

**Hangzhou Tuya Information Technology Co.,Ltd**

# RF TEST REPORT

**Report Type:**

FCC Part 22H RF report

**Model:**

NM1

**REPORT NUMBER:**

190801595SHA-001

**ISSUE DATE:**

October 28, 2019

**DOCUMENT CONTROL NUMBER:**

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**Applicant:** Hangzhou Tuya Information Technology Co.,Ltd  
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Zhejiang, China

**Manufacturer:** Hangzhou Tuya Information Technology Co.,Ltd  
Room701, Building 3, More Center, No.87 GuDun Road, Hangzhou,  
Zhejiang, China

**FCC ID:** 2ANDL-NM1

## SUMMARY:

The equipment complies with the requirements according to the following standard(s) or Specification:

**FCC Part 22H:** Cellular Radiotelephone Service.

## PREPARED BY:



Project Engineer  
Erick Liu

## REVIEWED BY:



Reviewer  
Wakeyou Wang

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**TEST REPORT**

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## Revision History

Report No.	Version	Description	Issued Date
190801595SHA-001	Rev. 01	Initial issue of report	October 28, 2019

## Measurement result summary

TEST ITEM	FCC REFERENCE	RESULT
OUTPUT POWER	-	Pass
OCCUPIED BANDWIDTH	FCC: §2.1049	Pass
BANDEDGE AND EMISSION MASK	FCC: §2.1051, §22.359	Pass
OUT OF BAND EMISSIONS	FCC: §2.1051, §22.917	Pass
RADIATED MEASUREMENT	FCC: §2.1046, §22.913	Pass
SPURIOUS RADIATION EMISSION	FCC: §2.1053, §22.917	Pass
FREQUENCY STABILITY	FCC: §2.1055, §22.355	Pass
Peak-to-Average Ratio	-	Pass

Notes: 1: NA =Not Applicable.

2. Determination of the test conclusion is based on IEC Guide 115 in consideration of measurement uncertainty.

3: Additions, Deviations and Exclusions from Standards: None.

## 1 GENERAL INFORMATION

### 1.1 Description of Equipment Under Test (EUT)

Product name:	NB IOT Module
Type/Model:	NM1
Description of EUT:	EUT is a NB IOT Module and has only one model.
Rating:	DC 5V from USB port
Category of EUT:	Class B
EUT type:	<input checked="" type="checkbox"/> Table top <input type="checkbox"/> Floor standing
Software Version:	/
Hardware Version:	/
Sample received date:	22 Sep. 2019
Date of test:	24 Sep. 2019 ~ 12 Oct. 2019

### 1.2 Technical Specification

Frequency Range:	Uplink: 824.1MHz-848.9MHz, Downlink: 869MHz-893.9MHz;
Category:	NB1
Type of Modulation:	BPSK, QPSK
Deployment:	stand-alone
Sub-carrier spacing:	3.75KHz, 15KHz
Ntone:	single, multi-tone
Antenna Information:	Pole antenna, 3dBi

### 1.3 RELATED SUBMITTAL(S) / GRANT (S)

This submittal(s) (test report) is intended for FCC ID: 2ANDL-NM1 filing to comply with the FCC Part 22H.

### 1.4 Description of Test Facility

Name:	Intertek Testing Services Shanghai
Address:	Building 86, No. 1198 Qinzhou Road(North), Shanghai 200233, P.R. China
Telephone:	86 21 61278200
Telefax:	86 21 54262353

The test facility is recognized, certified, or accredited by these organizations:	CNAS Accreditation Lab Registration No. CNAS L0139
	FCC Accredited Lab Designation Number: CN1175
	IC Registration Lab Registration code No.: 2042B-1
	VCCI Registration Lab Registration No.: R-4243, G-845, C-4723, T-2252
	A2LA Accreditation Lab Certificate Number: 3309.02



## 2 TEST SPECIFICATIONS

### 2.1 Standards or specification

The tests documented in this report were performed in accordance with ANSI/TIA-603-E-2016, FCC CFR 47 Part 2, Part 22, ANSI C63.26:2015.

### 2.2 WORST-CASE CONFIGURATION AND MODE

The worst-case scenario for all measurements is based on the investigation results.

The device has NB-IOT Band 5.

The Sub-carrier spacing was selected to measure for peak or average ERP and EIRP, which was based on the conducted power verification baseline data.

For the fundamental investigation of radiated emissions, the EUT is investigated for vertical and horizontal antenna orientations and X Y and Z orientations of the EUT alone. After the investigations the worst case was determined to be at X orientation for all NB-IOT bands.

### 2.3 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commission’s requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.4 EUT EXERCISE

The Transmitter was operated in the maximum output power mode through Communication Tester. The TX frequency was fixed which was for the purpose of the measurements.

### 2.5 CONFIGURATION OF EUT SYSTEM

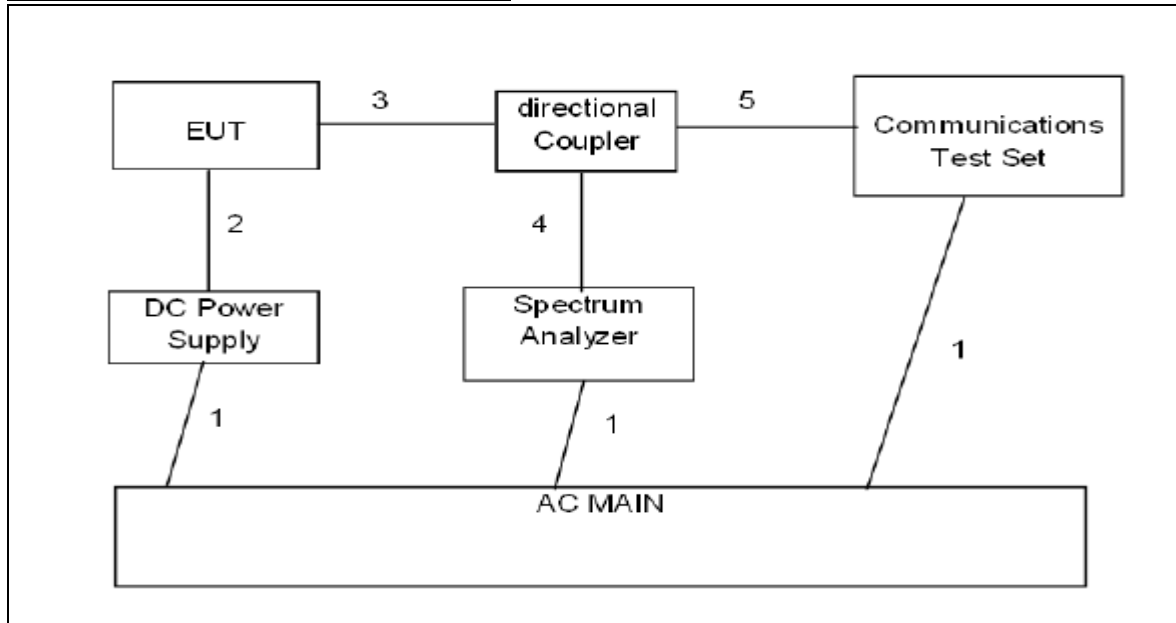
Table 2-1 Equipment Used in EUT System

Item	Equipment	Model No.	ID or Specification	Note
1	NB IOT Module	NM1	FCC ID: 2ANDL-NM1	EUT

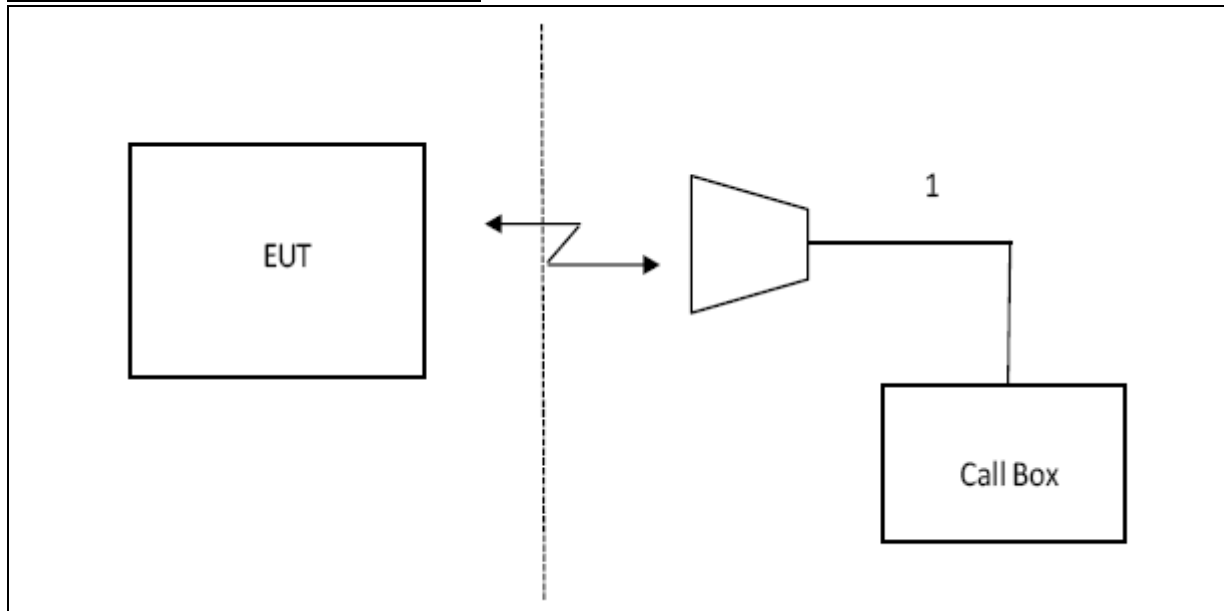
Note: All the accessories have been used during the test. the following “EUT” in setup diagram means EUT system.

## 2.6 TEST SETUP

### CONDUCTED SETUP DIAGRAM FOR TESTS



### RADIATED SETUP DIAGRAM FOR TESTS



## 2.7 TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

NAME OF EQUIPMENT	MANUFACTURER	MODEL	SERIAL NUMBER	NEXT CAL. DATE
SPECTRUM ANALYZER	AGILENT	N9020A	MY49100060	2020.08.27
TEST RECEIVER	R&S	ESCI	101318	2020.05.18
COMMUNICATION TESTER	R&S	CMU200	117858	2020.05.18
COMMUNICATION TESTER	R&S	CMW500	148500	2020.05.18
TEST RECEIVER	R&S	FCKL1528	A0304230	2020.05.18
LISN	SCHWARZBECK	NSLK8127	A0304233	2020.05.18
CLIMATE CHAMBER	ALBATROSS	--	--	2020.05.18
LOOP ANTENNA	DAZE	ZN30900N	SEL0097	2020.05.18
BIOLOGICAL ANTENNA	A.H. SYSTEMS INC.	SAS-521-4	N/A	2020.05.18
HORN ANTENNA	EM	EM-AH-10180	2011071402	2020.05.18
DC POWER SOURCE	N/A	PS-6005D	20170402923	2020.05.18

### 3 OUTPUT POWER

Test result: Pass

#### 3.1 OUTPUT POWER MEASUREMENT

NB-IOT Measurement Procedure:

All NB-IOT bands conducted power peak and average are obtained from the CMW500 telecommunication test set. The following tests were conducted according to the test requirements outlined in section 6.2.2F of the 3GPP TS36.101 specification.

