FCC Test Report

(PART 24–Cat-M1 B2)

Report No.:	RFBEIH-WTW-P22050972
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 / Designation Number:	788550 / TW0003 281270 / TW0032

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Release Control Record

Issue No.	Description	Date Issued
RFBEIH-WTW-P22050972	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 24, Subpart E

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 24 & Part 2			
FCC Clause	**Test Item**	**Result**	**Remarks**
2.1046 24.232	Equivalent Isotropic Radiated Power	Pass	Meet the requirement of limit.
2.1047	Modulation Characteristics	Pass	Meet the requirement.
24.232(d)	Peak to Average Ratio	Pass	Meet the requirement of limit.
2.1055 24.235	Frequency Stability	Pass	Meet the requirement of limit.
2.1049	Occupied Bandwidth	Pass	Meet the requirement of limit.
24.238	Band Edge Measurements	Pass	Meet the requirement of limit.
2.1051 24.238	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 24.238	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -29.33 dB at 3760.00 MHz.and 3815.00 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) (±)
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

Product	Airfinder Rechargeable SuperTag		
Brand	Sercomm, AirFinder		
Test Model	LL-AF2-ST-SM-RTK02		
Series Model	SM-RTK02		
Model Difference	Refer to Note as below		
Status of EUT	Engineering Sample		
Power Supply Rating	5 Vdc (adapter) 3.7 Vdc (Li-ion battery)		
Modulation Type	Cat-M1	QPSK, 16QAM	
Frequency Range	Cat-M1Band 2 (Channel Bandwidth: 1.4 MHz)	1850.7 ~ 1909.3 MHz	
	Cat-M1 Band 2 (Channel Bandwidth: 3 MHz)	1851.5 ~ 1908.5 MHz	
	Cat-M1 Band 2 (Channel Bandwidth: 5 MHz)	1852.5 ~ 1907.5 MHz	
	Cat-M1 Band 2 (Channel Bandwidth: 10 MHz)	1855.0 ~ 1905.0 MHz	
	Cat-M1 Band 2 (Channel Bandwidth: 15 MHz)	1857.5 ~ 1902.5 MHz	
	Cat-M1 Band 2 (Channel Bandwidth: 20 MHz)	1860.0 ~ 1900.0 MHz	
Max. EIRP Power		QPSK	16QAM
	Cat-M1 Band 2 (Channel Bandwidth: 1.4 MHz)	287.740 mW (24.59 dBm)	217.771 mW (23.38 dBm)
	Cat-M1 Band 2 (Channel Bandwidth: 3 MHz)	283.139 mW (24.52 dBm)	218.776 mW (23.40 dBm)
	Cat-M1 Band 2 (Channel Bandwidth: 5 MHz)	287.078 mW (24.58 dBm)	277.332 mW (24.43 dBm)
	Cat-M1 Band 2 (Channel Bandwidth: 10 MHz)	285.759 mW (24.56 dBm)	277.971 mW (24.44 dBm)
	Cat-M1 Band 2 (Channel Bandwidth: 15 MHz)	299.226 mW (24.76 dBm)	279.254 mW (24.46 dBm)
	Cat-M1 Band 2 (Channel Bandwidth: 20 MHz)	301.995 mW (24.80 dBm)	285.102 mW (24.55 dBm)
Emission Designator	Cat-M1 Band 2 (Channel Bandwidth: 1.4 MHz)	1M08D7W	
	Cat-M1 Band 2 (Channel Bandwidth: 3 MHz)	1M08D7W	
	Cat-M1 Band 2 (Channel Bandwidth: 5 MHz)	1M08D7W	
	Cat-M1 Band 2 (Channel Bandwidth: 10 MHz)	1M08D7W	
	Cat-M1 Band 2 (Channel Bandwidth: 15 MHz)	1M08D7W	
	Cat-M1 Band 2 (Channel Bandwidth: 20 MHz)	1M08D7W	
Antenna Type	Monopole Antenna with 1.4 dBi gain		
Accessory Device	N/A		
Data Cable Supplied	N/A		

