TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 27

FCC PART 22H, PART 24E

MEASUREMENT AND TEST REPORT

For

Shanghai MobileTek Communication Ltd.

Free Trade Zone No. 33, No. 17 building 6H Xiya Road, Shanghai, China 200131

FCC ID: 2AK9DL620

Report Type:	**Product Type:**
Original Report	NB-IoT Module

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Report Number:	RSHA180611001-00A
Report Date:	2018-11-13
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant:	Shanghai MobileTek Communication Ltd.
Tested Model:	L620
Product Type:	NB-IoT Module
Dimension:	17.6 mm (L) * 15.8 mm (W) * 2.3 mm (H)
Power Supply:	DC 3.3V

**All measurement and test data in this report was gathered from production sample serial number: 20181008001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2018-10-08)*

Objective

This type approval report is prepared on behalf of *Shanghai MobileTek Communication Ltd.* in accordance with Part 2, Part 22-Subpart H and Part 24-Subpart E and Part 27 of the Federal Communication Commission's rules.

The objective is to determine the compliance of EUT with FCC rules for output power, modulation characteristic, occupied bandwidth, and spurious emission at antenna terminal, spurious radiated emission, frequency stability, and band edge.

Related Submittal(s)/Grant(s)

N/A

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 2, Sub-Part J as well as the following parts:

Part 22 Subpart H - Public Mobile Services
Part 24 Subpart E - Personal Communication Services
Part 27 – Miscellaneous wireless communications services

Applicable Standards: TIA/EIA 603-D.

All radiated and conducted emissions measurements were performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	5.91dB
	1GHz~6GHz	4.68dB
	6GHz~18GHz	4.92dB
	18GHz~40GHz	5.21dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Justification

The EUT was configured for testing according to TIA/EIA-603-D.

The final qualification test was performed with the EUT operating at normal mode.

Channel List

Mode	Channel		Frequency (MHz)
NB-IoT Band 2	Low	18601	1850.1
	Middle	18900	1880.0
	High	19199	1909.9
NB-IoT Band 5	Low	20401	824.1
	Middle	20525	836.5
	High	20649	848.9
NB-IoT Band 12	Low	23011	699.1
	Middle	23095	707.5
	High	23179	715.9

Equipment Modifications

No modifications were made to the EUT.

Support Equipment List and Details

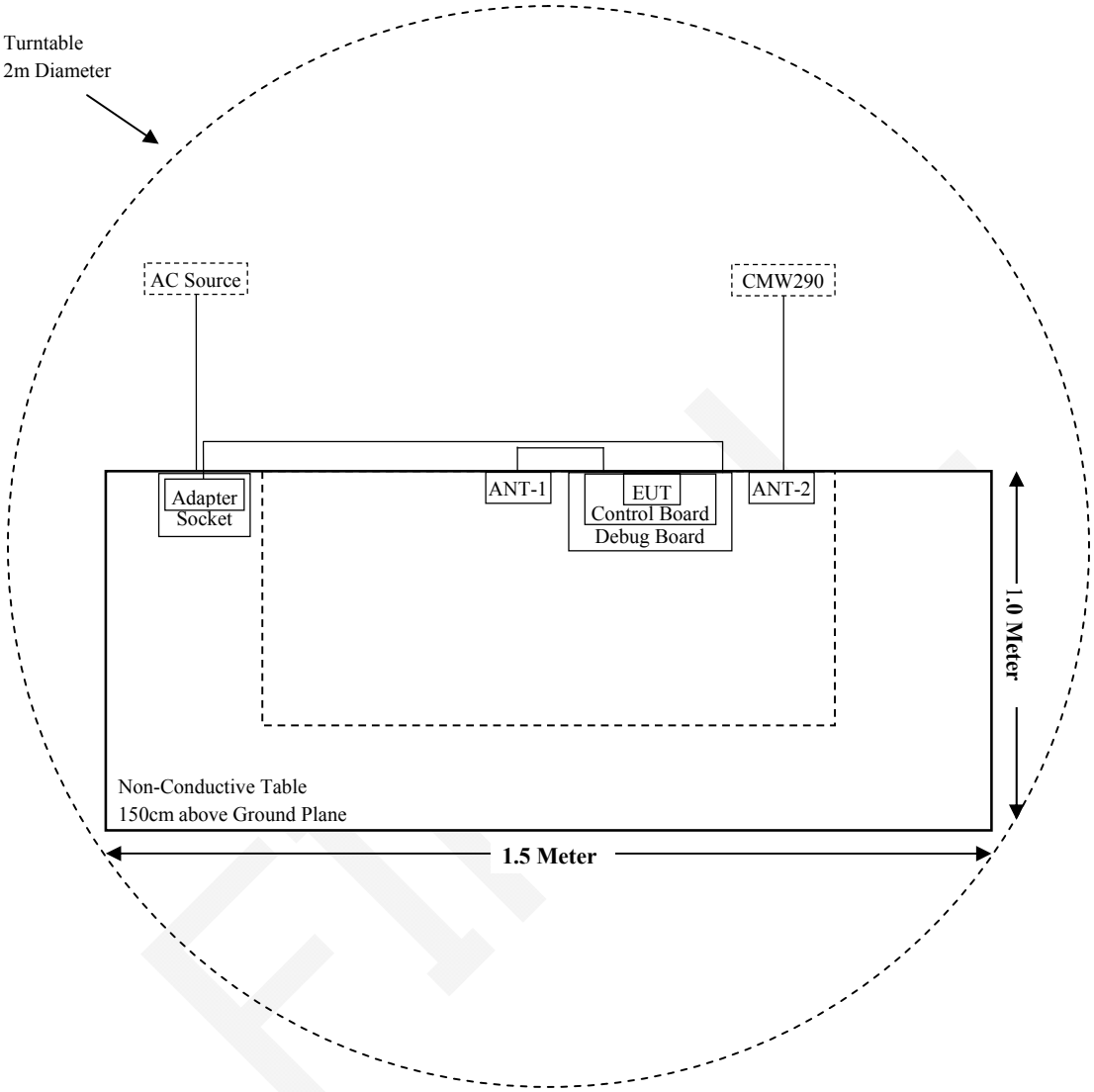
Manufacturer	Description	Model	Serial Number
Shanghai MobileTek	Debug Board	L620_EVB_V1_180201	/
Shanghai MobileTek	Control Board	L620_SUB_V1_170807	/
Shanghai MobileTek	Antenna-1	/	/
Aihuaixin Technology	Antenna-2	/	/
Shanghai MobileTek	Adapter	/	/
Rohde & Schwarz	Functional Radio Communication Tester	CMW290	1201.0002k29/101743

External I/O Cable

Cable Description	Length (m)	From Port	To
RF Cable-1	0.1	Control Board	Antenna-1
RF Cable-2	1.2	Antenna-2	CMW290
Power Cable	1.0	Debug Board	Adapter

Block Diagram of Test Setup

For Radiated Emissions(Below 1GHz & Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1307 & §2.1091	MAXIMUM PERMISSIBLE EXPOSURE (MPE)	Compliant
§2.1046; § 22.913 (a);§ 24.232 (c); § 27.50 (c)	RF Output Power	Compliant
§ 2.1047	Modulation Characteristics	Not Applicable
§ 2.1049; § 22.905; § 22.917; § 24.238	Occupied Bandwidth	Compliant
§ 2.1051; § 22.917 (a); § 24.238 (a); §27.53	Spurious Emissions at Antenna Terminal	Compliant
§ 2.1053; § 22.917 (a); § 24.238 (a); §27.53 (g)	Spurious Radiated Emissions	Compliant
§ 22.917 (a); § 24.238 (a); §27.53 (g)	Band Edge	Compliant
§ 2.1055; § 22.355; § 24.235; §27.54	Frequency stability	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 1#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
HP	Signal Generator	HP 8341B	2624A00116	2018-08-29	2019-08-28
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
Sonoma Instrunent	Pre-amplifier	310N	171205	2018-08-15	2019-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-8	008	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2018-08-15	2019-08-14
Rohde & Schwarz	Functional Radio Communication Tester	CMW290	1201.0002k29/101743	2018-09-30	2019-09-29
Radiated Emission Test（Chamber 2#）					
HP	Signal Generator	HP 8341B	2624A00116	2018-08-29	2019-08-28
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2018-08-27	2019-08-26
ETS-LINDGREN	Horn Antenna	3115	9311-4159	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
ETS-LINDGREN	Horn Antenna	3116	2516	2016-12-12	2019-12-12
A.H.Systems, inc	Amplifier	2641-1	466	2018-09-11	2019-09-10
EM Electronics Corporation	Amplifier	EM18G40G	060726	2018-03-22	2019-03-21
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-16	016	2018-08-15	2019-08-14
Rohde & Schwarz	Functional Radio Communication Tester	CMW290	1201.0002k29/101743	2018-09-30	2019-09-29

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-11-12	2018-11-11
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2018-07-23	2019-07-22
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
Rohde & Schwarz	Functional Radio Communication Tester	CMW290	1201.0002k29/101743	2018-09-30	2019-09-29
Mini-Ciruits	Power splitter	ZFRSC-14-S+	SF019411452	2017-11-10	2018-11-09
BACL	Temperature & Humidity Chamber	BTH-150	30023	2018-10-10	2019-10-09
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2018-10-10	2019-10-09
Shanghai MobileTek	RF Cable	MobileTekC01	C01	Each Time	/

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §1.1307 & §2.1091 –MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart §2.1091 and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:
Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

Calculation of maximum antenna gain based on ERP/EIRP

Mode	Max Tune-up Power (dBm)	ERP/EIRP Limit (dBm)	Max Antenna Gain
NB-IoT Band 2	24.00	33.00	9.0dBi
NB-IoT Band 5	24.00	38.45	16.60dBi (14.45dBd)
NB-IoT Band 12	24.00	34.77	12.92dBi (10.77dBd)

Note: 0dBd = 2.15dBi

Calculation of maximum antenna gain based on MPE

Mode	Frequency Range	Tune-up Conducted Power		Power Density Limit	Maximum Power Density	Evaluation Distance	Maximum Antenna Gain Allowed based on MPE	
	(MHz)	(dBm)	(mW)	(mW/cm^2)	(mW/cm^2)	(cm)	(dBi)	(numeric)
NB-IoT Band 2	1850.1-1909.9	24.00	251.19	1.0000	0.9995	20	13.01	20.00
NB-IoT Band 5	824.1-848.9	24.00	251.19	0.5494	0.5492	20	10.41	10.99
NB-IoT Band 12	699.1-715.9	24.00	251.19	0.4661	0.4658	20	9.69	9.32

Mode	Max Allowed Antenna Gain
NB-IoT (Band 2) Frequency Range: 1850.1-1909.9MHz	9.00dBi
NB-IoT (Band 5) Frequency Range: 824.1-848.9MHz	10.41dBi
NB-IoT (Band 12) Frequency Range: 699.1-715.9MHz	9.69dBi

Result: For NB-IoT mode, to meet RF exposure & ERP/ERIP, the maximum net gains of antennas allowed are 9.0dBi @ NB-IoT (Band 2), 10.41dBi @ NB-IoT (Band 5) and 9.69dBi @ NB-IoT (Band 12). The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC §2.1047 - MODULATION CHARACTERISTIC

According to FCC § 2.1047(d), Part 22H & 24E, Part 27 there is no specific requirement for digital modulation, therefore modulation characteristic is not presented.

FCC §2.1046; § 22.913 (a); § 24.232 (c); §27.50 (c) - RF OUTPUT POWER

Applicable Standards

According to FCC §2.1046 and §22.913 (a), the ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts (38.45dBm).

According to FCC §2.1046 and §24.232 (c), mobile and portable stations are limited to 2 watts (33dBm) EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

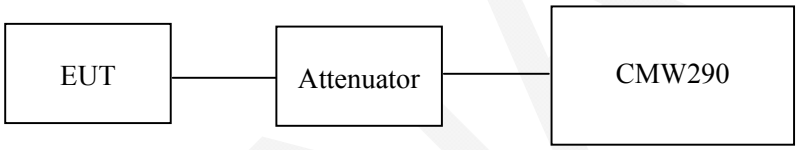
According to §27.50(c), the maximum EIRP must not exceed 3Watts (34.77dBm) for 699-716MHz.

The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB.

Test Procedure

Conducted method:

The RF output of the transmitter was connected to the CMW290 through sufficient attenuation.



Radiated Output Power:

The measurements procedures specified in ANSI/TIA-603-D were applied.

a) Connect the equipment as illustrated. Mount the equipment with the manufacturer specified antenna in a vertical orientation on a manufacturer specified mounting surface located on a non-conducting rotating platform of a RF anechoic chamber (preferred) or a standard radiation site.

b) Key the transmitter, then rotate the EUT 360o azimuthally and record spectrum analyzer power level (LVL) measurements at angular increments that are sufficiently small to permit resolution of all peaks. If a standard radiation test site is used, raise and lower the test antenna to obtain a maximum reading at each angular increment. (Note: several batteries may be needed to offset the effect of battery voltage droop, which should not exceed 5% of the manufactured specified battery voltage during transmission).

c) Replace the transmitter under test with a vertically polarized half-wave dipole (or an antenna whose gain is known relative to an ideal half-wave dipole). The center of the antenna should be at the same location as the center of the antenna under test.

d) Connect the antenna to a signal generator with a known output power and record the path loss (in dB) as LOSS. If a standard radiation test site is used,raise and lower the test antenna to obtain a maximum reading.
LOSS = Generator Output Power (dBm) – Analyzer reading (dBm)

e) Determine the effective radiated output power at each angular position from the readings in steps b) and d) using the following equation:
ERP (dBm) = LVL (dBm) + LOSS (dB)

f) The maximum ERP is the maximum value determined in the preceding step.
(Note: Effective Isotropic Radiated Power (EIRP) can be computed using the following:
EIRP (dBm) = ERP (dBm) + 2.15 (dB)

Test Data

Environmental Conditions

Temperature:	23.2℃
Relative Humidity:	51 %
ATM Pressure:	101.3kPa

The testing was performed by Hope Zhang on 2018-10-15.

Maximum Output Power:

NB-IoT Band 2

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Low Channel (dBm)	Middle Channel (dBm)	High Channel (dBm)
BPSK	3.75kHz	1#0	22.34	22.83	23.43
		1#47	22.32	22.84	23.50
	15kHz	1#0	22.21	22.73	23.30
		1#11	22.80	22.80	23.39
QPSK	3.75kHz	1#0	22.34	22.89	23.48
		1#47	22.33	22.87	23.46
	15kHz	1#0	22.28	22.76	23.38
		1#11	22.39	22.77	23.40
		12#0	20.32	21.03	21.36

NB-IoT Band 5

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Low Channel (dBm)	Middle Channel (dBm)	High Channel (dBm)
BPSK	3.75kHz	1#0	21.05	21.21	21.15
		1#47	21.06	21.36	21.18
	15kHz	1#0	20.94	21.32	21.34
		1#11	21.03	21.25	21.06
QPSK	3.75kHz	1#0	21.08	21.51	21.49
		1#47	21.36	21.54	21.05
	15kHz	1#0	21.06	21.45	21.13
		1#11	21.34	21.65	21.24
		12#0	21.41	21.38	21.21

NB-IoT Band 12

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Low Channel (dBm)	Middle Channel (dBm)	High Channel (dBm)
BPSK	3.75kHz	1#0	22.61	22.87	22.91
		1#47	22.56	22.91	23.04
	15kHz	1#0	22.65	22.45	22.58
		1#11	22.80	22.81	22.96
QPSK	3.75kHz	1#0	22.36	22.89	23.05
		1#47	22.33	22.58	22.94
	15kHz	1#0	22.28	22.69	22.94
		1#11	22.39	22.77	22.79
		12#0	20.36	21.56	21.45

Peak-to-average ratio (PAR):

NB-IoT Band 2

Modulation	Sub-carrier Spacing	Middle Channel (dB)	PAR Limit (dB)	Result
BPSK	3.75kHz	1.79	≤ 13	Pass
	15kHz	1.66	≤ 13	Pass
QPSK	3.75kHz	1.55	≤ 13	Pass
	15kHz	1.54	≤ 13	Pass

NB-IoT Band 5

Modulation	Sub-carrier Spacing	Middle Channel (dB)	PAR Limit (dB)	Result
BPSK	3.75kHz	1.59	≤ 13	Pass
	15kHz	1.51	≤ 13	Pass
QPSK	3.75kHz	0.89	≤ 13	Pass
	15kHz	1.40	≤ 13	Pass

NB-IoT Band 12

Modulation	Sub-carrier Spacing	Middle Channel (dB)	PAR Limit (dB)	Result
BPSK	3.75kHz	2.40	≤ 13	Pass
	15kHz	2.16	≤ 13	Pass
QPSK	3.75kHz	2.09	≤ 13	Pass
	15kHz	1.99	≤ 13	Pass

FCC §2.1049, §22.917, §22.905 & §24.238; §27.53- OCCUPIED BANDWIDTH

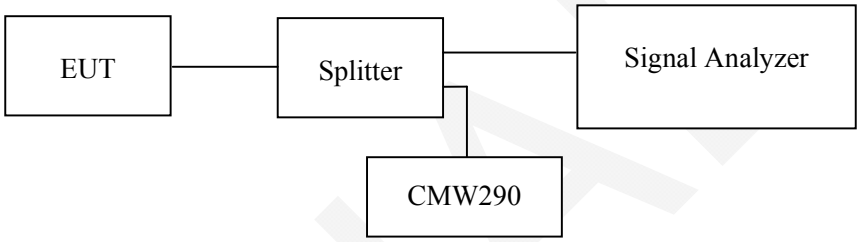
Applicable Standards

FCC 47 §2.1049, §22.917, §22.905 & §24.238 and §27.53.

Test Procedure

The RF output of the transmitter was connected to the simulator and the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 2 kHz, and the 26 dB & 99% bandwidth was recorded.



Test Data

Environmental Conditions

Temperature:	23.2℃
Relative Humidity:	51 %
ATM Pressure:	101.3kPa

The testing was performed by Hope Zhang from 2018-10-23 to 2018-11-08.

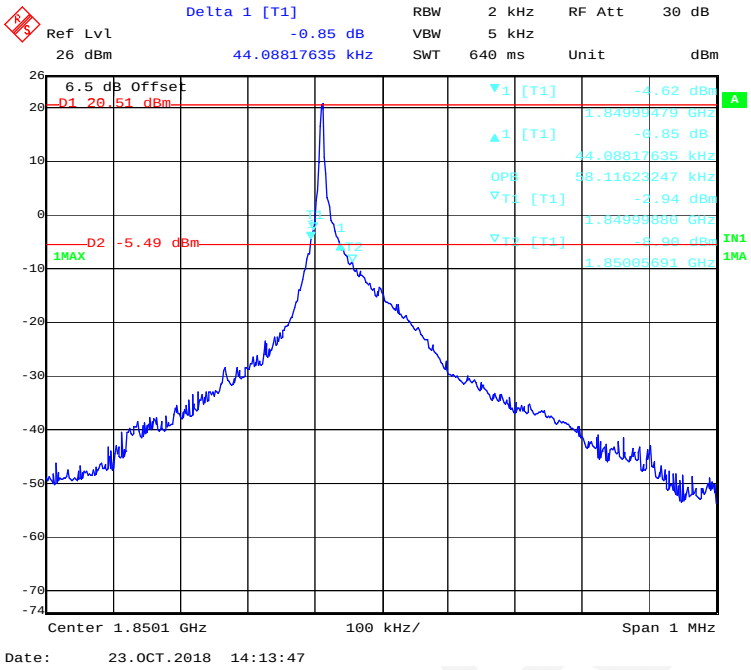
EUT operation mode: Transmitting

Test Result: Compliance.

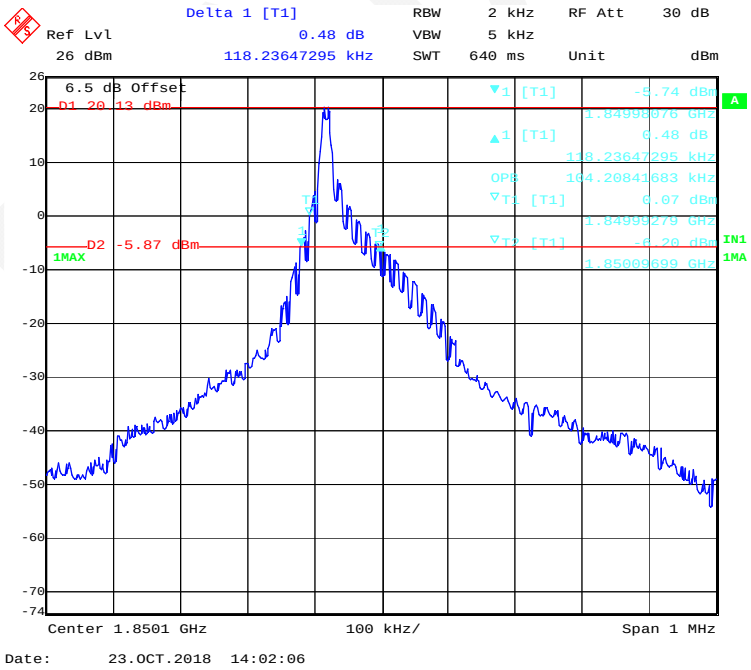
NB-IoT Band 2:

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Test Channel	26 dB Bandwidth	99% Occupied Bandwidth
				MHz	MHz
BPSK	3.75kHz	1#0	Low	0.044	0.058
	15kHz	1#0		0.118	0.104
	3.75kHz	1#0	Middle	0.048	0.058
	15kHz	1#0		0.118	0.104
	3.75kHz	1#0	High	0.044	0.056
	15kHz	1#0		0.118	0.100
QPSK	3.75kHz	1#0	Low	0.050	0.066
	15kHz	1#0		0.130	0.110
	15kHz	12#0		0.236	0.178
	3.75kHz	1#0	Middle	0.050	0.064
	15kHz	1#0		0.126	0.104
	15kHz	12#0		0.234	0.180
	3.75kHz	1#0	High	0.050	0.066
	15kHz	1#0		0.132	0.106
	15kHz	12#0		0.238	0.182

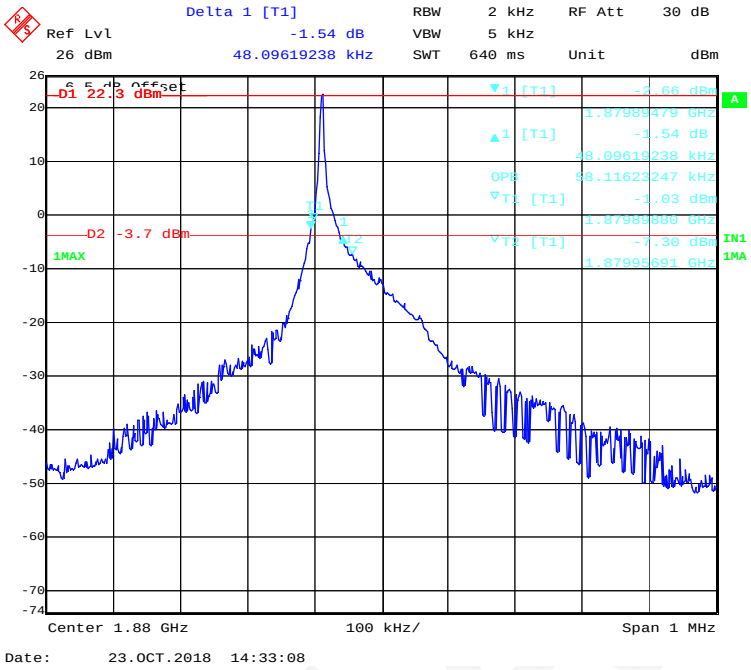
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



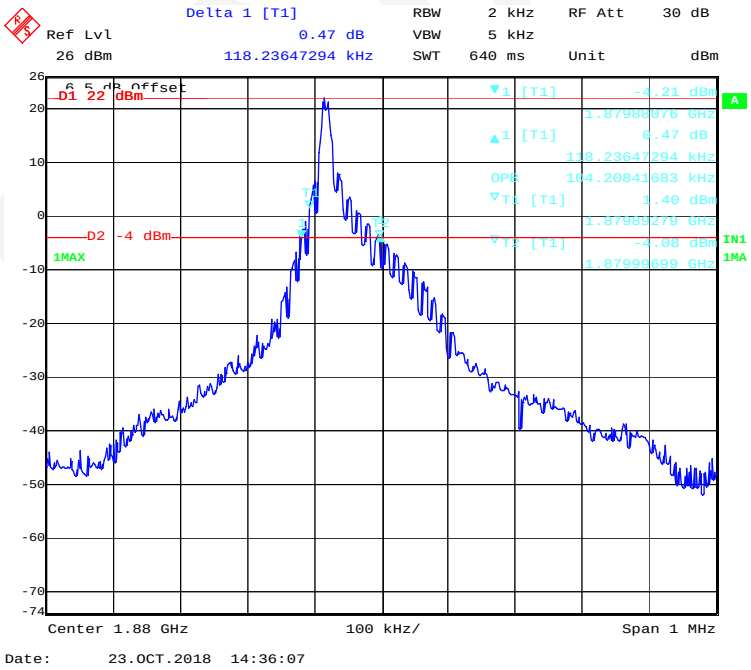
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



