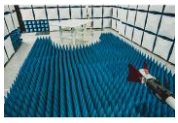
PCTEST
18855 Adams Court, Morgan Hill, CA 95037 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.pctest.com



DATA REFERENCE REPORT
PART 27

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

Date of Testing:
12/23/2020 - 03/05/2021
Test Site/Location:
PCTEST Lab. Morgan Hill, CA, USA
Test Report Serial No.:
1C2101020003-06-R1.BCG

FCC ID:	**BCGA2459**
Applicant Name:	**Apple Inc.**

Reference Model:	A2301
Variant Model:	A2459, A2460
EUT Type:	Tablet Device
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part:	27
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.

This revised Test Report (S/N: 1C2101020003-06-R1.BCG) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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.

Randy Ortanez
President

ACCREDITED
CERT #2041.02

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1.0 INTRODUCTION

1.1 Scope

Per manufacturer declaration, there are two tablet device models, A2301 and A2459(A2460), with high degree of similarity, reference model FCC ID: BCGA2301 and variant model **FCC ID: BCGA2459**. The reference model supports mmWave operations, while the variant model has the mmWave components/antennas removed. Both models share the same material, form factor, circuit design, and components, including antennas and their locations. The reference and variant models use the same power tables and have same tune-up tolerances.

Per FCC approved Data Referencing Test Plan, testing was done fully on the reference model FCC ID: BCGA2301, while radiated spot-check verification has been performed on variant model **FCC ID: BCGA2459**. Additionally, due to Antenna 4a location being close to the depopulated mmWave components, full radiated testing has been done for all supported technologies on Antenna 4a. Spot-check measurements were conducted, all measurements were investigated and found to be within acceptable tolerance.

Equipment Class	Reference Model FCC ID	Reference Report	Report Title
PCE	BCGA2301	1C2101020002-05-R1.BCG	RF Part 27b Test Report

Table 1-1. Reference Model Details

Reference model FCC ID: BCGA2301 test report has been included in Appendix A

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST. 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

- PCTEST 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.

- PCTEST 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).

- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID:BCGA2459**. 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 27.

Test Device Serial No.: H1931W7GTV, TM6JQGGX3H

2.2 Device Capabilities

This device contains the following capabilities:

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

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	WLAN	Bluetooth	GSM / WCDMA	LTE / FR1 NR			UNII
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	Mid Band	Mid Band	High Band	Ultra High Band	802.11 a/n/ac/ax
2a	Config 1	✓	×	×	×	×	✓	×
2a	Config 2	×	✓	×	×	×	✓	×
4a	Config 3	✓	×	×	×	×	✓	×
4a	Config 4	×	✓	×	×	×	✓	×
4b	Config 5	×	×	✓	×	×	×	✓
4b	Config 6	×	×	×	✓	×	×	✓
4b	Config 7	×	×	×	×	✓	×	✓

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for the testing.

Frequency [MHz]	Antenna Gain (dBi)					
	Antenna 3	Antenna 1	Antenna 4b	Antenna 4a	Antenna 2b	Antenna 2a
LTE Band 30	-1.4	-4.1	0.0	N/A	1.2	N/A
LTE Band 7	-4.5	-0.6	-1.4	N/A	-0.8	N/A
LTE Band 41	-4.5	-0.8	-1.4	N/A	-0.7	N/A
NR Band n41	-0.8	-4.5	-0.7		-1.4	
NR Band n77	-0.5	-1.6	N/A	1.7	N/A	-0.8

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro	Model:	A2141	S/N:	C02DV7VKMD6T
	w/AC/DC Adapter	Model:	A2166	S/N:	N/A
2	Apple USB-C Cable	Model:	Chimp	S/N:	420A57
3	USB-C Cable	Model:	A146	S/N:	N/A
	w/ AC Adapter	Model:	A2305	S/N:	N/A
4	Apple Pencil	Model:	N/A	S/N:	GQXYGSXBJKM9
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-3. Test Support Equipment

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 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.

Per FCC Approved Data Referencing Test Plan, Antenna 4a radiated testing and spot-check measurements have been conducted and reported. Spot-check Test Plan can be referred to below Table 2-4.

Technology	Test Case	FCC ID: BCGA2459	
		Mode	Channel
GSM, WCDMA, LTE, FR1 Single Carrier & IntraBand ULCA	Radiated Spurious Emissions	Antenna 3 LTE Band 5, 2, 7 Max BW, 1RB, QPSK	M

Table 2-4. FCC Approved Spot-Check Test Plan

Output powers were measured and confirmed to be consistent between Reference and Variant models prior to testing.

2.6 Software and Firmware

The test was conducted with firmware version 18E20700y 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.

3.0 DESCRIPTION OF TESTS

3.1 Measurement 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.

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:

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

And

$$EIRP_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8;$$

Where D 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 and TIA-603-E-2016.

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 (±dB)
Radiated Disturbance (<30MHz)	4.06
Radiated Disturbance (30MHz-1GHz)	4.30
Radiated Disturbance (1-18GHz)	4.78
Radiated Disturbance (>18GHz)	4.79

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	PXA Signal Analyzer (3Hz - 26.5 GHz)	7/24/2020	Annual	7/24/2021	MY55330128
Keysight Technology	N9040B	UXA Signal Analyzer	12/19/2020	Annual	12/19/2021	MY57212015
Keysight Technology	E7515B	UXM 5G Wireless Test Platform	11/14/2020	Annual	11/14/2021	MY60192562
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	8/11/2020	Annual	8/11/2021	T058701-01
ESPEC	SU-241	Tabletop Temperature Chamber	9/28/2020	Annual	9/28/2021	92009574
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	9/15/2020	Annual	9/15/2021	208204
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	4/21/2020	Annual	4/21/2021	205956
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	7/15/2020	Annual	7/15/2021	102356
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz - 18GHz)	12/3/2020	Annual	12/3/2021	101648
Rohde & Schwarz	ESW26	EMI Test Receiver	6/8/2020	Annual	6/8/2021	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	8/6/2020	Annual	8/6/2021	101668
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/13/2020	Annual	10/13/2021	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	4/16/2020	Annual	4/16/2021	166869
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	4/23/2020	Annual	4/23/2021	100052
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Antenna (400MHz-18GHz)	10/2/2020	Annual	10/2/2021	101063
Rohde & Schwarz	HFH2-Z2	Loop Antenna	3/12/2020	Annual	3/12/2021	100546

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.

6.0 SAMPLE CALCULATIONS

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.

7.0 TEST RESULTS (SPOT-CHECK DATA)

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCGA2459

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE

Technology	Test Configurations					Reference Model	Variant model	Delta
	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2301	FCC ID: BCGA2459	
						Average [dBm]	Average [dBm]	Average [dB]
LTE Band 7	Radiated Spurious Emissions	QPSK	20MHz / 1/50 RB	M	5070	-61.94	-62.33	0.39

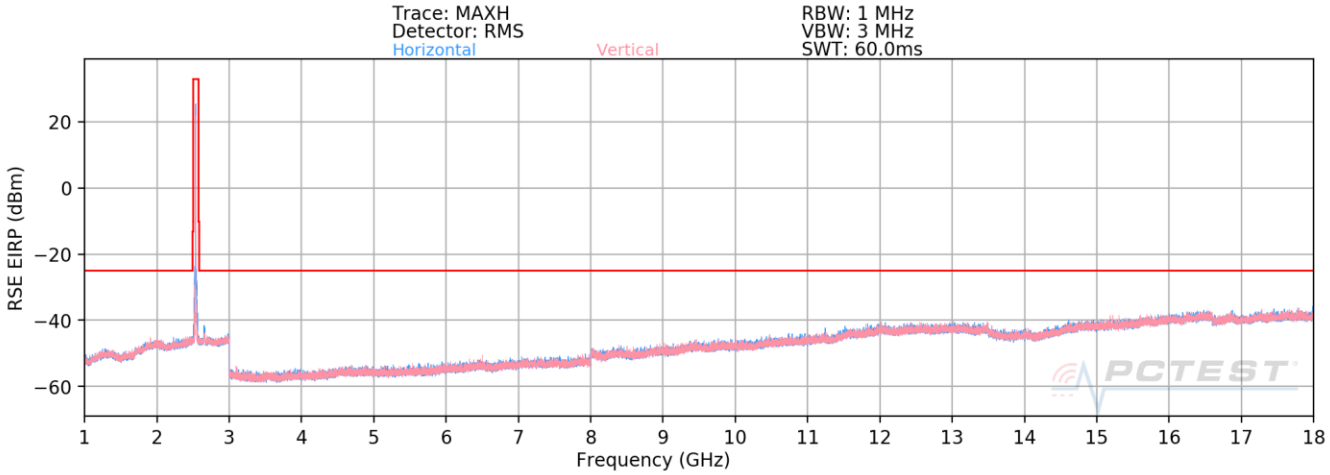
Table 7-1. Worst Case Spot-check Results

Spot-checks were conducted, all measurements were investigated and found to be within acceptable tolerance in accordance with FCC Approved Data Referencing Test Plan.

7.2 Radiated Spurious Emissions

§2.1053, 27.53(a), §2.1053, 27.53(m)

LTE Band 7



Plot 7-1. Radiated Spurious Emission above 1GHz (LTE Band 7)

Bandwidth (MHz):	20
Frequency (MHz):	2535.0
RB / Offset:	1 / 50

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
5070.0	H	-	-	-80.44	6.36	32.92	-62.33	-25.00	-37.33
7605.0	H	-	-	-80.40	9.01	35.61	-59.64	-25.00	-34.64
10140.0	H	-	-	-79.89	12.07	39.18	-56.07	-25.00	-31.07

Table 7-2. Radiated Spurious Data (LTE Band 7 – Mid Channel)

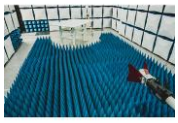
8.0 CONCLUSION

The spot-check data measured for variant model **FCC ID: BCGA2459** is in tolerance with reference model FCC ID: BCGA2301 per FCC Approved Data Referencing Test Plan.

9.0 APPENDIX A: REFERENCE MODEL TEST REPORT

Attached is the test report (1C2101020002-05-R1.BCG) from reference model FCC ID: BCGA2301, which includes referenced data results.

PCTEST
18855 Adams Court, Morgan Hill, CA 95037 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.pctest.com



PART 27 MEASUREMENT REPORT

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

Date of Testing:
12/23/2020 - 03/05/2021
Test Site/Location:
PCTEST Lab. Morgan Hill, CA, USA
Test Report Serial No.:
1C2101020002-05-R1.BCG

FCC ID:	**BCGA2301**
Applicant Name:	**Apple Inc.**

Application Type:	Certification
Model:	A2301
EUT Type:	Tablet Device
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part:	27
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.

This revised Test Report (S/N: 1C2101020002-05-R1.BCG) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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.

Randy Ortanez
President

ACCREDITED
CERT #2041.02

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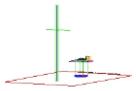
PART 27 MEASUREMENT REPORT



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	OBW [MHz]	EIRP		Emission Designator
					Max. Power [W]	Max. Power [dBm]	
LTE Band 30	10MHz	QPSK	2310.0	8.9979	0.200	23.00	9M00G7W
		16QAM	2310.0	9.0284	0.191	22.82	9M03D7W
		64QAM	2310.0	8.9990	0.161	22.08	9M00D7W
		256QAM	2310.0	8.9914	0.122	20.86	8M99D7W
	5 MHz	QPSK	2307.5 - 2312.5	4.5491	0.200	23.00	4M55G7W
		16QAM	2307.5 - 2312.5	4.5241	0.200	23.00	4M52D7W
		64QAM	2307.5 - 2312.5	4.5264	0.200	23.00	4M53D7W
		256QAM	2307.5 - 2312.5	4.5302	0.124	20.94	4M53D7W
LTE Band 7	20 MHz	QPSK	2510.0 - 2560.0	18.0100	0.240	23.80	18M0G7W
		16QAM	2510.0 - 2560.0	18.0220	0.202	23.05	18M0D7W
		64QAM	2510.0 - 2560.0	18.0080	0.177	22.49	18M0D7W
		256QAM	2510.0 - 2560.0	18.0080	0.095	19.77	18M0D7W
	15 MHz	QPSK	2507.5 - 2562.5	13.5630	0.240	23.80	13M6G7W
		16QAM	2507.5 - 2562.5	13.5630	0.207	23.15	13M6D7W
		64QAM	2507.5 - 2562.5	13.5720	0.186	22.70	13M6D7W
		256QAM	2507.5 - 2562.5	13.5550	0.095	19.78	13M6D7W
	10 MHz	QPSK	2505.0 - 2565.0	9.0062	0.240	23.80	9M01G7W
		16QAM	2505.0 - 2565.0	8.9698	0.200	23.01	8M97D7W
		64QAM	2505.0 - 2565.0	9.0182	0.175	22.42	9M02D7W
		256QAM	2505.0 - 2565.0	9.0091	0.097	19.87	9M01D7W
	5 MHz	QPSK	2502.5 - 2567.5	4.5690	0.220	23.43	4M57G7W
		16QAM	2502.5 - 2567.5	4.5282	0.191	22.81	4M53D7W
		64QAM	2502.5 - 2567.5	4.5149	0.166	22.20	4M51D7W
		256QAM	2502.5 - 2567.5	4.5353	0.098	19.90	4M54D7W
LTE Band 41 (PC2)	20 MHz	QPSK	2506.0 - 2680.0	18.0440	0.369	25.67	18M0G7W
		16QAM	2506.0 - 2680.0	17.9650	0.323	25.09	18M0D7W
		64QAM	2506.0 - 2680.0	17.9540	0.280	24.47	18M0D7W
		256QAM	2506.0 - 2680.0	17.9960	0.173	22.38	18M0D7W
	15 MHz	QPSK	2503.5 - 2682.5	13.5320	0.367	25.65	13M5G7W
		16QAM	2503.5 - 2682.5	13.4970	0.317	25.01	13M5D7W
		64QAM	2503.5 - 2682.5	13.5020	0.252	24.02	13M5D7W
		256QAM	2503.5 - 2682.5	13.5370	0.185	22.68	13M5D7W
	10 MHz	QPSK	2501.0 - 2685.0	9.0248	0.371	25.69	9M02G7W
		16QAM	2501.0 - 2685.0	9.0033	0.330	25.18	9M00D7W
		64QAM	2501.0 - 2685.0	8.9939	0.247	23.92	8M99D7W
		256QAM	2501.0 - 2685.0	9.0326	0.167	22.22	9M03D7W
	5 MHz	QPSK	2498.5 - 2687.5	4.5602	0.380	25.80	4M56G7W
		16QAM	2498.5 - 2687.5	4.5128	0.294	24.69	4M51D7W
		64QAM	2498.5 - 2687.5	4.5286	0.261	24.17	4M53D7W
		256QAM	2498.5 - 2687.5	4.5371	0.167	22.23	4M54D7W
LTE Band 41 (PC3)	20 MHz	QPSK	2506.0 - 2680.0	18.0440	0.240	23.80	18M0G7W
		16QAM	2506.0 - 2680.0	17.9650	0.201	23.03	18M0D7W
		64QAM	2506.0 - 2680.0	17.9540	0.151	21.80	18M0D7W
		256QAM	2506.0 - 2680.0	17.9960	0.095	19.76	18M0D7W
	15 MHz	QPSK	2503.5 - 2682.5	13.5320	0.240	23.80	13M5G7W
		16QAM	2503.5 - 2682.5	13.4970	0.190	22.78	13M5D7W
		64QAM	2503.5 - 2682.5	13.5020	0.156	21.92	13M5D7W
		256QAM	2503.5 - 2682.5	13.5370	0.093	19.68	13M5D7W
	10 MHz	QPSK	2501.0 - 2685.0	9.0248	0.239	23.79	9M02G7W
		16QAM	2501.0 - 2685.0	9.0033	0.207	23.17	9M00D7W
		64QAM	2501.0 - 2685.0	8.9939	0.152	21.83	8M99D7W
		256QAM	2501.0 - 2685.0	9.0326	0.094	19.73	9M03D7W
	5 MHz	QPSK	2498.5 - 2687.5	4.5602	0.234	23.70	4M56G7W
		16QAM	2498.5 - 2687.5	4.5128	0.180	22.55	4M51D7W
		64QAM	2498.5 - 2687.5	4.5286	0.148	21.69	4M53D7W
		256QAM	2498.5 - 2687.5	4.5371	0.101	20.03	4M54D7W
ULCA LTE Band 7	20 + 20 MHz	QPSK	2510.0 - 2560.0	37.6060	0.240	23.80	37M6G7W
		16QAM	2510.0 - 2560.0	37.6410	0.113	20.54	37M6D7W
		64QAM	2510.0 - 2560.0	37.5370	0.112	20.50	37M5D7W
		256QAM	2510.0 - 2560.0	37.5250	0.071	18.51	37M5D7W
ULCA LTE Band 41(PC2)	20 + 20 MHz	QPSK	2506.0 - 2680.0	37.5820	0.406	26.09	37M6G7W
		16QAM	2506.0 - 2680.0	37.6630	0.212	23.27	37M7D7W
		64QAM	2506.0 - 2680.0	37.6200	0.215	23.32	37M6D7W
		256QAM	2506.0 - 2680.0	37.6310	0.136	21.35	37M6D7W
ULCA LTE Band 41(PC3)	20 + 20 MHz	QPSK	2506.0 - 2680.0	37.5820	0.240	23.80	37M6G7W
		16QAM	2506.0 - 2680.0	37.6630	0.125	20.96	37M7D7W
		64QAM	2506.0 - 2680.0	37.6200	0.124	20.92	37M6D7W
		256QAM	2506.0 - 2680.0	37.6310	0.096	19.82	37M6D7W

EUT Overview

Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	OBW [MHz]	EIRP		Emission Designator
					Max. Power [W]	Max. Power [dBm]	
NR Band n41(PC2)	100 MHz	π/2 BPSK	2546.0 - 2640.0	96.6160	0.323	25.09	96M6G7W
		QPSK	2546.0 - 2640.0	97.5832	0.324	25.10	97M6G7W
		16QAM	2546.0 - 2640.0	97.6989	0.282	24.51	97M7D7W
		64QAM	2546.0 - 2640.0	97.5439	0.230	23.62	97M5D7W
		256QAM	2546.0 - 2640.0	97.5305	0.149	21.74	97M5D7W
	90 MHz	π/2 BPSK	2541.0 - 2645.0	85.9370	0.324	25.10	85M9G7W
		QPSK	2541.0 - 2645.0	87.8183	0.310	24.91	87M8G7W
		16QAM	2541.0 - 2645.0	87.7640	0.272	24.34	87M8D7W
		64QAM	2541.0 - 2645.0	87.6108	0.223	23.49	87M6D7W
		256QAM	2541.0 - 2645.0	87.6367	0.139	21.45	87M6D7W
	80 MHz	π/2 BPSK	2536.0 - 2650.0	77.1810	0.318	25.03	77M2G7W
		QPSK	2536.0 - 2650.0	77.5976	0.324	25.10	77M6G7W
		16QAM	2536.0 - 2650.0	77.5068	0.295	24.69	77M5D7W
		64QAM	2536.0 - 2650.0	77.6471	0.261	24.17	77M6D7W
		256QAM	2536.0 - 2650.0	77.5588	0.157	21.97	77M6D7W
	60 MHz	π/2 BPSK	2526.0 - 2660.0	58.0700	0.324	25.10	58M1G7W
		QPSK	2526.0 - 2660.0	58.2522	0.320	25.05	58M3G7W
		16QAM	2526.0 - 2660.0	58.1236	0.285	24.55	58M1D7W
		64QAM	2526.0 - 2660.0	58.0222	0.246	23.91	58M0D7W
		256QAM	2526.0 - 2660.0	58.1759	0.155	21.90	58M2D7W
	50 MHz	π/2 BPSK	2521.0 - 2665.0	46.1230	0.323	25.09	46M1G7W
		QPSK	2521.0 - 2665.0	47.7741	0.324	25.10	47M8G7W
		16QAM	2521.0 - 2665.0	47.7466	0.285	24.55	47M7D7W
		64QAM	2521.0 - 2665.0	47.8496	0.233	23.68	47M8D7W
		256QAM	2521.0 - 2665.0	47.7967	0.163	22.11	47M8D7W
	40 MHz	π/2 BPSK	2516.0 - 2670.0	35.9800	0.324	25.10	36M0G7W
		QPSK	2516.0 - 2670.0	37.9689	0.320	25.05	38M0G7W
		16QAM	2516.0 - 2670.0	38.0660	0.273	24.36	38M1D7W
		64QAM	2516.0 - 2670.0	38.0198	0.234	23.69	38M0D7W
		256QAM	2516.0 - 2670.0	38.0128	0.147	21.69	38M0D7W
	20 MHz	π/2 BPSK	2506.0 - 2680.0	18.0270	0.294	24.68	18M0G7W
		QPSK	2506.0 - 2680.0	18.3880	0.302	24.80	18M4G7W
		16QAM	2506.0 - 2680.0	18.3939	0.284	24.54	18M4D7W
		64QAM	2506.0 - 2680.0	18.3814	0.232	23.65	18M4D7W
		256QAM	2506.0 - 2680.0	18.3762	0.157	21.95	18M4D7W
NR Band n41(PC3)	100 MHz	π/2 BPSK	2546.0 - 2640.0	96.6160	0.230	23.61	96M6G7W
		QPSK	2546.0 - 2640.0	97.5832	0.229	23.61	97M6G7W
		16QAM	2546.0 - 2640.0	97.6989	0.172	22.36	97M7D7W
		64QAM	2546.0 - 2640.0	97.5439	0.130	21.14	97M5D7W
		256QAM	2546.0 - 2640.0	97.5305	0.082	19.16	97M5D7W
	90 MHz	π/2 BPSK	2541.0 - 2645.0	85.9370	0.240	23.80	85M9G7W
		QPSK	2541.0 - 2645.0	87.8183	0.234	23.69	87M8G7W
		16QAM	2541.0 - 2645.0	87.7640	0.177	22.47	87M8D7W
		64QAM	2541.0 - 2645.0	87.6108	0.125	20.97	87M6D7W
		256QAM	2541.0 - 2645.0	87.6367	0.079	18.97	87M6D7W
	80 MHz	π/2 BPSK	2536.0 - 2650.0	77.1810	0.230	23.62	77M2G7W
		QPSK	2536.0 - 2650.0	77.5976	0.223	23.49	77M6G7W
		16QAM	2536.0 - 2650.0	77.5068	0.172	22.35	77M5D7W
		64QAM	2536.0 - 2650.0	77.6471	0.130	21.14	77M6D7W
		256QAM	2536.0 - 2650.0	77.5588	0.082	19.16	77M6D7W
	60 MHz	π/2 BPSK	2526.0 - 2660.0	58.0700	0.238	23.76	58M1G7W
		QPSK	2526.0 - 2660.0	58.2522	0.229	23.60	58M3G7W
		16QAM	2526.0 - 2660.0	58.1236	0.186	22.69	58M1D7W
		64QAM	2526.0 - 2660.0	58.0222	0.124	20.93	58M0D7W
		256QAM	2526.0 - 2660.0	58.1759	0.078	18.94	58M2D7W
	50 MHz	π/2 BPSK	2521.0 - 2665.0	46.1230	0.229	23.59	46M1G7W
		QPSK	2521.0 - 2665.0	47.7741	0.221	23.44	47M8G7W
		16QAM	2521.0 - 2665.0	47.7466	0.179	22.53	47M7D7W
		64QAM	2521.0 - 2665.0	47.8496	0.129	21.09	47M8D7W
		256QAM	2521.0 - 2665.0	47.7967	0.081	19.07	47M8D7W
	40 MHz	π/2 BPSK	2516.0 - 2670.0	35.9800	0.237	23.75	36M0G7W
		QPSK	2516.0 - 2670.0	37.9689	0.230	23.62	38M0G7W
		16QAM	2516.0 - 2670.0	38.0660	0.173	22.37	38M1D7W
		64QAM	2516.0 - 2670.0	38.0198	0.129	21.11	38M0D7W
		256QAM	2516.0 - 2670.0	38.0128	0.083	19.20	38M0D7W
	20 MHz	π/2 BPSK	2506.0 - 2680.0	18.0270	0.224	23.50	18M0G7W
		QPSK	2506.0 - 2680.0	18.3880	0.220	23.43	18M4G7W
		16QAM	2506.0 - 2680.0	18.3939	0.173	22.37	18M4D7W
		64QAM	2506.0 - 2680.0	18.3814	0.130	21.14	18M4D7W
		256QAM	2506.0 - 2680.0	18.3762	0.085	19.27	18M4D7W

