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PART 24 MEASUREMENT REPORT

Applicant Name:

Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:

05/30/2022 - 9/6/2022

Test Site/Location:

Element Washington DC LLC. Morgan Hill, CA, USA

Test Report Serial No.:

1C2205090025-02.BCG

FCC ID:

BCGA2435

Applicant Name:

Apple Inc.

Application Type:

Certification

Model:

A2435

EUT Type:

Tablet Device

FCC Classification:

PCS Licensed Transmitter (PCB)

FCC Rule Part:

24

Test Procedure(s):

ANSI C63.26-2015, TIA-603-E-2016, KDB 971168 D01
v03r01

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 §2.947. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RJ Ortanez
Executive Vice President



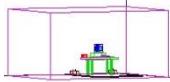
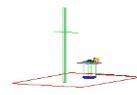
CERT #2041.02

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Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	OBW [MHz]	PAR at 0.1% [dB]	EIRP	Max. Power [W]	Max. Power [dBm]	Emission Designator
WCDMA1900	5 MHz	Spread Spectrum	1852.4 - 1907.6	4.1639	2.82	0.468	26.70	4M16F9W	
	1.4 MHz	QPSK	1850.7 - 1909.3	1.1107	5.00	0.457	26.60	1M11G7W	
		16QAM	1850.7 - 1909.3	1.1067	5.82	0.367	25.65	1M11D7W	
		64QAM	1850.7 - 1909.3	1.1159	6.47	0.294	24.68	1M12D7W	
	3 MHz	256QAM	1850.7 - 1909.3	1.1073	7.48	0.146	21.63	1M11D7W	
		QPSK	1851.5 - 1908.5	2.7306	4.65	0.457	26.60	2M73G7W	
		16QAM	1851.5 - 1908.5	2.7265	5.77	0.371	25.69	2M73D7W	
	5 MHz	64QAM	1851.5 - 1908.5	2.7275	6.54	0.302	24.80	2M73D7W	
		256QAM	1851.5 - 1908.5	2.7200	7.64	0.153	21.84	2M72D7W	
		QPSK	1852.5 - 1907.5	4.5457	4.89	0.457	26.60	4M55G7W	
		16QAM	1852.5 - 1907.5	4.5393	5.92	0.366	25.63	4M54D7W	
	10 MHz	64QAM	1852.5 - 1907.5	4.5511	6.53	0.281	24.49	4M55D7W	
		256QAM	1852.5 - 1907.5	4.5539	7.78	0.144	21.59	4M55D7W	
		QPSK	1855 - 1905	9.0492	4.98	0.457	26.60	9M05G7W	
LTE Band 2	15 MHz	16QAM	1855 - 1905	9.0492	5.90	0.394	25.96	9M05D7W	
		64QAM	1855 - 1905	9.0492	6.00	0.308	24.80	9M05D7W	
		256QAM	1855 - 1905	9.0499	6.82	0.165	22.18	9M05D7W	
		QPSK	1857.5 - 1902.5	13.5528	4.98	0.457	26.60	13M6G7W	
	20 MHz	16QAM	1857.5 - 1902.5	13.5571	6.03	0.404	26.06	13M6D7W	
		64QAM	1857.5 - 1902.5	13.5657	6.46	0.312	24.94	13M6D7W	
		256QAM	1857.5 - 1902.5	13.5302	6.66	0.152	21.81	13M5D7W	
	25 MHz	QPSK	1860 - 1900	18.0467	4.88	0.457	26.60	18M0G7W	
		16QAM	1860 - 1900	18.0436	5.83	0.416	26.19	18M0D7W	
		64QAM	1860 - 1900	18.0710	6.42	0.314	24.97	18M1D7W	
		256QAM	1860 - 1900	18.0036	6.65	0.157	21.95	18M0D7W	
LTE Band 25	1.4 MHz	QPSK	1850.7 - 1914.3	1.1107	5.00	0.457	26.60	1M11G7W	
		16QAM	1850.7 - 1914.3	1.1067	5.82	0.367	25.65	1M11D7W	
		64QAM	1850.7 - 1914.3	1.1159	6.47	0.294	24.68	1M12D7W	
		256QAM	1850.7 - 1914.3	1.1073	7.48	0.146	21.63	1M11D7W	
	3 MHz	QPSK	1851.5 - 1913.5	2.7306	4.65	0.457	26.60	2M73G7W	
		16QAM	1851.5 - 1913.5	2.7265	5.77	0.371	25.69	2M73D7W	
		64QAM	1851.5 - 1913.5	2.7275	6.54	0.302	24.80	2M73D7W	
	5 MHz	256QAM	1851.5 - 1913.5	2.7200	7.64	0.133	21.59	4M55D7W	
		QPSK	1852.5 - 1912.5	4.5457	4.98	0.457	26.60	4M55G7W	
		16QAM	1852.5 - 1912.5	4.5393	5.92	0.366	25.63	4M54D7W	
		64QAM	1852.5 - 1912.5	4.5511	6.53	0.281	24.49	4M55D7W	
	10 MHz	256QAM	1852.5 - 1912.5	4.5539	7.78	0.144	21.59	4M55D7W	
		QPSK	1855 - 1910	9.0492	4.98	0.457	26.60	9M05G7W	
		16QAM	1855 - 1910	9.0485	5.90	0.394	25.96	9M05D7W	
	15 MHz	64QAM	1855 - 1910	9.0208	6.60	0.308	24.89	9M02D7W	
		256QAM	1855 - 1910	9.0499	7.62	0.165	22.18	9M05D7W	
		QPSK	1857.5 - 1907.5	13.5533	4.98	0.457	26.60	13M6G7W	
		16QAM	1857.5 - 1907.5	13.587	6.03	0.404	26.06	13M6D7W	
	20 MHz	64QAM	1857.5 - 1907.5	13.5566	6.46	0.312	24.94	13M6D7W	
		256QAM	1857.5 - 1907.5	13.5307	6.66	0.152	21.81	13M5D7W	
		QPSK	1860 - 1905	18.0407	4.88	0.457	26.60	18M0G7W	
NR Band n2	5 MHz	16QAM	1855 - 1905	9.0485	5.90	0.394	25.96	9M05D7W	
		64QAM	1855 - 1905	9.0208	6.60	0.308	24.89	9M02D7W	
		256QAM	1855 - 1905	9.0499	7.62	0.165	22.18	9M05D7W	
		QPSK	1855.5 - 1907.5	13.5533	4.98	0.457	26.60	13M6G7W	
	10 MHz	16QAM	1855 - 1905	18.0444	5.83	0.416	26.19	18M0D7W	
		64QAM	1855 - 1905	18.0444	5.83	0.416	26.19	18M0D7W	
		256QAM	1855 - 1905	18.0407	6.65	0.157	21.95	18M0D7W	
	15 MHz	QPSK	1857.5 - 1907.5	13.5533	4.98	0.457	26.60	13M6G7W	
		16QAM	1857.5 - 1907.5	13.587	6.03	0.404	26.06	13M6D7W	
		64QAM	1857.5 - 1907.5	14.183	6.30	0.392	25.93	14M2D7W	
		256QAM	1857.5 - 1907.5	14.217	6.55	0.204	23.09	14M2D7W	
	20 MHz	QPSK	1860 - 1900	18.0344	4.08	0.457	26.60	18M0G7W	
		16QAM	1860 - 1900	19.054	5.41	0.453	26.56	19M1G7W	
		64QAM	1860 - 1900	19.100	6.38	0.279	24.45	19M1D7W	
NR Band n25	5 MHz	256QAM	1855 - 1905	9.0576	4.28	0.456	26.59	9M05G7W	
		QPSK	1855 - 1905	9.3871	5.45	0.454	26.57	9M30G7W	
		16QAM	1855 - 1905	9.3962	6.43	0.394	25.96	9M40D7W	
		64QAM	1855 - 1905	9.3786	6.62	0.281	24.48	9M30D7W	
	10 MHz	256QAM	1855 - 1905	9.3736	6.62	0.205	23.11	9M30D7W	
		QPSK	1857.5 - 1902.5	13.4944	4.14	0.457	26.60	13M5G7W	
		16QAM	1857.5 - 1902.5	14.211	6.45	0.292	24.65	14M2D7W	
	15 MHz	64QAM	1857.5 - 1902.5	14.217	6.55	0.204	23.09	14M2D7W	
		256QAM	1860 - 1900	18.0344	4.08	0.457	26.60	18M0G7W	
		QPSK	1855 - 1905	9.0576	4.28	0.456	26.59	9M05G7W	
		16QAM	1855 - 1905	9.3871	5.45	0.454	26.57	9M30G7W	
	20 MHz	64QAM	1855 - 1905	9.3962	6.43	0.394	25.96	9M40D7W	
		256QAM	1855 - 1905	9.3786	6.62	0.281	24.48	9M30D7W	
		QPSK	1857.5 - 1907.5	13.4944	4.14	0.457	26.60	13M5G7W	
NR Band n26	5 MHz	16QAM	1855 - 1905	9.0576	4.28	0.456	26.59	9M05G7W	
		64QAM	1855 - 1905	9.3871	5.45	0.454	26.57	9M30G7W	
		256QAM	1855 - 1905	9.3962	6.43	0.394	25.96	9M40D7W	
		QPSK	1855 - 1905	9.3786	6.62	0.281	24.48	9M30D7W	
	10 MHz	16QAM	1855 - 1905	9.3736	6.62	0.205	23.11	9M30D7W	
		64QAM	1855 - 1905	9.3786	6.62	0.205	23.11	9M30D7W	
		256QAM	1855 - 1905	9.3736	6.62	0.205	23.11	9M30D7W	
	15 MHz	QPSK	1857.5 - 1907.5	13.4944	4.14	0.457	26.60	13M5G7W	
		16QAM	1857.5 - 1907.5	14.196	5.42	0.456	26.59	14M2G7W	
		64QAM	1857.5 - 1907.5	14.183	6.30	0.392	25.93	14M2D7W	
		256QAM	1857.5 - 1907.5	14.211	6.45	0.292	24.48	14M2D7W	
	20 MHz	QPSK	1860 - 1905	18.0344	4.08	0.457	26.60	18M0G7W	
		16QAM	1860 - 1905	19.0514	5.41	0.453	26.56	19M1G7W	
		64QAM	1860 - 1905	19.100	6.38	0.279	24.45	19M1D7W	
NR Band n27	5 MHz	256QAM	1860 - 1905	18.0344	4.08	0.457	26.60	18M0D7W	
		QPSK	1860 - 1905	23.0341	4.23	0.457	26.60	23M0G7W	
		16QAM	1860 - 1905	23.0341	5.41	0.395	25.96	23M0D7W	
		64QAM	1860 - 1905	23.0341	6.43	0.284	24.48	23M0D7W	
	10 MHz	256QAM	1860 - 1905	23.0341	5.45	0.395	25.96	23M0D7W	
		QPSK	1862.5 - 1902.5	23.0341	5.45	0.394	25.96	23M0D7W	
		16QAM	1862.5 - 1902.5	23.0341	6.45	0.284	24.48	23M0D7W	
	15 MHz	64QAM	1862.5 - 1902.5	23.0341	6.45	0.284	24.48	23M0D7W	
		256QAM	1862.5 - 1902.5	23.0341	6.45	0.284	24.48	23M0D7W	
		QPSK	1865 - 1905	28.781	6.32	0.363	25.60	28M0D7W	
		16QAM	1865 - 1905	28.787	6.61	0.286	24.56	28M0D7W	
	20 MHz	64QAM	1865 - 1905	28.774	6.51	0.212	23.27	28M0D7W	
		256QAM	1865 - 1905	28.7803	6.53	0.191	22.82	28M0D7W	
		QPSK	1870 - 1895	38.920	4.32	0.457	26.60	38M0G7W	
NR Band n28	5 MHz	16QAM	1865 - 1905	38.841	5.52	0.456	26.59	38M0G7W	
		64QAM	1865 - 1905	38.823	6.32	0.376	25.75	38M0D7W	
		256QAM	1865 - 1905	38.878	6.65	0.339	25.30	38M0D7W	
		QPSK	1870 - 1895	38.796	6.62	0.203	23.07	38M0D7W	

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 Element Washington DC LLC Test Location

These measurement tests were conducted at the Element Washington DC LLC facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Washington DC LLC located in Morgan Hill, CA 95037, U.S.A.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).
- Element Washington DC LLC facility is a registered (22831) test laboratory with the site description on file with ISED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID:BCGA2435**. The test data contained in this report pertains only to the emissions due to the EUT's licensed transmitters that operate under the provisions of Part 24.

Test Device Serial No.: VL9QPR2R16, TVDFT4T9CV, M7QHWW6VGQ, MXYQDH6VMK, FL6Y63W99X, V68MLB20069

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 5G NR (FR1/FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), WPT, NB UNII (1x, HDR4, HDR8), 802.11a/ax WIFI 6E

This device supports BT Beamforming

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Antenna	Simultaneous Tx Config	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	✗	✗	✗	✗	✓
2a	Config 2	✗	✓	✗	✗	✗	✓
4a	Config 3	✓	✗	✓	✗	✗	✗
4a	Config 4	✗	✓	✗	✓	✗	✗

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; ✗ = Not Support

Note:

All the above simultaneous transmission configurations have been tested and the worst case configuration was found to be Config 2 and reported in Bluetooth and Part 96 RF test reports.

Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. For BT (2.4 GHz) in connected mode and Wi-Fi (2.4 GHz) – Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4 GHz) in disconnected mode and Wi-Fi (2.4 GHz) – BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power.

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2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Band	Antenna Gain (dBi)			
	Antenna 4b	Antenna 1	Antenna 3	Antenna 2b
WCNDA1900				
LTE Band2/25	-2.7	1.5	1.4	-4
FR1 Band n2/25				

Table 2-2. Highest Antenna Gain

Note: Antenna Specifications have been attached to Appendix A

2.4 Test Support Equipment

1	Apple MacBook Pro w/AC/DC Adapter	Model: A2141	S/N: C02DV7VKMD6T
2	Apple USB-C Cable	Model: Spartan	S/N: 000MKTR02U
3	USB-C Cable w/ AC Adapter	Model: A246	S/N: N/A
4	Apple Pencil	Model: N/A	S/N: GQXGSXBJKM9
5	DC Power Supply	Model: KPS3010D	S/N: N/A

Table 2-3. Test Support Equipment

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2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.26-2015, TIA-603-E-2016 and KDB 971168 D01 v03r01. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz and above 18GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

2.6 Software and Firmware

The test was conducted with firmware version 20A8359 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

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

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the document titled “Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards” (ANSI C63.26-2015/TIA-603-E-2016) and “Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems” (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

Deviation from Measurement Procedure.....None

3.2 Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer.

For radiated spurious emissions measurements and calculations, conversion method is used per the formulas in KDB 971168 Section 5.8.4. Field Strength (EIRP) is calculated using the following formulas:

$$E_{\text{dB}\mu\text{V/m}} = \text{Measured amplitude level}_{\text{dBm}} + 107 + \text{Cable Loss}_{\text{dB}} + \text{Antenna Factor}_{\text{dB/m}}$$

And

$$\text{EIRP}_{\text{dBm}} = E_{\text{dB}\mu\text{V/m}} + 20\log D - 104.8; \text{ where } D \text{ is the measurement distance in meters.}$$

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014.

Per KDB 414788 D01 v01r01, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was used while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

Radiated spurious emission levels are investigated with the receive antenna horizontally and vertically polarized per ANSI C63.26-2015 and TIA-603-E-2016.

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4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (\pm dB)
Conducted Bench Top Measurements	1.77
Radiated Disturbance (<30MHz)	4.38
Radiated Disturbance (30MHz-1GHz)	4.75
Radiated Disturbance (1-18GHz)	5.20
Radiated Disturbance (>18GHz)	4.72

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5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
Agilent Technologies	N9020A	MXA Signal Analyzer	4/26/2022	Annual	4/26/2023	MY56470202
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	1/19/2022	Annual	1/19/2023	T058701-02
ETS-Lindgren	3142E	Biconilog Antenna (26-6000MHz)	10/21/2021	Annual	10/21/2022	208204
ETS-Lindgren	3117	Double Ridged Guide Horn Antenna (1-18GHz)	10/25/2021	Annual	10/25/2022	227597
ETS-Lindgren	SU-241	Table Top Temperature Chamber	10/6/2021	Annual	10/6/2022	92009574
Keysight Technology	N9040B	UXA Signal Analyzer	2/8/2022	Annual	2/8/2023	MY57212015
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz-6GHz)	1/6/2022	Annual	1/6/2023	102328
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/11/2021	Annual	10/11/2022	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	11/4/2021	Annual	11/4/2022	151888
Rohde & Schwarz	ESW26	EMI Test Receiver	5/19/2022	Annual	5/19/2023	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	12/2/2021	Annual	12/2/2022	101570
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/4/2022	Annual	3/4/2023	101619
Rohde & Schwarz	FSVA3044	Signal Analyzer (up to 44 GHz)	5/12/2022	Annual	5/12/2023	101098
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/3/2022	Annual	4/3/2023	100546
Rohde & Schwarz	TC-TA18	Cross-Polarized Antenna 400MHz-18GHz	1/25/2022	Annual	1/25/2023	101063
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz-18GHz)	1/6/2022	Annual	1/6/2023	101639
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz-40GHz)	4/18/2022	Annual	4/18/2023	100050

Table 5-1. Test Equipment

Notes:

1. For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.
2. Equipment with a calibration date of "N/A" shown in this list was not used to make direct calibrated measurements.

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6.0 SAMPLE CALCULATIONS

Emission Designator

WCDMA Emission Designator

Emission Designator = 4M16F9W

WCDMA BW = 4.16 MHz

F = Frequency Modulation

9 = Composite Digital Info

W = Combination (Audio/Data)

$\pi/2$ BPSK / QPSK Modulation

Emission Designator = 8M62G7W

BW = 8.62 MHz

G = Phase Modulation

7 = Quantized/Digital Info

W = Combination of Any

QAM Modulation

Emission Designator = 8M45D7W

BW = 8.45 MHz

D = Amplitude/Angle Modulated

7 = Quantized/Digital Info

W = Combination of Any

Spurious Radiated Emission

Example: Spurious emission at 3700.40 MHz

The receive spectrum analyzer reading at 3 meters with the EUT on the turntable was -81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of -81.0 dBm on the spectrum analyzer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 3700.40 MHz. So 6.1 dB is added to the signal generator reading of -30.9 dBm yielding -24.80 dBm. The fundamental EIRP was 25.50 dBm so this harmonic was 25.50 dBm $- (-24.80) = 50.3$ dBc.

