TEST REPORT

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Test Report Number: SKT-RFC-230010

Date of issue: November 13, 2023

Applicant:	**Intellian Technologies, Inc.** 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri) Pyeongtaek-si, Gyeonggi-do, 17709 Korea
Manufacturer:	**Intellian Technologies, Inc.** 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri) Pyeongtaek-si, Gyeonggi-do, 17709 Korea
Product:	OW70L (P-P)
Model:	PS-OW70PP
FCC ID:	XXZ-INTOW70LPPE
Project number:	SKTEU23-1193
EUT received:	October 24, 2023

Applied standards:	ANSI C63.26-2015 ANSI C63.4-2014 and ANSI C63.4a-2017
Rule parts:	FCC 47 CFR Part 2, Part 25
Equipment Class:	**TNB: Licensed Non-Broadcast Station Transmitter**

Remarks to the standards:	None

The above equipment has been tested by SK Tech Co., Ltd., and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product or system, which was tested.

Inhee Bae **/ Testing Engineer**

Jongsoo Yoon **/ Technical Manager**

Revision History of Test Report

Rev.	Revisions	Effect page	Approved by	Date
-	Initial issue	All	Jongsoo Yoon	Nov. 13, 2023

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1 Summary of test results

Requirement	FCC, CFR 47 Section	Result
RF power output / Power limits / Off-Axis EIRP Spectral Density	§2.1046, 25.204(a), 25.218	Meets the requirements
Occupied bandwidth	§2.1049	Meets the requirements
Spurious emissions at antenna terminals (conducted emissions)	§2.1051, 25.202(f)	Meets the requirements
Field strength of spurious radiation (radiated emissions)	§2.1053, 25.202(f)	Meets the requirements
Transmitter frequency stability / Frequency tolerances	§2.1055, 25.202(d)	Meets the requirements

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2 Description of equipment under test (EUT)

Product:	OW70L (P-P)
Model:	PS-OW70PP
Serial number:	None (prototype)
Hardware version:	prototype
Software version:	prototype

Model differences:

Model name	Difference	Tested (checked)
PS-OW70PP	fully tested model that was provided by the applicant.	☒

Technical data:

Transmit frequency	Tx: 14.0 GHz to 14.5 GHz Rx: 10.7 GHz to 12.75 GHz
Declared maximum EIRP	35.6 dBW / 19.8 MHz (single carrier) 38.6 dBW / 39.6 MHz (dual carrier)
Antenna gain	39.0 dBi (Peak)
Authorized bandwidth	19.8 MHz / 39.6 MHz
Number of channels	Single carrier (Bandwidth 19.8 MHz): 24 Dual carrier (Bandwidth 39.6 MHz): 20
Type of modulation	TX: QPSK, 8PSK, 16QAM RX: QPSK, 8PSK, 16APSK
Type of radio transmission:	FDMA
Transmitter output power (conducted)	26.6 dBm (0.457 W) (average power; single carrier) 29.6 dBm (0.912 W) (average power; dual carrier)
Transmitter output power (radiated)	65.6 dBm (3630.8 W) (single carrier) 68.6 dBm (7244.4 W) (dual carrier) (calculated value with antenna gain)
Maximum occupied bandwidth	17.2 MHz / 37.4 MHz
Emission designator	17M2G7W, 17M2D7W, 37M4G7W, 37M4D7W
Antenna type	Parabolic antenna
Power source	AC 100 V to 240 V (DC 56 V for Customer Network Exchange)
Operation temperature range	-25 °C to +55 °C

Note:

I/O port	Type	Q'ty	Remark
EUT, Primary Antenna Unit			
Power & Data connector	F-type Connector (for Power + Data)	1	
RX	N-type Connector (for Rx + Power)	1	Note
TX	N-type Connector	1	Note
ETH	RJ-45 (for Ethernet)	1	Note
SIG	RJ-45 (for Control Signal)	1	Note
EUT, Customer Network Exchange (CNX-Rac)			
LAN	RJ-45 (To access to OneWeb services)	8	
SAT	F-type Connector (for Power + Data)	2	
POWER	AC Inlet	2	
USB	Type A	1	Engineer Port
Terminal block	2-pin	1	Not Supplied

Note: *The EUT is a product composed of Primary Antenna Unit – Primary Antenna Unit. This port connects Primary Antenna Unit – Secondary Antenna Unit, and its configuration has been verified by FCC ID: XXZ-INTOW70LE..*

Modification of EUT during the compliance testing: none

3 Test and measurement conditions

3.1. Operating modes

Operating modes of the sample:

No.	Description
-	Normal operating mode: the product can support the following channel plan.

Transmit (Earth-to-space)

Channel number	Carriers	Input IF Frequency (MHz)	LO (GHz)	RF Output Frequency (MHz)	
				Bandwidth 19.8 MHz	Bandwidth 39.6 MHz
1	1	4 063.0	9.950	14 013.0	14 022.9
	2	4 082.8		14 032.8	14 042.7
	3	4 102.6		14 052.6	14 062.5
	4	4 122.4		14 072.4	14 082.3
	5	4 142.2		14 092.2	14 102.1
	6	4 162.0		14 112.0	-
2	1	4 063.0	10.075	14 138.0	14 147.9
	2	4 082.8		14 157.8	14 167.7
	3	4 102.6		14 177.6	14 187.5
	4	4 122.4		14 197.4	14 207.3
	5	4 142.2		14 217.2	14 227.1
	6	4 162.0		14 237.0	-
3	1	4 063.0	10.200	14 263.0	14 272.9
	2	4 082.8		14 282.8	14 292.7
	3	4 102.6		14 302.6	14 312.5
	4	4 122.4		14 322.4	14 332.3
	5	4 142.2		14 342.2	14 352.1
	6	4 162.0		14 362.0	-
4	1	4 063.0	10.325	14 388.0	14 397.9
	2	4 082.8		14 407.8	14 417.7
	3	4 102.6		14 427.6	14 437.5
	4	4 122.4		14 447.4	14 457.3
	5	4 142.2		14 467.2	14 477.1
	6	4 162.0		14 487.0	-

Receive (space-to-Earth)

Channel number	Input RF Frequency (GHz)			LO (GHz)	IF Output Frequency (GHz)		
	Low	Center	High		Low	Center	High
1	10.70	10.825	10.95	8.85	1.85	1.975	2.10
2	10.95	11.075	11.20	9.10	1.85	1.975	2.10
3	11.20	11.325	11.45	9.35	1.85	1.975	2.10
4	11.45	11.575	11.70	9.60	1.85	1.975	2.10
5	11.70	11.825	11.95	9.85	1.85	1.975	2.10
6	11.95	12.075	12.20	10.10	1.85	1.975	2.10
7	12.20	12.325	12.45	10.35	1.85	1.975	2.10
8	12.45	12.575	12.70	10.60	1.85	1.975	2.10

Operating modes used for the Test:

No.	Operating mode
1	(a) The EUT was operated in the special Test mode, continuously transmitting the modulated/unmodulated RF signals without an off-time interval. The operating modes were controlled by the software (Tera Term, QPST, QRCT4 tool). (b) The tests were performed for each Bandwidth and Modulation at the following frequencies: TX single carrier (19.8 MHz BW) fLOW 14.013 GHz Channel number 1 + Carrier 1 fMID 14.263 GHz Channel number 3 + Carrier 1 fHIGH 14.487 GHz Channel number 4 + Carrier 6 TX dual carrier (39.6 MHz BW) fLOW 14.022 9 GHz Channel number 1 + Carrier (1+2) fMID 14.272 9 GHz Channel number 3 + Carrier (1+2) fHIGH 14.477 1 GHz Channel number 4 + Carrier (5+6)
2	CW carrier activated for the measurement of frequency stability

3.2. Description of support units (accessory equipment)

The following support units or accessories were used to form a representative test configuration during the tests.

