

FCC Test Report (Part 27 – NB-IoT B4/B12/B13)

Report No.: RFBCYD-WTW-P21090659-2

FCC ID: 2AQYP-TRACK1100

Test Model: SNT3.5 ULTRA

Received Date: Oct. 08, 2021

Test Date: Dec. 09, 2021 ~ May 28, 2022

Issued Date: May 30, 2022

Applicant: Sensolus NV

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
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**FCC Registration /
Designation Number:** 788550 / TW0003

Test Location (2): No. 70, Wenming Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)

**FCC Registration /
Designation Number:** 281270 / TW0032



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Release Control Record

Issue No.	Description	Date Issued
RFBCYD-WTW-P21090659-2	Original release	May 30, 2022

1 Certificate of Conformity

Product: TRACK1100

Brand: sensolus

Test Model: SNT3.5 ULTRA

Sample Status: Mass Production

Applicant: Sensolus NV

Test Date: Dec. 09, 2021 ~ May 28, 2022

Standards: FCC Part 27, Subpart C, F, H, L

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Celine Chou , **Date:** May 30, 2022
Celine Chou / Senior Specialist

Approved by : Jeremy Lin , **Date:** May 30, 2022
Jeremy Lin / Project Engineer

2 Summary of Test Results

For NB-IoT Band 4

Applied Standard: FCC Part 27 & Part 2			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50 (d)	Equivalent Isotropically radiated power	Pass	Meet the requirement of limit.
2.1047	Modulation characteristics	Pass	Meet the requirement
2.1055 27.54	Frequency Stability	Pass	Meet the requirement of limit.
2.1049	Emission Bandwidth	Pass	Meet the requirement of limit.
2.1051 27.53 (h)	Out of Band Emission Measurements	Pass	Meet the requirement of limit.
27.50 (d)(5)	Peak To Average Ratio	Pass	Meet the requirement of limit.
2.1051 27.53 (h)	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 27.53 (h)	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -24.52dB at 3465.00MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

For NB-IoT Band 12

Applied Standard: FCC Part 27 & Part 2			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50 (c)	Equivalent radiated power	Pass	Meet the requirement of limit.
2.1047	Modulation characteristics	Pass	Meet the requirement
2.1055 27.54	Frequency Stability	Pass	Meet the requirement of limit.
2.1049	Emission Bandwidth	Pass	Meet the requirement of limit.
2.1051 27.53 (g)	Out of Band Emission Measurements	Pass	Meet the requirement of limit.
--	Peak To Average Ratio	Pass	Meet the requirement of limit.
2.1051 27.53 (g)	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 27.53 (g)	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -31.51dB at 1398.40MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

For NB-IoT Band 13

Applied Standard: FCC Part 27 & Part 2			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50 (b)	Equivalent radiated power	Pass	Meet the requirement of limit.
2.1047	Modulation characteristics	Pass	Meet the requirement
2.1055 27.54	Frequency Stability	Pass	Meet the requirement of limit.
2.1049	Emission Bandwidth	Pass	Meet the requirement of limit.
2.1051 27.53 (c)	Out of Band Emission Measurements	Pass	Meet the requirement of limit.
--	Peak To Average Ratio	Pass	Meet the requirement of limit.
2.1051 27.53 (c)(f)	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 27.53 (c)(f)	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -3.10dB at 1564.00MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) ($\pm$)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.00 dB
	30MHz ~ 200MHz	2.91 dB
	200MHz ~ 1000MHz	2.92 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	1.76 dB
	18GHz ~ 40GHz	1.77 dB

2.2 Test Site and Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver Rohde & Schwarz	ESR3	102579	Jul. 05, 2021	Jul. 04, 2022
Spectrum Analyzer KEYSIGHT	N9020B	MY60110462	Dec. 18, 2020	Dec. 17, 2021
			Dec. 21, 2021	Dec. 20, 2022
BILOG Antenna SCHWARZBECK	VULB9168	995	Oct. 28, 2021	Oct. 27, 2022
HORN Antenna RF SPIN	DRH18-E	210104A18E	Nov. 14, 2021	Nov. 13, 2022
HORN Antenna SCHWARZBECK	BBHA 9170	9170-1049	Nov. 14, 2021	Nov. 13, 2022
Loop Antenna TESEQ	HLA 6121	45745	Jul. 21, 2021	Jul. 20, 2022
Preamplifier EMCI	EMC330N	980783	Jan. 19, 2021	Jan. 18, 2022
			Jan. 17, 2022	Jan. 16, 2023
Preamplifier EMCI	EMC118A45SE	980810	Jan. 06, 2021	Jan. 05, 2022
			Dec. 30, 2021	Dec. 29, 2022
Preamplifier EMCI	EMC184045SE	980787	Jan. 18, 2021	Jan. 17, 2022
			Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMC104-SM-SM-(9000+2000+1000)	201230+ 201242+ 210101	Jan. 18, 2021	Jan. 17, 2022
			Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMCCFD400-NM-NM-(9000+300+500)	201252+ 201250+ 201245	Jan. 18, 2021	Jan. 17, 2022
			Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMC101G-KM-KM-(5000+3000+2000)	201259+201256+201253	Jan. 18, 2021	Jan. 17, 2022
			Jan. 17, 2022	Jan. 16, 2023
Software BV CPS	ADT_Radiated_V7.6.15.9.5	NA	NA	NA
Turn Table Max-Full	MFT-151SS-0.5T	NA	NA	NA
Turn Table Controller Max-Full	MF-7802BS	MF780208675	NA	NA
Antenna Tower KaiTuo	NA	NA	NA	NA
Antenna Tower Controller KaiTuo	KT-2000	NA	NA	NA
Temperature & Humidity Chamber Giant Force	GTH-120-40-CP-AR	MAA1306-019	Sep. 10, 2021	Sep. 09, 2022
JFW 20dB attenuation	50HF-020-SMA	NA	NA	NA
True RMS Clamp Meter Fluke	325	31130711WS	Jun. 02, 2021	Jun. 01, 2022
DC power supply Keysight	U8002A	MY56330015	NA	NA
Radio Communication Analyzer Anritsu	MT8821C	6272278310	Jun. 23, 2021	Jun. 22, 2022

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in WM Chamber 7.

3 General Information

3.1 General Description of EUT

Product	TRACK1100	
Brand	sensolus	
Test Model	SNT3.5 ULTRA	
Sample Status	Mass Production	
Power Supply Rating	3.6Vdc from battery	
Subcarrier Spacing	3.75kHz, 15kHz	
Modulation Type	BPSK, QPSK	
Operating Frequency	NB-IoT Standalone	
	NB-IoT Band 4	1710.2MHz ~ 1754.8MHz
	NB-IoT Band 12	699.2MHz ~ 715.8MHz
	NB-IoT Band 13	777.2MHz ~ 786.8MHz
	NB-IoT In band	
	NB-IoT Band 4 (Channel Bandwidth 3MHz)	1711.5MHz ~ 1753.5MHz
	NB-IoT Band 4 (Channel Bandwidth 5MHz)	1712.5MHz ~ 1752.5MHz
	NB-IoT Band 4 (Channel Bandwidth 10MHz)	1715.0MHz ~ 1750.0MHz
	NB-IoT Band 4 (Channel Bandwidth 15MHz)	1717.5MHz ~ 1747.5MHz
	NB-IoT Band 4 (Channel Bandwidth 20MHz)	1720.0MHz ~ 1745.0MHz
	NB-IoT Band 12 (Channel Bandwidth 3MHz)	700.5MHz ~ 714.5MHz
	NB-IoT Band 12 (Channel Bandwidth 5MHz)	701.5MHz ~ 713.5MHz
	NB-IoT Band 12 (Channel Bandwidth 10MHz)	704.0MHz ~ 711.0MHz
	NB-IoT Band 12 (Channel Bandwidth 15MHz)	706.5MHz ~ 708.5MHz
	NB-IoT Band 13 (Channel Bandwidth 3MHz)	778.5MHz ~ 785.5MHz
	NB-IoT Band 13 (Channel Bandwidth 5MHz)	779.5MHz ~ 784.5MHz
	NB-IoT Band 13 (Channel Bandwidth 10MHz)	782.0MHz
	NB-IoT Guard band	
	NB-IoT Band 4 (Channel Bandwidth 5MHz)	1712.5MHz ~ 1752.5MHz
	NB-IoT Band 4 (Channel Bandwidth 10MHz)	1715.0MHz ~ 1750.0MHz
	NB-IoT Band 4 (Channel Bandwidth 15MHz)	1717.5MHz ~ 1747.5MHz
	NB-IoT Band 4 (Channel Bandwidth 20MHz)	1720.0MHz ~ 1745.0MHz
	NB-IoT Band 12 (Channel Bandwidth 5MHz)	701.5MHz ~ 713.5MHz
	NB-IoT Band 12 (Channel Bandwidth 10MHz)	704.0MHz ~ 711.0MHz
	NB-IoT Band 12 (Channel Bandwidth 15MHz)	706.5MHz ~ 708.5MHz
	NB-IoT Band 13 (Channel Bandwidth 5MHz)	779.5MHz ~ 784.5MHz
	NB-IoT Band 13 (Channel Bandwidth 10MHz)	782.0MHz

Max. EIRP Power		BPSK	QPSK
	NB-IoT Standalone		
	NB-IoT Band 4	393.550mW (25.95dBm)	429.536mW (26.33dBm)
	NB-IoT In band		
	NB-IoT Band 4 (Channel Bandwidth 3MHz)	395.367mW (25.97dBm)	389.942mW (25.91dBm)
	NB-IoT Band 4 (Channel Bandwidth 5MHz)	396.278mW (25.98dBm)	392.645mW (25.94dBm)
	NB-IoT Band 4 (Channel Bandwidth 10MHz)	384.592mW (25.85dBm)	380.189mW (25.80dBm)
	NB-IoT Band 4 (Channel Bandwidth 15MHz)	385.478mW (25.86dBm)	382.825mW (25.83dBm)
	NB-IoT Band 4 (Channel Bandwidth 20MHz)	386.367mW (25.87dBm)	381.066mW (25.81dBm)
	NB-IoT Guard band		
	NB-IoT Band 4 (Channel Bandwidth 5MHz)	377.572mW (25.77dBm)	373.250mW (25.72dBm)
	NB-IoT Band 4 (Channel Bandwidth 10MHz)	368.978mW (25.67dBm)	365.595mW (25.63dBm)
	NB-IoT Band 4 (Channel Bandwidth 15MHz)	365.595mW (25.63dBm)	362.243mW (25.59dBm)
	NB-IoT Band 4 (Channel Bandwidth 20MHz)	368.129mW (25.66dBm)	364.754mW (25.62dBm)

Max. ERP Power		BPSK	QPSK	
	NB-IoT Standalone			
	NB-IoT Band 12	185.353mW (22.68dBm)	182.810mW (22.62dBm)	
	NB-IoT Band 13	159.588mW (22.03dBm)	158.125mW (21.99dBm)	
	NB-IoT In band			
	NB-IoT Band 12 (Channel Bandwidth 3MHz)	182.810mW (22.62dBm)	181.134mW (22.58dBm)	
	NB-IoT Band 12 (Channel Bandwidth 5MHz)	182.810mW (22.62dBm)	181.134mW (22.58dBm)	
	NB-IoT Band 12 (Channel Bandwidth 10MHz)	175.388mW (22.44dBm)	174.582mW (22.42dBm)	
	NB-IoT Band 12 (Channel Bandwidth 15MHz)	175.388mW (22.44dBm)	173.380mW (22.39dBm)	
	NB-IoT Band 13 (Channel Bandwidth 3MHz)	162.930mW (22.12dBm)	160.694mW (22.06dBm)	
	NB-IoT Band 13 (Channel Bandwidth 5MHz)	159.221mW (22.02dBm)	157.036mW (21.96dBm)	
	NB-IoT Band 13 (Channel Bandwidth 10MHz)	158.125mW (21.99dBm)	156.675mW (21.95dBm)	
	NB-IoT Guard band			
	NB-IoT Band 12 (Channel Bandwidth 5MHz)	162.555mW (22.11dBm)	159.956mW (22.04dBm)	
	NB-IoT Band 12 (Channel Bandwidth 10MHz)	164.059mW (22.15dBm)	162.181mW (22.10dBm)	
	NB-IoT Band 12 (Channel Bandwidth 15MHz)	165.196mW (22.18dBm)	162.555mW (22.11dBm)	
	NB-IoT Band 13 (Channel Bandwidth 5MHz)	161.065mW (22.07dBm)	155.955mW (21.93dBm)	
	NB-IoT Band 13 (Channel Bandwidth 10MHz)	154.170mW (21.88dBm)	151.705mW (21.81dBm)	
	Emission Designator		BPSK	QPSK
		NB-IoT Standalone		
NB-IoT Band 4		60K8G7D	183KG7D	
NB-IoT Band 12		58K6G7D	181KG7D	
NB-IoT Band 13		57K7G7D	182KG7D	
Antenna Type	NB-IoT Band 4	SMD antenna with 2.5dBi gain		
	NB-IoT Band 12	SMD antenna with 0.5dBi gain		
	NB-IoT Band 13	SMD antenna with 0.5dBi gain		
Antenna Connector	NA			
Accessory Device	Battery			
Cable Supplied	NA			

Note:

1. The EUT consumes power from the Battery.

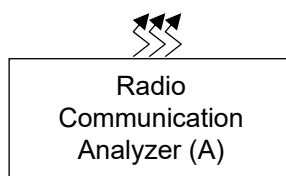
Battery	
Brand	RAMWAY
Model	ER17505-3
Rating	3.6Vdc, 10500mAh

2. The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

3.2 Configuration of System under Test



Remote site



3.2.1 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Radio Communication Analyzer	Anritsu	MT8821C	6201010284	NA	-

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as a communication partner to transfer data.

