



Element Washington DC LLC

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DATA REFERENCE REPORT PART 22

Applicant Name:

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

Date of Testing:

5/30/2022 - 9/16/2022

Test Site/Location:

Element Washington DC LLC, Morgan Hill, CA, USA

Test Report Serial No.:

1C2205090029-01.BCG

FCC ID:	BCGA2437
Applicant Name:	Apple Inc.

Reference Model: A2764

Variant Model: A2437 (A2766)

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.

RJ Ortiz
Executive Vice President



CERT #2041.02

FCC ID: BCGA2437		PART 22 DATA REFERENCE REPORT	
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1.0 INTRODUCTION

1.1 Scope

Per manufacturer declaration, there are two tablet device models, A2764 and A2437 (A2766), with high degree of similarity, reference model FCC ID: BCGA2764 and variant model **FCC ID: BCGA2437**. The reference models support mmWave operations, while the variant models have 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: BCGA2764, while radiated and conducted spot-check verification has been performed on variant model FCC ID: BCGA2437. 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
PCB	BCGA2764	1C2205090028-01.BCG	RF Part 22 Test Report

Table 1-1. Reference Model Details

Reference model FCC ID: BCGA2764 test report has been included in Appendix A

1.2 Element Washington DC LLC Test Location

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

1.3 Test Facility / Accreditations

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

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID:BCGA2437**. 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.: HHQXGQDW0V, VT04VPHP2V

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), NB UNII (1x, 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	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	✗	✗	✗	✗	✓
2a	Config 2	✗	✓	✗	✗	✗	✓
4a	Config 3	✓	✗	✓	✗	✗	✗
4a	Config 4	✗	✓	✗	✓	✗	✗

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; ✗ = Not Support

Note:

1. All the above simultaneous transmission configurations have been tested and the worst case configuration was found to be Bluetooth and LTE B48. Results can be found on RF Bluetooth and RF Part 96 Test Reports.
2. Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. Specific 2.4 GHz Wi-Fi antenna that can only transmit simultaneously with 2.4 GHz Bluetooth antenna is listed in the SAR test report. For BT (2.4 GHz) in connected mode and Wi-Fi (2.4 GHz) – Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4 GHz) in disconnected mode and Wi-Fi (2.4 GHz) – BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power..

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2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Band	Antenna Gain [dBi]	
	Antenna 3	Antenna 1
WCDMA850		
LTE Band 5/26	-2.7	-2
NR Band n5/26		

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro w/AC/DC Adapter	Model: A2141 Model: A2166	S/N: C02DV7VKMD6T S/N: N/A	
2	Apple USB-C Cable	Model: Spartan	S/N: 000MKTR02U	
3	USB-C Cable w/ AC Adapter	Model: A246 Model: A2305	S/N: N/A S/N: N/A	
4	Apple Pencil	Model: N/A	S/N: GQXGSXBJKM9	
5	DC Power Supply	Model: KPS3010D	S/N: N/A	

Table 2-3. Test Support Equipment

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2.5 Test Configuration

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

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration.

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, Antennas 1 and 3 spot-check measurements have been conducted and reported. Spot-check Test Plan can be referred to below Table 2-4.

Technology	Test Case	Antenna / Modes	FCC ID: BCGA2437	
			Mode	Channel
WCDMA, LTE, FR1 Single Carrier & IntraBand ULCA	Radiated Spurious Emissions (>1GHz)	Max. conducted Power Antenna	LTE Band 5, 2, 7 Max BW, 1RB (QPSK-highest power)	Mid
	Radiated Spurious Emissions (<1GHz)		LTE Band 5, 2, 7 Max BW, 1RB (QPSK-highest power)	Mid
	Conducted Power ERP/EIRP	All possible Antenna Configurations	LTE Band 5, 2, 7 Max BW, 1RB (QPSK-highest power)	Mid

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 20A8359 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

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

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3.0 DESCRIPTION OF TESTS

3.1 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:

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

And

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

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.

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4.0 MEASUREMENT UNCERTAINTY

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

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

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5.0 TEST EQUIPMENT CALIBRATION DATA

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

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

Table 5-1. Test Equipment

Notes:

1. For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

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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.

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7.0 TEST RESULTS (SPOT-CHECK DATA)

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCGA2437
 FCC Classification: PCS Licensed Transmitter (PCB)
 Mode(s): WCDMA/LTE/NR

Technology	Test Configurations					Reference Model	Variant Model	Delta
	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2764	FCC ID: BCGA2437	
						Average [dBm]	Average [dBm]	
LTE-B5	Radiated Spurious Emissions	QPSK	10MHz / 1/25 RB	M	2509.5	-48.97	-48.27	0.70
LTE-B5	Conducted Powers	QPSK	10MHz / 1/0 RB	M	836.5	25.64	25.70	0.06
WCDMA B5	Conducted Powers	QPSK	5MHz	M	836.6	25.65	25.63	0.02
NR n5	Conducted Powers	QPSK	20MHz / 1/1 RB	M	836.5	25.13	25.53	0.40

Table 7-1. Worst Case Antenna 3 Spot-Check Results

Technology	Test Configurations (PCC)					Test Configurations (SCC)					Reference Model	Variant Model	Delta
	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2764	FCC ID: BCGA2437	
											Average [dBm]	Average [dBm]	
ULCA - LTE Band 5	Conducted Powers	QPSK	10MHz / 1/49 RB	M	831.5	Conducted Powers	QPSK	10MHz / 1/0 RB	M	841.4	25.41	25.66	0.25

Table 7-2. Worst Case Antenna 3 ULCA Spot-Check Results

FCC ID: BCGA2437	 element	PART 22 DATA REFERENCE REPORT				Approved by: Technical Manager
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Technology	Test Configurations					Reference Model	Variant Model	Delta
	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2764	FCC ID: BCGA2437	
						Average [dBm]	Average [dBm]	
LTE-B5	Conducted Powers	QPSK	10MHz / 1/0 RB	M	836.5	23.90	23.90	0.00
WCDMA B5	Conducted Powers	QPSK	5MHz	M	836.5	23.86	23.90	0.04
NR B5	Conducted Powers	QPSK	5MHz / 1/1 RB	M	836.5	23.35	23.86	0.51

Table 7-3. Worst Case Antenna 1 Spot-Check Results

Technology	Test Configurations (PCC)					Test Configurations (SCC)					Reference Model	Variant Model	Delta
	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	Test Description	Modulation	BW / RB Config	Channel	Measurement Frequency [MHz]	FCC ID: BCGA2764	FCC ID: BCGA2437	
											Average [dBm]	Average [dBm]	
ULCA - LTE Band 5	Conducted Powers	QPSK	10MHz / 1/49 RB	M	831.5	Conducted Powers	QPSK	10MHz / 1/0 RB	M	841.4	23.75	23.80	0.17

Table 7-4. Worst Case Antenna 1 ULCA 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.

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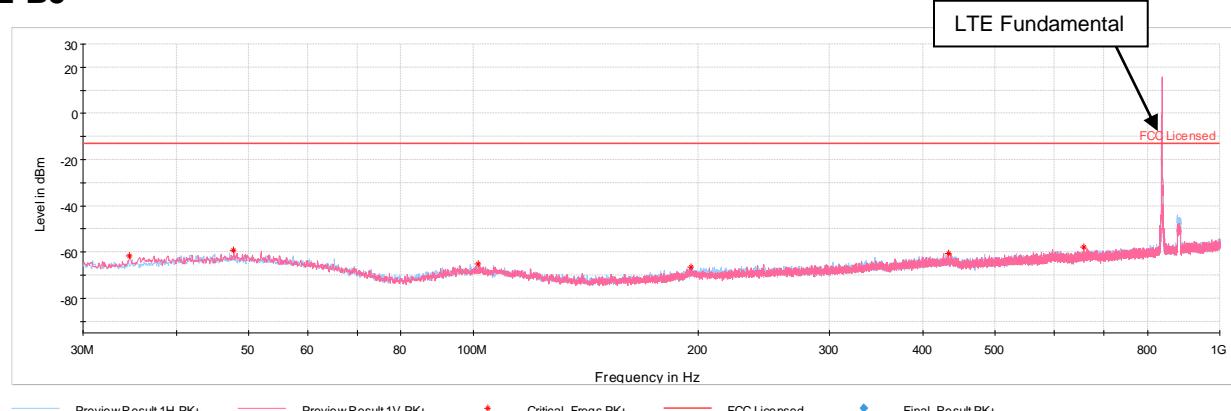
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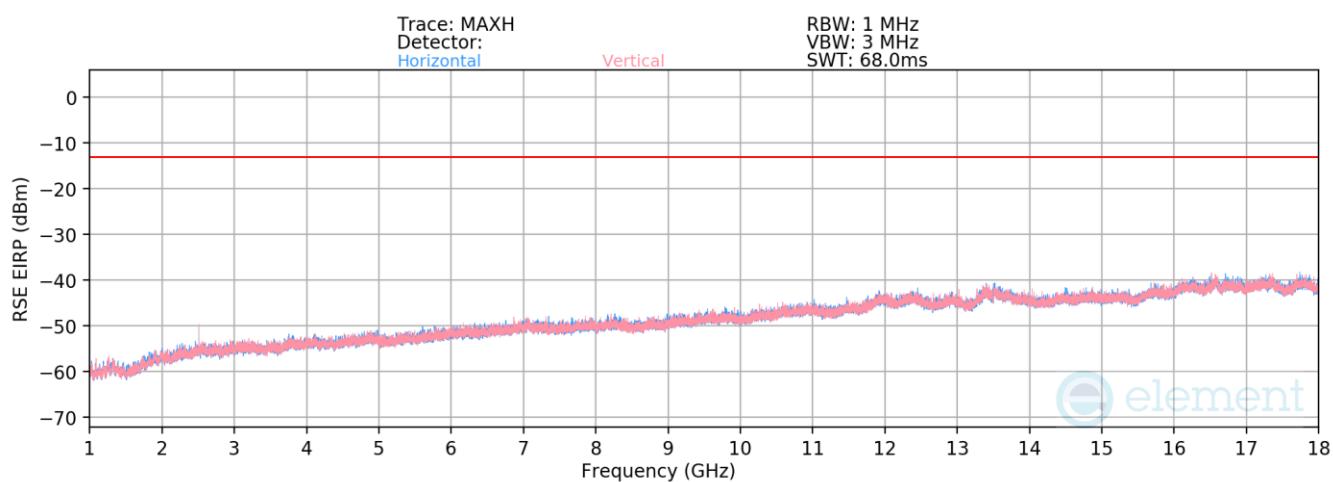
7.2 Antenna 3 Radiated Spurious Emissions

§2.1053, 22.917(a)

LTE-B5



Plot 7-1. Antenna 3 Radiated Spurious Plot below 1GHz (LTE Band 5)



Plot 7-2. Antenna 3 Radiated Spurious Emission above 1GHz (LTE Band 5)

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1673.0	H	-	-	-76.47	-2.50	28.03	-67.23	-13.00	-54.23
2509.5	V	302	122	-62.36	2.35	46.99	-48.27	-13.00	-35.27
3346.0	H	-	-	-79.36	3.12	30.76	-64.49	-13.00	-51.49
4182.5	H	-	-	-80.10	5.41	32.31	-62.95	-13.00	-49.95
5019.0	H	-	-	-80.57	6.08	32.51	-62.75	-13.00	-49.75

Table 7-5. Antenna 3 Radiated Spurious Data (LTE Band 5 – Mid Channel)

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7.3 Antenna 3 – ERP/EIRP

LTE-B5

Bandwidth	Mod.	Frequency [MHz]	Ant. Gain [dBi]	RB Size/Offset	Conducted Power [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
10 MHz	QPSK	836.5	-2.70	1 / 0	25.70	20.85	0.122	38.45	-17.60	23.00	0.200	40.61	-17.61

Table 7-6. Antenna 3 ERP/EIRP Data (LTE Band 5)

WCDMA Band 5

Frequency [MHz]	Mode	Conducted Power [dBm]	Ant. Gain [dBi]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
836.60	WCDMA850	25.63	-2.70	20.85	0.122	38.45	-17.60	22.93	0.196	40.61	-17.68

Table 7-7. Antenna 3 ERP/EIRP Data (WCDMA Band 5)

NR Band 5

Bandwidth	Mod.	Frequency [MHz]	Ant. Gain [dBi]	RB Size/Offset	Conducted Power [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
20 MHz	QPSK	836.5	-2.70	1 / 1	25.53	20.68	0.117	38.45	-17.77	22.83	0.192	40.61	-17.78

Table 7-8. Antenna 3 ERP/EIRP Data (NR Band n5)

ULCA - LTE-B5

Power State	Band	Bandwidth (PCC + SCC)	PCC				SCC				ULCA Tx. Power [dBm]	Ant. Gain [dBi]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]		
			Modulation	UL Channel	UL Frequency	UL # RB	UL RB Offset	Modulation	UL Channel	UL Frequency												
Max	LTE B5	10MHz + 10MHz	QPSK	20475	831.5	1	49	QPSK	20574	841.4	1	0	25.66	-2.70	20.81	0.121	38.45	-17.64	22.96	0.198	40.61	-17.65

Table 7-9. Antenna 3 ERP/EIRP Data (ULCA LTE Band n5)

FCC ID: BCGA2437		PART 22 DATA REFERENCE REPORT								Approved by: Technical Manager	
Test Report S/N: 1C2205090029-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device									Page 14 of 17

7.4 Antenna 1 – ERP/EIRP

LTE-B5

Bandwidth	Mod.	Frequency [MHz]	Ant. Gain [dBi]	RB Size/Offset	Conducted Power [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
10 MHz	QPSK	836.5	-2.00	1 / 0	23.90	19.75	0.094	38.45	-18.70	21.90	0.155	40.61	-18.71

Table 7-10. Antenna 1 ERP/EIRP Data (LTE Band 5)

WCDMA Band 5

Frequency [MHz]	Mode	Conducted Power [dBm]	Ant. Gain [dBi]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
836.60	WCDMA850	23.90	-2.00	19.75	0.094	38.45	-18.70	21.90	0.155	40.61	-18.71

Table 7-11. Antenna 1 ERP/EIRP Data (WCDMA Band 5)

NR Band 5

Bandwidth	Mod.	Frequency [MHz]	Ant. Gain [dBi]	RB Size/Offset	Conducted Power [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
20 MHz	QPSK	836.5	-2.00	1 / 1	23.86	19.71	0.094	38.45	-18.74	21.86	0.153	40.61	-18.75

Table 7-12. Antenna 1 ERP/EIRP Data (NR Band n5)

ULCA - LTE-B5

Power State	Band	Bandwidth (PCC + SCC)	PCC				SCC				ULCA Tx. Power [dBm]	Ant. Gain [dBi]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]		
			Modulation	UL Channel	UL Frequency	UL # RB	UL RB Offset	Modulation	UL Channel	UL Frequency												
Max	LTE B5	10MHz + 10MHz	QPSK	20475	831.5	1	49	QPSK	20574	841.4	1	0	23.80	-2.00	19.65	0.092	38.45	-18.80	21.80	0.151	40.61	-18.81

Table 7-13. Antenna 1 ERP/EIRP Data (ULCA LTE Band n5)

FCC ID: BCGA2437	 element	PART 22 DATA REFERENCE REPORT								Approved by:	
Test Report S/N: 1C2205090029-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device								Technical Manager	

Version 2.1 11/9/2021

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8.0 CONCLUSION

The spot-check data measured for variant model **FCC ID: BCGA2437** is in tolerance with reference model FCC ID: BCGA2764 per FCC Approved Data Referencing Test Plan.

FCC ID: BCGA2437	 element	PART 22 DATA REFERENCE REPORT		Approved by: Technical Manager
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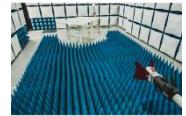


9.0 APPENDIX A: REFERENCE MODEL TEST REPORT

Attached is the test report (1C2205090028-01.BCG) from reference model FCC ID: BCGA2764, which includes referenced data results.

FCC ID: BCGA2437	element	PART 22 DATA REFERENCE REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090029-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 17 of 17

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PART 22 MEASUREMENT REPORT

Applicant Name:

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

Date of Testing:

5/30/2022 - 9/16/2022

Test Site/Location:

Element Washington DC LLC, Morgan Hill, CA, USA

Test Report Serial No.:

1C2205090028-01.BCG

FCC ID:**BCGA2764****Applicant Name:****Apple Inc.****Application Type:**

Certification

Model:

A2764

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.

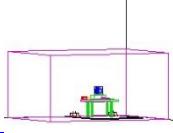
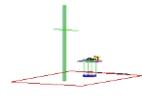

RJ Ortanez
Executive Vice President

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device	Page 1 of 111

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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]	
WCDMA850	Band 5	5 MHz	Spread Spectrum	826.4 - 846.6	4.1582	0.122	20.85	0.200	23.00	4M16F9W
			QPSK	824.7 - 848.3	1.1043	0.122	20.85	0.200	23.00	1M10G7W
			16QAM	824.7 - 848.3	1.1166	0.099	19.95	0.162	22.10	1M12D7W
			64QAM	824.7 - 848.3	1.1086	0.081	19.09	0.133	21.24	1M11D7W
			256QAM	824.7 - 848.3	1.0995	0.048	16.83	0.079	18.98	1M10D7W
		3 MHz	QPSK	825.5 - 847.5	2.7159	0.122	20.85	0.200	23.00	2M72G7W
			16QAM	825.5 - 847.5	2.7218	0.101	20.04	0.166	22.19	2M72D7W
			64QAM	825.5 - 847.5	2.7123	0.089	19.48	0.146	21.63	2M71D7W
			256QAM	825.5 - 847.5	2.6932	0.048	16.79	0.078	18.94	2M69D7W
		5 MHz	QPSK	826.5 - 846.5	4.5291	0.122	20.85	0.200	23.00	4M53G7W
			16QAM	826.5 - 846.5	4.5412	0.097	19.85	0.158	22.00	4M54D7W
			64QAM	826.5 - 846.5	4.5434	0.078	18.93	0.128	21.08	4M54D7W
			256QAM	826.5 - 846.5	4.5489	0.048	16.80	0.079	18.95	4M55D7W
		10 MHz	QPSK	829.0 - 844.0	9.0341	0.122	20.85	0.200	23.00	9M03G7W
			16QAM	829.0 - 844.0	9.0418	0.097	19.87	0.159	22.02	9M04D7W
			64QAM	829.0 - 844.0	9.0620	0.081	19.06	0.132	21.21	9M06D7W
			256QAM	829.0 - 844.0	9.0210	0.049	16.86	0.080	19.01	9M02D7W
		1.4 MHz	QPSK	824.7 - 848.3	1.1043	0.122	20.85	0.200	23.00	1M10G7W
			16QAM	824.7 - 848.3	1.1166	0.101	20.05	0.166	22.20	1M12D7W
			64QAM	824.7 - 848.3	1.1086	0.081	19.11	0.134	21.26	1M11D7W
			256QAM	824.7 - 848.3	1.0995	0.051	17.04	0.083	19.19	1M10D7W
		3 MHz	QPSK	825.5 - 847.5	2.7159	0.122	20.85	0.200	23.00	2M72G7W
			16QAM	825.5 - 847.5	2.7218	0.102	20.08	0.167	22.23	2M72D7W
			64QAM	825.5 - 847.5	2.7123	0.079	18.98	0.130	21.13	2M71D7W
			256QAM	825.5 - 847.5	2.6932	0.039	15.96	0.065	18.11	2M69D7W
		5 MHz	QPSK	826.5 - 846.5	4.5291	0.122	20.85	0.200	23.00	4M53G7W
			16QAM	826.5 - 846.5	4.5412	0.099	19.85	0.162	22.10	4M54D7W
			64QAM	826.5 - 846.5	4.5434	0.085	19.27	0.139	21.42	4M54D7W
			256QAM	826.5 - 846.5	4.5489	0.038	15.83	0.063	17.98	4M55D7W
		10 MHz	QPSK	829.0 - 844.0	9.0341	0.122	20.85	0.200	23.00	9M03G7W
			16QAM	829.0 - 844.0	9.0418	0.099	19.97	0.163	22.12	9M04D7W
			64QAM	829.0 - 844.0	9.0620	0.083	19.20	0.136	21.35	9M06D7W
			256QAM	829.0 - 844.0	9.0210	0.040	16.06	0.066	18.21	9M02D7W
ULCA Band 5	Band 26	10 + 10 MHz	QPSK	829.0 - 844.0	18.9159	0.119	20.76	0.195	22.91	18M9G7W
			16QAM	829.0 - 844.0	18.8885	0.064	18.05	0.105	20.20	18M9D7W
			64QAM	829.0 - 844.0	18.8789	0.063	17.97	0.103	20.12	18M9D7W
			256QAM	829.0 - 844.0	18.9045	0.039	15.87	0.063	18.02	18M9D7W
		5 MHz	T/2 BPSK	826.5 - 846.5	4.5925	0.121	20.84	0.199	22.99	4M59G7W
			QPSK	826.5 - 846.5	4.5339	0.122	20.85	0.200	23.00	4M53G7W
			16QAM	826.5 - 846.5	4.5372	0.097	19.85	0.158	22.00	4M54D7W
			64QAM	826.5 - 846.5	4.5569	0.077	18.84	0.126	20.99	4M56D7W
		10 MHz	T/2 BPSK	829.0 - 844.0	9.0361	0.122	20.85	0.200	23.00	9M04G7W
			QPSK	829.0 - 844.0	9.3688	0.120	20.80	0.197	22.95	9M37G7W
			16QAM	829.0 - 844.0	9.3503	0.097	19.85	0.158	22.00	9M35D7W
			64QAM	829.0 - 844.0	9.3459	0.077	18.88	0.127	21.03	9M35D7W
		15 MHz	T/2 BPSK	829.0 - 844.0	9.3762	0.039	15.86	0.063	18.01	9M38D7W
			QPSK	831.5 - 841.5	13.5446	0.122	20.85	0.200	23.00	13M5G7W
			16QAM	831.5 - 841.5	14.2189	0.121	20.84	0.199	22.99	14M2G7W
			64QAM	831.5 - 841.5	14.1996	0.097	19.85	0.158	22.00	14M2D7W
		20 MHz	T/2 BPSK	831.5 - 841.5	14.1908	0.077	18.87	0.126	21.02	14M2D7W
			QPSK	831.5 - 841.5	14.1998	0.041	16.14	0.067	18.29	14M2D7W
			16QAM	834.0 - 839.0	19.0246	0.096	19.82	0.157	21.97	19M0D7W
			64QAM	834.0 - 839.0	19.0957	0.077	18.85	0.126	21.00	19M1D7W
		NR Band n5	256QAM	834.0 - 839.0	19.0202	0.038	15.77	0.062	17.92	19M0D7W
			T/2 BPSK	826.5 - 846.5	4.5925	0.121	20.84	0.199	22.99	4M59G7W
			QPSK	826.5 - 846.5	4.5339	0.122	20.85	0.200	23.00	4M53G7W
			16QAM	826.5 - 846.5	4.5372	0.097	19.85	0.158	22.00	4M54D7W
		NR Band n26	64QAM	826.5 - 846.5	4.5569	0.077	18.84	0.126	20.99	4M56D7W
			256QAM	826.5 - 846.5	4.5263	0.038	15.78	0.062	17.93	4M53D7W
			T/2 BPSK	829.0 - 844.0	9.0361	0.122	20.85	0.200	23.00	9M04G7W
			QPSK	829.0 - 844.0	9.3688	0.120	20.80	0.197	22.95	9M37G7W
		10 MHz	16QAM	829.0 - 844.0	9.3503	0.097	19.85	0.158	22.00	9M35D7W
			64QAM	829.0 - 844.0	9.3459	0.077	18.88	0.127	21.03	9M35D7W
			256QAM	829.0 - 844.0	9.3762	0.039	15.86	0.063	18.01	9M38D7W

