



DATA REFERENCE REPORT PART 22

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.:

1C2101020003-03.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:

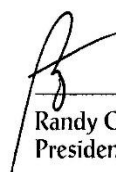
22

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.



Randy Ortanez
President



CERT #2041.02

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
Page 1 of 14		

TABLE OF CONTENTS

1.0	INTRODUCTION	3
1.1	Scope	3
1.2	PCTEST Test Location.....	3
1.3	Test Facility / Accreditations.....	3
2.0	PRODUCT INFORMATION.....	4
2.1	Equipment Description	4
2.2	Device Capabilities.....	4
2.3	Antenna Description	5
2.4	Test Support Equipment.....	5
2.5	Test Configuration	6
2.6	Software and Firmware	6
2.7	EMI Suppression Device(s)/Modifications	6
3.0	DESCRIPTION OF TESTS	7
3.1	Measurement Procedure.....	7
3.2	Radiated Spurious Emissions	7
4.0	MEASUREMENT UNCERTAINTY	8
5.0	TEST EQUIPMENT CALIBRATION DATA	9
6.0	SAMPLE CALCULATIONS	10
7.0	TEST RESULTS (SPOT-CHECK DATA)	11
7.1	Summary.....	11
7.2	Radiated Spurious Emissions	12
8.0	CONCLUSION.....	13
9.0	APPENDIX A: REFERENCE MODEL TEST REPORT.....	14

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 2 of 14

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	1C2101020002-02.BCG	RF Part 22 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 ISSED Standards (RSS).
- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISSED.

FCC ID: BCGA2459	 PCTEST Proud to be part of element	PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
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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 22.

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

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device

2.3 Antenna Description

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

Band	Antenna Gain (dBi)	
	Antenna 3	Antenna 1
GSM850	-1.9	-3.2
EDGE850		
WCDMA850		
LTE Band 5/26		
NR Band n5		

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

FCC ID: BCGA2459	 PCTEST Proud to be part of element	PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 5 of 14

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.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 6 of 14

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

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

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.

FCC ID: BCGA2459	 PCTEST Proud to be part of element	PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 7 of 14

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

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 8 of 14

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	3/4/2020	Annual	3/4/2021	MY49430244
Keysight Technology	N9040B	UXA Signal Analyzer	12/19/2020	Annual	12/19/2021	MY57212015
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	FSV40	Signal Analyzer (10Hz-40GHz)	3/2/2020	Annual	3/2/2021	101619
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	9/24/2020	Annual	9/24/2021	151888
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.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 9 of 14

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.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 10 of 14

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): GSM/GPRS/WCDMA/NR/LTE

Technology	Test Configurations					Reference Model	Variant Model	Delta
	Test Description	Modulation	BW	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2301	FCC ID: BCGA2459	
						Average [dBm]	Average [dBm]	Average [dB]
GPRS850	Radiated Spurious Emissions	GMSK	250kHz	M	2509.8	-45.16	-47.05	1.89

Table 7-1. Worst Case Spot-check Results

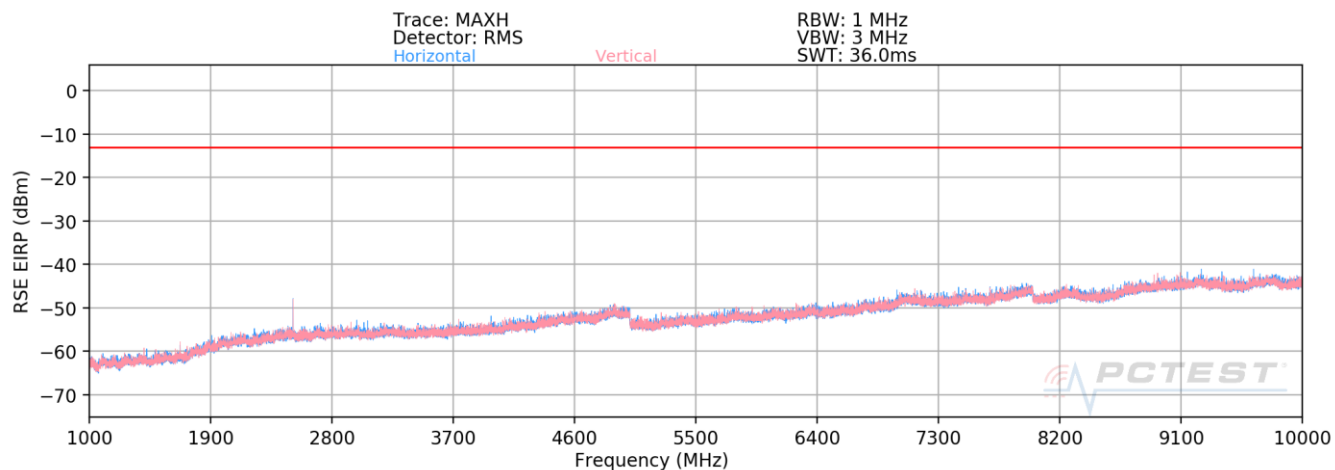
Spot-checks were conducted, all measurements were investigated and found to be within acceptable tolerance in accordance with FCC Approved Data Referencing Test Plan.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 11 of 14

7.2 Radiated Spurious Emissions

§2.1053, 22.917(a)

GPRS



Plot 7-1. Radiated Spurious Emission above 1GHz (GPRS Cell)

Mode:	GPRS 1 Tx Slot
Channel:	190
Frequency (MHz):	836.6

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]
1673.2	H	116	144	-66.21	-0.18	40.61	-54.64	-13.00	-41.64
2509.8	H	249	128	-63.64	4.84	48.20	-47.05	-13.00	-34.05
3346.4	H	-	-	-71.98	6.09	41.11	-54.15	-13.00	-41.15
4183.0	H	-	-	-72.88	7.92	42.04	-53.22	-13.00	-40.22
5019.6	H	-	-	-73.02	9.40	43.38	-51.88	-13.00	-38.88

Table 7-2. Radiated Spurious Data (GPRS Cell – Mid Channel)

FCC ID: BCGA2459	PCTEST Proud to be part of element	PART 22 DATA REFERENCE REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device		Page 12 of 14

8.0 CONCLUSION

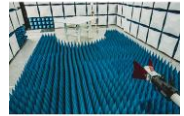
The spot-check data measured for variant model **FCC ID: BCGA2459** is in tolerance with reference model FCC ID: BCGA2301 per FCC Approved Data Referencing Test Plan.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 13 of 14

9.0 APPENDIX A: REFERENCE MODEL TEST REPORT

Attached is the test report (1C2101020002-02.BCG) from reference model FCC ID: BCGA2301, which includes referenced data results.

FCC ID: BCGA2459	 PART 22 DATA REFERENCE REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020003-03.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 14 of 14



PART 22 MEASUREMENT REPORT

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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.:

1C2101020002-02.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:

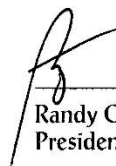
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Test Procedure(s):

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.



Randy Ortanez
President

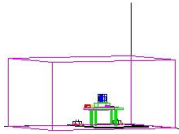


FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 1 of 108

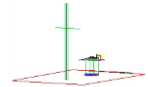
T A B L E O F C O N T E N T S

1.0	INTRODUCTION	4
1.1	Scope	4
1.2	PCTEST Test Location.....	4
1.3	Test Facility / Accreditations.....	4
2.0	PRODUCT INFORMATION.....	5
2.1	Equipment Description	5
2.2	Device Capabilities.....	5
2.3	Antenna Description	6
2.4	Test Support Equipment.....	6
2.5	Test Configuration	6
2.6	Software and Firmware	7
2.7	EMI Suppression Device(s)/Modifications	7
3.0	DESCRIPTION OF TESTS	8
3.1	Measurement Procedure.....	8
3.2	Radiated Spurious Emissions	8
4.0	MEASUREMENT UNCERTAINTY	9
5.0	TEST EQUIPMENT CALIBRATION DATA	10
6.0	SAMPLE CALCULATIONS	11
7.0	TEST RESULTS.....	12
7.1	Summary.....	12
7.2	Occupied Bandwidth	13
7.3	Spurious and Harmonic Emissions at Antenna Terminal	36
7.4	Band Edge Emissions at Antenna Terminal	61
7.5	Radiated Power (ERP/EIRP).....	78
7.6	Radiated Spurious Emissions	86
7.7	Frequency Tolerance / Temperature Variation	103
8.0	CONCLUSION.....	108

FCC ID: BCGA2301	 PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 2 of 108



PART 22 MEASUREMENT REPORT



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	OBW [MHz]	ERP		EIRP		Emission Designator
					Max. Power [W]	Max. Power [dBm]	Max. Power [W]	Max. Power [dBm]	
GSM850	250 kHz	GMSK	824.2 - 848.8	0.2468	0.773	28.88	1.268	31.03	247KGXW
EDGE850		8-PSK	824.2 - 848.8	0.2400	0.202	23.06	0.332	25.21	240KG7W
WCDMA850	5 MHz	Spread Spectrum	826.4 - 846.6	4.1701	0.146	21.65	0.240	23.80	4M17F9W
Band 5	10 MHz	QPSK	829.0 - 844.0	9.0024	0.146	21.65	0.240	23.80	9M03G7W
		16QAM	829.0 - 844.0	9.0256	0.130	21.13	0.213	23.28	9M03D7W
		64QAM	829.0 - 844.0	8.9997	0.105	20.20	0.172	22.35	9M00D7W
		256QAM	829.0 - 844.0	8.9953	0.049	16.92	0.081	19.07	9M00D7W
	5 MHz	QPSK	826.5 - 846.5	4.5483	0.146	21.65	0.240	23.80	4M55G7W
		16QAM	826.5 - 846.5	4.5261	0.130	21.14	0.213	23.29	4M53D7W
		64QAM	826.5 - 846.5	4.5270	0.105	20.20	0.172	22.35	4M53D7W
		256QAM	826.5 - 846.5	4.5165	0.055	17.39	0.090	19.54	4M52D7W
	3 MHz	QPSK	825.5 - 847.5	2.7158	0.146	21.65	0.240	23.80	2M72G7W
		16QAM	825.5 - 847.5	2.7166	0.132	21.20	0.216	23.35	2M72D7W
		64QAM	825.5 - 847.5	2.7165	0.106	20.25	0.174	22.40	2M72D7W
		256QAM	825.5 - 847.5	2.7114	0.050	17.00	0.082	19.15	2M71D7W
	1.4 MHz	QPSK	824.7 - 848.3	1.0879	0.146	21.65	0.240	23.80	1M09G7W
		16QAM	824.7 - 848.3	1.0947	0.132	21.20	0.216	23.35	1M09D7W
		64QAM	824.7 - 848.3	1.0923	0.105	20.23	0.173	22.38	1M09D7W
		256QAM	824.7 - 848.3	1.0958	0.055	17.39	0.090	19.54	1M10D7W
Band 26	10 MHz	QPSK	829.0 - 844.0	9.0024	0.146	21.65	0.240	23.80	9M03G7W
		16QAM	829.0 - 844.0	9.0256	0.129	21.12	0.212	23.27	9M03D7W
		64QAM	829.0 - 844.0	8.9997	0.112	20.48	0.183	22.63	9M00D7W
		256QAM	829.0 - 844.0	8.9953	0.054	17.31	0.088	19.46	9M00D7W
	5 MHz	QPSK	826.5 - 846.5	4.5483	0.140	21.46	0.230	23.61	4M55G7W
		16QAM	826.5 - 846.5	4.5261	0.109	20.36	0.178	22.51	4M53D7W
		64QAM	826.5 - 846.5	4.5270	0.101	20.03	0.165	22.18	4M53D7W
		256QAM	826.5 - 846.5	4.5165	0.049	16.92	0.081	19.07	4M52D7W
	3 MHz	QPSK	825.5 - 847.5	2.7158	0.146	21.65	0.240	23.80	2M72G7W
		16QAM	825.5 - 847.5	2.7166	0.124	20.94	0.204	23.09	2M72D7W
		64QAM	825.5 - 847.5	2.7165	0.107	20.29	0.175	22.44	2M72D7W
		256QAM	825.5 - 847.5	2.7114	0.053	17.27	0.087	19.42	2M71D7W
	1.4 MHz	QPSK	824.7 - 848.3	1.0879	0.146	21.65	0.240	23.80	1M09G7W
		16QAM	824.7 - 848.3	1.0947	0.100	19.99	0.164	22.14	1M09D7W
		64QAM	824.7 - 848.3	1.0923	0.087	19.38	0.142	21.53	1M09D7W
		256QAM	824.7 - 848.3	1.0958	0.048	16.77	0.078	18.92	1M10D7W
ULCA Band 5	10 + 10 MHz	QPSK	829.0 - 844.0	18.8320	0.146	21.65	0.240	23.80	18M8G7W
		16QAM	829.0 - 844.0	18.8300	0.073	18.65	0.120	20.80	18M8D7W
		64QAM	829.0 - 844.0	18.8380	0.082	19.15	0.135	21.30	18M8D7W
		256QAM	829.0 - 844.0	18.9000	0.046	16.65	0.076	18.80	18M9D7W
NR Band n5	20 MHz	$\pi/2$ BPSK	834.0 - 839.0	17.9090	0.143	21.56	0.235	23.71	17M9G7W
		QPSK	834.0 - 839.0	18.9930	0.146	21.65	0.240	23.80	19M0G7W
		16QAM	834.0 - 839.0	19.0410	0.111	20.45	0.182	22.60	19M0D7W
		64QAM	834.0 - 839.0	19.0320	0.087	19.39	0.143	21.54	19M0D7W
	15 MHz	$\pi/2$ BPSK	831.5 - 841.5	13.4830	0.141	21.50	0.232	23.65	13M5G7W
		QPSK	831.5 - 841.5	14.1870	0.146	21.65	0.240	23.80	14M2G7W
		16QAM	831.5 - 841.5	14.1650	0.120	20.79	0.197	22.94	14M2D7W
		64QAM	831.5 - 841.5	14.2010	0.088	19.44	0.144	21.59	14M2D7W
	10 MHz	$\pi/2$ BPSK	829.0 - 844.0	9.0249	0.142	21.52	0.233	23.67	9M02G7W
		QPSK	829.0 - 844.0	9.3173	0.146	21.65	0.240	23.80	9M32G7W
		16QAM	829.0 - 844.0	9.3089	0.115	20.60	0.189	22.75	9M31D7W
		64QAM	829.0 - 844.0	9.3506	0.088	19.44	0.144	21.59	9M35D7W
	5 MHz	$\pi/2$ BPSK	829.0 - 844.0	9.3493	0.055	17.40	0.090	19.55	9M35D7W
		$\pi/2$ BPSK	826.5 - 846.5	4.5635	0.145	21.62	0.238	23.77	4M56G7W
		QPSK	826.5 - 846.5	4.4940	0.146	21.65	0.240	23.80	4M49G7W
		16QAM	826.5 - 846.5	4.5151	0.118	20.72	0.194	22.87	4M52D7W
		64QAM	826.5 - 846.5	4.5035	0.087	19.39	0.142	21.54	4M50D7W
		256QAM	826.5 - 846.5	4.5017	0.056	17.45	0.091	19.60	4M50D7W

EUT Overview

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 3 of 108

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

FCC ID: BCGA2301	 PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 4 of 108

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 22.

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

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.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 5 of 108

2.3 Antenna Description

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

Band	Antenna Gain (dBi)	
	Antenna 3	Antenna 1
GSM850	-1.9	-3.2
EDGE850		
WCDMA850		
LTE Band 5/26		
NR Band n5		

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 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.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 6 of 108

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.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 7 of 108

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

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

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.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 8 of 108

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	1.65
Radiated Disturbance (<30MHz)	4.06
Radiated Disturbance (30MHz-1GHz)	4.30
Radiated Disturbance (1-18GHz)	4.78
Radiated Disturbance (>18GHz)	4.79

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
		Page 9 of 108

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.

FCC ID: BCGA2301	 PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 10 of 108

6.0 SAMPLE CALCULATIONS

GSM Emission Designator

Emission Designator = 250KGXW

GSM BW = 250 kHz

G = Phase Modulation

X = Cases not otherwise covered

W = Combination (Audio/Data)

EDGE Emission Designator

Emission Designator = 250KG7W

EDGE BW = 250 kHz

G = Phase Modulation

7 = Quantized/Digital Info

W = Combination (Audio/Data)

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

LTE 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.

FCC ID: BCGA2301	 PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 11 of 108

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCGA2301
 FCC Classification: PCS Licensed Transmitter (PCB)
 Mode(s): GSM/GPRS/WCDMA/NR/LTE

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, 22.917(a)	> 43 + 10log ₁₀ (P[Watts]) at Band Edge and for all out-of-band emissions	PASS	Sections 7.3, 7.4
	Transmitter Conducted Output Power	2.1046	N/A	N/A	See RF Exposure Report
	Effective Radiated Power / Equivalent Isotropic Radiated Power	22.913(a)(5)	< 7 Watts max. ERP	PASS	Section 7.5
	Frequency Tolerance	2.1055, 22.355	the frequency stability of the transmitter shall be maintained within ±0.00025% (±2.5 ppm) of the center frequency	PASS	Section 7.7
RADIATED	Radiated Spurious Emissions	2.1053, 22.917(a)	> 43 + 10 log ₁₀ (P[Watts]) for all out-of-band emissions	PASS	Section 7.6

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 are PCTEST 2G/3G Automation Version 4.5 and LTE Automation Version 5.3.

FCC ID: BCGA2301	 PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 12 of 108

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.

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 $\geq 3 \times$ 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.

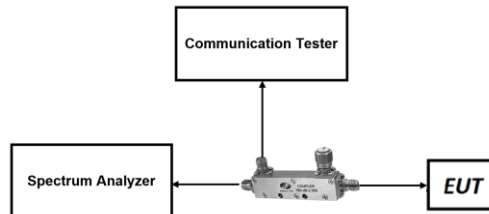


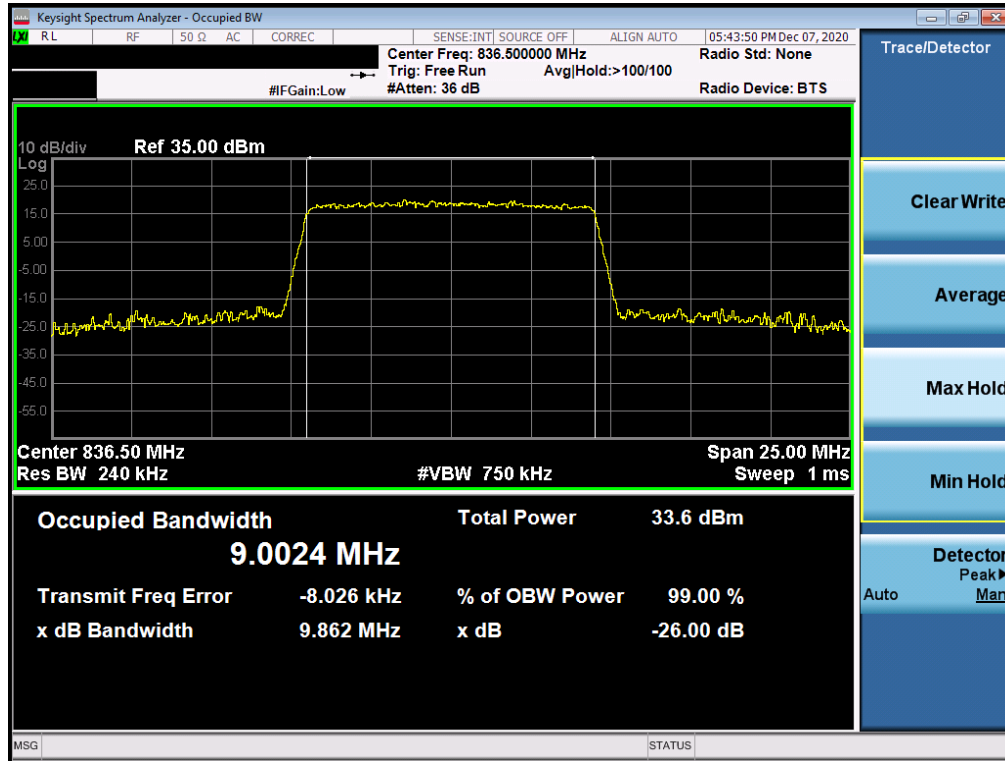
Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 13 of 108

LTE Band 26/5

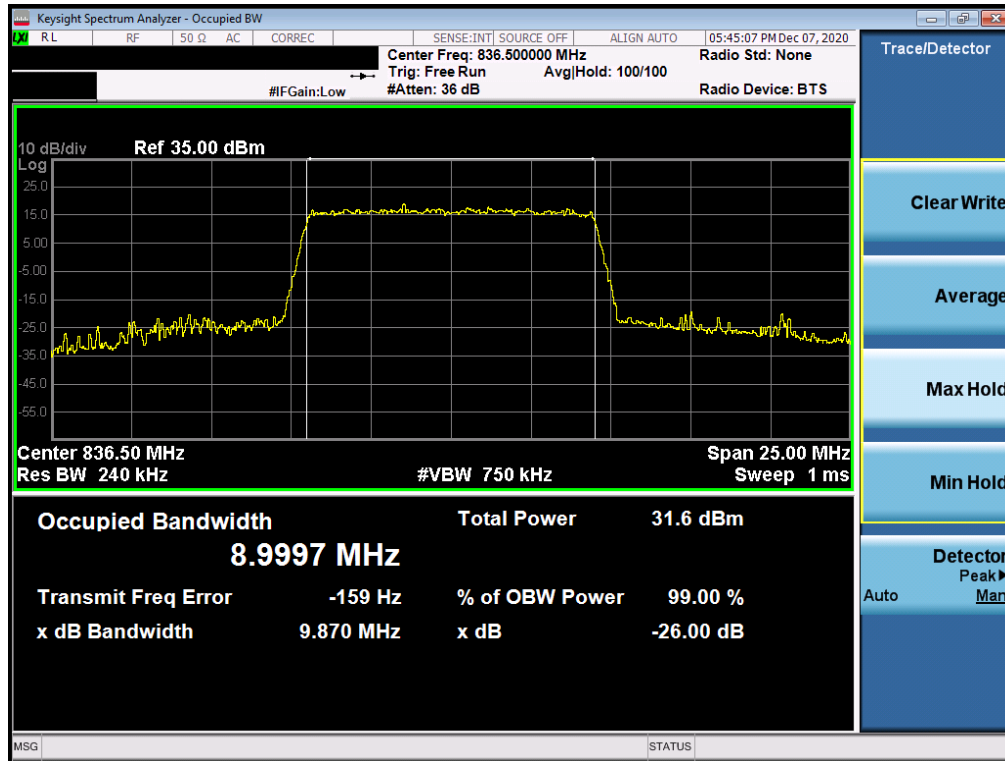


Plot 7-1. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz QPSK - Full RB Configuration)

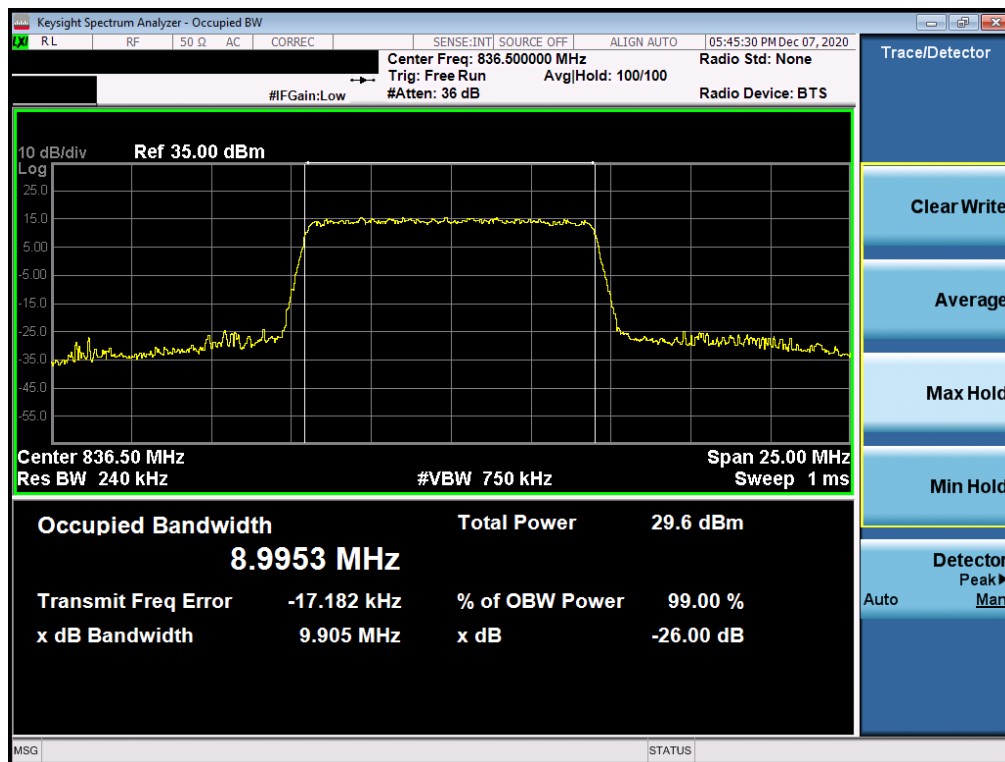


Plot 7-2. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 14 of 108

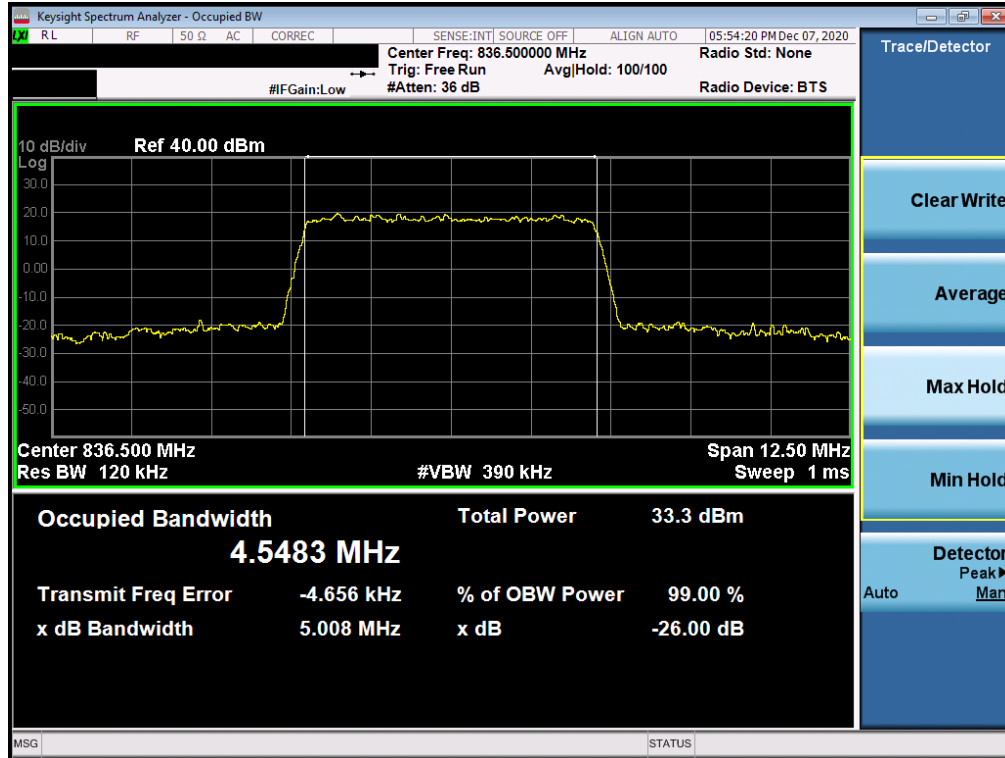


Plot 7-3. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 64-QAM - Full RB Configuration)

