## 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference waveguides used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

## 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 5000-6000 MHz REFERENCE WAVEGUIDE |
| Manufacturer | MVG |
| Model | SWG5500 |
| Serial Number | SN 13/14 WGA 33 |
| Product Condition (new / used) | Used |

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Waveguides are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards.

## 4 MEASUREMENT METHOD

### 4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

### 4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -8 dB or better. The S11 measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.



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### 4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

## 5 MEASUREMENT UNCERTAINTY

### 5.1 MECHANICAL DIMENSIONS

The estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/- 0.20 mm with respect to measurement conditions.

### 5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

### 5.3 SAR

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

## 6 CALIBRATION RESULTS

### 6.1 MECHANICAL DIMENSIONS

| Frequency (MHz) | L (mm) | | W (mm) | | $L_f$ (mm) | | $W_f$ (mm) | |
|---|---|---|---|---|---|---|---|---|
| | Required | Measured | Required | Measured | Required | Measured | Required | Measured |
| 5800 | 40.39 ± 0.13 | - | 20.19 ± 0.13 | - | 81.03 ± 0.13 | - | 61.98 ± 0.13 | - |

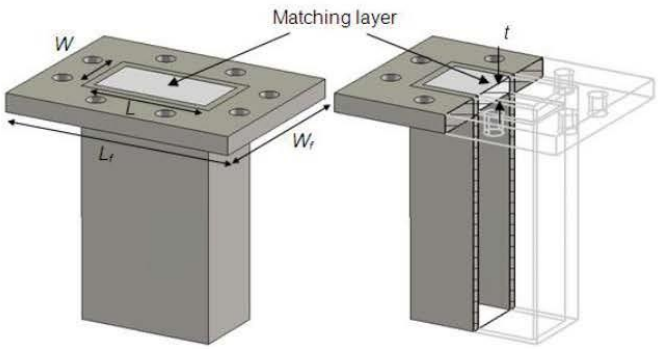


**Figure 1: Validation Waveguide Dimensions**



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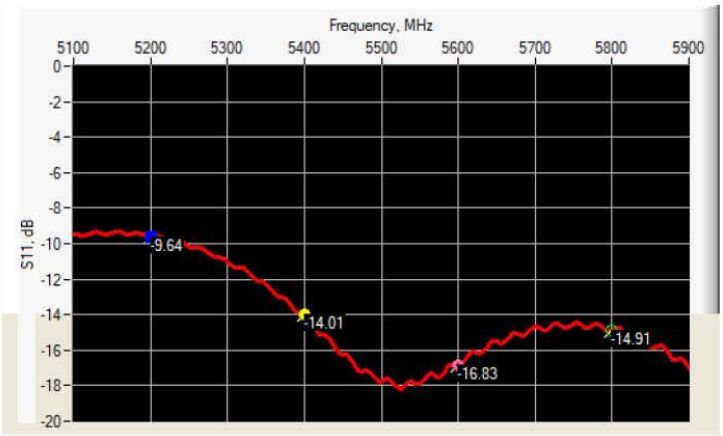
## 6.2 S11 PARAMETER

### 6.2.1 S11 parameter In Head Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 5200 | -9.64 | -8 | 25.80 Ω - 6.58 jΩ |
| 5400 | -14.01 | -8 | 51.53 Ω + 20.60 jΩ |
| 5600 | -16.83 | -8 | 44.12 Ω - 12.35 jΩ |
| 5800 | -14.91 | -8 | 38.53 Ω + 11.21 jΩ |

## 6.3 SAR

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference waveguide meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed with the matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell.

### 6.3.1 SAR With Head Liquid

At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by MVG, within the uncertainty for the system validation. All SAR values are normalized to 1 W net power. In bracket, the measured SAR is given with the used input power.



