

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



TESTING  
NVLAP LAB CODE: 100275-0

## **FCC Certification Part 30 Test Report**

### **Product Evaluated**

**FA3WA 5G n260 39GHz 8CC**  
**FA3WA 39 GHz Extension Module with AWEWA / AWEWB**  
**FCC ID: 2AD8UFA3WA01**

### **Customer**

**Nokia Solutions and Networks, OY**  
2000 Lucent Lane  
Naperville, Illinois 60563

### **Test Laboratory**

**Nokia Bell Labs**  
**Nokia, Global Product Compliance Laboratory**  
600-700 Mountain Avenue, Rm 5B-108  
Murray Hill, New Jersey 07974-0636 USA

### **Date**

**September 2, 2021**

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## Revisions

| Date      | Revision | Section | Change          |
|-----------|----------|---------|-----------------|
| 8/10/2021 | 0        |         | Initial Release |
| 9/2/2021  | 1        | 4.9     | Date correction |
|           |          |         |                 |
|           |          |         |                 |

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Prepared & Reviewed By: W. Steve Majkowski NCE

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9/2/2021

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9/2/2021

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9/2/2021

Compliance Engineer  
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## 1. ATTESTATION OF TEST RESULTS

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Equipment Under Test (EUT)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | FA3WA 5G n260 39GHz 8CC<br>FA3WA Extension Module with AWEWA / AWEWB                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Serial Number(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Radiated Emission, FA3WA YK2118000017 & YK2118000027 with AWEWB (DC) YK2118000031<br>Radio Tests: FA3WA YK2118000028 & YK2118000029, with AWEWB (DC) YK2118000001,<br>Frequency Stability Tests: FA3WA YK2118000033 & YK2118000034 with AWEWA (AC)<br>YK2118000002, AWEWB (DC) YK2118000015,                                                                                                                                                               |
| <b>FCC ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2AD8UFA3WA01                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Model Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ASMR Family – FA3WA, with AWEWA (AC), AWEWB (DC)                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Hardware Version</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | FA3WA - 475002A.X31, AWEWA - 475170A AWEWA / 475171A AWEWB /                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>GPCL Project Number</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2021-0072                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Manufacturer</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NOKIA SOLUTIONS AND NETWORKS OY<br>KARAKAARI 7, FI-02610 ESPOO<br>FINLAND                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Test Requirement</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• 47 CFR FCC Part 2 and Part 30 (Part 2.1047, 2.1055)</li> </ul>                                                                                                                                                                                                                                                                                                                                                    |
| <b>Test Standard(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• 47 CFR FCC Parts 2 and Part 30</li> <li>• KDB 971168 D01 Power Meas License Digital Systems v03r01 April 9, 2018</li> <li>• KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013</li> <li>• KDB 842590 D01 Upper Microwave Flexible Use Service v01r01–April 2020</li> <li>• Procedures on TRP Compliance for Out of Band and Spurious Emissions C63.26 mmWave JTG - Version # 1 July 14th, 2018</li> </ul> |
| <b>Reference(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>• ANSI C63.26 (2015)</li> <li>• ANSI C63.4 (2014)</li> <li>• TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014)</li> </ul>                                                                                                                                                                                                                                                                            |
| <b>Test Date</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | June 4, 2021 – July 20, 2021                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Test Performed By</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Nokia<br>Global Product Compliance Laboratory<br>600-700 Mountain Avenue<br>P.O. Box 636<br>Murray Hill, NJ 07974-0636                                                                                                                                                                                                                                                                                                                                     |
| <b>FCC Registered Test Site Number</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Designation Number: <b>US5302</b> , Test Firm Registration Number: <b>395774</b>                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Product Engineer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ron Remy, Obi Okorie                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Lead Engineer</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | W. Steve Majkowski                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Test Engineer (s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | W. Steve Majkowski, Mike Soli, Chris Polanco, Jaideep Yadav, Joe Bordonaro                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Test Results:</b> The EUT, <i>as tested</i> met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. 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. |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## 2. SUMMARY OF THE TEST RESULTS

| 47 CFR FCC Sections | Description of Tests                                 | Compliance Results |
|---------------------|------------------------------------------------------|--------------------|
| 2.1046, 30.202 (a)  | RF Power Output                                      | Pass               |
| 2.1047,             | Modulation Characteristics                           | Pass               |
| 2.1049, 30.203      | (a) Occupied Bandwidth<br>(b) Edge-of-Band Emissions | Pass               |
| 2.1051, 30.203      | Spurious Emissions at Antenna Terminals - Radiated   | Pass               |
| 2.1053, 30.203      | Field Strength of Spurious Radiation                 | Pass               |
| 2.1055,             | Measurement of Frequency Stability                   | Pass               |

### 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,<br>Edge of Band, | 10 Hz<br>100 Hz<br>10 kHz to 1 MHz<br>1MHz to 100 MHz | 9 kHz to 20 MHz<br>20 MHz to 1 GHz<br>1 GHz to 10 GHz<br>10 GHz to 40 GHz: | ±2.2 dB                               |
| Conducted Spurious Emissions         | 30 kHz to 100 MHz                                     | 10 MHz to 40 GHz:                                                          | ±2.8 dB                               |
| RF Power, Channel Power              | 10 Hz to 100 MHz                                      | 10 MHz to 40 GHz                                                           | ±1.4 dB                               |

### 3. GENERAL INFORMATION

#### 3.1 Product Descriptions

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

**Table 3.1.1 Product Specifications**

| Specification Items       | Description                                                                     |
|---------------------------|---------------------------------------------------------------------------------|
| Product Type              | FA3WA 5G n260 39GHz 8CC; FA3WA 5G AirScale 39 GHz mmWave Radio Extension Module |
| Radio Type                | Intentional Transceiver                                                         |
| Power Type                | DC                                                                              |
| Modulation                | QPSK, 16QAM, 64QAM, 256QAM                                                      |
| Operating Frequency Range | TDD Tx/Rx = 37 – 40.0 GHz, NR Band n260                                         |
| Channel Bandwidth         | 1400 MHz                                                                        |
| Max Radiated Power (EIRP) | 52 dBm EIRP per polarizations;<br>55 dBm EIRP Total for the two polarizations.  |
| Antenna Gain              | 23 dBi                                                                          |
| Operating Mode            | 2x2 MIMO (2 duplex Tx/Rx Ports)                                                 |
| Software Version          | 5G19B                                                                           |
| Hardware Version          | 475002A.X31 - FA3WA                                                             |
| Antenna(s)                | Refer to Section 3.2                                                            |

#### 3.2 EIRP/ PSD Compliance and Antenna Information.

The product incorporates integrated antennas. Externally mounted antennas cannot be attached to the unit or mounted remotely. The units integrated antennas are electronically steerable with a maximum gain of 23 dBi. There is a single antenna board assembly inside the product. This antenna assembly has two individually polarized antenna Tx/Rx modules. Each antenna Tx/Rx modules is an 8x12 matrix (96 elements each). One antenna Tx/Rx modules is vertically polarized, and the second antenna Tx/Rx modules is horizontally polarized. The antennas nominal RF drive level is 29 dBm. The 29 dBm RF power and 23 dBi gain results in a 52 dBm EIRP per assembly. The sum of the two 52 dBm EIRP beams results in a maximum EIRP of 55 dBm. Antenna Gain vs frequency is detailed in Exhibit 6 of the filing package. The FA3WA and AWEWA/B use the same antenna board assembly.

### 3.3 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

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

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

D is the maximum size of the radiating array  $\lambda$  = wavelength of the operating signal in meters

The individual polarization antenna array height is 135 mm and is 77 mm wide with a 155mm diagonal. The diagonal for both arrays is 301 mm.

At 40 GHz the individual array dimensions results in a minimum Fraunhofer far field distance,  $d_{ff}$ , of 6.4 meters.

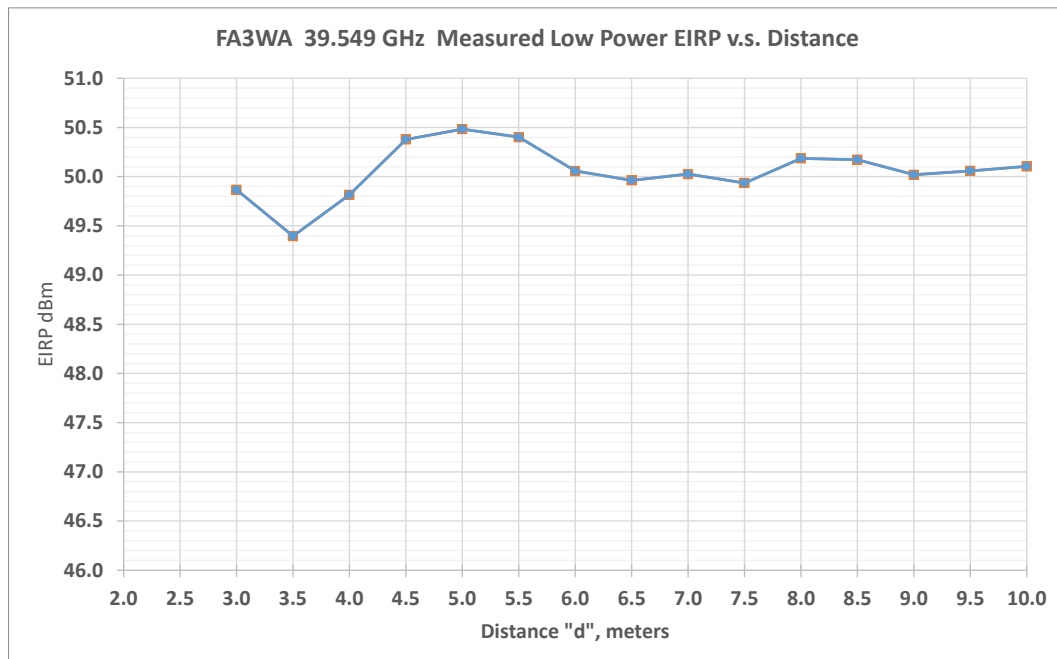
At 40 GHz the overall array dimensions results in a minimum Fraunhofer far field distance,  $d_{ff}$ , of 24 meters.

While the Fraunhofer far field distance is the minimum distance where the far field can occur, it does not predict the actual distance where the far field occurs. The Moongilan Test determines the actual distance where the far field occurs for the specific configuration under test.

Measurements for the Moongilan Test were performed at low power using a standard gain horn antenna. In the horizontal polarization the determined boundary was 6.0 m.

To eliminate any inconsistency all Power, OBW and OOB measurements were made at 6.5 m.

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



## 4. REQUIRED MEASUREMENTS AND RESULTS

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

**Table 4.0a Required Certification Measurements**

| 47 CFR FCC Sections                          | Description of Tests                                | Test Required for Class II Authorization |
|----------------------------------------------|-----------------------------------------------------|------------------------------------------|
| 2.1046, 30.202 (a)                           | RF Power Output<br>(a) Power Limits, EIRP, PSD      | Yes                                      |
| 2.1047,                                      | Modulation Characteristics                          | Yes                                      |
| 2.1049, 30.203                               | (a) Occupied Bandwidth<br>(b) Out-of-Band Emissions | Yes                                      |
| 2.1051, 30.203                               | Spurious Emissions at Antenna Terminals             | Yes                                      |
| 2.1053, 30.203,<br>30.204, 15.109(a) Class B | Field Strength of Spurious Radiation                | Yes                                      |
| 2.1055,                                      | Measurement of Frequency Stability                  | 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 4.0b below. The comprehensive list of tests performed included measurements at Left, Center and Right side of the Part 30 Band. These tests are presented to demonstrate compliance with FCC requirements.

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

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

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

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Standard(s)</b> | <ul style="list-style-type: none"> <li>• 47 CFR FCC Parts 2 and Part 30</li> <li>• KDB 971168 D01 Power Meas License Digital Systems v03r01 April 9, 2018</li> <li>• KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013</li> <li>• KDB 842590 D01 Upper Microwave Flexible Use Service v01r01–April 2020</li> <li>• Procedures on TRP Compliance for Out of Band and Spurious Emissions C63.26 mmWave JTG - Version # 1 July 14th 2018</li> </ul> |
| <b>Reference(s)</b>     | <ul style="list-style-type: none"> <li>• 47 CFR FCC Part 2 and Part 30</li> <li>• ANSI C63.26 (2015)</li> <li>• ANSI C63.4 (2014)</li> <li>• TR 14-1001, MMW Measurements with Harmonic Mixers (April-4-2014)</li> </ul>                                                                                                                                                                                                                                  |

#### 4.1 Section 2.1046 MEASUREMENT REQUIRED: RF POWER OUTPUT

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

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

The **Nokia AirScale 39 GHz Radio Unit (FA3WA), FCC ID: 2AD8UFA3WA01**, is a LTE TDD Remote radio head can be configured for one to eight carrier operation. It is specified to provide a maximum power output of 52 dBm /158.5 W EIRP per transmit polarization for a sum total of 55 dBm /317W EIRP per unit. The product is designed for the 5G global market including operation per 47 CFR Part 30 rules for use in the USA authorized portions of 5G New Radio Band, n260, from 37 - 40 GHz.

##### 4.1.1 RF Power Output Measurement

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

Radiated Power measurements of the 5G New Radio transmit signal were conducted with an FSW Spectrum Analyzer per KDB 971168 D01 and KDB 842590 D01. Measurements were performed at a 6.5 m distance using a nominal 68 dB offset. An additional FSW transducer correction factor is used to ascertain the actual measured EIRP power. The calculation of path loss, cable loss and measurement antenna gain are listed in Table 4.1.1. below. The unit was configured to transmit at its maximum power.

The Channel Power function of the FSW spectrum analyzer was used to measure the maximum average Horizontal and Vertical EIRP at the 6.5m boundary distance. The measurements were performed for one through eight carriers at the left, center and right side of the 37 -40 GHz Band. For all measurements a nominal 100 MHz bandwidth carrier with 5G-NR modulations was used. Channel power plots identify the individual carrier power, modulation and the total power.



# 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 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

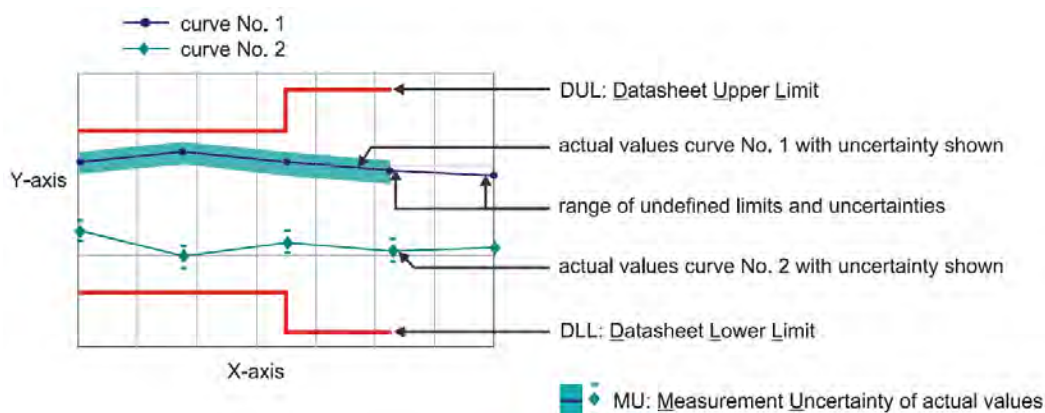
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

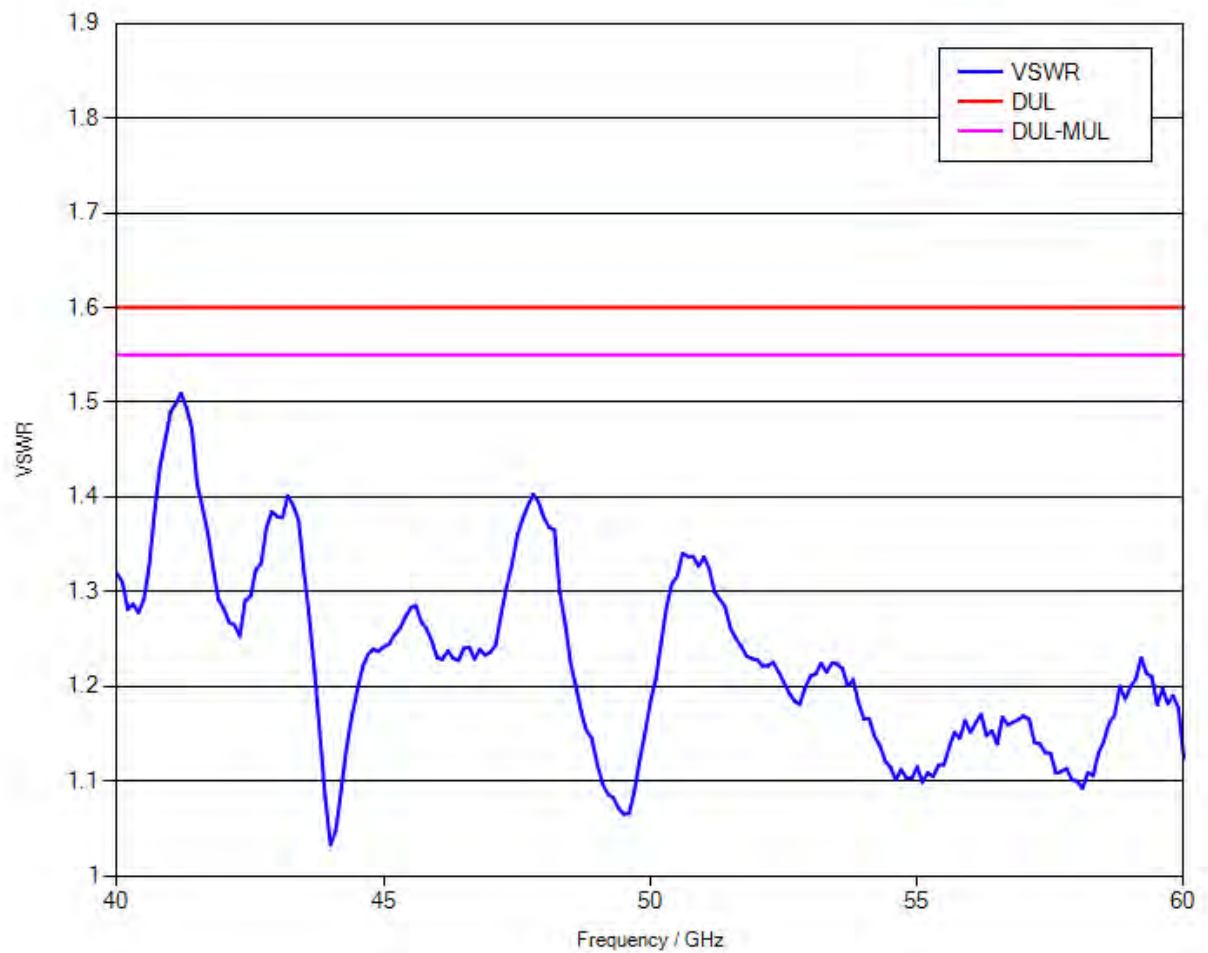
**Version**

2013  
7\_07

**Remark**

## 1.1 RF Input – VSWR

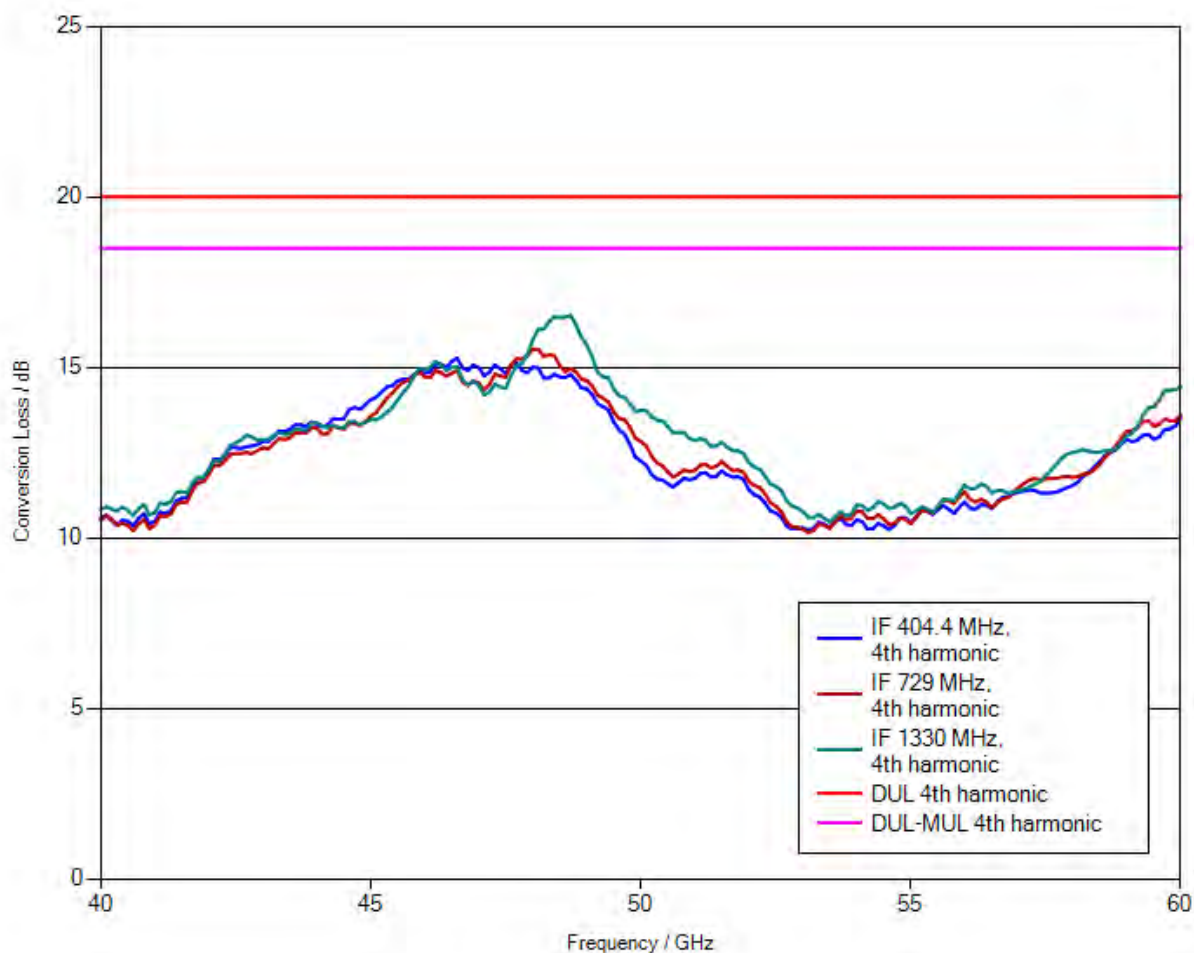
Measurement uncertainty: 0.05 (VSWR)



## 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<br>(worst case) | Evaluation |
|---------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>4th harmonic | 4 dB | 2.02 dB                | PASS       |
| IF = 729 MHz,<br>4th harmonic   | 4 dB | 1.78 dB                | PASS       |
| IF = 1330 MHz,<br>4th harmonic  | 4 dB | 2.35 dB                | PASS       |

# Calibration Certificate

Kalibrierschein

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

Zertifikatsnummer

## Unit Data

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

**Manufacturer** ROHDE & SCHWARZ  
Hersteller

**Type** R&S® FS-Z90  
Typ

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

**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, 2017-08-09**

**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**

## 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 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

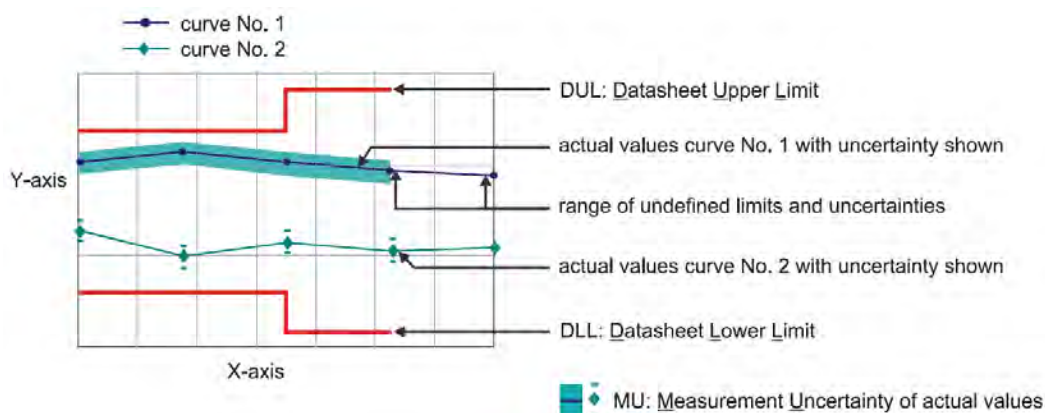
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

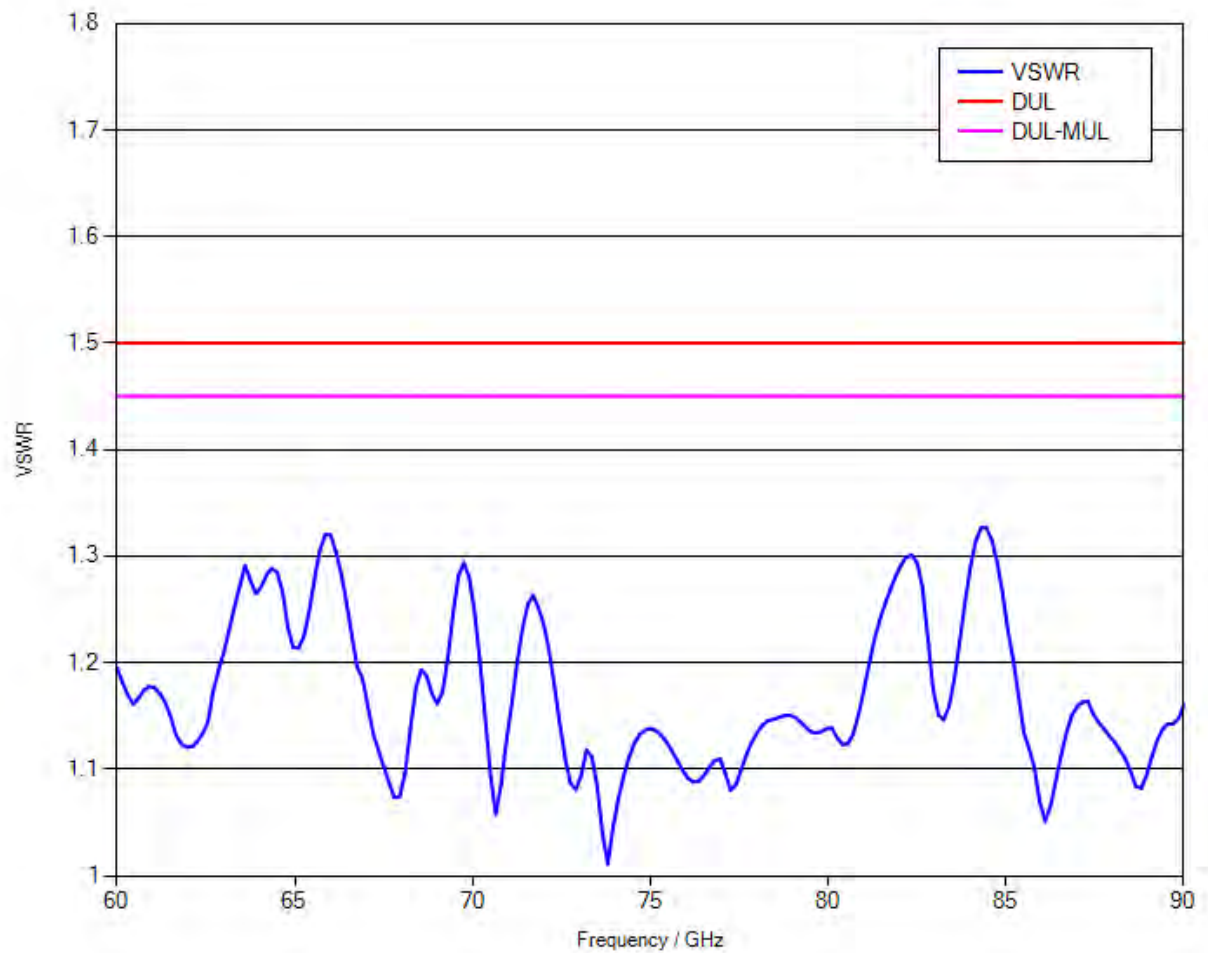
**Version**

2013  
only

**Remark**

## 1.1 RF Input – VSWR

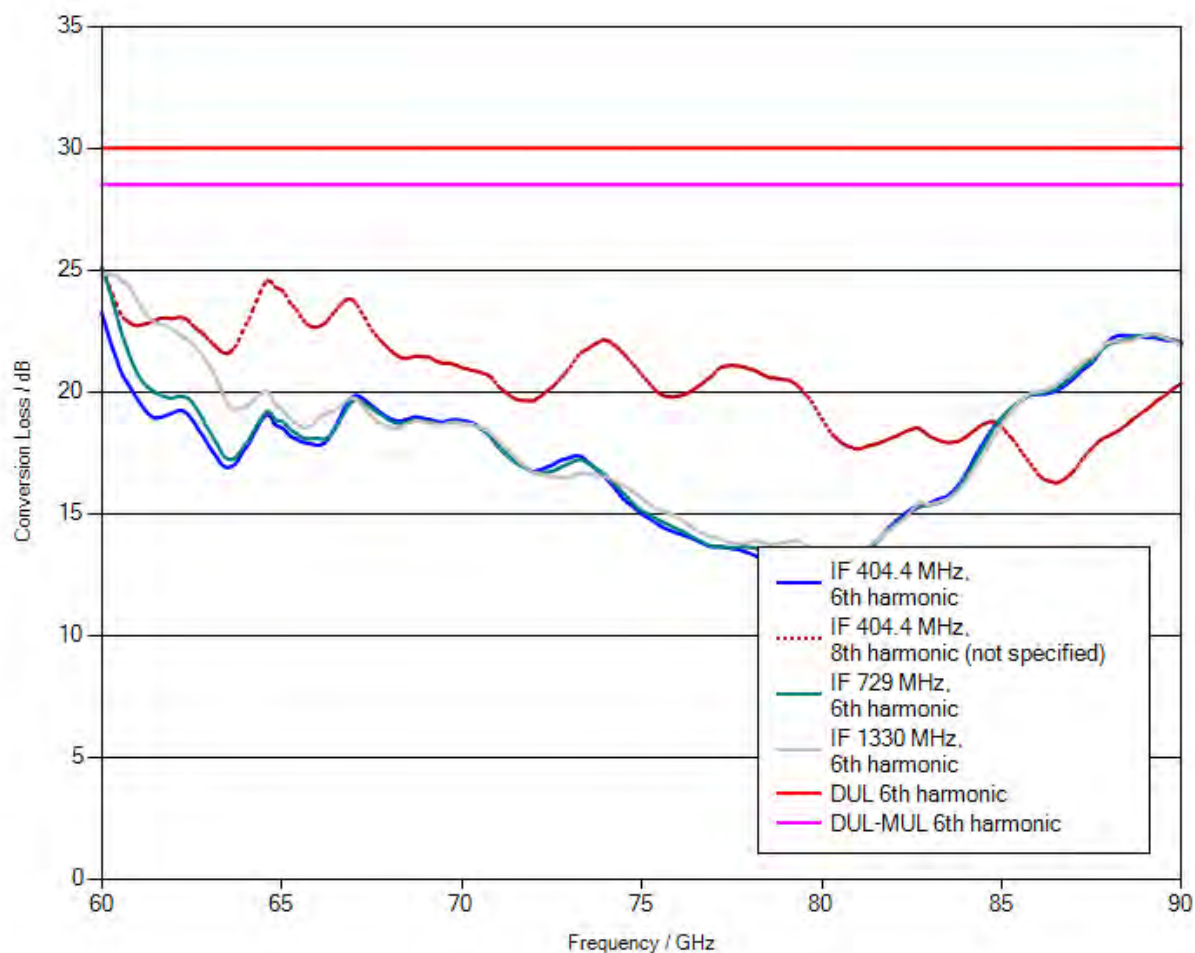
Measurement uncertainty: 0.05 (VSWR)



## 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<br>(worst case) | Evaluation    |
|---------------------------------|---------------|------------------------|---------------|
| IF = 404.4 MHz,<br>6th harmonic | 6 dB          | 3.33 dB                | PASS          |
| IF = 404.4 MHz,<br>8th harmonic | not specified | 2.73 dB                | not specified |
| IF = 729 MHz,<br>6th harmonic   | 6 dB          | 4.12 dB                | PASS          |
| IF = 1330 MHz,<br>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

Calibration Method  
Kalibrieranweisung

**RPG-PAQA-TN-2014-002**

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

Ambient Temperature  
Umgebungstemperatur

**(23 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>Kalibr. bis |
|-------------------------|--------------|-------------------------------|---------------------------------------------------------|-------------------------|
| Vector Network Analyzer | R&S® ZVA67   | 101097                        | 10-300319061                                            | 2017-08-06              |
| Powersensor             | R&S® NRP-Z55 | 140093                        | 20-541556                                               | 2017-05-12              |

**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'.

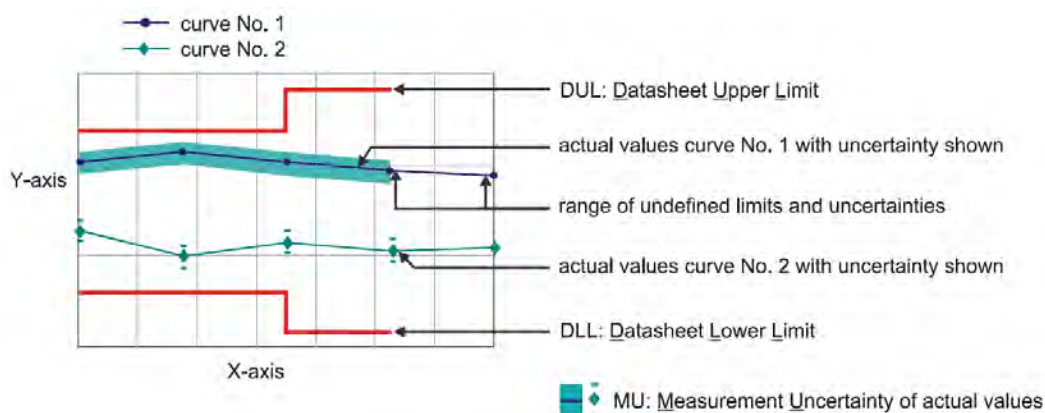
Notes  
Anmerkungen

## Outgoing Results

The following abbreviations may be used in this document

|            |                                                                                                                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| {a}        | No measurement uncertainty stated because the errors always add together.<br>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                                                                                                                                                                                                                                                      |

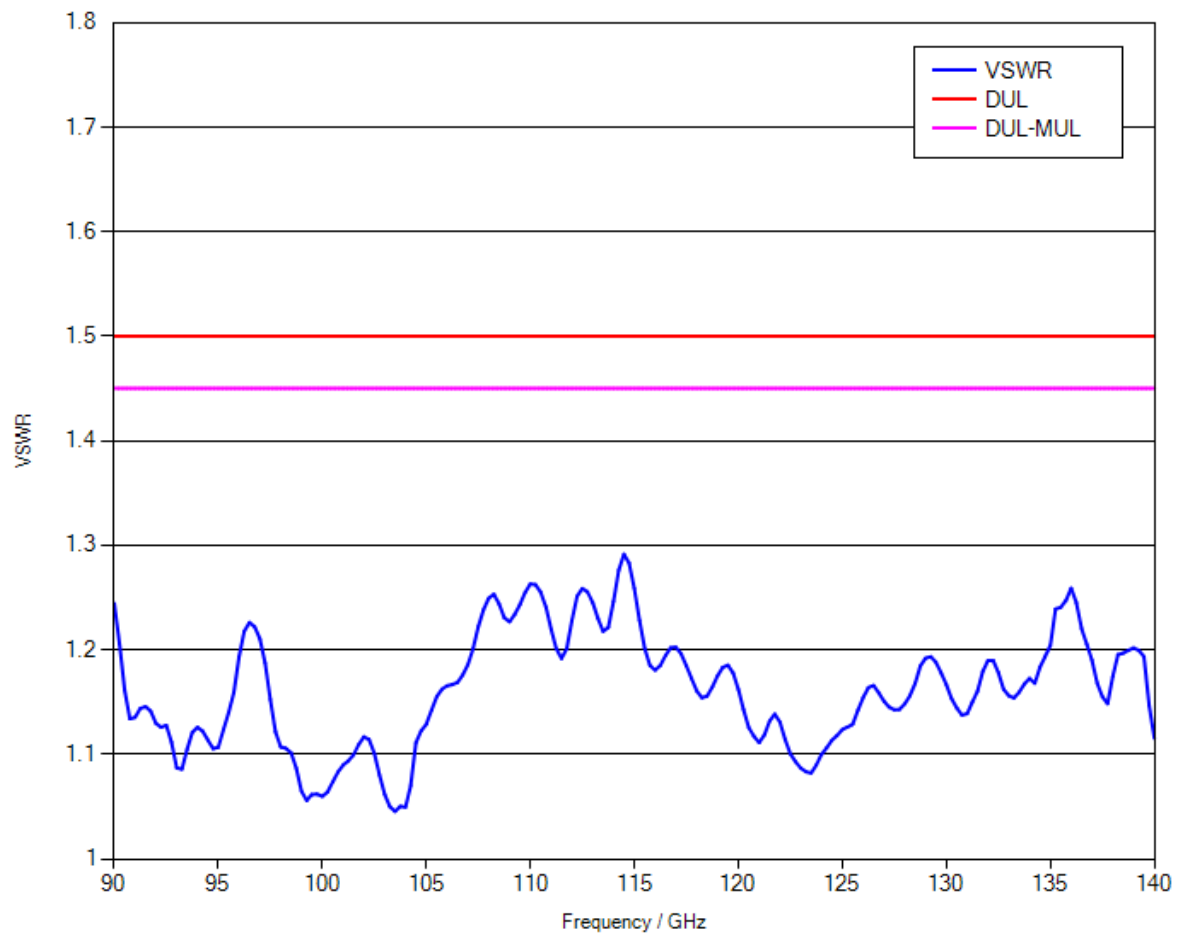
### Explanation of charts



**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<br>(worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>10th harmonic | 6 dB | 3.86 dB                | PASS       |
| IF = 729 MHz,<br>10th harmonic   | 6 dB | 3.48 dB                | PASS       |
| IF = 1330 MHz,<br>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

Calibration Method  
Kalibrieranweisung

**RPG-PAQA-TN-2014-002**

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

Ambient Temperature  
Umgebungstemperatur

**(23 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

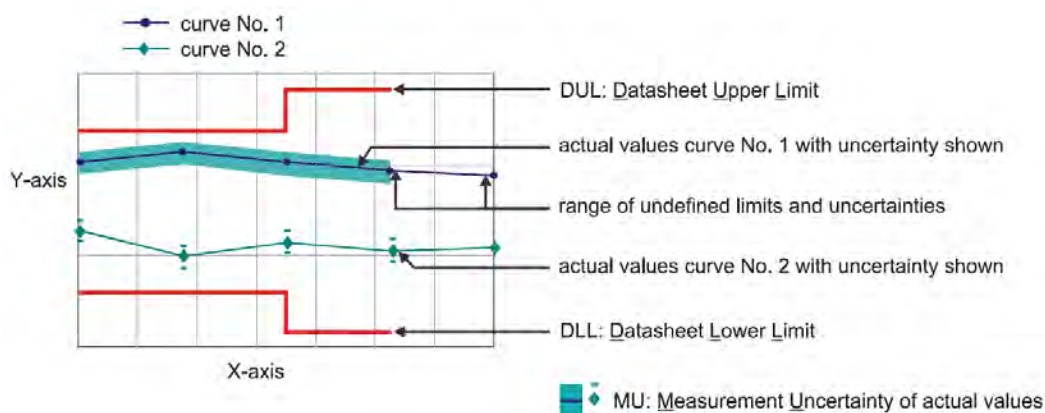
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

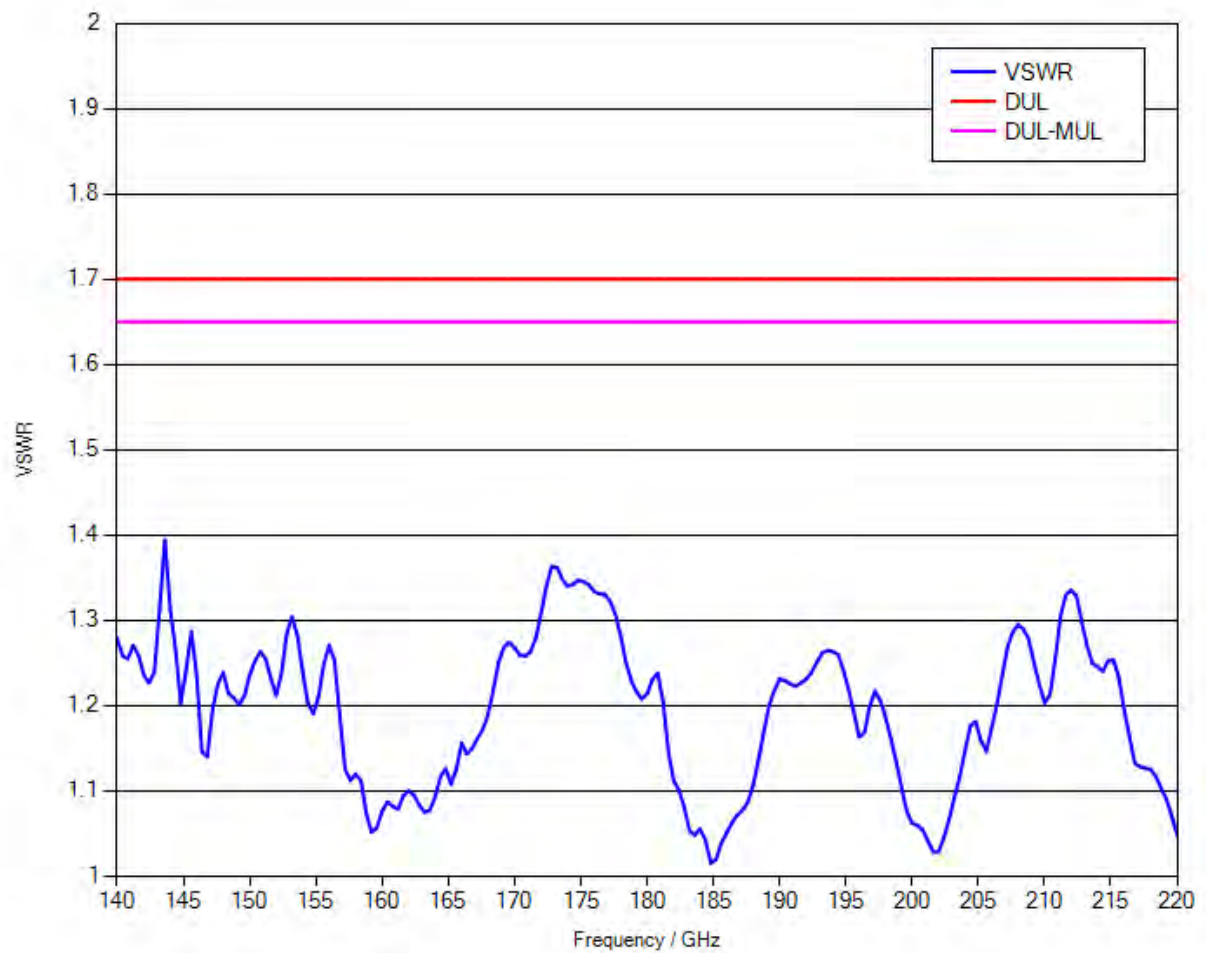
**Version**

2013  
7\_08

**Remark**

## 1.1 RF Input – VSWR

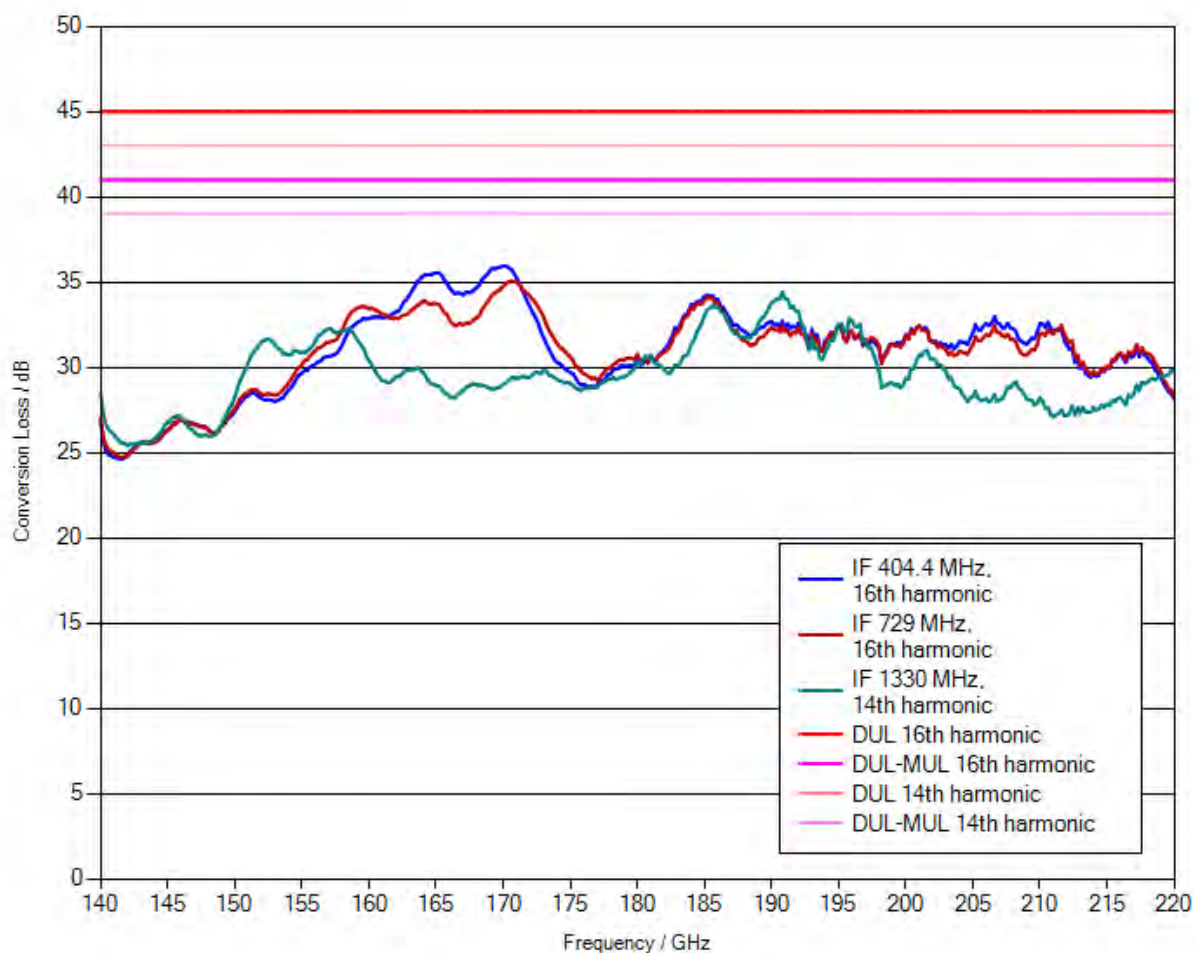
Measurement uncertainty: 0.05 (VSWR)



## 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.

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

**Table 4.1.1 Corrections For Transmitter Power Measurements**

| Frequency | Free Space Path Loss, "PL" | Measurement Antenna Gain, "G1" | Measurement Cable Loss, "L1" | Total Offset Required PL -G1 + L1 | FSW Measurement Offset | Required Final Correction |
|-----------|----------------------------|--------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------|
| GHz       | dB                         | dBi                            | dB                           | dB                                | dB                     | dB                        |
| 35.00     | 79.58                      | 23.96                          | 12.84                        | 68.46                             | 68                     | 0.460                     |
| 35.50     | 79.70                      | 23.52                          | 13.03                        | 69.21                             | 68                     | 1.214                     |
| 36.00     | 79.83                      | 24.27                          | 13.20                        | 68.75                             | 68                     | 0.754                     |
| 36.50     | 79.95                      | 23.28                          | 13.35                        | 70.01                             | 68                     | 2.015                     |
| 37.00     | 80.06                      | 24.42                          | 13.39                        | 69.04                             | 68                     | 1.040                     |
| 37.50     | 80.18                      | 23.27                          | 13.39                        | 70.29                             | 68                     | 2.293                     |
| 38.00     | 80.30                      | 24.29                          | 13.45                        | 69.45                             | 68                     | 1.455                     |
| 38.50     | 80.41                      | 23.18                          | 13.54                        | 70.76                             | 68                     | 2.762                     |
| 39.00     | 80.52                      | 23.65                          | 13.73                        | 70.60                             | 68                     | 2.604                     |
| 39.50     | 80.63                      | 23.03                          | 13.76                        | 71.36                             | 68                     | 3.358                     |
| 40.00     | 80.74                      | 23.00                          | 13.79                        | 71.53                             | 68                     | 3.530                     |
| 40.50     | 80.85                      | 23.35                          | 13.84                        | 71.34                             | 68                     | 3.343                     |
| 41.00     | 80.96                      | 23.22                          | 13.98                        | 71.72                             | 68                     | 3.717                     |
| 41.50     | 81.06                      | 23.28                          | 14.14                        | 71.93                             | 68                     | 3.927                     |
| 42.00     | 81.17                      | 23.39                          | 14.23                        | 72.01                             | 68                     | 4.014                     |
| 42.50     | 81.27                      | 23.81                          | 14.36                        | 71.81                             | 68                     | 3.815                     |
| 43.00     | 81.37                      | 23.55                          | 15.30                        | 73.11                             | 68                     | 5.114                     |
| 43.50     | 81.47                      | 23.60                          | 16.14                        | 74.01                             | 68                     | 6.008                     |

#### 4.1.1.1 RF Power Output Results

Power output measurements verified the expected performance of 52 dBm EIRP per polarization for a Total Power of 55 dBm. The maximum measured level was 53.33 dBm for a single polarization and 56.02 dBm total. This level is well within the maximum Part 30.202a limit of 75 dBm EIRP. Measurements were performed for each modulation.

