



Spurious emission between 18GHz to 40GHz worst case plot is reported as following.

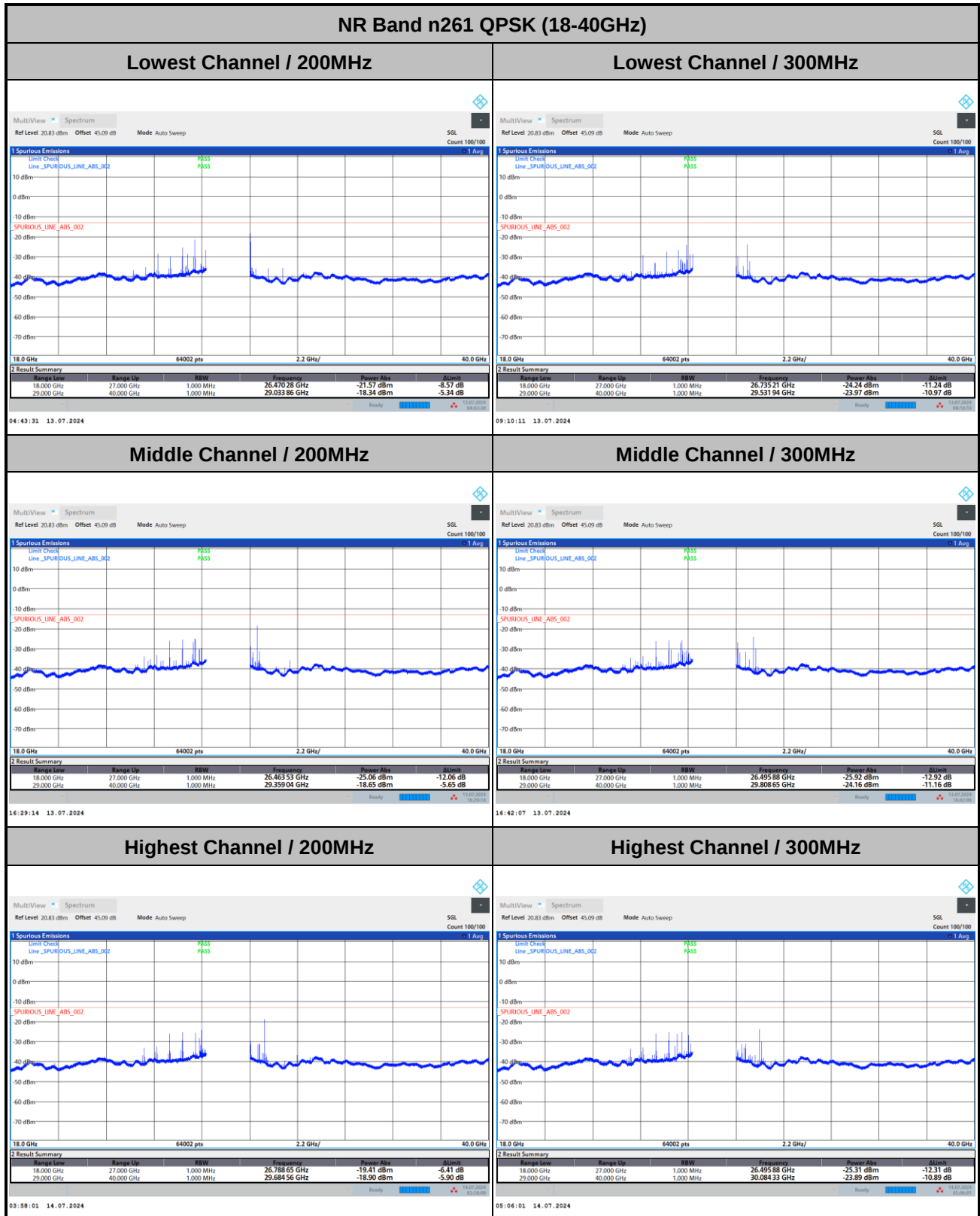
### DFT-s-OFDM Module 1



Remark: In band and out of band frequencies are omitted.



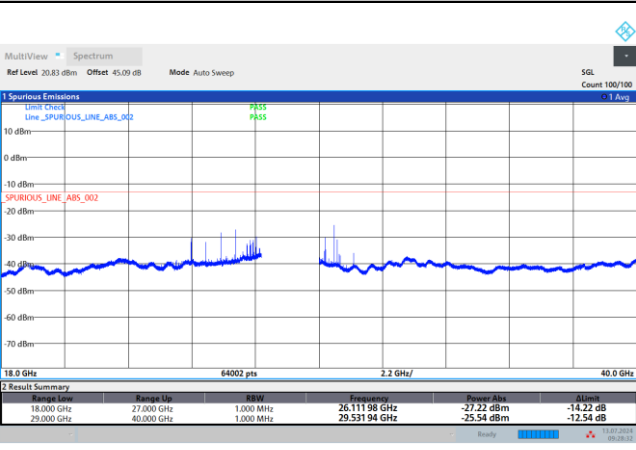
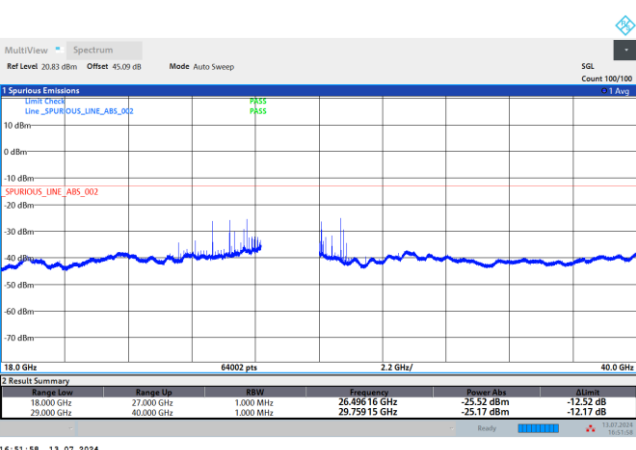
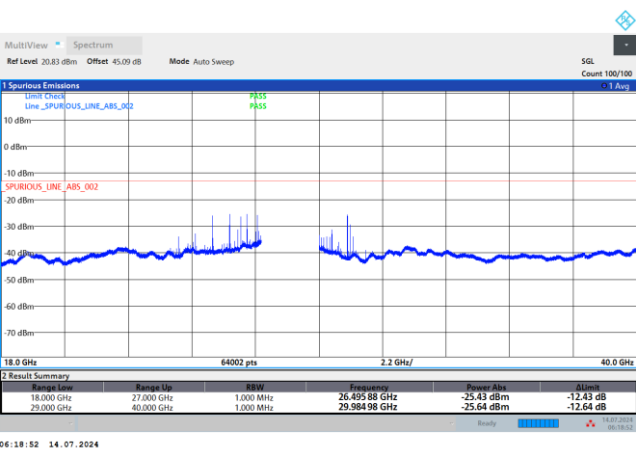
## DFT-s-OFDM Module 1



Remark: In band and out of band frequencies are omitted.



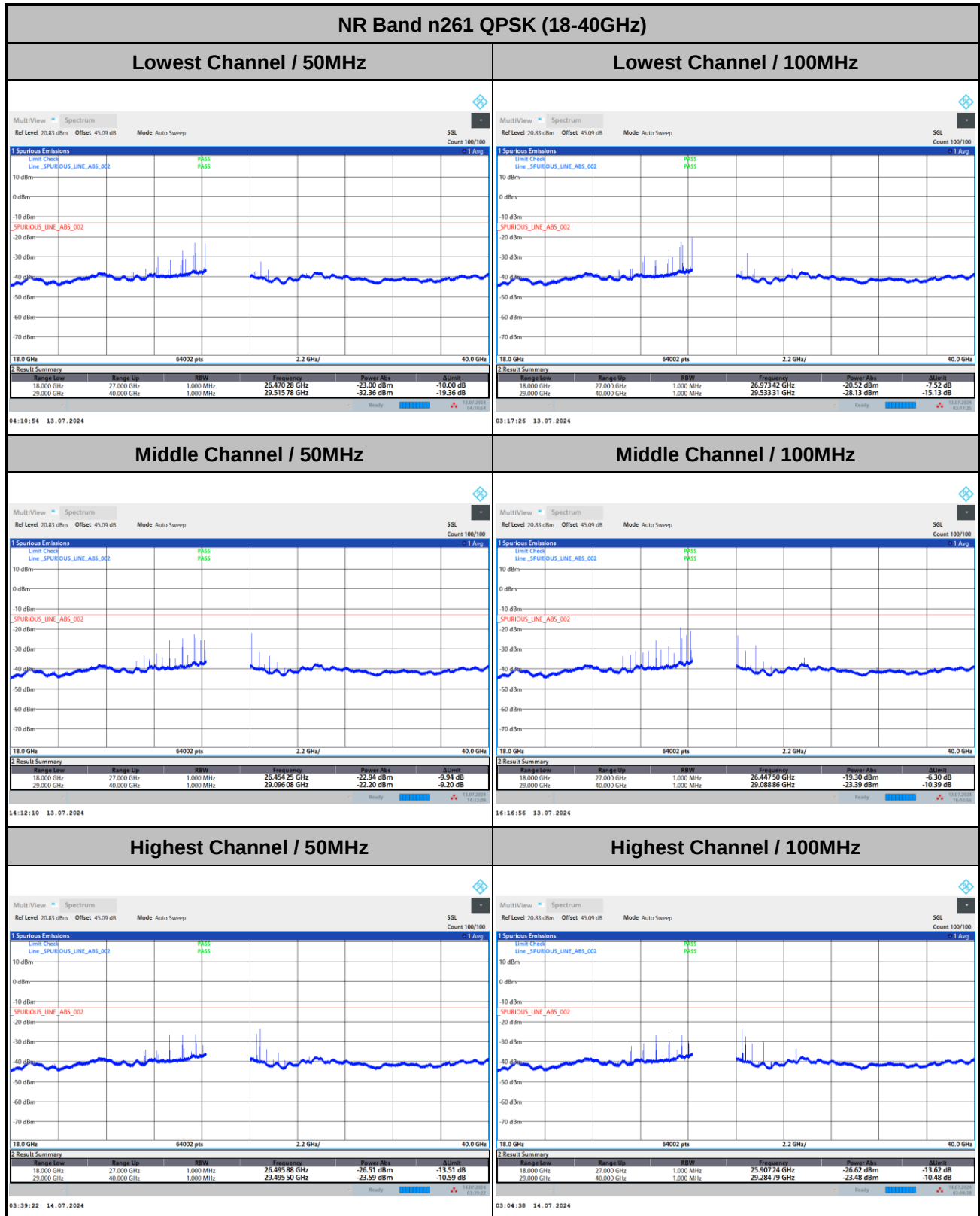
DFT-s-OFDM Module 1

| NR Band n261 QPSK (18-40GHz)                                                        |                     |
|-------------------------------------------------------------------------------------|---------------------|
| Lowest Channel / 400MHz                                                             |                     |
|    | intentionally blank |
| Middle Channel / 400MHz                                                             |                     |
|   | intentionally blank |
| Highest Channel / 400MHz                                                            |                     |
|  | intentionally blank |

Remark: In band and out of band frequencies are omitted.



## CP-OFDM Module 1



Remark: In band and out of band frequencies are omitted.



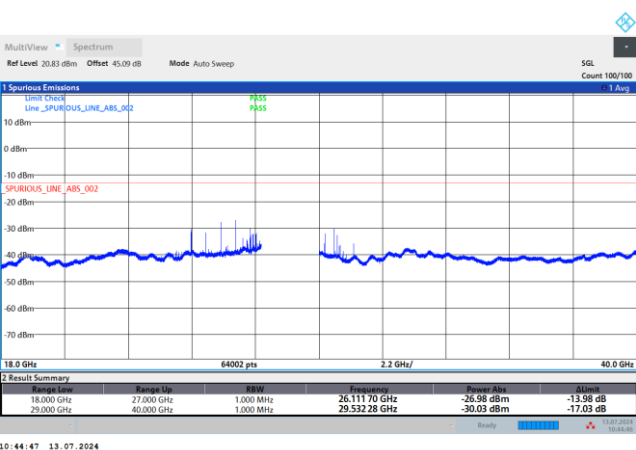
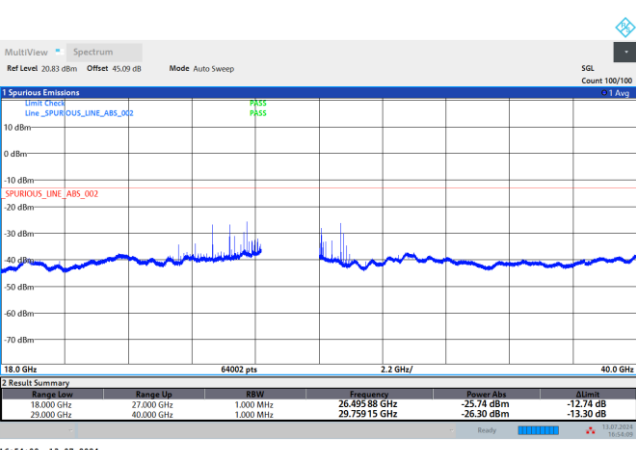
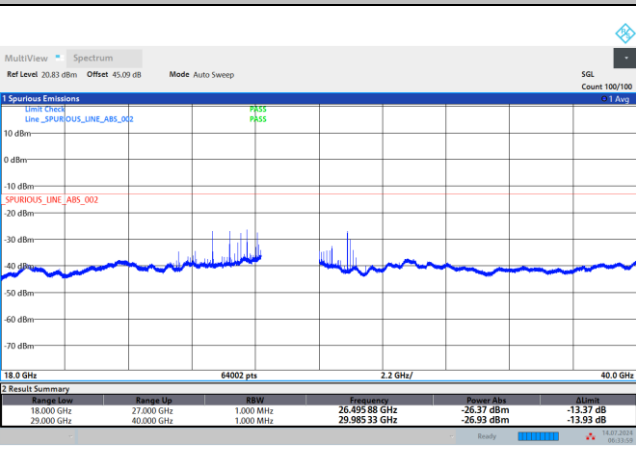
## CP-OFDM Module 1



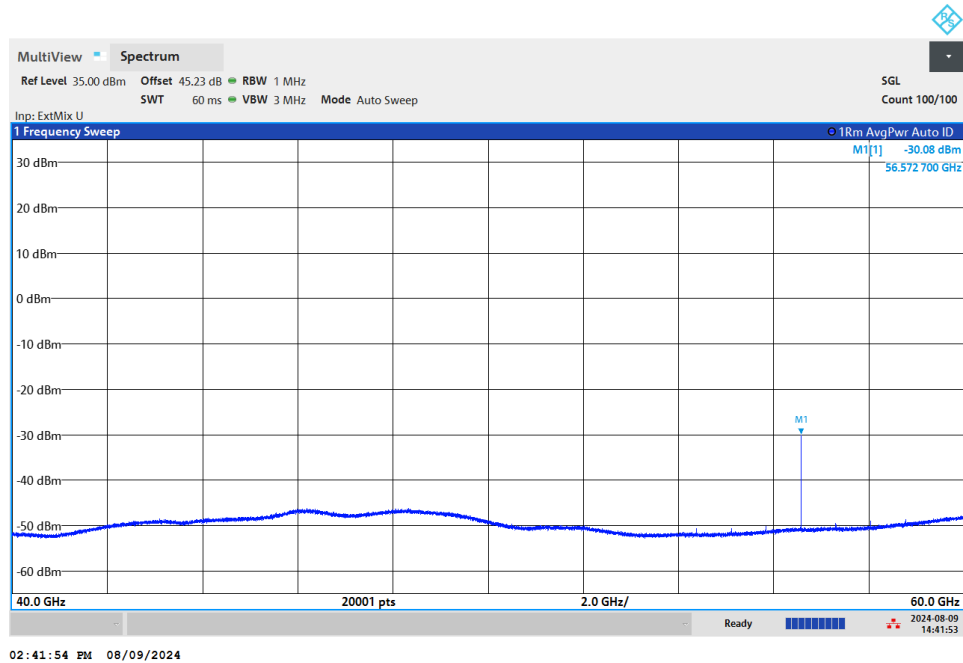
Remark: In band and out of band frequencies are omitted.