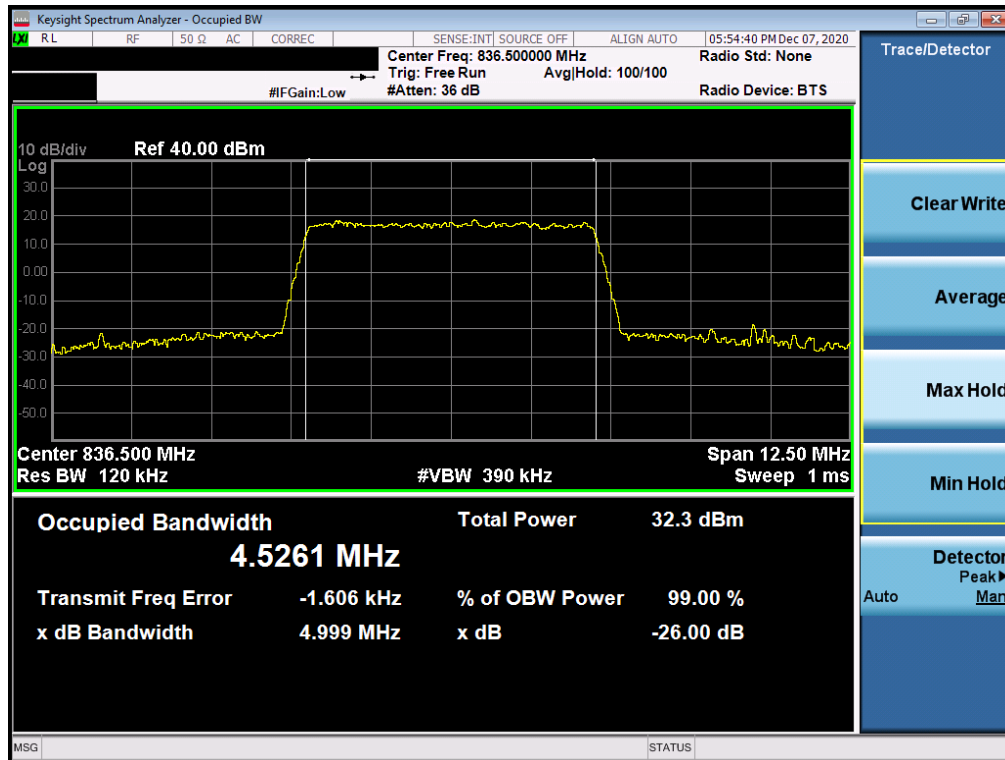


Plot 7-4. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 15 of 108

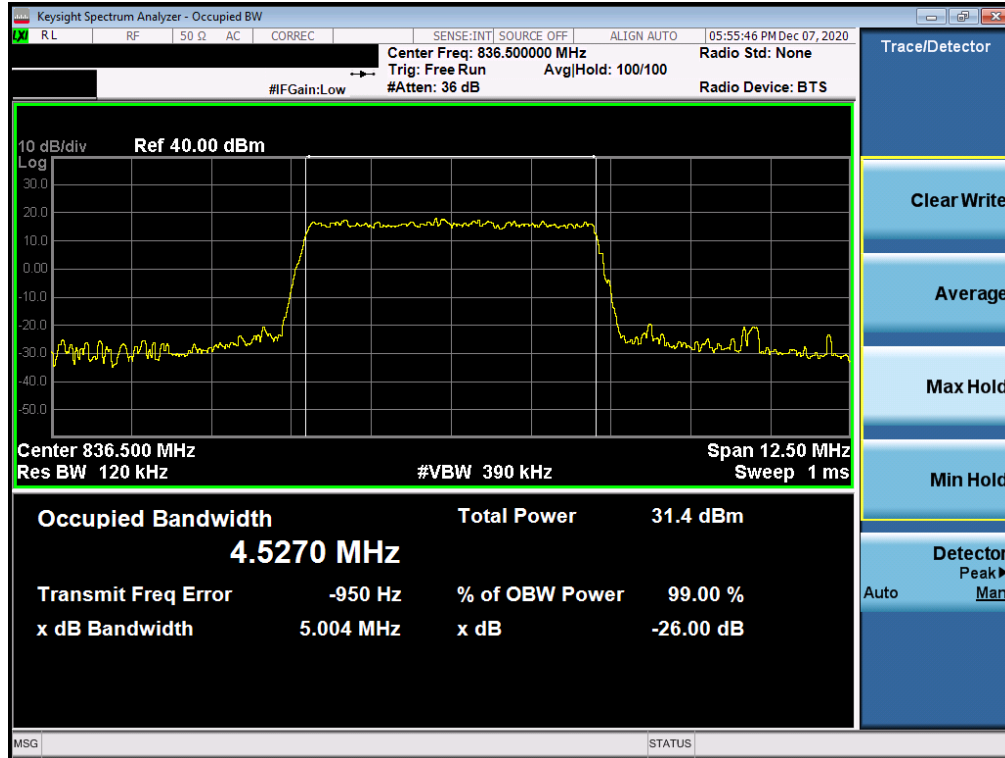


Plot 7-5. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz QPSK - Full RB Configuration)

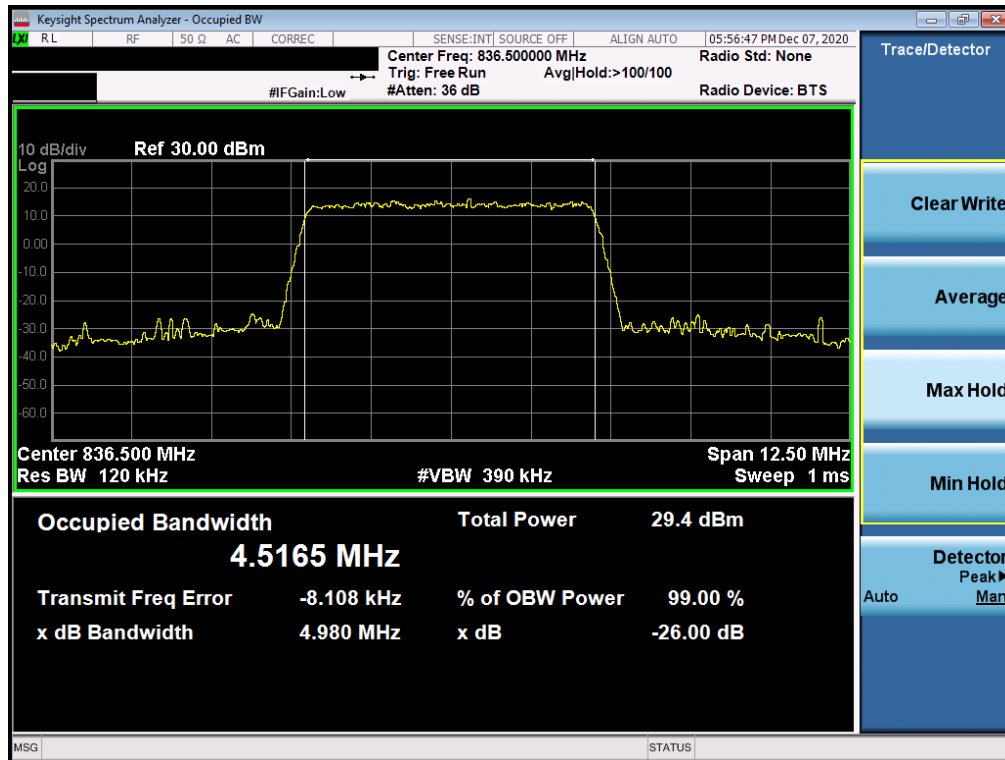


Plot 7-6. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 16 of 108

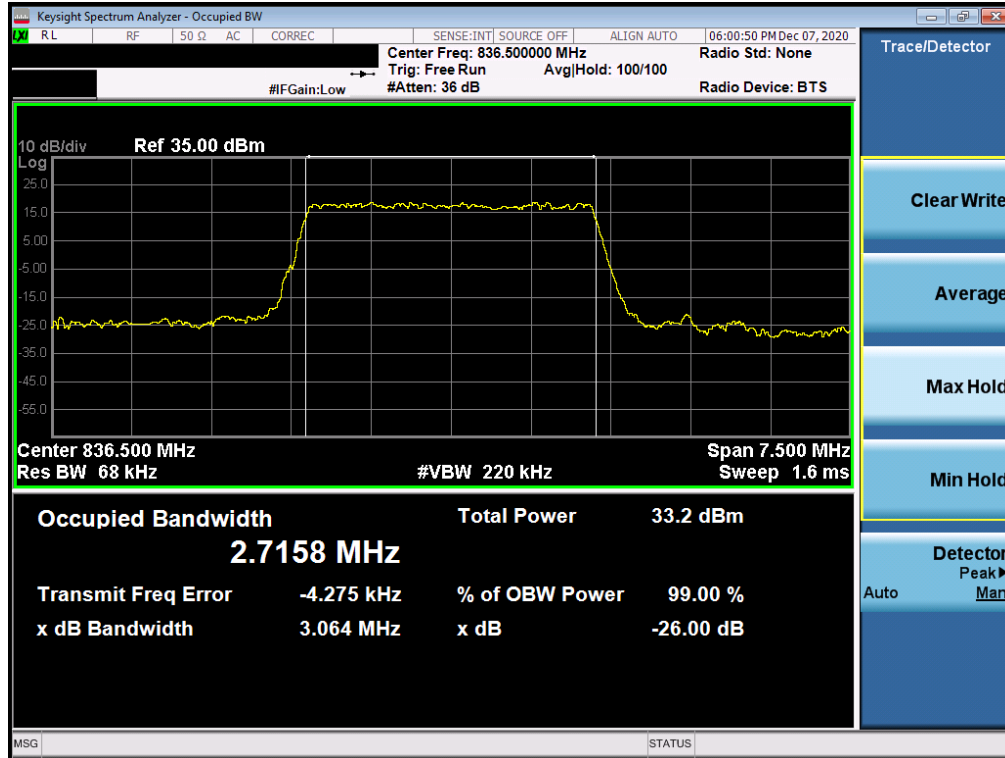


Plot 7-7. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 64-QAM - Full RB Configuration)

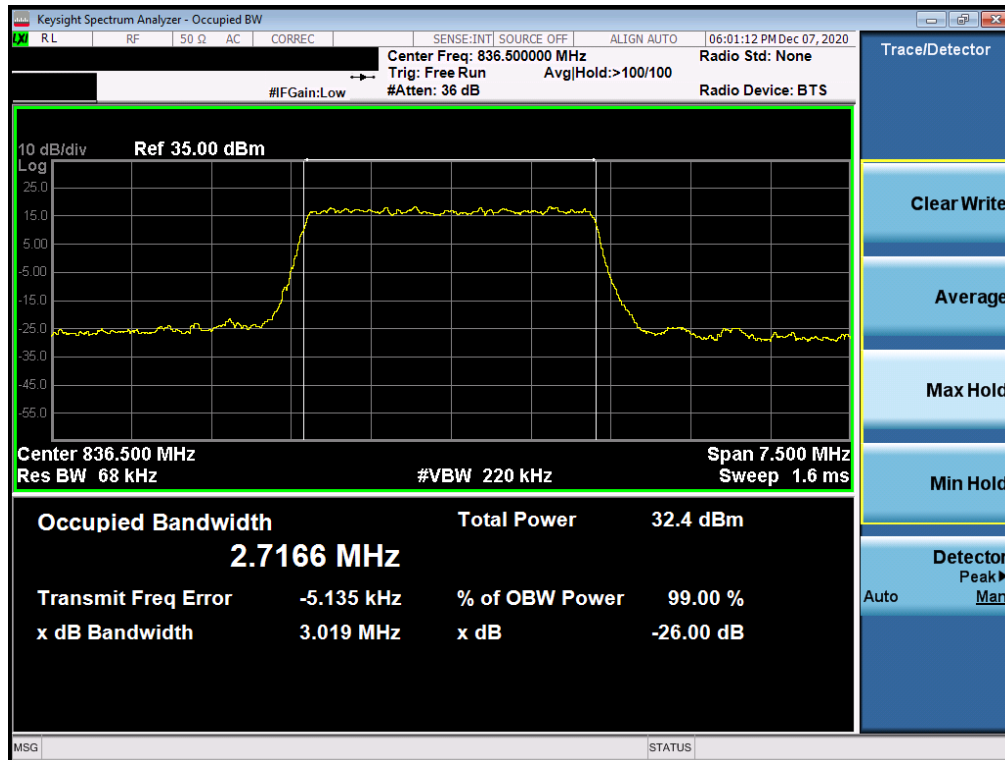


Plot 7-8. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 17 of 108

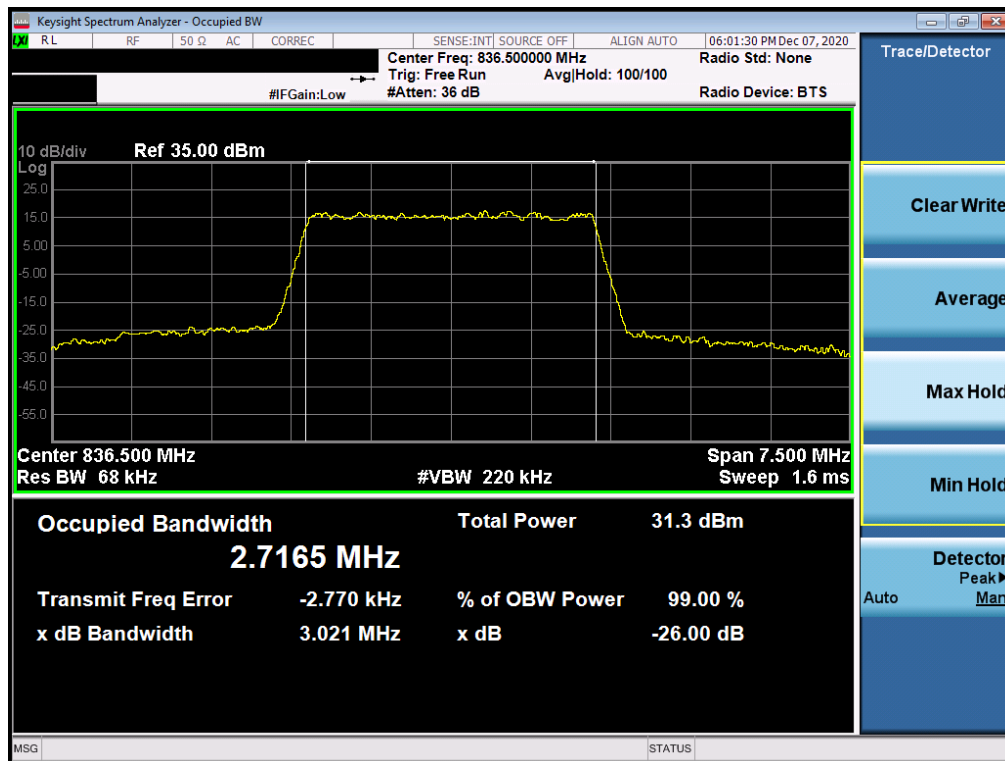


Plot 7-9. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz QPSK - Full RB Configuration)

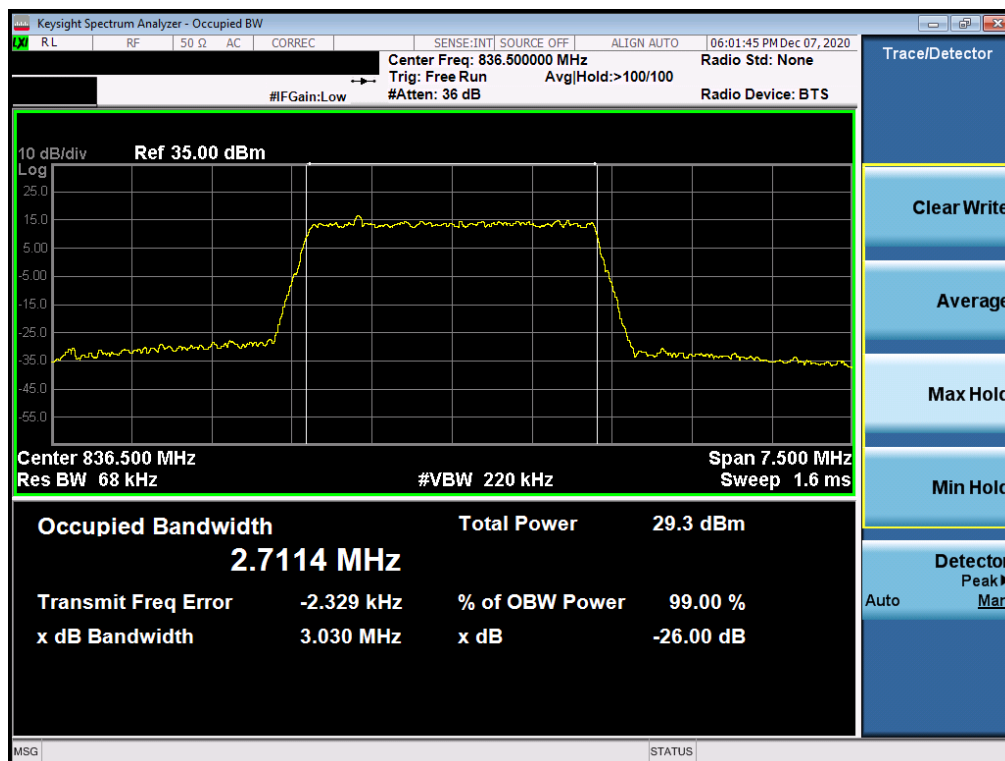


Plot 7-10. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 18 of 108

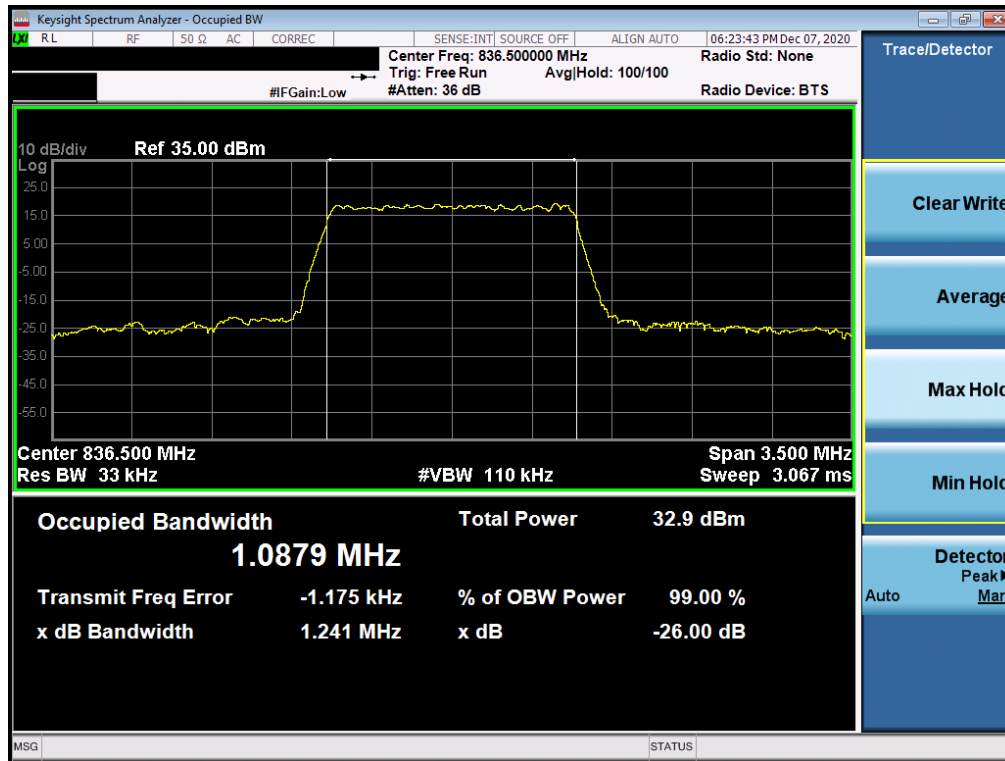


Plot 7-11. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 64-QAM - Full RB Configuration)

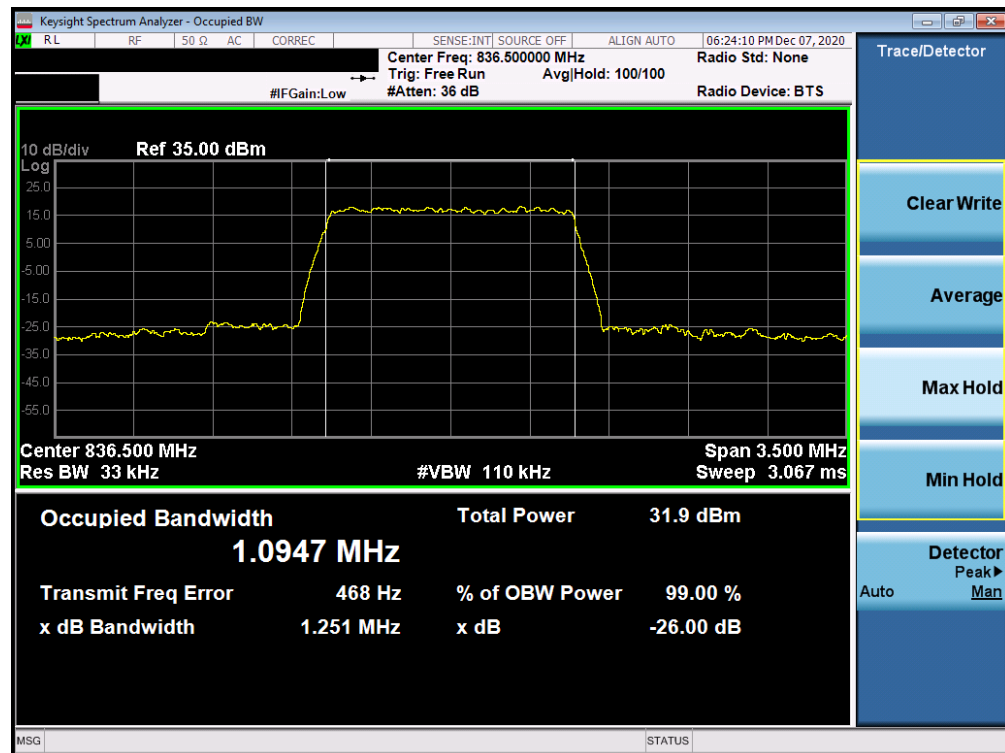


Plot 7-12. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 19 of 108

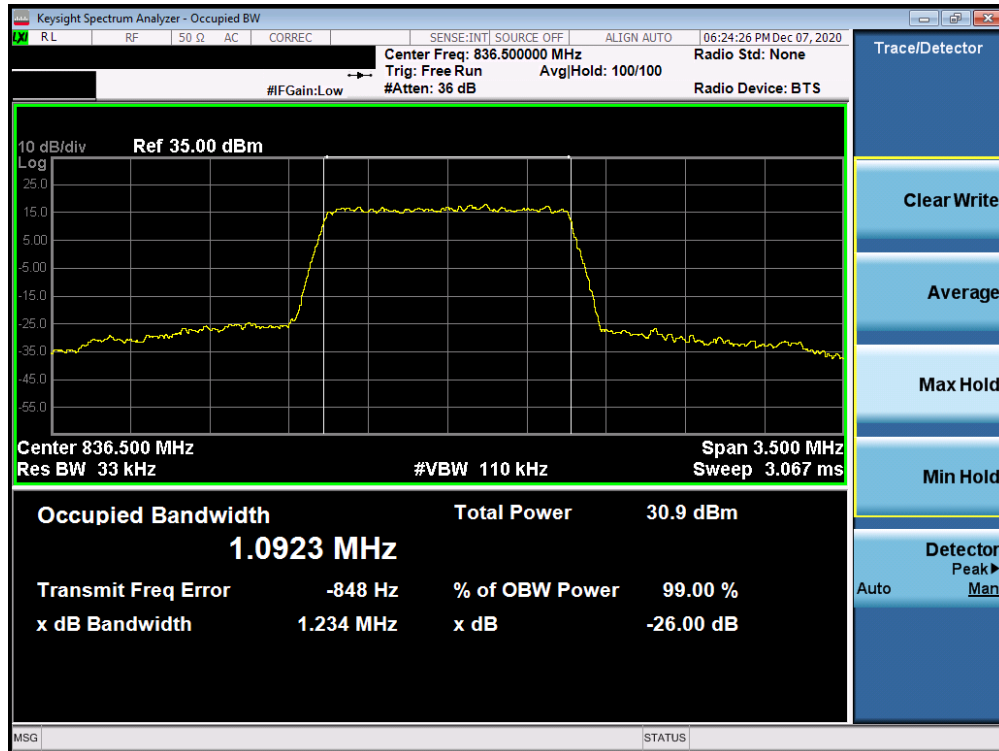


Plot 7-13. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz QPSK - Full RB Configuration)

