TEST REPORT

No. I19Z61503-WMD01

for

SIMCom Wireless Solutions Limited

NB-IoT Wireless Module

Model Name: SIM7020G

FCC ID: 2AJYU-8FCA101

with

Hardware Version: V4.02

Software Version: 1910B01SIM7020G

Issued Date: 2019-08-29

TESTING
NVLAP LAB CODE 600118-0

Note:

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The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S.Government.

Test Laboratory:

CTTL, Telecommunication Technology Labs, CAICT

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REPORT HISTORY

Report Number	Revision	Description	Issue Date
I19Z61503-WMD01	Rev.0	1st edition	2019-08-29

CONTENTS

1. Test Laboratory

1.1. Introduction & Accreditation

Telecommunication Technology Labs, CAICT is an ISO/IEC 17025:2005 accredited test laboratory under NATIONAL VOLUNTARY LABORATORY ACCREDITATION PROGRAM (NVLAP) with lab code 600118-0, and is also an FCC accredited test laboratory (CN5017), and ISED accredited test laboratory (CN0066). The detail accreditation scope can be found on NVLAP website.

1.2. Testing Location

Location 1: CTTL(huayuan North Road)

Address: No. 52, Huayuan North Road, Haidian District, Beijing, P. R. China 100191

Location 2: CTTL(Shouxiang)

Address: No. 51 Shouxiang Science Building, Xueyuan Road, Haidian District, Beijing, P. R. China 100191

Location 3:CTTL (BDA)

Address: No.18A, Kangding Street, Beijing Economic-Technology Development Area, Beijing, P. R. China 100176

1.3. Testing Environment

Normal Temperature: 15-35℃

Relative Humidity: 20-75%

1.4. Project data

Testing Start Date: 2019-08-19

Testing End Date: 2019-08-29

1.5. Signature

Dong Yuan

(Prepared this test report)

Zhou Yu

(Reviewed this test report)

Zhao Hui Lin

Deputy Director of the laboratory

(Approved this test report)

2. Client Information

2.1. Applicant Information

Company Name:	SIMCom Wireless Solutions Limited
Address /Post:	Bldg. B, SIM Technology Bldg.,No.633, Jinzhong Rd, Changning Dist., Shanghai, P.R.China,
Contact:	/
Email:	Yongsheng.li@simcom.com
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2.2. Manufacturer Information

Company Name:	SIMCom Wireless Solutions Limited
Address /Post:	Bldg. B, SIM Technology Bldg.,No.633, Jinzhong Rd, Changning Dist., Shanghai, P.R.China,
Contact:	/
Email:	Yongsheng.li@simcom.com
Telephone:	021-32523423
Fax:	021-32523020

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

3.1. About EUT

Description	NB-IoT Wireless Module
Model Name	SIM7020G
FCC ID	2AJYU-8FCA101
Antenna	External
Output power	26.14dBm maximum ERP measured for NB-IoT band 26
Extreme vol. Limits	3.0VDC to 3.3VDC (nominal: 3.6VDC)
Extreme temp. Tolerance	-30°C to +50°C

Note: Components list, please refer to documents of the manufacturer; it is also included in the original test record of CTTL.

3.2. Internal Identification of EUT used during the test

EUT ID*	IMEI	HW Version	SW Version	Date of receipt
UT03a	868334032569210	V4.02	1910B01SIM7020G	2019-08-15
UT04a	868334032570255	V4.02	1910B01SIM7020G	2019-08-15

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

3.3. General Description

The Equipment Under Test (EUT) is a model of NB-IoT Wireless Module with external antenna. Manual and specifications of the EUT were provided to fulfil the test.

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 90	PRIVATE LAND MOBILE RADIO SERVICES	10-1-18 Edition
ANSI/TIA-603-E	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards	2016
ANSI/TIA-102.CAAA-E	DIGITAL C4FMCQPSK TRANSCEIVER MEASUREMENT METHODS	2016
ANSI C63.26	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services	2015
KDB 971168 D01	MEASUREMENT GUIDANCE FOR CERTIFICATION OF LICENSED DIGITAL TRANSMITTERS	v03r01

5. LABORATORY ENVIRONMENT

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

Temperature	Min. = 15 ˚C, Max. = 35 ˚C
Relative humidity	Min. =20 %, Max. = 80 %
Shielding effectiveness	> 110 dB
Electrical insulation	>2 MΩ
Ground system resistance	< 0.5 Ω

Fully-anechoic chamber 2 (8.6 meters×6.1 meters×3.85 meters) did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ˚C, Max. = 30 ˚C
Relative humidity	Min. = 35 %, Max. = 60 %
Shielding effectiveness	> 110 dB
Electrical insulation	>2 MΩ
Ground system resistance	< 1 Ω
Site voltage standing-wave ratio (S_{VSWR})	Between 0 and 6 dB, from 1GHz to 18GHz
Uniformity of field strength	Between 0 and 6 dB, from 80 to 4000 MHz

Semi-anechoic chamber 2 / Fully-anechoic chamber 3 (10 meters×6.7 meters×6.15 meters) did not exceed following limits along the EMC testing:

Temperature	Min. = 15 ˚C, Max. = 30 ˚C
Relative humidity	Min. = 35 %, Max. = 60 %
Shielding effectiveness	> 100 dB
Electrical insulation	>2 MΩ
Ground system resistance	< 0.5 Ω
Normalised site attenuation (NSA)	<±3.5 dB, 3 m distance
Site voltage standing-wave ratio (S_{VSWR})	Between 0 and 6 dB, from 1GHz to 18GHz
Uniformity of field strength	Between 0 and 6 dB, from 80 to 3000 MHz

6. SUMMARY OF TEST RESULT

6.1. Summary of test results

NB-IoT Band 26(814MHz~824MHz)

Items	Test Name	Clause in FCC rules	Verdict
1	Output Power	90.635	P
2	Emission Limit	2.1051/90.691	P
3	Frequency Stability	2.1055	P
4	Occupied Bandwidth	2.1049	P
5	Emission Bandwidth	2.1049	P
6	Band Edge Compliance	90.691	P
7	Conducted Spurious Emission	90.691	P

Terms used in Verdict column

P	Pass. The EUT complies with the essential requirements in the standard.
NP	Not Performed. The test was not performed by CTTL.
NA	Not Applicable.The test was not applicable.
BR	Re-use test data from basic model report.
F	Fail. The EUT does not comply with the essential requirements in the standard.

6.2. Statements

The test cases listed in section 6.1 of this report for the EUT specified in section 3 were performed by CTTL according to the standards or reference documents in section 4.1

The EUT met all applicable requirements of the standards or reference documents in section 4.1.

This report only deals with the NB-IOT functions among the features described in section 3.

7. Test Equipments Utilized

NO.	Description	TYPE	series number	MANUFACTURE	CAL DUE DATE	Calibration interval
1	Universal Radio Communication Tester	SP8315	SP8315-1271	Starpoint	2020-07-12	1 year
2	Signal Generator	SMF100A	101295	R&S	2019-11-27	1 year
3	EMI Antenna	3117	00058889	ETS-Lindgren	2020-02-02	1 year
4	EMI Antenna	3117	00119024	ETS-Lindgren	2020-02-25	1 year
5	Radio Communication Analyzer	MT8821C	6201763159	Anritsu	2020-07-23	1 year
6	Spectrum Analyzer	FSU26	200030	R&S	2020-06-03	1 year
7	EMI Antenna	VULB9163	9163-235	Schwarzbeck	2019-11-20	1 year
8	Signal Generator	SMF100A	101295	R&S	2019-11-27	1 year
9	Climate chamber	SH-242	93008556	ESPEC	2019-12-21	2 year

ANNEX A: MEASUREMENT RESULTS

A.1 OUTPUT POWER

A.1.1 Summary

During the process of testing, the EUT was controlled via Anritsu MT8821C Radio Communication Analyzer 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

