



# MEASUREMENT REPORT

## FCC PART 30

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**FCC ID:** XIA-CFW2591  
**Applicant:** NetComm Wireless Pty Ltd  
  
**Application Type:** Certification  
**Product:** 5G High Power mmWave Outdoor CPE  
**Model No.:** CFW-2591  
**Brand Name:** Casa Systems  
**FCC Rule Part(s):** Part 30  
**Test Date:** November 05, 2021 ~ January 30, 2022

**Reviewed By:**

\_\_\_\_\_  
Sunny Sun

**Approved By:**

\_\_\_\_\_  
Robin Wu



The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.26-2015. Test results reported herein relate only to the item(s) tested.

The test report shall not be reproduced except in full without the written approval of MRT Technology (Suzhou) Co., Ltd.

## Revision History

Report No.	Version	Description	Issue Date	Note
2110RSU037-U7	Rev. 01	Initial Report	12-08-2021	Invalid
2110RSU037-U7	Rev. 02	updated the antenna description	12-16-2021	Invalid
2110RSU037-U7	Rev. 03	updated the frequency range of array gain	01-14-2022	Invalid
2110RSU037-U7	Rev. 04	Added the TRP test results	02-07-2022	Invalid
2110RSU037-U7	Rev. 05	Updated the section 4.1 with TRP test result	02-23-2022	Valid

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#### 1.4. Product Information

Product Name	5G High Power mmWave Outdoor CPE
Model No.	CFW-2591
Brand Name	Casa Systems
E-UTRA Band	Band 4, 5, 12, 17, 41, 48, 66
FR1 NR Band	n66
FR2 NR Band	n261
Bluetooth Specification	V4.1 BLE only
Antenna Information	Refer to section 1.6
Operating Temperature	-40 ~ 55 °C
Remark:	
1. The information of EUT was provided by the manufacturer, and the accuracy of the information shall be the responsibility of the manufacturer.	

#### 1.5. Radio Specification under Test

Frequency Range	n261: 27500 ~ 28350MHz
Component Carrier (CC)	1CC, 2CC
Support Bandwidth	Single Carrier: 50MHz, 100MHz, 200MHz, 400MHz Multi-Carrier: 50+50MHz, 100+100MHz
Modulation	CP-OFDM: QPSK / 16QAM / 64QAM DFT-s-OFDM: Pi/2 BPSK/QPSK / 16QAM / 64QAM / 256QAM

#### 1.6. Description of Available Antennas

Technology	Frequency Range (MHz)	Antenna Type	Antenna Gain (dBi)
n261	26500 ~ 29500	Patch Array	22.0

Note 1: All antenna information (Antenna type and Peak Gain) is provided by the manufacturer.

Note 2: There are 2 QTM527 antenna array modules. Each QTM527 contains 2 submodules. Each submodule consists of 2 4x4 subarrays providing V+H beam pair beam for 2x2 UL MIMO. These 5G arrays antenna modules can operate simultaneously. As for beam-steering/beam-forming mechanism, the wide beam-width on the best array, sweeps begin to improve link, and beam-width then reduces on best beam location. The codebook of antenna array configuration can find 8-element and 64-element patch antenna combination beam, Vertical and Horizontal beam can operate at the same time.

### 1.7. Test Methodology

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ANSI C63.26:2015
- FCC CFR 47 Part 30
- FCC KDB 971168 D01 v03r01: Power Meas License Digital Systems
- FCC KDB 842590 D01 Upper Microwave Flexible Use Service v01r02

### 1.8. Device Capabilities

The EUT can be configured to transmit a single beam (SISO), intra-band CA and beam-paired (MIMO) configurations, respectively.

Preliminary EIRP test was performed for all beam configurations by the manufacturer, so the EIRP worst case single beam / beam-pair were identified.

The NR radio operation is controlled via software tool QRCT FTM mode (Factory mode). The EUT is forced to operate continuously (100% duty cycle) with maximum output power during the tes. MIMO operation was achieved by enabling two Beam IDs at the same time.

### 1.9. Test Mode Applicability

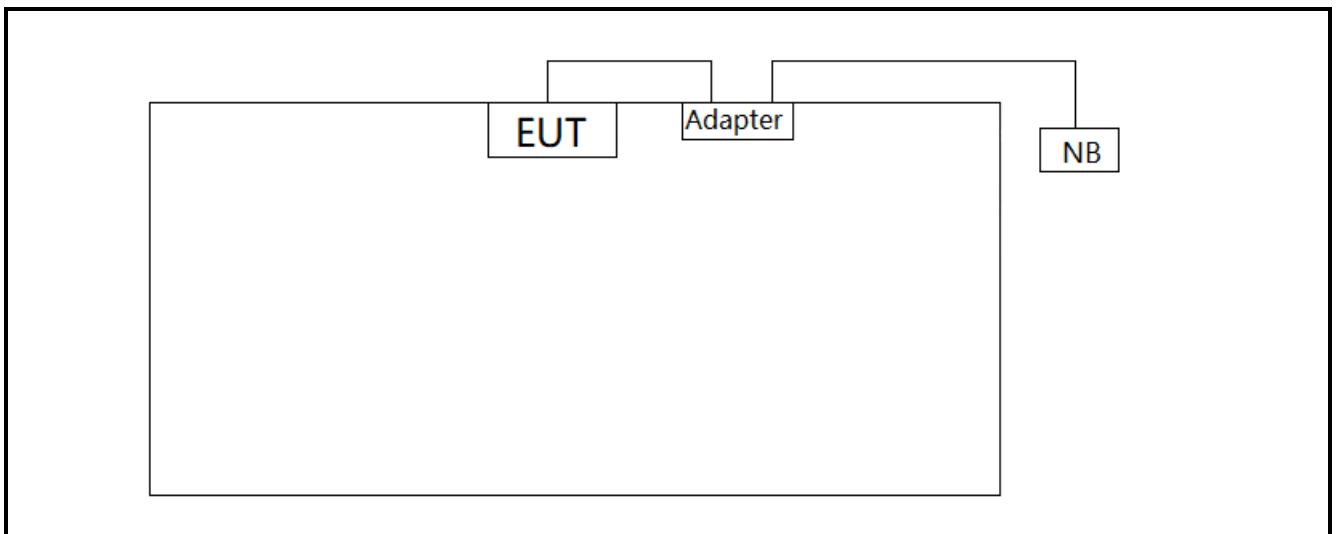
Test Item	Beam ID		Axis (X, Y, Z)
	SISO, Intra-Band CA	MIMO	
<b>n261_1CC</b>			
Occupied Bandwidth	63	--	X
EIRP	63	63+319	X
Spurious Emission	63	--	X
Band Edge	63	63+319	X
<b>n261_2CC</b>			
Occupied Bandwidth	63	--	X
EIRP	63	--	X
Spurious Emission	63	--	X
Band Edge	63	--	X
Note: EIRP test item was performed for all beam configurations (max array gain), then choose the worst Beam ID with other test items.			

Test Item	BW (MHz)		Modulation				CH.	RB		
	50	100	BPSK	QPSK	16QAM	64QAM		1	Inner	Full
<b>1CC</b>										
Occupied Bandwidth	√	√	√	√	√	√	L, M, H	--	--	√
EIRP	√	√	√	√	√	√	L, M, H	--	√	--
Spurious Emission	√	√	√	--	--	--	L, M, H	√	--	√
Band Edge	√	√	√	√	--	--	L, M	√	--	√
Frequency Stability	CW						M	CW		
<b>2CC, MIMO</b>										
Occupied Bandwidth	√	√	√	√	√	√	L, M, H	--	--	√
EIRP	√	√	√	√	√	√	L, M, H	--	√	√
Spurious Emission	√	√	√	--	--	--	L, M, H	√	--	√
Band Edge	√	√	√	√	--	--	L, M	√	--	√
Note: The mark "√" means that this configuration is chosen for testing.										

### 1.10. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

### 1.11. Configuration of Tested System





## 1.12. Calculations of Measurement Result

### EIRP Caculation

According to KDB 971168 D01 Section 5.8.4:

$E$  (dB $\mu$ V/m) = EIRP (dBm) - 20 log D + 104.8; where D is the measurement distance in meters.

$E$  (dBuV/m) = Spectrum Reading Level (dBm) + Antenna Factor (dB/m) + Cable Loss (dB) + 107

Then, the offset = Antenna Factor (dB/m) + Cable Loss (dB) + 107 + 20log (D) - 104.8

Example:

Offset = Antenna Factor (dB/m) + Cable Loss (dB) + 107 + 20log (D) - 104.8

= 42.4 + 5.5 + 107 + 20log (1) - 104.8

= 50.1 dB

### MIMO Power Caculation

According to KDB 662911 D02, with cross-polarization the two field strengths must be combined as vectors with one oriented at a 90 degree angle with respect to the other. The combined EIRP or ERP is equal to the sum of the individual EIRPs or ERPs.

Example:

MIMO EIRP =  $10^{\log \{10^{(\text{Horizontal EIRP} / 10)} + 10^{(\text{Vertical EIRP} / 10)}\}}$

## 1.13. Minimum Measurement Distance Evaluation

According to KDB842590 D01, the measurements of the fundamental emission, out of band, harmonics and spurious emissions shall be made in the far field of the measurement antenna. The far-field boundary for mmW antennas is greater than or equal to  $2D^2/\lambda$  (with D being the largest dimension of the antenna, and  $\lambda$  the wavelength of the emission). When the selected far-field measurement distance is different than the distance at which the applicable limit is specified, a linear inverse distance attenuation factor (20 dB/decade of distance change for field strength) shall be applied.

For fundamental or out-of-band emissions the largest far-field distance of either the EUT antenna or measurement antenna shall be used. For spurious emissions the far-field distance will be based on the measurement antenna.