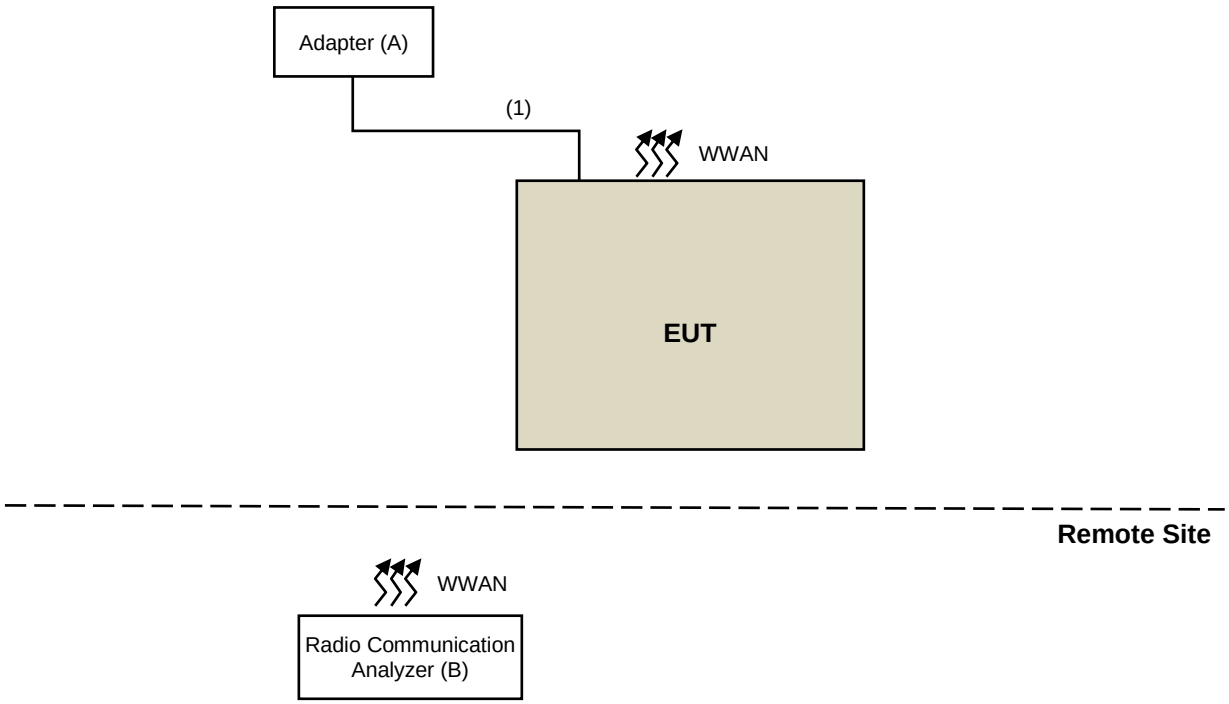
Note:

1. All models are listed as below.

Model	Difference
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



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 2	X-plane

Cat M1 Band 2

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	EIRP	18607 to 19193	18607, 18900, 19193	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		18615 to 19185	18615, 18900, 19185	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		18625 to 19175	18625, 18900, 19175	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		18650 to 19150	18650, 18900, 19150	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		18675 to 19125	18675, 18900, 19125	15 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
		18700 to 19100	18700, 18900, 19100	20 MHz	QPSK, 16QAM	1 RB / 0 RB Offset 1 RB / 6 RB Offset 6 RB / 0 RB Offset
-	Modulation Characteristics	18700 to 19100	18900	20 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Frequency Stability	18607 to 19193	18607, 19193	1.4 MHz	QPSK	1 RB / 0 RB Offset
		18615 to 19185	18615, 19185	3 MHz	QPSK	1 RB / 0 RB Offset
		18625 to 19175	18625, 19175	5 MHz	QPSK	1 RB / 0 RB Offset
		18650 to 19150	18650, 19150	10 MHz	QPSK	1 RB / 0 RB Offset
		18675 to 19125	18675, 19125	15 MHz	QPSK	1 RB / 0 RB Offset
		18700 to 19100	18700, 19100	20 MHz	QPSK	1 RB / 0 RB Offset
-	Occupied Bandwidth	18607 to 19193	18607, 18900, 19193	1.4 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		18615 to 19185	18615, 18900, 19185	3 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		18625 to 19175	18625, 18900, 19175	5 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		18650 to 19150	18650, 18900, 19150	10 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		18675 to 19125	18675, 18900, 19125	15 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
		18700 to 19100	18700, 18900, 19100	20 MHz	QPSK, 16QAM	6 RB / 0 RB Offset
-	Peak to Average Ratio	18607 to 19193	18607, 18900, 19193	1.4 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		18615 to 19185	18615, 18900, 19185	3 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		18625 to 19175	18625, 18900, 19175	5 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		18650 to 19150	18650, 18900, 19150	10 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		18675 to 19125	18675, 18900, 19125	15 MHz	QPSK, 16QAM	1 RB / 0 RB Offset
		18700 to 19100	18700, 18900, 19100	20 MHz	QPSK, 16QAM	1 RB / 0 RB Offset

