NOKIA Bell Labs

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TESTING
NVLAP LAB CODE: 100275-0

FCC Certification Part 30 Test Report

Product Evaluated
Nokia AirScale 39 GHz Radio Unit (AEWF) 4 carrier
AEWF-01,
FCC ID: VBNAEWF-01

Customer
Nokia Solutions and Networks US LLC
6000 Connection Drive
Irving, Texas 75039 USA

Test Laboratory
Nokia Bell Labs
Nokia, Global Product Compliance Laboratory
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Date: May 20, 2019

Revisions

Date	Revision	Section	Change
5/14/2019	0		Initial Release
5/20/2019	1	4.3.1.1	Carrier Aggregation

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Prepared By: W. Steve Majkowski NCE

5/20/2019

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5/20/2019

Technical Manager
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Nokia, Global Product Compliance Laboratory

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1. ATTESTATION OF TEST RESULTS

Company Name	**Nokia Solutions and Networks** 6000 Connection Drive Irving, Texas 75039 USA
FCC ID	**VBNAEWF-01**
Product Name	**AirScale 39 GHz Radio Unit (AEWF) Band 30** **(AEWF 39 GHz RRH - 4 Carrier)**
Model Name	**AEWF**
Part No	474870A.X21,
Serial Number(s)	DC Models: L1183707073
Test Standard(s)	• 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018 • KDB 842590 D01 Upper Microwave Flexible Use Service v01 April 5, 2019
Reference(s)	• 47 CFR FCC Part 2 and Part 30 • ANSI C63.26 (2015) • ANSI C63.4 (2014) • TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014)
Frequency Band	(Tx: 37 – 40.0 GHz), NR Band n260
Technology	5G-New Radio, LTE-TDD: 100M0G7W,
Test Frequency Range	30 MHz – 200 GHz
Operation Mode(s)	2x 54dBm EIRP, 57 dBm EIRP Total. MIMO, 1 to 4 Carriers
Submission Type	Class II Change
FCC Part 15	Compliance with Class B
Test Date	March 28 to May 14, 2019
Test Laboratory	Nokia Global Product Compliance Laboratory 600-700 Mountain Avenue, Rm 5B-108 Murray Hill, New Jersey 07974-0636 USA **NVLAP** Lab Code: 100275-0 **FCC Registration Number: 395774**

This is to certify that the above product has been evaluated and found to be in compliance with the Rules and Regulations set forth in the above standard(s). The data and the descriptions about the test setup, procedures and configuration presented in this report are accurate. The results of testing in this report apply only to the product/system which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Per the requirement of Section 2.911(d) Certification of Technical Test Data, I hereby certify that the technical test data are the results of tests either performed or supervised by me.

W. Steve Majkowski NCE
Member of Technical Staff
Nokia, Global Product Compliance Laboratory

2. SUMMARY OF THE TEST RESULTS

47 CFR FCC Sections	Description of Tests	Compliance Results
2.1046, 30.202 (a)	RF Power Output	Pass
2.1047,	Modulation Characteristics	Pass
2.1049, 30.203	(a) Occupied Bandwidth (b) Edge-of-Band Emissions	Pass
2.1051, 30.203	Spurious Emissions at Antenna Terminals - Radiated	Pass
2.1053, 30.203	Field Strength of Spurious Radiation	Pass
2.1055,	Measurement of Frequency Stability	Not Required

2.1 Measurement Uncertainty

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

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. Classical Emissions, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, using ESHS 30,	Conducted Emissions	0.009 - 30	±3.5 dB
	Radiated Emissions (AR-8 Semi-Anechoic Chamber)	30 MHz – 200MHz H 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz- 18 GHz	±5.4 dB ±5.4 dB ±4.7 dB ±4.7 dB ±3.3 dB

Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band,	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz to 100 MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	±2.2 dB
Conducted Spurious Emissions	30 kHz to 100 MHz	10 MHz to 40 GHz:	±2.8 dB
RF Power, Channel Power	10 Hz to 100 MHz	10 MHz to 40 GHz	±1.4 dB

3. GENERAL INFORMATION

3.1 Product Descriptions

The equipment under test (EUT) has the following specifications.

Table 3.1.1 Product Specifications

Specification Items	Description
Product Type	Compact Base Station LTE Module (2Tx, 2Rx), 2x2 MIMO
Radio Type	Intentional Transceiver
Power Type	115 VAC
Modulation	5G New Radio LTE-TDD with QPSK, 16QAM and 64QAM
Operating Frequency Range	TDD (Tx/Rx: 37.0-40.0 GHz),
Channel Bandwidth	100 MHz,
Max Radiated Power (EIRP)	54 dBm EIRP per polarizations; based upon 28 dBm Tx output. 57 dBm EIRP Total for the two polarizations.
Antenna Gain	29 dBi
Operating Mode	2x2 MIMO (2 duplex Tx/Rx Ports)
Software Version	FLF17SP
Hardware Version	474870A.X21
Antenna(s)	Refer to Section 3.2

The EUT supports the following carrier configurations:

Table 3.1.2 EUT Supported Configurations

Carrier Bandwidth (MHz)	Carriers per Path	MIMO Modes	Signal Type	Modulation
100	1	2x	LTE-TDD	QPSK, 16QAM & 64QAM

3.1.1 NR-ARFCN Calculation

The computational relationship between the NR-ARFCN and the RF reference frequency (or carrier center frequency) F_{ref} in MHz for the downlink and uplink is defined by the following equation, where the values of F_{offset} and N_{offset} depend on the frequency range as given in the table below and N_{ref} is the NR-ARFCN.

$$F_{ref} = F_{offset} + \Delta F\ (N_{ref} - N_{offset}) \quad (1)$$

$$N_{ref} = N_{offset} + (F_{ref} - F_{offset}) / \Delta F \quad (2)$$

So for the Upper Microwave Flexible Use Services (UMFUS) band:

$$F_{ref} = 24250 + 0.06(\text{NRARFCN}-2016667) \quad \text{MHz}$$

For a NR-ARFCN =2229999 the F_{ref} is:

$$F_{ref} = 37.04992 \text{ GHz} \quad = 24250 + 0.06(2229999-2016667)$$

Table 3.1.1 NR-ARFCN Calculation Parameters for UMFUS

Frequency Range	ΔF	F_{offset} [MHz]	N_{offset}	Range of N_{ref}
24250 – 100000 MHz	0.06 MHz	24250 MHz	2016667	2016667 – 3279167

3.1.2 Tested Frequencies

The as tested operating band consists of the following channels and spectrum:

New Radio - Absolute Radio Frequency Channel Number (**NRARFCN)**

Table 3.1.3 NRARFCN per 38.101-2, for n260 with 100 MHz Carriers

Channel Location in Band	NR-ARFCN	TDD Center Reference Frequency (MHz)	Width of Channel (MHz)
Left Side	2229999	37050.00	100.04
Left Side	2231667	37150.08	100.04
Left Side	2233335	37250.16	100.04
Left Side	2235003	37350.24	100.04
Middle	2251663	38349.84	100.04
Middle	2253331	38449.92	100.04
Middle	2254999	38550.00	100.04
Middle	2256667	38650.08	100.04
Middle Spread	2241667	37750.08	100.04
Middle Spread	2245003	37950.24	100.04
Middle Spread	2248339	38150.40	100.04
Middle Spread	2251675	38350.56	100.04
Right	2273327	39649.68	100.04
Right	2274995	39749.76	100.04
Right	2276663	39849.84	100.04
Right	2278331	39949.92	100.04

3.2 EIRP/ PSD Compliance and Antenna Information.

The product incorporates integrated antennas. Externally mounted antennas cannot be attached to the unit or mounted remotely. The units integrated antennas are electronically steerable with a maximum gain of 29 dBi. There are two antenna assembly boards inside the product. Each antenna assembly board is a pair of 16x16 matrix (a transmit matrix and a receive matrix with 256 elements each). One assembly board is vertically polarized and the second assembly board is horizontally polarized. The antennas nominal RF drive level is 28 dBm. The 28 dBm RF power and 29 dBi gain results in a 54 dBm EIRP per assembly. The sum of the two 54 dBm EIRP beams results in a maximum EIRP of 57 dBm. Antenna Gain vs frequency is detailed in Exhibit 6 of the filing package.

3.3 Antenna Far Field Determination Distance

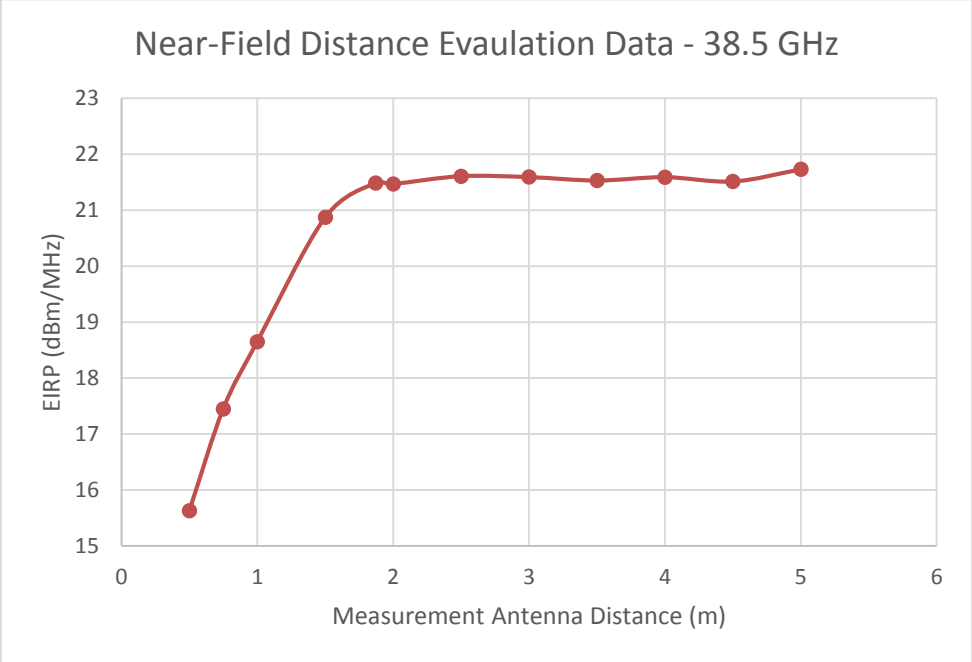
Calculations and low power measurements were performed to determine the far field boundary location for the antenna per the Fraunhofer distance calculated from

$$d_{ff} = 2D^2/\lambda$$

where d_{ff} = Far Field distance in meters,
D is the maximum size of the radiating array λ = wavelength of the operating signal in meters

The antenna patch height is 15 mm and 7.6 mm wide and the patches are 15 cm apart.
At 39 GHz the 15 cm dimension results in a far field distance d_{ff} of 5.85 meters.
At 39 GHz the 7.6 cm dimension results in a far field distance d_{ff} of 1.50 meters.

Measurements were performed at low power and using a small horn antenna
In horizontal polarization the determined boundary was 100 cm, which matches the horizontal dimension.
Based upon previous testing all power measurements were made at 4m.



4. REQUIRED MEASUREMENTS AND RESULTS

Per 47CFR FCC Section 2.1033(c)(14), the following certification tests are required by Section 2.1046 through Section 2.1057. These tests are identified in Table 4.0a below.

Table 4.0a Required Certification Measurements

47 CFR FCC Sections	Description of Tests	Test Required for Class II
2.1046, 30.202 (a)	**RF Power Output** **(a) Power Limits, EIRP, PSD**	**Yes**
2.1047,	**Modulation Characteristics**	**Yes**
2.1049, 30.203	**(a) Occupied Bandwidth** **(b) Out-of-Band Emissions**	**Yes**
2.1051, 30.203	**Spurious Emissions at Antenna Terminals**	**Yes**
2.1053, 30.203, **30.204, 15.109(a) Class B**	**Field Strength of Spurious Radiation**	**Yes**
2.1055,	**Measurement of Frequency Stability**	**N/A**

The measurements were conducted in accordance with the procedures set out in Section 2.1041 and as appropriate per the test Standards listed in Table 4.0b below. The comprehensive list of tests performed included measurements at Left, Center and Right side of the Part 30 Band. These tests are presented to demonstrate compliance with FCC requirements.

The procedures defined in ANSI C63.26-2015 and KDB 971168 D01 were developed for conducted measurements. The mmWave Joint Technical Group with FCC oversight has been working diligently on revisions to add mmWave measurements for Upper Microwave Flexible Use Service (UMFUS). The new KDB, 842590, is closely aligned with those efforts.

All of the measurements performed herein were performed as radiated measurements. In order to perform these measurements, the equipment settings required to enable the FSW internal noise reduction capability were used. This typically required the use of average detector, and multiple sweep averages. The individual test sections identify any changes in measurement process.

Table 4.0b Test Standards Used for Radiated Measurements of Radio Performance

Test Standard(s)	• 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018 • KDB 842590 D01 Upper Microwave Flexible Use Service v01 April 5, 2019
Reference(s)	• 47 CFR FCC Part 2 and Part 30 • ANSI C63.26 (2015) • ANSI C63.4 (2014) • TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014)

4.1 Section 2.1046 MEASUREMENT REQUIRED: RF POWER OUTPUT

The product incorporates internal antennas that are part of the signal source. There is no antenna terminal connection on the product. Therefore this test as implemented is not a measurement of the total conducted power at the antenna terminal but rather the total radiated power in terms of the maximum EIRP radiated by the product.

The FCC recognized that these products would use integrated antennas and likewise structured the requirements under Part 30. Under Part 30 the average power of the sum of all antenna elements is limited to an equivalent isotopically radiated power (EIRP) density of +75dBm/100 MHz.

The **Nokia AirScale 39 GHz Radio Unit (AEWF), FCC ID: VBNAEWF-01**, is a LTE TDD Remote radio head presently configured for single carrier operation. It is specified to provide a maximum power output of 54 dBm EIRP/500 W EIRP per transmit polarization for a sum total of 57 dBm EIRP /500W EIRP per unit. The product is designed for the 5G global market including operation per 47 CFR Part 30 rules for operation in the 5G New Radio Band n260 from 37 – 40 GHz.

4.1.1 RF Power Output Measurement

The product was configured for test as shown in Figure 4.1.1 below and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

Radiated Power measurements of the 5G New Radio transmit signal were conducted with an FSW Spectrum Analyzer per KDB 971168 D01 and KDB 842590 D01. Measurements were performed at a 4 m distance using a nominal 67.64 dB offset. An additional correction is necessary to ascertain the actual measured EIRP power. The calculation of path loss, cable loss and measurement antenna gain are listed in Table 4.1.1. below. The unit was configured to transmit at its maximum power.

The Channel Power function of the FSW spectrum analyzer was used to measure the maximum average Horizontal and Vertical EIRP at the 4m boundary distance. The measurements were performed at the Left, Center and Right side of the 37-40 GHz frequency range for a 100 MHz bandwidth carrier with 5G-NR 64QAM modulation. Channel power plots identify the individual carrier power and the total power.

Table 4.1.1 Corrections For Transmitter Power Measurements

Frequency	Free Space Path Loss, "PL"	Measurement Antenna Gain, "G1"	Measurement Cable Loss, "L1"	Total Offset Required PL -G1 + L1	FSW Measurement Offset	Required Final Correction
GHz	dB	dBi	dB	dB	dB	dB
35.0	75.36	23.25	14.59	66.71	67.64	-0.93
36.0	75.61	23.40	14.85	67.06	67.64	-0.58
37.0	75.85	23.45	15.11	67.50	67.64	-0.14
37.5	75.96	23.60	15.25	67.61	67.64	-0.03
38.0	76.08	23.60	15.38	67.86	67.64	0.22
38.5	76.19	23.60	15.49	68.09	67.64	0.45
39.0	76.30	23.70	15.67	68.27	67.64	0.63
39.5	76.41	23.78	15.81	68.44	67.64	0.80
40.0	76.52	23.80	15.85	68.57	67.64	0.93
41.0	76.74	23.85	16.03	68.92	67.64	1.28

4.1.1.1 RF Power Output Results

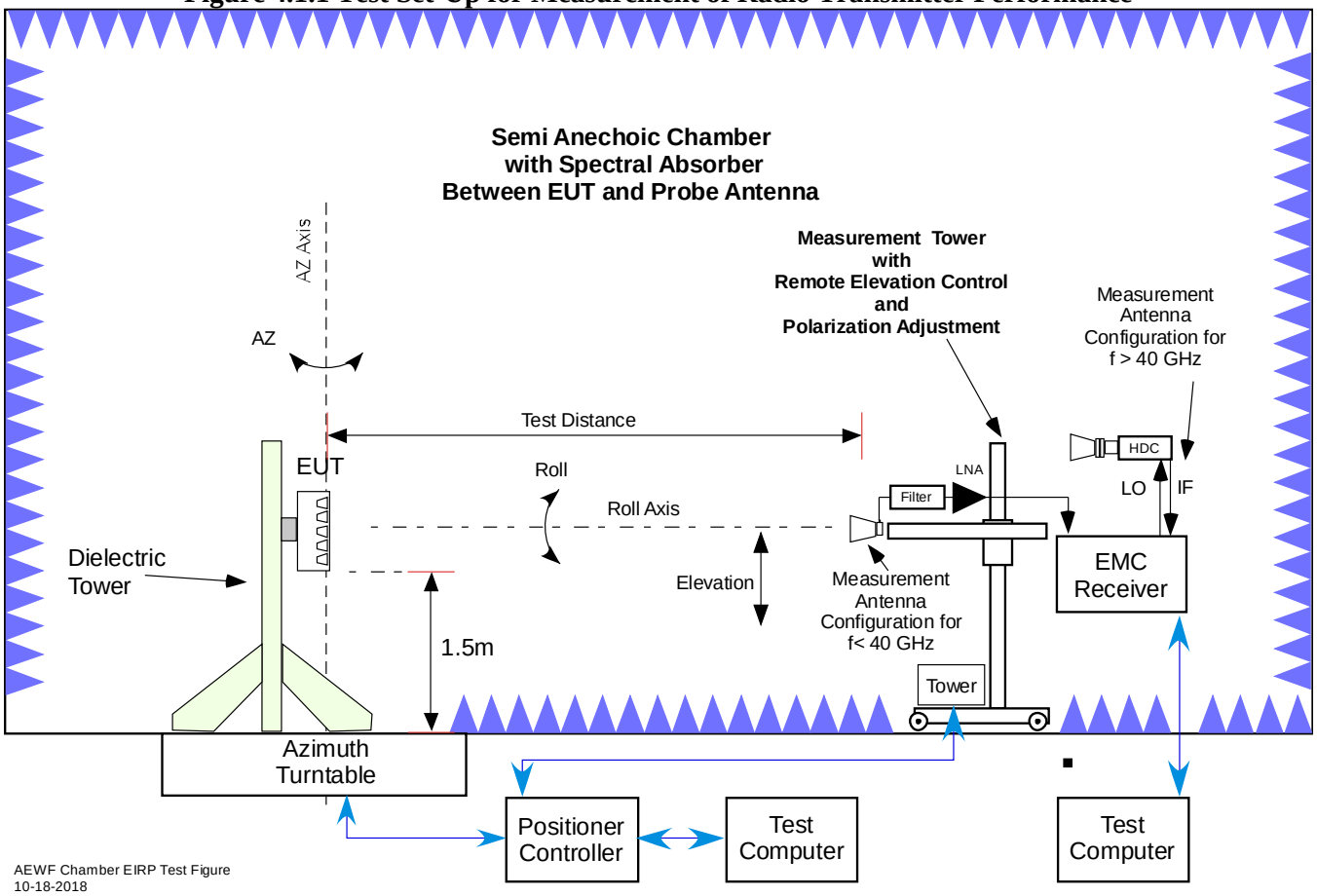
Power output measurements verified the expected performance of 54 dBm EIRP per polarization 57dBm Total. The maximum measured level was 57.23 dBm. This level is well within the maximum Part 30.202a limit of 75 dBm EIRP and are within the parameters as previously filed. Measurements were performed for each polarization as tabulated below.

