

# Schmid & Partner Engineering AG

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## Calibration Certificate

### 2450 MHz System Validation Dipole

Type:

**D2450V2**

Serial Number:

**724**

Place of Calibration:

**Zurich**

Date of Calibration:

**November 9, 2002**

Calibration Interval:

**24 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:

*W. Vetterli*

Approved by:

*Roberto Kofa*

**Schmid & Partner  
Engineering AG**

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**DASY**

**Dipole Validation Kit**

**Type: D2450V2**

**Serial: 724**

Manufactured: October 16, 2002  
Calibrated: November 9, 2002

## **1. Measurement Conditions**

The measurements were performed in the flat section of the new SAM twin phantom filled with head simulating solution of the following electrical parameters at 2450 MHz:

|                       |                   |            |
|-----------------------|-------------------|------------|
| Relative permittivity | <b>38.0</b>       | $\pm 5\%$  |
| Conductivity          | <b>1.87 mho/m</b> | $\pm 10\%$ |

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15 mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was  $250\text{mW} \pm 3\%$ . The results are normalized to 1W input power.

## **2 SAR Measurement**

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 are:

|                                                  |                  |
|--------------------------------------------------|------------------|
| averaged over $1\text{ cm}^3$ (1 g) of tissue:   | <b>55.6 mW/g</b> |
| averaged over $10\text{ cm}^3$ (10 g) of tissue: | <b>24.7 mW/g</b> |

### **3. Dipole impedance and return loss**

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

|                      |                 |                                       |
|----------------------|-----------------|---------------------------------------|
| Electrical delay:    | <b>1.151 ns</b> | (one direction)                       |
| Transmission factor: | <b>0.997</b>    | (voltage transmission, one direction) |

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

|                                  |                                   |
|----------------------------------|-----------------------------------|
| Feedpoint impedance at 2450 MHz: | $\text{Re}\{Z\} = 53.2 \, \Omega$ |
|                                  | $\text{Im}\{Z\} = 5.2 \, \Omega$  |
| Return Loss at 2450 MHz          | <b>- 24.6 dB</b>                  |

### **4. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

### **5. Design**

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

### **6. Power Test**

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.



Date/Time: 11/09/02 13:43:54

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN724\_SN1507\_HSL2450\_061102.da4

**DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN724**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium: HSL 2450 MHz ( $\sigma = 1.87$  mho/m,  $\epsilon = 38.03$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

**Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

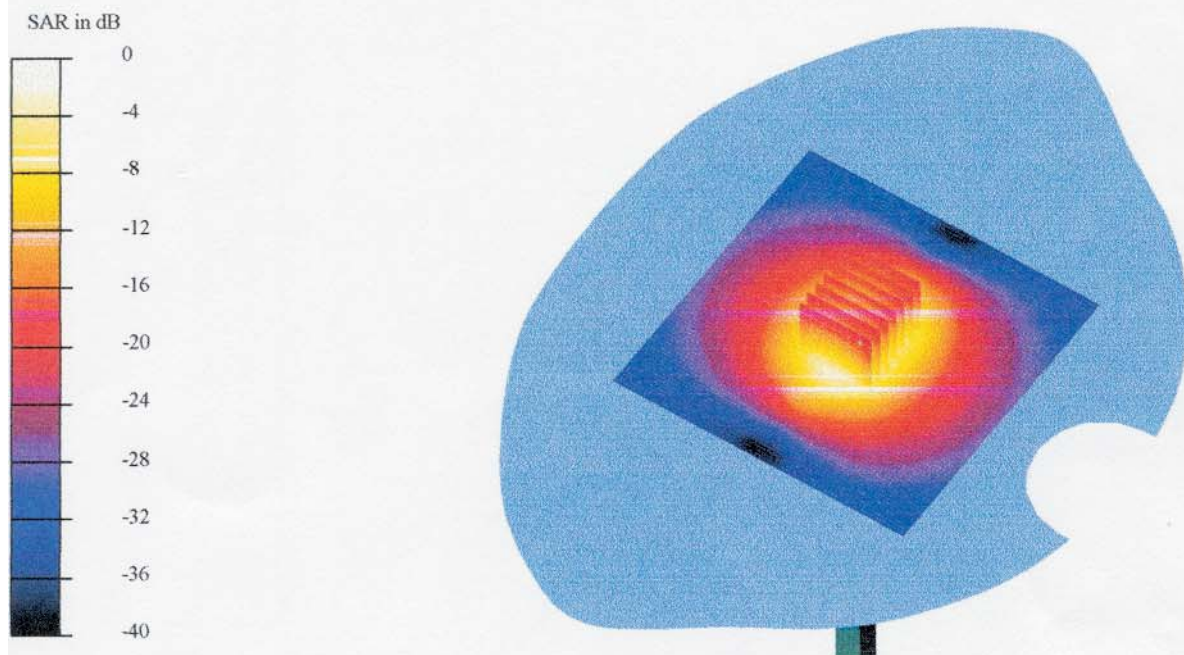
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm

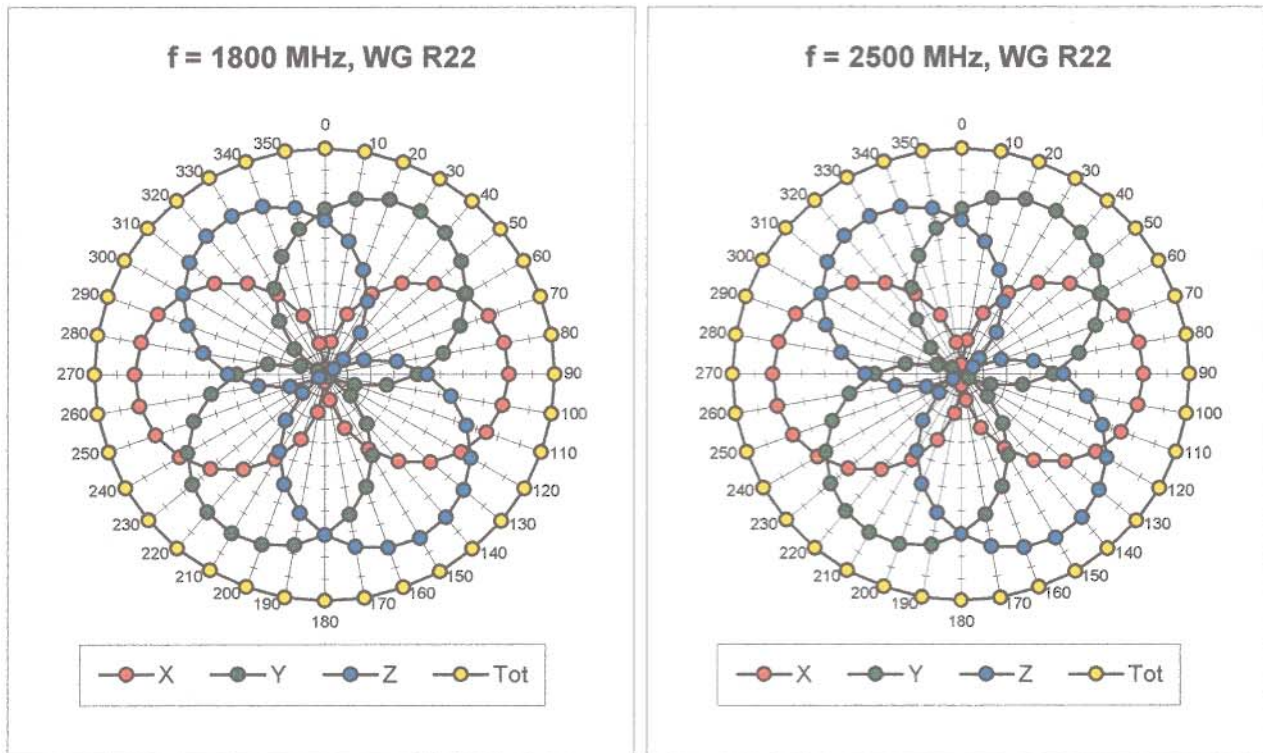
Reference Value = 96.6 V/m

Peak SAR = 30.9 mW/g

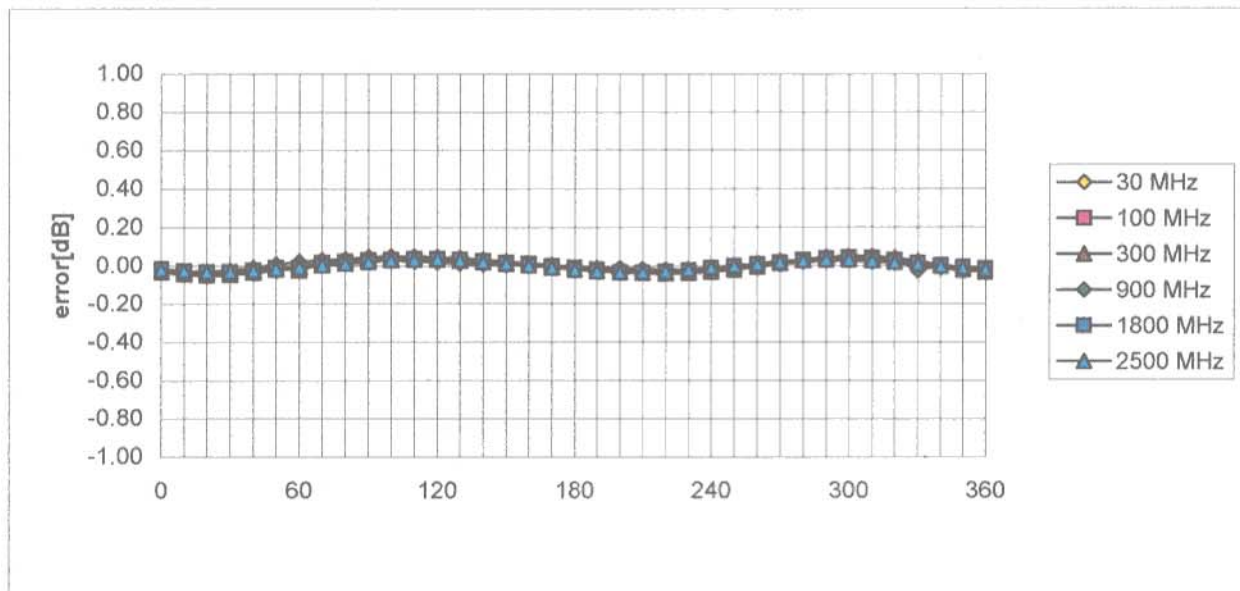
SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.17 mW/g

Power Drift = 0.002 dB





### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$





Client **EMC Technologies (AUS)**

## CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1380**

Calibration procedure(s) **QA CAL-01.v2  
Calibration procedure for dosimetric E-field probes**

Calibration date: **July 18, 2003**

Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

| Model Type                        | ID #         | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration  |
|-----------------------------------|--------------|-------------------------------------------|------------------------|
| RF generator HP 8684C             | US3642U01700 | 4-Aug-99 (SPEAG, in house check Aug-02)   | In house check: Aug-05 |
| Power sensor E4412A               | MY41495277   | 2-Apr-03 (METAS, No 252-0250)             | Apr-04                 |
| Power sensor HP 8481A             | MY41092180   | 18-Sep-02 (Agilent, No. 20020918)         | Sep-03                 |
| Power meter EPM E4419B            | GB41293874   | 2-Apr-03 (METAS, No 252-0250)             | Apr-04                 |
| Network Analyzer HP 8753E         | US37390585   | 18-Oct-01 (Agilent, No. 24BR1033101)      | In house check: Oct 03 |
| Fluke Process Calibrator Type 702 | SN: 6295803  | 3-Sep-01 (ELCAL, No.2360)                 | Sep-03                 |

|                |               |                     |                                                                                       |
|----------------|---------------|---------------------|---------------------------------------------------------------------------------------|
