Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 22
[869MHz – 894MHz]

FCC Part 27
[717MHz – 728MHz]

CERTIFICATE #: 0214.19

FCC ID: VBNAHBCB-01

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

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

Test Sites: Nokia Solutions and Networks
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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	8/7/2019	Initial Draft	Alex Mathews
1	8/12/2019	RED line changes as per customer rewiew	Alex Mathews

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SCOPE

Tests have been performed on Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHBCB, 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 47 Part 22 Subpart H
- 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 AHBCB 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 AHBCB. 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 AHBCB 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 22 Subpart H and IC RSS-132 Issue 3 (Base Stations Operating in the 869 to 894MHz Band)

AHBCB operating in 869MHz to 894MHz Frequency Band					
FCC	IC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics					
§22.905	RSS-132 Section 5.1	Frequency Ranges	LTE1.4: 869.7 – 893.3MHz LTE3: 870.5 – 892.5MHz LTE5: 871.5 – 891.5MHz LTE10: 874.0 – 889.0MHz 5G-NR 5MHz Channel BW: 871.5 – 891.5MHz 5G-NR 10MHz Channel BW: 874.0 – 889.0MHz	869.0MHz to 894.0MHz	Pass
§2.1047	RSS-132 Section 5.2	Modulation Type	QPSK, 16QAM, 64QAM and 256QAM for LTE1.4, LTE3, LTE5, LTE10, 5G-NR 5MHz Ch BW & 5G-NR 10MHz Ch BW	Digital	Pass
§22.913	RSS-132 Section 5.4	Output Power	Highest Conducted Power Output RMS: 46.68dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
	RSS-132 Section 5.4	Peak to Average Power Ratio	Highest Measured PAPR: 6.91dB	13dB	Pass
	RSS-Gen Section 6.7	99% Emission Bandwidth	LTE1.4: 1.1127MHz LTE3: 2.7115MHz LTE5: 4.4971MHz LTE10: 8.9804MHz 5G-NR 5MHz Channel BW: 4.4840MHz 5G-NR 10MHz Channel BW: 9.2987MHz	Remain in Block	Pass
§22.917(b)		26dB down Emission Bandwidth	LTE1.4: 1.250MHz LTE3: 2.941MHz LTE5: 4.839MHz LTE10: 9.666MHz 5G-NR 5MHz Channel BW: 4.847MHz 5G-NR 10MHz Channel BW: 9.888MHz	Remain in Block	Pass
Transmitter Spurious Emissions[1]					
§22.917	RSS-132 Section 5.5	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass
		Field Strength	37 dBu V/m at 3- meters Equivalent to -58dBm EIRP	-13dBm EIRP	Pass
Other Details					
§2.1057	RSS-132 Section 5.3	Frequency Stability	0.0018ppm	1.5ppm	Pass
§1.1310	RSS102	RF Exposure	N/A		Pass[2]

Note 1: Based on 100kHz 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 100kHz for measurements more than 1MHz from the band edge.
Note 2: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

869MHz to 894MHz Band Emission Designators								
Channel Bandwidth	**LTE-QPSK**		**LTE-16QAM**		**LTE-64QAM**		**LTE-256QAM**	
	FCC	**IC**	**FCC**	**IC**	**FCC**	**IC**	**FCC**	**IC**
1.4M	1M25F9W	1M11F9W	1M24F9W	1M11F9W	1M25F9W	1M11F9W	1M25F9W	1M11F9W
3M	2M94F9W	2M71F9W	2M93F9W	2M71F9W	2M92F9W	2M71F9W	2M92F9W	2M71F9W
5M	4M83F9W	4M49F9W	4M80F9W	4M49F9W	4M84F9W	4M50F9W	4M83F9W	4M50F9W
10M	9M64F9W	8M97F9W	9M61F9W	8M98F9W	9M67F9W	8M98F9W	9M67F9W	8M98F9W
Note: FCC based on 26dB emission bandwidth; IC based on 99% emission bandwidth.								

869MHz to 894MHz Band Emission Designators								
Channel Bandwidth	**5G-NR: QPSK**		**5G-NR: 16QAM**		**5G-NR: 64QAM**		**5G-NR: 256QAM**	
	FCC	**IC**	**FCC**	**IC**	**FCC**	**IC**	**FCC**	**IC**
5M	4M85G7W	4M48G7W	4M84G7W	4M47G7W	4M82G7W	4M48G7W	4M82G7W	4M48G7W
10M	9M88G7W	9M29G7W	9M89G7W	9M30G7W	9M86G7W	9M28G7W	9M84G7W	9M30G7W
Note: FCC based on 26dB emission bandwidth; IC based on 99% emission bandwidth.								

FCC Part 27 Subpart C and IC RSS-130 Issue 2 (Base Stations Operating in the 717 to 728MHz Band)