Table 4.1.1.1 RF Power Output Results

Tested Carrier Configuration	Horizontal Polarization Total Channel Power, EIRP dBm	Vertical Polarization Total Channel Power, EIRP dBm	Sum Total Channel Power EIRP dBm
4 Carriers - Left Side of Band	**54.15**	**54.22**	**57.20**
4 Carriers - Middle of Band	**54.04**	**54.04**	**57.05**
4 Carriers - Right Side of Band	**54.06**	**54.03**	**57.06**
4 Spread Carriers - Middle of Band	**54.10**	**54.33**	**57.23**
2 Carriers - Left Side of Band	**54.00**	**54.09**	**57.06**
3 Carriers - Right Side of Band	**54.25**	**54.03**	**57.15**

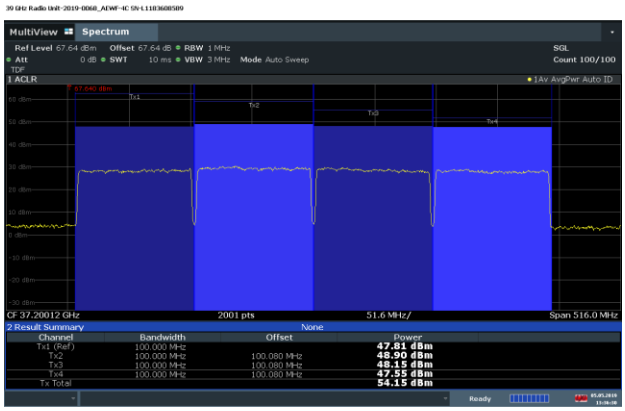
The measured performance was in full compliance with the Rules of the Commission. The data plots are detailed below.

Figure 4.1.1 Test Set-Up for Measurement of Radio Transmitter Performance

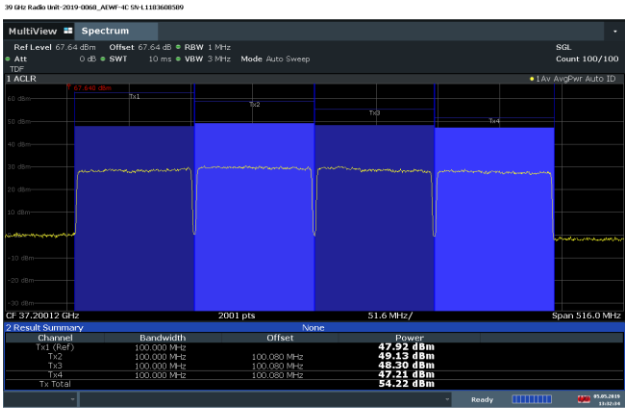


4m Channel Power Measurements.

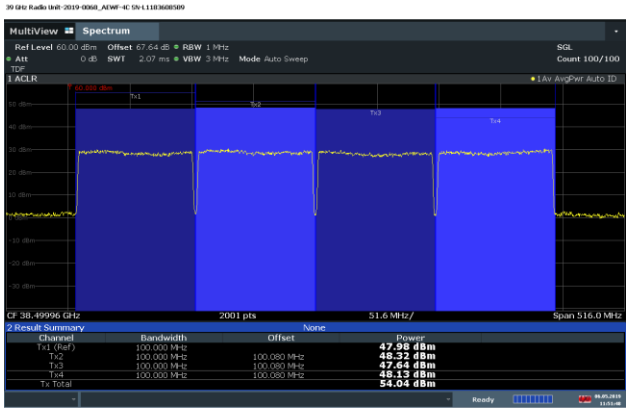
4c Left Side of Band - Horizontal



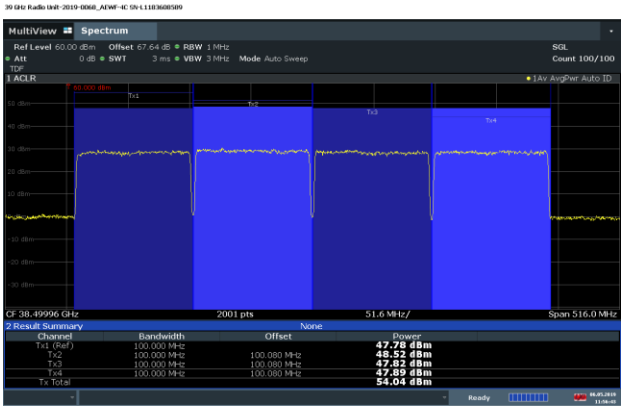
4c Left Side of Band - Vertical



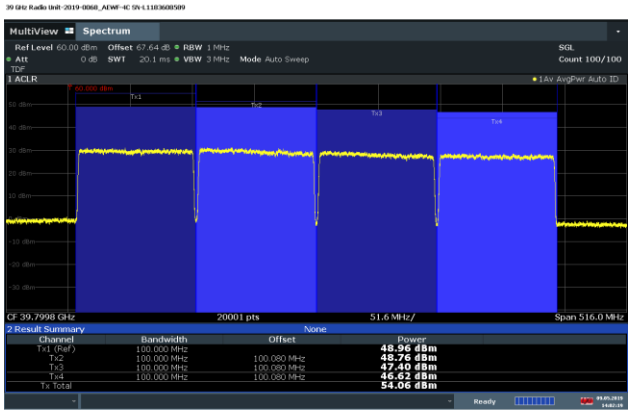
4c Middle of Band - Horizontal



4c Middle of Band - Vertical



4c Right Side of Band - Horizontal

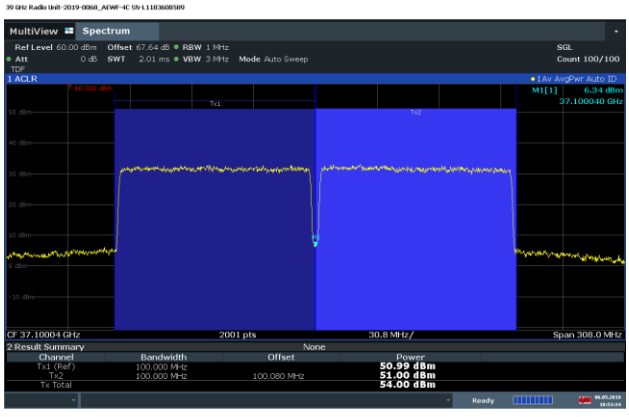


4c Right Side of Band - Vertical

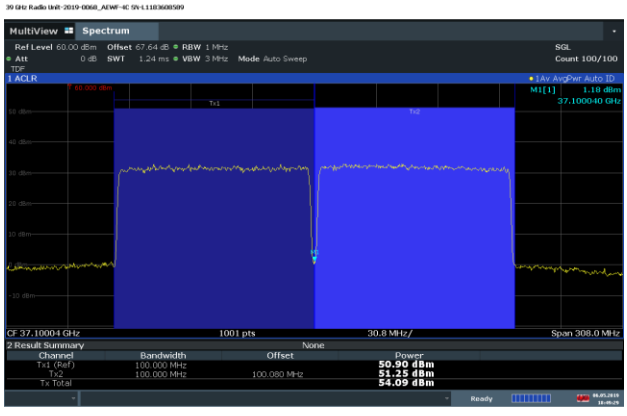
4c Spread - Middle of Band - Horizontal

4c Spread - Middle of Band - Vertical

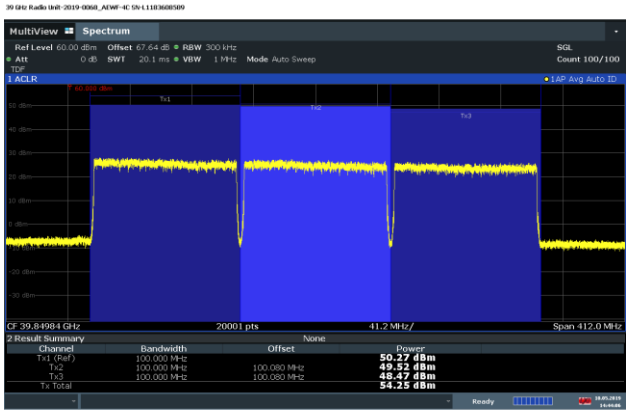
2c Left Side of Band - Horizontal



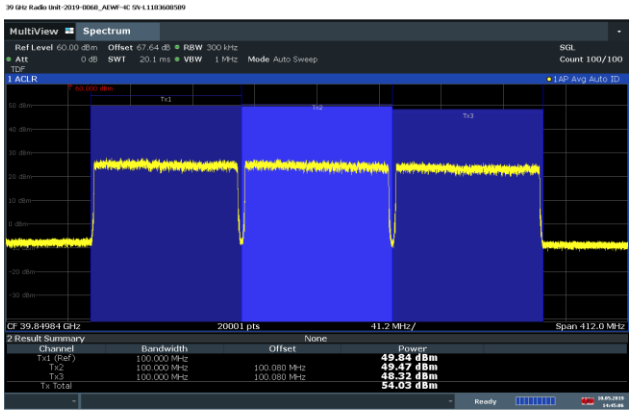
2c Left Side of Band - Vertical



3c Left Side of Band - Horizontal



3c Left Side of Band - Vertical



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4.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERISTICS

The **VBNAEWF-01** supports the 5G New Radio Modulation Format based upon LTE TDD technologies. LTE utilizes Orthogonal Frequency Division Multiplexing (OFDM) which splits the carrier frequency bandwidth into many small subcarriers. Each individual subcarrier can be modulated with QPSK, 16QAM and 64QAM digital modulation formats.

In QPSK, there are 4 possible symbol states and each symbol carries 2 bits of information. In 16QAM, there are 16 possible symbol states and each 16-QAM symbol carries 4 bits of information. In 64QAM, there are 64 possible symbol states and each 64-QAM symbol carries 6 bits of information. The higher-order modulations, those where the constellations are more dense, are more sensitive to poor channel conditions than the lower-order modulation.

The modulation characteristics measurement of LTE carriers measures the difference between the ideal symbols and the measured symbols after the equalization. The 5G-New Radio format is still in revision in 3GPP and Release 16 is expected Q4 of 2018. This present evolutionary nature of 5G-NR prevents all of the nominal EVM measurements from being performed at this time. However, constellations were recorded to assess that the subcarrier configurations were achieved.

There are no FCC Limits for Modulation and all of the formats above look spectrally the same from a channel edge and regrowth standpoint. It is expected that greater fidelity will be available after test equipment is configurable with the final format of Release 16. A Class II change is planned for this unit for Multi-carrier operation and Release 16 should be testable at that time.

4.2.1 Modulation Characteristics Measurement

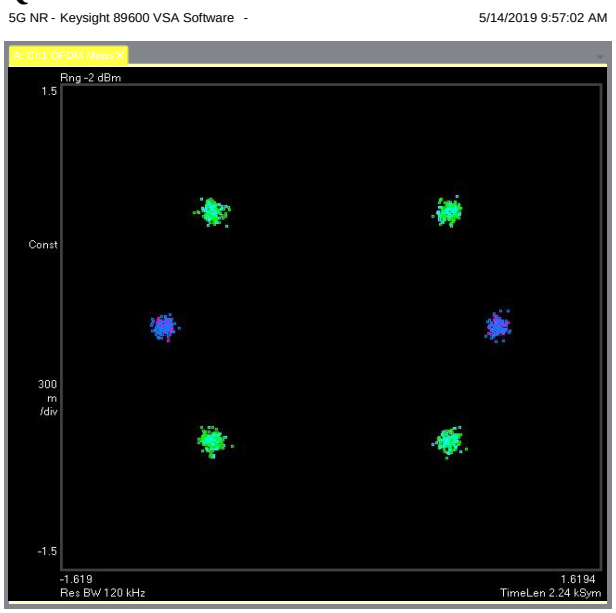
The measurements were performed at a distance of 4 m from the unit utilizing the test configuration in Figure 4.4.1 utilizing a Keysight 44 GHz MXA Signal analyzer with the 3GPP 5G-NR DL Measurement software option. Representative screen plots of the modulation measurement are attached below for all three of the subcarrier configurations and sample polarizations. Data was collected at left, center and right side of the 37-40 GHz frequency band.

4.2.2 Modulation Measurements Results:

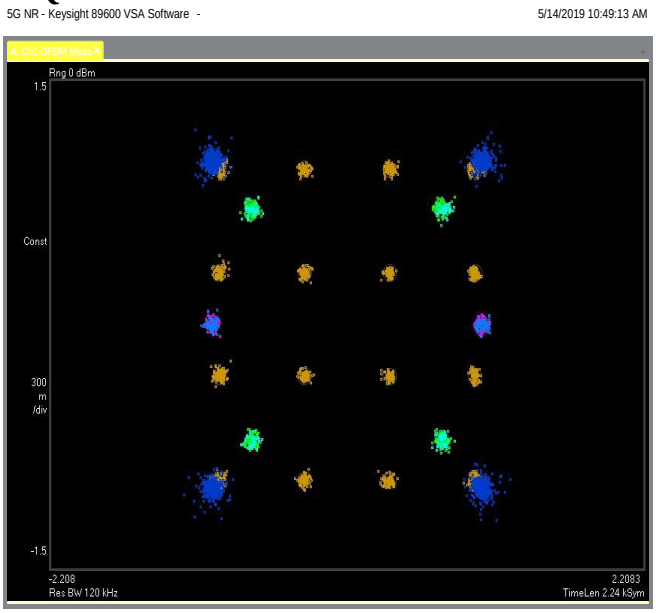
The typical measured modulation characteristics of the EUT are shown below:

Figure 4.2 Modulation Results

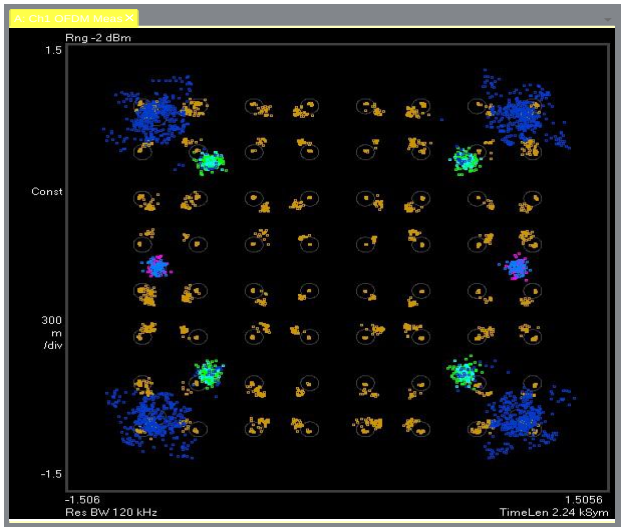
QPSK



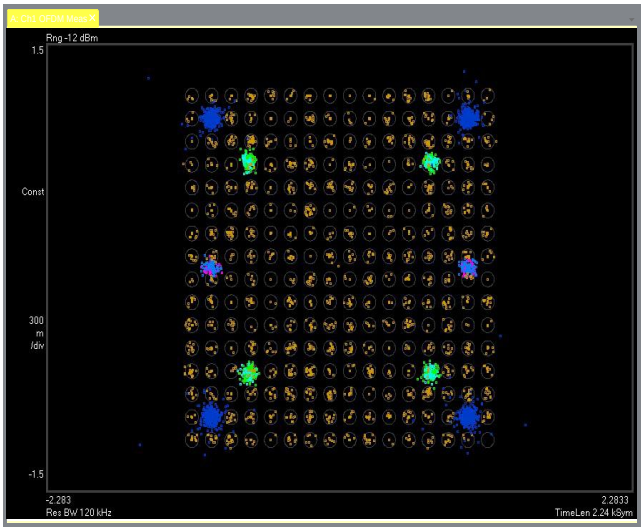
16QAM



64QAM



256QAM



4.3 Section 2.1049 MEASUREMENT REQUIRED: OCCUPIED BANDWIDTH and EDGE of BAND EMISSIONS

This test measures the Occupied Bandwidth of the transmitting carrier and the Edge of-Block Emissions in the frequency spectrum immediately outside and adjacent to the transmitting carrier(s).

For this test the occupied bandwidth (OBW) is defined as the 99% power OBW or a relative OBW. The 99% OBW is the signal bandwidth such that, below its lower and above its upper frequency limits, the mean power radiated or conducted are each equal to 0.5 percent of the total mean power radiated or conducted by a given emission. The relative -26 dB OBW is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated by at least 26 dB below the transmitter power.

Per KDB 971168 D01 v03r01, the relative OBW must be measured and reported when it is specified in the applicable rule part; otherwise, the 99% OBW shall be measured and reported. The OBW shall be measured per Subclause 5.4.4 of ANSI C63.26-2015 and when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment is operated.

The requirements defined in Subclause 5.4.4 of ANSI C63.26-2015 were developed for conducted measurements. However all of the measurements performed herein were performed as radiated measurements. The use of max hold and a peak detector were not used as the internal noise reduction functionality was required to make the measurement. All measurements were performed with a 100 sweep average using an average detector. The signal bandwidth measurements were performed with resolution bandwidths of 1, 3 & 5 MHz.

4.3.1 Results Occupied Bandwidth (Signal Bandwidth)

The measurements of 99% occupied bandwidth were performed with a Rohde & Schwartz FSW 67 GHz spectrum analyzer. The measurements of the intended 100 MHz 5G-NR carrier indicated compliance for the 97M5G7D emission designator. Sample results are presented below and shows that the measured signals are within the parameters of the 97M5G7D emissions designator.

Table 4.3.1 Occupied Bandwidth Results

Frequency, GHz	Resolution Bandwidth, MHz	Modulation	Occupied Bandwidth, MHz
37.05000	5	QPSK	96.58
39.94992	5	QPSK	97.45
37.05000	5	16QAM	96.37
37.15008	5	16QAM	96.40
38.34994	5	64QAM	96.51
38.44992	5	64QAM	96.89
39.74976	5	256QAM	96.70
39.94992	5	256QAM	96.50

4.3.1.1 Carrier Aggregation

The April 12, 2016 TCBC viewgraph package identified that Carrier Aggregation data need be supplied. This requirement is not yet formalized in a KDB for LTE, 5G-NR or UMFUS. The 4 carrier bandwidth of the AEWF is defined as follows. The individual carriers, 97.5 MHz maximum, are spaced 100.08 MHz apart and do not overlap. The overall signal bandwidth for 4 adjacent carriers is depicted in Figure 4.3.1.1. This documents the assessment that the 4 carrier aggregated bandwidth is 397.74 MHz.

Figure 4.3.1.1 Four Carrier Aggregation.

