Radio Test Report

Application for a Class II Permissive Change Equipment Authorization

FCC Part 27 Subpart C
617MHz – 652MHz
and
728MHz – 746MHz

CERTIFICATE #: 0214.19

FCC ID: VBNAHLOA-01

Product Name: Airscale Base Transceiver Station Remote Radio Head
Model: AHLOA

Applicant: Nokia Solutions and Networks
6000 Connection Drive
Irving, TX 75039

Test Sites: Nokia Solutions and Networks
6000 Connection Drive
Irving, TX 75039
and
National Technical Systems – Plano
1701 E Plano Pkwy #150
Plano, TX 75074

NTS Plano FCC Laboratory Designation No.: US1077
NTS Plano ISED Laboratory Assigned Code: 4319A

Test Dates: April 2 – 4, 2019
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Prepared By:

BreAnna Cheatham
Technical Writer

Approved By:

Kimberly Zavala
Quality Assurance

Reviewed By:

Alex Mathews
EMI Project Manager

REVISION HISTORY

Rev#	Date	Comments	Modified By
0	04/09/2019	Initial Draft	BreAnna Cheatham

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SCOPE

Tests have been performed on Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHLOA, pursuant to the relevant requirements of the following standard(s) to obtain device certification against the regulatory requirements of the Federal Communications Commission (FCC).

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR Title 47 Part 27 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards:

ANSI C63.26-2015
ANSI C63.4-2014
ANSI TIA-603-E
FCC KDB 971168 D01 v03r01
FCC KDB 971168 D03 v01
FCC KDB 662911D01 v02r01
TIA-102.CAAA-D

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC requirements.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHLOA and therefore apply only to the tested sample. The sample was selected and prepared by Hobert Smith and John Rattanavong of Nokia Solutions and Networks.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

Testing was performed only on Model AHLOA. No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product Airscale Base Transceiver Station Remote Radio Head (RRH) Model AHLOA complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

The following tables provide a summary of the test results:

FCC Part 27 Subpart C (Base Stations Operating in the 617 to 652MHz Band)

AHLOA operating in 617MHz to 652MHz Frequency Band – 5G NR Carriers				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
§27.5	Frequency Ranges	5MHz Channel BW: 619.5 – 649.5MHz 10MHz Channel BW: 622.0 – 647.0MHz 15MHz Channel BW: 624.5 – 644.5MHz 20MHz Channel BW: 627.0 – 642.0MHz	617.0MHz to 652.0MHz	Pass
§2.1033(c)(4)	Modulation Type	QPSK, 16QAM, 64QAM and 256QAM for 5MHz, 10MHz, 15MHz & 20MHz Channel BWs	Digital	Pass
§27.50	Output Power	Highest Conducted Power Output RMS: 47.64dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
Informational	Peak to Average Power Ratio	Highest Measured PAPR: 8.22dB	13dB	Pass
§2.1049	99% Emission Bandwidth	5MHz Channel BW: 4.4838MHz 10MHz Channel BW: 9.3014MHz 15MHz Channel BW: 14.1478MHz 20MHz Channel BW: 18.9666MHz	Remain in Block	Pass
	26dB down Emission Bandwidth	5MHz Channel BW: 4.842MHz Emission Designator: 4M84G7W 10MHz Channel BW: 9.898MHz Emission Designator: 9M90G7W 15MHz Channel BW: 14.966MHz Emission Designator: 15M0G7W 20MHz Channel BW: 20.085MHz Emission Designator: 20M1G7W	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
§27.53(g)	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass[1]
	Field Strength	41.942dBuV/m at 3m Eq. to -53.231dBm EIRP	-13dBm EIRP	Pass[2]
Other Details				
§27.54	Frequency Stability	Stays within authorized frequency block 0.0015ppm	Stays within block	Pass[2]
§1.1310	RF Exposure	N/A		Pass[3]

Note 1: Based on 100kHz RBW. In the 100kHz immediately outside and adjacent to the frequency block a RBW of 30kHz was used. The measurement bandwidth is 100kHz for measurements more than 100kHz from the band edge. See Section 27.53(g) for details.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

617MHz to 652MHz Band Emission Designators				
Channel Bandwidth	**5G-NR: QPSK**	**5G-NR: 16QAM**	**5G-NR: 64QAM**	**5G-NR: 256QAM**
5M	4M84G7W	4M84G7W	4M83G7W	4M83G7W
10M	9M89G7W	9M90G7W	9M86G7W	9M84G7W
15M	14M9G7W	15M0G7W	14M9G7W	14M9G7W
20M	20M1G7W	20M1G7W	20M0G7W	20M1G7W

Note: FCC based on 26dB emission bandwidth

FCC Part 27 Subpart C (Base Stations Operating in the 728 to 746MHz Band)

AHLOA operating in 728MHz to 746MHz Frequency Band– 5G NR Carriers				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
§27.5	Frequency Ranges	5MHz Channel BW: 731.5 – 743.5MHz 10MHz Channel BW: 734.0 – 741.0MHz	728.0MHz to 746.0MHz	Pass
§2.1033(c)(4)	Modulation Type	QPSK, 16QAM, 64QAM and 256QAM for 5MHz & 10MHz Channel BWs	Digital	Pass
§27.50	Output Power	Highest Conducted Power Output RMS: 47.43dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
Informational	Peak to Average Power Ratio	Highest Measured PAPR: 7.82dB	13dB	Pass
§2.1049	99% Emission Bandwidth	5MHz Channel BW: 4.4838MHz 10MHz Channel BW: 9.3024MHz	Remain in Block	Pass
	26dB down Emission Bandwidth	5MHz Channel BW: 4.845MHz Emission Designator: 4M85G7W 10MHz Channel BW: 9.888MHz Emission Designator: 9M89G7W	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
§27.53(g)	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass[1]
	Field Strength	41.523dBuV/m at 3m Eq. to -53.677dBm EIRP	-13dBm EIRP	Pass[2]
Other Details				
§27.54	Frequency Stability	Stays within authorized frequency block 0.0013ppm	Stays within block	Pass[2]
§1.1310	RF Exposure	N/A		Pass[3]

Note 1: Based on 100kHz RBW. In the 100kHz immediately outside and adjacent to the frequency block a RBW of 30kHz was used. The measurement bandwidth is 100kHz for measurements more than 100kHz from the band edge. See Section 27.53(g) for details.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

728MHz to 746MHz Band Emission Designators				
Channel Bandwidth	**5G-NR: QPSK**	**5G-NR: 16QAM**	**5G-NR: 64QAM**	**5G-NR: 256QAM**
5M	4M85G7W	4M84G7W	4M82G7W	4M82G7W
10M	9M89G7W	9M88G7W	9M86G7W	9M84G7W
Note: FCC based on 26dB emission bandwidth				

Extreme Conditions

Frequency stability is determined over extremes of temperature and voltage.

The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

Measurement Uncertainties

Measurement uncertainties of the test facility based on a 95% confidence level are as follows:

Test	**Uncertainty**
Radio frequency	± 0.2ppm
RF power conducted	±1.2 dB
RF power radiated	±3.3 dB
RF power density conducted	±1.2 dB
Spurious emissions conducted	±1.2 dB
Adjacent channel power	±0.4 dB
Spurious emissions radiated	±4 dB
Temperature	±1˚C
Humidity	±1.6 %
Voltage (DC)	±0.2 %
Voltage (AC)	±0.3 %

EQUIPMENT UNDER TEST (EUT) DETAILS

General

A class II permissive change on the original filing is being pursued to add 5G NR (new radio) carriers to the Airscale BTS RRH model AHLOA Federal Communication Commission certifications. The original FCC radio certification submittal was NTS Test Report Number PR078121 Revision 0 dated April 25, 2018. The original test effort includes testing for LTE technologies. Please refer to the test report on the original certification for details on all required testing.

All conducted RF testing performed for the original certification testing has been repeated using 5G NR carriers for this class II permissive change per correspondence/guidance from Nemko TCB. The same test methodology used in the original certification testing was used in this class II permissive change test effort. 5G NR carrier bandwidths of 5MHz, 10MHz, 15MHz and 20MHz with QPSK, 16QAM, 64QAM and 256QAM modulation types were verified under this effort. Tests performed under the class II change effort include RF power, peak to average power ratio, emission bandwidth (99% and 26 dB down), band edge spurious emissions, and conducted spurious emissions. The 5G NR carriers/modulation types for this testing are based upon 3GPP TS 38.141-1 Test Models and are NR-FR1-TM 1.1 (QPSK modulation type), NR-FR1-TM 3.2 (16QAM modulation type), NR-FR1-TM 3.1 (64QAM modulation type), and NR-FR1-TM 3.1a (256QAM modulation type).

The testing was performed on the same hardware (AHLOA) as the original certification test. The same AHLOA RF port (Ant 4) determined in the original certification testing to be the highest power port was used for all testing in this effort. The base station and remote radio head software for this testing is an updated release that includes 5G NR carrier support.

The radiated emissions and frequency stability measurements performed in the original certification was not repeated under this effort per TCB guidance. The radiated emission and frequency stability/accuracy results from the original certification had enough margin to preclude requiring additional testing. The same frequency stability/accuracy radio design is the same for all radio technologies/modulation types.

The equipment under test (EUT) is a Nokia Solutions and Networks AirScale Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model AHLOA. The AHLOA remote radio head is a multistandard multicarrier radio module designed to support LTE, narrow band IoT (internet of things) operations (in-band, guard band, standalone) and 5G NR. The scope of testing in this effort is for 5G NR operations.

The AHLOA RRH has four transmit/four receive antenna ports (4TX/4RX for NR Band n71 and 4TX/4RX for NR Band n85). Each antenna port supports 3GPP TS 38.104 NR Band n71 (BTS Rx: 663 to 698 MHz/BTS TX: 617 to 652 MHz) and 3GPP TS 38.104 NR Band n85 (BTS Rx: 698 to 716 MHz/BTS TX: 728 to 746 MHz). The maximum RF output power of the RRH is 240 Watts (60 watts per antenna port and 60 watts per carrier). The RRH can be operated as a 4x4 MIMO, 2x2 MIMO or as non-MIMO. The TX and RX instantaneous bandwidth cover the full operational bandwidth.

The RRH has external interfaces including DC power (DC In), ground, transmit/receive (ANT), external alarm (EAC), optical CPRI (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted. The RRH may be configured with optional cooling fan.

The AHLOA 5G NR downlink frequencies are as follows:

	Downlink Frequency (MHz)	**5G NR Channel Bandwidth**			
		5 MHz	**10 MHz**	**15 MHz**	**20 MHz**
5G NR Band n71 (Ant 1, 2, 3, 4)	617.0	Band Edge	Band Edge	Band Edge	Band Edge
	619.5	Bottom Ch			
	622.0		Bottom Ch		
	624.5			Bottom Ch	
	627.0				Bottom Ch
	634.5	Middle Ch	Middle Ch	Middle Ch	Middle Ch
	642.0				Top Channel
	644.5			Top Channel	
	647.0		Top Channel		
	649.5	Top Channel			
	652.0	Band Edge	Band Edge	Band Edge	Band Edge

AHLOA Downlink Band Edge 5G-NR Band n71 Frequency Channels

	Downlink Frequency (MHz)	5G-NR Channel Bandwidth	
		5 MHz	**10 MHz**
5G NR Band n85 (Ant 1, 2, 3, 4)	728.0	Band Edge	Band Edge
	730.5	Bottom Ch	
	733.0		Bottom Ch
	737.0	Middle Ch	Middle Ch
	741.0		Top Channel
	743.5	Top Channel	
	746.0	Band Edge	Band Edge

AHLOA Downlink Band Edge 5G-NR Band n85 Frequency Channels

EUT Hardware

The EUT hardware used in testing on April 2 – 4, 2019.

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AHLOA	AirScale BTS RRH	Part#: 474331A.101 Serial#: K9180540675	FCC ID: VBNAHLOA-01

Enclosure

The EUT enclosure is made of heavy-duty aluminum.

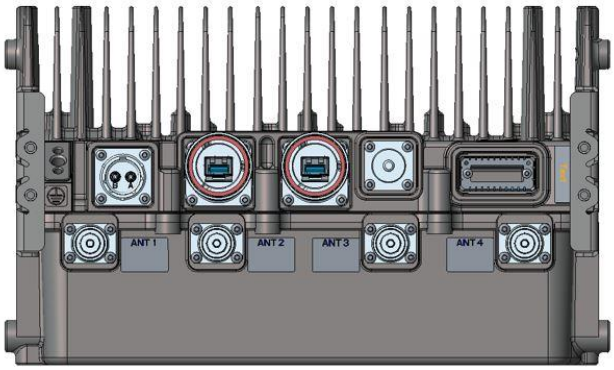
Support Equipment

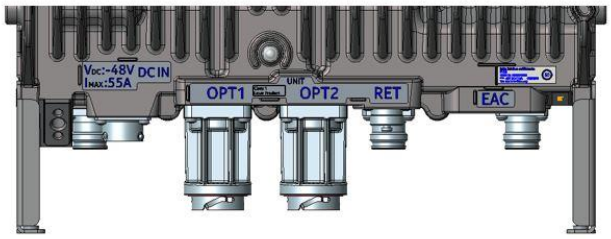
Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AMIA	Airscale System Module	Part#: 473098A.203 Serial#: RK182307106	N/A
HP	Elite Book 6930p	Laptop PC	N/A	N/A
Dell	Studio XPS	Instrumentation PC	N/A	N/A

Auxillary Equipment

Company	Description	Part Number	Serial Number
Nokia	FOTA 10GHz SFP Module (Plugs into RRH Opt Ports)	473471A.101	FR182418340
RLC Electronics	1.1GHz High Pass Filter -2W[1]	F-14699	0050
Weinschel	Attenuator 20dB -150 Watt[1]	66-20-33-LIM	BZ2075
Weinschel	Attenuator 20dB -150 Watt[1]	66-20-33-LIM	BZ1165
Weinschel	Attenuator 3dB-100 Watt[1]	47-3-33	CG5493
Huber & Suhner	RF Cable – 1 meter[1]	Sucoflex 104	551123/4
Huber & Suhner	RF Cable - 1 meter[1]	Sucoflex 106	297370
Note 1: Used only in antenna port RF conducted emission testing.			

AHLOA Connector Layout:





EUT External Interfaces

Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Quick Disconnect	2-pole Power Circular Connector
GND	1	Screw lug (2xM5/1xM8)	Ground
ANT	4	4.3-10	RF signal for Transmitter/Receiver (50 Ohm)
Unit	1	LED	Unit Status LED
EAC	1	MDR26	External Alarm Interface (4 alarms)
OPT	2	SFP+ cage	Optical CPRI Interface up to 10 Gps.
RET	1	8-pin circular connector conforming to IEC 60130-9 – Ed.3.0	AISG 2.0 to external devices
Fan	1	Molex Microfit	Power for RRH Fan. Located on the side of RRH.

EUT Interface Ports

The I/O cabling configuration during testing was as follows:

Cable	Type	Shield	Length	Used in Test	Quantity	Termination
Power Input	Power	No	~ 3 m	Yes	1	Power Supply
Earth	Earth	No	~ 1 m	Yes	1	Lab earth ground
Antenna	RF	Yes	~ 3 m	Yes	4	50Ω Loads
External Alarm	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Remote Electrical Tilt	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Multimode Optical	Optical	No	>6 m	Yes	1	System Module

EUT Operation

During testing, the EUT was transmitting continuously with 100% duty-cycle at full power on all chains.

EUT Software

The PC connects to the System Module over the LMP (Ethernet) port. The system module controls the RRH via the optical interface. The PC is used for changing configuration settings, monitoring tests and controlling the BTS. The following software versions are used for the testing:

(1) RRH Unit Software: AHLOA FRM-rfsw-image-install_20181201204755-multi
(2) System Module Software: FB_PS_REL_2018_12_022 with loaner SW (5GL1SW-loner_R50-FDD-CPRI.0.0.20190130-140149)

Modifications

No modifications were made to the EUT during testing.

TESTING

General Information

Antenna port measurements were taken with NTS personnel (Alex Mathews) at Nokia premises located at 6000 Connection Drive; Irving, Texas 75309. Radiated emissions and frequency accuracy/stability measurements were taken at NTS Plano branch located at 1701 E Plano Pkwy #150 Plano, TX 75074 during the original certification effort (see NTS Test Report Number PR078121 Revision 0 dated April 25, 2018 for details).

Measurement Procedures

The RMS average output power, emission bandwidth, conducted spurious and conducted band edge measurements were performed with a spectrum analyzer. The carrier frequency accuracy/stability, complementary cumulative distribution function (CCDF) and modulation characteristics measurements were performed with a signal analyzer. The EUT was operated at maximum RF output power for all tests. While measuring one transmit chain, the others were terminated with termination blocks. All measurements were corrected for the insertion loss of the RF network (attenuators, filters, and cables) inserted between the RF port of the EUT and the spectrum analyzer/signal analyzer. Block diagrams and photographs of the test setups are provided below.

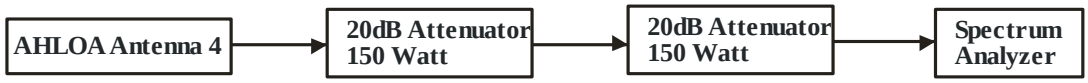
The 26dB emission bandwidth was measured in accordance with Section 4.1 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with Section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used and Keysight Benchvue Software was used to capture the spectrum analyzer screenshots. Spectrum analyzer settings are shown on their corresponding plots in test results section.

The emissions at the band edges were captured with Keysight Benchvue Software with settings described in the corresponding sections of the FCC and IC regulatory requirements. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Average output power measurements were performed in accordance with sections 5.4 of FCC KDB 971168 D01v03r01 and ANSI C63.26. Measurements were performed with the channel power function found in the spectrum analyzer and the screenshots were captured using Keysight Benchvue Software. Peak to average power ratio (PAPR) was measured in accordance with Section 5.7.2 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.2.3.4. Signal Analyzer CCDF screenshots were captured using Keysight Benchvue Software. Analyzer settings are shown on their corresponding plots in test results section. Conducted spurious emissions were captured with Keysight Benchvue Software across the 9kHz-8GHz frequency span. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1.1GHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) were accounted for by the spectrum analyzer reference level offset. Spectrum analyzer settings are described in the corresponding test result section.

