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Regulation:

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Client

Nokia Solutions and Networks, OY

Product Evaluated

Nokia AEWB AirScale MAA 8T8R 512AE 39 GHz, (AEWB)
FCC ID: 2AD8UAEWB02

Report Number:

TR-2019-0155-FCC2-30-CLII

Date Issued:

November 11, 2019

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Revisions


| Date | Revision | Section | Change |
|------------|----------|---------|-----------------|
| 10/15/2019 | 0 | | Initial Release |
| 11/11/2019 | 1 | Pg 1, 5 | Errata |
| | | | |
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1. System Information and Requirements

| | |
|--|--|
| Equipment Under Test (EUT): | Nokia AEWB AirScale MAA 8T8R 512AE 39 GHz (AEWB 39 GHz RRH) |
| FCC ID | 2AD8UAEWB02 |
| Serial Number(s) | AC/DC Models: L1192000602 |
| Hardware Version: | 09140404A.X32 |
| Software Version: | FLF17SP |
| Frequency Range: | Tx / Rx - 37000 – 40000 MHz - NR Band n260 |
| Technology | 5G-New Radio, LTE-TDD: Emissions DesignatorS 97M5G7W, 398MG7W, 798MG7W |
| Operation Mode(s) | 2x 57dBm EIRP, 60 dBm EIRP Total. MIMO, 5 to 8 Carriers |
| GPCL Project Number: | 2019-0155 |
| Manufacturer: | Nokia Solutions and Networks, OY 2000 W. Lucent Lane, Naperville, Illinois 60563 |
| Test Requirement(s): | Title 47 CFR Parts 2, 15B and 30. |
| Test Standard(s) | <ul style="list-style-type: none"> • 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v03 April 9, 2018 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018 |
| Measurement Procedure(s): | <ul style="list-style-type: none"> • FCC-IC-OB - GPCL Occupied Bandwidth and Power Measurement Test Procedure 12-4-2017 • FCC-IC-SE - GPCL Spurious Emissions Test Procedure 12-4-2017 |
| Reference(s) | <ul style="list-style-type: none"> • 47 CFR FCC Part 2 and Part 30 • ANSI C63.26 (2015) • ANSI C63.4 (2014) TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014) |
| Test Date | September 11- November 5, 2019 |
| Submission Type | Class II Change |
| Test Performed By: | Nokia Global Product Compliance Laboratory 600-700 Mountain Avenue, Rm 5B-108 Murray Hill, New Jersey 07974-0636 USA NVLAP Lab Code: 100275-0 FCC Registration Number: 395774 |
| Product Engineer(s): | Ron Remy |
| Lead Engineer: | W. Steve Majkowski NCE |
| Test Engineer: | Mike Soli |
| Test Results: The EUT, <i>as tested</i> met the above listed requirements. Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in New Providence, NJ. | |

1.1 Introduction

This Conformity test report applies to the **Nokia AEWB AirScale MAA 8T8R 512AE 39 GHz (AEWB 39 GHz RRH)**, hereinafter referred to as the Equipment Under Test (EUT).

1.2 Purpose and Scope

The purpose of this document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 30 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

The EUT was tested to provide data supporting an FCC Class II Permissive Change to FCC ID: **2AD8UAEWB02**. The Class II change requests expanded additional operation with 5 through 8 carriers of Emissions Designator 97M5G7W. Transmitter output power is unchanged from the existing Grant.

1.3 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) | 57 dBm EIRP per polarizations; based upon 28 dBm Tx output. 60 dBm EIRP Total for the two polarizations. |
| Antenna Gain | 29 dBi |
| Operating Mode | 2x2 MIMO (2 duplex Tx/Rx Ports) 5 to 8 carriers |
| Software Version | FLF17SP |
| Hardware Version | 474870A.X21 |
| Antenna(s) | Refer to Section 3.2 |

The EUT supports the following carrier configurations:

Table 1.3.2 EUT Supported Configurations

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

1.3.1 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.

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

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

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

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

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

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

Table 1.3.1 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 |

1.3.2 Tested Frequencies

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

New Radio - Absolute Radio Frequency Channel Number (NRARFCN)

Table 1.3.1.3 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 | 99.96 |
| Left Side | 2231665 | 37150.08 | 99.96 |
| Left Side | 2233331 | 37250.16 | 99.96 |
| Left Side | 2234997 | 37350.24 | 99.96 |
| | | | |
| Middle | 2251666 | 38350.020 | 99.96 |
| Middle | 2253332 | 38449.980 | 99.96 |
| Middle | 2254998 | 38549.940 | 99.96 |
| Middle | 2256664 | 38649.900 | 99.96 |
| | | | |
| Right Side | 2273334 | 39650.100 | 99.96 |
| Right Side | 2275000 | 39750.060 | 99.96 |
| Right Side | 2276666 | 39850.020 | 99.96 |
| Right Side | 2278332 | 39949.980 | 99.96 |

1.4 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 assemblies inside the product. Each antenna transmit assembly is a 16x16 matrix (256 elements). One assembly is vertically polarized and the second is horizontally polarized. The antennas RF drive level is nominally 28 dBm. The 28 dBm RF power and 29 dBi gain results in a 57 dBm EIRP per assembly. The sum of the two 57 dBm EIRP beams results in a maximum EIRP of 60 dBm. Antenna Gain vs frequency is detailed in Exhibit 6 of the filing package.

1.5 Antenna Far Field Determination Distance

The Moongilan Test (1) was performed to determine the far field boundary location using calculations and low power measurements. For the antenna array we can calculate the Fraunhofer distance from

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

where d_{ff} = Far Field distance in meters,

D is the maximum size of the radiating array

λ = wavelength of the operating signal in meters

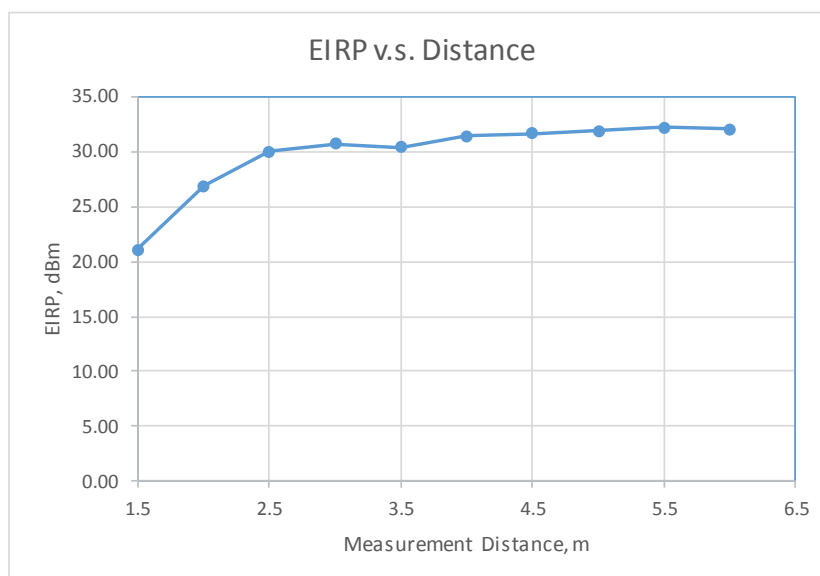
The antenna patch are 5 cm x 5 cm and the patches are 10 cm apart .

At 39 GHZ the diagonal 5 cm x 5 cm array dimensions results in a Fraunhofer far field distance d_{ff} of 1.3 meters. The Vertical to Horizontal patches are enclosed by a 15 cm circle which results in a d_{ff} of 5.85 meters

Measurements for the Moongilan Test were performed at low power using a standard gain horn antenna. In the horizontal polarization the determined boundary was 4 m.

To eliminate any inconsistency all Power, OBW and OOB measurements were made at 5m.

(1) *The Moongilan Test is named in honor of the late Dheena Moongilan who discovered it and formulated its use into C63.26.*



2. SUMMARY OF THE TEST RESULTS

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

2.1 Measurement Uncertainty

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

Worst-Case Estimated Measurement Uncertainties

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

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

3. 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 3.0a below.

Table 3.0a Required Certification Measurements

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

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 3.0b 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 semi-anechoic chambers maintained by Nokia Bell Lab's Global Product Compliance Laboratory in Murray Hill, NJ. The 35-41 GHz "radio" measurements and spurious measurements up to 200 GHz were performed in 10m chamber AR-8. The radiated emissions were performed in AR-8. In order to perform the spurious 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 3.0b Test Standards Used for Radiated Measurements of Radio Performance

| | |
|-------------------------|---|
| Test Standard(s) | <ul style="list-style-type: none"> • 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • Procedures on TRP Compliance for Out of Band and Spurious Emissions, C63.26 mmWave JTG - Version # 1 July 14th 2018 • KDB 842590 D01 Upper Microwave Flexible Use Service v01 April 5, 2019 |
| Reference(s) | <ul style="list-style-type: none"> • 47 CFR FCC Part 2 and Part 30 • ANSI C63.26 (2015) • ANSI C63.4 (2014) • TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014) |

3.1 Section 2.1046 MEASUREMENT REQUIRED: RF POWER OUTPUT

The product incorporates internal antennas that are integrated with 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 (AEWB)**, FCC ID: **2AD8UAEWB02**, is a 5G-NR LTE TDD radio head configured for one to four carrier operation. It is specified to provide a maximum power output of 57 dBm EIRP/500 W EIRP per transmit polarization for a sum total of 60 dBm EIRP /1000W 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.

3.1.1 RF Power Output Measurement

The product was configured for test as shown in Figure 3.1.1 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. These measurements were performed in 10m semi-anechoic chamber AR-8 with a 5 m measurement distance using a nominal 69 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 3.1.1. below. The unit was configured to transmit a single beam at maximum power.

The Channel Power function of the FSW spectrum analyzer was used to measure the maximum average Horizontal and Vertical EIRP at the 5m 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 various 5G-NR modulations. Channel power plots identify the individual carrier power and the total power.

Table 3.1.1 Corrections For Transmitter Power Measurements

| Freq. GHz | 5m Free Space Path Loss, PL dB | E1373 Measurement Antenna Gain, "G" dBi | Measurement Cable Loss, "L" dB | CH Power Correction, PL-G1+L1 dB | AEWB Antenna Gain, IEEE dB | OBE Required Adjustment dB |
|--------------|--|---|---|---|-------------------------------------|-------------------------------------|
| 35.0 | 77.30 | 24.26 | 14.59 | 67.63 | 26.50 | 41.133 |
| 35.5 | 77.43 | 24.27 | 14.73 | 67.88 | 27.10 | 40.785 |
| 36.0 | 77.55 | 24.33 | 14.85 | 68.07 | 27.75 | 40.322 |
| 36.5 | 77.67 | 24.38 | 14.96 | 68.25 | 28.30 | 39.948 |
| 37.0 | 77.79 | 24.44 | 15.11 | 68.46 | 28.80 | 39.657 |
| 37.5 | 77.90 | 24.50 | 15.25 | 68.65 | 29.10 | 39.552 |
| 38.0 | 78.02 | 24.49 | 15.38 | 68.91 | 29.40 | 39.507 |
| 38.5 | 78.13 | 24.48 | 15.49 | 69.14 | 29.50 | 39.637 |
| 39.0 | 78.24 | 24.52 | 15.67 | 69.39 | 29.60 | 39.793 |
| 39.5 | 78.35 | 24.56 | 15.81 | 69.61 | 29.50 | 40.107 |
| 40.0 | 78.46 | 24.58 | 15.85 | 69.74 | 29.40 | 40.336 |
| 40.5 | 78.57 | 24.60 | 15.94 | 69.91 | 29.25 | 40.664 |
| 41.0 | 78.68 | 24.66 | 16.05 | 70.07 | 29.10 | 40.968 |

3.1.2 RF Power Output Results

The Power output measurement results verified the expected performance of 57 dBm EIRP per polarization which is 60 dBm total. The maximum measured level was **57.73** dBm. This level is well within the maximum Part 30.202a limit of 75 dBm EIRP. Measurements were performed for each modulation.

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

3.1.3 RF Power Output Data

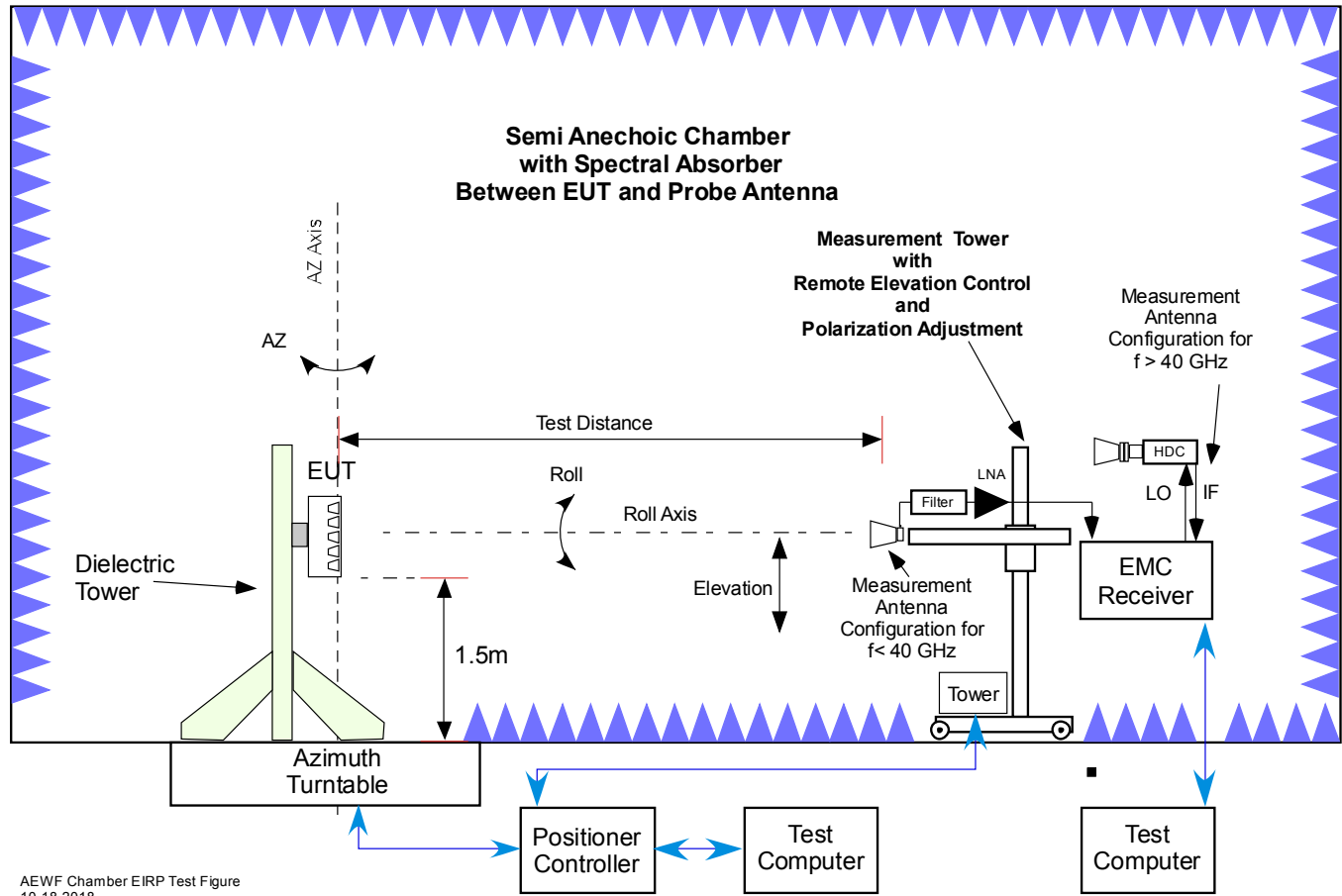
Table 3.1.3 below summarizes the Total Measured EIRP for the different configurations and modulations for 1 carrier, 2 carrier, 3 carrier and 4 carrier configurations. Sample data plots follow.

Table 3.1.3 - Summary of Channel Power Measurements

| Location in Band | Left Most Frequency , GHz | # of carriers | Modulation | Horizontal Polarization Total Channel Power, EIRP | Vertical Polarization Total Channel Power, EIRP | Sum Total Channel Power EIRP |
|------------------|---|---------------|------------|---|---|------------------------------|
| | | | | dBm | dBm | dBm |
| Left | 37.05000 | 5 | QPSK | 57.04 | 57.61 | 60.34 |
| Center | 37.05000, 37.14996, | 6 | 16QAM | 57.40 | 57.29 | 60.36 |
| Right | 39.75006, 39.85002, 39.94998, | 7 | 64QAM | 57.21 | 57.29 | 60.26 |
| Left | 37.05000, 37.14996, 37.24992, 37.34988, | 8 | 16QAM | 57.15 | 57.03 | 60.10 |
| Center | 38.35002, 38.44998, 38.54994, 38.64990, | 8 | 64QAM | 57.03 | 56.98 | 60.02 |
| Right | 39.65010 39.75006, 37.85002, 39.94998, | 8 | QPSK | 57.39 | 57.44 | 60.43 |

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

Figure 3.1.1 Test Set-Up for Measurement of Radio Transmitter Performance

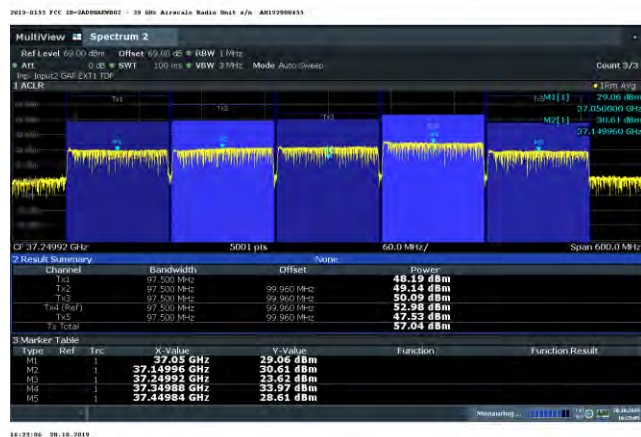


3.1.3.1 RF Power Output Sample Data

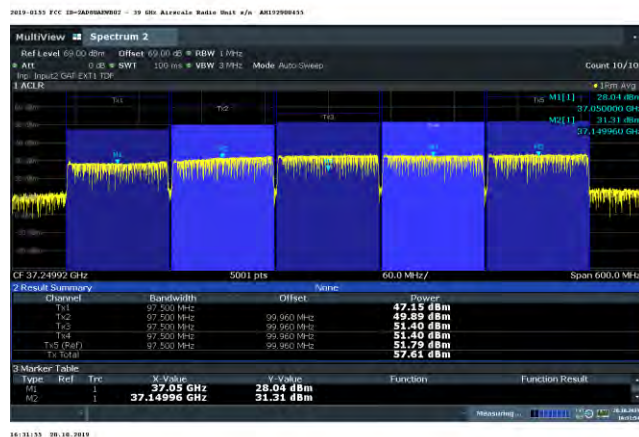
Channel Power Measurements, 5m, 5 Carrier