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7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCGA2435
 FCC Classification: PCS Licensed Transmitter (PCB)
 Mode(s): WCDMA/LTE/NR

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Occupied Bandwidth	2.1049	N/A	N/A	Section 7.2
	Conducted Band Edge / Spurious Emissions	2.1051, 24.238(a)	-13 dBm at Band Edge and for all out-of-band emissions	PASS	Sections 7.3, 7.4
	Peak-Average Ratio	24.232(d)	< 13 dB	PASS	Section 7.5
	Transmitter Conducted Output Power	2.1046	N/A	N/A	See RF Exposure Report
	Frequency Stability	2.1055, 24.235	Fundamental emissions stay within authorized frequency block over the temperature and voltage range as tested	PASS	Section 7.8
	Effective Radiated Power / Equivalent Isotropic Radiated Power	24.232(c)	< 2 Watts max. EIRP	PASS	Section 7.6
RADIATED	Radiated Spurious Emissions	2.1053, 24.238(a)	-13 dBm for all out-of-band emissions	PASS	Section 7.7

Table 7-1. Summary of Test Results

Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
4. All conducted emissions measurements are performed with automated test software to capture the corresponding plots necessary to show compliance. The measurement software utilized is Element EMC Software Tool v1.1.

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7.2 Occupied Bandwidth

§2.1049

Test Overview

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. All modes of operation were investigated and the worst case configuration results are reported in this section. All ports were tested and only the worst case data were reported.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 4.2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW \geq 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

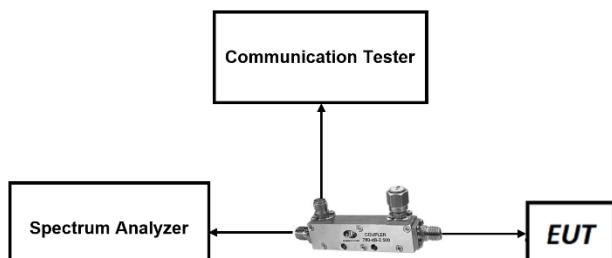


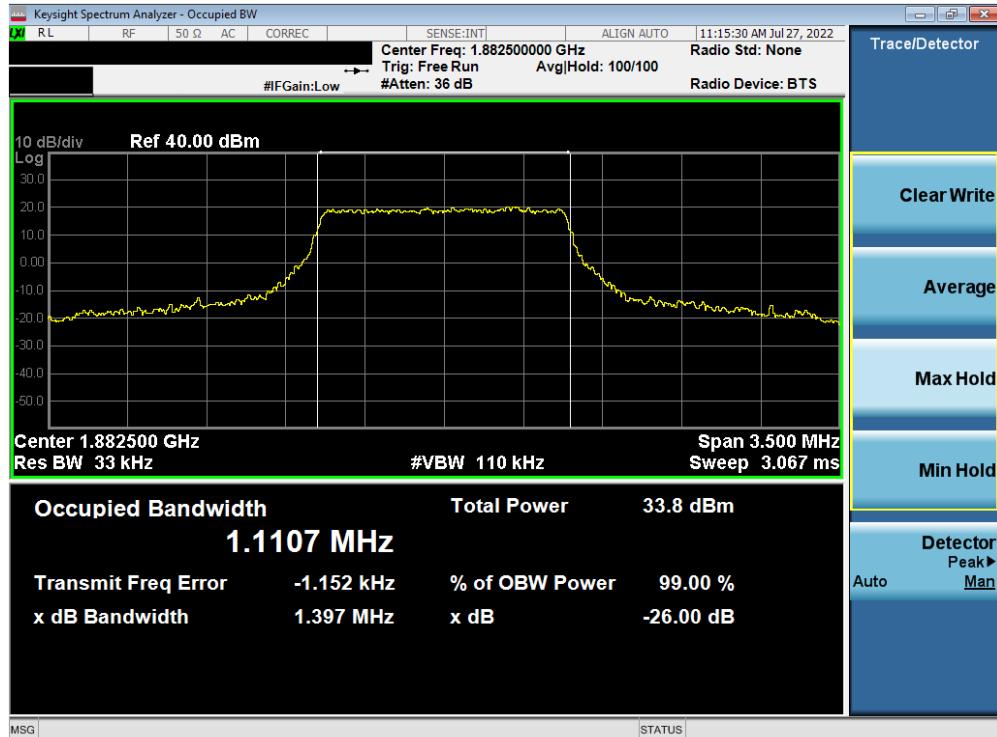
Figure 7-1. Test Instrument & Measurement Setup

Test Notes

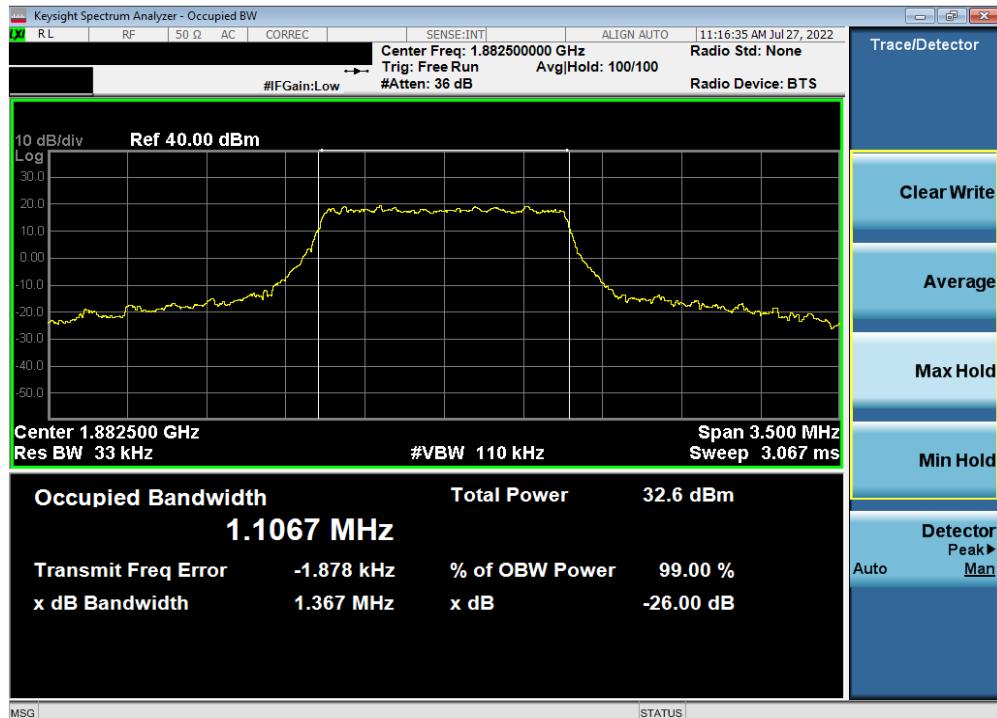
None.

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LTE Band 25/2

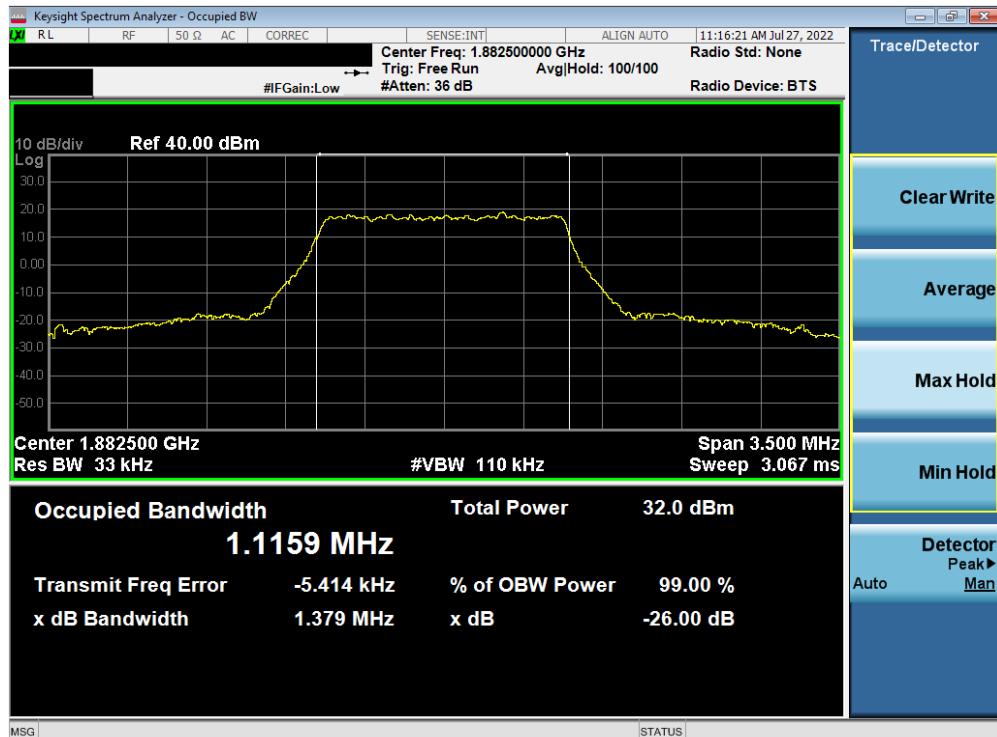


Plot 7-1. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz QPSK - Full RB Configuration)

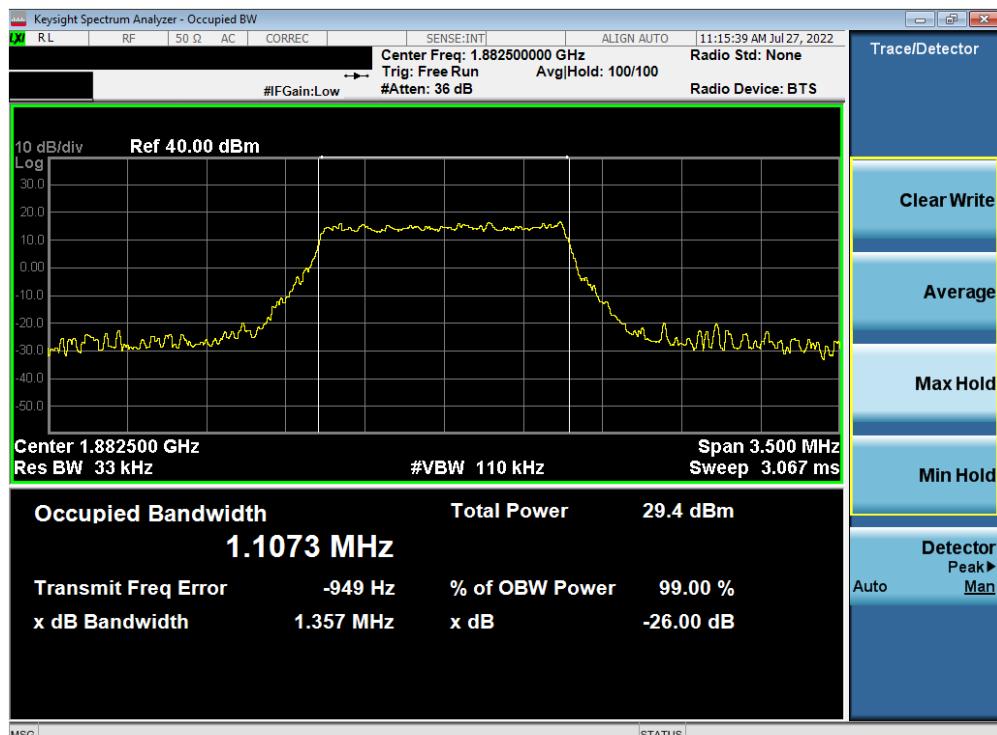


Plot 7-2. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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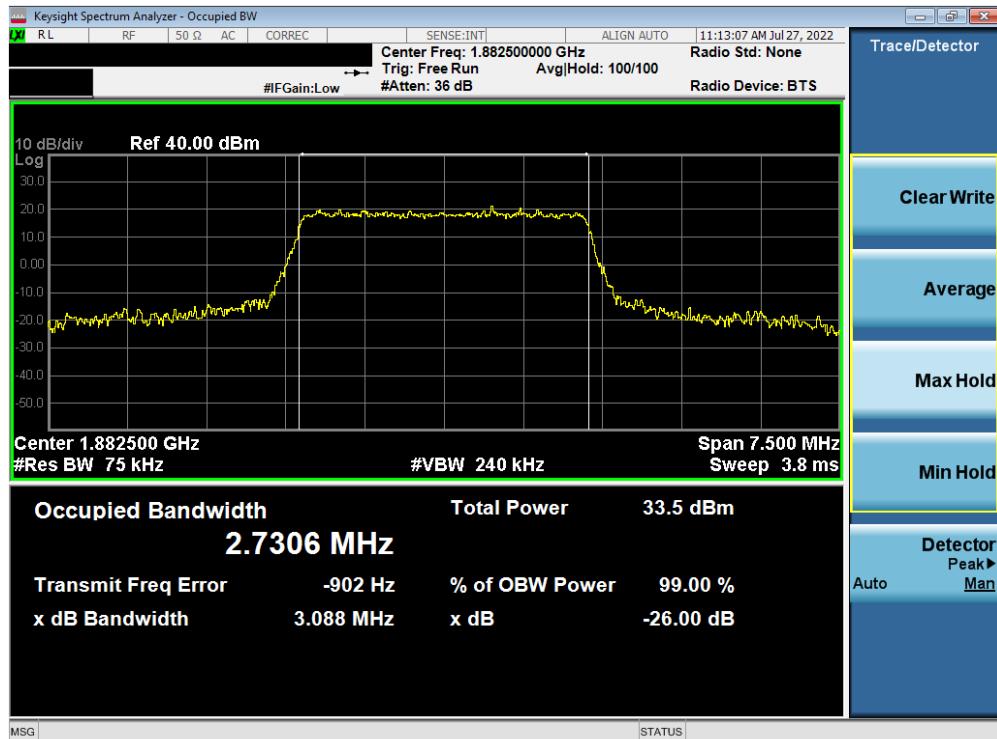


Plot 7-3. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz 64-QAM - Full RB Configuration)

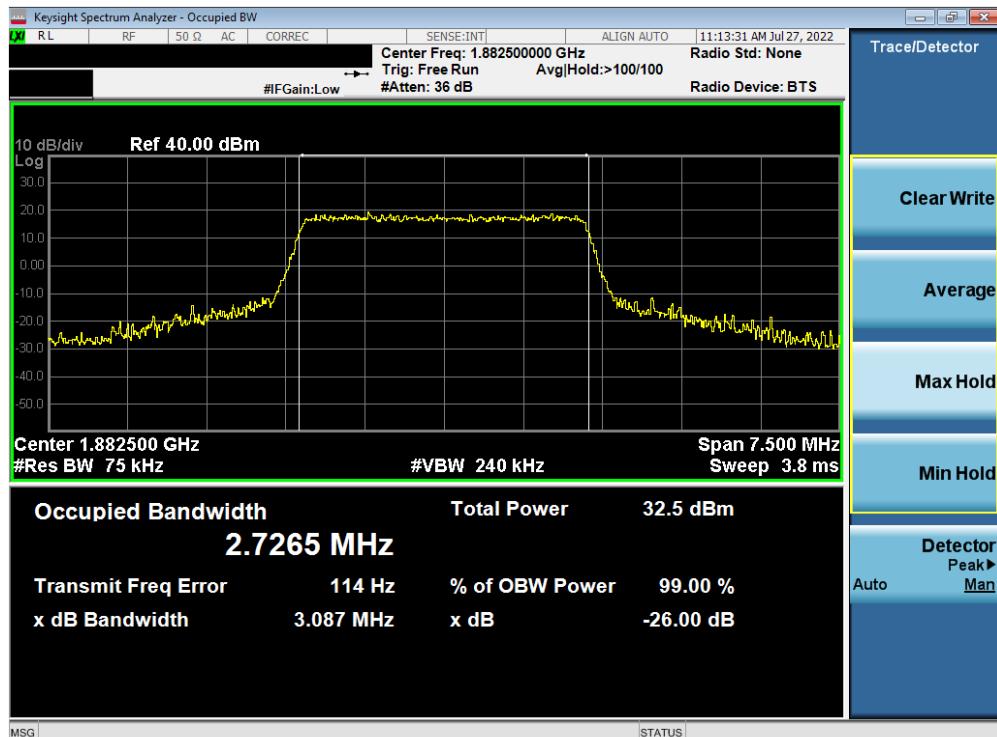


Plot 7-4. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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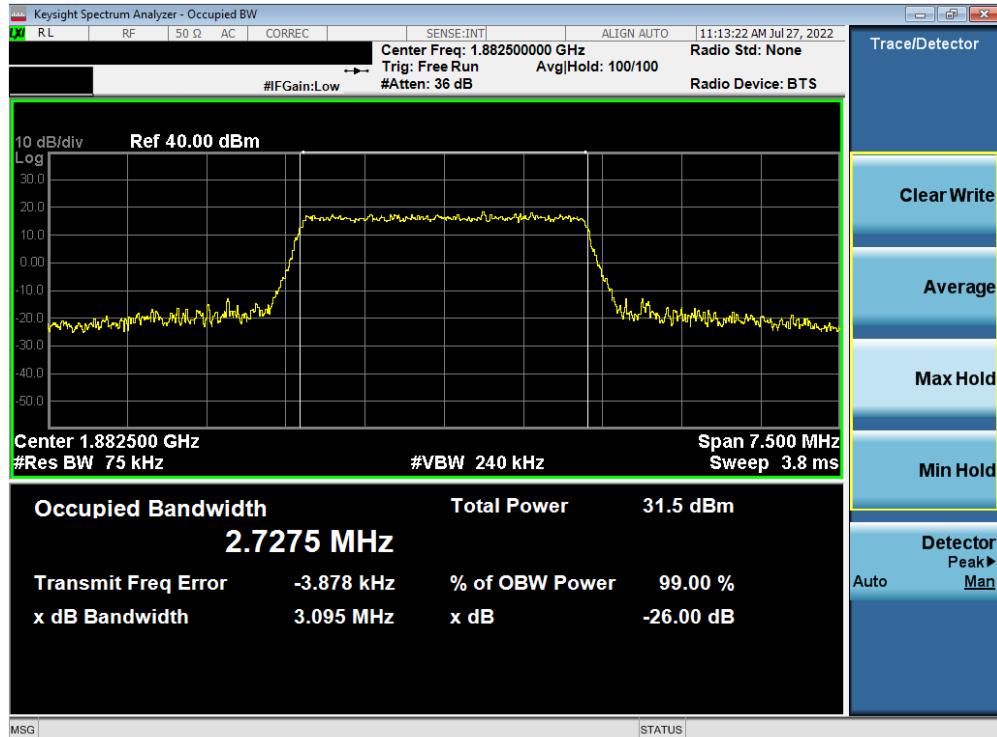