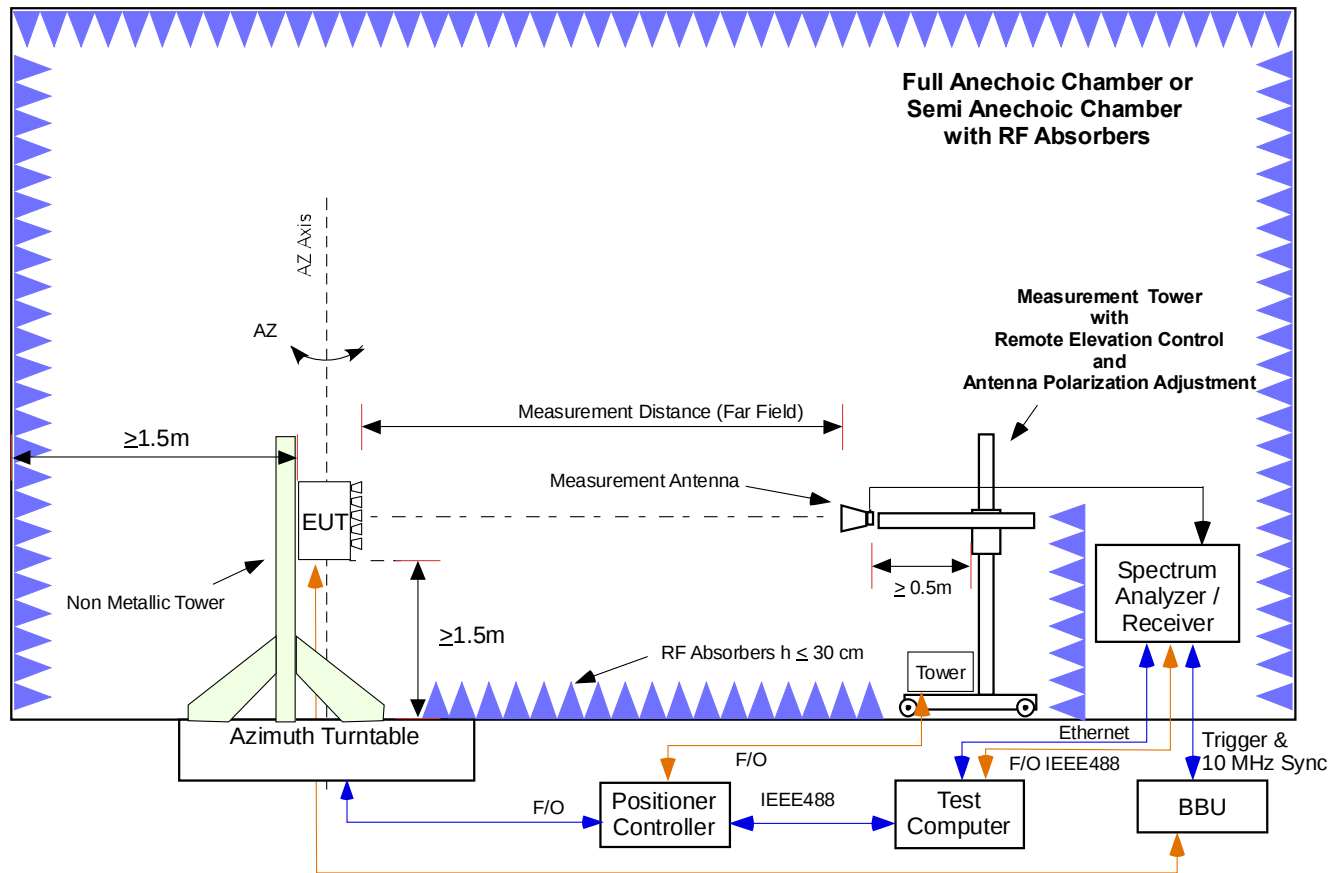
The measured performance was in full compliance with the Rules of the Commission. The data plots are detailed below.

**Table 4.1.1.1 – Channel Power Measurements (adjacent)**

| Location in Band | Channel Center Frequencies, 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             | 37.05                                                                                        | 1             | QPSK       | 52.71                                             | 52.27                                           | 55.51                        |
| Middle           | 38.44776                                                                                     | 1             | 16QAM      | 52.19                                             | 52.37                                           | 55.29                        |
| Right            | 39.94536                                                                                     | 1             | 64QAM      | 52.88                                             | 52.13                                           | 55.53                        |
| Left             | 37.05000<br>37.14984                                                                         | 2             | QPSK       | 52.73                                             | 52.75                                           | 55.75                        |
| Left             | 37.05000<br>37.14984                                                                         | 2             | 16QAM      | 52.73                                             | 52.75                                           | 55.75                        |
| Left             | 37.05000<br>37.14984<br>37.24968                                                             | 3             | QPSK       | 53.34                                             | 52.63                                           | 56.01                        |
| Left             | 37.05000<br>37.14984<br>37.24968<br>37.34952                                                 | 4             | QPSK       | 52.87                                             | 52.37                                           | 55.64                        |
| Left             | 37.05000<br>37.14984<br>37.24968<br>37.34952<br>37.44936                                     | 5             | QPSK       | 52.86                                             | 52.42                                           | 55.66                        |
| Left             | 37.05000<br>37.14984<br>37.24968<br>37.34952<br>37.44936<br>37.5492                          | 6             | QPSK       | 52.69                                             | 52.31                                           | 55.51                        |
| Left             | 37.05000<br>37.14984<br>37.24968<br>37.34952<br>37.44936<br>37.54920<br>37.64904             | 7             | QPSK       | 52.67                                             | 52.28                                           | 55.49                        |
| Left             | 37.05000<br>37.14984<br>37.24968<br>37.34952<br>37.44936<br>37.54920<br>37.64904<br>37.74888 | 8             | QPSK       | 52.78                                             | 52.91                                           | 55.86                        |
| Middle           | 38.14824<br>38.24808<br>38.34792<br>38.44776<br>38.54760<br>38.64744<br>38.74728<br>38.84712 | 8             | 16QAM      | 52.01                                             | 52.08                                           | 55.05                        |
| Right            | 39.24648<br>39.34632<br>39.44616<br>39.54600<br>39.64584<br>39.74568<br>39.84552<br>39.94536 | 8             | 64QAM      | 52.79                                             | 52.09                                           | 55.46                        |

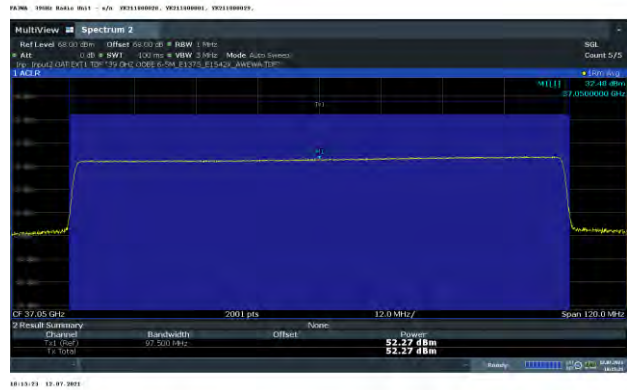
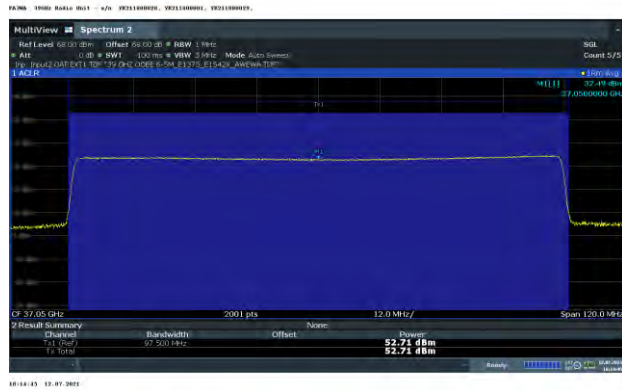
| 99.96 MHz Carrier Spacing |                                                                                              |   |       |       |       |       |
|---------------------------|----------------------------------------------------------------------------------------------|---|-------|-------|-------|-------|
| Middle                    | 38.14956<br>38.24952<br>38.34948<br>38.44944<br>38.54940<br>38.64936<br>38.74932<br>38.84928 | 8 | 16QAM | 53.42 | 52.00 | 55.78 |

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

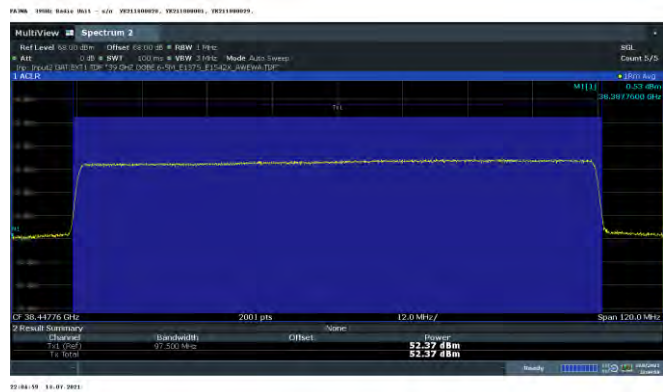
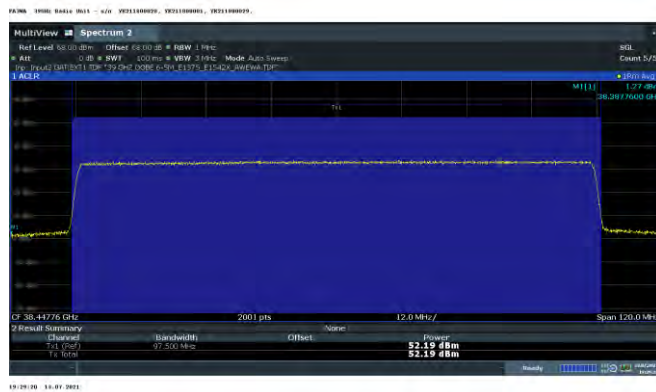


#### 4.1.1.1.1 Channel Power Measurement Plots

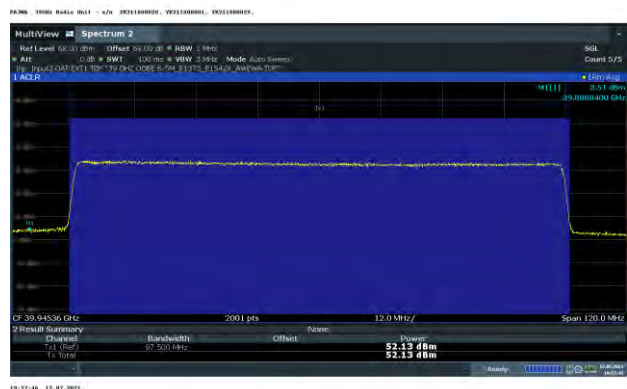
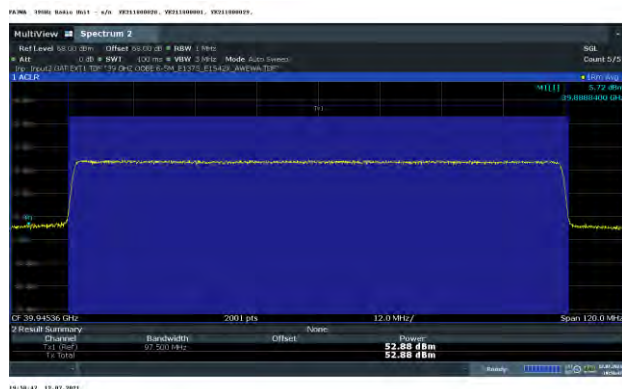
### Channel Power Measurements, 1 Carrier – QPSK - Left Side of Band



### Channel Power Measurements, 1 Carrier – 16QAM – Middle of Band

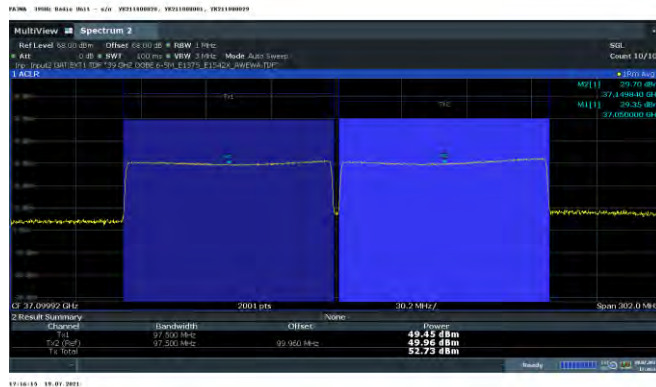


### Channel Power Measurements, 1 Carrier – 64QAM – Right Side of Band



## Channel Power Measurements, 2 Carrier –QPSK – Left Side of Band

### Horizontal

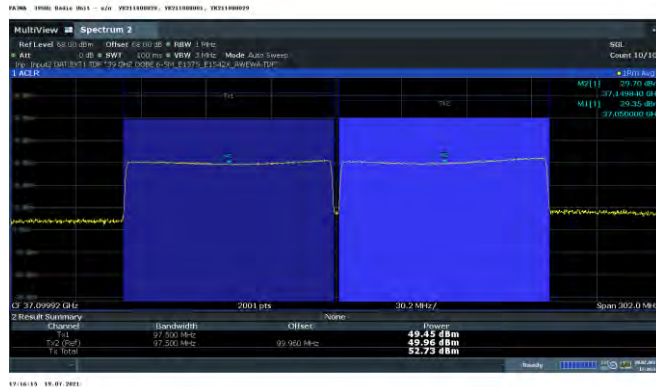


### Vertical



## Channel Power Measurements, 2 Carrier –16QAM – Left Side of Band

### Horizontal

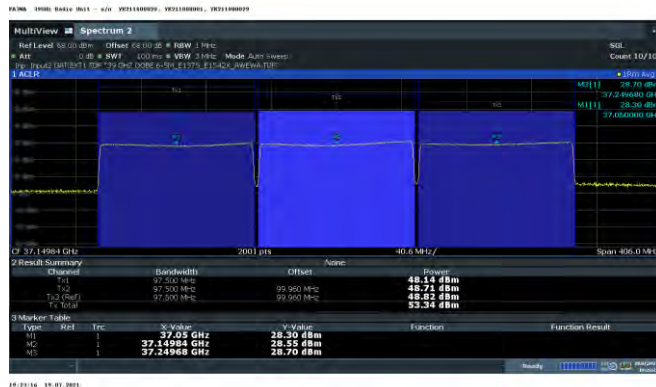


### Vertical

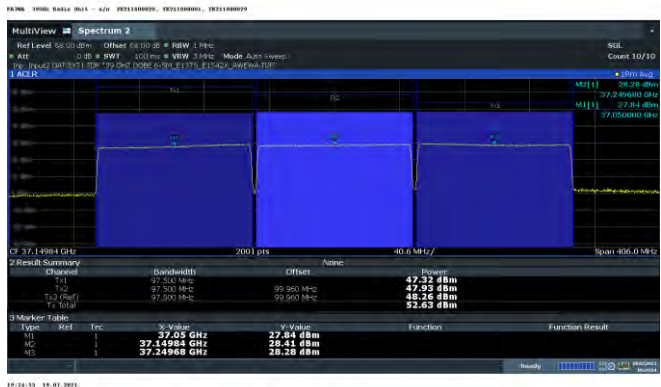


## Channel Power Measurements, 3 Carrier – QPSK – Left Side of Band

### Horizontal



### Vertical



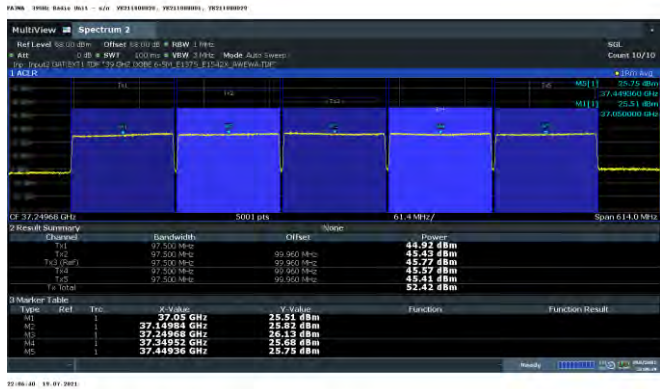
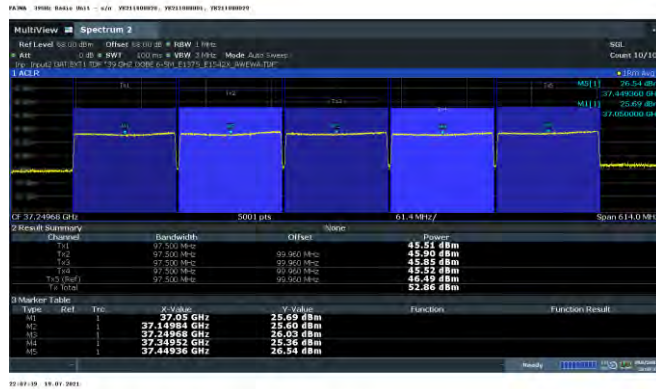
## Channel Power Measurements, 4 Carrier – QPSK – Left Side of Band

### Horizontal



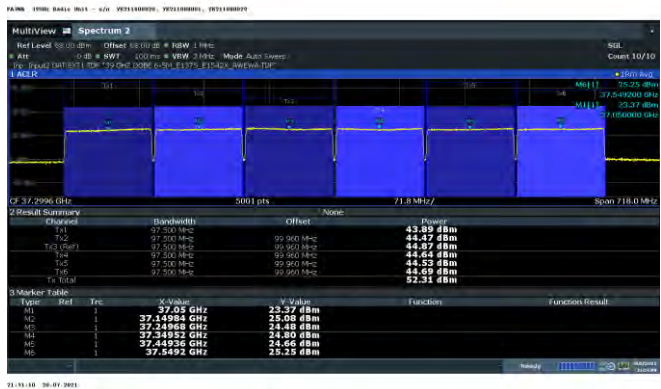
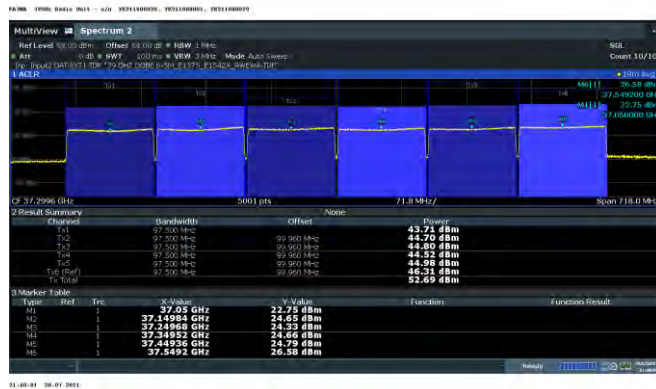
## Channel Power Measurements, 5 Carrier – QPSK – Left Side of Band

### Horizontal

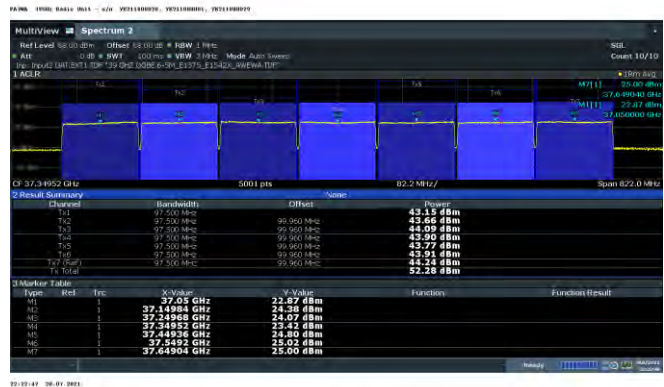
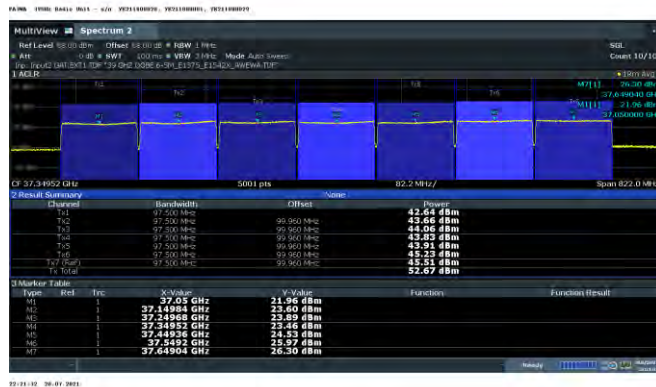


## Channel Power Measurements, 6 Carrier – QPSK – Left Side of Band

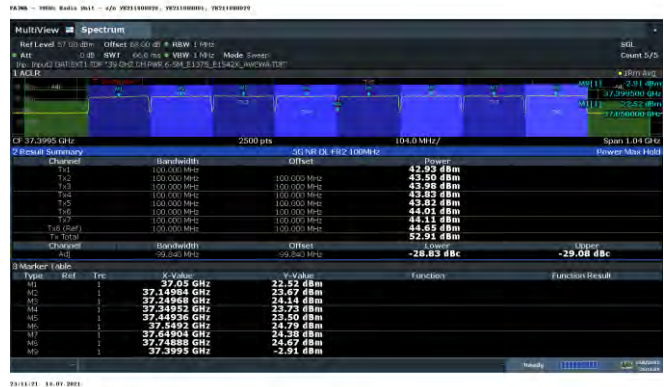
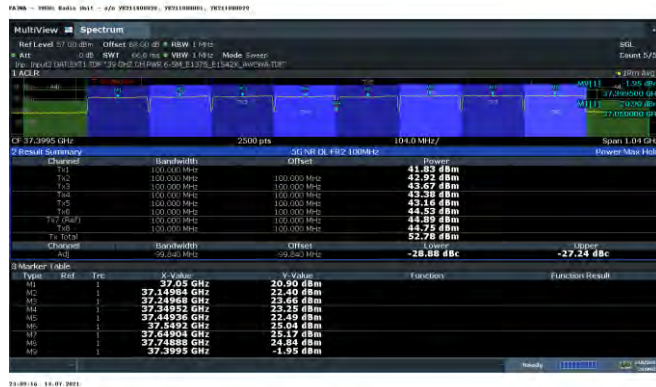
### Horizontal



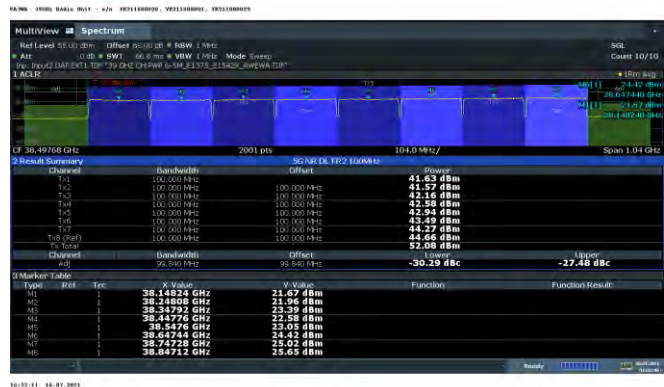
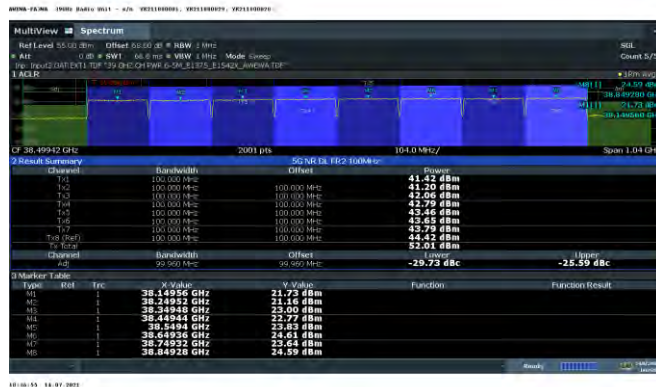
## Channel Power Measurements, 7 Carrier – QPSK – Left Side of Band



## Channel Power Measurements, 8 Carrier – QPSK – Left Side of Band

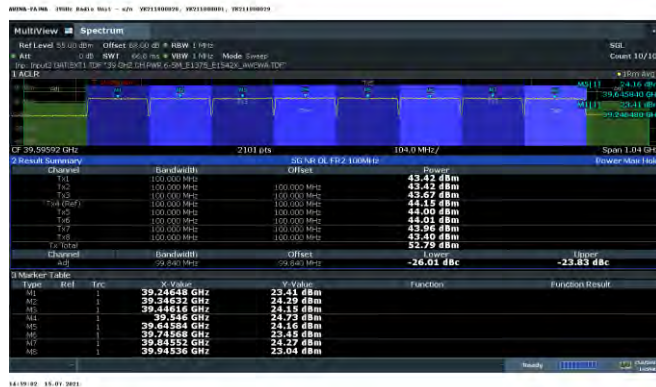


## Channel Power Measurements, 8 Carrier – 16QAM – Center of Band

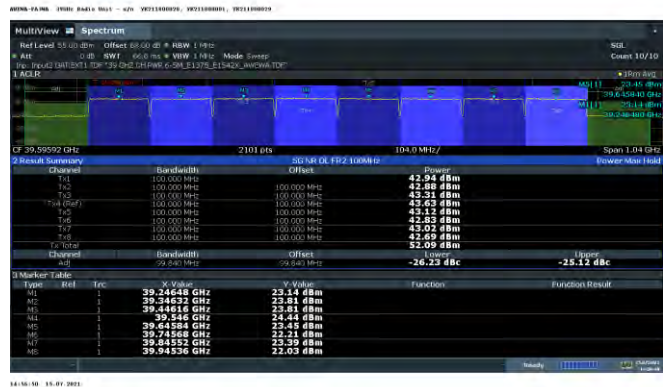


## Channel Power Measurements, 8 Carrier – 64QAM – Right Side of Band

### Horizontal



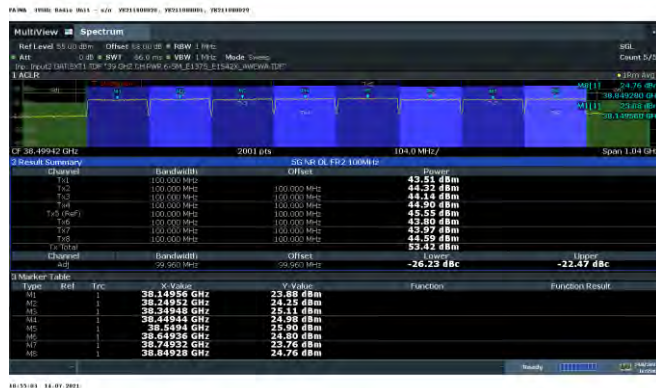
14/10/21 14:01:01



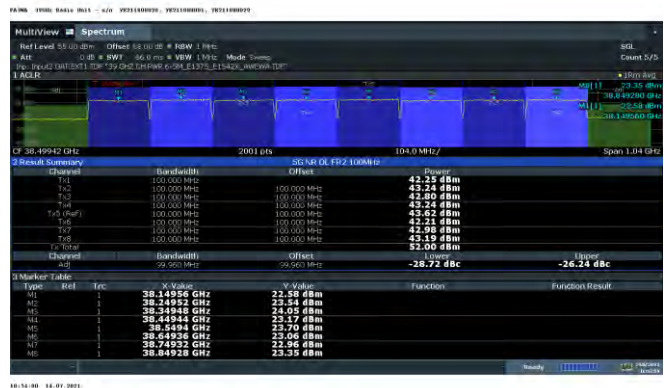
14/10/21 14:01:01

## Channel Power Measurements, 8 Carrier – 16QAM with 99.96 MHz channel spacing – Center of Band

### Horizontal



14/10/21 14:01:01



14/10/21 14:01:01

## 4.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERISTICS

The **2AD8UFA3WA01** 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 new Releases are expected. The constellations were recorded to assess that the subcarrier configurations were achieved.

There are no FCC Limits for Modulation and all of the formats presented look spectrally the same from a channel edge and regrowth standpoint and we are pleased with the fidelity that available with test equipment as configured.

### 4.2.1 Modulation Characteristics Measurement

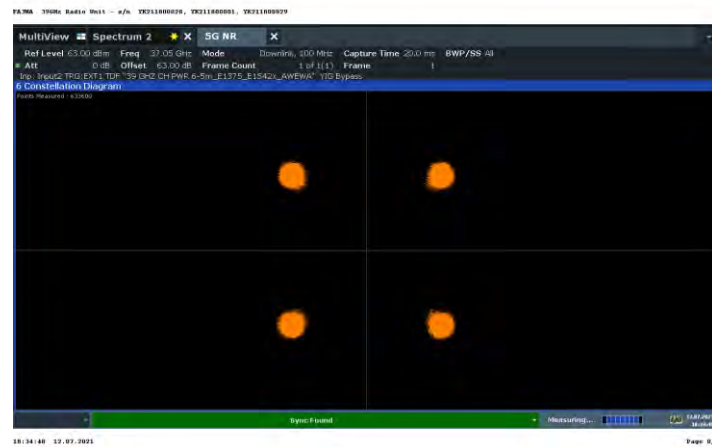
The measurements were performed at a distance of 6.5 m from the unit utilizing the test configuration in Figure 4.4.1 utilizing a Rohde & Schwarz FSW85 Signal analyzer with the 3GPP 5G-NR DL Measurement software option. Representative screen plots of the modulation measurement are attached below for all three of the subcarrier configurations and sample polarizations.

### 4.2.2 Modulation Measurements Results:

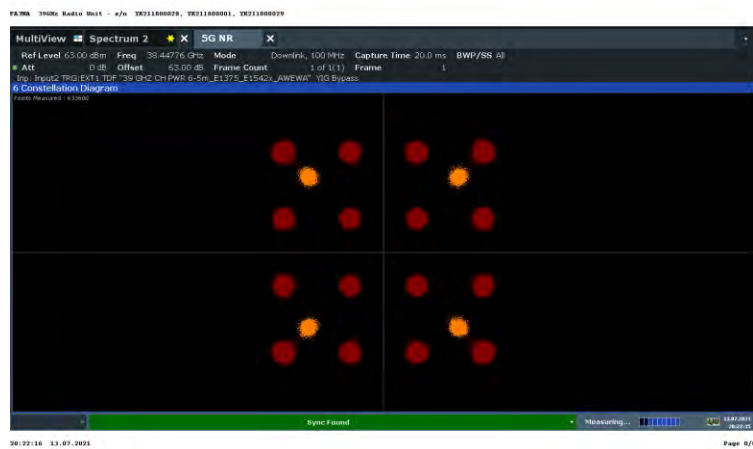
The typical measured modulation characteristics of the EUT are shown below:

Figure 4.2 Sample Modulation Results

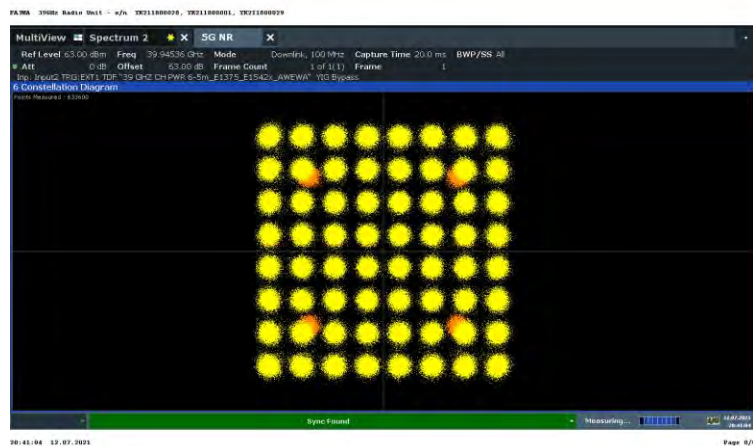
QPSK - Left - Vertical Polarization



16QAM - Middle - Vertical Polarization



64QAM - Right - Horizontal Polarization



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

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

The occupied bandwidth (OBW) is usually defined either 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 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 X dB below the transmitter power, where the value of X is typically specified as 26.

Per KDB 971168 D01 v02, 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 when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment is operated.

#### 4.3.1 Results Occupied Bandwidth (Signal Bandwidth)

The measurements of 99% occupied bandwidth were performed with a Rohde & Schwartz FSW85 GHz spectrum analyzer. The measurements of the intended 100 MHz 5G-NR carrier indicated compliance with the 97M0G7D emission designator. Sample results are presented below and shows that the measured signals are within the parameters of the 97M0G7D emissions designator. Most of the multicarrier measurements were made with a carrier spacing of 99.84 MHz. Center of band data for the 99.96MHz carrier spacing is also separately reported for the 8 carrier configuration.

Tabular Data – Occupied Bandwidth **1MHz** RBW

| Location in Band                 | Carrier Frequencies (GHz)        | Number of Carriers | Modulation | Horizontal Polarization Occupied Signal Bandwidth (MHz) | Vertical Polarization Occupied Signal Bandwidth (MHz) |
|----------------------------------|----------------------------------|--------------------|------------|---------------------------------------------------------|-------------------------------------------------------|
| Left                             | 37.05                            | 1                  | QPSK       | 94.338                                                  | 94.179                                                |
| Middle                           | 38.38776                         | 1                  | 16QAM      | 94.172                                                  | 94.137                                                |
| Right                            | 39.88536                         | 1                  | 64QAM      | 94.247                                                  | 94.281                                                |
| Left                             | 37.05<br>37.14984                | 2                  | QPSK       | 193.642                                                 | 193.037                                               |
| Left                             | 37.05000<br>37.14984<br>37.24968 | 3                  | QPSK       | 292.386                                                 | 291.710                                               |
| Left                             | 37.05<br>To<br>37.34952          | 4                  | QPSK       | 391.384                                                 | 390.396                                               |
| Left                             | 37.05<br>To<br>37.44936          | 5                  | QPSK       | 490.602                                                 | 489.518                                               |
| Left                             | 37.05<br>To<br>37.5492           | 6                  | QPSK       | 589.184                                                 | 589.183                                               |
| Left                             | 37.05<br>To<br>37.64904          | 7                  | QPSK       | 687.669                                                 | 686.709                                               |
| Left                             | 37.05<br>To<br>37.74888          | 8                  | QPSK       | 785.901                                                 | 785.698                                               |
| Middle                           | 38.14824<br>To<br>38.84712       | 8                  | 16QAM      | 786.983                                                 | 787.271                                               |
| Right                            | 39.24648<br>To<br>39.94536       | 8                  | 64QAM      | 787.011                                                 | 786.674                                               |
| <b>99.96 MHz Carrier Spacing</b> |                                  |                    |            |                                                         |                                                       |
| Middle                           | 38.14956<br>To<br>38.84928       | 8                  | 16QAM      | 788.072                                                 | 787.800                                               |

**Tabular Data – Occupied Bandwidth 3MHz RBW**

| Location in Band                 | Carrier Frequencies (GHz)        | Number of Carriers | Modulation | Horizontal Polarization Occupied Signal Bandwidth (MHz) | Vertical Polarization Occupied Signal Bandwidth (MHz) |
|----------------------------------|----------------------------------|--------------------|------------|---------------------------------------------------------|-------------------------------------------------------|
| Left                             | 37.05                            | 1                  | QPSK       | 95.468                                                  | 95.200                                                |
| Middle                           | 38.38776                         | 1                  | 16QAM      | 95.166                                                  | 95.111                                                |
| Right                            | 39.88536                         | 1                  | 64QAM      | 95.300                                                  | 95.366                                                |
| Left                             | 37.05<br>37.14984                | 2                  | QPSK       | 194.538                                                 | 193.540                                               |
| Left                             | 37.05000<br>37.14984<br>37.24968 | 3                  | QPSK       | 292.778                                                 | 291.878                                               |
| Left                             | 37.05<br>To<br>37.34952          | 4                  | QPSK       | 391.514                                                 | 390.470                                               |
| Left                             | 37.05<br>To<br>37.44936          | 5                  | QPSK       | 490.766                                                 | 489.242                                               |
| Left                             | 37.05<br>To<br>37.5492           | 6                  | QPSK       | 589.237                                                 | 588.020                                               |
| Left                             | 37.05<br>To<br>37.64904          | 7                  | QPSK       | 687.575                                                 | 686.924                                               |
| Left                             | 37.05<br>To<br>37.74888          | 8                  | QPSK       | 785.857                                                 | 785.637                                               |
| Middle                           | 38.14824<br>To<br>38.84712       | 8                  | 16QAM      | 786.916                                                 | 787.315                                               |
| Right                            | 39.24648<br>To<br>39.94536       | 8                  | 64QAM      | 786.836                                                 | 786.520                                               |
| <b>99.96 MHz Carrier Spacing</b> |                                  |                    |            |                                                         |                                                       |
| Middle                           | 38.14956<br>To<br>38.84928       | 8                  | 16QAM      | 787.800                                                 | 787.780                                               |

**Tabular Data – Occupied Bandwidth 5MHz RBW**

| Location in Band                 | Carrier Frequencies (GHz)        | Number of Carriers | Modulation | Horizontal Polarization Occupied Signal Bandwidth (MHz) | Vertical Polarization Occupied Signal Bandwidth (MHz) |
|----------------------------------|----------------------------------|--------------------|------------|---------------------------------------------------------|-------------------------------------------------------|
| Left                             | 37.05                            | 1                  | QPSK       | 97.237                                                  | 96.845                                                |
| Middle                           | 38.38776                         | 1                  | 16QAM      | 96.783                                                  | 96.697                                                |
| Right                            | 39.88536                         | 1                  | 64QAM      | 96.968                                                  | 97.060                                                |
| Left                             | 37.05<br>37.14984                | 2                  | QPSK       | 195.963                                                 | 194.625                                               |
| Left                             | 37.05000<br>37.14984<br>37.24968 | 3                  | QPSK       | 292.571                                                 | 292.571                                               |
| Left                             | 37.05<br>To<br>37.34952          | 4                  | QPSK       | 392.115                                                 | 390.877                                               |
| Left                             | 37.05<br>To<br>37.44936          | 5                  | QPSK       | 491.291                                                 | 489.741                                               |
| Left                             | 37.05<br>To<br>37.5492           | 6                  | QPSK       | 589.574                                                 | 588.292                                               |
| Left                             | 37.05<br>To<br>37.64904          | 7                  | QPSK       | 687.753                                                 | 686.808                                               |
| Left                             | 37.05<br>To<br>37.74888          | 8                  | QPSK       | 785.945                                                 | 785.694                                               |
| Middle                           | 38.14824<br>To<br>38.84712       | 8                  | 16QAM      | 786.922                                                 | 787.318                                               |
| Right                            | 39.24648<br>To<br>39.94536       | 8                  | 64QAM      | 786.977                                                 | 786.571                                               |
| <b>99.96 MHz Carrier Spacing</b> |                                  |                    |            |                                                         |                                                       |
| Middle                           | 38.14956<br>To<br>38.84928       | 8                  | 16QAM      | 788.205                                                 | 787.856                                               |

Tabular Data – Occupied Bandwidth **10MHz** RBW

| Location in Band                 | Carrier Frequencies (GHz)  | Number of Carriers | Modulation | Horizontal Polarization Occupied Signal Bandwidth (MHz) | Vertical Polarization Occupied Signal Bandwidth (MHz) |
|----------------------------------|----------------------------|--------------------|------------|---------------------------------------------------------|-------------------------------------------------------|
| Left                             | 37.05<br>To<br>37.74888    | 8                  | QPSK       | 786.937                                                 | 786.602                                               |
| Middle                           | 38.14824<br>To<br>38.84712 | 8                  | 16QAM      | 788.178                                                 | 788.567                                               |
| Right                            | 39.24648<br>To<br>39.94536 | 8                  | 64QAM      | 788.049                                                 | 787.522                                               |
| <b>99.96 MHz Carrier Spacing</b> |                            |                    |            |                                                         |                                                       |
| Middle                           | 38.14956<br>To<br>38.84928 | 8                  | 16QAM      | 789.446                                                 | 788.985                                               |

#### 4.3.1.1 Results - Occupied Bandwidth Carrier Aggregation

The April 12, 2016 TCBC viewgraph package identified that Carrier Aggregation data should be supplied during filing. This requirement is not yet formalized in a KDB for LTE, 5G-NR or UMFUS but we used the same rules as used for Part 15. The multi-carrier bandwidth of the **AWEWA/B** is thus defined as follows.

