



FCC LISTED.
REGISTRATION NUMBER:
720267

ISED LISTED
REGISTRATION NUMBER
ISED 4621A-4

Test report No:
NIE: 59675RRF.002

Test report

REFERENCE STANDARD:
USA FCC Part 24 & Part 27
CANADA IC RSS-130. RSS-133. RSS-139

Identification of item tested	IOT Module
Trademark	nRF91
Model and /or type reference	nRF9160
Other identification of the product	FCC ID: 2ANPO00NRF9160 IC: 24529-NRF9160 IMEI TAC: 35265610
Features	LTE Cat-M1. LTE-NB1. GPS
Applicant	Nordic Semiconductor ASA Otto Nielsens Vei 12, 7052 Trondheim, NORWAY
Test method requested. standard	USA FCC Part 24 10-1-18 Edition. USA FCC Part 27 10-1-18 Edition. CANADA IC RSS-130 Issue 1. Oct. 2013. CANADA IC RSS-133 Issue 6. Jan. 2013. CANADA IC RSS-139 Issue 3. Jul. 2015. ANSI C63.26 – 2015
Summary	IN COMPLIANCE
Approved by (name / position & signature)	A. Llamas RF Lab. Manager
Date of issue	2019-06-03
Report template No	FDT08_20

Index

Competences and guarantees3

General conditions3

Uncertainty3

Usage of samples4

Data provided by the client.....4

Test sample description4

Identification of the client.....6

Testing period and place.....6

Document history6

Environmental conditions6

Remarks and comments7

Testing verdicts.....8

Summary8

Appendix A: Test results for FCC Part 24 / RSS-1339

Appendix B: Test results for FCC Part 27 / RSS-139 / RSS-13044

Competences and guarantees

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

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212. Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-4.

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

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

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

The results presented in this Test Report apply only to the particular item under test established in this document.

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General conditions

1. This report is only referred to the item that has undergone the test.
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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 internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: the client.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
59678C/004	IOT Module	nRF9160	IMEI: 352656100030561	2019-01-15

1. Sample S/01 has undergone the following test(s):

All tests indicated in appendixes A and B.

Data provided by the client

The sample consist of a IOT Module that has Application CPU. LTE Cat-M1. Cat-NB1 Radio and GPS Receiver.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Test sample description

Ports..... :	Port name and description	Cable				
		Specified length [m]	Attached during test	Shielded		
	LTE RF	2	☒	☒		
	GPS	2	☒	☒		
			☐	☐		
Supplementary information to the ports..... :	N/A					
Rated power supply	Voltage and Frequency	Reference poles				
		L1	L2	L3	N	PE
	☐ AC:	☐	☐	☐	☐	☐
	☒ DC: 3.1 – 5.5Vdc.					
	☐ DC:					
Rated Power	1W					
Clock frequencies	32kHz. 32MHz					

Other parameters.....:	---		
Software version	mfw_nrf9160_0.7.0-29.alpha		
Hardware version.....:	DEV2.1.6		
Dimensions in cm (L x W x D)	11x16x1.1mm		
Mounting position.....:	☐	Table top equipment	
	☐	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☒	Other: SMD Module	
Modules/parts	Module/parts of test item	Type	Manufacturer
	N/A		
Accessories (not part of the test item)	Description	Type	Manufacturer
	N/A		
	N/A		
	N/A		
Documents as provided by the applicant.....:	Description	File name	Issue date
	User manual	4418_1177-0.3.1-20180905-140910-nRF9160_Objective_Product_Spec	23-Oct-2018
	Cover markings	SiP marking	23-Oct-2018

Copy of marking plate:



Identification of the client

NORDIC SEMICONDUCTOR ASA

Otto Nielsens Vei 12, 7052 Trondheim, NORWAY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2018-01-30
Date (finish)	2018-04-25

Document history

Report number	Date	Description
59675RRF.002	2019-06-03	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 Alberto Aranda.

Used instrumentation:

Conducted Measurements

	Last Cal. date	Cal. due date
1. Spectrum analyser Agilent E4440A	2017/10	2019/10
2. Vector signal analyzer Rohde & Schwarz FSQ8	2018/08	2020/08
3. Climatic chamber HERAEUS VM 04/35	2018/06	2020/06
4. DC power supply R&S NGPE 40/40	2018/02	2021/02
5. Universal Radio communication Tester R&S CMW50	2019/02	2020/02
6. Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07

Radiated Measurements

	Last Cal. date	Cal. due date
1. Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2. BiconicalLog antenna ETS LINDGREN 3142E	2017/09	2020/09
3. Multi Device Controller MESSTECHNIK DAV-RR	N.A.	N.A.
4. Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2018/01	2021/01
5. Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2018/07	2021/07
6. Spectrum analyser Rohde & Schwarz FSV40	2018/02	2020/02
7. EMI Test Receiver R&S ESU26	2018/02	2020/02
8. RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2019/04	2020/04
9. RF pre-amplifier 18-40 GHz NARDA JS44-18004000-33-8P	2019/02	2020/02
10. RF pre-amplifier 30-6 GHz Bonn Elektronik BLMA 0160-01N	2019/02	2020/08

Testing verdicts

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

Summary

FCC PART 24/IC RSS-133 PARAGRAPH		
Requirement – Test case	Verdict	Remark
Clause 24.232/RSS-133 Clause 6.4: RF output power	P	
Clause 2.1047/RSS-133 Clause 6.2: Modulation characteristics	P	
Clause 24.235/RSS-133 Clause 6.3: Frequency stability	P	
Clause 2.1049: Occupied Bandwidth	P	
Clause 24.238/RSS-133 Clause 6.5: Spurious emissions at antenna terminals	P	
Clause 24.238/RSS-133 Clause 6.5: Radiated emissions	P	
<u>Supplementary information and remarks:</u>		
None		

FCC PART 27 / RSS-139 / RSS-130 PARAGRAPH		
Requirement – Test case	Verdict	Remark
Clause 27.50 / RSS-139 Clause 6.5. / RSS-130 Clause 4.4.: RF output power	P	
Clause 2.1047 / RSS-139 Clause 6.2. / RSS-130 Clause 4.1.: Modulation characteristics	P	
Clause 27.54 / RSS-139 Clause 6.4. / RSS-130 Clause 4.3.: Frequency stability	P	
Clause 2.1049: Occupied Bandwidth	P	
Clause 27.53 / RSS-139 Clause 6.6. / RSS-130 Clause 4.6.: Spurious emissions at antenna terminals	P	
Clause 27.53 / RSS-139 Clause 6.6. / RSS-130 Clause 4.6.: Radiated emissions	P	
<u>Supplementary information and remarks:</u>		
None.		

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

TEST CONDITIONS.....	11
RF Output Power	12
Frequency Stability	16
Modulation Characteristics	20
Occupied Bandwidth	22
Spurious emissions at antenna terminals.....	30
Spurious emissions at antenna terminals at Block Edges.....	34
Radiated emissions.....	37

TEST CONDITIONS

Power supply (V):

Vnominal = 3.8 Vdc

Vmax = 4.37 Vdc

Vmin = 3.23 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 external power supply

Type of antenna = Integral antenna.

Declared Gain for antenna = +4.4 dBi.

TEST FREQUENCIES:

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 2)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
18602 (1850.2)	18900 (1880)	19198 (1909.8)

NOTE: Band 2 is completely included in band 25. so the channels of band 25 were tested to give conformity to the assigned block.

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 25)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
26042 (1850.2)	26365 (1882.5)	26688 (1914.8)

RF Output Power

SPECIFICATION

FCC §2.1046 and §24.232

Mobile/portable stations are limited to 2 Watts (33 dBm) Effective Isotropic Radiated Power (E.I.R.P.).
The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

RSS-133. Clause 6.4.

The peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest 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 peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

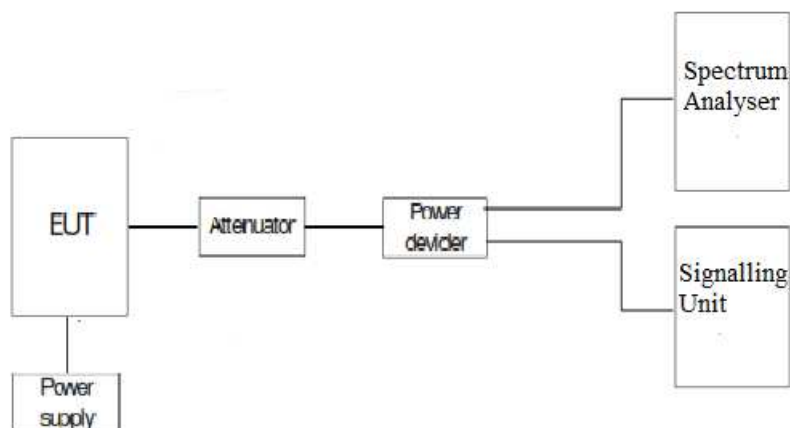
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Conducted average power.



Peak-to-average power ratio (PAPR)



RESULTS

MAXIMUM OUTPUT POWER (CONDUCTED).

NB-IoT. BAND 25.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)	PAPR (dB)
26042	1850.2	$\pi/2$ - BPSK	3.75	1	0	23.02	(*)
				1	47	22.96	(*)
			15	1	0	22.97	(*)
				1	11	22.95	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.98	(*)
				1	47	22.91	(*)
			15	1	0	23.05	(*)
				1	11	22.96	(*)
				3	0	22.96	3.43
				3	6	23.31	3.21
				6	0	22.18	4.21
				6	6	22.31	4.21
				12	0	21.28	3.81
26365	1882.5	$\pi/2$ - BPSK	3.75	1	0	22.48	(*)
				1	47	22.45	(*)
			15	1	0	22.42	(*)
				1	11	22.36	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.45	(*)
				1	47	22.44	(*)
			15	1	0	22.4	(*)
				1	11	22.25	(*)
				3	0	21.3	3.22
				3	6	21.29	4.54
				6	0	21.37	4.13
				6	6	19.91	6.62
				12	0	19.91	4.76
26688	1914.8	$\pi/2$ - BPSK	3.75	1	0	23.28	(*)
				1	47	23.32	(*)
			15	1	0	23.3	(*)
				1	11	23.3	(*)
		$\pi/4$ - QPSK	3.75	1	0	23.29	(*)
				1	47	23.34	(*)
			15	1	0	23.4	(*)
				1	11	23.33	(*)
				3	0	23.25	3.32
				3	6	23.89	2.98
				6	0	22.49	3.89
				6	6	22.61	3.91
				12	0	21.51	3.88

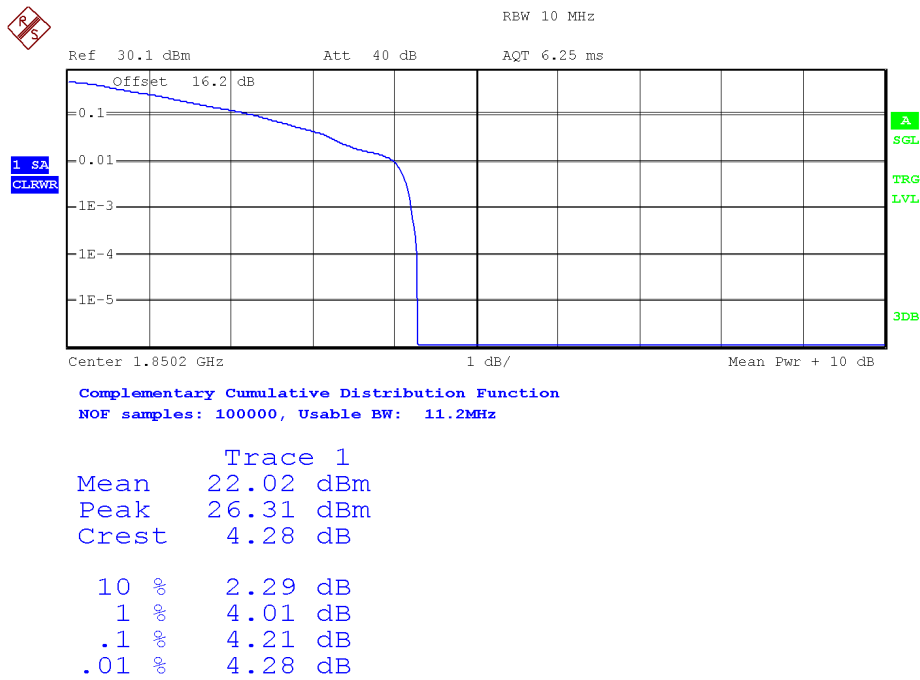
(*): Preliminary measurements determined that 3. 6 or 12 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

PEAK-TO-AVERAGE POWER RATIO (PAPR).

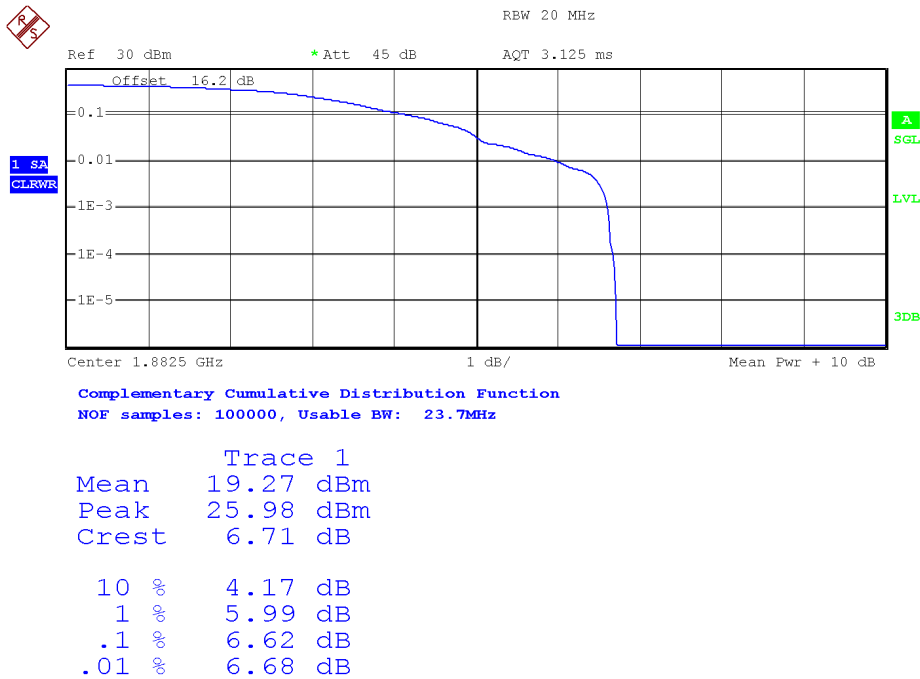
NB-IoT. BAND 25.

Preliminary measurements determined that 6 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

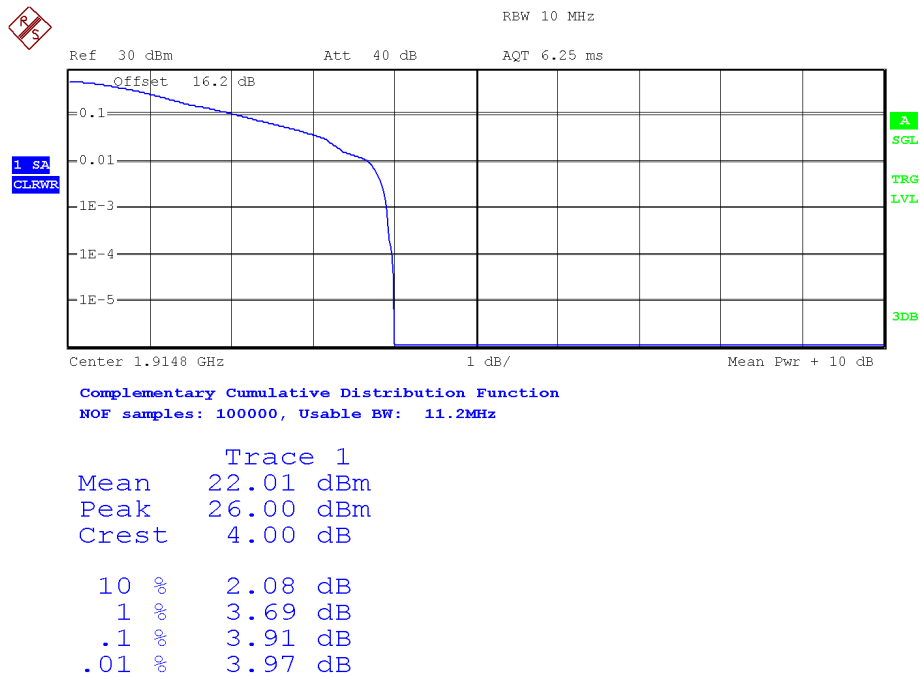
Channel Low:



Channel Middle:



Channel High:



NB-IoT BAND 25.

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)
Lowest	23.31	+4.4	27.71	25.56	4.21
Middle	22.48	+4.4	26.88	24.73	6.62
Highest	23.89	+4.4	28.29	26.14	3.91
Measurement uncertainty (dB)	<±1.11				

Verdict: PASS

Frequency Stability

SPECIFICATION

FCC §2.1055 and §24.235. The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

RSS-133. Clause 6.3. The carrier frequency shall not depart from the reference frequency in excess of ± 2.5 ppm for mobile stations.

METHOD

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

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

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

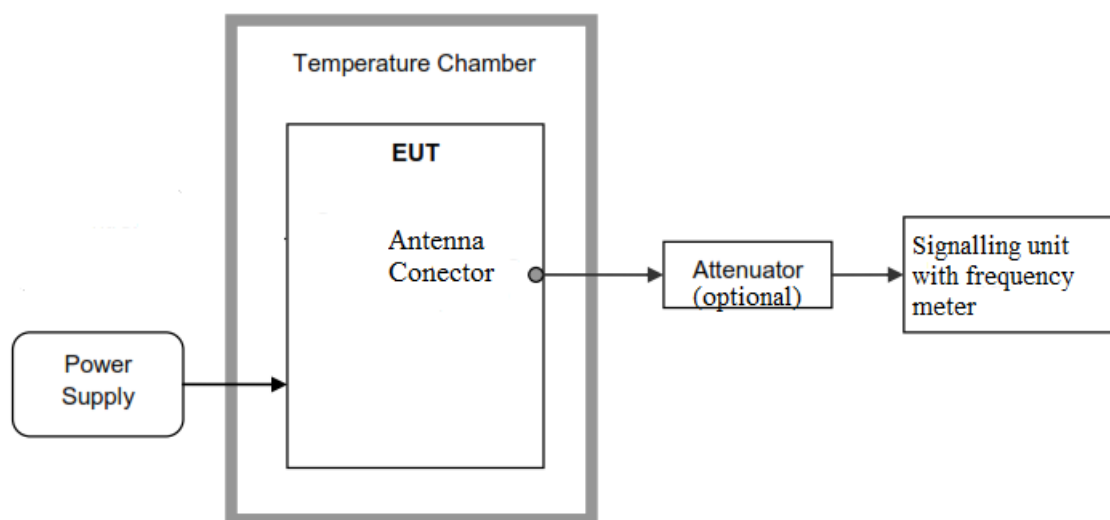
The worst case NB-IoT mode for conducted power was used for the test.

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.

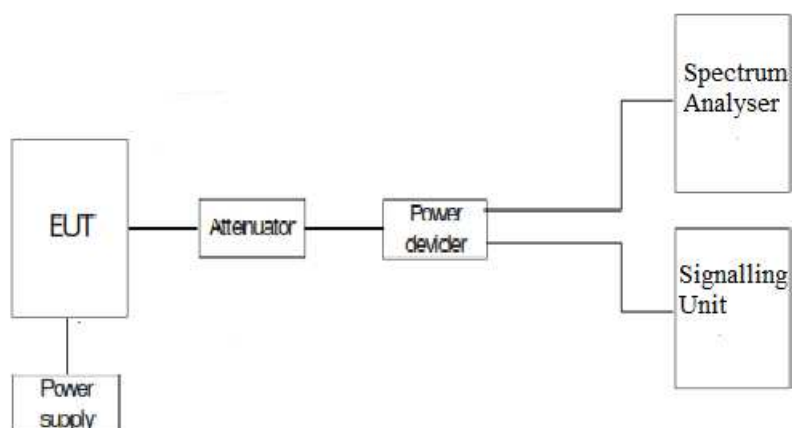
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Frequency tolerance.



Reference points f_L and f_H .



RESULTS

Frequency stability over temperature variations.

NBloT Band 25

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	5.25	0.002788845
+40	-25.13	-0.01334927
+30	45.09	0.023952191
+20	8.96	0.004759628
+10	-14.96	-0.007946879
0	11.69	0.006209827
-10	14.16	0.007521912
-20	5.98	0.003176627
-30	43.3	0.023001328

Frequency stability over voltage variations.

NBloT Band 25

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.37	-3.35	-0.001779548
Vmin	3.23	-5.18	-0.00275166

Reference points established at the applicable unwanted emissions limit (worst case):

	NBloT Band 25
f_L (MHz)	1850.0410
f_H (MHz)	1914.9630

Reference points f_L and f_H with the worst-case frequency offsets added or subtracted:

	NBLoT Band 25
f_L (MHz)	1850.0410
f_H (MHz)	1914.9630

The reference frequency points stay within the authorized blocks.

Verdict: PASS

Modulation Characteristics

SPECIFICATION

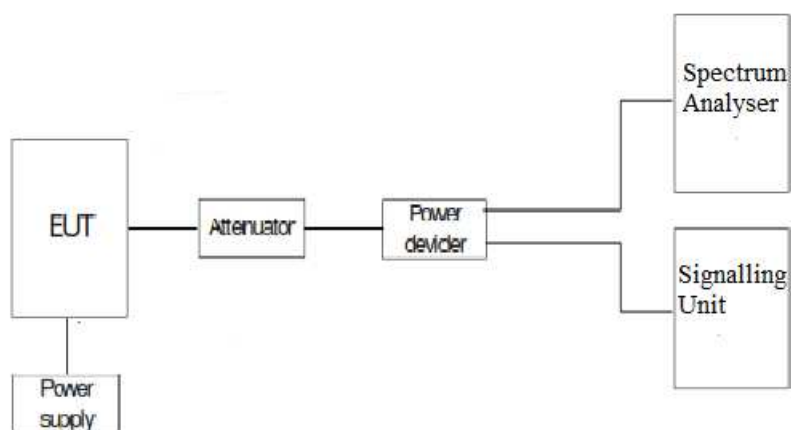
FCC §2.1047

RSS-133. Clause 6.2. Equipment certified under this standard shall use digital modulation.

METHOD

For NB-IoT the EUT operates with $\pi/2$ - BPSK and $\pi/4$ - QPSK modulation modes in which the information is digitised and coded into a bit stream.

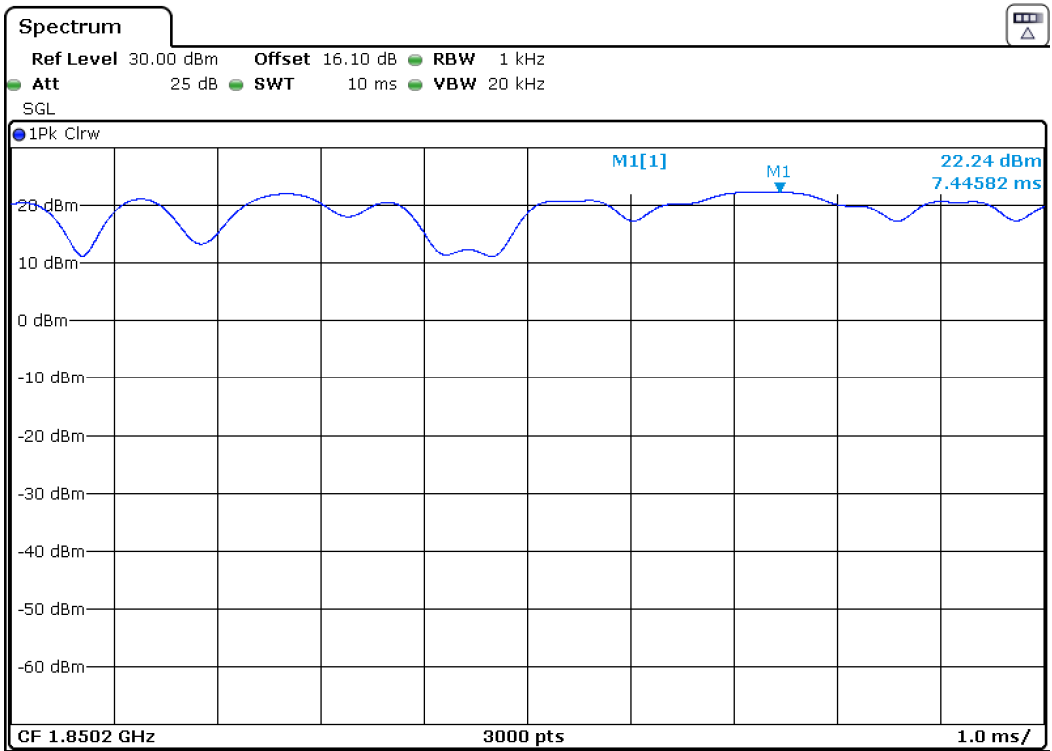
TEST SETUP



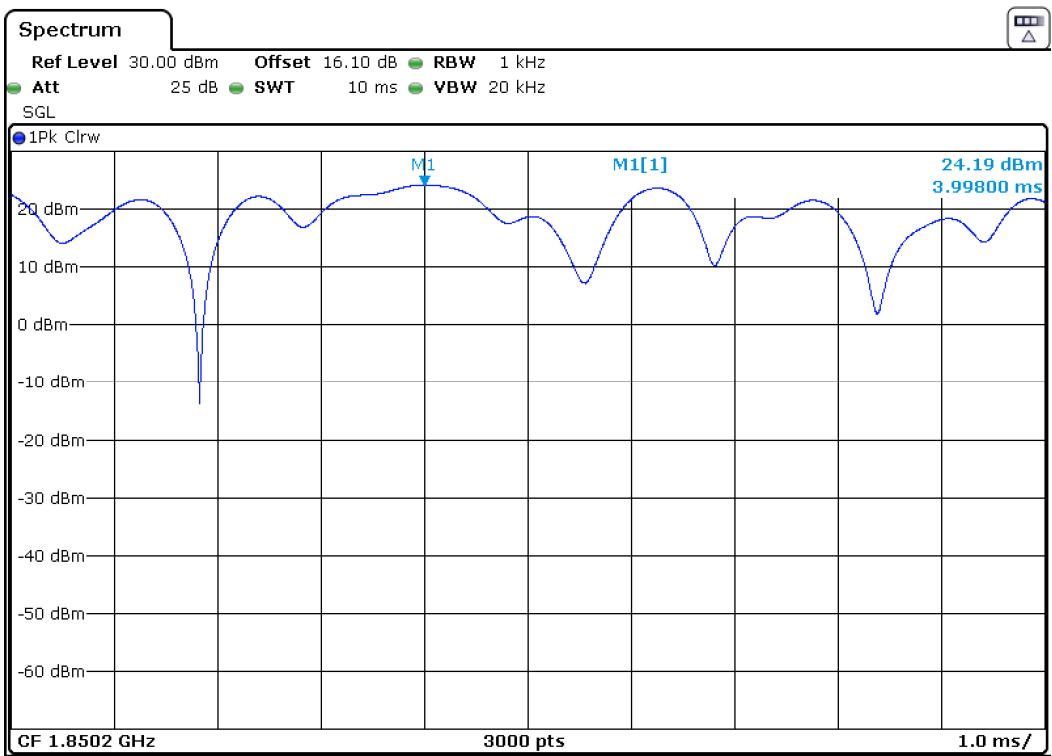
RESULTS

The following plot shows the modulation schemes in the EUT.

NBLoT MODULATION (Band 25). $\pi/2$ - BPSK.



NBLoT MODULATION (Band 25). $\pi/4$ - QPSK.



Occupied Bandwidth

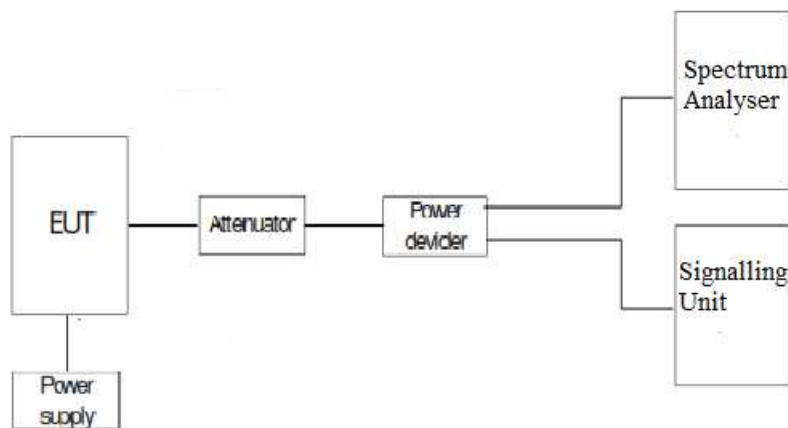
SPECIFICATION

§2.1049

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)

NB IoT BAND 25.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	58.800	60.000	59.600
-26 dBc bandwidth (kHz)	41.267	41.467	41.267
Measurement uncertainty (kHz)	< ± 0.05		

Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	63.130	63.460	63.800
-26 dBc bandwidth (kHz)	41.933	42.000	41.867
Measurement uncertainty (kHz)	< ± 0.05		

Tone 15 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	140.40000	140.80000	141.73000
-26 dBc bandwidth (kHz)	128.13000	128.80000	128.27000
Measurement uncertainty (kHz)	< $\pm$ 0.10		

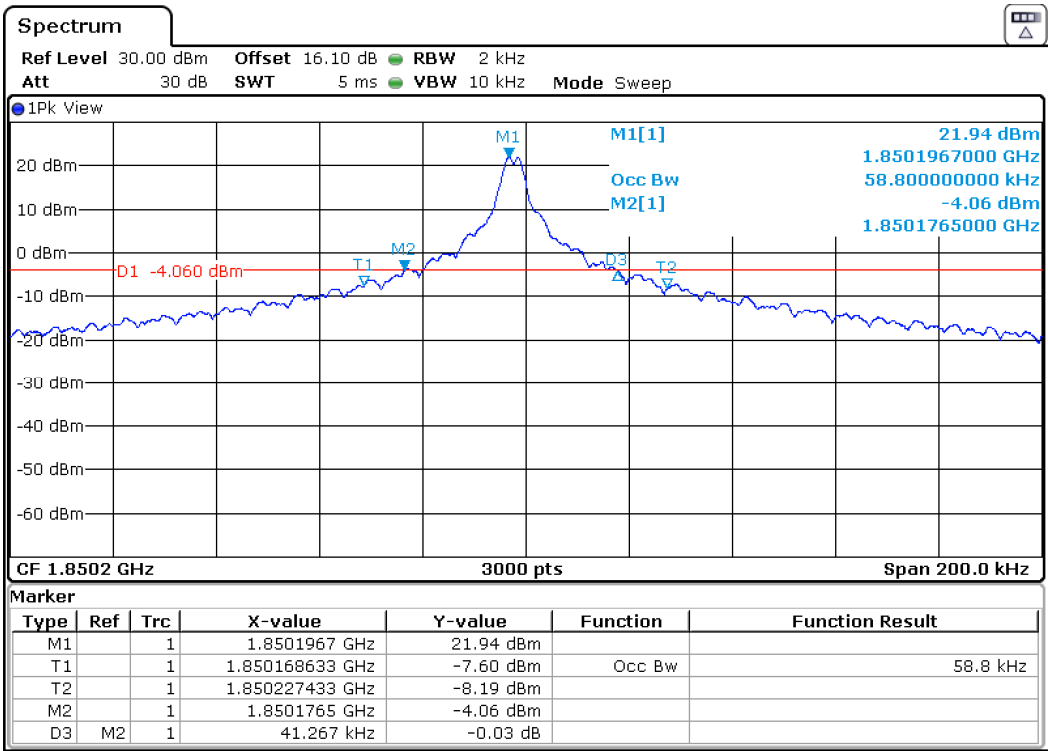
12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	200.130	204.000	204.660
-26 dBc bandwidth (kHz)	322.800	322.800	311.470
Measurement uncertainty (kHz)	< $\pm$ 0.12		

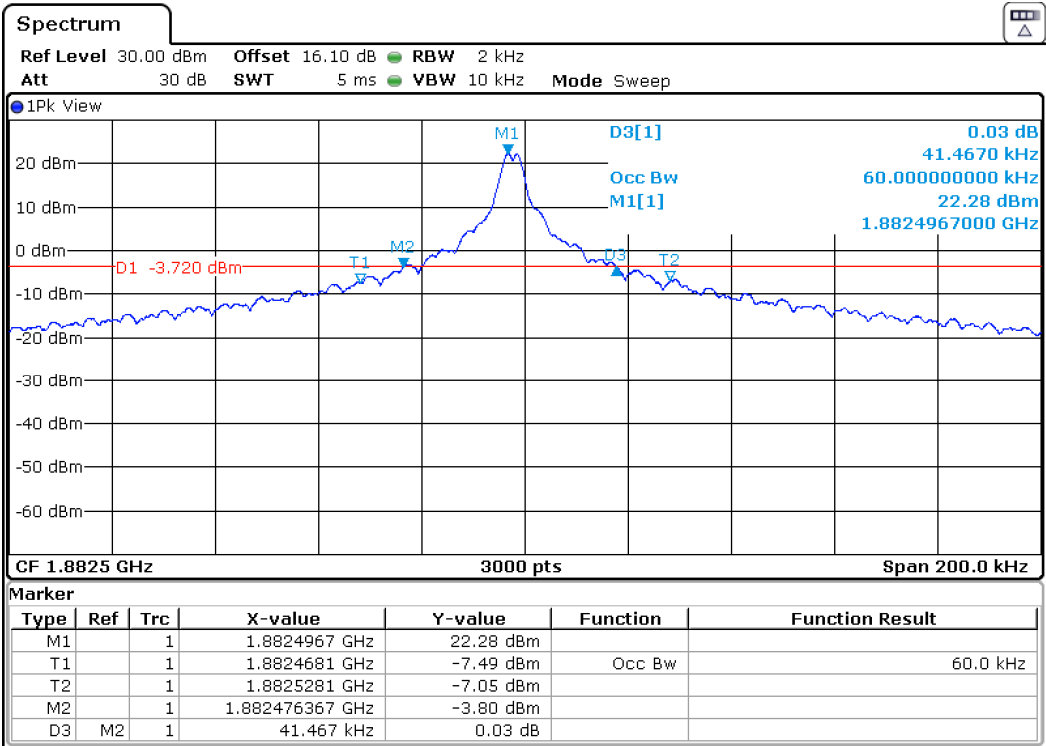
NB IoT BAND 25.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