#	Equipment	Manufacturer	Model No.	Serial No.
1	Notebook	HP Inc.	HSN-I26C	-
2	AC Adapter	Acbel Electronic Co., Ltd.	TPN-AA06	-
3	Dummy Load Resister	-	-	-

3.3. Interconnection and I/O cables

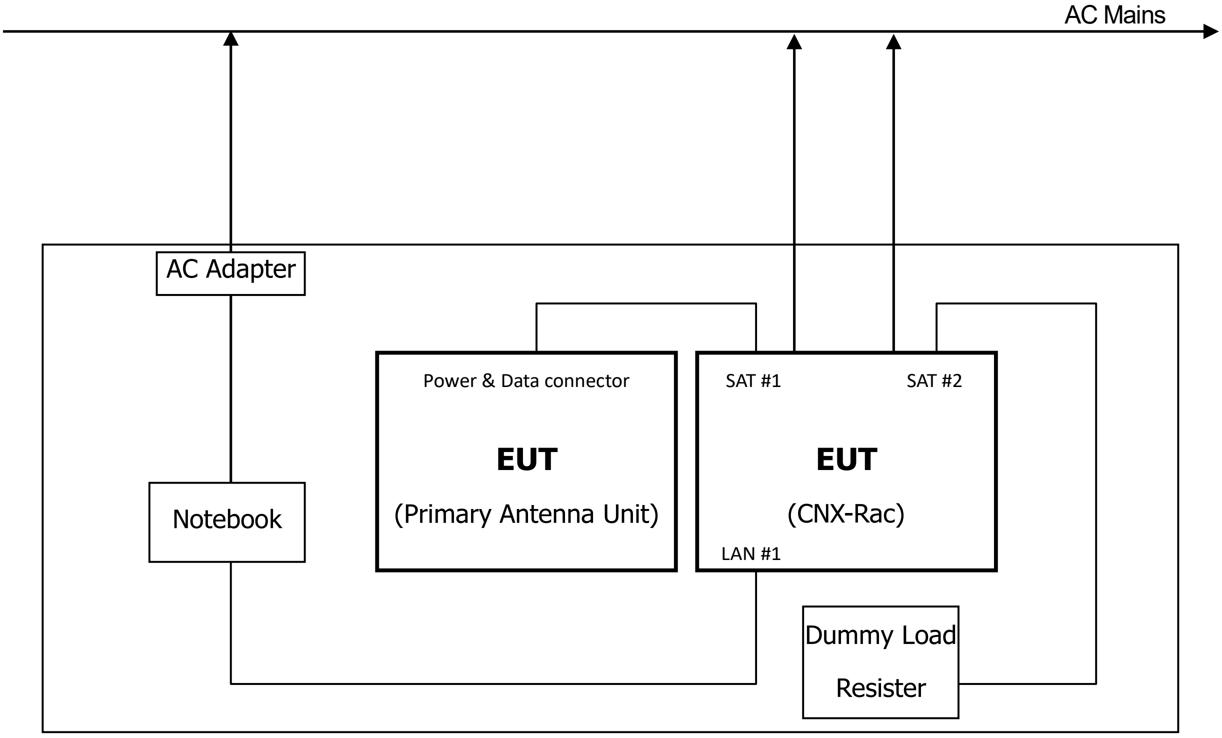
The following support units or accessories were used to form a representative test configuration during the tests.

#	Start		End		Cable	
	Name	I/O port	Name	I/O port	length (m)	shielded (Y/N)
1	EUT (Primary Antenna Unit)	(OMT and Feeder removed)	Dummy load	-	-	-
2	EUT (Primary Antenna Unit)	Power & DATA	EUT (CNX-Rac)	SAT #1	30.0	Y
3	EUT (CNX-Rac)	AC Input #1	AC Mains	AC Mains	1.8	N
4	EUT (CNX-Rac)	AC Input #2	AC Mains	AC Mains	1.8	N
5	EUT (CNX-Rac)	SAT #2	Dummy Load Resistor	ANT RX	30.0	Y
6	EUT (CNX-Rac)	LAN1	Notebook	LAN	3.0	Y
7	Notebook	DC Input	AC Adapter	DC output	1.7	N
8	AC Adapter	AC Input	AC Mains	AC Mains	1.5	N

Note: *All the operating conditions including the cable connection were selected by the applicant.*

3.4. Test configuration (arrangement of EUT)

The tests were performed without antenna feeder; the radiated spurious was measured with the antenna flange terminated by the dummy load, and the conducted spurious was measured via the waveguide coupler.
The EUT (CNX-Rac) connects and uses two Primary Antenna Units that are identical in terms of hardware and software. The two Primary Antenna Units do not transmit simultaneously. For the test, one Primary Antenna Unit and a Dummy load resistor were used for the test.



3.5. Test date

Date Tested	October 30, 2023 - November 7, 2023

4 Facilities and accreditations

4.1. Facilities

All of the measurements described in this report were performed at SK Tech Co., Ltd.

Site I: 88, Geulgaeul-ro, 81beon-gil, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea
Site II: 124-8, Geulgaeul-ro, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea

The sites are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-4. The sites comply with the Normalized Site Attenuation requirements given in ANSI C63.4, and site VSWR requirements specified in CISPR 16-1-4. The FAR used for the radiated spurious emissions fulfills the NSA requirements specified in ETSI TS 102 321 V1.1.1 (2004-05) and ETSI TR 102 273-2 V1.2.1 (2001-12). The measuring apparatus and ancillary equipment conform to CISPR 16-1 series.

4.2. Accreditations

The laboratory has been also notified to FCC and ISED by RRA as a Conformity Assessment Body, and designated to perform compliance testing on equipment subject to Certification under Parts 15, 18, 22, 24, 25, 27, 74, 90, 95, 97 and 101 of the FCC Rules, and RSS-GEN, RSS-170, RSS-210, RSS-247.

Designation No.	KR0007
Company Number (IC)	5429A

4.3. List of test and measurement instruments

4.3.1 Instruments for the conducted measurements

No	Description	Model	Manufacturer	Serial No.	Cal. due	Use
1	Spectrum Analyzer	FSW67	Rohde&Schwarz	101371	2024.06.16	☒
2	Waveguide Coupler	17132-20	Flann microwave	197960	2024.07.18	☒
3	Waveguide Dummy load	17101-300-CH10	Flann microwave	275168	2024.07.18	☒
4	Pre-amplifier (1 GHz - 18 GHz)	MLA-0118-J01-40	TSJ	14879	2024.04.18	☐
5	Pre-amplifier (18 GHz - 40 GHz)	MLA-1840-A01-50	TSJ	2610050	2024.04.26	☒
6	Pre-amplifier (40 GHz - 60 GHz)	MLA-4060-J02	TSJ	2Z00027	2024.04.27	☒
7	Harmonic Mixer (60 GHz - 75 GHz)	FS-Z75	Rohde & Schwarz	102063	2024.07.26	☒
8	RF cable assembly (2 m)	MWX241	JUNFLON MWX	R07-2	2024.04.27	☒
9	RF cable assembly (0.5 m)	ST40-01-9A40	SENSORVIEW	R08	2024.04.27	☒
10	RF cable assembly (1 m)	SCW-VWVW012-F1	ERAVANT	R15	2024.04.27	☒
11	RF cable assembly (0.3 m)	SCW-VWVW012-F1	ERAVANT	R16	2024.04.27	☒
12	RF cable assembly (6.5 m)	MWX241	SENSORVIEW	R06-2	2024.04.27	☒
13	High Pass Filter	WHW2-13500-18000-33000-40CC	Wainwright	7	2024.07.17	☒
14	Attenuator (10 dB)	50HFAR-010-2.9MM	JFW	-	2024.07.17	☒
15	Temperature Chamber	DJ-THC02	DAE JIN ENG.	06071	2024.09.13	☒
16	Multimeter	17B+	FLUKE	32700017WS	2024.01.16	☒
17	Digital Thermo-Hygrometer	608-H1	Testo	41383411	2024.05.18	☒

4.3.2 Instruments for the radiated measurements

No	Description	Model	Manufacturer	Serial No.	Cal. due	Use
1	EMI Test Receiver	ESR 26	Rohde&Schwarz	101441	2024.07.05	☐
2	EMI Test Receiver	ESIB40	Rohde&Schwarz	100277	2024.04.17	☐
3	EMI Test Receiver	N9048B	Keysight	MY62220109	2024.07.17	☒
4	Spectrum Analyzer	FSW67	Rohde&Schwarz	101371	2024.06.16	☒
5	Vector Signal Generator	SMBV100B	Rohde&Schwarz	101179	2024.04.19	☐
6	Signal Generator	SMB100A	Rohde&Schwarz	180704	2024.01.17	☐
7	Loop Antenna (9 kHz - 30 MHz)	HFH2-Z2E	Rohde&Schwarz	100883	2023.11.23	☒
8	BiLog broadband Antenna (30 MHz - 1 GHz)	VULB9168	Schwarzbeck	9168-189	2024.03.13	☒
9	Horn Antenna (1 GHz - 18 GHz)	3117	ETS Lindgren	00205960	2024.05.19	☒
10	Horn Antenna (6.5 GHz - 18 GHz)	LB-65180-20-C-SF	A-INFO	2110054000021	2024.01.22	☐
11	Horn Antenna (18 GHz - 26.5 GHz)	20240-20	Flann microwave	273364	2023.11.23	☒
12	Horn Antenna (26.5 GHz - 40 GHz)	22240-20	Flann microwave	274186	2023.11.23	☒
13	Horn Antenna (40 GHz - 60 GHz)	24240-20	Flann microwave	275175	2023.12.27	☒
14	Horn Antenna (60 GHz - 75 GHz)	25240-20	Flann microwave	273466	2023.12.10	☒
15	Pre-amplifier (30 MHz - 1 GHz)	MLA-10K01-B01-27	TSJ	2005350	2024.04.17	☒
16	Pre-amplifier (1 GHz - 18 GHz)	MLA-0118-J01-40	TSJ	14879	2024.04.18	☒
17	Pre-amplifier (18 GHz - 40 GHz)	MLA-1840-A01-50	TSJ	2610050	2024.04.26	☒
18	Pre-amplifier (40 GHz - 60 GHz)	MLA-4060-J02	TSJ	2Z00027	2024.04.27	☒
19	Harmonic Mixer (60 GHz - 75 GHz)	FS-Z75	Rohde & Schwarz	102063	2024.07.26	☒
20	Waveguide Dummy load	22101-250-CH10	Flann microwave	275202	2024.07.18	☒
21	Multimeter	17B+	FLUKE	32700017WS	2024.01.16	☒
22	Digital Thermo-Hygrometer	608-H1	Testo	41383411	2024.05.18	☒