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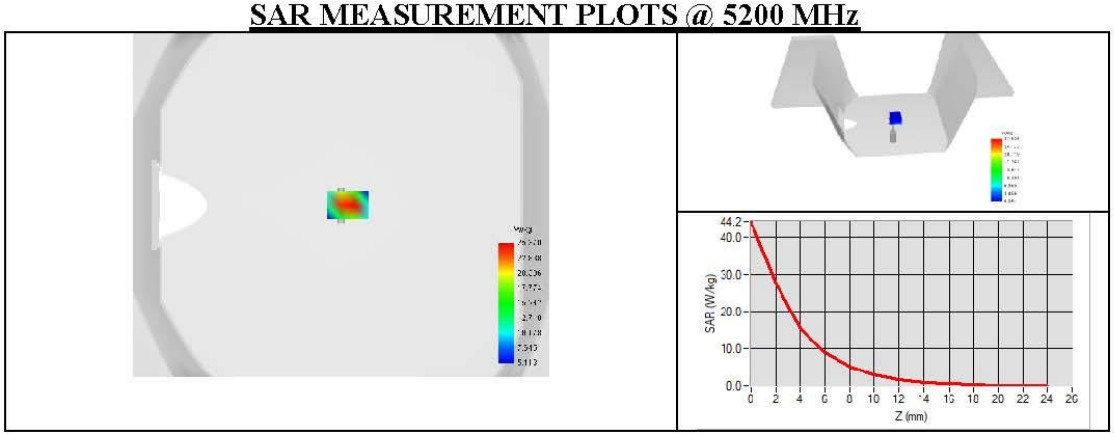
SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref : ACR.53.31.24.BES.A

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 3523-EPGO-429 |
| Liquid | Head Liquid Values 5200 MHz: eps' :34.16 sigma : 4.42<br>Head Liquid Values 5400 MHz: eps' :33.63 sigma : 4.64<br>Head Liquid Values 5600 MHz: eps' :33.12 sigma : 4.87<br>Head Liquid Values 5800 MHz: eps' :32.57 sigma : 5.12 |
| Distance between dipole waveguide and liquid | 0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=4mm/dy=4m/dz=2mm |
| Frequency | 5200 MHz<br>5400 MHz<br>5600 MHz<br>5800 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| Frequency (MHz) | 1 g SAR (W/kg) | | | 10 g SAR (W/kg) | | |
|---|---|---|---|---|---|---|
| | Measured | Measured normalized to 1W | Target normalized to 1W | Measured | Measured normalized to 1W | Target normalized to 1W |
| 5200 | 16.26 | 162.59 | 159.00 | 5.62 | 56.21 | 56.90 |
| 5400 | 15.98 | 159.81 | 166.40 | 5.50 | 55.00 | 58.43 |
| 5600 | 17.91 | 179.15 | 173.80 | 6.10 | 61.01 | 59.97 |
| 5800 | 18.22 | 182.20 | 181.20 | 6.13 | 61.32 | 61.50 |