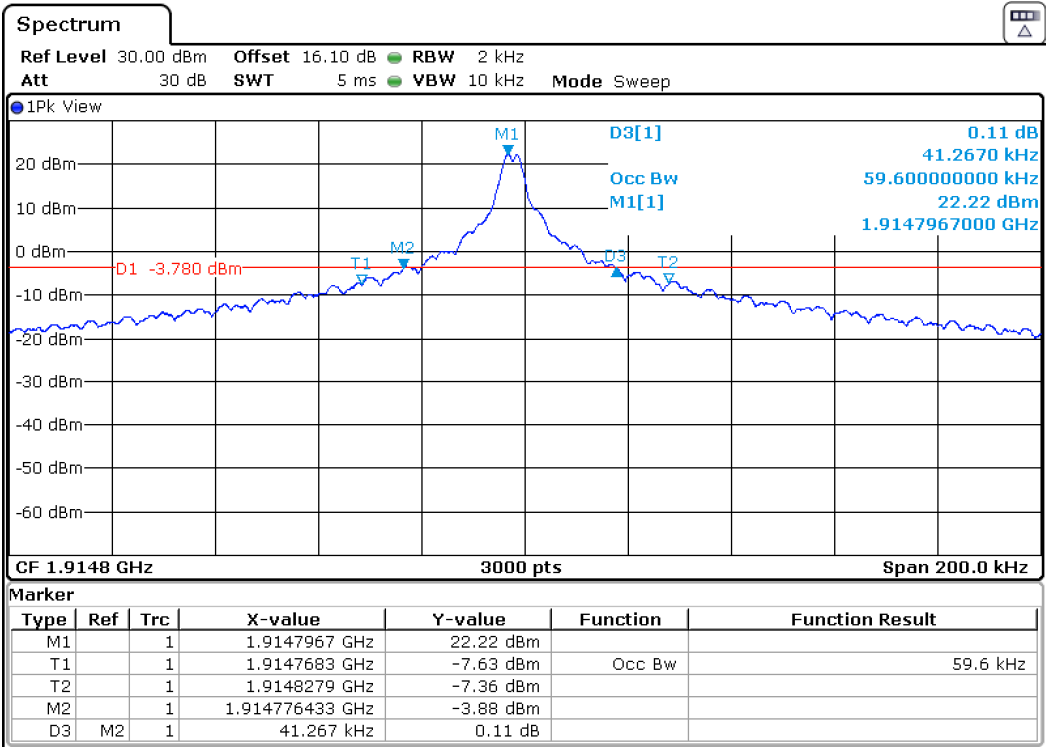
Lowest Channel



Middle Channel

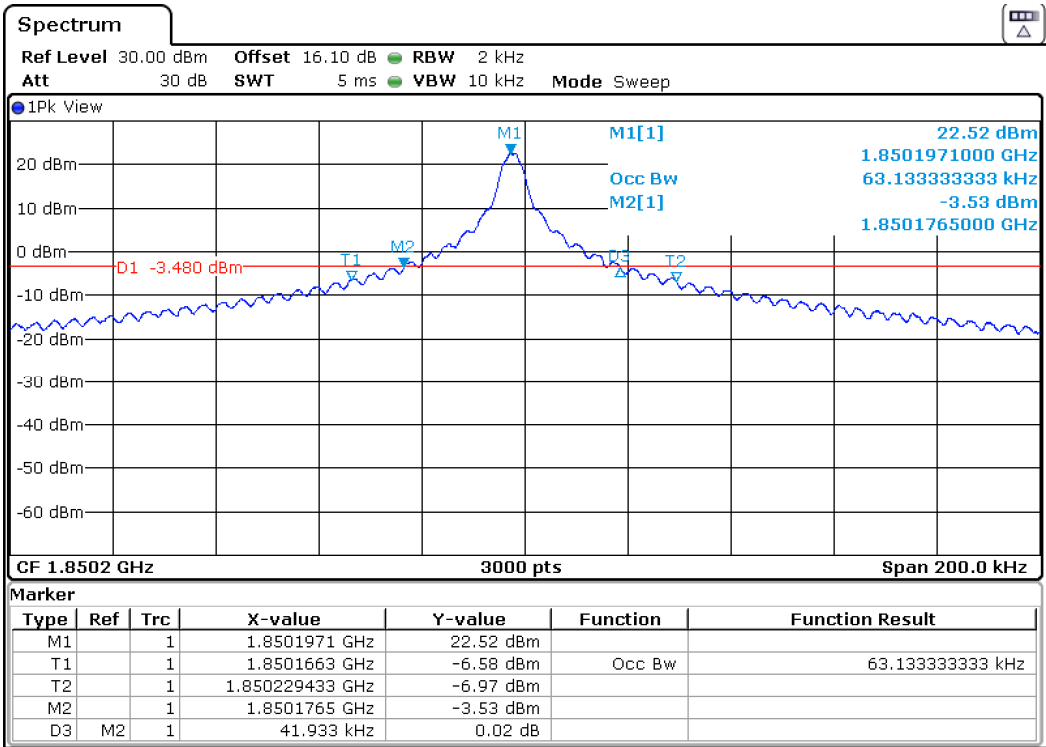


Highest Channel

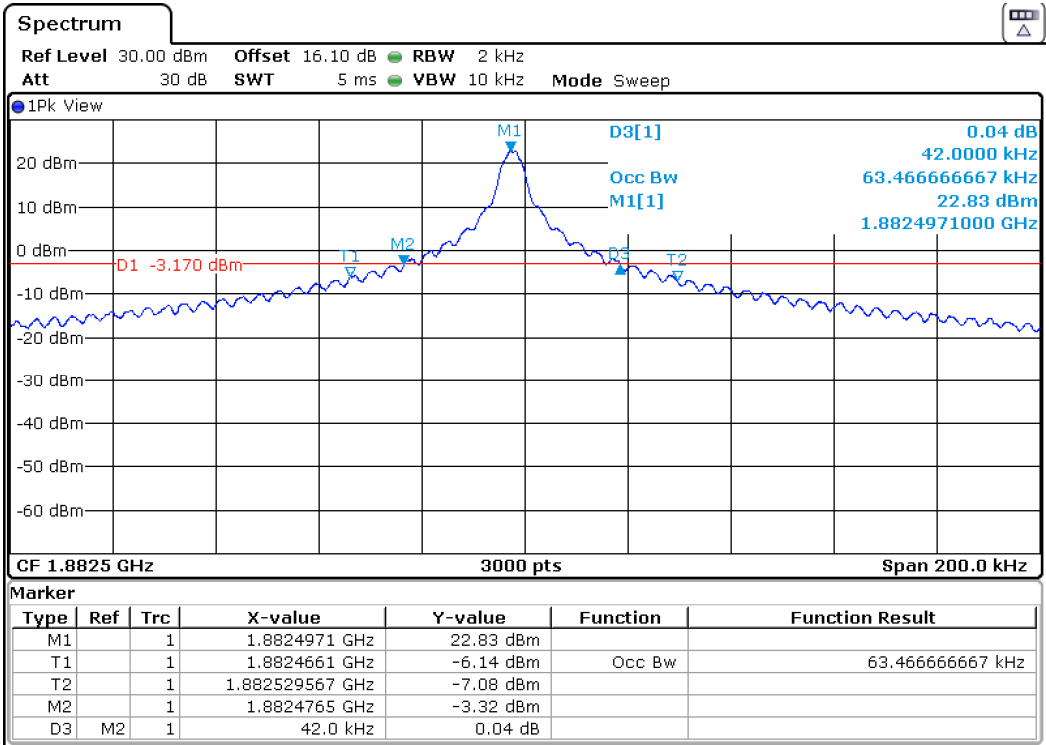


Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

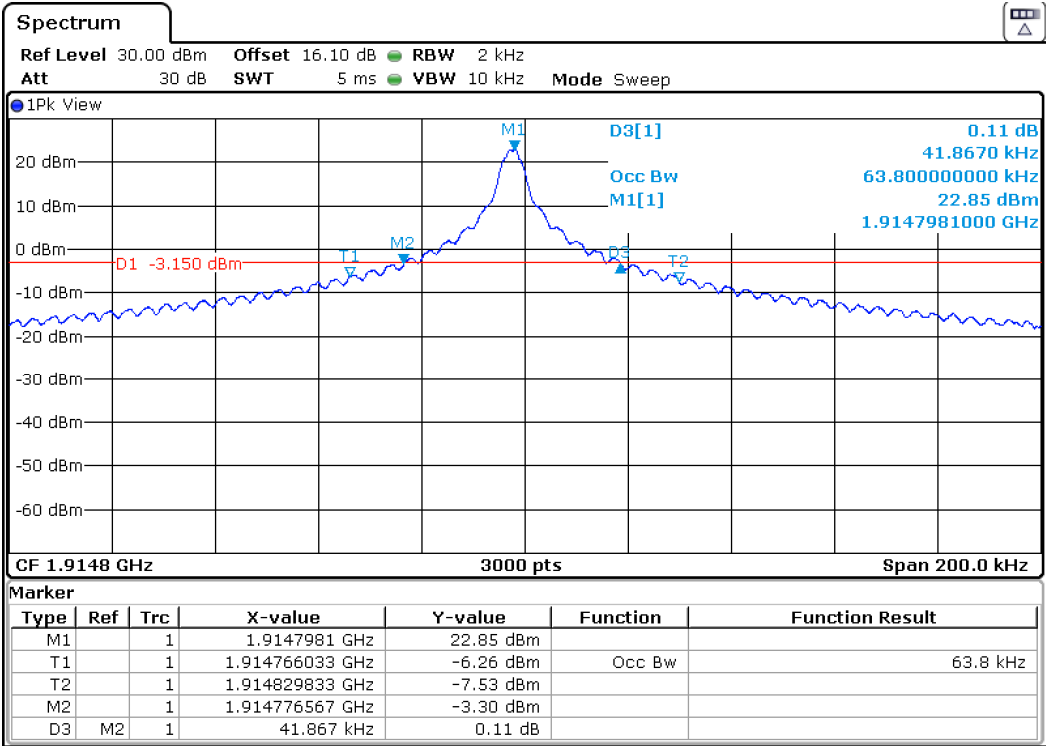
Lowest Channel



Middle Channel

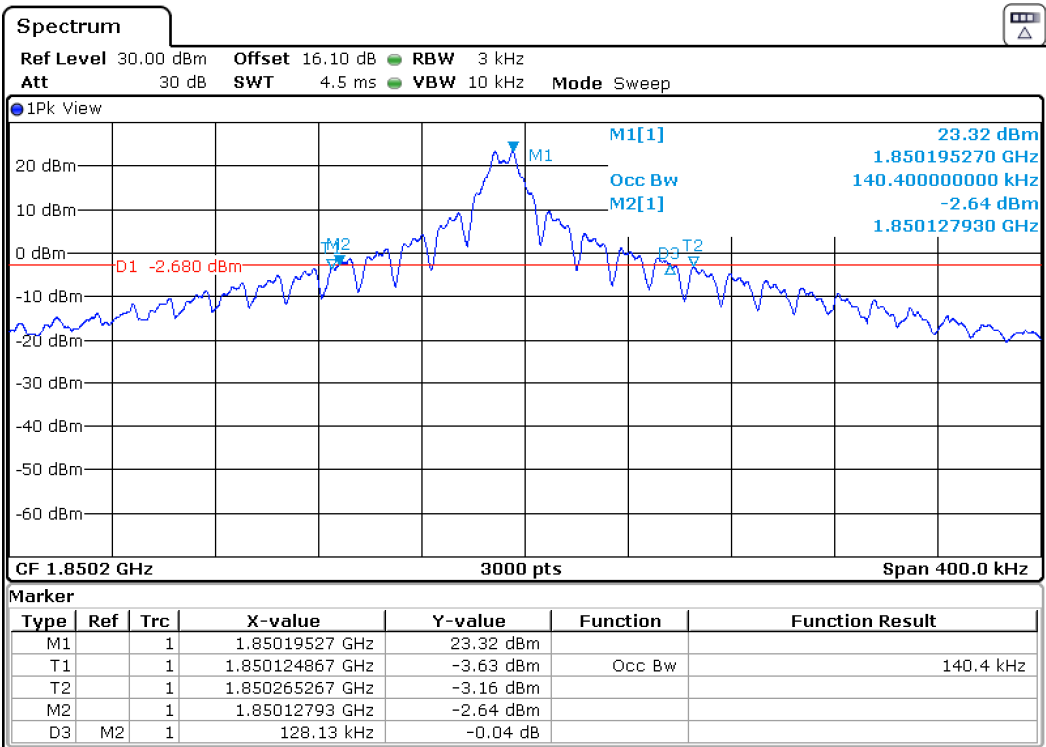


Highest Channel

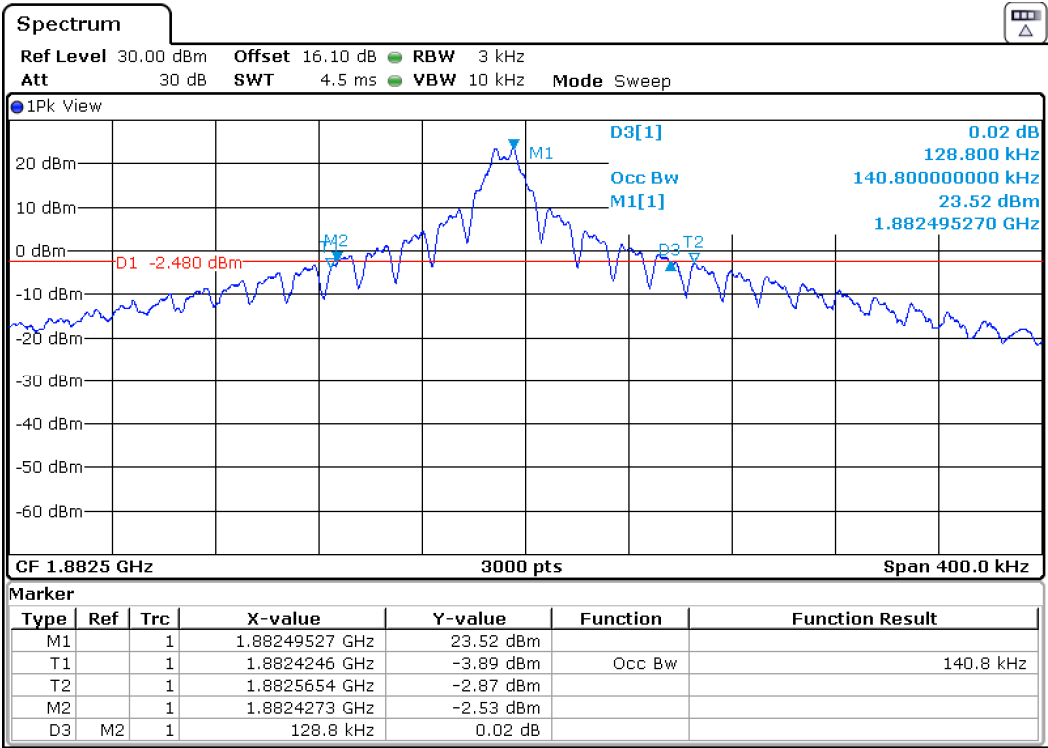


Tone 15 kHz. $\pi/2$ - BPSK MODULATION

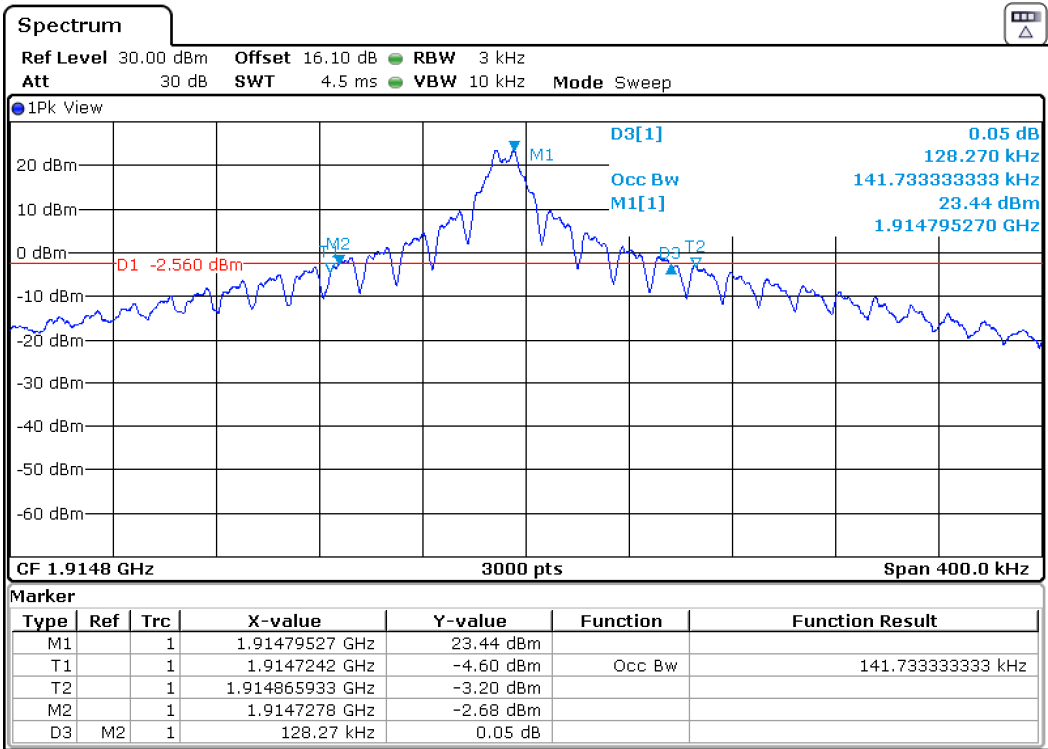
Lowest Channel



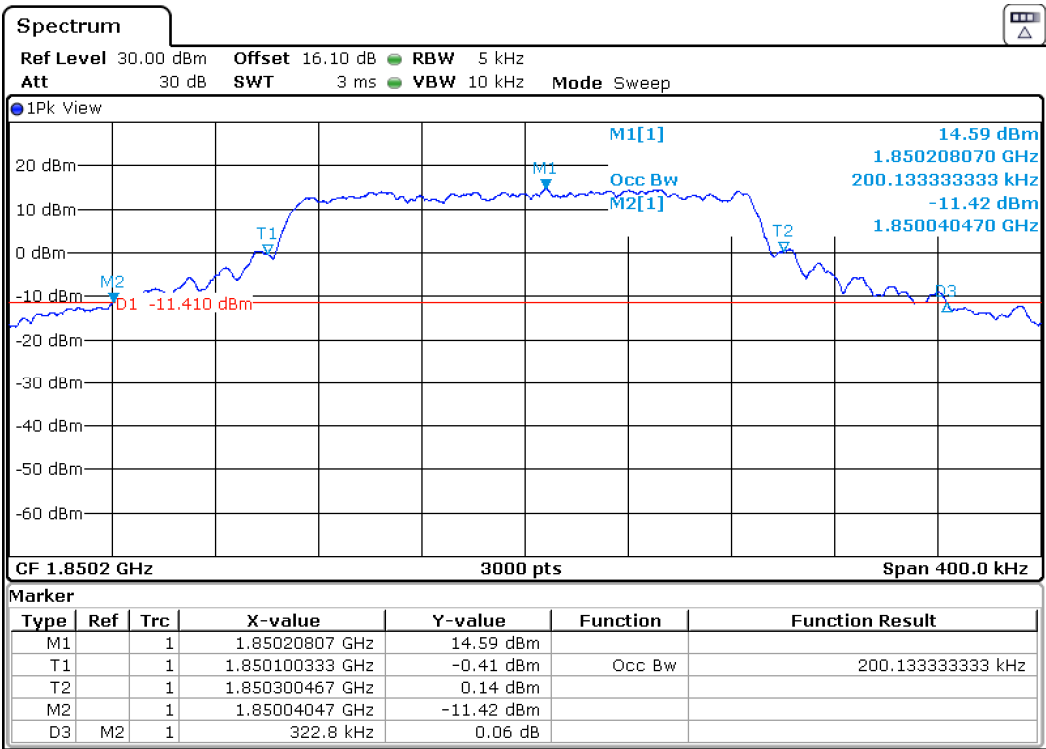
Middle Channel



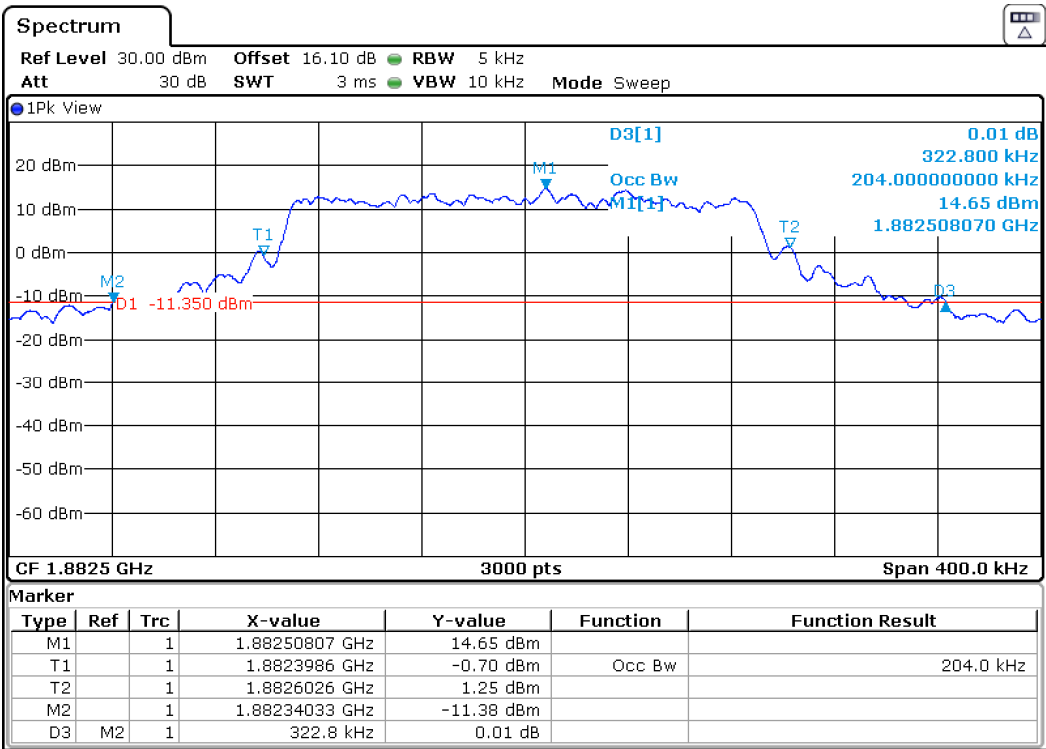
Highest Channel



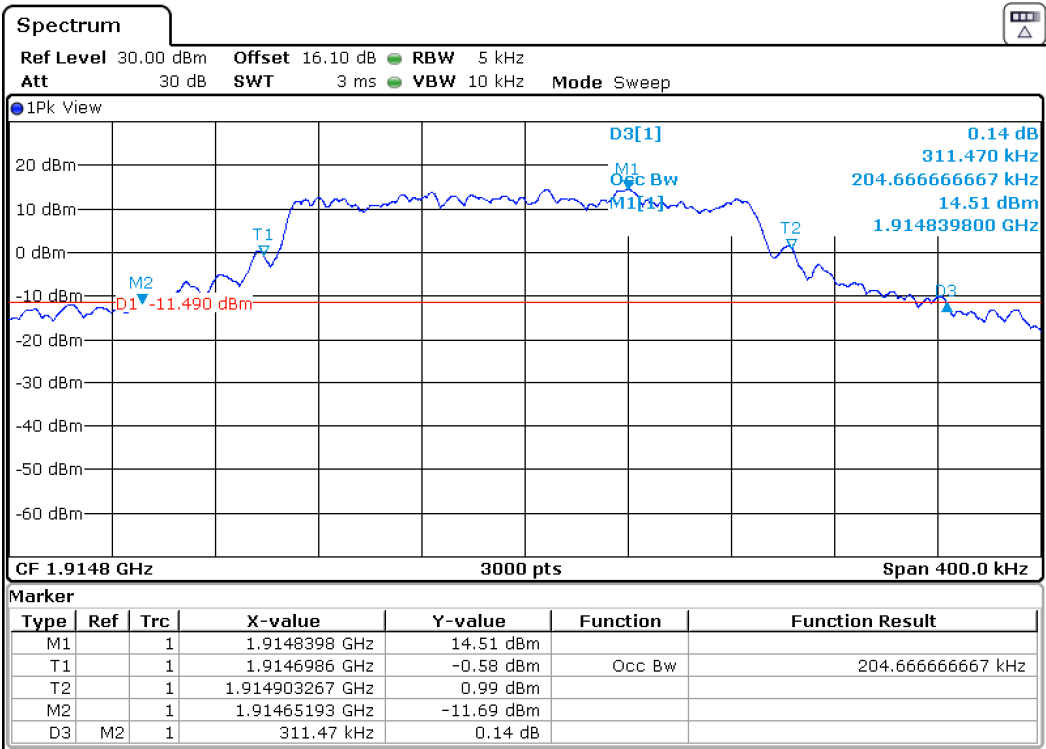
12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION
Lowest Channel



Middle Channel



Highest Channel



Spurious emissions at antenna terminals

SPECIFICATION

FCC §2.1051 and §24.238. RSS-133. Clause 6.5.

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.

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

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

METHOD

The 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 20 GHz for NB-IoT Band 25.

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.

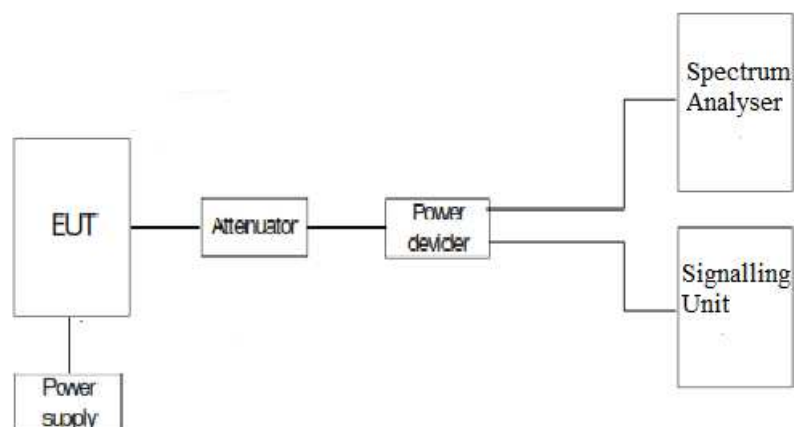
Measurement Limit:

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.

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

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

TEST SETUP



RESULTS (see plots in next pages)

NBloT Band 25

1. CHANNEL: LOWEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

2. CHANNEL: MIDDLE

No spurious signals were found at less than 20dB respect to the limit in all the range.

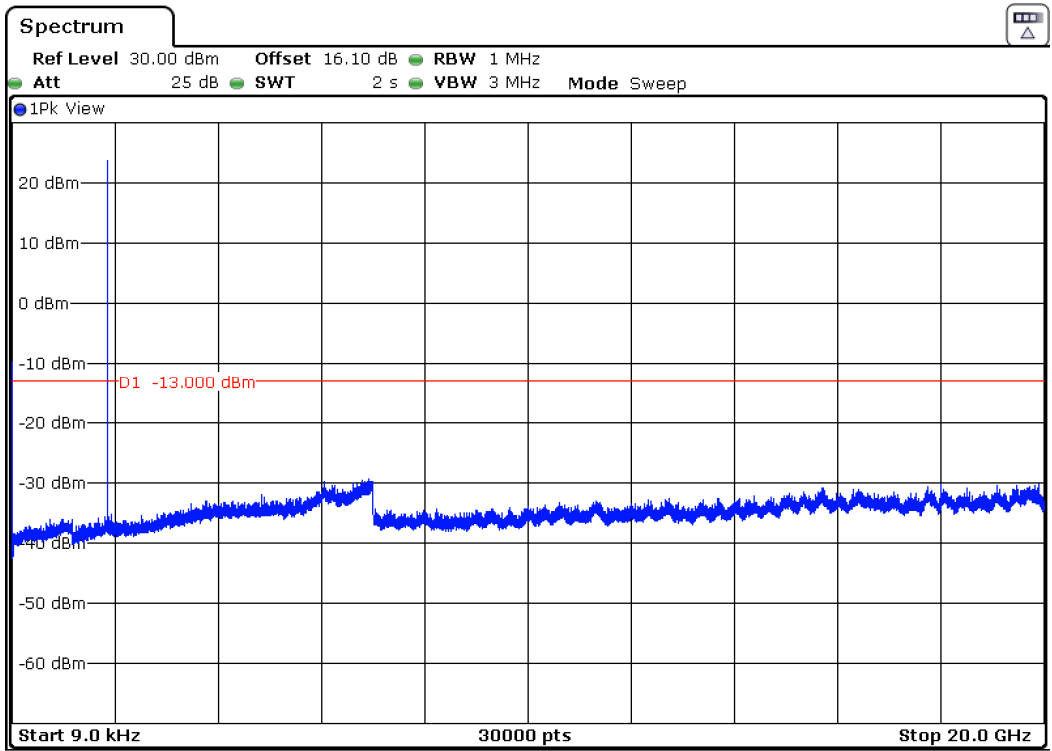
3. CHANNEL: HIGHEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

Verdict: PASS

1. CHANNEL: LOWEST

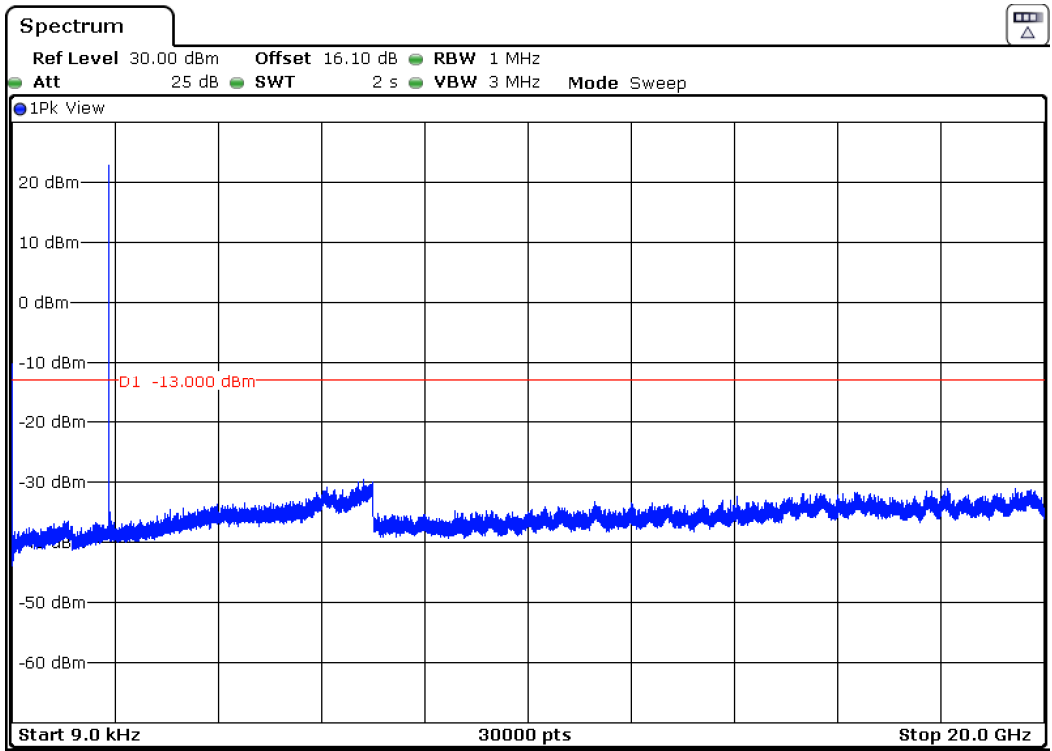
Frequency Range 9 kHz – 20 GHz



Note: The peak above the limit is the carrier frequency.

2. CHANNEL: MIDDLE

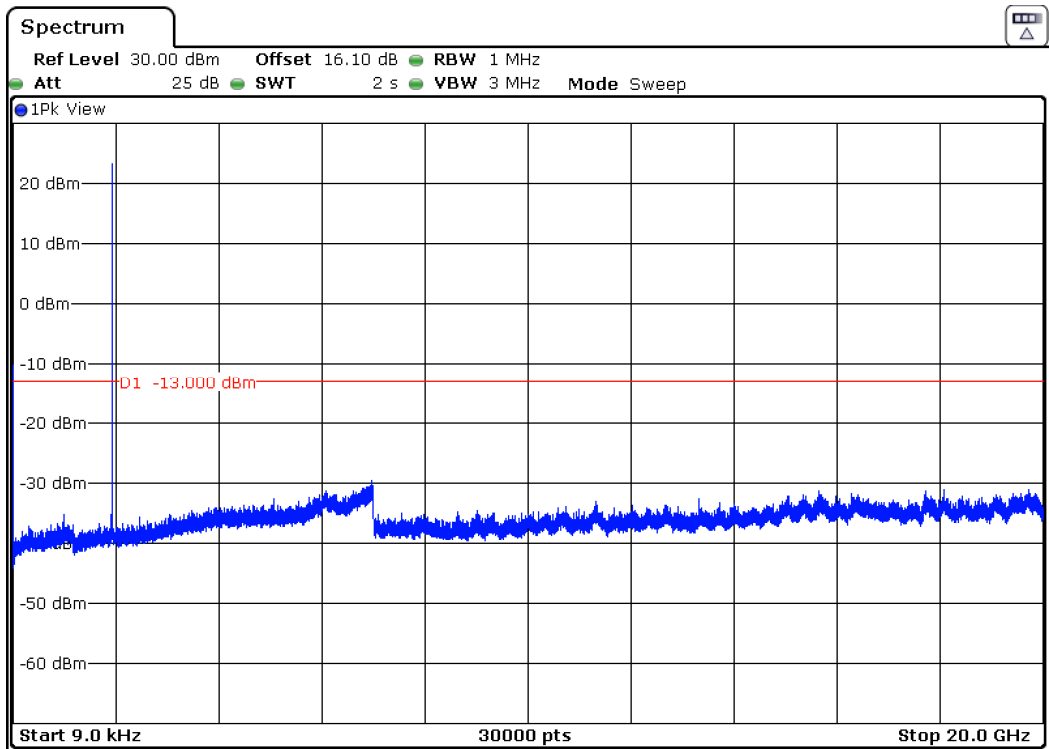
Frequency Range 9 kHz – 20 GHz



Note: The peak above the limit is the carrier frequency.

3. CHANNEL: HIGHEST

Frequency Range 9 kHz – 20 GHz



Note: The peak above the limit is the carrier frequency.

Spurious emissions at antenna terminals at Block Edges

SPECIFICATION

FCC §2.1051 and §24.238. RSS-133 Clause 6.5.

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.

As indicated in FCC part 24. 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/occupied bandwidth of the fundamental emission of the transmitter may be employed.

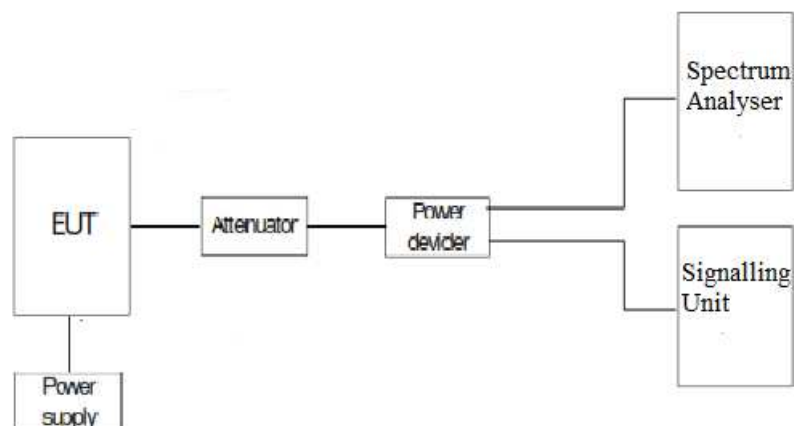
Measurement Limit:

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.

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

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

TEST SETUP



RESULTS (see plots in next pages)

NB IoT. BAND 25.

Preliminary measurements determined a tone with nominal bandwidth of 15 kHz as the worst case. The results in the next tables shows the results for this configuration.

(Channels in Band 25):	Tone= 15 kHz. Offset=0. $\pi/2$ - BPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-23.34

(Channels in Band 25):	Tone= 15 kHz. Offset=11. $\pi/2$ - BPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-22.83

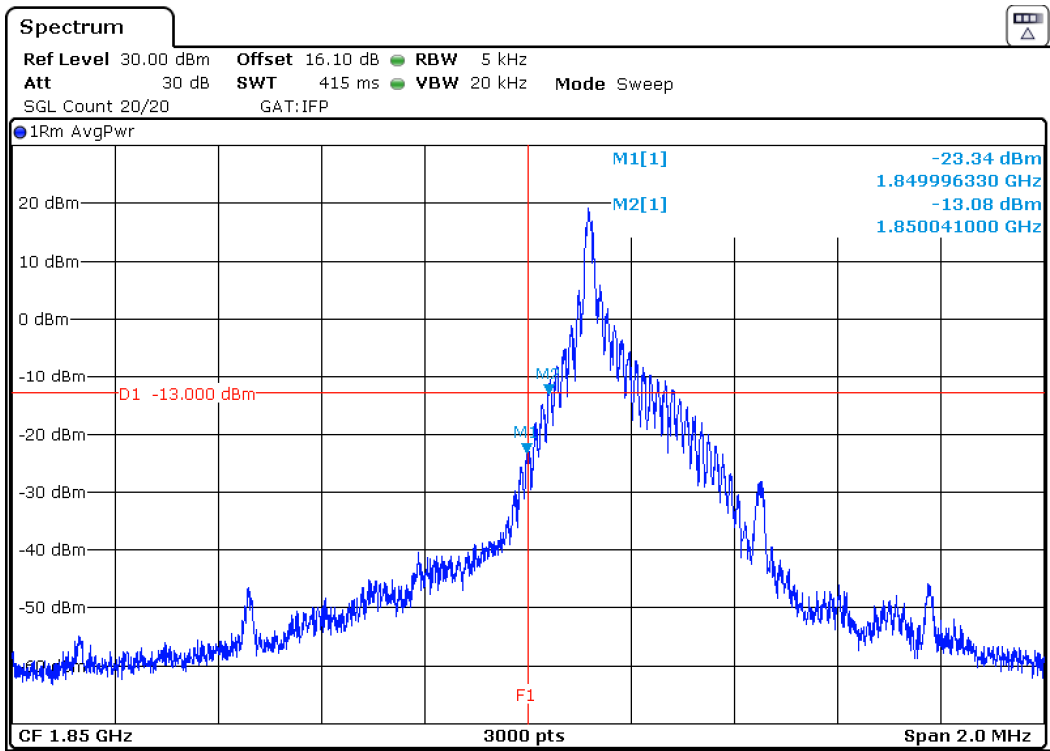
Measurement uncertainty = $<\pm 1.20$ dB.

Verdict: PASS

NB-IoT. BAND 25.

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 0

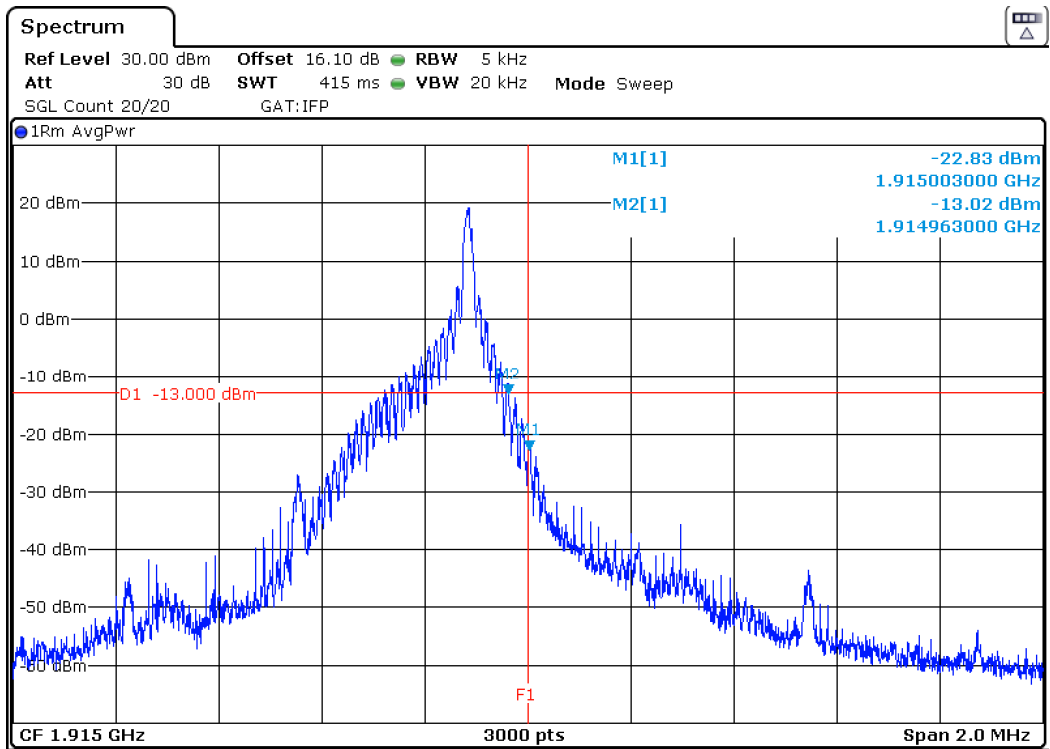
CHANNEL LOWEST



NOTE: The equipment transmits at the maximum output power

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 11

CHANNEL HIGHEST



Radiated emissions

SPECIFICATION

FCC § 24.238. RSS-133 Clause 6.5.

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.

METHOD

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

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

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

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

Measurement Limit:

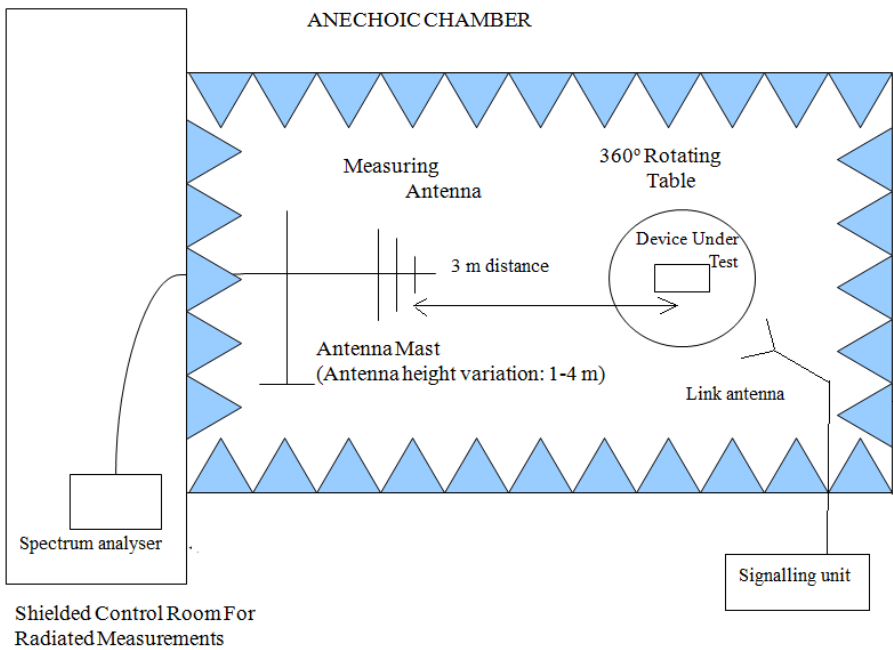
According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in watts.

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

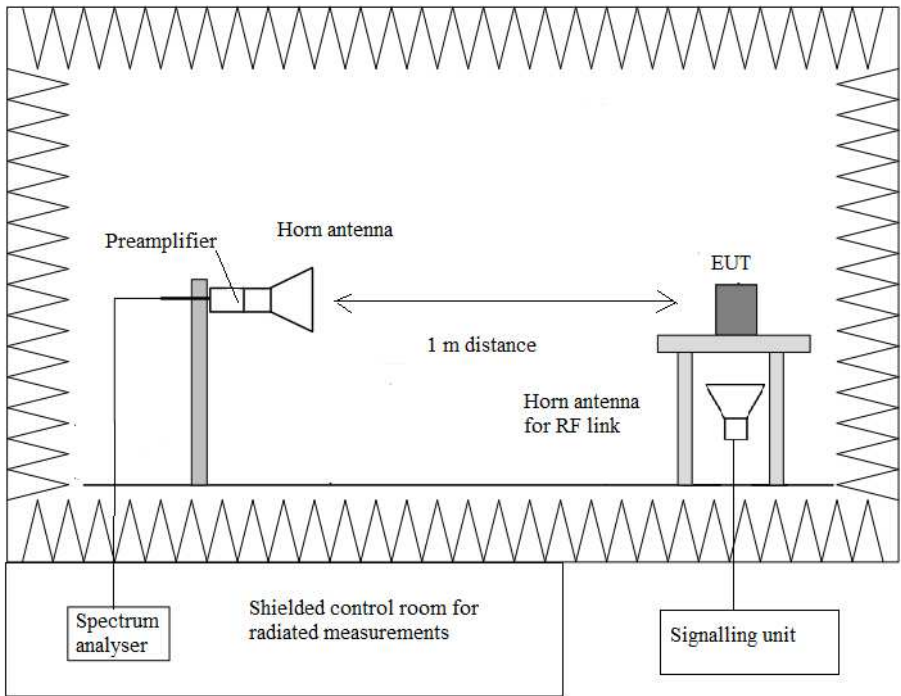
$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mwatts}) - 30] = - 13 \text{ dBm}$$

TEST SETUP

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS

NB IoT. BAND 25.

Preliminary measurements determined that 3 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 18 GHz-20 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 18 GHz-20 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

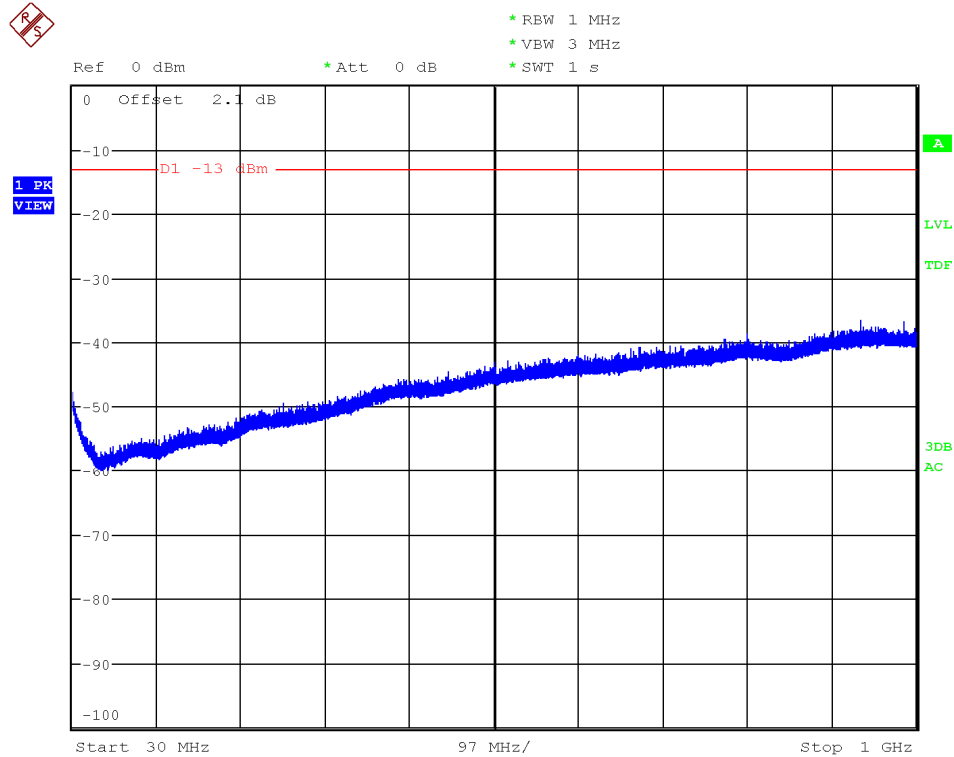
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 18 GHz-20 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Verdict: PASS

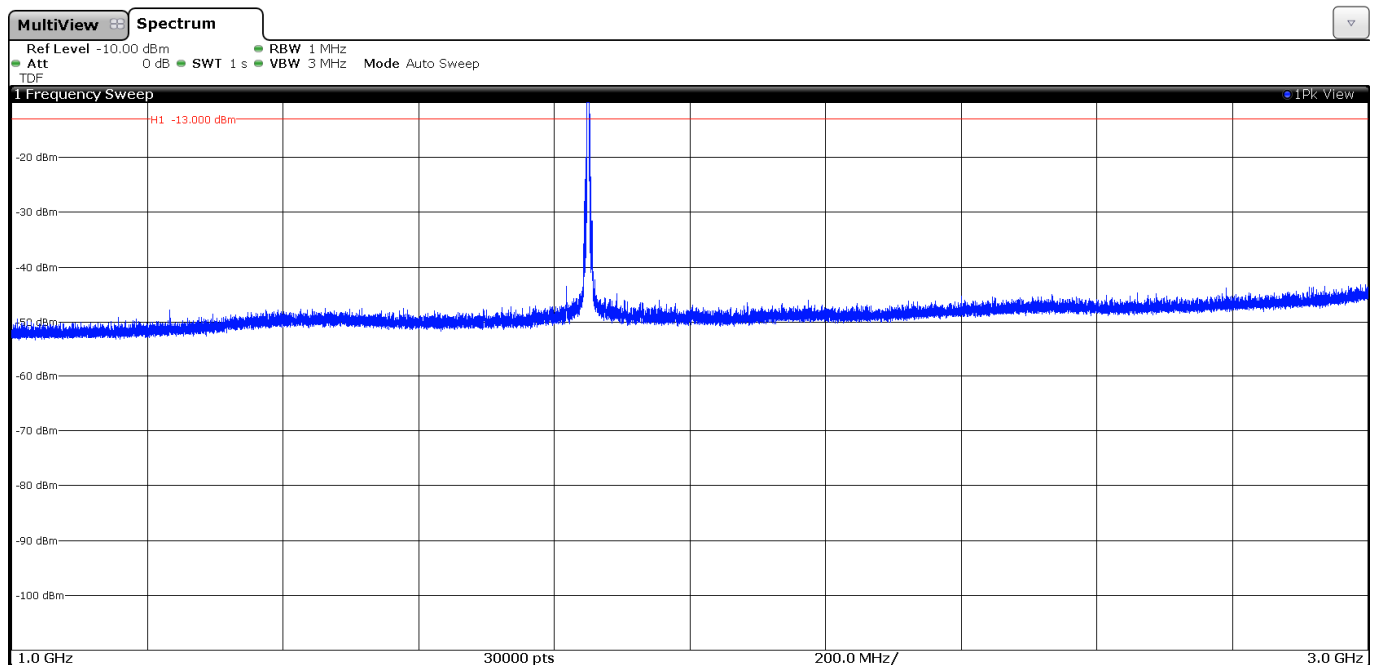
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels)

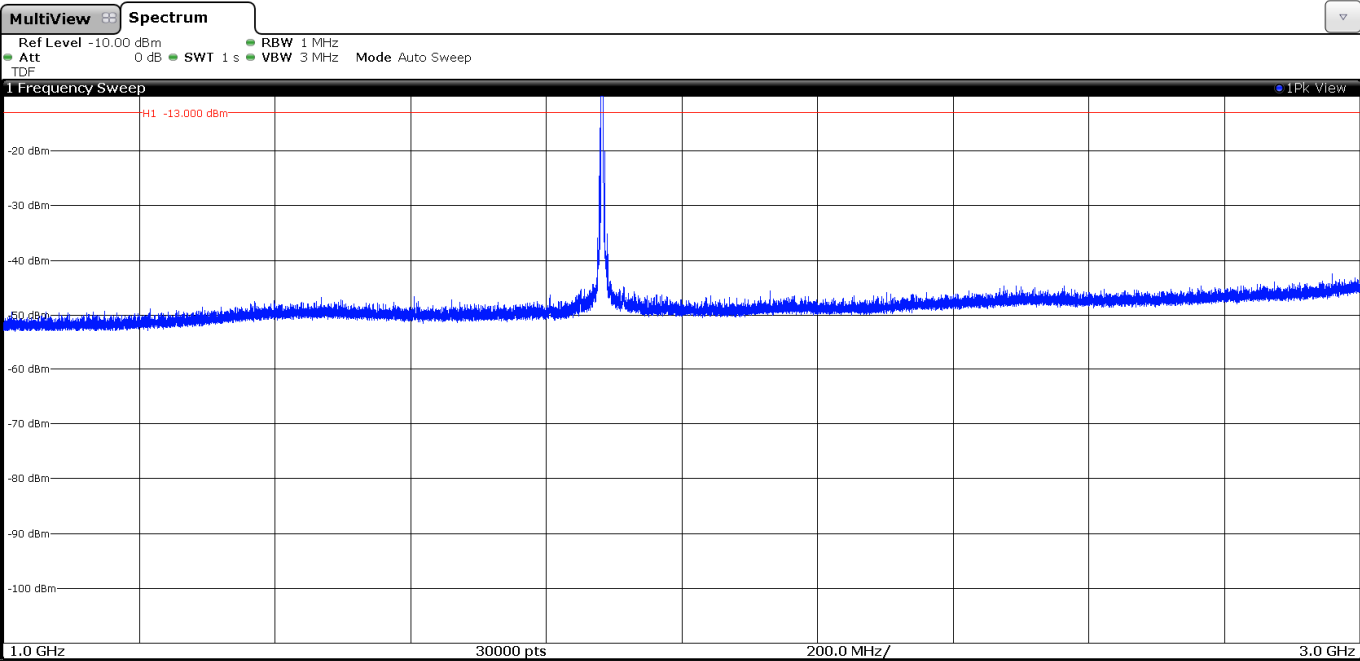
Frequency range 1 GHz to 3 GHz

CHANNEL: LOWEST



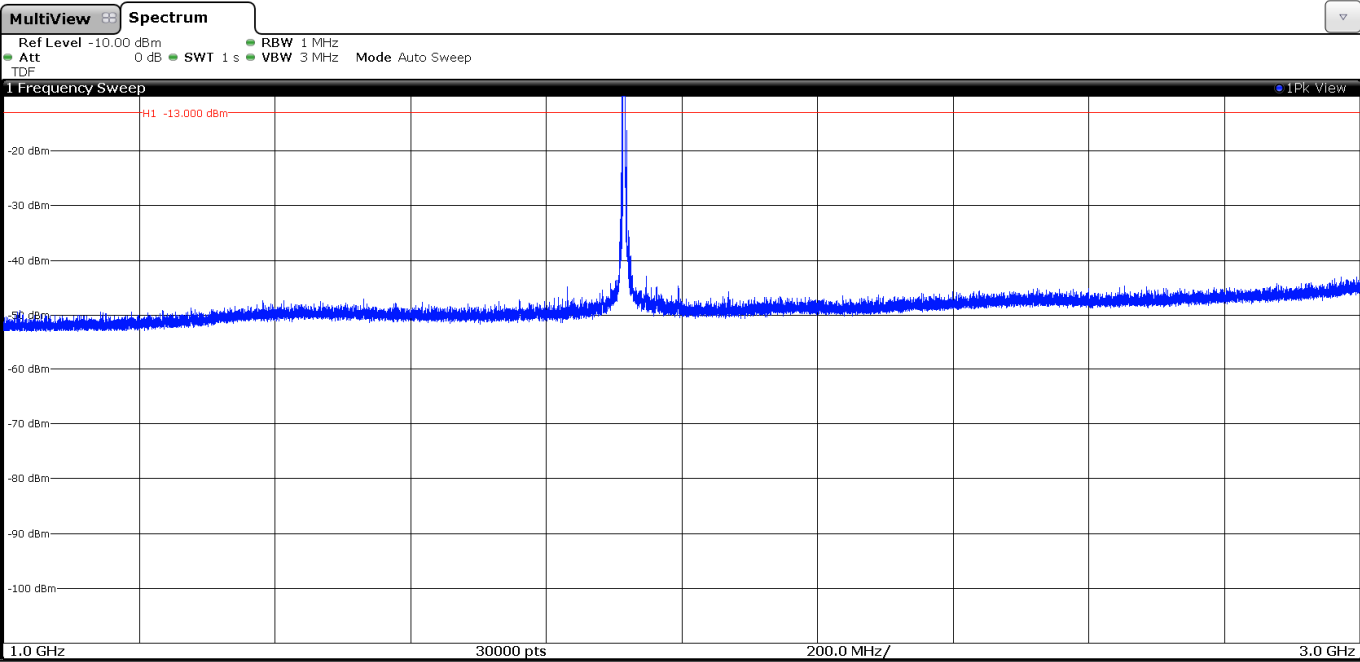
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

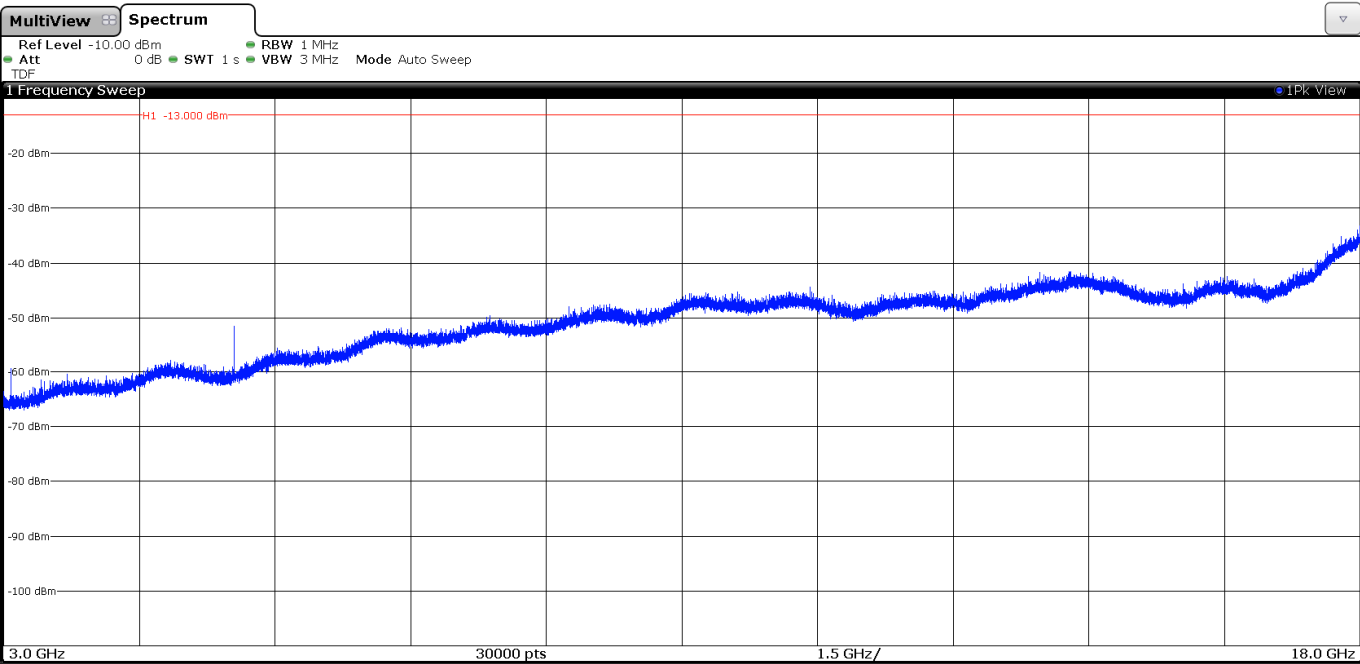
CHANNEL: HIGHEST



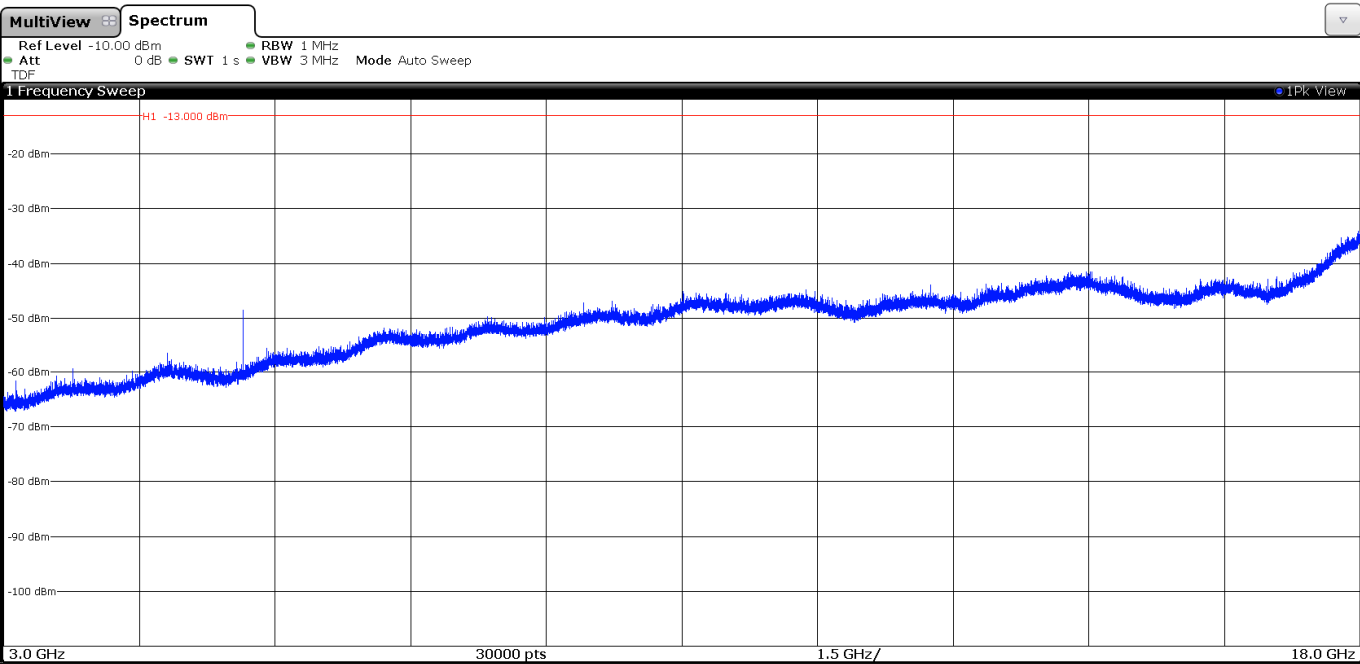
Note: The peak above the limit is the carrier frequency.