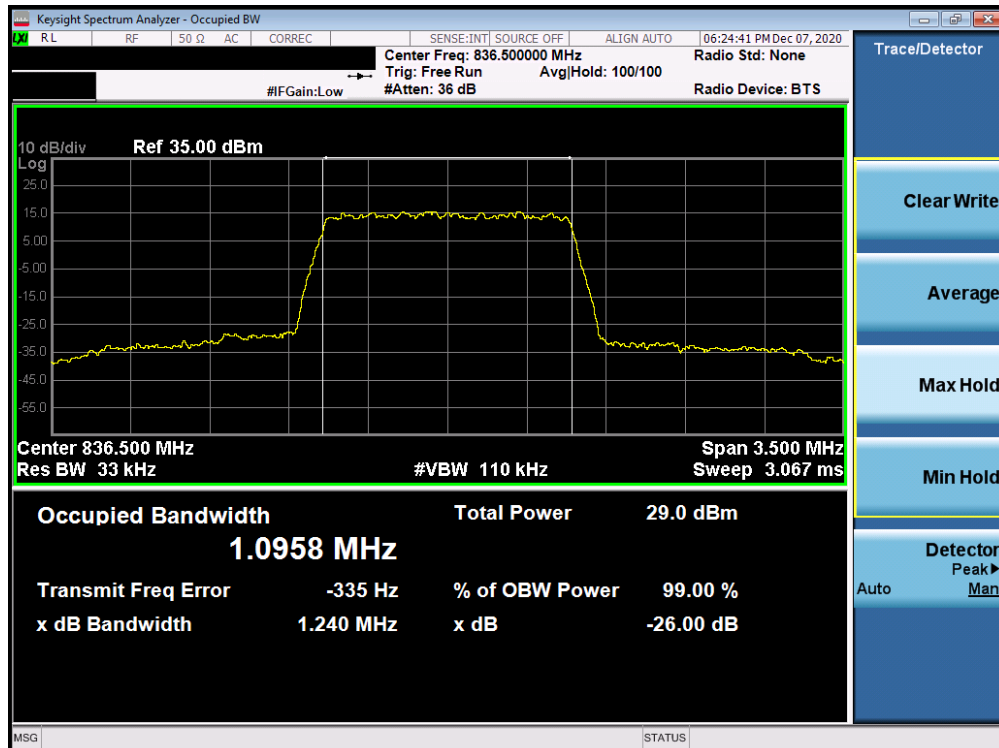


Plot 7-14. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 20 of 108



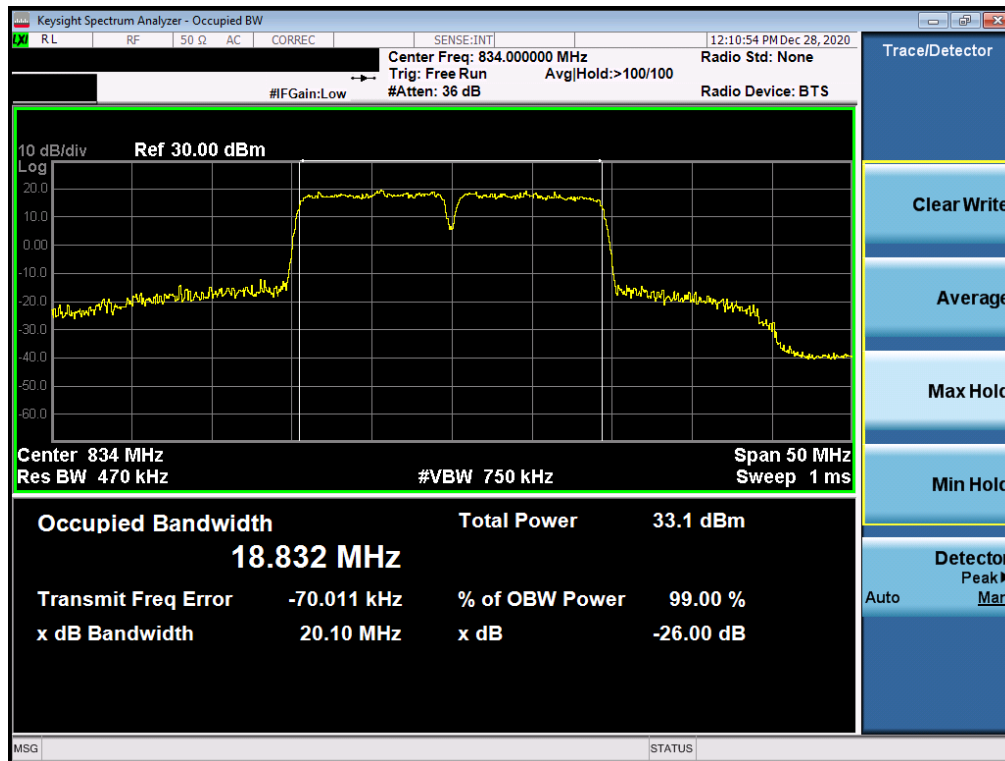
Plot 7-15. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 64-QAM - Full RB Configuration)



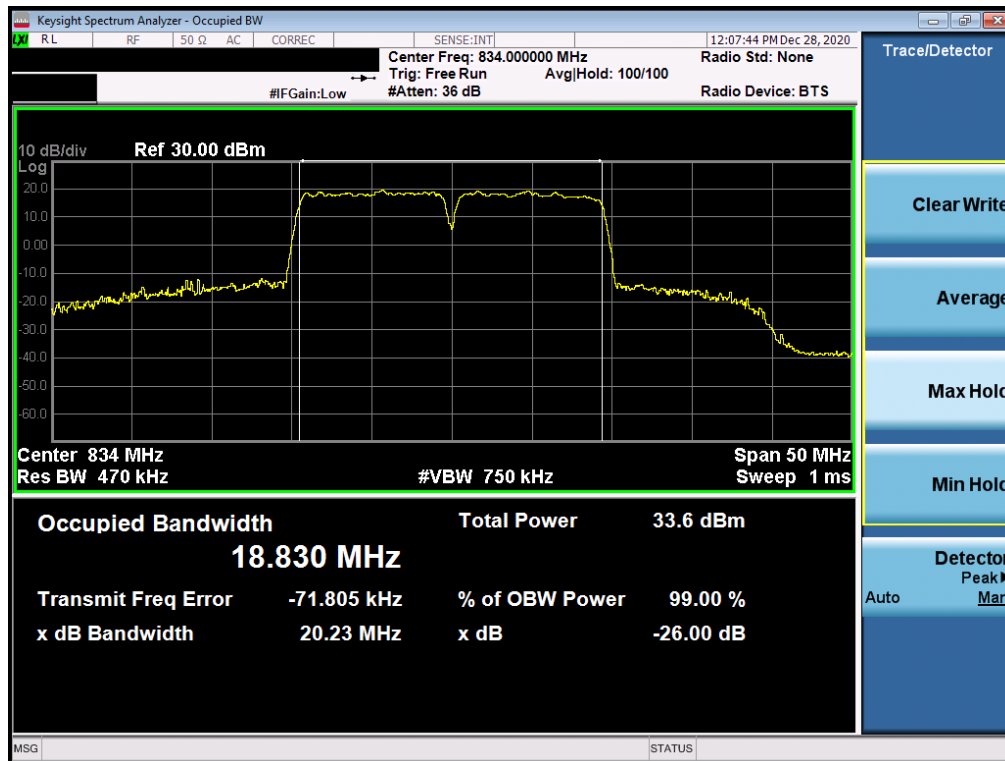
Plot 7-16. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 21 of 108

ULCA - LTE Band 5

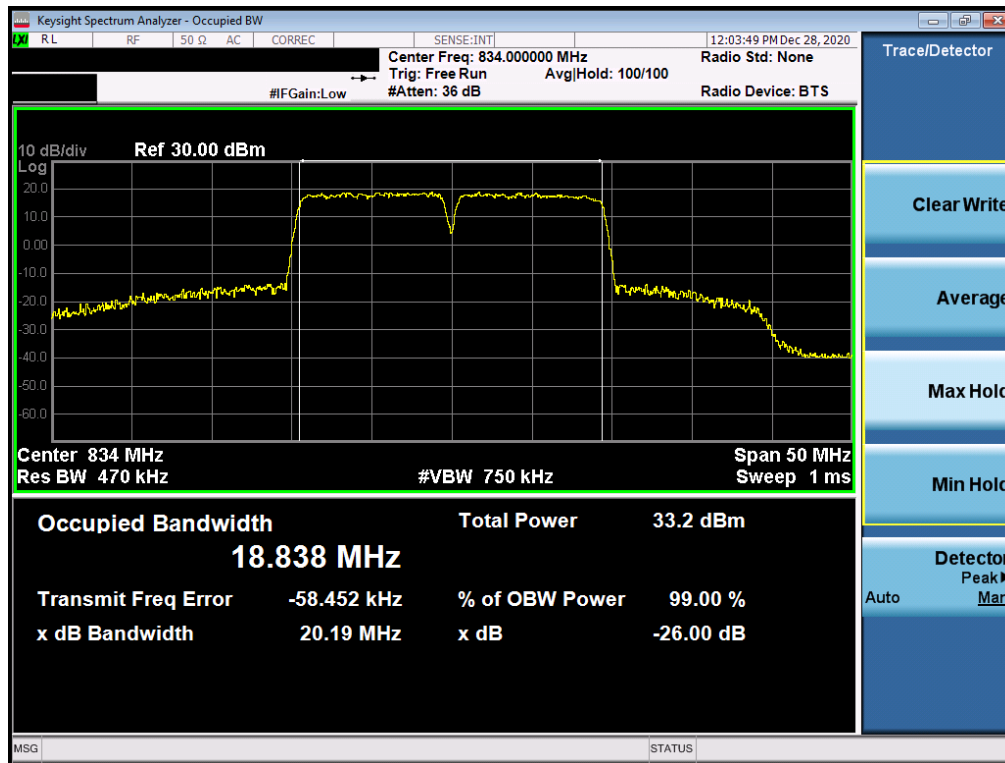


Plot 7-17. Occupied Bandwidth Plot (ULCA - LTE Band 5 - (10 + 10)MHz QPSK - Full RB Configuration)

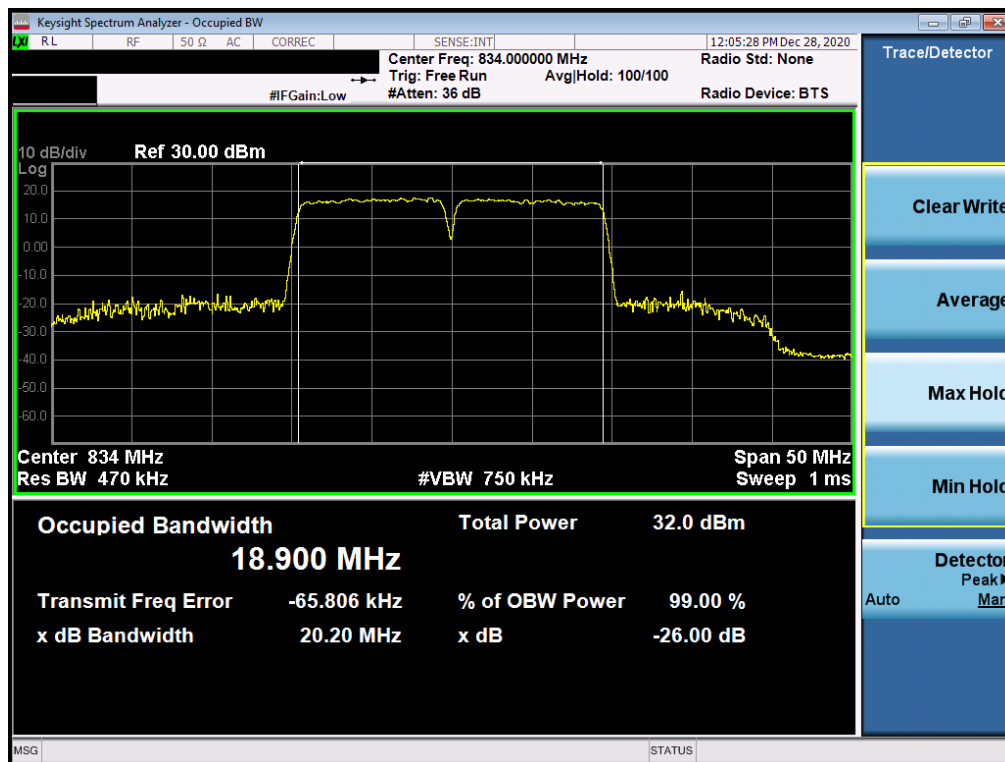


Plot 7-18. Occupied Bandwidth Plot (ULCA - LTE Band 5 - (10 + 10)MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 22 of 108



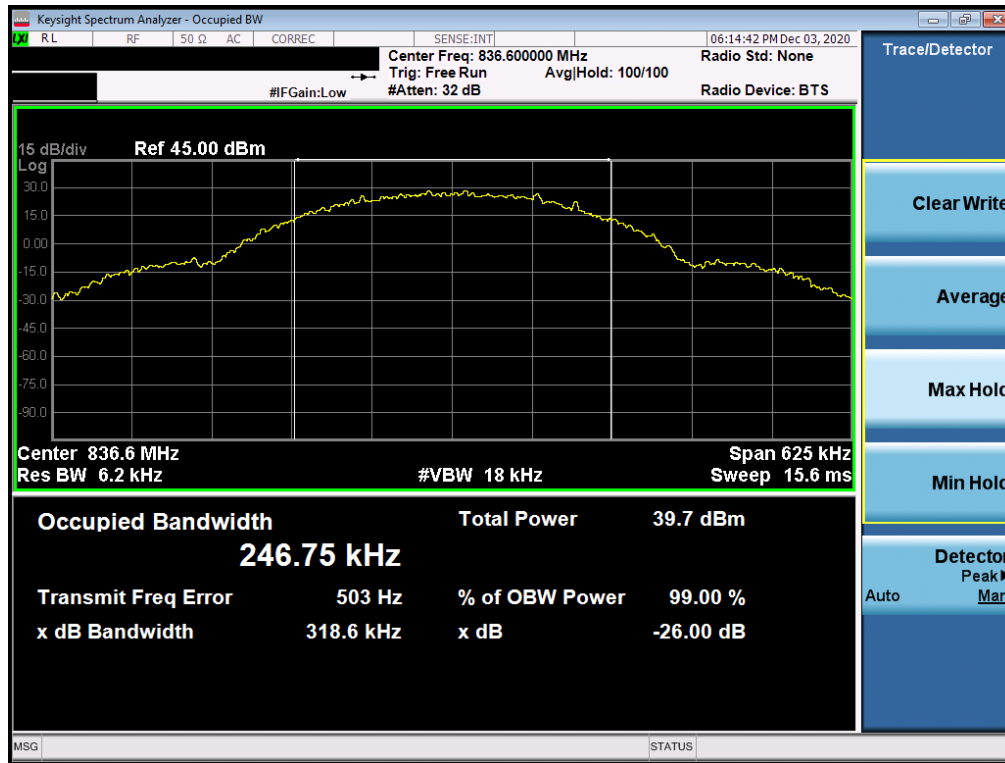
Plot 7-19. Occupied Bandwidth Plot (ULCA - LTE Band 5 - (10 + 10)MHz 64-QAM - Full RB Configuration)



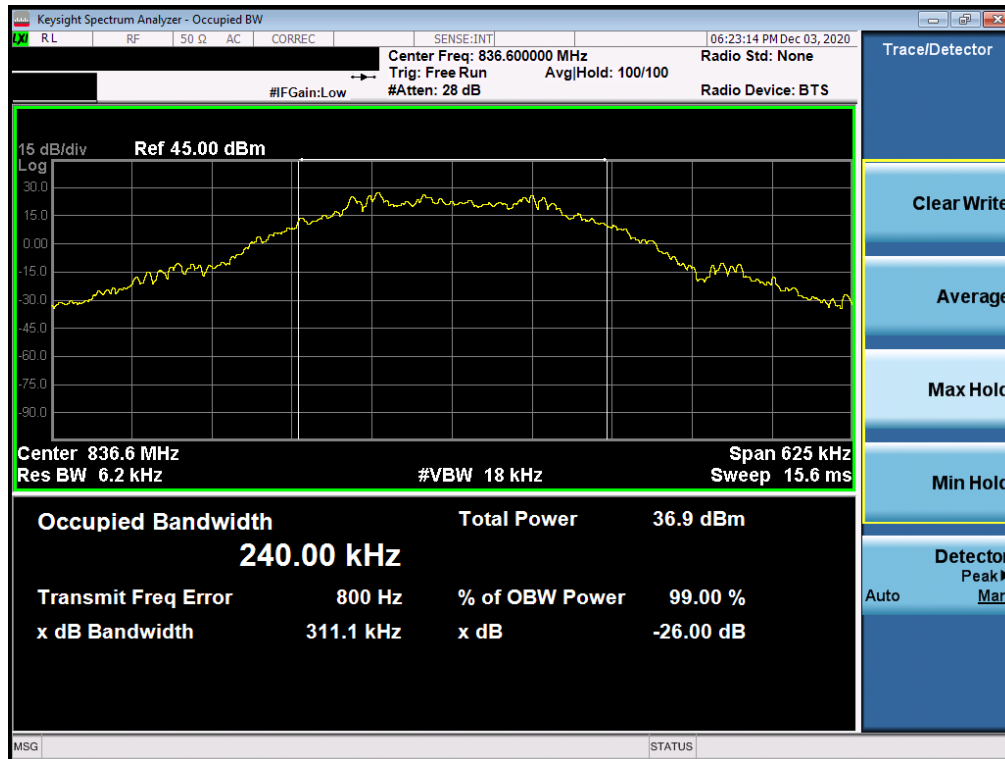
Plot 7-20. Occupied Bandwidth Plot (ULCA - LTE Band 5 - (10 + 10)MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 23 of 108

GPRS Cell



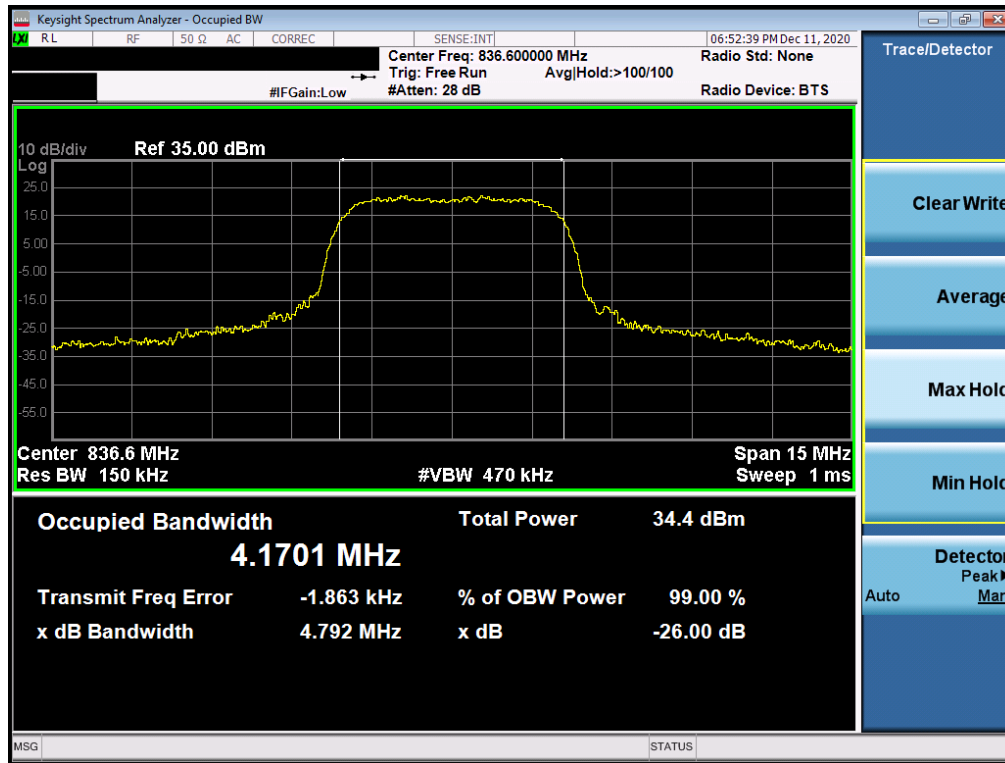
Plot 7-21. Occupied Bandwidth Plot (GPRS, Ch. 190)



Plot 7-22. Occupied Bandwidth Plot (EDGE, Ch. 190)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 24 of 108

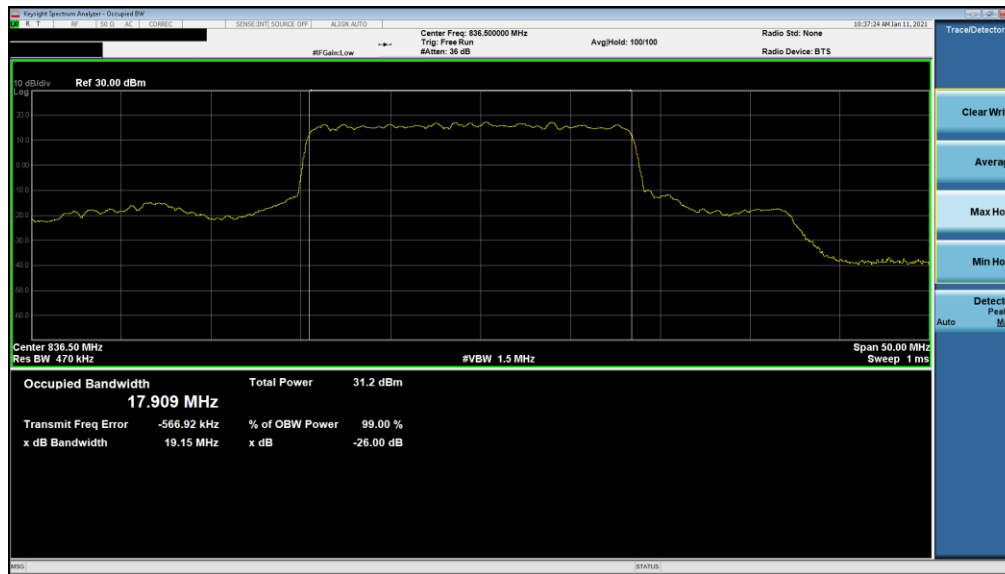
WCDMA Cell



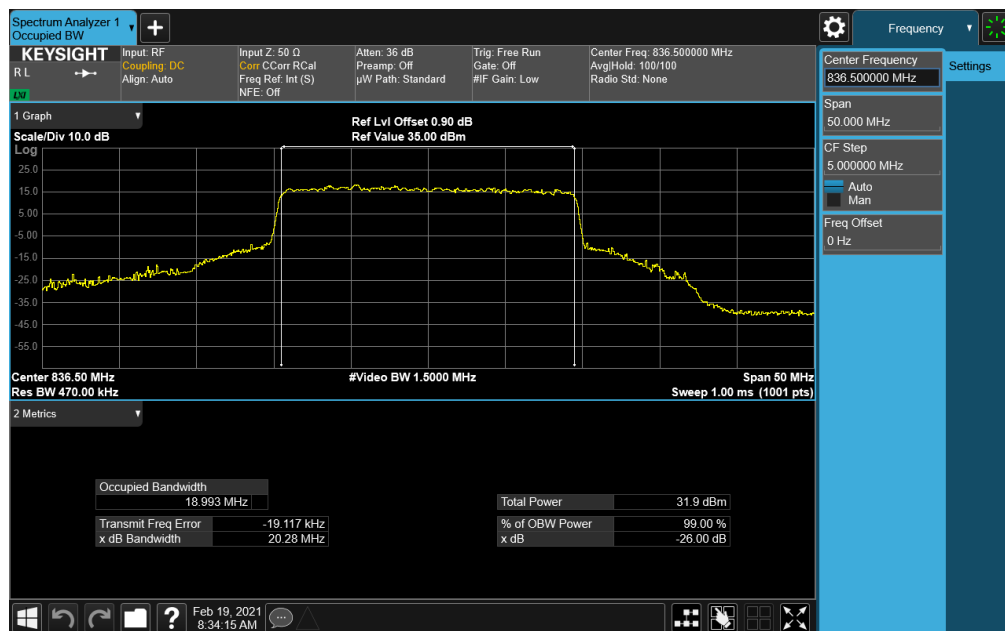
Plot 7-23. Occupied Bandwidth Plot (WCDMA, Ch. 4183)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 25 of 108