Plot 7-5. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz QPSK - Full RB Configuration)

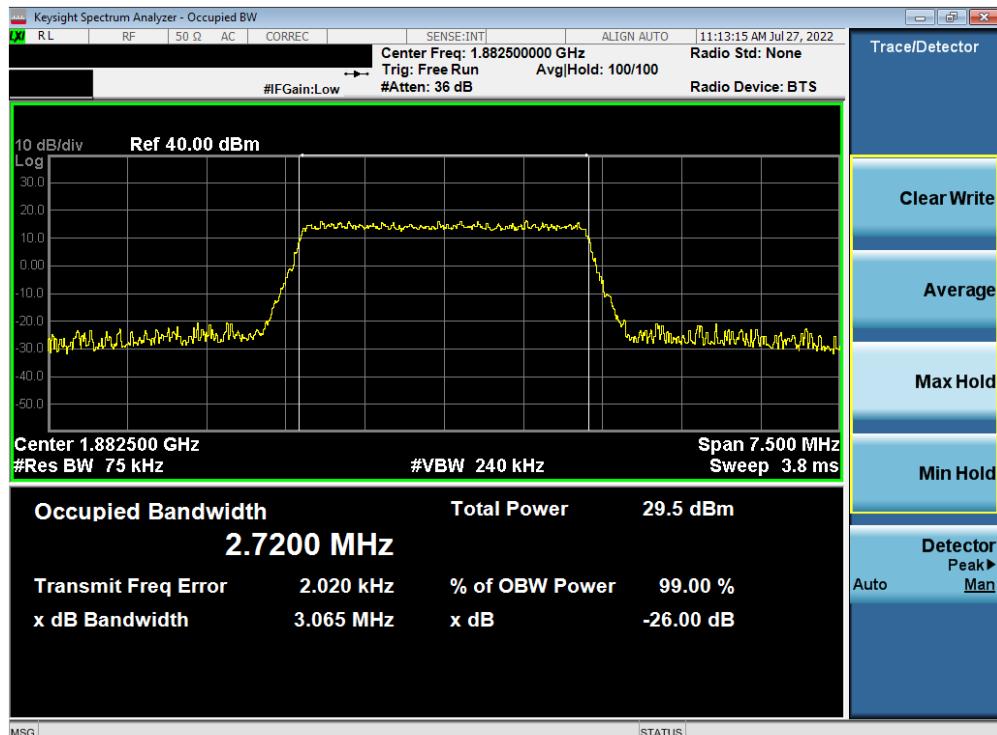


Plot 7-6. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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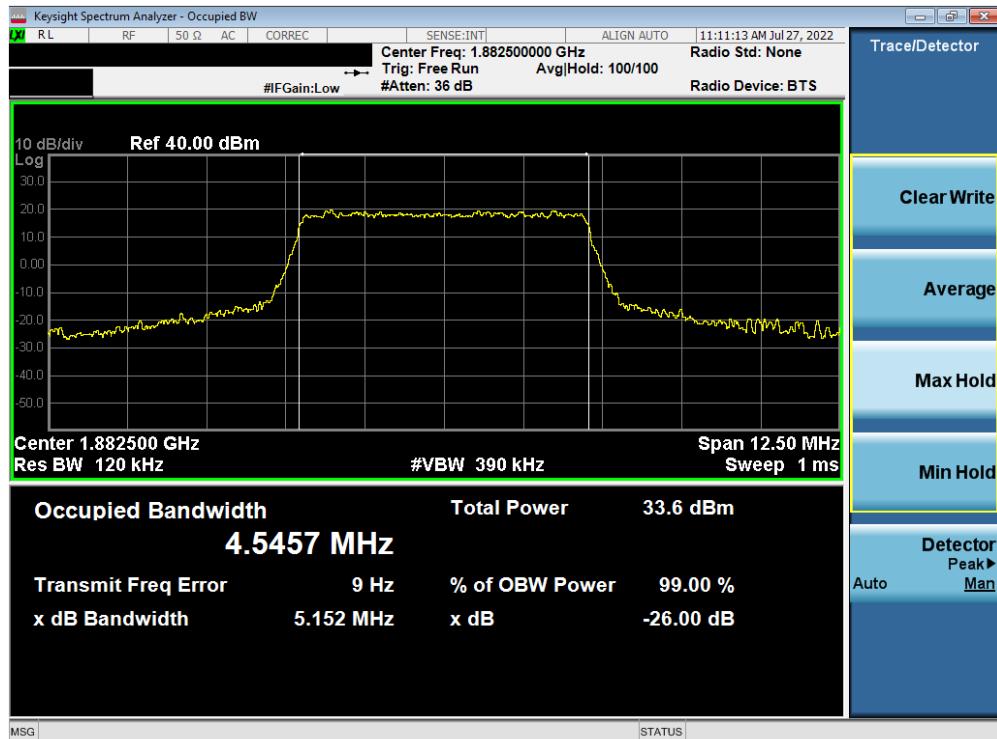


Plot 7-7. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz 64-QAM - Full RB Configuration)

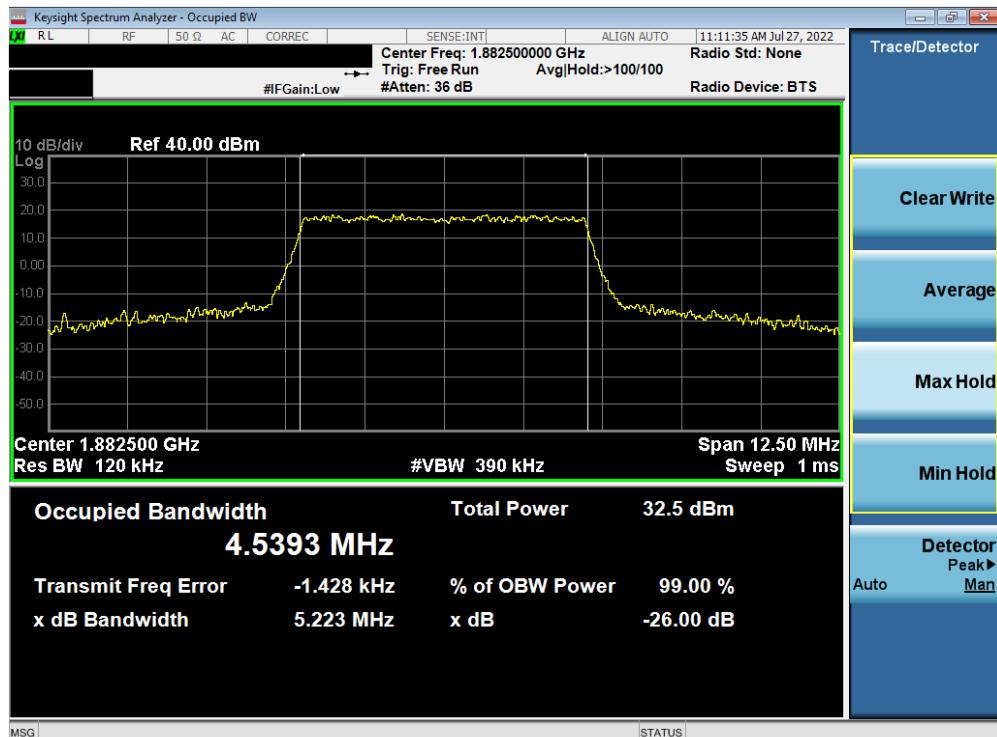


Plot 7-8. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-9. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz QPSK - Full RB Configuration)

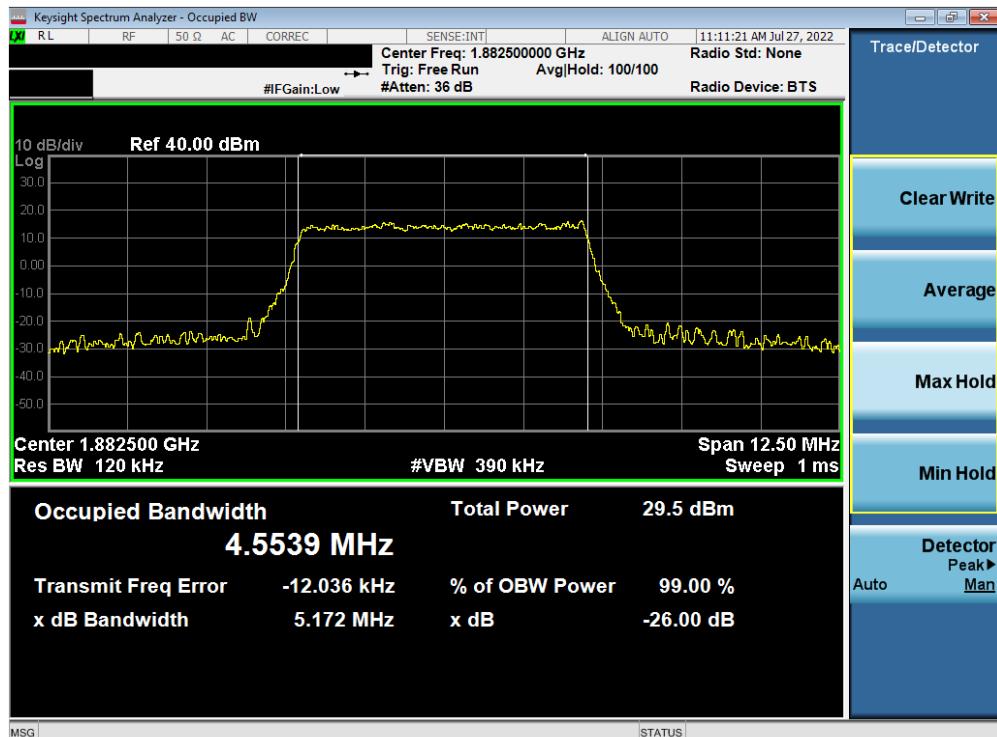


Plot 7-10. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-11. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz 64-QAM - Full RB Configuration)

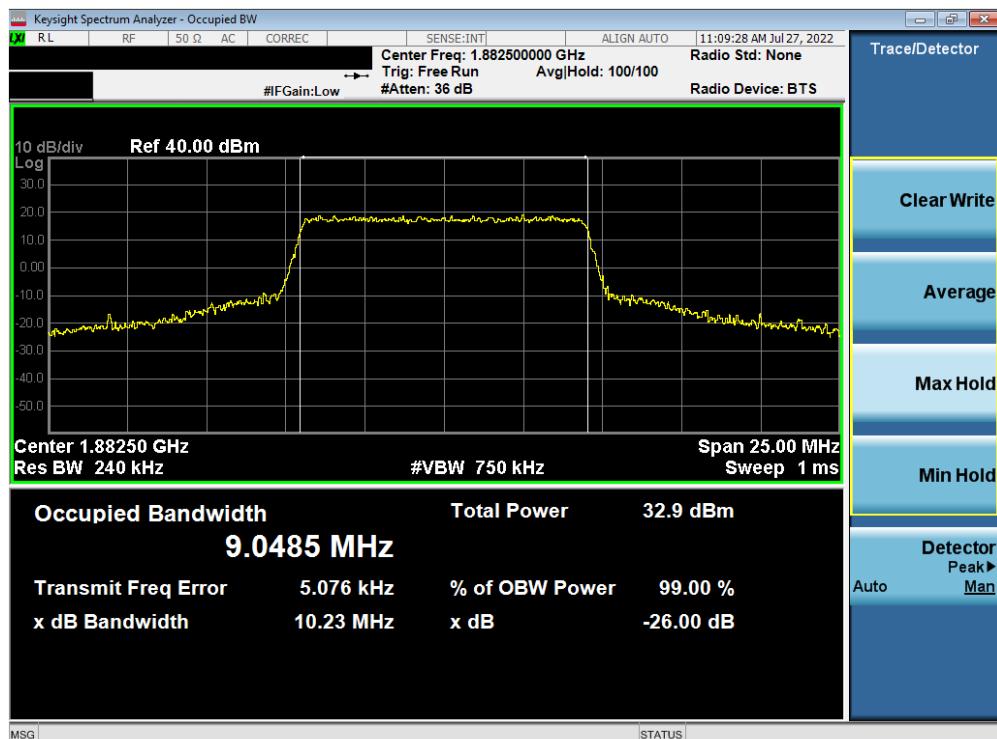


Plot 7-12. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-13. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz QPSK - Full RB Configuration)

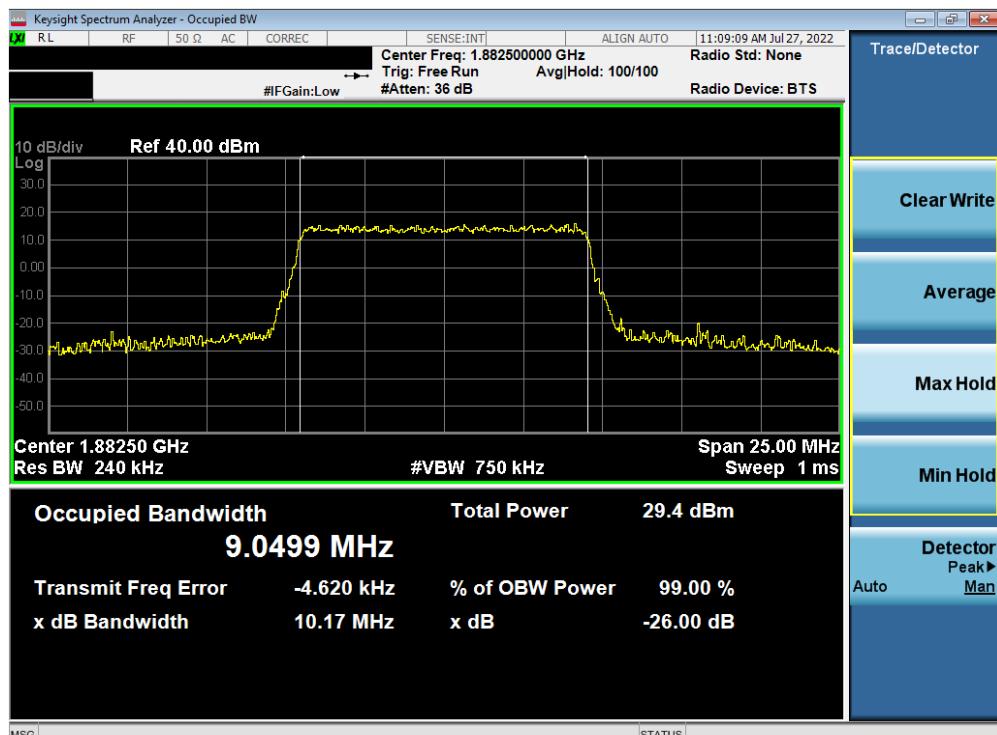


Plot 7-14. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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Plot 7-15. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz 64-QAM - Full RB Configuration)



Plot 7-16. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz 256-QAM - Full RB Configuration)

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Plot 7-17. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz QPSK - Full RB Configuration)

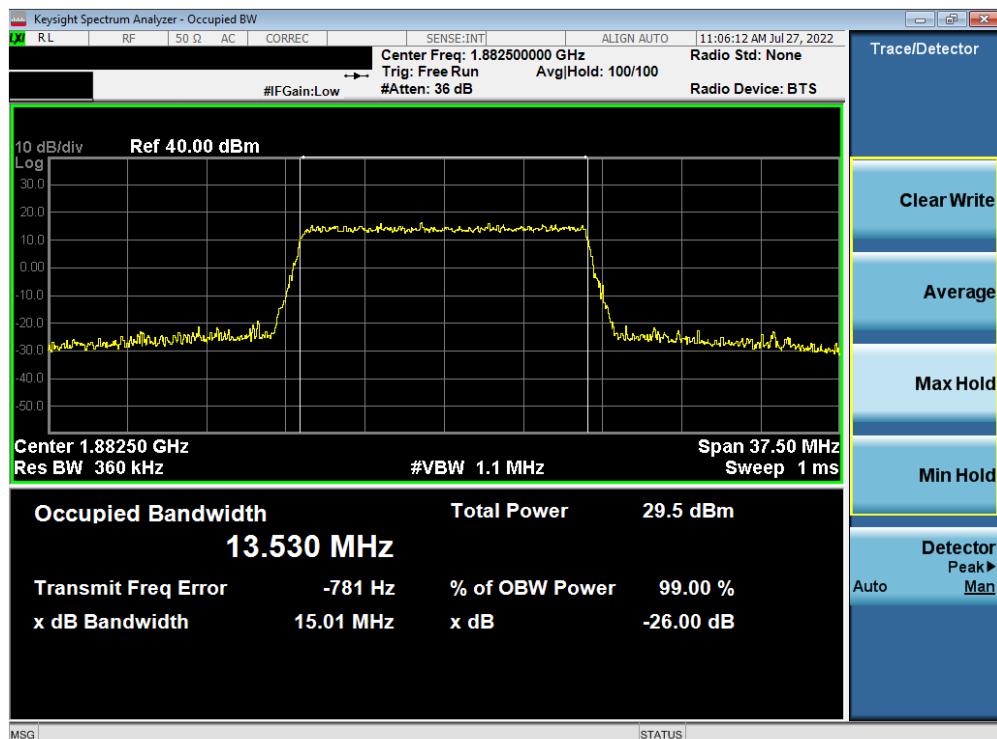


Plot 7-18. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-19. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz 64-QAM - Full RB Configuration)