CP-OFDM Module 1

| NR Band n261 QPSK (18-40GHz)                                                        |                     |
|-------------------------------------------------------------------------------------|---------------------|
| Lowest Channel / 400MHz                                                             |                     |
|    | intentionally blank |
| Middle Channel / 400MHz                                                             |                     |
|   | intentionally blank |
| Highest Channel / 400MHz                                                            |                     |
|  | intentionally blank |

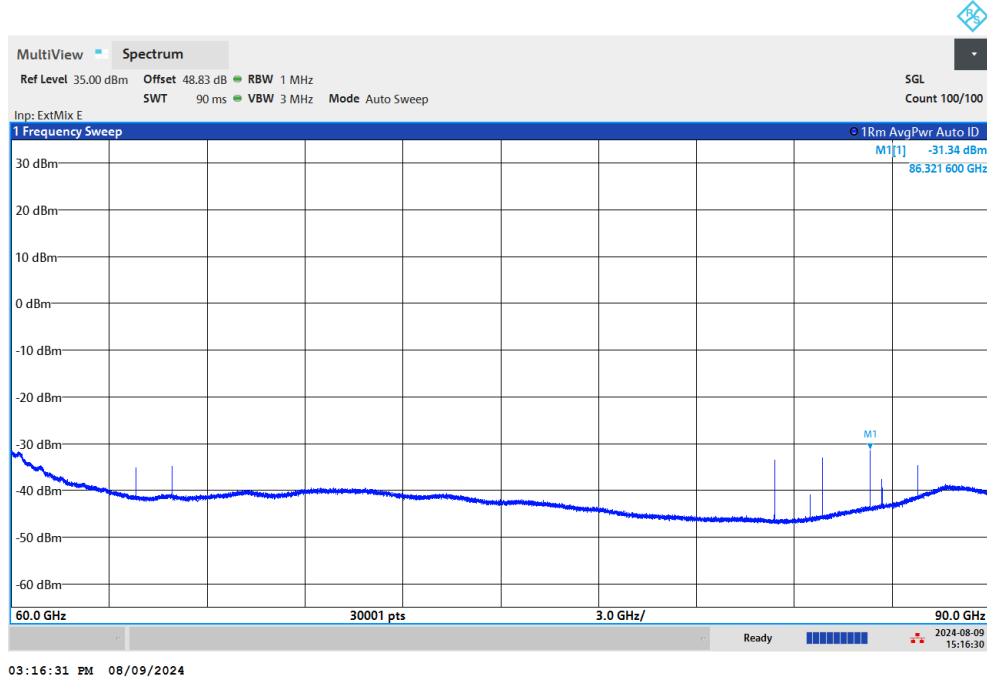
Remark: In band and out of band frequencies are omitted.

**NR Band n261**
**(40GHz-60GHz)**


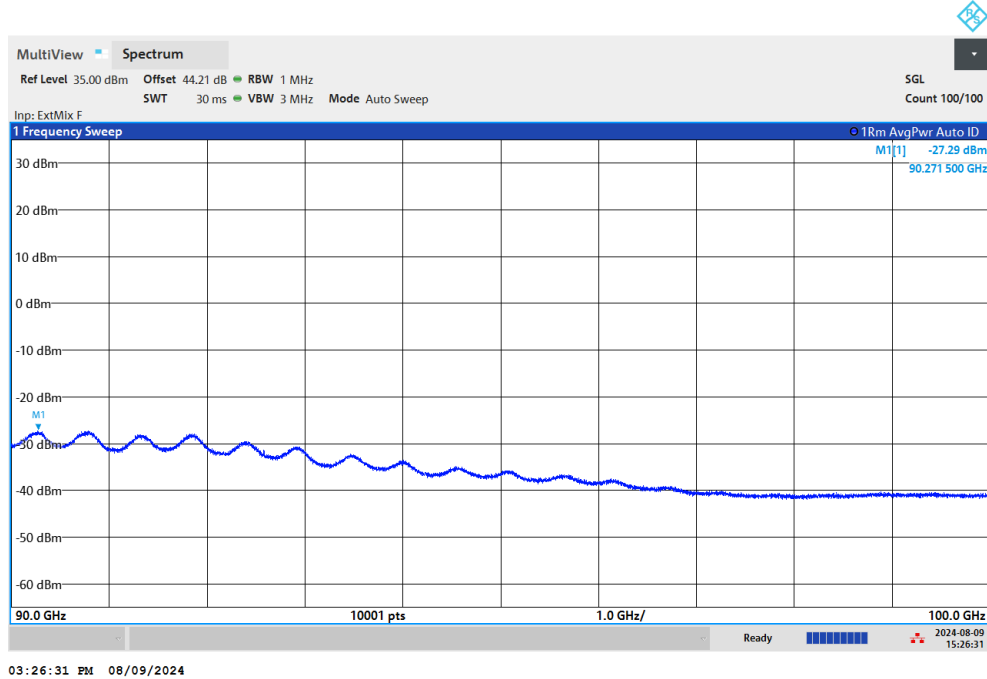
$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 42.6 + 0.43 + 107 + 20\log(1) - 104.8 = 45.23(\text{dB}) \end{aligned}$$

NR Band n261

(60GHz-90GHz)



$$\begin{aligned} \text{Offset} &= \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8 \\ &= 46.2 + 0.43 + 107 + 20\log(1) - 104.8 = 48.83 \text{ (dB)} \end{aligned}$$

**NR Band n261**
**(90GHz-100GHz)**


$$\text{Offset} = \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} + 107 + 20\log(D) - 104.8$$

$$= 47.6 + 0.43 + 107 + 20\log(0.5) - 104.8 = 44.21 \text{ (dB)}$$

## Frequency Stability

| Test Conditions  |                   | NR Band n261 / Middle Channel |                 |                 | Limit   |
|------------------|-------------------|-------------------------------|-----------------|-----------------|---------|
| Temperature (°C) | Voltage (Volt)    | CW tone                       |                 |                 | Note 2. |
|                  |                   | Frequency (GHz)               | Deviation (kHz) | Deviation (ppm) | Result  |
| 50               | Normal Voltage    | 27.9248132                    | 132.900         | 4.759           | Pass    |
| 40               | Normal Voltage    | 27.9248062                    | 139.900         | 5.010           |         |
| 30               | Normal Voltage    | 27.9248412                    | 104.900         | 3.756           |         |
| 20(Ref.)         | Normal Voltage    | 27.9249461                    | 0.000           | 0.000           |         |
| 10               | Normal Voltage    | 27.9248212                    | 124.900         | 4.473           |         |
| 0                | Normal Voltage    | 27.9247992                    | 146.900         | 5.261           |         |
| -10              | Normal Voltage    | 27.9248262                    | 119.900         | 4.294           |         |
| -20              | Normal Voltage    | 27.9248432                    | 102.900         | 3.685           |         |
| -30              | Normal Voltage    | 27.9248741                    | 72.000          | 2.578           |         |
| 20               | Maximum Voltage   | 27.9249271                    | 19.000          | 0.680           |         |
| 20               | Normal Voltage    | 27.9249341                    | 12.000          | 0.430           |         |
| 20               | Battery End Point | 27.9249201                    | 26.000          | 0.931           |         |

**Note:**

1. Normal Voltage = 56 V. ; Battery End Point (BEP) = 47.6 V. ; Maximum Voltage = 64.4 V.
2. The frequency fundamental emissions stay within the operation band.



## **Appendix B. R&S Mixer and Horn Antenna Calibration Reports**



# CALIBRATION CERTIFICATE



## Kalibrierschein

Certificate Number  
Zertifikatsnummer

**0001A300718726**

| General Data                                                                    |                                                                                                |
|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| <b>Item</b><br>Gegenstand                                                       | FS-Z60 HARMONIC MIXER 40-60GHZ                                                                 |
| <b>Manufacturer</b><br>Hersteller                                               | ROHDE & SCHWARZ                                                                                |
| <b>Type</b><br>Typ                                                              | FS-Z60                                                                                         |
| <b>Material Number</b><br>Materialnummer                                        | 1048.0171.02                                                                                   |
| <b>Serial Number</b><br>Seriennummer                                            | 100986                                                                                         |
| <b>Order Number</b><br>Bestellnummer                                            | Q786007                                                                                        |
| <b>Asset Number</b><br>Inventarnummer                                           |                                                                                                |
| <b>Customer</b><br>Auftraggeber                                                 | Sporton International Inc.<br><br>6F., Sec. 1, Hsin Tai Wu Rd 106<br>221 New Taipei City<br>TW |
| Performance                                                                     |                                                                                                |
| <b>Place and Date of Calibration</b><br>Ort und Datum der Kalibrierung          | 87700 Memmingen, Rohde-und-Schwarz-Str. 1<br>2023-10-31                                        |
| <b>Statement of Compliance (Incoming)</b><br>Konformitätsaussage (Anlieferung)  | All measured values are within the data sheet specifications.                                  |
| <b>Statement of Compliance (Outgoing)</b><br>Konformitätsaussage (Auslieferung) | All measured values are within the data sheet specifications.                                  |
| <b>Customers due Interval</b><br>Kalibrierintervall des Kunden                  |                                                                                                |
| <b>Extent of Calibration Document</b><br>Umfang des Kalibrierdokuments          | 3 Pages Certificate<br>6 Pages Outgoing Results<br>6 Pages Incoming Results                    |
| <b>Date of Issue</b><br>Ausstellungsdatum                                       | <b>Approval of the certificate by</b><br>Freigabe des Kalibrierscheins durch                   |
| 2023-11-08                                                                      | Dr. Gerhard Rösel<br>Johannes Negele                                                           |
|                                                                                 |                                                                                                |
| Laboratory management<br>Labormanagement                                        | Person responsible<br>Bearbeiter                                                               |

## Calibration Mark Kalibrierzeichen

|                     |
|---------------------|
| 300718726           |
| D-K-<br>15195-01-00 |
| 2023-10             |

Member of Deutscher Kalibrierdienst  
Mitglied im Deutschen Kalibrierdienst



This calibration certificate documents the metrological traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals. This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates with the full name of the approval responsible person are valid without signature.

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**Material No** 1048.0171.02    **Serial No** 100986    **Certificate** 0001A300718726  
**Page** 2/3    **Number**

## Calibration Procedure

The measuring object is an RF harmonic mixer, which converts an RF signal at one frequency into a signal at another frequency (here: IF). The conversion loss was measured using a vector network analyzer. The RF output power as well as the IF input power of the corresponding ports of the VNA were traced back to a power sensor. The conversion loss is defined as the ratio of the power at the IF frequency to the power at the RF frequency with a given LO power. (IF: Intermediate frequency; LO: Local Oscillator)  
 The traceability is represented in the table Working Standards used.

## Working Standards used

| Item                           | Type    | Serial Number | Calibration Certificate Number | Cal. Due   |
|--------------------------------|---------|---------------|--------------------------------|------------|
| Therm.Power Sensor DC-40GHz    | NRP-Z55 | 130179        | 0001A300682928                 | 2025-01-31 |
| Thermal Power Sensor           | NRP67T  | 100977        | 0001A300658977                 | 2025-07-31 |
| Vector Network Analyzer 4 Port | ZVA67   | 101100        | 0001A300698540                 | 2024-05-31 |

## Remarks

|  |
|--|
|  |
|--|



**Material No** 1048.0171.02    **Serial No** 100986    **Certificate** 0001A300718726  
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| Environmental Conditions |             |                   |         |
|--------------------------|-------------|-------------------|---------|
| Ambient Temperature      | (23 ± 1) °C | Relative Humidity | 20%-70% |

| Comments on Measurement Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The reported results apply only to those items specifically listed on this calibration certificate and have been tested for compliance with the specifications. The associated uncertainty of measurement has been taken into account if not otherwise stated.</p> <p>The non-binary decision rule with guard band is used according to ILAC G8:09/2019 'Guidelines on Decision Rules and Statements of Conformity'. Pass is normally not marked. Conditional Pass is marked with UGB1, Conditional Fail with UGB2 and Fail with Fail.</p> <p>The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95 %. It is consistent with the EA-4/02 M:2022.</p> <p>In addition to the calibration results, the calibration certificate includes functional measurements that might have an influence on the measurement uncertainty of the calibration results.</p> <p>The functional measurement results are marked and are not intended to be used to support the further dissemination of metrological traceability. They are intended to verify the requirements on the measurement object according to manufacturer specifications and technical standards.</p> |

## Outgoing Results

|                                  |                       |
|----------------------------------|-----------------------|
| Designation:                     | HARMONIC MIXER        |
| Type:                            | FS-Z60                |
| Material No.:                    | 1048.0171.02          |
| Serial No.:                      | 100986                |
| Certificate No.:                 | 0001A300718726        |
| Referring to Test Documentation: | 5038.8581.01-PB-02.00 |

|                  |                 |
|------------------|-----------------|
| Test Department: | 3MM-P           |
| Name:            | see certificate |
| Date:            | 2023-10-31      |



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1.2 Conversion Loss (IF = 729 MHz) ..... 5

1.3 Conversion Loss (IF = 1330 MHz) ..... 6

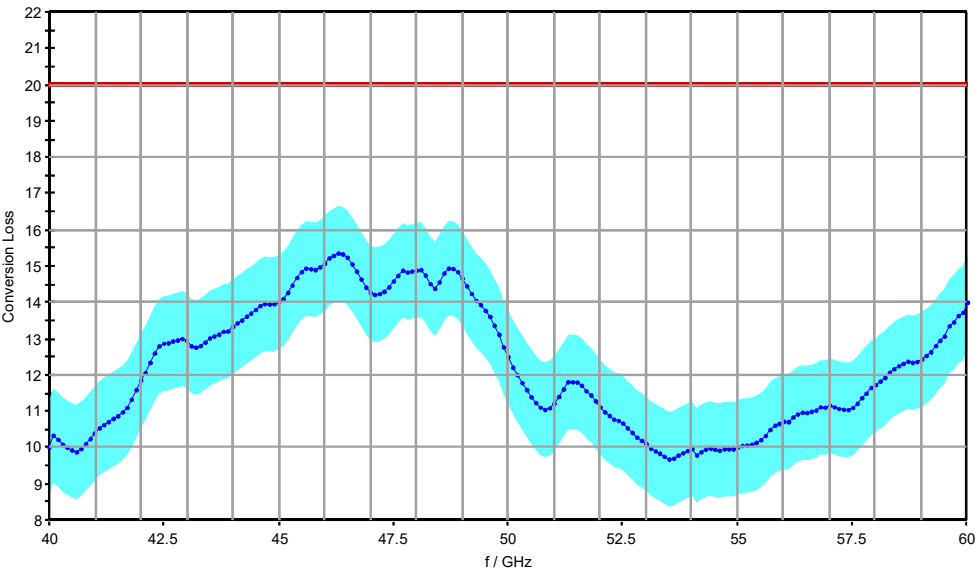
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| Software used for measurement |           |           |                             |
|-------------------------------|-----------|-----------|-----------------------------|
| Item                          | Type      | Version   | Remark                      |
| Suite                         | Setup     | V12.37.04 | Test Management Software G5 |
| Test Program (7012.8706.00_)  | Component | V01.05    |                             |

1. Conversion Loss (4. Harmonic)

1.1 Conversion Loss (IF = 404.4 MHz)

IF = 404.4 MHz, 4. Harmonic

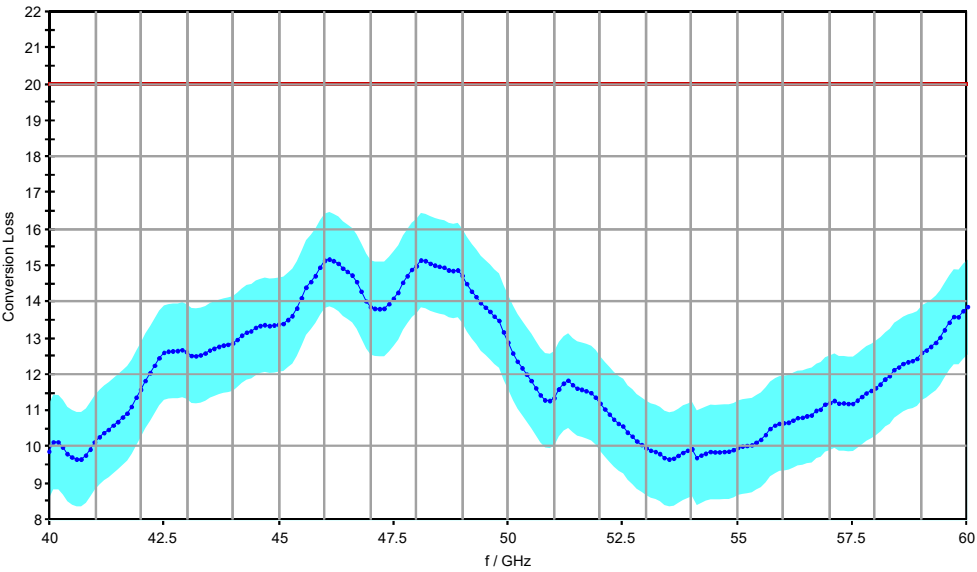


Conversion Loss (IF = 404.4 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 40.0           | 10.0                | ±1.3            |
| 41.0           | 10.4                | ±1.3            |
| 42.0           | 11.9                | ±1.3            |
| 43.0           | 13.0                | ±1.3            |
| 44.0           | 13.3                | ±1.3            |
| 45.0           | 14.0                | ±1.3            |
| 46.0           | 15.1                | ±1.3            |
| 47.0           | 14.3                | ±1.3            |
| 48.0           | 14.9                | ±1.3            |
| 49.0           | 14.7                | ±1.3            |
| 50.0           | 12.5                | ±1.3            |
| 51.0           | 11.2                | ±1.3            |
| 52.0           | 11.1                | ±1.3            |
| 53.0           | 10.1                | ±1.3            |
| 54.0           | 10.0                | ±1.3            |
| 55.0           | 10.0                | ±1.3            |
| 56.0           | 10.7                | ±1.3            |
| 57.0           | 11.2                | ±1.3            |
| 58.0           | 11.7                | ±1.3            |
| 59.0           | 12.5                | ±1.3            |
| 60.0           | 14.0                | ±1.3            |

