

Global Product Compliance Laboratory  
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Murray Hill, New Jersey 07974-0636 USA



# **Title 47 Code of Federal Regulations Test Report**

Regulation:  
FCC Part 2 and 22

Client:  
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:  
AHCF AirScale RRH 4T4R B5 200W

Report Number:  
TR-2023-0054-FCC2-22

Date Issued:  
May 21, 2023

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**Revisions**

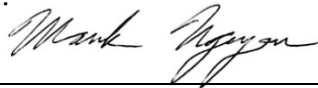
Date	Revision	Section	Change
11/02/2022	0		Initial Release

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Prepared By:

Signed:

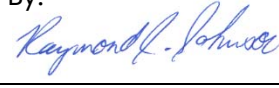


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## 1. System Information and Requirements

Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in Murray-Hill, NJ.

<b>Equipment Under Test (EUT):</b>	AHCF AirScale RRH 4T4R B5 200W
<b>FCC ID:</b>	VBNAHCF-01
<b>Serial Number:</b>	6Q201003935
<b>Hardware Version:</b>	475313A.101
<b>Software Version:</b>	SBTS20B (LTE) SBTS21B (5G)
<b>Frequency Range:</b>	869-894MHz
<b>GPCL Project Number:</b>	2023-0054
<b>Applicant</b>	Nokia Solutions and Networks US LLC 3201 Olympus Blvd Dallas, Texas 75019 Steve Mitchell
<b>Manufacturer:</b>	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
<b>Test Requirement(s):</b>	Title 47 CFR Parts 2 and 22
<b>Test Standards:</b>	Refer to Section 1.5.1
<b>Measurement Procedure(s):</b>	Refer to Section 1.5.2
<b>Test Date(s):</b>	6/10/2020 – 9/21/2021
<b>Test Performed By:</b>	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636 Test Site Number: US5302
<b>Product Engineer(s):</b>	Ron Remy
<b>Lead Engineer:</b>	Nilesh Patel
<b>Test Engineer (s):</b>	Nilesh Patel, Jaideep Yadav
<b>Test Results:</b> The EUT, <i>as tested</i> met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in New Providence, NJ.	

## 1.1 Introduction

This Conformity test report applies to the **AHCF AirScale RRH 4T4R B5 200W**, hereinafter referred to as the Equipment Under Test (EUT).

The Nokia AHCF AirScale RRH 4T4R B5 200W (RRH) (hereinafter referred to as “AHCF”) is a higher power RRH operating under the regulations of FCC Part 22 - Cellular Telephone Systems Operating in Band 5, 869-894 MHz. The AHCF supports 5G-NR and Long Term Evolution - Frequency Division Duplex (LTE FDD) technology, 4 MIMO ports configured for 2x60W + 2x40W or 4x40 MIMO. The AHCF also supports single and multiple carriers, with combinations of LTE + NB-IoT (Guardband and Inband), NB-IoT Standalone, and 5G-NR, as well as single and multiple carrier operations.

LTE and 5G-NR carrier tested configurations are as follows:

- 200kHz – Standalone NB-IoT
- 1.4 MHz – Single LTE carrier
- 3 MHz – Single LTE carrier
- 5 MHz – Single LTE carrier, 5 MHz LTE + NB-IoT Standalone, 5+5 MHz LTE + NB-IoT Standalone
- 10 MHz – Single LTE carrier, 10 MHz LTE with NB-IoT Inband or NB-IoT Guardband
- 5 MHz – Single 5G-NR carrier
- 10 MHz – Single 5G-NR carrier

RF Conducted testing was performed at the antenna port for two power levels 60W (TX1 and TX3) and at 40W (TX2 and TX4) for all four ports.

## 1.2 Purpose and Scope

The purpose of this document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 22, per requirements for Class II permissive changes certification, measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

## 1.3 EUT Details

### 1.3.1 Specifications

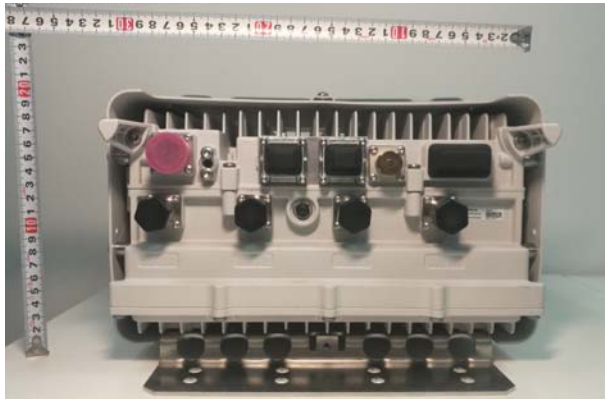
#### LTE& NB-IoT

Specification Items	Description		
Radio Access Technology	LTE, NB IoT		
Duplex Mode	FDD		
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM		
Channel Bandwidth	200 kHz, 1.4/3/5/10MHz		
Number of Tx Ports per Unit	4		
MIMO	Yes		
Max Conducted Power	2 x 47.8 dBm (60 W) + 2 x 46 dBm (40 W) or 4 x 46 dBm (40 W)		
Max Number of Carriers per Port	3		
Deployment Environment	Outdoor		
Environment Temperature Range	-40 °C to 55 °C		
Power Source	Voltage Ranges (VDC)		
	Minimum	Nominal	Maximum
	-40.0	-48.0	-57.0
Antenna	Detachable Directional Panel		

#### 5G-NR

Specification Items	Description		
Radio Access Technology	LTE, 5G-NR		
Duplex Mode	FDD		
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM		
Channel Bandwidth	5 ,10 MHz		
Number of Tx Ports per Unit	4		
MIMO	Yes		
Max Conducted Power	2 x 47.8 dBm (60 W) + 2 x 46.0 dBm (40 W) or 4 x 46.0 dBm (40 W)		
Max Number of Carriers per Port	4		
Deployment Environment	Outdoor		
Environment Temperature Range	-40 °C to 55 °C		
Power Source	Voltage Ranges (VDC)		
	Minimum	Nominal	Maximum
	-40.0	-48.0	-57.0
Antenna	Detachable Directional Panel		
Maxi Antenna Gain Allowed for Urban (dBi)	6.13 dBi		
Maxi Antenna Gain Allowed for non-Urban (dBi)	9.15 dBi		

### 1.3.2 Photographs



#### Serial Number



## 1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046	RF Power Output	Yes
2.1047	Modulation Characteristics	Yes
2.1049	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051	Conducted Out-of-Band Emissions Spurious Emissions at Antenna Terminals	Yes
2.1053, 22.917	Field Strength of Spurious Radiation	Yes

## 1.5 Standards & Procedures

### 1.5.1 Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 22.
- FCC KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013.
- ANSI C63.26 (2015), American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ANSI C63.4 (2014) entitled: "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz.

### 1.5.2 Procedures

- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019



### 1.5.3 MEASUREMENT UNCERTAINTY

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

**Worst-Case Estimated Measurement Uncertainties**

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. Classical Emissions, ( <i>e.g.</i> , ANSI C63.4, CISPR 11, 14, 22, <i>etc.</i> , using ESHS 30,	Conducted Emissions	0.009 - 30	±3.5 dB
	Radiated Emissions (AR-6 Semi-Anechoic Chamber)	30 MHz – 200MHz H 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz - 18 GHz	±5.1 dB ±5.1 dB ±4.7 dB ±4.7 dB ±3.3 dB

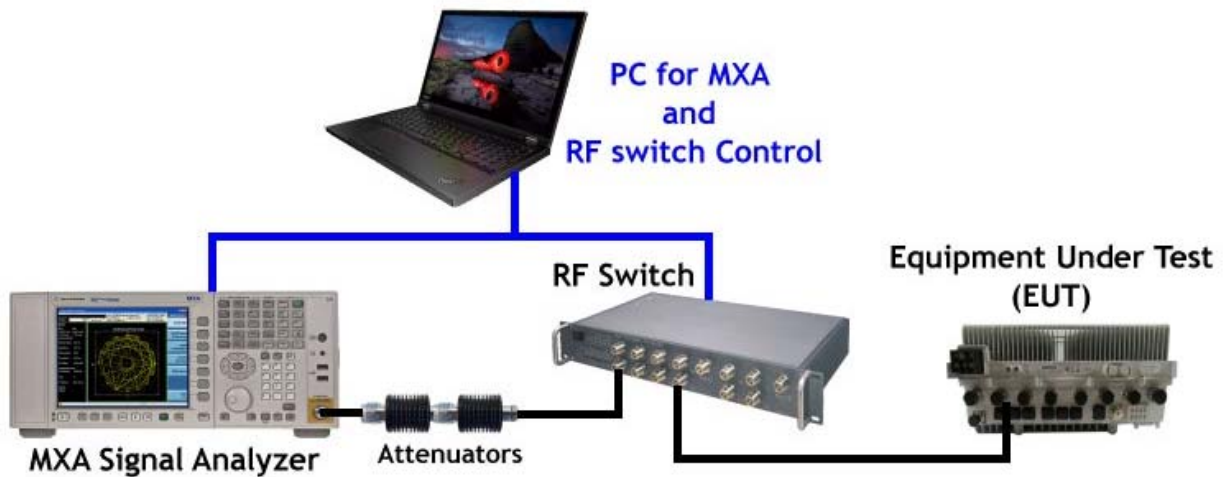
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	0.5 dB

## 1.6 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 22		
2.1046	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047	Modulation Characteristics	COMPLIES
2.1049	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 22.917	Field Strength of Spurious Radiation	COMPLIES

1. **COMPLIES** - Passed all applicable tests.
2. **N/A** – Not Applicable.
3. **NT** – Not Tested.

## 1.7 Test Configuration for all Antenna Port Measurements.



## 2. FCC Section 2.1046 - RF Power Output

### 2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26. The product is rated for 40 W (46 dBm +/- 2.0 dBm) or 60W (47.8 dBm +/- 2.0 dBm) per port for each of the four transmit ports.

Power measurements were made with an MXA Signal Analyzer.

#### 2.1.1 LTE 40W & 60W Results

Bandwidth (MHz)	Power (W)	Port	Center Frequency (MHz)	Channel Power (dBm)
1.4	60	TX1	885	48.10
	40	TX2	885	46.10
	60	TX3	885	47.84
	40	TX4	885	46.21
Summed Output Power				53.18
3	60	TX1	888.5	47.90
	40	TX2	888.5	46.11
	60	TX3	888.5	47.77
	40	TX4	888.5	46.33
Summed Output Power				53.12
5	60	TX1	887.5	48.16
	40	Tx2	887.5	46.33
	60	TX3	887.5	47.95
	40	TX4	887.5	46.33
Summed Output Power				53.30
10	60	TX1	885	47.96
	40	TX2	885	45.97
	60	TX3	885	47.75
	40	TX4	885	46.16
Summed Output Power				53.16
10 (NB-IoT Guardband)	60	TX1	885	48.15
	40	TX2	885	46.23
	60	TX3	885	47.97
	40	TX4	885	46.36
Summed Output Power				53.29
10 (NB-IoT Inband)	60	TX1	874	47.94
	40	TX2	874	46.01
	60	TX3	874	47.70
	40	TX4	874	46.14
Summed Output Power				53.06
5 + 0.2	60	TX1	871 + 893	47.52
	40	TX2	871 + 893	45.50
	60	TX3	871 + 893	47.29
	40	TX4	871 + 893	45.63
Summed Output Power				52.60
5 + 5 + 0.2	60	TX1	871 + 876 + 893	46.25
	40	TX2	871 + 876 + 893	44.98
	60	TX3	871 + 876 + 893	45.98
	40	TX4	871 + 876 + 893	45.06
Summed Output Power				51.62

## 2.1.2 5G-NR 40W, 4TX Results

1-Carrier - 40W, 4TX									
Signal BW - 5 MHz								Signal BW - 10 MHz	
Test Model 3.1 Modulation 64QAM Channel Frequency 871.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 877.5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 882.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 887.5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 874MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	46.38	1	46.29	1	46.37	1	46.35	1	46.27
2	46.51	2	46.46	2	<b>46.64</b>	2	46.35	2	46.43
3	<b>46.61</b>	3	<b>46.60</b>	3	46.59	3	<b>46.54</b>	3	<b>46.48</b>
4	46.22	4	46.19	4	46.23	4	46.29	4	46.19
Total Power (dBm)	52.45	Total Power (dBm)	52.41	Total Power (dBm)	52.48	Total Power (dBm)	52.40	Total Power (dBm)	52.36
Total Power (W)	175.92	Total Power (W)	174.12	Total Power (W)	177.06	Total Power (W)	173.95	Total Power (W)	172.37

