Global Product Compliance Laboratory
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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 27

Client:
NOKIA SOLUTIONS AND NETWORKS, OY

Product Evaluated:
AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W

Report Number:
TR-2020-0117-FCC2-27

Date Issued:
November 19, 2020

Table of Contents

Revisions

Date	Revision	Section	Change
11/19/2020	0		Initial Release

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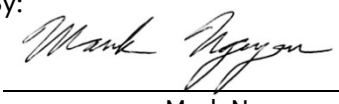
Prepared By:

Signed:  11/19/2020

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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.

Equipment Under Test (EUT):	AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W
Serial Number:	EB193661018
FCC ID:	2AD8UAWHHF01
Hardware Version:	475181A.X22
Software Version:	5G20A
Frequency Range:	2496-2690 MHz
GPCL Project Number:	2020-0117
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	NOKIA SOLUTIONS AND NETWORKS OY Terry Schwenk 2000 Lucent Lane, Naperville, IL 60563
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	• Title 47 CFR Parts 2 and 27 • KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018. • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • ANSI C63.26 (2015) • ANSI C63.4 (2014)
Measurement Procedure(s):	• 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
Test Date(s):	10/22/2020 – 11/18/2020
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636
Product Engineer(s):	Ron Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Nilesh Patel
Test Results: The EUT, *as tested* 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 AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W, hereinafter referred to as the Equipment Under Test (EUT).

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 27 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

This report covers the Class II Permissive change to add modes of operation for 20 and 80 MHz 5G-NR (G7W) carriers and 10 MHz LTE (F9W) at 80W to the existing Grant. In addition, multi carrier operation for three 10 and 20 MHz contiguous LTE Carriers encompassing between 30 MHz and 50 MHz is demonstrated. The multicarrier operation for one to three LTE 20 MHz carriers was previously demonstrated. The AWHHF product is certified under FCC ID: 2AD8UAWHHF01.

No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates).

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Radio Access Technology	5G-NR & LTE
Duplex Mode	Time Division Duplex (TDD)
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM
Operation Frequency Range	2496-2690 MHz
Channel Bandwidth	Single Carrier – 10 and 20 MHz (LTE), 40, 60, 80, 100 MHz (5G-NR); Multicarrier - 10+10+10, 10+10+20, 10+20+20, 20+20+20 MHz (LTE)
Number of Tx Ports per Unit	4
MIMO	Yes
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC

1.3.2 Photographs

Front View

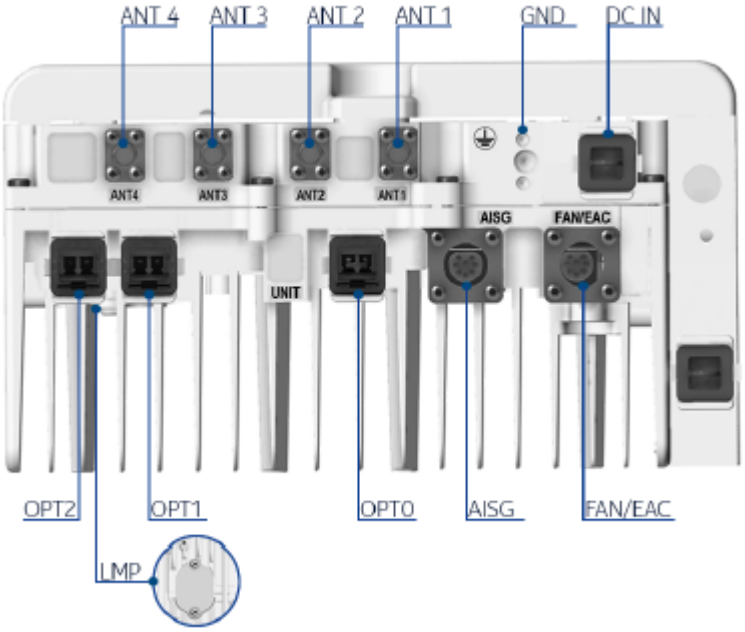
Rear View

Left View

Right View

Top View

Bottom View



Interface	Label on the HW	Number of interfaces	Connector type	Additional info
Power Connector	DC IN	1	DC OCTIS Plug Kit	Hot insert not supported
Antenna connector	ANT	4	NEX 10	-
External Alarm Connection/Fan	EAC/FAN	1	CIRC 8F IP67 Flange	Two external alarms supported
Optical interface	OPT	3	OCTIS Plug Kit SFP/SFP+	9.8 Gbps, CPRI
Ethernet	RJ	1	RJ45	-
Grounding	⏚	1	M8 or dual M5 screws	-
AISG connector	AISG	1	8-pin circular	-
Local Management Port (LMP)	-	1	2x20-pin female header	-

Serial Number

Power Information

1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 27.53	RF Power Output	Yes
2.1047, 27.53	Modulation Characteristics	Yes
2.1049, 27.53	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 27.53	Spurious Emissions at Antenna Terminals	Yes
2.1053, 27.53	Field Strength of Spurious Radiation	Yes
2.1055, 27.53	Frequency Stability	No[1]

[1] No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates).

1.5 Standards & Procedures

1.5.1 Test Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.
- KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- 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, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

1.5.2 Measurement 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, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, 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

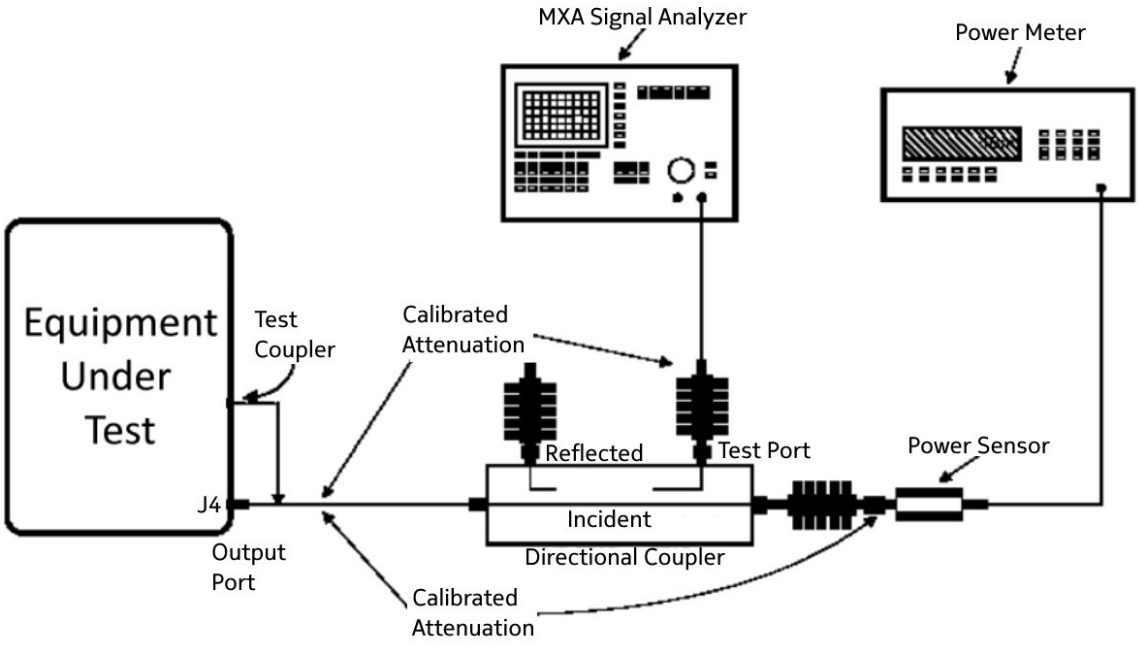
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz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