3.3 Test Mode Applicability and Tested Channel Detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports. The worst case was found when positioned on X-plane. Following channel(s) was (were) selected for the final test as listed below:

NB-IoT Band 4

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	EIRP	Standalone	19952 to 20398	19952 (1710.2MHz), 20175 (1732.5MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
					-	15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	EIRP	In-Band	19965 to 20385	19965 (1711.5MHz), 20175 (1732.5MHz), 20385 (1753.5MHz)	3MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			19975 to 20375	19975 (1712.5MHz), 20175 (1732.5MHz), 20375 (1752.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20000 to 20350	20000 (1715.0MHz), 20175 (1732.5MHz), 20350 (1750.0MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20025 to 20325	20025 (1717.5MHz), 20175 (1732.5MHz), 20325 (1747.5MHz)	15MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20050 to 20300	20050 (1720.0MHz), 20175 (1732.5MHz), 20300 (1745.0MHz)	20MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	EIRP	Guard-Band	19975 to 20375	19975 (1712.5MHz), 20175 (1732.5MHz), 20375 (1752.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20000 to 20350	20000 (1715.0MHz), 20175 (1732.5MHz), 20350 (1750.0MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20025 to 20325	20025 (1717.5MHz), 20175 (1732.5MHz), 20325 (1747.5MHz)	15MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			20050 to 20300	20050 (1720.0MHz), 20175 (1732.5MHz), 20300 (1745.0MHz)	20MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	Modulation Characteristics	Standalone	19952 to 20398	20175 (1732.5MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Frequency Stability	Standalone	19952 to 20398	19952 (1710.2MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Occupied Bandwidth	Standalone	19952 to 20398	19952 (1710.2MHz), 20175 (1732.5MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0
-	Band Edge	Standalone	19952 to 20398	19952 (1710.2MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	1@0 12@0
-	Peak To Average Ratio	Standalone	19952 to 20398	19952 (1710.2MHz), 20175 (1732.5MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0
-	Conducted Emission	Standalone	19952 to 20398	19952 (1710.2MHz), 20175 (1732.5MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	12@0
-	Radiated Emission Below 1GHz	Standalone	19952 to 20398	20175 (1732.5MHz)	-	3.75kHz	BPSK	1@0
-	Radiated Emission Above 1GHz	Standalone	19952 to 20398	19952 (1710.2MHz), 20175 (1732.5MHz), 20398 (1754.8MHz)	-	3.75kHz	BPSK	1@0

Note:

1. The output power for Stand-alone, In-band and Guard-band, measured value of Stand-alone is higher than In-band and Guard-band. The other test items were performed under Stand-alone mode only.
2. The Conducted Emission and Radiated Emission measurement were based on the worst maximum conducted power.
3. For radiated emission below 1GHz, select the worst radiated emission channel (above 1GHz) for final testing.

NB-IoT Band 12

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	ERP	Standalone	23012 to 23178	23012 (699.2MHz), 23095 (707.5MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
					-	15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
		In-Band	23025 to 23165	23025 (700.5MHz), 23095 (707.5MHz), 23165 (714.5MHz)	3MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23035 to 23155	23035 (701.5MHz), 23095 (707.5MHz), 23155 (713.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23060 to 23130	23060 (704.0MHz), 23095 (707.5MHz), 23130 (711.0 MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23085 to 23105	23085 (706.5MHz), 23095 (707.5MHz), 23105 (708.5 MHz)	15MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	ERP	Guard-Band	23035 to 23155	23035 (701.5MHz), 23095 (707.5MHz), 23155 (713.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23060 to 23130	23060 (704.0MHz), 23095 (707.5MHz), 23130 (711.0 MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23085 to 23105	23085 (706.5MHz), 23095 (707.5MHz), 23105 (708.5 MHz)	15MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
-	Modulation Characteristics	Standalone	23012 to 23178	23095 (707.5MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Frequency Stability	Standalone	23012 to 23178	23012 (699.2MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Occupied Bandwidth	Standalone	23012 to 23178	23012 (699.2MHz), 23095 (707.5MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0
-	Band Edge	Standalone	23012 to 23178	23012 (699.2MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	1@0 12@0
-	Peak To Average Ratio	Standalone	23012 to 23178	23012 (699.2MHz), 23095 (707.5MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	Conducted Emission	Standalone	23012 to 23178	23012 (699.2MHz), 23095 (707.5MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	12@0
-	Radiated Emission Below 1GHz	Standalone	23012 to 23178	23012 (699.2MHz)	-	3.75kHz	BPSK	1@0
-	Radiated Emission Above 1GHz	Standalone	23012 to 23178	23012 (699.2MHz), 23095 (707.5MHz), 23178 (715.8MHz)	-	3.75kHz	BPSK	1@0

Note:

1. The output power for Stand-alone, In-band and Guard-band, measured value of Stand-alone is higher than In-band and Guard-band. The other test items were performed under Stand-alone mode only.
2. The Conducted Emission and Radiated Emission measurement were based on the worst maximum conducted power.
3. For radiated emission below 1GHz, select the worst radiated emission channel (above 1GHz) for final testing.

NB-IoT Band 13

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	ERP	Standalone	23182 to 23278	23182 (777.2MHz), 23230 (782.0MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
					-	15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
		In-Band	23195 to 23265	23195 (778.5MHz), 23230 (782.0MHz), 23265 (785.5MHz)	3MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23205 to 23255	23205 (779.5MHz), 23230 (782.0MHz), 23255 (784.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23230	23230 (782.0MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	ERP	Guard-Band	23205 to 23255	23205 (779.5MHz), 23230 (782.0MHz), 23255 (784.5MHz)	5MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
			23230	23230 (782.0MHz)	10MHz	3.75kHz	BPSK	1@0 1@47
							QPSK	1@0 1@47
						15kHz	BPSK	1@0 1@11
							QPSK	1@0 1@11 3@3 12@0
-	Modulation Characteristics	Standalone	23182 to 23278	23230 (782.0MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Frequency Stability	Standalone	23182 to 23278	23182 (777.2MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	1@0
-	Occupied Bandwidth	Standalone	23182 to 23278	23182 (777.2MHz), 23230 (782.0MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0
-	Band Edge	Standalone	23182 to 23278	23182 (777.2MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	1@0 12@0
-	Peak To Average Ratio	Standalone	23182 to 23278	23182 (777.2MHz), 23230 (782.0MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0 1@47
						15kHz	QPSK	12@0
-	Conducted Emission	Standalone	23182 to 23278	23182 (777.2MHz), 23230 (782.0MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0
						15kHz	QPSK	12@0

EUT Configure Mode	Test item	Available channel		Tested Channel	Channel Bandwidth	Subcarrier Spacing	Modulation	Number of Subcarrier / Starting Subcarrier
-	Radiated Emission Below 1GHz	Standalone	23182 to 23278	23230 (782.0MHz)	-	3.75kHz	BPSK	1@0
-	Radiated Emission Above 1GHz	Standalone	23182 to 23278	23182 (777.2MHz), 23230 (782.0MHz), 23278 (786.8MHz)	-	3.75kHz	BPSK	1@0

Note:

1. The output power for Stand-alone, In-band and Guard-band, measured value of Stand-alone is higher than In-band and Guard-band. The other test items were performed under Stand-alone mode only.
2. The Conducted Emission and Radiated Emission measurement were based on the worst maximum conducted power.
3. For radiated emission below 1GHz, select the worst radiated emission channel (above 1GHz) for final testing.

Test Condition:

Test Item	Environmental Conditions	Input Power	Tested By
EIRP / ERP	25deg. C, 60%RH	3.6Vdc	James Yang
Modulation Characteristics	25deg. C, 60%RH	3.6Vdc	James Yang
Frequency Stability	25deg. C, 60%RH	3.6Vdc	James Yang
Occupied Bandwidth	25deg. C, 60%RH	3.6Vdc	James Yang
Band Edge	25deg. C, 60%RH	3.6Vdc	James Yang
Peak To Average Ratio	25deg. C, 60%RH	3.6Vdc	James Yang
Conducted Emission	25deg. C, 60%RH	3.6Vdc	James Yang
Radiated Emission	17deg. C, 62%RH	3.6Vdc	Wade Huang

3.4 EUT Operating Conditions

The EUT makes a call to the communication simulator. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency

3.5 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and References:

Test Standard:

FCC 47 CFR Part 2

FCC 47 CFR Part 27

ANSI/TIA/EIA-603-E 2016

ANSI 63.26-2015

References Test Guidance:

KDB 971168 D01 Power Meas License Digital Systems v03r01

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Output Power Measurement

4.1.1 Limits of Output Power Measurement

For NB-IoT Band 4:

Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP.

For NB-IoT Band 12:

Control and mobile stations in the 698-746 MHz band are limited to 30 watts ERP.

Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

For NB-IoT Band 13:

Control stations and mobile stations in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands and fixed stations transmitting in the 787-788 MHz and 805-806 MHz bands are limited to 30 watts ERP.

Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP.

4.1.2 Test Procedures

Conducted Power Measurement:

The EUT was set up for the maximum power with NB-IoT link data modulation and link up with simulator (Built-in power meter). Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

Maximum EIRP / ERP

The relevant equation for determining the maximum ERP or EIRP from the measured RF output power is given in Equation as follows:

$$\text{EIRP} = P_{\text{Meas}} + G_T$$

$$\text{ERP} = P_{\text{Meas}} + G_T - 2.15$$

where

ERP or EIRP effective radiated power or equivalent isotropically radiated power, respectively
(expressed in the same units as P_{Meas} , e.g., dBm or dBW)

P_{Meas} measured transmitter output power or PSD, in dBm or dBW

G_T gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP)

4.1.3 Test Setup

Conducted Power Measurement:



4.1.4 Test Results

Conducted Output Power (dBm)

NB-IoT Band 4 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		19952	20175	20398
		Frequency (MHz)		1710.2	1732.5	1754.8
3.75kHz	QPSK	1	0	23.22	23.35	23.35
		1	47	23.28	23.37	23.41
	BPSK	1	0	23.43	23.39	23.45
		1	47	23.41	23.40	23.41
BW	MCS Index	Channel		19952	20175	20398
		Frequency (MHz)		1710.2	1732.5	1754.8
15kHz	QPSK	1	0	23.32	23.33	23.36
		1	11	23.33	23.35	23.37
		3	3	23.80	22.88	23.05
		12	0	23.83	21.85	22.85
	BPSK	1	0	23.44	23.37	23.45
		1	11	23.39	23.38	23.41

NB-IoT Band 4 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	20M	QPSK	Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
		BPSK	1	0	23.29	23.27	23.17
			1	47	23.30	23.28	23.18
		BPSK	1	0	23.35	23.35	23.24
			1	47	23.33	23.37	23.23
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	23.29	23.31	23.26
			1	47	23.27	23.33	23.27
		BPSK	1	0	23.35	23.35	23.31
			1	47	23.33	23.34	23.32
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	23.30	23.29	23.27
			1	47	23.29	23.27	23.28
		BPSK	1	0	23.33	23.35	23.32
			1	47	23.34	23.33	23.33
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	23.30	23.32	23.44
			1	47	23.28	23.30	23.42
		BPSK	1	0	23.32	23.36	23.46
			1	47	23.34	23.35	23.48
	BW	MCS Index	Channel		19965	20175	20385
			Frequency (MHz)		1711.5	1732.5	1753.5
	3M	QPSK	1	0	23.28	23.32	23.41
			1	47	23.26	23.29	23.40
		BPSK	1	0	23.32	23.37	23.47
			1	47	23.34	23.36	23.45