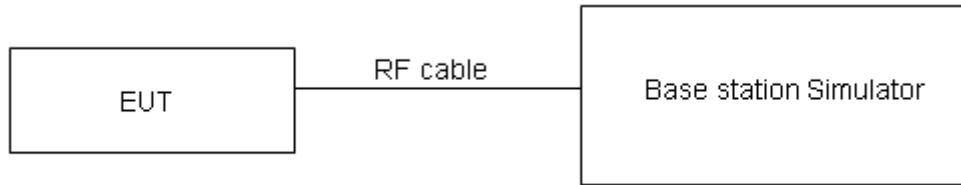
Table 6.2.2F-1: UE Power Class

EUTRA band	Class 3 (dBm)	Tolerance (dB)	Class 5 (dBm)	Tolerance (dB)	Class 6 (dBm)	Tolerance (dB)
1	23	±2	20	±2	14	±2.5
2	23	±2	20	±2	14	±2.5
3	23	±2	20	±2	14	±2.5
4	23	±2	20	±2	14	±2.5
5	23	±2	20	±2	14	±2.5
8	23	±2	20	±2	14	±2.5
11	23	±2	20	±2	14	±2.5
12	23	±2	20	±2	14	±2.5
13	23	±2	20	±2	14	±2.5
14	23	±2	20	±2	14	±2.5
17	23	±2	20	±2	14	±2.5
18	23	±2	20	±2	14	±2.5
19	23	±2	20	±2	14	±2.5
20	23	±2	20	±2	14	±2.5
21	23	±2	20	±2	14	±2.5
25	23	±2	20	±2	14	±2.5
26	23	±2	20	±2	14	±2.5
28	23	±2	20	±2	14	±2.5
31	23	±2	20	±2	14	±2.5
41	23	±2	20	±2	14	±2.5
66	23	±2	20	±2	14	±2.5

#### 3.2 Methods of Measurement

During the process of the testing, The EUT is controlled by the Base Station Simulator to ensure max power transmission and proper modulation.

### 3.3 Test Setup



### 3.4 Test Results

NB-IOT BAND 5

Mode	Modulation	Sub-carrier spacing (KHz)	Output Power (dBm) for low/mid/high			
			Ntones	20401/824.1	20525/836.5	20649/848.9
BAND 5 Stand alone	BPSK	3.75	<a href="#">1@0</a>	21.47	21.76	21.59
			<a href="#">1@47</a>	21.43	21.68	21.52
		15	<a href="#">1@0</a>	21.57	21.81	21.81
			<a href="#">1@11</a>	21.59	21.83	21.69
	QPSK	3.75	<a href="#">1@0</a>	21.45	21.72	21.62
			<a href="#">1@47</a>	21.56	21.79	21.71
		15	<a href="#">1@0</a>	21.71	21.93	21.73
			<a href="#">1@11</a>	21.65	21.91	21.77
		15	<a href="#">12@0</a>	19.73	20.00	19.56

## 4 OCCUPIED BANDWIDTH

Test result: Pass

### 4.1 Limit

For reporting purposes only

### 4.2 TEST PROCEDURE

The transmitter output was connected to a calibrated coaxial cable and coupler, the other end of which was connected to a spectrum analyzer. The occupied bandwidth was measured with the spectrum analyzer at the low, middle and high channel in each band. The -26dB bandwidth was also measured and recorded.

### 4.3 MODES TESTED

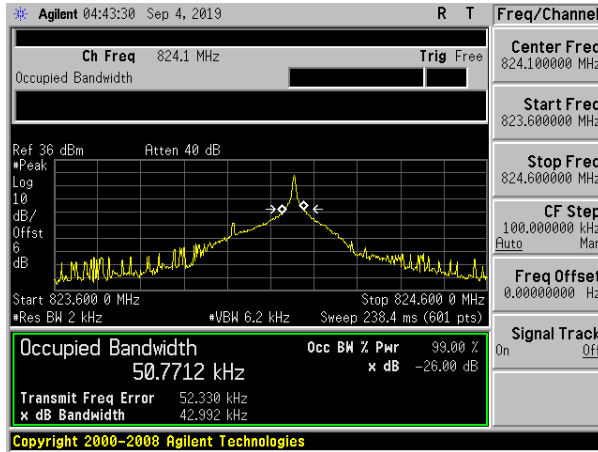
NB-IOT Band 5

### 4.4 TEST RESULTS

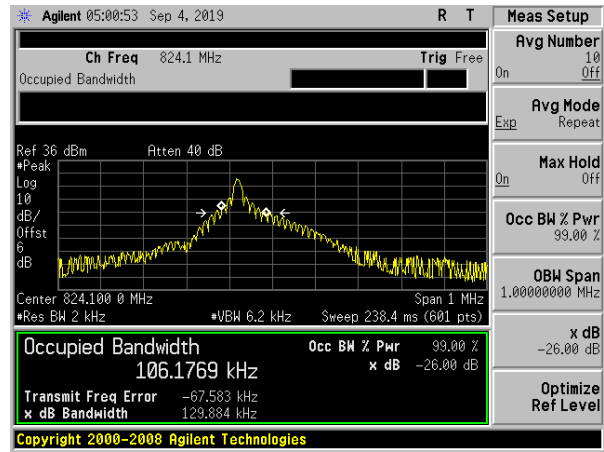
Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Bandwidth(KHz) for low/mid/high channel					
				20401/824.1		20525/836.5		20649/848.9	
				99% Power	-26dBc	99% Power	-26dBc	99% Power	-26dBc
Band 5 Standalone	BPSK	3.75	1@0	50.7712	42.992	48.9842	42.181	50.5147	42.750
	QPSK	3.75	1@0	51.7372	43.721	52.5576	43.710	51.1178	40.661
	BPSK	15	1@0	106.1769	129.884	102.2231	129.600	102.8168	117.131
	QPSK	15	1@0	109.5323	130.904	112.7748	129.824	104.1953	117.055
	QPSK	15	12@0	180.46	236.3	180.54	236.3	178.81	234.1

### Test plot

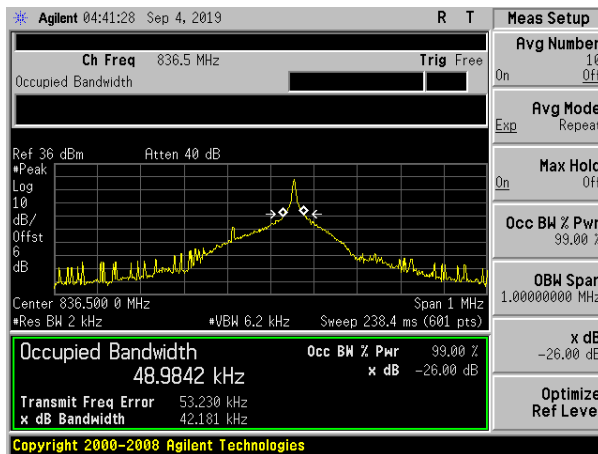
NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-Low



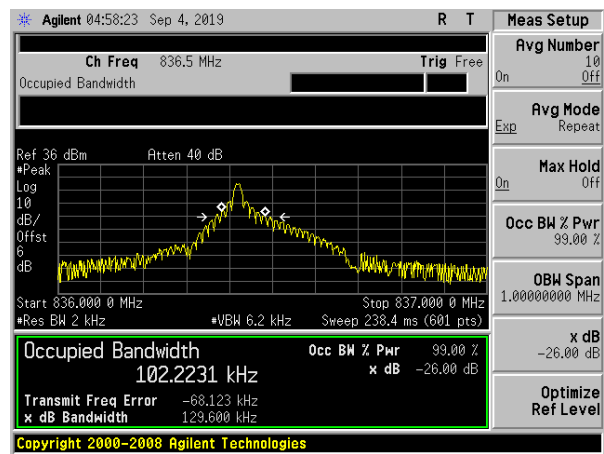
NB-IOT Band 5 BPSK 15kHz 1@0 CH-Low



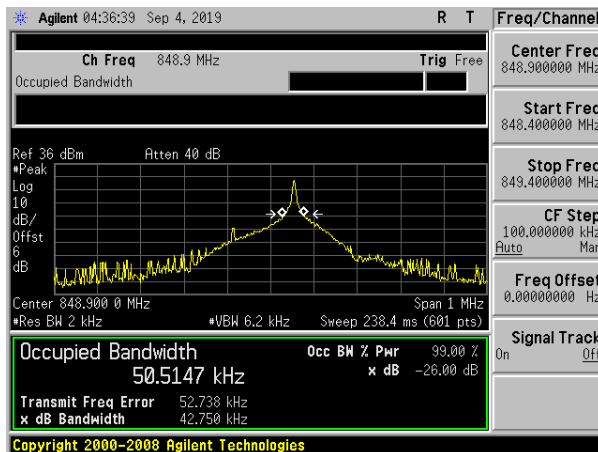
NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-Middle