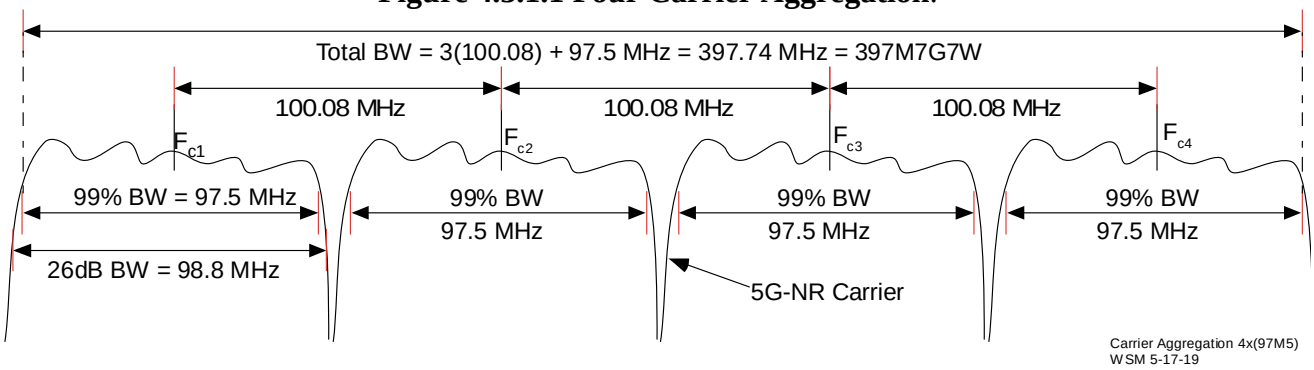


Figure 4.3.1- Occupied Bandwidth - 99% Signal Bandwidth

37.05 GHz – QPSK

39.94992 GHz - QPSK

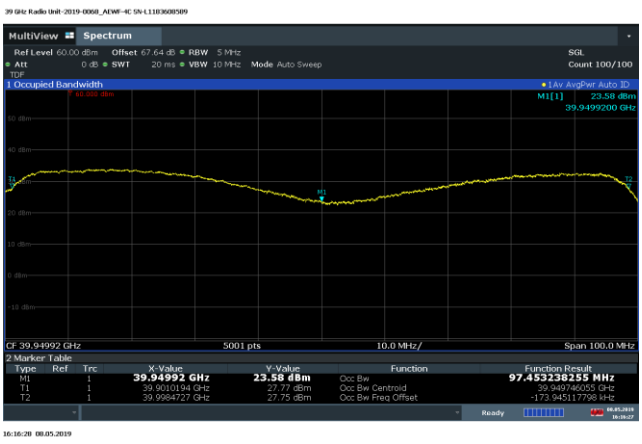
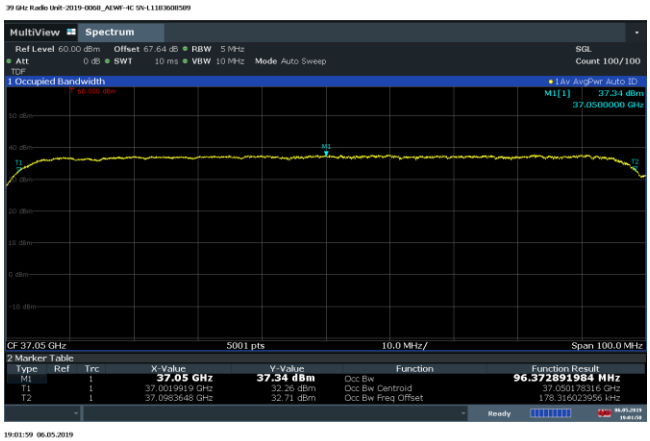
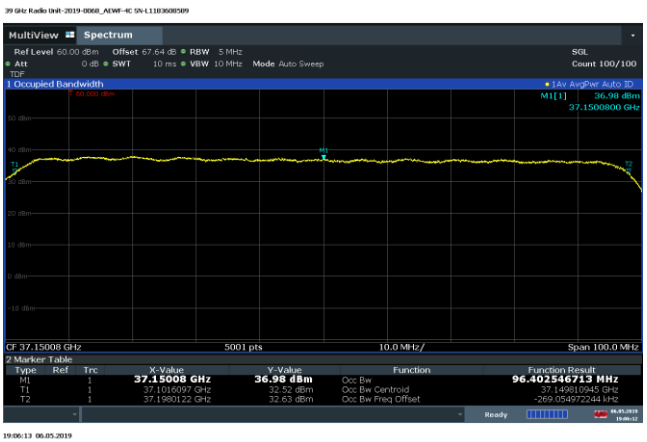


Figure 4.3.1- Occupied Bandwidth - 99% Signal Bandwidth *Continued*

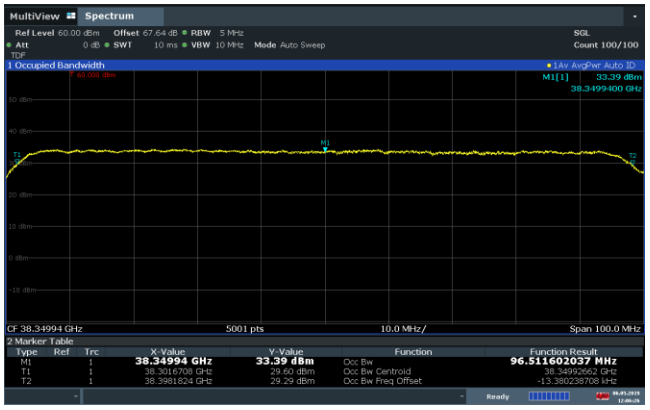
37.05 GHz - 16QAM



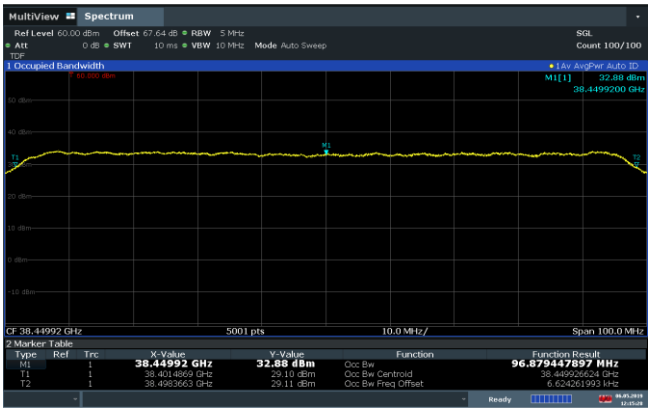
37.15008 GHz - 16QAM



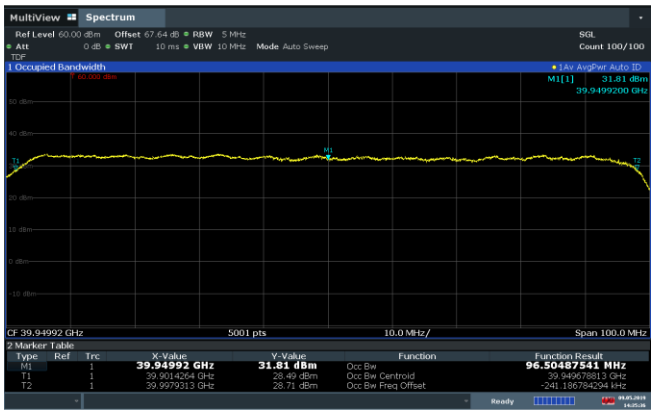
38.34994 GHz – 64QAM



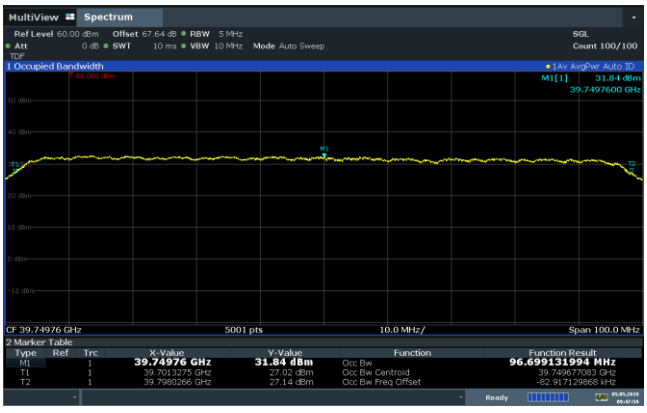
38.44992 GHz - 64QAM



39.94992 GHz - 256QAM



39.74976 GHz - 256QAM



4.3.2 Occupied Bandwidth-Edge of Band Emissions

Classical Occupied Bandwidth – Edge of Block Emissions is an evaluation of the transmit carrier compliance with edge of band requirements and characterizes Out-Of-Band Emissions (OOBE). This measurement documents the product's ability to maintain compliance with FCC Parts 2 and Part 30.203 limitations on emissions outside the band of operation. There are no internal blocks divisions for this band.

The **VBNAEWF-01** 39 GHz Radio Unit originally supported a single 5G-New Radio LTE TDD technology carrier. This evaluation addresses 2x2 MIMO operation with up to 4 carriers which are nominally 100 MHz each and may be placed anywhere within the active 800 MHz bandwidth of operation. In each test configuration the carriers were configured at the left, middle or right side of the Part 30 band as appropriate. All power measurements were performed prior to other measurements. Power was set to the total per polarization maximum of 54 dBm. The measurements are described below.

The occupied bandwidth of each of the signals identified in Table 4.3.6.1 was measured using a Rohde & Schwarz FSW Spectrum analyzer, a remote PC based instrumentation controller and the same calibrated RF attenuation path used for channel power. The measurement process meets the requirements of ANSI C63.26, KDB 842590 and ISO17025. The test setup was as shown in Figure 4.1.1. Measurements were performed at 5 m for both vertical and horizontal polarizations.

Plots are provided using the triggered functionality of the test analyzer and demonstrate compliance with edge of band limits. These sheets contain data for single carrier configurations for "Left Edge of Block", and "Right Edge of Block" across the Part 30 Upper Microwave Flexible Use Service spectrum.

4.3.3 Requirements 39 GHz Emissions Limits

The Limit in 47 CFR 30.203 for Emissions Limits is as follows:

> (a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be −13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be −5 dBm/MHz or lower.
>
> (b)(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.
>
> (2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.
>
> (3) The measurements of emission power can be expressed in peak or average values.

In order to address the limit as imposed for the requirement in 47CFR 30.203 we evaluated emissions per the requirements in ANSI C63.26 and per KDB 842590 Upper Microwave Flexible Use Service v01. The average detector function was used with multiple sweep averaging for all measurements.

4.3.4 Measurement Offset and MIMO

As this was a radiated EIRP measurement no MIMO adjustment was used.

4.3.5 Mask Parameters

The mask parameters are in units as stated in Part 30 and are listed in Table 4.3.5. Mask parameters are as stated in Table 4.3.5. Mask Edge Offsets = ½ the measurement Resolution Bandwidth were not used.

Table 4.3.5 - Mask Parameters Out Of Band / Edge of Band Emissions

Frequency	Part 30 Limit
GHz	dBm
35.00	-13
36.00	-13
36.99	-13
36.99	-5
37.00	-5
37.00	57
40.00	57
40.00	-5
40.01	-5
40.01	-13
41.00	-13
42.00	-13

4.3.6 Measurement Path Adjustments

The measured power at the spectrum analyzer input was adjusted for calculated free space loss, cable loss, measurement antenna gain and the product antenna gain over its applicable frequency range as documented in Exhibit 6 of the filing and in the table below. This is appropriate for Out Of Band Emissions / Edge of Band emissions only for the frequency range that the transmit antenna has documentable and consistent gain. Since different products have different gain responses vs frequency, the products documentable antenna gain only applies for the operational frequency range for which the product is designed.

Sample calculation: The sample calculation below is the formula and the correction for 37 GHz;

Adjustment = Free Space Path Loss - Measurement Antenna Gain + Cable Loss - Product Antenna Gain.

Total Required Adjustment (@37 GHz) = 40.50 dB = 77.79 dB -23.25dBi + 15.11dB - 29.15 dBi

This adjustment was only used for the OOBE/EoB frequency range. Table 4.3.6 below lists the offset correction factors used for the measurement distance of 4m including the AEWF product gain. The measurements were made using a flat offset of 40.49 dB with a transducer correction identified below.

Table 4.3.6 Measurement Correction for Edge of Band / Out of Band Emissions

Frequency	Free Space Path Loss, PL	Measurement Antenna Gain, "G"	Measurement Cable Loss, "L"	PL-G1+L1	AEWF Antenna Gain, IEEE	Total Required Adjustment	FSW Offset	Transducer Correction Factor
GHz	dB	dBi	dB	dB	dBi	dB	dB	dB
35.0	77.30	23.25	15.11	69.16	28.70	40.46	40.49	-0.03
36.0	77.55	23.25	15.11	69.41	28.93	40.48	40.49	-0.01
37.0	77.79	23.25	15.11	69.65	29.15	40.5	40.49	0.01
37.5	77.90	23.40	15.24	69.74	29.26	40.48	40.49	-0.01
38.0	78.02	23.45	15.37	69.94	29.38	40.56	40.49	0.07
38.5	78.13	23.60	15.49	70.02	29.49	40.53	40.49	0.04
39.0	78.24	23.60	15.67	70.31	29.60	40.71	40.49	0.22
39.5	78.35	23.60	15.81	70.56	29.70	40.86	40.49	0.37
40.0	78.46	23.70	15.85	70.61	29.80	40.81	40.49	0.32
41.0	78.68	23.70	15.85	70.83	30.00	40.83	40.49	0.34

4.3.7 Edge of Band Measurements

The Occupied Bandwidth and Edge-of-Band emissions measurements were made as a radiated measurement at a distance of 4m. The measurements were performed with an FSW spectrum analyzer in compliance with the procedure and requirements of ANSI C63.26. The test set-up diagram in Figure 4.1.1 was used. Testing was performed for the 100 MHz carrier configurations at the left side, and right side of the Part 30 Band. All of the Edge of Band measurements were performed at the specified 1 MHz resolution bandwidths. Adjustment factors were as described in Section 4.3.6 above.

4.3.7.1 Results - Occupied Bandwidth-Edge of Block Emissions

The Occupied Bandwidth and Edge-of-Band plots for operation at the left side, center and the right side of the band for the various multicarrier configurations of the nominal 100 MHz carriers are below. These include two, three and 4 carrier operation including non-adjacent carriers. The mask accurately depicts the limits for the Part 30 NAR Band to determine compliance with FCC requirements. From the out-of-band emissions plots attached below, it can be seen that all of the emissions are within the required emission mask and are compliant.

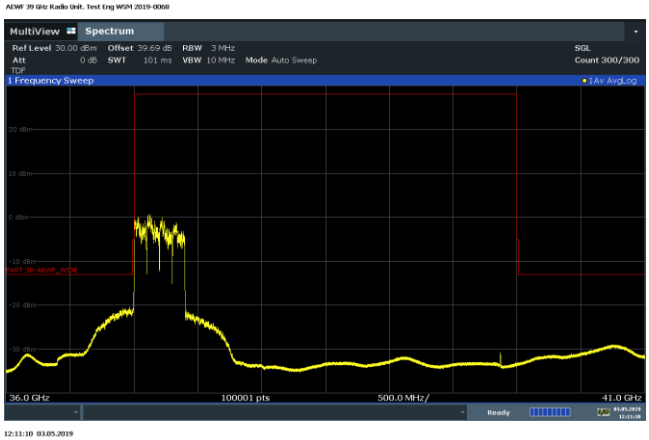
The results of the Occupied Bandwidth/ Edge-of-Band measurements document that the Out-Of-Band Emissions from 35 GHz to 42 GHz are compliant. The Plots and Table 4.3.7.1 demonstrate the full compliance with the Rules of the Commission for the UMFUS 39 GHz operating band.

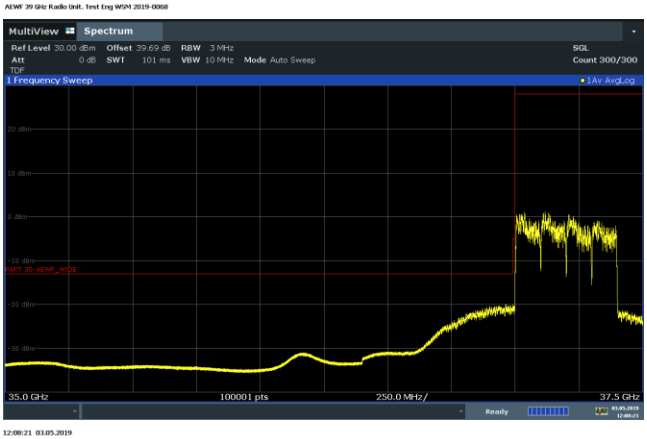
Table 4.3.7.1 Results - Occupied Bandwidth-Edge of Block Emissions/ OOBE

Center Frequencies of Edge Channels, GHz	Location	Number of Carriers	Modulation	Polarization	Occupied Bandwidth Edge of Block / OOBE Compliance
37.05000 to 37.35024	Left Side of Band	4 adjacent	QPSK	Horizontal	Compliant
				Vertical	Compliant
38.34984 to 38.65008	Middle of Band	4 adjacent	64QAM	Horizontal	Compliant
				Vertical	Compliant
37.75008 to 38.35056	Spread Carriers	4 non-adjacent	16QAM	Horizontal	Compliant
				Vertical	Compliant
39.64968 to 39.94992	Right Side of Band	4 adjacent	256QAM	Horizontal	Compliant
				Vertical	Compliant
37.05000 to 37.15008	Left Side of Band	2 adjacent	16QAM	Horizontal	Compliant
				Vertical	Compliant
39.74976 to 39.94992	Right Side of Band	3 adjacent	64QAM	Horizontal	Compliant
				Vertical	Compliant

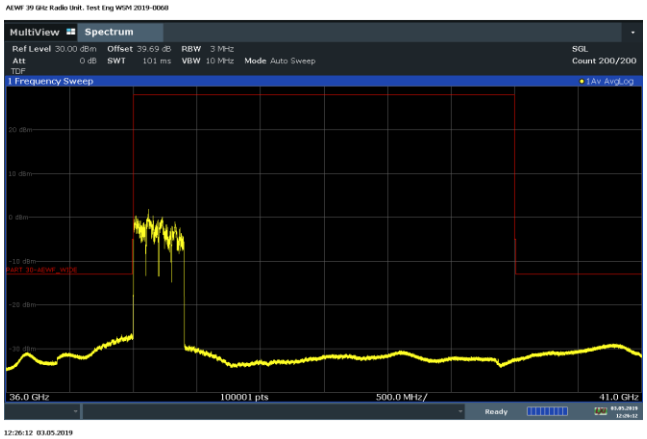
Figure 4.3.5 - Occupied Bandwidth - OOBE/EoB Band Charts E

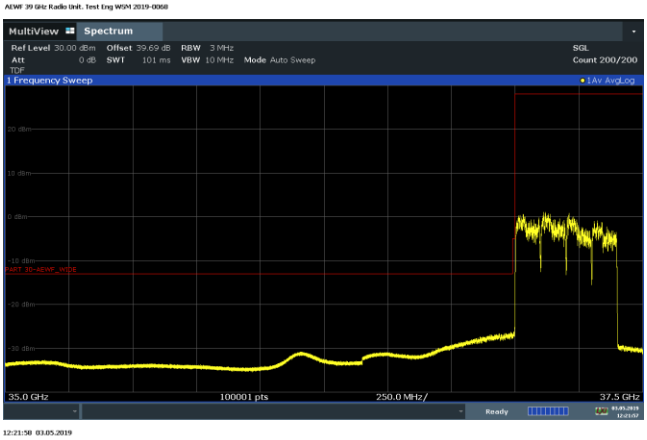
Horizontal Polarization - 4 Carriers - QPSK - Left Side of Band



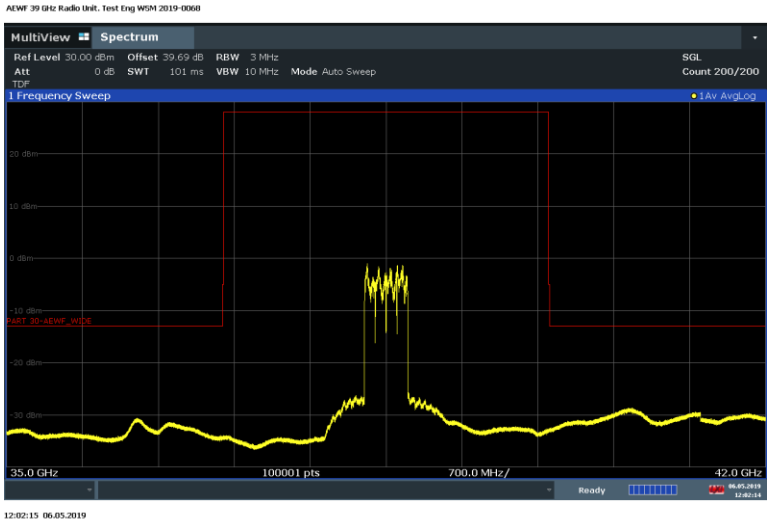


Vertical Polarization - 4 Carriers - QPSK - Left Side of Band.