|                | Name          | Function            | Signature                                                                             |
| Calibrated by: | Nico Vetterli | Technician          |  |
| Approved by:   | Katja Pokovic | Laboratory Director |  |

Date issued: July 18, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

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# Probe ET3DV6

## Additional Conversion Factors

### SN:1380

|                   |                  |
|-------------------|------------------|
| Manufactured:     | August 16, 1999  |
| Last calibration: | November 9, 2002 |
| Add ConvF:        | July 18, 2003    |

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)



## DASY - Parameters of Probe: ET3DV6 SN:1380

### Sensitivity in Free Space

|       |                                                 |
|-------|-------------------------------------------------|
| NormX | <b>1.67</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | <b>1.57</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | <b>1.73</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |

### Diode Compression

|       |           |    |
|-------|-----------|----|
| DCP X | <b>90</b> | mV |
| DCP Y | <b>90</b> | mV |
| DCP Z | <b>90</b> | mV |

### Sensitivity in Tissue Simulating Liquid

**Head**                      **2450 MHz**                       $\epsilon_r = 39.2 \pm 5\%$                        $\sigma = 1.80 \pm 5\% \text{ mho/m}$

Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>4.8</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>4.8</b> $\pm 9.5\%$ (k=2) | Alpha <b>1.10</b> |
| ConvF Z | <b>4.8</b> $\pm 9.5\%$ (k=2) | Depth <b>1.76</b> |

