Full

TEST REPORT

No. I17D00195-SRD11

For

Client : LongSung Technology (Shanghai)

Production : eMTC/NB-IoT/EGPRS Cellular Module

Model Name : A9500

FCC ID: XHZA9500

Hardware Version: QB1MX10A3

Software Version: QB10001_2.0.001

Issued date: 2017-07-07

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of ECIT Shanghai.

Test Laboratory:

ECIT Shanghai, East China Institute of Telecommunications

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Revision Version

Report Number	Revision	Date	Memo
I17D00195-SRD11	00	2017-07-05	Initial creation of test report
I17D00195-SRD11	01	2017-07-07	Second creation of test report

CONTENTS

1. TEST LABORATORY 5
1.1. TESTING LOCATION 5
1.2. TESTING ENVIRONMENT 5
1.3. PROJECT DATA 5
1.4. SIGNATURE 5
2. CLIENT INFORMATION 6
2.1. APPLICANT INFORMATION 6
2.2. MANUFACTURER INFORMATION 6
3. EQUIPMENT UNDER TEST (EUT) AND ANCILLARY EQUIPMENT (AE) 7
3.1. ABOUT EUT 7
3.2. INTERNAL IDENTIFICATION OF EUT USED DURING THE TEST 7
3.3. INTERNAL IDENTIFICATION OF AE USED DURING THE TEST 7
3.4. STATEMENTS 7
4. REFERENCE DOCUMENTS 8
4.1. REFERENCE DOCUMENTS FOR TESTING 8
5. SUMMARY OF TEST RESULTS 9
6. TEST EQUIPMENT UTILIZED 10
7. TEST ENVIRONMENT 12
ANNEX A. MEASUREMENT RESULTS 13
ANNEX A.1. OUTPUT POWER 13
ANNEX A.2. EMISSION LIMT 17
ANNEX A.3. FREQUENCY STABILITY 20
ANNEX A.4. OCCUPIED BANDWIDTH 22
ANNEX A.5. EMISSION BANDWIDTH 38
ANNEX A.6. BAND EDGE COMPLIANCE 44

ANNEX A.7. CONDUCTED SPURIOUS EMISSION 47

ANNEX A.8. PEAK-TO-AVERAGE POWER RATIO 49

ANNEX B. DEVIATIONS FROM PRESCRIBED TEST METHODS 51

1. Test Laboratory

1.1. Testing Location

Company Name:	ECIT Shanghai, East China Institute of Telecommunications
Address:	7-8F, G Area, No. 668, Beijing East Road, Huangpu District, Shanghai, P. R. China
Postal Code:	200001
Telephone:	(+86)-021-63843300
Fax:	(+86)-021-63843301
FCC Registration NO.:	489729

1.2. Testing Environment

Normal Temperature:	15-35℃
Extreme Temperature:	-10/+55℃
Relative Humidity:	20-75%

1.3. Project data

Project Leader:	Yu Anlu
Testing Start Date:	2017-07-01
Testing End Date:	2017-07-07

1.4. Signature

Yang Dejun
(Prepared this test report)

Ding Li
(Reviewed this test report)

Zheng Zhongbin
Director of the laboratory
(Approved this test report)

2. Client Information

2.1. Applicant Information

Company Name:	LongSung Technology (Shanghai) Co.,Ltd.
Address:	Room 606, Block B, Bldg. 1, No. 3000 Longdong Avenue., Zhangjiang Hi-Tech Park, Pudong District, Shanghai, P.R. China
Email:	chenjun@longsung.com
Postcode:	/

2.2. Manufacturer Information

Company Name:	LongSung Technology (Shanghai) Co.,Ltd.
Address:	Room 606, Block B, Bldg. 1, No. 3000 Longdong Avenue., Zhangjiang Hi-Tech Park, Pudong District, Shanghai, P.R. China
Email:	chenjun@longsung.com
Postcode:	/

3. Equipment Under Test (EUT) and Ancillary Equipment (AE)

3.1. About EUT

EUT Description	eMTC/NB-IoT/EGPRS Cellular Module
Model name	A9500
FCC ID	XHZA9500
Frequency	NBIOT Band5
Bandwidth	200K
Modulation	QPSK/BPSK
Extreme Temperature	-10/+55℃
Nominal Voltage	3.8V
Extreme High Voltage	4.2V
Extreme Low Voltage	3.3V

Note: Photographs of EUT are shown in ANNEX A of this test report.

3.2. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt
N06	866269035523129	QB1MX10A3	QB10001_2.0.001	2017-06-30

*EUT ID: is used to identify the test sample in the lab internally.

3.3. Internal Identification of AE used during the test

AE ID*	Description	SN
AE1	RF cable	/
UA05	USB Cable	/

*AE ID: is used to identify the test sample in the lab internally.

3.4. Statements

The product name A9500, supporting NBIOT, manufactured by LongSung Technology (Shanghai) Co.,Ltd., is a new product for testing.

ECIT has verified that the compliance of the tested device specified in section 5 of this test report is successfully evaluated according to the procedure and test methods as defined in type certification requirement listed in section 5 of this test report.

4. Reference Documents

4.1. Reference Documents for testing

The following documents listed in this section are referred for testing.

Reference	Title	Version
FCC Part 22	PUBLIC MOBILE SERVICES	2014
ANSI/TIA-603-E	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards	2016
ANSI C63.4	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	2014
KDB 971168 D01	Measurement Guidance for Certification of Licensed Digital Transmitters	v02r02

5. SUMMARY OF TEST RESULTS

NBIOT Band 5

Items	Test Name	Clause in FCC rules	Section in this report	Verdict
1	Output Power	§2.1046(a), 22.913(a)	A.1	P
2	Emission Limit	22.917, 2.1051	A.2	P
3	Frequency Stability	22.235, 2.1055	A.3	P
4	Occupied Bandwidth	2.1049(h)(i)	A.4	P
5	Emission Bandwidth	22.917(b)	A.5	P
6	Band Edge Compliance	22.917(b)	A.6	P
7	Conducted Spurious Emission	22.917, 2.1057	A.7	P

6. Test Equipment Utilized

Climate chamber

No.	Equipment	Model	Serial Number	Manufacturer	Calibration date	Cal.interval
1	Climate chamber	SH-641	92012011	ESPEC	2016-01-07	2 Year

Radiated emission test system

The test equipment and ancillaries used are as follows.

No.	Equipment	Model	Serial Number	Manufacturer	Calibration date	Cal.interval
1	Wireless test set	SP8315	SP8315-1201	Star Piont	2017-03-07	1 Year
2	Test Receiver	ESU40	100307	R&S	2017-05-11	1 Year
3	Trilog Antenna	VULB9163	VULB9163-515	Schwarzbeck	2014-11-05	3 Year
4	Double Ridged Guide Antenna	ETS-3117	135890	ETS	2017-01-11	3 Year
5	2-Line V-Network	ENV216	101380	R&S	2017-05-11	1 Year
6	Substitution Antenna	ETS-3117	00135890	ETS	2017-01-11	3 Year
7	RF Signal Generator	SMF100A	102314	R&S	2017-05-11	1 Year
8	Substitution Antenna	VUBA9117	9117-266	Schwarzbeck	2014-08-19	3 Year
9	Amplifier	SCU03	10009	R&S	2017-01-05	1 Year

10	Amplifier	NTWPA-008610F	12023024	Rflight	2017-01-05	1 Year
11	Attenuators	BW-N3W5+	/	MCL	2017-01-05	1 Year

Conducted test system

No.	Name	Type	SN	Manufacture	Calibration date	Cal.interval
1	Vector Signal Analyser	FSQ26	101096	Rohde&Schwarz	2017-05-11	1 Year
2	Wireless test set	SP8315	SP8315-1201	Star Piont	2017-03-07	1 Year
3	DC Power Supply	ZUP60-14	LOC-220Z006-0007	TDL-Lambda	2017-05-11	1 Year

7. Test Environment

Shielding Room1 (6.0 meters×3.0 meters×2.7 meters) did not exceed following limits along the conducted RF performance testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. = 20%, Max. = 75 %
Shielding effectiveness	> 100 dB
Ground system resistance	< 0.5 Ω

Control room did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. =25 %, Max. =75 %
Shielding effectiveness	> 100 dB
Electrical insulation	> 10 kΩ
Ground system resistance	< 0.5 Ω

Fully-anechoic chamber1 (6.9 meters×10.9 meters×5.4 meters) did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ℃, Max. = 35 ℃
Relative humidity	Min. = 25 %, Max. = 75 %
Shielding effectiveness	> 100 dB
Electrical insulation	> 10 kΩ
Ground system resistance	< 0.5 Ω
VSWR	Between 0 and 6 dB, from 1GHz to 18GHz
Site Attenuation Deviation	Between -4 and 4 dB,30MHz to 1GHz
Uniformity of field strength	Between 0 and 6 dB, from 80MHz to 3000 MHz

ANNEX A. MEASUREMENT RESULTS

ANNEX A.1. OUTPUT POWER

A.1.1. Summary

During the process of testing, the EUT was controlled via Star Piont Wireless test set (SP8315) to ensure max power transmission and proper modulation.
In all cases, output power is within the specified limits.

A.1.2. Conducted

A.1.2.1. Method of Measurements

The EUT was set up for the max output power with pseudo random data modulation.
These measurements were done at 3 frequencies (bottom, middle and top of operational frequency range) for each bandwidth.

A.1.2.2 Measurement result

NBIOT band 5

NB-IoT standalone Test frequencies for operating band 5

Test Frequency ID	N_{UL}	Frequency (MHz)	Power(dBm)	Power(dBm)
			QPSK	BPSK
Low Range	20401	824.1	22.65	21.42
Mid Range	20525	836.5	22.50	21.21
High Range	20649	848.9	22.50	21.16

NB-IoT in-band Test frequencies for operating band 5

Test Frequency ID	N_{UL}	Frequency (MHz)	Power(dBm)	Power(dBm)
			QPSK	BPSK
Low Range1	20406	824.6	22.70	21.39
Low Range2	20460	829.99	22.51	21.35
Low Range3	20469	830.89	22.50	21.38
Mid Range1	20516	835.6	22.55	21.41
Mid Range2	20535	837.49	22.54	21.36
Mid Range3	20544	838.39	22.51	21.37
High Range1	20644	848.4	22.54	21.35
High Range2	20610	844.99	22.55	21.32
High Range3	20619	845.89	22.50	21.33

NB-IoT guard-band Test frequencies for operating band 5

Test Frequency ID	N_{UL}	Frequency (MHz)	Power(dBm)	Power(dBm)
			QPSK	BPSK
Low Range	20401	824.1	22.65	21.22
Mid Range	20501	834.1	22.52	21.19
High Range	20649	848.9	22.51	21.16

A.1.3 Radiated

A.1.3.1 Description

This is the test for the maximum radiated power from the EUT.

Rule Part 24.232(b) specifies, "Mobile/portable stations are limited to 2 watts e.i.r.p. Peak power" and 24.232(c) specifies that "Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage."

Rule Part 27.50(d) specifies “Fixed, mobile, and portable (handheld) stations operating in the 1710–1755 MHz band are limited to 1 watt EIRP”.

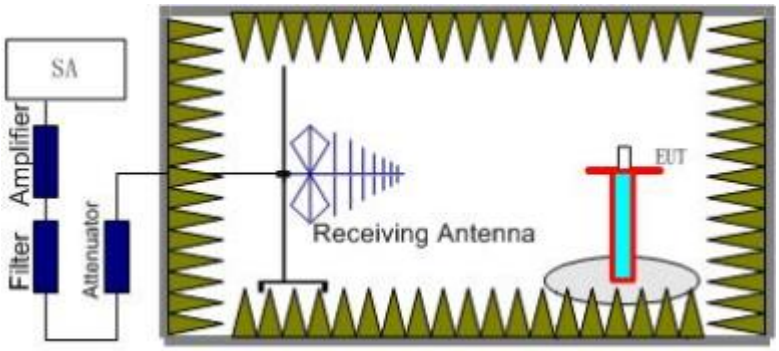
Rule Part 27.50(h)(2) specifies “Mobile stations are limited to 2.0 watts EIRP.”.

Rule Part 27.50(c) specifies “Portable stations (hand-held de-vices) are limited to 3 watts ERP.”.