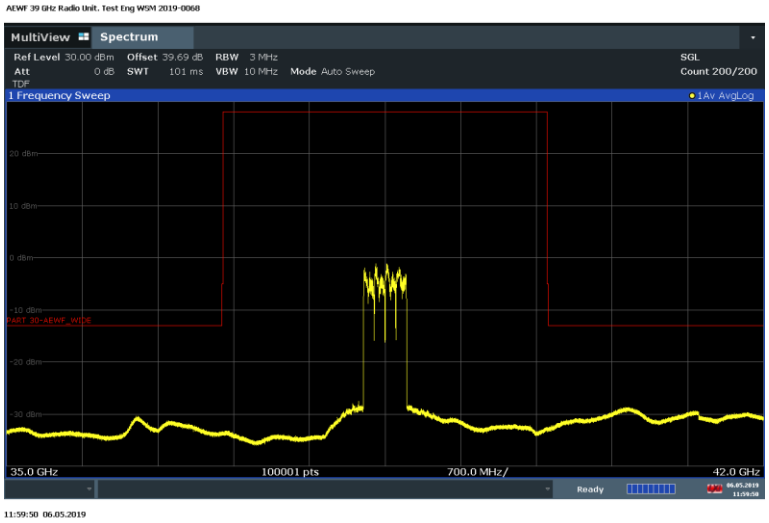




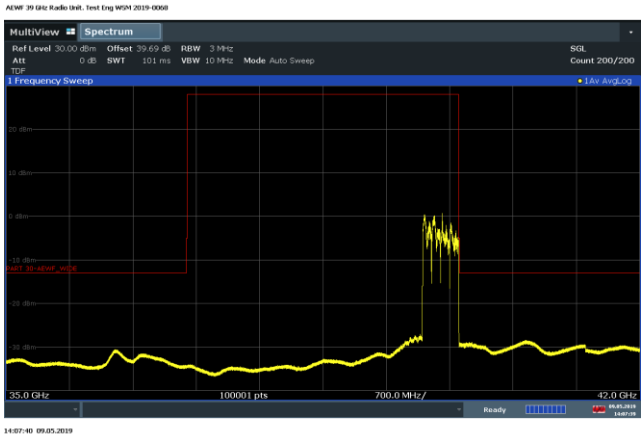
Horizontal Polarization - 4 Carriers - 64QAM - Middle of Band

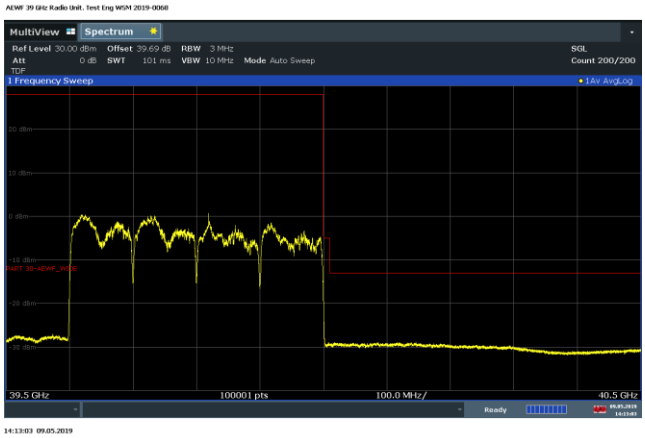


Vertical Polarization - 4 Carriers - 64QAM - Middle of Band

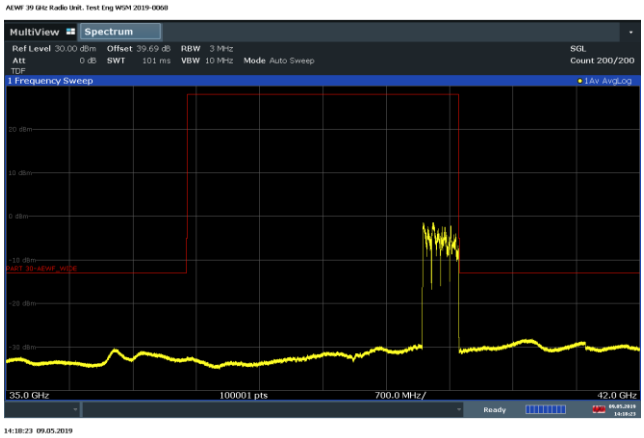


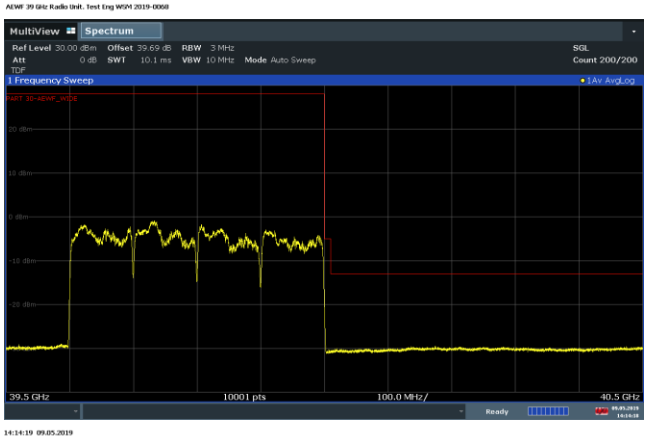
Horizontal Polarization - 4 Carriers - 256QAM - Right Side of Band.



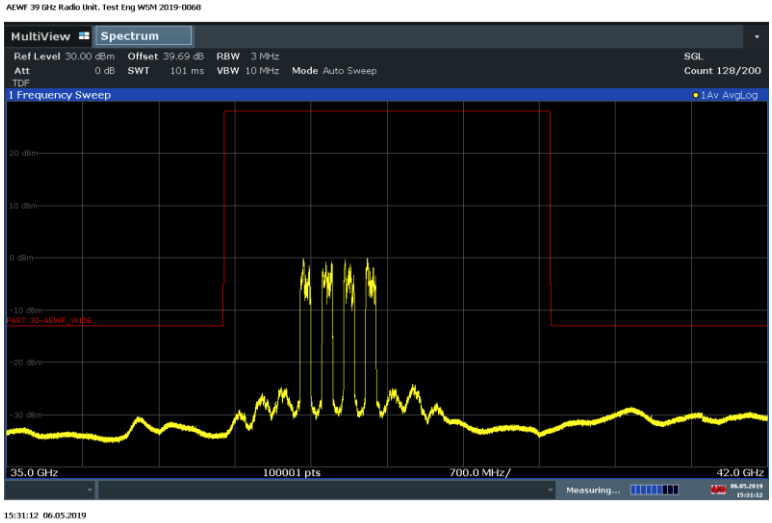


Vertical Polarization - 4 Carriers - 256QAM - Right Side of Band.

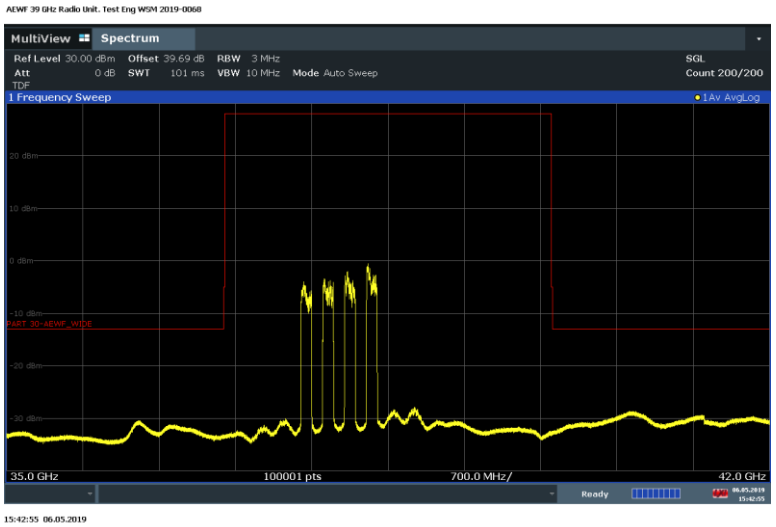




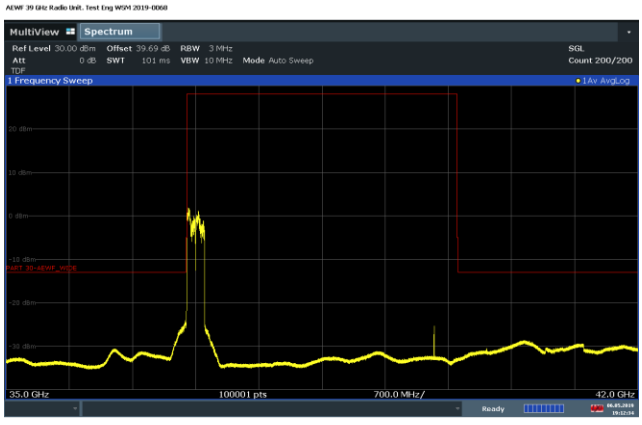
Horizontal Polarization - 4 Carriers - 16QAM – Spread Carriers.

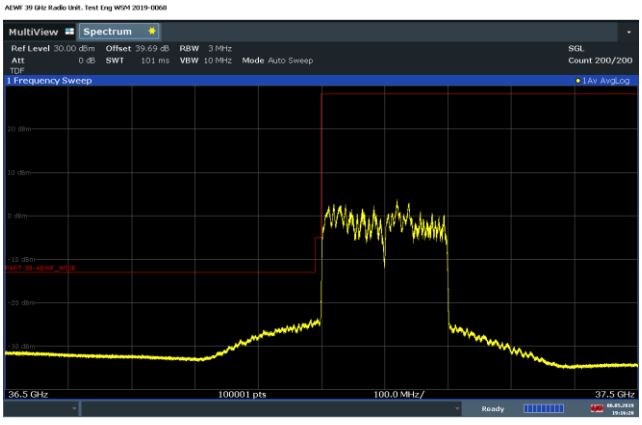


Vertical Polarization - 4 Carriers - 16QAM – Spread Carriers.

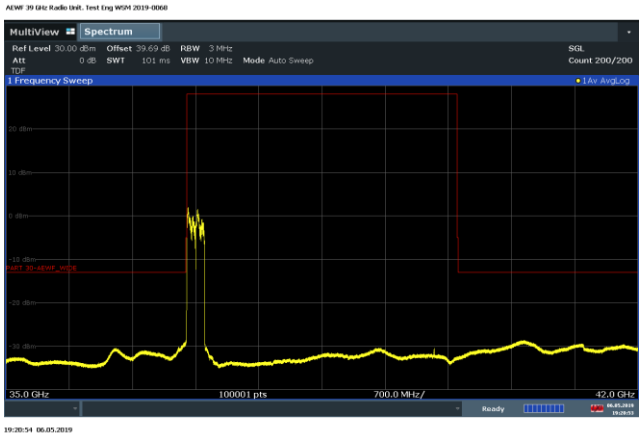


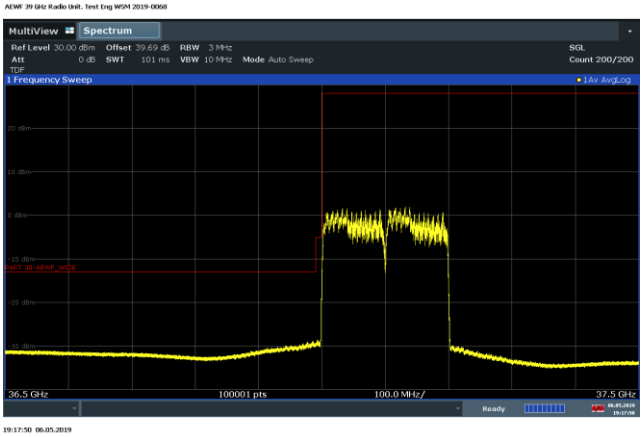
Horizontal Polarization - 2 Carriers - 16QAM - Left Side of Band.



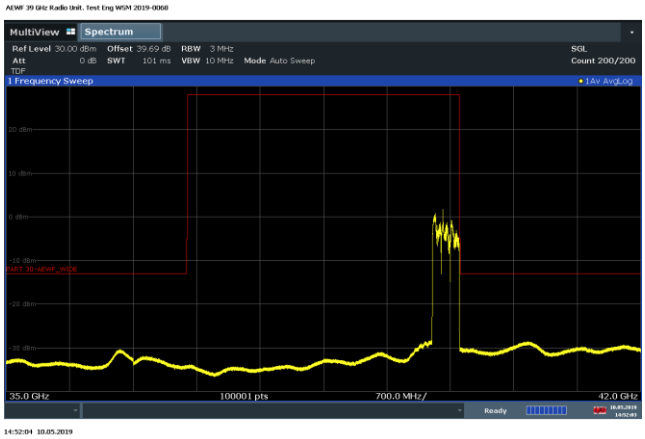


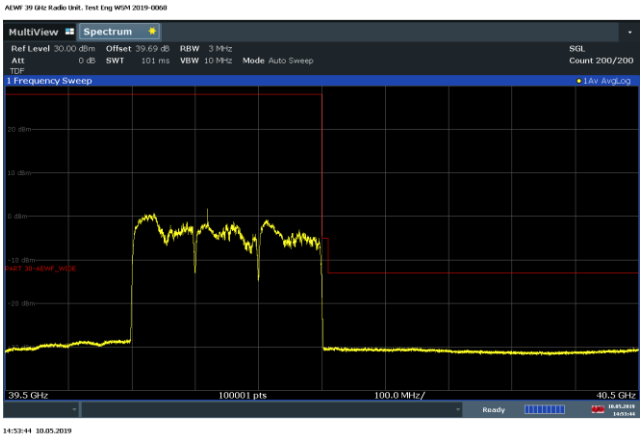
Vertical Polarization - 2 Carriers - 16QAM - Left Side of Band.



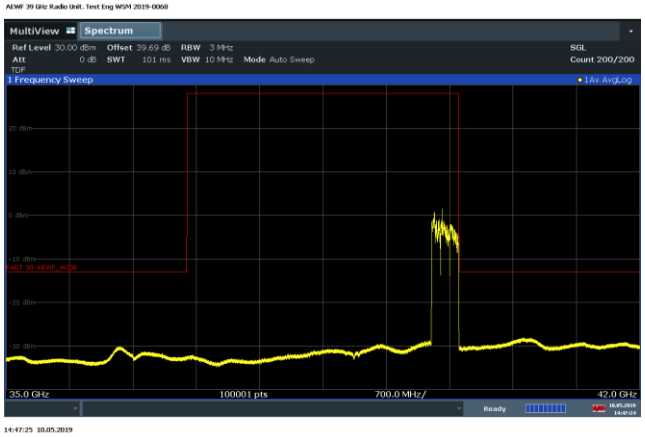


Horizontal Polarization - 3 Carriers - 256QAM - Right Side of Band.





Vertical Polarization - 4 Carriers - 256QAM - Right Side of Band.



4.4 Section 2.1051 MEASUREMENT REQUIRED: SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS

This test measures the emissions of spurious signals which may come from harmonic, parasitic, intermodulation and frequency conversion products and are outside the necessary bandwidth but excludes Edge-of-Band emissions.

4.4.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 30 MHz to 200 GHz as specified in 2.1057(a)(3).

2.1057(a)(3) If the equipment operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower.

4.4.2 Required Limit

The required emission limitation specified in **47CFR 30.203 (a)** was applied to these tests. Based upon the criterion given in Section 30 of the Code and as developed in 4.3.3, the required emission limit for emissions outside a licensee's frequency block is:

47CFR 30.203 (a) (a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be -13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be -5 dBm/MHz or lower.

4.4.3 Results

Since there is no antenna terminal, all measurements were performed as radiated measurements and standard radiated emissions. The Edge of Band emissions, presented in Section 4.3.7.1, document the 35 - 37 GHz and 40 - 42 GHz OOBE ranges. Those measurements are appropriate as the products antenna gain is documented over the same ranges. There were no emissions detected in these ranges.

The standard radiated emissions are documented in Section 4.5 "*Section 2.1053 Measurement Required: Field Strength of Spurious Radiation*". The test configuration is shown in Figure 4.4.1 documents the test set up used for the measurements.

The measurements were performed in compliance with ANSI C63.26, C63.26 mmWave JTG, and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW. The ESU-40 spectrum analyzer measurements examine the 30 MHz to 40 GHz range. The FSW based mmWave transmitter test system overlaps the transmit band for 37-40 GHz and extends the frequency range to examine the 40 GHz to 200 GHz range.

4.5 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

The field strength measurements of radiated spurious emissions were made in a FCC registered ten meter semi-anechoic chamber AR-8, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-8) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. The **VBNAEWF-01** (EUT) was configured in semi-anechoic chamber AR-8 in a manner simulating a normal field installation. The product's field installation hardware was used to mount the product to a wooden pole with the bottom of the product 1.5m above the turntable ground plane. The recommendations of ANSI C63.4–2014, C63.26-2015, KDB 842590 D01 and C63.26 mmWave JTG were followed for EUT testing setup and cabling. The EUT was configured to operate in a 5G-NR test model per the constraints identified in section 4.2. A photograph of this setup is in Exhibit 12 of the filing package.

The base station was configured into the full power forward beam transmit configuration to transmit two 54 dBm EIRP 100 MHz bandwidth 5G-NR carriers, one Vertical and one Horizontal polarization, with the total transmit power of 57 dBm EIRP. This configuration provides the highest power spectral density transmit signal for the product. The product utilizing the configurations below was evaluated over the 30 MHz to 200 GHz frequency range as required .

Table 4.5.1 EUT Configurations

Test Configuration NRARFCN	AEWF Tx Reference Frequencies MHz	Transmit Active Polarization	Signal Bandwidth, MHz	Modulation	Total Power, dBm EIRP	Radiated Emissions Pass / Fail
2251663 2253331 2254999 2256667	38349.84 38449.92 38550.00 38650.08	H & V	100	16QAM	57	Pass

4.5.1 Spurious Radiation and Radiated Emissions Requirements Below 40 GHz.

This product meets Part 15B, and Part 30.203 requirements. . FCC Part 15 Class B require emissions to be below 54.5 dBuV/m at 3m. Part 30.203 requires emissions to be below the value generated by a conducted emission of -13 dBm. This is a standard value for wireless products typically defined as

-43+10LogP=-13 dBm.