AHBCB operating in the 717MHz to 728MHz Frequency Band					
FCC	IC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics					
27.5(c)	RSS-130 Section 4.3	Frequency Ranges	LTE5: 719.5 – 725.5MHz LTE10: 722.0 – 723.0MHz	717.0 to 728.0MHz	Pass
2.1033(c)(4)	RSS-130 Section 4.2	Modulation Type	QPSK, 16QAM, 64QAM and 256QAM for LTE5 and LTE10	Digital	Pass
27.50(c)	RSS-130 Section 4.6	Output Power	Highest Conducted Power Output RMS: 46.12dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
	RSS-130 Section 4.6	Peak to Average Power Ratio	Highest Measured PAPR: 7.44dB	13dB	Pass
2.1049	RSS-Gen Section 6.7	99% Emission Bandwidth	LTE5: 4.4936MHz LTE10: 8.9708MHz	Remain in Block	Pass
		26dB down Emission Bandwidth	LTE5: 4.844MHz LTE10: 9.641MHz	Remain in Block	Pass
Transmitter Spurious Emissions					
27.53(g)	RSS-130 Section 4.7.1	At the antenna terminals	< -16dBm	-16dBm per Transmit Chain	Pass[1]
		Field strength	37 dBu V/m at 3- meters Equivalent to -58dBm EIRP	-13 dBm ERP	Pass
Other Details					
27.54	RSS-130 Sec 4.5	Frequency Stability	Stays within authorized frequency block 0.0021ppm	Stays within block	Pass
1.1310	RSS102	RF Exposure	N/A		Pass[2]

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(c)(5) and RSS 130 4.7 for details.
Note 2: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

717MHz to 728MHz Band Emission Designators								
Ch BW	LTE-QPSK		LTE-16QAM		LTE-64QAM		LTE-256QAM	
	FCC	IC	FCC	IC	FCC	IC	FCC	IC
5M	4M84F9W	4M49F9W	4M82F9W	4M48F9W	4M84F9W	4M49F9W	4M84F9W	4M49F9W
10M	9M63F9W	8M96F9W	9M62F9W	8M97F9W	9M64F9W	8M95F9W	9M63F9W	8M96F9W
Note: FCC based on 26dB emission bandwidth; IC based on 99% 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

The equipment under test (EUT) is a Nokia Solutions and Networks AirScale Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model AHBCB. The AHBCB 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 (fifth generation – new radio). The scope of testing in this effort is for LTE-FDD and 5G-NR operations.

The AHBCB RRH has four transmit/four receive antenna ports (4TX/4RX for Band 5 and 2TX for Band 29). Antenna ports 1 - 4 supports 3GPP frequency band 5 (BTS Rx: 824 to 849 MHz/BTS TX: 869 to 894 MHz). Antenna ports 1 & 2 supports 3GPP frequency band 29 (BTS TX: 717 to 728 MHz). The maximum RF output power of the RRH is 240 Watts (40 watts per carrier, 120 watts per antenna ports 1 & 2, 80 watts per antenna ports 3 & 4). 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 supports LTE bandwidths of 1.4, 3, 5 and 10MHz for 3GPP frequency band 5 operations. The RRH supports LTE bandwidths of 5 and 10MHz for 3GPP frequency band 29 operations. The RRH supports 5G-NR channel bandwidths of 5 and 10MHz for 3GPP frequency band n5 operations. The RRH supports four LTE and four 5G-NR downlink modulation types (QPSK, 16QAM, 64QAM and 256QAM). Multi-carrier operation is supported.

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 3GPP frequency band 5 (869-894 MHz) band edge downlink (BTS Transmit) EARFCNs for LTE channel bandwidths (1.4, 3, 5 and 10MHz) are provided below. The EARFCN is defined as E-UTRA Absolute Radio Frequency Channel Number. The spacing is 100 kHz between channel numbers.

	Downlink EARFCN	Downlink Frequency (MHz)	LTE Channel Bandwidth			
			1.4 MHz	3 MHz	5 MHz	10 MHz
AHBCB Band 5 (Ant 1, 2, 3, 4)	2400	869.0	Band Edge	Band Edge	Band Edge	Band Edge
	……					
	2407	869.7	Bottom Ch			
	……					
	2415	870.5		Bottom Ch		
	……					
	2425	871.5			Bottom Ch	
	……					
	2450	874.0				Bottom Ch
	……					
	2525	881.5	Middle Ch	Middle Ch	Middle Ch	Middle Ch
	……					
	2600	889.0				Top Channel
	……					
	2625	891.5			Top Channel	
	……					
	2635	892.5		Top Channel		
	……					
	2643	893.3	Top Channel			
	……					
	2650	894.0	Band Edge	Band Edge	Band Edge	Band Edge

AHBCB Downlink Band Edge LTE Band 5 Frequency Channels

The 3GPP frequency band 29 (717 - 728 MHz) band edge downlink (BTS Transmit) EARFCNs for LTE channel bandwidths (5 and 10 MHz) are provided below. The channel spacing is 100 kHz between channel numbers.

	Downlink EARFCN	Downlink Frequency (MHz)	LTE Channel Bandwidth	
			5 MHz	10 MHz
AHBCB Band 29 (Ant 1, 2)	9660	717.0	Band Edge	Band Edge
	……			
	9685	719.5	Bottom Channel	
	……			
	9710	722.0		Bottom Channel
	……			
	9715	722.5	Middle Channel	Middle Channel
	……			
	9720	723.0		Top Channel
	……			
	9745	725.5	Top Channel	
	……			
	9770	728.0	Band Edge	Band Edge

AHBCB Downlink Band Edge LTE Band 29 Frequency Channels

LTE Multicarrier Multiband Test Case

In Band 5_Three LTE1.4 carriers (based upon KDB 971168 D03v01) using two carriers (with minimum spacing between carrier frequencies) at the lower band edge (EARFCN 2407: 869.7 MHz and EARFCN 2421: 871.1 MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 2643: 893.3 MHz) at the upper band edge. In Band 29_ Two LTE5 carriers with maximum spacing at the lower and upper band edges (EARFCN 9685: 719.5 & EARFCN 9745: 725.5MHz. Three carrier operation is not available because it exceeds the Band 29 downlink bandwidth. The smallest channel bandwidth is selected to maximize carrier power spectral density. The carriers for both bands (5 & 29) are enabled simultaneously.