NB-IoT Band 4 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
15kHz	20M	QPSK	1	0	23.29	23.27	23.22
			1	11	23.31	23.29	23.20
			3	3	22.84	22.80	22.91
			12	0	21.69	21.75	21.54
		BPSK	1	0	23.35	23.33	23.20
			1	11	23.33	23.34	23.21
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	23.29	23.31	23.27
			1	11	23.30	23.28	23.29
			3	3	22.84	22.78	22.89
			12	0	21.69	21.78	21.71
		BPSK	1	0	23.34	23.34	23.33
			1	11	23.36	23.35	23.34
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	23.25	23.28	23.24
			1	11	23.28	23.27	23.26
			3	3	22.85	22.78	22.89
			12	0	21.75	21.70	21.72
		BPSK	1	0	23.33	23.33	23.34
			1	11	23.31	23.34	23.33
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	23.35	23.27	23.34
			1	11	23.34	23.24	23.32
			3	3	22.86	22.76	22.90
			12	0	21.66	21.75	21.79
		BPSK	1	0	23.32	23.30	23.40
			1	11	23.35	23.32	23.41
	BW	MCS Index	Channel		19965	20175	20385
			Frequency (MHz)		1711.5	1732.5	1753.5
	3M	QPSK	1	0	23.26	23.23	23.34
			1	11	23.27	23.24	23.35
			3	3	22.81	22.80	22.91
			12	0	21.74	21.63	21.79
		BPSK	1	0	23.32	23.29	23.39
			1	11	23.31	23.28	23.40

NB-IoT Band 4 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	20M	QPSK	Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
		BPSK	1	0	23.11	23.08	23.01
			1	47	23.12	23.09	23.02
		BPSK	1	0	23.15	23.12	23.05
			1	47	23.16	23.13	23.06
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	23.07	23.05	23.03
			1	47	23.06	23.07	23.02
		BPSK	1	0	23.11	23.12	23.09
			1	47	23.09	23.13	23.08
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	23.08	23.10	23.07
			1	47	23.07	23.09	23.05
		BPSK	1	0	23.14	23.15	23.13
			1	47	23.15	23.14	23.12
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	23.08	23.05	23.21
			1	47	23.06	23.06	23.22
		BPSK	1	0	23.12	23.12	23.26
			1	47	23.14	23.13	23.27

NB-IoT Band 4 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
15kHz	20M	QPSK	1	0	23.07	23.06	22.99
			1	11	23.09	23.05	23.00
			3	3	22.63	22.65	22.69
			12	0	21.47	21.53	21.48
		BPSK	1	0	23.13	23.09	23.02
			1	11	23.14	23.10	23.04
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	23.07	23.06	23.05
			1	11	23.09	23.09	23.07
			3	3	22.67	22.65	22.66
			12	0	21.47	21.56	21.52
		BPSK	1	0	23.12	23.13	23.12
			1	11	23.13	23.12	23.13
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	23.12	23.08	23.07
			1	11	23.13	23.09	23.05
			3	3	22.66	22.67	22.66
			12	0	21.56	21.47	21.54
		BPSK	1	0	23.15	23.15	23.16
			1	11	23.16	23.17	23.17
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	23.13	23.11	23.14
			1	11	23.14	23.10	23.15
			3	3	22.65	22.68	22.64
			12	0	21.53	21.55	21.58
		BPSK	1	0	23.19	23.14	23.20
			1	11	23.20	23.15	23.23

NB-IoT Band 12 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		23012	23095	23178
		Frequency (MHz)		699.2	707.5	715.8
3.75kHz	QPSK	1	0	24.13	24.27	24.01
		1	47	24.05	24.26	24.03
	BPSK	1	0	24.32	24.31	24.10
		1	47	24.23	24.33	24.01
BW	MCS Index	Channel		23012	23095	23178
		Frequency (MHz)		699.2	707.5	715.8
15kHz	QPSK	1	0	24.05	24.03	23.62
		1	11	24.10	24.03	23.77
		3	3	23.92	23.91	23.54
		12	0	24.11	22.25	23.22
	BPSK	1	0	24.05	24.00	23.85
		1	11	24.03	24.01	23.77

NB-IoT Band 12 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	15M	QPSK	Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
		BPSK	1	0	23.88	24.03	23.85
			1	47	23.89	24.04	23.84
		BPSK	1	0	23.95	24.08	23.90
			1	47	23.96	24.09	23.91
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	23.98	24.07	23.75
			1	47	23.99	24.06	23.77
		BPSK	1	0	24.03	24.09	23.83
			1	47	24.05	24.08	23.82
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	24.23	24.20	24.03
			1	47	24.21	24.19	24.02
		BPSK	1	0	24.27	24.21	24.10
			1	47	24.26	24.22	24.08
	BW	MCS Index	Channel		23025	23095	23165
			Frequency (MHz)		700.5	707.5	714.5
	3M	QPSK	1	0	24.23	24.16	23.96
			1	47	24.21	24.14	23.95
		BPSK	1	0	24.27	24.21	24.03
			1	47	24.26	24.22	24.04

NB-IoT Band 12 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
15kHz	15M	QPSK	1	0	23.86	23.91	23.75
			1	11	23.87	23.88	23.76
			3	3	23.70	23.67	23.59
			12	0	22.11	22.13	21.94
		BPSK	1	0	23.92	23.95	23.73
			1	11	23.93	23.92	23.70
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	23.72	23.87	23.63
			1	11	23.73	23.88	23.62
			3	3	23.63	23.61	23.52
			12	0	21.95	21.93	21.65
		BPSK	1	0	23.79	23.85	23.61
			1	11	23.78	23.84	23.59
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	23.76	23.56	23.58
			1	11	23.77	23.55	23.59
			3	3	23.55	23.51	23.47
			12	0	21.81	21.64	21.59
		BPSK	1	0	23.74	23.62	23.55
			1	11	23.73	23.63	23.54
	BW	MCS Index	Channel		23025	23095	23165
			Frequency (MHz)		700.5	707.5	714.5
	3M	QPSK	1	0	23.64	23.55	23.42
			1	11	23.65	23.54	23.41
			3	3	23.49	23.33	23.25
			12	0	21.87	21.64	21.51
		BPSK	1	0	23.71	23.61	23.48
			1	11	23.73	23.63	23.45

NB-IoT Band 12 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
3.75kHz	15M	QPSK	1	0	23.71	23.76	23.73
			1	47	23.69	23.74	23.74
		BPSK	1	0	23.76	23.80	23.82
			1	47	23.78	23.81	23.81
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	23.72	23.74	23.51
			1	47	23.70	23.72	23.52
		BPSK	1	0	23.74	23.79	23.57
			1	47	23.76	23.80	23.58
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	23.69	23.65	23.51
			1	47	23.68	23.67	23.53
		BPSK	1	0	23.75	23.71	23.59
			1	47	23.76	23.73	23.57

NB-IoT Band 12 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
15kHz	15M	QPSK	1	0	23.65	23.66	23.75
			1	11	23.62	23.63	23.73
			3	3	23.48	23.46	23.51
			12	0	21.68	21.78	21.79
		BPSK	1	0	23.77	23.73	23.82
			1	11	23.75	23.70	23.83
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	23.74	23.68	23.49
			1	11	23.75	23.66	23.51
			3	3	23.51	23.47	23.37
			12	0	21.79	21.70	21.70
		BPSK	1	0	23.72	23.71	23.47
			1	11	23.73	23.73	23.48
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	23.66	23.64	23.57
			1	11	23.65	23.65	23.56
			3	3	23.49	23.45	23.38
			12	0	21.79	21.65	21.49
		BPSK	1	0	23.72	23.68	23.55
			1	11	23.73	23.67	23.54

NB-IoT Band 13 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		23182	23230	23278
		Frequency (MHz)		777.2	782	786.8
3.75kHz	QPSK	1	0	23.37	23.62	23.45
		1	47	23.19	23.61	23.53
	BPSK	1	0	23.60	23.66	23.31
		1	47	23.47	23.67	23.44
BW	MCS Index	Channel		23182	23230	23278
		Frequency (MHz)		777.2	782	786.8
15kHz	QPSK	1	0	23.40	23.61	23.64
		1	11	23.47	23.63	23.56
		3	3	23.32	23.31	23.27
		12	0	21.59	21.86	21.72
	BPSK	1	0	23.46	23.68	23.59
		1	11	23.55	23.66	23.49

NB-IoT Band 13 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	10M	QPSK	Channel		-	23230	-
			Frequency (MHz)		-	782	-
		BPSK	1	0	-	23.59	
			1	47	-	23.60	
	5M	QPSK	1	0	-	23.62	
			1	47	-	23.64	
		BPSK	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	3M	QPSK	1	0	23.47	23.54	23.60
			1	47	23.49	23.53	23.59
		BPSK	1	0	23.54	23.63	23.66
			1	47	23.52	23.61	23.67
	1M	QPSK	Channel		23195	23230	23265
			Frequency (MHz)		778.5	782	785.5
		BPSK	1	0	23.47	23.55	23.71
			1	47	23.44	23.53	23.70

NB-IoT Band 13 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
15kHz	10M	QPSK	1	0	-	23.45	-
			1	11	-	23.41	-
			3	3	-	23.16	-
			12	0	-	21.62	-
		BPSK	1	0	-	23.47	-
			1	11	-	23.45	-
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	23.51	23.46	23.60
			1	11	23.52	23.49	23.61
			3	3	23.21	23.17	23.29
			12	0	21.66	21.64	21.86
		BPSK	1	0	23.56	23.52	23.65
			1	11	23.55	23.49	23.67
	BW	MCS Index	Channel		23195	23230	23265
			Frequency (MHz)		778.5	782	785.5
	3M	QPSK	1	0	23.36	23.47	23.65
			1	11	23.39	23.50	23.64
			3	3	23.19	23.17	23.27
			12	0	21.48	21.71	21.72
		BPSK	1	0	23.40	23.53	23.68
			1	11	23.43	23.54	23.67

NB-IoT Band 13 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
3.75kHz	10M	QPSK	1	0	-	23.46	
			1	47	-	23.44	
		BPSK	1	0	-	23.53	
			1	47	-	23.49	
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	23.46	23.53	23.57
			1	47	23.48	23.51	23.58
		BPSK	1	0	23.53	23.57	23.71
			1	47	23.54	23.58	23.72

NB-IoT Band 13 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
15kHz	10M	QPSK	1	0	-	23.44	-
			1	11	-	23.43	-
			3	3	-	23.15	-
			12	0	-	21.66	-
		BPSK	1	0	-	23.49	-
			1	11	-	23.50	-
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	23.52	23.46	23.56
			1	11	23.53	23.47	23.52
			3	3	23.22	23.16	23.27
			12	0	21.47	21.68	21.76
		BPSK	1	0	23.55	23.53	23.59
			1	11	23.57	23.54	23.61

EIRP / ERP Power (dBm)

NB-IoT Band 4 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		19952	20175	20398
		Frequency (MHz)		1710.2	1732.5	1754.8
3.75kHz	QPSK	1	0	25.72	25.85	25.85
		1	47	25.78	25.87	25.91
	BPSK	1	0	25.93	25.89	25.95
		1	47	25.91	25.90	25.91
BW	MCS Index	Channel		19952	20175	20398
		Frequency (MHz)		1710.2	1732.5	1754.8
15kHz	QPSK	1	0	25.82	25.83	25.86
		1	11	25.83	25.85	25.87
		3	3	26.30	25.38	25.55
		12	0	26.33	24.35	25.35
	BPSK	1	0	25.94	25.87	25.95
		1	11	25.89	25.88	25.91

NB-IoT Band 4 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	20M	QPSK	Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
		BPSK	1	0	25.79	25.77	25.67
			1	47	25.80	25.78	25.68
		BPSK	1	0	25.85	25.85	25.74
			1	47	25.83	25.87	25.73
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	25.79	25.81	25.76
			1	47	25.77	25.83	25.77
		BPSK	1	0	25.85	25.85	25.81
			1	47	25.83	25.84	25.82
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	25.80	25.79	25.77
			1	47	25.79	25.77	25.78
		BPSK	1	0	25.83	25.85	25.82
			1	47	25.84	25.83	25.83
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	25.80	25.82	25.94
			1	47	25.78	25.80	25.92
		BPSK	1	0	25.82	25.86	25.96
			1	47	25.84	25.85	25.98
	BW	MCS Index	Channel		19965	20175	20385
			Frequency (MHz)		1711.5	1732.5	1753.5
	3M	QPSK	1	0	25.78	25.82	25.91
			1	47	25.76	25.79	25.90
		BPSK	1	0	25.82	25.87	25.97
			1	47	25.84	25.86	25.95