NR Band n5

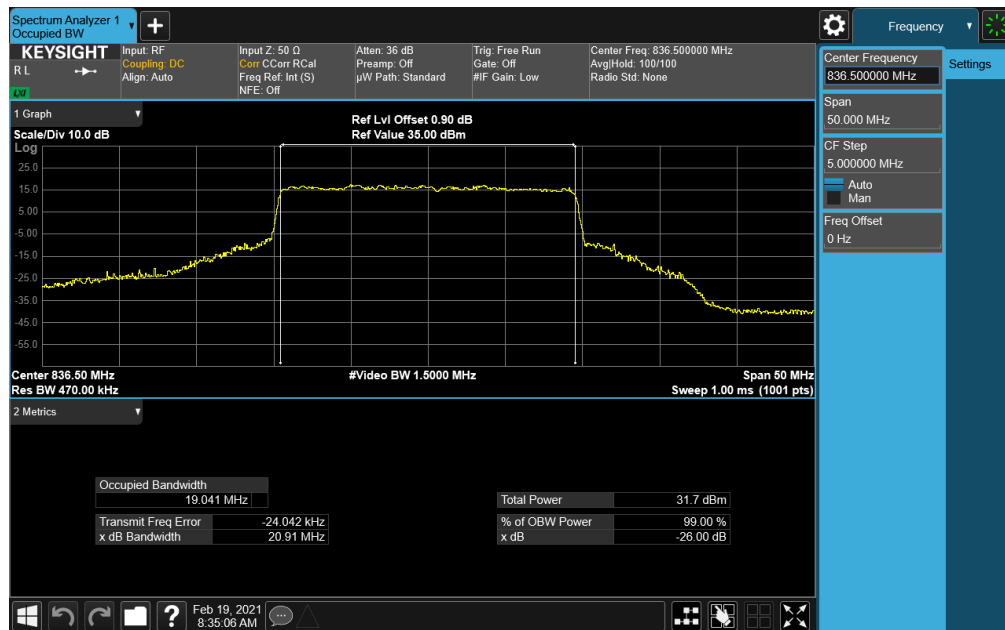


Plot 7-24. Occupied Bandwidth Plot (NR Band n5 - 20MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB Configuration)

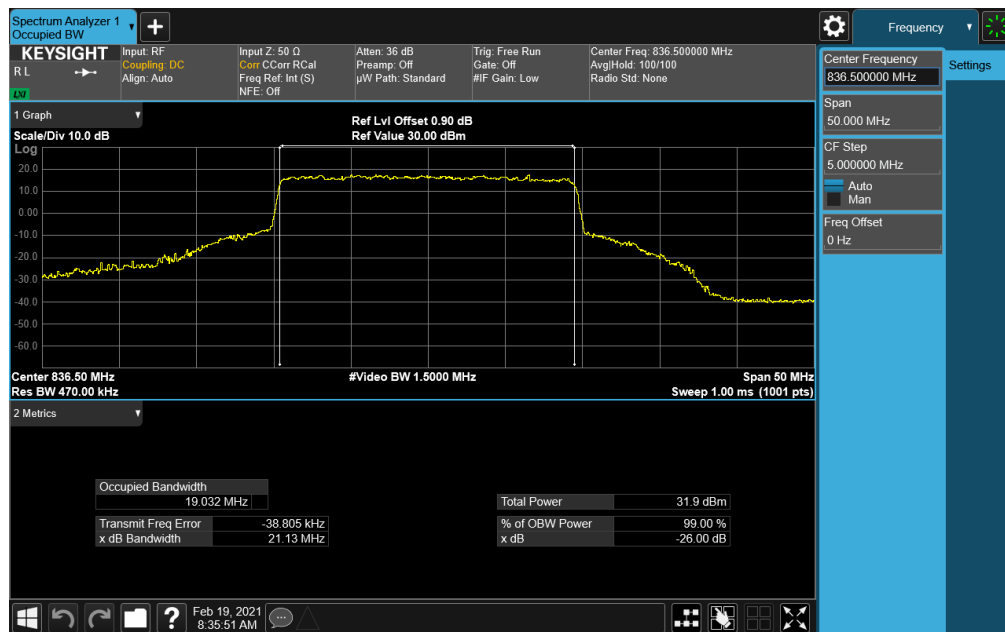


Plot 7-25. Occupied Bandwidth Plot (NR Band n5 - 20MHz CP-OFDM QPSK - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 26 of 108

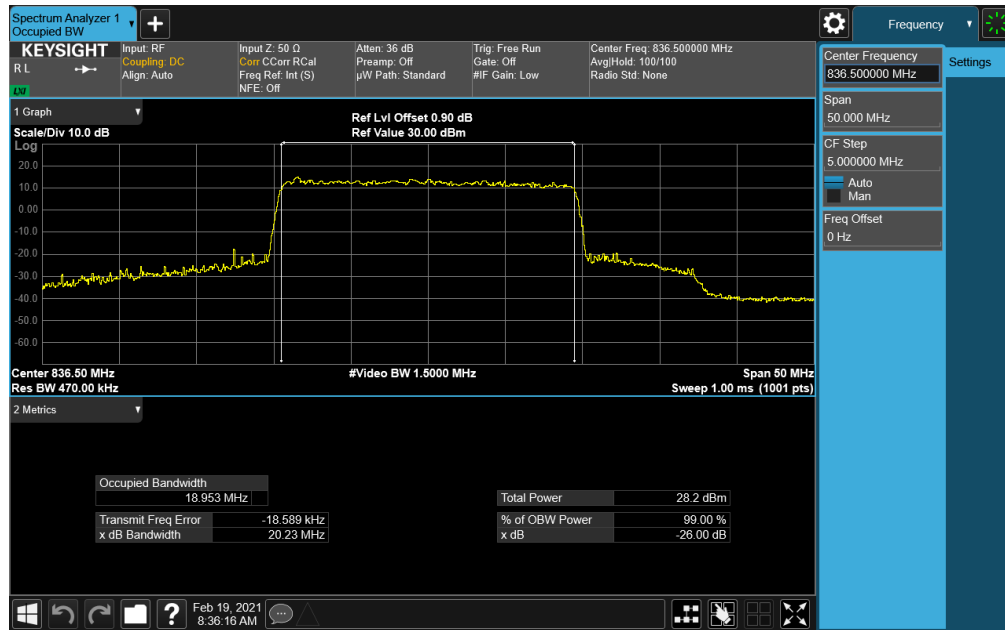


Plot 7-26. Occupied Bandwidth Plot (NR Band n5 - 20MHz CP-OFDM 16-QAM - Full RB Configuration)

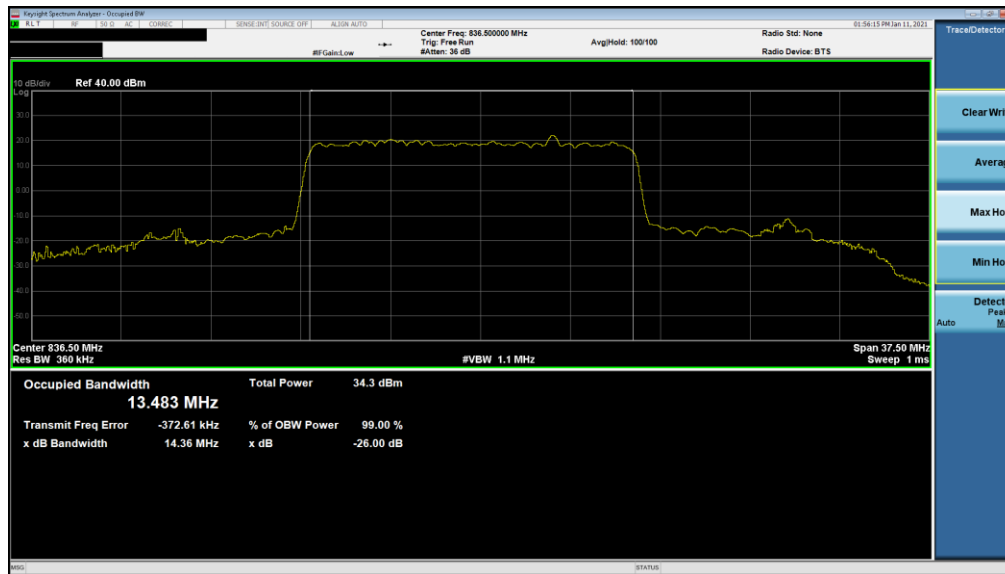


Plot 7-27. Occupied Bandwidth Plot (NR Band n5 - 20MHz CP-OFDM 64-QAM - Full RB Configuration)

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 27 of 108



Plot 7-28. Occupied Bandwidth Plot (NR Band n5 - 20MHz CP-OFDM 256-QAM - Full RB Configuration)

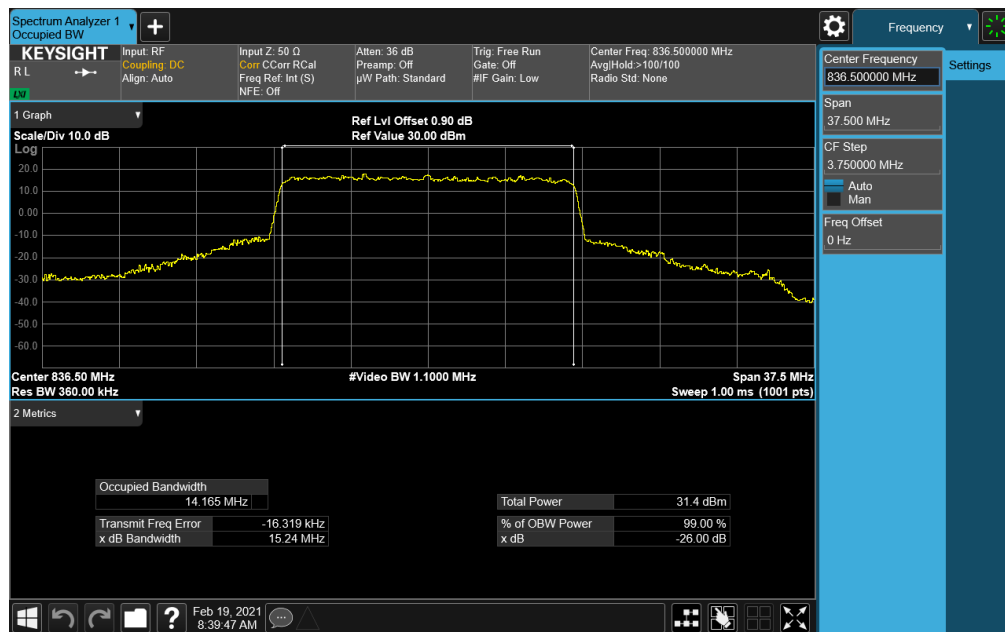


Plot 7-29. Occupied Bandwidth Plot (NR Band n5 - 15MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 28 of 108

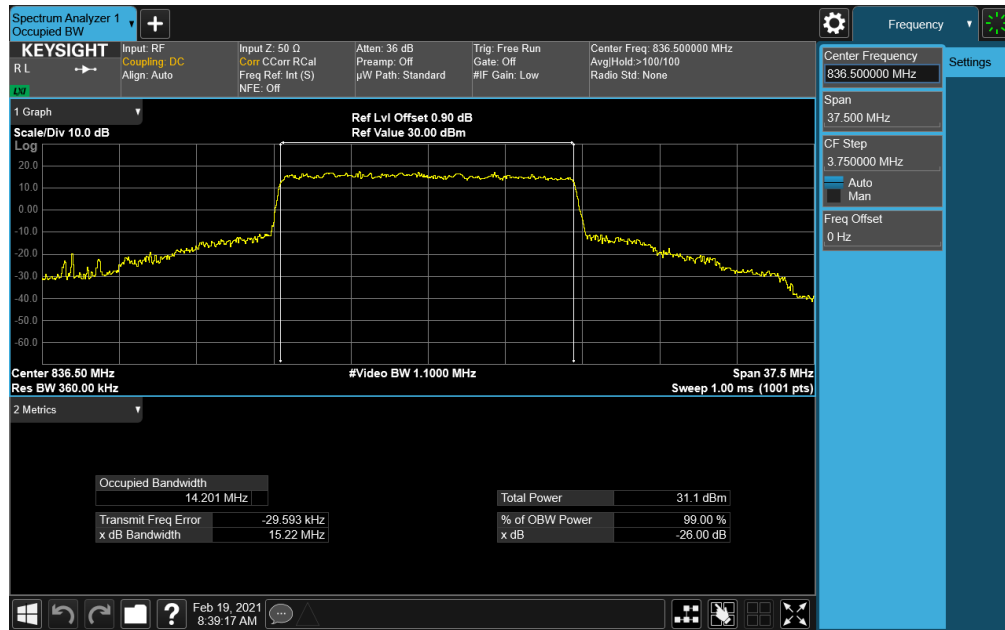


Plot 7-30. Occupied Bandwidth Plot (NR Band n5 - 15MHz CP-OFDM QPSK - Full RB Configuration)

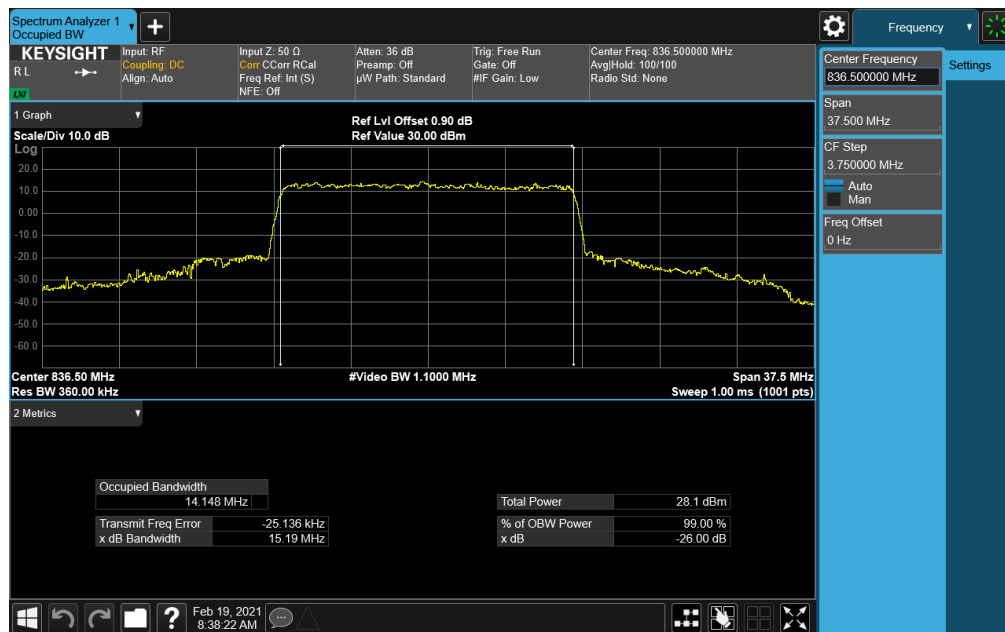


Plot 7-31. Occupied Bandwidth Plot (NR Band n5 - 15MHz CP-OFDM 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 29 of 108

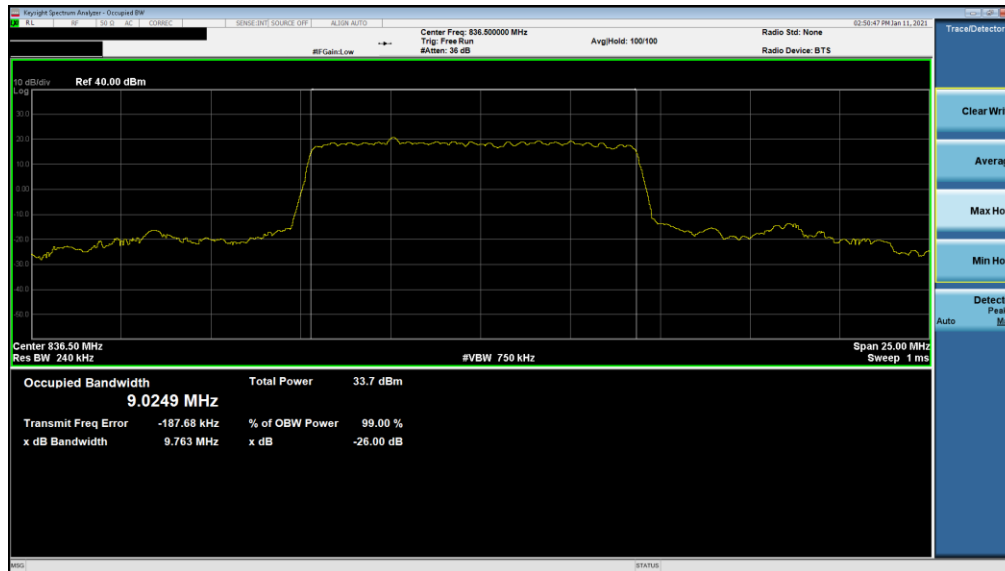


Plot 7-32. Occupied Bandwidth Plot (NR Band n5 - 15MHz CP-OFDM 64-QAM - Full RB Configuration)

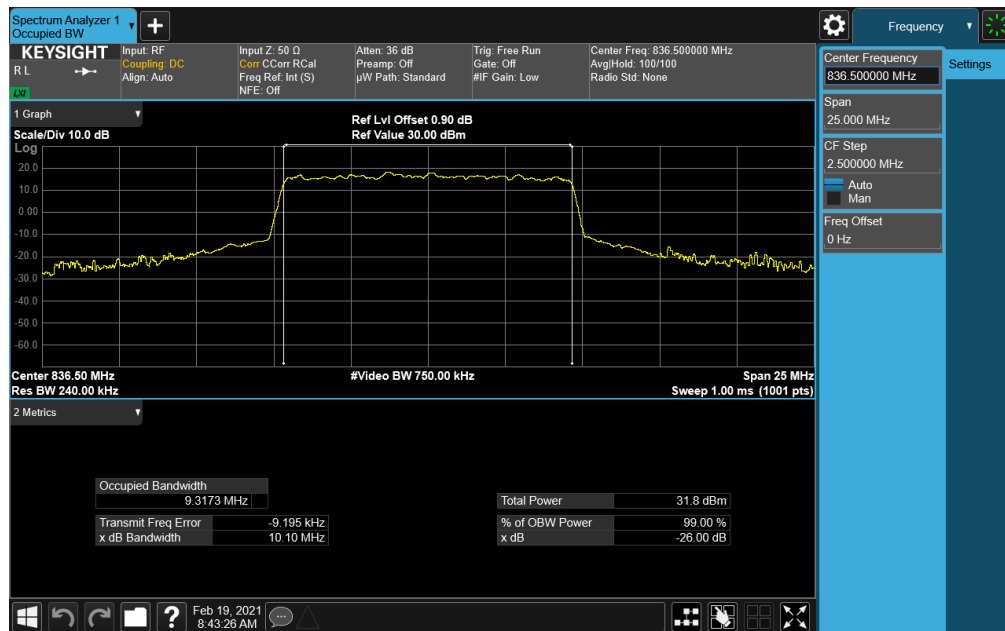


Plot 7-33. Occupied Bandwidth Plot (NR Band n5 - 15MHz CP-OFDM 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 30 of 108

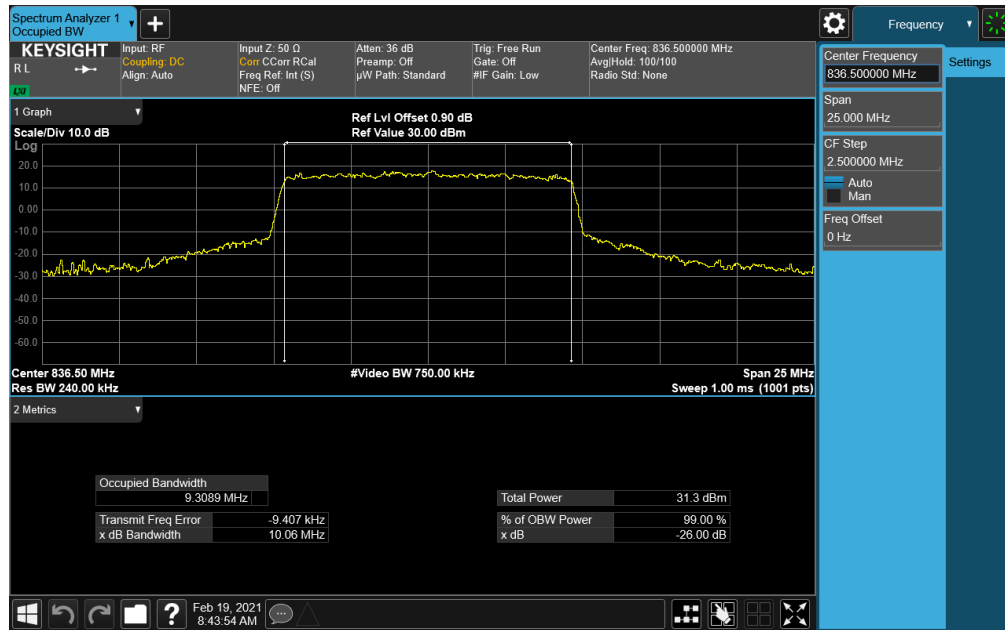


Plot 7-34. Occupied Bandwidth Plot (NR Band n5 - 10MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB Configuration)

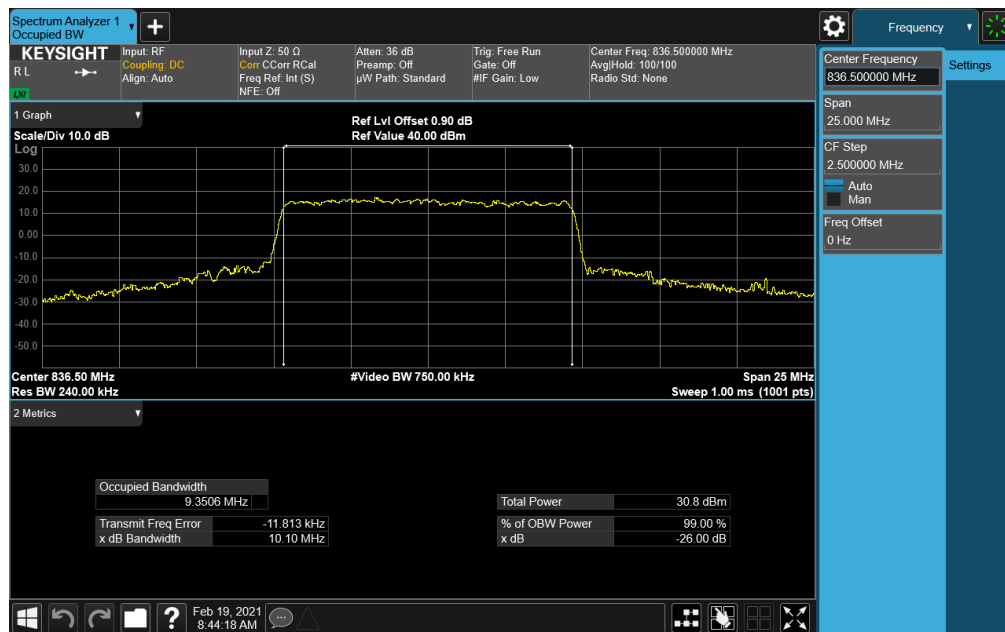


Plot 7-35. Occupied Bandwidth Plot (NR Band n5 - 10MHz CP-OFDM QPSK - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 31 of 108



Plot 7-36. Occupied Bandwidth Plot (NR Band n5 - 10MHz CP-OFDM 16-QAM - Full RB Configuration)

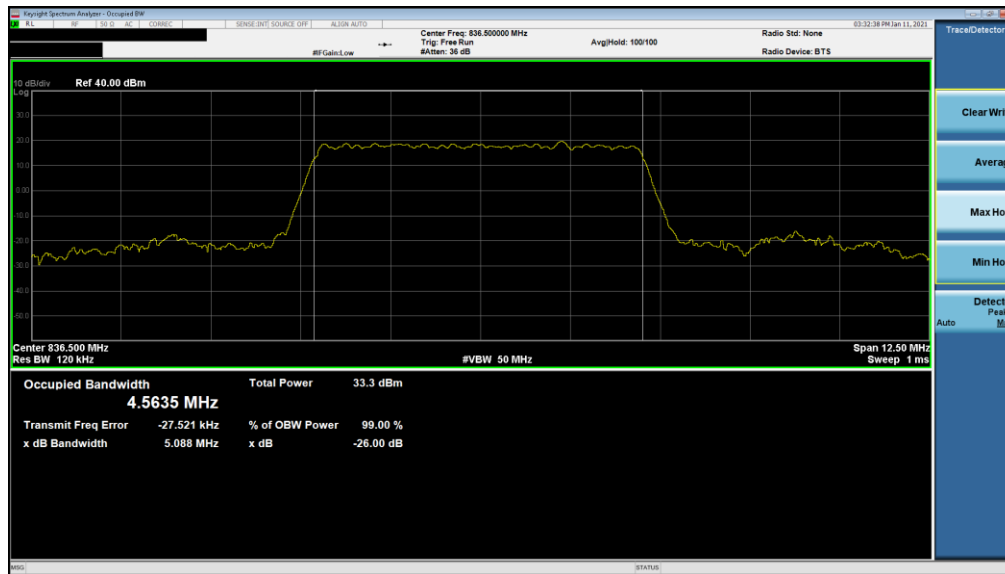


Plot 7-37. Occupied Bandwidth Plot (NR Band n5 - 10MHz CP-OFDM 64-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 32 of 108