NB-IoT band 26(814MHz~824MHz) standalone

Subcarrier Spacing	Subcarrier number/offset	Frequency (MHz)	Power(dBm)	
			BPSK	QPSK
3.75kHz	1@47	823.90	22.20	22.18
		814.10	22.14	22.12
	1@0	823.90	22.29	22.22
		814.10	22.23	22.18
15kHz	1@11	823.90	22.16	22.09
		814.10	22.18	22.13
	1@0	823.90	22.10	22.01
		814.10	22.04	22.01
	12@0	823.90	-	20.51
		814.10	-	20.47

NB-IoT band 26(814MHz~824MHz) guard-band

Subcarrier Spacing	Subcarrier number/offset	Frequency (MHz)	Power(dBm)	
			BPSK	QPSK
3.75kHz	1@47	823.90	22.80	22.77
		814.10	22.87	22.86
	1@0	823.90	22.85	22.78
		814.10	22.93	22.82
15kHz	1@11	823.90	22.79	22.72
		814.10	22.88	22.82
	1@0	823.90	22.71	22.70
		814.10	22.76	22.71
	12@0	823.90	-	20.64
		814.10	-	20.65

NB-IoT band 26(814MHz~824MHz) in-band-same PCI

Subcarrier Spacing	Subcarrier number/offset	Frequency (MHz)	Power(dBm)	
			BPSK	QPSK
3.75kHz	1@47	823.86	22.83	22.79
		814.14	22.82	22.80
	1@0	823.86	22.86	22.85
		814.14	22.81	22.78
15kHz	1@11	823.86	22.82	22.71
		814.14	22.86	22.81
	1@0	823.86	22.77	22.68
		814.14	22.83	22.82
	12@0	823.86	-	20.62
		814.14	-	20.66

NB-IoT band 26(814MHz~824MHz) in-band-different PCI

Subcarrier Spacing	Subcarrier number/offset	Frequency (MHz)	Power(dBm)	
			BPSK	QPSK
3.75kHz	1@47	823.86	22.92	22.88
		814.14	22.81	22.79
	1@0	823.86	22.93	22.87
		814.14	22.90	22.85
15kHz	1@11	823.86	22.70	22.64
		814.14	22.89	22.80
	1@0	823.86	22.64	22.51
		814.14	22.86	22.78
	12@0	823.86	-	20.51
		814.14	-	20.56

A.1.3 Radiated

A.1.3.1 Description

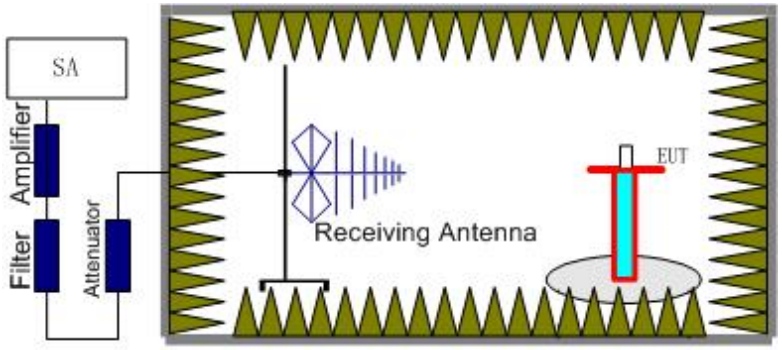
This is the test for the maximum radiated power from the EUT.

Rule Part 90.635(b) specifies “The maximum output power of the transmitter for mobile stations is 100 watts(50dBm)”.

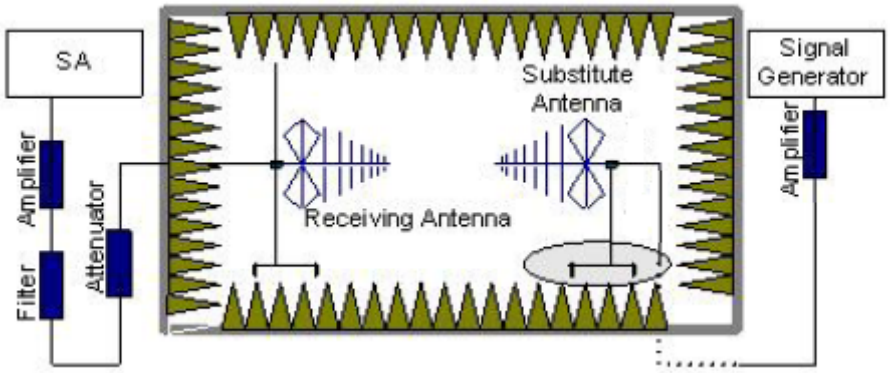
A.1.3.2 Method of Measurement

The measurements procedures in TIA-603E-2016 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

NB-IoT band 26 - ERP

Limits: ≤50.00dBm (100W)

NB-IoT band 26 in-band-different PCI_3.75kHz_BPSK

Frequency(MHz)	P_{Mea}(dBm)	P_{cl}(dB)	P_{Ag}(dB)	G_a (dBi)	Correction (dB)	ERP(dBm)	Limit(dBm)	Margin(dB)	Polarization
814.10	-17.02	2.13	45.86	0.89	2.15	25.45	50.00	24.55	H
819.00	-16.56	2.19	45.84	1.05	2.15	25.99	50.00	24.01	H
823.90	-15.81	2.24	45.79	0.55	2.15	26.14	50.00	23.86	H

Peak ERP(dBm) = P_{Mea}(-17.02dBm) - G_a (0.89dBi) - P_{Ag} (45.86dB) - P_{cl} (2.13dB) -2.15= 25.45dBm

Note: The measurement is performed for both horizontal and vertical antenna polarization and different modulations, only the data of worst mode is recorded in this report.

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.

Note: Expanded measurement uncertainty is U = 2.84 dB, k = 2.

A.2 EMISSION LIMIT

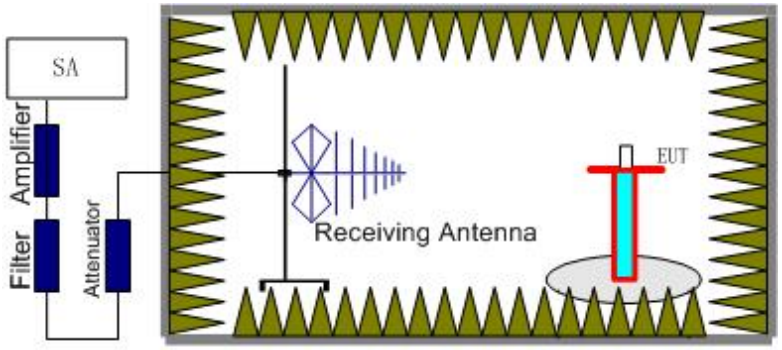
A.2.1 Measurement Method

The measurements procedures in TIA-603E-2016 are used. This measurement is carried out in fully-anechoic chamber FAC-3.

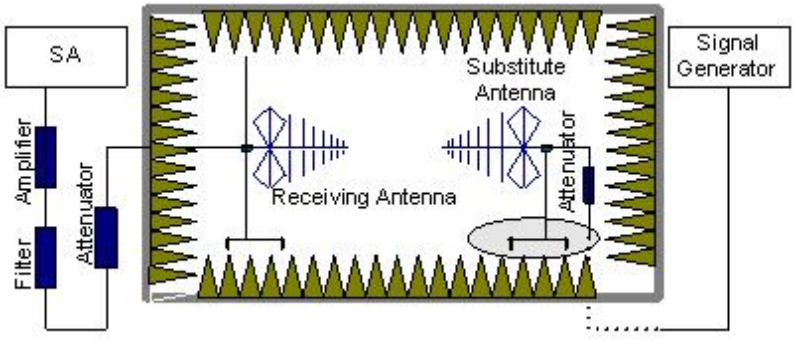
The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier. The resolution bandwidth is set 1MHz. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the NB-IoT band 26.

