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Title 47 Code of Federal Regulations C2PC Test Report

Regulation: FCC Part 2 and 27

Client: NOKIA SOLUTIONS AND NETWORKS OY

Product Evaluated: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G

> <u>Report Number:</u> TR-2020-0056-FCC2-27 Issue 1

> > Date Issued: May 13, 2020

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Revisions

Date	Revision	Section	Change
5/12/20	0		Initial Release
5/13/20 1			Cover Page Section 1.2
			Section 1.2

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Twe (Jura

5/13/2020

1. System Information and Requirements

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

Equipment Under Test (EUT):	AWHHF Single Carrier 60 & 100 MHz 4x20W 5G
Serial Number:	EB193661018
FCC ID:	2AD8UAWHHF01
Hardware Version:	475181A.X22
Software Version:	5G19B
Frequency Range:	2496-2690 MHz
GPCL Project Number:	2020-0056
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY
	KARAKAARI 7, FI-02610 ESPOO
	FINLAND
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	Title 47 CFR Parts 2 and 27
	KDB 971168 D01 Power Measurement License Digital Systems
	v03r01 April 9, 2018.
	KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013
	• ANSI C63.26 (2015)
	• ANSI C63.4 (2014)
Measurement Procedure(s):	FCC-IC-OB - GPCL Occupied Bandwidth and Power Measurement
	Test Procedure 12-4-2017
	FCC-IC-SE - GPCL Spurious Emissions Test Procedure 12-4-2017
Test Date(s):	5/5/2020 – 5/6/2020
Test Performed By:	Nokia
	Global Product Compliance Laboratory
	600-700 Mountain Ave.
	P.O. Box 636
	Murray Hill, NJ 07974-0636
Product Engineer(s):	Jeff Webb
Lead Engineer:	Steve Gordon
Test Engineer (s):	Jaideep Yadav
Test Results: The EUT, as tested	met the above listed requirements. Report copies and other information
not contained in this report are	held by either the product engineer or in an identified file at the Global
Product Compliance Laboratory i	n New Providence, NJ.

1.1 Introduction

This Conformity test report applies to the AWHHF Single Carrier 60 & 100 MHz 4x20W 5G, hereinafter referred to as the Equipment Under Test (EUT).

1.2 Purpose and Scope

The purpose of this document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 27 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

Previous approvals included 5G NR Single carrier 40, and LTE 20+20, and 20+20+20 MHz LTE under FCC ID: 2AD8UAWHHF01 in GPCL Project 2019-0189.

This testing is being performed to demonstrate the addition of Single Carrier 5G-NR operation for 60 and 100 MHz bandwidth support to the existing product. There were no changes to the basic frequency determining and stabilizing circuitry therefore no Frequency Stability testing was considered necessary.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description		
Radio Access Technology	5G NR		
Duplex Mode	Time Division Duplex (TDD)		
Modulation Type(s)	QPSK 16QAM 64QAM 256QAM		
Operation Frequency Range	2496-2690 MHz		
Channel Bandwidth	60 / 100 MHz		
Number of Tx Ports per Unit	4		
МІМО	Yes		
Deployment Environment	Outdoor		
Supply Voltage	-48.0 VDC		

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1.3.2 Photographs

Front View



Left View



Rear View



Right View



PUBLIC

Title 47 Code of Federal Regulations Test Report

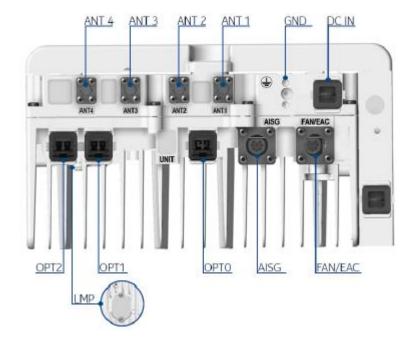
Global Product Compliance Laboratory Report No.: TR-2020-0056-FCC2-27

Report No.: TR-2020-0056-FCC2-27 Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G

Top View







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



1.4 Test Requirements

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

Each required measurement is listed below:

1.5 Standards & Procedures

1.5.1 Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.
- ANSI C63.26, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

1.5.2 Procedures

- 1. FCC-IC-OB and FCC-IC-SE
- ANSI C63.4 (2014) entitled: "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz", American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.
- 3. FCC KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018. FCC KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013

1.5.3 MEASUREMENT UNCERTAINTY

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

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

Worst-Case Estimated Measurement Uncertainties

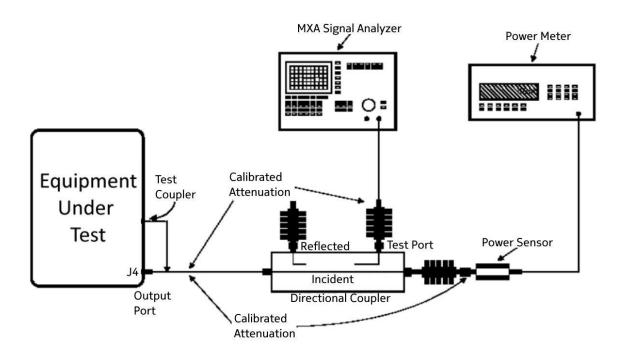
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
	10 Hz	9 kHz to 20 MHz	
Occupied Bandwidth, Edge of Band,	100 Hz	20 MHz to 1 GHz	1.78 dB
Conducted Spurious Emissions	10 kHz to 1 MHz	1 GHz to 10 GHz	1.70 UD
	1MHz	10 GHz to 40 GHz:	
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	0.5 dB

1.6 Executive Summary

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

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

1.7 Test Configuration for all Antenna Port Measurements.



2. FCC Section 2.1046 - RF Power Output

2.1 **RF Power Output**

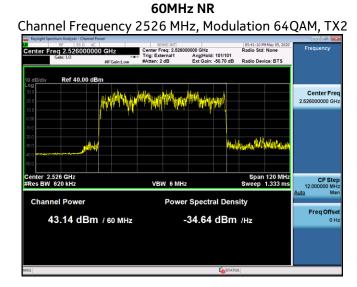
This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

Power measurements were made with an MXA Signal Analyzer.