EUT Overview

Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	OBW [MHz]	EIRP		Emission Designator
					Max. Power [W]	Max. Power [dBm]	
NR Band n77(PC2)	100 MHz	π/2 BPSK	3750.0 - 3930.0	96.9660	0.711	28.52	97M0G7W
		QPSK	3750.0 - 3930.0	97.9429	0.695	28.42	97M9G7W
		16QAM	3750.0 - 3930.0	98.2156	0.574	27.59	98M2D7W
		64QAM	3750.0 - 3930.0	98.0958	0.481	26.82	98M1D7W
		256QAM	3750.0 - 3930.0	98.0737	0.307	24.87	98M1D7W
	90 MHz	π/2 BPSK	3745.0 - 3935.0	86.1780	0.720	28.57	86M2G7W
		QPSK	3745.0 - 3935.0	88.0000	0.703	28.47	88M0G7W
		16QAM	3745.0 - 3935.0	87.7331	0.545	27.37	87M7D7W
		64QAM	3745.0 - 3935.0	87.9089	0.509	27.07	87M9D7W
		256QAM	3745.0 - 3935.0	87.7458	0.320	25.05	87M7D7W
	80 MHz	π/2 BPSK	3740.0 - 3940.0	77.6480	0.731	28.64	77M6G7W
		QPSK	3740.0 - 3940.0	78.1535	0.737	28.67	78M2G7W
		16QAM	3740.0 - 3940.0	78.0292	0.576	27.60	78M0D7W
		64QAM	3740.0 - 3940.0	77.8482	0.495	26.94	77M8D7W
		256QAM	3740.0 - 3940.0	78.0941	0.310	24.91	78M1D7W
	60 MHz	π/2 BPSK	3730.0 - 3950.0	58.2140	0.733	28.65	58M2G7W
		QPSK	3730.0 - 3950.0	58.2494	0.741	28.70	58M2G7W
		16QAM	3730.0 - 3950.0	58.3358	0.581	27.64	58M3D7W
		64QAM	3730.0 - 3950.0	58.4184	0.509	27.07	58M4D7W
		256QAM	3730.0 - 3950.0	58.2638	0.319	25.04	58M3D7W
	50 MHz	π/2 BPSK	3725.0 - 3955.0	45.9670	0.721	28.58	46M0G7W
		QPSK	3725.0 - 3955.0	47.7800	0.724	28.60	47M8G7W
		16QAM	3725.0 - 3955.0	47.7541	0.608	27.84	47M8D7W
		64QAM	3725.0 - 3955.0	47.8736	0.487	26.87	47M9D7W
		256QAM	3725.0 - 3955.0	47.7681	0.316	24.99	47M8D7W
	40 MHz	π/2 BPSK	3720.0 - 3960.0	35.9680	0.722	28.59	36M0G7W
		QPSK	3720.0 - 3960.0	37.9944	0.688	28.38	38M0G7W
		16QAM	3720.0 - 3960.0	38.1313	0.629	27.99	38M1D7W
		64QAM	3720.0 - 3960.0	38.1099	0.489	26.89	38M1D7W
		256QAM	3720.0 - 3960.0	38.0650	0.313	24.96	38M1D7W
	20 MHz	π/2 BPSK	3710.0 - 3970.0	18.0530	0.688	28.38	18M1G7W
		QPSK	3710.0 - 3970.0	18.3989	0.668	28.25	18M4G7W
		16QAM	3710.0 - 3970.0	18.3528	0.543	27.34	18M4D7W
		64QAM	3710.0 - 3970.0	18.4686	0.456	26.59	18M5D7W
		256QAM	3710.0 - 3970.0	18.4032	0.321	25.07	18M4D7W
NR Band n77(PC3)	100 MHz	π/2 BPSK	3750.0 - 3930.0	96.9660	0.550	27.40	97M0G7W
		QPSK	3750.0 - 3930.0	97.9429	0.543	27.34	97M9G7W
		16QAM	3750.0 - 3930.0	98.2156	0.452	26.55	98M2D7W
		64QAM	3750.0 - 3930.0	98.0958	0.388	25.89	98M1D7W
		256QAM	3750.0 - 3930.0	98.0737	0.263	24.19	98M1D7W
	90 MHz	π/2 BPSK	3745.0 - 3935.0	86.1780	0.550	27.40	86M2G7W
		QPSK	3745.0 - 3935.0	88.0000	0.541	27.33	88M0G7W
		16QAM	3745.0 - 3935.0	87.7331	0.427	26.31	87M7D7W
		64QAM	3745.0 - 3935.0	87.9089	0.411	26.14	87M9D7W
		256QAM	3745.0 - 3935.0	87.7458	0.259	24.13	87M7D7W
	80 MHz	π/2 BPSK	3740.0 - 3940.0	77.6480	0.548	27.39	77M6G7W
		QPSK	3740.0 - 3940.0	78.1535	0.550	27.40	78M2G7W
		16QAM	3740.0 - 3940.0	78.0292	0.434	26.37	78M0D7W
		64QAM	3740.0 - 3940.0	77.8482	0.385	25.86	77M8D7W
		256QAM	3740.0 - 3940.0	78.0941	0.261	24.17	78M1D7W
	60 MHz	π/2 BPSK	3730.0 - 3950.0	58.2140	0.549	27.40	58M2G7W
		QPSK	3730.0 - 3950.0	58.2494	0.550	27.40	58M2G7W
		16QAM	3730.0 - 3950.0	58.3358	0.458	26.61	58M3D7W
		64QAM	3730.0 - 3950.0	58.4184	0.390	25.91	58M4D7W
		256QAM	3730.0 - 3950.0	58.2638	0.267	24.27	58M3D7W
	50 MHz	π/2 BPSK	3725.0 - 3955.0	45.9670	0.548	27.39	46M0G7W
		QPSK	3725.0 - 3955.0	47.7800	0.550	27.40	47M8G7W
		16QAM	3725.0 - 3955.0	47.7541	0.491	26.91	47M8D7W
		64QAM	3725.0 - 3955.0	47.8736	0.392	25.94	47M9D7W
		256QAM	3725.0 - 3955.0	47.7681	0.270	24.31	47M8D7W
	40 MHz	π/2 BPSK	3720.0 - 3960.0	35.9680	0.550	27.40	36M0G7W
		QPSK	3720.0 - 3960.0	37.9944	0.547	27.38	38M0G7W
		16QAM	3720.0 - 3960.0	38.1313	0.547	27.38	38M1D7W
		64QAM	3720.0 - 3960.0	38.1099	0.395	25.96	38M1D7W
		256QAM	3720.0 - 3960.0	38.0650	0.268	24.28	38M1D7W
	20 MHz	π/2 BPSK	3710.0 - 3970.0	18.0530	0.513	27.10	18M1G7W
		QPSK	3710.0 - 3970.0	18.3989	0.510	27.08	18M4G7W
		16QAM	3710.0 - 3970.0	18.3528	0.424	26.27	18M4D7W
		64QAM	3710.0 - 3970.0	18.4686	0.373	25.72	18M5D7W
		256QAM	3710.0 - 3970.0	18.4032	0.260	24.16	18M4D7W

EUT Overview

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 PCTEST Test Location

These measurement tests were conducted at the PCTEST. 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

- PCTEST 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.

- PCTEST 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).

- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID:BCGA2301**. 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 27.

Test Device Serial No.: NQ73CFK6VJ, LGXMHP6X6Y

2.2 Device Capabilities

This device contains the following capabilities:

850/1900 GSM/GPRS/EDGE, 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

This device supports BT Beamforming

LTE Band 41 and FR1 Band n41 support NS04 for Antenna 3, Antenna 1, Antenna 4b, and Antenna 2b.

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	WLAN	Bluetooth	GSM / WCDMA	LTE / FR1 NR			UNII
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	Mid Band	Mid Band	High Band	Ultra High Band	802.11 a/n/ac/ax
2a	Config 1	✓	×	×	×	×	✓	×
2a	Config 2	×	✓	×	×	×	✓	×
4a	Config 3	✓	×	×	×	×	✓	×
4a	Config 4	×	✓	×	×	×	✓	×
4b	Config 5	×	×	✓	×	×	×	✓
4b	Config 6	×	×	×	✓	×	×	✓
4b	Config 7	×	×	×	×	✓	×	✓

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 6 and reported in UNII (OFDMA) and Part 27a test reports.

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for the testing.

Frequency [MHz]	Antenna Gain (dBi)					
	Antenna 3	Antenna 1	Antenna 4b	Antenna 4a	Antenna 2b	Antenna 2a
LTE Band 30	-1.4	-4.1	0.0	N/A	1.2	N/A
LTE Band 7	-4.5	-0.6	-1.4	N/A	-0.8	N/A
LTE Band 41	-4.5	-0.8	-1.4	N/A	-0.7	N/A
NR Band n41	-0.8	-4.5	-0.7		-1.4	
NR Band n77	-0.5	-1.6	N/A	1.7	N/A	-0.8

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro	Model:	A2141	S/N:	C02DV7VKMD6T
	w/AC/DC Adapter	Model:	A2166	S/N:	N/A
2	Apple USB-C Cable	Model:	Chimp	S/N:	420A57
3	USB-C Cable	Model:	A146	S/N:	N/A
	w/ AC Adapter	Model:	A2305	S/N:	N/A
4	Apple Pencil	Model:	N/A	S/N:	GQXYGSXBJKM9
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-3. Test Support Equipment

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 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 18E20700y 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.

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI C63.26 2015, TIA-603-E-2016) and "Measurement Guidance for Certification of Licensed Digital Transmitters" (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

3.2 Radiated Power and 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:

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

And

$$EIRP_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8;$$

Where D 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.

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 (±dB)
Conducted Bench Top Measurements	1.65
Radiated Disturbance (<30MHz)	4.06
Radiated Disturbance (30MHz-1GHz)	4.30
Radiated Disturbance (1-18GHz)	4.78
Radiated Disturbance (>18GHz)	4.79

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	PXA Signal Analyzer (3Hz - 26.5 GHz)	7/24/2020	Annual	7/24/2021	MY55330128
Keysight Technology	N9040B	UXA Signal Analyzer	12/19/2020	Annual	12/19/2021	MY57212015
Keysight Technology	E7515B	UXM 5G Wireless Test Platform	11/14/2020	Annual	11/14/2021	MY60192562
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	8/11/2020	Annual	8/11/2021	T058701-01
ESPEC	SU-241	Tabletop Temperature Chamber	9/28/2020	Annual	9/28/2021	92009574
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	9/15/2020	Annual	9/15/2021	208204
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	4/21/2020	Annual	4/21/2021	205956
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	7/15/2020	Annual	7/15/2021	102356
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz - 18GHz)	12/3/2020	Annual	12/3/2021	101648
Rohde & Schwarz	ESW26	EMI Test Receiver	6/8/2020	Annual	6/8/2021	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	8/6/2020	Annual	8/6/2021	101668
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/13/2020	Annual	10/13/2021	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	4/16/2020	Annual	4/16/2021	166869
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	4/23/2020	Annual	4/23/2021	100052
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Antenna (400MHz-18GHz)	10/2/2020	Annual	10/2/2021	101063
Rohde & Schwarz	HFH2-Z2	Loop Antenna	3/12/2020	Annual	3/12/2021	100546

Table 5-1. Test Equipment List

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.

6.0 SAMPLE CALCULATIONS

Emission Designator

π/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
W = 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.

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCGA2301

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE/NR/ULCA

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 (LTE Band 30)	2.1051, 27.53(a)	Undesirable emissions must meet the limits detailed in 27.53(a)	PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (LTE Band 7)	2.1051, 27.53(m)	Undesirable emissions must meet the limits detailed in 27.53(m)	PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (LTE Band 41)			PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (NR Band n41)			PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (NR Band n77)			PASS	Sections 7.3, 7.4
	Transmitter Conducted Output Power	2.1046	N/A	N/A	See RF Exposure Report
	Additional Maximum Power Reduction (A-MPR)	2.1046	N/A	N/A	Section 7.5
	Effective Radiated Power / Equivalent Isotropic Radiated Power (LTE Band 30)	27.50(a)(3)	< 0.25 Watts max. EIRP	PASS	Section 7.6
	Effective Radiated Power / Equivalent Isotropic Radiated Power (LTE Band 7)	27.50(h)(2)	< 2 Watts max. EIRP	PASS	Section 7.6
	Effective Radiated Power / Equivalent Isotropic Radiated Power (LTE Band 41)			PASS	Section 7.6
	Effective Radiated Power / Equivalent Isotropic Radiated Power (NR Band n41)			PASS	Section 7.6
	Effective Radiated Power / Equivalent Isotropic Radiated Power (NR Band n77)			PASS	Section 7.6
	Frequency Stability	2.1055, 27.54	Fundamental emissions stay within authorized frequency block over the temperature and voltage range as tested	PASS	Section 7.8
RADIATED	Radiated Spurious Emissions (LTE Band 30)	2.1053, 27.53(a)	> 70 + 10log$_{10}$(P[Watts])	PASS	Section 7.7
	Radiated Spurious Emissions (LTE Band 7)	2.1053, 27.53(m)	Undesirable emissions must meet the limits detailed in 27.53(m)	PASS	Section 7.7
	Radiated Spurious Emissions (LTE Band 41)			PASS	Section 7.7
	Radiated Spurious Emissions (NR Band n41)			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 was PCTEST 2G/3G Automation Version 4.5 and LTE Automation Version 5.3.

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 ≥ 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.

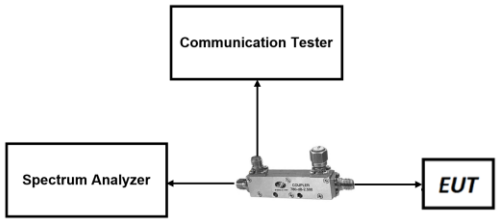
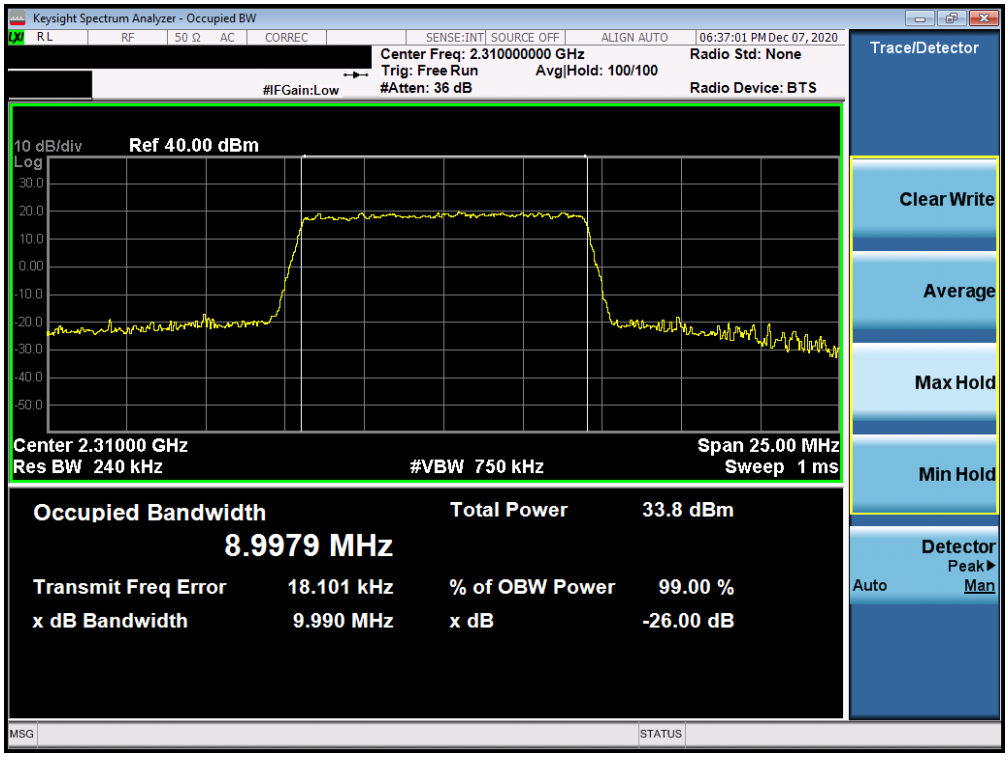


Figure 7-1. Test Instrument & Measurement Setup

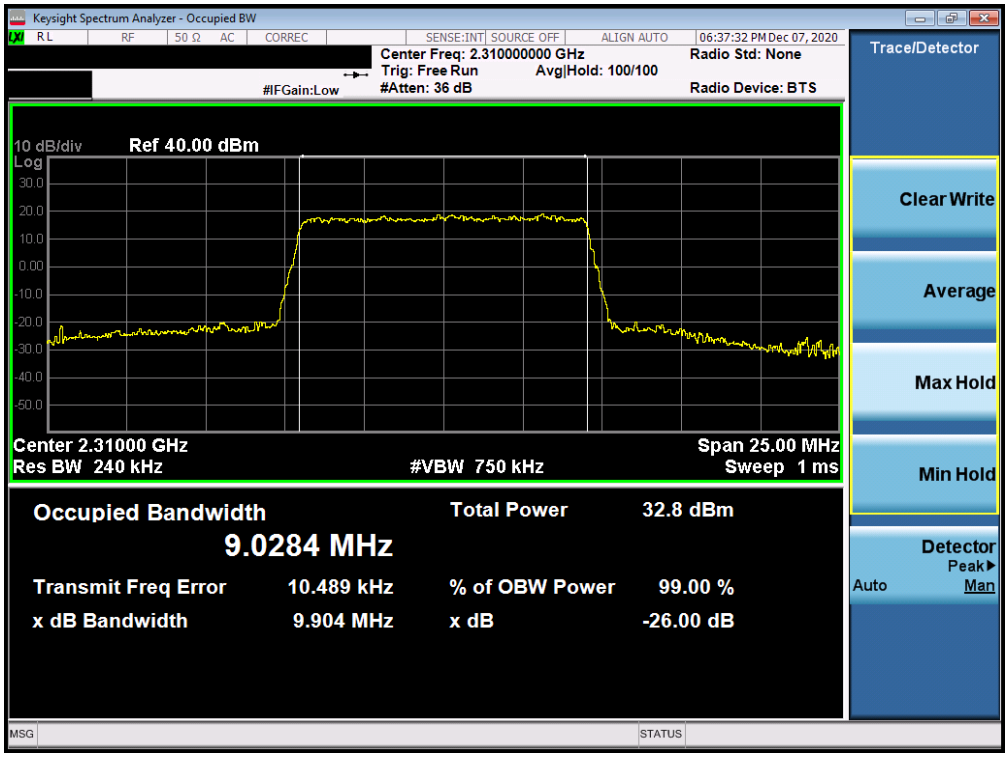
Test Notes

1. Uplink carrier aggregation for LTE Band 7 is only supported in this EUT while operating in Power Class 3.
2. Uplink carrier aggregation for LTE Band 41 is supported in this EUT while operating in Power Class 2 and Power Class 3.

