Radio Test Report

Application for a Class II Permissive Change of Equipment Authorization

FCC Part 24
[1930MHz – 1995MHz]

FCC Part 27
[2110MHz – 2200MHz]

CERTIFICATE #: 0214.19

FCC ID: VBNAHFIB-01

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

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

Test Sites: National Technical Systems – Plano
1701 E Plano Pkwy #150
Plano, TX 75074

Test Dates: September 23 - 26, 2019
Total Number of Pages: 135

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	10/03/2019	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 AHFIB, 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 24 Subpart E – Broadband PCS
- CFR Title 47 Part 27 Subpart C & L

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 AHFIB 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 and Canada, 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 AHFIB. 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 AHFIB 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 24 (Base Stations Operating in the 1930MHz to 1995MHz Band)

AHFIB operating in the PCS Band				
FCC	Description	Measured	Limit	Results
24.229	Frequency Ranges	5G-NR 5MHz Channel BW: 1932.5 – 1992.5MHz 5G-NR 10MHz Channel BW: 1935.0 – 1990.0MHz 5G-NR 15MHz Channel BW: 1937.5 – 1987.5MHz 5G-NR 20MHz Channel BW: 1940.0 – 1985.0MHz	1930.0MHz to 1995.0MHz	Pass
2.1047	Modulation Type	QPSK, 16QAM, 64QAM, 256QAM for 5G-NR 5, 10, 15 and 20MHz Channel Bandwidths	Digital	Pass
24.232	Output Power	Highest Conducted Power Output RMS: 46.54dBm EIRP depends on antenna gain which is unknown	1640W/MHz EIRP/MHz	Pass
24.232	Peak to Average Power Ratio	Highest Measured PAPR: 7.91dB	13dB	Pass
	99% Emission Bandwidth	5G-NR 5MHz Channel BW: 4.4989MHz 5G-NR 10MHz Channel BW: 9.3147MHz 5G-NR 15MHz Channel BW: 14.1360MHz 5G-NR 20MHz Channel BW: 18.9556MHz	Remain in Block	Pass
24.238	26dB down Emission Bandwidth	5G-NR 5MHz Channel BW: 4.838MHz Emission Designator: 4M84G7W 5G-NR 10MHz Channel BW: 9.884MHz Emission Designator: 9M88G7W 5G-NR 15MHz Channel BW: 14.933MHz Emission Designator: 14M9G7W 5G-NR 20MHz Channel BW: 20.019MHz Emission Designator: 20M0G7W	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
24.238	At the antenna terminals for 5G-NR	< -19dBm	-19dBm per Transmit Chain	Pass
	Field Strength	< -13dBm	-13dBm EIRP	Pass[2]
Other Details				
24.235	Frequency Stability	Stays within authorized frequency block	Stays within block	Pass[2]
1.1310	RF Exposure	N/A		Pass[3]

Note 1: Based on 1MHz RBW. In the 1MHz immediately outside and adjacent to the frequency block a RBW of at least 1% of the emission bandwidth was used. The measurement bandwidth is 1MHz for measurements more than 1MHz from the band edge.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR072254 Rev.1 dated March 16, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

FCC Emission Designators for the PCS Band				
Channel Bandwidth	**5G-NR: QPSK**	**5G-NR: 16QAM**	**5G-NR: 64QAM**	**5G-NR: 256QAM**
5M	4M84G7W	4M83G7W	4M82G7W	4M83G7W
10M	9M88G7W	9M88G7W	9M88G7W	9M88G7W
15M	14M9G7W	14M9G7W	14M9G7W	14M9G7W
20M	20M0G7W	20M0G7W	20M0G7W	20M0G7W
Note: FCC Emission Designators are based on 26dB emission bandwidth				

FCC Part 27 Subpart C&L (Base Stations Operating in the 2110 - 2200MHz Band)

AHFIB operating in the AWS Band				
FCC	Description	Measured	Limit	Results
27.5 (h)&(j)	Frequency Ranges	5G-NR 5MHz Channel BW: 2112.5 - 2197.5MHz 5G-NR 10MHz Channel BW: 2115.0 - 2195.0MHz 5G-NR 15MHz Channel BW: 2117.5 - 2192.5MHz 5G-NR 20MHz Channel BW: 2120.0 - 2190.0MHz	2110.0MHz to 2200.0MHz	Pass
2.1033 (c)(4)	Modulation Type	QPSK, 16QAM, 64QAM, 256QAM for 5G-NR 5, 10, 15 and 20MHz Channel Bandwidths	Digital	Pass
27.50 (d)(2)	Output Power	Highest Conducted Power Output RMS: 46.30dBm EIRP depends on antenna gain which is unknown	1640W/MHz EIRP/MHz	Pass
27.50 (d)(5)	Peak to Average Power Ratio	Highest Measured PAPR: 7.80dB	13dB	Pass
	99% Emission Bandwidth	5G-NR 5MHz Channel BW: 4.4991MHz 5G-NR 10MHz Channel BW: 9.3147MHz 5G-NR 15MHz Channel BW: 14.1200MHz 5G-NR 20MHz Channel BW: 18.9580MHz	Remain in Block	Pass
27.53 (h)(3)	26dB down Emission Bandwidth	5G-NR 5MHz Channel BW: 4.840MHz Emission Designator: 4M84G7W 5G-NR 10MHz Channel BW: 9.881MHz Emission Designator: 9M88G7W 5G-NR 15MHz Channel BW: 14.930MHz Emission Designator: 14M9G7W 5G-NR 20MHz Channel BW: 20.024MHz Emission Designator: 20M0G7W	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
27.53 (h)	At the antenna terminals for 5G-NR	< -19dBm	-19dBm per Transmit Chain	Pass
	Field strength	< -13dBm	-13 dBm EIRP	Pass[2]
Other Details				
27.54	Frequency Stability	Stays within authorized frequency block	Stays within block	Pass[2]
1.1310	RF Exposure	N/A		Pass[3]

Note 1: Based on 1MHz RBW. In the 1MHz immediately outside and adjacent to the frequency block a RBW of at least 1% of the emission bandwidth was used. The measurement bandwidth is 1MHz for measurements more than 1MHz from the band edge.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR072254 Rev.1 dated March 16, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

FCC Emission Designators for the AWS Band				
Channel Bandwidth	**5G-NR: QPSK**	**5G-NR: 16QAM**	**5G-NR: 64QAM**	**5G-NR: 256QAM**
5M	4M84G7W	4M82G7W	4M82G7W	4M84G7W
10M	9M88G7W	9M87G7W	9M88G7W	9M88G7W
15M	14M9G7W	14M9G7W	14M9G7W	14M9G7W
20M	20M0G7W	20M0G7W	20M0G7W	20M0G7W
Note: FCC Emission Designators are 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 AHFIB Federal Communication Commission certifications. The original FCC radio certification submittal was NTS Test Report Number PR072254 Revision 1 dated March 16, 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 (AHFIB) as the original certification test. The AHFIB antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in the original certification testing). 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 AHFIB. The AHFIB remote radio head is a multistandard multicarrier radio module designed to support GSM/EDGE, WCDMA, LTE, narrow band IoT (internet of things) operations (in-band, guard band, standalone) and 5G NR (fifth generation – new radio). The scope of testing in this effort is for 5G NR single carrier operations.

The AHFIB RRH has four transmit/four receive antenna ports (4TX/4RX for Band n25 and 4TX/4RX for Band n66). Each antenna port supports 3GPP frequency band n25 (BTS Rx: 1850 to 1915 MHz/BTS TX: 1930 to 1995 MHz) and 3GPP frequency band n66 (BTS Rx: 1710 to 1780 MHz/BTS TX: 2110 to 2200 MHz). The maximum RF output power of the RRH is 320 Watts (40 watts per carrier and 40 per port for band n25 operations; 40 watts per carrier and 40 per port for band n66 operations). The RRH can be operated as a 4x4 MIMO, 2x2 MIMO or as non-MIMO for 5G NR. The TX and RX instantaneous

bandwidth cover the full operational RRH bandwidth. Multi-carrier operation is not supported with this software release.

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 AHFIB downlink channel numbers and frequencies for 5G NR operations are as follows:

The 5G NR channel bandwidths are 5, 10, 15 and 20MHz. The channel spacing is 100 kHz between channel numbers.

	Downlink NR-ARFCN	Downlink Frequency (MHz)	5G NR Channel Bandwidth			
			5 MHz	10 MHz	15 MHz	20 MHz
AHFIB Band n25 (Ant 1, 2, 3, 4)	386000	1930.0	Band Edge	Band Edge	Band Edge	Band Edge
	386500	1932.5	Bottom Ch			
	387000	1935.0		Bottom Ch		
	387500	1937.5			Bottom Ch	
	388000	1940.0				Bottom Ch
	392500	1962.5	Middle Ch	Middle Ch	Middle Ch	Middle Ch
	397000	1985.0				Top Channel
	397500	1987.5			Top Channel	
	398000	1990.0		Top Channel		
	398500	1992.5	Top Channel			
	399000	1995.0	Band Edge	Band Edge	Band Edge	Band Edge

AHFIB Downlink Band Edge 5G NR PCS Band Frequency Channels

	Downlink NR-ARFCN	Downlink Frequency (MHz)	5G NR Channel Bandwidth			
			5 MHz	10 MHz	15 MHz	20 MHz
AHFIB Band n66 (Ant 1, 2, 3, 4)	422000	2110.0	Band Edge	Band Edge	Band Edge	Band Edge
	422500	2112.5	Bottom Ch			
	423000	2115.0		Bottom Ch		
	423500	2117.5			Bottom Ch	
	424000	2120.0				Bottom Ch
	431000	2155.0	Middle Ch	Middle Ch	Middle Ch	Middle Ch
	438000	2190.0				Top Channel
	438500	2192.5			Top Channel	
	439000	2195.0		Top Channel		
	439500	2197.5	Top Channel			
	440000	2200.0	Band Edge	Band Edge	Band Edge	Band Edge

AHFIB Downlink Band Edge 5G-NR AWS Band Frequency Channels

EUT Hardware

The EUT hardware used in testing on September 23-26, 2019.

Company	Model	Description	Part/Serial Number	FCC ID
Nokia Solutions and Networks	AHFIB	AirScale BTS RRH	Part#: 474216A.101 Serial#: K9174553644	FCC ID: VBNAHFIB-01

Enclosure

The EUT enclosure is made of heavy-duty aluminum.

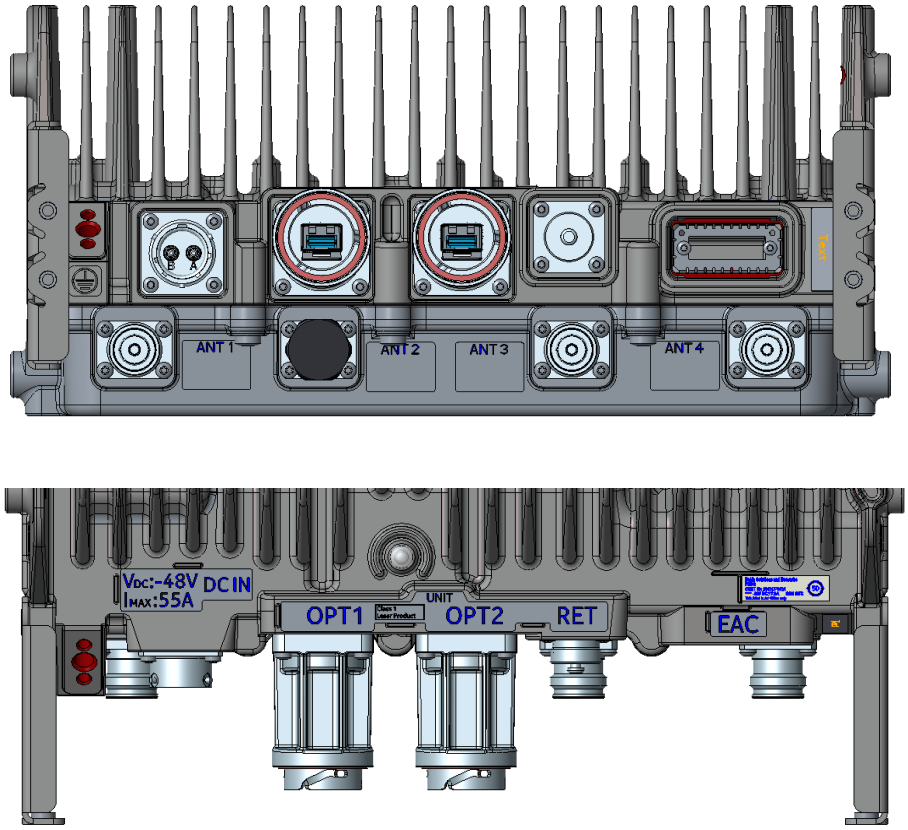
Support Equipment

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AMIA	Airscale System Module	Part#: 473098A.101 Serial#: RK164201509	N/A
HP	Pro Book 6470b	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	FR182418394
RLC Electronics	2.4GHz High Pass Filter -2 Watt	F-100-3000-5-R	0028
Microwave Circuits	1.4GHz Low Pass Filter -100 Watt	L13502G1	2454-01
Weinschel	Attenuator 20dB -150 Watt	66-20-33-LIM	BZ2075
Weinschel	Attenuator 20dB -150 Watt	66-20-33-LIM	BZ1165
Weinschel	Attenuator 3dB-100 Watt	47-3-33	CG5493
Huber & Suhner	RF Cable – 1 meter	Sucoflex 104	551426/4
Huber & Suhner	RF Cable -1 meter	Sucoflex 106	297371

AHFIB 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 laptop PC connects to the System Module over the LMP (Ethernet) port. The system module controls the RRH via the optical interface. The laptop 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: FRM59.01.R06
(2) System Module Software: 5GL1SW-loner_51.0.0.20190429-085726.tgz & FB_PS_REL_2018_12__022.zip

Modifications

No modifications were made to the EUT during testing.

TESTING

General Information

Antenna port measurements were taken at NTS Plano branch (by Christian Booker) located at 1701 E Plano Pkwy #150 Plano, TX 75074.