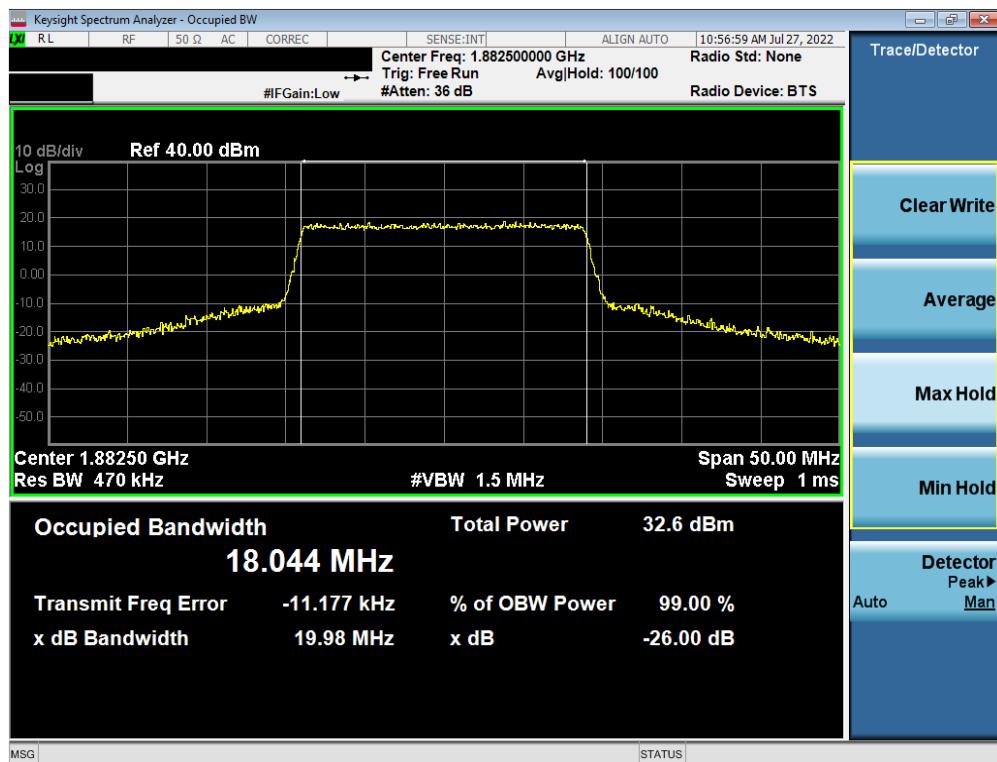


Plot 7-20. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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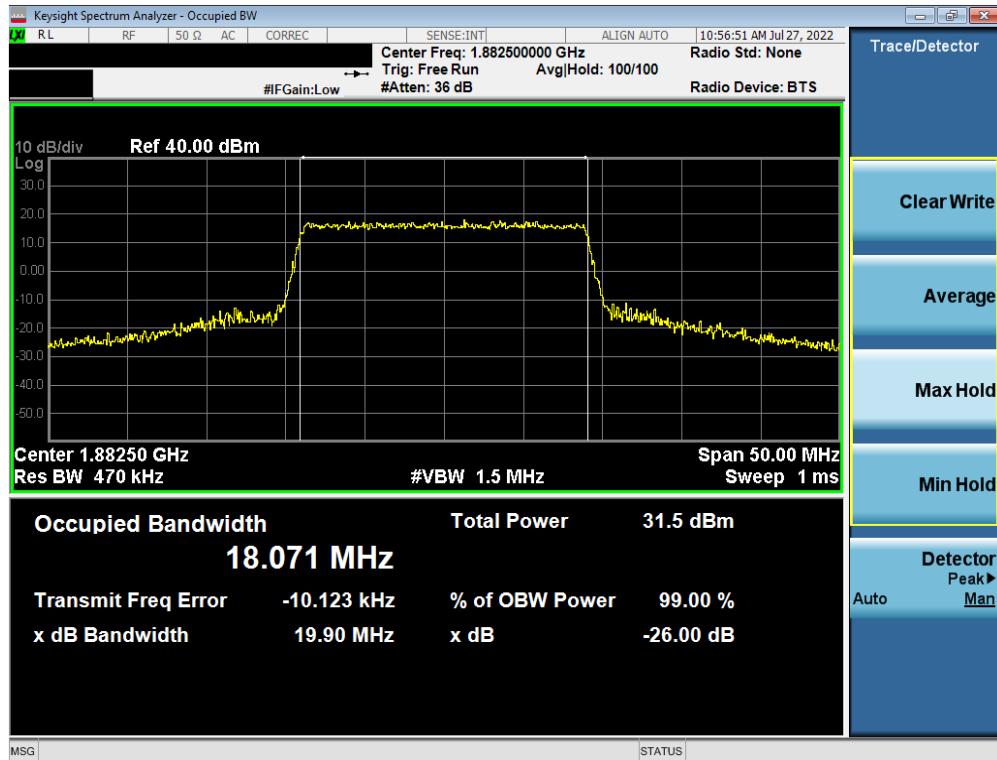


Plot 7-21. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz QPSK - Full RB Configuration)



Plot 7-22. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-23. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz 64-QAM - Full RB Configuration)



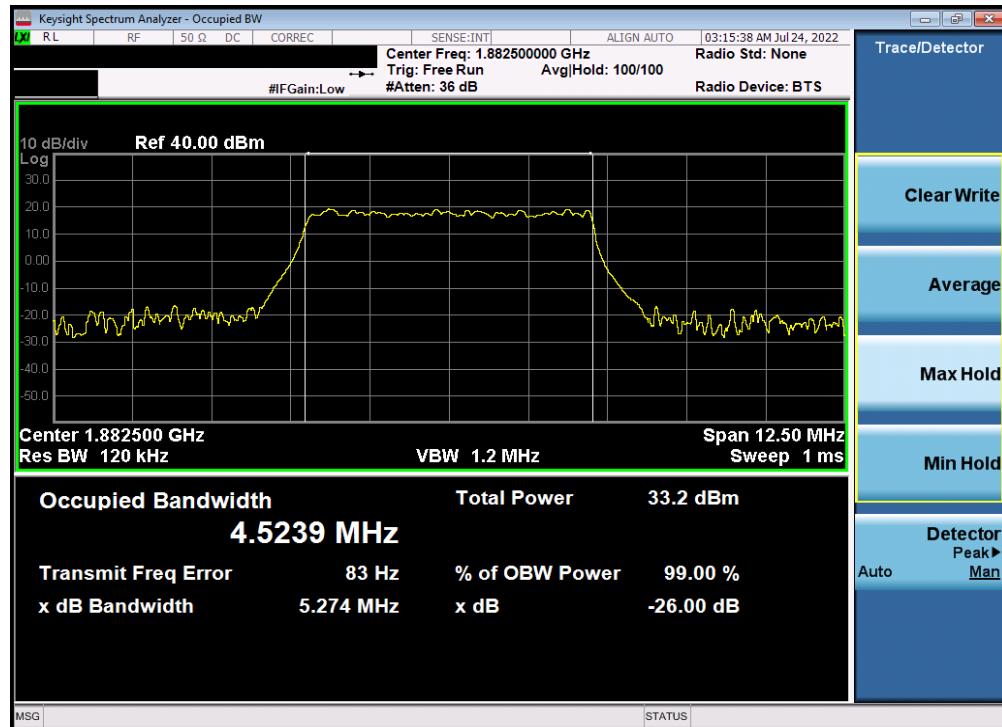
Plot 7-24. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2435	element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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NR Band n25/n2

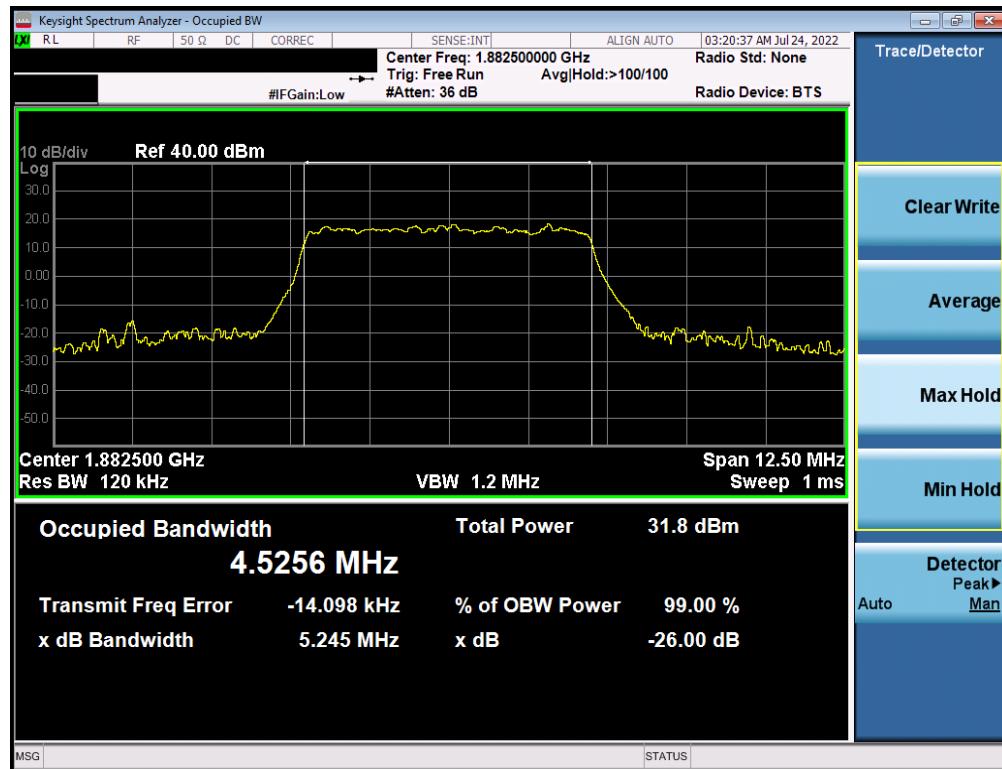


Plot 7-25. Occupied Bandwidth Plot (NR Band n25/n2 - 5.0MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB)



Plot 7-26. Occupied Bandwidth Plot (NR Band n25/n2 - 5.0MHz DFT-s-OFDM QPSK - Full RB)

FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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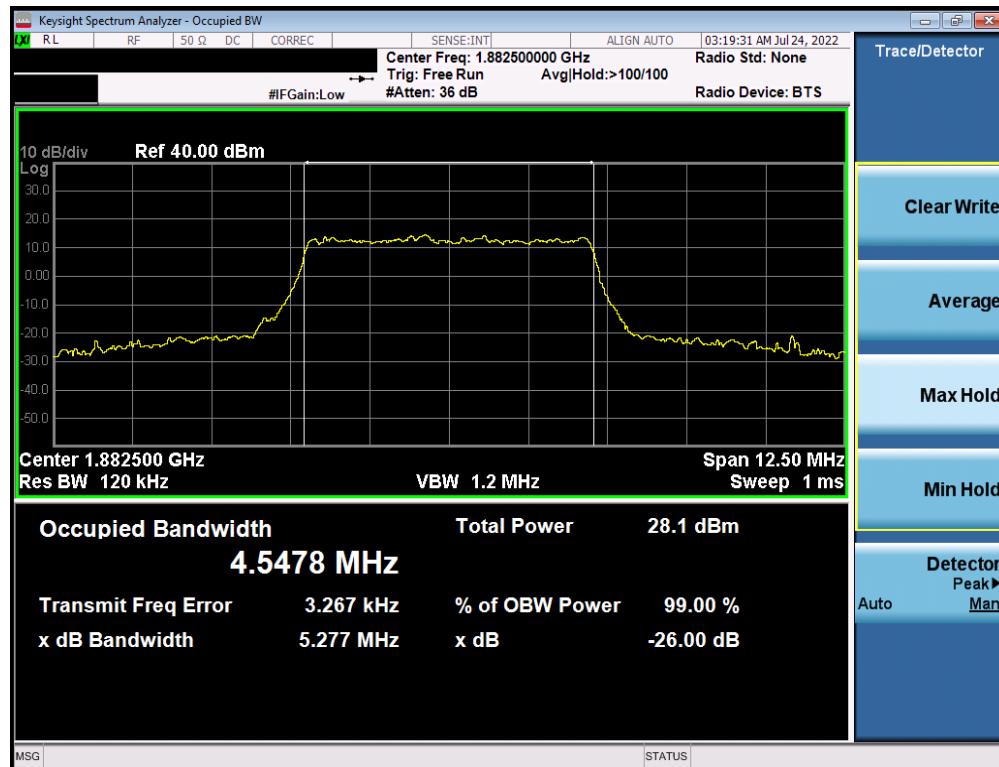


Plot 7-27. Occupied Bandwidth Plot (NR Band n25/n2 - 5.0MHz CP-OFDM 16QAM - Full RB)



Plot 7-28. Occupied Bandwidth Plot (NR Band n25/n2 - 5.0MHz CP-OFDM 64QAM - Full RB)

FCC ID: BCGA2435	element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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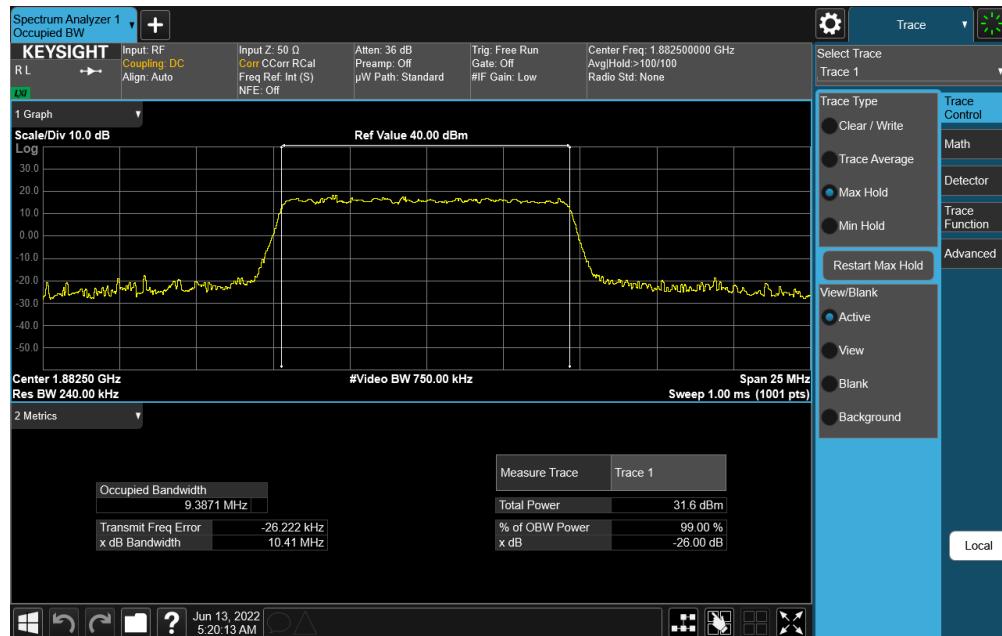


Plot 7-29. Occupied Bandwidth Plot (NR Band n25/n2 - 5.0MHz CP-OFDM 256QAM - Full RB)



Plot 7-30. Occupied Bandwidth Plot (NR Band n25/n2 - 10.0MHz DFT-s-OFDM π/2 BPSK - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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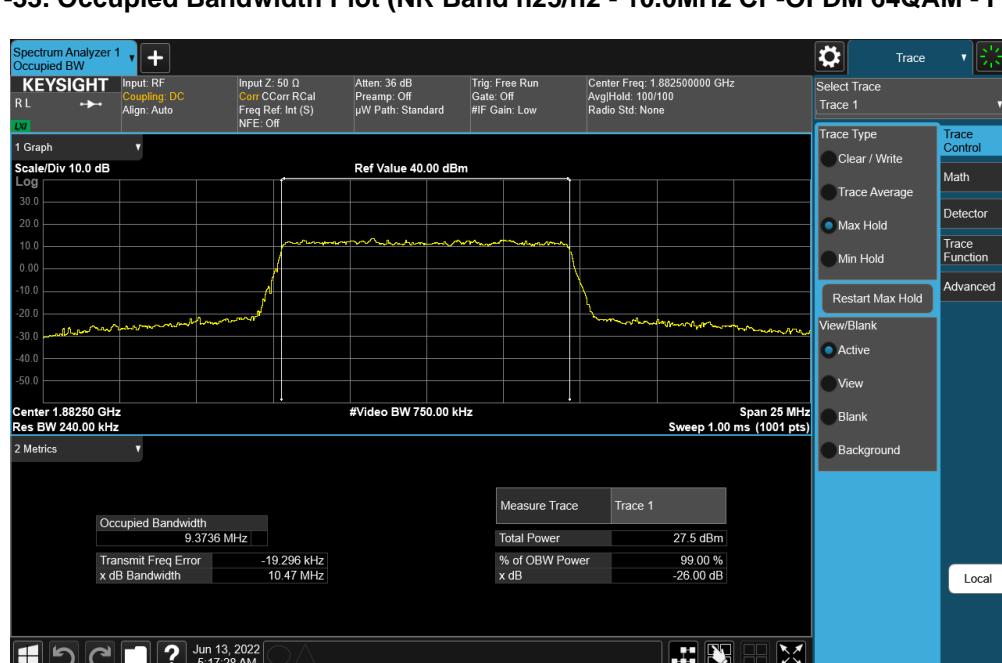
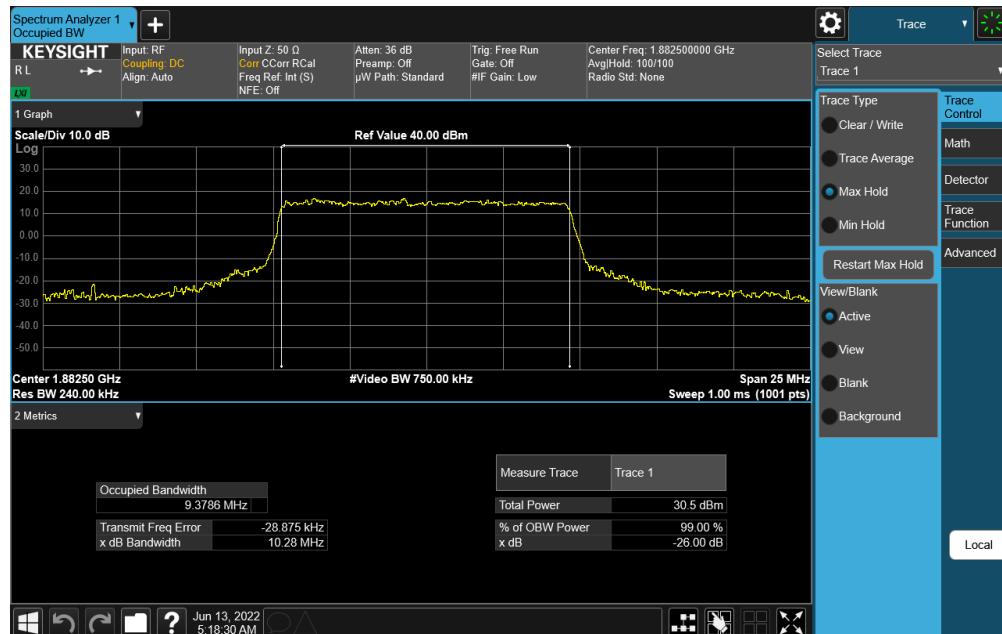