The N260 39 GHz Band can be assigned a total of 30 side by side carriers over the 37-40 GHz frequency range. The AWEWA/B can be operated anywhere within this 3 GHz wide band.

The AWEWA/B product can support up to eight carriers operating within its maximum instantaneous 1.4 GHz bandwidth. Additionally, we have evaluated carrier spacing configuration of 99.96 MHz and 99.84 MHz respectively. There is a 1% difference in the occupied signal bandwidth for eight aggregated carriers which was expected. There was no difference identified for Power, radiated spurious or OOB measurements with either spacing.

An example of the signal bandwidth for 4 adjacent carriers is depicted in Figure 4.3.1.1. The emissions designator for 2 thru seven is identical for either spacing. The eight carrier spacing using 99.84 MHz is 99.9% of the 99.96 spacing so a single emissions designator is appropriate.

The maximum calculated assessment for two through eight carriers using 99.96 and 99.84 channel spacings are identified below.

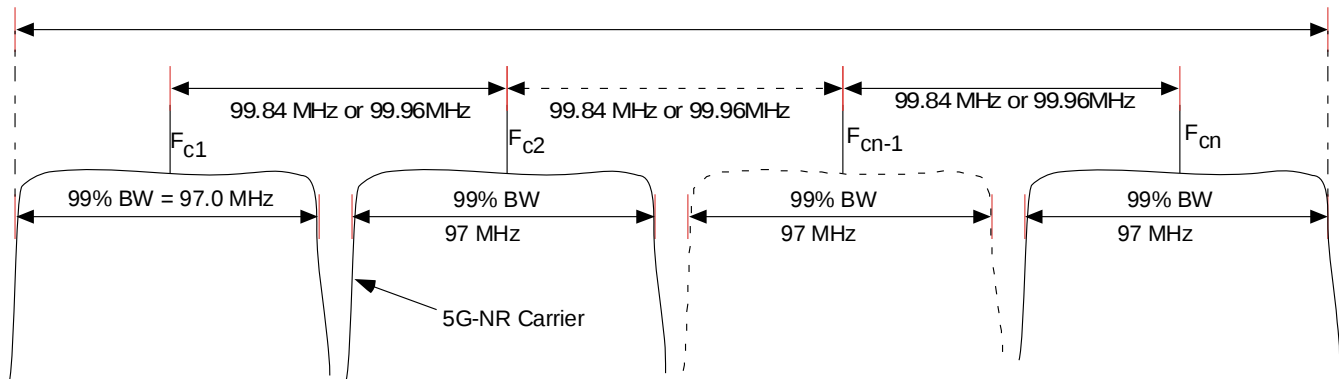
|                                     |                                            |
|-------------------------------------|--------------------------------------------|
| Two Carrier Aggregation Bandwidth   | = 1(99.96) + 97 MHz = 196.96 MHz = 197MG7W |
| Three Carrier Aggregation Bandwidth | = 2(99.96) + 97 MHz = 296.92 MHz = 297MG7W |
| Four Carrier Aggregation Bandwidth  | = 3(99.96) + 97 MHz = 396.88 MHz = 397MG7W |
| Five Carrier Aggregation Bandwidth  | = 4(99.96) + 97 MHz = 496.84 MHz = 497MG7W |
| Six Carrier Aggregation Bandwidth   | = 5(99.96) + 97 MHz = 596.80 MHz = 597MG7W |
| Seven Carrier Aggregation Bandwidth | = 6(99.96) + 97 MHz = 696.76 MHz = 697MG7W |
| Eight Carrier Aggregation Bandwidth | = 7(99.96) + 97 MHz = 796.72 MHz = 797MG7W |

The maximum calculated assessment for two through eight carriers using 99.84 channel spacing are identified below.

|                                     |                                            |
|-------------------------------------|--------------------------------------------|
| Two Carrier Aggregation Bandwidth   | = 1(99.84) + 97 MHz = 196.84 MHz = 197MG7W |
| Three Carrier Aggregation Bandwidth | = 2(99.84) + 97 MHz = 296.68 MHz = 297MG7W |
| Four Carrier Aggregation Bandwidth  | = 3(99.84) + 97 MHz = 396.52 MHz = 397MG7W |
| Five Carrier Aggregation Bandwidth  | = 4(99.84) + 97 MHz = 496.36 MHz = 497MG7W |
| Six Carrier Aggregation Bandwidth   | = 5(99.84) + 97 MHz = 596.20 MHz = 597MG7W |
| Seven Carrier Aggregation Bandwidth | = 6(99.84) + 97 MHz = 696.04 MHz = 697MG7W |
| Eight Carrier Aggregation Bandwidth | = 7(99.84) + 97 MHz = 795.88 MHz ≤ 797MG7W |

Since the values are identical for two through seven and nearly so for eight carriers the 99.96 set will be used.

Figure 4.3.1.1 Carrier Aggregation

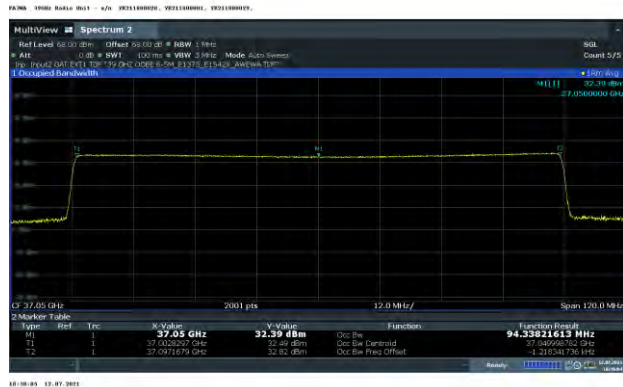


Carrier Aggregation nx(97M0)  
WSM 7-12-21

### 4.3.1.2 99% Signal Bandwidth Plots

1MHz RBW

#### 1 Carrier, Left, QPSK Horizontal



#### Vertical



#### 1 Carrier, Middle, 16QAM Horizontal



#### Vertical



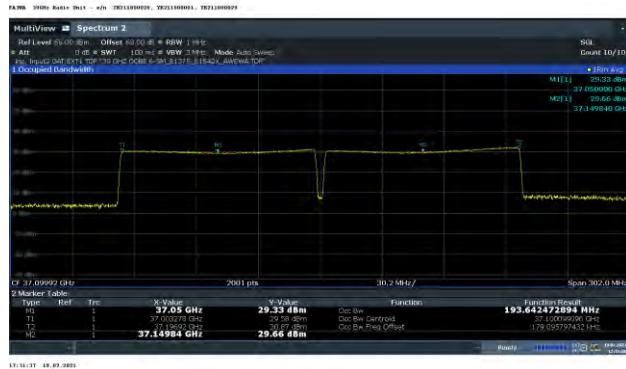
#### 1 Carrier, Right, 64QAM Horizontal



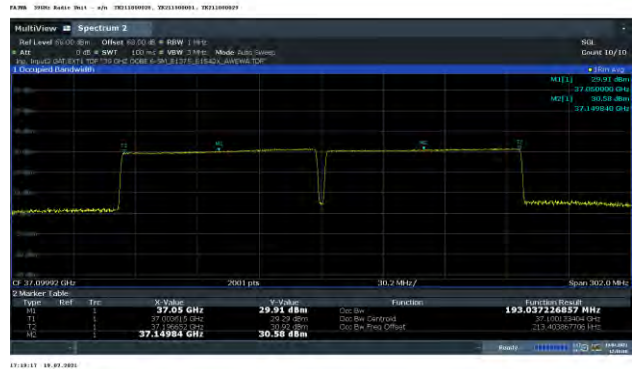
#### Vertical



## 2 Carrier, Left, QPSK Horizontal



## Vertical



## 3 Carrier, Left, QPSK Horizontal



## Vertical



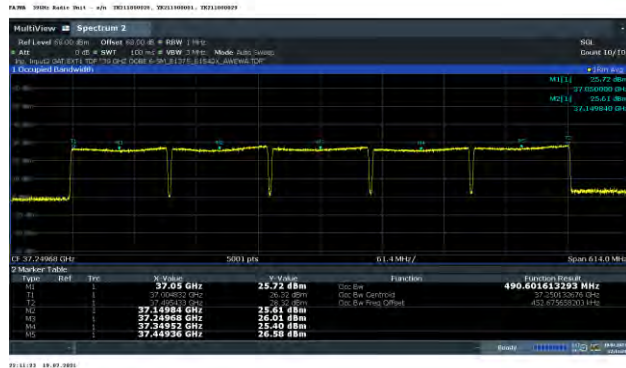
## 4 Carrier, Left, QPSK Horizontal



## Vertical



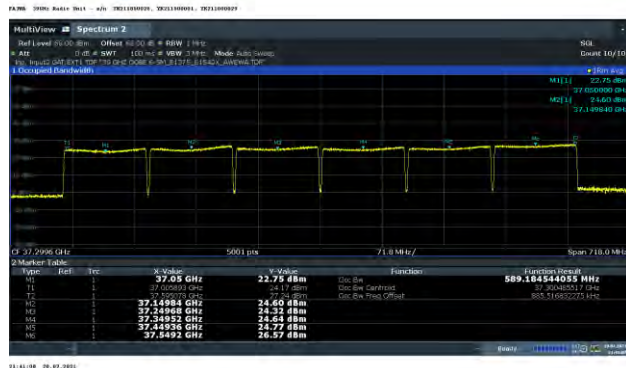
## 5 Carrier, Left, QPSK Horizontal



## Vertical



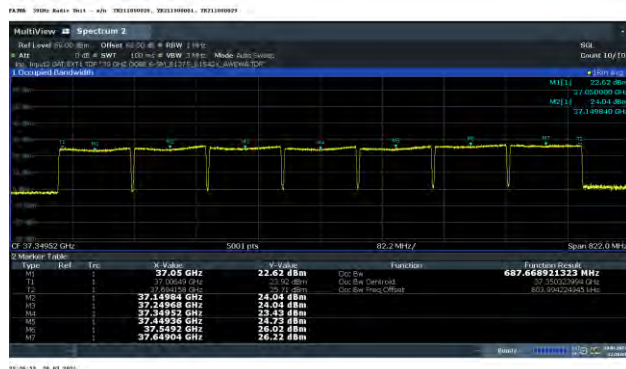
## 6 Carrier, Left, QPSK Horizontal



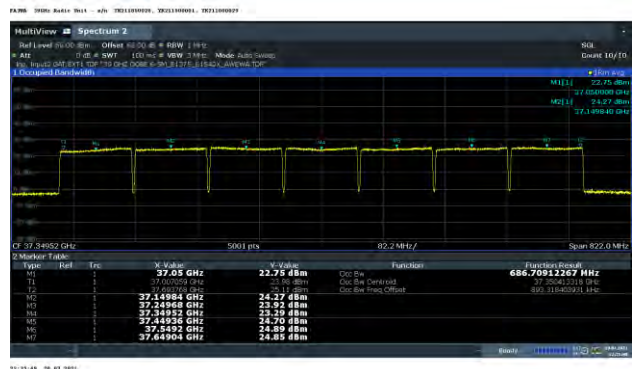
## Vertical



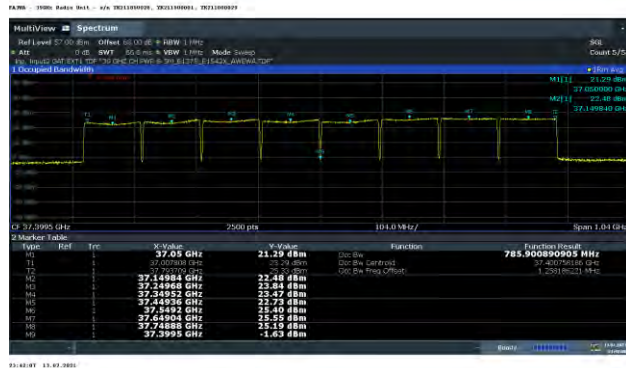
## 7 Carrier, Left, QPSK Horizontal



## Vertical



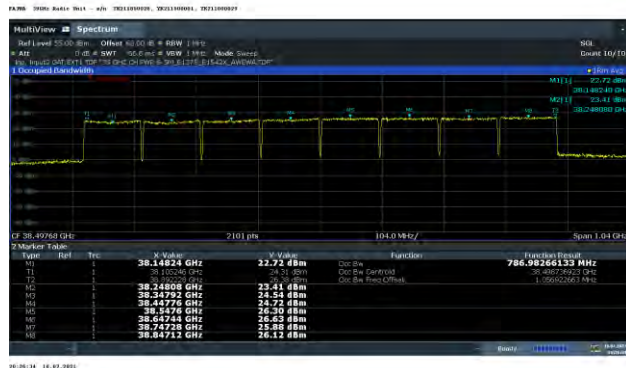
## 8 Carrier, Left, QPSK Horizontal



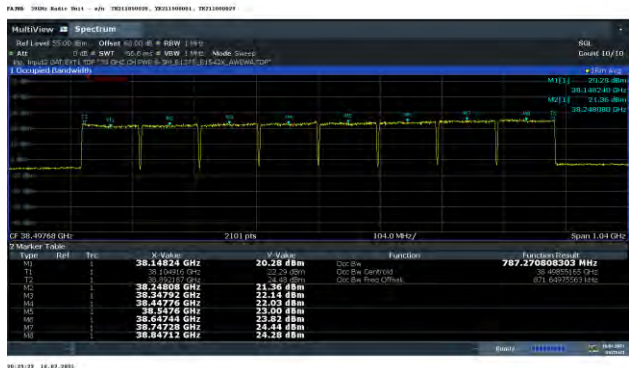
## Vertical



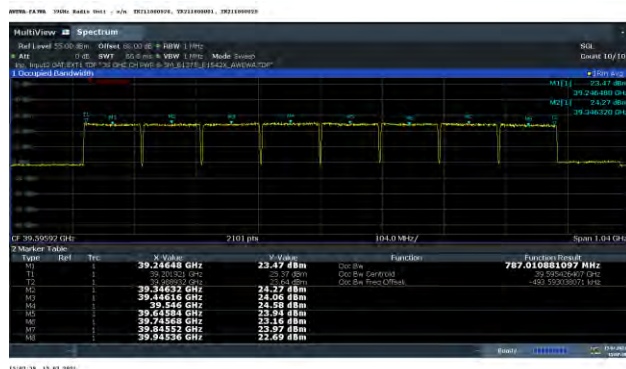
## 8 Carrier, Middle, 16QAM Horizontal



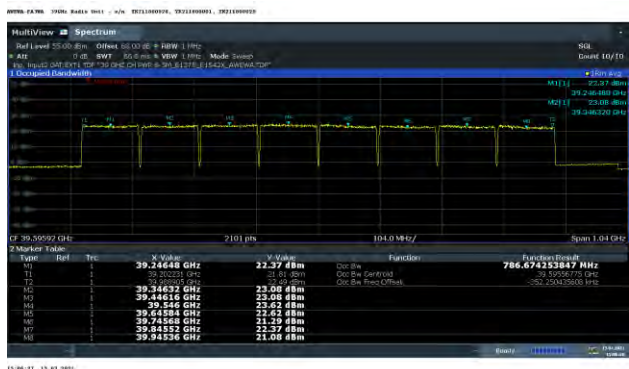
## Vertical



## 8 Carrier, Right, 64QAM Horizontal



## Vertical



8 Carrier, Middle, 16QAM with 99.96 MHz channel spacing  
Horizontal

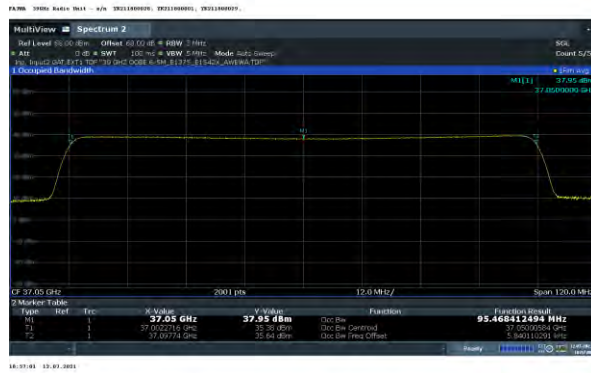


Vertical

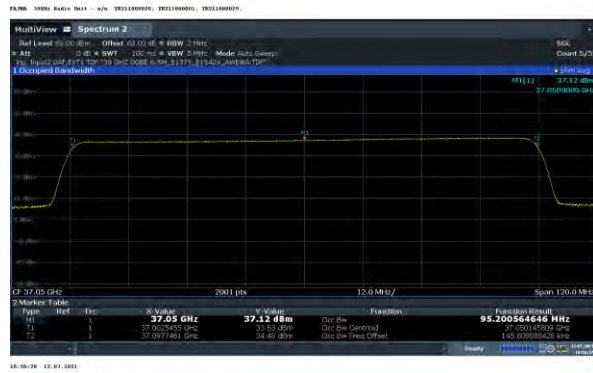


### 3MHz RBW

#### 1 Carrier, Left, QPSK Horizontal



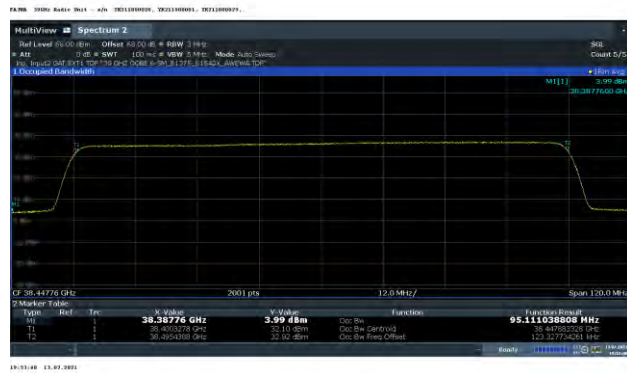
#### Vertical



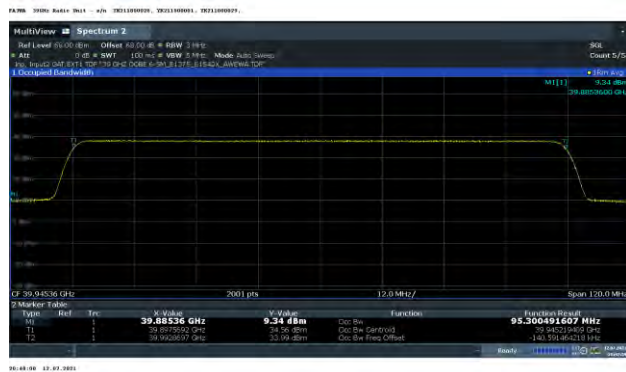
#### 1 Carrier, Middle, 16QAM Horizontal



#### Vertical



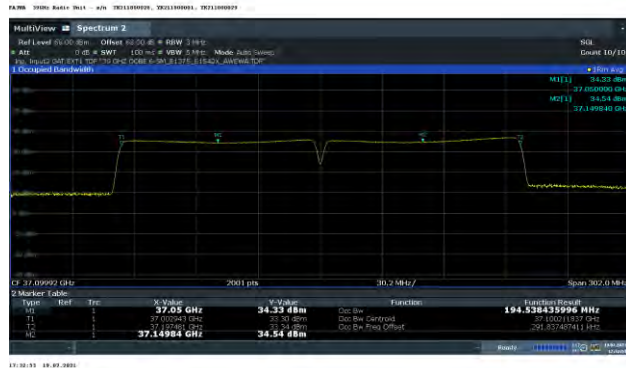
#### 1 Carrier, Right, 64QAM Horizontal



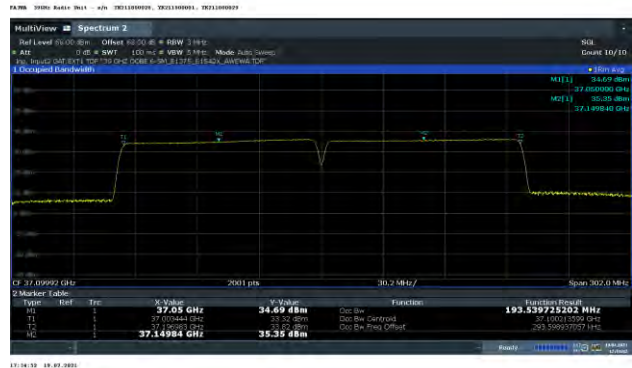
#### Vertical



## 2 Carrier, Left, QPSK Horizontal



## Vertical



## 3 Carrier, Left, QPSK Horizontal



## Vertical



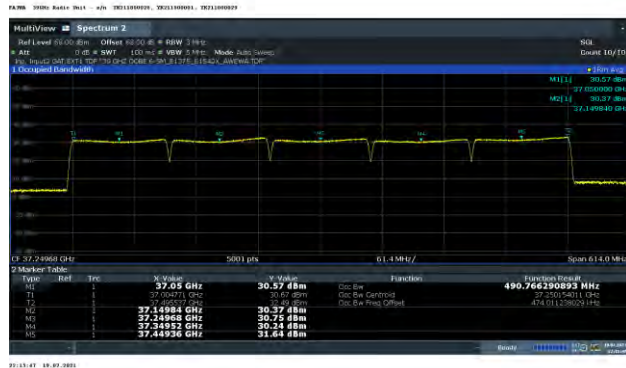
## 4 Carrier, Left, QPSK Horizontal



## Vertical



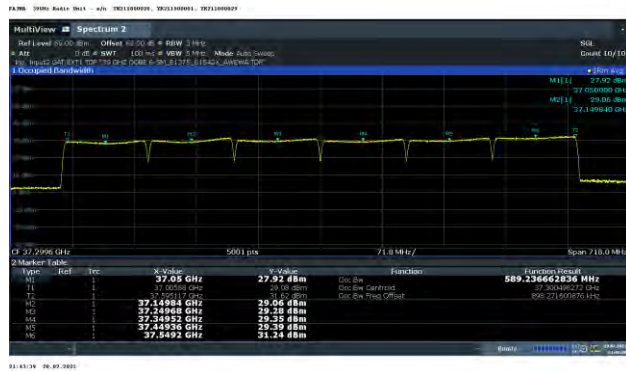
## 5 Carrier, Left, QPSK Horizontal



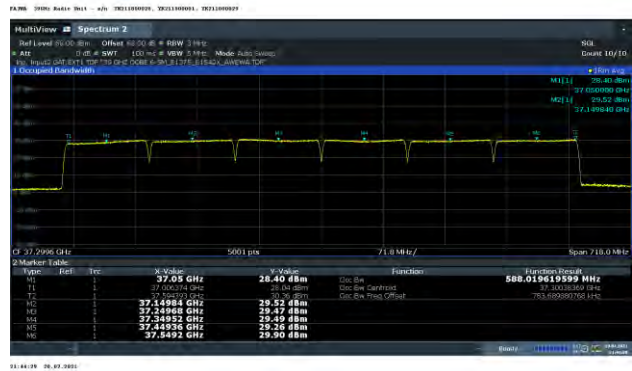
## Vertical



## 6 Carrier, Left, QPSK Horizontal



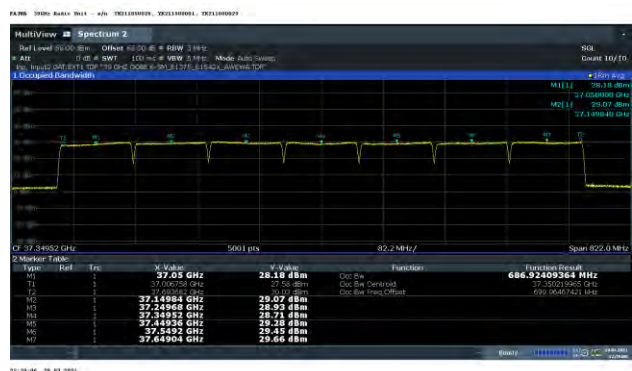
## Vertical



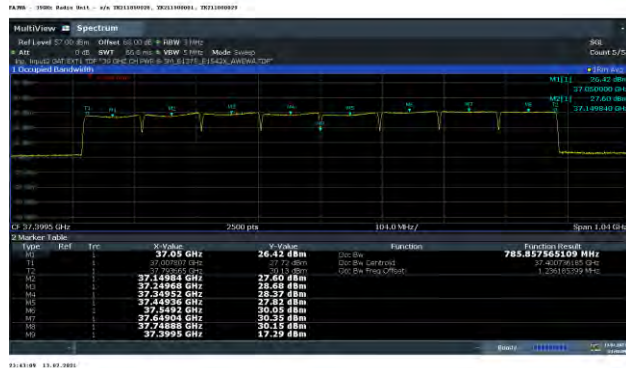
## 7 Carrier, Left, QPSK Horizontal



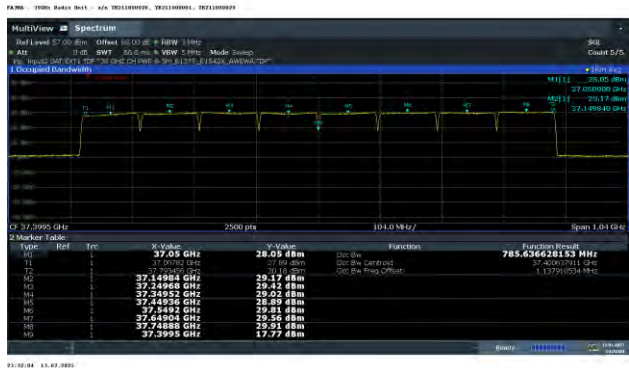
## Vertical



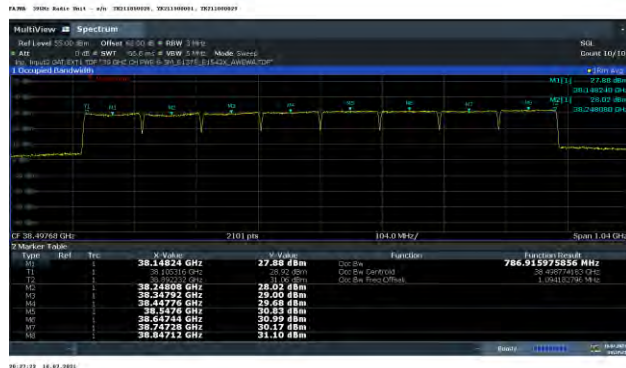
## 8 Carrier, Left, QPSK Horizontal



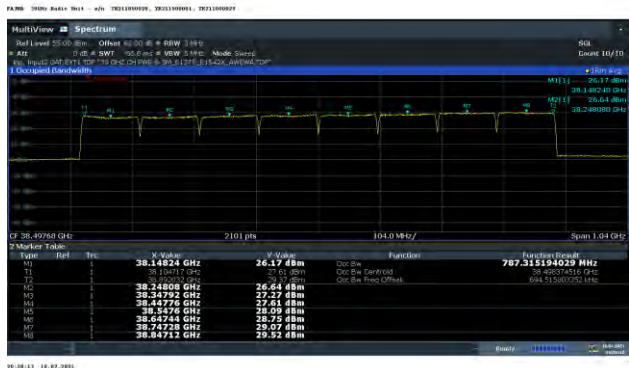
## Vertical



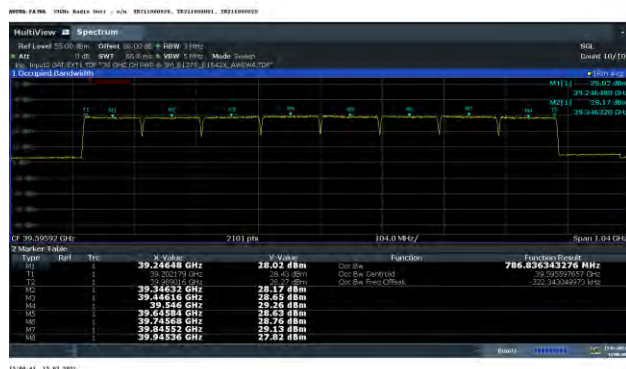
## 8 Carrier, Middle, 16QAM Horizontal



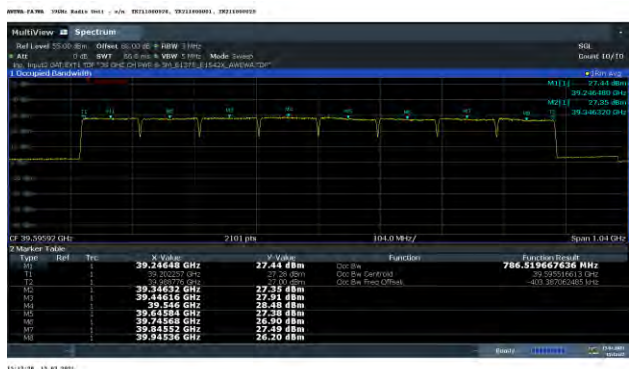
## Vertical



## 8 Carrier, Right, 64QAM Horizontal



## Vertical



8 Carrier, Middle, 16QAM with 99.96 MHz channel spacing  
Horizontal



### 1 Carrier, Left, QPSK Horizontal



## 19:08:54 12.07.2011

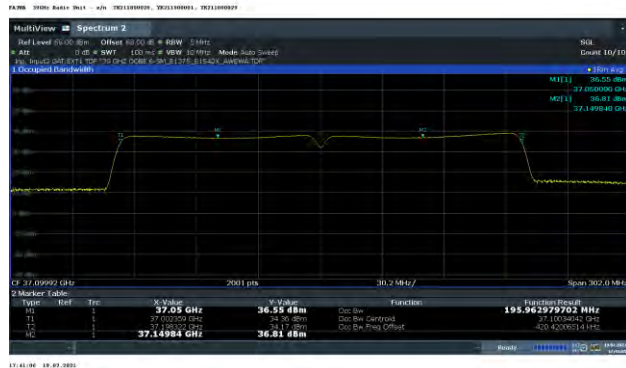
## 19:55:20 13.07.2021

## 19:54:25 - 13.07.2011

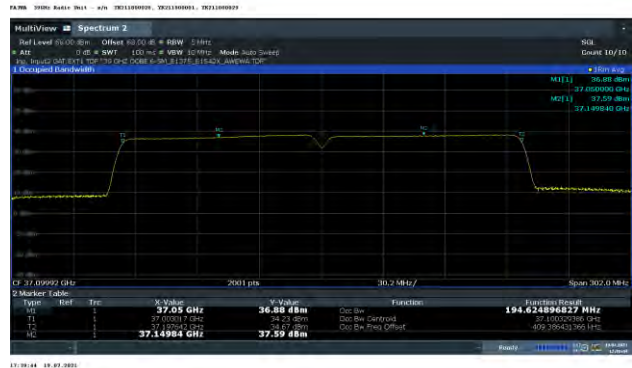
2010年11月16日 星期三 11:22:20

## 2016: 66:22 52-62-20

## 2 Carrier, Left, QPSK Horizontal



## Vertical



## 3 Carrier, Left, QPSK Horizontal



## Vertical



## 4 Carrier, Left, QPSK Horizontal



## Vertical



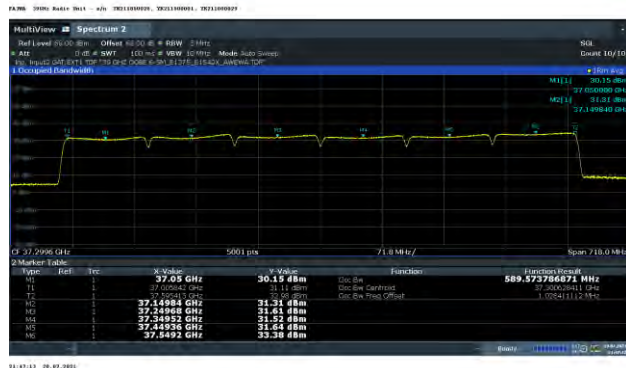
## 5 Carrier, Left, QPSK Horizontal



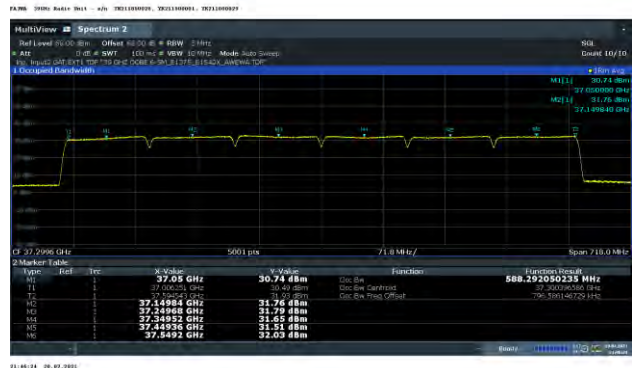
## Vertical



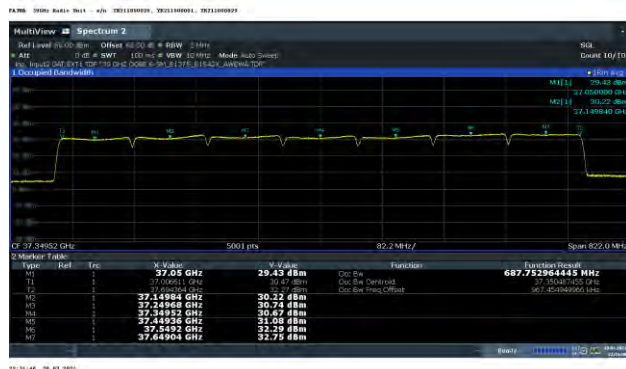
## 6 Carrier, Left, QPSK Horizontal



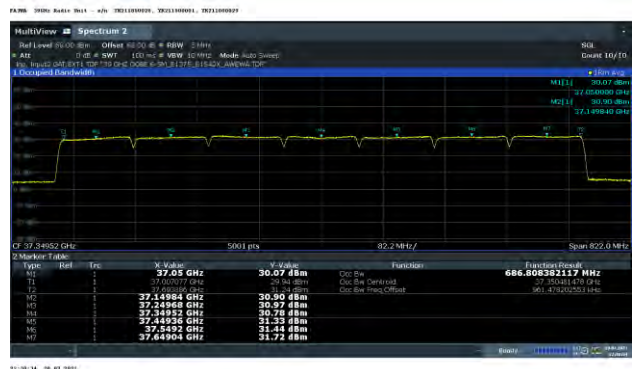
## Vertical



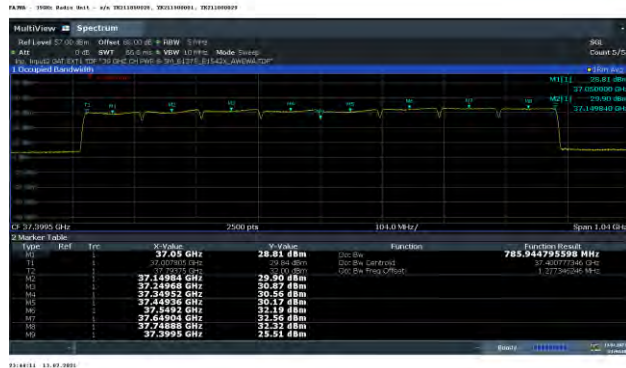
## 7 Carrier, Left, QPSK Horizontal



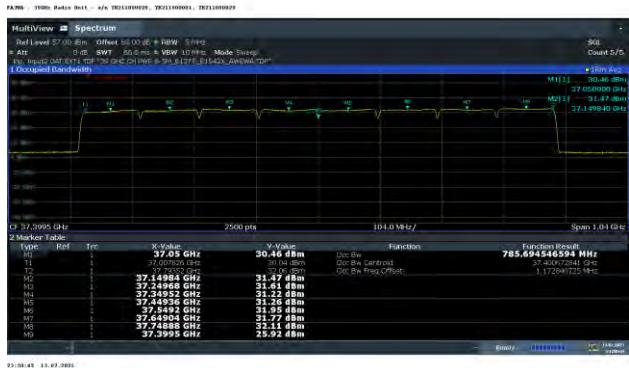
## Vertical



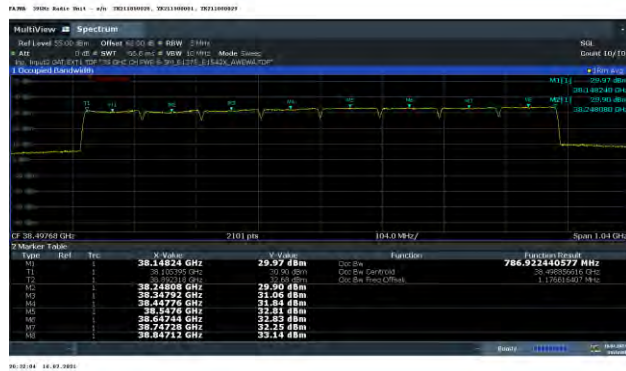
## 8 Carrier, Left, QPSK Horizontal



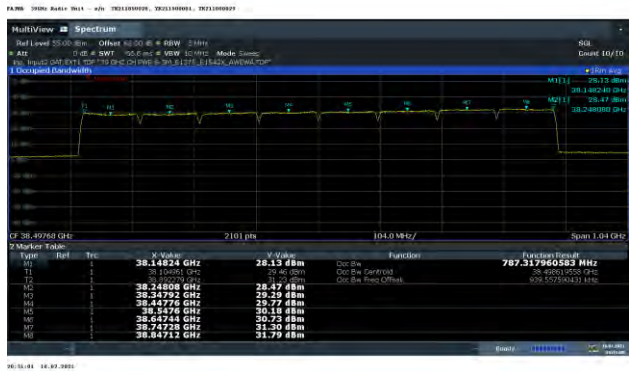
## Vertical



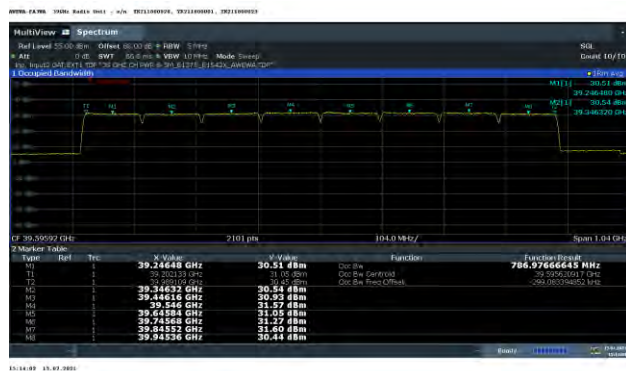
## 8 Carrier, Middle, 16QAM Horizontal



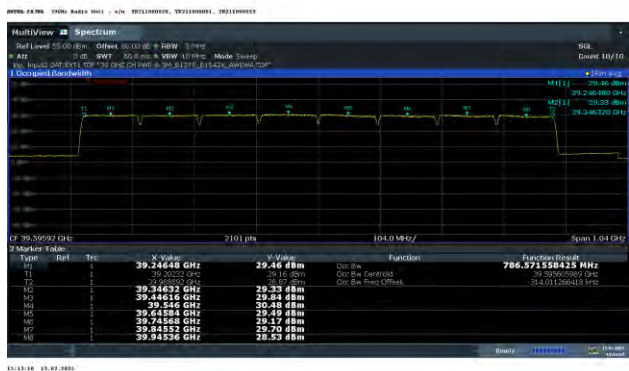
## Vertical



## 8 Carrier, Right, 64QAM Horizontal



## Vertical



8 Carrier, Middle, 16QAM with 99.96 MHz channel spacing  
Horizontal

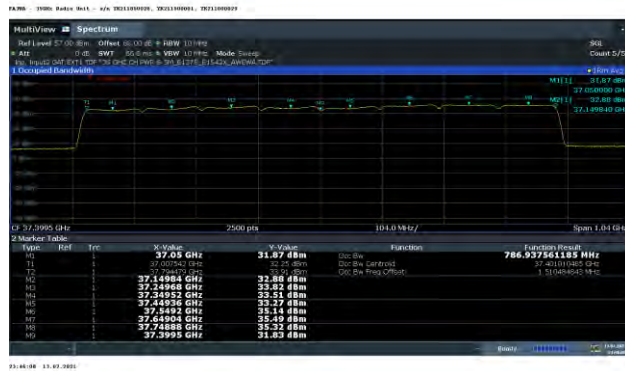


Vertical

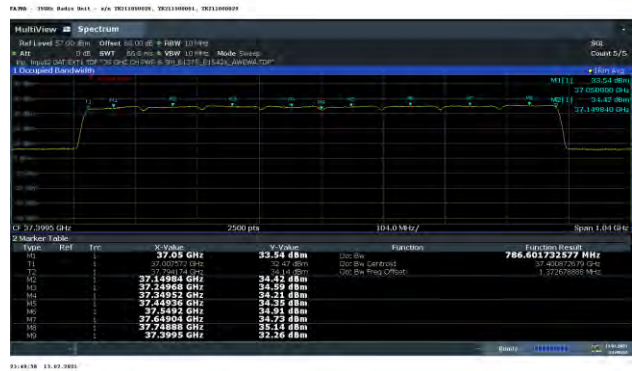


## 10MHz RBW

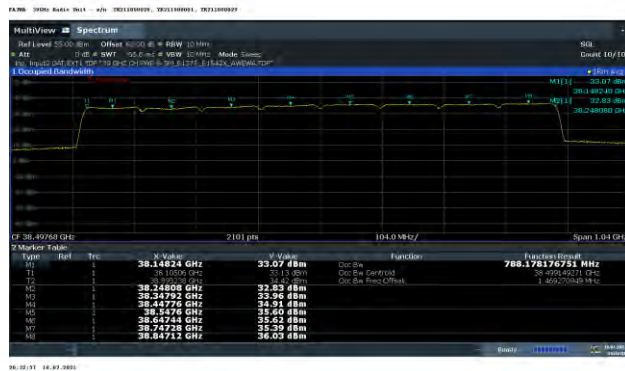
### 8 Carrier, Left, QPSK Horizontal



### Vertical



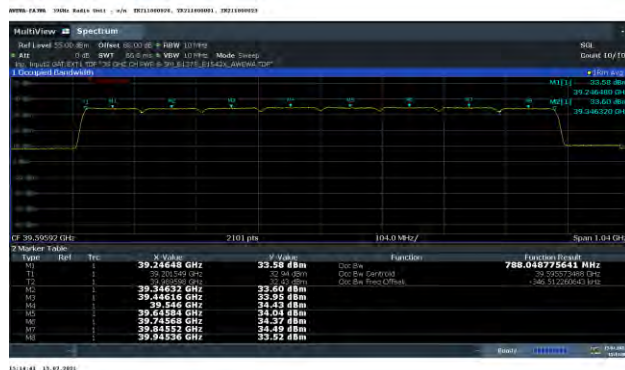
### 8 Carrier, Middle, 16QAM Horizontal



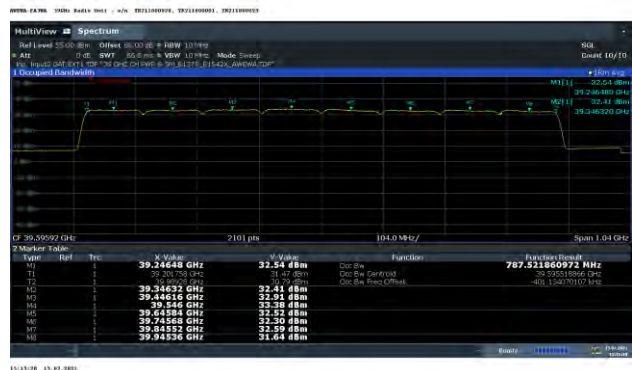
### Vertical



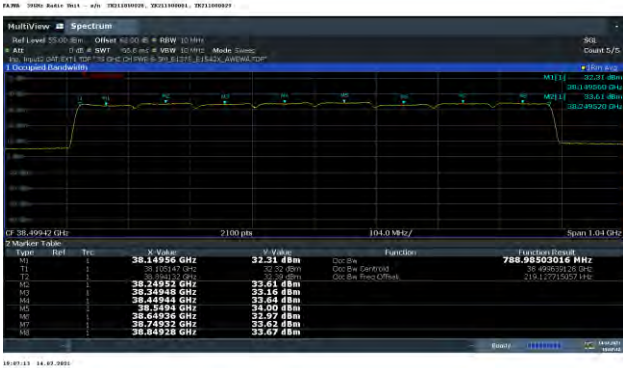
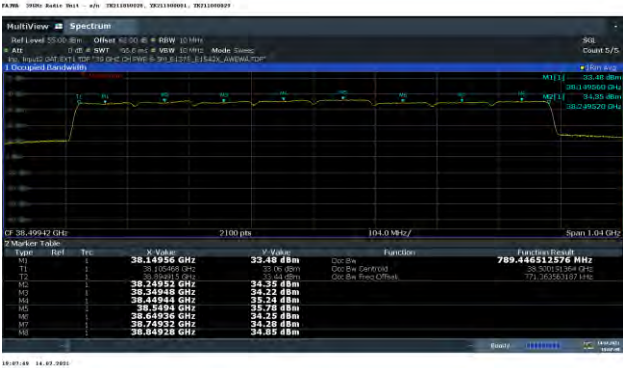
### 8 Carrier, Right, 64QAM Horizontal



### Vertical



8 Carrier, Middle, 16QAM with 99.96 MHz channel spacing  
Horizontal  
Vertical



#### 4.3.2 Occupied Bandwidth-Edge of Block Emissions

The classical Occupied Bandwidth measurement of Edge of Block Emissions or conveniently Out Of Band Emissions (OOBE) is an evaluation of the transmit carrier compliance with edge of block/edge of band requirements. This measurement documents the product's ability to maintain compliance with FCC Parts 2 and Part 30.203 limitations on emissions outside the block/ band of operation.