**Body**                      **2450 MHz**                       $\epsilon_r = 52.7 \pm 5\%$                        $\sigma = 1.95 \pm 5\% \text{ mho/m}$

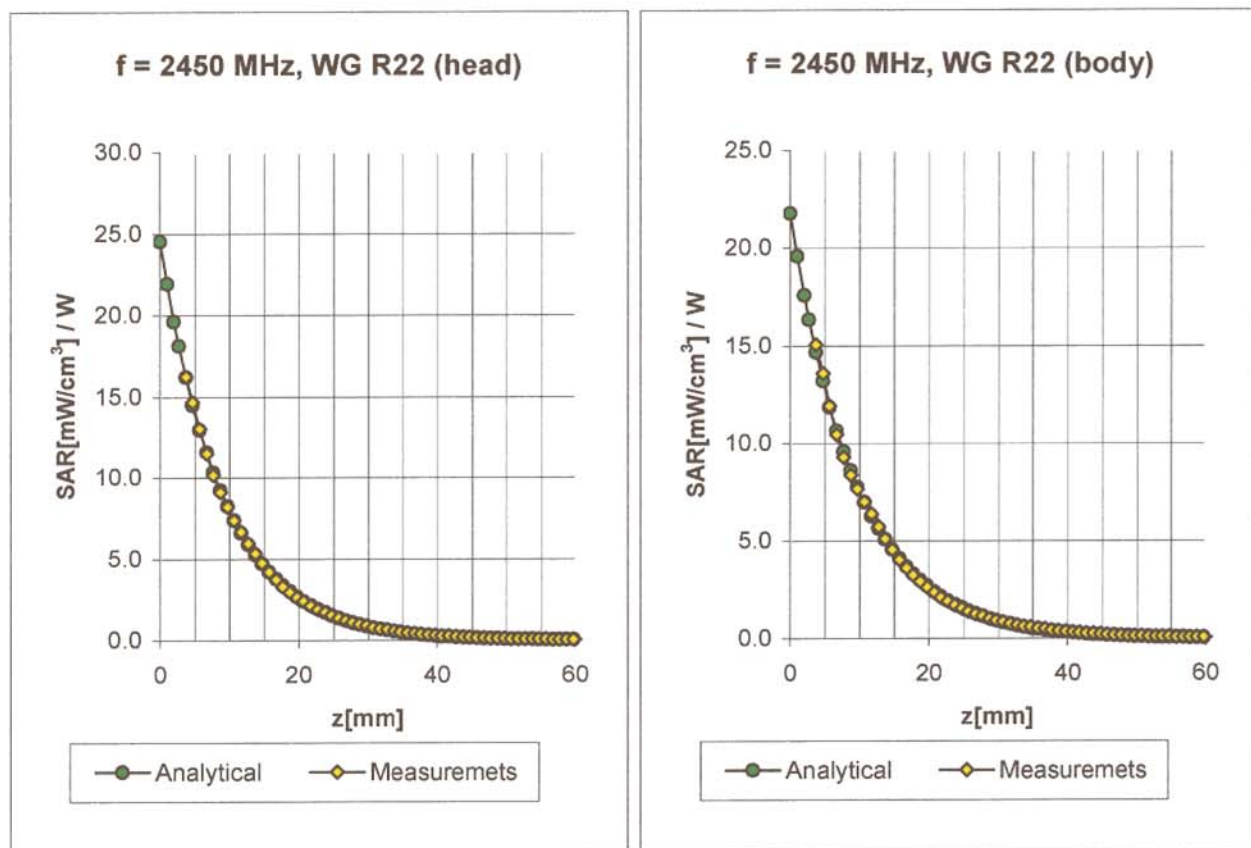
Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>4.5</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>4.5</b> $\pm 9.5\%$ (k=2) | Alpha <b>1.52</b> |
| ConvF Z | <b>4.5</b> $\pm 9.5\%$ (k=2) | Depth <b>1.42</b> |

### Sensor Offset

|                            |                                 |    |
|----------------------------|---------------------------------|----|
| Probe Tip to Sensor Center | <b>2.7</b>                      | mm |
| Optical Surface Detection  | <b>1.5 <math>\pm</math> 0.2</b> | mm |

## Conversion Factor Assessment



**Head      2450      MHz       $\epsilon_r = 39.2 \pm 5\%$        $\sigma = 1.80 \pm 5\%$  mho/m**

Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                  |             |
|---------|------------------------------|------------------|-------------|
| ConvF X | <b>4.8</b> $\pm 9.5\%$ (k=2) | Boundary effect: |             |
| ConvF Y | <b>4.8</b> $\pm 9.5\%$ (k=2) | Alpha            | <b>1.10</b> |
| ConvF Z | <b>4.8</b> $\pm 9.5\%$ (k=2) | Depth            | <b>1.76</b> |