The emissions at the Edge of Band were adjusted by the 29 dBi gain of the transmit antenna as the product is designed to operate globally over the 37 to 40 GHz frequency band. Emissions removed from the transmit band were evaluated identically to other wireless products.

Measurements were performed in compliance with Section 2.1053, FCC publication 442401, the requirements detailed above and clause 5.5 of ANSI C63.26. For this case the evaluation of acceptable radiated field strength is as follows.

The calculated emission levels were found by:

Pmeas (dBm) + Cable Loss(dB) + Antenna Factor(dB) + 107 (dBμV/dBm) -Amplifier Gain (dB) = Field Strength (dBμV/m)

Title 47CFR section 30.203 and 2.1053 contains the requirements for the levels of spurious radiation as a function of the EIRP of the modulated carrier with 100 MHz of bandwidth. The reference level for the modulated carrier is calculated as the field produced by an isotropic radiator excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 27-7, 6th edition, IT&T Corp.

$$\mathbf{E = (120\pi P)^{1/2} = [(30*P)^{1/2}] / R}$$

$$\mathbf{20 \log (E*10^{6}) - (43 + 10 \log P) = 82.23\ dB\ \mu V/meter}$$

Where: E = Field Intensity in Volts/ meter R = Distance in meters = 3 m
P = Transmitted Power, Watts = 53300 W

The field strength of radiated spurious emissions measured was determined by

$$E\ (\mathrm{dB}\mu\mathrm{V/m}) = V_{\mathrm{meas}}\ (\mathrm{dB}\mu\mathrm{V}) + \text{Cable Loss (dB)} + \text{Antenna Factor (dBi/m)}.$$

Field strength measurements of radiated spurious emissions were made in the 10m semi-anechoic chamber, AR-8 as detailed above. The recommendations of ANSI C63.4 and ANSI C63.26 were followed for EUT testing setup, cabling, and measurement approach and procedures. All the measurement equipment used, including antennas, was calibrated in accordance with ISO 9001 process. The EUT setup diagram is given in the Figure 4.5. The minimum margins to the Part 30.203 limit is as measured in accordance with 2.1053. The test data follows.

4.5.2 Radiated Spurious Emissions Measurements: 40 GHz - 200 GHz:

The radiated spurious emissions spectrum was investigated per 47CFR Section 2.1057(a)(1) for spurious emissions over the frequency range of 40 GHz to 200 GHz. The procedure and methodology followed the recommendations of ANSI C63.4–2014, C63.26-2015 and C63.26 mmWave JTG.

A Rohde & Schwarz FSW 67 was employed with external three port Harmonic Down Converters (HDC). The waveguide RF input converters provided coverage for 40-60 GHz (U), 60-90 GHz (E), 90-140 GHz (F) and 140-220 GHz (G) bands. The HDC's were paired with 25 dB Standard Gain Horns. A 40 GHz waveguide high pass filter was utilized to limit the transmit carrier emissions from overloading the 40-60 GHz HDC.

Operation of the harmonic down converters utilizes a swept LO with a fixed IF frequency of 1.325 GHz. The IF cable loss for the 4m of cable was 1.03 dB and was corrected internally to the FSW along with the Conversion loss for the harmonic down converters. Additional external shielding of the HDC's was necessary to limit carrier energy from creating immunity issues with the measurements.

Cable loss compensation for the LO cable loss was necessary to enable scan heights from 1-3 meters. The experience of this test indicated that a 3m maximum test height with this product is adequate (0.5 m above the top of product). This allowed for a reduction of the test cables length and reduce IF images which occurred at multiples of the 1.325 GHz IF frequency.

Measurements were performed at the following distances:

mmWave Band	Frequency Range, GHz	Measurement distance, meters
U	40-60	4
E	60-90	4
F	90-140	3
G	140-220	3

Operation was verified prior to testing by bore-sighting a mmWave signal generator or mmWave source module with an antenna identical to the measurement antenna at the test distance. The location of the maximum beams had previously been ascertained for both vertical and horizontal polarizations. The beam is extremely narrow and radiated power is down 19 dB at just $\pm$ 7 degrees off center. All of the emissions and harmonics were found to be centered on the beam as well.

Based upon previous experience a continuous max hold (average detector) sweep of the product in elevation and azimuth was employed for full coverage scanning of the product. For these measurements in each band the scan was started at the beam peak location of 350 degrees azimuth, and nominal elevations 170-175 cm for Vertical and 154-158 cm for Horizontal. The peak was first located for the most prominent emissions in the span. The elevation was then swept down to 1m and back up back to 3m and returned to the beam peak. The product was then rotated continuously to 360 degrees back to 0 degrees and back to 350 degrees. This method locates any emission and provides the maximum emissions but required operation without the analyzer internal noise reduction function. Peaks were noted using the marker function which were later formally measured with the required 1 MHz resolution bandwidth. Measurements for all four bands were performed this way.

4.5.2.1 Bandwidth Limits and Corrections: Radiated Measurements 40 GHz - 200 GHz,

All corrections were made to the signal level as detailed below.

4.5.2.2 Resolution Bandwidth and # of Points:

For measurements above 40 GHz we performed final measurement scans with the required 1 MHz resolution bandwidth and preliminary scans with either a 10 MHz or 3 MHz resolution bandwidth.

Final measurements were performed so that the resolution bandwidth and span limitations of ANSI C63.26 were followed so that the number of measurement points $\geq$ 2(Span/RBW).
Our FSW was upgraded from the original filing and now processes 100,000 data points across the screen which allows for 50 GHz spans with a 1 MHz RBW. Multiple spans were therefore used when necessary to evaluate the peak spurious emissions detected.

4.5.2.3 Part 30 Limit:

The -13 dBm emissions limit was not adjusted in any way.

4.5.2.4 Emissions Corrections.

The measured signal was corrected by the FSW for the harmonic downconverter (HDC) conversion loss. Additionally, a correction consisting of the free space radiated Path Loss, and the measurement antenna gain was applied as a fixed offset + a transducer factor. There was no adjustment applied for the product antenna gain as these measurements are outside the transmit frequency range.

Emissions Correction = Path Loss - Antenna Gain

Where Free Space Path Loss = $((4\pi d)/\lambda))^2$

Table 4.5.2.4 details the corrections for the three bands.

Table 4.5.2.4a Radiated Emissions Corrections for 40-60 GHz at 4m .

Frequency	λ	Measurement Distance, d	Path Loss	Rx Antenna Gain	Total	Offset	Transducer Factor
GHz	m	m	dB	dB	dB	dB	dB
40.0	0.007500	4	76.52	21.80	54.72	55.54	-0.82
42.5	0.007059	4	77.05	22.20	54.85	55.54	-0.69
45.0	0.006667	4	77.55	22.50	55.05	55.54	-0.49
47.5	0.006316	4	78.02	22.70	55.32	55.54	-0.22
50.0	0.006000	4	78.46	23.00	55.46	55.54	-0.08
52.5	0.005714	4	78.89	23.30	55.59	55.54	0.05
55.0	0.005455	4	79.29	23.40	55.89	55.54	0.35
57.5	0.005217	4	79.68	23.60	56.08	55.54	0.54
60.0	0.005000	4	80.05	23.70	56.35	55.54	0.81

Table 4.5.2.4b Radiated Emissions Corrections for 60-90 GHz at 4m.

Frequency	λ	Measurement Distance, d	Path Loss	Rx Antenna Gain	Total	Offset	Transducer Factor
GHz	m	m	dB	dB	dB	dB	dB
60.0	0.005000	4	80.05	21.80	58.25	59.01	-0.76
65.0	0.004615	4	80.74	22.30	58.44	59.01	-0.57
70.0	0.004286	4	81.38	22.70	58.68	59.01	-0.33
75.0	0.004000	4	81.98	23.00	58.98	59.01	-0.03
80.0	0.003750	4	82.54	23.40	59.14	59.01	0.13
85.0	0.003529	4	83.07	23.60	59.47	59.01	0.46
90.0	0.003333	4	83.57	23.80	59.77	59.01	0.76

Table 4.5.2.4c Radiated Emissions Corrections for 90-140GHz at 3m.

Frequency	λ	Measurement Distance, d	Path Loss	Rx Antenna Gain	Total	Offset	Transducer Factor
GHz	m	m	dB	dB	dB	dB	dB
90.0	0.003333	3	81.07	21.90	59.17	59.79	-0.62
95.0	0.003158	3	81.54	22.20	59.34	59.79	-0.45
100.0	0.003000	3	81.98	22.60	59.38	59.79	-0.41
105.0	0.002857	3	82.41	23.00	59.41	59.79	-0.38
110.0	0.002727	3	82.81	23.30	59.51	59.79	-0.28
115.0	0.002609	3	83.20	23.63	59.57	59.79	-0.22
120.0	0.002500	3	83.57	23.83	59.74	59.79	-0.05
125.0	0.002400	3	83.92	24.00	59.92	59.79	0.13
130.0	0.002308	3	84.26	24.20	60.06	59.79	0.27
135.0	0.002222	3	84.59	24.40	60.19	59.79	0.40
140.0	0.002143	3	84.91	24.50	60.41	59.79	0.62

Table 4.5.2.4d Radiated Emissions Corrections for 140-200GHz at 3m.

Frequency	λ	Measurement Distance, d	Path Loss	Rx Antenna Gain	Total	Offset	Tranducer Factor
GHz	m	m	dB	dB	dB	dB	dB
140.0	0.002143	3	84.91	23.40	61.51	62.07	-0.56
145.0	0.002069	3	85.21	23.65	61.56	62.07	-0.51
150.0	0.002000	3	85.51	23.90	61.61	62.07	-0.46
155.0	0.001935	3	85.79	24.15	61.64	62.07	-0.43
160.0	0.001875	3	86.07	24.30	61.77	62.07	-0.30
165.0	0.001818	3	86.33	24.55	61.78	62.07	-0.29
170.0	0.001765	3	86.59	24.70	61.89	62.07	-0.18
175.0	0.001714	3	86.84	24.95	61.89	62.07	-0.18
180.0	0.001667	3	87.09	25.10	61.99	62.07	-0.08
185.0	0.001622	3	87.33	25.25	62.08	62.07	0.01
190.0	0.001579	3	87.56	25.40	62.16	62.07	0.09
195.0	0.001538	3	87.78	25.55	62.23	62.07	0.16
200.0	0.001500	3	88.00	25.70	62.30	62.07	0.23

4.5.3 Field Strength of Spurious Radiation Results:

This product meets Part 15B limits below 10 GHz and Part 30 Requirements. For the Title 47CFR section 30.203 and 2.1053 test, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBμV/meter. Emissions equal to or less than 62.23 dBμV/meter are not reportable.

There were reportable emissions below 37 GHz. The minimum margin was 3.37 dB to the noise floor at 35913.6 MHz.

All other emissions below 37 GHz were below the Part 15 Class B limit.

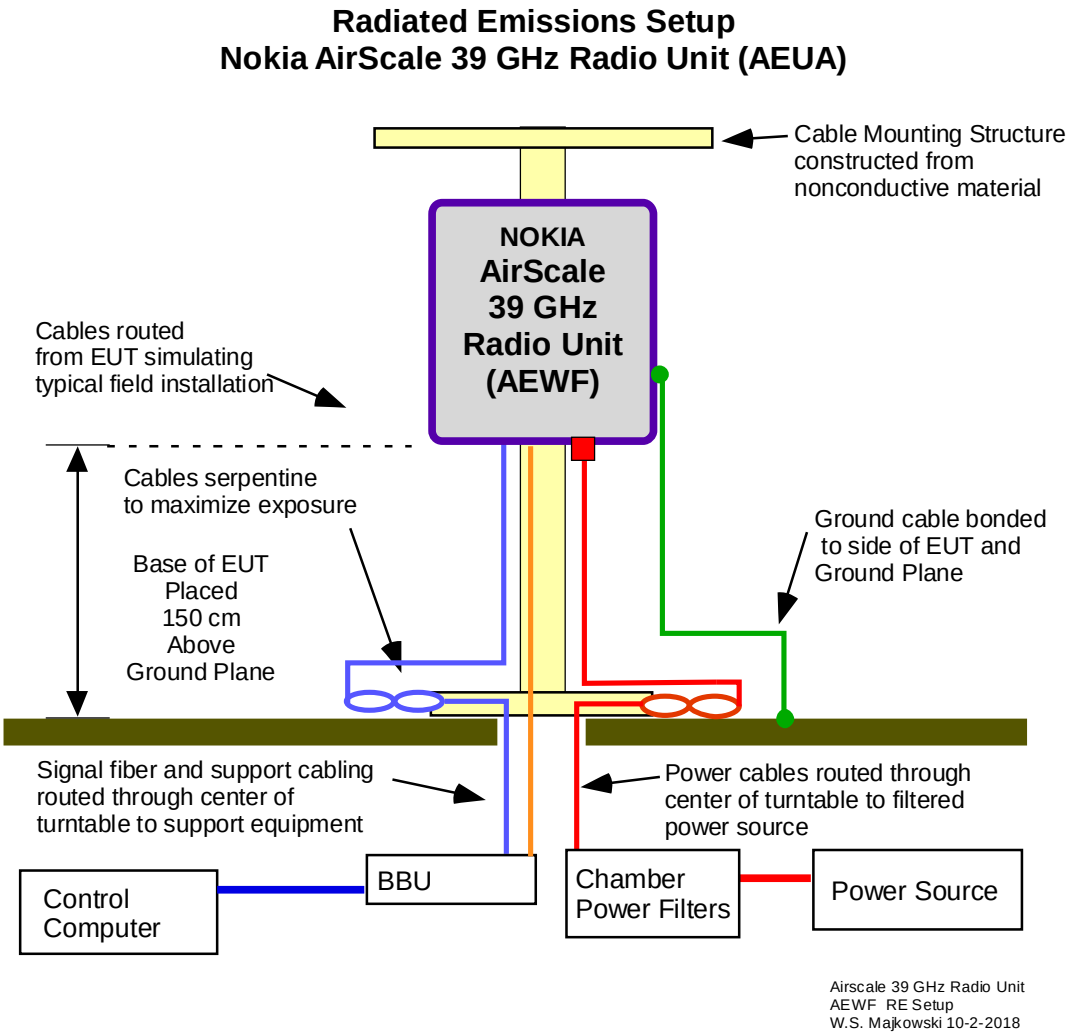
Presented results include the standard measurements from 30 MHz to 40 GHz followed by the four mmWave bands. The worst case emissions are presented. The scans are performed with the required 1 MHz resolution bandwidth and sufficient number of points per ANSI C63.26 with markers at the frequencies of interest. The limit in the measurement is the conducted -13 dBm limit as specified in Part 30.203. Corrections to the emissions levels consisted of only the HDC conversion loss, the Free Space Path Loss and the gain of the measurement antenna as detailed in Table 4.5.2.4.

Over the out of band spectrum investigated from 30 MHz to 200 GHz, reportable spurious emissions were detected and determined to be compliant with the Part 30 limit. The minimum margin, measured in the vertical polarization, was 5.20 dB at 190.64684 GHz. Additionally, from 30 MHz to 10 GHz all non-transmitter emissions were a minimum of 4.51 dB below the Part 15 Class B limit of 54.5 dBμV/m.

This demonstrates that the **AirScale 39 GHz Radio Unit (AEWF) Band 30, FCC ID: VBNAEWF-01**, the subject of this application, complies with FCC Part 15 Class B, and FCC Sections 2.1053, 30.203 and 2.1057 of the Rules.

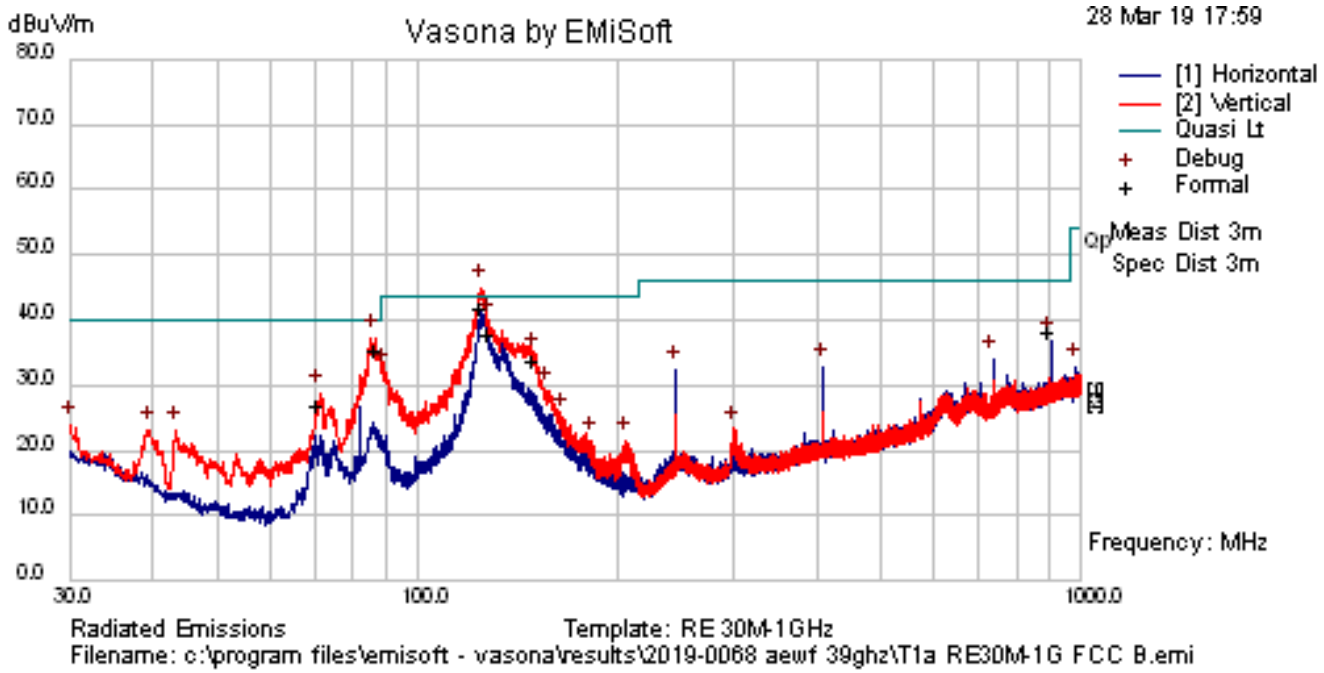
Photographs of the measurement setup are in the filing exhibits.

