

Global Product Compliance Laboratory 600-700 Mountain Avenue Room 5B-108 Murray Hill, New Jersey 07974-0636 USA



# Title 47 Code of Federal Regulations Test Report

Regulation: FCC Part 2 and 27

<u>Client:</u> Nokia Mobile Networks

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

> Report Number: TR-2019-0189-FCC2-27

> > Date Issued: January 21, 2020

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## Revisions

Date	Revision	Section	Change
1/21/20	0		Initial Release

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1/21/2020

## 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.

quipment Under Test (EUT):AWHHF Airscale Micro RRH 4T4R 5G n41 4x20Werial Number:EB193661018CC ID:2AD8UAWHHF01lardware Version:475181A.X22oftware Version:5G19Arequency Range:2496-2690 MHziPCL Project Number:2019-0189Manufacturer:NOKIA SOLUTIONS AND NETWORKS OY KARAPORTTI 3, FI-02610 ESPOO FINLANDrest Requirement(s):Title 47 CFR Parts 2 and 27•Title 47 CFR Parts 2 and 27			
CC ID:2AD8UAWHHF01lardware Version:475181A.X22oftware Version:5G19Arequency Range:2496-2690 MHziPCL Project Number:2019-0189Manufacturer:NOKIA SOLUTIONS AND NETWORKS OY KARAPORTTI 3, FI-02610 ESPOO FINLANDrest Requirement(s):Title 47 CFR Parts 2 and 27			
Image:       475181A.X22         oftware Version:       5G19A         requency Range:       2496-2690 MHz         IPCL Project Number:       2019-0189         Manufacturer:       NOKIA SOLUTIONS AND NETWORKS OY         KARAPORTTI 3, FI-02610 ESPOO         FINLAND         Test Requirement(s):			
oftware Version:       5G19A         requency Range:       2496-2690 MHz         iPCL Project Number:       2019-0189         fanufacturer:       NOKIA SOLUTIONS AND NETWORKS OY         KARAPORTTI 3, FI-02610 ESPOO         FINLAND         rest Requirement(s):			
requency Range:       2496-2690 MHz         iPCL Project Number:       2019-0189         fanufacturer:       NOKIA SOLUTIONS AND NETWORKS OY         KARAPORTTI 3, FI-02610 ESPOO         FINLAND         rest Requirement(s):			
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KARAPORTTI 3, FI-02610 ESPOO         FINLAND         Title 47 CFR Parts 2 and 27			
FINLAND         est Requirement(s):       Title 47 CFR Parts 2 and 27			
est Requirement(s):     Title 47 CFR Parts 2 and 27			
• Title 47 CFR Parts 2 and 27			
<ul> <li>KDB 971168 D01 Power Measurement License Digital Systems</li> </ul>			
v03r01 April 9, 2018.			
<ul> <li>KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013</li> </ul>			
<ul> <li>ANSI C63.26 (2015)</li> </ul>			
• ANSI C63.4 (2014)			
Ieasurement 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):December 2019 – January 2020			
est Performed By: Nokia			
Global Product Compliance Laboratory			
600-700 Mountain Ave.			
P.O. Box 636			
Murray Hill, NJ 07974-0636			
roduct Engineer(s): Jeff Webb			
ead Engineer: Steve Gordon			
fest Engineer (s):       Steve Gordon, Joe Bordonaro, Nilesh Patel			
est 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			
roduct Compliance Laboratory in New Providence, NJ.			

## 1.1 Introduction

This Conformity test report applies to the AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W, hereinafter referred to as the Equipment Under Test (EUT).

## 1.2 Purpose and Scope

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

## 1.3 EUT Details

## 1.3.1 Specifications

Specification Items	Description		
Radio Access Technology	LTE-TDD, 5G NR		
Duplex Mode	Time Division Duplex (TDD)		
Modulation Type(s)	QPSK 16QAM 64QAM 256QAM		
<b>Operation Frequency Range</b>	2496-2690 MHz		
Channel Bandwidth	40 MHz		
Number of Tx Ports per Unit	4		
МІМО	Yes		
Deployment Environment	Outdoor		
Supply Voltage	-48.0 VDC		

PUBLIC

#### **Global Product Compliance Laboratory** Report No.: TR-2019-0189-FCC2-27 Product: AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W

## 1.3.2 Photographs

Front View



## Left View



#### Rear View



## **Right View**



PUBLIC

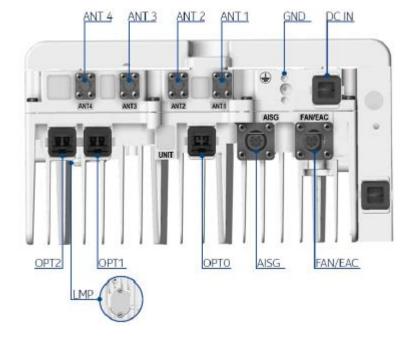
#### Global Product Compliance Laboratory Report No.: TR-2019-0189-FCC2-27 Product: AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W

Top View



**Bottom View** 





Interface	Label on the HW	Number of interfaces	Connector type	Additional info
Power Connector	DC IN	1	DC OCTIS Plug Kit	Hot insert not supported
Antenna connector	ANT	4	NEX 10	-
External Alarm Connection/Fan	EAC/FAN	1	CIRC 8F IP67 Flange	Two external alarms supported
Optical interface	OPT	3	OCTIS Plug Kit SFP/SFP+	9.8 Gbps, CPRI
Ethernet	RJ	1	RJ45	-
Grounding	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**

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 27.53	RF Power Output	Yes
2.1047, 27.53	Modulation Characteristics	Yes
2.1049, 27.53	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 27.53	Spurious Emissions at Antenna Terminals	Yes
2.1053, 27.53	Field Strength of Spurious Radiation	Yes
2.1055, 27.53	Frequency Stability	Yes

## 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-0B 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**

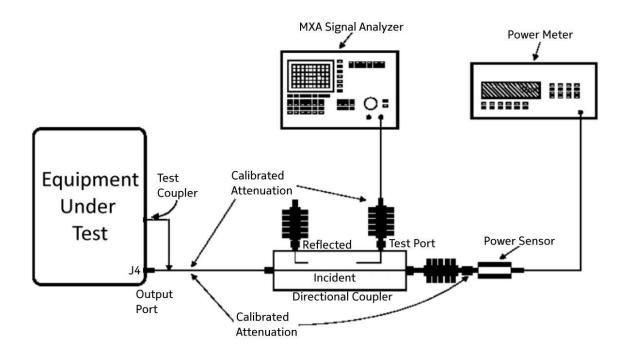
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
	10 Hz	9 kHz to 20 MHz	
Occupied Bandwidth, Edge of Band,	100 Hz	20 MHz to 1 GHz	1.78 dB
Conducted Spurious Emissions	10 kHz to 1 MHz	1 GHz to 10 GHz	1.70 UD
	1MHz	10 GHz to 40 GHz:	
RF Power	10 Hz to 20 MHz	50 MHz 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	COMPLIES
	Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth	COMPLIES
	(b) Edge of Band Emissions	
2.1051, 27.53	Spurious Emissions at Antenna	COMPLIES
	Terminals	
2.1053, 27.53	Field Strength of Spurious Radiation	COMPLIES
2.1055, 27.53	Frequency Stability	COMPLIES

- 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

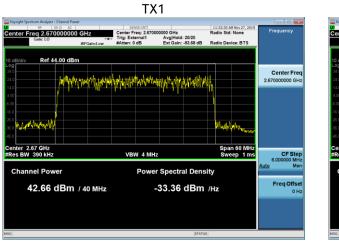
This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

Power measurements were made with an MXA Signal Analyzer.