Radiated emission measurement software (9 kHz to 30 MHz, 30 MHz to 1 GHz): TEPTO-DV/RE_Version: 3.1.0051
Radiated spurious emission measurement software (1 GHz to 75 GHz): TEPTO-DV/RSE_Version: 31.06.0000

5 Test and measurements

5.1. RF Power Output / Power limits / Off-axis EIRP spectral density

5.1.1 Regulation

FCC, CFR 47 Section

According to 2.1046, Measurements required: RF power output:

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in According to 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in According to 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

According to 25.204, Power limits for earth stations

(a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

+40 dBW in any 4 kHz band for $\theta \le 0°$

+40 + 3θ dBW in any 4 kHz band for $0° < \theta \le 5°$

where θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

(c) For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

According to 25.218, Off-axis EIRP density envelopes for FSS earth stations transmitting in certain frequency bands

(f) Digital earth station operation in the conventional Ku-band.

(1) For co-polarized transmissions in the plane tangent to the GSO arc:

$15-25\log_{10}\theta$	dBW/4 kHz	for $1.5° \le \theta \le 7°$
-6	dBW/4 kHz	for $7° < \theta \le 9.2°$
$18-25\log_{10}\theta$	dBW/4 kHz	for $9.2° < \theta \le 19.1°$
-14	dBW/4 kHz	for $19.1° < \theta \le 180°$

Where θ is as defined in paragraph (c)(1) of this section. The EIRP density levels specified for θ > 7° may be exceeded by up to 3 dB in up to 10% of the range of theta (θ) angles from ±7-180°, and by up to 6 dB in the region of main reflector spillover energy.

(2) For co-polarized transmissions in the plane perpendicular to the GSO arc, as defined in § 25.103:

$18-25\log_{10}\theta$	dBW/4 kHz	for 3° ≤ θ ≤ 19.1°
-14	dBW/4 kHz	for 19.1° < θ ≤ 180°

Where θ is as defined in paragraph (c)(1) of this section. These EIRP density levels may be exceeded by up to 6 dB in the region of main reflector spillover energy and in up to 10% of the range of θ angles not included in that region, on each side of the line from the earth station to the target satellite.

(3) For cross-polarized transmissions in the plane tangent to the GSO arc and in the plane perpendicular to the GSO arc:

$5-25\log_{10}\theta$	dBW/4 kHz	for 1.5° ≤ θ ≤ 7°

Where θ is as defined in paragraph (c)(1) of this section.

NOTE: subtracting the antenna gain values specified in §25.209 Earth station antenna performance standards from these limits, the maximum conducted Off-axis density limit is -14 dBW/4kHz.

5.1.2 Test Procedure

The RF output power were measured with the following setting according to Subclause 5.2.4.2, 5.2.4.3 and/or 5.2.4.4 of ANSI C63.26-2015.

Procedure for measuring average power with an average power meter:
An average power meter can always be used to perform the measurement when the EUT can be configured to transmit continuously. If the EUT cannot be configured to transmit continuously (i.e., burst duty cycle < 98%), the measurement should be measured during the active transmission bursts if the gating parameters can be adjusted, otherwise the duty cycle correction should be considered.

Procedure for measuring average power of a narrowband signal with spectrum analyzer:

(a) Set span to 2 × to 3 × the OBW.
(b) Set RBW ≥ OBW.
(c) Set VBW ≥ 3 × RBW.
(d) Set number of measurement points in sweep ≥ 2 × span / RBW.
(e) Sweep time:
  (1) Set ≥ auto-couple, and enable trace averaging, or
  (2) Set ≥ [10 × (number of points in sweep) × (transmission symbol period)] and enable a single sweep (automation-compatible) measurement. The sweep time should never be faster than the auto-coupled sweep time.
(f) Detector = power averaging (rms).
(g) If the EUT can be configured to transmit continuously, then set the trigger to free run.
(h) Trace average at least 100 traces in power averaging (i.e., rms) mode if sweep is set to auto-couple. (To accurately determine the average power over multiple transmit symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.)
(i) Use the peak marker function to determine the maximum amplitude level.

Procedure for measuring average power of a broadband signal with spectrum analyzer:

(a) Set span to 2 × to 3 × the OBW.

(b) Set RBW = 1% to 5% of the OBW.

(c) Set VBW ≥ 3 × RBW.

(d) Set number of measurement points in sweep ≥ 2 × span / RBW.

(e) Sweep time:

(1) Set = auto-couple, or

(2) Set ≥ [10 × (number of points in sweep) × (transmission period)] for single sweep (automation-compatible) measurement. Transmission period is the on and off time of the transmitter.

(f) Detector = power averaging (rms).

(g) If the EUT can be configured to transmit continuously, then set the trigger to free run.

(h) If the EUT cannot be configured to transmit continuously, then use a sweep trigger with the level set to enable triggering only on full power bursts and configure the EUT to transmit at full power for the entire duration of each sweep. Verify that the sweep time is less than or equal to the transmission burst duration. Time gating can also be used under similar constraints (i.e., configured such that measurement data is collected only during active full-power transmissions).

(i) Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. To accurately determine the average power over multiple symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.

(j) Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

Procedure for RF power output in any 4 kHz band:
The average power spectral density was measured according to Subclause 5.2.4.5 of ANSI C63.26-2015. The same test procedure for the measurements of Spurious Emissions at Antenna Terminals (Out-of-band emissions measurements) was used.

NOTE: As shown in the Figure 3, during the measurements, the insertion loss (Waveguide coupler, RF cable assembly) was included in the spectrum analyzer as the TDF, and bandwidth correction factor (1.25 dB) were applied as the Offset.

Procedure for Off-axis EIRP spectral density in any 4 kHz band:
The average power spectral density was measured according to Subclause 5.2.4.5 of ANSI C63.26-2015. The same test procedure for the measurements of Spurious Emissions at Antenna Terminals (Out-of-band emissions measurements) was used, except for subtracting the antenna gain.

NOTE : As shown in the Figure 4, during the measurements, the insertion loss (Waveguide coupler, RF cable assembly) was included in the spectrum analyzer as the TDF, and the bandwidth correction factor (1.25 dB) were applied as the Offset which the antenna gain was set to zero.

5.1.3 Result: PASS

Table 1: Measured values of RF Power Output

Bandwidth (carrier)	Modulation	Antenna power [dBm] (NOTE 1)			EIRP [dBm] (NOTE 2)		
		f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}
19.8 MHz (single carrier)	QPSK	26.6	26.6	26.6	65.6	65.6	65.6
	8PSK	26.6	26.6	26.6	65.6	65.6	65.6
	16QAM	26.6	26.6	26.6	65.6	65.6	65.6
39.6 MHz (dual carrier)	QPSK	29.6	29.6	29.6	68.6	68.6	68.6
	8PSK	29.6	29.6	29.6	68.6	68.6	68.6
	16QAM	29.6	29.6	29.6	68.6	68.6	68.6

NOTE 1: As shown in the Figure 1, during the measurements, the insertion loss (Waveguide coupler, RF cable assembly) was included in the spectrum analyzer as the TDF.

NOTE 2: Transmitter radiated output power including the antenna gain (39.0 dBi).

Table 2: Measured values of RF Power Output (measured with Spectrum Analyzer in any 4 kHz band)

Bandwidth (carrier)	Modulation	Measured data [dBm] (NOTE 1)			EIRP [dBm] (NOTE 2)			LIMIT [dBm]
		f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}	
19.8 MHz (single carrier)	QPSK	0.83	0.86	0.67	39.83	39.86	39.67	70
	8PSK	0.94	0.87	0.66	39.94	39.87	39.66	70
	16QAM	0.94	0.81	0.64	39.94	39.81	39.64	70
39.6 MHz (dual carrier)	QPSK	0.82	0.64	0.37	39.82	39.64	39.37	70
	8PSK	0.85	0.62	0.39	39.85	39.62	39.39	70
	16QAM	0.82	0.61	0.50	39.82	39.61	39.50	70

NOTE 1: The values were obtained from the Figure 4.

NOTE 2: Transmitter radiated output power including the antenna gain (39.0 dBi).