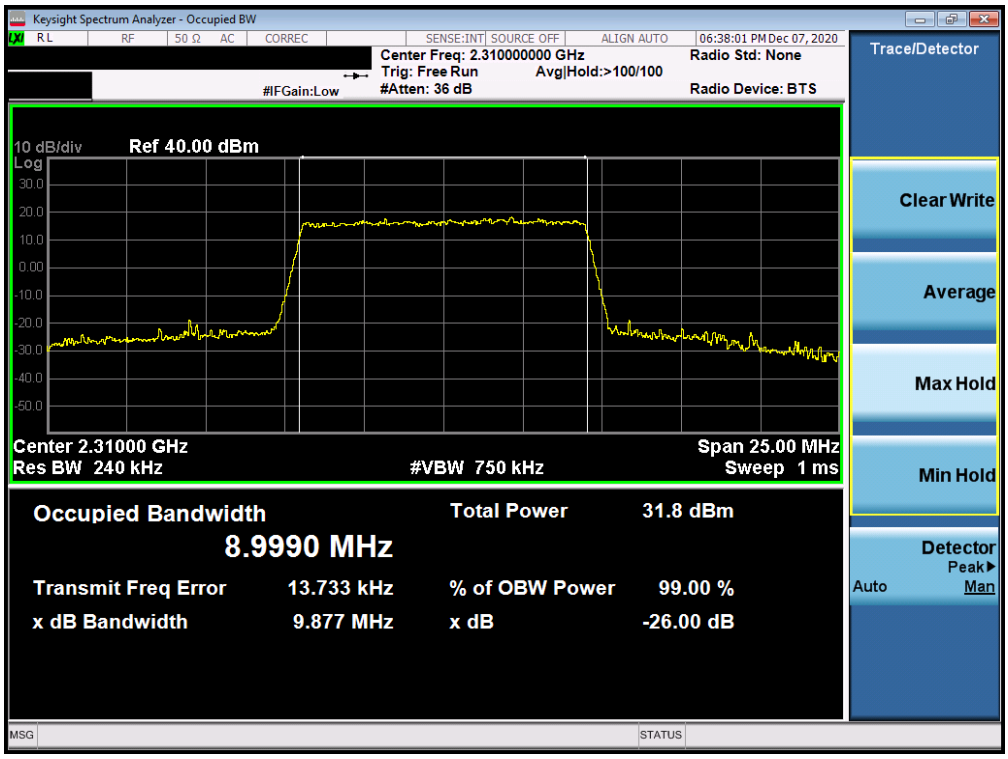
Band 30



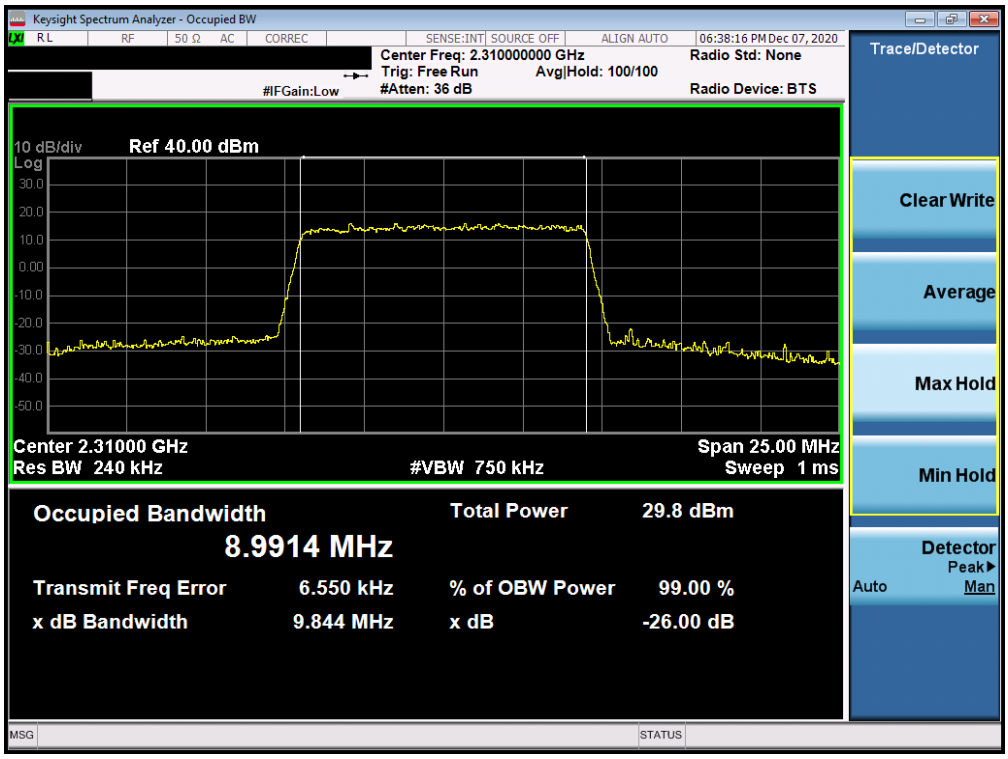
Plot 7-1. Occupied Bandwidth Plot (Band 30 - 10.0MHz QPSK - Full RB Configuration)



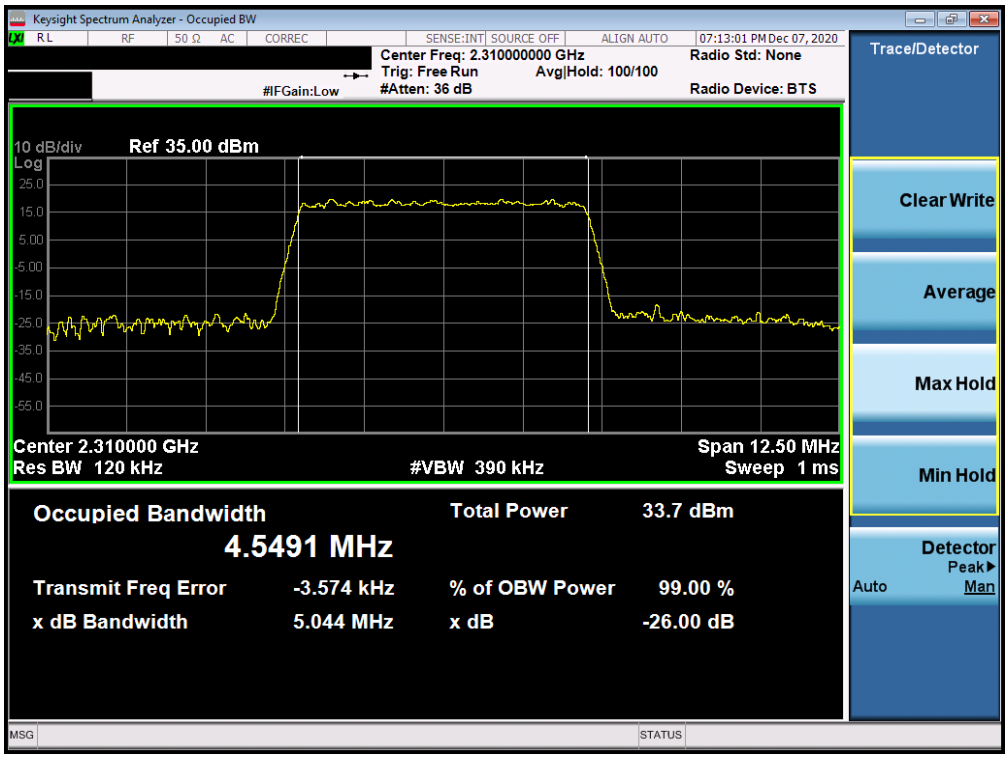
Plot 7-2. Occupied Bandwidth Plot (Band 30 - 10.0MHz 16-QAM - Full RB Configuration)



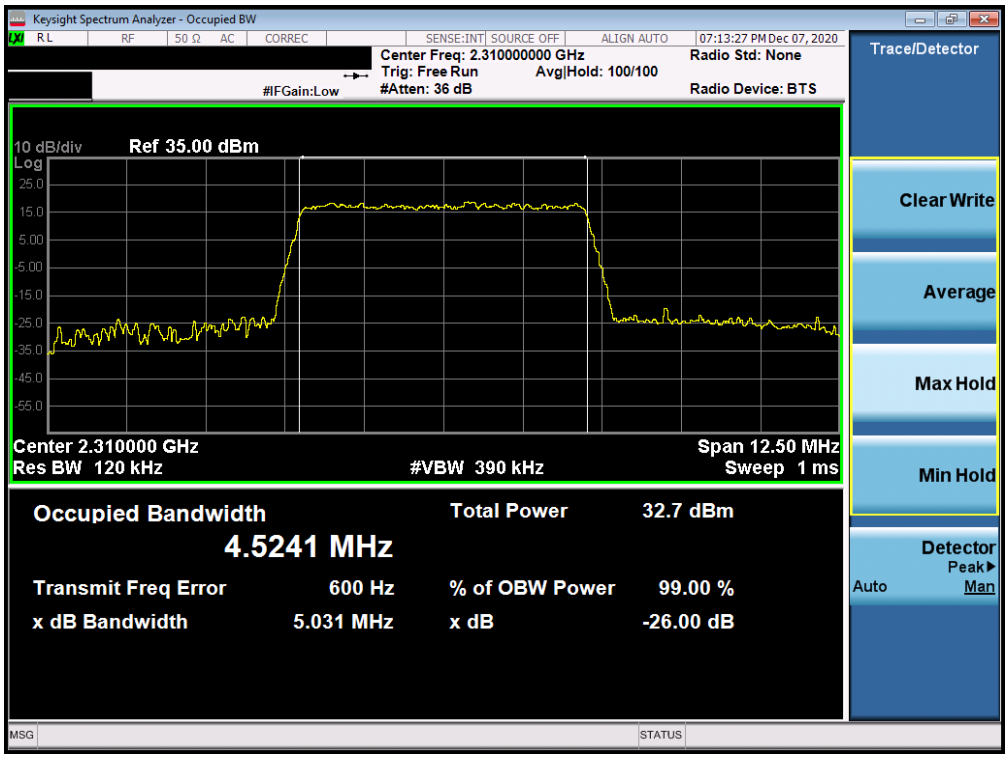
Plot 7-3. Occupied Bandwidth Plot (Band 30 - 10.0MHz 64-QAM - Full RB Configuration)



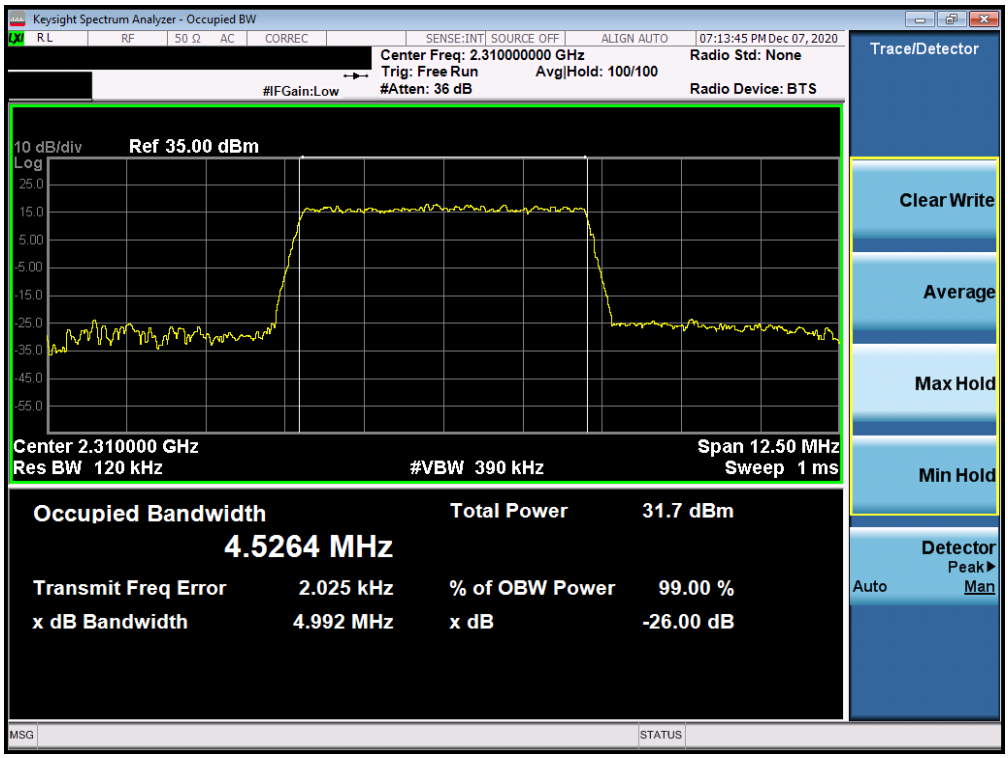
Plot 7-4. Occupied Bandwidth Plot (Band 30 - 10.0MHz 256-QAM - Full RB Configuration)



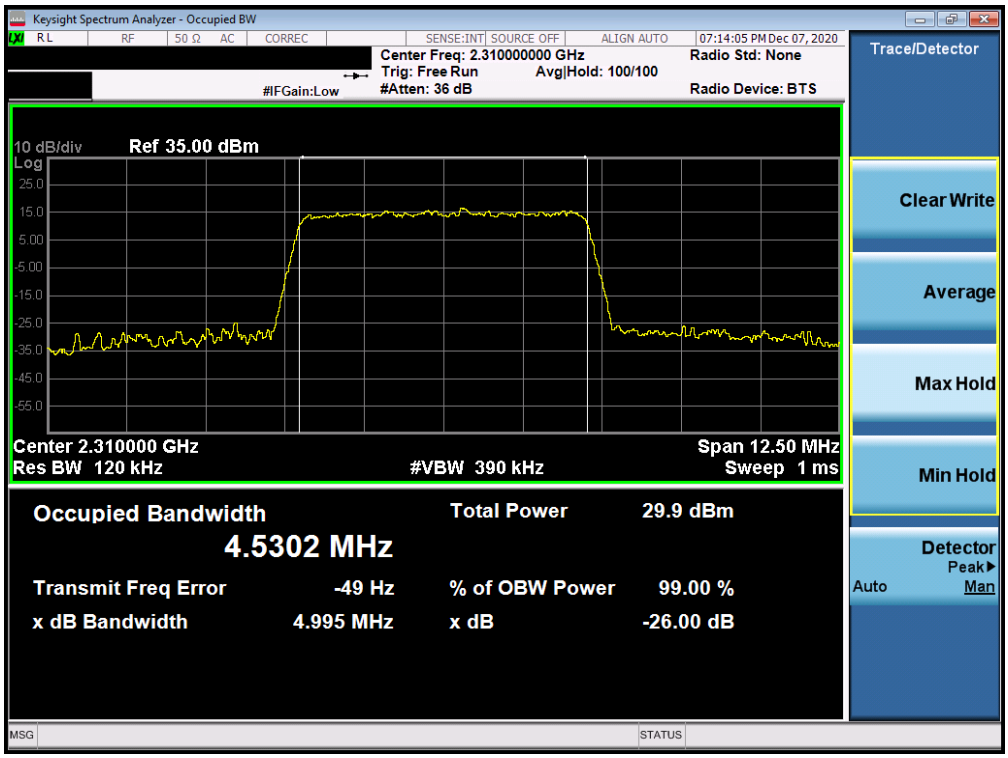
Plot 7-5. Occupied Bandwidth Plot (Band 30 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-6. Occupied Bandwidth Plot (Band 30 - 5.0MHz 16-QAM - Full RB Configuration)



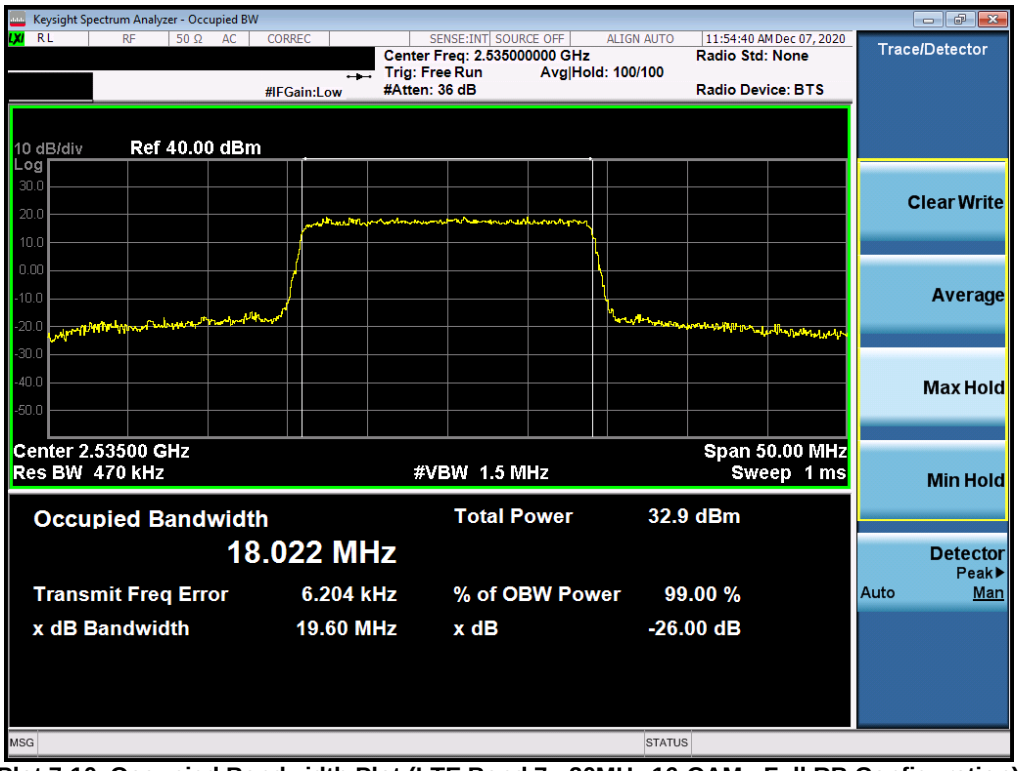
Plot 7-7. Occupied Bandwidth Plot (Band 30 - 5.0MHz 64-QAM - Full RB Configuration)



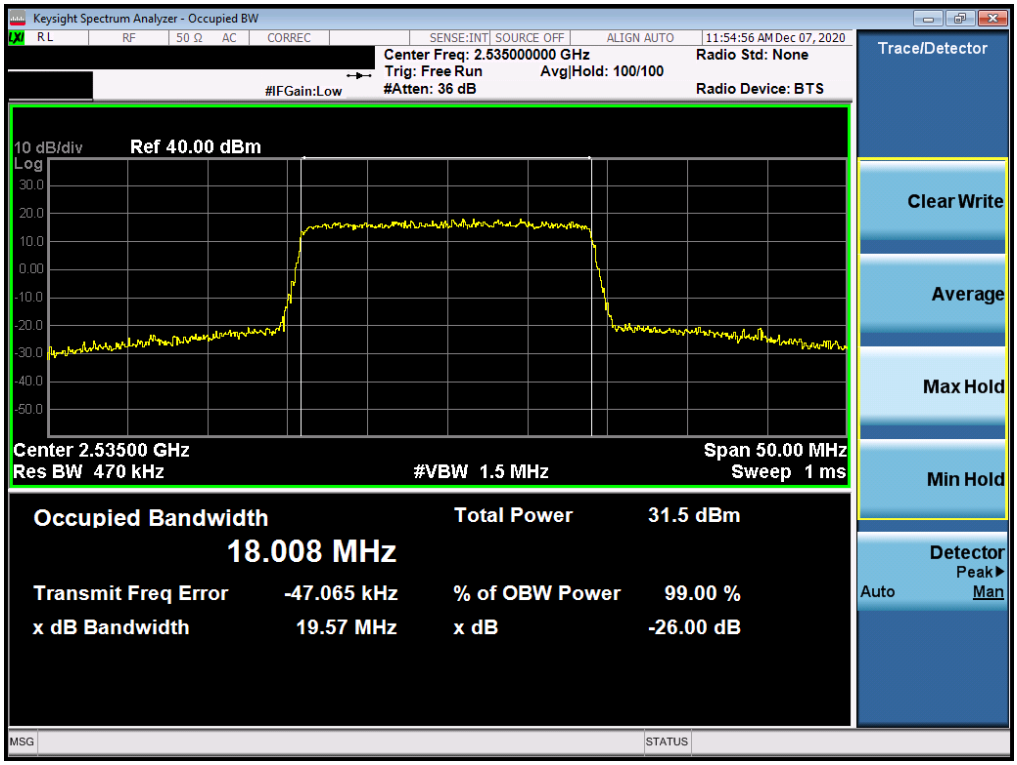
Plot 7-8. Occupied Bandwidth Plot (Band 30 - 5.0MHz 256-QAM - Full RB Configuration)

LTE Band 7

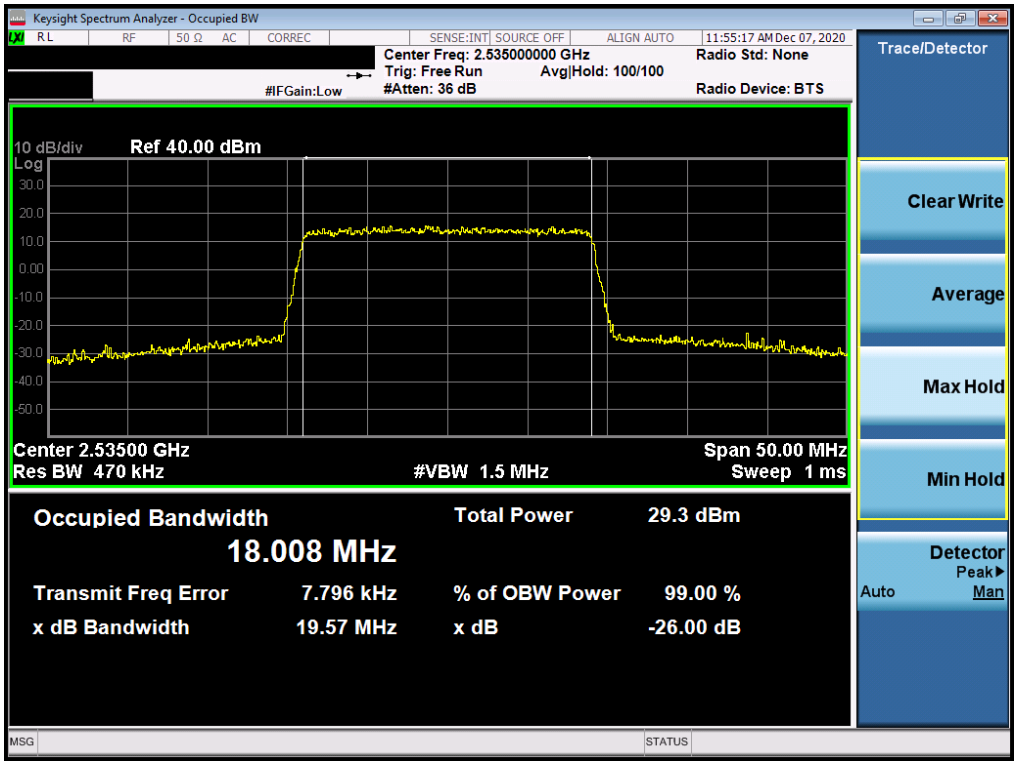
Plot 7-9. Occupied Bandwidth Plot (LTE Band 7 - 20MHz QPSK - Full RB Configuration)



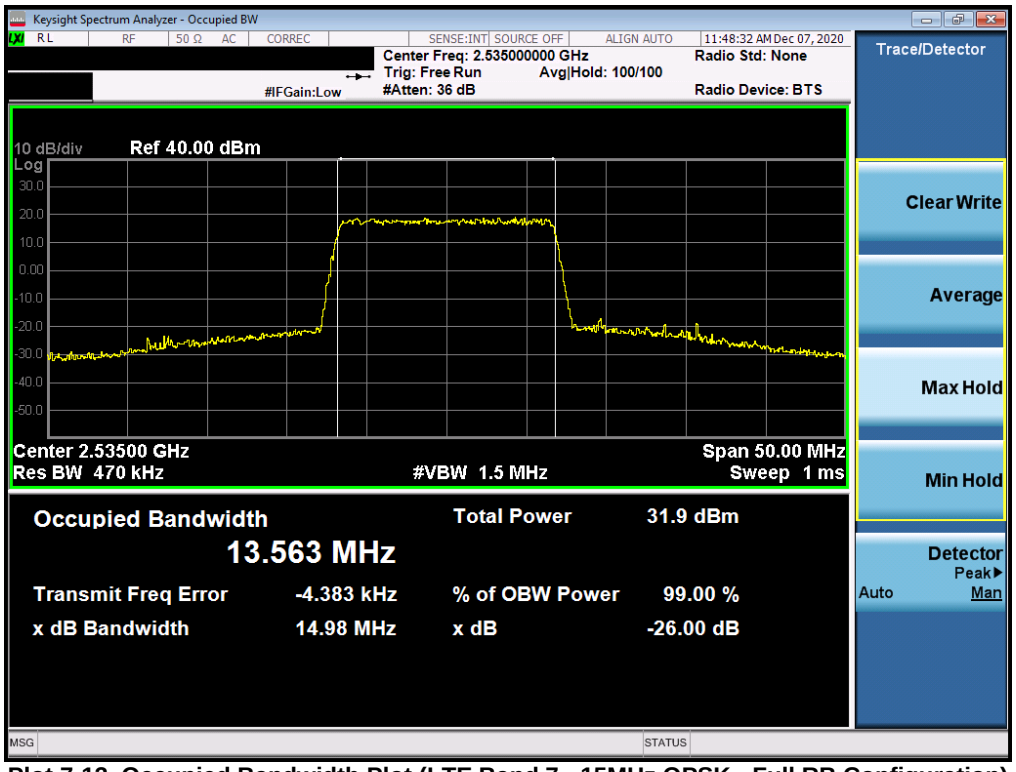
Plot 7-10. Occupied Bandwidth Plot (LTE Band 7 - 20MHz 16-QAM - Full RB Configuration)