ТМ	тх	Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
1.1	1	2670	40	QPSK	42.66
1.1	2	2670	40	QPSK	42.53
1.1	3	2670	40	QPSK	42.38
1.1	4	2670	40	QPSK	42.99
3.1a	1	2670	40	256QAM	42.73
3.1a	2	2670	40	256QAM	42.79
3.1a	3	2670	40	256QAM	42.64
3.1a	4	2670	40	256QAM	42.69
3.2	1	2593	40	QPSK/16QAM	42.62
3.2	2	2593	40	QPSK/16QAM	42.46
3.2	3	2593	40	QPSK/16QAM	42.36
3.2	4	2593	40	QPSK/16QAM	42.38
3.1	1	2516	40	64QAM	42.73
3.1	2	2516	40	64QAM	42.4
3.1	3	2516	40	64QAM	42.8
3.1	4	2516	40	64QAM	42.92

Tabular Data – Channel RF Power

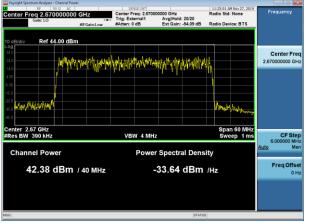
## 2.1.1 Channel RF Power - Plots



#### TX2 11:28:29 AM Nov 27 Radio Std: None er Freq 2.6700 2.67 000 GH Radio Device: BTS Ref 44.00 dBm Center Free 2.670 mnW. 4. Center 2.67 GHz #Res BW 390 kH Span 60 MHz Sweep 1 ms VBW 4 MHz CF Ste **Channel Power** Power Spectral Density Freq Offs 42.53 dBm / 40 MHz -33.49 dBm /Hz

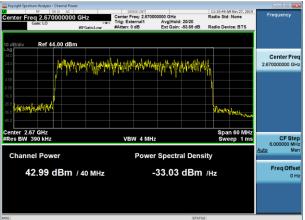
## TM1.1 / Channel Frequency 2670 MHz / Signal BW 40 MHz / Modulation QPSK

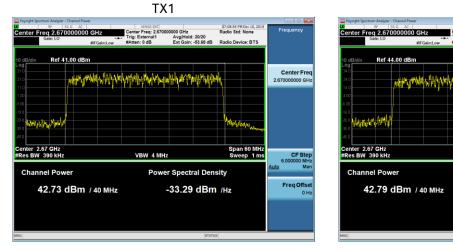




TX3

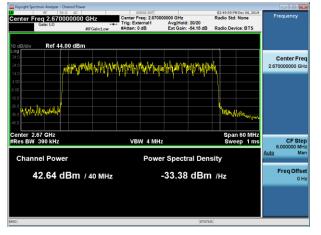
TX4





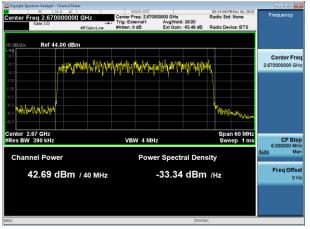
#### TM3 .1a / Channel Frequency 2670 MHz / Signal BW 40 MHz / Modulation 256QAM

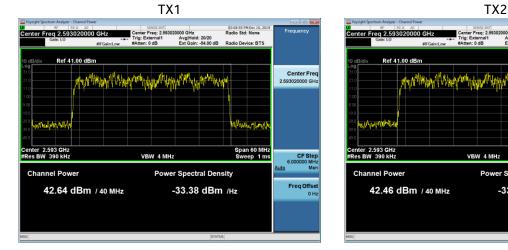




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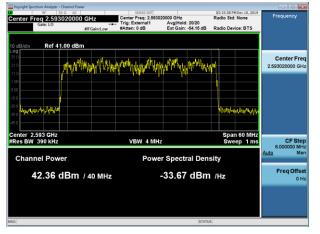


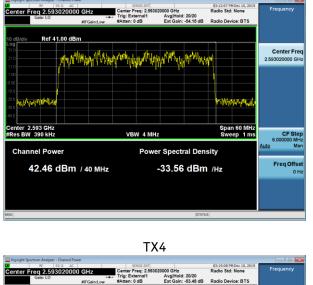


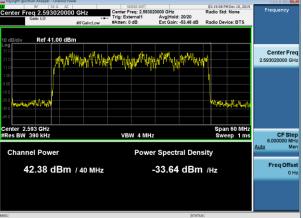


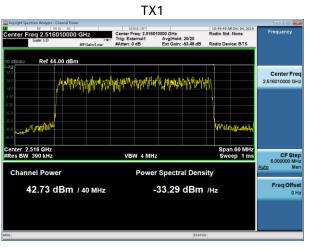
#### TM3.2 / Channel Frequency 2593 MHz / Signal BW 40 MHz / Modulation QPSK 16QAM



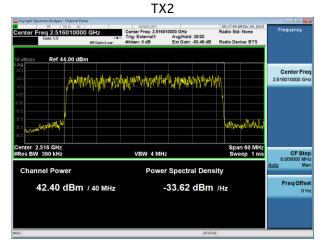


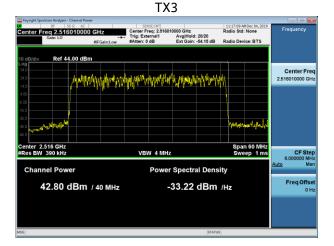


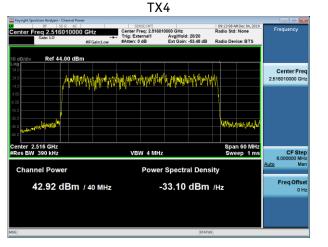




#### TM3.1 / Channel Frequency 2516 MHz / Signal BW 40 MHz / Modulation 64QAM

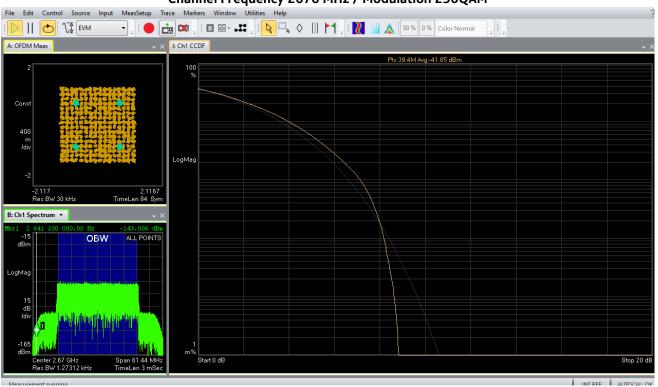




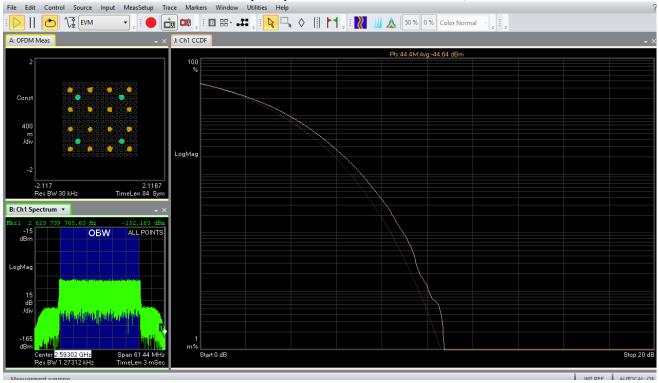


## 2.1.2 Peak-to-Average Power Ratio (PAPR) – Plots

The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 40MHz bandwidths. The PAPR values of all carriers measured are below 13dB.

