

# FCC Test Report

## (PART 27–Cat-M1 B4, 12, 13)

**Report No.:** RFBEIH-WTW-P22050972-1

**FCC ID:** P27SMRTK02

**Test Model:** LL-AF2-ST-SM-RTK02

**Series Model:** SM-RTK02 (refer to item 3.1 for more details)

**Received Date:** May 30, 2022

**Test Date:** Jun. 06 ~ Jun. 14, 2022

**Issued Date:** Jul. 04, 2022

**Applicant:** Sercomm Corporation

**Address:** 8F, No. 3-1, YuanQu St., NanKang, Taipei

**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch  
Lin Kou Laboratories

**Lab Address:** No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan

**Test Location (1):** No.19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City  
33383, Taiwan

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

**FCC Registration /** 788550 / TW0003

**Designation Number:** 281270 / TW0032



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### Release Control Record

Issue No.	Description	Date Issued
RFBEIH-WTW-P22050972-1	Original Release	Jul. 04, 2022

## 1 Certificate of Conformity

**Product:** Airfinder Rechargeable SuperTag

**Brand:** Sercomm, AirFinder

**Test Model:** LL-AF2-ST-SM-RTK02

**Series Model:** SM-RTK02 (refer to item 3.1 for more details)

**Sample Status:** Engineering Sample

**Applicant:** Sercomm Corporation

**Test Date:** Jun. 06 ~ Jun. 14, 2022

**Standards:** FCC Part 27, Subpart C, H, F, 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 :** *Lena Wang* , **Date:** Jul. 04, 2022  
Lena Wang / Specialist

**Approved by :** *Jeremy Lin* , **Date:** Jul. 04, 2022  
Jeremy Lin / Project Engineer

## 2 Summary of Test Results

Applied Standard: FCC Part 27 & Part 2 (Cat-M1 Band 4)			
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 -18.30 dB at 3465.00 MHz.

Applied Standard: FCC Part 27 & Part 2 (Cat-M1 Band 12)			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50(c)	Effective 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 -46.60 dB at 957.83 MHz.

Applied Standard: FCC Part 27 & Part 2 (Cat-M1 Band 13)			
FCC Clause	Test Item	Result	Remarks
2.1046 27.50(b)	Effective 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 -5.14 dB at 1564.00 MHz.

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	2.93 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.	Date of Calibration	Due Date of Calibration
Test Receiver Rohde & Schwarz	ESR3	102782	Dec. 10, 2021	Dec. 09, 2022
Spectrum Analyzer Rohde & Schwarz	FSW43	101582	Apr. 13, 2022	Apr. 12, 2023
BILOG Antenna SCHWARZBECK	VULB9168	9168-1213	Oct. 27, 2021	Oct. 26, 2022
HORN Antenna RF SPIN	DRH18-E	210103A18E	Nov. 14, 2021	Nov. 13, 2022
HORN Antenna SCHWARZBECK	BBHA 9170	9170-1048	Nov. 14, 2021	Nov. 13, 2022
Loop Antenna TESEQ	HLA 6121	45745	Jul. 21, 2021	Jul. 20, 2022
Preamplifier EMCI	EMC330N	980782	Jan. 17, 2022	Jan. 16, 2023
Preamplifier EMCI	EMC118A45SE	980808	Dec. 30, 2021	Dec. 29, 2022
Preamplifier EMCI	EMC184045SE	980788	Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMC104-SM-SM- (9000+2000+1000)	201243+ 201231+ 210102	Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMCCFD400-NM- NM-(9000+300+500)	201236+ 201235+ 201233	Jan. 17, 2022	Jan. 16, 2023
RF signal cable EMCI	EMC101G-KM-KM- (5000+3000+2000)	201260+201257+ 201254	Jan. 17, 2022	Jan. 16, 2023
Software BV ADT	ADT_Radiated_V7.6. 15.9.5	NA	NA	NA
Antenna Tower Max-Full	MFT-151SS-0.5T	NA	NA	NA
Turn Table Max-Full	MF-7802BS	NA	NA	NA
Turn Table Controller Max-Full	MF-7802BS	MF780208674	NA	NA
Spectrum Analyzer KEYSIGHT	N9030B	MY57140953	Jul. 06, 2021	Jul. 05, 2022
Radio Communication Analyzer Anritsu	MT8821C	6261806803	Feb. 16, 2022	Feb. 15, 2023
Temperature & Humidity Chamber TERCHY	HRM-120RF	931022	Jan. 03, 2022	Jan. 02, 2023
DC power supply Keysight	U8002A	MY56330015	NA	NA
Digital Multimeter Fluke	87-III	70360755	Jul. 08, 2021	Jul. 07, 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 8.



### 3 General Information

#### 3.1 General Description of EUT

<b>Product</b>	Airfinder Rechargeable SuperTag		
<b>Brand</b>	Sercomm, AirFinder		
<b>Test Model</b>	LL-AF2-ST-SM-RTK02		
<b>Series Model</b>	SM-RTK02		
<b>Model Difference</b>	Refer to Note as below		
<b>Status of EUT</b>	Engineering Sample		
<b>Power Supply Rating</b>	5 Vdc (adapter) 3.7 Vdc (Li-ion battery)		
<b>Modulation Type</b>	Cat-M1	QPSK, 16QAM	
<b>Frequency Range</b>	Cat-M1 Band 4 (Channel Bandwidth: 1.4 MHz)	1710.7 ~ 1754.3 MHz	
	Cat-M1 Band 4 (Channel Bandwidth: 3 MHz)	1711.5 ~ 1753.5 MHz	
	Cat-M1 Band 4 (Channel Bandwidth: 5 MHz)	1712.5 ~ 1752.5 MHz	
	Cat-M1 Band 4 (Channel Bandwidth: 10 MHz)	1715.0 ~ 1750.0 MHz	
	Cat-M1 Band 4 (Channel Bandwidth: 15 MHz)	1717.5 ~ 1747.5 MHz	
	Cat-M1 Band 4 (Channel Bandwidth: 20 MHz)	1720.0 ~ 1745.0 MHz	
	Cat-M1 Band 12 (Channel Bandwidth: 1.4 MHz)	699.7 ~ 715.3 MHz	
	Cat-M1 Band 12 (Channel Bandwidth: 3 MHz)	700.5 ~ 714.5 MHz	
	Cat-M1 Band 12 (Channel Bandwidth: 5 MHz)	701.5 ~ 713.5 MHz	
	Cat-M1 Band 12 (Channel Bandwidth: 10 MHz)	704.0 ~ 711.0 MHz	
	Cat-M1 Band 13 (Channel Bandwidth: 5 MHz)	779.5 ~ 784.5 MHz	
	Cat-M1 Band 13 (Channel Bandwidth: 10 MHz)	782.0 MHz	
<b>Emission Designator</b>	Cat-M1 Band 4 (Channel Bandwidth: 1.4 MHz)	1M08D7W	
	Cat-M1 Band 4 (Channel Bandwidth: 3 MHz)	1M08D7W	
	Cat-M1 Band 4 (Channel Bandwidth: 5 MHz)	1M08D7W	
	Cat-M1 Band 4 (Channel Bandwidth: 10 MHz)	1M08D7W	
	Cat-M1 Band 4 (Channel Bandwidth: 15 MHz)	1M08D7W	
	Cat-M1 Band 4 (Channel Bandwidth: 20 MHz)	1M08D7W	
	Cat-M1 Band 12 (Channel Bandwidth: 1.4 MHz)	1M08G7D	
	Cat-M1 Band 12 (Channel Bandwidth: 3 MHz)	1M08G7D	
	Cat-M1 Band 12 (Channel Bandwidth: 5 MHz)	1M08G7D	
	Cat-M1 Band 12 (Channel Bandwidth: 10 MHz)	1M08D7W	
	Cat-M1 Band 13 (Channel Bandwidth: 5 MHz)	1M08D7W	
	Cat-M1 Band 13 (Channel Bandwidth: 10 MHz)	1M08D7W	
<b>Max. ERP Power</b>		QPSK	16QAM
	Cat-M1 Band 12 (Channel Bandwidth: 1.4 MHz)	64.565 mW (18.10 dBm)	59.020 mW (17.71 dBm)
	Cat-M1 Band 12 (Channel Bandwidth: 3 MHz)	67.920 mW (18.32 dBm)	51.523 mW (17.12 dBm)
	Cat-M1 Band 12 (Channel Bandwidth: 5 MHz)	64.714 mW (18.11 dBm)	62.373 mW (17.95 dBm)
	Cat-M1 Band 12 (Channel Bandwidth: 10 MHz)	63.387 mW (18.02 dBm)	61.376 mW (17.88 dBm)
	Cat-M1 Band 13 (Channel Bandwidth: 5 MHz)	95.280 mW (19.79 dBm)	88.105 mW (19.45 dBm)
	Cat-M1 Band 13 (Channel Bandwidth: 10 MHz)	94.189 mW	87.700 mW

		(19.74 dBm)	(19.43 dBm)
<b>Max. EIRP Power</b>	Cat-M1 Band 4 (Channel Bandwidth: 1.4 MHz)	411.150 mW (26.14 dBm)	299.916 mW (24.77 dBm)
	Cat-M1 Band 4 (Channel Bandwidth: 3 MHz)	391.742 mW (25.93 dBm)	298.538 mW (24.75 dBm)
	Cat-M1 Band 4 (Channel Bandwidth: 5 MHz)	399.945 mW (26.02 dBm)	381.066 mW (25.81 dBm)
	Cat-M1 Band 4 (Channel Bandwidth: 10 MHz)	399.025 mW (26.01 dBm)	383.707 mW (25.84 dBm)
	Cat-M1 Band 4 (Channel Bandwidth: 15 MHz)	399.945 mW (26.02 dBm)	381.066 mW (25.81 dBm)
	Cat-M1 Band 4 (Channel Bandwidth: 20 MHz)	403.645 mW (26.06 dBm)	379.315 mW (25.79 dBm)
<b>Antenna Type</b>	Monopole Antenna		
<b>Antenna Gain</b>	Cat-M1 Band 4	2.7 dBi	
	Cat-M1 Band 12	-4.1 dBi	
	Cat-M1 Band 13	-2.9 dBi	
<b>Accessory Device</b>	N/A		
<b>Data Cable Supplied</b>	N/A		