Figure 4.5 Radiated Emissions Product Setup



4.5.4 Transmitter Measurements of Radiated Spurious Emissions 30 MHz – 36 GHz

T1a Radiated Emissions 30M-1GHz FCC Class B DC Powered



Results Title:	RE 30M-1GHz
File Name:	c:\program files\emisoft - vasona\results\2019-0068 AEWF 39GHz\T1a RE30M-1G FCC B.emi
Test Laboratory:	AR4-MH, 25C, 38% 991mB
Test Engineer:	JY / MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AEWF, 39GHz. PN:474870A.X21, SN: L1183608589, 4C, Modulation 16QAM, 51dBm/polarity, transmitting @38.50G, 38.60G, 38.70G, 38.80GHz.
Configuration:	Powered by -48VDC, Tested to FCC Class B, RE 30M-1GHz, @ 3-Meters, Bilog Antenna E766 with 4dB pad, Preamp-E813, ESI-E907, PCS-Notch Filter E980. Internal attenuation 10dB, Preview BW (default); Formal BW (default).
Date:	2019-03-28 17:59:46

Formal Data

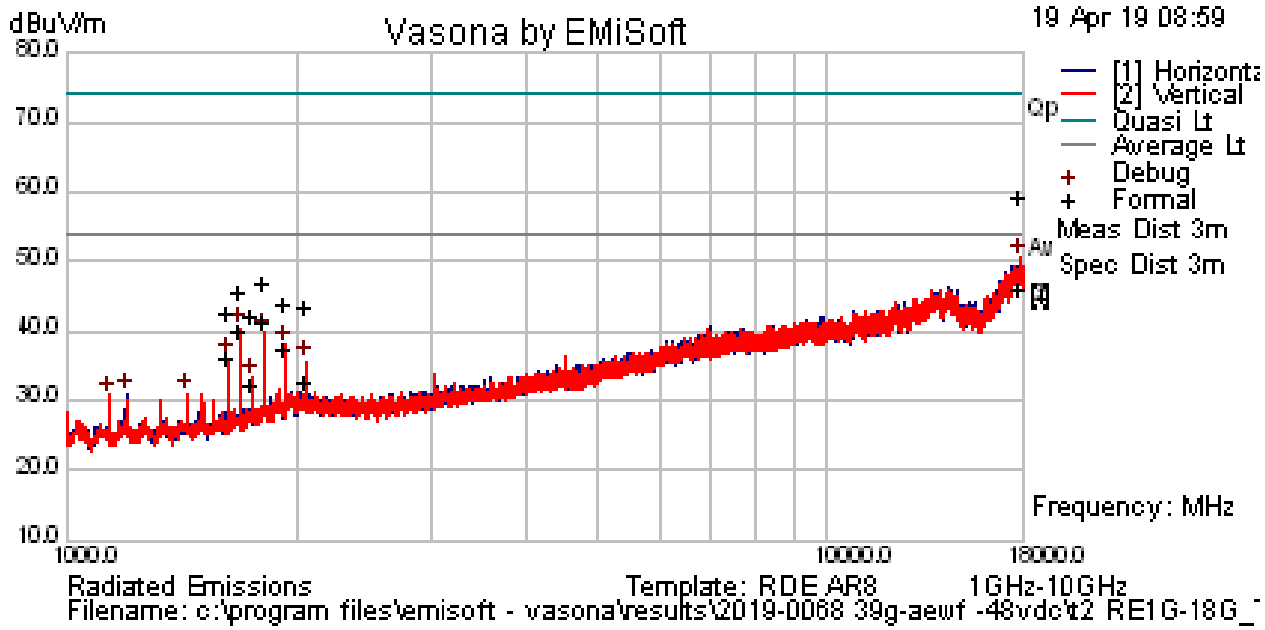
Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
125.279	47.34	1.19	-9.55	38.99	Quasi Max	V	116	98	43.5	-4.51	Pass	
86.417	49.02	1.01	-17.5	32.51	Quasi Max	V	99	180	40	-7.49	Pass	
128.501	43.1	1.2	-9.49	34.82	Quasi Peak	V	107	149	43.5	-8.68	Pass	
901.132	34.88	2.96	-2.49	35.36	Quasi Max	H	101	343	46	-10.64	Pass	
150.433	38.8	1.28	-9.21	30.87	Quasi Max	V	138	22	43.5	-12.63	Pass	
71.275	43.62	0.92	-20.4	24.09	Quasi Max	V	156	144	40	-15.91	Pass	

Preview Data

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
125.134	53.25	1.19	-9.55	44.9	Preview	V	100	135	43.5	1.4	Fail	
86.3687	53.63	1.01	-17.5	37.1	Preview	V	100	135	40	-2.9	Pass	
128.501	47.97	1.2	-9.49	39.68	Preview	V	100	135	43.5	-3.82	Pass	
150.433	42.55	1.28	-9.21	34.62	Preview	V	180	45	43.5	-8.88	Pass	
901.118	36.38	2.96	-2.49	36.85	Preview	H	100	0	46	-9.15	Pass	
71.2665	48.31	0.92	-20.4	28.78	Preview	V	100	135	40	-11.22	Pass	
89.2545	48.09	1.03	-16.9	32.19	Preview	V	100	180	43.5	-11.31	Pass	
737.303	35.71	2.57	-4.35	33.93	Preview	H	100	315	46	-12.07	Pass	
409.671	40.61	2.05	-9.7	32.97	Preview	H	100	45	46	-13.03	Pass	
245.76	42.55	1.52	-11.7	32.37	Preview	H	200	0	46	-13.63	Pass	
157.551	38.12	1.3	-10.3	29.13	Preview	V	100	135	43.5	-14.37	Pass	
30	32.7	0.64	-9.3	24.04	Preview	V	100	225	40	-15.96	Pass	
43.1784	38.59	0.73	-16.1	23.24	Preview	V	100	45	40	-16.76	Pass	
39.523	36.72	0.7	-14.4	23.07	Preview	V	100	0	40	-16.93	Pass	
166.208	35.16	1.33	-11.5	24.95	Preview	V	100	180	43.5	-18.55	Pass	
983.074	31.45	3.02	-1.62	32.84	Preview	H	380	0	54	-21.16	Pass	
183.234	33.9	1.38	-13.7	21.61	Preview	V	100	270	43.5	-21.89	Pass	
206.513	35.48	1.44	-15.4	21.56	Preview	V	100	225	43.5	-21.94	Pass	
300.397	34.02	1.61	-12.3	23.32	Preview	V	100	0	46	-22.68	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T2 Radiated Emissions 1 GHz - 18 GHz TX OFF Part 15B



Results Title:	RDE AR8 1GHz-18GHz
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Test Laboratory:	AR8 MH 25C, 11% RH 1016mB
Test Engineer:	MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia Wireless
EUT Details:	AEWF, 39GHz. PN:474870A.X21, SN: L1183608589, Not transmitting LO off.Powered by -48Vdc 8A,
Configuration:	Radiated Emissions 1GHz - 18GHz FCC Class B limit measurement at 3-Meters, Antenna E057, ESI-1G E907, Pre-Amp E447, 28G-Notch Filter E1361. Internal attenuation 0dB, Preview BW (100 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW). Radiated Emissions; FCC Pt15 Class B, 3 Meters, 1GHz-18GHz.
Date:	2019-04-19 08:59:01

FORMAL DATA

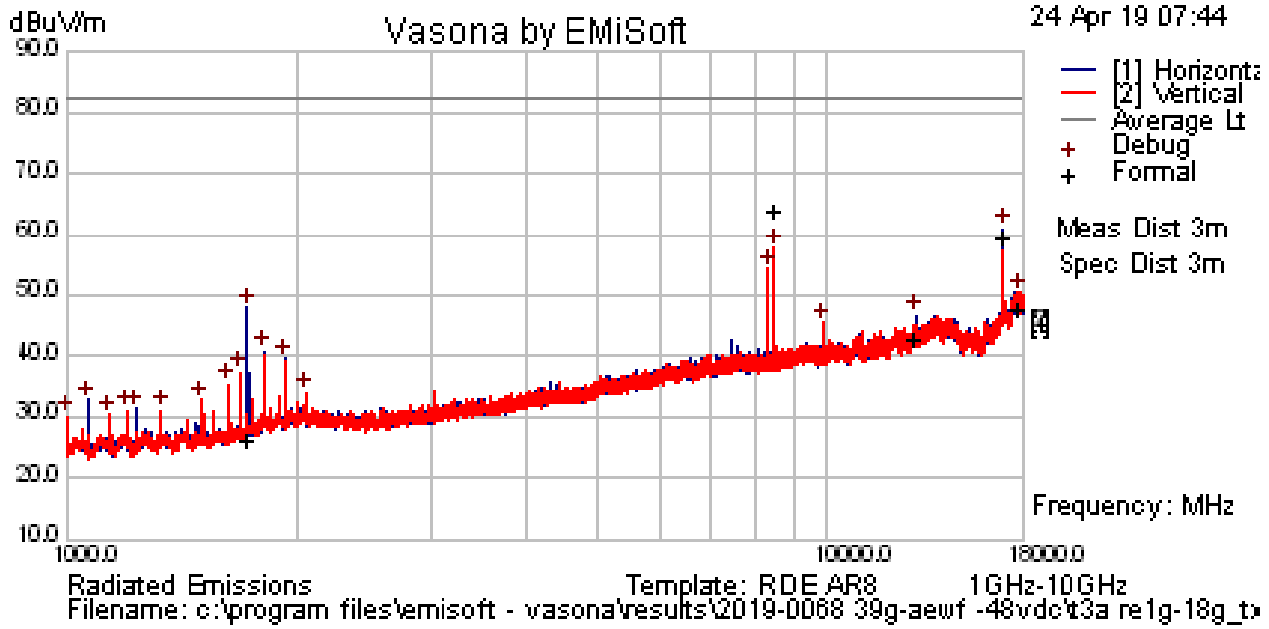
Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBµV/m	Margin dB	Pass /Fail	Comments
17911.1	23.9	14.09	6.1	44.09	Average	V	331	295	54	-9.91	Pass	
1812.5	46.46	4.32	-11.7	39.05	Average	V	106	357	54	-14.95	Pass	
1687.5	46.5	4.17	-12.7	37.96	Average	V	110	336	54	-16.04	Pass	
17911.1	37.05	14.09	6.1	57.24	Peak	V	331	295	74	-16.76	Pass	
1937.5	41.62	4.45	-10.8	35.26	Average	V	196	219	54	-18.74	Pass	
1625	43.02	4.1	-13.2	33.89	Average	V	141	312	54	-20.11	Pass	
2062.48	36.45	4.59	-10.4	30.63	Average	V	226	0	54	-23.37	Pass	
1750	38.26	4.25	-12.2	30.29	Average	V	100	320	54	-23.71	Pass	
1812.5	52.16	4.32	-11.7	44.75	Peak	V	106	357	74	-29.25	Pass	
1687.5	52.16	4.17	-12.7	43.62	Peak	V	110	336	74	-30.38	Pass	
1937.5	48.12	4.45	-10.8	41.76	Peak	V	196	219	74	-32.24	Pass	
2062.48	47.09	4.59	-10.4	41.26	Peak	V	226	0	74	-32.74	Pass	
1625	49.65	4.1	-13.2	40.52	Peak	V	141	312	74	-33.48	Pass	
1750	47.99	4.25	-12.2	40.03	Peak	V	100	320	74	-33.97	Pass	

PREVIEW DATA

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17911.1	30.18	14.09	6.1	50.37	Preview	V	385	66	54	-3.63	Pass	
1688.01	48.97	4.17	-12.7	40.44	Preview	V	100	352	54	-13.56	Pass	
1811.78	47.16	4.32	-11.7	39.75	Preview	V	100	0	54	-14.25	Pass	
1937.17	44.46	4.45	-10.8	38.1	Preview	V	200	220	54	-15.9	Pass	
1625.32	45.27	4.1	-13.2	36.14	Preview	V	100	308	54	-17.86	Pass	
2062.55	41.48	4.59	-10.4	35.66	Preview	V	100	176	54	-18.34	Pass	
1750.7	41.29	4.25	-12.2	33.33	Preview	V	200	330	54	-20.67	Pass	
1437.24	41.63	3.85	-14.5	30.96	Preview	V	200	330	54	-23.04	Pass	
1200.13	42.74	3.49	-15.3	30.95	Preview	H	185	176	54	-23.05	Pass	
1139.85	42.8	3.38	-15.5	30.68	Preview	V	100	66	54	-23.32	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T3a Radiated Emissions 1GHz - 18GHz TX ON - Part 30



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Test Laboratory:	AR8 MH 25C, 11% RH 1016mB
Test Engineer:	NPA
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia Wireless
EUT Details:	AEWF, 39GHz. PN:474870A.X21, SN: L1183608589, Transmitting. Powered by -48Vdc 8A,
Configuration:	Radiated Emissions 1GHz - 18GHz FCC Part 30 Average Limit measurement at 3-Meters, Antenna E057, ESI-1G E907, Pre-Amp E447, and 28G-Notch Filter E1361. Internal attenuation 0dB, Preview BW (100 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW).
Date:	2019-04-24 07:44:43

FORMAL DATA

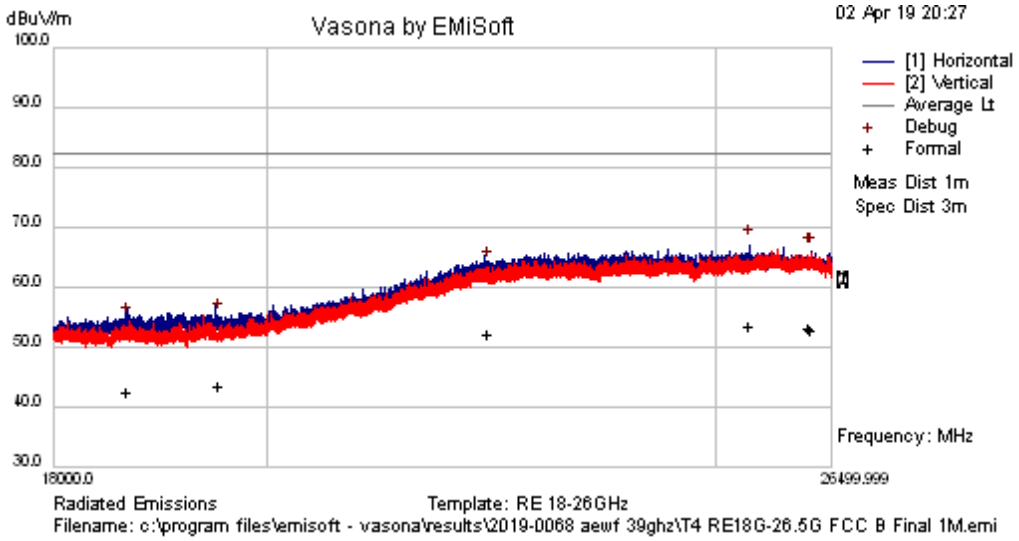
Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
8499.6	54.00	9.2	-1.73	61.47	Average	V	100	355	82.23	-20.76	Pass	
16999.2	39.52	13.65	4.17	57.34	Average	H	202	336	82.23	-24.89	Pass	
17868.2	25.26	14.07	6.09	45.43	Average	V	258	270	82.23	-36.8	Pass	
12991.9	26.09	11.6	2.64	40.33	Average	H	154	98	82.23	-41.9	Pass	
1729	32.00	4.22	-12.4	23.85	Average	H	321	209	82.23	-58.38	Pass	

PREVIEW DATA

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
16999.4	43.01	13.65	4.17	60.82	Preview	H	185	308	82.23	-21.41	Pass	
8499.77	50.13	9.2	-1.73	57.6	Preview	V	200	0	82.23	-24.63	Pass	
8337.41	46.98	9.13	-1.77	54.34	Preview	V	100	0	82.23	-27.89	Pass	
17868.2	30.27	14.07	6.09	50.44	Preview	V	300	22	82.23	-31.79	Pass	
1729	56.12	4.22	-12.4	47.97	Preview	H	100	0	82.23	-34.26	Pass	
12991.9	32.47	11.6	2.64	46.71	Preview	H	100	132	82.23	-35.52	Pass	
9829.97	36.68	9.75	-1.02	45.41	Preview	V	100	22	82.23	-36.82	Pass	
1811.78	48.15	4.32	-11.7	40.73	Preview	H	100	22	82.23	-41.5	Pass	
1937.17	46.08	4.45	-10.8	39.72	Preview	H	100	22	82.23	-42.51	Pass	
1688.01	45.98	4.17	-12.7	37.44	Preview	H	100	154	82.23	-44.79	Pass	
1625.32	44.55	4.1	-13.2	35.42	Preview	V	100	308	82.23	-46.81	Pass	
2062.55	39.87	4.59	-10.4	34.04	Preview	V	100	198	82.23	-48.19	Pass	
1065.1	45.3	3.25	-15.8	32.76	Preview	H	185	330	82.23	-49.47	Pass	
1499.93	43.12	3.94	-14.3	32.72	Preview	V	200	286	82.23	-49.51	Pass	
1229.07	42.85	3.53	-15.2	31.21	Preview	H	185	0	82.23	-51.02	Pass	
1330.34	42.22	3.69	-14.8	31.07	Preview	V	200	88	82.23	-51.16	Pass	
1200.13	42.73	3.49	-15.3	30.93	Preview	V	200	264	82.23	-51.3	Pass	
1139.85	42.41	3.38	-15.5	30.29	Preview	V	200	66	82.23	-51.94	Pass	
1000	42.94	3.12	-16.1	30	Preview	V	100	88	82.23	-52.23	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T4B Radiated Emissions 18 GHz – 26.5 GHz FCC Part 30



Results Title:	Radiated Emissions 18-26GHz
File Name:	c:\program files\emisoft - vasona\results\2019-0068 aewf 39ghz\T4 RE18G-26.5G FCC B Final 1M.emi
Test Laboratory:	AR4-MH, 29C, 38% 991mB
Test Engineer:	JY / MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AEWF, 39GHz. PN:474870A.X21, SN: L1183608589, 4C, Modulation 16QAM, 51dBm/polarity, transmitting @39.65G, 39.75G, 39.85G, 39.95GHz.
Configuration:	Powered by -48VDC, Tested to FCC Class B, RE 18G-26.5GHz, @ 1-Meter, Double Ridge E520, Preamp-E1356, ESU-EIH69, PCS-Notch Filter E1361. Internal attenuation 0dB, Preview RBW 100k; Formal RBW 1M.
Date:	2019-04-02 20:27:47

Formal Data

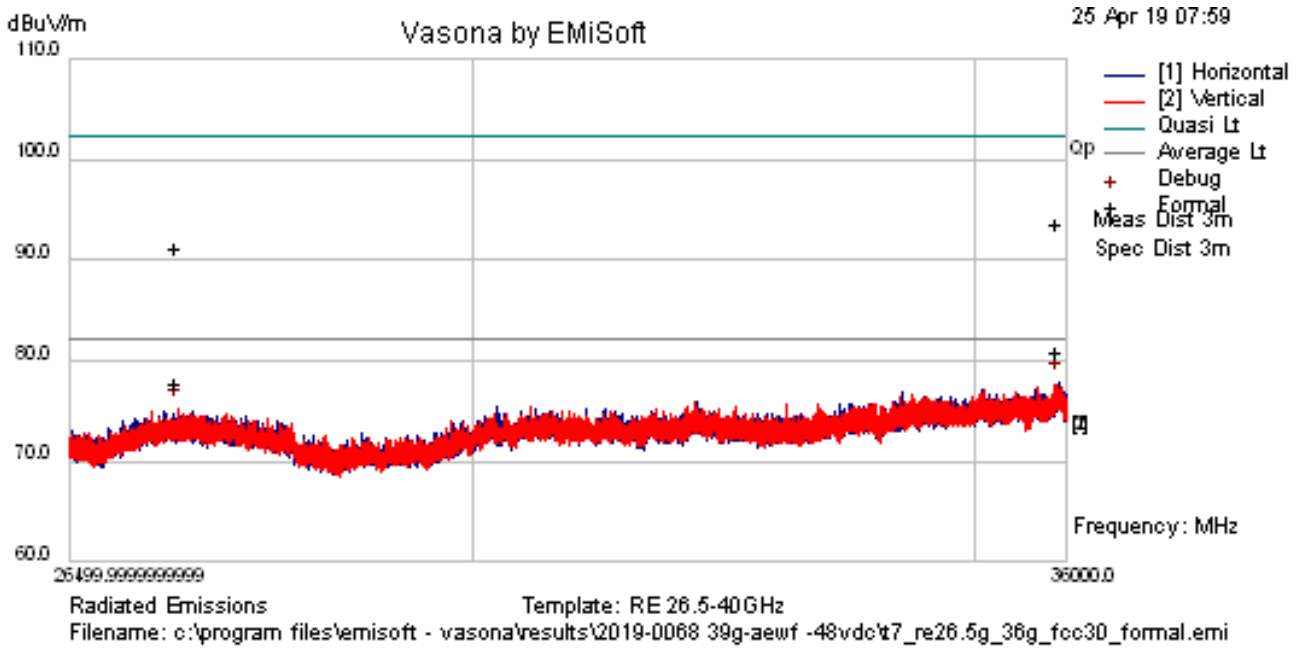
Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
25432	28.84	18.66	3.46	50.95	Average	H	201	337	82.23	-31.28	Pass	
26216.3	27.7	17.94	4.82	50.45	Average	H	202	139	82.23	-31.78	Pass	
26237.4	27.53	17.86	4.86	50.26	Average	H	109	117	82.23	-31.97	Pass	
22335.8	28.26	18.12	3.13	49.51	Average	H	106	290	82.23	-32.72	Pass	
19534.3	25.65	13.98	1.32	40.95	Average	H	101	54	82.23	-41.28	Pass	
18673.7	25.27	13.33	1.15	39.75	Average	H	201	360	82.23	-42.48	Pass	

Preview Data

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
25432	45.05	18.66	3.46	67.17	Preview	H	250	132	82.23	-15.06	Pass	
26237.4	43.13	17.86	4.86	65.86	Debug	H	102	352	82.23	-16.37	Pass	
26216.3	43.06	17.94	4.82	65.82	Debug	H	102	352	82.23	-16.41	Pass	
22335.8	42.17	18.12	3.13	63.42	Debug	H	102	352	82.23	-18.81	Pass	
19534.3	39.53	13.98	1.32	54.83	Debug	H	102	352	82.23	-27.4	Pass	
18673.7	39.74	13.33	1.15	54.22	Debug	H	102	352	82.23	-28.01	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T7 Radiated Emissions 26.5 GHz - 36 GHz FCC Part 30.