Plot 7-31. Occupied Bandwidth Plot (NR Band n25/n2 - 10.0MHz CP-OFDM QPSK - Full RB)



Plot 7-32. Occupied Bandwidth Plot (NR Band n25/n2 - 10.0MHz CP-OFDM 16QAM - Full RB)

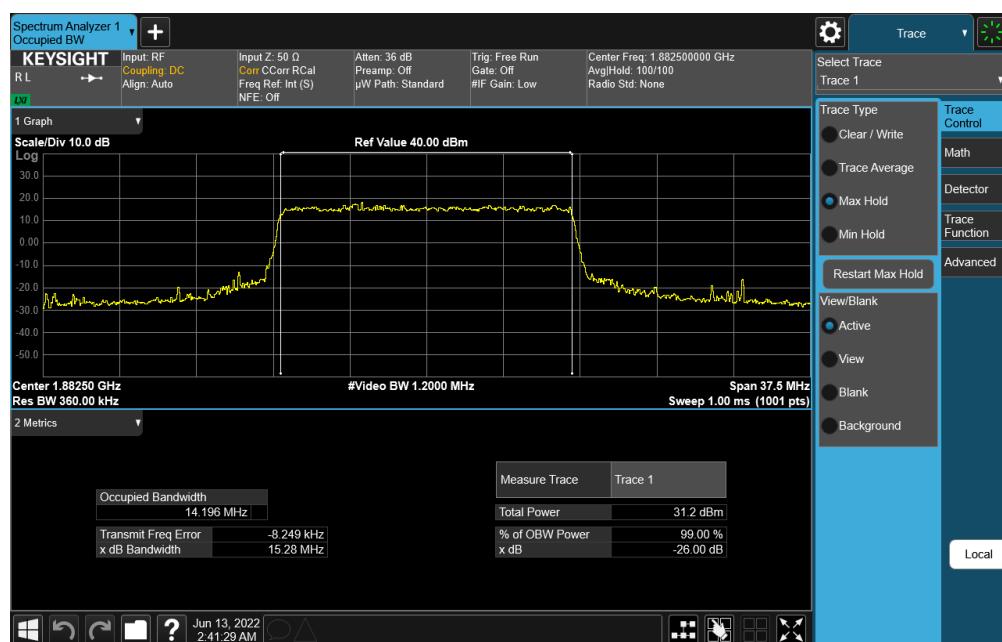
FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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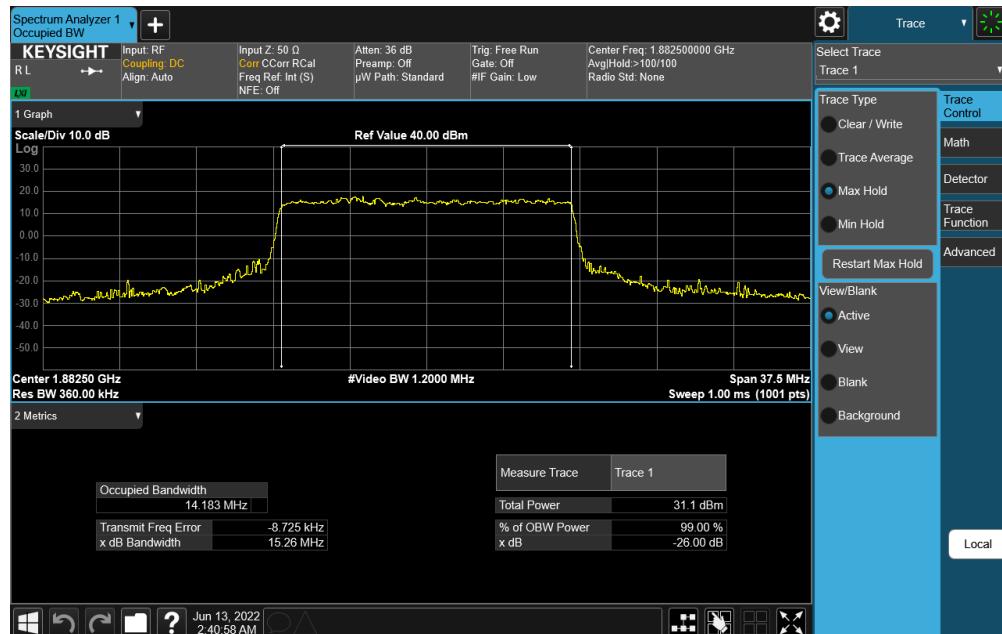


Plot 7-35. Occupied Bandwidth Plot (NR Band n25/n2 - 15.0MHz DFT-s-OFDM π/2 BPSK - Full RB)



Plot 7-36. Occupied Bandwidth Plot (NR Band n25/n2 - 15.0MHz CP-OFDM QPSK - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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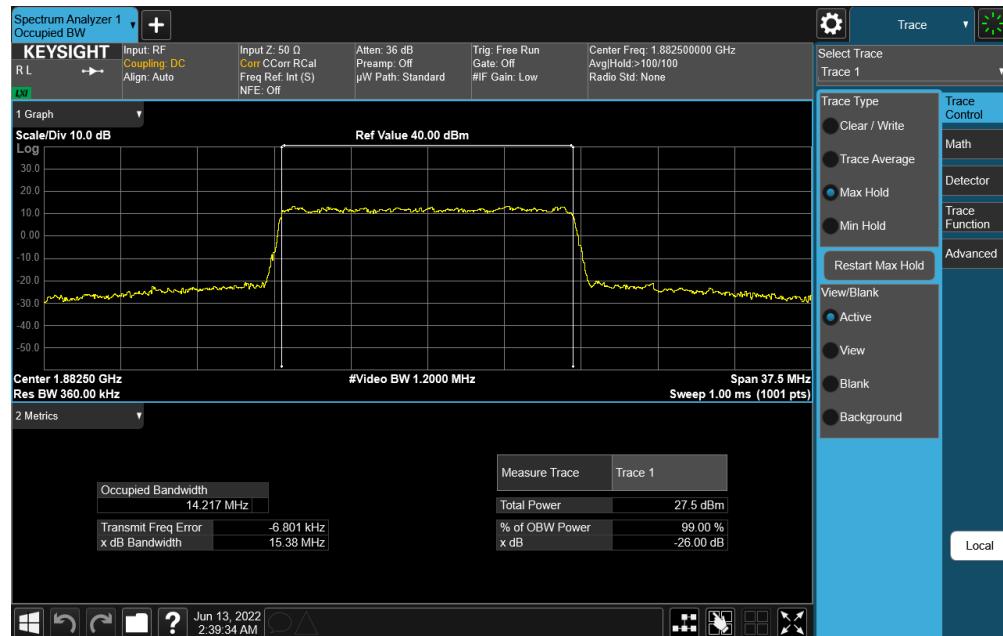


Plot 7-37. Occupied Bandwidth Plot (NR Band n25/n2 - 15.0MHz CP-OFDM 16QAM - Full RB)

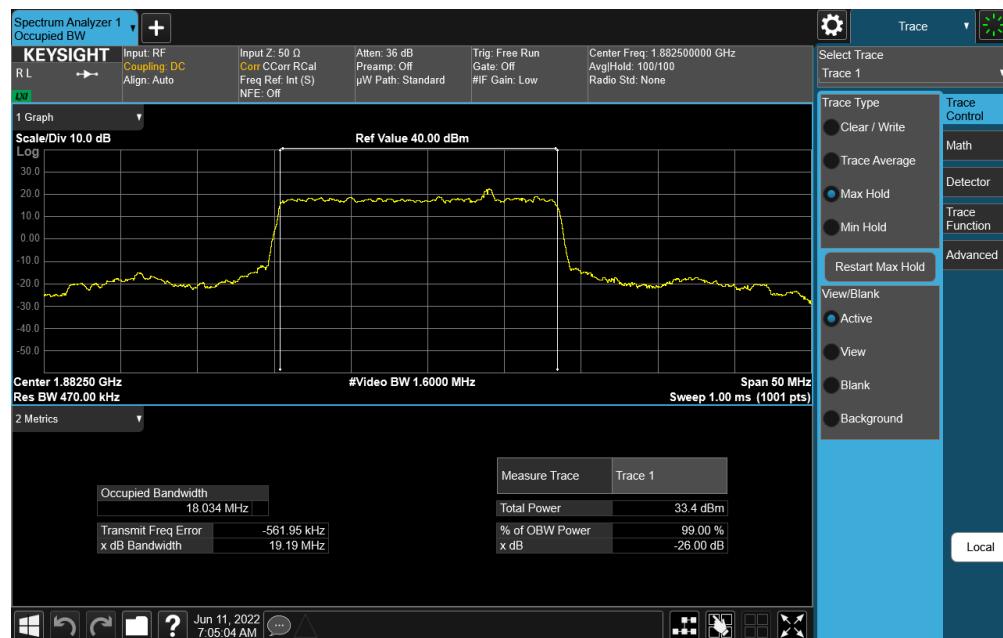


Plot 7-38. Occupied Bandwidth Plot (NR Band n25/n2 - 15.0MHz CP-OFDM 64QAM - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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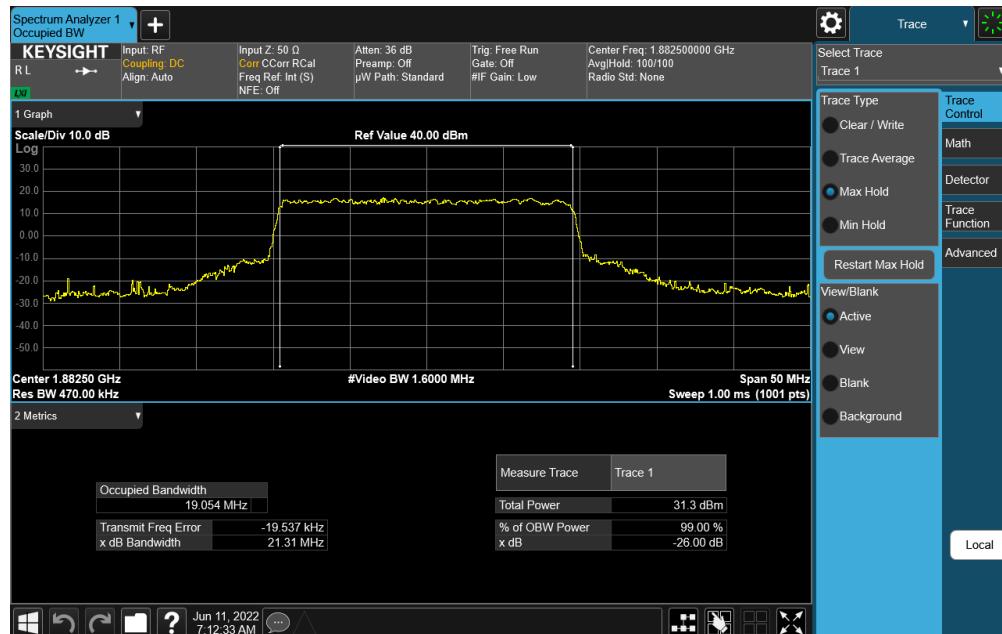


Plot 7-39. Occupied Bandwidth Plot (NR Band n25/n2 - 15.0MHz CP-OFDM 256QAM - Full RB)



Plot 7-40. Occupied Bandwidth Plot (NR Band n25/n2 - 20.0MHz DFT-s-OFDM π/2 BPSK - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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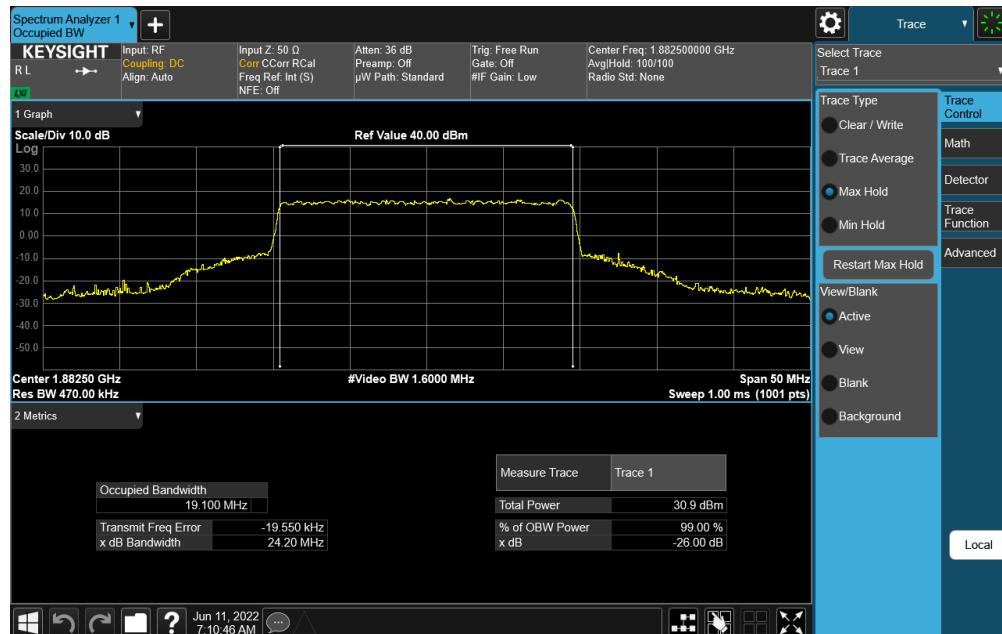


Plot 7-41. Occupied Bandwidth Plot (NR Band n25/n2 - 20.0MHz CP-OFDM QPSK - Full RB)



Plot 7-42. Occupied Bandwidth Plot (NR Band n25/n2 - 20.0MHz CP-OFDM 16QAM - Full RB)

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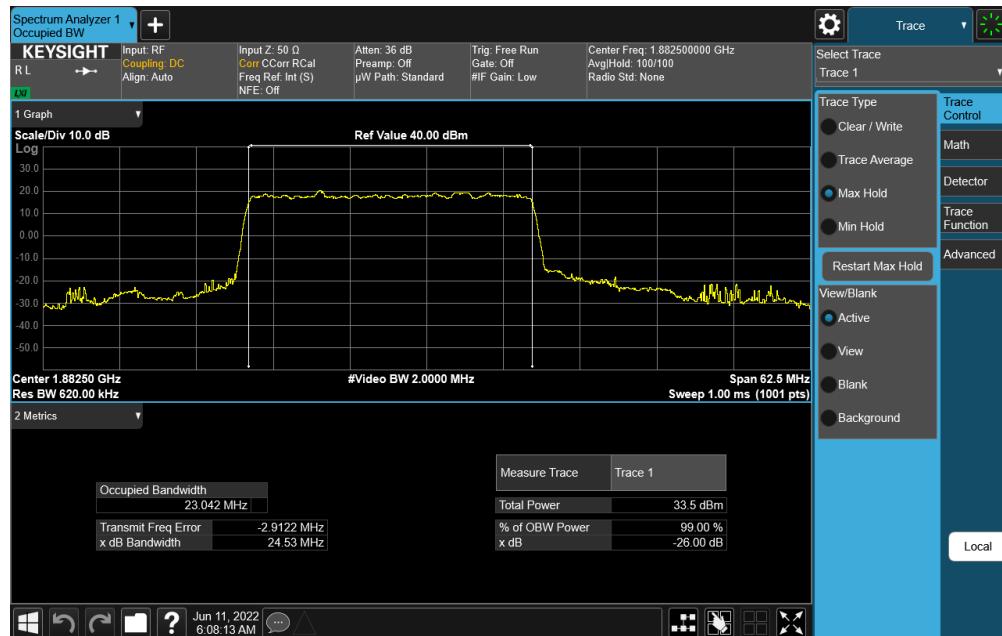


Plot 7-43. Occupied Bandwidth Plot (NR Band n25/n2 - 20.0MHz CP-OFDM 64QAM - Full RB)

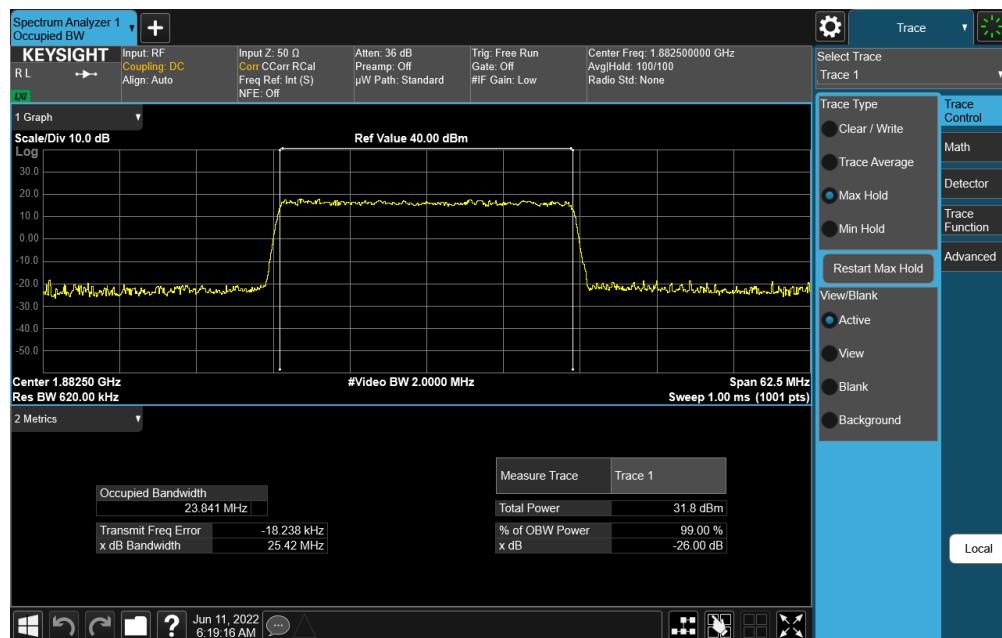


Plot 7-44. Occupied Bandwidth Plot (NR Band n25/n2 - 20.0MHz CP-OFDM 256QAM - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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Plot 7-45. Occupied Bandwidth Plot (NR Band n25 - 25.0MHz DFT-s-OFDM π/2 BPSK - Full RB)