Antenna Port Conducted RF Measurement Test Setup Diagrams

The following setups were used in the RF conducted emissions testing. Photographs of the test setups are also provided.



Setup for 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 600MHz, 600 to 800MHz and 800MHz to 1.1GHz Measurements

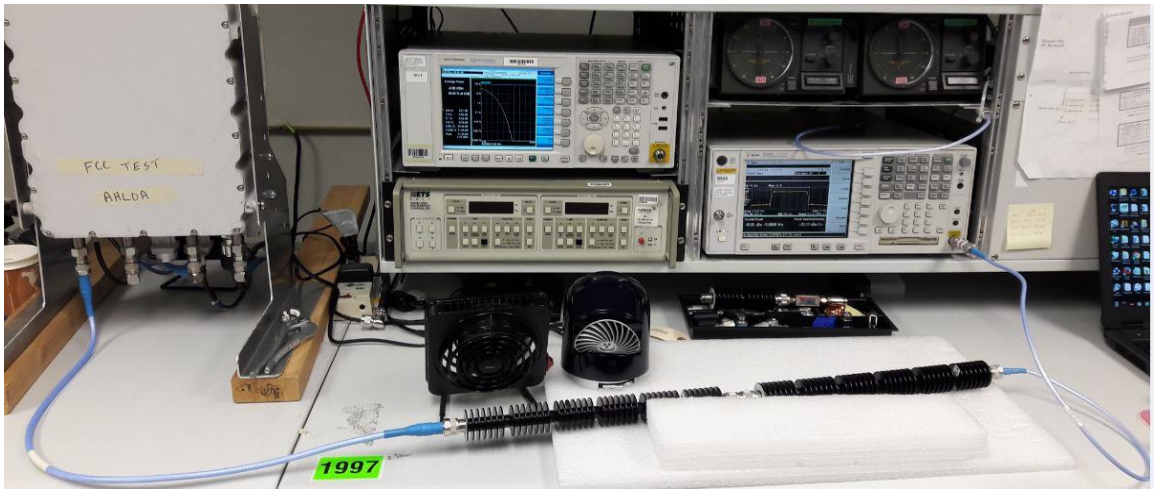
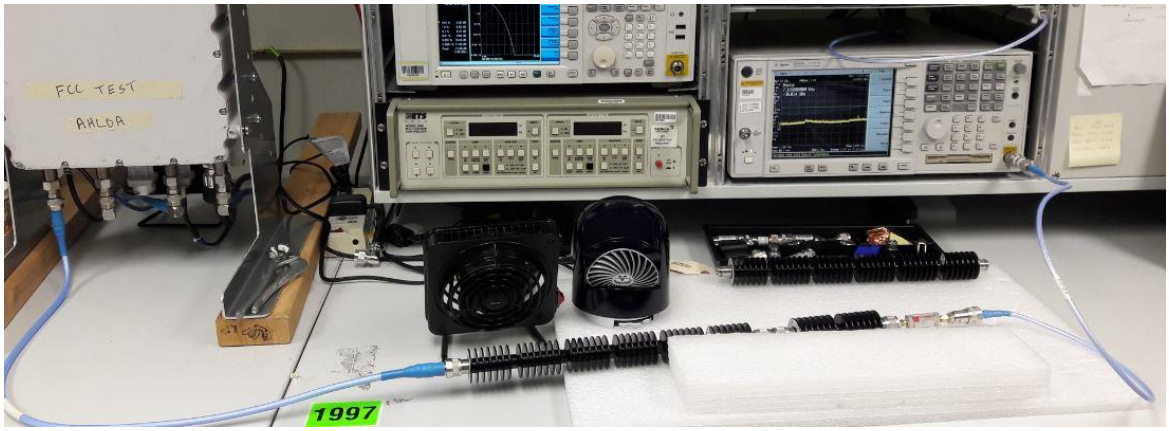


Photo of 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 600MHz, 600 to 800MHz and 800MHz to 1.1GHz Setup

Setup for 1.1GHz to 8GHz Measurements



Photograph of 1.1GHz to 8GHz Test Setup

Test Measurement Equipment

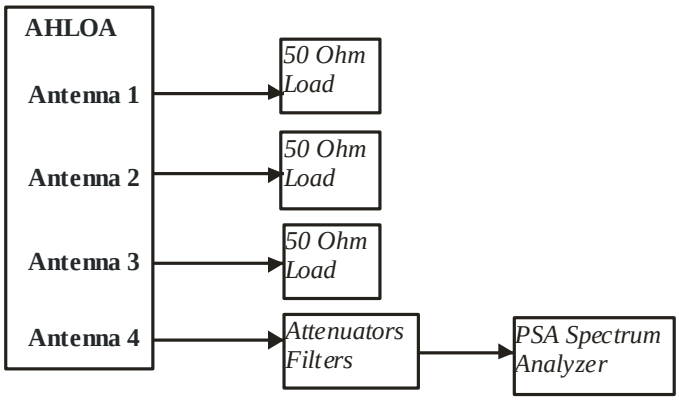
Nokia Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
120194	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	10/17/2019
NM04509	Network Analyzer	Rohde & Schwarz	ZVL 3	12 Months	02/12/2020
NM06345	Network Analyzer	Keysight	E5063A	12 Months	12/15/2019
NM04508	MXA Signal Analyzer	Agilent	N9020A	24 Months	05/02/2019

APPENDIX A: ANTENNA PORT TEST DATA FOR BAND N71 (617-652MHz)

All conducted RF measurements in this section were made at AHLOA antenna port 4. The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 4) determined in the original certification testing to be the highest power port was used for all testing in this effort.

The 5G NR carrier bandwidths of 5MHz, 10MHz, 15MHz and 20MHz with QPSK, 16QAM, 64QAM and 256QAM modulation types were measured. The 5G NR carriers/modulation types for this testing are based upon 3GPP TS 38.141-1 Test Models and are NR-FR1-TM 1.1 (QPSK modulation type), NR-FR1-TM 3.2 (16QAM modulation type), NR-FR1-TM 3.1 (64QAM modulation type), and NR-FR1-TM 3.1a (256QAM modulation type).

The test setup used is provided below.



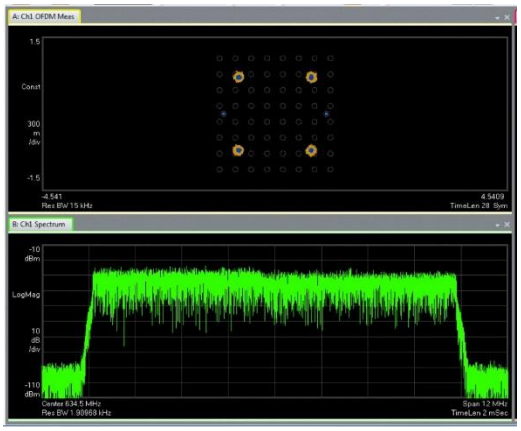
Test Setup Used for AHLOA Conducted RF Measurements

Modulation Characteristics of the 5G-NR Modulation Types

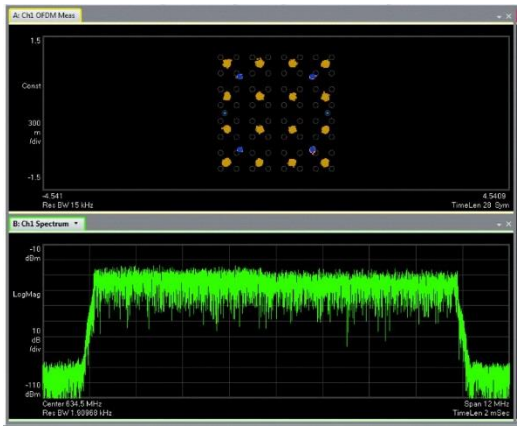
The 5G NR carriers/modulation types for this testing are based upon 3GPP TS 38.141-1 Test Models and are NR-FR1-TM 1.1 (QPSK modulation type), NR-FR1-TM 3.2 (16QAM modulation type), NR-FR1-TM 3.1 (64QAM modulation type), and NR-FR1-TM 3.1a (256QAM modulation type). The 5G NR test models for a 10MHz channel bandwidth at the Band n71 middle channel (634.5MHz) were demodulated with a signal analyser at AHLOA port 4. This measurement is for informational purposes to show that the test models correspond to the appropriate modulation types.

Demodulation of 5G NR Test Models (Constellation Patterns and Channel Bandwidth Plots) using a 10MHz Channel Bandwidth at the Middle Channel (634.5MHz) :

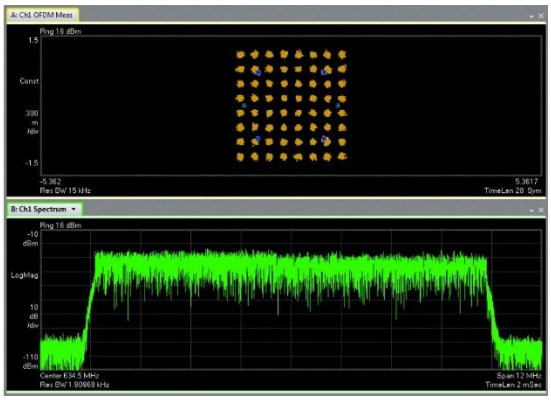
NR-FR1-TM 1.1 _QPSK modulation type



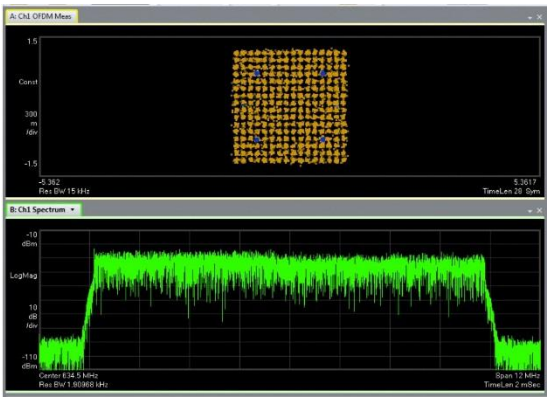
NR-FR1-TM 3.2 _16QAM modulation type



NR-FR1-TM 3.1 _64QAM modulation type



NR-FR1-TM 3.1a _256QAM modulation type



RF Output Power

The AHLOA was operated at maximum RF output power. RF output power has been measured in RMS Average terms at the AHLOA Antenna Port 4 transmit chain [5G NR Band n71 (617 to 652MHz)] at the bottom, middle and top frequency channels for all 5G NR modulation types (QPSK, 16QAM, 64QAM and 256QAM) and channel bandwidths (5, 10, 15 and 20MHz) as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. The peak to average power ratio (PAPR) has been measured using the signal analyzer complementary cumulative distribution function (CCDF) for a probability of 0.1% as described in section 5.7.2 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.4. All results are presented in tabular form below. The highest measured values are highlighted.

All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 38.8 dB and is accounted for by the spectrum analyzer reference level offset.

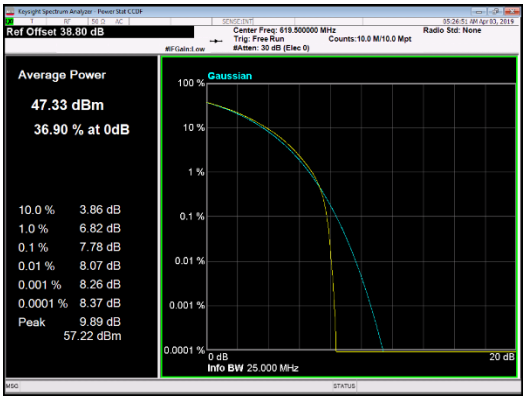
5G NR Channel BW	Modulation	Frequency _ Channel	PAPR (dB)	Ave (dBm)
5MHz	QPSK	619.5MHz _ Bottom Channel	7.78	47.36
		634.5MHz _ Middle Channel	7.77	47.49
		649.5MHz _ Top Channel	7.87	47.29
	16QAM	619.5MHz _ Bottom Channel	7.86	47.25
		634.5MHz _ Middle Channel	7.77	47.49
		649.5MHz _ Top Channel	7.72	47.27
	64QAM	619.5MHz _ Bottom Channel	7.77	47.28
		634.5MHz _ Middle Channel	7.75	47.29
		649.5MHz _ Top Channel	7.78	47.13
	256QAM	619.5MHz _ Bottom Channel	7.89	47.33
		634.5MHz _ Middle Channel	7.84	47.29
		649.5MHz _ Top Channel	7.78	47.14
10MHz	QPSK	622.0MHz _ Bottom Channel	7.93	47.57
		634.5MHz _ Middle Channel	7.70	47.52
		647.0MHz _ Top Channel	7.86	47.53
	16QAM	622.0MHz _ Bottom Channel	7.86	47.56
		634.5MHz _ Middle Channel	7.65	47.55
		647.0MHz _ Top Channel	7.81	47.46
	64QAM	622.0MHz _ Bottom Channel	7.87	47.51
		634.5MHz _ Middle Channel	7.66	47.57
		647.0MHz _ Top Channel	7.83	47.50
	256QAM	622.0MHz _ Bottom Channel	7.87	47.59
		634.5MHz _ Middle Channel	7.69	47.52
		647.0MHz _ Top Channel	7.88	47.59

Figure Continues…

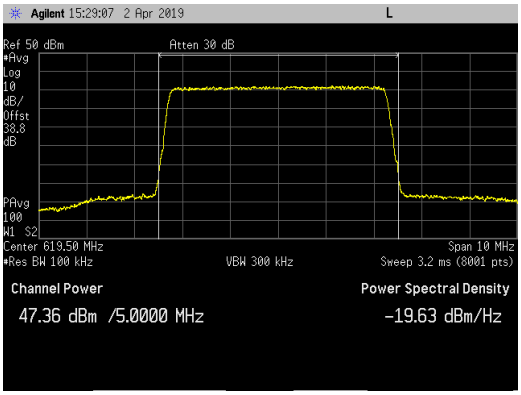
15MHz	QPSK	624.5MHz _ Bottom Channel	8.01	**47.64**
		634.5MHz _ Middle Channel	7.68	47.41
		644.5MHz _ Top Channel	8.06	47.46
	16QAM	624.5MHz _ Bottom Channel	7.96	47.44
		634.5MHz _ Middle Channel	7.61	**47.64**
		644.5MHz _ Top Channel	8.09	47.53
	64QAM	624.5MHz _ Bottom Channel	8.03	47.51
		634.5MHz _ Middle Channel	7.64	47.46
		644.5MHz _ Top Channel	8.00	47.56
	256QAM	624.5MHz _ Bottom Channel	8.06	47.44
		634.5MHz _ Middle Channel	7.66	47.47
		644.5MHz _ Top Channel	8.00	47.63
20MHz	QPSK	627.0MHz _ Bottom Channel	8.04	47.43
		634.5MHz _ Middle Channel	7.71	47.28
		642.0MHz _ Top Channel	8.18	47.55
	16QAM	627.0MHz _ Bottom Channel	8.12	47.53
		634.5MHz _ Middle Channel	7.65	47.29
		642.0MHz _ Top Channel	**8.22**	47.32
	64QAM	627.0MHz _ Bottom Channel	8.05	47.51
		634.5MHz _ Middle Channel	7.72	47.36
		642.0MHz _ Top Channel	8.12	47.41
	256QAM	627.0MHz _ Bottom Channel	8.14	47.41
		634.5MHz _ Middle Channel	7.71	47.30
		642.0MHz _ Top Channel	8.16	47.33

5G NR 5MHz Channel Power Plots for the QPSK Modulation Type:

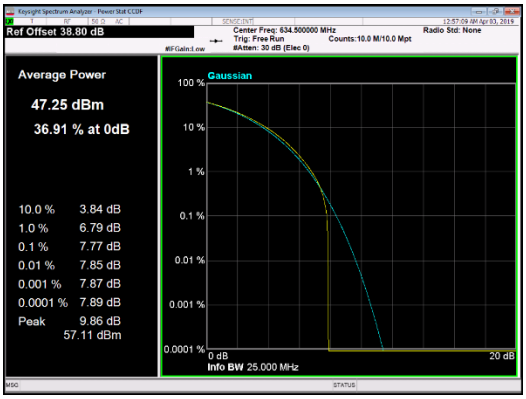
Port 4 - Bottom Channel_ CCDF



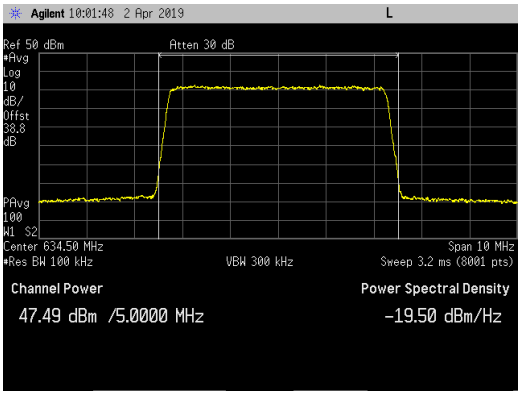
Port 4 - Bottom Channel_ Average



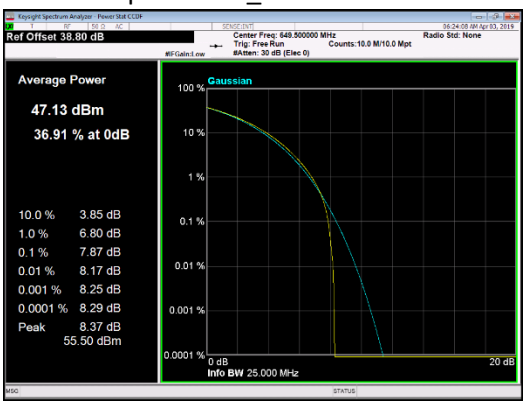
Port 4 - Middle Channel_ CCDF



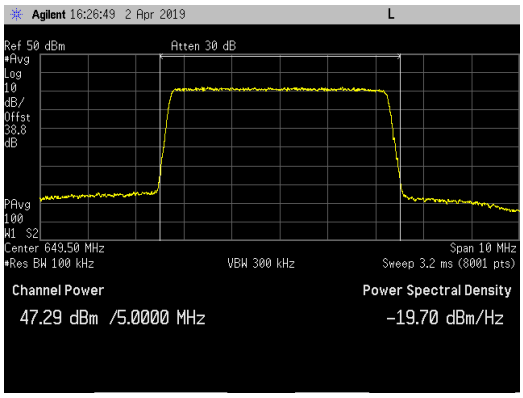
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