## SAR MEASUREMENT PLOTS @ 5200 MHz



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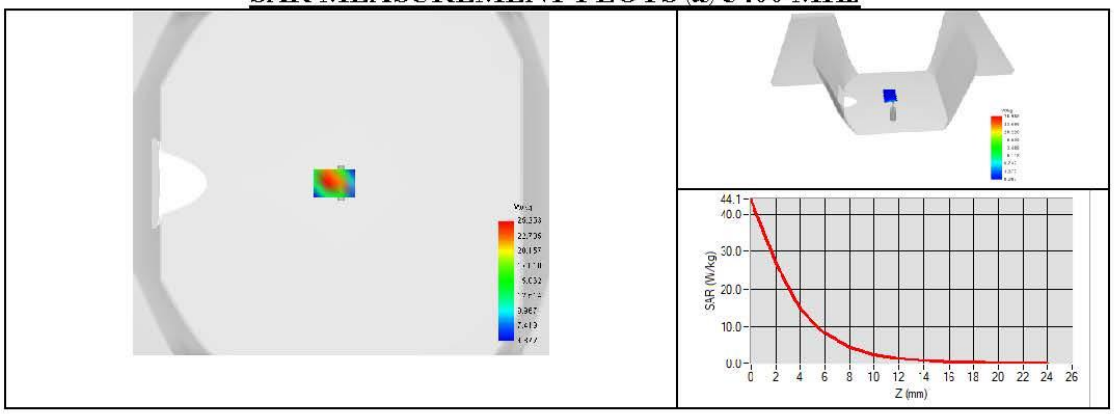
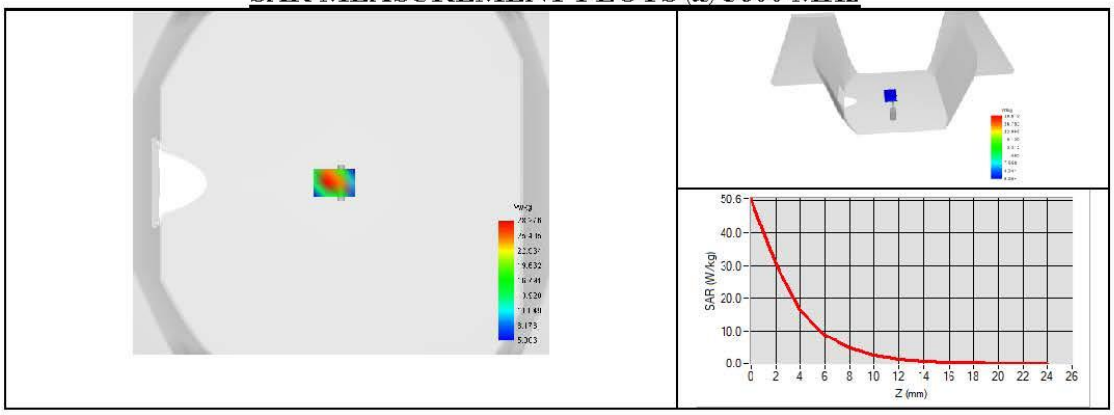
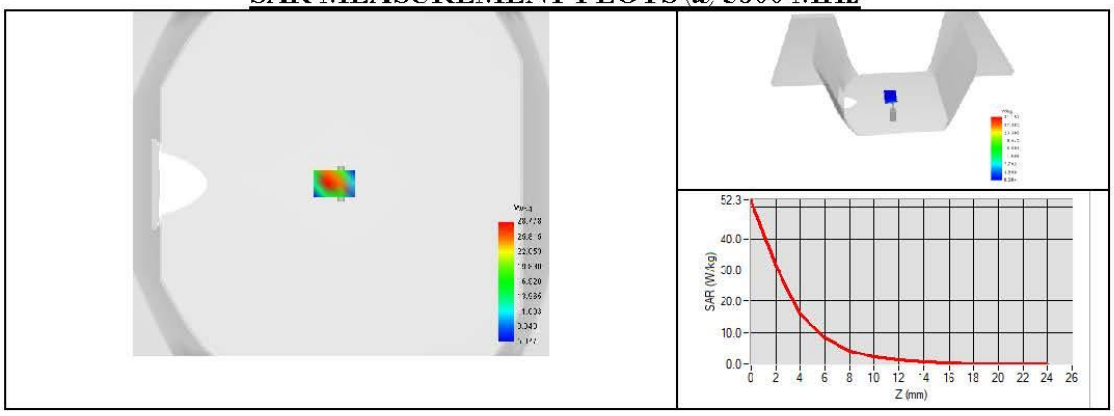
## SAR MEASUREMENT PLOTS @ 5400 MHz




## SAR MEASUREMENT PLOTS @ 5600 MHz




## SAR MEASUREMENT PLOTS @ 5800 MHz



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## 7 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| SAM Phantom | MVG | SN 13/09 SAM68 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2021 | 08/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 3623-EPGO-431 | 11/2023 | 11/2024 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 03/2022 | 03/2025 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2021 | 06/2024 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2022 | 10/2025 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |



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**<Justification of the extended calibration>**

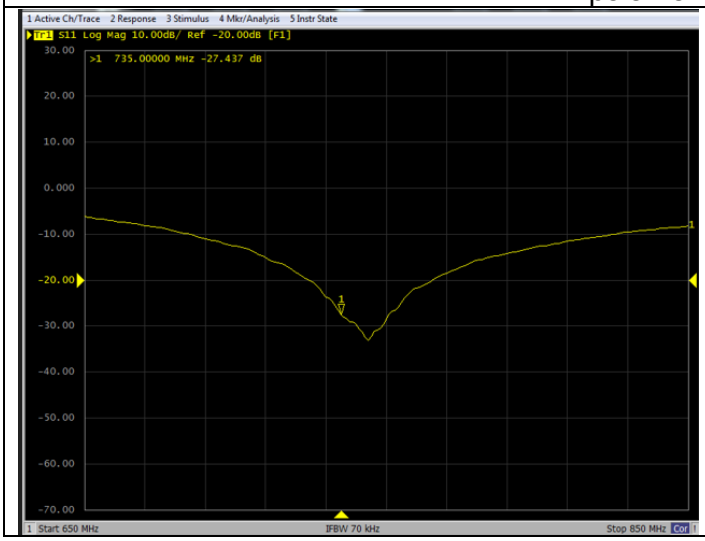
If dipoles are verified in return loss (<-20dB, within 20% of prior calibration for below 3GHz, and <-8dB, within 20% of prior calibration for 5GHz to 6GHz), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