2-Carrier - 40W, 4TX											
Signal BW - 5+5 MHz								Signal BW - 10+5 MHz		Signal BW - 10+10 MHz	
Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 871.5+877.5 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 871.5+ 887.5MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 871.5+887.5 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 882.5+887.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 874+887.5MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 874+885MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	46.12	1	46.30	1	46.17	1	46.24	1	46.51	1	<b>46.36</b>
2	<b>46.30</b>	2	46.45	2	46.37	2	46.47	2	46.68	2	46.33
3	46.28	3	<b>46.48</b>	3	<b>46.40</b>	3	<b>46.47</b>	3	<b>46.69</b>	3	46.32
4	46.13	4	46.19	4	46.07	4	46.17	4	46.44	4	46.23
Total Power (dBm)	52.23	Total Power (dBm)	52.38	Total Power (dBm)	52.28	Total Power (dBm)	52.36	Total Power (dBm)	52.60	Total Power (dBm)	52.33
Total Power (W)	167.07	Total Power (W)	172.87	Total Power (W)	168.86	Total Power (W)	172.19	Total Power (W)	182.05	Total Power (W)	171.04

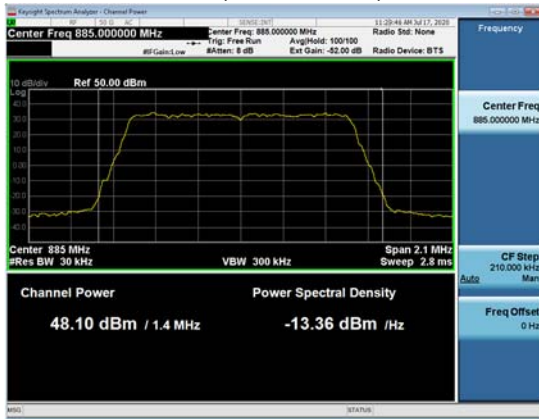
## 2.1.3 5G-NR 60W, 2TX Results

1-Carrier - 60W, 2TX									
Signal BW - 5 MHz								Signal BW - 10 MHz	
Test Model 3.1 Modulation 64QAM Channel Frequency 871.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 877.5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 882.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 887.5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 874MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	48.13	1	48.11	1	48.11	1	48.14	1	47.99
3	<b>48.16</b>	3	<b>48.27</b>	3	<b>48.40</b>	3	<b>48.36</b>	3	<b>48.22</b>
Total Power (dBm)	51.16	Total Power (dBm)	51.20	Total Power (dBm)	51.27	Total Power (dBm)	51.26	Total Power (dBm)	51.12
Total Power (W)	130.48	Total Power (W)	131.86	Total Power (W)	133.9	Total Power (W)	133.71	Total Power (W)	129.32

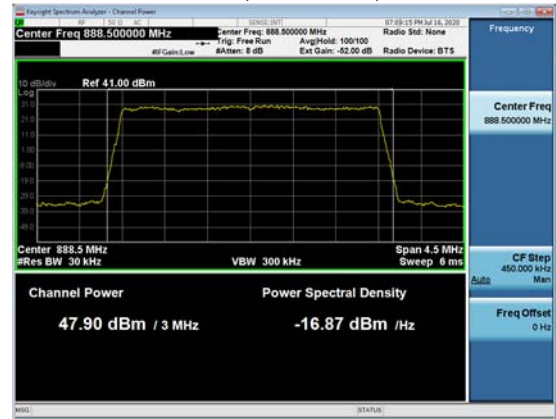
2-Carrier - 60W, 2TX											
Signal BW - 5+5 MHz								Signal BW - 10+5 MHz		Signal BW - 10+10 MHz	
Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 871.5+877.5 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 871.5+ 887.5MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 871.5+887.5 MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 882.5+887.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 874+887.5MHz		Test Model 3.1a Modulation QPSK/16QAM Channel Frequency 874+855MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	47.88	1	47.99	1	47.82	1	48.12	1	48.08	1	47.94
3	<b>48.03</b>	3	<b>48.17</b>	3	<b>48.04</b>	3	<b>48.30</b>	3	<b>48.23</b>	3	<b>48.10</b>
Total Power (dBm)	50.97	Total Power (dBm)	51.09	Total Power (dBm)	50.94	Total Power (dBm)	51.22	Total Power (dBm)	51.17	Total Power (dBm)	51.03
Total Power (W)	124.91	Total Power (W)	128.57	Total Power (W)	124.21	Total Power (W)	132.47	Total Power (W)	130.80	Total Power (W)	126.80

## 2.1.4 Channel RF Power – Plots (LTE)

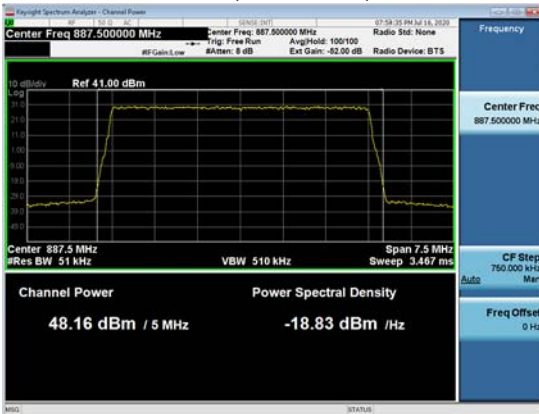
Channel Frequency 885MHz, 64QAM  
1-Carrier, 1.4MHz BW, TX1



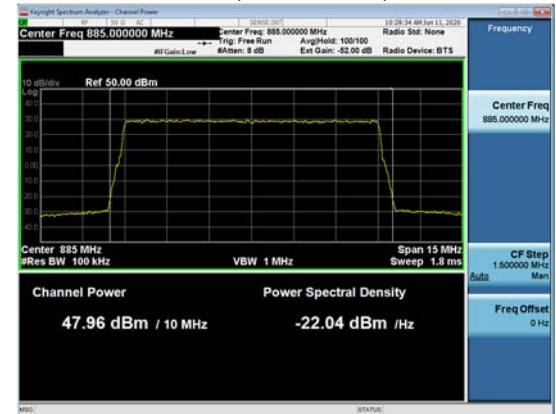
Channel Frequency 888.5MHz, QPSK/16QAM  
1-Carrier, 3MHz BW, TX1

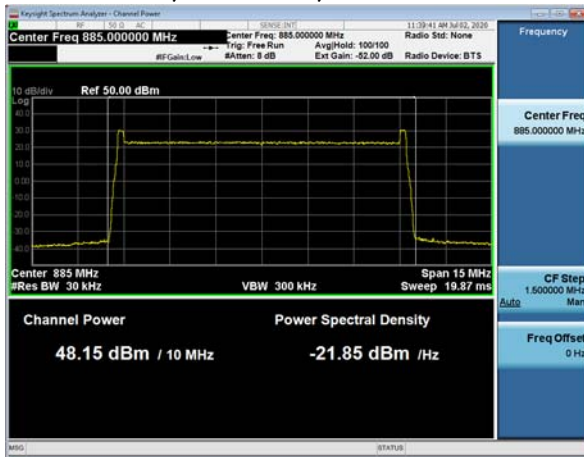
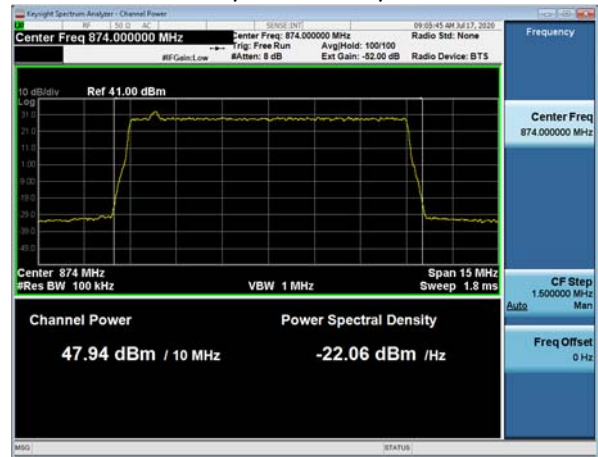
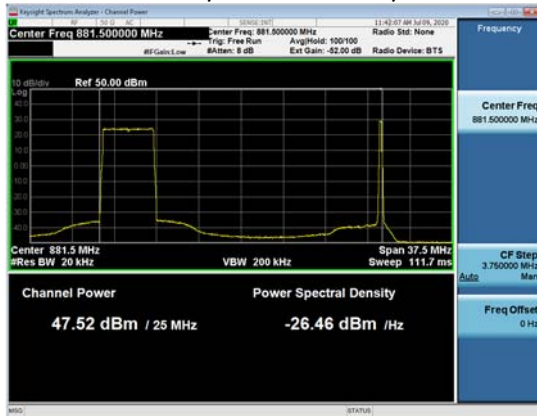
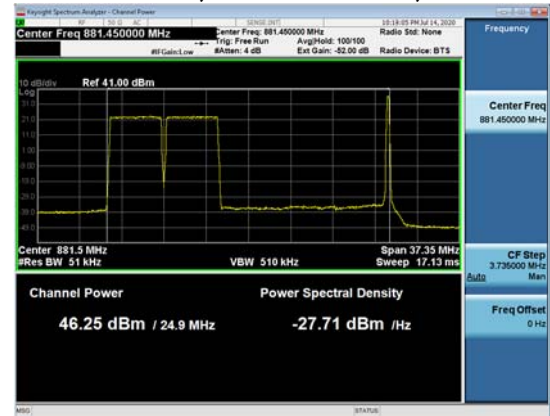


Channel Frequency 887.5MHz, QPSK  
1-Carrier, 5MHz BW, TX1



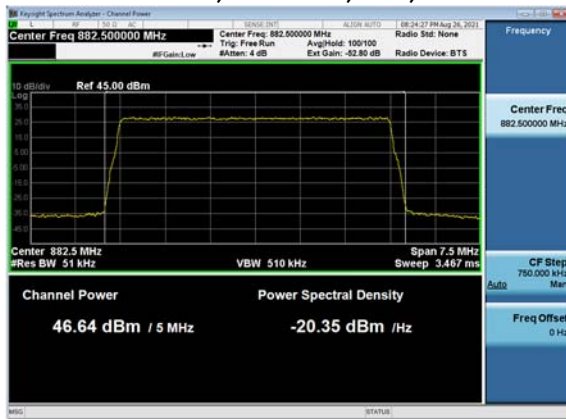
Channel Frequency 885MHz, 256QAM  
1-Carrier, 10MHz BW, TX1



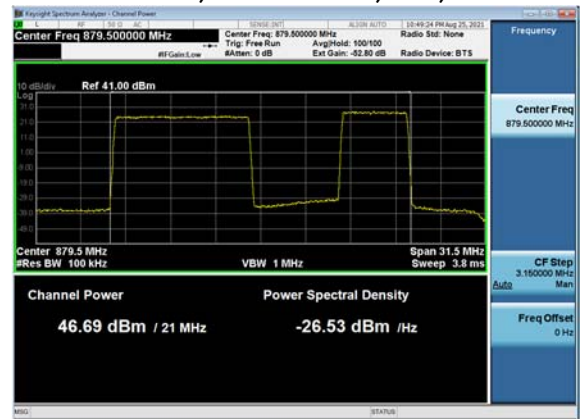
**Channel Frequency 885MHz, QPSK  
1-Carrier, 10MHz BW, TX1 (Guardband)****Channel Frequency 874MHz, QPSK  
1-Carrier, 10MHz BW, TX1 (IB)****Channel Frequency 874MHz, QPSK  
2-Carrier, 5+0.2MHz BW, TX1****Channel Frequency 874MHz, QPSK  
3-Carrier, 5+5+0.2MHz BW, TX1**

## 2.1.5 Channel RF Power – Plots (5G-NR)

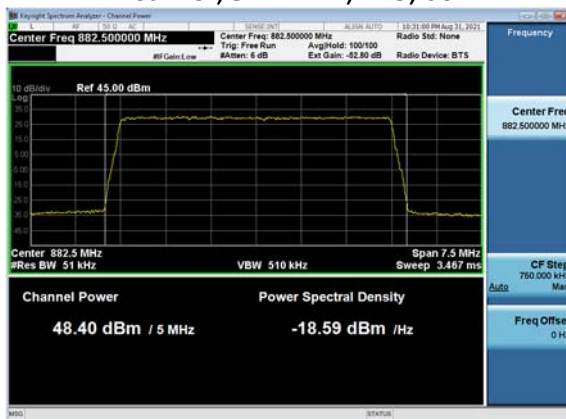
**Channel Frequency 882.5MHz, 64QAM  
1-Carrier, 5MHz BW, TX2, 40W**



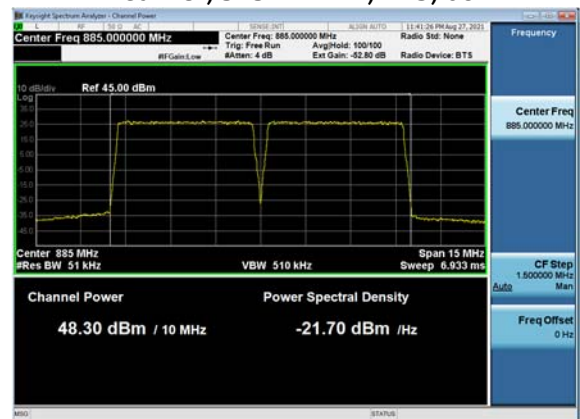
**Channel Frequency 874+887.5MHz, 256QAM  
2-Carrier, 10+5MHz BW, TX3, 40W**



**Channel Frequency 882.5MHz, 64QAM  
1-Carrier, 5MHz BW, TX3, 60W**



**Channel Frequency 882.5+887.5MHz, QPSK/16QAM  
2-Carrier, 5+5MHz BW, TX3, 60W**





## 2.2 Peak-to-Average Power Ratio (PAPR)

The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168. The PAPR values of all carriers measured are below 13dB.