1.6 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.53	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 27.53	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 27.53	Field Strength of Spurious Radiation	COMPLIES
2.1055, 27.53	Frequency Stability	N/A

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 the section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

Power measurements were made with an MXA Signal Analyzer.

Tabular Data – Channel RF Power (LTE)

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
2685	10	64QAM	1	40.63
			2	40.55
			3	41.08
			4	40.91
2593	10	256QAM	1	40.61
			2	40.59
			3	41.08
			4	40.92
2501	10	QPSK/16QAM	1	41.08
			2	40.39
			3	41.65
			4	41.39

Tabular Data – Channel RF Power (5G-NR)

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
2506	20	QPSK	1	43.51
			2	43.34
			3	43.40
			4	43.84
2680	20	QPSK	1	43.21
			2	43.16
			3	42.84
			4	43.55
2593	20	QPSK/16QAM	1	42.82
			2	42.74
			3	43.02
			4	43.08

Tabular Data – Channel RF Power (5G-NR)

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
2593	80	QPSK	1	43.28
			2	43.15
			3	43.54
			4	43.55
2650	80	64QAM	1	43.13
			2	43.09
			3	43.27
			4	43.46
2536	80	QPSK/16QAM	1	43.29
			2	43.16
			3	43.26
			4	43.59

Tabular Data – Channel RF Power - 3xLTE (QPSK + 16QAM + 256QAM)

Channel Frequency MHz	Signal BW MHz	TX Port	Channel Power dBm
2501 + 2511 + 2521	10 + 10 +10	1	43.11
		2	42.92
		3	43.30
		4	43.49
2583 + 2593 + 2603	10 + 10 +10	1	42.89
		2	42.68
		3	42.68
		4	43.27
2665 + 2675 + 2685	10 + 10 +10	1	42.83
		2	42.73
		3	42.94
		4	43.14

Tabular Data – Channel RF Power - 3xLTE (QPSK + 16QAM + 256QAM)

Channel Frequency MHz	Signal BW MHz	TX Port	Channel Power dBm
2501 + 2511 + 2526	10 + 10 +20	1	43.23
		2	43.00
		3	43.55
		4	43.61
2583 + 2593 + 2608	10 + 10 +20	1	43.02
		2	42.88
		3	43.25
		4	43.36
2655 + 2665 + 2680	10 + 10 +20	1	43.79
		2	42.79
		3	43.06
		4	43.28

Tabular Data – Channel RF Power - 3xLTE (QPSK + 16QAM + 256QAM)

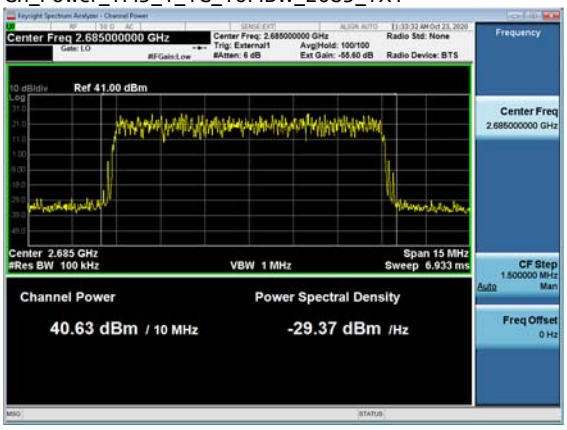
Channel Frequency MHz	Signal BW MHz	TX Port	Channel Power dBm
2501 + 2516 + 2536	10 + 20 +20	1	43.13
		2	42.96
		3	43.22
		4	43.46
2578 + 2593 + 2613	10 + 20 +20	1	43.00
		2	42.76
		3	43.20
		4	43.27
2645 + 2660 + 2680	10 + 20 +20	1	42.79
		2	42.65
		3	43.04
		4	43.15

2.1.1 Channel RF Power – Plots

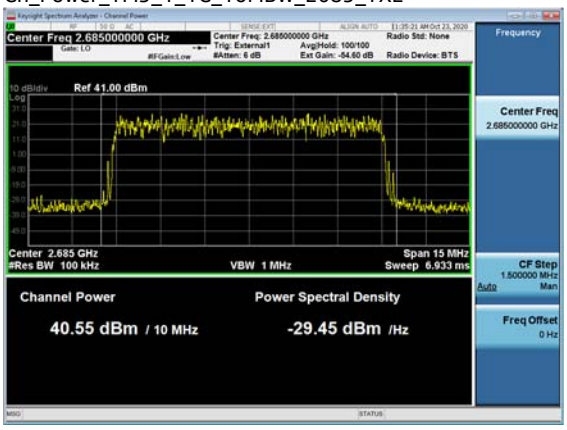
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