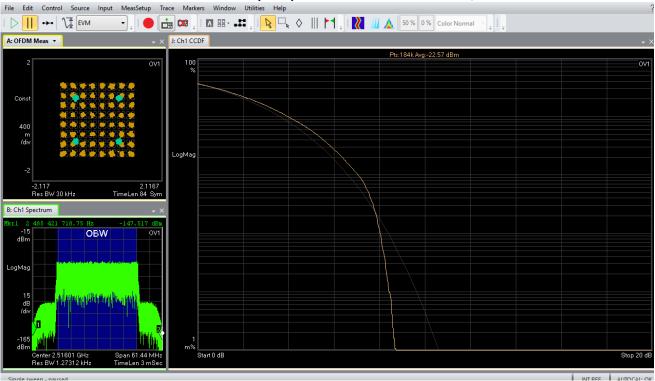


#### Channel Frequency 2670 MHz / Modulation 256QAM



#### Channel Frequency 2593 MHz / Modulation 16QAM

Channel Frequency 2516 MHz / Modulation 64QAM

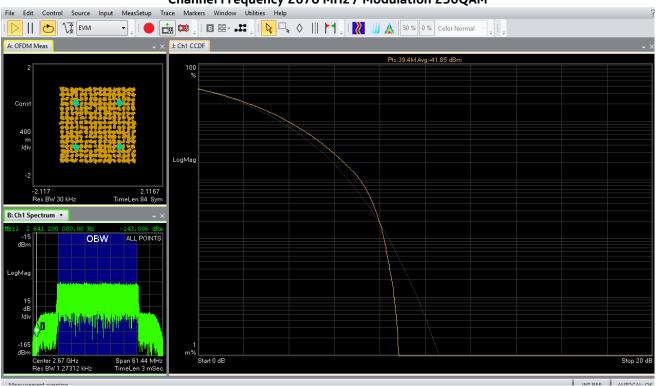


## 3. FCC Section 2.1047 - Modulation Characteristics

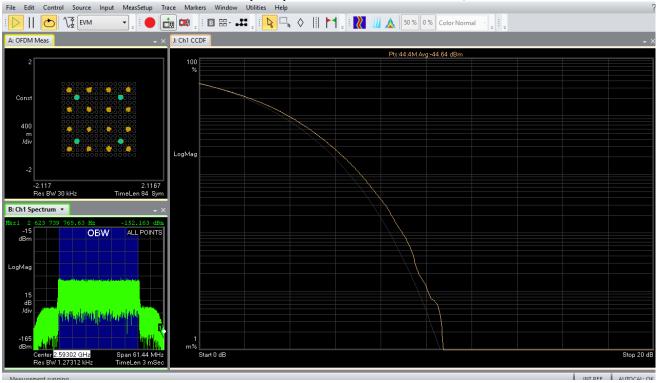
## 3.1 Modulation Characteristics

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

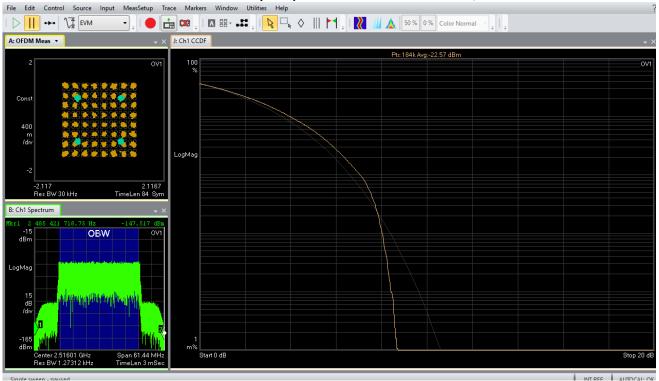


Channel Frequency 2670 MHz / Modulation 256QAM



#### Channel Frequency 2593 MHz / Modulation 16QAM

Channel Frequency 2516 MHz / Modulation 64QAM



## 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.

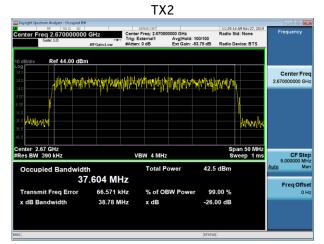
The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

ТМ	тх	Channel Frequency MHz	Signal BW MHz	Modulation	Occupied BW MHz
1.1	1	2670	40	QPSK	37.599
1.1	2	2670	40	QPSK	37.604
1.1	3	2670	40	QPSK	37.599
1.1	4	2670	40	QPSK	37.592
3.1a	1	2670	40	256QAM	37.759
3.1a	2	2670	40	256QAM	37.761
3.1a	3	2670	40	256QAM	37.756
3.1a	4	2670	40	256QAM	37.755
3.2	1	2593	40	QPSK/16QAM	37.421
3.2	2	2593	40	QPSK/16QAM	37.397
3.2	3	2593	40	QPSK/16QAM	37.419
3.2	4	2593	40	QPSK/16QAM	37.413
3.1	1	2516	40	64QAM	37.873
3.1	2	2516	40	64QAM	37.877
3.1	3	2516	40	64QAM	37.872
3.1	4	2516	40	64QAM	37.869

## 4.1.1 Occupied Bandwidth – Plots

		TX	1		
Keysight Spectrum Analyzer - Occupied BW					
Gate: LO		SENSE:INT Center Freq: 2.670000 rig: External1 Atten: 0 dB	000 GHz Avg Hold: 100/100 Ext Gain: -53.68 dB	11:33:20 AM Nov 27, 2019 Radio Std: None Radio Device: BTS	Frequency
0 dB/div Ref 44.00 dBm					
	Yewnywydaushafa	listerier mehr po	lwhen on the		Center Freq 2.670000000 GHz
Center 2.67 GHz Res BW 390 kHz		VBW 4 MHz		Span 50 MHz Sweep 1 ms	CF Step 5.000000 MHz
Occupied Bandwidth 37	, .599 MHz	Total Po	ower 42.7	7 dBm	Auto Man Freg Offset
Transmit Freq Error x dB Bandwidth	68.222 kHz 38.78 MHz			9.00 % .00 dB	0 Hz
			STATU		

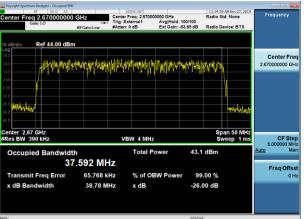
## TM1.1 / Channel Frequency 2670 MHz / Signal BW 40 MHz / Modulation QPSK



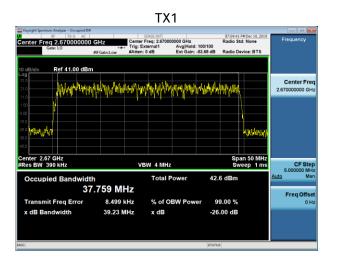


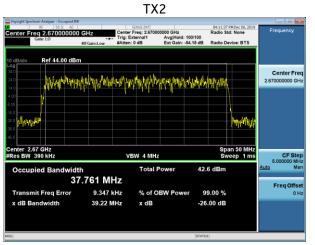
RF S0 2 AC Center Freq 2.67000000 Gate: L0	) GHz Cent	SENSE:INT er Freq: 2.670000000 GHz External1 Avg Hold en: 0 dB Ext Gain:	Radio 100/100	H8 AM Nov 27, 2019 Std: None Device: BTS	Frequency
Interference         Ref 44.00 dBi           10 dBidity         Ref 44.00 dBi           140 dBidity         Ref 44.00 dBi	late conduct at at late	stradopilwiato	Mu, Mu and	n V Nahara	Center Freq 2.67000000 GHz
Center 2.67 GHz #Res BW 390 kHz		/BW 4 MHz		pan 50 MHz Sweep 1 ms	CF Step 5.000000 MHz
Occupied Bandwid	<sup>th</sup> 7.599 MHz	Total Power	42.5 dBm		Auto Man Freg Offset
Transmit Freq Error x dB Bandwidth	62.425 kHz 38.78 MHz	% of OBW Powe x dB	er 99.00 % -26.00 dB		0 Hz
ŝG			STATUS		





#### TM3.1a / Channel Frequency 2670 MHz / Signal BW 40 MHz / Modulation 256QAM



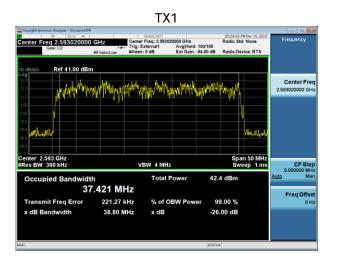


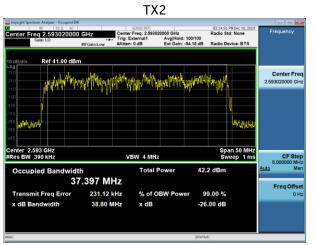
## тхз

Keysight Spectrum Analyzer - Occupied BV	v	SENSE: JNT		03:51:51 PM Dec 06, 2019	- • •
Center Freq 2.67000000		nter Freq: 2.6700000	000 GHz AvgiHold: 100/100	Radio Std: None	Frequency
Gate: LO			Ext Gain: -54.15 dB	Radio Device: BTS	
10 dB/div Ref 44.00 dBr	n				
34.0					Center Freq
24.0	nd kirken windered	havatha babhliva	nenomine statule	植物动植植	2.67000000 GHz
	d bu, ditt soin su	fus war in	S. W. M. H. WILLSON	a st danak	
4.00					
16.0					
26.0					
ss o VANANI VI				Und wither)	
46.0					
Center 2.67 GHz				Span 50 MHz	
Res BW 390 kHz		VBW 4 MHz		Sweep 1 ms	
Occupied Bandwid	th	Total Po	ower 42	5 dBm	Auto Man
	 7.756 MHz				
					Freq Offset
Transmit Freq Error	6.512 kHz	% of OB	W Power 9	9.00 %	0 Hz
x dB Bandwidth	39.23 MHz	x dB	-26	.00 dB	
50			STATU	8	

TX4 04:15:58 PMDec 06, Radio Std: None ter Freq: 2.670000000 GHz er Freq 2.670 Avg|Ho Ext Gai 100/100 -53.48 dB Radio Device: BTS Ref 44.00 dBm Center Free 2.67000 ALC MARTINE AND ter 2.67 GHz Span 50 MHz Sweep 1 ms VBW 4 MHz CF Ste 5.000000 MH Total Power 42.5 dBm cupied Bandwidt 37.755 MHz Freq Off Transmit Freq Error 6.174 kHz % of OBW Power 99.00 % 39.22 MHz -26.00 dB x dB Band x dB