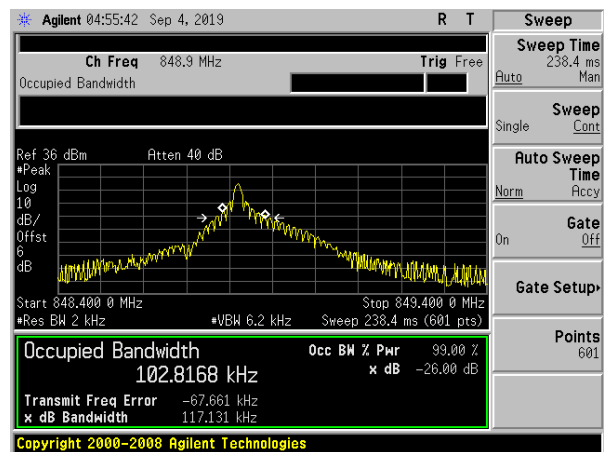
NB-IOT Band 5 BPSK 15kHz 1@0 CH-Middle



NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-High

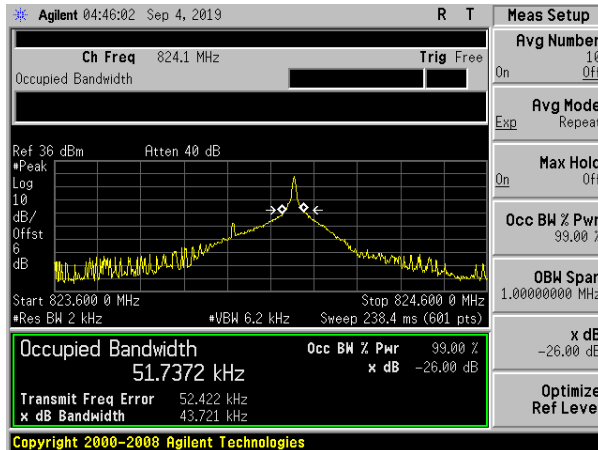


NB-IOT Band 5 BPSK 15kHz 1@0 CH-High

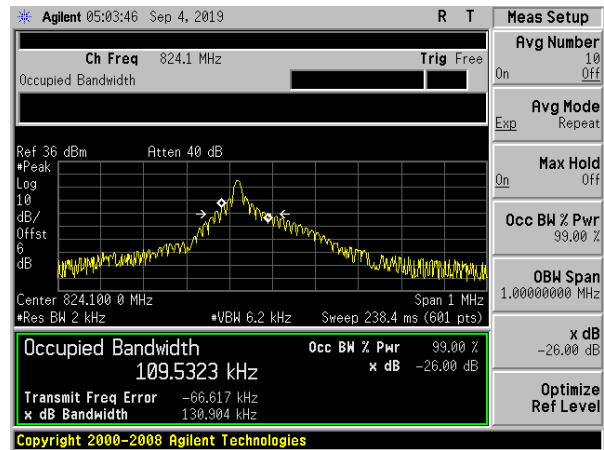


### Test plot

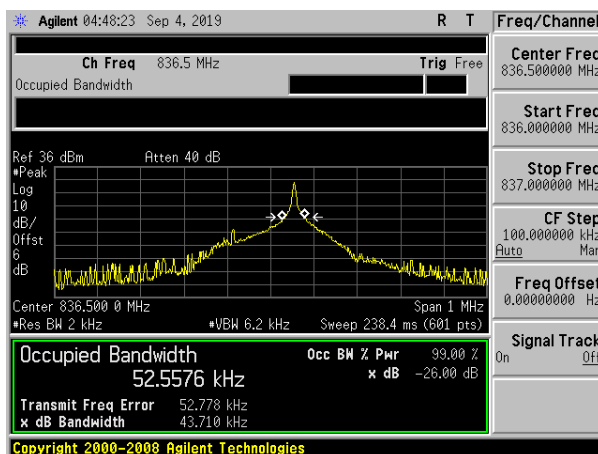
NB-IOT Band 5 QPSK 3.75kHz 1@0 CH-Low



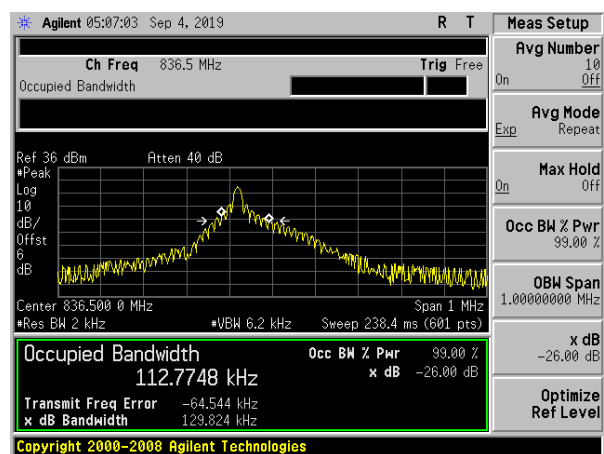
NB-IOT Band 5 QPSK 15kHz 1@0 CH-Low



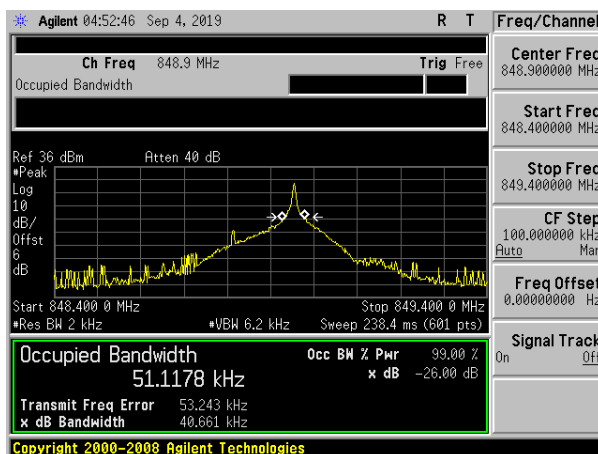
NB-IOT Band 5 QPSK 3.75kHz 1@0 CH-Middle



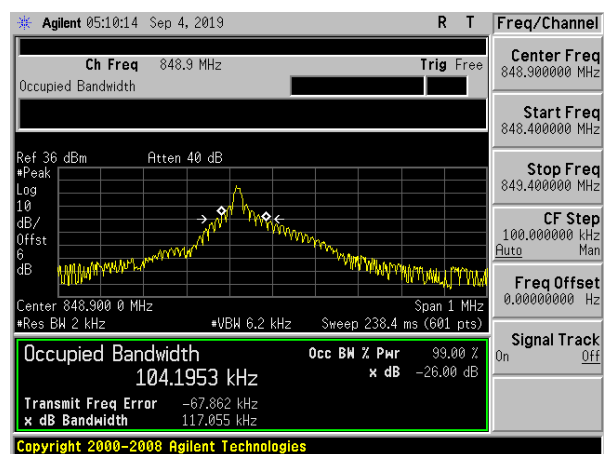
NB-IOT Band 5 QPSK 15kHz 1@0 CH-Middle



NB-IOT Band 5 QPSK 3.75kHz 1@0 CH-High



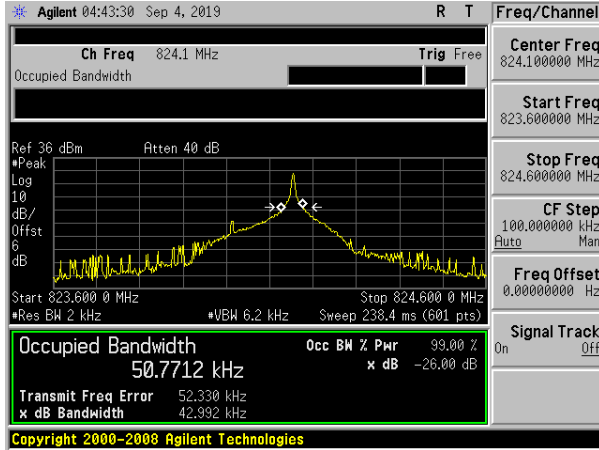
NB-IOT Band 5 QPSK 15kHz 1@0 CH-High



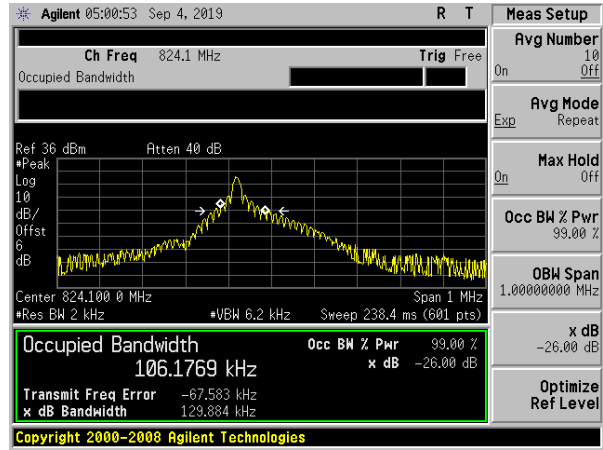


### Test plot

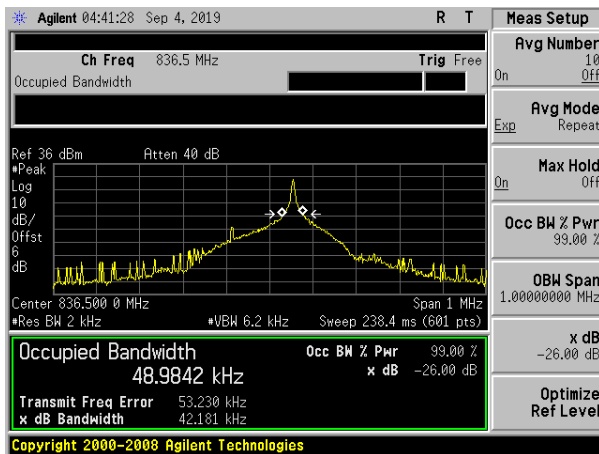
NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-Low



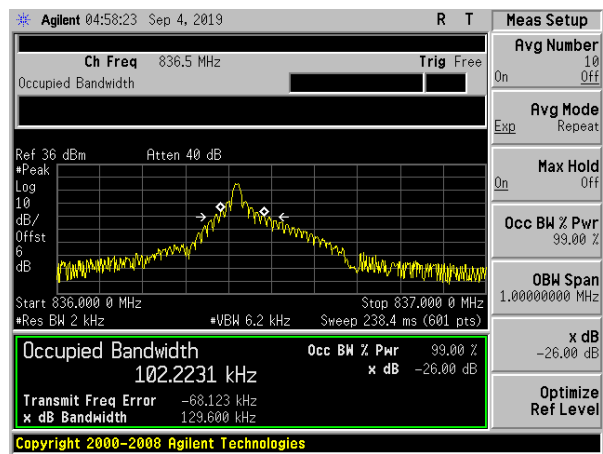
NB-IOT Band 5 BPSK 15kHz 1@0 CH-Low



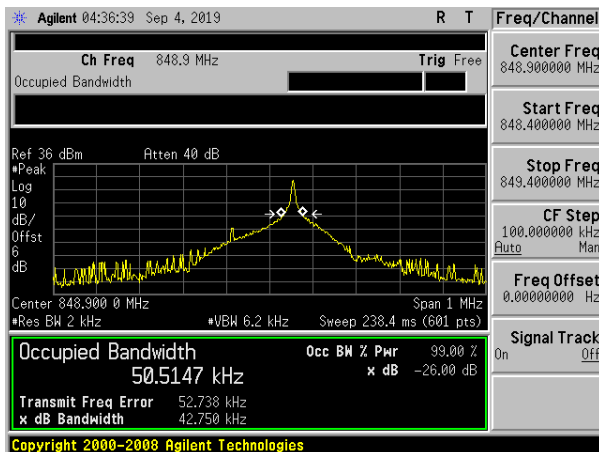
NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-Middle