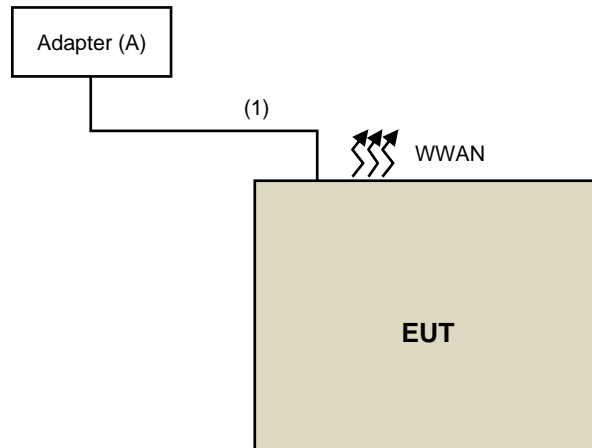
Note:

1. All models are listed as below.

<b>Model</b>	<b>Difference</b>
LL-AF2-ST-SM-RTK02	Brand: AirFinder
SM-RTK02	Brand: Sercomm,

2. The above Antenna information refers to the manufacturer's antenna specifications, the laboratory shall not be held responsible.
3. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or user's manual.

### 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.

No.	Product	Brand	Model No.	Serial No.	FCC ID
A	Adapter	Liteon	PA-1050-39	NA	NA
B	Radio Communication Analyzer	Anritsu	MT8821C	6201462755	NA

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1	Micro USB Cable	1	1	Y	0	--

Note:

1. All power cords of the above support units are non-shielded (1.8m).

### 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 as the table below. Following channel(s) was (were) selected for the final test as listed below:

Band	Radiated Emission
Cat-M1 Band 4	X-plane
Cat-M1 Band 12	Y-plane
Cat-M1 Band 13	Y-plane

#### Cat-M1 Band 4

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	EIRP	19957 to 20393	19957, 20175, 20393	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		19965 to 20385	19965, 20175, 20385	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		19975 to 20375	19975, 20175, 20375	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		20000 to 20350	20000, 20175, 20350	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		20025 to 20325	20025, 20175, 20325	15 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		20050 to 20300	20050, 20175, 20300	20 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
-	Modulation Characteristics	20050 to 20300	20175	20 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Frequency Stability	19957 to 20393	19957, 20393	1.4 MHz	QPSK	1 RB / 0 RB Offset
		19965 to 20385	19965, 20385	3 MHz	QPSK	1 RB / 0 RB Offset
		19975 to 20375	19975, 20375	5 MHz	QPSK	1 RB / 0 RB Offset
		20000 to 20350	20000, 20350	10 MHz	QPSK	1 RB / 0 RB Offset
		20025 to 20325	20025, 20325	15 MHz	QPSK	1 RB / 0 RB Offset
		20050 to 20300	20050, 20300	20 MHz	QPSK	1 RB / 0 RB Offset
-	Occupied Bandwidth	19957 to 20393	19957, 20175, 20393	1.4 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		19965 to 20385	19965, 20175, 20385	3 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		19975 to 20375	19975, 20175, 20375	5 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		20000 to 20350	20000, 20175, 20350	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		20025 to 20325	20025, 20175, 20325	15 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		20050 to 20300	20050, 20175, 20300	20 MHz	QPSK, 16QAM	6 RB / 0 RB Offset

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode		
-	Peak to Average Ratio	19957 to 20393	19957, 20175, 20393	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
		19965 to 20385	19965, 20175, 20385	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
		19975 to 20375	19975, 20175, 20375	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
		20000 to 20350	20000, 20175, 20350	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
		20025 to 20325	20025, 20175, 20325	15 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
		20050 to 20300	20050, 20175, 20300	20 MHz	QPSK, 16QAM	1 RB / 0 RB Offset		
-	Band Edge	19957 to 20393	19957	1.4 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20393	1.4 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		19965 to 20385	19965	3 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20385	3 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		19975 to 20375	19975	5 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20375	5 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		20000 to 20350	20000	10 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20350	10 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		20025 to 20325	20025	15 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20325	15 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		20050 to 20300	20050	20 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset		
			20300	20 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset		
		-	Conducted Emission	19957 to 20393	19957, 20175, 20393	1.4 MHz	QPSK	1 RB / 0 RB Offset
				19965 to 20385	19965, 20175, 20385	3 MHz	QPSK	1 RB / 0 RB Offset
				19975 to 20375	19975, 20175, 20375	5 MHz	QPSK	1 RB / 0 RB Offset
				20000 to 20350	20000, 20175, 20350	10 MHz	QPSK	1 RB / 0 RB Offset
				20025 to 20325	20025, 20175, 20325	15 MHz	QPSK	1 RB / 0 RB Offset
				20050 to 20300	20050, 20175, 20300	20 MHz	QPSK	1 RB / 0 RB Offset
-	Radiated Emission	19957 to 20393	19957, 20175, 20393	1.4 MHz	QPSK	1 RB / 0 RB Offset		
		19975 to 20375	19975, 20175, 20375	5 MHz	QPSK	1 RB / 0 RB Offset		
		20050 to 20300	20050, 20175, 20300	20 MHz	QPSK	1 RB / 0 RB Offset		

**Note:**

1. This device was tested under all bandwidths, RB configurations and modulations. The worst case was found in QPSK modulation.
2. For radiated emission above 1 GHz, according to 3GPP 36.521 Section 6.6.3.1.4, choose the lowest, 5 MHz & highest channel bandwidth for final test.

### Cat-M1 Band 12

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	ERP	23017 to 23173	23017, 23095, 23173	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		23025 to 23165	23025, 23095, 23165	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		23035 to 23155	23035, 23095, 23155	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		23060 to 23130	23060, 23095, 23130	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
-	Modulation Characteristics	23060 to 23130	23095	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Frequency Stability	23017 to 23173	23017, 23173	1.4 MHz	QPSK	1 RB / 0 RB Offset
		23025 to 23165	23025, 23165	3 MHz	QPSK	1 RB / 0 RB Offset
		23035 to 23155	23035, 23155	5 MHz	QPSK	1 RB / 0 RB Offset
		23060 to 23130	23060, 23130	10 MHz	QPSK	1 RB / 0 RB Offset
-	Occupied Bandwidth	23017 to 23173	23017, 23095, 23173	1.4 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		23025 to 23165	23025, 23095, 23165	3 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		23035 to 23155	23035, 23095, 23155	5 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		23060 to 23130	23060, 23095, 23130	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Peak to Average Ratio	23017 to 23173	23017, 23095, 23173	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		23025 to 23165	23025, 23095, 23165	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		23035 to 23155	23035, 23095, 23155	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		23060 to 23130	23060, 23095, 23130	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
-	Band Edge	23017 to 23173	23017	1.4 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23173	1.4 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset
		23025 to 23165	23025	3 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23165	3 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset
		23035 to 23155	23035	5 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23155	5 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset
		23060 to 23130	23060	10 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23130	10 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	Conducted Emission	23017 to 23173	23017, 23095, 23173	1.4 MHz	QPSK	1 RB / 0 RB Offset
		23025 to 23165	23025, 23095, 23165	3 MHz	QPSK	1 RB / 0 RB Offset
		23035 to 23155	23035, 23095, 23155	5 MHz	QPSK	1 RB / 0 RB Offset
		23060 to 23130	23060, 23095, 23130	10 MHz	QPSK	1 RB / 0 RB Offset
-	Radiated Emission	23017 to 23173	23017, 23095, 23173	1.4 MHz	QPSK	1 RB / 0 RB Offset
		23035 to 23155	23035, 23095, 23155	5 MHz	QPSK	1 RB / 0 RB Offset
		23060 to 23130	23060, 23095, 23130	10 MHz	QPSK	1 RB / 0 RB Offset

**Note:**

1. This device was tested under all bandwidths, RB configurations and modulations. The worst case was found in QPSK modulation.
2. For radiated emission above 1 GHz, according to 3GPP 36.521 Section 6.6.3.1.4, choose the lowest, 5 MHz & highest channel bandwidth for final test.

### Cat-M1 Band 13

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	ERP	23205 to 23255	23205, 23230, 23255	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		23230	23230	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
-	Modulation Characteristics	23230	23230	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Frequency Stability	23205 to 23255	23205, 23255	5 MHz	QPSK	1 RB / 0 RB Offset
		23230	23230	10 MHz	QPSK	1 RB / 0 RB Offset
-	Occupied Bandwidth	23205 to 23255	23205, 23230, 23255	5 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		23230	23230	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Peak to Average Ratio	23205 to 23255	23205, 23230, 23255	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		23230	23230	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
-	Band Edge	23205 to 23255	23205	5 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23255	5 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset
		23230	23230	10 MHz	QPSK	1 RB / 0 RB Offset 6 RB / 0 RB Offset
			23230	10 MHz	QPSK	1 RB / 5 RB Offset 6 RB / 0 RB Offset

**Note:**

1. This device was tested under all bandwidths, RB configurations and modulations. The worst case was found in QPSK modulation.
2. For radiated emission above 1 GHz, according to 3GPP 36.521 Section 6.6.3.1.4, choose the lowest, 5 MHz & highest channel bandwidth for final test.