### **Fundamental or out-of-band emissions**

Frequency Range (GHz)	Antenna Dimension (EUT)		Far Field Distance (m)		Measurement Distance (m)
	Width (mm)	Heigth (mm)			
27.5 ~ 40	42.6	42.6	0.33	0.48	1

### Spurious Emission

Frequency Range GHz)	Measurement Antenna Model	Antenna Dimension (Measurement Antenna)		Far Field Distance (m)		Measurement Distance (m)
		Width (mm)	Height (mm)			
18 ~ 40	BBHA 9170	60	44	0.43	0.96	1
40 ~ 50	261U-25	46	34.7	0.56	0.71	1
50 ~ 75	LB-15-25-A	38	31	0.48	0.72	1
75 ~ 110	LB-10-25-A	28	22	0.39	0.57	1
110 ~ 140	261F	21	17	0.32	0.41	1
140 ~ 220	261G	14	12	0.18	0.29	1

#### 1.14. Test Environment Condition

Ambient Temperature	15 ~ 35°C
Relative Humidity	20 ~ 75%RH

## 2. TEST EQUIPMENT CALIBRATION DATE

Instrument	Manufacturer	Type No.	Asset No.	Characteristics	Cali. Due Date
EMI Test Receiver	R&S	ESR3	MRTSUE06613	9kHz~3.6GHz	2022/06/24
EXA Signal Analyzer	Keysight	N9030B	MRTSUE06395	3Hz-50GHz	2022/08/08
Bilog Period Antenna	Schwarzbeck	VULB9168	MRTSUE06646	30MHz~1GHz	2022/08/26
Horn Antenna	Schwarzbeck	BBHA9120D	MRTSUE06648	1GHz~18GHz	2022/11/09
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	MRTSUE06599	18GHz~40GHz	2022/10/20
Preamplifier	EMCI	EMC051845SE	MRTSUE06644	500MHz~18GHz	2022/11/08
Micro-Wave Antenna	MI-WWAVE	261U-25	MRTSUE06273	40~60GHz	N/A
Standard Gain Horn Antenna	A-INFOMW	LB-15-25-A	MRTSUE06409	50-75GHz	N/A
Standard Gain Horn Antenna	A-INFOMW	LB-10-25-A	MRTSUE06410	75-110GHz	N/A
Waveguide Harmonic Mixer	Keysight	M1970V	MRTSUE06271	50~75GHz	N/A
Waveguide Harmonic Mixer	Keysight	M1970W	MRTSUE06272	75~110GHz	N/A
Thermal Hygrometer	testo	608-H1	MRTSUE06624	T: 0~50°C; H: 10~95%RH	2022/12/02
Anechoic Chamber	RIKEN	SIP-AC2	MRTSUE06781	N/A	2022/12/23
EMC Cable	HUBER+SUHNER	SF106	MRTSUE06875	N/A	2022/12/24
EMC Cable	HUBER+SUHNER	SF106	MRTSUE06878	N/A	2022/12/24
High & Low Temperature Chamber	BAOYT	BYG-408CS	MRTSUE06847	-70~150°C	2022/02/23

### Radiated Spurious Emission & TRP Test Software

Software	Version	Function
EMI Software	V3	EMI Test Software

### 3. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k = 2$ .

#### Radiated Spurious Emissions

Measurement Uncertainty for a Level of Confidence of 95% ( $U=2Uc(y)$ ):

Horizontal: 9kHz ~ 300MHz: 5.04dB

300MHz ~ 1GHz: 4.95dB

1GHz ~ 40GHz: 6.40dB

40GHz ~ 200GHz: 6.88dB

Vertical: 9kHz ~ 300MHz: 5.24dB

300MHz ~ 1GHz: 6.03dB

1GHz ~ 40GHz: 6.40dB

40GHz ~ 200GHz: 6.88dB

## 4. TEST RESULT

### 4.1. Summary

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1049	Occupied Bandwidth	N/A	Radiated	Pass	Section 4.2
2.1055	Frequency Stability	Within the band		Pass	Section 4.3
30.202	EIRP	< 55 dBm		Pass	Section 4.4
30.203	Out-of-Band Emission at the Band Edge	-13dBm/MHz for all out-of-band emissions, -5dBm/MHz from the band edge up to 10% of the channel BW		Pass	Section 4.5
30.203	Out-of-Band Emission with TRP Method	Total radiated power of any emission outside a licensee's frequency block shall be -13 dBm/MHz or lower.		Pass	Section 4.5
30.203	Spurious Emission	< -13dBm/MHz		Pass	Section 4.6

#### Notes:

- 1) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
- 2) Per 2.1057(a)(2), spurious emissions were investigated up to 100GHz for n261.
- 3) The device is investigated from 30MHz to 100GHz of fundamental signal for radiated spurious emission test under different RB size and modulations in exploratory test. Subsequently, only the worst case emissions are reported.
- 4) The simultaneous transmission of multiple radios, millimeter wave (n261), LTE were verified, and no new emissions were found.

## 4.2. Occupied Bandwidth

### 4.2.1. Test Limit

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.

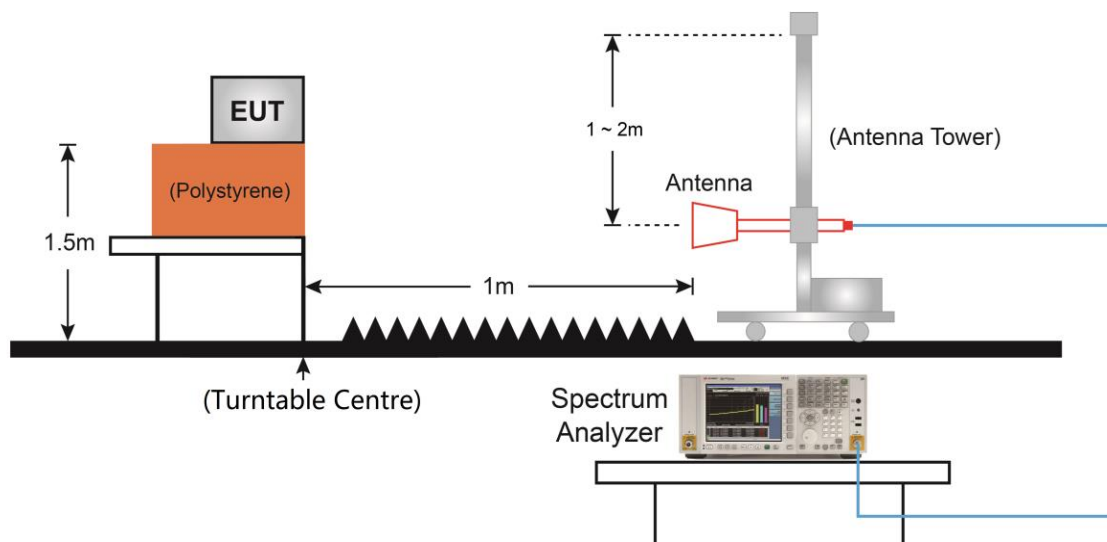
### 4.2.2. Test Procedure

ANSI C63.26-2015 - Section 5.4

### 4.2.3. Test Setting

1. Set center frequency to the nominal EUT channel center frequency
2. RBW = The nominal RBW shall be in the range of 1% to 5% of the anticipated OBW
3. VBW  $\geq 3 \times$  RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. Allow the trace to stabilize
8. Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

### 4.2.4. Test Setup



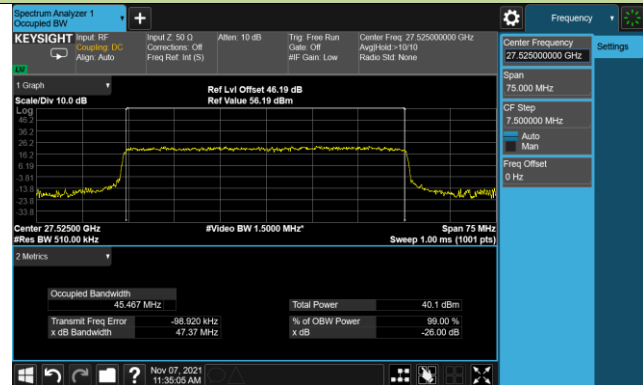
**4.2.5.Test Result**

Product	5G High Power mmWave Outdoor CPE	Test Site	SIP-AC2
Test Engineer	Allen Zou	Test Date	2021/11/07
Test Mode	n261_SISO Mode_ DFT		

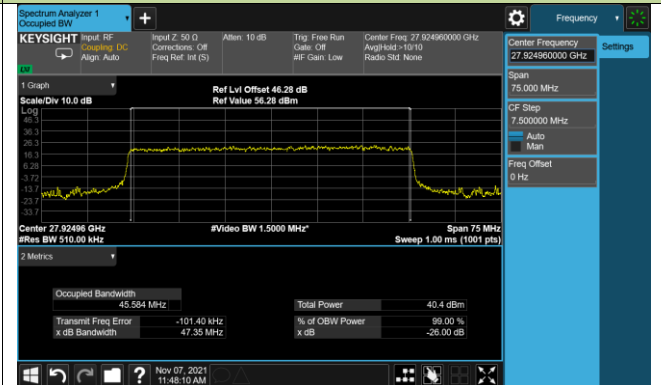
Channel	99% Occupied Bandwidth (MHz)				
	BPSK	QPSK	16QAM	64QAM	256QAM
<b>50MHz</b>					
Low CH	45.47	45.54	45.66	45.63	45.55
Middle CH	45.58	45.64	45.63	45.57	45.57
High CH	45.48	45.68	45.70	45.70	45.53
<b>100MHz</b>					
Low CH	91.35	91.30	91.23	91.40	91.10
Middle CH	91.15	91.27	91.24	91.31	91.26
High CH	91.34	91.61	91.40	91.43	91.33
<b>200MHz</b>					
Low CH	182.48	182.49	182.38	182.36	182.99
Middle CH	182.50	182.76	182.62	182.43	182.85
High CH	182.95	183.09	182.83	182.83	183.14
<b>400MHz</b>					
Low CH	364.45	364.53	365.28	364.56	365.11
Middle CH	363.95	364.04	364.55	364.23	364.41
High CH	364.53	364.26	364.87	364.36	364.40