	ТМ	тх	Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
COMU-	3.1	2	2526	60	64QAM	43.14
60MHz NR	3.2	2	2593	60	QPSK/16QAM	42.81
	3.1a	2	2660	60	256QAM	42.81
100MU-	3.2	2	2546	100	QPSK/16QAM	42.57
100MHz NR	3.1	2	2593	100	64QAM	42.62
	3.1a	2	2660	100	256QAM	42.37

4x20W 5G

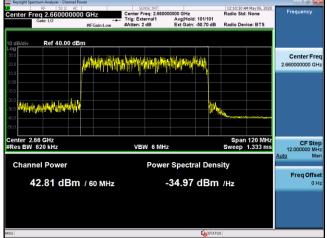
2.1.1 Channel RF Power - Plots

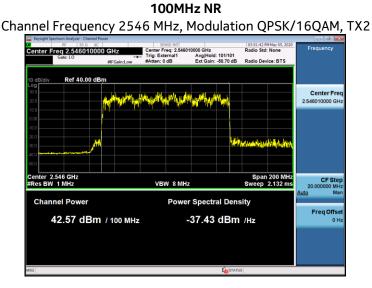


Channel Frequency 2593 MHz, Modulation QPSK/16QAM, TX2

Kyrsight Spectrum Analyzer - Channel	00 GHz #IFGain:Low	Center Freq: 2.5930 Trig: External #Atten: 2 dB	20000 GHz Avg Hold: 101/1 Ext Gain: -50.70		lone	Frequency
20.0		inin kanalan na manalan ka	levine many but			Center Freq 2.593020000 GHz
0.00 -10.0 -20.0 -20.0 -20.0 -20.0 -20.0				h,hondiya, jiridiy	uhana	
Center 2.593 GHz #Res BW 620 kHz Channel Power		VBW 6 MHz Power	Spectral D	Sweep 1	120 MHz .333 ms	CF Step 12.000000 MHz Auto Man
42.81 dBn	1 / 60 MHz		34.97 dB			Freq Offset 0 Hz
MSG			(o	ITATUS		

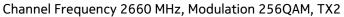


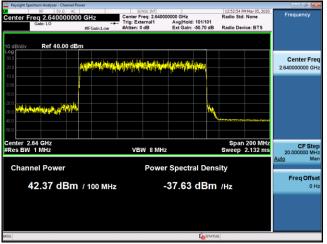




Channel Frequency 2593 MHz, Modulation 64QAM, TX2

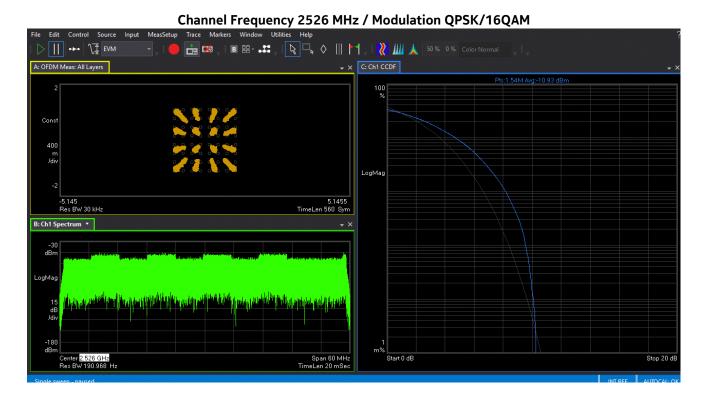
Keysight Spectrum Analyzer - Channel Po	ver						
RF 50Ω AC Center Freq 2.593020000	GHz	SENSE:INT Center Freq: 2.5			Radio Std	MMay 05, 2020 None	Frequency
Gate: LO	#IFGain:Low	Trig: External1 #Atten: 0 dB	Avg Hold: 1 Ext Gain: -5		Radio Dev	vice: BTS	
0 dB/div Ref 40.00 dBr	n						
30.0	الداده وار مرا الهور	ability of the	althouse to the	last			Center Fre
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o.o biski ki je prokologice (¹⁹⁹⁰ k.) vil				Mb	alhinikikaya	No. No. of Street, Stre	
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50.0							
enter 2.593 GHz						200 MHz	CF Ste
Res BW 1 MHz		VBW 8N	ЛНz		Sweep	2.132 ms	20.000000 Mi Auto Mi
Channel Power		Pov	ver Spectra	Dens	ity		Auto Mi
channel Power		101	ver opeena	Dena	sicy		Freq Offs
42.62 dBm	/ 100 MHz		-37.38 (dBm	/Hz		01
iG				STATU	s		





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

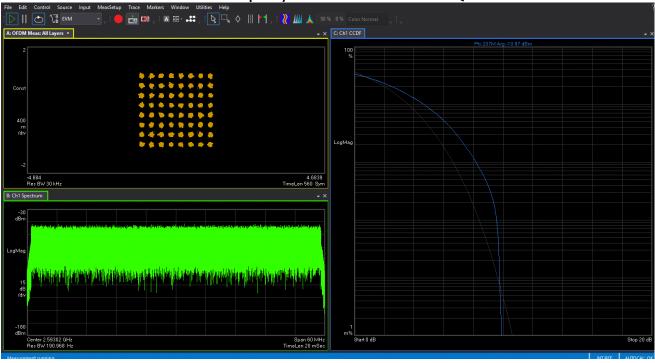
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 60 MHz and 100 MHz bandwidths. The PAPR values of all carriers measured are below 13dB.



60MHZ Data

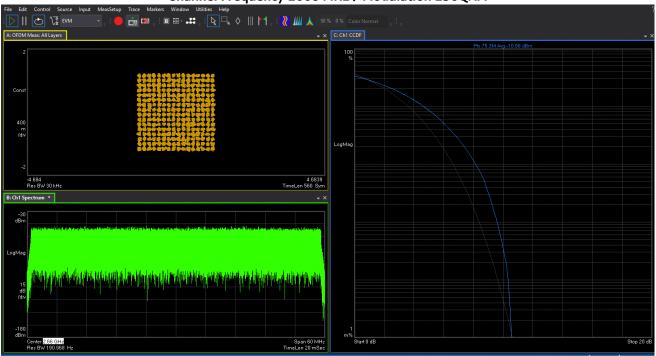
Global Product Compliance Laboratory

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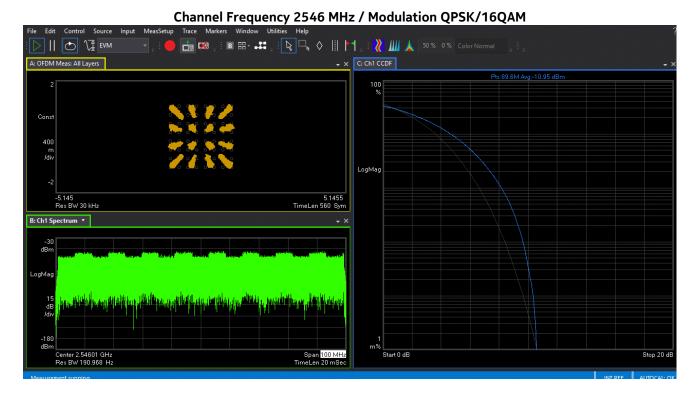
Channel Frequency 2593 MHz / Modulation 64QAM