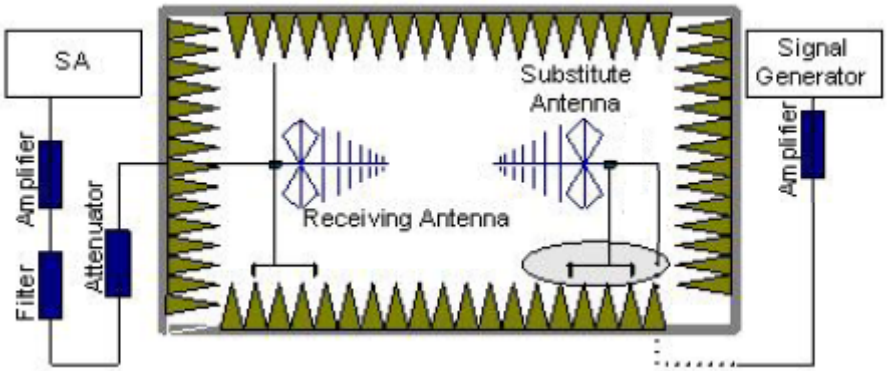
A.1.3.2 Method of Measurement

The measurements procedures in TIA-603D-2010 are used.

1. EUT was placed on a 1.5 meter high non-conductive stand at a 3 meter test distance from the receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT for emission measurements. The height of receiving antenna is 1.5m. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all transmit frequencies in three channels (High, Middle, Low) were measured with peak detector.



2. The EUT is then put into continuously transmitting mode at its maximum power level during the test. And the maximum value of the receiver should be recorded as (Pr).
3. The EUT shall be replaced by a substitution antenna. The test setup refers to figure below.



In the chamber, a substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (P_{Mea}) is applied to the input of the substitution antenna. Adjust the level of the signal generator output until the value of the receiver reaches the previously recorded (P_r). The power of signal source (P_{Mea}) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.

4. An amplifier should be connected to the Signal Source output port. And the cable should be connected between the amplifier and the substitution antenna.
   The cable loss (P_{cl}), the substitution antenna Gain (G_a) and the amplifier Gain (P_{Ag}) should be recorded after test.
   The measurement results are obtained as described below:
   Power (EIRP) = P_{Mea} - P_{Ag} - P_{cl} - G_a
5. This value is EIRP since the measurement is calibrated using an antenna of known gain (unit dBi) and known input power.
6. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP = EIRP -2.15.

A.1.3.3 Measurement result

NBIOT Band 5- ERP 22.913(a)

Limits: ≤38.45dBm (7W)

NB-IoT standalone Test frequencies for operating band 5 QPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.1	-8.4	3.1	37	-2.87	22.63	38.45	15.82	H
836.5	-8.34	3.1	37	-3.11	22.45	38.45	16	H
848.9	-8.65	3.1	37	-3.11	22.14	38.45	16.31	H

NB-IoT in-band Test frequencies for operating band 5 QPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.6	-8.76	3.1	37	-2.87	22.27	38.45	16.18	H
829.99	-8.57	3.1	37	-2.87	22.46	38.45	15.99	H
830.89	-8.28	3.1	37	-3.11	22.51	38.45	15.94	H
835.6	-8.71	3.1	37	-3.11	22.08	38.45	16.37	H
837.49	-8.1	3.1	37	-3.11	22.69	38.45	15.76	H
838.39	-8.64	3.1	37	-3.11	22.15	38.45	16.3	H
848.4	-8.56	3.1	37	-3.11	22.23	38.45	16.22	H
844.99	-8.17	3.1	37	-3.11	22.62	38.45	15.83	H
845.89	-8.07	3.1	37	-3.11	22.72	38.45	15.73	H

NB-IoT guard-band Test frequencies for operating band 5 QPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.1	-8.38	3.1	37	-2.87	22.65	38.45	15.8	H
834.1	-8.78	3.1	37	-3.11	22.01	38.45	16.44	H
848.9	-8.61	3.1	37	-3.11	22.18	38.45	16.27	H

Peak ERP(dBm)=P_{Mea}(-8.38dBm)+G_a(-2.87dBi)+P_{Ag}(37dB)-P_{cl} (3.1)dB =22.65 dBm

NB-IoT standalone Test frequencies for operating band 5 BPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.1	-9.45	3.1	37	-2.87	21.58	38.45	16.87	H
836.5	-9.73	3.1	37	-3.11	21.06	38.45	17.39	H
848.9	-8.96	3.1	37	-3.11	21.83	38.45	16.62	H

NB-IoT in-band Test frequencies for operating band 5 BPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.6	-8.99	3.1	37	-2.87	22.04	38.45	16.41	H
829.99	-9.52	3.1	37	-2.87	21.51	38.45	16.94	H
830.89	-9.5	3.1	37	-3.11	21.29	38.45	17.16	H
835.6	-8.86	3.1	37	-3.11	21.93	38.45	16.52	H
837.49	-9.42	3.1	37	-3.11	21.37	38.45	17.08	H
838.39	-8.76	3.1	37	-3.11	22.03	38.45	16.42	H
848.4	-9.48	3.1	37	-3.11	21.31	38.45	17.14	H
844.99	-9.8	3.1	37	-3.11	20.99	38.45	17.46	H
845.89	-8.92	3.1	37	-3.11	21.87	38.45	16.58	H

NB-IoT guard-band Test frequencies for operating band 5 BPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a Antenna Gain(dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
824.1	-8.94	3.1	37	-2.87	22.09	38.45	16.36	H
834.1	-8.97	3.1	37	-3.11	21.82	38.45	16.63	H
848.9	-9.72	3.1	37	-3.11	21.07	38.45	17.38	H

Peak ERP(dBm)=P_{Mea}(-8.94dBm)+G_a(-2.87dBi)+P_{Ag}(37dB)-P_{cl} (3.1)dB =22.09 dBm

ANALYZER SETTINGS:

RBW = VBW = 8MHz for occupied bandwdiths equal to or less than 5MHz.

RBW = VBW = 20MHz for occupied bandwidths equal to or greater than 10MHz.

ANNEX A.2. EMISSION LIMT

Reference

FCC: CFR 2.1051, 22.917,24.238(a), 27.53(g), 27.53(h) , 27.53(m).

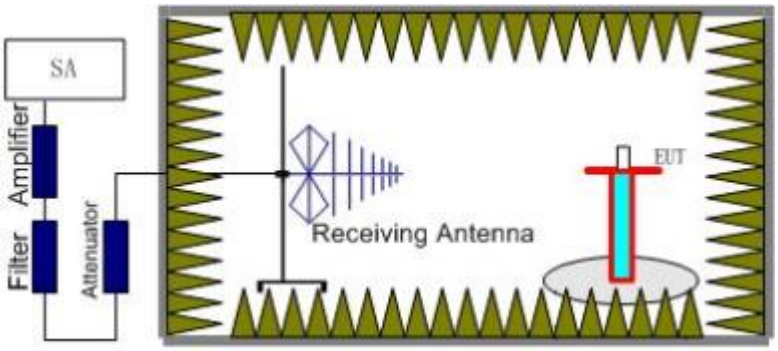
A.2.1 Measurement Method

The measurements procedures in TIA-603D-2010 are used. This measurement is carried out in fully-anechoic chamber FAC-3.

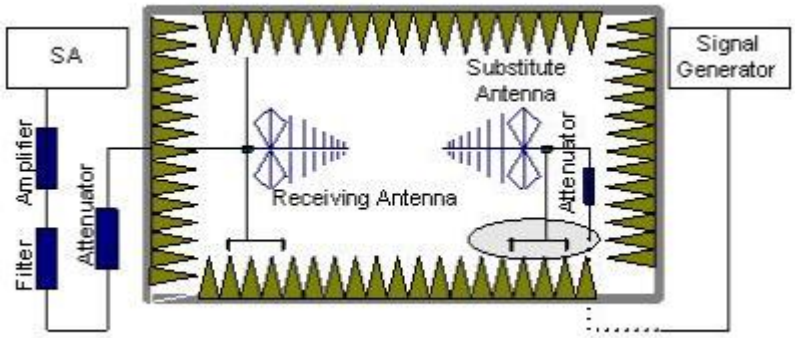
The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier. The resolution bandwidth is set 1MHz as outlined in Part 22.917,Part 24.238(a), Part 27.53(g), Part 27.53(h), Part 27.53(m). The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the NBIOT Bands 5.

The procedure of radiated spurious emissions is as follows:

1. EUT was placed on a 1.5 meter high non-conductive stand at a 3 meter test distance from the receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT for emission measurements. The height of receiving antenna is 1.5m. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all non-harmonic and harmonics of the transmit frequency through the 10th harmonic were measured with peak detector.



2. The EUT is then put into continuously transmitting mode at its maximum power level during the test. And the maximum value of the receiver should be recorded as (Pr).
3. The EUT shall be replaced by a substitution antenna. The test setup refers to figure below.



In the chamber, an substitution antenna for the frequency band of interest is placed at the

reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (P_{Mea}) is applied to the input of the substitution antenna. Adjust the level of the signal generator output until the value of the receiver reaches the previously recorded (P_r). The power of signal source (P_{Mea}) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.

4. The Path loss (P_{pl}) between the Signal Source with the Substitution Antenna and the Substitution Antenna Gain (G_a) should be recorded after test.
   An amplifier should be connected in for the test.
   The Path loss (P_{pl}) is the summation of the cable loss and the gain of the amplifier.
   The measurement results are obtained as described below:
   Power (EIRP)=P_{Mea}+ P_{pl} + G_a
5. This value is EIRP since the measurement is calibrated using an antenna of known gain (unit: dBi) and known input power.
6. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP = EIRP -2.15dB.

A.2.2 Measurement Limit

Part 22.917,Part 24.238(a), Part 27.53(g), Part 27.53(h), Part 27.53(m) all specify that the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB. The specification that emissions shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB, translates in the relevant power range (1 to 0.001 W) to -13 dBm. At 1 W the specified minimum attenuation becomes 43 dB and relative to a 30 dBm (1 W) carrier becomes a limit of -13 dBm. At 0.001 W (0 dBm) the minimum attenuation is 13 dB, which again yields a limit of -13 dBm. In this way a translation of the specification from relative to absolute terms is carried out.

A.2.3 Measurement Results

7. Radiated emissions measurements were made only at the upper, middle, and lower carrier frequencies of the NBIOT Bands 5. It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the NBIOT Bands 5 into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this. The evaluated frequency range is from 30MHz to 26GHz.

NBIOT Band 5, 200KHz, QPSK, Channel 20406

Frequency(MHz)	P_{Mea}(dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit （dBm）	Margin(dB)	Polarization
1603.307692	-52.42	4.3	3.2	-53.52	-13.00	40.52	H
2401.923077	-43.87	4.8	3.5	-45.17	-13.00	32.17	V
3164.800000	-51.26	6.0	4.8	-52.46	-13.00	39.46	H
4029.200000	-53.82	6.9	7.2	-53.52	-13.00	40.52	V
4836.000000	-51.92	7.6	7.4	-52.12	-13.00	39.12	V
5618.000000	-53.66	8.4	10.1	-51.96	-13.00	38.96	V

NBIOT Band 5, 200KHz, QPSK, Channel 20516

Frequency(MHz)	P_{Mea}(dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit （dBm）	Margin(dB)	Polarization
1257.153846	-48.43	3.8	2.0	-50.23	-13.00	37.23	H
1784.000000	-40.71	4.5	2.9	-42.31	-13.00	29.31	H
2642.307692	-38.57	5.5	3.8	-40.27	-13.00	27.27	H
3574.400000	-51.68	6.4	6.1	-51.98	-13.00	38.98	H
4970.000000	-52.79	7.7	9.0	-51.49	-13.00	38.49	V
6647.200000	-48.04	9.1	11.8	-45.34	-13.00	32.34	V

NBIOT Band 5, 200KHz, QPSK, Channel 20644

Frequency(MHz)	P_{Mea}(dBm)	Path Loss	Antenna Gain	Peak ERP(dBm)	Limit （dBm）	Margin(dB)	Polarization
1692.961538	-42.9	4.4	2.7	-44.60	-13.00	31.60	H
2539.230769	-37.67	5.4	3.7	-39.37	-13.00	26.37	H
3318.800000	-44.89	6.2	5.8	-45.29	-13.00	32.29	H
4656.000000	-49.41	7.5	7.8	-49.11	-13.00	36.11	H
6638.800000	-48.63	9.1	11.8	-45.93	-13.00	32.93	H
8269.900000	-54.65	10.1	17.4	-47.35	-13.00	34.35	H

ANNEX A.3. FREQUENCY STABILITY

Reference

FCC: CFR Part 2.1055, 22.235,24.235, 27.54.