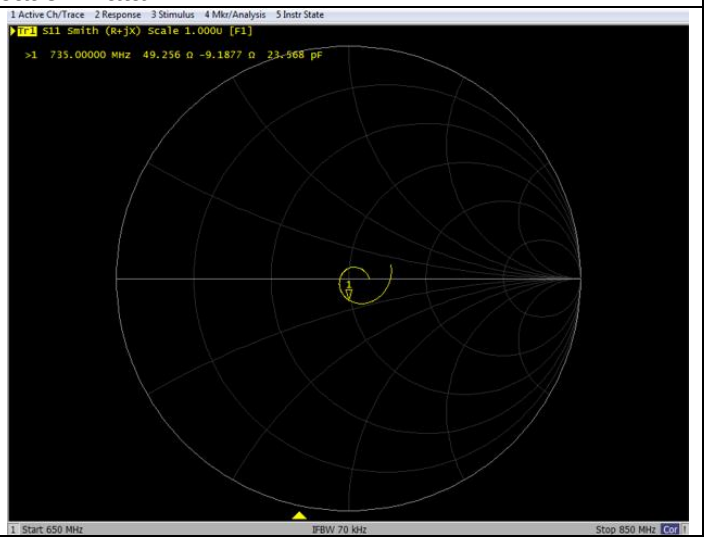
**<Head 750MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -29.875 | - | 52.798 | - | Feb. 13, 2025 |
| -27.437 | 8.16 | 49.256 | 3.542 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



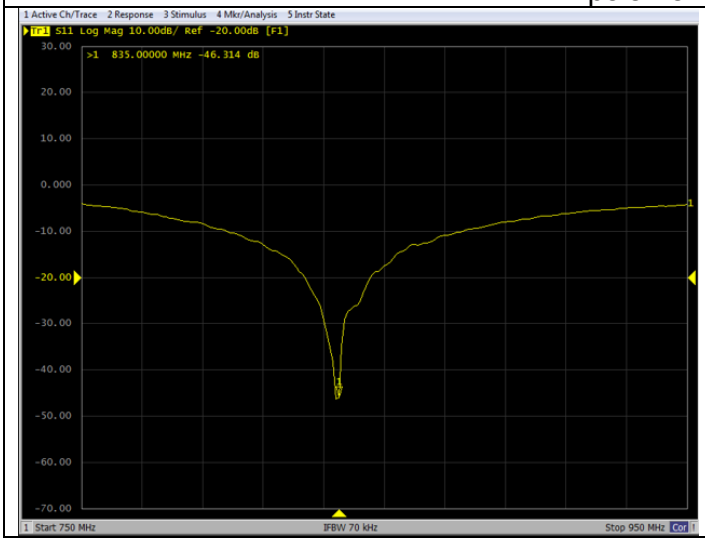



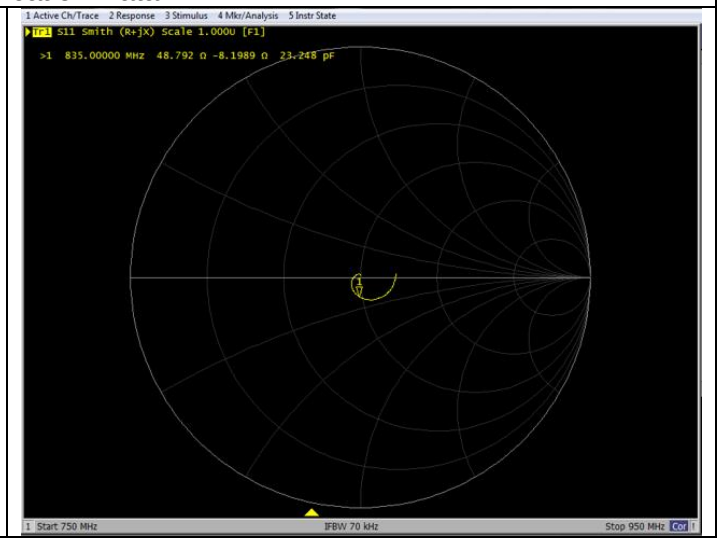
**<Head 835MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -46.216 | - | 51.571 | - | Feb. 13, 2025 |
| -46.314 | 0.212 | 48.792 | 2.779 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