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 90.691 states that out-of-band emission requirement shall apply only to the ‘‘outer’’ channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:For any frequency removed from the EA licensee’s frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $116\text{Log}_{10}(f/6.1)$ decibels or 50 + 10 $\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz. For any frequency removed from the EA licensee’s frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + $10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

A.2.3 Measurement Results

Radiated emissions measurements were made only at the upper, middle, and lower carrier frequencies of the NB-IoT band 26. 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 NB-IoT band 26 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.

NB-IoT band 26, BPSK, Channel 26691

Frequency(MHz)	P_{Mea}(dBm)	Path Loss(dB)	Antenna Gain(dBi)	Correction (dB)	Peak ERP(dBm)	Limit (dBm)	Margin(dB)	Polarization
1628.01	-45.89	3.55	5.27	2.15	-46.32	-13.00	33.32	V
2436.50	-35.00	4.56	5.91	2.15	-35.80	-13.00	22.80	V
3256.02	-39.10	5.28	7.61	2.15	-38.92	-13.00	25.92	V
4070.02	-52.15	6.04	8.97	2.15	-51.37	-13.00	38.37	H
4885.01	-54.57	6.72	9.79	2.15	-53.65	-13.00	40.65	H
5702.01	-54.82	7.29	10.56	2.15	-53.70	-13.00	40.70	H

NB-IoT band 26, BPSK, Channel 26740

Frequency(MHz)	P_{Mea}(dBm)	Path Loss(dB)	Antenna Gain(dBi)	Correction (dB)	Peak ERP(dBm)	Limit (dBm)	Margin(dB)	Polarization
1638.00	-46.19	3.56	5.25	2.15	-46.65	-13.00	33.65	H
2447.50	-31.40	4.57	5.94	2.15	-32.18	-13.00	19.18	H
3276.02	-38.36	5.28	7.66	2.15	-38.13	-13.00	25.13	H
4100.02	-54.38	6.04	9.00	2.15	-53.57	-13.00	40.57	H
4915.01	-53.13	6.73	9.82	2.15	-52.19	-13.00	39.19	H
5713.01	-54.50	7.30	10.56	2.15	-53.39	-13.00	40.39	H

NB-IoT band 26, BPSK, Channel 26789

Frequency(MHz)	P_{Mea}(dBm)	Path Loss(dB)	Antenna Gain(dBi)	Correction (dB)	Peak ERP(dBm)	Limit (dBm)	Margin(dB)	Polarization
1647.51	-45.91	3.56	5.23	2.15	-46.39	-13.00	33.39	H
2469.50	-28.51	4.59	6.01	2.15	-29.24	-13.00	16.24	V
3295.02	-38.60	5.29	7.71	2.15	-38.33	-13.00	25.33	V
4125.02	-52.46	6.04	9.03	2.15	-51.62	-13.00	38.62	H
4949.01	-53.22	6.69	9.85	2.15	-52.21	-13.00	39.21	H
5831.01	-52.90	7.17	10.53	2.15	-51.69	-13.00	38.69	V

Note: The measurement is performed for both horizontal and vertical antenna polarization and different modulations, only the data of worst mode is recorded in this report.

Note: The maximum value of expanded measurement uncertainty for this test item is U = 5.16 dB, k = 2.

A.3 FREQUENCY STABILITY

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 Anritsu MT8821C Radio Communication Analyzer.

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 MT8821C and in a simulated call on middle channel for NB-IoT band 26, 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 MT8821C 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 ℃increments from -30℃ to +50℃. 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.

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 3.0VDC and 3.3VDC, with a nominal voltage of 3.6VDC. 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.

A.3.2 Measurement results

NB-IoT band 26(814MHz~824MHz) standalone 15kHz subcarrier spacing (worst case of all subcarrier spacing)

Frequency Error vs Voltage

Voltage (V)	Frequency error (Hz)		Frequency error (ppm)	
	BPSK	QPSK	BPSK	QPSK
3.0	15.20	15.00	0.0186	0.0183
3.3	17.60	-12.10	0.0215	0.0148
3.6	16.90	13.60	0.0206	0.0166

Frequency Error vs Temperature

Temperature (℃)	Frequency error (Hz)		Frequency error (ppm)	
	BPSK	QPSK	BPSK	QPSK
50	18.10	-9.80	0.0221	0.0120
40	15.20	14.60	0.0186	0.0178
30	16.40	16.60	0.0200	0.0203
20	18.00	-10.50	0.0220	0.0128
10	14.50	-11.30	0.0177	0.0138
0	21.40	13.20	0.0261	0.0161
-10	17.10	-7.20	0.0209	0.0088
-20	18.10	5.90	0.0221	0.0072
-30	16.70	-7.10	0.0204	0.0087

A.4 OCCUPIED BANDWIDTH

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.

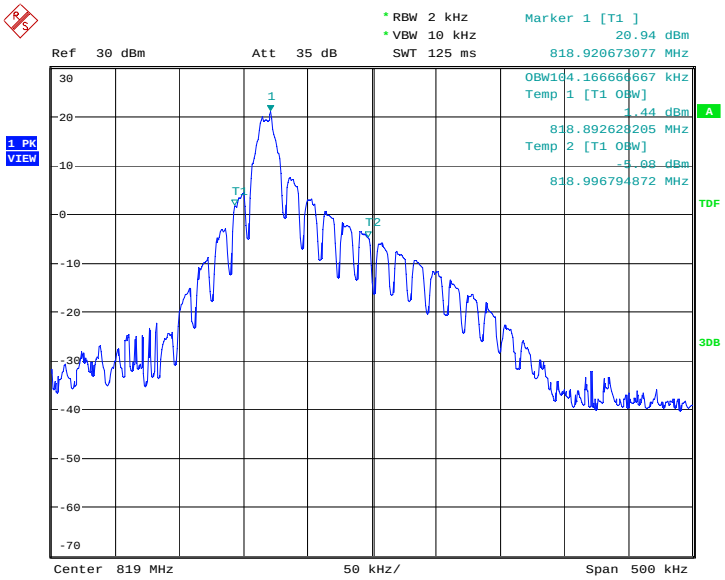
d) Set the detection mode to peak, and the trace mode to max hold.

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

NB-IoT band 26(814MHz~824MHz) standalone (99%)

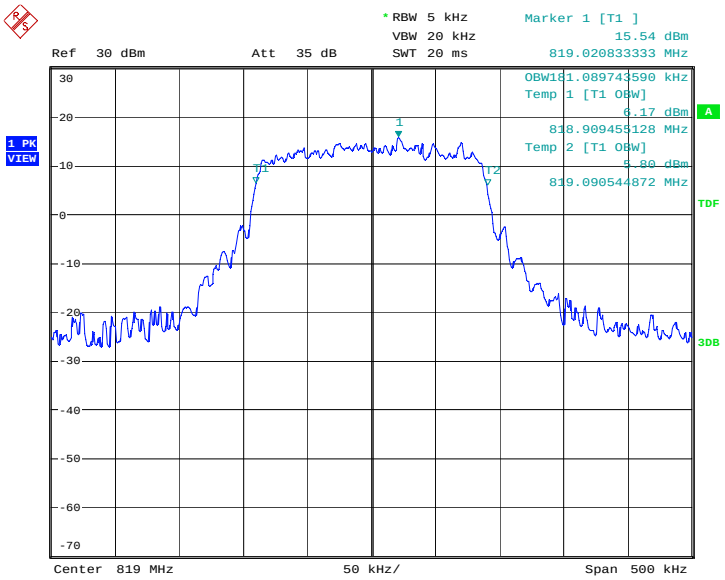
Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (99%)(kHz)
819.00	15kHz	1@0	BPSK	104.17
		12@0	QPSK	181.09

NB-IoT band 26(814MHz~824MHz) standalone Bandwidth, BPSK_15kHz_1@0 (99% BW)



Date: 29.AUG.2019 14:06:35

NB-IoT band 26(814MHz~824MHz) standalone Bandwidth, QPSK_15kHz_12@0 (99% BW)