Channel Frequency 2660 MHz / Modulation 256QAM

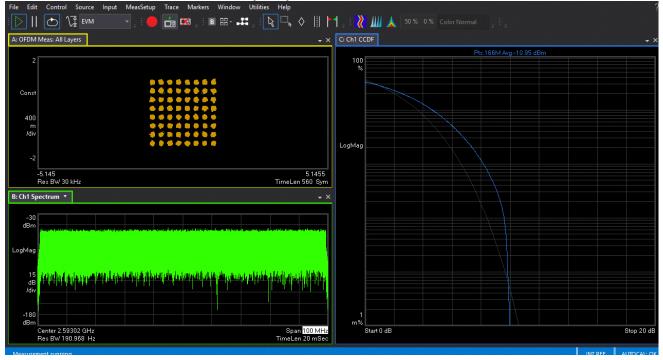


4x20W 5G

100MHZ Data

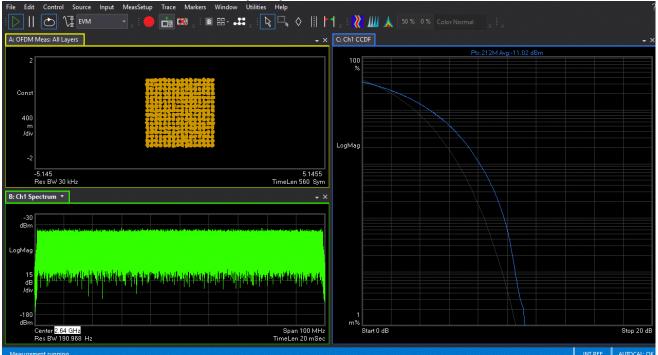


Channel Frequency 2593 MHz / Modulation 64QAM



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Channel Frequency 2640 MHz / Modulation 256QAM

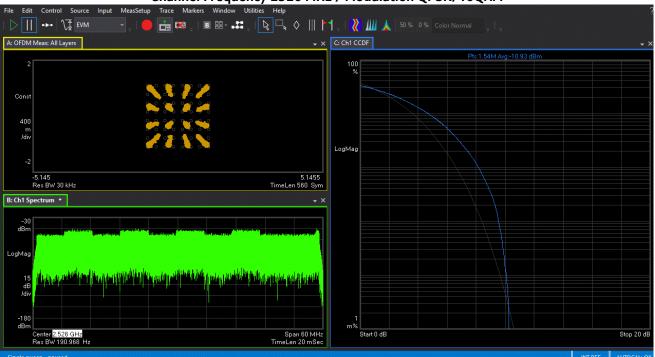
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

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

3.1.1 Modulation Characteristics – Plots

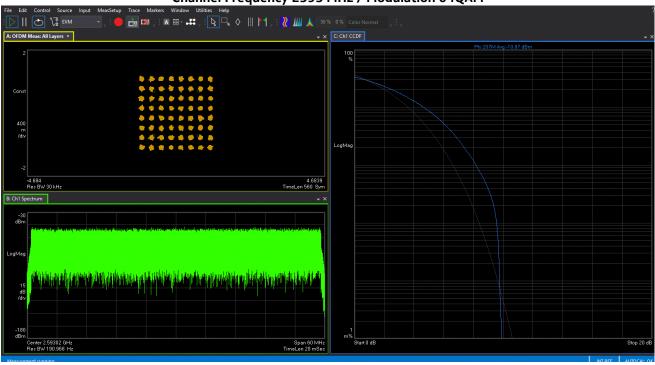
60MHZ Data



Channel Frequency 2526 MHz / Modulation QPSK/16QAM

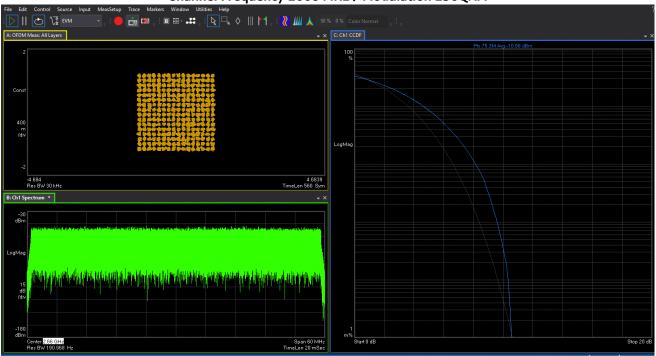
Global Product Compliance Laboratory

Report No.: TR-2020-0056-FCC2-27 Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G



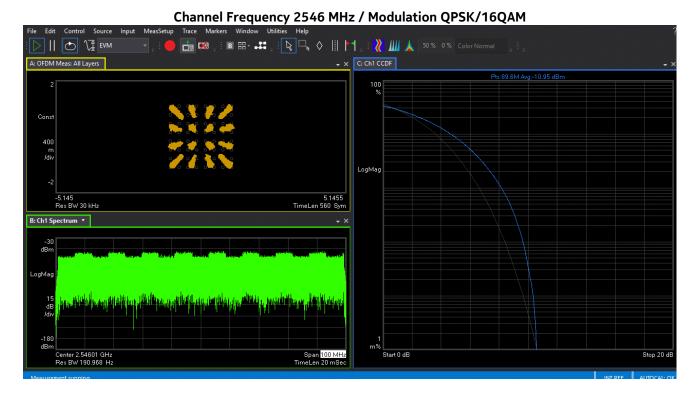
Channel Frequency 2593 MHz / Modulation 64QAM

Channel Frequency 2660 MHz / Modulation 256QAM

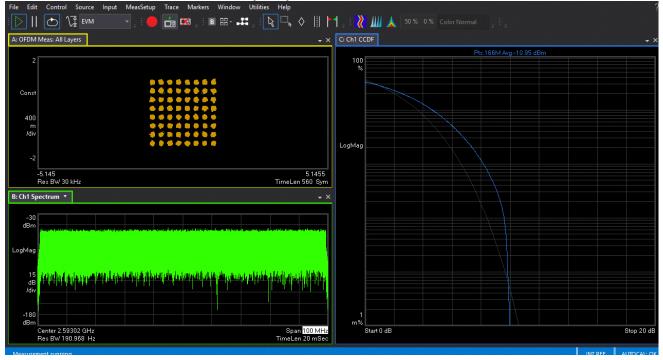


4x20W 5G

100MHZ Data

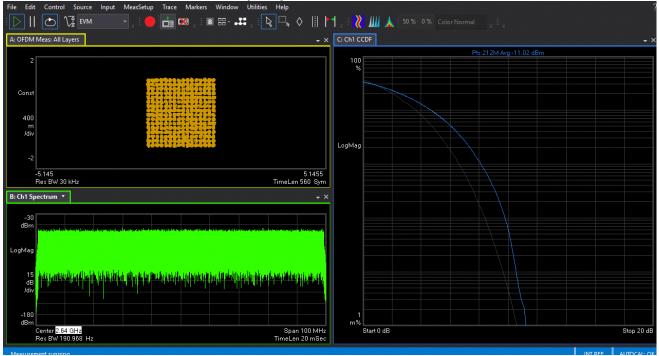


Channel Frequency 2593 MHz / Modulation 64QAM



Global Product Compliance Laboratory

Report No.: TR-2020-0056-FCC2-27 Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G



Channel Frequency 2640 MHz / Modulation 256QAM

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

4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

"The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable."