**Test Condition:**

Test Item	Environmental Conditions	Input Power	Tested By
ERP / EIRP	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Modulation Characteristics	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Frequency Stability	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Occupied Bandwidth	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Band Edge	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Peak to Average Ratio	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Conducted Emission	26 deg. C, 58 % RH	3.7 Vdc	Willy Cheng
Radiated Emission	22 deg. C, 66 % RH	120 Vac, 60 Hz	Han Wu, 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 63.26-2015**

**Note:** All test items have been performed and recorded as per the above standards.

**References Test Guidance:**

**KDB 971168 D01 Power Meas License Digital Systems v03r01**

**ANSI/TIA/EIA-603-E 2016**

**Note:** 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 Cat-M1 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.

For Cat-M1 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 Cat-M1 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.

#### 4.1.2 Test Procedures

##### Conducted Power Measurement:

- a. The EUT was set up for the maximum power with Cat-M1 link data modulation and link up with simulator (Built-in power meter).
- b. 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:

$$\text{EIRP} = P_{\text{Meas}} + G_{\text{T}}$$

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

where

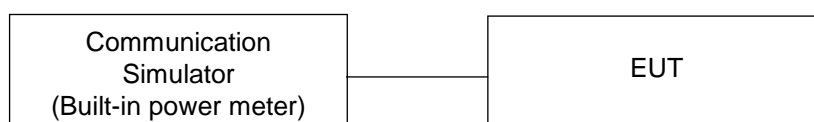
ERP or EIRP effective radiated power or equivalent isotropically radiated power, respectively  
(expressed in the same units as  $P_{\text{Meas}}$ , e.g., dBm or dBW)

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

$G_{\text{T}}$  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)

Cat-M1 Band 4						
BW	MCS Index	Channel		19957	20175	20393
		Frequency (MHz)		1710.7	1732.5	1754.3
1.4M	QPSK	1	0	23.27	23.26	<b>23.44</b>
		1	6	23.13	23.20	23.29
		6	0	20.96	20.94	21.09
	16QAM	1	0	21.87	21.84	22.01
		1	6	21.96	21.94	<b>22.07</b>
		6	0	20.91	20.92	21.04
BW	MCS Index	Channel		19965	20175	20385
		Frequency (MHz)		1711.5	1732.5	1753.5
3M	QPSK	1	0	23.17	23.13	<b>23.23</b>
		1	6	23.14	23.07	23.21
		6	0	21.13	21.11	21.21
	16QAM	1	0	21.91	21.91	21.98
		1	6	21.98	21.94	<b>22.05</b>
		6	0	20.89	20.93	21.06
BW	MCS Index	Channel		19975	20175	20375
		Frequency (MHz)		1712.5	1732.5	1752.5
5M	QPSK	1	0	23.07	23.06	23.19
		1	6	23.27	23.26	<b>23.32</b>
		6	0	22.35	22.32	22.39
	16QAM	1	0	23.01	22.97	22.82
		1	6	<b>23.11</b>	23.07	22.84
		6	0	20.37	20.31	21.69
BW	MCS Index	Channel		20000	20175	20350
		Frequency (MHz)		1715	1732.5	1750
10M	QPSK	1	0	23.16	23.17	23.23
		1	6	23.21	23.25	<b>23.31</b>
		6	0	22.36	22.33	22.39
	16QAM	1	0	23.04	23.09	23.12
		1	6	23.06	23.13	<b>23.14</b>
		6	0	20.49	20.33	20.44

Cat-M1 Band 4						
BW	MCS Index	Channel		20025	20175	20325
		Frequency (MHz)		1717.5	1732.5	1747.5
15M	QPSK	1	0	23.17	23.16	23.17
		1	6	23.22	23.21	23.23
		6	0	<b>23.32</b>	23.31	23.28
	16QAM	1	0	23.05	23.06	<b>23.11</b>
		1	6	23.03	23.04	23.06
		6	0	22.41	22.42	22.35
BW	MCS Index	Channel		20050	20175	20300
		Frequency (MHz)		1720	1732.5	1745
20M	QPSK	1	0	23.19	23.23	23.23
		1	6	23.25	23.25	23.12
		6	0	23.26	<b>23.36</b>	23.31
	16QAM	1	0	23.07	23.08	23.05
		1	6	23.05	<b>23.09</b>	23.04
		6	0	22.49	22.44	22.49

Cat-M1 Band 12						
BW	MCS Index	Channel		23017	23095	23173
		Frequency (MHz)		699.7	707.5	715.3
1.4M	QPSK	1	0	23.95	23.89	24.17
		1	6	23.79	23.79	<b>24.35</b>
		6	0	21.94	23.65	23.98
	16QAM	1	0	23.42	23.71	23.76
		1	6	23.45	23.70	<b>23.96</b>
		6	0	21.36	23.11	21.87
BW	MCS Index	Channel		23025	23095	23165
		Frequency (MHz)		700.5	707.5	714.5
3M	QPSK	1	0	23.98	24.19	<b>24.57</b>
		1	6	23.74	23.98	24.17
		6	0	22.00	22.27	22.53
	16QAM	1	0	22.78	23.00	23.26
		1	6	22.88	23.11	<b>23.37</b>
		6	0	22.08	22.26	22.56

Cat-M1 Band 12						
BW	MCS Index	Channel		23035	23095	23155
		Frequency (MHz)		701.5	707.5	713.5
5M	QPSK	1	0	23.90	24.08	24.32
		1	6	23.79	24.12	<b>24.36</b>
		6	0	23.25	23.47	23.62
	16QAM	1	0	23.76	23.93	24.15
		1	6	23.77	24.02	<b>24.20</b>
		6	0	21.16	21.48	21.77
BW	MCS Index	Channel		23060	23095	23130
		Frequency (MHz)		704	707.5	711
10M	QPSK	1	0	23.93	24.02	24.21
		1	6	24.01	24.11	<b>24.27</b>
		6	0	23.27	23.46	23.55
	16QAM	1	0	23.88	23.99	<b>24.13</b>
		1	6	23.83	23.94	24.06
		6	0	21.20	21.35	21.45

Cat-M1 Band 13						
BW	MCS Index	Channel		23205	23230	23255
		Frequency (MHz)		779.5	782	784.5
5M	QPSK	1	0	24.54	24.58	24.63
		1	6	24.78	24.81	<b>24.84</b>
		6	0	23.90	23.83	23.90
	16QAM	1	0	24.34	24.36	24.47
		1	6	24.41	24.42	<b>24.50</b>
		6	0	21.91	22.16	22.11
BW	MCS Index	Channel		23230		
		Frequency (MHz)		782		
10M	QPSK	1	0	24.68		
		1	6	<b>24.79</b>		
		6	0	23.93		
	16QAM	1	0	<b>24.48</b>		
		1	6	24.43		
		6	0	22.04		

**EIRP Power(dBm)**

Cat-M1 Band 4						
BW	MCS Index	Channel		19957	20175	20393
		Frequency (MHz)		1710.7	1732.5	1754.3
1.4M	QPSK	1	0	25.97	25.96	<b>26.14</b>
		1	6	25.83	25.90	25.99
		6	0	23.66	23.64	23.79
	16QAM	1	0	24.57	24.54	24.71
		1	6	24.66	24.64	<b>24.77</b>
		6	0	23.61	23.62	23.74
BW	MCS Index	Channel		19965	20175	20385
		Frequency (MHz)		1711.5	1732.5	1753.5
3M	QPSK	1	0	25.87	25.83	<b>25.93</b>
		1	6	25.84	25.77	25.91
		6	0	23.83	23.81	23.91
	16QAM	1	0	24.61	24.61	24.68
		1	6	24.68	24.64	<b>24.75</b>
		6	0	23.59	23.63	23.76
BW	MCS Index	Channel		19975	20175	20375
		Frequency (MHz)		1712.5	1732.5	1752.5
5M	QPSK	1	0	25.77	25.76	25.89
		1	6	25.97	25.96	<b>26.02</b>
		6	0	25.05	25.02	25.09
	16QAM	1	0	25.71	25.67	25.52
		1	6	<b>25.81</b>	25.77	25.54
		6	0	23.07	23.01	24.39
BW	MCS Index	Channel		20000	20175	20350
		Frequency (MHz)		1715	1732.5	1750
10M	QPSK	1	0	25.86	25.87	25.93
		1	6	25.91	25.95	<b>26.01</b>
		6	0	25.06	25.03	25.09
	16QAM	1	0	25.74	25.79	25.82
		1	6	25.76	25.83	<b>25.84</b>
		6	0	23.19	23.03	23.14

\*EIRP = Conducted + antenna gain (2.7dBi)

Cat-M1 Band 4						
BW	MCS Index	Channel		20025	20175	20325
		Frequency (MHz)		1717.5	1732.5	1747.5
15M	QPSK	1	0	25.87	25.86	25.87
		1	6	25.92	25.91	25.93
		6	0	<b>26.02</b>	26.01	25.98
	16QAM	1	0	25.75	25.76	<b>25.81</b>
		1	6	25.73	25.74	25.76
		6	0	25.11	25.12	25.05
BW	MCS Index	Channel		20050	20175	20300
		Frequency (MHz)		1720	1732.5	1745
20M	QPSK	1	0	25.89	25.93	25.93
		1	6	25.95	25.95	25.82
		6	0	25.96	<b>26.06</b>	26.01
	16QAM	1	0	25.77	25.78	25.75
		1	6	25.75	<b>25.79</b>	25.74
		6	0	25.19	25.14	25.19

\*EIRP = Conducted + antenna gain (2.7dBi)