EUT Overview

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT				Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device				

1.0 INTRODUCTION

1.1 Scope

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

1.2 Element Washington DC LLC Test Location

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

1.3 Test Facility / Accreditations

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

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

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 4 of 111

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2764**. 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.: DLX2184009B1M9L1M, KRRF2YPXDHM, H4QHXFRX21, CC6D2QF1Q5

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1, FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), NB UNII (1x, 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	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	✗	✗	✗	✗	✓
2a	Config 2	✗	✓	✗	✗	✗	✓
4a	Config 3	✓	✗	✓	✗	✗	✗
4a	Config 4	✗	✓	✗	✓	✗	✗

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; ✗ = Not Support

Note:

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

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

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 5 of 111

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Band	Antenna Gain [dBi]	
	Antenna 1	Antenna 3
WCDMA850		
LTE Band5/26	-2.0	-2.7
NR Band n5/26		

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro w/AC/DC Adapter	Model: A2141 Model: A2166	S/N: C02DV7VKMD6T S/N: N/A	
2	Apple USB-C Cable	Model: Spartan	S/N: 000MKTR02U	
3	USB-C Cable w/ AC Adapter	Model: A246 Model: A2305	S/N: N/A S/N: N/A	
4	Apple Pencil	Model: N/A	S/N: GQXGSXBJKM9	
5	DC Power Supply	Model: KPS3010D	S/N: N/A	

Table 2-3. Test Support Equipment

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 6 of 111

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 were tested with the highest transmitting power and the worst case channel.

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

2.6 Software and Firmware

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

2.7 EMI Suppression Device(s)/Modifications

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

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device	Page 7 of 111

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.

Deviation from Measurement Procedure.....None

3.2 Radiated Spurious Emissions

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

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

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

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

And

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

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

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

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

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4.0 MEASUREMENT UNCERTAINTY

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

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

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5.0 TEST EQUIPMENT CALIBRATION DATA

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

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

Table 5-1. Test Equipment

Notes:

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

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6.0 SAMPLE CALCULATIONS

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 = 8M62G7D

LTE BW = 8.62 MHz

G = Phase Modulation

7 = Quantized/Digital Info

W = Data transmission, telemetry, telecommand

QAM Modulation

Emission Designator = 8M45W7D

LTE BW = 8.45 MHz

D = Amplitude/Angle Modulated

7 = Quantized/Digital Info

W = Data transmission, telemetry, telecommand

Spurious Radiated Emission

Example: Spurious emission at 3700.40 MHz

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

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7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCGA2764
 FCC Classification: PCS Licensed Transmitter (PCB)
 Mode(s): 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)	-13 dBm 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 Stability	2.1055, 22.355	±2.5 ppm	PASS	Section 7.7
RADIATED	Radiated Spurious Emissions	2.1053, 22.917(a)	-13 dBm 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 is Element EMC Software Tool v1.1.

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7.2 Occupied Bandwidth

§2.1049

Test Overview

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section. All ports were tested and only the worst case data were reported.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 4.2

Test Settings

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

Test Setup

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

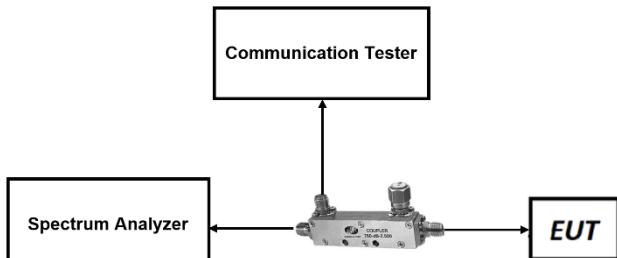


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

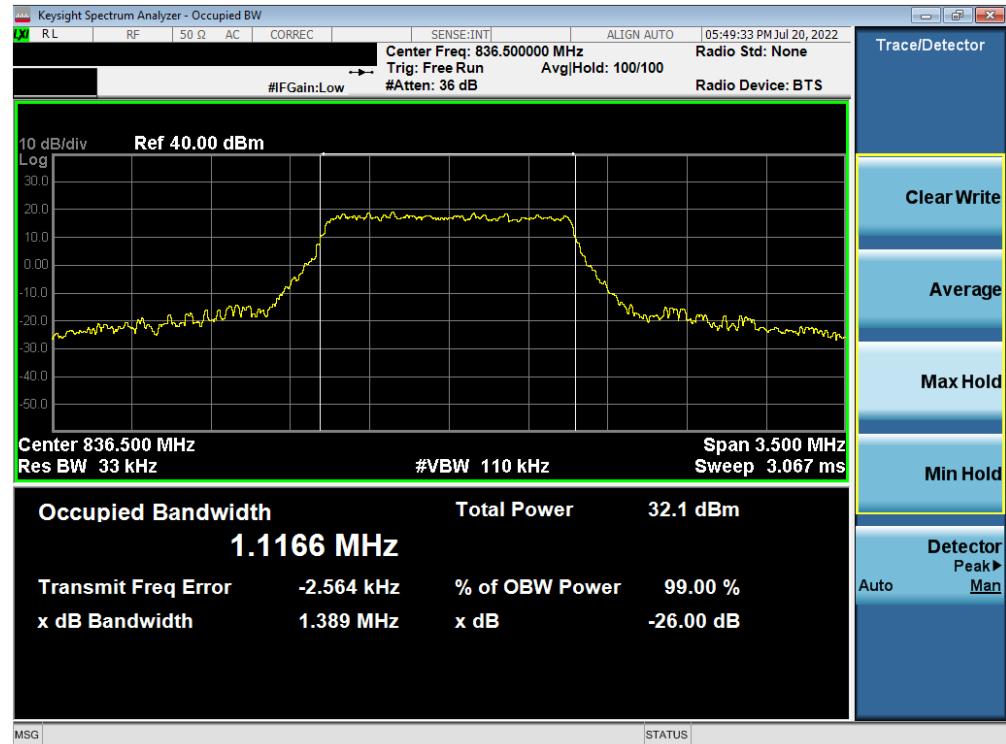
None.

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LTE Band 26/5

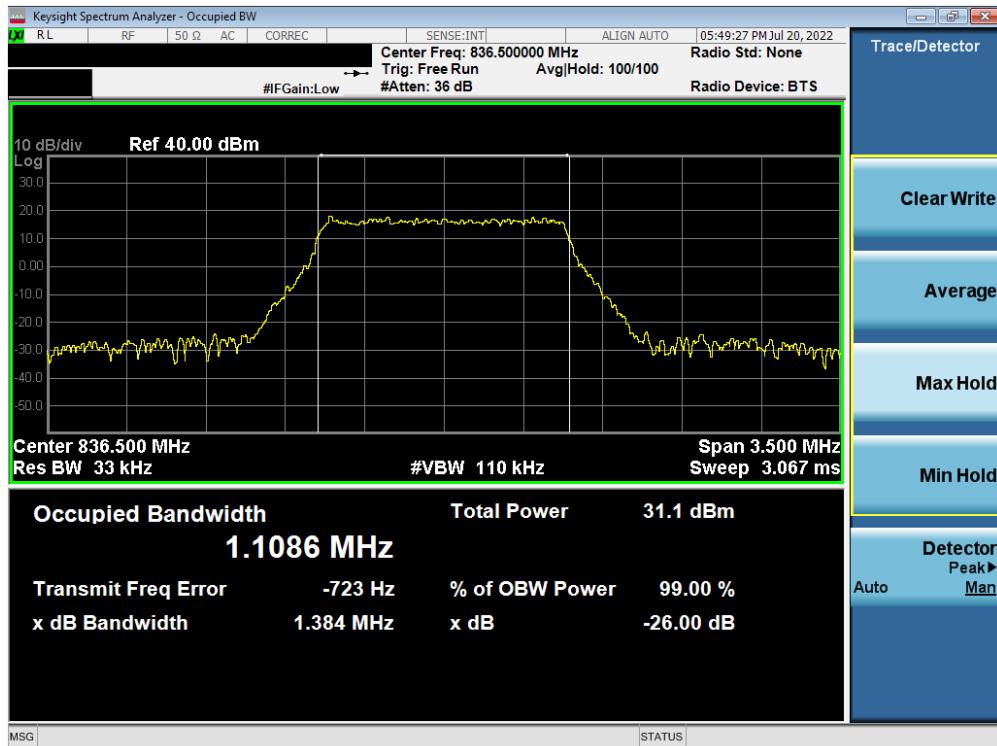


Plot 7-1. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-2. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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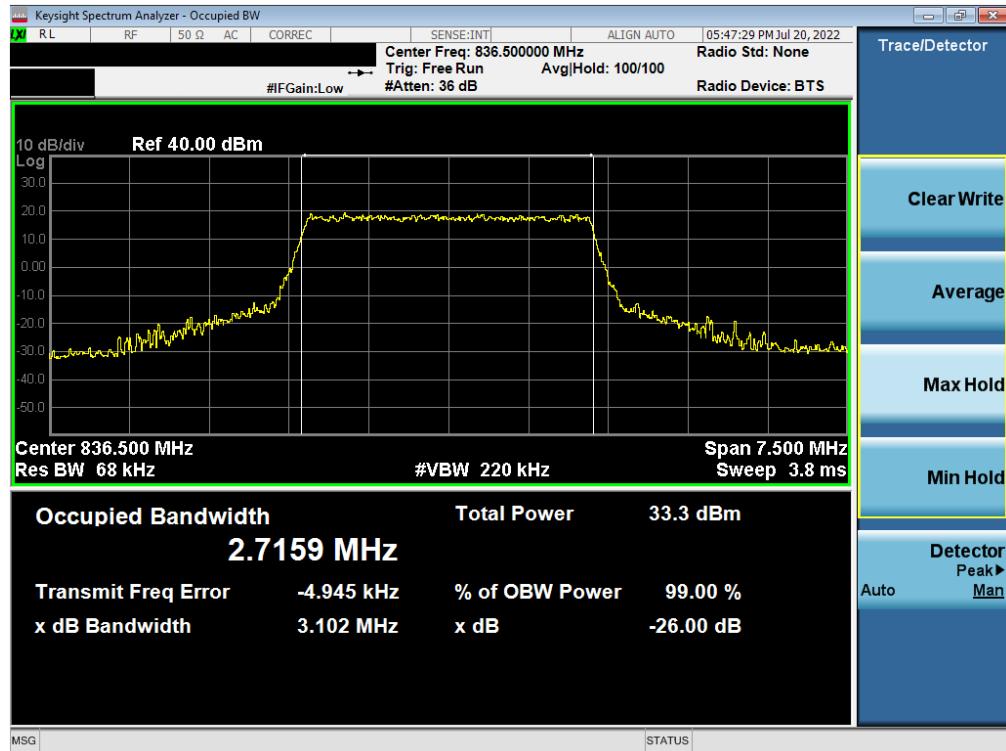


Plot 7-3. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 64-QAM - Full RB Configuration)

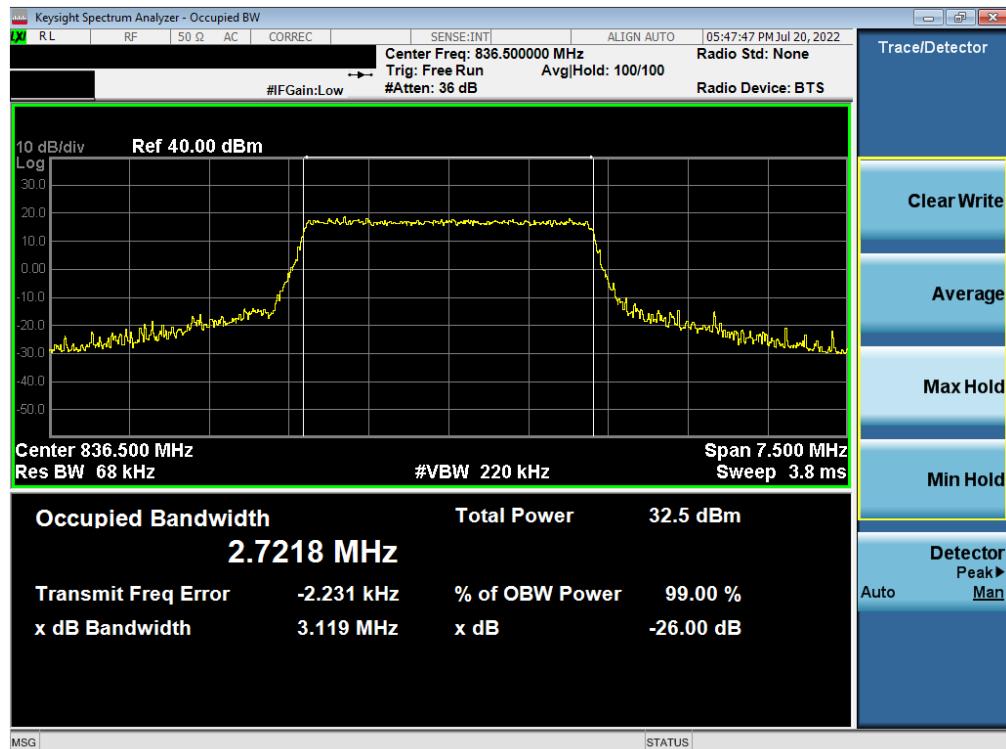


Plot 7-4. Occupied Bandwidth Plot (LTE Band 26/5 - 1.4MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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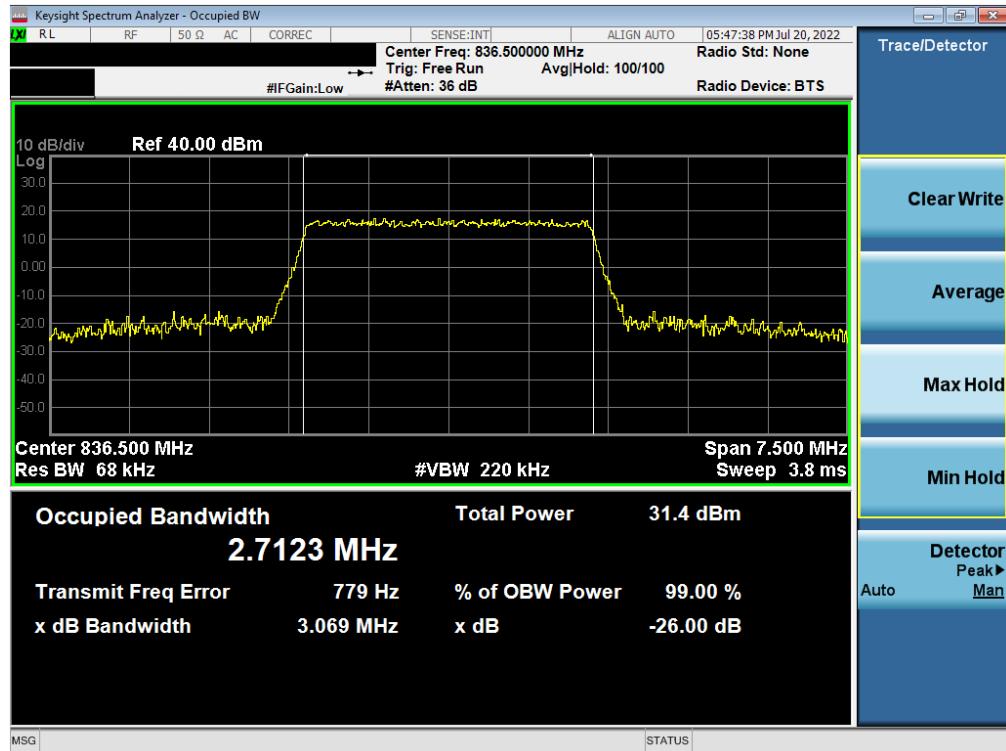


Plot 7-5. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz QPSK - Full RB Configuration)

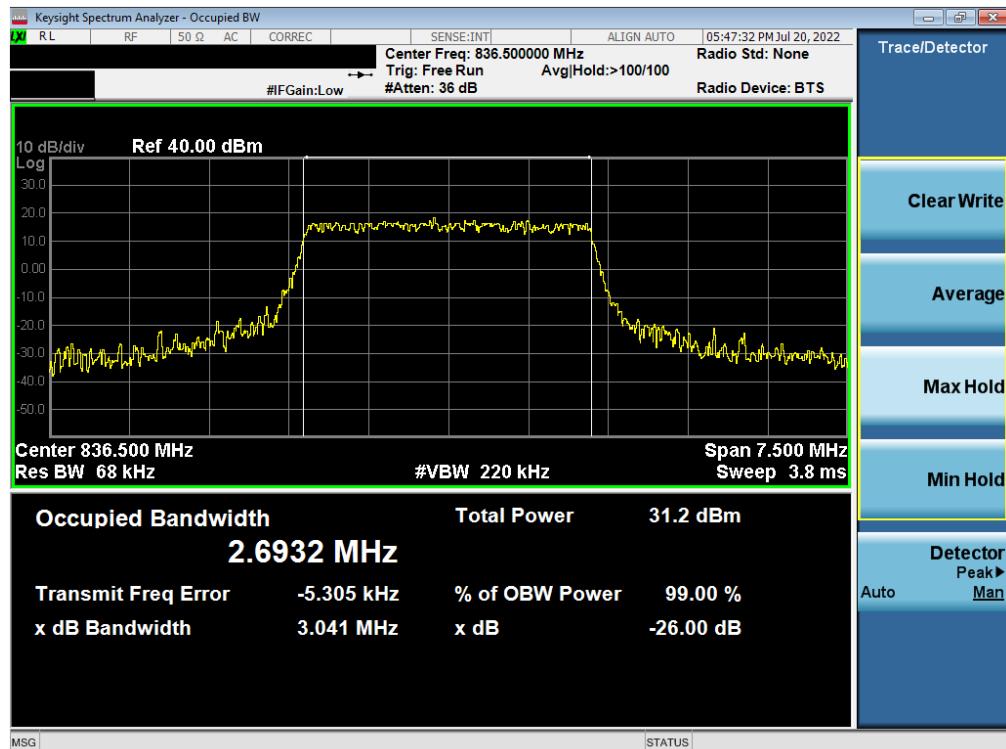


Plot 7-6. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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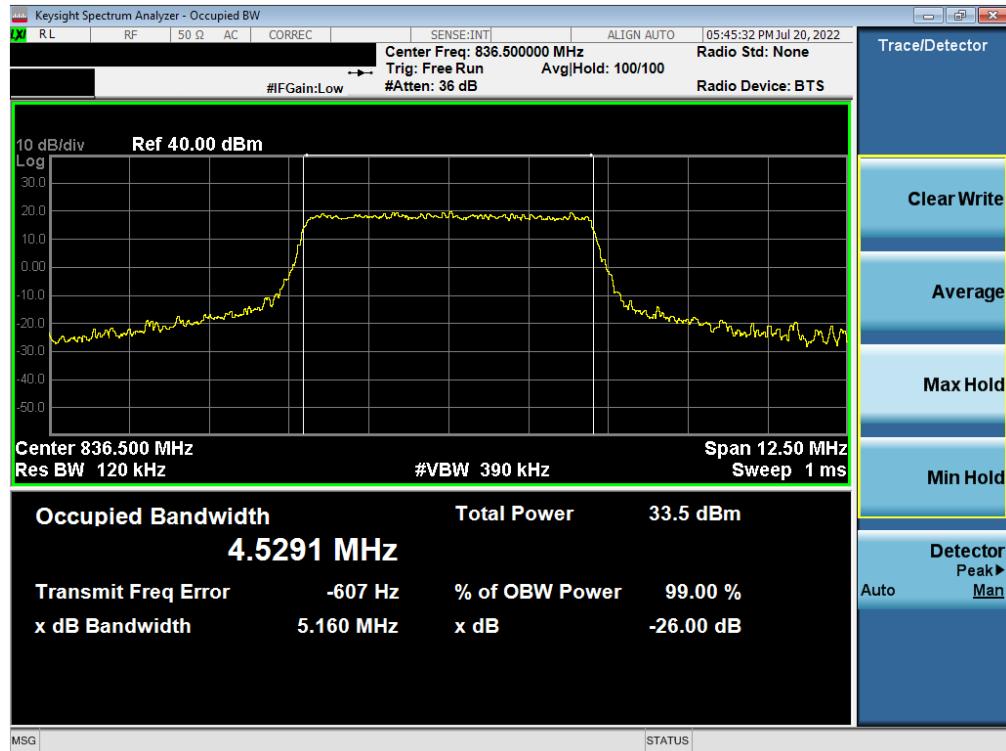