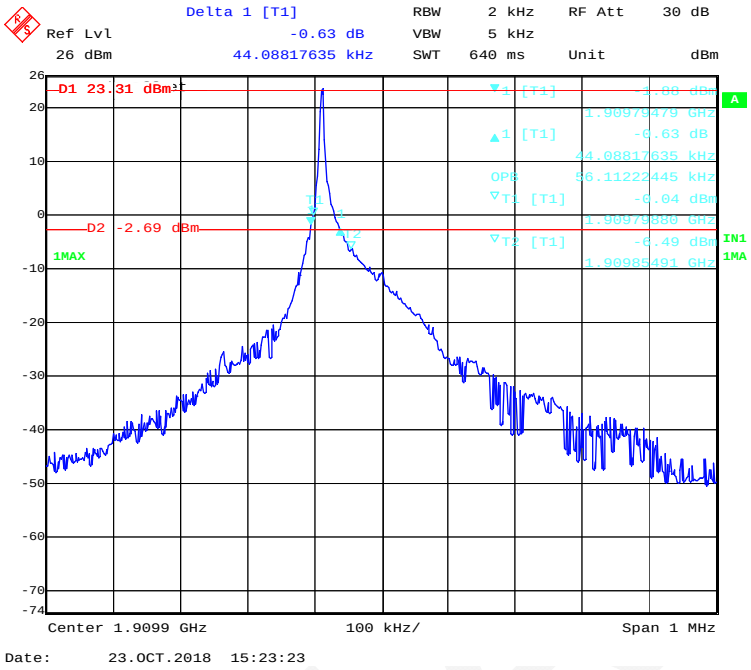
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



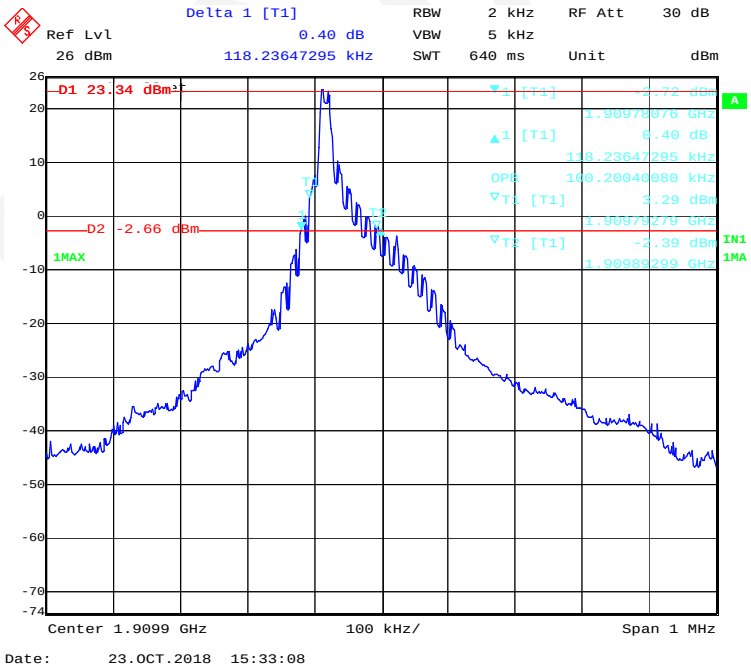
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



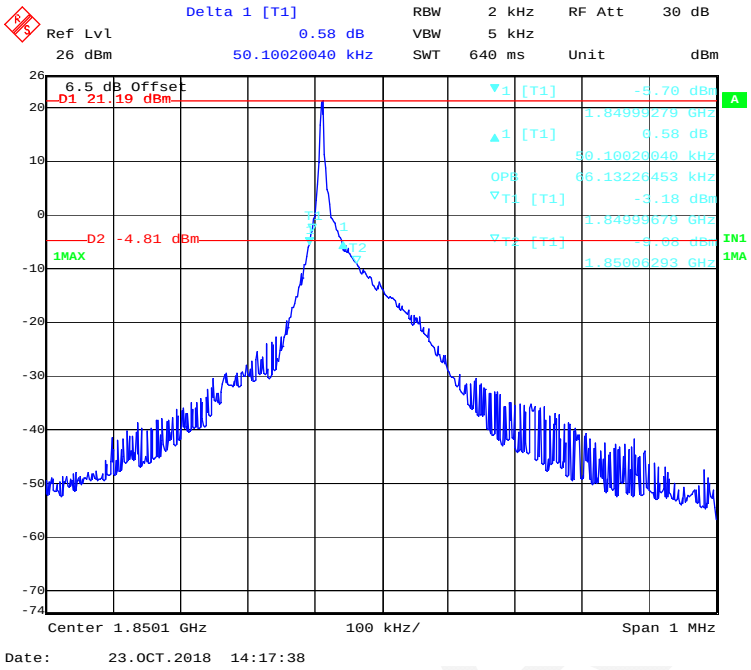
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



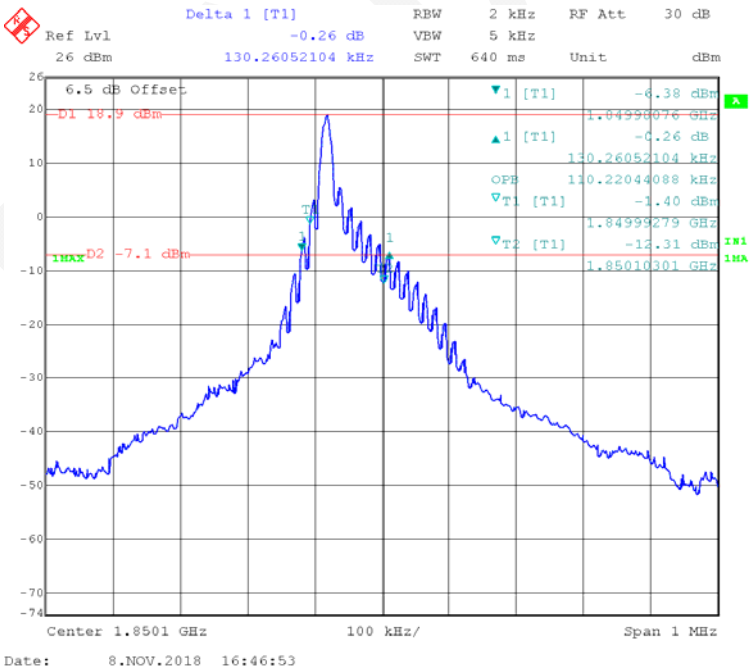
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



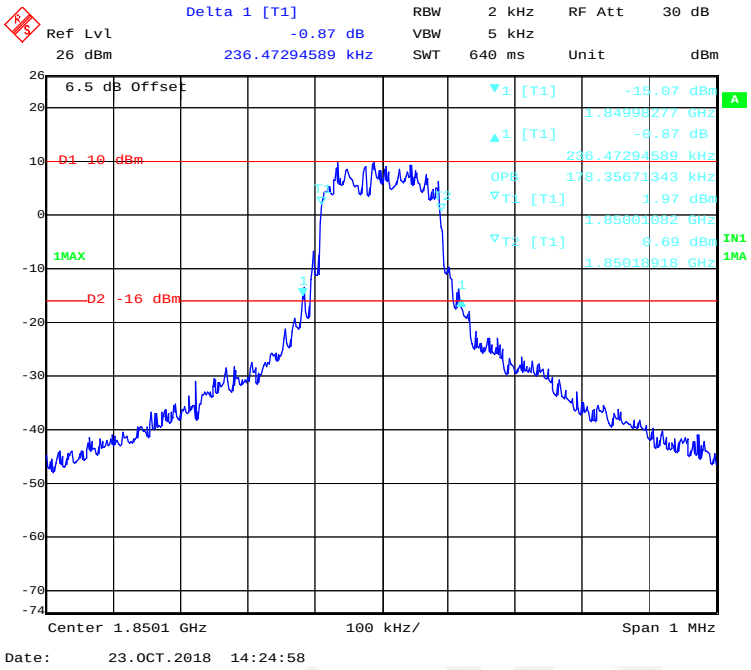
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



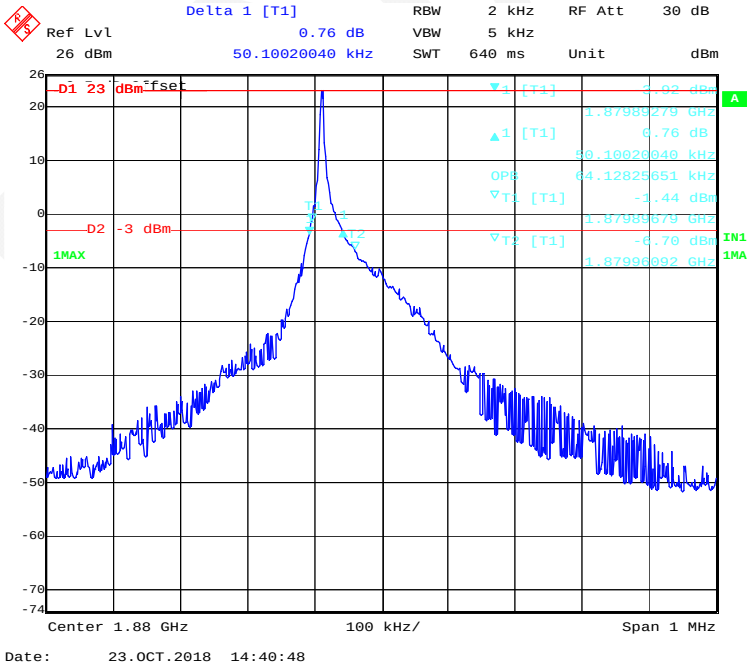
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



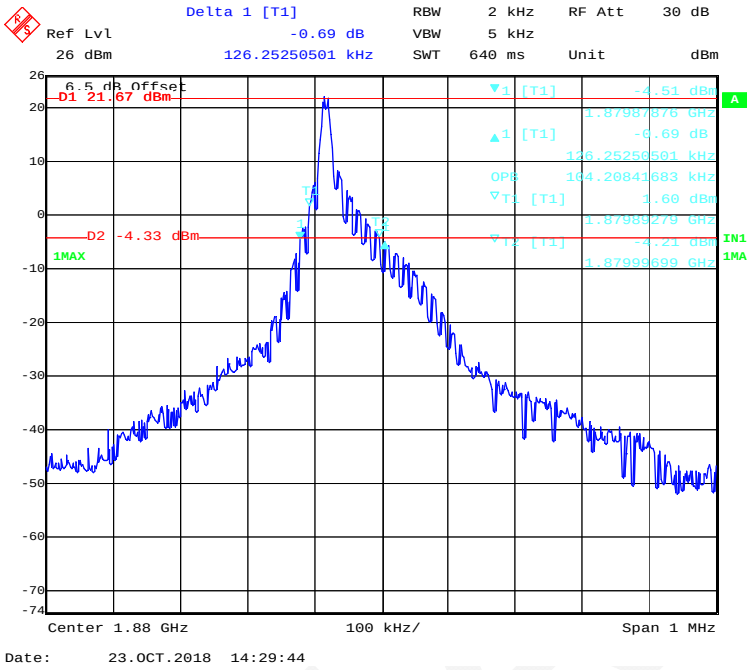
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



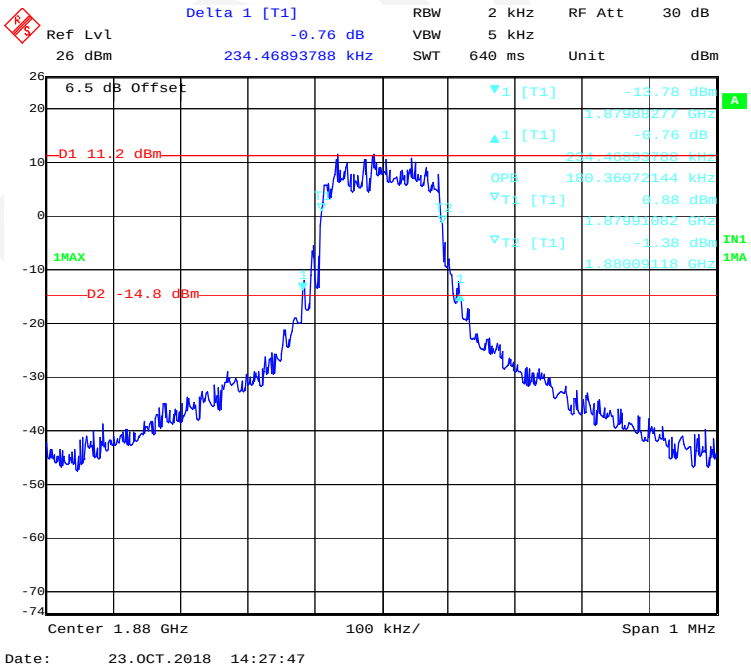
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



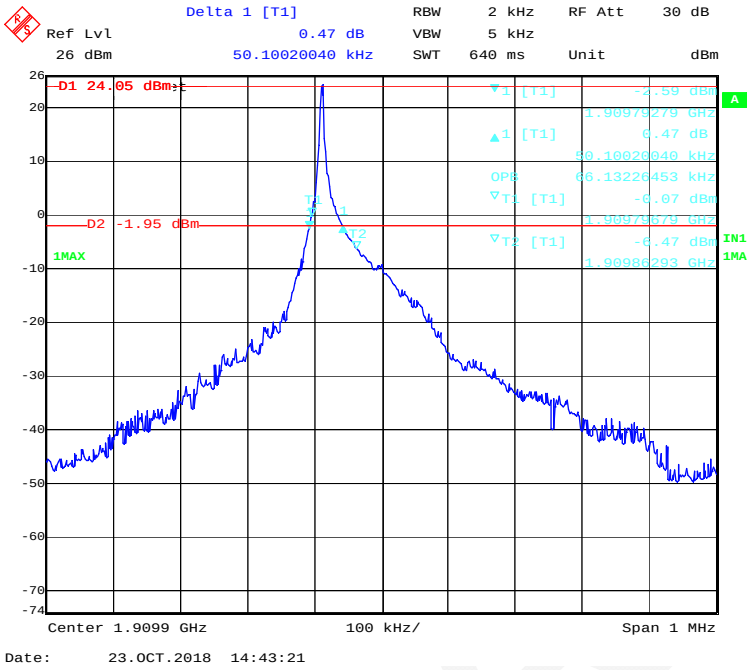
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



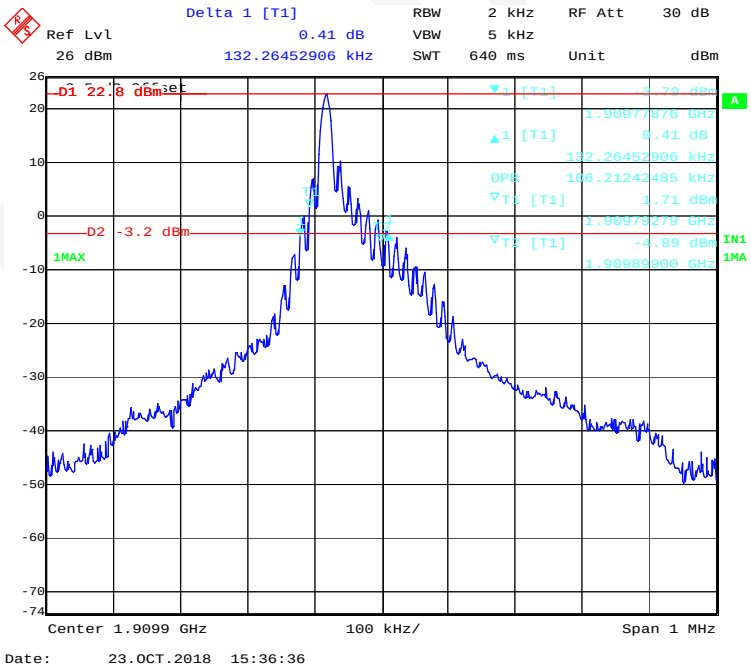
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



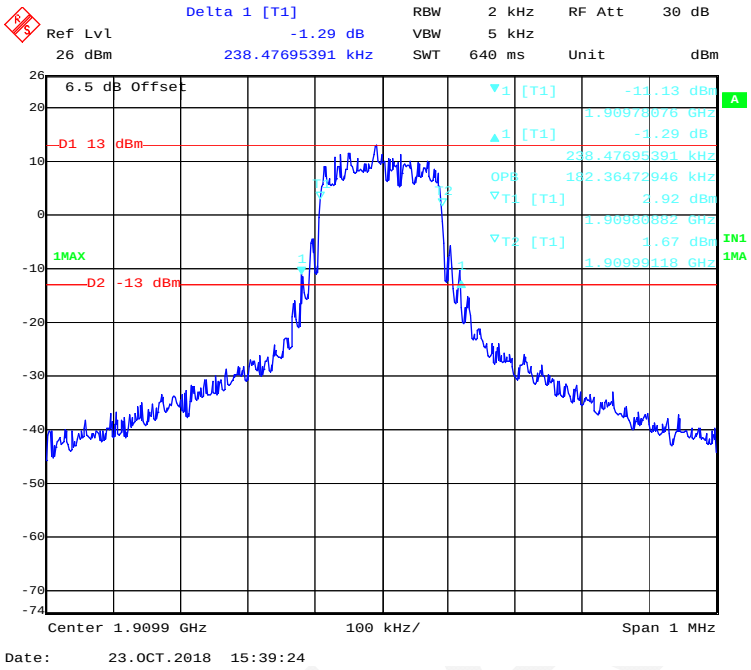
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



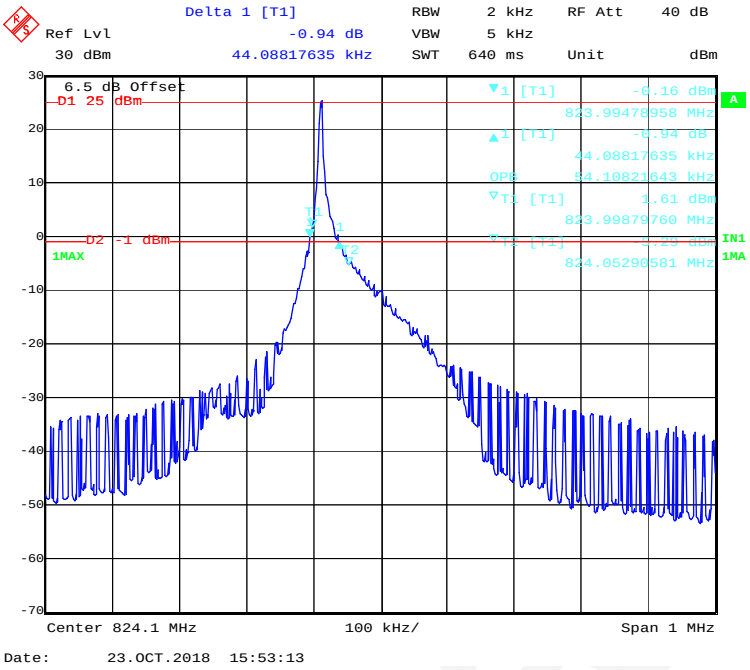
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



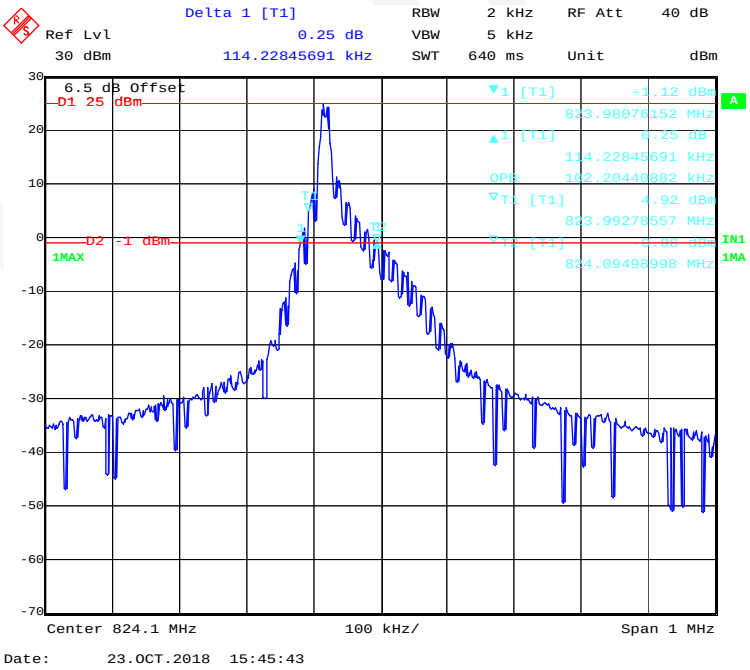
NB-IoT Band 5:

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Test Channel	26 dB Bandwidth	99% Occupied Bandwidth
				MHz	MHz
BPSK	3.75kHz	1#0	Low	0.044	0.054
	15kHz	1#0		0.114	0.102
	3.75kHz	1#0	Middle	0.044	0.052
	15kHz	1#0		0.118	0.104
	3.75kHz	1#0	High	0.044	0.054
	15kHz	1#0		0.118	0.104
QPSK	3.75kHz	1#0	Low	0.050	0.064
	15kHz	1#0		0.130	0.106
	15kHz	12#0		0.238	0.180
	3.75kHz	1#0	Middle	0.050	0.064
	15kHz	1#0		0.132	0.104
	15kHz	12#0		0.234	0.178
	3.75kHz	1#0	High	0.050	0.064
	15kHz	1#0		0.130	0.104
	15kHz	12#0		0.238	0.182

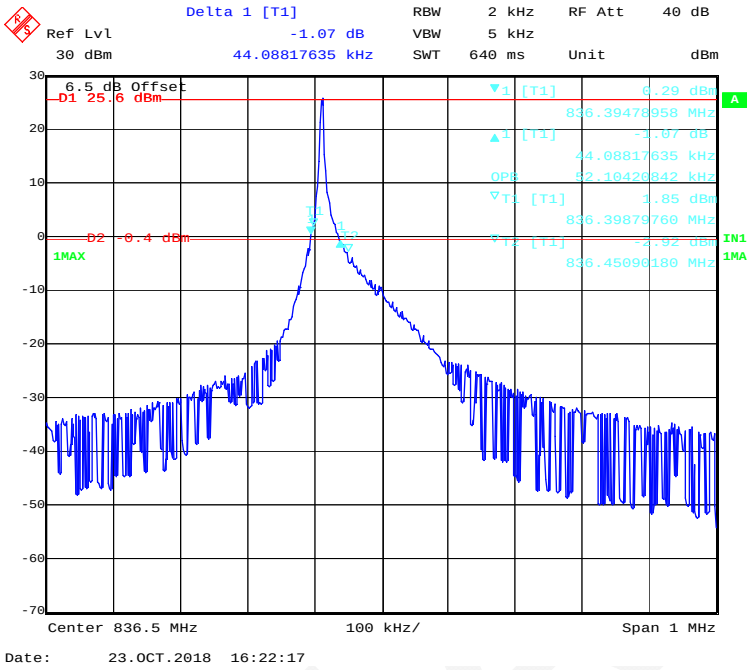
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



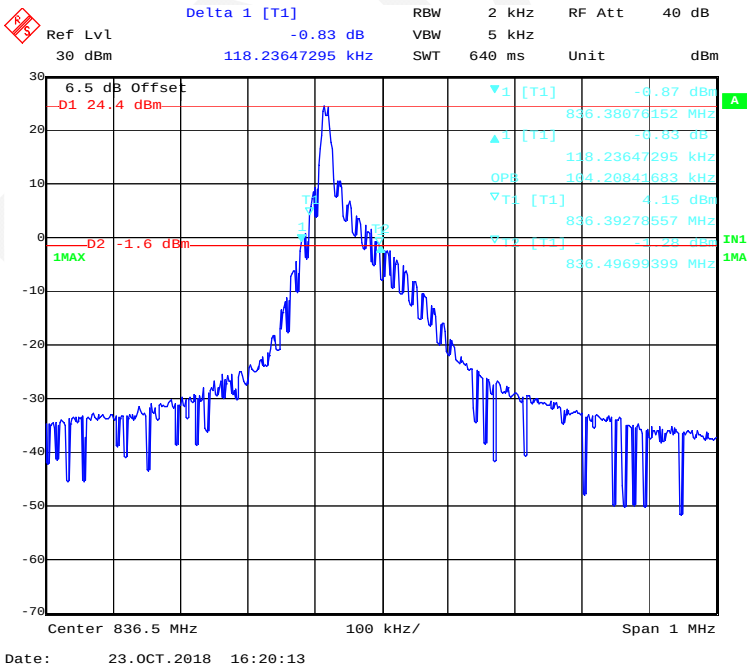
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