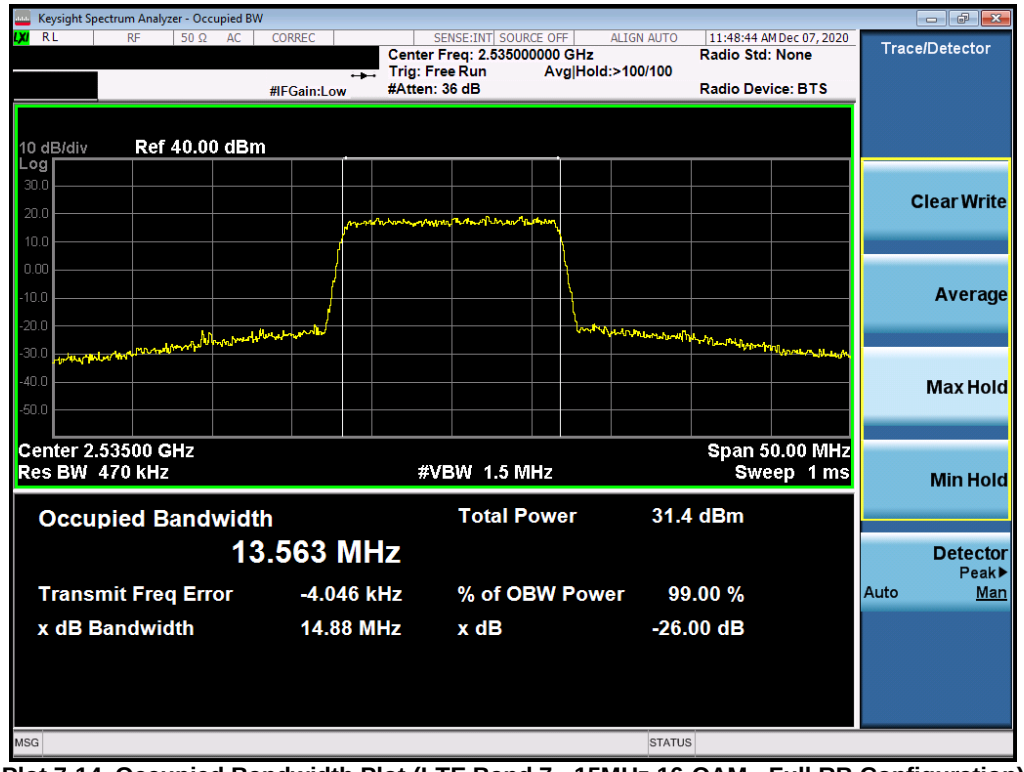
Plot 7-11. Occupied Bandwidth Plot (LTE Band 7 - 20MHz 64-QAM - Full RB Configuration)



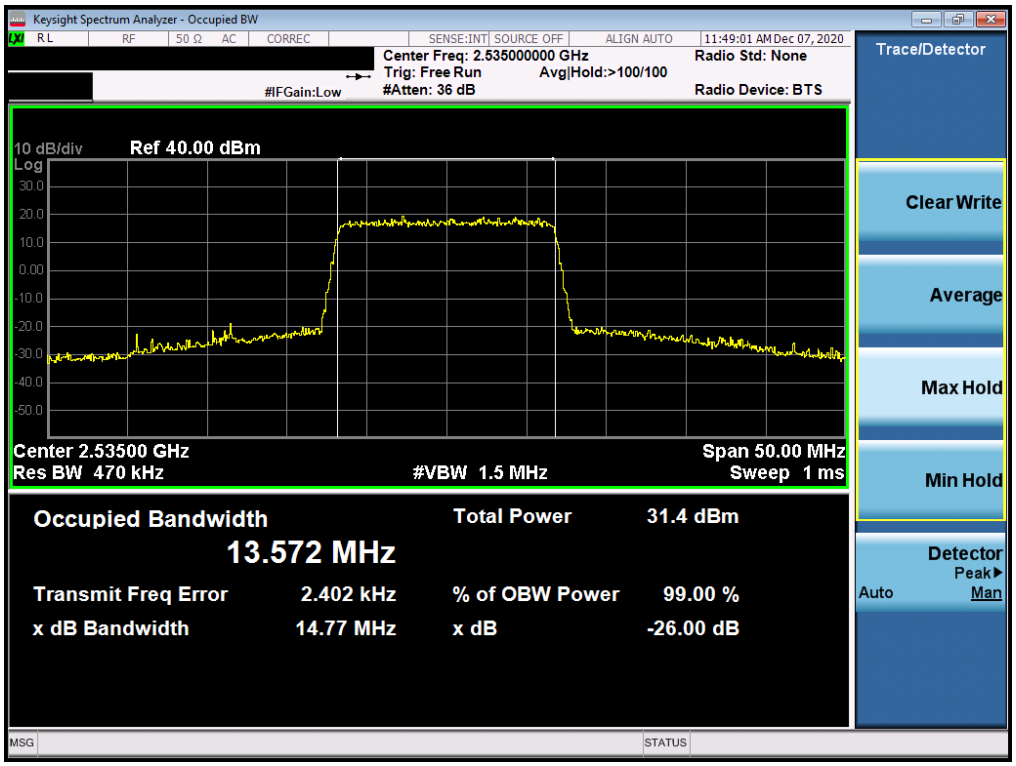
Plot 7-12. Occupied Bandwidth Plot (LTE Band 7 - 20MHz 256-QAM - Full RB Configuration)



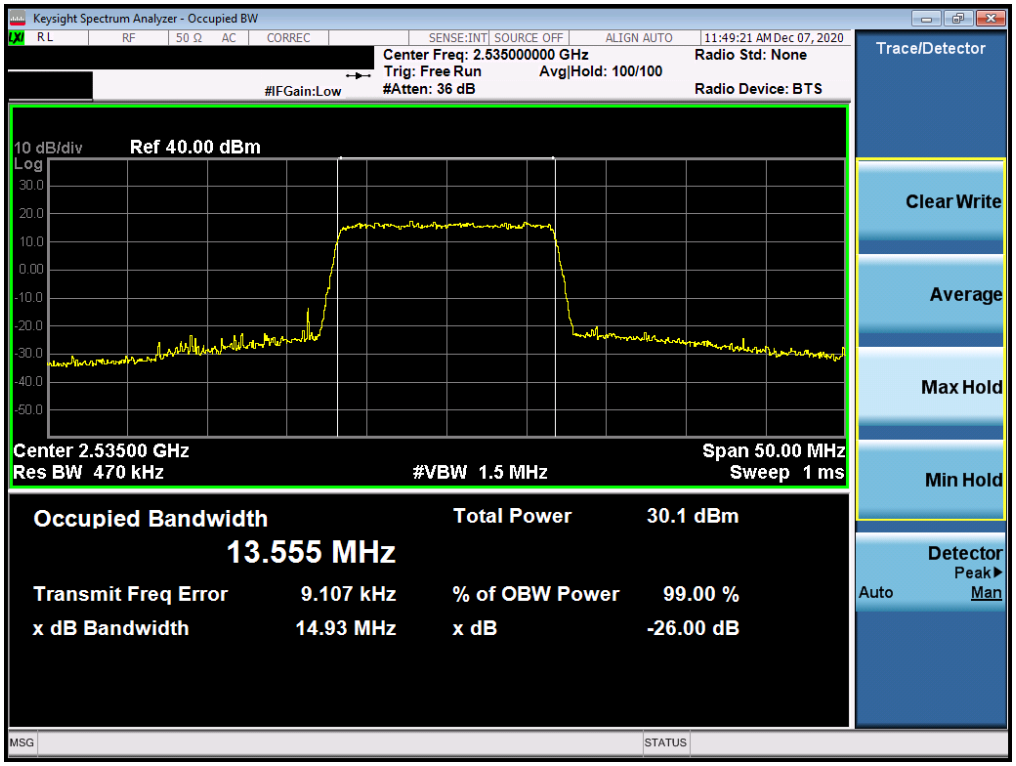
Plot 7-13. Occupied Bandwidth Plot (LTE Band 7 - 15MHz QPSK - Full RB Configuration)



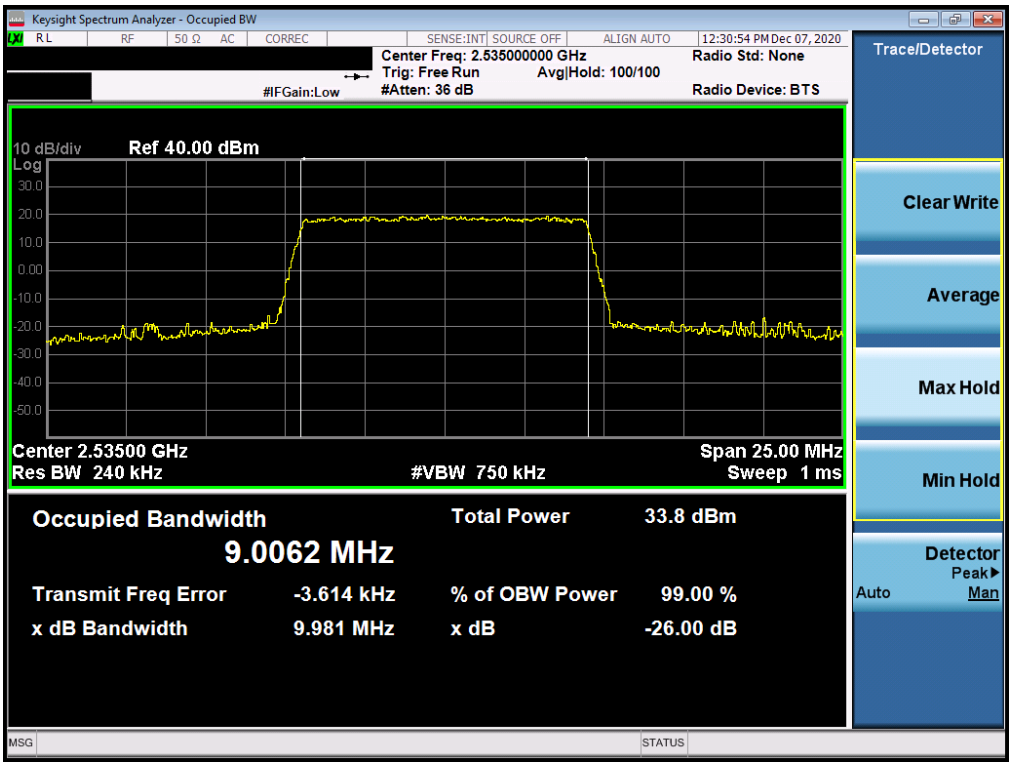
Plot 7-14. Occupied Bandwidth Plot (LTE Band 7 - 15MHz 16-QAM - Full RB Configuration)



Plot 7-15. Occupied Bandwidth Plot (LTE Band 7 - 15MHz 64-QAM - Full RB Configuration)

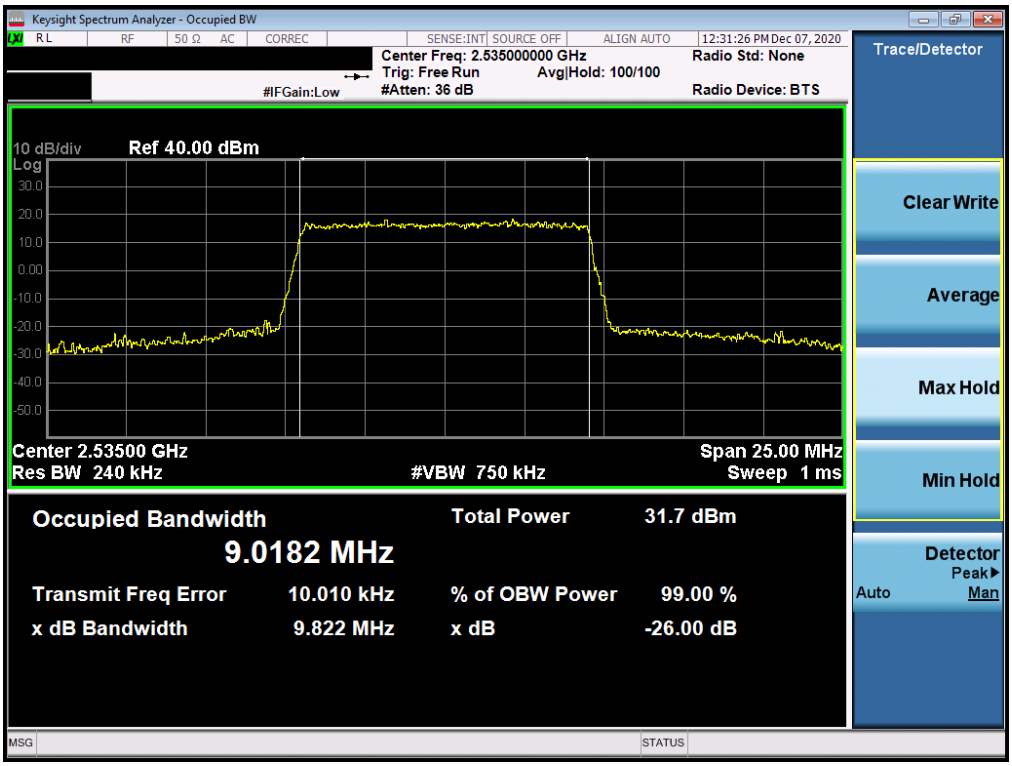


Plot 7-16. Occupied Bandwidth Plot (LTE Band 7 - 15MHz 256-QAM - Full RB Configuration)

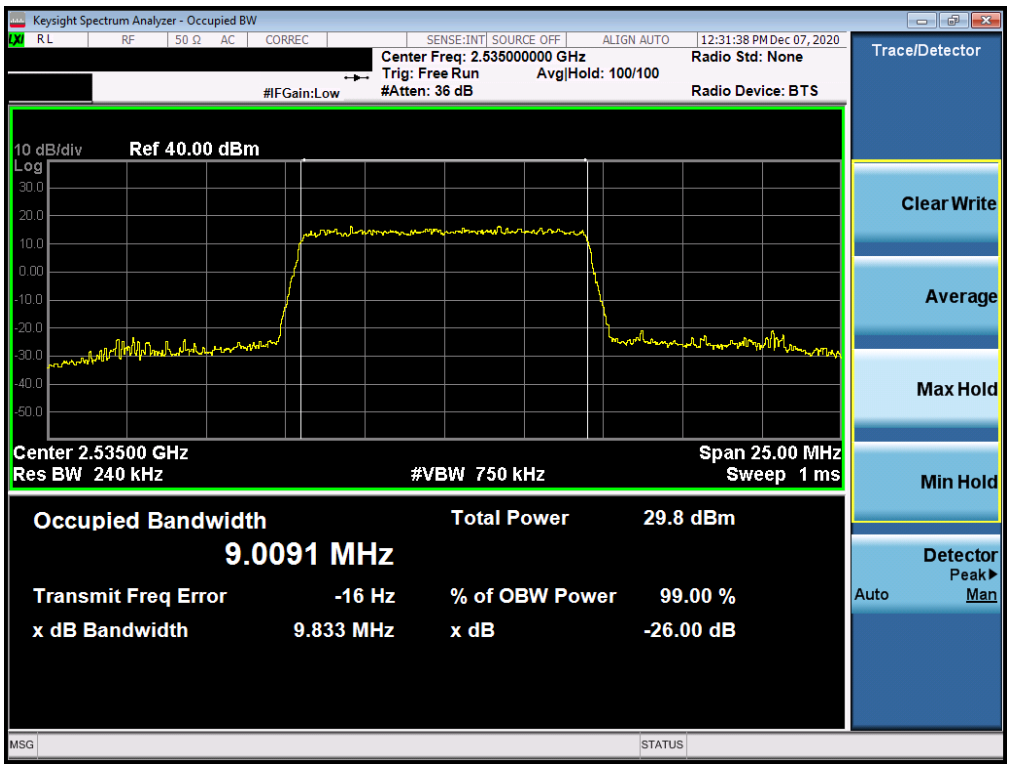


Plot 7-17. Occupied Bandwidth Plot (LTE Band 7 - 10MHz QPSK - Full RB Configuration)

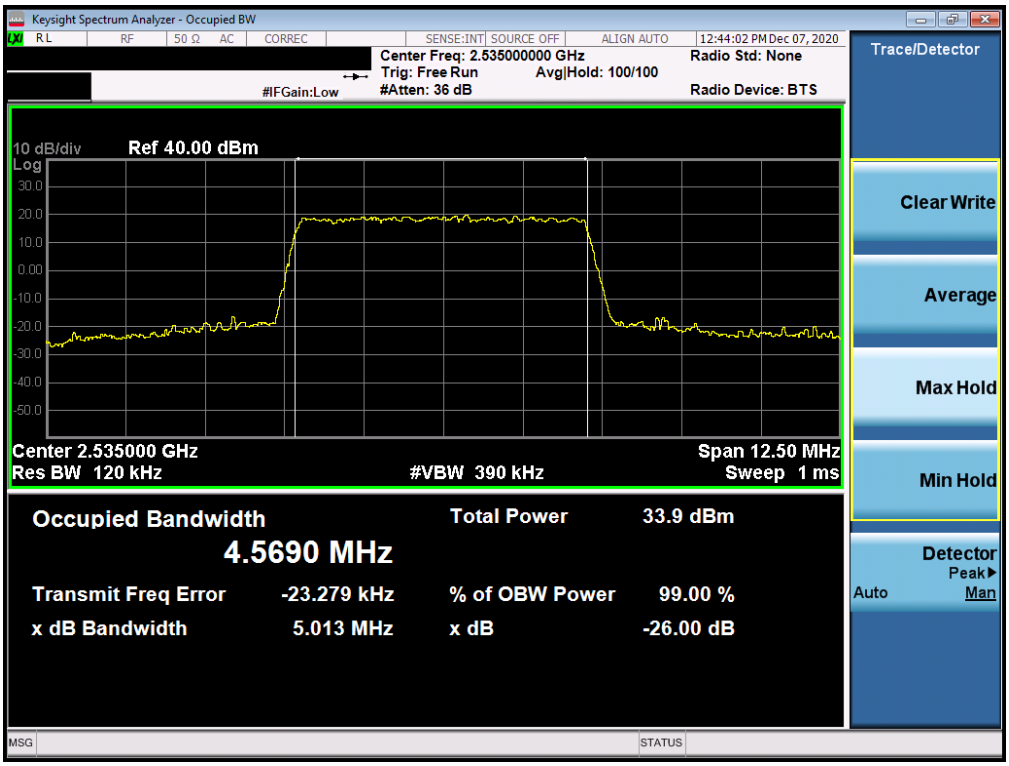
Plot 7-18. Occupied Bandwidth Plot (LTE Band 7 - 10MHz 16-QAM - Full RB Configuration)



Plot 7-19. Occupied Bandwidth Plot (LTE Band 7 - 10MHz 64-QAM - Full RB Configuration)



Plot 7-20. Occupied Bandwidth Plot (LTE Band 7 - 10MHz 256-QAM - Full RB Configuration)

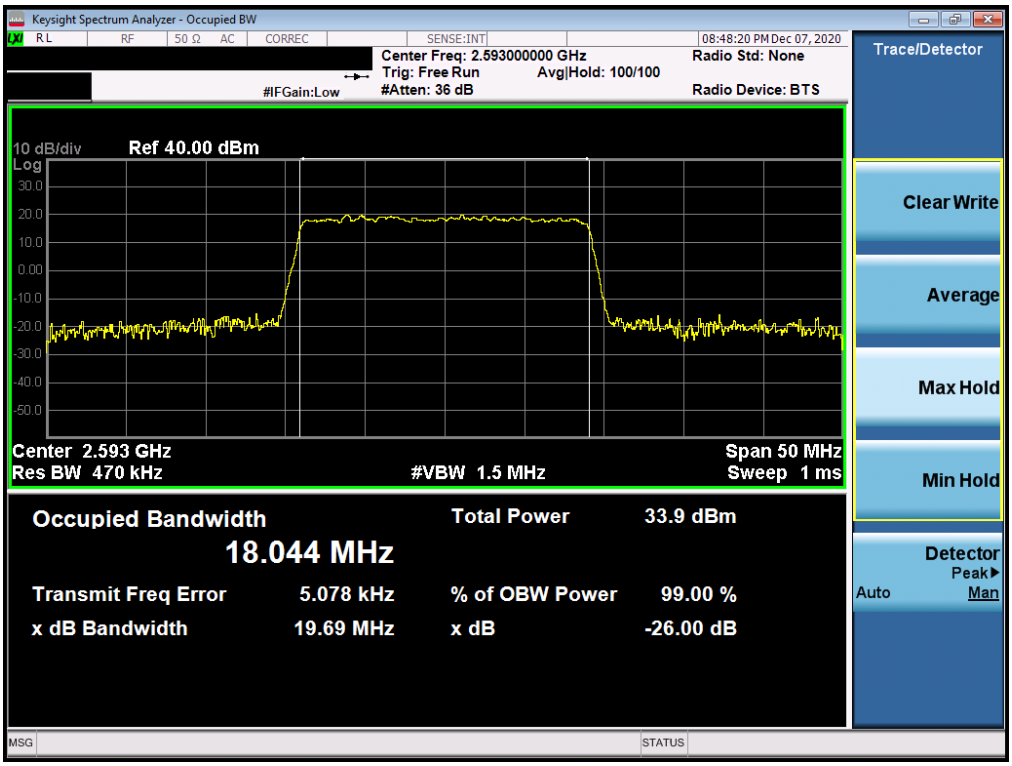


Plot 7-21. Occupied Bandwidth Plot (LTE Band 7 - 5MHz QPSK - Full RB Configuration)