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

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

	ТМ	тх	Channel Frequency MHz	Signal BW MHz	Modulation	Occupied BW MHz
COMU-	3.1	2	2526	60	64QAM	57.826
60MHz NR	3.2	2	2593	60	QPSK/16QAM	57.878
INK	3.1a	2	2660	60	256QAM	57.666
1001411-	3.2	2	2546	100	QPSK/16QAM	96.568
100MHz NR	3.1	2	2593	100	64QAM	97.306
INK	3.1a	2	2660	100	256QAM	97.479

Tabular Data – 1 Carrier Occupied Bandwidth

4.1.1 Occupied Bandwidth – Plots

<u>Channel Frequ</u>	ency 252	26 MHz, №	1odulat	ion 640	
Keysight Spectrum Analyzer - Occupied BW RF 50 Ω AC Center Freq 2.526000000 Gate: L0	Trig:		Rad d: 100/100	41:32 PM May 05, 2020 io Std: None io Device: BTS	Frequency
10 dB/div Ref 40.00 dBm Log 20.0 10.0	hryfferfaldet fils ynhyf	had participation of the state	N^{ad}Majaylana tin	hun	Center Freq 2.52600000 GHz
-10.0 -20.0 -30.0 -40.0				Niliver'	
Center 2.526 GHz #Res BW 620 kHz		/BW 6 MHz		Span 70 MHz Sweep 1 ms	CF Step 7.000000 MH; <u>Auto</u> Mar
	.826 MHz	Total Power	42.5 dB		Freq Offset
Transmit Freq Error x dB Bandwidth	323.06 kHz 59.36 MHz	% of OBW Pow x dB	ver 99.00 -26.00 c		0 H2
MSG			STATUS		

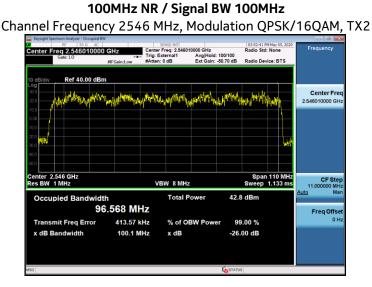
60MHz NR / Signal BW 60MHz

Channel Frequency 2593 MHz, Modulation QPSK/16QAM, TX2

Keysight Sper	ctrum Analyzer - Occ										6 X
LX0	RF 50 Ω	AC	_		NSE:INT reg: 2.59302	0000 011-		08:34:11 PM Radio Std:	May 05, 2020	Frequ	encv
Center Fr	eq 2.59302	0000 GF	Z			Avg Hold	: 100/100	Radio Std:	None		
	Gale. EO	#IF(Gain:Low	#Atten: 2	dB	Ext Gain:	-50.70 dB	Radio Devi	e: BTS		
10 dB/div	Ref 40.0	0 dBm									
Log											
30.0	الريقية المربقة	n, altra la su	a cold.	dia na ak	a de antal	ab., Jost (Ja	والم المقارسة	a dank ia			ter Freq
20.0	MAY PRIM	Wallin Pris	网络科科科	t w W W	WARK ALLAN	ed the shaft	riir ann	(Martin Martin		2.593020	0000 GH;
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0.00	<u> </u>								1		
-10.0											
-20.0											
and WWW									Wildes		
40.0											
-50.0											
Center 2.	593 GHz							Snar	70 MHz		
#Res BW				VB	W 6 MHz				ep 1 ms		CF Step
										Auto	Man
Occup	bied Band	width			Total P	ower	42.	5 dBm			
		57 8	78 MI	17							
										Fre	q Offset 0 Hz
Transn	nit Freq Err	or	5.580 I	(Hz	% of O	3W Pow	er 9	9.00 %			0 H2
x dB B	andwidth		59.43 N	IHz	x dB		-26	.00 dB			
MSG							STATU	IS			

Channel Frequency 2660 MHz, Modulation 256QAM, TX2

Keysight Spectrum Analyzer - Occupied I RF 50 Ω AC	3W	SENSE:INT			May 06, 2020	
Center Freq 2.66000000		Center Freq: 2.66000	00000 GHz	Radio Std:		Frequency
Gate: LO	++-	Trig: External1	Avg Hold: 100/100			
	#IFGain:Low	#Atten: 2 dB	Ext Gain: -50.70 d	B Radio Devi	ce: BTS	
0 dB/div Ref 40.00 dB	m					
.og						
		a contractions	and the same at the s	1.1.1.1.0.1		Center Fre
0.0 ———————————————————————————————————	新生的 "新用的	ining the second second	的机构体机能力	地的地位		2.66000000 G
	e i dir surd	14 Y 1. 11	ate, it sollare	tool most of the	N I	
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10.0						
20.0					1	
0.0 TTMP					Part A	
0.0						
50.0						
50.0						
enter 2.66 GHz				Spar	70 MHz	05.04
Res BW 620 kHz		VBW 6 MHz		Swe	ep 1 ms	CF Ste 7.000000 M
						Auto Mi
Occupied Bandwid	th	Total P	ower 4	2.5 dBm		
	7.666 MH	-				
J	7.000 IVIT	Z				Freq Offs
Transmit Freq Error	-133.87 kl	Hz % of O	BW Power	99.00 %		01
x dB Bandwidth	59.46 MI	Hz xdB	-2	26.00 dB		
36			L ST	- No 10		
56			10 ST/	lius		



Channel Frequency 2593 MHz, Modulation 64QAM, TX2

Keysight Spectrum Analyzer - Occupied	BM				
RF 50 Ω AC Center Freq 2.59302000 Gate: L0 Gate: L0	Trig	SENSE:INT ter Freq: 2.593020000 GHz p: External1 Avg/Ho		PM May 05, 2020 f: None	Frequency
Gate. LO	#IFGain:Low #Att		in: -50.70 dB Radio De	vice: BTS	
0 dB/div Ref 40.00 dE	100				
demokrative and the	under Western where	ahanahadi hahan daga	heither the black die be	ama 2	Center Fre 593020000 GH
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.00					
0.0					
				Val.	
0.0					
0.0					
enter 2.593 GHz			Spar	n 110 MHz	CF Ste
es BW 1 MHz		VBW 8 MHz		1.133 ms	11.000000 MH
Occupied Bandwid	ith	Total Power	42.7 dBm	Aut	2 Ma
9	7.306 MHz				Freq Offs
Transmit Freg Error	57.508 kHz	% of OBW Po	wer 99.00 %		01
x dB Bandwidth	100.2 MHz	x dB	-26.00 dB		
X dB Balluwidul	100.2 MHZ	A UB	-20.00 uB		
iG			STATUS		

Channel Frequency 2660 MHz, Modulation 256QAM, TX2

Keysight Spectrum Analyzer - Occupied	BM				
Center Freq 2.64000000 Gate: LO	10 GHz	SENSE:INT Center Freq: 2.64000 Trig: External1 #Atten: 0 dB	00000 GHz Avg Hold: 100/100 Ext Gain: -50.70 dB	Radio Device: BTS	Frequency
10 dB/div Ref 40.00 dE					
	ysieltingepoolekele	anachterqua	Mere Maldaportal april ta pipela	atupogetili ventropa	Center Freq 2.64000000 GHz
10.0					
40.0					
Center 2.64 GHz Res BW 1 MHz		VBW 8 MHz	· · · · · · · · · · · · · · · · · · ·	Span 110 MH: Sweep 1.133 ms	
Occupied Bandwig		Total P	ower 42.	6 dBm	<u>Auto</u> Man
9	7.479 MH	Z			Freq Offset
Transmit Freq Error	-113.43 ki	Hz % of O	BW Power 9	9.00 %	0 Hz
x dB Bandwidth	99.97 Mł	Hz xdB	-26	.00 dB	
SG			STATU	IS	

4.2 Edge of band Emissions

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and test coupler. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths. The Top of Mask corresponds to the set rated power level as confirmed by the RF power meter.