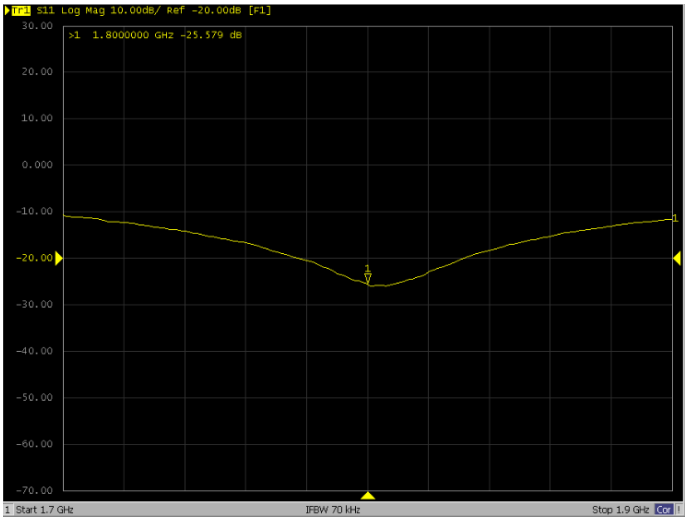



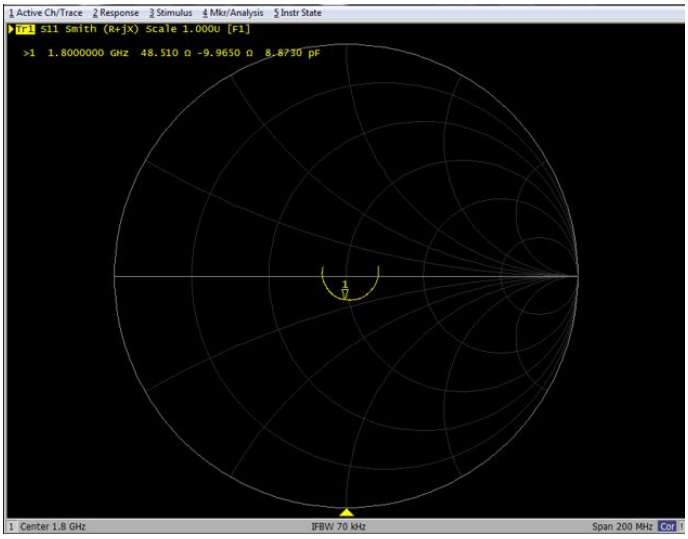
**<Head 1800MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -25.579 | - | 44.876 | - | Feb. 13, 2025 |
| -25.140 | 1.716 | 48.510 | 3.634 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