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 (NTS Test Report Number PR072254 Revision 1 dated March 16, 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 complementary cumulative distribution function (CCDF) measurements were performed with a signal analyzer. The EUT was operated at maximum RF output power for all tests (unless otherwise noted). While measuring one transmit chain, the other ones 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. Block diagrams and photographs of the test setups are provided below.

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 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.

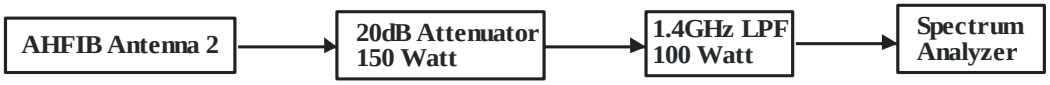
The emissions at the band edges were captured with Keysight Benchvue Software with settings described in the corresponding sections of the FCC and IC regulatory requirements. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Average output power measurements were performed in accordance with sections 5.4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 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.

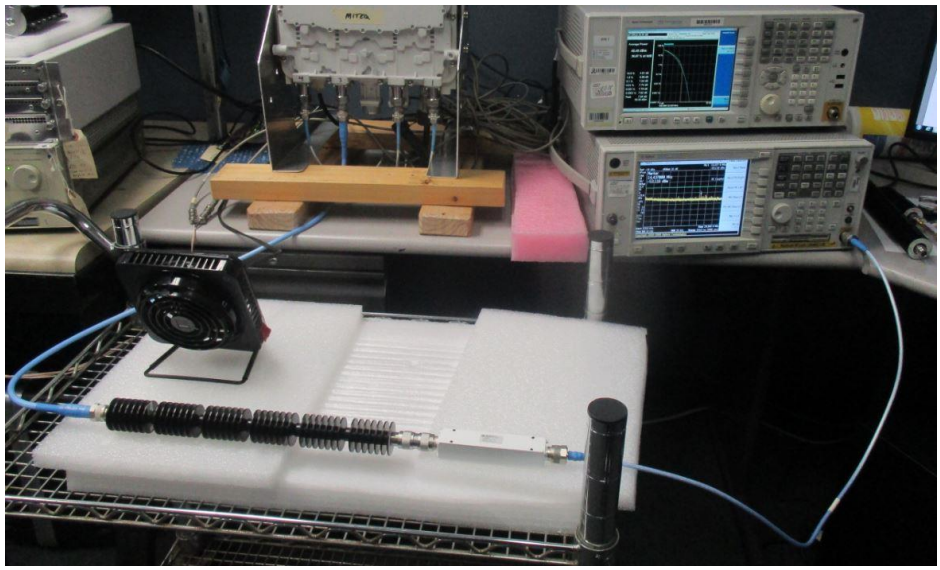
Conducted spurious emissions were captured with Keysight Benchvue Software across the 9 kHz-22GHz frequency span. A low pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges below 20MHz. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 6GHz. The total measurement RF path loss of the test setup (attenuators, filters 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 AHFIB RF conducted emissions testing. The photographs of the test setups are also provided.

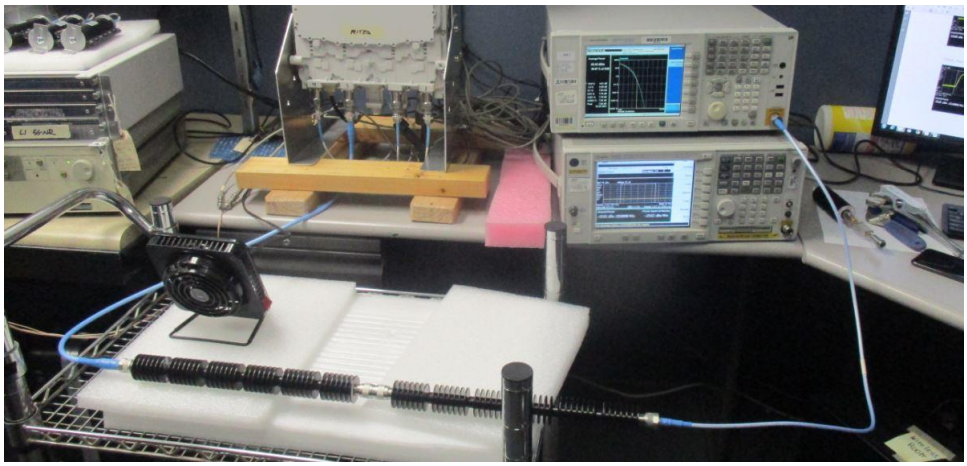


Setup for 9 kHz to 150 kHz and 150 kHz to 20MHz Measurements



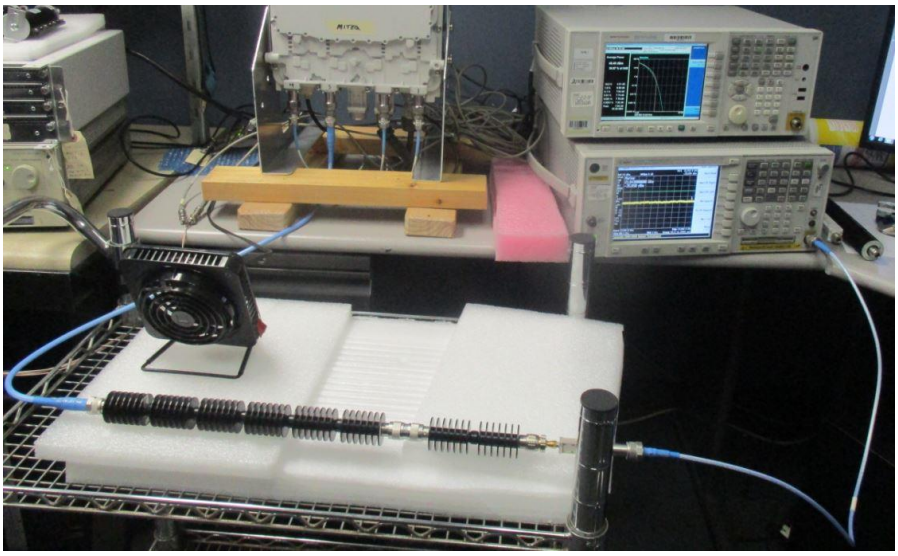
Photograph of 9 kHz to 150 kHz and 150 kHz to 20MHz Test Setup

Setup for 20MHz to 3GHz and 3GHz to 6GHz Measurements



Photograph of 20MHz to 3GHz and 3GHz to 6GHz Test Setup

Setup for 6GHz to 22GHz Measurements



Photograph of for 6GHz to 22GHz Test Setup

Test Measurement Equipment

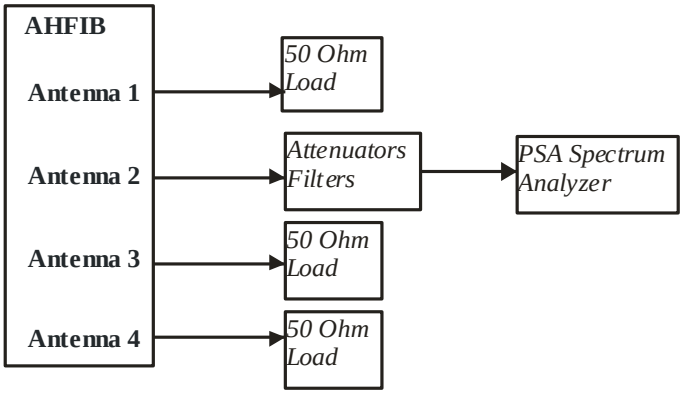
NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
WC021617	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	06/04/2020
WC021598	Signal Generator	HP	83732B	12 Months	08/09/2020
WC026985	Signal Generator	IFR	2025	12 Months	11/13/2019
WC066402	MXA Signal Analyzer	Agilent	N9020A	24 Months	08/05/2021

APPENDIX A: ANTENNA PORT 5G NR TEST DATA FOR PCS BAND

All conducted RF measurements in this section were made at AHFIB antenna ports. The testing was performed on the same hardware (EUT) as the original certification test. The antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in the original certification testing). All testing in this section was performed with 5G NR modulation types.

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.



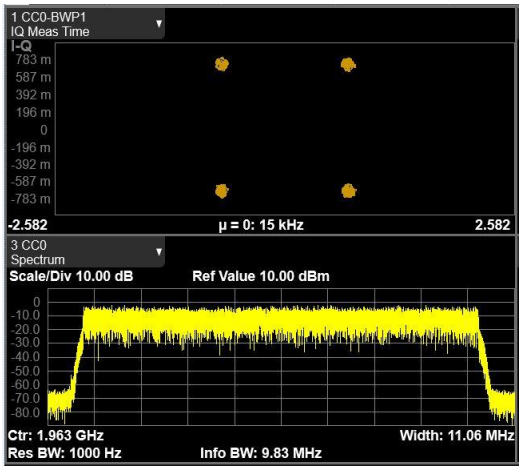
Test Setup Used for AHFIB Conducted RF Measurements

Modulation Characteristics of the 5G-NR Modulation Types

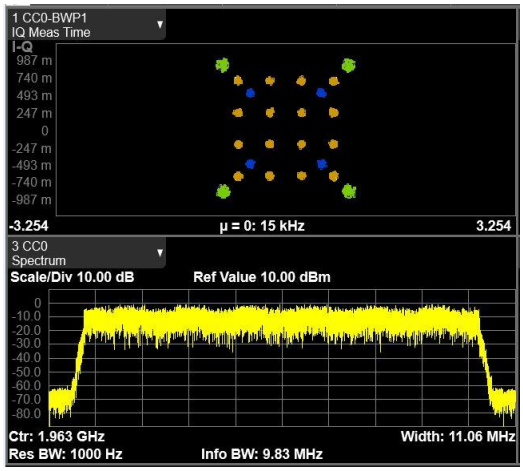
The 5G NR carriers/modulation types for this testing are based upon 3GPP TS 38.141-1 Test Models and are NR-FR1-TM 1.1 (QPSK modulation type), NR-FR1-TM 3.2 (16QAM modulation type), NR-FR1-TM 3.1 (64QAM modulation type), and NR-FR1-TM 3.1a (256QAM modulation type). The 5G NR test models for a 10MHz channel bandwidth at the Band n25 middle channel (1962.5MHz) were demodulated with a signal analyser at the AHFIB antenna ports. 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 PCS Band Middle Channel (1962.5MHz):

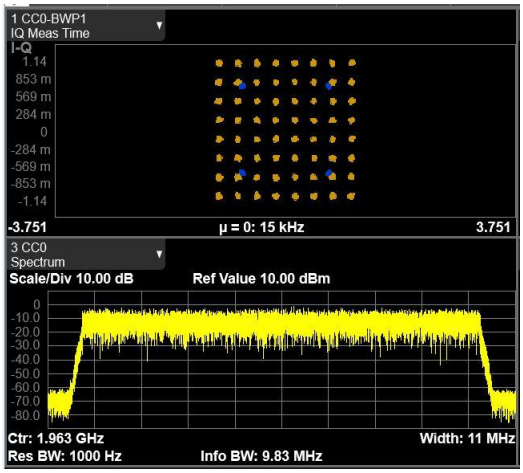
NR-FR1-TM 1.1 _QPSK modulation type



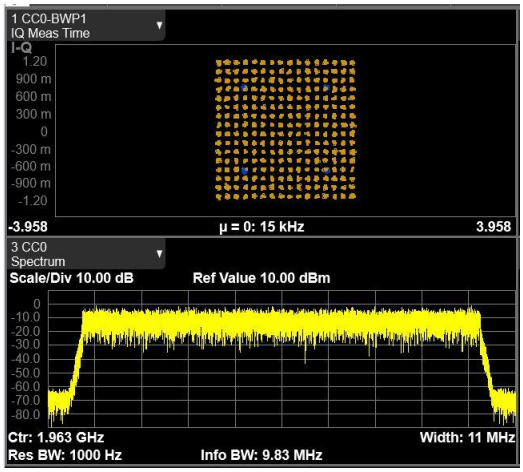
NR-FR1-TM 3.2 _16QAM modulation type



NR-FR1-TM 3.1 _64QAM modulation type



NR-FR1-TM 3.1a _256QAM modulation type



RF Output Power

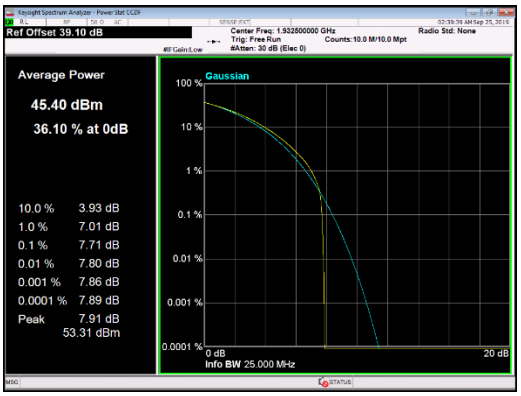
The AHFIB was operated at maximum RF output power. RF output power has been measured in RMS Average terms at the AHFIB Antenna Port transmit chain [5G NR Band n25 (1930 to 1995MHz)] at the bottom, middle and top frequency channels for all 5G NR modulation types (QPSK, 16QAM, 64QAM and 256QAM) and channel 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 39.1 dB and is accounted for by the spectrum analyzer reference level offset.