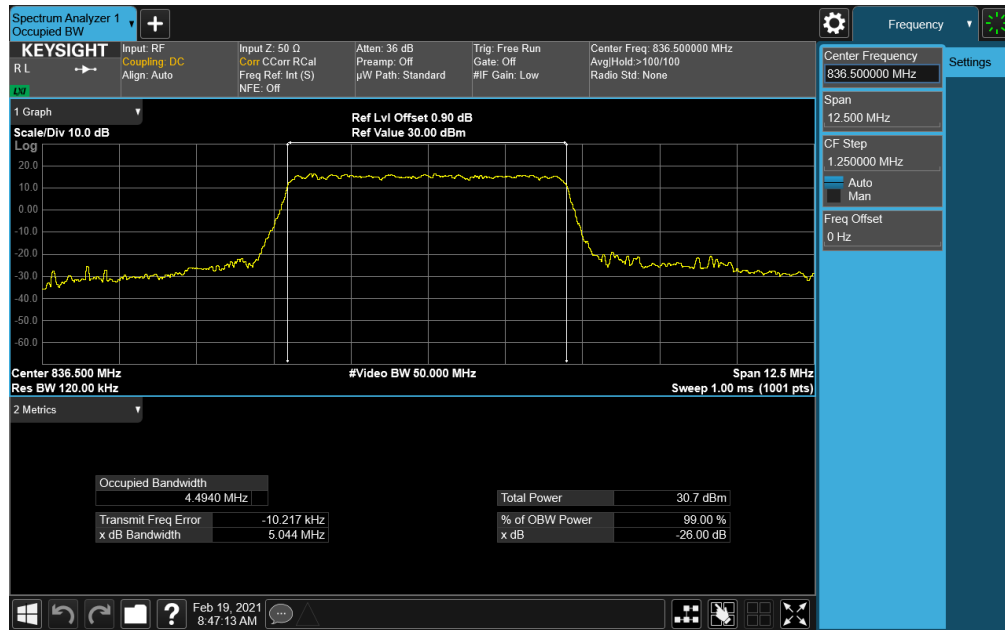


Plot 7-38. Occupied Bandwidth Plot (NR Band n5 - 10MHz CP-OFDM 256-QAM - Full RB Configuration)

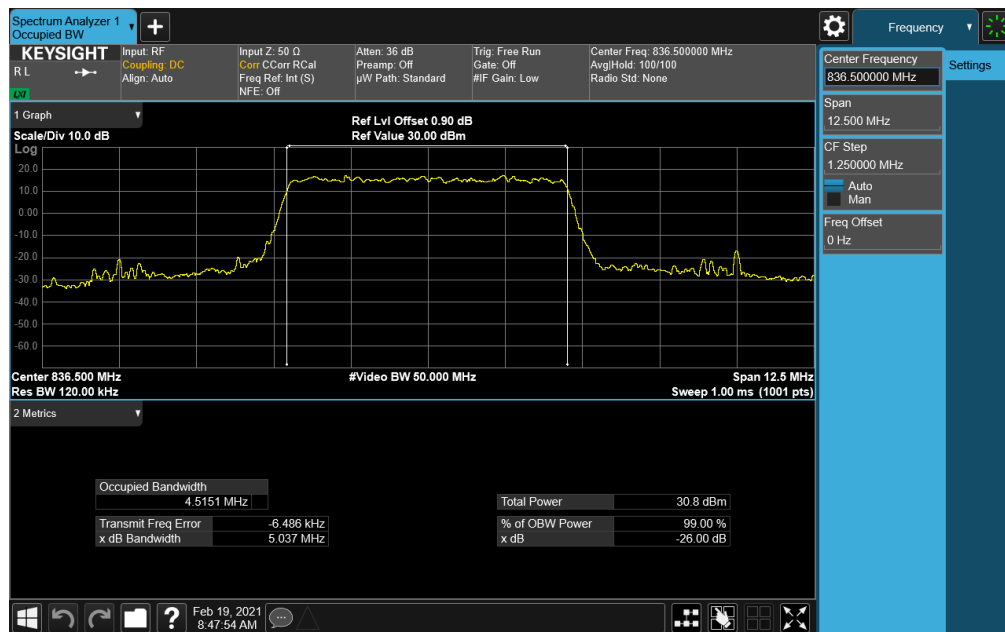


Plot 7-39. Occupied Bandwidth Plot (NR Band n5 - 5MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 33 of 108

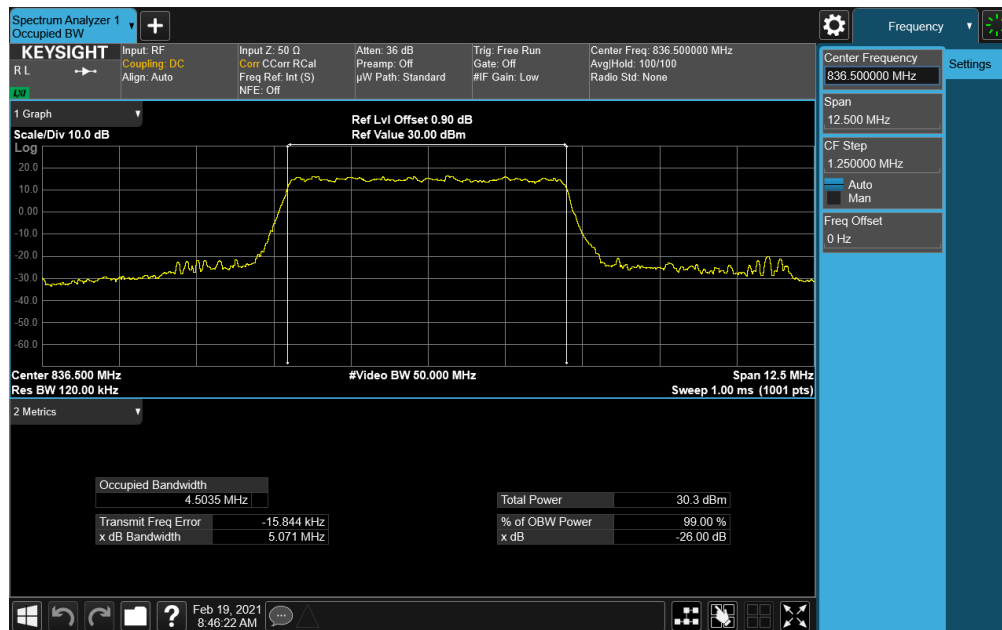


Plot 7-40. Occupied Bandwidth Plot (NR Band n5 - 5MHz CP-OFDM QPSK - Full RB Configuration)

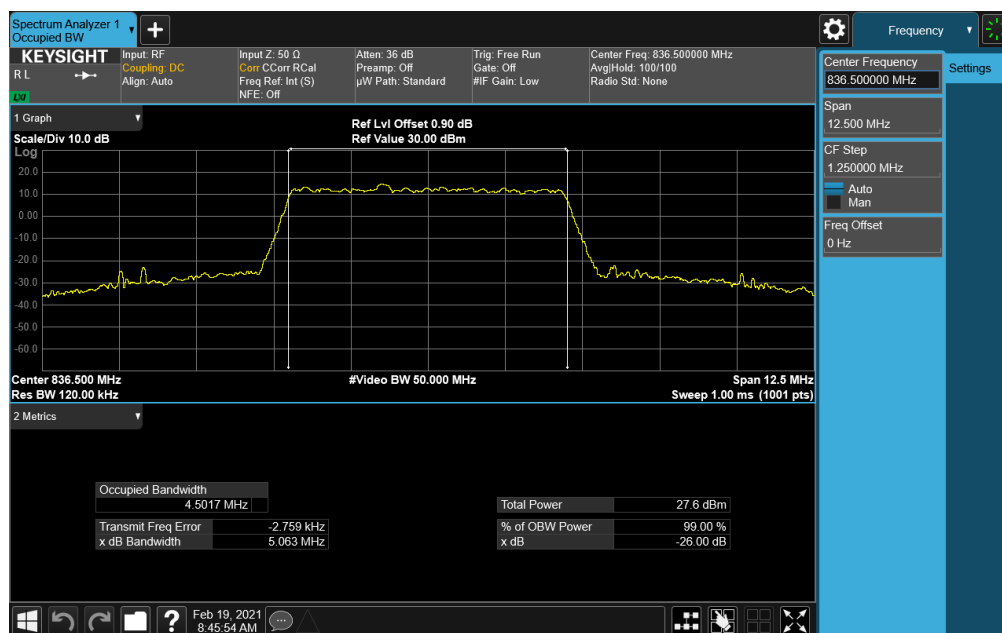


Plot 7-41. Occupied Bandwidth Plot (NR Band n5 - 5MHz CP-OFDM 16-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 34 of 108



Plot 7-42. Occupied Bandwidth Plot (NR Band n5 - 5MHz CP-OFDM 64-QAM - Full RB Configuration)



Plot 7-43. Occupied Bandwidth Plot (NR Band n5 - 5MHz CP-OFDM 256-QAM - Full RB Configuration)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 35 of 108

7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051, 22.917(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.

The minimum permissible attenuation level of any spurious emission is $43 + 10 \log_{10}(P_{\text{Watts}})$, 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 10GHz (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.

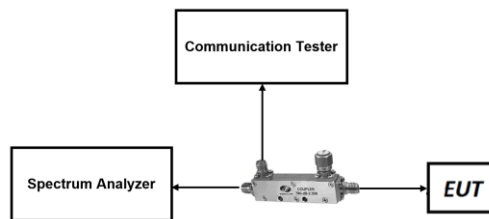


Figure 7-2. Test Instrument & Measurement Setup

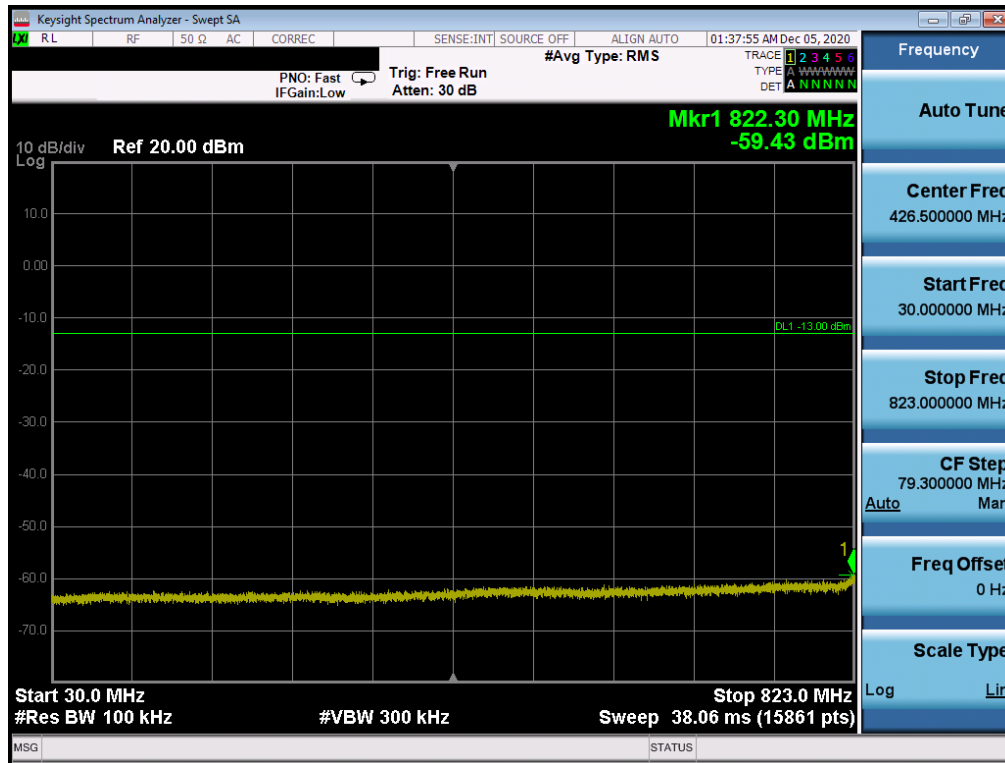
FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 36 of 108

Test Notes

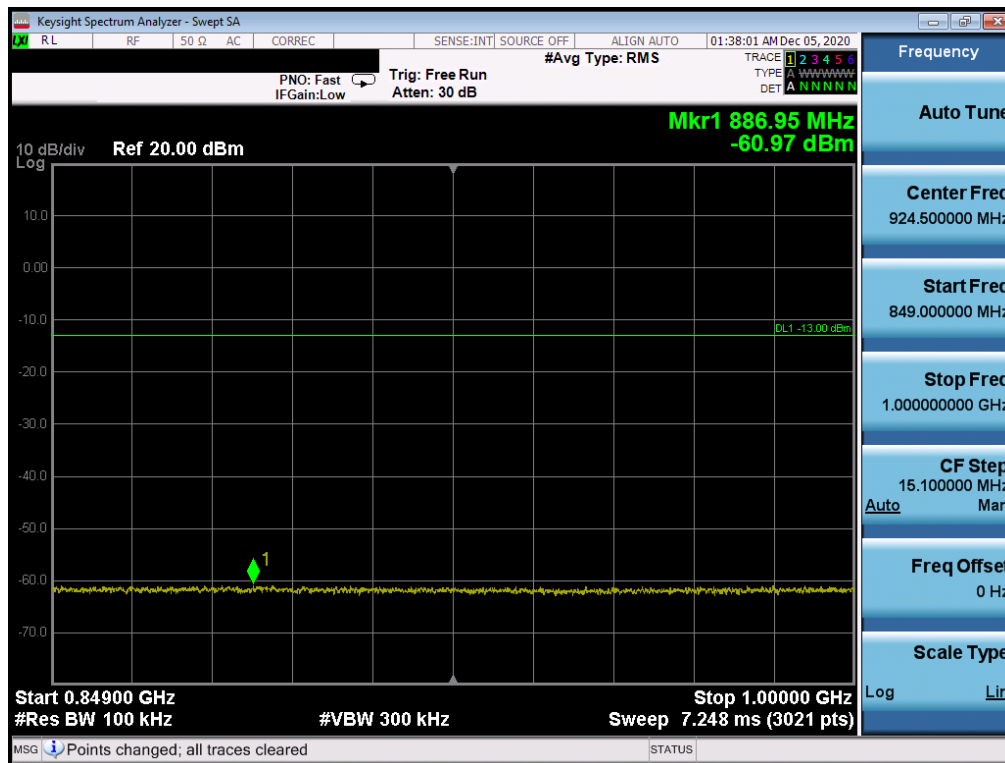
1. Per Part 22, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth 100 kHz or greater for measurements below 1GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least 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. Uplink carrier aggregation conducted spurious emissions measurements were evaluated for the two contiguous channels using various combinations of RB size, RB offset, modulation, and channel bandwidth. The worst case (highest) powers were found while operating with QPSK modulation with both carriers set to transmit using 1RB.
4. Uplink carrier aggregation inter-band emission was investigated and found to not be the worst case

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT		Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 37 of 108