The AHBCB 5G NR downlink frequencies are as follows:

	Downlink Frequency (MHz)	5G-NR Channel Bandwidth	
		5 MHz	10 MHz
AHBCB 5G NR Band n5 (Ant 1, 2, 3, 4)	869.0	Band Edge	Band Edge
	871.5	Bottom Ch	
	874.0		Bottom Ch
	881.5	Middle Ch	Middle Ch
	889.0		Top Channel
	891.5	Top Channel	
	894.0	Band Edge	Band Edge

AHBCB Downlink Band Edge 5G-NR Band n5 Frequencies

Multicarrier operations are not currently supported by the AHBCB 5G NR software.

EUT Hardware

The EUT hardware used in testing on July 15 – August 5, 2019.

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AHBCB	AirScale BTS RRH	Part#: 474242A.101 Serial#: K919508243	FCC ID: VBNAHBCB-01

Enclosure

The EUT enclosure is made of heavy duty aluminum and has the following physical characteristics:

Configuration	Approximate Weight	Approximate Dimensions	Approximate Volume
AHBCB	38 kg	308x560x189 mm	33 Liters

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

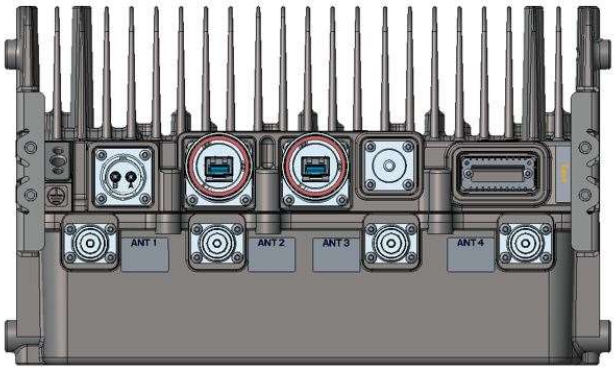
Company	Description	Part Number	Serial Number
Nokia	FOUC 10GHz SFP Module (Plugs into RRH Opt Ports)	473842A.101	MA17331610207
Nokia	FOTA 10GHz SFP Module (Plugs into RRH Opt Ports)	473471A.101	FR182418340
RLC Electronics	1.1GHz High Pass Filter[1]	F-14699	0050
Weinschel	Attenuator 40dB-250 Watt[1]	58-40-43-LIM	TC909
Weinschel	Attenuator 20dB-150 Watt[1]	66-20-33	BZ2075
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. Note 2: The FOUC SFP was used for LTE testing and the FOTA SFP was used for 5G-NR testing.			

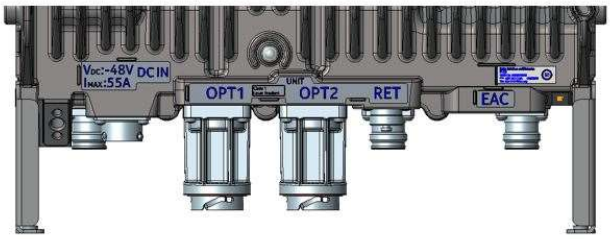
EUT Interface Ports

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

AHBCB 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 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 (CPRI) 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: FRM59.06.R11 for LTE testing and FRM59.01.R06 for 5G-NR testing
(2) BTS Software: SBTS19A_ENB_0000_000173_000000_release_BTSSM_downloadable_A50.zip

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.

Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4-2014: "*American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" and CISPR 16-1-4:2010-04: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus* – Antennas and test sites for radiated disturbance measurements". They are on file with the FCC.

Site	Registration Numbers		Location
	FCC		
Chamber 1	A2LA Accredited Designation Number US1077		1701 E Plano Pkwy #150 Plano, TX 75074.

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

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. 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-9GHz 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.

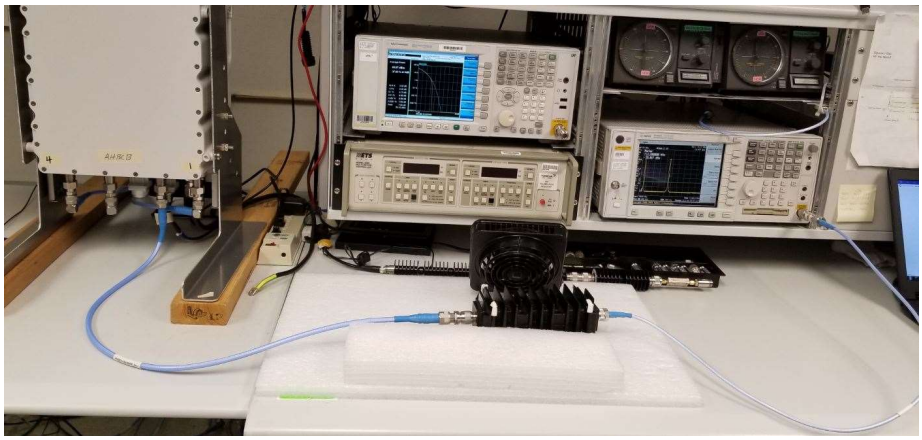
For frequency stability/accuracy measurements, the EUT was placed inside a temperature chamber with all support and test equipment located outside of the chamber. Temperature was varied across the specified range in 10 degree increments and EUT was allowed enough time to stabilize at each temperature step (a minimum of 30 minutes per step). The input voltage was varied as required by FCC/IC regulatory requirements. An LTE signal analyzer as detailed in the test equipment section was used for frequency stability/accuracy measurements.