Frequency range 3 GHz to 18 GHz

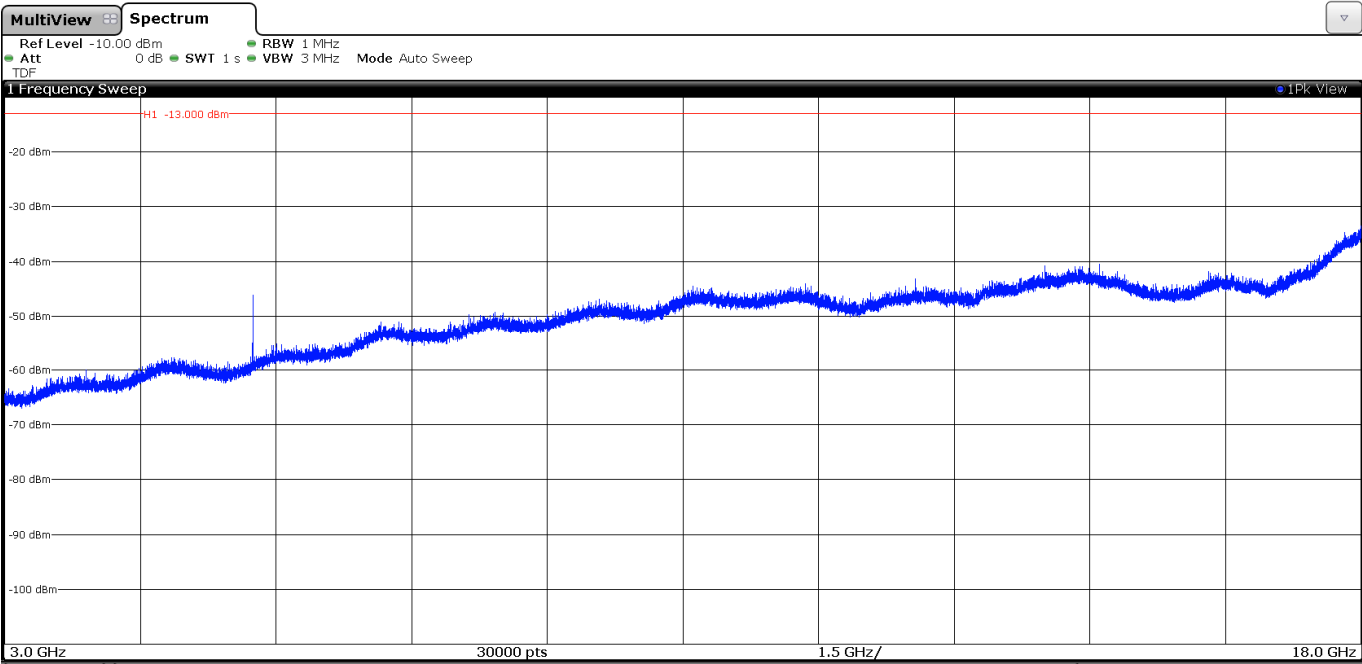
CHANNEL: LOWEST



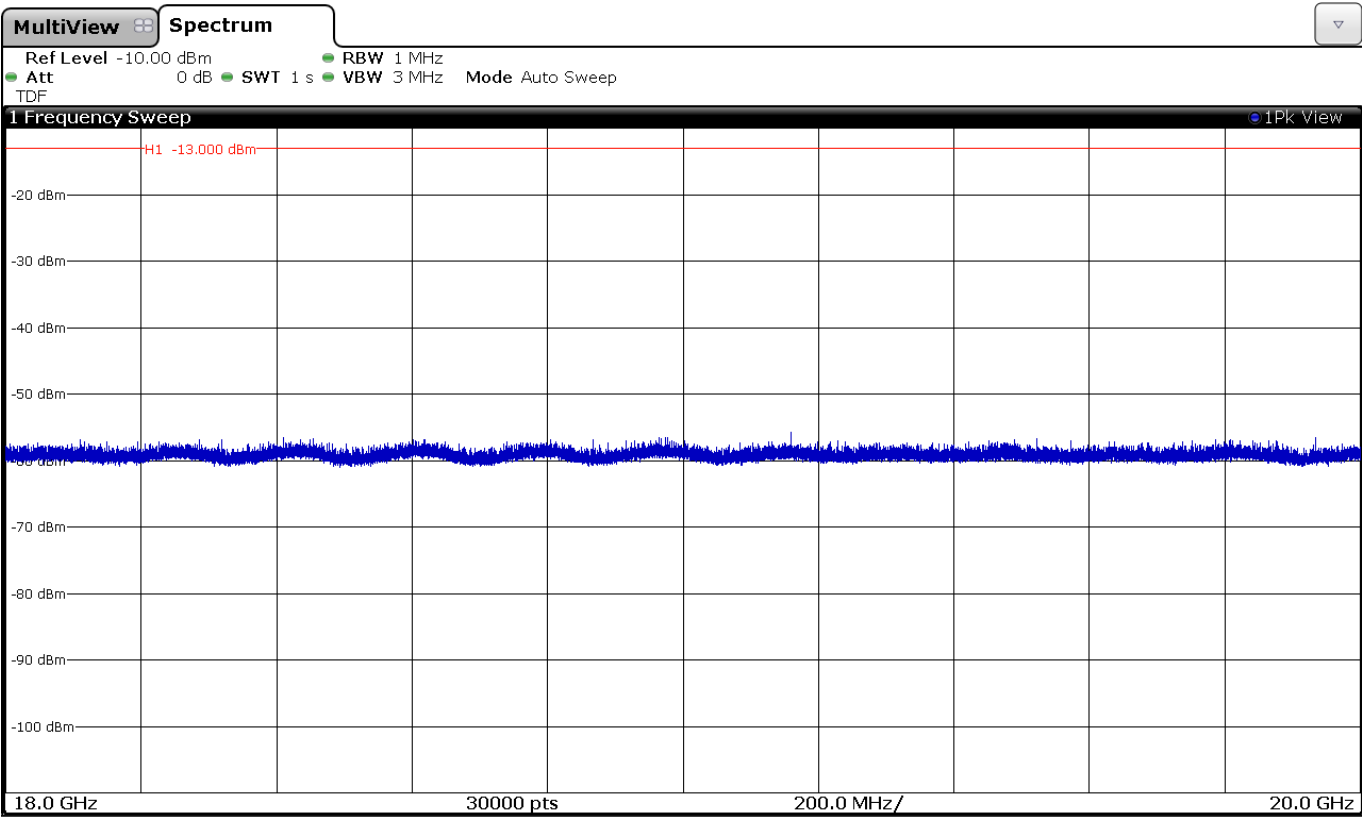
CHANNEL: MIDDLE



CHANNEL: HIGHEST



Frequency range 18 GHz to 20 GHz



(This plot is valid for all three channels)

Appendix B: Test results for FCC Part 27 / RSS-139 / RSS-130

TEST CONDITIONS.....	46
RF Output Power	48
Frequency Stability	59
Modulation Characteristics	64
Occupied Bandwidth	68
Spurious emissions at antenna terminals.....	89
Spurious emissions at antenna terminals at Block Edges.....	99
Radiated emissions.....	106

TEST CONDITIONS

Power supply (V):

Vnominal = 3.8 Vdc

Vmax = 4.37 Vdc

Vmin = 3.23 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 external power supply

Type of antenna = Integral antenna.

Declared Gain for antenna = +2.6 dBi for Band 12. Band 13 and Band 17 and +4.4 dBi for Band 4 and Band 66.

TEST FREQUENCIES:

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 4)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
19952 (1710.2)	20175 (1732.5)	20398 (1754.8)

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

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 12)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23012 (699.2)	23095 (707.5)	23178 (715.8)

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 13)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23182 (777.2)	23230 (782)	23278 (786.8)

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 17)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23732 (704.2)	23790 (710)	23848 (715.8)

NOTE: Band 17 is completely included in band 12. so the channels of band 12 were tested to give conformity to the assigned block

NBLoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 66)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
131974 (1710.2)	132322 (1745)	132670 (1779.8)

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 (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 Clause 4.4.

The e.i.r.p. shall not exceed 50 watts (46.99 dBm) for mobile equipment or for outdoor fixed subscriber equipment nor shall it exceed 5 watts (36.99 dBm) for portable equipment or for indoor fixed subscriber equipment.

The peak-to-average power ratio (PAPR) of the transmission shall not exceed 13 dB.

FCC §27.50 (d) (4). RSS-139 Clause 6.5.

Fixed. mobile. and portable (hand-held) stations operating in the 1710-1755 MHz band are limited to 1 watt EIRP (30 dBm). 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.

The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

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.

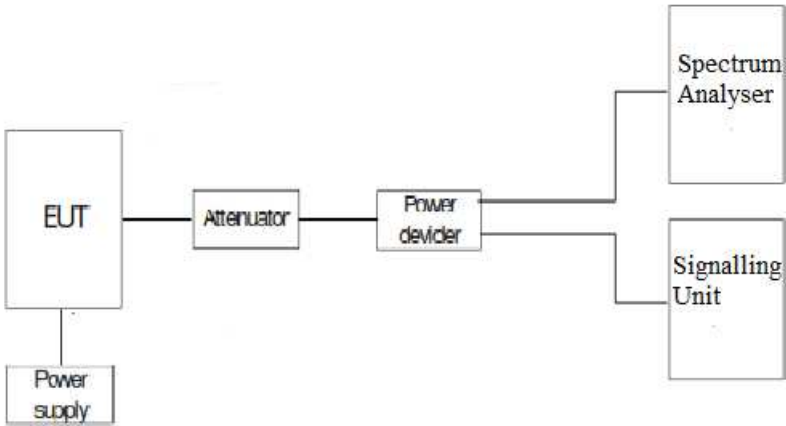
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Conducted average power.



Peak-to-average power ratio (PAPR)



RESULTS

MAXIMUM OUTPUT POWER (CONDUCTED).

NBLoT. BAND 12.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)	PAPR (dB)
23012	699.2	$\pi/2$ - BPSK	3.75	1	0	22.84	(*)
				1	47	22.79	(*)
			15	1	0	22.95	(*)
				1	11	22.95	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.9	(*)
				1	47	22.81	(*)
			15	1	0	22.86	(*)
				1	11	22.94	(*)
				3	0	22.83	3.17
				3	6	23.19	3.14
				6	0	22.03	3.94
				6	6	22.13	3.88
				12	0	21.14	3.61
23095	707.5	$\pi/2$ - BPSK	3.75	1	0	23.01	(*)
				1	47	23.11	(*)
			15	1	0	23.16	(*)
				1	11	23.13	(*)
		$\pi/4$ - QPSK	3.75	1	0	23.01	(*)
				1	47	23.09	(*)
			15	1	0	23.15	(*)
				1	11	23.1	(*)
				3	0	22.97	3.21
				3	6	23.17	3.17
				6	0	21.97	3.89
				6	6	21.98	3.96
				12	0	20.95	3.88
23178	715.8	$\pi/2$ - BPSK	3.75	1	0	22.85	(*)
				1	47	22.86	(*)
			15	1	0	22.83	(*)
				1	11	22.82	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.81	(*)
				1	47	22.85	(*)
			15	1	0	22.9	(*)
				1	11	22.86	(*)
				3	0	22.71	3.22
				3	6	23.16	3.01
				6	0	22.03	3.97
				6	6	22.09	3.97
				12	0	21.18	3.91

(*): Preliminary measurements determined that 3. 6 or 12 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

NBLoT. BAND 13.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)	PAPR (dB)
23182	777.20	$\pi/2$ - BPSK	3.75	1	0	22.97	(*)
				1	47	22.95	(*)
			15	1	0	22.96	(*)
				1	11	22.95	(*)
		$\pi/4$ - QPSK	3.75	1	0	23.04	(*)
				1	47	22.95	(*)
			15	1	0	23.14	(*)
				1	11	23.12	(*)
				3	0	22.76	3.19
				3	6	23.22	3.08
				6	0	22.13	3.86
				6	6	22.21	3.85
				12	0	21.22	3.53
23230	782	$\pi/2$ - BPSK	3.75	1	0	22.97	(*)
				1	47	22.85	(*)
			15	1	0	22.92	(*)
				1	11	22.89	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.93	(*)
				1	47	22.87	(*)
			15	1	0	22.91	(*)
				1	11	22.89	(*)
				3	0	22.66	3.3
				3	6	23.01	3.24
				6	0	21.72	4.02
				6	6	21.7	3.96
				12	0	20.74	4.02
23278	786.8	$\pi/2$ - BPSK	3.75	1	0	23.1	(*)
				1	47	23.03	(*)
			15	1	0	23.07	(*)
				1	11	23.05	(*)
		$\pi/4$ - QPSK	3.75	1	0	23.13	(*)
				1	47	23.03	(*)
			15	1	0	23.05	(*)
				1	11	23.13	(*)
				3	0	22.9	3.24
				3	6	23.26	3.09
				6	0	22.18	3.86
				6	6	22.26	3.83
				12	0	21.29	3.8

(*): Preliminary measurements determined that 3, 6 or 12 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

NBLoT. BAND 66.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)	PAPR (dB)
131974	1710.2	$\pi/2$ - BPSK	3.75	1	0	22.96	(*)
				1	47	22.92	(*)
			15	1	0	22.98	(*)
				1	11	22.96	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.99	(*)
				1	47	22.9	(*)
			15	1	0	22.99	(*)
				1	11	22.96	(*)
				3	0	22.83	3.45
				3	6	23.31	3.13
				6	0	22.2	4.05
				6	6	22.29	4.04
				12	0	21.19	3.78
132322	1745	$\pi/2$ - BPSK	3.75	1	0	22.75	(*)
				1	47	22.69	(*)
			15	1	0	22.75	(*)
				1	11	22.73	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.74	(*)
				1	47	22.66	(*)
			15	1	0	22.73	(*)
				1	11	22.72	(*)
				3	0	22.4	3.32
				3	6	22.46	3.3
				6	0	21.55	4.41
				6	6	21.54	4.33
				12	0	20.54	4.28
132670	1779.8	$\pi/2$ - BPSK	3.75	1	0	23.11	(*)
				1	47	23.03	(*)
			15	1	0	23.12	(*)
				1	11	23.16	(*)
		$\pi/4$ - QPSK	3.75	1	0	23.12	(*)
				1	47	23.1	(*)
			15	1	0	23.13	(*)
				1	11	23.1	(*)
				3	0	22.98	3.38
				3	6	23.39	3.24
				6	0	22.21	4.41
				6	6	22.38	4.28
				12	0	21.26	4.29

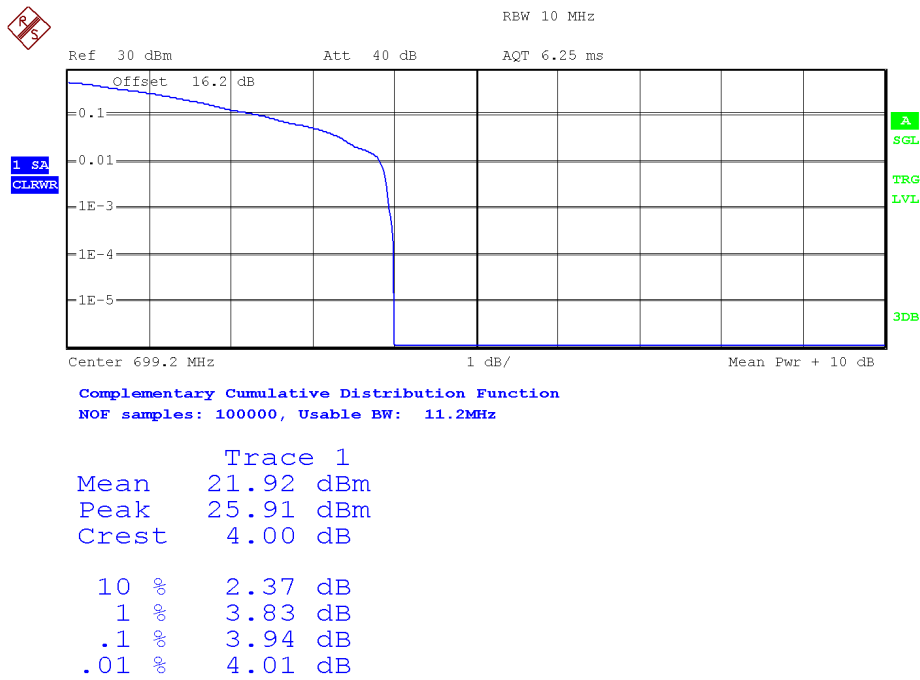
(*): Preliminary measurements determined that 3. 6 or 12 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

PEAK-TO-AVERAGE POWER RATIO (PAPR).

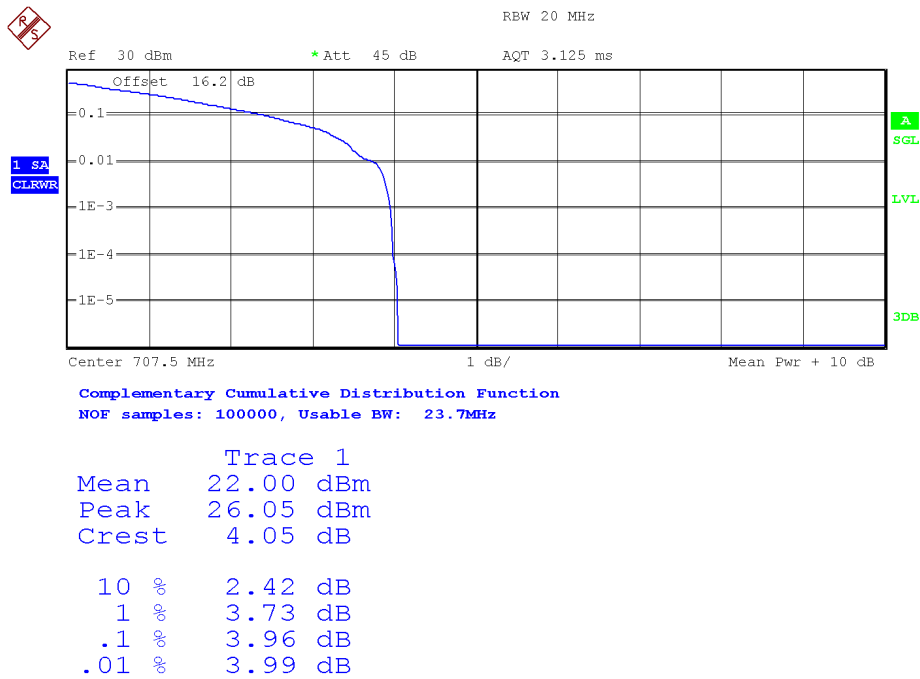
NB-IoT BAND 12.

Preliminary measurements determined that 6 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

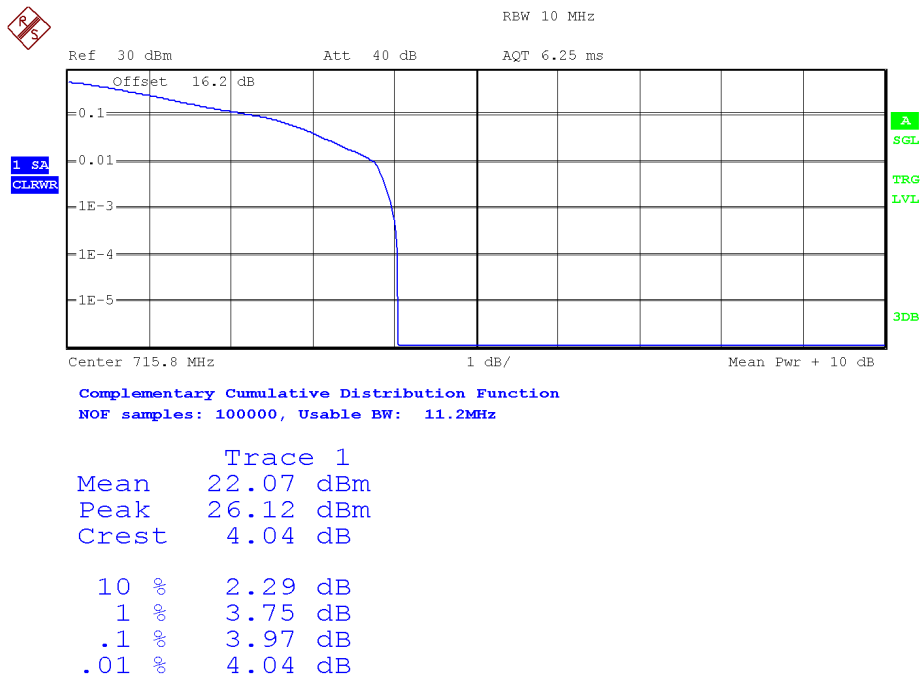
Channel Low:



Channel Middle:



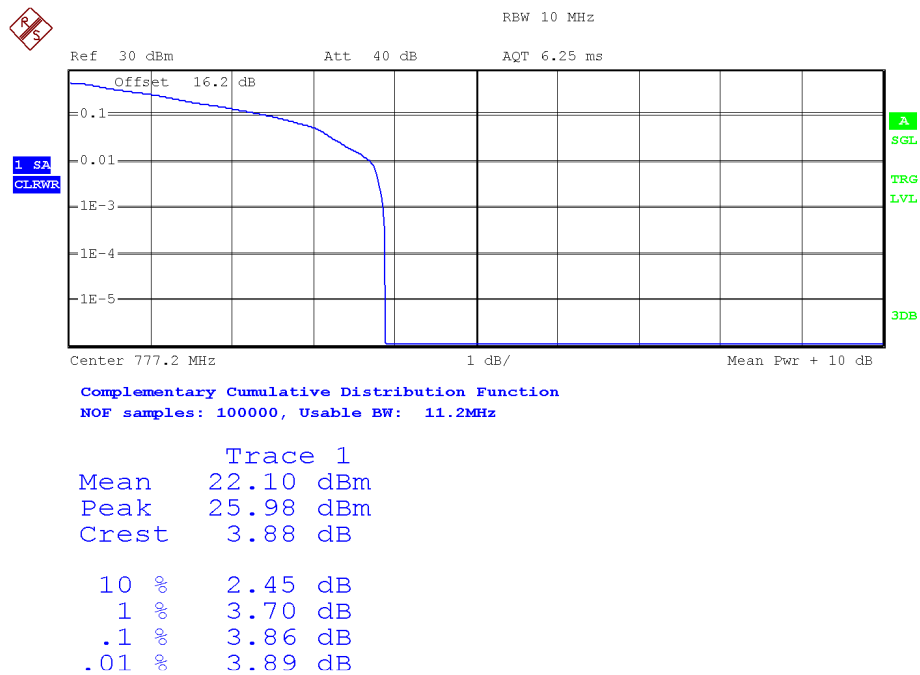
Channel High:



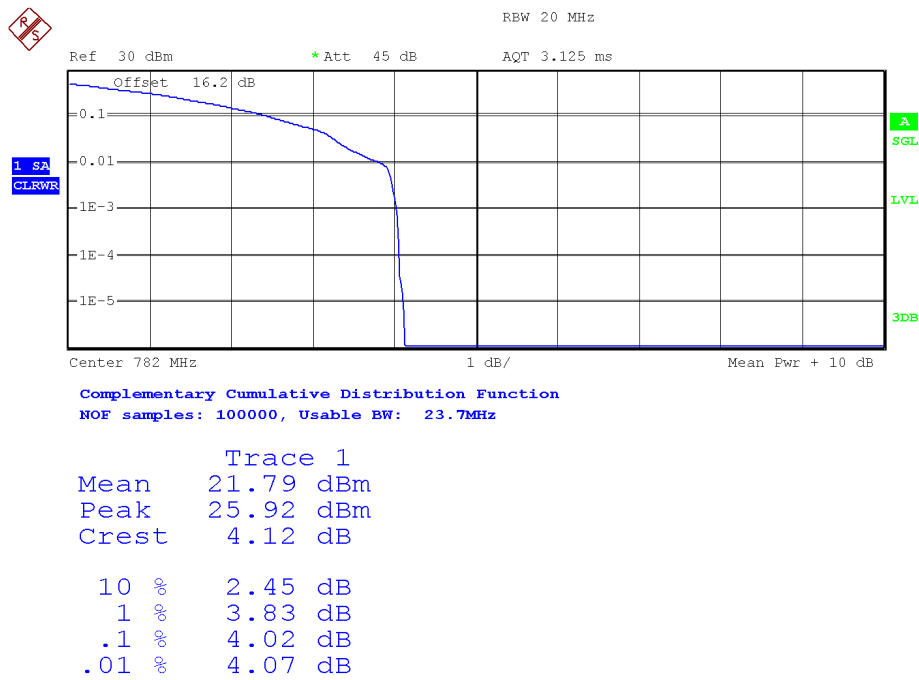
NBIoT. BAND 13.

Preliminary measurements determined that 6 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

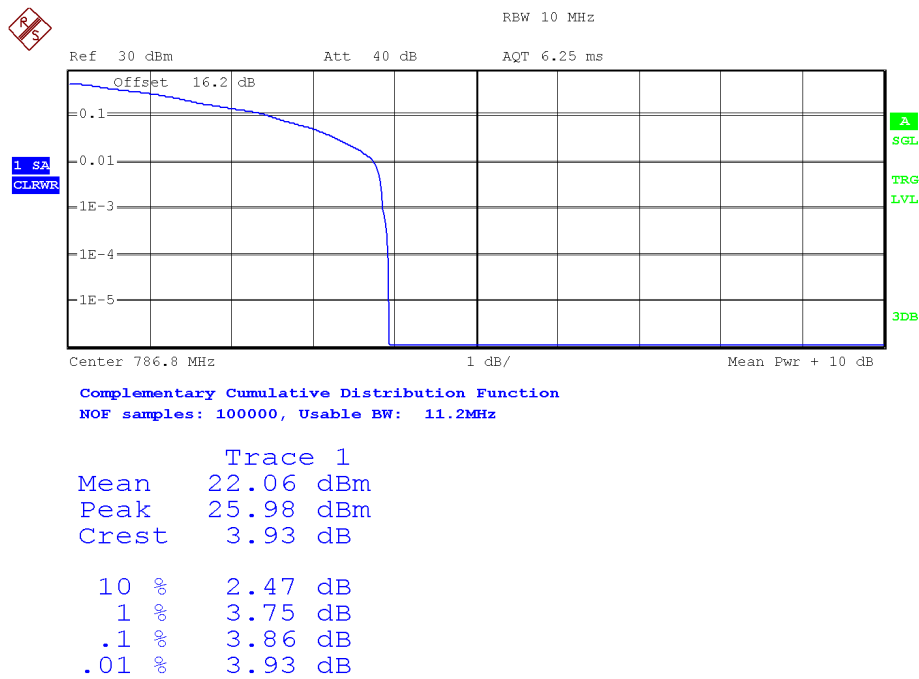
Channel Low:



Channel Middle:



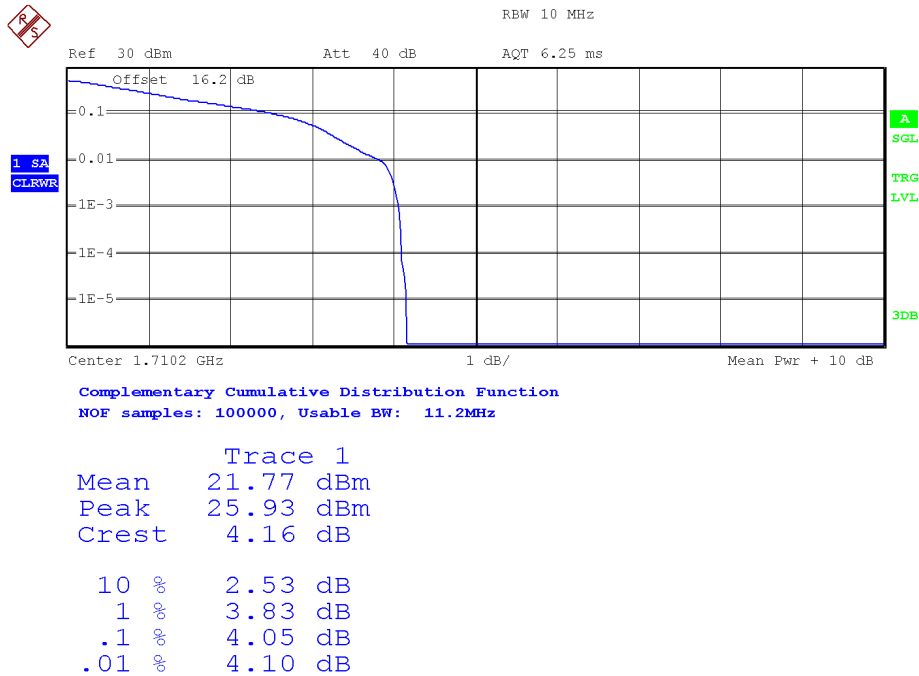
Channel High:



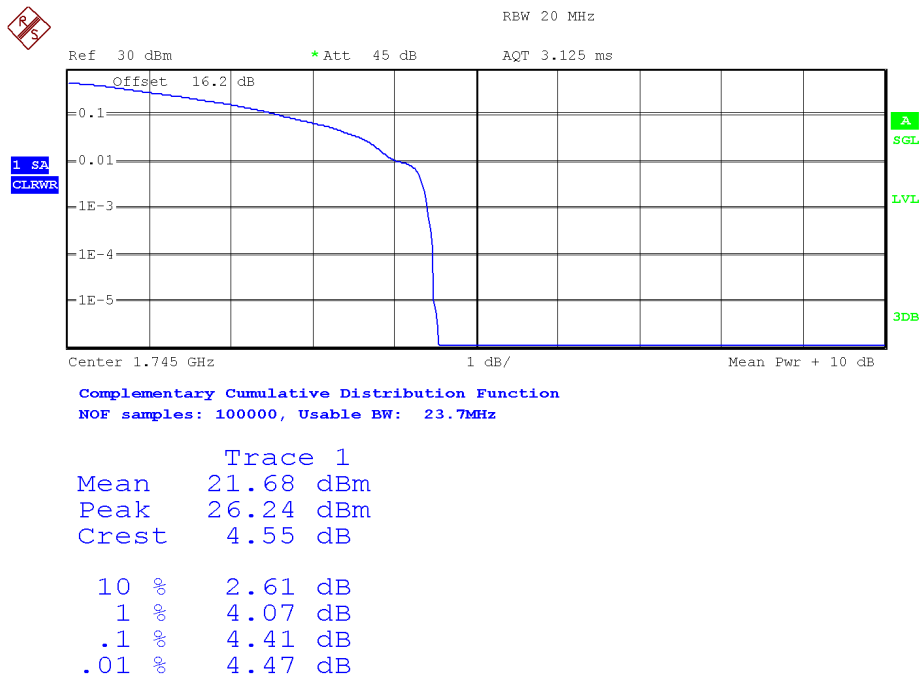
NB IoT. BAND 66.

Preliminary measurements determined that 6 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

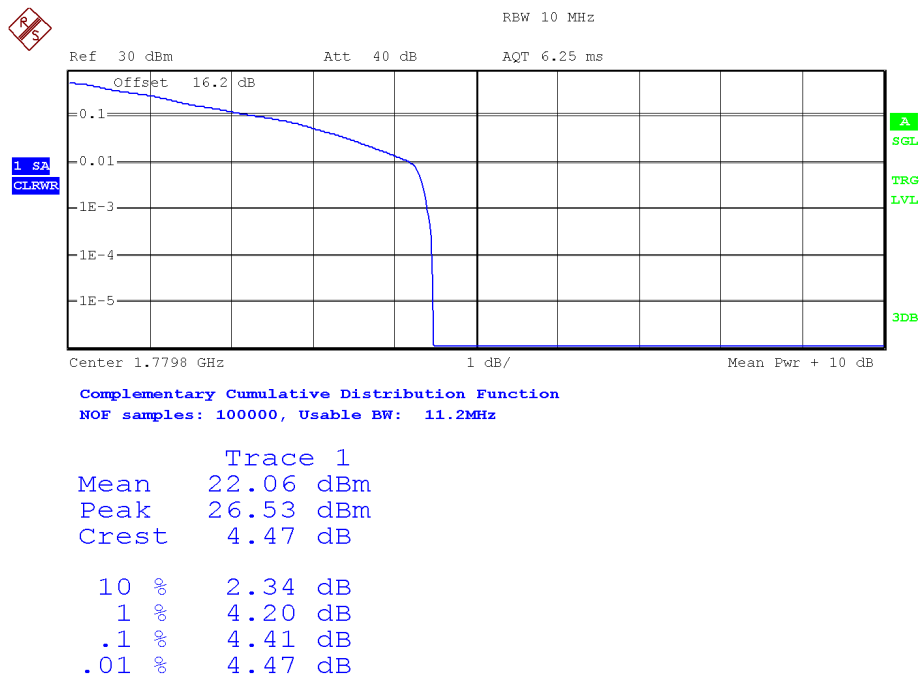
Channel Low:



Channel Middle:



Channel High:



NBLoT 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)
Lowest	23.19	+2.6	25.79	23.64	3.94
Middle	23.17	+2.6	25.77	23.62	3.96
Highest	23.16	+2.6	25.76	23.61	3.97
Measurement uncertainty (dB)	<±1.11				

NBLoT BAND 13.

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)
Lowest	23.22	+2.6	25.82	23.67	3.86
Middle	23.01	+2.6	25.61	23.46	4.02
Highest	23.26	+2.6	25.86	23.71	3.86
Measurement uncertainty (dB)	<±1.11				

NBLoT BAND 66.

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)
Lowest	23.31	+4.4	27.71	25.56	4.05
Middle	22.76	+4.4	27.16	25.01	4.41
Highest	23.39	+4.4	27.9	25.64	4.41
Measurement uncertainty (dB)	<±1.11				

Verdict: PASS

Frequency Stability

SPECIFICATION

FCC §2.1055 and §27.54.

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

RSS-130. Clause 4.3.

The applicant shall ensure frequency stability by showing that f_L minus the frequency offset and f_H plus the frequency offset shall be within the frequency range in which the equipment is designed to operate.

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 $+50^{\circ}\text{C}$. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to $+50^{\circ}\text{C}$.

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

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

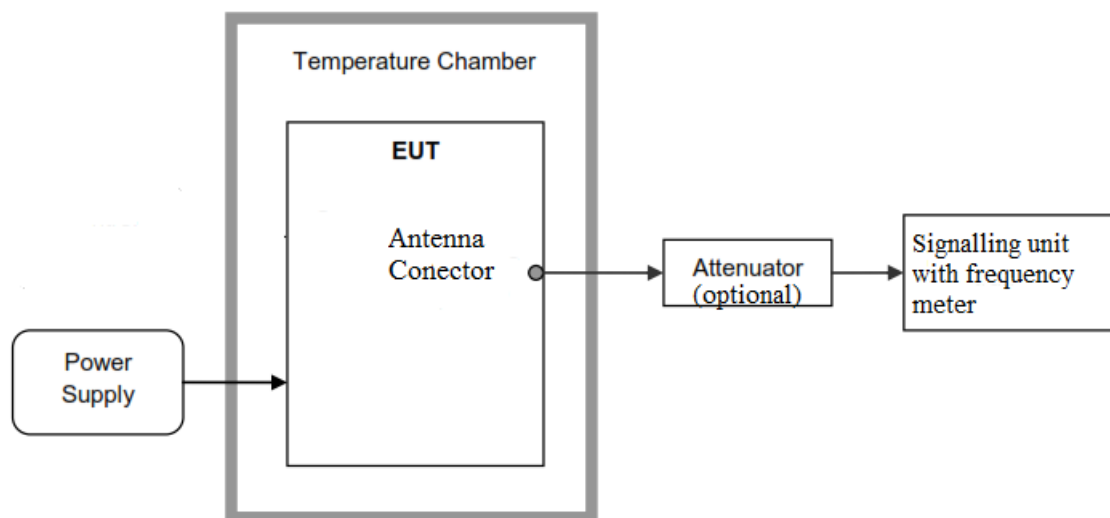
The worst case NB-IoT mode for conducted power was used for the test.

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 f_L and f_H respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of f_L and f_H to check that the resulting frequencies remain within the band.

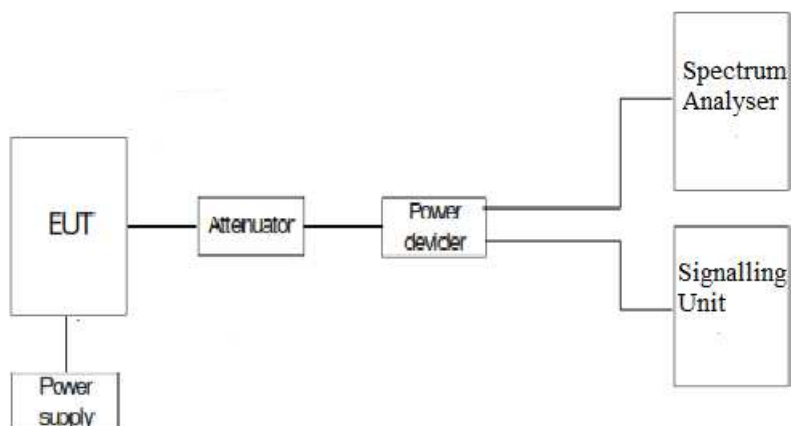
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Frequency tolerance.



Reference points f_L and f_H .



RESULTS

Frequency stability over temperature variations.

NBloT Band 12

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	7.25	0.01024735
+40	16.01	0.022628975
+30	8.31	0.011745583
+20	5.81	0.008212014
+10	12.89	0.018219081
0	2.15	0.003038869
-10	5.41	0.007646643
-20	-2.8	-0.003957597
-30	19.6	0.02770318

NBloT Band 13

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	7.18	0.009181586
+40	28.45	0.036381074
+30	8.38	0.010716113
+20	1.6	0.002046036
+10	16.75	0.021419437
0	-2.1	-0.002685422
-10	8.58	0.010971867
-20	-19.57	-0.025025575
-30	37.62	0.048107417

NBloT Band 66

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	20.97	0.012017192
+40	27.64	0.015839542
+30	-23.99	-0.013747851
+20	11.46	0.006567335
+10	25.42	0.014567335
0	17.6	0.01008596
-10	28.17	0.016143266
-20	-16.06	-0.009203438
-30	30.4	0.017421203

Frequency stability over voltage variations.

NBLoT Band 12

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.37	7.71	0.010897527
Vmin	3.23	9.21	0.013017668

NBLoT Band 13

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.37	2.13	0.002723785
Vmin	3.23	4.88	0.006240409

NBLoT Band 66

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.37	13.7	0.007851003
Vmin	3.23	9.56	0.00547851

Reference points established at the applicable unwanted emissions limit (worst case):

	NBLoT Band 12
f_L (MHz)	698.9357
f_H (MHz)	715.9913

	NBLoT Band 13
f_L (MHz)	777.0074
f_H (MHz)	786.9911

	NBLoT Band 66
f_L (MHz)	1710.0383
f_H (MHz)	1779.9623

Reference points f_L and f_H with the worst-case frequency offsets added or subtracted:

	NBLoT Band 12
f_L (MHz)	698.9357
f_H (MHz)	715.9913

	NBLoT Band 13
f_L (MHz)	777.0074
f_H (MHz)	786.9911

	NBLoT Band 66
f_L (MHz)	1710.0383
f_H (MHz)	1779.9624

The reference frequency points stay within the authorized blocks.

Verdict: PASS

Modulation Characteristics

SPECIFICATION

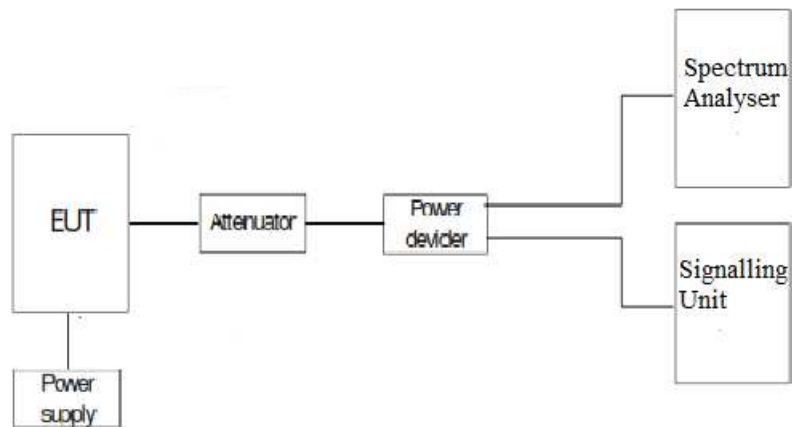
FCC §2.1047

RSS-130. Clause 4.1 and RSS-133. Clause 6.2. Equipment certified under this standard shall use digital modulation.