99% Bandwidth - BPSK

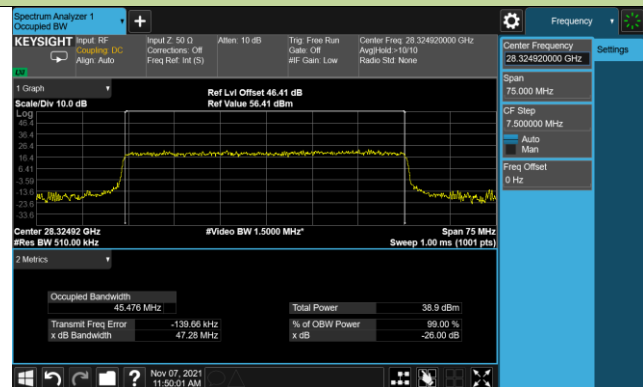
50MHz Low Channel



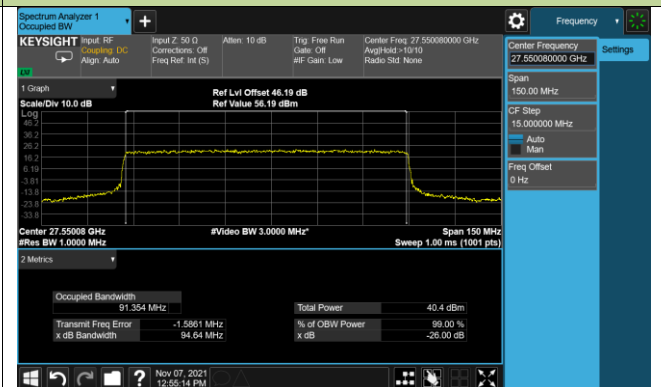
50MHz Middle Channel



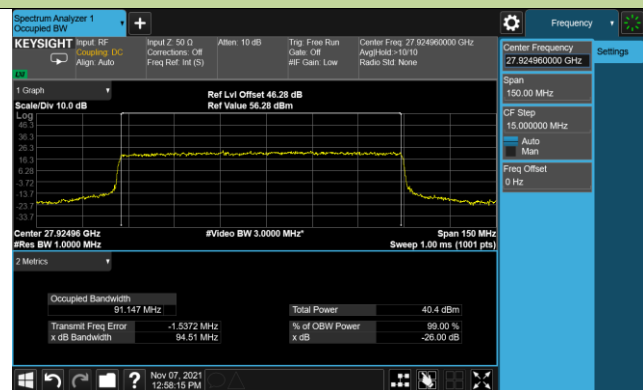
50MHz High Channel



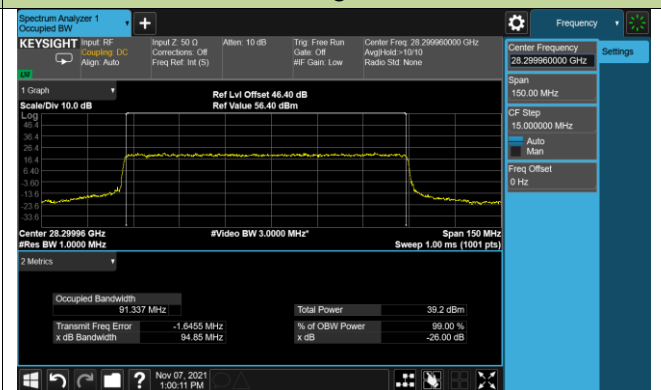
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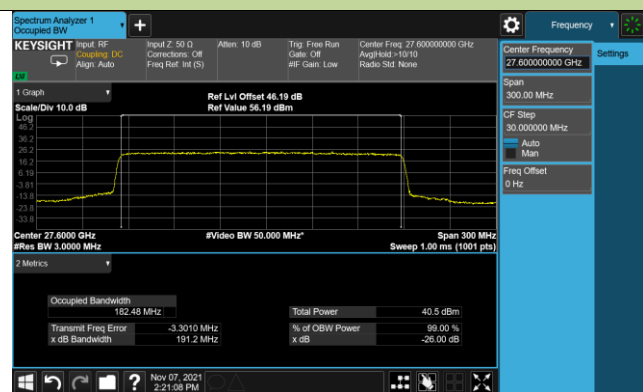
100MHz Middle Channel