Plot 7-7. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 64-QAM - Full RB Configuration)

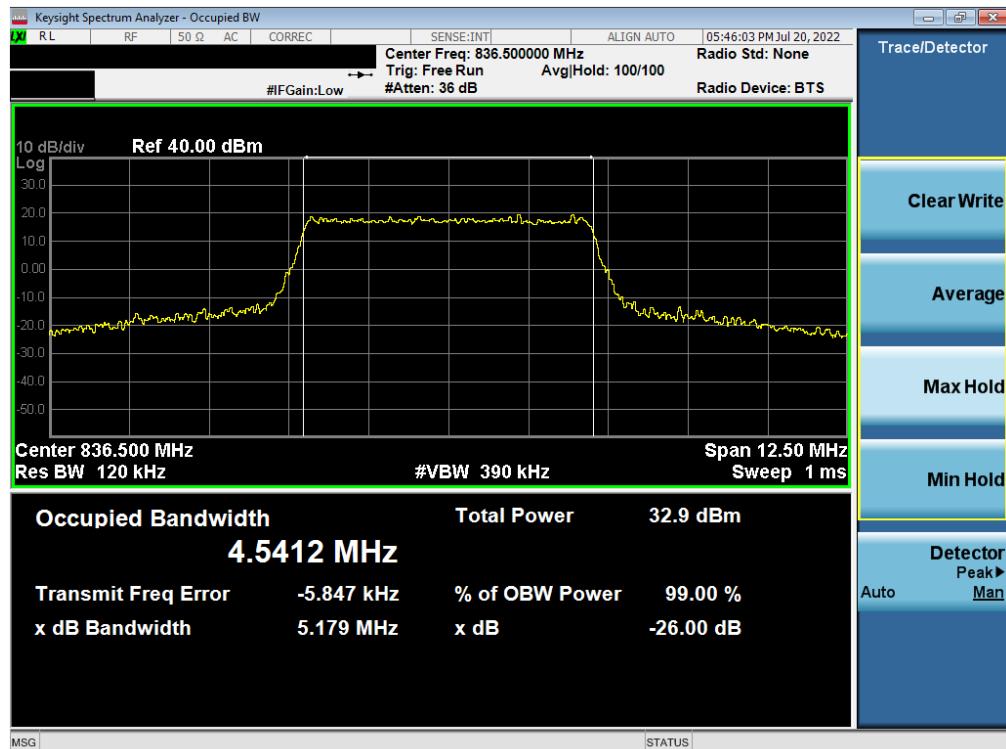


Plot 7-8. Occupied Bandwidth Plot (LTE Band 26/5 - 3MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-9. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz QPSK - Full RB Configuration)

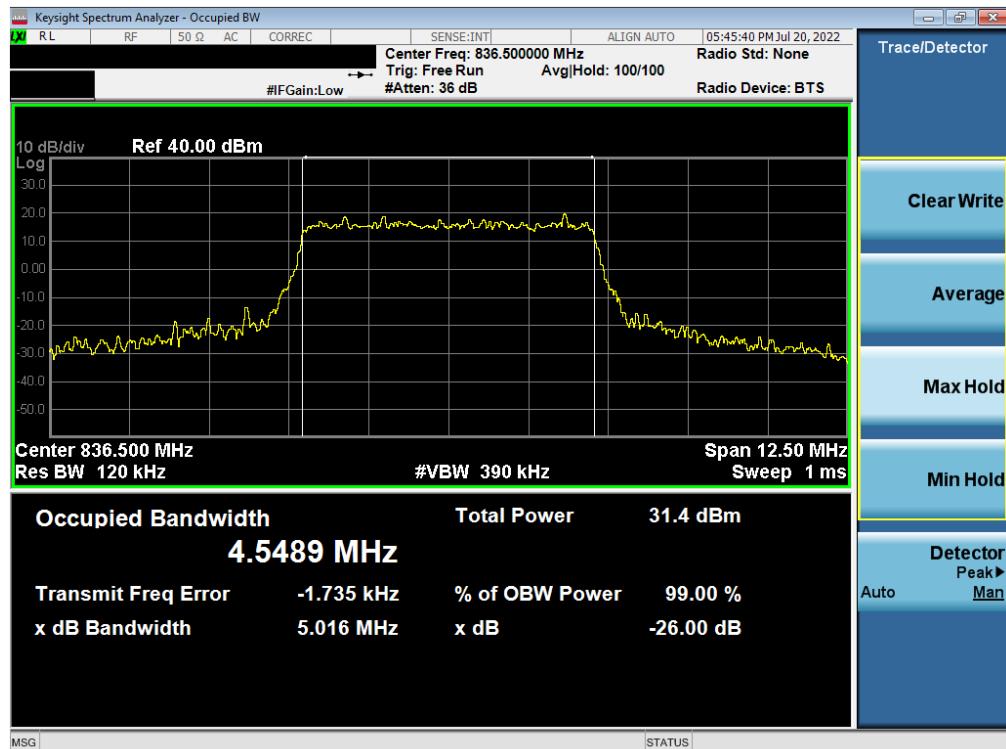


Plot 7-10. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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Plot 7-11. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 64-QAM - Full RB Configuration)

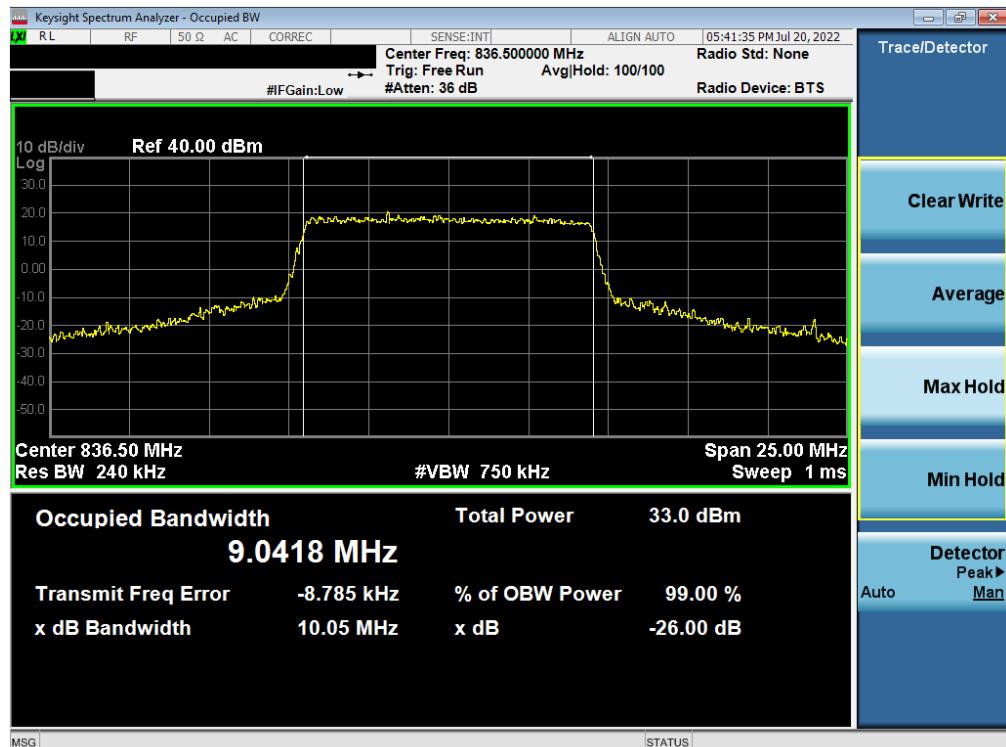


Plot 7-12. Occupied Bandwidth Plot (LTE Band 26/5 - 5MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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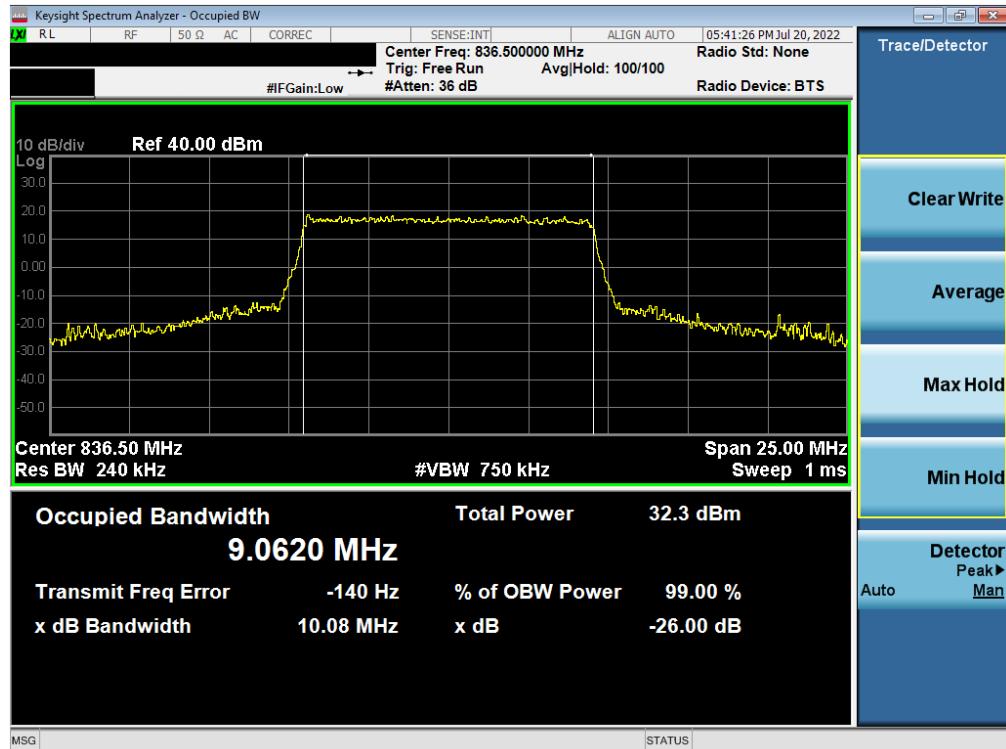


Plot 7-13. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz QPSK - Full RB Configuration)



Plot 7-14. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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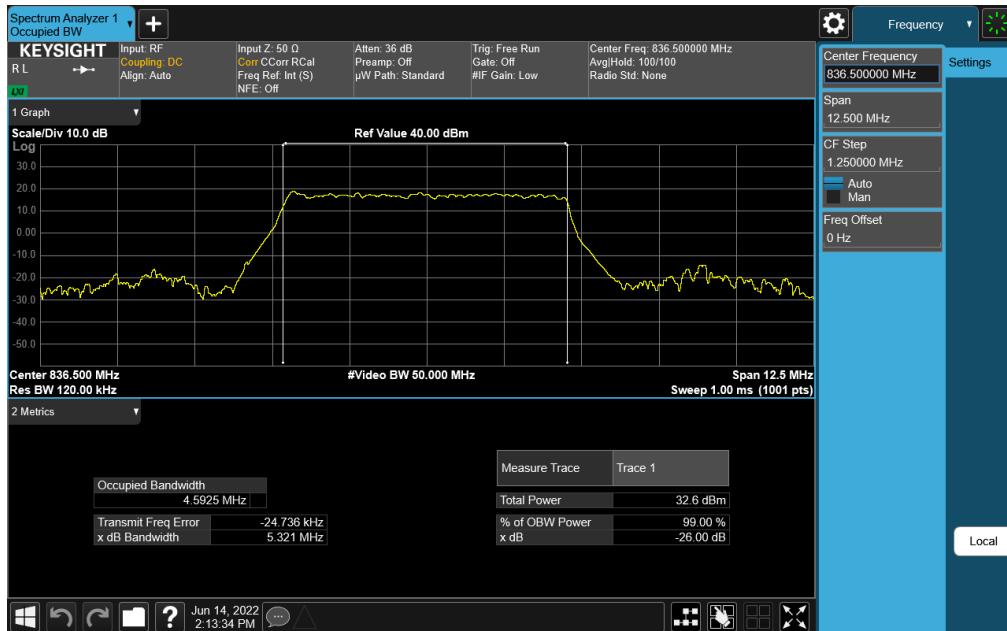
Plot 7-15. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 64-QAM - Full RB Configuration)



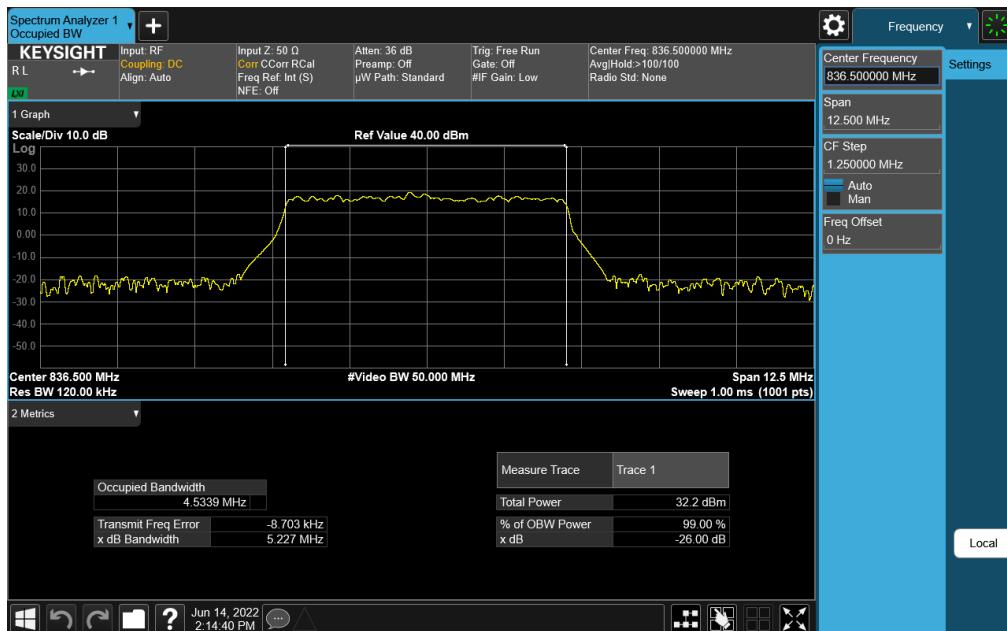
Plot 7-16. Occupied Bandwidth Plot (LTE Band 26/5 - 10MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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NR Band n26/5

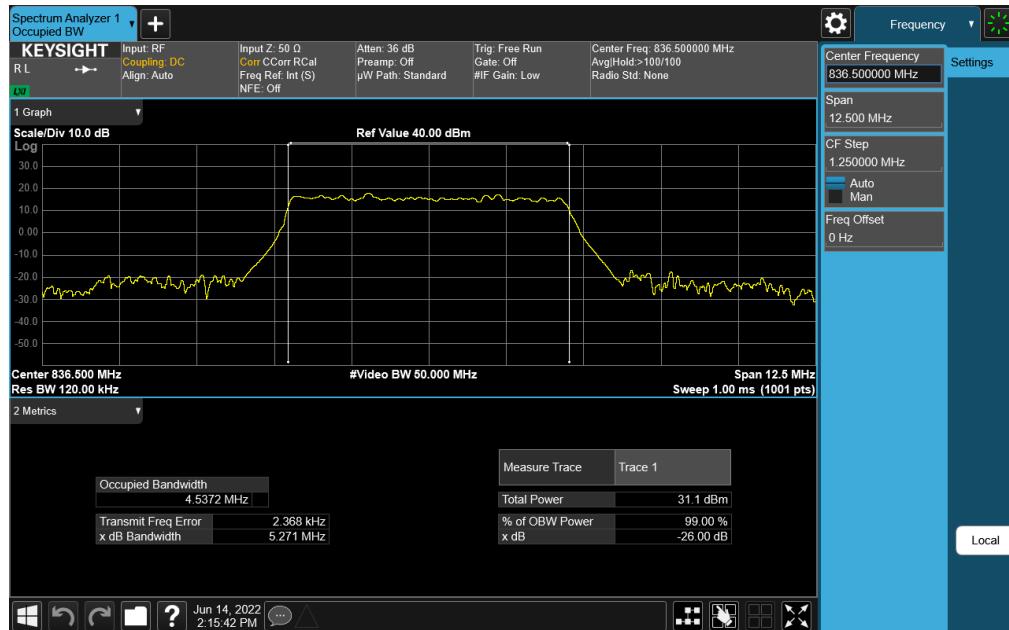


Plot 7-17. Occupied Bandwidth Plot (NR Band n26/5 - 5MHz DFT-s-OFDM $\pi/2$ BPSK - Full RB Configuration)

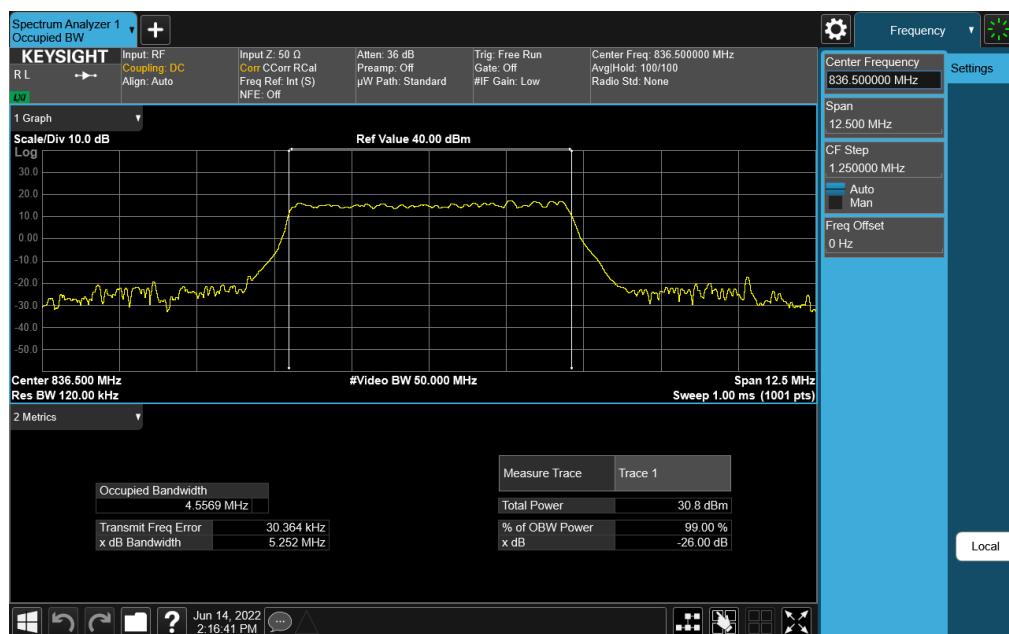


Plot 7-18. Occupied Bandwidth Plot (NR Band n26/5 - DFT-s-OFDM 5MHz QPSK - Full RB Configuration)