The **2AD8UFA3WA01 AWEWA/B 5G AirScale 39 GHz mmWave Radio** Unit presently supports nominal 100 MHz bandwidth 5G-New Radio LTE TDD technologies. The Out Of Band evaluation addresses operation with one through eight carriers.

The OOBE evaluation is used to measure the maximum average spurious levels outside the transmit band as measured at the 6.5m boundary distance. The measurements were performed for one carrier which is the maximum spectral density carrier at the left, center and right side of band, two thru eight carriers at the left side of band and eight carriers at the left, center and right side of band. Additionally, the eight carrier non-adjacent configurations when spaced across the maximum instantaneous bandwidth of 1.4 GHz were evaluated at left side and right side of the band.

For each configuration channel power and modulation were verified prior to other measurements. The measurement process meets the requirements of ANSI C63.26 and ISO17025. The test setup was as shown in Figure 4.1.1. Measurements were performed in the far field at 6.5m for both vertical and horizontal polarizations.

The Out Of Band Emissions of each of the signals identified in Table 4.3.6 was measured using a Rohde & Schwarz FSW85 Spectrum analyzer, a remote PC based instrumentation controller and the same calibrated RF attenuation path used for channel power. The correction included the products antenna gain to correct the emissions to the relative "antenna connection" port. All spurious emissions > 10% Signal BW outside the band was evaluated for compliance without the product gain as is required.

Plots are provided using the triggered functionality of the test analyzer and demonstrate compliance with edge of band limits.

These sheets contain data for multiple mixed carrier configurations for Left Edge, Center and Right Edge of the 39 GHz Part 30 Upper Microwave Flexible Use Service spectrum.

#### 4.3.3 Requirements 39 GHz Emissions Limits

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

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

In order to address the limit as imposed for the requirement in 47CFR 96.41 we evaluated emissions per the requirements in ANSI C63.26 and per KDB 940660 D01 Part 30 CBRS Equipment.

The average detector function was used for all MXA measurements and the Peak detector function were used for EMC receiver measurements.

#### 4.3.4 Measurement Offset and MIMO

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

#### 4.3.5 Mask Parameters

The mask parameters are in units as stated in Part 30 and are listed in Table 4.3.5. Mask parameters are as stated in Table 4.3.5. The Guard band was adjusted for 10% of the maximum signal bandwidth (80 MHz).

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

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

| Frequency | Part 30 Limit |
|-----------|---------------|
| GHz       | dBm           |
| 35.00     | -13           |
| 36.00     | -13           |
| 36.92     | -13           |
| 36.92     | -5            |
| 37.00     | -5            |
| 37.00     | 57            |
| 40.00     | 57            |
| 40.00     | -5            |
| 40.08     | -5            |
| 40.08     | -13           |
| 43.00     | -13           |

#### 4.3.6 Measurement Path Adjustments

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

**Sample calculation:** The sample calculation below is the formula and the correction for 35 GHz;  
Adjustment = Free Space Path Loss - Measurement Antenna Gain + Cable Loss - Product Antenna Gain.  
Total Required Adjustment (@35 GHz) = **50.32 dB** = 79.58 dB -23.96dBi + 12.84dB – 18.14 dBi

This adjustment was only used for the OOBE/EoB frequency range. Table 4.3.6 below lists the offset correction factors used for the measurement distance of 6.5m including the FA3WA product gain. The measurements were made using a flat offset of 44 dB with a transducer correction identified below.

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

| Frequency | Free Space Path Loss, PL | Measurement Antenna Gain, "G" | Measurement Cable Loss, "L" | PL-G1+L1 | AEWF Antenna Gain, IEEE | Total Required Adjustment | FSW Offset | Transducer Correction Factor |
|-----------|--------------------------|-------------------------------|-----------------------------|----------|-------------------------|---------------------------|------------|------------------------------|
| GHz       | dB                       | dBi                           | dB                          | dB       | dBi                     | dB                        | dB         | dB                           |
| 35.00     | 79.58                    | 23.96                         | 12.84                       | 68.46    | 18.14                   | 50.32                     | 44         | 6.324                        |
| 35.50     | 79.70                    | 23.52                         | 13.03                       | 69.21    | 20.05                   | 49.16                     | 44         | 5.162                        |
| 36.00     | 79.83                    | 24.27                         | 13.20                       | 68.75    | 21.97                   | 46.78                     | 44         | 2.784                        |
| 36.50     | 79.95                    | 23.28                         | 13.35                       | 70.01    | 22.81                   | 47.20                     | 44         | 3.203                        |
| 37.00     | 80.06                    | 24.42                         | 13.39                       | 69.04    | 23.65                   | 45.39                     | 44         | 1.387                        |
| 37.50     | 80.18                    | 23.27                         | 13.39                       | 70.29    | 23.82                   | 46.47                     | 44         | 2.469                        |
| 38.00     | 80.30                    | 24.29                         | 13.45                       | 69.45    | 23.99                   | 45.46                     | 44         | 1.461                        |
| 38.50     | 80.41                    | 23.18                         | 13.54                       | 70.76    | 24.11                   | 46.65                     | 44         | 2.653                        |
| 39.00     | 80.52                    | 23.65                         | 13.73                       | 70.60    | 24.22                   | 46.38                     | 44         | 2.382                        |
| 39.50     | 80.63                    | 23.03                         | 13.76                       | 71.36    | 24.10                   | 47.26                     | 44         | 3.256                        |
| 40.00     | 80.74                    | 23.00                         | 13.79                       | 71.53    | 23.98                   | 47.55                     | 44         | 3.547                        |
| 40.50     | 80.85                    | 23.35                         | 13.84                       | 71.34    | 23.91                   | 47.43                     | 44         | 3.433                        |
| 41.00     | 80.96                    | 23.22                         | 13.98                       | 71.72    | 23.84                   | 47.88                     | 44         | 3.880                        |
| 41.50     | 81.06                    | 23.28                         | 14.14                       | 71.93    | 23.20                   | 48.73                     | 44         | 4.731                        |
| 42.00     | 81.17                    | 23.39                         | 14.23                       | 72.01    | 22.56                   | 49.46                     | 44         | 5.459                        |
| 42.50     | 81.27                    | 23.81                         | 14.36                       | 71.81    | 21.52                   | 50.29                     | 44         | 6.290                        |
| 43.00     | 81.37                    | 23.55                         | 15.30                       | 73.11    | 20.49                   | 52.62                     | 44         | 8.620                        |
| 43.50     | 81.47                    | 23.60                         | 16.14                       | 74.01    | 18.55                   | 55.46                     | 44         | 11.462                       |

### 4.3.7 Edge of Band Measurements

The Occupied Bandwidth and Edge-of-Band emissions measurements were made as a radiated measurement at a distance of 6.5m. 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 4.1.1 was used. Testing was performed for the 100 MHz carrier configurations at the left side, and right side of the Part 30 Band. All of the Edge of Band measurements were performed at the specified 1 MHz resolution bandwidths. Adjustment factors were as described in Section 4.3.6 above.

#### 4.3.7.1 Initial Results - Edge of Band Measurements

The initial Occupied Bandwidth and Edge-of-Band emissions measurements identified a single significant Out Of Band Emissions (OOBE). This emission was identified as a single LO narrowband spurious signal at 40.6489 GHz. Multiple transmit configurations were evaluated to determine the worst case operating configuration for generating the maximum spurious signal at 40.6489 GHz. Multiple scans confirmed that the maximum signal was generated by a single full power QPSK carrier at the Left side of the band.

The OOBE measurements determined that the 40.6489 GHz signal maximum value was 8.39 dBm when not adjusted for the AWEUA's Transmit Antenna gain. Per KDB 842590 D01 guidance these emissions needed to be evaluated using the Total Radiated Power methodology.

#### 4.3.8 Total Radiated Power Evaluation of Out Of Band Emissions

Per KDB 842590 D01 the use of product array gain to reference the radiated spurious to the conducted transmit signal is not valid at greater than 10% of signal bandwidth outside the band. For reference, if the gain was allowable for the 40.6489 GHz spur it would result in a final value of -15.52 dBm which is 2.52 dB of margin to the limit. Without the consideration for transmit antenna gain the OOB measurements determined that the 40.6489 GHz signals maximum value was 8.39 dBm and needed to be evaluated for Total Radiated Power.

Following the requirements and guidance of KDB 842590 D01 a Two and Three Cut Total Radiated Power (TRP) evaluation was performed on the spurious signals.

Two Cut and Three cut TRP evaluations were performed at a measurement distance of 4m per KDB 842590 D01. We used our ISO 17025 accredited Radiated Emissions measurement process software with updated software drivers for control of the FSW85 analyzer and modifications for data export. Measurements were performed every 4 degrees. For cuts one and two the maximum beam height was 180 cm. For Cut 3 the height was 170 cm. The first cut was performed with the receive antenna Vertically polarized and the second cut was performed with the receive antenna Horizontally polarized. The product under test has two arrays (H&V) which are at the same height and their peak beam is also at the same height but about 1 degrees apart in azimuth. There was no attempt to duplicate the data cuts as it would not result in any change in average value. The sweeps were performed with the following settings as follows:

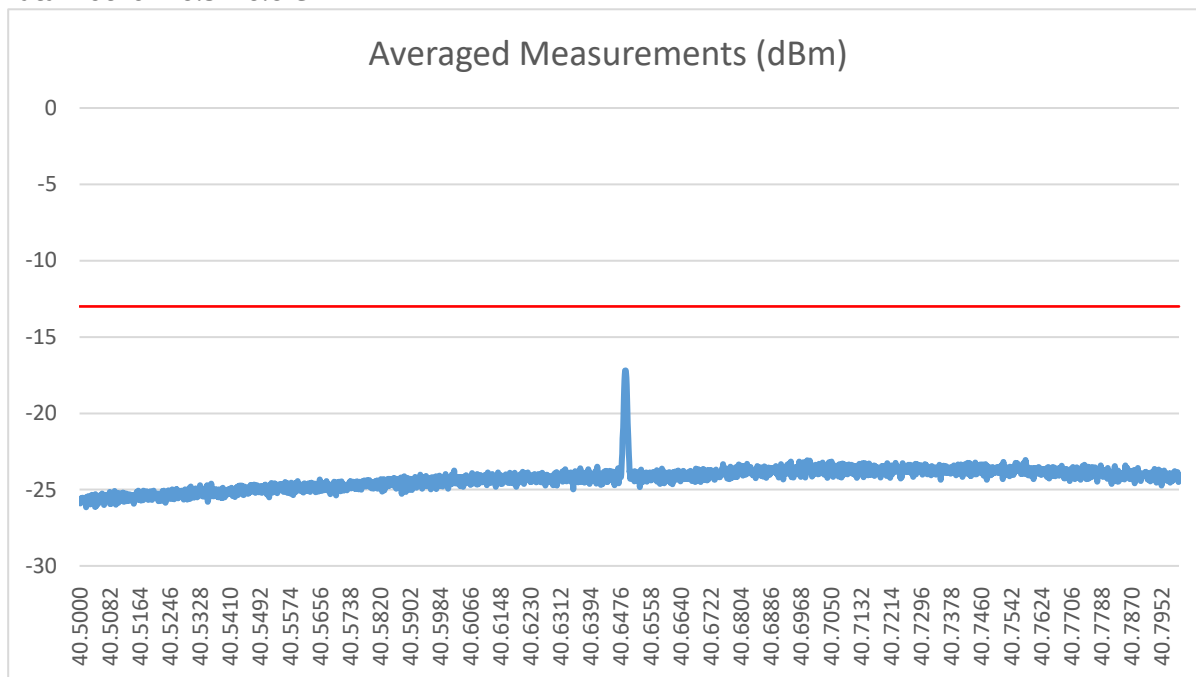
|                             | <b><u>Spur #1</u></b> |
|-----------------------------|-----------------------|
| Frequency range:            | 40.5 GHz to 40.8 GHz  |
| Resolution Bandwidth:       | 1 MHz                 |
| Video bandwidth:            | 3 MHz                 |
| Detector:                   | RMS                   |
| Trace averaging Factor      | 120                   |
| Number of points            | 3001                  |
| Turntable step size         | 4 degrees             |
| Three cut correction factor | 1.5 dB                |

##### 4.3.8.1 Total Radiated Power Results

The net result for the Spur was a maximum corrected TRP value of -17.654 dBm at 40.6492 GHz. Which demonstrates 4.654 dB margin to the -13 dBm limit. This emission is reportable.

The plot of the Three Cut Average TRP measurements over frequency are plotted below.

TRP Data Plot for 40.5-40.8 GHz



#### 4.3.8.2 Out Of Band Emissions Results

The Out Of Band Emissions plots for the tested configurations of one through eight carriers operation are below. These Occupied Bandwidth and Edge-of-Band emissions measurements were made as a radiated measurement at the verified far field measurement distance of 6.5m. The plots show compliance to the Part 30 FCC limit for the n260 Band for all signals except the single narrowband local oscillator spurious at 40.6489 GHz. This spur was evaluated for compliance using the three cut TRP method and found to be compliant.

The out-of-band emissions plots attached below document that all the emissions are compliant.

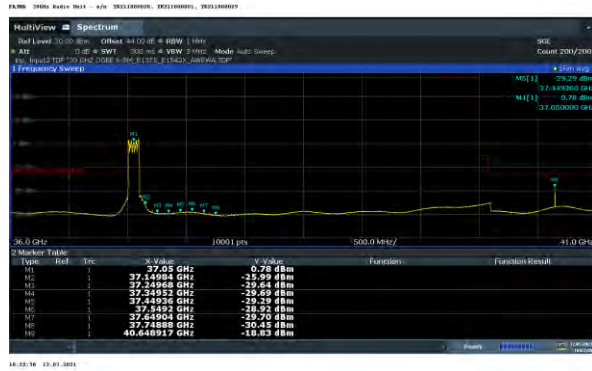
The measurement results of the occupied bandwidth and the out-of-band emissions as documented in the plots and Table 4.3.6.1 demonstrate the full compliance with the Rules of the Commission for the operating band.

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

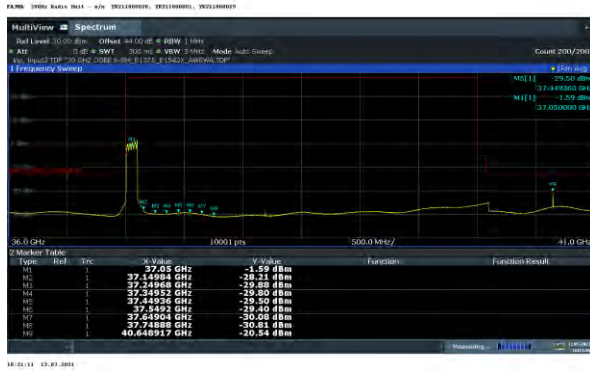
| Center Frequencies of Edge Channels, GHz | Location                            | Number of Carriers | Modulation | Polarization | Occupied Bandwidth Edge of Block / OOB Compliance |
|------------------------------------------|-------------------------------------|--------------------|------------|--------------|---------------------------------------------------|
| 37.05                                    | Left Side of Lower Band             | 1                  | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 38.447760                                | Middle of Overall Band              | 1                  | 16QAM      | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 39.945360                                | Right Side of Upper Band            | 1                  | 64QAM      | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.14984                        | Left Side of Band                   | 2 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.24968                        | Left Side of Band                   | 3 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.34952                        | Left Side of Band                   | 4 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.44936                        | Left Side of Band                   | 5 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.5492                         | Left Side of Band                   | 6 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.64904                        | Left Side of Band                   | 7 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 37.05<br>37.74888                        | Left Side of Band                   | 8 adjacent         | QPSK       | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 38.14824<br>38.84712                     | Middle of Overall Band              | 8 adjacent         | 16QAM      | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 39.24648<br>39.94536                     | Right Side of Upper Band            | 8 adjacent         | 64QAM      | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |
| 38.14956<br>38.84928                     | Middle w/ 99.96 MHz channel spacing | 8 adjacent         | 16QAM      | Horizontal   | Compliant                                         |
|                                          |                                     |                    |            | Vertical     | Compliant                                         |
|                                          |                                     |                    |            |              |                                                   |

#### 4.3.8.2.1 Occupied Bandwidth Edge of Band Plots

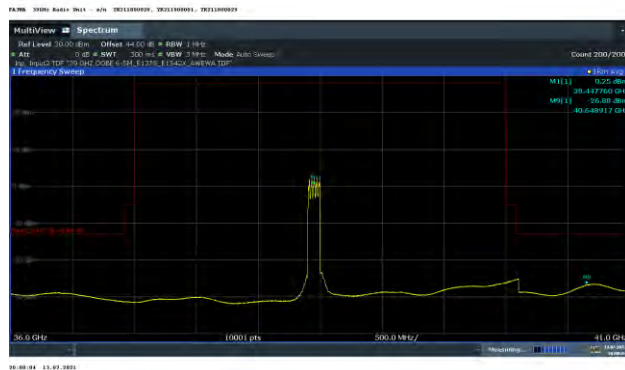
##### 1 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



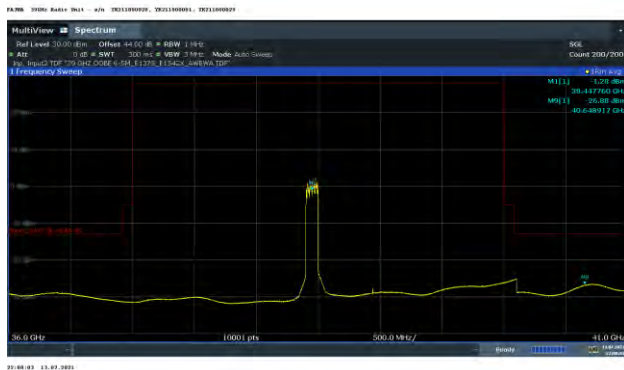
##### OOBE/EoB – Vertical Polarization



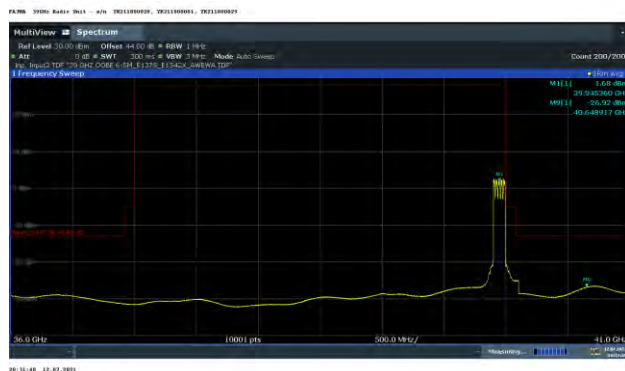
##### 1 Carrier – 16QAM / Middle OOBE/EoB – Horizontal Polarization



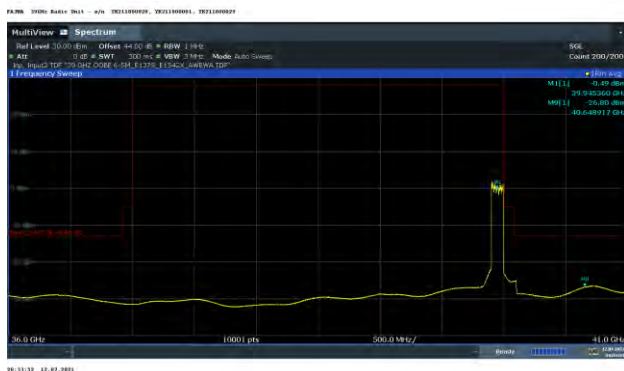
##### OOBE/EoB – Vertical Polarization



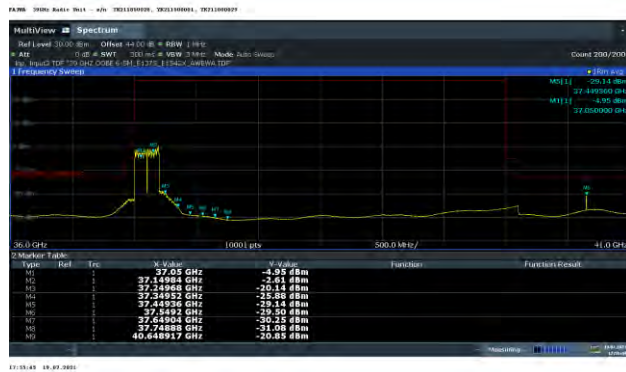
##### 1 Carrier – 64QAM / Right OOBE/EoB – Horizontal Polarization



##### OOBE/EoB – Vertical Polarization



## 2 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



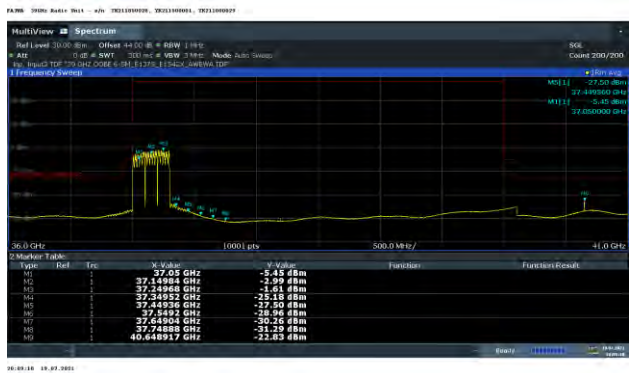
## OOBE/EoB – Vertical Polarization



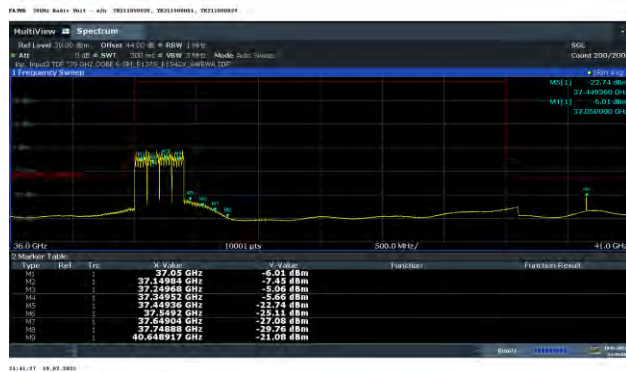
## 3 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



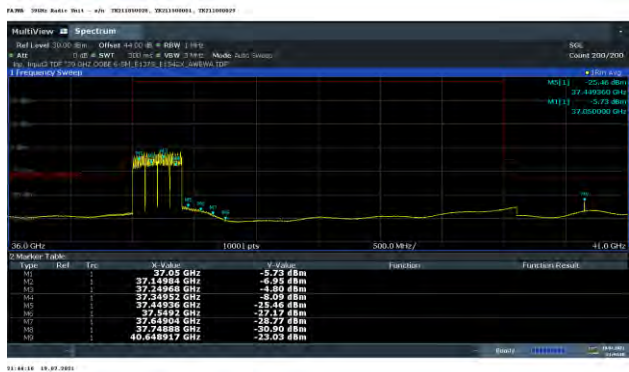
## OOBE/EoB – Vertical Polarization



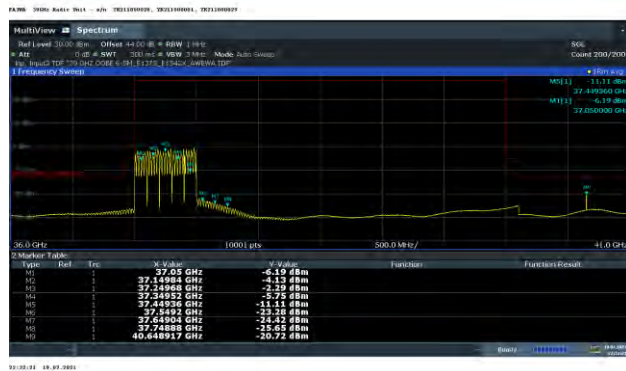
## 4 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



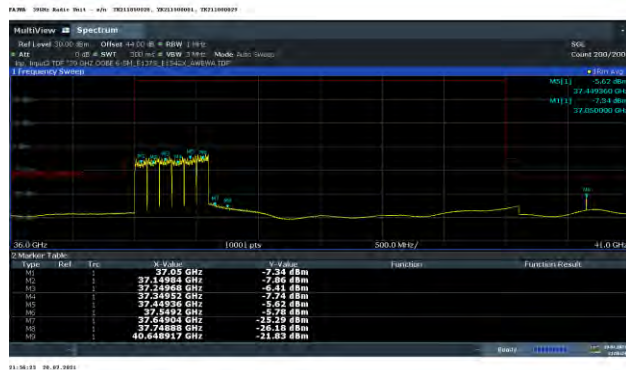
## 5 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



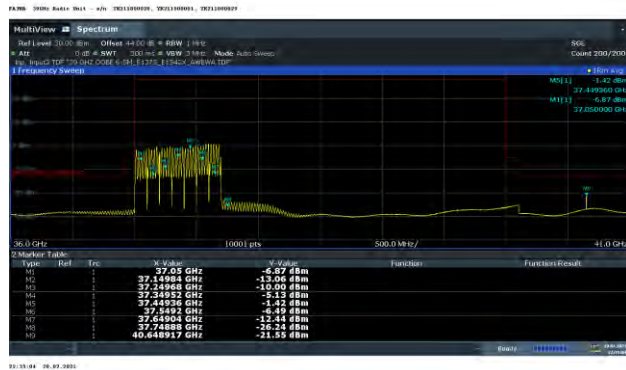
## 6 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



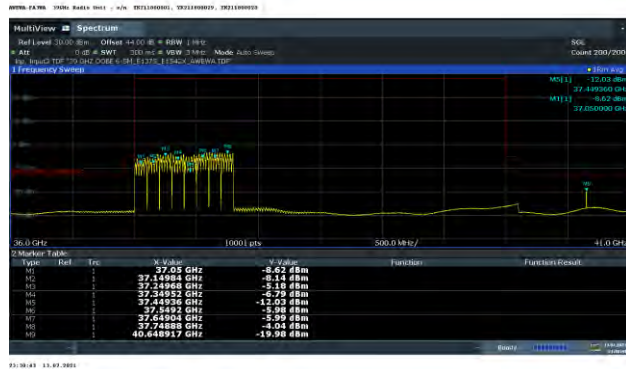
## 7 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



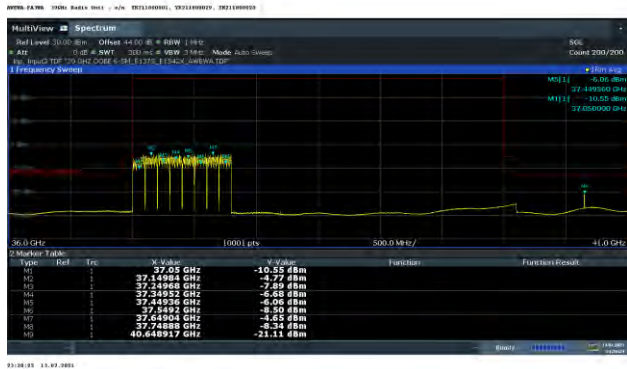
## OOBE/EoB – Vertical Polarization



## 8 Carrier – QPSK / Left OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



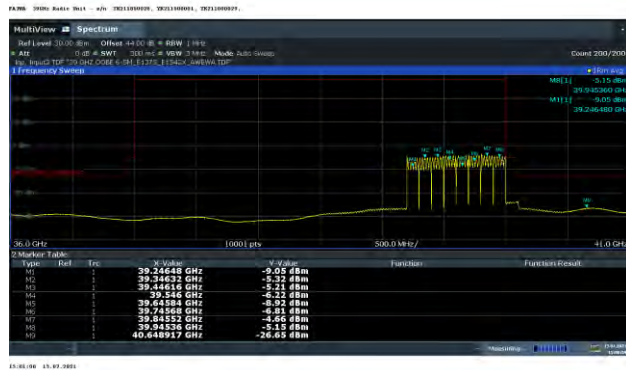
## 8 Carrier – 16QAM / Middle OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



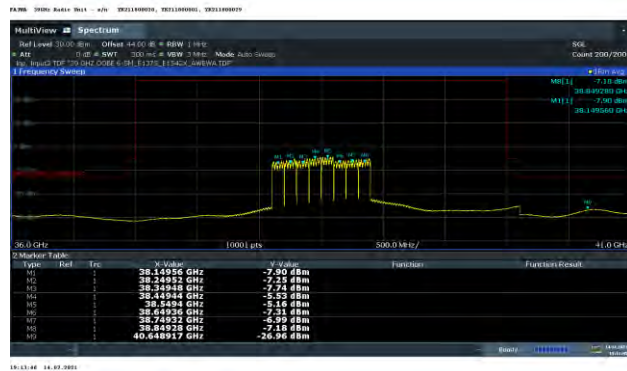
## 8 Carrier – 64QAM / Right OOBE/EoB – Horizontal Polarization



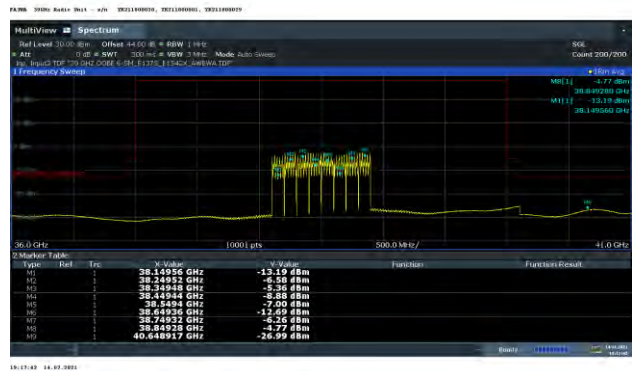
## OOBE/EoB – Vertical Polarization



## 8 Carrier – 16QAM with 99.96 MHz channel spacing / Middle OOBE/EoB – Horizontal Polarization



## OOBE/EoB – Vertical Polarization



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

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

##### 4.4.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 30 MHz to 200 GHz as specified in 2.1057(a)(2).

2.1057(a) In all of the measurements set forth in §§2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(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.

(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

##### 4.4.2 Required Limit

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

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

##### 4.4.3 Results

Since there is no antenna terminal, all measurements were performed as radiated measurements and standard radiated emissions. The Edge of Band emissions, presented in Section 4.3.7 and the Total Radiated Power (TRP) evaluation in 4.3.8 document the OOB compliance for the 36-41 GHz frequency range which is around the Transmit ranges of 37 - 40 GHz. Those measurements are appropriate as the products antenna gain is documented over the same ranges. There was one significant emission detected and was shown to be compliant in Section 4.3.8.1. There were no other emissions detected in these ranges within 20 dB of the limit.

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

The measurements were performed in compliance with ANSI C63.26, KDB 842590 D01, C63.26 mmWave JTG, and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be  $> 2 \times \text{Span/RBW}$ . The ESW-44 spectrum analyzer measurements examine the 30 MHz to 40 GHz range. The FSW based mmWave transmitter test system were used to provide measurement capability from 40 GHz to 220 GHz range.

#### 4.5 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

The field strength measurements of radiated spurious emissions were made in FCC registered five and ten meter semi-anechoic chambers AR-4 and AR-8 , (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-4 & 8) which are maintained by Nokia Bell Labs in Murray Hill, New Jersey.

The **2AD8UFA3WA01** (EUT) was configured in semi-anechoic chambers AR-4 & AR-8 in a manner simulating a normal field installation. The product's field installation hardware was used to mount the Base Unit and Two Extension Modules to a wooden pole with the bottom of the product 1.5m above the turntable ground plane. The recommendations of ANSI C63.4–2014, C63.26-2015, KDB 842590 D01 and C63.26 mmWave JTG were followed for EUT testing setup and cabling. The EUT was configured to operate in a 5G-NR test model per the constraints identified in section 4.2. A photograph of this setup is in Exhibit 12 of the filing package.

The Main Radio Unit was configured into the full power forward beam transmit configuration as defined in Table 4.5.1. The unit was configured with the maximum transmit bandwidth of eight carriers for each polarization. The Vertical and Horizontal polarizations each transmitted 52 dBm EIRP, with the total transmit power of 55 dBm EIRP. The product in the below configurations was evaluated over the 30 MHz to 100 GHz frequency range as required.

**Table 4.5.1 EUT Transmit Configuration**

| # of Carriers | Test Configuration NR-ARFCN                                                          | FA3WA Tx Frequencies GHz                                                                     | Active Transmit Polarizations | Signal Bandwidth, MHz | Modulation | Total EIRP Power, dBm | Radiated Emissions Pass / Fail |
|---------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------|-----------------------|------------|-----------------------|--------------------------------|
| 1             | 2229999                                                                              | 37.05000                                                                                     | H & V                         | 100                   | QPSK       | 55                    | Pass                           |
| 8             | 2266607<br>2268271<br>2269935<br>2271599<br>2273263<br>2274927<br>2276591<br>2278255 | 39.24648<br>39.34632<br>39.44616<br>39.54600<br>39.64584<br>39.74568<br>39.84552<br>39.94536 | H & V                         | 100                   | 64QAM      | 55                    | Pass                           |

#### 4.5.1 Spurious Radiation and Radiated Emissions Requirements.

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

$$-43+10\log P=-13 \text{ dBm.}$$

The evaluation of emissions at the Edge of Band was detailed in Sections 4.3.7 and 4.3.8. 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:

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

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.

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

Where: E = Field Intensity in Volts/ meter      R = Distance in meters = 3 m  
P = Transmitted Power, Watts = 316.23 W

The field strength of radiated spurious emissions measured was determined by

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

Field strength measurements of radiated spurious emissions were made in the 5m semi-anechoic chamber, AR-4 as detailed above. The recommendations of ANSI C63.4 and ANSI C63.26 were followed for EUT testing setup, cabling, and measurement approach and procedures. All the measurement equipment used, including antennas, was calibrated in accordance with ISO 9001 process. The EUT setup diagram is given in the Figure 4.5. The minimum margins to the Part 30.203 limit is as measured in accordance with 2.1053. The test data follows.

#### 4.5.2 Radiated Spurious Emissions Measurements: 40 GHz - 100 GHz

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

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

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

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

Measurements were performed at the following distances:

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

Operation was verified prior to testing by bore-sighting a mmWave signal generator or mmWave source module with an antenna identical to the measurement antenna at the test distance. The location of the maximum beams had previously been ascertained for both vertical and horizontal polarizations. The beam is narrow and radiated power is down 23 dB at just  $\pm 12$  degrees off center. All of the emissions and harmonics were found to be centered on the beam as well.

Based upon previous experience a continuous max hold (average detector) sweep of the product in elevation and azimuth was employed for full coverage scanning of the product. For these measurements in each band the scan was started at the beam peak location of 21 degrees azimuth, and a nominal elevations 172 cm for Vertical and 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 21 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 40-200 GHz were performed this way for the 1 carrier and the 8 carrier transmit configurations.

#### 4.5.2.1 Bandwidth Limits and Corrections: Radiated Measurements 40 GHz - 100 GHz

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

#### 4.5.2.2 Resolution Bandwidth and # of Points:

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

Final measurements were performed so that the resolution bandwidth and span limitations of ANSI C63.26 were followed so that the number of measurement points  $> 2(\text{Span}/\text{RBW})$ .

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.

#### 4.5.2.3 Part 30 Limit:

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

#### 4.5.2.4 Emissions Corrections

The measured signal was corrected by the FSW for the harmonic downconverter (HDC) conversion loss. In addition, a correction consisting of the radiated path loss, the gain of the measurement antenna and a 1 dB IF cable loss (at 1.3 GHz) was applied. There was no correction applied for the product antenna gain as these measurements are outside the transmit frequency range.

$$\text{Emissions Correction} = \text{Path Loss} - \text{Antenna Gain} + \text{IF Cable loss (1 dB)}$$

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

Table 4.5.2.4 details the correction for the three bands.

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

| Frequency | $\lambda$ | Measurement Distance, d | Path Loss | Measurement Antenna Gain | IF Cable Loss | Emissions Correction Total |
|-----------|-----------|-------------------------|-----------|--------------------------|---------------|----------------------------|
| GHz       | m         | m                       | dB        | dB                       | dB            | dB                         |
| 40.0      | 0.0075    | 4                       | 76.52     | 21.80                    | 1.03          | 55.75                      |
| 42.5      | 0.0071    | 4                       | 77.05     | 22.20                    | 1.03          | 55.87                      |
| 45.0      | 0.0067    | 4                       | 77.55     | 22.50                    | 1.03          | 56.07                      |
| 47.5      | 0.0063    | 4                       | 78.02     | 22.70                    | 1.03          | 56.34                      |
| 50.0      | 0.0060    | 4                       | 78.46     | 23.00                    | 1.03          | 56.49                      |
| 52.5      | 0.0057    | 4                       | 78.89     | 23.30                    | 1.03          | 56.61                      |
| 55.0      | 0.0055    | 4                       | 79.29     | 23.40                    | 1.03          | 56.91                      |
| 57.5      | 0.0052    | 4                       | 79.68     | 23.60                    | 1.03          | 57.10                      |
| 60.0      | 0.0050    | 4                       | 80.05     | 23.70                    | 1.03          | 57.37                      |

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

| Frequency | $\lambda$ | Measurement Distance, d | Path Loss | Measurement Antenna Gain | IF Cable Loss | Emissions Correction Total |
|-----------|-----------|-------------------------|-----------|--------------------------|---------------|----------------------------|
| GHz       | m         | m                       | dB        | dB                       | dB            | dB                         |
| 60.0      | 0.0050    | 4                       | 80.05     | 21.80                    | 1.03          | 59.276                     |
| 65.0      | 0.0046    | 4                       | 80.74     | 22.30                    | 1.03          | 59.471                     |
| 70.0      | 0.0043    | 4                       | 81.38     | 22.70                    | 1.03          | 59.715                     |
| 75.0      | 0.0040    | 4                       | 81.98     | 23.00                    | 1.03          | 60.014                     |
| 80.0      | 0.0038    | 4                       | 82.54     | 23.40                    | 1.03          | 60.175                     |
| 85.0      | 0.0035    | 4                       | 83.07     | 23.60                    | 1.03          | 60.501                     |
| 90.0      | 0.0033    | 4                       | 83.57     | 23.80                    | 1.03          | 60.798                     |

**Table 4.5.2.4c Radiated Emissions Corrections for 90-100GHz at 3m**

| Frequency | $\lambda$ | Measurement Distance, d | Path Loss | Measurement Antenna Gain | IF Cable Loss | Emissions Correction Total |
|-----------|-----------|-------------------------|-----------|--------------------------|---------------|----------------------------|
| GHz       | m         | m                       | dB        | dB                       | dB            | dB                         |
| 90.0      | 0.0033    | 3                       | 81.07     | 21.90                    | 1.03          | 60.199                     |
| 95.0      | 0.0032    | 3                       | 81.54     | 22.30                    | 1.03          | 60.269                     |
| 100.0     | 0.0030    | 3                       | 81.98     | 22.60                    | 1.03          | 60.414                     |
| 105.0     | 0.0029    | 3                       | 82.41     | 22.95                    | 1.03          | 60.488                     |
| 110.0     | 0.0027    | 3                       | 82.81     | 23.30                    | 1.03          | 60.542                     |
| 115.0     | 0.0026    | 3                       | 83.20     | 23.60                    | 1.03          | 60.628                     |
| 120.0     | 0.0025    | 3                       | 83.57     | 23.85                    | 1.03          | 60.748                     |
| 125.0     | 0.0024    | 3                       | 83.92     | 24.05                    | 1.03          | 60.902                     |
| 130.0     | 0.0023    | 3                       | 84.26     | 24.18                    | 1.03          | 61.113                     |
| 135.0     | 0.0022    | 3                       | 84.59     | 24.35                    | 1.03          | 61.271                     |
| 140.0     | 0.0021    | 3                       | 84.91     | 24.50                    | 1.03          | 61.437                     |

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

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

### 4.5.3 Field Strength of Spurious Radiation Results:

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

There was a single reportable emission at 40.6489 GHz. This signal was addressed in section 4.3.7 and 4.3.8. This signal also was compliant during normal radiated emissions testing. The TRP measured spurious signal level of -17.654 dBm at 40.6492 GHz demonstrates a 4.654 dB margin to the -13 dBm limit.

All other emissions below 40 GHz were below the Part 15 Class B limit.

Presented results include the standard measurements from 30 MHz to 40 GHz followed by the four mmWave bands. The worst-case emissions are presented. The scans are performed with the required 1 MHz resolution bandwidth and sufficient number of points per ANSI C63.26 with markers at the frequencies of interest. The limit in the measurement is the conducted -13 dBm limit as specified in Part 30.203.