NB-IoT Band 4 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
15kHz	20M	QPSK	1	0	25.79	25.77	25.72
			1	11	25.81	25.79	25.70
			3	3	25.34	25.30	25.41
			12	0	24.19	24.25	24.04
		BPSK	1	0	25.85	25.83	25.70
			1	11	25.83	25.84	25.71
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	25.79	25.81	25.77
			1	11	25.80	25.78	25.79
			3	3	25.34	25.28	25.39
			12	0	24.19	24.28	24.21
		BPSK	1	0	25.84	25.84	25.83
			1	11	25.86	25.85	25.84
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	25.75	25.78	25.74
			1	11	25.78	25.77	25.76
			3	3	25.35	25.28	25.39
			12	0	24.25	24.20	24.22
		BPSK	1	0	25.83	25.83	25.84
			1	11	25.81	25.84	25.83
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	25.85	25.77	25.84
			1	11	25.84	25.74	25.82
			3	3	25.36	25.26	25.40
			12	0	24.16	24.25	24.29
		BPSK	1	0	25.82	25.80	25.90
			1	11	25.85	25.82	25.91
	BW	MCS Index	Channel		19965	20175	20385
			Frequency (MHz)		1711.5	1732.5	1753.5
	3M	QPSK	1	0	25.76	25.73	25.84
			1	11	25.77	25.74	25.85
			3	3	25.31	25.30	25.41
			12	0	24.24	24.13	24.29
		BPSK	1	0	25.82	25.79	25.89
			1	11	25.81	25.78	25.90

NB-IoT Band 4 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	20M	QPSK	Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
		BPSK	1	0	25.61	25.58	25.51
			1	47	25.62	25.59	25.52
		BPSK	1	0	25.65	25.62	25.55
			1	47	25.66	25.63	25.56
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	25.57	25.55	25.53
			1	47	25.56	25.57	25.52
		BPSK	1	0	25.61	25.62	25.59
			1	47	25.59	25.63	25.58
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	25.58	25.60	25.57
			1	47	25.57	25.59	25.55
		BPSK	1	0	25.64	25.65	25.63
			1	47	25.65	25.64	25.62
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	25.58	25.55	25.71
			1	47	25.56	25.56	25.72
		BPSK	1	0	25.62	25.62	25.76
			1	47	25.64	25.63	25.77

NB-IoT Band 4 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		20050	20175	20300
			Frequency (MHz)		1720	1732.5	1745
15kHz	20M	QPSK	1	0	25.57	25.56	25.49
			1	11	25.59	25.55	25.50
			3	3	25.13	25.15	25.19
			12	0	23.97	24.03	23.98
		BPSK	1	0	25.63	25.59	25.52
			1	11	25.64	25.60	25.54
	BW	MCS Index	Channel		20025	20175	20325
			Frequency (MHz)		1717.5	1732.5	1747.5
	15M	QPSK	1	0	25.57	25.56	25.55
			1	11	25.59	25.59	25.57
			3	3	25.17	25.15	25.16
			12	0	23.97	24.06	24.02
		BPSK	1	0	25.62	25.63	25.62
			1	11	25.63	25.62	25.63
	BW	MCS Index	Channel		20000	20175	20350
			Frequency (MHz)		1715	1732.5	1750
	10M	QPSK	1	0	25.62	25.58	25.57
			1	11	25.63	25.59	25.55
			3	3	25.16	25.17	25.16
			12	0	24.06	23.97	24.04
		BPSK	1	0	25.65	25.65	25.66
			1	11	25.66	25.67	25.67
	BW	MCS Index	Channel		19975	20175	20375
			Frequency (MHz)		1712.5	1732.5	1752.5
	5M	QPSK	1	0	25.63	25.61	25.64
			1	11	25.64	25.60	25.65
			3	3	25.15	25.18	25.14
			12	0	24.03	24.05	24.08
		BPSK	1	0	25.69	25.64	25.70
			1	11	25.70	25.65	25.73

NB-IoT Band 12 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		23012	23095	23178
		Frequency (MHz)		699.2	707.5	715.8
3.75kHz	QPSK	1	0	22.48	22.62	22.36
		1	47	22.40	22.61	22.38
	BPSK	1	0	22.67	22.66	22.45
		1	47	22.58	22.68	22.36
BW	MCS Index	Channel		23012	23095	23178
		Frequency (MHz)		699.2	707.5	715.8
15kHz	QPSK	1	0	22.40	22.38	21.97
		1	11	22.45	22.38	22.12
		3	3	22.27	22.26	21.89
		12	0	22.46	20.60	21.57
	BPSK	1	0	22.40	22.35	22.20
		1	11	22.38	22.36	22.12

NB-IoT Band 12 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	15M	QPSK	Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
		BPSK	1	0	22.23	22.38	22.20
			1	47	22.24	22.39	22.19
		BPSK	1	0	22.30	22.43	22.25
			1	47	22.31	22.44	22.26
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	22.33	22.42	22.10
			1	47	22.34	22.41	22.12
		BPSK	1	0	22.38	22.44	22.18
			1	47	22.40	22.43	22.17
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	22.58	22.55	22.38
			1	47	22.56	22.54	22.37
		BPSK	1	0	22.62	22.56	22.45
			1	47	22.61	22.57	22.43
	BW	MCS Index	Channel		23025	23095	23165
			Frequency (MHz)		700.5	707.5	714.5
	3M	QPSK	1	0	22.58	22.51	22.31
			1	47	22.56	22.49	22.30
		BPSK	1	0	22.62	22.56	22.38
			1	47	22.61	22.57	22.39

NB-IoT Band 12 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
15kHz	15M	QPSK	1	0	22.21	22.26	22.10
			1	11	22.22	22.23	22.11
			3	3	22.05	22.02	21.94
			12	0	20.46	20.48	20.29
		BPSK	1	0	22.27	22.30	22.08
			1	11	22.28	22.27	22.05
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	22.07	22.22	21.98
			1	11	22.08	22.23	21.97
			3	3	21.98	21.96	21.87
			12	0	20.30	20.28	20.00
		BPSK	1	0	22.14	22.20	21.96
			1	11	22.13	22.19	21.94
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	22.11	21.91	21.93
			1	11	22.12	21.90	21.94
			3	3	21.90	21.86	21.82
			12	0	20.16	19.99	19.94
		BPSK	1	0	22.09	21.97	21.90
			1	11	22.08	21.98	21.89
	BW	MCS Index	Channel		23025	23095	23165
			Frequency (MHz)		700.5	707.5	714.5
	3M	QPSK	1	0	21.99	21.90	21.77
			1	11	22.00	21.89	21.76
			3	3	21.84	21.68	21.60
			12	0	20.22	19.99	19.86
		BPSK	1	0	22.06	21.96	21.83
			1	11	22.08	21.98	21.80

NB-IoT Band 12 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
3.75kHz	15M	QPSK	1	0	22.06	22.11	22.08
			1	47	22.04	22.09	22.09
		BPSK	1	0	22.11	22.15	22.17
			1	47	22.13	22.16	22.16
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	22.07	22.09	21.86
			1	47	22.05	22.07	21.87
		BPSK	1	0	22.09	22.14	21.92
			1	47	22.11	22.15	21.93
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	22.04	22.00	21.86
			1	47	22.03	22.02	21.88
		BPSK	1	0	22.10	22.06	21.94
			1	47	22.11	22.08	21.92

NB-IoT Band 12 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		23085	23095	23105
			Frequency (MHz)		706.5	707.5	708.5
15kHz	15M	QPSK	1	0	22.00	22.01	22.10
			1	11	21.97	21.98	22.08
			3	3	21.83	21.81	21.86
			12	0	20.03	20.13	20.14
		BPSK	1	0	22.12	22.08	22.17
			1	11	22.10	22.05	22.18
	BW	MCS Index	Channel		23060	23095	23130
			Frequency (MHz)		704	707.5	711
	10M	QPSK	1	0	22.09	22.03	21.84
			1	11	22.10	22.01	21.86
			3	3	21.86	21.82	21.72
			12	0	20.14	20.05	20.05
		BPSK	1	0	22.07	22.06	21.82
			1	11	22.08	22.08	21.83
	BW	MCS Index	Channel		23035	23095	23155
			Frequency (MHz)		701.5	707.5	713.5
	5M	QPSK	1	0	22.01	21.99	21.92
			1	11	22.00	22.00	21.91
			3	3	21.84	21.80	21.73
			12	0	20.14	20.00	19.84
		BPSK	1	0	22.07	22.03	21.90
			1	11	22.08	22.02	21.89

NB-IoT Band 13 Standalone						
Subcarrier Spacing	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
		Channel		23182	23230	23278
		Frequency (MHz)		777.2	782	786.8
3.75kHz	QPSK	1	0	21.72	21.97	21.80
		1	47	21.54	21.96	21.88
	BPSK	1	0	21.95	22.01	21.66
		1	47	21.82	22.02	21.79
BW	MCS Index	Channel		23182	23230	23278
		Frequency (MHz)		777.2	782	786.8
15kHz	QPSK	1	0	21.75	21.96	21.99
		1	11	21.82	21.98	21.91
		3	3	21.67	21.66	21.62
		12	0	19.94	20.21	20.07
	BPSK	1	0	21.81	22.03	21.94
		1	11	21.90	22.01	21.84

NB-IoT Band 13 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
3.75kHz	10M	QPSK	Channel		-	23230	-
			Frequency (MHz)		-	782	-
		BPSK	1	0	-	21.94	
			1	47	-	21.95	
		BPSK	1	0	-	21.97	
			1	47	-	21.99	
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	21.82	21.89	21.95
			1	47	21.84	21.88	21.94
		BPSK	1	0	21.89	21.98	22.01
			1	47	21.87	21.96	22.02
	BW	MCS Index	Channel		23195	23230	23265
			Frequency (MHz)		778.5	782	785.5
	3M	QPSK	1	0	21.82	21.90	22.06
			1	47	21.79	21.88	22.05
		BPSK	1	0	21.86	21.97	22.12
			1	47	21.88	21.95	22.10

NB-IoT Band 13 In-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
15kHz	10M	QPSK	1	0	-	21.80	-
			1	11	-	21.76	-
			3	3	-	21.51	-
			12	0	-	19.97	-
		BPSK	1	0	-	21.82	-
			1	11	-	21.80	-
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	21.86	21.81	21.95
			1	11	21.87	21.84	21.96
			3	3	21.56	21.52	21.64
			12	0	20.01	19.99	20.21
		BPSK	1	0	21.91	21.87	22.00
			1	11	21.90	21.84	22.02
	BW	MCS Index	Channel		23195	23230	23265
			Frequency (MHz)		778.5	782	785.5
	3M	QPSK	1	0	21.71	21.82	22.00
			1	11	21.74	21.85	21.99
			3	3	21.54	21.52	21.62
			12	0	19.83	20.06	20.07
		BPSK	1	0	21.75	21.88	22.03
			1	11	21.78	21.89	22.02

NB-IoT Band 13 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
3.75kHz	10M	QPSK	1	0	-	21.81	
			1	47	-	21.79	
		BPSK	1	0	-	21.88	
			1	47	-	21.84	
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	21.81	21.88	21.92
			1	47	21.83	21.86	21.93
		BPSK	1	0	21.88	21.92	22.06
			1	47	21.89	21.93	22.07

NB-IoT Band 13 Guard-Band							
Subcarrier Spacing	BW	MCS Index	Number of Subcarrier	Starting Subcarrier	Low	Mid	High
			Channel		-	23230	-
			Frequency (MHz)		-	782	-
15kHz	10M	QPSK	1	0	-	21.79	-
			1	11	-	21.78	-
			3	3	-	21.50	-
			12	0	-	20.01	-
		BPSK	1	0	-	21.84	-
			1	11	-	21.85	-
	BW	MCS Index	Channel		23205	23230	23255
			Frequency (MHz)		779.5	782	784.5
	5M	QPSK	1	0	21.87	21.81	21.91
			1	11	21.88	21.82	21.87
			3	3	21.57	21.51	21.62
			12	0	19.82	20.03	20.11
		BPSK	1	0	21.90	21.88	21.94
			1	11	21.92	21.89	21.96