4.2.1 Edge of Band Emissions - Plots.

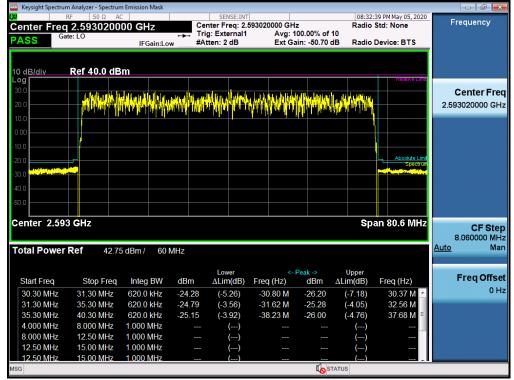
All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.

	ctrum Analyzer - Spect	rum Emission Mask	-	-					
	RF 50 Ω req 2.526000 Gate: LO	000 GHz	Trig	: External1	26000000 GHz Avg: 10	0.00% of 1	Radio S	9 PM May 05, 2020 Std: None	Frequency
PASS		IFGain:L	ow #At	ten: 2 dB	Ext Gai	n: -50.70 d	IB Radio I	evice: BTS	
10 dB/div	Ref 40.0 c	IBm							
Log		and the	11-11	ath a				Relative Limit	Center Freq
20.0					"which and the first of the second		Wardelt		2.526000000 GHz
10.0 0.00									
-10.0									
-20.0								Absolute Limit	
-30.0									
-50.0									
Center 2.	526 GH7						Spa	n 80.6 MHz	
									CF Step 8.060000 MHz
Total Pov	ver Ref 42	.70 dBm / 60	MHz						<u>Auto</u> Man
Start Freq	Stop Fre	g Integ BW	dBm	Lower ∆Lim(dB)	<- P Freg (Hz)	eak -> dBm	Upper ∆Lim(dB)	Freq (Hz)	Freq Offset
30.30 MH	•		-24.65	(-5.63)	-31.23 M	-23.93	(-4.91)	30.62 M	0 Hz
31.30 MH			-23.98	(-2.75)	-34.04 M	-23.97	(-2.73)	31.96 M	
35.30 MH	z 40.30 MHz	620.0 kHz	-27.45	(-6.21)	-35.55 M	-25.12	(-3.88)	38.90 M ≡	
4.000 MH				()			()		
8.000 MH				()			()		
12.50 MH				()			()		
12.50 MH	z 15.00 MHz	1.000 MHz		()		-	()		
MSG						I 🚺 ST	ATUS		

Channel Frequency 2526 MHz / Signal BW 60 MHz

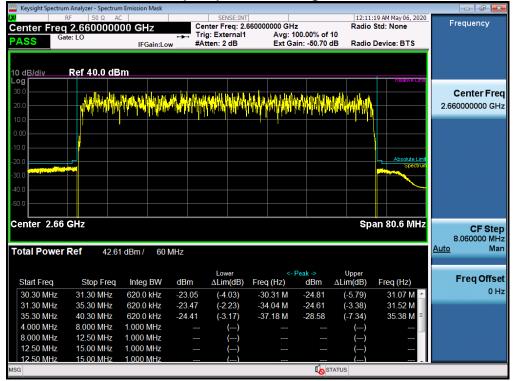
Global Product Compliance Laboratory

Report No.: TR-2020-0056-FCC2-27 Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G



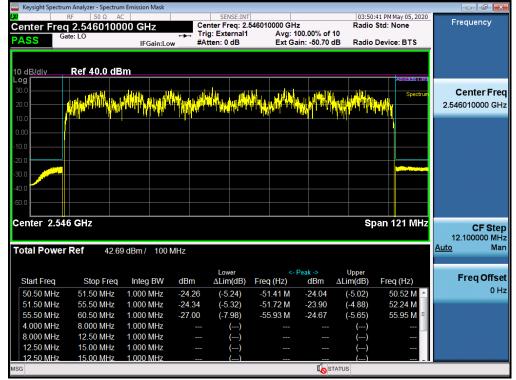
Channel Frequency 2593 MHz / Signal BW 60 MHz

Channel Frequency 2660 MHz / Signal BW 60 MHz



Global Product Compliance Laboratory

Report No.: TR-2020-0056-FCC2-27 Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G



Channel Frequency 2546 MHz / Signal BW 100 MHz

Channel Frequency 2593 MHz / Signal BW 100 MHz

	m Analyzer - Spectru								
Center Fred	RF 50 Ω A 2.5930200 ate: LO		Trig	SENSE:INT Iter Freq: 2.8 g: External1 ten: 0 dB		0.00% of n: -50.70	Radio 10	13 PM May 05, 2020 Std: None Device: BTS	Frequency
10 dB/div	Ref 40.0 dE	3m							•
20.0	ere Honord Anne	at a Nilaw (at last)		<u>, ek nev stude</u>	and the second second	1 <mark>1</mark> 141 144	,		Center Freq 2.593020000 GHz
10.0 0.00 -10.0									
-20.0									
-40.0									
Center 2.59 Total Power		5 dBm / 100	MHz				Sp	oan 121 MHz	CF Step 12.100000 MHz Auto Man
Start Freq	Stop Freq	Integ BW	dBm	Lower ∆Lim(dB)	<- P Freq (Hz)	eak -> dBm	Upper ∆Lim(dB)	Freq (Hz)	Freq Offset
50.50 MHz	51.50 MHz	1.000 MHz	-22.92	(-3.90)	-51.41 M	-24.45	(-5.43)	50.59 M	0 Hz
51.50 MHz	55.50 MHz	1.000 MHz	-23.48	(-4.46)	-51.72 M	-24.31	(-5.29)	52.70 M	
55.50 MHz	60.50 MHz	1.000 MHz	-23.87	(-4.85)	-58.80 M	-24.93	(-5.91)	55.58 M ≡	
4.000 MHz	8.000 MHz	1.000 MHz		()			()		
8.000 MHz 12.50 MHz	12.50 MHz 15.00 MHz	1.000 MHz 1.000 MHz		()			()		
12.50 MHZ 12.50 MHz	15.00 MHz	1.000 MHz		() ()			() ()		
						4	TATUS	-	and the second se