A.3.1 Method of Measurement

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the EUT in a “call mode”. This is accomplished with the use of Star Piont SP8315 Wireless test set.

1. Measure the carrier frequency at room temperature.
2. Subject the EUT to overnight soak at -30℃.
3. With the EUT, powered via nominal voltage, connected to the SP8315 and in a simulated call on middle channel for NBIOT band 5, measure the carrier frequency. These measurements should be made within 2 minutes of Powering up the EUT, to prevent significant self-warming.
4. Repeat the above measurements at 10℃ increments from -30℃ to +50℃. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Re-measure carrier frequency at room temperature with nominal voltage. Vary supply voltage from minimum voltage to maximum voltage, in 0.1Volt increments re-measuring carrier frequency at each voltage. Pause at nominal voltage for 1.5 hours unpowered, to allow any self-heating to stabilize, before continuing.
6. Subject the EUT to overnight soak at +50℃.
7. With the EUT, powered via nominal voltage, connected to the SP8315 and in a simulated call on the centre channel, measure the carrier frequency. These measurements should be made within 2 minutes of Powering up the EUT, to prevent significant self-warming.
8. Repeat the above measurements at 10 ℃ decrements from +50℃ to -30℃. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
9. At all temperature levels hold the temperature to +/- 0.5℃ during the measurement procedure.

A.3.2 Measurement Limit

According to the JTC standard the frequency stability of the carrier shall be accurate to within 0.1 ppm of the received frequency from the base station. This accuracy is sufficient to meet Sec. 24.235, Frequency Stability. The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block. As this transceiver is considered "Hand carried, battery powered equipment" Section 2.1055(d) (2) applies. This requires that the lower voltage for frequency stability testing be specified by the manufacturer. This transceiver is specified to operate with an input voltage of between 3.3VDC and 4.2VDC, with a nominal voltage of 3.8VDC. Operation above or below these voltage limits is prohibited by transceiver software in order to prevent improper operation as well as to protect components from overstress. For the purposes of measuring frequency stability these voltage limits are to be used.

A.3.3 Measurement results

NBIOT Band 5, 200 KHz bandwidth (worst case of all bandwidths)

Frequency Error vs Voltage

Voltage (V)	Frequency error (Hz)		Frequency error (ppm)	
	QPSK	BPSK	QPSK	BPSK
3.6	0.75	1.26	0.001	0.001
4	1.25	0.54	0.001	0.001
4.35	-1.21	2.11	0.001	0.001

Frequency Error vs Temperature

Temperature (℃)	Frequency error (Hz)		Frequency error (ppm)	
	QPSK	BPSK	QPSK	BPSK
50°	0.85	-0.54	0.001	0.001
40°	1.23	1.03	0.001	0.001
30°	1.26	0.89	0.001	0.001
20°	0.45	1.49	0.001	0.001
10°	-0.84	-0.21	0.001	0.001
0°	-0.52	-1.21	0.001	0.001
- 10°	1.06	0.73	0.001	0.001
- 20°	0.77	2.30	0.001	0.001
- 30°	0.82	0.32	0.001	0.001

ANNEX A.4. OCCUPIED BANDWIDTH

Reference

FCC: CFR Part 2.1049(h)(i)

A.4.1 Occupied Bandwidth Results

Occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the US Cellular/PCS frequency bands. The table below lists the measured 99% BW. Spectrum analyzer plots are included on the following pages.

The measurement method is from KDB 971168 4.2:

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (i.e., two to five times the OBW).

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.

c) Set the reference level of the instrument as required to keep the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope must be at least 10log (OBW / RBW) below the reference level.

d) Set the detection mode to peak, and the trace mode to max hold.

e) Use the 99 % power bandwidth function of the spectrum analyzer and report the measured bandwidth.

NBIOT band 5, 200 KHz (99%)

NB-IoT standalone Test frequencies for operating band 5(99%)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (99%)(kHz)	Occupied Bandwidth (99%)(kHz)
			QPSK	BPSK
Low Range	20401	824.1	142.628	155.448
Mid Range	20525	836.5	141.025	153.846
High Range	20649	848.9	141.025	153.846

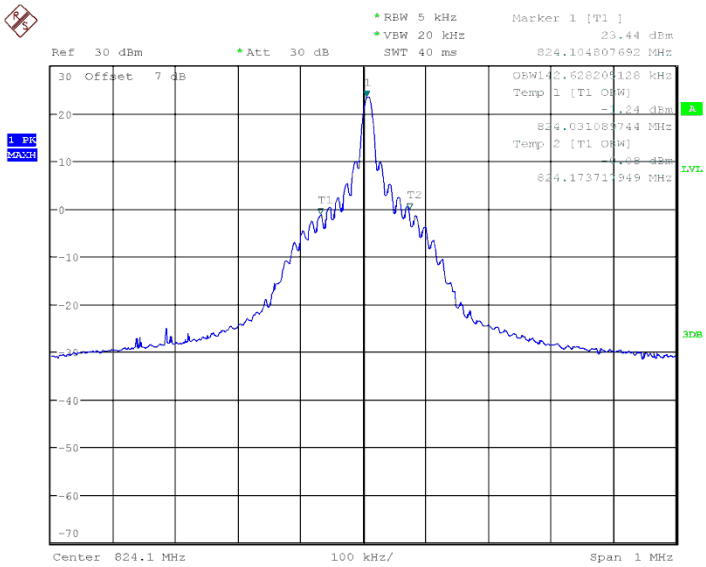
NB-IoT in-band Test frequencies for operating band 5(99%)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (99%)(kHz)	Occupied Bandwidth (99%)(kHz)
			QPSK	BPSK
Low Range1	20406	824.6	141.025	155.448
Low Range2	20460	829.99	141.025	155.448
Low Range3	20469	830.89	141.025	153.846
Mid Range1	20516	835.6	141.025	153.846
Mid Range2	20535	837.49	141.025	155.448
Mid Range3	20544	838.39	141.025	155.448
High Range1	20644	848.4	142.628	155.448
High Range2	20610	844.99	141.025	155.448
High Range3	20619	845.89	141.025	155.448

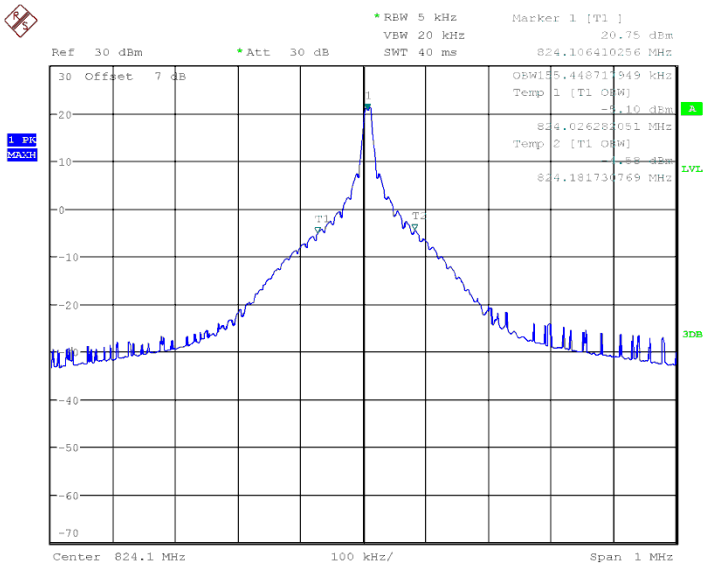
NB-IoT guard-band Test frequencies for operating band 5(99%)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (99%)(kHz)	Occupied Bandwidth (99%)(kHz)
			QPSK	QPSK
Low Range	20401	824.1	142.628	155.448
Mid Range	20501	834.1	141.025	153.846
High Range	20649	848.9	141.025	155.448

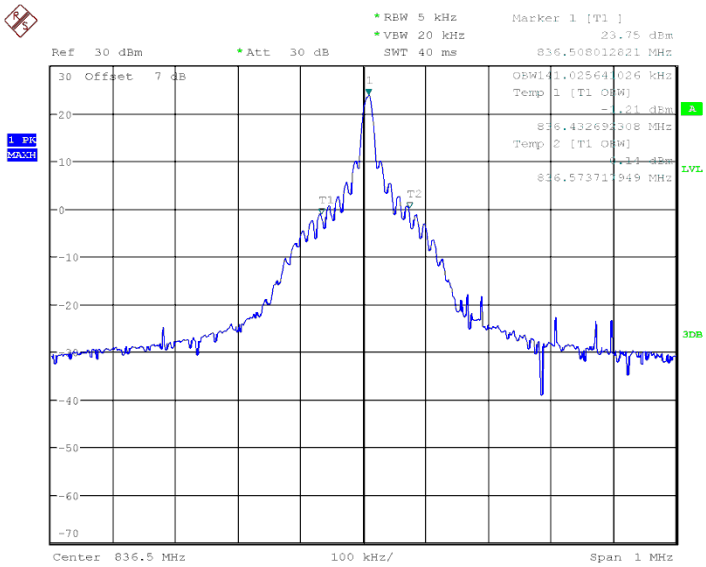
NB-IoT standalone band 5 20401 QPSK(99% BW)



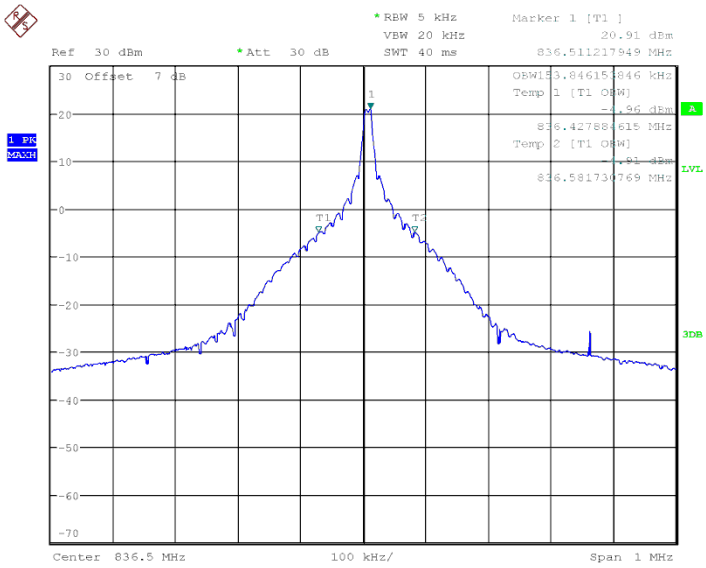
NB-IoT standalone band 5 20401 BPSK(99% BW)



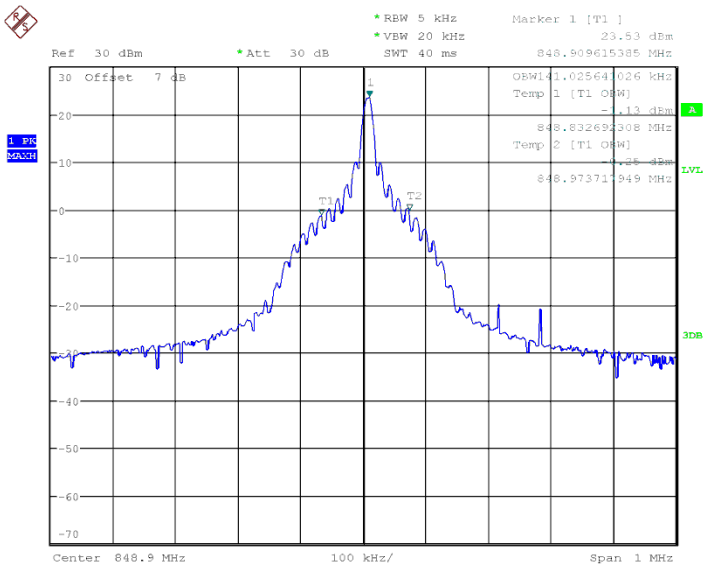
NB-IoT standalone band 5 20525 QPSK (99% BW)