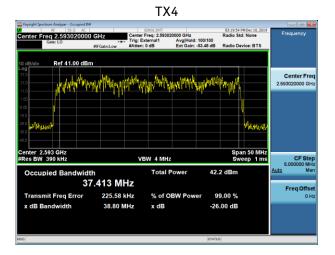
### TM3.2 / Channel Frequency 2593 MHz / Signal BW 40 MHz / Modulation QPSK 16QAM

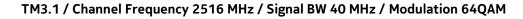


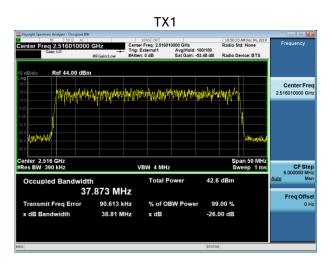


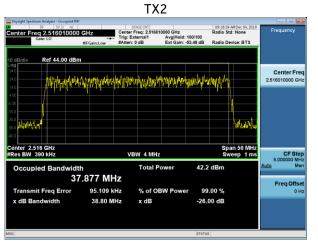
## тхз

Keysight Spectrum Analyzer - Occupied BW					
Center Freq 2.593020000 Gate: LO	Trig		Hz Hold: 100/100 Sain: -54.15 dB	(3:16:23 PM Dec 10, 201 Radio Std: None Radio Device: BTS	Frequency
0 dB/div Ref 41.00 dBm					
	w <sup>ana</sup> ny man	WANN WANNAM	MA WARNA	hyp/1	Center Freq 2.593020000 GHz
				North Contractions	
enter 2.593 GHz Res BW 390 kHz		VBW 4 MHz		Span 50 MH: Sweep 1 ms	CF Step 5.000000 MH
Occupied Bandwidtl	.419 MHz	Total Powe	r 42.'	1 dBm	Auto Mar
Transmit Freq Error x dB Bandwidth	223.46 kHz 38.80 MHz	% of OBW F x dB		9.00 % .00 dB	0 H
0			STATUS		









#### ТХЗ

Keysight Spectrum Analyzer - Occupied BV	/					
RF 50 Q AC		SENSE:INT Center Freq: 2.51601	0000 CH-	11:18:57 Radio S	AM Dec 04, 2019	Frequency
Center Freq 2.516010000		Trig: External1	AvgiHold: 100		u. None	
Gale. LO	#FGain:Low	#Atten: 0 dB	Ext Gain: -54.	15 dB Radio D	evice: BTS	
0 dB/div Ref 44.00 dBr						
og						
34.0						Center Free
24.0 NIAM and the	A health california	ahthill the day of the Al	HANNAL AMADA	ala Protect i An		2.516010000 GH
4.0	ս մին են հեկու մ. են	a fishir a hard from the	t suit sit suidin	an a nadal i		
	1 1			1 N		
					h l	
6.0					1	
S.O IL Nexe .					the set of	
ero <b>utila "nativ</b> a						
6.0						
enter 2.516 GHz					an 50 MHz	
Res BW 390 kHz		VBW 4 MHz			veep 1 ms	CF Ster
NOS BIT OSO KIL					геер тапо	5.000000 MH
Occupied Bandwidt	th	Total P	ower	42.6 dBm		Auto Mar
	7.872 MH	_				
3	.8/2 IVITI	Z				Freq Offse
Transmit Freq Error	90.284 kH	z % of O	BW Power	99.00 %		0 H
x dB Bandwidth	38.81 MH	lz x dB		-26.00 dB		
0				STATUS		



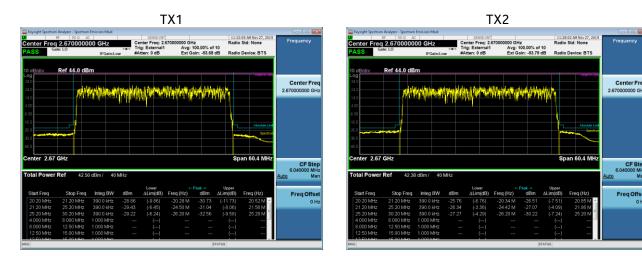


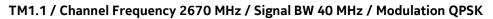
## 4.2 Edge of band Emissions

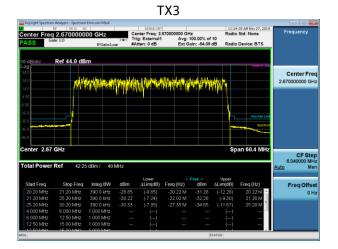
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the 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.

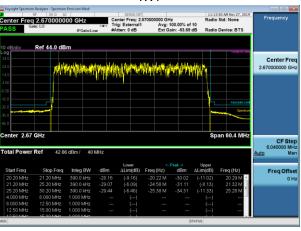
All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.



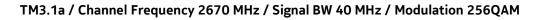


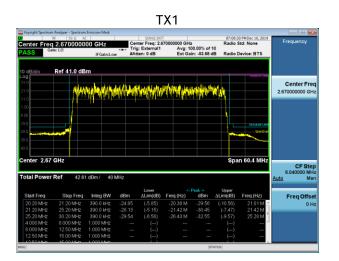


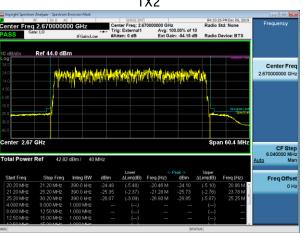




PUBLIC







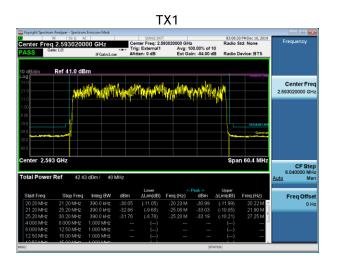
т	v	2
- 1	Λ	2

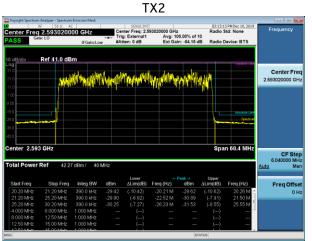
				SENSE:1NT			10.00		
enter Fred	2.6700000	00 GHz		nter Freq: 2.6	70000000 GHz		Radio	05 PM Dec 06, 2019 Std: None	Frequency
	ite: LO			g: External1 ten: 0 dB		0.00% of 1 h: -54.15 d		Device: BTS	
		IFGain:Lo	W #41	ten: U dB	Ext Gai	1: -04.10 0	B Radio	Device: BTS	
dB/div	Ref 44.0 dE	3m						Santaria	
ю									Center Fre
	ada a	and the plate .	11011	and the second	independent of the second	a din th			2.67000000 GH
	NM	CROMENTS N	NY NY NY	Also to to	n an		. NG		2.67000000 GF
	11	, աներելել			1.1.1.4121	11.			
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.0	+ <b>-</b>							Absolute Linit	
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Section and the section of the secti	and							Spectrum	
0							1000	and the second sec	
.0									
	GHz						Spa	an 60.4 MHz	
.0	GHz						Spa	an 60.4 MHz	
enter 2.67		6dBm/ 40	MHz				Spa	an 60.4 MHz	6.040000 MH
.0		6 dBm / 40	MHz				Spa	an 60.4 MHz	6.040000 MH
enter 2.67	Ref 42.6			Lower		leak ->	Upper		6.040000 MH Auto Ma
enter 2.67 otal Power	Ref 42.6 Stop Freq	Integ BW	dBm	ΔLim(dB)	Freq (Hz)	dBm	Upper ∆Lim(dB)	Freq (Hz)	6.040000 MH Auto Ma
otal Power Start Freq 20.20 MHz	Ref 42.6 Stop Freq 21.20 MHz	Integ BW 390.0 kHz	dBm -29.55	ΔLim(dB) (-10.55)	Freq (Hz) -20.56 M	dBm -30.87	Upper ΔLim(dB) (-11.87)	Freq (Hz) 20.23 M	6.040000 MH Auto Ma
enter 2.67 otal Power Start Freq 20 20 MHz 21.20 MHz	Ref 42.6 Stop Freq 21.20 MHz 25.20 MHz	Integ BW 390.0 kHz 390.0 kHz	dBm -29.55 -29.74	ΔLim(dB) (-10.55) (-6.76)	Freq (Hz) -20.56 M -21.50 M	dBm -30.87 -32.39	Upper ∆Lim(dB) (-11.87) (-9.41)	Freq (Hz) 20.23 M 22.70 M	6.040000 MH Auto Ma
enter 2.67 Dtal Power Start Freq 20 20 MHz 21.20 MHz 25 20 MHz	Ref 42.6 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz	dBm -29.55 -29.74 -30.33	ΔLim(dB) (-10.55) (-6.76) (-7.35)	Freq (Hz) -20.56 M -21.50 M -26.43 M	dBm -30.87 -32.39 -34.49	Upper ΔLim(dB) (-11.87) (-9.41) (-11.51)	Freq (Hz) 20.23 M	6.040000 MH Auto Ma
enter 2.67 otal Power Start Freq 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz	Ref 42.6 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -29.55 -29.74 -30.33 	ΔLim(dB) (-10.55) (-6.76) (-7.35) ()	Freq (Hz) -20.56 M -21.50 M	dBm -30.87 -32.39 -34.49 	Upper ΔLim(dB) (-11.87) (-9.41) (-11.51) ()	Freq (Hz) 20.23 M 22.70 M	6.040000 MH Auto Ma
Start Freq           20.20 MHz           21.20 MHz           4.000 MHz           8.000 MHz	Ref 42.6 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz 12.50 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz 1.000 MHz	dBm -29.55 -29.74 -30.33 	ΔLim(dB) (-10.55) (-6.76) (-7.35) () ()	Freq (Hz) -20.56 M -21.50 M -26.43 M 	dBm -30.87 -32.39 -34.49 	Upper ΔLim(dB) (-11.87) (-9.41) (-11.51) () ()	Freq (Hz) 20.23 M 22.70 M	CF Ste 6.040000 Mi- <u>Auto</u> Ma Freq Offsi 0 H
enter 2.67 otal Power Start Freq 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz	Ref 42.6 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -29.55 -29.74 -30.33 	ΔLim(dB) (-10.55) (-6.76) (-7.35) ()	Freq (Hz) -20.56 M -21.50 M -26.43 M	dBm -30.87 -32.39 -34.49 	Upper ΔLim(dB) (-11.87) (-9.41) (-11.51) ()	Freq (Hz) 20.23 M 22.70 M	6.040000 MH Auto Ma