EUT Configure Mode	Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation	Mode
-	Band Edge	18607 to 19193	18607	1.4 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19193	1.4 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
		18615 to 19185	18615	3 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19185	3 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
		18625 to 19175	18625	5 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19175	5 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
		18650 to 19150	18650	10 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19150	10 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
		18675 to 19125	18675	15 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19125	15 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
		18700 to 19100	18700	20 MHz	QPSK	1 RB / 0 RB Offset
						6 RB / 0 RB Offset
			19100	20 MHz	QPSK	1 RB / 5 RB Offset
						6 RB / 0 RB Offset
-	Conducted Emission	18607 to 19193	18607, 18900, 19193	1.4 MHz	QPSK	1 RB / 0 RB Offset
		18615 to 19185	18615, 18900, 19185	3 MHz	QPSK	1 RB / 0 RB Offset
		18625 to 19175	18625, 18900, 19175	5 MHz	QPSK	1 RB / 0 RB Offset
		18650 to 19150	18650, 18900, 19150	10 MHz	QPSK	1 RB / 0 RB Offset
		18675 to 19125	18675, 18900, 19125	15 MHz	QPSK	1 RB / 0 RB Offset
		18700 to 19100	18700, 18900, 19100	20 MHz	QPSK	1 RB / 0 RB Offset
-	Radiated Emission	18607 to 19193	18607, 18900, 19193	1.4 MHz	QPSK	1 RB / 0 RB Offset
		18625 to 19175	18625, 18900, 19175	5 MHz	QPSK	1 RB / 0 RB Offset
		18700 to 19100	18700, 18900, 19100	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. Therefore, only EIRP, modulation characteristics, occupied bandwidth and peak to average ratio items had been tested under QPSK, 16QAM mode, the other items were performed under QPSK mode only.
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.
3. For radiated emissions below 1 GHz, select the worst radiated emission channel for final testing.

Test Condition:

Test Item	Environmental Conditions	Input Power	Tested By
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 24
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

Mobile / Portable station are limited to 2 watts e.i.r.p.

4.1.2 Test Procedures

Conducted Power Measurement:

The EUT was set up for the maximum power with Cat M1 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:

$EIRP = P_{Meas} + G_T$

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

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)

Cat M1 Band 2						
BW	**MCS Index**	**RB Size**	**RB Offset**	**Low**	**Mid**	**High**
		Channel		**18607**	**18900**	**19193**
		Frequency (MHz)		**1850.7**	**1880**	**1909.3**
1.4M	QPSK	1	0	22.84	**23.19**	23.03
		1	6	22.80	23.09	23.02
		6	0	20.67	20.92	20.89
	16QAM	1	0	21.53	21.85	21.86
		1	6	21.63	**21.98**	21.97
		6	0	20.57	20.92	20.90
W	**MCS Index**	**Channel**		**18615**	**18900**	**19185**
		Frequency (MHz)		**1851.5**	**1880**	**1908.5**
3M	QPSK	1	0	22.89	**23.12**	22.95
		1	6	22.74	22.92	22.93
		6	0	20.88	21.16	21.09
	16QAM	1	0	21.65	21.89	21.87
		1	6	21.76	**22.00**	21.96
		6	0	20.81	21.17	21.05
BW	**MCS Index**	**Channel**		**18625**	**18900**	**19175**
		Frequency (MHz)		**1852.5**	**1880**	**1907.5**
5M	QPSK	1	0	22.65	23.09	23.05
		1	6	22.73	**23.18**	23.16
		6	0	22.07	22.33	22.39
	16QAM	1	0	22.66	22.98	23.00
		1	6	22.65	22.99	**23.03**
		6	0	20.14	20.38	20.34
BW	**MCS Index**	**Channel**		**18650**	**18900**	**19150**
		Frequency (MHz)		**1855**	**1880**	**1905**
10M	QPSK	1	0	22.84	23.15	23.06
		1	6	22.94	23.05	**23.16**
		6	0	22.08	22.33	22.36
	16QAM	1	0	22.74	23.03	23.01
		1	6	22.73	22.99	**23.04**
		6	0	20.19	20.27	20.35