METHOD

For NBloT the EUT operates with $\pi/2$ - BPSK and $\pi/4$ - QPSK modulation modes in which the information is digitised and coded into a bit stream.

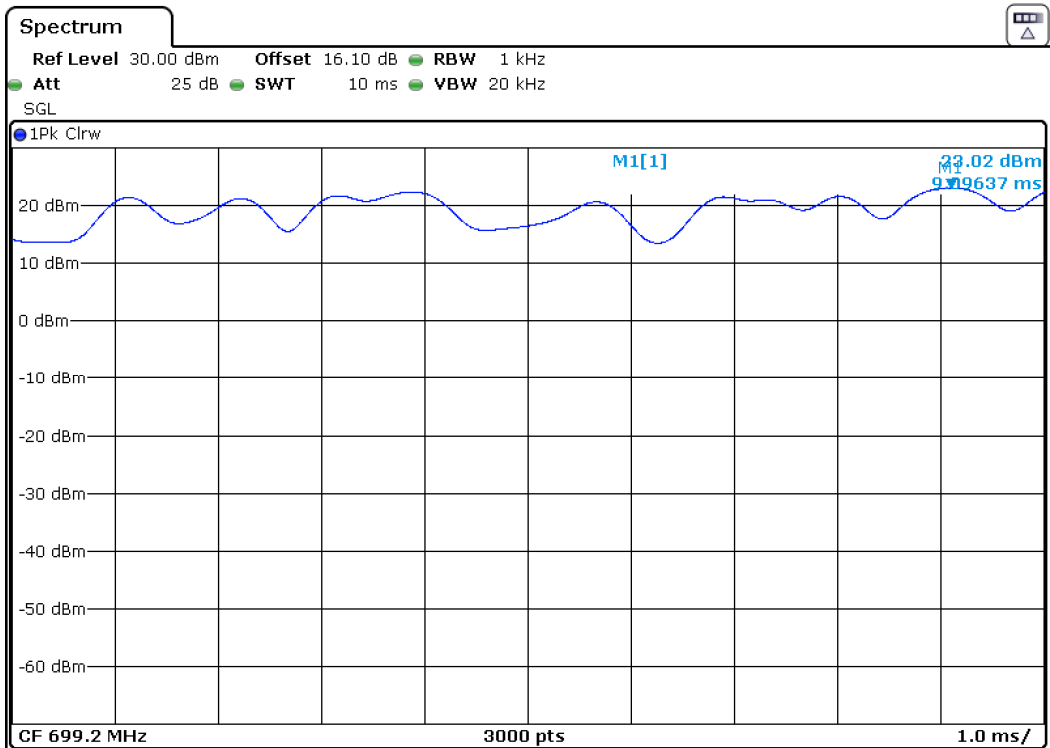
TEST SETUP



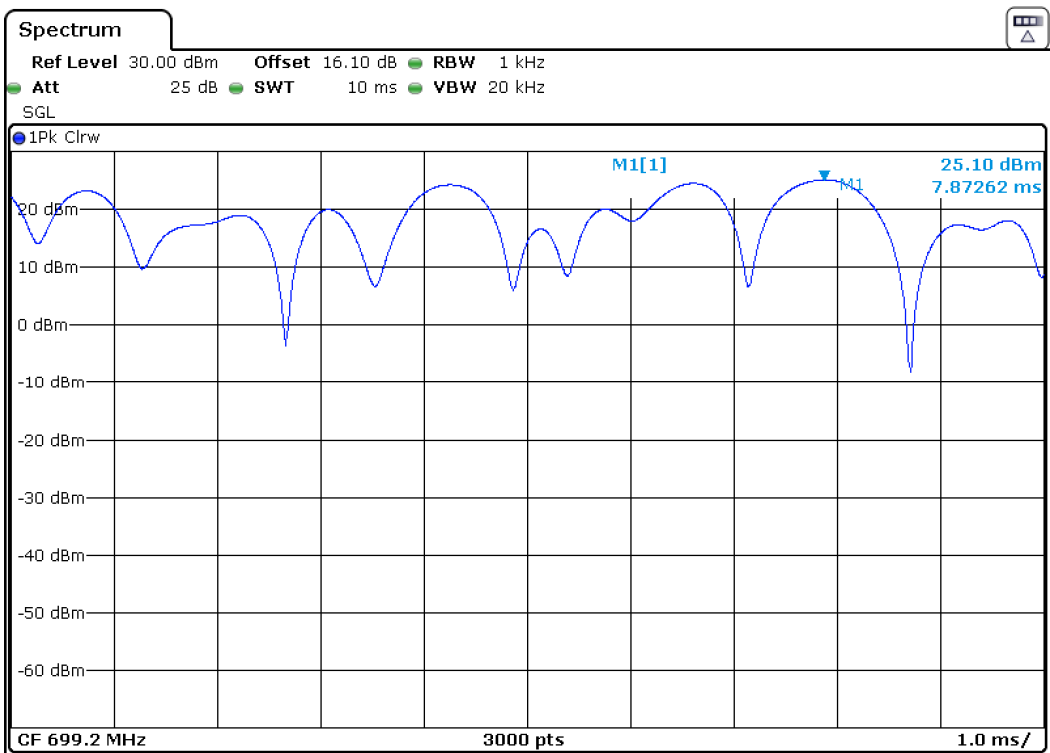
RESULTS

The following plot shows the modulation schemes in the EUT.

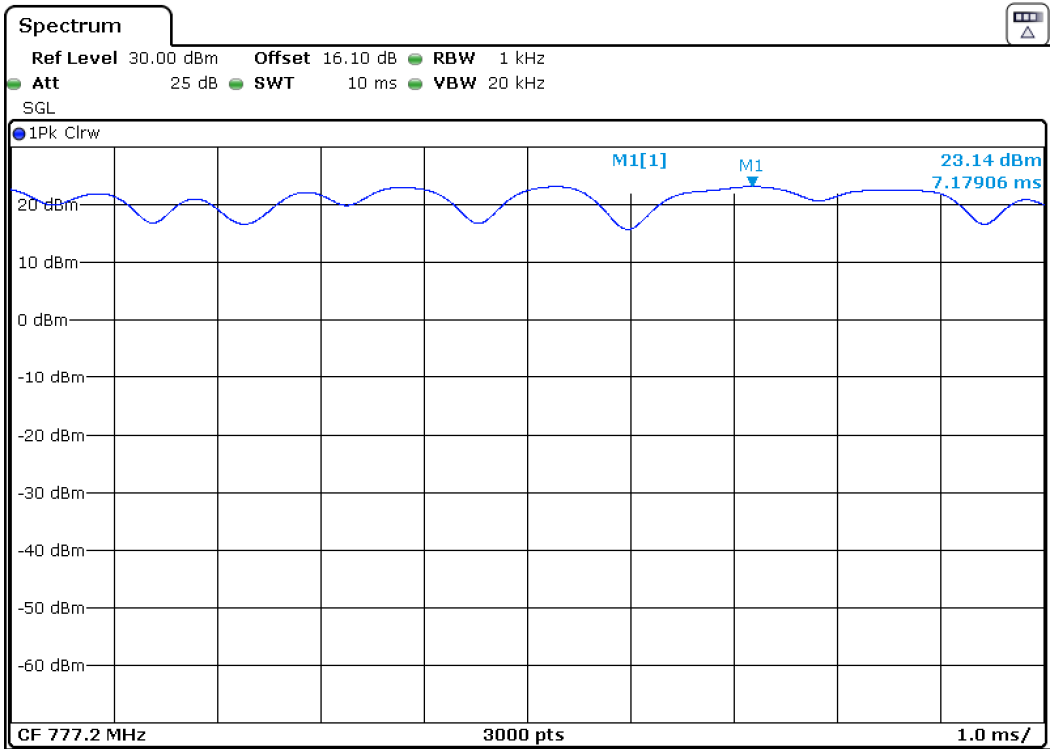
NB-IoT MODULATION (Band 12). $\pi/2$ - BPSK.



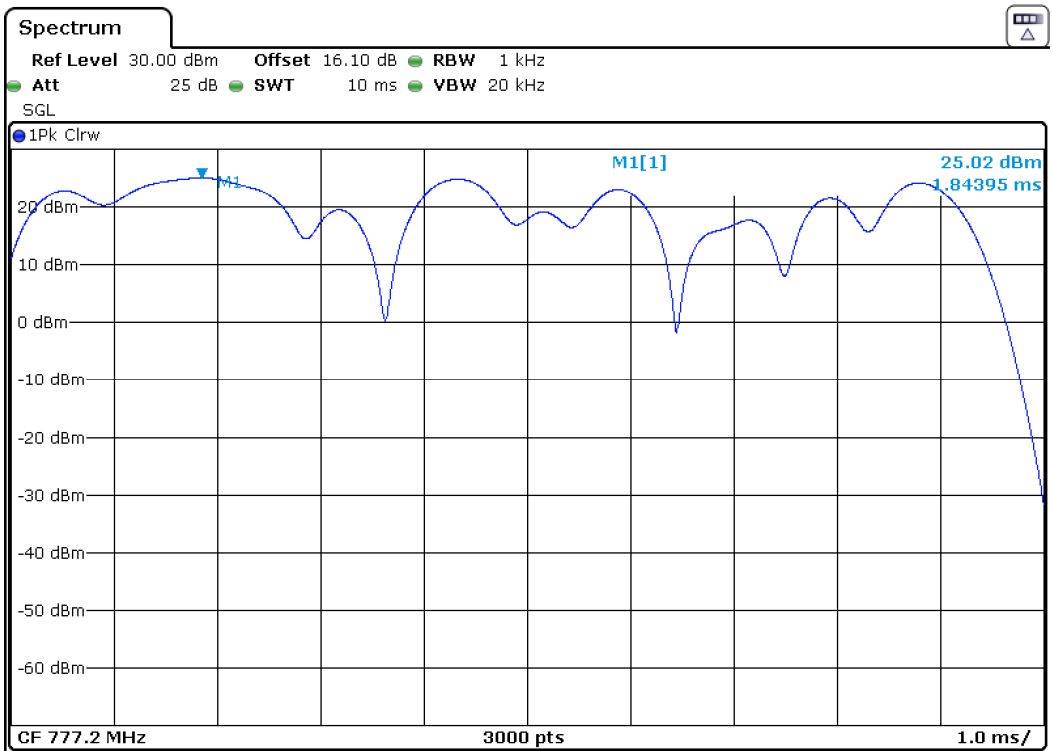
NB-IoT MODULATION (Band 12). $\pi/4$ - QPSK.



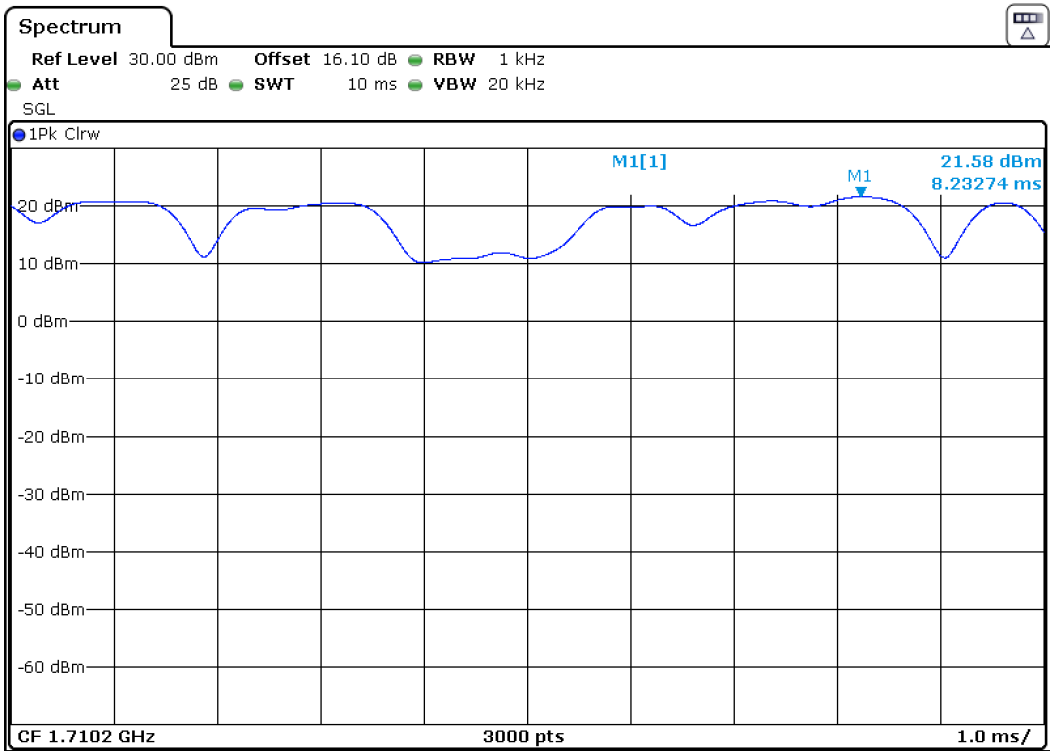
NB-IoT MODULATION (Band 13). $\pi/2$ - BPSK.



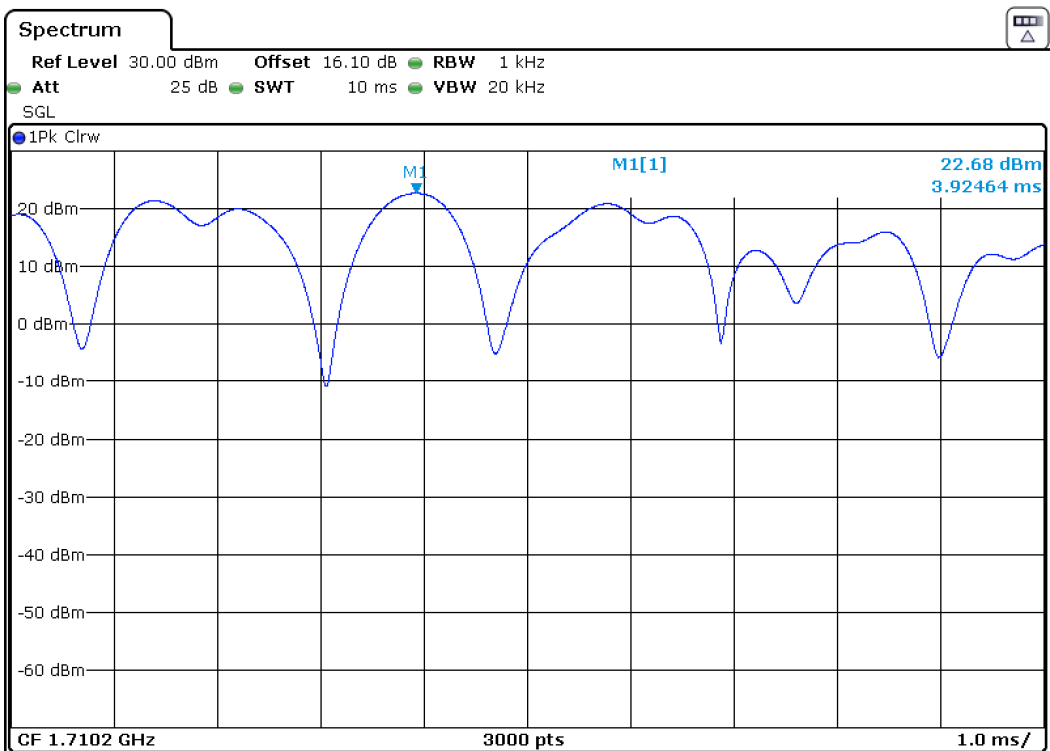
NB-IoT MODULATION (Band 13). $\pi/4$ - QPSK.



NB-IoT MODULATION (Band 66). $\pi/2$ - BPSK.



NB-IoT MODULATION (Band 66). $\pi/4$ - QPSK.



Occupied Bandwidth

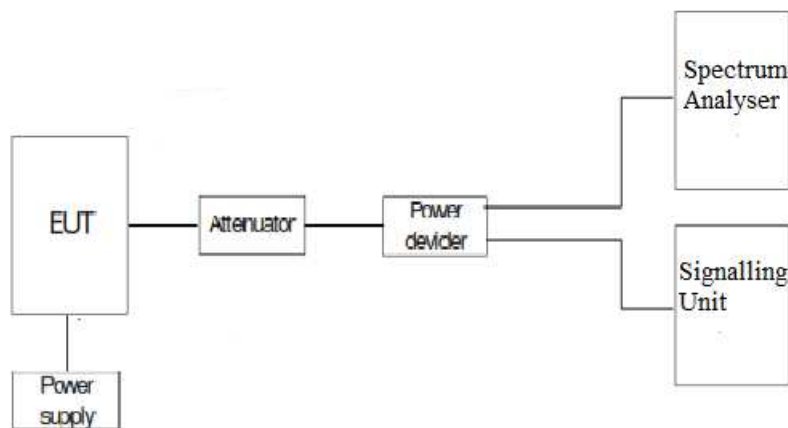
SPECIFICATION

§2.1049

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)

NB IoT BAND 12.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	57.60	57.60	57.86
-26 dBc bandwidth (kHz)	41.533	41.533	41.467
Measurement uncertainty (kHz)	< ± 0.05		

Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	61.86	61.93	62.00
-26 dBc bandwidth (kHz)	41.933	41.867	41.867
Measurement uncertainty (kHz)	< ± 0.05		

Tone 15 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	137.60	137.60	137.73
-26 dBc bandwidth (kHz)	127.27	127.33	127.47
Measurement uncertainty (kHz)	< ± 0.10		

12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	202.53	202.53	202.53
-26 dBc bandwidth (kHz)	307.60	308.27	300.27
Measurement uncertainty (kHz)	< ± 0.12		

NB-IoT BAND 13.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	58.60	58.66	58.80
-26 dBc bandwidth (kHz)	41.467	41.533	41.533
Measurement uncertainty (kHz)	< ± 0.05		

Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	62.46	62.40	62.66
-26 dBc bandwidth (kHz)	41.867	41.867	41.867
Measurement uncertainty (kHz)	< ± 0.05		

Tone 15 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	138.53	138.93	138.66
-26 dBc bandwidth (kHz)	127.47	127.47	127.47
Measurement uncertainty (kHz)	< ± 0.10		

12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	203.33	202	203.46
-26 dBc bandwidth (kHz)	326.93	308.40	317.33
Measurement uncertainty (kHz)	< ± 0.12		

NB IoT BAND 66.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	59.20	59.73	59.40
-26 dBc bandwidth (kHz)	41.467	41.33	41.40
Measurement uncertainty (kHz)	< ± 0.05		

Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	62.53	62.66	62.60
-26 dBc bandwidth (kHz)	41.80	41.80	42.00
Measurement uncertainty (kHz)	< ± 0.05		

Tone 15 kHz. $\pi/2$ - BPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	140.53	139.86	139.06
-26 dBc bandwidth (kHz)	127.78	127.60	127.60
Measurement uncertainty (kHz)	< ± 0.10		

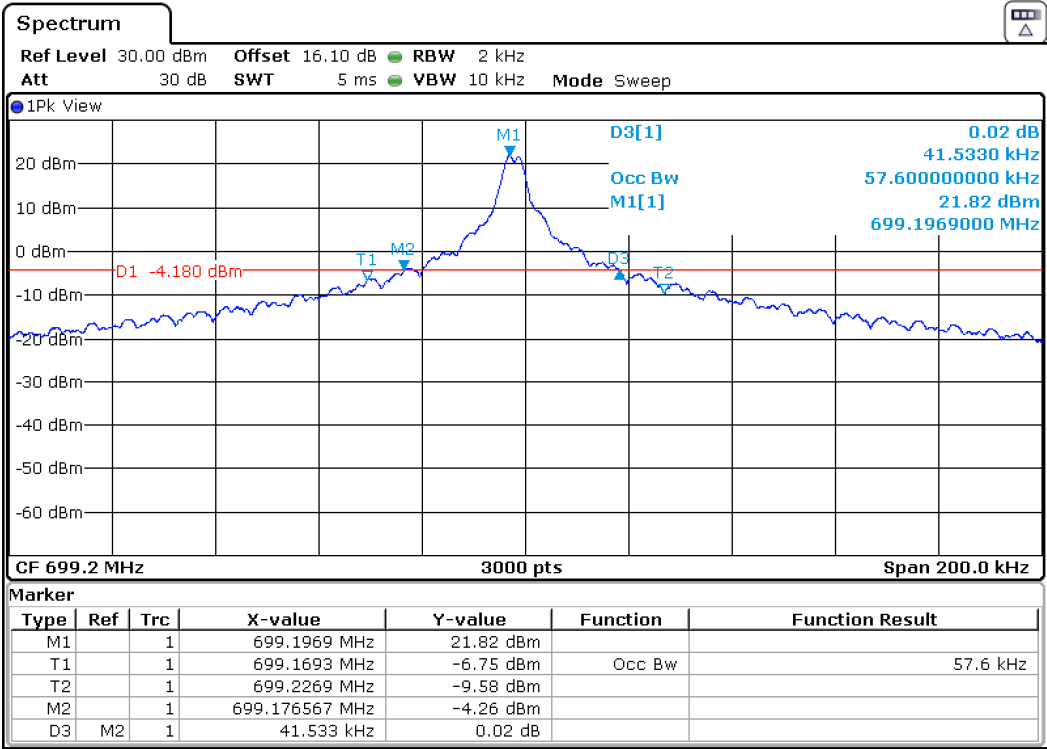
12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	203.20	204.26	203.33
-26 dBc bandwidth (kHz)	325.33	320.80	322.40
Measurement uncertainty (kHz)	< ± 0.12		

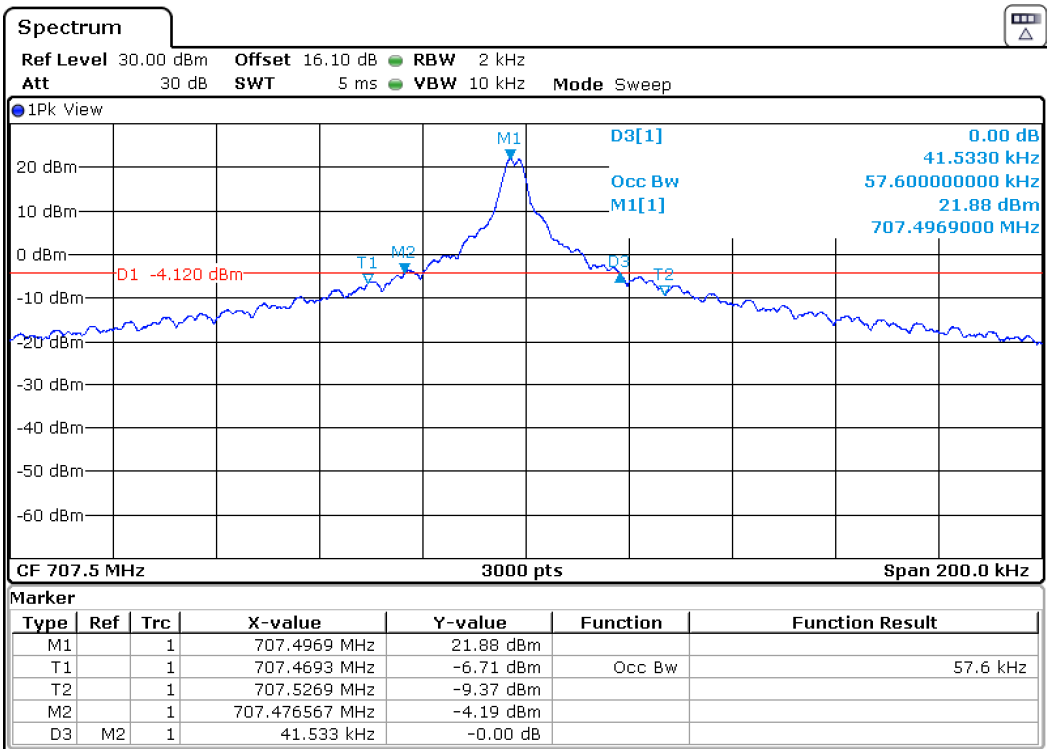
NB-IoT BAND 12.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

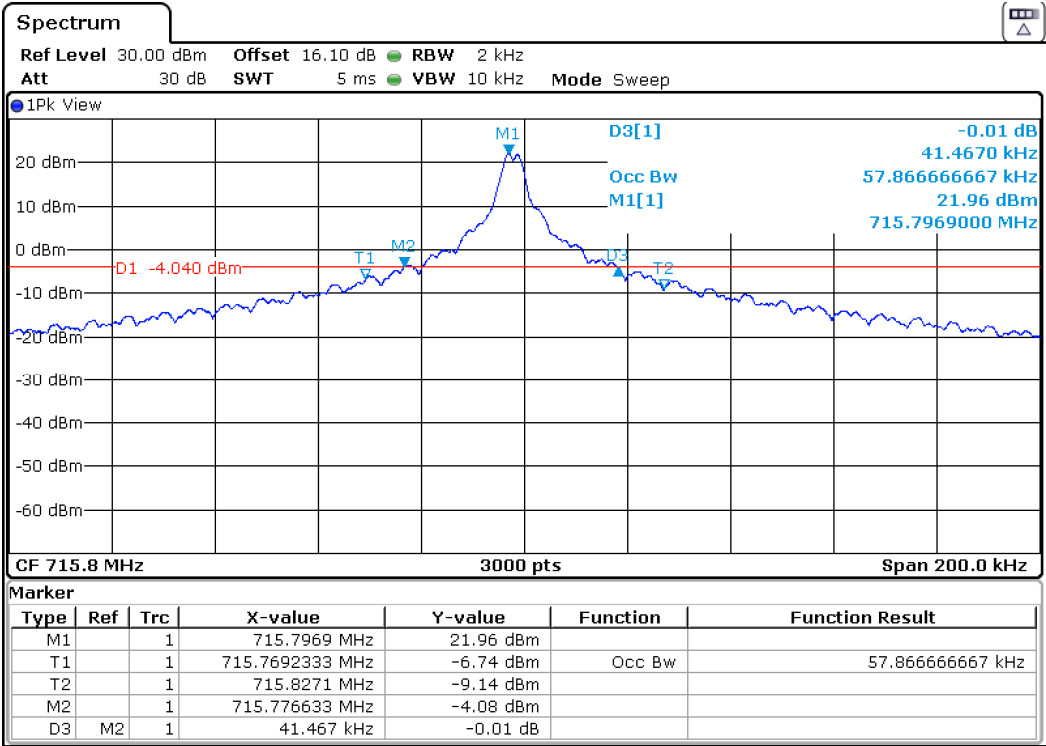
Lowest Channel



Middle Channel

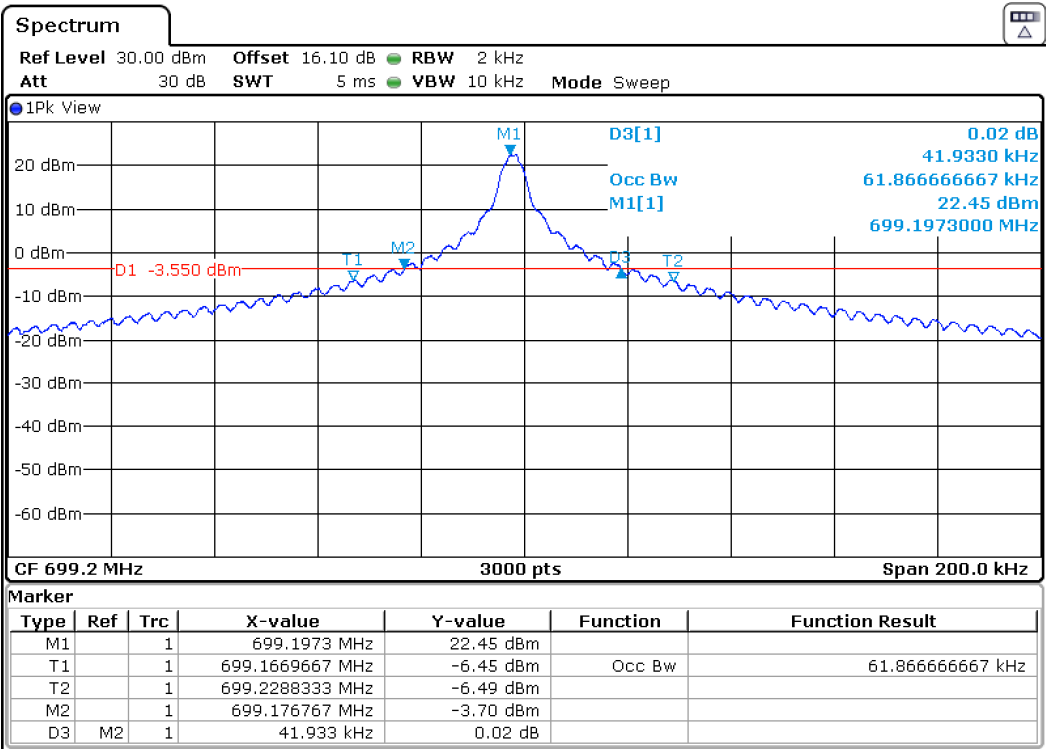


Highest Channel

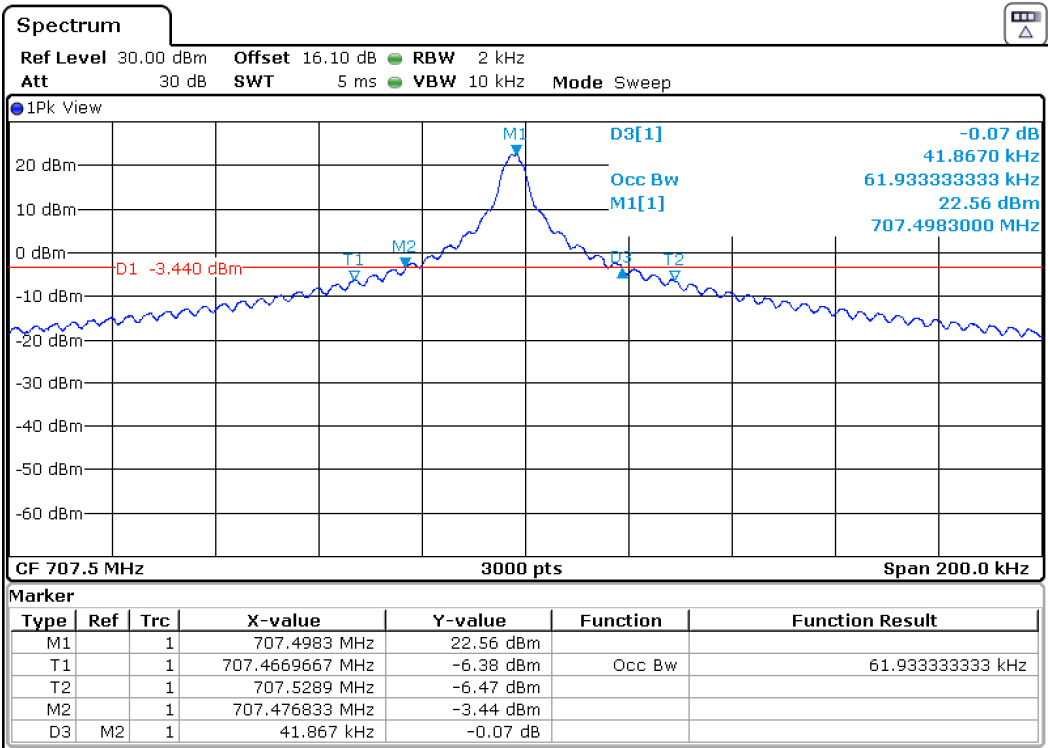


Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

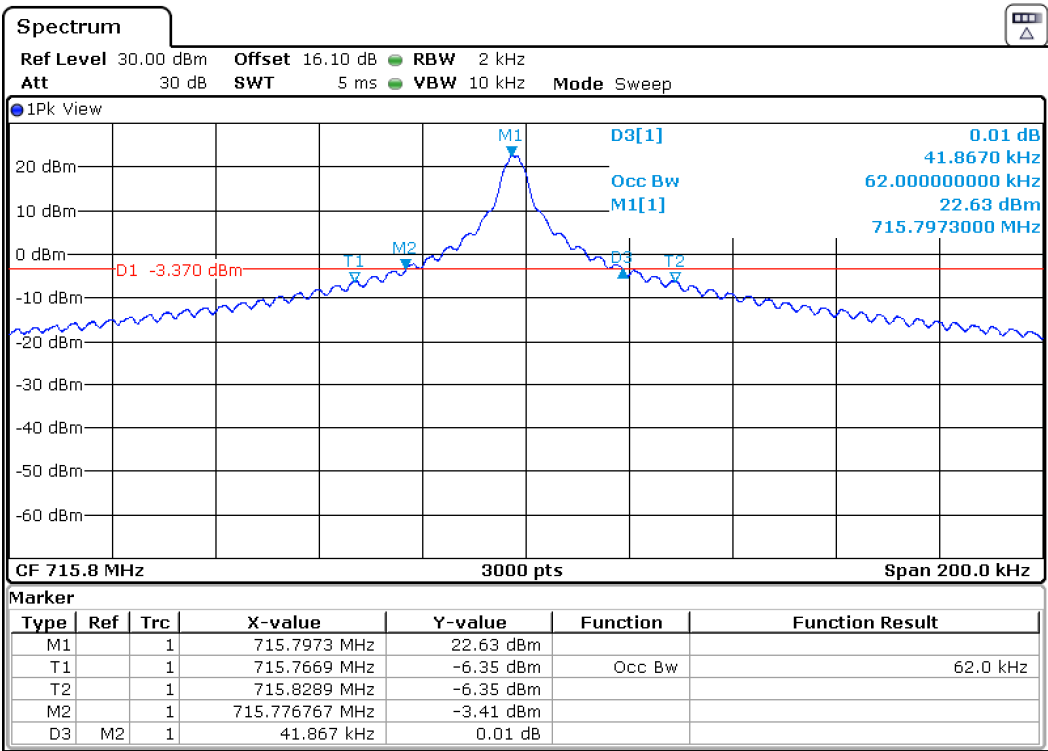
Lowest Channel



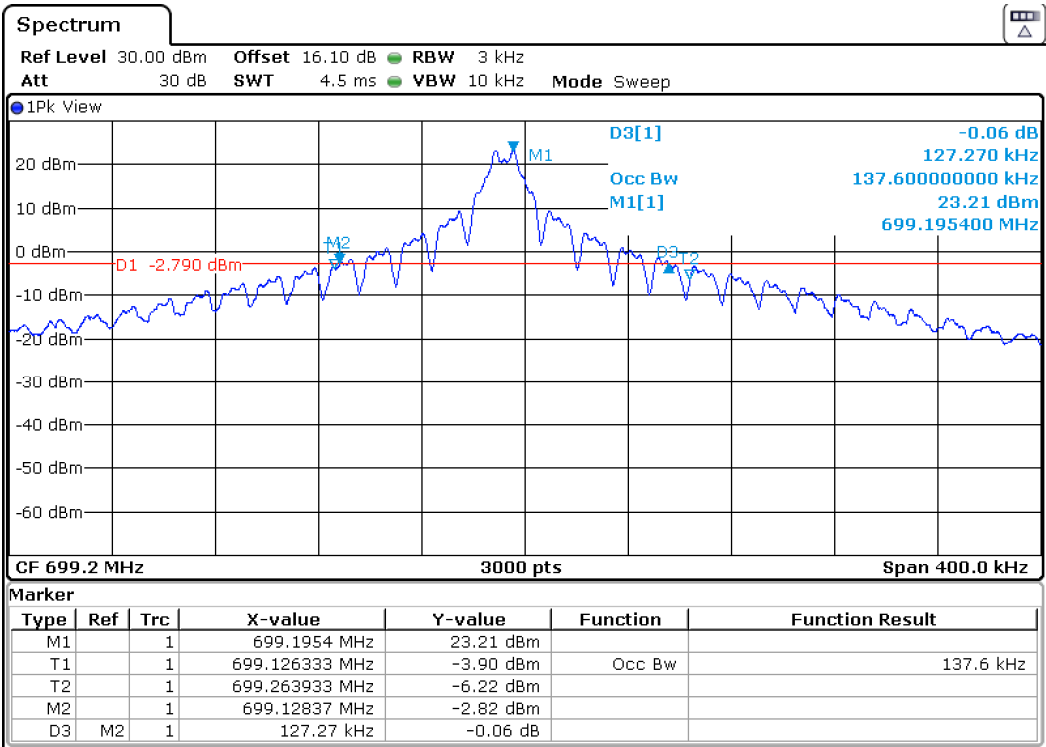
Middle Channel



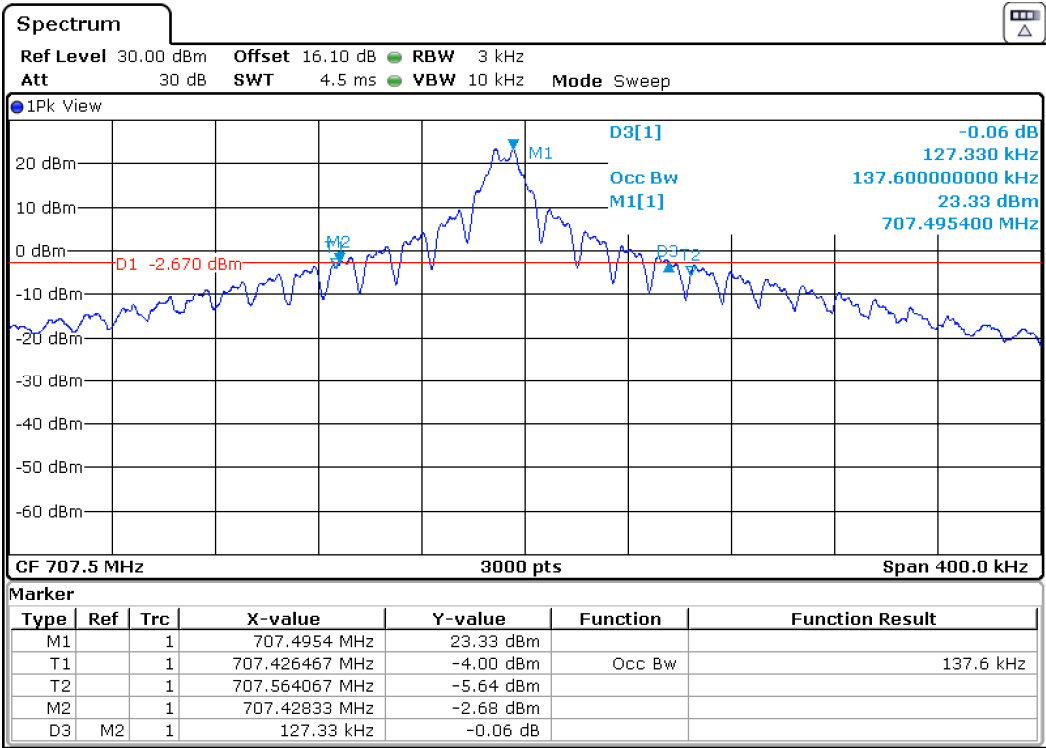
Highest Channel



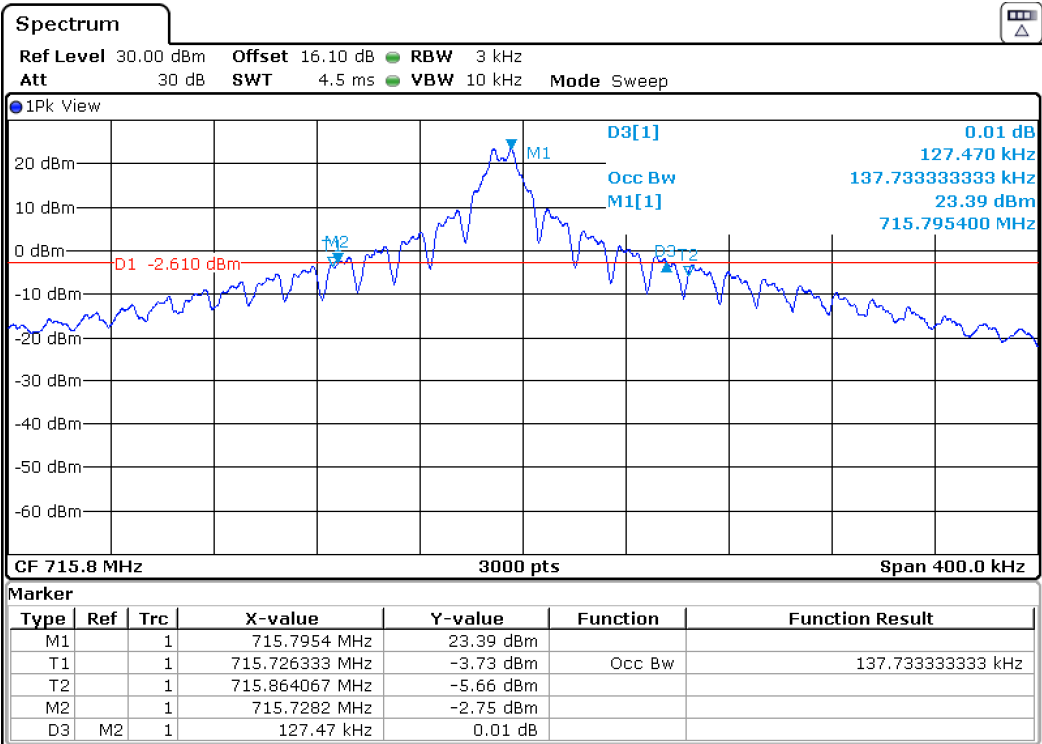
Tone 15 kHz. $\pi/2$ - BPSK MODULATION
Lowest Channel