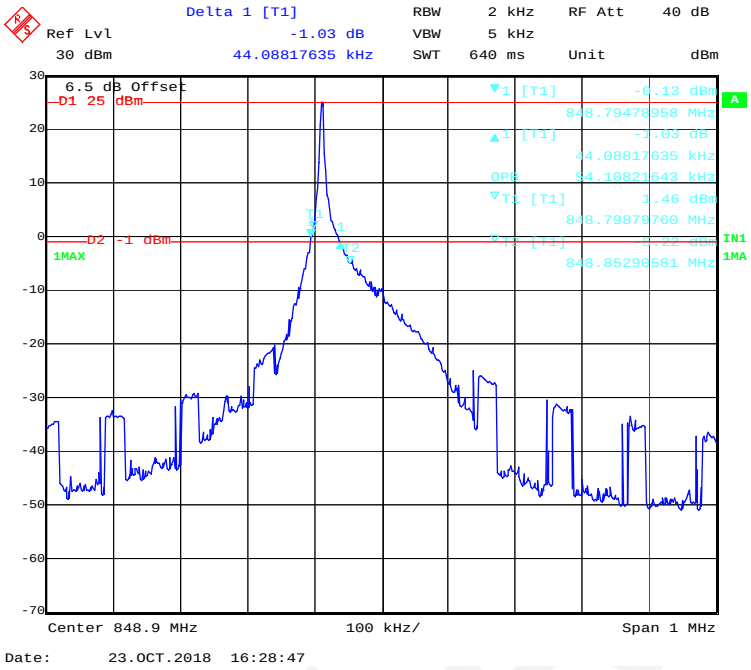
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



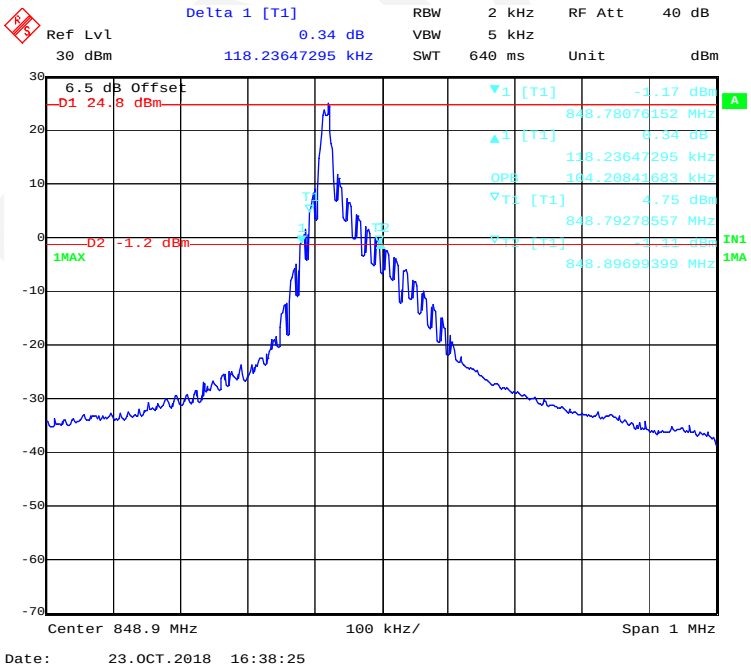
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



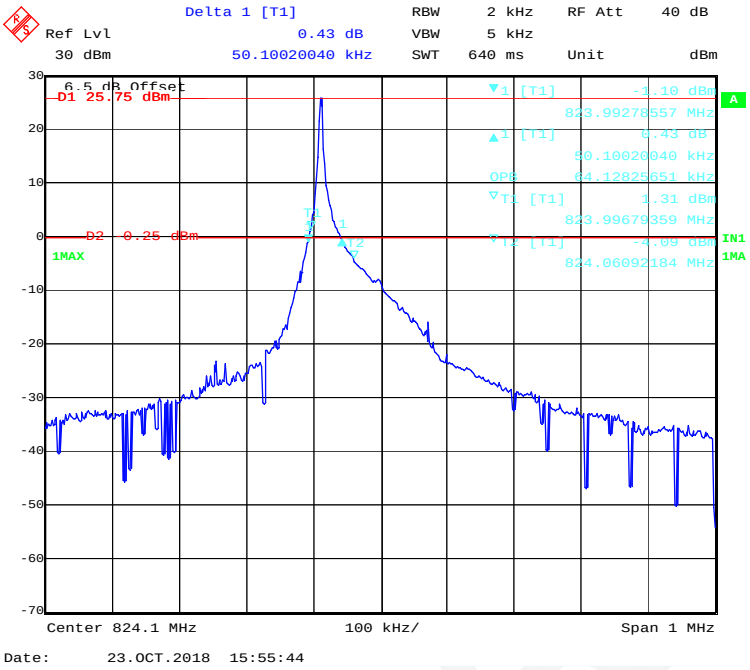
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



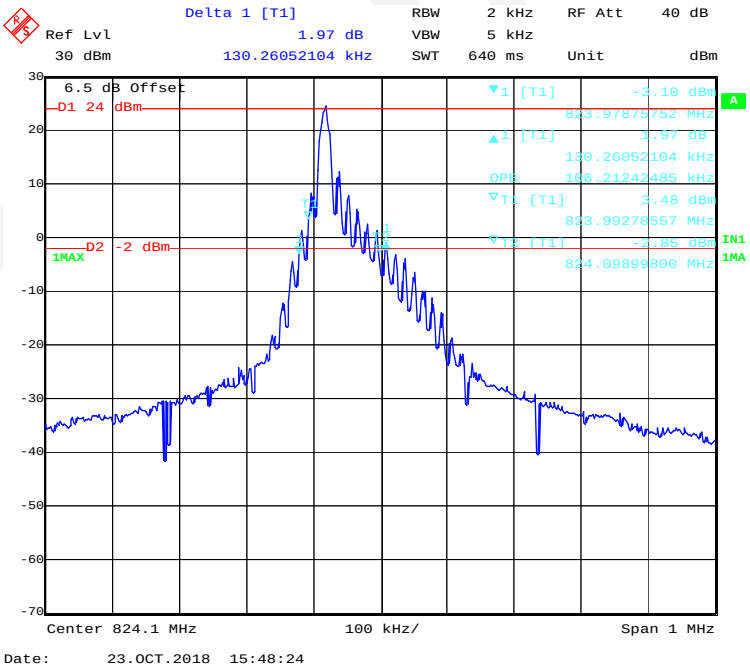
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



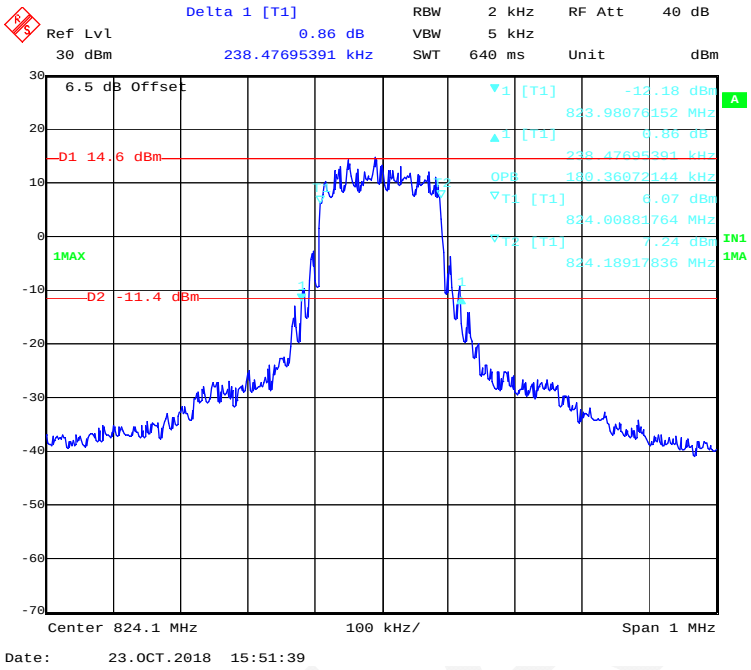
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



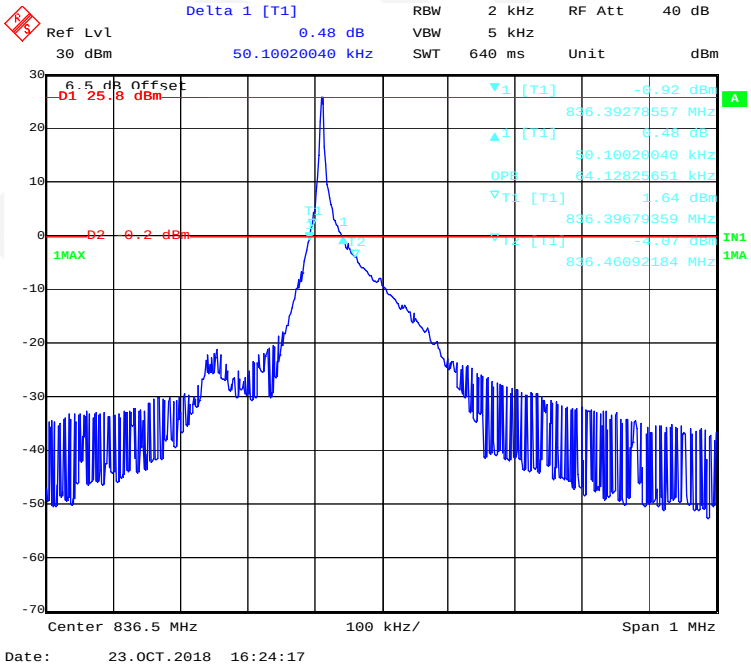
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



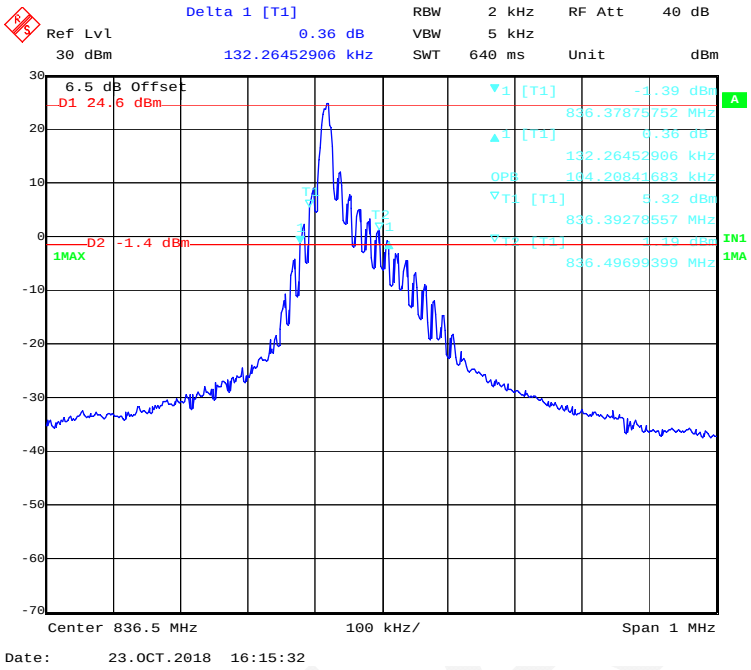
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



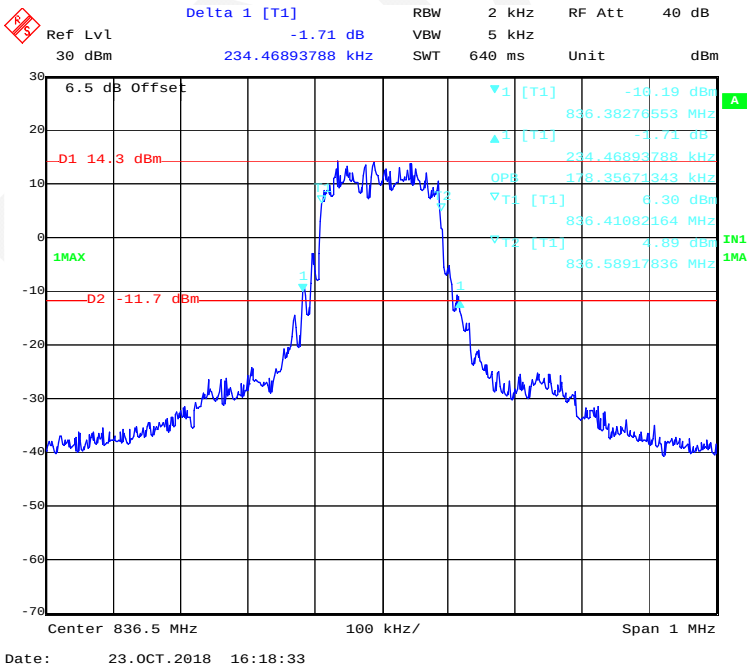
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



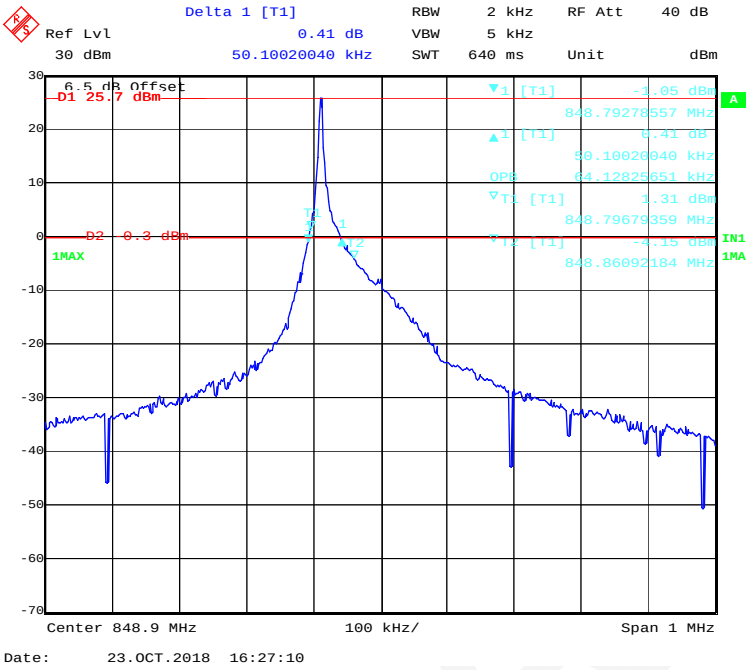
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



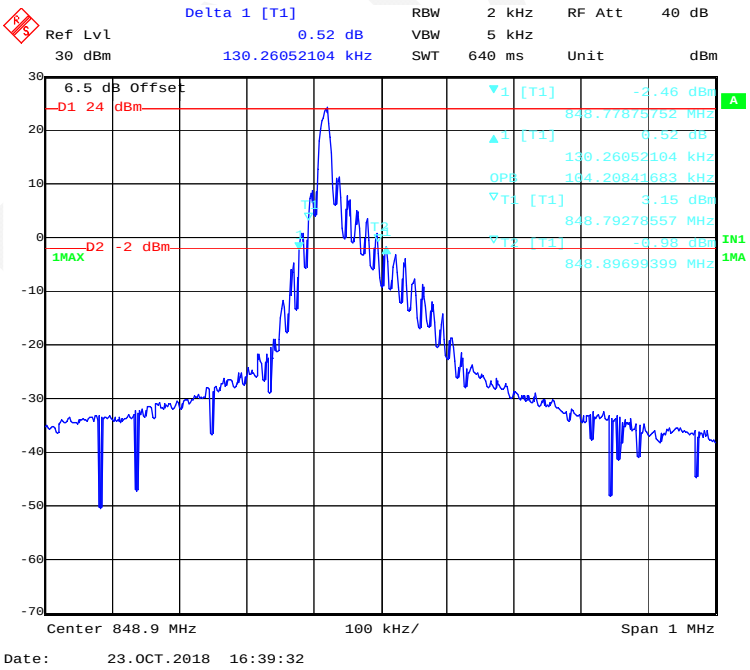
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



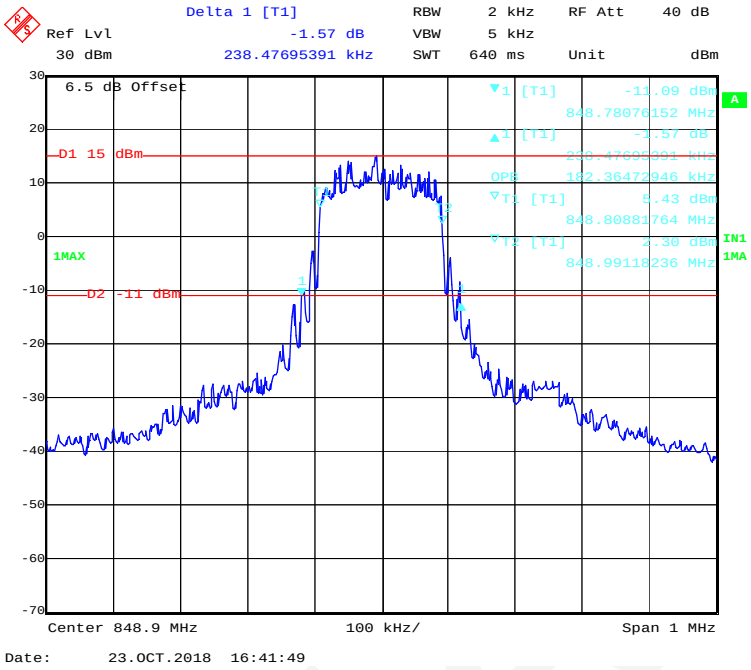
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



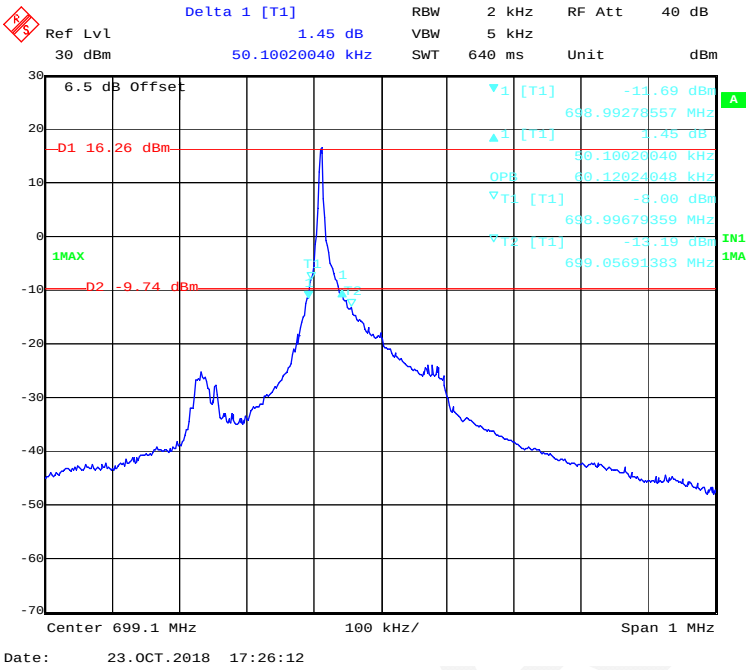
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



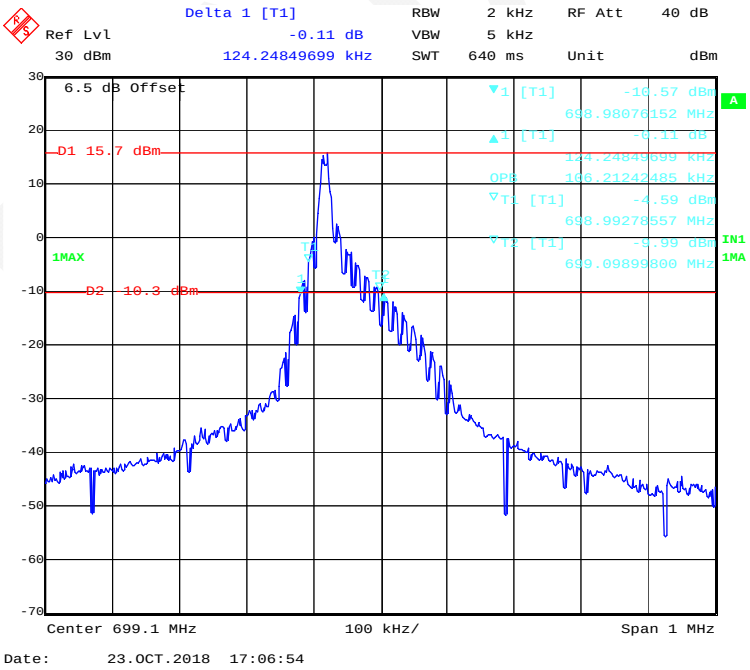
NB-IoT Band 12:

Test Modulation	Sub-carrier Spacing	Resource Block & RB offset	Test Channel	26 dB Bandwidth	99% Occupied Bandwidth
				MHz	MHz
BPSK	3.75kHz	1#0	Low	0.050	0.060
	15kHz	1#0		0.124	0.106
	3.75kHz	1#0	Middle	0.044	0.054
	15kHz	1#0		0.122	0.108
	3.75kHz	1#0	High	0.044	0.054
	15kHz	1#0		0.124	0.106
QPSK	3.75kHz	1#0	Low	0.050	0.062
	15kHz	1#0		0.130	0.106
	15kHz	12#0		0.236	0.178
	3.75kHz	1#0	Middle	0.050	0.062
	15kHz	1#0		0.128	0.106
	15kHz	12#0		0.232	0.182
	3.75kHz	1#0	High	0.050	0.064
	15kHz	1#0		0.130	0.102
	15kHz	12#0		0.234	0.178

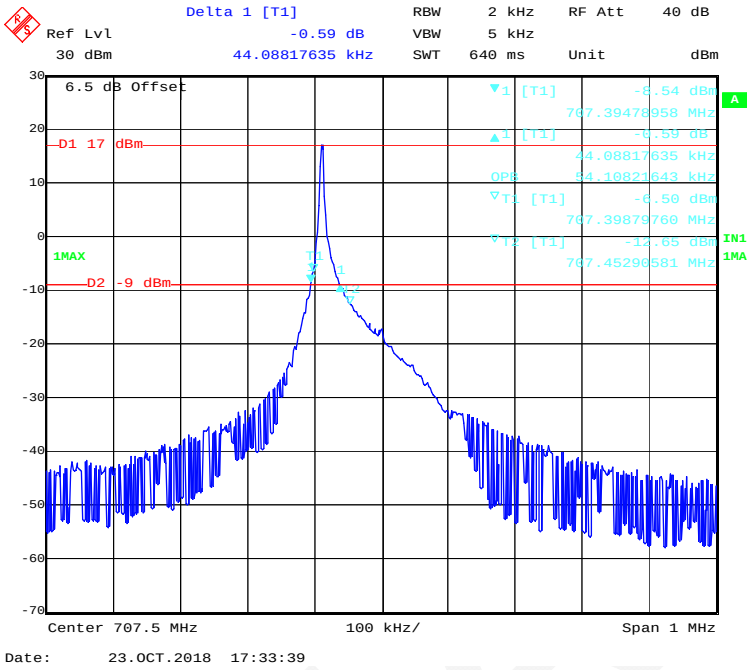
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



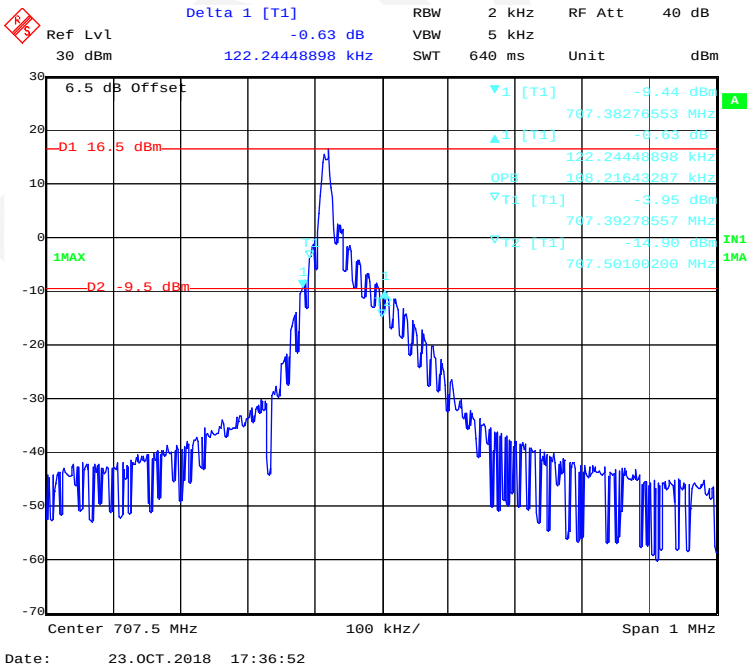
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