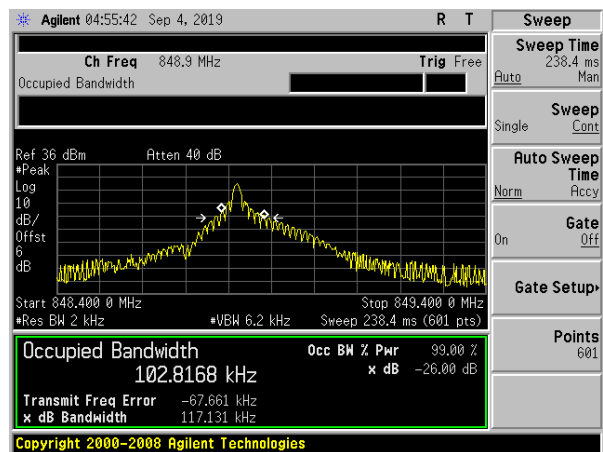
NB-IOT Band 5 BPSK 15kHz 1@0 CH-Middle



NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-High

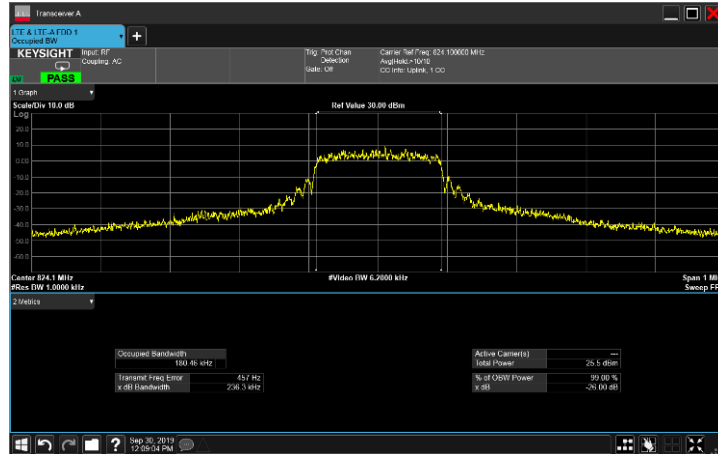


NB-IOT Band 5 BPSK 15kHz 1@0 CH-High

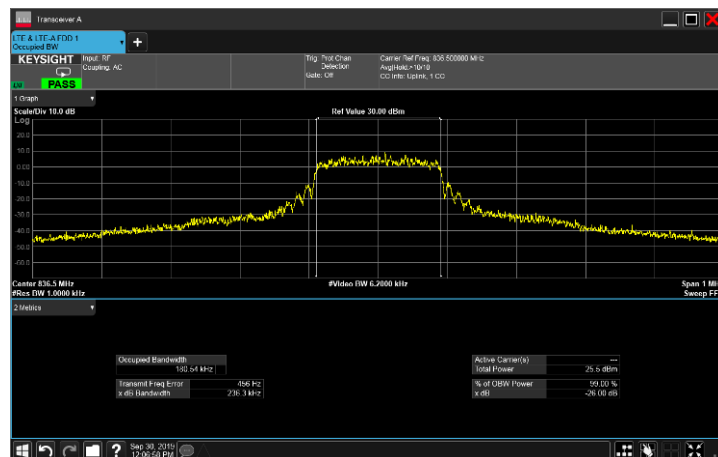


## Test plot

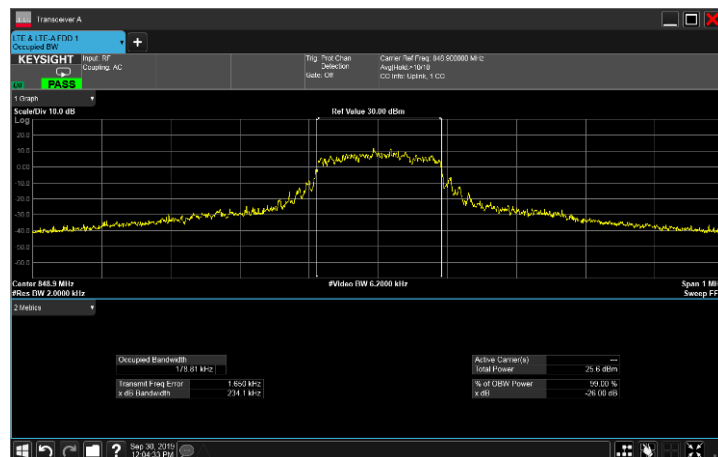
### NB-IOT Band 5 QPSK 15kHz 12@0 CH-Low



### NB-IOT Band 5 QPSK 15kHz 12@0 CH-Middle



### NB-IOT Band 5 QPSK 15kHz 12@0 CH-High



**TEST REPORT****5 BANDEDGE AND EMISSION MASK****Test result: Pass****5.1 LIMITS**

FCC: §22.359,

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.

**5.2 TEST PROCEDURE**

The transmitter output was connected to a CMW500 Test Set and configured to operate at maximum power. The band edge emissions were measured at the required operating frequencies in each band on the Spectrum Analyzer.

For each band edge measurement:

Set the spectrum analyzer span to include the block edge frequency.

Set a marker to point the corresponding band edge frequency in each test case.

Set display line at -13 dBm

Set resolution bandwidth to at least 1% of emission bandwidth.

