NOKIA Bell Labs

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

**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**
600-700 Mountain Avenue, Rm 5B-108
Murray Hill, New Jersey 07974-0636 USA

**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

Product Certification Filing Lead
Nokia Bell Labs
Nokia, Global Product Compliance Laboratory

Approved By: Ray Johnson

5/20/2019

Technical Manager
Nokia Bell Labs
Nokia, Global Product Compliance Laboratory

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# 1. ATTESTATION OF TEST RESULTS

| | |
|---|---|
| **Company Name** | **Nokia Solutions and Networks**<br>6000 Connection Drive<br>Irving, Texas 75039 USA |
| **FCC ID** | **VBNAEWF-01** |
| **Product Name** | **AirScale 39 GHz Radio Unit (AEWF) Band 30**<br>**(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<br>• KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018<br>• KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013<br>• Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018<br>• KDB 842590 D01 Upper Microwave Flexible Use Service v01 April 5, 2019 |
| **Reference(s)** | • 47 CFR FCC Part 2 and Part 30<br>• ANSI C63.26 (2015)<br>• ANSI C63.4 (2014)<br>• 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<br>600-700 Mountain Avenue, Rm 5B-108<br>Murray Hill, New Jersey 07974-0636 USA<br>**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<br>(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<br>30 MHz – 200 MHz V<br>200 MHz – 1000 MHz H<br>200 MHz – 1000 MHz V<br>1 GHz- 18 GHz | ±5.4 dB<br>±5.4 dB<br>±4.7 dB<br>±4.7 dB<br>±3.3 dB |

| Antenna Port Test | Signal Bandwidth | Frequency Range | Expanded Uncertainty (k=2), Amplitude |
|---|---|---|---|
| Occupied Bandwidth, Edge of Band, | 10 Hz<br>100 Hz<br>10 kHz to 1 MHz<br>1MHz to 100 MHz | 9 kHz to 20 MHz<br>20 MHz to 1 GHz<br>1 GHz to 10 GHz<br>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

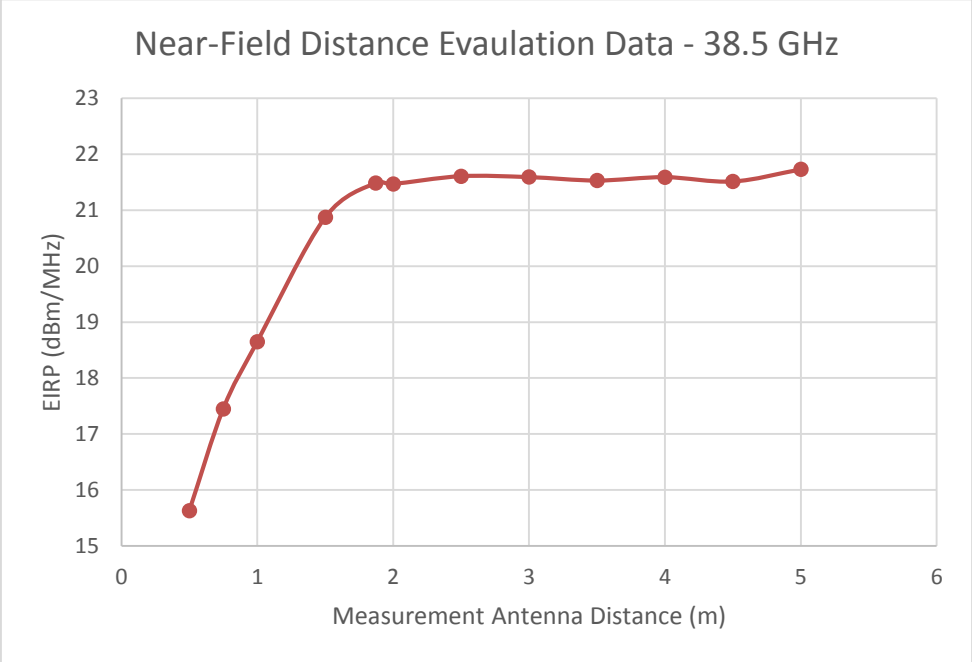
Calculations and low power measurements were performed to determine the far field boundary location for the antenna per the Fraunhofer distance calculated from

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

where $d_{ff}$ = Far Field distance in meters,
D is the maximum size of the radiating array $\lambda$ = 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**<br>**(a) Power Limits, EIRP, PSD** | **Yes** |
| **2.1047,** | **Modulation Characteristics** | **Yes** |
| **2.1049, 30.203** | **(a) Occupied Bandwidth**<br>**(b) Out-of-Band Emissions** | **Yes** |
| **2.1051, 30.203** | **Spurious Emissions at Antenna Terminals** | **Yes** |
| **2.1053, 30.203,**<br>**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<br>• KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018<br>• KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013<br>• Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018<br>• KDB 842590 D01 Upper Microwave Flexible Use Service v01 April 5, 2019 |
| **Reference(s)** | • 47 CFR FCC Part 2 and Part 30<br>• ANSI C63.26 (2015)<br>• ANSI C63.4 (2014)<br>• 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

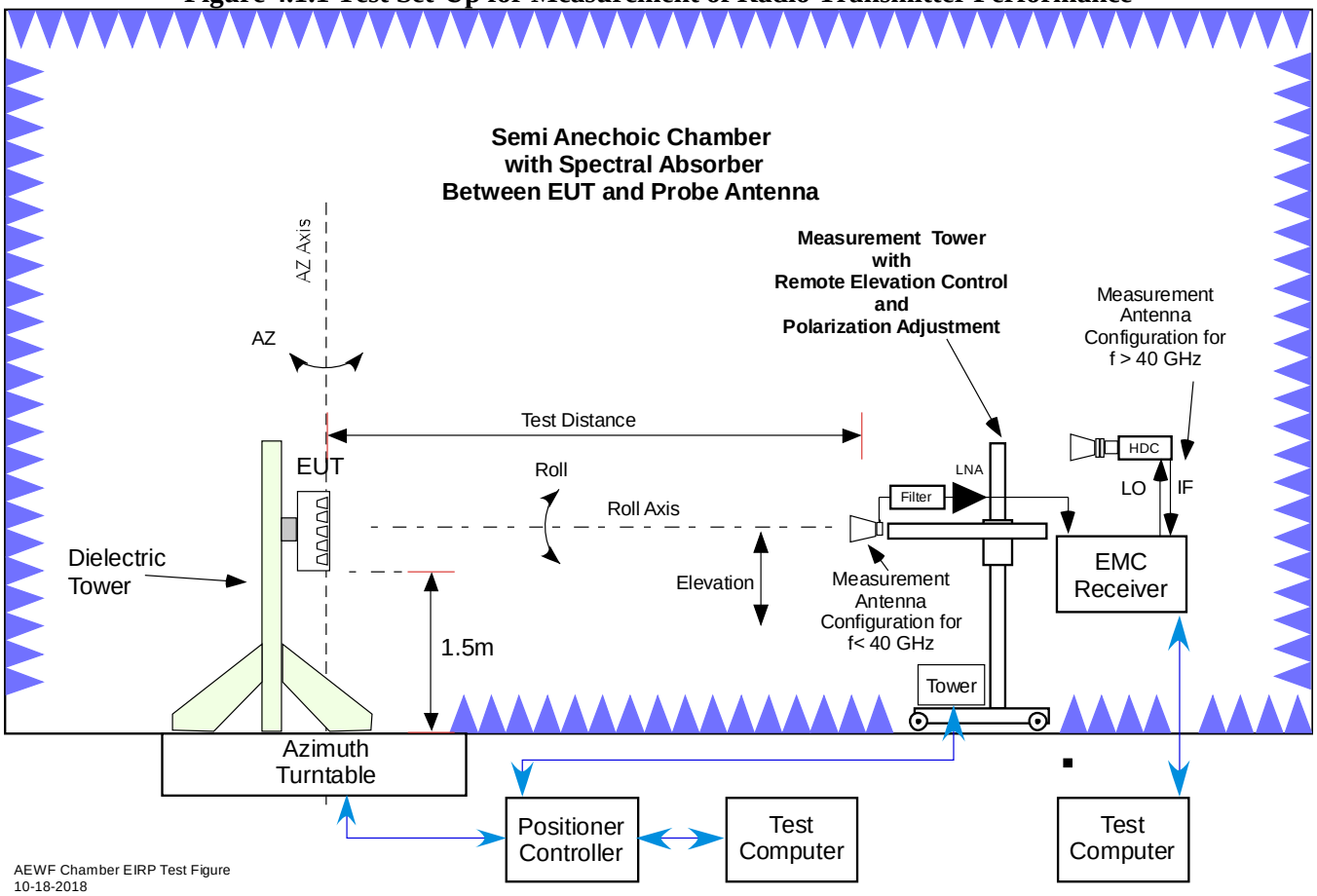
Power output measurements verified the expected performance of 54 dBm EIRP per polarization 57dBm Total. The maximum measured level was 57.23 dBm. This level is well within the maximum Part 30.202a limit of 75 dBm EIRP and are within the parameters as previously filed. Measurements were performed for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

**Table 4.1.1.1 RF Power Output Results**

| Tested Carrier Configuration | Horizontal Polarization Total Channel Power, EIRP<br>dBm | Vertical Polarization Total Channel Power, EIRP<br>dBm | Sum Total Channel Power EIRP<br>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** |

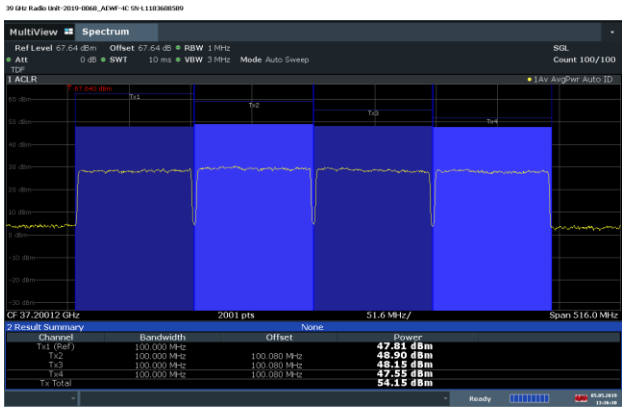
The measured performance was in full compliance with the Rules of the Commission. The data plots are detailed below.