**ERP Power (dBm)**

Cat-M1 Band 12						
BW	MCS Index	Channel		23017	23095	23173
		Frequency (MHz)		699.7	707.5	715.3
1.4M	QPSK	1	0	17.70	17.64	17.92
		1	6	17.54	17.54	<b>18.10</b>
		6	0	15.69	17.40	17.73
	16QAM	1	0	17.17	17.46	17.51
		1	6	17.20	17.45	<b>17.71</b>
		6	0	15.11	16.86	15.62
BW	MCS Index	Channel		23025	23095	23165
		Frequency (MHz)		700.5	707.5	714.5
3M	QPSK	1	0	17.73	17.94	<b>18.32</b>
		1	6	17.49	17.73	17.92
		6	0	15.75	16.02	16.28
	16QAM	1	0	16.53	16.75	17.01
		1	6	16.63	16.86	<b>17.12</b>
		6	0	15.83	16.01	16.31
BW	MCS Index	Channel		23035	23095	23155
		Frequency (MHz)		701.5	707.5	713.5
5M	QPSK	1	0	17.65	17.83	18.07
		1	6	17.54	17.87	<b>18.11</b>
		6	0	17.00	17.22	17.37
	16QAM	1	0	17.51	17.68	17.90
		1	6	17.52	17.77	<b>17.95</b>
		6	0	14.91	15.23	15.52
BW	MCS Index	Channel		23060	23095	23130
		Frequency (MHz)		704	707.5	711
10M	QPSK	1	0	17.68	17.77	17.96
		1	6	17.76	17.86	<b>18.02</b>
		6	0	17.02	17.21	17.30
	16QAM	1	0	17.63	17.74	<b>17.88</b>
		1	6	17.58	17.69	17.81
		6	0	14.95	15.10	15.20

\*ERP = Conducted + antenna gain (-4.1dBi)-2.15



Cat-M1 Band 13						
BW	MCS Index	Channel		23205	23230	23255
		Frequency (MHz)		779.5	782	784.5
5M	QPSK	1	0	19.49	19.53	19.58
		1	6	19.73	19.76	<b>19.79</b>
		6	0	18.85	18.78	18.85
	16QAM	1	0	19.29	19.31	19.42
		1	6	19.36	19.37	<b>19.45</b>
		6	0	16.86	17.11	17.06
BW	MCS Index	Channel		23230		
		Frequency (MHz)		782		
10M	QPSK	1	0	19.63		
		1	6	<b>19.74</b>		
		6	0	18.88		
	16QAM	1	0	<b>19.43</b>		
		1	6	19.38		
		6	0	16.99		

\*ERP = Conducted + antenna gain (-2.9dBi)-2.15

## 4.2 Modulation Characteristics Measurement

### 4.2.1 Limits of Modulation Characteristics

N/A

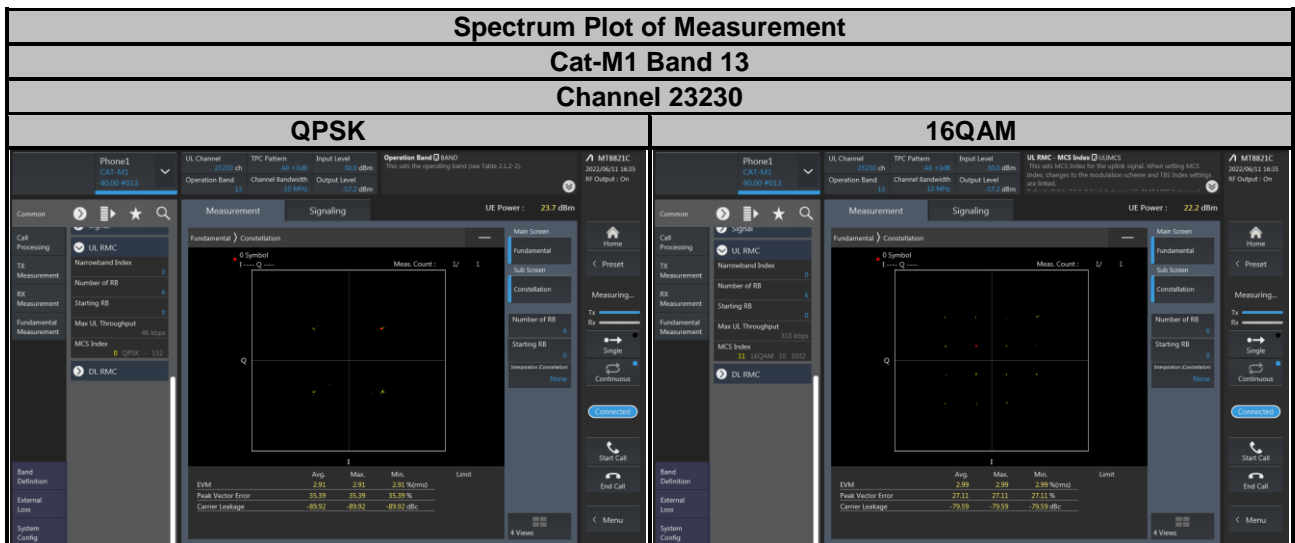
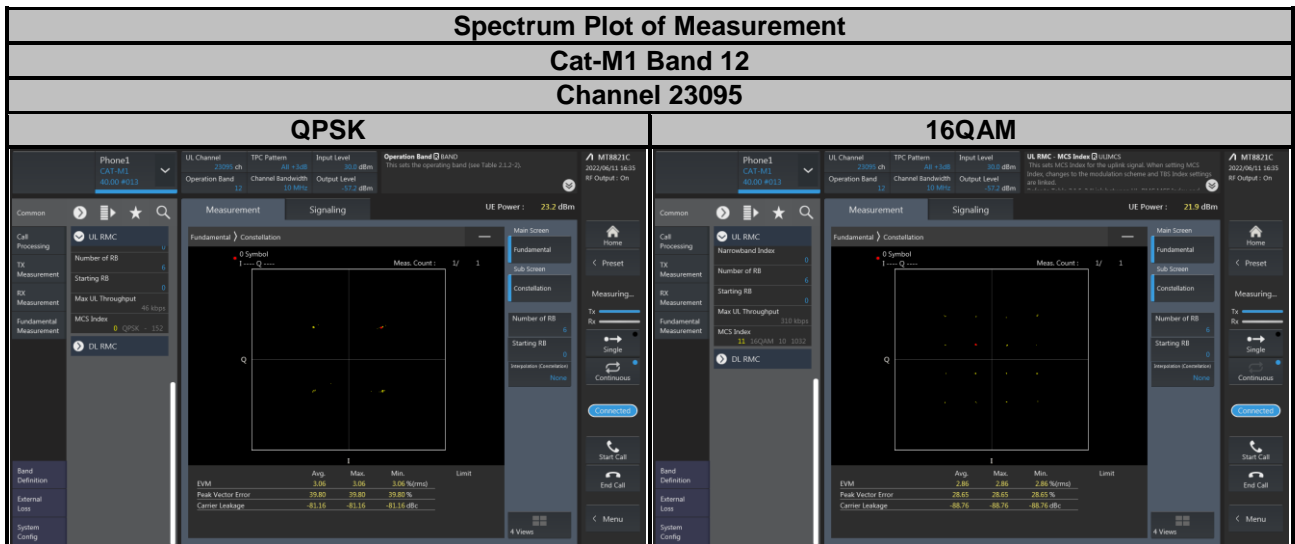
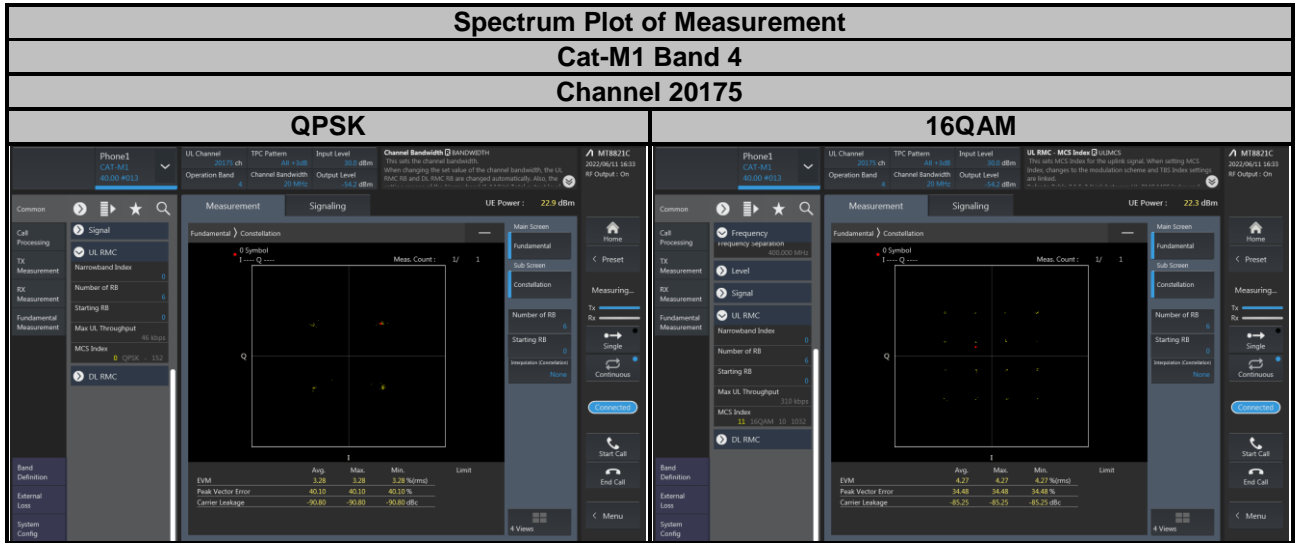
### 4.2.2 Test Setup