1.2 Conversion Loss (IF = 729 MHz)

IF = 729 MHz, 4. Harmonic

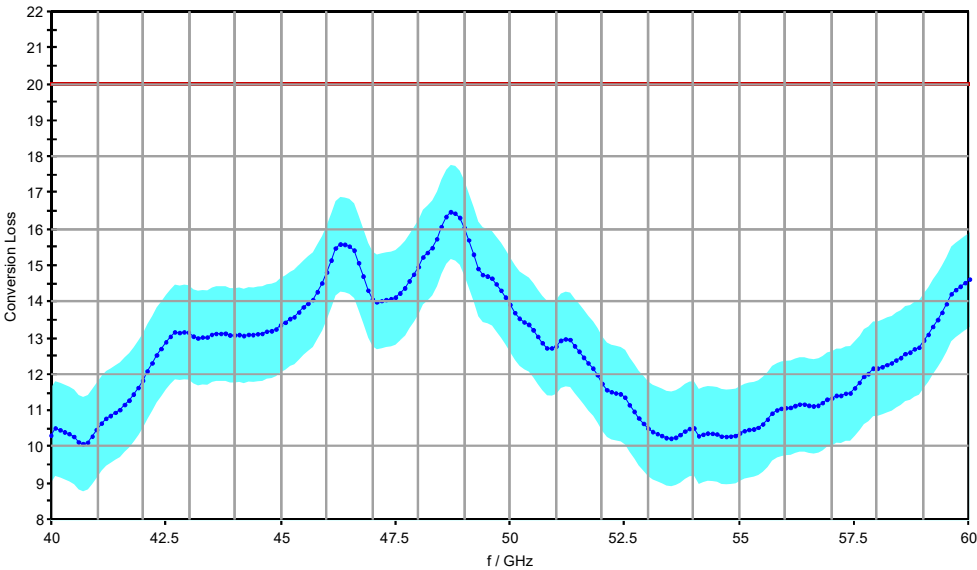


Conversion Loss (IF = 729 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 40.0           | 9.9                 | ±1.3            |
| 41.0           | 10.2                | ±1.3            |
| 42.0           | 11.6                | ±1.3            |
| 43.0           | 12.6                | ±1.3            |
| 44.0           | 12.9                | ±1.3            |
| 45.0           | 13.4                | ±1.3            |
| 46.0           | 15.1                | ±1.3            |
| 47.0           | 13.9                | ±1.3            |
| 48.0           | 15.0                | ±1.3            |
| 49.0           | 14.7                | ±1.3            |
| 50.0           | 12.9                | ±1.3            |
| 51.0           | 11.4                | ±1.3            |
| 52.0           | 11.2                | ±1.3            |
| 53.0           | 10.0                | ±1.3            |
| 54.0           | 10.0                | ±1.3            |
| 55.0           | 10.0                | ±1.3            |
| 56.0           | 10.7                | ±1.3            |
| 57.0           | 11.2                | ±1.3            |
| 58.0           | 11.6                | ±1.3            |
| 59.0           | 12.6                | ±1.3            |
| 60.0           | 13.9                | ±1.3            |

1.3 Conversion Loss (IF = 1330 MHz)

IF = 1330 MHz, 4. Harmonic



Conversion Loss (IF = 1330 MHz)

| Frequency<br>/GHz | Conversion Loss<br>/dB | Uncertainty<br>/dB |
|-------------------|------------------------|--------------------|
| 40.0              | 10.3                   | ±1.3               |
| 41.0              | 10.5                   | ±1.3               |
| 42.0              | 11.9                   | ±1.3               |
| 43.0              | 13.2                   | ±1.3               |
| 44.0              | 13.1                   | ±1.3               |
| 45.0              | 13.4                   | ±1.3               |
| 46.0              | 14.8                   | ±1.3               |
| 47.0              | 14.1                   | ±1.3               |
| 48.0              | 15.0                   | ±1.3               |
| 49.0              | 16.1                   | ±1.3               |
| 50.0              | 13.9                   | ±1.3               |
| 51.0              | 12.8                   | ±1.3               |
| 52.0              | 11.8                   | ±1.3               |
| 53.0              | 10.5                   | ±1.3               |
| 54.0              | 10.5                   | ±1.3               |
| 55.0              | 10.4                   | ±1.3               |
| 56.0              | 11.1                   | ±1.3               |
| 57.0              | 11.4                   | ±1.3               |
| 58.0              | 12.2                   | ±1.3               |
| 59.0              | 13.0                   | ±1.3               |
| 60.0              | 14.6                   | ±1.3               |

1.4 Continuity response within 1 GHz

Continuity response within any 1 GHz Band, 4. Harmonic

|                         | DUL<br>/dB | Continuity<br>/dB |
|-------------------------|------------|-------------------|
| max. at IF = 404.4 MHz: | 6.0        | 2.37              |
| max. at IF = 729 MHz:   | 6.0        | 2.19              |
| max. at IF = 1330 MHz:  | 6.0        | 2.19              |

## Incoming Results

|                                  |                       |
|----------------------------------|-----------------------|
| Designation:                     | HARMONIC MIXER        |
| Type:                            | FS-Z60                |
| Material No.:                    | 1048.0171.02          |
| Serial No.:                      | 100986                |
| Certificate No.:                 | 0001A300718726        |
| Referring to Test Documentation: | 5038.8581.01-PB-02.00 |

|                  |                 |
|------------------|-----------------|
| Test Department: | 3MM-P           |
| Name:            | see certificate |
| Date:            | 2023-10-31      |



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| 1.4 Continuity response within 1 GHz ..... | 6 |

Incoming Results

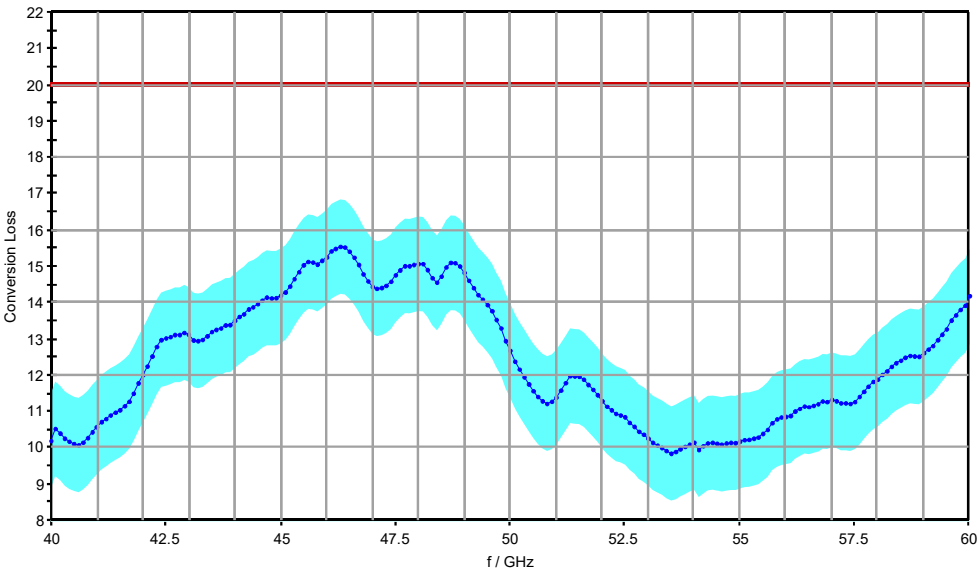
| Software used for measurement |           |           |                             |
|-------------------------------|-----------|-----------|-----------------------------|
| Item                          | Type      | Version   | Remark                      |
| Suite                         | Setup     | V12.37.04 | Test Management Software G5 |
| Test Program (7012.8706.00_)  | Component | V01.05    |                             |

Incoming Results

1. Conversion Loss (4. Harmonic)

1.1 Conversion Loss (IF = 404.4 MHz)

IF = 404.4 MHz, 4. Harmonic



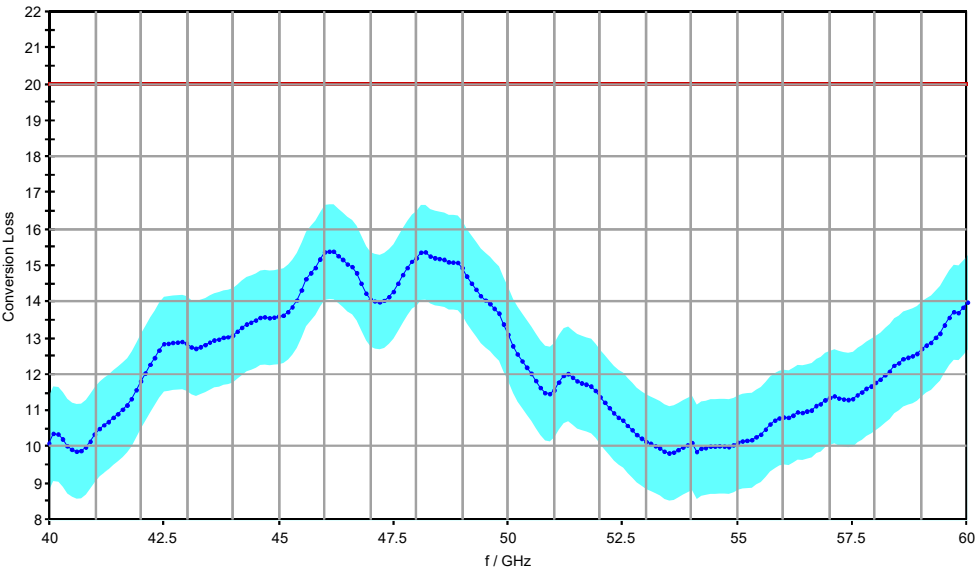
Conversion Loss (IF = 404.4 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 40.0           | 10.2                | ±1.3            |
| 41.0           | 10.6                | ±1.3            |
| 42.0           | 12.0                | ±1.3            |
| 43.0           | 13.1                | ±1.3            |
| 44.0           | 13.5                | ±1.3            |
| 45.0           | 14.2                | ±1.3            |
| 46.0           | 15.3                | ±1.3            |
| 47.0           | 14.4                | ±1.3            |
| 48.0           | 15.1                | ±1.3            |
| 49.0           | 14.8                | ±1.3            |
| 50.0           | 12.7                | ±1.3            |
| 51.0           | 11.4                | ±1.3            |
| 52.0           | 11.3                | ±1.3            |
| 53.0           | 10.3                | ±1.3            |
| 54.0           | 10.2                | ±1.3            |
| 55.0           | 10.2                | ±1.3            |
| 56.0           | 10.9                | ±1.3            |
| 57.0           | 11.3                | ±1.3            |
| 58.0           | 11.9                | ±1.3            |
| 59.0           | 12.6                | ±1.3            |
| 60.0           | 14.2                | ±1.3            |

Incoming Results

1.2 Conversion Loss (IF = 729 MHz)

IF = 729 MHz, 4. Harmonic



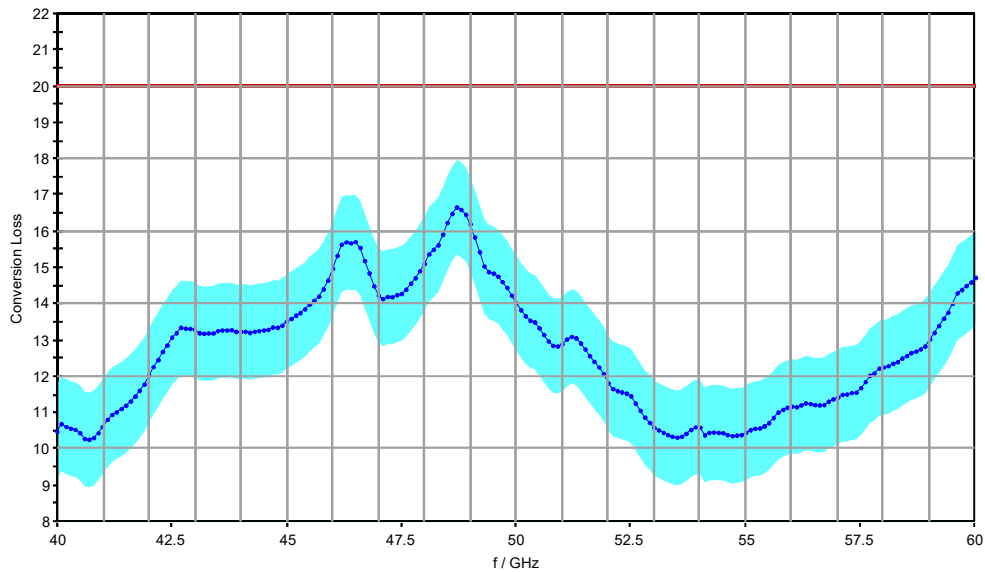
Conversion Loss (IF = 729 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 40.0           | 10.1                | ±1.3            |
| 41.0           | 10.4                | ±1.3            |
| 42.0           | 11.8                | ±1.3            |
| 43.0           | 12.9                | ±1.3            |
| 44.0           | 13.1                | ±1.3            |
| 45.0           | 13.6                | ±1.3            |
| 46.0           | 15.4                | ±1.3            |
| 47.0           | 14.1                | ±1.3            |
| 48.0           | 15.2                | ±1.3            |
| 49.0           | 14.9                | ±1.3            |
| 50.0           | 13.1                | ±1.3            |
| 51.0           | 11.6                | ±1.3            |
| 52.0           | 11.4                | ±1.3            |
| 53.0           | 10.2                | ±1.3            |
| 54.0           | 10.1                | ±1.3            |
| 55.0           | 10.1                | ±1.3            |
| 56.0           | 10.8                | ±1.3            |
| 57.0           | 11.4                | ±1.3            |
| 58.0           | 11.8                | ±1.3            |
| 59.0           | 12.7                | ±1.3            |
| 60.0           | 14.0                | ±1.3            |

Incoming Results

1.3 Conversion Loss (IF = 1330 MHz)

IF = 1330 MHz, 4. Harmonic



Conversion Loss (IF = 1330 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 40.0           | 10.5                | ±1.3            |
| 41.0           | 10.6                | ±1.3            |
| 42.0           | 12.1                | ±1.3            |
| 43.0           | 13.3                | ±1.3            |
| 44.0           | 13.2                | ±1.3            |
| 45.0           | 13.5                | ±1.3            |
| 46.0           | 15.0                | ±1.3            |
| 47.0           | 14.2                | ±1.3            |
| 48.0           | 15.1                | ±1.3            |
| 49.0           | 16.2                | ±1.3            |
| 50.0           | 14.0                | ±1.3            |
| 51.0           | 12.9                | ±1.3            |
| 52.0           | 11.8                | ±1.3            |
| 53.0           | 10.6                | ±1.3            |
| 54.0           | 10.6                | ±1.3            |
| 55.0           | 10.5                | ±1.3            |
| 56.0           | 11.2                | ±1.3            |
| 57.0           | 11.4                | ±1.3            |
| 58.0           | 12.3                | ±1.3            |
| 59.0           | 13.0                | ±1.3            |
| 60.0           | 14.7                | ±1.3            |

1.4 Continuity response within 1 GHz

Continuity response within any 1 GHz Band, 4. Harmonic

|                         | DUL /dB | Continuity /dB |
|-------------------------|---------|----------------|
| max. at IF = 404.4 MHz: | 6.0     | 2.35           |
| max. at IF = 729 MHz:   | 6.0     | 2.18           |
| max. at IF = 1330 MHz:  | 6.0     | 2.22           |

Incoming Results



# CALIBRATION CERTIFICATE



## Kalibrierschein

Certificate Number  
Zertifikatsnummer

**0001A300718729**

| General Data                                                                    |                                                                                                |
|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| <b>Item</b><br>Gegenstand                                                       | FS-Z90 HARMONIC MIXER 60-90GHZ                                                                 |
| <b>Manufacturer</b><br>Hersteller                                               | ROHDE & SCHWARZ                                                                                |
| <b>Type</b><br>Typ                                                              | FS-Z90                                                                                         |
| <b>Material Number</b><br>Materialnummer                                        | 1048.0371.02                                                                                   |
| <b>Serial Number</b><br>Seriennummer                                            | 101811                                                                                         |
| <b>Order Number</b><br>Bestellnummer                                            | Q786007                                                                                        |
| <b>Asset Number</b><br>Inventarnummer                                           |                                                                                                |
| <b>Customer</b><br>Auftraggeber                                                 | Sporton International Inc.<br><br>6F., Sec. 1, Hsin Tai Wu Rd 106<br>221 New Taipei City<br>TW |
| Performance                                                                     |                                                                                                |
| <b>Place and Date of Calibration</b><br>Ort und Datum der Kalibrierung          | 87700 Memmingen, Rohde-und-Schwarz-Str. 1<br>2023-10-31                                        |
| <b>Statement of Compliance (Incoming)</b><br>Konformitätsaussage (Anlieferung)  | All measured values are within the data sheet specifications.                                  |
| <b>Statement of Compliance (Outgoing)</b><br>Konformitätsaussage (Auslieferung) | All measured values are within the data sheet specifications.                                  |
| <b>Customers due Interval</b><br>Kalibrierintervall des Kunden                  |                                                                                                |
| <b>Extent of Calibration Document</b><br>Umfang des Kalibrierdokuments          | 3 Pages Certificate<br>7 Pages Outgoing Results<br>7 Pages Incoming Results                    |
| <b>Date of Issue</b><br>Ausstellungsdatum                                       | <b>Approval of the certificate by</b><br>Freigabe des Kalibrierscheins durch                   |
| 2023-11-08                                                                      | Dr. Gerhard Rösel<br>Johannes Negele                                                           |
|                                                                                 |                                                                                                |
| Laboratory management<br>Labormanagement                                        | Person responsible<br>Bearbeiter                                                               |

## Calibration Mark Kalibrierzeichen

|                     |
|---------------------|
| 300718729           |
| D-K-<br>15195-01-00 |
| 2023-10             |

Member of Deutscher Kalibrierdienst  
Mitglied im Deutschen Kalibrierdienst



This calibration certificate documents the metrological traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals. This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates with the full name of the approval responsible person are valid without signature.