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

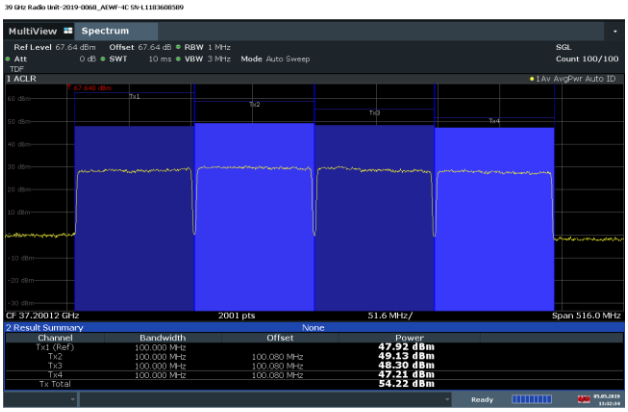


## 4m Channel Power Measurements.

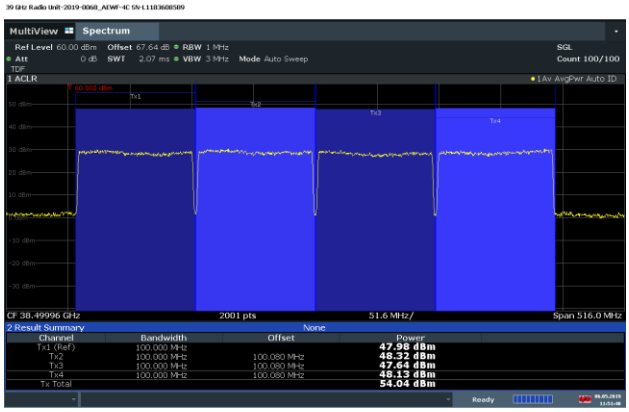
### 4c Left Side of Band - Horizontal



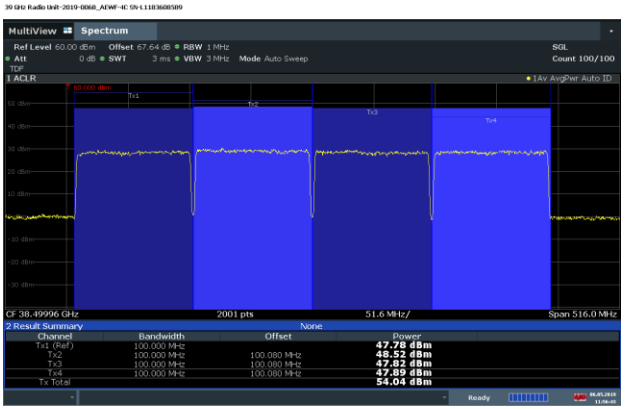

### 4c Left Side of Band - Vertical



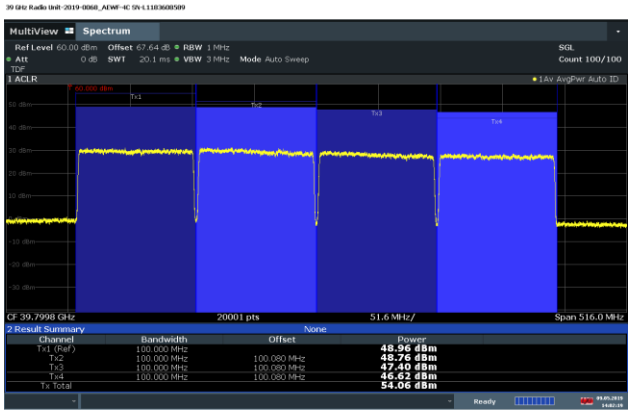

### 4c Middle of Band - Horizontal




### 4c Middle of Band - Vertical




### 4c Right Side of Band - Horizontal

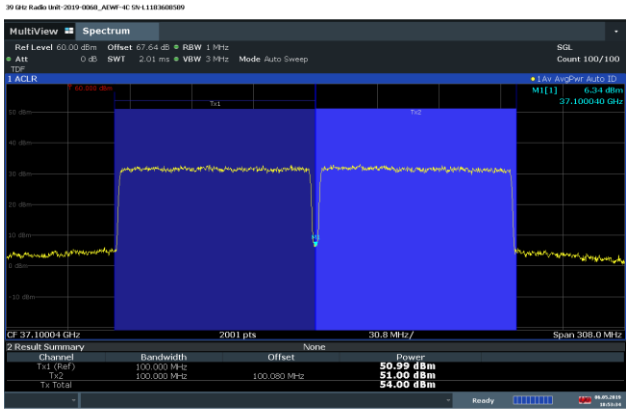



### 4c Right Side of Band - Vertical

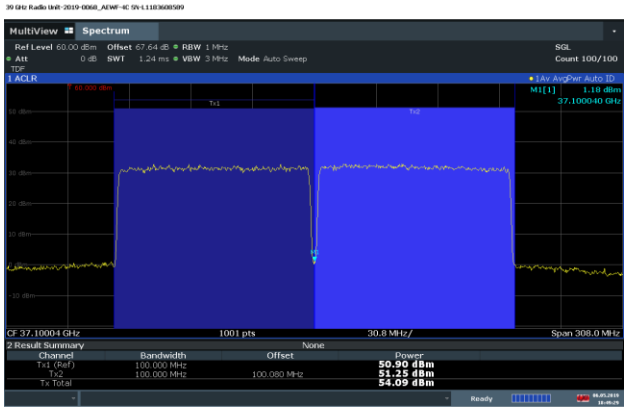
## 4c Spread - Middle of Band - Horizontal


## 4c Spread - Middle of Band - Vertical

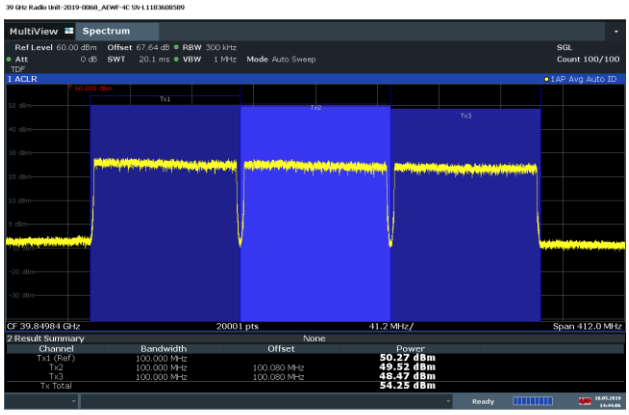

## 2c Left Side of Band - Horizontal



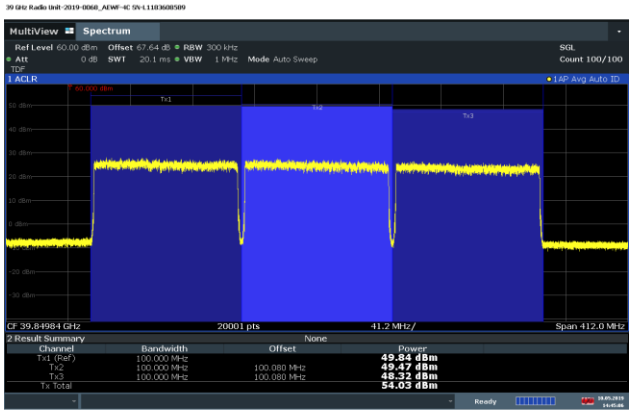

## 2c Left Side of Band - Vertical




## 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

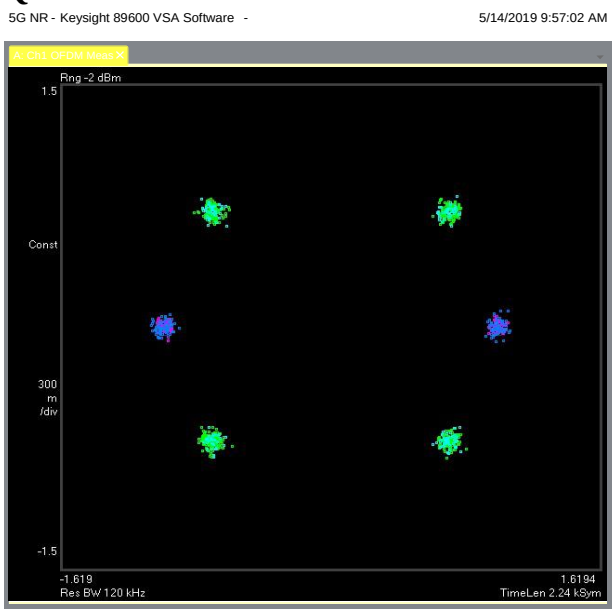
The measurements were performed at a distance of 4 m from the unit utilizing the test configuration in Figure 4.4.1 utilizing a Keysight 44 GHz MXA Signal analyzer with the 3GPP 5G-NR DL Measurement software option. Representative screen plots of the modulation measurement are attached below for all 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:

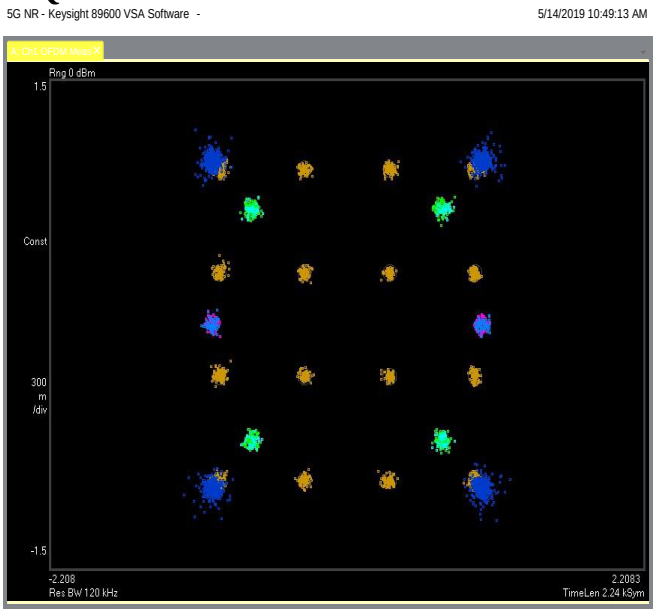
The typical measured modulation characteristics of the EUT are shown below:

**Figure 4.2 Modulation Results**

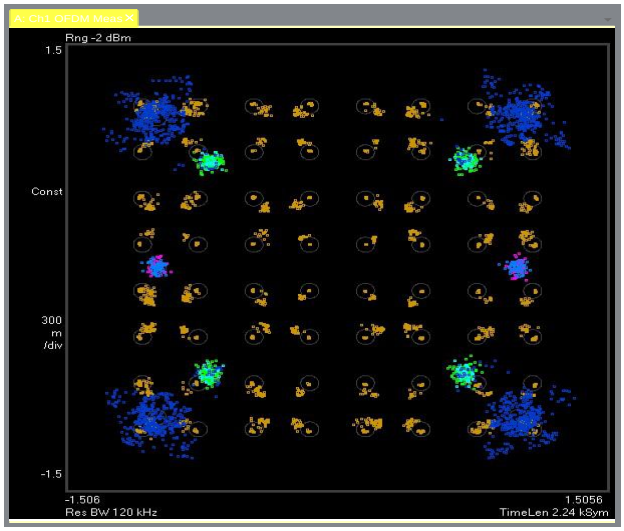
## QPSK



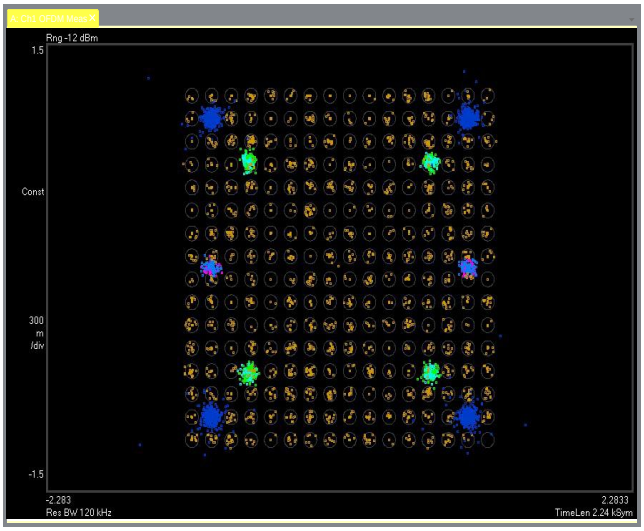

## 16QAM




## 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**.

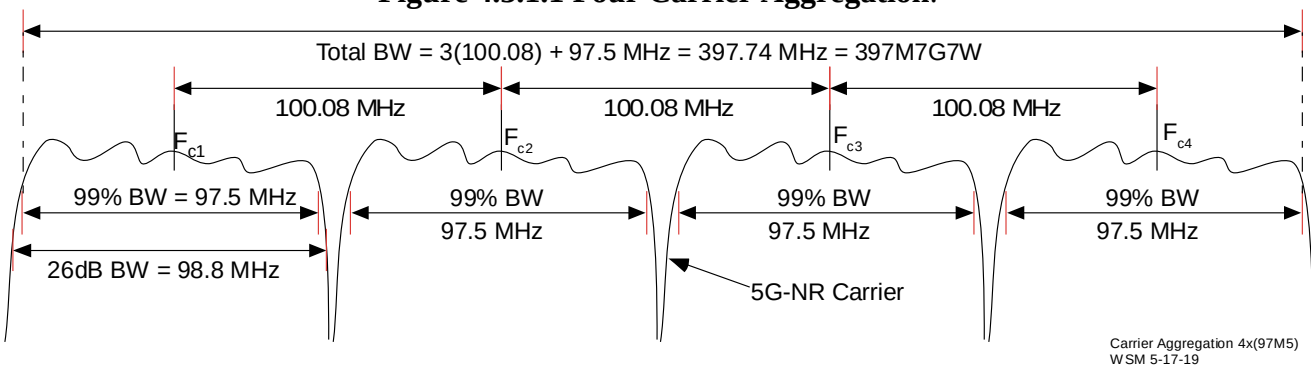



**Figure 4.3.1- Occupied Bandwidth - 99% Signal Bandwidth**

**37.05 GHz – QPSK**


**39.94992 GHz - QPSK**

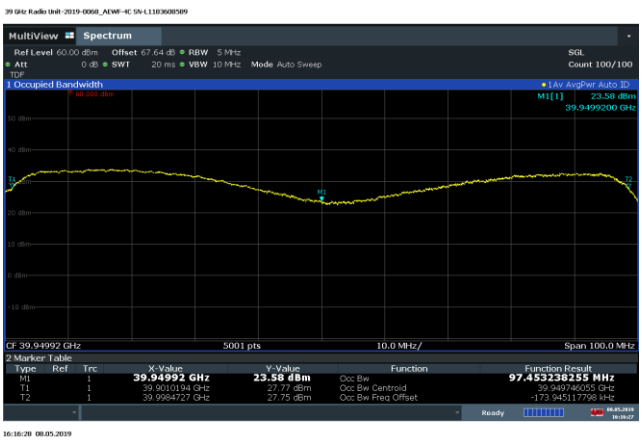
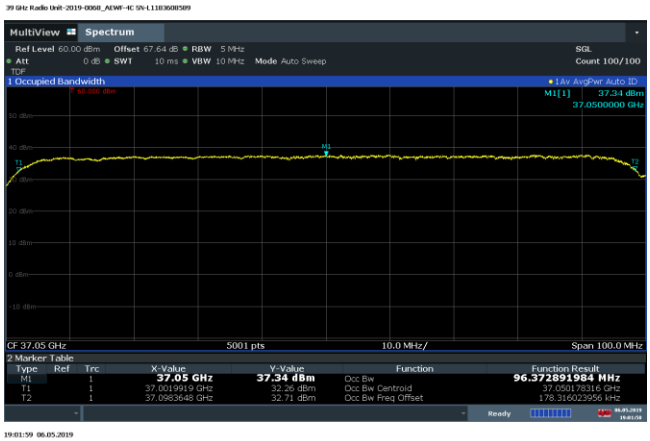
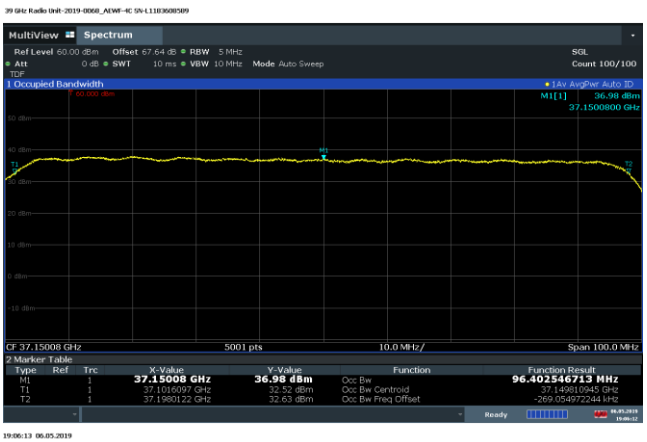


**Figure 4.3.1- Occupied Bandwidth - 99% Signal Bandwidth *Continued***

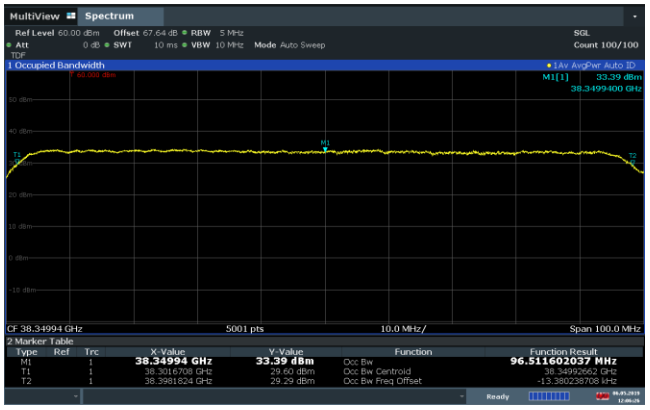
## 37.05 GHz - 16QAM



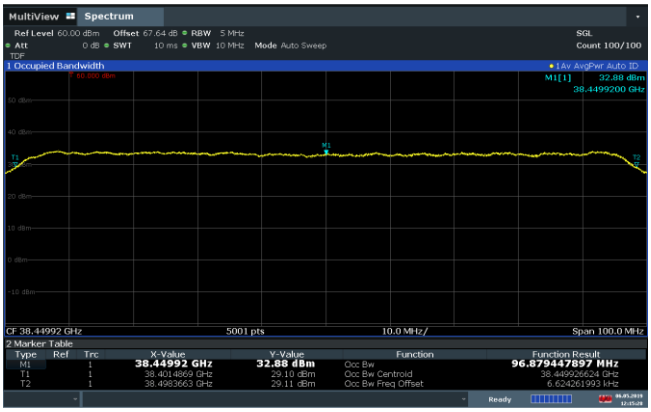

## 37.15008 GHz - 16QAM



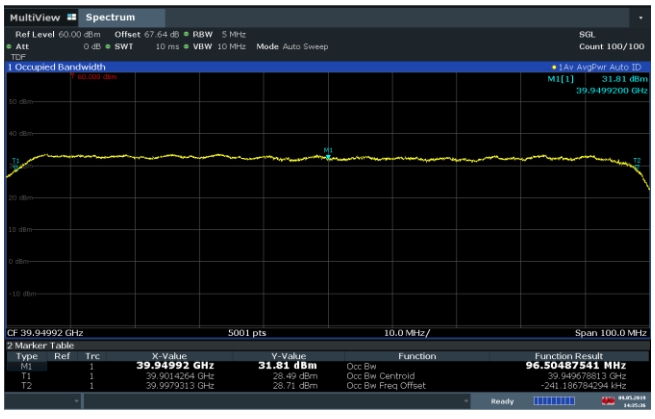

## 38.34994 GHz – 64QAM



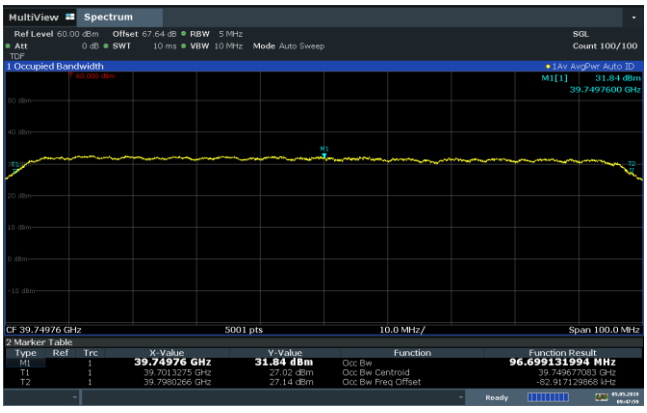

## 38.44992 GHz - 64QAM




## 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.

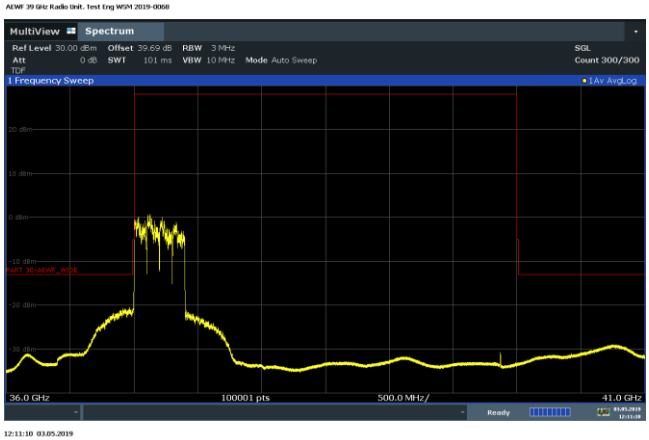
The results of the Occupied Bandwidth/ Edge-of-Band measurements document that the Out-Of-Band Emissions from 35 GHz to 42 GHz are compliant. The Plots and Table 4.3.7.1 demonstrate the full compliance with the Rules of the Commission for the UMFUS 39 GHz operating band.

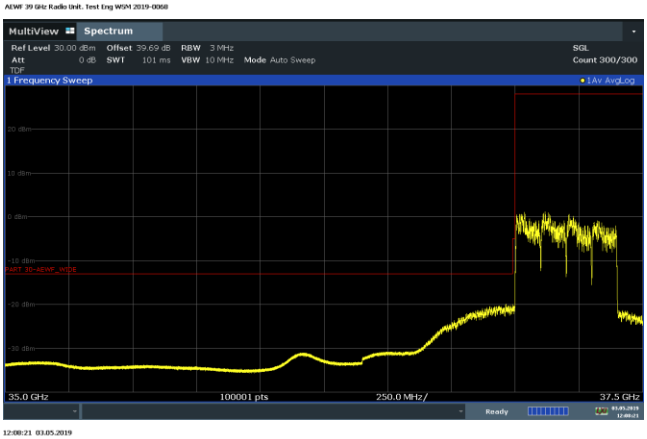
**Table 4.3.7.1 Results - Occupied Bandwidth-Edge of Block Emissions/ OOBE**

| 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 |

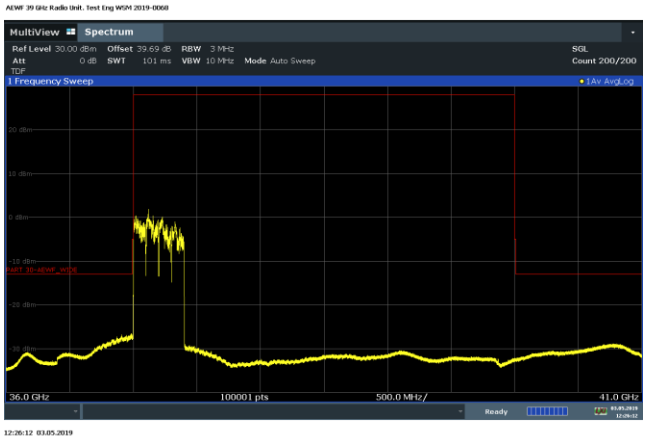
## Figure 4.3.5 - Occupied Bandwidth - OOBE/EoB Band Charts E

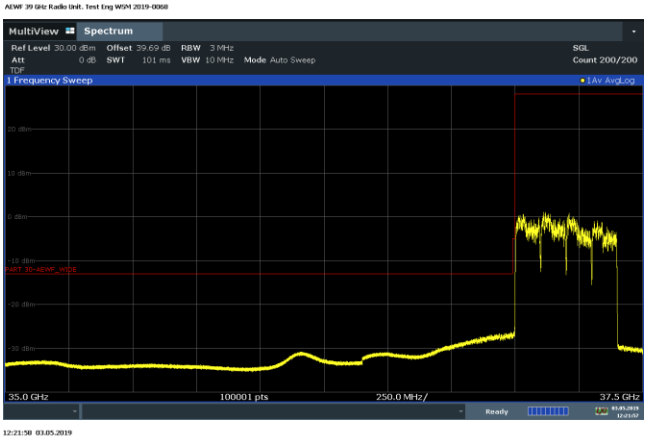
### Horizontal Polarization - 4 Carriers - QPSK - Left Side of Band