				Т	Χ4				
Keysight Spectrum A	Analyzer - Spectrum	Emission Mask							
Center Freq S Gate	2.6700000		Trig:	sense:INT er Freq: 2.6 External1 en: 0 dB		0.00% of 10 :: -53.48 dB	Radio	13 PM Dec 06, 2019 Std: None Device: BTS	Frequency
	Ref 44.0 dB	m							
24.0 14.0	NAM	nin <mark>pan</mark> akina	in i han i	nd hater	rtwind years	alle state	14		Center Freq 2.670000000 GHz
4.00 5.00 16.0								Absolute Littl	
6.0 6.0								Spectrum	
enter 2.67 G	SHz						Spa	ın 60.4 MHz	CF Ster
otal Power R	Ref 42.7	1dBm/ 401	MHz						6.040000 MHz Auto Man
Start Freq		Integ BW	40	Lower ∆Lim(dB)		eak ->	Upper	From (Lin)	
20.20 MHz	Stop Freq 21.20 MHz	390.0 kHz	dBm -28.99	ΔLim(dB) (-9.99)	-20.58 M		Lim(dB) (-11.99)	20.24 M	Freq Offset
20.20 MHz	25.20 MHz	390.0 kHz 390.0 kHz	-20.99	(-5.86)	-20.56 M	-30.99	(-11.99) (-9.19)	20.24 M	0 Ha
25.20 MHz	30.20 MHz	390.0 kHz	-29.91	(-6.93)	-26.33 M		(-12.19)	25.28 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							
19.50 MH=	15.00 MHz	4.000 MHz				STAT	US		

TX2



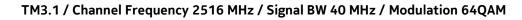




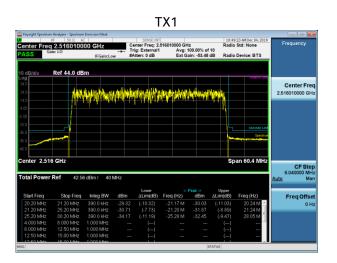


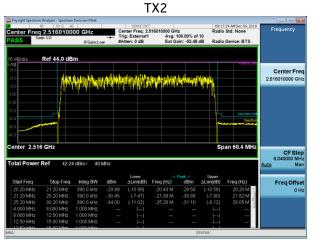
	RF 50 Q Ad 2.5930200 te: L0	00 GHz IFGain:Los	Tri	SENSE:INT nter Freq: 2.5 g: External1 tten: 0 dB	93020000 GHz Avg: 10	0.00% of 1 n: -54.15 d	Radio	12 PMDec 10, 2019 Std: None Device: BTS	Frequency
dB/div	Ref 41.0 dB	m							
og 1.0 1.0 1.0	, subj	the second s	Wagenegist	Trephyl <sup>a</sup> lla	Windelm	W	4		Center Fred 2.593020000 GH:
9.0								Absolute Linit	
9.0								Special	
enter 2.59		6 dBm / 40	MHz				Spa	n 60.4 MHz	CF Ste 6.040000 MH <u>Auto</u> Ma
enter 2.59		5 dBm / 40	MHz	Lower ∆Lim(dB)	Freq (Hz)	Peak -> dBm	Spa Upper ∆Lim(dB)	n 60.4 MHz Freg (Hz)	6.040000 MH <u>Auto</u> Ma
enter 2.59 otal Power Start Freq 20.20 MHz	Ref 42.16 Stop Freq 21.20 MHz	Integ BW 390.0 kHz	dBm -29.98	ΔLim(dB) (-10.98)		dBm -30.71	Upper	Freq (Hz)	6.040000 MH
enter 2.59 otal Power Start Freq 20.20 MHz	Ref 42.16 Stop Freq	Integ BW	dBm	∆Lim(dB)	Freq (Hz)	dBm	Upper ∆Lim(dB)	Freq (Hz)	6.040000 MH Auto Ma
enter 2.593 otal Power Start Freq 20 20 MHz 21 20 MHz 25 20 MHz	Ref 42.16 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz	dBm -29.98	ΔLim(dB) (-10.98)	Freq (Hz) -20.23 M	dBm -30.71	Upper ΔLim(dB) (-11.71)	Freq (Hz)	6.040000 MH Auto Ma
enter 2.593 otal Power 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz	Ref 42.16 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -29.98 -31.36	ΔLim(dB) (-10.98) (-8.39) (-8.82) ()	Freq (Hz) -20.23 M -25.08 M	dBm -30.71 -32.63	Upper ∆Lim(dB) (-11.71) (-9.65)	Freq (Hz) 20.27 M A 22.94 M	6.040000 MH Auto Ma
enter 2.593 otal Power 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz 8.000 MHz	Ref 42.16 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz 12.50 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz 1.000 MHz	dBm -29.98 -31.36 -31.80	ΔLim(dB) (-10.98) (-8.39) (-8.82)	Freq (Hz) -20.23 M -25.08 M -25.20 M	dBm -30.71 -32.63 -32.97	Upper ∆Lim(dB) (-11.71) (-9.65) (-10.00)	Freq (Hz) 20.27 M A 22.94 M	6.040000 MH Auto Ma
enter 2.593 otal Power Start Freq 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz	Ref 42.16 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -29.98 -31.36 -31.80	ΔLim(dB) (-10.98) (-8.39) (-8.82) ()	Freq (Hz) -20.23 M -25.08 M -25.20 M	dBm -30.71 -32.63 -32.97	Upper <u>∆Lim(dB)</u> (-11.71) (-9.65) (-10.00) ()	Freq (Hz) 20.27 M A 22.94 M	6.040000 MH Auto Ma