Dieser Kalibrierschein dokumentiert die metrologische Rückführbarkeit auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European cooperation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich. Dieser Kalibrierschein darf nur vollständig weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine sind bei Nennung des für die Freigabe Verantwortlichen in Klarschrift auch ohne Unterschrift gültig.



Material No

1048.0371.02

Serial No

101811

Certificate

0001A300718729

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Number

| Calibration Procedure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The measuring object is an RF harmonic mixer, which converts an RF signal at one frequency into a signal at another frequency (here: IF). The conversion loss was measured using a vector network analyzer. The RF output power as well as the IF input power of the corresponding ports of the VNA were traced back to a power sensor. The conversion loss is defined as the ratio of the power at the IF frequency to the power at the RF frequency with a given LO power. (IF: Intermediate frequency; LO: Local Oscillator)<br>The traceability is represented in the table Working Standards used. |

| Working Standards used         |          |               |                                |            |
|--------------------------------|----------|---------------|--------------------------------|------------|
| Item                           | Type     | Serial Number | Calibration Certificate Number | Cal. Due   |
| Therm.Power Sensor DC-40GHz    | NRP-Z55  | 130179        | 0001A300682928                 | 2025-01-31 |
| Thermal Waveguide Power Sensor | NRP90TWG | 910001        | 20A1129129                     | 2026-04-30 |
| Vector Network Analyzer 4 Port | ZVA67    | 101100        | 0001A300698540                 | 2024-05-31 |

| Remarks |
|---------|
|         |



**Material No** 1048.0371.02    **Serial No** 101811    **Certificate** 0001A300718729  
**Page** 3/3    **Number**

| Environmental Conditions |             |                   |         |
|--------------------------|-------------|-------------------|---------|
| Ambient Temperature      | (23 ± 1) °C | Relative Humidity | 20%-70% |

| Comments on Measurement Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The reported results apply only to those items specifically listed on this calibration certificate and have been tested for compliance with the specifications. The associated uncertainty of measurement has been taken into account if not otherwise stated.</p> <p>The non-binary decision rule with guard band is used according to ILAC G8:09/2019 'Guidelines on Decision Rules and Statements of Conformity'. Pass is normally not marked. Conditional Pass is marked with UGB1, Conditional Fail with UGB2 and Fail with Fail.</p> <p>The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95 %. It is consistent with the EA-4/02 M:2022.</p> <p>In addition to the calibration results, the calibration certificate includes functional measurements that might have an influence on the measurement uncertainty of the calibration results.</p> <p>The functional measurement results are marked and are not intended to be used to support the further dissemination of metrological traceability. They are intended to verify the requirements on the measurement object according to manufacturer specifications and technical standards.</p> |

## Outgoing Results

|                                  |                       |
|----------------------------------|-----------------------|
| Designation:                     | HARMONIC MIXER        |
| Type:                            | FS-Z90                |
| Material No.:                    | 1048.0371.02          |
| Serial No.:                      | 101811                |
| Certificate No.:                 | 0001A300718729        |
| Referring to Test Documentation: | 5038.8323.01-PB-02.00 |

|                  |                 |
|------------------|-----------------|
| Test Department: | 3MM-P           |
| Name:            | see certificate |
| Date:            | 2023-10-31      |



## The following abbreviations may be used in this document

|            |                                                                                                                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| {a}        | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass.                                                                                                                             |
| {b}        | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c}        | Functional test, therefore no measurement uncertainty is stated.                                                                                                                                                                                                           |
| {d}        | Typical value, refer to performance test.                                                                                                                                                                                                                                  |
| {e}        | The measurement uncertainty is taken into account when setting the measuring system.                                                                                                                                                                                       |
| {g}        | Verification of specified requirements, non-accredited measurements. Technical operations that consist of the determination of one or more characteristics to a specified procedure (formerly {f}).                                                                        |
| DL or DT   | Data Limit for symmetrical tolerance limits                                                                                                                                                                                                                                |
| DLL        | Datasheet Lower Limit                                                                                                                                                                                                                                                      |
| DUL        | Datasheet Upper Limit                                                                                                                                                                                                                                                      |
| MU         | Symmetrical Measurement Uncertainty                                                                                                                                                                                                                                        |
| MLL or MLV | Measurement Uncertainty Lower Value                                                                                                                                                                                                                                        |
| MUL or MUV | Measurement Uncertainty Upper Value                                                                                                                                                                                                                                        |
| Nom.       | Nominal Value                                                                                                                                                                                                                                                              |
| Dev.       | Deviation                                                                                                                                                                                                                                                                  |
| Act.       | Actual Value                                                                                                                                                                                                                                                               |
| UGB        | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit.                                                                                                                                                                                             |
| UGB1       | A compliance statement may be possible where a confidence level of less than 95 % is acceptable.                                                                                                                                                                           |
| UGB2       | A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.                                                                                                                                                                       |
| DU         | Datasheet Uncertainty                                                                                                                                                                                                                                                      |

## Explanation of charts

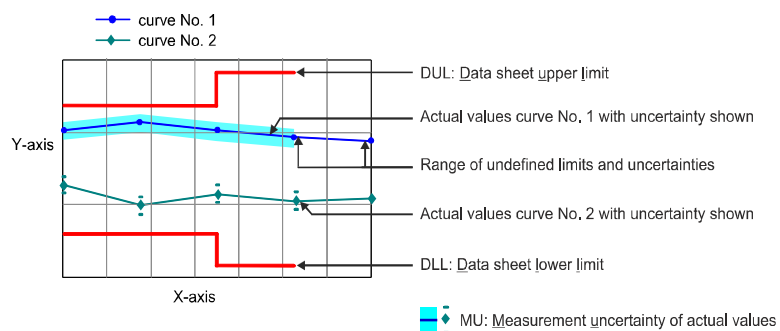


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1.3 Conversion Loss (IF = 1330 MHz) ..... 7

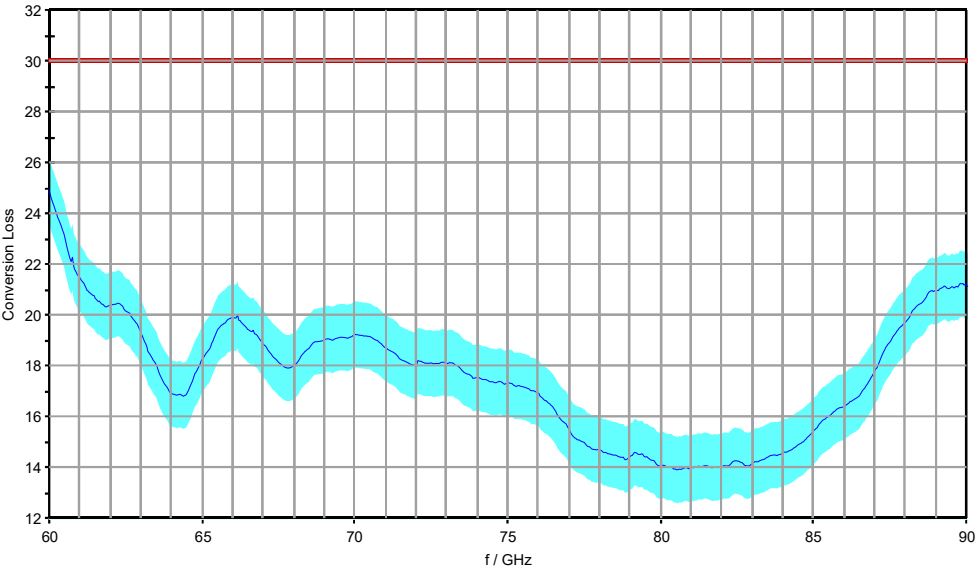
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| Software used for measurement |           |           |                             |
|-------------------------------|-----------|-----------|-----------------------------|
| Item                          | Type      | Version   | Remark                      |
| Suite                         | Setup     | V12.37.04 | Test Management Software G5 |
| Test Program (7012.8706.00_)  | Component | V01.05    |                             |

1. Conversion Loss (6. Harmonic)

1.1 Conversion Loss (IF = 404.4 MHz)

IF = 404.4 MHz, 6. Harmonic

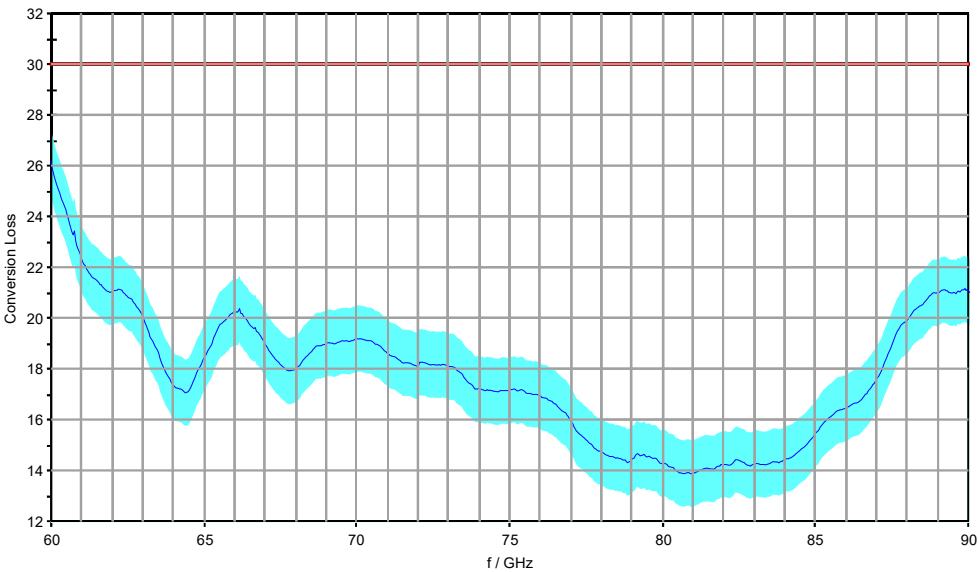


Conversion Loss (IF = 404.4 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 60.0           | 24.9                | ±1.3            |
| 61.0           | 21.5                | ±1.3            |
| 62.0           | 20.4                | ±1.3            |
| 63.0           | 19.4                | ±1.3            |
| 64.0           | 16.9                | ±1.3            |
| 65.0           | 18.3                | ±1.3            |
| 66.0           | 19.9                | ±1.3            |
| 67.0           | 18.9                | ±1.3            |
| 68.0           | 18.0                | ±1.3            |
| 69.0           | 19.1                | ±1.3            |
| 70.0           | 19.3                | ±1.3            |
| 71.0           | 18.7                | ±1.3            |
| 72.0           | 18.0                | ±1.3            |
| 73.0           | 18.1                | ±1.3            |
| 74.0           | 17.6                | ±1.3            |
| 75.0           | 17.4                | ±1.3            |
| 76.0           | 16.9                | ±1.3            |
| 77.0           | 15.5                | ±1.3            |
| 78.0           | 14.7                | ±1.3            |
| 79.0           | 14.5                | ±1.3            |
| 80.0           | 14.1                | ±1.3            |
| 81.0           | 14.0                | ±1.3            |
| 82.0           | 14.1                | ±1.3            |
| 83.0           | 14.2                | ±1.3            |
| 84.0           | 14.6                | ±1.3            |
| 85.0           | 15.5                | ±1.3            |
| 86.0           | 16.5                | ±1.3            |
| 87.0           | 17.9                | ±1.3            |
| 88.0           | 19.8                | ±1.3            |
| 89.0           | 21.0                | ±1.3            |
| 90.0           | 21.1                | ±1.3            |

1.2 Conversion Loss (IF = 729 MHz)

IF = 729 MHz, 6. Harmonic

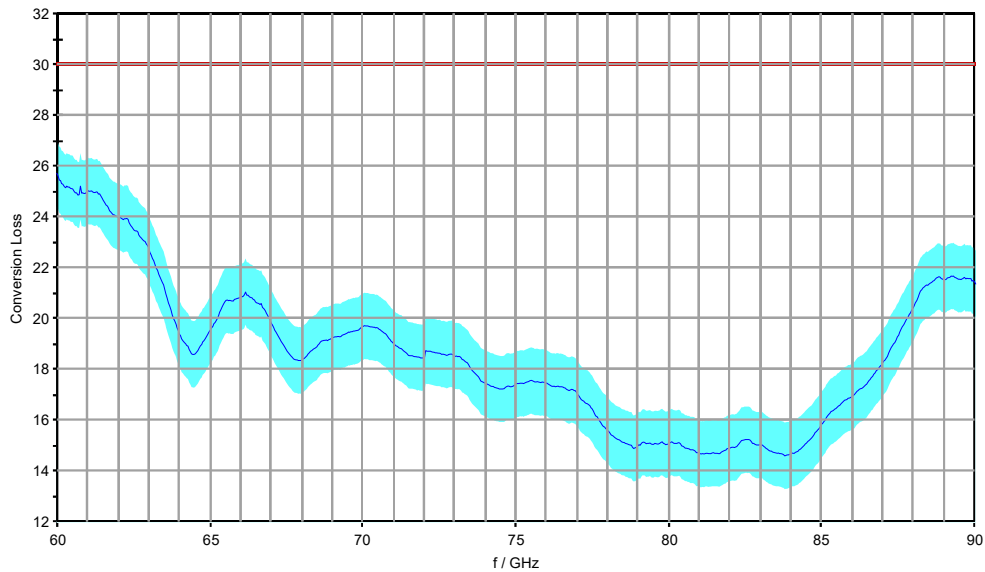


Conversion Loss (IF = 729 MHz)

| Frequency<br>/GHz | Conversion Loss<br>/dB | Uncertainty<br>/dB |
|-------------------|------------------------|--------------------|
| 60.0              | 26.2                   | ±1.3               |
| 61.0              | 22.4                   | ±1.3               |
| 62.0              | 21.1                   | ±1.3               |
| 63.0              | 20.1                   | ±1.3               |
| 64.0              | 17.4                   | ±1.3               |
| 65.0              | 18.5                   | ±1.3               |
| 66.0              | 20.3                   | ±1.3               |
| 67.0              | 19.0                   | ±1.3               |
| 68.0              | 18.0                   | ±1.3               |
| 69.0              | 19.0                   | ±1.3               |
| 70.0              | 19.2                   | ±1.3               |
| 71.0              | 18.6                   | ±1.3               |
| 72.0              | 18.1                   | ±1.3               |
| 73.0              | 18.1                   | ±1.3               |
| 74.0              | 17.3                   | ±1.3               |
| 75.0              | 17.2                   | ±1.3               |
| 76.0              | 17.0                   | ±1.3               |
| 77.0              | 15.9                   | ±1.3               |
| 78.0              | 14.8                   | ±1.3               |
| 79.0              | 14.5                   | ±1.3               |
| 80.0              | 14.3                   | ±1.3               |
| 81.0              | 14.0                   | ±1.3               |
| 82.0              | 14.3                   | ±1.3               |
| 83.0              | 14.3                   | ±1.3               |
| 84.0              | 14.5                   | ±1.3               |
| 85.0              | 15.5                   | ±1.3               |
| 86.0              | 16.5                   | ±1.3               |
| 87.0              | 17.7                   | ±1.3               |
| 88.0              | 20.0                   | ±1.3               |
| 89.0              | 21.0                   | ±1.3               |
| 90.0              | 21.0                   | ±1.3               |