### 4.2.3 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.

### 4.2.4 Test Results



### 4.3 Frequency Stability Measurement

#### 4.3.1 Limits of Frequency Stability Measurement

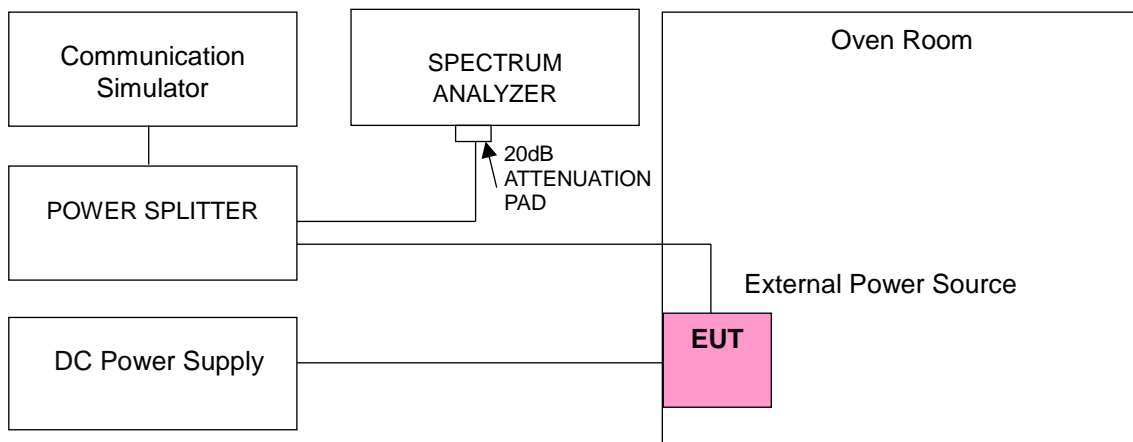
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

#### 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 Setup



#### 4.3.4 Test Results

##### Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1710.700002	0.001	1754.300004	0.002
3.7	1710.700003	0.002	1754.300004	0.002
4.2	1710.700003	0.002	1754.300002	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

##### Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1710.700003	0.002	1754.300004	0.002
-20	1710.700002	0.001	1754.300003	0.002
-10	1710.700002	0.001	1754.300004	0.002
0	1710.700003	0.002	1754.300001	0.001
10	1710.699997	-0.002	1754.299996	-0.002
20	1710.699996	-0.002	1754.299997	-0.002
30	1710.699996	-0.002	1754.299996	-0.002
40	1710.699998	-0.001	1754.299996	-0.002
50	1710.699998	-0.001	1754.299998	-0.001

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1711.500004	0.002	1753.500001	0.001
3.7	1711.500003	0.002	1753.500002	0.001
4.2	1711.500001	0.001	1753.500001	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1711.500003	0.002	1753.500002	0.001
-20	1711.500002	0.001	1753.500001	0.001
-10	1711.500004	0.002	1753.500001	0.001
0	1711.500003	0.002	1753.500003	0.002
10	1711.499999	-0.001	1753.499997	-0.002
20	1711.499998	-0.001	1753.499997	-0.002
30	1711.499999	-0.001	1753.499998	-0.001
40	1711.499996	-0.002	1753.499999	-0.001
50	1711.499996	-0.002	1753.499998	-0.001

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1712.500001	0.001	1752.500001	0.001
3.7	1712.500004	0.002	1752.500004	0.002
4.2	1712.500002	0.001	1752.500004	0.002

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1712.500004	0.002	1752.500001	0.001
-20	1712.500003	0.002	1752.500003	0.002
-10	1712.500004	0.002	1752.500003	0.002
0	1712.500003	0.002	1752.500001	0.001
10	1712.499999	-0.001	1752.499996	-0.002
20	1712.499999	-0.001	1752.499998	-0.001
30	1712.499997	-0.002	1752.499998	-0.001
40	1712.499998	-0.001	1752.499996	-0.002
50	1712.499999	-0.001	1752.499998	-0.001

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1715.000004	0.002	1750.000002	0.001
3.7	1715.000002	0.001	1750.000003	0.002
4.2	1715.000001	0.001	1750.000002	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1715.000001	0.001	1750.000004	0.002
-20	1715.000003	0.002	1750.000004	0.002
-10	1715.000003	0.002	1750.000003	0.002
0	1715.000001	0.001	1750.000004	0.002
10	1714.999999	-0.001	1749.999998	-0.001
20	1714.999996	-0.002	1749.999997	-0.002
30	1714.999997	-0.002	1749.999999	-0.001
40	1714.999996	-0.002	1749.999996	-0.002
50	1714.999998	-0.001	1749.999996	-0.002



## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 15 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1717.500001	0.001	1747.500001	0.001
3.7	1717.500003	0.002	1747.500001	0.001
4.2	1717.500001	0.001	1747.500004	0.002

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 15 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1717.500004	0.002	1747.500002	0.001
-20	1717.500004	0.002	1747.500001	0.001
-10	1717.500004	0.002	1747.500001	0.001
0	1717.500003	0.002	1747.500004	0.002
10	1717.499996	-0.002	1747.499997	-0.002
20	1717.499998	-0.001	1747.499998	-0.001
30	1717.499997	-0.002	1747.499996	-0.002
40	1717.499998	-0.001	1747.499996	-0.002
50	1717.499997	-0.002	1747.499999	-0.001

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 4			
	Channel Bandwidth: 20 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1720.000003	0.002	1745.000002	0.001
3.7	1720.000001	0.001	1745.000001	0.001
4.2	1720.000003	0.002	1745.000001	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 4			
	Channel Bandwidth: 20 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1720.000002	0.001	1745.000003	0.002
-20	1720.000001	0.001	1745.000002	0.001
-10	1720.000001	0.001	1745.000001	0.001
0	1720.000002	0.001	1745.000003	0.002
10	1719.999997	-0.002	1744.999997	-0.002
20	1719.999998	-0.001	1744.999998	-0.001
30	1719.999998	-0.001	1744.999999	-0.001
40	1719.999999	-0.001	1744.999999	-0.001
50	1719.999996	-0.002	1744.999997	-0.002

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 12			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	699.700004	0.006	715.300001	0.001
3.7	699.700003	0.004	715.300001	0.001
4.2	699.700003	0.004	715.300001	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 12			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	699.700003	0.004	715.300003	0.004
-20	699.700004	0.006	715.300001	0.001
-10	699.700004	0.006	715.300004	0.006
0	699.700004	0.006	715.300003	0.004
10	699.699998	-0.003	715.299997	-0.004
20	699.699996	-0.006	715.299996	-0.006
30	699.699996	-0.006	715.299996	-0.006
40	699.699999	-0.001	715.299999	-0.001
50	699.699996	-0.006	715.299999	-0.001

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 12			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	700.500004	0.006	714.500001	0.001
3.7	700.500004	0.006	714.500003	0.004
4.2	700.500002	0.003	714.500002	0.003

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 12			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	700.500001	0.001	714.500004	0.006
-20	700.500004	0.006	714.500004	0.006
-10	700.500001	0.001	714.500003	0.004
0	700.500003	0.004	714.500003	0.004
10	700.499997	-0.004	714.499996	-0.006
20	700.499997	-0.004	714.499999	-0.001
30	700.499999	-0.001	714.499996	-0.006
40	700.499997	-0.004	714.499997	-0.004
50	700.499997	-0.004	714.499996	-0.006

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 12			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	701.500002	0.003	713.500003	0.004
3.7	701.500004	0.006	713.500001	0.001
4.2	701.500004	0.006	713.500003	0.004

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 12			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	701.500004	0.006	713.500004	0.006
-20	701.500001	0.001	713.500001	0.001
-10	701.500002	0.003	713.500001	0.001
0	701.500001	0.001	713.500001	0.001
10	701.499999	-0.001	713.499996	-0.006
20	701.499999	-0.001	713.499996	-0.006
30	701.499996	-0.006	713.499998	-0.003
40	701.499999	-0.001	713.499997	-0.004
50	701.499997	-0.004	713.499998	-0.003

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 12			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	704.000002	0.003	711.000004	0.006
3.7	704.000004	0.006	711.000003	0.004
4.2	704.000004	0.006	711.000001	0.001

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 12			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	704.000002	0.003	711.000004	0.006
-20	704.000001	0.001	711.000002	0.003
-10	704.000003	0.004	711.000004	0.006
0	704.000004	0.006	711.000003	0.004
10	703.999996	-0.006	710.999998	-0.003
20	703.999997	-0.004	710.999996	-0.006
30	703.999998	-0.003	710.999999	-0.001
40	703.999997	-0.004	710.999999	-0.001
50	703.999997	-0.004	710.999997	-0.004

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 13			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	779.500004	0.005	784.500004	0.005
3.7	779.500004	0.005	784.500001	0.001
4.2	779.500003	0.004	784.500004	0.005

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 13			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	779.500001	0.001	784.500003	0.004
-20	779.500004	0.005	784.500001	0.001
-10	779.500002	0.003	784.500001	0.001
0	779.500001	0.001	784.500002	0.003
10	779.499999	-0.001	784.499999	-0.001
20	779.499998	-0.003	784.499996	-0.005
30	779.499996	-0.005	784.499999	-0.001
40	779.499998	-0.003	784.499997	-0.004
50	779.499997	-0.004	784.499998	-0.003

## Frequency Error vs. Voltage

Voltage (Volts)	Cat-M1 Band 13	
	Channel Bandwidth: 10 MHz	
	Frequency (MHz)	Frequency Error (ppm)
3.1	782.000001	0.001
3.7	782.000001	0.001
4.2	782.000002	0.003

**Note:** The applicant defined the normal working voltage of the battery is from 3.1 Vdc to 4.2 Vdc.

## Frequency Error vs. Temperature

Temp. (°C)	Cat-M1 Band 13	
	Channel Bandwidth: 10 MHz	
	Frequency (MHz)	Frequency Error (ppm)
-30	782.000004	0.005
-20	782.000001	0.001
-10	782.000003	0.004
0	782.000004	0.005
10	781.999996	-0.005
20	781.999998	-0.003
30	781.999996	-0.005
40	781.999997	-0.004
50	781.999998	-0.003



## 4.4 Occupied Bandwidth Measurement

### 4.4.1 Limits of Occupied Bandwidth Measurement

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

### 4.4.2 Test Procedure

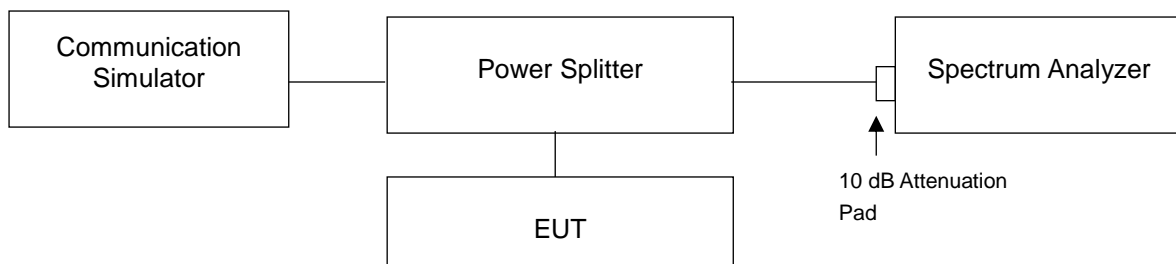
The EUT makes a call to the communication simulator. All measurements were done at low, middle and high operational frequency range. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency.