FCC ID: BCGA2764	element		PART 22 MEASUREMENT REPORT	Approved by: Technical Manager
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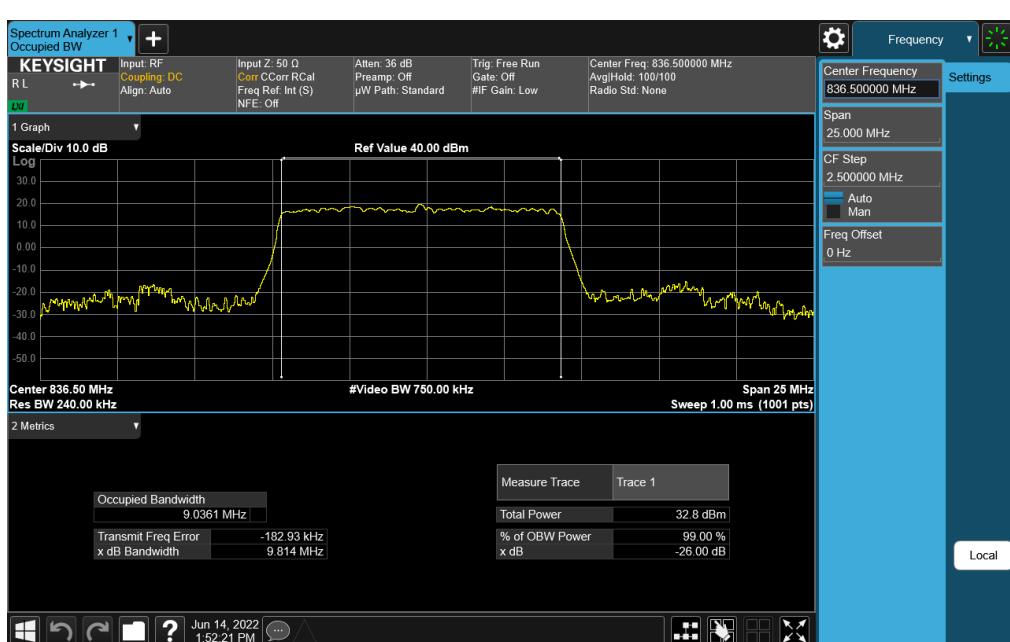
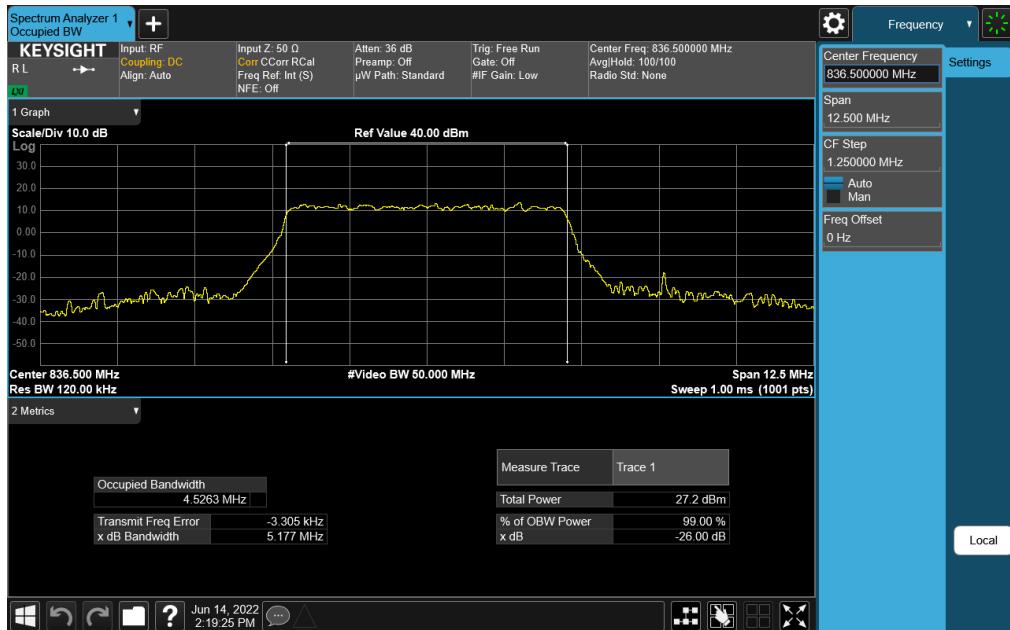


Plot 7-19. Occupied Bandwidth Plot (NR Band n26/5 - DFT-s-OFDM 5MHz 16-QAM - Full RB Configuration)

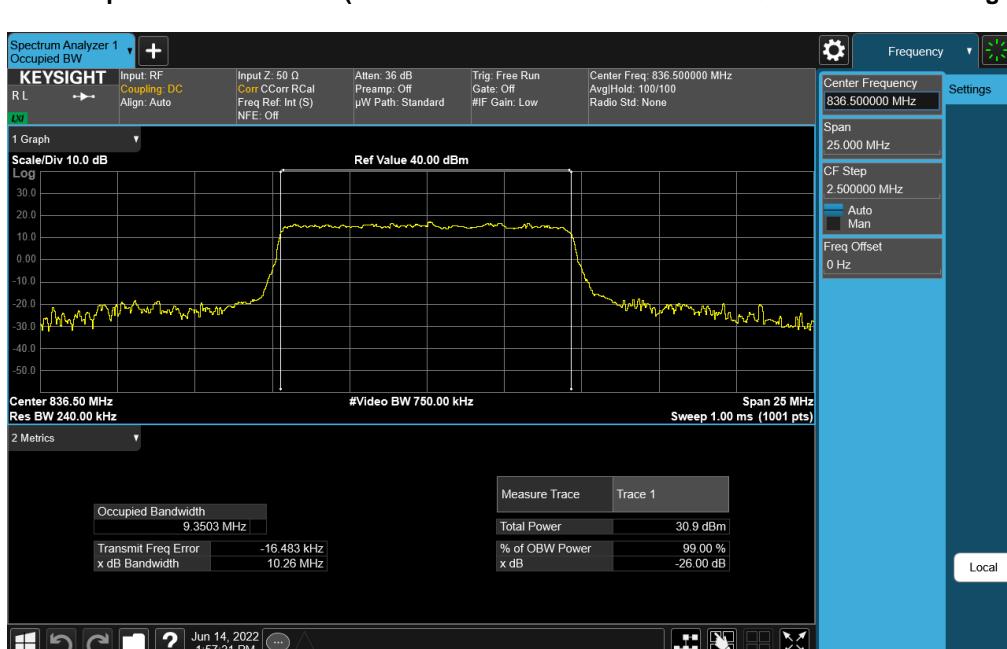
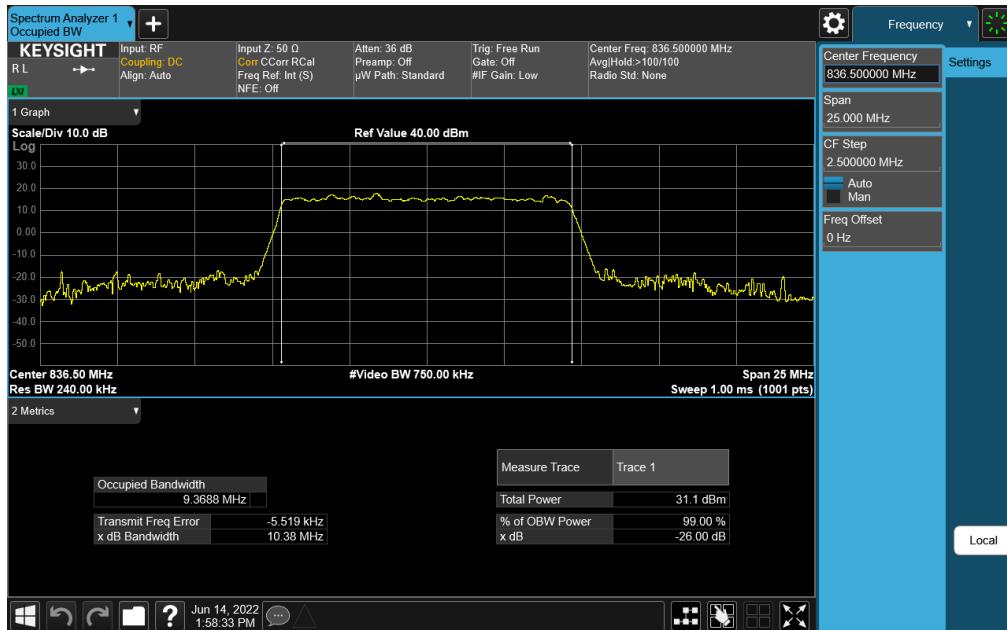


Plot 7-20. Occupied Bandwidth Plot (NR Band n26/5 - DFT-s-OFDM 5MHz 64-QAM - Full RB Configuration)

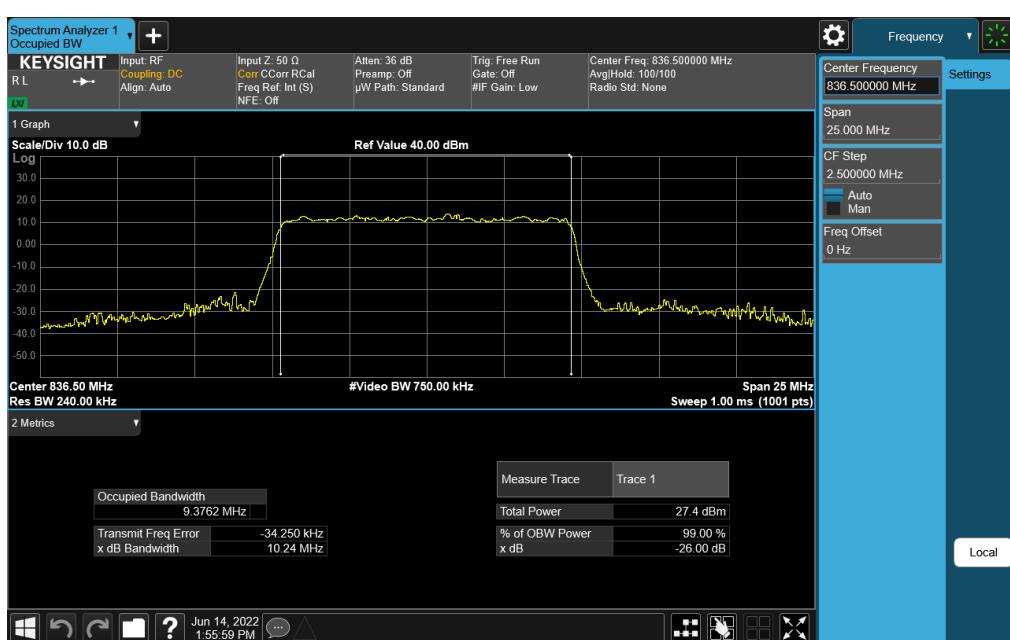
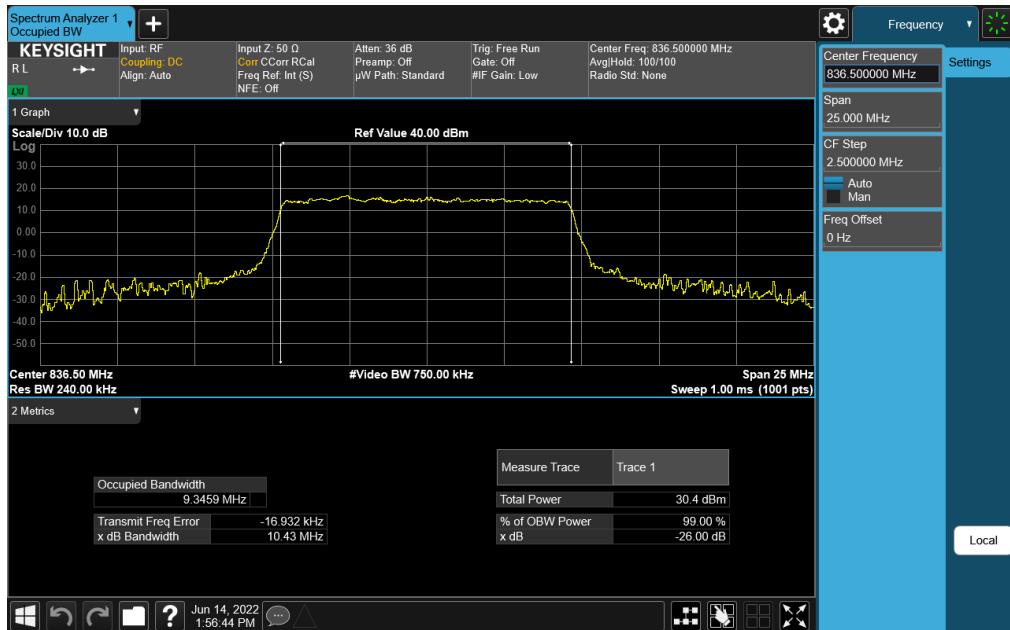
FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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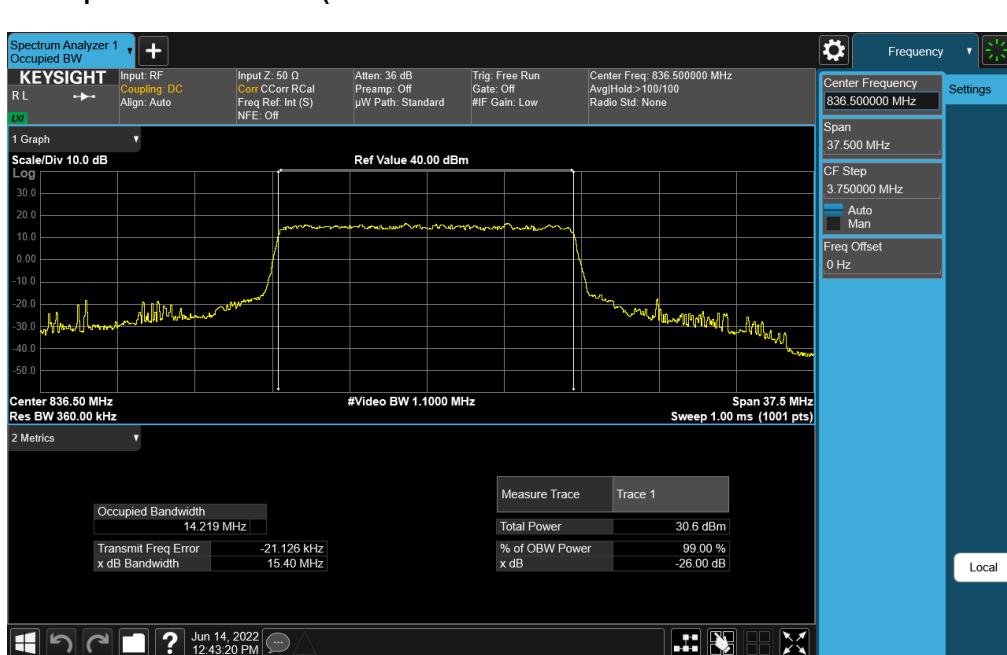
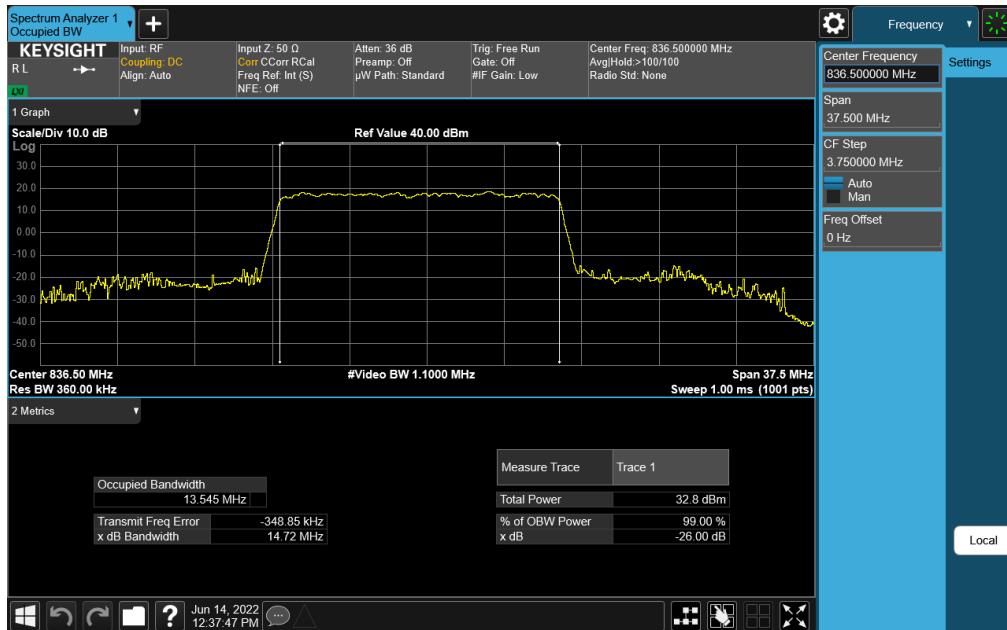
FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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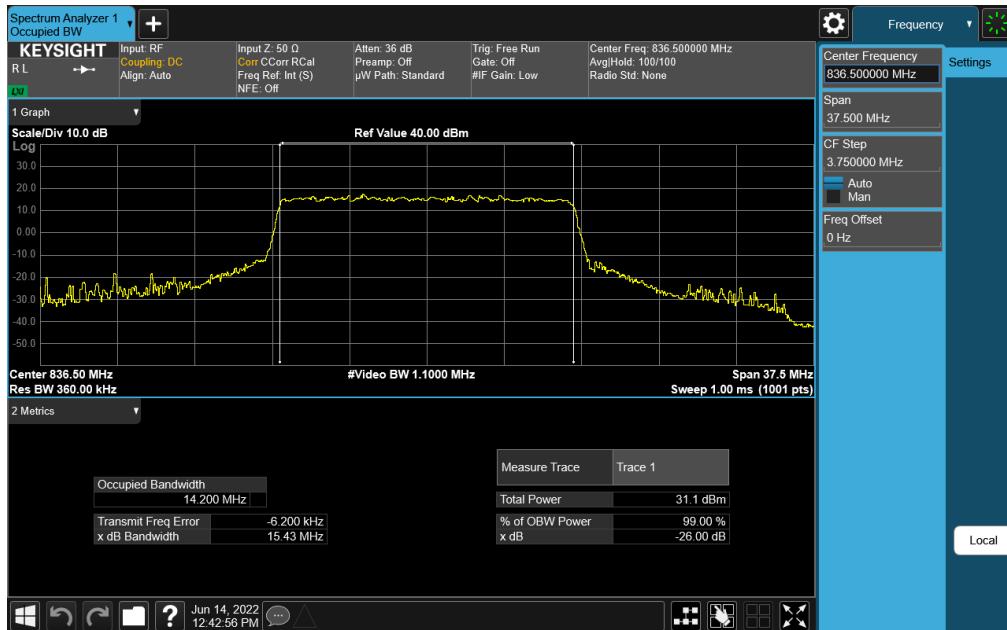
FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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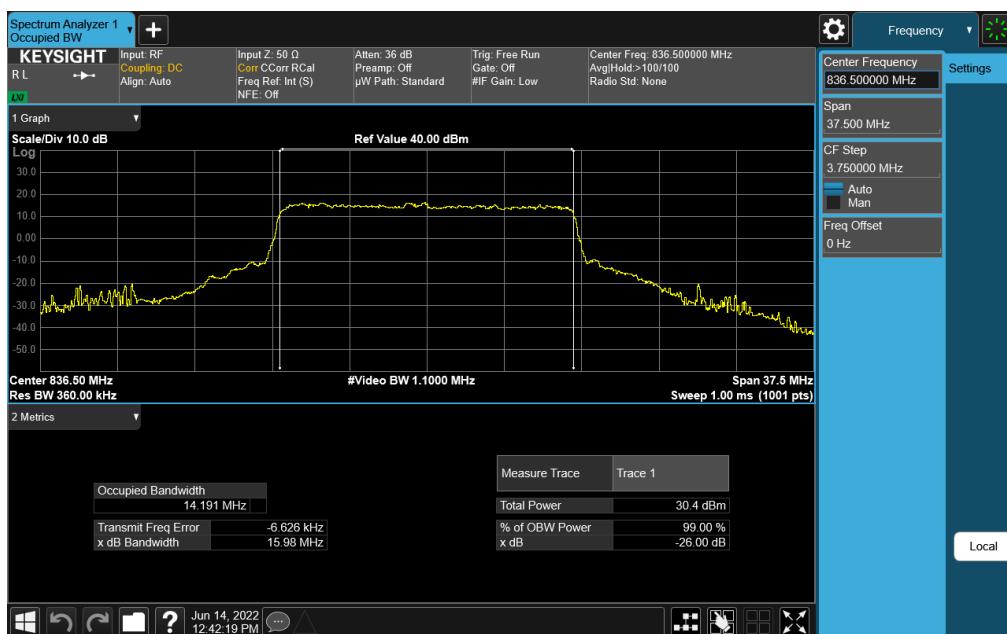
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Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device	Approved by: Technical Manager



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Plot 7-29. Occupied Bandwidth Plot (NR Band n5 - CP-OFDM 15MHz 16-QAM - Full RB Configuration)

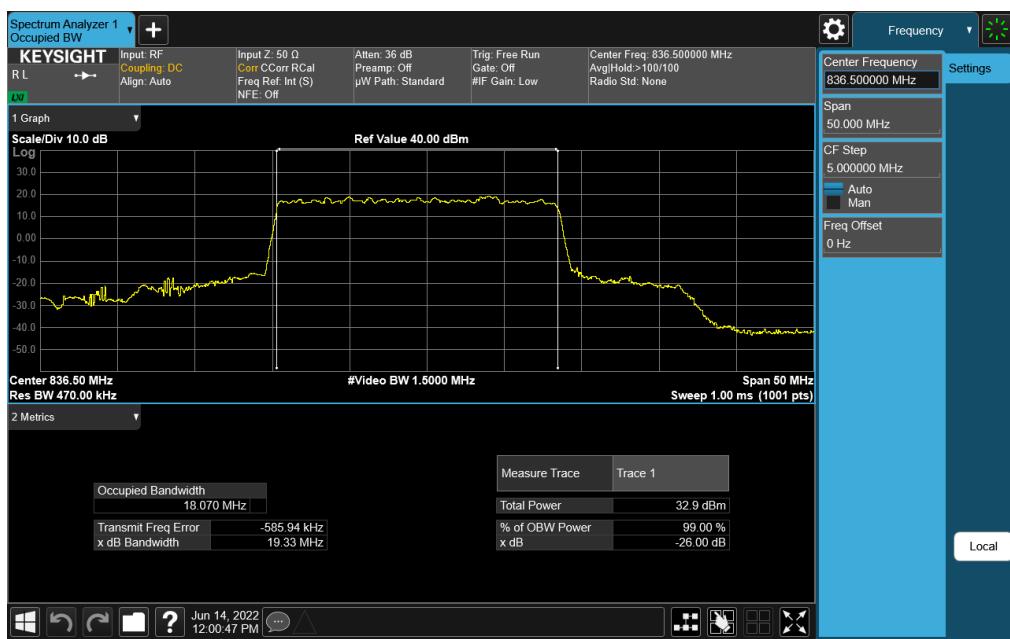


Plot 7-30. Occupied Bandwidth Plot (NR Band n5 - CP-OFDM 15MHz 64-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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Plot 7-31. Occupied Bandwidth Plot (NR Band n5 - CP-OFDM 15MHz 256-QAM - Full RB Configuration)