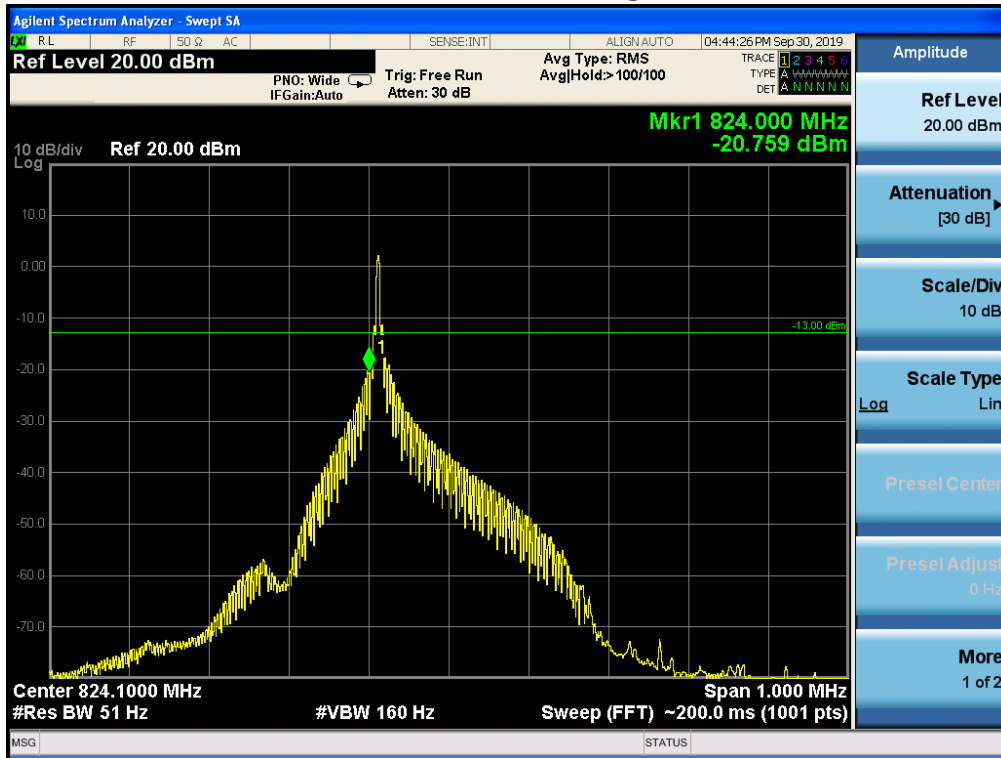
**5.3 MODES TESTED**

NB-IOT Band 5

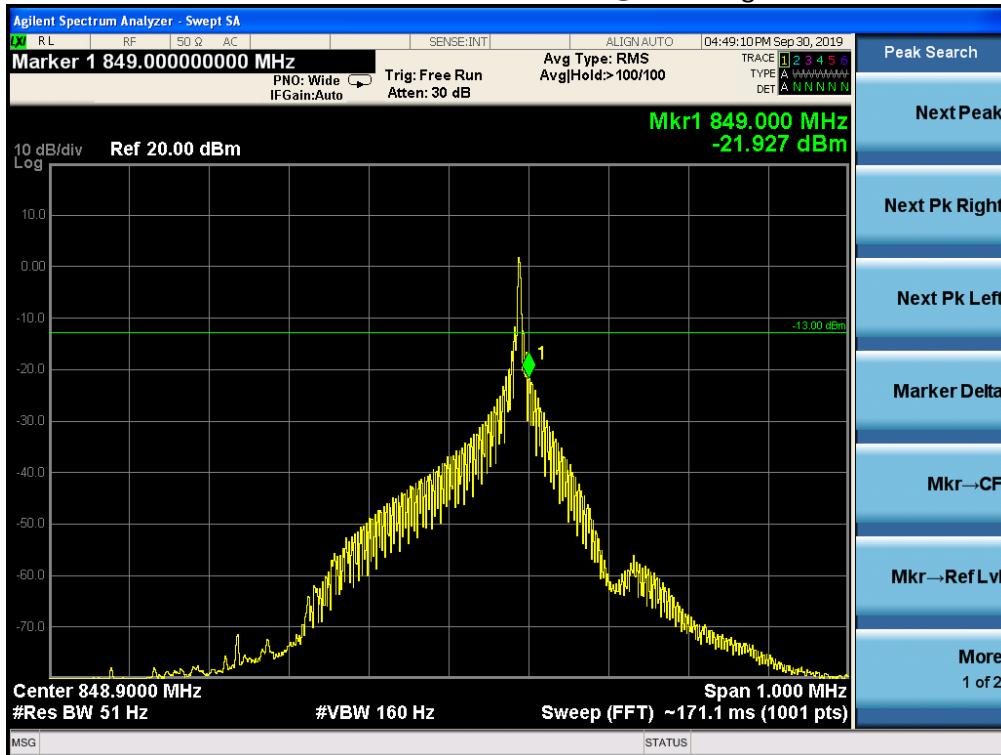
**5.4 TEST RESULTS**

NB-IOT BAND 5

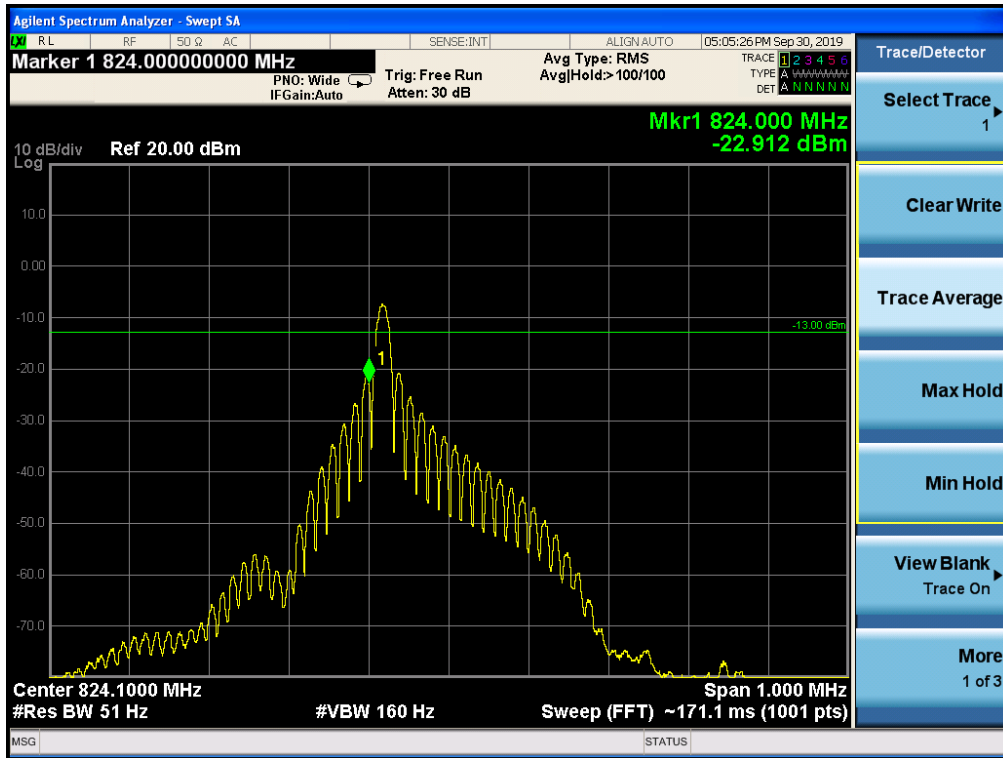
NB-IOT Band 5 BPSK 3.75kHz 1@0 CH-Low



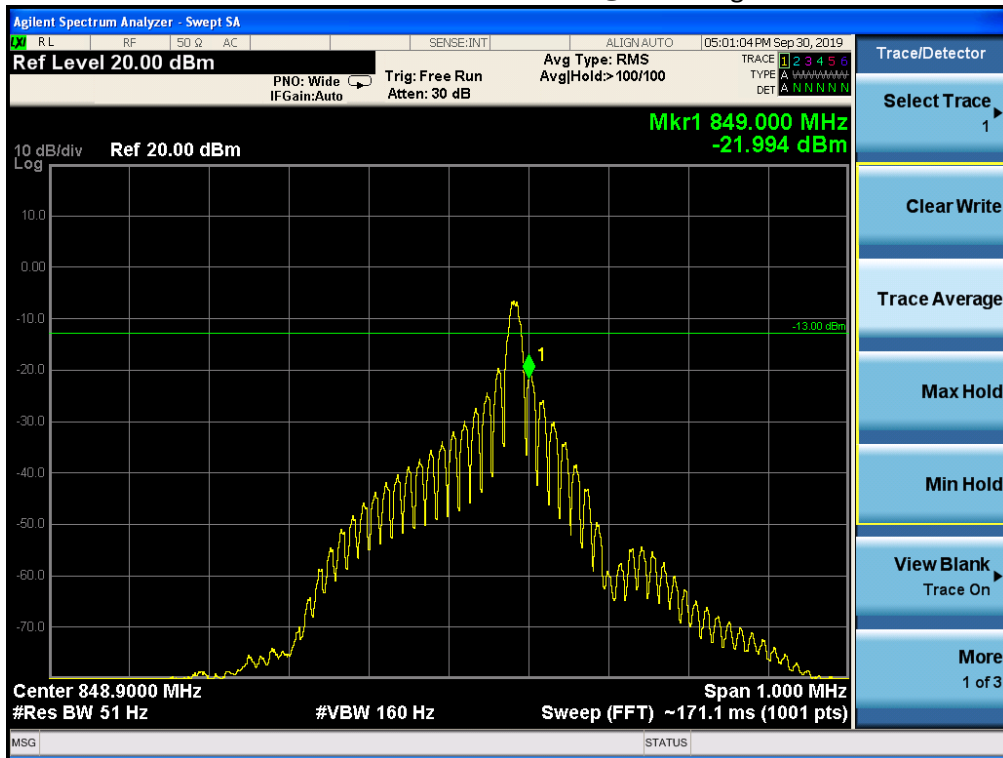
NB-IOT Band 5 BPSK 3.75kHz 1@47 CH-High



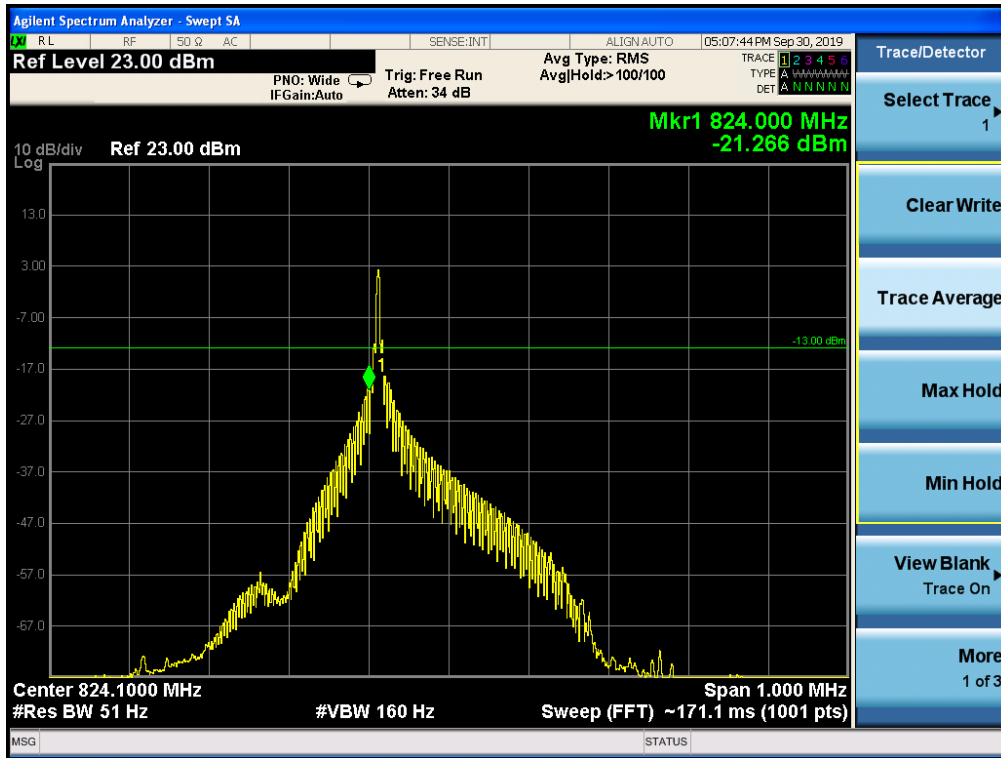
## NB-IOT Band 5 BPSK 15kHz 1@0 CH-Low



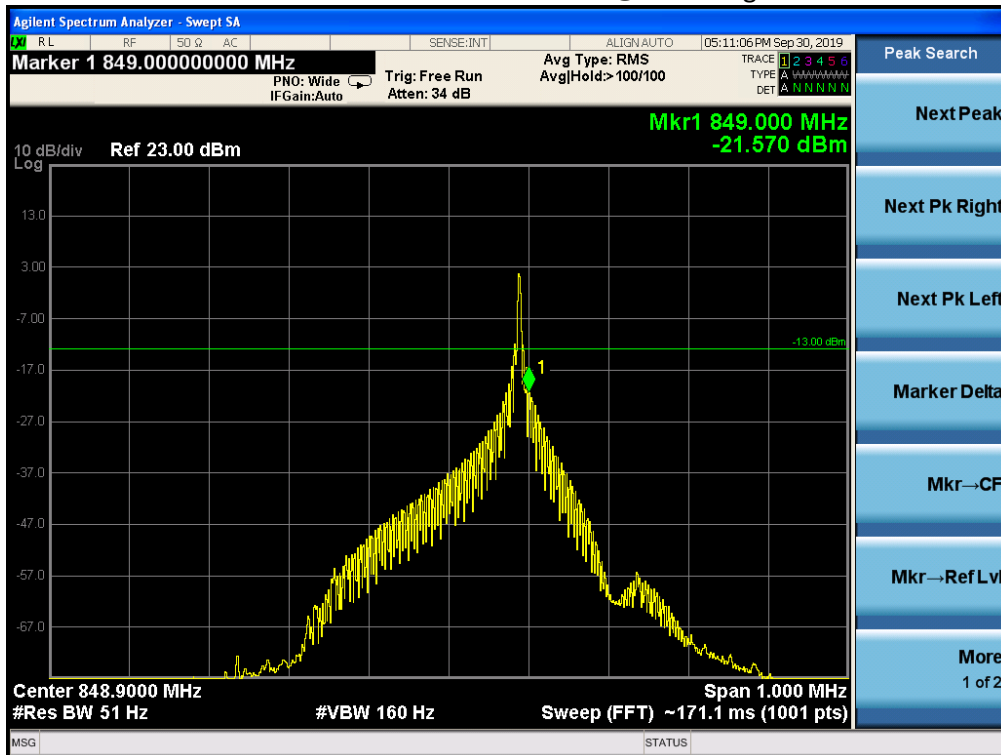
## NB-IOT Band 5 BPSK 15kHz 1@11 CH-High



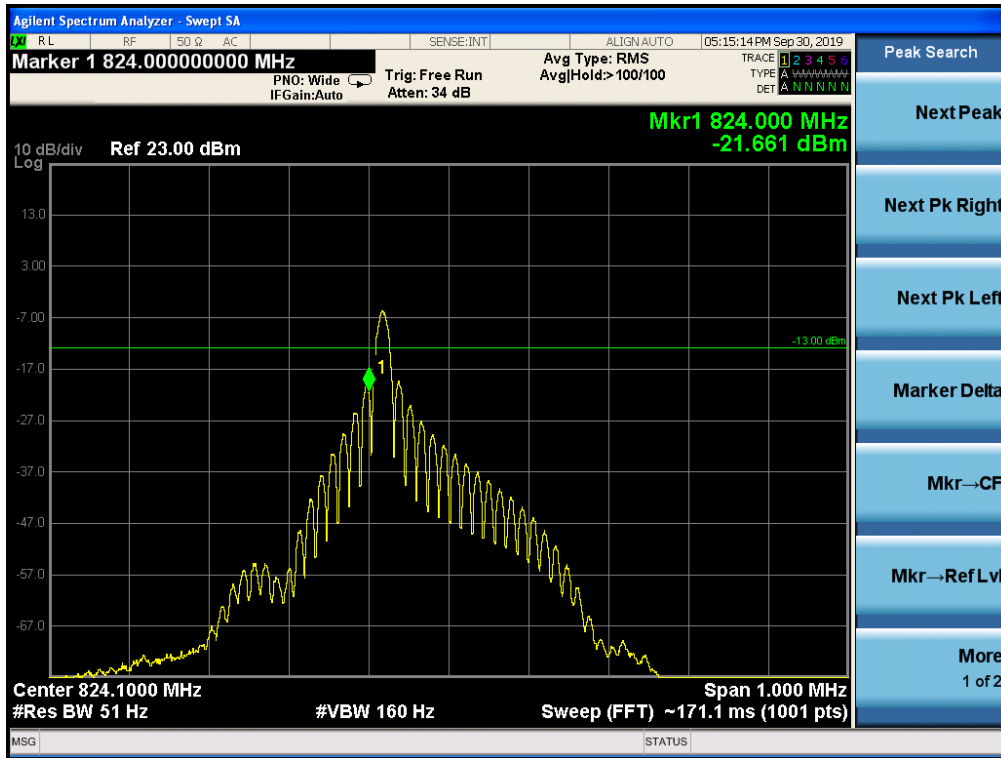
### NB-IOT Band 5 QPSK 3.75kHz 1@0 CH-Low