4.2 Modulation Characteristics Measurement

4.2.1 Limits of Modulation Characteristics

N/A

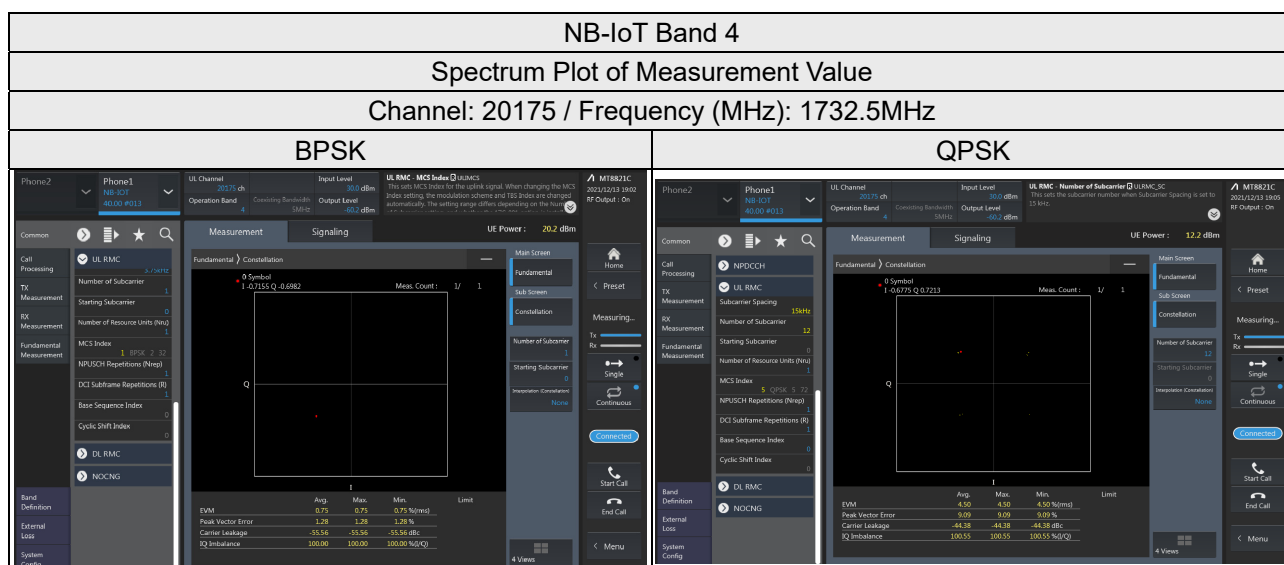
4.2.2 Test Procedure

Connect the EUT to Communication Simulator via the antenna connector, The frequency band is set as EUT supported Modulation and Channels, the EUT output is matched with 50 ohm load, the waveform quality and constellation of the EUT was tested.

4.2.3 Test Setup



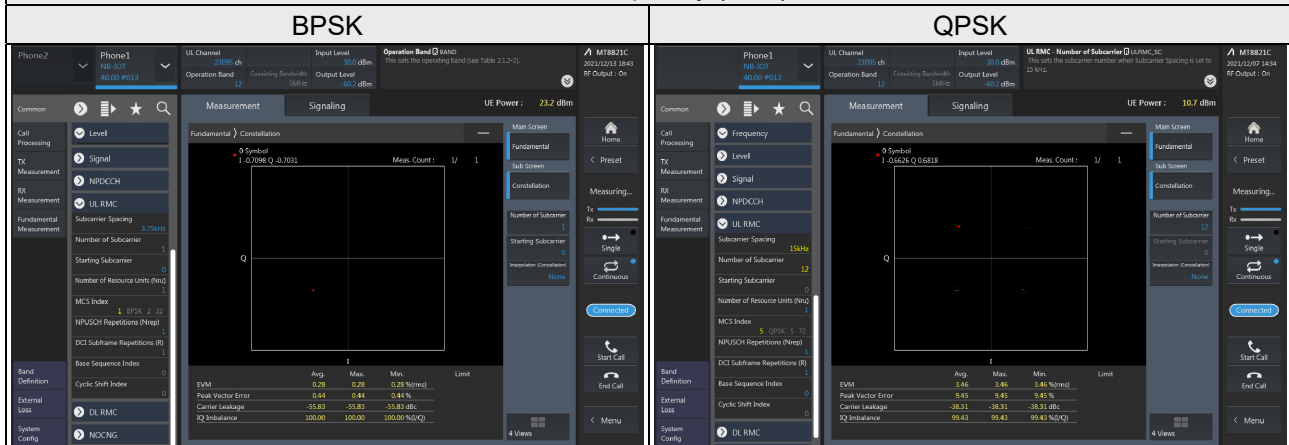
4.2.4 Test Results



NB-IoT Band 12

Spectrum Plot of Measurement Value

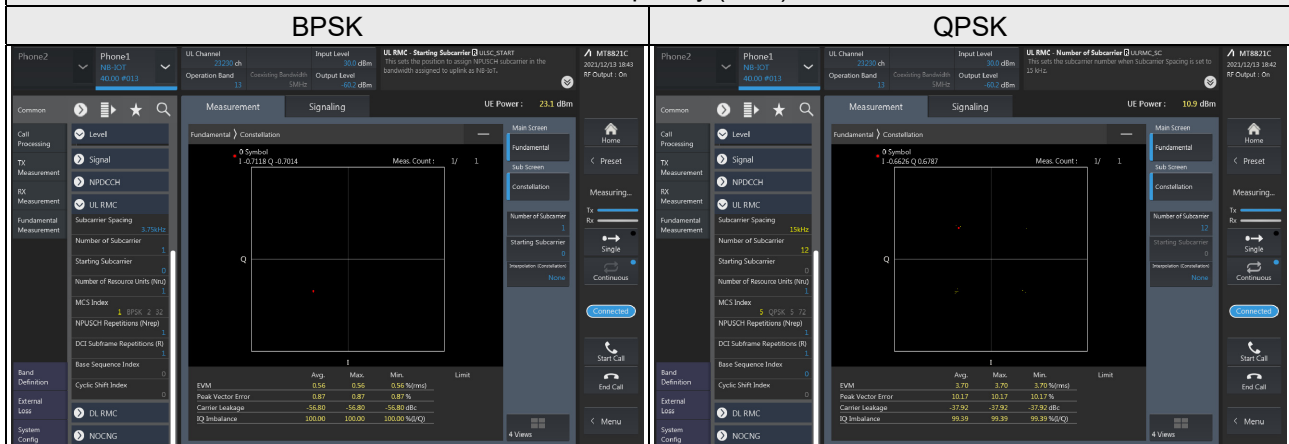
Channel: 23095 / Frequency (MHz): 707.5MHz



NB-IoT Band 13

Spectrum Plot of Measurement Value

Channel: 23230 / Frequency (MHz): 782.0MHz



4.3 Frequency Stability Measurement

4.3.1 Limits of Frequency Stability Measurement

According to the FCC part 2.1055 shall be tested the frequency stability. The rule is defined that "The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block." The test extreme voltage is according to the 2.1055(d)(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment and the extreme temperature rule is comply with specification of EUT $-30^{\circ}\text{C} \sim 50^{\circ}\text{C}$.

4.3.2 Test Procedure

- Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.
- EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.
- The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the $\pm 0.5^{\circ}\text{C}$ during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

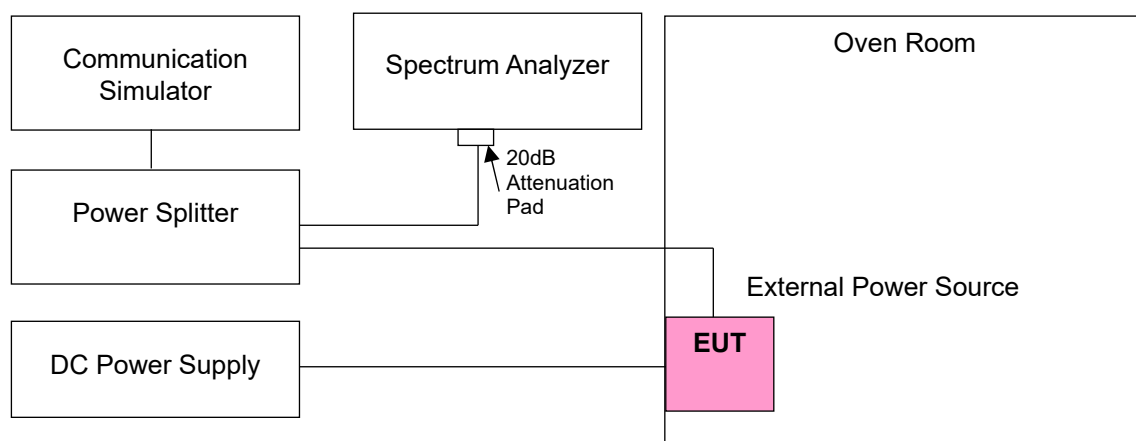
Note: The frequency error was recorded frequency error from the communication simulator.

4.3.3 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Radio Communication Analyzer Anritsu	MT8821C	6272278310	Jun. 23, 2021	Jun. 22, 2022
Temperature & Humidity Chamber Giant Force	GTH-120-40-CP-A R	MAA1306-019	Sep. 10, 2021	Sep. 09, 2022
Digital Multimeter Fluke	87-III	70360742	Jun. 24, 2021	Jun. 23, 2022
DC Power Supply Topward	6306A	727263	NA	NA

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.

4.3.4 Test Setup



4.3.5 Test Results

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 4			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	1710.200002	0.001	1754.800002	0.001
3.60	1710.200003	0.002	1754.800004	0.002
4.14	1710.200003	0.002	1754.800003	0.002

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 4			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	1710.200003	0.002	1754.800003	0.002
-10	1710.200004	0.002	1754.800003	0.002
0	1710.200002	0.001	1754.800004	0.002
10	1710.200002	0.001	1754.800001	0.001
20	1710.199999	-0.001	1754.799996	-0.002
30	1710.199997	-0.002	1754.799996	-0.002
40	1710.199999	-0.001	1754.799997	-0.001
50	1710.199997	-0.002	1754.799996	-0.002
60	1710.199996	-0.002	1754.799996	-0.002

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 4			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	1710.200002	0.001	1754.800003	0.002
3.60	1710.200004	0.002	1754.800003	0.002
4.14	1710.200003	0.002	1754.800001	0.001

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 4			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	1710.200002	0.001	1754.800002	0.001
-10	1710.200003	0.002	1754.800003	0.002
0	1710.200002	0.001	1754.800003	0.002
10	1710.200003	0.002	1754.800003	0.002
20	1710.199996	-0.002	1754.799997	-0.002
30	1710.199997	-0.002	1754.799999	-0.001
40	1710.199997	-0.002	1754.799998	-0.001
50	1710.199997	-0.002	1754.799997	-0.002
60	1710.199999	-0.001	1754.799997	-0.002

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 12			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	699.200002	0.003	715.800002	0.003
3.60	699.200004	0.006	715.800004	0.005
4.14	699.200004	0.006	715.800002	0.003

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 12			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	699.200001	0.002	715.800001	0.002
-10	699.200003	0.004	715.800003	0.004
0	699.200002	0.003	715.800003	0.004
10	699.200003	0.004	715.800003	0.004
20	699.199998	-0.003	715.799999	-0.002
30	699.199997	-0.004	715.799997	-0.005
40	699.199996	-0.005	715.799998	-0.003
50	699.199998	-0.003	715.799998	-0.003
60	699.199998	-0.003	715.799998	-0.003

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 12			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	699.200002	0.002	715.800002	0.002
3.60	699.200003	0.004	715.800002	0.003
4.14	699.200002	0.002	715.800004	0.005

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 12			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	699.200003	0.004	715.800002	0.003
-10	699.200002	0.003	715.800002	0.002
0	699.200003	0.004	715.800004	0.006
10	699.200002	0.002	715.800002	0.003
20	699.199997	-0.005	715.799998	-0.003
30	699.199997	-0.004	715.799996	-0.006
40	699.199998	-0.002	715.799998	-0.003
50	699.199999	-0.002	715.799998	-0.002
60	699.199998	-0.003	715.799998	-0.003

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 13			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	777.200003	0.004	786.800002	0.002
3.60	777.200004	0.005	786.800002	0.002
4.14	777.200001	0.001	786.800001	0.002

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 13			
	SubcarrierSpacing 3.75kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	777.200003	0.004	786.800003	0.003
-10	777.200003	0.004	786.800002	0.002
0	777.200003	0.003	786.800003	0.004
10	777.200002	0.002	786.800002	0.003
20	777.199999	-0.001	786.799998	-0.002
30	777.199998	-0.003	786.799998	-0.003
40	777.199998	-0.003	786.799996	-0.005
50	777.199996	-0.005	786.799999	-0.001
60	777.199998	-0.003	786.799998	-0.003

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

Frequency Error vs. Voltage

Voltage (Vdc)	NB-IoT Band 13			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.06	777.200002	0.003	786.800002	0.003
3.60	777.200001	0.002	786.800003	0.004
4.14	777.200002	0.002	786.800002	0.003

Note: The applicant defined the normal working voltage is from 3.06Vdc to 4.14Vdc.