LTE Band 26/5

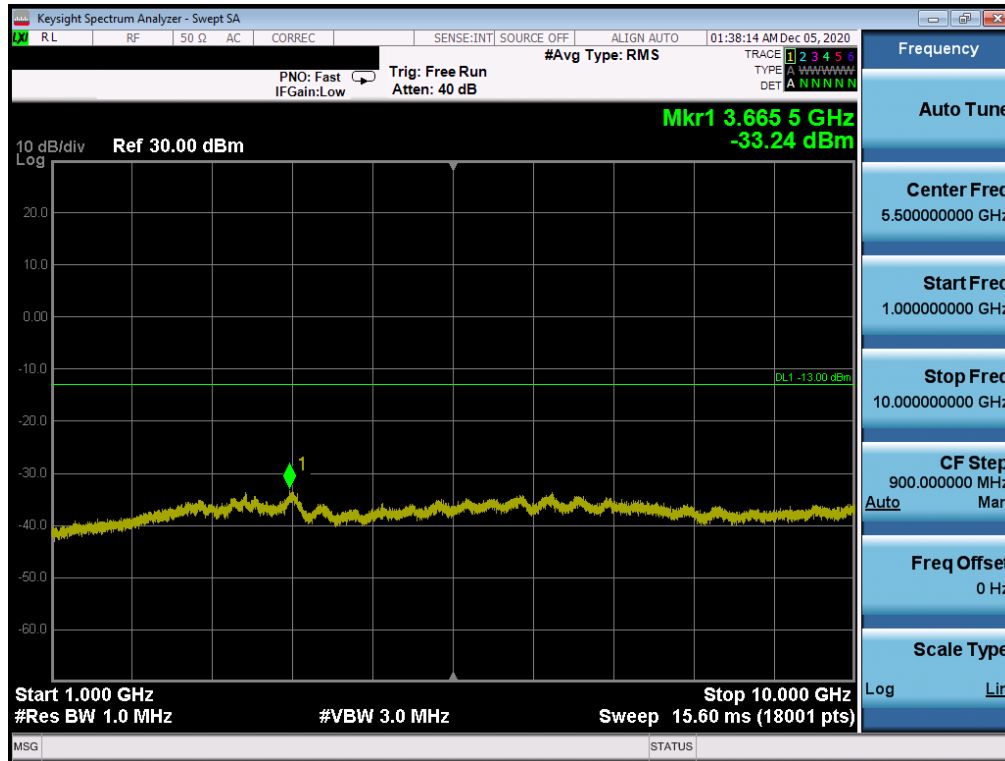


Plot 7-44. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

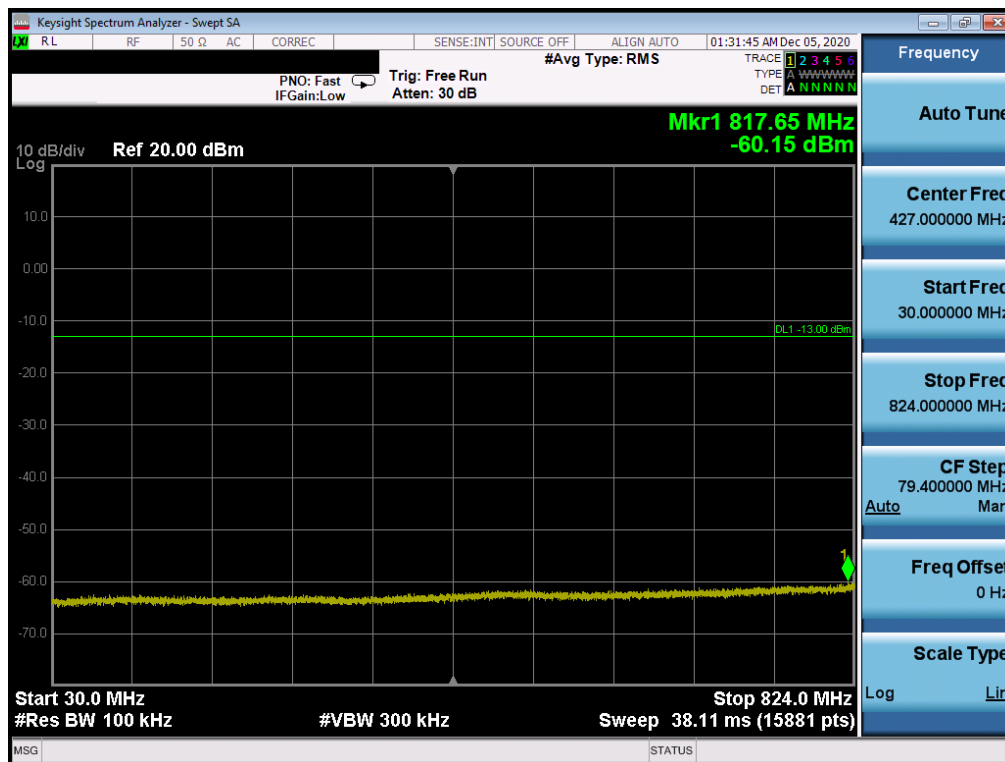


Plot 7-45. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 38 of 108

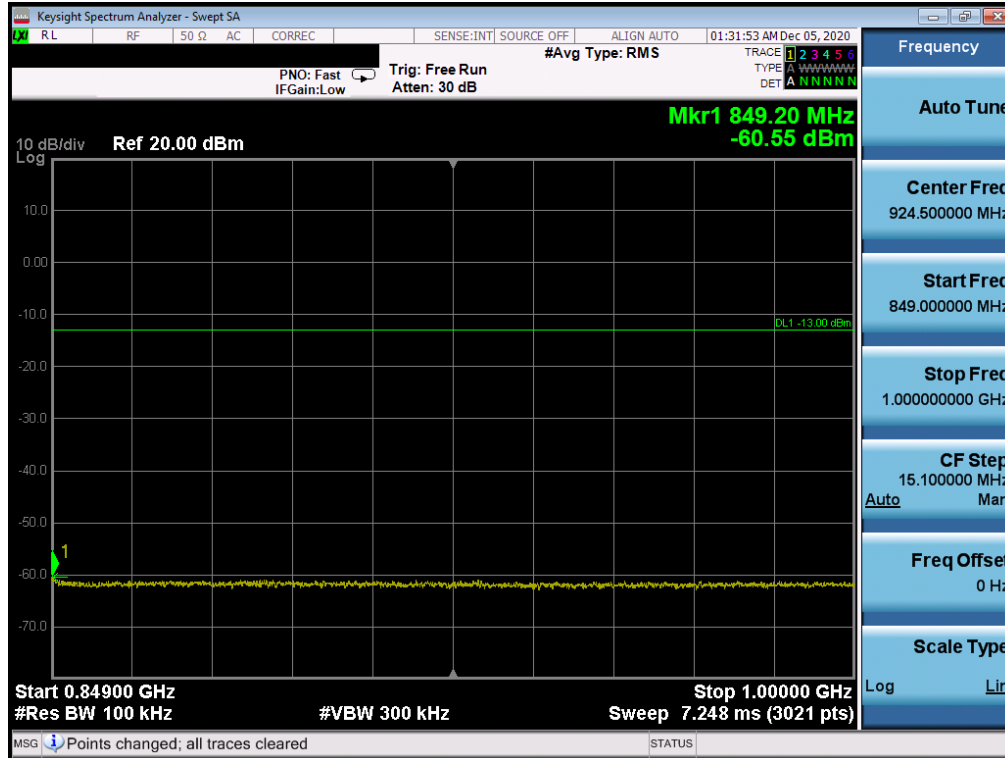


Plot 7-46. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

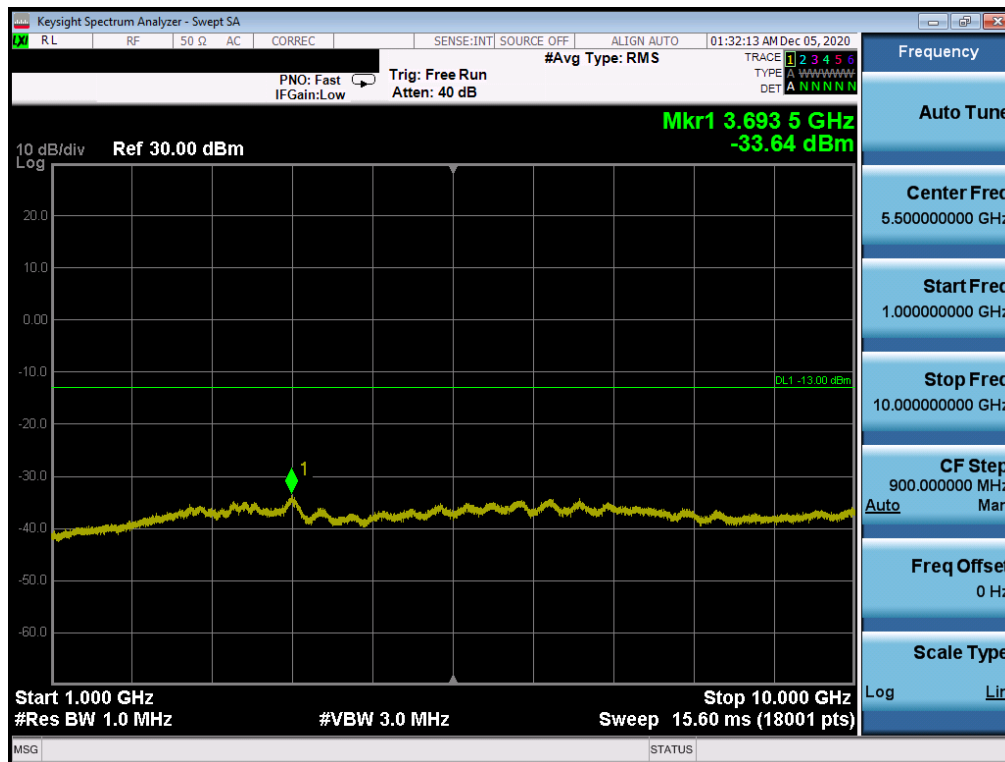


Plot 7-47. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 39 of 108

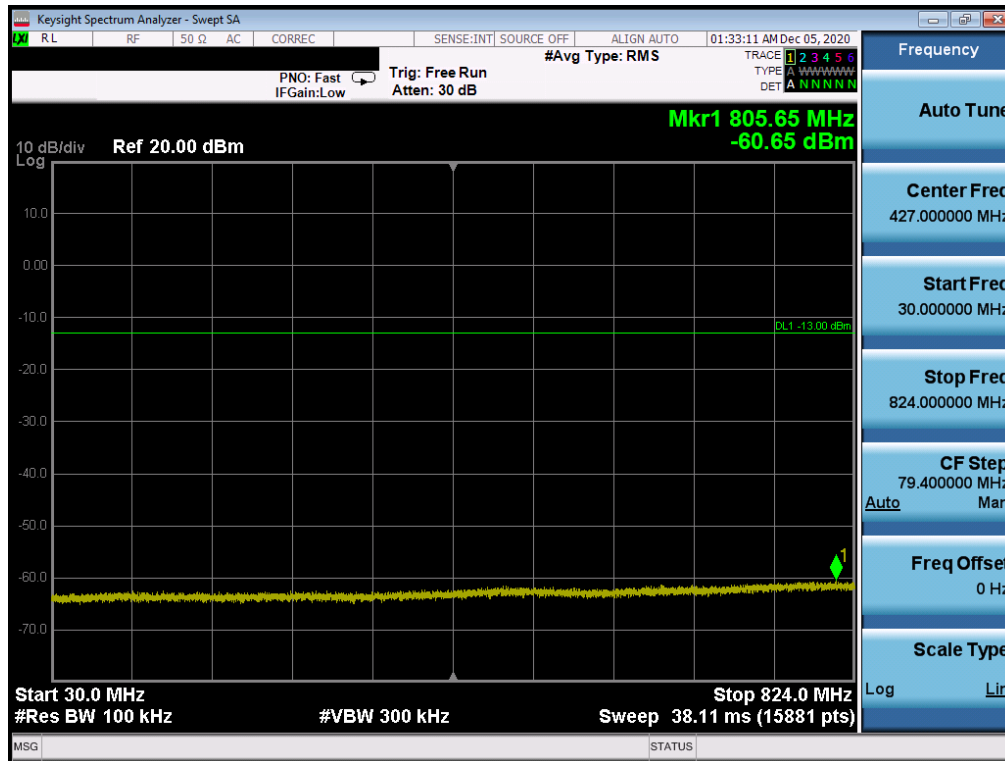


Plot 7-48. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

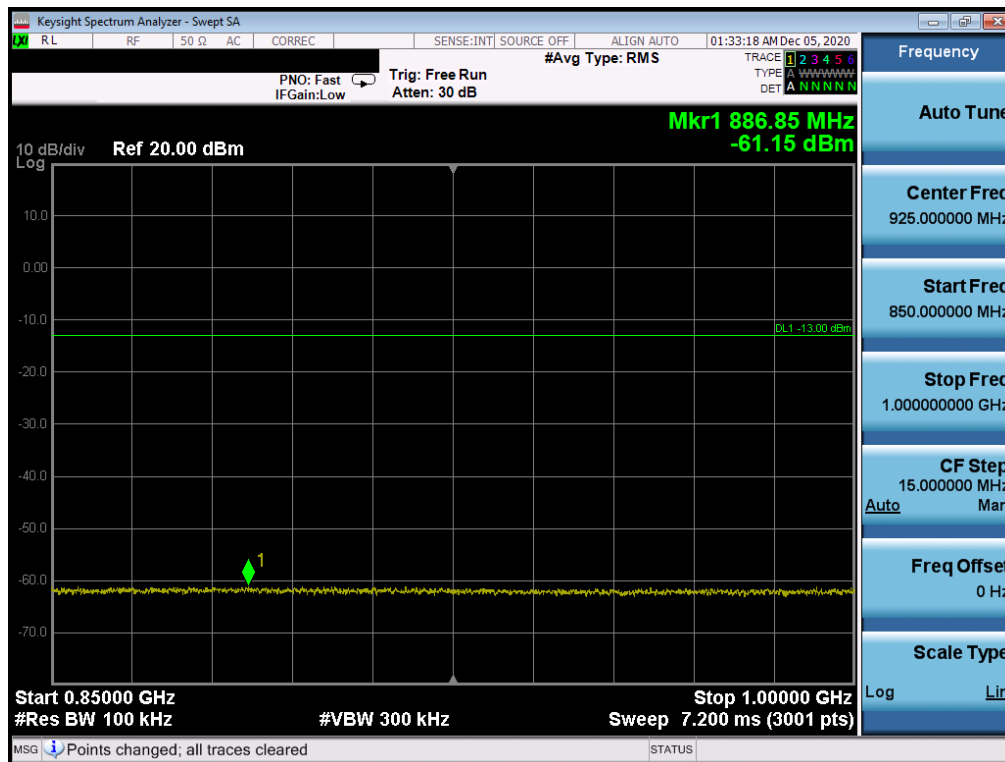


Plot 7-49. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 40 of 108

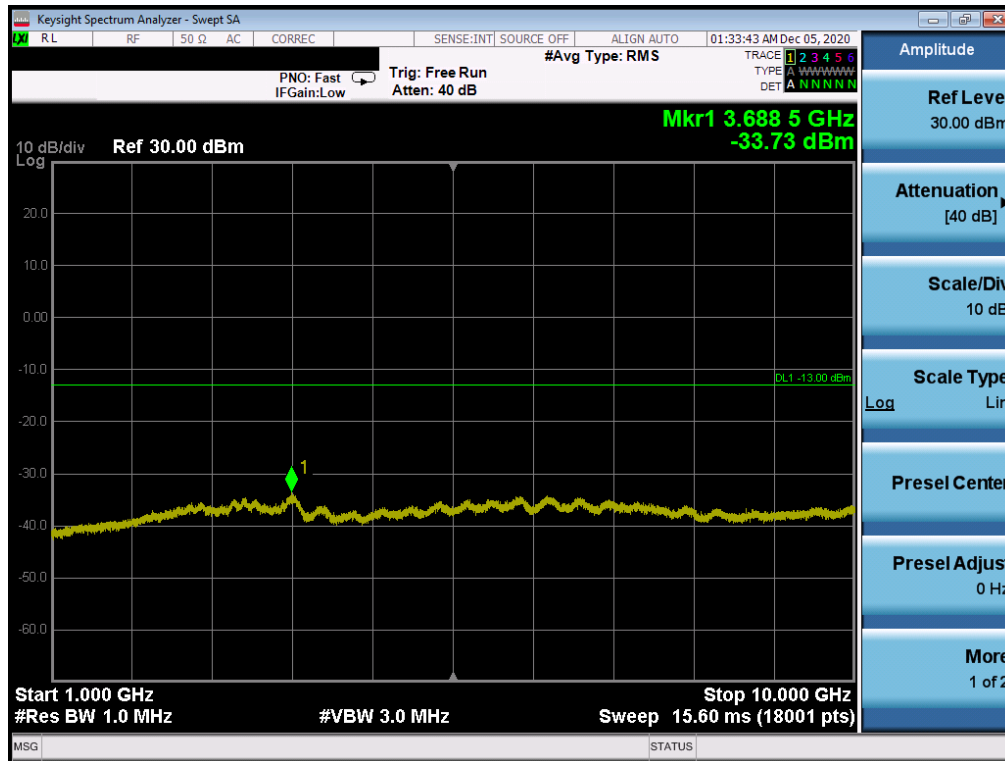


Plot 7-50. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-51. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

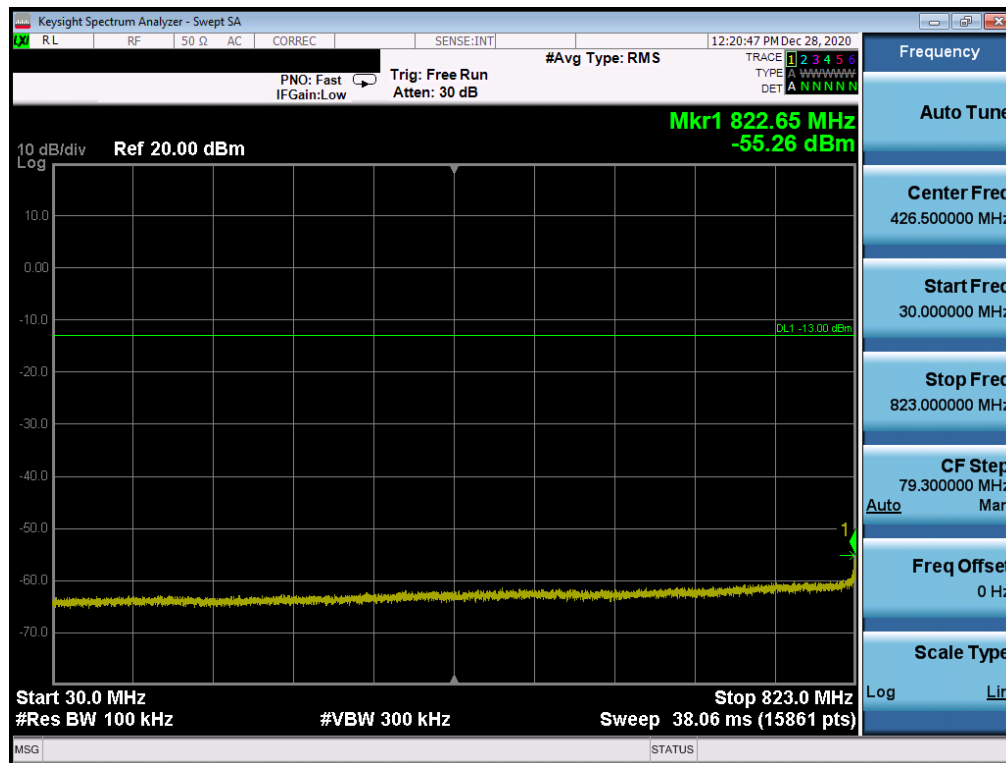
FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 41 of 108



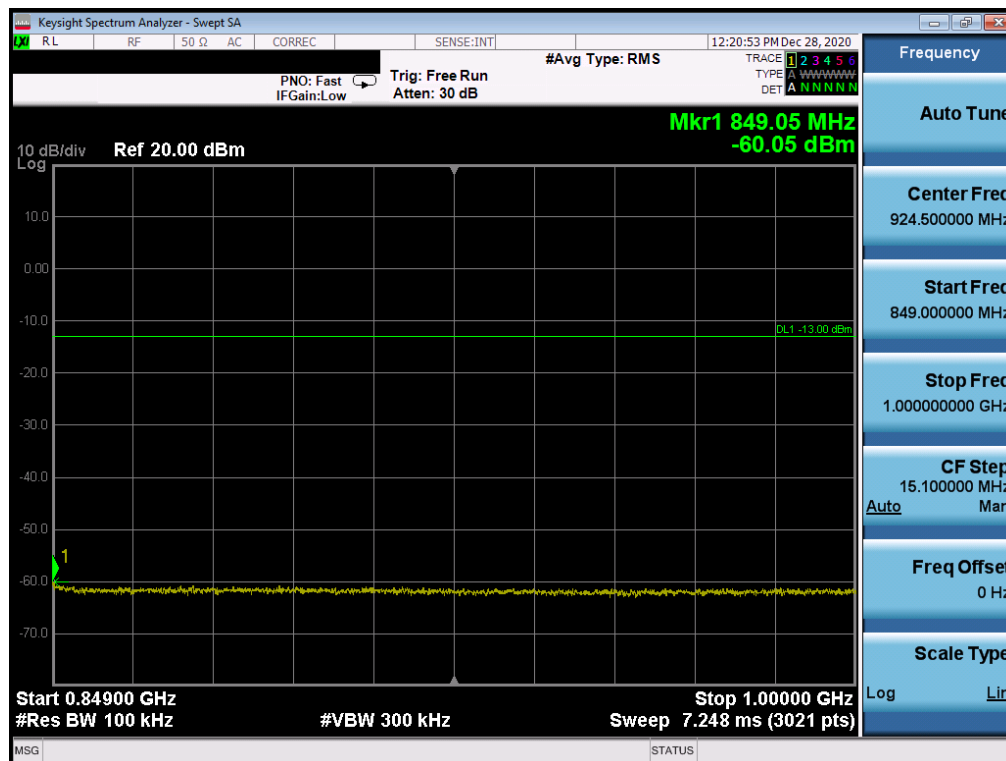
Plot 7-52. CSE (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 42 of 108

ULCA LTE Band 5



Plot 7-53. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/49 SCC 1/0 - Low Channel)

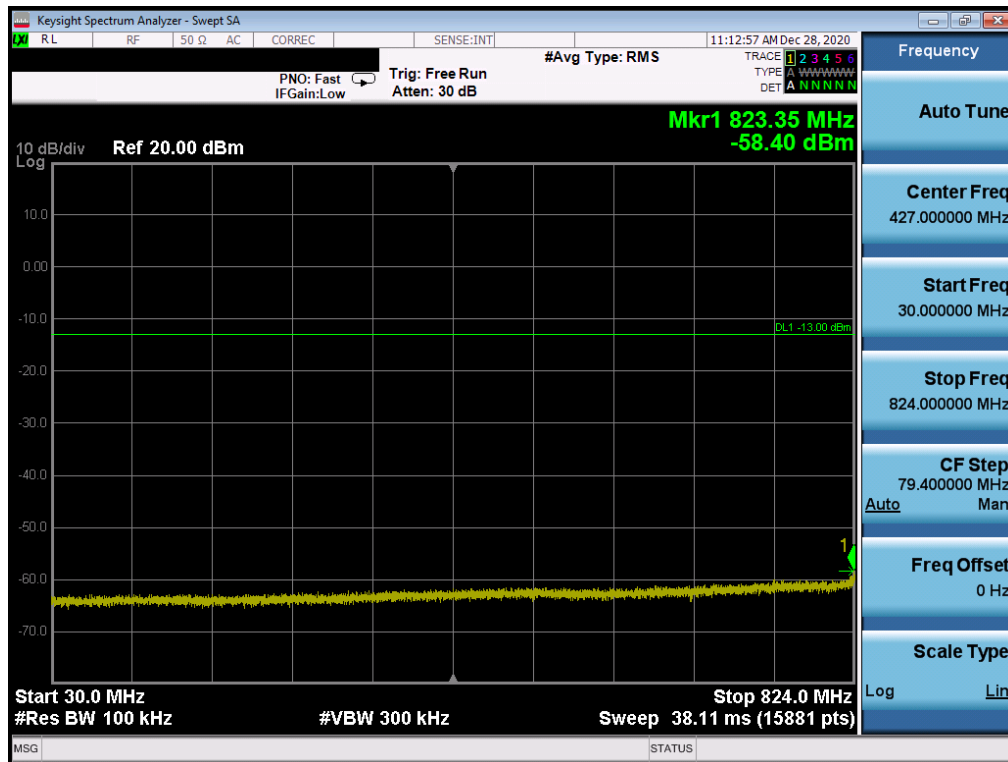


Plot 7-54. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/49 SCC 1/0 - Low Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 43 of 108

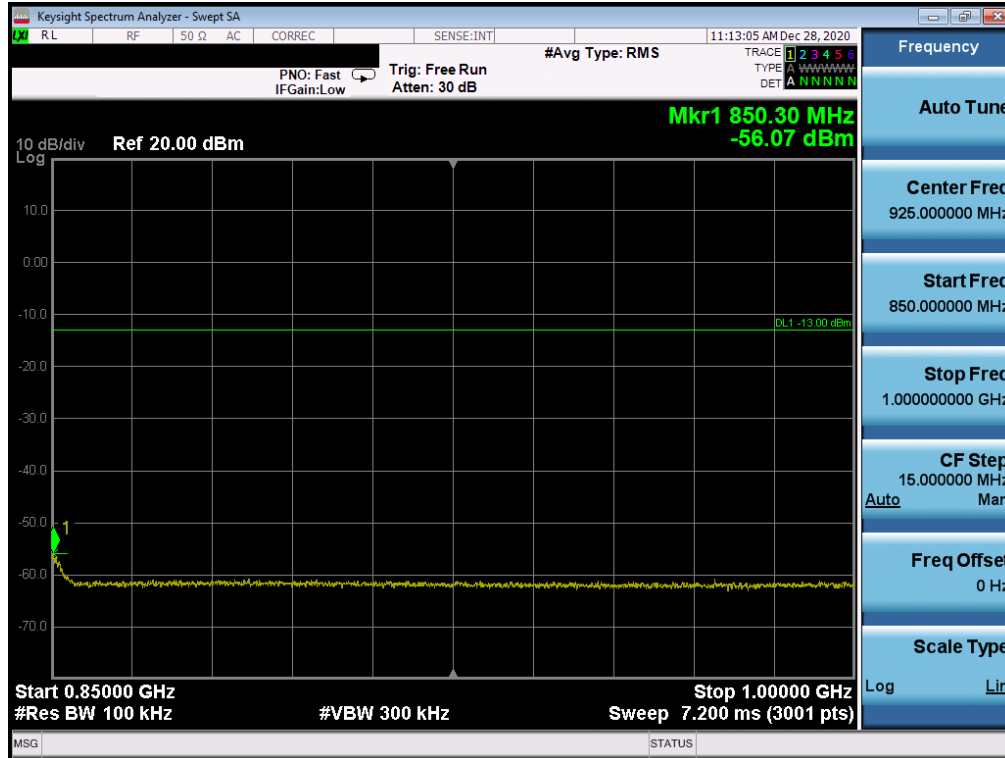


Plot 7-55. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/49 SCC 1/0 - Low Channel)

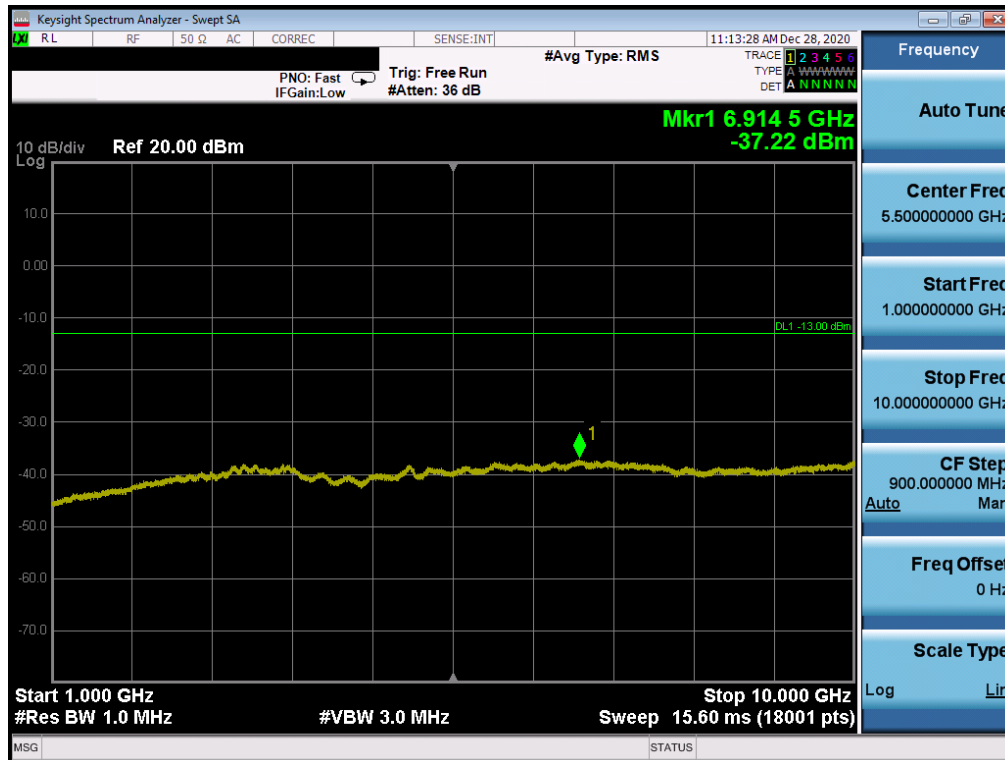


Plot 7-56. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/0 SCC 1/49 - High Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 44 of 108



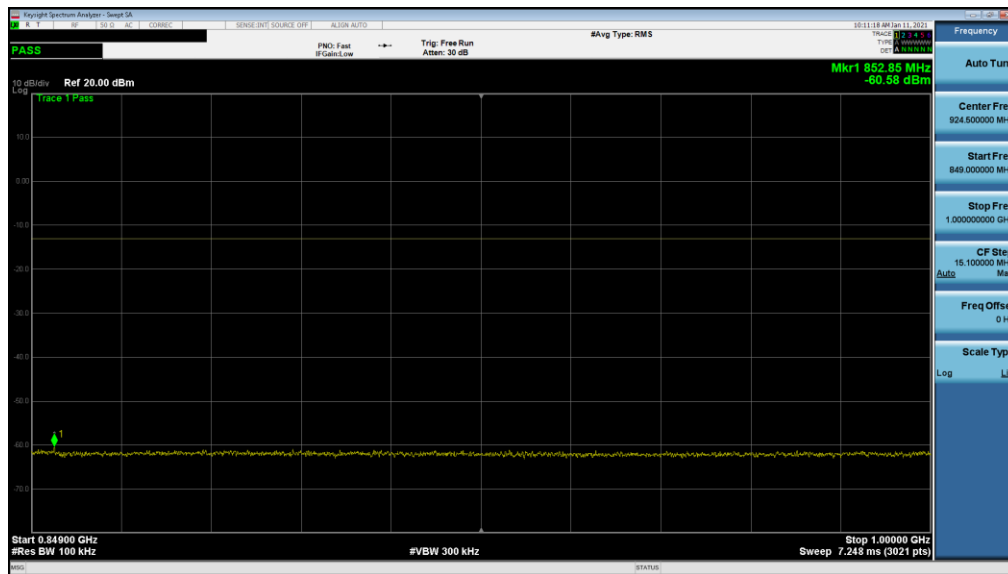
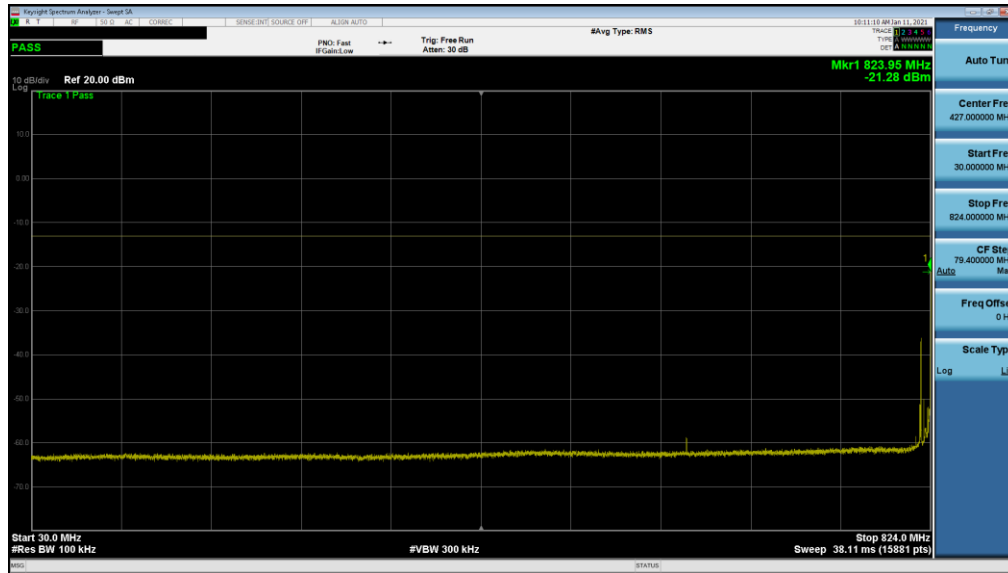
Plot 7-57. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/0 SCC 1/49 - High Channel)



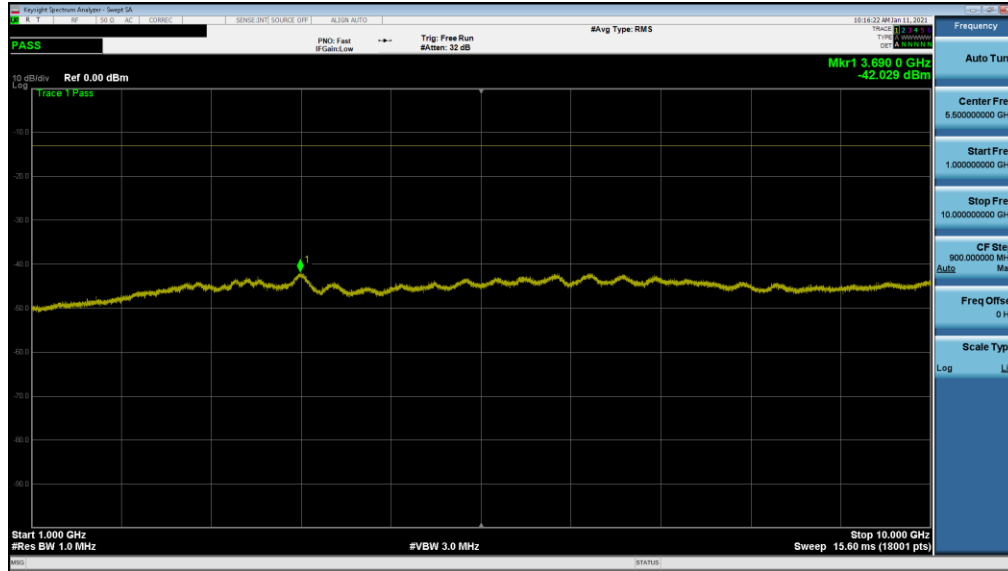
Plot 7-58. CSE (ULCA LTE Band 5 - (10 + 10)MHz QPSK - PCC 1/0 SCC 1/49 - High Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 45 of 108