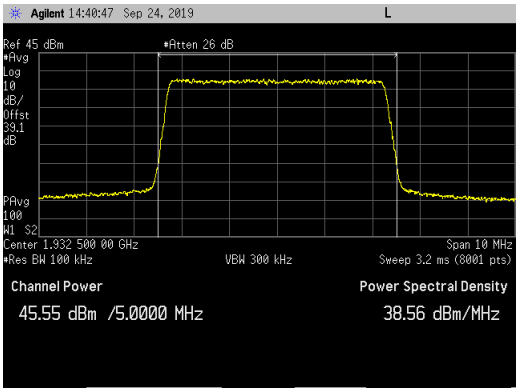
5G NR Channel BW	Modulation	Frequency _ Channel	PAPR (dB)	Ave (dBm)
5MHz	QPSK	1932.5MHz _ Bottom Channel	7.71	45.55
		1962.5MHz _ Middle Channel	7.69	45.58
		1992.5MHz _ Top Channel	7.69	45.66
	16QAM	1932.5MHz _ Bottom Channel	7.05	46.23
		1962.5MHz _ Middle Channel	7.03	46.32
		1992.5MHz _ Top Channel	7.04	46.40
	64QAM	1932.5MHz _ Bottom Channel	7.72	45.55
		1962.5MHz _ Middle Channel	7.67	45.66
		1992.5MHz _ Top Channel	7.67	45.65
	256QAM	1932.5MHz _ Bottom Channel	7.75	45.49
		1962.5MHz _ Middle Channel	7.72	45.54
		1992.5MHz _ Top Channel	7.72	45.57
10MHz	QPSK	1935.0MHz _ Bottom Channel	7.85	45.64
		1962.5MHz _ Middle Channel	7.77	45.66
		1990.0MHz _ Top Channel	7.76	45.81
	16QAM	1935.0MHz _ Bottom Channel	7.22	46.39
		1962.5MHz _ Middle Channel	7.03	46.44
		1990.0MHz _ Top Channel	7.08	**46.54**
	64QAM	1935.0MHz _ Bottom Channel	7.88	45.60
		1962.5MHz _ Middle Channel	7.77	45.61
		1990.0MHz _ Top Channel	7.81	45.74
	256QAM	1935.0MHz _ Bottom Channel	7.88	45.65
		1962.5MHz _ Middle Channel	7.80	45.55
		1990.0MHz _ Top Channel	7.81	45.74
15MHz	QPSK	1937.5MHz _ Bottom Channel	7.89	45.46
		1962.5MHz _ Middle Channel	7.72	45.55
		1987.5MHz _ Top Channel	7.76	45.43
	16QAM	1937.5MHz _ Bottom Channel	7.29	46.24
		1962.5MHz _ Middle Channel	7.02	46.29
		1987.5MHz _ Top Channel	7.07	46.32
	64QAM	1937.5MHz _ Bottom Channel	**7.91**	45.56
		1962.5MHz _ Middle Channel	7.72	45.54
		1987.5MHz _ Top Channel	7.77	45.62
	256QAM	1937.5MHz _ Bottom Channel	7.88	45.47
		1962.5MHz _ Middle Channel	7.74	45.48
		1987.5MHz _ Top Channel	7.77	45.73
20MHz	QPSK	1940.0MHz _ Bottom Channel	7.87	45.51
		1962.5MHz _ Middle Channel	7.63	45.51
		1985.0MHz _ Top Channel	7.73	45.80
	16QAM	1940.0MHz _ Bottom Channel	7.38	46.13
		1962.5MHz _ Middle Channel	7.00	46.29
		1985.0MHz _ Top Channel	7.12	46.48
	64QAM	1940.0MHz _ Bottom Channel	7.85	45.50
		1962.5MHz _ Middle Channel	7.66	45.48
		1985.0MHz _ Top Channel	7.68	45.59
	256QAM	1940.0MHz _ Bottom Channel	7.90	45.72
		1962.5MHz _ Middle Channel	7.64	45.58
		1985.0MHz _ Top Channel	7.71	45.61

5G NR 5MHz Channel Power Plots for the QPSK Modulation Type for Antenna Port 3:

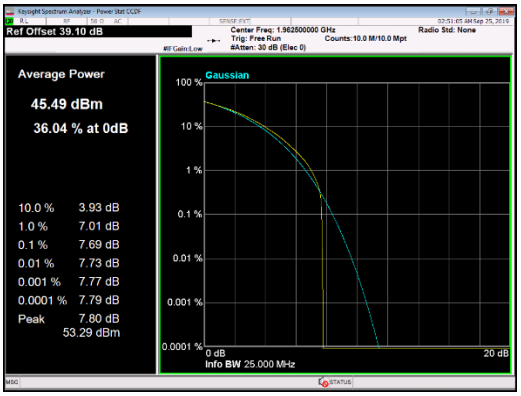
Bottom Channel_ CCDF



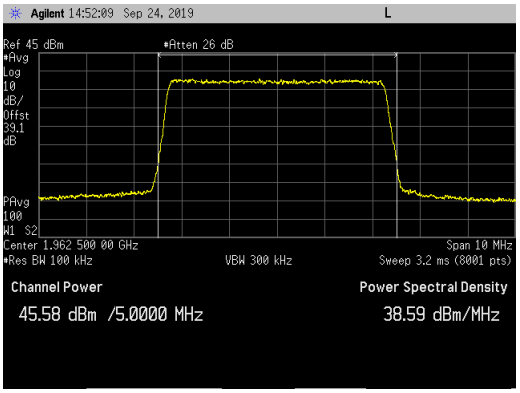
Bottom Channel_ Average



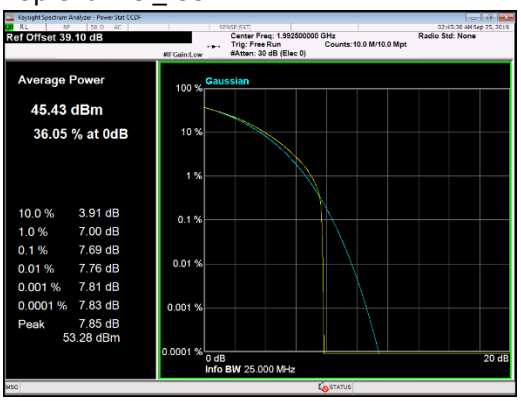
Middle Channel_ CCDF



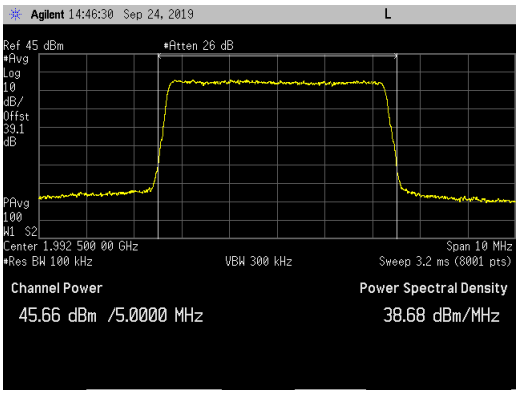
Middle Channel_ Average



Top Channel_ CCDF

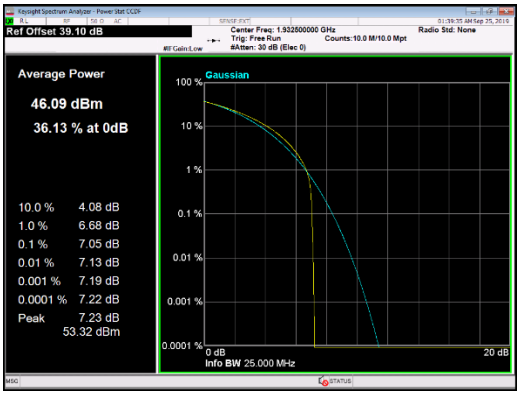


Top Channel_ Average

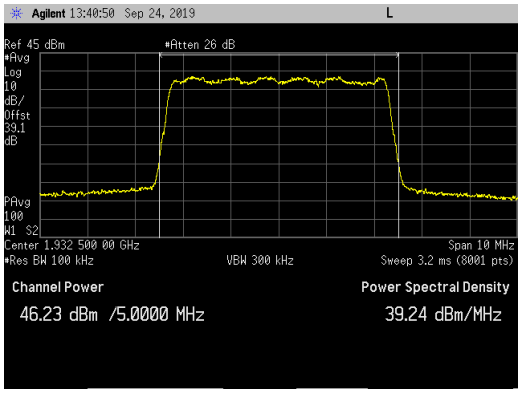


5G NR 5MHz Channel Power Plots for the 16QAM Modulation Type for Antenna Port 3:

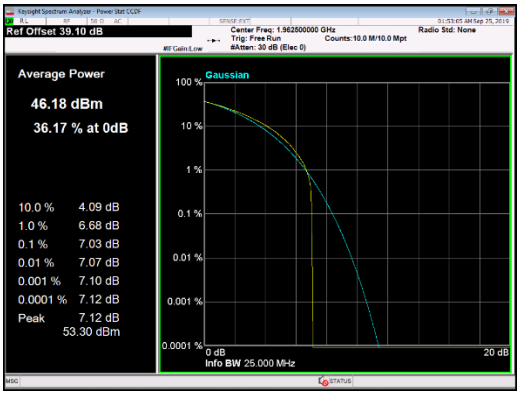
Bottom Channel_ CCDF



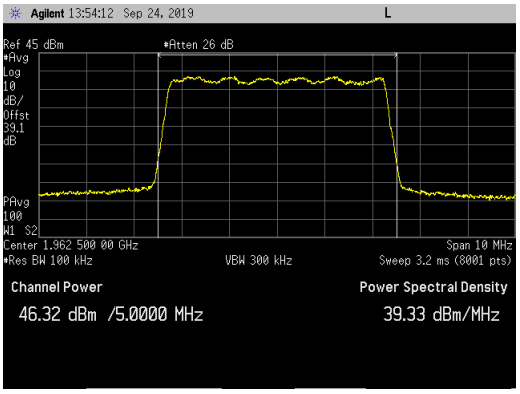
Bottom Channel_ Average



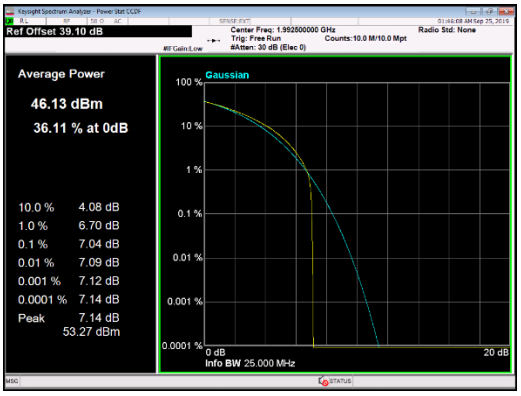
Middle Channel_ CCDF



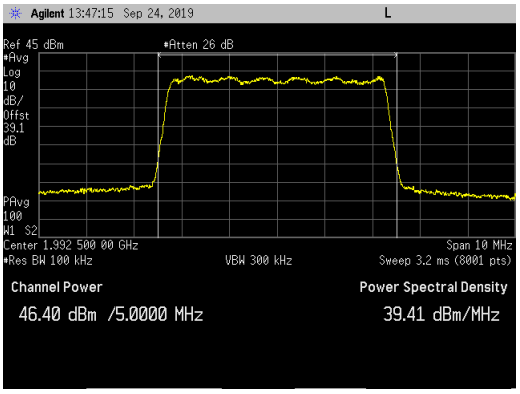
Middle Channel_ Average



Top Channel_ CCDF

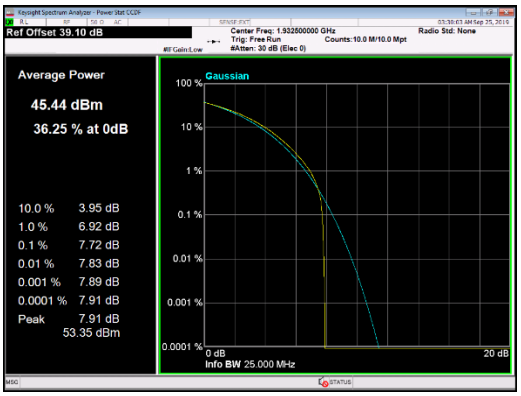


Top Channel_ Average

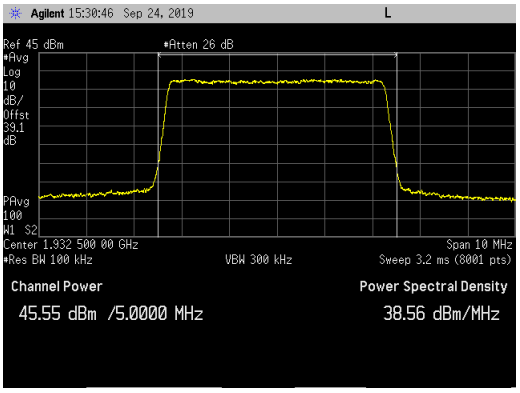


5G NR 5MHz Channel Power Plots for the 64QAM Modulation Type for Antenna Port 3:

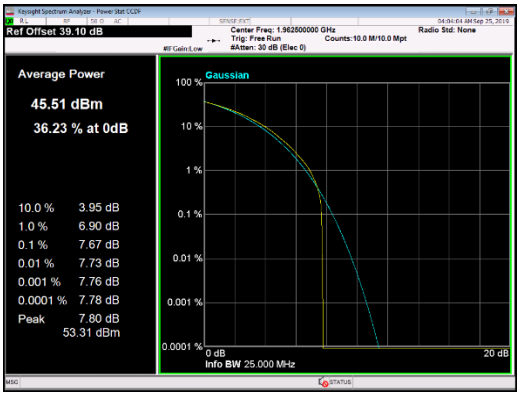
Bottom Channel_ CCDF



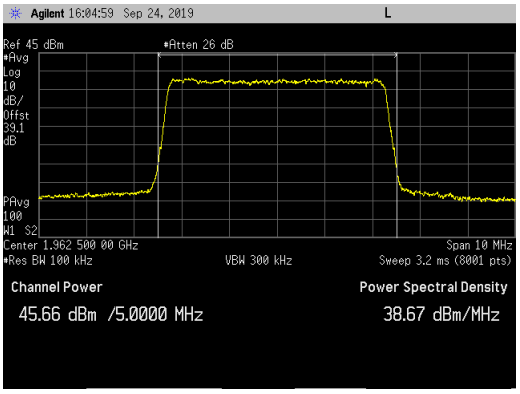
Bottom Channel_ Average



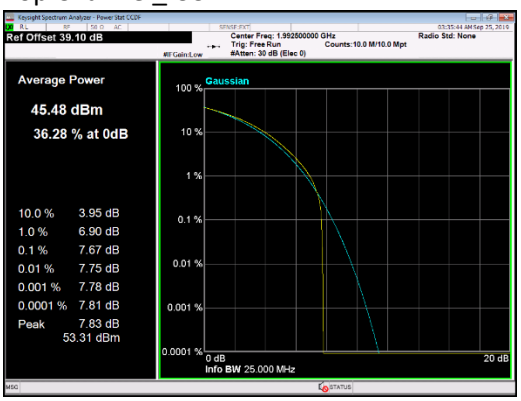
Middle Channel_ CCDF



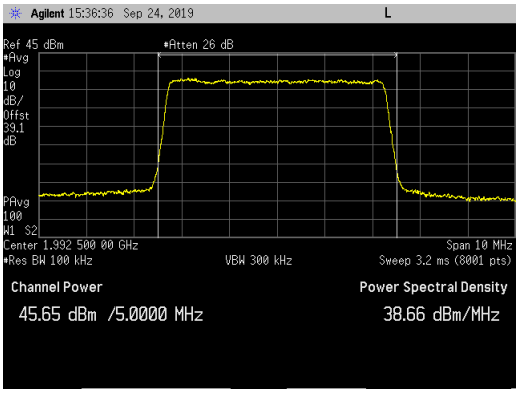
Middle Channel_ Average



Top Channel_ CCDF

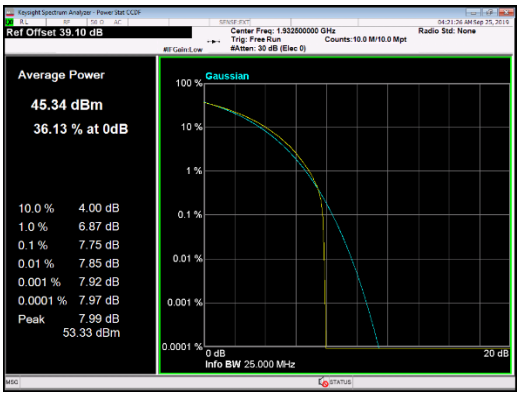


Top Channel_ Average

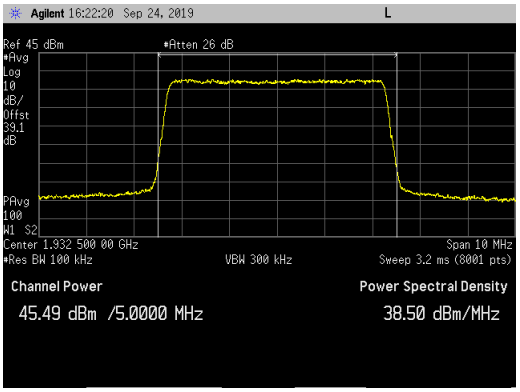


5G NR 5MHz Channel Power Plots for the 256QAM Modulation Type for Antenna Port 3:

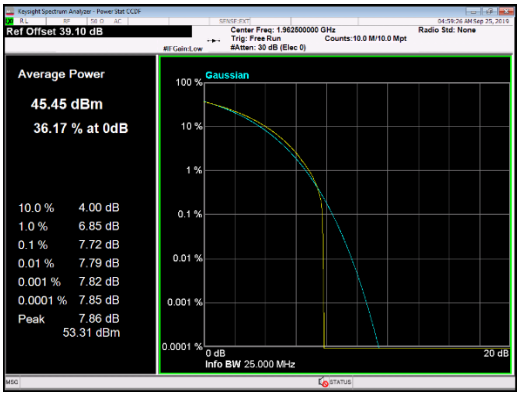
Bottom Channel_ CCDF



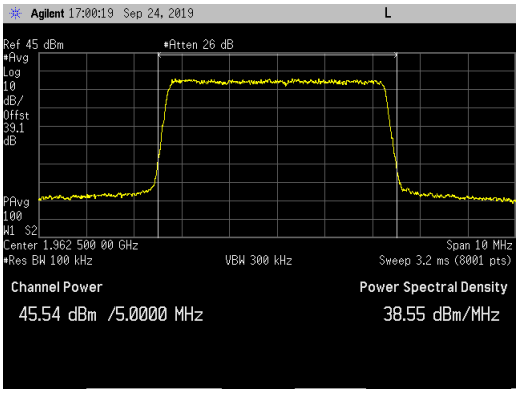
Bottom Channel_ Average



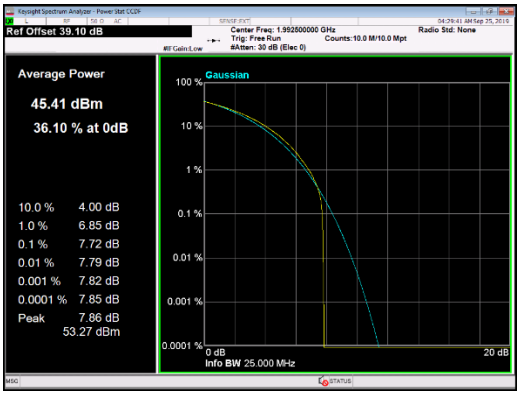
Middle Channel_ CCDF



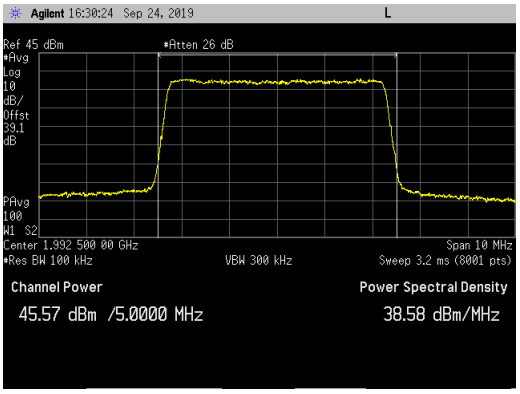
Middle Channel_ Average



Top Channel_ CCDF

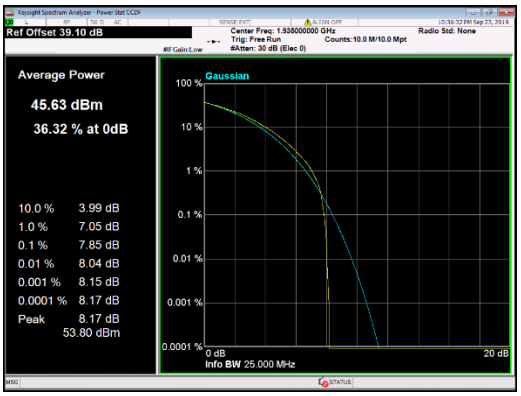


Top Channel_ Average

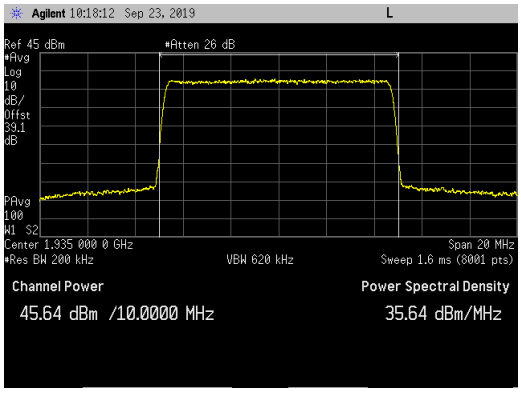


5G NR 10MHz Channel Power Plots for the QPSK Modulation Type for Antenna Port 2:

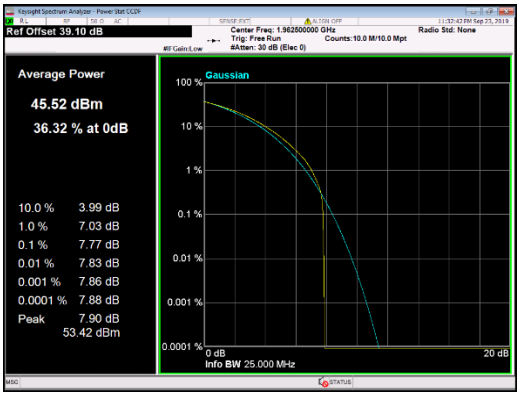
Bottom Channel_ CCDF



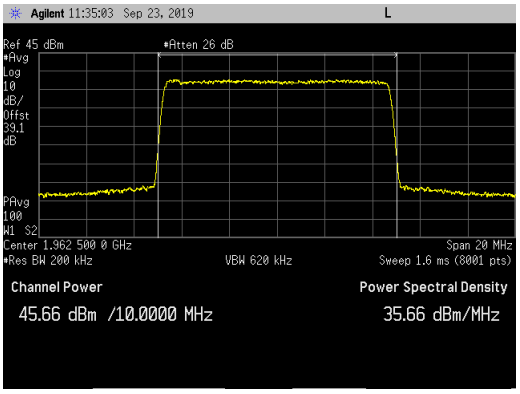
Bottom Channel_ Average



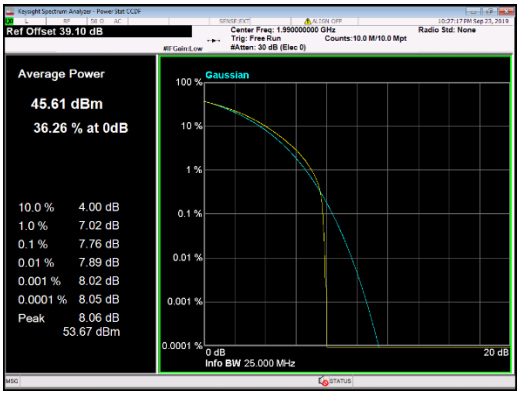
Middle Channel_ CCDF



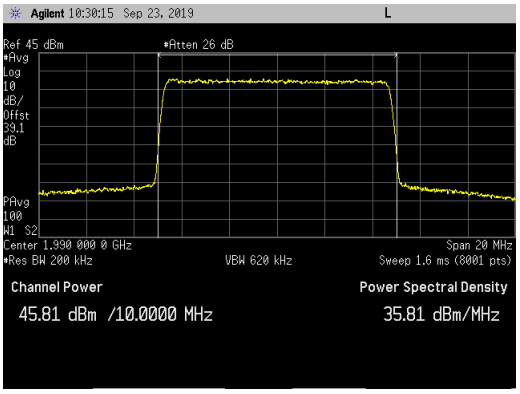
Middle Channel_ Average



Top Channel_ CCDF

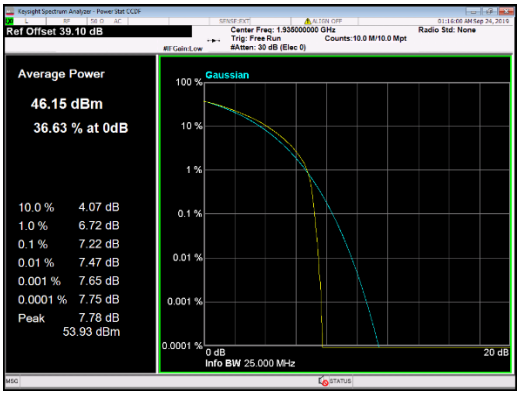


Top Channel_ Average

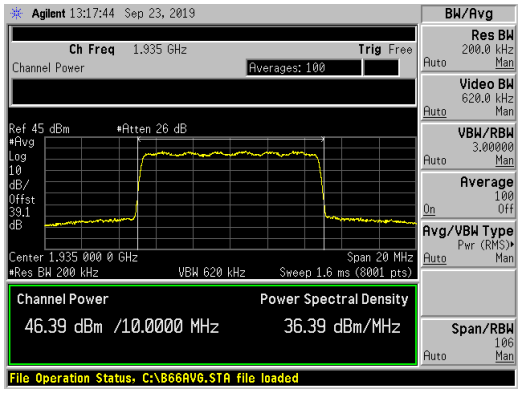


5G NR 10MHz Channel Power Plots for the 16QAM Modulation Type for Antenna Port 2:

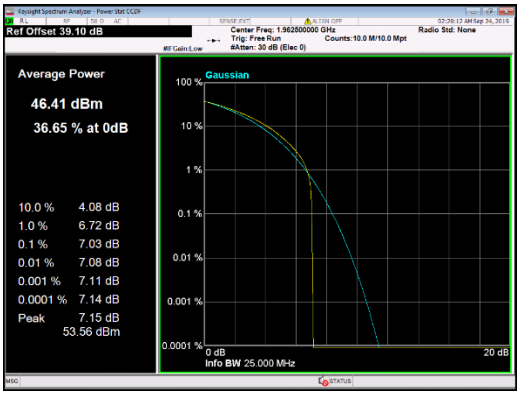
Bottom Channel_ CCDF



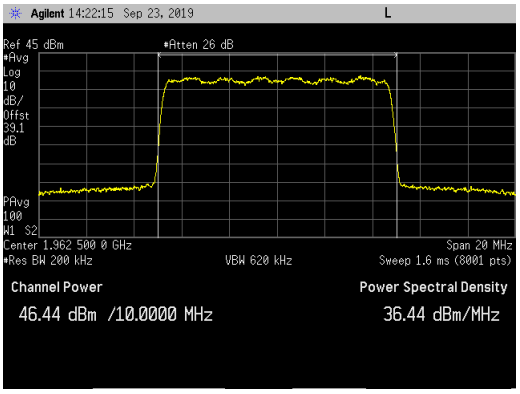
Bottom Channel_ Average



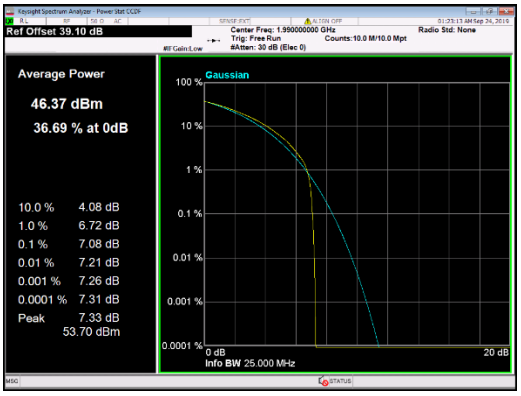
Middle Channel_ CCDF



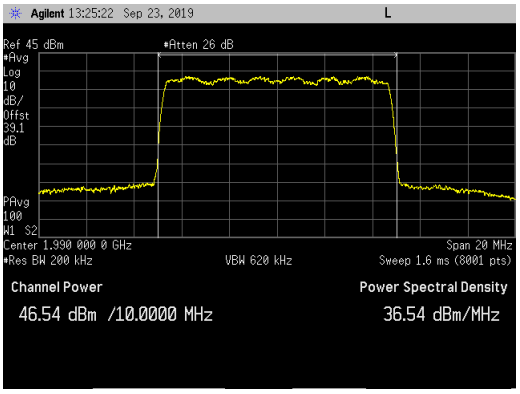
Middle Channel_ Average



Top Channel_ CCDF

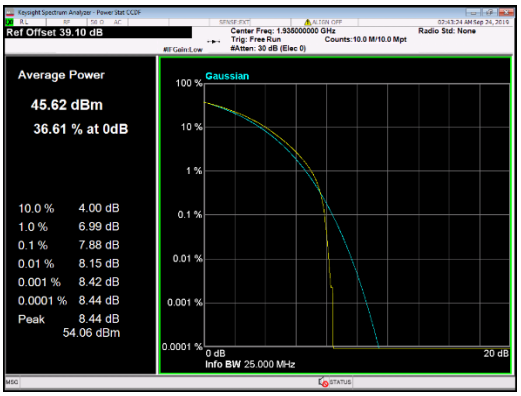


Top Channel_ Average

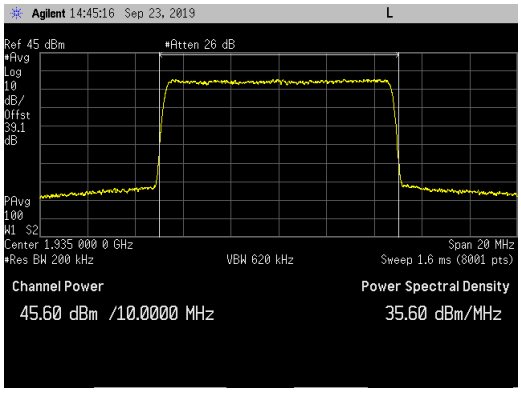


5G NR 10MHz Channel Power Plots for the 64QAM Modulation Type for Antenna Port 2:

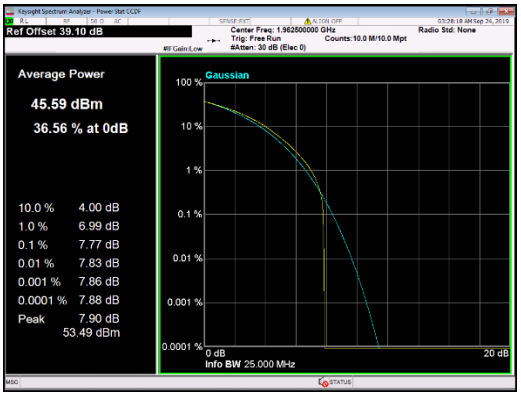
Bottom Channel_ CCDF



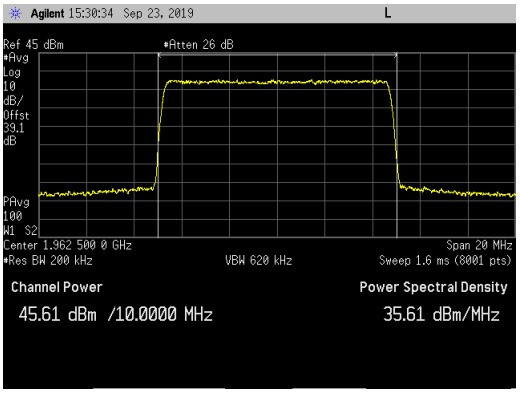
Bottom Channel_ Average



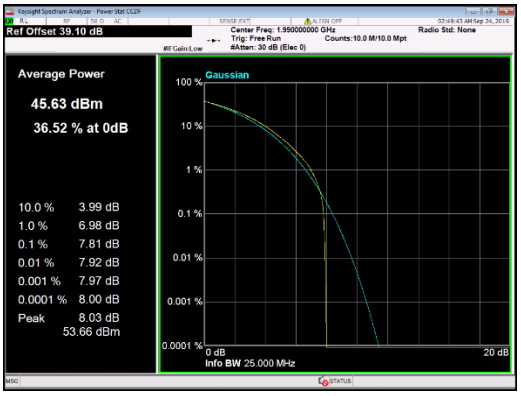
Middle Channel_ CCDF



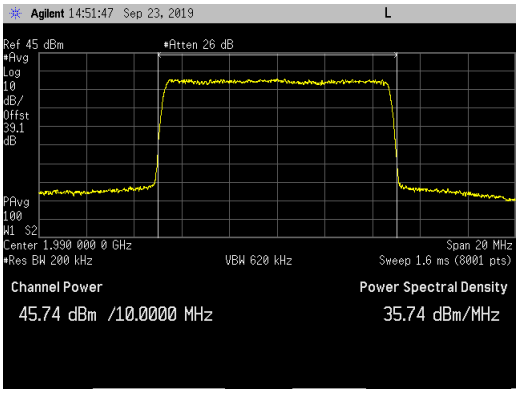
Middle Channel_ Average



Top Channel_ CCDF

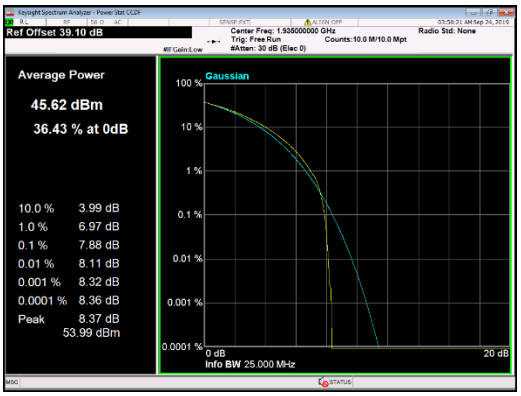


Top Channel_ Average

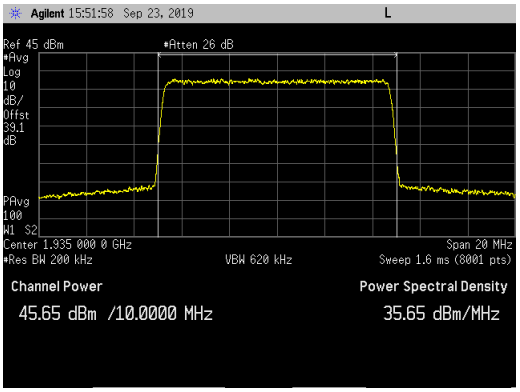


5G NR 10MHz Channel Power Plots for the 256QAM Modulation Type for Antenna Port 2:

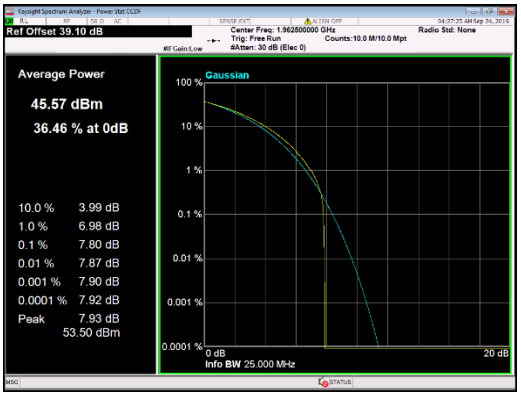
Bottom Channel_ CCDF



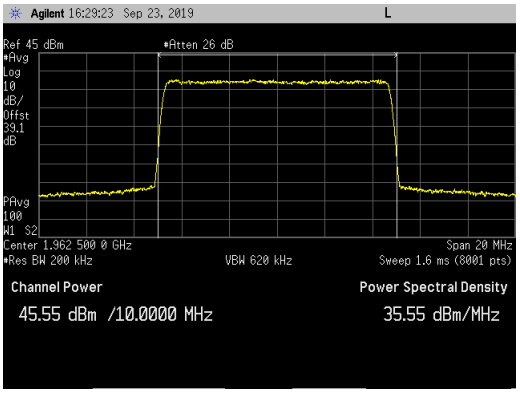
Bottom Channel_ Average



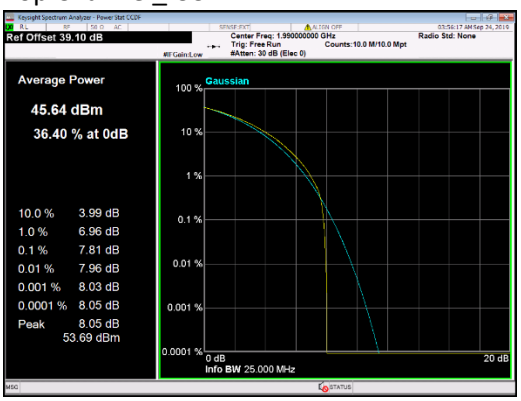
Middle Channel_ CCDF



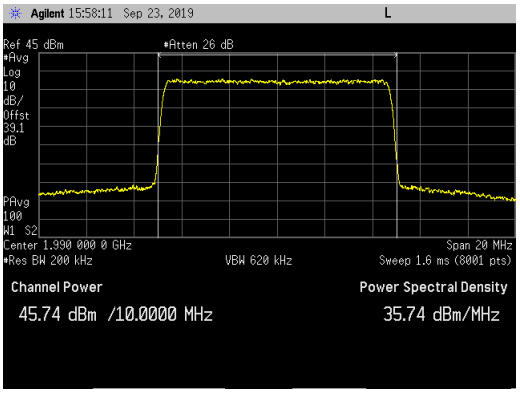
Middle Channel_ Average



Top Channel_ CCDF

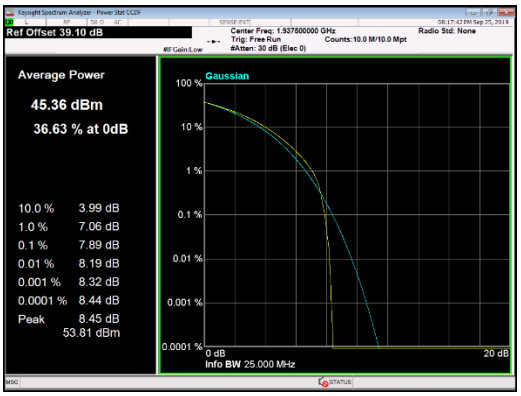


Top Channel_ Average

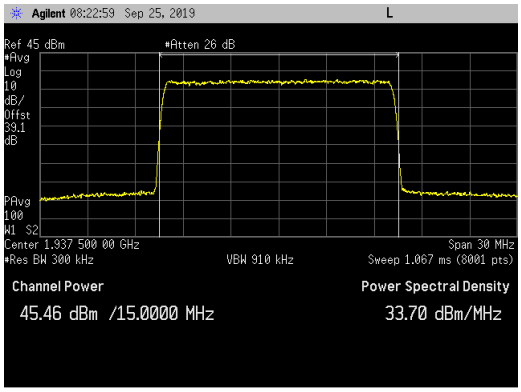


5G NR 15MHz Channel Power Plots for the QPSK Modulation Type for Antenna Port 3:

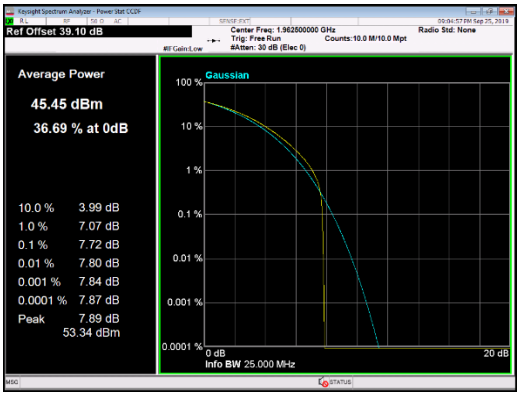
Bottom Channel_ CCDF



Bottom Channel_ Average



Middle Channel_ CCDF



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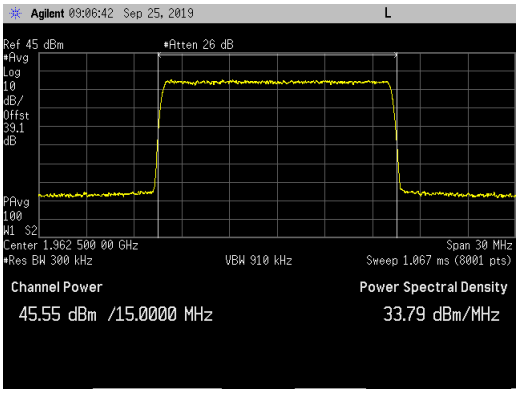
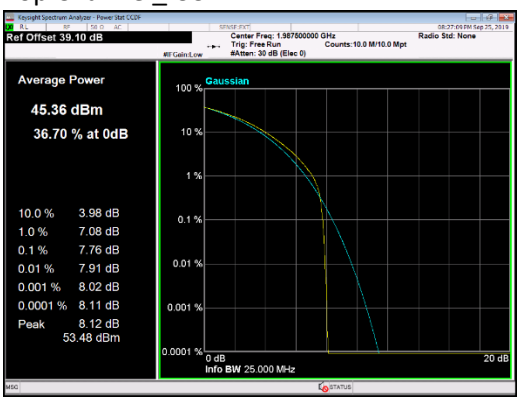
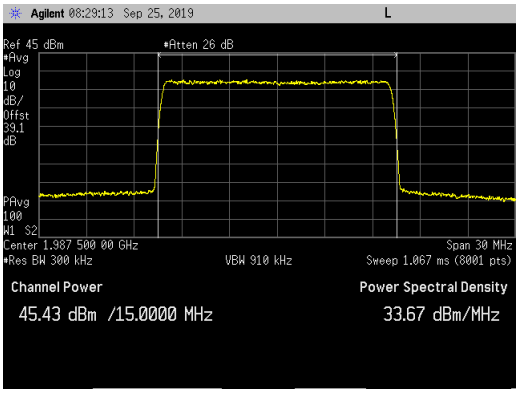