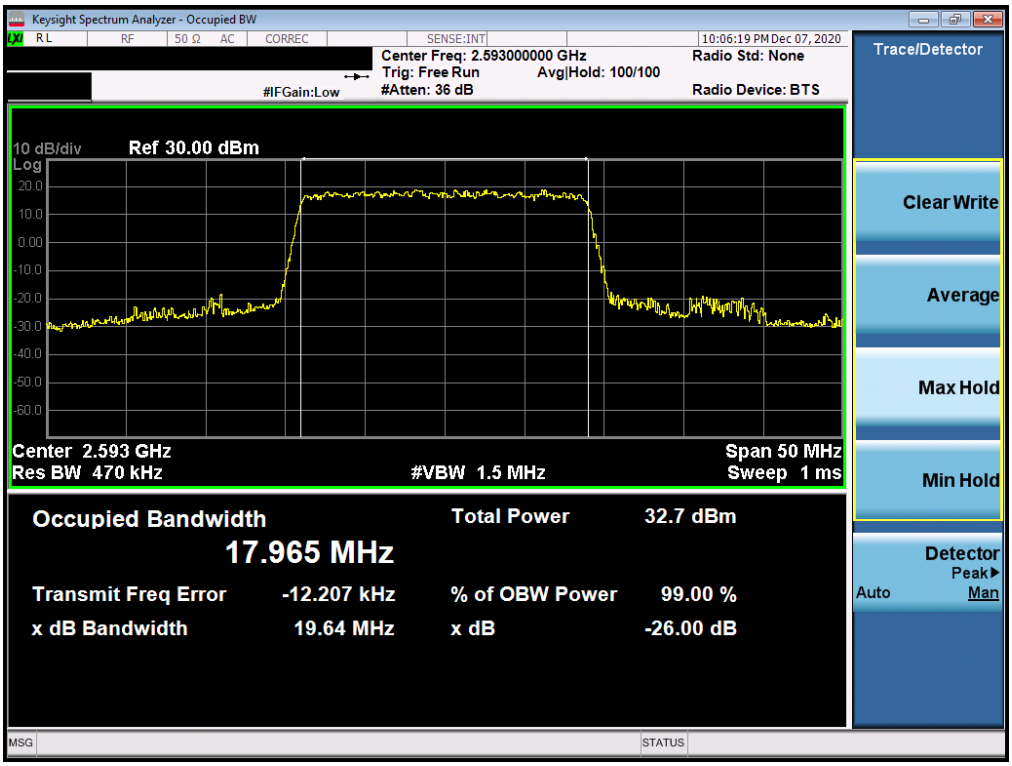
Plot 7-22. Occupied Bandwidth Plot (LTE Band 7 - 5MHz 16-QAM - Full RB Configuration)

Plot 7-23. Occupied Bandwidth Plot (LTE Band 7 - 5MHz 64-QAM - Full RB Configuration)

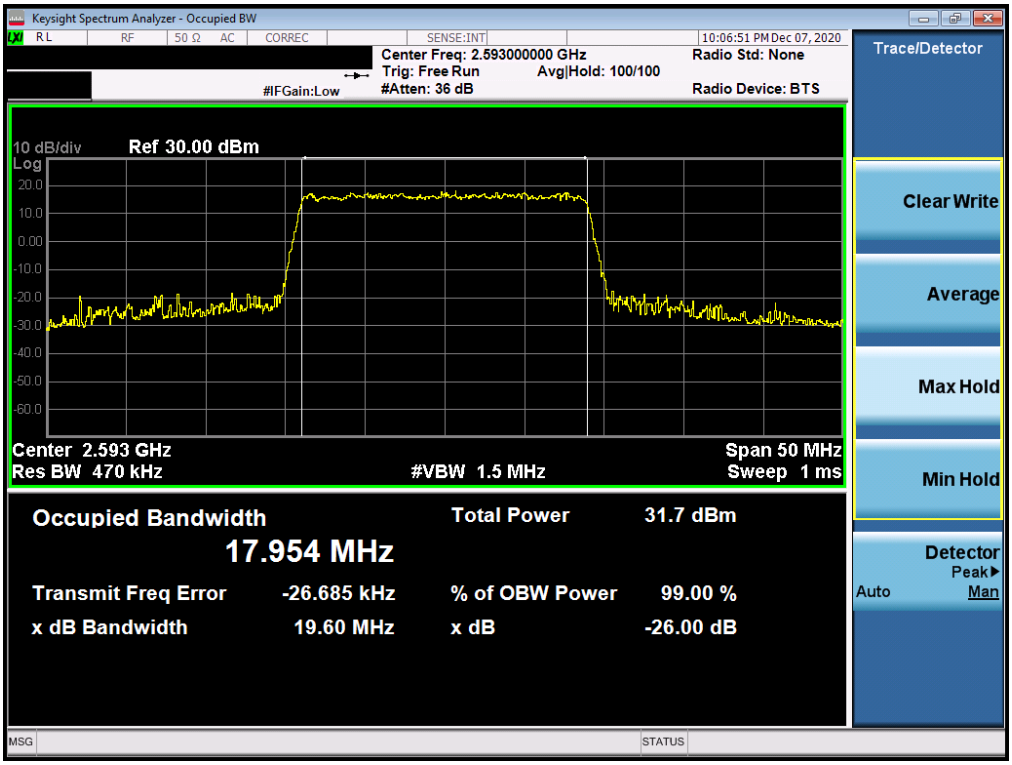
Plot 7-24. Occupied Bandwidth Plot (LTE Band 7 - 5MHz 256-QAM - Full RB Configuration)



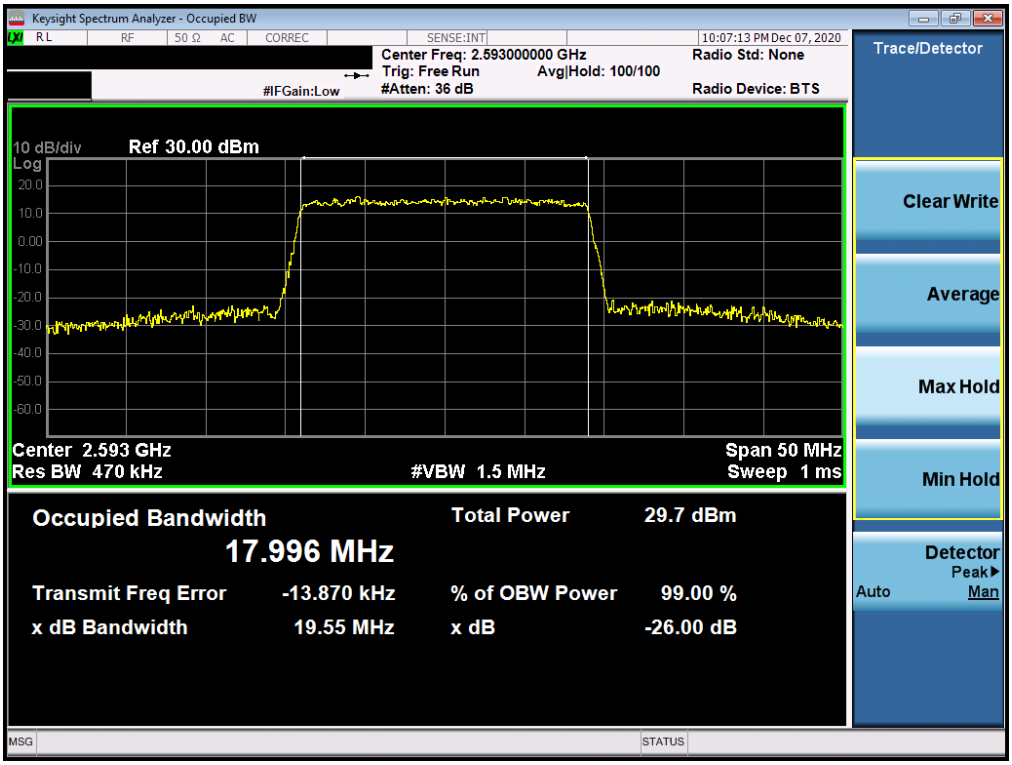
Plot 7-25. Occupied Bandwidth Plot (LTE Band 41 - 20MHz QPSK - Full RB Configuration)



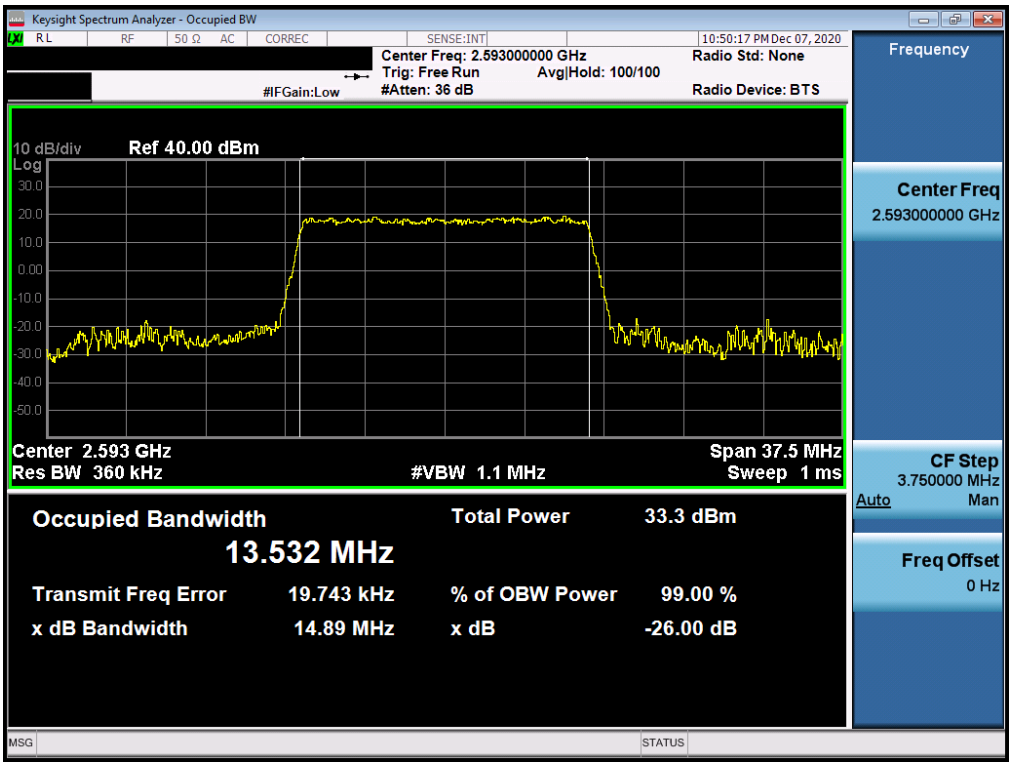
Plot 7-26. Occupied Bandwidth Plot (LTE Band 41 - 20MHz 16-QAM - Full RB Configuration)



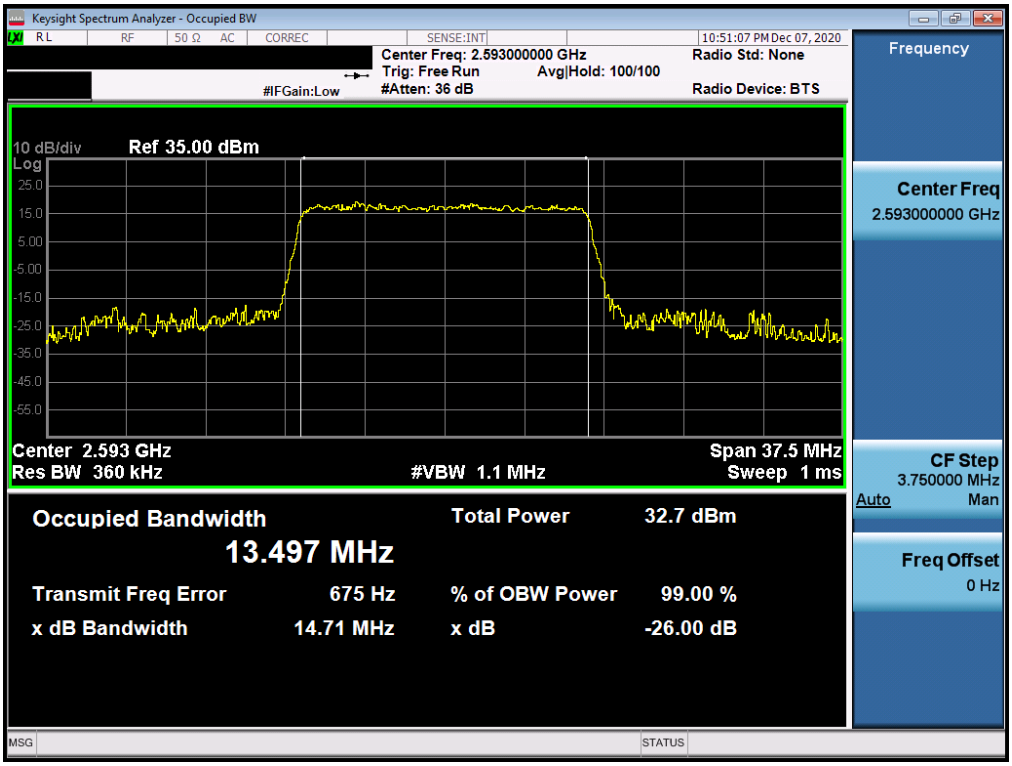
Plot 7-27. Occupied Bandwidth Plot (LTE Band 41 - 20MHz 64-QAM - Full RB Configuration)



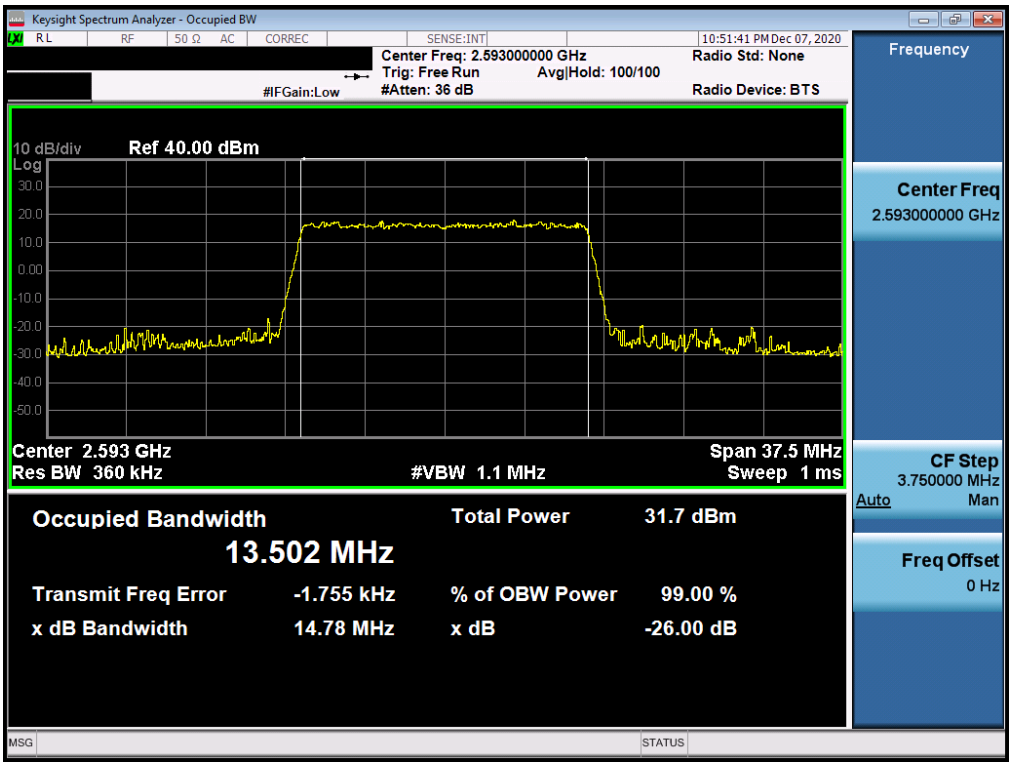
Plot 7-28. Occupied Bandwidth Plot (LTE Band 41 - 20MHz 256-QAM - Full RB Configuration)



Plot 7-29. Occupied Bandwidth Plot (LTE Band 41 - 15MHz QPSK - Full RB Configuration)

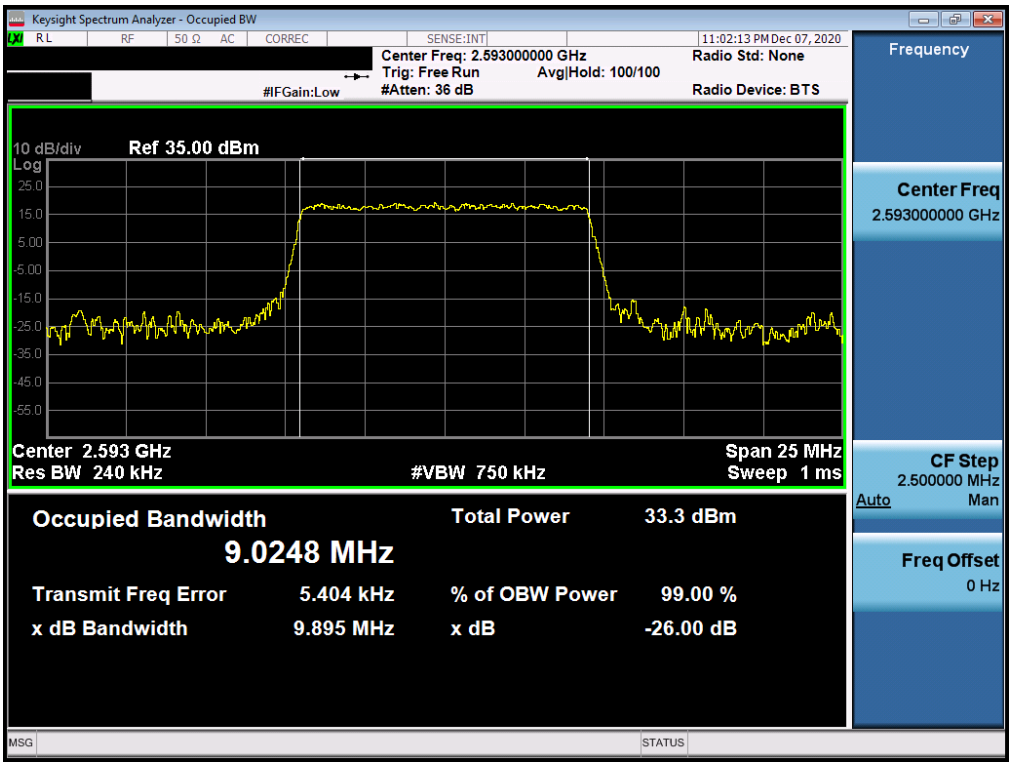


Plot 7-30. Occupied Bandwidth Plot (LTE Band 41 - 15MHz 16-QAM - Full RB Configuration)

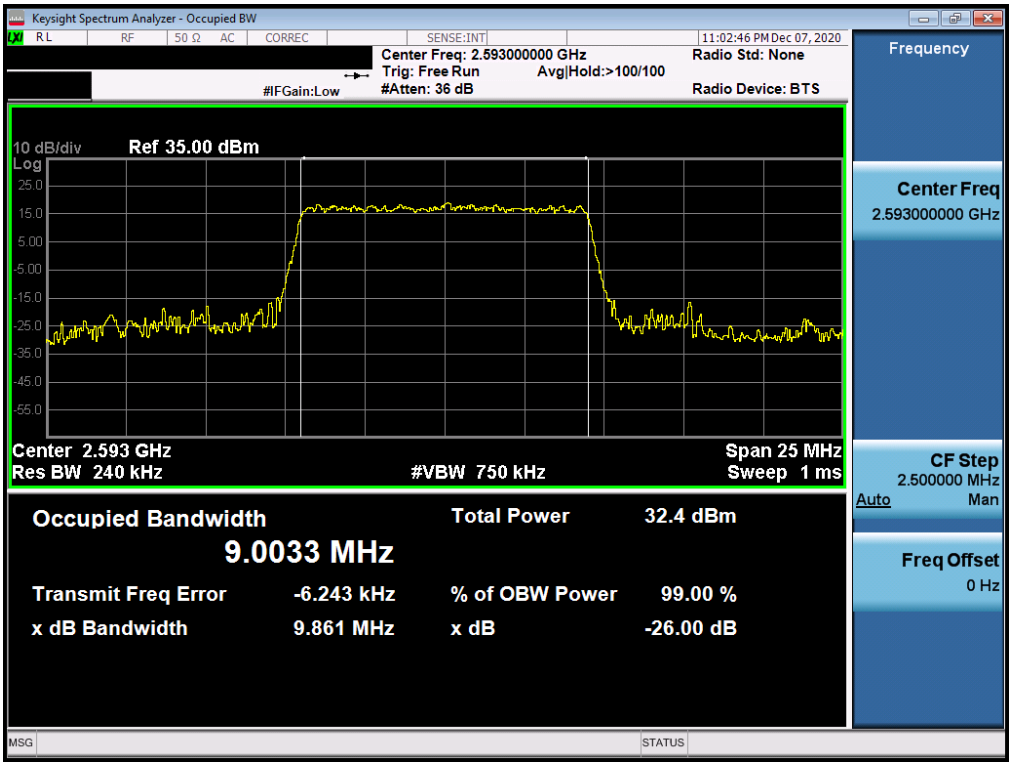


Plot 7-31. Occupied Bandwidth Plot (LTE Band 41 - 15MHz 64-QAM - Full RB Configuration)

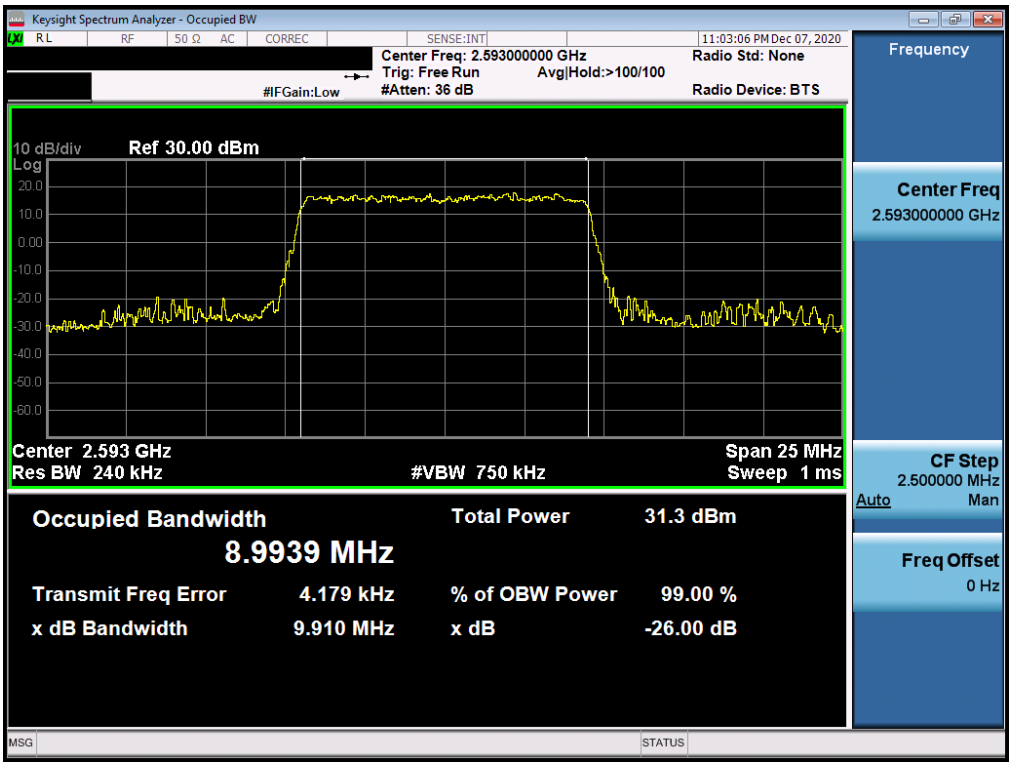
Plot 7-32. Occupied Bandwidth Plot (LTE Band 41 - 15MHz 256-QAM - Full RB Configuration)