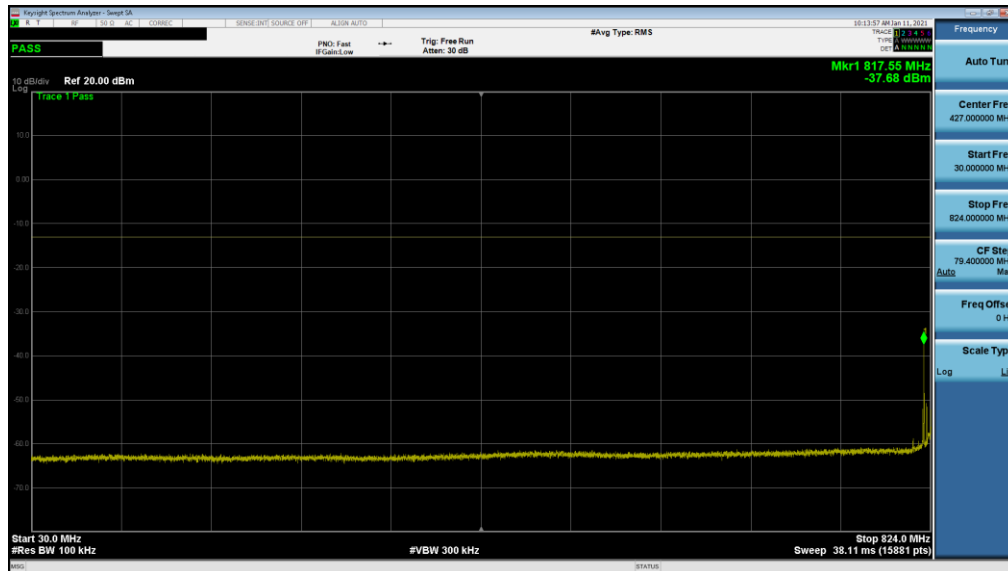
NR Band n5



FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 46 of 108

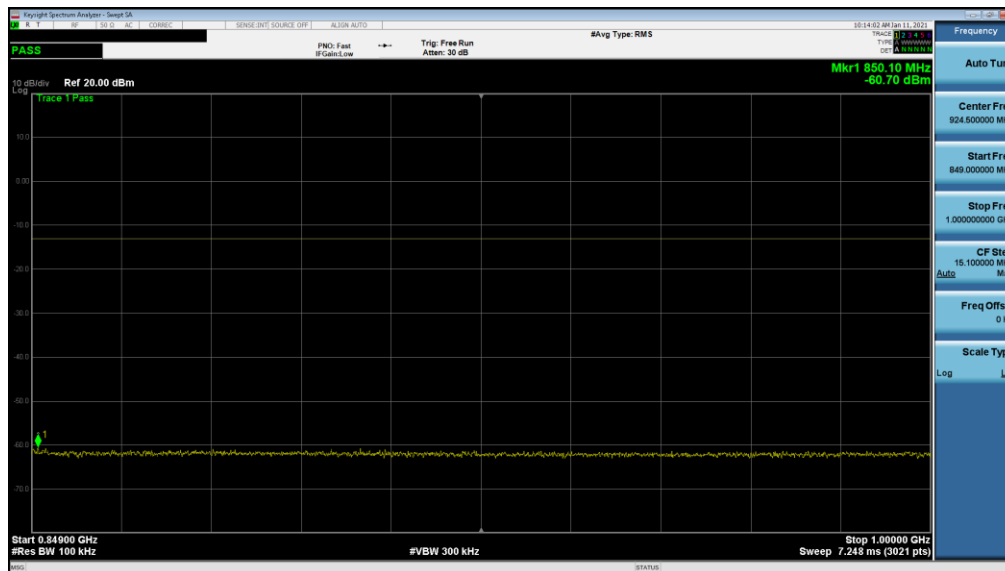


Plot 7-61. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

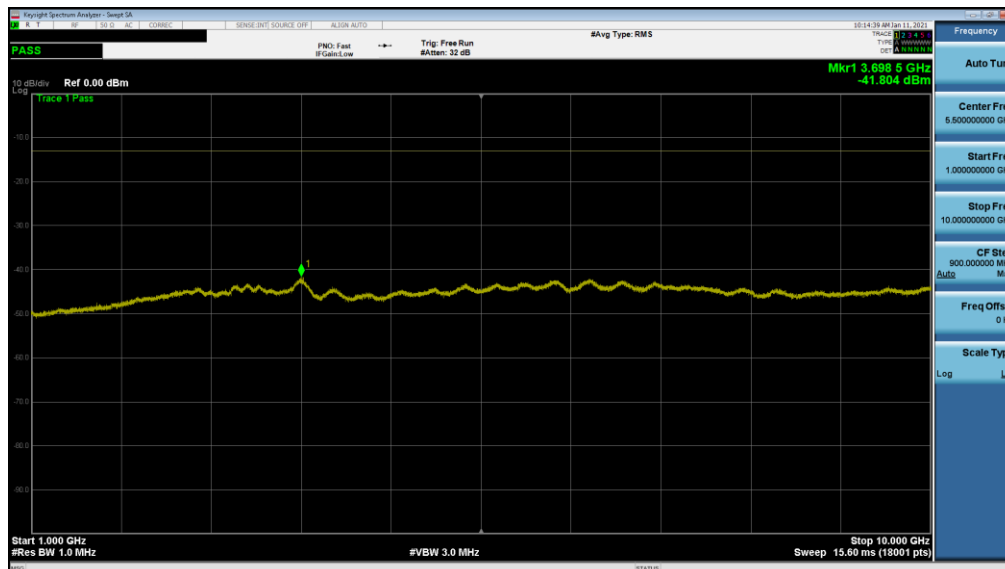


Plot 7-62. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 47 of 108

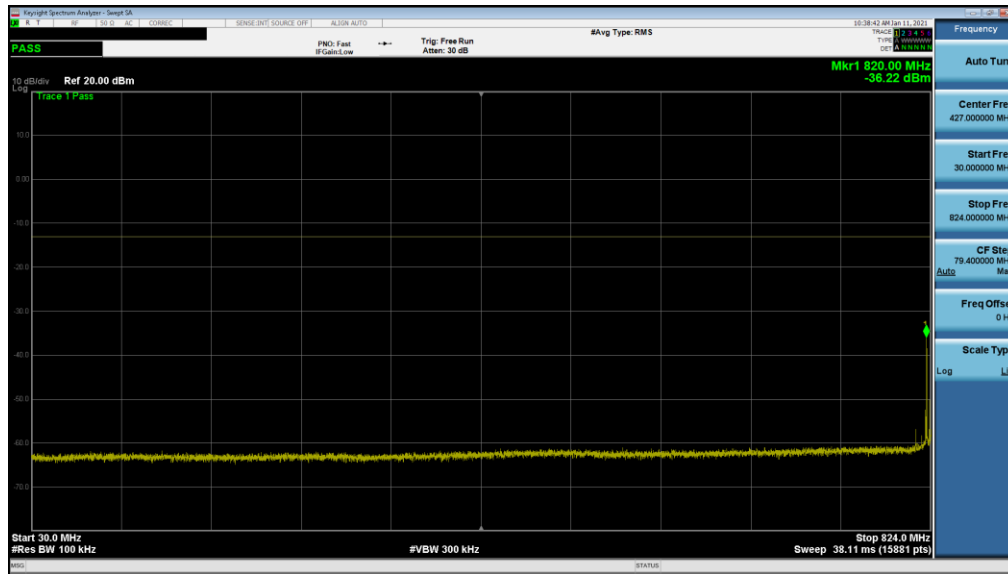


Plot 7-63. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

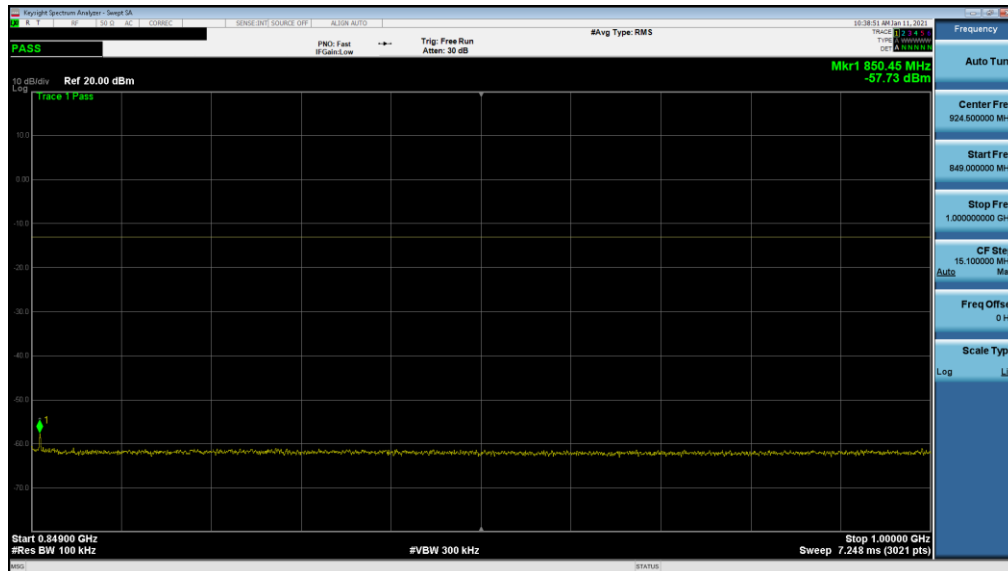


Plot 7-64. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 48 of 108

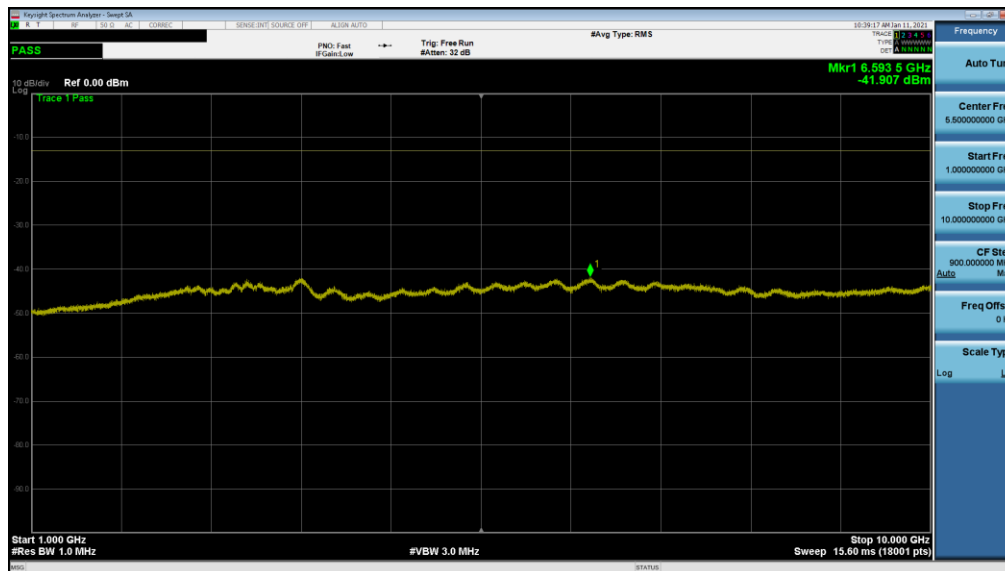


Plot 7-65. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-66. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

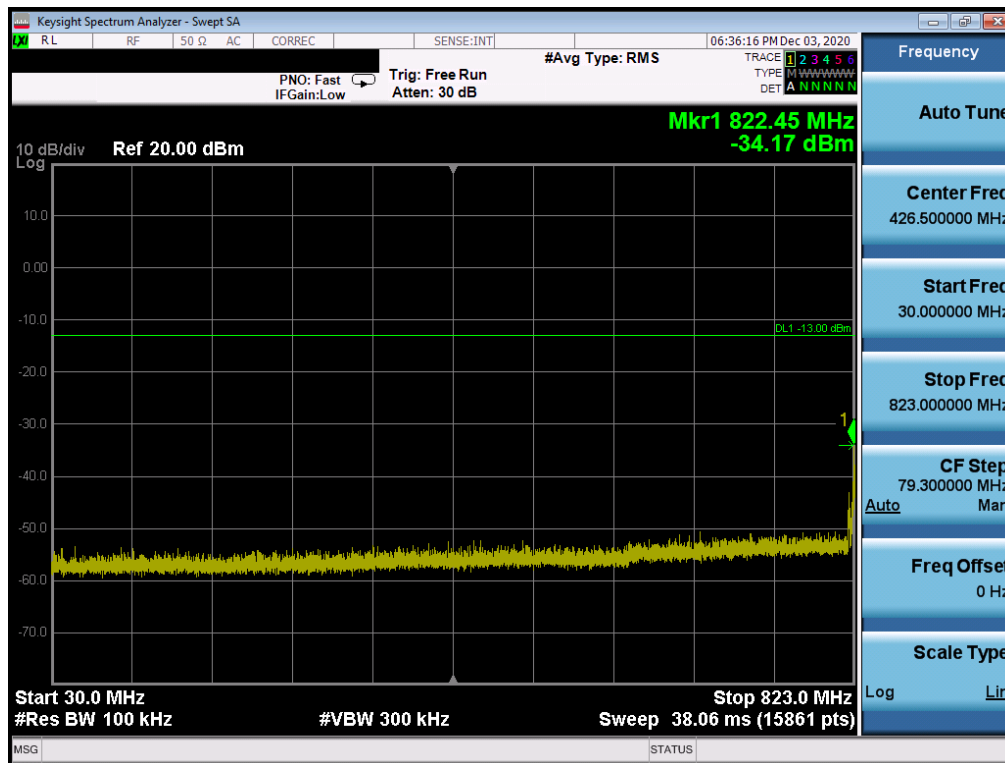
FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 49 of 108



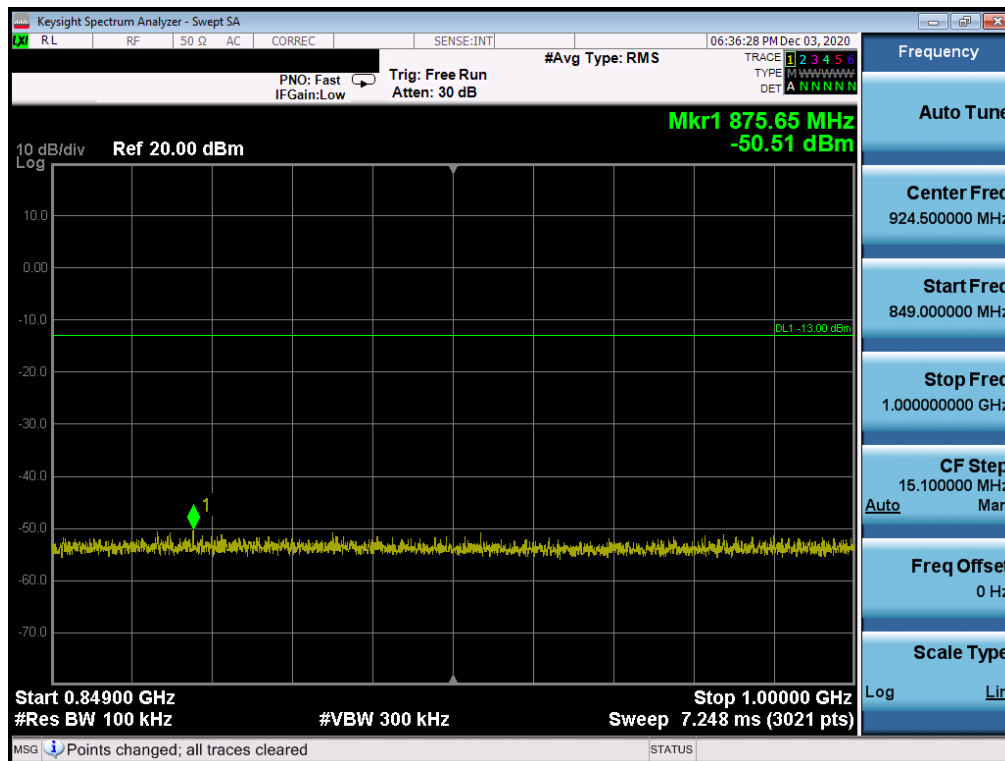
Plot 7-67. CSE (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 50 of 108

GSM/GPRS Cell

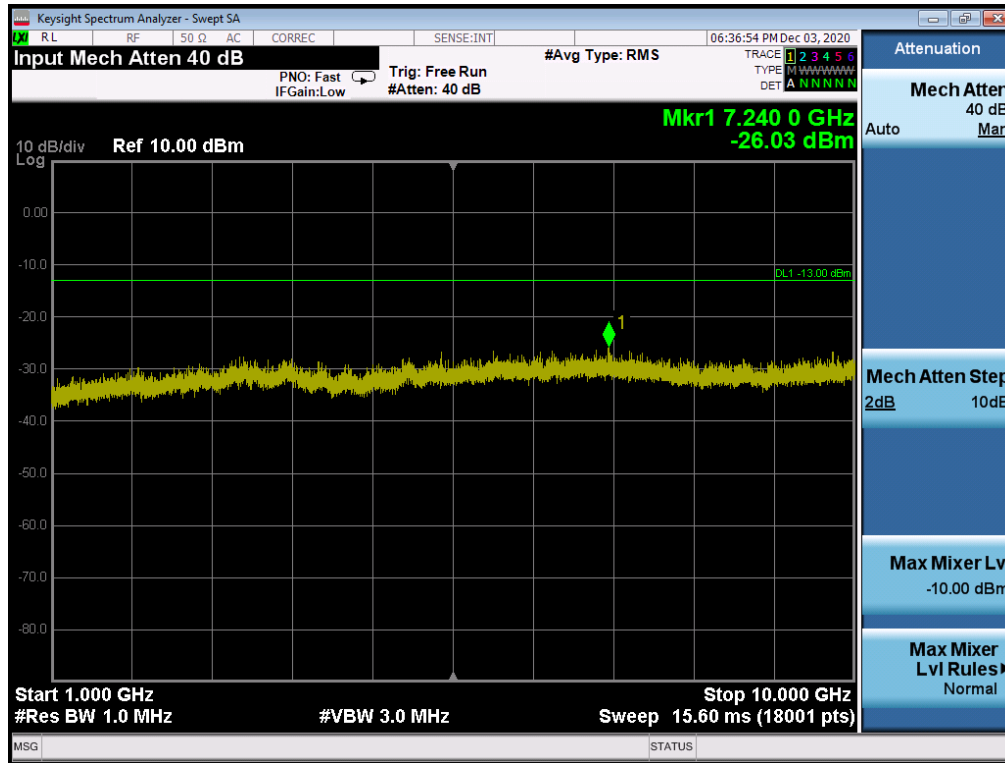


Plot 7-68. CSE (GPRS Ch. 128)

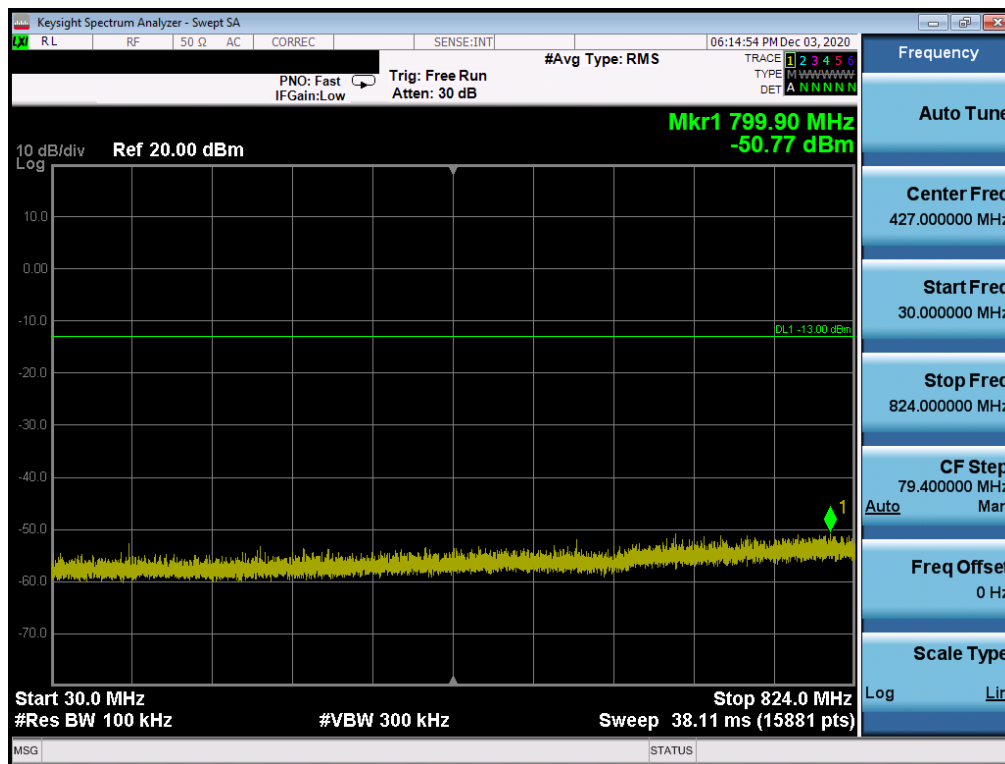


Plot 7-69. CSE (GPRS Ch. 128)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 51 of 108

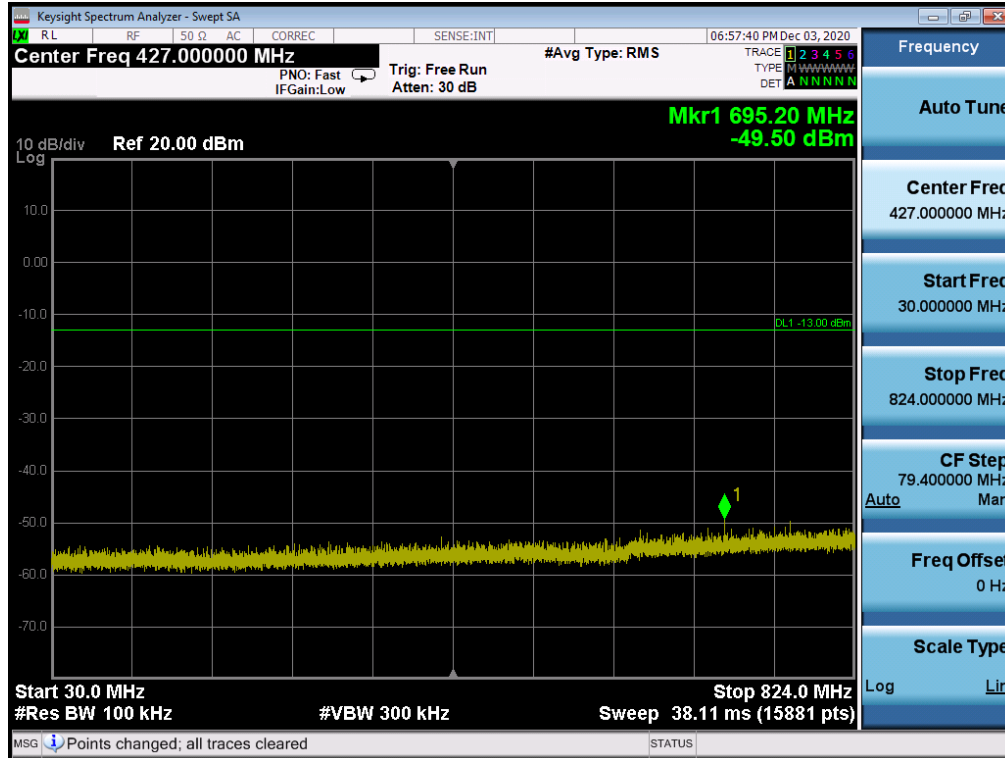


Plot 7-70. CSE (GPRS Ch. 128)

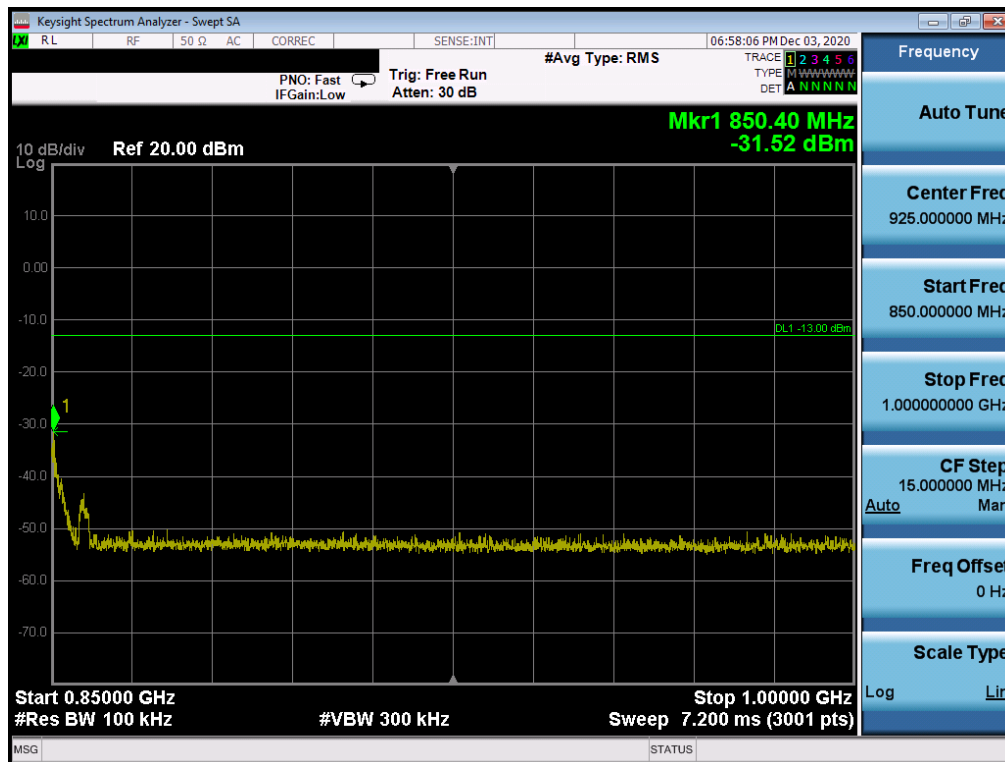


Plot 7-71. CSE (GPRS Ch. 190)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 52 of 108