	trum Analyzer - Spect	rum Emission	Mask							
	RF 50 Ω eq 2.640000 Gate: 10	AC 0000 GH			SENSE:IN Iter Freq: 2 g: External1	.640000000 GI	Hz 100.00% of	Radio	:22 PM May 05, 2020 Std: None	Frequency
ASS	Gate: LU	IFO	Gain:Low		ten: 0 dB		ain: -50.70		Device: BTS	
0 dB/div	Ref 40.0 d	IBm							sasalokati mi	-
- og 30.0 20.0			Nation		u thur h u	un in the second se	r fi franklikert, kird	htp://thi	Spectrum	Center Fre 2.640000000 GH
10.0 0.00 10.0										
20.0	1									
enter 2.6		47 dDm /	100 MU					SI	pan 121 MHz	12.100000 M
enter 2.6		.47 dBm /	100 MH	z				SI	pan 121 MHz	12.100000 M
0.0 Senter 2.6				z	Lower <u> <u> </u> </u>		- Peak -> dBm	Upper ΔLim(dB)	pan 121 MHz Freq (Hz)	12.100000 M Auto M Freq Offs
Center 2.6	er Ref 42. Stop Free z 51.50 MHz	q Integ : 1.000	BW o MHz -	IBm 22.89	ΔLim(dB) (-3.87)	Freq (Hz) -50.54 M	dBm -24.23	Upper ∆Lim(dB) (-5.21)	Freq (Hz) 50.52 M 🚄	12.100000 Mi Auto M
Start Freq 50.50 MHz 51.50 MHz	er Ref 42. Stop Free 51.50 MHz 55.50 MHz	q Integ : 1.000 : 1.000	BW c MHz - MHz -	IBm 22.89 23.60	∆Lim(dB) (-3.87) (-4.58)	Freq (Hz) -50.54 M -54.30 M	dBm -24.23 -24.72	Upper ΔLim(dB) (-5.21) (-5.70)	Freq (Hz) 50.52 M ▲ 52.48 M	12.100000 Mi Auto M
Cotal Power Start Freq 50.50 MHz 51.50 MHz 55.50 MHz	er Ref 42 Stop Free 2 51.50 MHz 2 55.50 MHz 2 60.50 MHz	q Integ 1.000 1.000 1.000	BW c MHz MHz MHz	IBm 22.89	ΔLim(dB) (-3.87) (-4.58) (-4.66)	Freq (Hz) -50.54 M	dBm -24.23	Upper ΔLim(dB) (-5.21) (-5.70) (-9.00)	Freq (Hz) 50.52 M 🚄	12.100000 Mi Auto M
Cotal Power Start Freq 50.50 MHz 51.50 MHz 4.000 MHz	er Ref 42 Stop Free 51.50 MHz 55.50 MHz 60.50 MHz 8.000 MHz	q Integ 1.000 1.000 1.000 1.000	BW c MHz - MHz - MHz - MHz -	IBm 22.89 23.60	ΔLim(dB) (-3.87) (-4.58) (-4.66) ()	Freq (Hz) -50.54 M -54.30 M	dBm -24.23 -24.72	Upper ∆Lim(dB) (-5.21) (-5.70) (-9.00) ()	Freq (Hz) 50.52 M ▲ 52.48 M	12.100000 M Auto M Freq Offs
50.50 MHz 51.50 MHz 55.50 MHz 4.000 MHz 8.000 MHz	er Ref 42. Stop Free 51.50 MHz 55.50 MHz 60.50 MHz 60.50 MHz 2 8.000 MHz 2 12.50 MHz	q Integ 1.000 1.000 1.000 1.000 1.000 1.000	BW c MHz MHz MHz MHz MHz MHz	IBm 22.89 23.60	ΔLim(dB) (-3.87) (-4.58) (-4.66) () ()	Freq (Hz) -50.54 M -54.30 M	dBm -24.23 -24.72	Upper ΔLim(dB) (-5.21) (-5.70) (-9.00) () ()	Freq (Hz) 50.52 M ▲ 52.48 M	12.100000 MI
Center 2.6 Cotal Power Start Freq 50.50 MHz 51.50 MHz 55.50 MHz 4.000 MHz	er Ref 42. Stop Free 55.50 MHz 60.50 MHz 60.50 MHz 2 8.000 MHz 2 12.50 MHz 2 12.50 MHz	q Integ 1.000 1.000 1.000 1.000 1.000 1.000	BW C MHz MHz MHz MHz MHz MHz MHz	IBm 22.89 23.60	ΔLim(dB) (-3.87) (-4.58) (-4.66) ()	Freq (Hz) -50.54 M -54.30 M	dBm -24.23 -24.72	Upper ∆Lim(dB) (-5.21) (-5.70) (-9.00) ()	Freq (Hz) 50.52 M ▲ 52.48 M	12.100000 Mi Auto Mi

Channel Frequency 2640 MHz / Signal BW 100 MHz

5. FCC Section 2.1051 - Spurious Emissions at Transmit Antenna Port

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 10 GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a coupled RF Power Meter.

The required emission limitation is specified as appropriate in 27.53. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. There were no reportable emissions. Data below documents performance up to 27 GHz.

5.1.1 Spurious Emissions at Tx Port - Plots

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

🔤 Keysight Spe	ectrum Analyzer	- Spurious Emissions					
Zenter F PASS		50 Ω ▲ DC 8020000 GHz IFGain	Center Fro		Radio 25/25	12 PM May 05, 2020 Std: None Device: BTS	Frequency
15 dB/div Log	Ref 2	5.00 dBm				6447 MHz .599 dBm	
-5.00							Center Free 2.593020000 GH
-20.0 -35.0 -50.0	1						
-65.0	an a	an de se de la constant de la const La constant de la cons	ng manyang sa kanang na kanang na kanang na	nya ing kang diang ping ping ping ping ping ping ping pi	et de stel des en gistigen des pris en franzis	ana ila da aya kara ta nya kara ta	
-95.0							
Start 9 kl	Hz				<u> </u>	Stop 30 MHz FFT	CF Ste 7.000000 MH
Spur	Range	Frequency	Amplitude	Limit	Δ Limit		<u>Auto</u> Ma
1	1	3.645 MHz	-54.81 dBm	-22.00 dBr	n -32.81 di	3	
2	1	7.440 MHz	-55.73 dBm	-22.00 dBr	n -33.73 di	3	FreqOffse
3	1	3.795 MHz	-55.94 dBm	-22.00 dBr			0 H
4	1	22.15 MHz	-57.22 dBm	-22.00 dBr	n -35.22 di	3	
5	1	28.35 MHz	-57.35 dBm	-22.00 dBr			
6	1	21.47 MHz	-57.88 dBm	-22.00 dBr			
7	1	25.19 MHz	-58.03 dBm	-22.00 dBr	n -36.03 de	3 .	
🗤 sg 🤃 File •	<spurious_1< td=""><td>FM3_2_1C_60MB</td><td>W_2593_TX2_0_to_</td><td>_30.png> saved</td><td>To STATUS 1. DC</td><td>Coupled</td><td></td></spurious_1<>	FM3_2_1C_60MB	W_2593_TX2_0_to_	_30.png> saved	To STATUS 1. DC	Coupled	