Left Side of Band – 37050.00 + 37149.96 + 37249.92 + 37349.88 + 37449.84 MHz

Horizontal



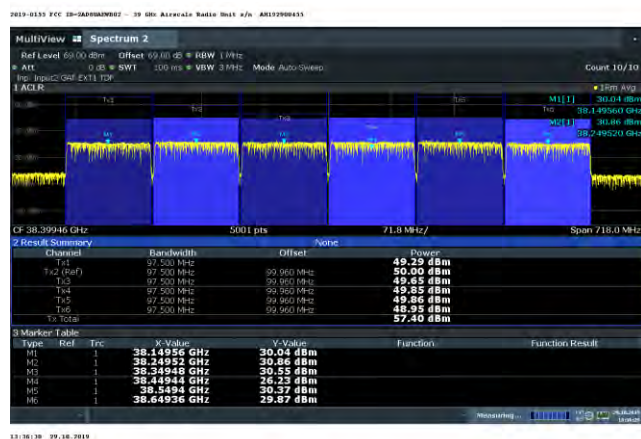
Vertical



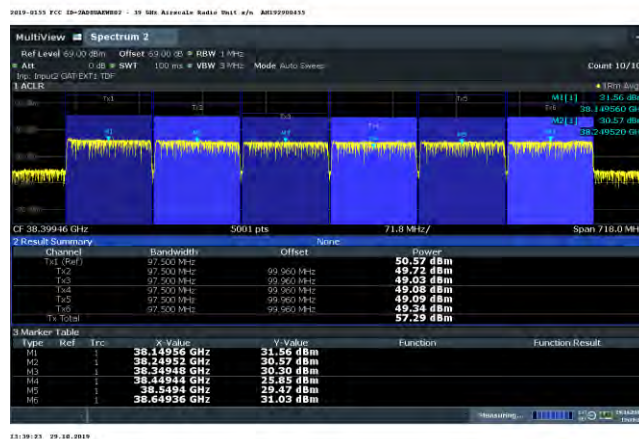
Channel Power Measurements, 5m, 6 Carrier

Middle of Band – 38149.56 + 38249.52 + 38349.48 + 38449.44 + 38549.40 + 39649.36 MHz

Horizontal

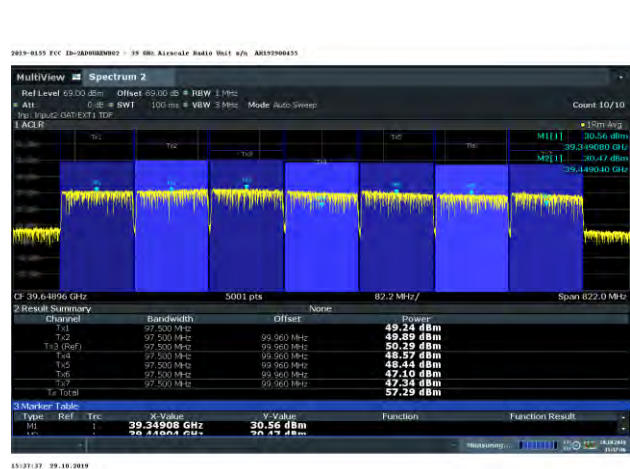


Vertical



Channel Power Measurements, 5m, 7 Carrier

Right Side of Band –39349.08+39449.04+39549.00+39548.96+39648.92+39748.88+39848.84 MHz

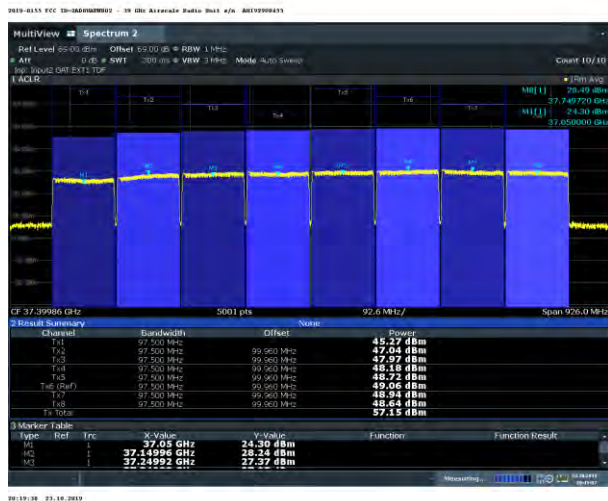


Channel Power Measurements, 5m, 8 Carriers

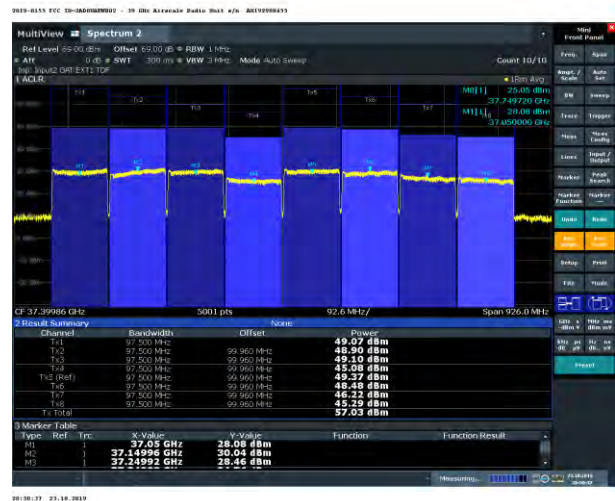
Left Side of Band. – 64QAM

37050.00 + 37149.96 + 37249.92 + 37349.88 + 37449.84 + 37549.80 + 37649.76 + 37749.72 MHz

Horizontal -

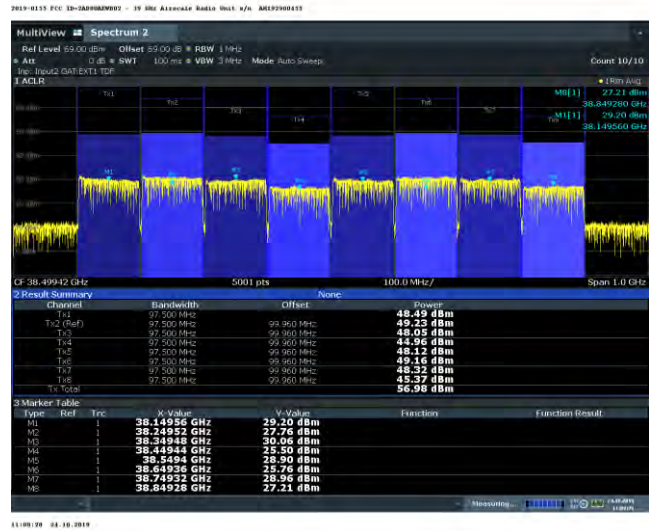
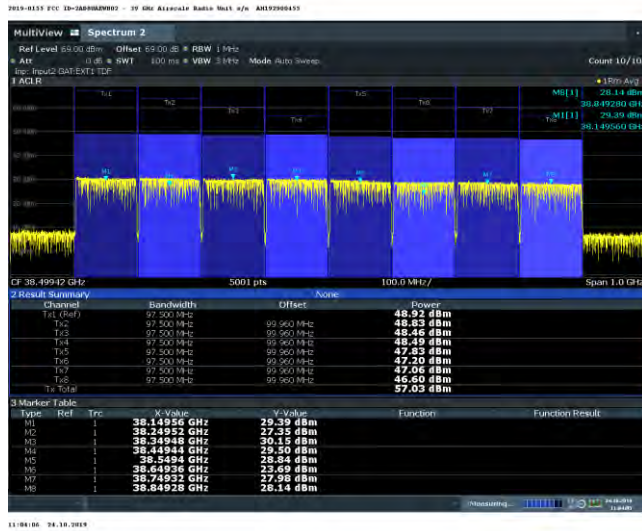


Vertical-



Channel Power Measurements, 5m, 8 Carrier Middle of Band – 64 QAM

38149.56 + 38249.52 + 38349.48 + 38449.44 + 38549.40 + 39649.36 + 38749.32 + 38849.28 MHz
Horizontal Vertical



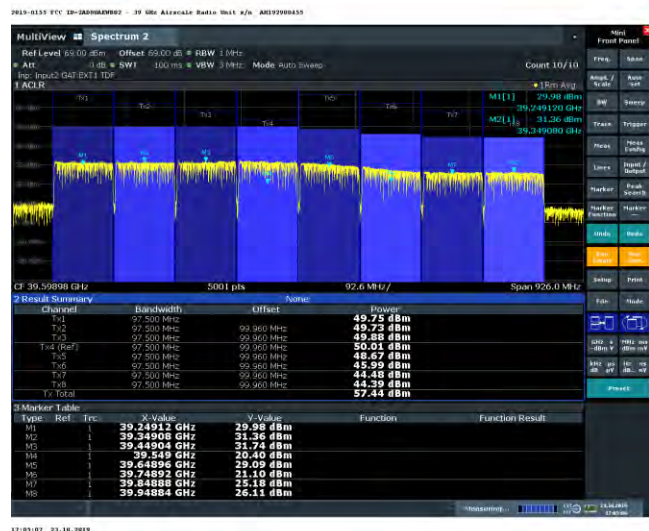
Channel Power Measurements, 5m, 8 Carrier Right Side of Band - 64QAM

39349.08 + 39449.04 + 39549.00 + 39648.96 + 39748.92 + 39848.88 + 39948.84 + 40048.80 MHz

Horizontal



Vertical



3.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERISTICS

The **2AD8UAEWB02** 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. Typical Constellations of each waveform type 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. Future Class II changes are planned for this unit for additional Multi-carrier operation and Release 16 should be testable at that time.

3.2.1 Modulation Characteristics Measurement

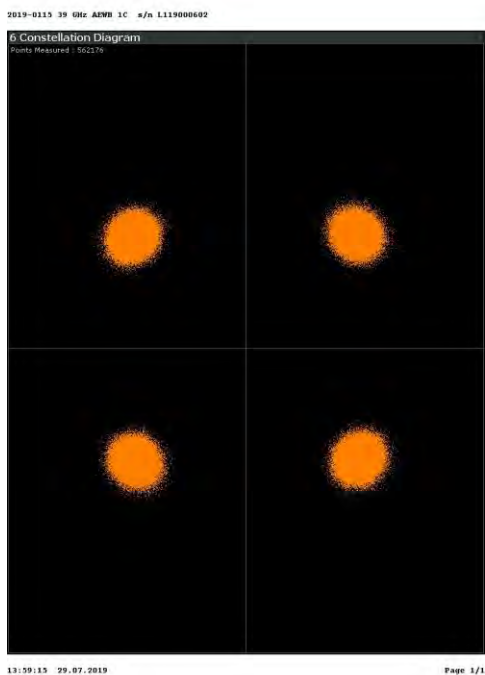
The measurements were performed at a distance of 4 m from the unit utilizing the test configuration in Figure 3.1.1 utilizing a Rohde & Schwarz FSW - 85 with the 3GPP 5G-NR DL Measurement software options. Representative screen plots of the modulation measurement are attached below for all three of the subcarrier configurations and sample polarizations. Data was collected for each of the tested configurations.

3.2.2 Modulation Measurements Results:

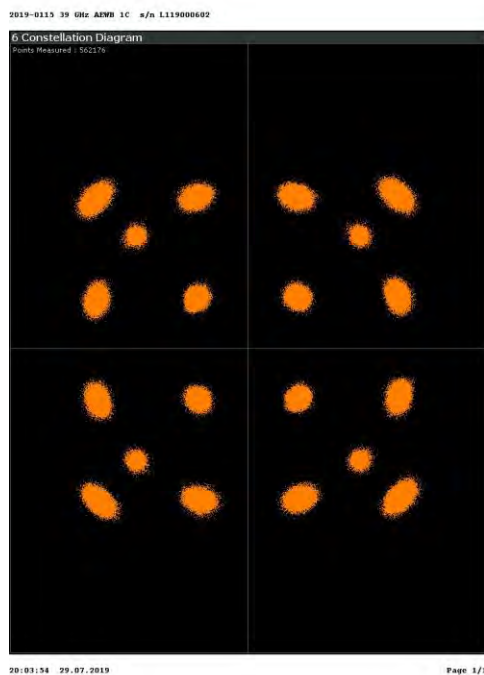
The typical measured modulation characteristics of the EUT are shown below:

Figure 3.2 Modulation Results

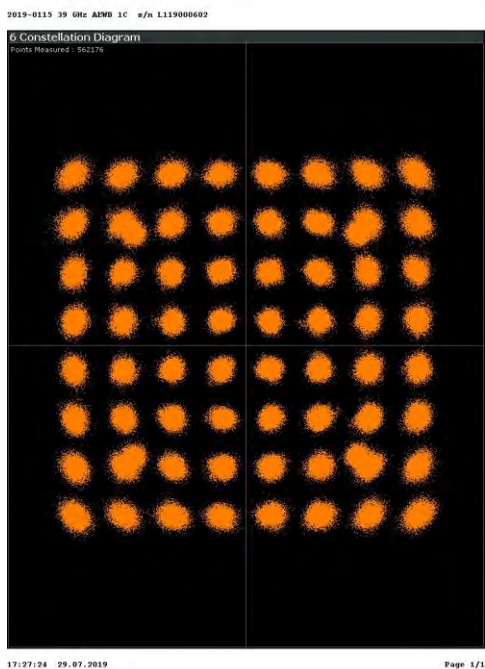
Sample QPSK



Sample 16QA64



Sample 64QAM



3.3 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 OBW functionality was used to make the measurement. All measurements were performed with a 10 sweep average using an RMS detector. The signal bandwidth measurements were performed with resolution bandwidths of 3 & 5 MHz for single carrier and 5 MHz and 10 MHz for multiple carriers.

3.3.1 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 AEWB is defined as follows. The individual carriers, 97.5 MHz maximum, are spaced 99.96 MHz apart and do not overlap. The overall signal bandwidth for 4-8 adjacent carriers is depicted in Figure 3.3.1.1. The calculated assessment is that the 4 carrier aggregated bandwidth is 397.5 MHz which results in an emissions designator of 398MG7W. The maximum measured value was 395.56 MHz

The 8 carrier bandwidth of the AEWB is defined as follows. The individual carriers, 97.5 MHz maximum, are spaced 99.96 MHz apart and do not overlap. The overall signal bandwidth for 8 adjacent carriers is depicted in Figure 3.3.1.1. The calculated assessment that the 8 carrier aggregated bandwidth is 797.2 MHz which results in an emissions designator of 798MG7W. The maximum measured value was 791.52 MHz

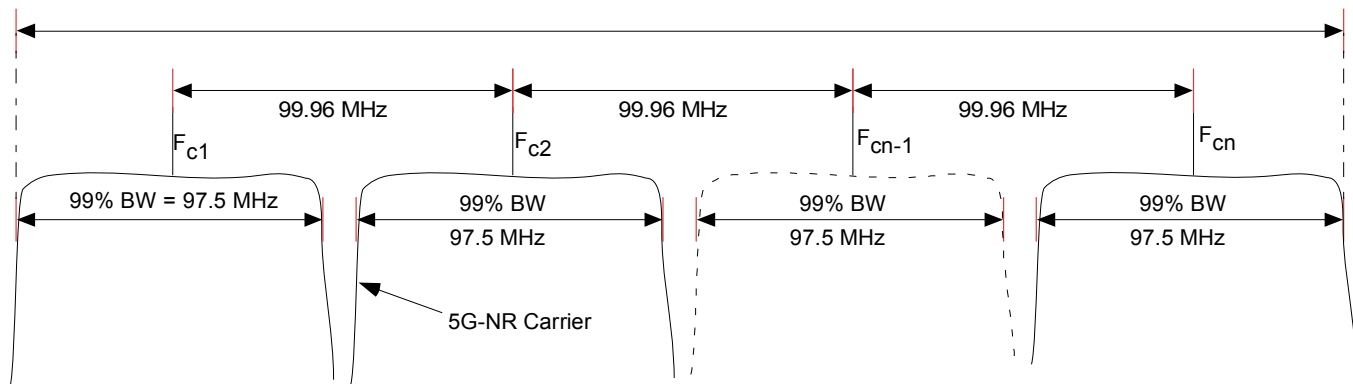
Other aggregation bandwidths between one and eight can be calculated using the formula

$$\text{Aggregation Bandwidth} = (n-1)(99.96 \text{ MHz}) + 97.5 \text{ MHz}$$

Where n is equal to the number of carriers.

Figure 3.3.1. - Carrier Aggregation

Total Carrier Aggregation Bandwidth = $(n-1)(99.96 \text{ MHz}) + 97.5 \text{ MHz}$
For 4 carriers = $(4-1)(99.96 \text{ MHz}) + 97.5 \text{ MHz} = 397.4 \text{ MHz} = 398\text{MG7W}$
For 8 carriers = $(8-1)(99.96 \text{ MHz}) + 97.5 \text{ MHz} = 797.2 \text{ MHz} = 798\text{MG7W}$



Carrier Aggregation nx(97M5)
WSM 11-05-19

3.3.2 Results Occupied Bandwidth (Signal Bandwidth)

The 99% occupied bandwidth was measured with a Rohde & Schwarz FSW spectrum analyzer using the occupied bandwidth functionality. The results for multiple configurations and modulations are tabulated in Table 3.3.2 below. The measurement of 8 adjacent carriers resulted in a maximum 8 carrier bandwidth of 791.52 MHz. The results document that the individual measured signals are within the parameters of the 97M5G7W emissions designator. The results also document that the aggregated 8 carriers was measured to be within the parameters of the 798MG7W emissions designator. Sample carrier measurements are documented in 3.3.2.1 below.

Table 3.3.2 Occupied Bandwidth - Signal Bandwidth Measurements

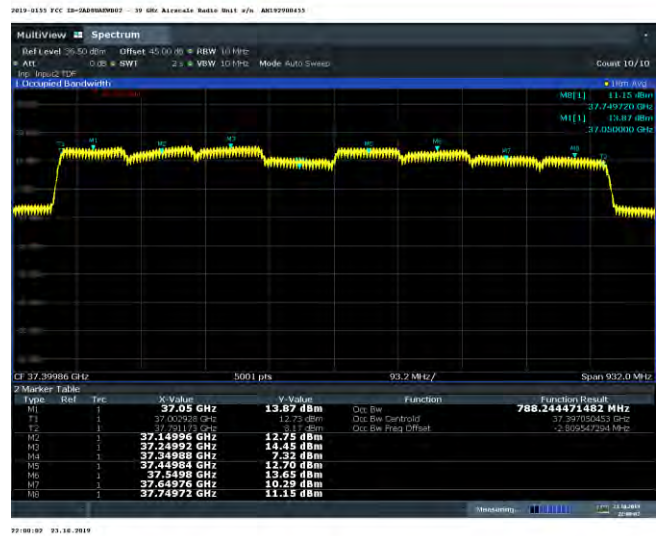
| Carrier Location in Band | Tx. Carriers Center Frequency, GHz | Number of Tx. Carriers | Modulation | Measured w/10 MHz RBW | |
|-----------------------------|--|------------------------------|------------|-----------------------|----------|
| | | | | Horizontal | Vertical |
| | | | | MHz | MHz |
| Left | 37050.00 37149.96 37249.92 37349.88 37449.84 37549.80 37649.76 37749.72 | 8 | 64QAM | 786.11 | 787.62 |
| Center | 38149.56 38249.52 38349.48 38449.44 38549.40 38649.36 38749.32 38849.28 | 8 | 64QAM | 790.29 | 791.52 |
| Right | 39249.12 39349.08 39449.04 39549.00 39648.96 39748.92 39848.88 39948.84 | 8 | 64QAM | 784.11 | 783.80 |

3.3.2.1 Results - Occupied Bandwidth Sample Data - 99% Signal Bandwidth

Eight Carrier 99% Signal Bandwidth Horizontal - 64QAM



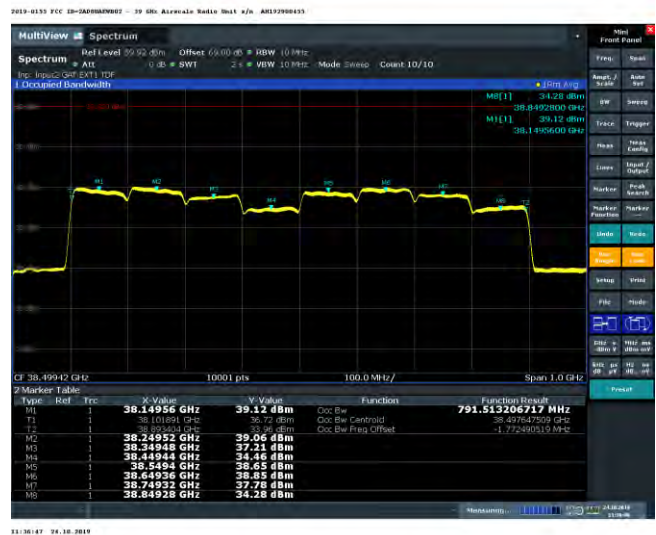
Left Side of Band Vertical - 64QAM



99% Signal Bandwidth Horizontal - 64QAM



Middle of Band Vertical - 64QAM



Eight Carrier

99% Signal Bandwidth 10 MHz RBW
Horizontal - 64QAM



Right Side of Band
Vertical - 64QAM



3.3.3 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 **2AD8UAEWB02** 39 GHz Radio Unit supports from one to four 5G-New Radio LTE TDD carriers. This evaluation addresses 2x2 MIMO operation with up to 4 carriers which are nominally 100 MHz each and are placed anywhere within the active 800 MHz operational bandwidth. 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 57 dBm. The measurements are described below.