Results Title:	RE 26.5-40GHz
File Name:	c:\program files\emisoft - vasona\results\2019-0068 39g-aewf -48vdc\t7_re26.5g_36g_fcc30_formal.emi
Test Laboratory:	AR8 MH 25C, 11% RH 1016mB
Test Engineer:	MJS / WSM / NPA
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia Wireless
EUT Details:	AEWF, 39GHz. PN:474870A.X21, SN: L1183608589, Transmitting @38.5002G, 38.6004G, 38.7006G, 38.8008GHz Powered by -48Vdc 8A,
Configuration:	Radiated Emissions 26.5GHz - 36GHz FCC Part 30 Average / Peak Limit. Measurement 3M Distance at 3-Meters, Antenna E1328, ESU-1G E954, and 39 G-Notch Filters E1361. Internal attenuation 0dB, Preview RBW 30 kHz Formal RBW 1MHz.
Date:	2019-04-25 07:59:19

FORMAL DATA

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
35913.6	24.59	17.25	37.02	78.86	Average	H	158	242	82.23	-3.37	Pass	
27396.7	25.08	14.84	35.77	75.7	Average	V	228	70	82.23	-6.53	Pass	
35913.6	37.45	17.25	37.02	91.71	Peak	H	158	242	102.23	-10.52	Pass	
27396.7	38.57	14.84	35.77	89.19	Peak	V	228	70	102.23	-13.04	Pass	

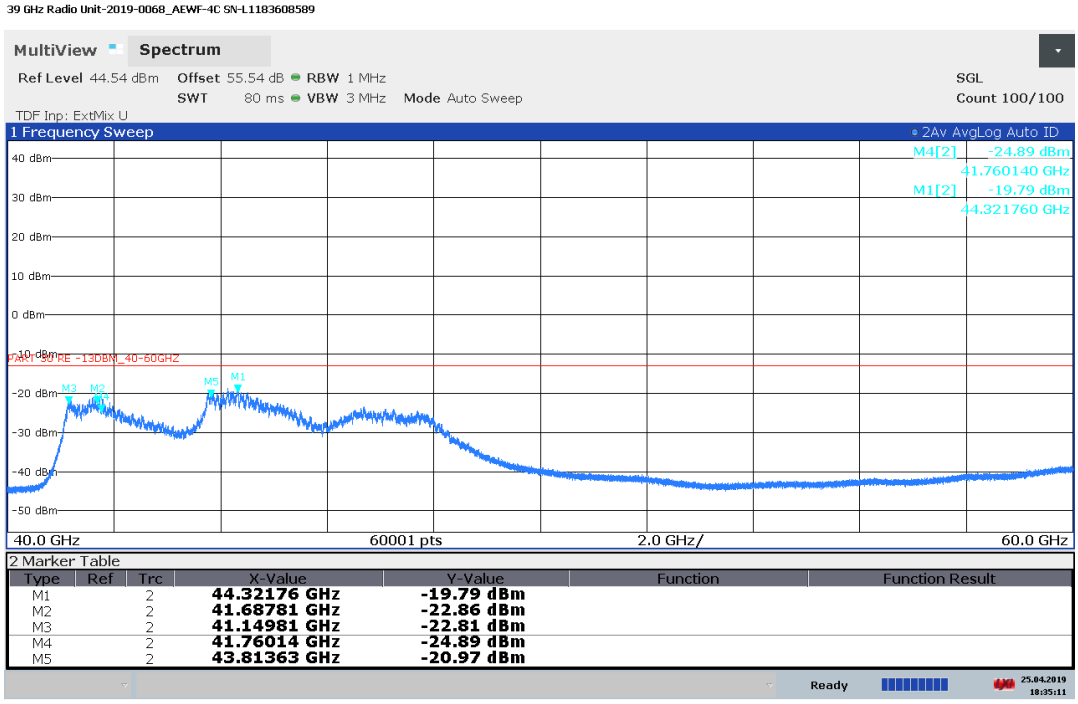
PREVIEW DATA

Frequency. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. Deg.	Limit dBuV/m	Margin dB	Pass /Fail	Comments
35913.6	23.63	17.25	37.02	77.89	Preview	H	225	198	82.23	-4.34	Pass	
27396.7	24.66	14.84	35.77	75.28	Preview	V	125	132	82.23	-6.95	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

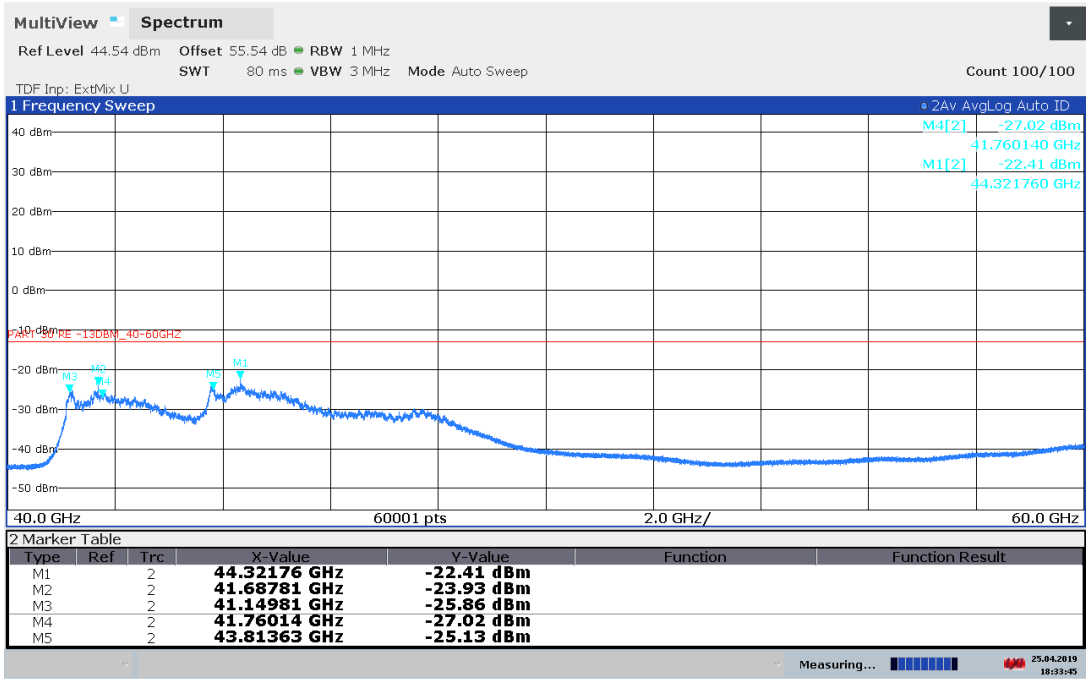
4.5.5 Maximum Radiated Emissions -U Band 40GHz-60GHz - 4m

Vertical Polarization - 1 MHz RBW - 350 degree Azimuth; 1.75m Elevation



18:35:11 25.04.2019

Horizontal Polarization - 1 MHz RBW - 350 degree Azimuth; 1.55m Elevation

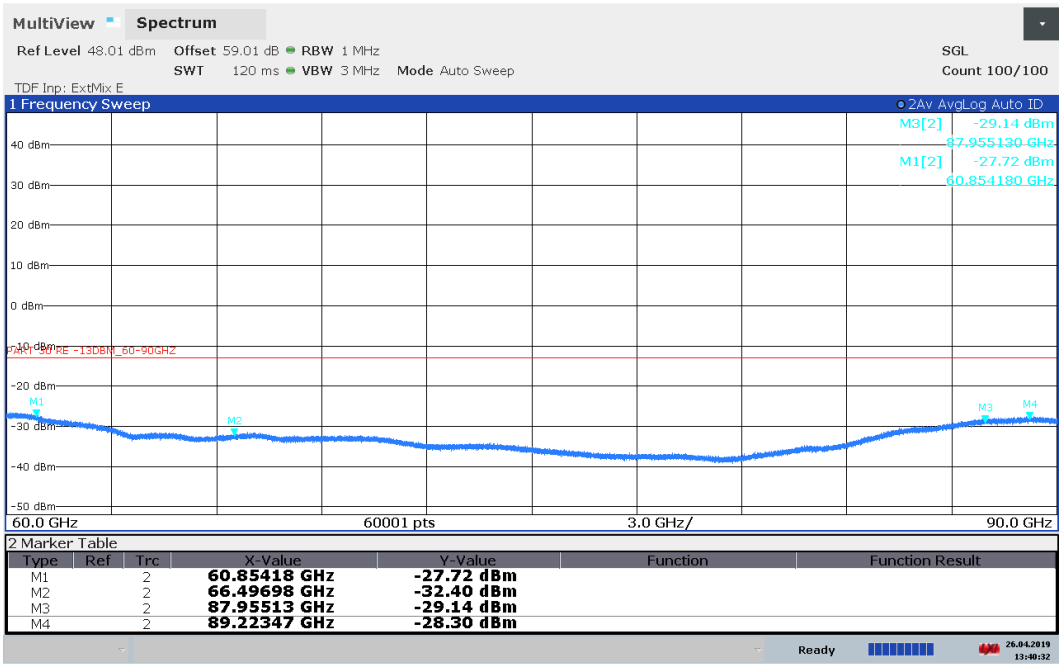


18:33:46 25.04.2019

4.5.6 Maximum Radiated Emissions -E Band 60GHz-90GHz - 4m

Vertical Polarization - 1 MHz RBW - 350 degree Azimuth; 1.75m Elevation

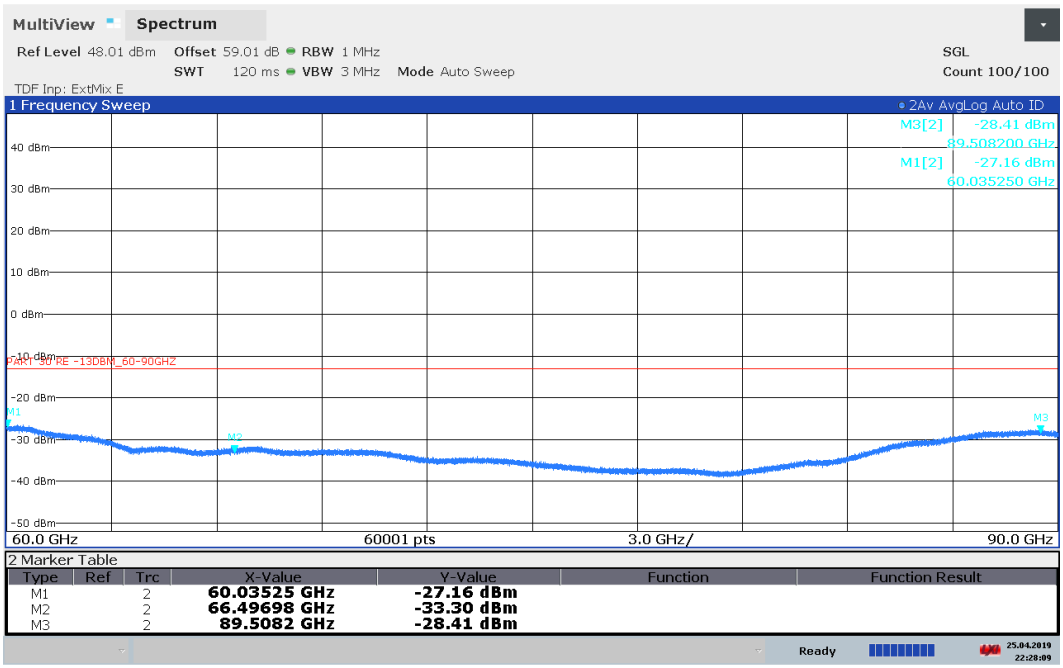
39 GHz Radio Unit-2019-0068_AEWF-4C SN-L1183608589



13:40:33 26.04.2019

Horizontal Polarization -1 MHz RBW - 350 degree Azimuth; 1.55m Elevation

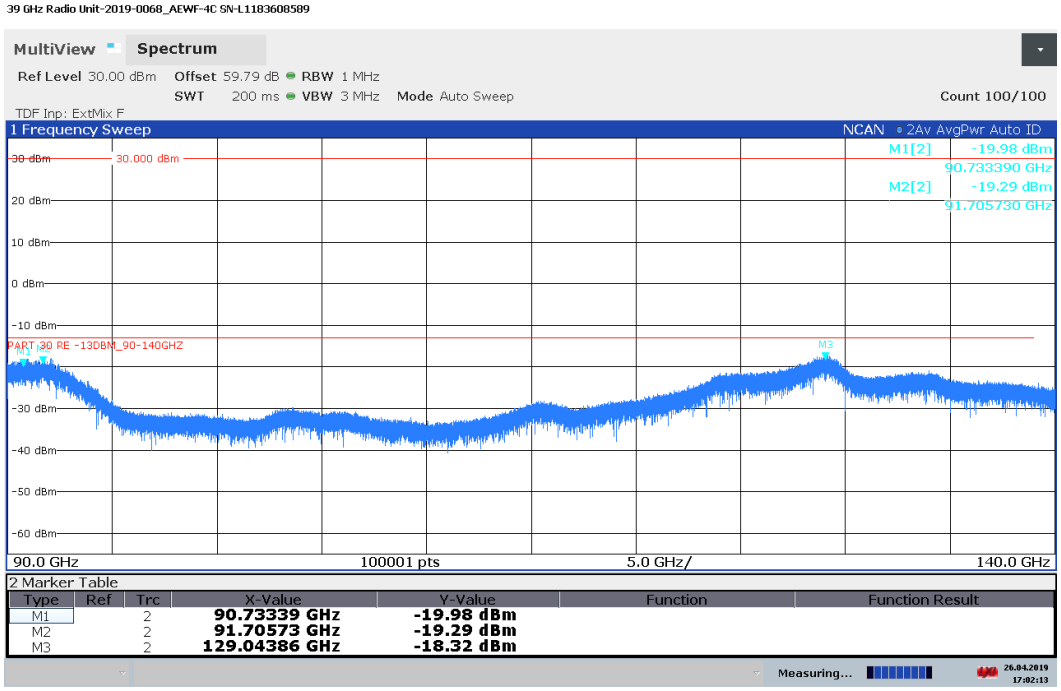
39 GHz Radio Unit-2019-0068_AEWF-4C SN-L1183608589



22:28:10 25.04.2019

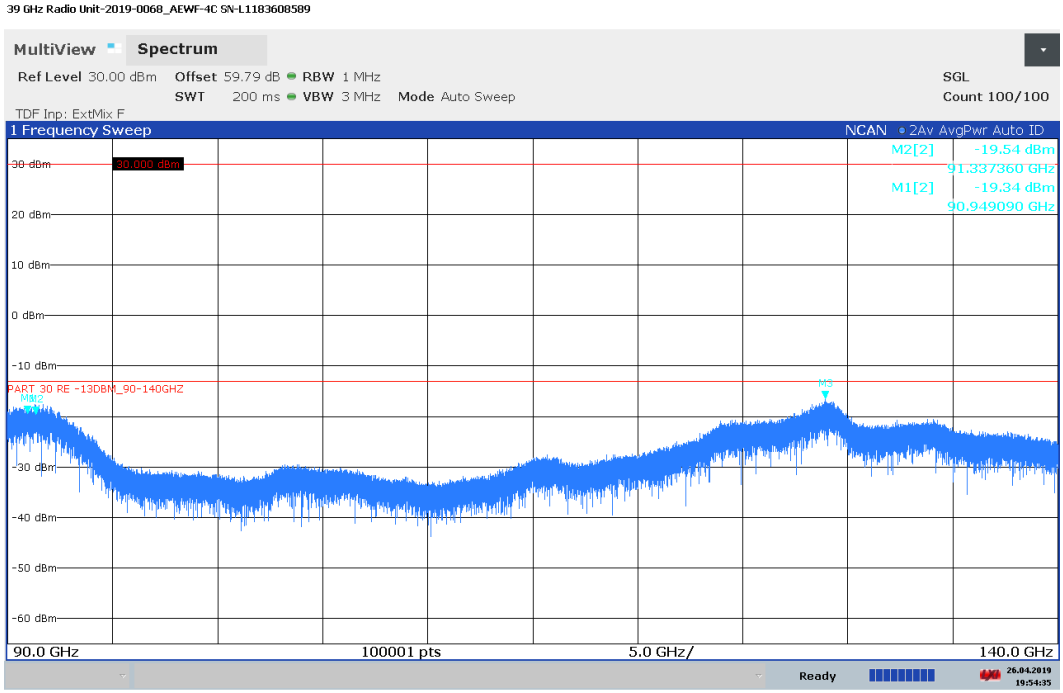
4.5.7 Maximum Radiated Emissions -F Band 90GHz-140GHz - 3m