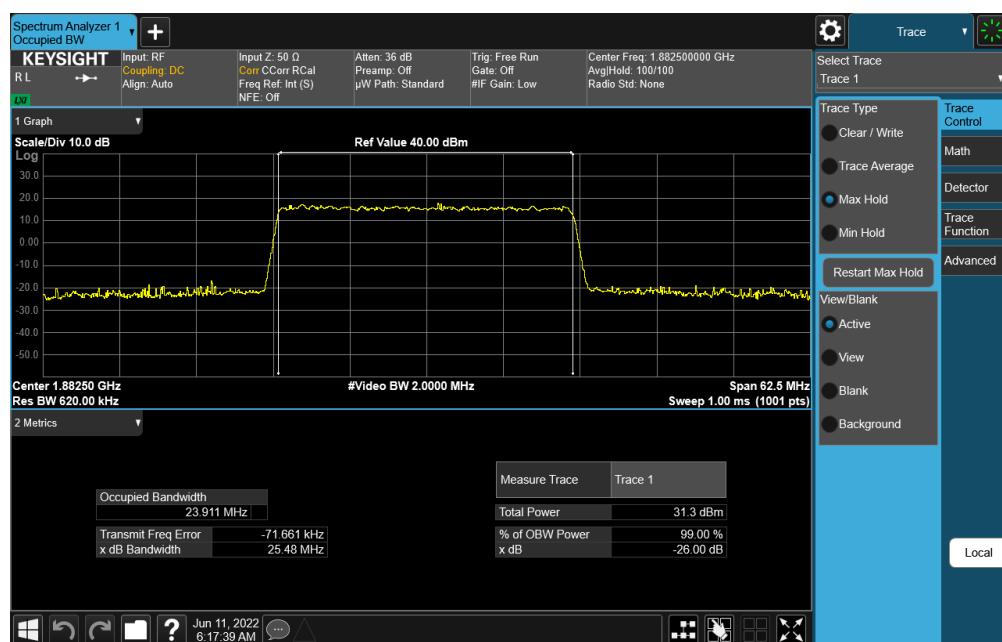


Plot 7-46. Occupied Bandwidth Plot (NR Band n25 - 25.0MHz CP-OFDM QPSK - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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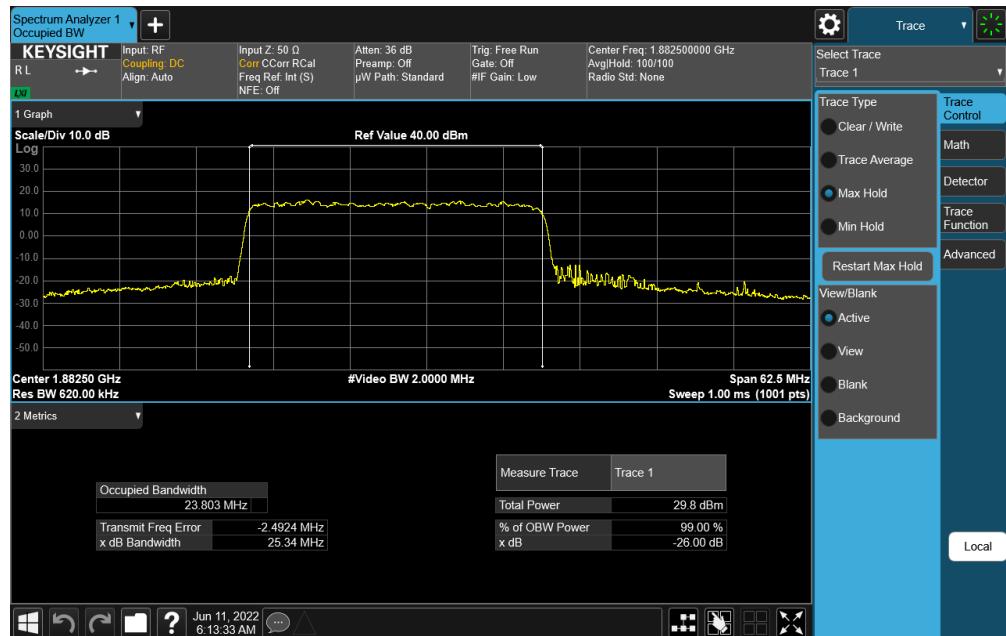


Plot 7-47. Occupied Bandwidth Plot (NR Band n25 - 25.0MHz CP-OFDM 16QAM - Full RB)



Plot 7-48. Occupied Bandwidth Plot (NR Band n25 - 25.0MHz CP-OFDM 64QAM - Full RB)

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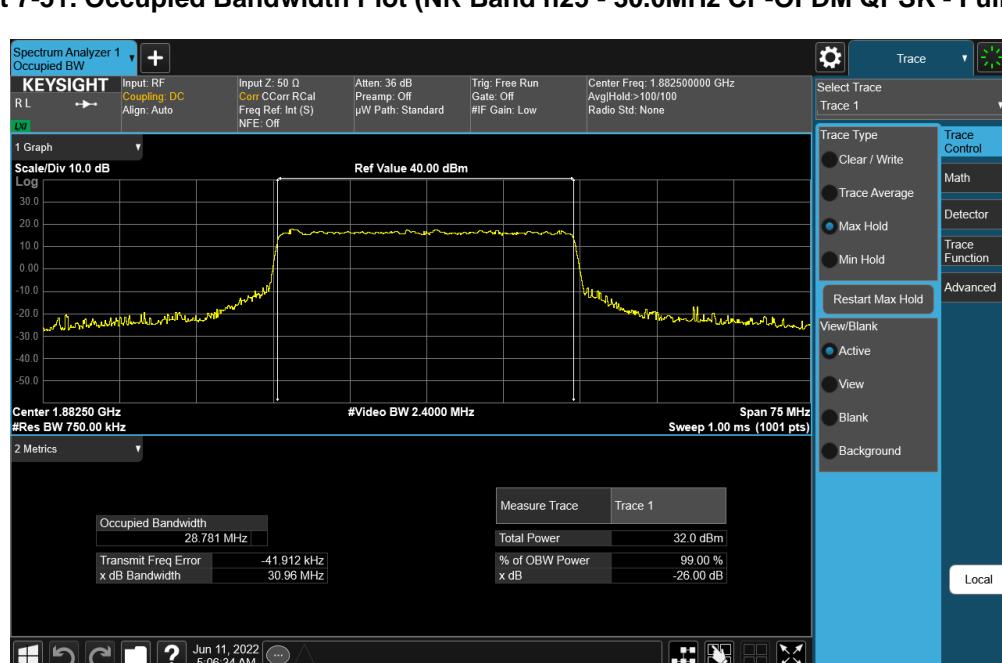
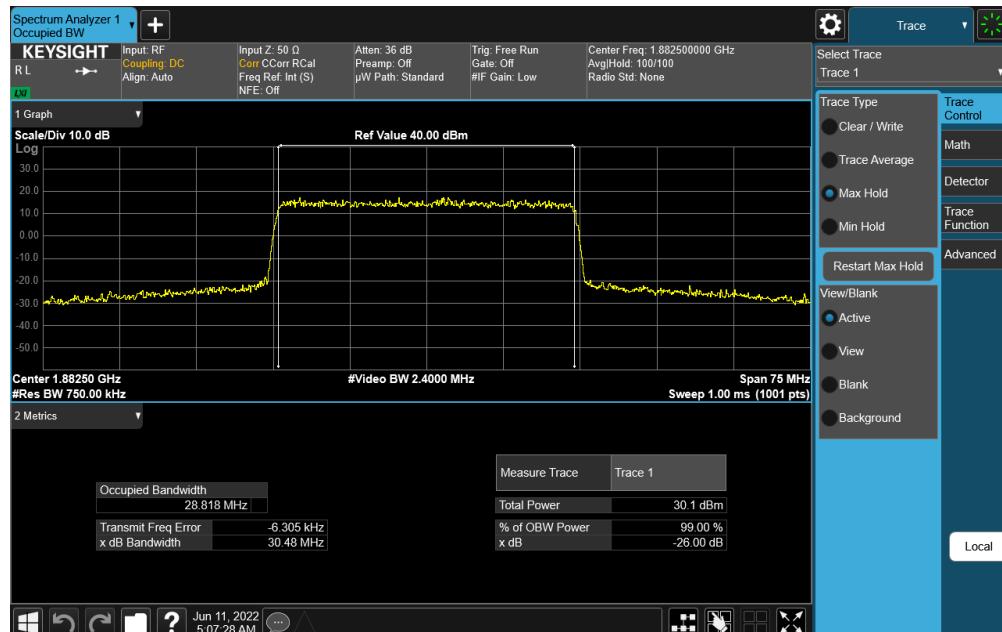


Plot 7-49. Occupied Bandwidth Plot (NR Band n25 - 25.0MHz CP-OFDM 256QAM - Full RB)

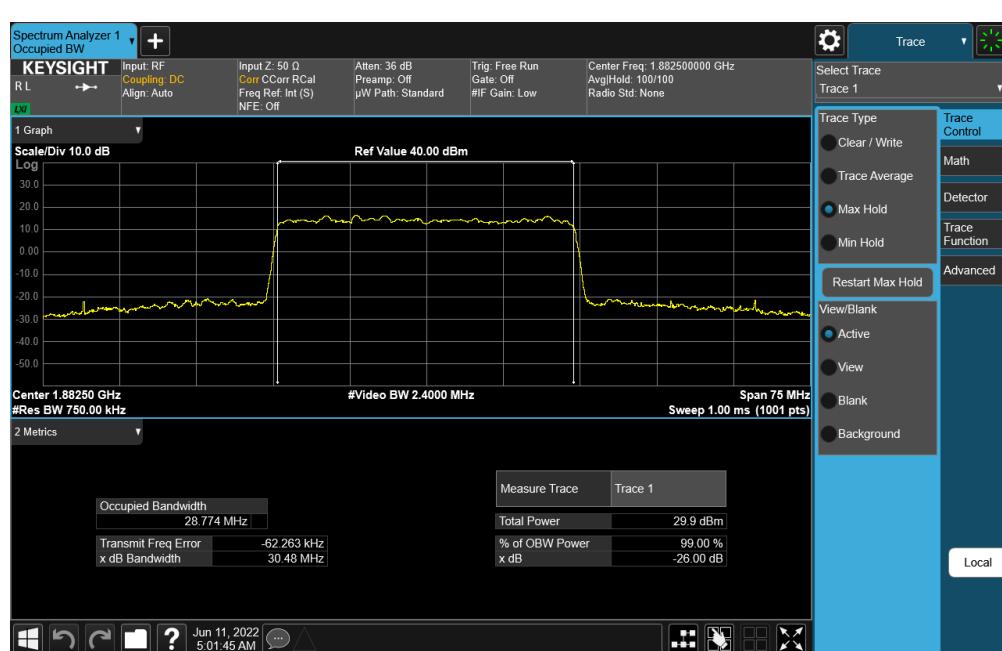


Plot 7-50. Occupied Bandwidth Plot (NR Band n25 - 30.0MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB)

FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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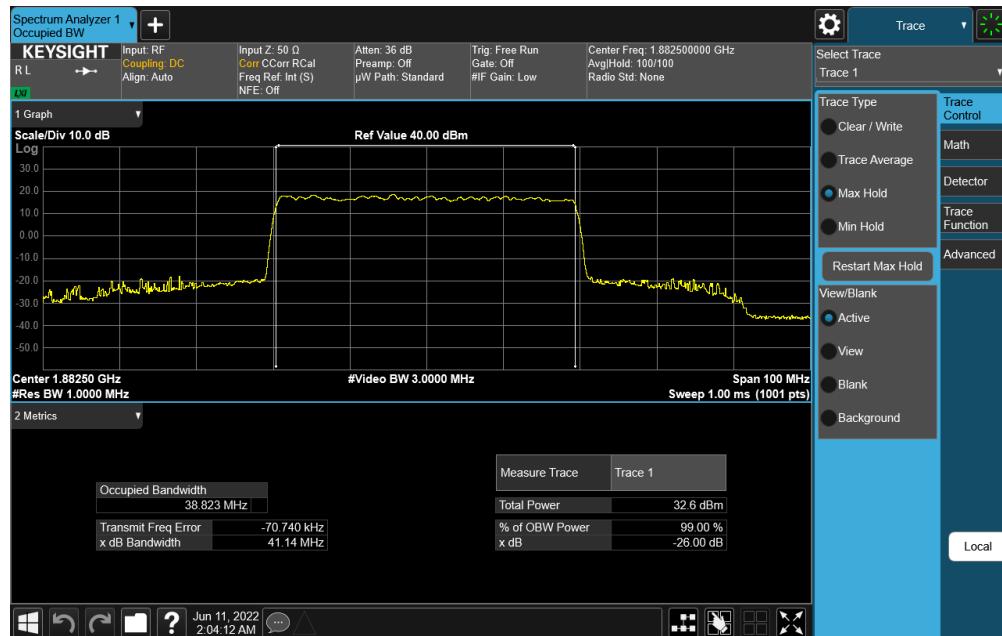


Plot 7-55. Occupied Bandwidth Plot (NR Band n25 - 40.0MHz DFT-s-OFDM π/2 BPSK - Full RB)

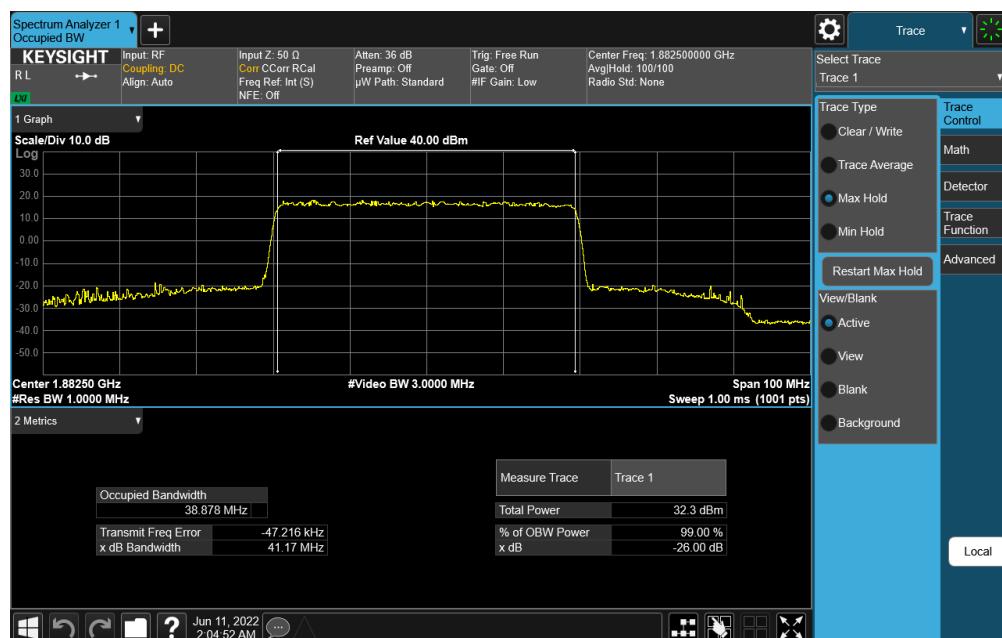


Plot 7-56. Occupied Bandwidth Plot (NR Band n25 - 40.0MHz DFT-s-OFDM QPSK - Full RB)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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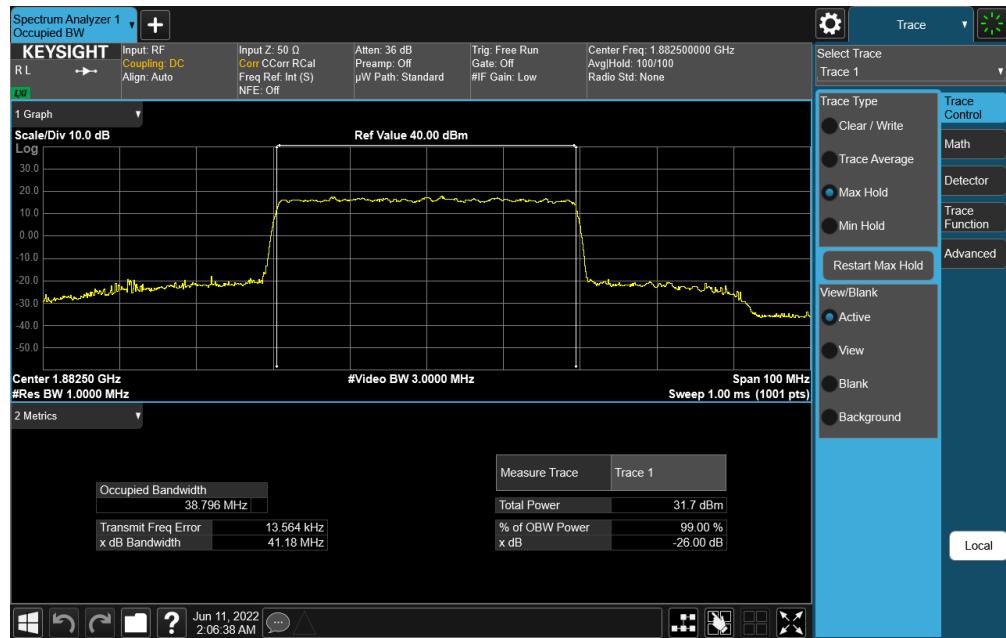


Plot 7-57. Occupied Bandwidth Plot (NR Band n25 - 40.0MHz DFT-s-OFDM 16QAM - Full RB)



Plot 7-58. Occupied Bandwidth Plot (NR Band n25 - 40.0MHz DFT-s-OFDM 64QAM - Full RB)

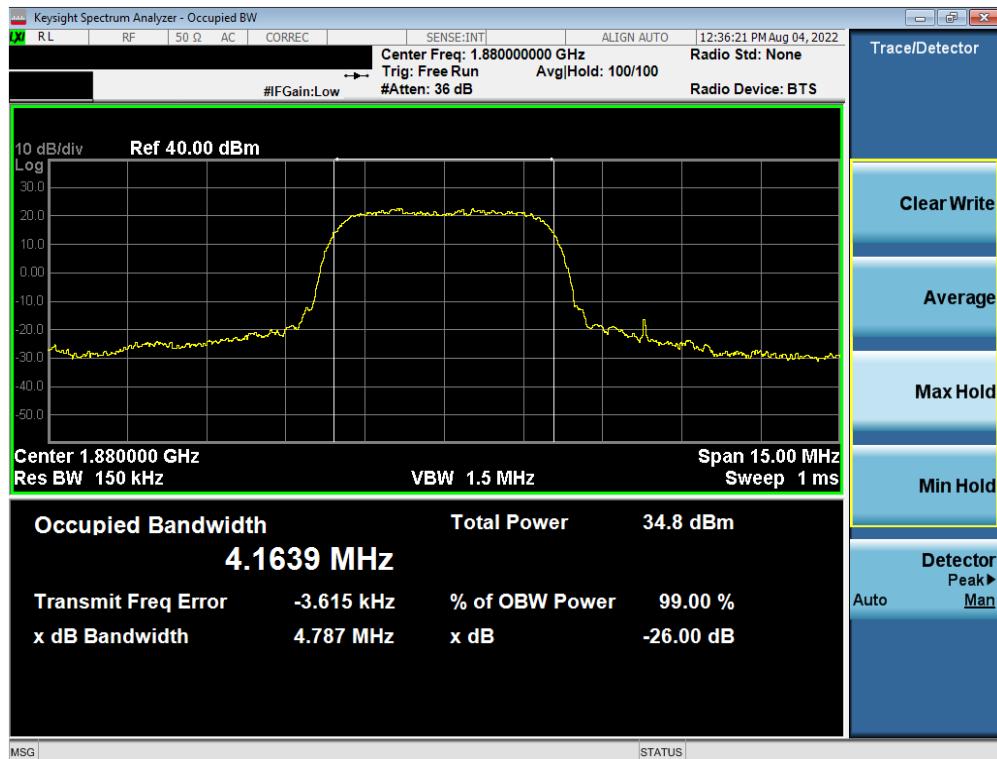
FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-59. Occupied Bandwidth Plot (NR Band n25 - 40.0MHz DFT-s-OFDM 256QAM - Full RB)

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WCDMA PCS



Plot 7-60. Occupied Bandwidth Plot (WCDMA, Ch. 9400)

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7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051, §24.238(a)

Test Overview

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section. All ports were tested and only the worst case data were reported.