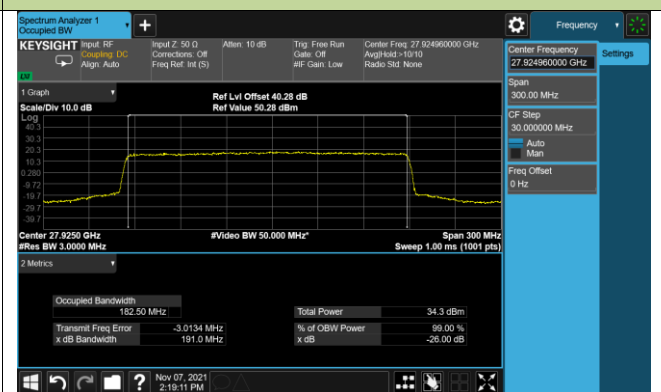
100MHz High Channel



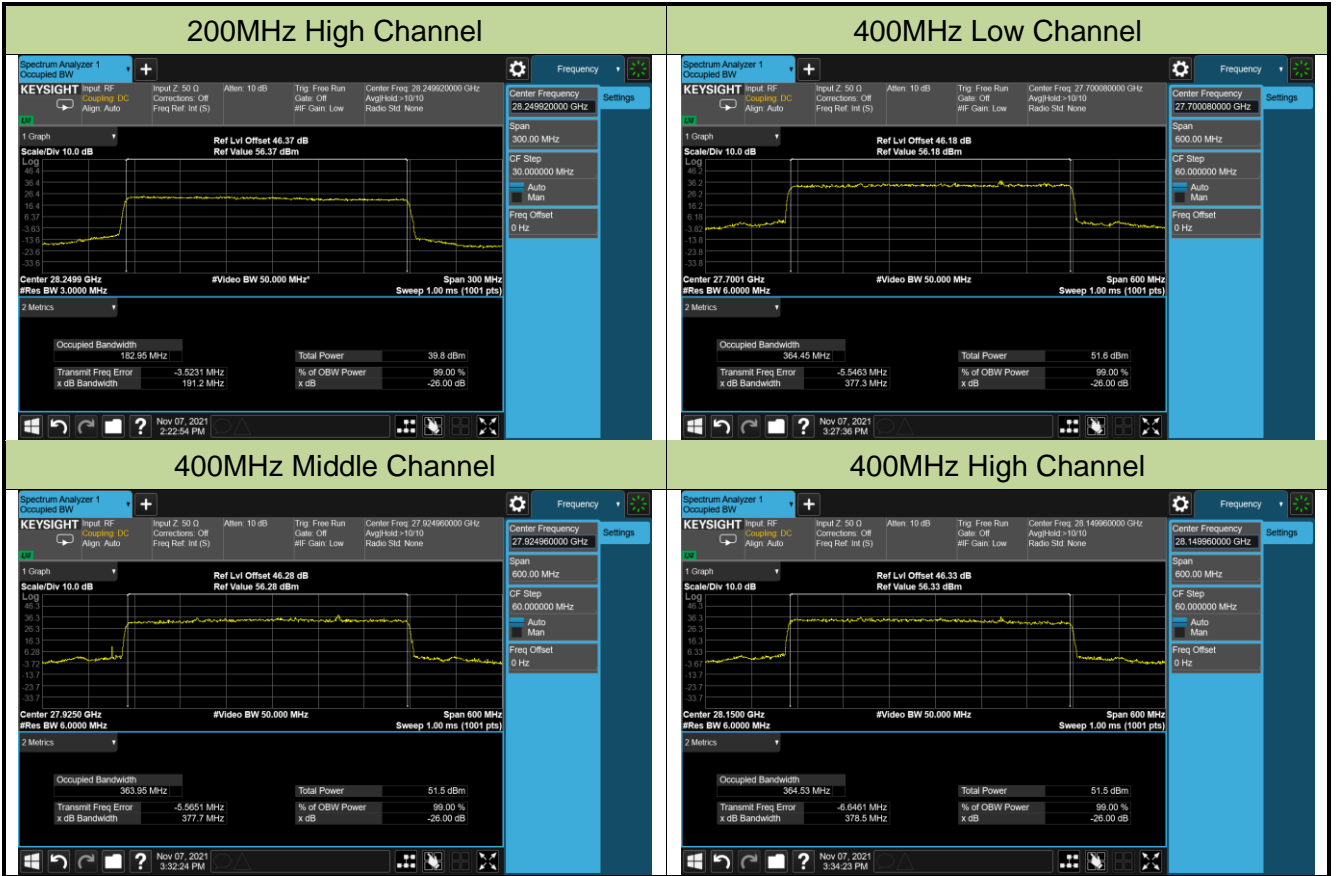
200MHz Low Channel



200MHz Middle Channel

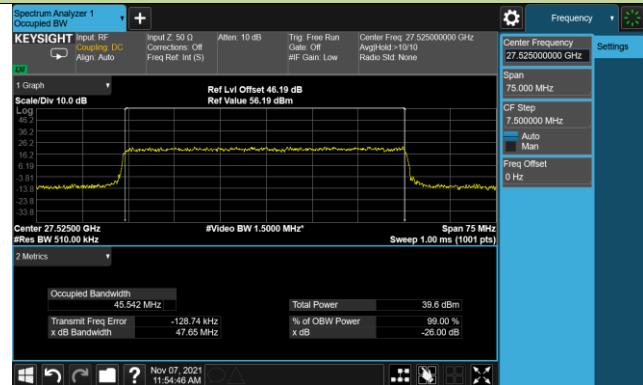




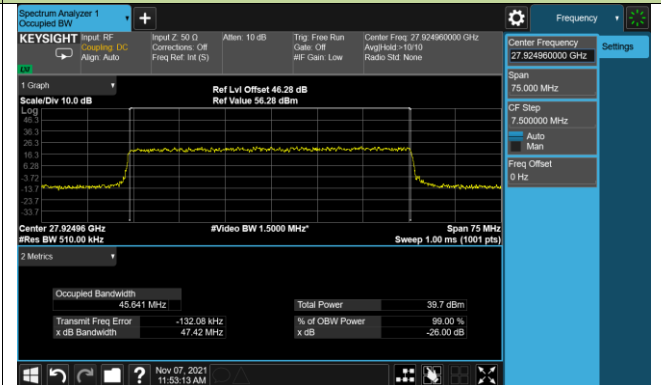


99% Bandwidth - QPSK

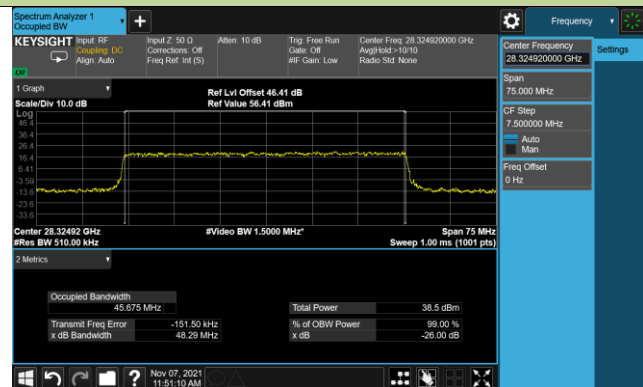
50MHz Low Channel



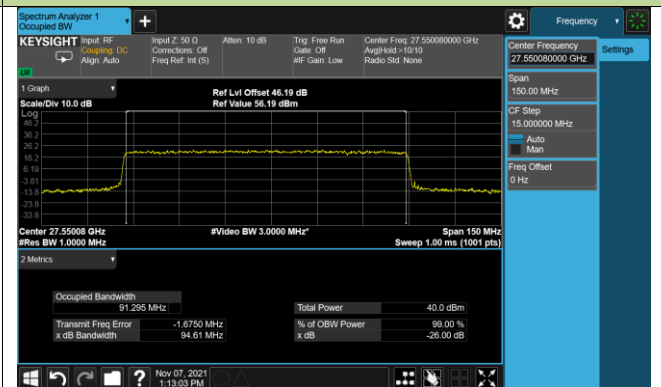
50MHz Middle Channel



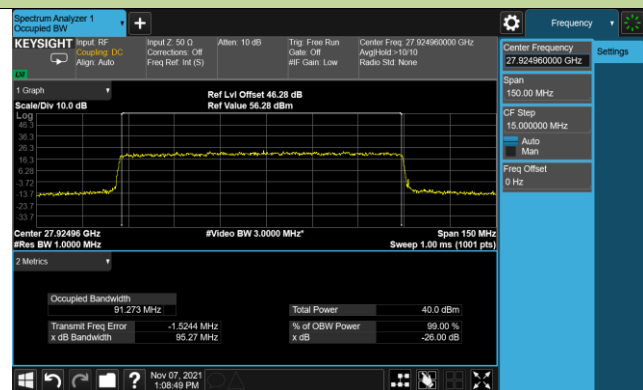
50MHz High Channel



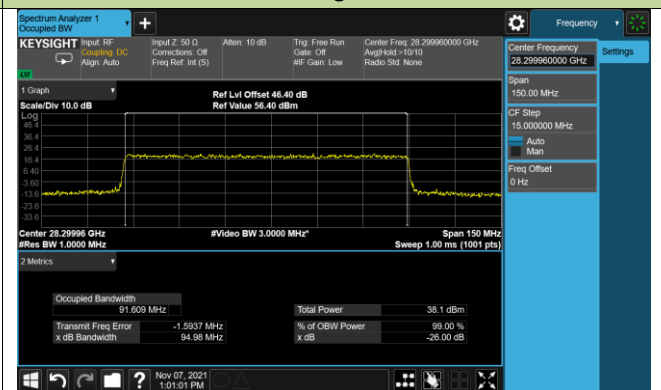
100MHz Low Channel



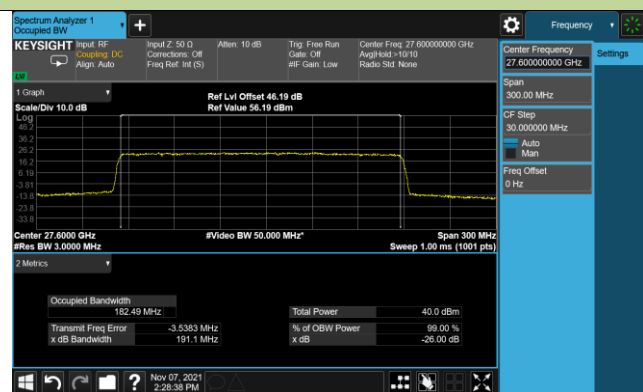
100MHz Middle Channel



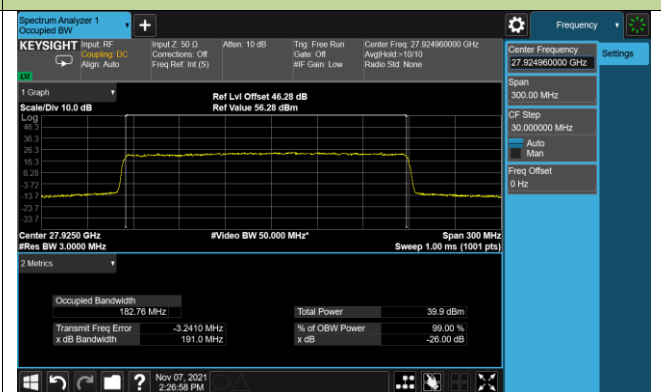
100MHz High Channel

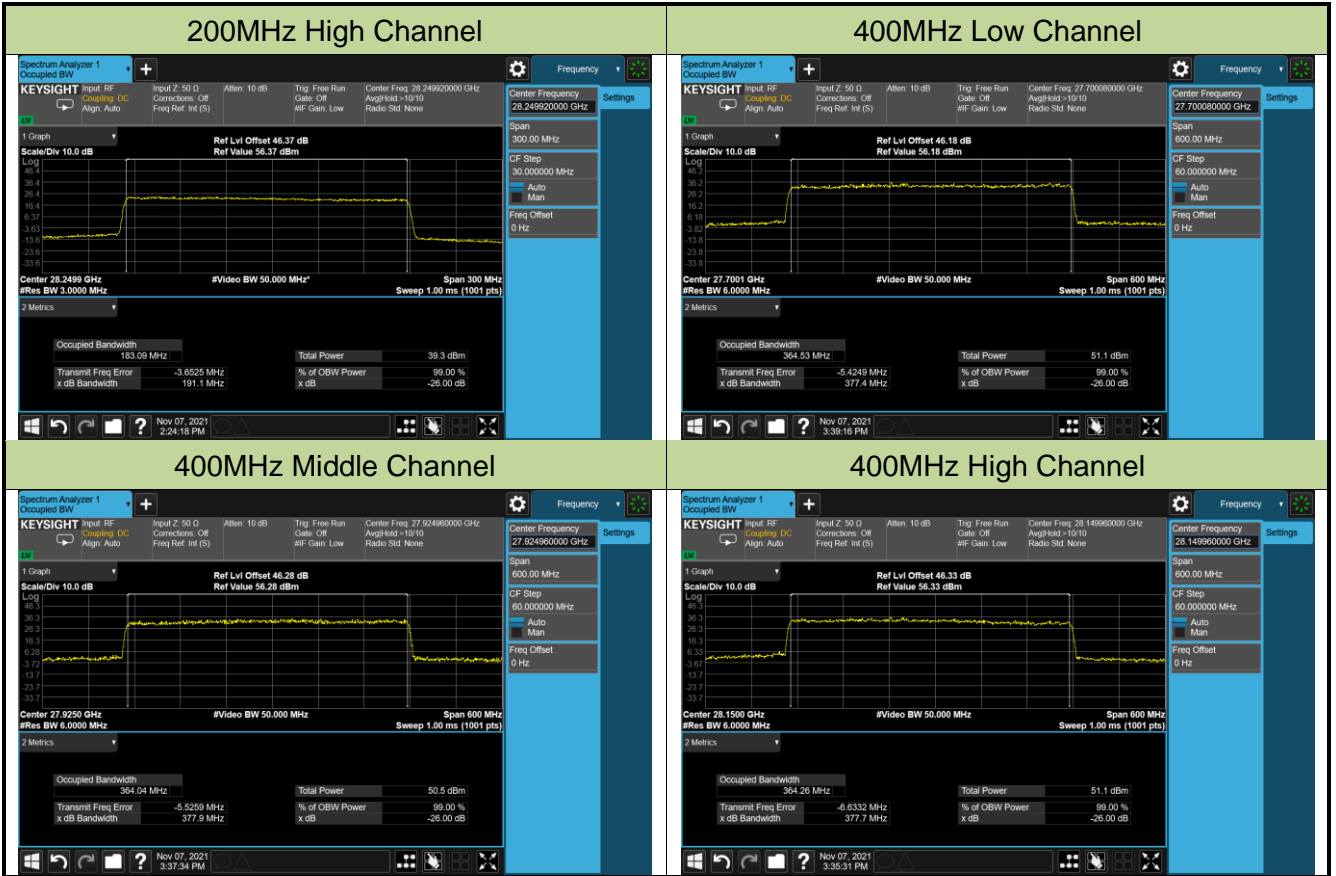


200MHz Low Channel



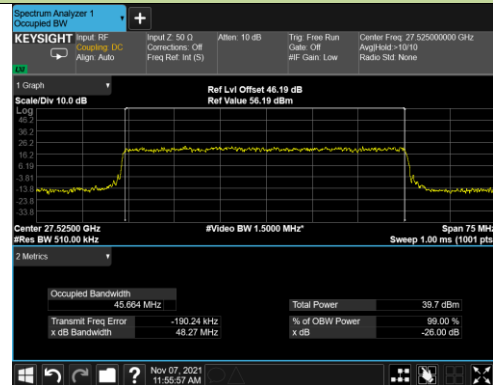
200MHz Middle Channel