### 1.3 Conversion Loss (IF = 1330 MHz)

IF = 1330 MHz, 6. Harmonic



Conversion Loss (IF = 1330 MHz)

| Frequency<br>/GHz | Conversion Loss<br>/dB | Uncertainty<br>/dB |
|-------------------|------------------------|--------------------|
| 60.0              | 25.7                   | ±1.3               |
| 61.0              | 25.0                   | ±1.3               |
| 62.0              | 24.0                   | ±1.3               |
| 63.0              | 22.8                   | ±1.3               |
| 64.0              | 19.4                   | ±1.3               |
| 65.0              | 19.5                   | ±1.3               |
| 66.0              | 20.9                   | ±1.3               |
| 67.0              | 19.8                   | ±1.3               |
| 68.0              | 18.4                   | ±1.3               |
| 69.0              | 19.3                   | ±1.3               |
| 70.0              | 19.7                   | ±1.3               |
| 71.0              | 19.0                   | ±1.3               |
| 72.0              | 18.5                   | ±1.3               |
| 73.0              | 18.5                   | ±1.3               |
| 74.0              | 17.5                   | ±1.3               |
| 75.0              | 17.5                   | ±1.3               |
| 76.0              | 17.5                   | ±1.3               |
| 77.0              | 17.0                   | ±1.3               |
| 78.0              | 15.6                   | ±1.3               |
| 79.0              | 15.1                   | ±1.3               |
| 80.0              | 15.1                   | ±1.3               |
| 81.0              | 14.7                   | ±1.3               |
| 82.0              | 15.0                   | ±1.3               |
| 83.0              | 15.1                   | ±1.3               |
| 84.0              | 14.7                   | ±1.3               |
| 85.0              | 15.9                   | ±1.3               |
| 86.0              | 17.0                   | ±1.3               |
| 87.0              | 18.3                   | ±1.3               |
| 88.0              | 20.5                   | ±1.3               |
| 89.0              | 21.5                   | ±1.3               |
| 90.0              | 21.4                   | ±1.3               |

### 1.4 Continuity response within 1 GHz

Continuity response within any 1 GHz Band, 6. Harmonic

|                         | DUL<br>/dB | Continuity<br>/dB |
|-------------------------|------------|-------------------|
| max. at IF = 404.4 MHz: | 6.0        | 3.42              |
| max. at IF = 729 MHz:   | 6.0        | 3.82              |
| max. at IF = 1330 MHz:  | 6.0        | 3.35              |

## Incoming Results

|                                  |                       |
|----------------------------------|-----------------------|
| Designation:                     | HARMONIC MIXER        |
| Type:                            | FS-Z90                |
| Material No.:                    | 1048.0371.02          |
| Serial No.:                      | 101811                |
| Certificate No.:                 | 0001A300718729        |
| Referring to Test Documentation: | 5038.8323.01-PB-02.00 |

|                  |                 |
|------------------|-----------------|
| Test Department: | 3MM-P           |
| Name:            | see certificate |
| Date:            | 2023-10-31      |



## The following abbreviations may be used in this document

|            |                                                                                                                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| {a}        | No measurement uncertainty stated because the errors always add together. So it is sure that a measurement result evaluated as "PASS" is pass.                                                                                                                             |
| {b}        | The measurement uncertainty depends on the measurement result. The stated measurement uncertainty is valid for the close area around the specification. Measurement results outside the close area have a higher measurement uncertainty but are within the specification. |
| {c}        | Functional test, therefore no measurement uncertainty is stated.                                                                                                                                                                                                           |
| {d}        | Typical value, refer to performance test.                                                                                                                                                                                                                                  |
| {e}        | The measurement uncertainty is taken into account when setting the measuring system.                                                                                                                                                                                       |
| {g}        | Verification of specified requirements, non-accredited measurements. Technical operations that consist of the determination of one or more characteristics to a specified procedure (formerly {f}).                                                                        |
| DL or DT   | Data Limit for symmetrical tolerance limits                                                                                                                                                                                                                                |
| DLL        | Datasheet Lower Limit                                                                                                                                                                                                                                                      |
| DUL        | Datasheet Upper Limit                                                                                                                                                                                                                                                      |
| MU         | Symmetrical Measurement Uncertainty                                                                                                                                                                                                                                        |
| MLL or MLV | Measurement Uncertainty Lower Value                                                                                                                                                                                                                                        |
| MUL or MUV | Measurement Uncertainty Upper Value                                                                                                                                                                                                                                        |
| Nom.       | Nominal Value                                                                                                                                                                                                                                                              |
| Dev.       | Deviation                                                                                                                                                                                                                                                                  |
| Act.       | Actual Value                                                                                                                                                                                                                                                               |
| UGB        | Uncertainty Guard Band: Measuring uncertainty violates the data (spec.) limit.                                                                                                                                                                                             |
| UGB1       | A compliance statement may be possible where a confidence level of less than 95 % is acceptable.                                                                                                                                                                           |
| UGB2       | A non-compliance statement may be possible where a confidence level of less than 95 % is acceptable.                                                                                                                                                                       |
| DU         | Datasheet Uncertainty                                                                                                                                                                                                                                                      |

## Explanation of charts

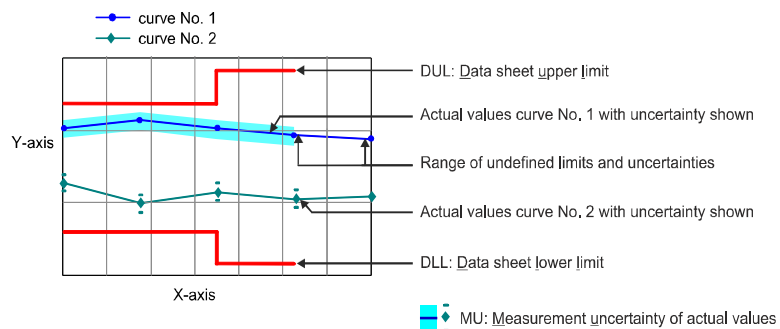


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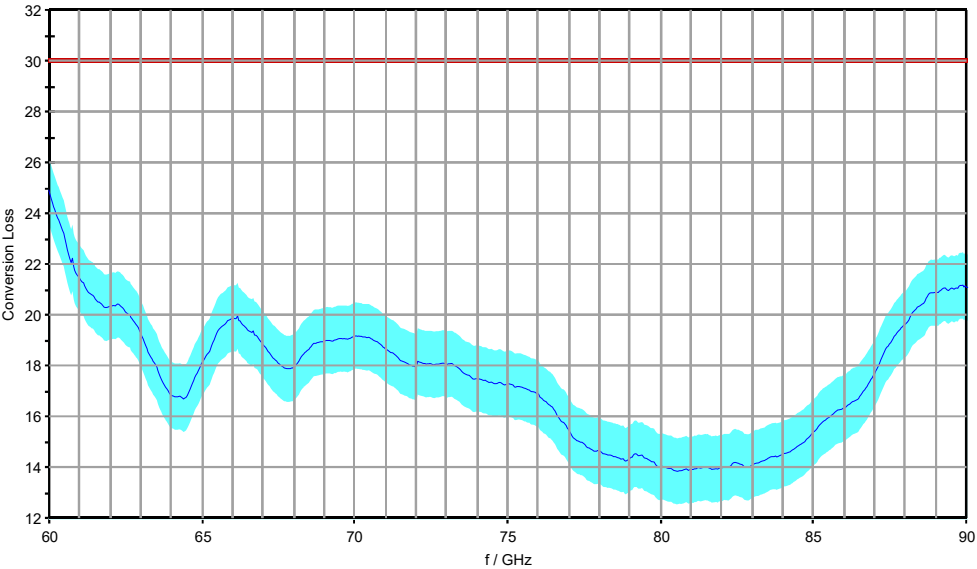
Incoming Results

| Software used for measurement |           |           |                             |
|-------------------------------|-----------|-----------|-----------------------------|
| Item                          | Type      | Version   | Remark                      |
| Suite                         | Setup     | V12.37.04 | Test Management Software G5 |
| Test Program (7012.8706.00_)  | Component | V01.05    |                             |

1. Conversion Loss (6. Harmonic)

1.1 Conversion Loss (IF = 404.4 MHz)

IF = 404.4 MHz, 6. Harmonic



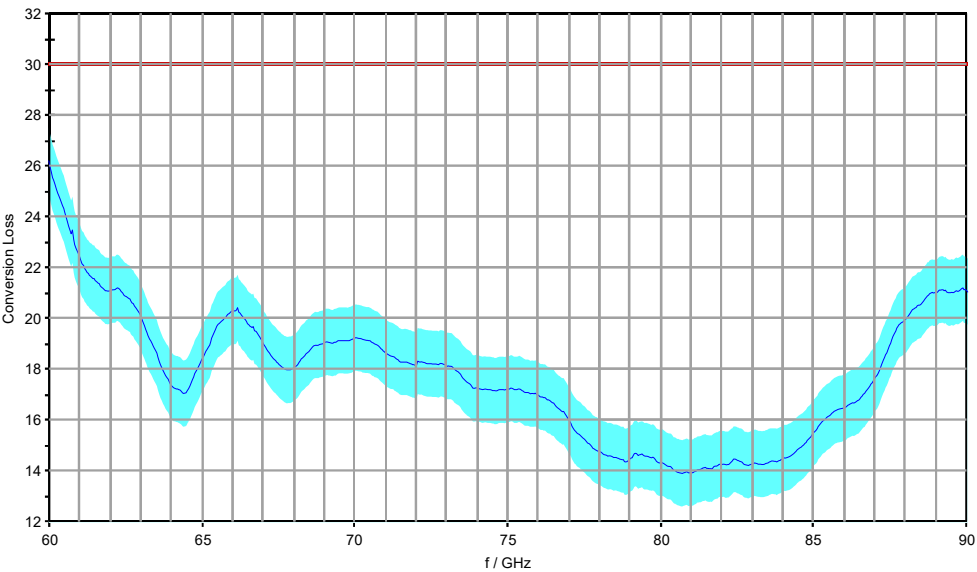
Conversion Loss (IF = 404.4 MHz)

| Frequency<br>/GHz | Conversion Loss<br>/dB | Uncertainty<br>/dB |
|-------------------|------------------------|--------------------|
| 60.0              | 24.9                   | ±1.3               |
| 61.0              | 21.5                   | ±1.3               |
| 62.0              | 20.4                   | ±1.3               |
| 63.0              | 19.3                   | ±1.3               |
| 64.0              | 16.9                   | ±1.3               |
| 65.0              | 18.2                   | ±1.3               |
| 66.0              | 19.9                   | ±1.3               |
| 67.0              | 18.8                   | ±1.3               |
| 68.0              | 18.0                   | ±1.3               |
| 69.0              | 19.0                   | ±1.3               |
| 70.0              | 19.2                   | ±1.3               |
| 71.0              | 18.7                   | ±1.3               |
| 72.0              | 18.0                   | ±1.3               |
| 73.0              | 18.1                   | ±1.3               |
| 74.0              | 17.5                   | ±1.3               |
| 75.0              | 17.3                   | ±1.3               |
| 76.0              | 16.9                   | ±1.3               |
| 77.0              | 15.4                   | ±1.3               |
| 78.0              | 14.7                   | ±1.3               |
| 79.0              | 14.4                   | ±1.3               |
| 80.0              | 14.1                   | ±1.3               |
| 81.0              | 14.0                   | ±1.3               |
| 82.0              | 14.0                   | ±1.3               |
| 83.0              | 14.2                   | ±1.3               |
| 84.0              | 14.6                   | ±1.3               |
| 85.0              | 15.5                   | ±1.3               |
| 86.0              | 16.4                   | ±1.3               |
| 87.0              | 17.8                   | ±1.3               |
| 88.0              | 19.7                   | ±1.3               |
| 89.0              | 20.9                   | ±1.3               |
| 90.0              | 21.1                   | ±1.3               |

Incoming Results

1.2 Conversion Loss (IF = 729 MHz)

IF = 729 MHz, 6. Harmonic



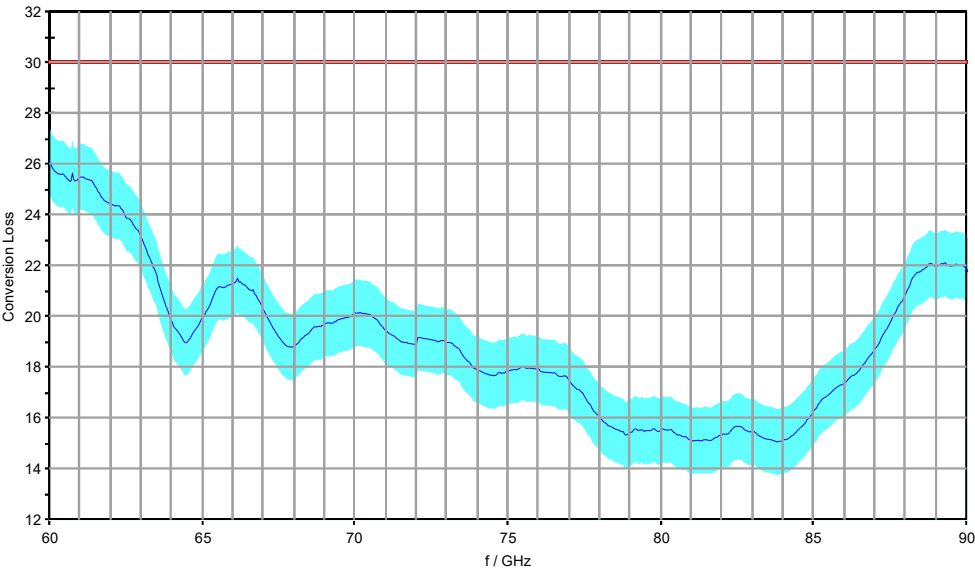
Conversion Loss (IF = 729 MHz)

| Frequency<br>/GHz | Conversion Loss<br>/dB | Uncertainty<br>/dB |
|-------------------|------------------------|--------------------|
| 60.0              | 26.2                   | ±1.3               |
| 61.0              | 22.5                   | ±1.3               |
| 62.0              | 21.1                   | ±1.3               |
| 63.0              | 20.1                   | ±1.3               |
| 64.0              | 17.4                   | ±1.3               |
| 65.0              | 18.4                   | ±1.3               |
| 66.0              | 20.3                   | ±1.3               |
| 67.0              | 19.0                   | ±1.3               |
| 68.0              | 18.1                   | ±1.3               |
| 69.0              | 19.1                   | ±1.3               |
| 70.0              | 19.3                   | ±1.3               |
| 71.0              | 18.7                   | ±1.3               |
| 72.0              | 18.2                   | ±1.3               |
| 73.0              | 18.2                   | ±1.3               |
| 74.0              | 17.3                   | ±1.3               |
| 75.0              | 17.3                   | ±1.3               |
| 76.0              | 17.0                   | ±1.3               |
| 77.0              | 16.0                   | ±1.3               |
| 78.0              | 14.8                   | ±1.3               |
| 79.0              | 14.5                   | ±1.3               |
| 80.0              | 14.4                   | ±1.3               |
| 81.0              | 14.0                   | ±1.3               |
| 82.0              | 14.3                   | ±1.3               |
| 83.0              | 14.3                   | ±1.3               |
| 84.0              | 14.5                   | ±1.3               |
| 85.0              | 15.6                   | ±1.3               |
| 86.0              | 16.5                   | ±1.3               |
| 87.0              | 17.7                   | ±1.3               |
| 88.0              | 20.0                   | ±1.3               |
| 89.0              | 21.0                   | ±1.3               |
| 90.0              | 21.1                   | ±1.3               |