Frequency Error vs. Temperature

Temp. (°C)	NB-IoT Band 13			
	SubcarrierSpacing 15kHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-20	777.200003	0.004	786.800003	0.004
-10	777.200003	0.004	786.800001	0.001
0	777.200004	0.005	786.800003	0.003
10	777.200003	0.004	786.800003	0.004
20	777.199997	-0.005	786.799996	-0.005
30	777.199997	-0.004	786.799997	-0.004
40	777.199999	-0.002	786.799997	-0.004
50	777.199997	-0.003	786.799996	-0.005
60	777.199997	-0.004	786.799999	-0.002

Note: When the EUT temperature is below -20°C, it will shut down and will not work.

4.4 Emission Bandwidth Measurement

4.4.1 Limits of Emission Bandwidth Measurement

According to FCC 2.1049, the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 % of the total mean power radiated by a given emission.

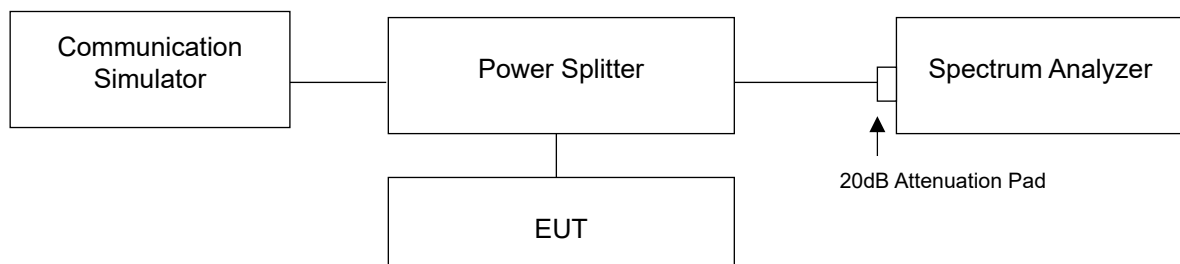
4.4.2 Test Procedure

For the 26dBc bandwidth measurement method, please refer to section 5.4.3 of ANSI C63.26.

- The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be wide enough to see sufficient roll off of the signal to make the measurement.
- The nominal RBW shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set $\geq 3 \times \text{RBW}$.
- Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. See guidance provided in 4.2.3.
- The dynamic range of the spectrum analyzer at the selected RBW shall be more than 10 dB below the target “-X dB” requirement, i.e., if the requirement calls for measuring the -26 dB OBW, the spectrum analyzer noise floor at the selected RBW shall be at least 36 dB below the reference level.
- Set spectrum analyzer detection mode to peak, and the trace mode to max hold.
- Determine the following reference values: Set the EUT to transmit a modulated signal. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
- Determine the “-X dB amplitude” as equal to (Reference Value - X). Alternatively, this calculation can be performed on the spectrum analyzer using the delta-marker measurement function.
- Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display such that each marker is at or slightly below the “-X dB amplitude” determined in step f). If a marker is below this “-X dB amplitude” value it should be as close as possible to this value. The OBW is the positive frequency difference between the two markers.
- The OBW shall be reported by providing plot(s) of the measuring instrument display, to include markers depicting the relevant frequency and amplitude information (e.g., marker table). The frequency and amplitude axis and scale shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

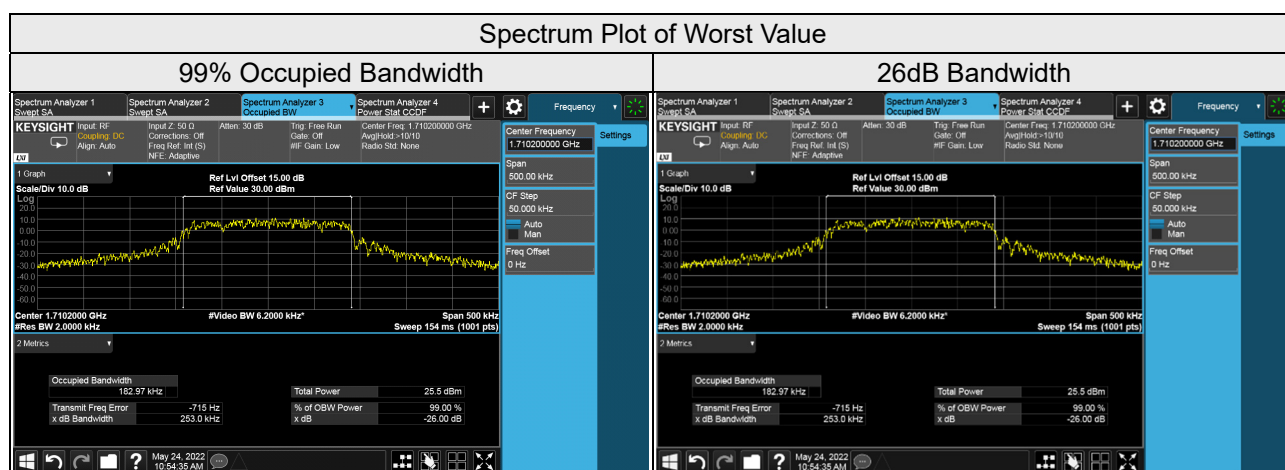
For the occupied bandwidth measurement method, please refer to section 5.4.4 of ANSI C63.26.

4.4.3 Test Setup

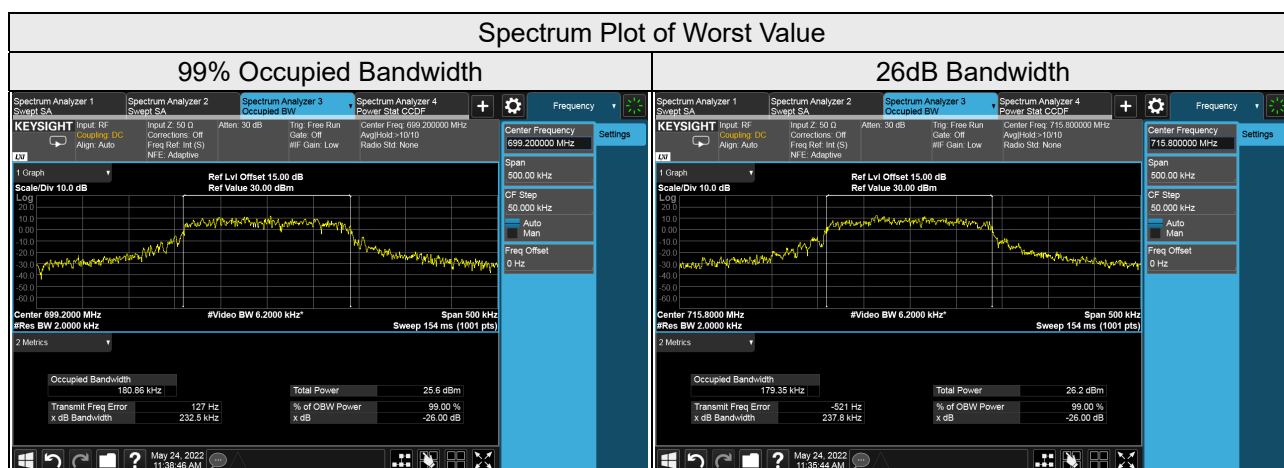


4.4.4 Test Result

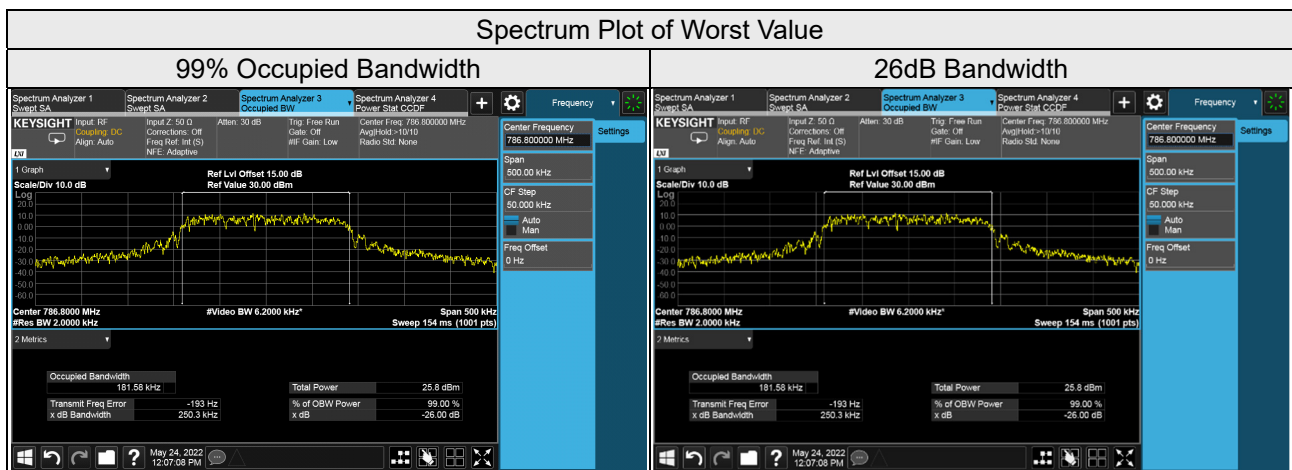
NB-IoT Band 4						
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	99% Occupied Bandwidth (kHz)	26dB Bandwidth (kHz)
19952	1710.2	3.75	1@0	BPSK	59.89	41.87
		15	12@0	QPSK	182.97	253.00
20175	1732.5	3.75	1@0	BPSK	59.90	41.27
		15	12@0	QPSK	181.05	236.00
20398	1754.8	3.75	1@47	BPSK	60.84	41.78
		15	12@0	QPSK	180.04	245.60



NB-IoT Band 12						
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	99% Occupied Bandwidth (kHz)	26dB Bandwidth (kHz)
23012	699.2	3.75	1@0	BPSK	57.82	41.86
		15	12@0	QPSK	180.86	232.50
23095	707.5	3.75	1@0	BPSK	58.62	41.83
		15	12@0	QPSK	177.65	230.00
23178	715.8	3.75	1@47	BPSK	57.73	41.45
		15	12@0	QPSK	179.35	237.80



NB-IoT Band 13						
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	99% Occupied Bandwidth (kHz)	26dB Bandwidth (kHz)
23182	777.2	3.75	1@0	BPSK	57.00	41.78
		15	12@0	QPSK	179.49	235.50
23230	782.0	3.75	1@0	BPSK	57.68	41.88
		15	12@0	QPSK	179.33	234.60
23278	786.8	3.75	1@47	BPSK	57.58	41.62
		15	12@0	QPSK	181.58	250.30



4.5 Channel Edge / Out-of-Band Emissions Measurement

4.5.1 Limits of Band Edge / Out-of-Band Emissions Measurement

For NB-IoT Band 4:

According to FCC 27.53(h), for operations in the 1695-1710MHz, 1710-1755MHz, 1755-1780 MHz, 1915-1920MHz, 1995-2000 MHz, 2000-2020MHz, 2110-2155MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log (P)$ dB. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

For NB-IoT Band 12:

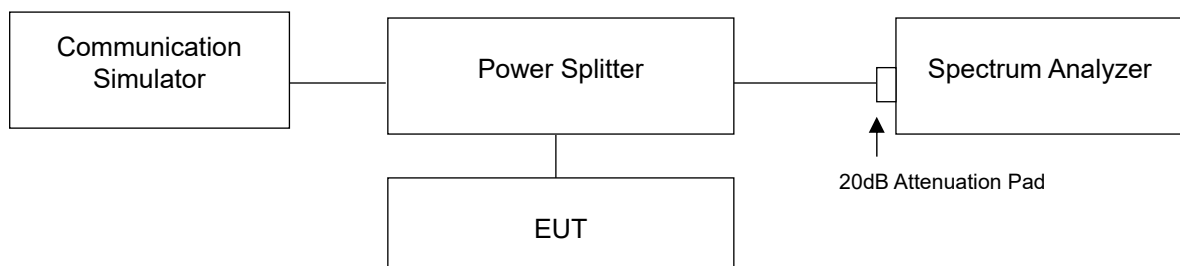
According to FCC 27.53(g), for operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log (P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

For NB-IoT Band 13:

According to FCC 27.53(c)(2), for on any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

According to 27.53(c)(4), on all frequencies between 763-775MHz and 793-805MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations

4.5.2 Test Setup



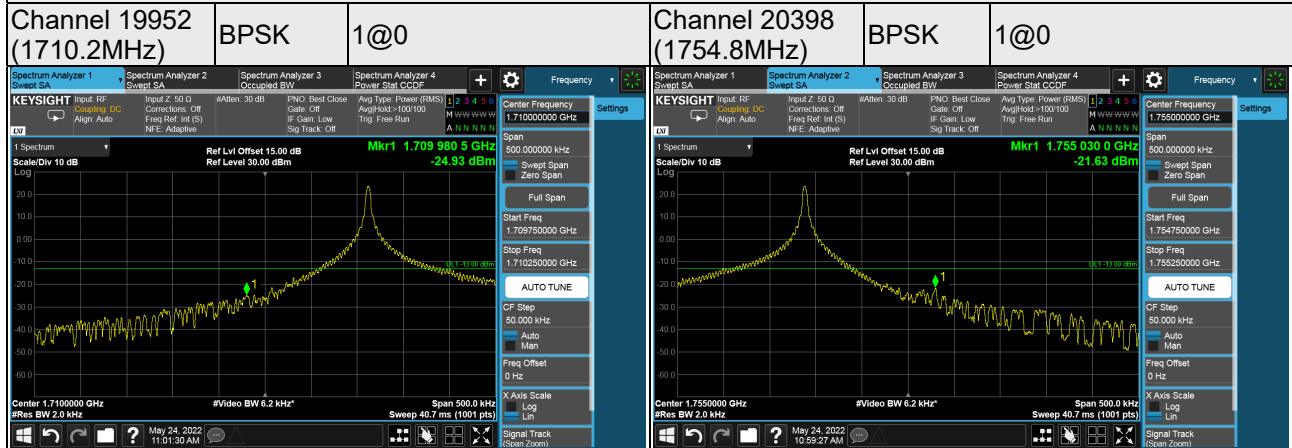
4.5.3 Test Procedures

- The EUT was set up for the rated peak power. The power was measured with Spectrum Analyzer. Band edge measurements were done at 2 channels: low and high operational frequency range.
- Measurement refer to ANSI C63.26 section 5.7.2 and FCC Part 27 section 27.53.
- Record the max trace plot into the test report.