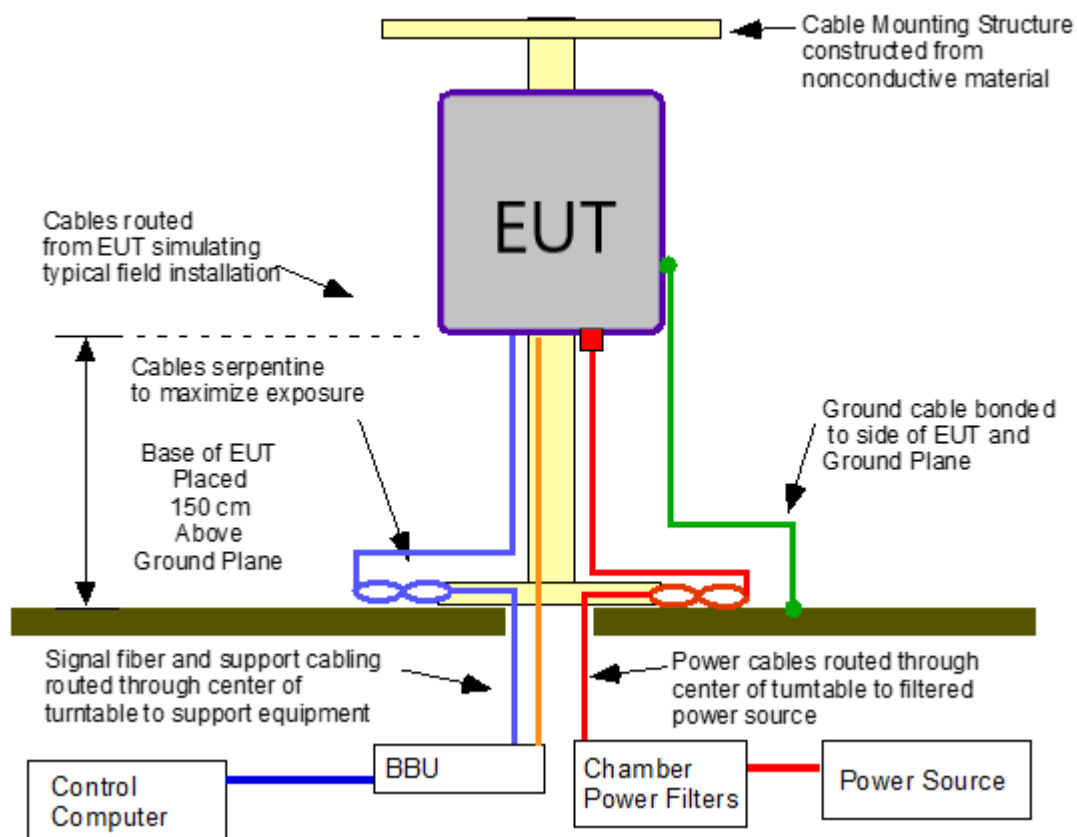
Corrections to the emissions levels consisted of only the HDC conversion loss, the Free Space Path Loss and the gain of the measurement antenna as detailed in Table 4.5.2.4.

Over the out of band spectrum investigated from 30 MHz to 200 GHz, reportable spurious emissions were detected and determined to be compliant with the Part 30 limit. The minimum margin, measured in the horizontal polarization, was **3.07 dB at 128.98436 GHz**. Additionally, from 30 MHz to 40 GHz all non-transmitter emissions were a minimum of 1.61 dB below the Part 15 Class B limit.

This demonstrates that the **AWEWA/B 5G AirScale 39 GHz mmWave Radio FCC ID: 2AD8UFA3WA01**, the subject of this application, complies with FCC Part 15 Class B, and FCC Sections 2.1053, 30.203 and 2.1057 of the Rules.

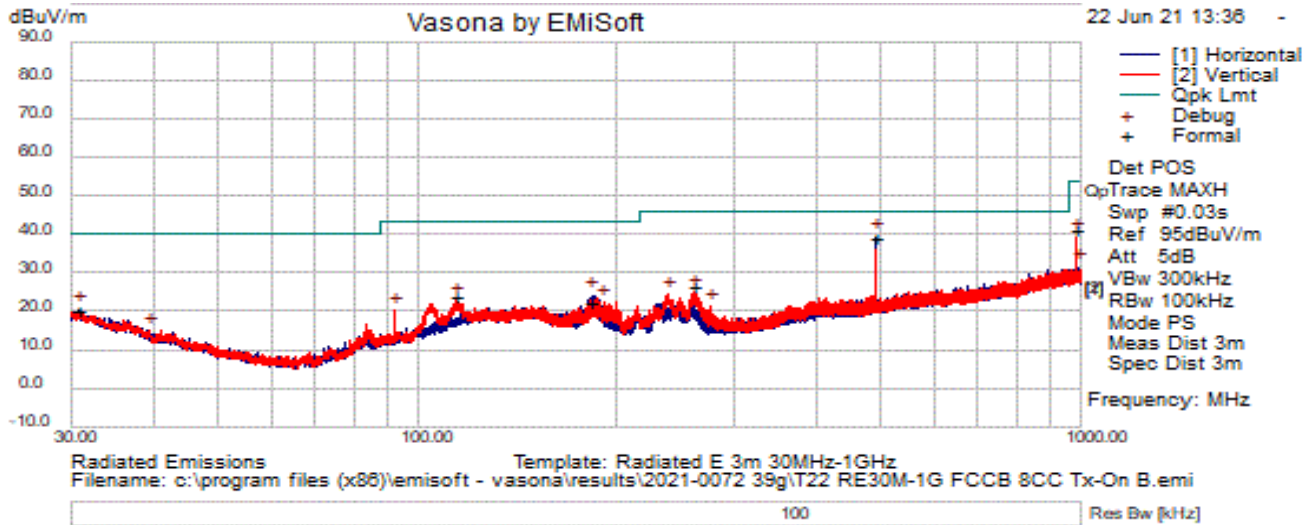
Photographs of the measurement setup are in the filing exhibits.

Figure 4.5 Radiated Emissions Product Setup



#### 4.5.4 Transmitter Measurements of Radiated Spurious Emissions

T23 Radiated Emissions 3m 30MHz-1GHz 8CC TX-On Part 15B



#### Test Information

|                 |                                                                                                                                                                                                                           |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Results Title   | Radiated Emissions 3m 30MHz-1GHz                                                                                                                                                                                          |
| File Name       | T23 RE30M-1G FCCB 8CC Tx-On M.emi                                                                                                                                                                                         |
| Test Laboratory | MH-AR4, 52.4%RH, 20.6C, 997hPa                                                                                                                                                                                            |
| Test Engineer   | MJS/CP                                                                                                                                                                                                                    |
| Test Software   | Vasona by EMIsoft, version 6.061                                                                                                                                                                                          |
| Equipment       | Nokia Wireless Group                                                                                                                                                                                                      |
| EUT Details     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800007, AM2-YK211800027, AM3-YK211800031, FA3WA Extension Unit - 8CC Middle Tx-On.                                                                                                |
| Configuration   | Powered by 120V/60Hz AC. Tested to FCC Part 15b, RE 30MHz-15GHz, @ 3-Meters, Bilog Antenna E601, LPF-E980, Preamp-E813, FSW67-E1260, Cables AR4 set. Internal attenuation 5dB, Previews RBW Default; Formals RBW Default. |
| Date            | 2021-06-22 14:53:20                                                                                                                                                                                                       |

#### Formal Data

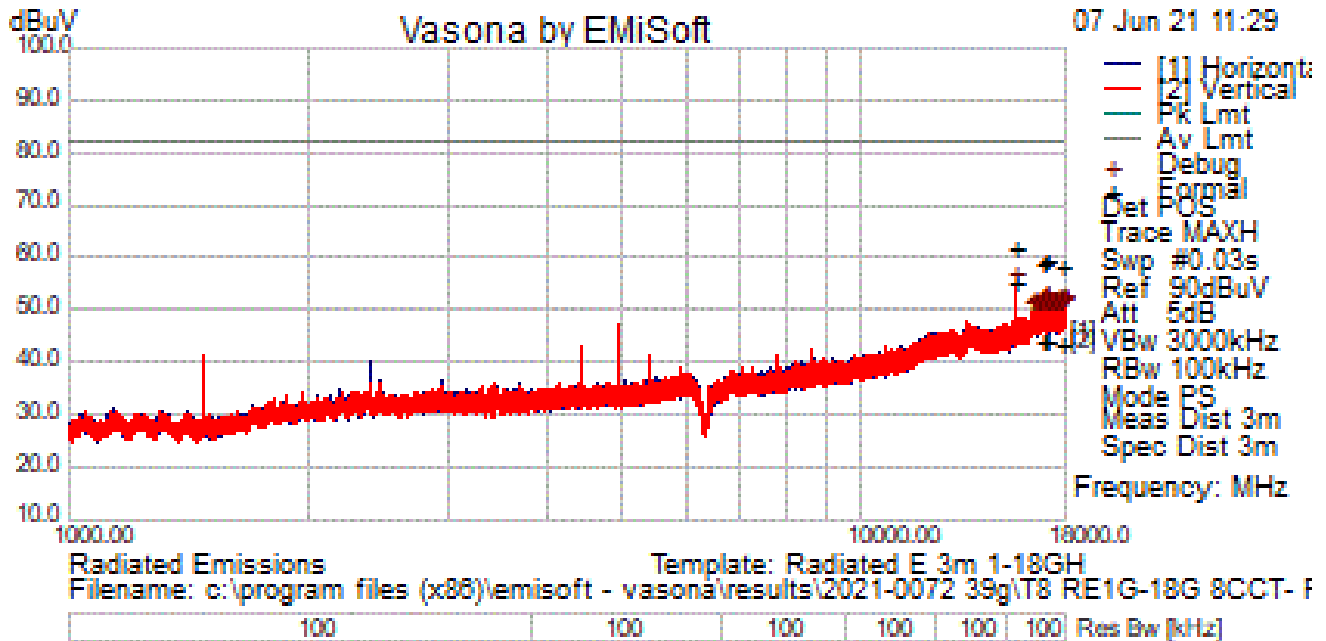
| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 491.493667  | 45.67      | 3.02       | -9.69       | 39.00          | QuasiMax      | H         | 105     | 338      | 46.00          | -7.00       | Pass      |          |
| 983.025     | 38.90      | 5.03       | -2.80       | 41.13          | QuasiMax      | V         | 138     | 29       | 54.00          | -12.87      | Pass      |          |
| 261.603667  | 36.96      | 2.14       | -12.53      | 26.57          | QuasiMax      | V         | 171     | 59       | 46.00          | -19.43      | Pass      |          |
| 30.711333   | 29.09      | 0.80       | -9.35       | 20.54          | QuasiMax      | H         | 294     | 286      | 40.00          | -19.46      | Pass      |          |
| 114.099     | 34.03      | 1.44       | -11.58      | 23.89          | QuasiMax      | V         | 107     | 219      | 43.50          | -19.61      | Pass      |          |
| 182.775     | 34.64      | 1.81       | -14.17      | 22.28          | QuasiMax      | H         | 168     | 180      | 43.50          | -21.22      | Pass      |          |

**Preview Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 491.493667  | 45.91      | 3.02       | -9.69       | 39.24          | Debug         | H         | 100     | 352      | 46.00          | -6.76       | Pass      |          |
| 983.025     | 37.06      | 5.03       | -2.80       | 39.29          | Debug         | V         | 100     | 352      | 54.00          | -14.71      | Pass      |          |
| 182.775     | 36.42      | 1.81       | -14.17      | 24.07          | Debug         | H         | 100     | 180      | 43.50          | -19.43      | Pass      |          |
| 30.711333   | 28.92      | 0.80       | -9.35       | 20.37          | Debug         | H         | 175     | 352      | 40.00          | -19.63      | Pass      |          |
| 114.099     | 32.95      | 1.44       | -11.58      | 22.81          | Debug         | V         | 100     | 225      | 43.50          | -20.69      | Pass      |          |
| 261.603667  | 35.30      | 2.14       | -12.53      | 24.91          | Debug         | V         | 175     | 45       | 46.00          | -21.09      | Pass      |          |
| 190.535     | 35.33      | 1.84       | -14.94      | 22.23          | Debug         | V         | 175     | 0        | 43.50          | -21.27      | Pass      |          |
| 239.326     | 35.22      | 2.06       | -13.00      | 24.28          | Debug         | V         | 175     | 45       | 46.00          | -21.72      | Pass      |          |
| 989.297667  | 29.07      | 5.07       | -2.71       | 31.43          | Debug         | H         | 250     | 0        | 54.00          | -22.57      | Pass      |          |
| 92.144667   | 34.75      | 1.30       | -15.87      | 20.17          | Debug         | V         | 100     | 315      | 43.50          | -23.33      | Pass      |          |
| 276.444667  | 33.11      | 2.20       | -14.15      | 21.17          | Debug         | V         | 175     | 45       | 46.00          | -24.83      | Pass      |          |
| 39.247333   | 28.04      | 0.90       | -13.95      | 14.98          | Debug         | V         | 175     | 315      | 40.00          | -25.02      | Pass      |          |

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

**T8 Radiated Emissions 3m 1GHz – 18GHz 8CC TX-On Top**



**Test Information**

|                 |                                                                                                                                                                                                                        |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Results Title   | Radiated Emissions 3m 1-18GHz                                                                                                                                                                                          |
| File Name       | T8 RE1G-18G 8CCT- FCC-P30-ExtP.emi                                                                                                                                                                                     |
| Test Laboratory | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                         |
| Test Engineer   | CP                                                                                                                                                                                                                     |
| Test Software   | Vasona by EMISoft, version 6.061                                                                                                                                                                                       |
| Equipment       | Nokia Wireless Group                                                                                                                                                                                                   |
| EUT Details     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, 8CC Top-TX-On, FA3WA Extension ON.                                                                                                   |
| Configuration   | Powered by -48Vdc Tested to FCC Part 30, RE 1GHz-18GHz, @ 3-Meters, Horn Antenna E1074, LPF-E1476, Preamp-E447, FSW67-E1260, Cables E1503 and E1504. Internal attenuation 0dB, Previews RBW 100K; Formals RBW 1M / 3M. |
| Date            | 2021-06-07 11:33:20                                                                                                                                                                                                    |

**Formal Data**

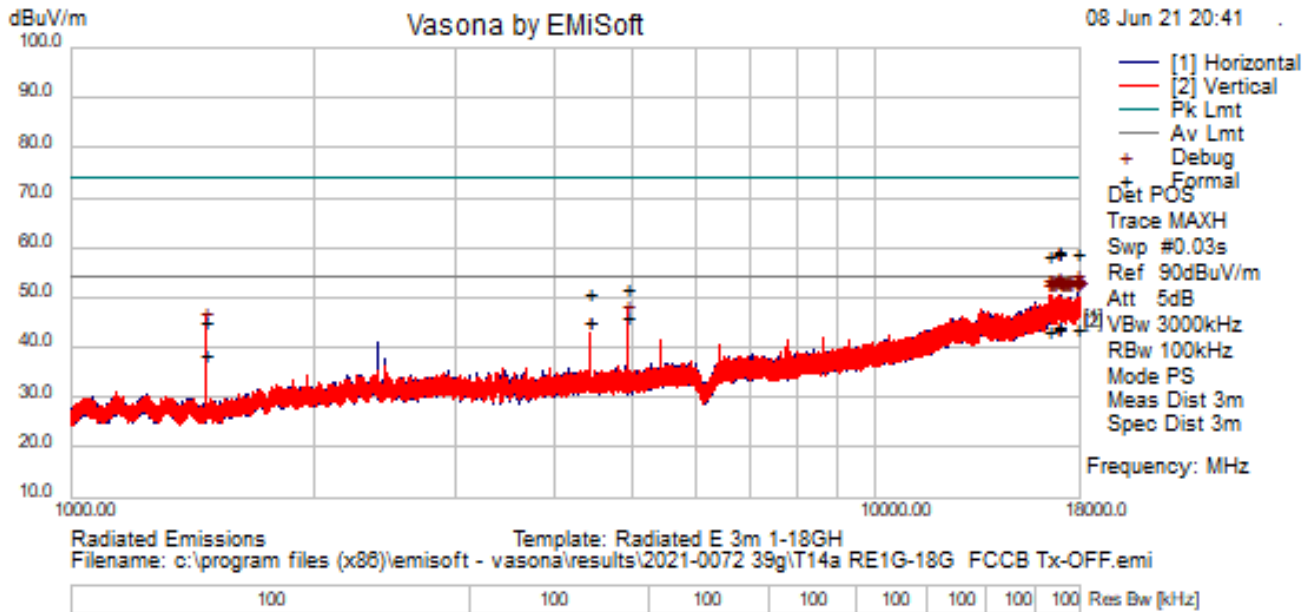
| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 15603.756   | 41.31      | 12.18      | 2.05        | 55.54          | AvgMax        | V         | 146     | 162      | 82.23          | -26.69      | Pass      |          |
| 17005.595   | 26.83      | 12.39      | 4.88        | 44.11          | AvgMax        | H         | 322     | 92       | 82.23          | -38.12      | Pass      |          |
| 16924.656   | 27.01      | 12.37      | 4.70        | 44.08          | AvgMax        | V         | 146     | 33       | 82.23          | -38.15      | Pass      |          |
| 16996.528   | 26.80      | 12.39      | 4.88        | 44.07          | AvgMax        | H         | 186     | 175      | 82.23          | -38.16      | Pass      |          |
| 16929.850   | 26.96      | 12.37      | 4.72        | 44.04          | AvgMax        | H         | 175     | 148      | 82.23          | -38.19      | Pass      |          |
| 17858.144   | 26.69      | 12.85      | 4.14        | 43.69          | AvgMax        | H         | 282     | 252      | 82.23          | -38.54      | Pass      |          |

**Preview Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 15603.756   | 40.15      | 12.18      | 2.05        | 54.38          | Debug         | V         | 175     | 150      | 82.23          | -27.85      | Pass      |          |
| 17005.595   | 33.85      | 12.39      | 4.88        | 51.13          | Debug         | H         | 325     | 330      | 82.23          | -31.10      | Pass      |          |
| 16996.528   | 33.57      | 12.39      | 4.88        | 50.84          | Debug         | H         | 325     | 60       | 82.23          | -31.39      | Pass      |          |
| 16924.656   | 33.56      | 12.37      | 4.70        | 50.63          | Debug         | V         | 325     | 120      | 82.23          | -31.60      | Pass      |          |
| 17858.144   | 33.55      | 12.85      | 4.14        | 50.55          | Debug         | H         | 175     | 90       | 82.23          | -31.68      | Pass      |          |
| 16929.850   | 33.23      | 12.37      | 4.72        | 50.31          | Debug         | H         | 250     | 30       | 82.23          | -31.92      | Pass      |          |
| 17999.244   | 33.13      | 12.99      | 4.15        | 50.27          | Debug         | H         | 100     | 270      | 82.23          | -31.96      | Pass      |          |
| 17965.622   | 33.15      | 12.96      | 4.15        | 50.26          | Debug         | V         | 325     | 120      | 82.23          | -31.97      | Pass      |          |
| 16957.239   | 33.07      | 12.38      | 4.78        | 50.23          | Debug         | H         | 325     | 210      | 82.23          | -32.00      | Pass      |          |
| 17676.906   | 33.38      | 12.66      | 4.14        | 50.18          | Debug         | V         | 325     | 60       | 82.23          | -32.05      | Pass      |          |
| 17942.389   | 32.91      | 12.93      | 4.15        | 49.99          | Debug         | H         | 325     | 60       | 82.23          | -32.24      | Pass      |          |
| 17896.300   | 32.96      | 12.89      | 4.15        | 49.99          | Debug         | H         | 325     | 90       | 82.23          | -32.24      | Pass      |          |
| 16943.450   | 32.83      | 12.37      | 4.75        | 49.95          | Debug         | H         | 250     | 270      | 82.23          | -32.28      | Pass      |          |
| 17348.995   | 33.12      | 12.45      | 4.36        | 49.93          | Debug         | H         | 325     | 120      | 82.23          | -32.30      | Pass      |          |
| 17046.300   | 32.71      | 12.40      | 4.82        | 49.93          | Debug         | V         | 325     | 120      | 82.23          | -32.30      | Pass      |          |
| 17243.783   | 32.95      | 12.44      | 4.52        | 49.90          | Debug         | H         | 325     | 60       | 82.23          | -32.33      | Pass      |          |
| 17825.372   | 32.87      | 12.82      | 4.14        | 49.82          | Debug         | V         | 250     | 150      | 82.23          | -32.41      | Pass      |          |
| 17076.995   | 32.58      | 12.41      | 4.77        | 49.76          | Debug         | H         | 100     | 150      | 82.23          | -32.47      | Pass      |          |
| 17488.867   | 33.10      | 12.48      | 4.15        | 49.73          | Debug         | V         | 325     | 210      | 82.23          | -32.50      | Pass      |          |
| 17633.367   | 32.94      | 12.62      | 4.14        | 49.70          | Debug         | H         | 175     | 90       | 82.23          | -32.53      | Pass      |          |
| 16820.767   | 32.92      | 12.33      | 4.44        | 49.69          | Debug         | H         | 325     | 60       | 82.23          | -32.54      | Pass      |          |
| 17627.133   | 32.92      | 12.61      | 4.14        | 49.66          | Debug         | V         | 325     | 330      | 82.23          | -32.57      | Pass      |          |
| 16859.583   | 32.75      | 12.34      | 4.54        | 49.63          | Debug         | V         | 325     | 120      | 82.23          | -32.60      | Pass      |          |
| 17251.906   | 32.69      | 12.44      | 4.50        | 49.63          | Debug         | V         | 175     | 240      | 82.23          | -32.60      | Pass      |          |
| 17830.378   | 32.65      | 12.82      | 4.14        | 49.62          | Debug         | V         | 250     | 210      | 82.23          | -32.61      | Pass      |          |
| 16457.439   | 33.87      | 12.23      | 3.51        | 49.61          | Debug         | V         | 175     | 210      | 82.23          | -32.62      | Pass      |          |
| 17641.017   | 32.78      | 12.63      | 4.14        | 49.54          | Debug         | H         | 100     | 90       | 82.23          | -32.69      | Pass      |          |
| 17529.383   | 32.89      | 12.51      | 4.13        | 49.54          | Debug         | V         | 100     | 120      | 82.23          | -32.69      | Pass      |          |
| 17211.106   | 32.53      | 12.43      | 4.57        | 49.52          | Debug         | H         | 250     | 180      | 82.23          | -32.71      | Pass      |          |
| 16512.028   | 33.61      | 12.22      | 3.66        | 49.49          | Debug         | V         | 325     | 330      | 82.23          | -32.74      | Pass      |          |
| 17219.511   | 32.49      | 12.43      | 4.55        | 49.48          | Debug         | V         | 325     | 30       | 82.23          | -32.75      | Pass      |          |
| 17113.639   | 32.35      | 12.41      | 4.72        | 49.47          | Debug         | V         | 325     | 240      | 82.23          | -32.76      | Pass      |          |
| 16842.583   | 32.63      | 12.34      | 4.50        | 49.46          | Debug         | H         | 250     | 180      | 82.23          | -32.77      | Pass      |          |
| 17504.922   | 32.83      | 12.49      | 4.13        | 49.45          | Debug         | V         | 325     | 300      | 82.23          | -32.78      | Pass      |          |
| 17342.572   | 32.59      | 12.45      | 4.37        | 49.41          | Debug         | V         | 250     | 330      | 82.23          | -32.82      | Pass      |          |
| 16365.828   | 33.88      | 12.26      | 3.26        | 49.40          | Debug         | V         | 175     | 0        | 82.23          | -32.83      | Pass      |          |
| 17299.128   | 32.50      | 12.45      | 4.43        | 49.38          | Debug         | H         | 250     | 240      | 82.23          | -32.85      | Pass      |          |
| 17232.545   | 32.41      | 12.43      | 4.53        | 49.38          | Debug         | H         | 325     | 90       | 82.23          | -32.85      | Pass      |          |
| 17150.567   | 32.30      | 12.42      | 4.66        | 49.37          | Debug         | H         | 325     | 0        | 82.23          | -32.86      | Pass      |          |
| 17190.989   | 32.34      | 12.43      | 4.60        | 49.36          | Debug         | H         | 100     | 0        | 82.23          | -32.87      | Pass      |          |
| 17097.489   | 32.21      | 12.41      | 4.74        | 49.36          | Debug         | V         | 175     | 210      | 82.23          | -32.87      | Pass      |          |
| 17333.222   | 32.51      | 12.45      | 4.38        | 49.35          | Debug         | V         | 100     | 60       | 82.23          | -32.88      | Pass      |          |
| 17165.206   | 32.28      | 12.42      | 4.64        | 49.34          | Debug         | H         | 100     | 90       | 82.23          | -32.89      | Pass      |          |

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

**T14a Radiated Emissions 3m 1GHz – 18GHz 1CC TX-Off Top**



**Test Information**

|                        |                                                                                                                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Results Title</b>   | Radiated Emissions 3m 1-18GHz                                                                                                                                                                                           |
| <b>File Name</b>       | T14a RE1G-18G FCCB Tx-Off_Pass.emi                                                                                                                                                                                      |
| <b>Test Laboratory</b> | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                          |
| <b>Test Engineer</b>   | JY                                                                                                                                                                                                                      |
| <b>Test Software</b>   | Vasona by EMISoft, version 6.061                                                                                                                                                                                        |
| <b>Equipment</b>       | Nokia Wireless Group                                                                                                                                                                                                    |
| <b>EUT Details</b>     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, FA3WA & Main Unit - 1CC Top-Tx-OFF.                                                                                                   |
| <b>Configuration</b>   | Powered by -48Vdc Tested to FCC Part 15b, RE 1GHz-18GHz, @ 3-Meters, Horn Antenna E1074, LPF-E1476, Preamp-E447, FSW67-E1260, Cables E1503 and E1504. Internal attenuation 5dB, Previews RBW 100K; Formals RBW 1M / 3M. |
| <b>Date</b>            | 2021-06-08 20:41:31                                                                                                                                                                                                     |

**Formal Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 4915.269    | 43.87      | 6.45       | -3.88       | 46.44          | AvgMax        | V         | 159     | 5        | 54.00          | -7.56       | Pass      |          |
| 4423.690    | 43.39      | 5.89       | -4.16       | 45.12          | AvgMax        | V         | 164     | 51       | 54.00          | -8.88       | Pass      |          |
| 16999.692   | 27.02      | 12.39      | 4.89        | 44.31          | AvgMax        | H         | 128     | 335      | 54.00          | -9.69       | Pass      |          |
| 16941.608   | 27.08      | 12.37      | 4.74        | 44.20          | AvgMax        | H         | 227     | 321      | 54.00          | -9.80       | Pass      |          |
| 16993.742   | 26.78      | 12.39      | 4.87        | 44.04          | AvgMax        | V         | 243     | 14       | 54.00          | -9.96       | Pass      |          |
| 17882.063   | 26.98      | 12.87      | 4.15        | 43.99          | AvgMax        | H         | 323     | 179      | 54.00          | -10.01      | Pass      |          |
| 16984.321   | 26.71      | 12.39      | 4.85        | 43.95          | AvgMax        | V         | 102     | 102      | 54.00          | -10.05      | Pass      |          |
| 16475.738   | 27.56      | 12.22      | 3.56        | 43.35          | AvgMax        | V         | 302     | 316      | 54.00          | -10.65      | Pass      |          |
| 16999.692   | 42.34      | 12.39      | 4.89        | 59.62          | PeakMax       | H         | 128     | 335      | 74.00          | -14.38      | Pass      |          |
| 16984.321   | 41.97      | 12.39      | 4.85        | 59.21          | PeakMax       | V         | 102     | 102      | 74.00          | -14.79      | Pass      |          |
| 17882.063   | 42.07      | 12.87      | 4.15        | 59.08          | PeakMax       | H         | 323     | 179      | 74.00          | -14.92      | Pass      |          |

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 16941.608   | 41.94      | 12.37      | 4.74        | 59.06          | PeakMax       | H         | 227     | 321      | 74.00          | -14.94      | Pass      |          |
| 16993.742   | 41.77      | 12.39      | 4.87        | 59.04          | PeakMax       | V         | 243     | 14       | 74.00          | -14.96      | Pass      |          |
| 1474.583    | 46.72      | 3.19       | -11.38      | 38.53          | AvgMax        | V         | 117     | 54       | 54.00          | -15.47      | Pass      |          |
| 16475.738   | 42.59      | 12.22      | 3.56        | 58.38          | PeakMax       | V         | 302     | 316      | 74.00          | -15.62      | Pass      |          |
| 4915.269    | 49.31      | 6.45       | -3.88       | 51.88          | PeakMax       | V         | 159     | 5        | 74.00          | -22.12      | Pass      |          |
| 4423.690    | 49.26      | 5.89       | -4.16       | 51.00          | PeakMax       | V         | 164     | 51       | 74.00          | -23.00      | Pass      |          |
| 1474.583    | 53.65      | 3.19       | -11.38      | 45.47          | PeakMax       | V         | 117     | 54       | 74.00          | -28.53      | Pass      |          |

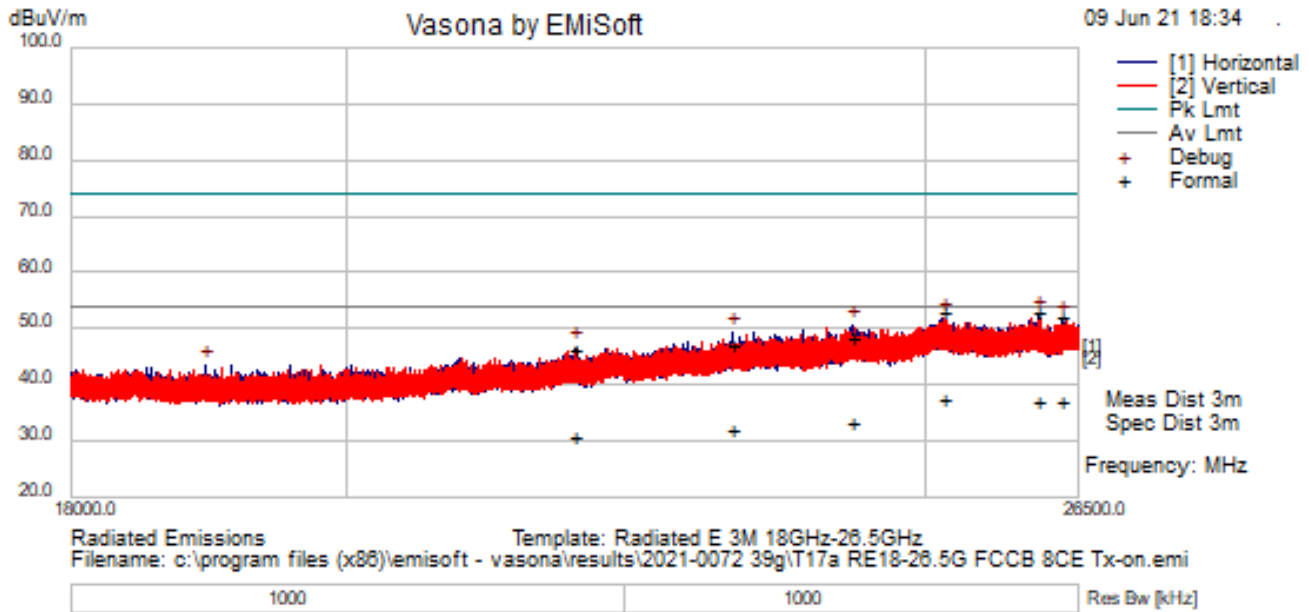
#### Preview Data

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 17882.063   | 34.08      | 12.87      | 4.15        | 51.10          | Debug         | H         | 325     | 90       | 54.00          | -2.90       | Pass      |          |
| 16999.692   | 33.38      | 12.39      | 4.89        | 50.66          | Debug         | H         | 175     | 330      | 54.00          | -3.34       | Pass      |          |
| 16941.608   | 33.38      | 12.37      | 4.74        | 50.49          | Debug         | H         | 250     | 90       | 54.00          | -3.51       | Pass      |          |
| 16475.738   | 34.62      | 12.22      | 3.56        | 50.40          | Debug         | V         | 250     | 60       | 54.00          | -3.60       | Pass      |          |
| 16984.321   | 33.05      | 12.39      | 4.85        | 50.29          | Debug         | V         | 175     | 330      | 54.00          | -3.71       | Pass      |          |
| 16993.742   | 33.00      | 12.39      | 4.87        | 50.27          | Debug         | V         | 325     | 330      | 54.00          | -3.73       | Pass      |          |
| 16574.267   | 34.21      | 12.24      | 3.82        | 50.27          | Debug         | V         | 325     | 330      | 54.00          | -3.73       | Pass      |          |
| 17945.954   | 33.12      | 12.94      | 4.15        | 50.20          | Debug         | V         | 325     | 300      | 54.00          | -3.80       | Pass      |          |
| 17923.358   | 33.12      | 12.92      | 4.15        | 50.18          | Debug         | V         | 325     | 120      | 54.00          | -3.82       | Pass      |          |
| 17422.496   | 33.44      | 12.47      | 4.25        | 50.16          | Debug         | H         | 100     | 60       | 54.00          | -3.84       | Pass      |          |
| 16952.588   | 32.97      | 12.38      | 4.77        | 50.12          | Debug         | V         | 175     | 300      | 54.00          | -3.88       | Pass      |          |
| 17896.442   | 33.06      | 12.89      | 4.15        | 50.09          | Debug         | V         | 100     | 150      | 54.00          | -3.91       | Pass      |          |
| 17541.921   | 33.42      | 12.52      | 4.13        | 50.08          | Debug         | H         | 175     | 0        | 54.00          | -3.92       | Pass      |          |
| 16484.946   | 34.27      | 12.22      | 3.59        | 50.07          | Debug         | V         | 175     | 60       | 54.00          | -3.93       | Pass      |          |
| 17982.292   | 32.89      | 12.98      | 4.15        | 50.02          | Debug         | V         | 325     | 270      | 54.00          | -3.98       | Pass      |          |
| 17956.367   | 32.92      | 12.95      | 4.15        | 50.01          | Debug         | V         | 100     | 30       | 54.00          | -3.99       | Pass      |          |
| 17358.321   | 33.17      | 12.46      | 4.34        | 49.97          | Debug         | V         | 175     | 180      | 54.00          | -4.03       | Pass      |          |
| 17056.925   | 32.77      | 12.40      | 4.80        | 49.97          | Debug         | H         | 175     | 0        | 54.00          | -4.03       | Pass      |          |
| 16913.488   | 32.93      | 12.36      | 4.67        | 49.97          | Debug         | H         | 250     | 300      | 54.00          | -4.03       | Pass      |          |
| 17882.346   | 32.92      | 12.87      | 4.15        | 49.94          | Debug         | V         | 100     | 150      | 54.00          | -4.06       | Pass      |          |
| 17024.696   | 32.68      | 12.40      | 4.85        | 49.93          | Debug         | V         | 325     | 150      | 54.00          | -4.07       | Pass      |          |
| 17088.588   | 32.76      | 12.41      | 4.75        | 49.92          | Debug         | V         | 325     | 30       | 54.00          | -4.08       | Pass      |          |
| 17087.313   | 32.65      | 12.41      | 4.76        | 49.82          | Debug         | H         | 100     | 240      | 54.00          | -4.18       | Pass      |          |
| 17938.233   | 32.69      | 12.93      | 4.15        | 49.77          | Debug         | V         | 250     | 30       | 54.00          | -4.23       | Pass      |          |
| 16844.708   | 32.92      | 12.34      | 4.50        | 49.76          | Debug         | V         | 175     | 60       | 54.00          | -4.24       | Pass      |          |
| 17994.263   | 32.62      | 12.99      | 4.15        | 49.76          | Debug         | H         | 100     | 150      | 54.00          | -4.24       | Pass      |          |
| 17065.992   | 32.53      | 12.40      | 4.79        | 49.72          | Debug         | H         | 250     | 150      | 54.00          | -4.28       | Pass      |          |
| 17034.683   | 32.48      | 12.40      | 4.84        | 49.71          | Debug         | V         | 250     | 90       | 54.00          | -4.29       | Pass      |          |
| 16912.142   | 32.65      | 12.36      | 4.67        | 49.68          | Debug         | H         | 325     | 300      | 54.00          | -4.32       | Pass      |          |
| 16562.933   | 33.65      | 12.23      | 3.79        | 49.68          | Debug         | V         | 100     | 0        | 54.00          | -4.32       | Pass      |          |
| 17886.100   | 32.63      | 12.88      | 4.15        | 49.66          | Debug         | V         | 250     | 90       | 54.00          | -4.34       | Pass      |          |
| 17415.979   | 32.92      | 12.47      | 4.26        | 49.65          | Debug         | H         | 250     | 60       | 54.00          | -4.35       | Pass      |          |
| 17351.167   | 32.78      | 12.45      | 4.35        | 49.59          | Debug         | V         | 325     | 60       | 54.00          | -4.41       | Pass      |          |
| 17803.296   | 32.65      | 12.79      | 4.14        | 49.59          | Debug         | H         | 325     | 60       | 54.00          | -4.41       | Pass      |          |
| 17111.608   | 32.43      | 12.41      | 4.72        | 49.56          | Debug         | V         | 175     | 0        | 54.00          | -4.44       | Pass      |          |
| 17463.933   | 32.88      | 12.47      | 4.18        | 49.54          | Debug         | V         | 175     | 240      | 54.00          | -4.46       | Pass      |          |
| 16709.558   | 33.08      | 12.29      | 4.16        | 49.54          | Debug         | V         | 325     | 300      | 54.00          | -4.46       | Pass      |          |

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 17928.033   | 32.46      | 12.92      | 4.15        | 49.53          | Debug         | V         | 100     | 300      | 54.00          | -4.47       | Pass      |          |
| 17848.275   | 32.54      | 12.84      | 4.14        | 49.52          | Debug         | V         | 100     | 30       | 54.00          | -4.48       | Pass      |          |
| 16634.404   | 33.28      | 12.26      | 3.97        | 49.51          | Debug         | V         | 100     | 0        | 54.00          | -4.49       | Pass      |          |
| 16459.375   | 33.76      | 12.23      | 3.52        | 49.50          | Debug         | H         | 175     | 330      | 54.00          | -4.50       | Pass      |          |
| 16473.967   | 33.70      | 12.22      | 3.56        | 49.48          | Debug         | V         | 325     | 210      | 54.00          | -4.52       | Pass      |          |
| 16733.642   | 32.95      | 12.30      | 4.22        | 49.47          | Debug         | H         | 250     | 270      | 54.00          | -4.53       | Pass      |          |
| 17116.071   | 32.33      | 12.41      | 4.71        | 49.46          | Debug         | V         | 175     | 150      | 54.00          | -4.54       | Pass      |          |
| 17151.346   | 32.38      | 12.42      | 4.66        | 49.45          | Debug         | V         | 175     | 0        | 54.00          | -4.55       | Pass      |          |
| 17223.383   | 32.45      | 12.43      | 4.55        | 49.43          | Debug         | V         | 325     | 330      | 54.00          | -4.57       | Pass      |          |
| 17314.971   | 32.57      | 12.45      | 4.41        | 49.43          | Debug         | H         | 325     | 270      | 54.00          | -4.57       | Pass      |          |
| 17507.425   | 32.80      | 12.49      | 4.13        | 49.42          | Debug         | H         | 100     | 330      | 54.00          | -4.58       | Pass      |          |
| 17387.363   | 32.65      | 12.46      | 4.30        | 49.41          | Debug         | V         | 250     | 120      | 54.00          | -4.59       | Pass      |          |
| 16557.408   | 33.40      | 12.23      | 3.78        | 49.41          | Debug         | V         | 250     | 180      | 54.00          | -4.59       | Pass      |          |
| 4915.269    | 42.57      | 6.45       | -3.88       | 45.14          | Debug         | V         | 0       | 330      | 54.00          | -8.86       | Pass      |          |
| 1474.583    | 52.02      | 3.19       | -11.38      | 43.84          | Debug         | V         | 0       | 330      | 54.00          | -10.16      | Pass      |          |
| 4423.690    | 40.25      | 5.89       | -4.16       | 41.98          | Debug         | V         | 0       | 330      | 54.00          | -12.02      | Pass      |          |

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

**T17a Radiated Emissions 3m 18GHz – 26.5GHz 8CC TX-On Top**



**Test Information**

|                        |                                                                                                                                                                                                                            |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Results Title</b>   | Radiated Emissions 3M 18GHz-26.5GHz                                                                                                                                                                                        |
| <b>File Name</b>       | T17a RE18g-26.5G FCCB 8C-Ext Tx-on.emi                                                                                                                                                                                     |
| <b>Test Laboratory</b> | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                             |
| <b>Test Engineer</b>   | MJS                                                                                                                                                                                                                        |
| <b>Test Software</b>   | Vasona by EMISoft, version 6.061                                                                                                                                                                                           |
| <b>Equipment</b>       | Nokia Wireless Group                                                                                                                                                                                                       |
| <b>EUT Details</b>     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, FA3WA Extension Unit - 8CC Top-Tx-On.                                                                                                    |
| <b>Configuration</b>   | Powered by -48Vdc Tested to FCC Part 15b, RE 18GHz-26.5GHz, @ 3-Meters, Horn Antenna E1452, LPF-E1516, Preamp-E447, FSW67-E1260, Cables E1501 and E1502. Internal attenuation 0dB, Previews RBW 100K; Formals RBW 1M / 3M. |
| <b>Date</b>            | 2021-06-09 18:34:52                                                                                                                                                                                                        |

**Formal Data**

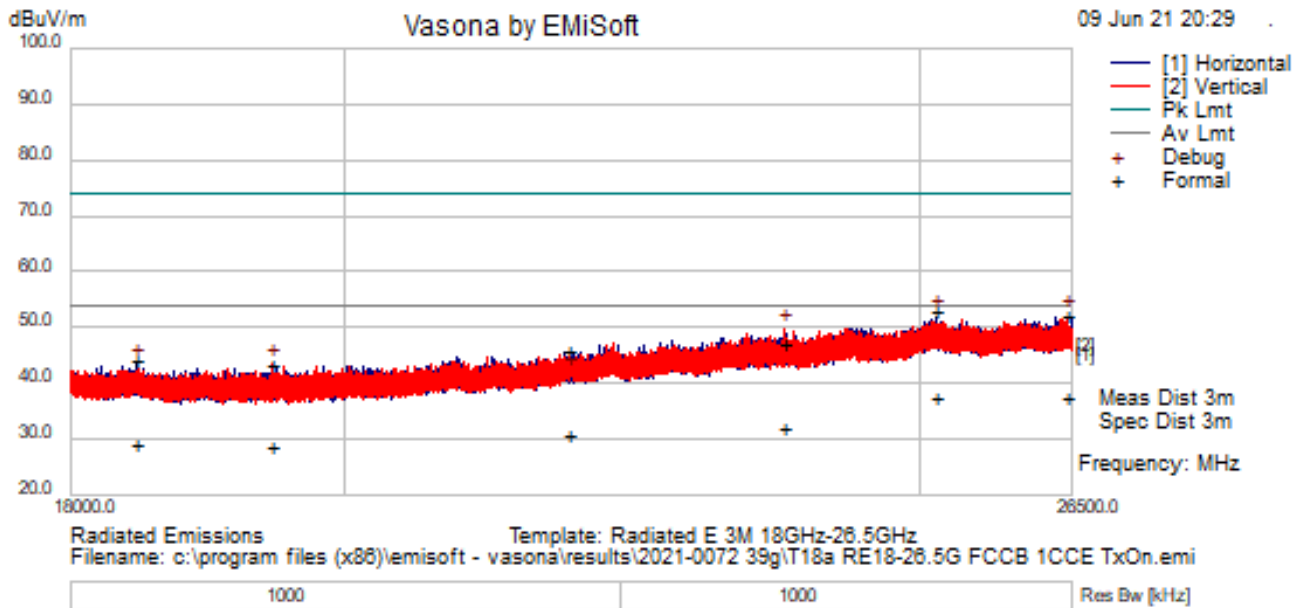
| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 25162.241   | 26.61      | 14.25      | -3.20       | 37.66          | AvgMax        | V         | 179     | 256      | 54.00          | -16.34      | Pass      |          |
| 26340.057   | 26.08      | 14.48      | -3.23       | 37.32          | AvgMax        | H         | 167     | 192      | 54.00          | -16.68      | Pass      |          |
| 26089.307   | 25.94      | 14.42      | -3.17       | 37.19          | AvgMax        | H         | 298     | 77       | 54.00          | -16.81      | Pass      |          |
| 24299.491   | 23.34      | 13.78      | -3.69       | 33.43          | AvgMax        | H         | 322     | 197      | 54.00          | -20.57      | Pass      |          |
| 25162.241   | 42.24      | 14.25      | -3.20       | 53.29          | PeakMax       | V         | 179     | 256      | 74.00          | -20.71      | Pass      |          |
| 26089.307   | 41.73      | 14.42      | -3.17       | 52.99          | PeakMax       | H         | 298     | 77       | 74.00          | -21.01      | Pass      |          |
| 23202.425   | 23.56      | 13.71      | -5.03       | 32.24          | AvgMax        | H         | 153     | 343      | 54.00          | -21.76      | Pass      |          |
| 26340.057   | 40.88      | 14.48      | -3.23       | 52.13          | PeakMax       | H         | 167     | 192      | 74.00          | -21.87      | Pass      |          |
| 21839.308   | 25.42      | 13.01      | -7.45       | 30.97          | AvgMax        | H         | 318     | 355      | 54.00          | -23.03      | Pass      |          |
| 24299.491   | 38.22      | 13.78      | -3.69       | 48.31          | PeakMax       | H         | 322     | 197      | 74.00          | -25.69      | Pass      |          |
| 23202.425   | 38.54      | 13.71      | -5.03       | 47.21          | PeakMax       | H         | 153     | 343      | 74.00          | -26.79      | Pass      |          |
| 21839.308   | 40.70      | 13.01      | -7.45       | 46.25          | PeakMax       | H         | 318     | 355      | 74.00          | -27.75      | Pass      |          |