Top Channel_ CCDF

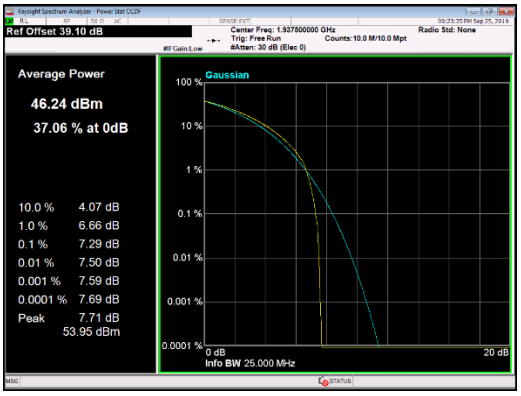


Top Channel_ Average

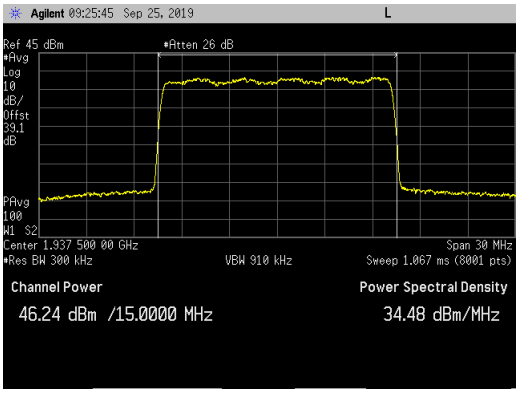


5G NR 15MHz Channel Power Plots for the 16QAM Modulation Type for Antenna Port 3:

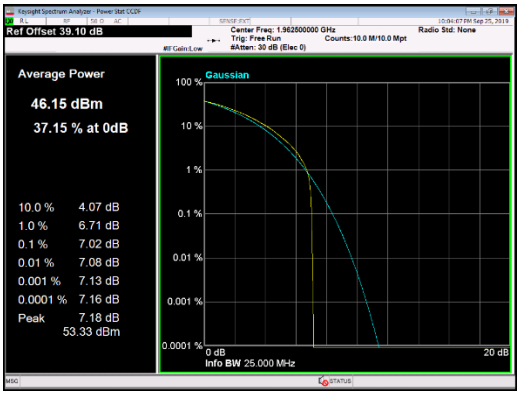
Bottom Channel_ CCDF



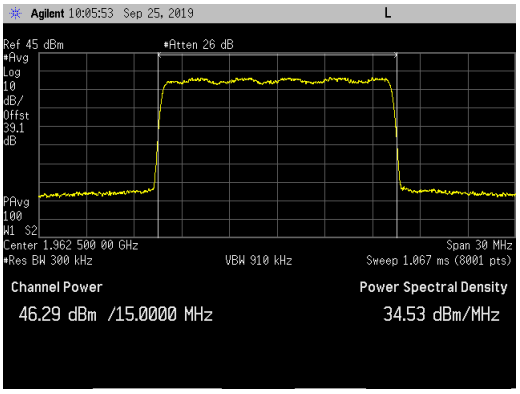
Bottom Channel_ Average



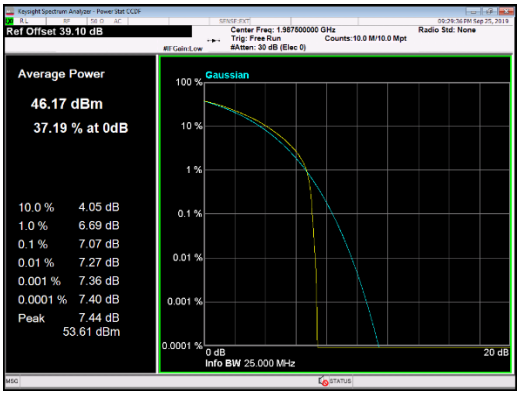
Middle Channel_ CCDF



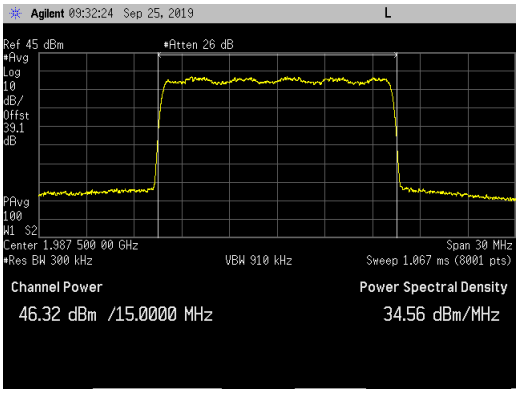
Middle Channel_ Average



Top Channel_ CCDF

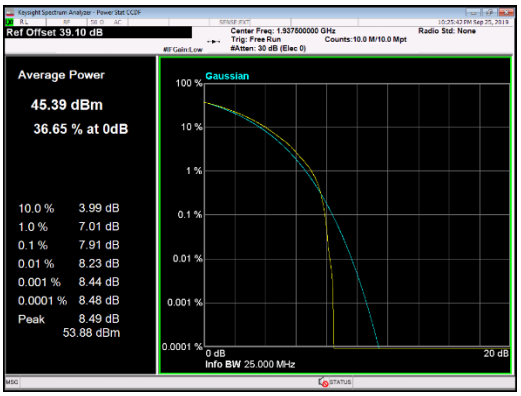


Top Channel_ Average

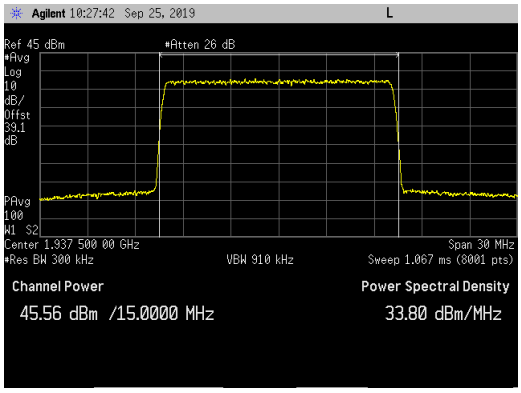


5G NR 15MHz Channel Power Plots for the 64QAM Modulation Type for Antenna Port 3:

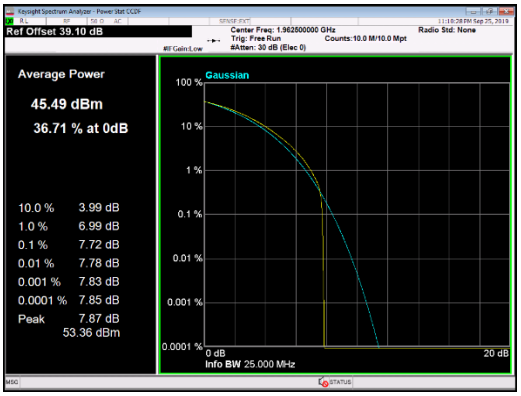
Bottom Channel_ CCDF



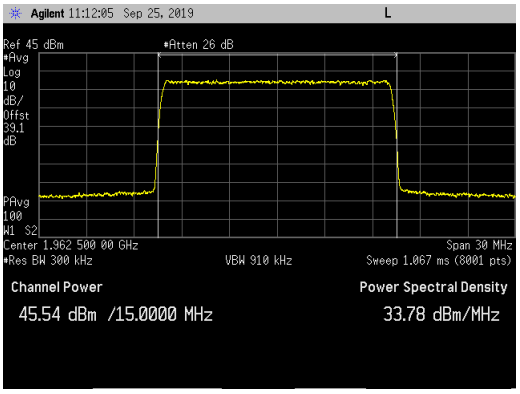
Bottom Channel_ Average



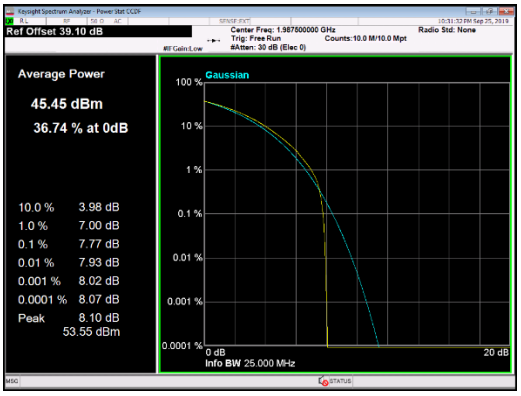
Middle Channel_ CCDF



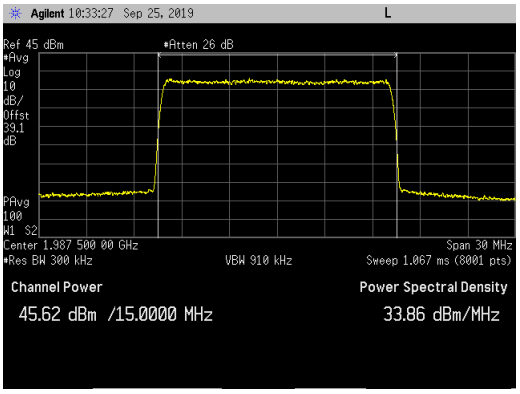
Middle Channel_ Average



Top Channel_ CCDF

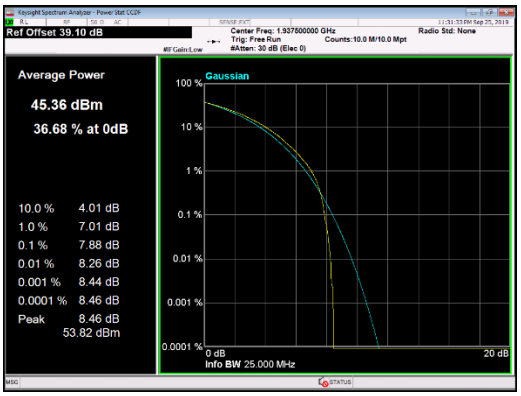


Top Channel_ Average

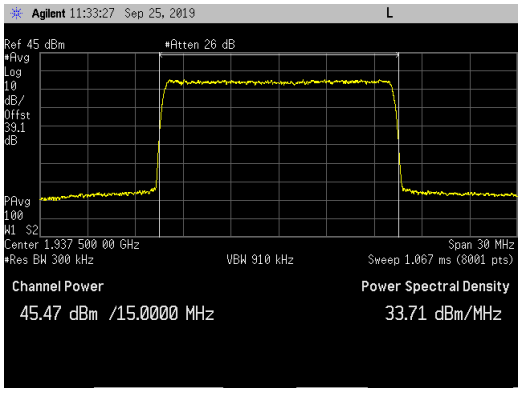


5G NR 15MHz Channel Power Plots for the 256QAM Modulation Type for Antenna Port 3:

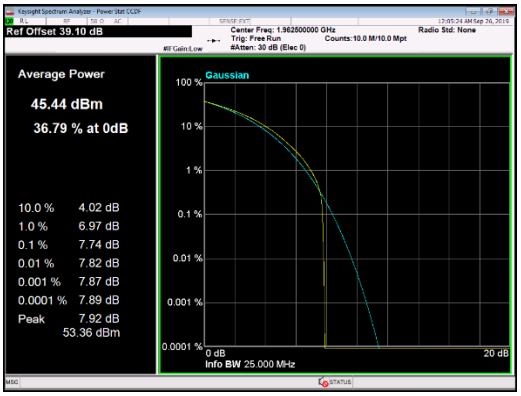
Bottom Channel_ CCDF



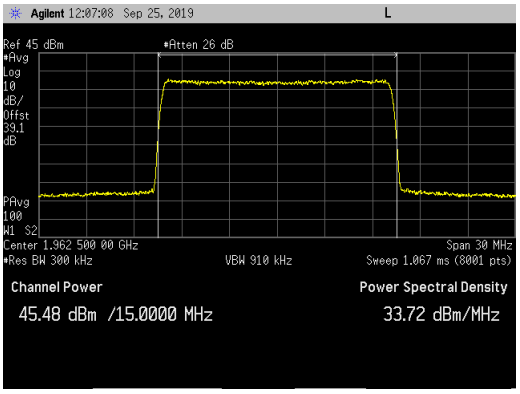
Bottom Channel_ Average



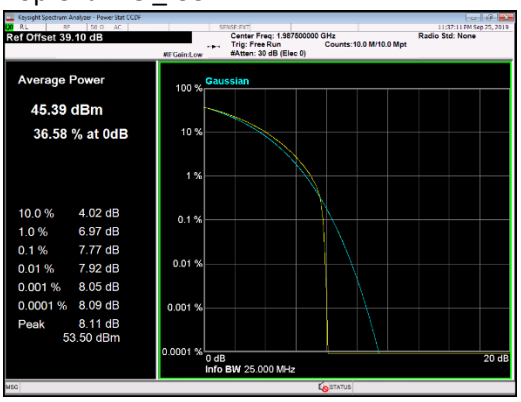
Middle Channel_ CCDF



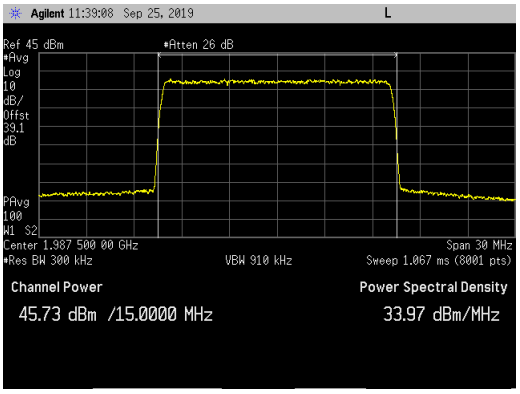
Middle Channel_ Average



Top Channel_ CCDF

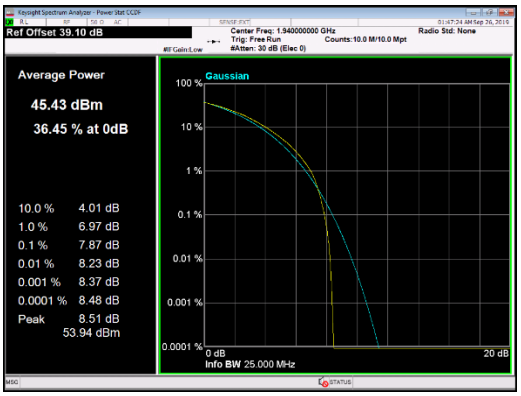


Top Channel_ Average

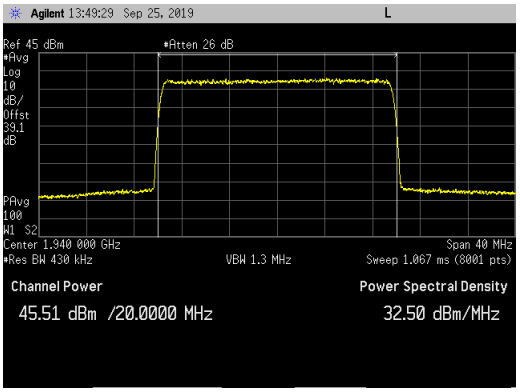


5G NR 20MHz Channel Power Plots for the QPSK Modulation Type for Antenna Port 3:

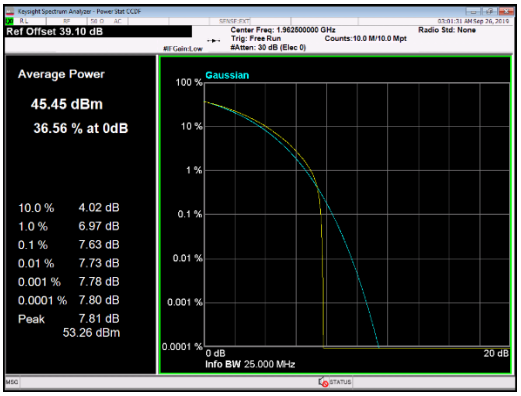
Bottom Channel_ CCDF



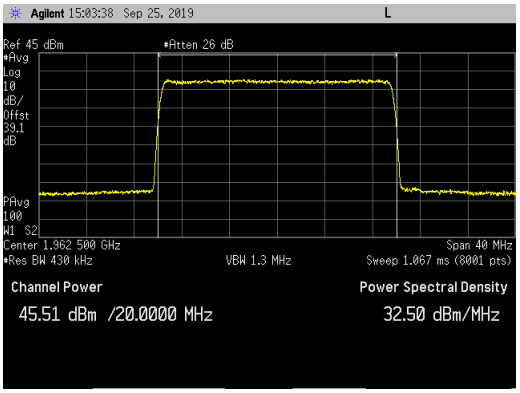
Bottom Channel_ Average



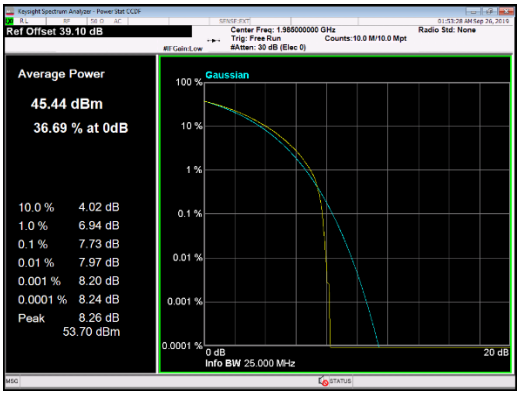
Middle Channel_ CCDF



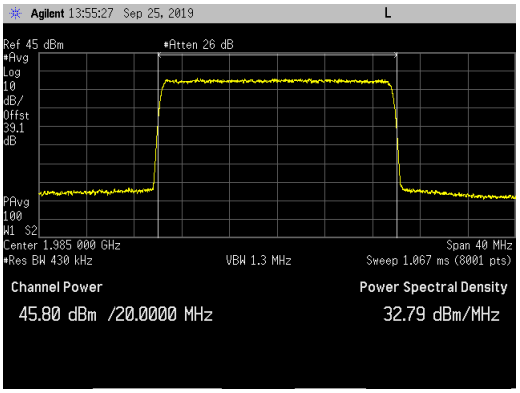
Middle Channel_ Average



Top Channel_ CCDF

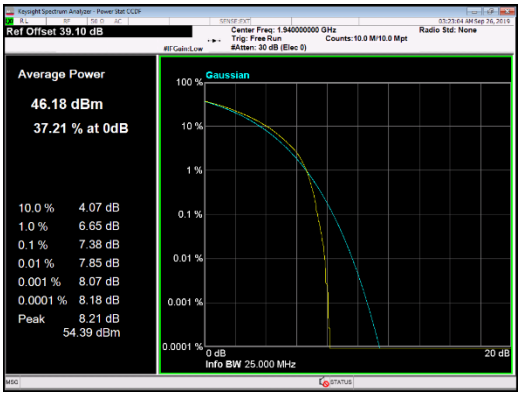


Top Channel_ Average

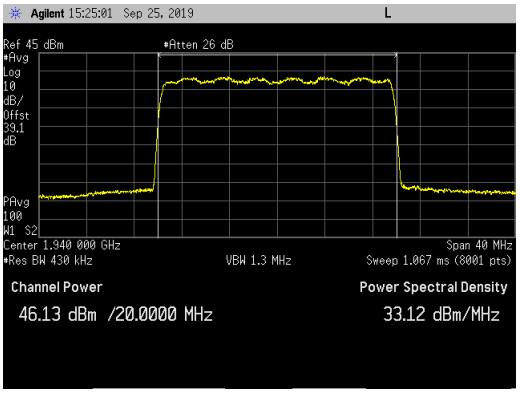


5G NR 20MHz Channel Power Plots for the 16QAM Modulation Type for Antenna Port 3:

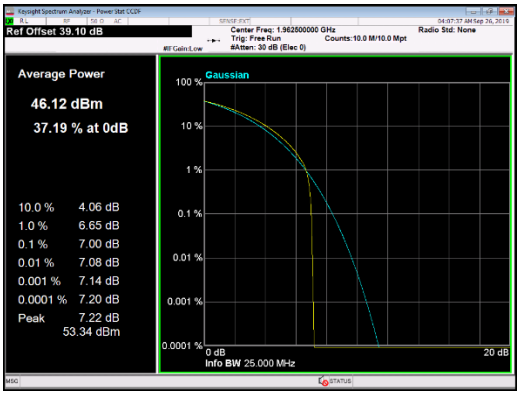
Bottom Channel_ CCDF



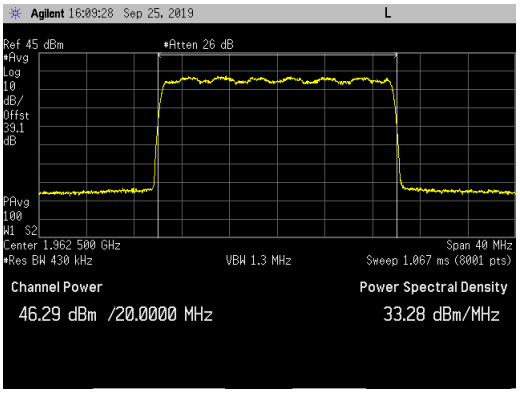
Bottom Channel_ Average



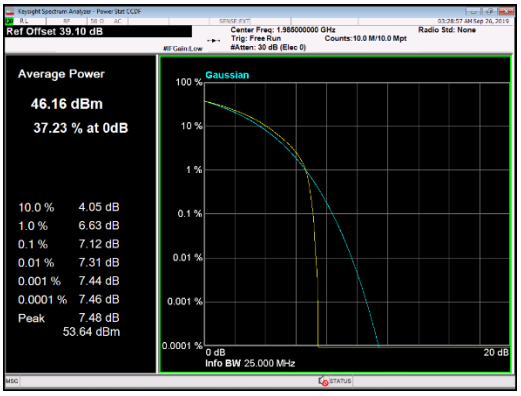
Middle Channel_ CCDF



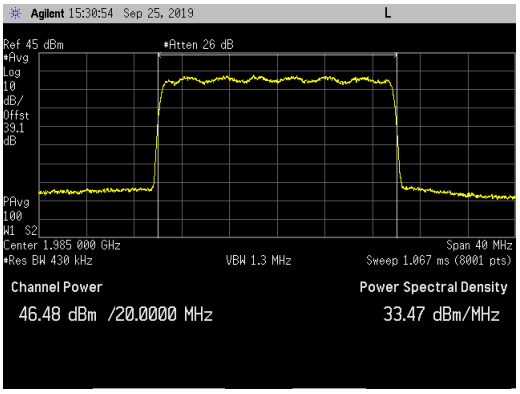
Middle Channel_ Average



Top Channel_ CCDF

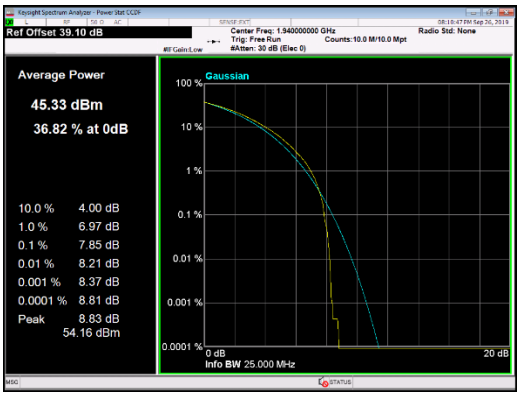


Top Channel_ Average

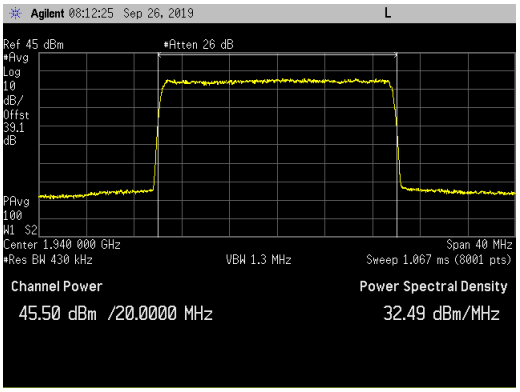


5G NR 20MHz Channel Power Plots for the 64QAM Modulation Type for Antenna Port 3:

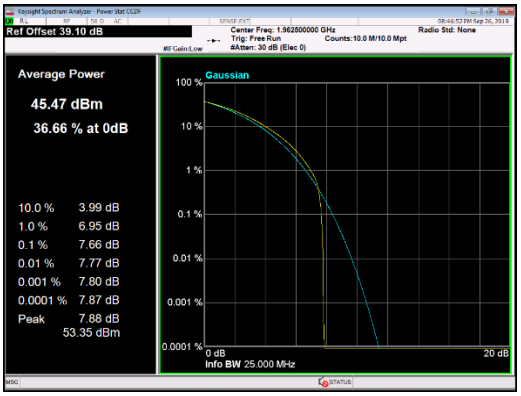
Bottom Channel_ CCDF



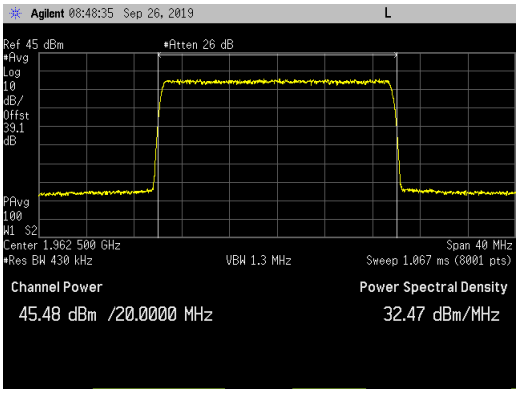
Bottom Channel_ Average



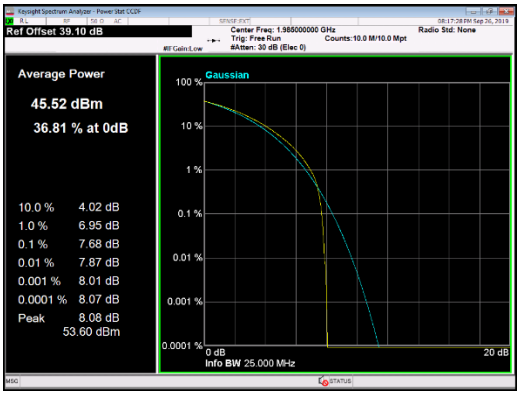
Middle Channel_ CCDF



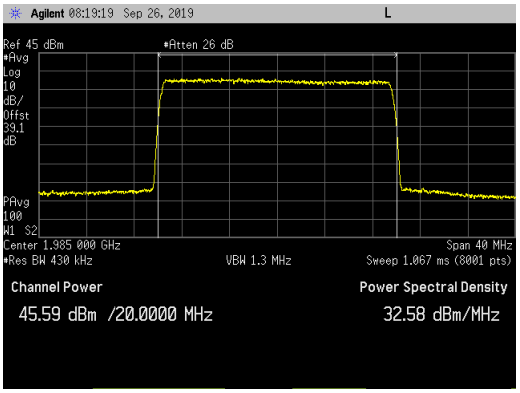
Middle Channel_ Average



Top Channel_ CCDF

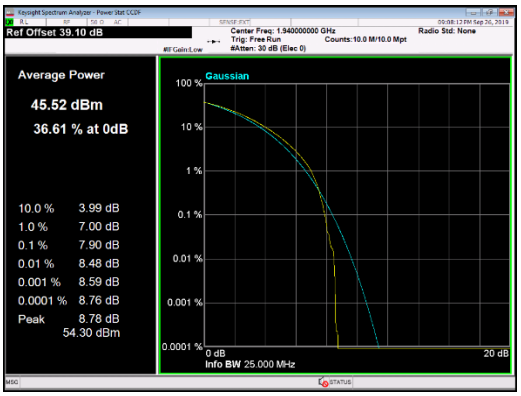


Top Channel_ Average

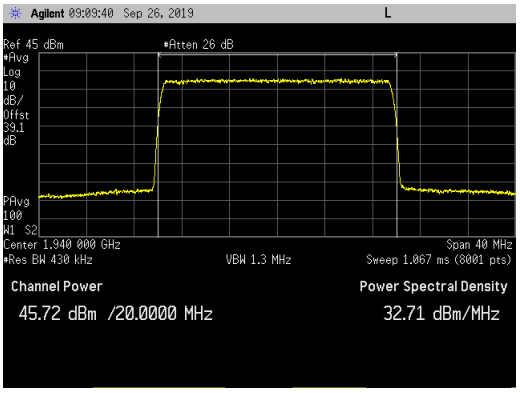


5G NR 20MHz Channel Power Plots for the 256QAM Modulation Type for Antenna Port 3:

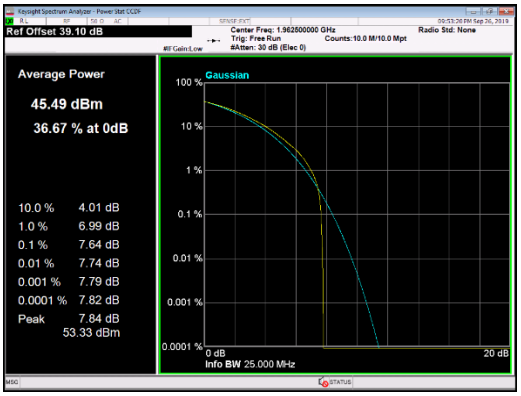
Bottom Channel_ CCDF



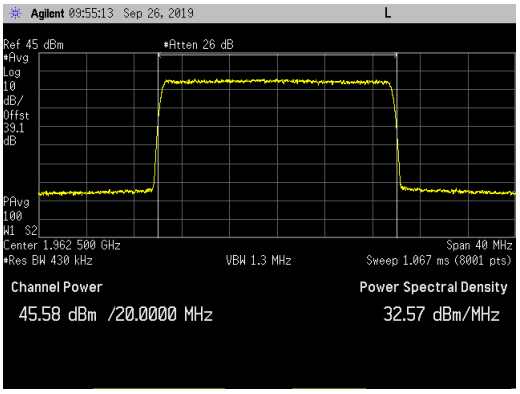
Bottom Channel_ Average



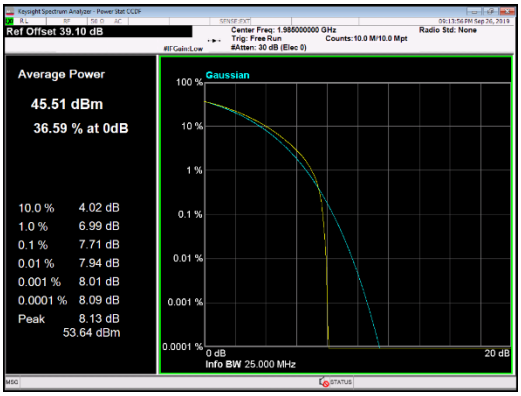
Middle Channel_ CCDF



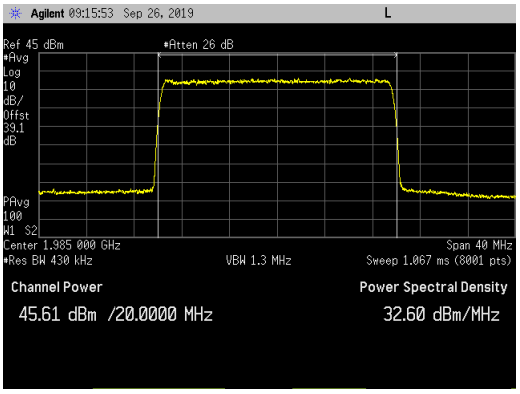
Middle Channel_ Average



Top Channel_ CCDF



Top Channel_ Average



Emission Bandwidth (26 dB down and 99%)

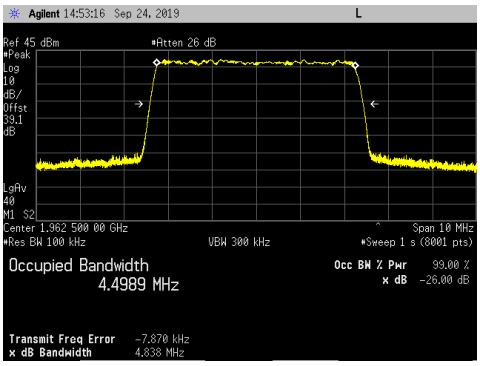
Emission bandwidth measurements were made at antenna port 2/3 on the middle channel with maximum RF output power. All available 5G NR modulations (QPSK, 16QAM, 64QAM, 256QAM) were used. All available 5G NR channel bandwidths (5MHz, 10MHz, 15MHz and 20MHz) were used. The results are provided in the following 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	**4.838**	**4.4989**	4.825	4.4827	4.821	4.4960	4.834	4.4977
10 MHz	9.878	9.3070	9.880	9.2580	**9.884**	**9.3147**	9.879	9.2877
15 MHz	**14.933**	14.1115	14.923	14.1006	14.882	14.1185	14.907	**14.1360**
20 MHz	19.998	18.9074	**20.019**	18.9473	19.981	**18.9556**	20.012	18.9361

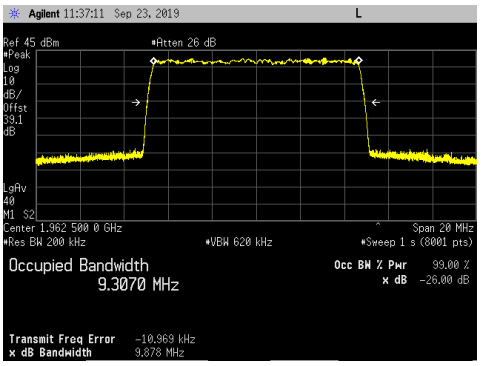
Emission bandwidth measurement data are provided in the following pages.

5G NR_ 5 and 10MHz Ch BW Emission Bandwidth Plots on the Middle Channel:

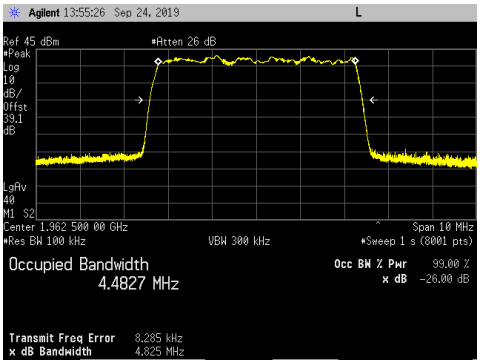
5G NR_ 5MHz_ QPSK_ Ant 3



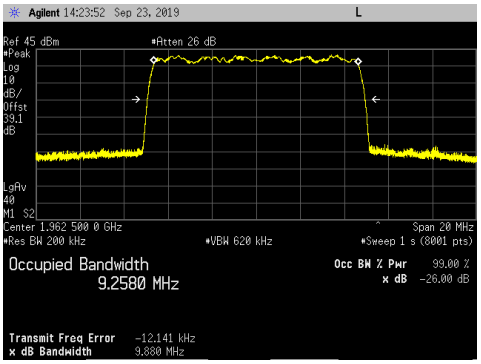
5G NR_ 10MHz_ QPSK_ Ant 2



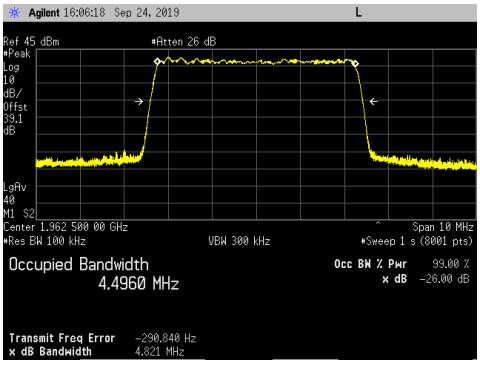
5G NR_ 5MHz_ 16QAM_ Ant 3



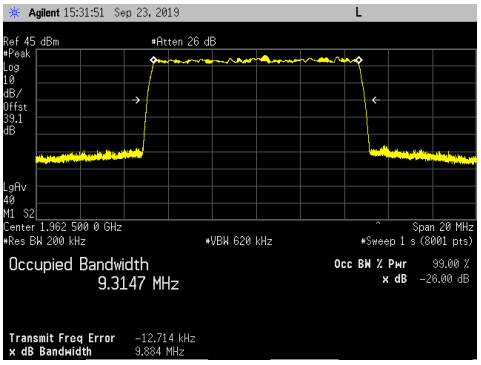
5G NR_ 10MHz_ 16QAM_ Ant 2



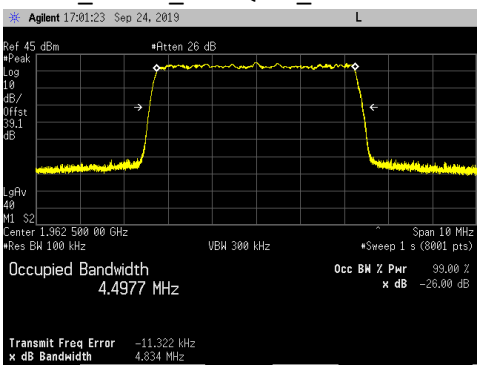
5G NR_ 5MHz_ 64QAM_ Ant 3



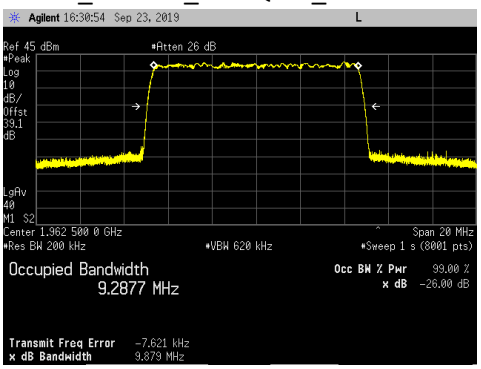
5G NR_ 10MHz_ 64QAM_ Ant 2



5G NR_ 5MHz_ 256QAM_ Ant 3

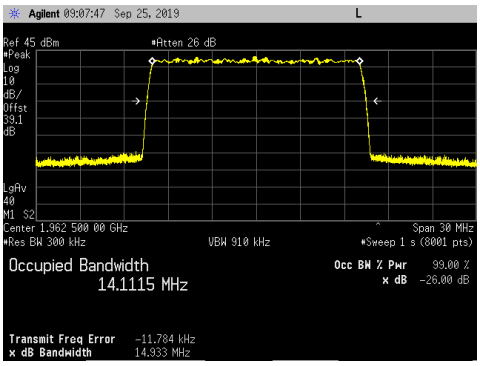


5G NR_ 10MHz_ 256QAM_ Ant 2

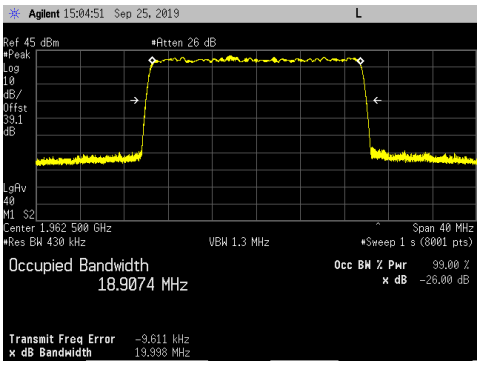


5G NR_ 15 and 20MHz Ch BW Emission Bandwidth Plots on the Middle Channel for Antenna Port 3:

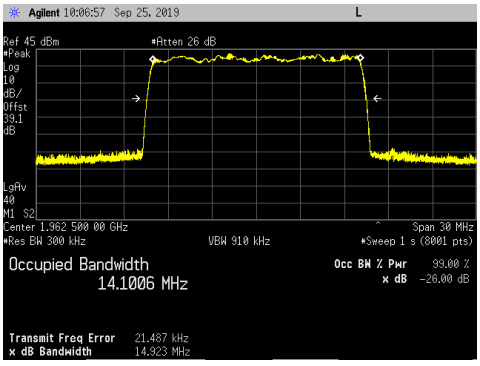
5G NR_ 15MHz_ QPSK



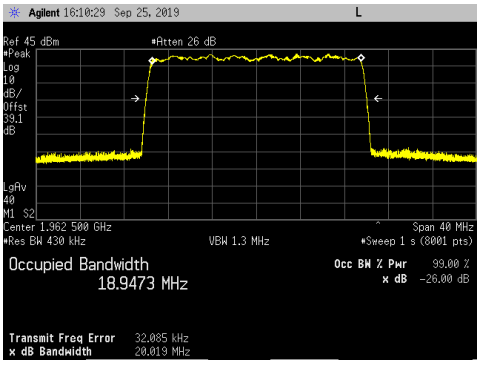
5G NR_ 20MHz_ QPSK



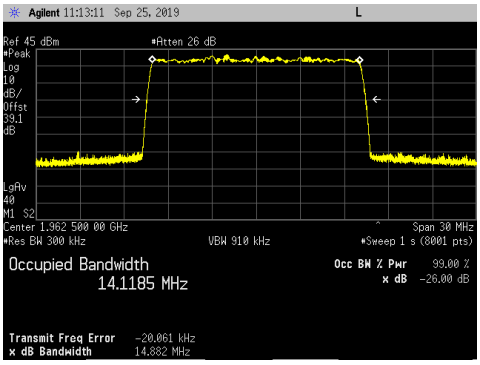
5G NR_ 15MHz_ 16QAM



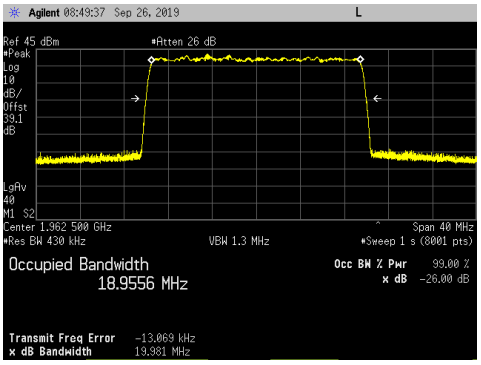
5G NR_ 20MHz_ 16QAM



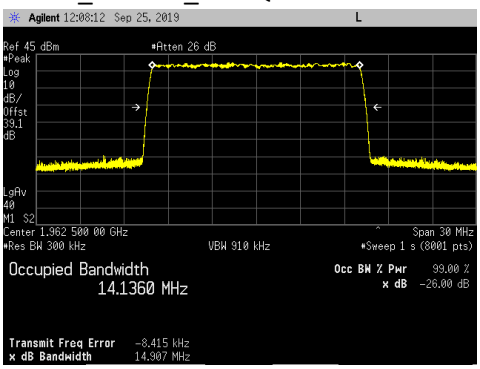
5G NR_ 15MHz_ 64QAM



5G NR_ 20MHz_ 64QAM



5G NR_ 15MHz_ 256QAM



5G NR_ 20MHz_ 256QAM