Table 3: Measured values of Off-axis EIRP spectral density

Bandwidth (carrier)	Modulation	EIRP [dBm] (NOTE 1)			LIMIT [dBm]
		f_{LOW}	f_{MID}	f_{HIGH}	
19.8 MHz (single carrier)	QPSK	0.83	0.86	0.67	16.0
	8PSK	0.94	0.87	0.66	16.0
	16QAM	0.94	0.81	0.64	16.0
39.6 MHz (dual carrier)	QPSK	0.82	0.64	0.37	16.0
	8PSK	0.85	0.62	0.39	16.0
	16QAM	0.82	0.61	0.50	16.0

NOTE 1: The values were obtained from the Figure 4. The gain for the off-axis antenna was 0 dBi for the calculation.

Figure 1. Plot of RF Power Output

RF Power output for each Bandwidth and Modulation

f_{LOW} (19.8 MHz, QPSK)

f_{LOW} (39.6 MHz, QPSK)

f_{LOW} (19.8 MHz, 8PSK)

f_{LOW} (39.6 MHz, 8PSK)

f_{LOW} (19.8 MHz, 16QAM)

f_{LOW} (39.6 MHz, 16QAM)

RF Power output for each Bandwidth and Modulation

f_{MID} (19.8 MHz, QPSK)

f_{MID} (39.6 MHz, QPSK)

f_{MID} (19.8 MHz, 8PSK)

f_{MID} (39.6 MHz, 8PSK)

f_{MID} (19.8 MHz, 16QAM)

f_{MID} (39.6 MHz, 16QAM)

RF Power output for each Bandwidth and Modulation

f_{HIGH} (19.8 MHz, QPSK)

f_{HIGH} (39.6 MHz, QPSK)

f_{HIGH} (19.8 MHz, 8PSK)

f_{HIGH} (39.6 MHz, 8PSK)

f_{HIGH} (19.8 MHz, 16QAM)

f_{HIGH} (39.6 MHz, 16QAM)

5.2. Occupied Bandwidth

5.2.1 Regulation

FCC, CFR 47 Section

According to 2.1049, Measurements required: Occupied bandwidth: 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 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of 2.1049 (a) through (i) as applicable.

5.2.2 Test Procedure

The Occupied bandwidth (99 %) were measured with the following setting according to subclause 5.4.4 of ANSI C63.26.

(a) Set the spectrum analyzer to be entered in OBW measurement.
(b) The spectrum analyzer center frequency was set to the nominal EUT channel center frequency.
(c) The span range for the spectrum analyzer should be wide enough to see sufficient roll off of the signal to make the measurement.
(d) The RBW should be in the range of 1% to 5% of the anticipated OBW, and the VBW should be set ≥ 3 × RBW.
(e) Set spectrum analyzer detection mode to peak, and the trace mode to max hold.

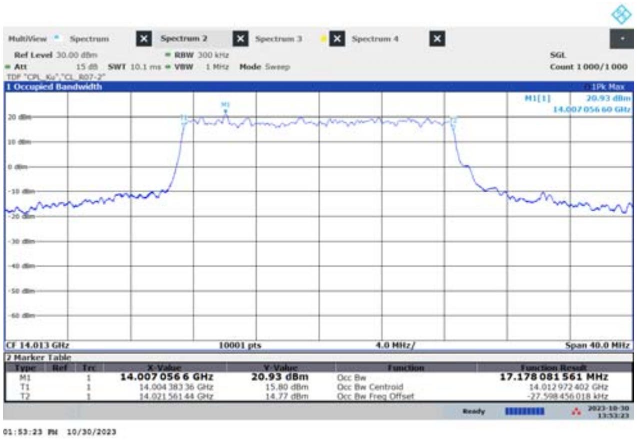
5.2.3 Result: PASS

Table 4: Measured values of Occupied Bandwidth

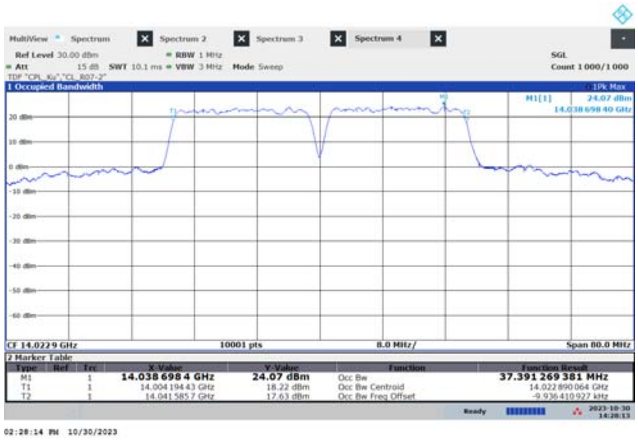
Bandwidth (carrier)	Modulation	Occupied bandwidth [MHz]		
		f_{LOW}	f_{MID}	f_{HIGH}
19.8 MHz (single carrier)	QPSK	17.2	17.2	17.2
	8PSK	17.2	17.2	17.2
	16QAM	17.2	17.2	17.2
39.6 MHz (dual carrier)	QPSK	37.4	37.4	37.4
	8PSK	37.4	37.4	37.4
	16QAM	37.4	37.4	37.4

Figure 2. Plot of Occupied Bandwidth

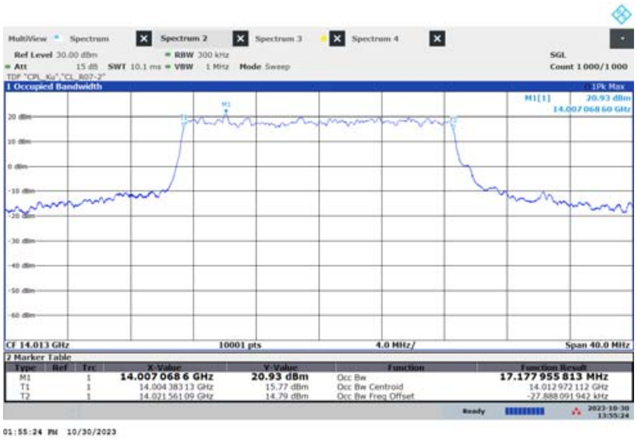
Occupied bandwidth for each Bandwidth and Modulation



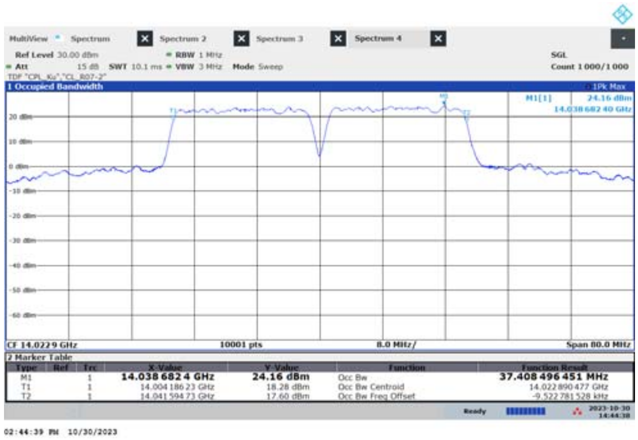
f_{LOW} (19.8 MHz, QPSK)



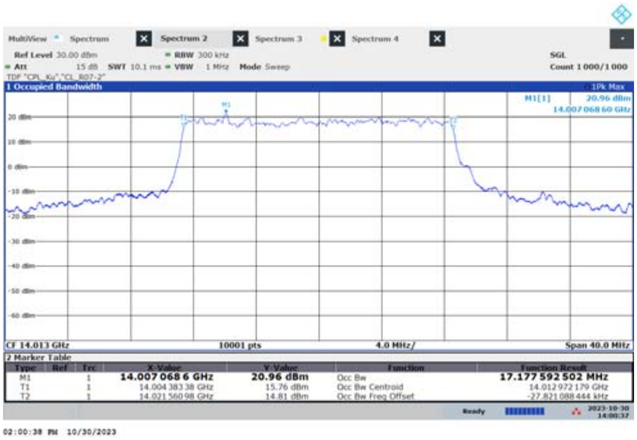
f_{LOW} (39.6 MHz, QPSK)



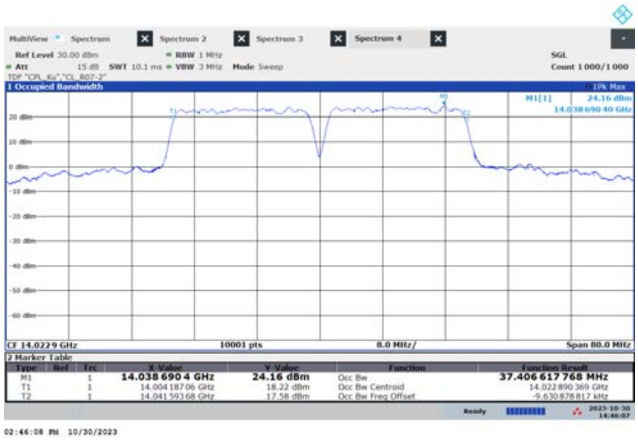
f_{LOW} (19.8 MHz, 8PSK)



f_{LOW} (39.6 MHz, 8PSK)