The minimum permissible attenuation level of any spurious emission is $43 + 10 \log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 20GHz (separated into at least two plots per channel)
2. Detector = RMS
3. Trace mode = trace average for continuous emissions, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

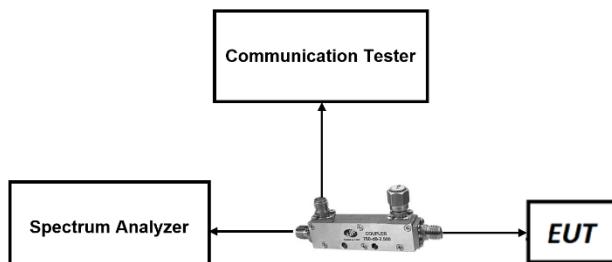


Figure 7-2. Test Instrument & Measurement Setup

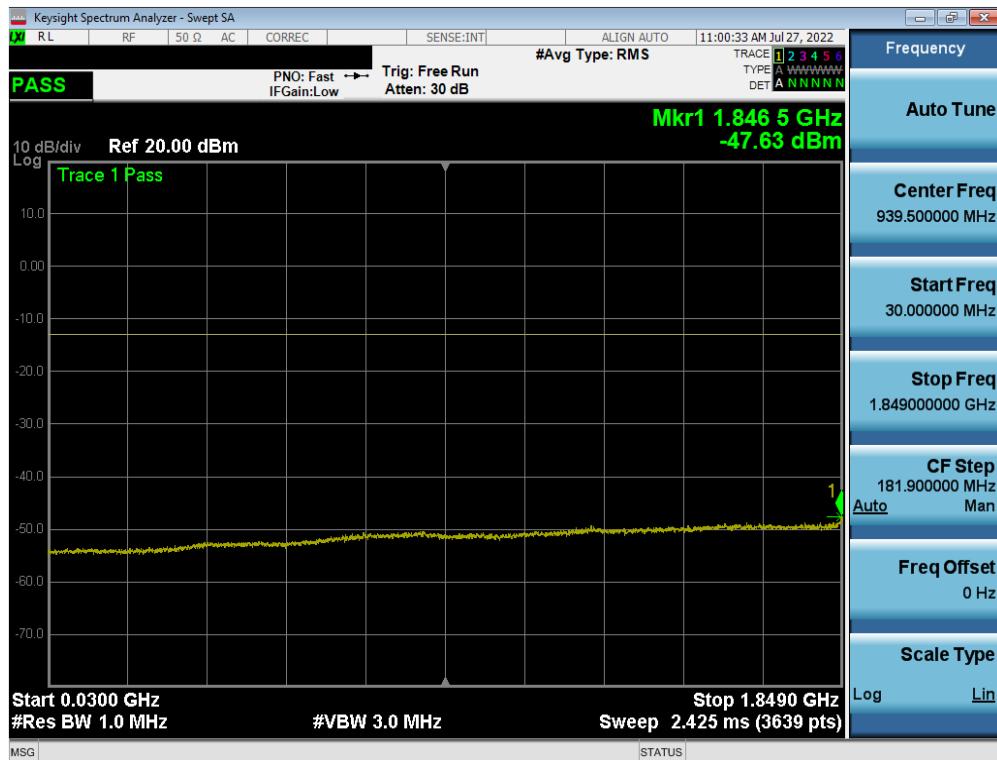
FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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Test Notes

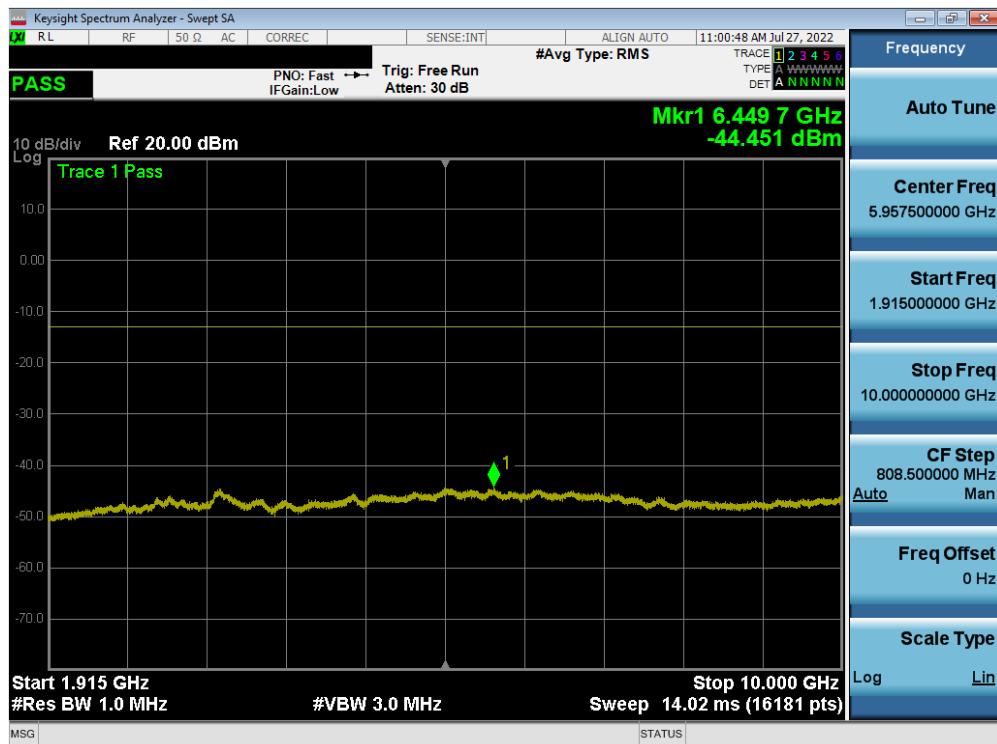
1. Per Part 24, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth 100 kHz or greater for measurements below 1GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.
2. For NR operation, all subcarrier spacings (SCS) and transmission schemes (e.g. CP-OFDM and DFT-s-OFDM) were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.
3. N band n25 overlaps the entire frequency range of NR band 2. Therefore, the conducted emissions data of band n25 provided in this report covers NR band n2.

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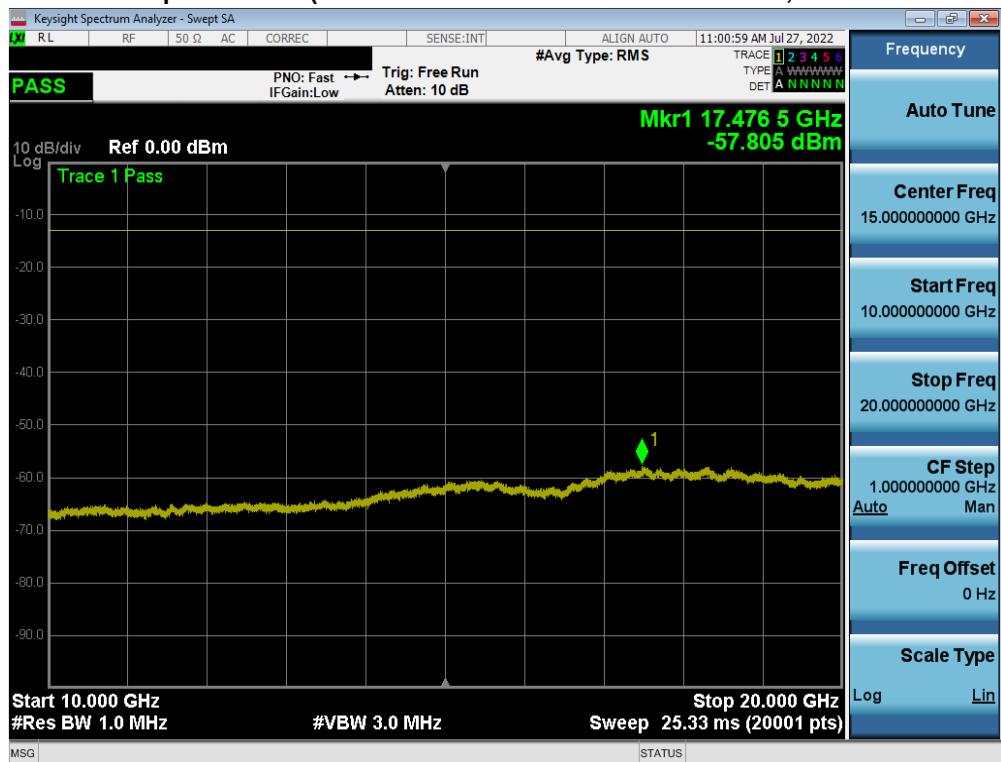
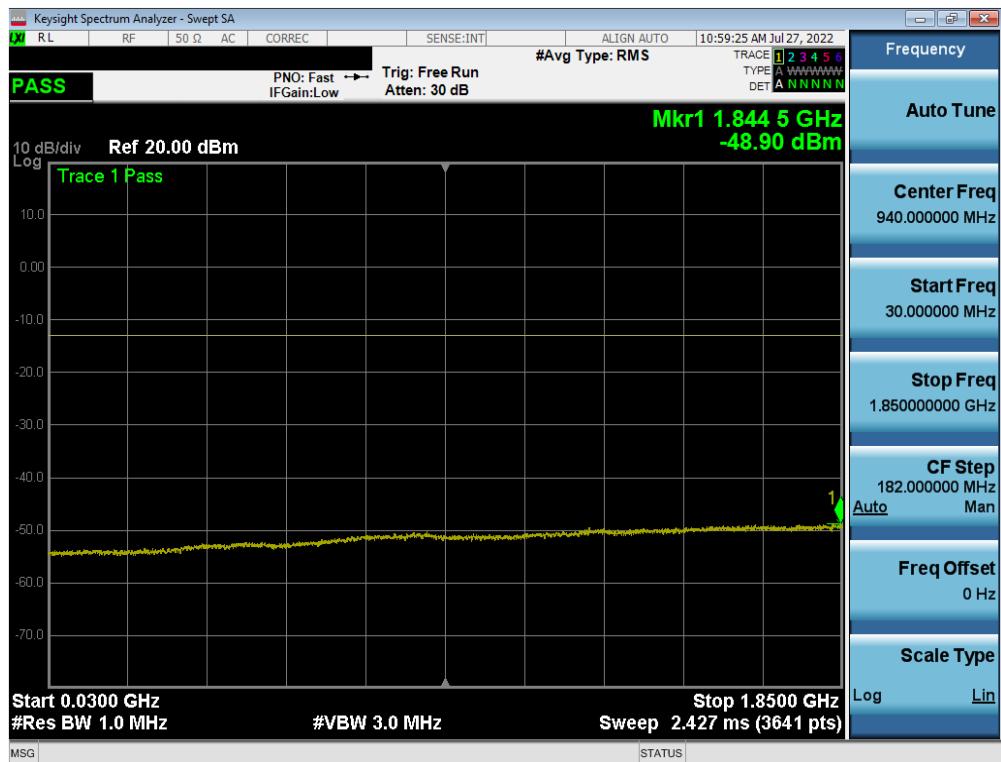
LTE Band 25/2



Plot 7-61. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



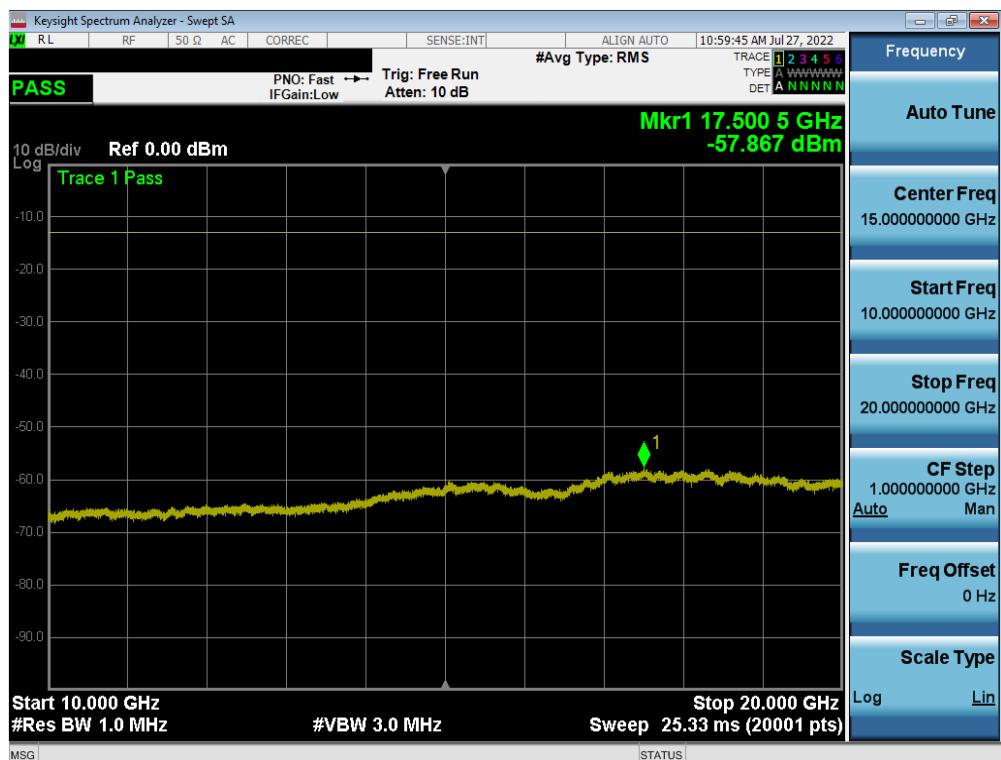
FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT	
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Plot 7-62. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

Plot 7-63. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

Plot 7-64. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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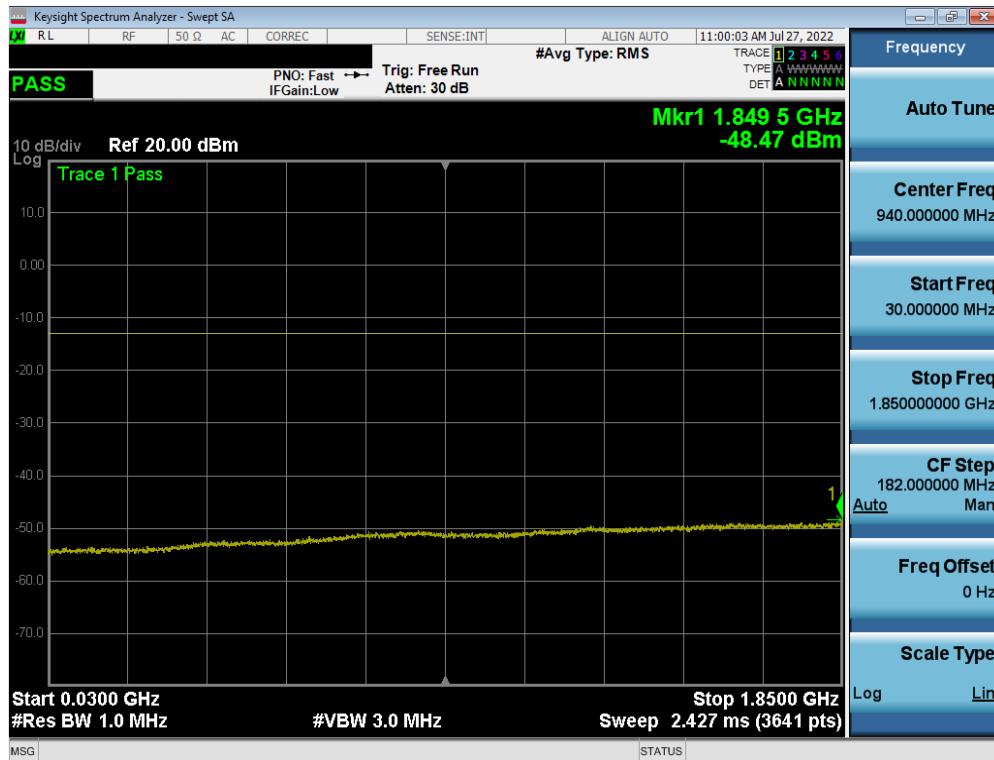