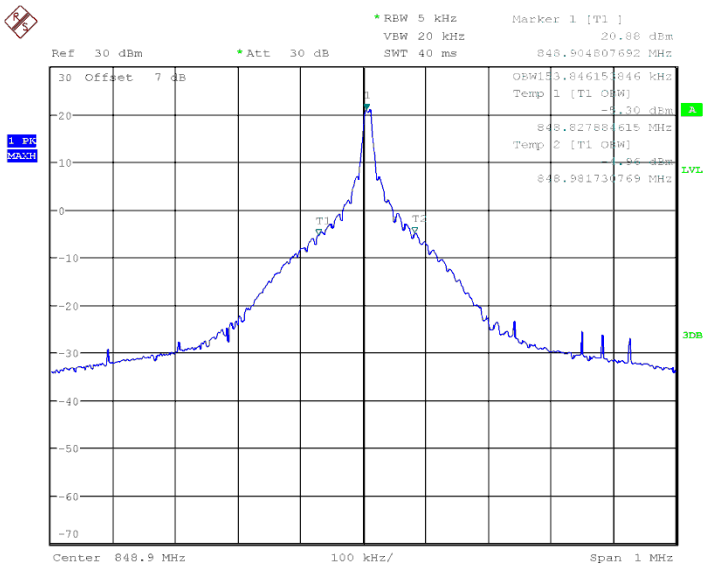
NB-IoT standalone band 5 20525 BPSK (99% BW)



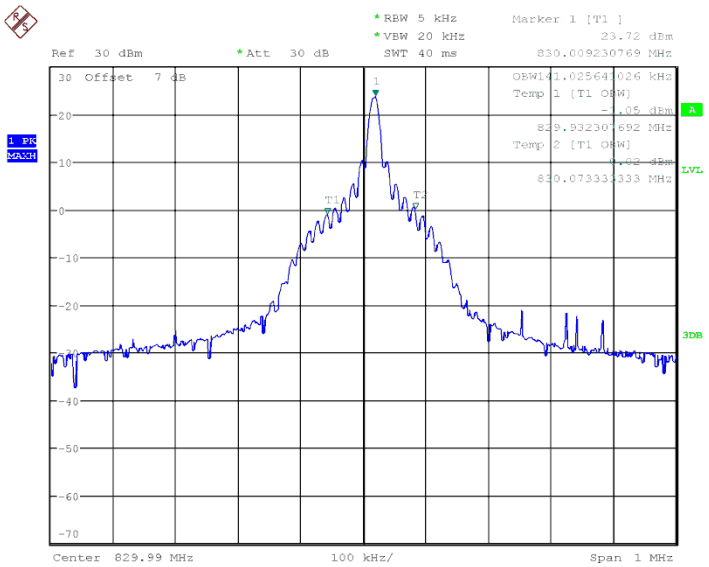
NB-IoT standalone band 5 20649 QPSK (99% BW)



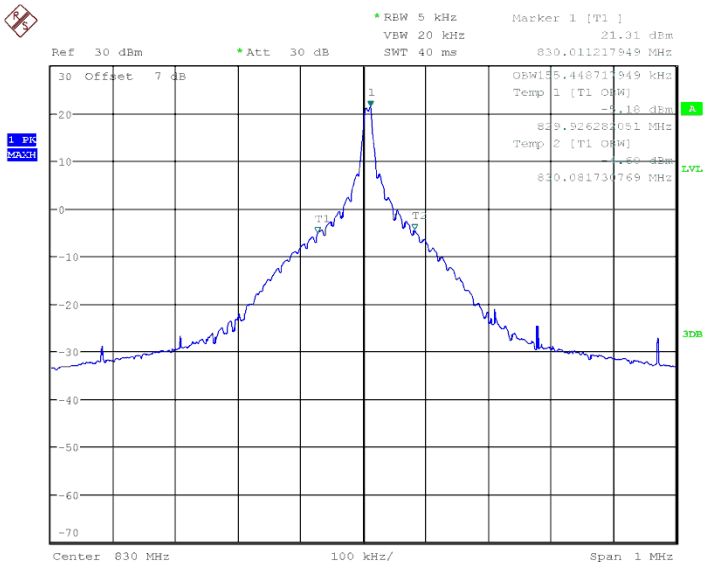
NB-IoT standalone band 5 20649 BPSK (99% BW)



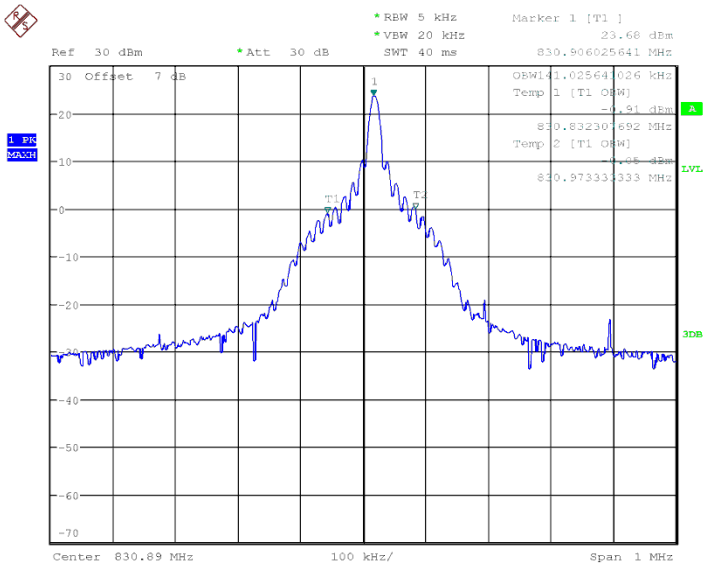
NB-IoT in-band band 5 20406 QPSK (99%)



NB-IoT in-band band 5 20406 BPSK (99%)



NB-IoT in-band band 5 20460 QPSK (99%)



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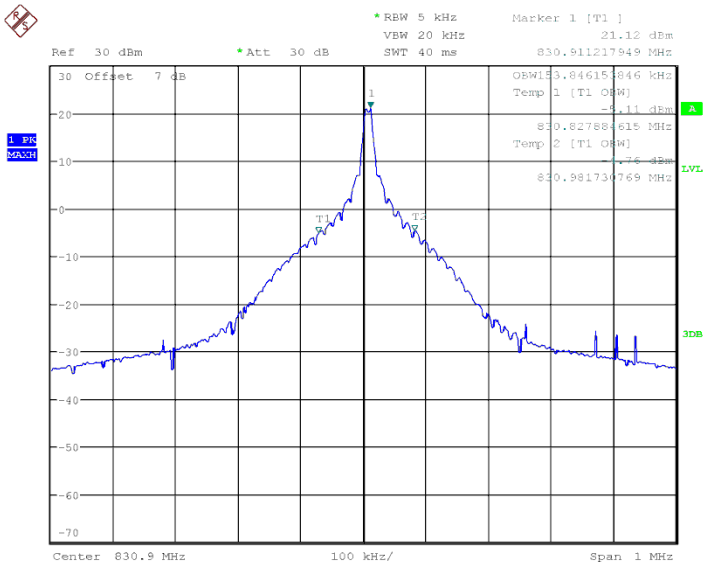
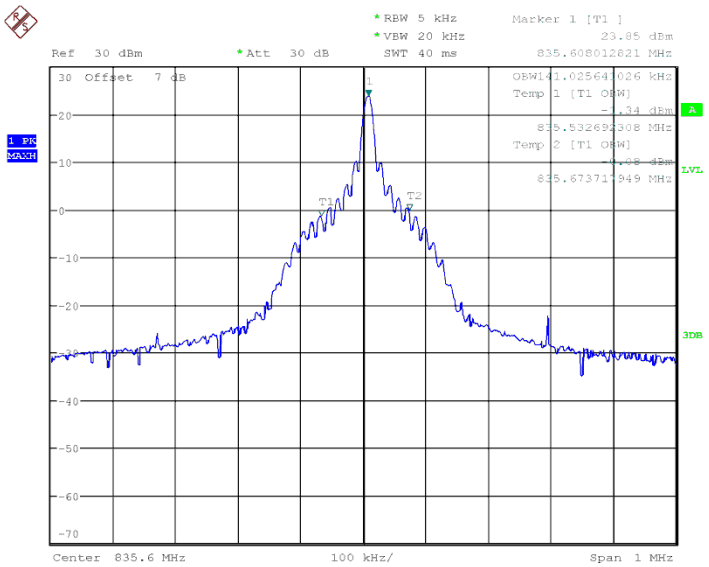


NB-IoT in-band band 5 20469 QPSK (99%)



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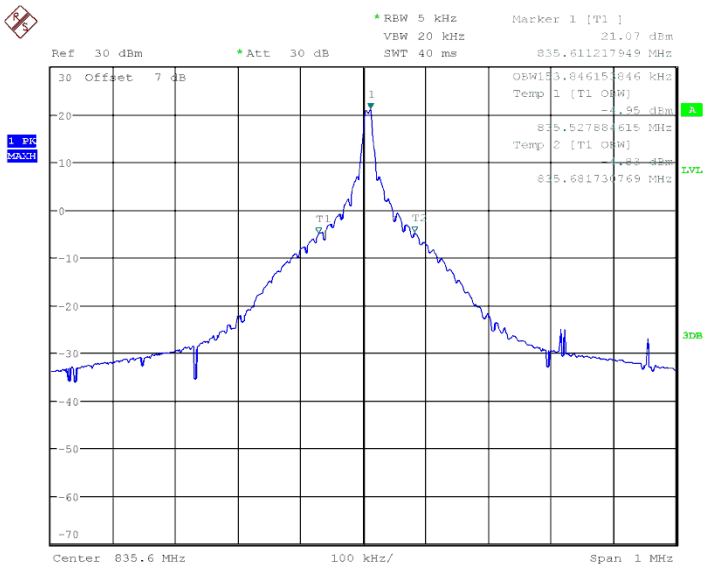
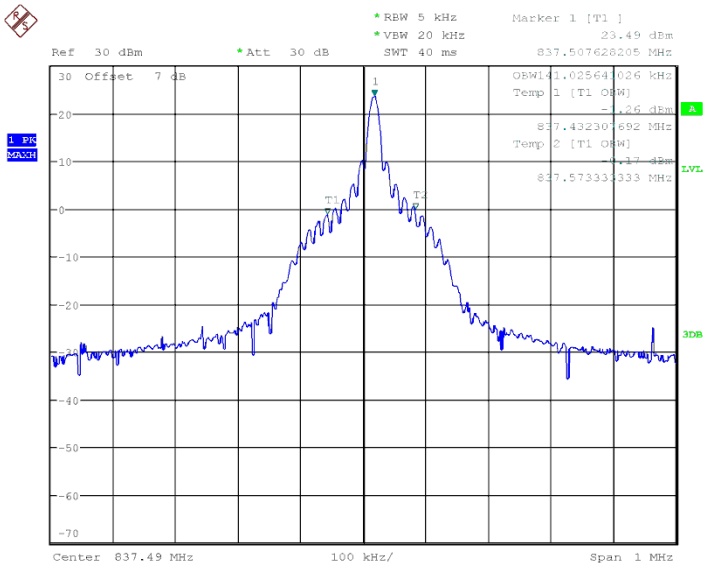
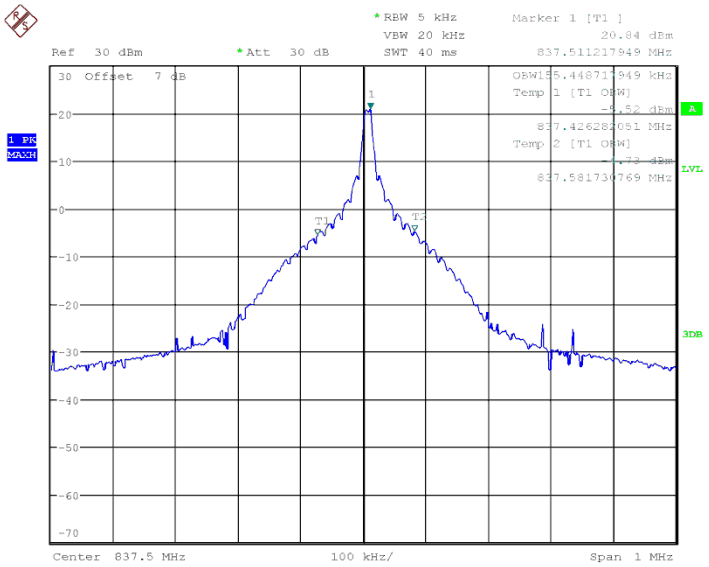