Plot 7-33. Occupied Bandwidth Plot (LTE Band 41 - 10MHz QPSK - Full RB Configuration)

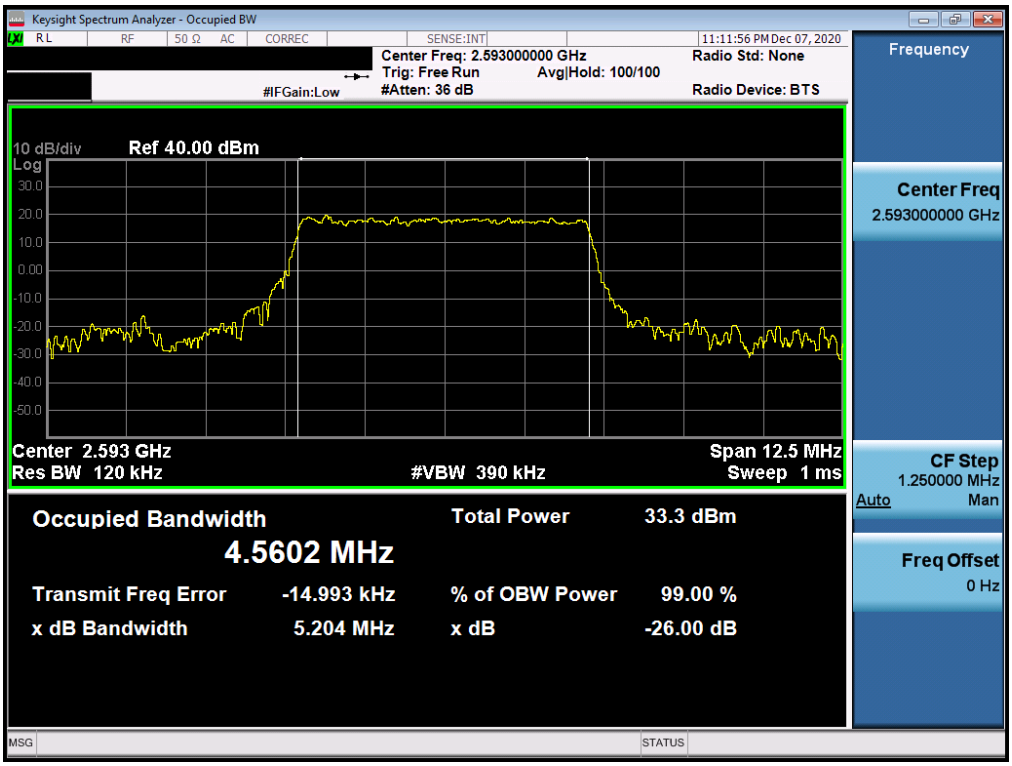


Plot 7-34. Occupied Bandwidth Plot (LTE Band 41 - 10MHz 16-QAM - Full RB Configuration)

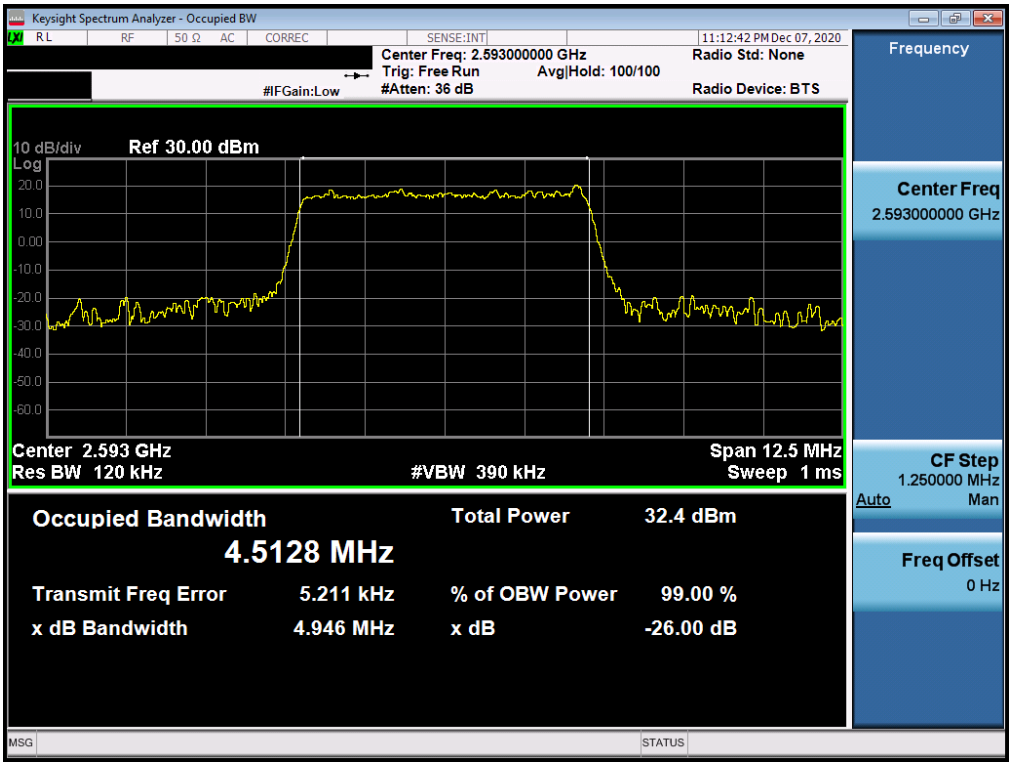


Plot 7-35. Occupied Bandwidth Plot (LTE Band 41 - 10MHz 64-QAM - Full RB Configuration)

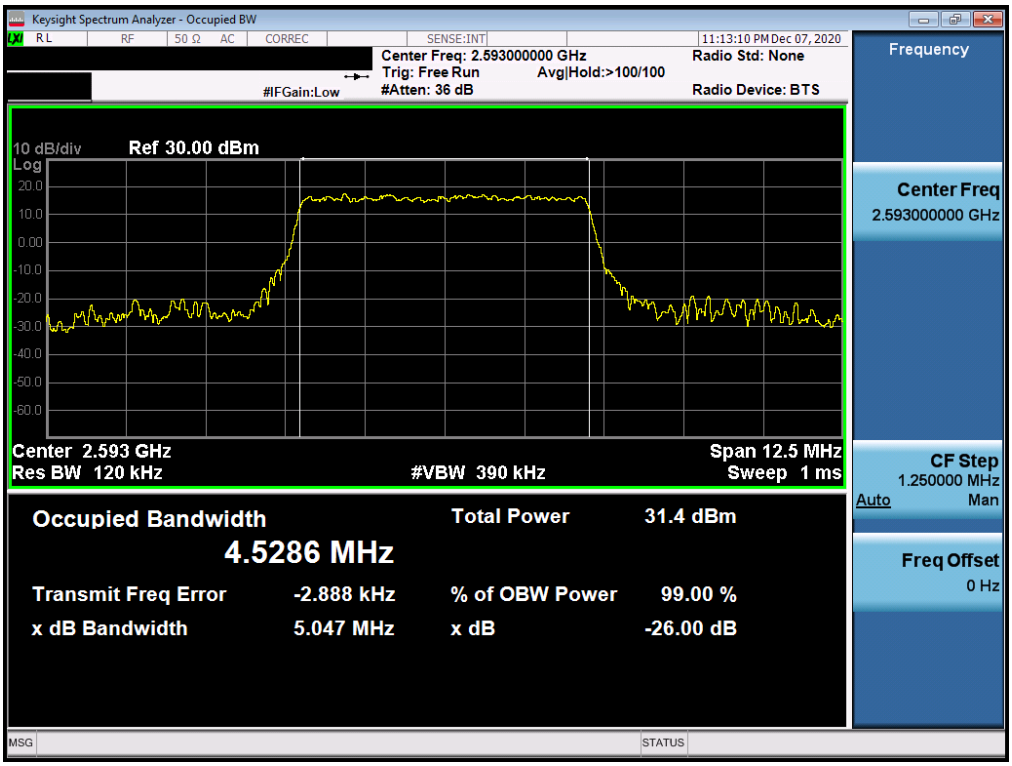
Plot 7-36. Occupied Bandwidth Plot (LTE Band 41 - 10MHz 256-QAM - Full RB Configuration)



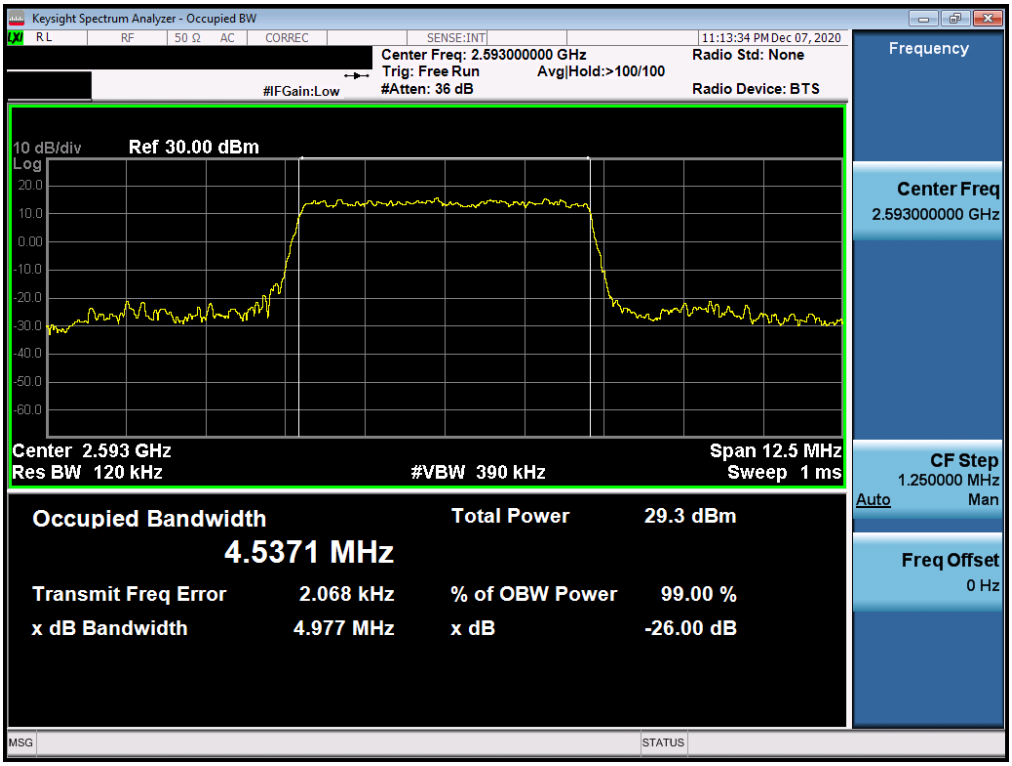
Plot 7-37. Occupied Bandwidth Plot (LTE Band 41 - 5MHz QPSK - Full RB Configuration)



Plot 7-38. Occupied Bandwidth Plot (LTE Band 41 - 5MHz 16-QAM - Full RB Configuration)

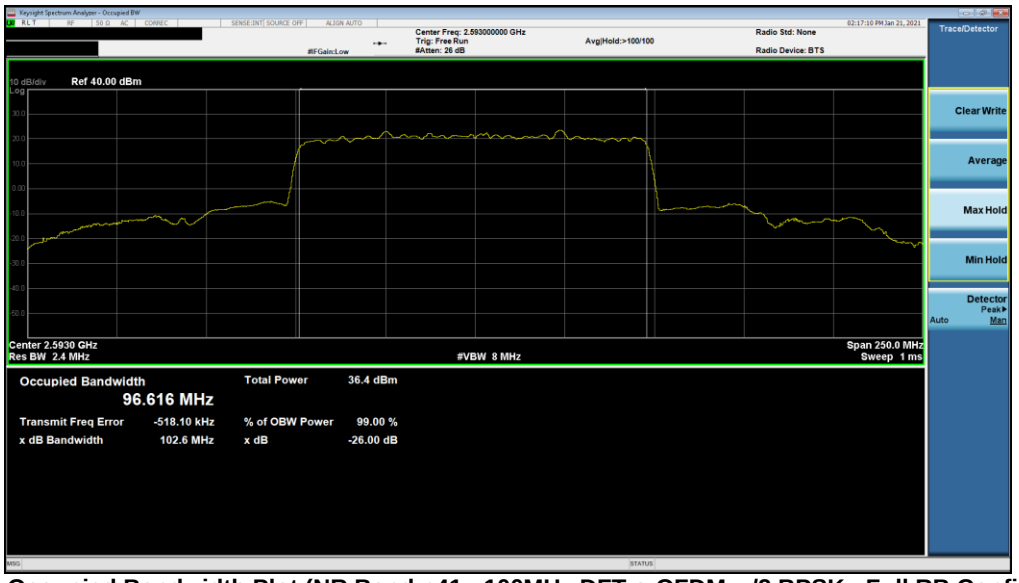


Plot 7-39. Occupied Bandwidth Plot (LTE Band 41 - 5MHz 64-QAM - Full RB Configuration)

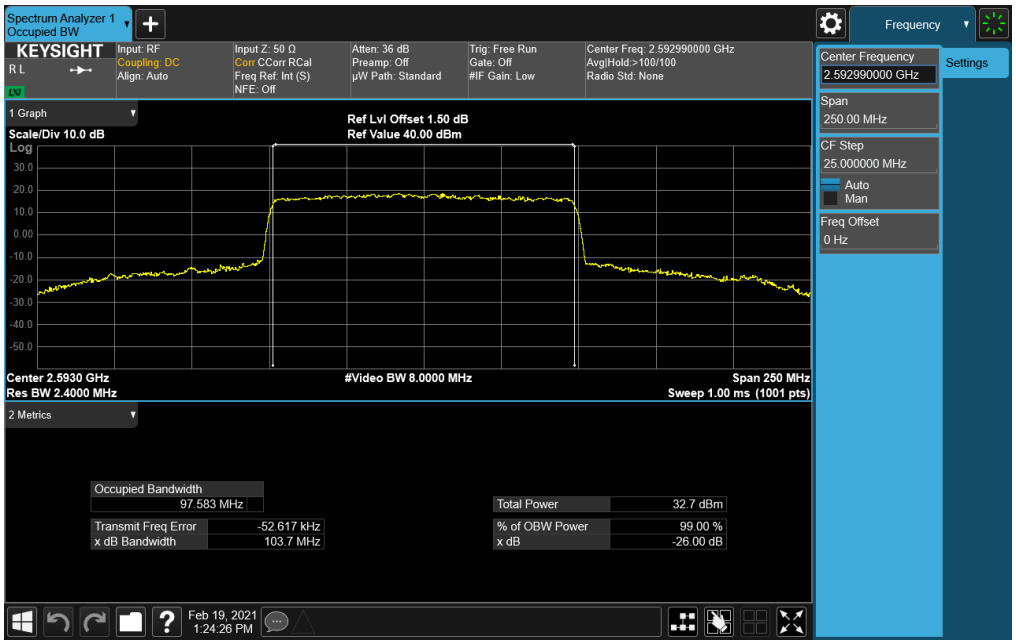


Plot 7-40. Occupied Bandwidth Plot (LTE Band 41 - 5MHz 256-QAM - Full RB Configuration)

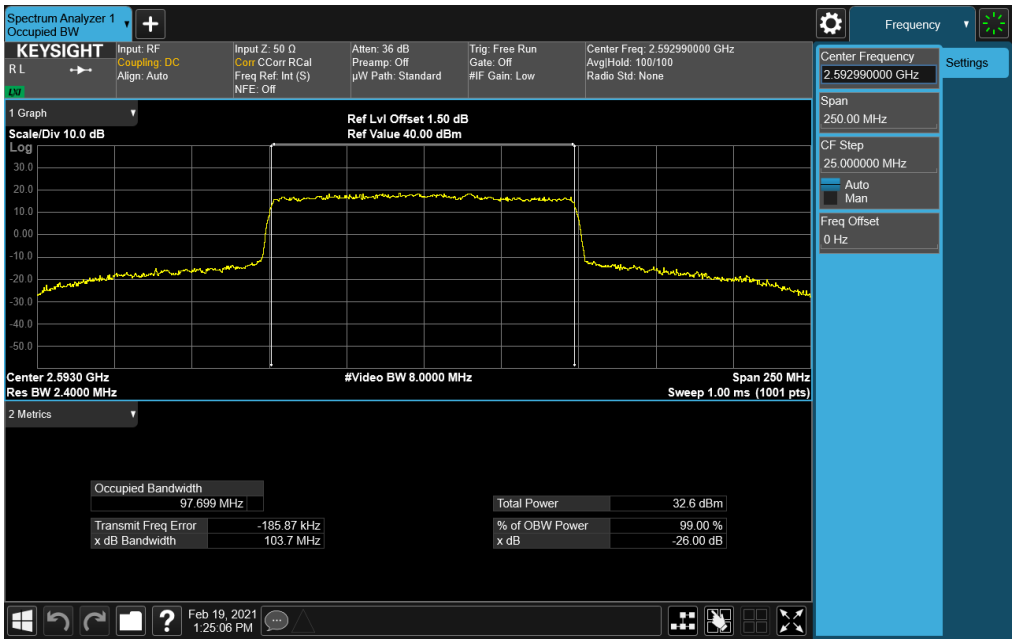
NR Band n41



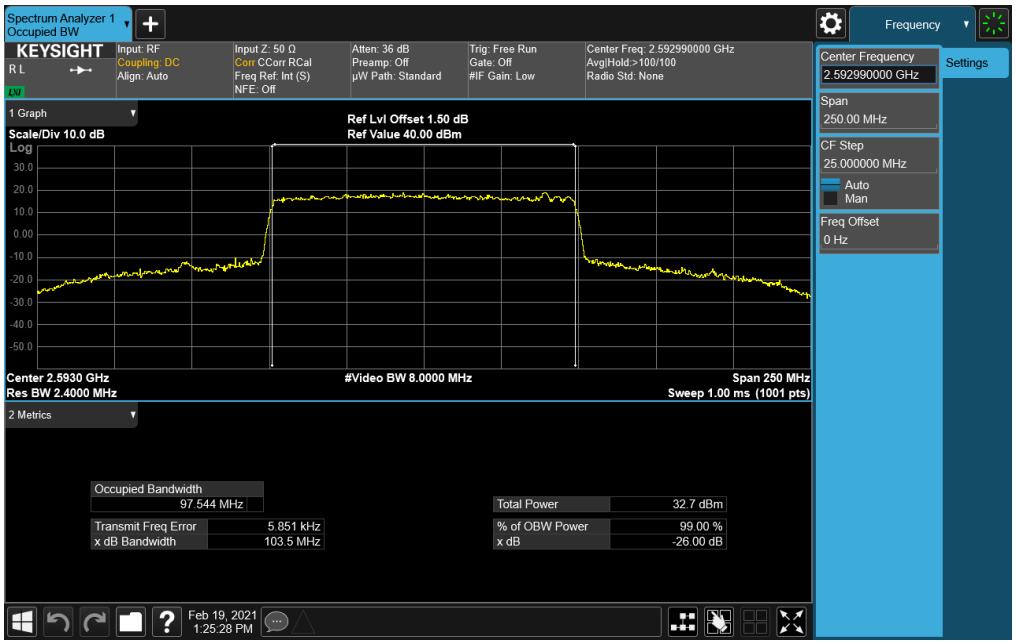
Plot 7-41. Occupied Bandwidth Plot (NR Band n41 - 100MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)



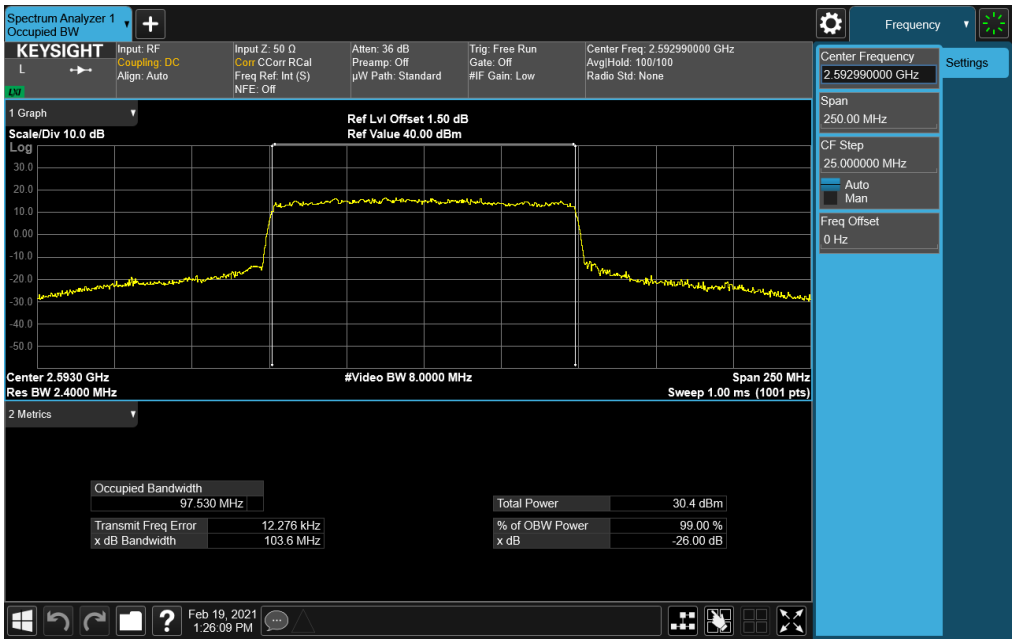
Plot 7-42. Occupied Bandwidth Plot (NR Band n41 - 100MHz CP-OFDM QPSK - Full RB Configuration)