60MHz NR Spurious TM3 2 1C 60MBW 2593 TX2 0 to 30

- K - 1 - K			<u>1115_2_1C_</u>	00MBW_2593		<u> </u>	1000		
Keysight Spe		- Spurious Emissions 50 Ω AC	SE	NSE:INT		08:40:41 P	M May 05, 2020	_	
Center F		3020000 GHz	Center Fr	req: 2.593020000 GHz		Radio Std:		Ra	nge Table
PASS	Gate: LO		Trig: Ext						Dama
TASS		IFGain	:Low #Atten: 2	dB Ext Gain:	-50.20 dB	Radio Dev			Rang
							00 MHz	On	Of
15 dB/div	Ref 0	.00 dBm				-48.6	58 dBm		
Log									
-15.0									Start Fre
-30.0 🗧 🕇								30	0.000000 MH
-45.0 🔶 📥								_	
-60.0									
									Stop Fre
-75.0								1.00	0000000 GH
-90.0									
-105									
-120									Res BI 100.00 kH
-135								Auto	Ma
155									
Start 30 I	MHz					St	op 1 GHz		Video B
									300.00 kH
								Auto	Ma
Spur	Range	Frequency	Amplitude	Limit	4	Limit			
1	1	36.40 MHz	-48.66 dBm	-22.00 dB	m -20	6.66 dB			
2	1	890.0 MHz	-48.91 dBm	-22.00 dB	m -20	6.91 dB		I	Filter Type
									Gaussian
									Mo
									1 of
				1000	F 1	-			
isg 🜙 File <	<spurious_< td=""><td>IM3_2_1C_60MBV</td><td>/V_2593_TX2_30_t</td><td>o_1000.png> saved</td><td></td><td>5</td><td></td><td></td><td></td></spurious_<>	IM3_2_1C_60MBV	/V_2593_TX2_30_t	o_1000.png> saved		5			

Spurious_TM3_2_1C_60MBW_2593_TX2_30_to_1000

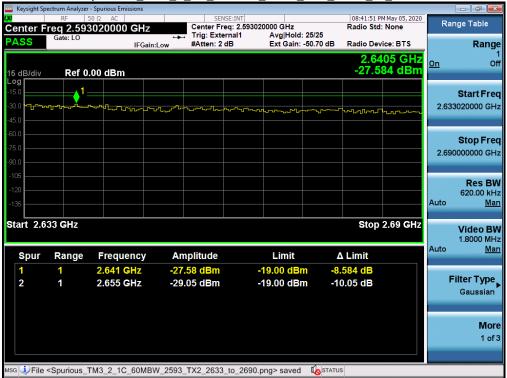
Spurious_TM3_2_1C_60MBW_2593_TX2_1000_to_2496



RF	3020000 GHz	Center Freq:	: 2.593020000 GHz al1 Avg Hold: 25	Radio Sto 5/25	I: None	Ra	nge Table Rang
Ref 0	.00 dBm			2.52 -29.7	245 GHz ′37 dBm	<u>On</u>	0
	~		~16~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	,1 		2.49	Start Fre 6000000 G⊦
						2.53	Stop Fre 3020000 GH
						Auto	Res B 620.00 kl <u>M</u> :
96 GHz				Stop 2	2.533 GHz		Video B 1.8000 M
Range	Frequency	Amplitude	Limit	∆ Limit		Auto	M
1 1	2.525 GHz 2.516 GHz	-29.74 dBm -29.91 dBm	-19.00 dBm -19.00 dBm	-10.74 dB -10.91 dB		F	Filter Type Gaussiar
							Mo 1 o
	Ref 0 Ref 0 96 GHz Range	RF 50 Ω AC req 2,593020000 GHz IFGain: Ref 0.00 dBm IFGain: 96 GHz IFGain: Range Frequency 1 2,525 GHz	Ref 50 Ω AC SENSE Ref 0.00 dBm #Atten: 2 dB Ref 0.00 dBm 96 GHz Range Frequency Amplitude 1 2.525 GHz -29.74 dBm	RF 50 Ω AC SENSE:INT req 2,593020000 GHz Trig: 2,593020000 GHz Trig: 2,593020000 GHz Avg Hold: 2/ Gate: L0 IFGain:Low #Atten: 2 dB Ext Gain: -50 Ref 0.00 dBm IFGain:Low #Atten: 2 dB Ext Gain: -50 96 GHz IFGain:Low Iffair Comparison of the second of the s	RF 50 Ω AC SENSE.INT 08:41:53 Gate: L0 IFGain:Low Center Freq: 2.593020000 GHz Avg[Hold: 25/25] Radio Str Trig: External Avg[Hold: 25/25] Ext Gain: -50.70 dB Radio De Ref 0.00 dBm -2.57 -29.7 -29.7 IFGain:Low If Gain: Low If Gain: Low If Gain: Low If Gain: Low 96 GHz Stop Stop Stop If Gain: Low If Gain: Low 96 GHz Stop Stop If Gain: Low 96 GHz Stop If Gain: Low If Gain: Low<	RF 50 Ω AC SENSE:INT 08:41:53 PM May 05, 2020 Gate: L0 Frig.in:Low Center Freq: 2.693020000 GHz Radio Std: None Radio Std: None Gate: L0 IFGain:Low Frig.in:Low Trig: External Avg[Hold: 28/25] Radio Device: BTS Ref 0.00 dBm -2.5245 GHz -29.737 dBm 06 GHz 0 </td <td>RF 50 Ω AC SENSE:INT 08:41:53 PMMay 05, 2020 Radio Std: None Gate: L0 IFGain:Low Frig: 2,593020000 GHz Avg[Hold: 25/25] Radio Device: BTS on Ref 0.00 dBm -29.737 dBm -29.737 dBm 0n 2.49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>	RF 50 Ω AC SENSE:INT 08:41:53 PMMay 05, 2020 Radio Std: None Gate: L0 IFGain:Low Frig: 2,593020000 GHz Avg[Hold: 25/25] Radio Device: BTS on Ref 0.00 dBm -29.737 dBm -29.737 dBm 0n 2.49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Spurious_TM3_2_1C_60MBW_2593_TX2_2496_to_2533