### Preview Data

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 26089.307   | 40.82      | 14.42      | -3.17       | 52.07          | Debug         | H         | 325     | 132      | 54.00          | -1.93       | Pass      |          |
| 25162.241   | 40.76      | 14.25      | -3.20       | 51.82          | Debug         | V         | 100     | 242      | 54.00          | -2.18       | Pass      |          |
| 26340.057   | 40.00      | 14.48      | -3.23       | 51.25          | Debug         | H         | 175     | 286      | 54.00          | -2.75       | Pass      |          |
| 24299.491   | 40.42      | 13.78      | -3.69       | 50.51          | Debug         | H         | 175     | 220      | 54.00          | -3.49       | Pass      |          |
| 23202.425   | 40.39      | 13.71      | -5.03       | 49.06          | Debug         | H         | 100     | 330      | 54.00          | -4.94       | Pass      |          |
| 21839.308   | 40.82      | 13.01      | -7.45       | 46.37          | Debug         | H         | 325     | 154      | 54.00          | -7.63       | Pass      |          |
| 18952.425   | 40.39      | 11.91      | -8.91       | 43.39          | Debug         | H         | 100     | 330      | 54.00          | -10.61      | Pass      |          |

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

**T18a Radiated Emissions 3m 18GHz – 26.5GHz 1CC TX-On Top**



**Test Information**

|                 |                                                                                                                                                                                                                            |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Results Title   | Radiated Emissions 3M 18GHz-26.5GHz                                                                                                                                                                                        |
| File Name       | T18a RE18-26.5G FCCB 1CC Ext Unit Tx-On.emi                                                                                                                                                                                |
| Test Laboratory | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                             |
| Test Engineer   | MJS                                                                                                                                                                                                                        |
| Test Software   | Vasona by EMIsoft, version 6.061                                                                                                                                                                                           |
| Equipment       | Nokia Wireless Group                                                                                                                                                                                                       |
| EUT Details     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, FA3WA Extension Unit - 1CC Top-Tx-On.                                                                                                    |
| Configuration   | Powered by -48Vdc Tested to FCC Part 15b, RE 18GHz-26.5GHz, @ 3-Meters, Horn Antenna E1452, LPF-E1516, Preamp-E447, FSW67-E1260, Cables E1501 and E1502. Internal attenuation 0dB, Previews RBW 100K; Formals RBW 1M / 3M. |
| Date            | 2021-06-09 20:29:06                                                                                                                                                                                                        |

**Formal Data**

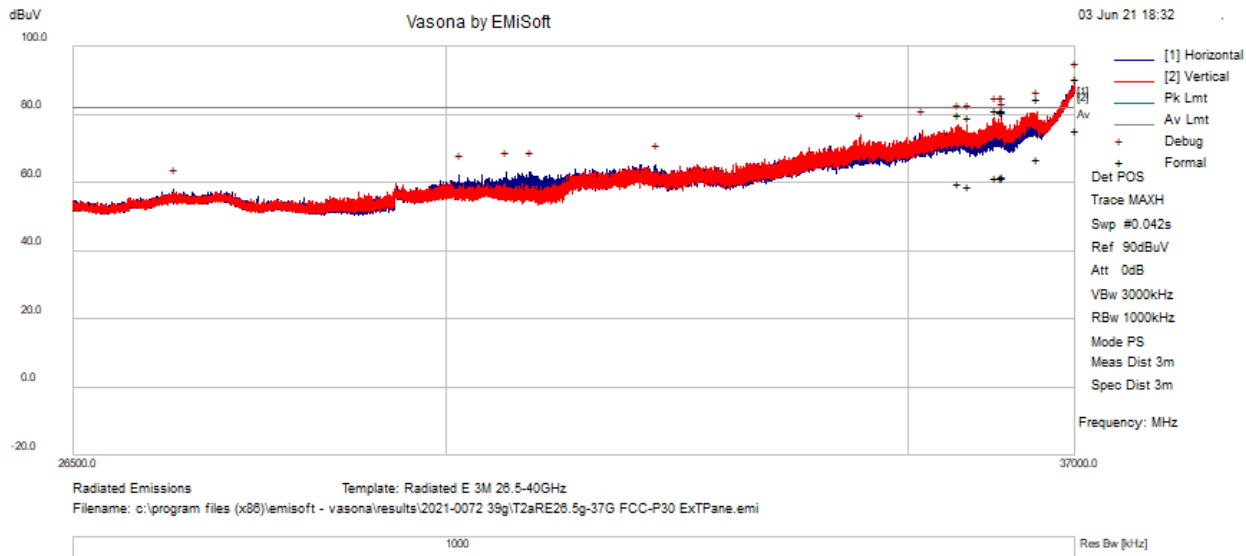
| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 25154.308   | 26.62      | 14.25      | -3.21       | 37.66          | AvgMax        | H         | 108     | 248      | 54.00          | -16.34      | Pass      |          |
| 26447.724   | 26.17      | 14.50      | -3.22       | 37.46          | AvgMax        | V         | 248     | 93       | 54.00          | -16.54      | Pass      |          |
| 25154.308   | 42.26      | 14.25      | -3.21       | 53.30          | PeakMax       | H         | 108     | 248      | 74.00          | -20.70      | Pass      |          |
| 26447.724   | 41.10      | 14.50      | -3.22       | 52.38          | PeakMax       | V         | 248     | 93       | 74.00          | -21.62      | Pass      |          |
| 23706.191   | 23.12      | 13.71      | -4.70       | 32.13          | AvgMax        | V         | 282     | 322      | 54.00          | -21.87      | Pass      |          |
| 21823.441   | 25.45      | 13.00      | -7.49       | 30.96          | AvgMax        | V         | 284     | 249      | 54.00          | -23.04      | Pass      |          |
| 18463.533   | 25.96      | 11.88      | -8.57       | 29.28          | AvgMax        | H         | 110     | 27       | 54.00          | -24.72      | Pass      |          |
| 19456.192   | 25.96      | 12.03      | -9.24       | 28.76          | AvgMax        | V         | 172     | 17       | 54.00          | -25.24      | Pass      |          |
| 23706.191   | 38.28      | 13.71      | -4.70       | 47.29          | PeakMax       | V         | 282     | 322      | 74.00          | -26.71      | Pass      |          |
| 21823.441   | 40.62      | 13.00      | -7.49       | 46.13          | PeakMax       | V         | 284     | 249      | 74.00          | -27.87      | Pass      |          |
| 18463.533   | 41.05      | 11.88      | -8.57       | 44.36          | PeakMax       | H         | 110     | 27       | 74.00          | -29.64      | Pass      |          |
| 19456.192   | 40.70      | 12.03      | -9.24       | 43.50          | PeakMax       | V         | 172     | 17       | 74.00          | -30.50      | Pass      |          |

**Preview Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 26447.724   | 40.66      | 14.50      | -3.22       | 51.94          | Debug         | V         | 175     | 198      | 54.00          | -2.06       | Pass      |          |
| 25154.308   | 40.79      | 14.25      | -3.21       | 51.84          | Debug         | H         | 250     | 330      | 54.00          | -2.16       | Pass      |          |
| 23706.191   | 40.60      | 13.71      | -4.70       | 49.62          | Debug         | V         | 175     | 0        | 54.00          | -4.38       | Pass      |          |
| 19456.192   | 40.60      | 12.03      | -9.24       | 43.40          | Debug         | V         | 175     | 0        | 54.00          | -10.60      | Pass      |          |
| 18463.533   | 39.88      | 11.88      | -8.57       | 43.19          | Debug         | H         | 175     | 330      | 54.00          | -10.81      | Pass      |          |
| 21823.441   | 35.85      | 13.00      | -7.49       | 41.36          | Debug         | V         | 99      | 352      | 54.00          | -12.64      | Pass      |          |

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

**T2a Radiated Emissions 3m 26.5GHz – 37GHz 8CC TX-On Top**



**Test Information**

|                        |                                                                                                                                                                                                                             |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Results Title</b>   | Radiated Emissions 3M 26.5-40GHz                                                                                                                                                                                            |
| <b>File Name</b>       | T2a RE26.5g-37G 8cc FCC-P30 ExT Panel.emi                                                                                                                                                                                   |
| <b>Test Laboratory</b> | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                              |
| <b>Test Engineer</b>   | MJS / WSM                                                                                                                                                                                                                   |
| <b>Test Software</b>   | Vasona by EMISoft, version 6.061                                                                                                                                                                                            |
| <b>Equipment</b>       | Nokia Wireless Group                                                                                                                                                                                                        |
| <b>EUT Details</b>     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, Tx-On 8CC. FA3WA Extension Module                                                                                                         |
| <b>Configuration</b>   | Powered by -48Vdc, Tested to FCCB, RE 26.5G-37GHz, @ 3-Meters, Horn Antenna E1373, Preamp-E1525, FSW67-E1260, and HPF-Filter E1516, Cables E1501 and E1502. Internal attenuation 0dB, Previews RBW 1M; Formals RBW 1M / 3M. |
| <b>Date</b>            | 2021-06-03 18:32:02                                                                                                                                                                                                         |

**Formal Data**

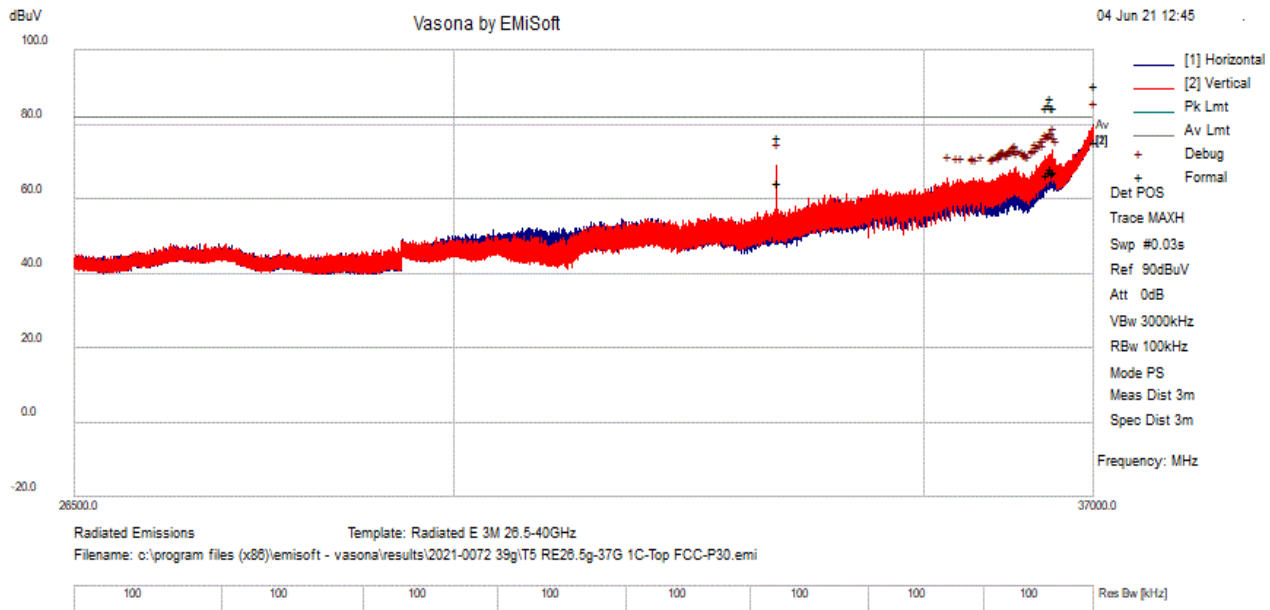
| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 36995.100   | 29.13      | 49.41      | -2.98       | 75.57          | AvgMax        | V         | 168     | 207      | 82.23          | -6.66       | Pass      |          |
| 36533.450   | 35.62      | 33.66      | -2.15       | 67.13          | AvgMax        | V         | 169     | 277      | 82.23          | -15.10      | Pass      |          |
| 36112.050   | 41.79      | 22.68      | -2.34       | 62.12          | AvgMax        | V         | 174     | 269      | 82.23          | -20.11      | Pass      |          |
| 36096.300   | 41.83      | 22.37      | -2.36       | 61.84          | AvgMax        | V         | 180     | 268      | 82.23          | -20.39      | Pass      |          |
| 36019.300   | 42.84      | 21.24      | -2.34       | 61.74          | AvgMax        | V         | 163     | 269      | 82.23          | -20.49      | Pass      |          |
| 36101.550   | 41.59      | 22.46      | -2.36       | 61.69          | AvgMax        | V         | 170     | 266      | 82.23          | -20.54      | Pass      |          |
| 35581.450   | 42.62      | 18.93      | -1.40       | 60.15          | AvgMax        | V         | 173     | 270      | 82.23          | -22.08      | Pass      |          |
| 35691.000   | 41.73      | 19.13      | -1.61       | 59.25          | AvgMax        | V         | 167     | 281      | 82.23          | -22.98      | Pass      |          |

**Preview Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 36995.100   | 42.81      | 49.41      | -2.98       | 89.25          | Debug         | V         | 250     | 330      | 82.23          | 7.02        | Fail      |          |
| 36533.450   | 49.14      | 33.66      | -2.15       | 80.66          | Debug         | V         | 175     | 264      | 82.23          | -1.57       | Pass      |          |
| 36101.550   | 59.24      | 22.46      | -2.36       | 79.35          | Debug         | V         | 175     | 264      | 82.23          | -2.88       | Pass      |          |
| 36096.300   | 59.21      | 22.37      | -2.36       | 79.23          | Debug         | V         | 175     | 264      | 82.23          | -3.00       | Pass      |          |
| 36019.300   | 60.31      | 21.24      | -2.34       | 79.21          | Debug         | V         | 175     | 264      | 82.23          | -3.02       | Pass      |          |
| 36112.050   | 57.00      | 22.68      | -2.34       | 77.34          | Debug         | V         | 175     | 264      | 82.23          | -4.89       | Pass      |          |
| 35581.450   | 59.43      | 18.93      | -1.40       | 76.96          | Debug         | V         | 175     | 264      | 82.23          | -5.27       | Pass      |          |
| 35691.000   | 59.38      | 19.13      | -1.61       | 76.90          | Debug         | V         | 175     | 264      | 82.23          | -5.33       | Pass      |          |
| 35158.300   | 59.50      | 17.57      | -1.63       | 75.44          | Debug         | V         | 175     | 264      | 82.23          | -6.79       | Pass      |          |
| 34447.450   | 58.12      | 16.96      | -1.06       | 74.02          | Debug         | V         | 175     | 264      | 82.23          | -8.21       | Pass      |          |
| 32178.750   | 49.74      | 16.16      | -0.50       | 65.41          | Debug         | H         | 175     | 286      | 82.23          | -16.82      | Pass      |          |
| 30860.650   | 48.26      | 15.33      | -0.50       | 63.09          | Debug         | H         | 175     | 286      | 82.23          | -19.14      | Pass      |          |
| 30612.500   | 48.17      | 15.29      | -0.40       | 63.06          | Debug         | H         | 175     | 286      | 82.23          | -19.17      | Pass      |          |
| 30134.050   | 47.02      | 15.15      | 0.14        | 62.31          | Debug         | H         | 175     | 286      | 82.23          | -19.92      | Pass      |          |
| 27403.700   | 43.56      | 14.52      | -0.03       | 58.04          | Debug         | H         | 175     | 22       | 82.23          | -24.19      | Pass      |          |

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

**T5 Radiated Emissions 3m 26.5GHz – 37GHz 1CC TX-On Top**



**Test Information**

|                        |                                                                                                                                                                                                                             |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Results Title</b>   | Radiated Emissions 3M 26.5-40GHz                                                                                                                                                                                            |
| <b>File Name</b>       | T5 RE26.5g-37G 1C-Top FCC-P30.emi                                                                                                                                                                                           |
| <b>Test Laboratory</b> | MH-AR4, 49.2%RH, 20.6C, 997hPa                                                                                                                                                                                              |
| <b>Test Engineer</b>   | MJS / WSM                                                                                                                                                                                                                   |
| <b>Test Software</b>   | Vasona by EMISoft, version 6.061                                                                                                                                                                                            |
| <b>Equipment</b>       | Nokia Wireless Group                                                                                                                                                                                                        |
| <b>EUT Details</b>     | AR4-2021-0072, 39GHz ASMR - SN-AM1-YK211800017, AM2-YK211800027, AM3-YK211800031, Tx-On 1CC, FA3WA Extension Unit TX-On.                                                                                                    |
| <b>Configuration</b>   | Powered by -48Vdc Tested to FCCB, RE 26.5G-37Hz, @ 3-Meters, Horn Antenna E1373, Preamp-E1525, FSW67-E1260, and HPF-Filter E1516, Cables E1501 and E1502. Internal attenuation 5dB, Previews RBW 100K; Formals RBW 1M / 3M. |
| <b>Date</b>            | 2021-06-04 13:00:10                                                                                                                                                                                                         |

**Formal Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 36996.500   | 29.19      | 49.47      | -2.98       | 75.68          | AvgMax        | H         | 157     | 30       | 82.23          | -6.55       | Pass      |          |
| 36473.600   | 38.62      | 31.92      | -2.06       | 68.47          | AvgMax        | V         | 169     | 276      | 82.23          | -13.76      | Pass      |          |
| 36501.863   | 36.82      | 32.73      | -2.09       | 67.47          | AvgMax        | V         | 164     | 266      | 82.23          | -14.76      | Pass      |          |
| 36454.656   | 38.11      | 31.38      | -2.05       | 67.44          | AvgMax        | V         | 180     | 274      | 82.23          | -14.79      | Pass      |          |
| 36489.963   | 37.03      | 32.39      | -2.08       | 67.34          | AvgMax        | V         | 182     | 275      | 82.23          | -14.89      | Pass      |          |
| 36415.806   | 38.59      | 30.26      | -2.02       | 66.84          | AvgMax        | V         | 176     | 270      | 82.23          | -15.39      | Pass      |          |
| 33351.669   | 49.16      | 16.12      | -0.83       | 64.45          | AvgMax        | V         | 162     | 272      | 82.23          | -17.78      | Pass      |          |

**Preview Data**

| Freq. (MHz) | Raw (dBuV) | Cable (dB) | Factor (dB) | Level (dBuV/m) | Emission Type | Pol (H/V) | Ht (cm) | Az (deg) | Limit (dBuV/m) | Margin (dB) | Pass/Fail | Comments |
|-------------|------------|------------|-------------|----------------|---------------|-----------|---------|----------|----------------|-------------|-----------|----------|
| 36996.500   | 33.40      | 49.47      | -2.98       | 79.89          | Debug         | H         | 325     | 44       | 82.23          | -2.34       | Pass      |          |
| 36501.863   | 42.51      | 32.73      | -2.09       | 73.15          | Debug         | V         | 175     | 264      | 82.23          | -9.08       | Pass      |          |
| 36489.963   | 41.76      | 32.39      | -2.08       | 72.08          | Debug         | V         | 175     | 264      | 82.23          | -10.15      | Pass      |          |
| 36473.600   | 42.07      | 31.92      | -2.06       | 71.93          | Debug         | V         | 175     | 264      | 82.23          | -10.30      | Pass      |          |
| 36415.806   | 43.16      | 30.26      | -2.02       | 71.41          | Debug         | V         | 175     | 264      | 82.23          | -10.82      | Pass      |          |
| 36454.656   | 42.03      | 31.38      | -2.05       | 71.35          | Debug         | V         | 175     | 264      | 82.23          | -10.88      | Pass      |          |
| 36465.288   | 41.64      | 31.68      | -2.06       | 71.26          | Debug         | V         | 175     | 264      | 82.23          | -10.97      | Pass      |          |
| 36416.419   | 42.61      | 30.28      | -2.02       | 70.88          | Debug         | V         | 175     | 264      | 82.23          | -11.35      | Pass      |          |
| 36535.244   | 39.14      | 33.71      | -2.15       | 70.70          | Debug         | V         | 175     | 264      | 82.23          | -11.53      | Pass      |          |
| 36505.625   | 39.95      | 32.84      | -2.09       | 70.70          | Debug         | V         | 175     | 264      | 82.23          | -11.53      | Pass      |          |
| 36379.144   | 42.70      | 29.24      | -2.02       | 69.91          | Debug         | V         | 175     | 264      | 82.23          | -12.32      | Pass      |          |
| 36537.606   | 38.15      | 33.78      | -2.15       | 69.77          | Debug         | V         | 175     | 264      | 82.23          | -12.46      | Pass      |          |
| 36370.394   | 42.76      | 29.00      | -2.02       | 69.74          | Debug         | V         | 175     | 264      | 82.23          | -12.49      | Pass      |          |
| 36390.869   | 42.13      | 29.56      | -2.01       | 69.68          | Debug         | V         | 175     | 264      | 82.23          | -12.55      | Pass      |          |
| 33351.644   | 53.73      | 16.12      | -0.83       | 69.02          | Debug         | V         | 175     | 264      | 82.23          | -13.21      | Pass      |          |
| 36303.719   | 43.82      | 27.16      | -2.07       | 68.91          | Debug         | V         | 175     | 264      | 82.23          | -13.32      | Pass      |          |
| 36348.869   | 42.41      | 28.40      | -2.04       | 68.78          | Debug         | V         | 175     | 264      | 82.23          | -13.45      | Pass      |          |
| 36381.331   | 41.43      | 29.30      | -2.01       | 68.71          | Debug         | V         | 175     | 286      | 82.23          | -13.52      | Pass      |          |
| 36061.650   | 49.11      | 21.86      | -2.35       | 68.63          | Debug         | V         | 175     | 264      | 82.23          | -13.60      | Pass      |          |
| 36048.306   | 48.90      | 21.67      | -2.35       | 68.22          | Debug         | V         | 175     | 264      | 82.23          | -14.01      | Pass      |          |
| 36323.406   | 42.42      | 27.70      | -2.05       | 68.06          | Debug         | V         | 175     | 264      | 82.23          | -14.17      | Pass      |          |
| 36000.006   | 48.93      | 20.96      | -2.34       | 67.55          | Debug         | V         | 175     | 264      | 82.23          | -14.68      | Pass      |          |
| 36293.263   | 42.69      | 26.89      | -2.08       | 67.49          | Debug         | V         | 175     | 264      | 82.23          | -14.74      | Pass      |          |
| 36053.338   | 48.05      | 21.74      | -2.35       | 67.45          | Debug         | V         | 175     | 264      | 82.23          | -14.78      | Pass      |          |
| 36257.519   | 43.48      | 25.98      | -2.15       | 67.31          | Debug         | V         | 175     | 264      | 82.23          | -14.92      | Pass      |          |
| 36095.731   | 47.29      | 22.36      | -2.36       | 67.30          | Debug         | V         | 175     | 264      | 82.23          | -14.93      | Pass      |          |
| 36005.869   | 48.40      | 21.04      | -2.34       | 67.11          | Debug         | V         | 175     | 264      | 82.23          | -15.12      | Pass      |          |
| 36263.600   | 43.01      | 26.14      | -2.14       | 67.01          | Debug         | V         | 175     | 264      | 82.23          | -15.22      | Pass      |          |
| 36017.638   | 48.09      | 21.22      | -2.34       | 66.97          | Debug         | V         | 175     | 264      | 82.23          | -15.26      | Pass      |          |
| 35906.075   | 48.99      | 20.05      | -2.14       | 66.91          | Debug         | V         | 175     | 264      | 82.23          | -15.32      | Pass      |          |
| 35919.638   | 48.81      | 20.18      | -2.17       | 66.83          | Debug         | V         | 175     | 264      | 82.23          | -15.40      | Pass      |          |
| 35916.794   | 48.83      | 20.16      | -2.16       | 66.82          | Debug         | V         | 175     | 264      | 82.23          | -15.41      | Pass      |          |
| 36149.981   | 45.64      | 23.47      | -2.31       | 66.81          | Debug         | V         | 175     | 264      | 82.23          | -15.42      | Pass      |          |
| 35985.219   | 48.23      | 20.81      | -2.30       | 66.74          | Debug         | V         | 175     | 264      | 82.23          | -15.49      | Pass      |          |
| 36070.663   | 47.08      | 21.99      | -2.35       | 66.72          | Debug         | V         | 175     | 264      | 82.23          | -15.51      | Pass      |          |
| 36171.113   | 45.02      | 23.92      | -2.29       | 66.65          | Debug         | V         | 175     | 264      | 82.23          | -15.58      | Pass      |          |
| 35881.138   | 48.77      | 19.88      | -2.08       | 66.57          | Debug         | V         | 175     | 264      | 82.23          | -15.66      | Pass      |          |
| 35921.256   | 48.52      | 20.20      | -2.17       | 66.55          | Debug         | V         | 175     | 264      | 82.23          | -15.68      | Pass      |          |
| 35949.169   | 48.25      | 20.47      | -2.23       | 66.49          | Debug         | V         | 175     | 264      | 82.23          | -15.74      | Pass      |          |
| 35909.269   | 48.37      | 20.08      | -2.14       | 66.32          | Debug         | V         | 175     | 264      | 82.23          | -15.91      | Pass      |          |
| 35969.950   | 47.76      | 20.67      | -2.27       | 66.16          | Debug         | V         | 175     | 264      | 82.23          | -16.07      | Pass      |          |
| 36160.569   | 44.71      | 23.70      | -2.30       | 66.11          | Debug         | V         | 175     | 264      | 82.23          | -16.12      | Pass      |          |

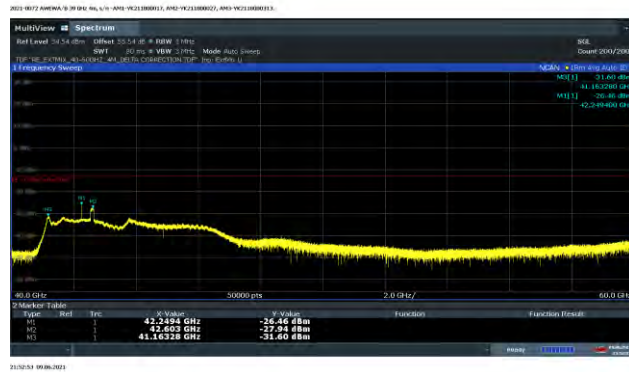
Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in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

## Maximum Measured Radiated Emissions -U Band 40GHz-60GHz

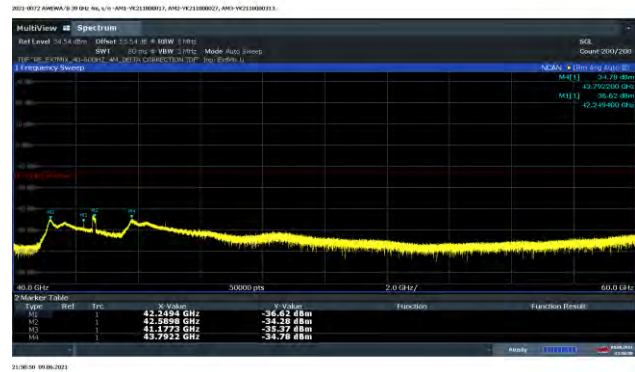
## FCC B Part 30

### 1CC

#### Vertical Polarization - 1 MHz RBW

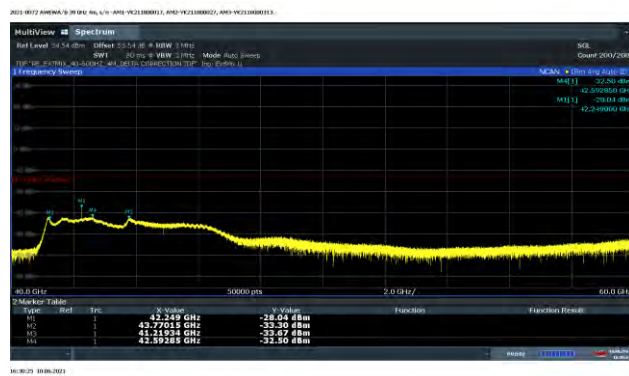


#### Horizontal Polarization - 1 MHz RBW

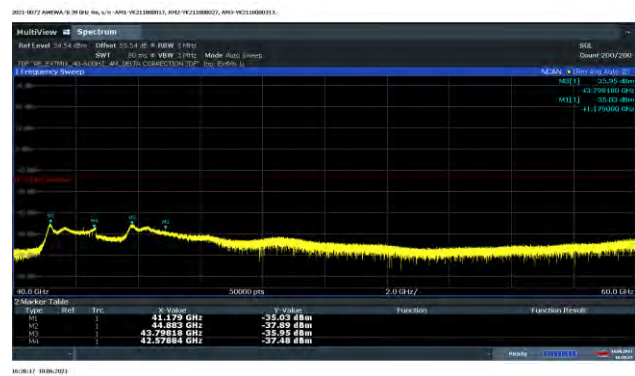


### 8CC

#### Vertical Polarization - 1 MHz RBW



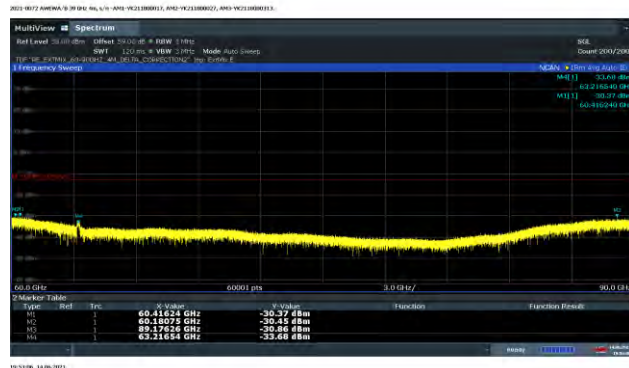
#### Horizontal Polarization - 1 MHz RBW



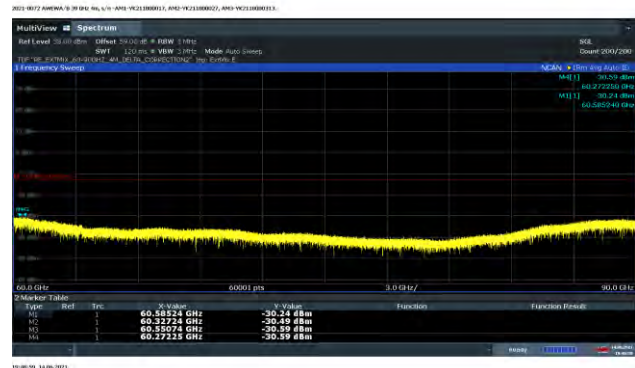
# Maximum Measured Radiated Emissions -U Band 60GHz-90GHz 1CC

## FCC B Part 30

### Vertical Polarization - 1 MHz RBW

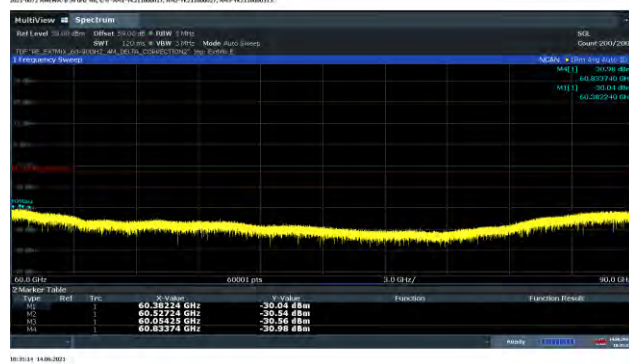


### Horizontal Polarization - 1 MHz RBW

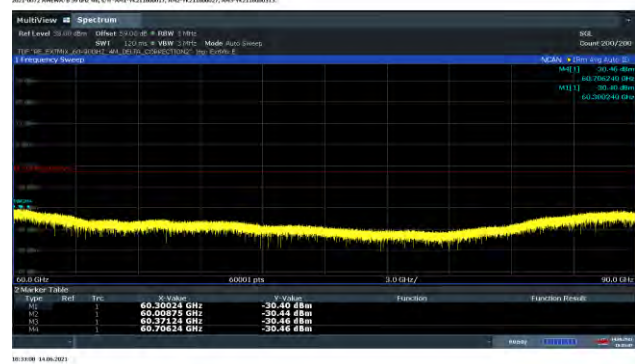


## 8CC

### Vertical Polarization - 1 MHz RBW



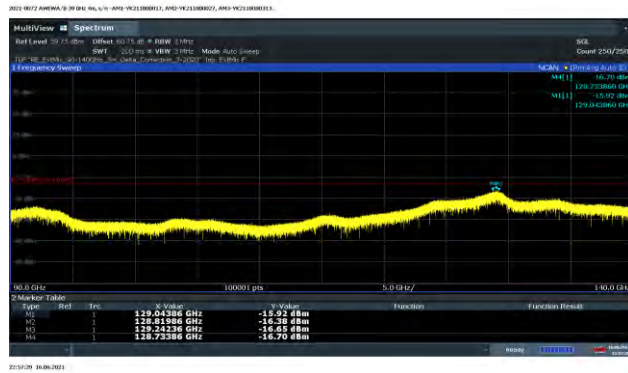
### Horizontal Polarization - 1 MHz RBW



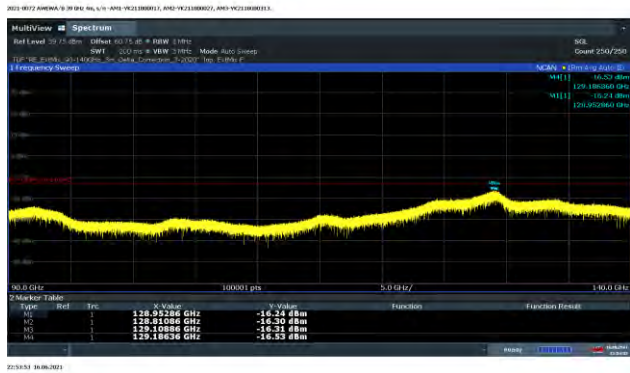
Maximum Measured Radiated Emissions -U Band 90GHz-140GHz  
1CC

FCC B Part 30

Vertical Polarization - 1 MHz RBW

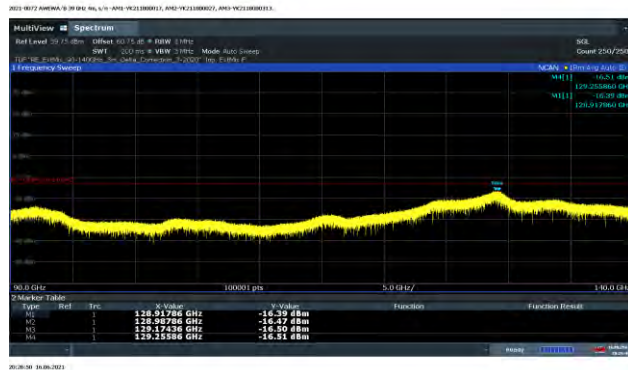


Horizontal Polarization - 1 MHz RBW

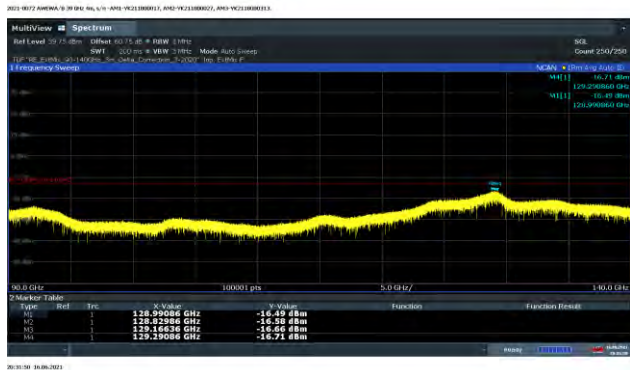


8CC

Vertical Polarization - 1 MHz RBW



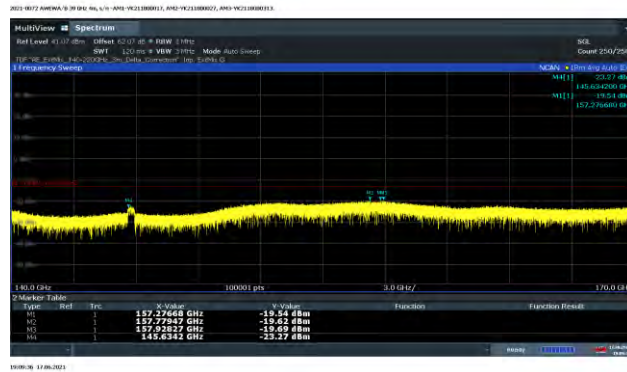
Horizontal Polarization - 1 MHz RBW



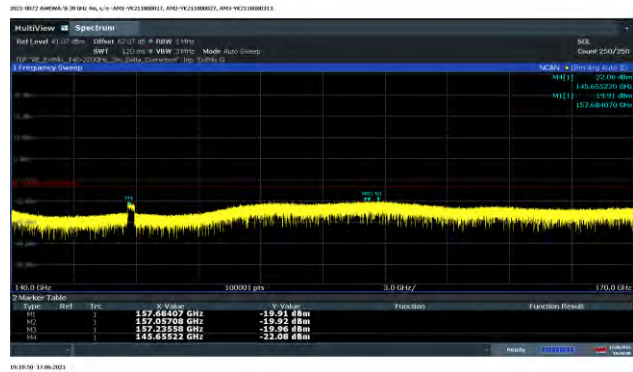
## Maximum Measured Radiated Emissions -U Band 140GHz-170GHz FCC B Part 30

### 1CC

#### Vertical Polarization - 1 MHz RBW

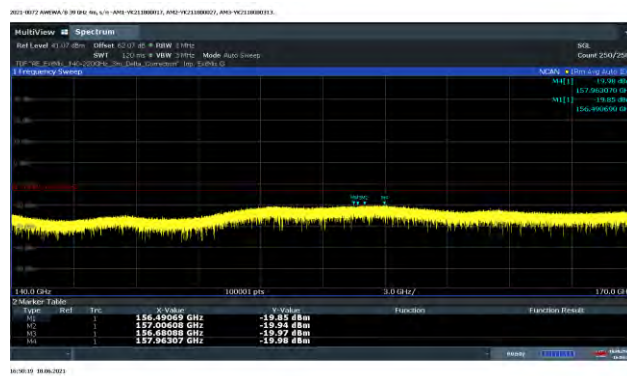


#### Horizontal Polarization - 1 MHz RBW

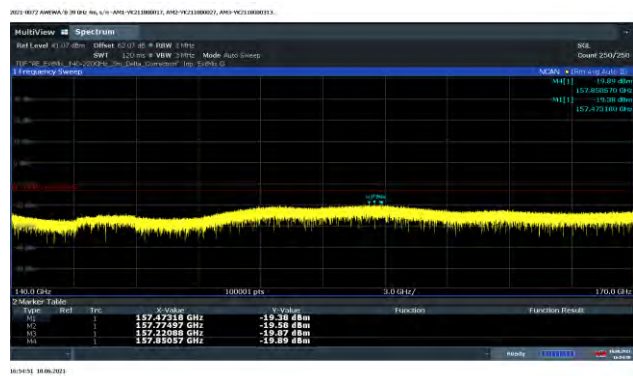


### 8CC

#### Vertical Polarization - 1 MHz RBW



#### Horizontal Polarization - 1 MHz RBW



**1CC**  
**Vertical Polarization - 1 MHz RBW**



## 20:19:00 17/06/2012

## 22/01/11 17:00:2021

## 22:16:00 1786.202

#### 4.6 Section 2.1055 MEASUREMENT OF FREQUENCY STABILITY

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

##### 4.6.1 Frequency Stability Results AC Model:

Frequency Stability testing was completed on a FA3WA Extension Modules powered and supported by an AC version 39 GHz ASMR main unit (CF = 38,447.76MHz). Testing was performed from 06/21/2021 through 06/22/2021 on the radio, which was located in the T-16 Thermal chamber of the Global Product Compliance Laboratory (GPCL) test facility located in Building 4, Room 4-280, Murray Hill, NJ, by Joe Bordonaro from GPCL.

**Table A: AC Unit Under Test**

| Series | Vendor | Serial Number | Model       |
|--------|--------|---------------|-------------|
| FA3WA  | Nokia  | YK211800033   | 475002A.X31 |
| FA3WA  | Nokia  | YK211800034   | 475002A.X31 |
| AWEWA  | Nokia  | YK211800002   | 475170A.X31 |

Note: A fan was not installed on the radio during testing.

The temperatures to which the UUT were subjected ranged from a high temperature of +50°C system ambient to a low temperature of -30°C system ambient with measurements recorded at 10C increments.

Transmit frequency error measures the deviation between the actual transmit frequency and the assigned frequency. The transmit frequency error in this case was measured by capturing the transmitted signal using a receiving antenna and then cabling it to an MXA signal analyzer. A maximum deviation of 33.868 Hz was recorded which demonstrates compliance with the established design criteria of +/-1922.4 Hz ( $\pm 0.05$ ppm).

##### 4.6.2 Frequency Stability Results DC Model:

Frequency Stability testing was completed on FA3WA with AWEWA DC powered 39GHz ASMR (CF = 38,447.76MHz). Testing was performed from 06/23/2021 through 06/24/2021 on the radio, which was located in the T-16 Thermal chamber of the Global Product Compliance Laboratory (GPCL) test facility located in Building 4, Room 4-280, Murray Hill, NJ, by Joe Bordonaro from GPCL.