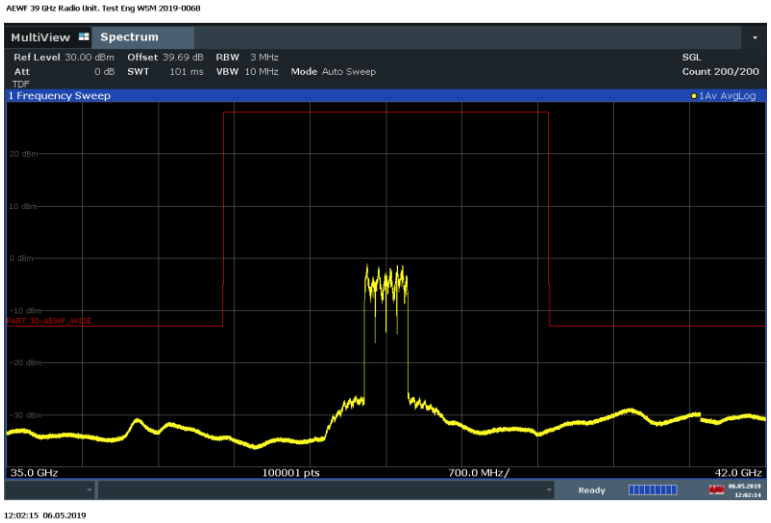




### Vertical Polarization - 4 Carriers - QPSK - Left Side of Band.

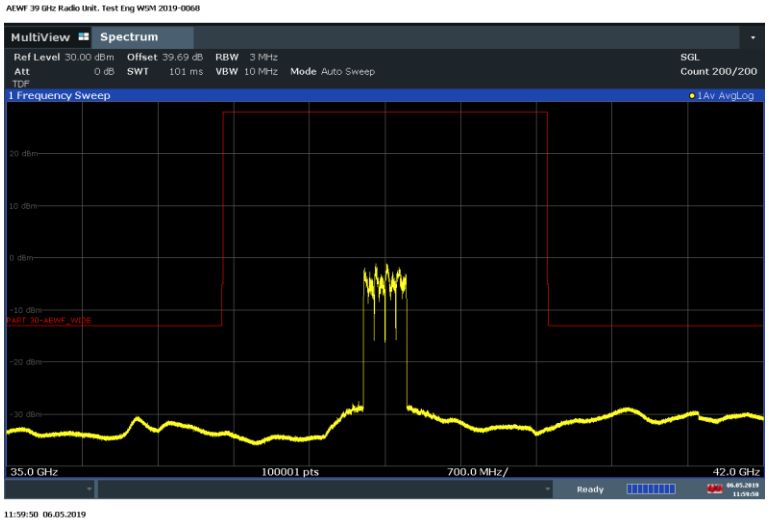


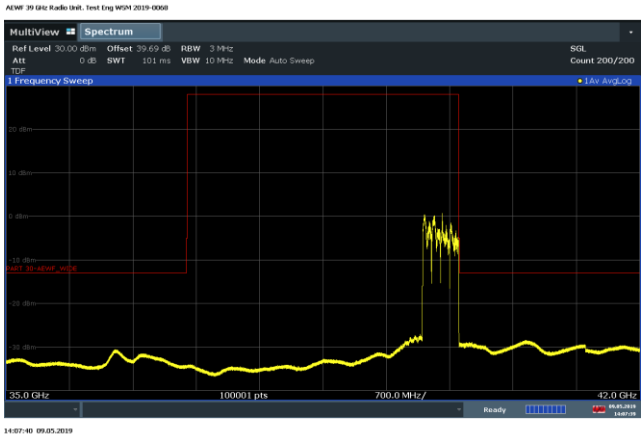

### Horizontal Polarization - 4 Carriers - 64QAM - Middle of Band

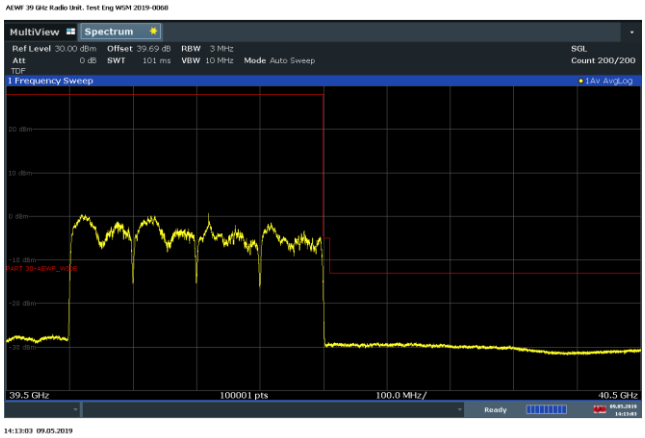


## Vertical Polarization - 4 Carriers - 64QAM - Middle of Band

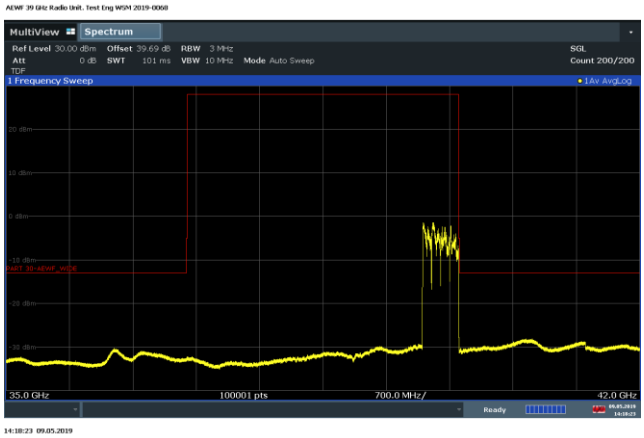


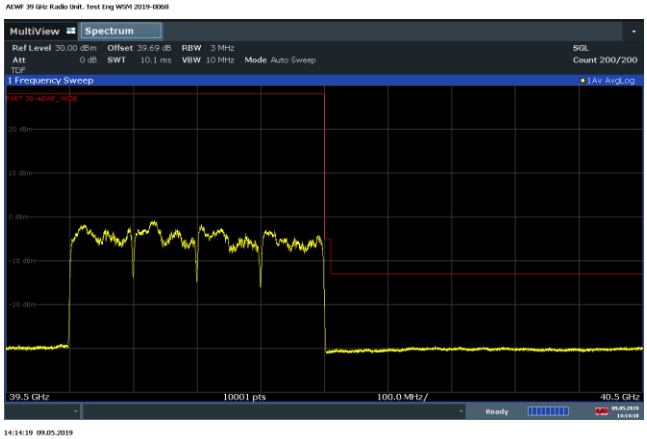

## Horizontal Polarization - 4 Carriers - 256QAM - Right Side of Band.



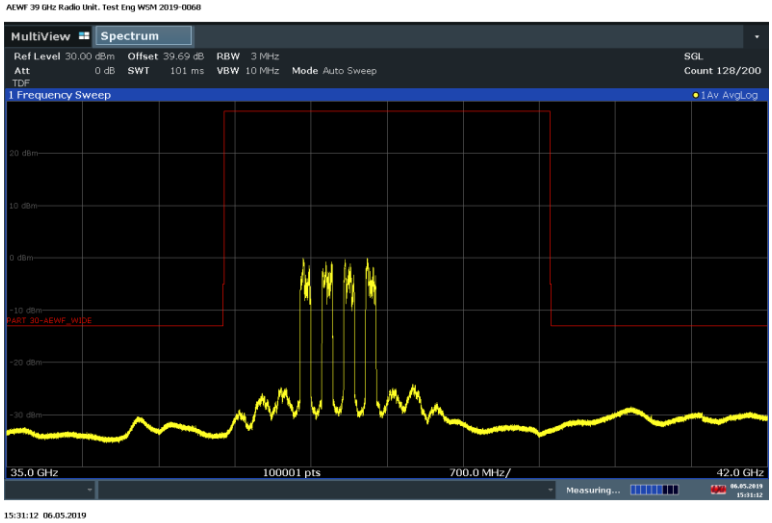




## Vertical Polarization - 4 Carriers - 256QAM - Right Side of Band.

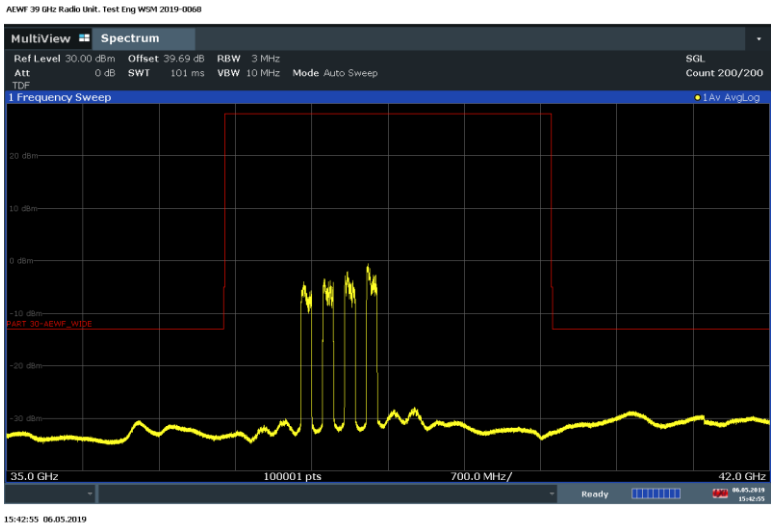


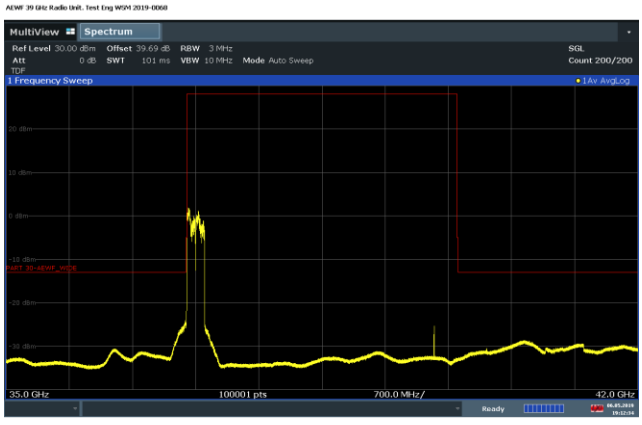
## Horizontal Polarization - 4 Carriers - 16QAM – Spread Carriers.