Cat M1 Band 2						
BW	**MCS Index**	**Channel**		**18675**	**18900**	**19125**
		Frequency (MHz)		**1857.5**	**1880**	**1902.5**
15M	QPSK	1	0	22.78	23.07	23.09
		1	6	22.87	23.17	23.19
		6	0	22.96	23.26	**23.36**
	16QAM	1	0	22.72	22.99	**23.06**
		1	6	22.72	22.95	23.02
		6	0	22.30	22.44	22.54
BW	**MCS Index**	**Channel**		**18700**	**18900**	**19100**
		Frequency (MHz)		**1860**	**1880**	**1900**
20M	QPSK	1	0	22.76	23.07	23.25
		1	6	22.91	23.17	23.28
		6	0	23.01	23.24	**23.40**
	16QAM	1	0	22.78	22.87	**23.15**
		1	6	22.75	22.91	23.11
		6	0	22.27	22.36	22.45

EIRP Power (dBm)

Cat M1 Band 2						
BW	**MCS Index**	**RB Size**	**RB Offset**	**Low**	**Mid**	**High**
		Channel		**18607**	**18900**	**19193**
		Frequency (MHz)		**1850.7**	**1880**	**1909.3**
1.4M	QPSK	1	0	24.24	**24.59**	24.43
		1	6	24.20	24.49	24.42
		6	0	22.07	22.32	22.29
	16QAM	1	0	22.93	23.25	23.26
		1	6	23.03	**23.38**	23.37
		6	0	21.97	22.32	22.30
BW	**MCS Index**	**Channel**		**18615**	**18900**	**19185**
		Frequency (MHz)		**1851.5**	**1880**	**1908.5**
3M	QPSK	1	0	24.29	**24.52**	24.35
		1	6	24.14	24.32	24.33
		6	0	22.28	22.56	22.49
	16QAM	1	0	23.05	23.29	23.27
		1	6	23.16	**23.40**	23.36
		6	0	22.21	22.57	22.45
BW	**MCS Index**	**Channel**		**18625**	**18900**	**19175**
		Frequency (MHz)		**1852.5**	**1880**	**1907.5**
5M	QPSK	1	0	24.05	24.49	24.45
		1	6	24.13	**24.58**	24.56
		6	0	23.47	23.73	23.79
	16QAM	1	0	24.06	24.38	24.40
		1	6	24.05	24.39	**24.43**
		6	0	21.54	21.78	21.74
BW	**MCS Index**	**Channel**		**18650**	**18900**	**19150**
		Frequency (MHz)		**1855**	**1880**	**1905**
10M	QPSK	1	0	24.24	24.55	24.46
		1	6	24.34	24.45	**24.56**
		6	0	23.48	23.73	23.76
	16QAM	1	0	24.14	24.43	24.41
		1	6	24.13	24.39	**24.44**
		6	0	21.59	21.67	21.75

*EIRP = Conducted + antenna gain (1.4dBi)

Cat M1 Band 2						
BW	**MCS Index**	**Channel**		**18675**	**18900**	**19125**
		Frequency (MHz)		**1857.5**	**1880**	**1902.5**
15M	QPSK	1	0	24.18	24.47	24.49
		1	6	24.27	24.57	24.59
		6	0	24.36	24.66	**24.76**
	16QAM	1	0	24.12	24.39	**24.46**
		1	6	24.12	24.35	24.42
		6	0	23.70	23.84	23.94
BW	**MCS Index**	**Channel**		**18700**	**18900**	**19100**
		Frequency (MHz)		**1860**	**1880**	**1900**
20M	QPSK	1	0	24.16	24.47	24.65
		1	6	24.31	24.57	24.68
		6	0	24.41	24.64	**24.80**
	16QAM	1	0	24.18	24.27	**24.55**
		1	6	24.15	24.31	24.51
		6	0	23.67	23.76	23.85

*EIRP = Conducted + antenna gain (1.4dBi)