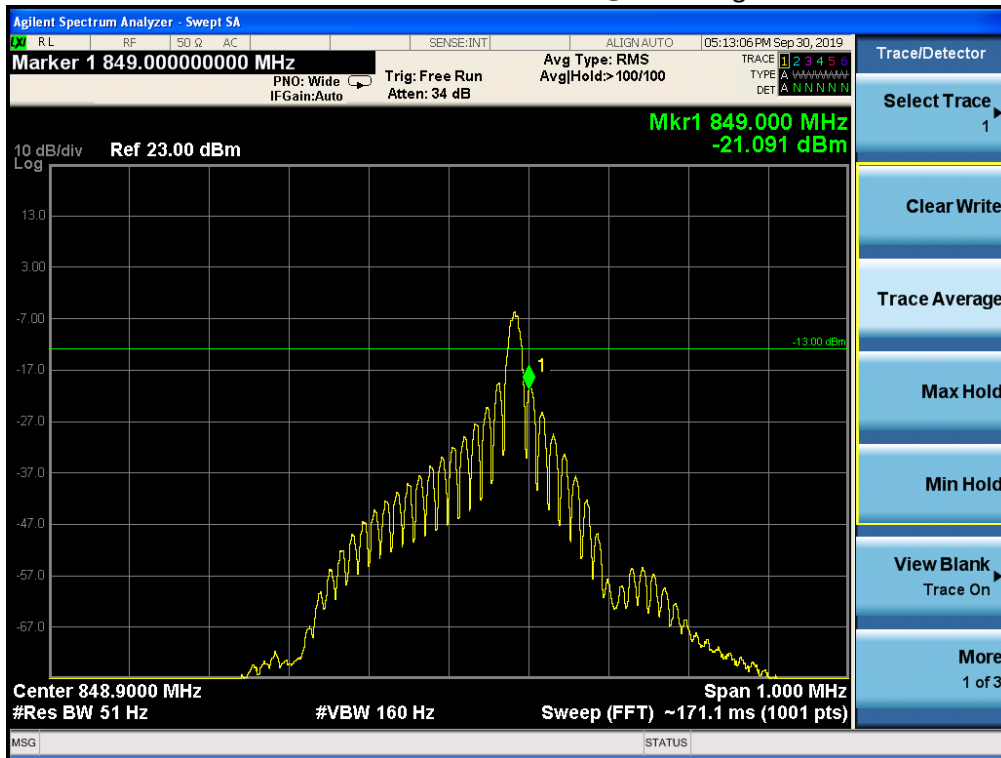
### NB-IOT Band 5 QPSK 3.75kHz 1@47 CH-High



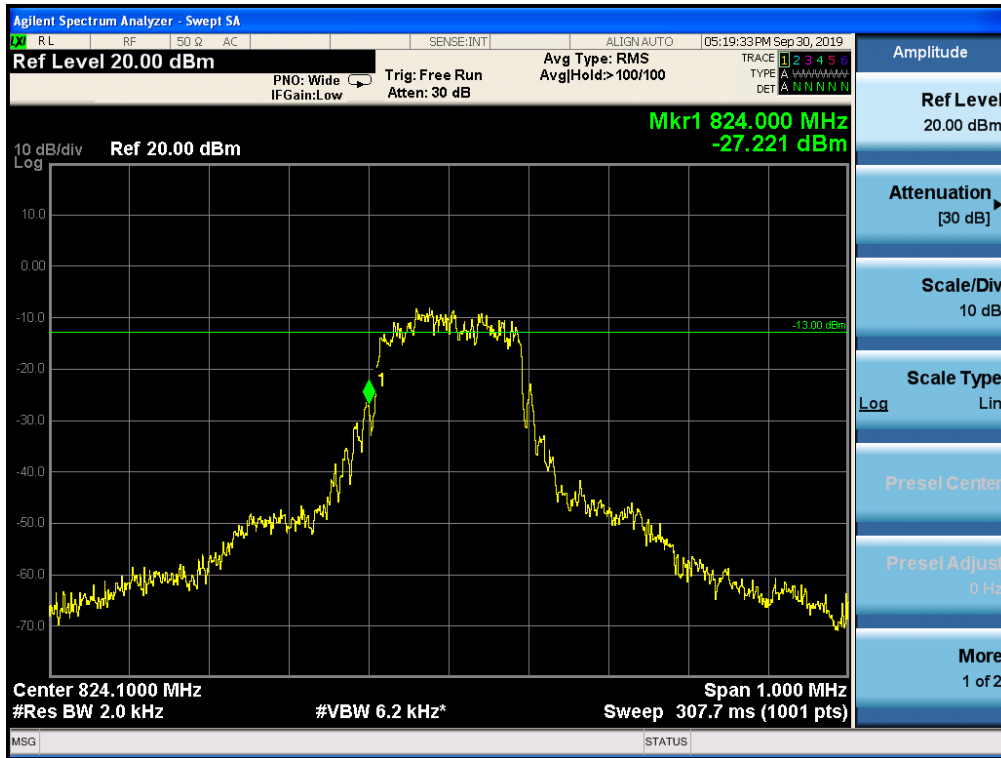
## NB-IOT Band 5 QPSK 15kHz 1@0 CH-Low



## NB-IOT Band 5 QPSK 15kHz 1@11 CH-High



## NB-IOT Band 5 QPSK 15kHz 12@0 CH-Low



## NB-IOT Band 5 QPSK 15kHz 12@0 CH-High





## 6 OUT OF BAND EMISSIONS

**Test result:** Pass

### 6.1 LIMITS

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.

### 6.2 TEST PROCEDURE

The RF output of the transmitter was connected to a spectrum analyzer through a calibrated coaxial cable. Sufficient scans were taken to show the out-of-band Emissions, if any, up to 10th harmonic. Multiple sweeps were recorded in maximum hold mode using a peak detector to ensure that the worst-case emissions were caught.

For each out of band emissions measurement:

- Set display line at -13 dBm
- Set RBW & VBW to 100 kHz for the measurement below 1 GHz, and 1 MHz for the measurement above 1 GHz.

### **6.3 MODES TESTED**

NB-IOT Band 5

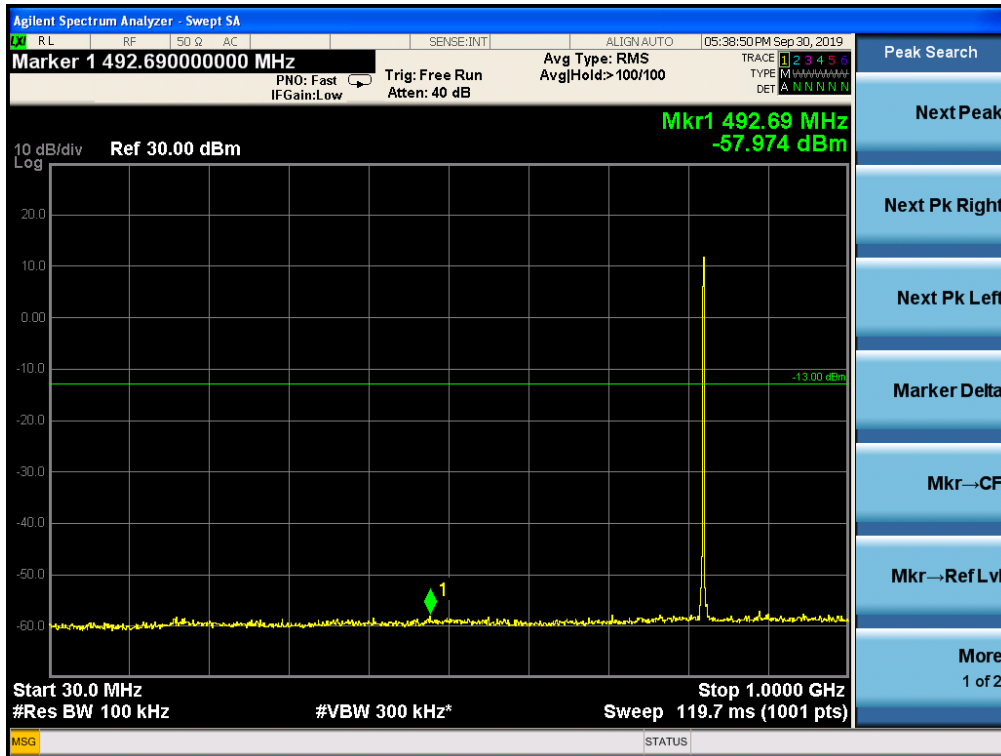
### **6.4 MEASUREMENT METHOD**

The test set up and general procedure is similar to conducted peak output power test. Only different for setting the measurement configuration of the measuring instrument of Spectrum Analyzer.