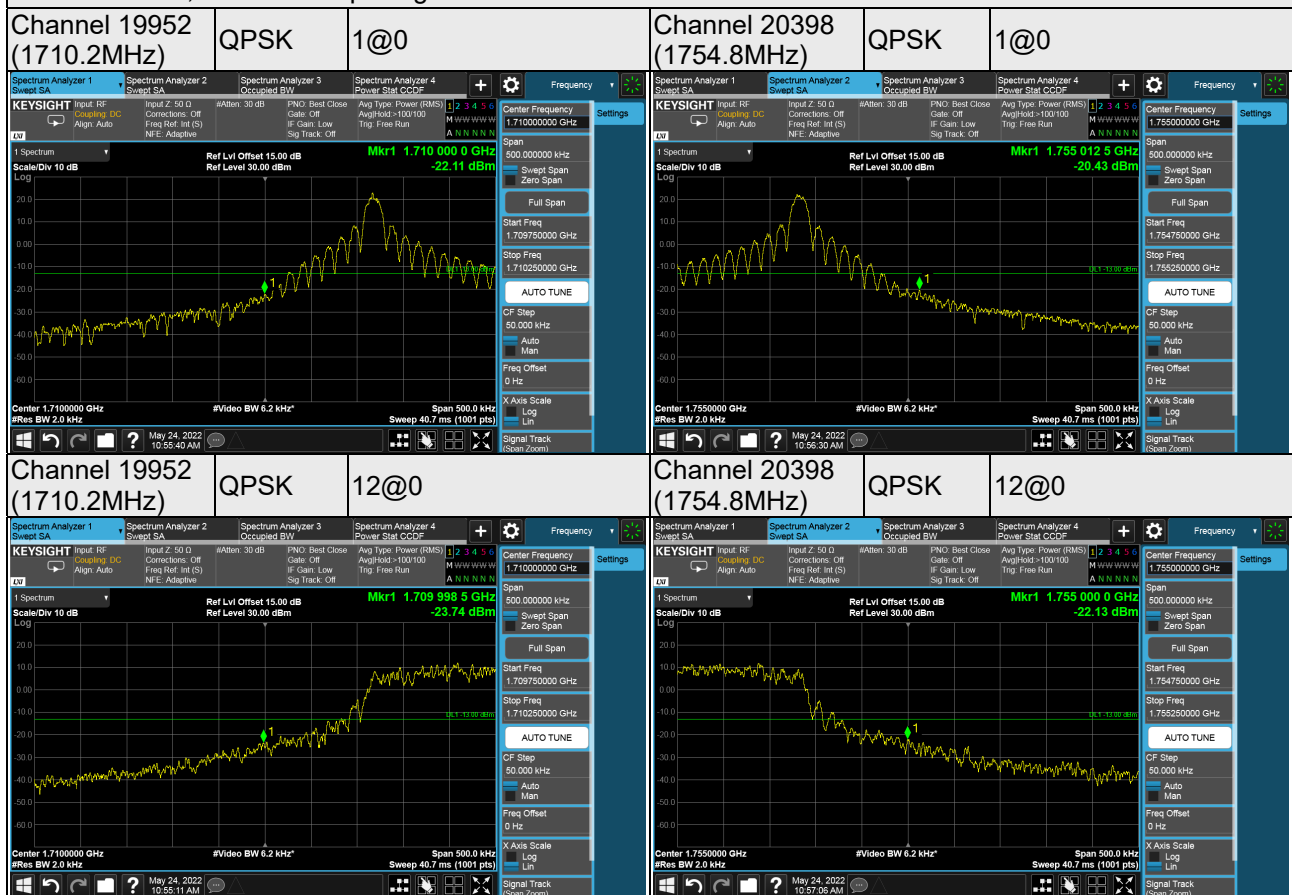
4.5.4 Test Results

Band Edge

NB-IoT Band 4, Subcarrier Spacing 3.75kHz

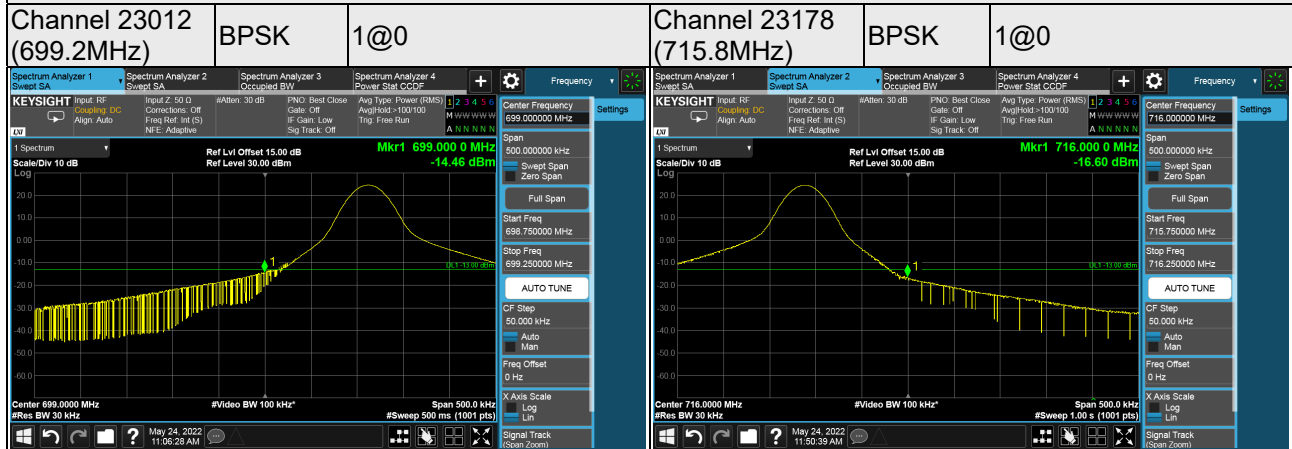


NB-IoT Band 4, Subcarrier Spacing 15kHz

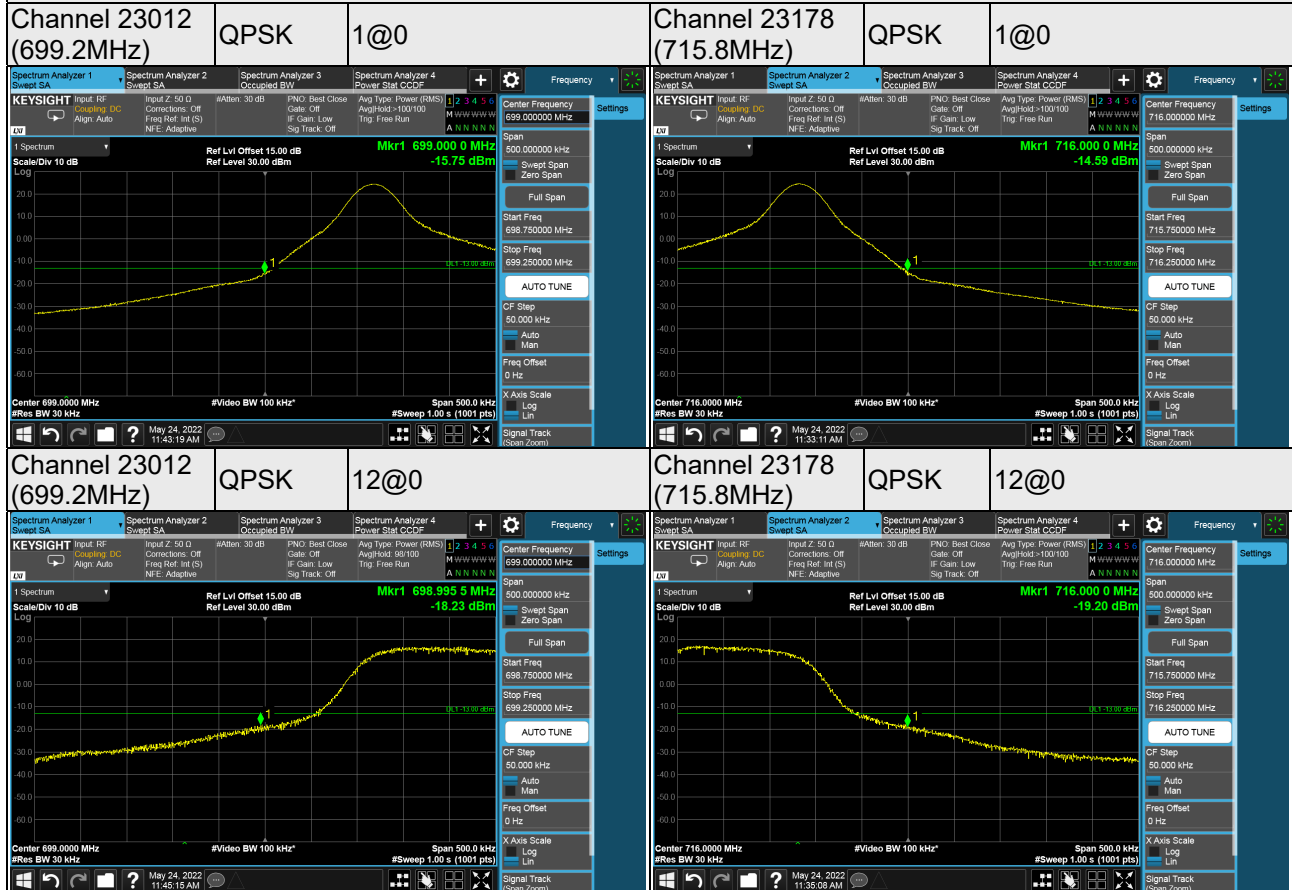


Band Edge

NB-IoT Band 12, Subcarrier Spacing 3.75kHz

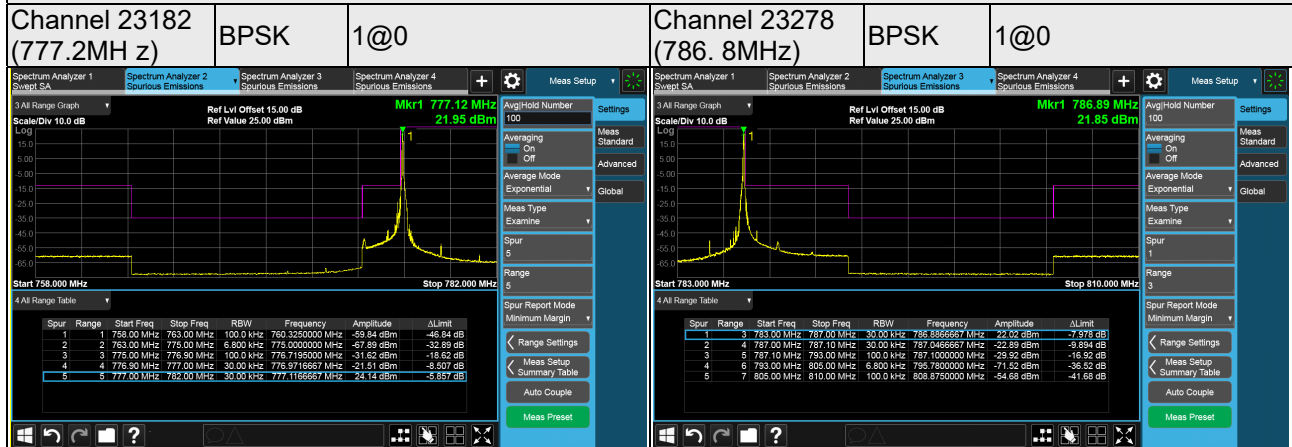


NB-IoT Band 12, Subcarrier Spacing 15kHz

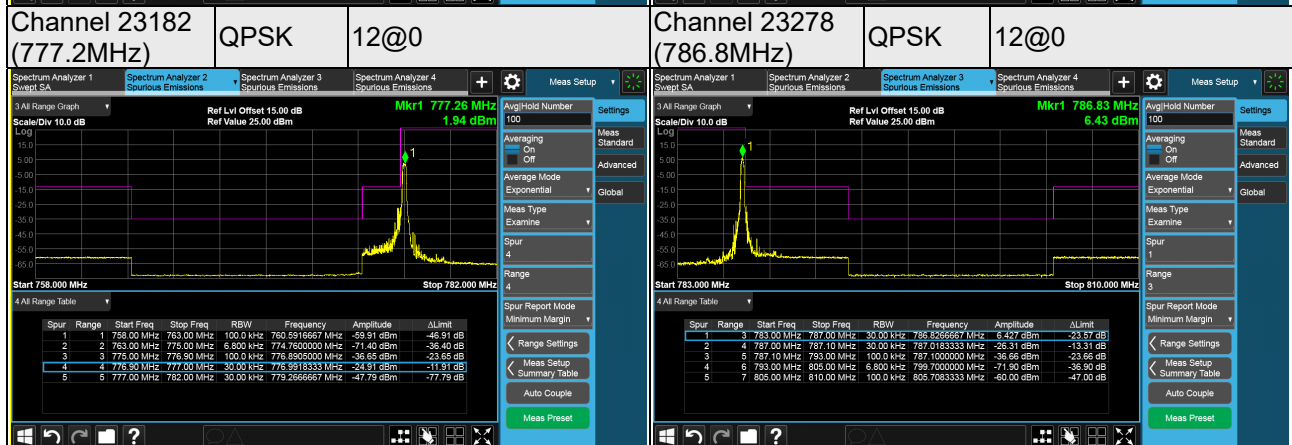
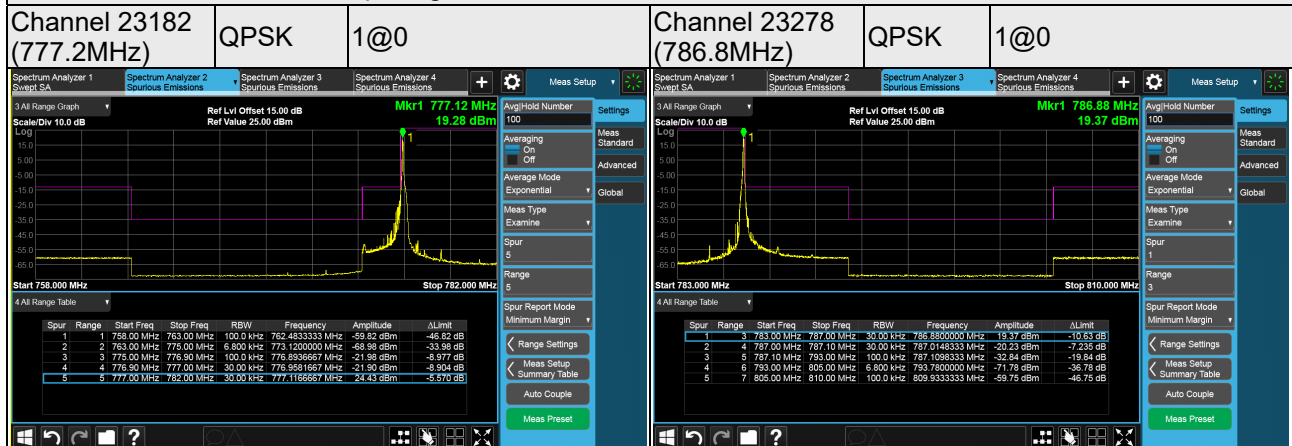


Band Edge

NB-IoT Band 13, Subcarrier Spacing 3.75kHz



NB-IoT Band 13, Subcarrier Spacing 15kHz

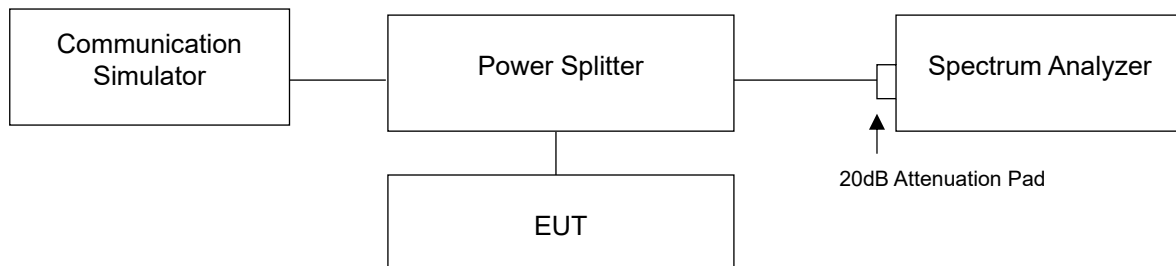


4.6 Peak to Average Ratio

4.6.1 Limits of Peak to Average Ratio Measurement

In measuring transmissions in this band using an average power technique, the peak to-average ratio (PAR) of the transmission may not exceed 13 dB

4.6.2 Test Setup

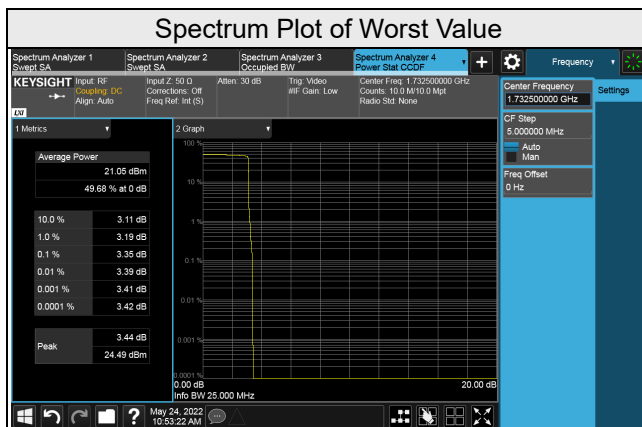


4.6.3 Test Procedures

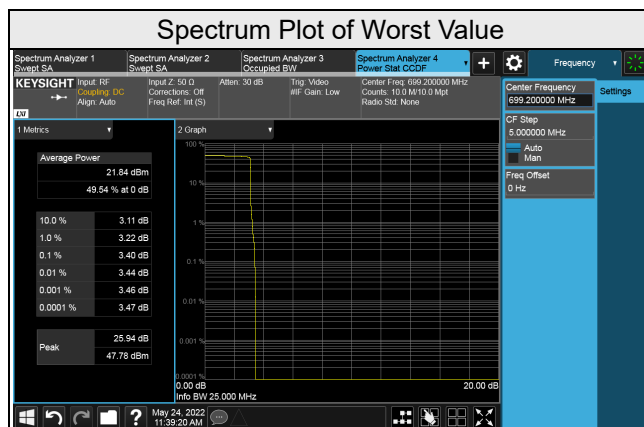
- Set resolution/measurement bandwidth $\geq$ signal's occupied bandwidth;
- Set the number of counts to a value that stabilizes the measured CCDF curve;
- Record the maximum PAPR level associated with a probability of 0.1%.

4.6.4 Test Results

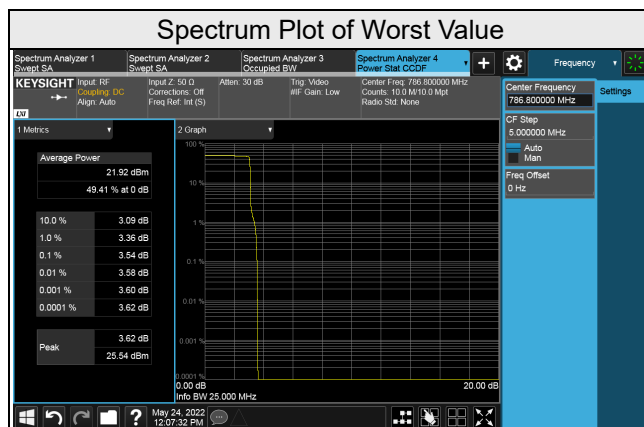
NB-IoT Band 4					
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	Peak To Average Ratio (dB)
19952	1710.2	3.75	1@0	BPSK	0.78
		15	12@0	QPSK	3.31
20175	1732.5	3.75	1@0	BPSK	0.52
		15	12@0	QPSK	3.35
20398	1754.8	3.75	1@47	BPSK	0.55
		15	12@0	QPSK	3.30



NB-IoT Band 12					
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	Peak To Average Ratio (dB)
23012	699.2	3.75	1@0	BPSK	0.82
		15	12@0	QPSK	3.40
23095	707.5	3.75	1@0	BPSK	0.86
		15	12@0	QPSK	3.33
23178	715.8	3.75	1@47	BPSK	0.89
		15	12@0	QPSK	3.37



NB-IoT Band 13					
Channel	Frequency (MHz)	Subcarrier Spacing (kHz)	Number of Subcarrier / Starting Subcarrier	Modulation	Peak To Average Ratio (dB)
23182	777.2	3.75	1@0	BPSK	0.83
		15	12@0	QPSK	3.38
23230	782.0	3.75	1@0	BPSK	0.86
		15	12@0	QPSK	3.52
23278	786.8	3.75	1@47	BPSK	0.83
		15	12@0	QPSK	3.54



4.7 Conducted Spurious Emissions

4.7.1 Limits of Conducted Spurious Emissions Measurement

For NB-IoT Band 4:

According to FCC 27.53(h), for operations in the 1695-1710MHz, 1710-1755MHz, 1755-1780 MHz bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log (P)$ dB.

For NB-IoT Band 12:

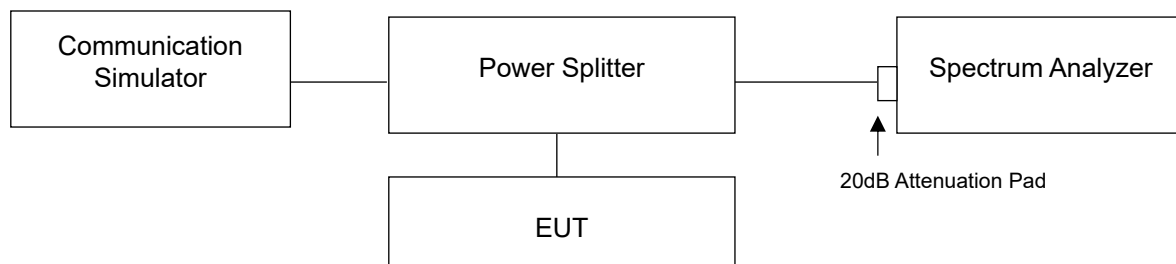
According to FCC 27.53(g), for operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log (P)$ dB. The limit of emissions is equal to -13 dBm.

For NB-IoT Band 13:

According to FCC 27.53(c)(2), for on any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB. The limit of emissions is equal to -13 dBm.

According to FCC 27.53(f), for operations in the 775-788 MHz, emissions in the band 1559-1610MHz shall be limited to -70 dBW/MHz (EIRP). The limit of emissions is equal to -40 dBm.

4.7.2 Test Setup



4.7.3 Test Procedure

- All measurements were done at low, middle and high channels operational frequency range.
- Measuring frequency range is from 9kHz to 10GHz / 20GHz. 20dB attenuation pad is connected with spectrum. RBW=1MHz and VBW=3MHz are used for conducted emission measurement.