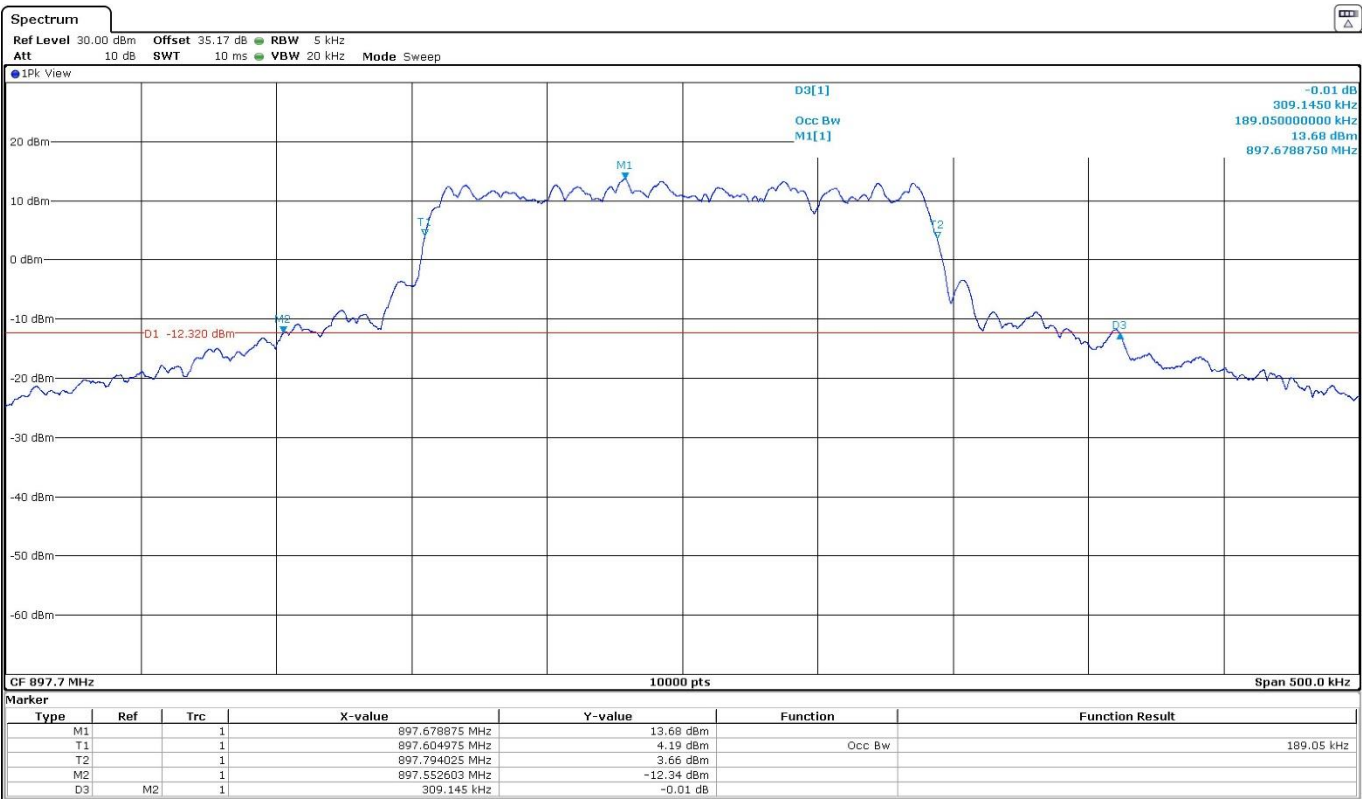
High Channel:



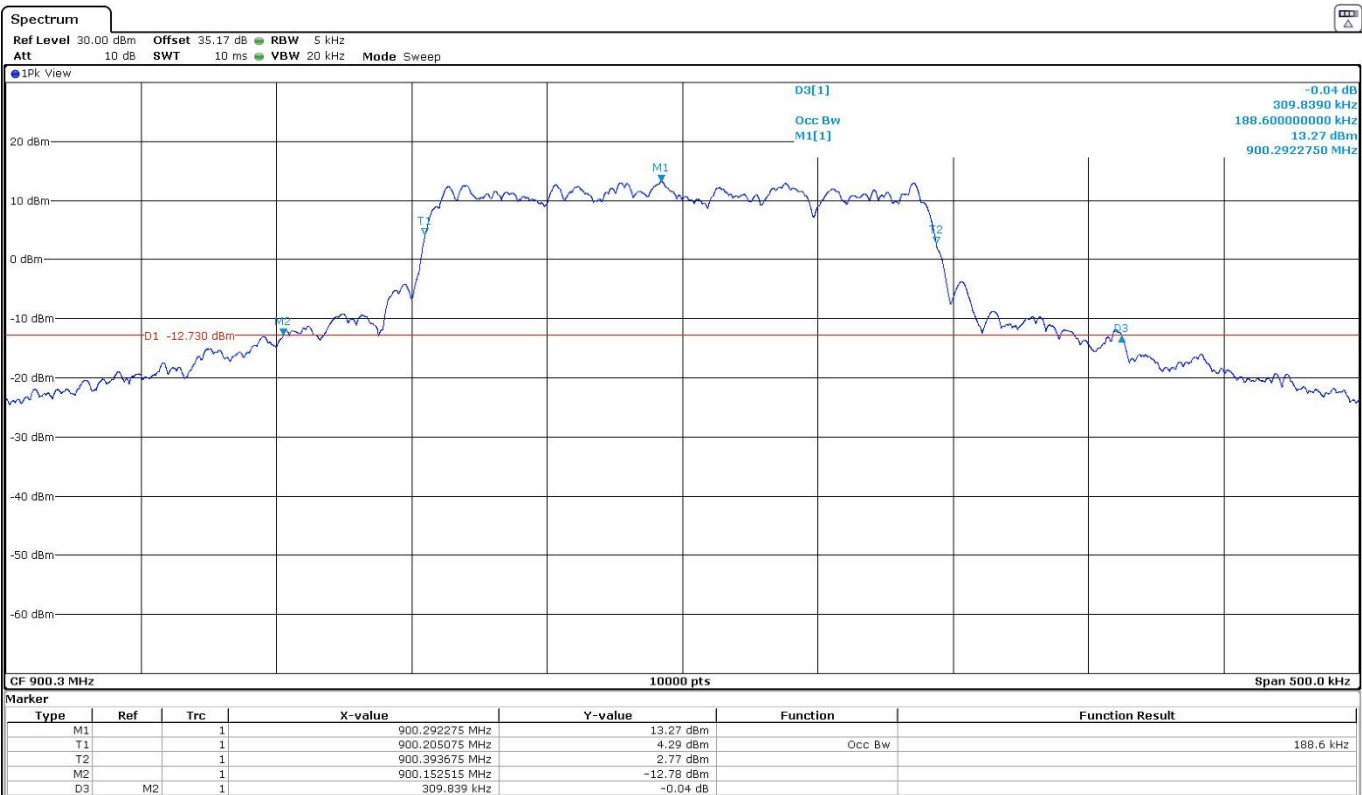
Date: 15.MAR.2024 12:06:41

LTE Cat NB1 Band 8. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

Low Channel:



High Channel:



LTE Cat NB1 Band 13:

LTE Cat NB1 Band 13. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

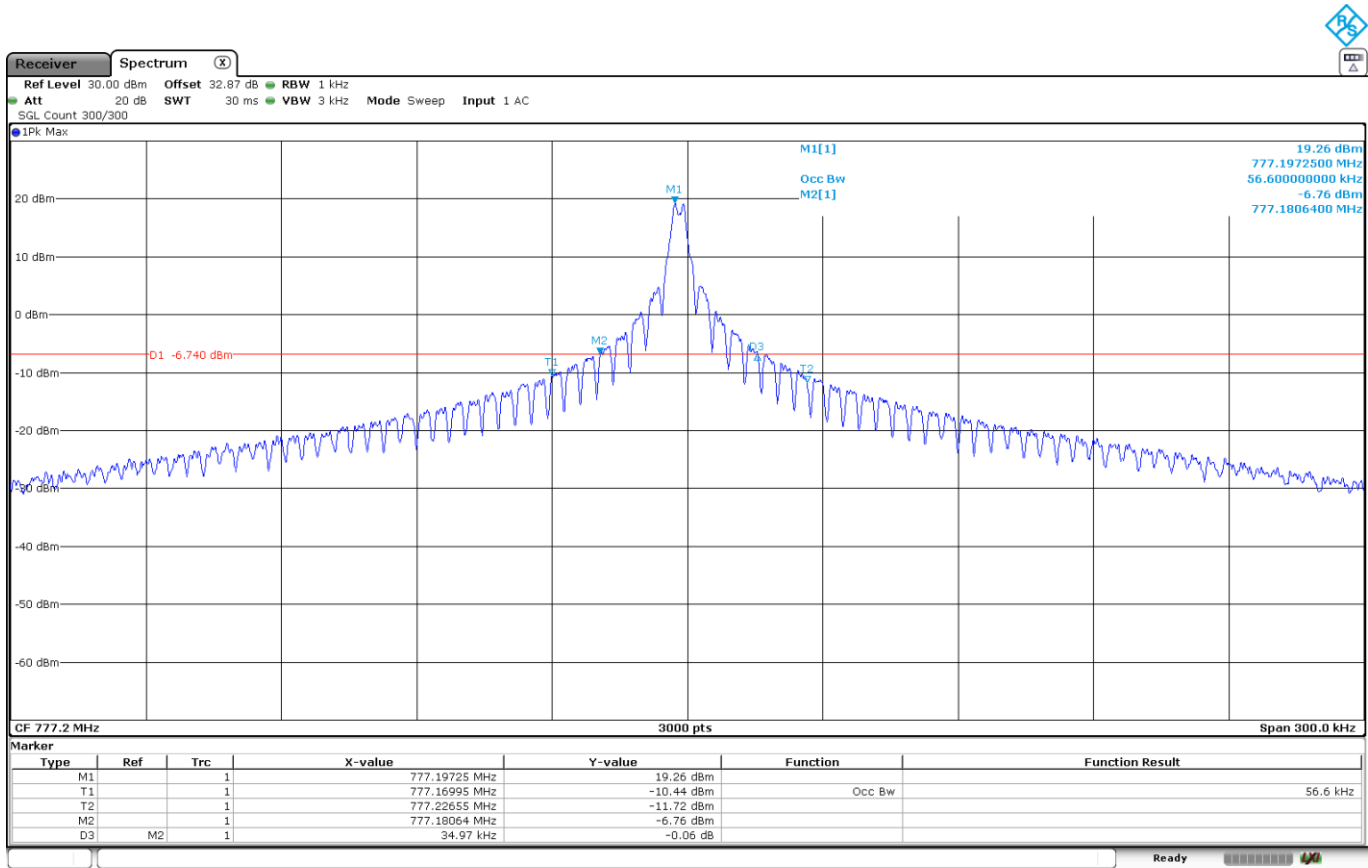
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	56.60000	56,00000
-26 dBc Bandwidth (kHz)	34.97000	35,01000
Measurement uncertainty (kHz)	<±0.35	