**PAPR Tabular Data (LTE)**

Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
LTE	1	64QAM	1.4	1	890	6.75
LTE	1	QPSK/16QAM	3	1	888	6.70
LTE	1	QPSK	5	1	887	6.70
LTE	1	256QAM	10	1	885	6.79
LTE (Guardband)	1	QPSK	10	1	874	6.63
LTE (Guardband)	1	QPSK	10	1	885	6.68
LTE (Inband)	1	QPSK	10	1	874	6.79
LTE (Inband)	1	QPSK	10	1	885	6.82
LTE	2	QPSK	5+0.2	1	871+893	7.15
LTE	3	QPSK	5+5+0.2	1	871.5+876.5+893	6.79
LTE	3	QPSK	5+5+0.2	1	882.5+887.5+893	6.93

**PAPR Tabular Data (5G-NR) 40W**

Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
5G-NR	1	64QAM	5	3	871.5	7.70
5G-NR	1	64QAM	10	3	874	7.75
5G-NR	1	256QAM	5	3	877.5	7.75
5G-NR	1	64QAM	5	2	882.5	7.73
5G-NR	1	256QAM	5	3	887.5	7.76
5G-NR	2	QPSK/16QAM	5+5	2	871.5+877.5	8.25
5G-NR	2	256QAM	5+5	3	871.5+887.5	7.66
5G-NR	2	QPSK/16QAM	5+5	3	871.5+887.5	8.15
5G-NR	2	QPSK/16QAM	10+10	1	874+885	8.07
5G-NR	2	256QAM	10+5	3	874+887.5	7.77
5G-NR	2	256QAM	5+5	2	882.5+887.5	8.15

**PAPR Tabular Data (5G-NR) 60W**

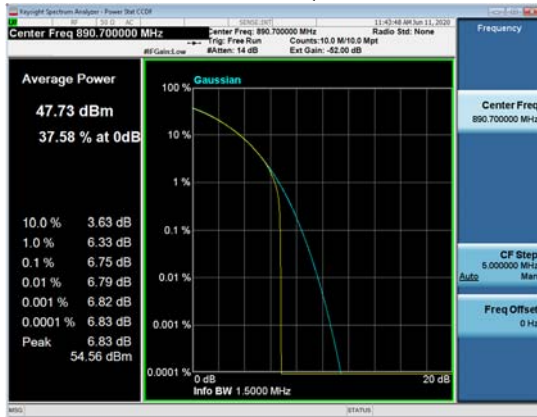
Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
5G-NR	1	64QAM	5	3	871.5	7.27
5G-NR	1	64QAM	10	3	874	7.27
5G-NR	1	256QAM	5	3	877.5	7.24
5G-NR	1	64QAM	5	3	882.5	7.24
5G-NR	1	256QAM	5	3	887.5	7.26
5G-NR	2	QPSK/16QAM	5+5	3	871.5+877.5	7.43
5G-NR	2	256QAM	5+5	3	871.5+887.5	7.46
5G-NR	2	QPSK/16QAM	5+5	3	871.5+887.5	7.61
5G-NR	2	QPSK/16QAM	10+10	3	874+885	7.28
5G-NR	2	256QAM	10+5	3	874+887.5	7.33
5G-NR	2	QPSK/16QAM	5+5	3	882.5+887.5	7.26

## 2.2.1 Peak-to-Average Power Ratio (PAPR) – Plots

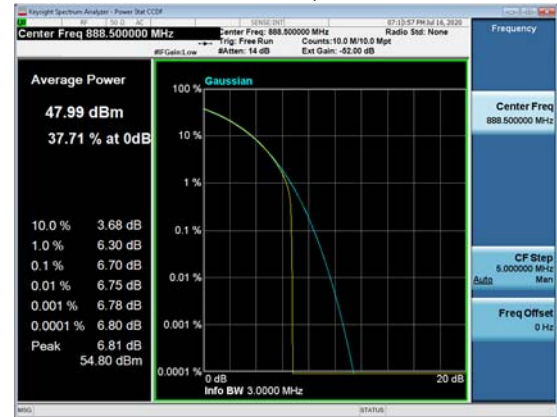
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168. The PAPR values of all carriers measured are below 13dB.

### 2.2.1.1 LTE Plots

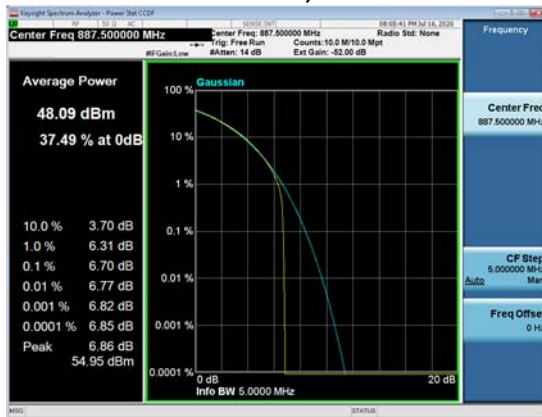
Channel Frequency 890MHz, 1C, 64QAM,  
1.4MHz BW, TX1



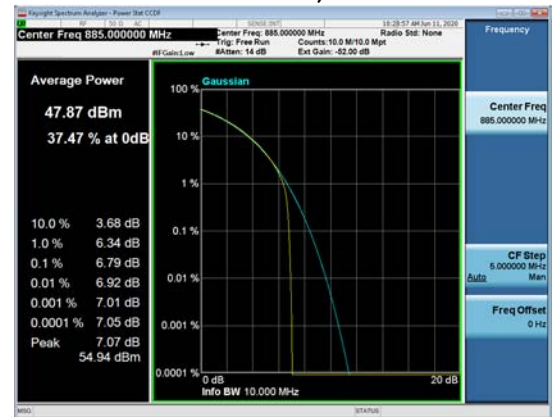
Channel Frequency 888MHz, 1C, QPSK/16QAM,  
3MHz BW, TX1

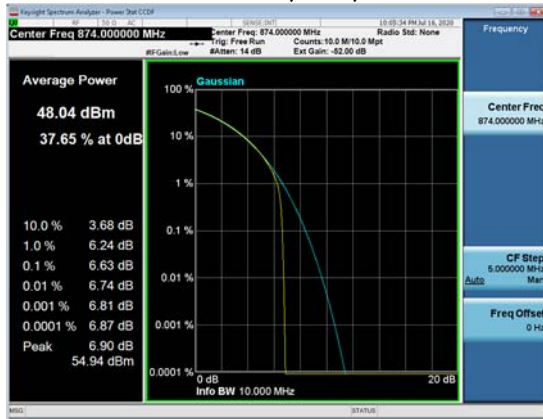
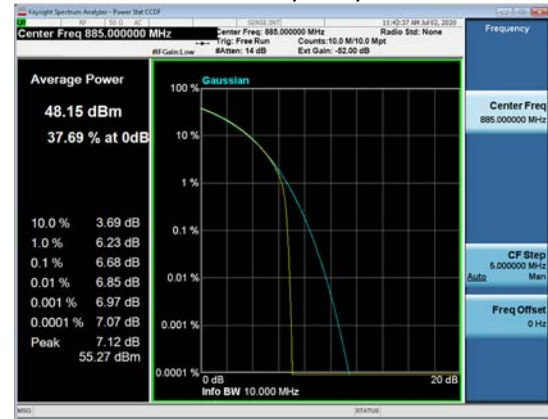
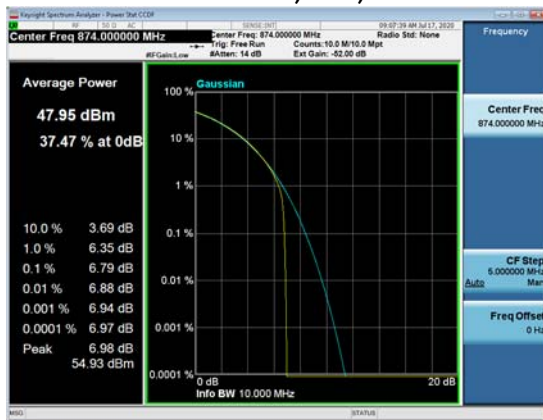
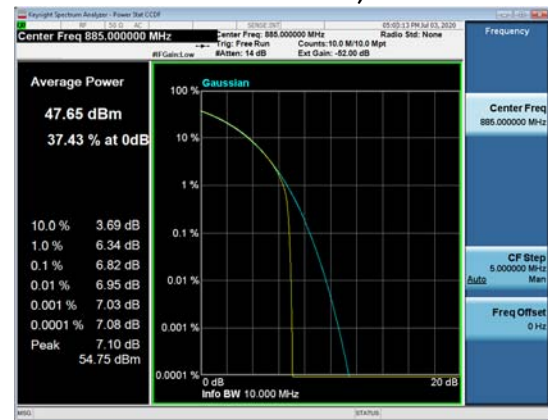
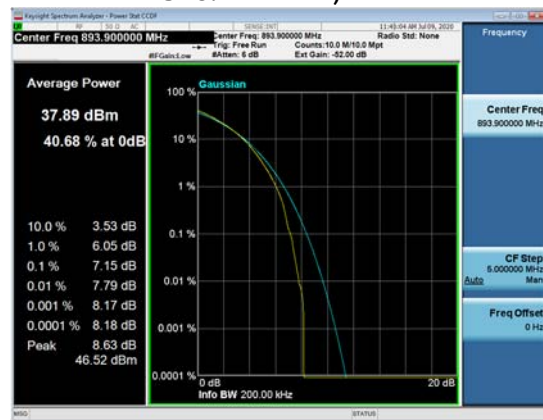
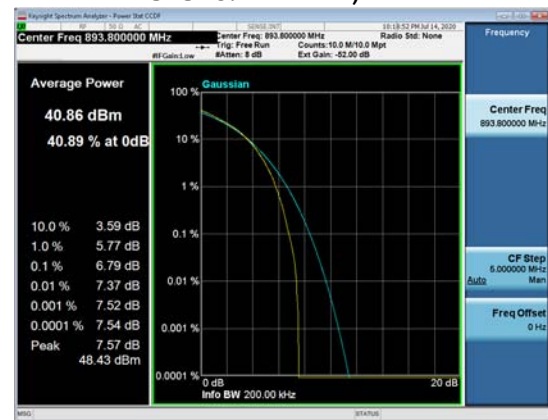


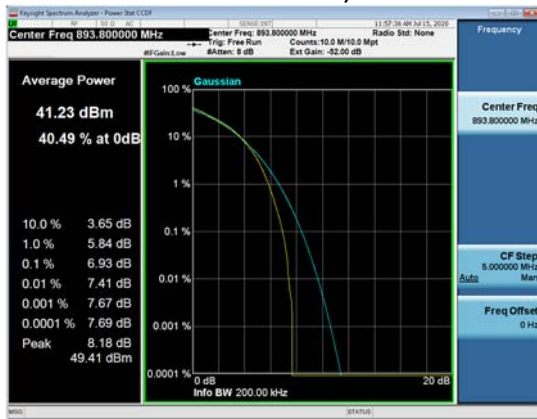
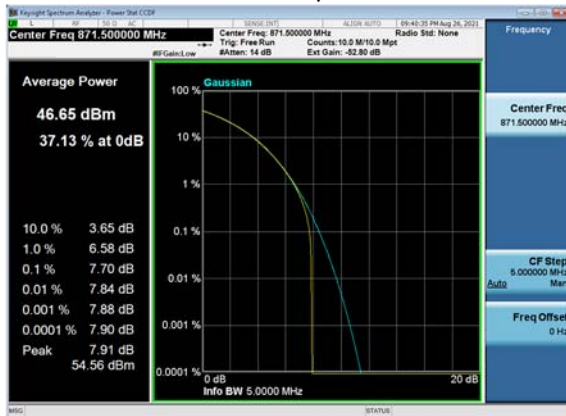
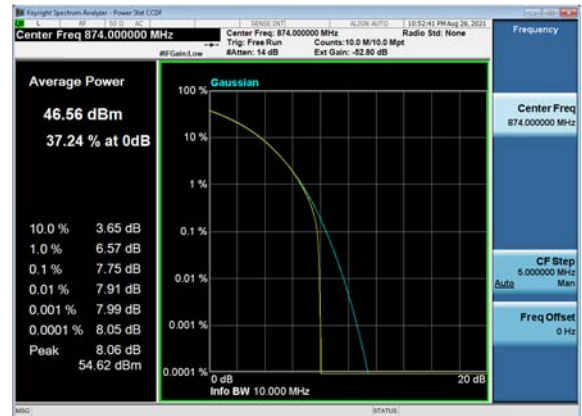
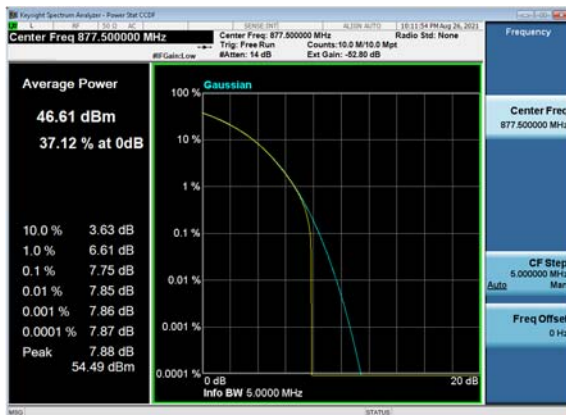
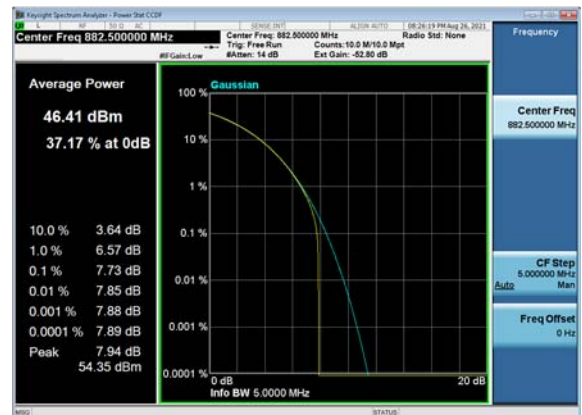
Channel Frequency 887MHz, 1C, QPSK,  
5MHz BW, TX1