The occupied bandwidth of each of the signals identified in Table 4.3.8.1 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 3.1.1. Measurements were performed at 4.5m 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. Data is supplied for one, two, three and four carrier configurations for the Left, Center and Right side of the 39 GHz band in the Part 30 Upper Microwave Flexible Use Service spectrum.

3.3.4 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.

3.3.5 Measurement Offset and MIMO

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

3.3.6 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 3.3.6. Mask Edge Offsets = $\frac{1}{2}$ the measurement Resolution Bandwidth were not used.

Table 3.3.6 - 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 | 28 |
| 40.00 | 28 |
| 40.00 | -5 |
| 40.01 | -5 |
| 40.01 | -13 |
| 41.00 | -13 |
| 42.00 | -13 |

3.3.7 Measurement Path Correction

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 Table 3.3.7 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.

This adjustment was only used for the OOBE/EoB frequency range. Table 3.3.7 below lists the offset correction factors used for the measurement distance of 5m including the AEWB product gain. The measurements were made using a flat offset of 40.5 dB with a transducer correction identified below.

3.3.7.1 OOBE Sample calculation

Sample calculation: The sample calculation below is the formula and the correction for 39 GHz;

OOBE Correction Factor = Free Space Path Loss – Measurement Antenna Gain + Cable Loss – Product Gain.

The following sample calculation is the correction for 39 GHz;

Sample calculation at 39 GHz: Correction = 77.33 dB -23.6 dBi + 15.67dB - 29.60 dBi = 39.797 dB
= Offset Value (40.0 dB) + Transducer Factor (-0.203 dB)

All measurements were made using a flat offset of 40 dB and the transducer factor from the Table 4.3.6.

Table 3.3.7 Measurement Correction for Edge of Band / Out of Band Emissions

| Freq. | 5m Free Space Path Loss, PL | E1373 Measurement Antenna Gain, “G” | Measurement Cable Loss, “L” | Channel Power Correction PL-G1+L1 | AEWF Antenna Gain, IEEE | OOBE Required Adjustment | FSW Offset | Transducer Correction Factor |
|-------|--------------------------------------|--|-----------------------------------|--|----------------------------------|--------------------------------|---------------|------------------------------------|
| GHz | dB | dB _i | dB | dB | dB _i | dB | dB | dB |
| 35.0 | 77.30 | 24.26 | 14.59 | 67.63 | 26.50 | 41.133 | 40.5 | 0.633 |
| 35.5 | 77.43 | 24.27 | 14.73 | 67.88 | 27.10 | 40.785 | 40.5 | 0.285 |
| 36.0 | 77.55 | 24.33 | 14.85 | 68.07 | 27.75 | 40.322 | 40.5 | -0.178 |
| 36.5 | 77.67 | 24.38 | 14.96 | 68.25 | 28.30 | 39.948 | 40.5 | -0.552 |
| 37.0 | 77.79 | 24.44 | 15.11 | 68.46 | 28.80 | 39.657 | 40.5 | -0.843 |
| 37.5 | 77.90 | 24.50 | 15.25 | 68.65 | 29.10 | 39.552 | 40.5 | -0.948 |
| 38.0 | 78.02 | 24.49 | 15.38 | 68.91 | 29.40 | 39.507 | 40.5 | -0.993 |
| 38.5 | 78.13 | 24.48 | 15.49 | 69.14 | 29.50 | 39.637 | 40.5 | -0.863 |
| 39.0 | 78.24 | 24.52 | 15.67 | 69.39 | 29.60 | 39.793 | 40.5 | -0.707 |
| 39.5 | 78.35 | 24.56 | 15.81 | 69.61 | 29.50 | 40.107 | 40.5 | -0.393 |
| 40.0 | 78.46 | 24.58 | 15.85 | 69.74 | 29.40 | 40.336 | 40.5 | -0.164 |
| 40.5 | 78.57 | 24.60 | 15.94 | 69.91 | 29.25 | 40.664 | 40.5 | 0.164 |
| 41.0 | 78.68 | 24.66 | 16.05 | 70.07 | 29.10 | 40.968 | 40.5 | 0.468 |

3.3.8 Edge of Band Measurements

The Occupied Bandwidth and Edge-of-Band emissions measurements were made as a radiated measurement at a distance of 5m. 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 3.1.1 was used. Testing was performed for the nominal 100 MHz carrier configurations at the left side, center 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 3.3.7 above.

3.3.8.1 Results - Occupied Bandwidth Out Of Band Emissions /-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 are below. These include one, two, three and four carrier operation. 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.

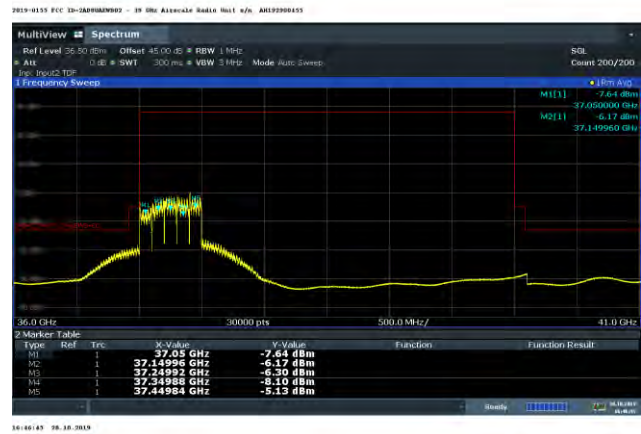
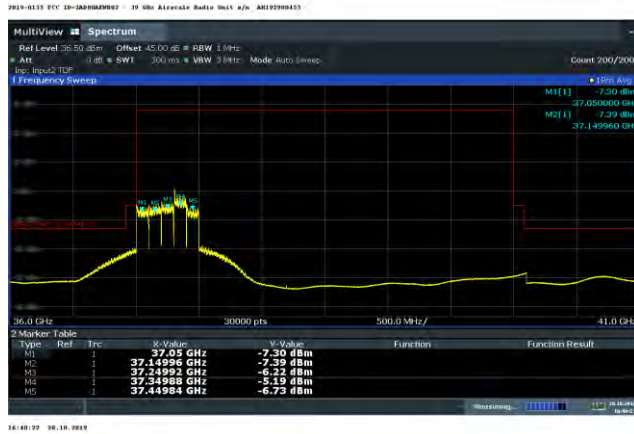
The results of the Occupied Bandwidth/ Edge-of-Band measurements document that the Out-Of-Band Emissions from 35 GHz to 42 GHz are compliant. The Plots and Table 3.3.7.1 demonstrate the full compliance with the Rules of the Commission for the UMFUS 39 GHz operating band.

Table 3.3.8.1 Results - Occupied Bandwidth-Edge of Block Emissions/ OOB

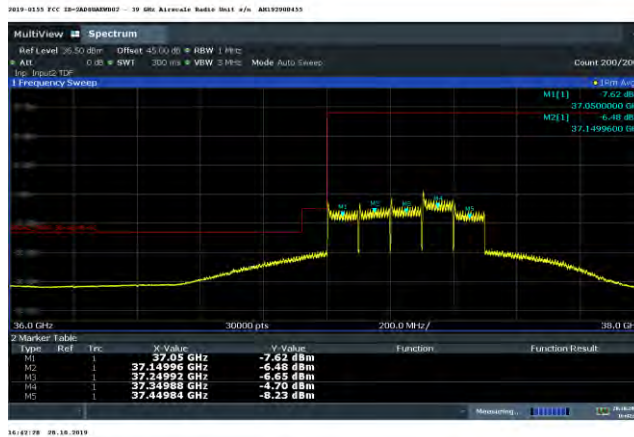
| Carrier Location in Band | Transmit Carriers Center Frequency, GHz | Number of Transmit Carriers | Modulation | Occupied Bandwidth Edge of Block / OOB Compliance | |
|--------------------------|--|-----------------------------|------------|---|-----------|
| | | | | Horizontal | Vertical |
| Left | 37050.00, 37149.96 37249.92, 37349.88 37449.84 | 5 | QPSK | Compliant | Compliant |
| Center | 38149.56, 38249.52 38349.48, 38449.44 38549.40, 38649.36 | 6 | 16QAM | Compliant | Compliant |
| Right | 39349.08, 39449.04 39549.00, 39648.96 39748.92, 39848.88 39948.84 | 7 | 64QAM | Compliant | Compliant |
| Left | 37050.00, 37149.96 37249.92, 37349.88 37449.84, 37549.80 37649.76, 37749.72 | 8 | 64QAM | Compliant | Compliant |
| Center | 38149.56, 38249.52 38349.48, 38449.44 38549.40, 38649.36 38749.32, 38849.28 | 8 | 64QAM | Compliant | Compliant |
| Right | 39249.12, 39349.08 39449.04, 39549.00 39648.96, 39748.92 39848.88, 39948.84 | 8 | 64QAM | Compliant | Compliant |

Figure 3.3.8.1a - Occupied Bandwidth - OOB/EoB Band Charts 5, 6 & 7 Carrier

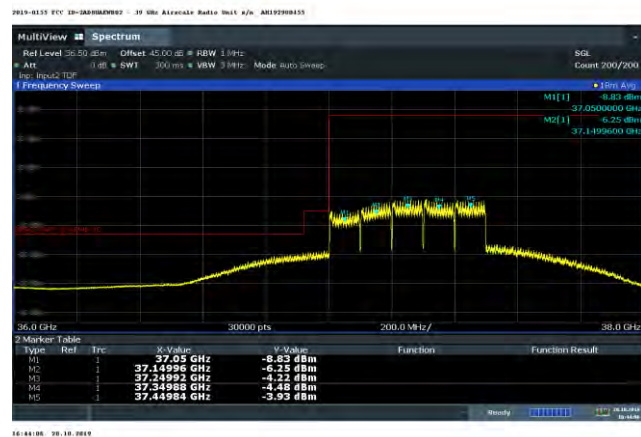
Left Side of Band QPSK 5 Carrier - 37050.00 + 37149.96 + 37249.92 + 37349.88 + 37449.84 MHz
OOB/EoB - H - QPSK.



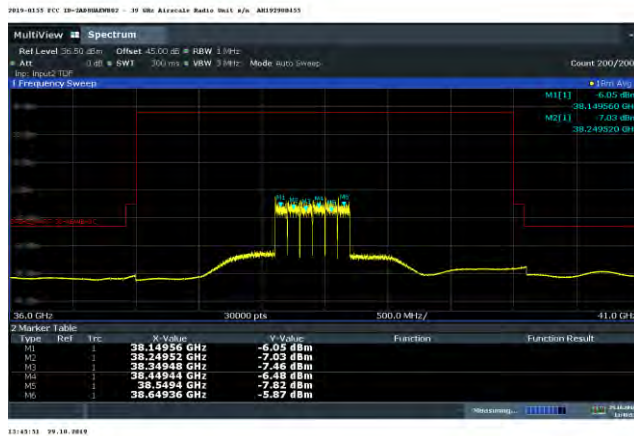
OOB/EoB - H - QPSK -



OOB/EoB - V - QPSK



Middle of Band 16 QAM 6 Carrier
38149.56 + 38249.52 + 38349.48 + 38449.44 + 38549.40 + 38649.36
OOB/EoB - H - 16QAM - 38.49996 GHz.

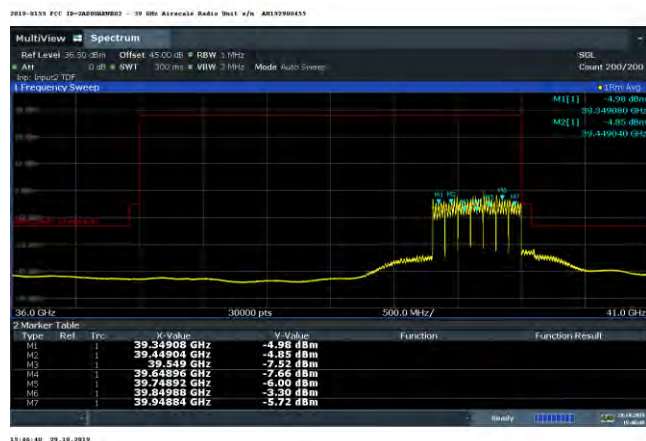


Right Side of Band 64QAM 7 Carrier

39349.08 = 39449.04 = 39549.00 = 39648.96 = 39748.92 = 39848.88 = 39948.84 MHz

OOBE/EoB – H – 64QAM –

OOBE/EoB – V – 64QAM –



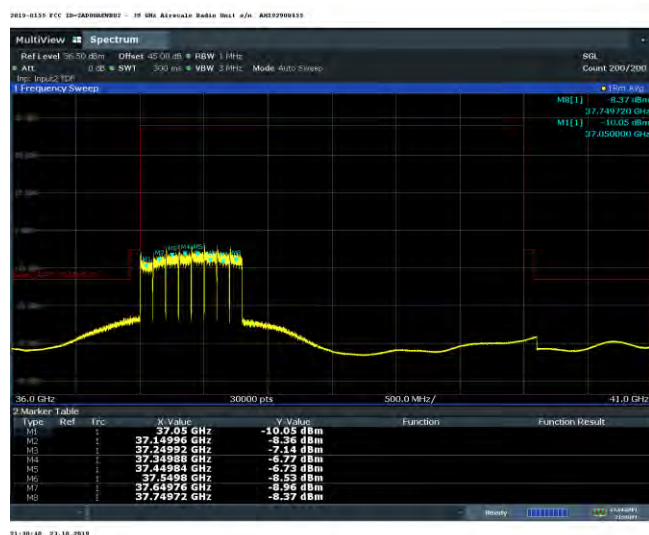
The Occupied Bandwidth and Edge-of-Band emissions measurements were made as a radiated measurement at a distance of 5m

Figure 4.3.8.1b - Occupied Bandwidth - OOB/EoB Band – 8 Carrier

Left Side of Band - 64QAM – 8 Carrier

37050.00 + 37149.96 + 37249.92 + 37349.88 + 37449.84 + 37549.80 + 37649.76 + 37749.72 MHz

Horizontal Polarization



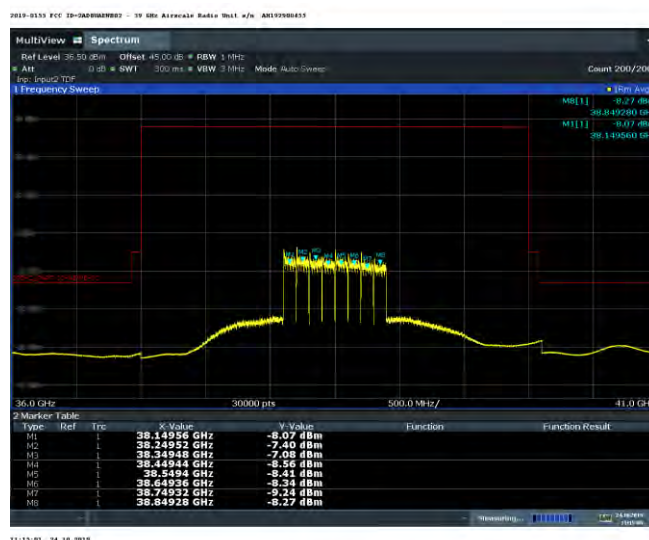
Vertical Polarization



Middle of Band - 64QAM - 8 Carrier

38149.56 + 38249.52 + 38349.48 + 38449.44 + 38549.40 + 38649.36 + 38749.32 + 38849.28 MHz

Horizontal Polarization

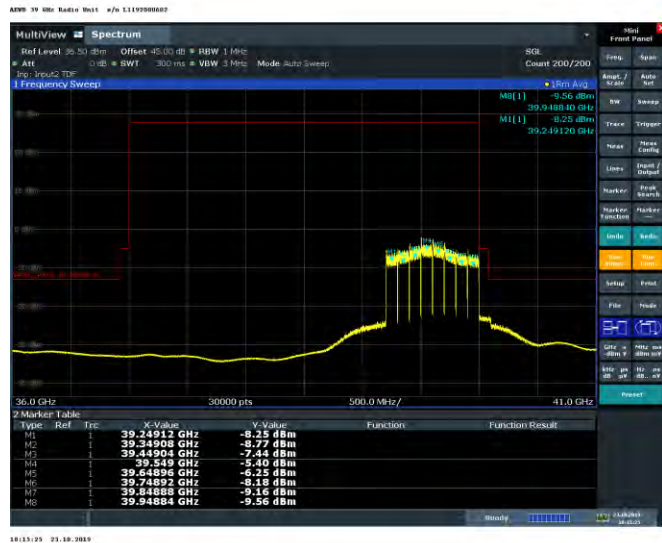


Vertical Polarization



Figure 4.3.8.1b - Occupied Bandwidth - OOBE/EoB Band - Three carrier

Right Side of Band QPSK - 39.75006 GHz + 39.85002 GHz + 39.94998 GHz
Horizontal Polarization



Vertical Polarization



3.4 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.

3.4.1 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.

3.4.2 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 3.3.3, 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.

3.4.3 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 OOB 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 3.5 "*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, KDB 842590 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 $> 2 \times \text{Span/RBW}$. 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.

3.5 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

The field strength measurements of radiated spurious emissions were made in a FCC registered 10 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 **2AD8UAEWB02** (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 3.2. A photograph of this setup is in Exhibit 12 of the filing package and this report.

The base station was configured into the full power forward beam transmit configuration to transmit two 57 dBm EIRP 100 MHz bandwidth 5G-NR carriers, one Vertical and one Horizontal polarization, with the total transmit power of 60 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 3.5.1 EUT Configurations

| Test Configuration NRARFCN | AEWB Tx Reference Frequencies MHz | Transmit Active Polarization | Nominal Signal Bandwidth, MHz | Modulation | Total Power, dBm EIRP | Radiated Emissions Pass / Fail |
|-------------------------------|--|------------------------------------|--|------------|--------------------------------|--------------------------------------|
| 2229999 To 2278332 | 37.05000 To 39.94998 | H & V | 97.5 MHz & 798 MHz | 64QAM | 60 | Pass |

3.5.1 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 $-43+10\text{LogP}=-13$ 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:

$$\begin{aligned} P_{\text{meas}} (\text{dBm}) + \text{Cable Loss}(\text{dB}) + \text{Antenna Factor}(\text{dB}) + 107 (\text{dB}\mu\text{V}/\text{dBm}) - \text{Amplifier Gain} (\text{dB}) \\ = \text{Field Strength} (\text{dB}\mu\text{V}/\text{m}) \end{aligned}$$

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.

$$E = (120\pi P)^{1/2} = [(30 * P)^{1/2}] / R$$
$$20 \log (E * 10^6) - (43 + 10 \log P) = 82.23 \text{ dB } \mu\text{V/meter}$$

Where: E = Field Intensity in Volts/ meter R = Distance in meters = 3 m
 P = Transmitted Power, Watts = 1000 W

The field strength of radiated spurious emissions measured was determined by

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

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 3.5 below. The minimum margins to the Part 30.203 limit is as measured in accordance with 2.1053. The test data follows.