2.1.1.1 LTE 10MHz BW (2685MHz) Plots

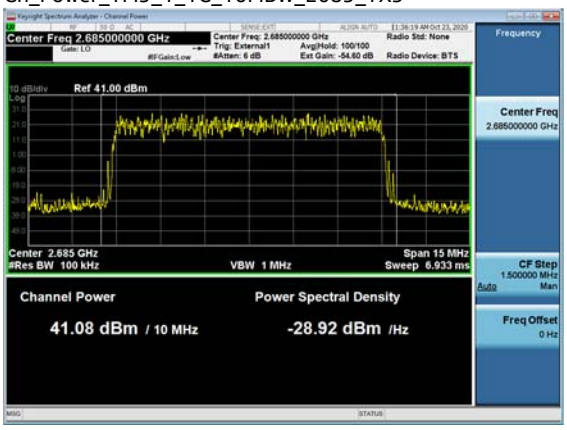
Ch_Power_TM3_1_1C_10MBW_2685_TX1



Ch_Power_TM3_1_1C_10MBW_2685_TX2



Ch_Power_TM3_1_1C_10MBW_2685_TX3



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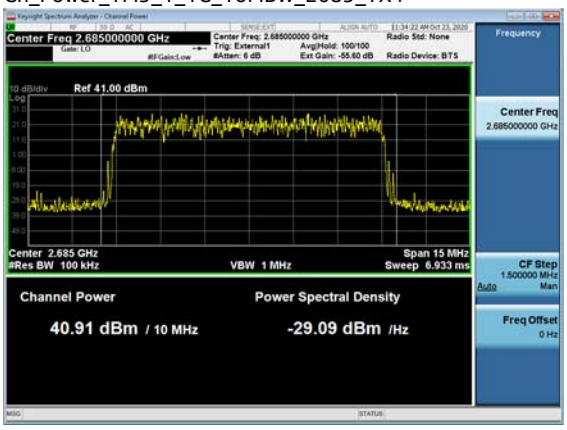

2.1.1.2 5G-NR 20MHz BW (2506MHz) Plots

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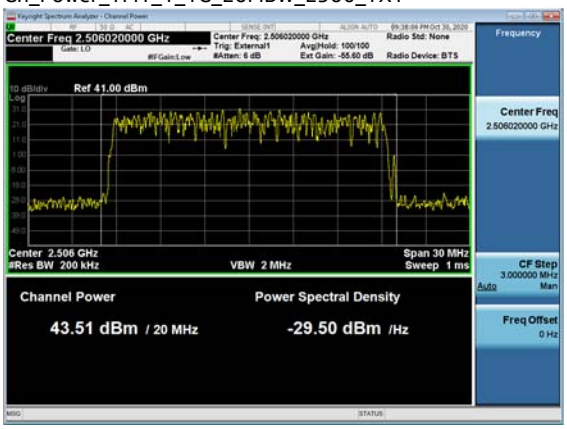
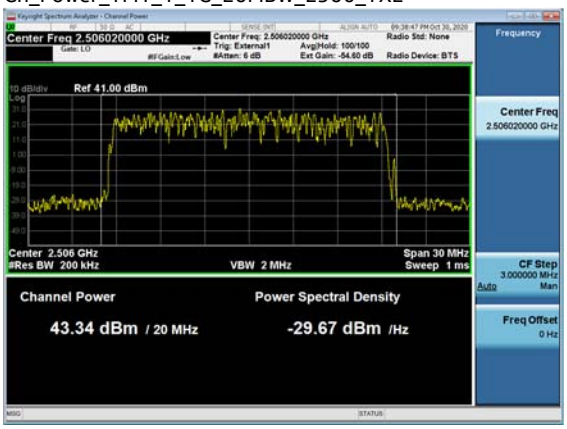
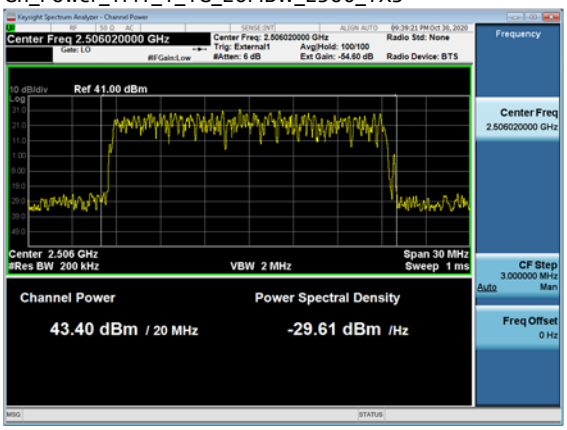


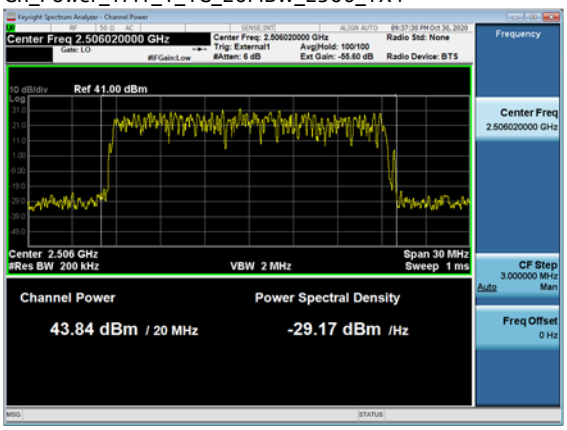
Ch_Power_TM1_1_1C_20MBW_2506_TX2



Ch_Power_TM1_1_1C_20MBW_2506_TX3



Ch_Power_TM1_1_1C_20MBW_2506_TX4



2.1.1.3 5G-NR 80MHz BW (2593MHz) Plots

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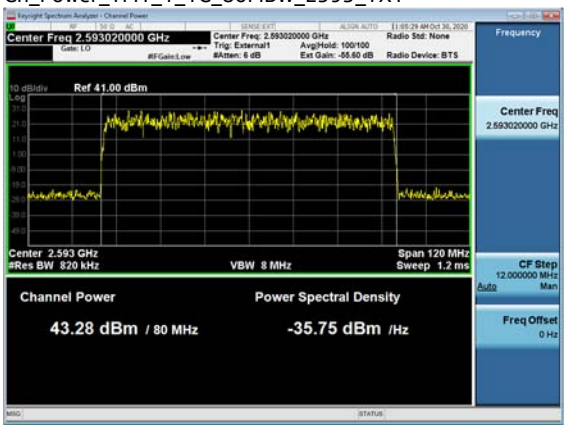
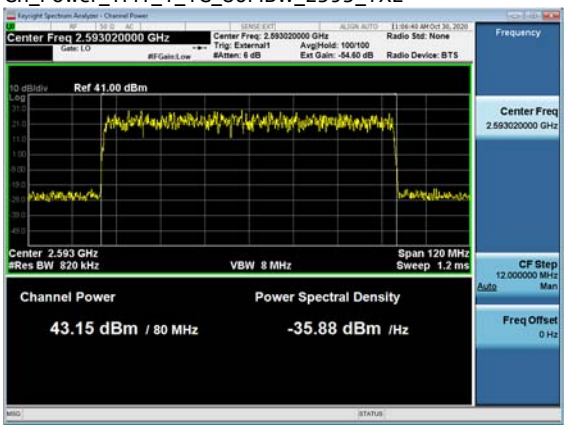