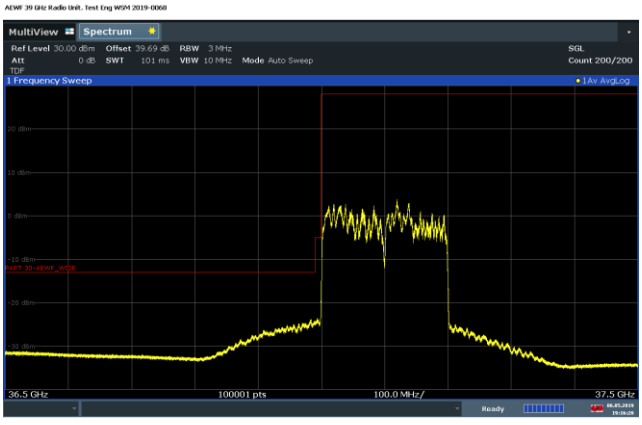



## Vertical Polarization - 4 Carriers - 16QAM – Spread Carriers.

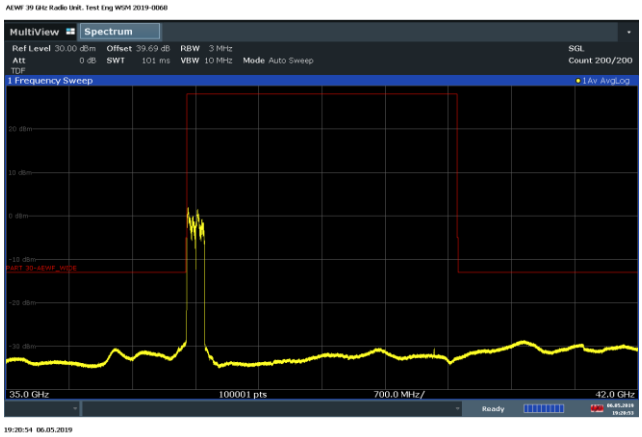


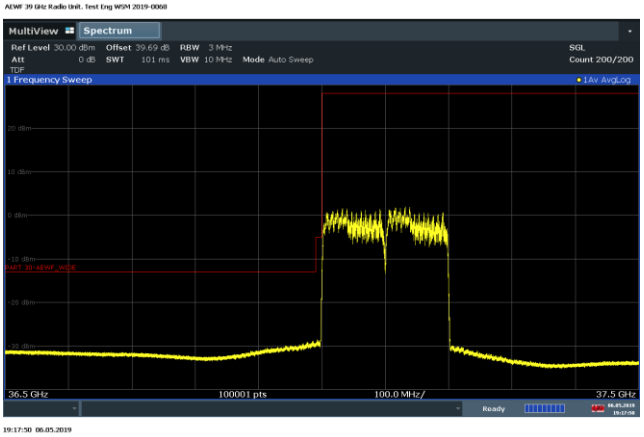

## Horizontal Polarization - 2 Carriers - 16QAM - Left Side of Band.



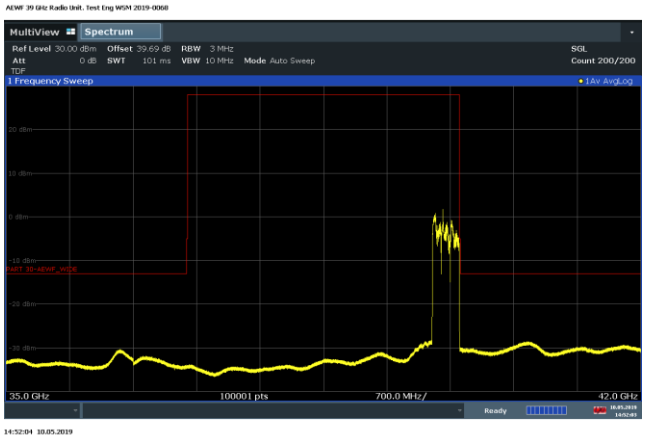



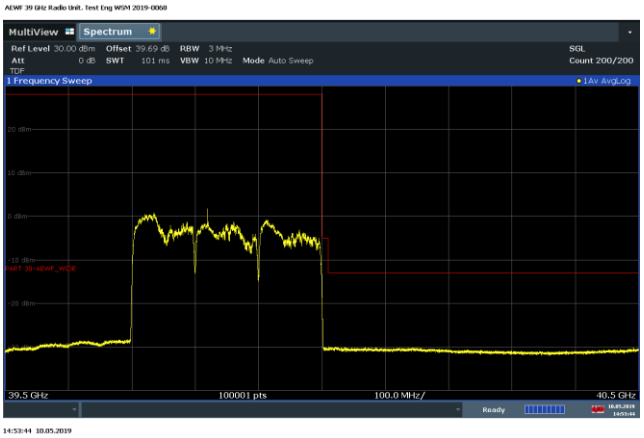
## Vertical Polarization - 2 Carriers - 16QAM - Left Side of Band.



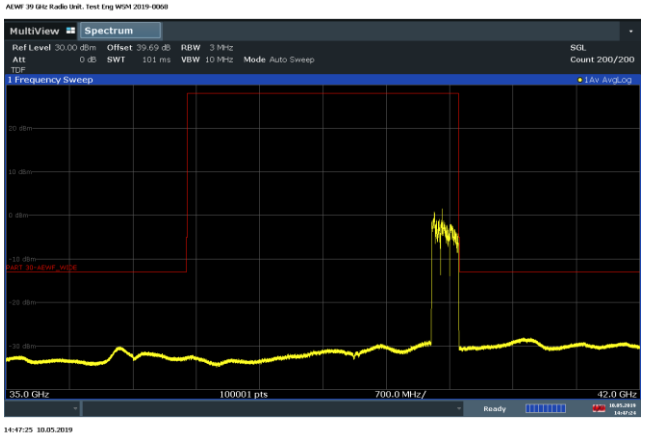




## Horizontal Polarization - 3 Carriers - 256QAM - Right Side of Band.




## 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<br>2253331<br>2254999<br>2256667 | 38349.84<br>38449.92<br>38550.00<br>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 | $\lambda$ | 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.

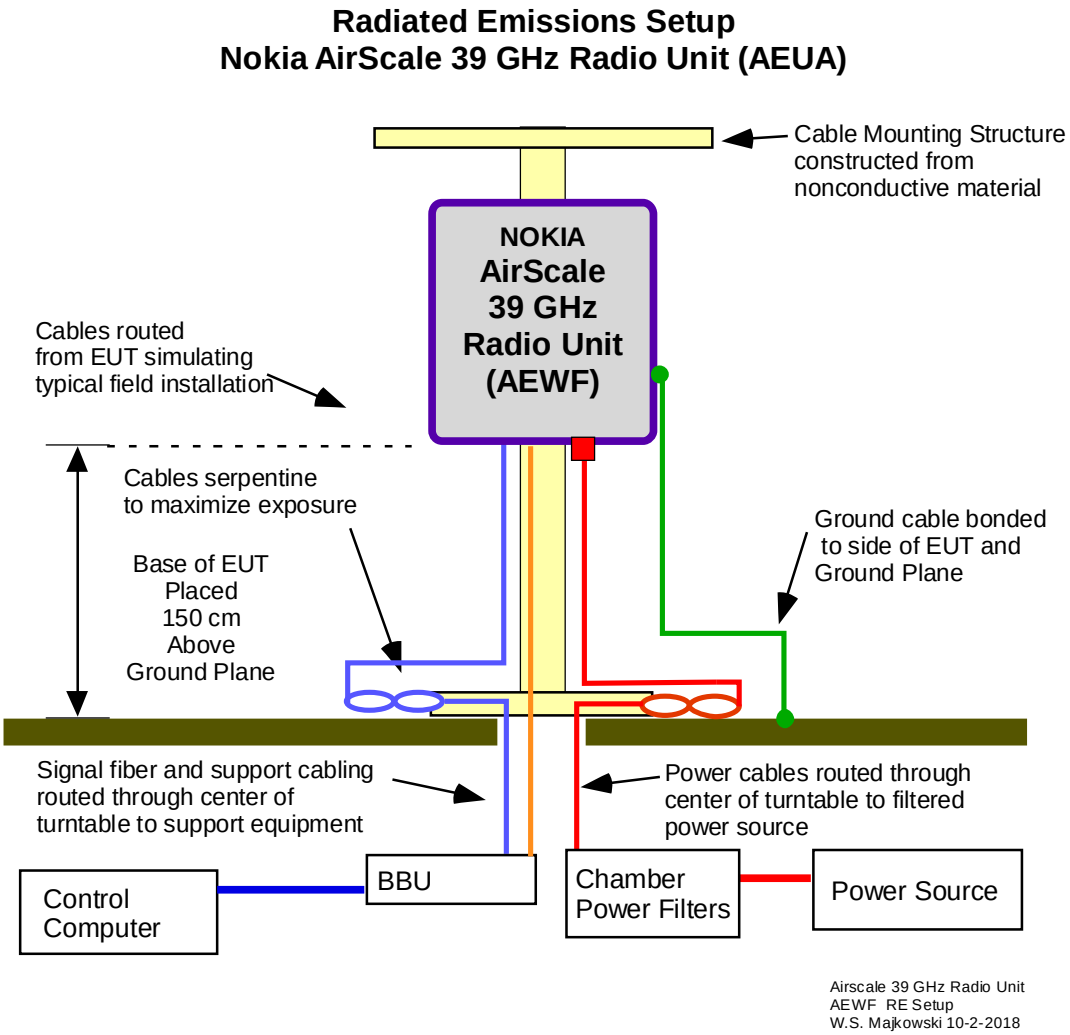
Presented results include the standard measurements from 30 MHz to 40 GHz followed by the four mmWave bands. The worst case emissions are presented. The scans are performed with the required 1 MHz resolution bandwidth and sufficient number of points per ANSI C63.26 with markers at the frequencies of 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.

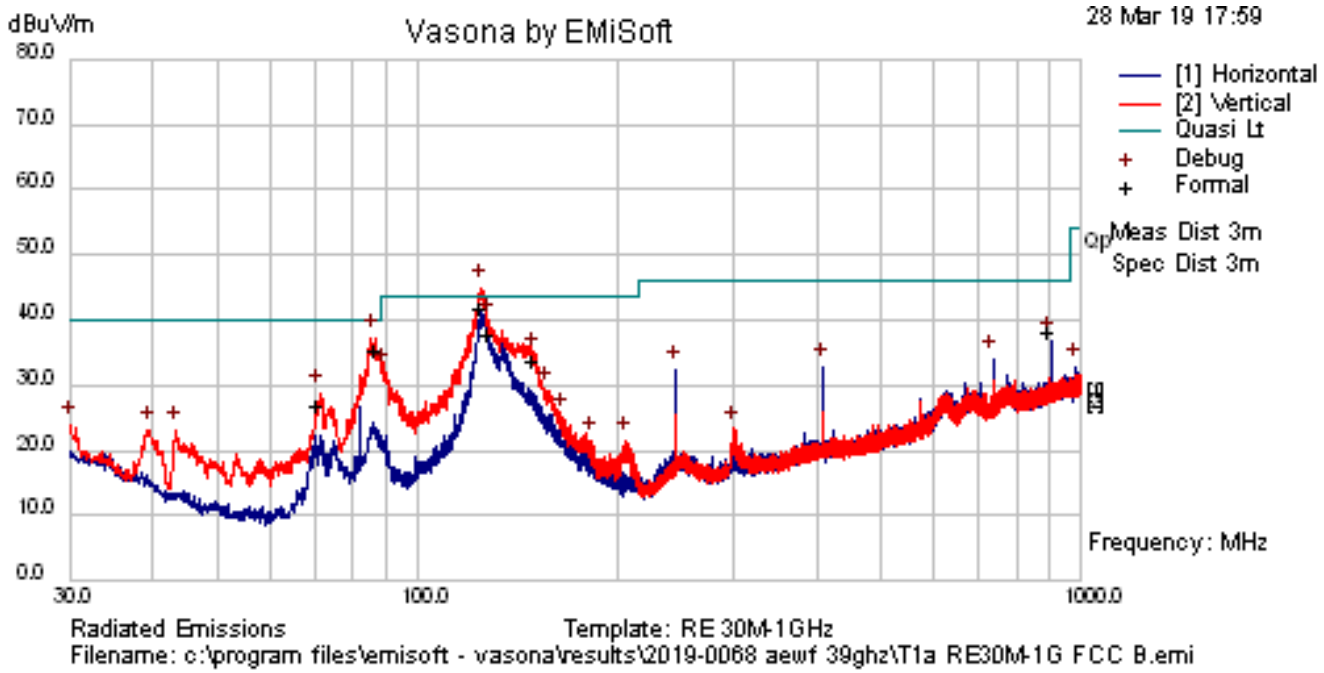
Photographs of the measurement setup are in the filing exhibits.