3.5.2 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 4 m 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 ± 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 the 5m AR-4 Chamber, for each band the scan was started at the beam peak location of 20 degrees azimuth, and nominal elevations 186 cm for Vertical and 189 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 20 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.

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

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

3.5.2.2 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 $\geq 2(\text{Span}/\text{RBW})$.

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.

3.5.2.3 Part 30 Limit:

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

3.5.2.4 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.

$$\text{Emissions Correction} = \text{Path Loss} - \text{Antenna Gain}$$

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

Table 4.5.2.4 details the corrections for the three bands.

Table 3.5.2.4a Radiated Emissions Corrections for 40-60 GHz at 4m .

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

Table 3.5.2.4b 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 3.5.2.4c 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 3.5.2.4d 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 |

3.5.3 Field Strength of Spurious Radiation Results:

This product meets Part 15B limits below 1 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 dB μ V/meter. Emissions equal to or less than 62.23 dB μ V/meter are not reportable.

There were reportable emissions below 37 GHz. The minimum margin was 6.23 dB between the noise floor and the 82.23 dB μ V/meter limit at 36191.0 MHz.

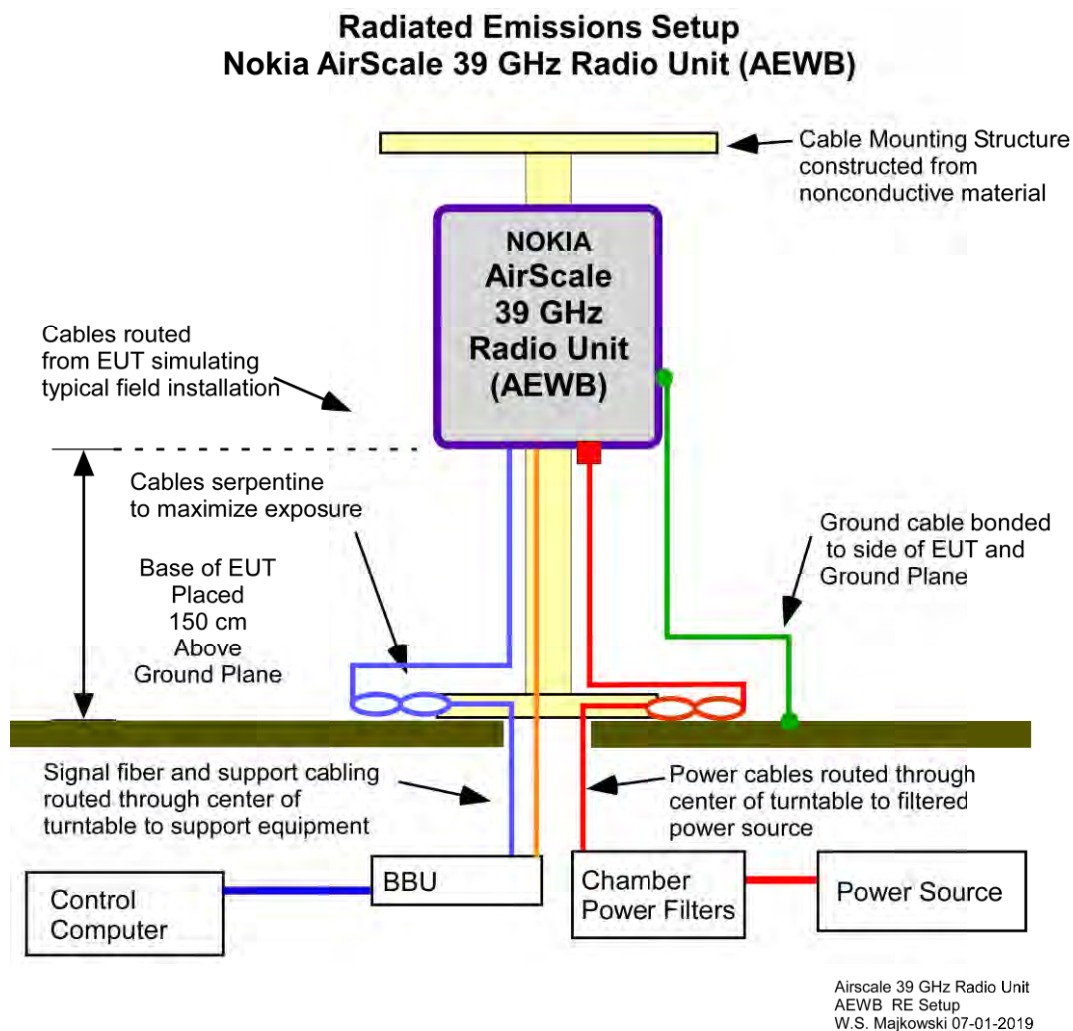
All other emissions below 26.5 GHz were below the Part 30 Non Report 3m limit of 62.23 dB μ V/meter.

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 3.5.2.4.

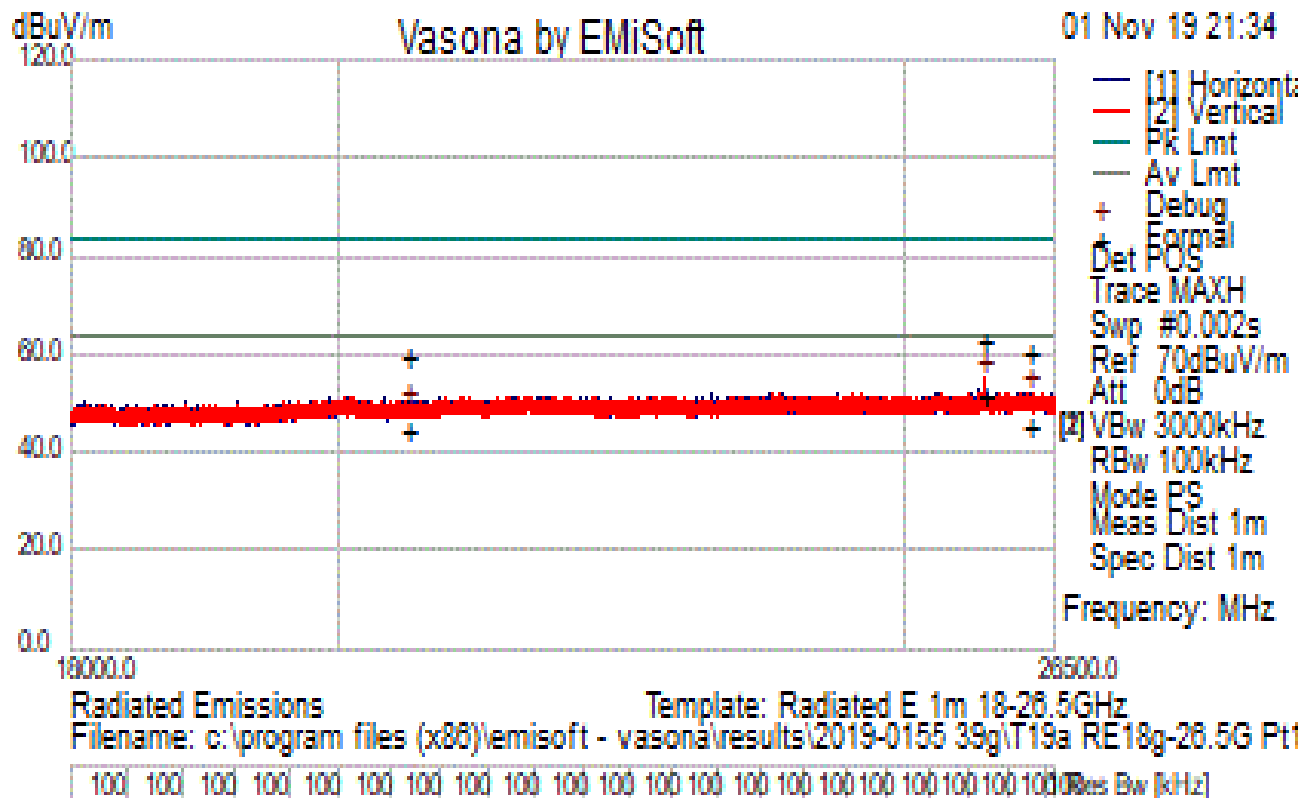
Over the out of band spectrum investigated from 40 GHz to 200 GHz, reportable spurious emissions were detected and determined to be compliant with the Part 30 limit. The minimum margin, measured in the vertical polarization to the noise floor was a margin of 3.13 dB at 128.56386 GHz. Additionally, from 30 MHz to 1 GHz all emissions were a minimum of 12.23 dB below the Part 15 Class B limit.

This demonstrates that the **AirScale 39 GHz Radio Unit (AEWB) Band 30, FCC ID: 2AD8UAEWB02**, 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.

Figure 3.5 Radiated Emissions Product Setup



T19a Radiated Emissions 18 GHz-26.5 GHz- FCC Part 15B @1M



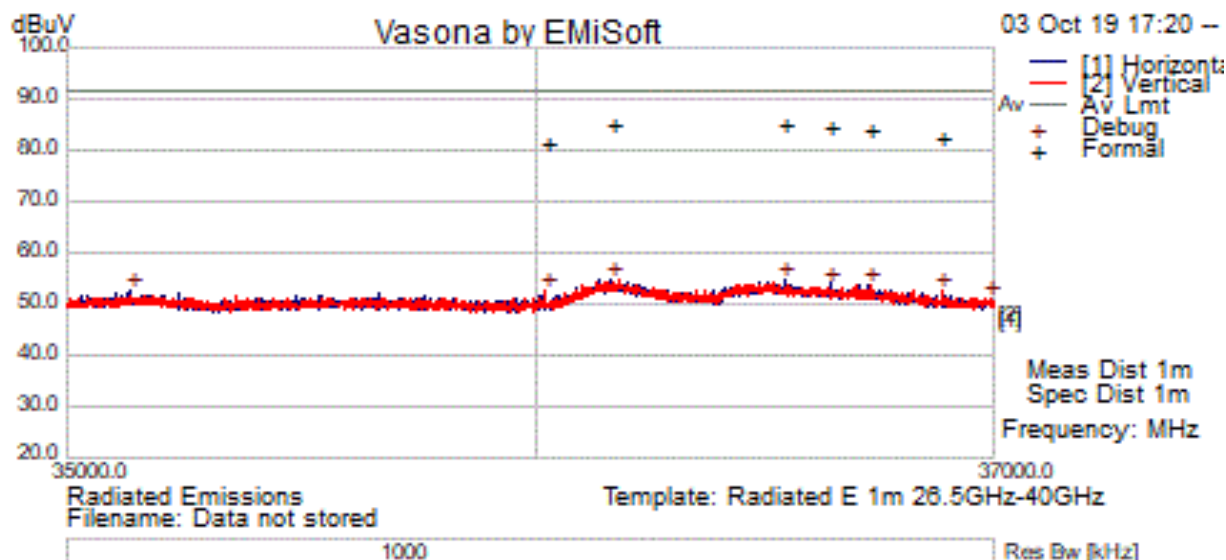
Test Information

| | |
|-----------------|--|
| Results Title | Radiated Emissions 1m 18-26.5 GHz |
| File Name | T19a RE18g-26.5G Pt15b1M Final.emi |
| Test Laboratory | EMiSoft Test Laboratories |
| Test Engineer | MJS |
| Test Software | Vasona by EMIsoft, version 6.061 |
| Equipment | Nokia Wireless Group |
| EUT Details | 2019-0155, FCC ID= 288UAEWB02 - AEWB 39 GHz Air scale Radio Unit, SNAH192900455, w/8C 57.37dBm, Upper Band, total 60 dBm. LMI board disconnected for two formals |
| Configuration | Powered by -48Vdc, 9 Amps, freq- 39.94998GHz, Antenna E520, Notch Filter= E1361 and E1362, FSW=E1387, RE 18GHz - 26.5GHz @1-meter, FCC Part 15 Class B limit. 0 internal attenuation, 100k-RES BW / Default Video BW. Formals 1M / 3M. |
| Date | 2019-11-01 21:34:10 |

Formal Data

| Freq. MHz | Raw dBμV | Cable dB | Factor dB | Level dBμV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBμV/m | Margin dB | Pass /Fail | Comments |
|-----------|----------|----------|-----------|--------------|---------------|---------|--------|----------|--------------|-----------|------------|----------|
| 25781.159 | 49.09 | 19.01 | -5.34 | 62.75 | PeakMax | V | 125 | 6 | 83.50 | -20.75 | Pass | |
| 26227.951 | 46.59 | 19.20 | -5.16 | 60.63 | PeakMax | H | 209 | 34 | 83.50 | -22.87 | Pass | |
| 20557.550 | 49.50 | 16.80 | -6.76 | 59.53 | PeakMax | H | 200 | 284 | 83.50 | -23.97 | Pass | |
| 25781.159 | 38.38 | 19.01 | -5.34 | 52.05 | AvgMax | V | 125 | 6 | 63.50 | -11.45 | Pass | |
| 26227.951 | 31.92 | 19.20 | -5.16 | 45.96 | AvgMax | H | 209 | 34 | 63.50 | -17.54 | Pass | |
| 20557.550 | 34.51 | 16.80 | -6.76 | 44.54 | AvgMax | H | 200 | 284 | 63.50 | -18.96 | Pass | |

T15 Radiated Emissions 35GHz-37GHz FCC Part 30 @1M



Test Information

| | |
|-----------------|--|
| Results Title | Radiated Emissions @1m 35 GHz - 37 GHz |
| File Name | T15 RE35G-37G P30 final 1M.emi |
| Test Laboratory | EMiSoft Test Laboratories |
| Test Engineer | MJS |
| Test Software | Vasona by EMiSoft, version 6.061 |
| Equipment | Nokia Wireless Group |
| EUT Details | 2019-0155, FCC ID= 288UAEWB02 - AEWB 39 GHz Air scale Radio Unit, SNAH192900455, w/8C 57.37dBm, total 60 dBm. |
| Configuration | Powered by -48Vdc, 9 Amps, freq- 39.94996 GHz-Top of band, Antenna A-INFO E1373, Notch Filter= E1361, FSW=E1260, RE 35 -37GHz @1 m, FCC Part 30, 1 meter, 10 internal attenuation, 1M-RES BW / Default Video BW. |
| Date | 2019-10-03 17:31:46 |

Formal Data

| Freq. MHz | Raw dBμV | Cable dB | Factor dB | Level dBμV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBμV/m | Margin dB | Pass /Fail | Comments |
|-----------|----------|----------|-----------|--------------|---------------|---------|--------|----------|--------------|-----------|------------|----------|
| 36162.000 | 30.92 | 17.54 | 37.02 | 85.48 | AvgMax | H | 146 | 146 | 91.77 | -6.29 | Pass | |
| 36540.000 | 29.68 | 18.56 | 37.07 | 85.32 | AvgMax | H | 123 | 53 | 91.77 | -6.45 | Pass | |
| 36640.000 | 28.88 | 18.77 | 37.08 | 84.73 | AvgMax | H | 138 | 326 | 91.77 | -7.04 | Pass | |
| 36729.000 | 28.19 | 18.95 | 37.09 | 84.23 | AvgMax | V | 111 | 222 | 91.77 | -7.54 | Pass | |
| 36884.000 | 26.95 | 18.80 | 37.11 | 82.85 | AvgMax | V | 155 | 283 | 91.77 | -8.92 | Pass | |
| 36019.000 | 27.35 | 17.30 | 37.00 | 81.65 | AvgMax | V | 152 | 314 | 91.77 | -10.12 | Pass | |

Preview Data

| Freq. MHz | Raw dBμV | Cable dB | Factor dB | Level dBμV/m | Emission Type | Pol H/V | Ht. cm | Az. Deg. | Limit dBμV/m | Margin dB | Pass /Fail | Comments |
|-----------|----------|----------|-----------|--------------|---------------|---------|--------|----------|--------------|-----------|------------|----------|
| 36162.000 | 0.24 | 17.54 | 37.02 | 54.80 | Debug | H | 100 | 66 | 91.77 | -36.97 | Pass | |
| 36540.000 | -0.98 | 18.56 | 37.07 | 54.65 | Debug | H | 100 | 330 | 91.77 | -37.12 | Pass | |
| 36640.000 | -1.88 | 18.77 | 37.08 | 53.97 | Debug | H | 200 | 286 | 91.77 | -37.80 | Pass | |
| 36729.000 | -2.35 | 18.95 | 37.09 | 53.69 | Debug | V | 100 | 264 | 91.77 | -38.08 | Pass | |
| 36884.000 | -3.20 | 18.80 | 37.11 | 52.71 | Debug | V | 200 | 220 | 91.77 | -39.06 | Pass | |
| 36019.000 | -1.62 | 17.30 | 37.00 | 52.68 | Debug | V | 200 | 88 | 91.77 | -39.09 | Pass | |
| 35134.000 | -1.38 | 17.03 | 36.85 | 52.51 | Debug | H | 100 | 44 | 91.77 | -39.26 | Pass | |
| 36992.000 | -4.56 | 18.64 | 37.12 | 51.20 | Debug | H | 150 | 22 | 91.77 | -40.57 | Pass | |