Ch_Power_TM1_1_1C_80MBW_2593_TX2



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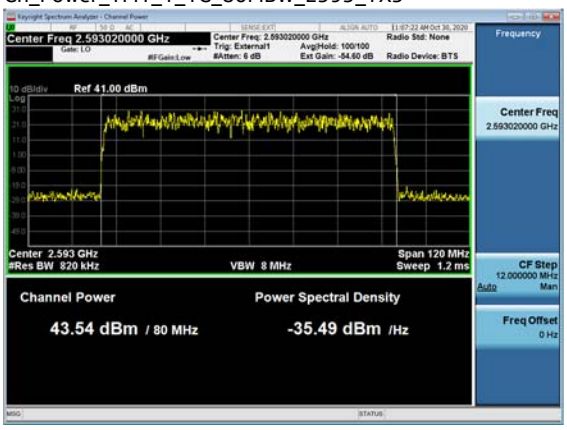
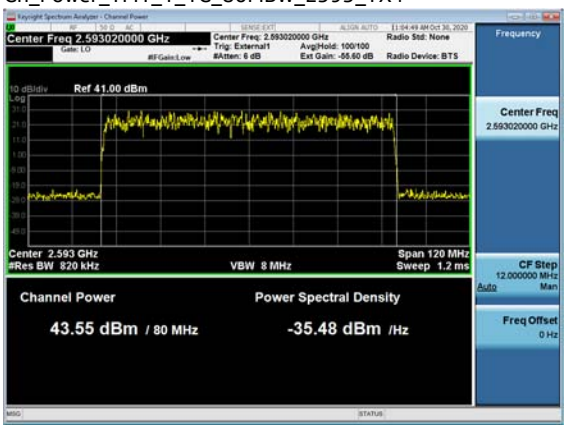


Ch_Power_TM1_1_1C_80MBW_2593_TX4



2.1.1.4 3xLTE (10MHz + 10MHz + 10MHz) BW Plots

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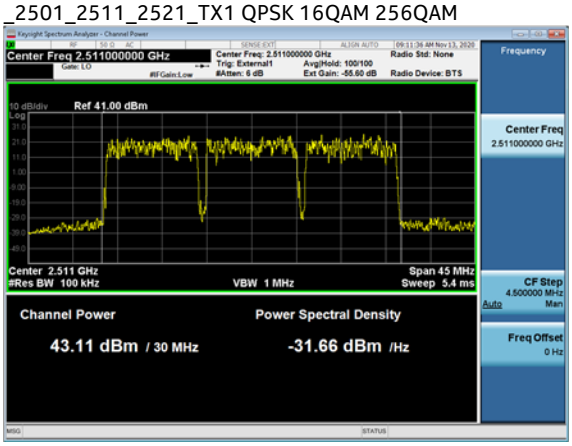
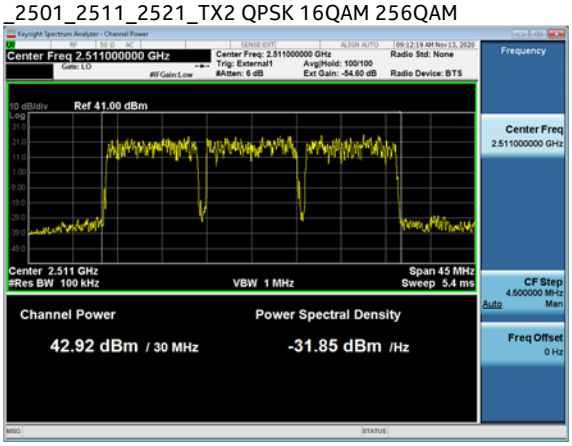
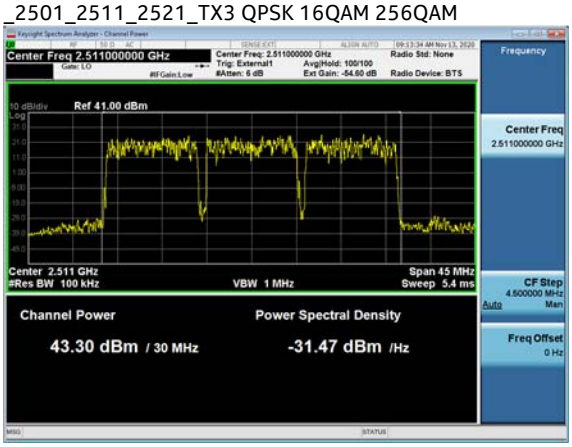
_2501_2511_2521_TX1 QPSK 16QAM 256QAM



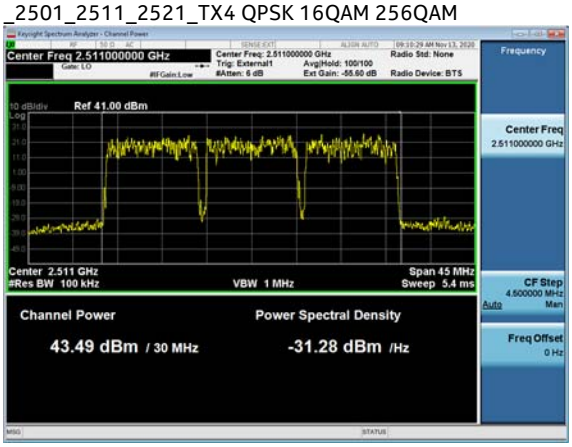
Ch_Power_TM1_1_3C_10+10+10MBW
_2501_2511_2521_TX2 QPSK 16QAM 256QAM