Plot 7-32. Occupied Bandwidth Plot (NR Band n5 - DFT-s-OFDM 20MHz π/2 BPSK - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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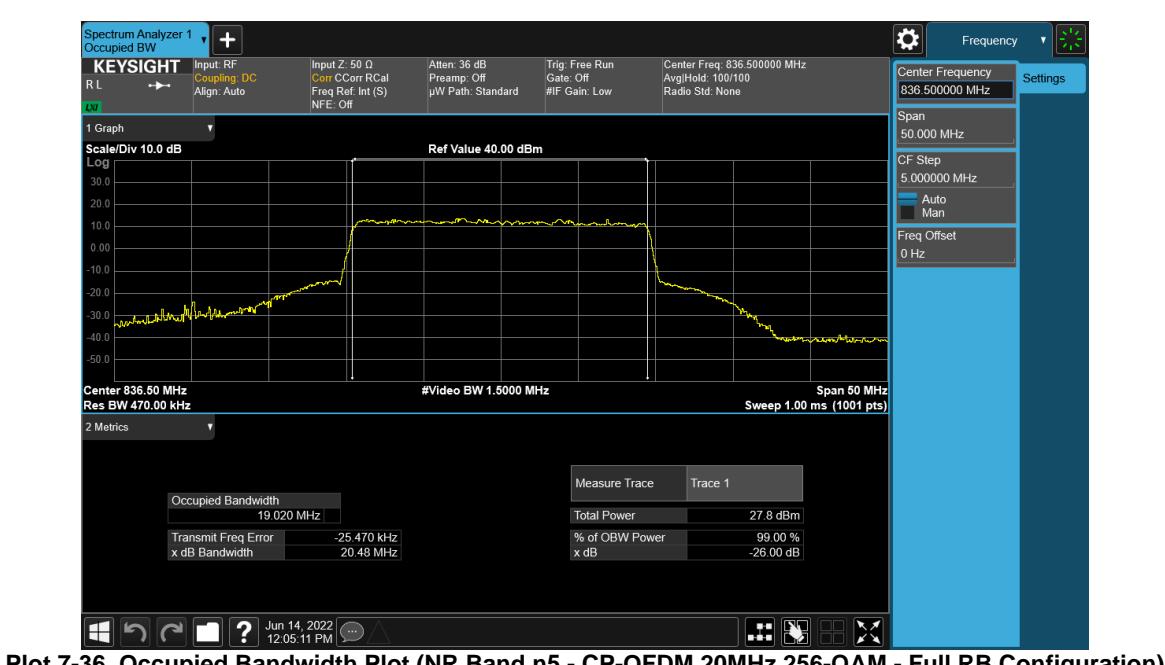


Plot 7-33. Occupied Bandwidth Plot (NR Band n5 - CP-OFDM 20MHz QPSK - Full RB Configuration)



Plot 7-34. Occupied Bandwidth Plot (NR Band n5 - CP-OFDM 20MHz 16-QAM - Full RB Configuration)

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ULCA – LTE Band 5



Plot 7-37. Conducted Spurious Plot (ULCA LTE Band 5 – (10 + 10) MHz QPSK - Full RB Configuration)



Plot 7-38. Conducted Spurious Plot (ULCA LTE Band 5 – (10 + 10)MHz 16-QAM - Full RB Configuration)

FCC ID: BCGA2764	element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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Plot 7-39. Conducted Spurious Plot (ULCA LTE Band – (10 + 10) MHz 64-QAM - Full RB Configuration)



Plot 7-40. Conducted Spurious Plot (ULCA LTE Band – (10 + 10) MHz 256-QAM - Full RB Configuration)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 33 of 111

WCDMA Cell



Plot 7-41. Occupied Bandwidth Plot (WCDMA, Ch. 4183)

FCC ID: BCGA2764	element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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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. All ports were tested and only the worst case data were reported.

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

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 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.

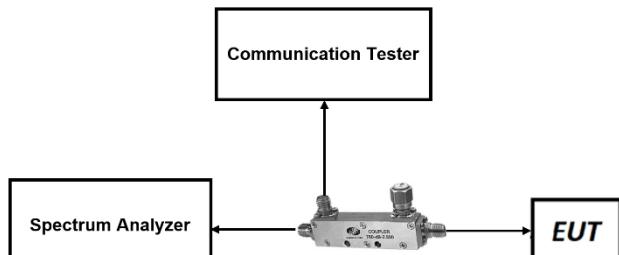


Figure 7-2. Test Instrument & Measurement Setup

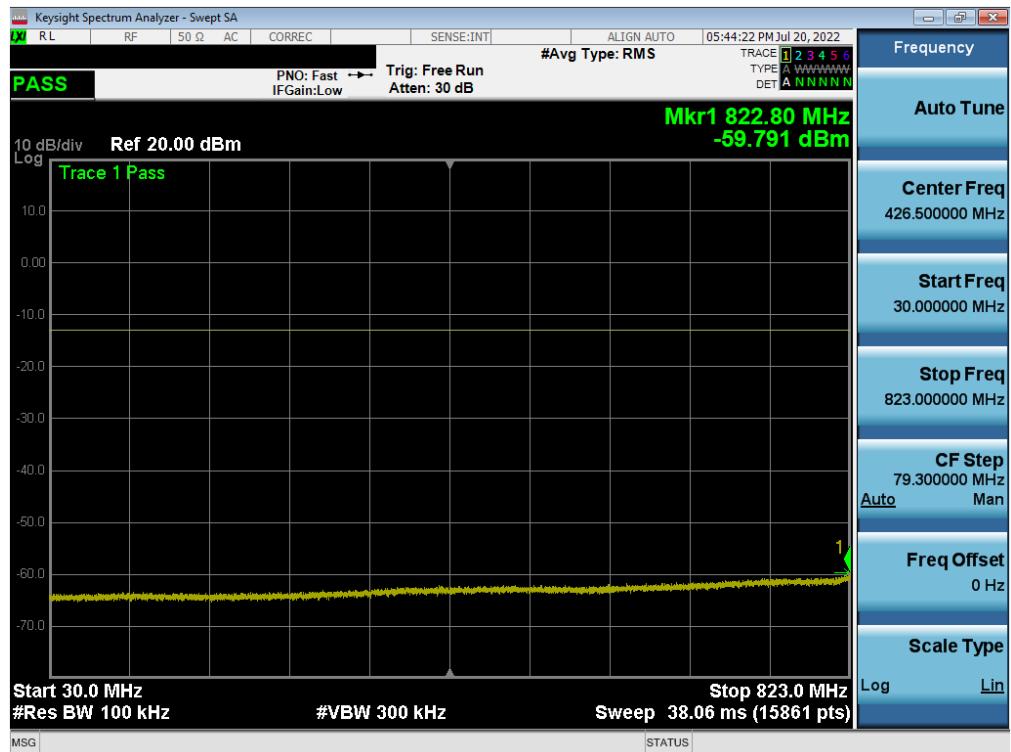
FCC ID: BCGA2764	element		PART 22 MEASUREMENT REPORT	Approved by: Technical Manager
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Test Notes

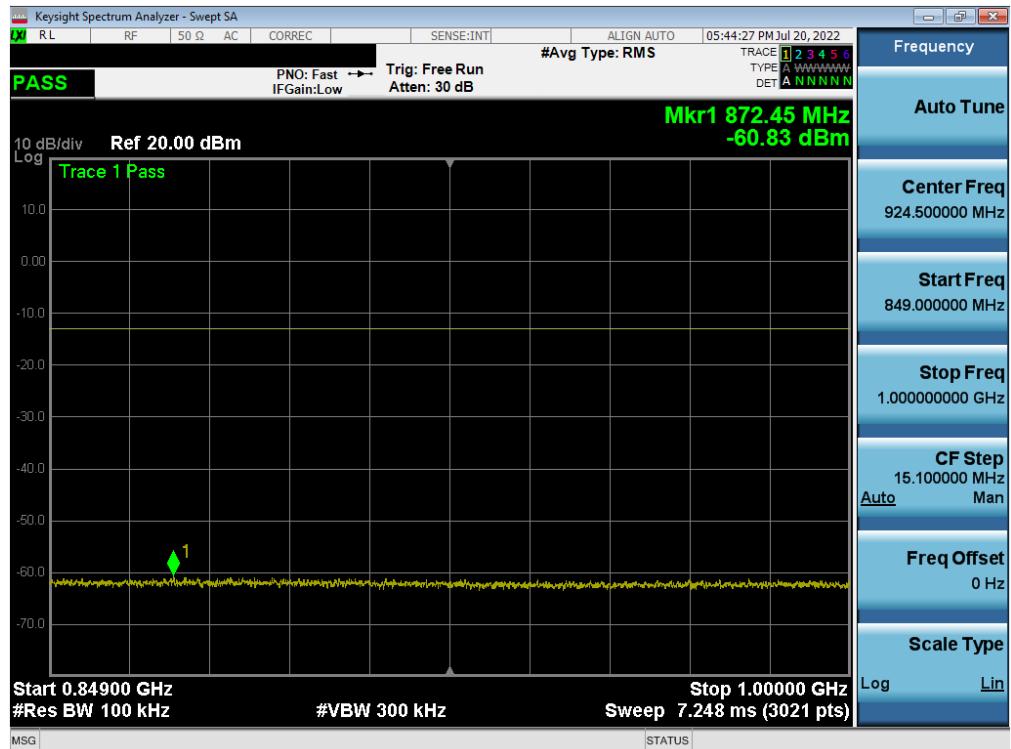
1. Per Part 22, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth 100 kHz or greater for measurements below 1GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least 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

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LTE Band 26/5

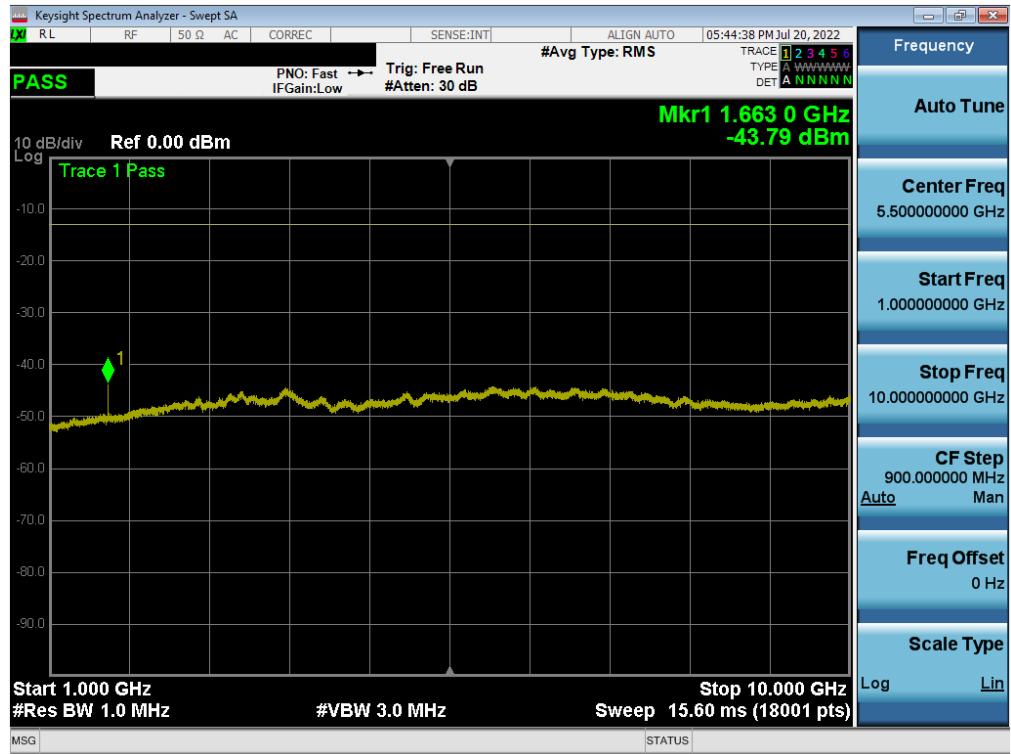


Plot 7-42. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

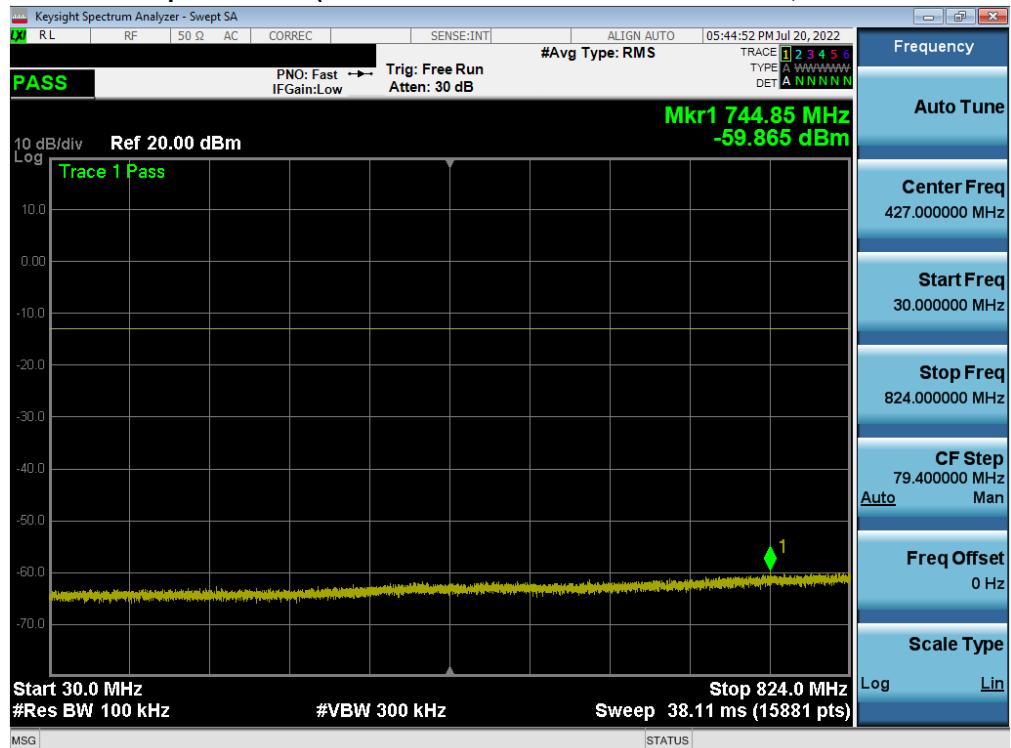


Plot 7-43. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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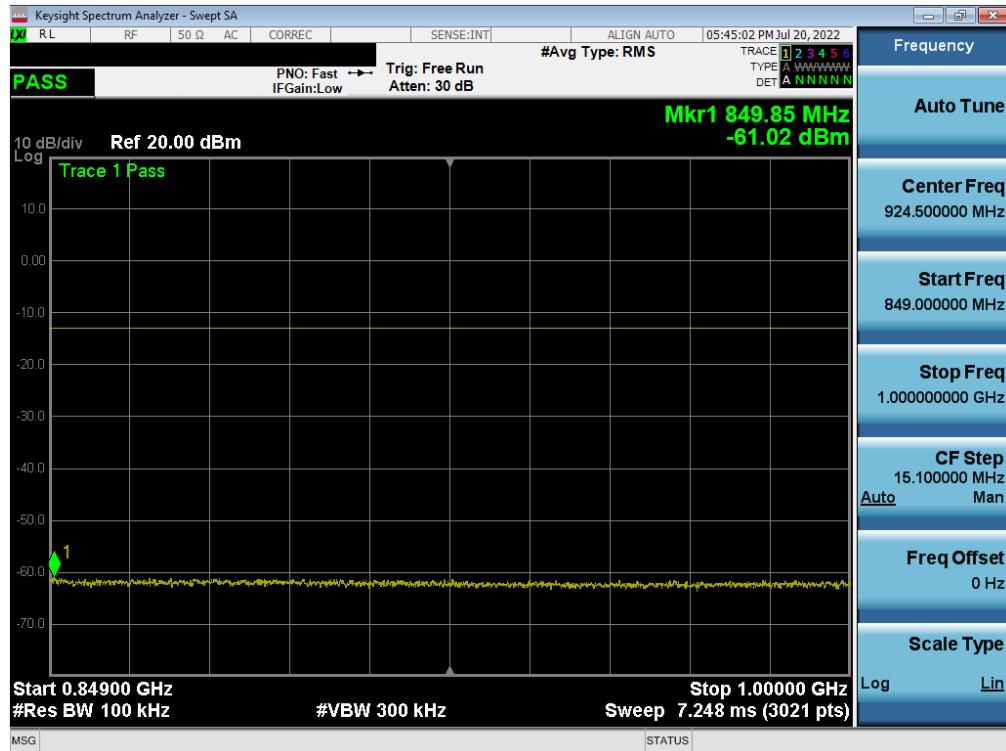