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

Vertical Polarization - 1 MHz RBW - 342 degree Azimuth; 1.93m Elevation

2019-0155 FCC-ID 2AD8UAEWB02 SHA1192900455



Horizontal Polarization - 1 MHz RBW - 341 degree Azimuth; 1.91m Elevation

2019-0121 28 GHz AEWB/AEWE s/n L1192413253, L1192304478

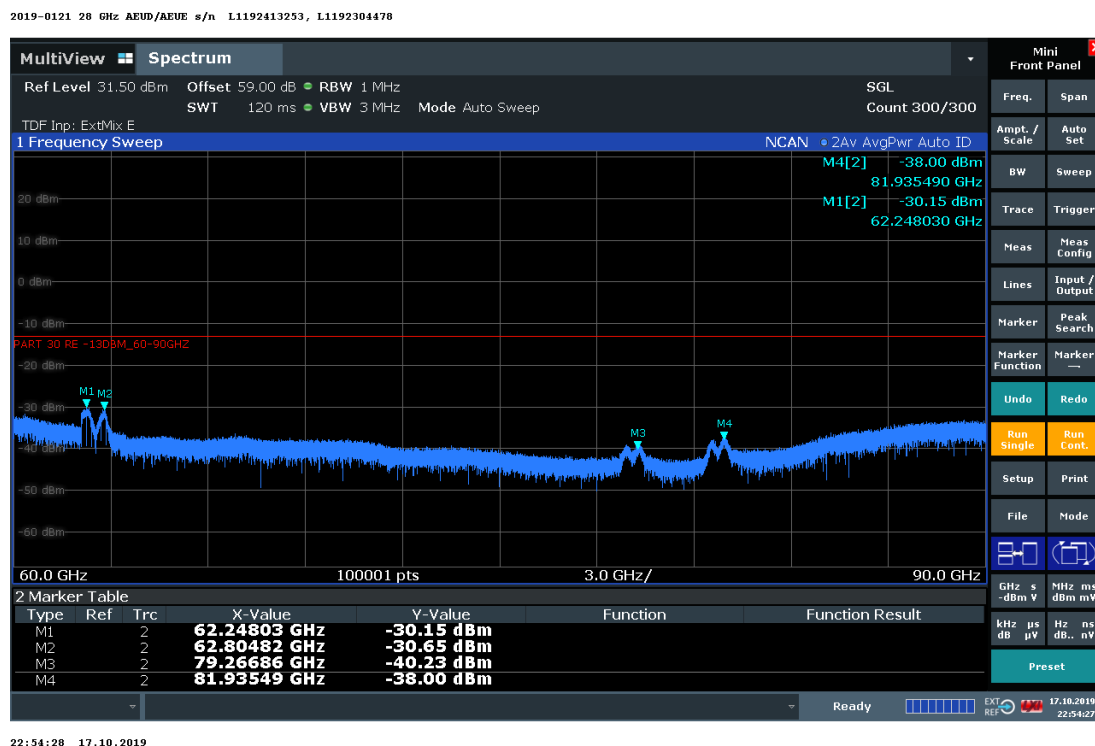


3.5.6 Maximum Radiated Emissions -E Band 60GHz-90GHz - 4m

Vertical Polarization - 1 MHz RBW - 342 degree Azimuth; 1.93m Elevation



Horizontal Polarization -1 MHz RBW - 341 degree Azimuth; 1.91m Elevation



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

Vertical Polarization - 1 MHz RBW - 342 degree Azimuth; 1.93m Elevation

2019-0155 FCC-ID 2AD8UAEWB02 SHAH192900455



Horizontal Polarization -1 MHz RBW - 341 degree Azimuth; 1.91m Elevation

2019-0155 FCC-ID 2AD8UAEWB02 SHAH192900455



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

Vertical Polarization - 1 MHz RBW - 342 degree Azimuth; 1.93m Elevation

2019-0121 28 GHz AEWB/AEUE s/n L1192413253, L1192304478



00:43:45 18.10.2019

Horizontal Polarization -1 MHz RBW - 341 degree Azimuth; 1.91m Elevation

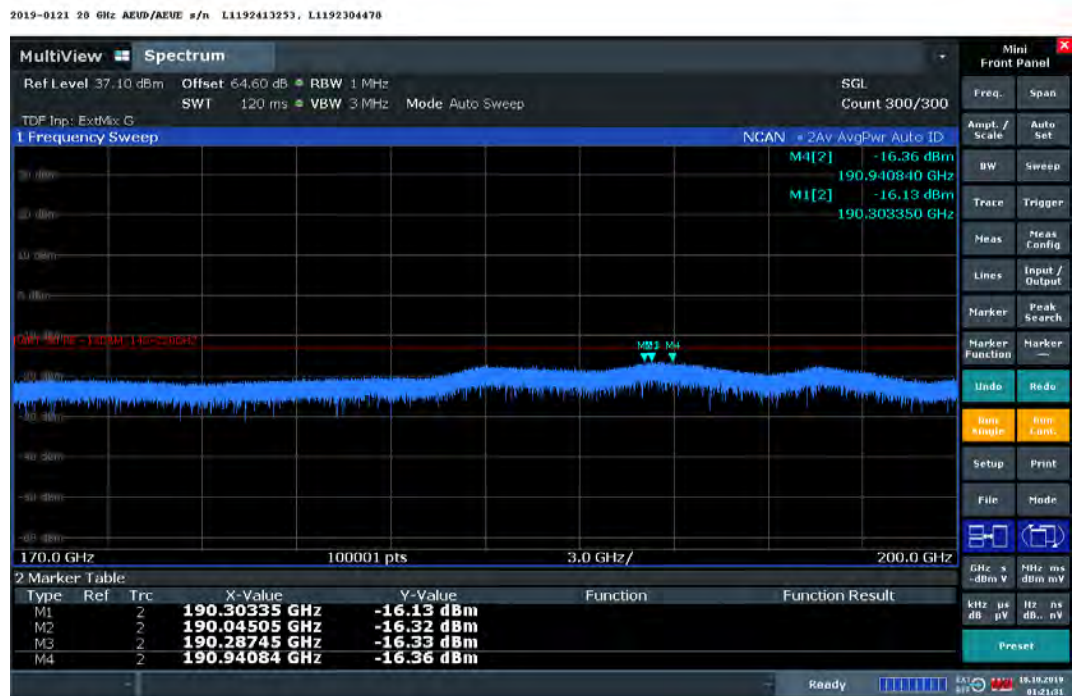
2019-0155 FCC-ID: 2AD8UAEWB02 SHAH192900455



20:10:04 18.10.2019

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

Vertical Polarization - 1 MHz RBW - 342 degree Azimuth; 1.93m Elevation



01:21:32 18.10.2019

Horizontal Polarization -1 MHz RBW - 341 degree Azimuth; 1.91m Elevation



01:37:19 18.10.2019

3.6 Section 2.1055 MEASUREMENT REQUIRED: FREQUENCY STABILITY N/A

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.

3.6.1 Frequency Stability Test – N/A

There was no change to the Frequency Generating and stabilizing portions of the product. Frequency stability testing is therefore not required.

3.7 LIST OF TEST EQUIPMENT

3.7.1 Test Equipment Used For Radiated Emissions and Radio Measurements

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

Table 3.7.1a Radiated Emissions and Radio Measurements

| Asset ID | Manufacturer | Type | Description | Model | Serial | Cal Date | Cal Due | Cal Type |
|------------------------|--|----------------------|---|------------------|------------|--|------------|----------------------|
| E1328 | A-Info | Horn Antenna | 26.5-40GHz WR28 dB | LB-28-25-C2-KF | J202023250 | 2018-10-16 | 2021-10-16 | Requires Calibration |
| E1363 | A-Info | Horn Antenna | 26.5-40GHz WR28 dB | LB-28-25-C2-KF | J202062675 | 2018-10-16 | 2021-10-16 | Requires Calibration |
| E1373 | A-Info | Horn Antenna | 26.5-40GHz WR28 dB | LB-28-25-C2-KF | J202062735 | 2018-12-05 | 2021-12-05 | Requires Calibration |
| E1338r | KeySight Technologies | MXA Signal Analyzer | 10 Hz–44 GHz | N9020B | MY57431033 | 2018-08-2 | 2020-08-22 | Requires Calibration |
| E1264 | KeySight Technologies | PSG Signal Generator | Analog Sig Gen 100kHz-67 GHz | E8257D | MY53402943 | 2017-08-28 | 2019-08-28 | Requires Calibration |
| E1308 | Rohde & Schwarz | Harmonic Mixer | Down Converter 90-140GHz | FS-Z140 | 101008 | 2017-04-06, Put in service 2018-07-01 | | Factory |
| E1311 | Rohde & Schwarz | Harmonic Mixer | Down Converter 40-60GHz | FS-Z60 | 100977 | 2017-12-21, Put in service 2018-07-01 | | Factory |
| E1312 | Rohde & Schwarz | Harmonic Mixer | Down Converter 60-90GHz | FS-Z90 | 101719 | 2017-08-09, in Put in service 2018-07-01 | | Factory |
| E1313 | Rohde & Schwarz | Harmonic Mixer | Down Converter 140-220GHz | FS-Z220 | 100960 | 2017-08-09 in Put in service 2018-07-01 | | Factory |
| E1315 | RS Microwave Company, Inc. | Microwave Filter | | P/N 60733A | 007 | 2018-01-17, Put in service 2018-07-01 | | Verification |
| E1H69 | Rohde & Schwarz | Test Receiver | 20 Hz-40 GHz | ESU40 | 100247 | 2018-05-22 | 2020-05-22 | Requires Calibration |
| E1260 | Rohde & Schwarz | Spectrum Analyzer | 2 Hz - 67 GHz | FSW67 | 104007 | 2018-02-12 | 2020-02-12 | Requires Calibration |
| E1384 | Rohde & Schwarz | Spectrum Analyzer | 2 Hz - 85 GHz | FSW85 | 101537 | 2018-12-17 | 2020-12-17 | Requires Calibration |
| E1323 | Mi-Wave Millimeter Wave Products, Inc. | Horn Antenna | G-band pyramidal horn antenna 25dB 140 - 220 GHz | 261G-25/387 | | Put in service 2018-07-01 | | Factory |
| E1330 | Sage Millimeter, Inc. | Horn Antenna | U-band pyramidal horn antenna - 40 to 60 GHz | SAR-2309-19-S2 | 14853-01 | Put in service 2018-07-01 | | Factory |
| E1331 | Sage Millimeter, Inc. | Horn Antenna | U-band pyramidal horn antenna - 40 to 60 GHz | SAR-2309-19VF-R2 | 14853-01 | Put in service 2018-07-01 | | Factory |
| E1332 | Sage Millimeter, Inc. | Horn Antenna | E-band pyramidal horn antenna - 60 to 90 GHz. | SAR-2309-12-S2 | 14853-01 | Put in service 2018-07-01 | | Factory |
| E1335 | Sage Millimeter, Inc. | Horn Antenna | F-band pyramidal horn antenna - 90 to 140 GHz | SAR-2309-08-S2 | 14853-02 | Put in service 2018-07-01 | | Factory |
| E1340 | Sage Millimeter, Inc. | Horn Antenna | Ka band pyramidal horn antenna - 26.5 to 40 GHz, 25 dB gain | SAR-2507-28-S2 | 15309-01 | Put in service 2018-07-01 | | Factory |

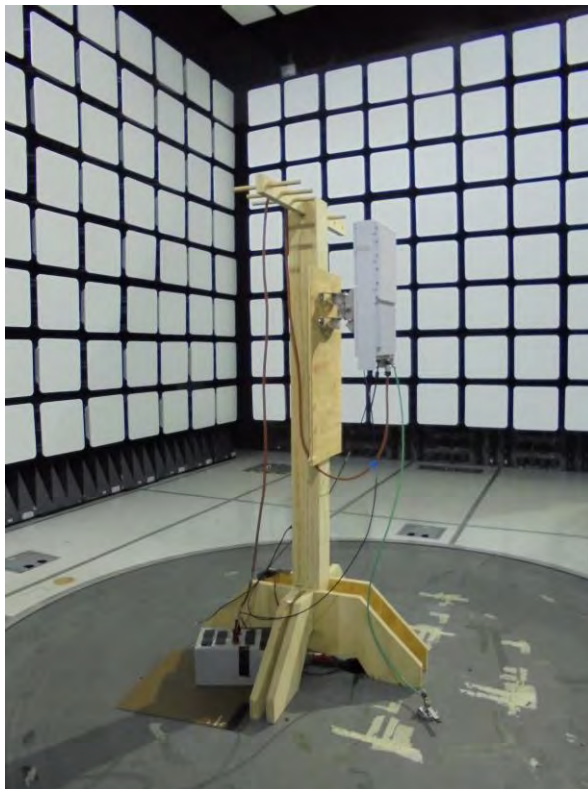
Table 3.7.1b Radiated Emissions and Radio Measurements

| Asset ID | Manufacturer | Type | Description | Model | Serial | Cal Date | Cal Due | Cal Type |
|-----------------------|-----------------------|-------------------------|--|---------------|------------|------------|------------|--------------------------|
| 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 0.01-2 GHz | 10LC1790-3-AA | PCS-LPF-12 | 2019-06-21 | 2020-06-21 | Verification |
| E889 | Weinschel | Attenuator | 6 dB DC-18GHz 5 Watt | 2-6 | BX3438 | 2018-05-23 | 2020-05-23 | Requires Calibration |
| E766 | A.H. Systems Inc. | Biological Antenna | 25 - 2000 MHz | SAS-521-2 | 457 | 2019-02-13 | 2021-02-13 | Requires Calibration |
| E526 | A.H. Systems Inc. | Horn Antenna | Ridged Horn 26.5 GHz - 40 GHz | SAS-200/573 | 137 | 2017-10-04 | 2019-10-04 | Requires Calibration |
| E1074 | ETS Lindgren | Horn Antenna | Ridged Waveguide Horn 1-18 GHz | 3117 | 00135194 | 2019-05-01 | 2021-05-01 | Requires Calibration |
| E520 | EMC Test Systems | Horn Antenna | Double Ridged Horn 18-40 GHz | 3116 | 2537 | 2018-08-09 | 2020-08-09 | Requires Calibration |
| E1150 | Extech | Data Logger | Pressure Humidity Temp Data Logger | SD700 | Q752767 | 2019-01-16 | 2021-01-16 | 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 – 37 GHz | FLP-3660 | N/A | 2019-06-21 | 2020-06-21 | Verification |
| E1260 | Rohde & Schwarz | Spectrum Analyzer | FSW signal and spectrum analyzer 2 Hz – 67 GHz | FSW67 | 104007 | 2018-02-12 | 2020-02-12 | Requires Calibration |
| E813 | Sonoma Instrument Co. | Amplifier | 9kHz-1GHz | 310N | 186750 | 2018-09-14 | 2020-09-14 | Requires Calibration |
| E772 | Sunol Sciences Corp | Modular Controller | Tower Controller. | SC104V | 0 | | | Calibration Not Required |
| E1255 | ETS Lindgren | Multi-Device Controller | Turntable Controller | 2090 | 00078509 | | | Calibration Not Required |
| E485 | Kikusui | Power Supply | DC 55 Volts 120 Amps | PAD 55-120L | DL000416 | | | Calibration Not Required |

3.8 PHOTOGRAPHS OF THE TEST SETUPS

Response: The photographs of the test setups for the AirScale 39 GHz Radio Unit (AEWB) Band 30, FCC ID: 2AD8UAEWB02 are below.