	n Analyzer - Spectrum RF 50 Q Al			SENSE:INT			63:18:	13 PM Dec 10, 2019	
	2.5930200	00 GHz		ter Freq: 2.5 External1	93020000 GHz	0.00% of 1		Std: None	Frequency
SS Ga	te: LO	IEGain:Los		ten: 0 dB		0.00% of 1 h:-53.48 d		Device: BTS	
dB/div	Ref 41.0 dB								
aB/div	Ref 41.0 dE	m		_				Relative Lands	
0 					1			_	Center Fr
0	cath	制作品的	a and the	الاستديار	Le de la Carte de	ALC: NO.	LUA -		2.593020000 G
n	1000	an defendent	n shiketin.	1. 1. 1. 1. 1.	all faune al				LIODODECCOOLO
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0									
	3 GHZ						Sna	in 60.4 MHz	
nter 2.59							-pe		CF St
nter 2.59									6.040000 M
	B-/								Auto M
	Ref 42.1	9 dBm / 40 1	MHz						
	Ref 42.11	9 dBm / 40 1	MHz	lowar	6.6	lank .o	Unner		
tal Power	Ref 42.11	9 dBm / 40 l	MHz dBm	Lower ∆Lim(dB)	<- P Freq (Hz)	eak.⇒ dBm	Upper ∆Lim(dB)	Freq (Hz)	
<b>tal Power</b> Start Freq							ΔLim(dB)	Freq (Hz)	Freq Offs
tal Power tart Freq 20.20 MHz	Stop Freq	Integ BW	dBm	$\Delta Lim(dB)$	Freq (Hz)	dBm			Freq Offs
tal Power tart Freq 20.20 MHz 21.20 MHz	Stop Freq 21.20 MHz	Integ BW 390.0 kHz	dBm -28.79	ΔLim(dB) (-9.79)	Freq (Hz) -20.23 M	dBm -30.12	ΔLim(dB) (-11.12)	20.27 M 🛆	Freq Offs
tal Power tart Freq 20.20 MHz 21.20 MHz 25.20 MHz	Stop Freq 21.20 MHz 25.20 MHz	Integ BW 390.0 kHz 390.0 kHz	dBm -28.79 -30.46	ΔLim(dB) (-9.79) (-7.48)	Freq (Hz) -20.23 M -21.26 M	dBm -30.12 -31.84	ΔLim(dB) (-11.12) (-8.86)	20.27 M 23.36 M	Freq Offs
nter 2.59 tal Power Start Freq 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz 3.000 MHz	Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz	dBm -28.79 -30.46 -31.27	ΔLim(dB) (-9.79) (-7.48) (-8.29)	Freq (Hz) -20.23 M -21.26 M -25.20 M	dBm -30.12 -31.84 -32.12	ΔLim(dB) (-11.12) (-8.86) (-9.14)	20.27 M 23.36 M	Freq Offs 0



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## ТХЗ

	RF 50.0 AI			SENSE:INT				8:10 AM Dec 04, 2019	
nter Fred	2.5160100		Ce	enter Freq: 2	516010000 GH	z	Radi	o Std: None	Frequency
SS Ga	ate: LO	IEGain:Lo		ig: External1 atten: 0 dB		00.00% of ain: -54.15		o Device: BTS	
		PGalit.Lo	w	aten. e ub	Exton			o Democ. D To	
dB/div	Ref 44.0 dB	1ma							
g	Rel 44.0 dB	111						2007001000	
.0									Center Fre
.0		And the barries	e de la de la de	alina di Ali	<b>Book short</b>	a faist of	Mail:		2.516010000 GH
.0	1900	all al mai	dial in the	le di biki i b	de fa fan ten ster	and and the	17 M A		
	<b>/</b> '						]l		
10							1		
o									
0								Absolute Lind	
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and the second se									
enter 2.510	6 GHz						s	pan 60.4 MHz	
.0	6 GHz						S	pan 60.4 MHz	
.0		0 dBm / 40	MHz				S	pan 60.4 MHz	6.040000 MH
enter 2.510		0 dBm / 40 1	MHz					pan 60.4 MHz	6.040000 MH
enter 2.510	Ref 42.60			Lower		Peak >	Upper		6.040000 MH <u>Auto</u> Ma
enter 2.510 otal Power	Ref 42.60 Stop Freq	Integ BW	dBm	$\Delta Lim(dB)$	Freq (Hz)	dBm	Upper ΔLim(dB)	Freq (Hz)	6.040000 MH <u>Auto</u> Ma Freq Offs
otal Power Start Freq 20.20 MHz	Ref 42.60 Stop Freq 21.20 MHz	Integ BW 390.0 kHz	dBm -30.97	ΔLim(dB) (-11.97)	Freq (Hz) -21.15 M	dBm -30.59	Upper ∆Lim(dB) (-11.59)	Freq (Hz) 20.20 M 📩	6.040000 MH <u>Auto</u> Ma Freq Offs
otal Power Start Freq 20.20 MHz 21.20 MHz	Ref 42.60 Stop Freq	Integ BW	dBm	$\Delta Lim(dB)$	Freq (Hz)	dBm	Upper ΔLim(dB)	Freq (Hz)	6.040000 MH <u>Auto</u> Ma Freq Offs
enter 2.510	Ref 42.60 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -30.97 -31.35	ΔLim(dB) (-11.97) (-8.37)	Freq (Hz) -21.15 M -21.20 M	dBm -30.59 -31.35	Upper <u>∆Lim(dB)</u> (-11.59) (-8.37)	Freq (Hz) 20.20 M ▲ 21.40 M	6.040000 MH <u>Auto</u> Ma Freq Offs
otal Power Start Freq 20.20 MHz 21.20 MHz 4.000 MHz 8.000 MHz	Ref         42.60           Stop Freq         21.20 MHz           25.20 MHz         30.20 MHz           30.20 MHz         12.50 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz 1.000 MHz	dBm -30.97 -31.35 -34.57	ΔLim(dB) (-11.97) (-8.37) (-11.59) () ()	Freq (Hz) -21.15 M -21.20 M -25.28 M	dBm -30.59 -31.35	Upper ∆Lim(dB) (-11.59) (-8.37) (-9.26) () ()	Freq (Hz) 20.20 M ▲ 21.40 M	6.040000 MH <u>Auto</u> Ma Freq Offs
enter 2.510 otal Power Start Freq 20.20 MHz 21.20 MHz 25.20 MHz 4.000 MHz	Ref 42.60 Stop Freq 21.20 MHz 25.20 MHz 30.20 MHz 8.000 MHz	Integ BW 390.0 kHz 390.0 kHz 390.0 kHz 1.000 MHz	dBm -30.97 -31.35 -34.57 	ΔLim(dB) (-11.97) (-8.37) (-11.59) ()	Freq (Hz) -21.15 M -21.20 M -25.28 M	dBm -30.59 -31.35 -32.24 	Upper ∆Lim(dB) (-11.59) (-8.37) (-9.26) ()	Freq (Hz) 20.20 M ▲ 21.40 M	СF Ste 6.040000 Мн <u>Auto</u> Ма Freq Offs 0 H

						Mask			ectrum Analyzer	rysight Sp
Frequency	:43 AM Dec 04, 2019 Std: None				SEN		AC		RF	_
riequency	Std: None		z 00.00% of 10	2.5160100 al1	Center Fre Trig: Exte	iz 👘	000 GH	60100	Gate: LO	
	Device: BTS		in: -53.48 dB		#Atten: 0	Sain:Low	IFG		Gate: LO	SS
							Зm	14.0 dE	Ref 4	B/div
	Scionce Line									
Center Freq		In the second	Lillion Maria	hadan da s	a ha al a an	A	4.4.4	44.4		
2.516010000 GHz		anna.	e nava in	a Marti		Nov Nil	<b>BANK</b>	- ANN		
		110	1	1.1			1.16.1			
		-"\								· —
	Absolute Lind									
	Spectrum									
									A REAL PROPERTY.	
									2.516 GHz	nter 2
05.01	an 60.4 MHz	Sp								
CF Step	an 60.4 MHz	Sp								
CF Step 6.040000 MHz Auto Man	an 60.4 MHz	Sp				40 MHz	75 dBm /		wer Ref	tal Po
6.040000 MHz	an 60.4 MHz					40 MHz	'5 dBm /		wer Ref	tal Po
6.040000 MHz <u>Auto</u> Mar	an 60.4 MHz Freq (Hz)	Sp Upper ALim(dB)		3) Freq (1	Lowe n ∆Lim					
6.040000 MH Auto Mar Freq Offse		Upper	dBm ΔLi		n ∆Lim	BW dBm		42.7	q Sto	tart Fre
6.040000 MH <u>Auto</u> Mar	Freq (Hz)	Upper ΔLim(dB)	dBm ΔLi -29.57 (-	-21.1	n ∆Lim 48 (-10.4	BW dBm kHz -29.4 kHz -29.5	Integ 390.0 390.0	42.7 op Freq 20 MHz 20 MHz	<b>q Sto</b> Hz 21.2 Hz 25.2	tart Fre 0.20 M 1.20 M
6.040000 MH Auto Mar Freq Offse	Freq (Hz) 21.06 M	Upper ΔLim(dB) (-10.57) (-7.60) (-8.40)	dBm ΔLi -29.57 (- -30.58 (	-21.1 -21.2 -25.2	n ΔLim 48 (-10.4 98 (-7.0 80 (-10.8	BW dBm kHz -29.4 kHz -29.8 kHz -33.8	Integ 390.0 390.0 390.0	42.7 op Freq 20 MHz 20 MHz 20 MHz 20 MHz	<b>q St</b> Hz 21.2 Hz 25.2 Hz 30.2	tart Fre 0.20 M 1.20 M 5.20 M
6.040000 MH Auto Mar Freq Offse	Freq (Hz) 21.06 M ^ 21.24 M	Upper ΔLim(dB) (-10.57) (-7.60) (-8.40) ()	dBm ΔLi -29.57 (- -30.58 (	-21.1 -21.2 -25.2	n ΔLim 48 (-10.4 98 (-7.0 80 (-10.8 (	BW dBm kHz -29.4 kHz -29.9 kHz -33.8 MHz	Integ 390.0 390.0 390.0 1.000 M	42.7 op Freq 20 MHz 20 MHz 20 MHz 20 MHz 20 MHz 20 MHz	<b>q Str</b> Hz 21.2 Hz 25.2 Hz 30.2 Hz 8.00	tart Fre 0.20 M 1.20 M 5.20 M
6.040000 MH Auto Mar Freq Offse	Freq (Hz) 21.06 M ^ 21.24 M	Upper ΔLim(dB) (-10.57) (-7.60) (-8.40)	dBm ΔLi -29.57 (- -30.58 ( -31.38 (	-21.1 -21.2 -25.2	n ΔLim 48 (-10.4 98 (-7.0 80 (-10.8	BW dBm kHz -29.4 kHz -29.9 kHz -33.8 MHz MHz	Integ 390.0 390.0 390.0	42.7 op Freq 20 MHz 20 MHz 20 MHz 20 MHz	<b>q St</b> Hz 21.2 Hz 25.2 Hz 30.2 Hz 8.00 Hz 12.5	tart Fre 10.20 M 10.20 M 10.20 M 10.00 M 10.00 M 12.50 M