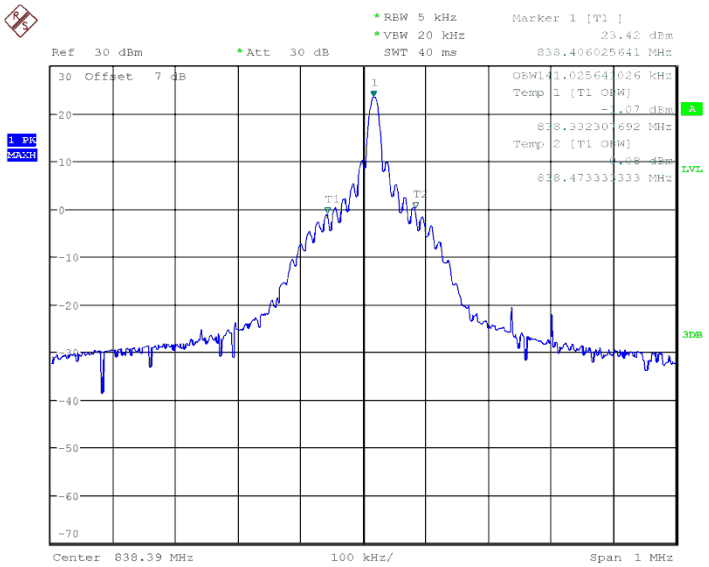
NB-IoT in-band band 5 20516 QPSK (99%)



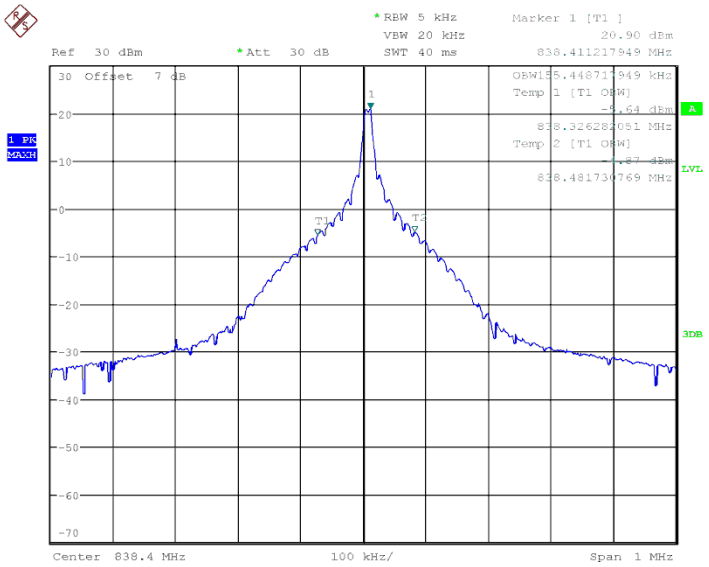
NB-IoT in-band band 5 20516 BPSK (99%)



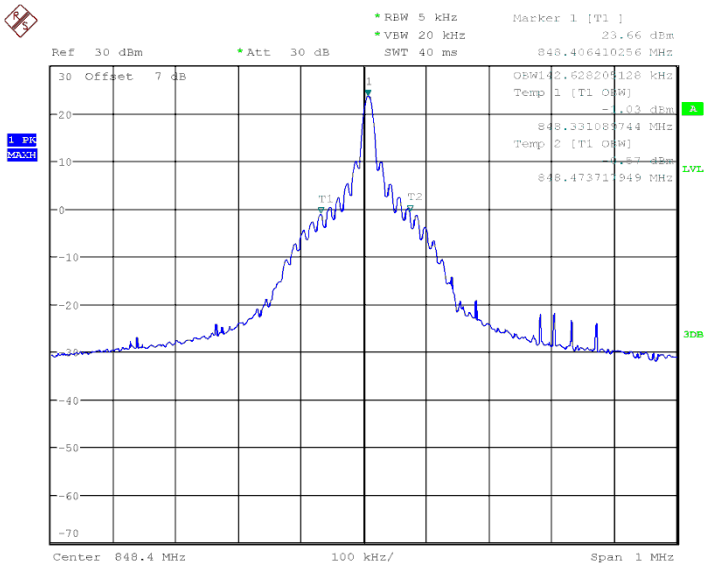
NB-IoT in-band band 5 20535 QPSK (99%)



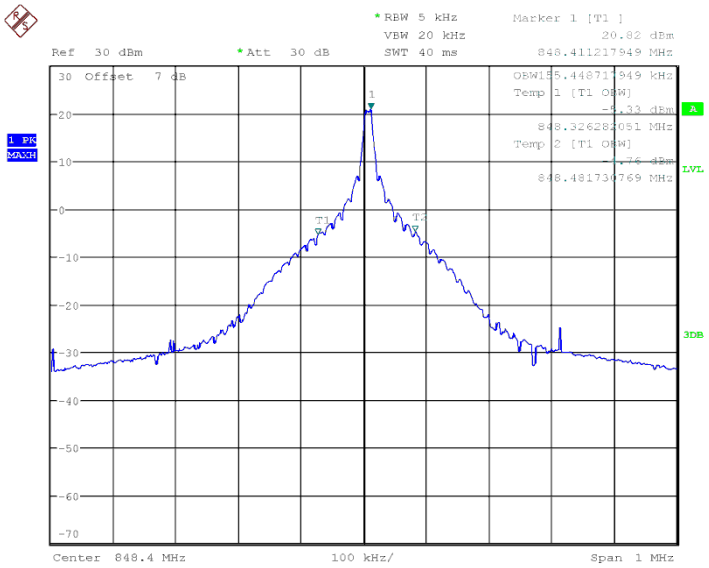
NB-IoT in-band band 5 20535 BPSK (99%)



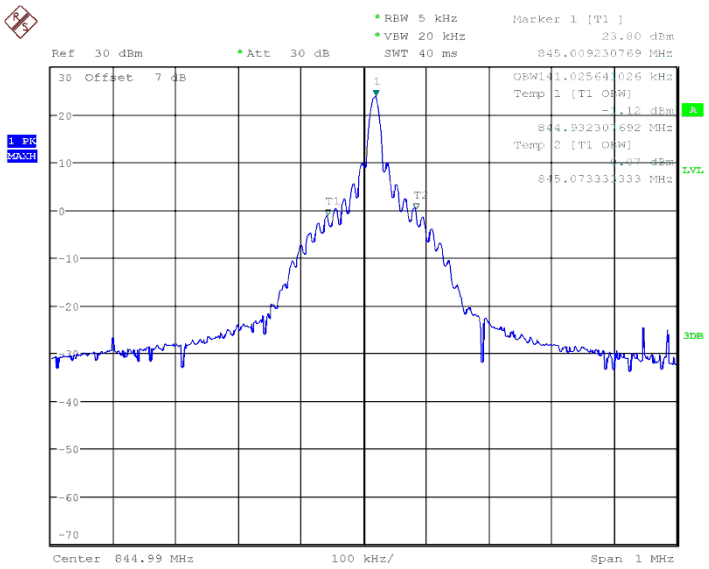
NB-IoT in-band band 5 20544 QPSK (99%)



NB-IoT in-band band 5 20544 BPSK (99%)



NB-IoT in-band band 5 20610 QPSK (99%)



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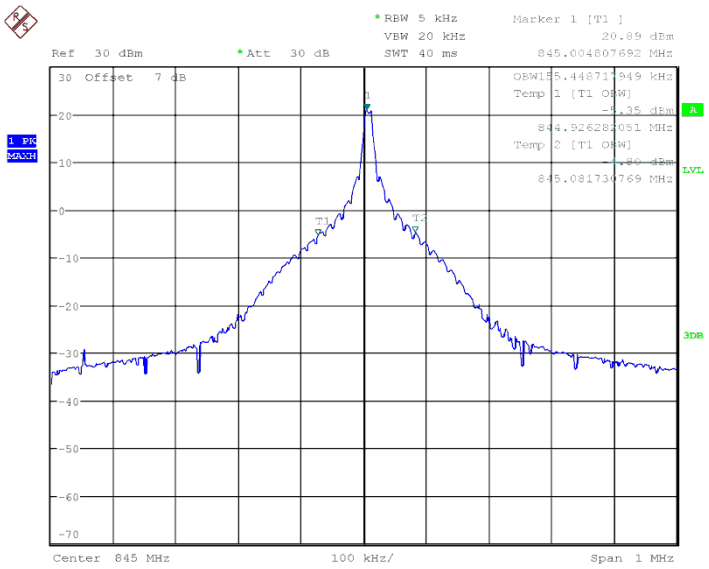
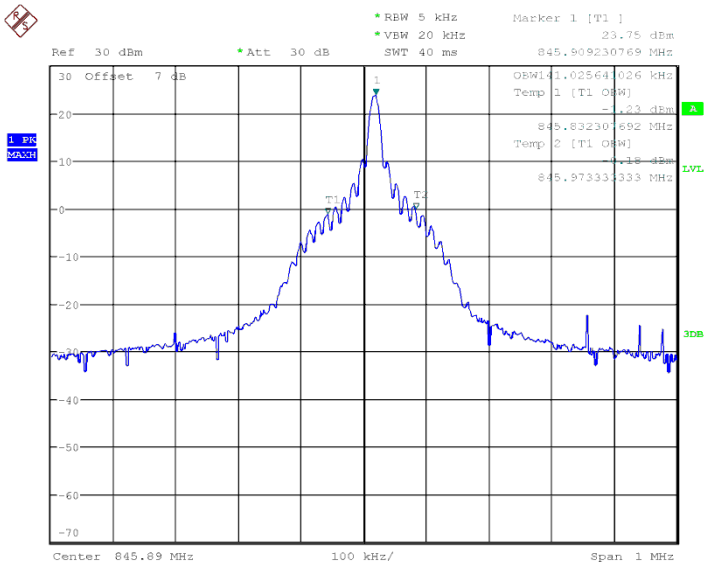
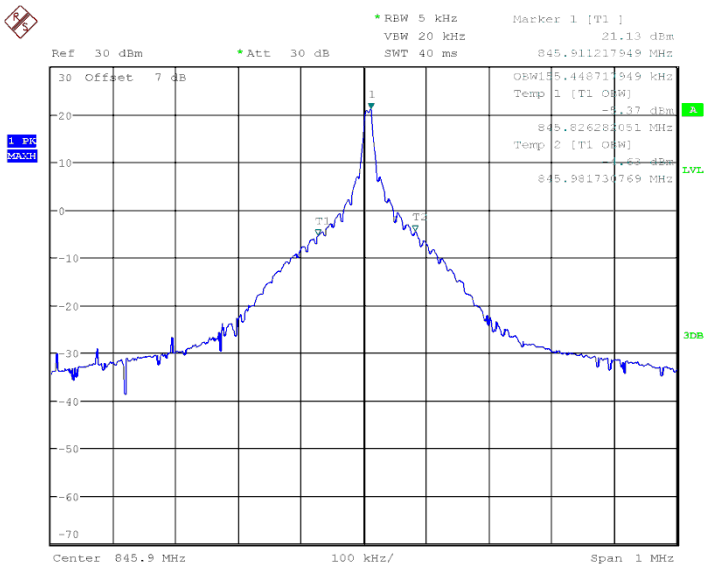