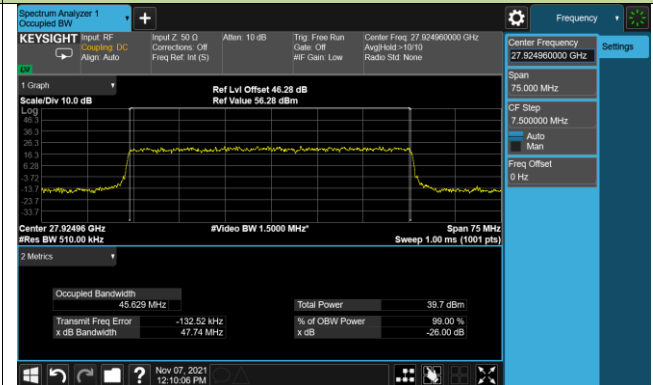


99% Bandwidth - 16QAM

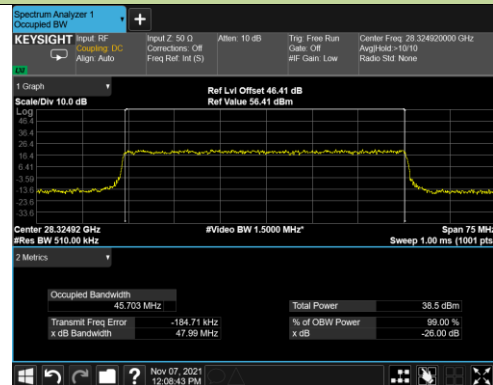
50MHz Low Channel



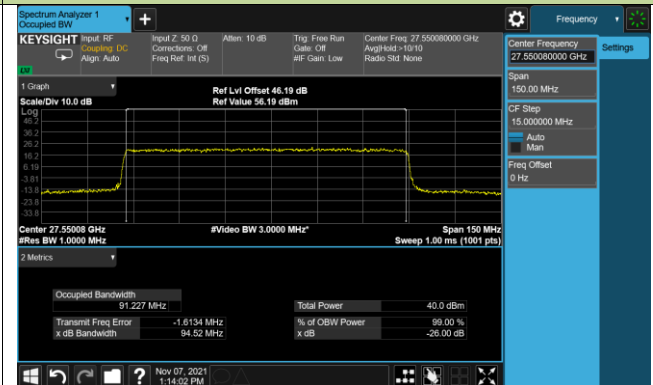
50MHz Middle Channel



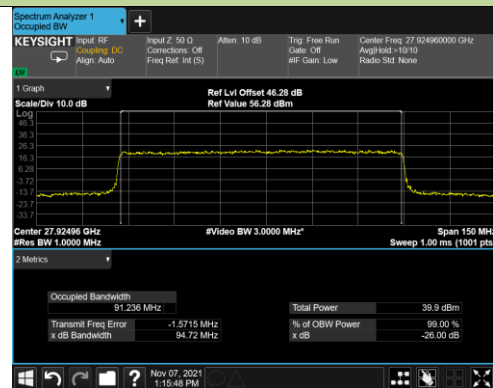
50MHz High Channel



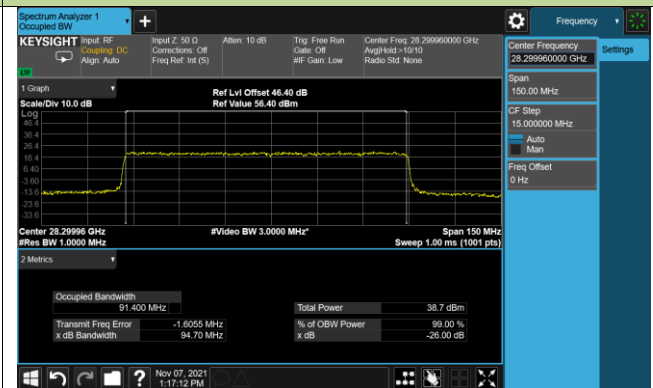
100MHz Low Channel



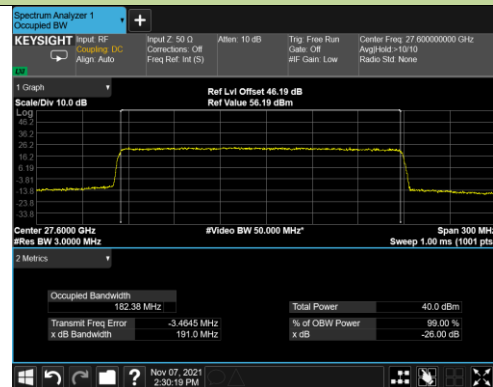
100MHz Middle Channel



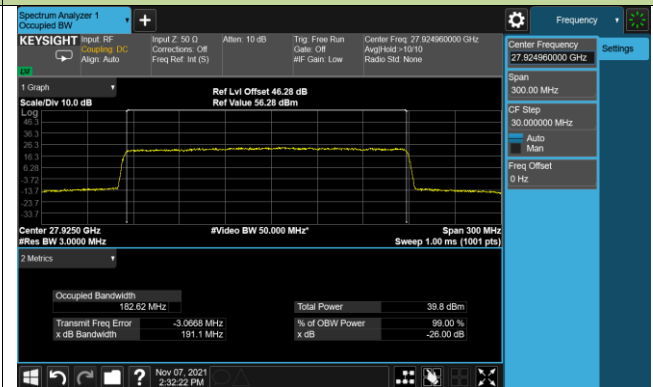
100MHz High Channel



200MHz Low Channel



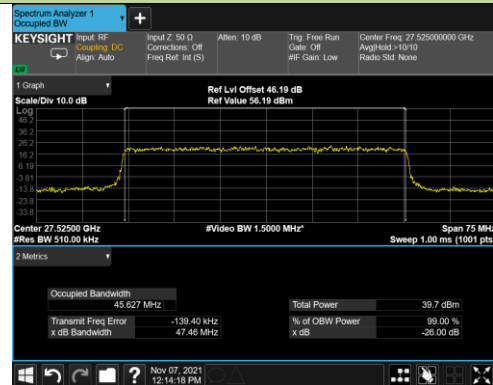
200MHz Middle Channel



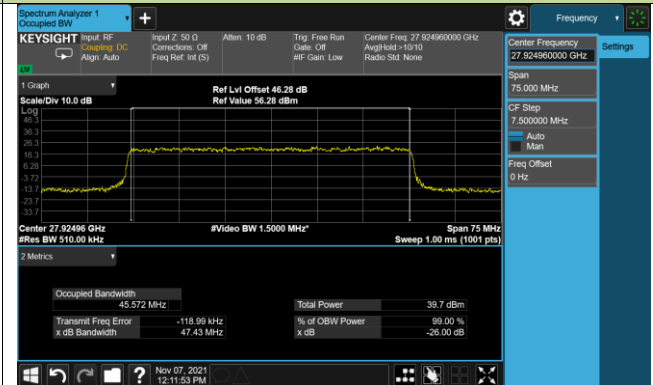


99% Bandwidth - 64QAM

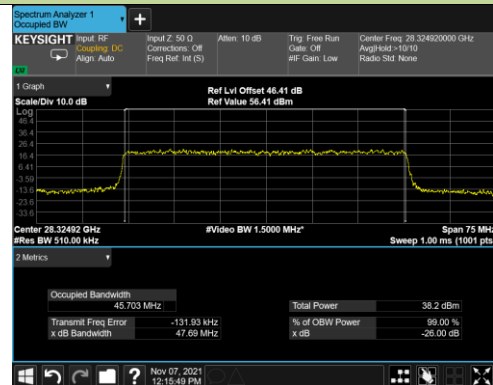
50MHz Low Channel



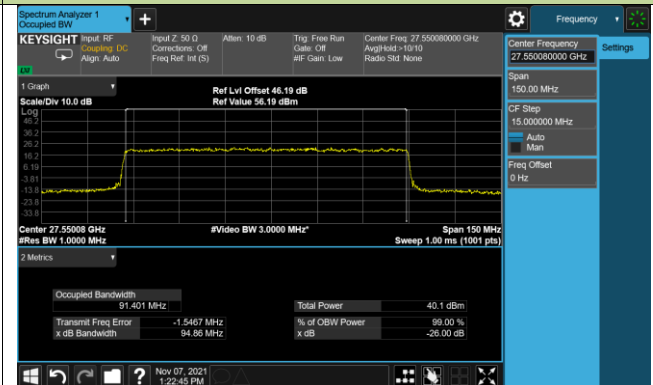
50MHz Middle Channel