Ch_Power_TM1_1_3C_10+10+10MBW
_2501_2511_2521_TX3 QPSK 16QAM 256QAM

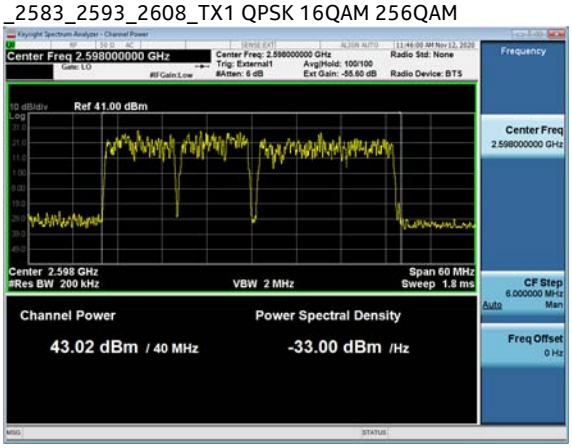


Ch_Power_TM1_1_3C_10+10+10MBW
_2501_2511_2521_TX4 QPSK 16QAM 256QAM



2.1.1.5 3xLTE (10MHz + 10MHz + 20MHz) BW Plots

Ch_Power_TM1_1_3C_10+10+20MBW _2583_2593_2608_TX1 QPSK 16QAM 256QAM



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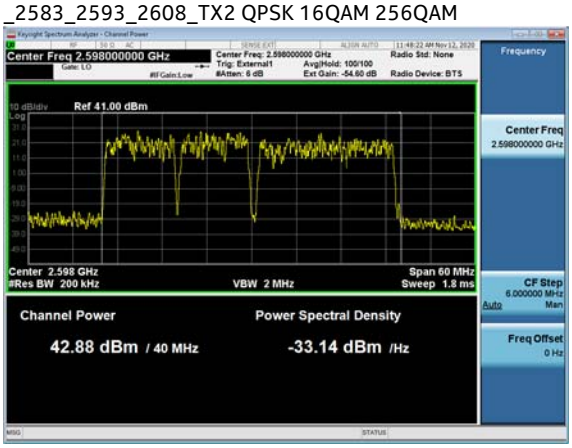
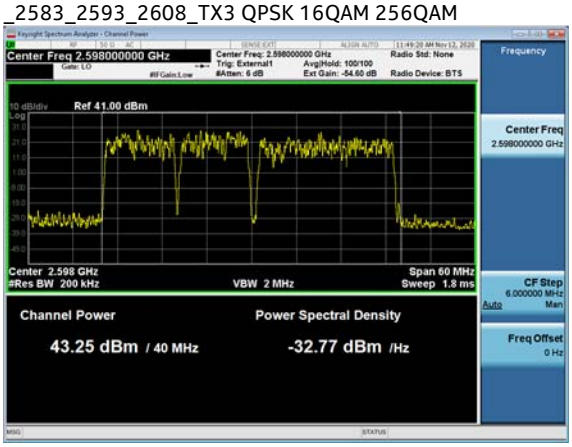
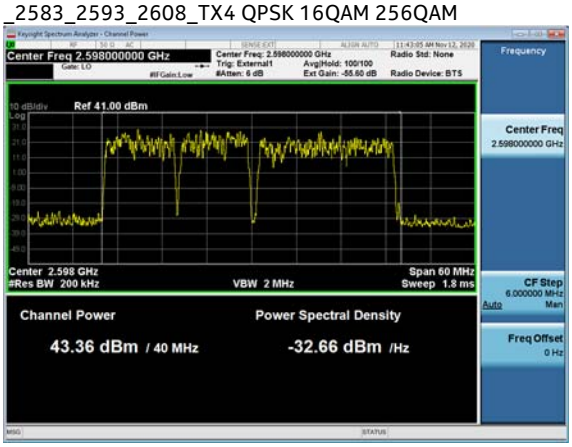


Ch_Power_TM1_1_3C_10+10+20MBW _2583_2593_2608_TX3 QPSK 16QAM 256QAM

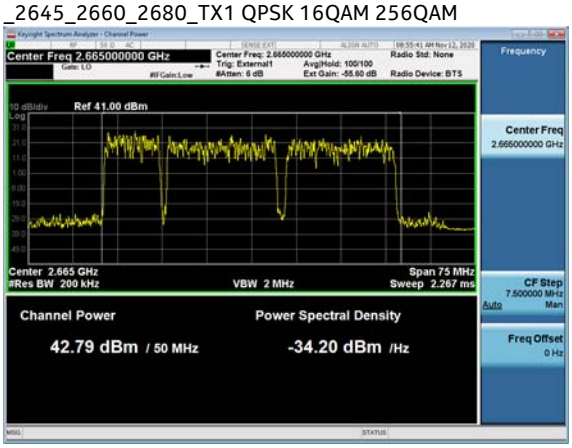


Ch_Power_TM1_1_3C_10+10+20MBW _2583_2593_2608_TX4 QPSK 16QAM 256QAM



2.1.1.6 3xLTE (10MHz + 20MHz + 20MHz) BW Plots

Ch_Power_TM1_1_3C_10+20+20MBW _2645_2660_2680_TX1 QPSK 16QAM 256QAM



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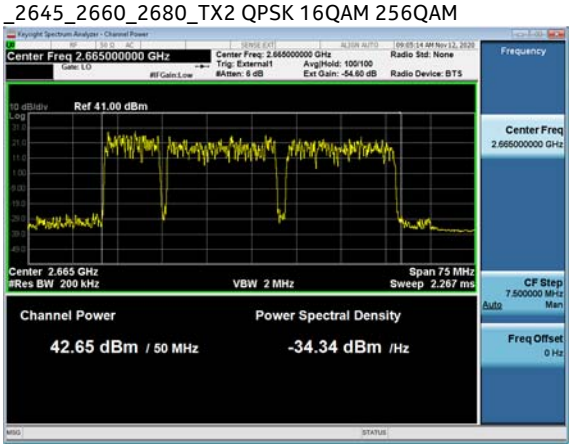
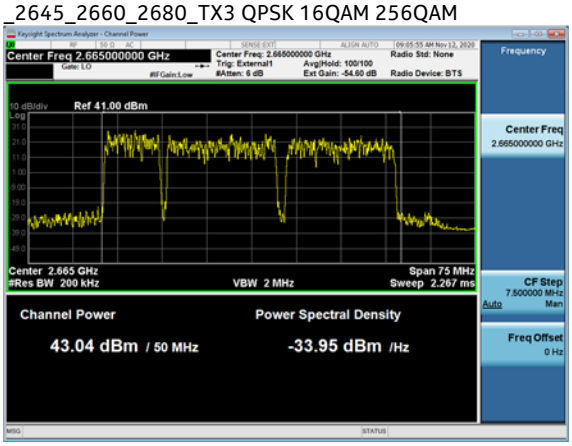
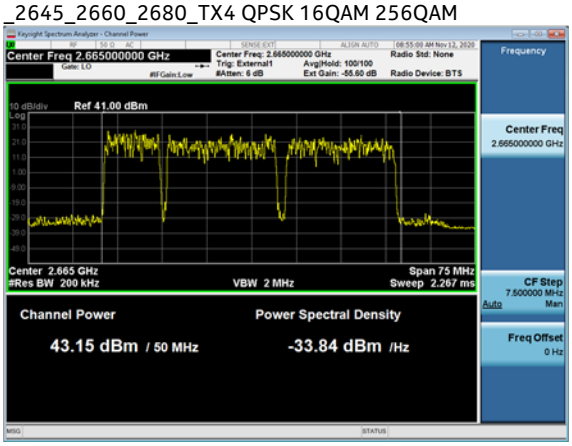