3.8.1 Radiated Emissions and Radio Measurements Test Photos



Product Set up AR-8

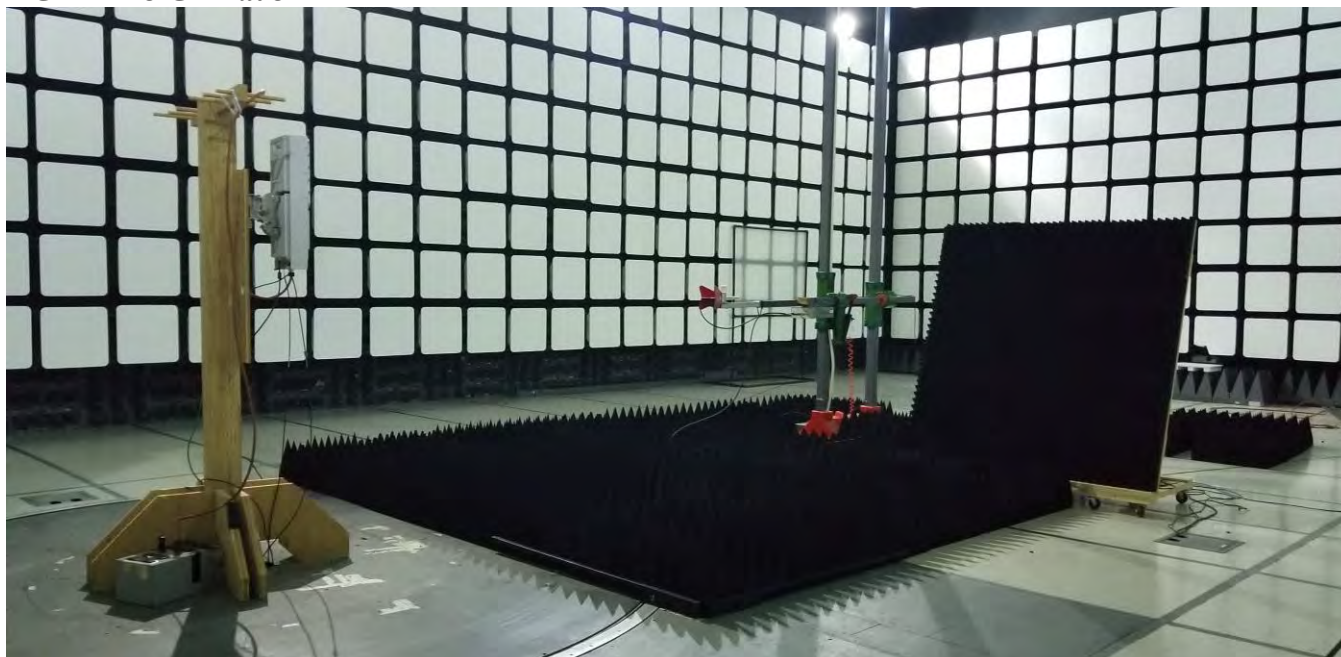
Base of Unit



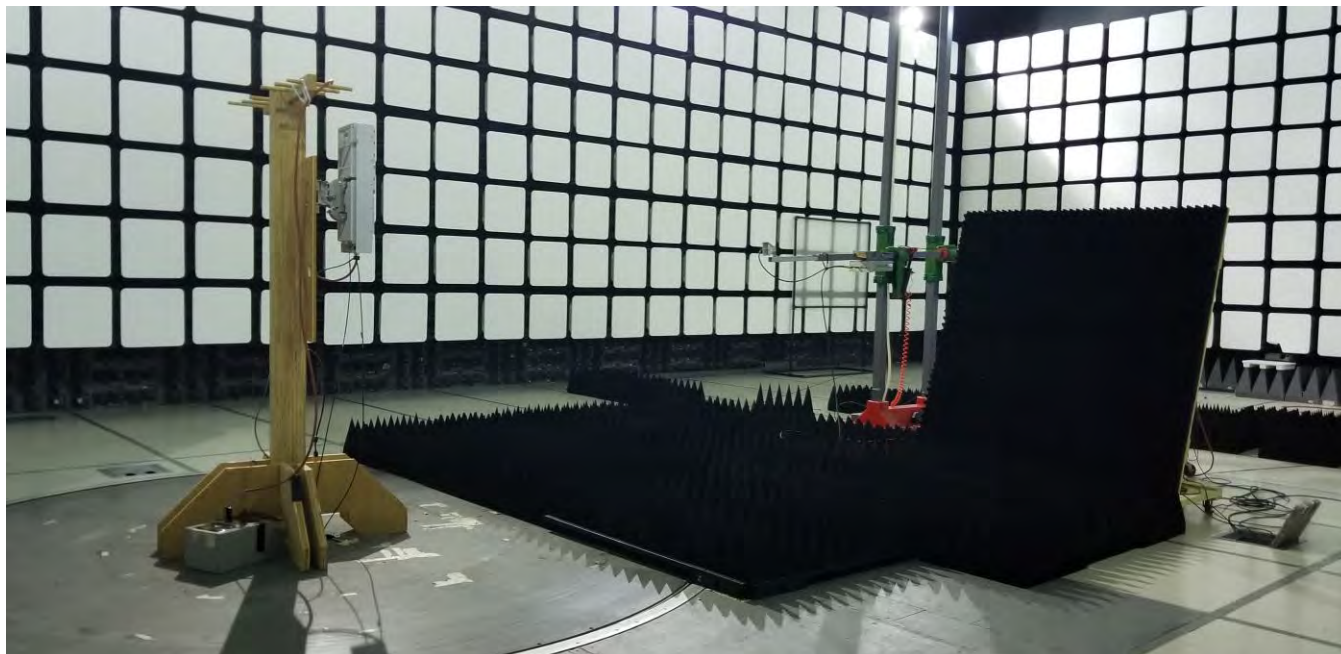
30 MHz- 1 GHz at 3m



1 GHz – 18 GHz at 3m



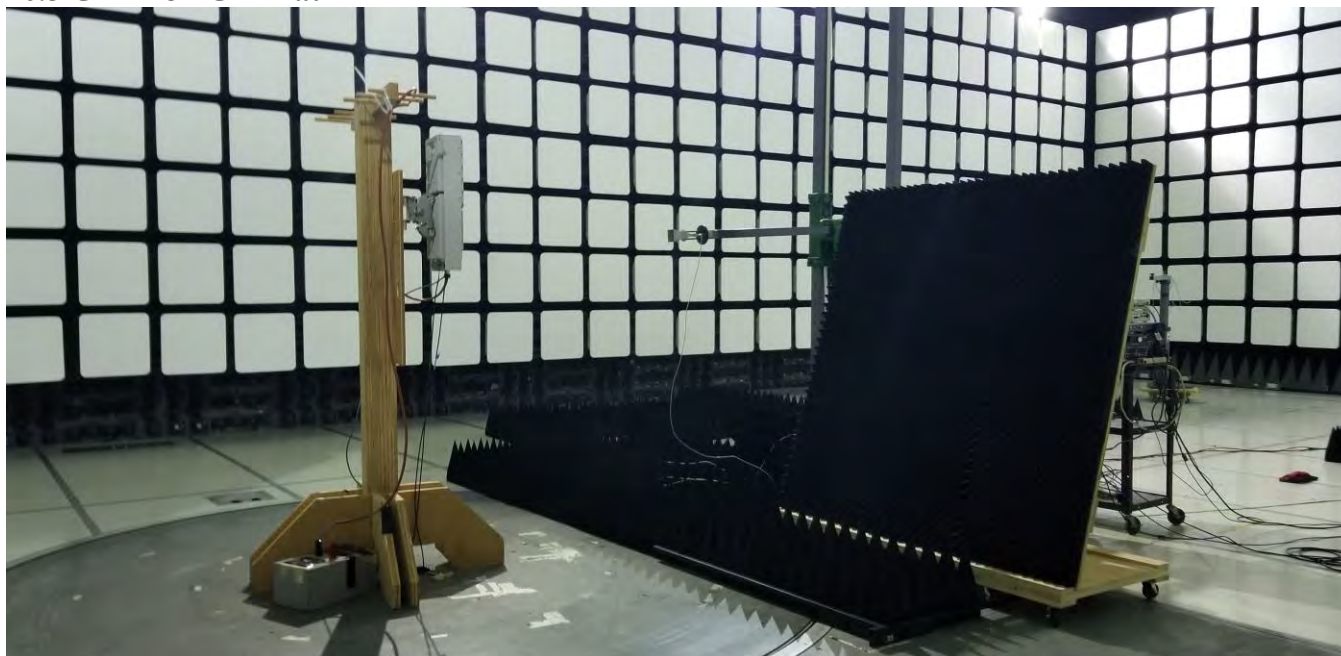
18 GHz – 26.5 GHz at 3m



18 GHz – 26.5 GHz at 1m



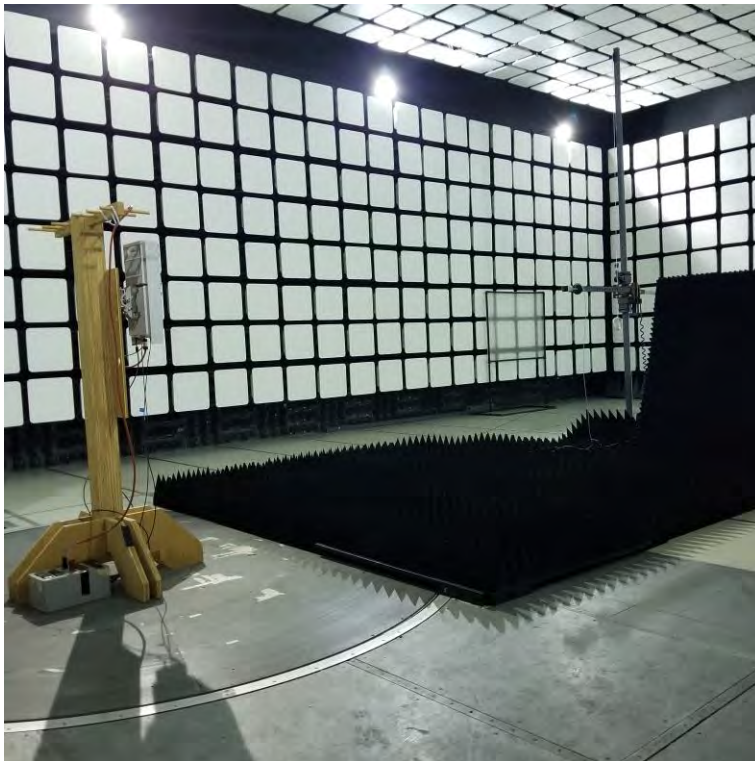
26.5 GHz – 37 GHz at 1m



40 GHz – 60 GHz at 5m



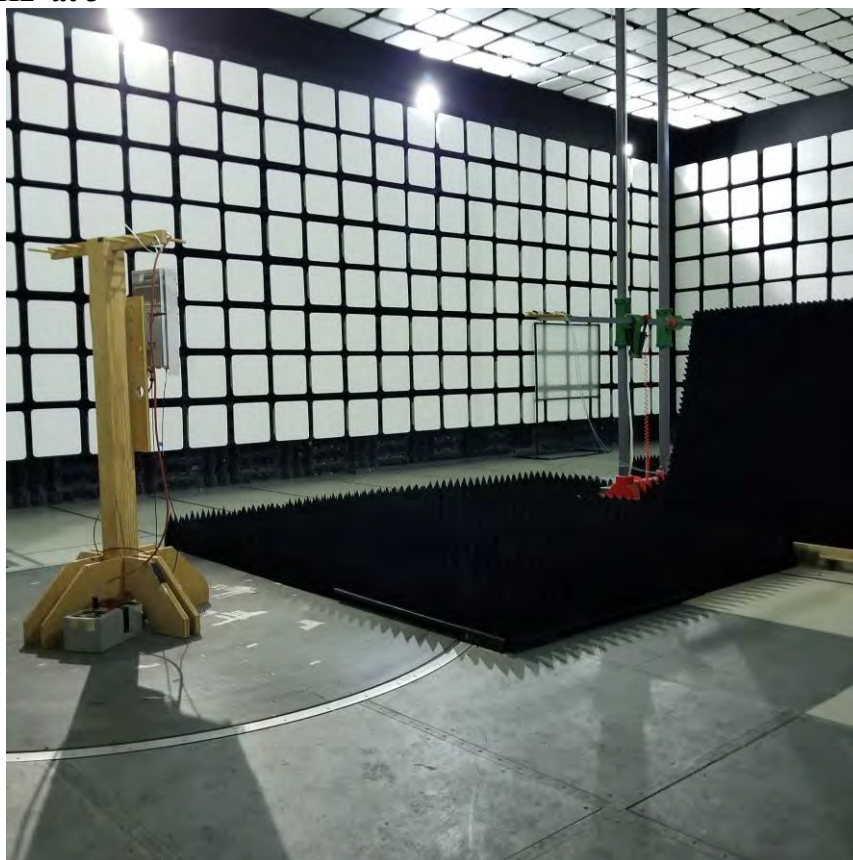
60 GHz – 90 GHz at 4m



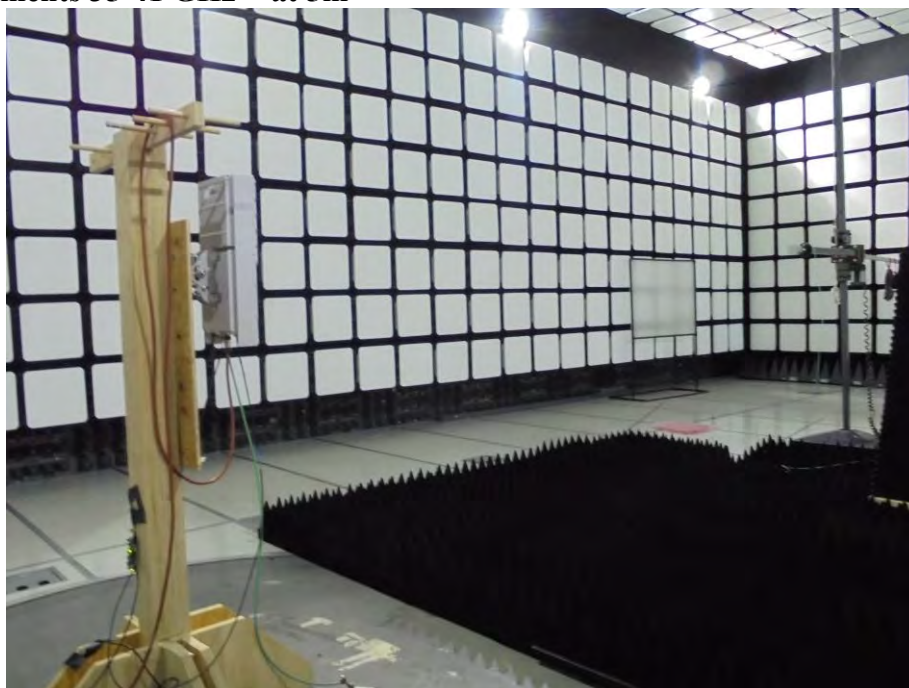
90 GHz – 140 GHz at 3



140 GHz – 200 GHz at 3



Radio Measurements 35-41 GHz at 5m



Support and Radio Measurements Control Room



3.9 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®num_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.



4. APPENDIX A - CALIBRATION CERTIFICATES.

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



Calibration Certificate

Kalibrierschein

Certificate Number 24-0060-100977-01

Zertifikatsnummer

Unit Data

Item
Gegenstand Harmonic Mixer, 40 GHz to 60 GHz

Manufacturer
Hersteller RPG

Type
Typ RPG FS-Z60

Material Number
Materialnummer 1048.0171.02

Serial Number
Seriennummer 100977

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2017-12-21

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance
(Incoming)
Konformitätsaussage
(Anlieferung)

New device

Statement of Compliance
(Outgoing)
Konformitätsaussage
(Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

2 pages Calibration Certificate
5 pages Outgoing Results

Radiometer Physics GmbH; Meckenheim

Date of Issue
Ausstellungsdatum

2017-12-21

Head of Laboratory
Laborleitung

Schulze

Person Responsible
Bearbeiter

Wildfang

Page (Seite) 1/2
Vers2010-05-05/
RPG2014-02-28

Calibration Method
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity **20 % - 80 %**
Relative Luftfeuchte

Ambient Temperature
Umgebungstemperatur

(23 ⁺⁷₋₃) °C

Working standards used (having a significant effect on the accuracy)
Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

| Item Gegenstand | Type Typ | Serial Number Seriennummer | Calibration Certificate Number Kalibrierscheinnummer | Cal. Due Kalibr. bis |
|-------------------------|--------------|-------------------------------|---|-------------------------|
| Vector Network Analyzer | R&S® ZVA67 | 101097 | 20-300432406 | 2020-07-21 |
| Powersensor | R&S® NRP-Z55 | 140093 | 20-300426315 | 2018-05-17 |
| Powersensor | R&S® NRP-Z57 | 101423 | 20-541799 | 2019-04-27 |

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes

Anmerkungen

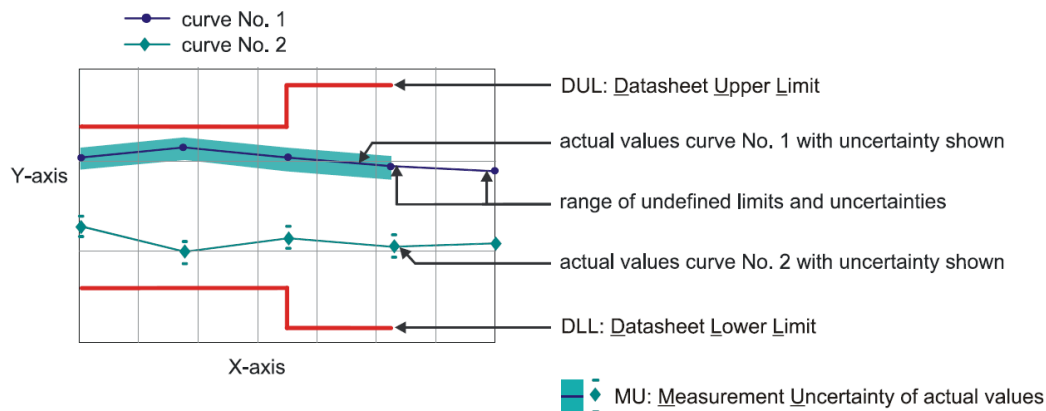
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

| | |
|------------|--|
| {a} | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass. |
| {b} | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c} | Functional test, therefore no measurement uncertainty is stated. |
| {d} | Typical value, refer to performance test. |
| {e} | The measurement uncertainty is taken into account when setting the measuring system. |
| DL or DT | Data Limit for symmetrical tolerance limits |
| DLL | Datasheet Lower Limit |
| DUL | Datasheet Upper Limit |
| MU | Measurement Uncertainty |
| MLL or MLV | Measurement Uncertainty Lower Value |
| MUL or MUV | Measurement Uncertainty Upper Value |
| Nom. | Nominal Value |
| Dev. | Deviation |
| MErr. | Measurement Error |
| Act. | Actual Value |
| UGB | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit. |
| UGB1 | Measurement results marked as UGB1 show conformity with a probability of >50 % and <95 %. |
| UGB2 | Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %. |
| DU | Datasheet Uncertainty |

Explanation of charts



Software used for measurement**Item Type**

Measurement Studio Professional Edition
MixerCertification

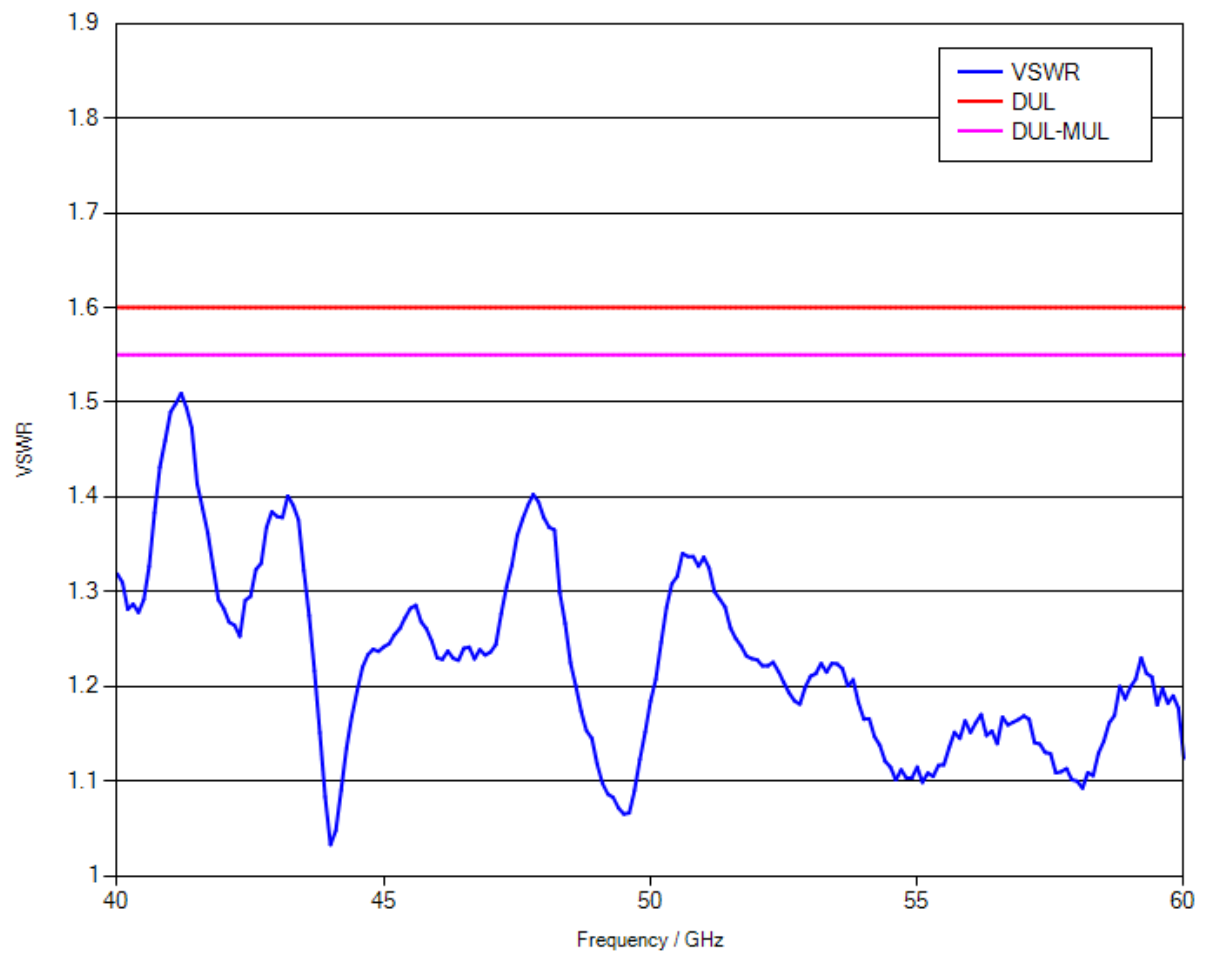
Version

2013
7_07

Remark

1.1 RF Input – VSWR

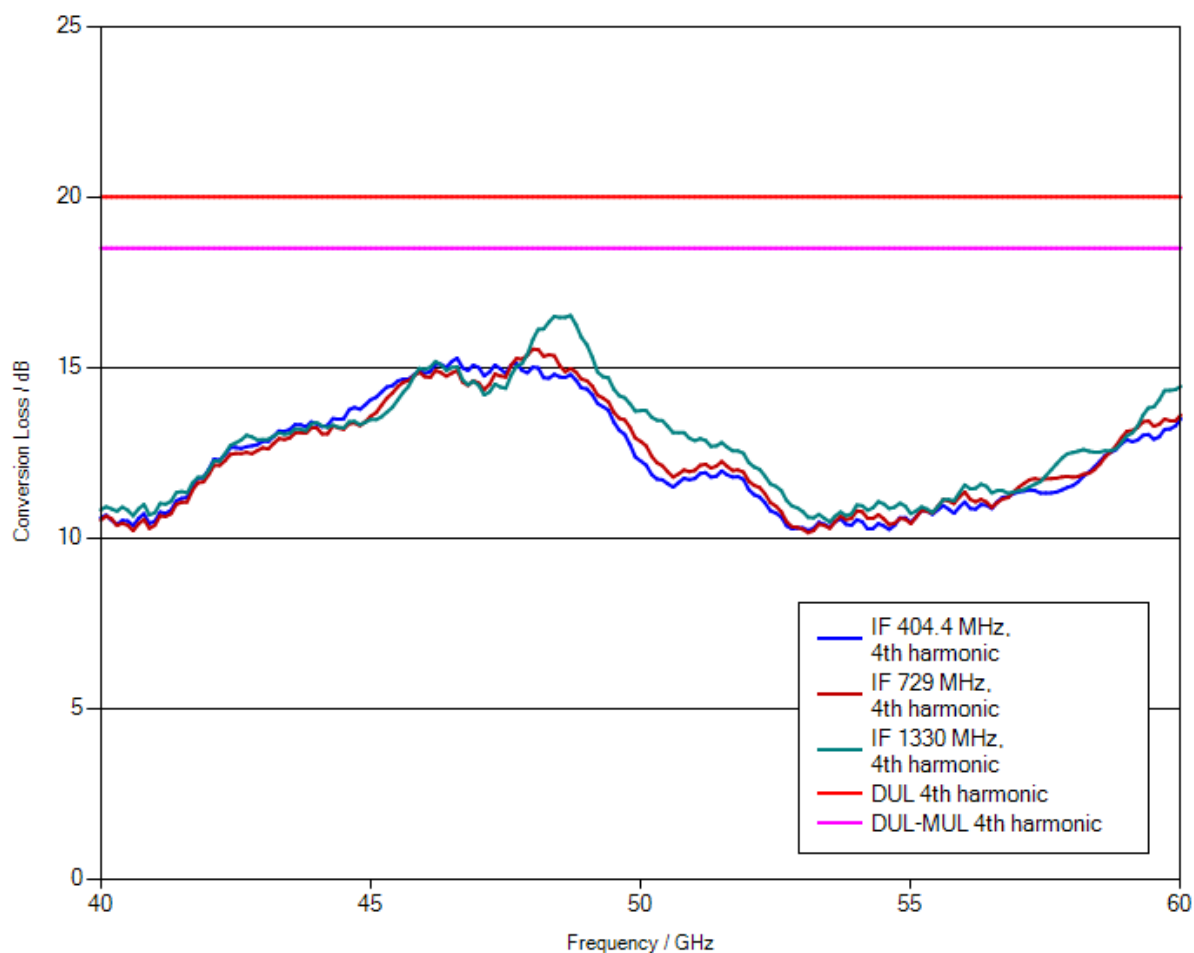
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +13 dBm nominal
Bias 0 A

Measurement uncertainty: 1.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

The file has been renamed for safety reasons.