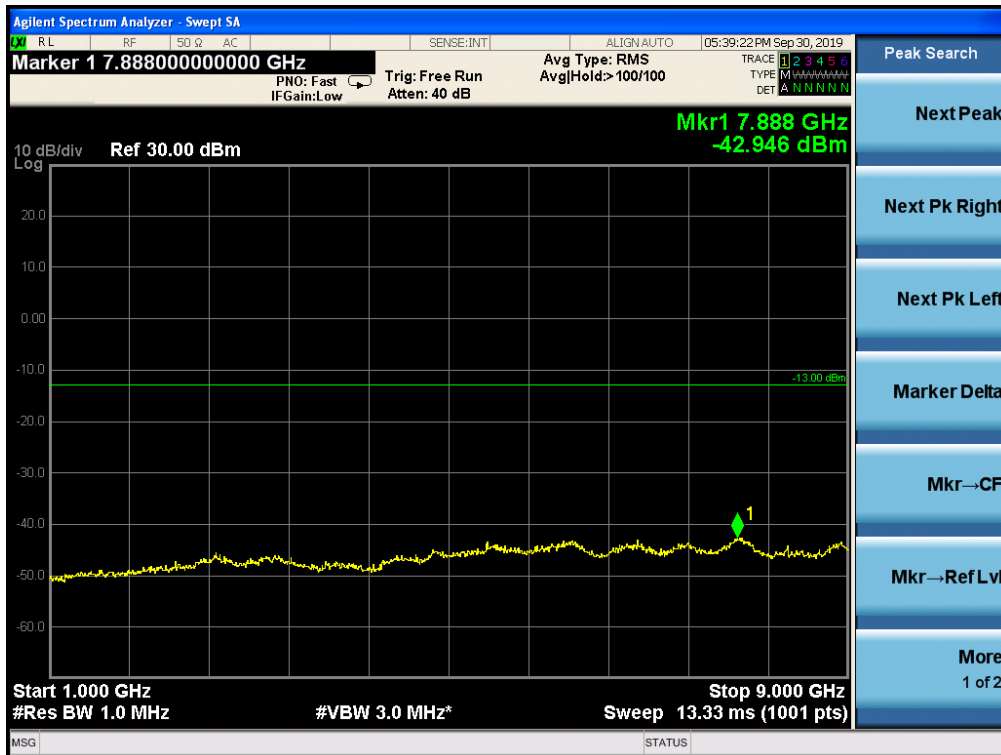
### **6.5 TEST RESULTS**

### NB-IOT BAND 5

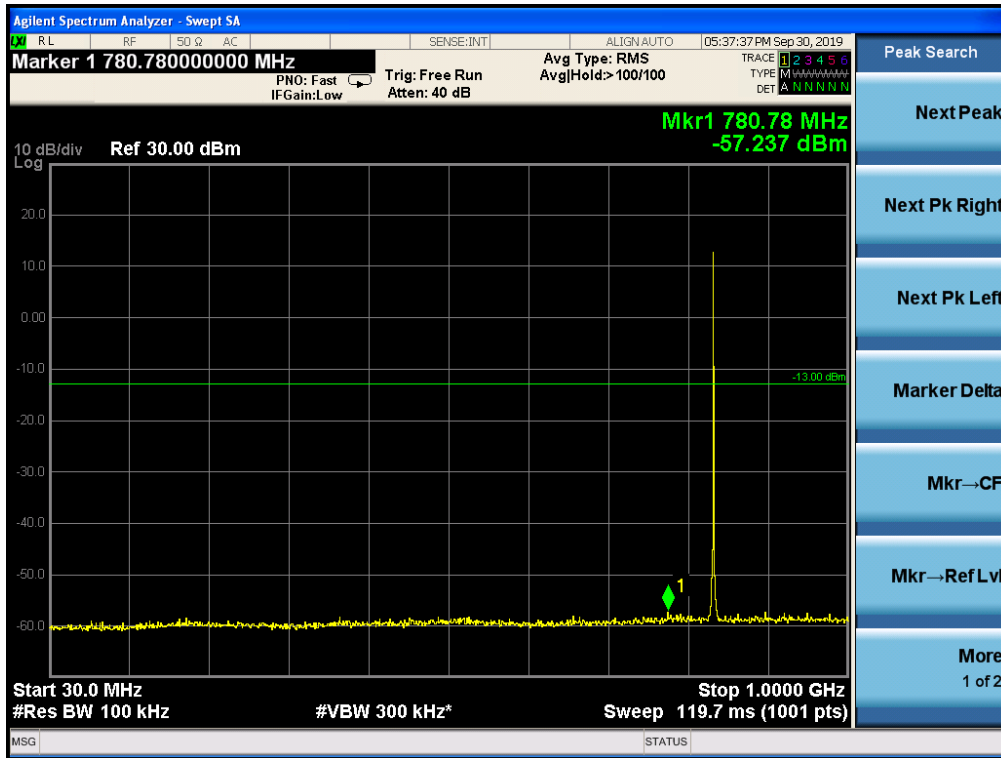
#### NB-IOT Band 5 CH-Low 30MHz-1GHz



#### NB-IOT Band 5 CH-Low 1GHz-9GHz



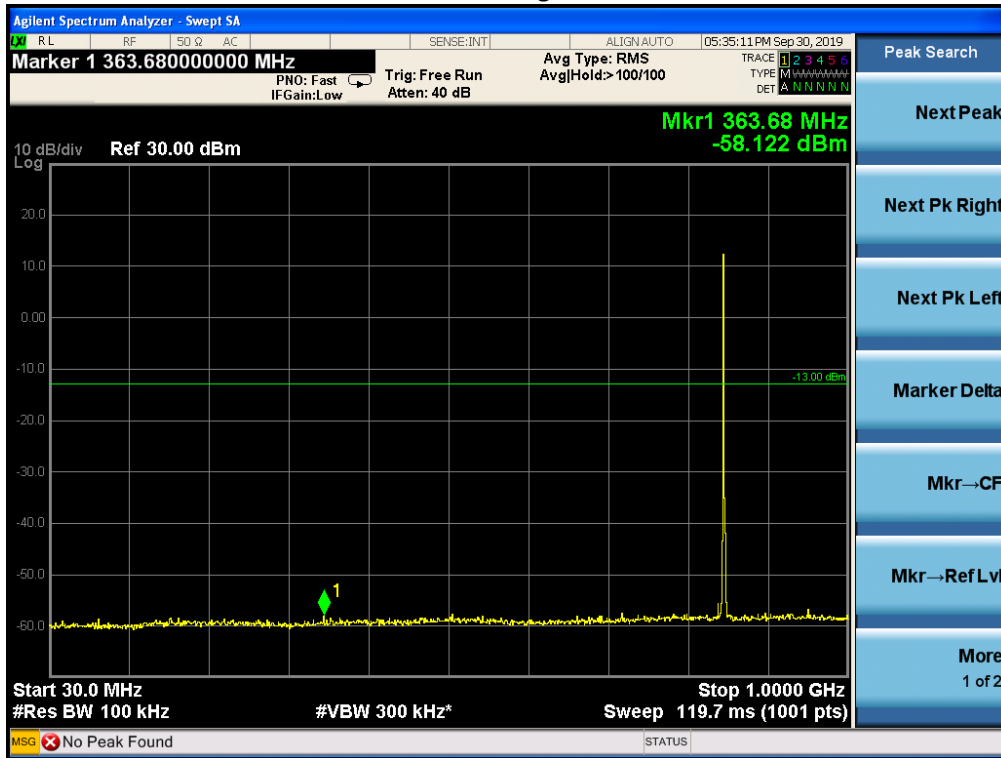
## NB-IOT Band 5 CH-Middle 30MHz-1GHz



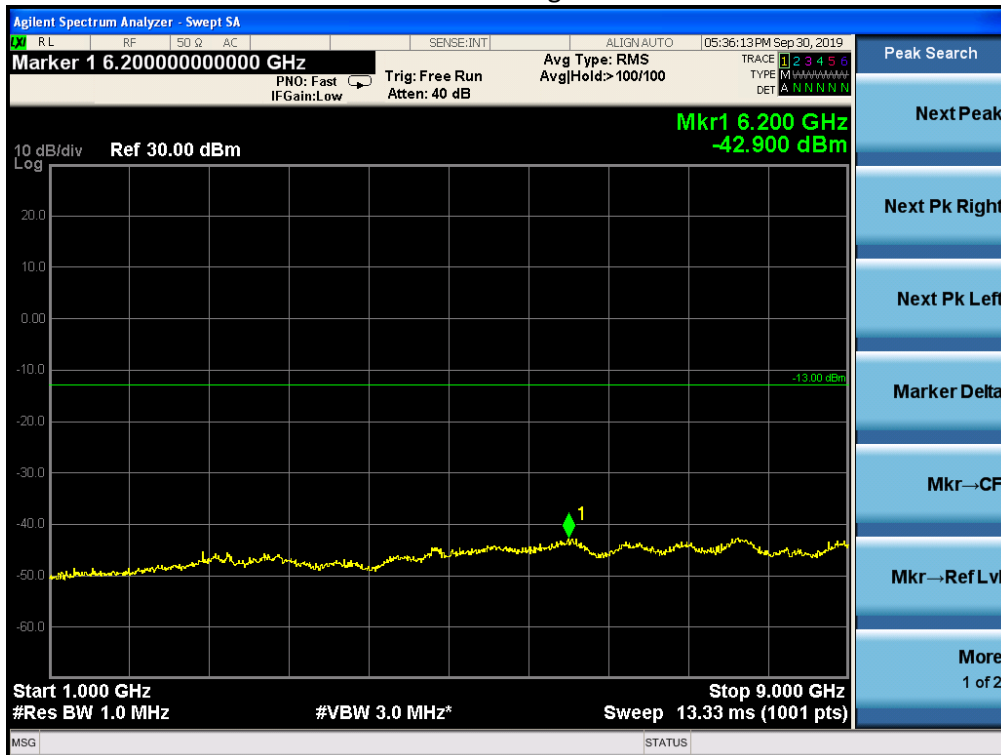
## NB-IOT Band 5 CH-Middle 1GHz-9GHz



## NB-IOT Band 5 CH-High 30MHz-1GHz



## NB-IOT Band 5 CH-High 1GHz-9GHz



## 7 RADIATED MEASUREMENT

**Test result:** Pass

### 7.1 LIMITS

22.913(a) - The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

### 7.2 TEST PROCEDURE

ANSI/TIA-603-E Clause 2.2.17

KDB 971168 v02r01 RF power output using broadband peak and average power meter method.

KDB 971168 D01 Power Meas License Digital Systems v02r01, "Measurement Guidance for Certification of Licensed Digital Transmitters

### 7.3 MODES TESTED

NB-IOT Band 5

### 7.4 TEST RESULTS

NB-IOT BAND 5

Radiated Power (EIRP) for Band 5										
Mode	RB/RB SIZE	Frequency	Result					Max. EIRP Average (dBm)	Polarization Of Max. ERP	Conclusion
			SG Level (dBm)	Cable Loss (dBm)	Antenna Gain (dB)	Max. EIRP Average (dBm)	Max. EIRP Average (mW)			
3.75KHz BPSK	1/0	824.1	-1.63	3.76	28.24	22.85	192.752	Vertical	Pass	
		836.5	-1.30	3.91	28.22	23.01	199.986	Vertical	Pass	
		848.9	-1.36	3.93	28.20	22.91	195.434	Vertical	Pass	
15KHz BPSK	1/0	824.1	-2.24	3.76	28.24	22.24	167.494	Vertical	Pass	
		836.5	-1.97	3.91	28.22	22.34	171.396	Vertical	Pass	
		848.9	-2.08	3.93	28.20	22.19	165.577	Vertical	Pass	
3.75KHz QPSK	1/0	824.1	-1.57	3.77	28.23	22.89	194.536	Vertical	Pass	
		836.5	-1.46	3.91	28.24	22.87	193.642	Vertical	Pass	
		848.9	-1.36	3.94	28.25	22.95	197.242	Vertical	Pass	
15KHz QPSK	1/0	824.1	-2.13	3.77	28.23	22.33	171.002	Vertical	Pass	
		836.5	-2.08	3.91	28.24	22.25	167.880	Vertical	Pass	
		848.9	-2.05	3.94	28.25	22.26	168.267	Vertical	Pass	
3.75KHz BPSK	1/0	824.1	-2.07	3.76	28.24	22.41	174.181	Horizontal	Pass	
		836.5	-1.79	3.91	28.22	22.52	178.649	Horizontal	Pass	
		848.9	-1.80	3.93	28.20	22.47	176.604	Horizontal	Pass	
15KHz BPSK	1/0	824.1	-2.53	3.76	28.24	21.95	156.675	Horizontal	Pass	
		836.5	-2.46	3.91	28.22	21.85	153.109	Horizontal	Pass	
		848.9	-2.48	3.93	28.20	21.79	151.008	Horizontal	Pass	
3.75KHz QPSK	1/0	824.1	-2.10	3.77	28.23	22.36	172.187	Horizontal	Pass	
		836.5	-1.89	3.91	28.24	22.44	175.388	Horizontal	Pass	
		848.9	-1.82	3.94	28.25	22.49	177.419	Horizontal	Pass	
15KHz QPSK	1/0	824.1	-2.78	3.77	28.23	21.68	147.231	Horizontal	Pass	
		836.5	-2.59	3.91	28.24	21.74	149.279	Horizontal	Pass	
		848.9	-2.48	3.94	28.25	21.83	152.405	Horizontal	Pass	

Note:

SG Level= Signal generator output

Max. EIRP Average (dBm)= Antenna Gain(dB)+ SG Level (dBm)- Cable Loss(dBm)

## 8 SPURIOUS RADIATION EMISSION

**Test result:** Pass

### 8.1 LIMITS

§22.917 (e): 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.