Middle Channel

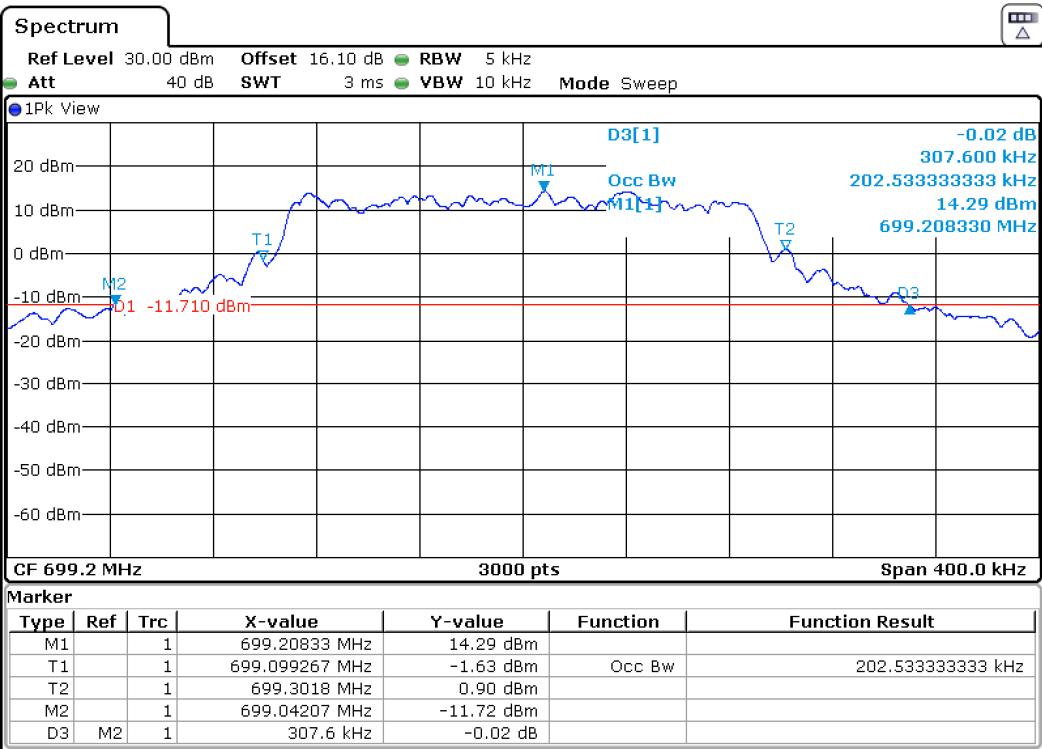


Highest Channel

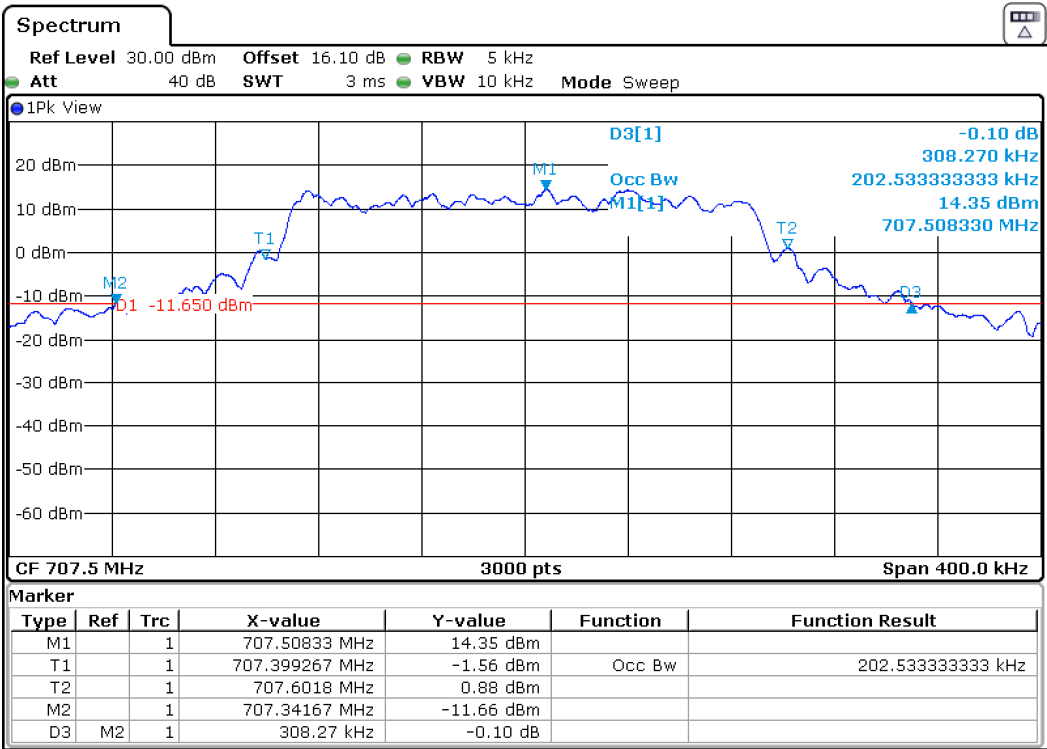


12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

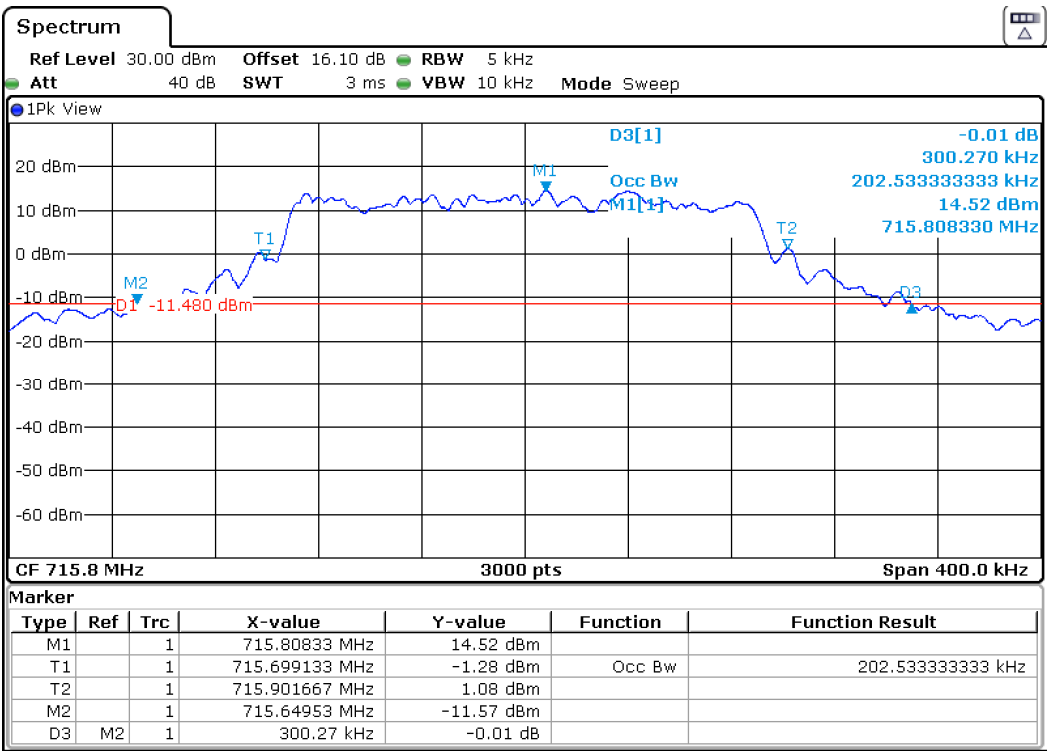
Lowest Channel



Middle Channel



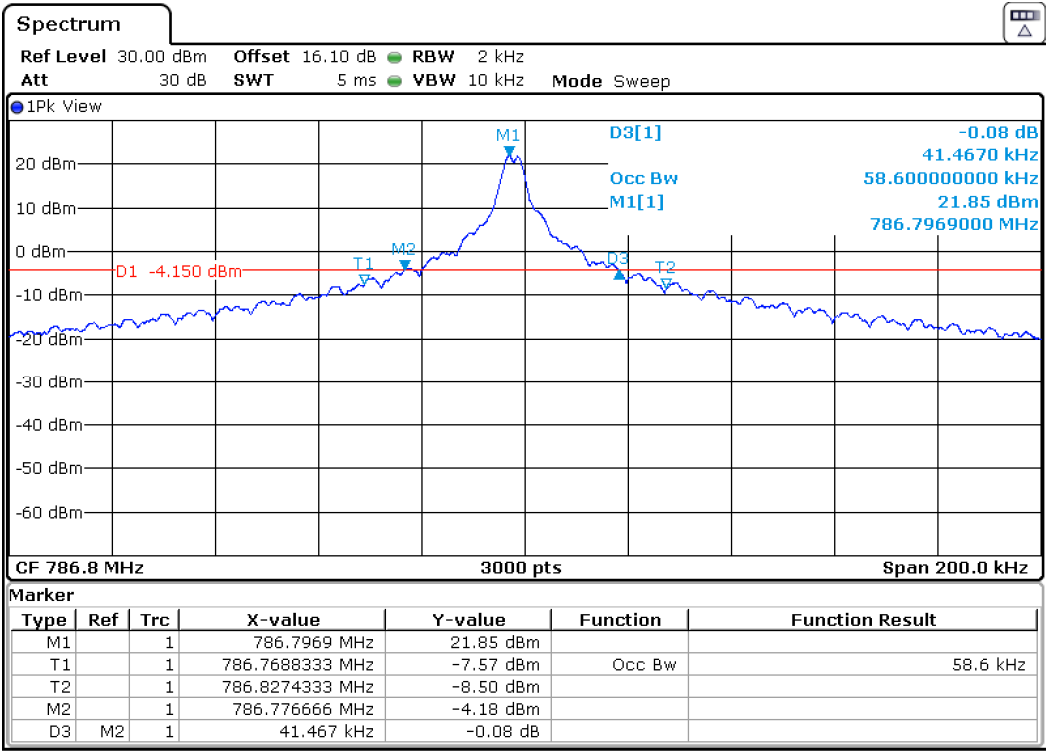
Highest Channel



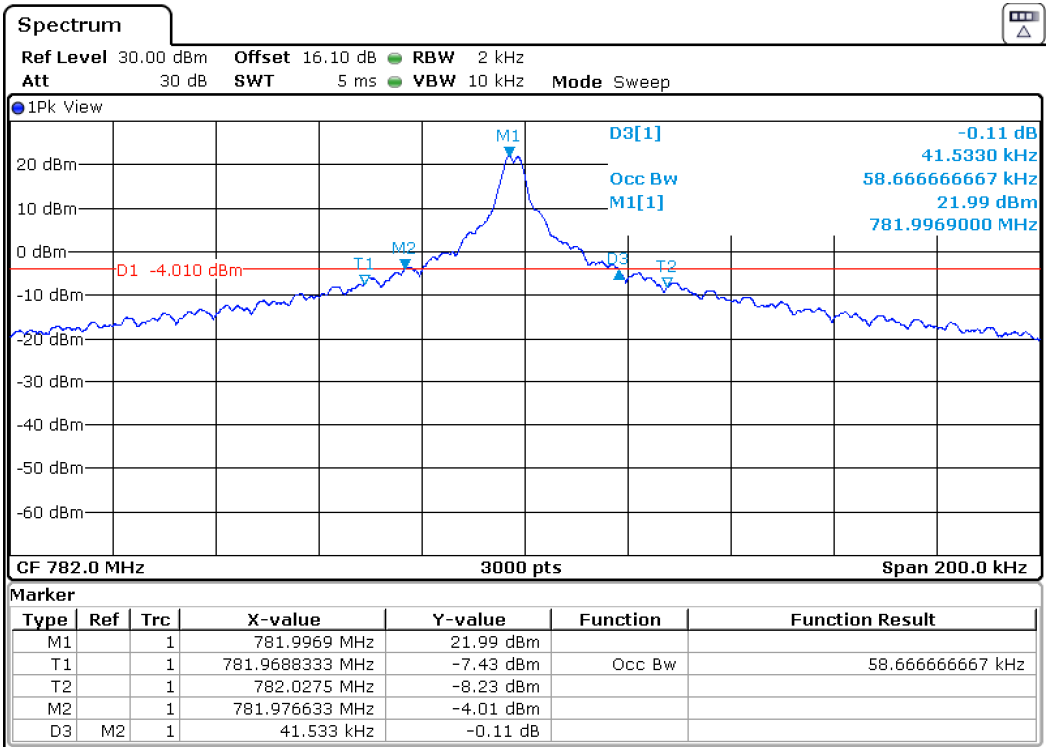
NB IoT BAND 13.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

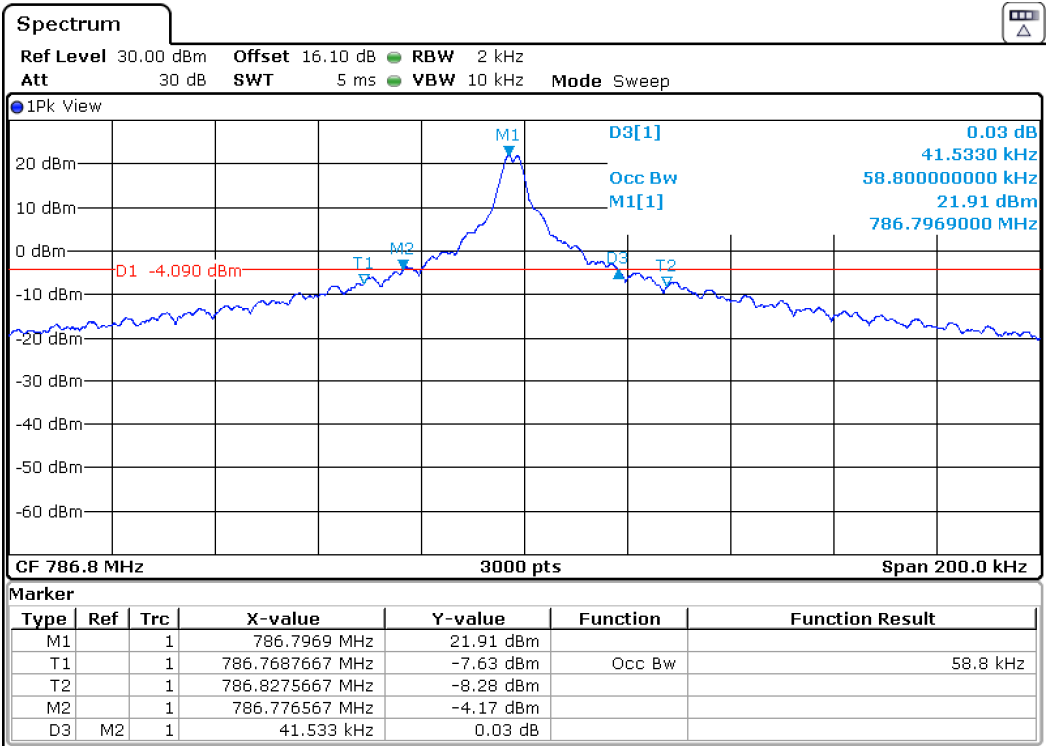
Lowest Channel



Middle Channel

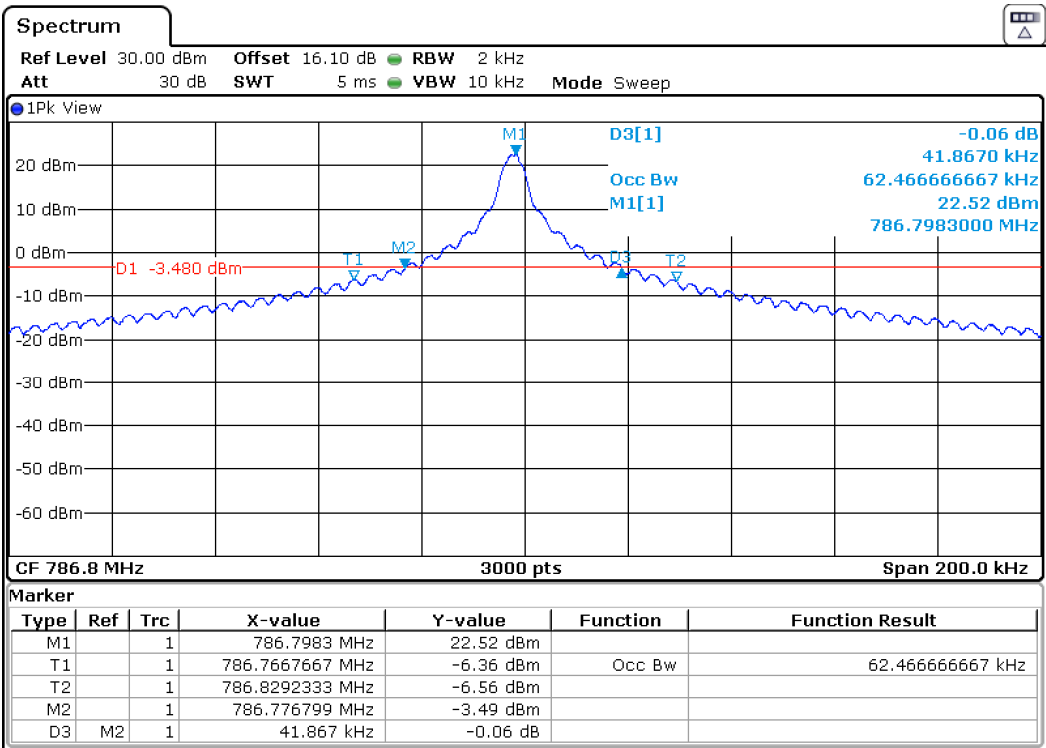


Highest Channel

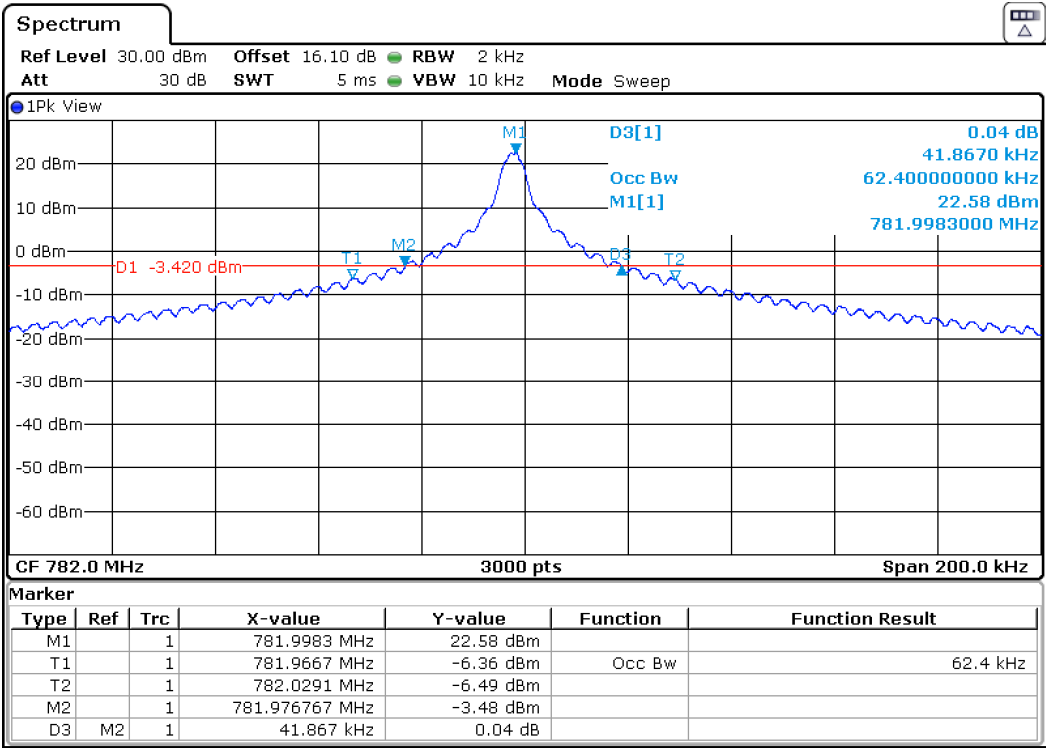


Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

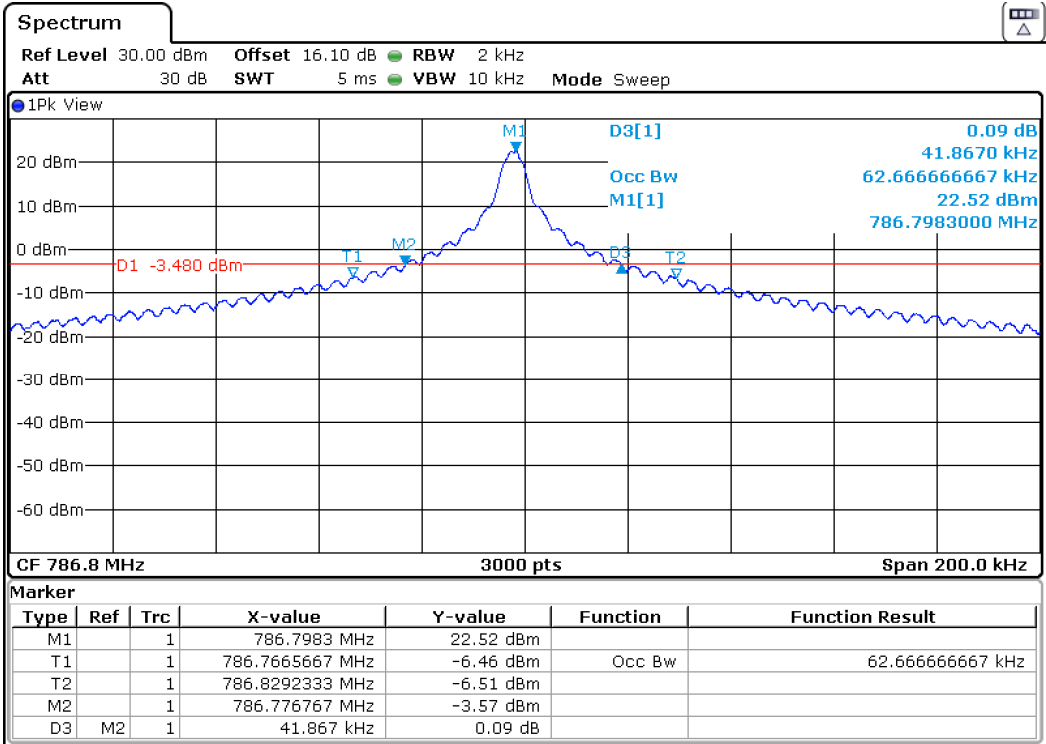
Lowest Channel



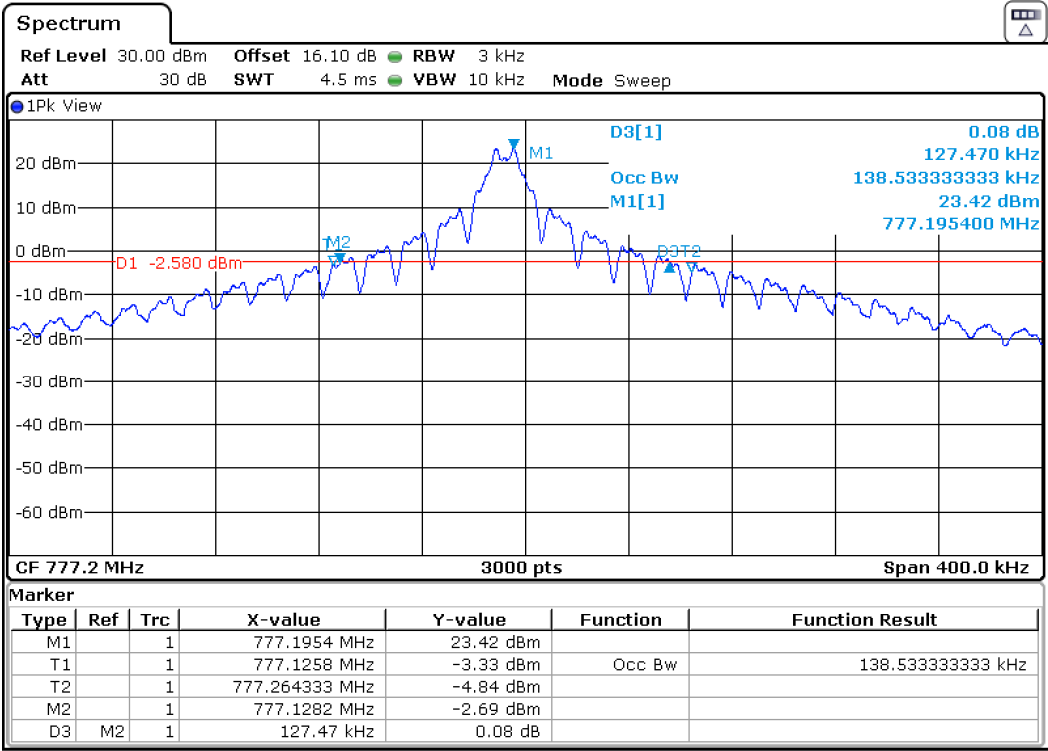
Middle Channel



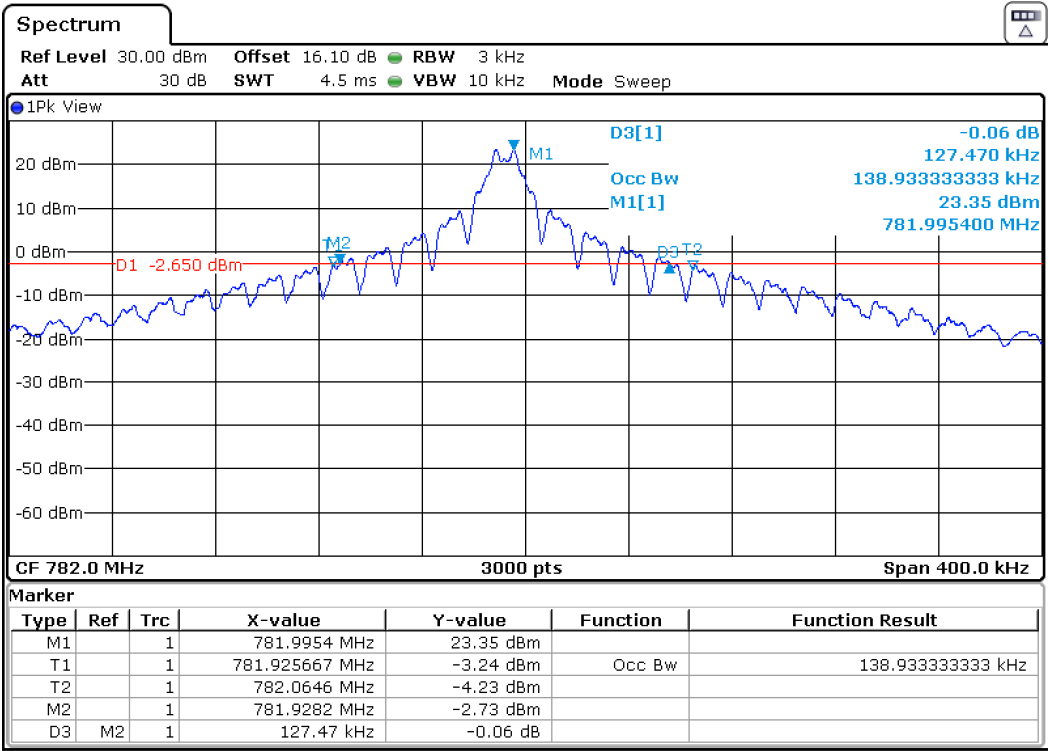
Highest Channel



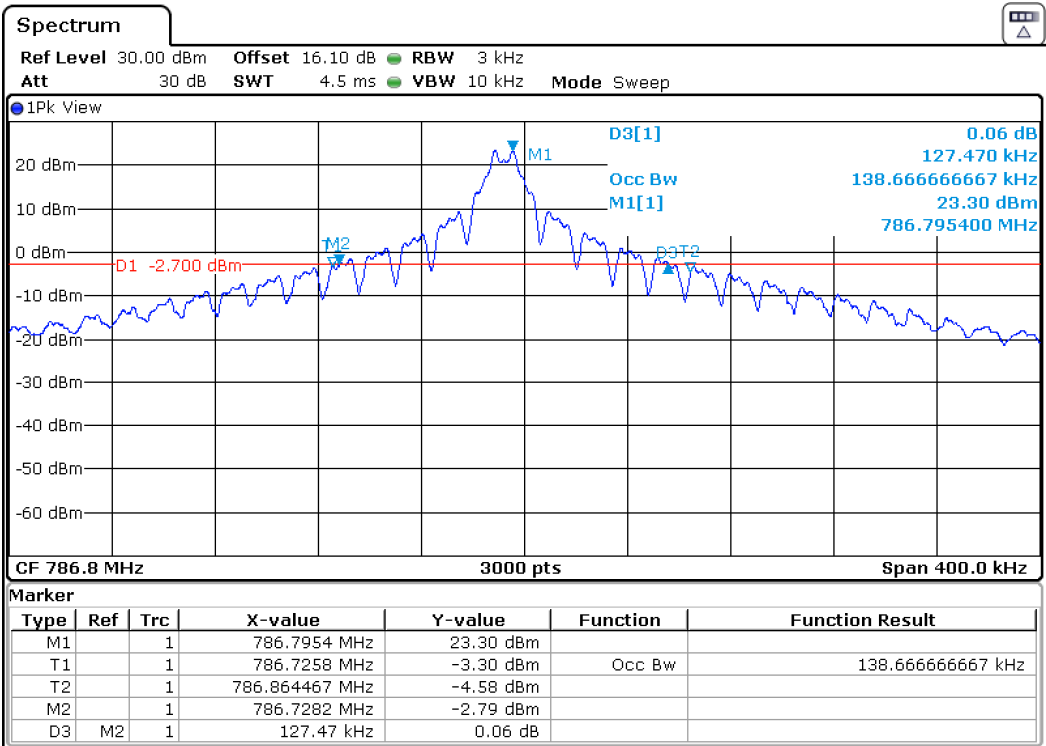
Tone 15 kHz. $\pi/2$ - BPSK MODULATION
Lowest Channel



Middle Channel

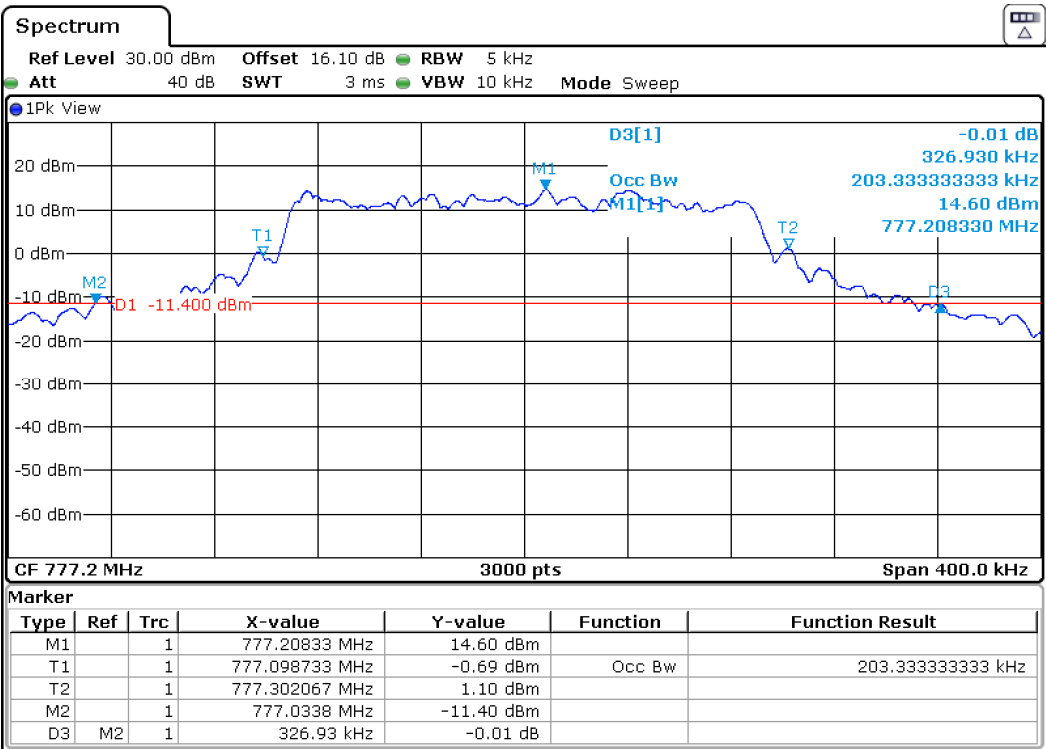


Highest Channel

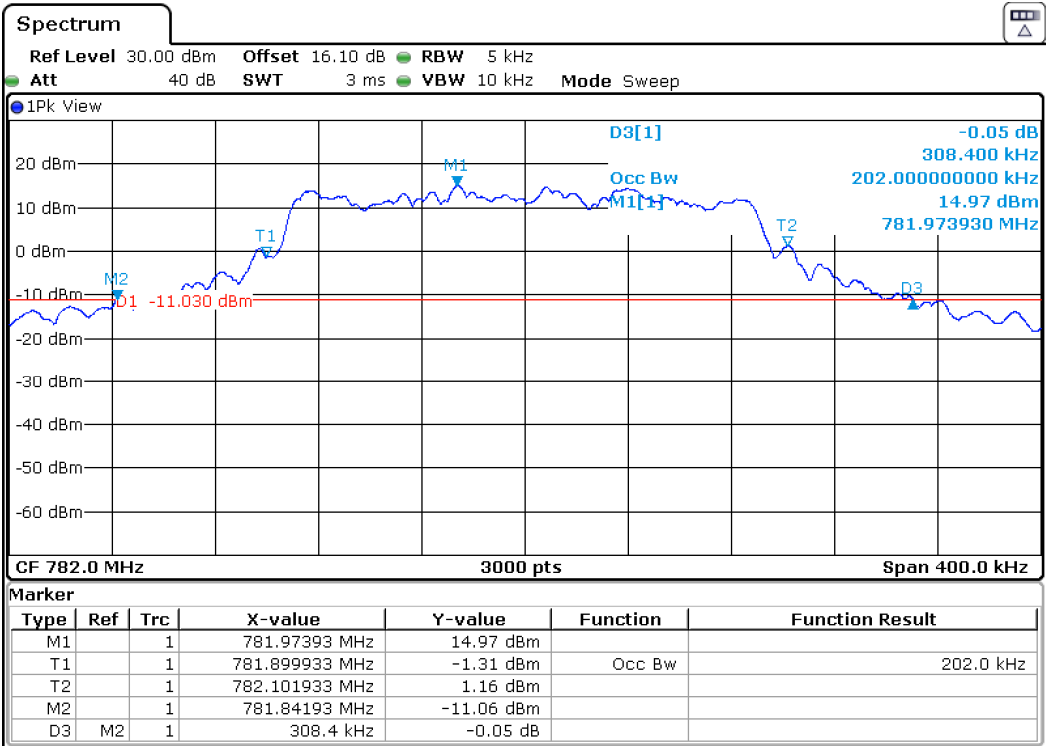


12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

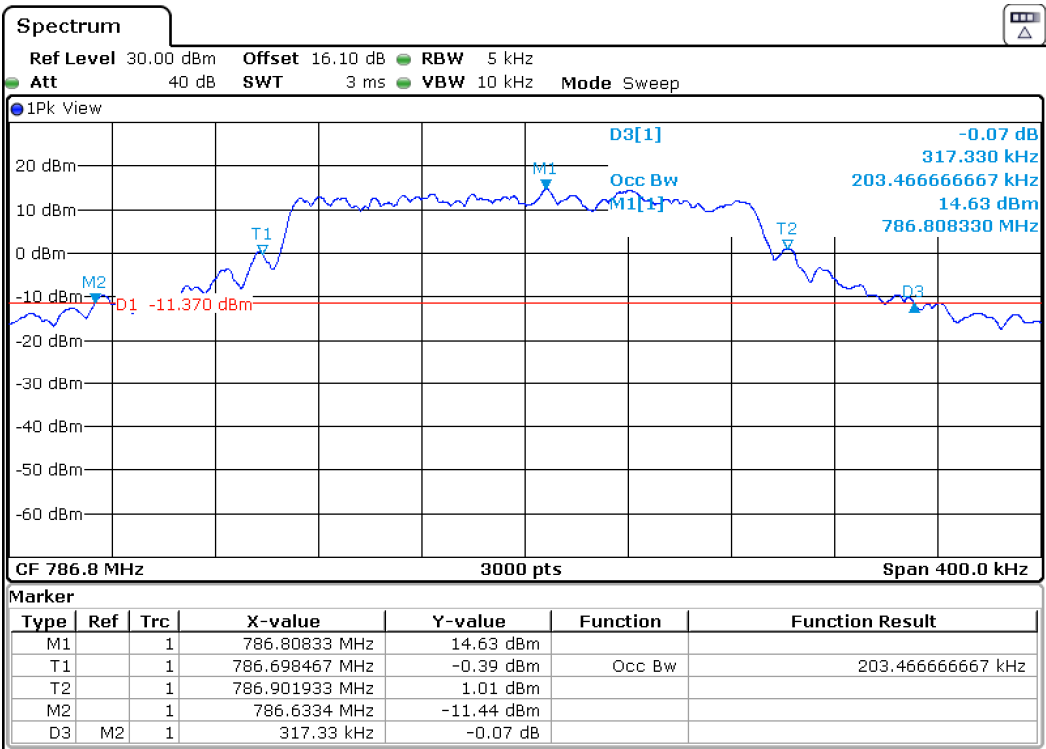
Lowest Channel



Middle Channel



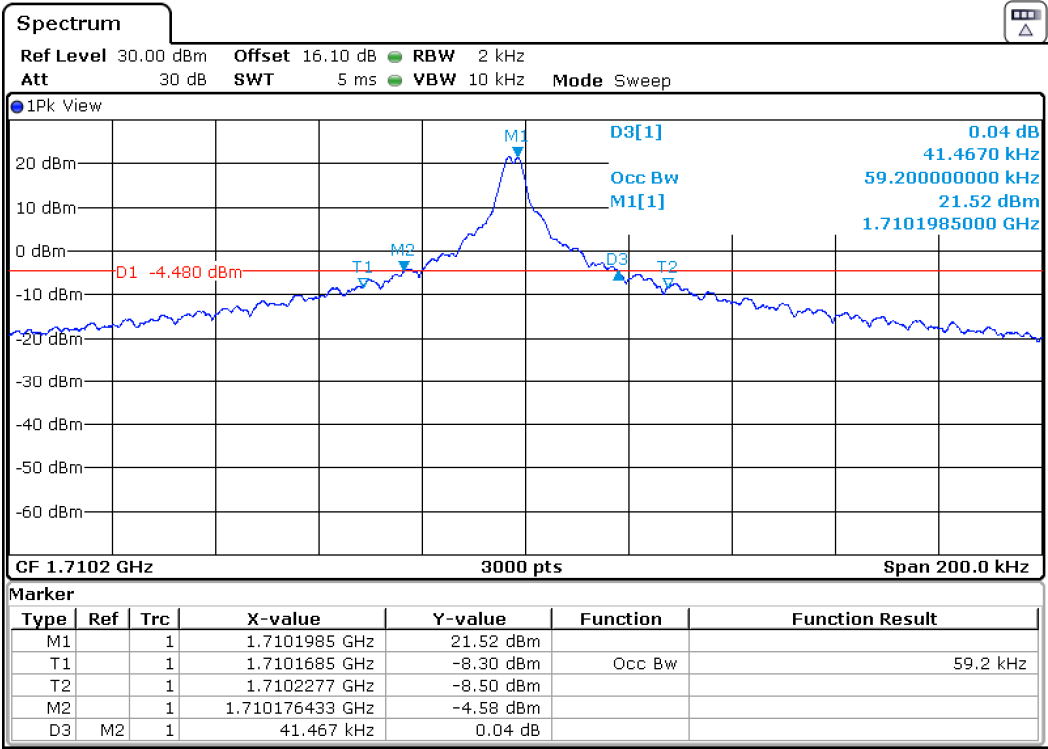
Highest Channel



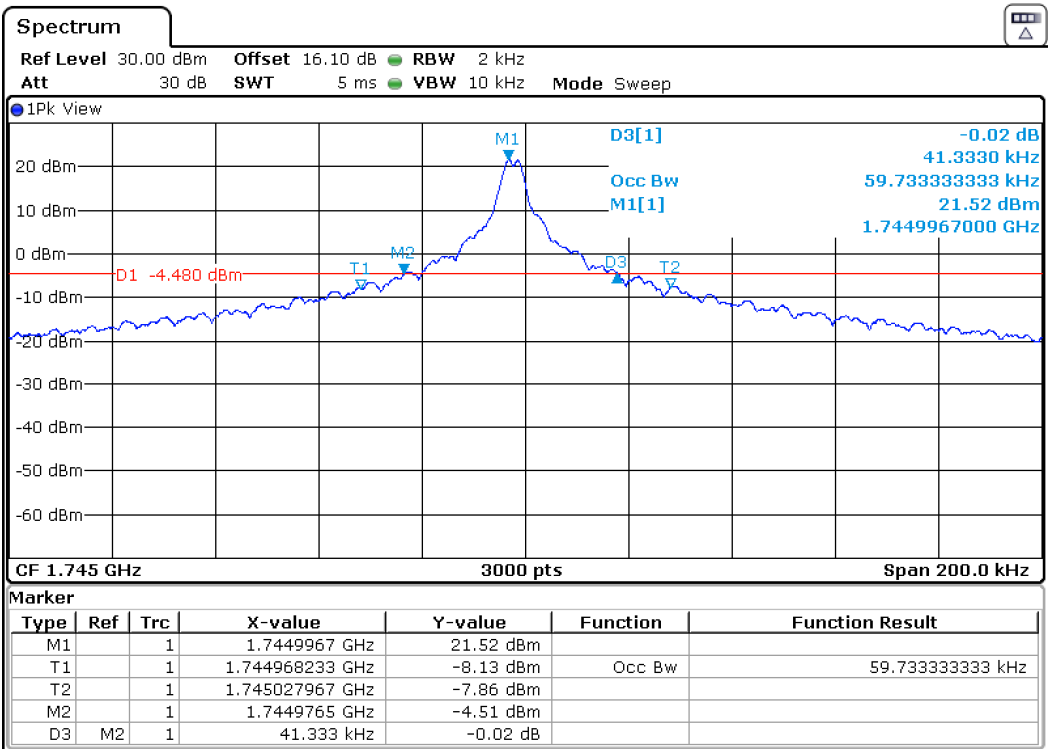
NB IoT BAND 66.