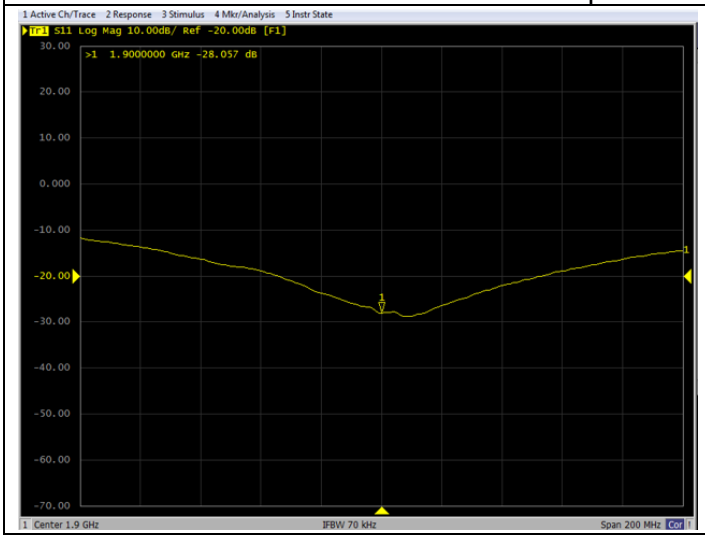



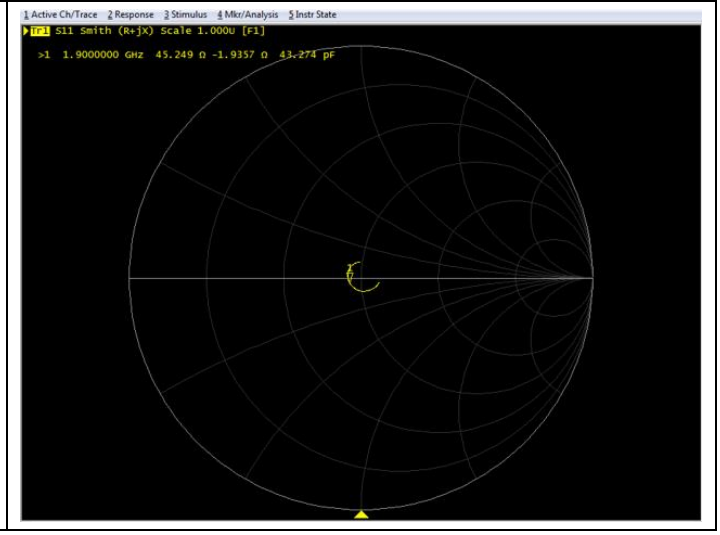
**<Head 1900MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -27.206 | - | 46.948 | - | Feb. 13, 2025 |
| -28.057 | 3.128 | 45.249 | 1.699 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



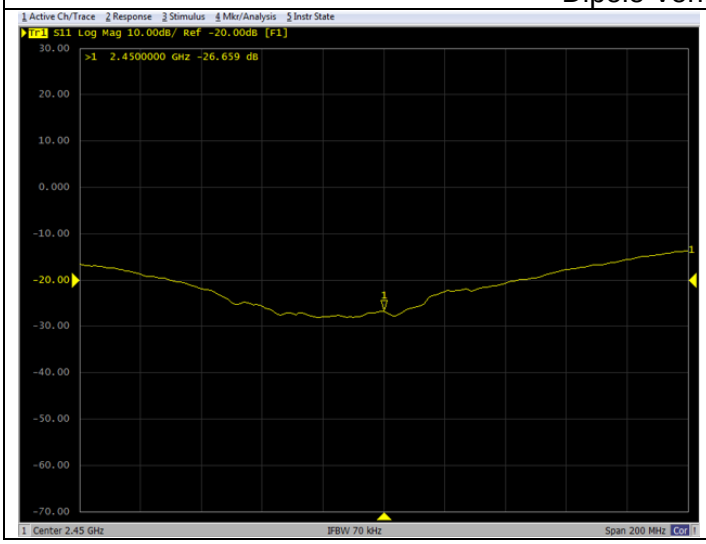



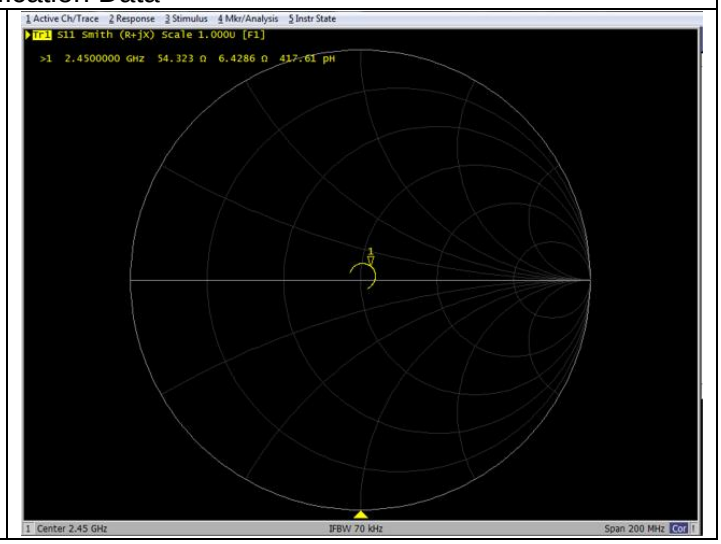
**<Head 2450MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -25.738 | - | 55.969 | - | Feb. 13, 2025 |
| -26.659 | 3.578 | 54.323 | 1.646 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