Plot 7-65. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

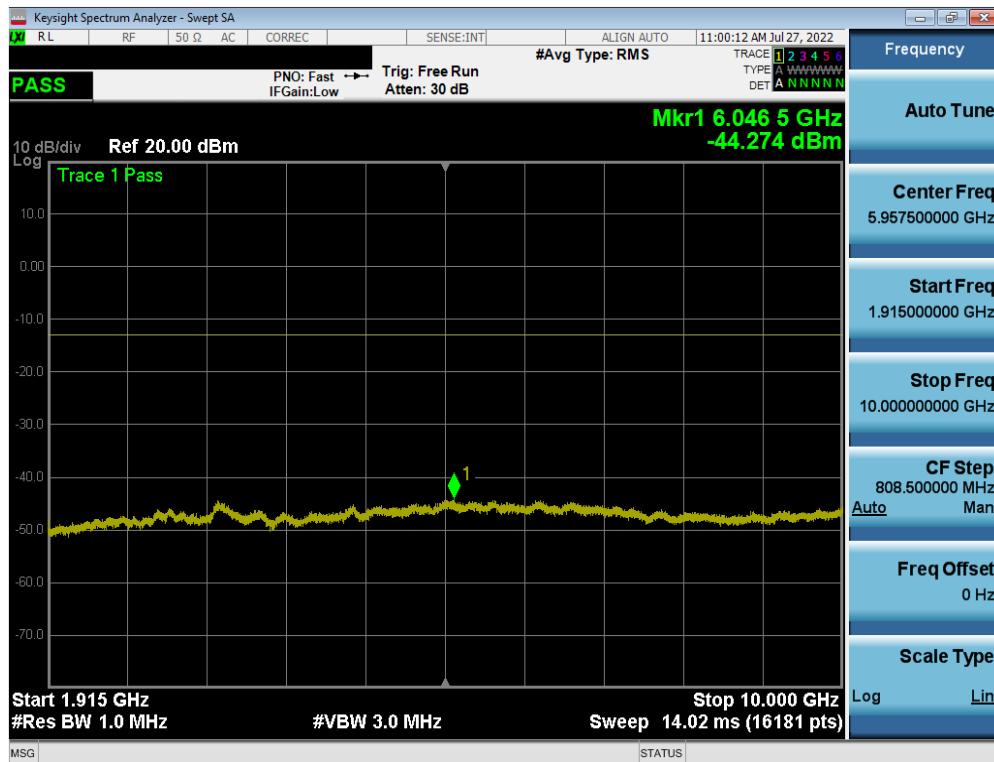


Plot 7-66. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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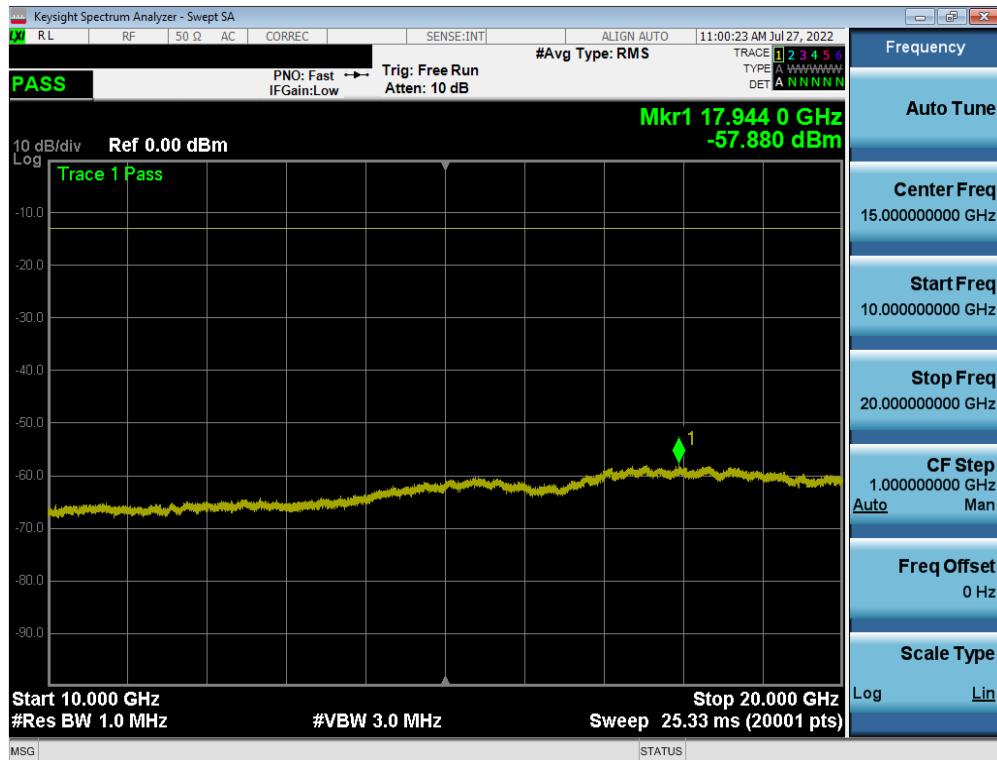


Plot 7-67. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-68. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

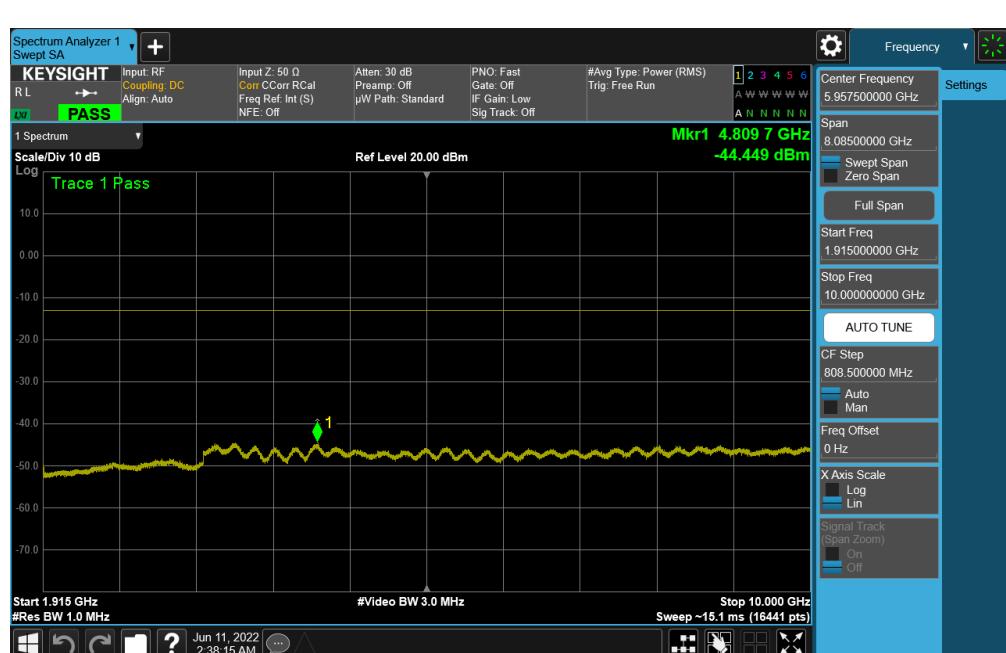
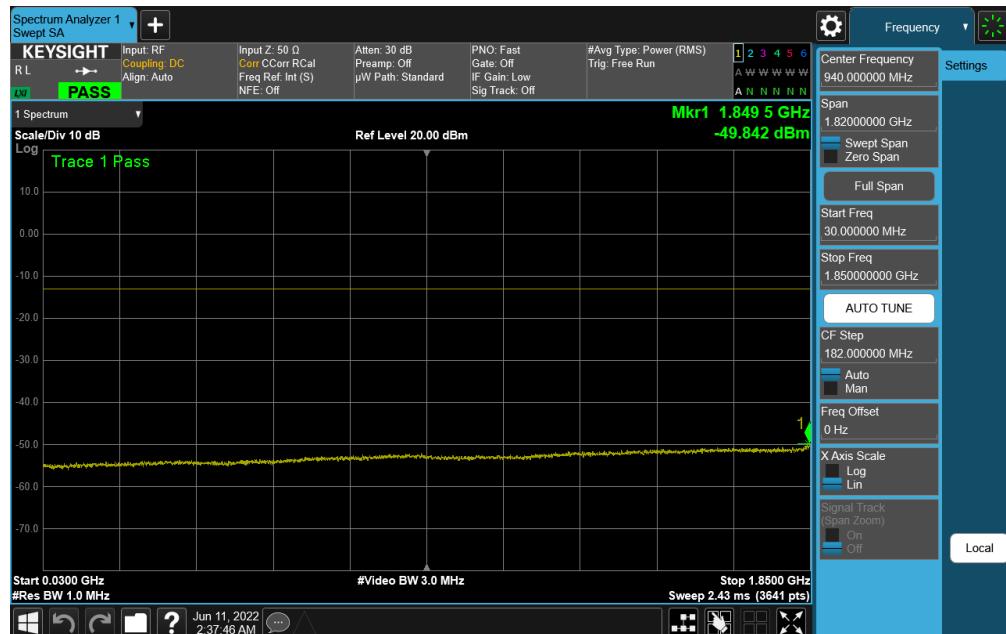
FCC ID: BCGA2435	 element	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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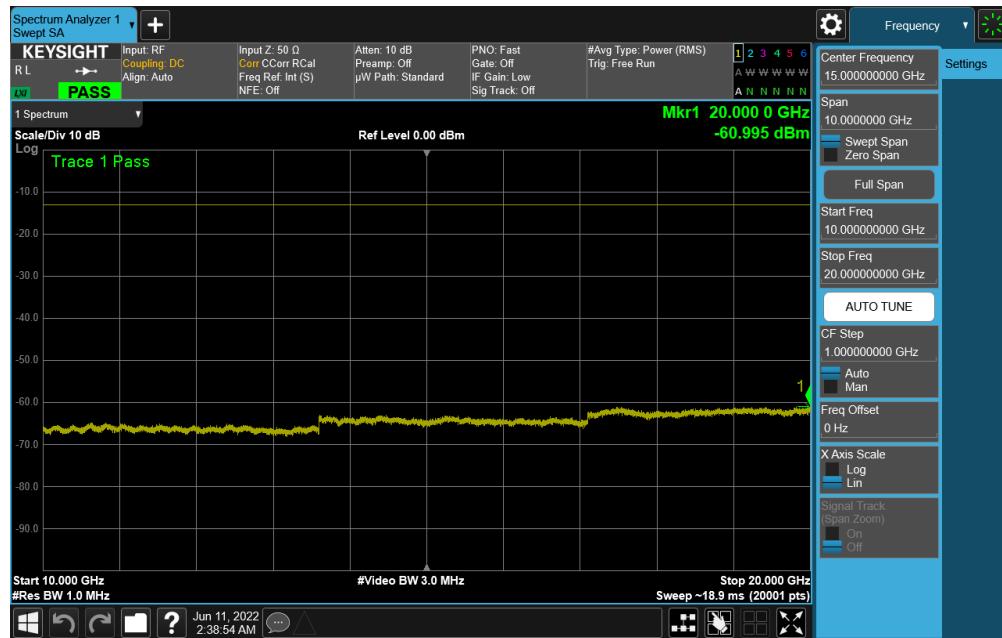
Plot 7-69. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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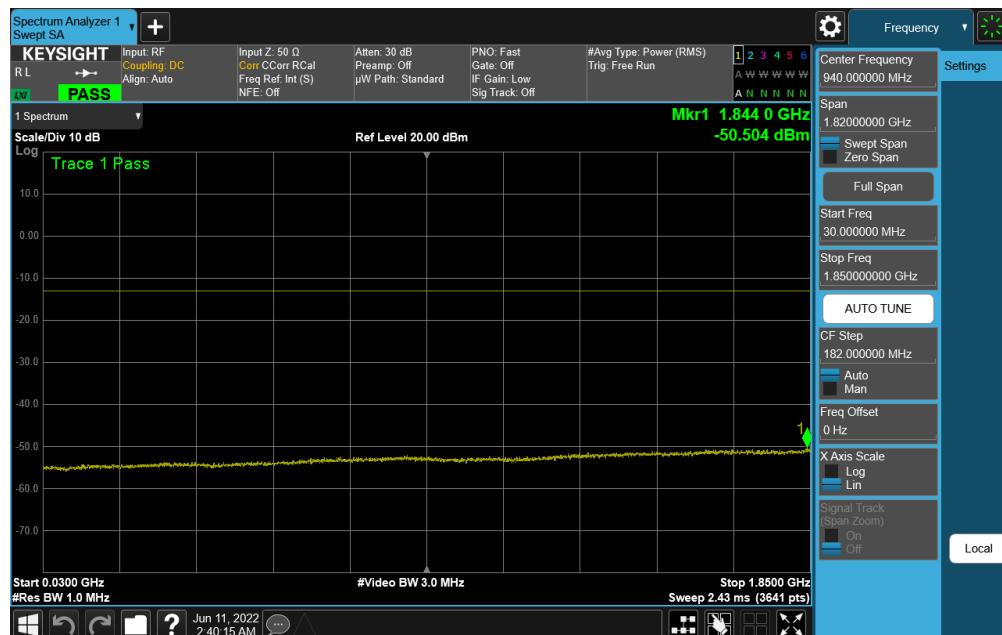
NR Band n25/n2



FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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Plot 7-72. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-73. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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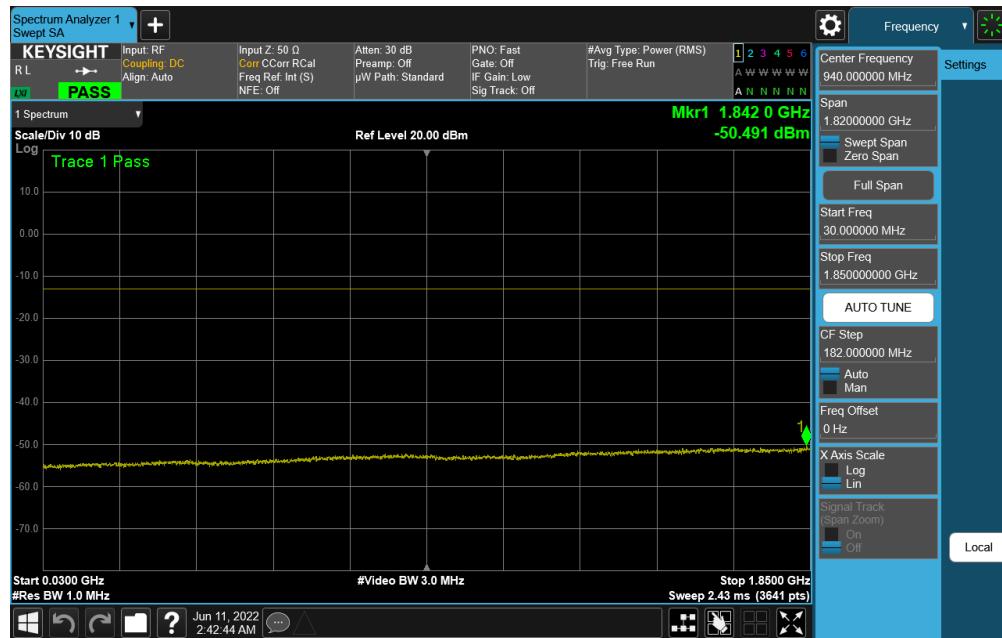


Plot 7-74. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

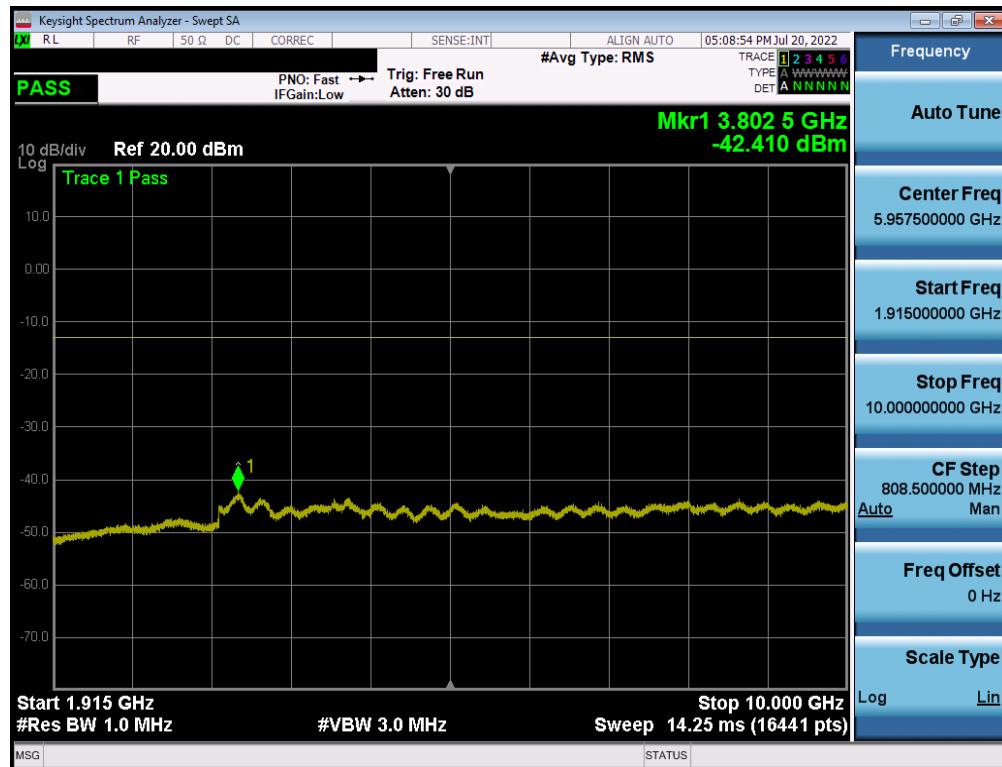


Plot 7-75. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-76. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-77. Conducted Spurious Plot (NR Band n25/n2 - 40.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2435	PART 24 MEASUREMENT REPORT		Approved by: Technical Manager
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