### 8.2 TEST PROCEDURE

For Cellular equipment - Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

For PCS equipment - Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth ( i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

The unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth in the 1 MHz band immediately outside and adjacent to the channel edge of the equipment. Beyond the 1 MHz band immediately outside the channel edge of the equipment, a resolution bandwidth of 1 MHz shall be employed. A narrower resolution bandwidth is allowed to be used provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz or 1% of the occupied bandwidth as applicable.

The power of any unwanted emissions measured from the channel edge of the equipment shall be attenuated below the transmitter power, P (dBW), as follows:

- a. for base station and subscriber equipment, other than mobile subscriber equipment, the attenuation shall not be less than  $43 + 10 \text{Log}_{10} (p)$ , dB; and
- b. for mobile subscriber equipment, the attenuation shall not be less than  $43 + 10 \text{Log}_{10} (p)$ , dB at the channel edges and  $55 + 10 \text{Log}_{10} (p)$  at 5.5 MHz away and beyond the channel edges where p in (a) and (b) is the transmitter power measured in watts.



**TEST REPORT**

**8.3 MODES TESTED**

NB-IOT Band 5

**8.4 TEST RESULTS**

NB-IOT BAND 5

**BPSK EIRP POWER FOR NB-IOT BAND 5**

Test Results for Low Channel 824.1MHz							
Frequency(MHz)	SG Level(dBm)	Cable Loss(dB)	Antenna Gain(dB)	Absolute Level(dBm)	Limit ( dBm )	Margin(dBm)	Polarity
1649.4	-55.61	2.78	27.50	-30.89	-13	-17.89	Horizontal
1649.4	-59.95	2.78	27.50	-35.23	-13	-22.23	Vertical
2474.1	-52.82	2.90	27.80	-27.92	-13	-14.92	Vertical
2474.1	-56.63	2.90	27.80	-31.73	-13	-18.73	Horizontal
Test Results For Mid Channel 836.5MHz							
1673	-54.17	2.78	27.48	-29.47	-13	-16.47	Horizontal
1673	-55.28	2.78	27.48	-30.58	-13	-17.58	Vertical
2509.5	-54.13	2.91	27.70	-29.34	-13	-16.34	Vertical
2509.5	-56.22	2.91	27.70	-31.43	-13	-18.43	Horizontal
Test Results for High Channel 848.9MHz							
1696.6	-53.98	2.78	27.43	-29.33	-13	-16.33	Horizontal
1696.6	-57.64	2.78	27.43	-32.99	-13	-19.99	Vertical
2544.9	-53.31	2.92	27.74	-28.49	-13	-15.49	Vertical
2544.9	-54.45	2.92	27.74	-29.63	-13	-16.63	Horizontal

**QPSK EIRP POWER FOR NB-IOT BAND 5**

Test Results for Low Channel 824.1MHz							
Frequency(MHz)	SG Level(dBm)	Cable Loss(dB)	Antenna Gain(dB)	Absolute Level(dBm)	Limit ( dBm )	Margin(dBm)	Polarity
1649.4	-55.73	2.78	27.50	-31.01	-13	-18.01	Horizontal
1649.4	-54.41	2.78	27.50	-29.69	-13	-16.69	Vertical
2474.1	-56.85	2.90	27.80	-31.95	-13	-18.95	Vertical
2474.1	-54.72	2.90	27.80	-29.82	-13	-16.82	Horizontal
Test Results For Mid Channel 836.5MHz							
1673	-56.92	2.78	27.48	-32.22	-13	-19.22	Horizontal
1673	-57.41	2.78	27.48	-32.71	-13	-19.71	Vertical
2509.5	-56.32	2.91	27.70	-31.53	-13	-18.53	Vertical
2509.5	-54.11	2.91	27.70	-29.32	-13	-16.32	Horizontal
Test Results for High Channel 848.9MHz							
1696.6	-57.82	2.78	27.43	-33.17	-13	-20.17	Horizontal
1696.6	-55.92	2.78	27.43	-31.27	-13	-18.27	Vertical
2544.9	-56.36	2.92	27.74	-31.54	-13	-18.54	Vertical
2544.9	-54.41	2.92	27.74	-29.59	-13	-16.59	Horizontal

Note:  $P_{Mea}(dBm) = Power(dBm) + ARpl(dBm)$

Over Limit=:  $P_{Mea}(dBm) - Limit(dBm)$

We test both H direction and V direction, recorded worst case direction.

## 9 FREQUENCY STABILITY

Test result: Tested

### 9.1 LIMITS

§22.355 - The carrier frequency shall not depart from the reference frequency in excess of  $\pm 2.5$  ppm for mobile stations.

### 9.2 TEST PROCEDURE

Use CMW 500 with Frequency Error measurement capability.

Temp. =  $-30^{\circ}$  to  $+50^{\circ}$ C

Voltage = low voltage, DC 3.3V, Normal, DC 2.1V and High voltage, DC 3.6V.

#### Frequency Stability vs Temperature:

The EUT is placed inside a temperature chamber. The temperature is set to  $-30^{\circ}$ C and allowed to stabilize. After sufficient soak time, the transmitting frequency error is measured. The temperature is increased by 10 degrees, allowed to stabilize and soak, and then the measurement is repeated. This is repeated until  $+50^{\circ}$ C is reached.

#### Frequency Stability vs Voltage:

The peak frequency error is recorded (worst-case).

### 9.3 MODES TESTED

NB-IOT Band 5

**TEST REPORT**

**9.4 TEST RESULTS**

NB-IOT BAND 5

**BPSK**

**Frequency error vs. Voltage**

Voltage [Vdc]	Frequency [MHz]	Frequency* Error[Hz]	Frequency Error[ppm]	Limit [ppm]
<b>BAND 5 BPSK</b>				
2.1	836.5	11	0.013150	2.5
3.3	836.5	8.7	0.010400	2.5
3.6	836.5	7.3	0.008727	2.5

**Frequency error vs. Temperature**

Temperature [°C]	Frequency [MHz]	Frequency* Error[Hz]	Frequency Error[ppm]	Limit [ppm]
<b>BAND 5 QPSK</b>				
Normal (25C)	836.5	-7.4	-0.008846	2.5
Extreme (50C)	836.5	-11.6	-0.013867	2.5
Extreme (40C)	836.5	12.3	0.014704	2.5
Extreme (30C)	836.5	5.6	0.006695	2.5
Extreme (10C)	836.5	9.6	0.011476	2.5
Extreme (0C)	836.5	8.4	0.010042	2.5
Extreme (-10C)	836.5	-7	-0.008368	2.5
Extreme (-20C)	836.5	8.6	0.010281	2.5
Extreme (-30C)	836.5	-7.3	-0.008727	2.5

**QPSK**

**Frequency error vs. Voltage**

Voltage [Vdc]	Frequency [MHz]	Frequency* Error[Hz]	Frequency Error[ppm]	Limit [ppm]
<b>BAND 5 QPSK</b>				
2.1	836.5	6.9	0.008249	2.5
3.3	836.5	7.7	0.009205	2.5
3.6	836.5	-13.4	-0.016019	2.5

**TEST REPORT**

**Frequency error vs. Temperature**

Temperature [°C]	Frequency [MHz]	Frequency* Error[Hz]	Frequency Error[ppm]	Limit [ppm]
<b>BAND 5 QPSK</b>				
Normal (25C)	836.5	12.5	0.014943	2.5
Extreme (50C)	836.5	8.4	0.010042	2.5
Extreme (40C)	836.5	9.3	0.011118	2.5
Extreme (30C)	836.5	-8.1	-0.009683	2.5
Extreme (10C)	836.5	-7.2	-0.008607	2.5
Extreme (0C)	836.5	5.5	0.006575	2.5
Extreme (-10C)	836.5	7	0.008368	2.5
Extreme (-20C)	836.5	6	0.007173	2.5
Extreme (-30C)	836.5	8.9	0.010640	2.5

**\*Note:** Frequency error measurements were made by using the build-in capability of the Wireless Communication Test Set.

## 10 Peak-to-Average Ratio

### 10.1 Description of the PAR Measurement

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

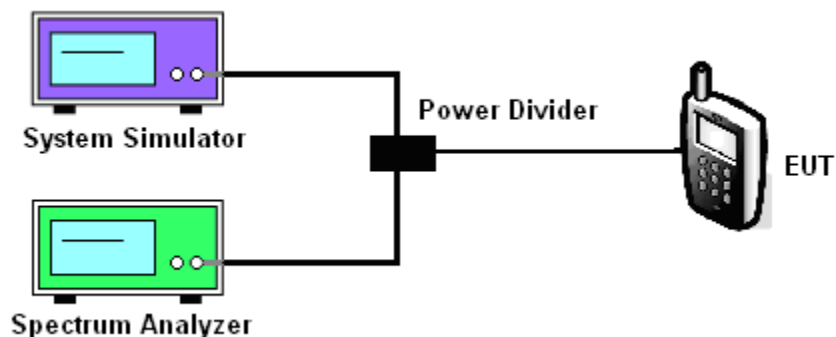
### 10.2 Measuring Instruments

See list of measuring instruments of this test report.

### 10.3 Test Procedures

1. The EUT was connected to Spectrum Analyzer and Base Station via power divider.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. For GSM/EGPRS operating modes:
  - a. Set the RBW = 1MHz, VBW = 1MHz, Peak detector in spectrum analyzer.
  - b. Set EUT in maximum power output, and triggered the burst signal.
  - c. Measured respectively the Peak level and Mean level, and the deviation was recorded as Peak to Average Ratio.
4. For UMTS operating modes:
  - a. Set the CCDF (Complementary Cumulative Distribution Function) option in spectrum analyzer.
  - b. The highest RF powers were measured and recorded the maximum PAPR level associated with a probability of 0.1 %.

### 10.4 TEST SETUP



**TEST REPORT**

**10.5 MODES TESTED**

NB-IOT Band 5

**10.6 TEST RESULTS**

Mode	Modulation	Sub-carrier spacing (KHz)	Channel/ Frequency (MHz)	Peak-to-Average Power Ratio (PAPR)		
				Peak(dBm)	Avg(dBm)	PAPR(dB)
Band 5 Stand alone	BPSK	3.75	20525/836.5	26.24	22.05	4.19
	QPSK	3.75	20525/836.5	25.69	22.02	3.67
	BPSK	15	20525/836.5	25.91	18.95	6.96
	QPSK	15	20525/836.5	25.67	18.97	6.70

\*\*\*\*\* END \*\*\*\*\*