Incoming Results

1.3 Conversion Loss (IF = 1330 MHz)

IF = 1330 MHz, 6. Harmonic



Conversion Loss (IF = 1330 MHz)

| Frequency /GHz | Conversion Loss /dB | Uncertainty /dB |
|----------------|---------------------|-----------------|
| 60.0           | 26.2                | ±1.3            |
| 61.0           | 25.5                | ±1.3            |
| 62.0           | 24.5                | ±1.3            |
| 63.0           | 23.2                | ±1.3            |
| 64.0           | 19.9                | ±1.3            |
| 65.0           | 19.9                | ±1.3            |
| 66.0           | 21.3                | ±1.3            |
| 67.0           | 20.3                | ±1.3            |
| 68.0           | 18.8                | ±1.3            |
| 69.0           | 19.7                | ±1.3            |
| 70.0           | 20.1                | ±1.3            |
| 71.0           | 19.5                | ±1.3            |
| 72.0           | 18.9                | ±1.3            |
| 73.0           | 19.0                | ±1.3            |
| 74.0           | 17.9                | ±1.3            |
| 75.0           | 17.9                | ±1.3            |
| 76.0           | 18.0                | ±1.3            |
| 77.0           | 17.5                | ±1.3            |
| 78.0           | 16.0                | ±1.3            |
| 79.0           | 15.5                | ±1.3            |
| 80.0           | 15.6                | ±1.3            |
| 81.0           | 15.1                | ±1.3            |
| 82.0           | 15.4                | ±1.3            |
| 83.0           | 15.5                | ±1.3            |
| 84.0           | 15.2                | ±1.3            |
| 85.0           | 16.3                | ±1.3            |
| 86.0           | 17.4                | ±1.3            |
| 87.0           | 18.8                | ±1.3            |
| 88.0           | 20.9                | ±1.3            |
| 89.0           | 22.0                | ±1.3            |
| 90.0           | 21.8                | ±1.3            |

1.4 Continuity response within 1 GHz

Continuity response within any 1 GHz Band, 6. Harmonic

|                         | DUL /dB | Continuity /dB |
|-------------------------|---------|----------------|
| max. at IF = 404.4 MHz: | 6.0     | 3.46           |
| max. at IF = 729 MHz:   | 6.0     | 3.75           |
| max. at IF = 1330 MHz:  | 6.0     | 3.34           |

Incoming Results



## Calibration Certificate

Kalibrierschein

Certificate Number 24-0140-101128-03

Zertifikatsnummer

### Unit Data

Item  
Gegenstand  
**Harmonic Mixer, 90 GHz to 140 GHz**

Manufacturer  
Hersteller  
**RPG Radiometer physics GmbH**

Type  
Typ  
**RPG FS-Z140**

Material Number  
Materialnummer  
**3622.0708.02**

Serial Number  
Seriennummer  
**101128**

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  
**Sporton International Inc.  
6F., Sec. 1, Hsin Tai Wu Rd 106  
Xizhi Dist.  
221 New Taipei City  
Taiwan**

Order Number  
Bestellnummer  
**8800047909**

Date of Receipt  
Eingangsdatum  
**2023-10-27**

### Performance

Place and Date of Calibration  
Ort und Datum der Kalibrierung

**Meckenheim, 2023-11-03**

Scope of Calibration  
Umfang der Kalibrierung

**Standard Calibration**

Statement of Compliance  
(Incoming)  
Konformitätsaussage  
(Anlieferung)

**All measured values are within the data sheet specifications.**

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  
4 pages Outgoing Results  
3 pages Incoming Results**

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

**RPG Radiometer physics GmbH; Meckenheim**

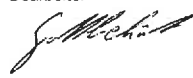
Date of Issue  
Ausstellungsdatum

**2023-11-06**

Head of Laboratory  
Laborleitung

  
**Emons**

Person Responsible  
Bearbeiter

  
**Gottbehüt**

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

Calibration Method  
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity 20 % - 80 %  
Relative LuftfeuchteAmbient Temperature  
Umgebungstemperatur(23 <sup>+7</sup><sub>-3</sub>) °CWorking 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® ZVA40   | 100103                        | 0001A300715526                                          | 2026-10-04              |
| Powersensor             | R&S® NRP-Z55 | 140093                        | 0001-300700427                                          | 2025-06-06              |

**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

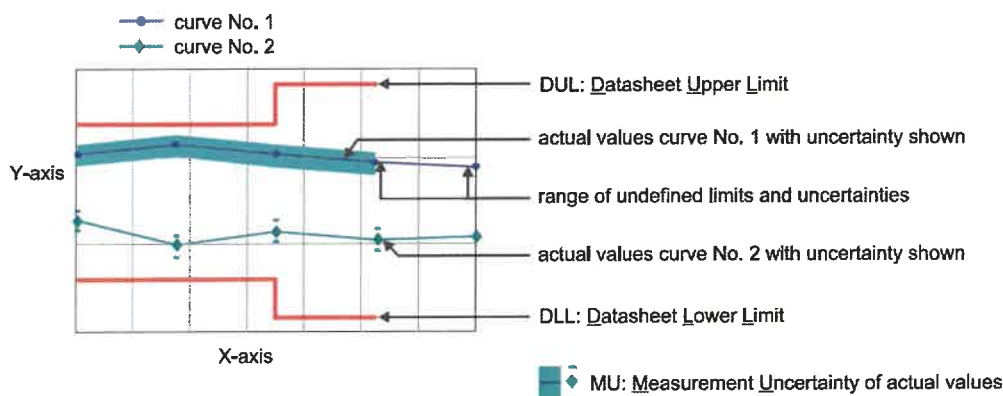
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

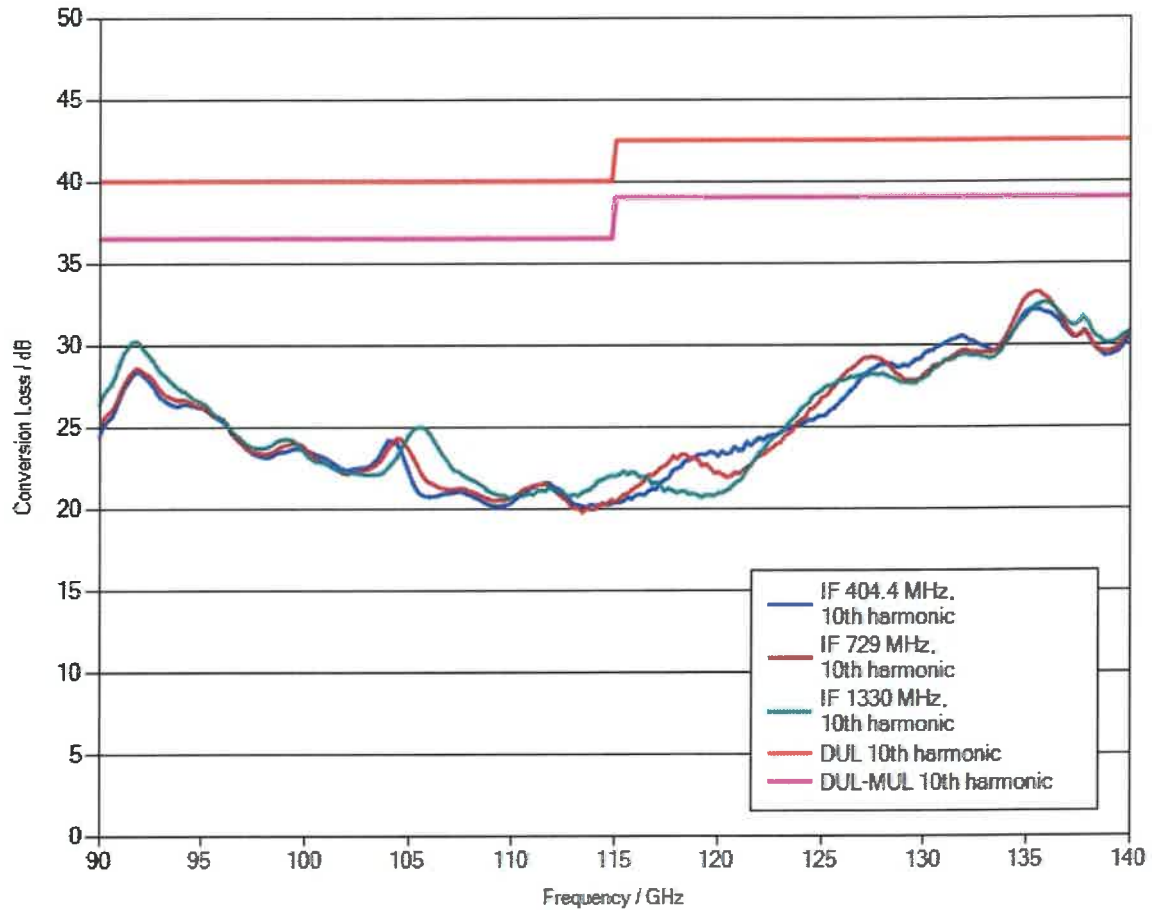


**Software used for measurement****Item Type**Measurement Studio Professional Edition  
MixerCertification**Version**2013  
7\_15**Remark**

## 1.1 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.**

## 1.2 Frequency response within 1 GHz

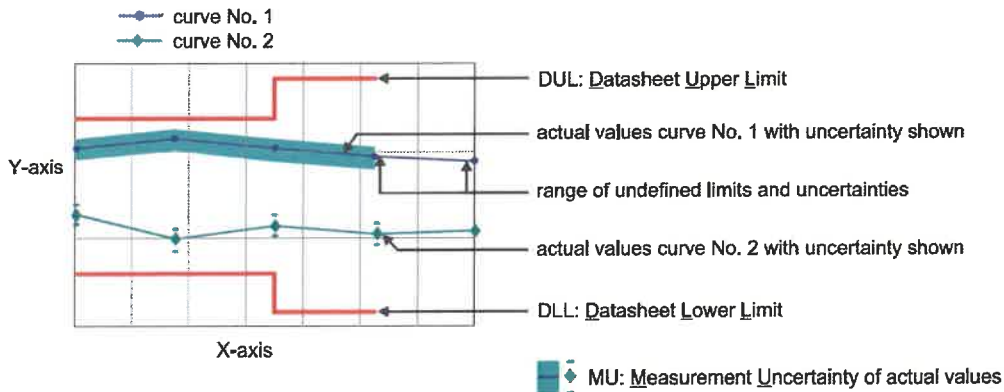
|                                  | DUL  | Actual<br>(worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>10th harmonic | 6 dB | 2.49 dB                | PASS       |
| IF = 729 MHz,<br>10th harmonic   | 6 dB | 2.09 dB                | PASS       |
| IF = 1330 MHz,<br>10th harmonic  | 6 dB | 2.24 dB                | PASS       |

# 1 Incoming Results

The following abbreviations may be used in this document

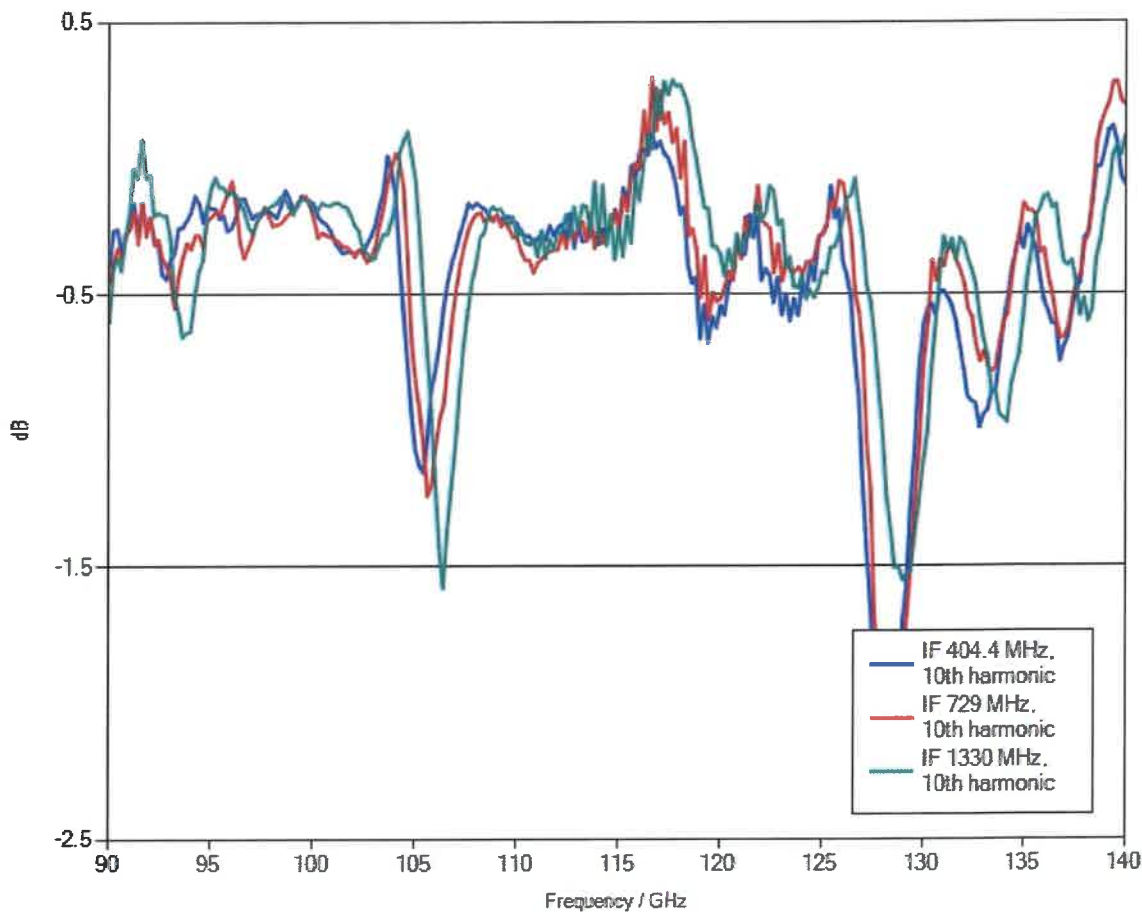
|            |                                                                                                                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| {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                               | Version | Remark |
| Measurement Studio Professional Edition | 2013    |        |
| MixerCertification                      | 7_15    |        |

1.1 Deviation between actual and previous conversion loss



Incoming Report



## Calibration Certificate

Kalibrierschein

Certificate Number **24-0220-101014-03**

Zertifikatsnummer

### Unit Data

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

Manufacturer  
Hersteller **RPG Radiometer physics GmbH**

Type  
Typ **RPG FS-Z220**

Material Number  
Materialnummer **3593.3250.02**      Serial Number  
Seriennummer **101014**

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 **Sporton International Inc.  
6F., Sec. 1, Hsin Tai Wu Rd 106  
Xizhi Dist.  
221 New Taipei City  
Taiwan**

Order Number  
Bestellnummer **8800047911**

Date of Receipt  
Eingangsdatum **2023-10-27**

Dieser Kalibrierschein dokumentiert, dass der genannte Gegenstand nach festgelegten Vorgaben geprüft und gemessen wurde. Die Messwerte liegen 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, 2023-11-06**

Scope of Calibration  
Umfang der Kalibrierung

**Standard Calibration**

Statement of Compliance  
(Incoming)  
Konformitätsaussage  
(Anlieferung)

**All measured values are within the data sheet specifications.**

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  
4 pages Outgoing Results  
3 pages Incoming Results**

### RPG Radiometer physics GmbH; Meckenheim

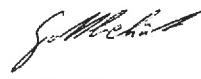
Date of Issue  
Ausstellungsdatum

**2023-11-06**

Head of Laboratory  
Laborleitung

  
**Emons**

Person Responsible  
Bearbeiter

  
**Gottbehüt**

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

Calibration Method  
Kalibrieranweisung

RPG-PAQA-TN-2014-002

Relative Humidity 20 % - 80 %  
Relative LuftfeuchteAmbient Temperature  
Umgebungstemperatur(23 <sup>+7</sup><sub>-3</sub>) °CWorking 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® ZVA40   | 100103                        | 0001A300715526                                          | 2026-10-04              |
| Powersensor             | R&S® NRP-Z55 | 140093                        | 0001-300700427                                          | 2025-06-06              |

**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

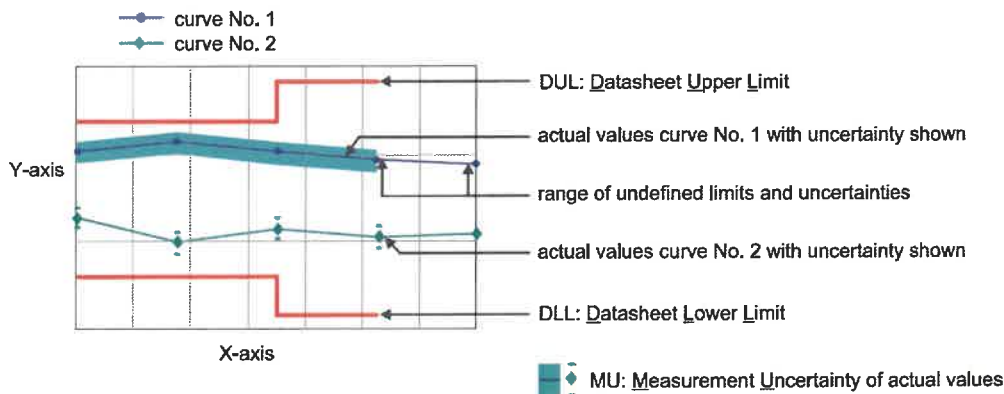
If the new product is stored under the climate conditions as specified in the data sheet upon delivery, the product's accuracy is not significantly affected within 12 month after its calibration in our factory. In this case, the recommended calibration interval starts on the date when the product is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