Ch_Power_TM1_1_3C_10+20+20MBW _2645_2660_2680_TX3 QPSK 16QAM 256QAM



Ch_Power_TM1_1_3C_10+20+20MBW _2645_2660_2680_TX4 QPSK 16QAM 256QAM



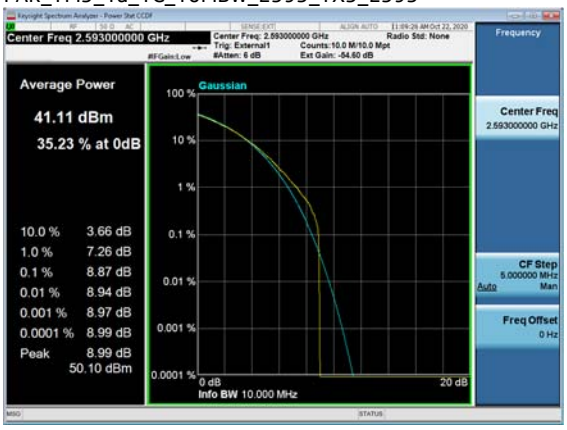
2.1.2 Peak-to-Average Power Ratio (PAPR) – Plots

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

2.1.2.1 LTE 10MHz BW Plots

PAR_TM3_1_1C_10MBW_2685_TX3_2685

PAR_TM3_1a_1C_10MBW_2593_TX3_2593



PAR_TM3_2_1C_10MBW_2501_TX3_2501

2.1.2.2 3xLTE (10MHz + 10MHz + 10MHz) BW Plots

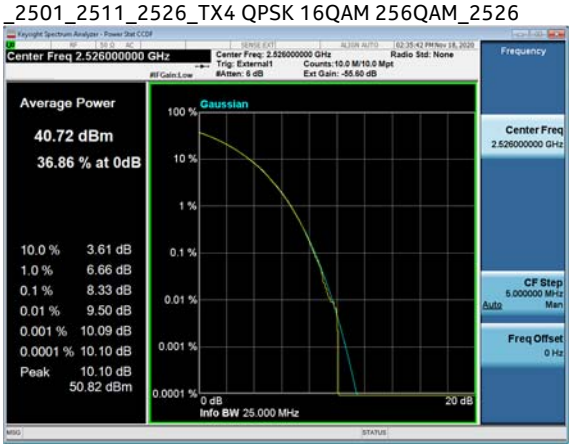
PAR_TM1_1_3C_10+10+10MBW
_2501_2511_2521_TX4 QPSK 16QAM 256QAM_2521

PAR_TM1_1_3C_10+10+10MBW
_2583_2593_2603_TX4 QPSK 16QAM 256QAM_2603

PAR_TM1_1_3C_10+10+10MBW
_2665_2675_2685_TX4 QPSK 16QAM 256QAM_2685

2.1.2.3 3xLTE (10MHz + 10MHz + 20MHz) BW Plots

PAR_TM1_1_3C_10+10+20MBW
_2501_2511_2526_TX4 QPSK 16QAM 256QAM_2526

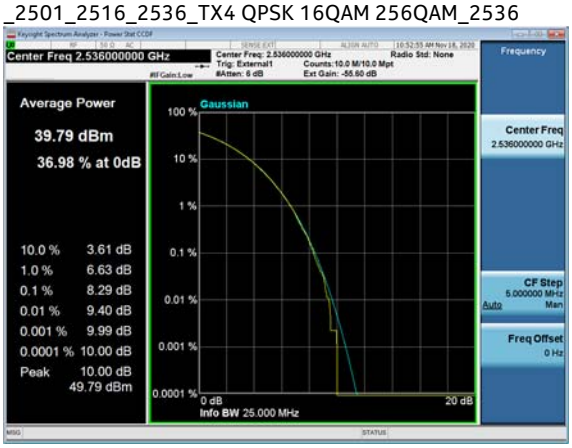


PAR_TM1_1_3C_10+10+20MBW
_2583_2593_2608_TX4 QPSK 16QAM 256QAM_2608

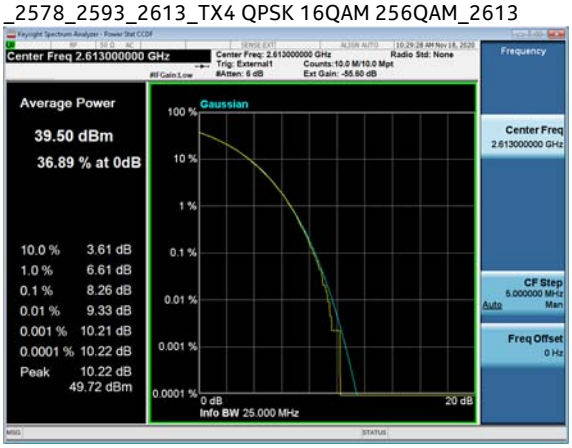
PAR_TM1_1_3C_10+10+20MBW
_2655_2665_2680_TX4 QPSK 16QAM 256QAM_2680

2.1.2.4 3xLTE (10MHz + 20MHz + 20MHz) BW Plots

PAR_TM1_1_3C_10+20+20MBW
_2501_2516_2536_TX4 QPSK 16QAM 256QAM_2536



PAR_TM1_1_3C_10+20+20MBW
_2578_2593_2613_TX4 QPSK 16QAM 256QAM_2613



PAR_TM1_1_3C_10+20+20MBW
_2645_2660_2680_TX4 QPSK 16QAM 256QAM_2680

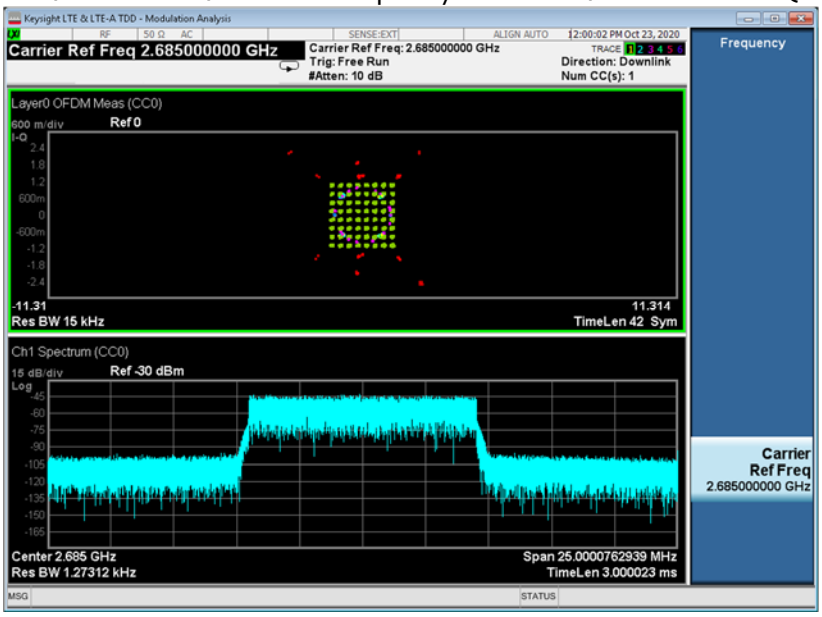
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