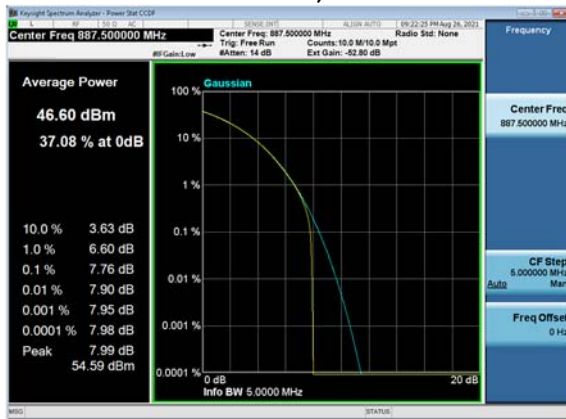
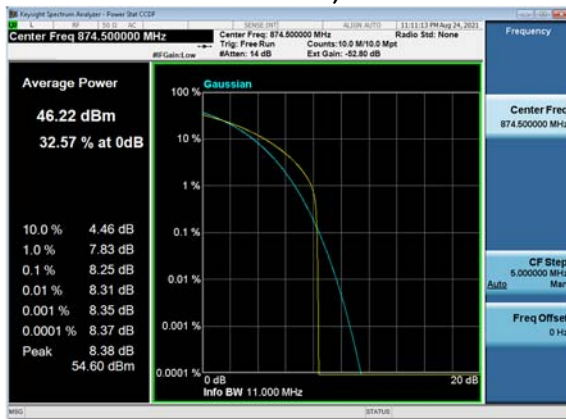
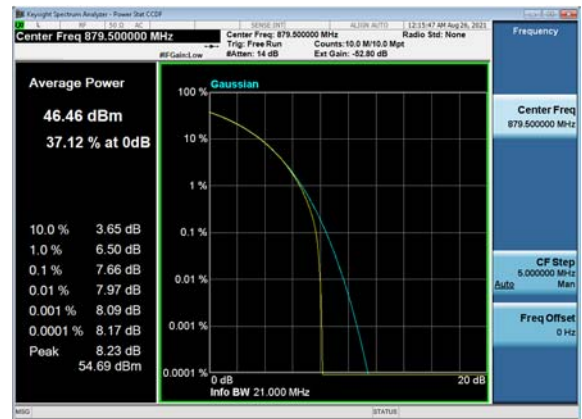
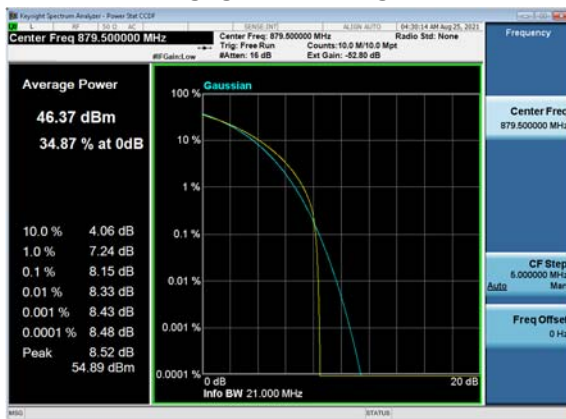
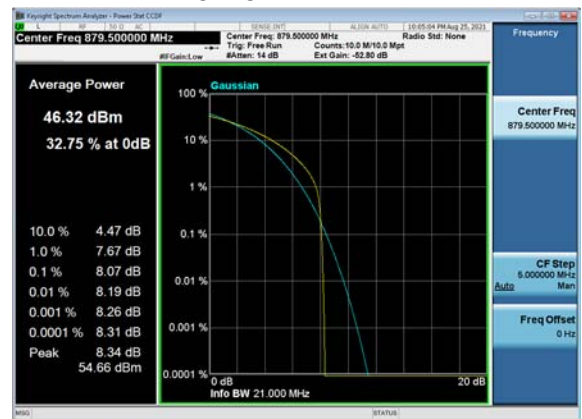


Channel Frequency 885MHz, 1C, 256QAM,  
10MHz BW, TX1

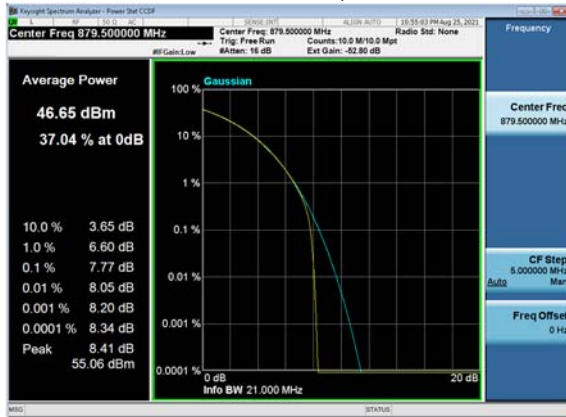
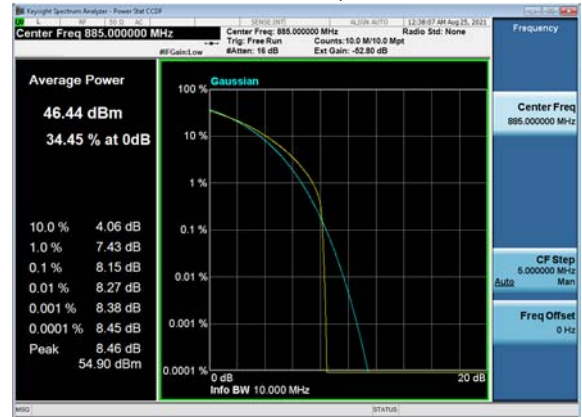


Channel Frequency 874MHz, 1C, QPSK,  
10MHz BW, TX1, GBChannel Frequency 885MHz, 1C, QPSK,  
10MHz BW, TX1, GBChannel Frequency 874MHz, 1C, QPSK,  
10MHz BW, TX1, IBChannel Frequency 885MHz, 1C, QPSK,  
10MHz BW TX1, IBChannel Frequency 871+893MHz, 2C, QPSK,  
5+0.2MHz BW, TX1Channel Frequency 871.5+876.5+893MHz, 3C, 64QAM,  
5+5+0.2MHz BW, TX1

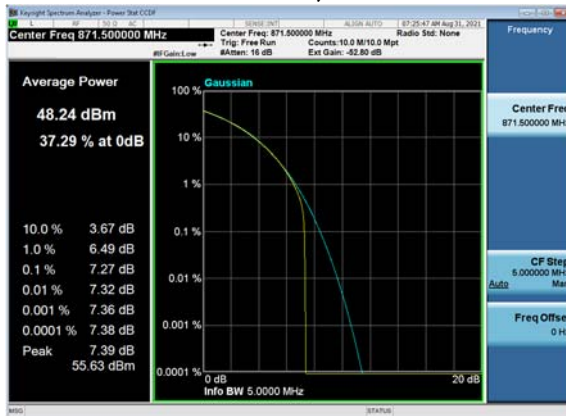
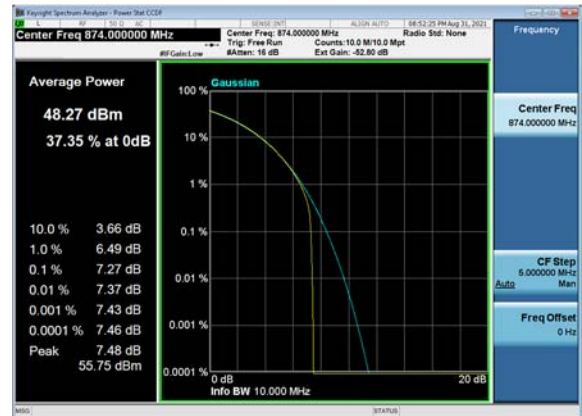
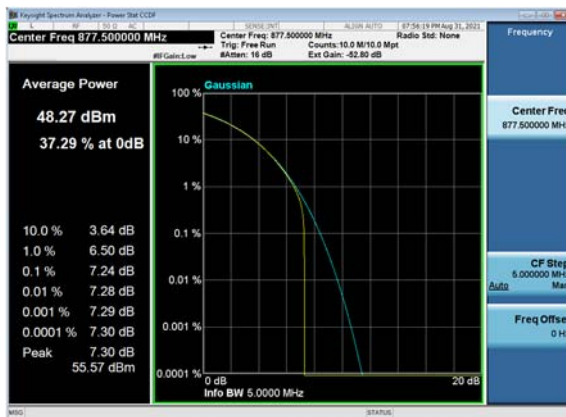
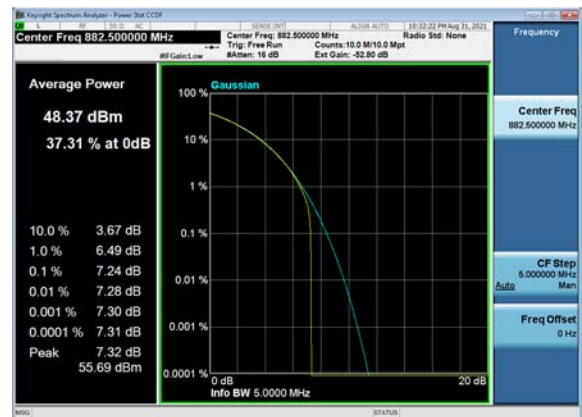
**Channel Frequency 871.5+876.5+893MHz, 3C, QPSK,  
5+5+0.2MHz BW, TX1****2.2.1.2 5G-NR 40W Plots****Channel Frequency 871.5MHz, 1C, 64QAM,  
5MHz BW, TX3****Channel Frequency 874MHz, 1C, 64QAM,  
10MHz BW TX3****Channel Frequency 877.5Hz, 1C, 256QAM,  
5MHz BW TX3****Channel Frequency 882.5MHz, 1C, 64QAM,  
5MHz BW TX2**