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

- a) 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.
- b) The nominal RBW shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set  $\geq 3 \times$  RBW.
- c) 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.
- d) 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.
- e) Set spectrum analyzer detection mode to peak, and the trace mode to max hold.
- f) 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).
- g) 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.
- h) 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.
- i) 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).

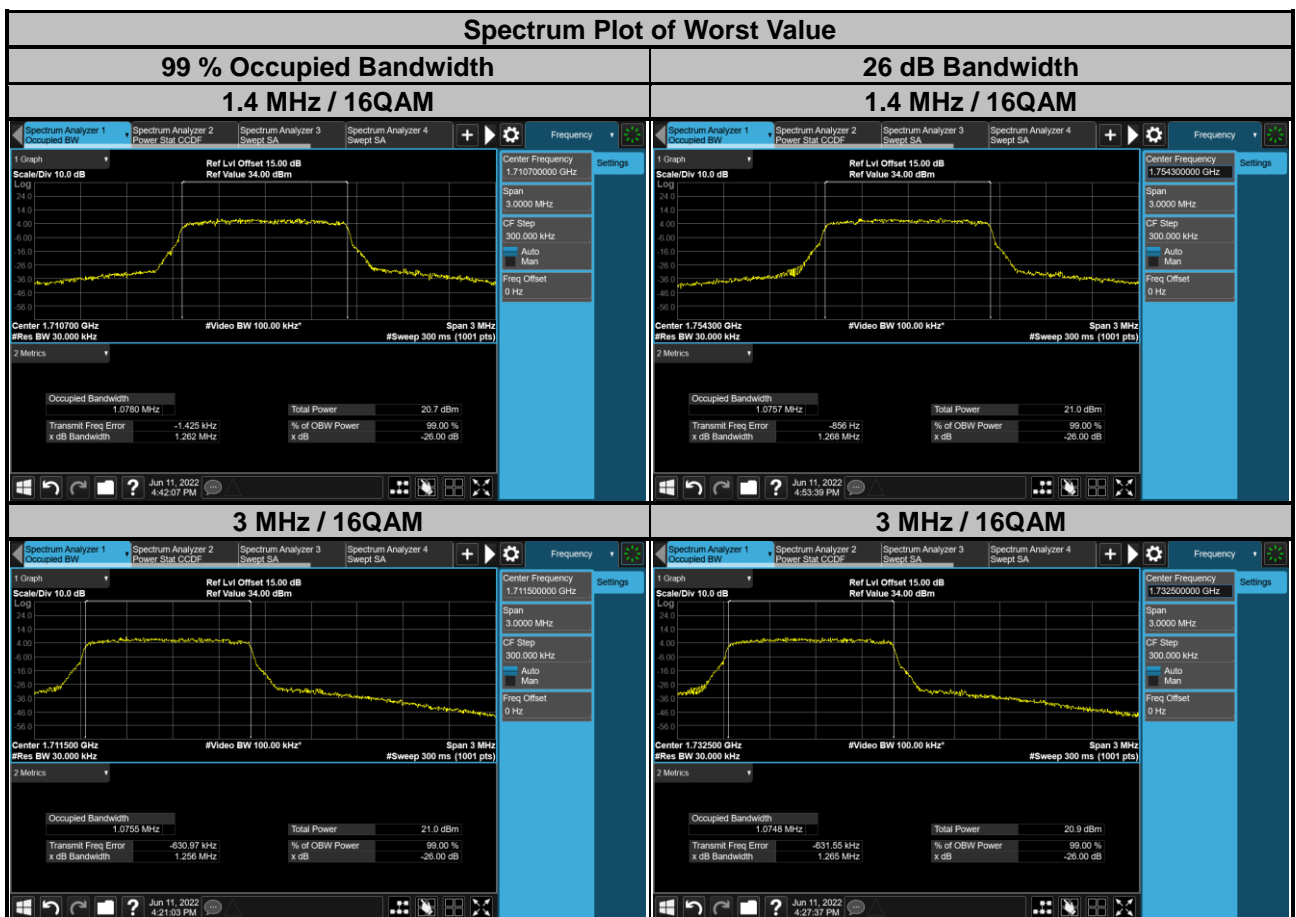
For the occupied bandwidth measurement method, please refer to section 5.4.4 of ANSI C63.26.

### 4.4.3 Test Setup



#### 4.4.4 Test Result

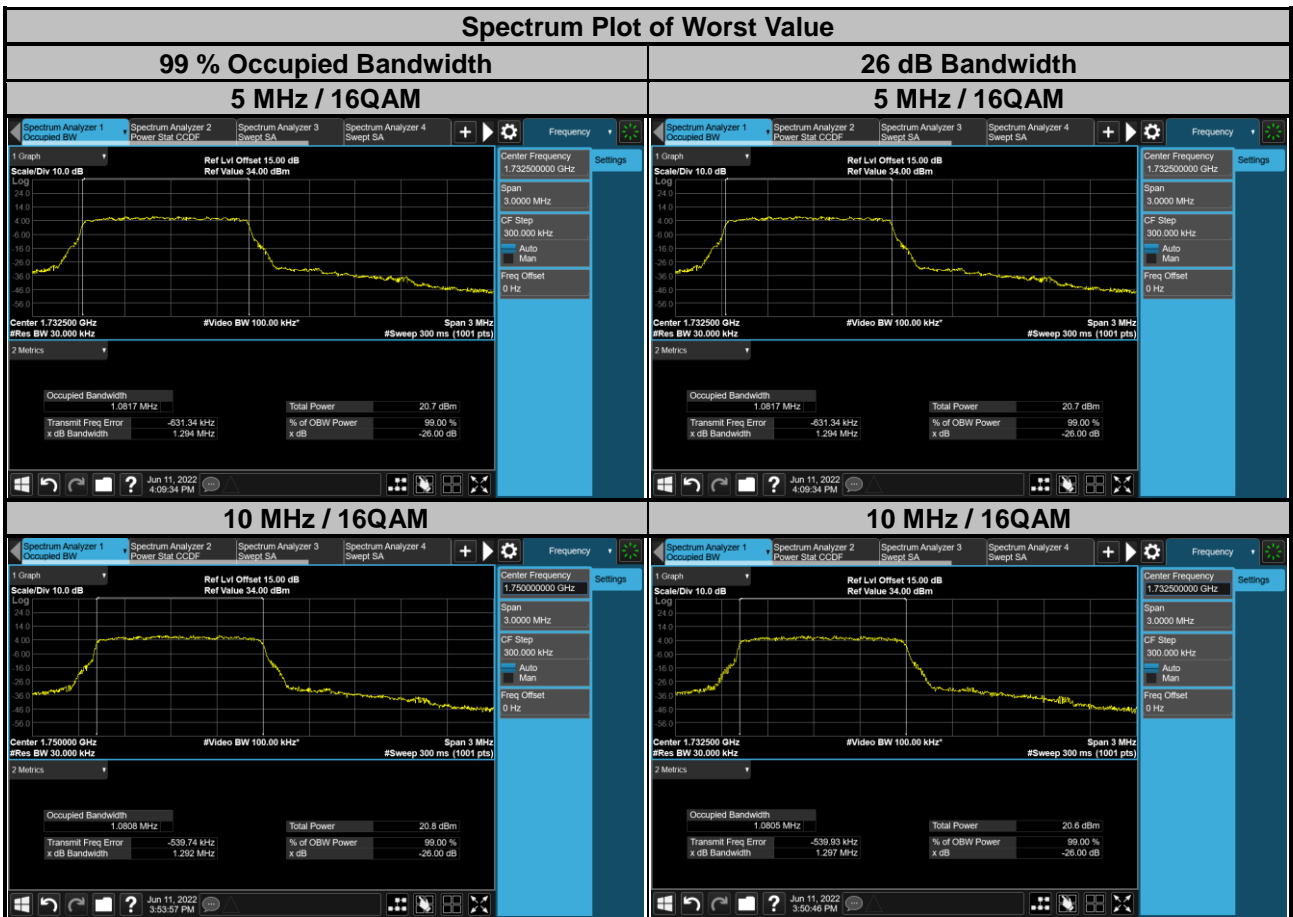
Cat-M1 Band 4					
Channel Bandwidth: 1.4 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
19957	1710.7	1.07	1.08	1.26	1.26
20175	1732.5	1.07	1.08	1.26	1.26
20393	1754.3	1.07	1.07	1.25	1.27
Channel Bandwidth: 3 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
19965	1711.5	1.08	1.08	1.26	1.26
20175	1732.5	1.07	1.07	1.25	1.27
20385	1753.5	1.07	1.07	1.25	1.26