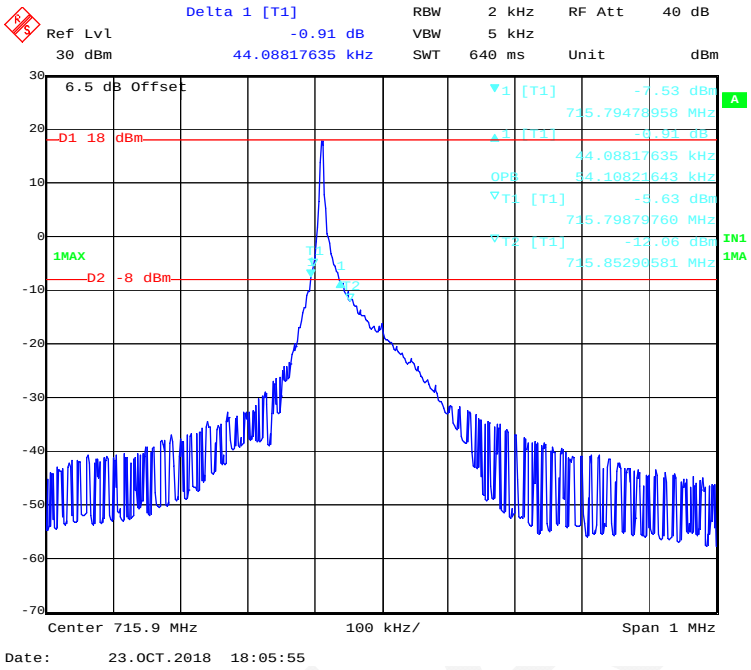
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



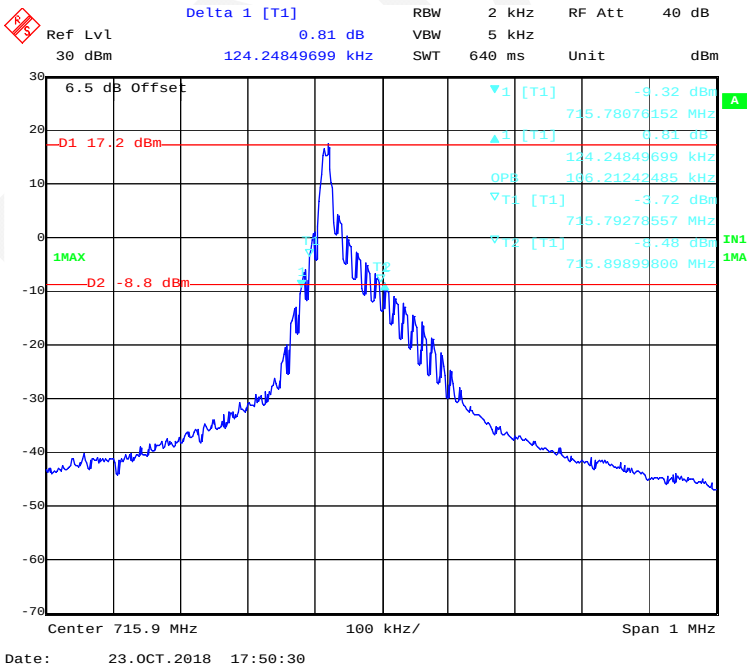
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



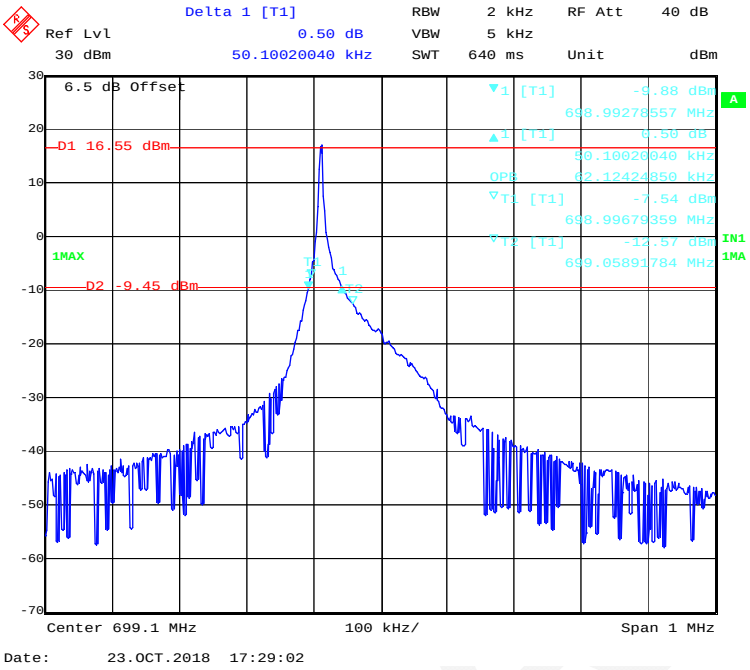
BPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



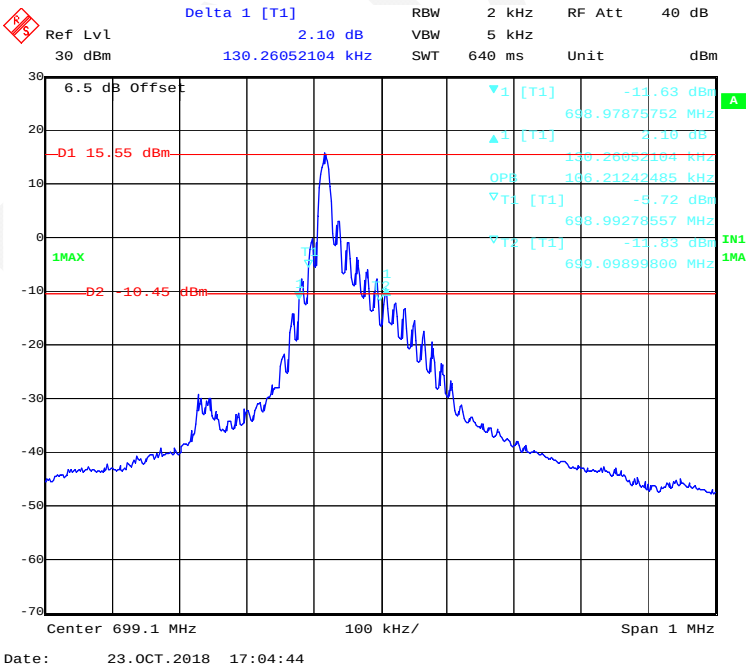
BPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



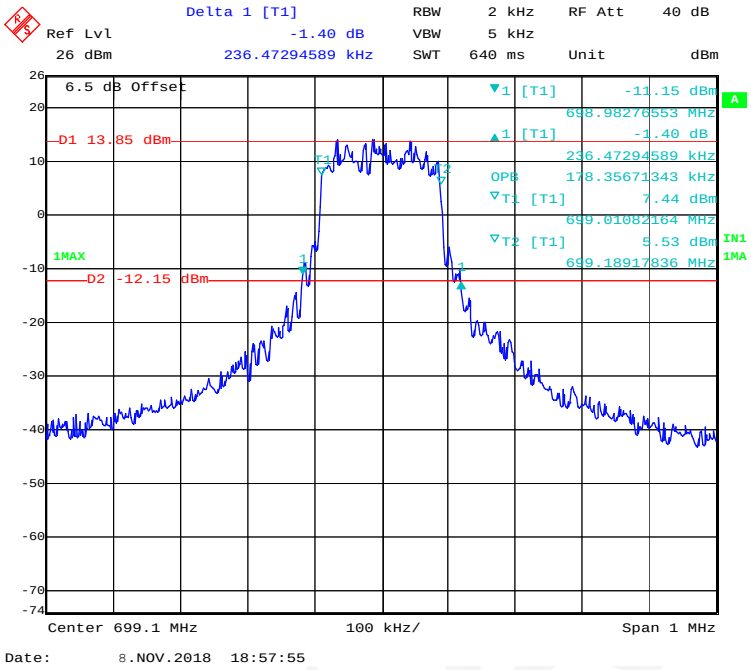
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



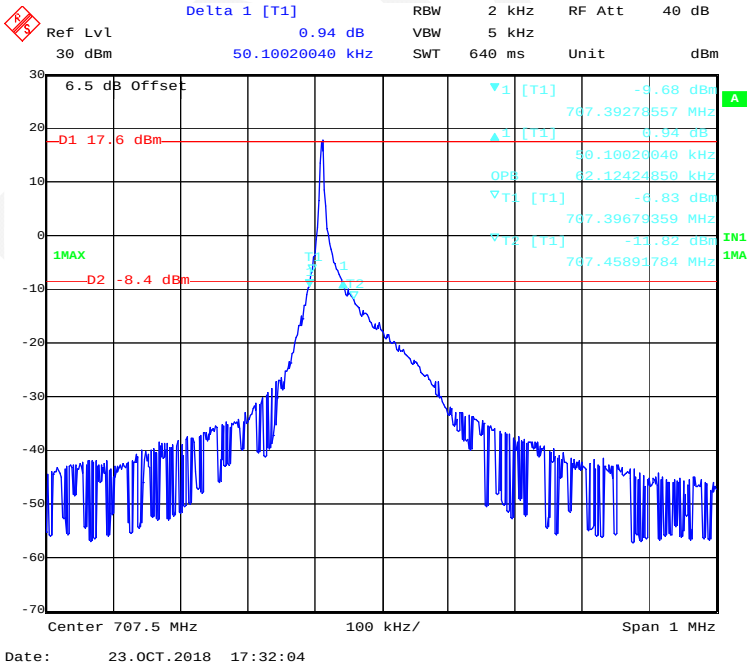
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



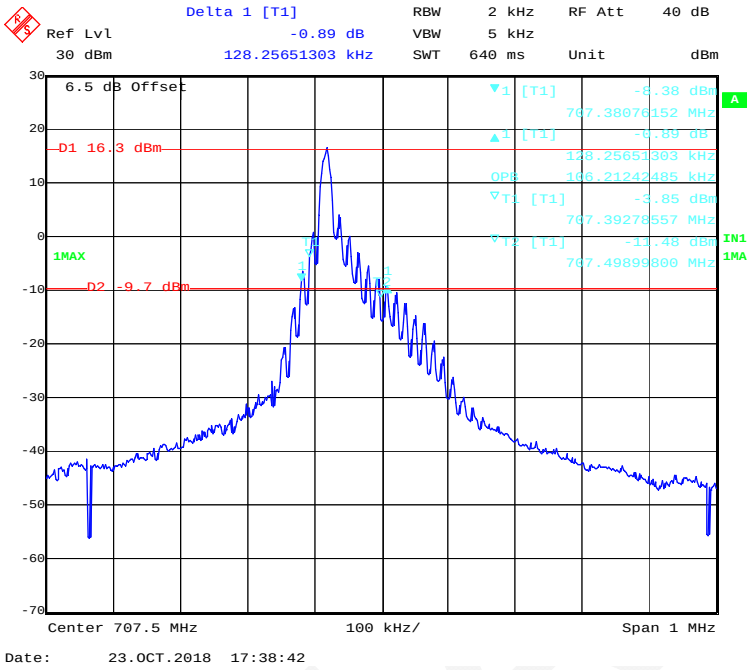
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Low channel



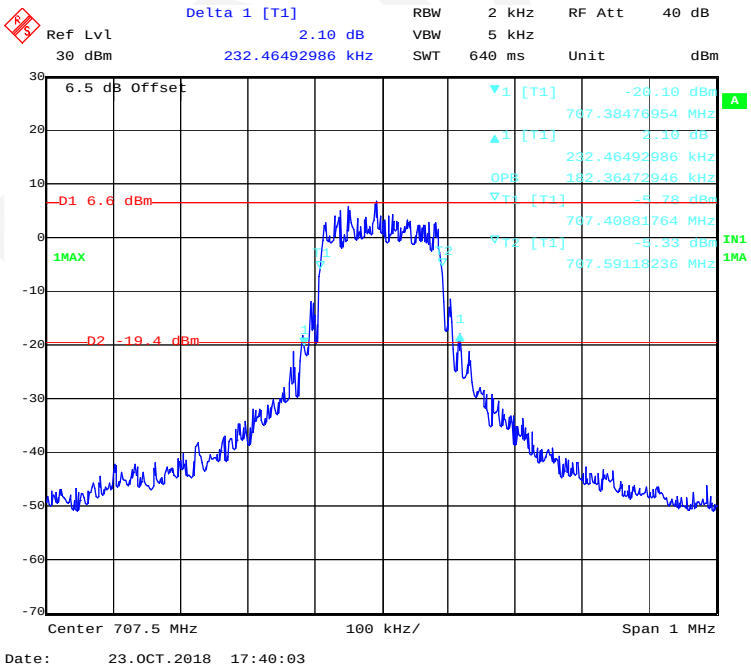
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



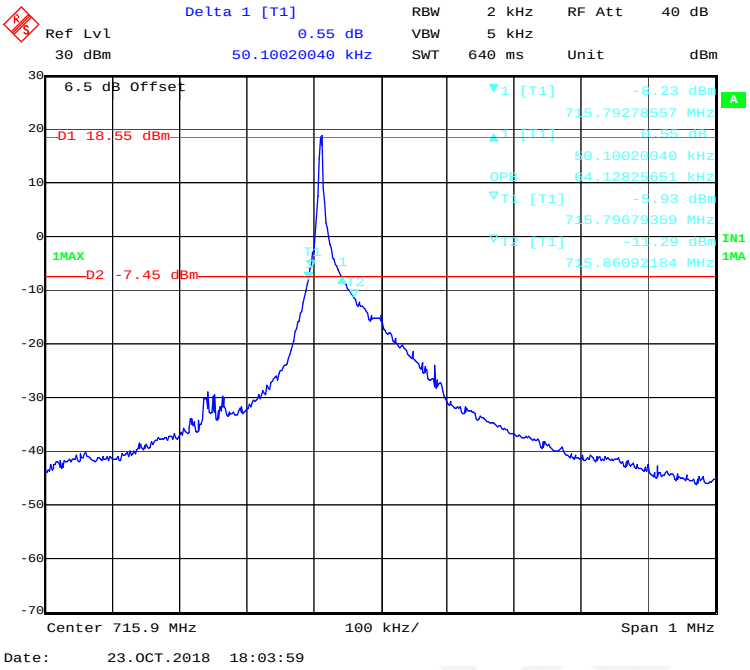
QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



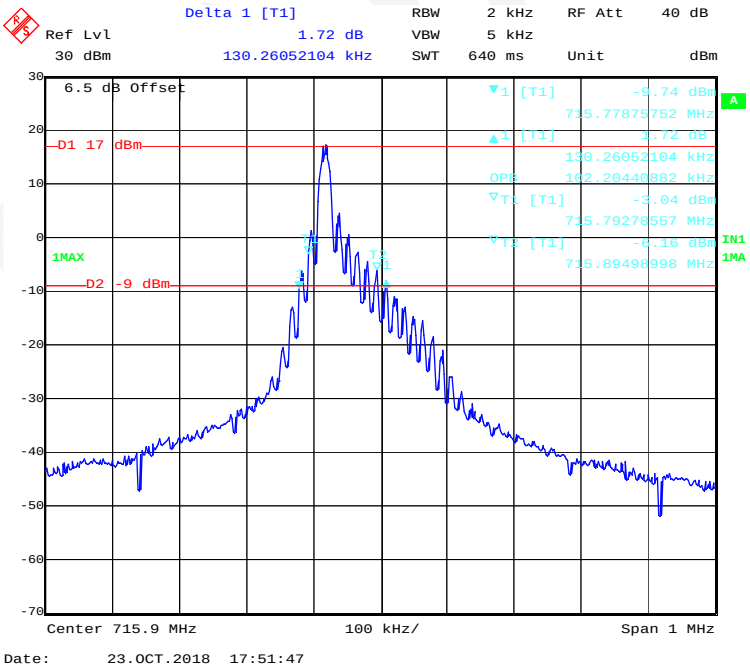
QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, Middle channel



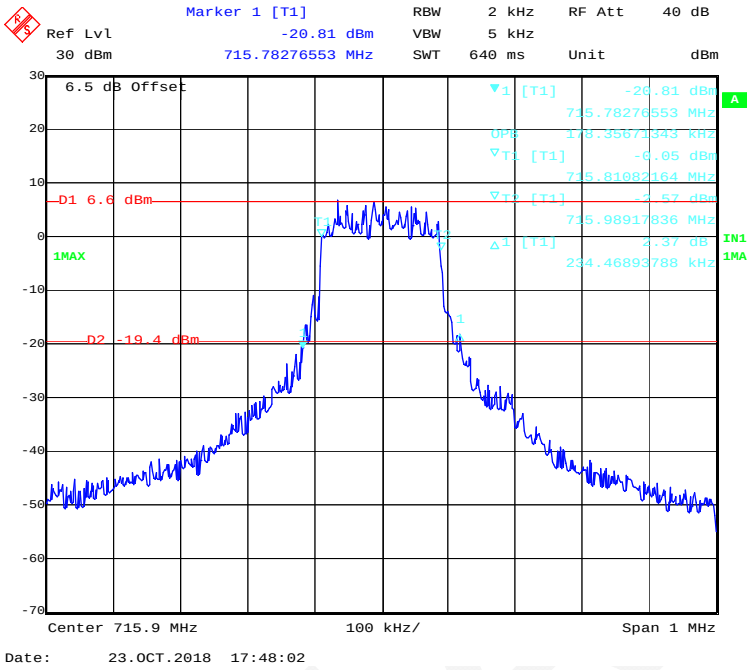
QPSK (3.75kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



QPSK (15kHz,1#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



QPSK (15kHz,12#0) - 99% Occupied & 26 dB Emissions Bandwidth, High channel



FCC § 2.1051; § 22.917 (a); § 24.238 (a); §27.53 (g) - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

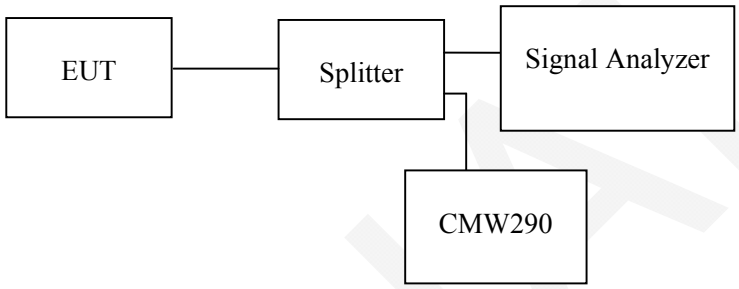
Applicable Standards

FCC §2.1051, §22.917(a) and §24.238(a) and §27.53(g) (m).

The spectrum was to be investigated to the tenth harmonics of the highest fundamental frequency as specified in § 2.1051.

Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer and simulator through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for below 1GHz & 1MHz for above 1GHz. sufficient scans were taken to show any out of band emissions up to 10th harmonic.



Test Data

Environmental Conditions

Temperature:	23.2℃
Relative Humidity:	51 %
ATM Pressure:	101.3kPa

The testing was performed by Hope Zhang on 2018-10-23 & 2018-11-08.

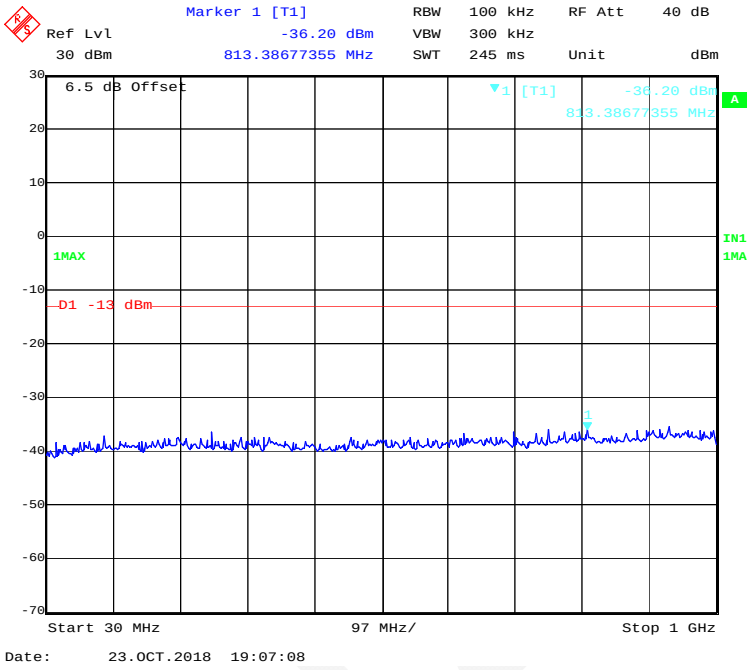
EUT operation mode: Transmitting

*(Data for the **worst case** with **15 kHz subcarrier spacing and QPSK mode** was recorded)*

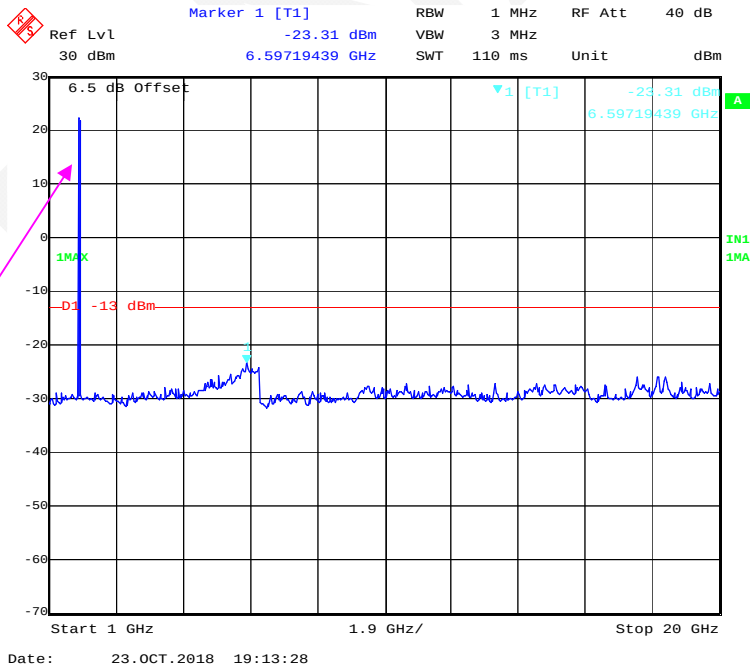
Test Result: Compliance.