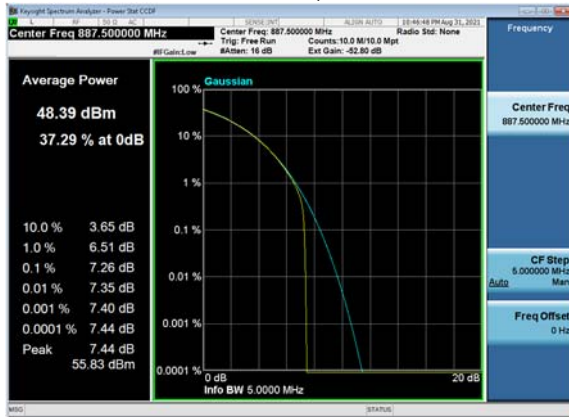
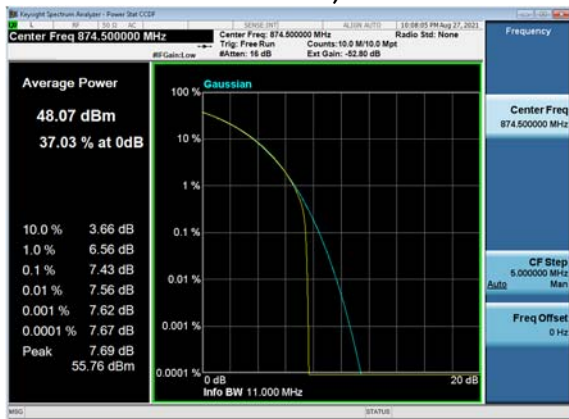
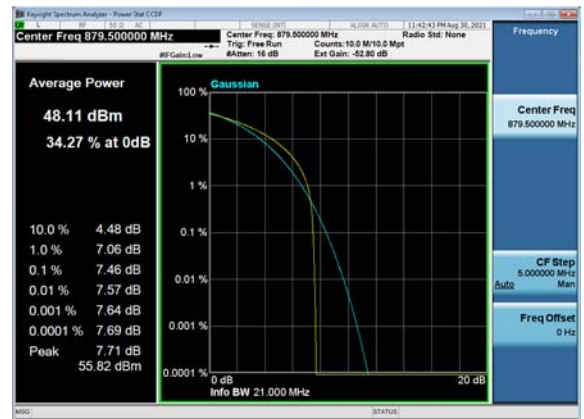
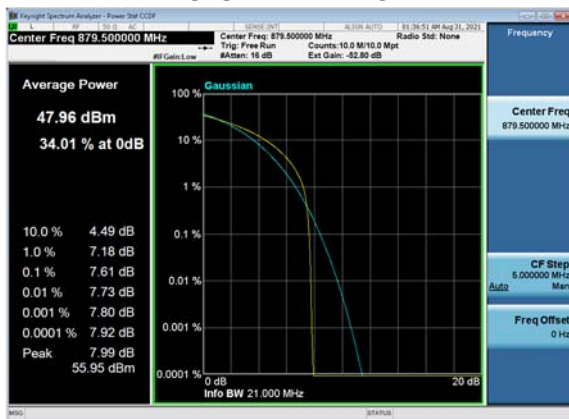
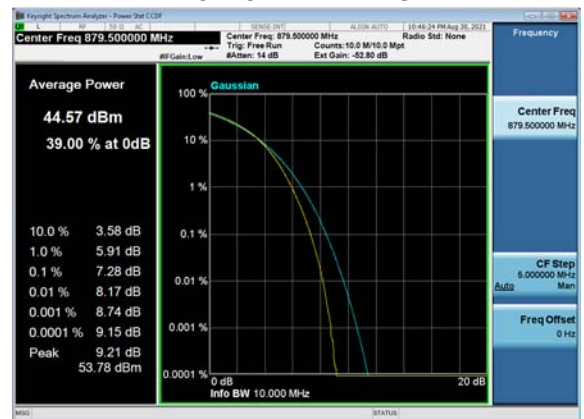
**Channel Frequency 887.5MHz, 1C, 256QAM  
5MHz BW, TX3****Channel Frequency 871.5+877.5MHz, 2C, QPSK/16QAM,  
5+5MHz BW, TX2****Channel Frequency 871.5+887.5MHz, 2C, 256QAM,  
5+5MHz BW TX3****Channel Frequency 871.5+887.5Hz, 2C, QPSK/16QAM,  
5+5MHz BW TX3****Channel Frequency 874+885MHz, 2C, QPSK/16QAM,  
10+10MHz BW TX1**



Channel Frequency 874+887.5MHz, 2C, 256QAM  
10+5MHz BW, TX3Channel Frequency 882.5+887.5MHz, 2C, 256QAM  
5+5MHz BW, TX2

## 2.2.1.3 5G-NR 60W Plots

Channel Frequency 871.5MHz, 1C, 64QAM,  
5MHz BW, TX3Channel Frequency 874MHz, 1C, 64QAM,  
10MHz BW TX3Channel Frequency 877.5Hz, 1C, 256QAM,  
5MHz BW TX3Channel Frequency 882.5MHz, 1C, 64QAM,  
5MHz BW TX3

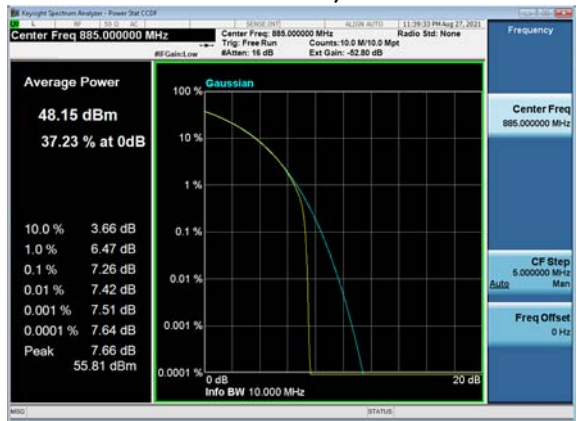
**Channel Frequency 887.5MHz, 1C, 256QAM  
5MHz BW, TX3****Channel Frequency 871.5+877.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX2****Channel Frequency 871.5+887.5MHz, 2C, 256QAM  
5+5MHz BW TX3****Channel Frequency 871.5+887.5Hz, 2C, QPSK/16QAM  
5+5MHz BW TX3****Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW TX3**



Channel Frequency 874+887.5MHz, 2C, 256QAM  
10+5MHz BW, TX3



Channel Frequency 882.5+887.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX3



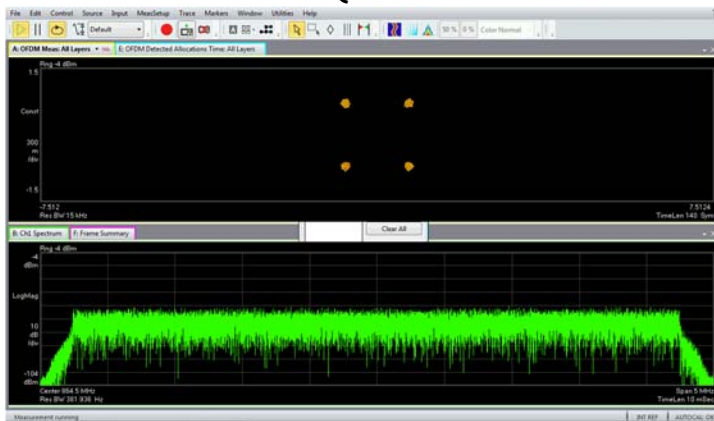
### 3. FCC Section 2.1047 - Modulation Characteristics

#### 3.1 Modulation Characteristics

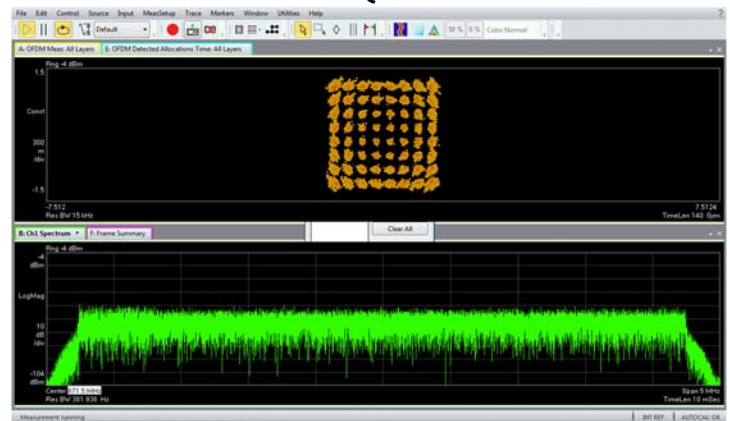
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

##### 3.1.1 Modulation Characteristics – Plots

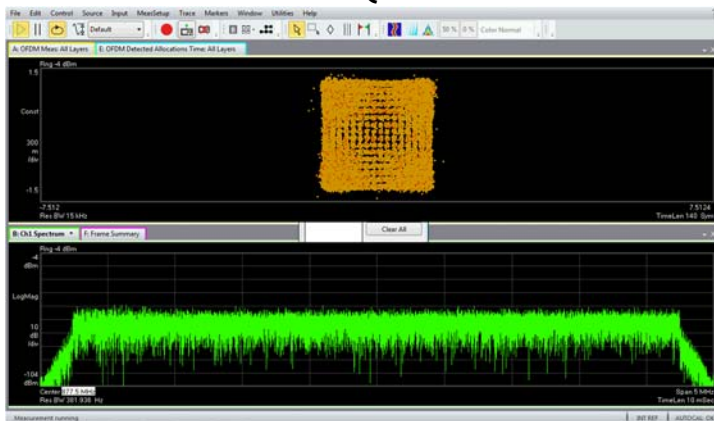
**QPSK**



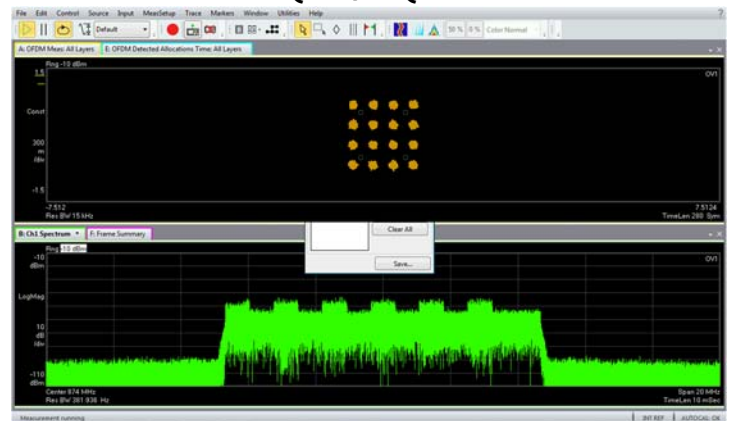
**64QAM**



**256QAM**



**QPSK/16QAM**



## 4. FCC Section 2.1049 – Occupied Bandwidth/Edge of Band Emissions

### 4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

“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 under the following conditions as applicable.”

This required measurement is the 99% Occupied Bandwidth, also called the designated signal bandwidth and needs to be within the parameters of the products specified emissions designator. During these measurements it is customary to evaluate the Edge of Band emissions at block/band edges.

The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

**Tabular Data – Occupied Bandwidth (LTE)**

Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency (MHz)	Occupied BW (MHz)
LTE	1	QPSK	1.4	1	869	<b>1.1016</b>
LTE	1	64QAM	3	1	885	<b>2.6965</b>
LTE	1	QPSK	5	1	887	<b>4.4773</b>
LTE	1	256QAM	10	1	885	8.9485
LTE (Guardband)	1	QPSK	10	1	874	<b>9.4159</b>
LTE (Guardband)	1	QPSK	10	1	885	9.3662
LTE (Inband)	1	QPSK	10	1	874	8.9307
LTE (Inband)	1	QPSK	10	1	885	8.9264
LTE	2	QPSK	5+0.2	1	871+893	4.4706+0.19342
LTE	3	QPSK	5+5+0.2	1	871.5+876.5+893	9.4276+ <b>0.19409</b>
LTE	3	QPSK	5+5+0.2	1	882.5+887.5+893	9.4382+0.19409

**Tabular Data – Occupied Bandwidth (5G-NR) 40W**

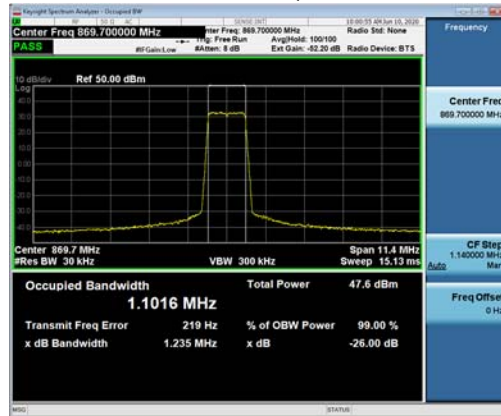
Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency (MHz)	Occupied BW (MHz)
5G-NR	1	64QAM	5	3	871.5	4.4657
5G-NR	1	64QAM	10	3	874	<b>9.2740</b>
5G-NR	1	256QAM	5	3	877.5	4.4604
5G-NR	1	64QAM	5	2	882.5	4.4603
5G-NR	1	256QAM	5	3	887.5	4.4586
5G-NR	2	QPSK/16QAM	5+5	2	871.5+877.5	4.4771+4.4772
5G-NR	2	256QAM	5+5	3	871.5+887.5	4.4793+ <b>4.4861</b>
5G-NR	2	QPSK/16QAM	5+5	3	871.5+887.5	4.4787+4.4770
5G-NR	2	QPSK/16QAM	10+10	1	874+885	9.2178+9.2217
5G-NR	2	256QAM	10+5	3	874+887.5	9.2632+4.4777
5G-NR	2	256QAM	5+5	2	882.5+887.5	9.4316

**Tabular Data – Occupied Bandwidth (5G-NR) 60W**

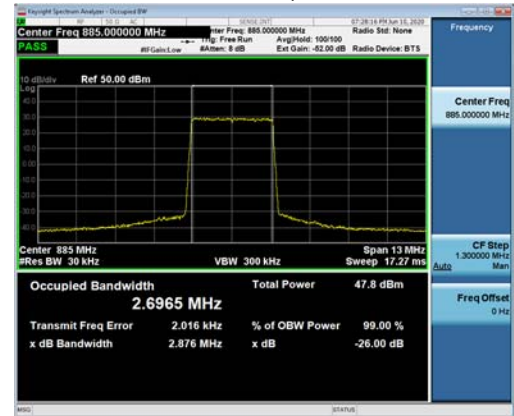
Radio Technology	Carrier	Modulation	BW MHz	TX Port	Channel Frequency (MHz)	Occupied BW (MHz)
5G-NR	1	64QAM	5	3	871.5	4.4637
5G-NR	1	64QAM	10	3	874	9.2707
5G-NR	1	256QAM	5	3	877.5	4.4549
5G-NR	1	64QAM	5	2	882.5	4.4651
5G-NR	1	256QAM	5	3	887.5	4.4564
5G-NR	2	QPSK/16QAM	5+5	3	871.5+877.5	4.4683+4.4747
5G-NR	2	256QAM	5+5	3	871.5+887.5	4.4789+4.4808
5G-NR	2	QPSK/16QAM	5+5	3	871.5+887.5	4.4745+4.4758
5G-NR	2	QPSK/16QAM	10+10	3	874+885	9.2361+9.2298
5G-NR	2	256QAM	10+5	3	874+887.5	9.2676+4.4738
5G-NR	2	256QAM	5+5	3	882.5+887.5	9.4091