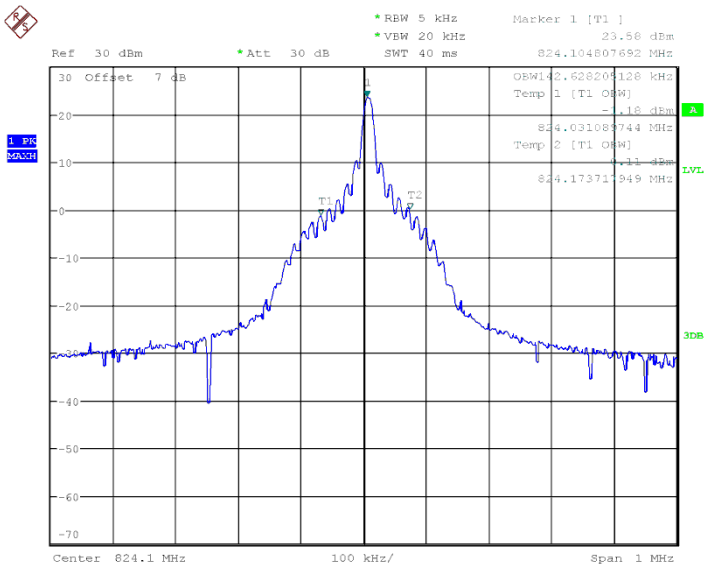
NB-IoT in-band band 5 20619 QPSK (99%)



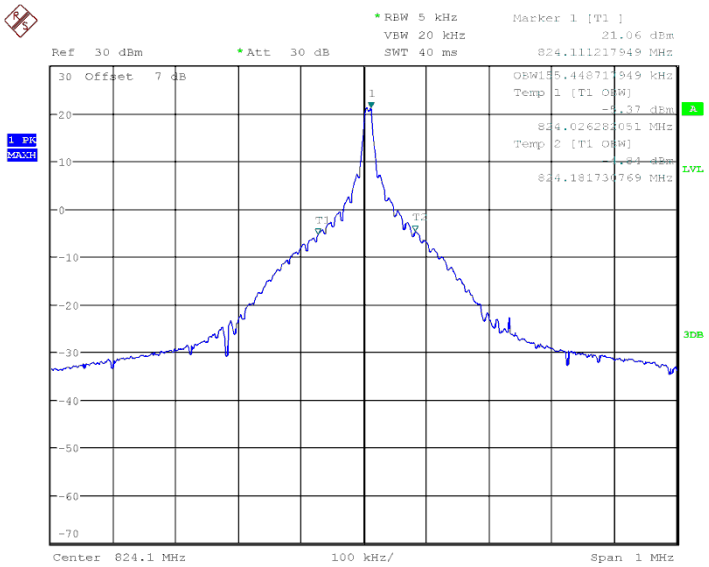
NB-IoT in-band band 5 20619 BPSK (99%)



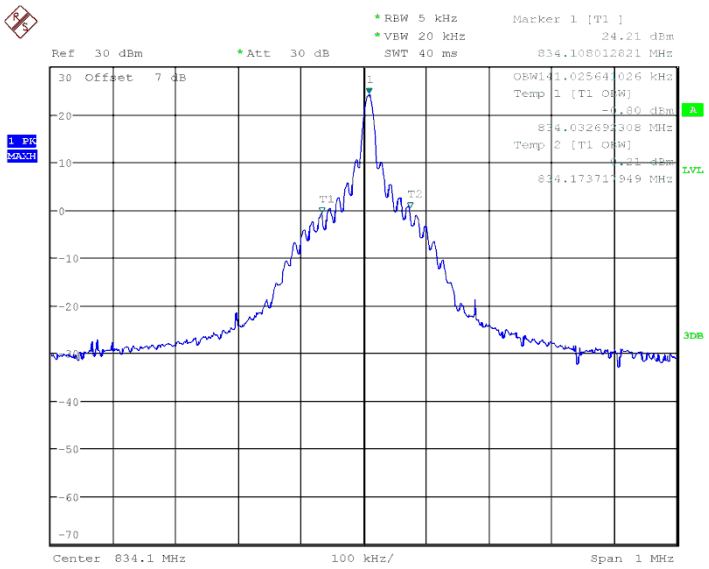
NB-IoT guard-band band 5 20401 QPSK (99%)



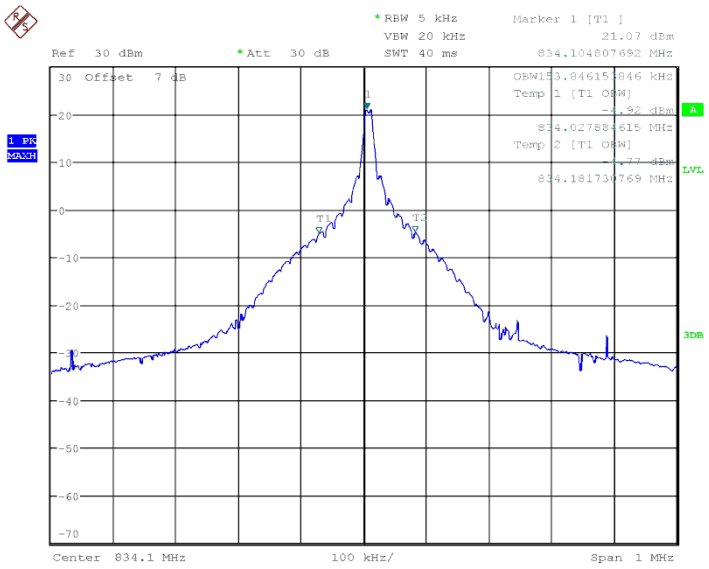
NB-IoT guard-band band 5 20401 BPSK (99%)



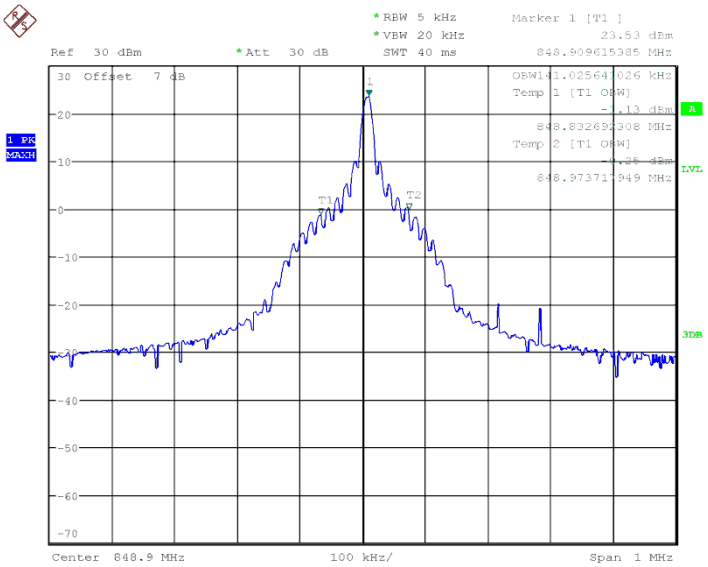
NB-IoT guard-band band 5 20501 QPSK (99%)



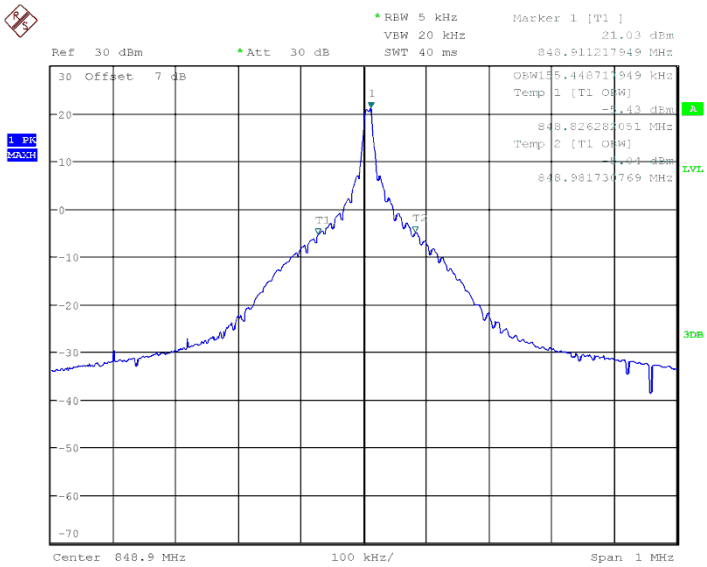
NB-IoT guard-band band 5 20501 BPSK (99%)



NB-IoT guard-band band 5 20649 QPSK (99%)



NB-IoT guard-band band 5 20649 BPSK (99%)



ANNEX A.5. EMISSION BANDWIDTH

Reference

FCC: CFR Part 22.917(b),24.238(a), 27.53(g),27.53(h), 27.53(m)

A.5.1Emission Bandwidth Results

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. Table below lists the measured -26dBc BW. Spectrum analyzer plots are included on the following pages.

NBIOT band 5, 200KHz (-26dBc)

NB-IoT standalone Test frequencies for operating band 5(-26dBc)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (-26dBc)(kHz)	Occupied Bandwidth (-26dBc)(kHz)
			QPSK	BPSK
Mid Range	20525	836.5	123.397	139.423

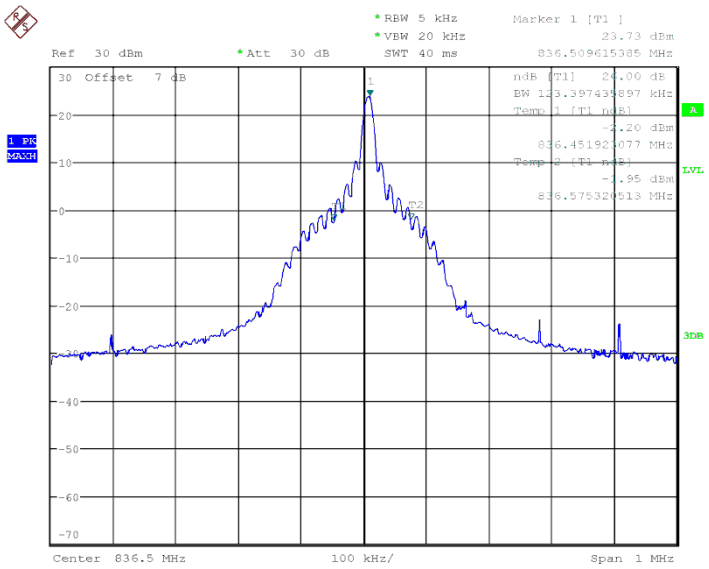
NB-IoT in-band Test frequencies for operating band 5(-26dBc)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (-26dBc)(kHz)	Occupied Bandwidth (-26dBc)(kHz)
			QPSK	BPSK
Mid Range1	20516	835.6	123.397	139.423
Mid Range2	20535	837.49	112.179	139.423
Mid Range3	20544	838.39	112.179	139.423

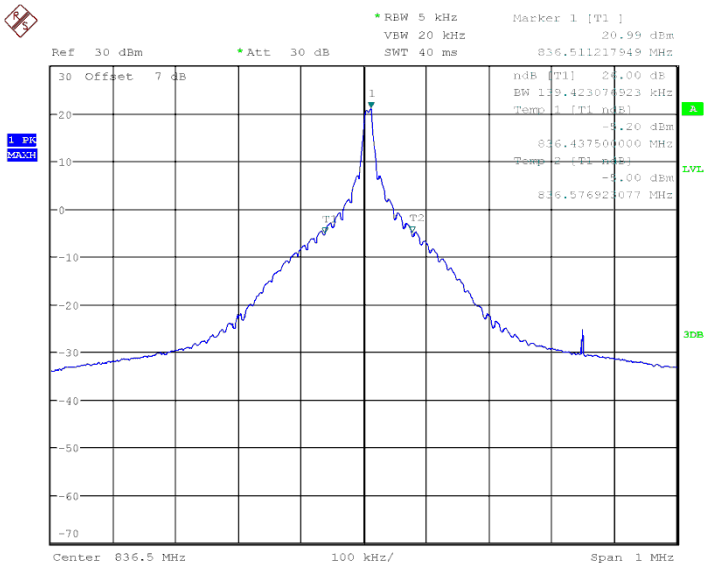
NB-IoT guard-band Test frequencies for operating band 5(-26dBc)

Test Frequency ID	N_{UL}	Frequency (MHz)	Occupied Bandwidth (-26dBc)(kHz)	Occupied Bandwidth (-26dBc)(kHz)
			QPSK	BPSK
Mid Range	20501	834.1	110.576	137.820