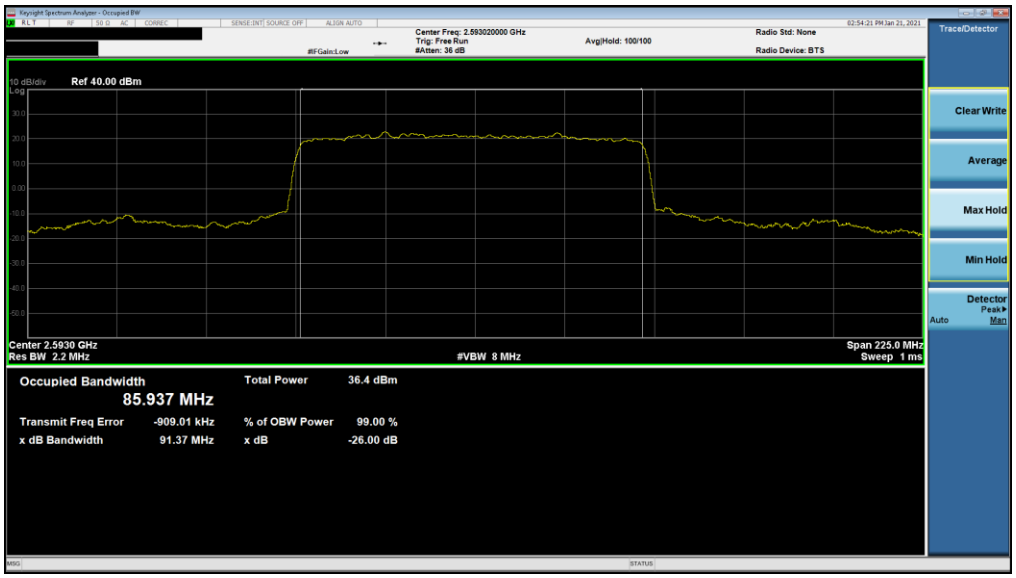
Plot 7-43. Occupied Bandwidth Plot (NR Band n41 - 100MHz CP-OFDM 16-QAM - Full RB Configuration)



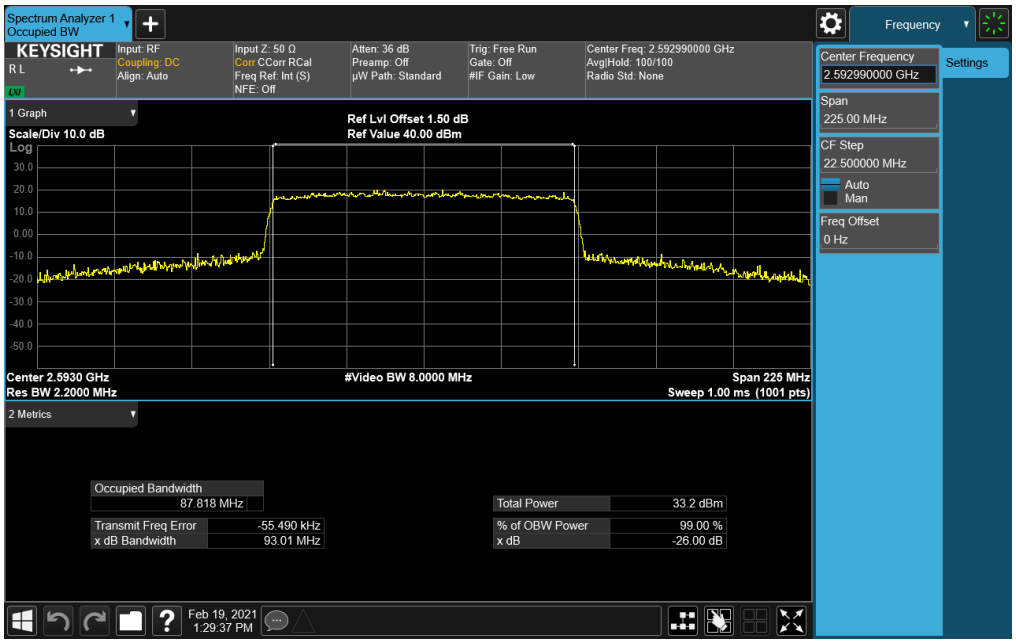
Plot 7-44. Occupied Bandwidth Plot (NR Band n41 - 100MHz CP-OFDM 64-QAM - Full RB Configuration)



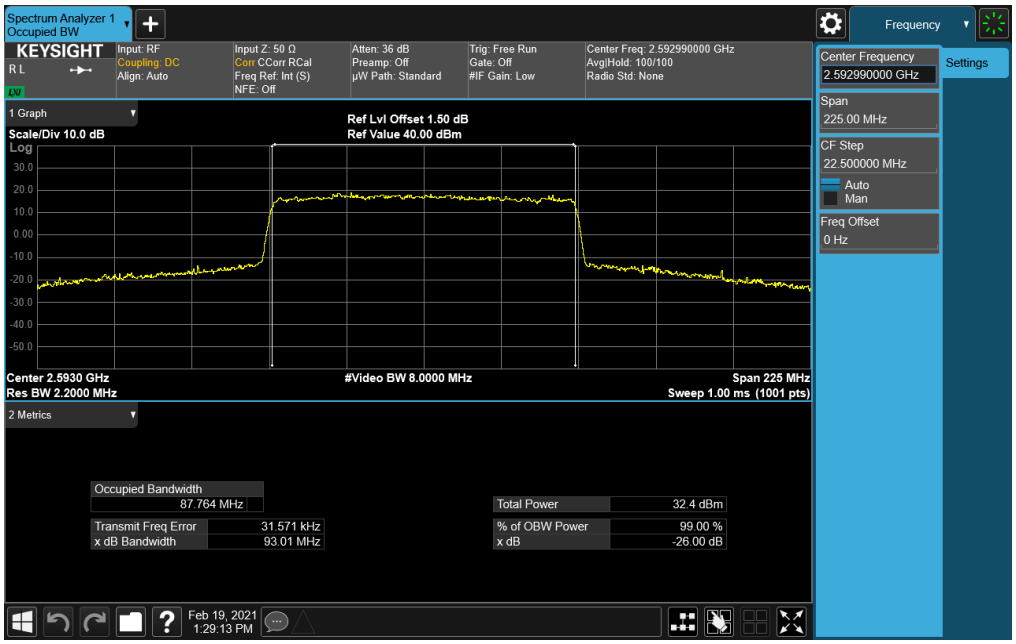
Plot 7-45. Occupied Bandwidth Plot (NR Band n41 - 100MHz CP-OFDM 256-QAM - Full RB Configuration)



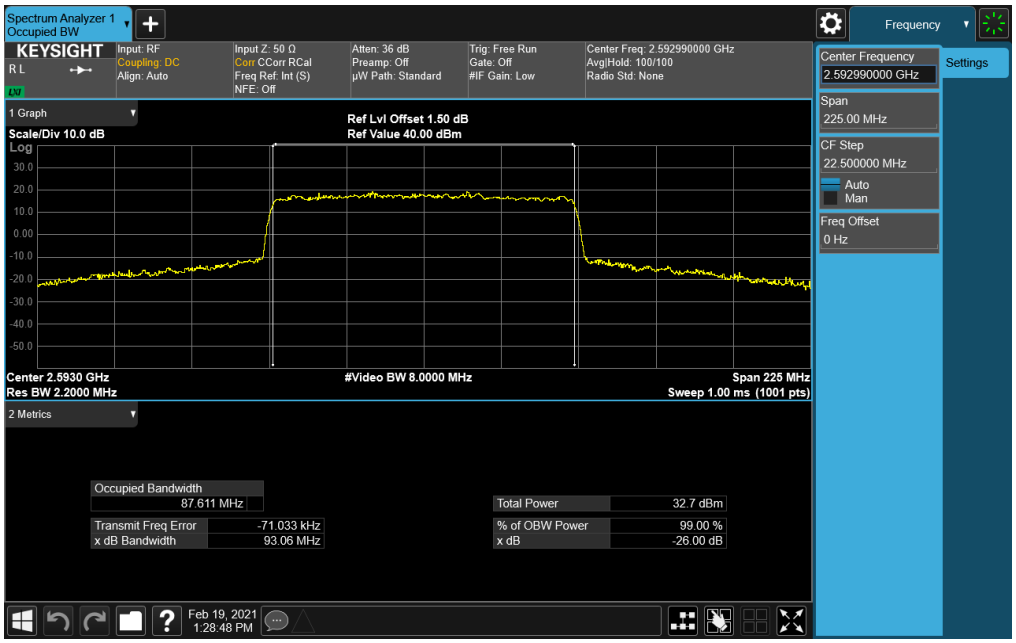
Plot 7-46. Occupied Bandwidth Plot (NR Band n41 - 90MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)



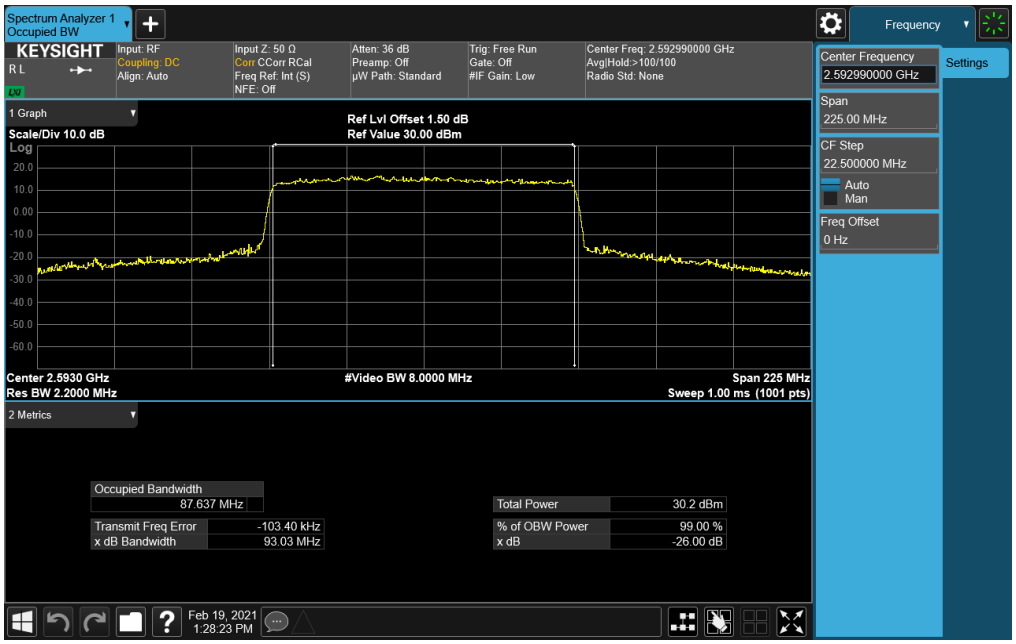
Plot 7-47. Occupied Bandwidth Plot (NR Band n41 - 90MHz CP-OFDM QPSK - Full RB Configuration)



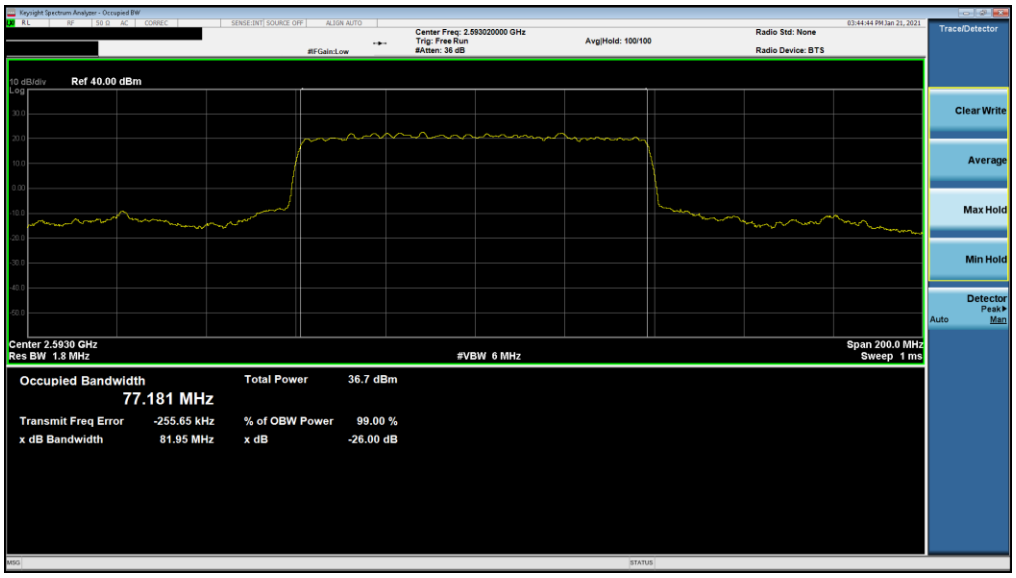
Plot 7-48. Occupied Bandwidth Plot (NR Band n41 - 90MHz CP-OFDM 16-QAM - Full RB Configuration)



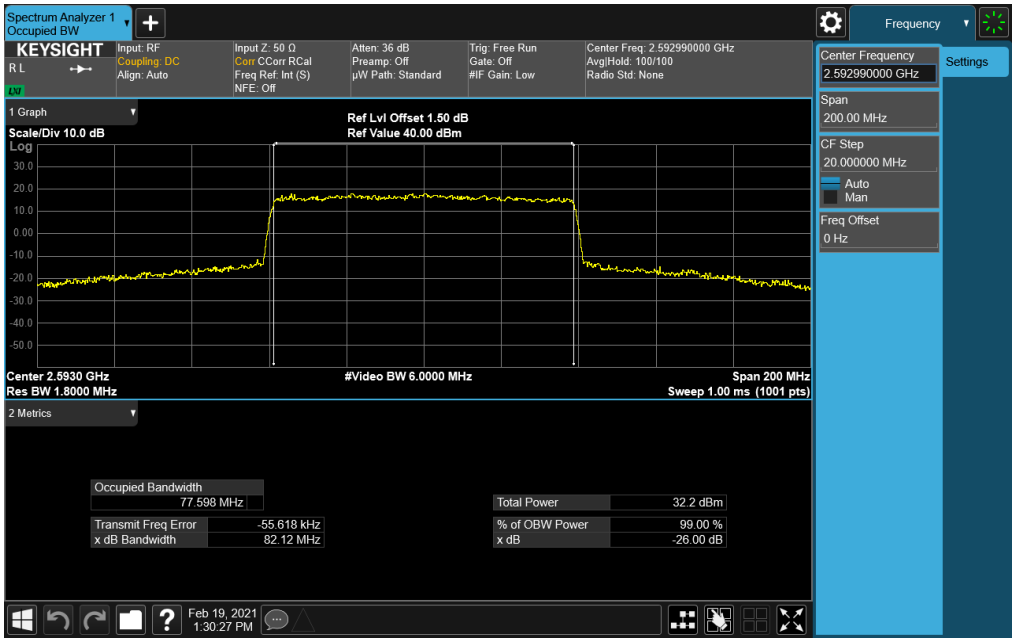
Plot 7-49. Occupied Bandwidth Plot (NR Band n41 - 90MHz CP-OFDM 64-QAM - Full RB Configuration)



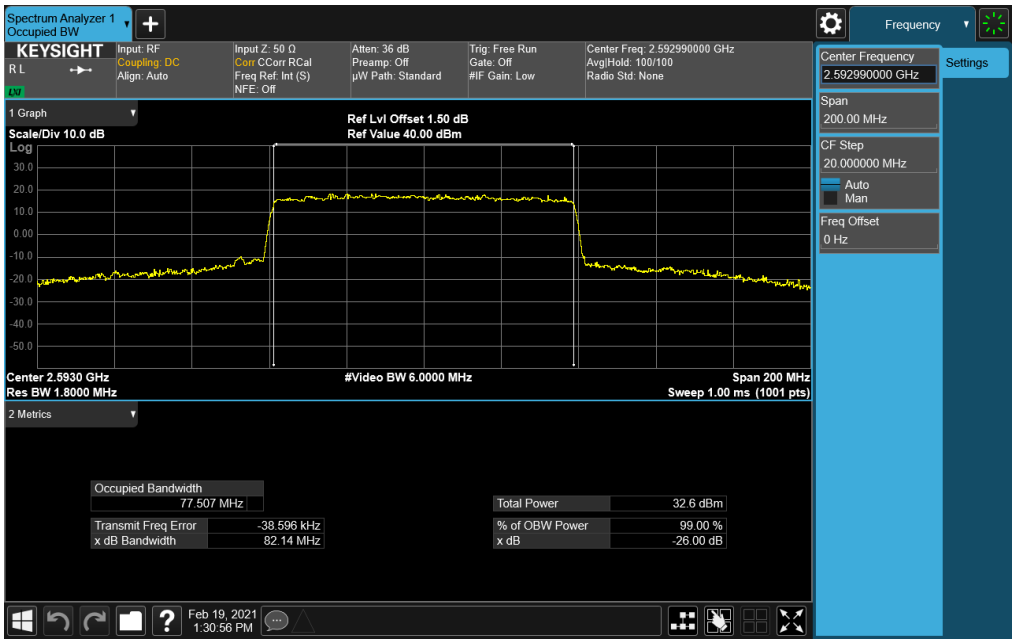
Plot 7-50. Occupied Bandwidth Plot (NR Band n41 - 90MHz CP-OFDM 256-QAM - Full RB Configuration)



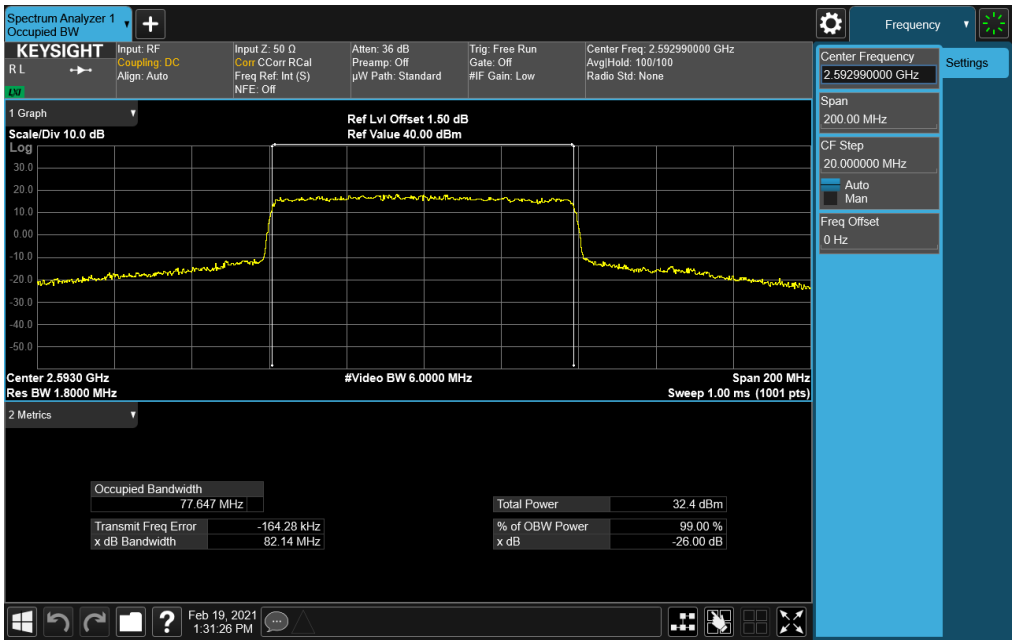
Plot 7-51. Occupied Bandwidth Plot (NR Band n41 - 80MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)



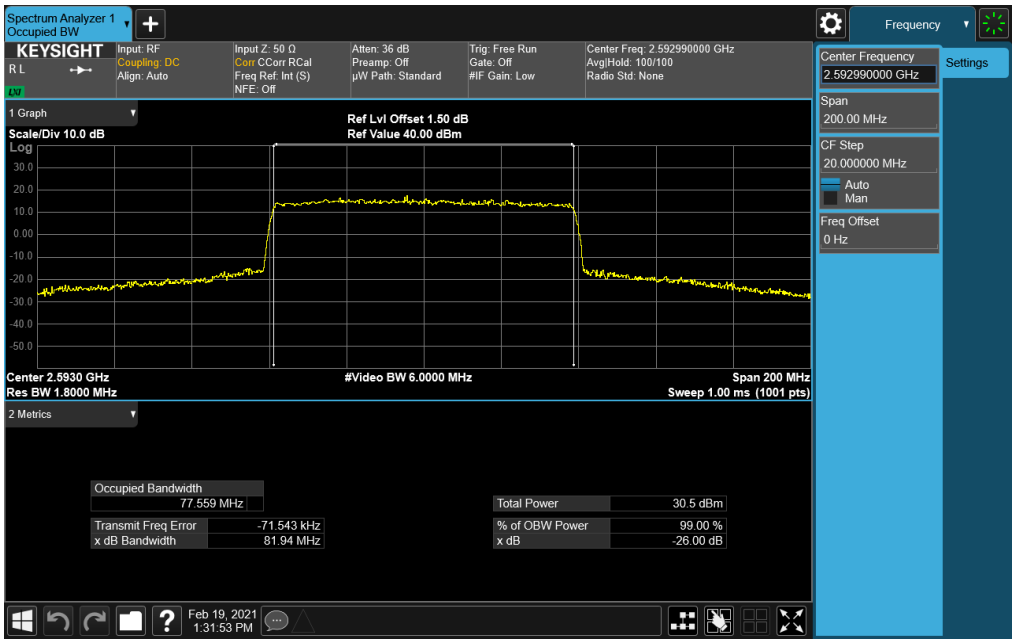
Plot 7-52. Occupied Bandwidth Plot (NR Band n41 - 80MHz CP-OFDM QPSK - Full RB Configuration)



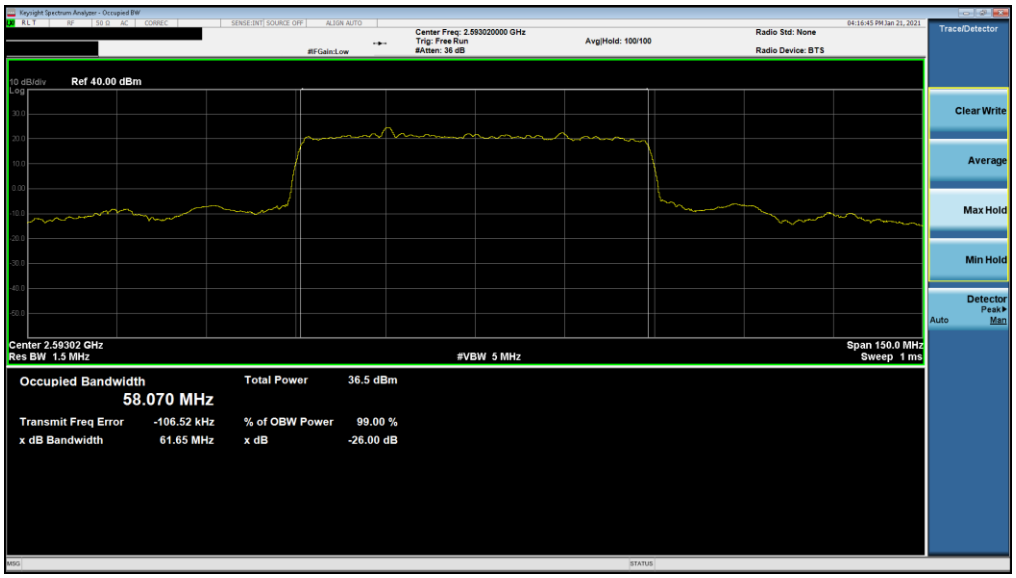
Plot 7-53. Occupied Bandwidth Plot (NR Band n41 - 80MHz CP-OFDM 16-QAM - Full RB Configuration)