#### 4.1.1 Occupied Bandwidth – LTE Plots

Channel Frequency 869MHz, 1C, QPSK  
1.4MHz BW, TX1



Channel Frequency 885MHz, 1C, 64QAM  
3MHz BW, TX1



Channel Frequency 887MHz, 1C, QPSK  
5MHz BW, TX1



Channel Frequency 885MHz, 1C, 256QAM  
10MHz BW, TX1



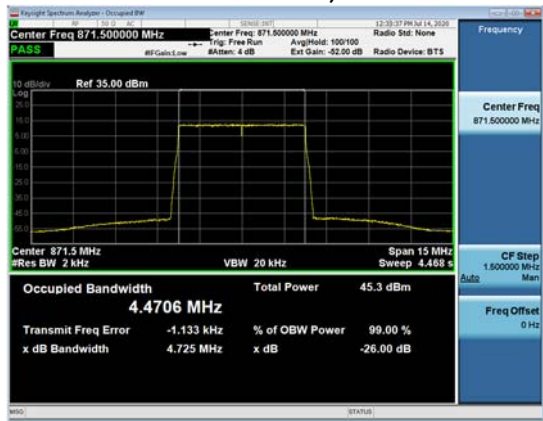
Channel Frequency 874MHz, 1C, QPSK  
10MHz BW, TX1, Guardband



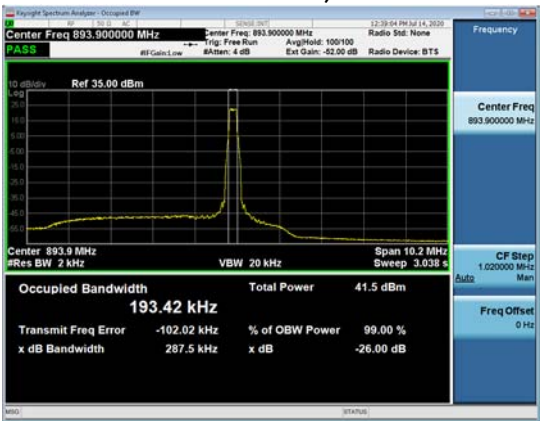
Channel Frequency 874MHz, 1C, QPSK  
10MHz BW, TX1, Inband



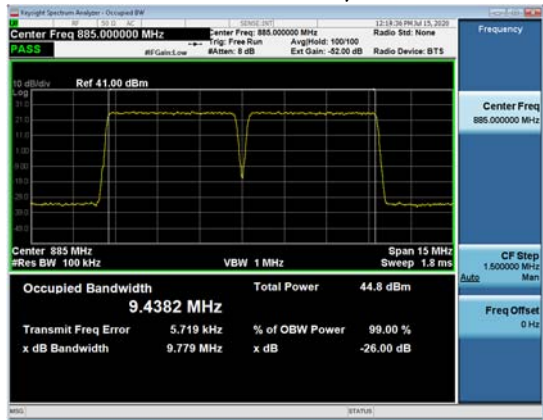
Channel Frequency 871+893MHz, 2C, QPSK  
5+0.2MHz BW, TX1



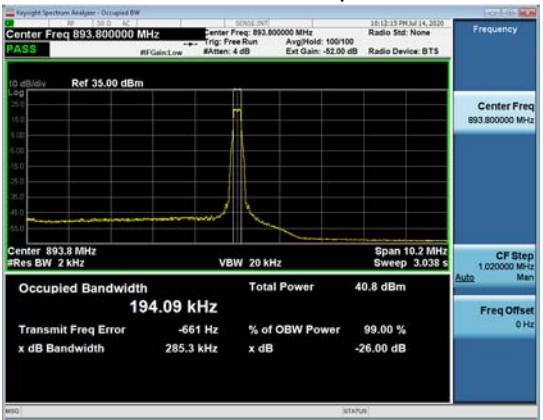
Channel Frequency 871+893MHz, 2C, QPSK  
5+0.2MHz BW, TX1



Channel Frequency 882.5+887.5+893MHz, 3C, QPSK  
5+5+0.2MHz BW, TX1

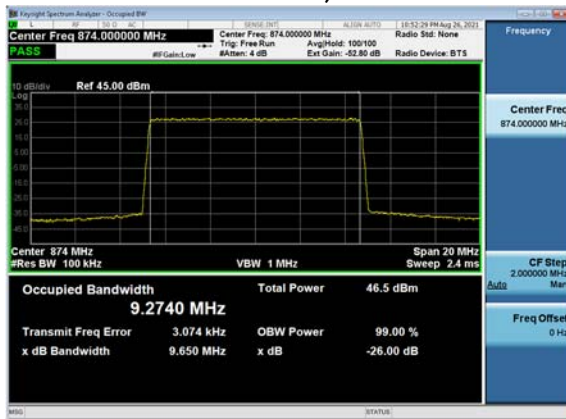
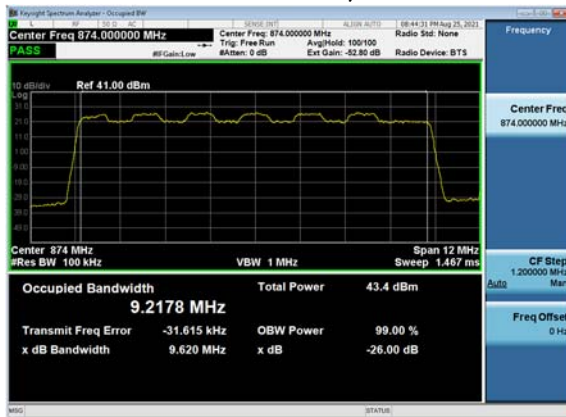
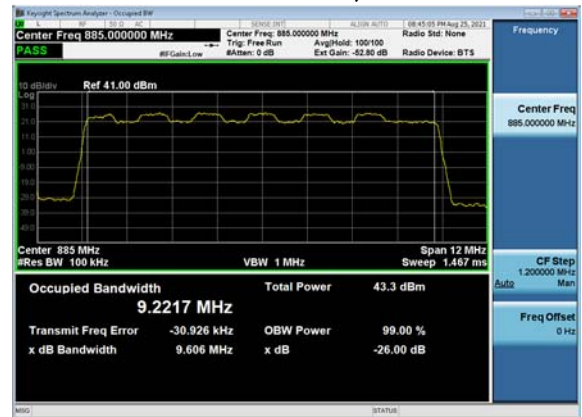


Channel Frequency 882.5+887.5+893MHz, 3C, QPSK  
5+5+0.2MHz BW, TX1



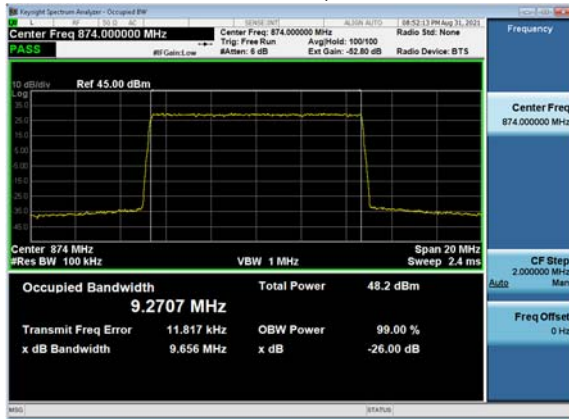


## 4.1.2 Occupied Bandwidth – 5G NR 40W Plots

Channel Frequency 874MHz, 1C, 64QAM  
10MHz BW, TX3Channel Frequency 871.5MHz, 1C, 64QAM  
5MHz BW, TX3Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX1Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX1

### 4.1.3 Occupied Bandwidth – 5G NR 60W Plots

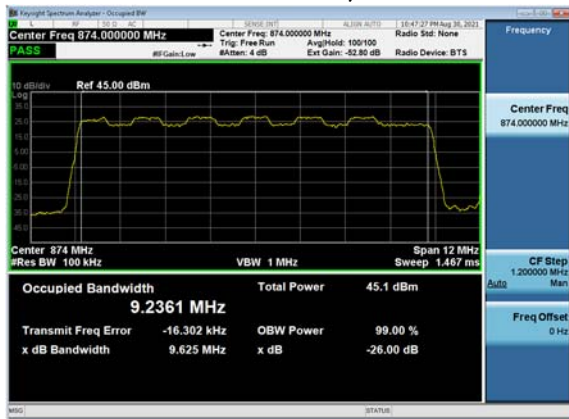
Channel Frequency 874MHz, 1C, 64QAM  
10MHz BW, TX3



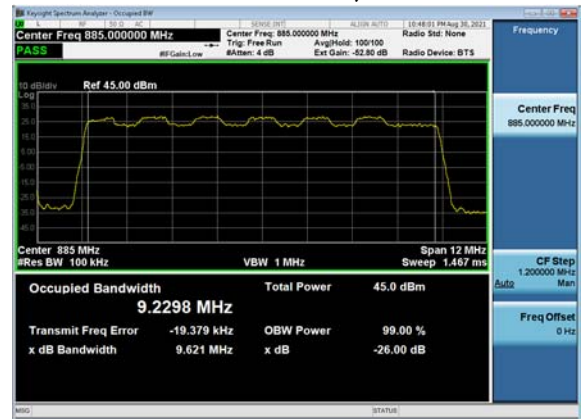
Channel Frequency 882.5MHz, 1C, 64QAM  
5MHz BW, TX2



Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX3



Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX3





## 4.2 Edge of band Emissions

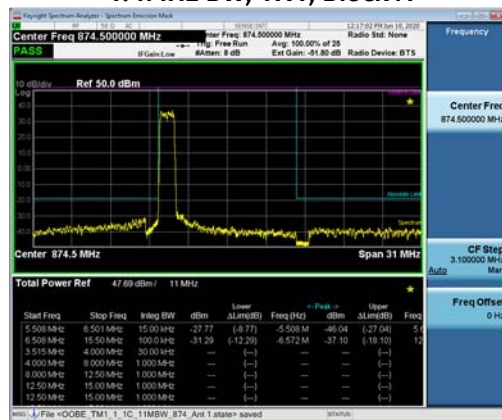
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and RF Switch. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths.

### 4.2.1 Edge of Band Emissions – Plots

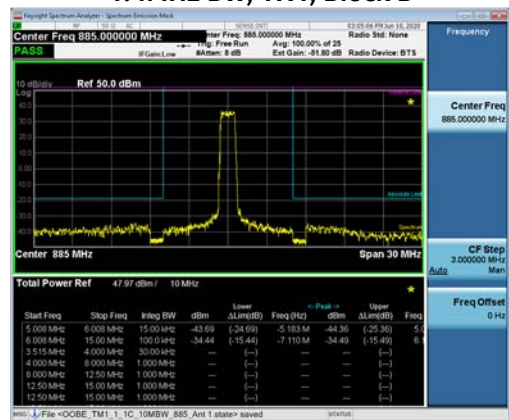
All of the measurements met the requirements of Part 2.1049. The limit line was set to -19 dBm to reflect the -13 dBm limit corrected for MIMO operation using 10 log (4).