NB-IoT Band 2:

30 MHz - 1 GHz, Low Channel

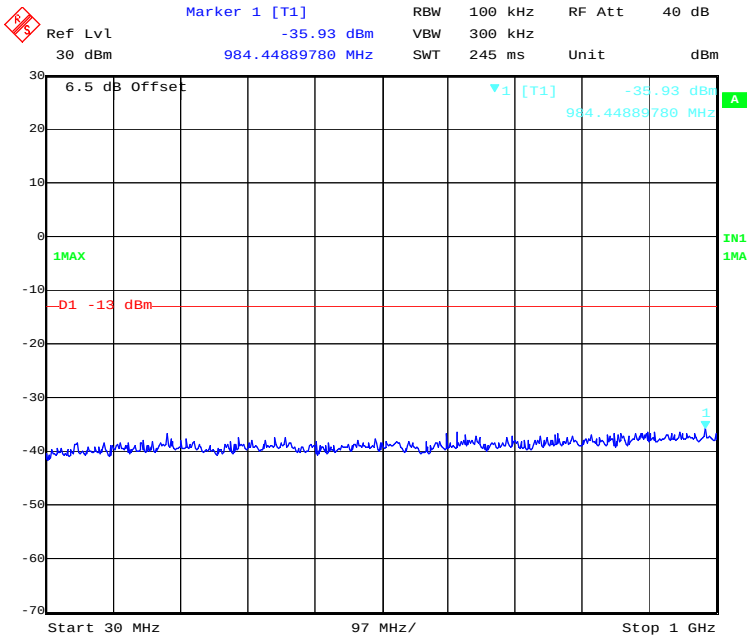


1 GHz – 20 GHz, Low Channel

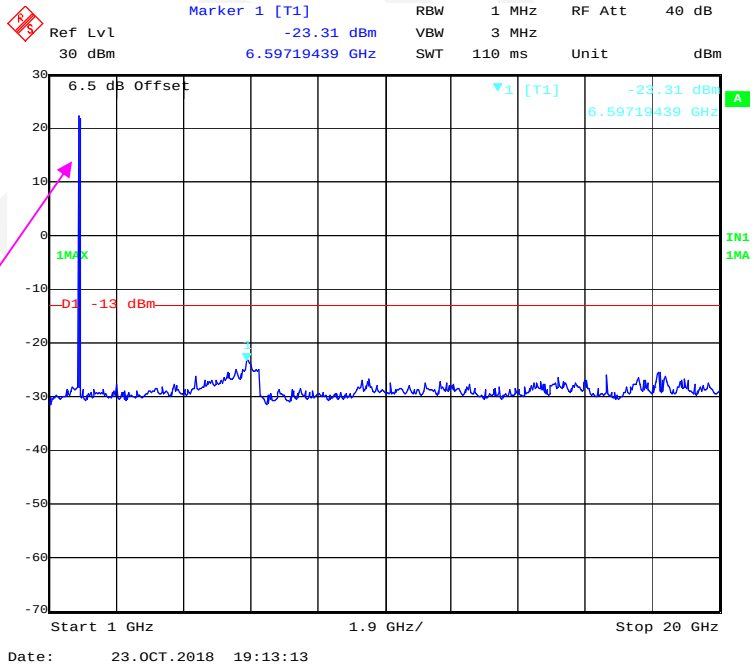


Fundamental

30 MHz - 1 GHz, Middle Channel

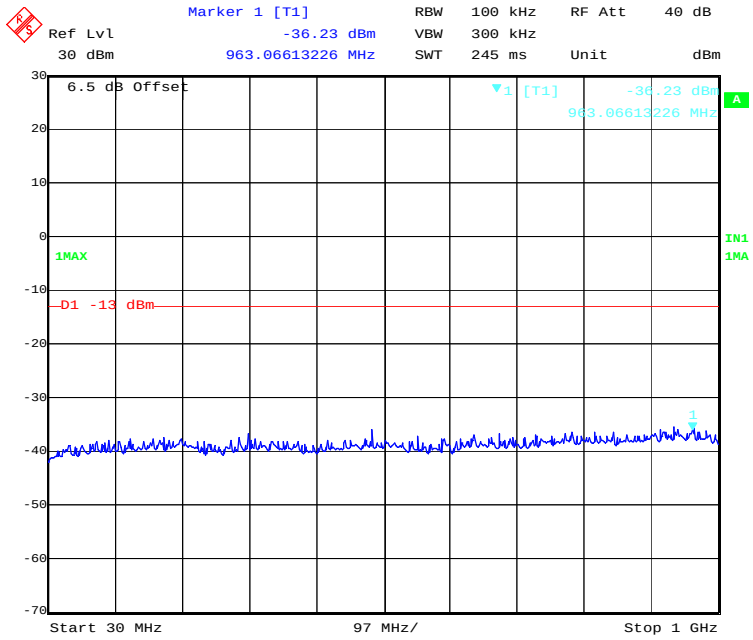


1 GHz – 20 GHz, Middle Channel

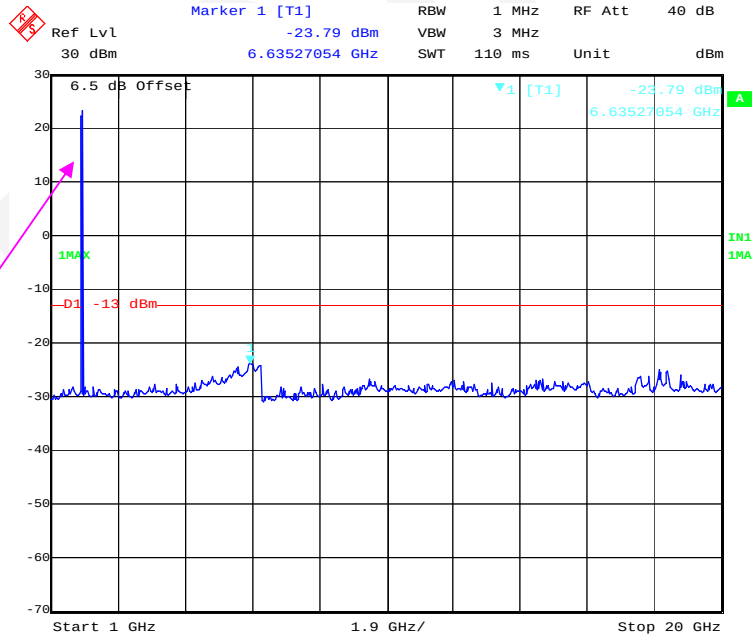


Fundamental

30 MHz - 1 GHz, High Channel



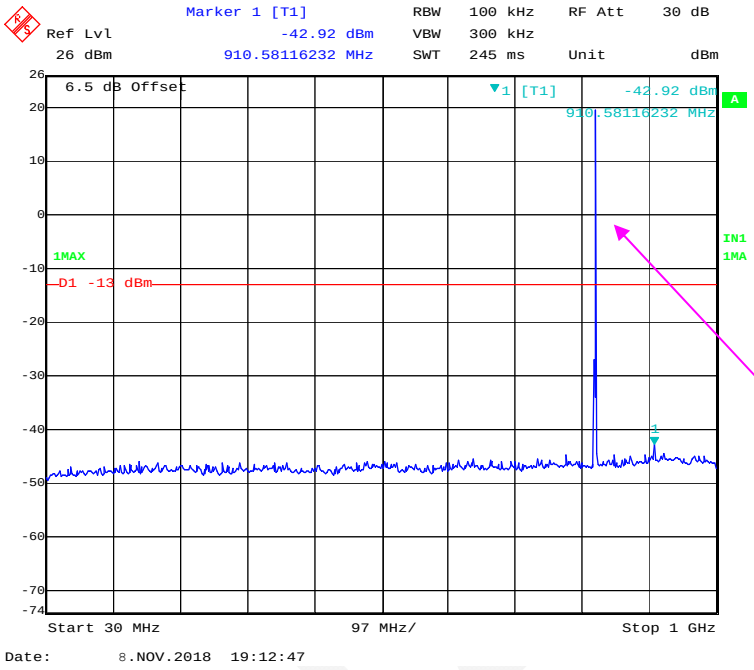
1 GHz – 20 GHz, High Channel



Fundamental

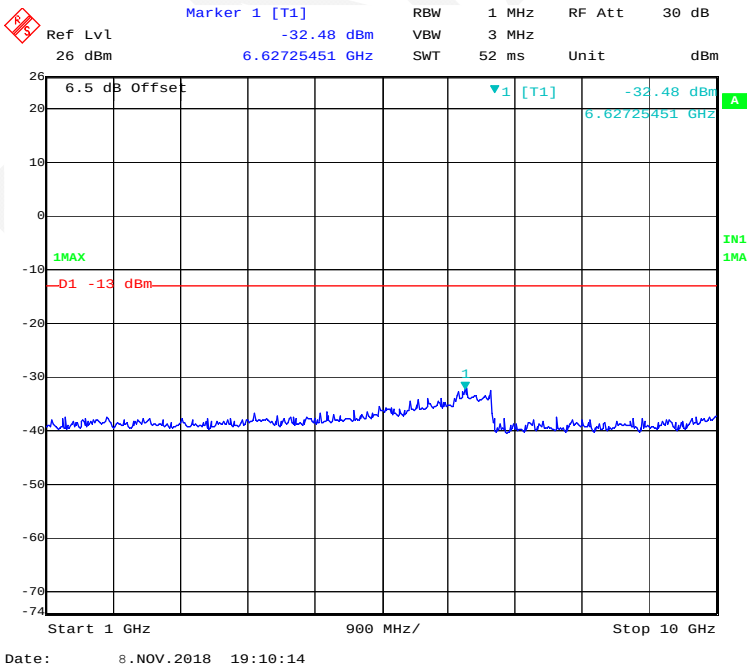
NB-IoT Band 5:

30 MHz - 1 GHz, Low Channel

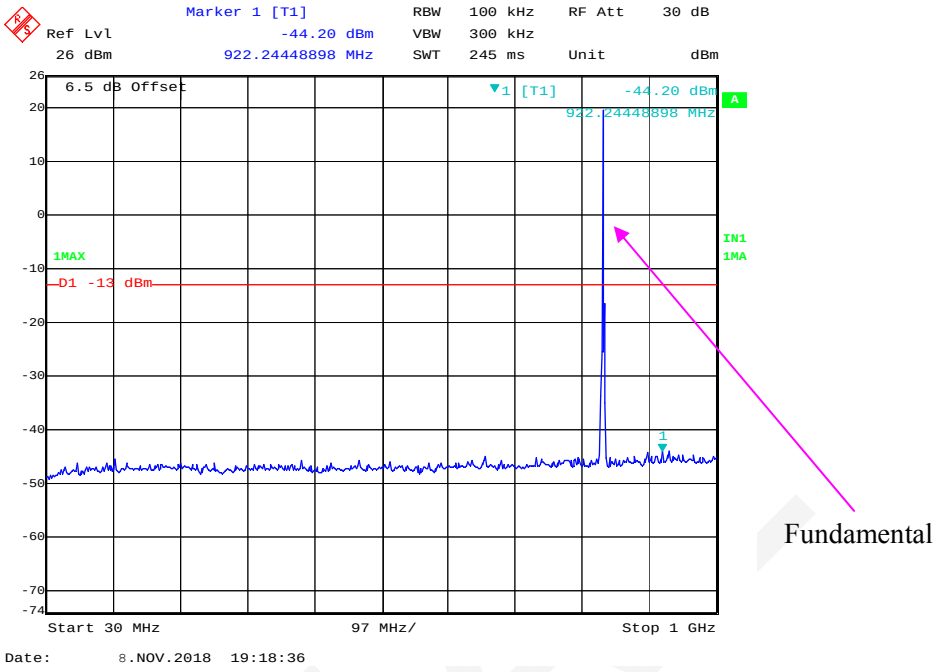


Fundamental

1 GHz – 10 GHz, Low Channel

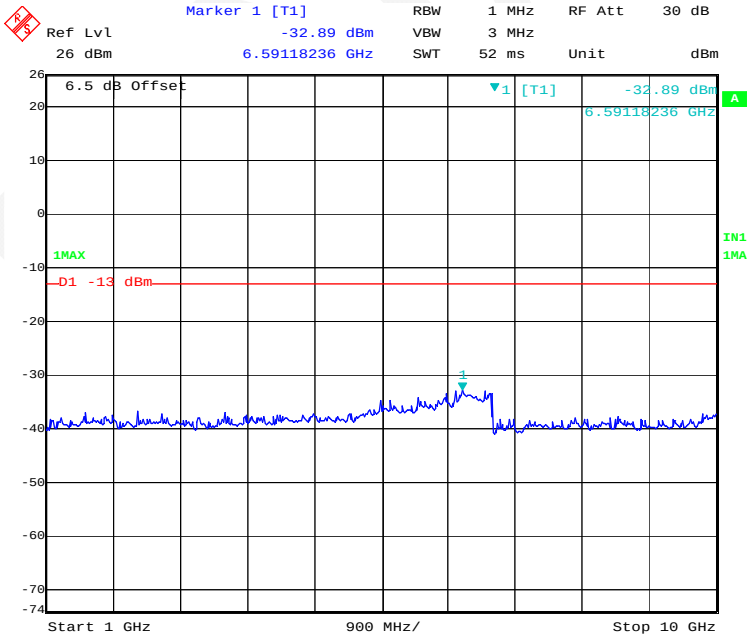


30 MHz - 1 GHz, Middle Channel



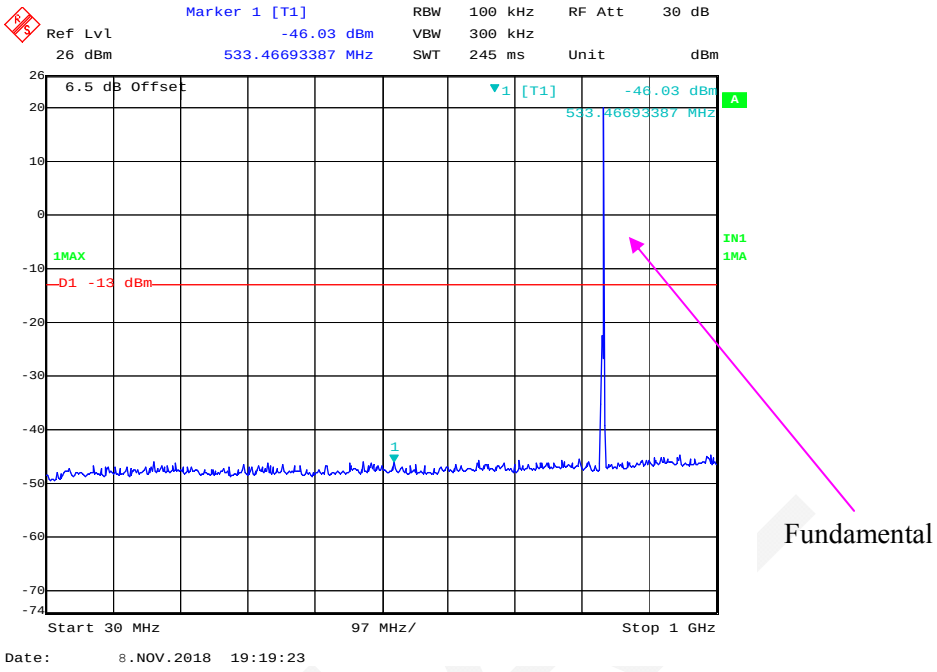
Date: 8.NOV.2018 19:18:36

1 GHz – 10 GHz, Middle Channel



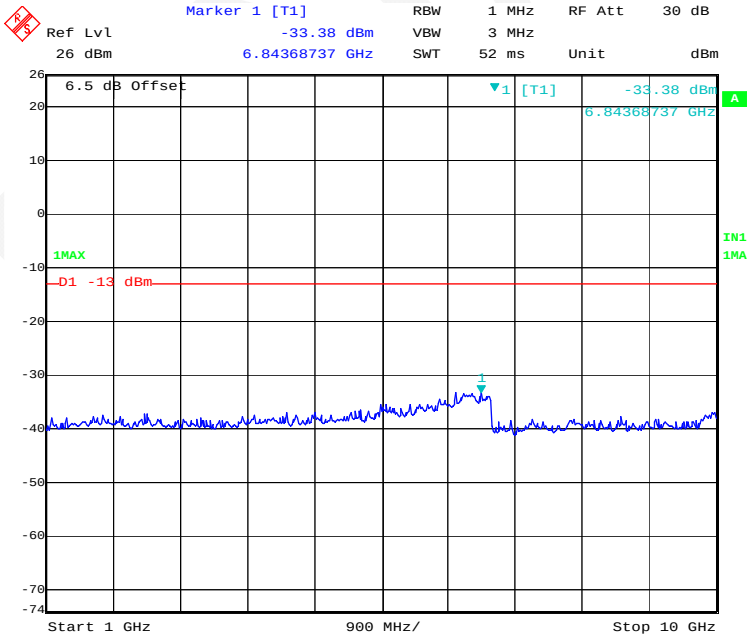
Date: 8.NOV.2018 19:10:45

30 MHz - 1 GHz, High Channel



Date: 8.NOV.2018 19:19:23

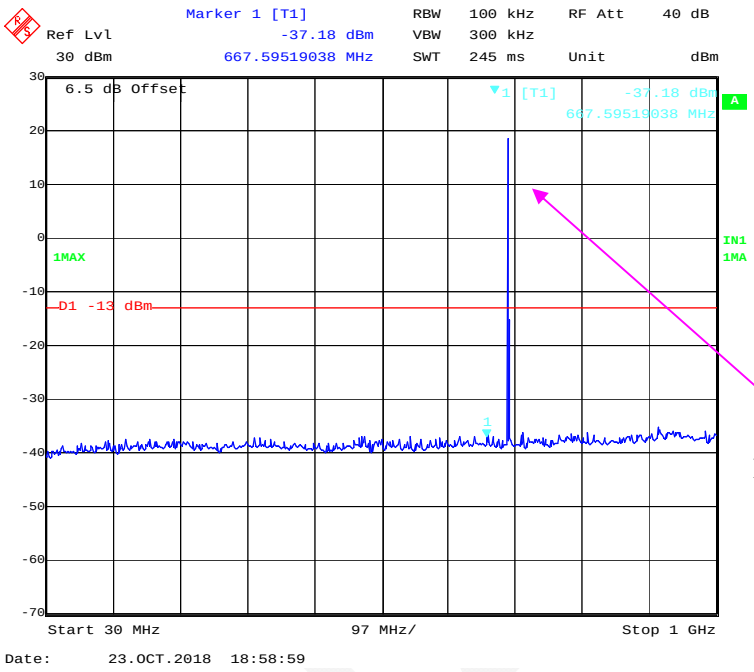
1 GHz – 10 GHz, High Channel



Date: 8.NOV.2018 19:11:10

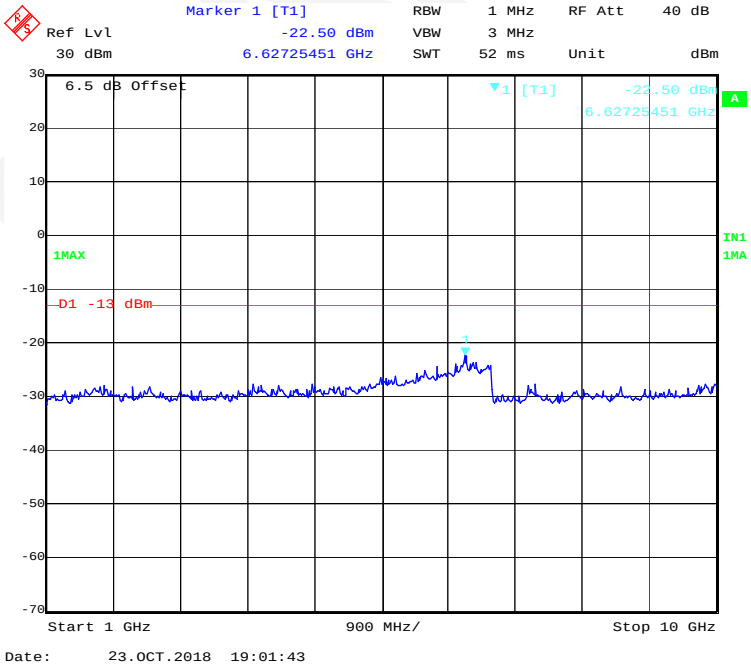
NB-IoT Band 12:

30 MHz - 1 GHz, Low Channel

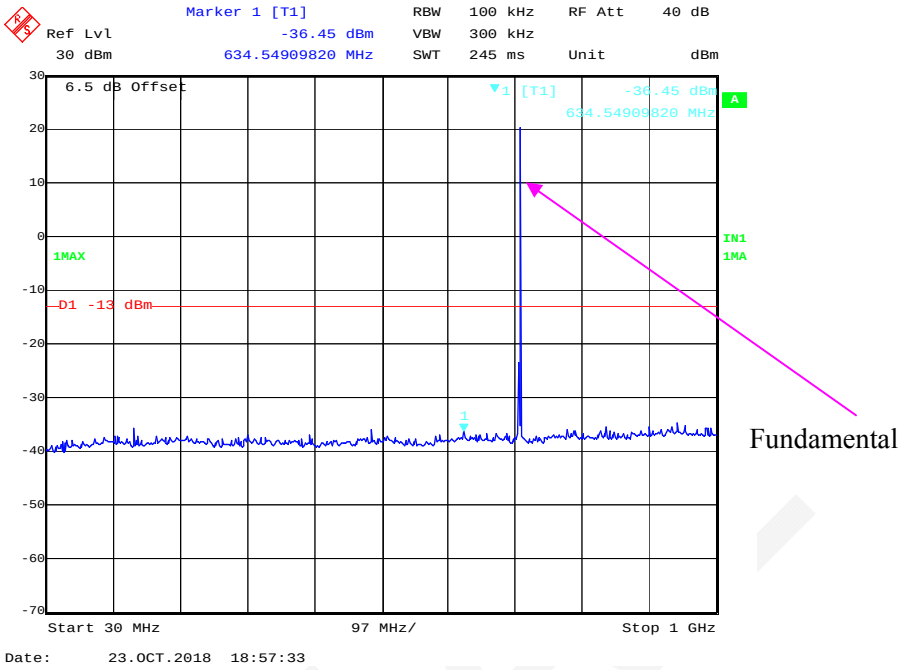


Fundamental

1 GHz – 10 GHz, Low Channel

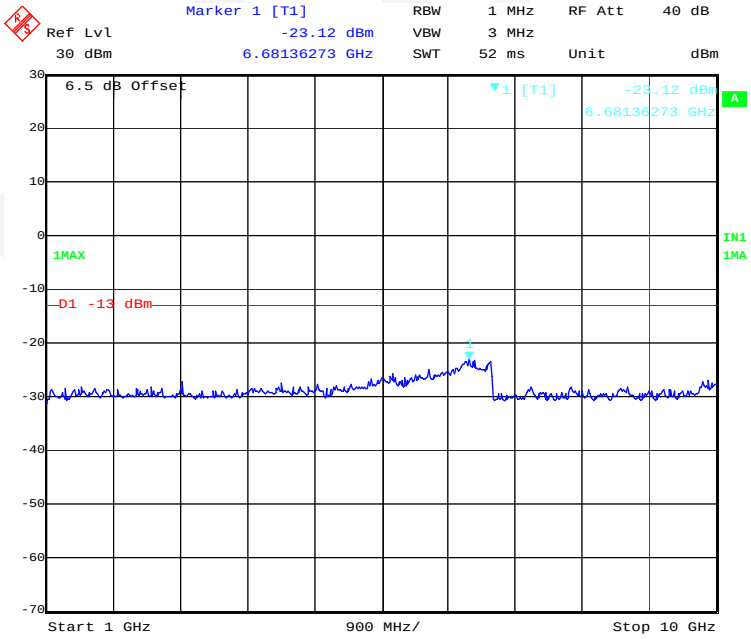


30 MHz - 1 GHz, Middle Channel



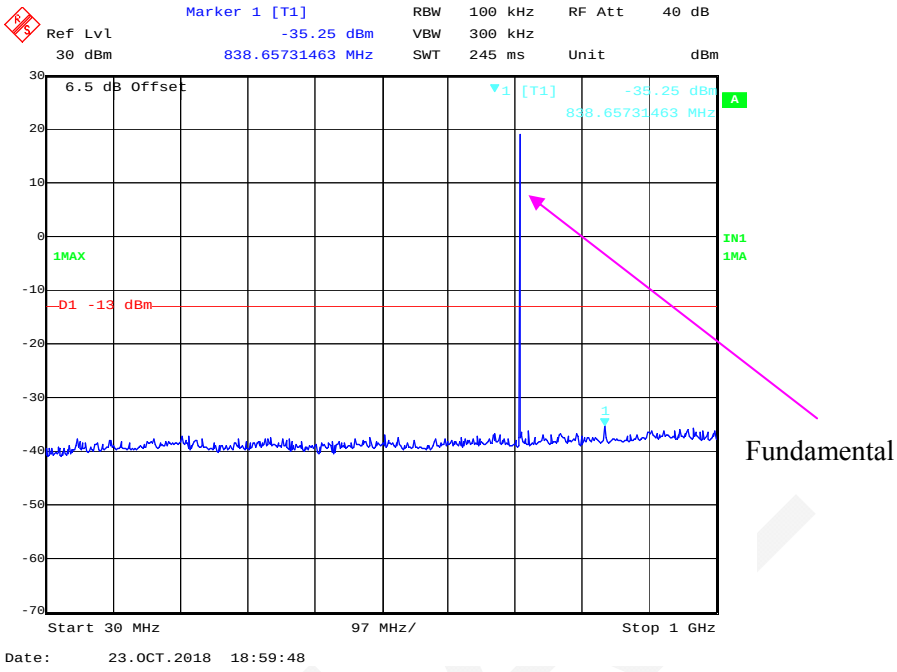
Date: 23.OCT.2018 18:57:33

1 GHz – 10 GHz, Middle Channel



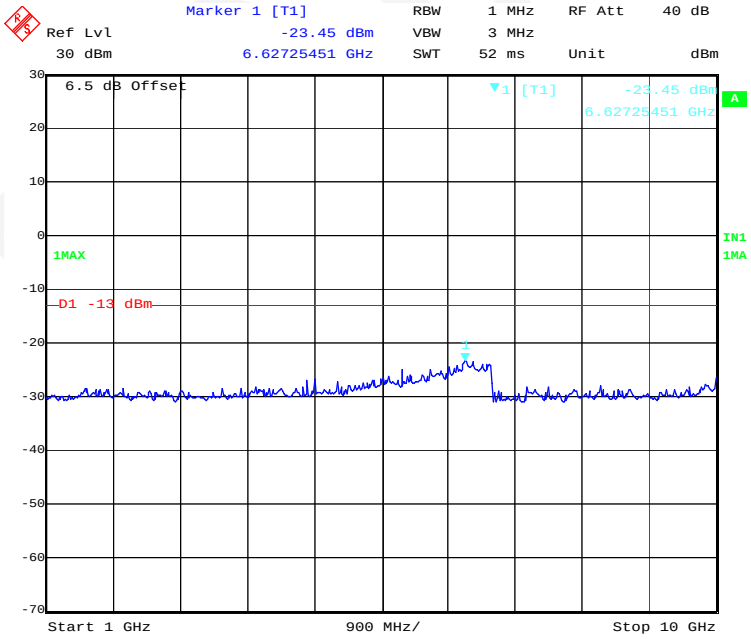
Date: 23.OCT.2018 19:01:16

30 MHz - 1 GHz, High Channel



Date: 23.OCT.2018 18:59:48

1 GHz – 10 GHz, High Channel



Date: 23.OCT.2018 19:00:38

FCC § 2.1053; § 22.917 (a); § 24.238 (a); §27.53 (g) - SPURIOUS RADIATED EMISSIONS

Applicable Standards

FCC § 2.1053, §22.917(a) and § 24.238(a) and § 27.53(g) (m)

22.917 (a) Out of band emissions. 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.