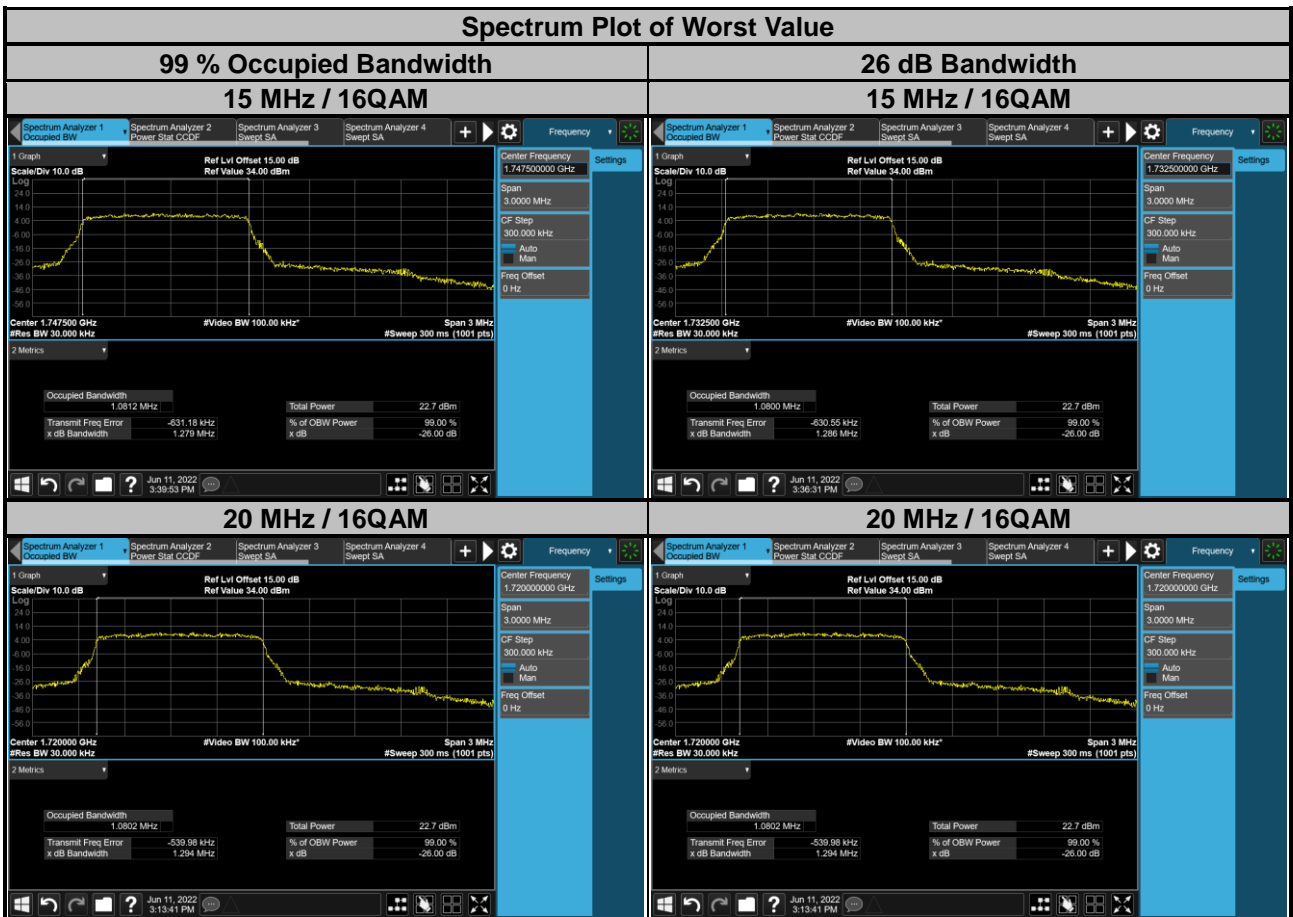
Cat-M1 Band 4					
Channel Bandwidth: 5 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
19975	1712.5	1.08	1.08	1.26	1.28
20175	1732.5	1.08	1.08	1.27	1.29
20375	1752.5	1.07	1.08	1.27	1.29

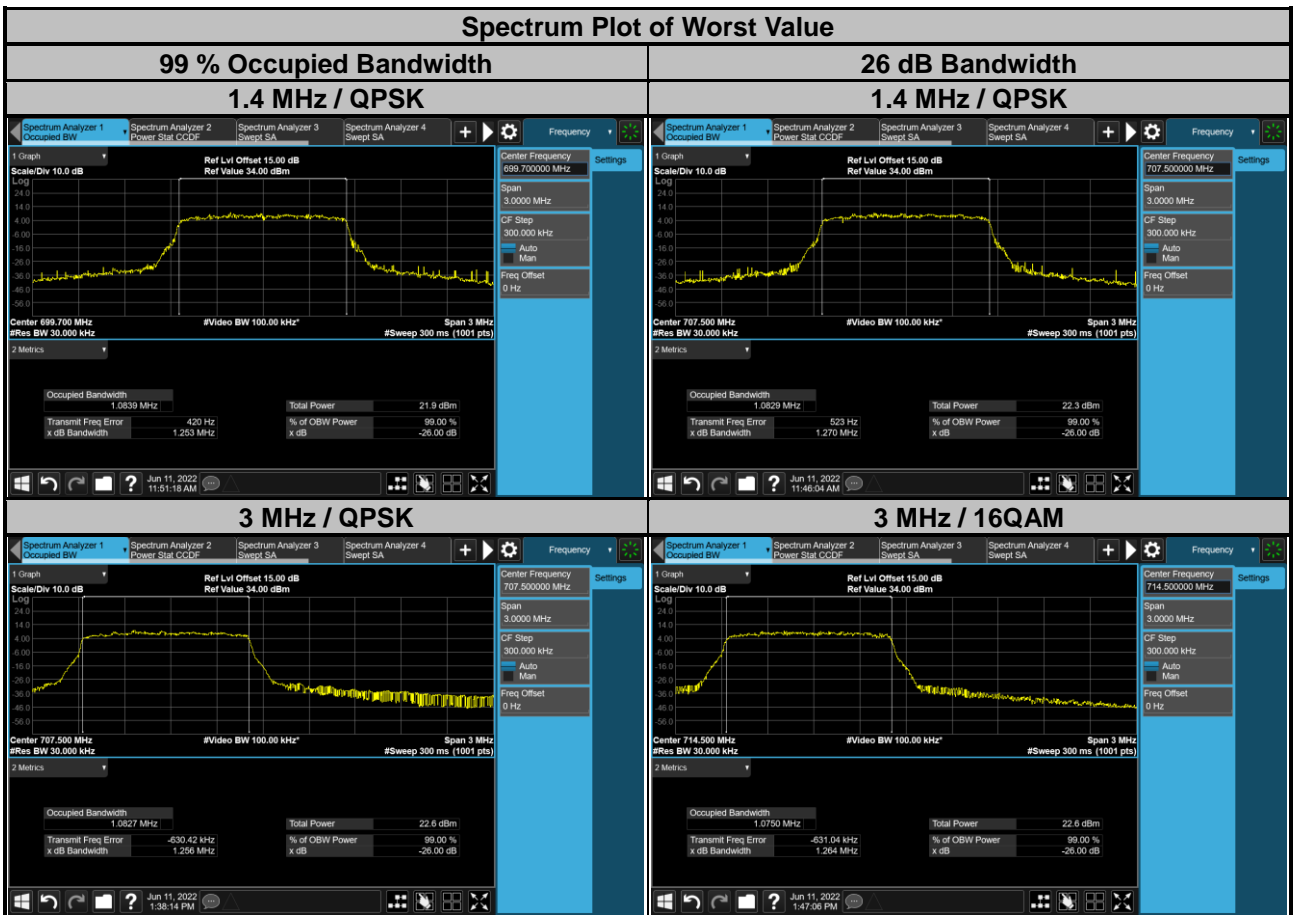
Channel Bandwidth: 10 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
20000	1715.0	1.08	1.08	1.25	1.30
20175	1732.5	1.08	1.08	1.25	1.30
20350	1750.0	1.08	1.08	1.25	1.29