#### 4.2.1.1.1 LTE Plots

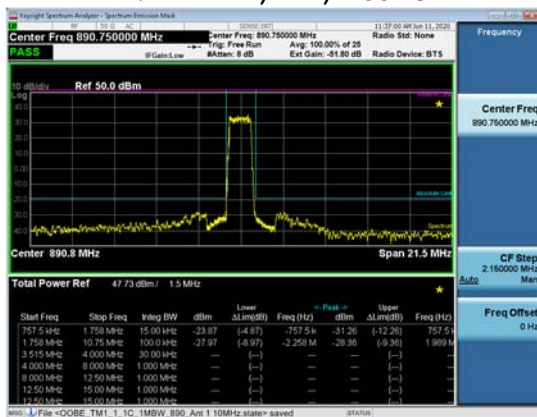
Channel Frequency 869MHz, 1C, QPSK  
1.4MHz BW, TX1, Block A



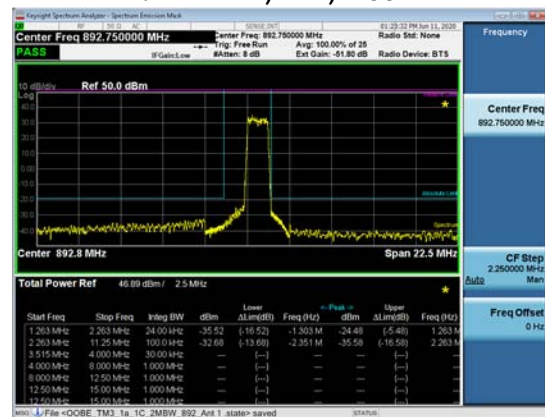
Channel Frequency 885MHz, 1C, 64QAM  
1.4MHz BW, TX1, Block B

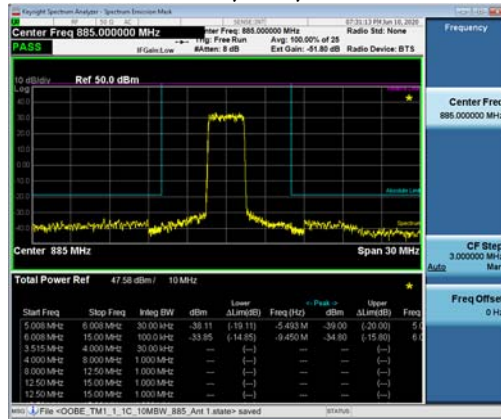
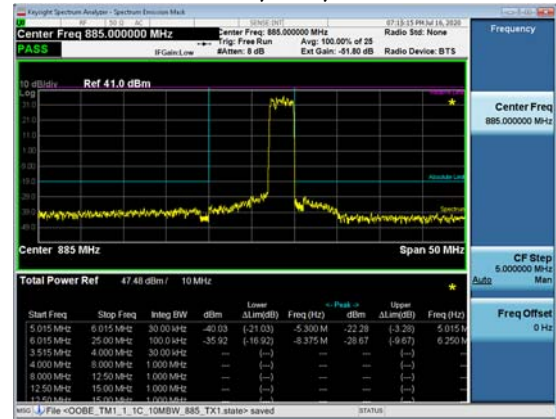
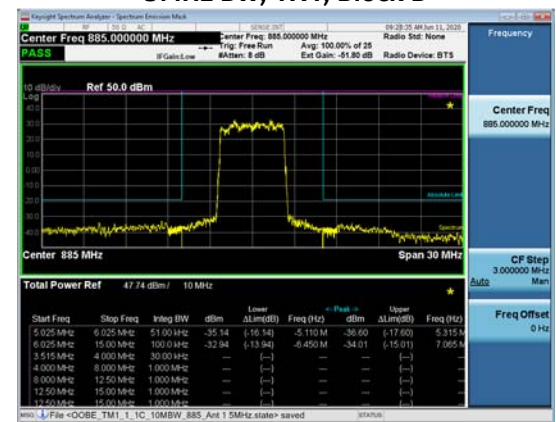
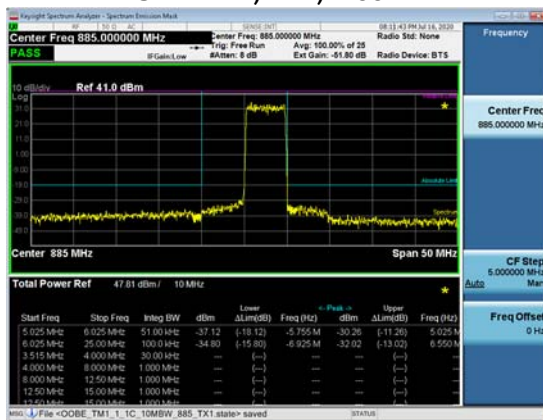


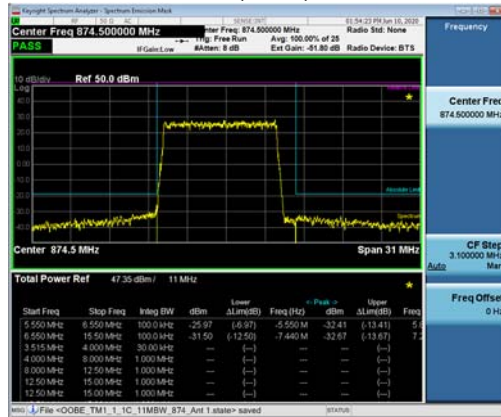
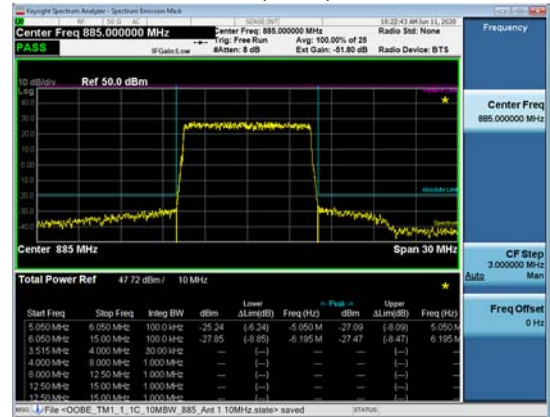
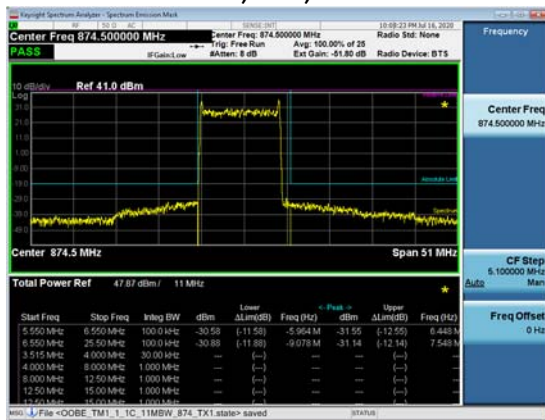
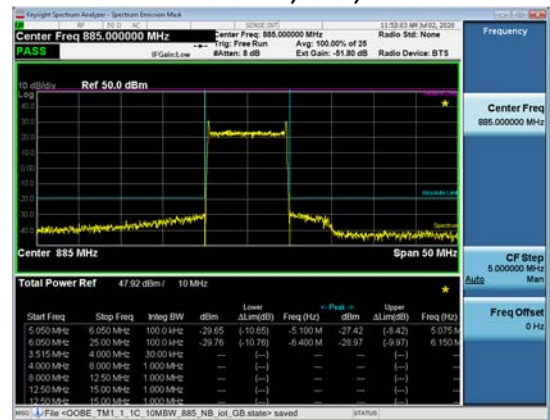
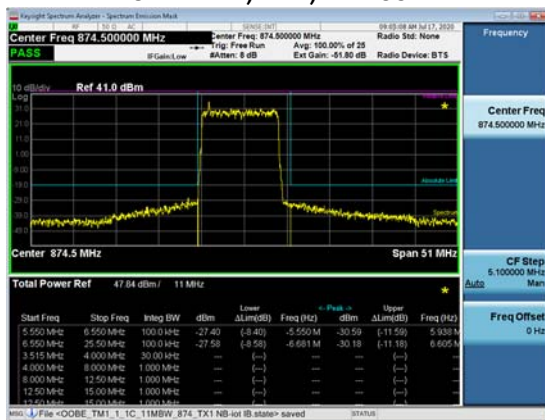
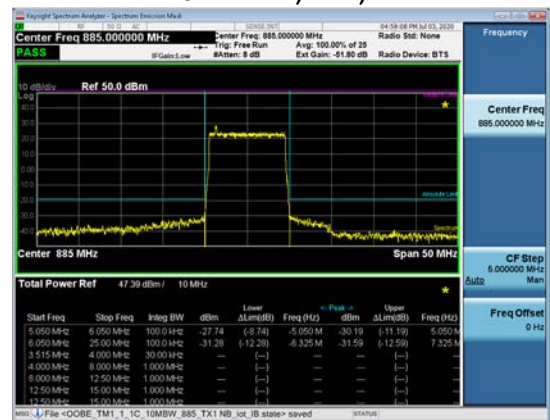
Channel Frequency 890MHz, 1C, 64QAM  
1.4MHz BW, TX1, Block C



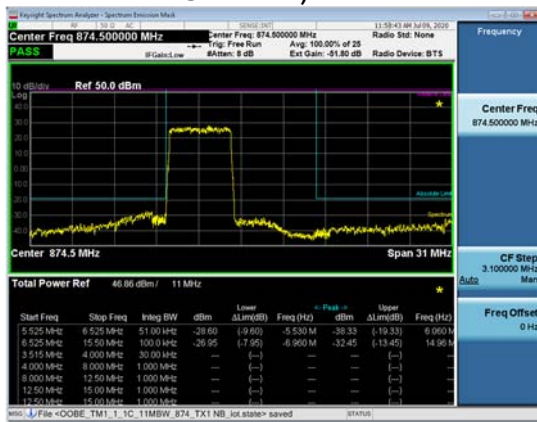
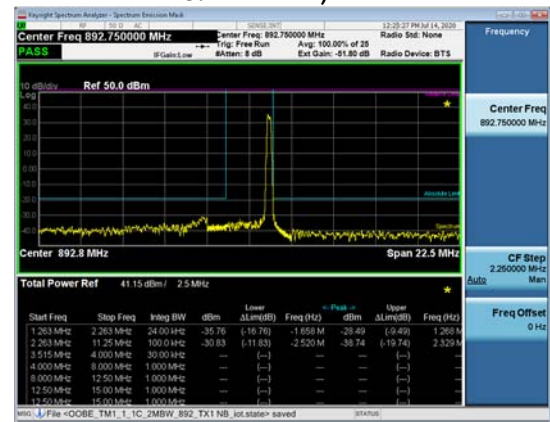
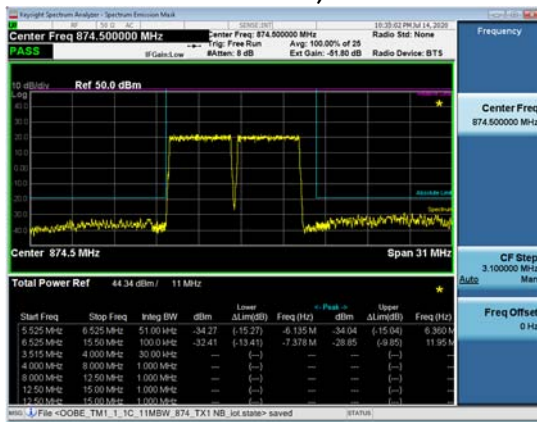
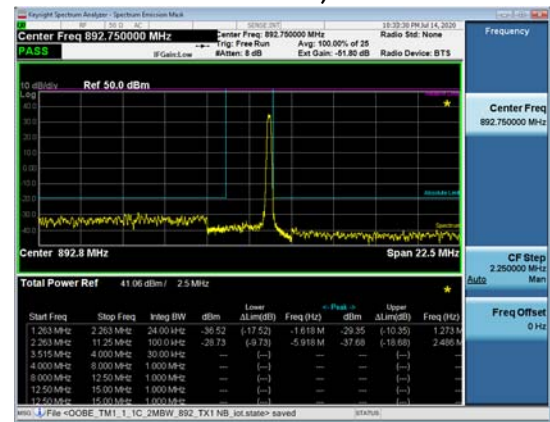
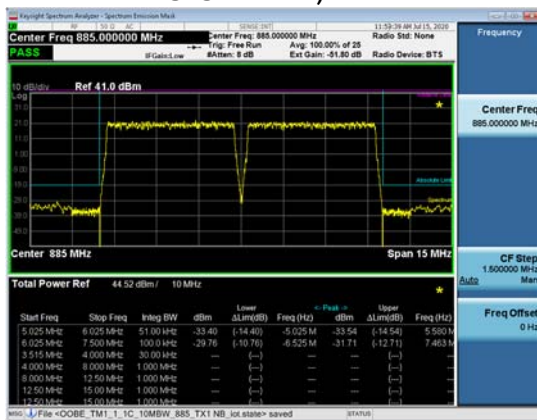
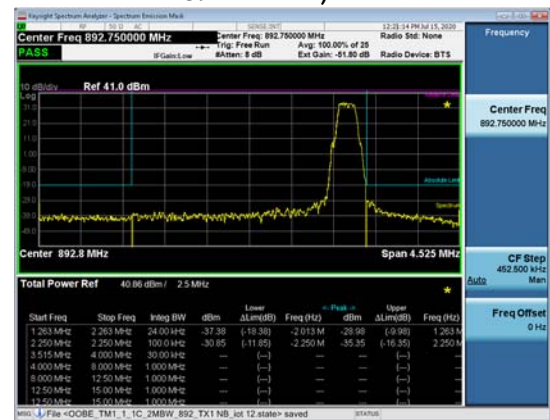
Channel Frequency 893MHz, 1C, 256QAM  
1.4MHz BW, TX1, Block D