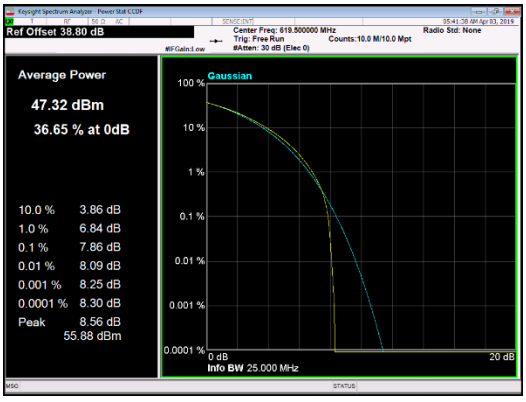


Port 4 - Top Channel_ Average

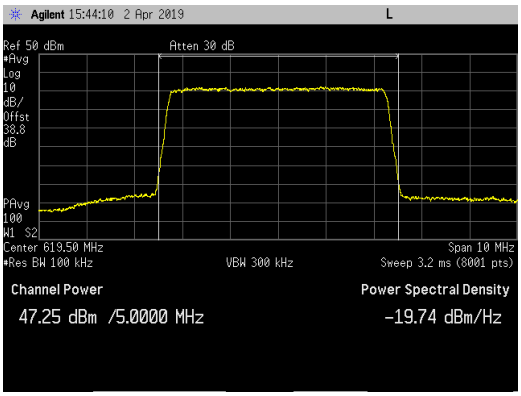


5G NR 5MHz Channel Power Plots for the 16QAM Modulation Type:

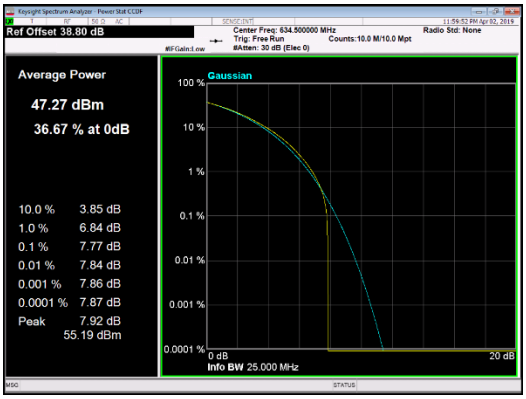
Port 4 - Bottom Channel_ CCDF



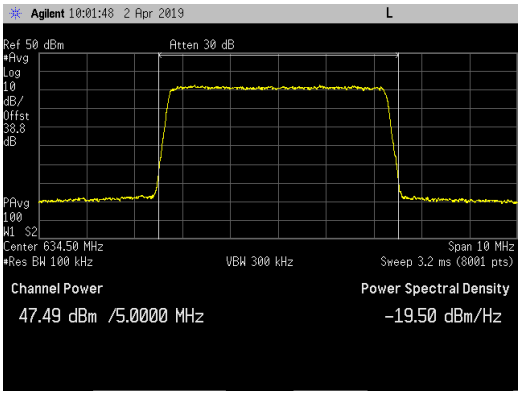
Port 4 - Bottom Channel_ Average



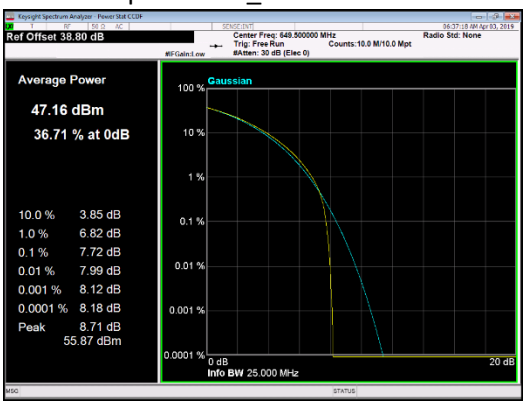
Port 4 - Middle Channel_ CCDF



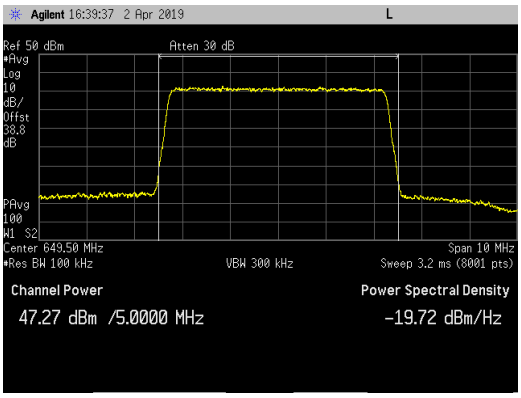
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

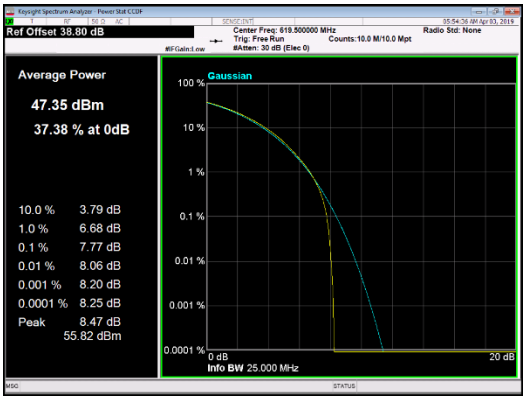


Port 4 - Top Channel_ Average

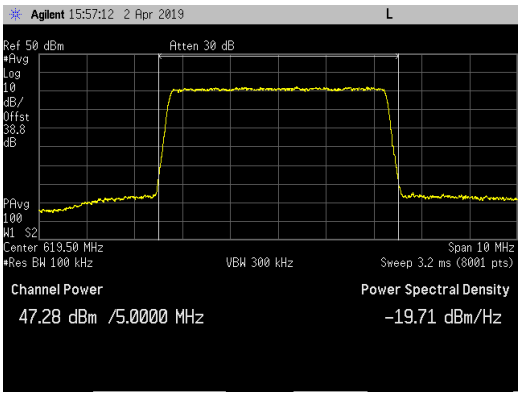


5G NR 5MHz Channel Power Plots for the 64QAM Modulation Type:

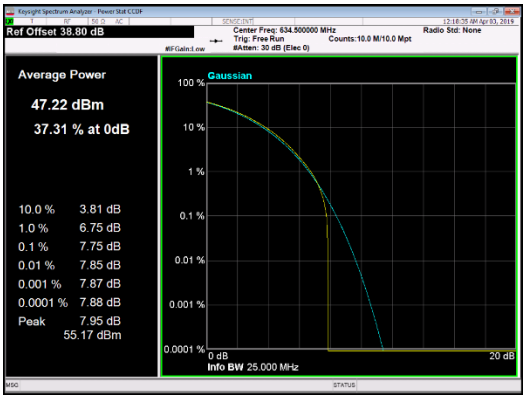
Port 4 - Bottom Channel_ CCDF



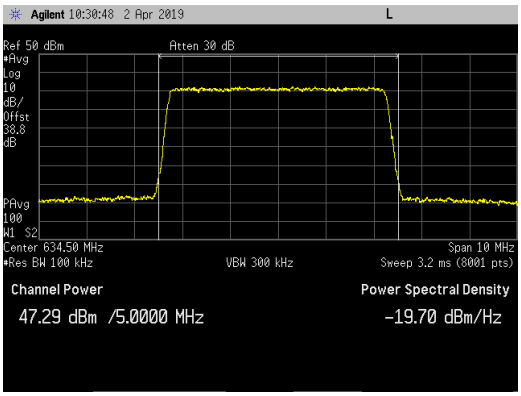
Port 4 - Bottom Channel_ Average



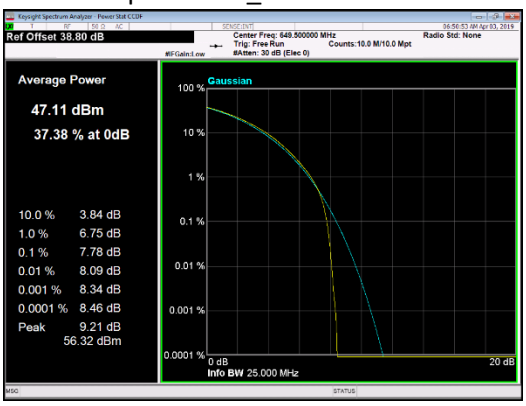
Port 4 - Middle Channel_ CCDF



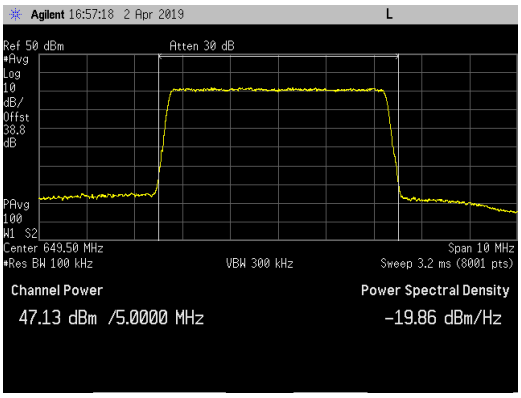
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

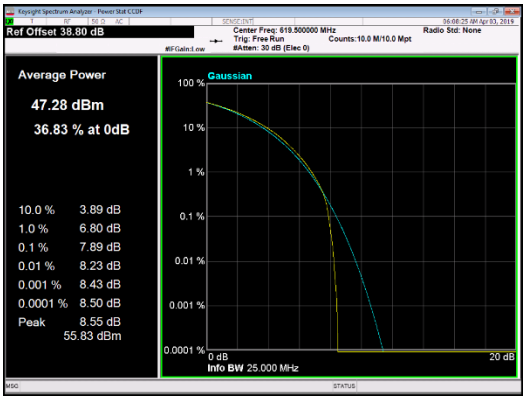


Port 4 - Top Channel_ Average

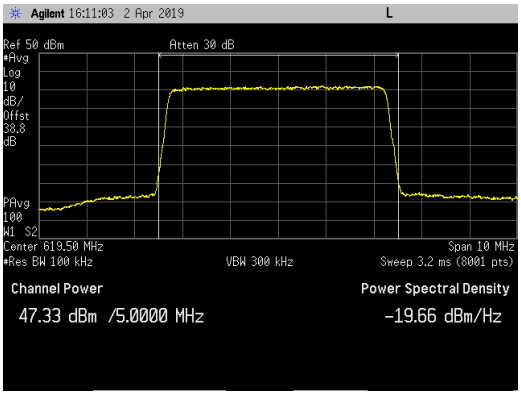


5G NR 5MHz Channel Power Plots for the 256QAM Modulation Type:

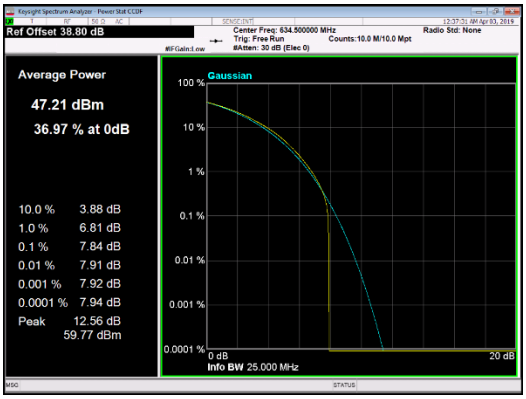
Port 4 - Bottom Channel_ CCDF



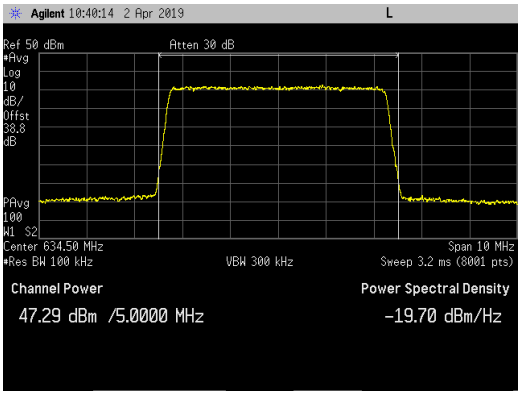
Port 4 - Bottom Channel_ Average



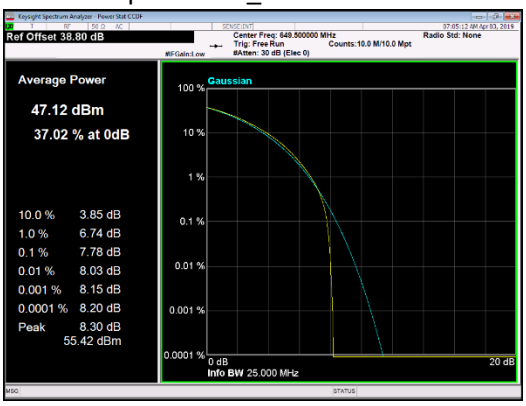
Port 4 - Middle Channel_ CCDF



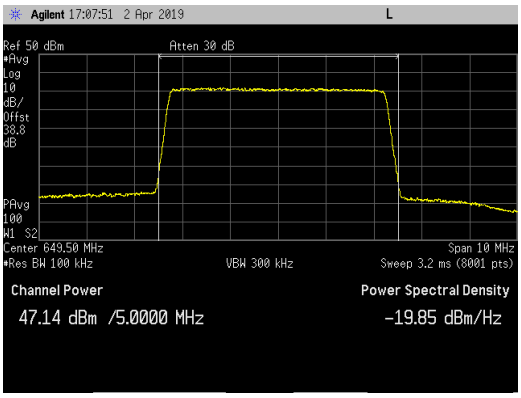
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

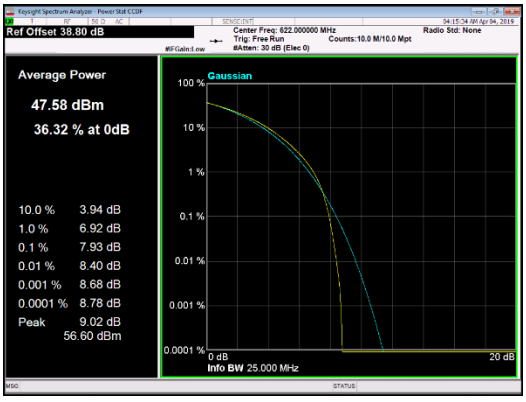


Port 4 - Top Channel_ Average

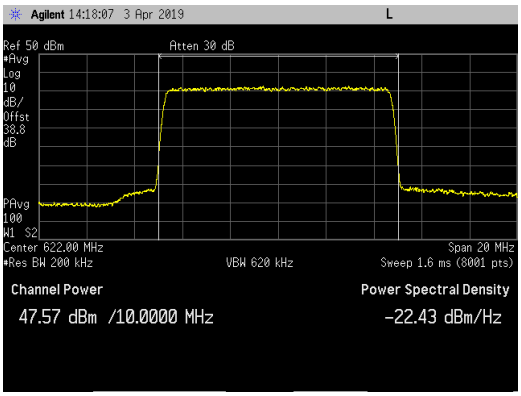


5G NR 10MHz Channel Power Plots for the QPSK Modulation Type:

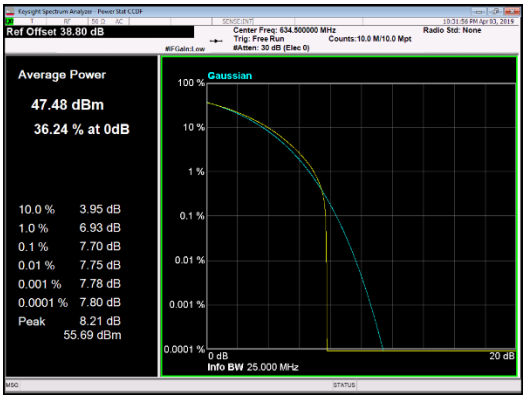
Port 4 - Bottom Channel_ CCDF



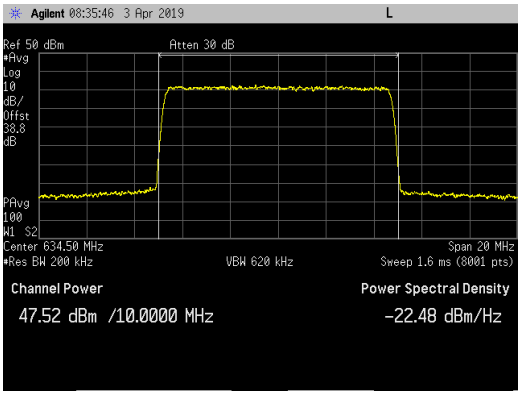
Port 4 - Bottom Channel_ Average



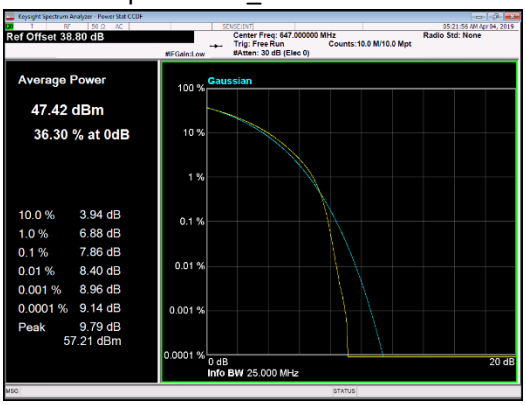
Port 4 - Middle Channel_ CCDF



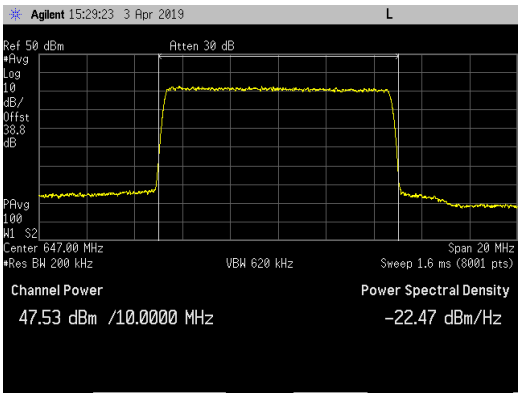
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