Tone 3.75 kHz. $\pi/2$ - BPSK MODULATION

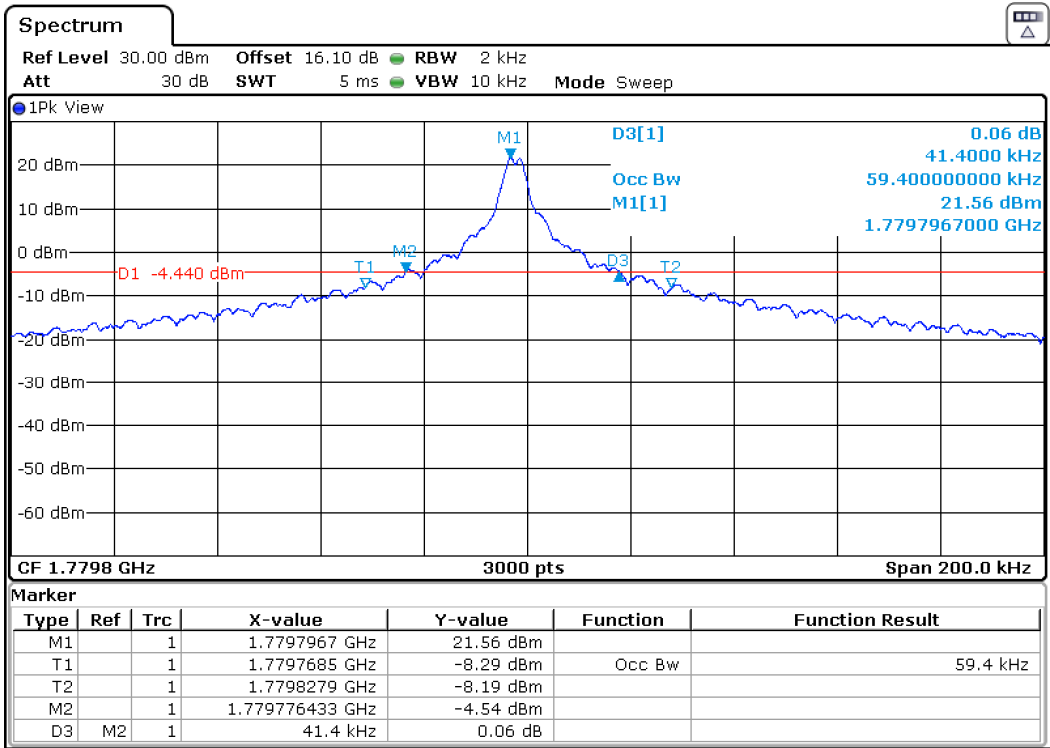
Lowest Channel



Middle Channel

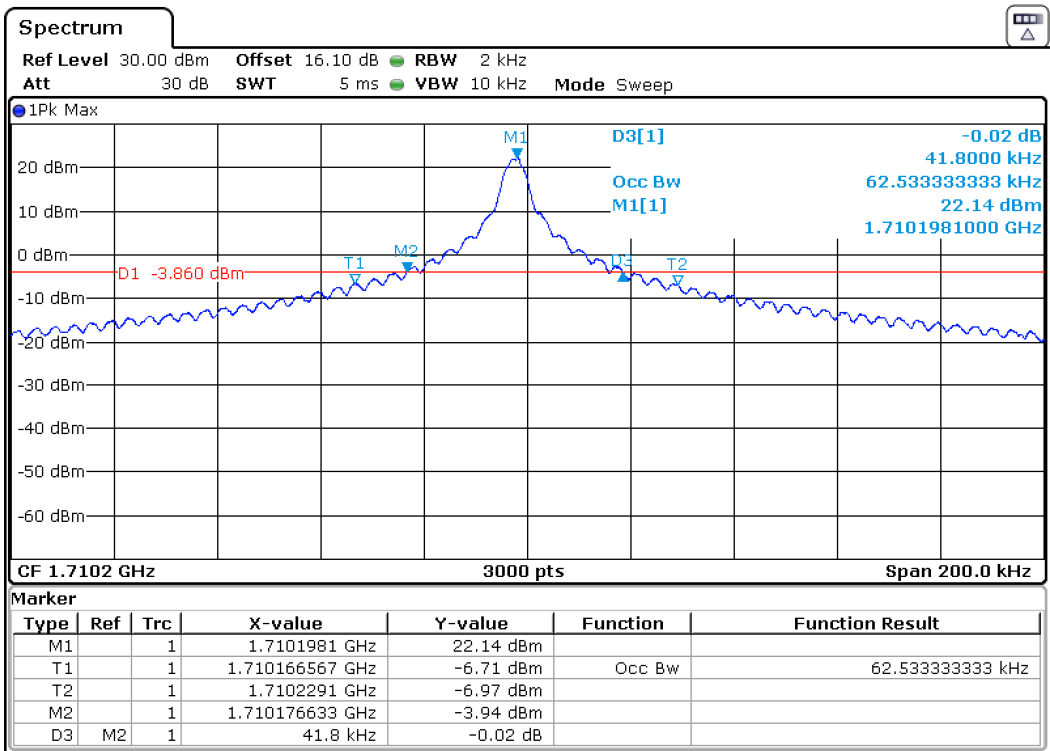


Highest Channel

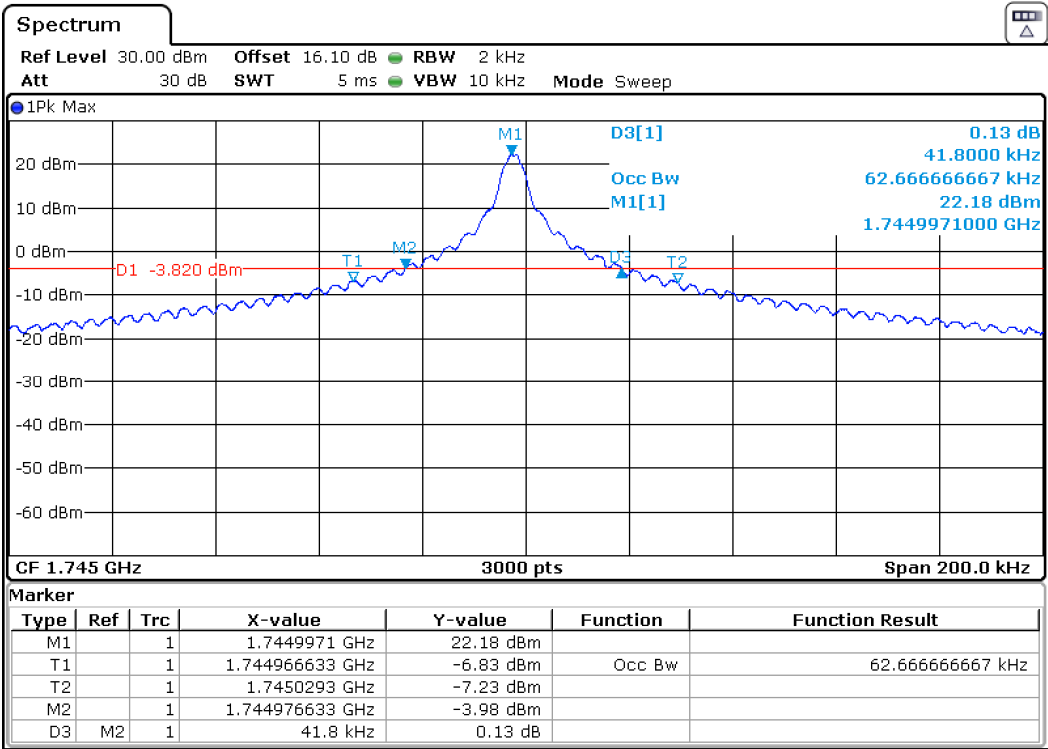


Tone 3.75 kHz. $\pi/4$ - QPSK MODULATION

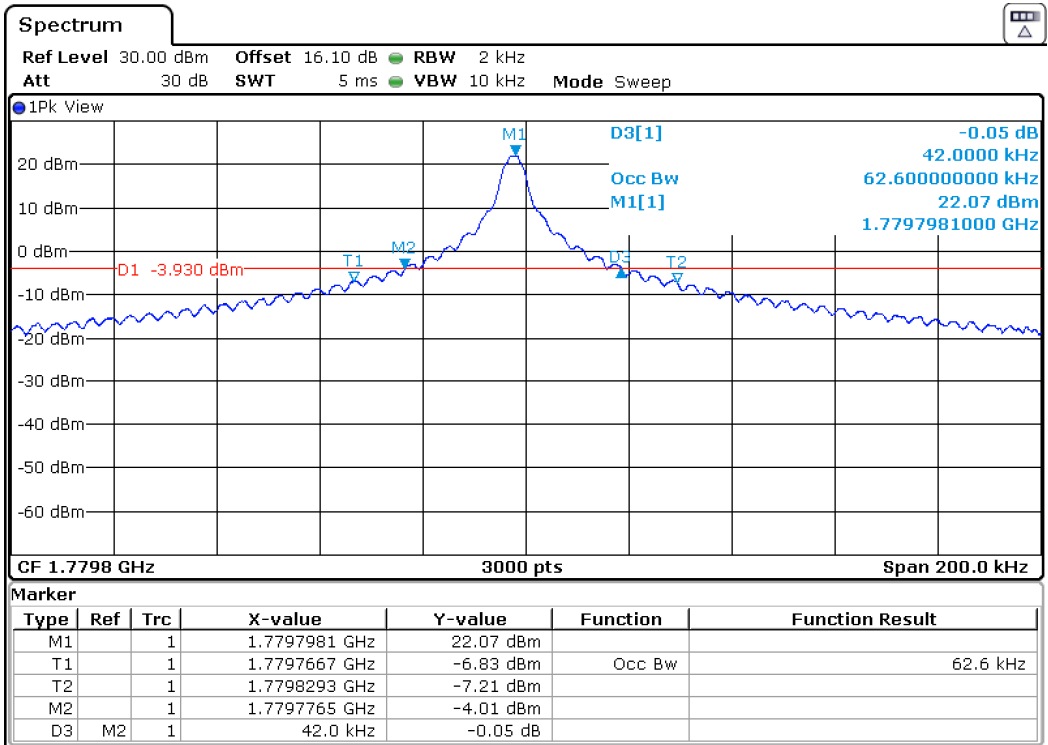
Lowest Channel



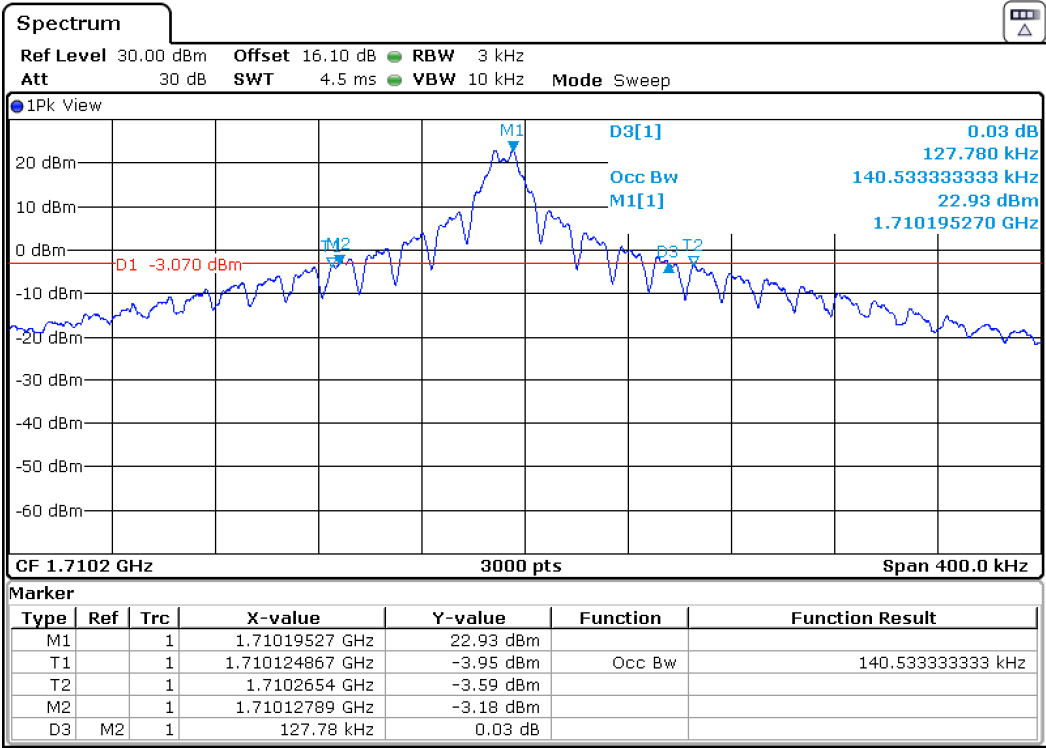
Middle Channel



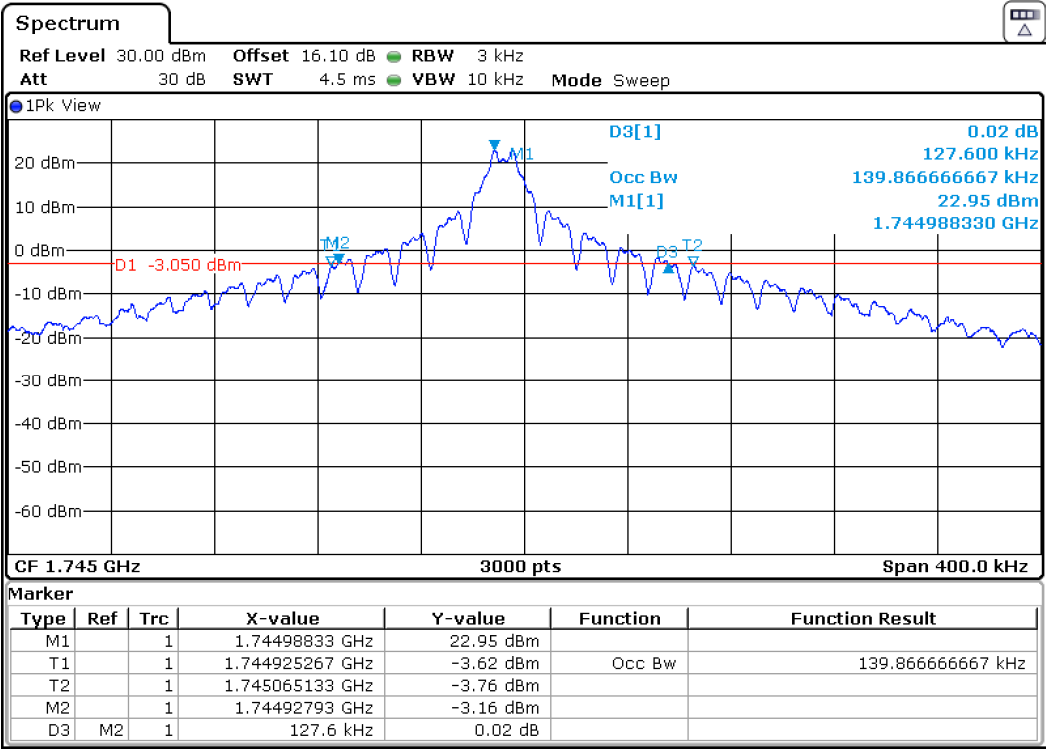
Highest Channel



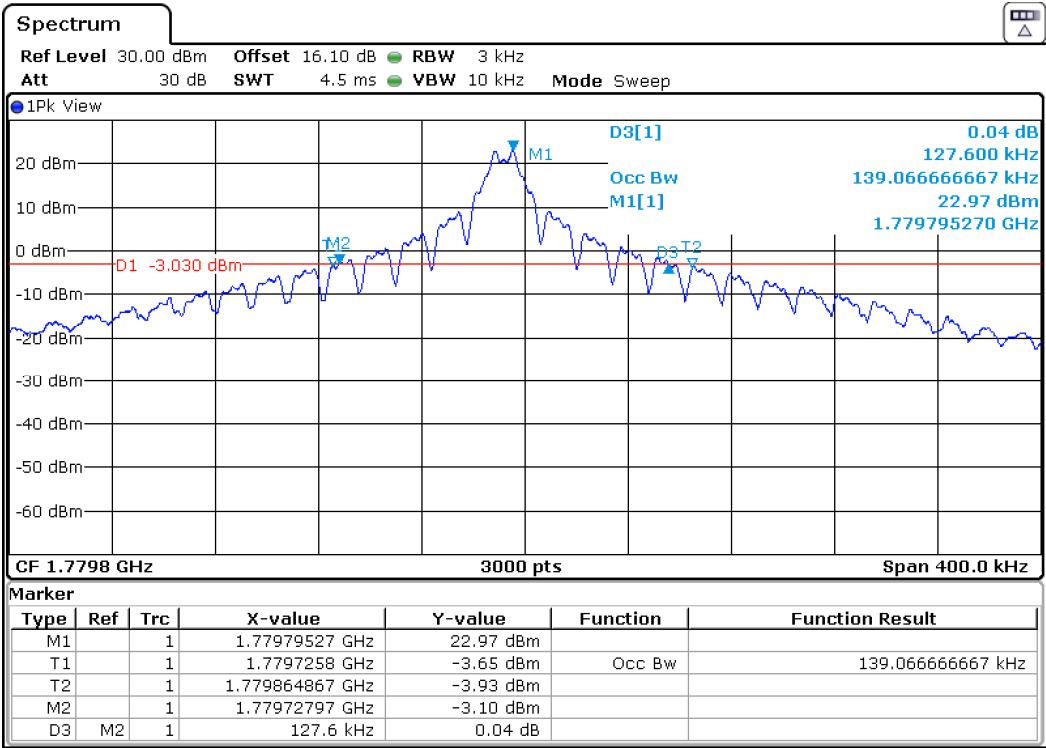
Tone 15 kHz. $\pi/2$ - BPSK MODULATION
Lowest Channel



Middle Channel

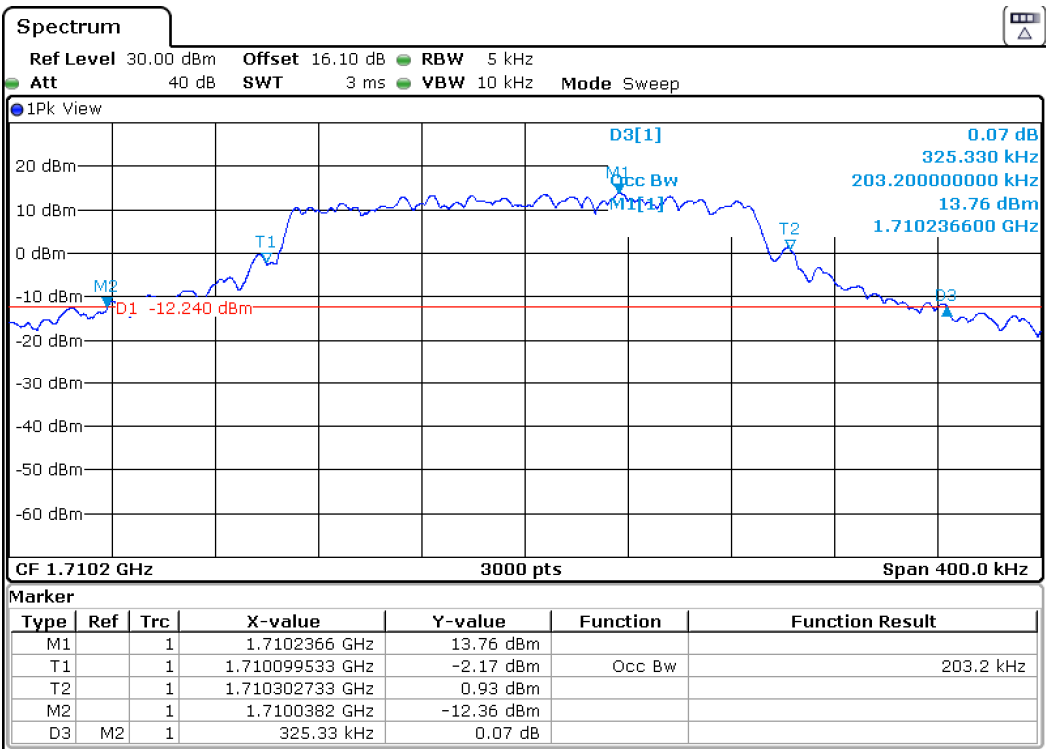


Highest Channel

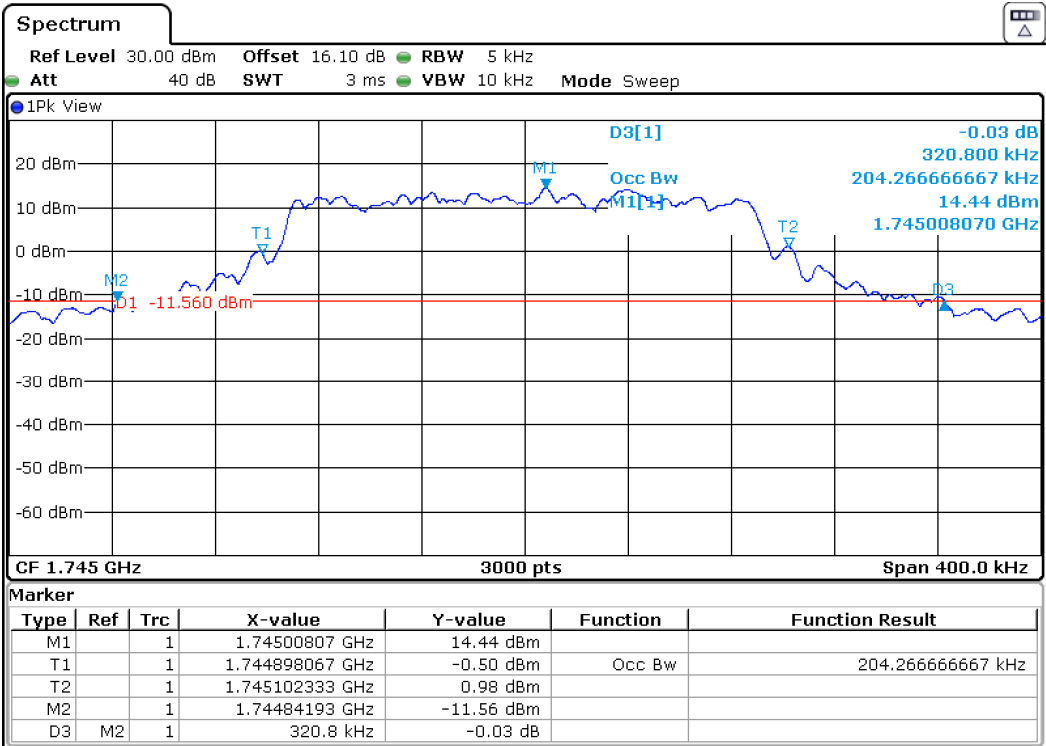


12 Tones 15 kHz. $\pi/4$ - QPSK MODULATION

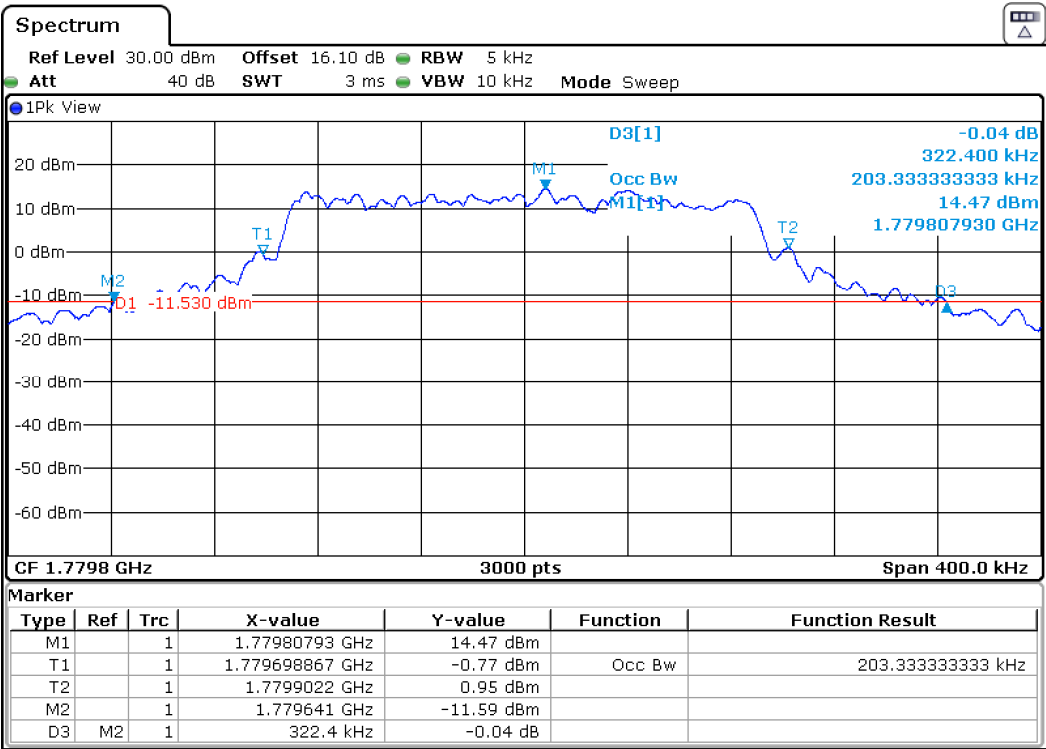
Lowest Channel



Middle Channel



Highest 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. 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 (c).

On any frequency outside the 776-788 MHz band. the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB.

On all frequencies between 763-775 MHz and 793-805 MHz. by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment. for mobile and portable stations.

RSS-130 Clause 4.6.

The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power. P (dBW). by at least $43 + 10 \log_{10} p$ (watts). dB.

The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power. P (dBW). by at least $65 + 10 \log_{10} p$ (watts). dB. for mobile and portable equipment.

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.

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

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

At P_o transmitting power. the specified minimum attenuation becomes $65+10 \log (P_o)$. and the level in dBm relative P_o becomes:

P_o (dBm) – $[65 + 10 \log (P_o \text{ in mwatts}) - 30] = -35$ dBm.

METHOD

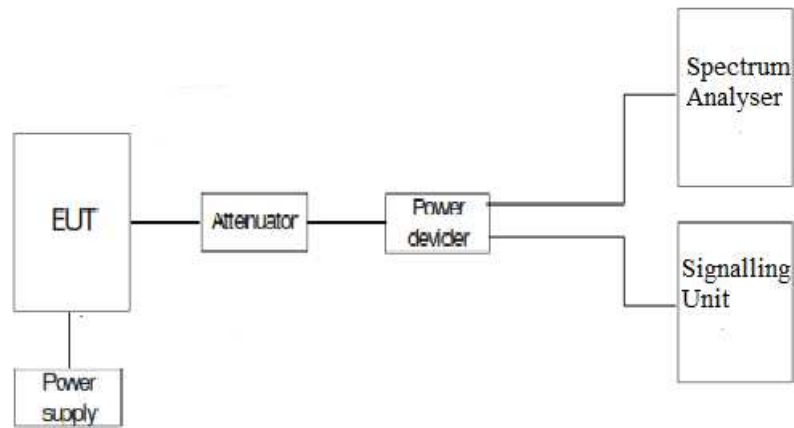
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 18 GHz for NBLoT Band 66 and from 9 kHz to 8 GHz for NBLoT Band 12 and 13.

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 tones and modulation which is the worst case for conducted power was used.

TEST SETUP



RESULTS (see plots in next pages)

NBLoT Band 12

1. CHANNEL: LOWEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

2. CHANNEL: MIDDLE

No spurious signals were found at less than 20dB respect to the limit in all the range.

3. CHANNEL: HIGHEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

NBLoT Band 13

1. CHANNEL: LOWEST

Frequency (MHz)	Level (dBm)	Limit (dBm)
765.0847	-57.94	-35.00
768.9319	-52.85	-35.00
771.0972	-49.01	-35.00
774.9048	-51.84	-35.00

2. CHANNEL: MIDDLE

Frequency (MHz)	Level (dBm)	Limit (dBm)
773.7298	-52.86	-35.00

3. CHANNEL: HIGHEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

NBLoT Band 66

1. CHANNEL: LOWEST

No spurious signals were found at less than 20dB respect to the limit in all the range.

2. CHANNEL: MIDDLE

No spurious signals were found at less than 20dB respect to the limit in all the range.

3. CHANNEL: HIGHEST

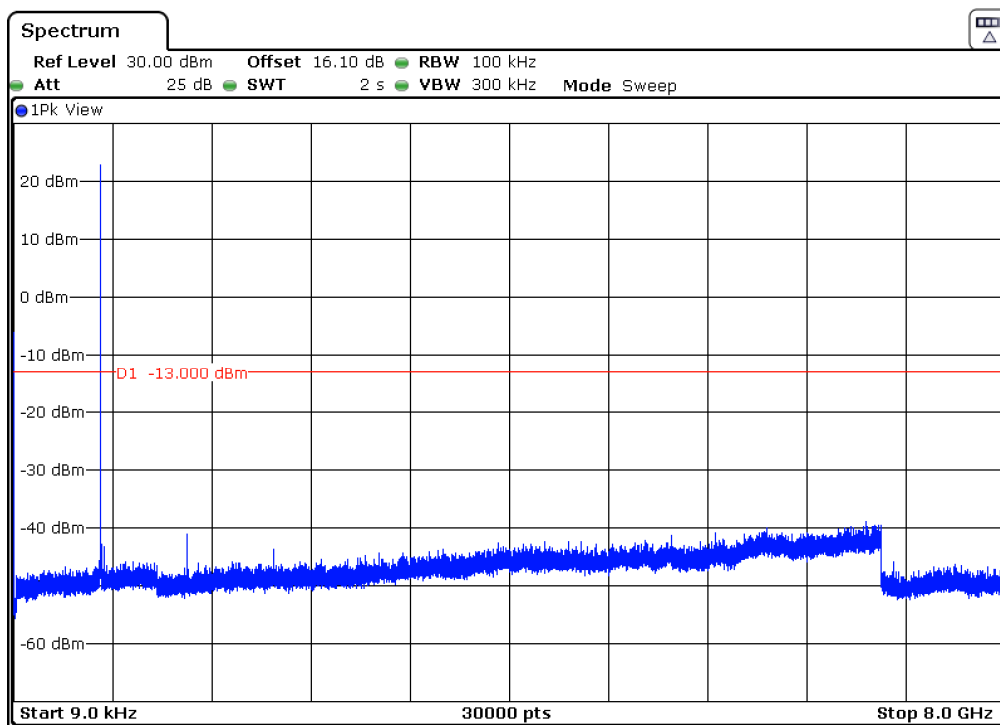
No spurious signals were found at less than 20dB respect to the limit in all the range.

Verdict: PASS

NBLoT Band 12

1. CHANNEL: LOWEST

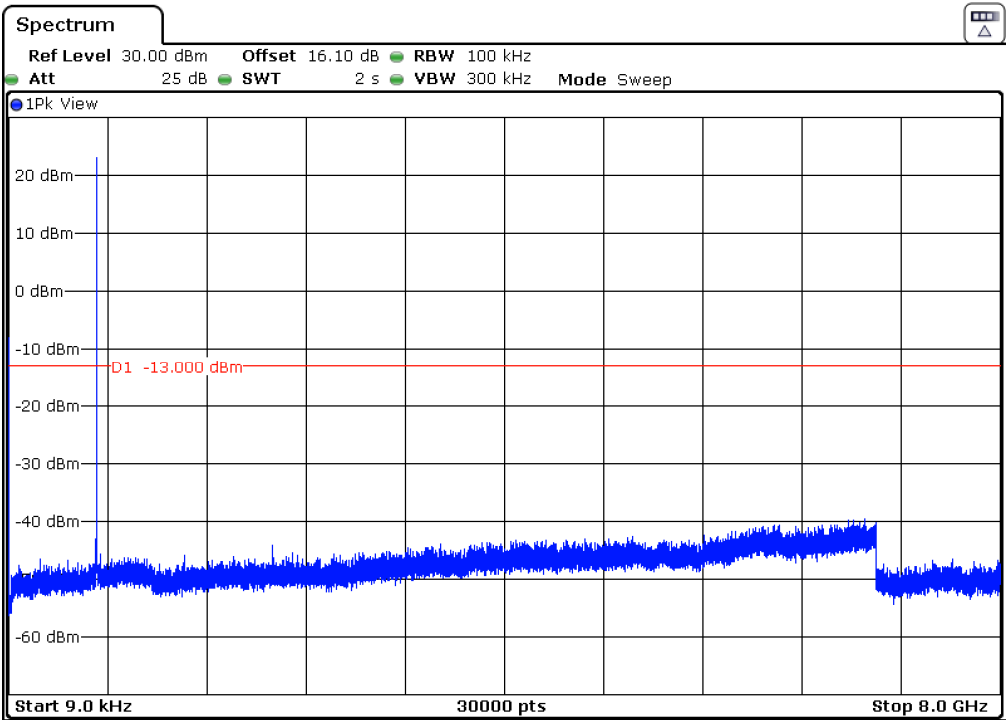
Frequency Range 9 kHz – 8 GHz



Note: The peak above the limit is the carrier frequency.

2. CHANNEL: MIDDLE

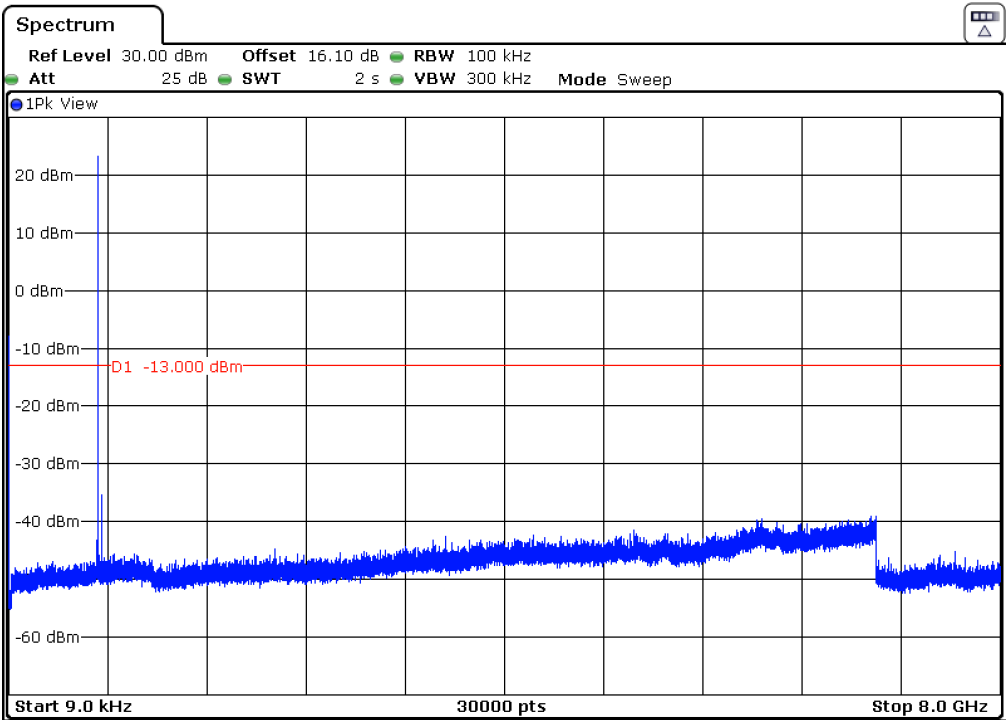
Frequency Range 9 kHz – 8 GHz



Note: The peak above the limit is the carrier frequency.

3. CHANNEL: HIGHEST

Frequency Range 9 kHz – 8 GHz

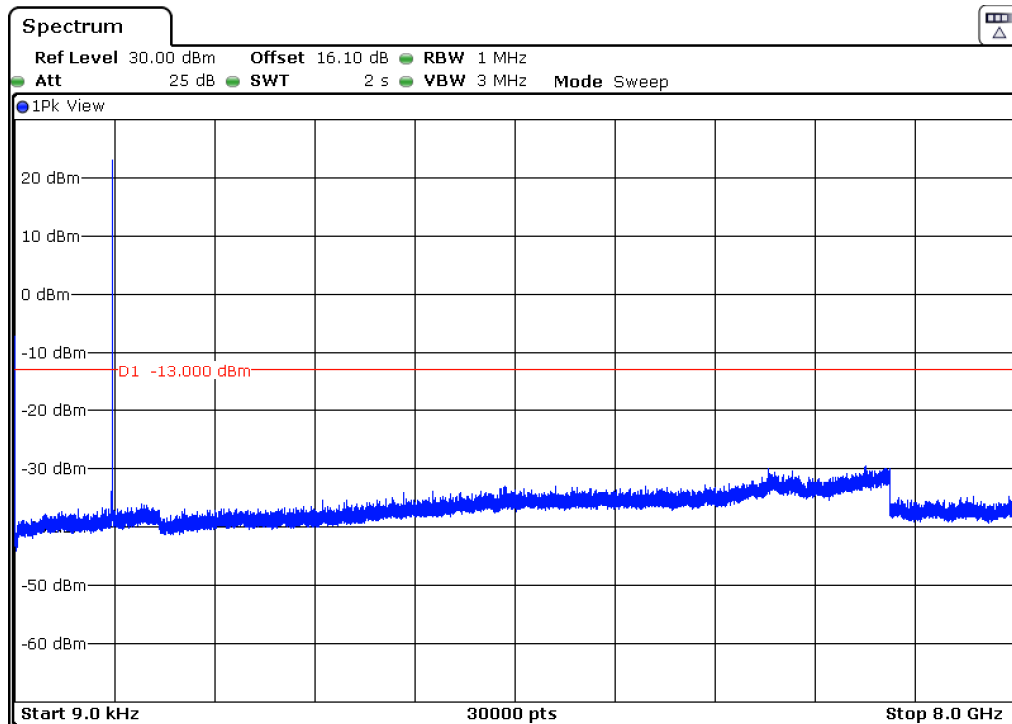


Note: The peak above the limit is the carrier frequency.

NBLoT Band 13

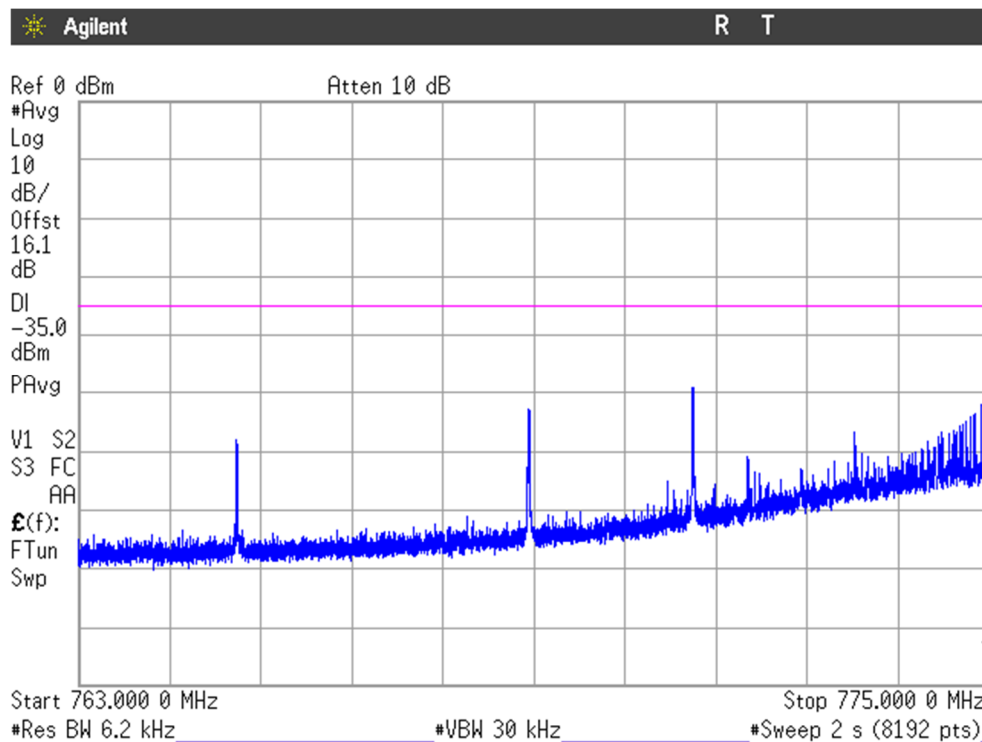
1. CHANNEL: LOWEST

Frequency Range 9 kHz – 8 GHz

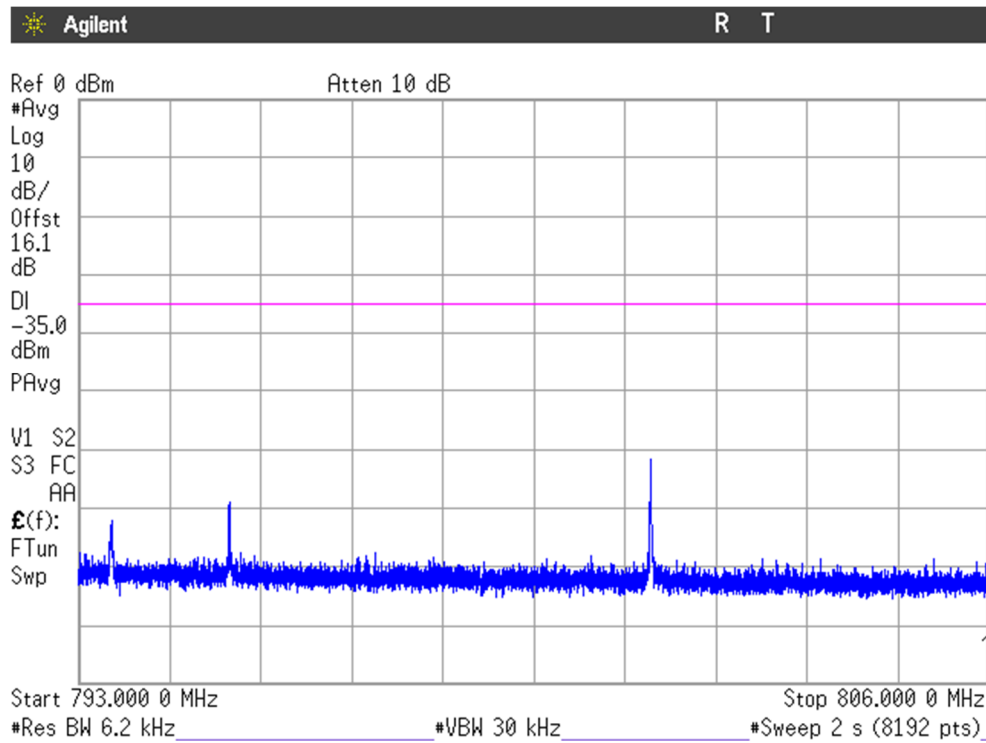


Note: The peak above the limit is the carrier frequency.

Frequency Range 763 MHz - 775 MHz

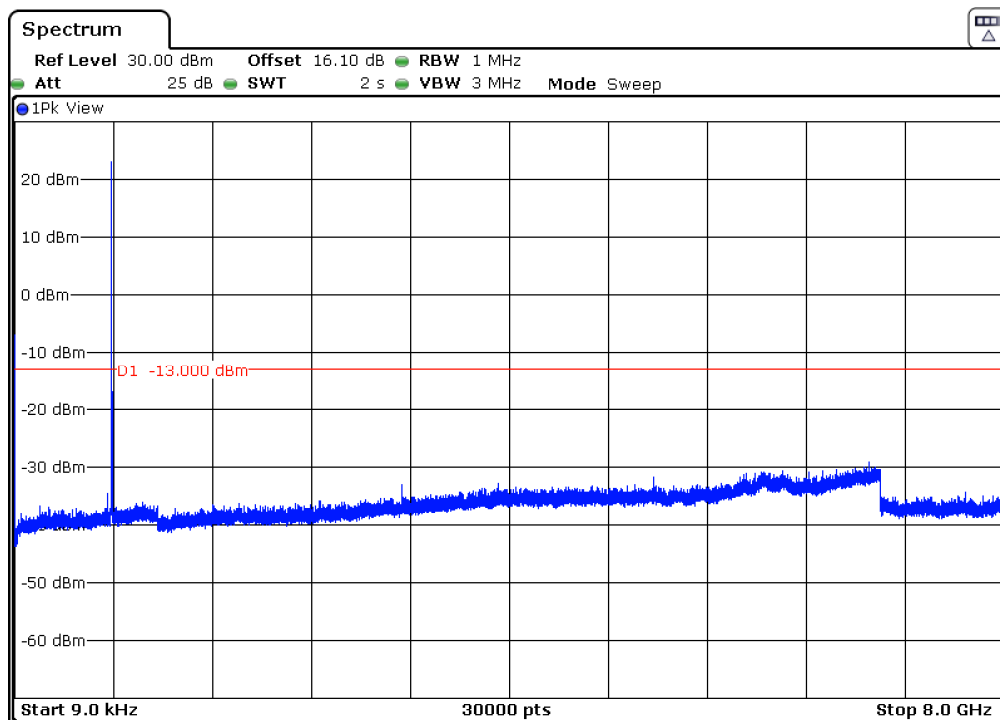


Frequency Range 793 MHz - 806 MHz



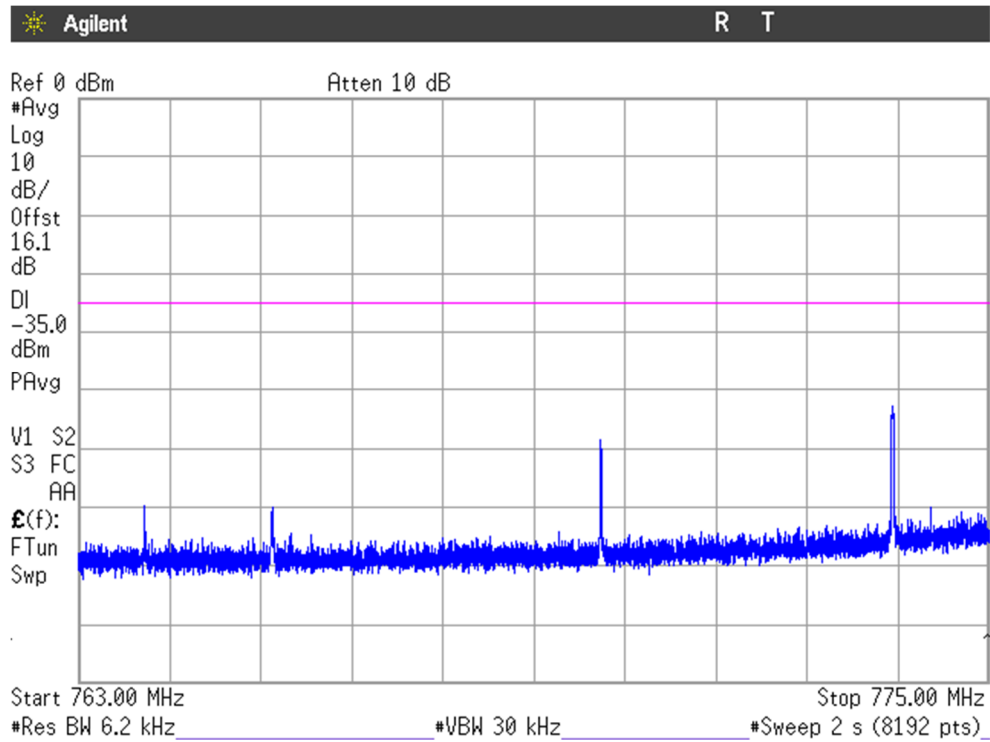
2. CHANNEL: MIDDLE

Frequency Range 9 kHz – 8 GHz

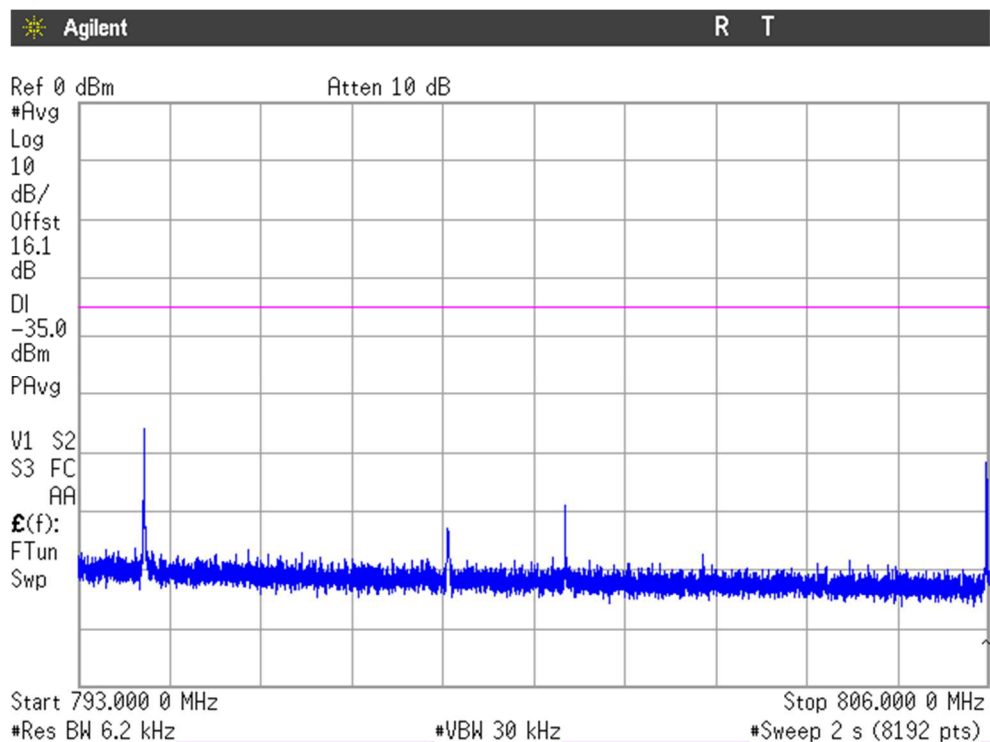


Note: The peak above the limit is the carrier frequency.

Frequency Range 763 MHz - 775 MHz

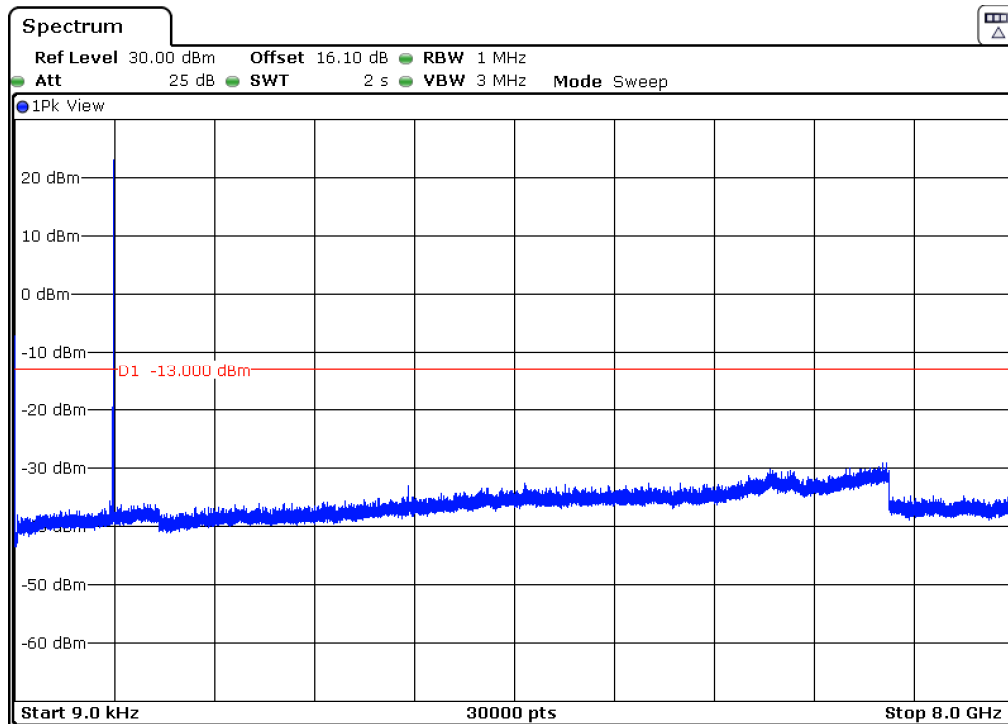


Frequency Range 793 MHz - 806 MHz



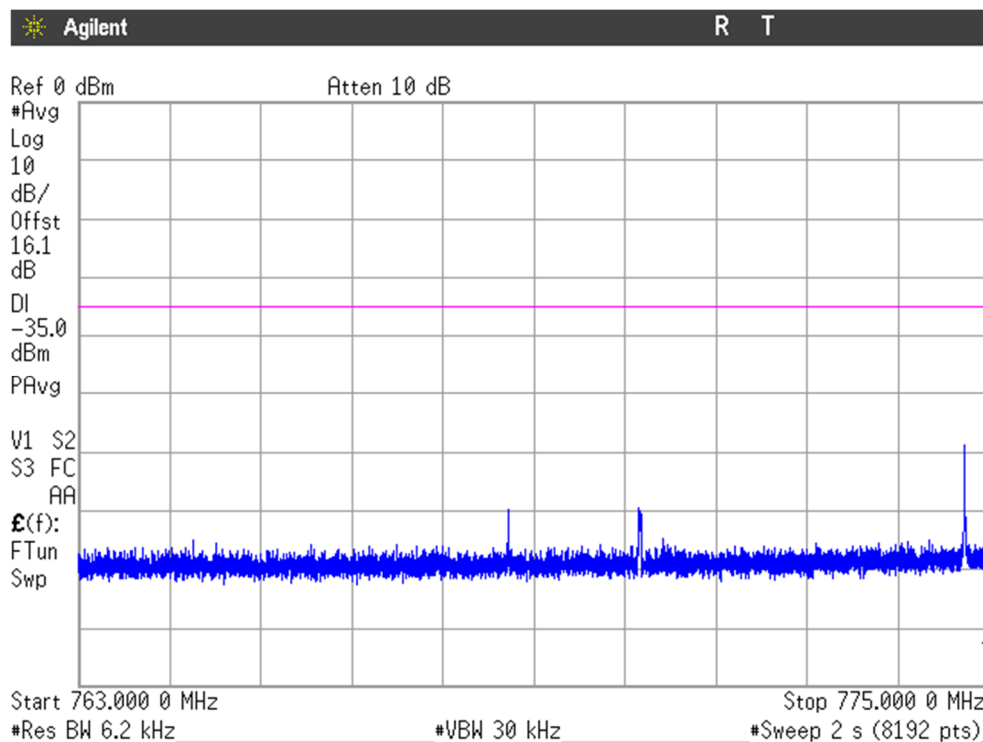
3. CHANNEL: HIGHEST

Frequency Range 9 kHz – 8 GHz

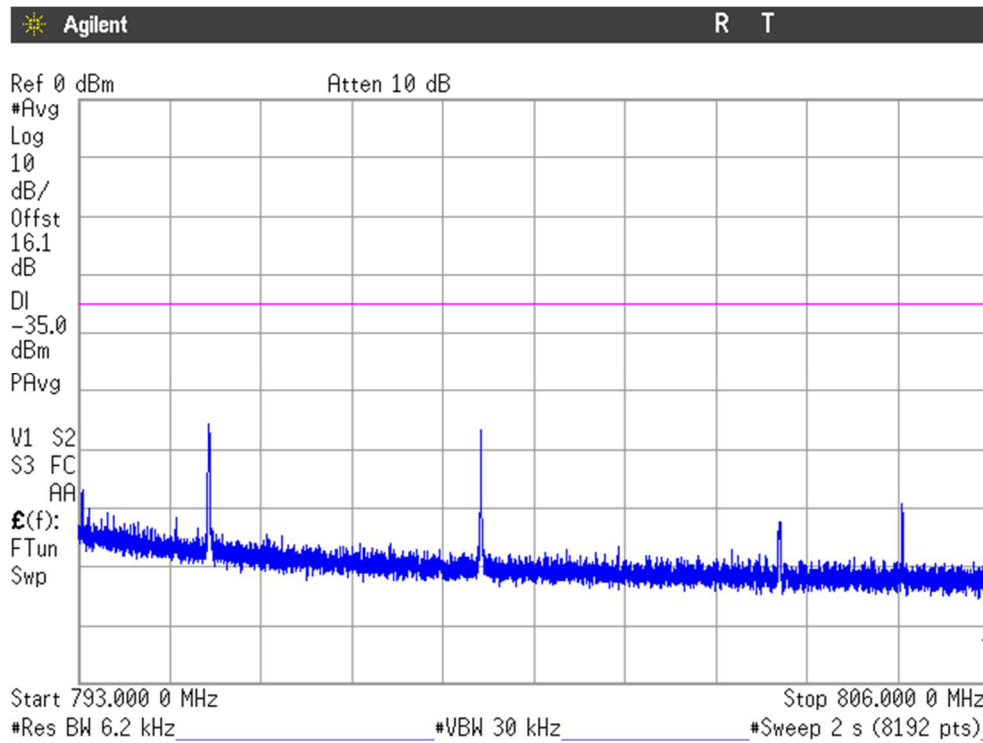


Note: The peak above the limit is the carrier frequency.