When downloading the file onto your PC, please delete the “.file” extension and unzip the data.

1.3 Frequency response within 1 GHz

| | DUL | Actual (worst case) | Evaluation |
|---------------------------------|------|------------------------|------------|
| IF = 404.4 MHz, 4th harmonic | 4 dB | 2.02 dB | PASS |
| IF = 729 MHz, 4th harmonic | 4 dB | 1.78 dB | PASS |
| IF = 1330 MHz, 4th harmonic | 4 dB | 2.35 dB | PASS |

Calibration Certificate

Kalibrierschein

Certificate Number **24-0090-101719-01**

Zertifikatsnummer

Unit Data

Item
Gegenstand **Harmonic Mixer, 60 GHz to 90 GHz**

Manufacturer
Hersteller **ROHDE & SCHWARZ**

Type
Typ **R&S® FS-Z90**

Material Number
Materialnummer **1048.0371.02** **Serial Number**
Seriennummer **101719**

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2017-08-09

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance (Incoming)
Konformitätsaussage (Anlieferung)

New device

Statement of Compliance (Outgoing)
Konformitätsaussage (Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

**2 pages Calibration Certificate
5 pages Outgoing Results**

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Radiometer Physics GmbH; Meckenheim

Date of Issue
Ausstellungsdatum

2017-08-11

Head of Laboratory
Laborleitung

Ceru

Person Responsible
Bearbeiter

Heinze

Page (Seite) 1/2
Vers2010-05-05/
RPG2014-02-28

Calibration Method
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity **20 % - 80 %**
Relative Luftfeuchte

Ambient Temperature
Umgebungstemperatur

(23 ⁺⁷₋₃) °C

Working standards used (having a significant effect on the accuracy)
Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

| Item Gegenstand | Type Typ | Serial Number Seriennummer | Calibration Certificate Number Kalibrierscheinnummer | Cal. Due Kalibr. bis |
|-------------------------|--------------|-------------------------------|---|-------------------------|
| Vector Network Analyzer | R&S® ZVA67 | 101097 | 20-300432406 | 2020-07-21 |
| Powersensor | R&S® NRP-Z55 | 140093 | 20-300426315 | 2018-05-17 |
| Powersensor | R&S® NRP-Z58 | 101063 | 20-611482 | 2018-07-21 |
| Calibration kit | WR12 | E10001 | RPG-PAQA-TN-2014-005 | 2019-02-01 |

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes

Anmerkungen

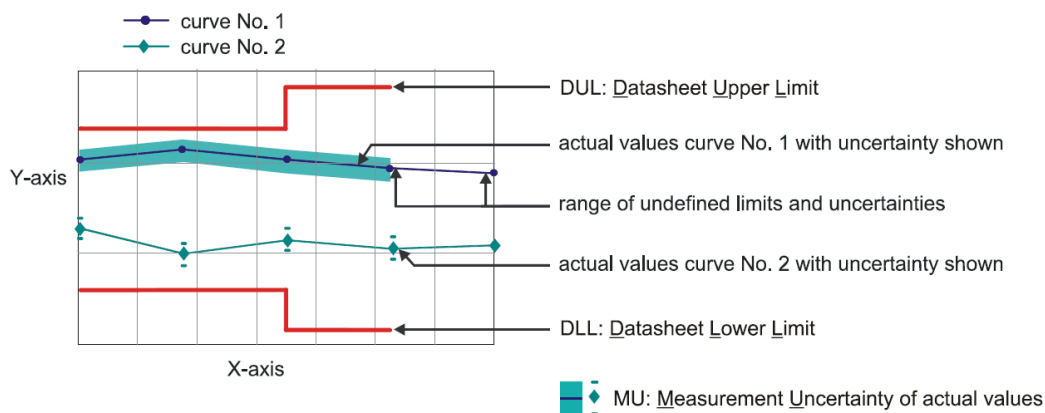
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

| | |
|------------|--|
| {a} | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass. |
| {b} | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c} | Functional test, therefore no measurement uncertainty is stated. |
| {d} | Typical value, refer to performance test. |
| {e} | The measurement uncertainty is taken into account when setting the measuring system. |
| DL or DT | Data Limit for symmetrical tolerance limits |
| DLL | Datasheet Lower Limit |
| DUL | Datasheet Upper Limit |
| MU | Measurement Uncertainty |
| MLL or MLV | Measurement Uncertainty Lower Value |
| MUL or MUV | Measurement Uncertainty Upper Value |
| Nom. | Nominal Value |
| Dev. | Deviation |
| MErr. | Measurement Error |
| Act. | Actual Value |
| UGB | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit. |
| UGB1 | Measurement results marked as UGB1 show conformity with a probability of >50 % and <95 %. |
| UGB2 | Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %. |
| DU | Datasheet Uncertainty |

Explanation of charts



Software used for measurement**Item Type**

Measurement Studio Professional Edition
MixerCertification

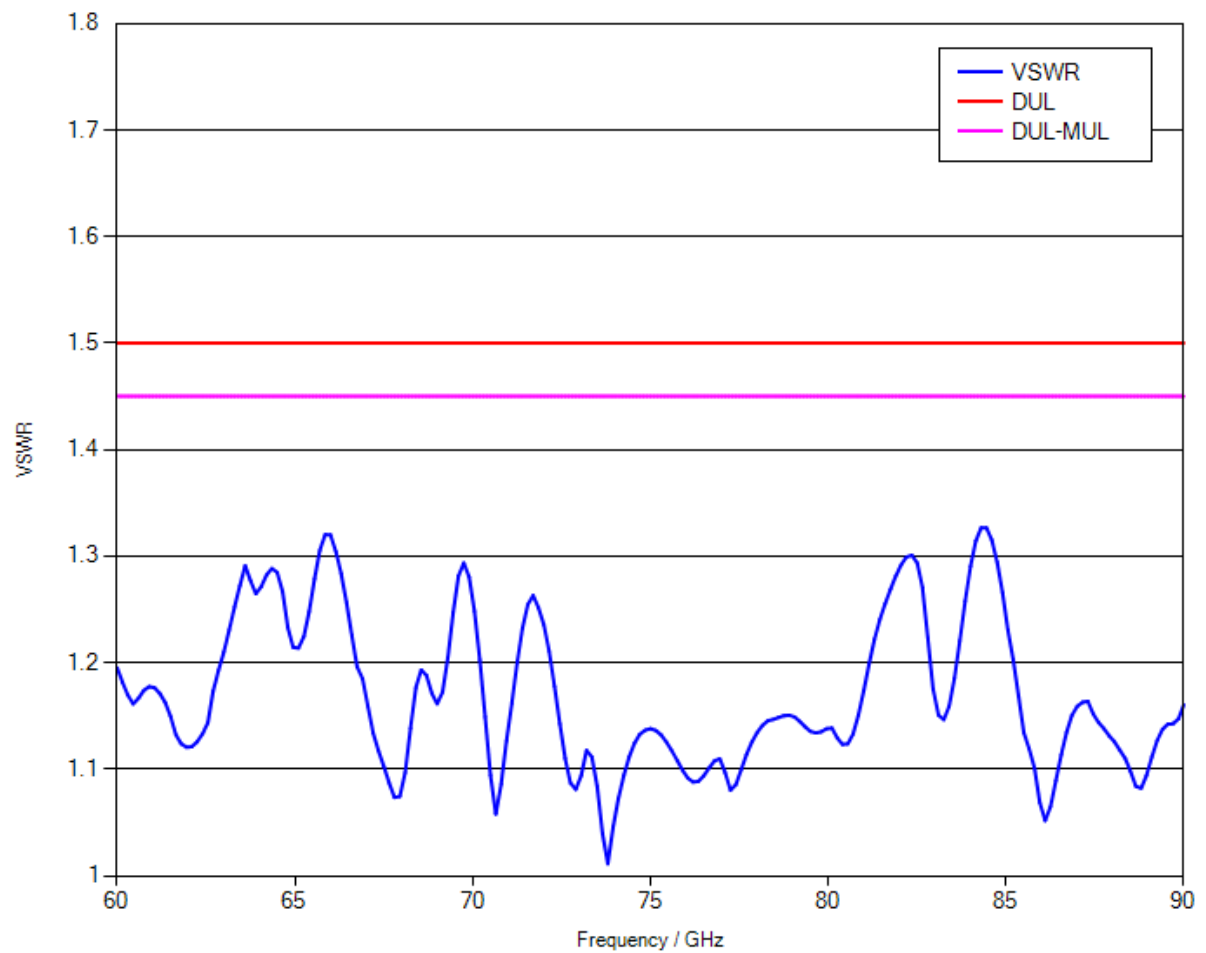
Version

2013
only

Remark

1.1 RF Input – VSWR

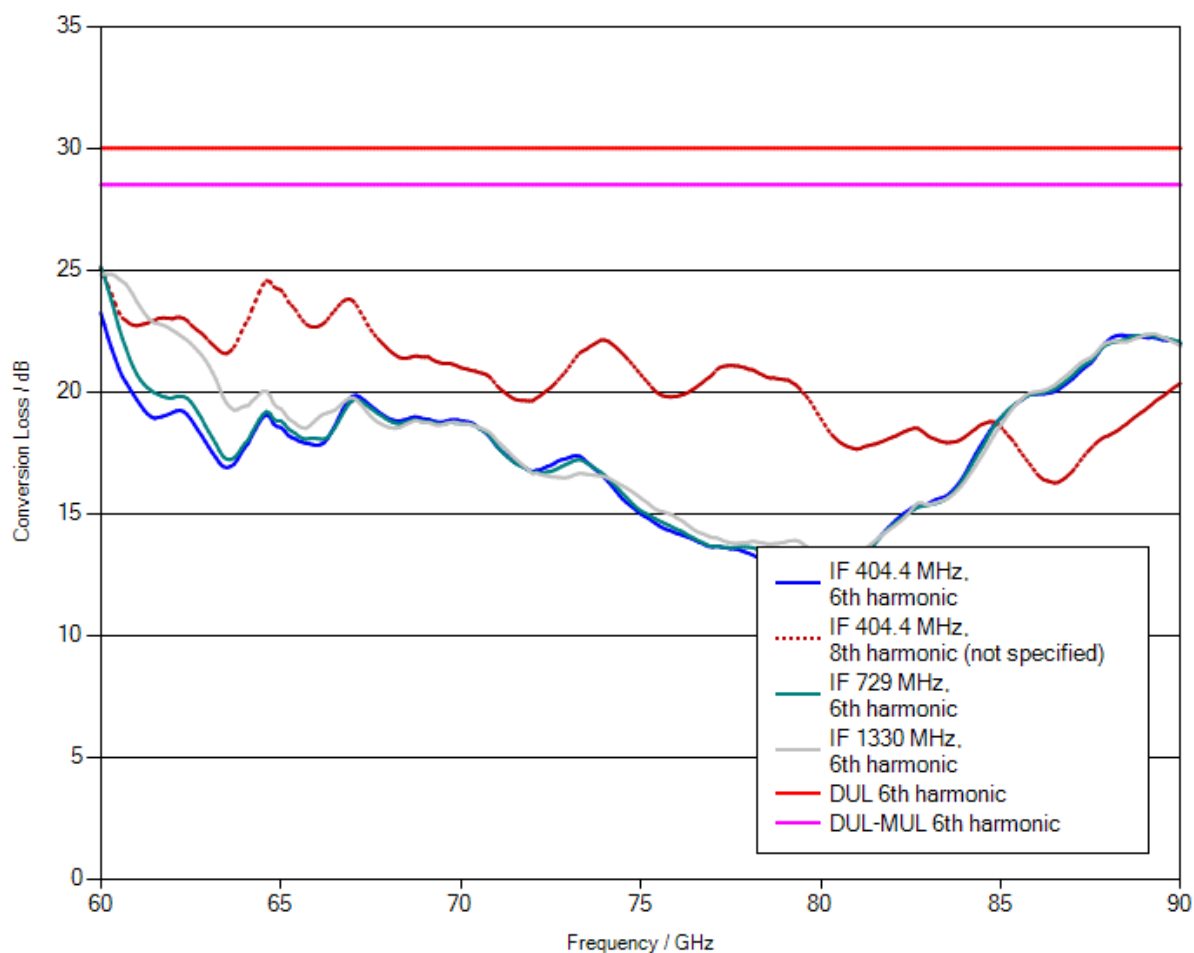
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +14 dBm nominal
Bias 0 A

Measurement uncertainty: 1.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

The file has been renamed for safety reasons.
When downloading the file onto your PC, please delete the “.file” extension and unzip the data.

1.3 Frequency response within 1 GHz

| | DUL | Actual (worst case) | Evaluation |
|---------------------------------|---------------|------------------------|---------------|
| IF = 404.4 MHz, 6th harmonic | 6 dB | 3.33 dB | PASS |
| IF = 404.4 MHz, 8th harmonic | not specified | 2.73 dB | not specified |
| IF = 729 MHz, 6th harmonic | 6 dB | 4.12 dB | PASS |
| IF = 1330 MHz, 6th harmonic | 6 dB | 2.32 dB | PASS |



Calibration Certificate

Kalibrierschein

Certificate Number 24-0140-101008-01

Zertifikatsnummer

Unit Data

Item
Gegenstand
Harmonic Mixer, 90 GHz to 140 GHz

Manufacturer
Hersteller
RPG

Type
Typ
RPG FS-Z140

Material Number
Materialnummer
3622.0708.02

Serial Number
Seriennummer
101008

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2017-04-06

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance
(Incoming)
Konformitätsaussage
(Anlieferung)

New device

Statement of Compliance
(Outgoing)
Konformitätsaussage
(Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

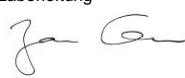
**2 pages Calibration Certificate
5 pages Outgoing Results**

Radiometer Physics GmbH; Meckenheim

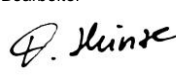
Date of Issue
Ausstellungsdatum

2017-04-07

Head of Laboratory
Laborleitung


Ceru

Person Responsible
Bearbeiter

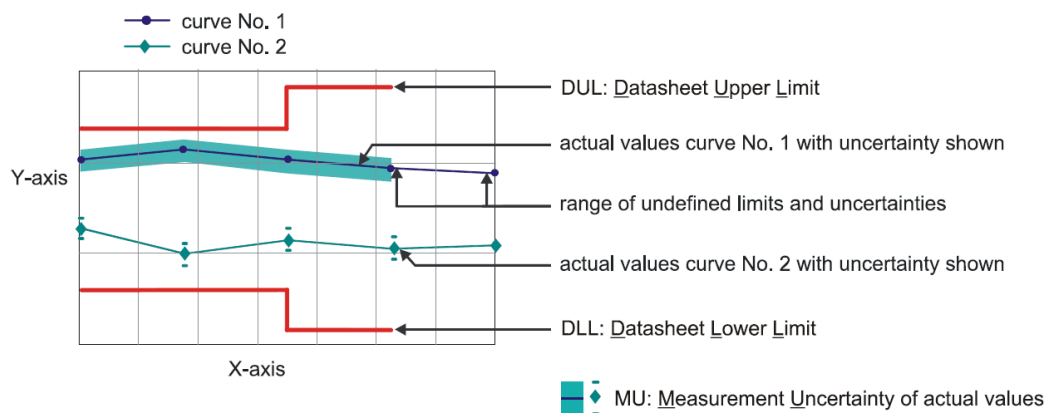

Heinze

Outgoing Results

The following abbreviations may be used in this document

| | |
|------------|--|
| {a} | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass. |
| {b} | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c} | Functional test, therefore no measurement uncertainty is stated. |
| {d} | Typical value, refer to performance test. |
| {e} | The measurement uncertainty is taken into account when setting the measuring system. |
| DL or DT | Data Limit for symmetrical tolerance limits |
| DLL | Datasheet Lower Limit |
| DUL | Datasheet Upper Limit |
| MU | Measurement Uncertainty |
| MLL or MLV | Measurement Uncertainty Lower Value |
| MUL or MUV | Measurement Uncertainty Upper Value |
| Nom. | Nominal Value |
| Dev. | Deviation |
| MErr. | Measurement Error |
| Act. | Actual Value |
| UGB | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit. |
| UGB1 | Measurement results marked as UGB1 show conformity with a probability of >50 % and <95 %. |
| UGB2 | Measurement results marked as UGB2 show non-conformity with a probability of >50 % and <95 %. |
| DU | Datasheet Uncertainty |

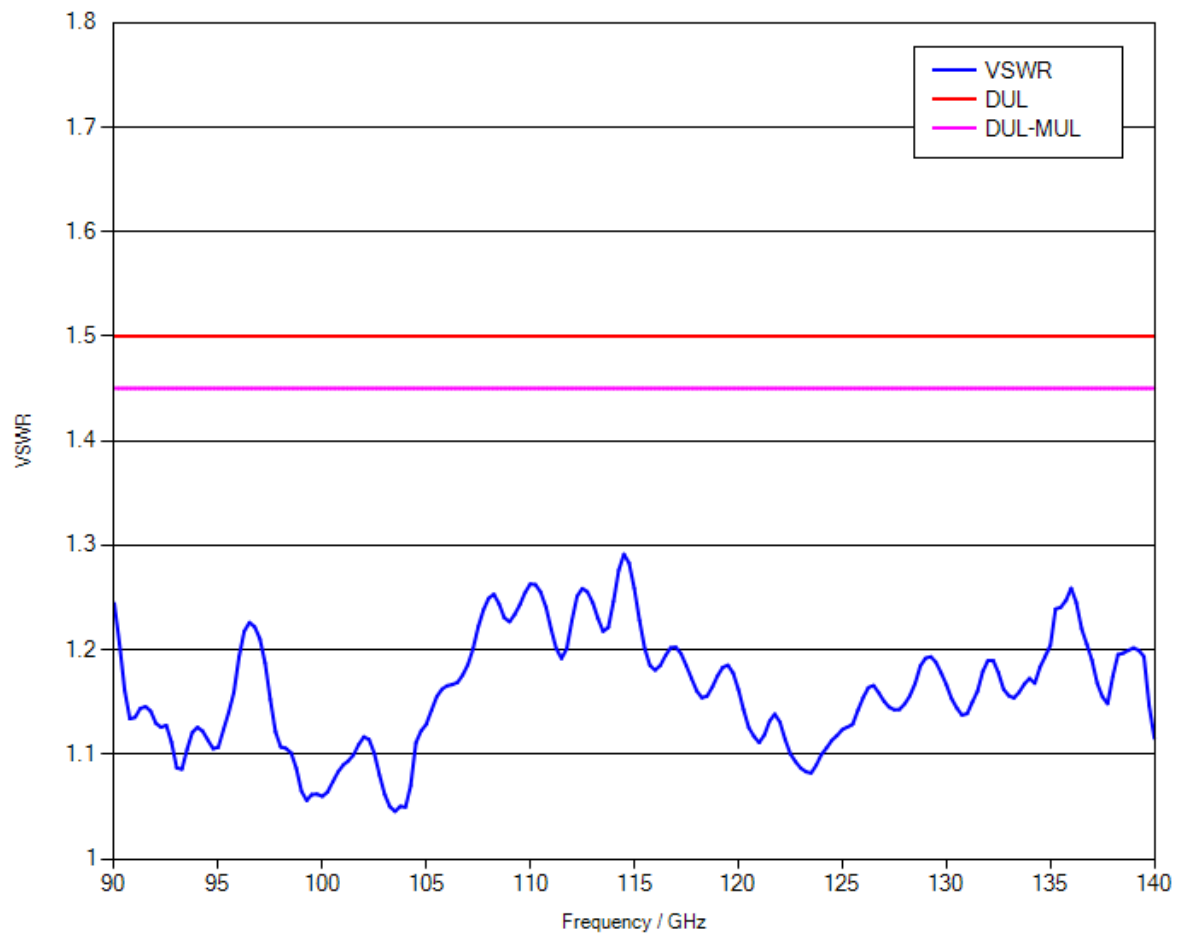
Explanation of charts



Software used for measurement**Item Type**Measurement Studio Professional Edition
MixerCertification**Version**2013
7_04**Remark**