Transmitter radiated spurious emissions measurements were made in accordance with ANSI C63.4 by measuring the field strength of the emissions from the device at 3m test distance. The eirp/ERP limit as specified in the relevant rule part(s) is converted to a field strength at the test distance and the emissions from the EUT are then compared to that limit. Only emissions within 20dB of this limit are subjected to a substitution measurement in accordance with TIA-603. Both preliminary and final measurements were performed at the same FCC listed test chamber. Preliminary scans were performed with TILE6 software. This software corrected the measurements for antenna factors, cable losses and pre-amplifier gains. Both polarizations of the receiving antenna were scanned from 30MHz to 9GHz with a peak detector (RBW=100kHz, VBW=300kHz, with trace max hold over multiple sweeps). Based on the preliminary scan results, frequencies of interest have been maximized via rotating the EUT 360 degrees and varying the height of the test antenna (1m to 4m). Final measurements were also taken with the peak detector as described above. A biconilog antenna was used for 30MHz-1GHz range. A double ridged waveguide horn antenna was used for 1-9GHz range. The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. The EUT was placed on a non-conductive RF transparent structure to provide 80cm height from the ground floor for frequencies $\leq$ 1GHz and 150cm height from the ground floor for frequencies > 1GHz in accordance with ANSI C63.26-2015. A motorized turntable allowed it to be rotated during testing to determine the angle with the highest level of emissions.

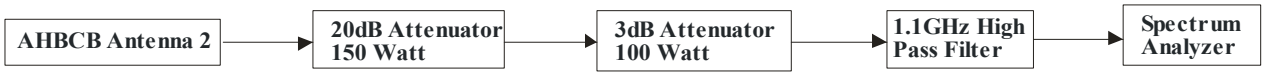
Antenna Port Conducted RF Measurement Test Setup Diagrams

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

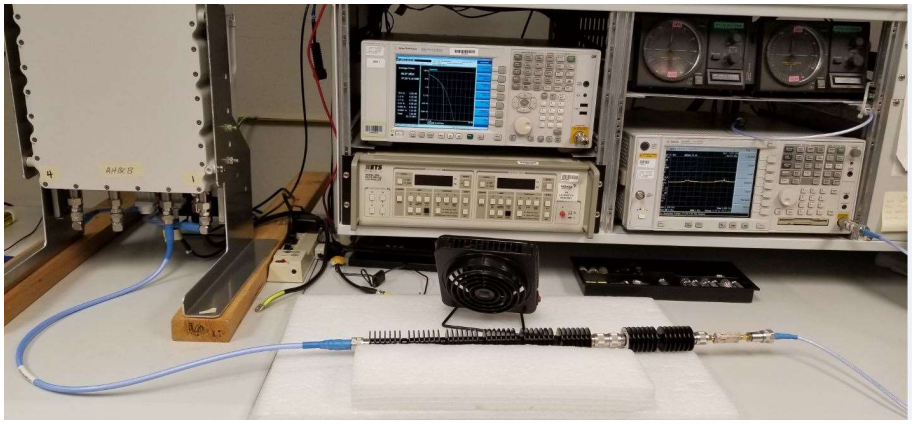
Setup for 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, and 700MHz to 1.1GHz Measurements



Photograph of 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, and 700MHz to 1.1GHz Test Setup



Setup for 1.1GHz to 9GHz Measurement



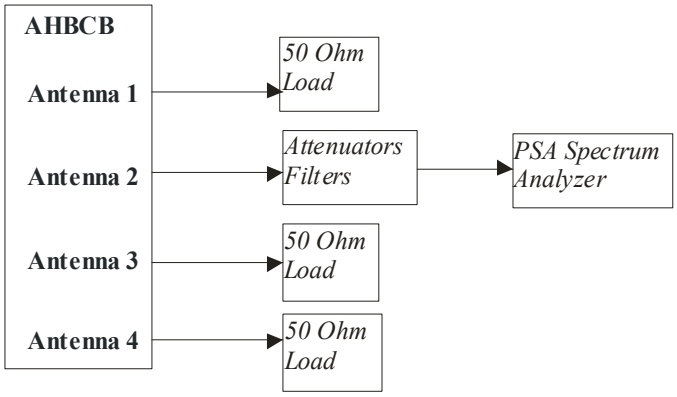
Photograph of 1.1GHz to 9GHz Test Setup

Test Measurement Equipment

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
WC021377	RMS Multimeter	Fluke	87V	12 Months	12/26/2019
WC021659	ENV Chamber #5	Thermotron	N/A	N/A	N/A
WC038555	Temp Controller	Watlow	F4	12 Months	8/22/2019
WC021613	Spectrum Analyzer	Aglent	E4440A	12 Months	2/14/2020
WC020916	Bilog Antenna	ETS	3142C	12 Months	1/2/2020
WC021206	Horn Antenna	EMCO	3115	12 Months	1/23/2020
WC021480	Pre-Amp	Miteq	AM1431-N-1179-WP	12 Months	11/8/2019
WC066384	Spectrum Analyzer	Agilent	E4446A	12 Months	6/14/2024
WC066266	Pre Amp	Miteq	RRA 1840-35-HG	12 Months	1/16/2020
WC021208	Horn Antenna	EMCO	3116	12 Months	12/4/2019
120194[1]	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	10/17/2019
NM04508[1]	MXA Signal Analyzer	Agilent	N9020A	24 Months	05/08/2021
NM04192[1]	MXA Signal Analyzer	Agilent	N9020A	24 Months	05/23/2020
NM06345[1]	ENA Network Analyzer	Keysight	E5063A	12 Months	12/15/2019
NM04509[1]	Network Analyzer	Rohde & Schwarz	ZVL 3	12 Months	2/12/2020
Note 1: Customer equipment used in antenna port RF conducted emission testing.					