Plot 7-44. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

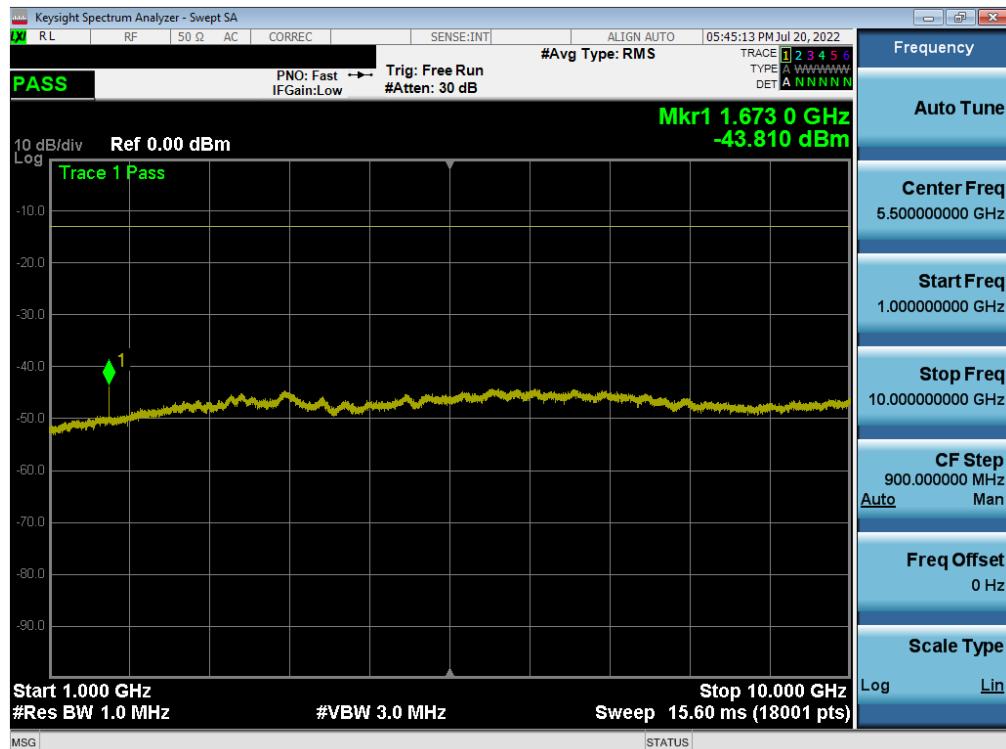


Plot 7-45. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 38 of 111

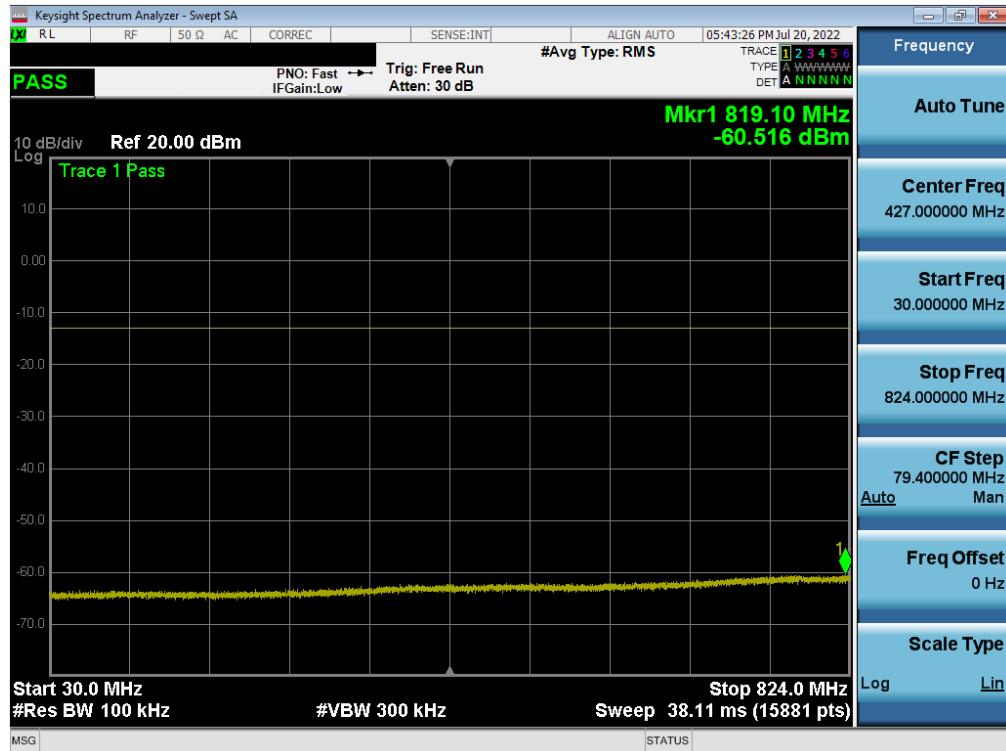


Plot 7-46. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

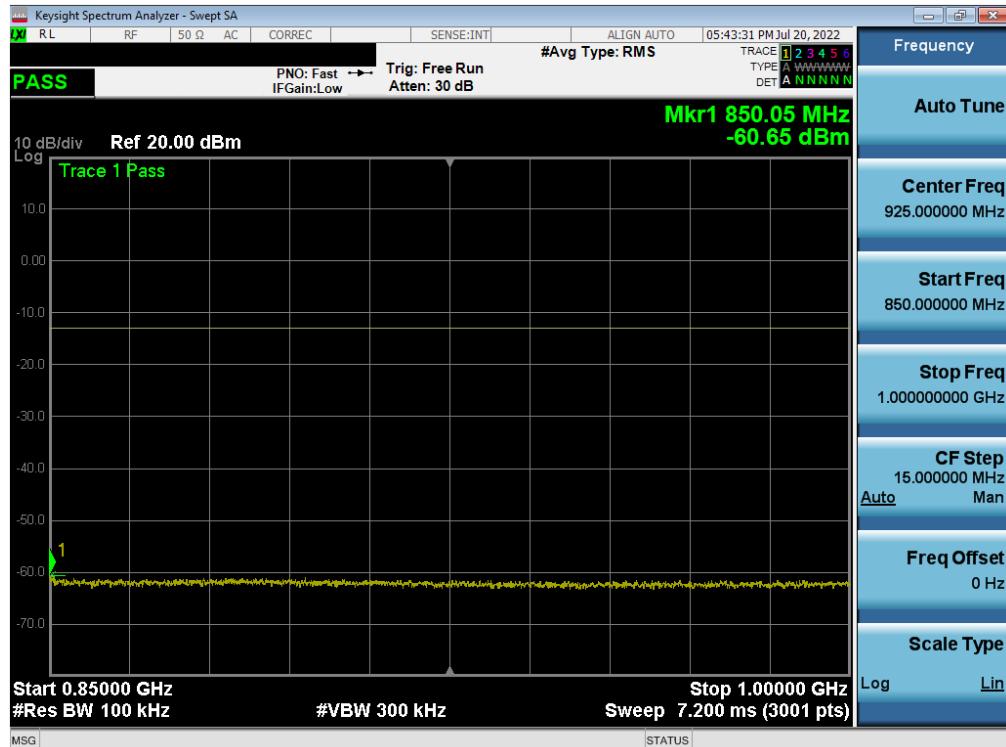


Plot 7-47. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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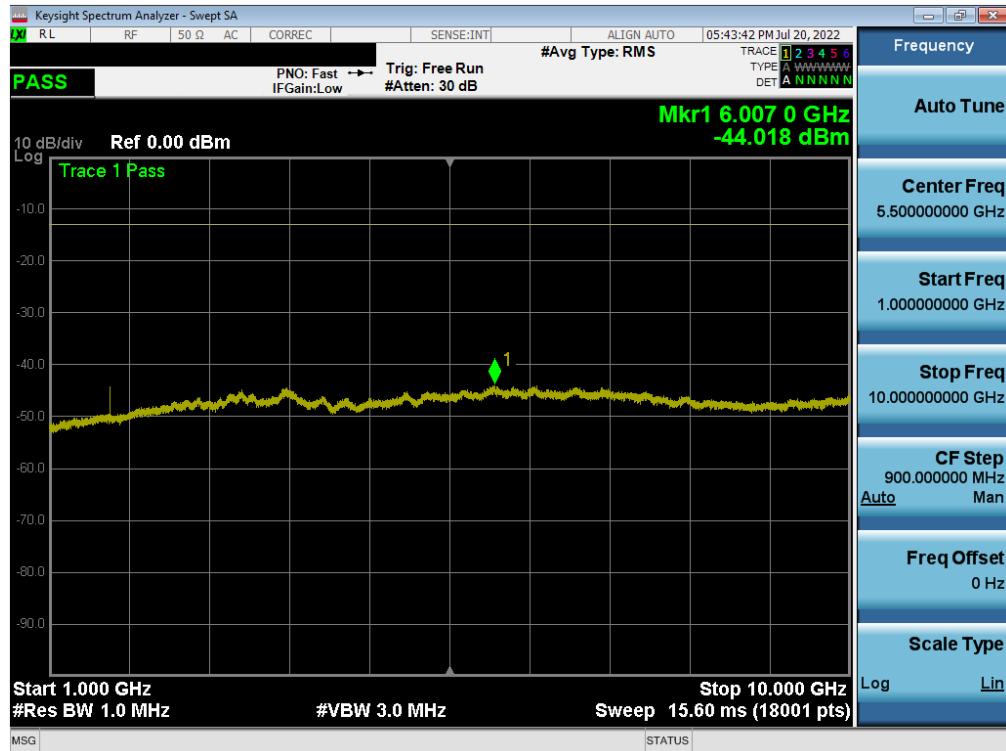


Plot 7-48. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



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

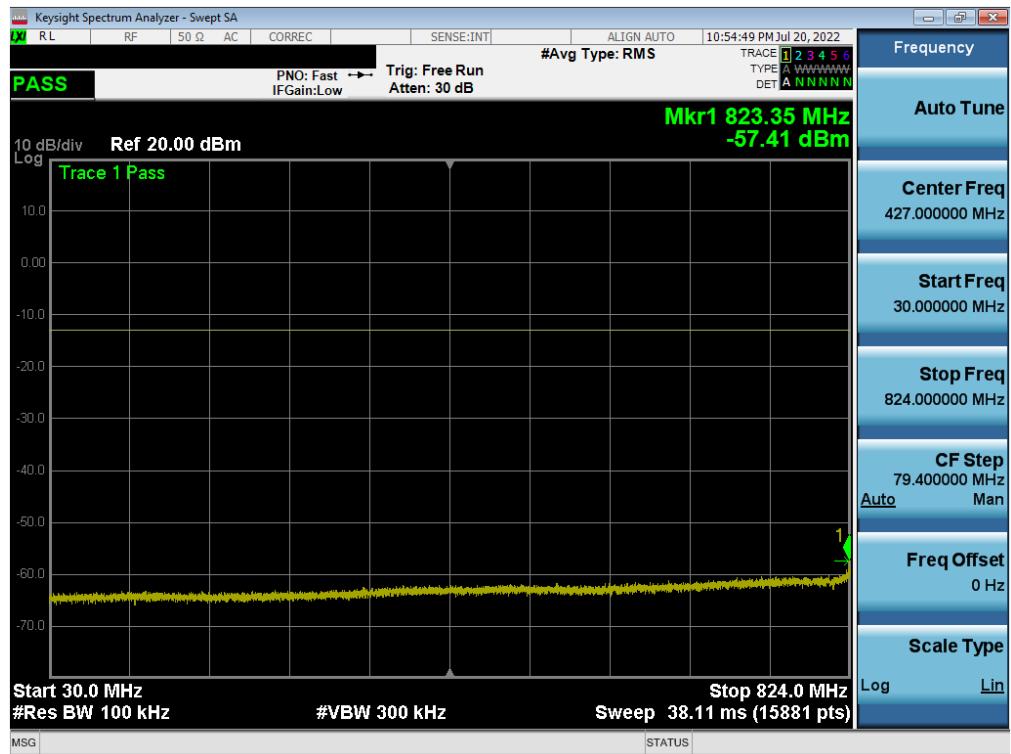
FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 40 of 111



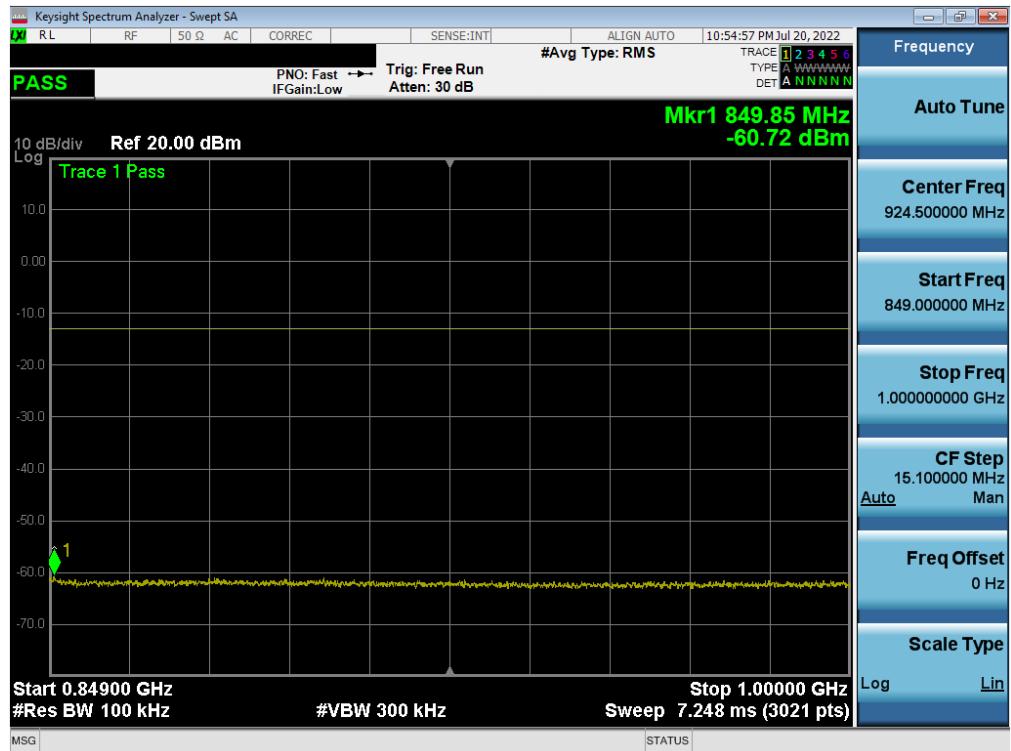
Plot 7-50. Conducted Spurious Plot (LTE Band 26/5 - 10MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device	Page 41 of 111

ULCA LTE Band 5

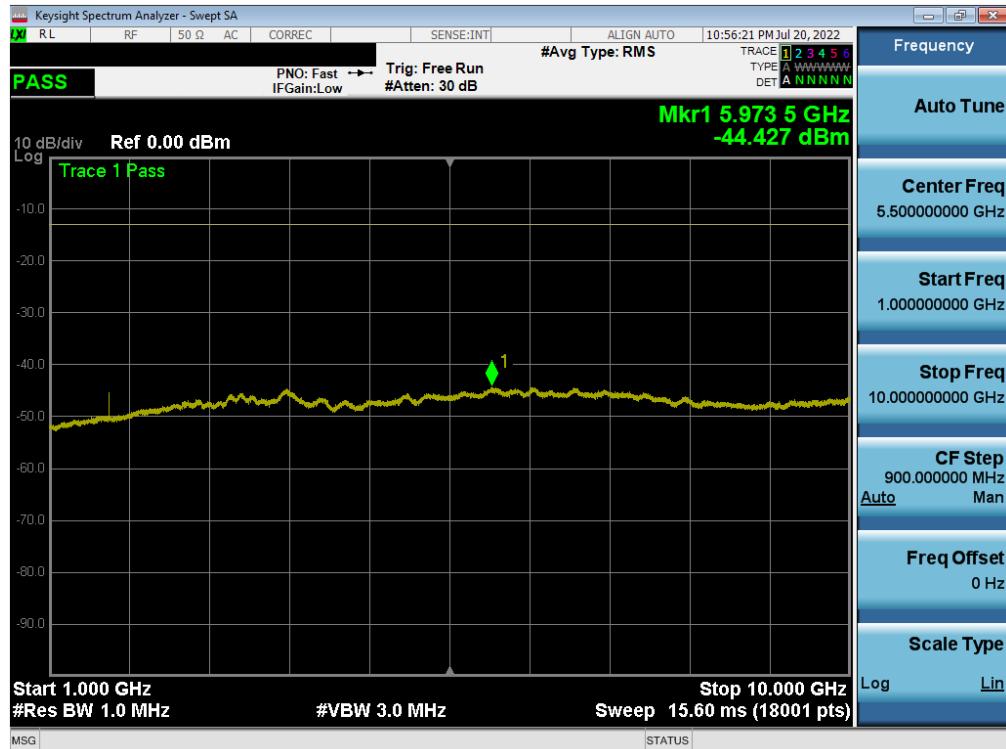


Plot 7-51. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/49 SCC 1/0 - Low Channel)

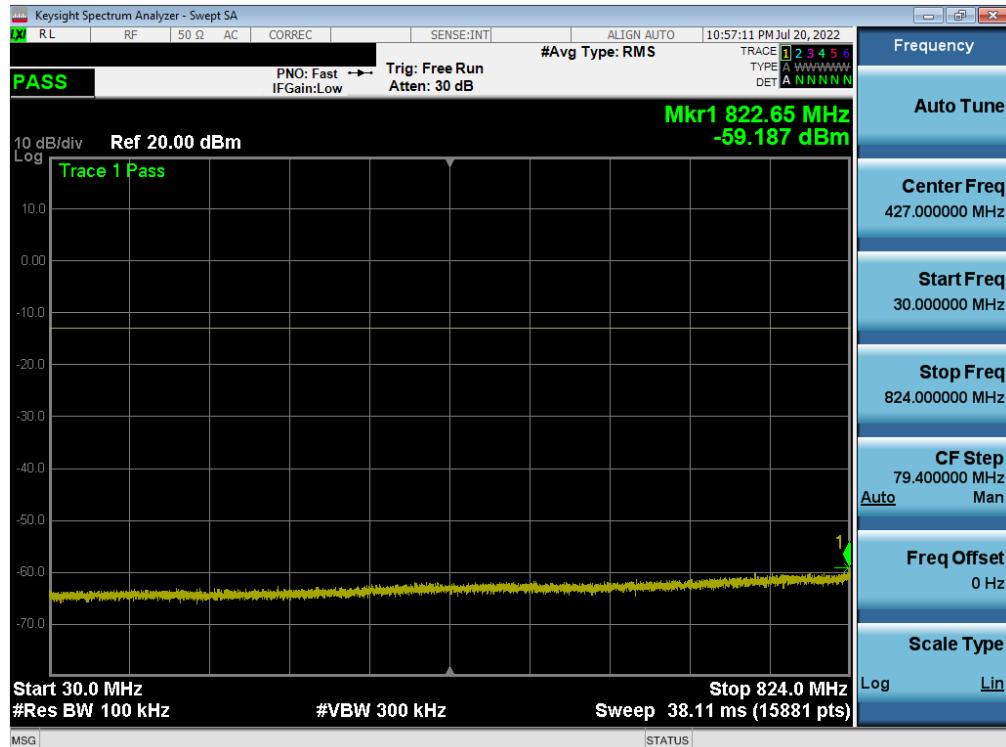


Plot 7-52. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/49 SCC 1/0 - Low Channel)

FCC ID: BCGA2764	element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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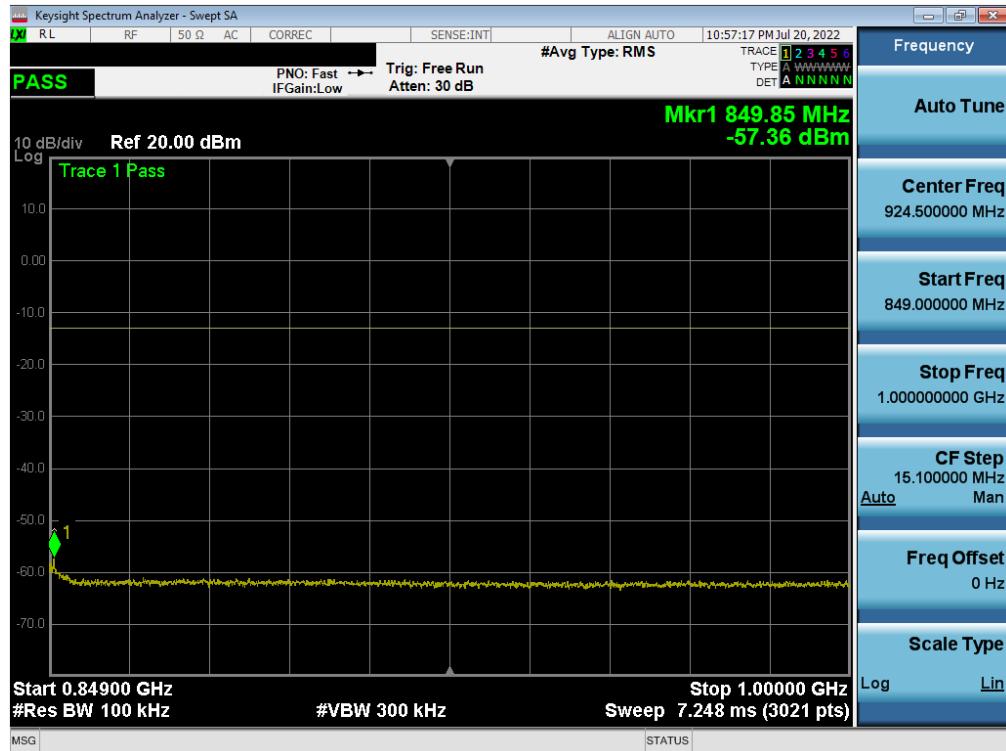


Plot 7-53. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/49 SCC 1/0 - Low Channel)

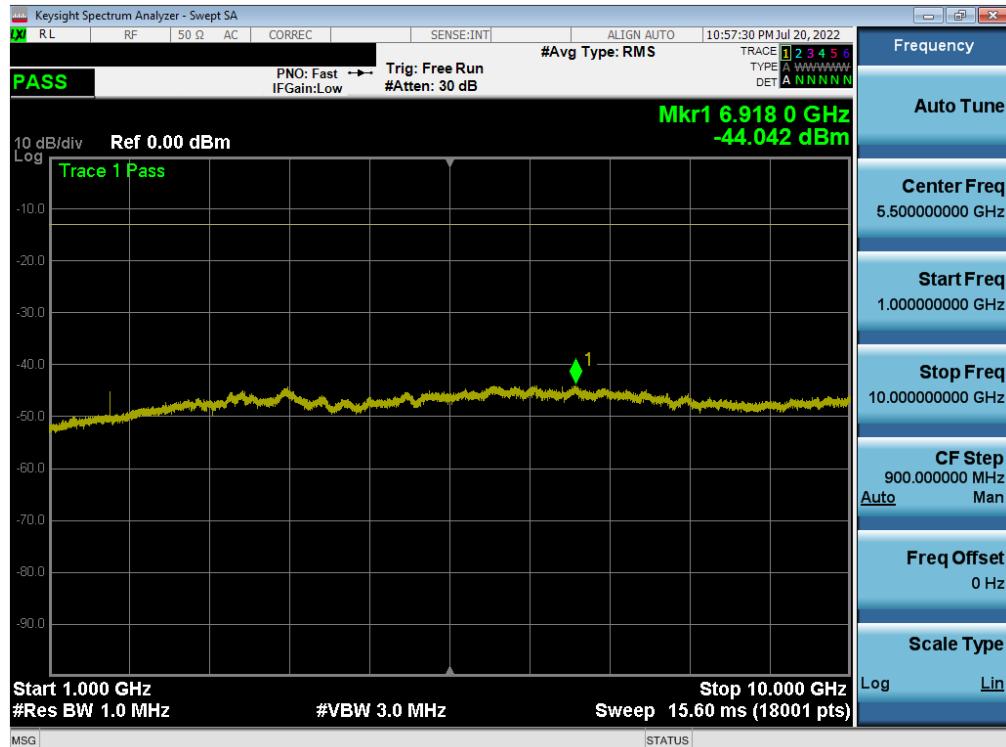


Plot 7-54. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/0 SCC 1/49 - High Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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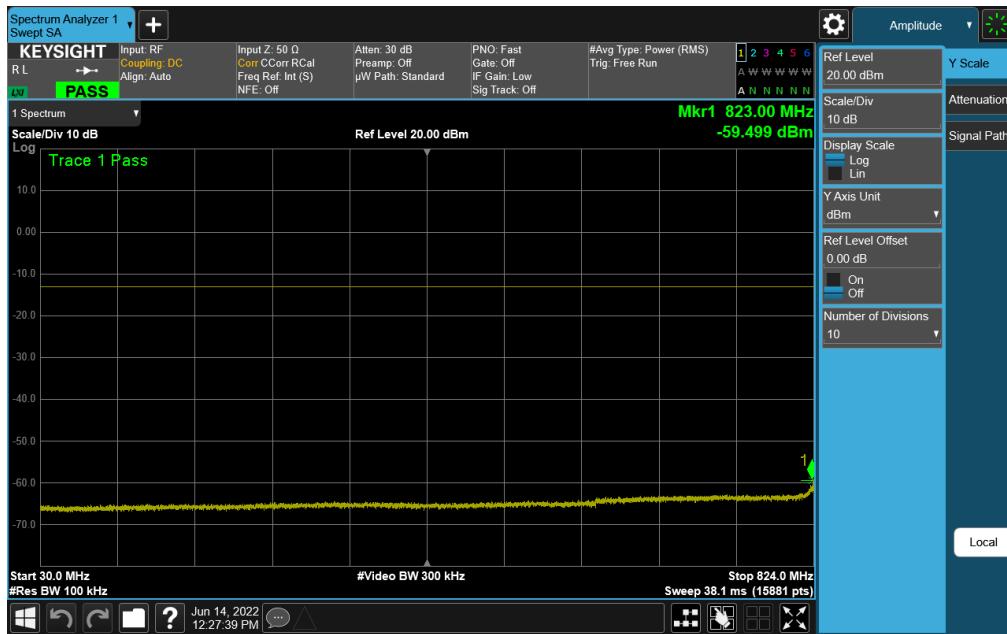
Plot 7-55. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/0 SCC 1/49 - High Channel)