Frequency Range 763 MHz - 775 MHz

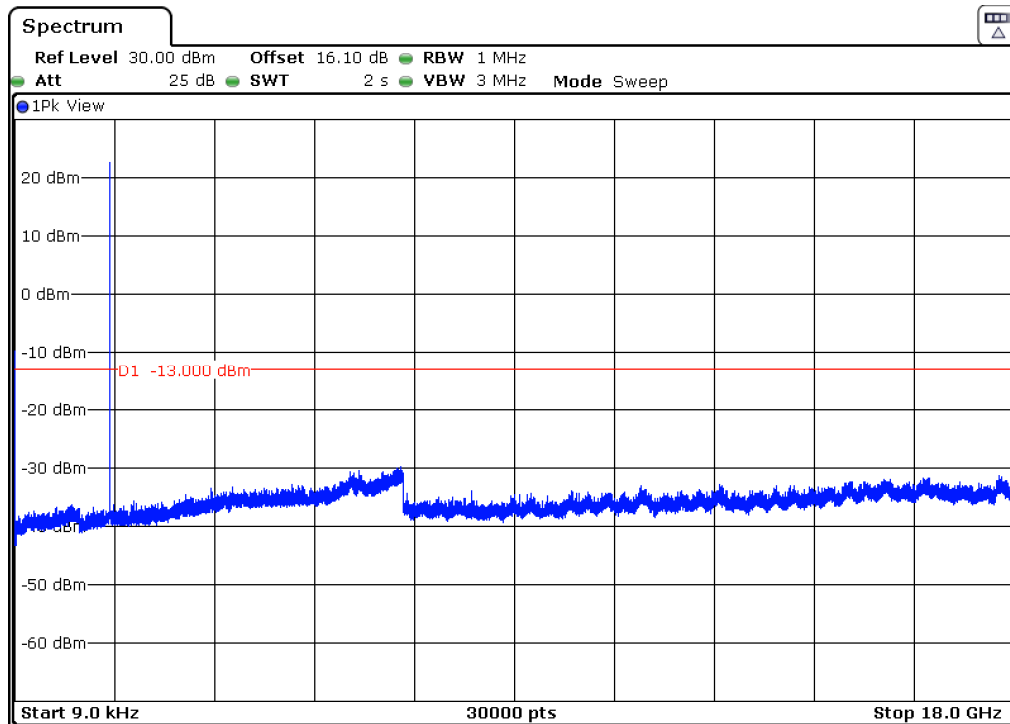


Frequency Range 793 MHz - 806 MHz



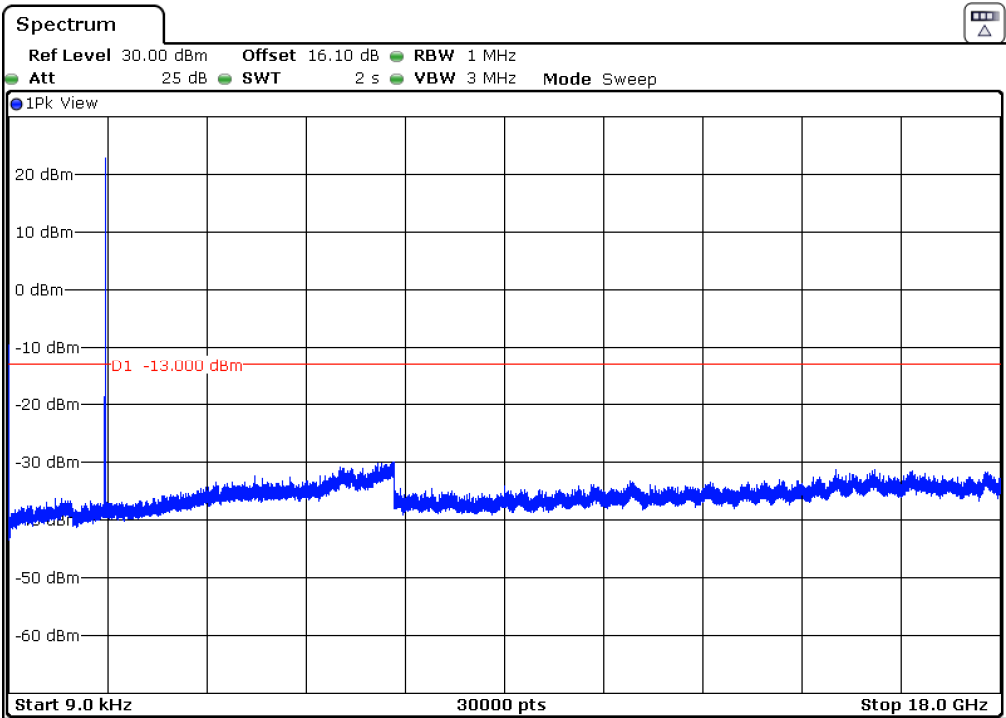
NB IoT Band 66

1. CHANNEL: LOWEST



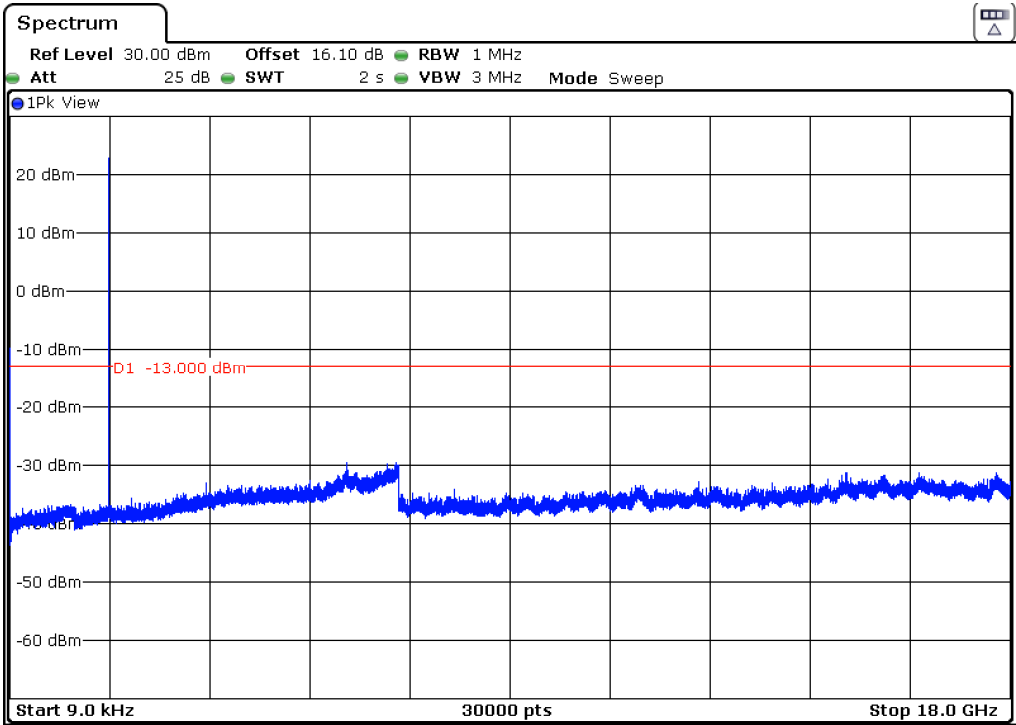
Note: The peak above the limit is the carrier frequency.

2. CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

3. CHANNEL: HIGHEST



Note: The peak above the limit is the carrier frequency.

Spurious emissions at antenna terminals at Block Edges

SPECIFICATION

FCC §27.53 (c) & (g) & (h). RSS-130 Clause 4.6. . 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.

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

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

METHOD

The 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.

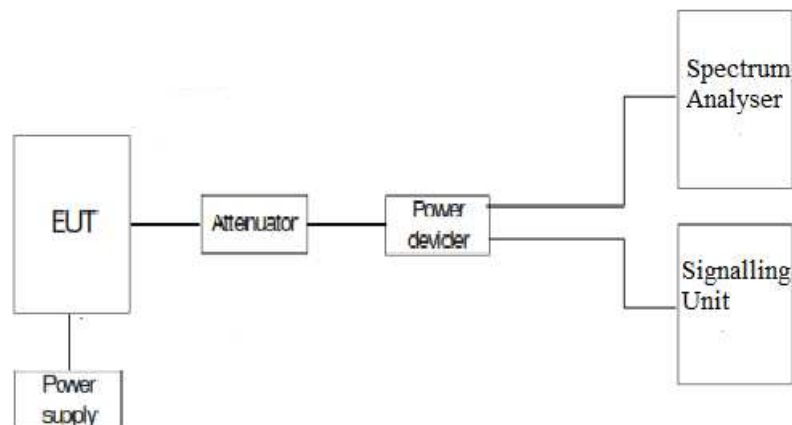
The configuration of modulation which is the worst case for conducted power was used.

For NBLoT Band12. as indicated in FCC part 27.53 (g) /RSS-130 Clause 4.6., 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.

For NBLoT Band 13. as indicated in FCC part 27.53 (c) (5) /RSS-130 Clause 4.6., 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.

For NBLoT Band 66. 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/occupied bandwidth of the fundamental emission of the transmitter may be employed.

TEST SETUP



RESULTS (see plots in next pages)

NBLoT BAND 12.

Preliminary measurements determined a tone with nominal bandwidth of 15 kHz as the worst case. The results in the next tables shows the results for this configuration.

(Channels in Band 12):	Tone= 15 kHz. Offset=0. $\pi/2$ - BPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-48.04

(Channels in Band 12):	Tone= 15 kHz. Offset=11. $\pi/2$ - BPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-19.66

NBLoT. BAND 13.

Preliminary measurements determined a tone with nominal bandwidth of 15 kHz as the worst case. The results in the next tables shows the results for this configuration.

(Channels in Band 13):	Tone= 15 kHz. Offset=0. $\pi/2$ - BPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-19.53

(Channels in Band 13):	Tone= 15 kHz. Offset=11. $\pi/2$ - BPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-19.74

NBLoT. BAND 66.

Preliminary measurements determined a tone with nominal bandwidth of 15 kHz as the worst case. The results in the next tables shows the results for this configuration.

(Channels in Band 66):	Tone= 15 kHz. Offset=0. $\pi/2$ - BPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-23.72

(Channels in Band 66):	Tone= 15 kHz. Offset=11. $\pi/2$ - BPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-22.38

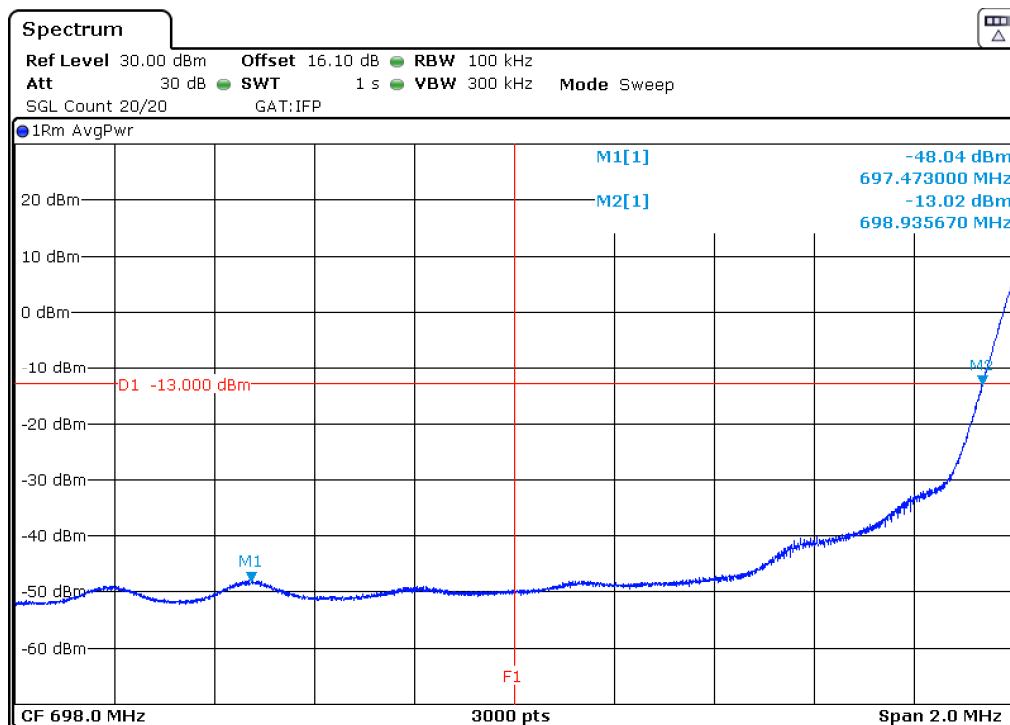
Measurement uncertainty = ± 1.20 dB.

Verdict: PASS

NBLoT. BAND 12.

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 0

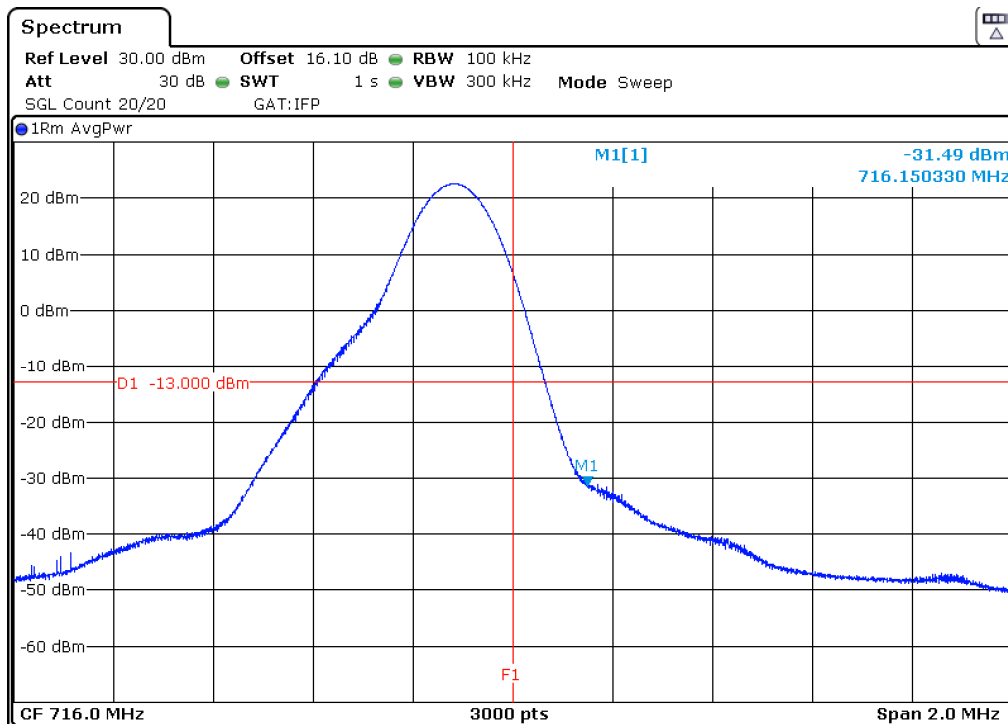
CHANNEL LOWEST



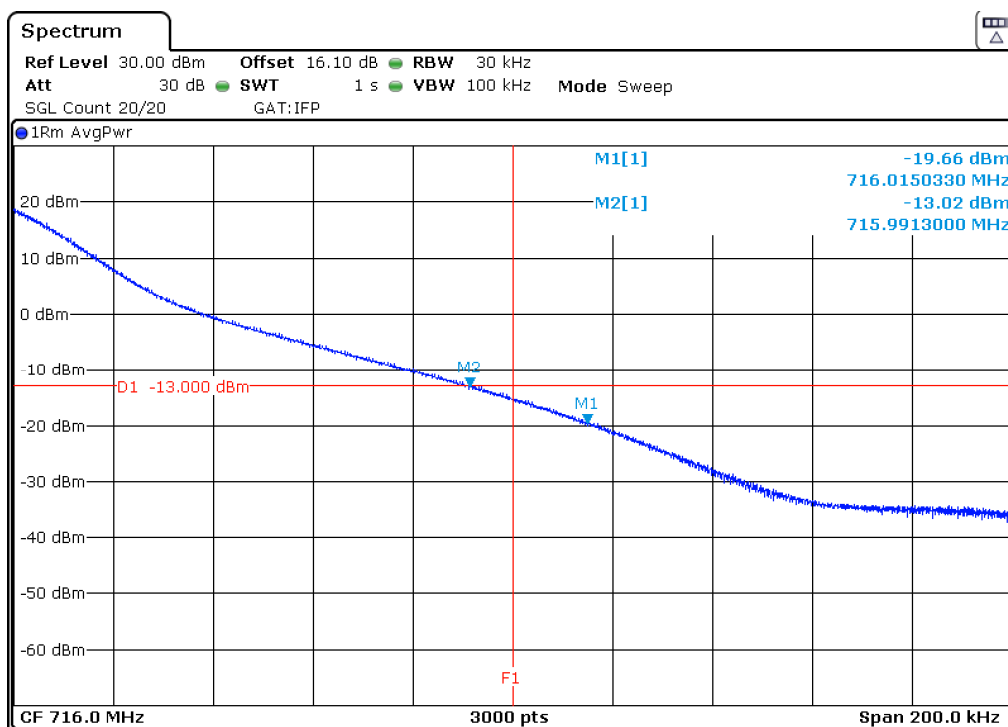
NOTE: The equipment transmits at the maximum output power

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 11

CHANNEL HIGHEST



NOTE: The equipment transmits at the maximum output power

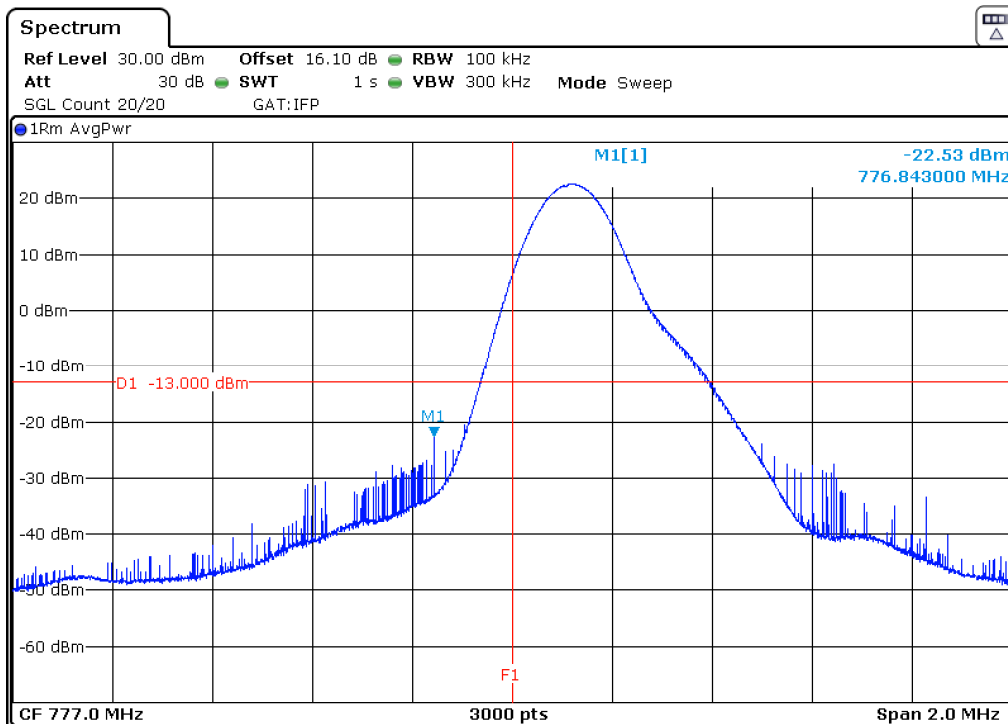


NOTE: Zoom (100KHz) with RBW=30KHz.

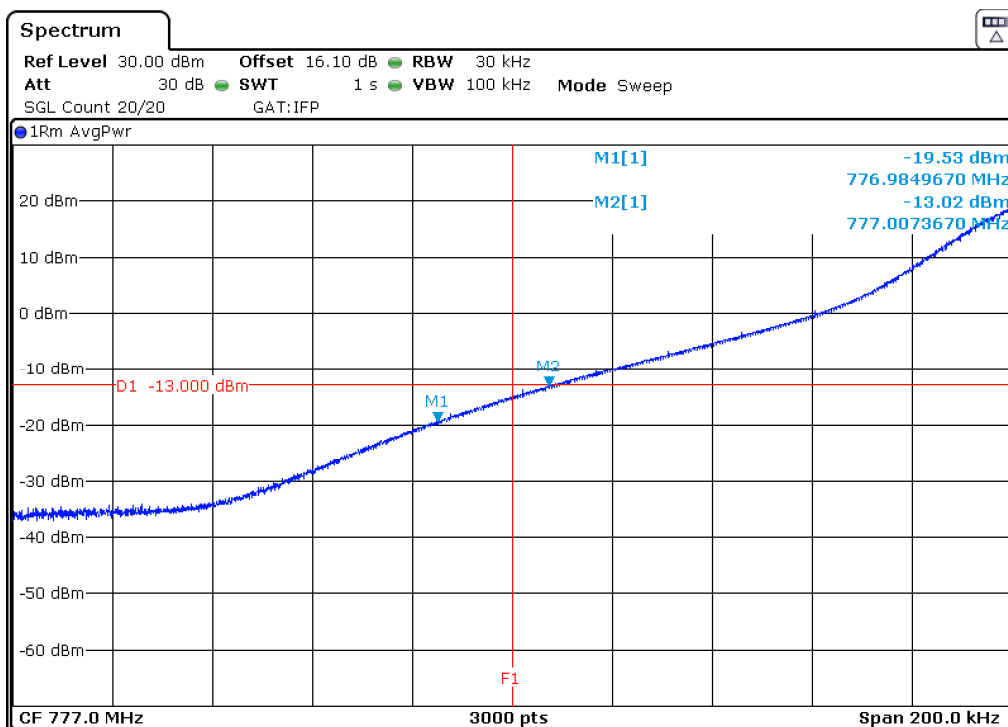
NB-IoT. BAND 13.

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



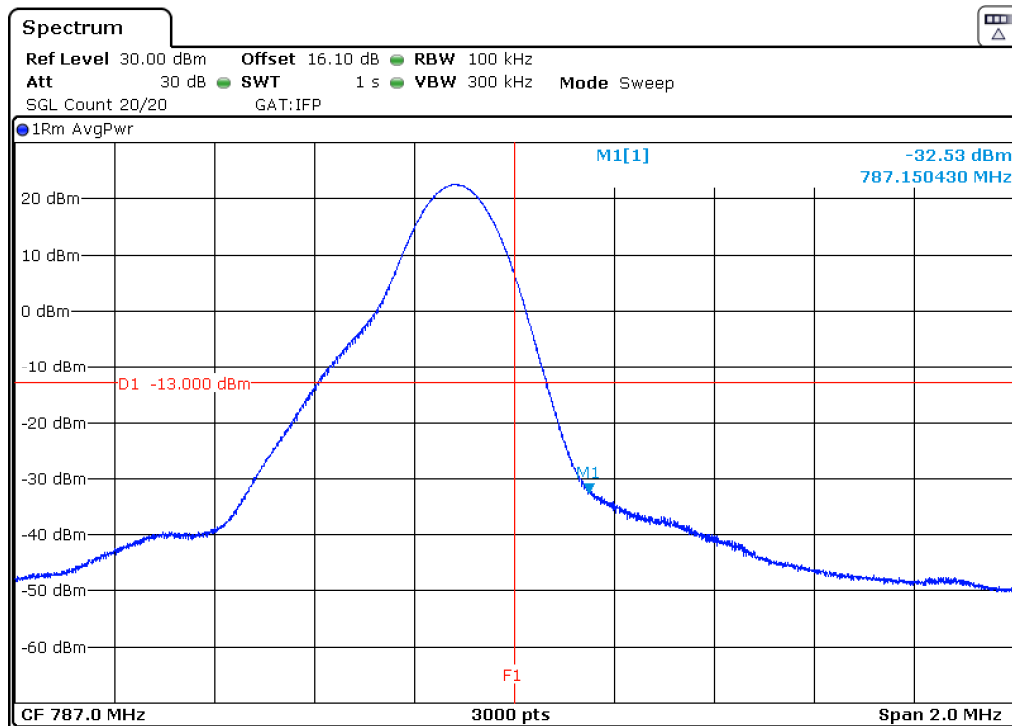
NOTE: The equipment transmits at the maximum output power



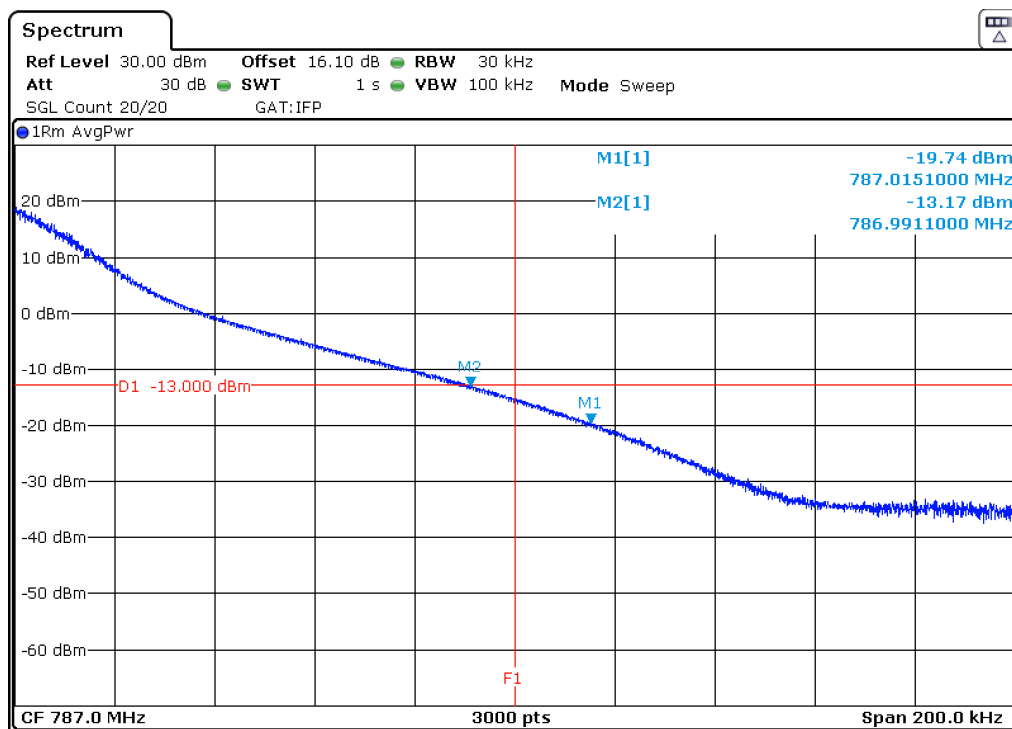
NOTE: Zoom (100KHz) with RBW=30KHz.

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 11

CHANNEL HIGHEST



NOTE: The equipment transmits at the maximum output power

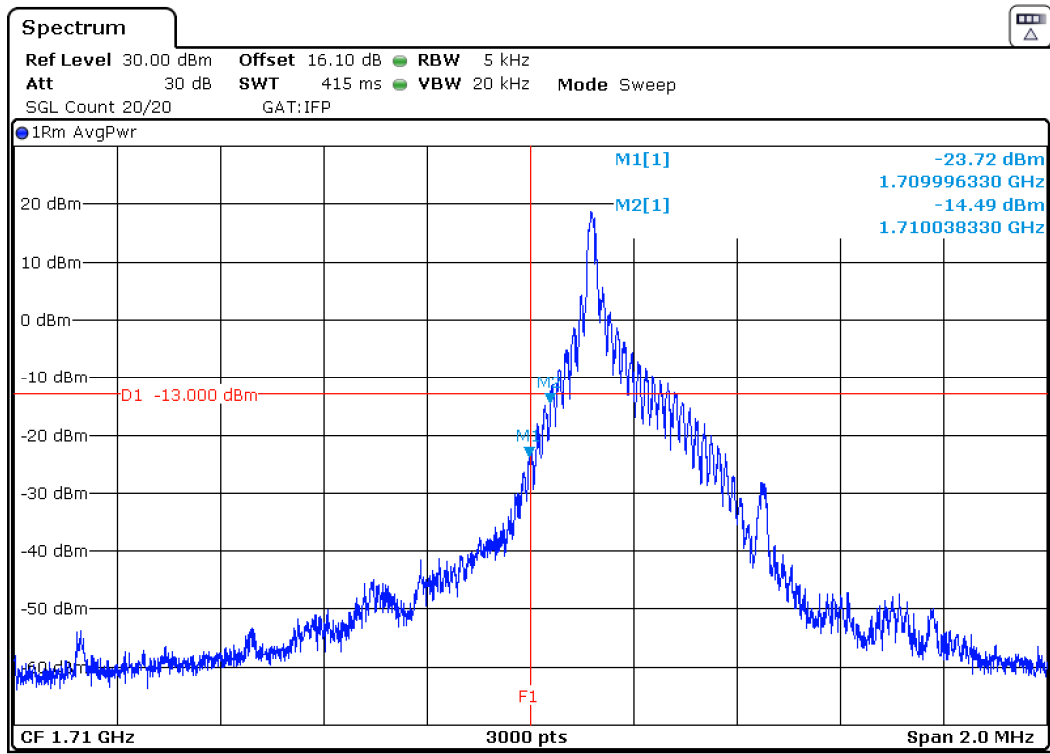


NOTE: Zoom (100KHz) with RBW=30KHz.

NB IoT. BAND 66.

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 0

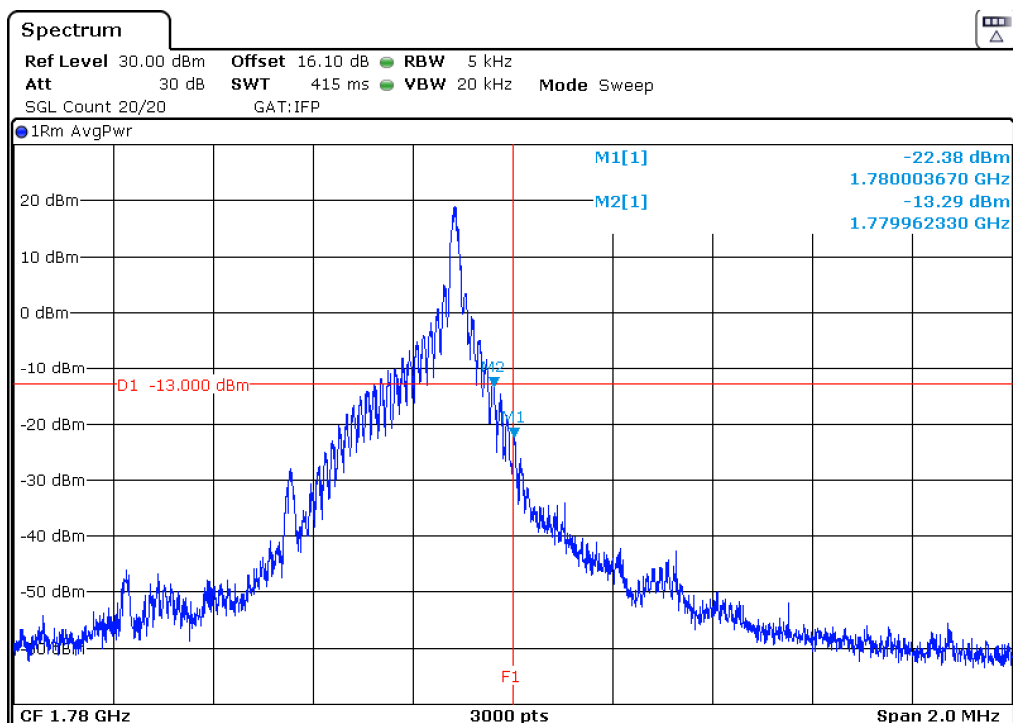
CHANNEL LOWEST



NOTE: The equipment transmits at the maximum output power

1 tone $\pi/2$ – BPSK. BW=15 kHz Offset = 11

CHANNEL HIGHEST



NOTE: The equipment transmits at the maximum output power

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. 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 (c) & (f).

On any frequency outside the 776-788 MHz band. the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB.

On all frequencies between 763-775 MHz and 793-805 MHz. by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment. for mobile and portable stations.

For operations in the 746-758 MHz. 775-788 MHz. and 805-806 MHz bands. emissions in the band 1559-1610 MHz shall be limited to -70 dBW (-40 dBm)/MHz equivalent isotropically radiated power (EIRP) for wideband signals. and -80 dBW (-50 dBm) EIRP for discrete emissions of less than 700 Hz bandwidth.

RSS-130 Clause 4.6.

The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power. P (dBW). by at least $43 + 10 \log_{10} p$ (watts). dB.

The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power. P (dBW). by at least $65 + 10 \log_{10} p$ (watts). dB. for mobile and portable equipment.

The e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW (-40 dBm) /MHz for wideband signal and -80 dBW (-50 dBm) for discrete emission with bandwidth less than 700 Hz.

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.

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

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

At P_o transmitting power. the specified minimum attenuation becomes $65+10 \log (P_o)$. and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [65 + 10 \log (P_o \text{ in mwatts}) - 30] = -35 \text{ dBm.}$$

METHOD

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

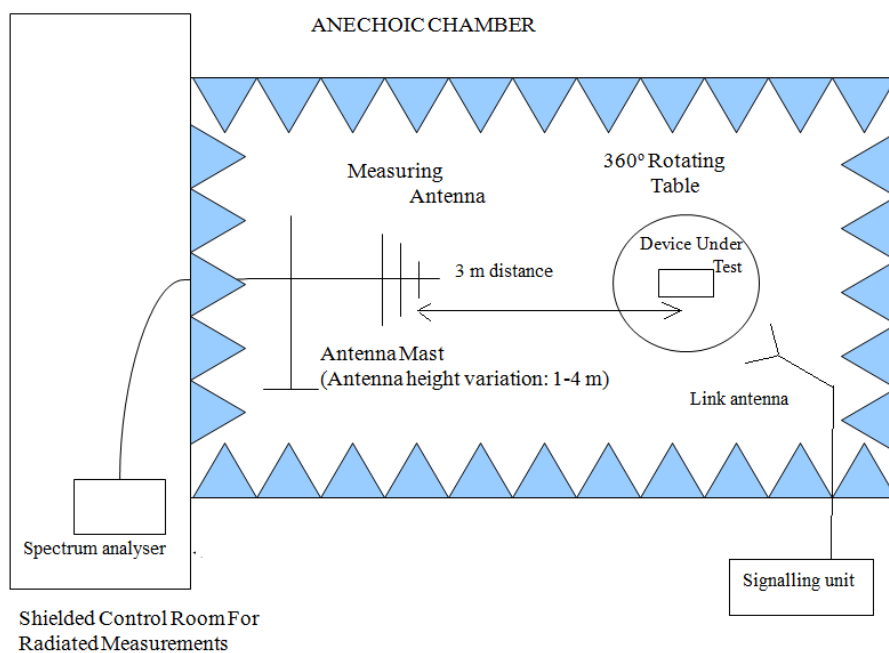
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.

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

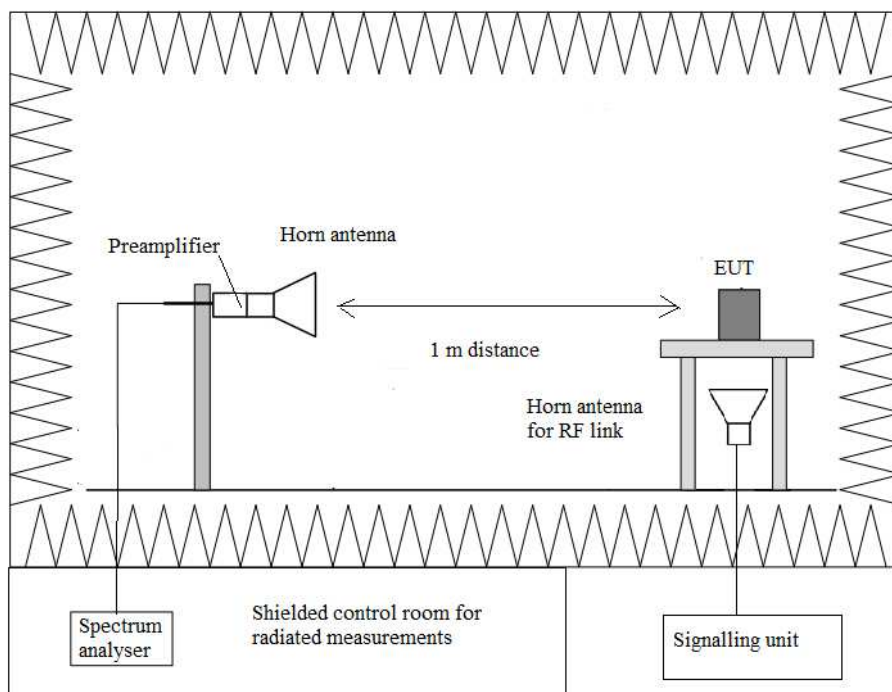
Each detected emission at less than 20 dB respect to the limit is substituted by the Substitution method in accordance with the ANSI/TIA-603-E: 2016.

TEST SETUP

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS

NBLoT. BAND 12.

Preliminary measurements determined that 3 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

NBLoT. BAND 13.

Preliminary measurements determined that 3 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	Polarization	RBW	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain G_i (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
1563.82	-56.59	Horizontal	1 kHz	-68.36	1.14	8.33	-61.17
1564.63	-46.52	Horizontal	1 MHz	-58.28	1.14	8.33	-51.09

No discrete signals were detected. Only wideband signals were detected.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

NB IoT. BAND 66.

Preliminary measurements determined that 3 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-18 GHz.

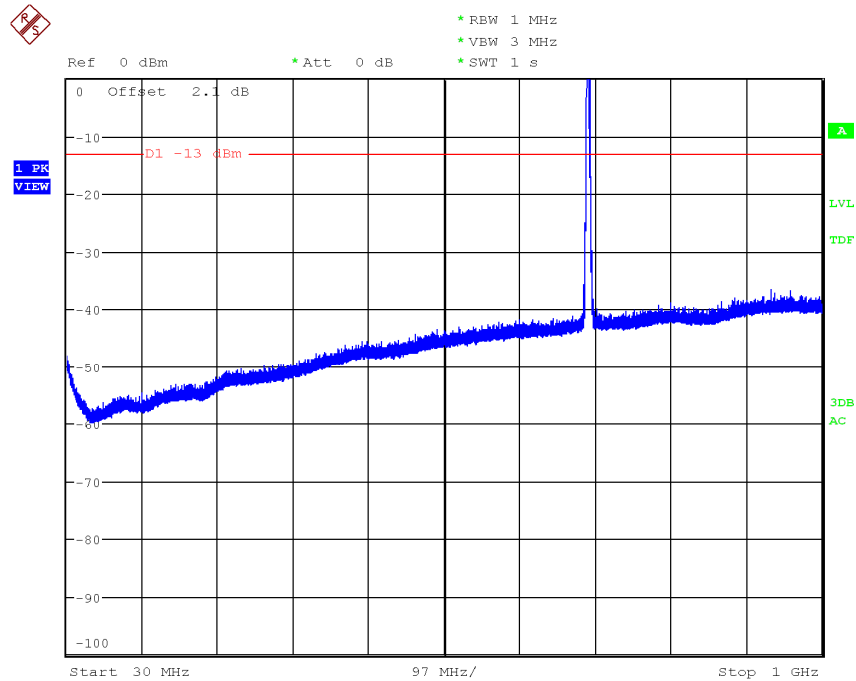
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

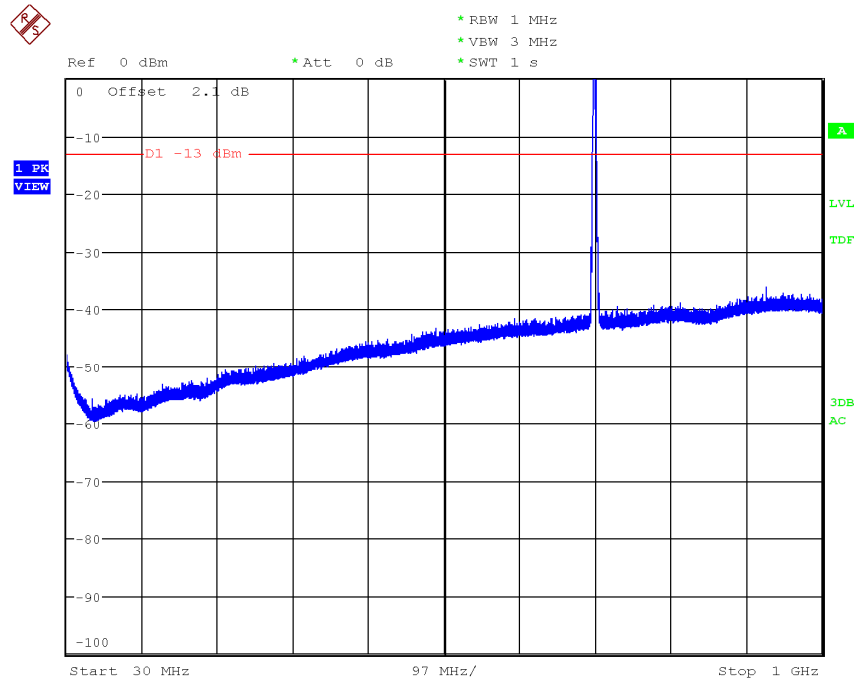
NB IoT Band 12

CHANNEL: LOWEST



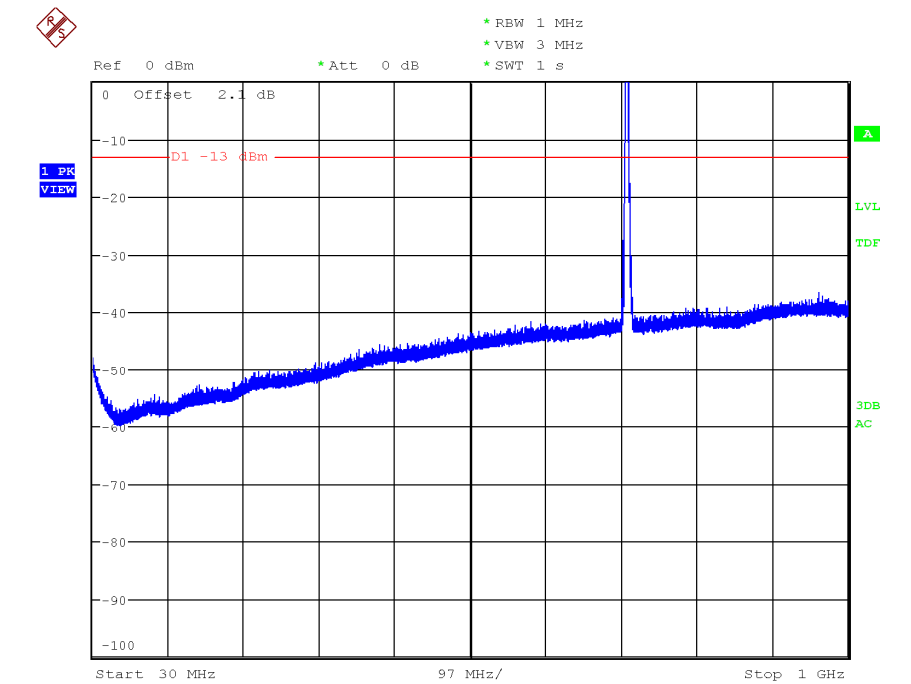
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

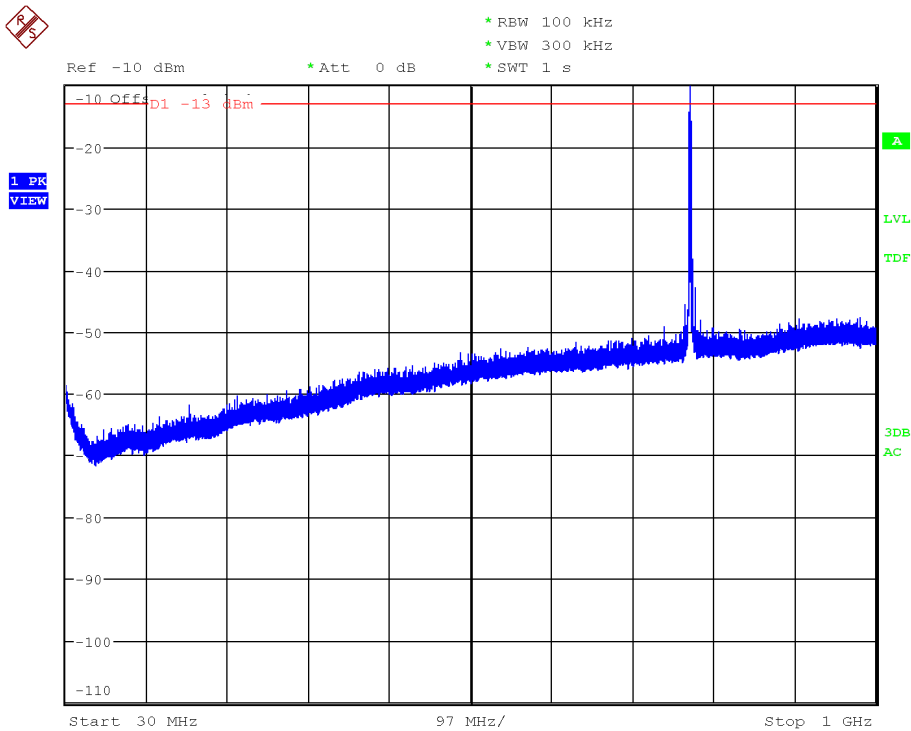
CHANNEL: HIGHEST



Note: The peak above the limit is the carrier frequency.