APPENDIX A: ANTENNA PORT LTE TEST DATA FOR BAND 5 (869-894MHZ)

All conducted RF measurements in this section were made at AHBCB antenna ports. All available LTE channel bandwidths (1.4, 3, 5 & 10MHz) with all available modulation types (QPSK, 16QAM, 64QAM & 256QAM) were measured. The LTE modulation types are setup according to 3GPP TS 36.141 E-UTRA Test Models (E-TM) as follows E-TM 1.1: QPSK, E-TM 3.1: 64QAM, E-TM3.1a: 256QAM and E-TM 3.2: 16QAM. The test setup used is provided below.



Test Setup Used for Conducted RF Measurements on AHBCB

RF Output Power

RF output power has been measured in RMS Average terms for each Band 5 transmit chain at the middle channel (881.5MHz) for 256QAM modulation and LTE5 bandwidth as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. The RRH was operated at maximum RF output power. 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.

Antenna	LTE Bandwidth	LTE - 256QAM	
		PAPR (dB)	Average (dBm)
Port 1 Middle Channel	**5M**	6.72	46.11
Port 2 Middle Channel	**5M**	**6.73**	**46.14**
Port 3 Middle Channel	**5M**	6.72	46.09
Port 4 Middle Channel	**5M**	**6.73**	46.11

The variation in RMS output power levels between the antenna ports is 0.05 dB per data sample provided above. Pre-compliance testing (and testing of similar EUTs) shows that the output power variation between antenna ports is small (the output ports are essentially electrically identical). The highest power port was selected as the worst case.

Pre-compliance testing has shown that the output power variation between modulation types is small. Antenna port 2 power output measurements for the LTE5 bandwidth for all modulation types on the middle (center) channel are provided below.

	Modulation Type							
	QPSK		16QAM		64QAM		256QAM	
	PAPR (dB)	Ave (dBm)	PAPR (dB)	Ave (dBm)	PAPR (dB)	Ave (dBm)	PAPR (dB)	Ave (dBm)
Antenna Port 2 Middle Channel LTE5	6.72	**46.15**	6.72	**46.15**	6.72	46.12	6.73	46.14

The output power variation between modulation types is small in this measurement snapshot (and from past efforts on similar hardware as well). The variation of average power output versus modulation type is 0.03dB for the data snapshot provided. The variation of PAPR versus modulation type is 0.01dB for the data snapshot provided. All power measurements in this report (except the sample test noted above) were performed with the EUT operating with 256QAM modulation.

Based on the results above, Port 2 had the highest LTE RMS average power for Band 5 (represents the worst case) and therefore it was selected for all the remaining antenna port tests. Port 2 has the highest combined LTE RMS average power for the Band 5 + Band 29 .
Subsequently output power levels on bottom, middle, and top channels in all four Band 5 LTE channel bandwidths and 256QAM modulation type were tested only at Port 2 and the results presented below. The highest measured values are highlighted.

Antenna LTE Channel	LTE Bandwidth	LTE - 256QAM	
		PAPR (dB)	Average (dBm)
Port 2 Bottom Channel	1.4M	6.73	45.93
	3M	6.72	46.02
	5M	6.74	45.98
	10M	6.88	46.05
Port 2 Middle Channel	1.4M	6.73	46.12
	3M	6.70	46.11
	5M	6.73	**46.14**
	10M	6.73	46.11
Port 2 Top Channel	1.4M	6.74	45.57
	3M	6.74	45.85
	5M	6.84	45.87
	10M	**6.91**	46.05

The data provided in the table shows (and testing of similar EUTs) that the output RMS power variation between channel bandwidths at the center frequency channel is small (0.03dB).

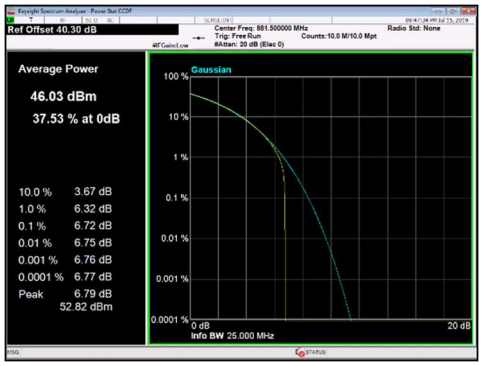
RF output power has been measured in RMS Average terms for the Band 5 multicarrier test configuration to verify/document the power levels. All results are presented in tabular form below.

Measured RMS Average Carrier Power Level for the Multicarrier Configuration at Antenna Port 2		
Band 5 Multicarrier LTE1.4		Band 29 Multicarrier LTE5
Bottom Carriers 869.7 & 871.1MHz	Top Carrier 893.3MHz	Bottom & Top Carriers 719.5 & 725.5MHz
44.07 dBm (25.5 Watts)	40.78 dBm (12.0 Watts)	46.10 dBm (40.7 Watts)
Total Band 5 Carrier Power is 37.5 Watts or 45.74 dBm		Total Band 29 Carrier Power is 40.7 Watts or 46.1 dBm
Total Antenna Port 2 Carrier Power (Band 5 & Band 29 Carriers are enabled simultaneously) is 78.2 Watts or 48.9 dBm		

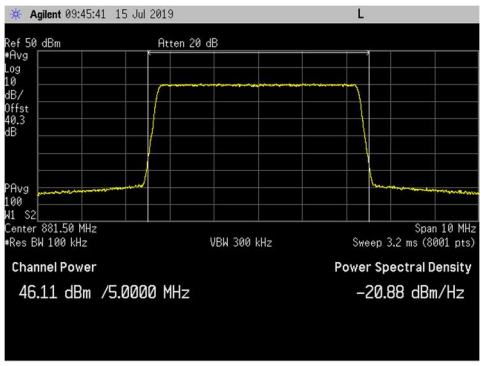
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 40.3 dB and is accounted for by the spectrum analyzer reference level offset.