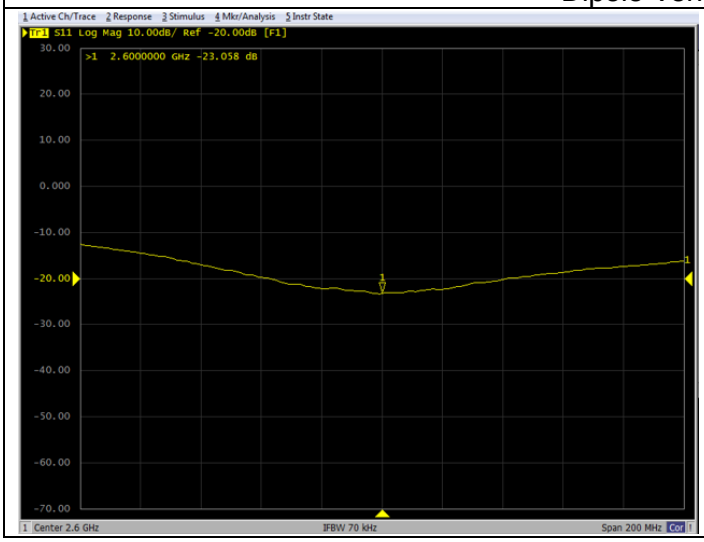



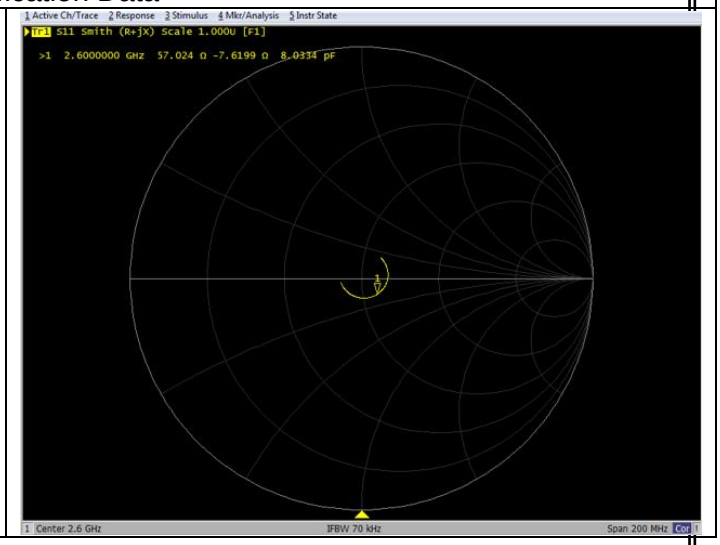
**<Head 2600MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -23.352 | - | 55.439 | - | Feb. 13, 2025 |
| -23.058 | 1.259 | 57.024 | 1.585 | Feb. 10, 2026 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