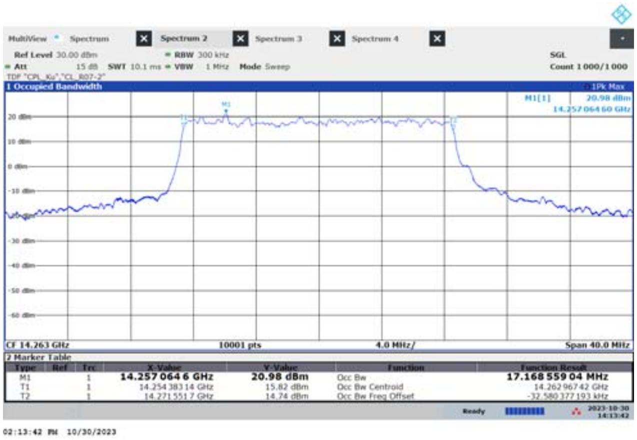


f_{LOW} (19.8 MHz, 16QAM)

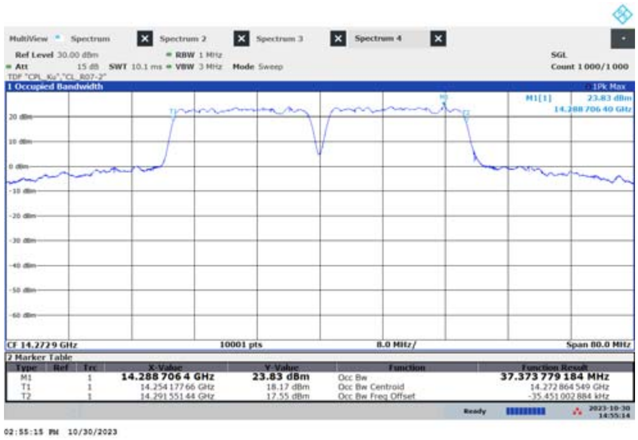


f_{LOW} (39.6 MHz, 16QAM)

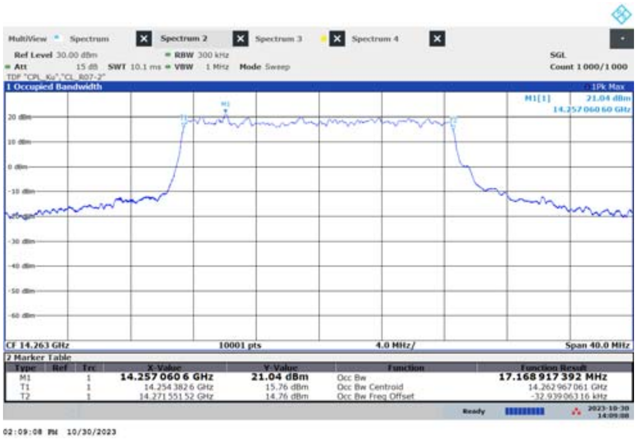
Occupied bandwidth for each Bandwidth and Modulation



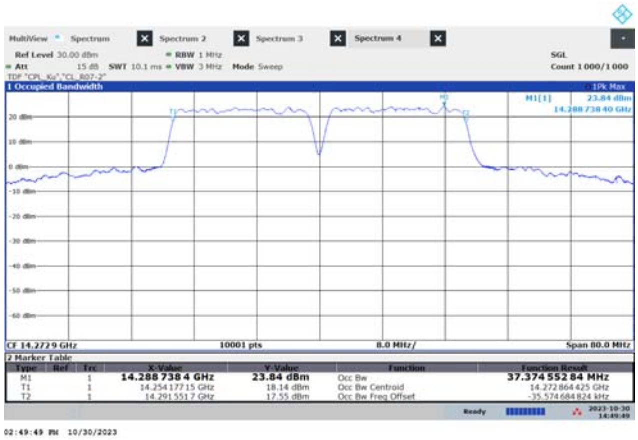
f_{MID} (19.8 MHz, QPSK)



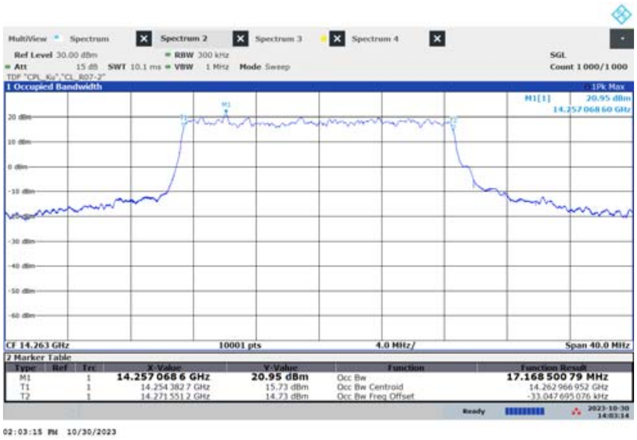
f_{MID} (39.6 MHz, QPSK)



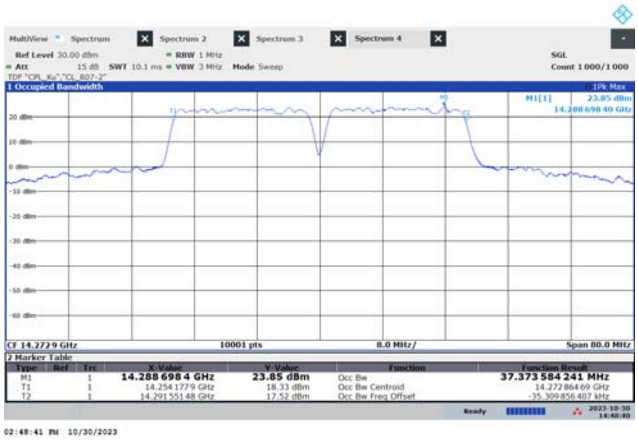
f_{MID} (19.8 MHz, 8PSK)



f_{MID} (39.6 MHz, 8PSK)

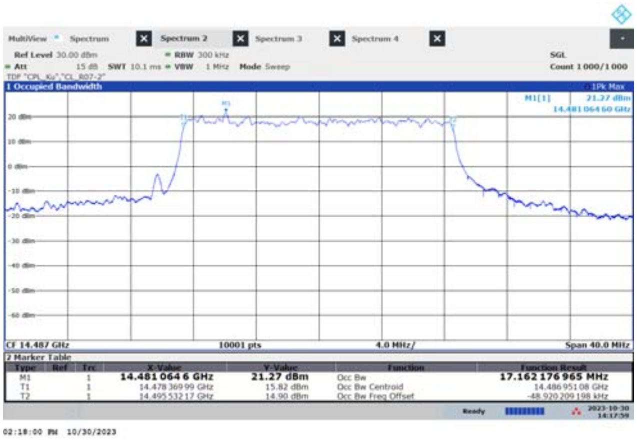


f_{MID} (19.8 MHz, 16QAM)

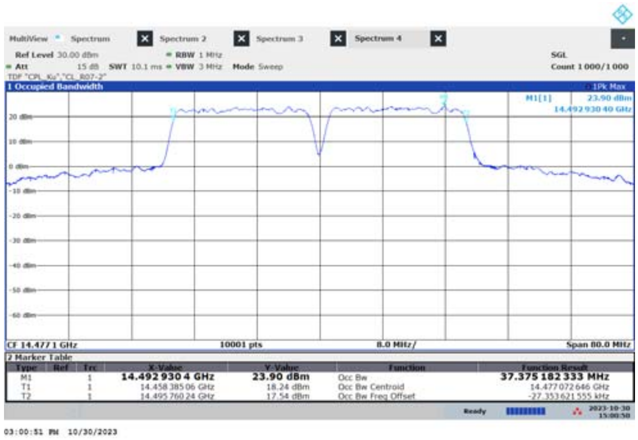


f_{MID} (39.6 MHz, 16QAM)

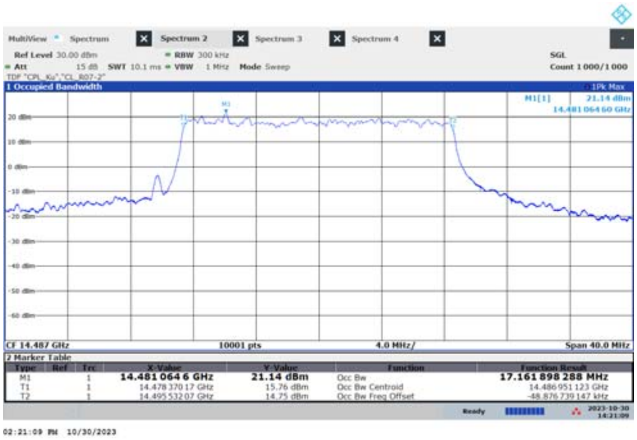
Occupied bandwidth for each Bandwidth and Modulation