LTE Cat NB1 Band 13. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

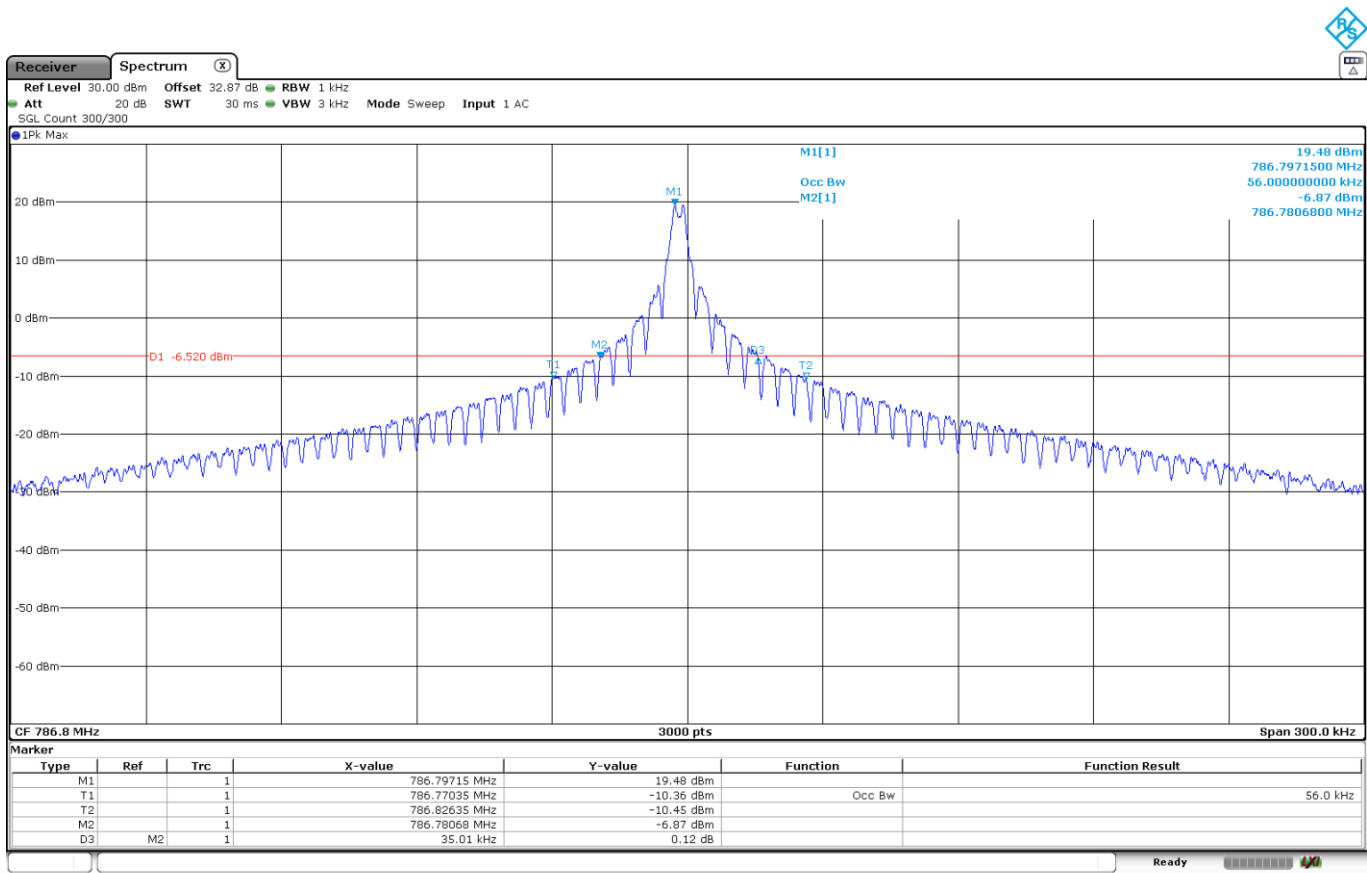
	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	55.50000	55.70000
-26 dBc Bandwidth (kHz)	40.77000	41.41000
Measurement uncertainty (kHz)	<±0.35	

LTE Cat NB1 Band 13. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

Low Channel:

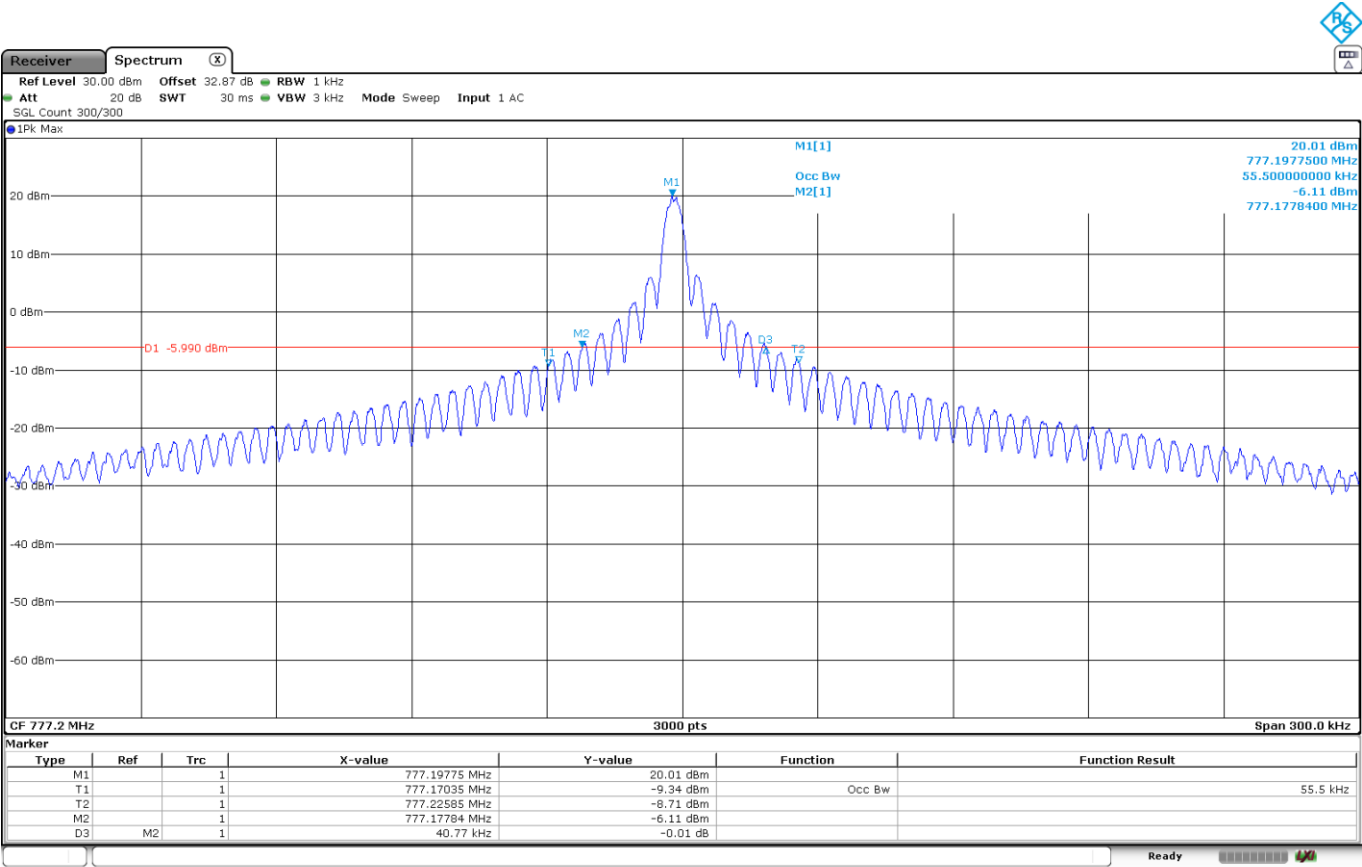


High Channel:

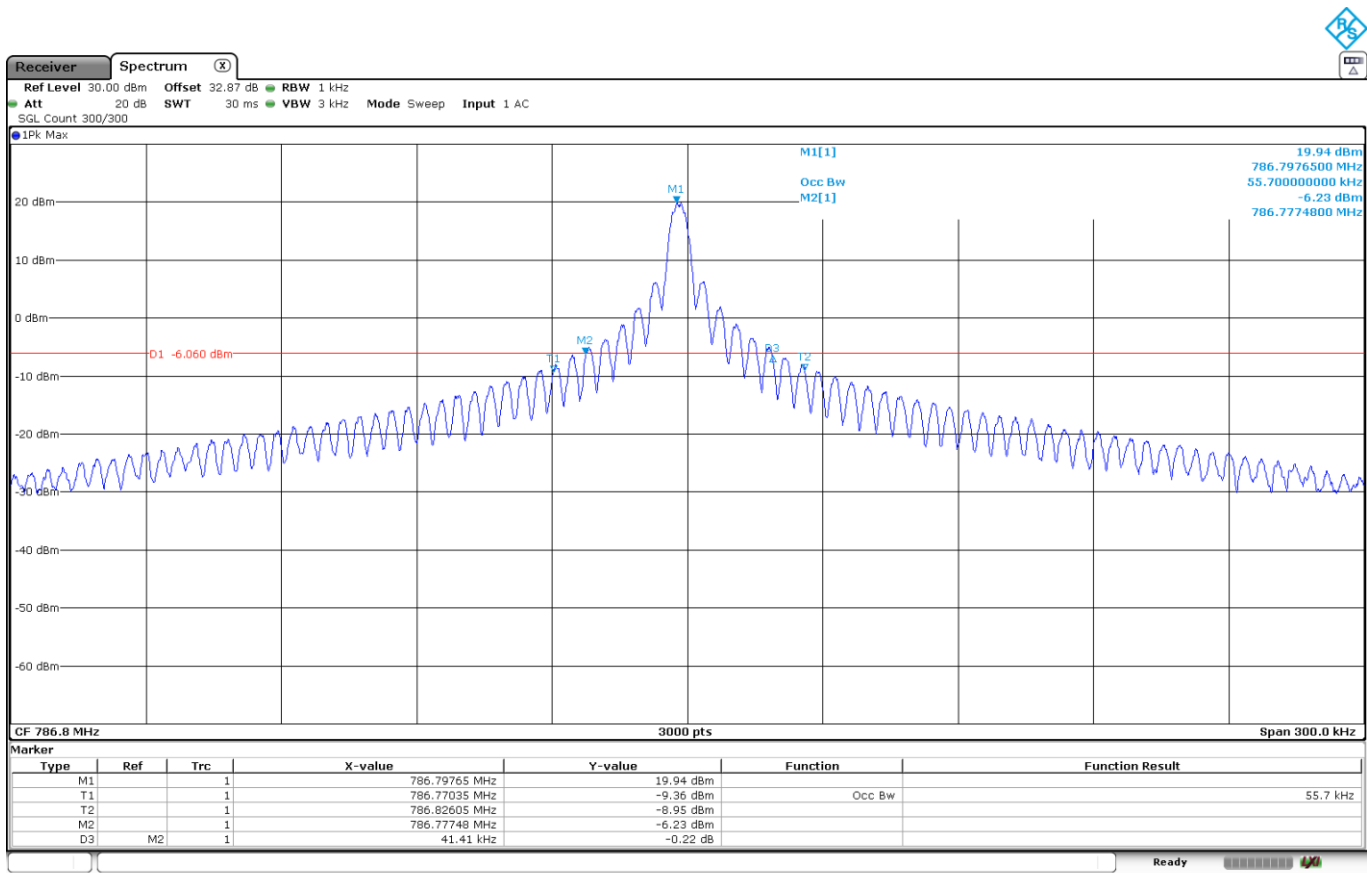


LTE Cat NB1 Band 13. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

Low Channel:



High Channel:



LTE Cat NB1 Band 13. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.

	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	131.16667	131.16667
-26 dBc Bandwidth (kHz)	128.31000	128.32000
Measurement uncertainty (kHz)	<±0.58	

LTE Cat NB1 Band 13. Pi/4-QPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=3.

	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	136.66667	137.00000
-26 dBc Bandwidth (kHz)	154.04700	144.25800
Measurement uncertainty (kHz)	<±0.58	

LTE Cat NB1 Band 13. QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

	Low Channel	High Channel
99% Occupied Bandwidth (kHz)	189.50000	188.83333
-26 dBc Bandwidth (kHz)	306.00000	308.57000
Measurement uncertainty (kHz)	<±0.58	