Vertical Polarization 1 MHz RBW - 350 degree Azimuth; 1.75m Elevation



17:02:13 26.04.2019

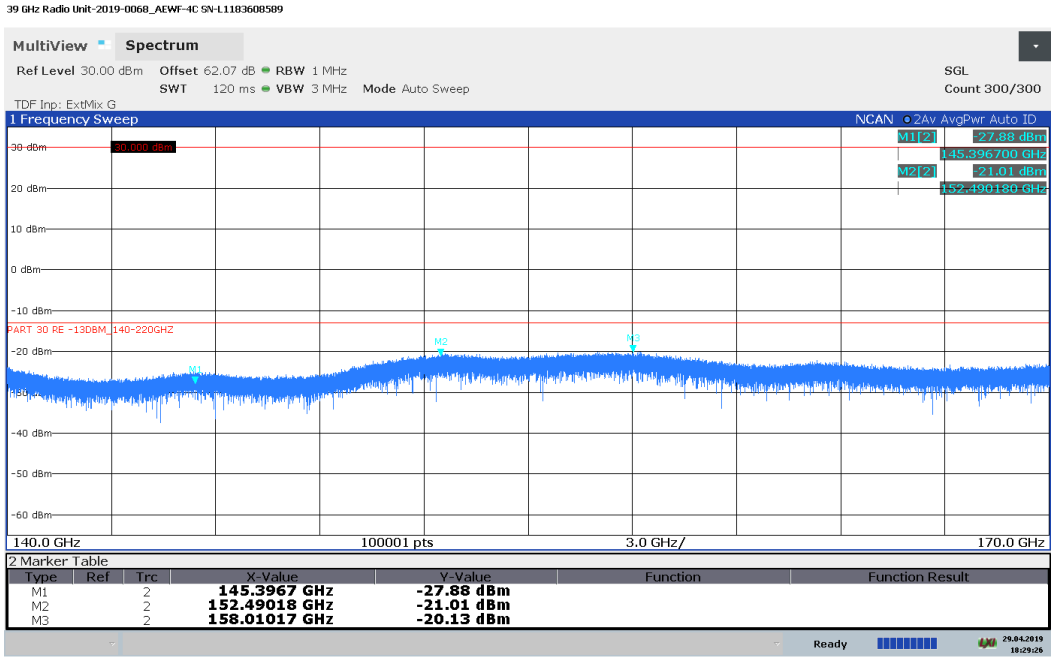
Horizontal Polarization - 1 MHz RBW- 3.05 degree Azimuth; 1.55m Elevation



19:54:36 26.04.2019

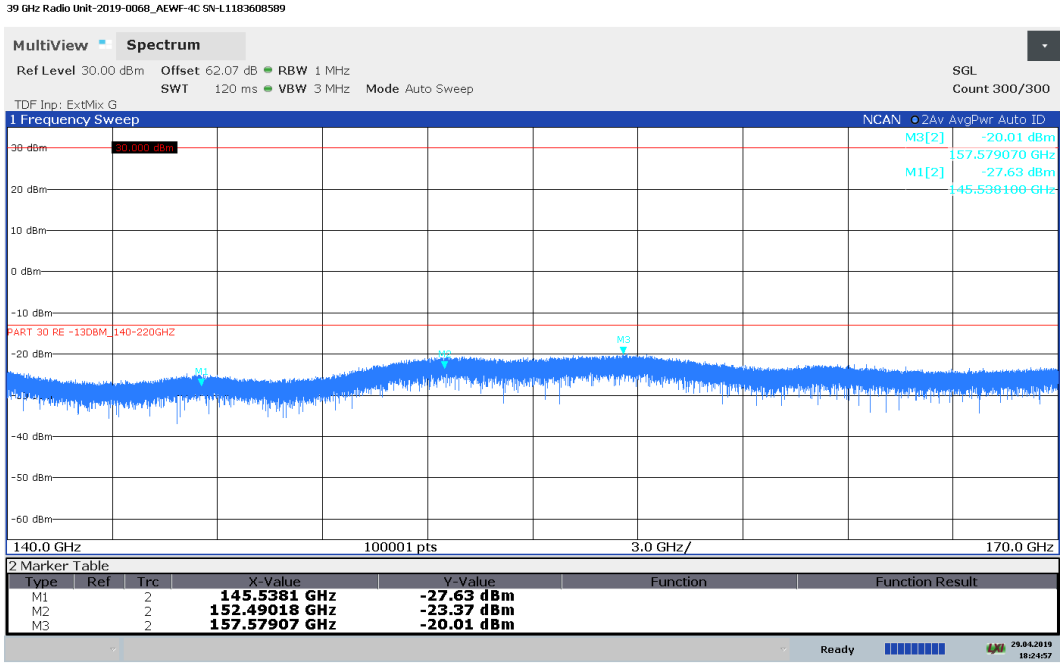
4.5.8 Maximum Radiated Emissions - G Band 140 - 170GHz - 3m

Vertical Polarization - 1 MHz RBW - 350 degree Azimuth; 1.75m Elevation 3m



18:29:26 29.04.2019

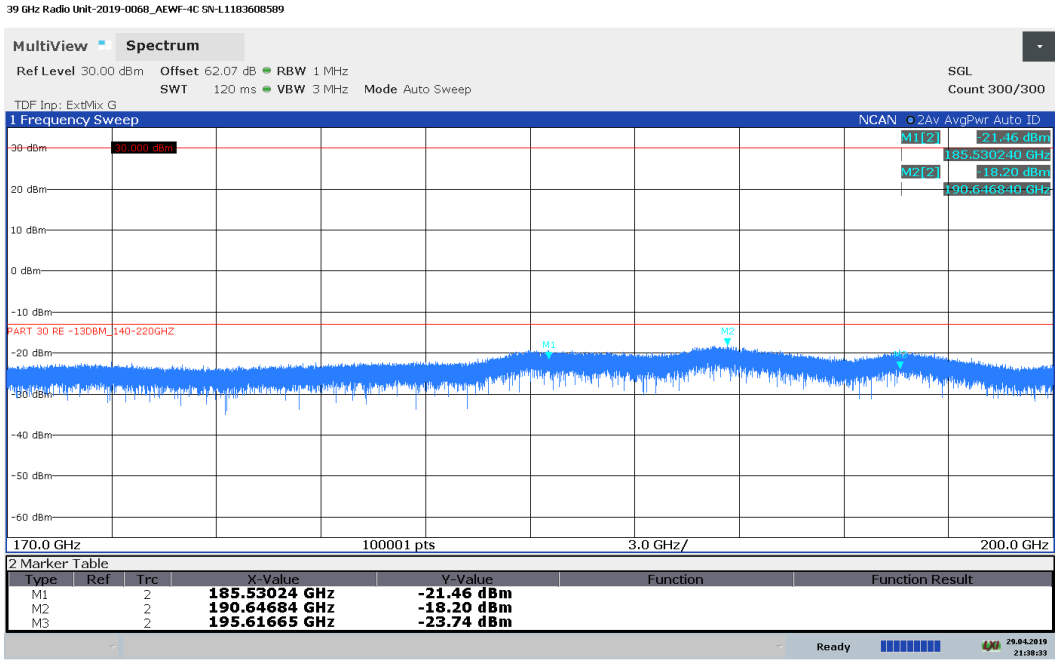
Horizontal Polarization - 1 MHz RBW- 350 degree Azimuth; 1.55m Elevation 3m



18:24:58 29.04.2019

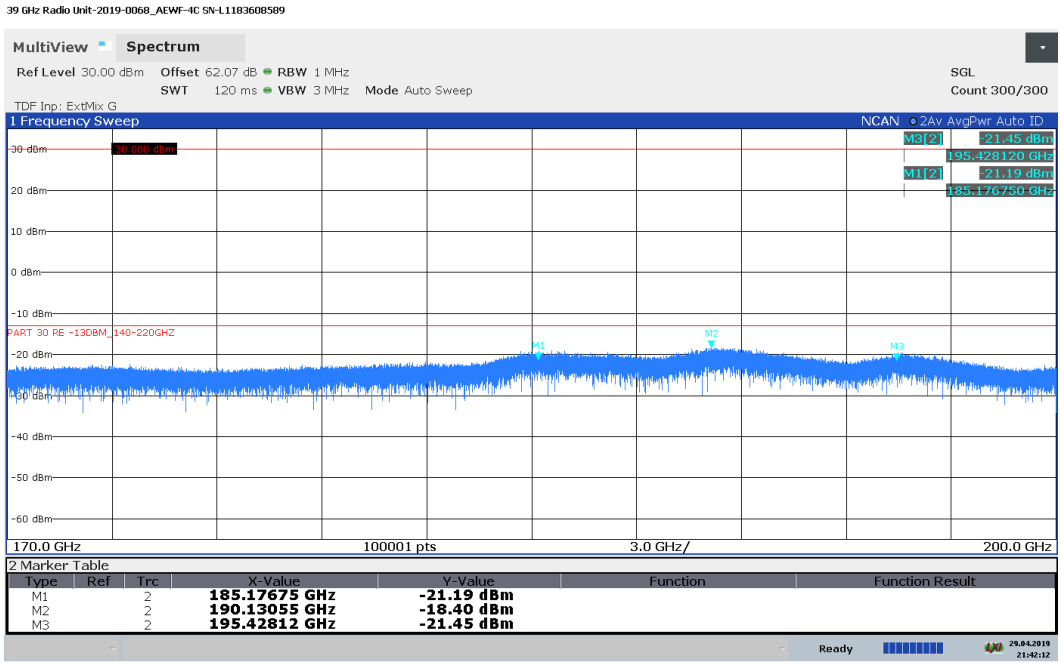
4.5.9 Maximum Radiated Emissions - G Band 170 - 200GHz - 3m

Vertical Polarization - 1 MHz RBW - 350 degree Azimuth; 1.75m Elevation



21:38:34 29.04.2019

Horizontal Polarization - 1 MHz RBW- 350 degree Azimuth; 1.55m Elevation - at 3m



21:42:13 29.04.2019

4.6 Section 2.1055 MEASUREMENT REQUIRED: FREQUENCY STABILITY

This measurement evaluates the frequency difference between the actual transmit carrier frequency and the specified transmit frequency assignment. Only the portion of the transmitter system containing the frequency determining and stabilizing circuitry need be put in an environmental chamber and subjected to the temperature variation test per FCC Section 2.1055 and RSS-133. The unit which provides baseband signals, such as BBU (baseband unit), can be located outside the chamber if it is a separated unit.

4.6.1 Frequency Stability Test - Not Required

There was no change to the Frequency Generating and stabilizing circuitry. Frequency stability testing was therefore not required.

4.6.2 Frequency Stability – Original Results:

The worst case results of the original Frequency Stability over temperature and voltage for the DC Product was **-916.3 Hz** which is **-0.0239 ppm.**
This performance is within the +/- 0.05ppm desired performance required for LTE operation.

4.7 List of Test Equipment

4.7.1 List of Radiated Emissions Test Equipment

The following equipment was used for the measurement of Radiated Emissions.

Asset ID	Manufacturer	Type	Description	Model	Serial	Cal Date	Cal Due	Cal Type
E766	A.H. Systems Inc.	Bilogical Antenna	25 MHz - 2000 MHz	SAS-521-2	457	2019-02-13	2021-02-13	Requires Calibration
E907	Rohde & Schwarz	Test Receiver	EMI 20Hz to 40 GHz	ESIB40	100101	2018-04-17	2020-04-17	Requires Calibration
E813	Sonoma Instrument Co.	Amplifier	9kHz-1GHz	310N	186750	2018-09-14	2020-09-14	Requires Calibration
E588	Sunol Sciences Corp	System Controller	Turntable & Tower Controller	SC99V	32802-1			Calibration Not Required
E980	Trilithic	Low Pass Filter	PCS	10LC1790-3-AA	PCS-LPF-12			Calibration Not Required
E1328	A-Info	Horn Antenna	26.5-40GHz WR28	LB-28-25-C2-KF	J202023250	2018-10-16	2021-10-16	Requires Calibration
E520	EMC Test Systems	Horn Antenna	Double Ridged Horn 18-40 GHz	3116	2537	2018-08-09	2020-08-09	Requires Calibration
E1356	Hewlett Packard	Pre-Amplifier	Pre-Amplifier 1-26.5GHz	8449B	3008A01353	2018-09-10	2020-09-10	Requires Calibration
E1361	Marki Microwave	Low Pass Filter	D/C 1645	FLP-3660	N/A	2019-01-25	2020-01-25	Calibration Not Required, Must Be Verified
EIH69	Rohde & Schwarz	Test Receiver	EMI 20Hz – 40 GHz	ESU40	100247	2018-05-22	2020-05-22	Requires Calibration
E513	ETS Lindgren	Horn Antenna	Double Ridged Horn 18-40 GHz	3116	2539	2017-06-16	2019-06-16	Requires Calibration
E1073	ETS Lindgren	Horn Antenna	Double-Ridged Horn 1-18 GHz	3117	00135198	2017-06-09	2019-06-09	Requires Calibration
E1255	ETS Lindgren	Multi-Device Controller	Tower/Turntable Controller	2090	00078509			Calibration Not Required
E481	Hewlett Packard	HP-IB Extender	Bus Extender	37204	3212U31136			Calibration Not Required
E479	Hewlett Packard	HP-IB Extender	Bus Extender	37204	3212U31137			Calibration Not Required
E1356	Hewlett Packard	Pre-Amplifier	Pre-Amplifier 1- 26.5 GHz	8449B	3008A01353	2018-09-10	2020-09-10	Requires Calibration
E447	Hewlett Packard	Pre-Amplifier	Preamplifier 1- 26.5 GHz	8449B	3008A01384	2018-04-10	2020-04-10	Requires Calibration
E1315	RS Microwave Company, Inc.	Microwave Filter	40 GHz High Pass Filter	P/N 60733A	007	2019-01-25	2020-01-25	Calibration Not Required, Must Be Verified
EIH69	Rohde & Schwarz	Test Receiver	EMI 20Hz - 40GHz - 155 dBm +30 dBm	ESU40	100247	2018-05-22	2020-05-22	Requires Calibration
E1328	A-Info	Horn Antenna	26.5-40GHz WR28 dB	LB-28-25-C2-KF	J202023250	2018-10-16	2021-10-16	Requires Calibration
E601	A.H. Systems Inc.	Bilogical Antenna	25 - 2000 MHz	SAS-521-2	408	2017-07-11	2019-07-11	Requires Calibration
E812	Sonoma Instrument Co.	Amplifier	9kHz-1GHz Vasona File TRANS 261	310N	186744	2018-09-14	2020-09-14	Requires Calibration
E980	Trilithic	Low Pass Filter	PCS	10LC1790-3-AA	PCS-LPF-12	2019-01-25	2020-01-25	Calibration Not Required-Verify
EIH69	Rohde & Schwarz	Test Receiver	EMI 20Hz - 40GHz - 155 dBm +30 dBm	ESU40	100247	2018-05-22	2020-05-22	Requires Calibration

Asset ID	Manufacturer	Type	Description	Model	Serial	Cal Date	Cal Due	Cal Type
E1260	Rohde & Schwarz	Spectrum Analyzer	2 Hz- 67 GHz	FSW67	104007	2/12/2018	2/12/2020	Requires Calibration
E1384	Spectrum Analyzer	Rohde & Schwarz	2 Hz- 85 GHz	FSW85	101537	1/02/2019	01/02/2021	Factory
E1264	KeySight Technologies	Signal Generator	PSG Analog Sig Gen 100 kHz - 67 GHz	E8257D	MY53402943	8/28/2017	8/28/2019	Requires Calibration
E1308	Rohde & Schwarz	Harmonic Mixer	Down Converter 90-140GHz	FS-Z140	101008			Factory
E1311	Rohde & Schwarz	Harmonic Mixer	Down Converter, 40-60GHz	FS-Z60	100977			Factory
E1312	Rohde & Schwarz	Harmonic Mixer	Down Converter, 60-90GHz	FS-Z90	101719			Factory
E1313	Rohde & Schwarz	Harmonic Mixer	Down Converter, 140-220GHz	FS-Z220	100960			Factory
E1315	RS Microwave Company, Inc.	Microwave Filter	37 GHz High Pass Filter	P/N 60733A	7	10/6/2018	11/6/2019	Verification
E1323	Mi-Wave Millmeter Wave Products, Inc.	Horn Antenna	G-band pyramidal horn antenna 25dB 140 - 220 GHz	261G-25/387				Factory
E1328	A-Info	Horn Antenna	26.5 - 40GHz WR28 25 dB Gain	LB-28-25-C2-KF	J202023250	10/16/2018	10/16/2021	
E1330	Sage Millimeter, Inc.	Horn Antenna	U-band pyramidal horn antenna 25dB - 40 to 60 GHz	SAR-2309-19-S2	14853-01	4/17/2018		Factory
E1332	Sage Millimeter, Inc.	Horn Antenna	E-band pyramidal horn antenna 25dB - 60 to 90 GHz.	SAR-2309-12-S2	14853-01	4/17/2018		Factory
E1335	Sage Millimeter, Inc.	Horn Antenna	F-band pyramidal horn antenna 25dB - 90 to 140 GHz	SAR-2309-08-S2	14853-02	4/17/2018		Factory
E1338	KeySight Technologies	MXA Signal Analyzer	10 Hz - 44 GHz	N9020B	MY57430927	9/13/2018	9/13/2020	Requires Calibration
E1340	Sage Millimeter, Inc.	Horn Antenna	Ka-band Pyramidal horn antenna 25dB gain - 26.5 to 40 GHz,	SAR-2507-28-S2	15309-01	4/17/2018		Factory
E1363	A-Info	Horn Antenna	26.5 - 40GHz WR28 25 dB Gain	LB-28-25-C2-KF	J202062675	10/16/2018	10/16/2021	Requires Calibration

4.8 PHOTOGRAPHS OF THE TEST SETUPS

Response:

The photographs of the test setups for the **AirScale 39 GHz Radio Unit (AEWF) Band 30, FCC ID: VBNAEWF-01** are provided in the Filing exhibits.

4.9 FACILITIES AND ACCREDITATION

Measurement facilities at Nokia, Global Product Compliance Laboratory (GPCL) a member of the Nokia family of companies, was used to collect the measurement data in the test report. The laboratory, which is part of Nokia Bell Labs, is located at 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636 USA.

The field strength measurements of radiated spurious emissions were made in a FCC registered three meter semi-anechoic chamber AR-8, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-8) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

Nokia Global Product Compliance Laboratory FCC OET Accredited Test Firm Scope List is accessible at:

https://apps.fcc.gov/oetcf/eas/reports/ViewTestFirmAccredScopes.cfm?calledFromFrame=N&RequestTimeout=500&regnum_specified=N&test_firm_id=7007

and is as listed in the Table below.

OET Accredited Test Firm Scope List

Test Firm: Nokia, Global Product Compliance Lab

Scope	FCC Rule Parts	Maximum Assessed Frequency, MHz	Status	Expiration Date	Recognition Date
Unintentional Radiators	FCC Part15, Subpart B	40000	Approved	9/30/2018	7/6/2017
Intentional Radiators	FCC Part 15 Subpart C	40000	Approved	9/30/2018	6/5/2018
U-NII without DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
U-NII with DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
Commercial Mobile Services	Part 22 (cellular), Part 24, Part 25 (below 3 GHz), Part 27	40000	Approved	9/30/2018	6/5/2018
General Mobile Radio Services	Part 22 (non-cellular), Part 90 (below 3 GHz), Part 95 (below 3 GHz), Part 97 (below 3 GHz), Part 101 (below 3 GHz)	40000	Approved	9/30/2018	6/5/2018
Citizens Broadband Radio Services	Part 96	40000	Approved	9/30/2018	7/6/2017
Microwave and Millimeter Bands Radio Services	Part 25, Part30, Part 74, Part 90 (90M DSRC, Y, Z), Part 95 (M & L), Part 101	200000	Approved	9/30/2018	7/6/2017

Nokia Global Product Compliance Laboratory is accredited with the US Department of Commerce National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations for offering test services for selected test methods in Electromagnetic Compatibility; Voluntary Control Council for Interference (VCCI), Japan; Australian Communications and Media Authority (ACMA). The laboratory is ISO 9001:2008 Certified.

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2018-09-05 through 2019-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program

5. APPENDIX A - CALIBRATION CERTIFICATES.

The attached Calibration certificates represent the Harmonic Downconverters used in this testing.