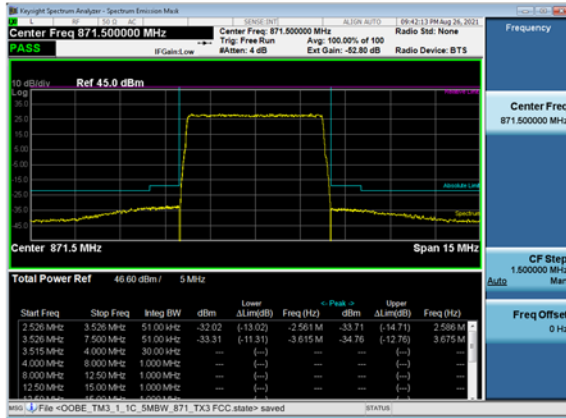
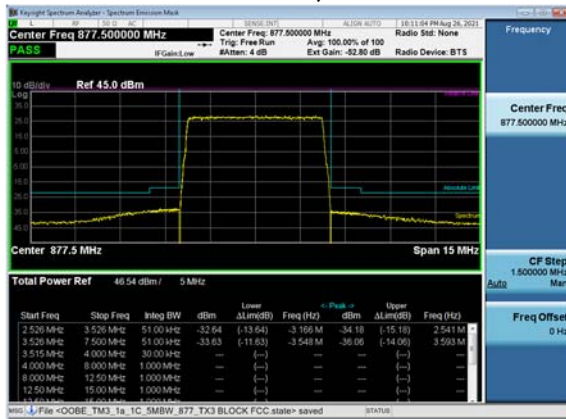
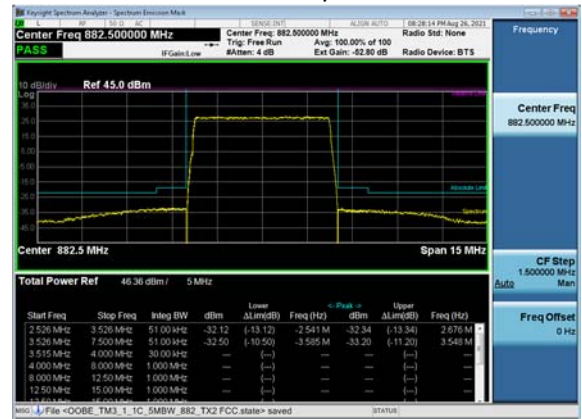
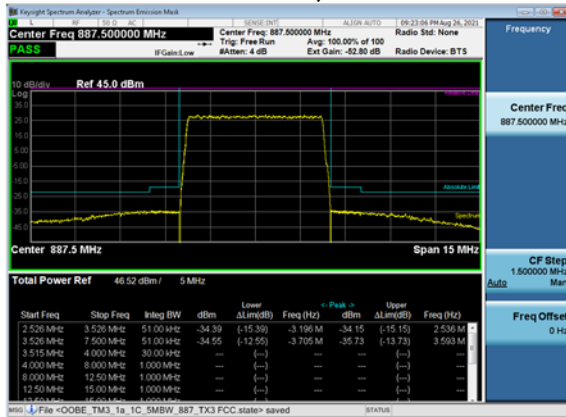
**Channel Frequency 885MHz, 1C, 64QAM  
3MHz BW, TX1, Block B****Channel Frequency 888MHz, 1C, QPSK/16QAM  
3MHz BW, TX1, Block B****Channel Frequency 871MHz, 1C, 64QAM  
5MHz BW, TX1, Block A****Channel Frequency 885MHz, 1C, QPSK/16QAM  
5MHz BW, TX1, Block B****Channel Frequency 887MHz, 1C, QPSK  
5MHz BW, TX1, Block B**

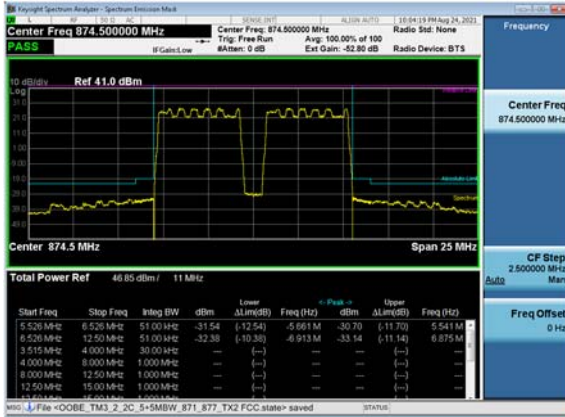
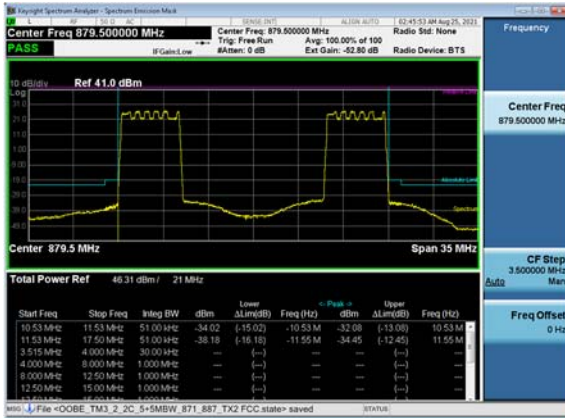
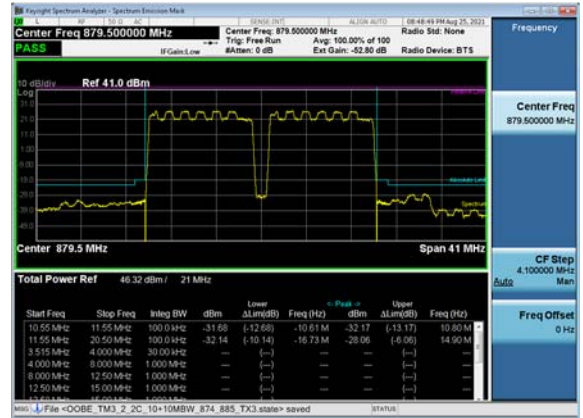
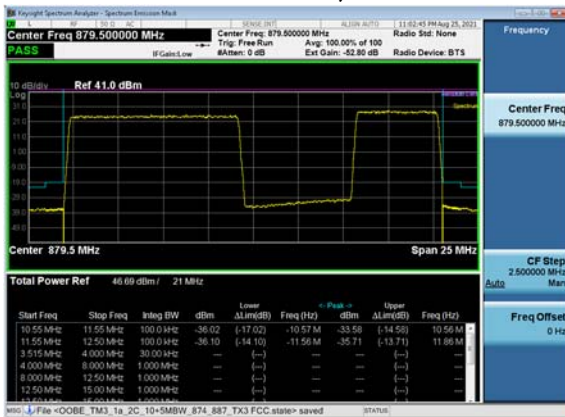
Channel Frequency 874MHz, 1C, 64QAM  
10MHz BW, TX1, Block AChannel Frequency 885MHz, 1C, 256QAM  
10MHz BW, TX1, Block BChannel Frequency 874MHz, 1C, QPSK  
10MHz BW, TX1, GB Block AChannel Frequency 885MHz, 1C, QPSK  
10MHz BW, TX1, GBChannel Frequency 874MHz, 1C, QPSK  
10MHz BW, TX1, IB Block AChannel Frequency 885MHz, 1C, QPSK  
10MHz BW, TX1, IB



Channel Frequency 871+893MHz, 2C, QPSK  
5MHz BW, TX1Channel Frequency 874+893MHz, 2C, QPSK  
0.2MHz BW, TX1Channel Frequency 871.5+876.5+893MHz, 3C, QPSK  
5+5MHz BW, TX1Channel Frequency 871.5+876.5+893MHz, 3C, QPSK  
0.2MHz BW, TX1Channel Frequency 882.5+887.5+893MHz, 3C, QPSK  
5+5MHz BW, TX1Channel Frequency 882.5+887.5+893MHz, 3C, QPSK  
0.2MHz BW, TX1

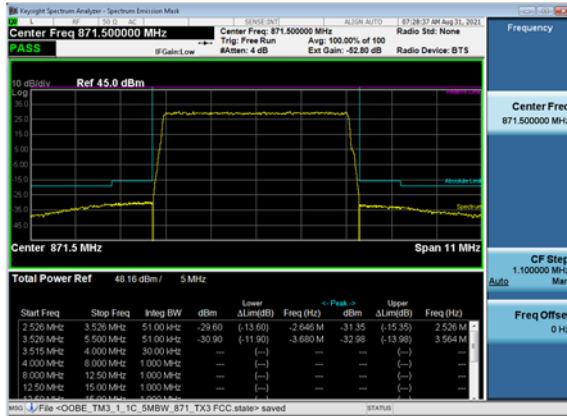
## 4.2.1.1.2 5G-NR 40W Plots

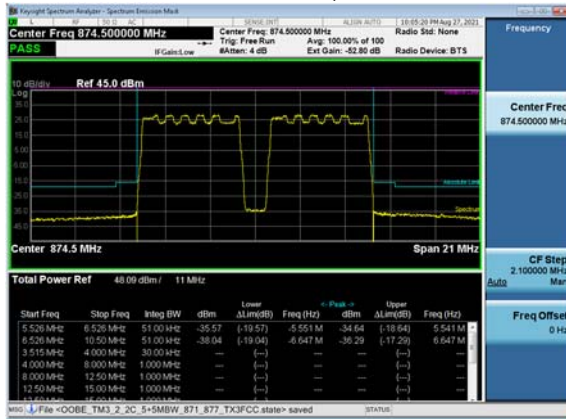
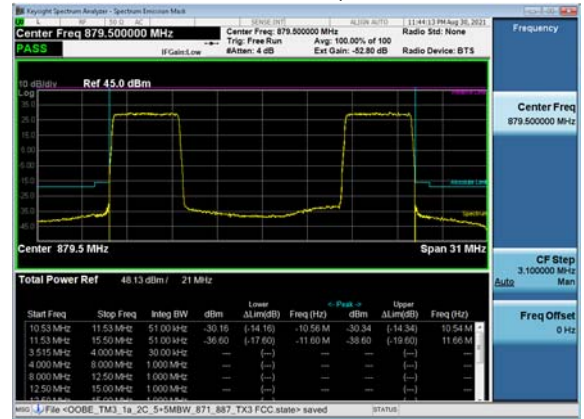
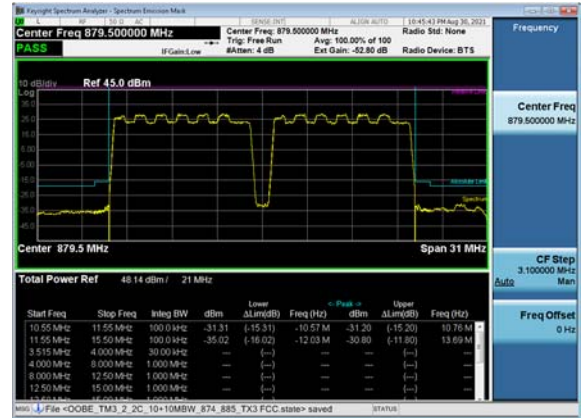
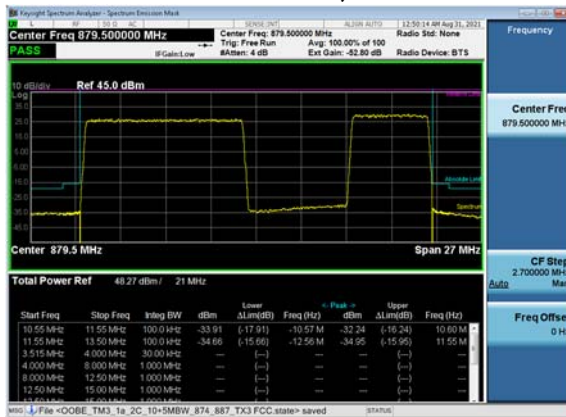
Channel Frequency 871MHz, 1C, 64QAM  
5MHz BW, TX3Channel Frequency 874MHz, 1C, 64QAM  
10MHz BW, TX3Channel Frequency 877.5MHz, 1C, 256QAM  
5MHz BW, TX3Channel Frequency 882.5MHz, 1C, 64QAM  
5MHz BW, TX2Channel Frequency 887.5MHz, 1C, 256QAM  
5MHz BW, TX3

**Channel Frequency 871.5+877.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX2****Channel Frequency 871.5+887.5MHz, 2C, 256QAM  
5+5MHz BW, TX3****Channel Frequency 871.5+887.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX3****Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX1****Channel Frequency 874+887.5MHz, 2C, 256QAM  
10+5MHz BW, TX3****Channel Frequency 882.5+887.5MHz, 2C, 256QAM  
5+5MHz BW, TX2**



## 4.2.1.1.3 5G-NR 60W Plots

Channel Frequency 871.5MHz, 1C, 64QAM  
5MHz BW, TX3Channel Frequency 874MHz, 1C, 64QAM  
10MHz BW, TX3Channel Frequency 877.5MHz, 1C, 256QAM  
5MHz BW, TX3Channel Frequency 882.5MHz, 1C, 64QAM  
5MHz BW, TX3Channel Frequency 887.5MHz, 1C, 256QAM  
5MHz BW, TX3

Channel Frequency 871.5+877.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX3Channel Frequency 871.5+887.5MHz, 2C, 256QAM  
5+5MHz BW, TX3Channel Frequency 871.5+887.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX3Channel Frequency 874+885MHz, 2C, QPSK/16QAM  
10+10MHz BW, TX3Channel Frequency 874+887.5MHz, 2C, 256QAM  
10+5MHz BW, TX3Channel Frequency 882.5+887.5MHz, 2C, QPSK/16QAM  
5+5MHz BW, TX2