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## 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.

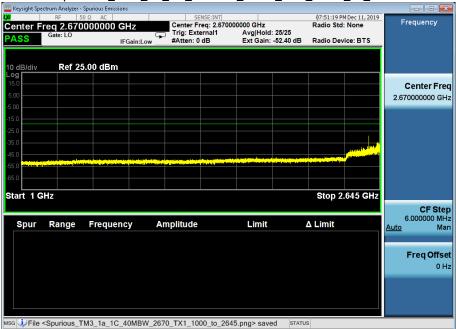
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🔤 Keysight Spe		Spurious Emissions							- • ×
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FA35		IFGair	:Low 📕 #Atten: 0	dB Ext Ga	in: -49.00 dB	Radio Dev	ice: BTS		
10 dB/div	Ref 2	5.00 dBm							
Log									
15.0								C	enter Freg
5.00									000000 GHz
								2.670	000000 GHZ
-5.00									
-15.0									
-25.0									
-35.0									
-45.0									
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Spurious\_TM3\_1a\_1C\_40MBW\_2670\_TX1\_0\_to\_30

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Spurious\_TM3\_1a\_1C\_40MBW\_2670\_TX1\_30\_to\_1000

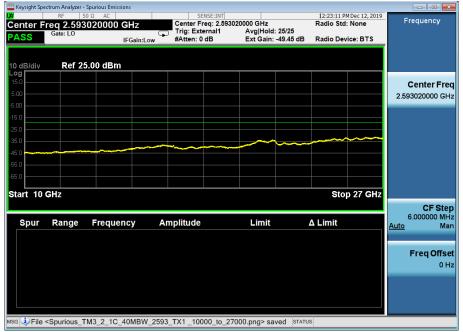
Spurious\_TM3\_1a\_1C\_40MBW\_2670\_TX1\_1000\_to\_2645



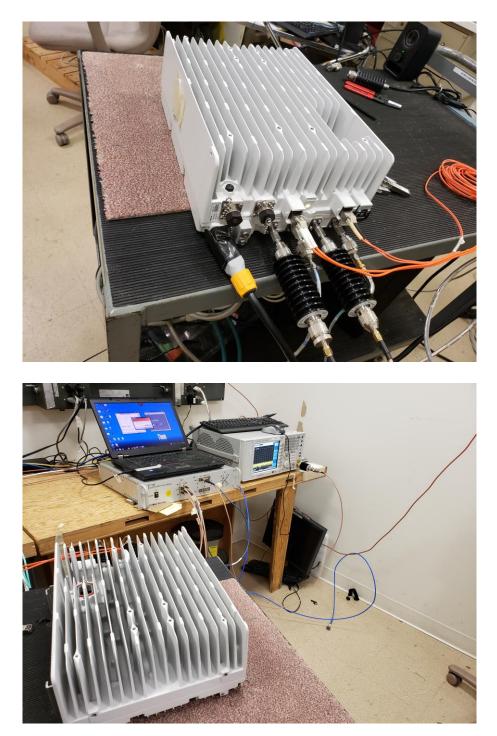
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10 dB/div	Ref 2	5.00 dBm									
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Spurious\_TM3\_1a\_1C\_40MBW\_2670\_TX1\_2695\_to\_10000

Spurious\_TM3\_2\_1C\_40MBW\_2593\_TX1 \_10000\_to\_27000



## Photographs



Asset ID	Manufacturer	Туре	Description	Model	Serial	Calibration Date	Calibration Due
E1152	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz Analyzer	N9020A	MY53420147	2019-04-24	2021-04-24
E1006	Weinschel	Attenuator	30 dB DC-18GHz 150W	6528-30- 34-LIM	BN4172	CNR	CNR
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2019-01-31	2021-01-31
E1120	Extech	Data Logger	Pressure Humidity Temp Data Logger	SD700	Q673552	2019-01-16	2021-01-16

## **Test Equipment**

CNR: Calibration Not Required

Environmental Conditions: RH= 16.2.0%, Temp=23.4oC, Pressure=1010.6hPa

## 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, 4<sup>th</sup> edition, IT&T Corp.

20 log (E\*10<sup>6</sup>) – (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 $\mu$ V) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dB $\mu$ 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 $\mu$ V/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dB $\mu$ 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. FCC Section 2.1055 - Measurement of Frequency Stability

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC					
Time	Transmit Carrier Deviation				
(minutes)	(Hz)				
0	0.39811				
0.5	-1.7246				
1.0	-2.6574				
1.5	1.5104				
2.0	0.19546				
2.5	-1.4250				
3.0	-1.1909				
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)				
	$\pm 0.05$ ppm = $\pm$ 129.65 Hz				
FCC RESULT	PASS				

## Frequency Block Tested: CF = 2593.02MHz

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC					
Time	Transmit Carrier Deviation				
(minutes)	(Hz)				
0	0.9979				
0.5	1.3618				
1.0	0.80534				
1.5	3.1875				
2.0	1.5903				
2.5	3.5339				
3.0	-1.4292				
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)				
	$\pm 0.05$ ppm = $\pm$ 129.65 Hz				
FCC RESULT	PASS				

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC					
Time	Transmit Carrier Deviation				
(minutes)	(Hz)				
0	0.93014				
0.5	-1.0828				
1.0	1.2968				
1.5	0.28392				
2.0	1.3072				
2.5	-0.2146				
3.0	1.2500				
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)				
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz				
FCC RESULT	PASS				

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.0769
0.5	2.2056
1.0	1.7379
1.5	0.5800
2.0	1.6963
2.5	1.0385
3.0	1.1579
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.8270
0.5	-0.64430
1.0	1.0341
1.5	0.11581
2.0	2.4718
2.5	0.28472
3.0	1.2596
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.5555
0.5	0.45559
1.0	0.76444
1.5	-2.4604
2.0	2.0686
2.5	-2.1009
3.0	-0.8551
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.2283
0.5	1.2998
1.0	2.0418
1.5	0.849
2.0	0.174
2.5	1.0213
3.0	-0.296
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.607
0.5	-1.2890
1.0	-1.3821
1.5	0.6215
2.0	0.1685
2.5	0.2269
3.0	4.0008
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.3189
0.5	-1.8871
1.0	-4.0669
1.5	1.8748
2.0	0.1112
2.5	-0.5211
3.0	1.4123
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

PUBLIC

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.3363
0.5	0.4015
1.0	0.281
1.5	0.2588
2.0	0.6081
2.5	-0.4272
3.0	1.6795
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Upon return to +20°C, vary voltage to +15% and -15% of nominal and record frequency difference. Result will be 12 readings for each voltage (nominal, +15%, and nominal, -15%).