**Body      2450      MHz       $\epsilon_r = 52.7 \pm 5\%$        $\sigma = 1.95 \pm 5\%$  mho/m**

Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

|         |                              |                  |             |
|---------|------------------------------|------------------|-------------|
| ConvF X | <b>4.5</b> $\pm 9.5\%$ (k=2) | Boundary effect: |             |
| ConvF Y | <b>4.5</b> $\pm 9.5\%$ (k=2) | Alpha            | <b>1.52</b> |
| ConvF Z | <b>4.5</b> $\pm 9.5\%$ (k=2) | Depth            | <b>1.42</b> |

| Frequency       | e'     | e''/e'  |
|-----------------|--------|---------|
| 300.000000 MHz  | 4.6029 | 0.0208  |
| 344.000000 MHz  | 4.3846 | -0.0209 |
| 388.000000 MHz  | 4.5963 | 0.0008  |
| 432.000000 MHz  | 4.4582 | -0.0061 |
| 476.000000 MHz  | 4.5861 | 0.0127  |
| 520.000000 MHz  | 4.4932 | 0.0044  |
| 564.000000 MHz  | 4.5140 | 0.0167  |
| 608.000000 MHz  | 4.5535 | 0.0030  |
| 652.000000 MHz  | 4.4146 | 0.0020  |
| 696.000000 MHz  | 4.4890 | 0.0104  |
| 740.000000 MHz  | 4.4702 | 0.0150  |
| 784.000000 MHz  | 4.5612 | 0.0199  |
| 828.000000 MHz  | 4.4420 | 0.0145  |
| 872.000000 MHz  | 4.4165 | 0.0220  |
| 916.000000 MHz  | 4.4464 | 0.0082  |
| 960.000000 MHz  | 4.4586 | 0.0224  |
| 1.004000000 GHz | 4.3909 | 0.0215  |
| 1.048000000 GHz | 4.4336 | 0.0192  |
| 1.092000000 GHz | 4.4031 | 0.0218  |
| 1.136000000 GHz | 4.4546 | 0.0180  |
| 1.180000000 GHz | 4.4111 | 0.0254  |
| 1.224000000 GHz | 4.4472 | 0.0244  |
| 1.268000000 GHz | 4.4522 | 0.0251  |
| 1.312000000 GHz | 4.4401 | 0.0260  |
| 1.356000000 GHz | 4.4953 | 0.0214  |
| 1.400000000 GHz | 4.4405 | 0.0218  |
| 1.444000000 GHz | 4.4588 | 0.0266  |
| 1.488000000 GHz | 4.4277 | 0.0248  |
| 1.532000000 GHz | 4.4716 | 0.0286  |
| 1.576000000 GHz | 4.4530 | 0.0250  |
| 1.620000000 GHz | 4.4487 | 0.0289  |
| 1.664000000 GHz | 4.4442 | 0.0231  |
| 1.708000000 GHz | 4.4210 | 0.0267  |
| 1.752000000 GHz | 4.4473 | 0.0234  |

|                 |        |        |
|-----------------|--------|--------|
| 1.796000000 GHz | 4.4257 | 0.0285 |
| 1.840000000 GHz | 4.4162 | 0.0301 |
| 1.884000000 GHz | 4.4008 | 0.0237 |
| 1.928000000 GHz | 4.3629 | 0.0293 |
| 1.972000000 GHz | 4.3700 | 0.0235 |
| 2.016000000 GHz | 4.3536 | 0.0259 |
| 2.060000000 GHz | 4.3282 | 0.0198 |
| 2.104000000 GHz | 4.3064 | 0.0114 |
| 2.148000000 GHz | 4.3269 | 0.0099 |
| 2.192000000 GHz | 4.4059 | 0.0058 |
| 2.236000000 GHz | 4.4015 | 0.0116 |
| 2.280000000 GHz | 4.4687 | 0.0181 |
| 2.324000000 GHz | 4.4551 | 0.0221 |
| 2.368000000 GHz | 4.5100 | 0.0287 |
| 2.412000000 GHz | 4.5291 | 0.0304 |
| 2.456000000 GHz | 4.4896 | 0.0299 |
| 2.500000000 GHz | 4.5201 | 0.0379 |