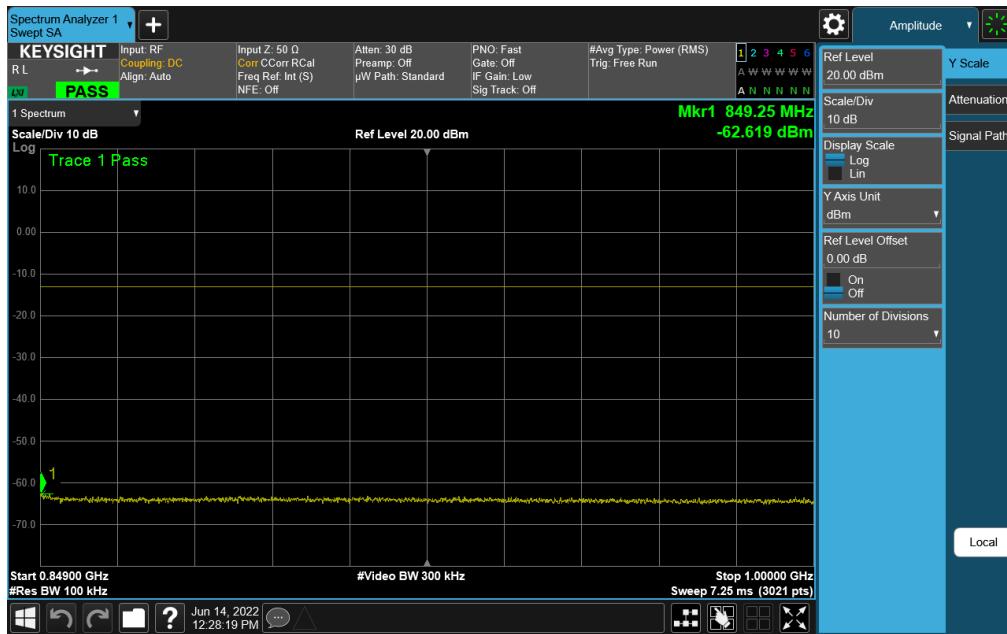
Plot 7-56. CSE (ULCA LTE Band 5 – (10 + 10)MHz QPSK – PCC 1/0 SCC 1/49 - High Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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NR Band n5

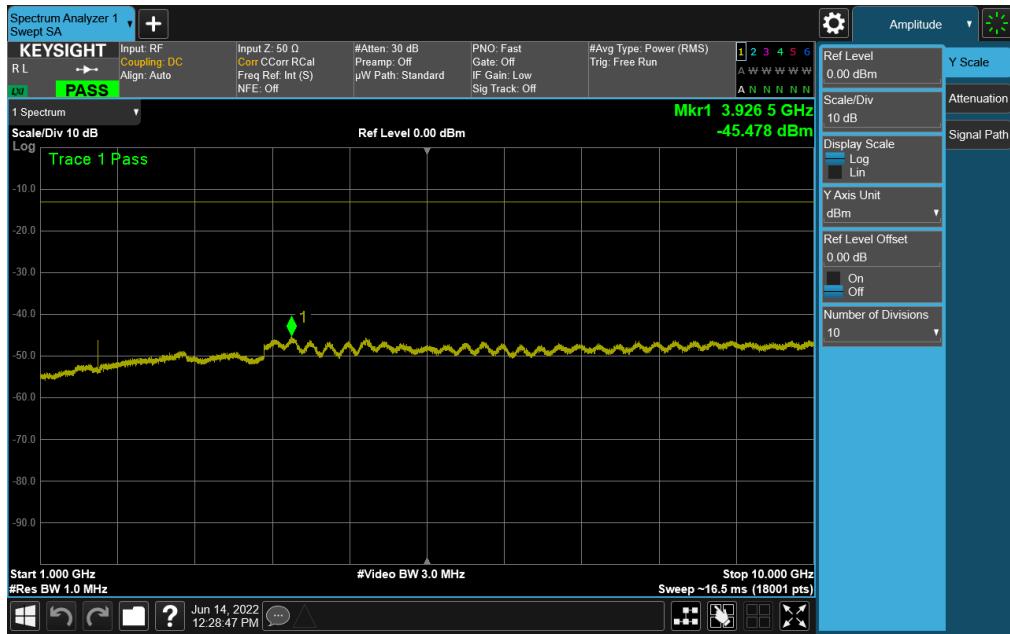


Plot 7-57. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

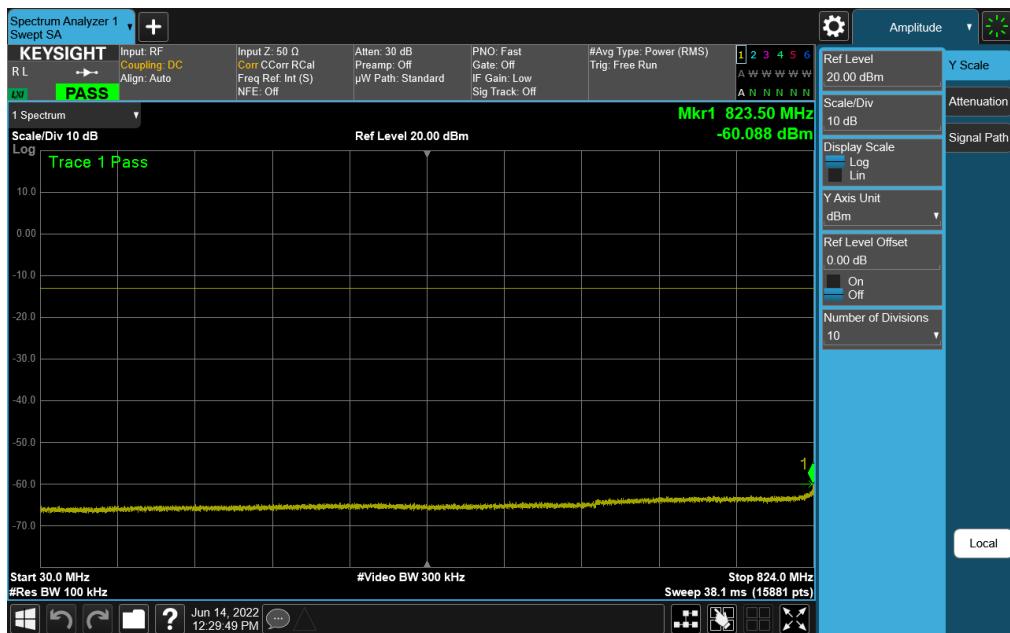


Plot 7-58. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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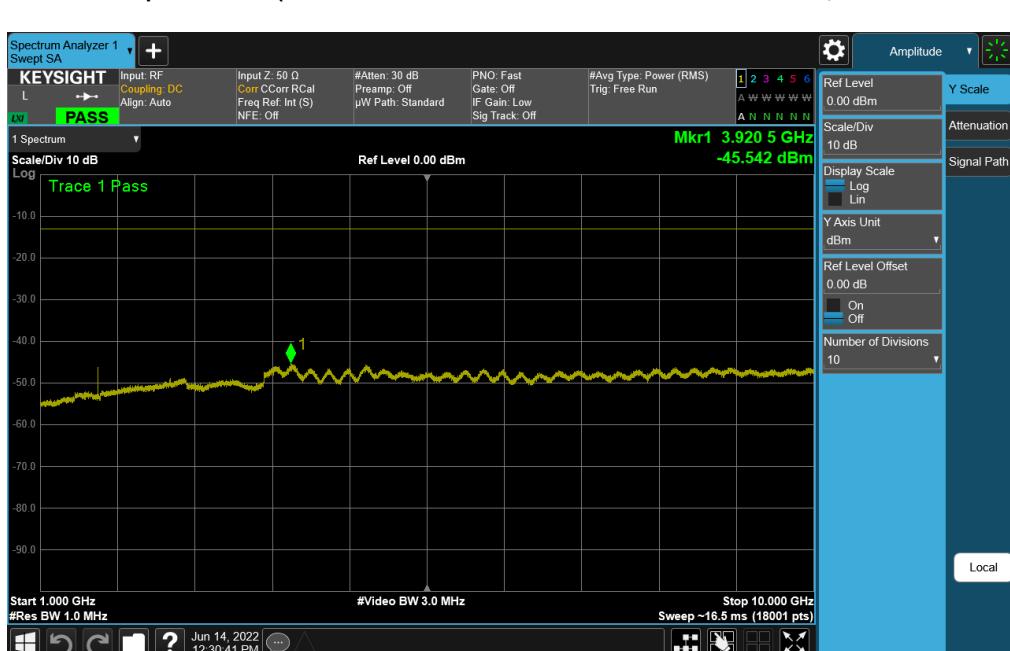
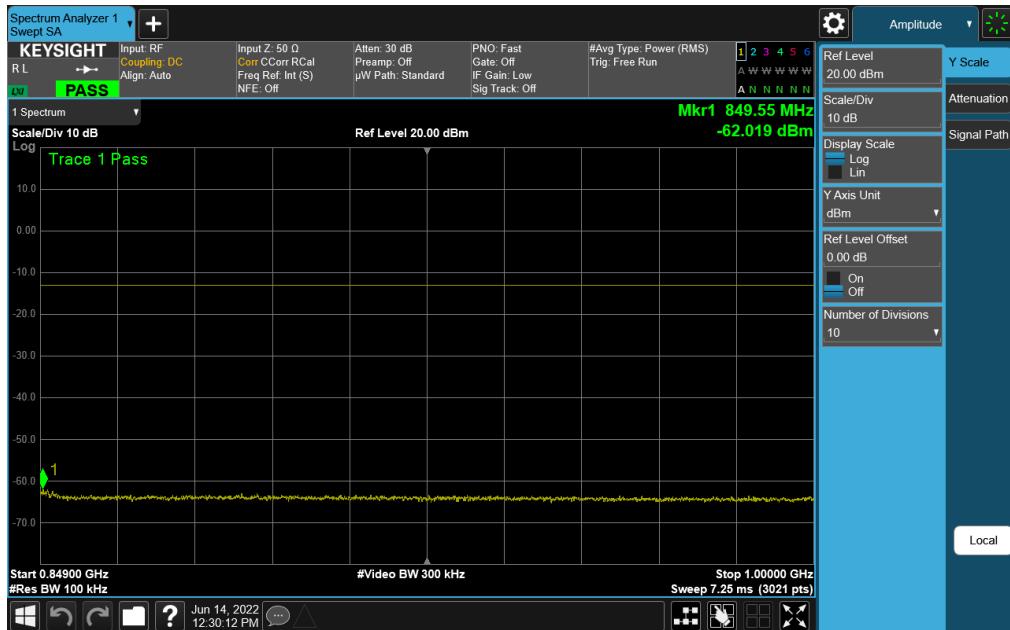


Plot 7-59. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

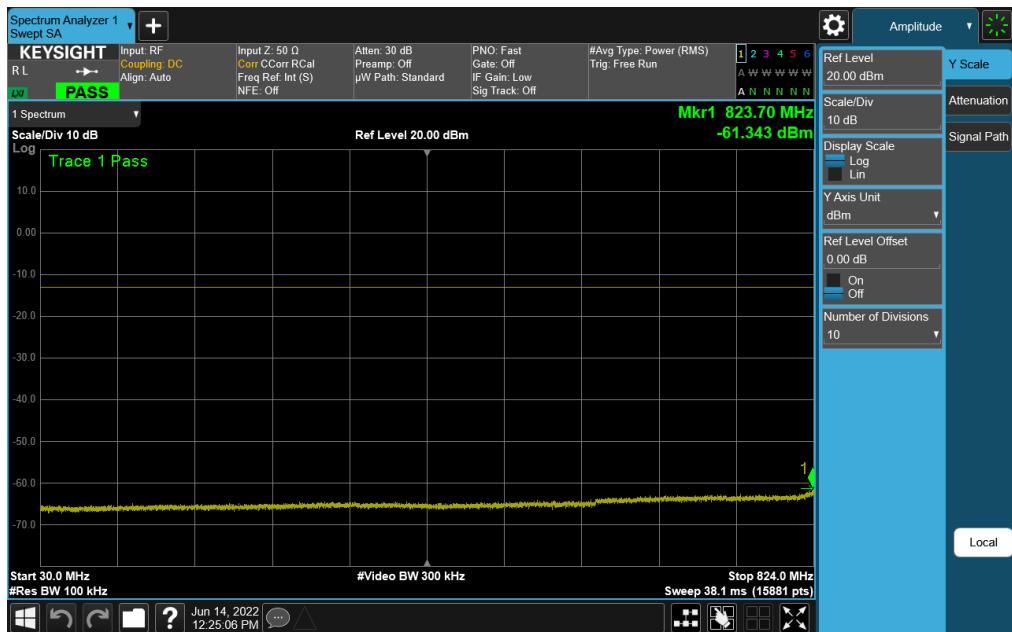


Plot 7-60. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

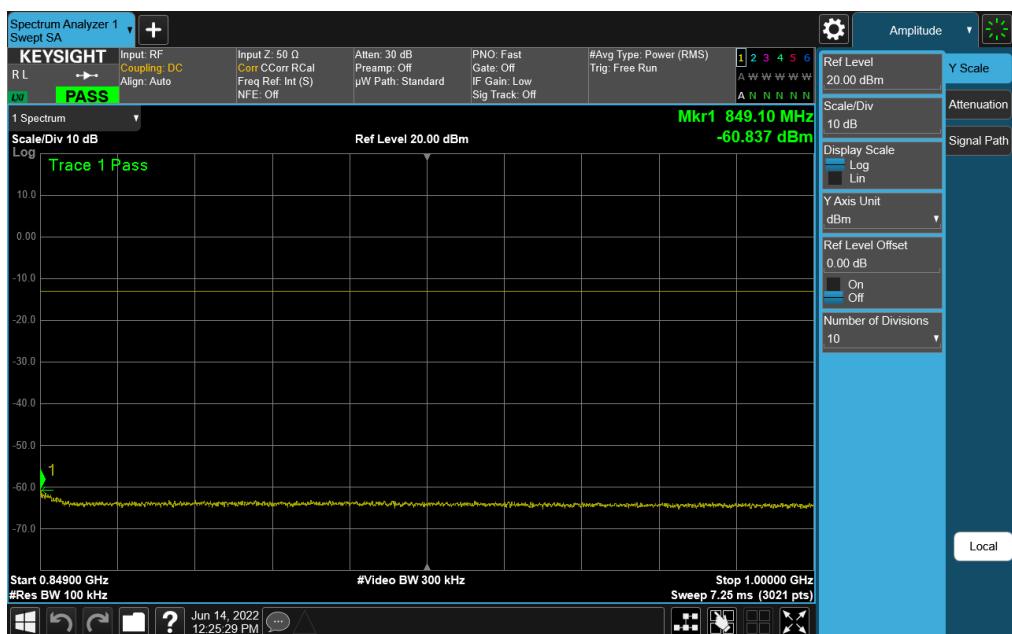
FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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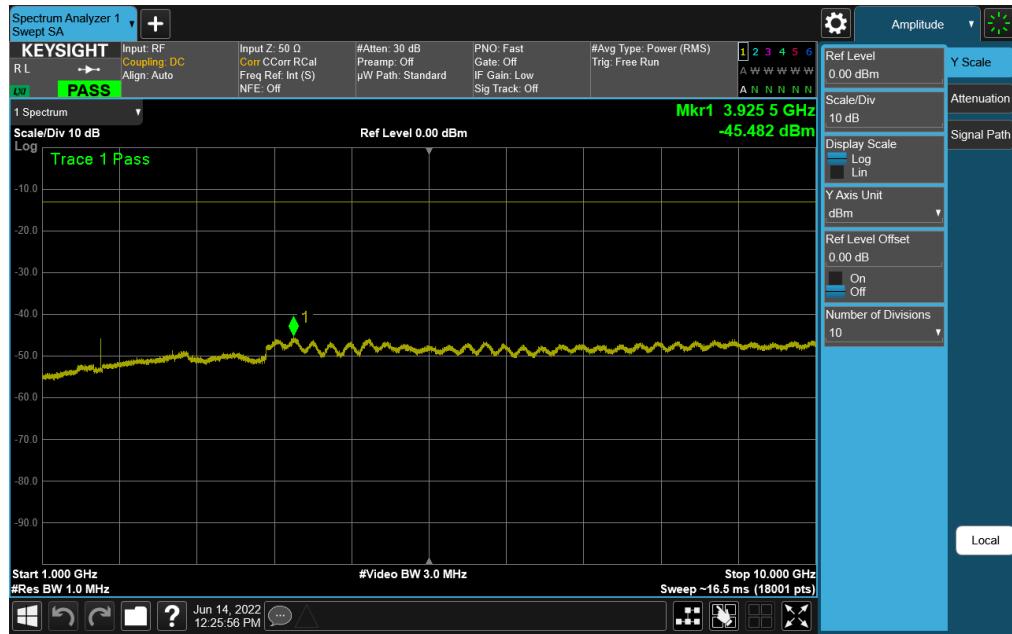


Plot 7-63. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)



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

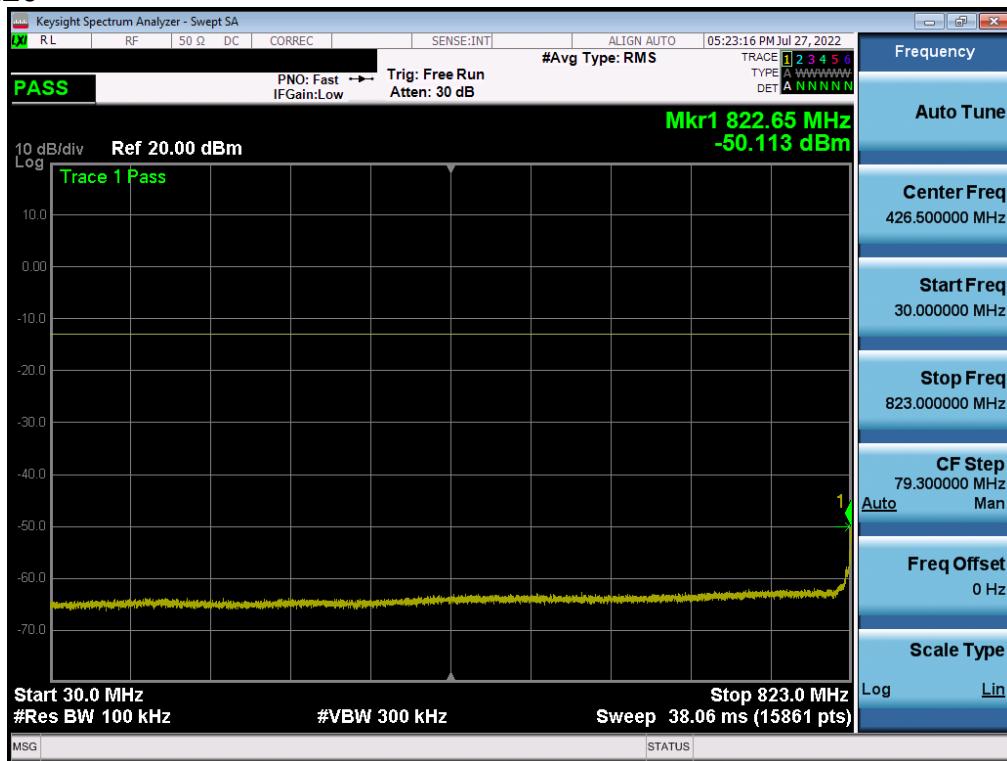
FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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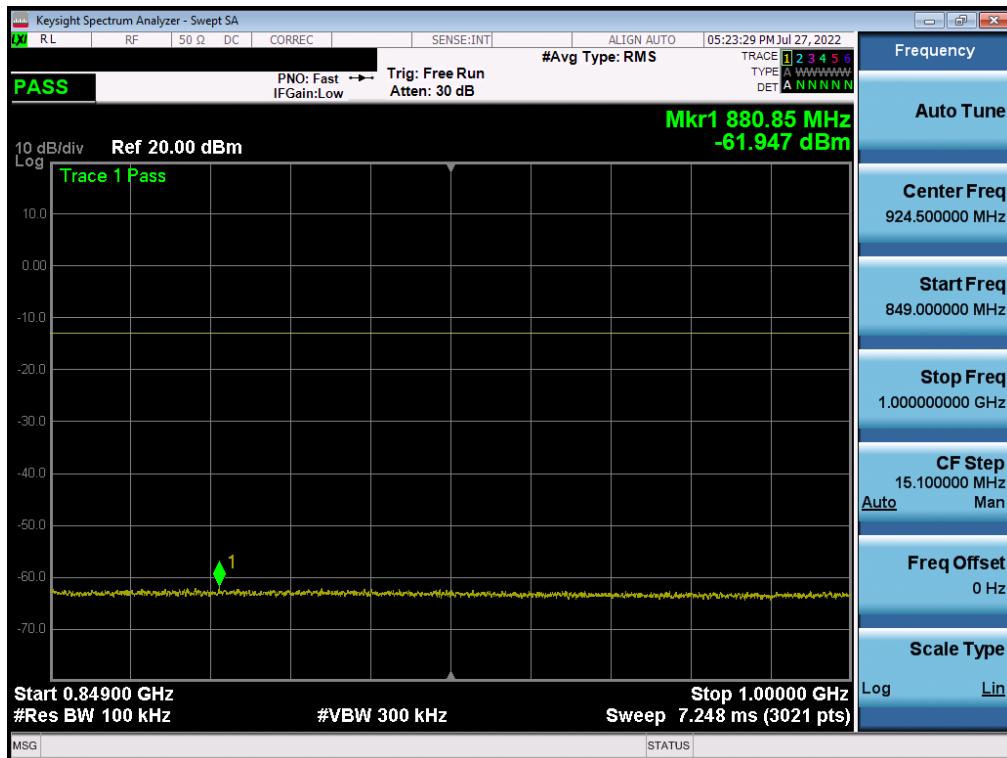
Plot 7-65. Conducted Spurious Plot (NR Band n5 - 20.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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NR Band n26