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.6096
0.5	0.91679
1.0	-0.4410
1.5	2.9278
2.0	1.5315
2.5	0.34731
3.0	-2.8089
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	±0.05ppm = ± 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 115% of Nominal Voltage, -55.20VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.4490
0.5	0.87357
1.0	2.1270
1.5	0.9390
2.0	-1.0557
2.5	2.0732
3.0	0.24001
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

## Return to +20°C at -48.0 VDC

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48.0VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.6742
0.5	-0.4032
1.0	-1.6011
1.5	-0.2587
2.0	-1.9243
2.5	1.1673
3.0	1.7334
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	±0.05ppm = ± 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at -15% of Nominal Voltage, -40.80VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.30241
0.5	-0.7324
1.0	2.4608
1.5	2.8715
2.0	-2.4876
2.5	1.4782
3.0	2.8620
FCC SPECIFICATION	2593.02 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 129.65 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	2.6656
0.5	0.50794
1.0	1.8018
1.5	0.63887
2.0	1.3157
2.5	-0.1759
3.0	0.37050
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

## Frequency Block Tested: low F = 2516.01MHz

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.8405
0.5	30.772
1.0	-1.1359
1.5	0.90560
2.0	1.1323
2.5	1.3433
3.0	-1.9677
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.6957
0.5	0.8321
1.0	3.3029
1.5	-0.4822
2.0	1.4971
2.5	1.8425
3.0	- 0.8068
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.3231
0.5	-1.3355
1.0	1.0142
1.5	0.16143
2.0	1.4914
2.5	-1.5646
3.0	-0.1627
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.12877
0.5	-1.316
1.0	1.2124
1.5	0.66811
2.0	1.5633
2.5	-1.0591
3.0	-0.6764
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm 125.80$ Hz
FCC RESULT	PASS

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-2.1620
0.5	3.1239
1.0	-0.3912
1.5	-2.5813
2.0	0.4706
2.5	0.5606
3.0	0.3189
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.4927
0.5	2.2975
1.0	4.2367
1.5	0.0657
2.0	0.7727
2.5	2.3976
3.0	2.0212
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.40498
0.5	-1.5519
1.0	2.7204
1.5	1.8186
2.0	1.4626
2.5	0.43675
3.0	-3.1571
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm 125.80$ Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.9024
0.5	2.4360
1.0	3.6934
1.5	3.8080
2.0	-1.4877
2.5	-1.4019
3.0	-0.9678
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Upon return to +20°C, vary voltage to +15% and -15% of nominal and record frequency difference. Result will be 12 readings for each voltage (nominal, +15%, and nominal, -15%).

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.6859
0.5	0.46823
1.0	1.0995
1.5	0.03672
2.0	0.86061
2.5	0.74933
3.0	1.1776
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 115% of Nominal Voltage, -55.20VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.33691
0.5	1.9266
1.0	-1.5814
1.5	1.8463
2.0	-0.1123
2.5	-0.5455
3.0	- 1.5244
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	±0.05ppm = ± 125.80 Hz
FCC RESULT	PASS

### Return to +20°C @ 48.0VDC

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48.0VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.47762
0.5	-1.4368
1.0	2.6702
1.5	2.5575
2.0	-0.1546
2.5	2.1727
3.0	0.68323
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +2 40.80VDC	0°C at -15% of Nominal Voltage, -
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.62864
0.5	2.1134
1.0	-0.2969
1.5	-2.6502
2.0	1.9950
2.5	2.4228
3.0	1.0790
FCC SPECIFICATION	2516.01 MHz (±0.05ppm)
	±0.05ppm = ± 125.80 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.40174
0.5	3.0125
1.0	-2.0262
1.5	1.0017
2.0	0.32382
2.5	0.30169
3.0	1.7814
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

### Frequency Block Tested: High F = 2670.00MHz

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.7755
0.5	-0.3926
1.0	1.1787
1.5	0.71426
2.0	-1.2734
2.5	-0.7797
3.0	1.7799
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.8128
0.5	-1.8563
1.0	1.3993
1.5	4.7146
2.0	1.7591
2.5	1.0726
3.0	0.01421
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.79086
0.5	0.58800
1.0	1.3872
1.5	1.1079
2.0	-1.6097
2.5	3.82508
3.0	- 0.6958
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	3.4315
0.5	-0.4122.
1.0	-0.2073.
1.5	-1.1516
2.0	-0.3371
2.5	1.2196
3.0	1.1654
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.6599
0.5	0.1362
1.0	2.3757
1.5	-1.5477
2.0	-0.06488
2.5	- 0.5547
3.0	- 0.1941
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.1868
0.5	1.1075
1.0	0.54036
1.5	0.58766
2.0	0.16289
2.5	-1.5906
3.0	-0.1431
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	±0.05ppm = ± 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	2.1410
0.5	-1.6355
1.0	0.4356
1.5	2.6764
2.0	2.4992
2.5	0.77876
3.0	1.5563
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm 0.05$ ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	1.2706
0.5	-0.7344
1.0	1.9295
1.5	-1.4735
2.0	2.7419
2.5	0.3897
3.0	1.0828
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Upon return to +20°C, vary voltage to +15% and -15% of nominal and record frequency difference. Result will be 12 readings for each voltage (nominal, +15%, and nominal, -15%).

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.2130
0.5	0.65086
1.0	1.7293
1.5	-0.8766
2.0	0.10983
2.5	3.2373
3.0	-0.3850
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at 115% of Nominal Voltage, -55.20VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	0.14521
0.5	1.0674
1.0	0.82206
1.5	1.4580
2.0	0.89183
2.5	0.73733
3.0	3.1978
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	$\pm$ 0.05ppm = $\pm$ 133.50 Hz
FCC RESULT	PASS

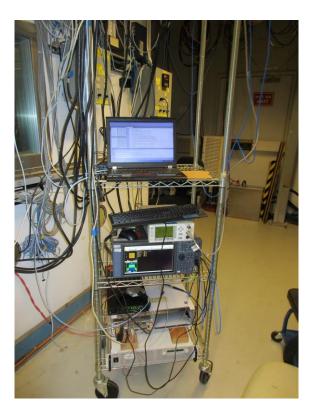
### Return to +20°C @ 48.0VDC

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48.0VDC	
Time	Transmit Carrier Deviation
(minutes)	(Hz)
0	-1.4540
0.5	2.3033
1.0	1.8232
1.5	-1.3119
2.0	-1.6720
2.5	- 2.6816
3.0	- 0.4982
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)
	±0.05ppm = ± 133.50 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +20°C at -15% of Nominal Voltage, -40.80VDC					
Time	Transmit Carrier Deviation				
(minutes)	(Hz)				
0	0.39351				
0.5	-0.5183				
1.0	1.3488				
1.5	0.69154				
2.0	0.48122				
2.5	-1.1247				
3.0	1.9495				
FCC SPECIFICATION	2670.00 MHz (±0.05ppm)				
	±0.05ppm = ± 133.50 Hz				
FCC RESULT	PASS				

**Global Product Compliance Laboratory** Report No.: TR-2019-0189-FCC2-27 Product: AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W

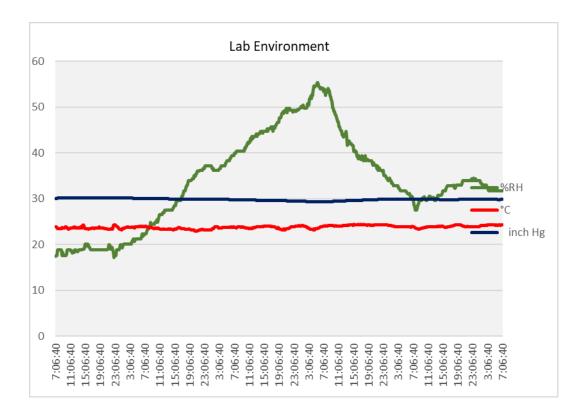
# Photographs





Asset ID	Manufacturer	Туре	Description	Model	Serial	Calibration Date	Calibration Due
TH534-T13	Envirotronics	Controller		Envirotronics SPPCM	SP000638	2019-05-22	2021-05-22
TH-T13	Envirotronics	Thermal Chamber		N/A	0999-4722	2018-09-20	2020-09-20
TH069	Extech	Data Logger	Barometric Pressure/Humidity/Te mperature	SD700	Q690305	2019-06-26	2021-06-26
TH054	Yokogawa	Recorder	MobileCorder Paperless Videographic Recorder	MV2048	S5JC04076	2019-02-26	2021-02-26

# **Test Equipment**



# 8. NVLAP Certificate of Accreditation