1.1 RF Input – VSWR

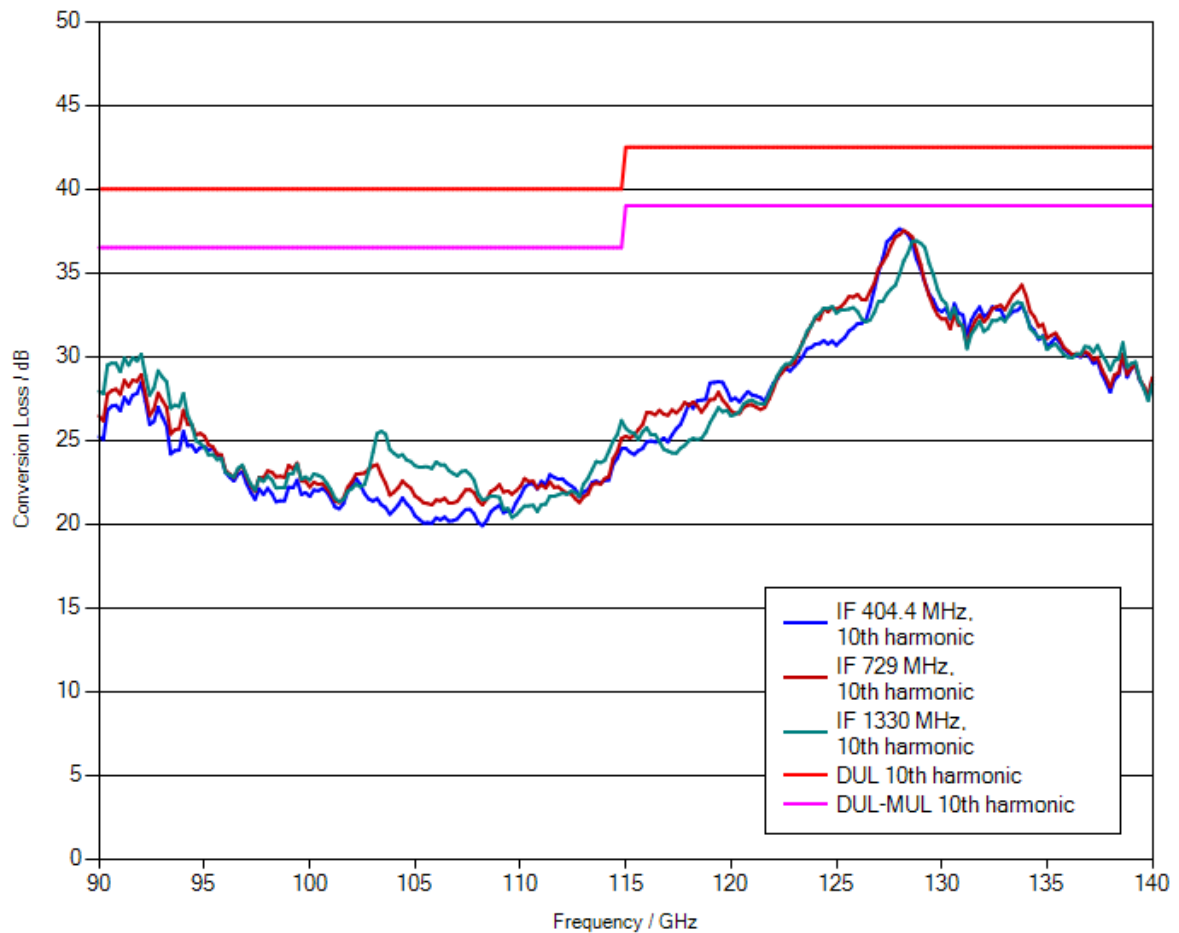
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +14 dBm nominal
Bias 0 A

Measurement uncertainty: 3.5 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

The file has been renamed for safety reasons.

When downloading the file onto your PC, please delete the “.file” extension and unzip the data.

1.3 Frequency response within 1 GHz

| | DUL | Actual (worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz, 10th harmonic | 6 dB | 3.86 dB | PASS |
| IF = 729 MHz, 10th harmonic | 6 dB | 3.48 dB | PASS |
| IF = 1330 MHz, 10th harmonic | 6 dB | 3.19 dB | PASS |



Calibration Certificate

Kalibrierschein

Certificate Number 24-0220-100960-01

Zertifikatsnummer

Unit Data

Item
Gegenstand
Harmonic Mixer, 140 GHz to 220 GHz

Manufacturer
Hersteller
RPG

Type
Typ
RPG FS-Z220

Material Number
Materialnummer
3593.3250.02

Serial Number
Seriennummer
100960

Asset Number
Inventarnummer

This calibration certificate documents, that the named item is tested and measured against defined specifications. Measurement results are located usually in the corresponding interval with a probability of approx. 95% (coverage factor $k = 2$). Calibration is performed with test equipment and standards directly or indirectly traceable by means of approved calibration techniques to the PTB/DKD or other national/international standards, which realize the physical units of measurement according to the International System of Units (SI). In all cases where no standards are available, measurements are referenced to standards of the R&S laboratories. Principles and methods of calibration correspond with EN ISO/IEC 17025. This calibration certificate may not be reproduced other than in full. Calibration certificates without signatures are not valid. The user is obliged to have the object recalibrated at appropriate intervals.

Order Data

Customer
Auftraggeber

Order Number
Bestellnummer

Date of Receipt
Eingangsdatum

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte lagen im Regelfall mit einer Wahrscheinlichkeit von annähernd 95% im zugeordneten Werteintervall (Erweiterte Messunsicherheit mit $k = 2$). Die Kalibrierung erfolgte mit Messmitteln und Normalen, die direkt oder indirekt durch Ableitung mittels anerkannter Kalibriertechniken rückgeführt sind auf Normale der PTB/DKD oder anderer nationaler/internationaler Standards zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Wenn keine Normale existieren, erfolgt die Rückführung auf Bezugsnormale der R&S-Laboratorien. Grundsätze und Verfahren der Kalibrierung beziehen sich auf EN ISO/IEC 17025. Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Kalibrierscheine ohne Unterschriften sind ungültig. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Performance

Place and Date of Calibration
Ort und Datum der Kalibrierung

Meckenheim, 2018-01-17

Scope of Calibration
Umfang der Kalibrierung

Standard Calibration

Statement of Compliance (Incoming)
Konformitätsaussage (Anlieferung)

New device

Statement of Compliance (Outgoing)
Konformitätsaussage (Auslieferung)

All measured values are within the data sheet specifications.

Extend of Calibration Documents
Umfang des Kalibrierdokuments

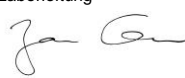
**2 pages Calibration Certificate
5 pages Outgoing Results**

Radiometer Physics GmbH; Meckenheim

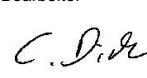
Date of Issue
Ausstellungsdatum

2018-01-19

Head of Laboratory
Laborleitung


Ceru

Person Responsible
Bearbeiter


Dick

Page (Seite) 1/2
Vers2010-05-05/
RPG2014-02-28

Calibration Method
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity **20 % - 80 %**
Relative Luftfeuchte

Ambient Temperature
Umgebungstemperatur

(23 ⁺⁷₋₃) °C

Working standards used (having a significant effect on the accuracy)
Verwendete Gebrauchsnormale (mit signifikantem Einfluss auf die Genauigkeit)

| Item Gegenstand | Type Typ | Serial Number Seriennummer | Calibration Certificate Number Kalibrierscheinnummer | Cal. Due Kalibr. bis |
|-------------------------|--------------|-------------------------------|---|-------------------------|
| Vector Network Analyzer | R&S® ZVA67 | 101097 | 20-300432406 | 2020-07-21 |
| Powersensor | R&S® NRP-Z55 | 140093 | 20-300426315 | 2018-05-17 |

UGB1 A compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

UGB2 A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.
Die Bestätigung der Nicht-Konformität ist möglich, sofern ein Grad des Vertrauens von weniger als 95 % akzeptabel ist.

Ref.: ILAC-G8:03/2009 'Guidelines on the Reporting of Compliance with Specification'.

Notes

Anmerkungen

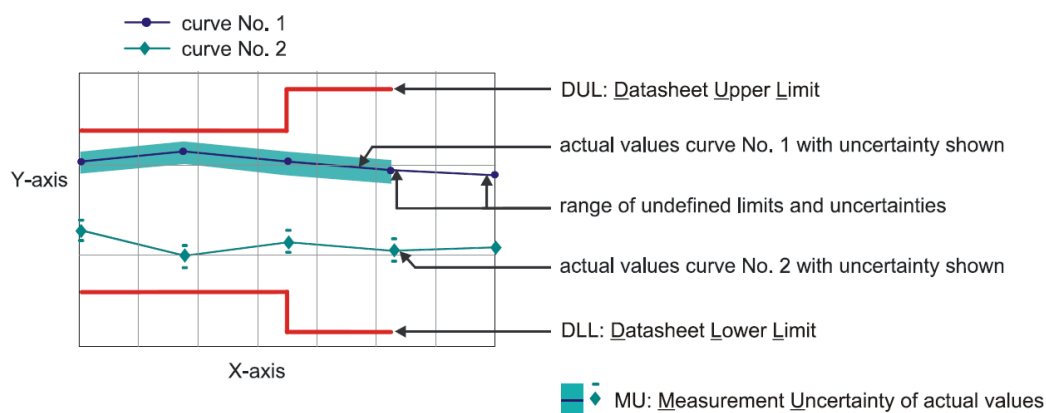
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is actually put into operation.

Outgoing Results

The following abbreviations may be used in this document

| | |
|------------|--|
| {a} | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass. |
| {b} | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c} | Functional test, therefore no measurement uncertainty is stated. |
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| UGB | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit. |
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| DU | Datasheet Uncertainty |

Explanation of charts



Software used for measurement**Item Type**

Measurement Studio Professional Edition
MixerCertification

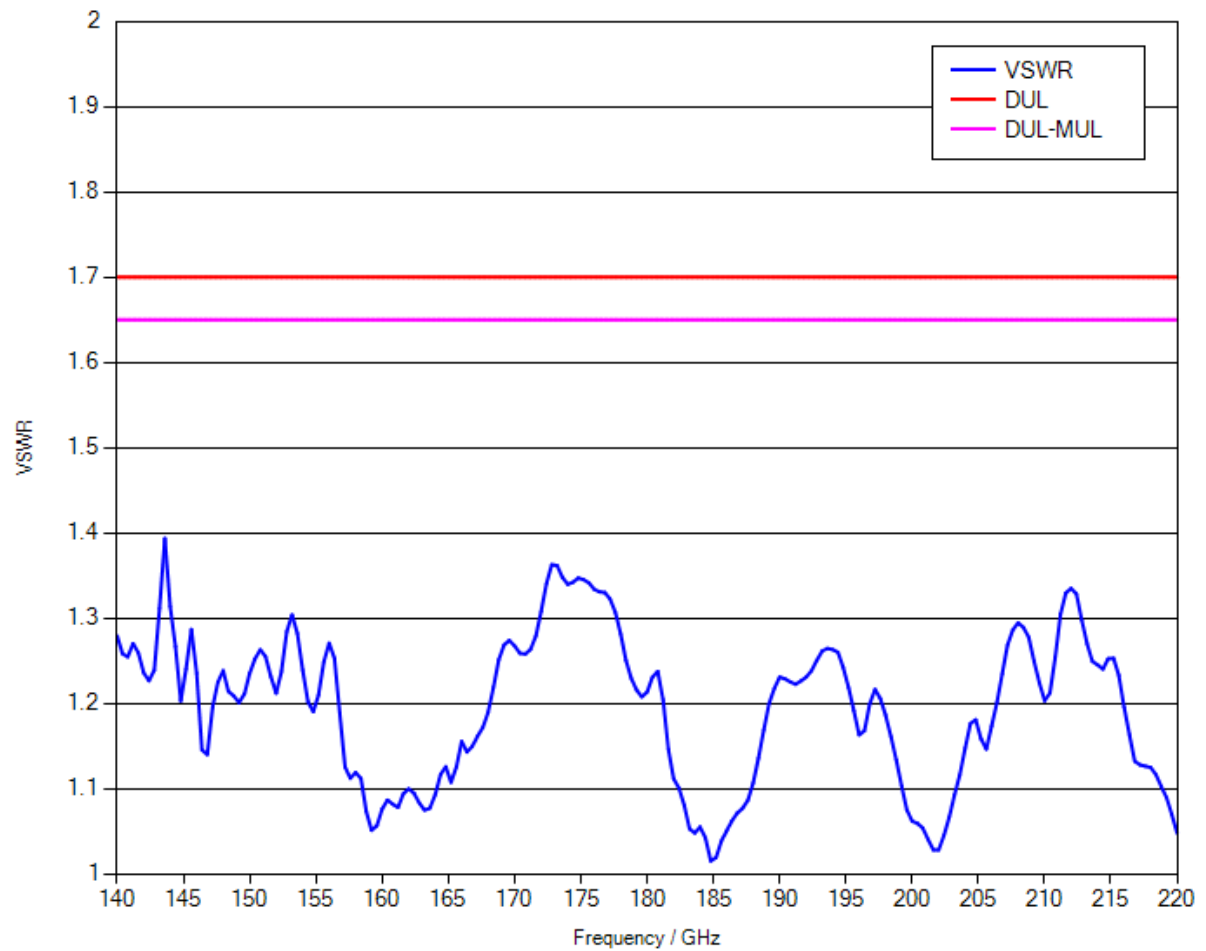
Version

2013
7_08

Remark

1.1 RF Input – VSWR

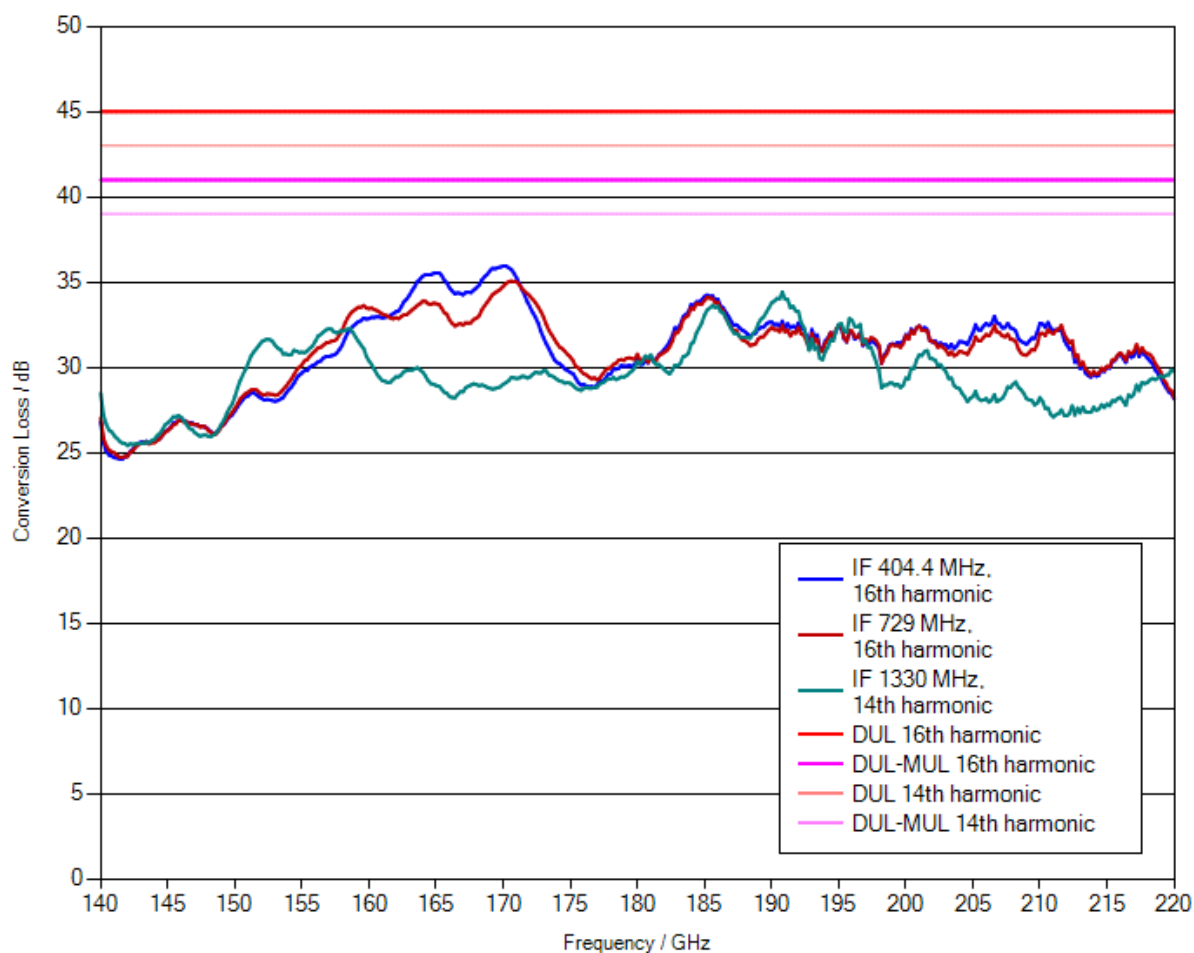
Measurement uncertainty: 0.05 (VSWR)



1.2 Conversion loss

LO level +13 dBm nominal
Bias 0 A

Measurement uncertainty: 4 dB



Note: Numeric calibration data can be found attached to the PDF file of the calibration certificate. Click the “paper clip” symbol to display the file.

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1.3 Frequency response within 1 GHz

| | DUL | Actual (worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz, 16th harmonic | 6 dB | 2.1 dB | PASS |
| IF = 729 MHz, 16th harmonic | 6 dB | 2.05 dB | PASS |
| IF = 1330 MHz, 14th harmonic | 6 dB | 2.48 dB | PASS |