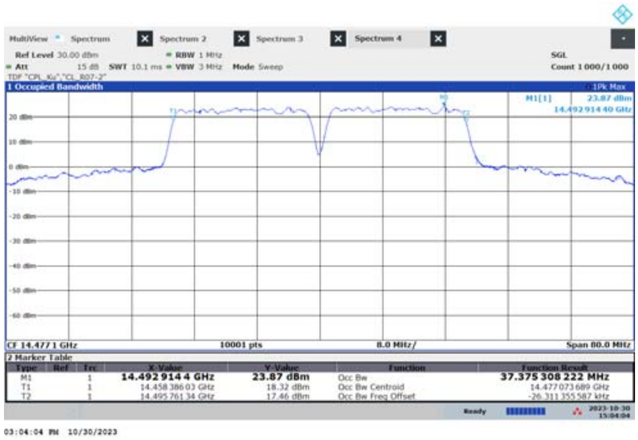
f_{HIGH} (19.8 MHz, QPSK)



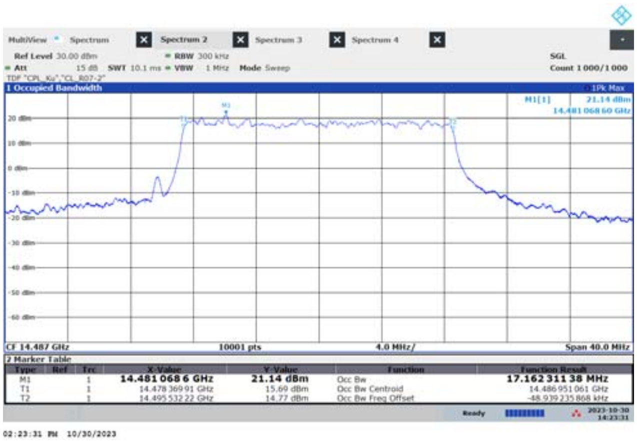
f_{HIGH} (39.6 MHz, QPSK)



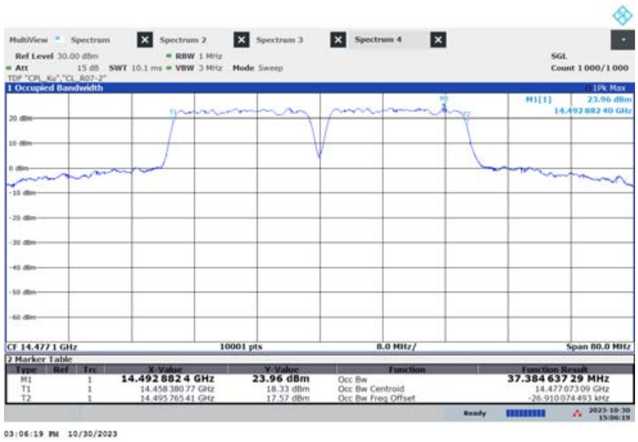
f_{HIGH} (19.8 MHz, 8PSK)



f_{HIGH} (39.6 MHz, 8PSK)



f_{HIGH} (19.8 MHz, 16QAM)



f_{HIGH} (39.6 MHz, 16QAM)

5.3. Spurious Emissions at Antenna Terminals (conducted emissions)

5.3.1 Regulation

FCC, CFR 47 Section

According to 2.1051, Measurements required: Spurious emissions at antenna terminals: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

According to 25.202(f), Emission limitations. Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

5.3.2 Test Procedure

The Spurious Emissions at Antenna Terminals were measured with the following setting according to subclause 5.7.3 and 5.7.4 of ANSI C63.26.
Connect the EUT antenna output port to the spectrum analyzer via an appropriate RF cable. Insert external attenuation as necessary and adjust the spectrum analyzer settings to account for the corresponding insertion loss. The unwanted emission limit was expressed in terms of "average" power. The use of "Max Hold" will not result in a true average power measurement. Instead, the proper trace mode for performing an average measurement was the "trace average" mode. Alternatively, a single sweep measurement could be used with the sweep speed set such that a relatively long dwell was realized in each trace bucket (typically at least 1 ms per trace point).

Out-of-band emissions measurements:

(a) Set the spectrum analyzer center frequency to the block, band, or channel edge frequency.

(b) Set the span wide enough to capture the fundamental emission closest to the authorized block or band edge, and to include all modulation products that spill into the immediately adjacent frequency band. In some cases, it may be possible to set the center frequency and span so as to encompass the fundamental emission and the unwanted out-of-band (band-edge) emissions on either side of the authorized block, band, or channel. This could be accomplished with a single (slow) sweep, if adequate overload protection and sufficient dynamic range could be maintained.

(c) Set the number of points in sweep ≥ 2 × span / RBW.

(d) Sweep time should be auto for peak detection. For rms detection the sweep time should be set as follows:

(1) If the device could be configured to transmit continuously, set the (sweep time) > (number of points in sweep) × (symbol period) (e.g., by a factor of 10 × symbol period × number of points). Increasing the sweep time (i.e., slowing the sweep speed) will allow for averaging over multiple symbols.

(2) If the device could not transmit continuously, a gated sweep should be used when possible, set the sweep time > (number of points in sweep) × (symbol period) but the sweep time should always be maintained at a value that was less than or equal to the minimum transmission time.

(3) If the device could not be configured to transmit continuously and a free running sweep must be used, set the sweep time so that the averaging was performed over multiple on/off cycles by setting the sweep time > (number of points in sweep) × (transmitter period) (i.e., the transmit on-time + the off-time). The spectrum analyzer readings should subsequently be corrected by [10 log (1/duty cycle)]. This assumes that the transmission period and duty cycle was relatively constant (duty cycle variation ≤ ±2%).

(4) If the device could not be configured to transmit continuously and a free-running sweep must be used, and if the transmissions exhibit a non-constant duty cycle (duty cycle variations > ±2%), set the sweep time so that the averaging was performed over the on-period by setting the sweep time > (symbol period) × (number of points), while also maintaining the sweep time < (transmitter on-time). The trace mode should be set to max hold, since not every display point will be averaged only over just the on-time. Thus, multiple sweeps (e.g., 100) in maximum hold are necessary to ensure that the maximum power was measured.

Conducted spurious emissions measurements:

(a) Set the spectrum analyzer start frequency to the lowest frequency generated by the EUT, without going below 9 kHz, and the stop frequency to the lower frequency covered by the out-of-band emissions measurements. [remark: the measurements were performed from the waveguide cutoff frequency]

(b) When using an average power (rms) detector, ensure that the number of points in the sweep ≥ 2 × (span / RBW). This may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the spectrum analyzer capabilities. This requirement does not apply to peak-detected power measurements. When average power was specified by the applicable regulation, a peak-detector could be utilized for preliminary measurements to accommodate wider frequency spans. Any emissions found in the preliminary measurement to exceed the applicable limit(s) should be further examined using a power averaging (rms) detector with the minimum number of measurement points as defined above.

(c) The sweep time should be set to auto-couple for performing peak-detector measurements. For measurements that use a power averaging (rms) detector, the sweep time should be set as described for out-of-band emissions measurements.

(d) Identify and measure the highest spurious emission levels in each frequency range. It was not necessary to re-measure the out-of-band emissions as a part of this test. Record the frequencies and amplitudes corresponding to the measured emissions and capture the data plots.

(e) Repeat step (b) through step (d) for the upper spurious emission frequency range if not already captured by a wide span measurement.

(f) Compare the results with the corresponding limit in the applicable regulation.

Calculation of bandwidth correction factor 5.7.2 of ANSI C63.26:

If the measurement bandwidth used to perform the measurement is less than the reference bandwidth, the following scaling is applied: 10 × log [(reference bandwidth) / (resolution or measurement bandwidth)]

For example, the reference bandwidth is specified as 4 kHz and the RBW 3 kHz is used during the measurement, the bandwidth correction factor = 10 × log (4 kHz / 3 kHz) = 1.25 [dB]

NOTE 1: As shown in the Figure 3, during the Out-of-band emission measurements, the peak detector was used with RBW 10 kHz for the preliminary measurements. The insertion loss (Waveguide coupler, Preamplifier, RF cable assembly) was included in the spectrum analyzer as the TDF. The final measurements (RMS detector with RBW 3 kHz, and adding the bandwidth correction factor) were not performed because the emissions were very low against the limit.

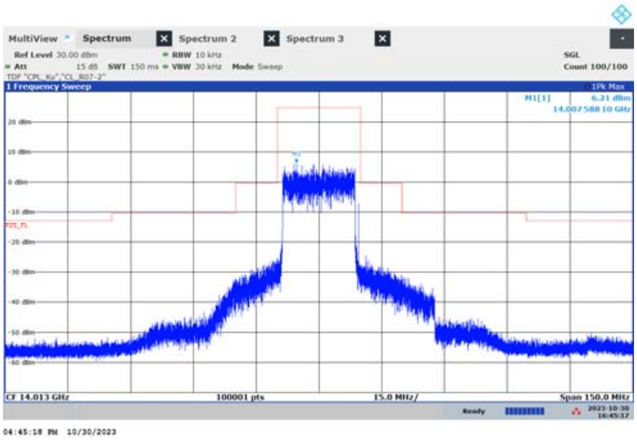
NOTE 2: As shown in the Figure 4, during the Off-axis EIRP spectral measurements, the insertion loss (Waveguide coupler, RF cable assembly) was included in the spectrum analyzer as the TDF, and the bandwidth correction factor (1.25 dB) were applied as the Offset.