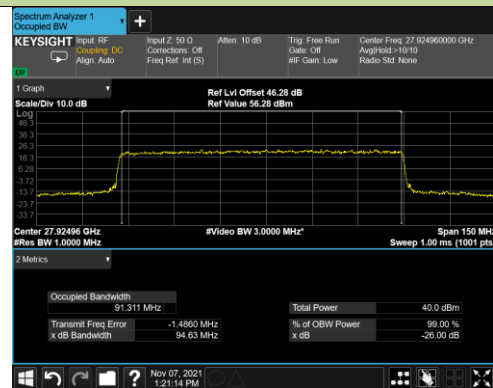
50MHz High Channel



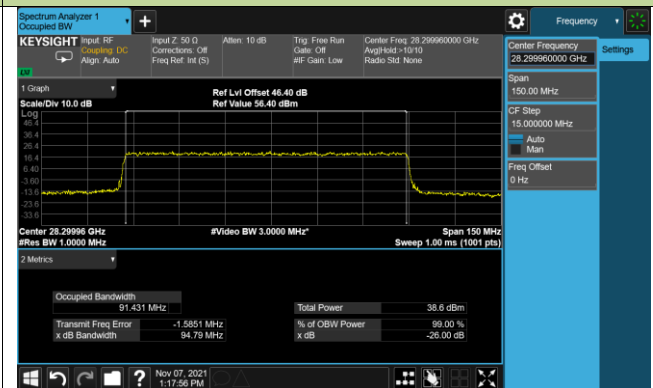
100MHz Low Channel



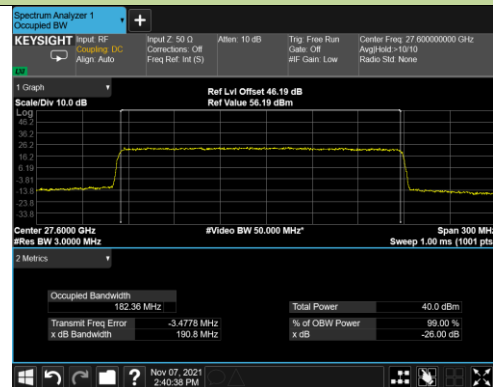
100MHz Middle Channel



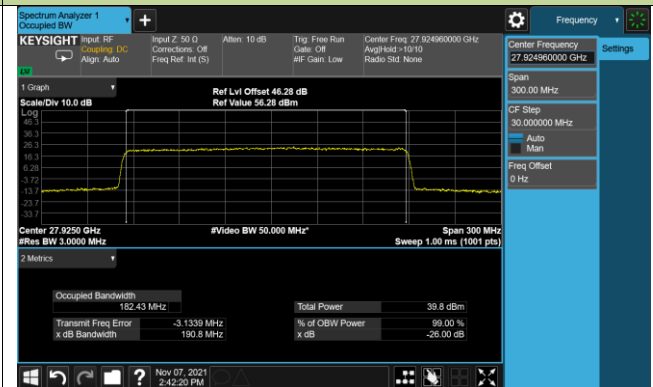
100MHz High Channel

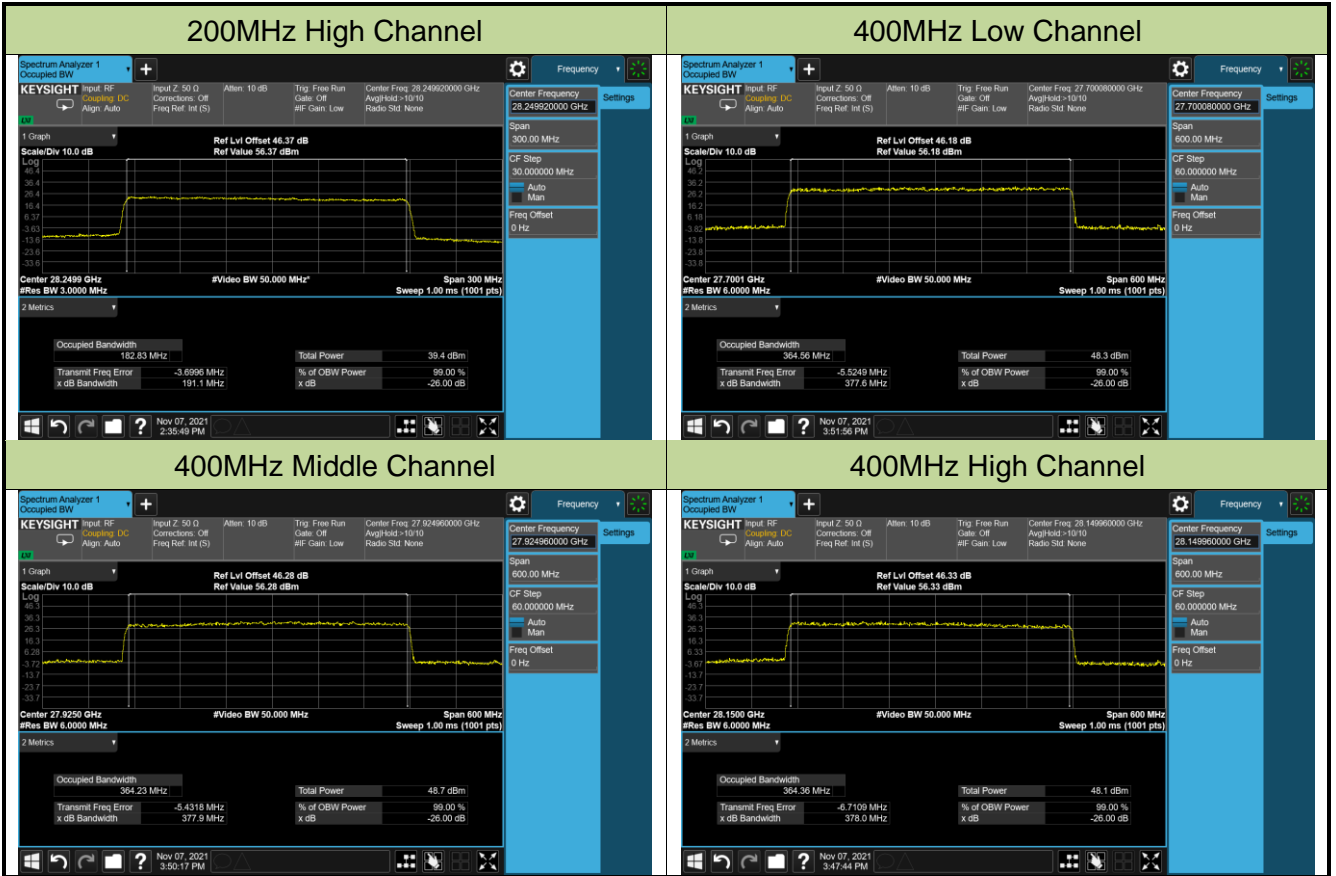


200MHz Low Channel



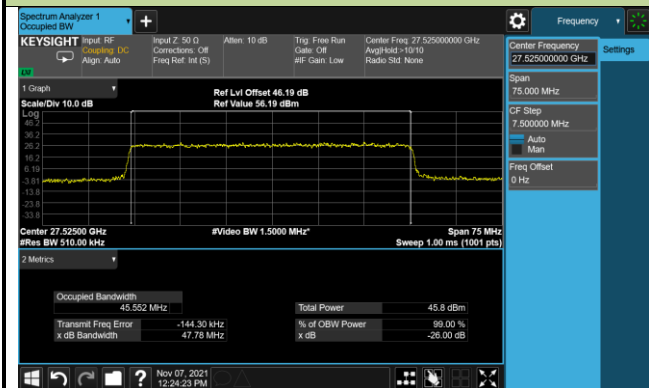
200MHz Middle Channel



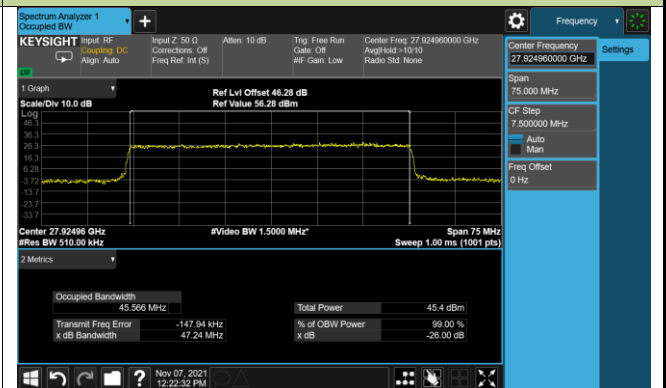


## 99% Bandwidth - 256QAM

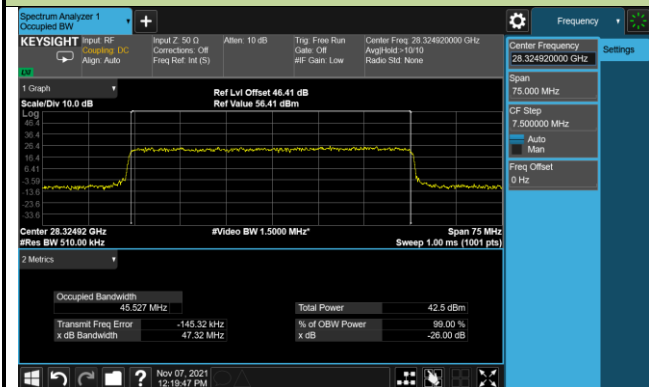
## 50MHz Low Channel



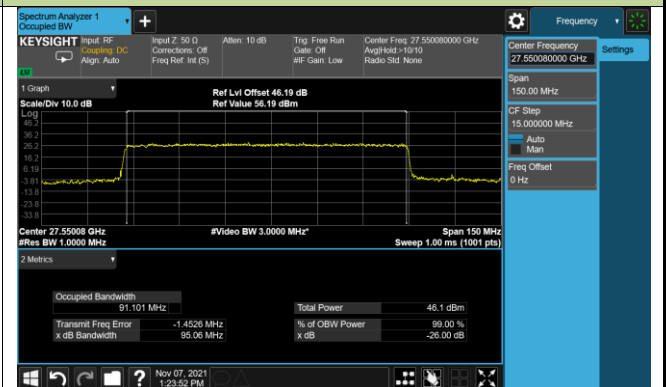
## 50MHz Middle Channel



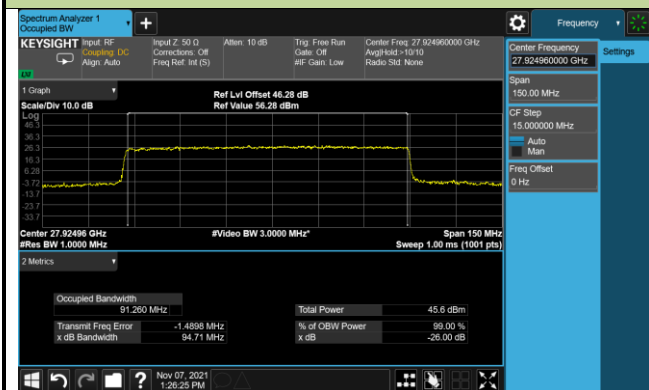
## 50MHz High Channel



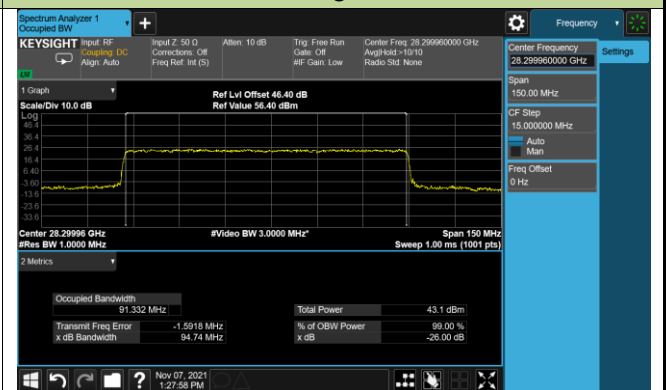
## 100MHz Low Channel



## 100MHz Middle Channel



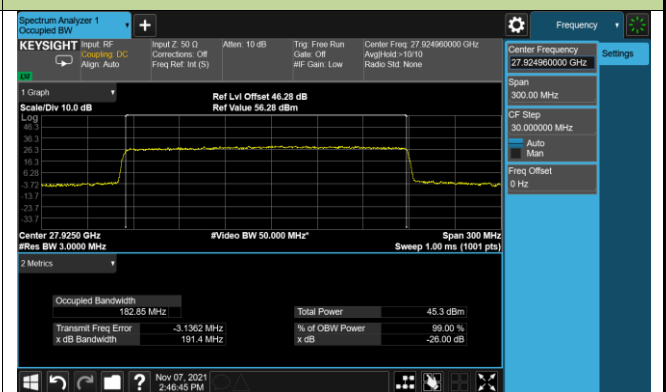