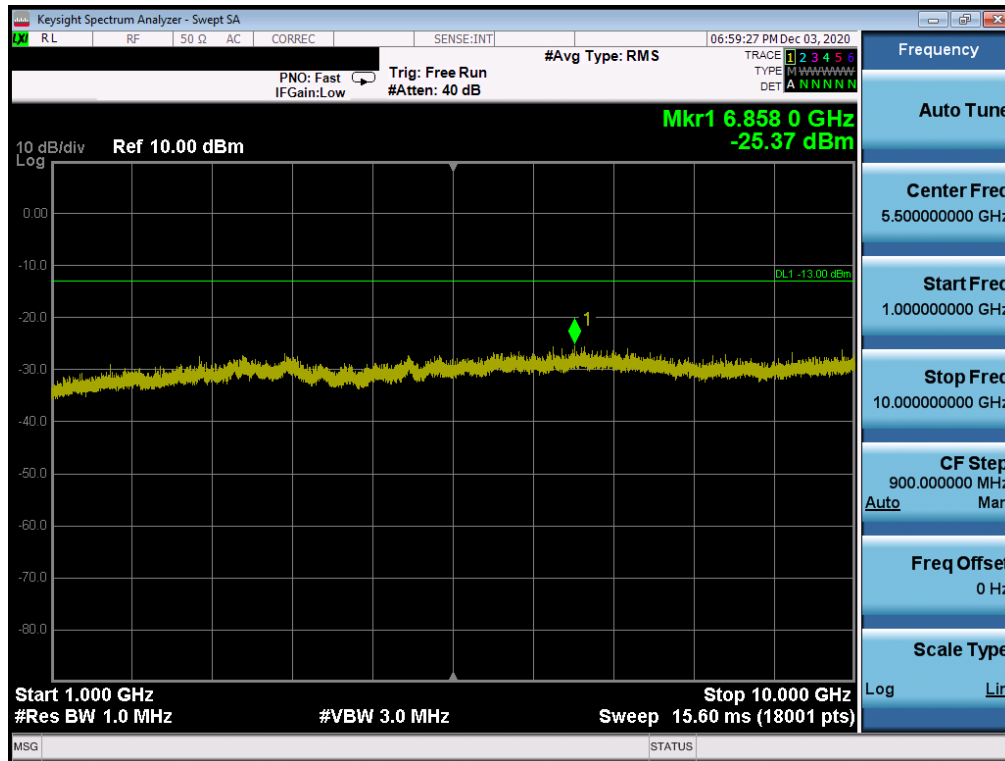


Plot 7-74. CSE (GPRS Ch. 251)



Plot 7-75. CSE (GPRS Ch. 251)

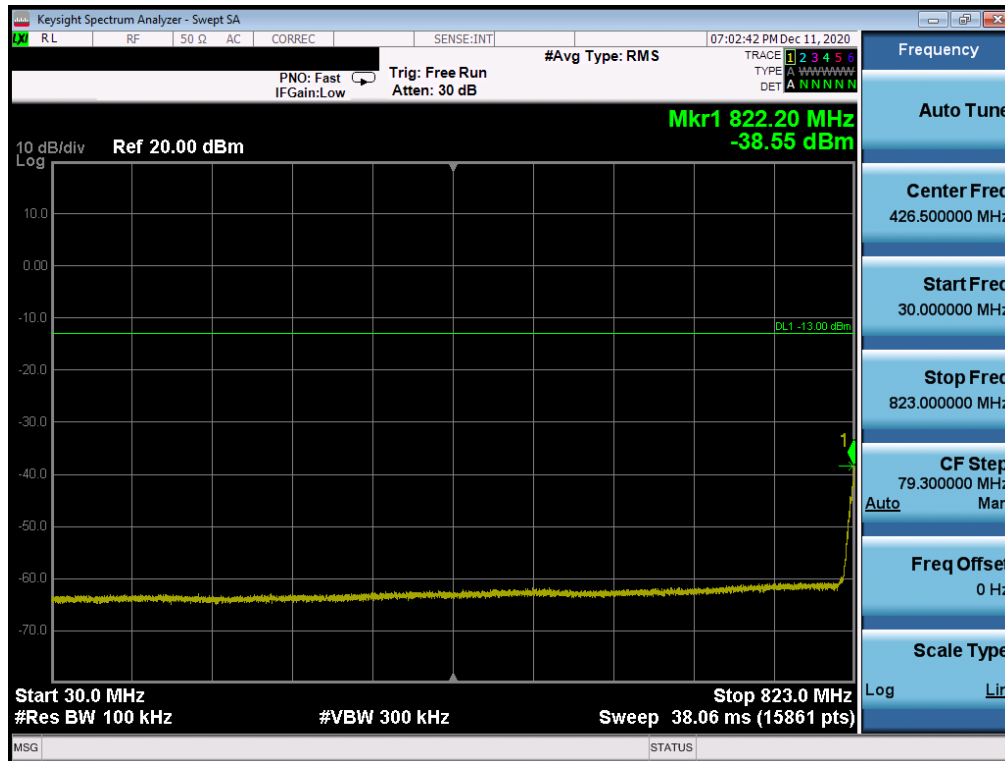
FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 54 of 108



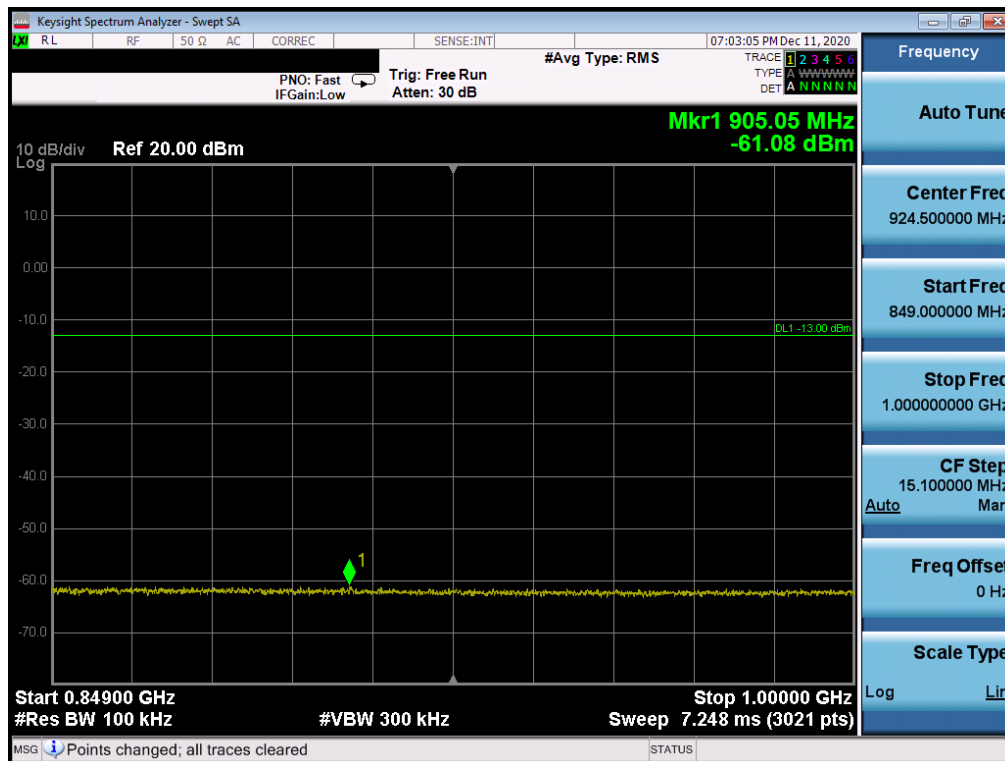
Plot 7-76. CSE (GPRS Ch. 251)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 55 of 108

WCDMA Cell

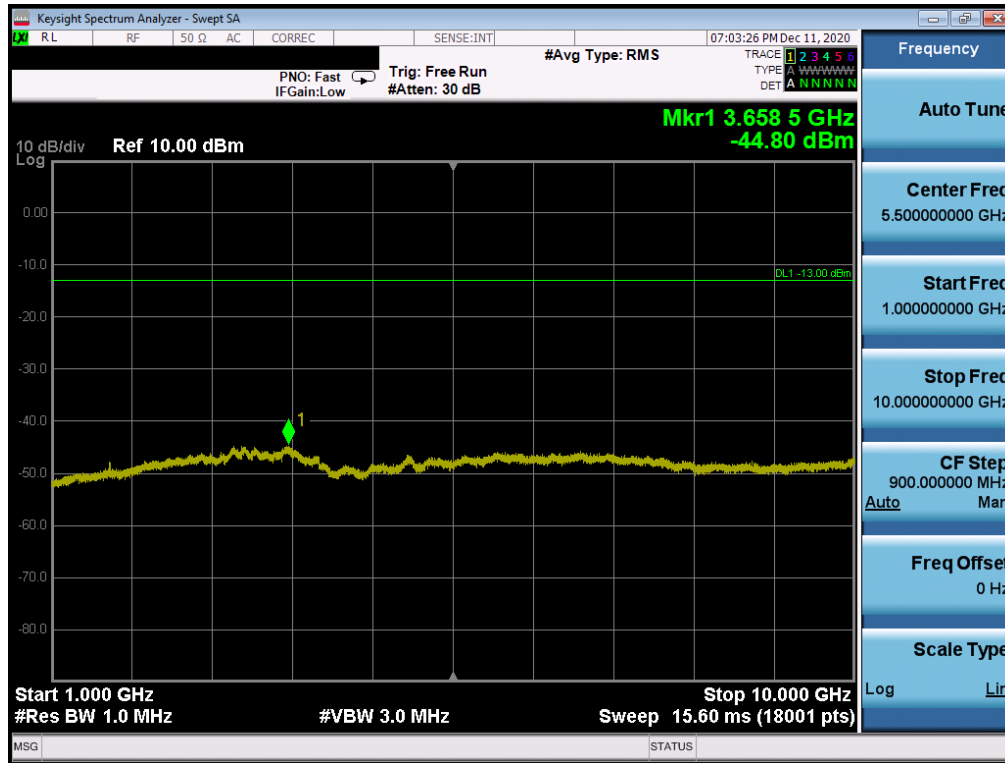


Plot 7-77. CSE (WCDMA Ch. 4132)

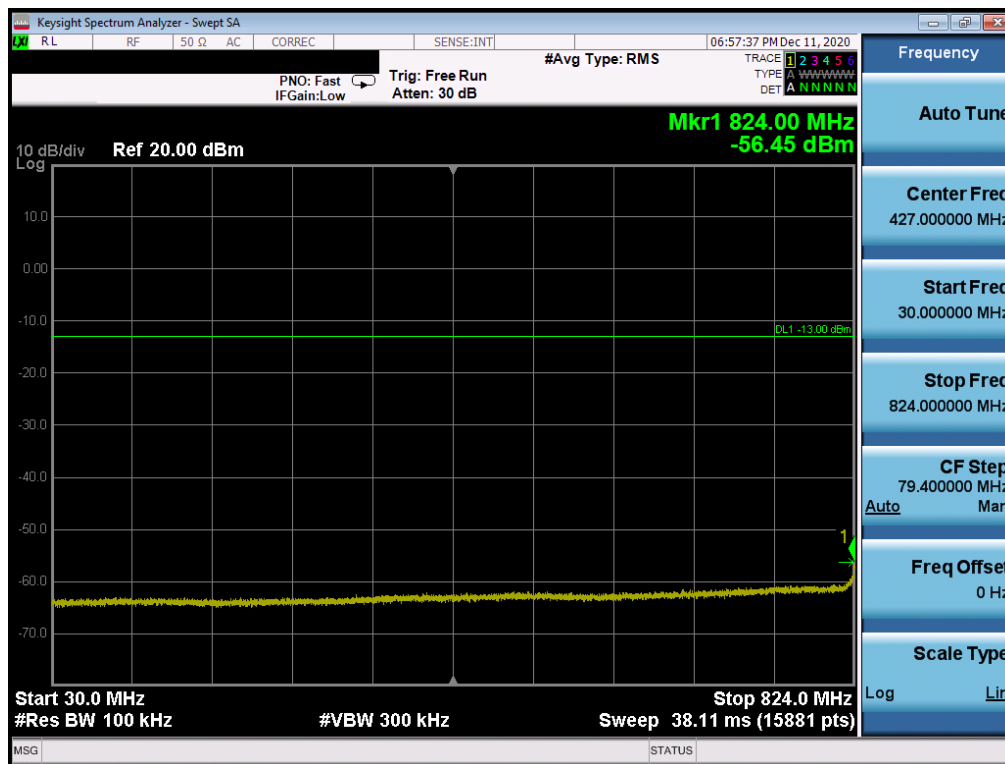


Plot 7-78. CSE (WCDMA Ch. 4132)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 56 of 108

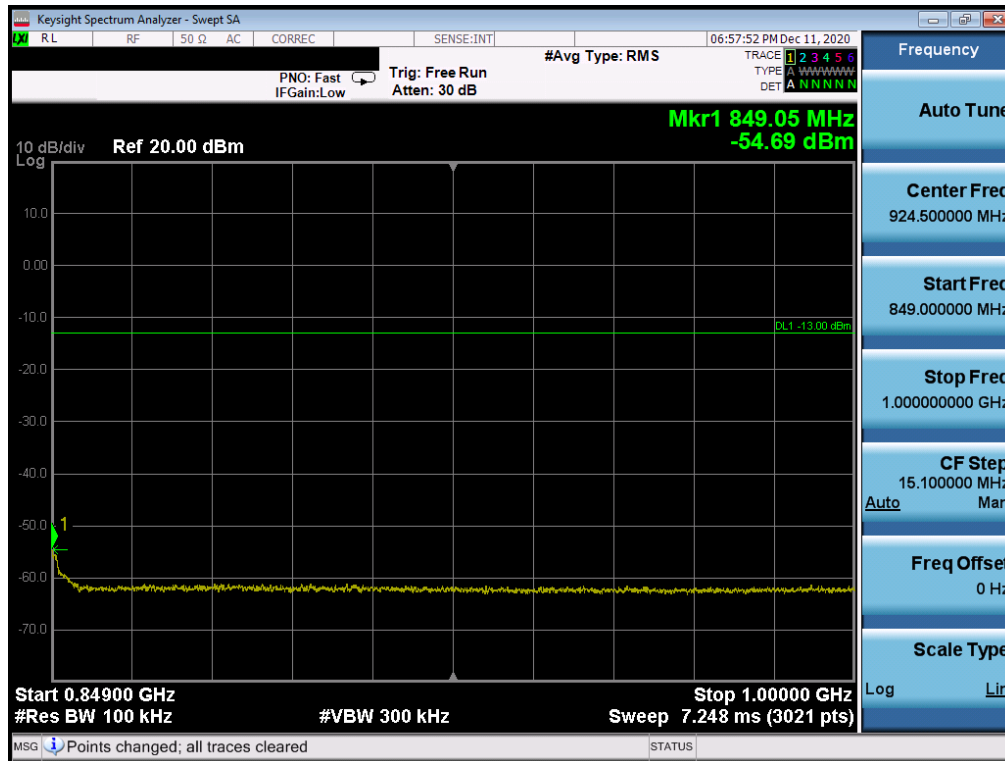


Plot 7-79. CSE (WCDMA Ch. 4132)

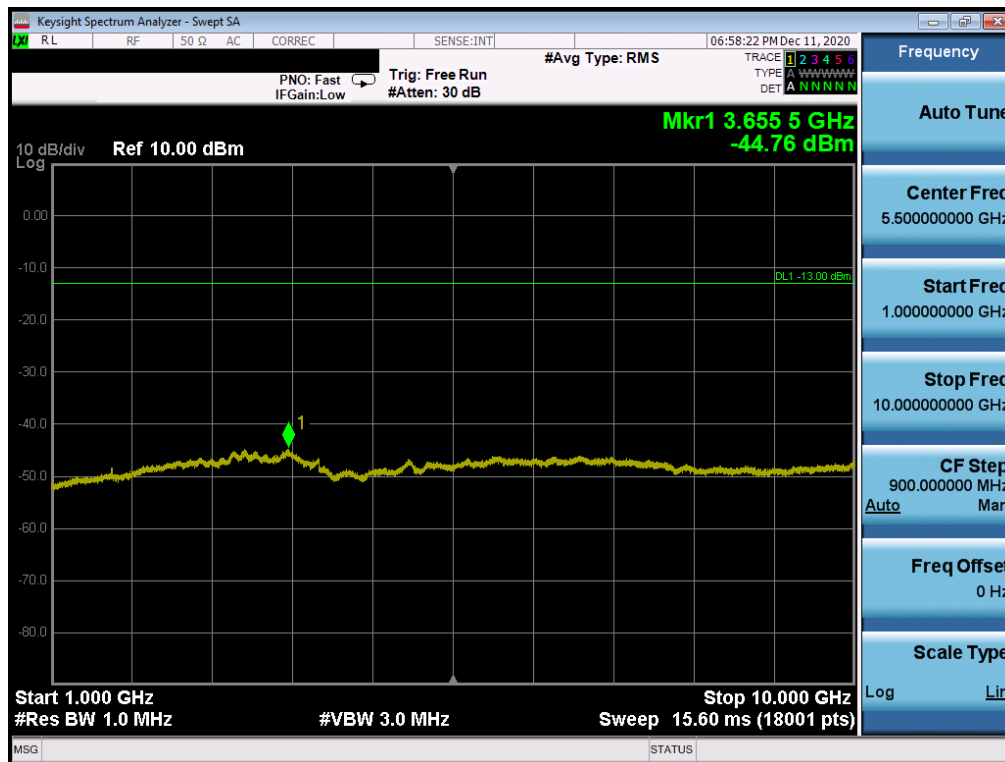


Plot 7-80. CSE (WCDMA Ch. 4183)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 57 of 108

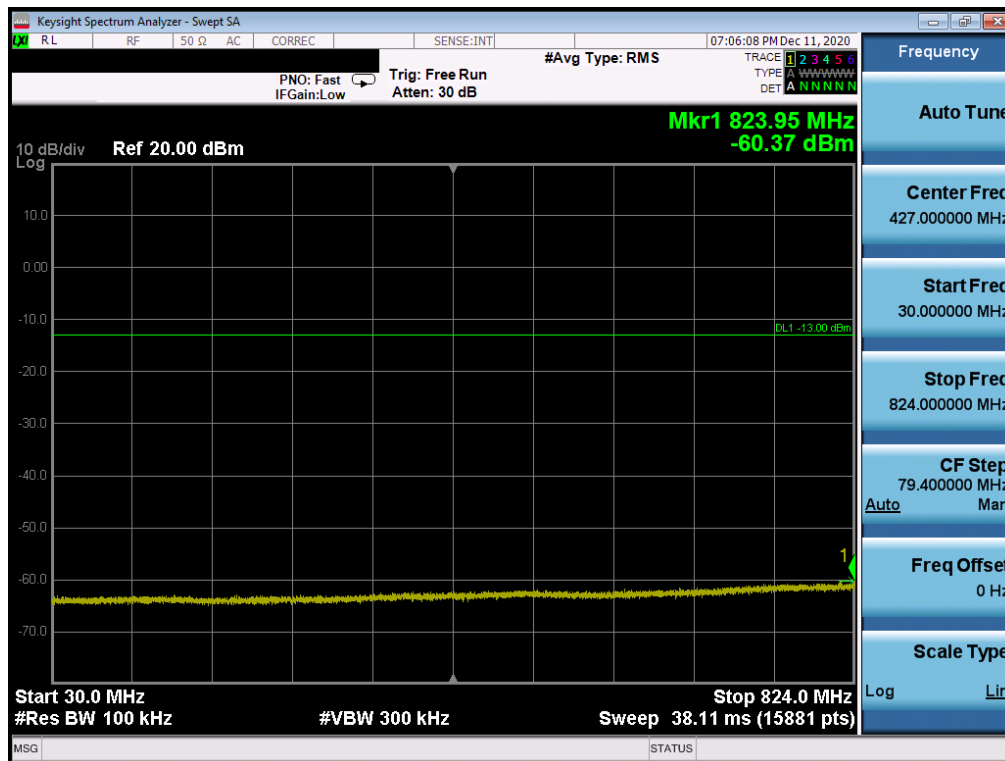


Plot 7-81. CSE (WCDMA Ch. 4183)

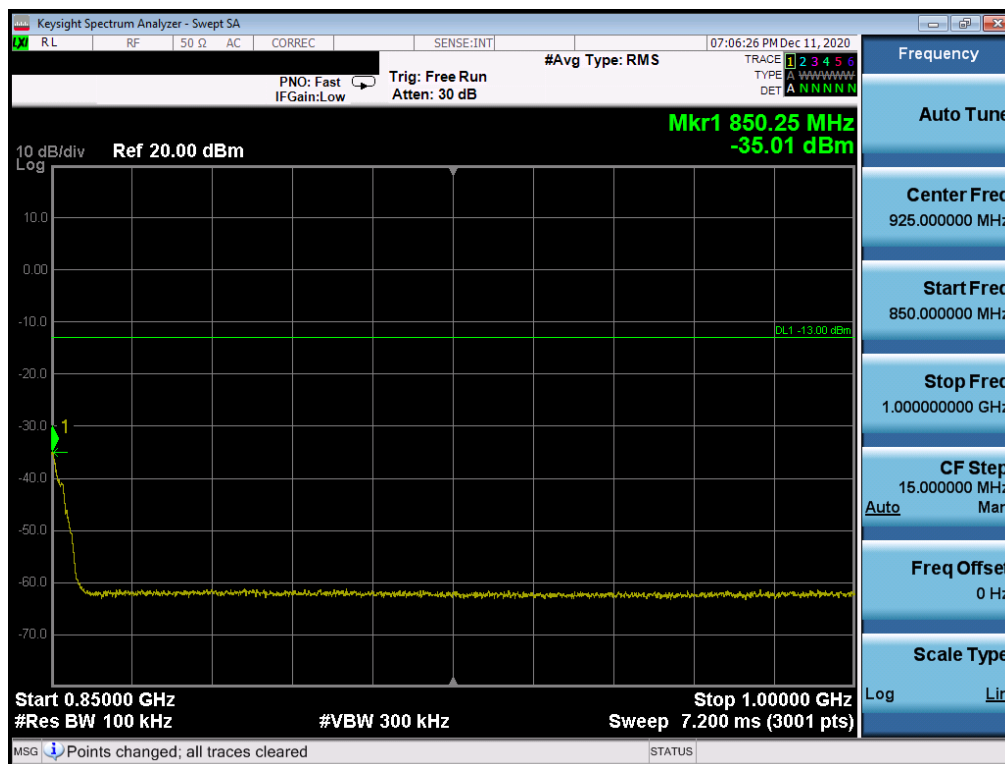


Plot 7-82. CSE (WCDMA Ch. 4183)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 58 of 108

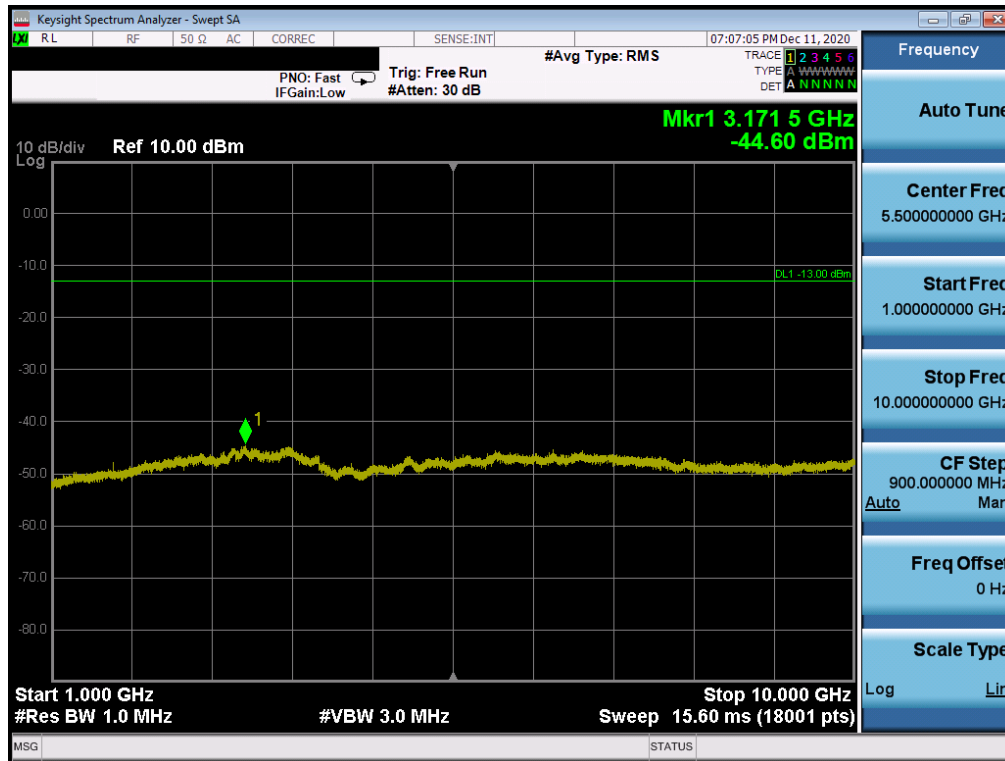


Plot 7-83. CSE (WCDMA Ch. 4233)



Plot 7-84. CSE (WCDMA Ch. 4233)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 59 of 108



Plot 7-85. CSE (WCDMA Ch. 4233)

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 60 of 108

7.4 Band Edge Emissions at Antenna Terminal

§2.1051, 22.917(a)

Test Overview

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.

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

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW $\geq 1\%$ of the emission bandwidth
4. VBW $\geq 3 \times$ RBW
5. Detector = RMS
6. Number of sweep points $\geq 2 \times$ Span/RBW
7. Trace mode = trace average for continuous emissions, max hold for pulse emissions
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

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

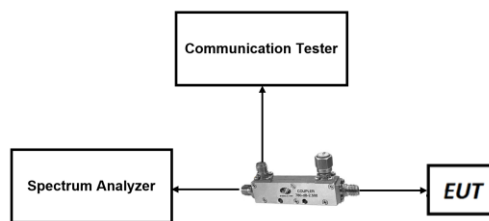


Figure 7-3. Test Instrument & Measurement Setup

FCC ID: BCGA2301	PCTEST Proud to be part of element	PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device	Page 61 of 108

Test Notes

1. Per 22.917(b), 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 to demonstrate compliance with the out-of-band emissions limit. 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.

FCC ID: BCGA2301	 PART 22 MEASUREMENT REPORT	Approved by: Quality Manager
Test Report S/N: 1C2101020002-02.BCG	Test Dates: 12/23/2020 - 03/05/2021	EUT Type: Tablet Device
Page 62 of 108		