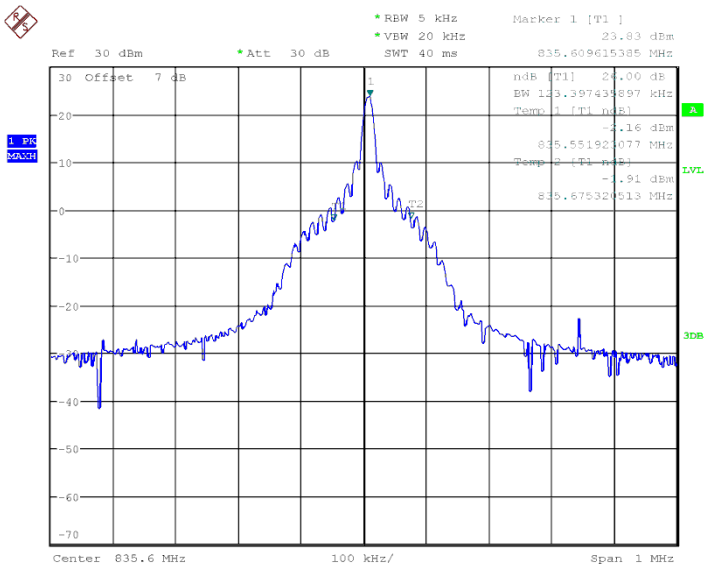
NB-IoT standalone band 5 20525 QPSK(-26dBc)



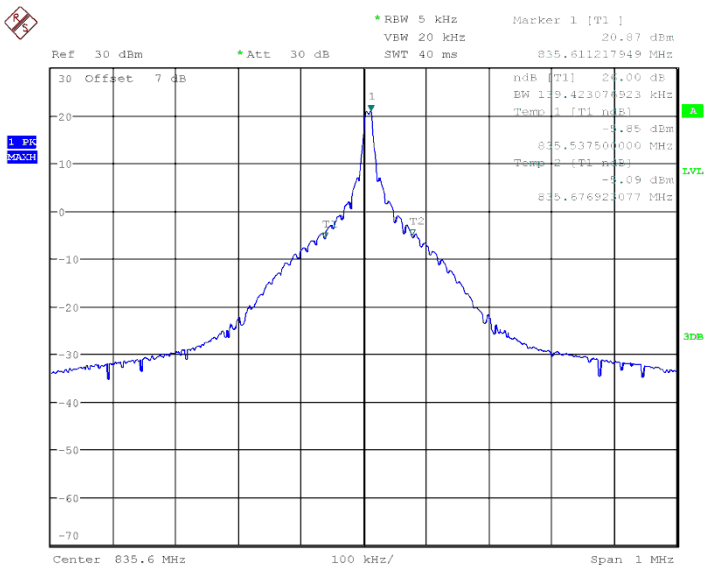
NB-IoT standalone band 5 20525 BPSK(-26dBc)



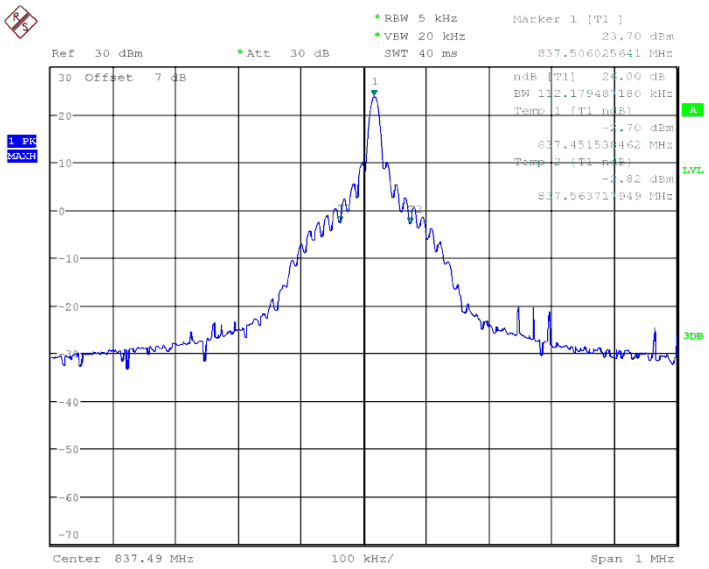
NB-IoT in-band band 5 20516 QPSK (-26dBc)



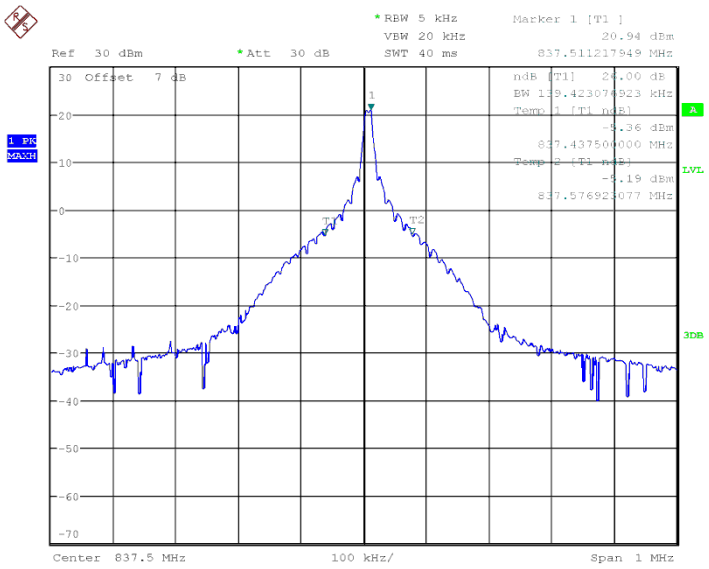
NB-IoT in-band band 5 20516 BPSK (-26dBc)



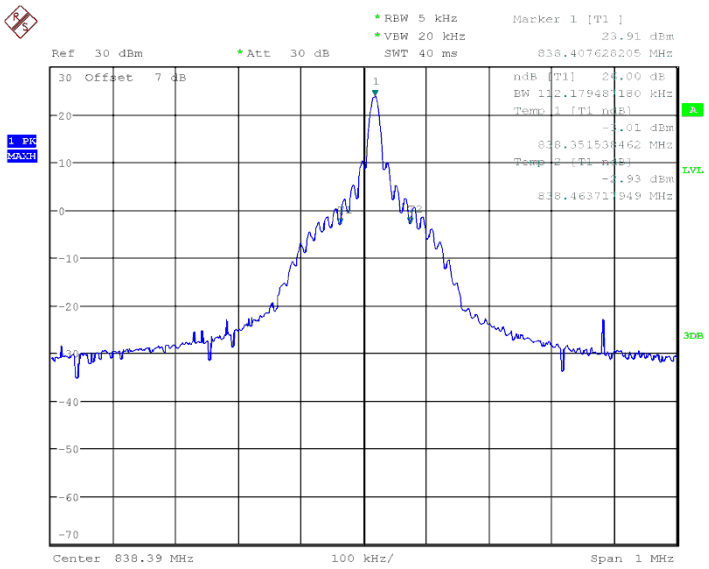
NB-IoT in-band band 5 20535 QPSK (-26dBc)



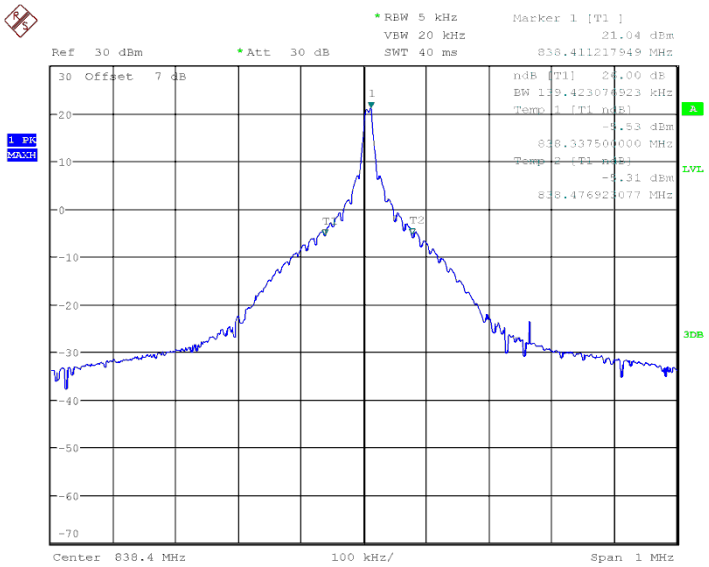
NB-IoT in-band band 5 20535 BPSK (-26dBc)



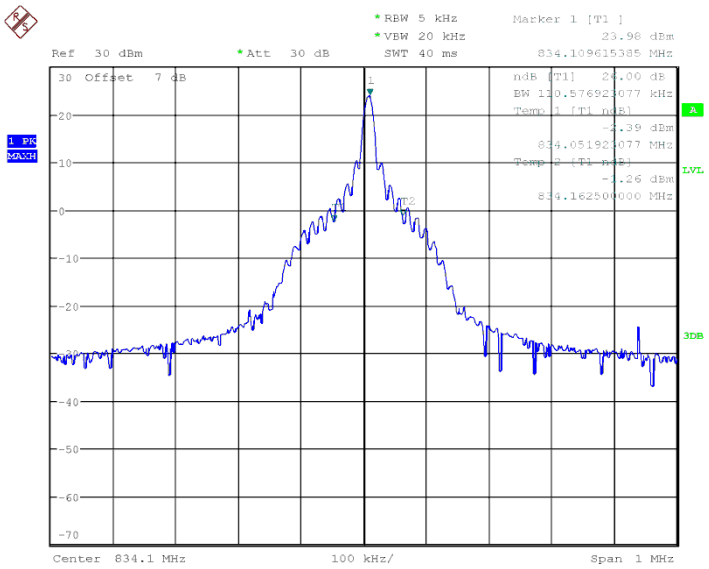
NB-IoT in-band band 5 20544 QPSK (-26dBc)



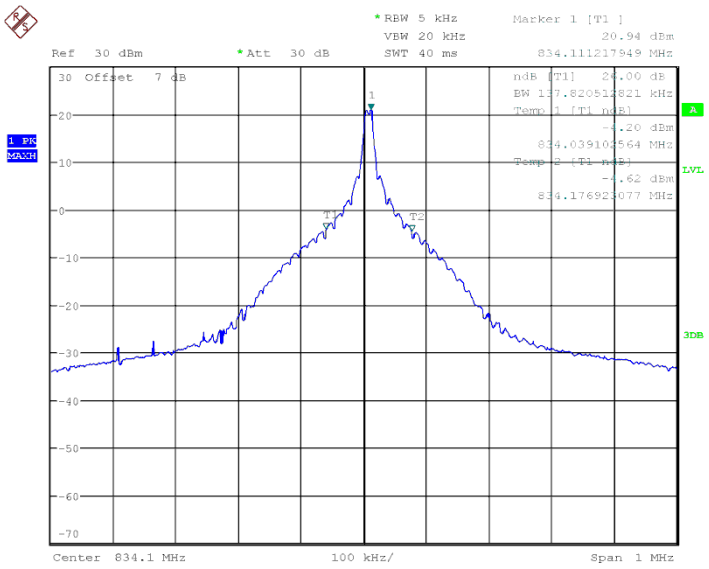
NB-IoT in-band band 5 20544 BPSK (-26dBc)



NB-IoT guard-band band 5 20501 QPSK (-26dBc)



NB-IoT guard-band band 5 20501 BPSK (-26dBc)



ANNEX A.6. BAND EDGE COMPLIANCE

Reference

FCC: CFR Part 22.917(b),24.238(a), 27.53(g),27.53(h), 27.53(m)

A.6.1 Measurement limit

Part 22.917(b),24.238(a), 27.53(g),27.53(h), 27.53(m) state that on any frequency outside frequency band of the US Cellular/PCS spectrum, the power of any emission shall be attenuated below the transmitter power (P, in Watts) by at least 43+10Log (P) dB. For all power levels +30 dBm to 0 dBm, this becomes a constant specification limit of -13 dBm.