## 100MHz High Channel



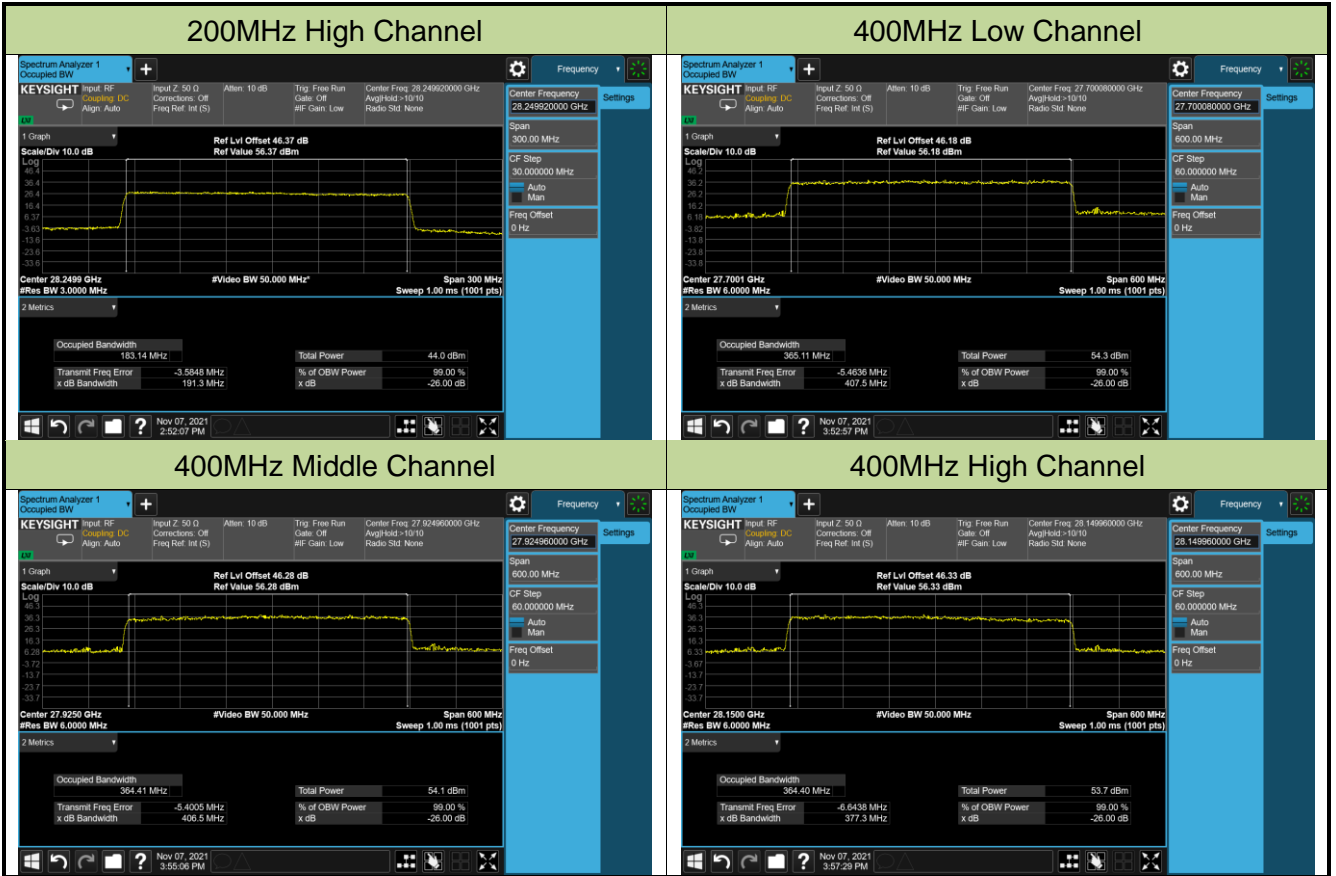
## 200MHz Low Channel



## 200MHz Middle Channel

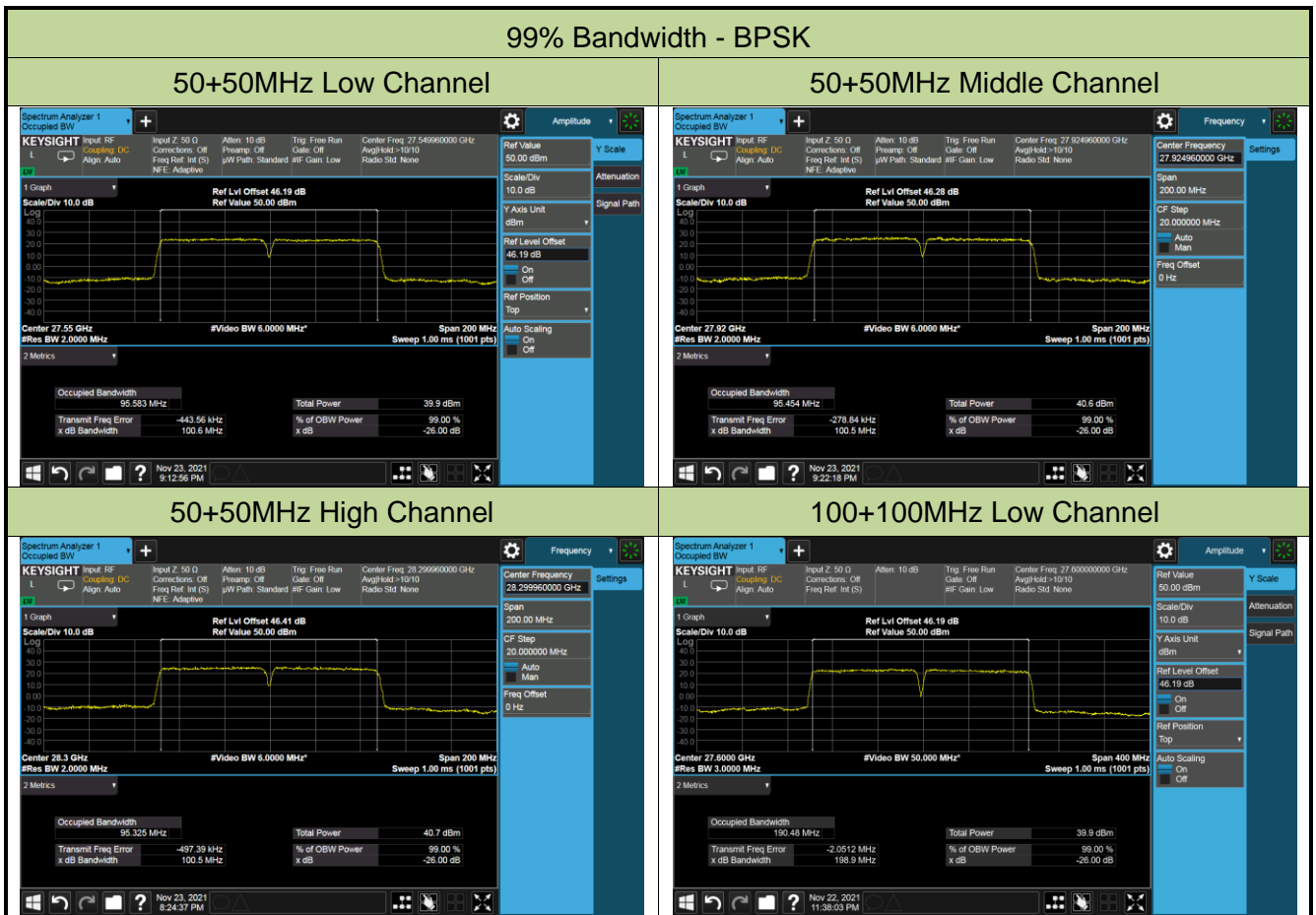


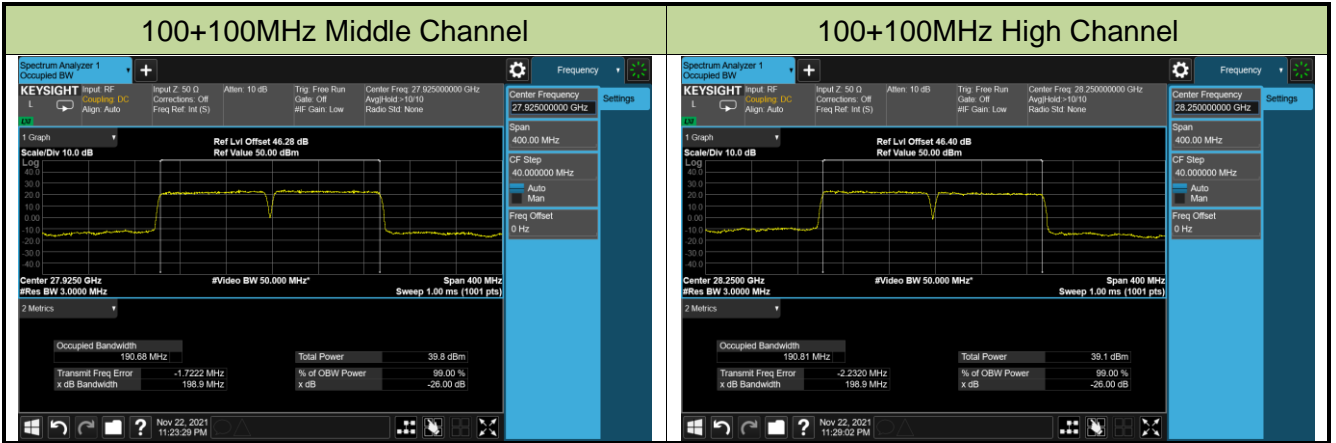




Product	5G High Power mmWave Outdoor CPE	Test Site	SIP-AC2
Test Engineer	Allen Zou	Test Date	2021/11/23 ~ 2021/12/04
Test Mode	n261_2CC		

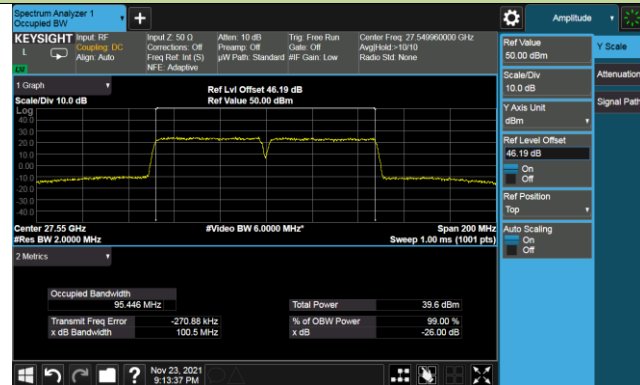
Channel	99% Occupied Bandwidth (MHz)				
	BPSK	QPSK	16QAM	64QAM	256QAM
<b>50+50MHz</b>					
Low CH	95.58	95.45	95.46	95.58	95.96
Middle CH	95.45	95.38	95.26	95.15	96.11
High CH	95.33	95.32	95.14	95.31	96.00
<b>100+100MHz</b>					
Low CH	190.48	190.64	190.41	190.52	191.31
Middle CH	190.68	190.45	190.53	190.65	190.92
High CH	190.81	190.98	190.80	191.05	190.93