24.238 (a) Out of band emissions. 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.

27.53(g) (m), 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.

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = 10 lg (TX pwr in Watts/0.001) – the absolute level

Spurious attenuation limit in dB = 43 + 10 Log_{10} (power out in Watts)

Test Data

Environmental Conditions

Temperature:	23.2℃
Relative Humidity:	51 %
ATM Pressure:	101.3kPa

The testing was performed by Hope Zhang on 2018-10-20.

Test mode: Transmitting (Pre-scan with low, middle and high channels, and the worse case data as below)

30 MHz ~ 20 GHz:

NB-IoT Band 2

Frequency (MHz)	Receiver Reading (dBμV)	Turntable Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height (cm)	Polar (H/V)	Submitted Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd/dBi)			
BPSK, 3.75kHz, Middle Channel										
559.98	38.89	77	189	H	-65.61	0.58	-1.17	-67.36	-13	54.36
559.98	37.67	105	176	V	-63.07	0.58	-1.17	-64.82	-13	51.82
3760.00	43.56	323	150	H	-53.15	0.95	9.74	-44.36	-13	31.36
3760.00	44.13	253	241	V	-52.75	0.95	9.74	-43.96	-13	30.96
5640.00	50.54	162	207	H	-43.39	1.15	10.47	-34.07	-13	21.07
5640.00	51.10	254	168	V	-42.86	1.15	10.47	-33.54	-13	20.54
BPSK, 15kHz, Middle Channel										
559.98	37.98	334	133	H	-66.52	0.58	-1.17	-68.27	-13	55.27
559.98	38.23	101	184	V	-62.51	0.58	-1.17	-64.26	-13	51.26
3760.00	44.23	146	167	H	-52.48	0.95	9.74	-43.69	-13	30.69
3760.00	44.29	67	231	V	-52.59	0.95	9.74	-43.80	-13	30.80
5640.00	45.78	107	153	H	-48.15	1.15	10.47	-38.83	-13	25.83
5640.00	45.12	76	134	V	-48.84	1.15	10.47	-39.52	-13	26.52
QPSK, 3.75kHz, Middle Channel										
559.98	39.89	248	230	H	-64.61	0.58	-1.17	-66.36	-13	53.36
559.98	38.26	183	133	V	-62.48	0.58	-1.17	-64.23	-13	51.23
3760.00	44.23	195	201	H	-52.48	0.95	9.74	-43.69	-13	30.69
3760.00	43.78	336	103	V	-53.10	0.95	9.74	-44.31	-13	31.31
5640.00	45.23	293	101	H	-48.70	1.15	10.47	-39.38	-13	26.38
5640.00	46.13	52	155	V	-47.83	1.15	10.47	-38.51	-13	25.51
QPSK, 15kHz, Middle Channel										
559.98	39.78	164	248	H	-64.72	0.58	-1.17	-66.47	-13	53.47
559.98	38.89	217	127	V	-61.85	0.58	-1.17	-63.60	-13	50.60
3760.00	44.32	206	250	H	-52.39	0.95	9.74	-43.60	-13	30.60
3760.00	43.56	180	193	V	-53.32	0.95	9.74	-44.53	-13	31.53
5640.00	45.67	24	247	H	-48.26	1.15	10.47	-38.94	-13	25.94
5640.00	45.58	49	164	V	-48.38	1.15	10.47	-39.06	-13	26.06

30 MHz ~ 10 GHz:

NB-IoT Band 5

Frequency (MHz)	Receiver Reading (dBμV)	Turntable Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height (cm)	Polar (H/V)	Submitted Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd/dBi)			
BPSK, 3.75kHz, Middle Channel										
237.20	38.59	336	230	H	-63.91	0.43	-2.69	-67.03	-13	54.03
237.20	40.50	265	111	V	-68.02	0.43	-2.69	-71.14	-13	58.14
1673.00	73.21	321	233	H	-30.18	0.84	8.48	-22.54	-13	9.54
1673.00	72.67	223	103	V	-31.22	0.84	8.48	-23.58	-13	10.58
2509.50	74.54	178	216	H	-26.41	0.89	10.09	-17.21	-13	4.21
2509.50	73.56	324	153	V	-27.38	0.89	10.09	-18.18	-13	5.18
BPSK, 15kHz, Middle Channel										
237.20	40.12	136	193	H	-62.38	0.43	-2.69	-65.50	-13	52.50
237.20	41.49	30	142	V	-67.03	0.43	-2.69	-70.15	-13	57.15
1673.00	72.19	52	108	H	-31.20	0.84	8.48	-23.56	-13	10.56
1673.00	71.98	222	203	V	-31.91	0.84	8.48	-24.27	-13	11.27
2509.50	74.50	248	221	H	-26.45	0.89	10.09	-17.25	-13	4.25
2509.50	75.01	151	172	V	-25.93	0.89	10.09	-16.73	-13	3.73
QPSK, 3.75kHz, Middle Channel										
237.20	40.34	20	165	H	-62.16	0.43	-2.69	-65.28	-13	52.28
237.20	39.98	138	229	V	-68.54	0.43	-2.69	-71.66	-13	58.66
1673.00	72.98	338	172	H	-30.41	0.84	8.48	-22.77	-13	9.77
1673.00	73.09	58	239	V	-30.80	0.84	8.48	-23.16	-13	10.16
2509.50	74.58	44	238	H	-26.37	0.89	10.09	-17.17	-13	4.17
2509.50	75.09	187	192	V	-25.85	0.89	10.09	-16.65	-13	3.65
QPSK, 15kHz, Middle Channel										
237.20	39.01	64	220	H	-63.49	0.43	-2.69	-66.61	-13	53.61
237.20	40.68	89	119	V	-67.84	0.43	-2.69	-70.96	-13	57.96
1673.00	72.19	178	124	H	-31.20	0.84	8.48	-23.56	-13	10.56
1673.00	73.02	97	130	V	-30.87	0.84	8.48	-23.23	-13	10.23
2509.50	75.07	357	207	H	-25.88	0.89	10.09	-16.68	-13	3.68
2509.50	74.98	195	202	V	-25.96	0.89	10.09	-16.76	-13	3.76

NB-IoT Band 12

Frequency (MHz)	Receiver Reading (dBμV)	Turntable Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height (cm)	Polar (H/V)	Submitted Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd/dBi)			
BPSK, 3.75kHz, Middle Channel										
376.00	39.08	82	159	H	-67.63	0.51	-1.54	-69.68	-13	56.68
376.00	40.21	166	235	V	-64.10	0.51	-1.54	-66.15	-13	53.15
1415.00	69.54	120	213	H	-35.43	0.83	8.56	-27.70	-13	14.70
1415.00	70.78	217	169	V	-34.78	0.83	8.56	-27.05	-13	14.05
2122.50	73.45	180	101	H	-27.81	0.86	9.27	-19.40	-13	6.40
2122.50	72.46	224	208	V	-29.08	0.86	9.27	-20.67	-13	7.67
BPSK, 15kHz, Middle Channel										
376.00	39.09	271	227	H	-67.62	0.51	-1.54	-69.67	-13	56.67
376.00	40.01	315	219	V	-64.30	0.51	-1.54	-66.35	-13	53.35
1415.00	69.46	47	151	H	-35.51	0.83	8.56	-27.78	-13	14.78
1415.00	70.34	355	157	V	-35.22	0.83	8.56	-27.49	-13	14.49
2122.50	73.78	289	196	H	-27.48	0.86	9.27	-19.07	-13	6.07
2122.50	74.23	20	115	V	-27.31	0.86	9.27	-18.90	-13	5.90
QPSK, 3.75kHz, Middle Channel										
376.00	40.34	140	167	H	-66.37	0.51	-1.54	-68.42	-13	55.42
376.00	41.23	324	186	V	-63.08	0.51	-1.54	-65.13	-13	52.13
1415.00	69.97	132	161	H	-35.00	0.83	8.56	-27.27	-13	14.27
1415.00	70.21	222	216	V	-35.35	0.83	8.56	-27.62	-13	14.62
2122.50	73.76	266	211	H	-27.50	0.86	9.27	-19.09	-13	6.09
2122.50	74.09	166	235	V	-27.45	0.86	9.27	-19.04	-13	6.04
QPSK, 15kHz, Middle Channel										
376.00	41.21	107	185	H	-65.50	0.51	-1.54	-67.55	-13	54.55
376.00	40.22	105	124	V	-64.09	0.51	-1.54	-66.14	-13	53.14
1415.00	70.21	230	118	H	-34.76	0.83	8.56	-27.03	-13	14.03
1415.00	69.01	219	225	V	-36.55	0.83	8.56	-28.82	-13	15.82
2122.50	73.45	80	116	H	-27.81	0.86	9.27	-19.40	-13	6.40
2122.50	73.98	291	226	V	-27.56	0.86	9.27	-19.15	-13	6.15

Note:
1) Absolute Level (dBm) = Submitted Level (dBm) - Cable loss (dB) + Antenna Gain (dBd/dBi)
2) Margin (dB) = Limit (dBm) - Absolute Level (dBm)

FCC § 22.917 (a); § 24.238 (a); §27.53 (g) - BAND EDGES

Applicable Standards

According to § 22.917(a), the power of any emissions 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.

According to §24.238(a), the power of any emissions 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.

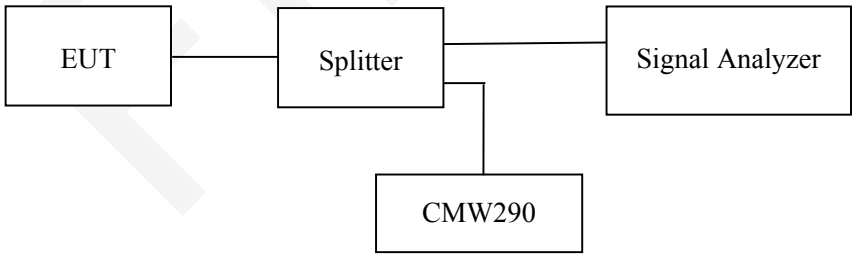
According to FCC §27.53 (h) (m), the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

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.

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The center of the spectrum analyzer was set to block edge frequency.



Test Data

Environmental Conditions

Temperature:	23.2-23.4℃
Relative Humidity:	50-51 %
ATM Pressure:	101.1-101.3kPa

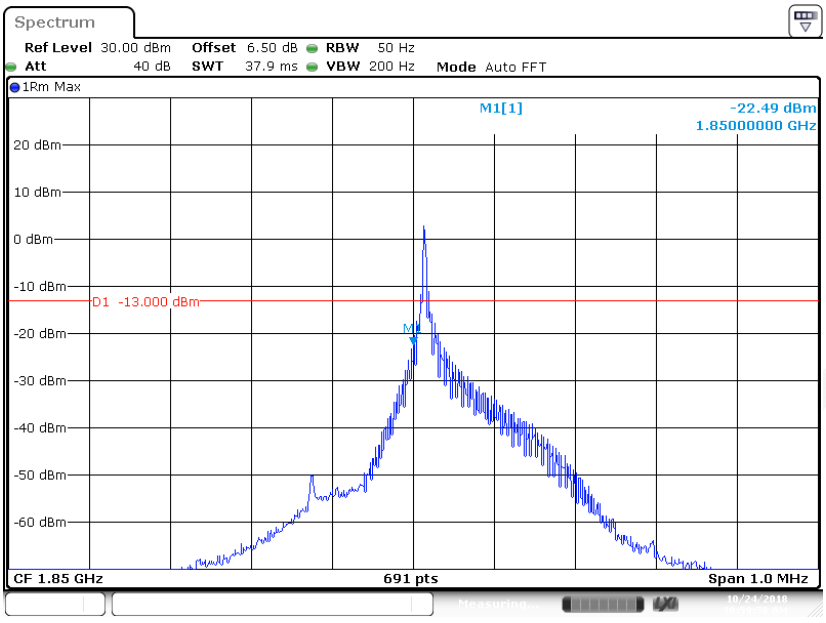
The testing was performed by Hope Zhang on 2018-10-20 & 2018-10-24.

EUT operation mode: Transmitting

Test Result: Compliance.

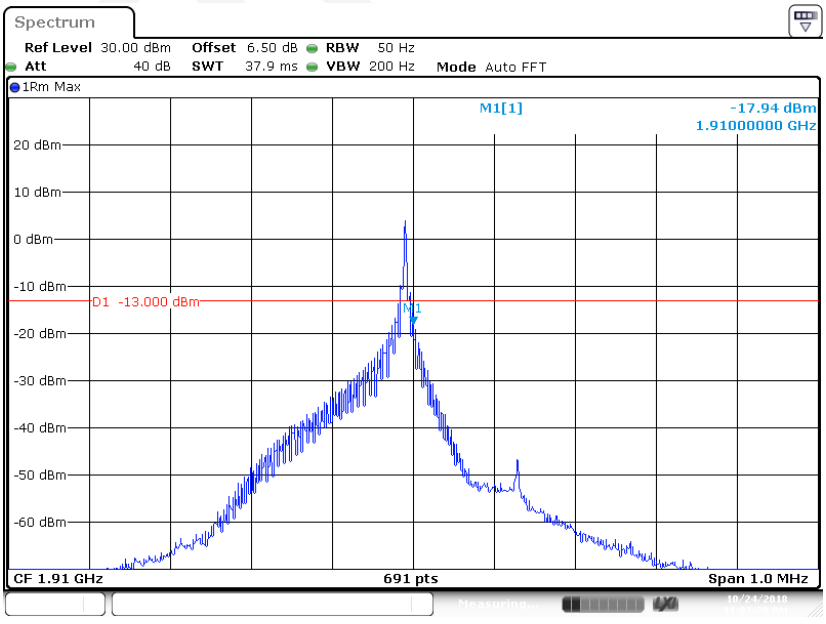
NB-IoT Band 2:

BPSK (3.75kHz, 1#0) - Left Band Edge



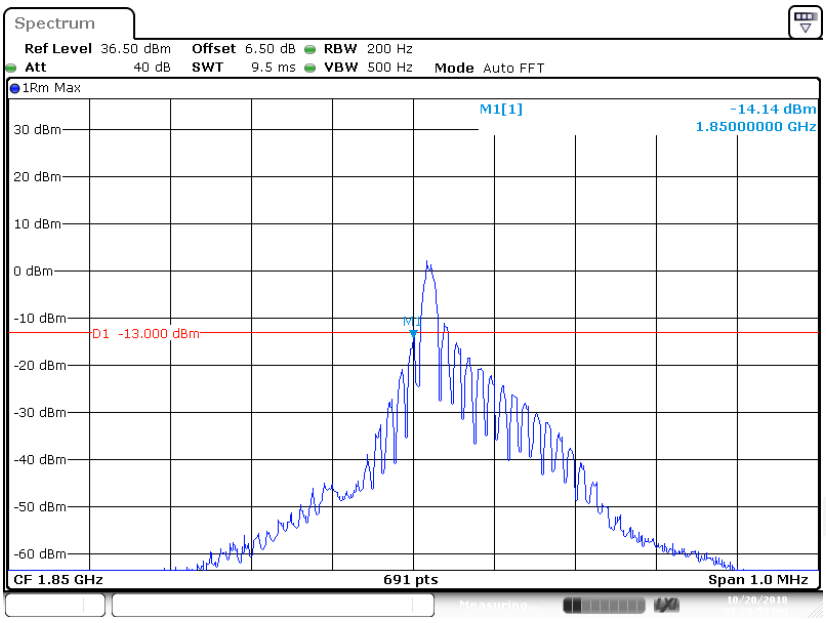
Date:24.OCT.2018 10:59:58

BPSK (3.75kHz, 1#47) - Right Band Edge



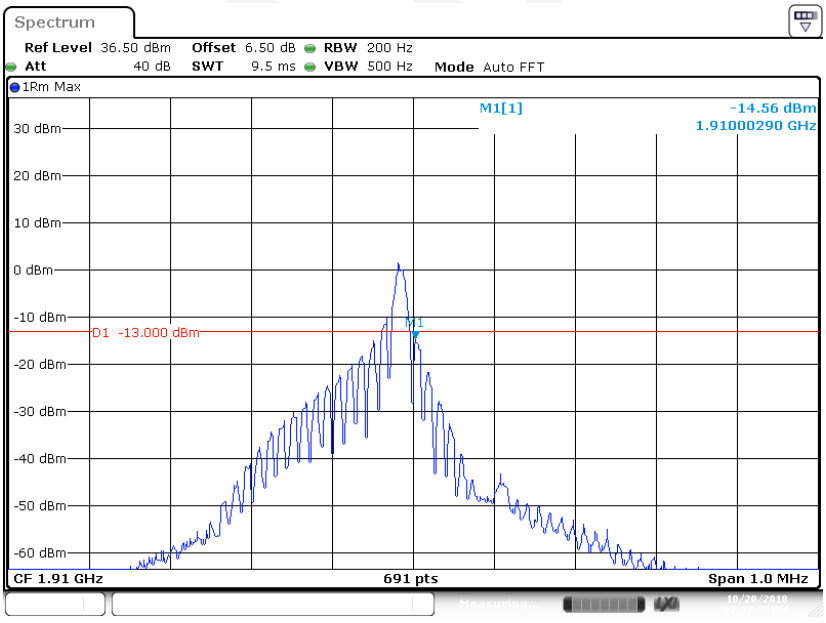
Date:24.OCT.2018 11:07:20

BPSK (15kHz, 1#0) - Left Band Edge



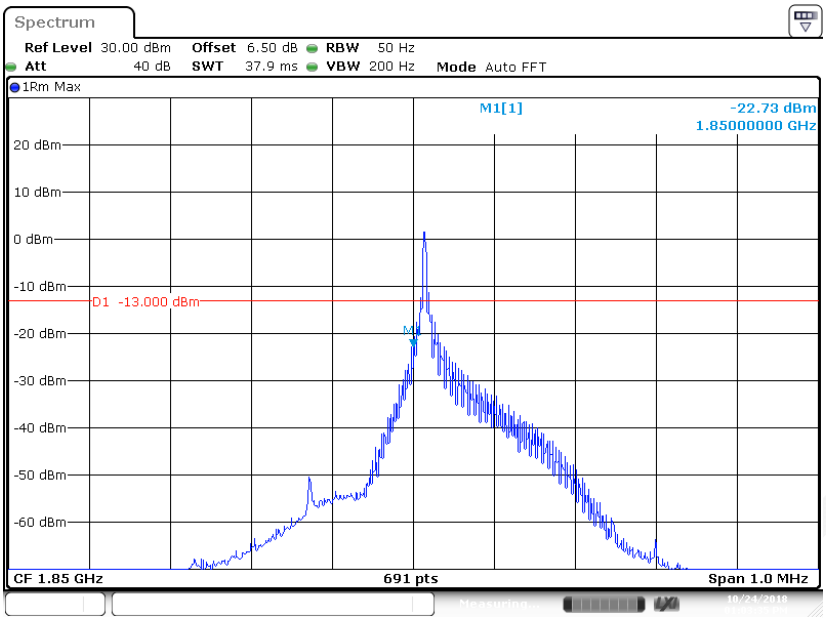
Date: 20.OCT.2018 19:28:57

BPSK (15kHz, 1#11) - Right Band Edge



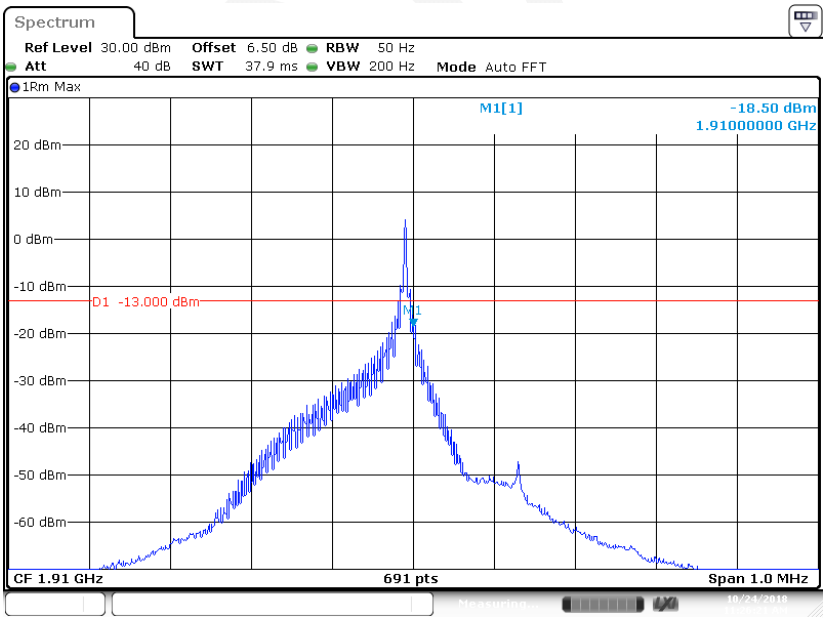
Date: 20.OCT.2018 19:37:55

QPSK (3.75kHz, 1#0) - Left Band Edge



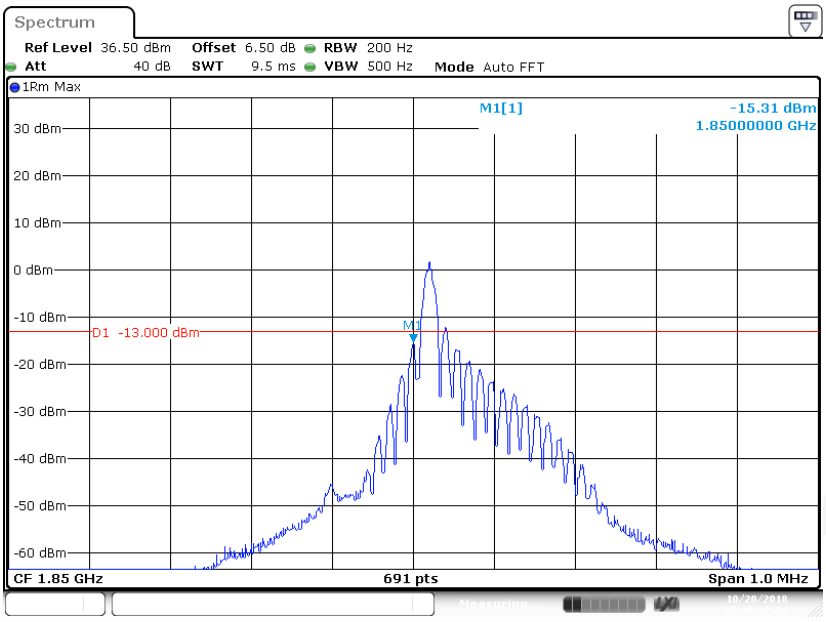
Date: 24.OCT.2018 13:03:36

QPSK (3.75kHz, 1#47) - Right Band Edge



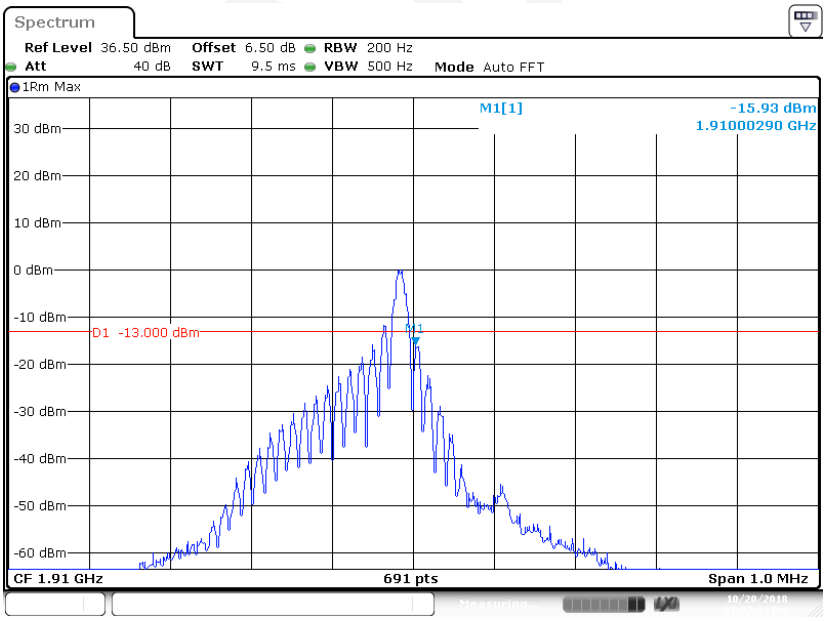
Date: 24.OCT.2018 11:26:21

QPSK (15kHz, 1#0) - Left Band Edge



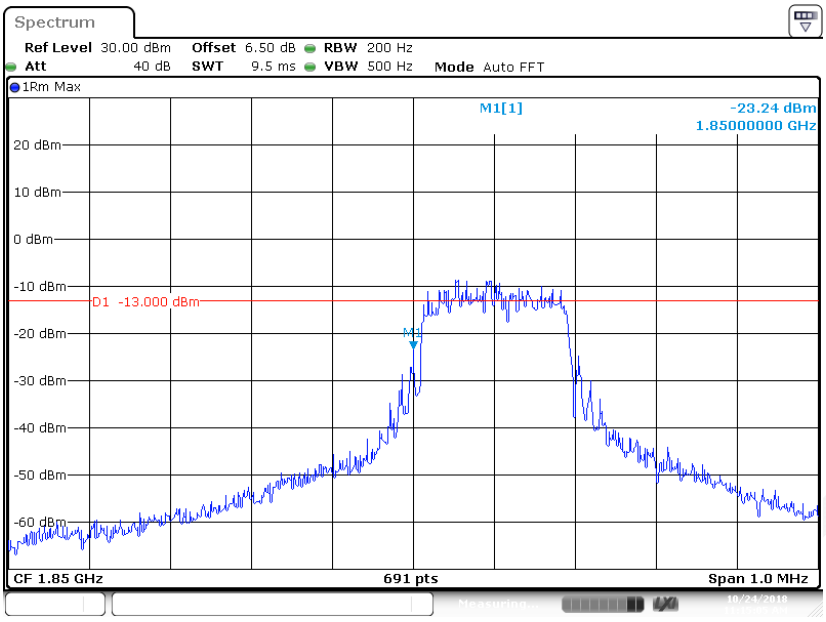
Date: 20.OCT.2018 19:30:22

QPSK (15kHz, 1#11) - Right Band Edge



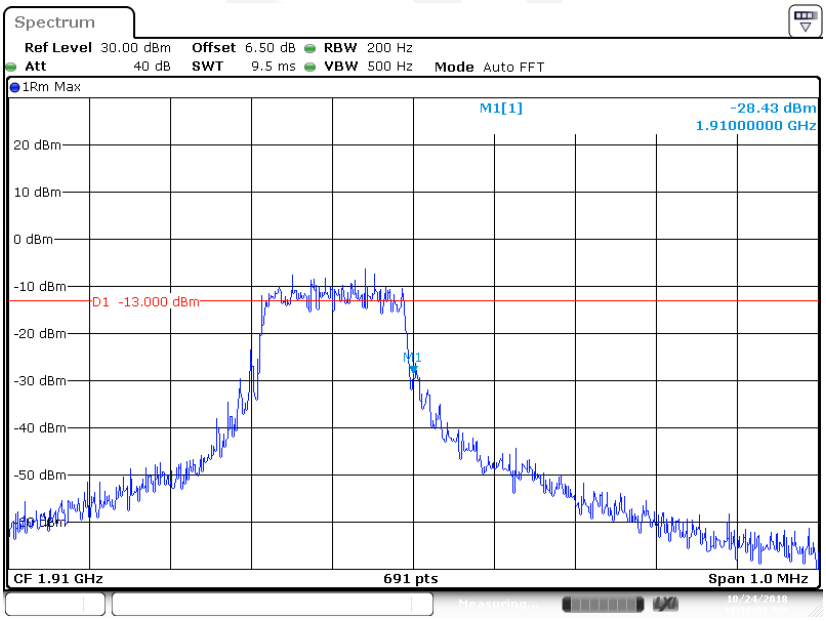
Date: 20.OCT.2018 19:37:19

QPSK (15kHz, 12#0) - Left Band Edge



Date: 24.OCT.2018 11:15:05

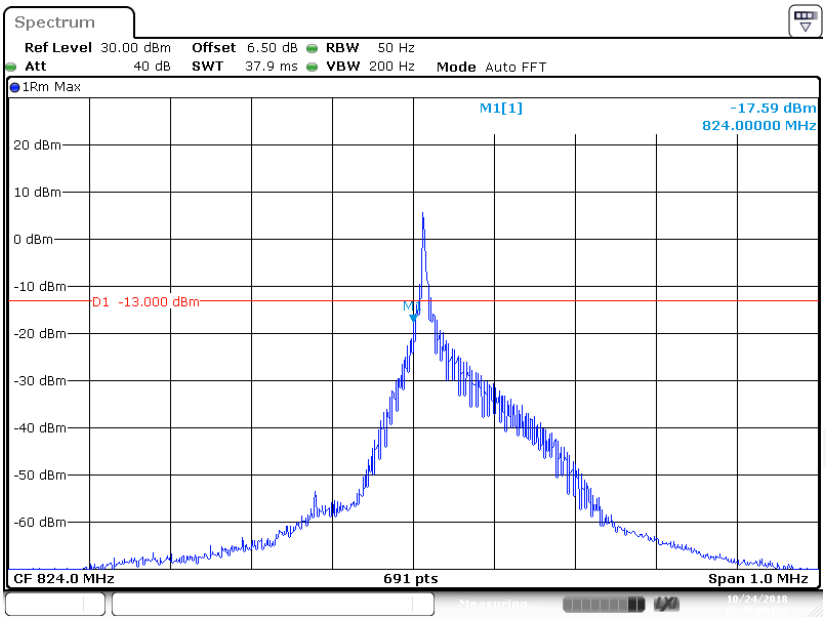
QPSK (15kHz, 12#0) - Right Band Edge



Date: 24.OCT.2018 11:18:31

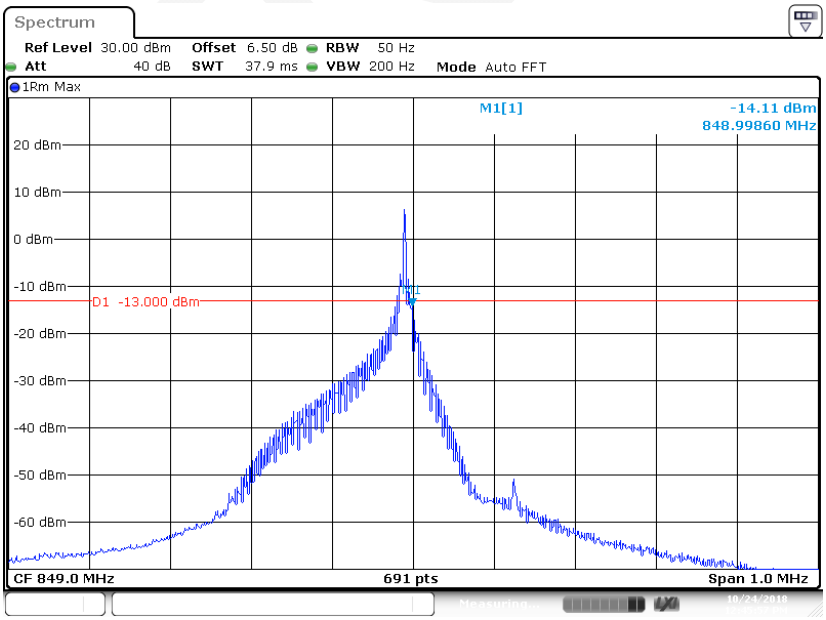
NB-IoT Band 5:

BPSK (3.75kHz, 1#0) - Left Band Edge



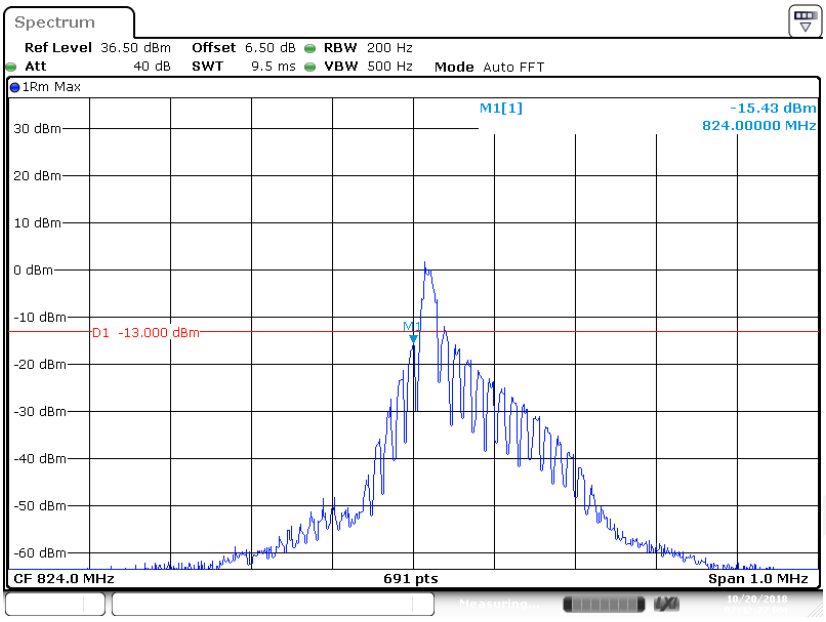
Date: 24.OCT.2018 12:40:00

BPSK (3.75kHz, 1#47) - Right Band Edge



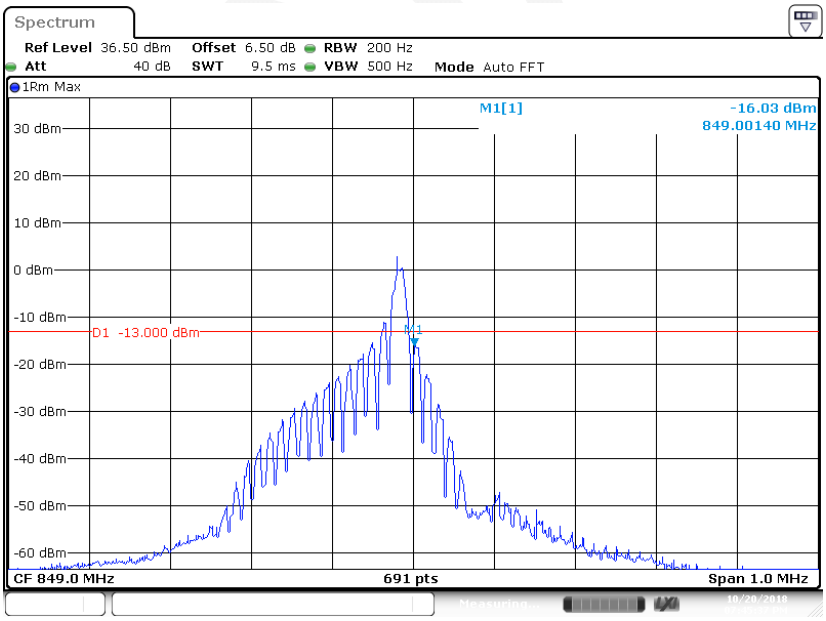
Date: 24.OCT.2018 12:45:57

BPSK (15kHz, 1#0) - Left Band Edge



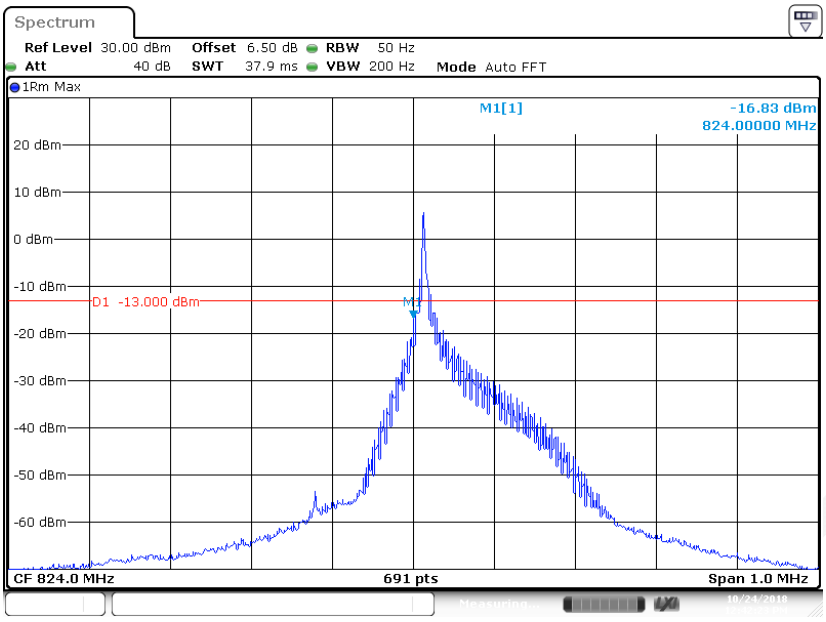
Date: 20.OCT.2018 19:42:27

BPSK (15kHz, 1#11) - Right Band Edge



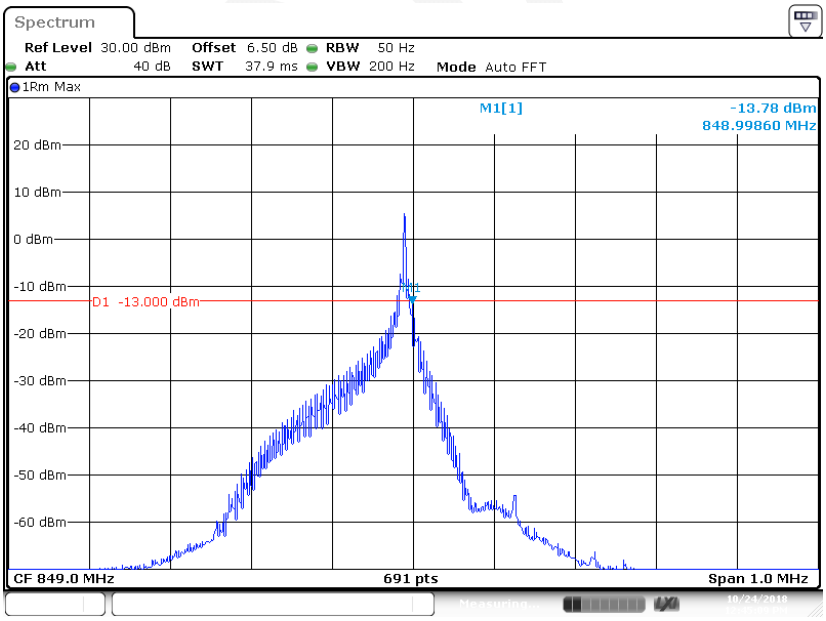
Date: 20.OCT.2018 19:45:37

QPSK (3.75kHz, 1#0) - Left Band Edge



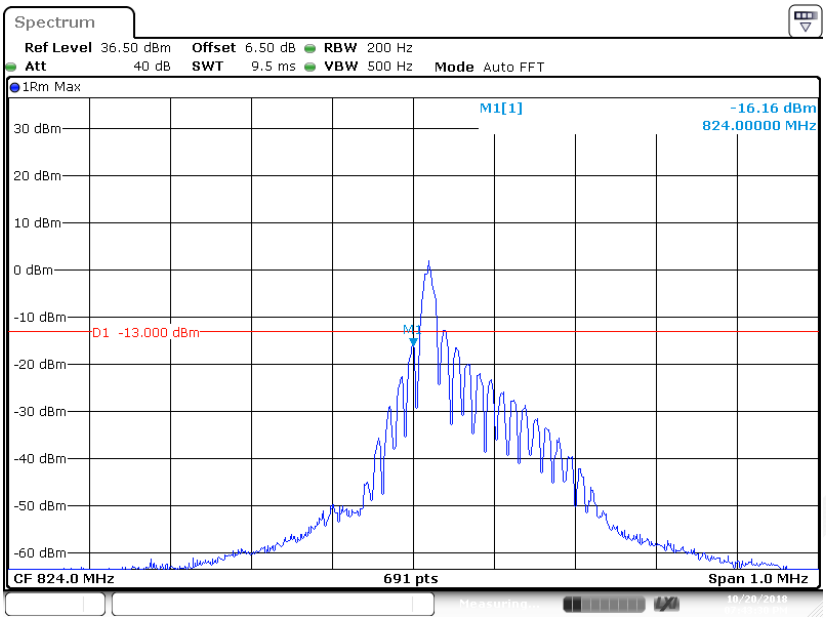
Date: 24.OCT.2018 12:42:23

QPSK (3.75kHz, 1#47) - Right Band Edge



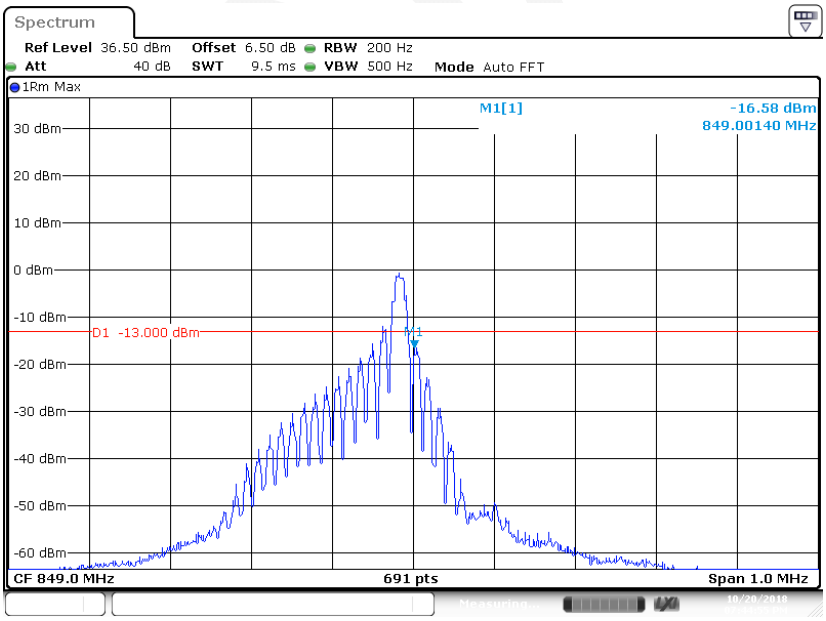
Date: 24.OCT.2018 12:45:09

QPSK (15kHz, 1#0) - Left Band Edge



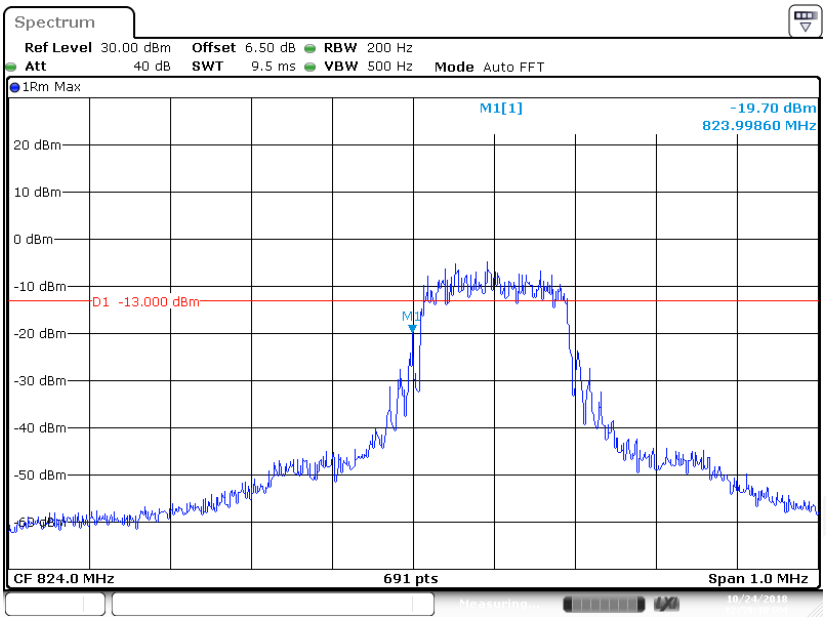
Date: 20.OCT.2018 19:43:30

QPSK (15kHz, 1#11) - Right Band Edge



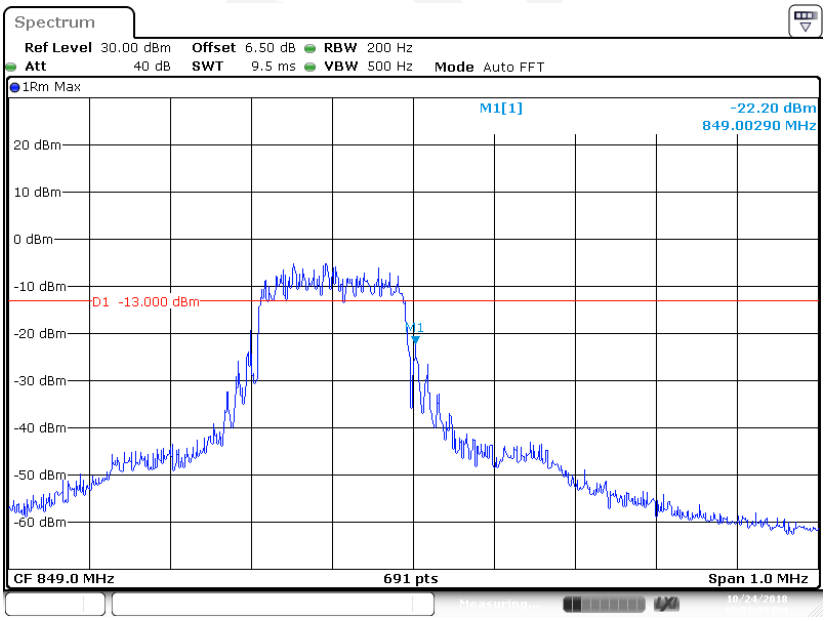
Date: 20.OCT.2018 19:44:55

QPSK (15kHz, 12#0) - Left Band Edge



Date: 24.OCT.2018 12:59:18

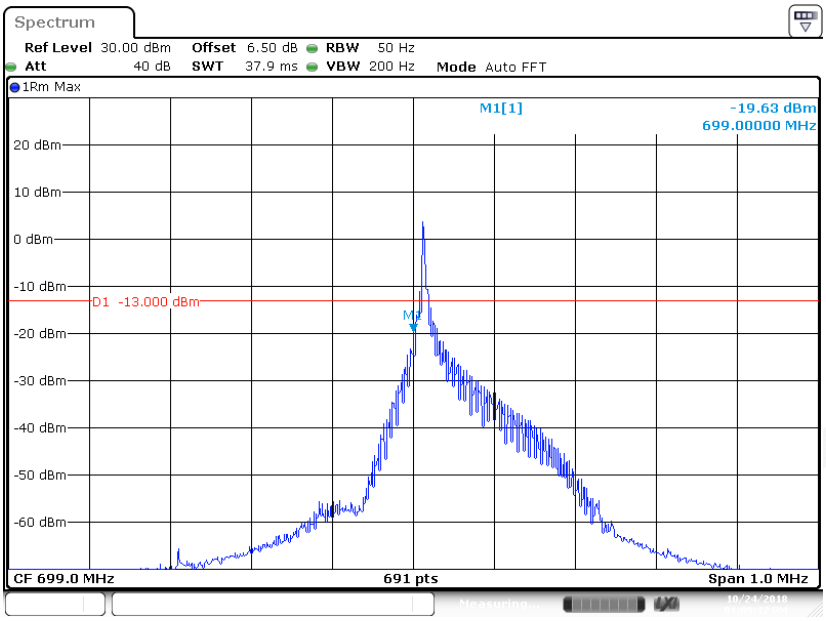
QPSK (15kHz, 12#0) - Right Band Edge



Date: 24.OCT.2018 12:51:29

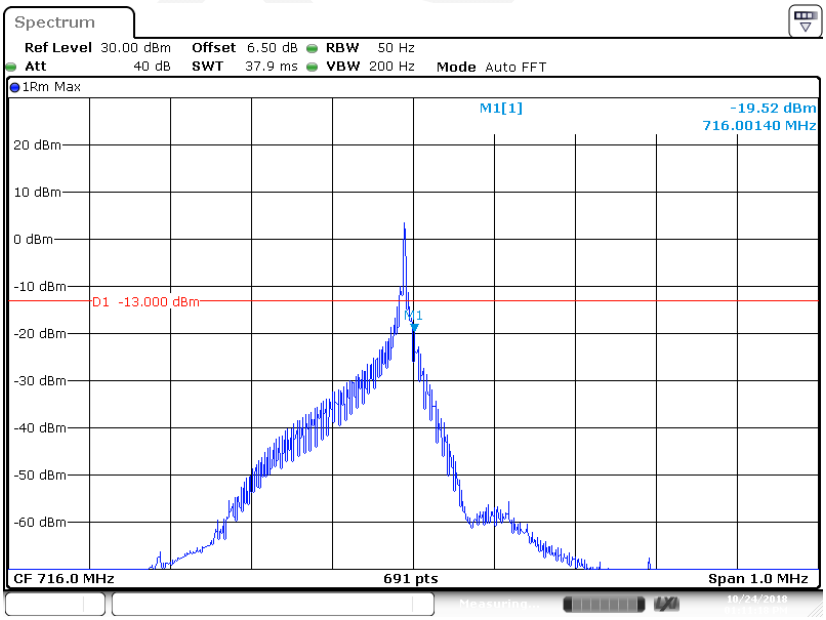
NB-IoT Band 12:

BPSK (3.75kHz, 1#0) - Left Band Edge



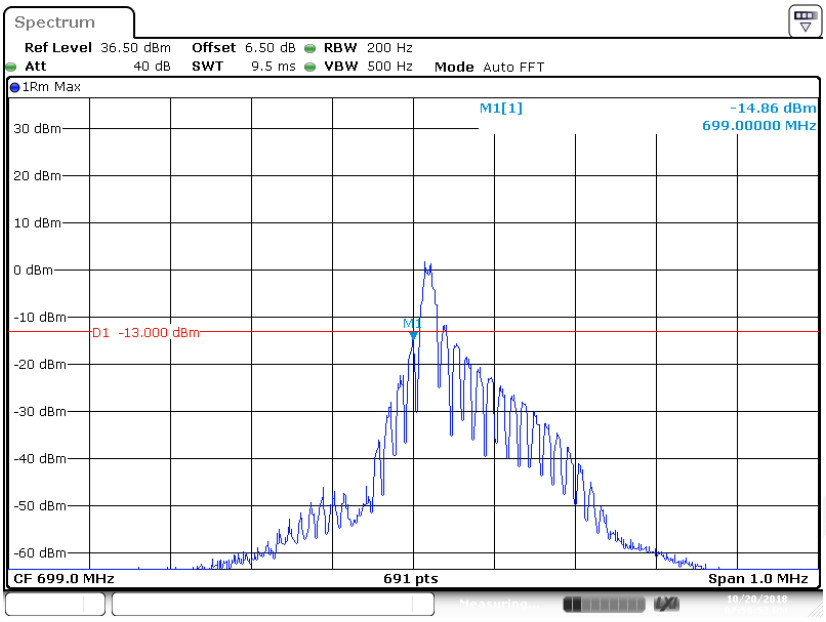
Date: 24.OCT.2018 13:09:12

BPSK (3.75kHz, 1#47) - Right Band Edge



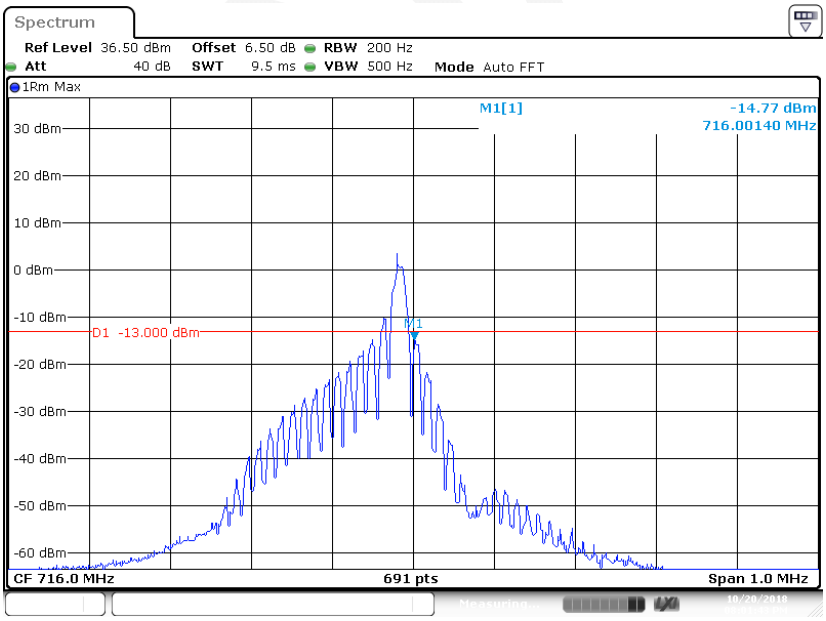
Date: 24.OCT.2018 13:11:17

BPSK (15kHz, 1#0) - Left Band Edge



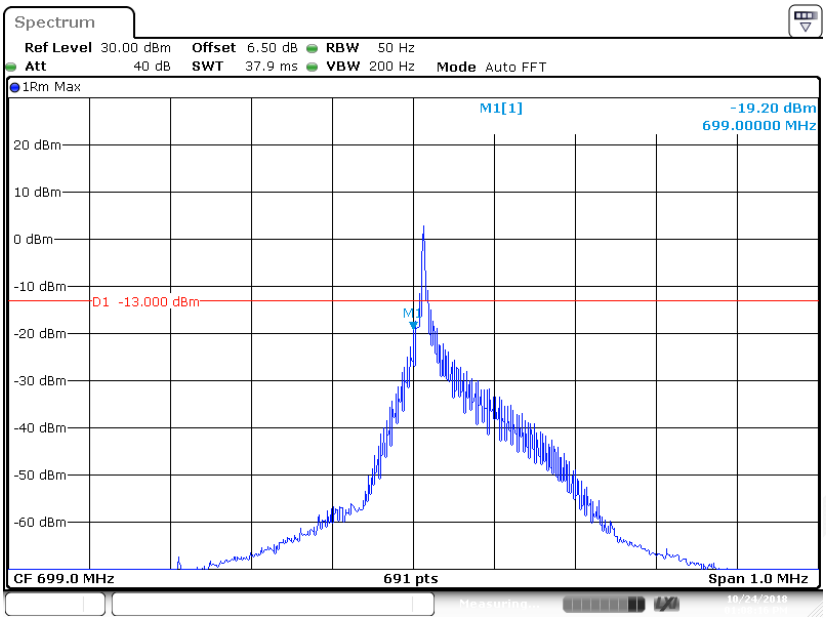
Date: 20.OCT.2018 19:58:51

BPSK (15kHz, 1#11) - Right Band Edge

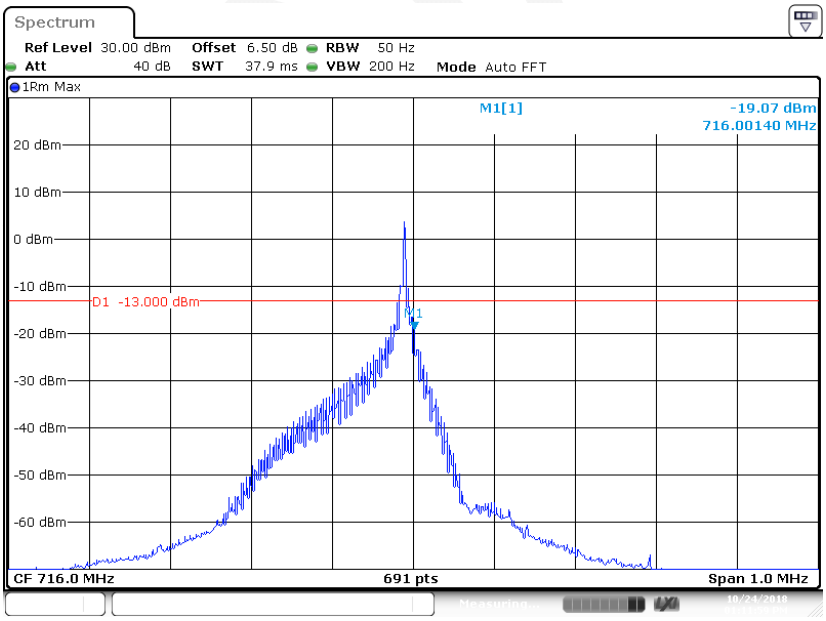


Date: 20.OCT.2018 20:01:44

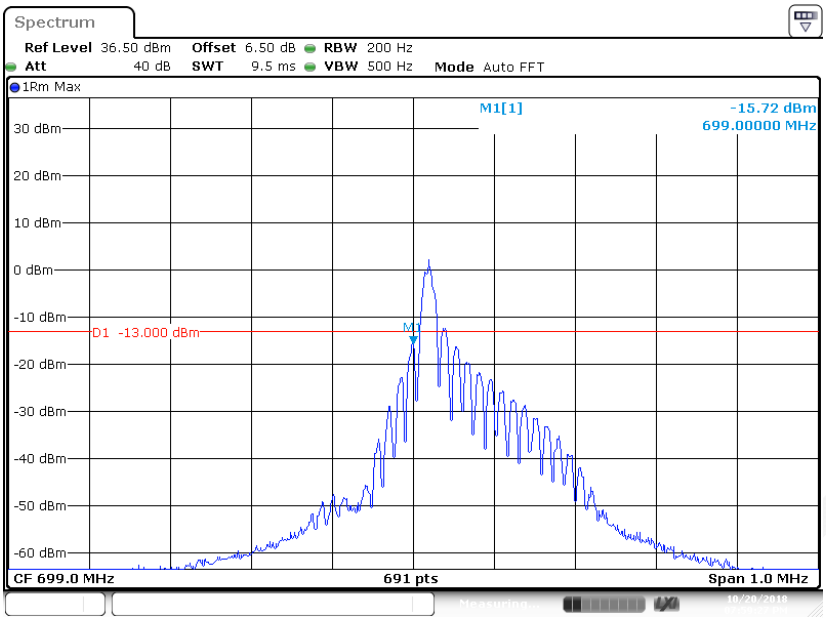
QPSK (3.75kHz, 1#0) - Left Band Edge



QPSK (3.75kHz, 1#47) - Right Band Edge

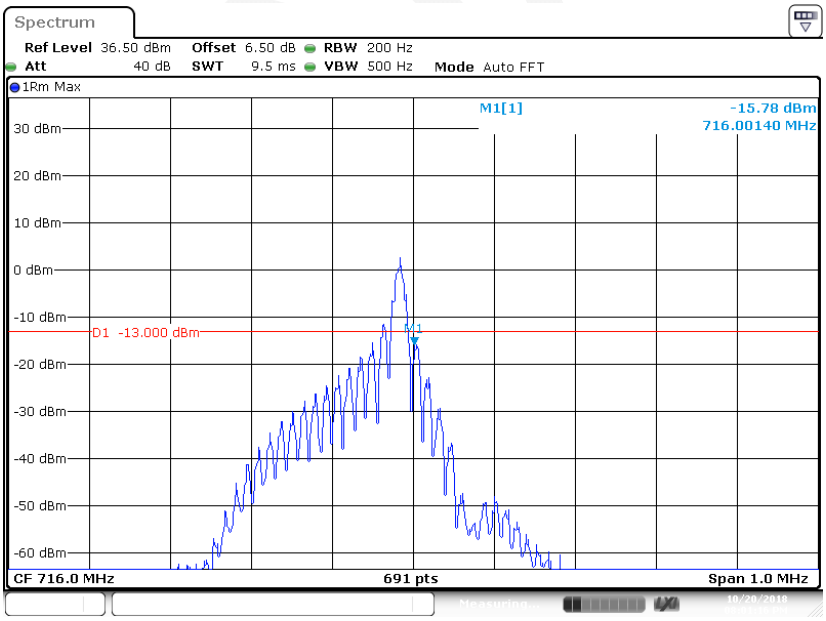


QPSK (15kHz, 1#0) - Left Band Edge



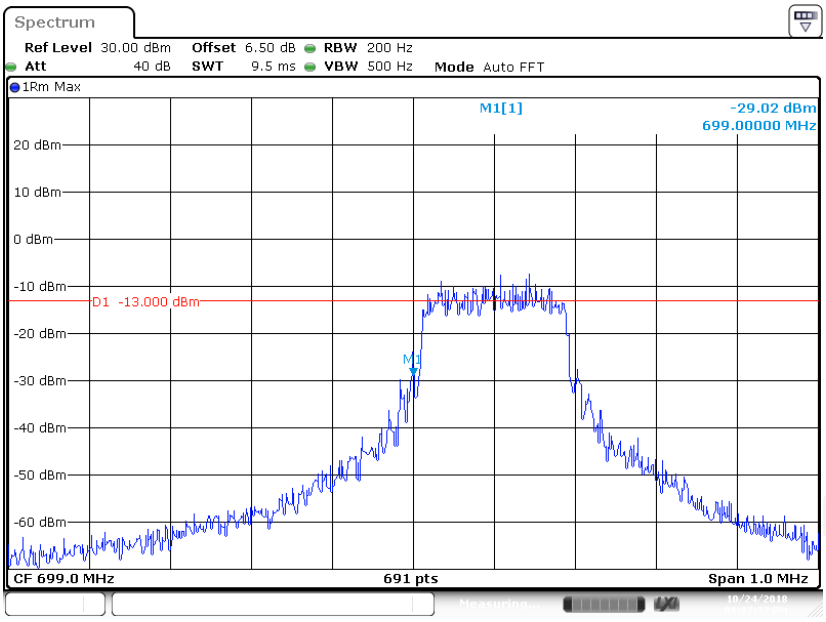
Date: 20.OCT.2018 19:59:28

QPSK (15kHz, 1#11) - Right Band Edge



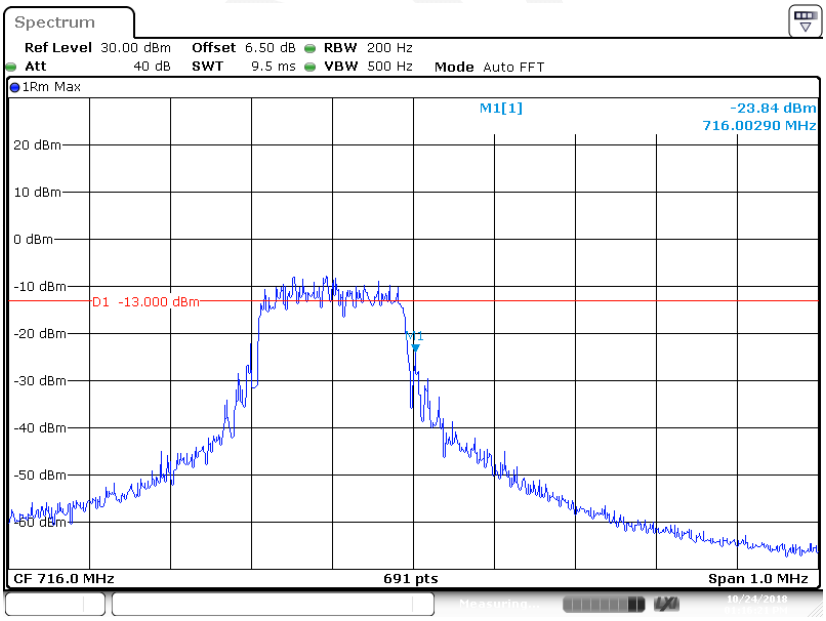
Date: 20.OCT.2018 20:01:16

QPSK (15kHz, 12#0) - Left Band Edge



Date: 24.OCT.2018 13:17:32

QPSK (15kHz, 12#0) - Right Band Edge



Date: 24.OCT.2018 13:16:21

FCC § 2.1055; § 22.355; § 24.235; §27.54- FREQUENCY STABILITY

Applicable Standards

FCC § 2.1055, §22.355, §24.235 and §27.54.

According to FCC §2.1055, the frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

According to §22.355, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table below:

Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency Range (MHz)	Base, fixed (ppm)	Mobile > 3 watts (ppm)	Mobile ≤ 3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929.	5.0	N/A	N/A
929 to 960.	1.5	N/A	N/A
2110 to 2220	10.0	N/A	N/A

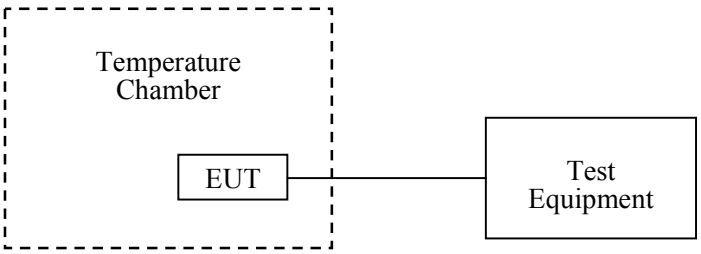
According to §24.235, the frequency stability shall be sufficient to ensure that the fundamental emissions stays within the authorized frequency block.

Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to communication test set via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the communication test set.

Frequency Stability vs. Voltage: For hand carried, battery powered equipment; reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.



Test Data

Environmental Conditions

Temperature:	23.2℃
Relative Humidity:	51 %
ATM Pressure:	101.3kPa

The testing was performed by Hope Zhang on 2018-10-15.

EUT operation mode: Transmitting

Test Result: Compliance.

NB-IoT Band 2:

3.75kHz Low Channel & High Channel (BPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	1850.0705	1909.9276	1850	1910
-20		1850.0711	1909.9280	1850	1910
-10		1850.0701	1909.9270	1850	1910
0		1850.0727	1909.9298	1850	1910
10		1850.0719	1909.9291	1850	1910
20		1850.0715	1909.9285	1850	1910
30		1850.0715	1909.9286	1850	1910
40		1850.0709	1909.9280	1850	1910
50		1850.0702	1909.9275	1850	1910
25	V min.= 2.8	1850.0710	1909.9280	1850	1910
25	V max.= 3.8	1850.0709	1909.9279	1850	1910

3.75kHz Low Channel & High Channel (QPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	1850.0653	1909.9312	1850	1910
-20		1850.0678	1909.9338	1850	1910
-10		1850.0661	1909.9321	1850	1910
0		1850.0688	1909.9348	1850	1910
10		1850.0683	1909.9346	1850	1910
20		1850.0676	1909.9338	1850	1910
30		1850.0668	1909.9331	1850	1910
40		1850.0673	1909.9332	1850	1910
50		1850.0655	1909.9317	1850	1910
25	V min.= 2.8	1850.0670	1909.9330	1850	1910
25	V max.= 3.8	1850.0652	1909.9311	1850	1910

15kHz Low Channel & High Channel (BPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	1850.0490	1909.9512	1850	1910
-20		1850.0494	1909.9514	1850	1910
-10		1850.0480	1909.9500	1850	1910
0		1850.0464	1909.9483	1850	1910
10		1850.0472	1909.9491	1850	1910
20		1850.0488	1909.9510	1850	1910
30		1850.0481	1909.9502	1850	1910
40		1850.0475	1909.9495	1850	1910
50		1850.0461	1909.9480	1850	1910
25	V min.= 2.8	1850.0480	1909.9500	1850	1910
25	V max.= 3.8	1850.0474	1909.9496	1850	1910

15kHz Low Channel & High Channel (QPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	1850.0459	1909.9550	1850	1910
-20		1850.0447	1909.9536	1850	1910
-10		1850.0424	1909.9514	1850	1910
0		1850.0433	1909.9521	1850	1910
10		1850.0422	1909.9512	1850	1910
20		1850.0448	1909.9540	1850	1910
30		1850.0428	1909.9519	1850	1910
40		1850.0444	1909.9536	1850	1910
50		1850.0442	1909.9531	1850	1910
25	V min.= 2.8	1850.0440	1909.9530	1850	1910
25	V max.= 3.8	1850.0452	1909.9541	1850	1910

NB-IoT Band 5:

3.75kHz Middle Channel, f_o =836.5 MHz (BPSK)				
Temperature (℃)	**Power Supplied (V_{DC})**	**Frequency Error (Hz)**	**Frequency Error (ppm)**	**Limit (ppm)**
-30	3.3	-2	-0.0024	2.5
-20		-4	-0.0048	2.5
-10		-2	-0.0024	2.5
0		2	0.0024	2.5
10		0	0.0000	2.5
20		1	0.0012	2.5
30		3	0.0036	2.5
40		-1	-0.0012	2.5
50		-3	-0.0036	2.5
25	V min.= 2.8	1	0.0012	2.5
25	V max.= 3.8	2	0.0024	2.5

3.75kHz Middle Channel, f_o =836.5 MHz (QPSK)				
Temperature (℃)	**Power Supplied (V_{DC})**	**Frequency Error (Hz)**	**Frequency Error (ppm)**	**Limit (ppm)**
-30	3.3	-1	-0.0012	2.5
-20		-5	-0.0060	2.5
-10		-2	-0.0024	2.5
0		2	0.0024	2.5
10		0	0.0000	2.5
20		1	0.0012	2.5
30		-4	-0.0048	2.5
40		-3	-0.0036	2.5
50		0	0.0000	2.5
25	V min.= 2.8	2	0.0024	2.5
25	V max.= 3.8	3	0.0036	2.5

15kHz Middle Channel, f_o =836.5 MHz (BPSK)				
Temperature (℃)	**Power Supplied (V_{DC})**	**Frequency Error (Hz)**	**Frequency Error (ppm)**	**Limit (ppm)**
-30	3.3	-1	-0.0012	2.5
-20		-3	-0.0036	2.5
-10		1	0.0012	2.5
0		3	0.0036	2.5
10		-1	-0.0012	2.5
20		4	0.0048	2.5
30		3	0.0036	2.5
40		2	0.0024	2.5
50		-2	-0.0024	2.5
25	V min.= 2.8	1	0.0012	2.5
25	V max.= 3.8	-1	-0.0012	2.5

15kHz Middle Channel, f_o =836.5 MHz (QPSK)				
Temperature (℃)	**Power Supplied (V_{DC})**	**Frequency Error (Hz)**	**Frequency Error (ppm)**	**Limit (ppm)**
-30	3.3	-1	-0.0012	2.5
-20		-4	-0.0048	2.5
-10		-1	-0.0012	2.5
0		0	0.0000	2.5
10		1	0.0012	2.5
20		3	0.0036	2.5
30		-3	-0.0036	2.5
40		-3	-0.0036	2.5
50		-1	-0.0012	2.5
25	V min.= 2.8	2	0.0024	2.5
25	V max.= 3.8	0	0.0000	2.5

NB-IoT Band 12:

3.75kHz Low Channel & High Channel (BPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	699.0757	715.9298	699	716
-20		699.0746	715.9288	699	716
-10		699.0749	715.9289	699	716
0		699.0722	715.9264	699	716
10		699.0712	715.9253	699	716
20		699.0730	715.9270	699	716
30		699.0736	715.9278	699	716
40		699.0759	715.9302	699	716
50		699.0734	715.9278	699	716
25	V min.= 2.8	699.0731	715.9274	699	716
25	V max.= 3.8	699.0715	715.9257	699	716

3.75kHz Low Channel & High Channel (QPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	699.0688	715.9309	699	716
-20		699.0676	715.9295	699	716
-10		699.0703	715.9321	699	716
0		699.0680	715.9300	699	716
10		699.0697	715.9316	699	716
20		699.0690	715.9310	699	716
30		699.0671	715.9290	699	716
40		699.0689	715.9306	699	716
50		699.0685	715.9307	699	716
25	V min.= 2.8	699.0707	715.9328	699	716
25	V max.= 3.8	699.0674	715.9294	699	716

15kHz Low Channel & High Channel (BPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	699.0469	715.9548	699	716
-20		699.0481	715.9562	699	716
-10		699.0459	715.9537	699	716
0		699.0486	715.9563	699	716
10		699.0452	715.9531	699	716
20		699.0460	715.9540	699	716
30		699.0488	715.9566	699	716
40		699.0471	715.9550	699	716
50		699.0481	715.9561	699	716
25	V min.= 2.8	699.0455	715.9535	699	716
25	V max.= 3.8	699.0484	715.9565	699	716

15kHz Low Channel & High Channel (QPSK)					
Temperature (℃)	**Power Supplied (V_{DC})**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**
-30	3.3	699.0496	715.9553	699	716
-20		699.0453	715.9512	699	716
-10		699.0473	715.9535	699	716
0		699.0490	715.9550	699	716
10		699.0469	715.9528	699	716
20		699.0470	715.9530	699	716
30		699.0453	715.9515	699	716
40		699.0471	715.9530	699	716
50		699.0496	715.9554	699	716
25	V min.= 2.8	699.0472	715.9532	699	716
25	V max.= 3.8	699.0492	715.9551	699	716

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