**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**

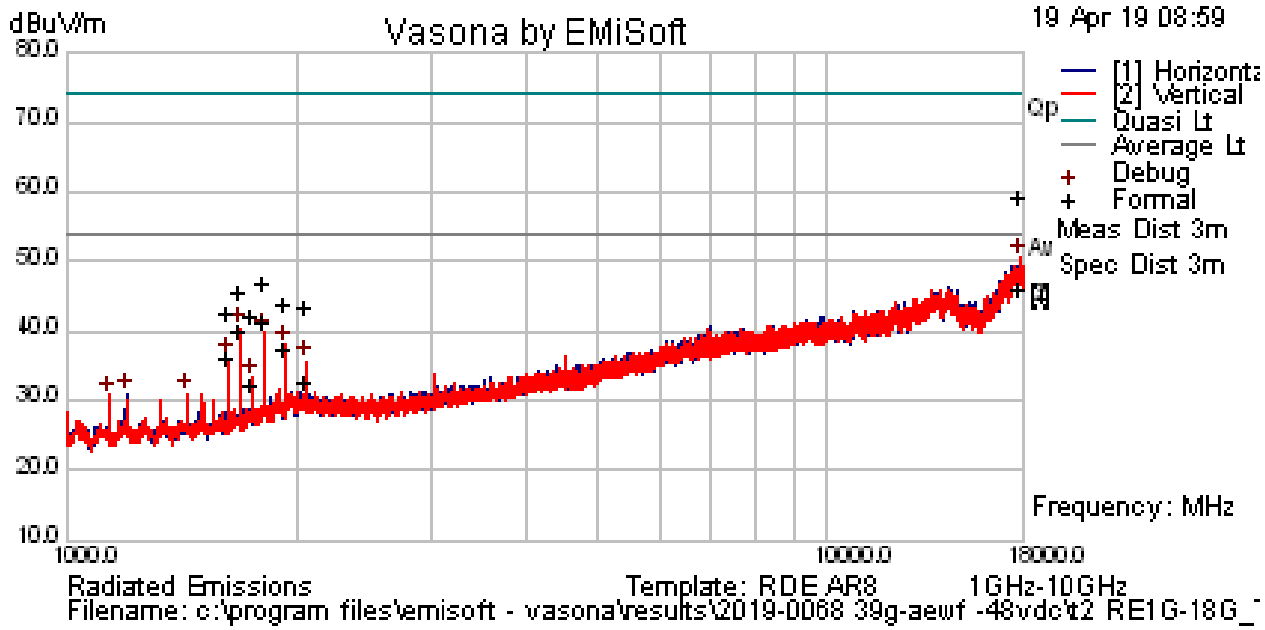
| Frequency. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125.279 | 47.34 | 1.19 | -9.55 | 38.99 | Quasi Max | V | 116 | 98 | 43.5 | -4.51 | 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 |
| **File Name:** | c:\program files\emisoft - vasona\results\2019-0068 39g-aewf -48vdc\t2 RE1G-18G_TX_OFF.emi |
| **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**

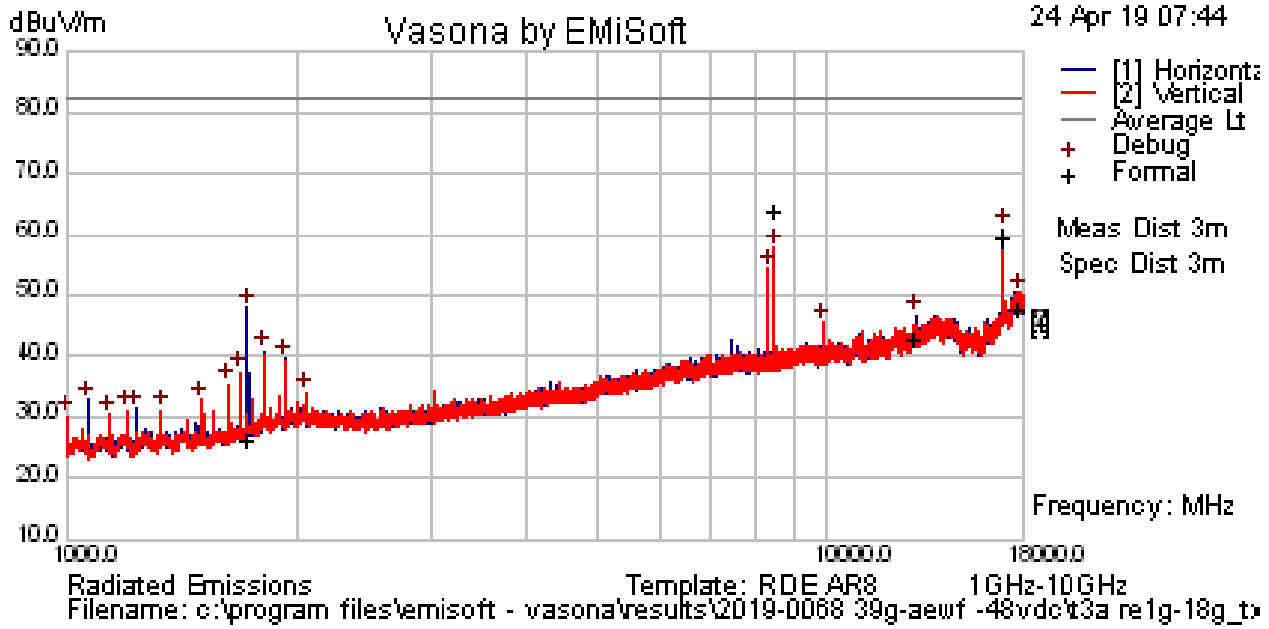
| Frequency. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBµV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17911.1 | 23.9 | 14.09 | 6.1 | 44.09 | Average | V | 331 | 295 | 54 | -9.91 | Pass | |
| 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




| | |
|---|---|
| **Results Title:** | RDE AR8 1GHz-18GHz |
| **File Name:** | c:\program files\emisoft - vasona\results\2019-0068 39g-aewf -48vdc\t3a re1g-18g_tx_on_form.emi |
| **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.<br>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**

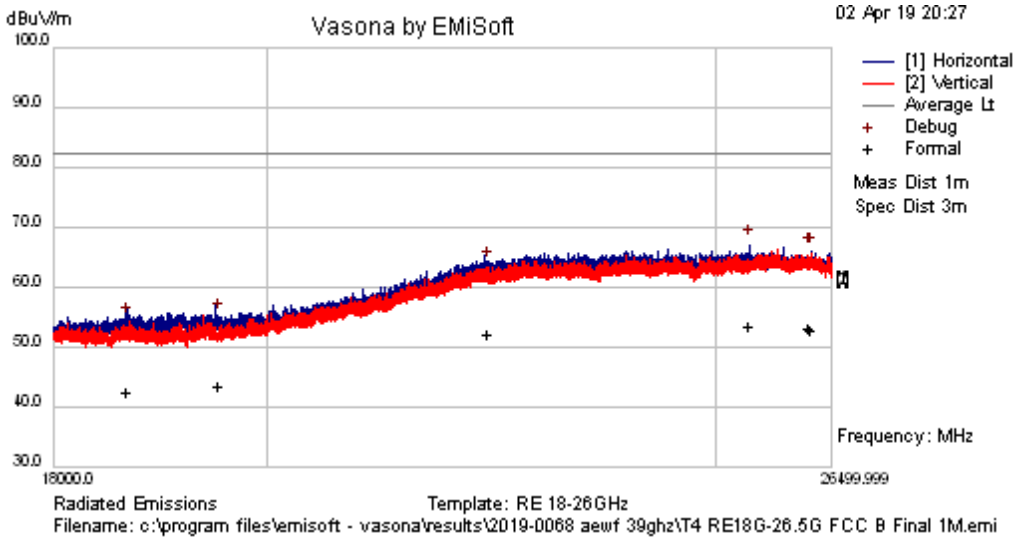
| Frequency. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8499.6 | 54.00 | 9.2 | -1.73 | 61.47 | Average | V | 100 | 355 | 82.23 | -20.76 | 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

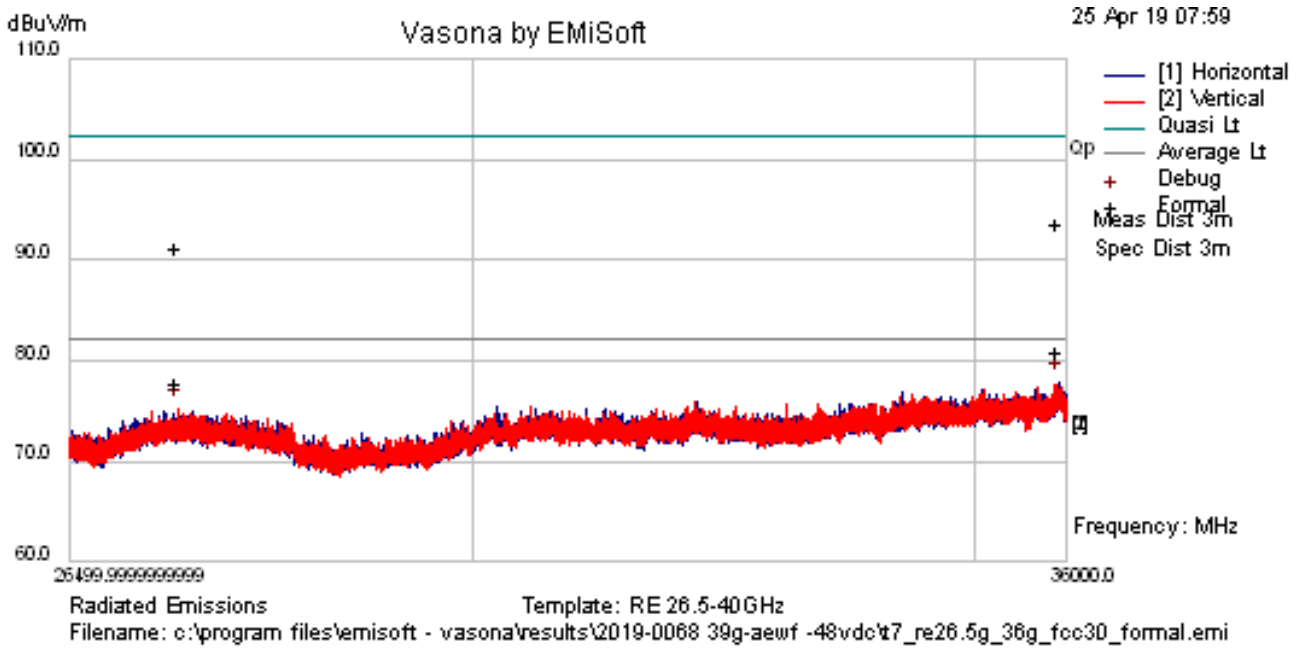
| Frequency. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25432 | 28.84 | 18.66 | 3.46 | 50.95 | Average | H | 201 | 337 | 82.23 | -31.28 | 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 | |