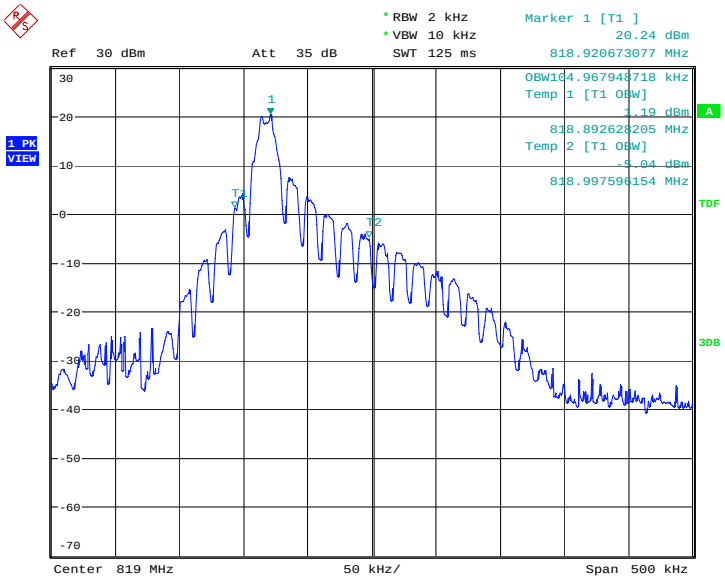


Date: 28.AUG.2019 16:42:58

NB-IoT band 26(814MHz~824MHz) guard-band (99%)

Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (99%)(kHz)
819.00	15kHz	1@0	BPSK	104.97
		12@0	QPSK	181.09

NB-IoT band 26(814MHz~824MHz) guard-band Bandwidth, BPSK_15kHz_1@0 (99% BW)



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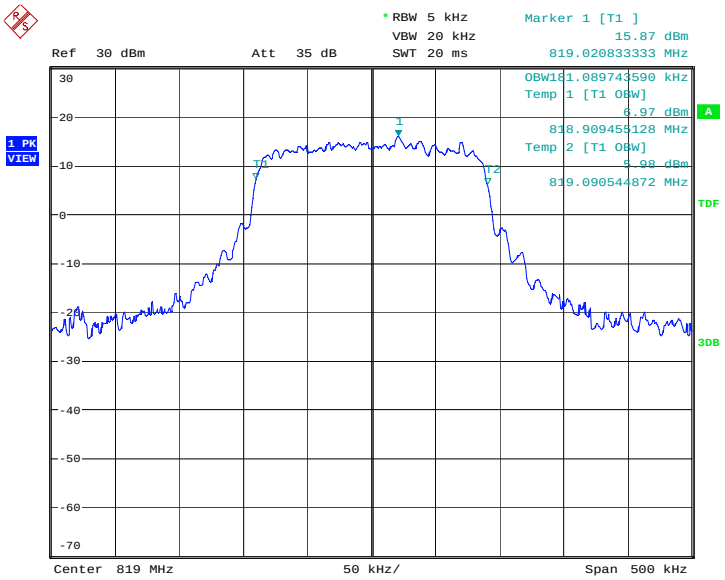
NB-IoT band 26(814MHz~824MHz) guard-band Bandwidth, QPSK_15kHz_12@0 (99% BW)

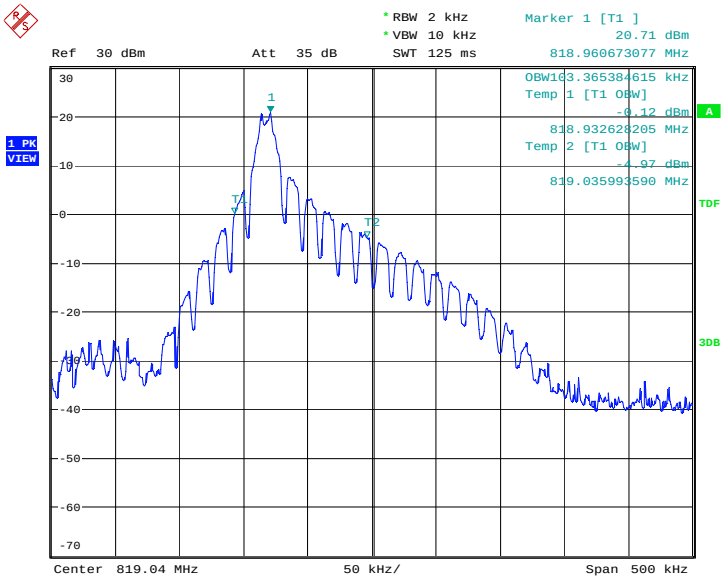


Date: 28.AUG.2019 16:49:45

NB-IoT band 26(814MHz~824MHz) in-band-same PCI (99%)

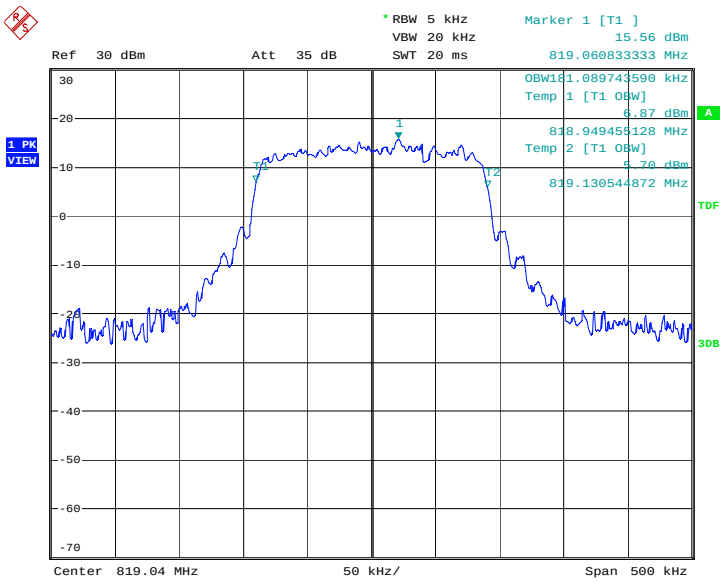
Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (99%)(kHz)
819.04	15kHz	1@0	BPSK	103.37
		12@0	QPSK	181.09

NB-IoT band 26(814MHz~824MHz) in-band-same PCI Bandwidth, BPSK_15kHz_1@0 (99% BW)



Date: 29.AUG.2019 14:25:01

NB-IoT band 26(814MHz~824MHz) in-band-same PCI Bandwidth, QPSK_15kHz_12@0 (99% BW)