4.2 Modulation Characteristics Measurement

4.2.1 Limits of Modulation Characteristics

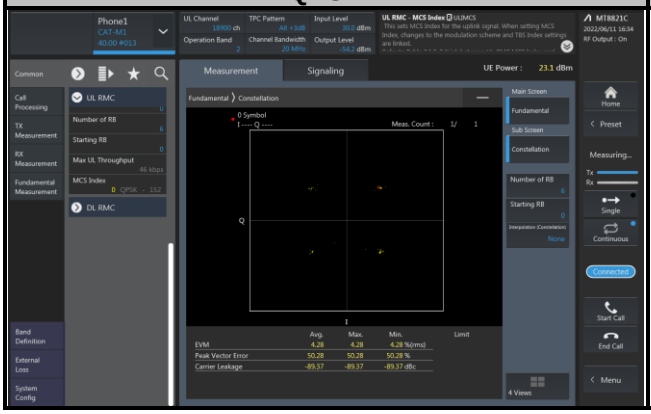
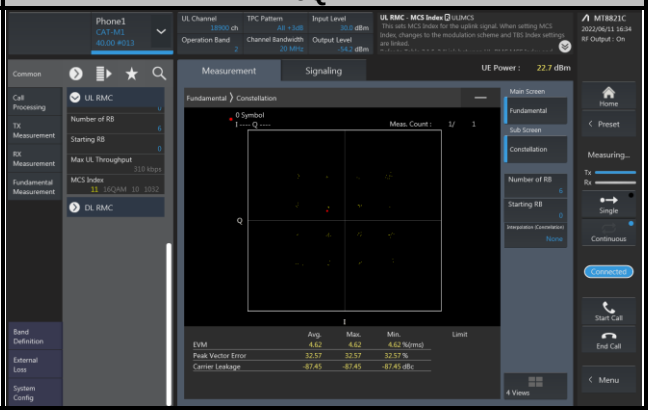
N/A

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

Spectrum Plot of Measurement	
Cat M1 Band 2	
Channel 18900	
QPSK	16QAM
	

4.3 Frequency Stability Measurement

4.3.1 Limits of Frequency Stability Measurement

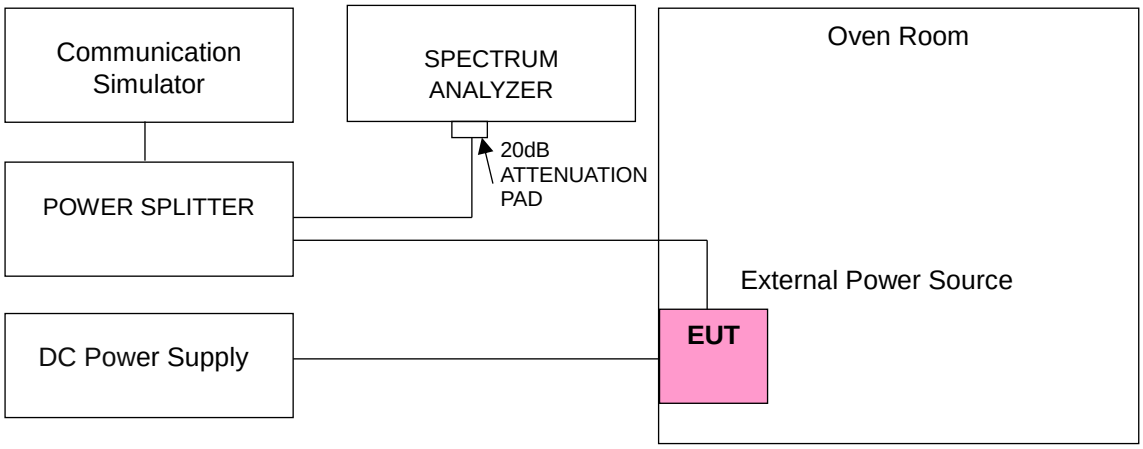
The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

4.3.2 Test Procedure

a. 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.
b. 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.
c. The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the ±0.5℃ 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 2			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1850.700004	0.002	1909.300000	0.001
3.7	1850.700004	0.002	1909.300004	0.002
4.2	1850.700003	0.002	1909.300001	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 1.4 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1850.700001	0.001	1909.300004	0.002
-20	1850.700003	0.002	1909.300003	0.002
-10	1850.700002	0.001	1909.300004	0.002
0	1850.700001	0.001	1909.300002	0.001
10	1850.699998	-0.001	1909.299997	-0.002
20	1850.699997	-0.002	1909.299999	-0.001
30	1850.699996	-0.002	1909.299997	-0.002
40	1850.699999	-0.001	1909.299998	-0.001
50	1850.699999	-0.001	1909.299996	-0.002

Frequency Error vs. Voltage

Voltage (Volts)	Cat M1 Band 2			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1851.500004	0.002	1908.500002	0.001
3.7	1851.500004	0.002	1908.500003	0.002
4.2	1851.500003	0.002	1908.500001	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 3 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1851.500003	0.002	1908.500002	0.001
-20	1851.500001	0.001	1908.500001	0.001
-10	1851.500004	0.002	1908.500001	0.001
0	1851.500001	0.001	1908.500004	0.002
10	1851.499999	-0.001	1908.499996	-0.002
20	1851.499999	-0.001	1908.499998	-0.001
30	1851.499999	-0.001	1908.499996	-0.002
40	1851.499996	-0.002	1908.499999	-0.001
50	1851.499998	-0.001	1908.499998	-0.001