Spurious_TM3_2_1C_60MBW_2593_TX2_2633_to_2690





🔤 Keysight Spe		Spurious Emission	s						-		
Center Fr		0 Ω AC 020000 GI	lz	Center Fr	NSE:INT eq: 2.593020			08:41:49 P Radio Std	M May 05, 2020 None	Rai	nge Table
PASS	Gate: LO			Trig: Externant #Atten: 2		Avg Hold: Ext Gain:		Radio Dev	ice: BTS		Range
15 dB/div	Ref 0.	00 dBm							00 GHz 96 dBm	<u>On</u>	ັ1 Off
-15.0 1 -30.0 -45.0										2.69	Start Freq 0000000 GHz
-60.0 -75.0 -90.0										10.00	Stop Freq 0000000 GHz
-105 -120 -135										Auto	Res BW 1.0000 MHz <u>Man</u>
Start 2.69	9 GHz							Sto	p 10 GHz		Video BW 3.0000 MHz
Spur	Range	Frequenc	y A	mplitude		Limit	4	Limit		Auto	<u>Man</u>
1	1	2.690 GHz	: -3	0.90 dBm	-3	22.00 dBr	n -8.	.896 dB		F	Gaussian
											More 1 of 3
мsg 🧼 File <	<spurious_t< td=""><td>M3_2_1C_60</td><td>MBW_259</td><td>3_TX2_2690</td><td>_to_10000.</td><td>png> saved</td><td>d 🕼 statu:</td><td>s</td><td></td><td></td><td></td></spurious_t<>	M3_2_1C_60	MBW_259	3_TX2_2690	_to_10000.	png> saved	d 🕼 statu:	s			

Spurious_TM3_1_1C_60MBW_2593_TX2_10000_to_27000



Keysight Spe	ectrum Analyzer	- Spurious Emissions	<u></u>	10011011_25	<u>55_172_0_0</u>	0_30	
Center Fi		0 Ω <u>∧</u> DC 8020000 GHz	Trig: Externa	: 2.593020000 GHz al1 Avg Hold:>	Radio Sto 25/25		Range Table
5 dB/div	Ref 0.	IFGain: 00 dBm	LowAtten: 0 dB	Ext Gain: -	114		Rang On O
-og 15.0 30.0 - 1							Start Fre 9.000 kH
60.0	n genericatif termer	jela grjulane min antinistriti manadin	elation of the state of the sta				Stop Fre 30.000000 M⊦
-105							Res BI 10.000 k⊢ Auto <u>Ma</u>
Start 9 kl		_				p 30 MHz FFT	Video B 30.000 kH Auto <u>Ma</u>
Spur	Range	Frequency	Amplitude	Limit	∆ Limit		
1	1	114.0 kHz	-40.89 dBm	-19.00 dBm		Â	Filter Type
2	1	179.0 kHz	-46.36 dBm	-19.00 dBm			Gaussian
3	1	289.1 kHz	-47.95 dBm	-19.00 dBm		E	
4 5	1 1	259.1 kHz 354.1 kHz	-49.94 dBm -50.52 dBm	-19.00 dBm -19.00 dBm			
6	1	11.31 MHz	-51.36 dBm	-19.00 dBm			Мо
7	1	619.1 kHz	-51.36 dBm	-19.00 dBm			1 oi
🛛 🗘 File •	<spurious_t< td=""><td>M3_1_1C_100MB</td><td>W_2593_TX2_0_to_3</td><td>0.png> saved</td><td>To STATUS</td><td>upled</td><td></td></spurious_t<>	M3_1_1C_100MB	W_2593_TX2_0_to_3	0.png> saved	To STATUS	upled	

100MHz NR Spurious TM3 1 1C 100MBW 2593 TX2 0 to 30

Spurious_TM3_1_1C_100MBW_2593_TX2_30_to_1000







Spurious_TM3_1_1C_100MBW_2593_TX2_2653_to_10000



Spurious TM3 1 1C 100MBW 2593.02 TX2 10000 to 27000

Keysight Spe		- Spurious Emissi	ons			1					
Center Fi		50 Ω AC 3020000 0	GHz	Center Fr	ISE:INT eq: 2.59302			04:13:38 P Radio Std	MMay 06, 2020 : None	Ra	nge Table
PASS	Gate: LO		IFGain:Low	+++ Trig: Exte #Atten: 2		Avg Hold Ext Gain:		Radio Dev	rice: BTS		Range
15 dB/div Log	Ref 0.	.00 dBm						25.6 -48.2	50 GHz 24 dBm	<u>On</u>	1 Off
-15.0 -30.0 -45.0										10.00	Start Freq 0000000 GHz
-60.0 -75.0 -90.0										27.00	Stop Freq 0000000 GHz
-105 -120 -135										Auto	Res BW 1.0000 MHz <u>Man</u>
Start 10 (GHz							Sto	p 27 GHz		Video BW 3.0000 MHz
Spur	Range	Frequer	icy	Amplitude		Limit	Δ	Limit		Auto	<u>Man</u>
1	1	25.65 Gł	iz ·	-48.22 dBm	-	22.00 dBr	n -20	5.22 dB		F	Filter Type Gaussian
											More 1 of 3
MSG							I STATUS				

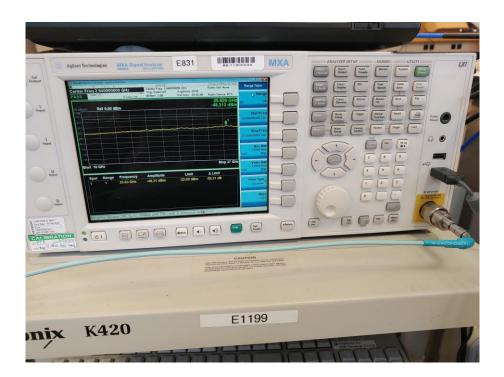
Global Product Compliance Laboratory Report No.: TR-2020-0056-FCC2-27

Photographs

Product: AWHHF Single Carrier 60 & 100 MHz 4x20W 5G







Asset ID	Manufacturer Type		Description	Model	Serial	Calibration Date	Calibration Due
E831	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz	N9020A	MY48011791	2018-02-15	2020-05-15
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2019-01-31	2021-01-31
E1208	RLC Electronics Inc	Filter, High Pass	2.5 - 26 GHz	F-19391	1440-001	CNR-V	CNR-V
E1237	Weinschel	Attenuator	10dB 25 Watt	46-10-34	BH8105	CNR-V	CNR-V
E583	Weinschel	Attenuator	10dB 25W DC-18 GHz	46-10-34	BL7552	2018-05-23	2020-05-23
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065	CNR-V	CNR-V

Test Equipment

CNR: Calibration Not Required

CNR-V: Calibration Not Required, must be Verified

6. FCC Section 2.1053 - Field strength of spurious radiation

6.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in an FCC registered 3m Semi-Anechoic Chamber which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. A complete description and full measurement data for the site is on file with the Commission (Site Registration Number: 515091).

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 10 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

6.2 Field Strength of Spurious Emissions - Limits

Sections 2.1053 and 27.53 contain the requirements for the levels of spurious radiation as a function of the level of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an ideal dipole excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 676, 4th edition, IT&T Corp.

E= [(30*P)^{1/2}]/R

20 log (E*10⁶) – (43 + 10 log P) = 82.23 dBµV/meter

Where:

E = Field Intensity in Volts/meter P = Transmitted Power in Watts R = Measurement distance in meters = 3 m

The Part 27 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m The Part 27 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

Measured level (dB μ V) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dB μ V/m)

RESULTS:

For compliance with 47CFR Parts 2 and 27, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dB μ V/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dB μ V/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 10 GHz), no reportable spurious emissions were detected.

7. NVLAP Certificate of Accreditation