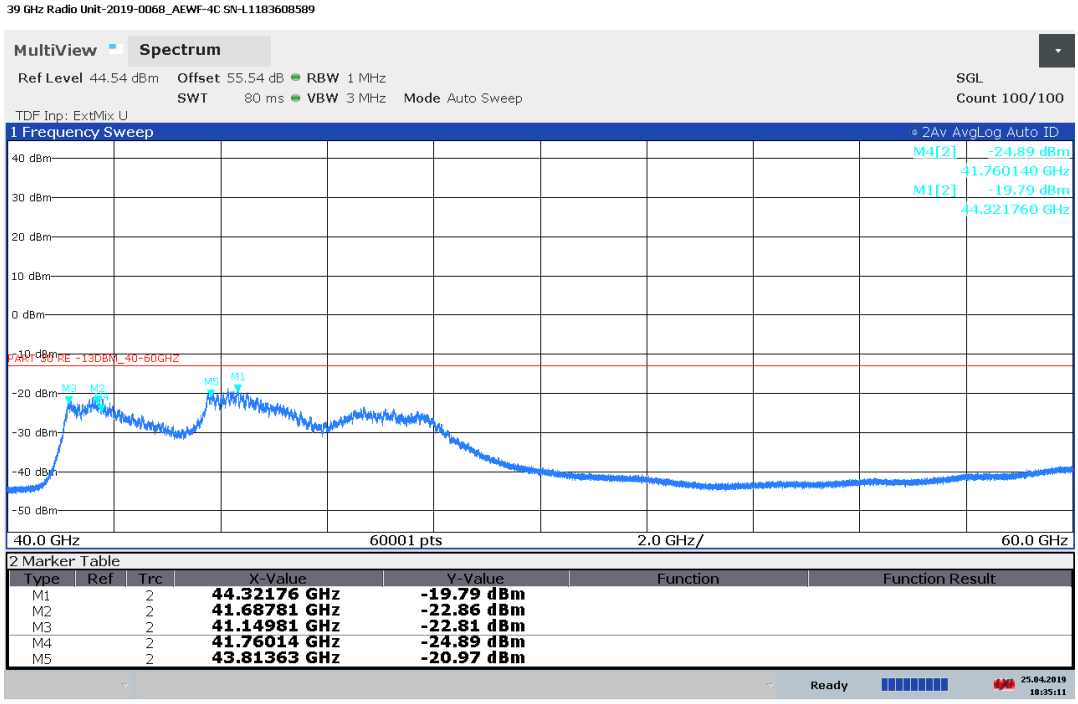
**PREVIEW DATA**

| 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.

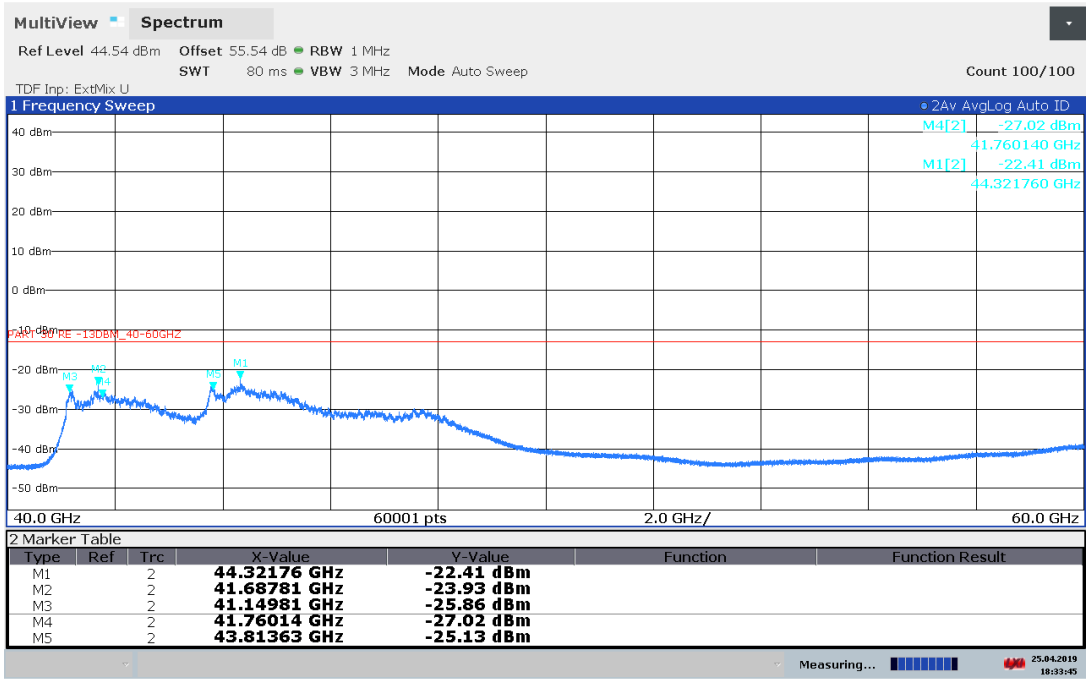
### 4.5.5 Maximum Radiated Emissions -U Band 40GHz-60GHz - 4m

## 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

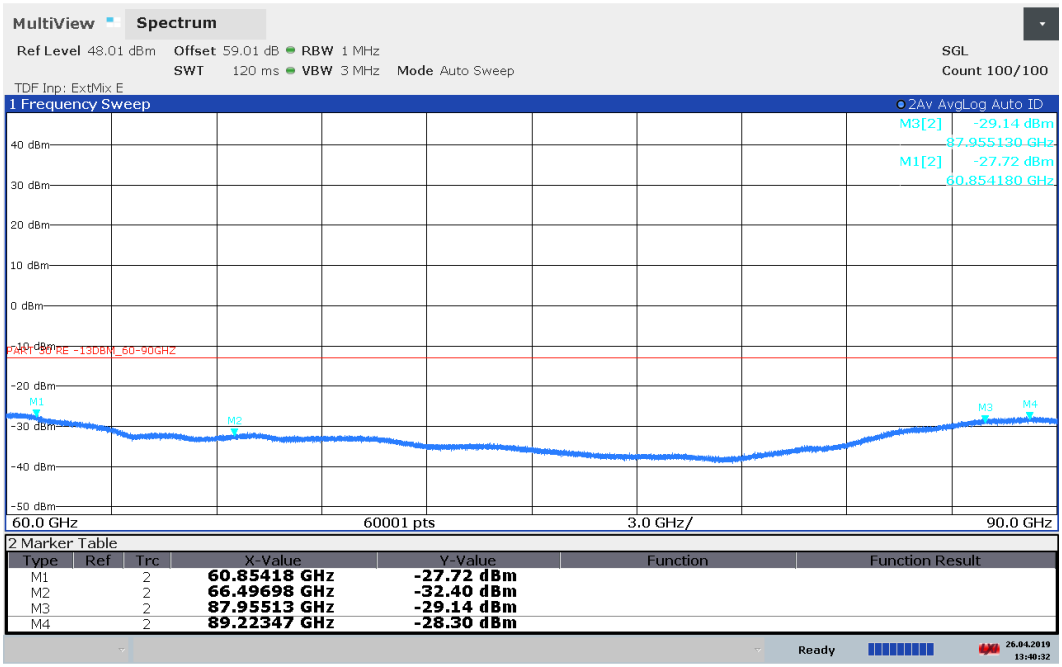



18:33:46 25.04.2019

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

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

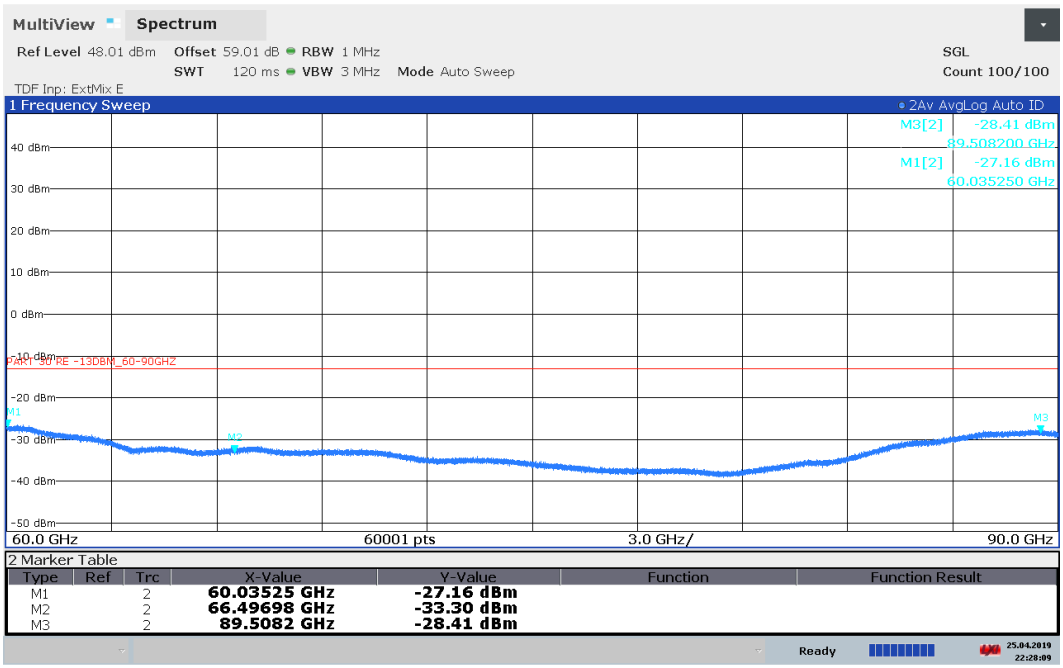
39 GHz Radio Unit-2019-0068_AEWF-4C SN-L1183608589




13:40:33 26.04.2019

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

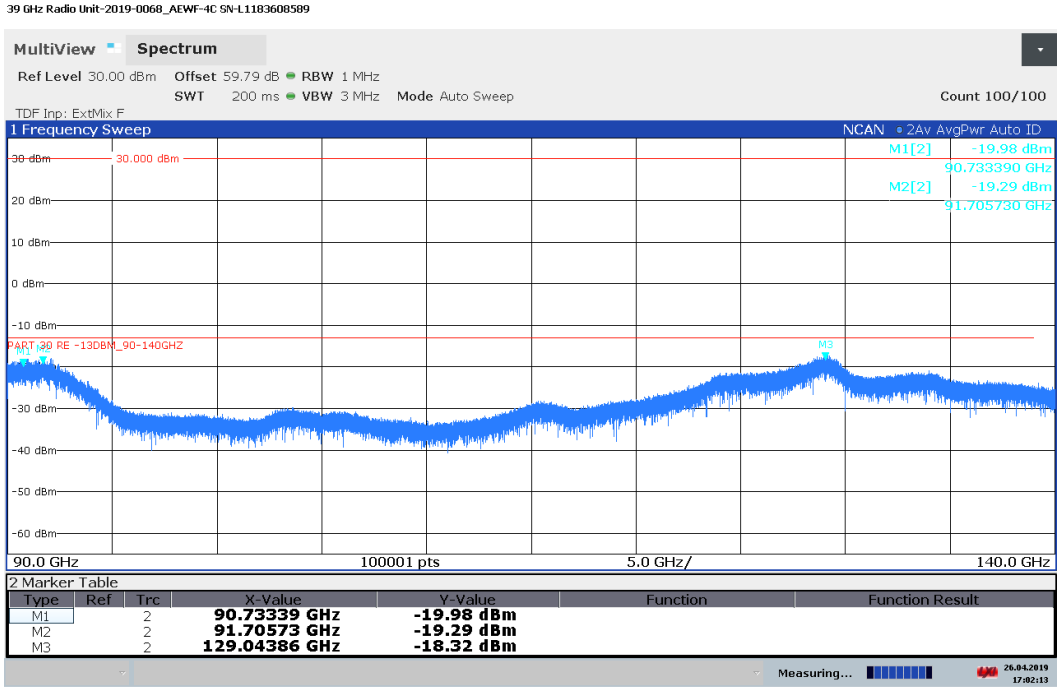
39 GHz Radio Unit-2019-0068_AEWF-4C SN-L1183608589