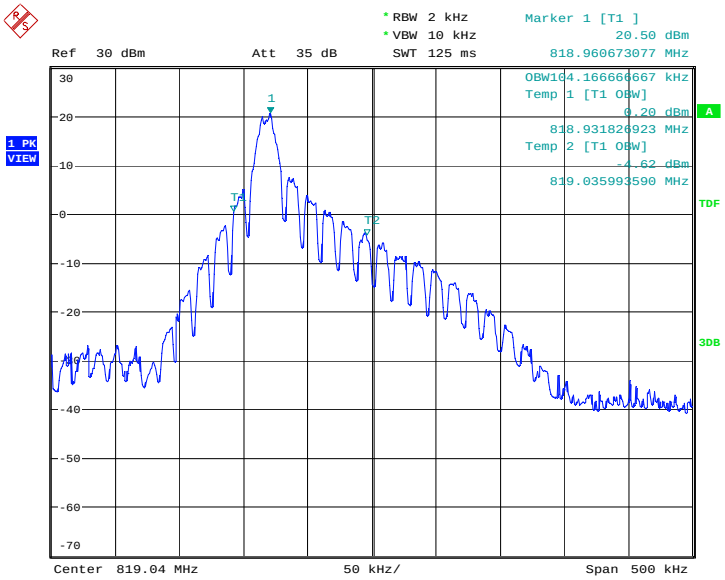


Date: 28.AUG.2019 16:53:16

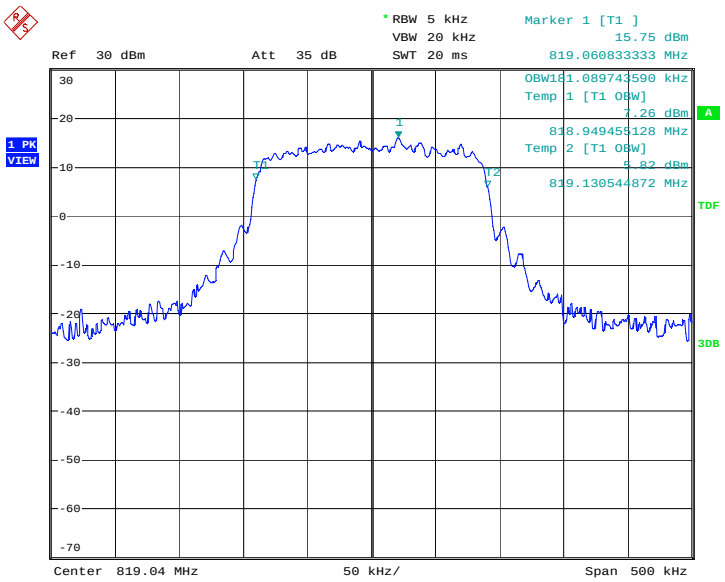
NB-IoT band 26(814MHz~824MHz) in-band-different PCI (99%)

Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (99%)(kHz)
819.04	15kHz	1@0	BPSK	104.17
		12@0	QPSK	181.09

NB-IoT band 26(814MHz~824MHz) in-band-different PCI Bandwidth, BPSK_15kHz_1@0 (99% BW)



NB-IoT band 26(814MHz~824MHz) in-band-different PCI Bandwidth, QPSK_15kHz_12@0 (99% BW)



A.5 EMISSION BANDWIDTH

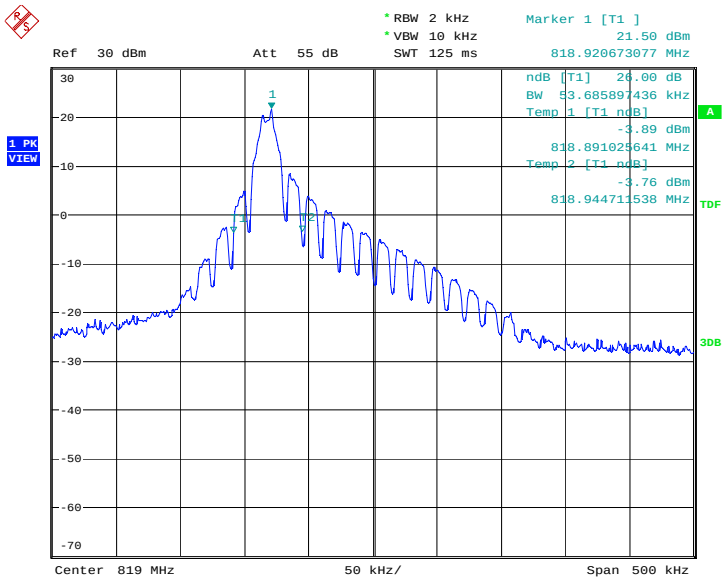
A.5.1Emission Bandwidth Results

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 at least 26 dB below the transmitter power. Table below lists the measured -26dBc BW. Spectrum analyzer plots are included on the following pages.

NB-IoT band 26(814MHz~824MHz) standalone (-26dBc)

Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (-26dBc)(kHz)
819.00	15kHz	1@0	BPSK	53.69
		12@0	QPSK	219.55

NB-IoT band 26(814MHz~824MHz) standalone Bandwidth, BPSK_15kHz_1@0 (-26dBc BW)



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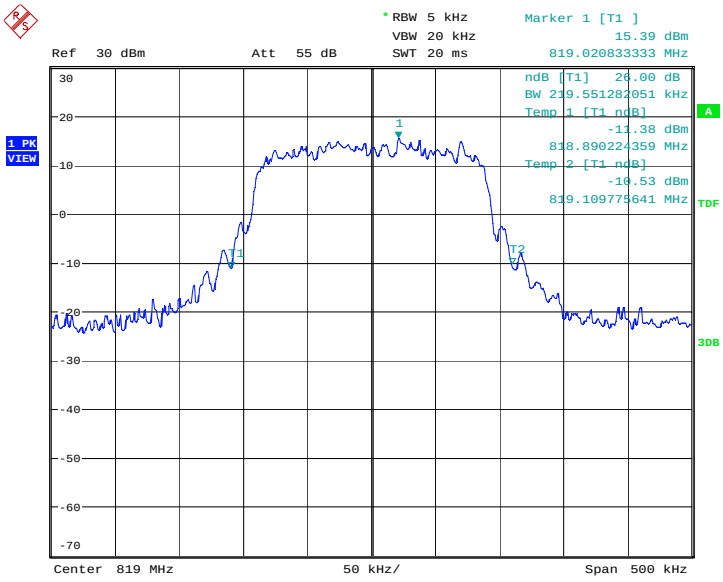
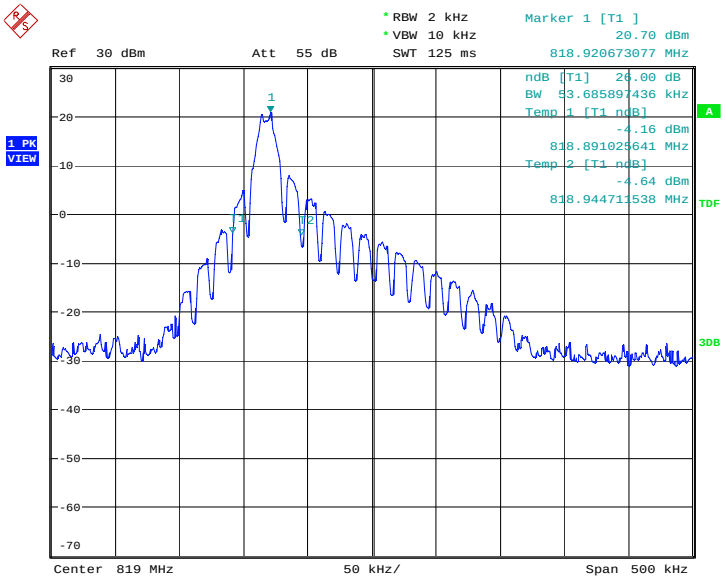
NB-IoT band 26(814MHz~824MHz) standalone Bandwidth, QPSK_15kHz_12@0 (-26dBc BW)



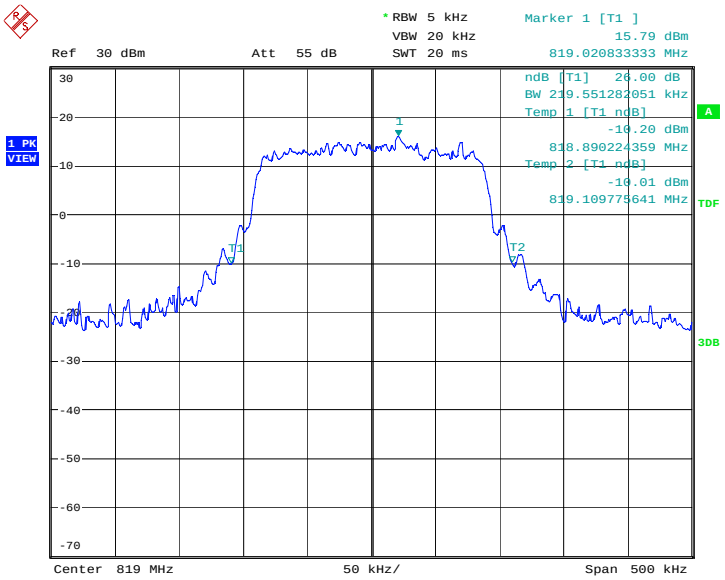
NB-IoT band 26(814MHz~824MHz) guard-band (-26dBc)

Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (-26dBc)(kHz)
819.00	15kHz	1@0	BPSK	53.59
		12@0	QPSK	219.55