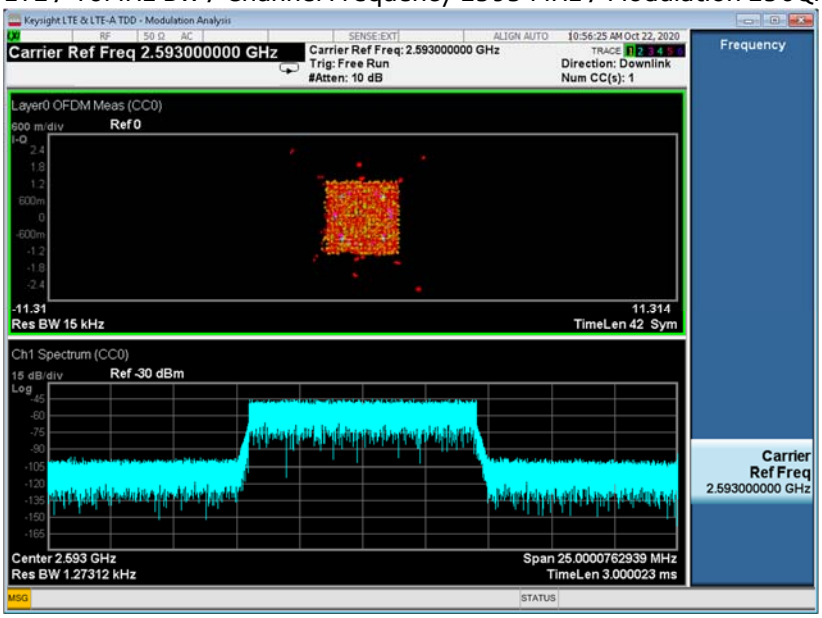
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

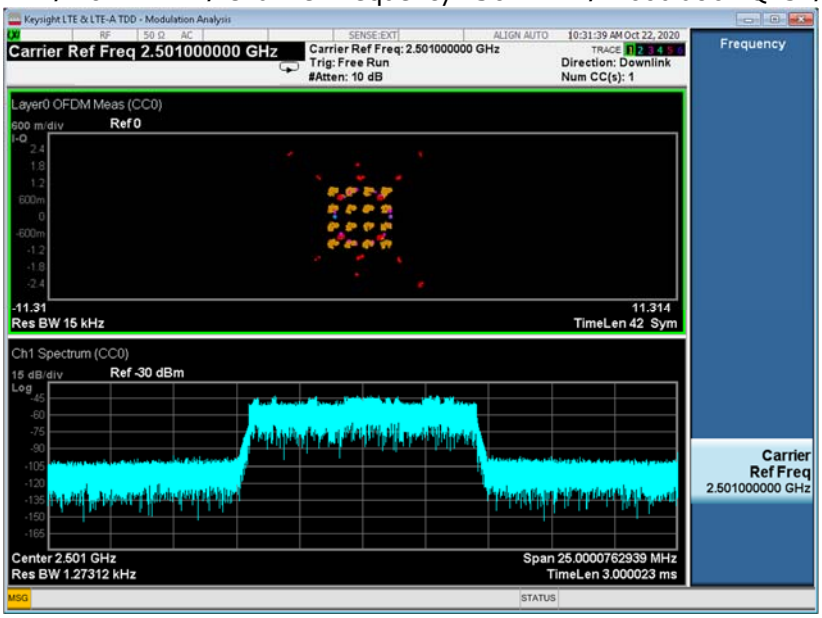
LTE / 10MHz BW / Channel Frequency 2685 MHz / Modulation 64QAM



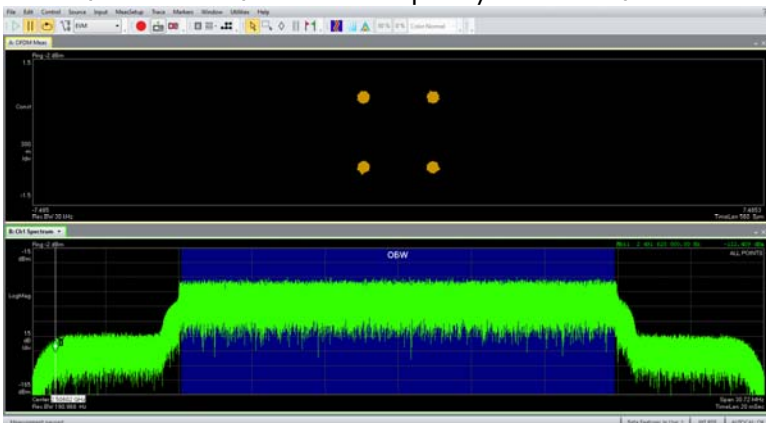
LTE / 10MHz BW / Channel Frequency 2593 MHz / Modulation 256QAM



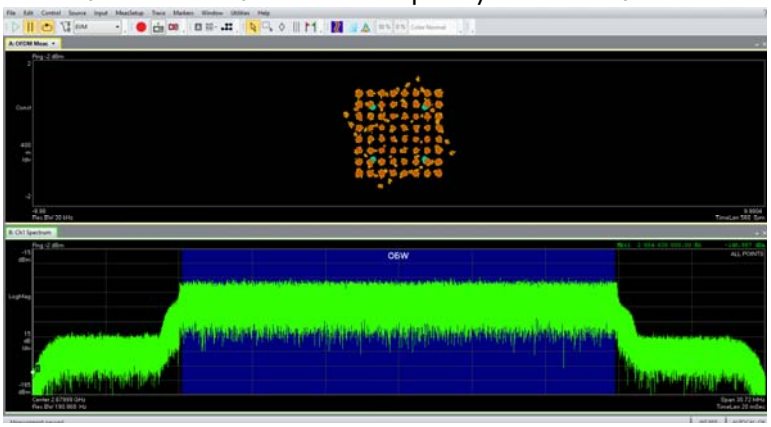
LTE / 10MHz BW / Channel Frequency 2501 MHz / Modulation QPSK/16QAM