Frequency Error vs. Voltage

Voltage (Volts)	Cat M1 Band 2			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1852.500003	0.002	1907.500004	0.002
3.7	1852.500004	0.002	1907.500003	0.002
4.2	1852.500003	0.002	1907.500002	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 5 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1852.500003	0.002	1907.500003	0.002
-20	1852.500003	0.002	1907.500003	0.002
-10	1852.500002	0.001	1907.500002	0.001
0	1852.500003	0.002	1907.500002	0.001
10	1852.499998	-0.001	1907.499997	-0.002
20	1852.499999	-0.001	1907.499999	-0.001
30	1852.499999	-0.001	1907.499997	-0.002
40	1852.499998	-0.001	1907.499996	-0.002
50	1852.499996	-0.002	1907.499999	-0.001

Frequency Error vs. Voltage

Voltage (Volts)	Cat M1 Band 2			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1855.000001	0.001	1905.000004	0.002
3.7	1855.000004	0.002	1905.000001	0.001
4.2	1855.000004	0.002	1905.000001	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 10 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1855.000001	0.001	1905.000004	0.002
-20	1855.000001	0.001	1905.000002	0.001
-10	1855.000003	0.002	1905.000001	0.001
0	1855.000001	0.001	1905.000004	0.002
10	1854.999996	-0.002	1904.999998	-0.001
20	1854.999999	-0.001	1904.999997	-0.002
30	1854.999999	-0.001	1904.999998	-0.001
40	1854.999997	-0.002	1904.999998	-0.001
50	1854.999999	-0.001	1904.999998	-0.001

Frequency Error vs. Voltage

Voltage (Volts)	Cat M1 Band 2			
	Channel Bandwidth: 15 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1857.500002	0.001	1902.500003	0.002
3.7	1857.500003	0.002	1902.500002	0.001
4.2	1857.500001	0.001	1902.500002	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 15 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1857.500004	0.002	1902.500001	0.001
-20	1857.500004	0.002	1902.500003	0.002
-10	1857.500003	0.002	1902.500002	0.001
0	1857.500002	0.001	1902.500004	0.002
10	1857.499999	-0.001	1902.499998	-0.001
20	1857.499997	-0.002	1902.499996	-0.002
30	1857.499996	-0.002	1902.499998	-0.001
40	1857.499999	-0.001	1902.499997	-0.002
50	1857.499996	-0.002	1902.499996	-0.002

Frequency Error vs. Voltage

Voltage (Volts)	Cat M1 Band 2			
	Channel Bandwidth: 20 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
3.1	1860.000003	0.002	1900.000002	0.001
3.7	1860.000003	0.002	1900.000002	0.001
4.2	1860.000003	0.002	1900.000002	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. (℃)	Cat M1 Band 2			
	Channel Bandwidth: 20 MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
-30	1860.000002	0.001	1900.000003	0.002
-20	1860.000003	0.002	1900.000002	0.001
-10	1860.000001	0.001	1900.000001	0.001
0	1860.000003	0.002	1900.000001	0.001
10	1859.999996	-0.002	1899.999996	-0.002
20	1859.999998	-0.001	1899.999997	-0.002
30	1859.999996	-0.002	1899.999997	-0.002
40	1859.999996	-0.002	1899.999999	-0.001
50	1859.999998	-0.001	1899.999997	-0.002

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

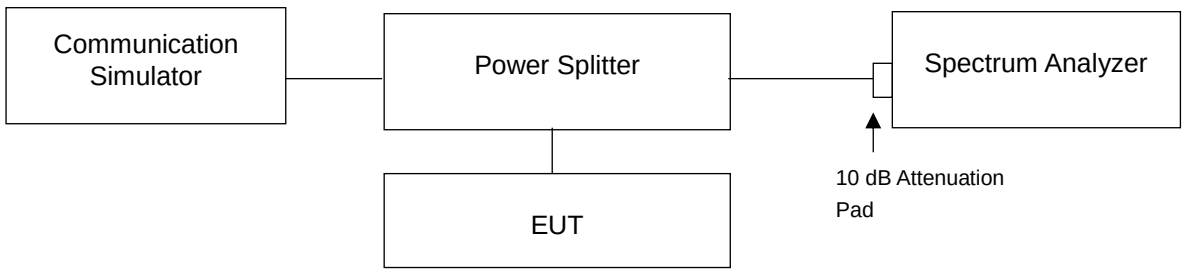
The EUT makes a call to the communication simulator. All measurements were done at low, middle and high operational frequency range. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency.