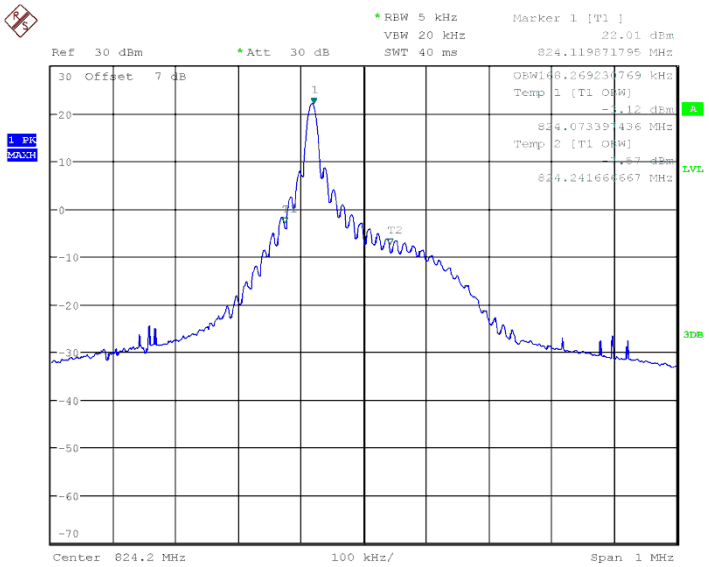
According to KDB 971168 6.0, a relaxation of the reference bandwidth is often provided for measurements within a specified frequency range at the edge of the authorized frequency block/band. This is often implemented by permitting the use of a narrower RBW (typically limited to a minimum RBW of 1% of the OBW) for measuring the out-of-band emissions without a requirement to integrate the result over the full reference bandwidth.

Part 27.53(m) states that for mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

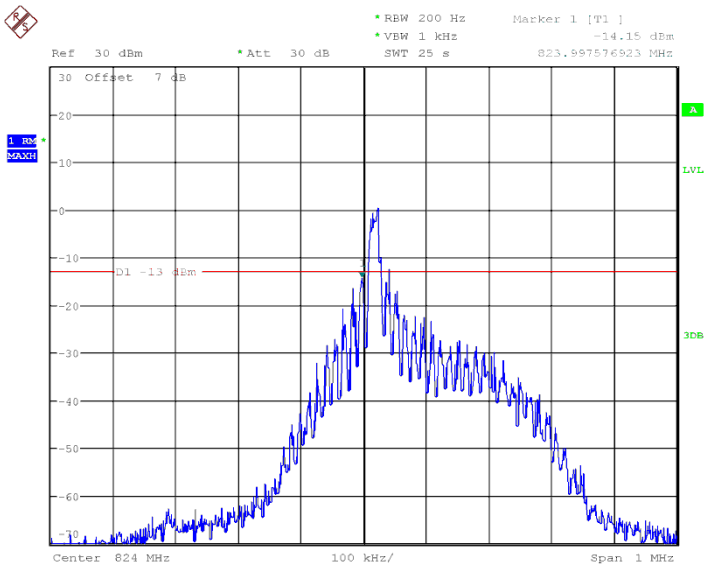
A.6.2 Measurement result

NB-IoT in-band Test frequencies for operating band 5

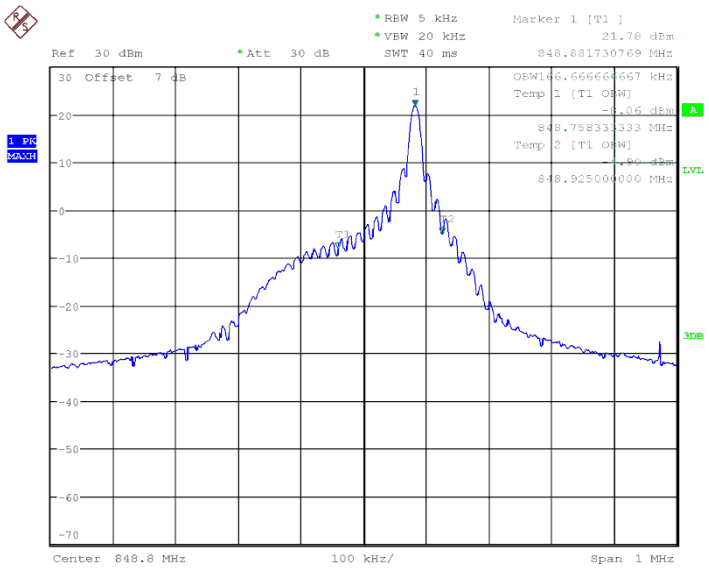
OBW: low channel 20402



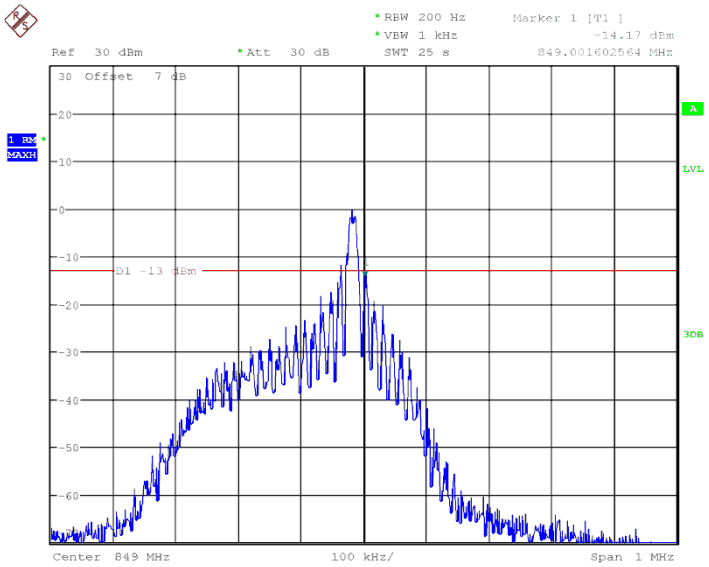
LOW BAND EDGE



OBW: high channel 20648



HIGH BAND EDGE



ANNEX A.7. CONDUCTED SPURIOUS EMISSION

Reference

FCC: CFR Part 22.917(b),24.238(a), 27.53(g),27.53(h), 27.53(m)

A.7.1 Measurement Method

The following steps outline the procedure used to measure the conducted emissions from the EUT.

1. Determine frequency range for measurements: From CFR 2.1057 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 13 MHz to 9 GHz, data taken from 10 MHz to 25 GHz.
2. Determine EUT transmit frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.
3. The number of sweep points of spectrum analyzer is set to 30001 which is greater than span/RBW.

A. 7.2 Measurement Limit

Part 22.917(b),24.238(a), 27.53(g),27.53(h), 27.53(m) specify that the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

The specification that emissions shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB, translates in the relevant power range (1 to 0.001 W) to -13 dBm. At 1 W the specified minimum attenuation becomes 43 dB and relative to a 30 dBm (1 W) carrier becomes a limit of -13 dBm. At 0.001 W (0 dBm) the minimum attenuation is 13 dB, which again yields a limit of -13 dBm. In this way a translation of the specification from relative to absolute terms is carried out.

Part 27.53(m)(4) specifies for mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

22GHz≤ f ≤26GHz	2.20

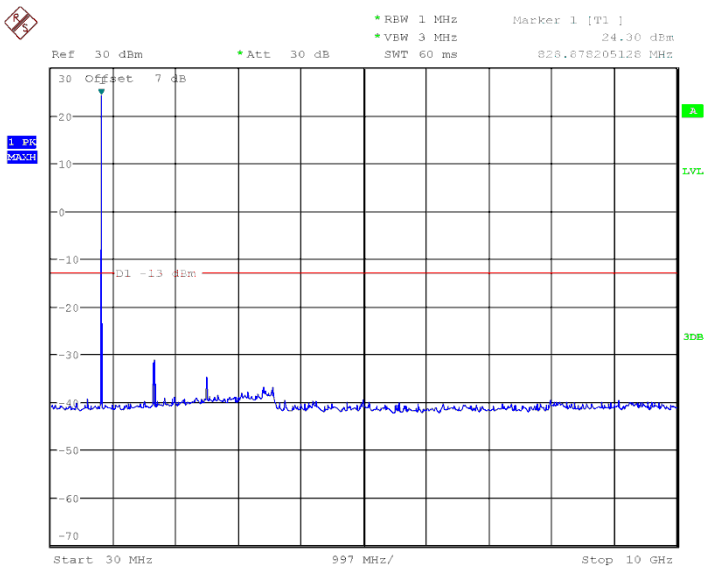
Measurement Uncertainty:

Frequency Range	Uncertainty
30MHz≤ f ≤2GHz	0.63

2GHz≤ f ≤3.6GHz	0.82
3.6GHz≤ f ≤8GHz	1.55
8GHz≤ f ≤20GHz	1.86
20GHz≤ f ≤22GHz	1.90

A. 7.3 Measurement result

Only worst case result is given below



NBIOT band 5: 30MHz – 10GHz

Spurious emission limit –13dBm.

ANNEX A.8. PEAK-TO-AVERAGE POWER RATIO

Reference

FCC: CFR Part 24.232 (d), 27.50(a)

The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB. The PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that PAPR will not exceed 13 dB for more than 0.1 percent of the time or other Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

According to KDB 971168 v02r02 5.7.1:

a)Refer to instrument's analyzer instruction manual for details on how to use the power statistics/CCDF function;

b) Set resolution/measurement bandwidth ⩾ signal' s occupied bandwidth;

c) Set the number of counts to a value that stabilizes the measured CCDF curve;

d) Set the measurement interval to 1 ms

e)Record the maximum PAPR level associated with a probability of 0.1%

A.8.1 Measurement limit

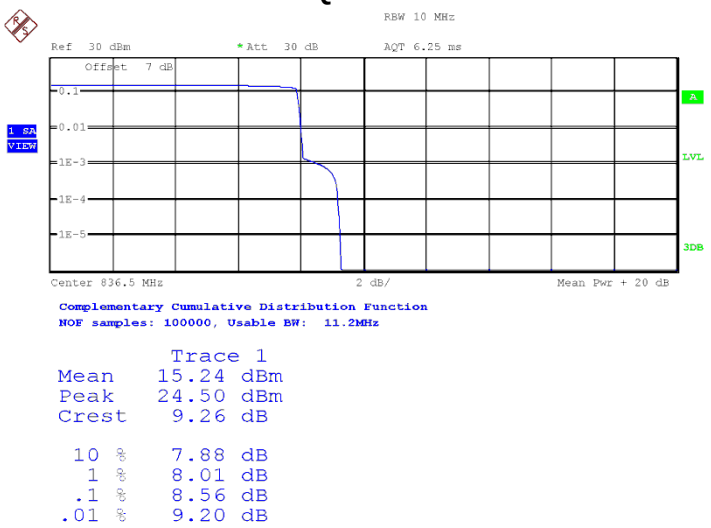
not exceed 13 dB

A.8.2 Measurement results

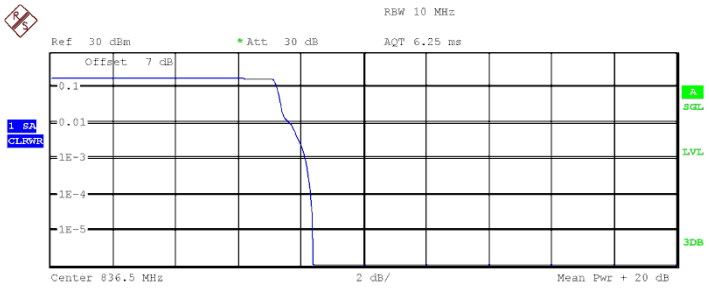
NBIOT band 5, 200KHz

Frequency(MHz)	PAPR(dB)	PAPR(dB)
836.5	QPSK	BPSK
	8.56	8.14

PEAK-TO-AVERAGE POWER RATIO for QPSK



PEAK-TO-AVERAGE POWER RATIO for BPSK



Complementary Cumulative Distribution Function
NOF samples: 100000, Usable BW: 11.2MHz

	Trace 1
Mean	14.57 dBm
Peak	22.95 dBm
Crest	8.38 dB
10 %	7.24 dB
1 %	7.66 dB
.1 %	8.14 dB
.01 %	8.33 dB

ANNEX B. Deviations from Prescribed Test Methods

No deviation from Prescribed Test Methods.

************End The Report************