NOTE 3: As shown in the Figure 5, during the spurious emission measurements, the peak detector was used with RBW 100 kHz for the preliminary measurements. The insertion loss (Waveguide coupler, Preamplifier, RF cable assembly) was included in the spectrum analyzer as the TDF.

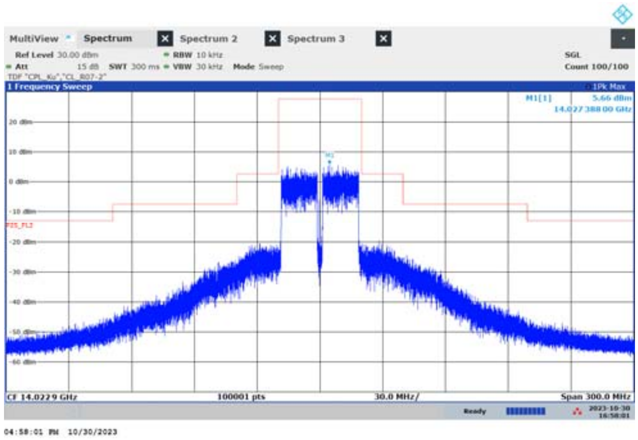
5.3.3 Result: PASS

Figure 3. Plot of Out-of-band Emissions (conducted emissions measurements)

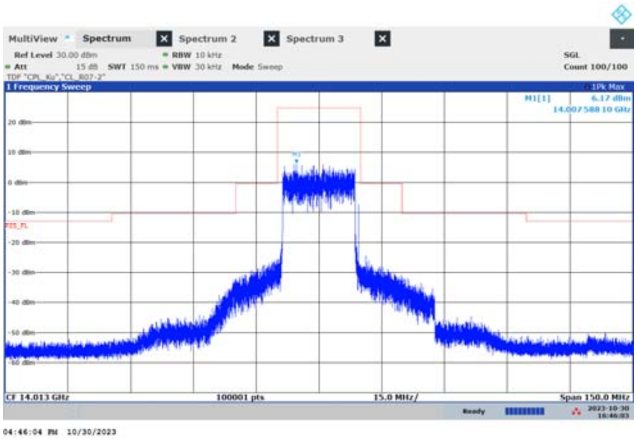
Out-of-band emissions (OOBE) and Band-edge measurements for each Bandwidth and Modulation



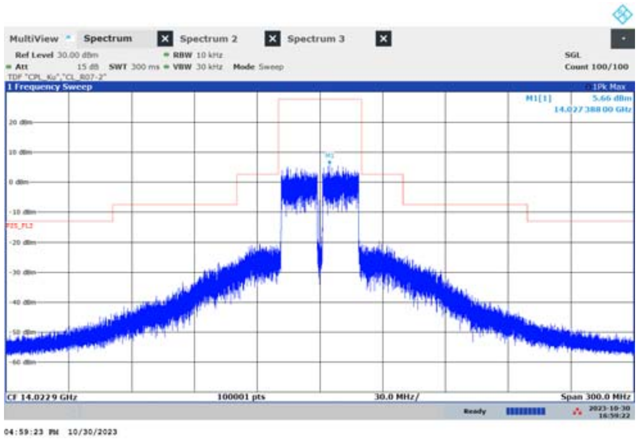
f_{LOW} (19.8 MHz, QPSK)



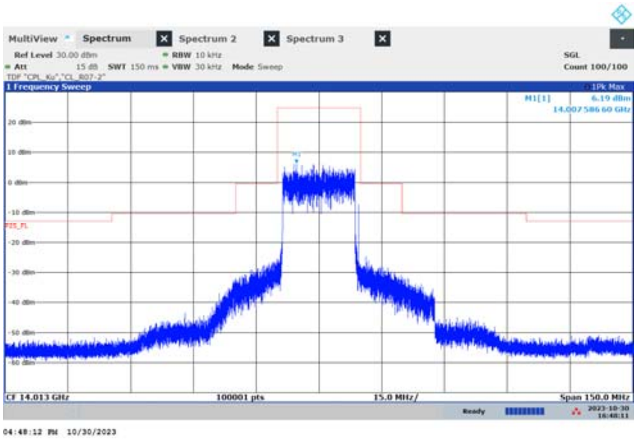
f_{LOW} (39.6 MHz, QPSK)



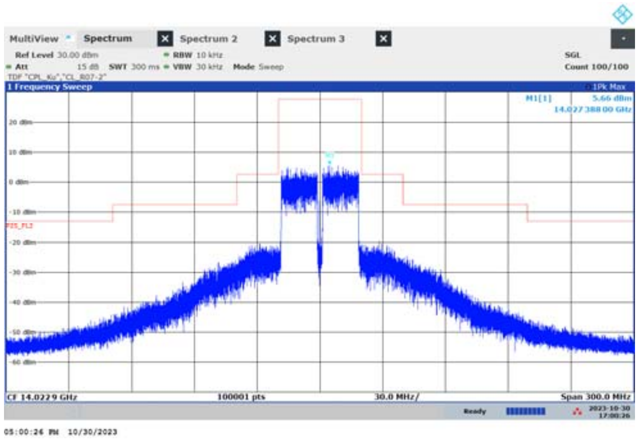
f_{LOW} (19.8 MHz, 8PSK)



f_{LOW} (39.6 MHz, 8PSK)

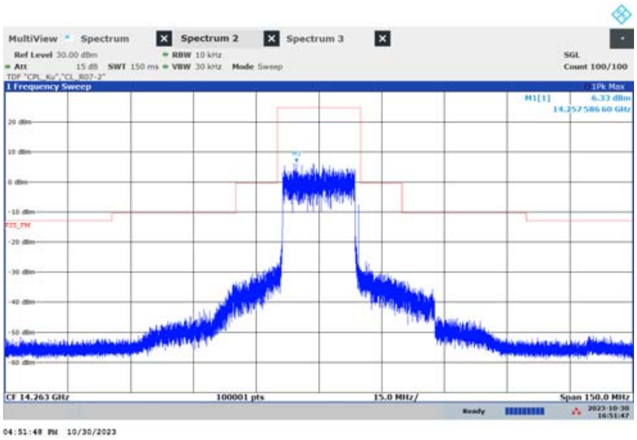


f_{LOW} (19.8 MHz, 16QAM)

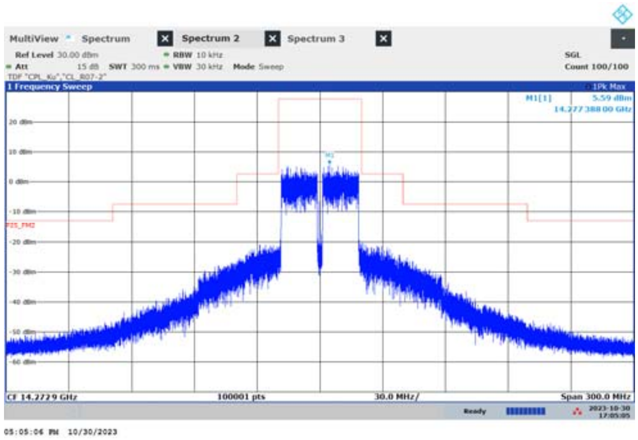


f_{LOW} (39.6 MHz, 16QAM)

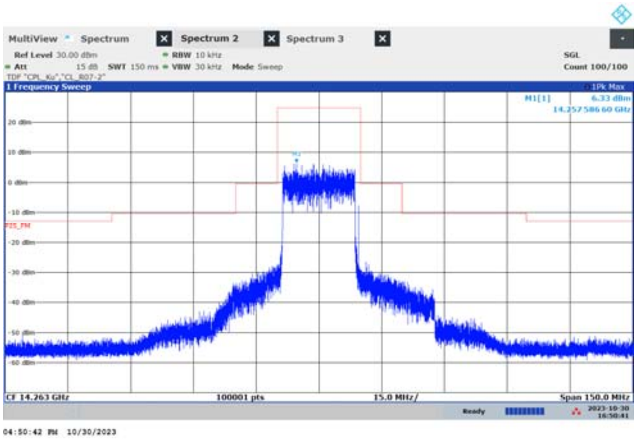
Out-of-band emissions (OOBE) and Band-edge measurements for each Bandwidth and Modulation