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 ≥ 3 × 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).

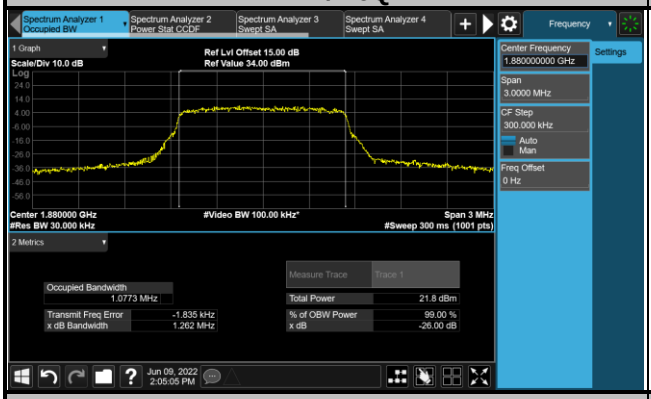
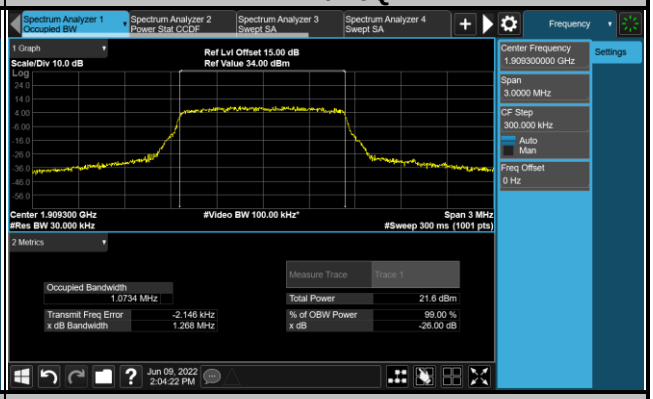
For the occupied bandwidth measurement method, please refer to section 5.4.4 of ANSI C63.26.

4.4.3 Test Setup

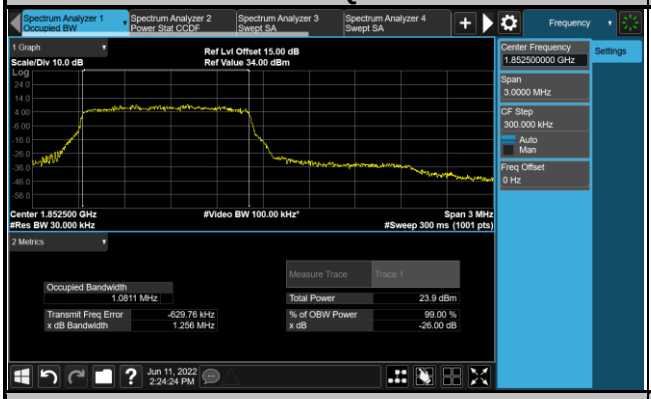
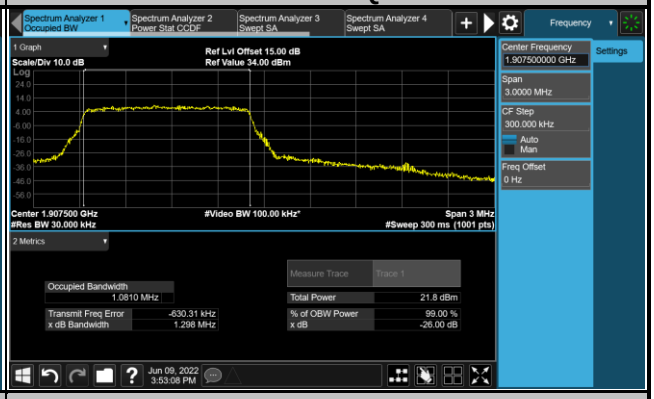
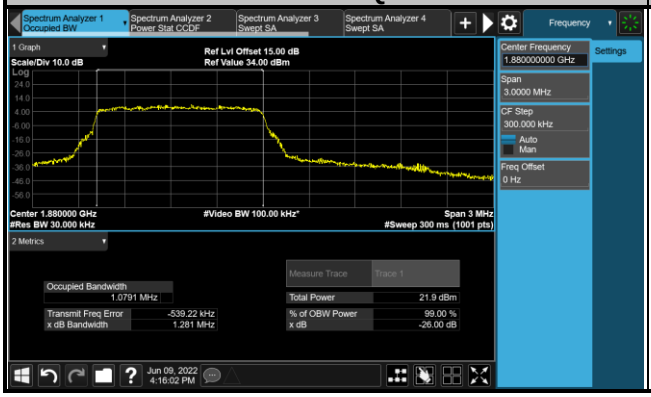