NB-IoT band 26(814MHz~824MHz) guard-band Bandwidth, BPSK_15kHz_1@0 (-26dBc BW)



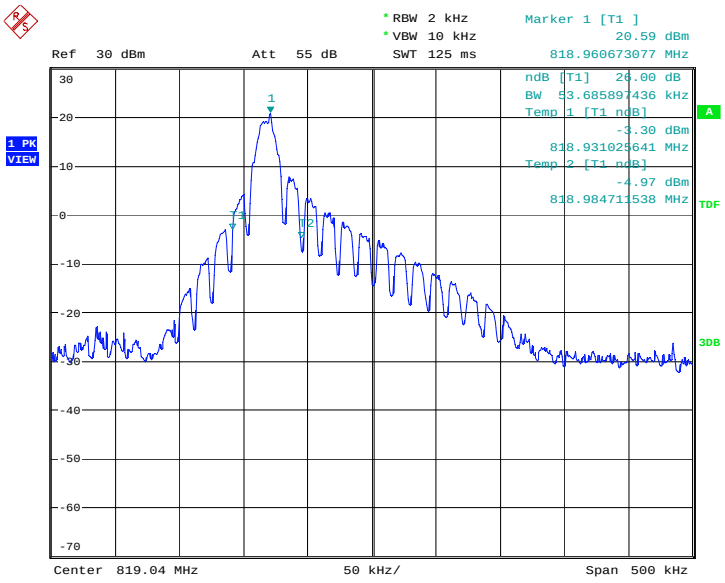
NB-IoT band 26(814MHz~824MHz) guard-band Bandwidth, QPSK_15kHz_12@0 (-26dBc BW)



NB-IoT band 26(814MHz~824MHz) in-band-same PCI (-26dBc)

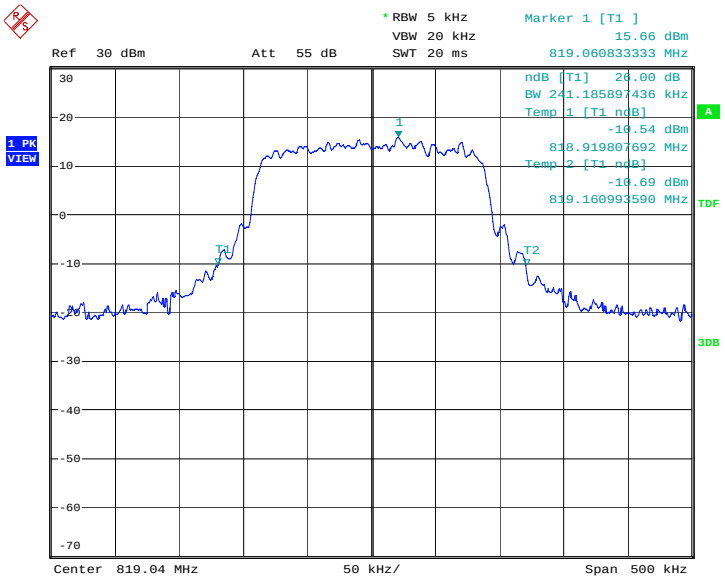
Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (-26dBc)(kHz)
819.04	15kHz	1@0	BPSK	53.69
		12@0	QPSK	241.19

NB-IoT band 26(814MHz~824MHz) in-band-same PCI Bandwidth, BPSK_15kHz_1@0 (-26dBc BW)



Date: 29.AUG.2019 14:25:35

NB-IoT band 26(814MHz~824MHz) in-band-same PCI Bandwidth, QPSK_15kHz_12@0 (-26dBc BW)



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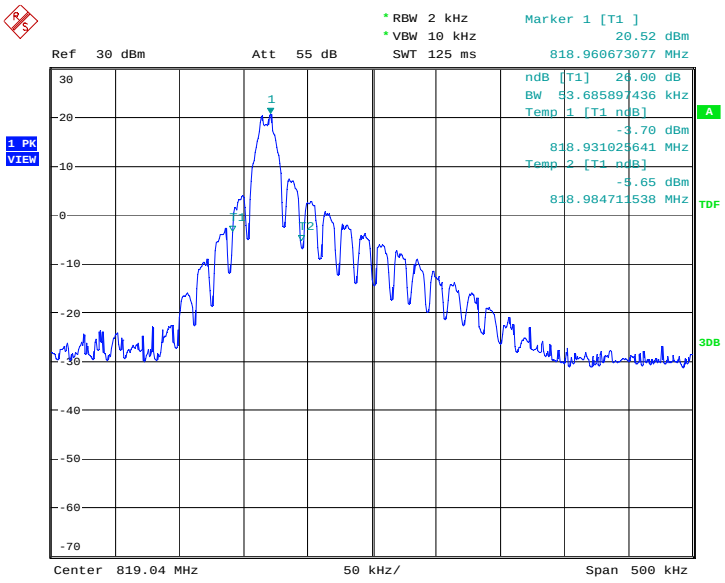
NB-IoT band 26(814MHz~824MHz) in-band-different PCI (-26dBc)

Frequency(MHz)	Subcarrier Spacing	Subcarrier number/offset	Modulation	Occupied Bandwidth (-26dBc)(kHz)
819.04	15kHz	1@0	BPSK	53.69
		12@0	QPSK	229.97

NB-IoT band 26(814MHz~824MHz) in-band-different PCI Bandwidth, BPSK_15kHz_1@0 (-26dBc BW)



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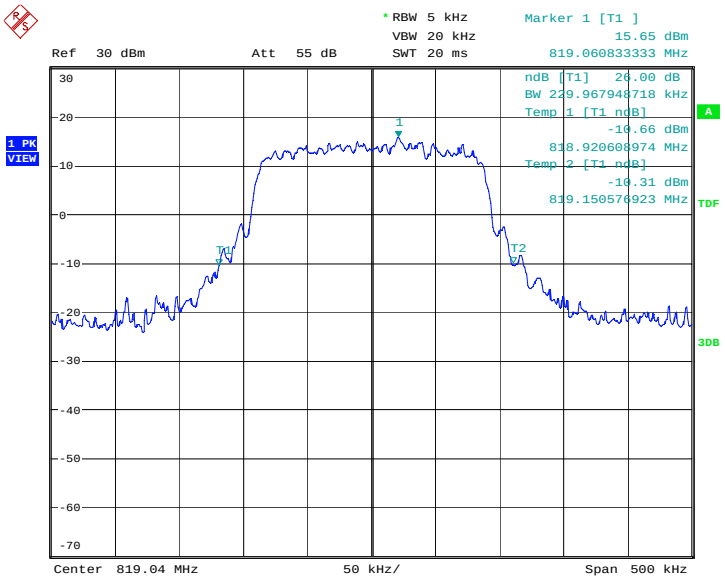
NB-IoT band 26(814MHz~824MHz) in-band-different PCI Bandwidth, QPSK_15kHz_12@0 (-26dBc BW)



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A.6 BAND EDGE COMPLIANCE

A.6.1 Measurement limit

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.

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.