22:28:10 25.04.2019

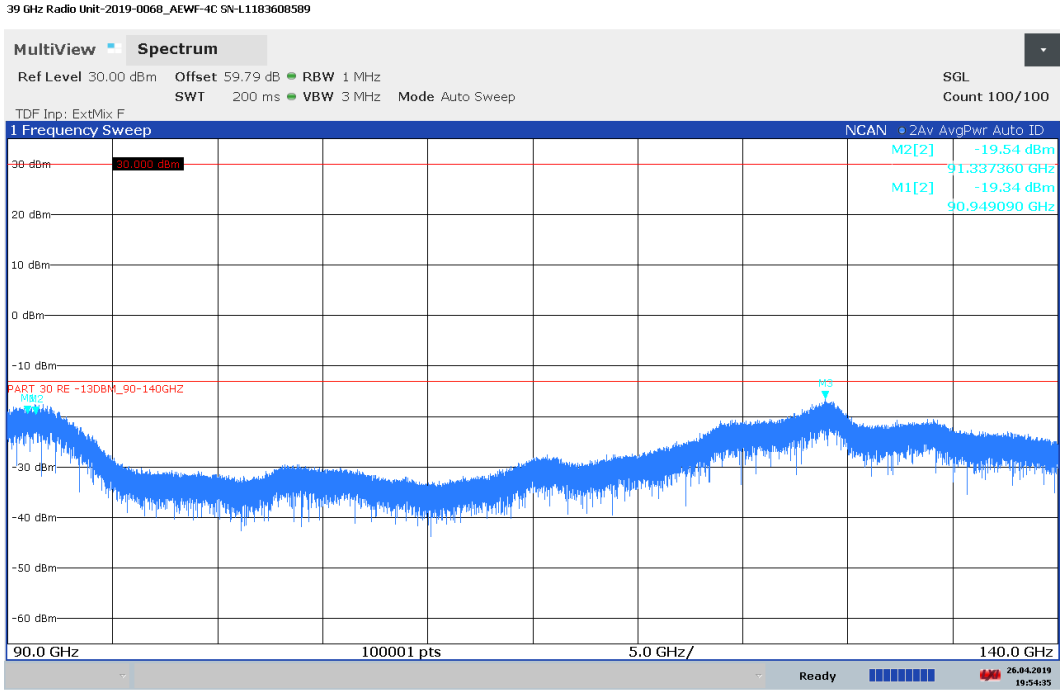
## 4.5.7 Maximum Radiated Emissions -F Band 90GHz-140GHz - 3m

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




17:02:13 26.04.2019

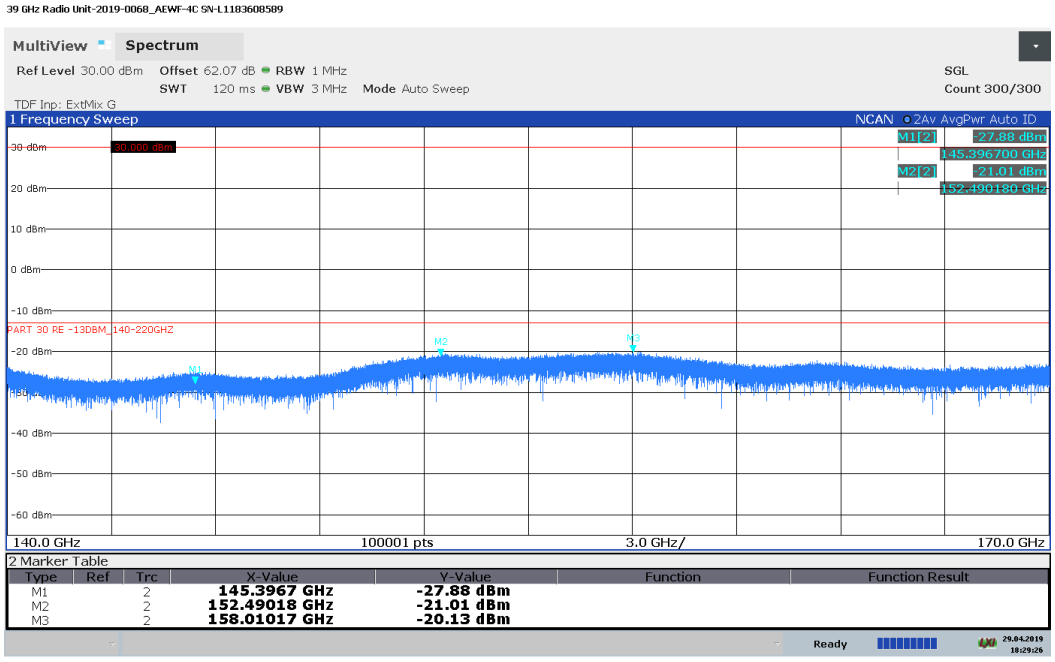
## Horizontal Polarization - 1 MHz RBW- 3.05 degree Azimuth; 1.55m Elevation




19:54:36 26.04.2019

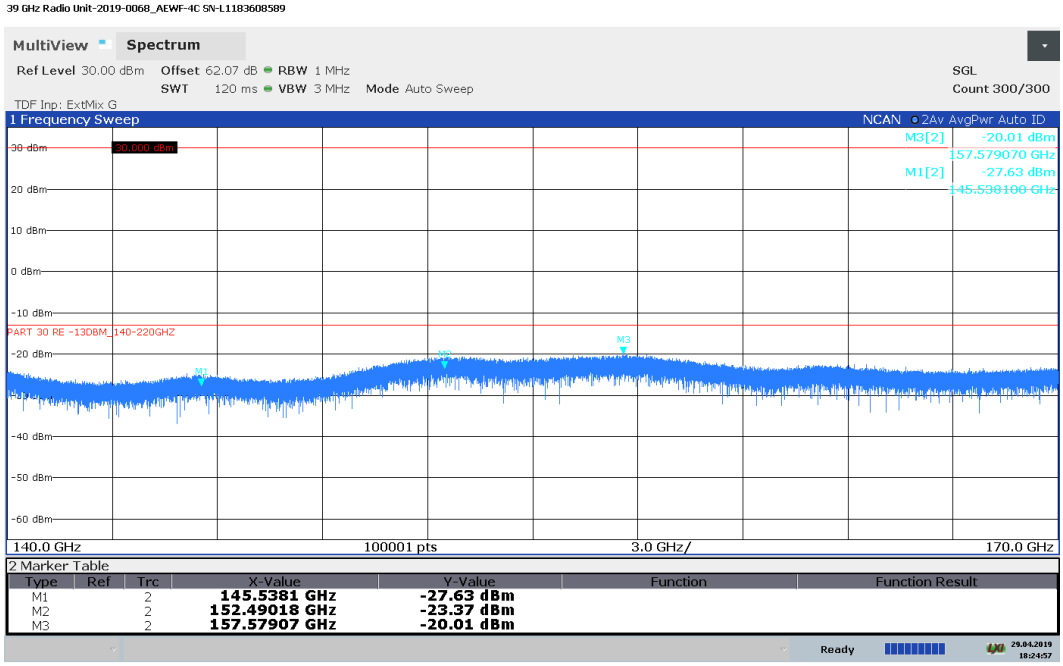
### 4.5.8 Maximum Radiated Emissions - G Band 140 - 170GHz - 3m

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




18:29:26 29.04.2019

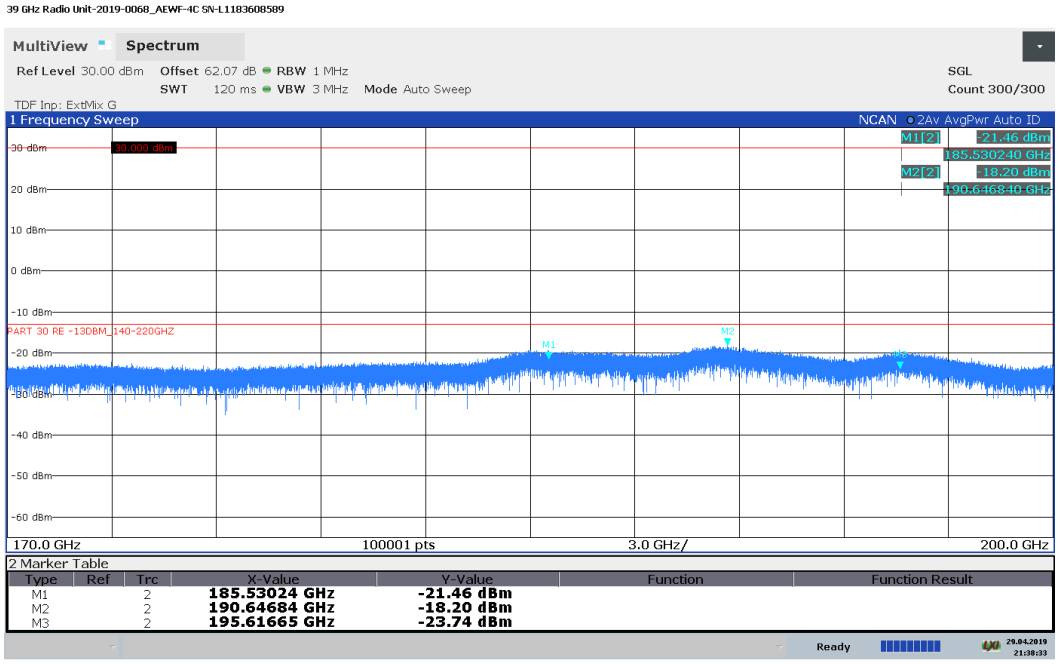
## Horizontal Polarization - 1 MHz RBW- 350 degree Azimuth; 1.55m Elevation 3m




18:24:58 29.04.2019

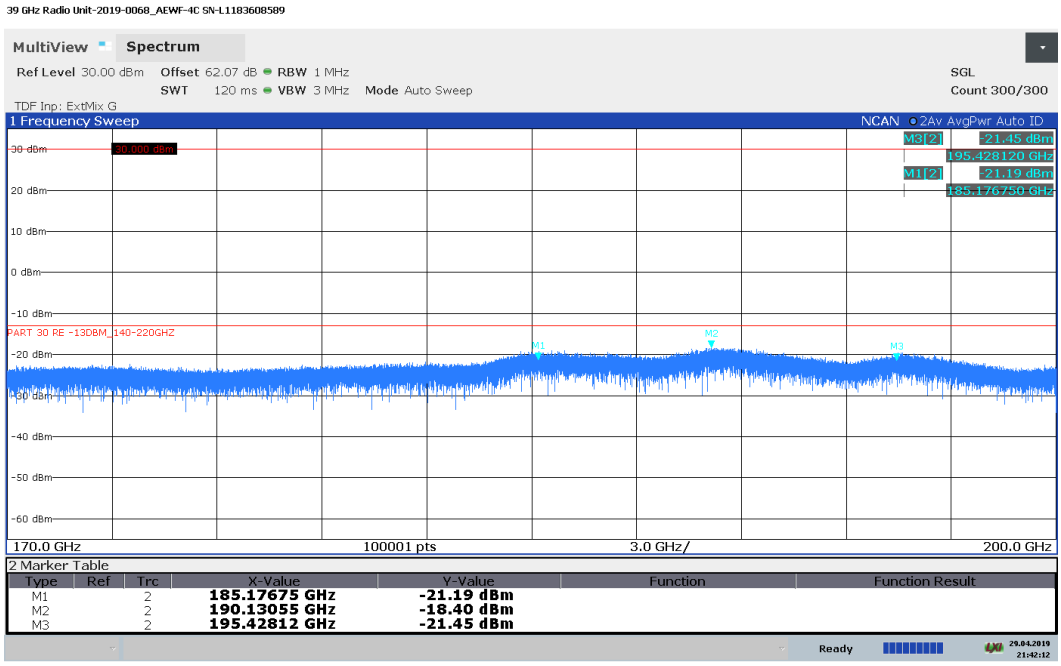
### 4.5.9 Maximum Radiated Emissions - G Band 170 - 200GHz - 3m

## 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.