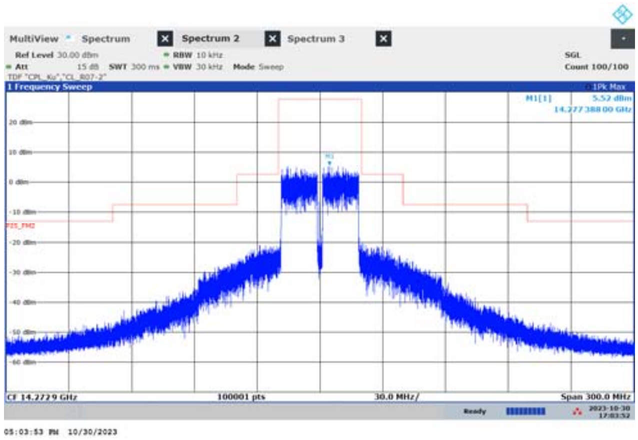
f_{MID} (19.8 MHz, QPSK)



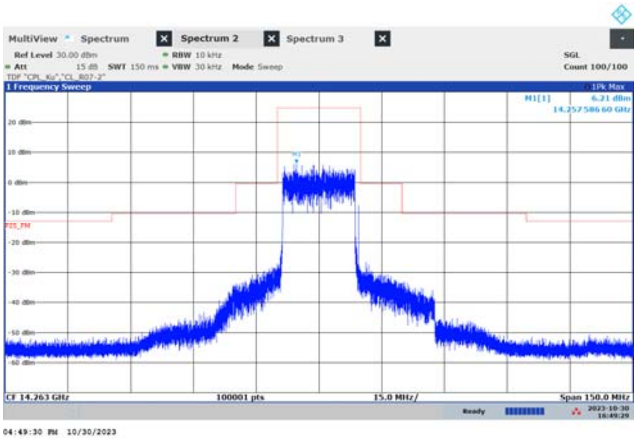
f_{MID} (39.6 MHz, QPSK)



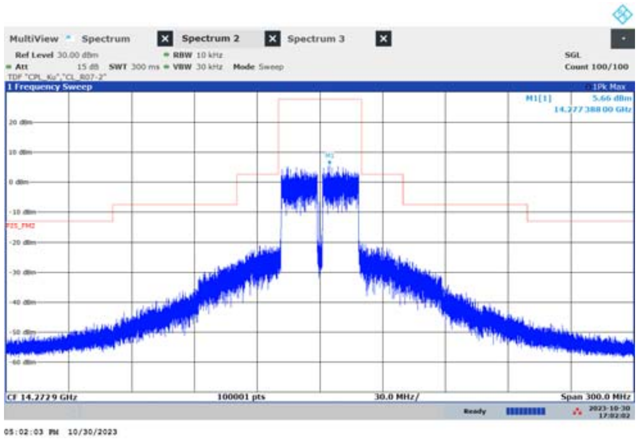
f_{MID} (19.8 MHz, 8PSK)



f_{MID} (39.6 MHz, 8PSK)

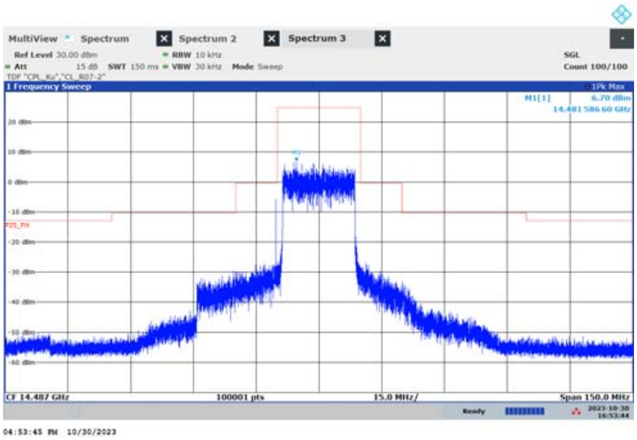


f_{MID} (19.8 MHz, 16QAM)

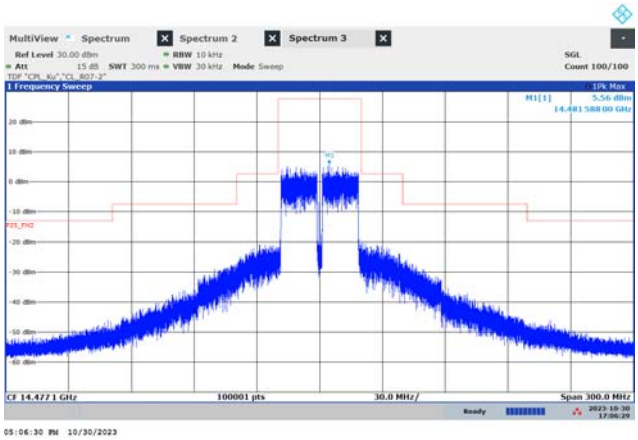


f_{MID} (39.6 MHz, 16QAM)

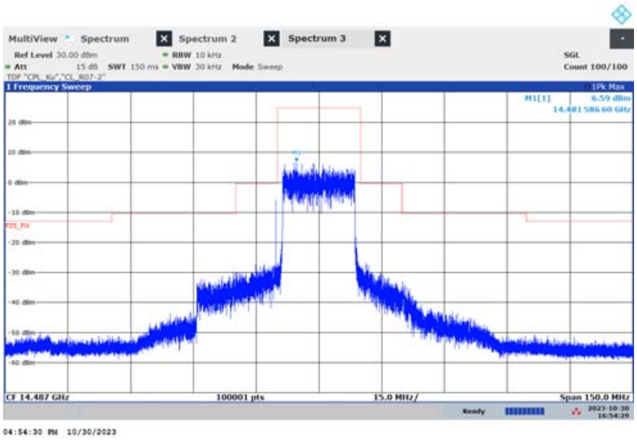
Out-of-band emissions (OOBE) and Band-edge measurements for each Bandwidth and Modulation



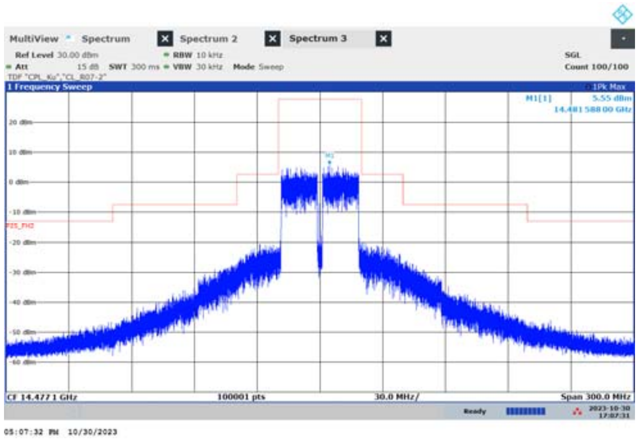
f_{HIGH} (19.8 MHz, QPSK)



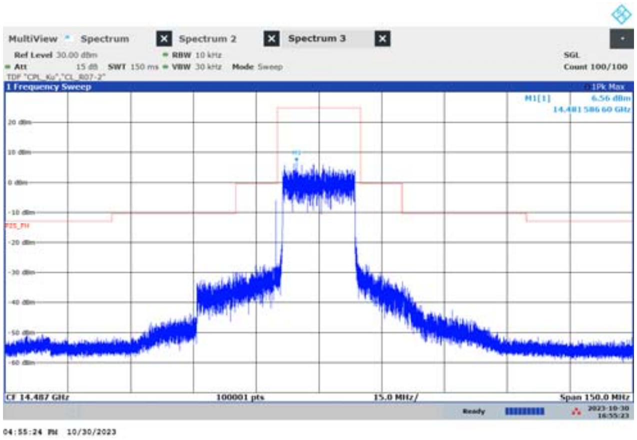
f_{HIGH} (39.6 MHz, QPSK)



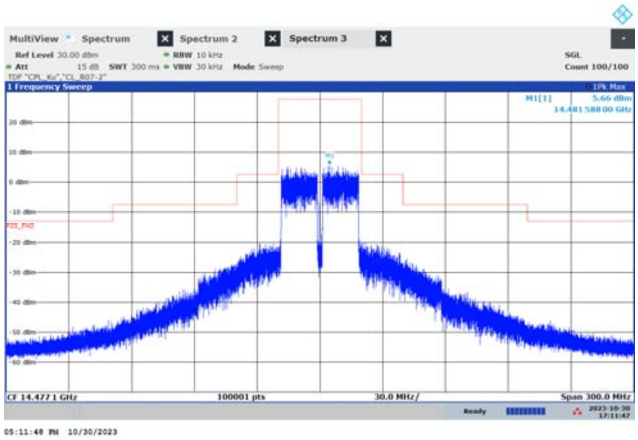
f_{HIGH} (19.8 MHz, 8PSK)



f_{HIGH} (39.6 MHz, 8PSK)



f_{HIGH} (19.8 MHz, 16QAM)



f_{HIGH} (39.6 MHz, 16QAM)