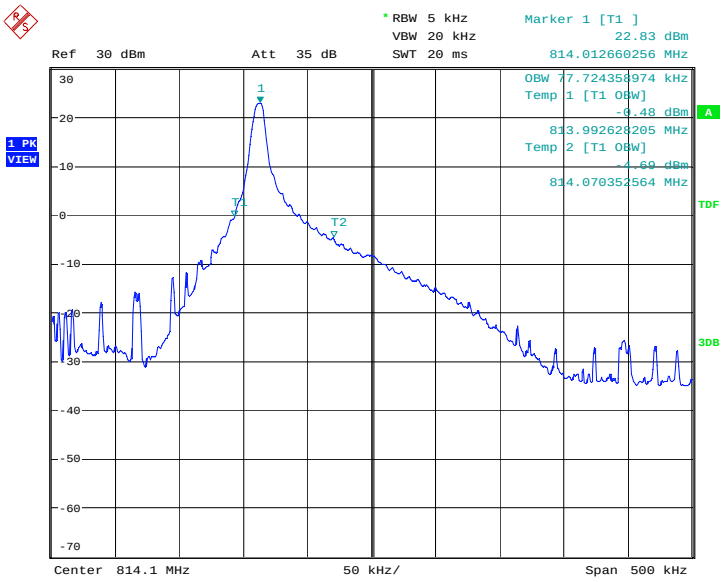
Part 90.691 states that out-of-band emission requirement shall apply only to the ‘‘outer’’ channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows: For any frequency removed from the EA licensee’s frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $116\text{Log}_{10}(f/6.1)$ decibels or 50 + 10 $\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz. For any frequency removed from the EA licensee’s frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + $10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

A.6.2 Measurement result

Only worst case result is given below

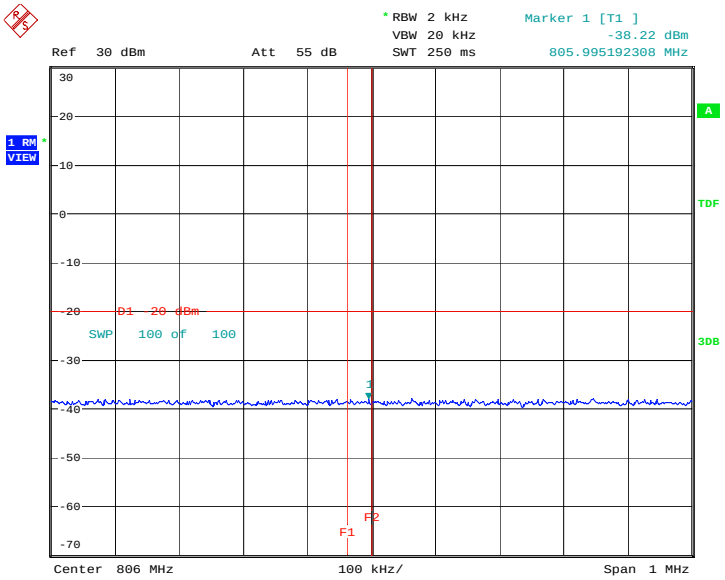
NB-IoT band 26(814MHz~824MHz)

OBW: 1RB-low_offset

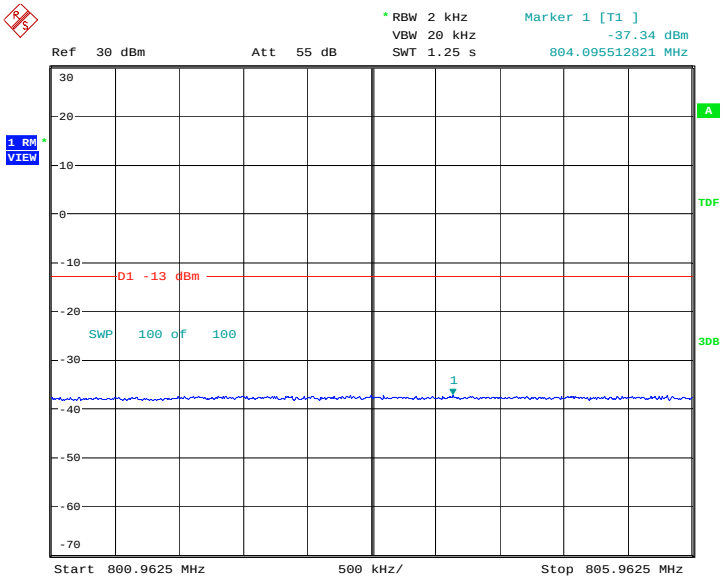


Date: 28.AUG.2019 18:27:55

LOW BAND EDGE BLOCK-1RB-low_offset

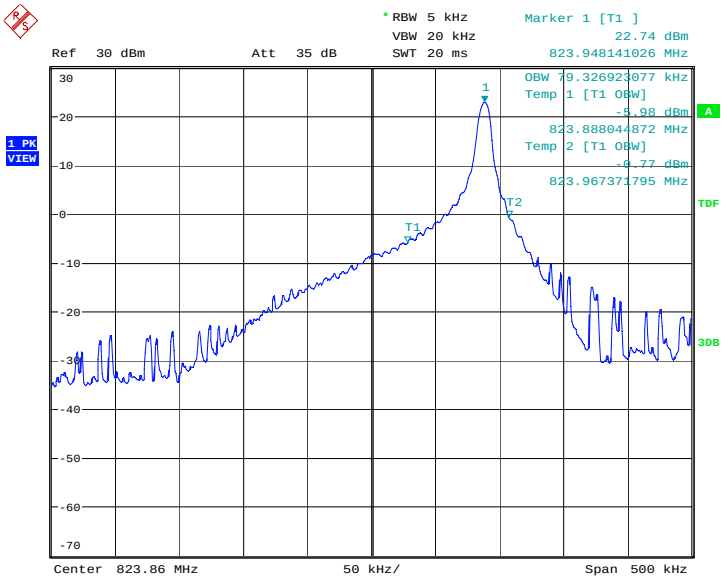


Date: 28.AUG.2019 18:31:02



Date: 28.AUG.2019 18:34:45

OBW: 1RB-high_offset



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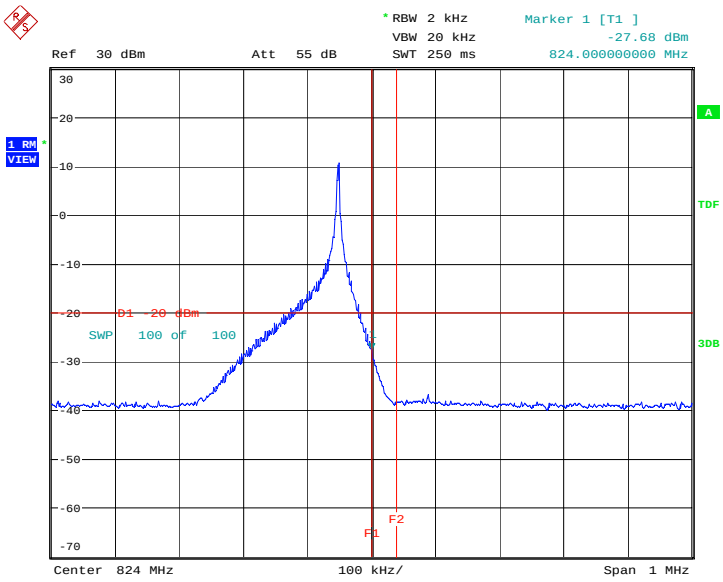
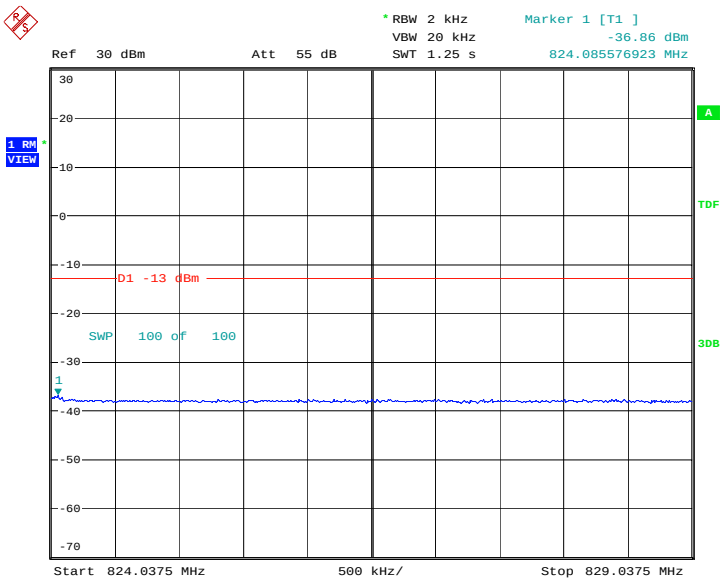
HIGH BAND EDGE BLOCK-1RB-high_offset