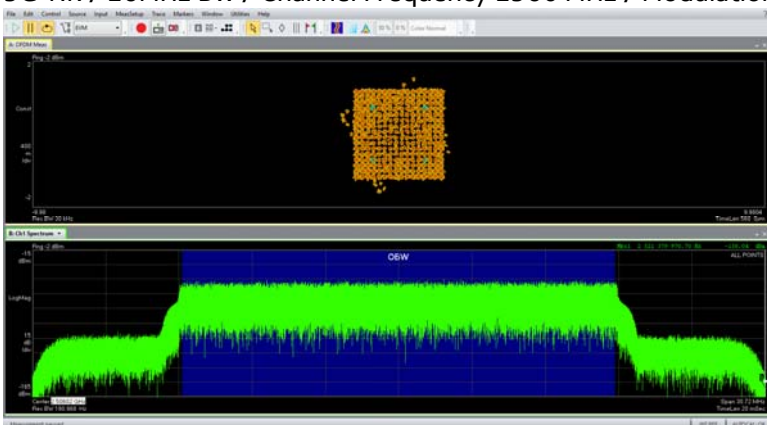
5G-NR / 20MHz BW / Channel Frequency 2506 MHz / Modulation QPSK



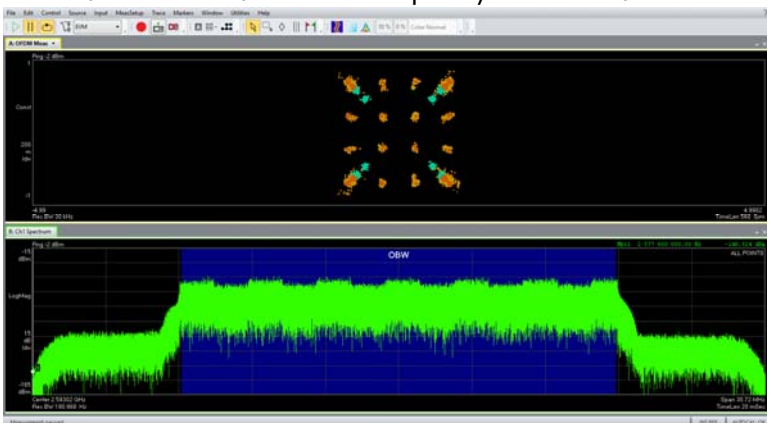
5G-NR / 20MHz BW / Channel Frequency 2680 MHz / Modulation 64QAM



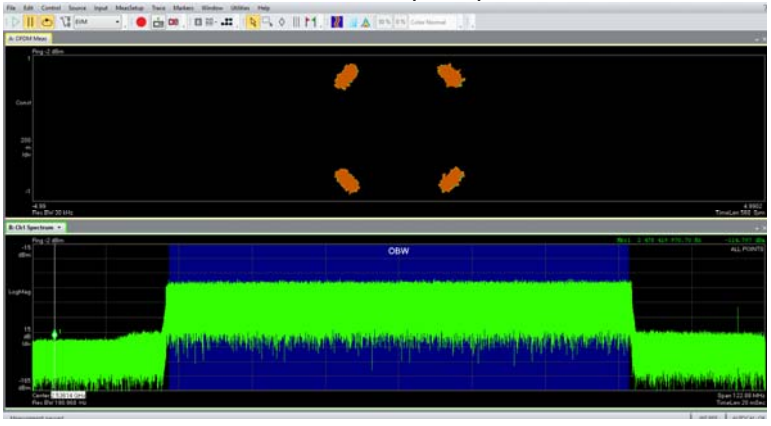
5G-NR / 20MHz BW / Channel Frequency 2506 MHz / Modulation 256QAM



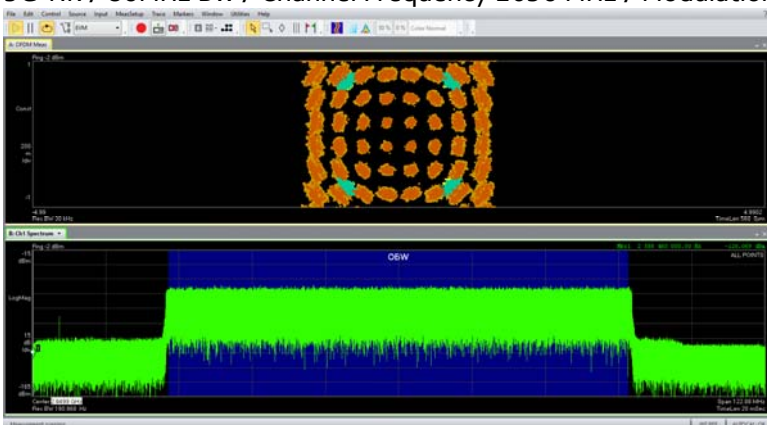
5G-NR / 20MHz BW / Channel Frequency 2593 MHz / Modulation QPSK/16QAM



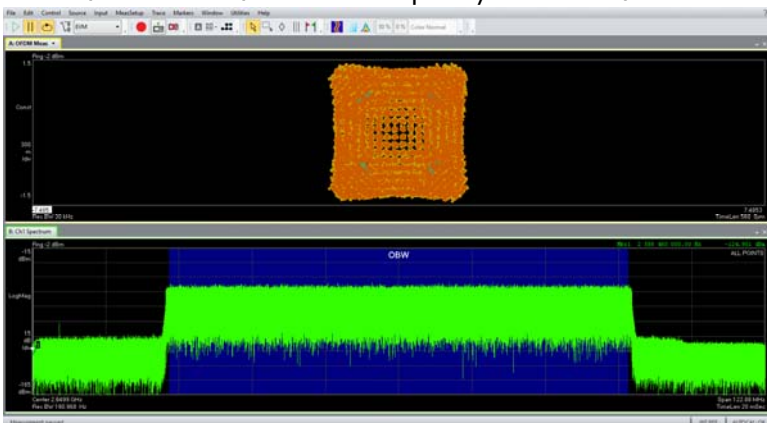
5G-NR / 80MHz BW / Channel Frequency 2536 MHz / Modulation QPSK



5G-NR / 80MHz BW / Channel Frequency 2650 MHz / Modulation 64QAM



5G-NR / 80MHz BW / Channel Frequency 2650 MHz / Modulation 256QAM



5G-NR / 80MHz BW / Channel Frequency 2593 MHz / Modulation QPSK/16QAM