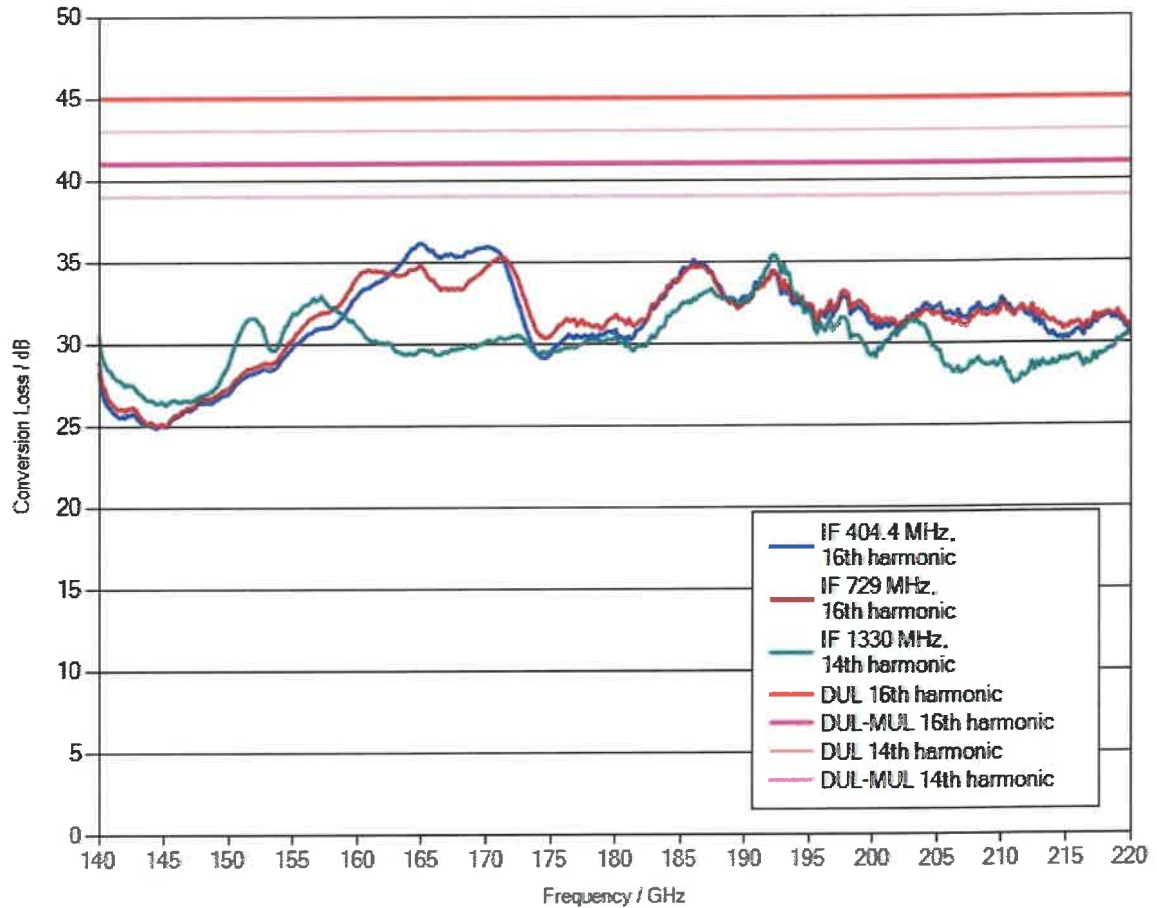


**Software used for measurement****Item Type**Measurement Studio Professional Edition  
MixerCertification**Version**2013  
7\_15**Remark**

## 1.1 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.

## 1.2 Frequency response within 1 GHz

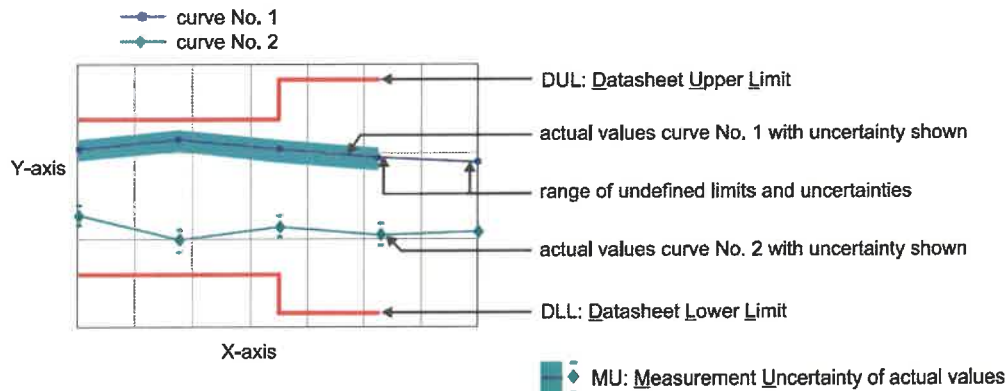
|                                  | DUL  | Actual<br>(worst case) | Evaluation |
|----------------------------------|------|------------------------|------------|
| IF = 404.4 MHz,<br>16th harmonic | 6 dB | 2.61 dB                | PASS       |
| IF = 729 MHz,<br>16th harmonic   | 6 dB | 2.54 dB                | PASS       |
| IF = 1330 MHz,<br>14th harmonic  | 6 dB | 2.39 dB                | PASS       |

# 1 Incoming 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



Material Number 3593.3250.02

Serial Number 101014

Certificate Number 24-0220-101014-03

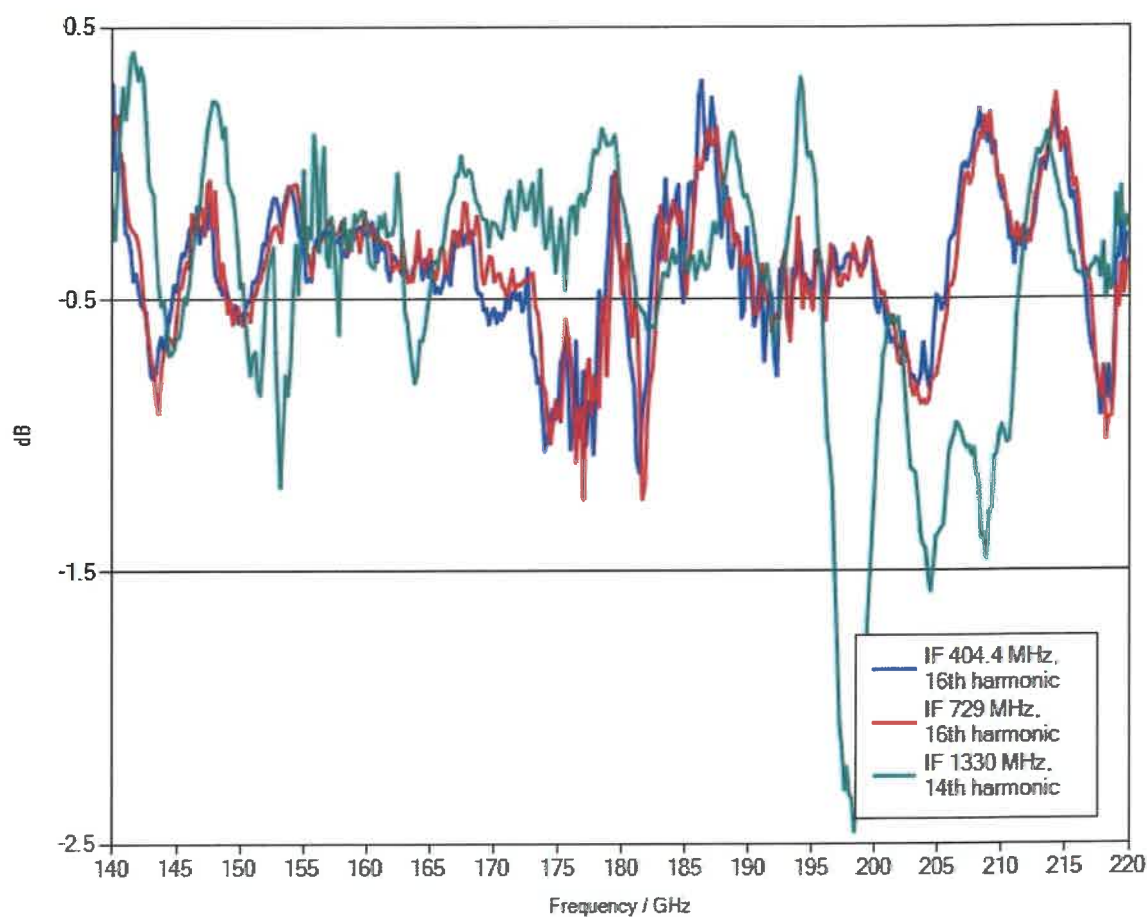
(Incoming)

Software used for measurement

| Item Type                               | Version | Remark |
|-----------------------------------------|---------|--------|
| Measurement Studio Professional Edition | 2013    |        |
| MixerCertification                      | 7_15    |        |

Incoming Report

## 1.1 Deviation between actual and previous conversion loss



Incoming Report

- Certificate No : IC-2024-057639  
- Calibration No : C-2024-067808

page : 1 of 5

**1. Client**

- Name : SPORTON INTERNATIONAL INC.  
- Address : No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd., Guishan Dist., Taoyuan City 333, Taiwan, R.O.C.

**2. Calibration Subject**

◇Registration No : 527313

- Description : ANTENNA  
- Manufacturer and Model Name : QUINSTAR / QWH-UPRR00  
- Serial Number : 1410300003

**3. Date of Calibration**

: 2024.06.27

**4. Environment**

- Temperature : ( 22.7 ± 0.1 ) °C - Humidity : ( 48 ± 2 ) % R.H.  
- Location : Permanent Calibration Lab  
(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea)

**5. Traceability****Calibration method and/or brief description**

This certifies that the equipment has been calibrated using applicable HCT procedure(HCT-CS-264-40707), (HCT-CS-264-40707), in compliance with ISO/IEC 17025. Measurement are traceable to the International System of Unit (SI) via national metrology institutes.

**List of used standards/specifications**

| Description                        | Manufacturer / Model Name     | Serial Number | The due date of next Calibration | Calibration laboratory |
|------------------------------------|-------------------------------|---------------|----------------------------------|------------------------|
| PNA SERIES NETWORK ANALYZER        | AGILENT/E8363B                | MY43030182    | 2025/06/18                       | HCT CO., LTD.          |
| NETWORK ANALYZER                   | AGILENT/N5230C                | MY49001853    | 2024/09/27                       | HCT CO., LTD.          |
| TRANSMISSION/REFLECTION MODULE SET | OML/V15VNA2-T/R               | 200722-1      | 2024/10/18                       | HCT CO., LTD.          |
| CALIBRATION KIT(2.4 mm)            | KEYSIGHT/85056D               | MY53400508    | 2025/02/28                       | KRISS                  |
| CALIBRATION KIT                    | Keysight Technologies/V11644A | MY46042094    | 2024/10/06                       | Keysight Technologies  |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |

**6. Calibration result**

: Refer to attachment

**7. Measurement uncertainty**

: Refer to attachment

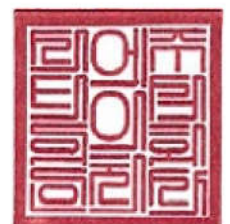
(Confidence level about 95 %, k = 2 )

|             |                              |             |                                                        |             |
|-------------|------------------------------|-------------|--------------------------------------------------------|-------------|
| affirmation | Measurements performed by    | (signature) | Approved by                                            | (signature) |
|             | Name : <b>Minhyeong Shin</b> |             | Title Technical Cal. Manager<br>Name <b>Jaesang So</b> |             |

The above calibration certificate is the accredited calibration items by Korea Laboratory Accreditation Scheme, which signed the ILAC-MRA.

**2024. 06. 27**

Accredited by KOLAS, Republic of KOREA

**HCT Co., Ltd.**

(NOTE) If any significant instability or other adverse factor(overload, temperature, humidity etc.) manifests itself before, during or after calibration, and is likely to affect the validity of the calibration.

# Calibration Results



Certificate No : IC-2024-057639

Calibration No : C-2024-067808

page : 2 of 5

## 1. Antenna Factor & Gain

| Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) | Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) | Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) |
|--------------------|-----------------|---------------|--------------------|-----------------|---------------|--------------------|-----------------|---------------|
| 40.00              | 39.9            | 22.4          | 43.70              | 40.4            | 22.6          | 47.40              | 41.0            | 22.8          |
| 40.10              | 39.9            | 22.3          | 43.80              | 40.4            | 22.6          | 47.50              | 41.0            | 22.8          |
| 40.20              | 40.0            | 22.3          | 43.90              | 40.5            | 22.6          | 47.60              | 41.0            | 22.8          |
| 40.30              | 40.0            | 22.3          | 44.00              | 40.5            | 22.6          | 47.70              | 41.1            | 22.7          |
| 40.40              | 40.1            | 22.3          | 44.10              | 40.6            | 22.5          | 47.80              | 41.1            | 22.7          |
| 40.50              | 40.1            | 22.3          | 44.20              | 40.7            | 22.5          | 47.90              | 41.1            | 22.7          |
| 40.60              | 40.1            | 22.3          | 44.30              | 40.7            | 22.4          | 48.00              | 41.2            | 22.7          |
| 40.70              | 40.1            | 22.3          | 44.40              | 40.8            | 22.4          | 48.10              | 41.2            | 22.7          |
| 40.80              | 40.1            | 22.3          | 44.50              | 40.8            | 22.4          | 48.20              | 41.2            | 22.7          |
| 40.90              | 40.1            | 22.3          | 44.60              | 40.8            | 22.4          | 48.30              | 41.2            | 22.7          |
| 41.00              | 40.1            | 22.4          | 44.70              | 40.8            | 22.4          | 48.40              | 41.2            | 22.7          |
| 41.10              | 40.1            | 22.4          | 44.80              | 40.8            | 22.4          | 48.50              | 41.2            | 22.8          |
| 41.20              | 40.1            | 22.4          | 44.90              | 40.8            | 22.5          | 48.60              | 41.1            | 22.8          |
| 41.30              | 40.1            | 22.4          | 45.00              | 40.7            | 22.6          | 48.70              | 41.1            | 22.9          |
| 41.40              | 40.1            | 22.4          | 45.10              | 40.7            | 22.6          | 48.80              | 41.1            | 22.9          |
| 41.50              | 40.2            | 22.4          | 45.20              | 40.7            | 22.7          | 48.90              | 41.1            | 22.9          |
| 41.60              | 40.2            | 22.4          | 45.30              | 40.6            | 22.7          | 49.00              | 41.1            | 22.9          |
| 41.70              | 40.2            | 22.4          | 45.40              | 40.6            | 22.7          | 49.10              | 41.1            | 22.9          |
| 41.80              | 40.2            | 22.4          | 45.50              | 40.7            | 22.7          | 49.20              | 41.2            | 22.9          |
| 41.90              | 40.2            | 22.4          | 45.60              | 40.7            | 22.7          | 49.30              | 41.2            | 22.9          |
| 42.00              | 40.2            | 22.4          | 45.70              | 40.7            | 22.7          | 49.40              | 41.3            | 22.8          |
| 42.10              | 40.2            | 22.5          | 45.80              | 40.8            | 22.6          | 49.50              | 41.3            | 22.8          |
| 42.20              | 40.3            | 22.5          | 45.90              | 40.9            | 22.6          | 49.60              | 41.4            | 22.7          |
| 42.30              | 40.3            | 22.5          | 46.00              | 41.0            | 22.5          | 49.70              | 41.4            | 22.7          |
| 42.40              | 40.3            | 22.5          | 46.10              | 41.0            | 22.5          | 49.80              | 41.5            | 22.7          |
| 42.50              | 40.3            | 22.5          | 46.20              | 41.1            | 22.5          | 49.90              | 41.5            | 22.7          |
| 42.60              | 40.4            | 22.4          | 46.30              | 41.1            | 22.4          | 50.00              | 41.5            | 22.8          |
| 42.70              | 40.4            | 22.4          | 46.40              | 41.1            | 22.5          | 50.10              | 41.4            | 22.8          |
| 42.80              | 40.5            | 22.4          | 46.50              | 41.1            | 22.5          | 50.20              | 41.4            | 22.8          |
| 42.90              | 40.5            | 22.4          | 46.60              | 41.0            | 22.5          | 50.30              | 41.4            | 22.8          |
| 43.00              | 40.5            | 22.4          | 46.70              | 41.0            | 22.6          | 50.40              | 41.4            | 22.9          |
| 43.10              | 40.5            | 22.4          | 46.80              | 41.0            | 22.7          | 50.50              | 41.4            | 22.9          |
| 43.20              | 40.5            | 22.4          | 46.90              | 40.9            | 22.7          | 50.60              | 41.4            | 22.9          |
| 43.30              | 40.5            | 22.4          | 47.00              | 40.9            | 22.8          | 50.70              | 41.4            | 22.9          |
| 43.40              | 40.5            | 22.5          | 47.10              | 40.9            | 22.8          | 50.80              | 41.4            | 22.9          |
| 43.50              | 40.5            | 22.5          | 47.20              | 40.9            | 22.8          | 50.90              | 41.4            | 22.9          |
| 43.60              | 40.4            | 22.6          | 47.30              | 40.9            | 22.8          | 51.00              | 41.5            | 22.9          |