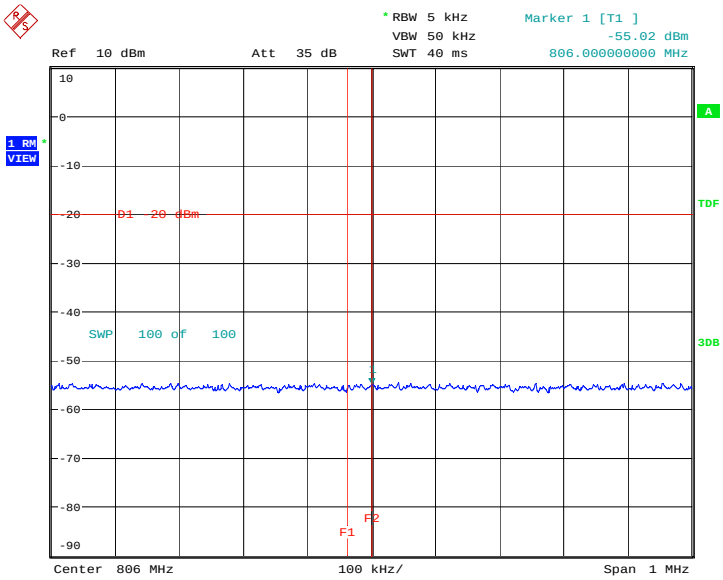


Date: 28.AUG.2019 18:44:44

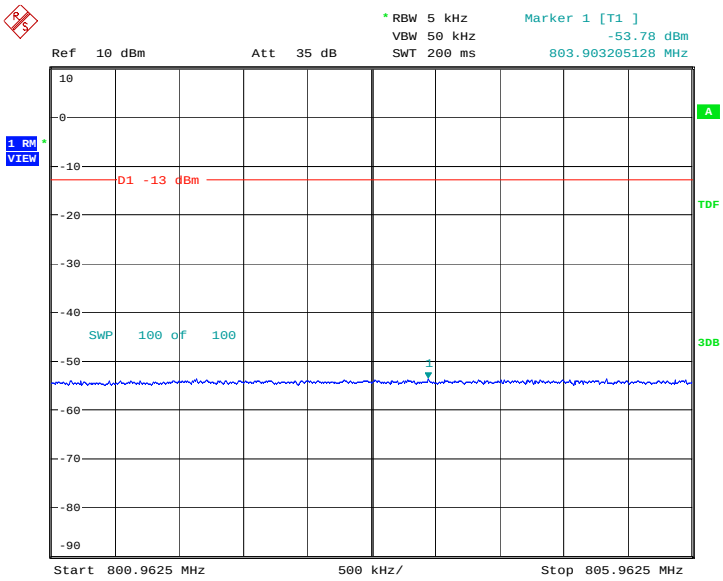


Date: 28.AUG.2019 18:49:07

LOW BAND EDGE BLOCK-10MHz-100%RB

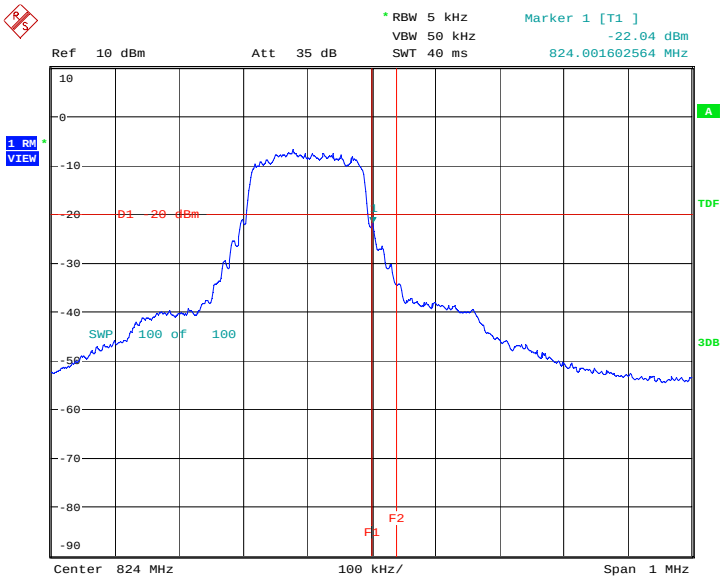


Date: 28.AUG.2019 17:11:59



Date: 28.AUG.2019 17:18:49

HIGH BAND EDGE BLOCK-10MHz-100%RB



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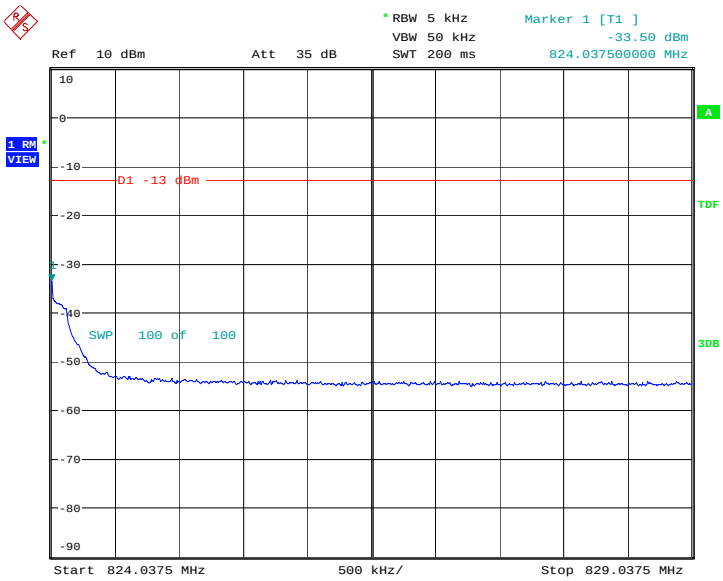

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A.7 CONDUCTED SPURIOUS EMISSION

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

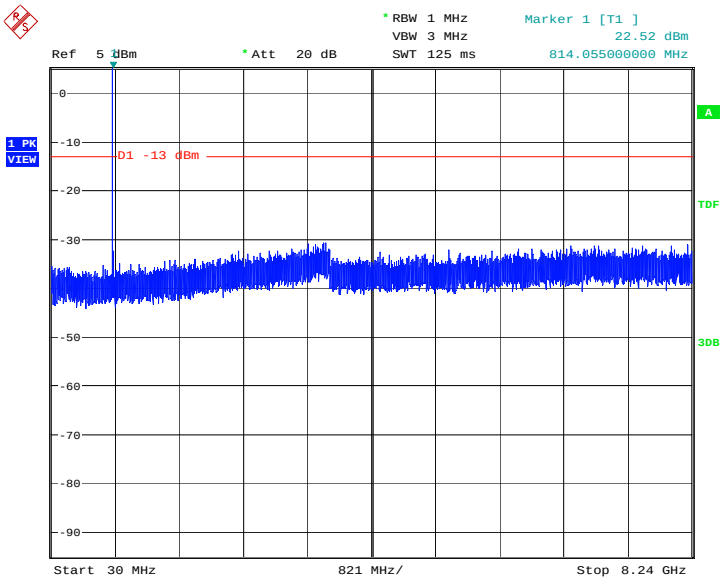
The specification that emissions shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB, translates in the relevant power range (1 to 0.001 W) to -13 dBm. At 1 W the specified minimum attenuation becomes 43 dB and relative to a 30 dBm (1 W) carrier becomes a limit of -13 dBm. 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 90.691 states that out-of-band emission requirement shall apply only to the ‘‘outer’’ channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows: For any frequency removed from the EA licensee’s frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $116\text{Log}_{10}(f/6.1)$ decibels or $50 + 10\ \text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz. For any frequency removed from the EA licensee’s frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

A. 7.2 Measurement result

Only worst case result is given below

NB-IoT band 26(814MHz~824MHz): 30MHz – 8.24GHz



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ANNEX B: Accreditation Certificate

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 600118-0

Telecommunication Technology Labs, CAICT
Beijing
China

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2018-09-28 through 2019-09-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

*****END OF REPORT*****