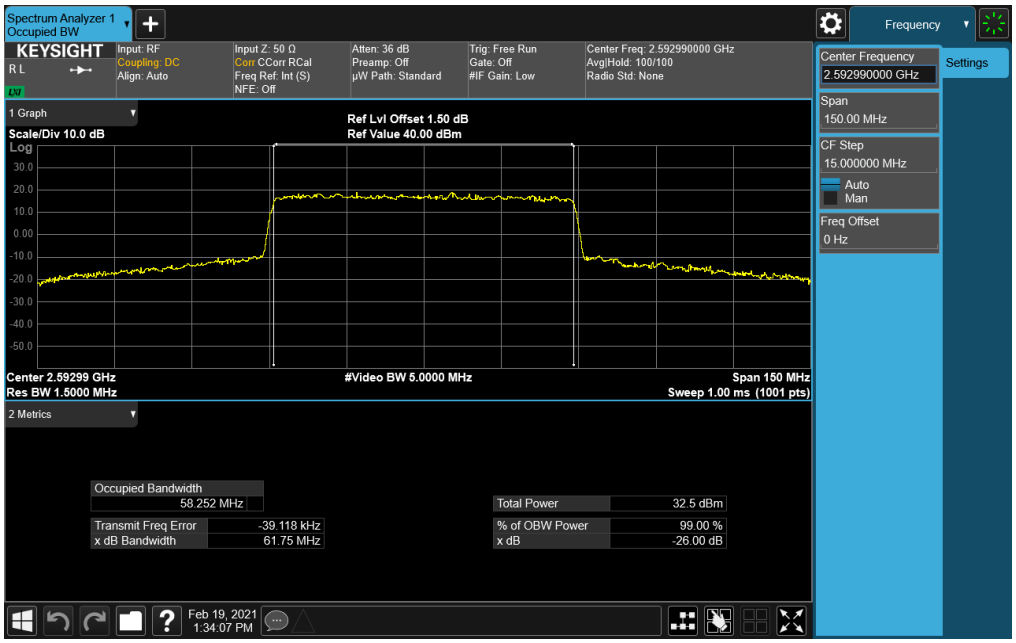
Plot 7-54. Occupied Bandwidth Plot (NR Band n41 - 80MHz CP-OFDM 64-QAM - Full RB Configuration)



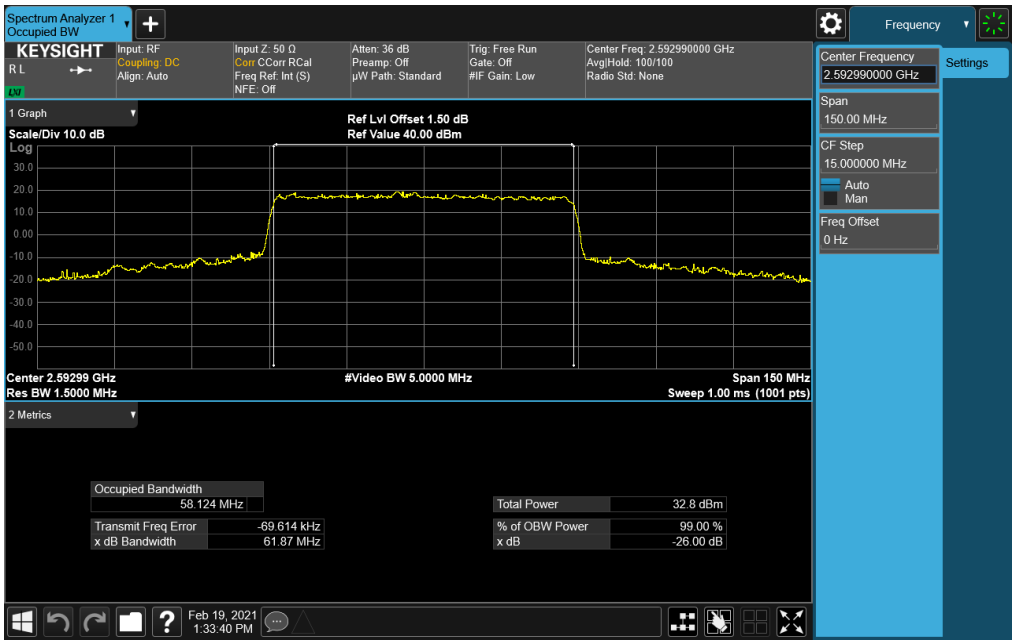
Plot 7-55. Occupied Bandwidth Plot (NR Band n41 - 80MHz CP-OFDM 256-QAM - Full RB Configuration)



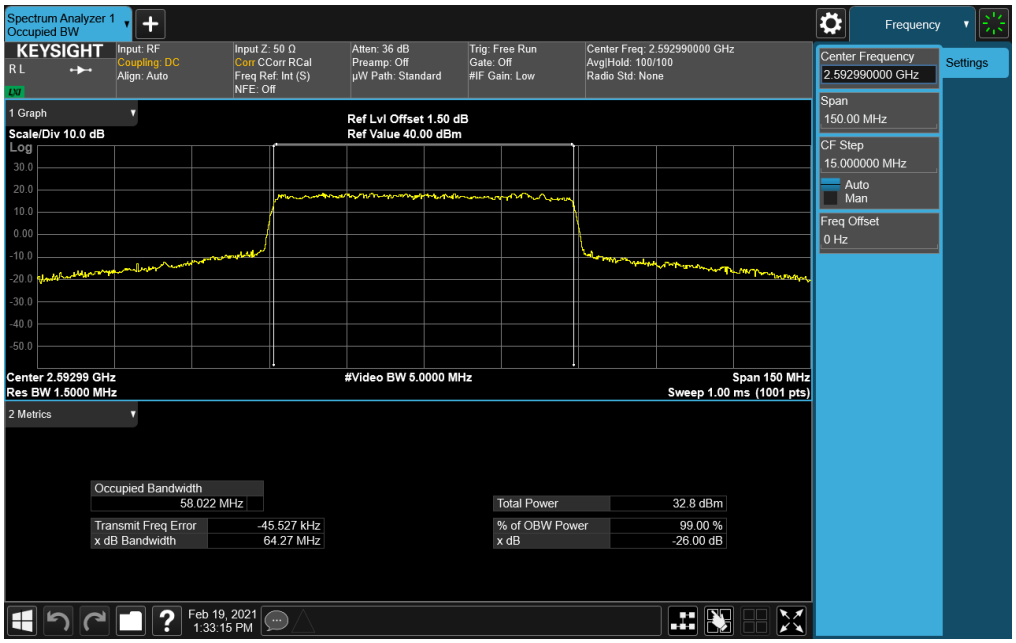
Plot 7-56. Occupied Bandwidth Plot (NR Band n41 - 60MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)



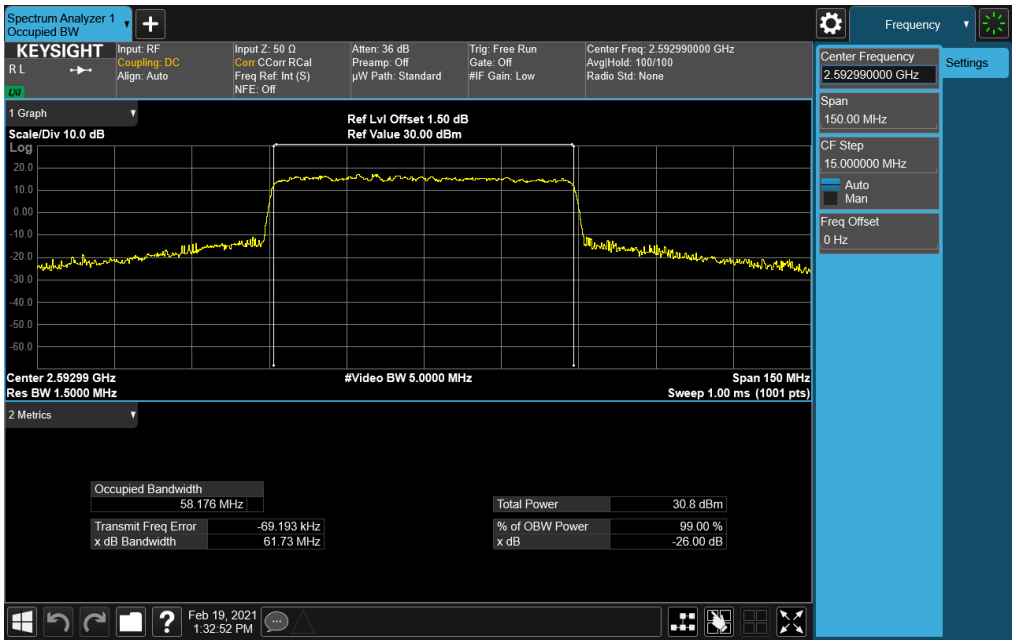
Plot 7-57. Occupied Bandwidth Plot (NR Band n41 - 60MHz CP-OFDM QPSK - Full RB Configuration)



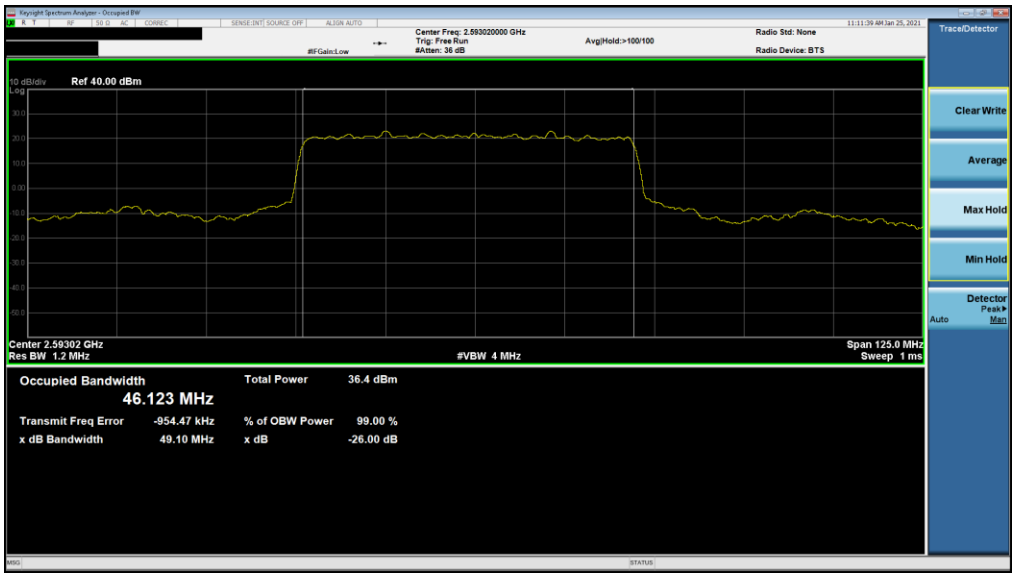
Plot 7-58. Occupied Bandwidth Plot (NR Band n41 - 60MHz CP-OFDM 16-QAM - Full RB Configuration)



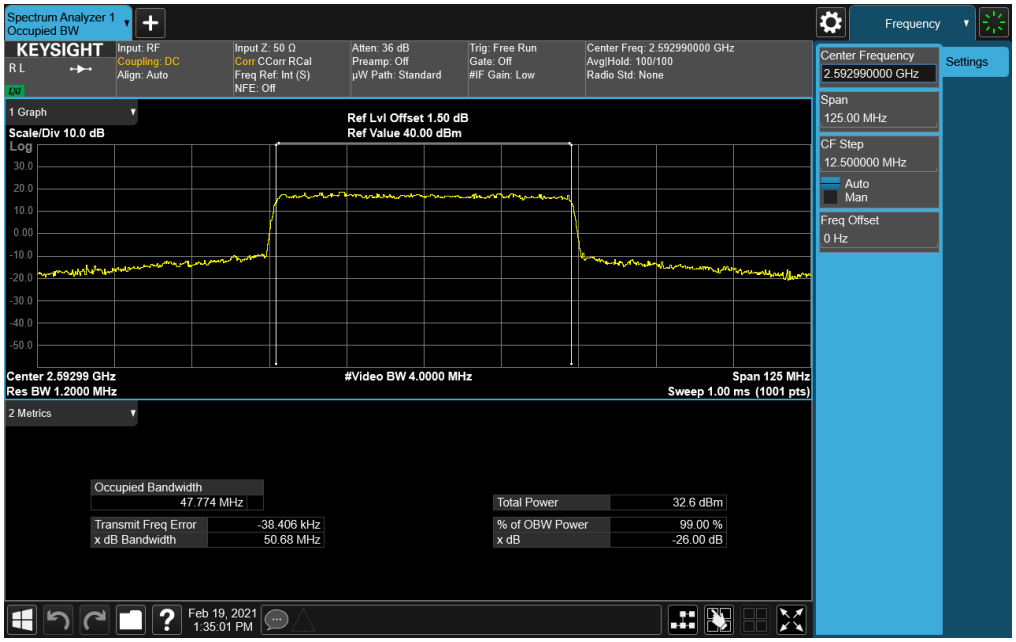
Plot 7-59. Occupied Bandwidth Plot (NR Band n41 - 60MHz CP-OFDM 64-QAM - Full RB Configuration)



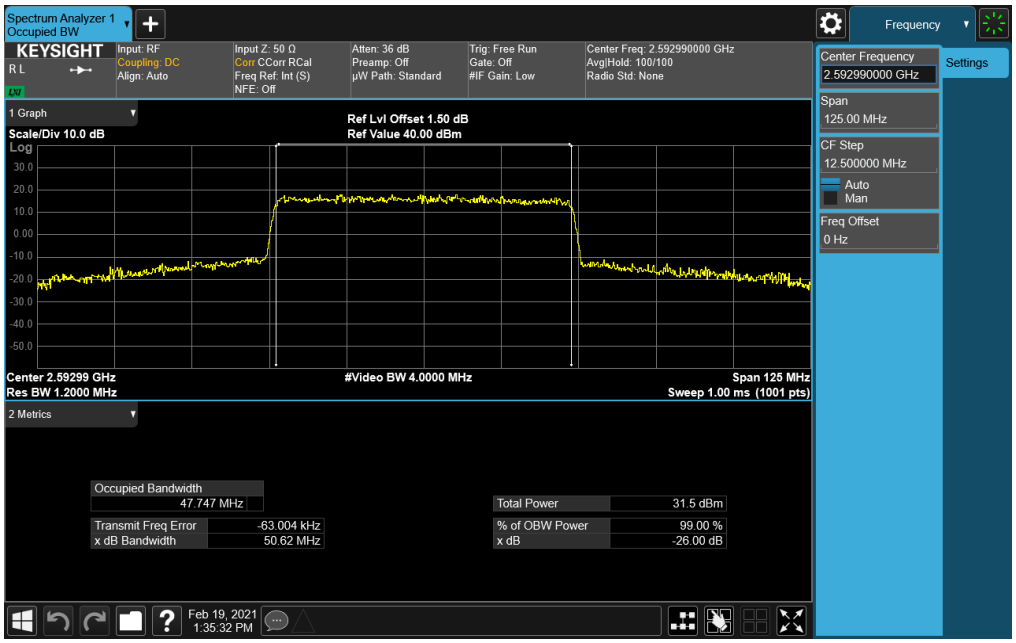
Plot 7-60. Occupied Bandwidth Plot (NR Band n41 - 60MHz CP-OFDM 256-QAM - Full RB Configuration)



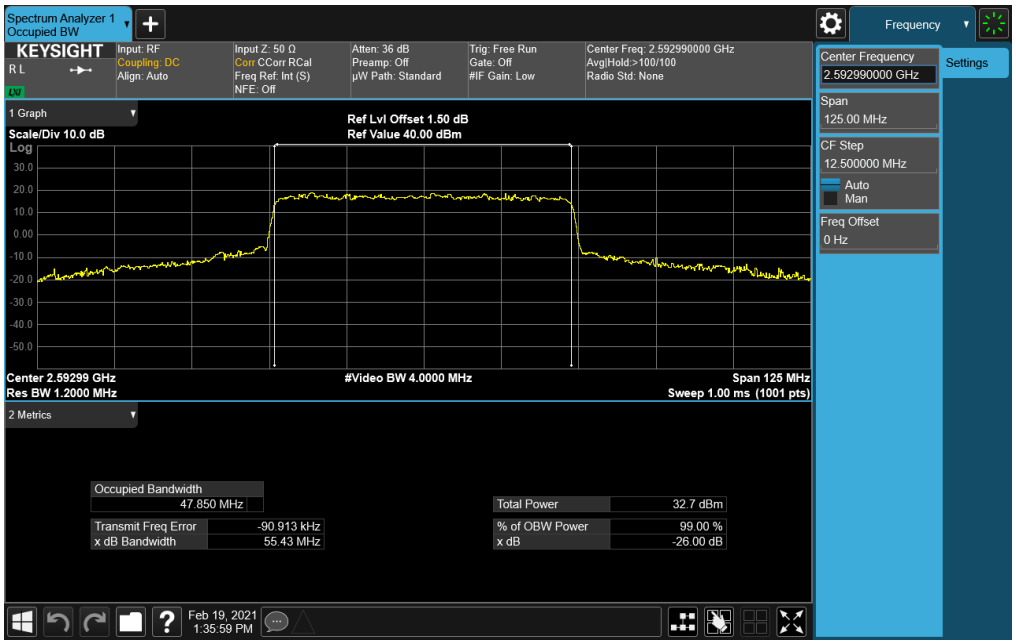
Plot 7-61. Occupied Bandwidth Plot (NR Band n41 - 50MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)



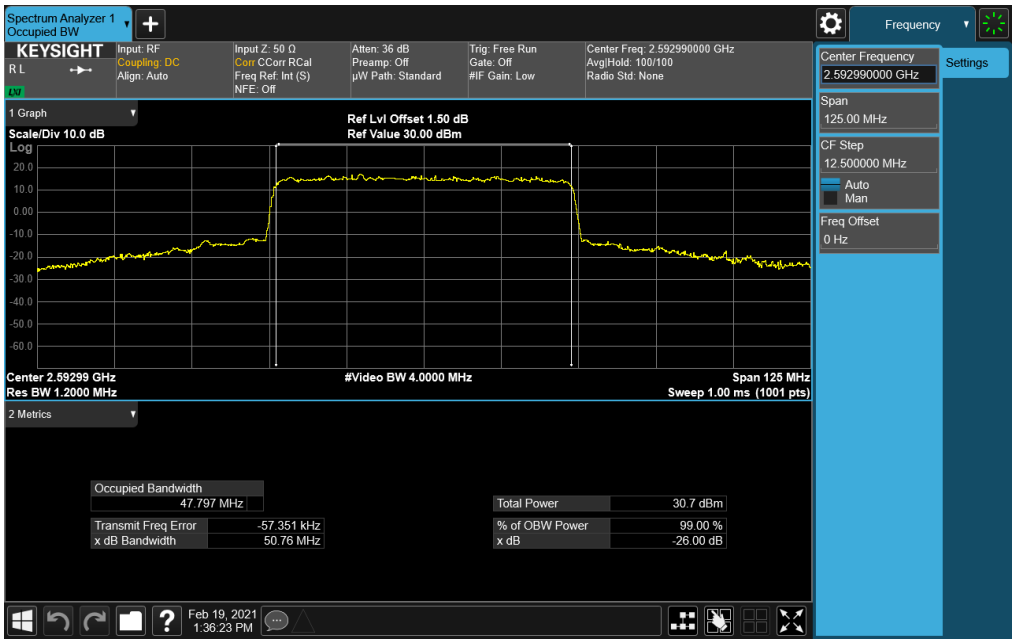
Plot 7-62. Occupied Bandwidth Plot (NR Band n41 - 50MHz CP-OFDM QPSK - Full RB Configuration)



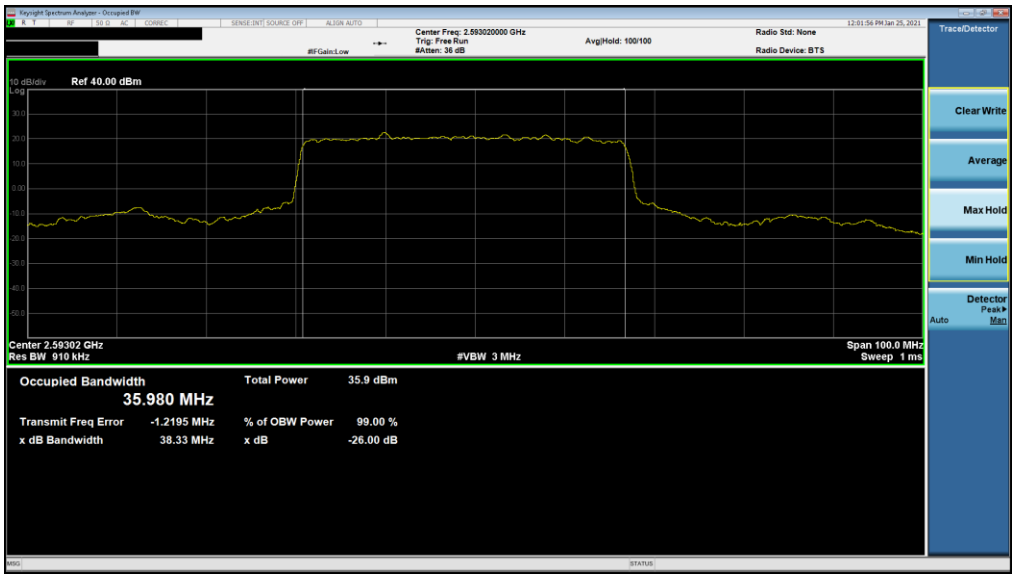
Plot 7-63. Occupied Bandwidth Plot (NR Band n41 - 50MHz CP-OFDM 16-QAM - Full RB Configuration)



Plot 7-64. Occupied Bandwidth Plot (NR Band n41 - 50MHz CP-OFDM 64-QAM - Full RB Configuration)



Plot 7-65. Occupied Bandwidth Plot (NR Band n41 - 50MHz CP-OFDM 256-QAM - Full RB Configuration)



Plot 7-66. Occupied Bandwidth Plot (NR Band n41 - 40MHz DFT-s-OFDM π/2 BPSK - Full RB Configuration)