# Calibration Results



Certificate No : IC-2024-057639

Calibration No : C-2024-067808

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## 1. Antenna Factor & Gain (cont.)

| Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) | Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) | Frequency<br>(GHz) | AF<br>[dB(1/m)] | Gain<br>(dBi) |
|--------------------|-----------------|---------------|--------------------|-----------------|---------------|--------------------|-----------------|---------------|
| 51.10              | 41.5            | 22.9          | 54.10              | 41.9            | 22.9          | 57.10              | 42.6            | 22.7          |
| 51.20              | 41.6            | 22.8          | 54.20              | 41.9            | 23.0          | 57.20              | 42.6            | 22.7          |
| 51.30              | 41.6            | 22.8          | 54.30              | 41.9            | 23.0          | 57.30              | 42.6            | 22.8          |
| 51.40              | 41.7            | 22.8          | 54.40              | 41.9            | 23.0          | 57.40              | 42.6            | 22.8          |
| 51.50              | 41.7            | 22.7          | 54.50              | 42.0            | 23.0          | 57.50              | 42.6            | 22.8          |
| 51.60              | 41.8            | 22.7          | 54.60              | 42.0            | 22.9          | 57.60              | 42.6            | 22.9          |
| 51.70              | 41.8            | 22.7          | 54.70              | 42.1            | 22.9          | 57.70              | 42.6            | 22.9          |
| 51.80              | 41.8            | 22.7          | 54.80              | 42.2            | 22.8          | 57.80              | 42.6            | 22.9          |
| 51.90              | 41.8            | 22.8          | 54.90              | 42.2            | 22.8          | 57.90              | 42.6            | 22.9          |
| 52.00              | 41.7            | 22.8          | 55.00              | 42.3            | 22.7          | 58.00              | 42.6            | 22.9          |
| 52.10              | 41.7            | 22.8          | 55.10              | 42.3            | 22.7          | 58.10              | 42.6            | 22.9          |
| 52.20              | 41.7            | 22.9          | 55.20              | 42.4            | 22.7          | 58.20              | 42.7            | 22.9          |
| 52.30              | 41.7            | 22.9          | 55.30              | 42.4            | 22.7          | 58.30              | 42.7            | 22.8          |
| 52.40              | 41.7            | 22.9          | 55.40              | 42.4            | 22.7          | 58.40              | 42.8            | 22.8          |
| 52.50              | 41.7            | 22.9          | 55.50              | 42.4            | 22.8          | 58.50              | 42.8            | 22.7          |
| 52.60              | 41.7            | 22.9          | 55.60              | 42.3            | 22.8          | 58.60              | 42.9            | 22.7          |
| 52.70              | 41.7            | 22.9          | 55.70              | 42.3            | 22.8          | 58.70              | 42.9            | 22.7          |
| 52.80              | 41.8            | 22.9          | 55.80              | 42.3            | 22.8          | 58.80              | 43.0            | 22.6          |
| 52.90              | 41.8            | 22.9          | 55.90              | 42.3            | 22.8          | 58.90              | 43.0            | 22.6          |
| 53.00              | 41.8            | 22.9          | 56.00              | 42.3            | 22.9          | 59.00              | 43.0            | 22.6          |
| 53.10              | 41.9            | 22.8          | 56.10              | 42.3            | 22.9          | 59.10              | 43.0            | 22.7          |
| 53.20              | 42.0            | 22.8          | 56.20              | 42.3            | 22.9          | 59.20              | 42.9            | 22.7          |
| 53.30              | 42.0            | 22.7          | 56.30              | 42.4            | 22.9          | 59.30              | 42.9            | 22.8          |
| 53.40              | 42.1            | 22.7          | 56.40              | 42.4            | 22.9          | 59.40              | 42.8            | 22.9          |
| 53.50              | 42.1            | 22.7          | 56.50              | 42.4            | 22.9          | 59.50              | 42.7            | 23.0          |
| 53.60              | 42.2            | 22.7          | 56.60              | 42.5            | 22.8          | 59.60              | 42.7            | 23.1          |
| 53.70              | 42.1            | 22.7          | 56.70              | 42.5            | 22.8          | 59.70              | 42.6            | 23.1          |
| 53.80              | 42.1            | 22.7          | 56.80              | 42.6            | 22.8          | 59.80              | 42.6            | 23.1          |
| 53.90              | 42.1            | 22.8          | 56.90              | 42.6            | 22.7          | 59.90              | 42.6            | 23.2          |
| 54.00              | 42.0            | 22.9          | 57.00              | 42.6            | 22.7          | 60.00              | 42.6            | 23.2          |

※ The measurement uncertainty of this result is 1.2 dB (Confidence level about 95 %,  $k = 2$ )

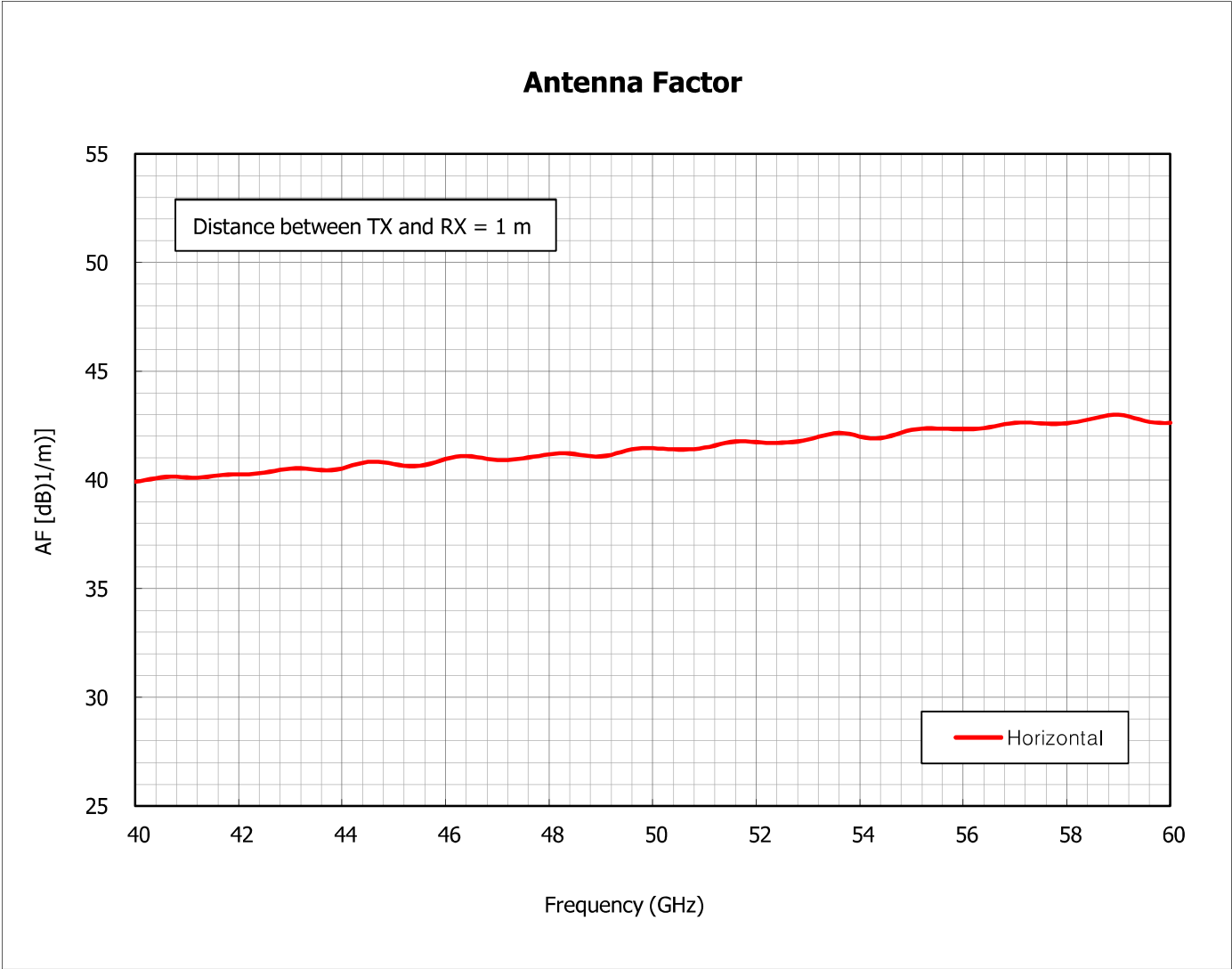
# Calibration Results



Certificate No : IC-2024-057639  
Calibration No : C-2024-067808

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## 2. Antenna Factor Curve



# Calibration Results

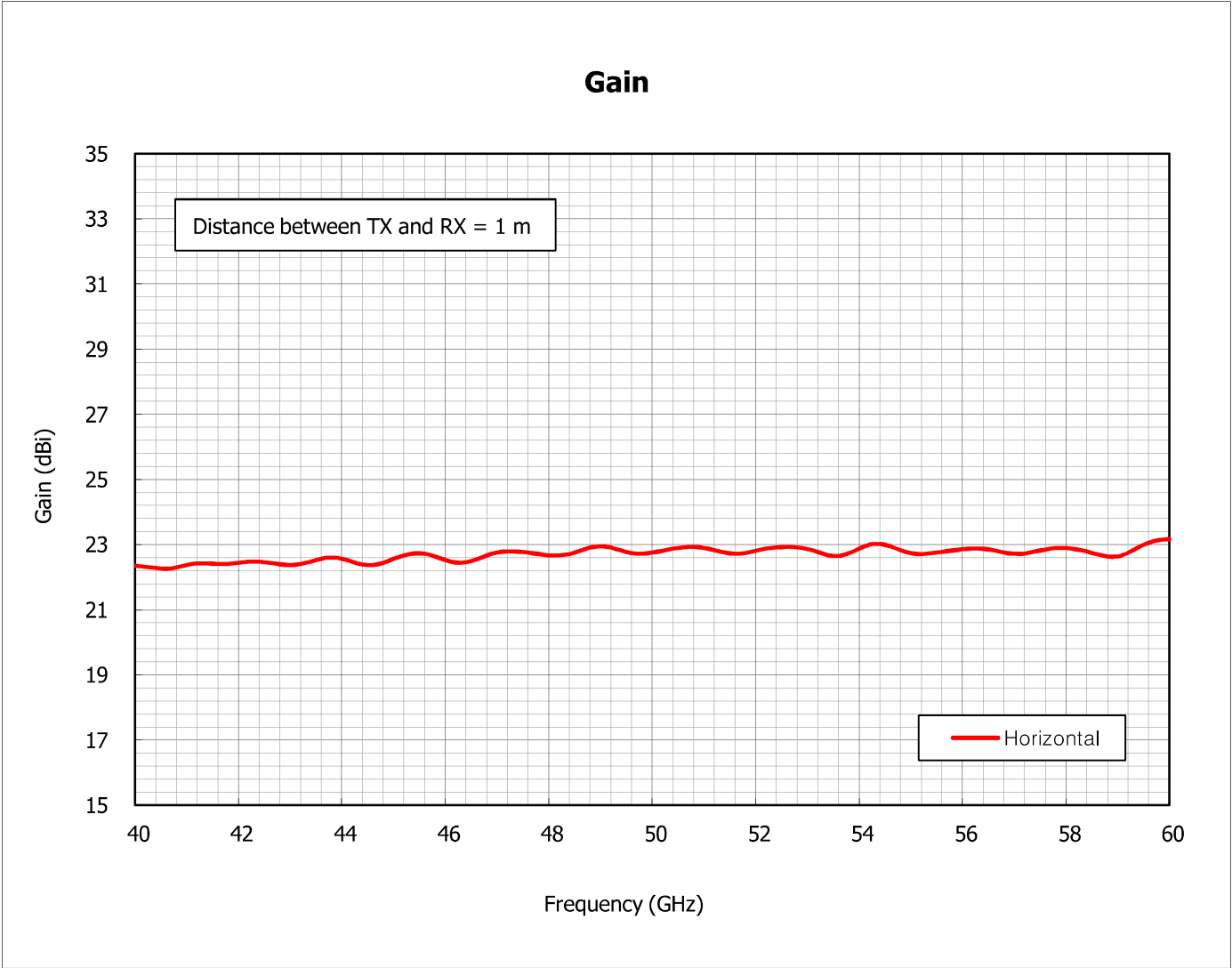


Certificate No : IC-2024-057639

Calibration No : C-2024-067808

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### 3. Gain Curve



END.

- Certificate No : IC-2024-057635  
- Calibration No : C-2024-067804

page : 1 of 6

**1. Client**

- Name : SPORTON INTERNATIONAL INC.  
- Address : No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd., Guishan Dist., Taoyuan City 333, Taiwan, R.O.C.

**2. Calibration Subject**

◇Registration No : 527309

- Description : ANTENNA  
- Manufacturer and Model Name : QUINSTAR / QWH-EPRR00  
- Serial Number : 1372000000

**3. Date of Calibration**

: 2024.06.27

**4. Environment**

- Temperature : ( 22.6  $\pm$  0.1 ) °C - Humidity : ( 46  $\pm$  2 ) % R.H.  
- Location : Permanent Calibration Lab  
(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea)

**5. Traceability****Calibration method and/or brief description**

This certifies that the equipment has been calibrated using applicable HCT procedure(HCT-CS-264-40707), (HCT-CS-264-40707), in compliance with ISO/IEC 17025. Measurement are traceable to the International System of Unit (SI) via national metrology institutes.

**List of used standards/specifications**

| Description                        | Manufacturer / Model Name     | Serial Number | The due date of next Calibration | Calibration laboratory |
|------------------------------------|-------------------------------|---------------|----------------------------------|------------------------|
| PNA SERIES NETWORK ANALYZER        | AGILENT/E8363B                | MY43030182    | 2025/06/18                       | HCT CO., LTD.          |
| TRANSMISSION/REFLECTION MODULE SET | OML/V15VNA2-T/R               | 200722-1      | 2024/10/18                       | HCT CO., LTD.          |
| TRANSMISSION/REFLECTION MODULE SET | OML/V10VNA2-T/R               | 200722-1      | 2024/10/18                       | HCT CO., LTD.          |
| CALIBRATION KIT                    | Keysight Technologies/V11644A | MY46042094    | 2024/10/06                       | Keysight Technologies  |
| CALIBRATION KIT                    | Keysight Technologies/W11644A | MY46042118    | 2024/10/08                       | Keysight Technologies  |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |
|                                    |                               |               |                                  |                        |

**6. Calibration result**

: Refer to attachment

**7. Measurement uncertainty**

: Refer to attachment

(Confidence level about 95 %,  $k = 2$ )

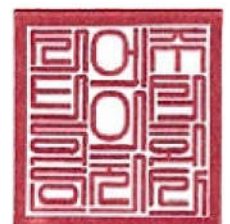
|             |                           |             |                                                 |             |
|-------------|---------------------------|-------------|-------------------------------------------------|-------------|
| affirmation | Measurements performed by | (signature) | Approved by                                     | (signature) |
|             | Name : Minhyeong Shin     |             | Title Technical Cal. Manager<br>Name Jaesang So |             |

The above calibration certificate is the accredited calibration items by Korea Laboratory Accreditation Scheme, which signed the ILAC-MRA.

2024. 06. 27

Accredited by KOLAS, Republic of KOREA

HCT Co., Ltd.



(NOTE) If any significant instability or other adverse factor(overload, temperature, humidity etc.) manifests itself before, during or after calibration, and is likely to affect the validity of the calibration.