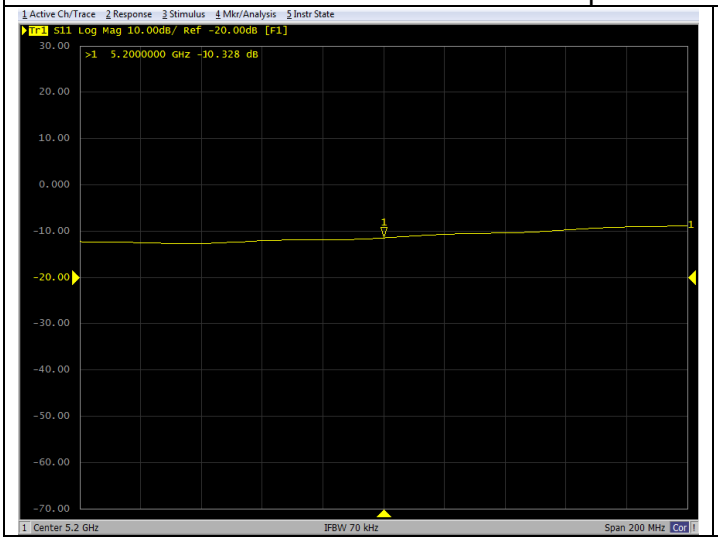



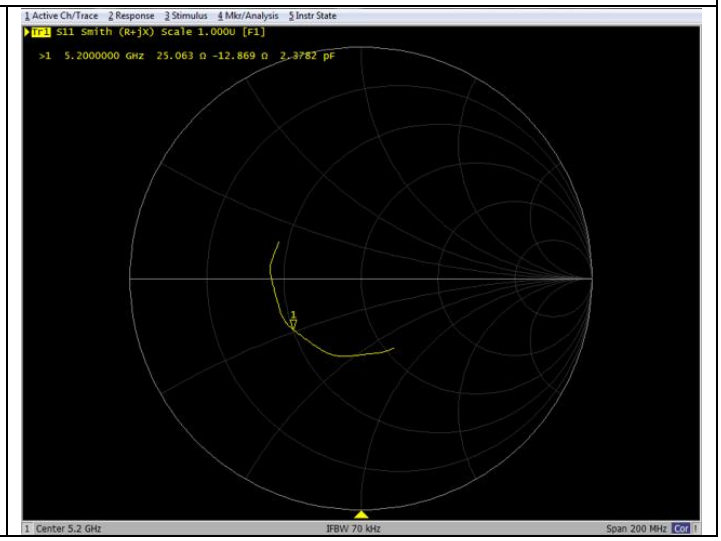
**<Head 5200MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -9.494 | - | 26.574 | - | Feb. 13, 2025 |
| -10.328 | 8.784 | 25.063 | 1.511 | Feb. 10, 2026 |

The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data



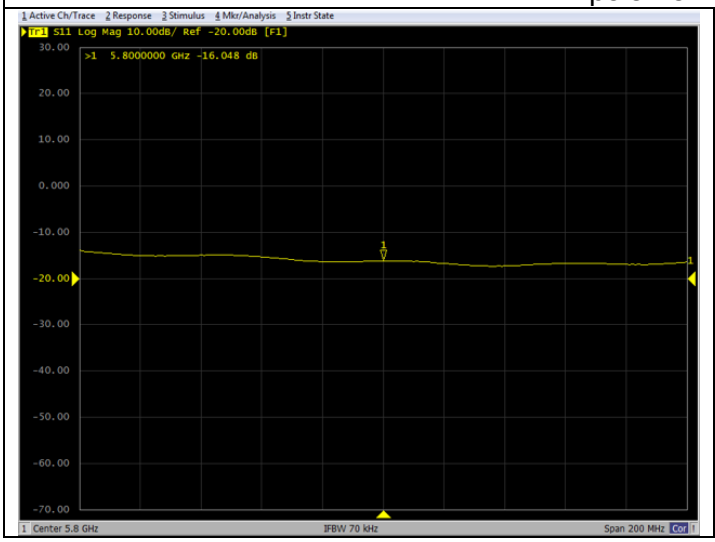



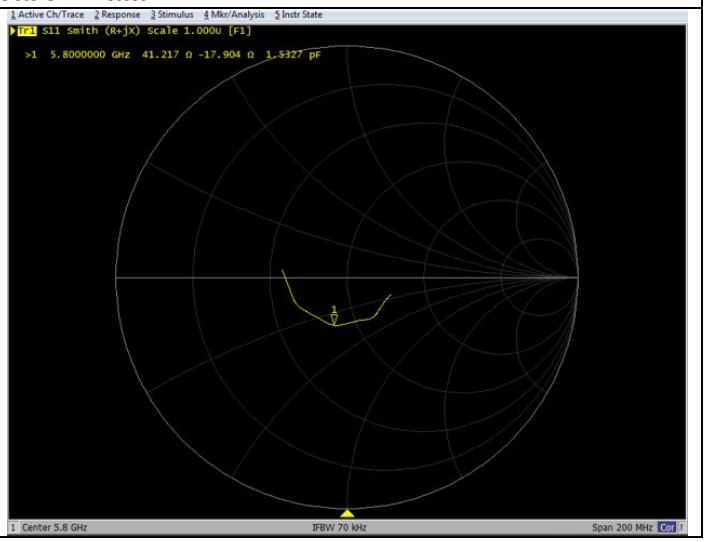
**<Head 5800MHz>**

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|---|---|---|---|---|
| -15.039 | - | 40.791 | - | Feb. 13, 2025 |
| -16.048 | 6.709 | 41.217 | 0.426 | Feb. 10, 2026 |

The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data




**END**