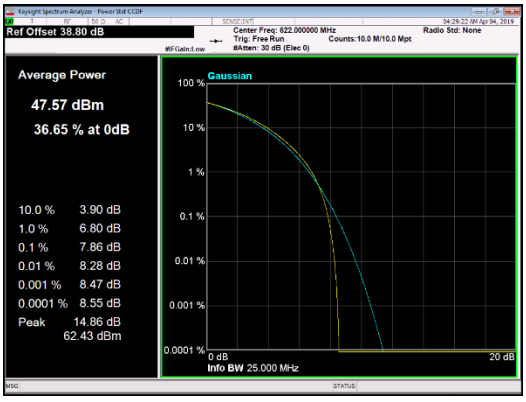


Port 4 - Top Channel_ Average

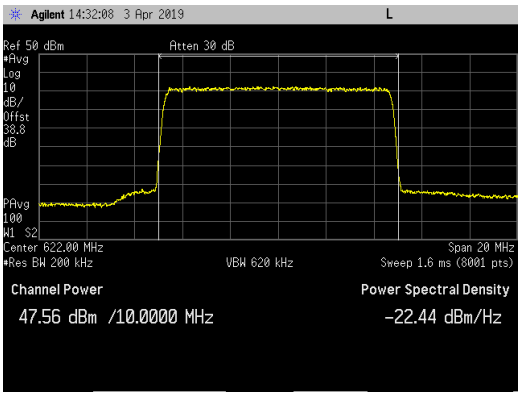


5G NR 10MHz Channel Power Plots for the 16QAM Modulation Type:

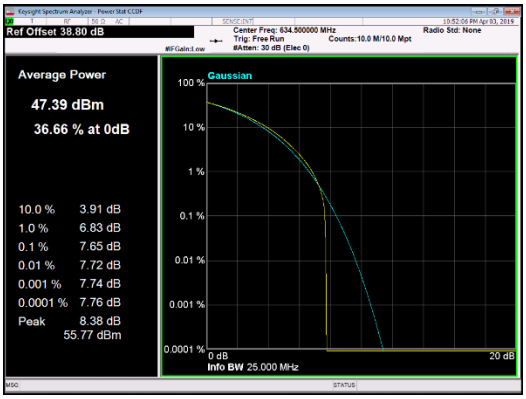
Port 4 - Bottom Channel_ CCDF



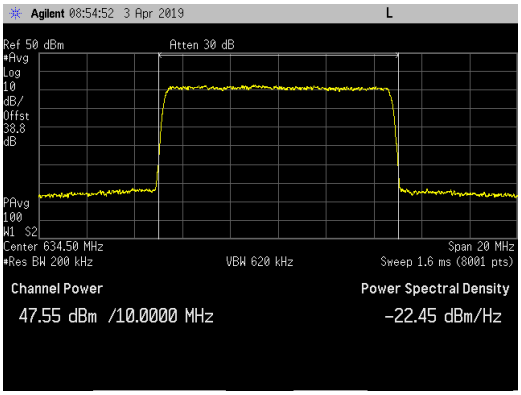
Port 4 - Bottom Channel_ Average



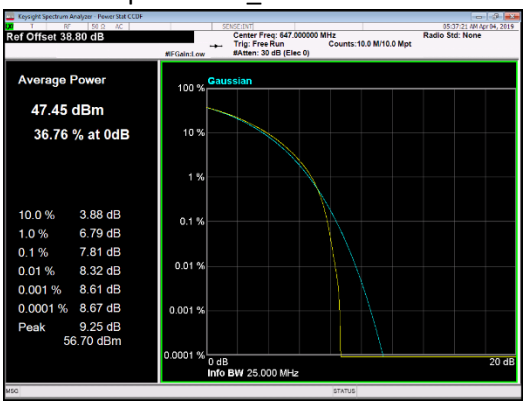
Port 4 - Middle Channel_ CCDF



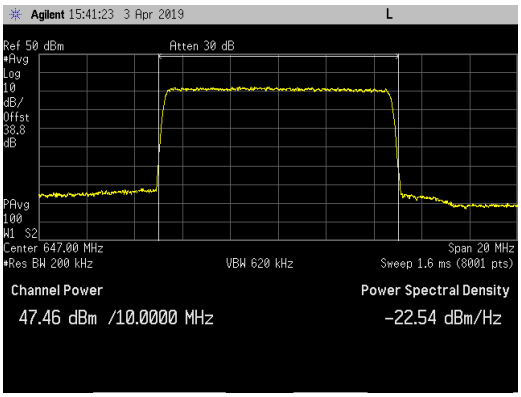
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

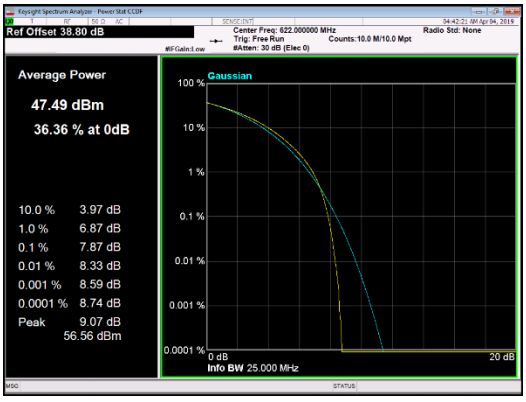


Port 4 - Top Channel_ Average

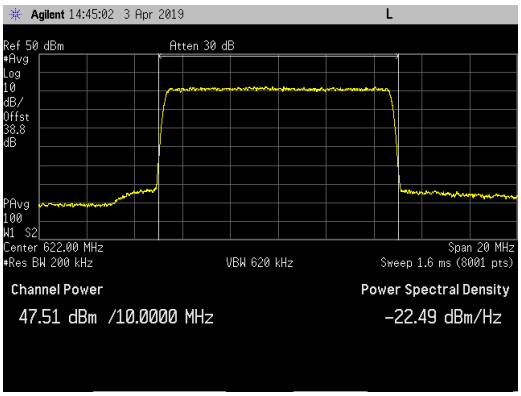


5G NR 10MHz Channel Power Plots for the 64QAM Modulation Type:

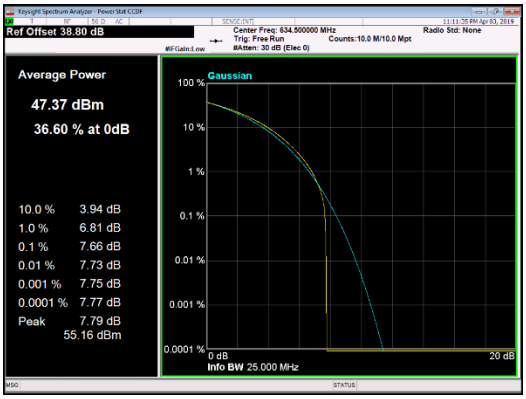
Port 4 - Bottom Channel_ CCDF



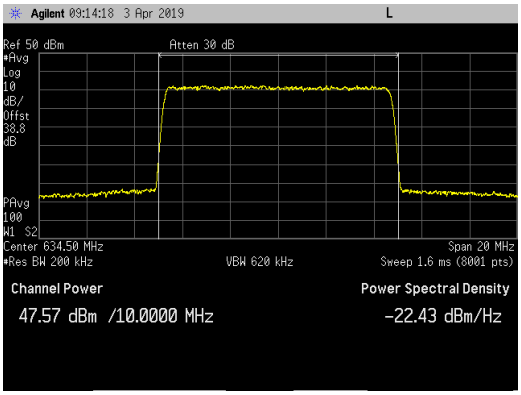
Port 4 - Bottom Channel_ Average



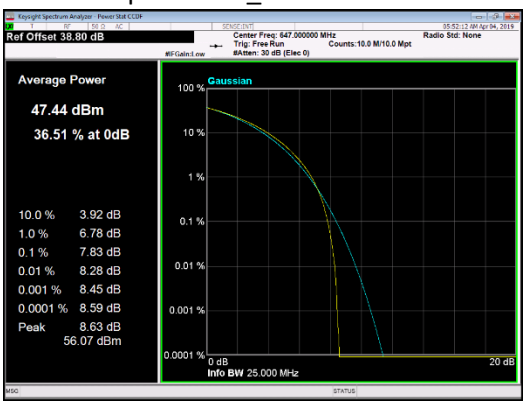
Port 4 - Middle Channel_ CCDF



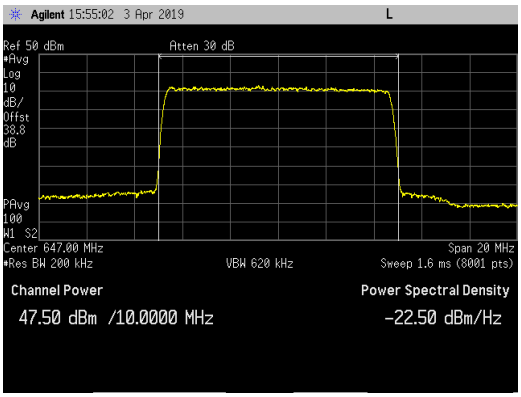
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

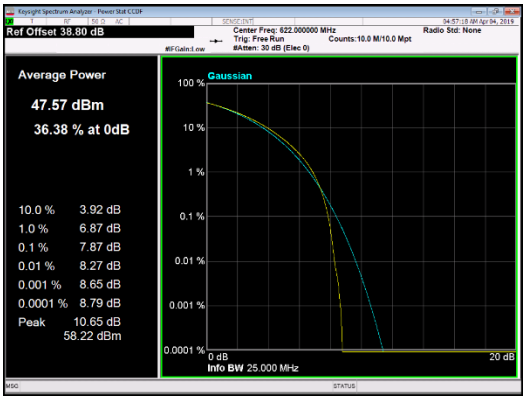


Port 4 - Top Channel_ Average

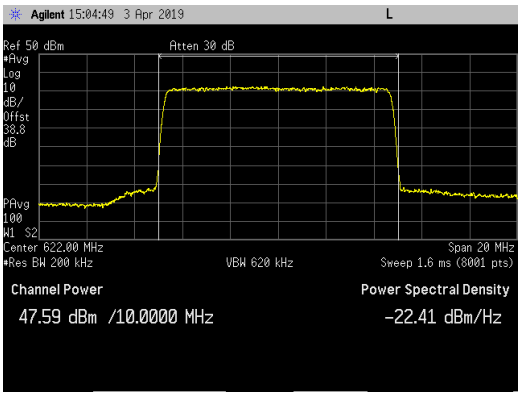


5G NR 10MHz Channel Power Plots for the 256QAM Modulation Type:

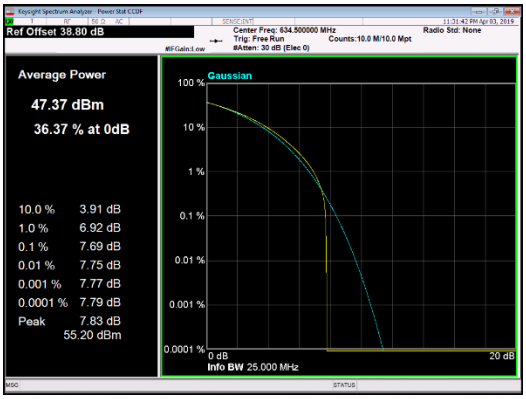
Port 4 - Bottom Channel_ CCDF



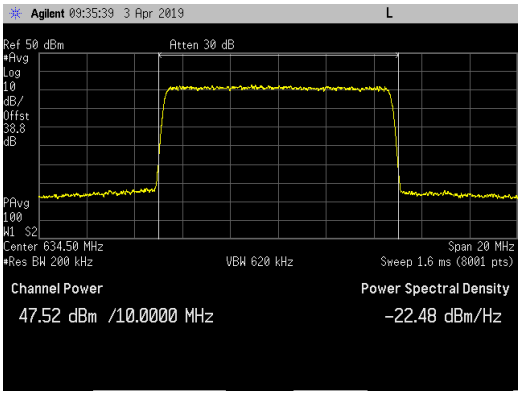
Port 4 - Bottom Channel_ Average



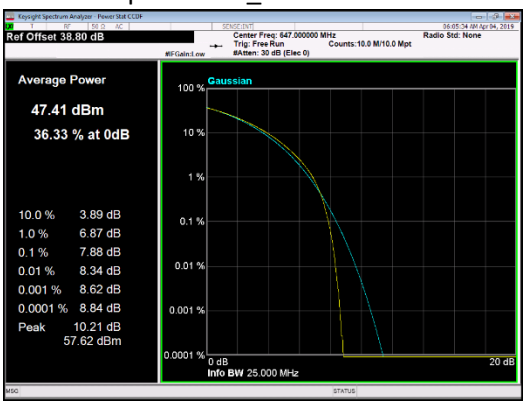
Port 4 - Middle Channel_ CCDF



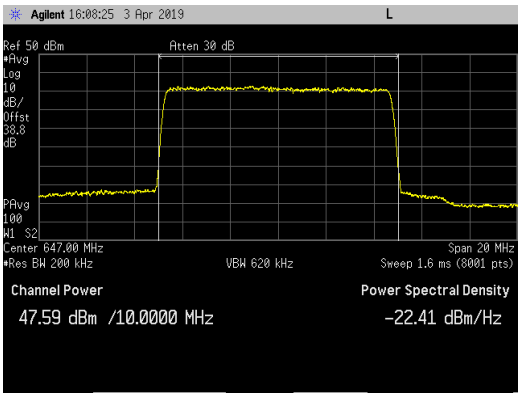
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

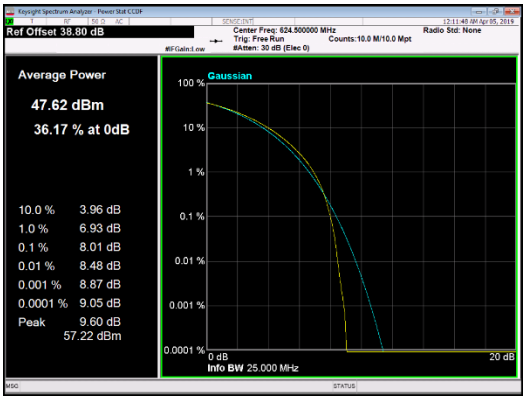


Port 4 - Top Channel_ Average

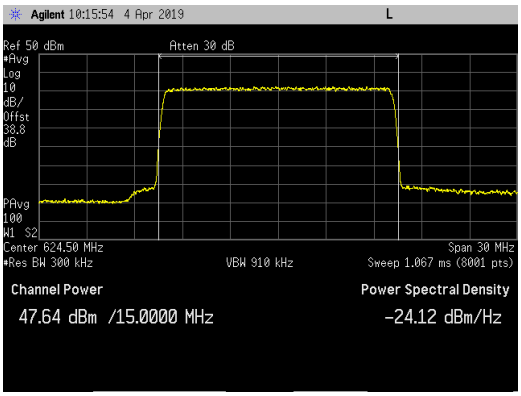


5G NR 15MHz Channel Power Plots for the QPSK Modulation Type:

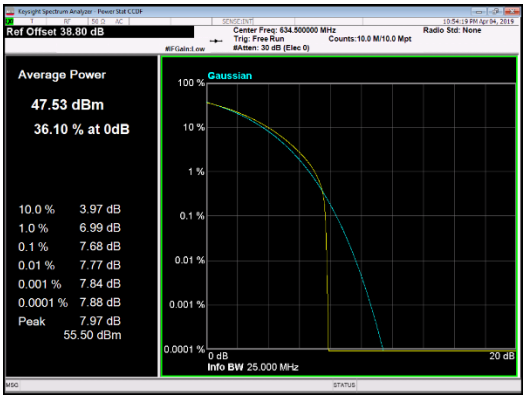
Port 4 - Bottom Channel_ CCDF



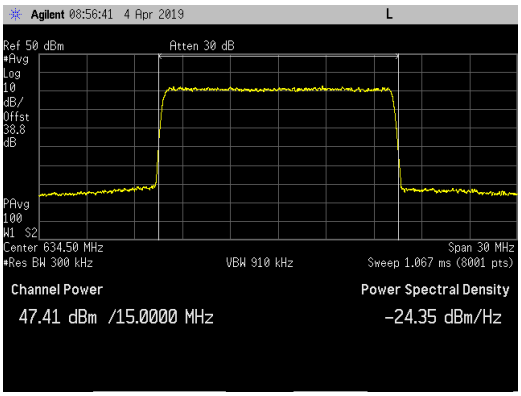
Port 4 - Bottom Channel_ Average



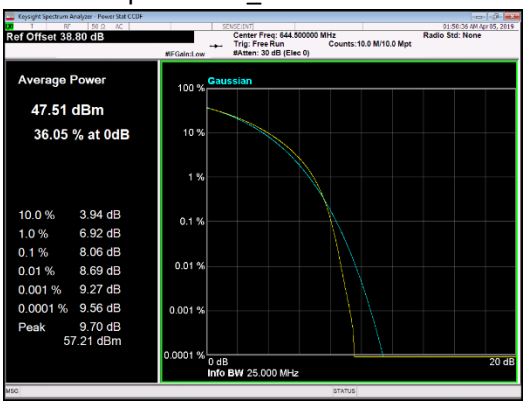
Port 4 - Middle Channel_ CCDF



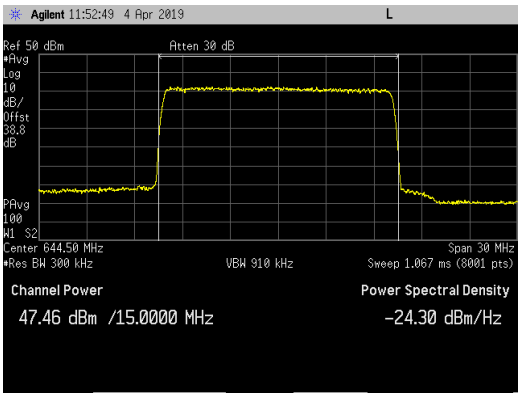
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