**Table B: DC Unit Under Test**

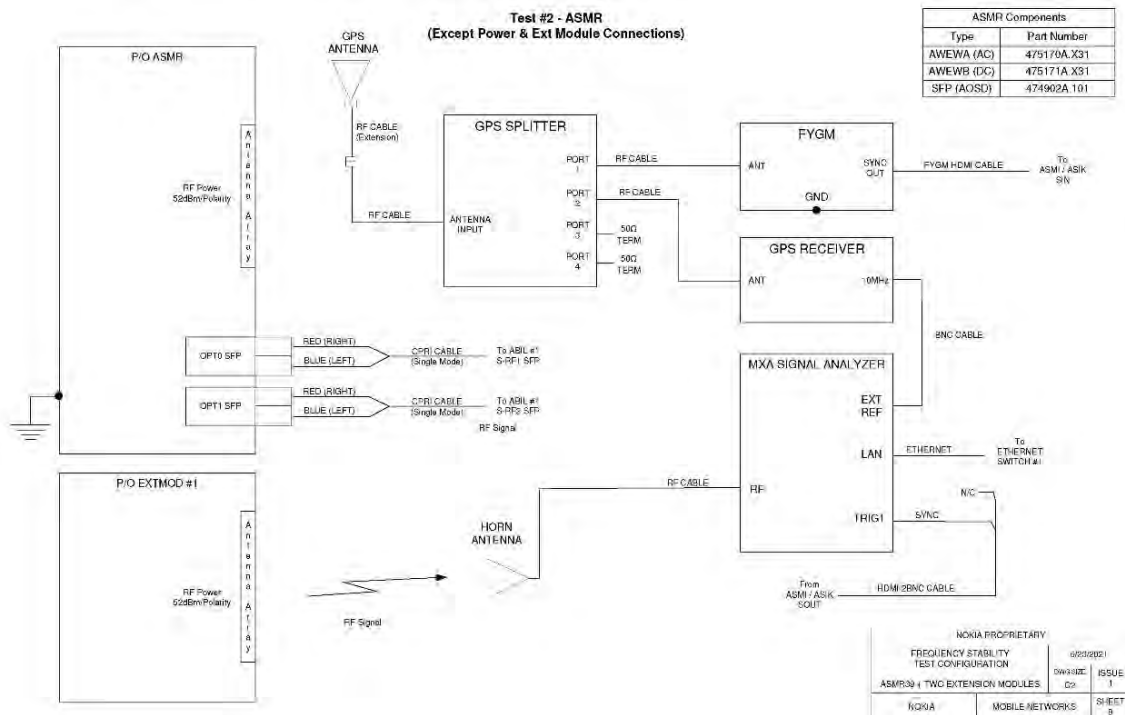
| Series | Vendor | Serial Number | Com Code #  |
|--------|--------|---------------|-------------|
| FA3WA  | Nokia  | YK211800033   | 475002A.X31 |
| FA3WA  | Nokia  | YK211800034   | 475002A.X31 |
| AWEWB  | Nokia  | YK211800015   | 475171A.X31 |

Note: A fan was not installed on the radio during testing.

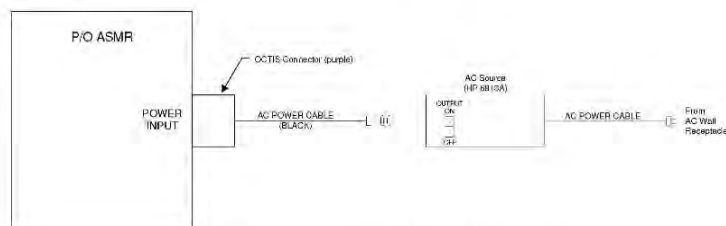
The temperatures to which the UUT were subjected ranged from a high temperature of +50°C system ambient to a low temperature of -30°C system ambient with measurements recorded at 10C increments.

Transmit frequency error measures the deviation between the actual transmit frequency and the assigned frequency. The transmit frequency error in this case was measured by capturing the transmitted signal using a receiving antenna and then cabling it to an MXA signal analyzer. A maximum deviation of 34.980 Hz was recorded which demonstrates compliance with the established design criteria of +/-1922.4 Hz ( $\pm 0.05$ ppm).

### FIGURE 1: TEST BLOCK DIAGRAM



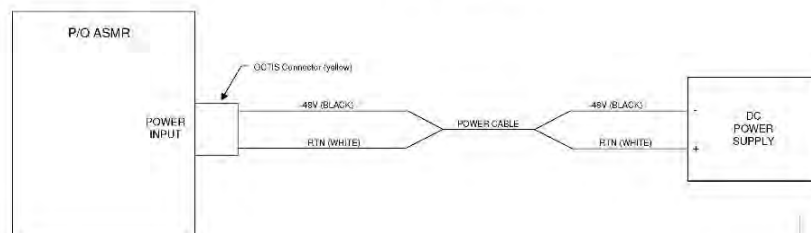
**Test #1 - ASMR (AWEWA)  
AC Power**



| AC POWER DATA  |                  |
|----------------|------------------|
| Voltage        | Current @ 120VAC |
| 100 to 250 VAC | <2.5 A           |

Notes:  
1. Data recorded with chamber set to +50C  
2. This was the maximum current observed

**Test #2 - ASMR (AWEWB)  
DC Power**

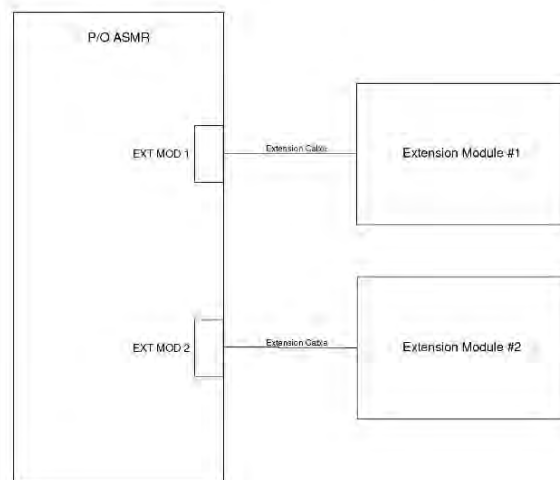


| DC POWER DATA |         |
|---------------|---------|
| Voltage       | Current |
| -48Vdc        | < 5.0A  |

Notes:  
1. Data recorded at room temperature

| NOKIA PROPRIETARY                         |                 |           |          |
|-------------------------------------------|-----------------|-----------|----------|
| FREQUENCY STABILITY<br>TEST CONFIGURATION |                 | DATE      | ISSUE    |
| ASMR39 + TWO EXTENSION MODULES            |                 | 6/23/2021 | 1        |
| NOKIA                                     | MOBILE NETWORKS |           | SHEET 10 |

**Test #1 & #2 - ASMR Connected to Extension Modules**



| Extension Module |             |
|------------------|-------------|
| Name             | Part Number |
| FA3WA            | 475002A.X31 |

| NOKIA PROPRIETARY                         |                 |           |          |
|-------------------------------------------|-----------------|-----------|----------|
| FREQUENCY STABILITY<br>TEST CONFIGURATION |                 | DATE      | ISSUE    |
| ASMR39 + TWO EXTENSION MODULES            |                 | 6/23/2021 | 1        |
| NOKIA                                     | MOBILE NETWORKS |           | SHEET 11 |

**FA3UA + AWEWA - AC Version**

Frequency Block Tested: 39 GHz RADIO (CF = 38,447.76MHz)

Baseline Measurement at +25°C

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 13.111                                   |
| 0.5                                                                      | 0.78801                                  |
| 1.0                                                                      | 10.795                                   |
| 1.5                                                                      | 12.861                                   |
| 2.0                                                                      | 14.655                                   |
| 2.5                                                                      | 6.6406                                   |
| 3.0                                                                      | 12.787                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | -3.2418                                  |
| 0.5                                                                      | 13.115                                   |
| 1.0                                                                      | -8.0514                                  |
| 1.5                                                                      | 10.144                                   |
| 2.0                                                                      | -0.4928                                  |
| 2.5                                                                      | 14.392                                   |
| 3.0                                                                      | 5.8396                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 15.695                                   |
| 0.5                                                                      | 3.3412                                   |
| 1.0                                                                      | 10.168                                   |
| 1.5                                                                      | -3.8514                                  |
| 2.0                                                                      | -9.1557                                  |
| 2.5                                                                      | 5.6470                                   |
| 3.0                                                                      | 20.858                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 4.7404                                   |
| 0.5                                                                      | 12.430                                   |
| 1.0                                                                      | 4.3301                                   |
| 1.5                                                                      | -11.230                                  |
| 2.0                                                                      | -7.7532                                  |
| 2.5                                                                      | 12.445                                   |
| 3.0                                                                      | 5.9113                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 8.3116                                   |
| 0.5                                                                      | 4.5011                                   |
| 1.0                                                                      | 17.955                                   |
| 1.5                                                                      | 1.5506                                   |
| 2.0                                                                      | -6.1657                                  |
| 2.5                                                                      | 14.027                                   |
| 3.0                                                                      | -1.2359                                  |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 5.8857                                   |
| 0.5                                                                      | 12.715                                   |
| 1.0                                                                      | 1.8021                                   |
| 1.5                                                                      | -6.3238                                  |
| 2.0                                                                      | 19.839                                   |
| 2.5                                                                      | 10.521                                   |
| 3.0                                                                      | -0.83318                                 |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, 120VAC |                                          |
|------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                         | Transmit Carrier Deviation (Hz)          |
| 0                                                                      | 16.681                                   |
| 0.5                                                                    | 4.5097                                   |
| 1.0                                                                    | -0.7665                                  |
| 1.5                                                                    | 5.2510                                   |
| 2.0                                                                    | 18.751                                   |
| 2.5                                                                    | 4.6458                                   |
| 3.0                                                                    | -4.2273                                  |
| FCC SPECIFICATION                                                      | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                             | Pass                                     |

| Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 13.002                                   |
| 0.5                                                                      | -2.2340                                  |
| 1.0                                                                      | 8.7299                                   |
| 1.5                                                                      | -7.2664                                  |
| 2.0                                                                      | 9.4134                                   |
| 2.5                                                                      | 19.129                                   |
| 3.0                                                                      | 6.2202                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 5.1157                                   |
| 0.5                                                                      | 13.770                                   |
| 1.0                                                                      | 1.8577                                   |
| 1.5                                                                      | 6.8028                                   |
| 2.0                                                                      | 5.6239                                   |
| 2.5                                                                      | 9.0679                                   |
| 3.0                                                                      | 14.552                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 11.200                                   |
| 0.5                                                                      | 2.6812                                   |
| 1.0                                                                      | -5.3370                                  |
| 1.5                                                                      | 3.8333                                   |
| 2.0                                                                      | -2.3281                                  |
| 2.5                                                                      | 10.248                                   |
| 3.0                                                                      | 7.2584                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

Upon return to +25°C

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, 120VAC |                                          |
|--------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)          |
| 0                                                                        | 14.080                                   |
| 0.5                                                                      | 13.318                                   |
| 1.0                                                                      | 25.566                                   |
| 1.5                                                                      | 8.1983                                   |
| 2.0                                                                      | 10.559                                   |
| 2.5                                                                      | -4.8542                                  |
| 3.0                                                                      | 11.513                                   |
| FCC SPECIFICATION                                                        | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                               | Pass                                     |

| Transmit Frequency Deviation at +25°C at +15% of Nominal Voltage, 138.0VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 13.018                                   |
| 0.5                                                                        | -4.5630                                  |
| 1.0                                                                        | 5.6430                                   |
| 1.5                                                                        | 20.375                                   |
| 2.0                                                                        | 8.4732                                   |
| 2.5                                                                        | 15.843                                   |
| 3.0                                                                        | 33.868                                   |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at +12% of Nominal Voltage, 134.40VAC |                                          |
|-----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)          |
| 0                                                                           | 8.1775                                   |
| 0.5                                                                         | -0.5158                                  |
| 1.0                                                                         | 18.759                                   |
| 1.5                                                                         | 9.9124                                   |
| 2.0                                                                         | 2.6433                                   |
| 2.5                                                                         | 5.0576                                   |
| 3.0                                                                         | -2.0275                                  |
| FCC SPECIFICATION                                                           | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                  | Pass                                     |

| Transmit Frequency Deviation at +25°C at +9% of Nominal Voltage, 130.80VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 7.5559                                   |
| 0.5                                                                        | 12.249                                   |
| 1.0                                                                        | 8.2609                                   |
| 1.5                                                                        | -0.9278                                  |
| 2.0                                                                        | 11.600                                   |
| 2.5                                                                        | 1.0150                                   |
| 3.0                                                                        | 4.9411                                   |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at +6% of Nominal Voltage, 127.20VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 6.4640                                   |
| 0.5                                                                        | -0.8967                                  |
| 1.0                                                                        | 5.1581                                   |
| 1.5                                                                        | 12.431                                   |
| 2.0                                                                        | -9.4260                                  |
| 2.5                                                                        | 3.2700                                   |
| 3.0                                                                        | -6.0713                                  |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at +3% of Nominal Voltage, 123.60VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 7.0284                                   |
| 0.5                                                                        | 12.990                                   |
| 1.0                                                                        | -3.7400                                  |
| 1.5                                                                        | 6.4070                                   |
| 2.0                                                                        | 1.0252                                   |
| 2.5                                                                        | 9.4424                                   |
| 3.0                                                                        | 11.359                                   |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, 116.40VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 6.2074                                   |
| 0.5                                                                        | 1.4952                                   |
| 1.0                                                                        | 17.105                                   |
| 1.5                                                                        | 10.991                                   |
| 2.0                                                                        | 25.165                                   |
| 2.5                                                                        | 6.6824                                   |
| 3.0                                                                        | 3.8268                                   |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, 112.80VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 9.8699                                   |
| 0.5                                                                        | 3.7053                                   |
| 1.0                                                                        | 1.3225                                   |
| 1.5                                                                        | 11.222                                   |
| 2.0                                                                        | 0.6512                                   |
| 2.5                                                                        | 17.392                                   |
| 3.0                                                                        | 2.3274                                   |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, 109.20VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | 14.030                                   |
| 0.5                                                                        | 5.1072                                   |
| 1.0                                                                        | 1.3910                                   |
| 1.5                                                                        | 12.270                                   |
| 2.0                                                                        | 3.0453                                   |
| 2.5                                                                        | 5.3259                                   |
| 3.0                                                                        | -0.6639                                  |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

| Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, 105.60VAC |                                          |
|-----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)          |
| 0                                                                           | -3.9776                                  |
| 0.5                                                                         | 13.600                                   |
| 1.0                                                                         | 19.753                                   |
| 1.5                                                                         | 6.3323                                   |
| 2.0                                                                         | 4.3180                                   |
| 2.5                                                                         | -2.3764                                  |
| 3.0                                                                         | 9.8002                                   |
| FCC SPECIFICATION                                                           | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                  | Pass                                     |

| Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, 102.0VAC |                                          |
|----------------------------------------------------------------------------|------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)          |
| 0                                                                          | -0.0482                                  |
| 0.5                                                                        | 19.662                                   |
| 1.0                                                                        | 2.2966                                   |
| 1.5                                                                        | 8.1748                                   |
| 2.0                                                                        | -2.0069                                  |
| 2.5                                                                        | 15.993                                   |
| 3.0                                                                        | -1.5567                                  |
| FCC SPECIFICATION                                                          | +/-1922.4Hz (±0.05ppm)<br>±0.05ppm = ±Hz |
| FCC RESULT                                                                 | Pass                                     |

**FA3WA + AWEWB + - DC Version**

**Baseline Measurement at +25°C**

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 5.3717                                           |
| 0.5                                                                      | 9.1716                                           |
| 1.0                                                                      | -6.2743                                          |
| 1.5                                                                      | 7.7106                                           |
| 2.0                                                                      | -0.1346                                          |
| 2.5                                                                      | 5.7867                                           |
| 3.0                                                                      | -3.7020                                          |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 2.7994                                           |
| 0.5                                                                      | 13.860                                           |
| 1.0                                                                      | -3.7563                                          |
| 1.5                                                                      | -10.063                                          |
| 2.0                                                                      | 5.3310                                           |
| 2.5                                                                      | -7.8576                                          |
| 3.0                                                                      | 11.628                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 4.9815                                           |
| 0.5                                                                      | 11.152                                           |
| 1.0                                                                      | -0.18084                                         |
| 1.5                                                                      | 5.7859                                           |
| 2.0                                                                      | 18.643                                           |
| 2.5                                                                      | 22.894                                           |
| 3.0                                                                      | -3.0847                                          |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 2.9555                                           |
| 0.5                                                                      | -3.7904                                          |
| 1.0                                                                      | 14.497                                           |
| 1.5                                                                      | 5.1026                                           |
| 2.0                                                                      | 16.990                                           |
| 2.5                                                                      | 11.386                                           |
| 3.0                                                                      | 3.9316                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 7.9572                                           |
| 0.5                                                                      | 2.0672                                           |
| 1.0                                                                      | -3.2580                                          |
| 1.5                                                                      | 19.936                                           |
| 2.0                                                                      | 5.8211                                           |
| 2.5                                                                      | 7.1661                                           |
| 3.0                                                                      | 3.9313                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 6.5647                                           |
| 0.5                                                                      | 10.176                                           |
| 1.0                                                                      | 0.1091                                           |
| 1.5                                                                      | 9.6805                                           |
| 2.0                                                                      | 6.8924                                           |
| 2.5                                                                      | -1.5072                                          |
| 3.0                                                                      | 12.604                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC |                                                                     |
|------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                         | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                      | 19.993                                                              |
| 0.5                                                                    | 9.3070                                                              |
| 1.0                                                                    | 1.3352                                                              |
| 1.5                                                                    | -2.2986                                                             |
| 2.0                                                                    | 9.0385                                                              |
| 2.5                                                                    | -4.7677                                                             |
| 3.0                                                                    | -3.0167                                                             |
| FCC SPECIFICATION                                                      | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                             | PASS                                                                |

| Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC |                                                                     |
|--------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                        | 5.1961                                                              |
| 0.5                                                                      | 0.61847                                                             |
| 1.0                                                                      | 15.476                                                              |
| 1.5                                                                      | 8.1087                                                              |
| 2.0                                                                      | 14.949                                                              |
| 2.5                                                                      | 12.804                                                              |
| 3.0                                                                      | -8.8906                                                             |
| FCC SPECIFICATION                                                        | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                               | PASS                                                                |

| Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC |                                                                     |
|--------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                        | -1.9848                                                             |
| 0.5                                                                      | 14.175                                                              |
| 1.0                                                                      | 6.2946                                                              |
| 1.5                                                                      | 15.101                                                              |
| 2.0                                                                      | -4.8754                                                             |
| 2.5                                                                      | 6.0201                                                              |
| 3.0                                                                      | -2.8523                                                             |
| FCC SPECIFICATION                                                        | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                               | PASS                                                                |

| Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | 19.852                                           |
| 0.5                                                                      | 34.980                                           |
| 1.0                                                                      | 8.2369                                           |
| 1.5                                                                      | 2.8516                                           |
| 2.0                                                                      | -7.1159                                          |
| 2.5                                                                      | 12.406                                           |
| 3.0                                                                      | 3.3541                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

Upon return to +25°C.

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC |                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                           | Transmit Carrier Deviation (Hz)                  |
| 0                                                                        | -7.1416                                          |
| 0.5                                                                      | 5.6805                                           |
| 1.0                                                                      | 1.6613                                           |
| 1.5                                                                      | -7.2289                                          |
| 2.0                                                                      | 0.55693                                          |
| 2.5                                                                      | 12.828                                           |
| 3.0                                                                      | 2.2910                                           |
| FCC SPECIFICATION                                                        | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                               | PASS                                             |

| Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC |                                                  |
|-----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                  |
| 0                                                                           | -3.2775                                          |
| 0.5                                                                         | 8.3858                                           |
| 1.0                                                                         | -0.5131                                          |
| 1.5                                                                         | 4.0309                                           |
| 2.0                                                                         | 12.369                                           |
| 2.5                                                                         | 11.200                                           |
| 3.0                                                                         | 2.8653                                           |
| FCC SPECIFICATION                                                           | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                  | PASS                                             |

| Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC |                                                                     |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                           | 22.487                                                              |
| 0.5                                                                         | 10.983                                                              |
| 1.0                                                                         | 2.4532                                                              |
| 1.5                                                                         | 9.8378                                                              |
| 2.0                                                                         | 3.5910                                                              |
| 2.5                                                                         | 10.508                                                              |
| 3.0                                                                         | 4.6842                                                              |
| FCC SPECIFICATION                                                           | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                                  | PASS                                                                |

| Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC |                                                                     |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                           | 4.6812                                                              |
| 0.5                                                                         | 6.7634                                                              |
| 1.0                                                                         | 1.9768                                                              |
| 1.5                                                                         | -5.6610                                                             |
| 2.0                                                                         | 18.270                                                              |
| 2.5                                                                         | 4.8324                                                              |
| 3.0                                                                         | -2.4254                                                             |
| FCC SPECIFICATION                                                           | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                                  | PASS                                                                |

| Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC |                                                                     |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                                     |
| 0                                                                           | 4.4481                                                              |
| 0.5                                                                         | 9.0950                                                              |
| 1.0                                                                         | -7.1927                                                             |
| 1.5                                                                         | 14.007                                                              |
| 2.0                                                                         | -2.0294                                                             |
| 2.5                                                                         | 14.618                                                              |
| 3.0                                                                         | 5.0757                                                              |
| FCC SPECIFICATION                                                           | 38,447.76MHz ( $\pm 0.05$ ppm)<br>$\pm 0.05$ ppm = $\pm 1922.45$ Hz |
| FCC RESULT                                                                  | PASS                                                                |

| Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC |                                                  |
|-----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                  |
| 0                                                                           | 8.3026                                           |
| 0.5                                                                         | 14.010                                           |
| 1.0                                                                         | 2.2780                                           |
| 1.5                                                                         | 14.137                                           |
| 2.0                                                                         | 23.107                                           |
| 2.5                                                                         | 5.8085                                           |
| 3.0                                                                         | -4.0131                                          |
| FCC SPECIFICATION                                                           | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                  | PASS                                             |

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC |                                                  |
|----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)                  |
| 0                                                                          | -9.9890                                          |
| 0.5                                                                        | 10.407                                           |
| 1.0                                                                        | -4.7079                                          |
| 1.5                                                                        | 2.2624                                           |
| 2.0                                                                        | 10.187                                           |
| 2.5                                                                        | 1.3859                                           |
| 3.0                                                                        | 4.1272                                           |
| FCC SPECIFICATION                                                          | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                 | PASS                                             |

| Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC |                                                  |
|----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)                  |
| 0                                                                          | 10.171                                           |
| 0.5                                                                        | 0.56579                                          |
| 1.0                                                                        | 13.813                                           |
| 1.5                                                                        | -1.7037                                          |
| 2.0                                                                        | -6.7878                                          |
| 2.5                                                                        | -13.105                                          |
| 3.0                                                                        | 8.0425                                           |
| FCC SPECIFICATION                                                          | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                 | PASS                                             |

| Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC |                                                  |
|----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)                  |
| 0                                                                          | -3.4635                                          |
| 0.5                                                                        | 16.086                                           |
| 1.0                                                                        | -1.8561                                          |
| 1.5                                                                        | 2.6651                                           |
| 2.0                                                                        | 8.6077                                           |
| 2.5                                                                        | -4.2673                                          |
| 3.0                                                                        | 12.419                                           |
| FCC SPECIFICATION                                                          | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                 | PASS                                             |

| Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC |                                                  |
|----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                             | Transmit Carrier Deviation (Hz)                  |
| 0                                                                          | 10.350                                           |
| 0.5                                                                        | -4.3117                                          |
| 1.0                                                                        | 16.768                                           |
| 1.5                                                                        | 7.2068                                           |
| 2.0                                                                        | -0.6209                                          |
| 2.5                                                                        | 7.5892                                           |
| 3.0                                                                        | 17.007                                           |
| FCC SPECIFICATION                                                          | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                 | PASS                                             |

| Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC |                                                  |
|-----------------------------------------------------------------------------|--------------------------------------------------|
| Time (minutes)                                                              | Transmit Carrier Deviation (Hz)                  |
| 0                                                                           | -3.5629                                          |
| 0.5                                                                         | 1.4070                                           |
| 1.0                                                                         | -3.5125                                          |
| 1.5                                                                         | 2.2096                                           |
| 2.0                                                                         | -14.592                                          |
| 2.5                                                                         | 7.0721                                           |
| 3.0                                                                         | 15.479                                           |
| FCC SPECIFICATION                                                           | 38,447.76MHz (±0.05ppm)<br>±0.05ppm = ±1922.45Hz |
| FCC RESULT                                                                  | PASS                                             |

| <b>Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC</b> |                                                          |
|------------------------------------------------------------------------------------|----------------------------------------------------------|
| <b>Time<br/>(minutes)</b>                                                          | <b>Transmit Carrier Deviation<br/>(Hz)</b>               |
| <b>0</b>                                                                           | <b>10.906</b>                                            |
| <b>0.5</b>                                                                         | <b>15.003</b>                                            |
| <b>1.0</b>                                                                         | <b>-0.7521</b>                                           |
| <b>1.5</b>                                                                         | <b>7.2081</b>                                            |
| <b>2.0</b>                                                                         | <b>15.326</b>                                            |
| <b>2.5</b>                                                                         | <b>2.5654</b>                                            |
| <b>3.0</b>                                                                         | <b>-1.9956</b>                                           |
| <b>FCC SPECIFICATION</b>                                                           | <b>38,447.76MHz (±0.05ppm)<br/>±0.05ppm = ±1922.45Hz</b> |
| <b>FCC RESULT</b>                                                                  | <b>PASS</b>                                              |

## 4.7 List of Test Equipment

### 4.7.1 List of Radio Measurements Test Equipment

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

| Asset ID | Manufacturer        | Type               | Description                        | Model          | Serial     | Calibration Date | Calibration Due |
|----------|---------------------|--------------------|------------------------------------|----------------|------------|------------------|-----------------|
| E1373    | A-Info              | Horn Antenna       | 26.5-40GHz WR28 25 dB              | LB-28-25-C2-KF | J202062735 | 2018-12-05       | 2021-12-05      |
| E1375    | A-Info              | Horn Antenna       | 26.5-40GHz WR28 25 dB              | LB-28-25-C2-KF | J202023249 | 2020-7-27        | 2022-7-27       |
| E1384    | Rohde & Schwarz     | Spectrum Analyzer  | 2 Hz to 85 GHz                     | FSW85          | 101537     | 2020-08-25       | 2022-08-25      |
| E483     | Kikusui             | Power Supply       | DC 55 Volts 120 Amps               | PAD 55-120L    | DM000112   | CNR              | CNR             |
| E772     | Sunol Sciences Corp | Modular Controller | Tower / Turntable Controller       | SC104V         | 060107-1   | CNR              | CNR             |
| E1255    | ETS Lindgren        | Controller         | Multi-Device Controller            | 2090           | 00078509   | CNR              | CNR             |
| E1150    | Extech              | Data Logger        | Pressure Humidity Temp Data Logger | SD700          | Q752767    | 2021-01-11       | 2023-01-11      |

CNR: Calibration Not Required

CNR-V: Calibration Not Required, Must Be Verified

SPV: System Performance Verified

### 4.7.2 List of Radiated Emissions Test Equipment

| Asset ID | Manufacturer          | Type               | Description                           | Model          | Serial     | Calibration Date | Calibration Due |
|----------|-----------------------|--------------------|---------------------------------------|----------------|------------|------------------|-----------------|
| E601     | A.H. Systems Inc.     | Biological Antenna | 25 - 2000 MHz                         | SAS-521-2      | 408        | 2019-12-03       | 2021-12-03      |
| E1074    | ETS Lindgren          | Horn Antenna       | Double-Ridged Waveguide Horn 1-18 GHz | 3117           | 00135194   | 2019-05-01       | 2021-08-01      |
| E1373    | A-Info                | Horn Antenna       | 26.5-40GHz WR28 25 dB                 | LB-28-25-C2-KF | J202062735 | 2018-12-05       | 2021-12-05      |
| E1452    | A-Info                | Horn Antenna       | 18 to 26.5 GHz WR42 25 dB             | LB-42-25-C2-KF | J202066361 | 2020-08-11       | 2022-08-11      |
| E1260    | Rohde & Schwarz       | Spectrum Analyzer  | 2 Hz-67 GHz                           | FSW67          | 104007     | 2020-08-21       | 2022-08-21      |
| E447     | Hewlett Packard       | Pre-Amplifier      | Preamplifier 1-26.5 GHz               | 8449B          | 3008A01384 | 2020-08-31       | 2022-08-31      |
| E813     | Sonoma Instrument Co. | Amplifier          | 9kHz-1GHz                             | 310N           | 186750     | 2020-10-20       | 2022-10-20      |
| E1525    | A.H. Systems Inc.     | Pre-Amplifier      | 18 GHz-40 GHz, 37 dB                  | PAM-1840VH     | 186        | 2020-11-30       | 2022-11-30      |
| E980     | Trilithic             | Filter, Low Pass   | PCS                                   | 10LC1790-3-AA  | PCS-LPF-12 | CNR-V            | CNR-V           |

| Asset ID | Manufacturer                           | Type              | Description                                      | Model          | Serial   | Calibration Date                          | Calibration Due |
|----------|----------------------------------------|-------------------|--------------------------------------------------|----------------|----------|-------------------------------------------|-----------------|
| E1516    | Reactel, Inc.                          | Filter, Low Pass  | 1 - 34 GHz, 2.0 dB                               | 11LS-X34GK11   | SN20-01  | 2021-03-15                                | 2022-03-15      |
| E1476    | Reactel, Inc.                          | Filter, Low Pass  | DC - 20 GHz                                      | 11LS-X20GS11   | SN20-01  | 2020-09-15                                | 2021-09-15      |
| E1119    | Extech                                 | Data Logger       | Pressure Humidity Temp data logger               | SD700          | Q668960  | 2021-01-11                                | 2023-01-11      |
| E483     | Kikusui                                | Power Supply      | DC 55 Volts 120 Amps                             | PAD 55-120L    | DM000112 | CNR                                       | CNR             |
| E588     | Sunol Sciences Corp                    | System Controller | Tower / Turntable Controller                     | SC99V          | 32802-1  | CNR                                       | CNR             |
| E1308    | Rohde & Schwarz                        | Harmonic Mixer    | Down Converter 90-140GHz                         | FS-Z140        | 101008   | 2017-04-06,<br>- in Service<br>2018-07-01 | SPV             |
| E1311    | Rohde & Schwarz                        | Harmonic Mixer    | Down Converter 40-60GHz                          | FS-Z60         | 100977   | 2017-12-21,<br>- in Service<br>2018-07-01 | SPV             |
| E1312    | Rohde & Schwarz                        | Harmonic Mixer    | Down Converter 60-90GHz                          | FS-Z90         | 101719   | 2017-08-09<br>-in Service 2018-07-01      | SPV             |
| E1313    | Rohde & Schwarz                        | Harmonic Mixer    | Down Converter, 140-220GHz                       | FS-Z220        | 100960   | 2017-12-21,<br>- in Service<br>2018-07-01 | SPV             |
| E1315    | RS Microwave Company, Inc.             | Microwave Filter  | 40 GHz High Pass Filter                          | P/N 60733A     | 007      | CNR-V                                     | CNR-V           |
| E1323    | Mi-Wave Millimeter Wave Products, Inc. | Horn Antenna      | G-band pyramidal horn antenna 25dB 140 - 220 GHz | 261G-25/387    |          | 2017-12-21,<br>- in Service<br>2018-07-01 | SPV             |
| E1330    | Sage Millimeter, Inc.                  | Horn Antenna      | U-band pyramidal horn antenna - 40 to 60 GHz     | SAR-2309-19-S2 | 14853-01 | Factory,<br>- in Service<br>2018-07-01    | SPV             |
| E1332    | Sage Millimeter, Inc.                  | Horn Antenna      | E-band pyramidal horn antenna - 60 to 90 GHz.    | SAR-2309-12-S2 | 14853-01 | Factory,<br>- in Service<br>2018-07-01    | SPV             |
| E1335    | Sage Millimeter, Inc.                  | Horn Antenna      | F-band pyramidal horn antenna - 90 to 140 GHz    | SAR-2309-08-S2 | 14853-02 | Factory,<br>- in Service<br>2018-07-01    | SPV             |

CNR: Calibration Not Required

CNR-V: Calibration Not Required, Must Be Verified

SPV: System Performance Verified

Note\* - This is a brand-new factory calibrated equipment. Keysight Liberty Labs who does the 17025-calibration was closed due to Covid-19. Prior to testing, a verification test of this equipment was performed in house with a17025 calibrated network analyzer and the factory calibration was verified.

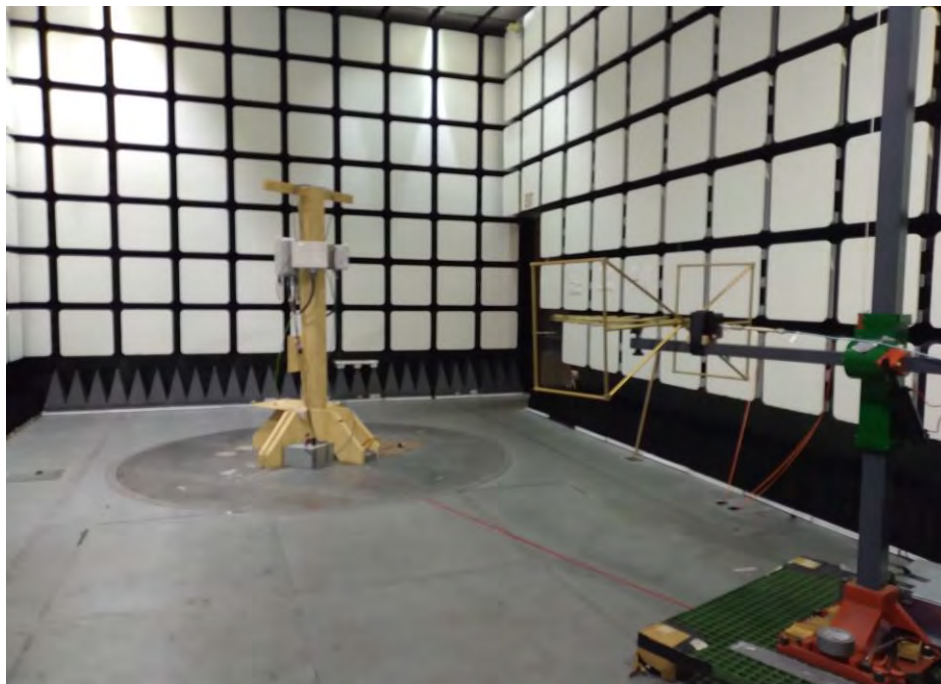
### 4.7.3 List of Frequency Stability Test Equipment

| Asset ID  | Manufacturer          | Type                  | Description         | Model               | Serial      | Calibration Date | Calibration Due |
|-----------|-----------------------|-----------------------|---------------------|---------------------|-------------|------------------|-----------------|
| TH514-T16 | Envirotronics         | Controller            |                     | Envirotronics SPPCM | SP000637    | 2021-06-08       | 2023-06-08      |
| TH-T16    | Envirotronics         | Thermal Chamber       |                     | N/A                 | 3015243     | N/A              | N/A             |
| TH149     | Fluke                 | Multimeter            | Digital Multimeter  | 87III               | 7519030337  | 2019-07-22       | 2021-07-22      |
| EIH74     | KeySight Technologies | EMI Receiver          | MXA Signal Analyzer | N9020B              | MY57120303  | 2020-12-21       | 2022-12-21      |
| TH288     | Yokogawa              | Data Acquisition Unit | Recorder            | MV2048-2-4-2-1-1D   | S5JC04071   | 2021-02-25       | 2023-02-25      |
| N/A       | HP                    | Power Supply          | AC Source           | 6813A               | 3524A-00321 | N/A              | N/A             |
| N/A       | Agilent               | Power Supply          | DC Source           | N5767At             | US13N5074M  | N/A              | N/A             |