LTE5 Channel Power Plots at Middle Channel and 256QAM Modulation:

Port 1_ Middle Channel_ CCDF

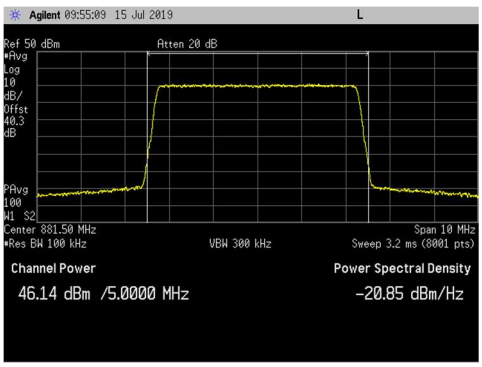


Port 1_ Middle Channel_ Average

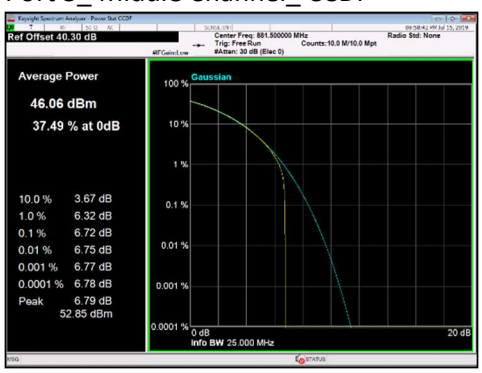


Port 2_ Middle Channel_ CCDF

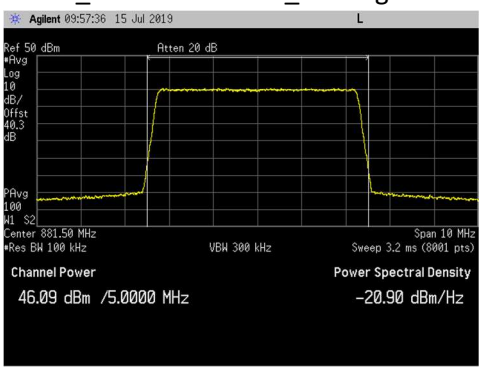
Port 2_ Middle Channel_ Average



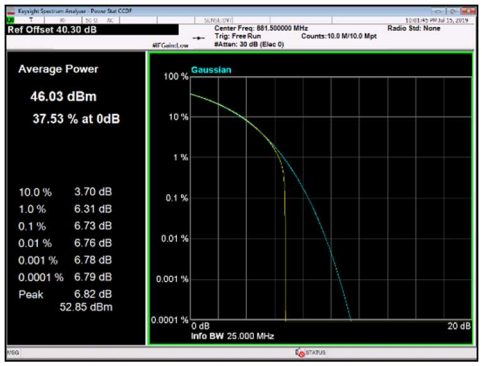
Port 3_ Middle Channel_ CCDF



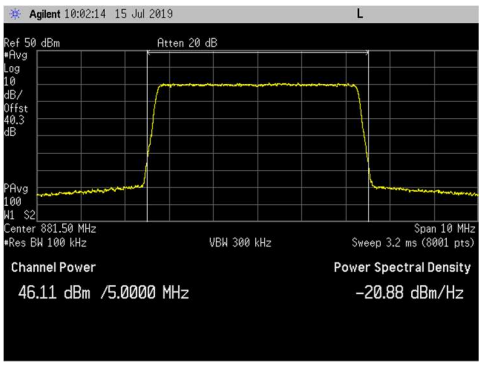
Port 3_ Middle Channel_ Average



Port 4_ Middle Channel_ CCDF

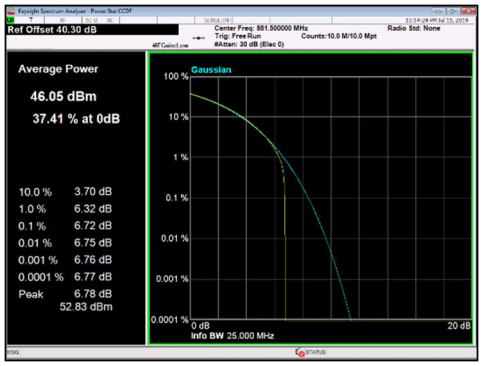


Port 4_ Middle Channel_ Average

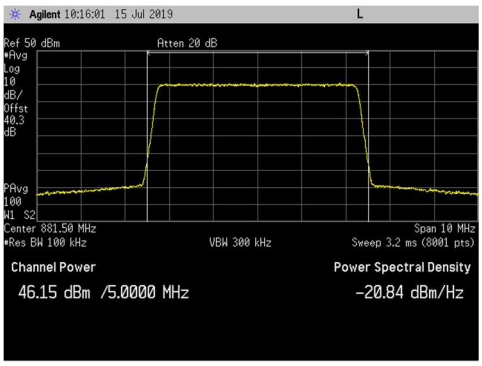


LTE5 Channel Power Plots for Antenna Port 2 at Middle Channel and all Modulation Types:

QPSK_ CCDF

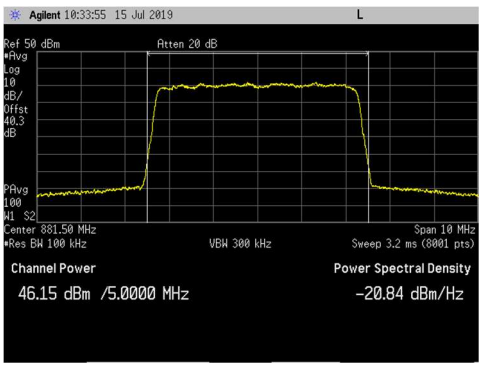


QPSK_ Average



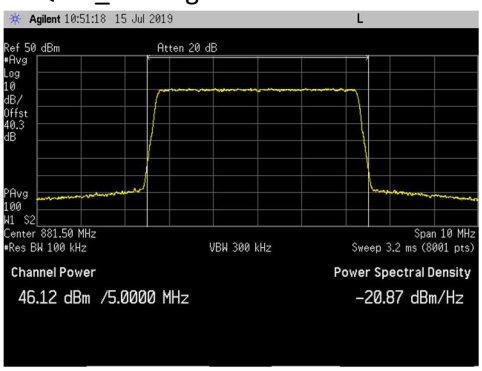
16QAM_ CCDF

16QAM_ Average

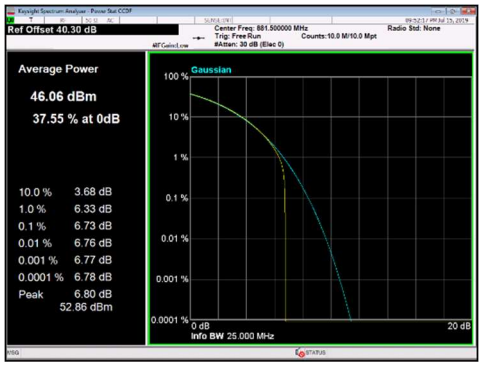


64QAM_ CCDF

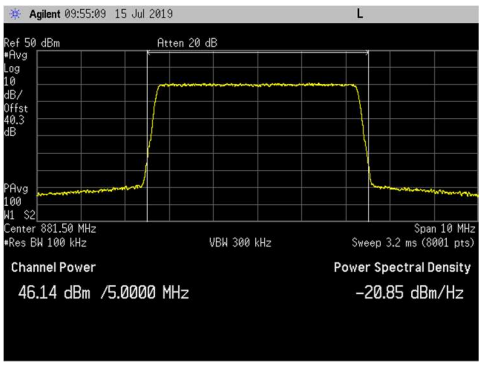
64QAM_ Average



256QAM_ CCDF

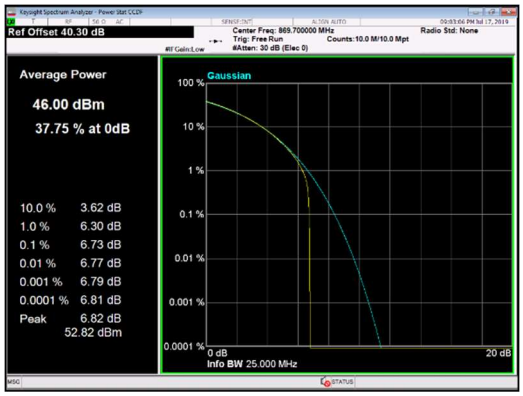


256QAM_ Average

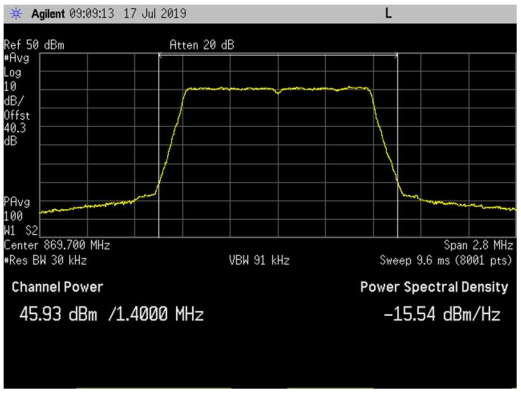


LTE1.4 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

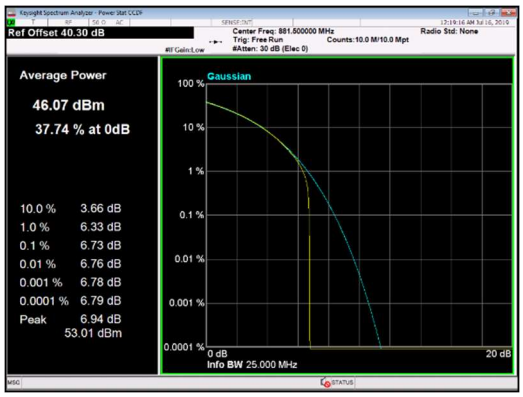
Bottom Channel_ CCDF



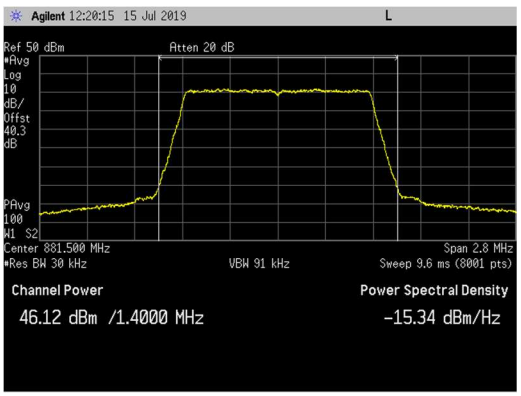
Bottom Channel_ Average