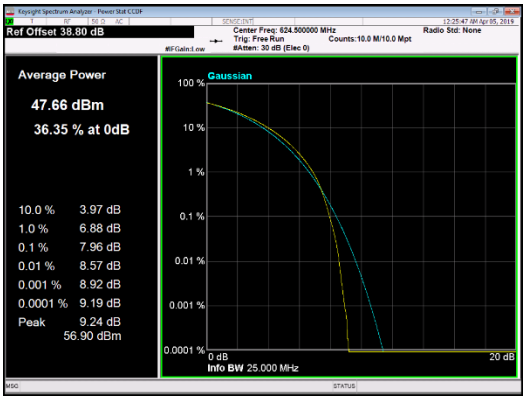


Port 4 - Top Channel_ Average

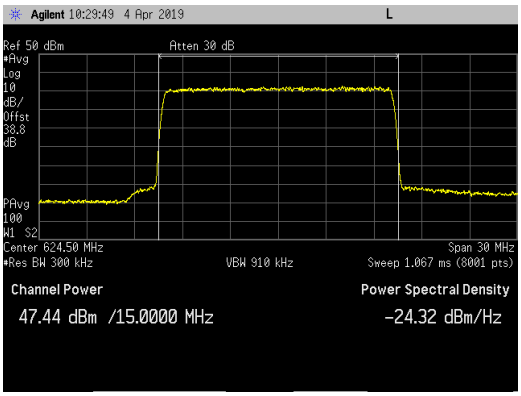


5G NR 15MHz Channel Power Plots for the 16QAM Modulation Type:

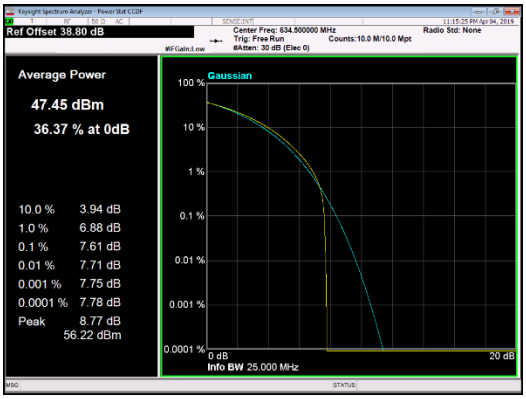
Port 4 - Bottom Channel_ CCDF



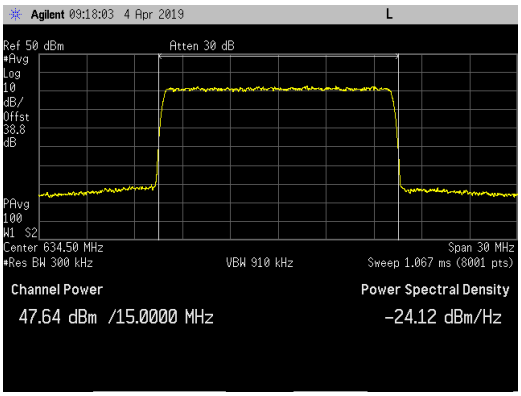
Port 4 - Bottom Channel_ Average



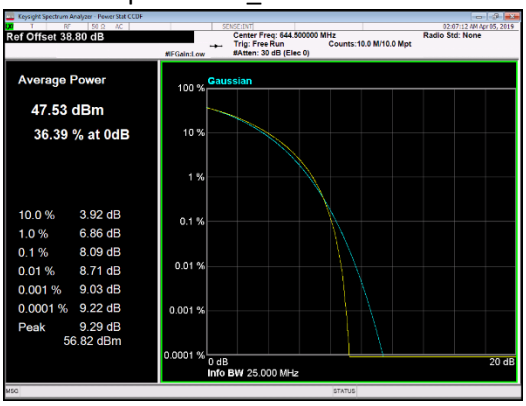
Port 4 - Middle Channel_ CCDF



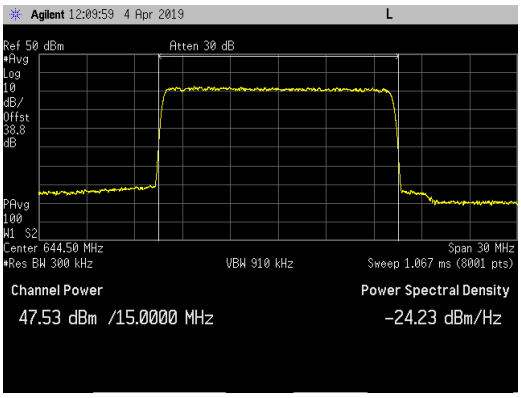
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

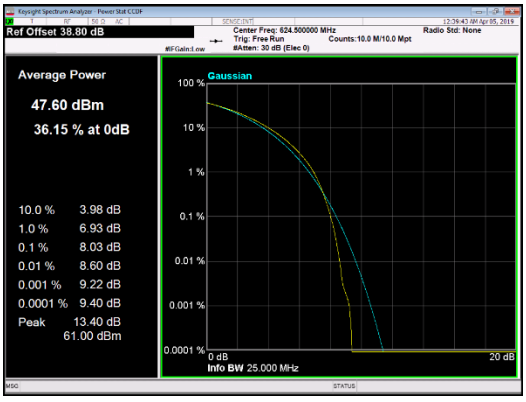


Port 4 - Top Channel_ Average

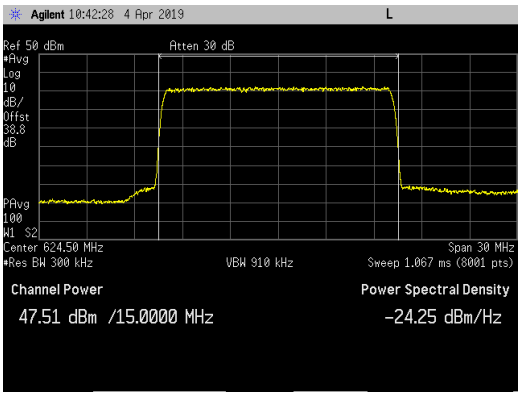


5G NR 15MHz Channel Power Plots for the 64QAM Modulation Type:

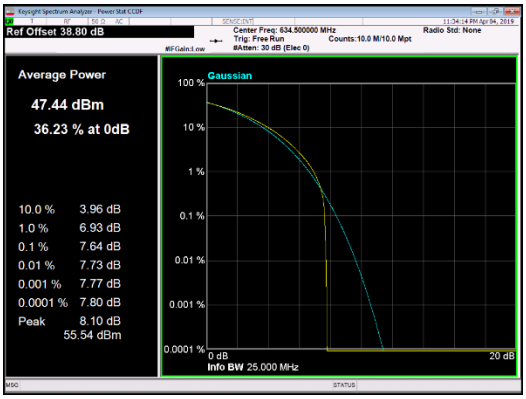
Port 4 - Bottom Channel_ CCDF



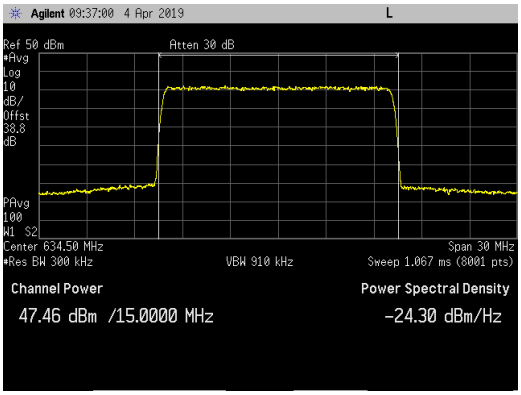
Port 4 - Bottom Channel_ Average



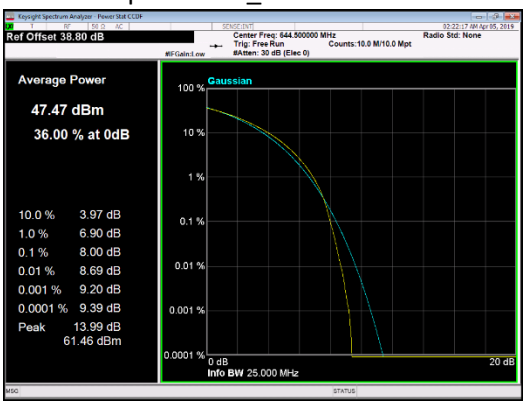
Port 4 - Middle Channel_ CCDF



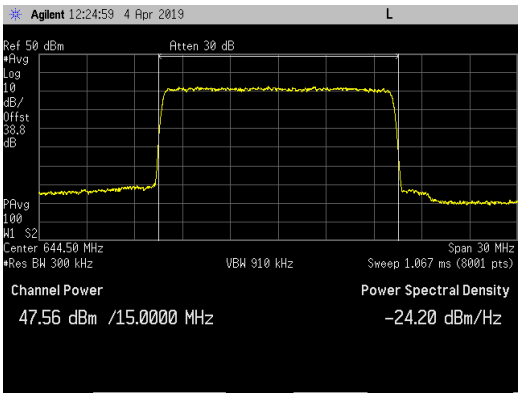
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

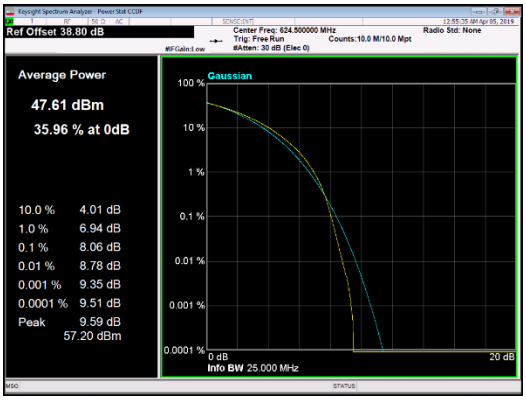


Port 4 - Top Channel_ Average

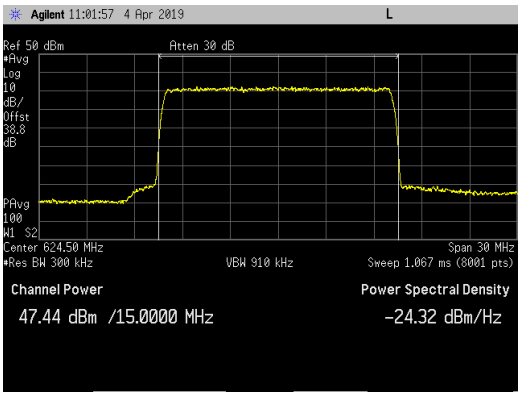


5G NR 15MHz Channel Power Plots for the 256QAM Modulation Type:

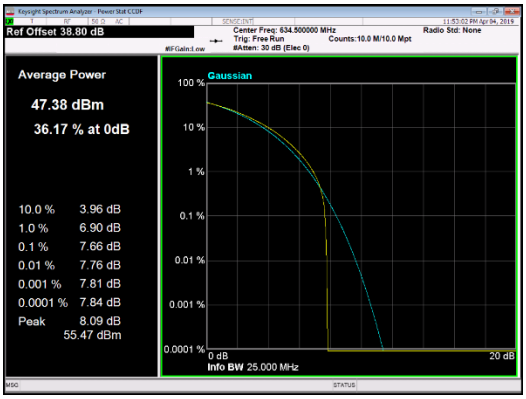
Port 4 - Bottom Channel_ CCDF



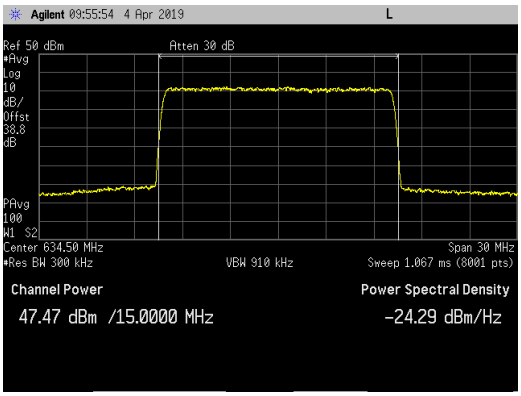
Port 4 - Bottom Channel_ Average



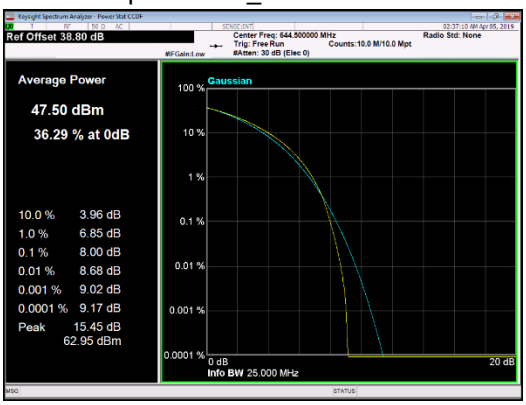
Port 4 - Middle Channel_ CCDF



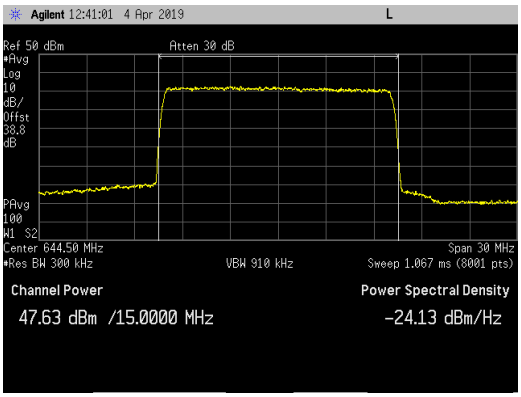
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

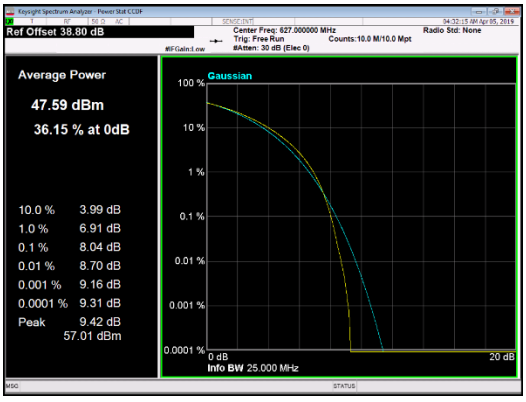


Port 4 - Top Channel_ Average

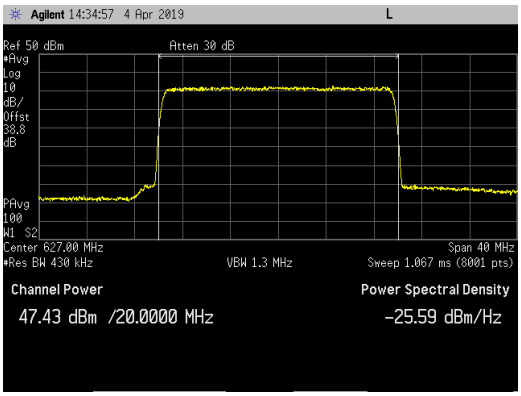


5G NR 20MHz Channel Power Plots for the QPSK Modulation Type:

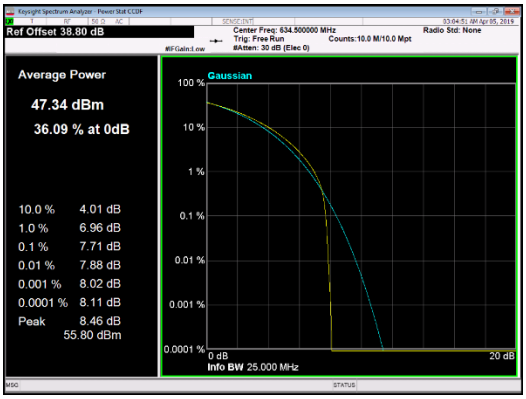
Port 4 - Bottom Channel_ CCDF



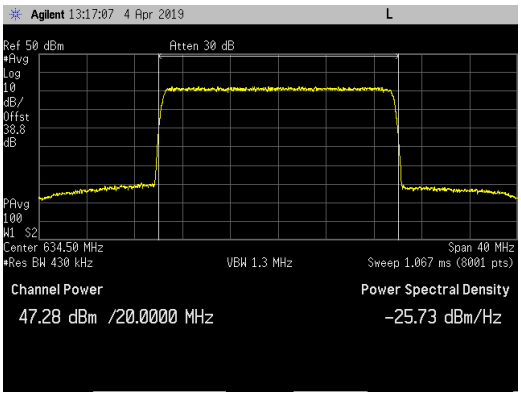
Port 4 - Bottom Channel_ Average



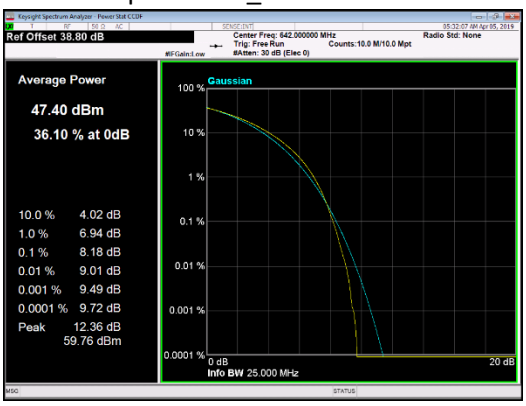
Port 4 - Middle Channel_ CCDF



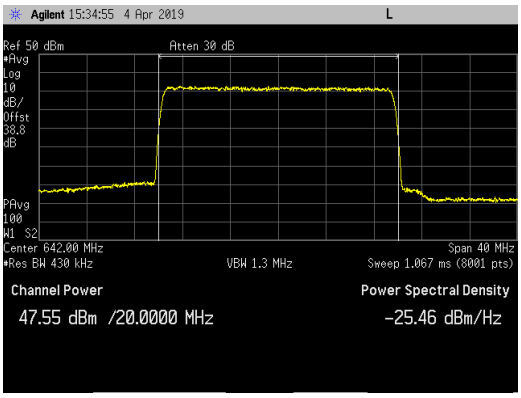
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

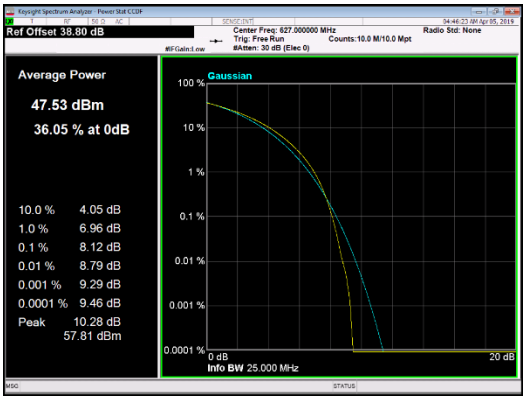


Port 4 - Top Channel_ Average

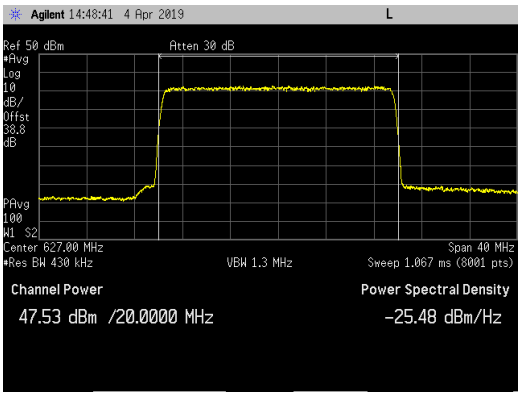


5G NR 20MHz Channel Power Plots for the 16QAM Modulation Type:

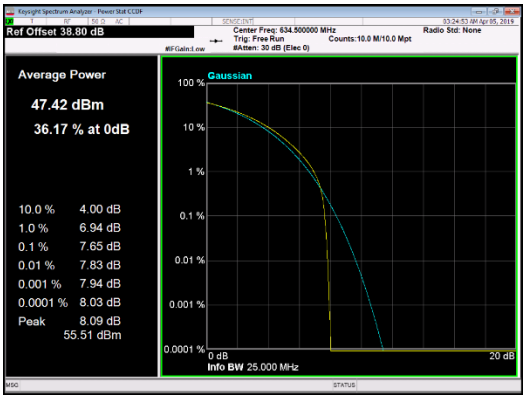
Port 4 - Bottom Channel_ CCDF



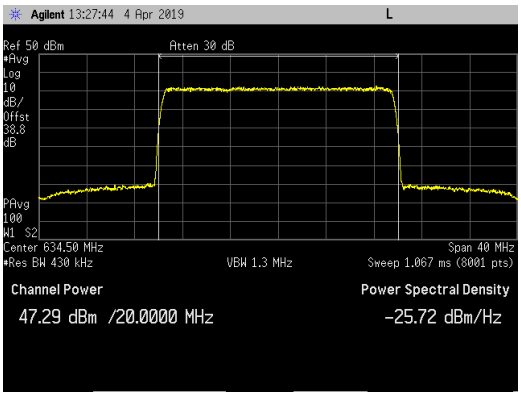
Port 4 - Bottom Channel_ Average



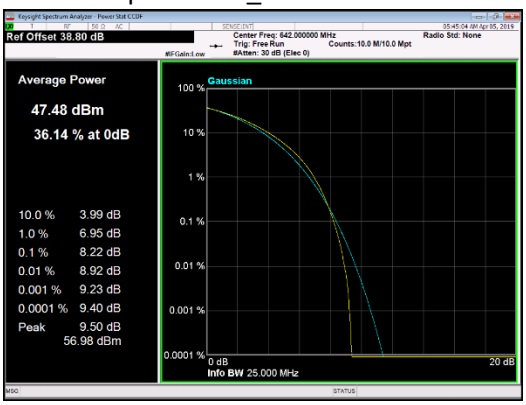
Port 4 - Middle Channel_ CCDF



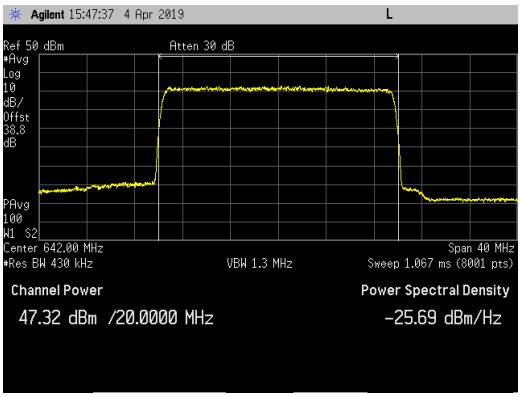
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

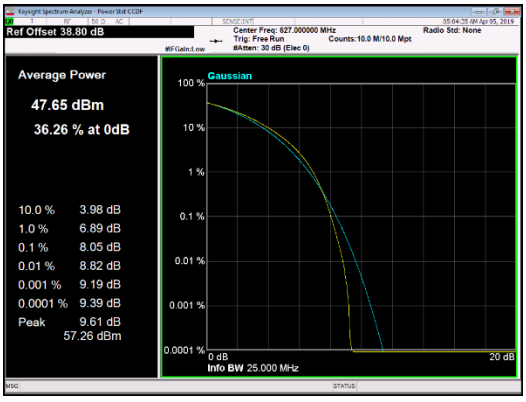


Port 4 - Top Channel_ Average

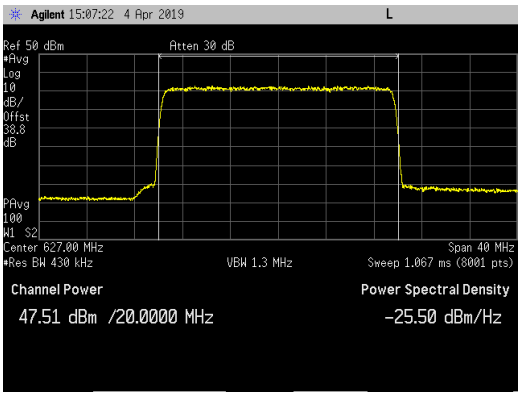


5G NR 20MHz Channel Power Plots for the 64QAM Modulation Type:

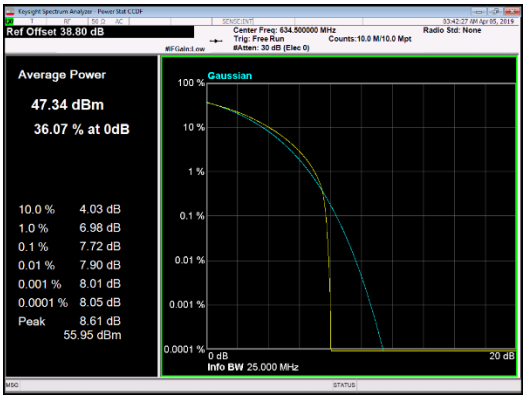
Port 4 - Bottom Channel_ CCDF



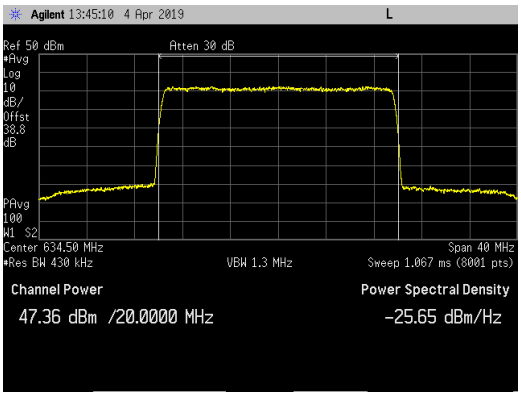
Port 4 - Bottom Channel_ Average



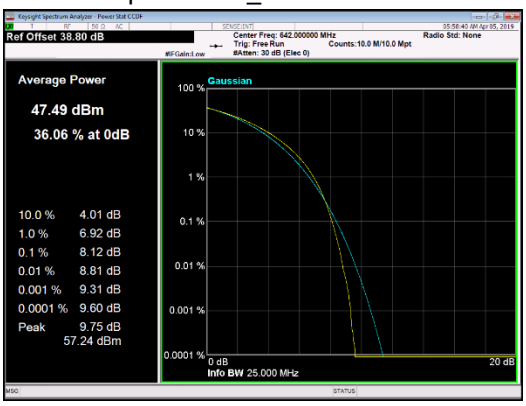
Port 4 - Middle Channel_ CCDF



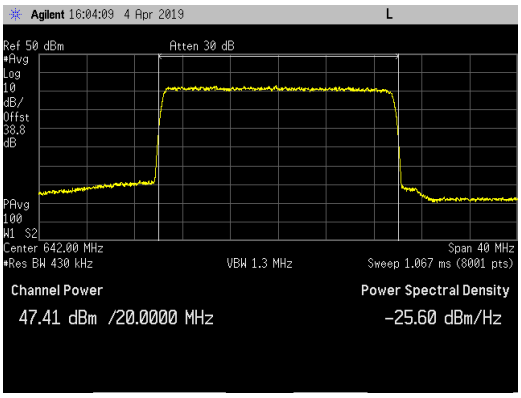
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF

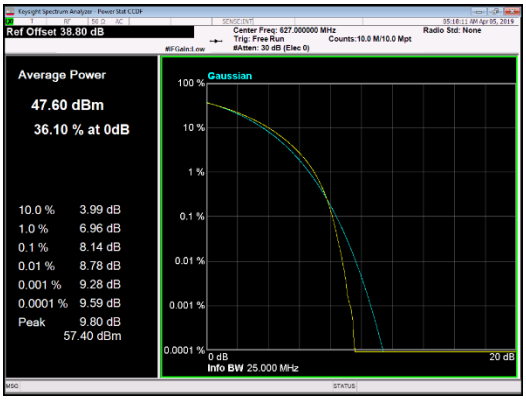


Port 4 - Top Channel_ Average

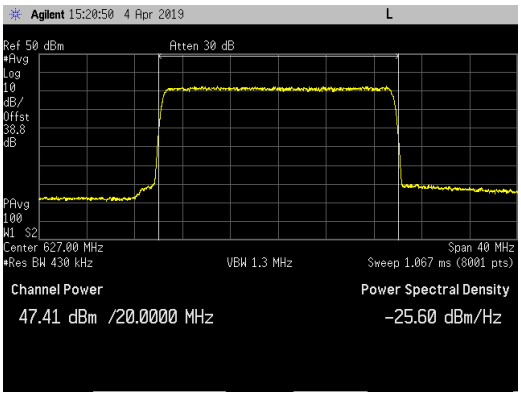


5G NR 20MHz Channel Power Plots for the 256QAM Modulation Type:

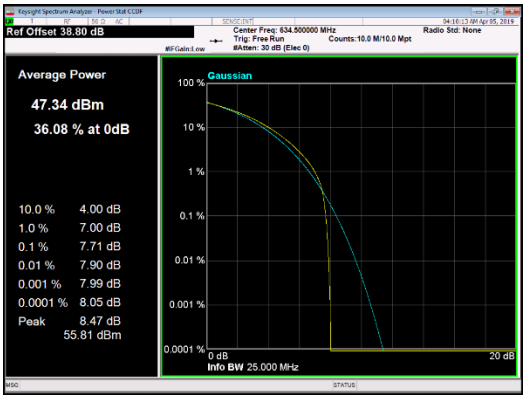
Port 4 - Bottom Channel_ CCDF



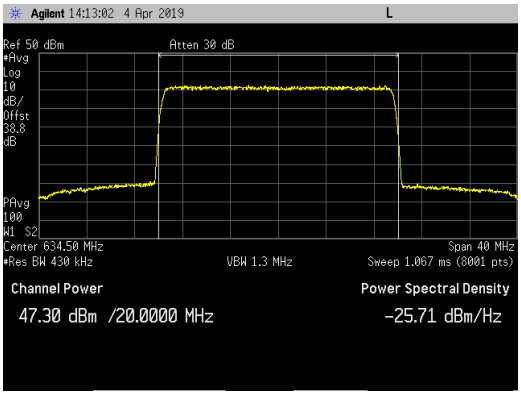
Port 4 - Bottom Channel_ Average



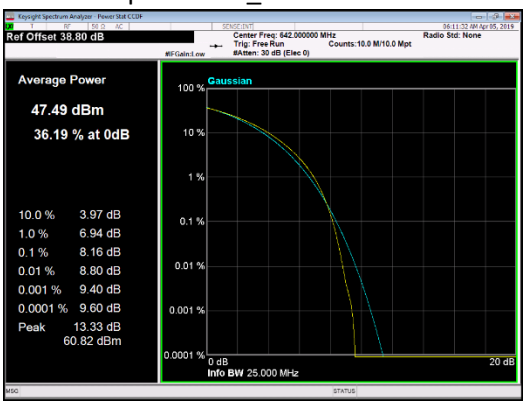
Port 4 - Middle Channel_ CCDF



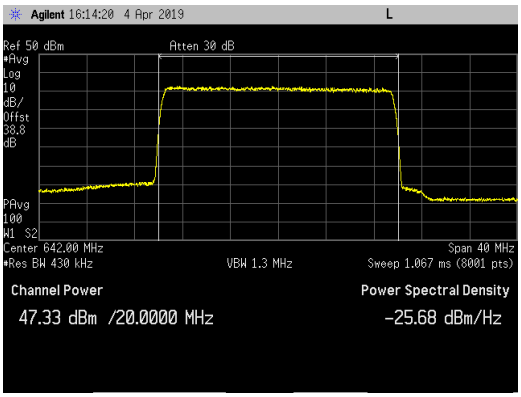
Port 4 - Middle Channel_ Average



Port 4 - Top Channel_ CCDF



Port 4 - Top Channel_ Average



Emission Bandwidth (26 dB down and 99%)

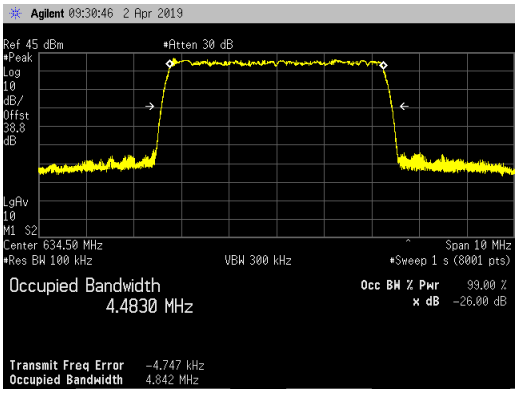
Emission bandwidth measurements were made at antenna port 4 on the middle channel with maximum RF output power. All available 5G NR modulations (QPSK, 16QAM, 64QAM, 256QAM) were used. All available 5G NR channel bandwidths (5MHz, 10MHz, 15MHz and 20MHz) were used. The results are provided in the following table. The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used. The results are provided in the following table. The largest emission bandwidths are highlighted.

5G NR Channel Bandwidth	5G NR Modulation Type							
	QPSK		16QAM		64QAM		256QAM	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
5 MHz	**4.842**	4.4830	4.838	4.4760	4.831	**4.4838**	4.826	4.4759
10 MHz	9.887	**9.3014**	**9.898**	9.2919	9.862	9.2782	9.835	9.3000
15 MHz	14.922	**14.1478**	**14.966**	14.1342	14.927	14.1280	14.922	14.1036
20 MHz	20.075	18.9008	20.066	18.9604	20.036	**18.9666**	**20.085**	18.9625

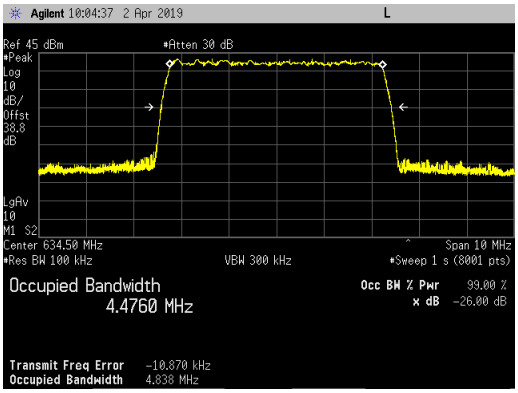
Emission bandwidth measurement data are provided in the following pages.

5G NR 5MHz Channel Bandwidth Emission Bandwidth Plots on the Middle Channel for Antenna Port 4:

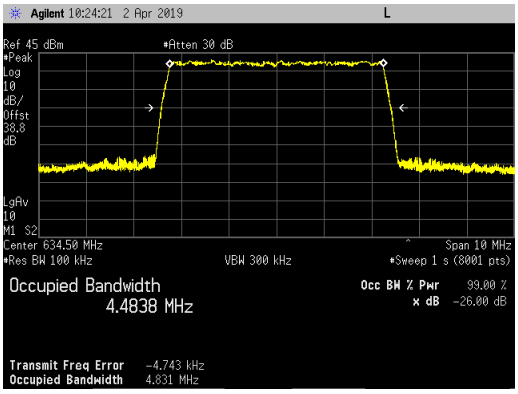
QPSK



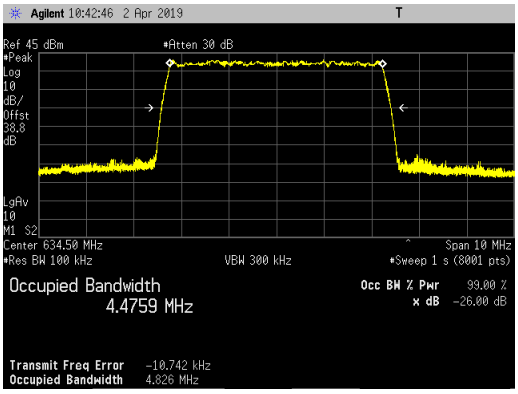
16QAM



64QAM

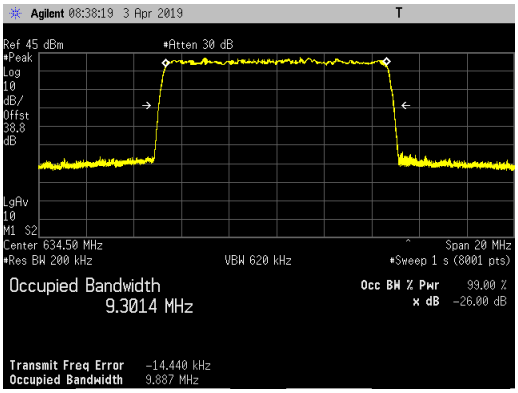


256QAM

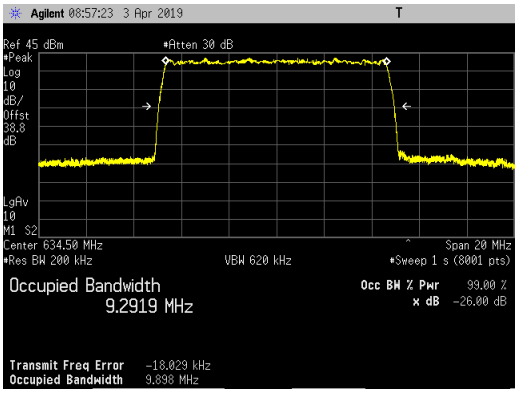


5G NR 10MHz Channel Bandwidth Emission Bandwidth Plots on the Middle Channel for Antenna Port 4:

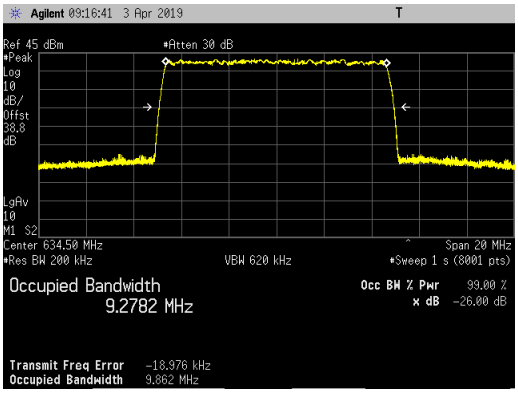
QPSK



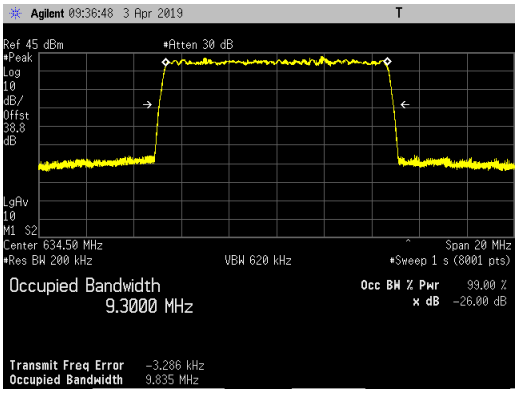
16QAM



64QAM

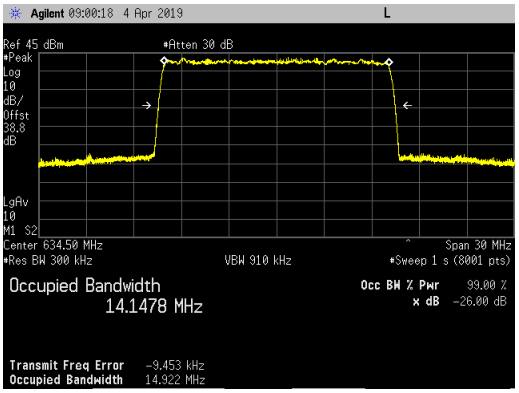


256QAM

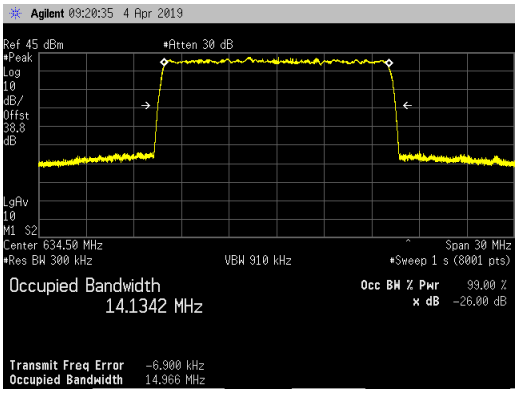


5G NR 15MHz Channel Bandwidth Emission Bandwidth Plots on the Middle Channel for Antenna Port 4:

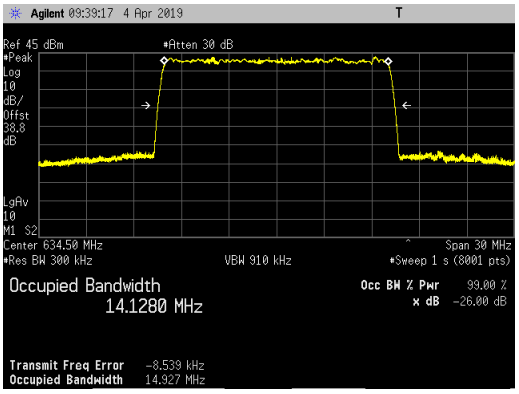
QPSK



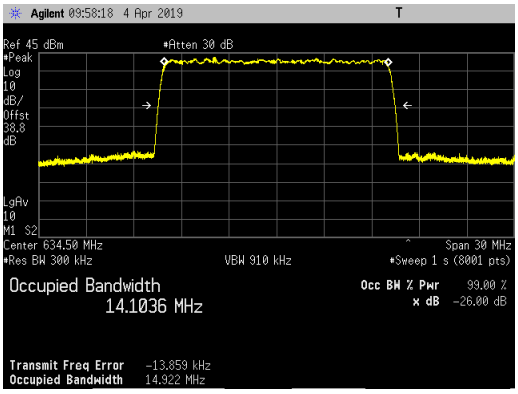
16QAM



64QAM

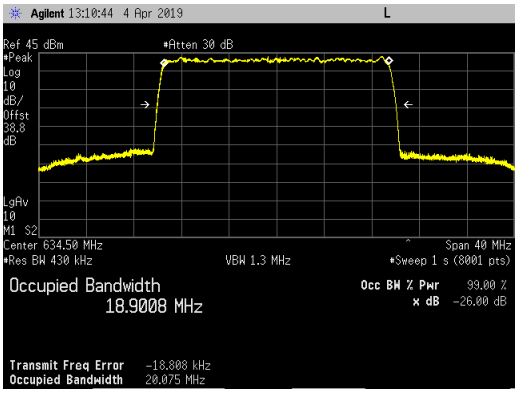


256QAM

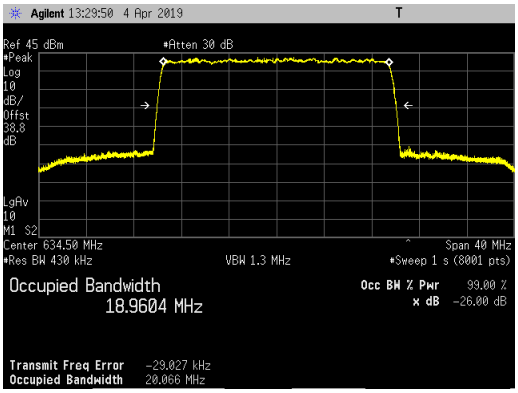


5G NR 20MHz Channel Bandwidth Emission Bandwidth Plots on the Middle Channel for Antenna Port 4:

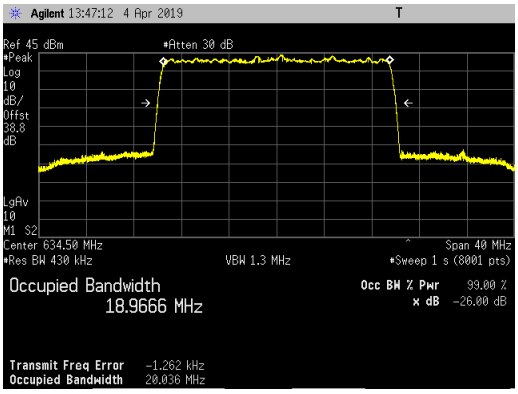
QPSK



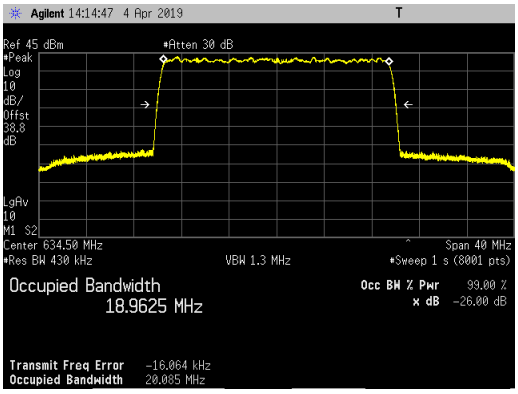
16QAM



64QAM



256QAM



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 4. The RRH was operated at the Band n71 band edge frequencies with a single 5G NR carrier at maximum power (60W) with all modulation types (QPSK, 16QAM, 64QAM, 256QAM) for 5MHz, 10MHz, 15MHz and 20MHz channel bandwidths.

The same limit of -19dBm used in the original certification testing is used for this testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter.

Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. In the 100kHz bands outside and adjacent to the frequency block, a resolution bandwidth of 30kHz as allowed by FCC 27.53(g) was used. Outside the 100kHz band edge noted above, a 100kHz RBW and 300kHz VBW was used. Measurements were performed in the frequency range from the band edge to ≥20 MHz outside the band edge (i.e.: 597 to 617MHz and 652 to 672MHz bands).

The results are summarized in the following table. The highest (worst case) emissions from the measurement data are provided.

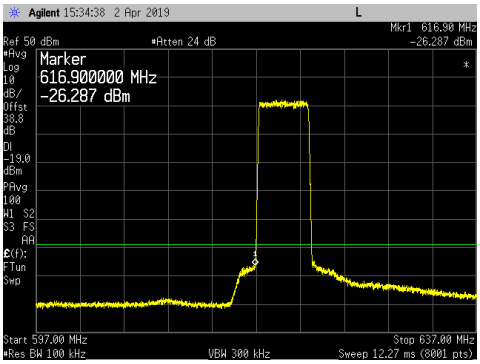
Channel BW, Carrier Frequency, Carrier Power	Lower Band Edge (dBm)				Upper Band Edge (dBm)			
Band n71	**QPSK**	**16QAM**	**64QAM**	**256QAM**	**QPSK**	**16QAM**	**64QAM**	**256QAM**
Single 5MHz Carrier, 619.5MHz (BC), 60W	-26.287	-26.903	-27.145	-27.836	N/A	N/A	N/A	N/A
Single 10MHz Carrier, 622.0MHz (BC), 60W	-27.892	-27.319	-26.757	-27.358	N/A	N/A	N/A	N/A
Single 15MHz Carrier, 624.5MHz (BC), 60W	-26.469	-26.537	-26.686	-26.369	N/A	N/A	N/A	N/A
Single 20MHz Carrier, 627.0MHz (BC), 60W	-27.758	-27.813	-27.597	-28.105	N/A	N/A	N/A	N/A
Single 5MHz Carrier, 649.5MHz (TC), 60W	N/A	N/A	N/A	N/A	**-26.015**	-26.789	-27.909	-27.652
Single 10MHz Carrier, 647.0MHz (TC), 60W	N/A	N/A	N/A	N/A	-28.508	-29.771	-28.694	-28.861
Single 15MHz Carrier, 644.5MHz (TC), 60W	N/A	N/A	N/A	N/A	-29.219	-29.388	-28.891	-28.694
Single 20MHz Carrier, 642.0MHz (TC), 60W	N/A	N/A	N/A	N/A	-29.529	-29.339	-29.756	-29.498

The total measurement RF path loss of the test setup (attenuator and test cables) was 38.8 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

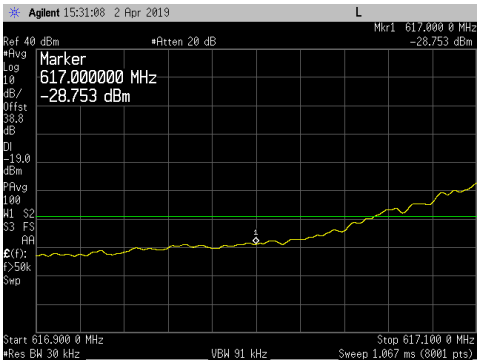
Conducted band edge measurements are provided in the following pages.

5G NR_ 5MHz Channel Bandwidth_ Lower Band Edge Plots for Antenna Port 4:

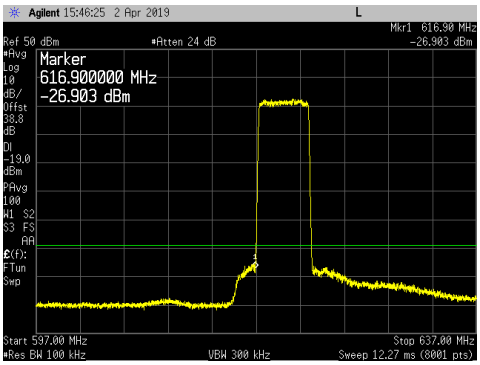
QPSK_ Bot Ch_ 597 to 637MHz



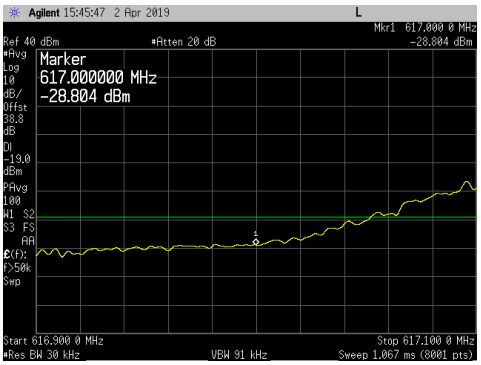
QPSK_ Bot Ch_ 616.9 to 617.1MHz



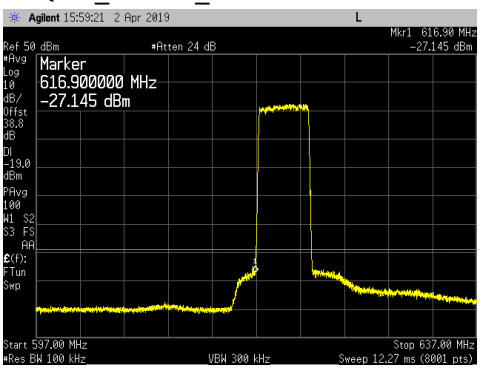
16QAM_ Bot Ch_ 597 to 637MHz



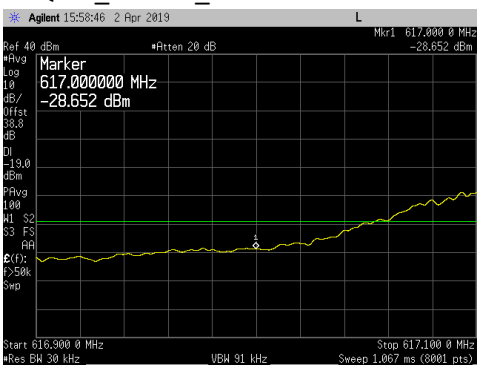
16QAM_ Bot Ch_ 616.9 to 617.1MHz



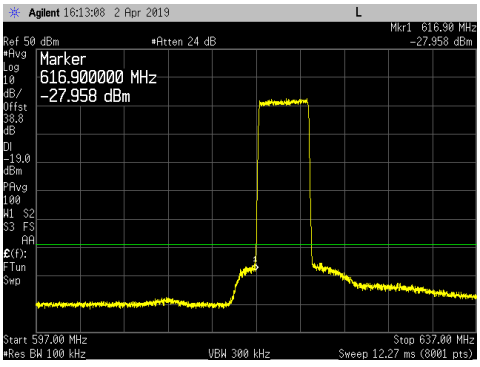
64QAM_ Bot Ch_ 597 to 637MHz



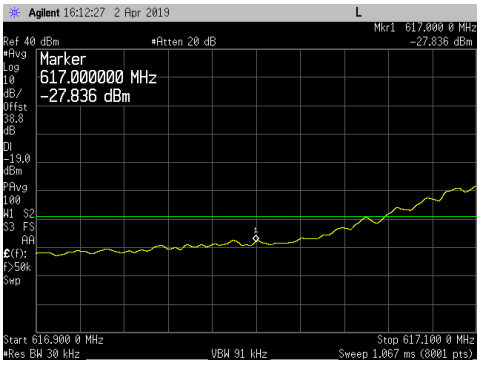
64QAM_ Bot Ch_ 616.9 to 617.1MHz



256QAM_ Bot Ch_ 597 to 637MHz

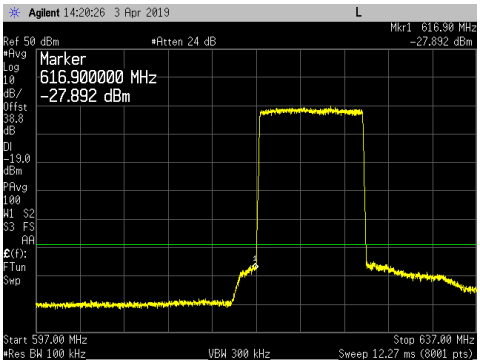


256QAM_ Bot Ch_ 616.9 to 617.1MHz

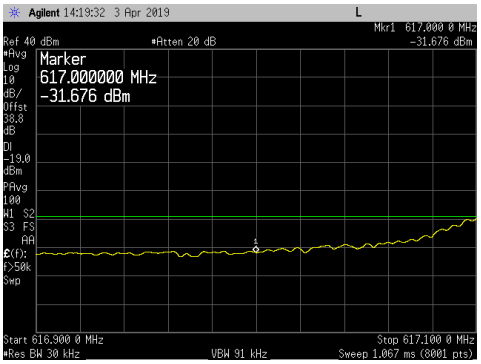


5G NR_ 10MHz Channel Bandwidth_ Lower Band Edge Plots for Antenna Port 4:

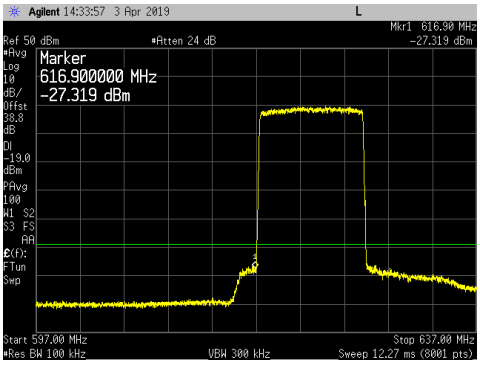
QPSK_ Bot Ch_ 597 to 637MHz



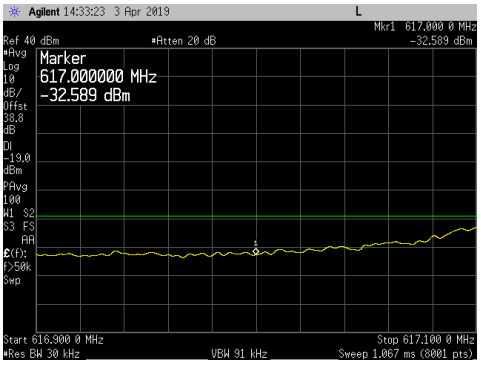
QPSK_ Bot Ch_ 616.9 to 617.1MHz



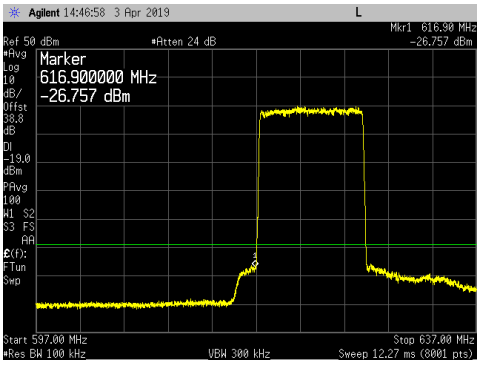
16QAM_ Bot Ch_ 597 to 637MHz



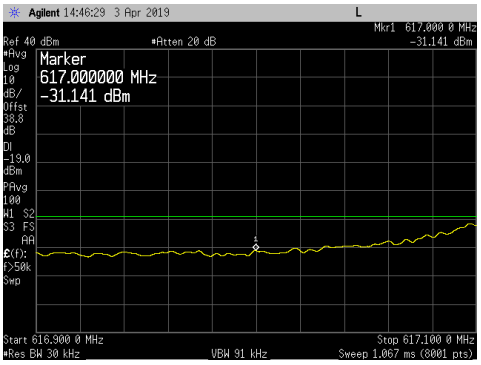
16QAM_ Bot Ch_ 616.9 to 617.1MHz



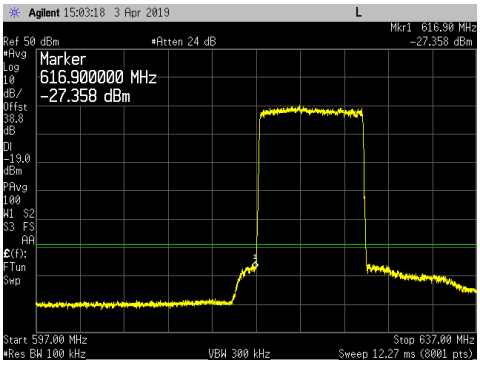
64QAM_ Bot Ch_ 597 to 637MHz



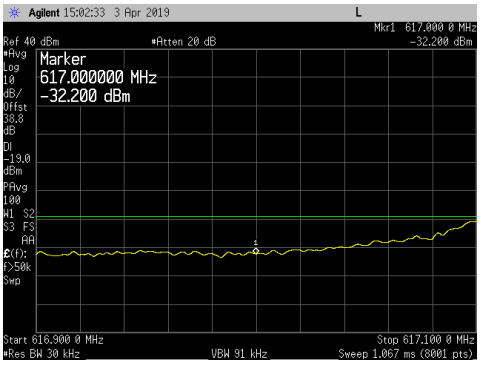
64QAM_ Bot Ch_ 616.9 to 617.1MHz



256QAM_ Bot Ch_ 597 to 637MHz

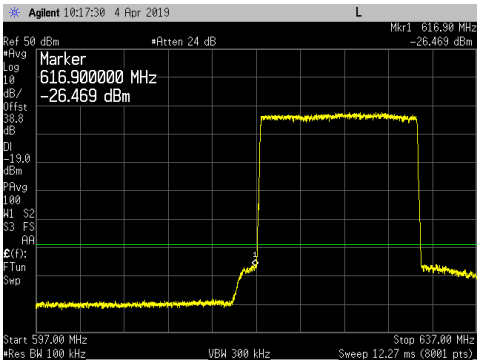


256QAM_ Bot Ch_ 616.9 to 617.1MHz

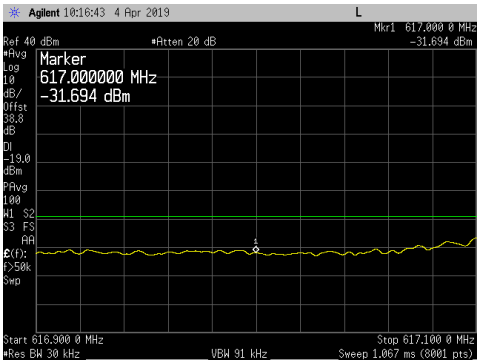


5G NR_ 15MHz Channel Bandwidth_ Lower Band Edge Plots for Antenna Port 4:

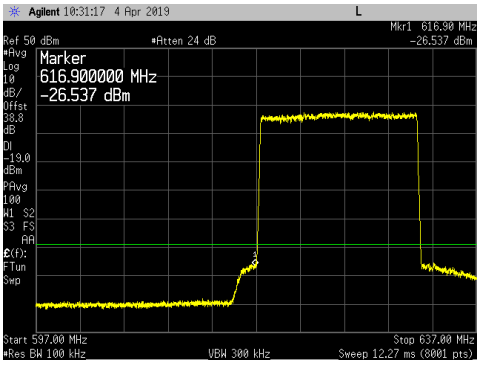
QPSK_ Bot Ch_ 597 to 637MHz



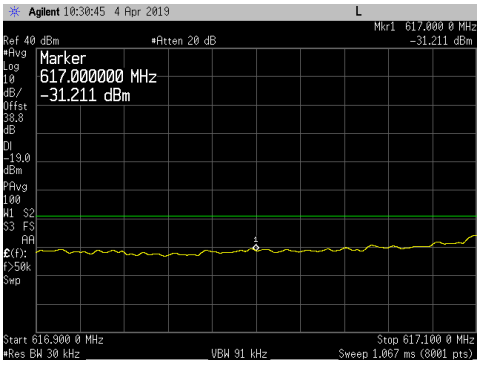
QPSK_ Bot Ch_ 616.9 to 617.1MHz



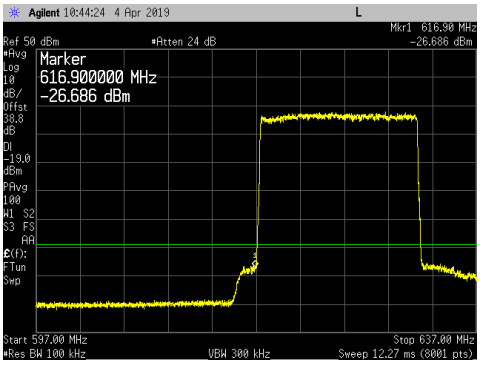
16QAM_ Bot Ch_ 597 to 637MHz



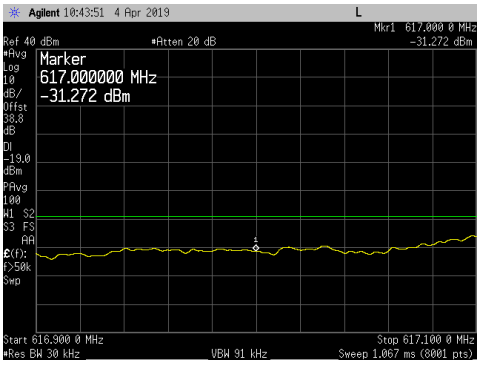
16QAM_ Bot Ch_ 616.9 to 617.1MHz



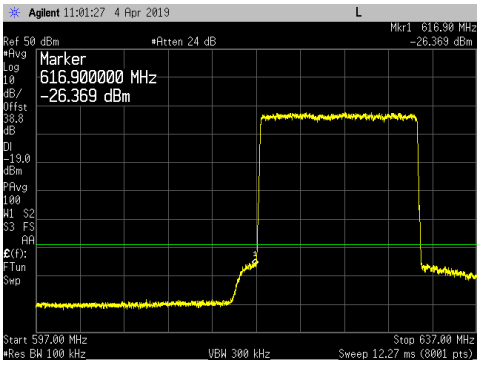
64QAM_ Bot Ch_ 597 to 637MHz



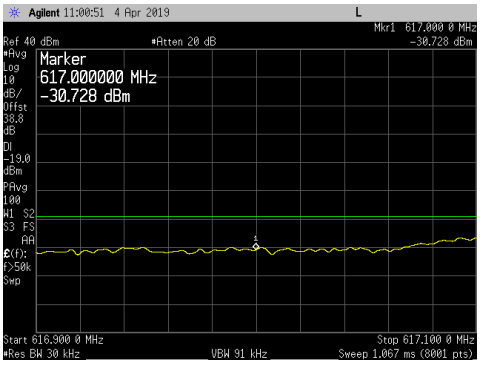
64QAM_ Bot Ch_ 616.9 to 617.1MHz



256QAM_ Bot Ch_ 597 to 637MHz

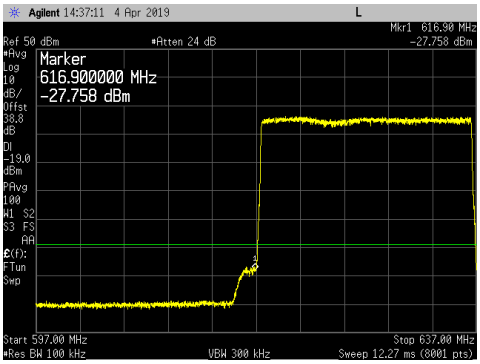


256QAM_ Bot Ch_ 616.9 to 617.1MHz

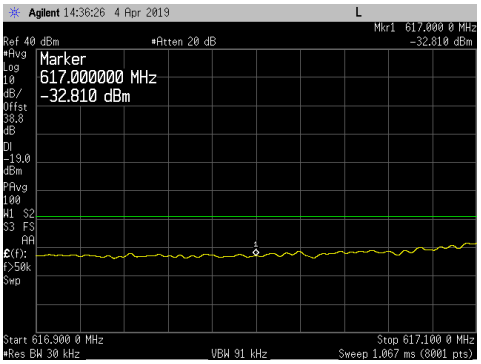


5G NR_ 20MHz Channel Bandwidth_ Lower Band Edge Plots for Antenna Port 4:

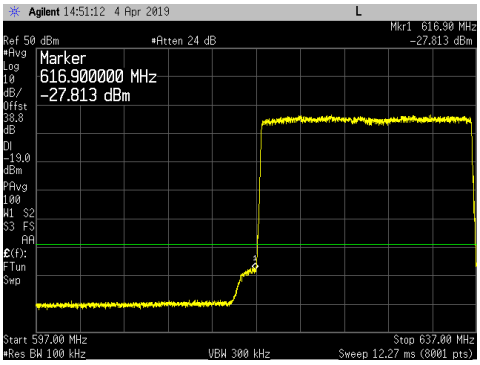
QPSK_ Bot Ch_ 597 to 637MHz



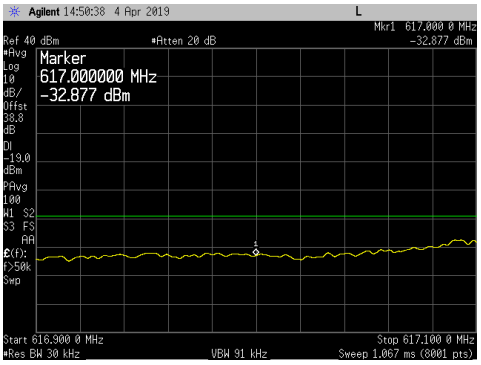
QPSK_ Bot Ch_ 616.9 to 617.1MHz



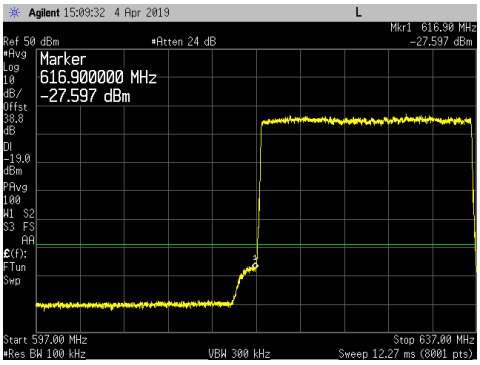
16QAM_ Bot Ch_ 597 to 637MHz



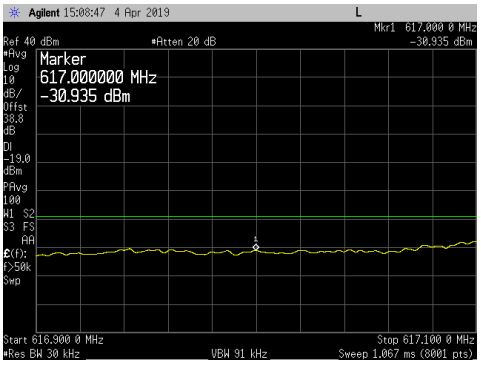
16QAM_ Bot Ch_ 616.9 to 617.1MHz



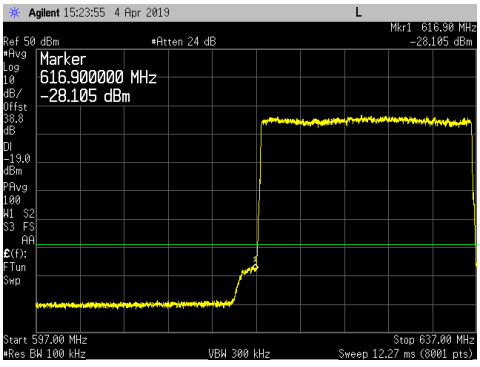
64QAM_ Bot Ch_ 597 to 637MHz



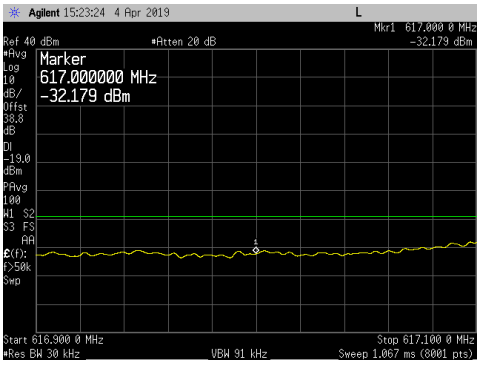
64QAM_ Bot Ch_ 616.9 to 617.1MHz



256QAM_ Bot Ch_ 597 to 637MHz

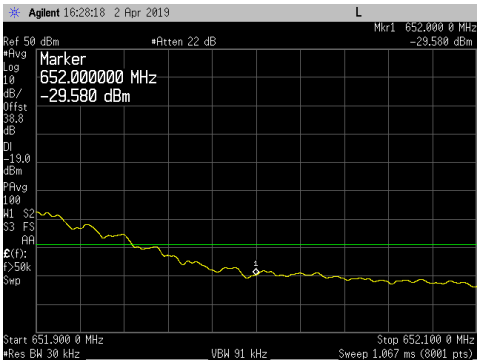


256QAM_ Bot Ch_ 616.9 to 617.1MHz

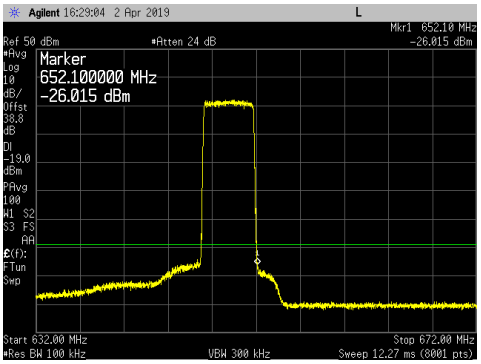


5G NR_ 5MHz Channel Bandwidth_ Upper Band Edge Plots for Antenna Port 4:

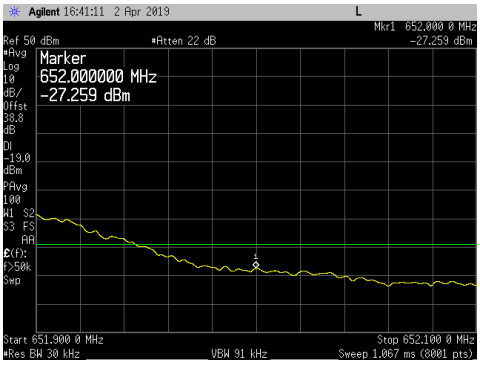
QPSK_ Top Ch_ 651.9 to 652.1MHz



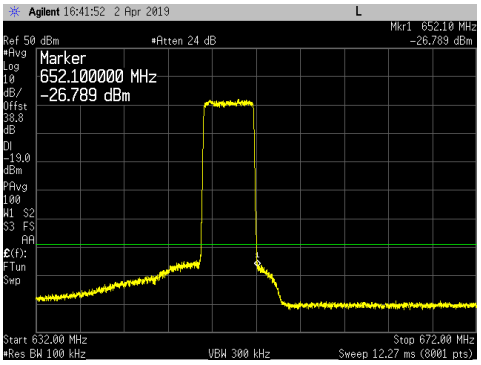
QPSK_ Top Ch_ 632 to 672MHz



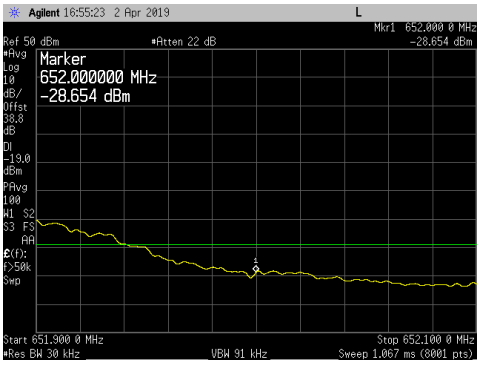
16QAM_ Top Ch_ 651.9 to 652.1MHz



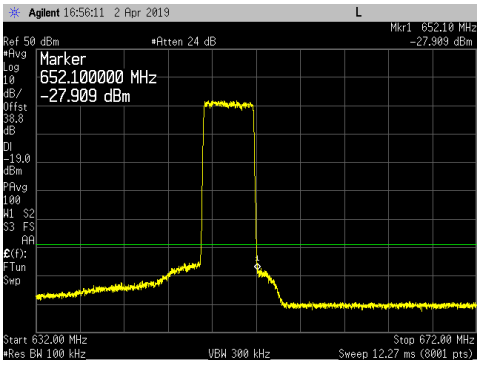
16QAM_ Top Ch_ 632 to 672MHz



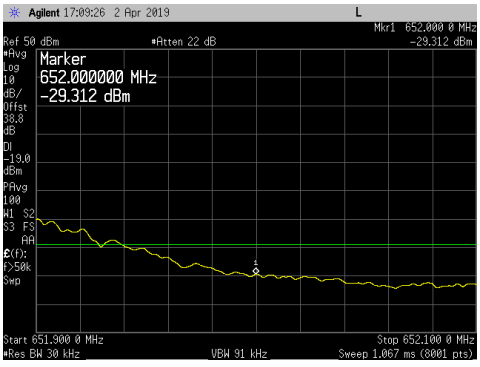
64QAM_ Top Ch_ 651.9 to 652.1MHz



64QAM_ Top Ch_ 632 to 672MHz



256QAM_ Top Ch_ 651.9 to 652.1MHz



256QAM_ Top Ch_ 632 to 672MHz