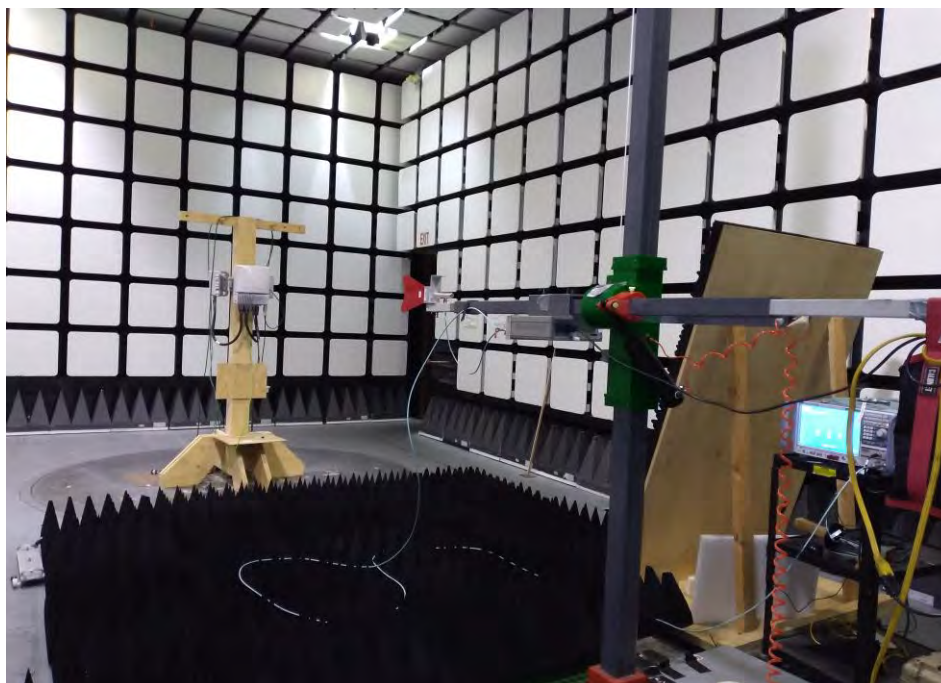
## 4.8 PHOTOGRAPHS OF THE TEST SETUPS

### Radio Measurements and Radiated Emissions Test

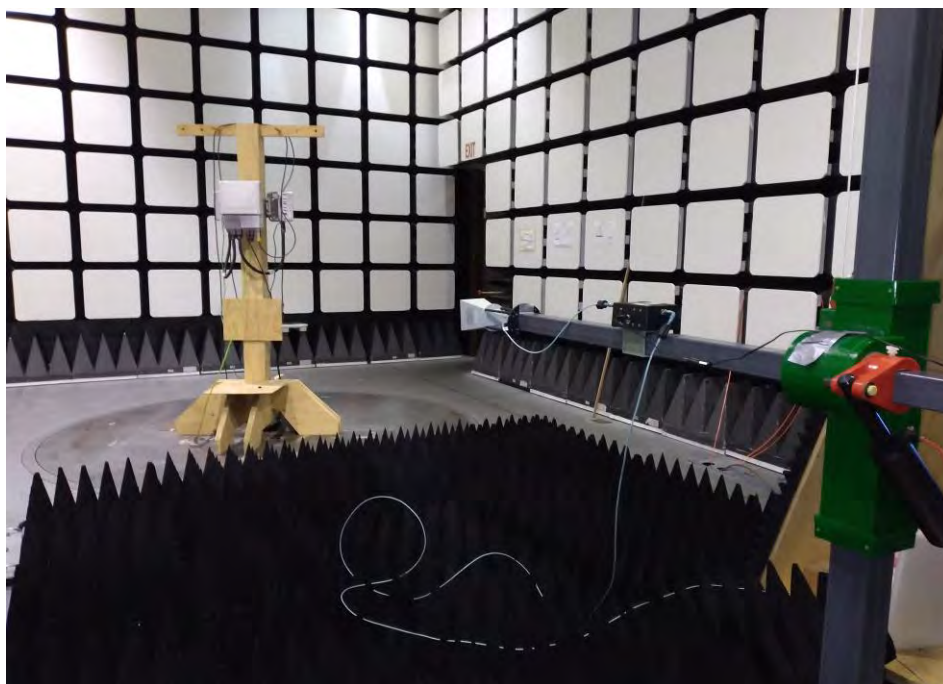
30 MHz–1 GHz



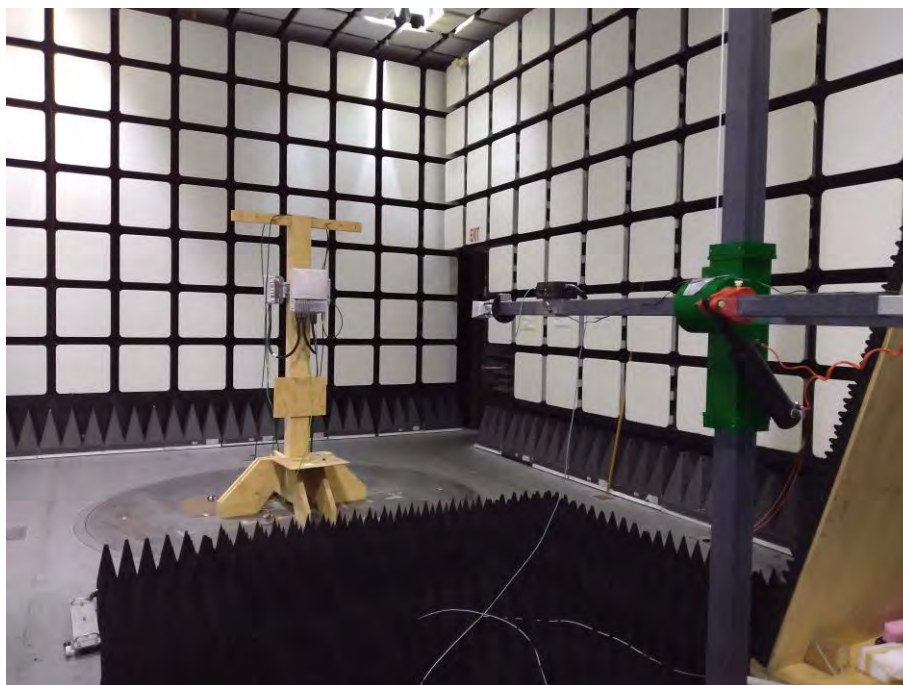
1 GHz – 18 GHz



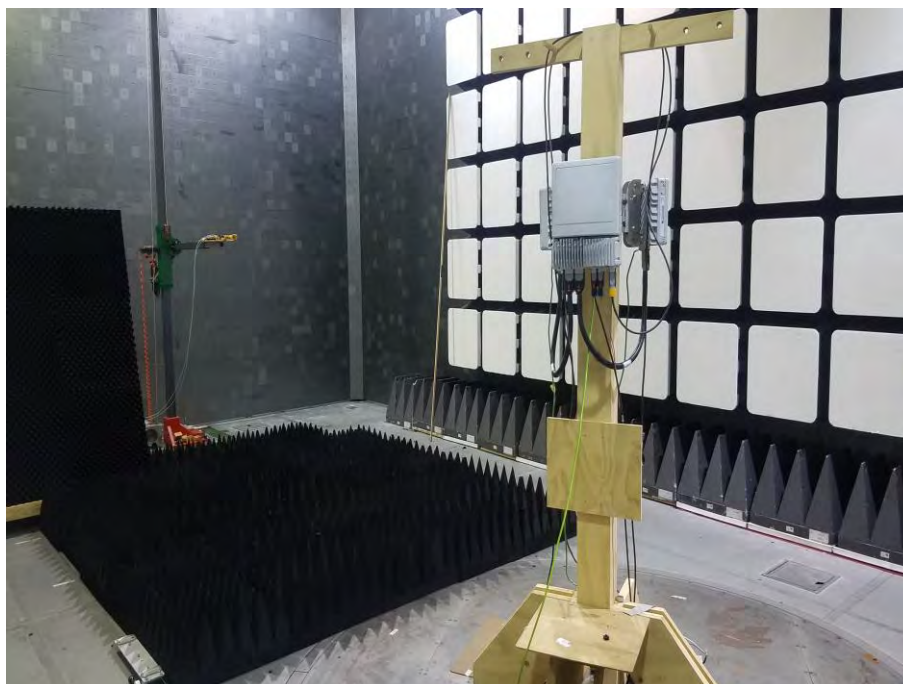
**18GHz-26.5GHz**



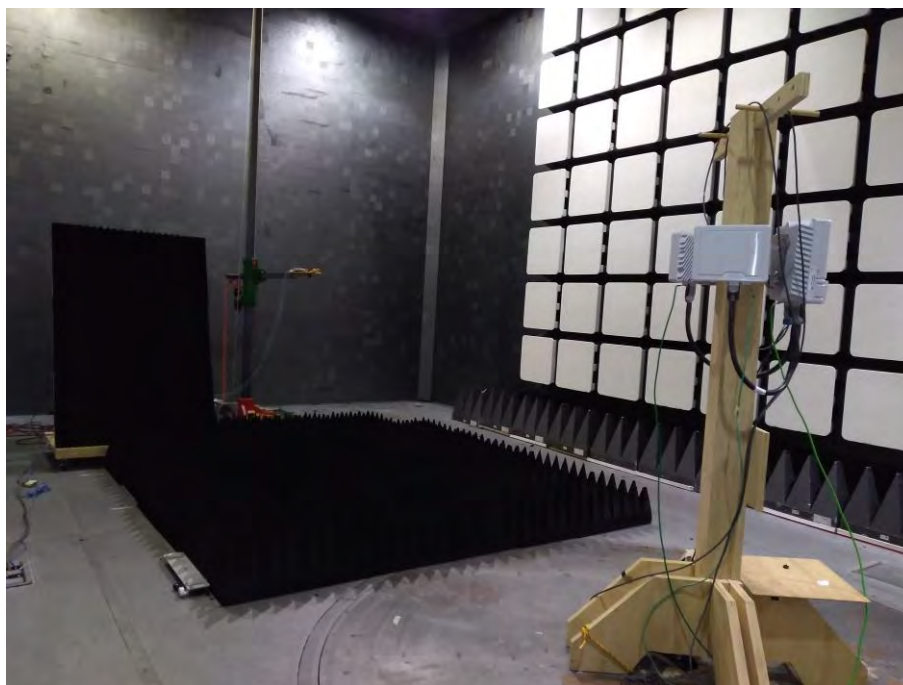
**26.5GHz-40 GHz**



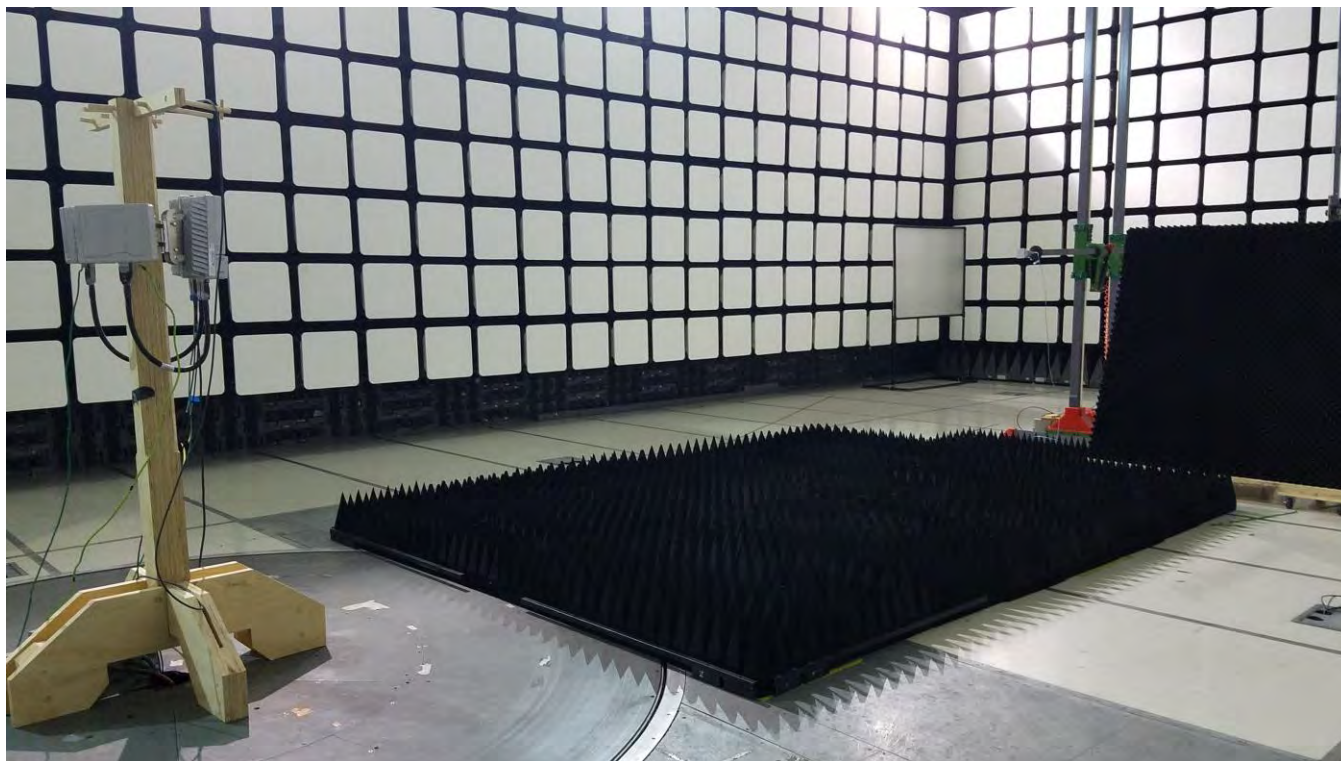
**40GHz-60 GHz**



**60GHz-90 GHz**



## Radio Testing



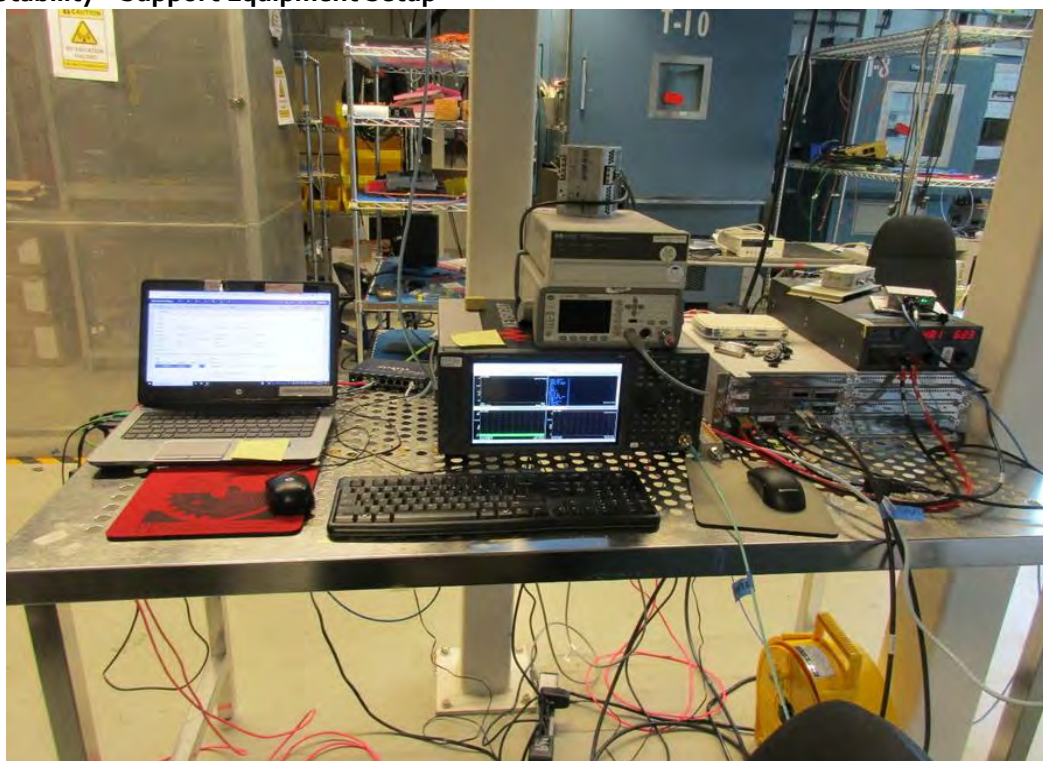
**Frequency Stability Test - in thermal chamber**



### Frequency Stability Test – Measurement Antenna in thermal chamber



### Frequency Stability - Support Equipment Setup



## 4.9 FACILITIES AND ACCREDITATION

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

The field strength measurements of radiated spurious emissions were made in a FCC registered five meter semi-anechoic chamber AR-5, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

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

[https://apps.fcc.gov/oetcf/eas/reports/ViewTestFirmAccredScopes.cfm?calledFromFrame=N&RequestTimeout=500&regnum\\_specified=N&test\\_firm\\_id=7007](https://apps.fcc.gov/oetcf/eas/reports/ViewTestFirmAccredScopes.cfm?calledFromFrame=N&RequestTimeout=500&regnum_specified=N&test_firm_id=7007)

and is as listed in the Table below.

**OET Accredited Test Firm Scope List**  
**Test Firm: Nokia, Global Product Compliance Lab**

| Scope                                         | FCC Rule Parts                                                                                                      | Maximum Assessed Frequency, MHz | Status   | Expiration Date | Recognition Date |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------|----------|-----------------|------------------|
| Unintentional Radiators                       | FCC Part15, Subpart B                                                                                               | 40000                           | Approved | 9/30/2021       | 7/6/2017         |
| Intentional Radiators                         | FCC Part 15 Subpart C                                                                                               | 40000                           | Approved | 9/30/2021       | 6/5/2018         |
| U-NII without DFS Intentional Radiators       | FCC Part 15, Subpart E                                                                                              | 40000                           | Approved | 9/30/2021       | 6/5/2018         |
| U-NII with DFS Intentional Radiators          | FCC Part 15, Subpart E                                                                                              | 40000                           | Approved | 9/30/2021       | 6/5/2018         |
| Commercial Mobile Services                    | Part 22 (cellular), Part 24, Part 25 (below 3 GHz), Part 27                                                         | 40000                           | Approved | 9/30/2021       | 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 | 9/30/2021       | 6/5/2018         |
| Citizens Broadband Radio Services             | Part 30                                                                                                             | 40000                           | Approved | 9/30/2021       | 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 | 9/30/2021       | 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.



## **5. 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 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

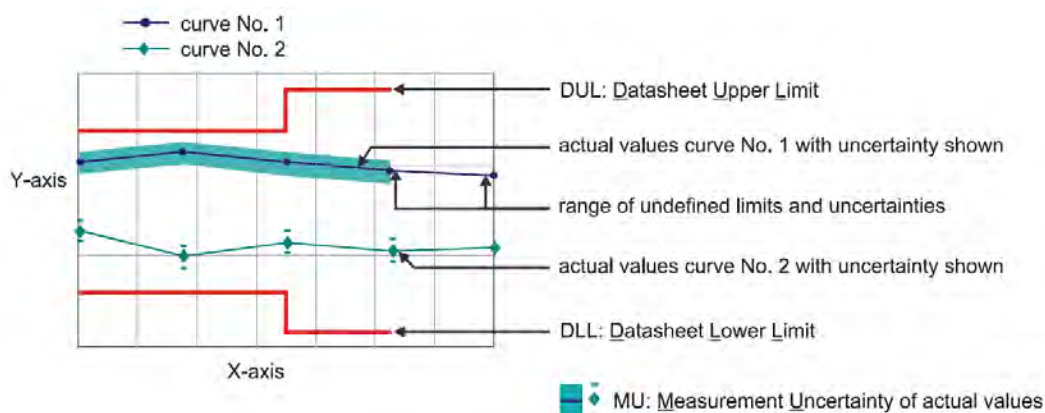
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

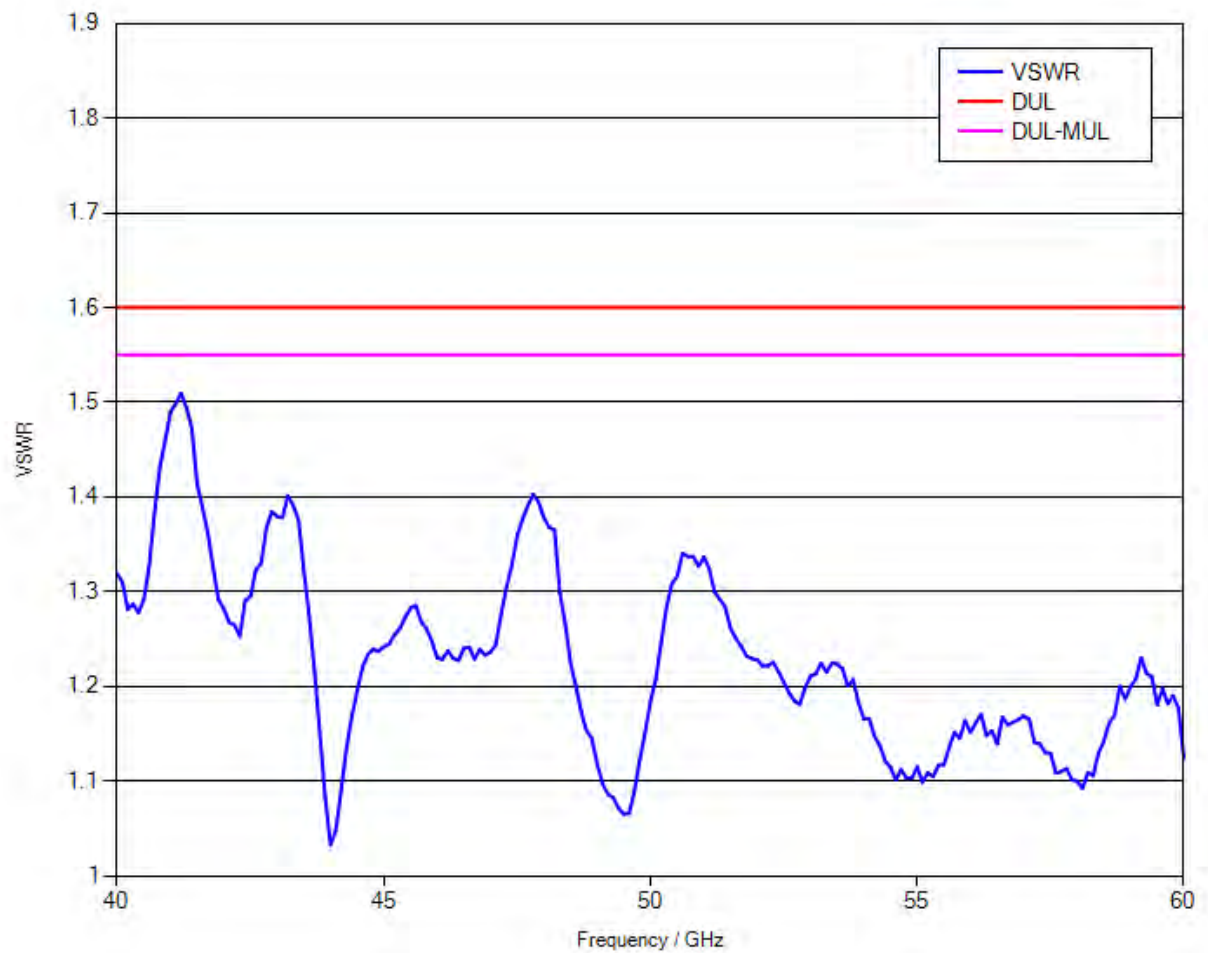
**Version**

2013  
7\_07

**Remark**

## 1.1 RF Input – VSWR

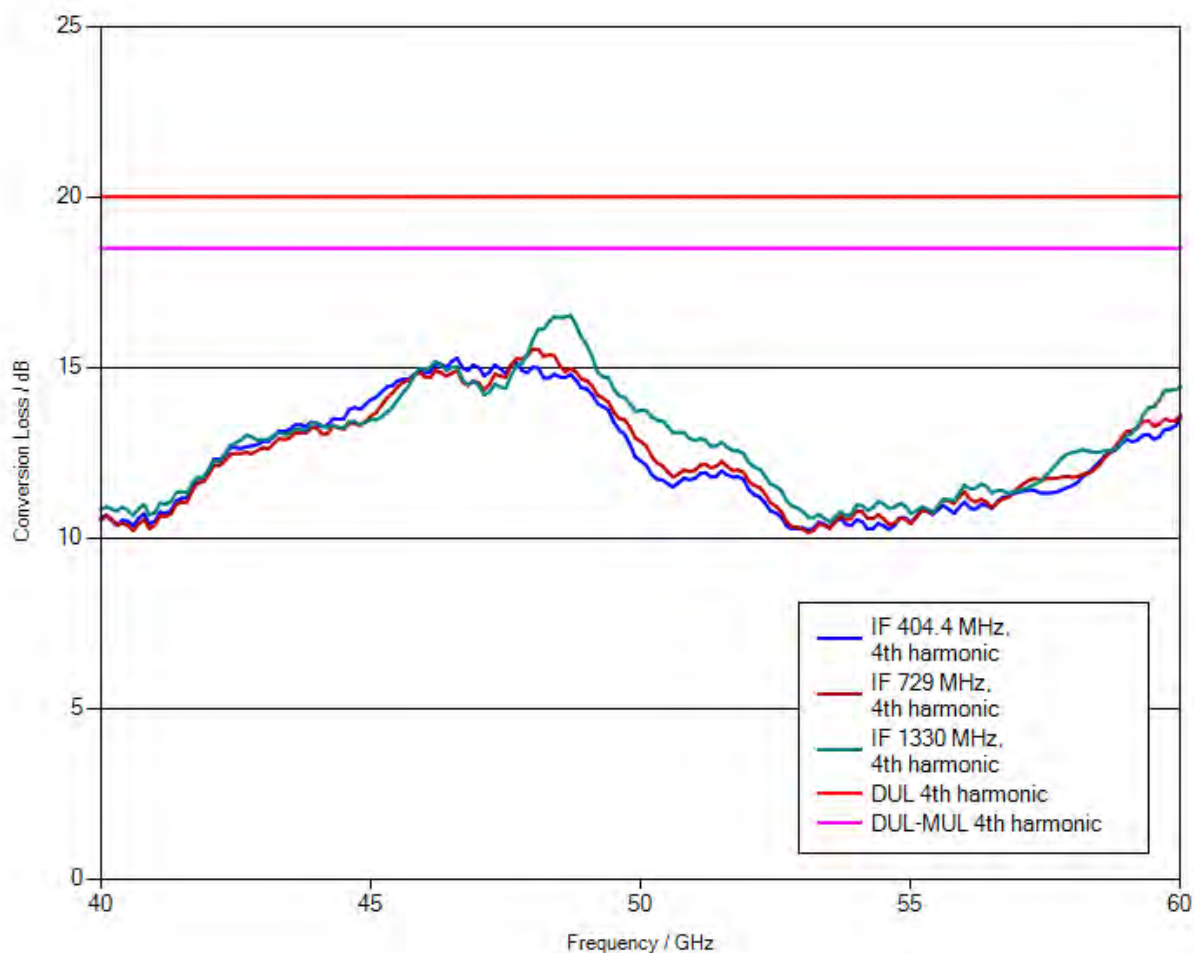
Measurement uncertainty: 0.05 (VSWR)



## 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<br>(worst case) | Evaluation |
|---------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>4th harmonic | 4 dB | 2.02 dB                | PASS       |
| IF = 729 MHz,<br>4th harmonic   | 4 dB | 1.78 dB                | PASS       |
| IF = 1330 MHz,<br>4th harmonic  | 4 dB | 2.35 dB                | PASS       |

# Calibration Certificate

Kalibrierschein

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

Zertifikatsnummer

## Unit Data

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

**Manufacturer** ROHDE & SCHWARZ  
Hersteller

**Type** R&S® FS-Z90  
Typ

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

**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, 2017-08-09**

**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**

## 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 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

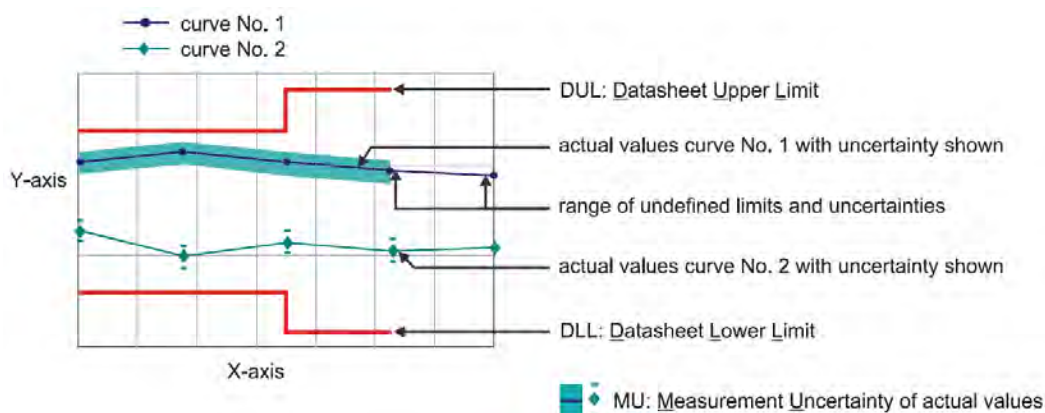
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

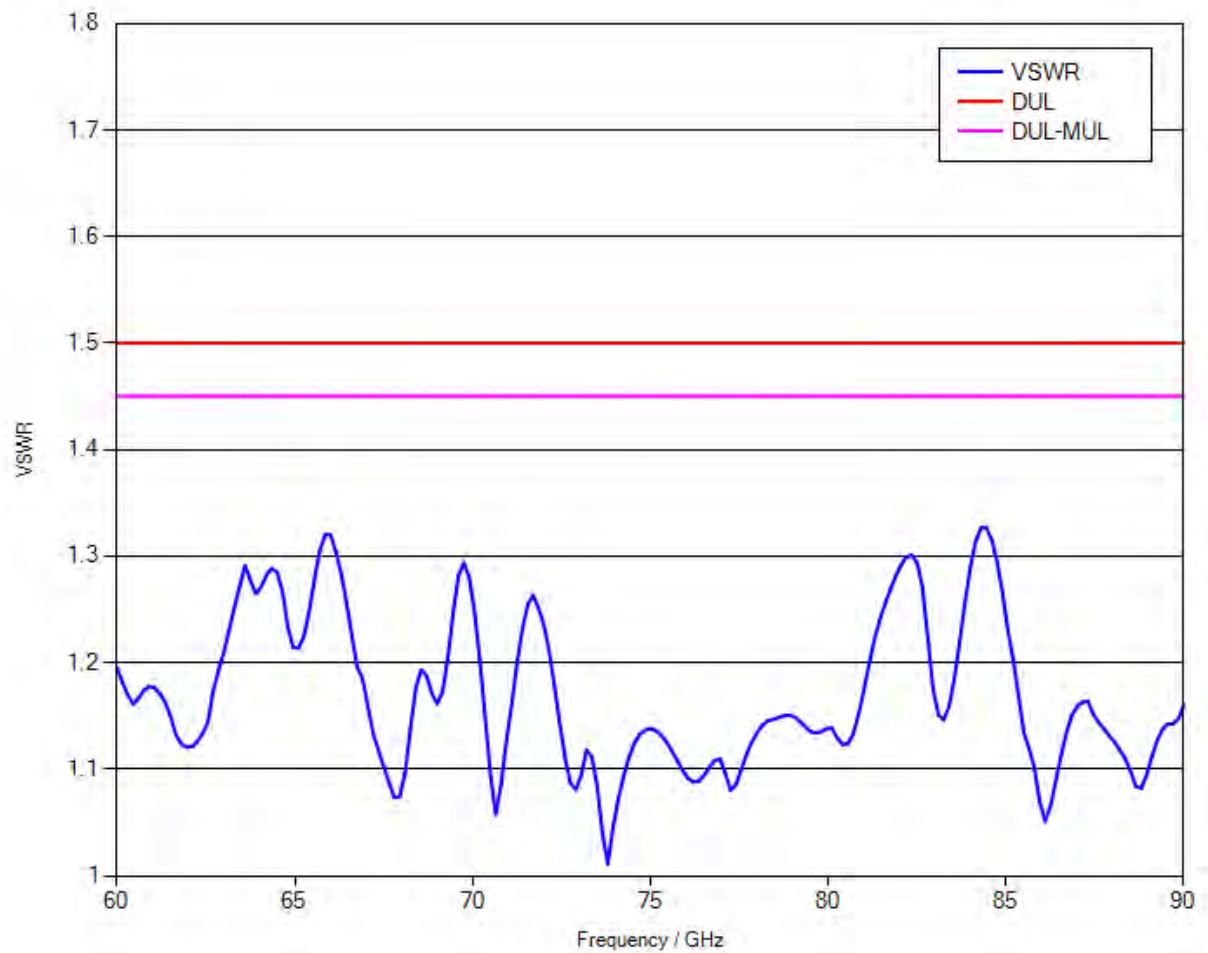
### Explanation of charts



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

## 1.1 RF Input – VSWR

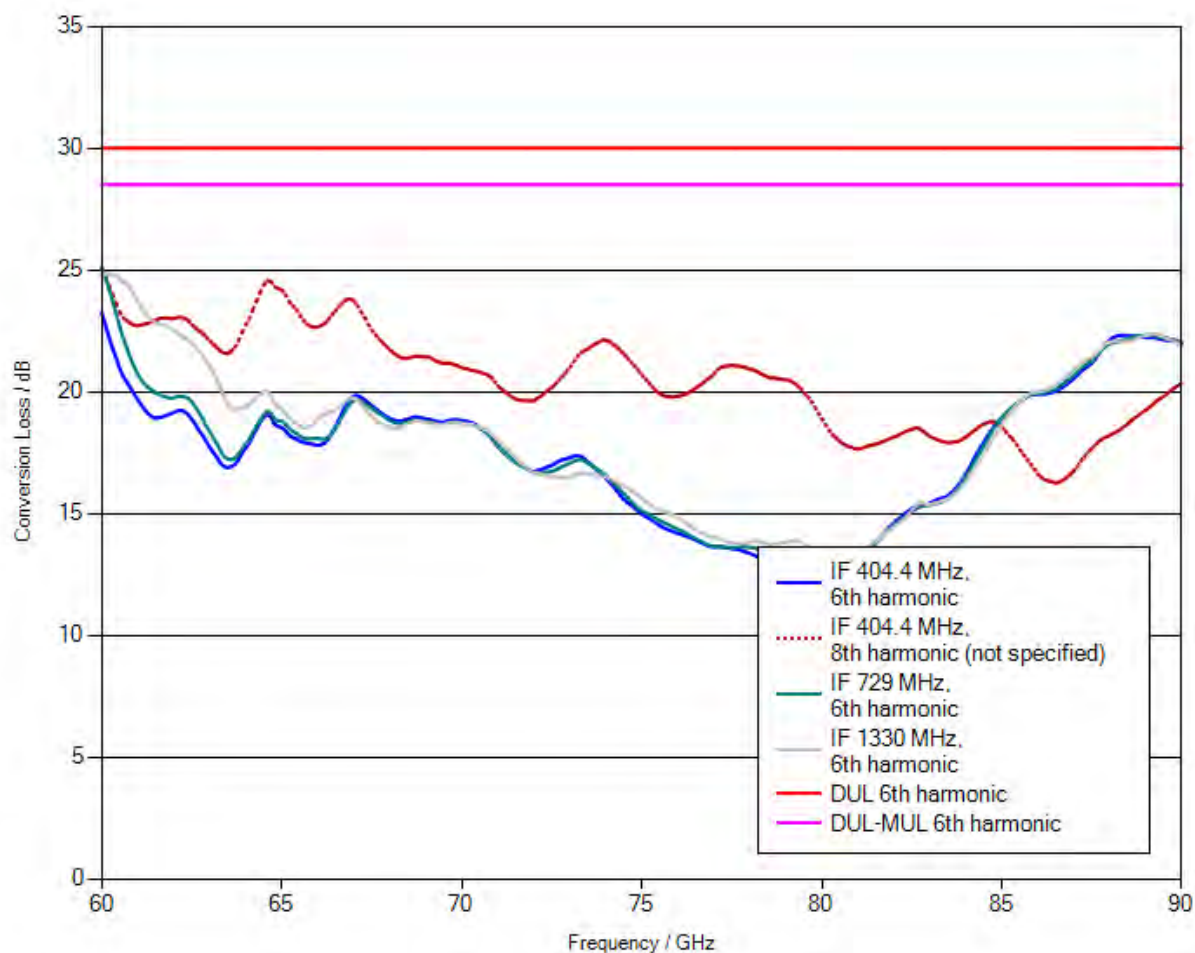
Measurement uncertainty: 0.05 (VSWR)



## 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<br>(worst case) | Evaluation    |
|---------------------------------|---------------|------------------------|---------------|
| IF = 404.4 MHz,<br>6th harmonic | 6 dB          | 3.33 dB                | PASS          |
| IF = 404.4 MHz,<br>8th harmonic | not specified | 2.73 dB                | not specified |
| IF = 729 MHz,<br>6th harmonic   | 6 dB          | 4.12 dB                | PASS          |
| IF = 1330 MHz,<br>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

Calibration Method  
Kalibrieranweisung

**RPG-PAQA-TN-2014-002**

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

Ambient Temperature  
Umgebungstemperatur

**(23 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>Kalibr. bis |
|-------------------------|--------------|-------------------------------|---------------------------------------------------------|-------------------------|
| Vector Network Analyzer | R&S® ZVA67   | 101097                        | 10-300319061                                            | 2017-08-06              |
| Powersensor             | R&S® NRP-Z55 | 140093                        | 20-541556                                               | 2017-05-12              |

**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'.

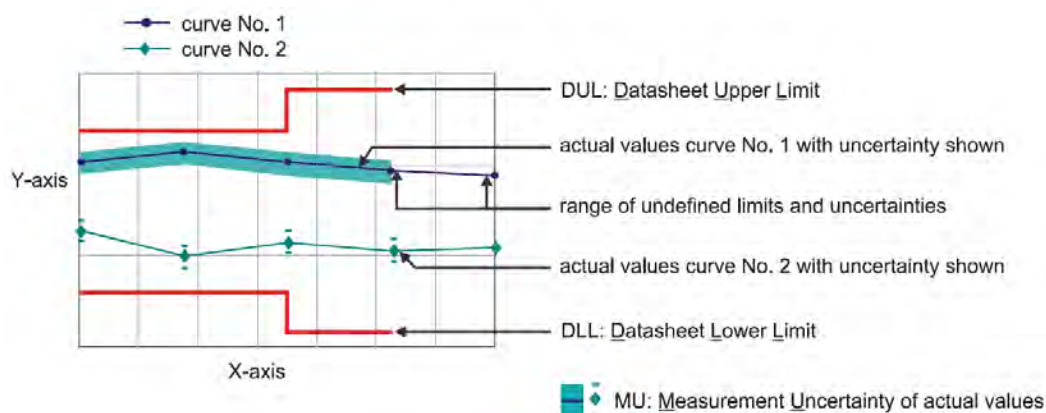
Notes  
Anmerkungen

## Outgoing Results

The following abbreviations may be used in this document

|            |                                                                                                                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| {a}        | No measurement uncertainty stated because the errors always add together.<br>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                                                                                                                                                                                                                                                      |

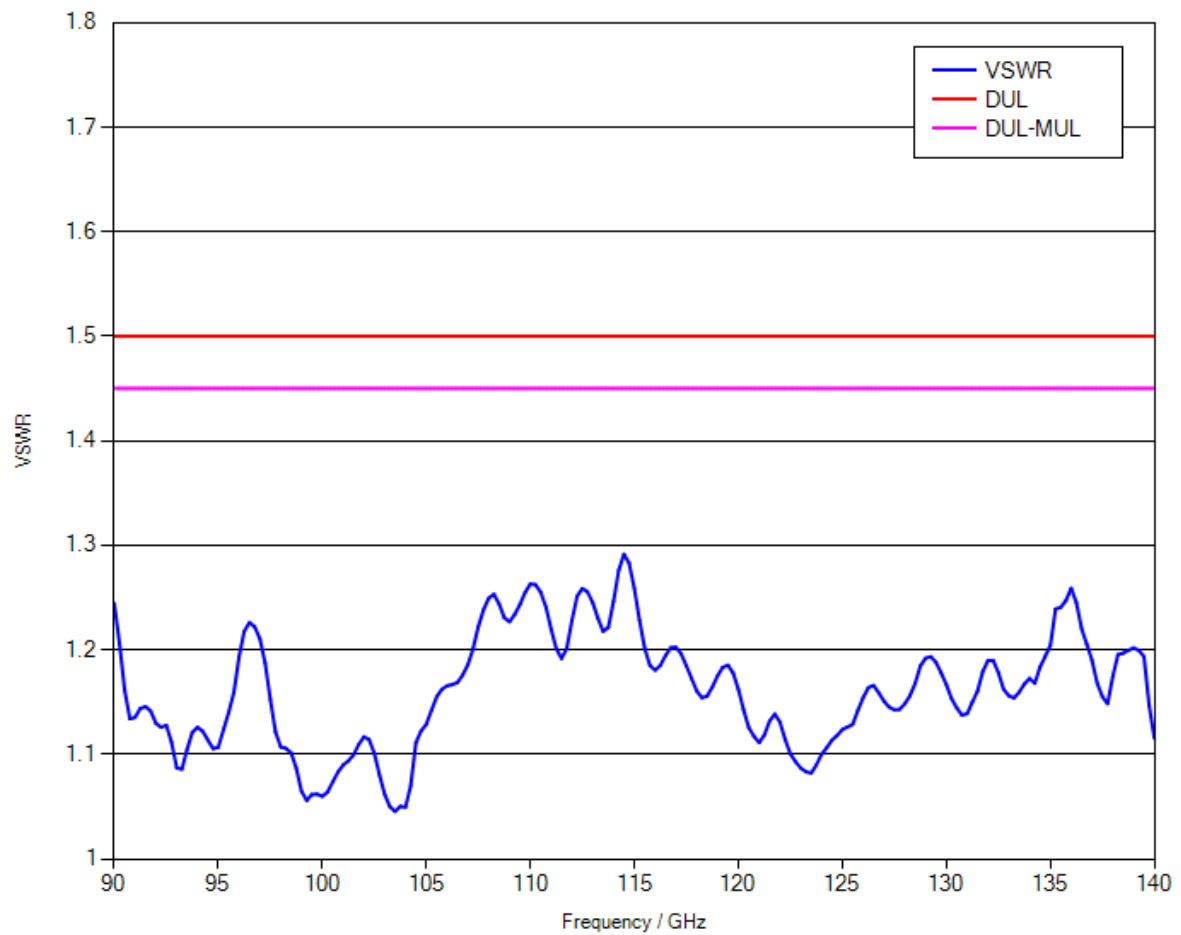
### Explanation of charts



**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<br>(worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>10th harmonic | 6 dB | 3.86 dB                | PASS       |
| IF = 729 MHz,<br>10th harmonic   | 6 dB | 3.48 dB                | PASS       |
| IF = 1330 MHz,<br>10th harmonic  | 6 dB | 3.19 dB                | PASS       |



# Calibration Certificate

Kalibrierschein

Certificate Number 24-0220-100960-01

Zertifikatsnummer

## Unit Data

**Item** Harmonic Mixer, 140 GHz to 220 GHz  
**Gegenstand**

**Manufacturer** RPG  
**Hersteller**

**Type** RPG FS-Z220  
**Typ**

**Material Number** 3593.3250.02 **Serial Number** 100960  
**Materialnummer** **Seriennummer**

**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

Calibration Method  
Kalibrieranweisung

**RPG-PAQA-TN-2014-002**

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

Ambient Temperature  
Umgebungstemperatur

**(23 <sup>+7</sup><sub>-3</sub>) °C**

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

| Item<br>Gegenstand      | Type<br>Typ  | Serial Number<br>Seriennummer | Calibration Certificate Number<br>Kalibrierscheinnummer | Cal. Due<br>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

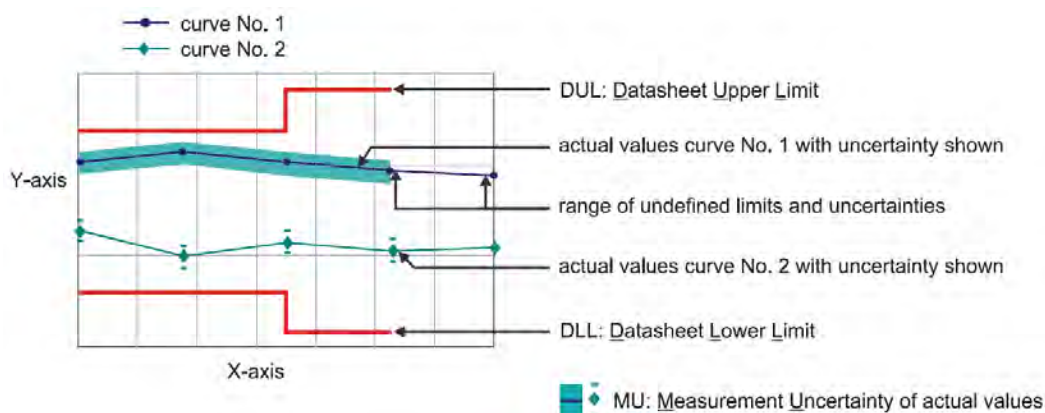
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

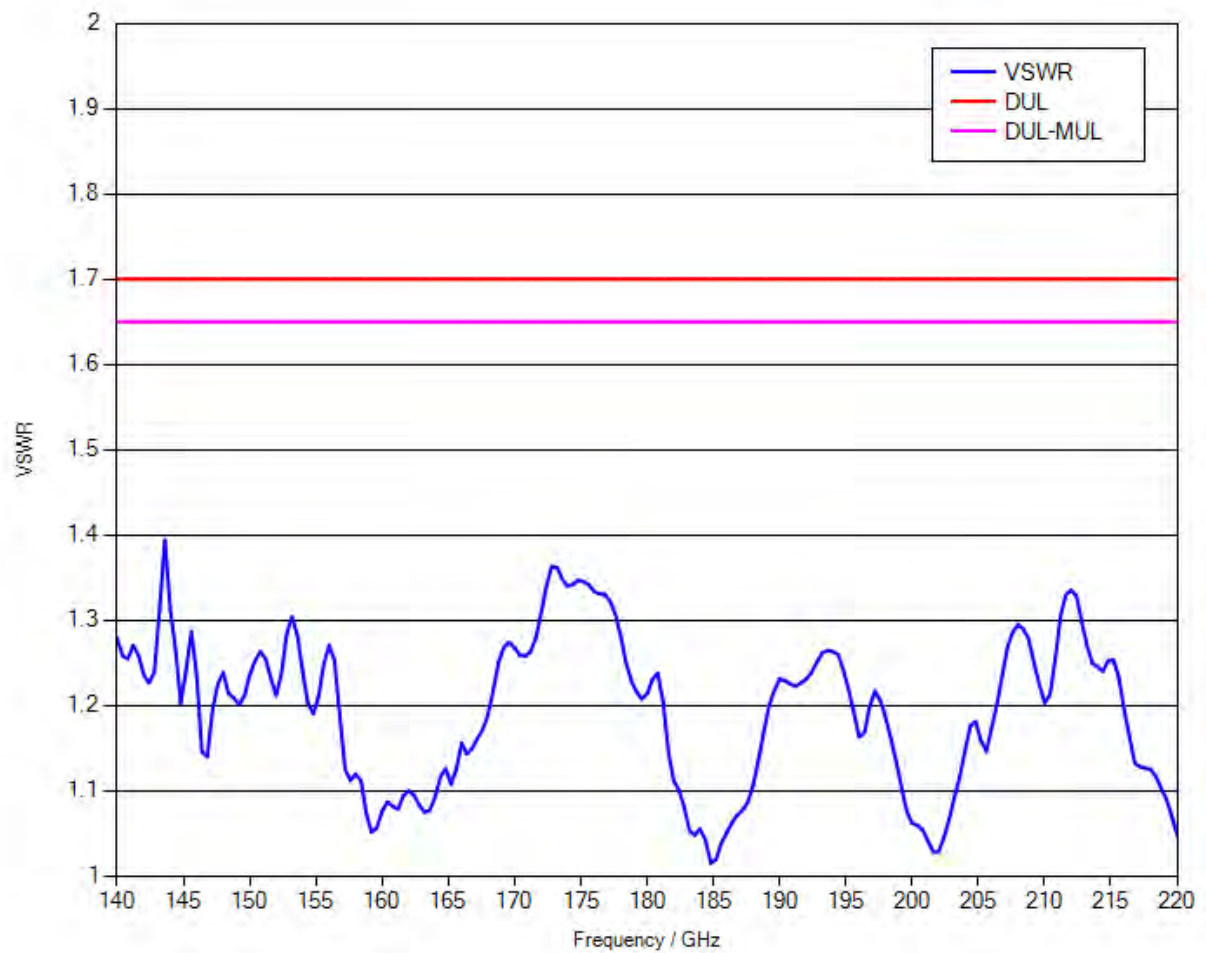
**Version**

2013  
7\_08

**Remark**

## 1.1 RF Input – VSWR

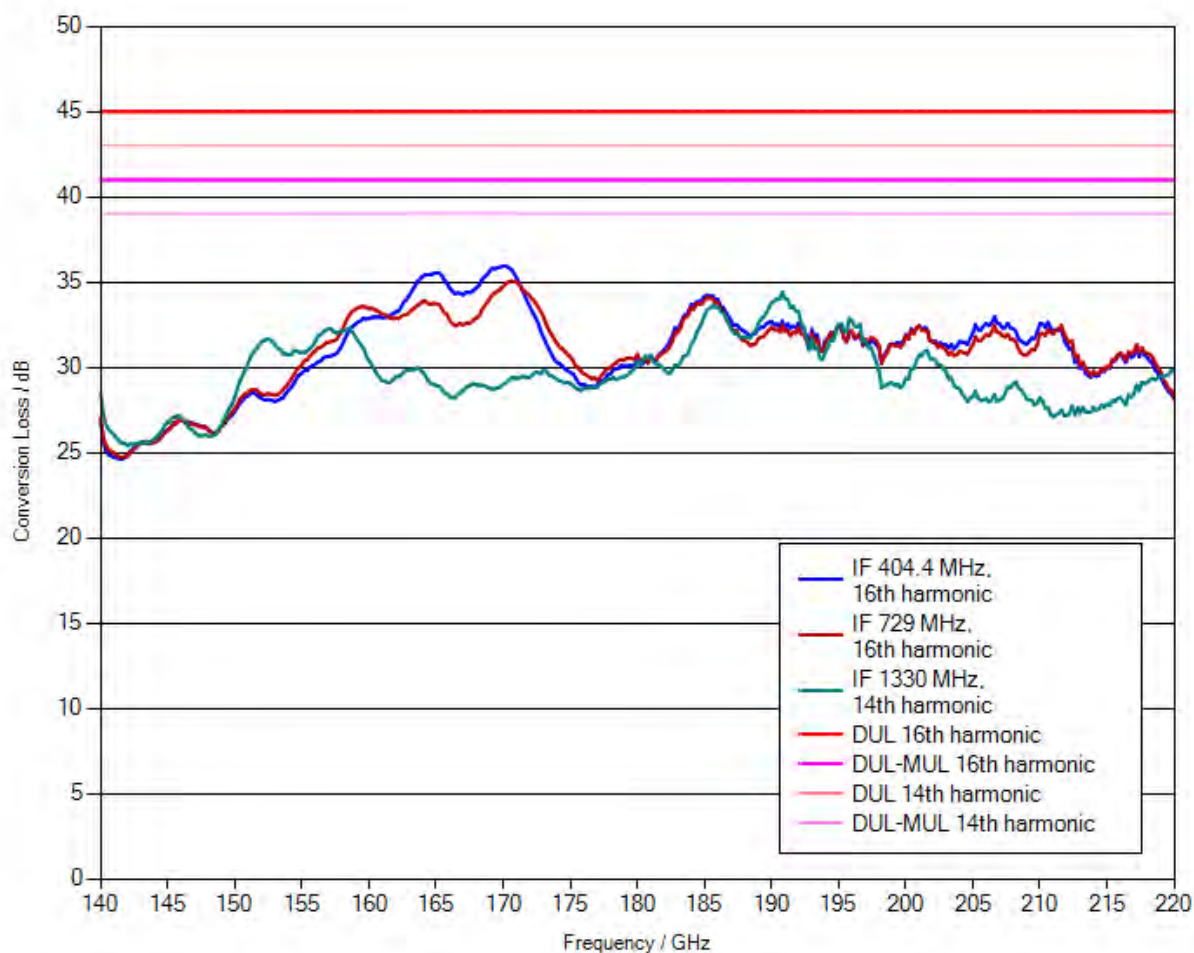
Measurement uncertainty: 0.05 (VSWR)



## 1.2 Conversion loss

LO level +13 dBm nominal  
Bias 0 A

Measurement uncertainty: 4 dB



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### 1.3 Frequency response within 1 GHz

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