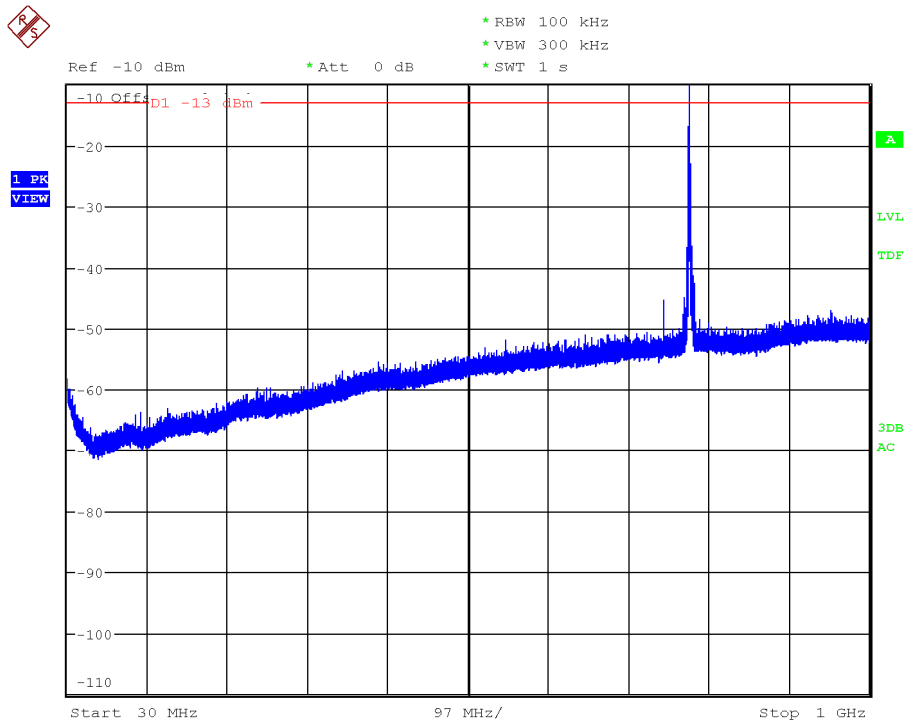
NB IoT Band 13

CHANNEL: LOWEST



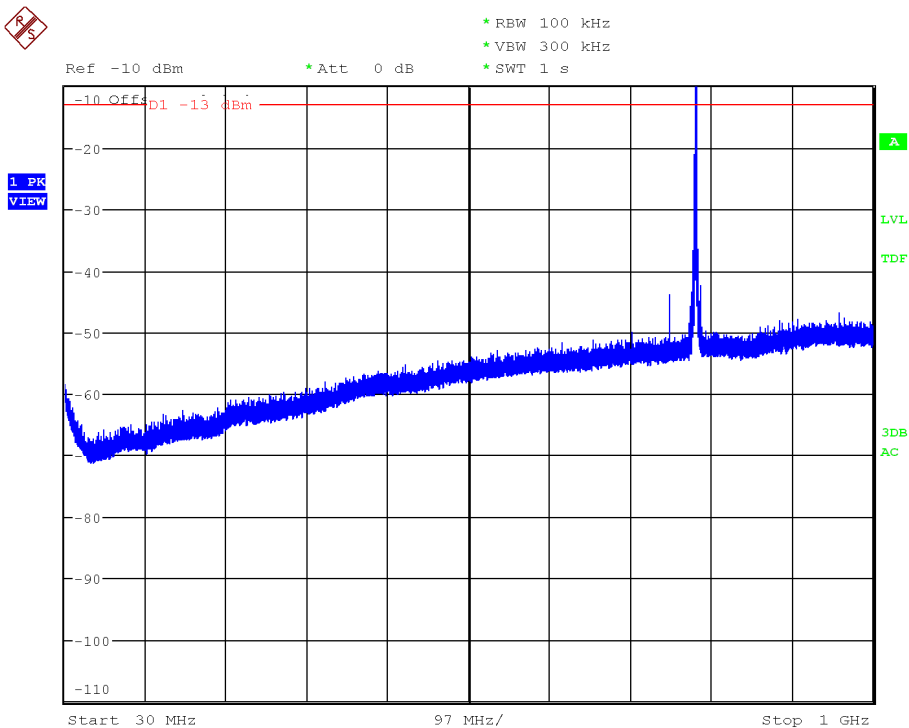
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



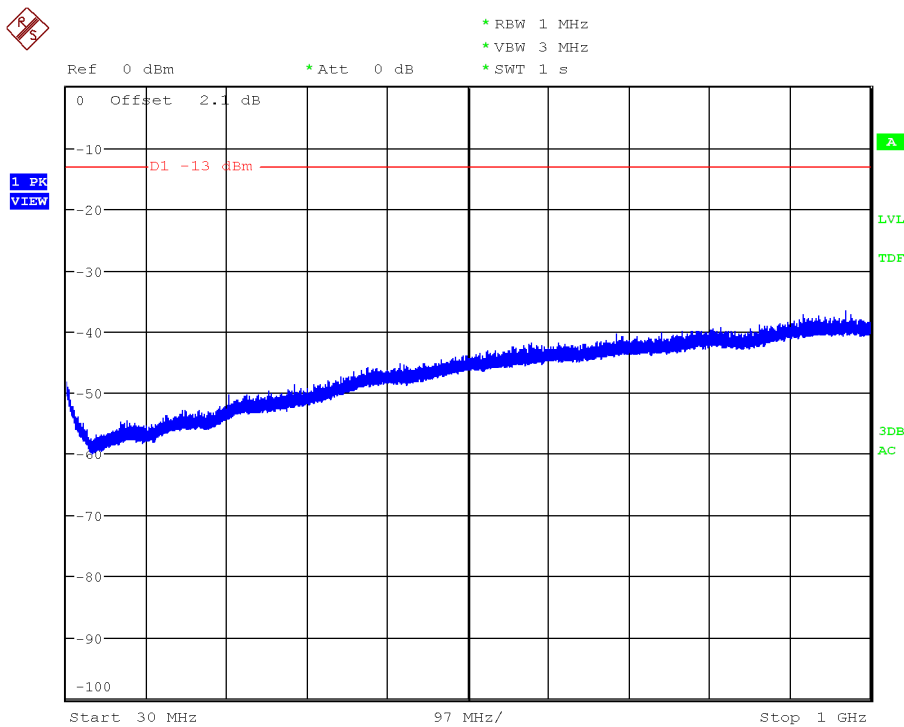
Note: The peak above the limit is the carrier frequency.

CHANNEL: HIGHEST



Note: The peak above the limit is the carrier frequency.

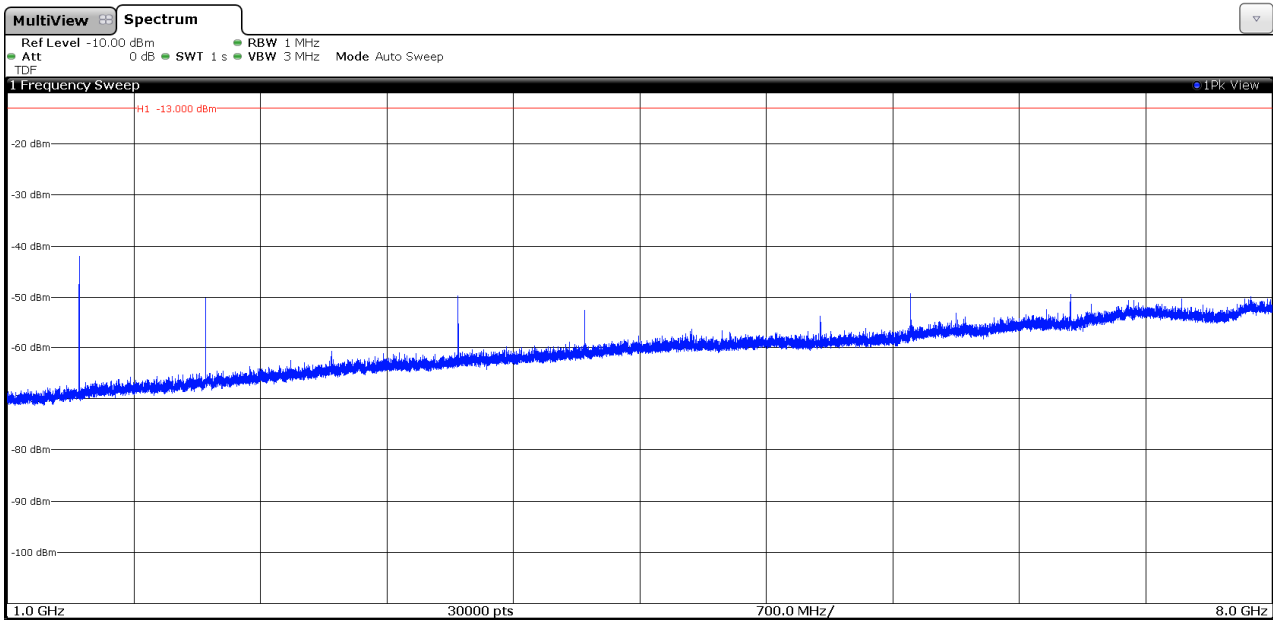
NB-IoT Band 66



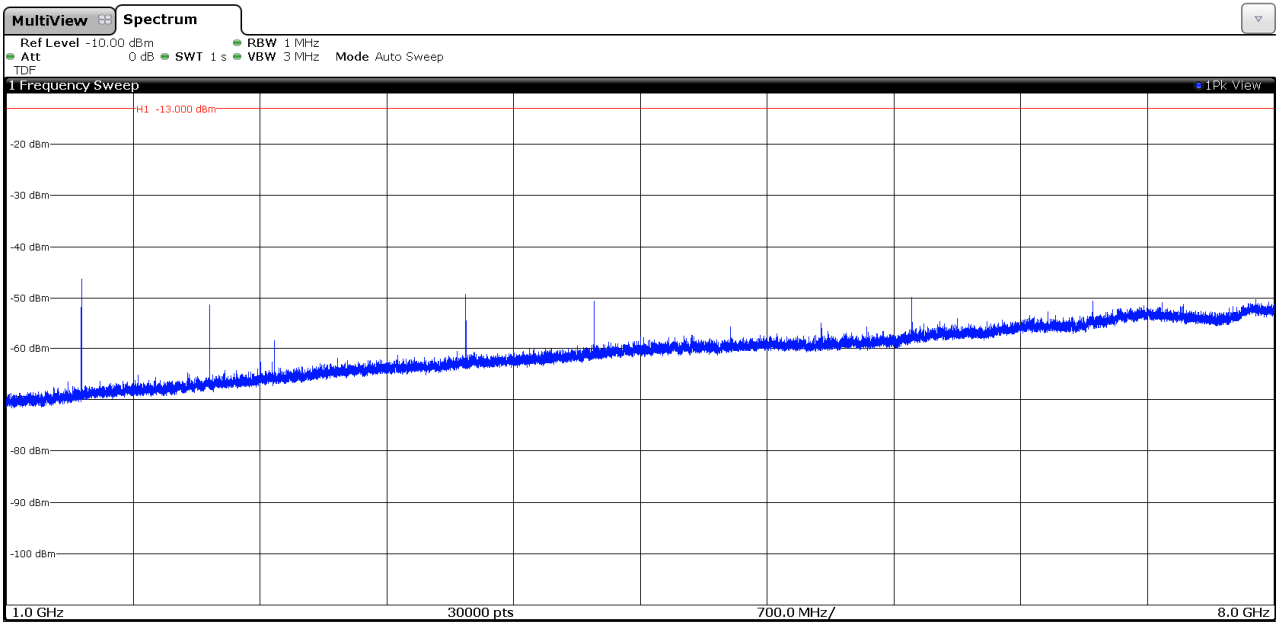
(This plot is valid for all three channels)

NB-IoT Band 12. Frequency range 1 GHz to 8 GHz.

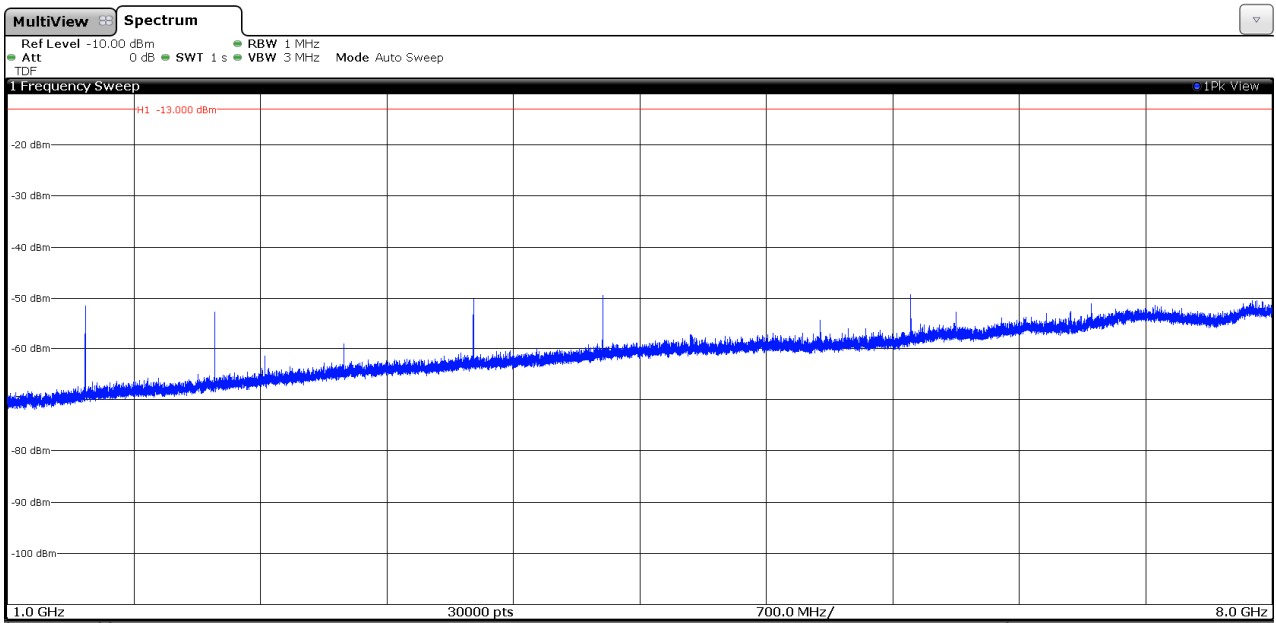
CHANNEL: LOWEST



CHANNEL: MIDDLE

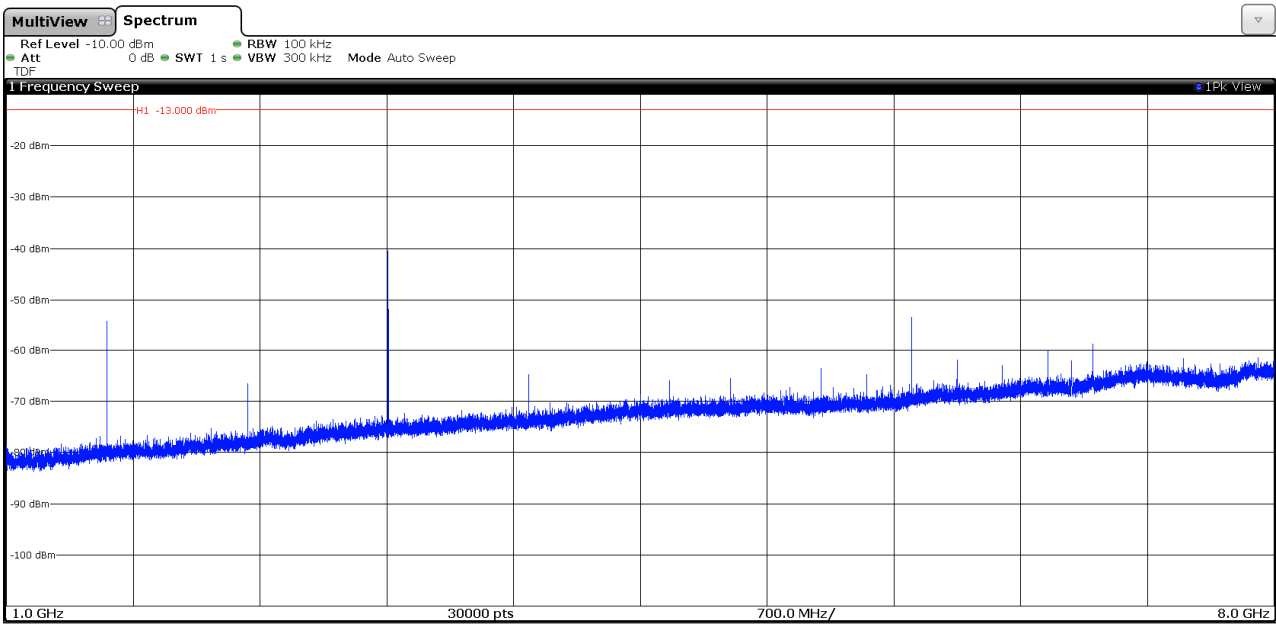


CHANNEL: HIGHEST

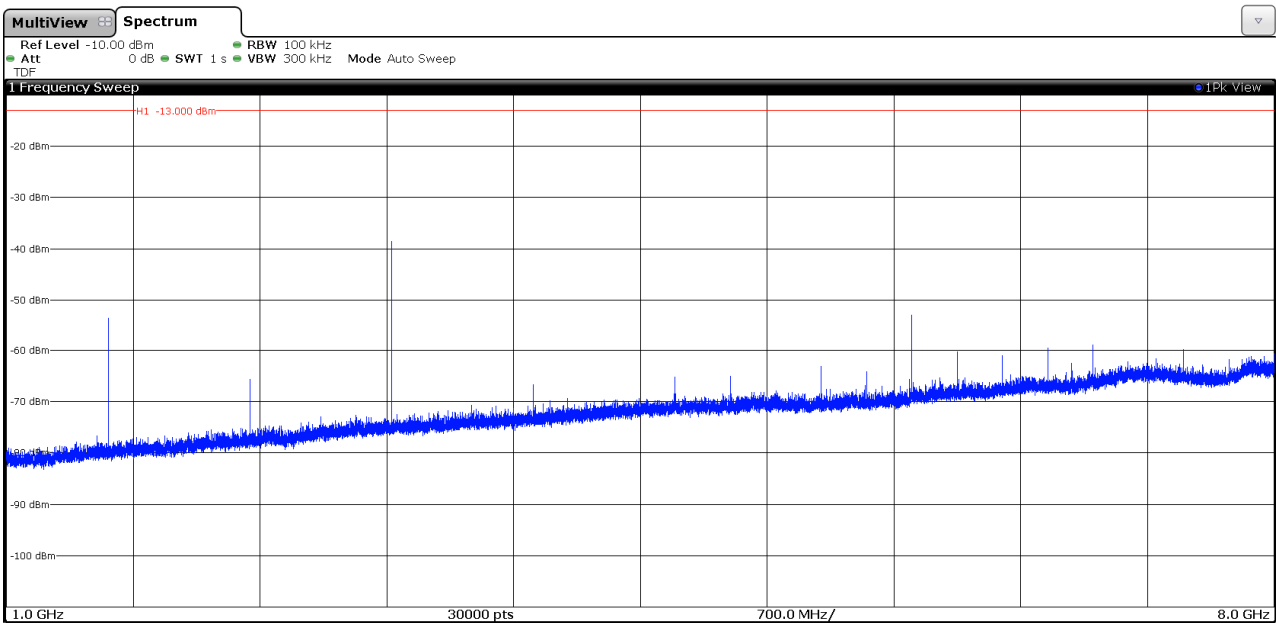


NB IoT Band 13. Frequency range 1 GHz to 8 GHz.

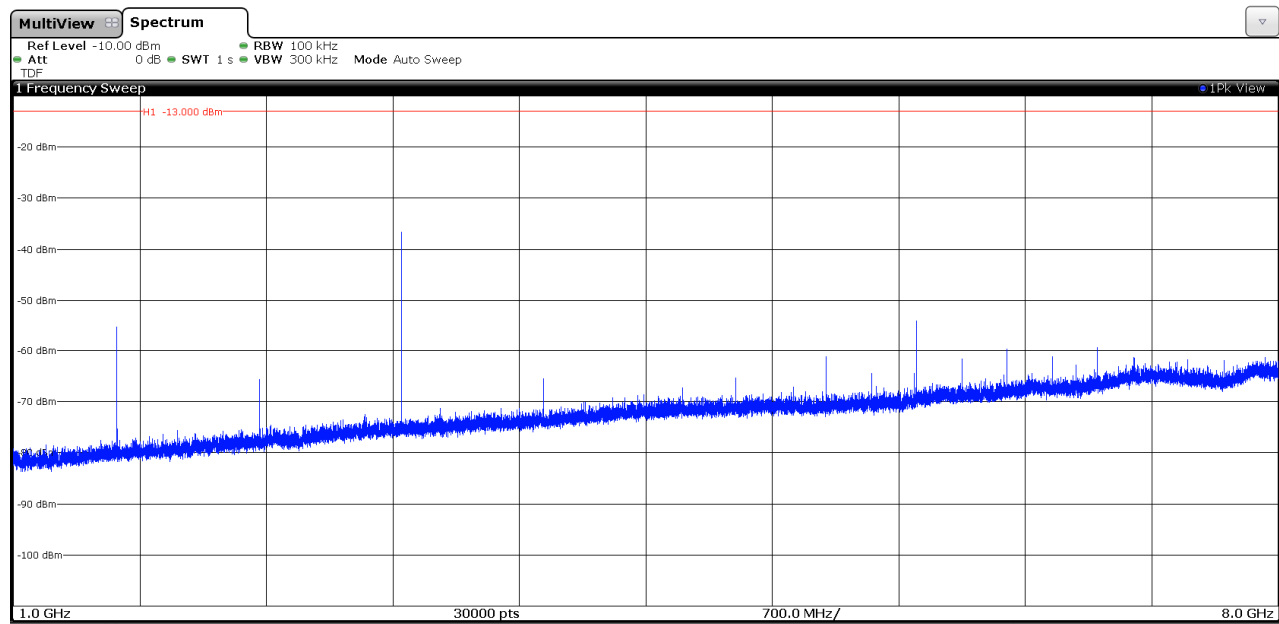
CHANNEL: LOWEST



CHANNEL: MIDDLE

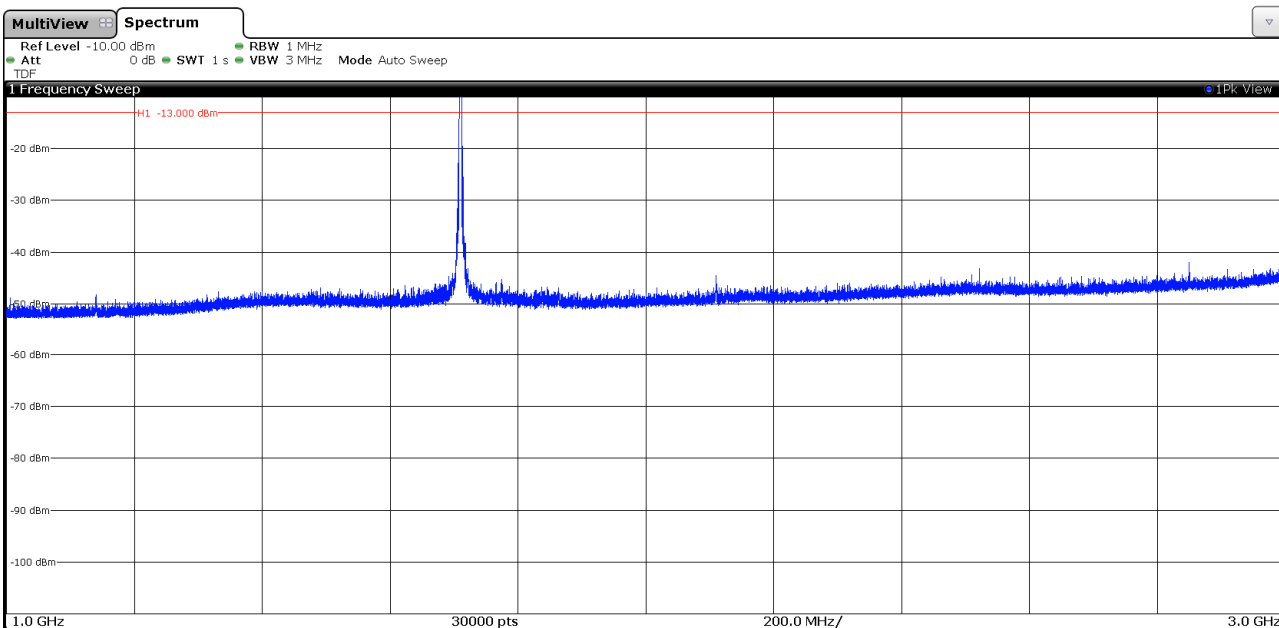


CHANNEL: HIGHEST



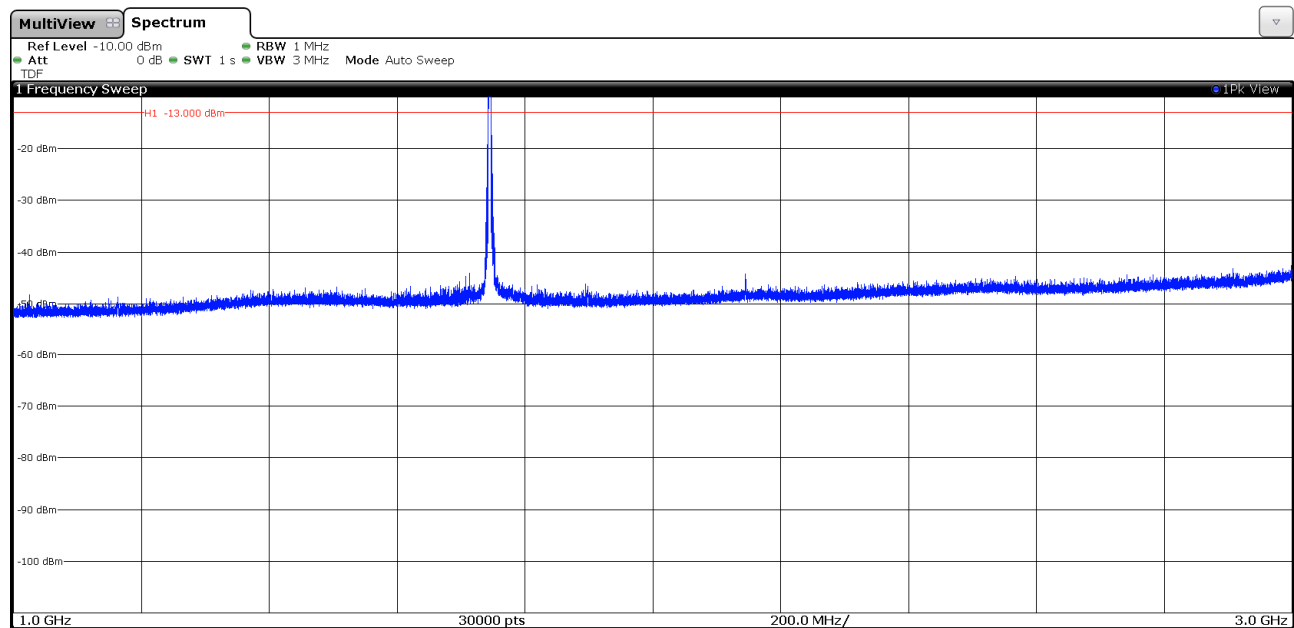
NB-IoT Band 66. Frequency range 1 GHz to 3 GHz

CHANNEL: LOWEST



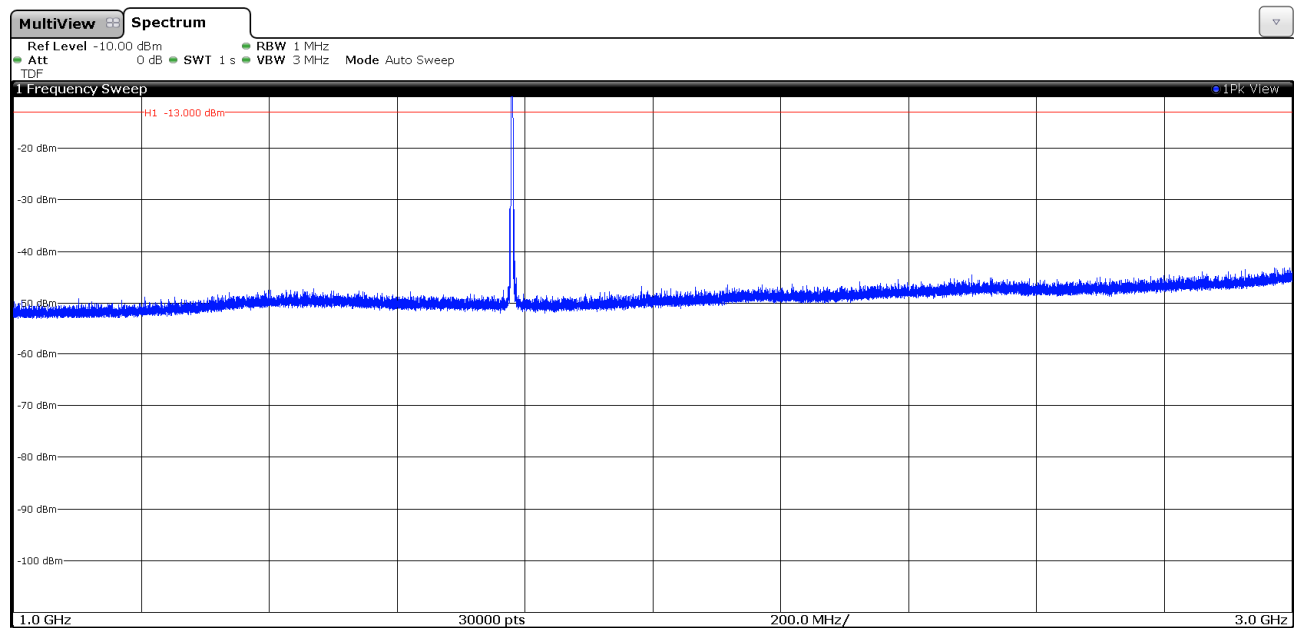
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

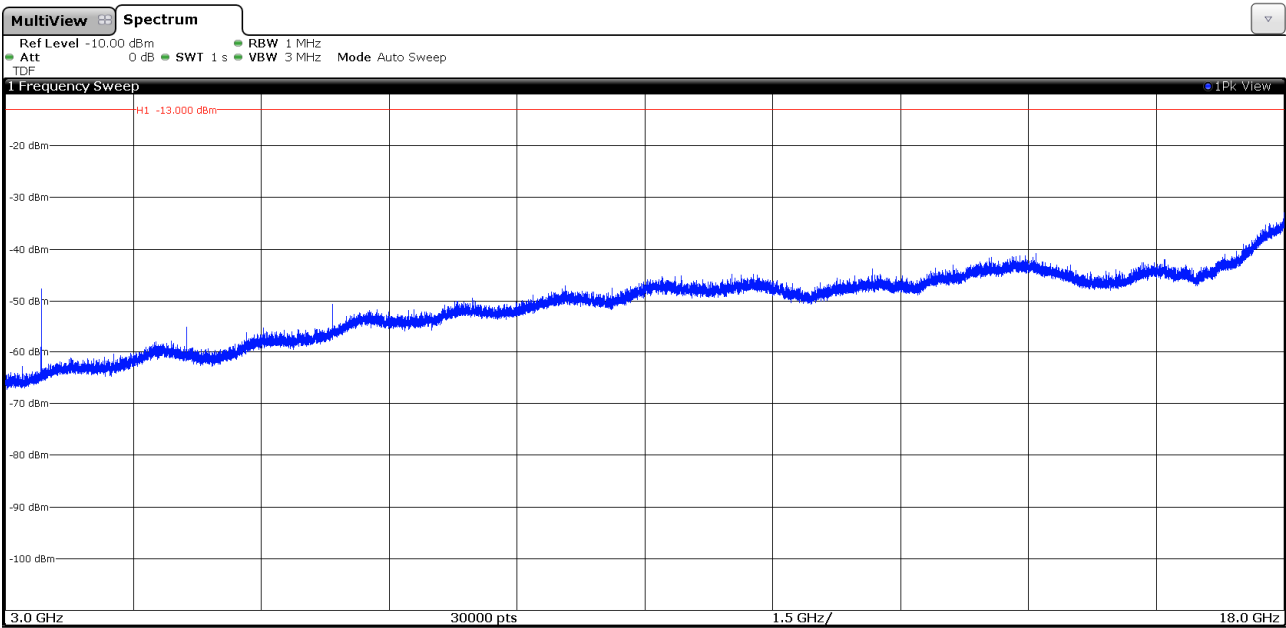
CHANNEL: HIGHEST



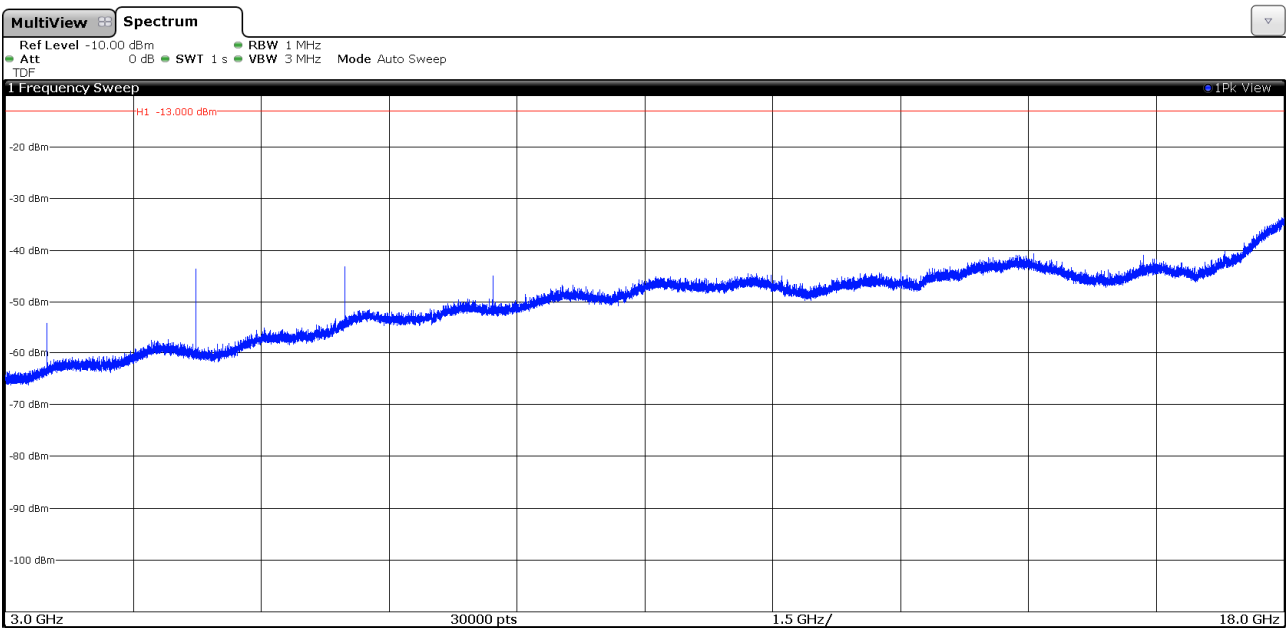
Note: The peak above the limit is the carrier frequency.

NB-IoT Band 66. Frequency range 3 GHz to 18 GHz

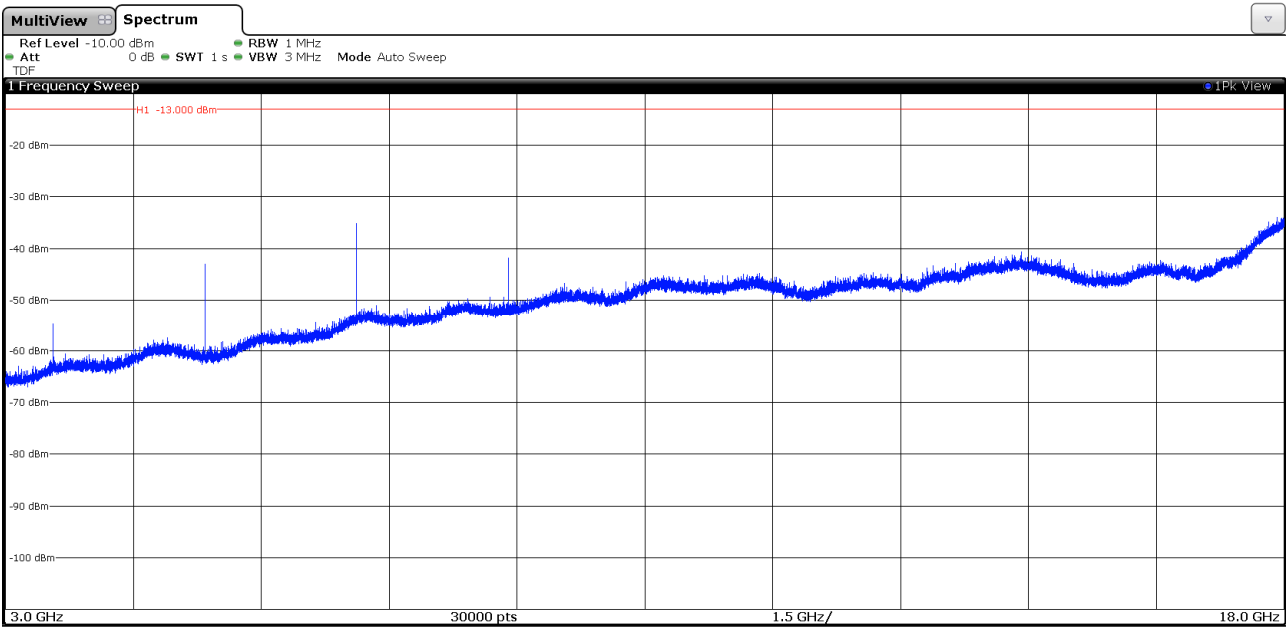
CHANNEL: LOWEST



CHANNEL: MIDDLE

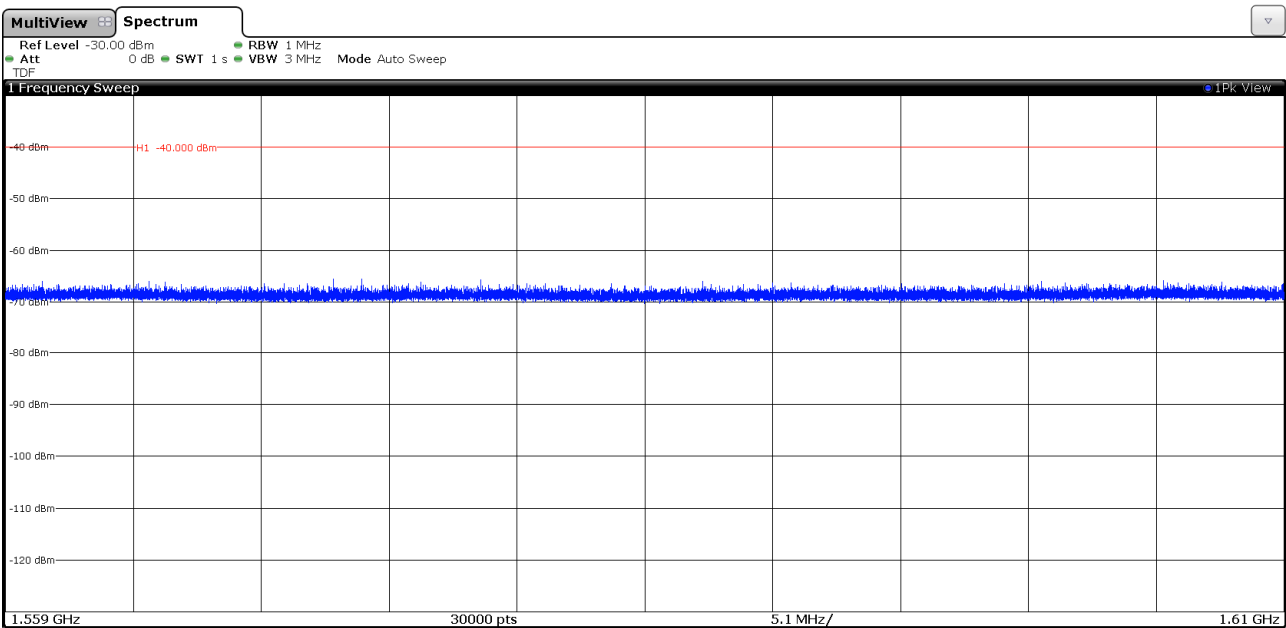


CHANNEL: HIGHEST

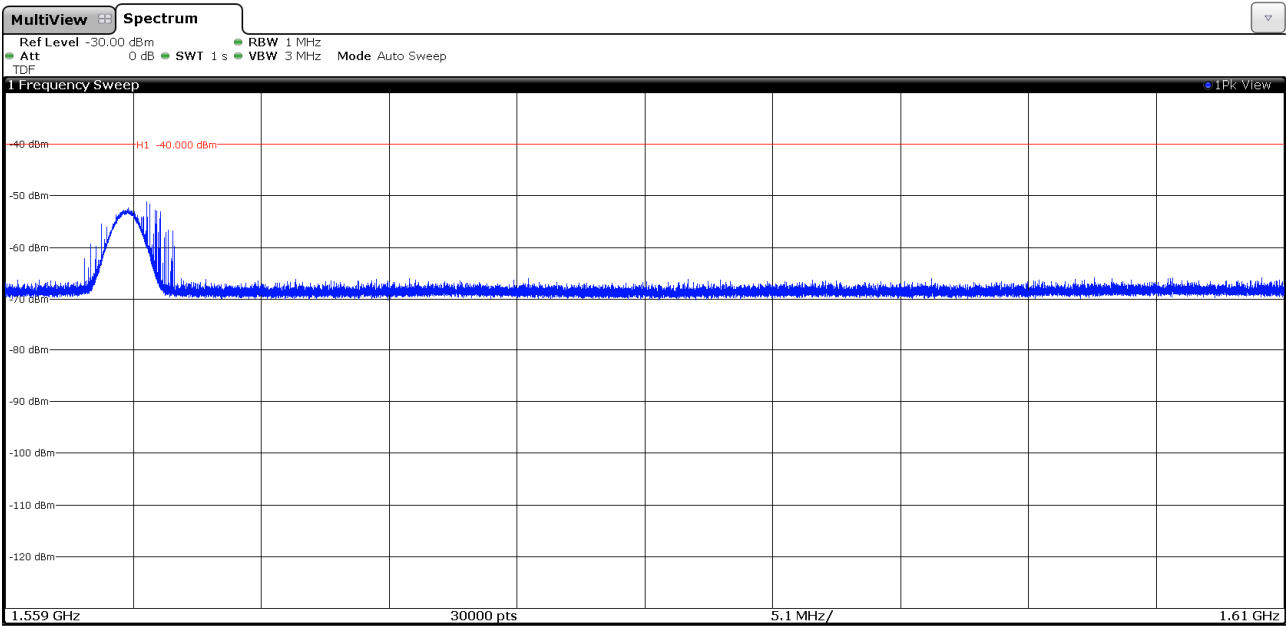


NB IoT Band 13. Frequency range 1559 MHz to 1610 MHz.

CHANNEL: LOWEST



CHANNEL: MIDDLE



CHANNEL: HIGHEST