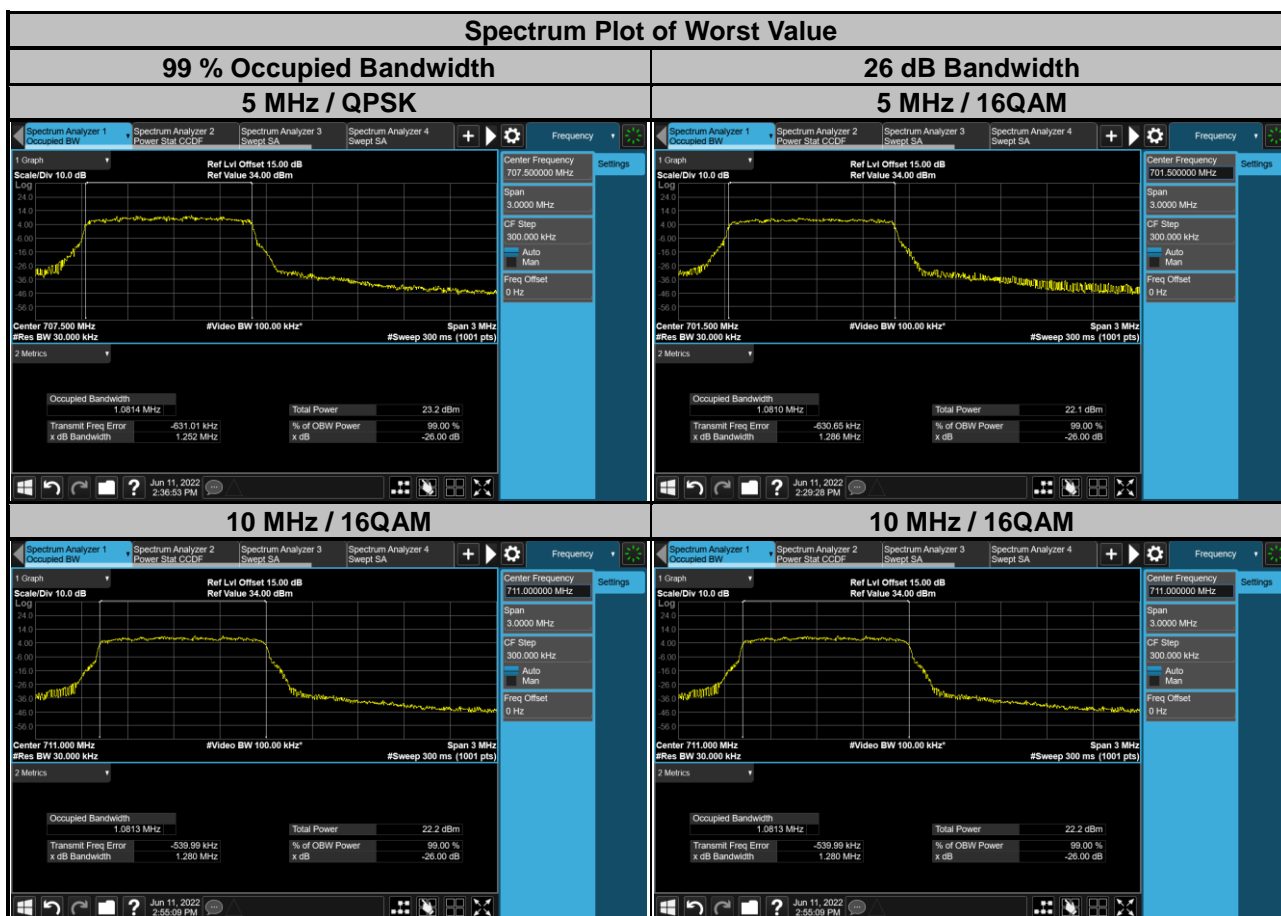
Cat-M1 Band 4					
Channel Bandwidth: 15 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
20025	1717.5	1.08	1.08	1.26	1.27
20175	1732.5	1.08	1.08	1.26	1.29
20325	1747.5	1.08	1.08	1.26	1.28
Channel Bandwidth: 20 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
20050	1720.0	1.08	1.08	1.25	1.29
20175	1732.5	1.08	1.08	1.26	1.29
20300	1745.0	1.08	1.08	1.26	1.29



Cat-M1 Band 12					
Channel Bandwidth: 1.4 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23017	699.7	1.08	1.08	1.25	1.26
23095	707.5	1.08	1.08	1.27	1.26
23173	715.3	1.08	1.07	1.26	1.26
Channel Bandwidth: 3 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23025	700.5	1.08	1.08	1.25	1.26
23095	707.5	1.08	1.07	1.26	1.26
23165	714.5	1.08	1.08	1.26	1.26



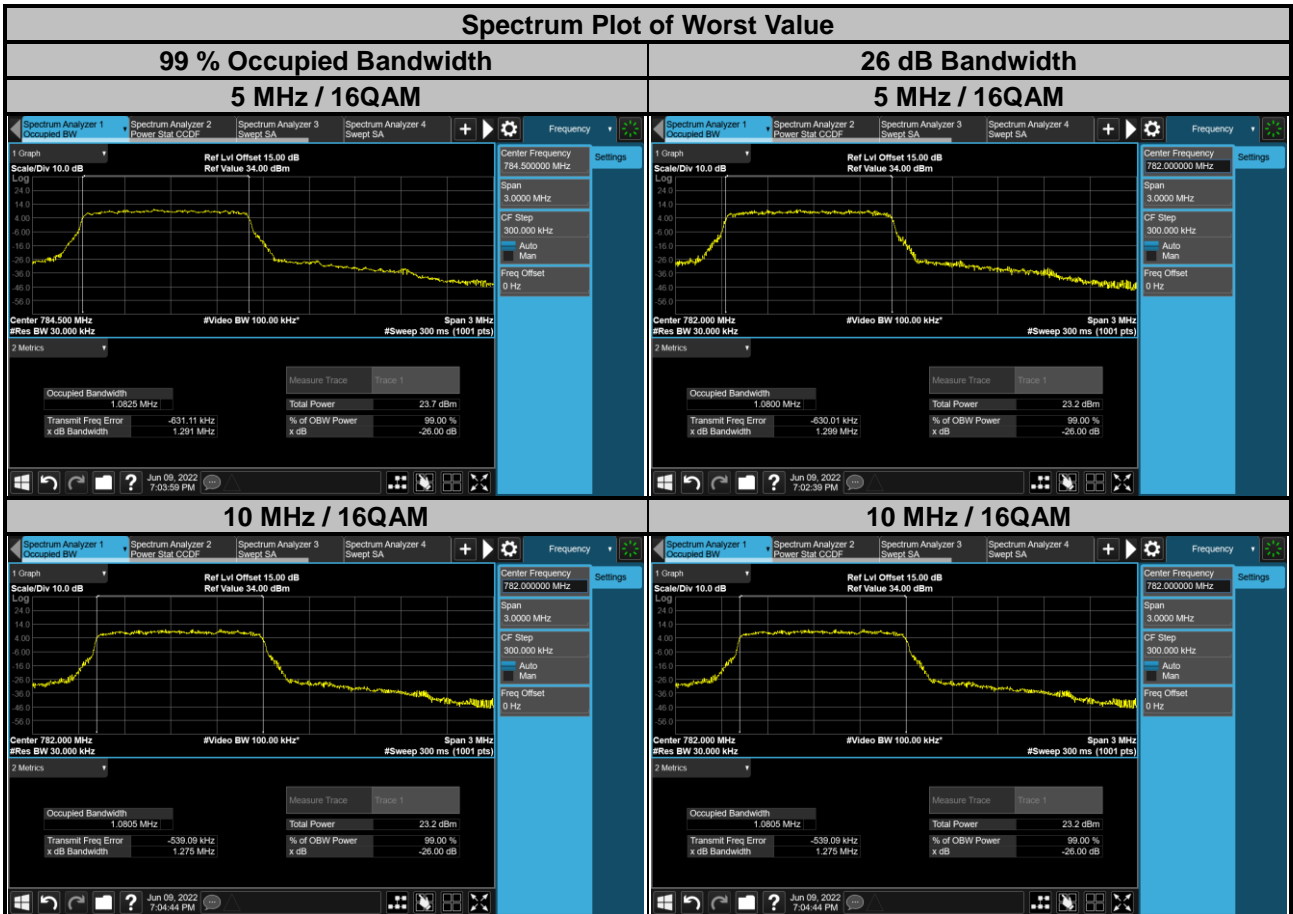
Cat-M1 Band 12					
Channel Bandwidth: 5 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23035	701.5	1.08	1.08	1.26	1.29
23095	707.5	1.08	1.08	1.25	1.28
23155	713.5	1.08	1.08	1.27	1.26
Channel Bandwidth: 10 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23060	704.0	1.08	1.08	1.25	1.28
23095	707.5	1.07	1.08	1.26	1.28
23130	711.0	1.08	1.08	1.26	1.28



Cat-M1 Band 13					
Channel Bandwidth: 5 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23205	779.5	1.08	1.08	1.27	1.28
23230	782.0	1.08	1.08	1.26	1.30
23255	784.5	1.08	1.08	1.27	1.29

Channel Bandwidth: 10 MHz					
Channel	Frequency (MHz)	99 % Occupied Bandwidth (MHz)		26 dB Bandwidth (MHz)	
		QPSK	16QAM	QPSK	16QAM
23230	782.0	1.08	1.08	1.26	1.28



## 4.5 Band Edge Measurement

### 4.5.1 Limits of Band Edge Measurement

For Cat-M1 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 Cat-M1 Band 12:

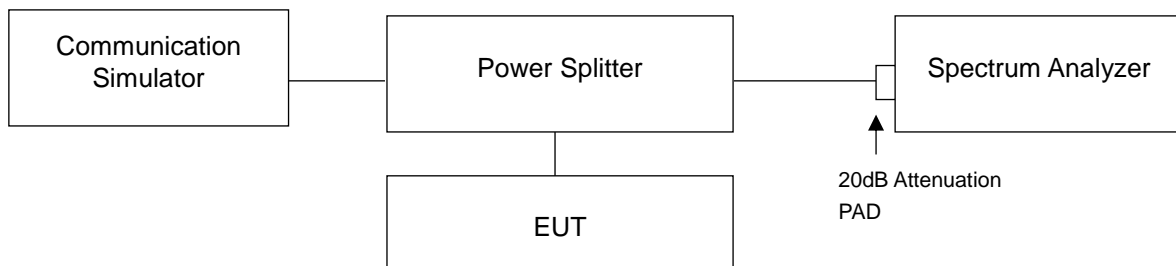
According to FCC 27.53(g), for operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  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 Cat-M1 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

- a. All measurements were done at low and high operational frequency range.
- b. The center frequency of spectrum is the band edge frequency and span is 1 MHz. RB of the spectrum is 15 kHz and VB of the spectrum is 51 kHz (Cat-M1 Band 4).
- c. The center frequency of spectrum is the band edge frequency and span is 1 MHz. RB of the spectrum is 30 kHz and VB of the spectrum is 100 kHz (Cat-M1 Band 12).
- d. For Cat-M1 Band 13 measurements in the 763 - 775 MHz and 793 - 805 MHz band, the FCC limit is  $65 + 10 \log (P[\text{watt}])$  in a 6.25 kHz bandwidth. Since it was not possible to set the resolution bandwidth to 6.25 kHz with the available equipment, a bandwidth of 6.8 kHz was used instead to show compliance, and the correction factor is compensated at the spectrum.
- e. Record the max. trace plot into the test report.