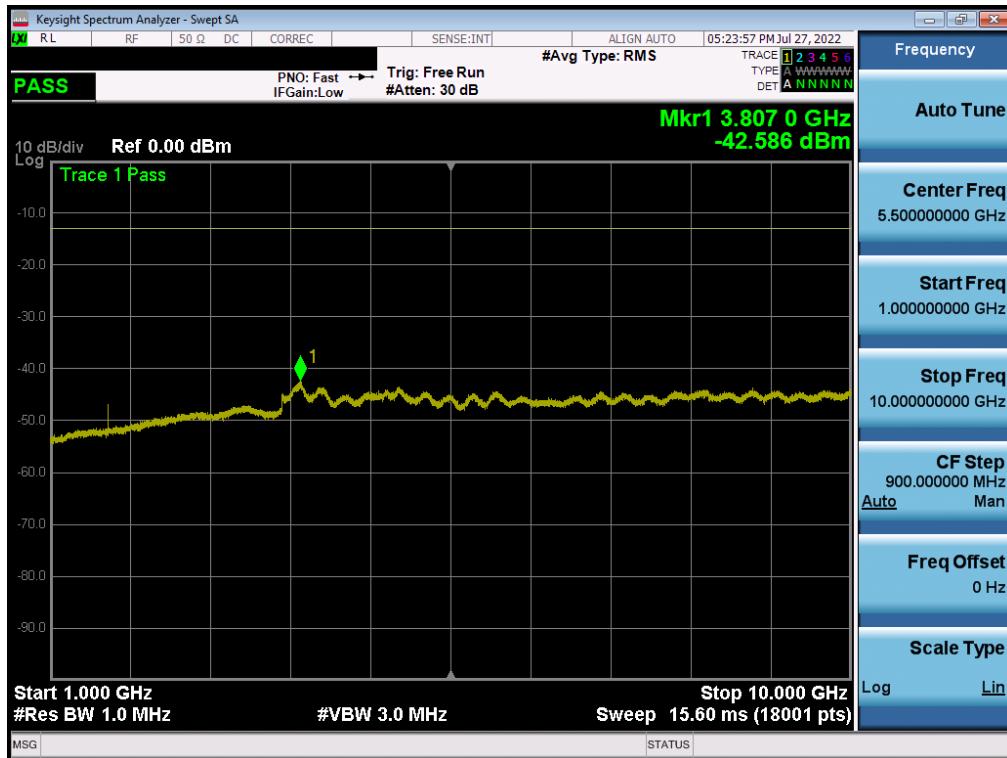


Plot 7-66. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-67. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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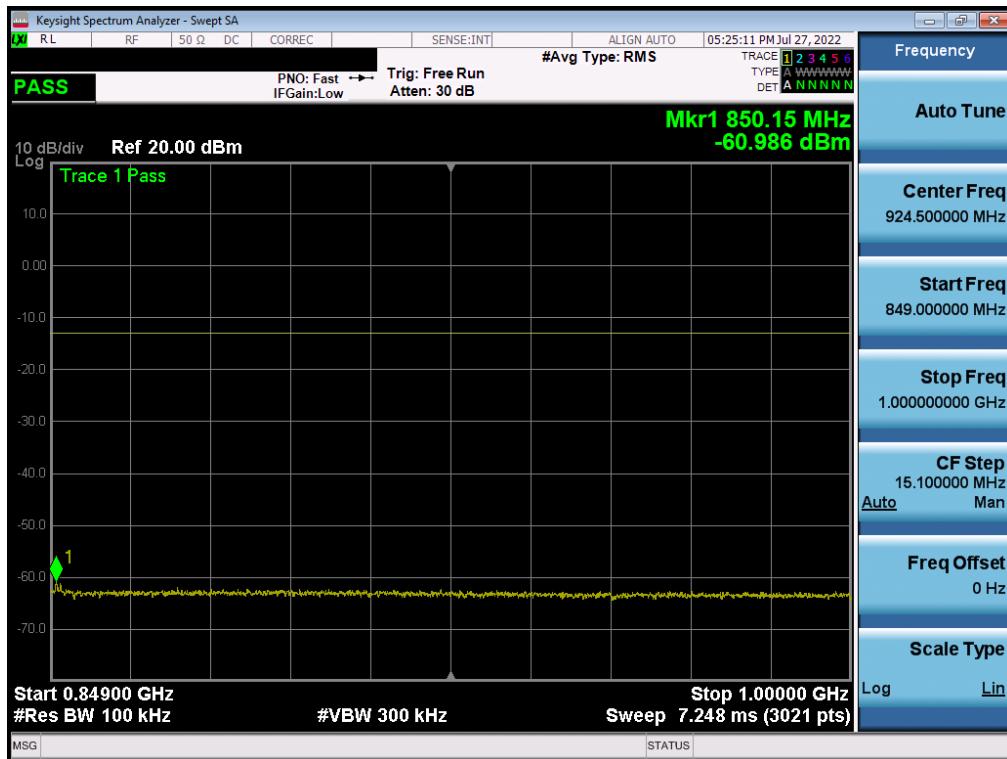


Plot 7-68. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Low Channel)

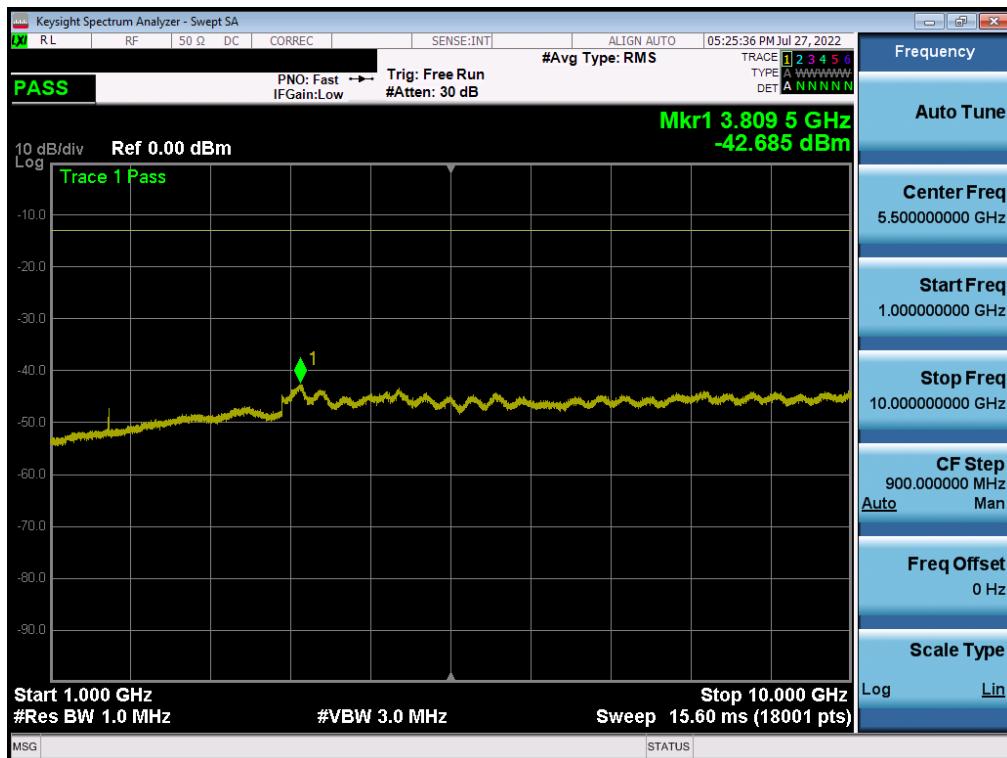


Plot 7-69. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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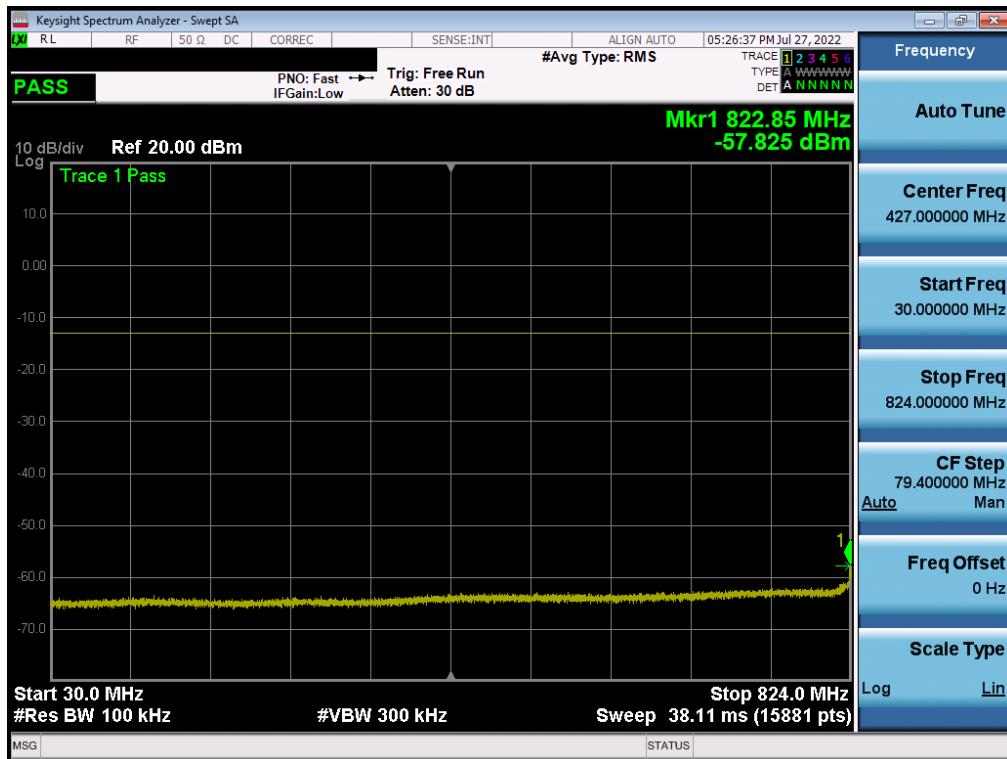


Plot 7-70. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

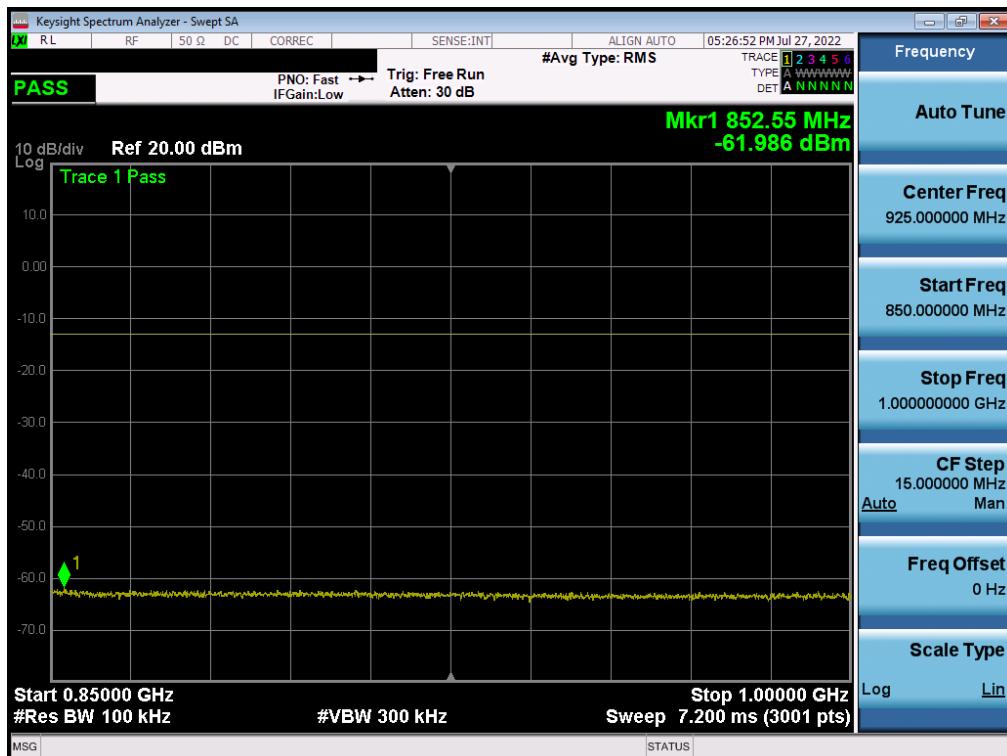


Plot 7-71. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - Mid Channel)

FCC ID: BCGA2764	 element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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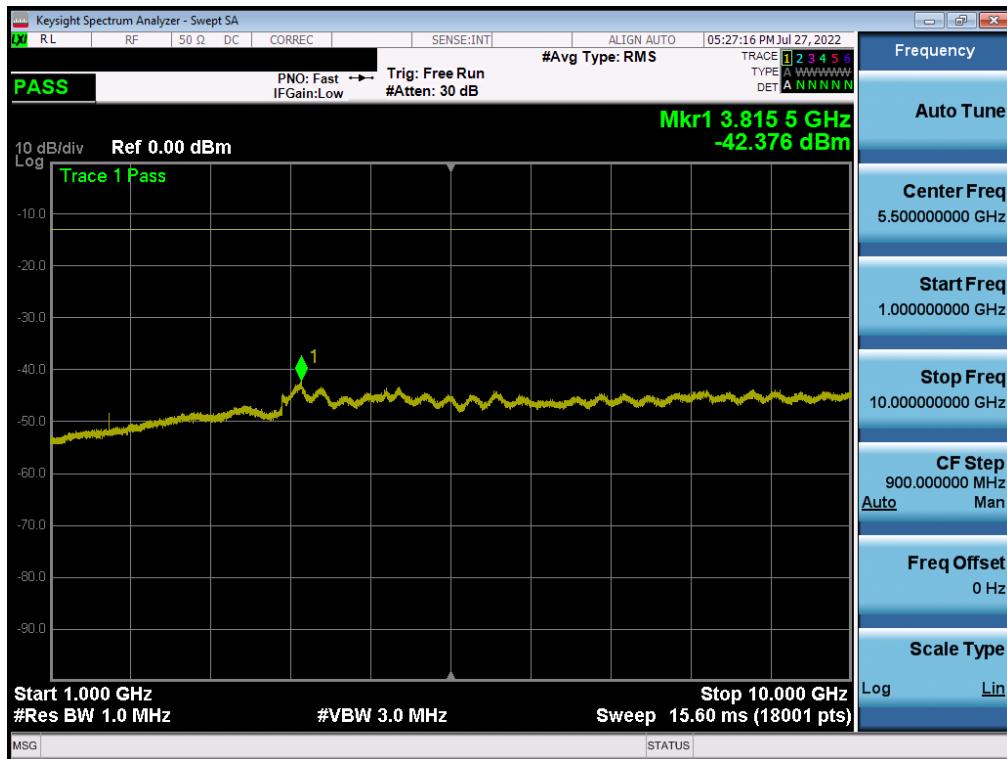


Plot 7-72. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-73. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

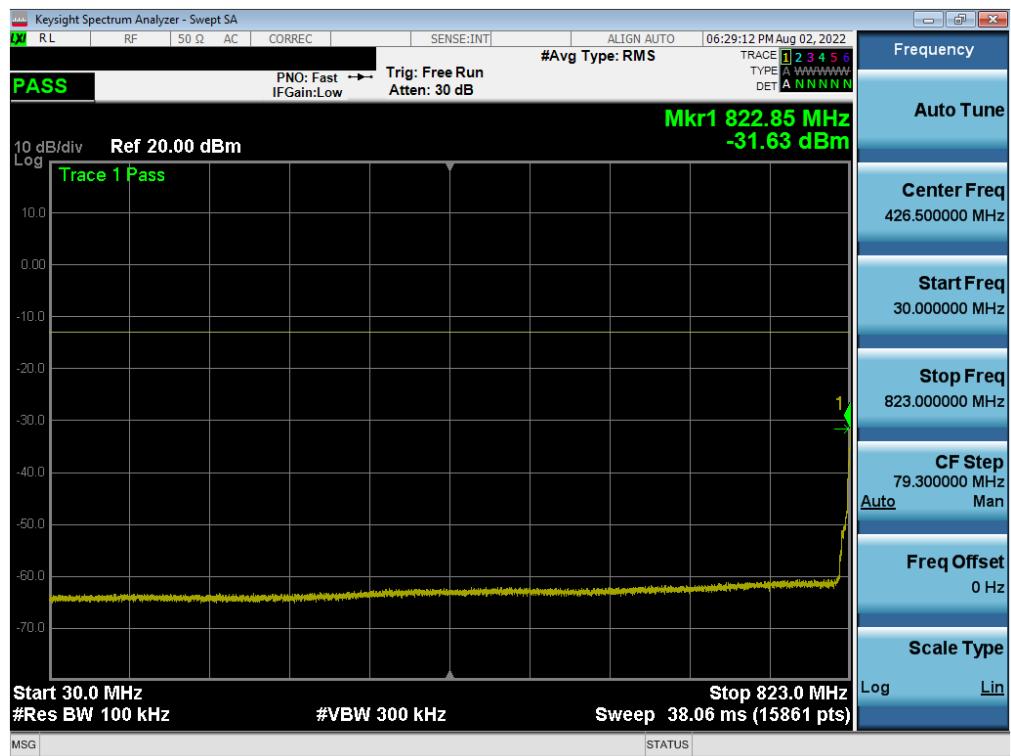
FCC ID: BCGA2764	element	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
Test Report S/N: 1C2205090028-01.BCG	Test Dates: 5/30/2022 - 9/16/2022	EUT Type: Tablet Device		Page 53 of 111



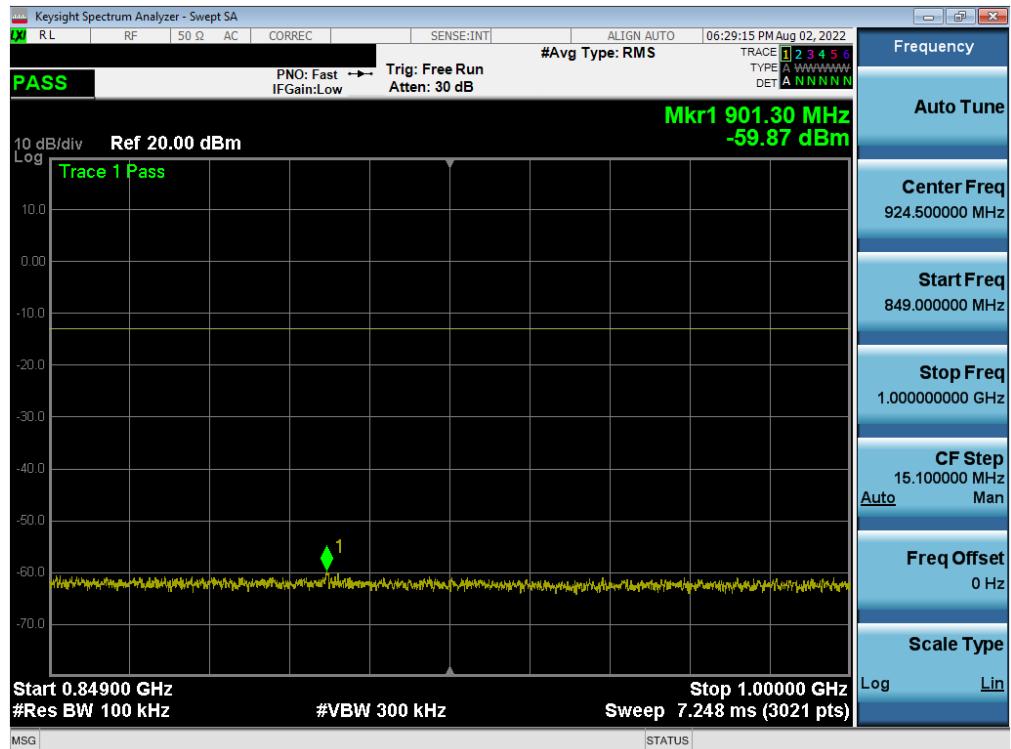
Plot 7-74. CSE (NR Band n26 - 10.0MHz DFT-s-OFDM QPSK - RB Size 1, RB Offset 0 - High Channel)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT		Approved by: Technical Manager
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WCDMA Cell



Plot 7-75. Conducted Spurious Plot (WCDMA Ch. 4132)



Plot 7-76. Conducted Spurious Plot (WCDMA Ch. 4132)

FCC ID: BCGA2764	PART 22 MEASUREMENT REPORT			Approved by: Technical Manager
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