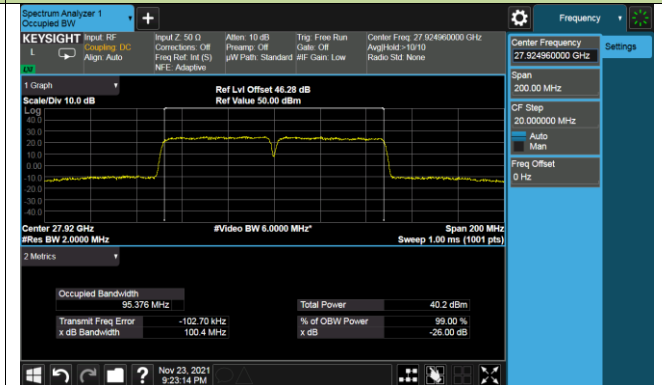


99% Bandwidth - QPSK

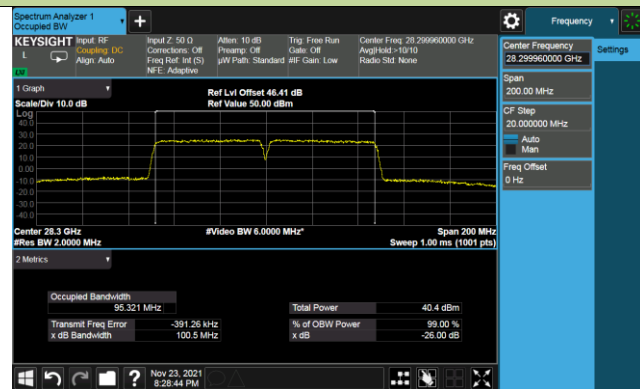
50+50MHz Low Channel



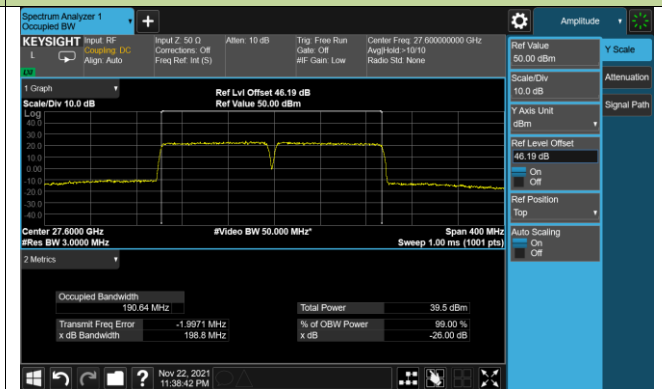
50+50MHz Middle Channel



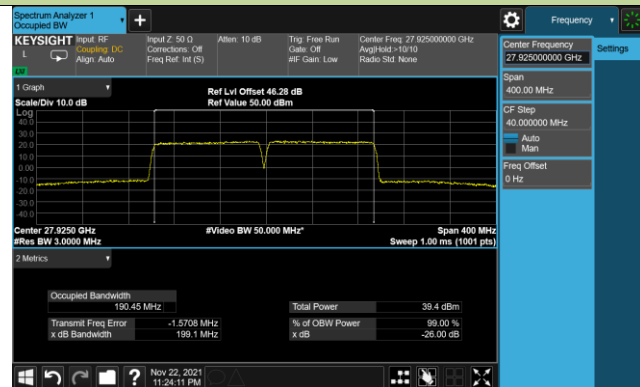
50+50MHz High Channel



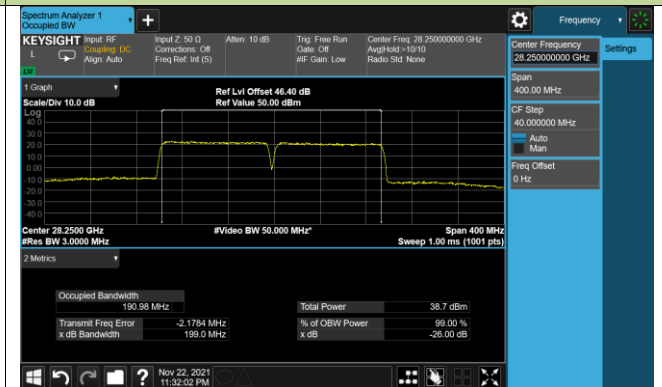
100+100MHz Low Channel



100+100MHz Middle Channel

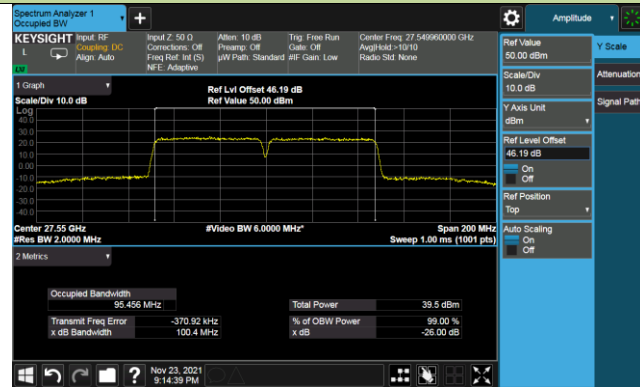


100+100MHz High Channel

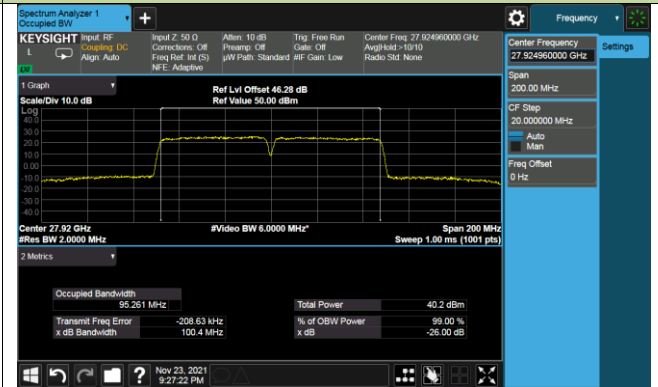


## 99% Bandwidth - 16QAM

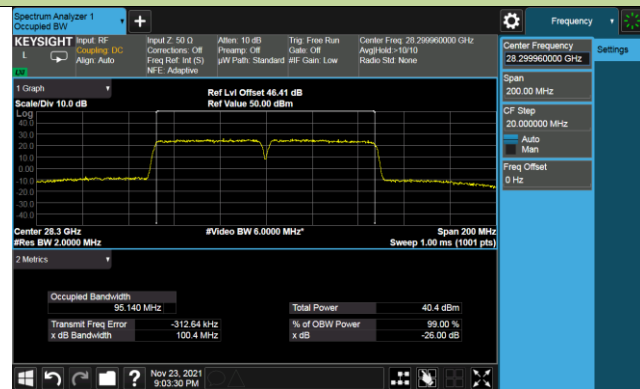
## 50+50MHz Low Channel



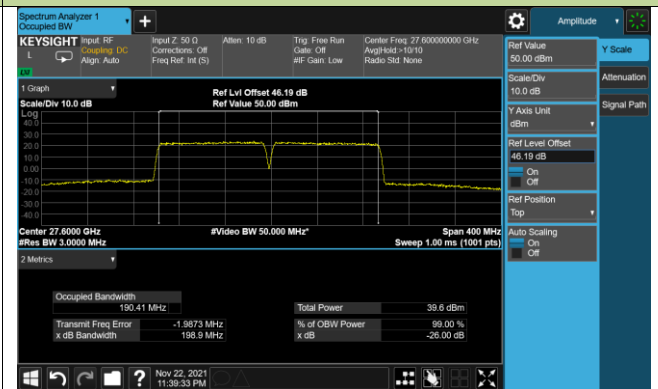
## 50+50MHz Middle Channel



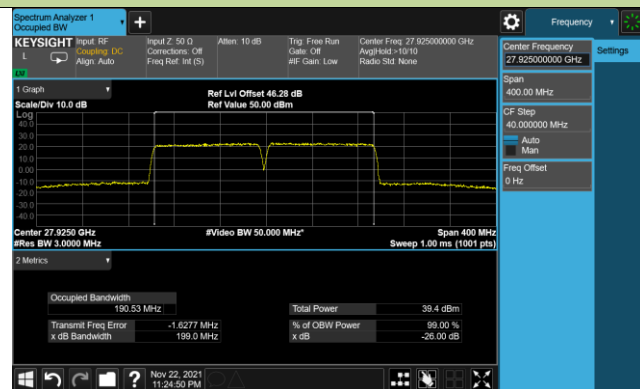
## 50+50MHz High Channel



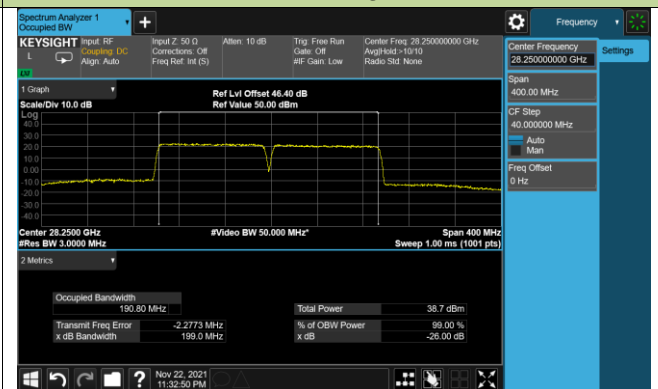
## 100+100MHz Low Channel



## 100+100MHz Middle Channel

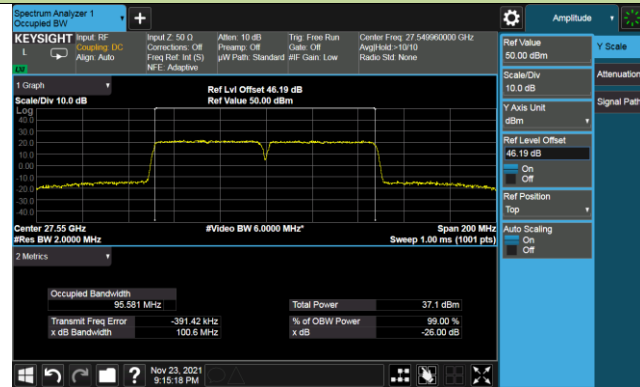


## 100+100MHz High Channel

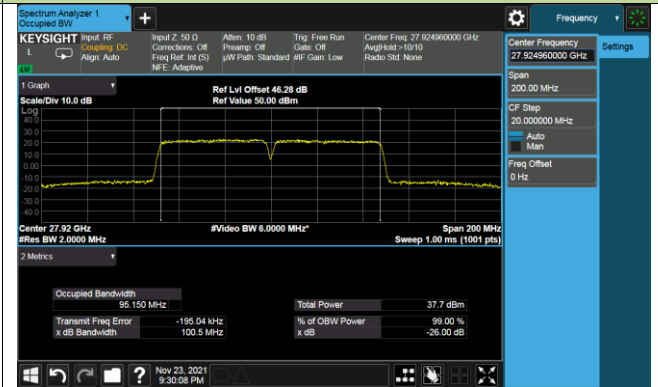


99% Bandwidth - 64QAM

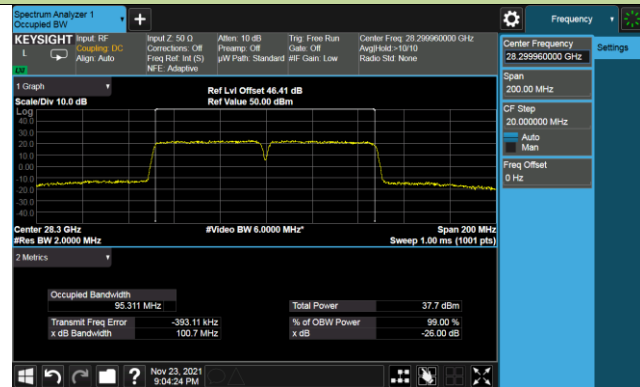
50+50MHz Low Channel



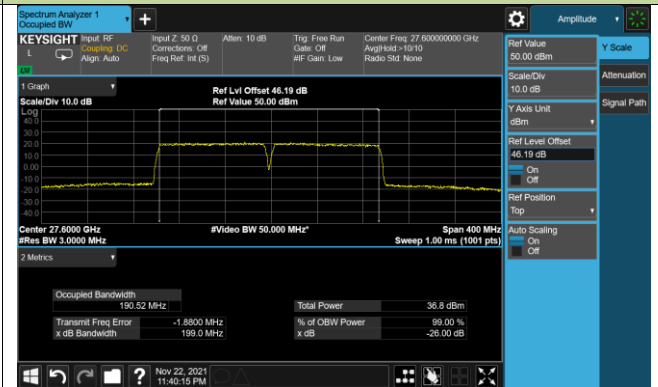
50+50MHz Middle Channel



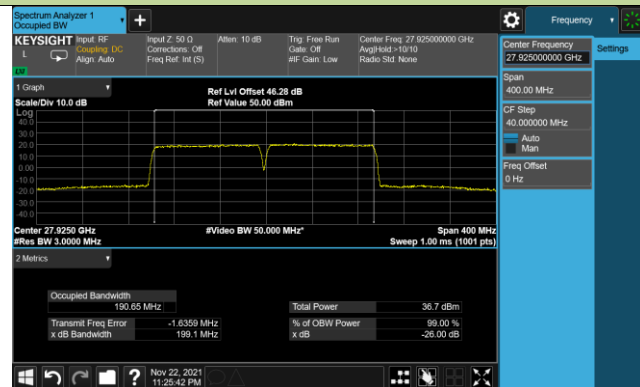
50+50MHz High Channel



100+100MHz Low Channel



100+100MHz Middle Channel



100+100MHz High Channel