4.4.4 Test Result

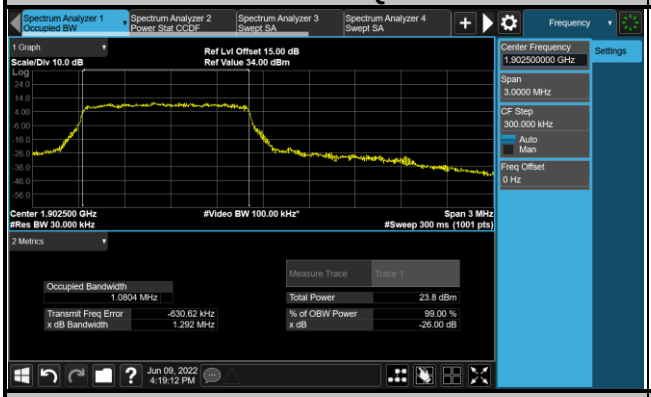
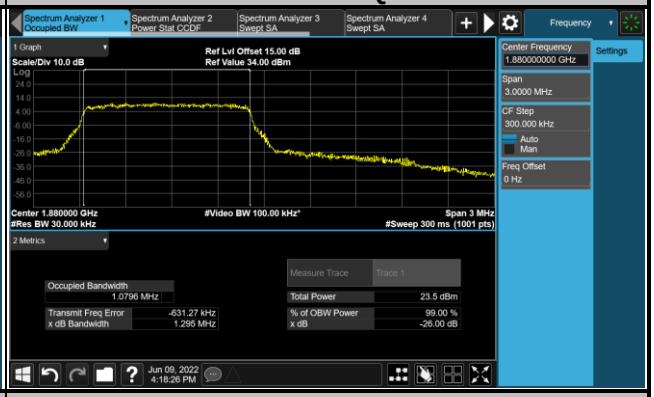
Cat M1 Band 2					
Channel Bandwidth: 1.4 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18607	1850.7	1.07	1.08	1.26	1.26
18900	1880.0	1.08	1.08	1.25	1.26
19193	1909.3	1.07	1.07	1.26	1.27
Channel Bandwidth: 3 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18615	1851.5	1.07	1.08	1.26	1.27
18900	1880.0	1.07	1.07	1.26	1.26
19185	1908.5	1.07	1.07	1.26	1.27

Spectrum Plot of Worst Value	
99 % Occupied Bandwidth	**26 dB Bandwidth**
1.4 MHz / 16QAM	**1.4 MHz / 16QAM**
	
3 MHz / 16QAM	**3 MHz / 16QAM**
	

Cat M1 Band 2					
Channel Bandwidth: 5 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18625	1852.5	1.08	1.08	1.26	1.27
18900	1880.0	1.08	1.08	1.27	1.28
19175	1907.5	1.08	1.08	1.26	1.30
Channel Bandwidth: 10 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18650	1855.0	1.08	1.08	1.26	1.27
18900	1880.0	1.08	1.08	1.25	1.28
19150	1905.0	1.08	1.08	1.26	1.27

Spectrum Plot of Worst Value	
99 % Occupied Bandwidth	**26 dB Bandwidth**
5 MHz / QPSK	**5 MHz / 16QAM**
	
10 MHz / 16QAM	**10 MHz / 16QAM**
	

Cat M1 Band 2					
Channel Bandwidth: 15 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18675	1857.5	1.08	1.08	1.27	1.29
18900	1880.0	1.08	1.08	1.26	1.30
19125	1902.5	1.08	1.08	1.26	1.29
Channel Bandwidth: 20 MHz					
Channel	**Frequency (MHz)**	**99 % Occupied Bandwidth (MHz)**		**26 dB Bandwidth (MHz)**	
		QPSK	**16QAM**	**QPSK**	**16QAM**
18700	1860.0	1.08	1.08	1.27	1.28
18900	1880.0	1.08	1.08	1.27	1.28
19100	1900.0	1.07	1.08	1.27	1.29

Spectrum Plot of Worst Value	
99 % Occupied Bandwidth	**26 dB Bandwidth**
15 MHz / 16QAM	**15 MHz / 16QAM**
	
20 MHz / 16QAM	**20 MHz / 16QAM**