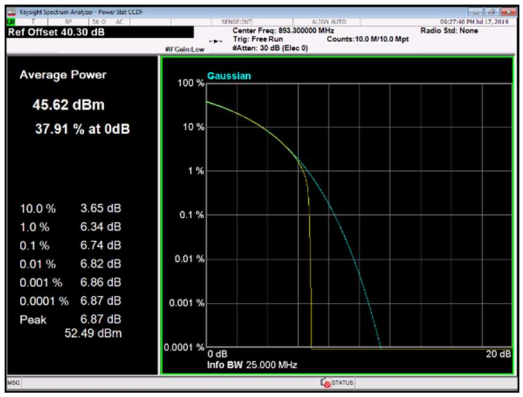
Middle Channel_ CCDF



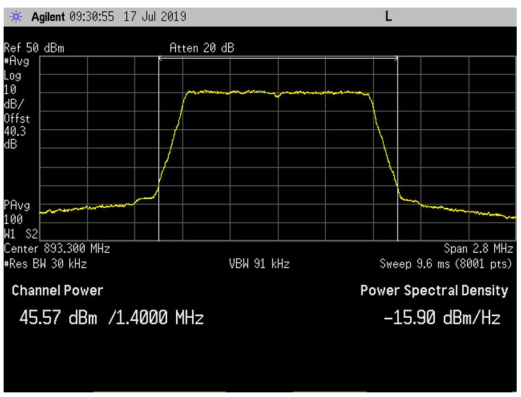
Middle Channel_ Average



Top Channel_ CCDF

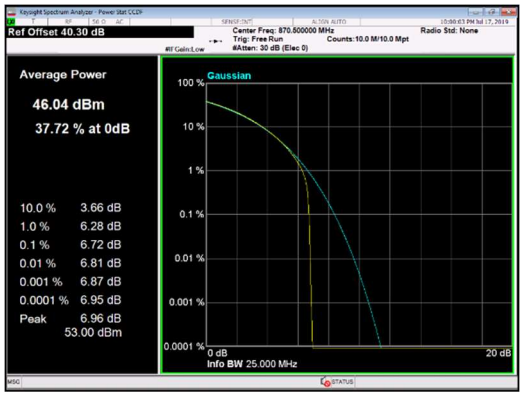


Top Channel_ Average

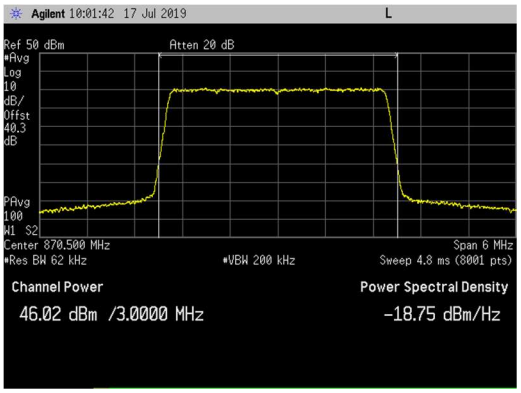


LTE3 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

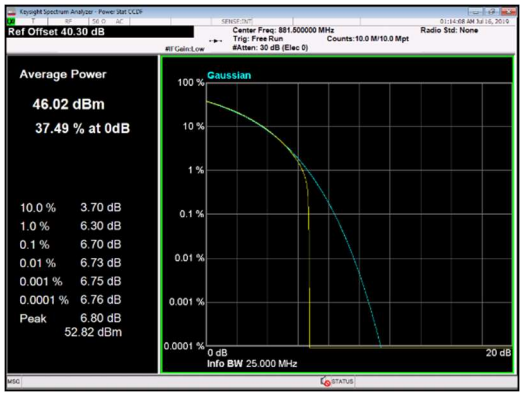
Bottom Channel_ CCDF



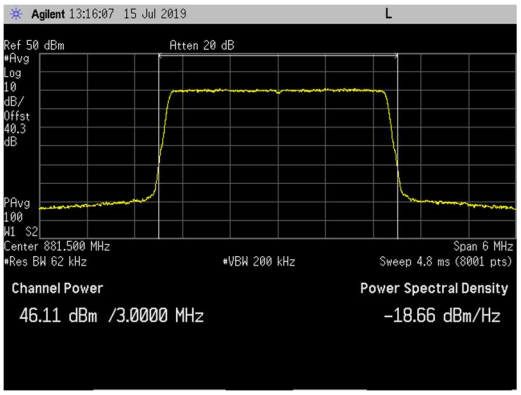
Bottom Channel_ Average



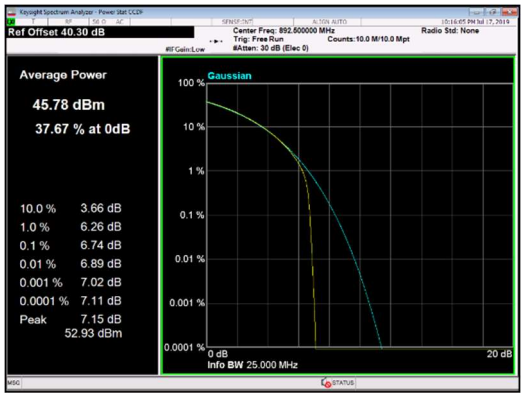
Middle Channel_ CCDF



Middle Channel_ Average



Top Channel_ CCDF



Top Channel_ Average