
ATTACHMENT S: PROBE & DIPOLE CALIBRATION

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client **Digital EMC (Dymstec)**

CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1702**

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

Calibration date: **February 17, 2004**

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

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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 |
|-----------------------------------|----------------|---|------------------------|
| Power meter EPM E4419B | GB41293874 | 2-Apr-03 (METAS, No 252-0250) | Apr-04 |
| Power sensor E4412A | MY41495277 | 2-Apr-03 (METAS, No 252-0250) | Apr-04 |
| Reference 20 dB Attenuator | SN: 5086 (20b) | 3-Apr-03 (METAS, No. 251-0340) | Apr-04 |
| Fluke Process Calibrator Type 702 | SN: 6295803 | 8-Sep-03 (Sintrel SCS No. E-030020) | Sep-04 |
| Power sensor HP 8481A | MY41092180 | 18-Sep-02 (SPEAG, in house check Oct-03) | In house check: Oct 05 |
| RF generator HP 8684C | US3642U01700 | 4-Aug-99 (SPEAG, in house check Aug-02) | In house check: Aug-05 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Oct-03) | In house check: Oct 05 |

| | | | |
|----------------|---------------|---------------------|---|
| | Name | Function | Signature |
| Calibrated by: | Katja Pokovic | Laboratory Director |  |
| Approved by: | Niels Kuster | Quality Manager |  |

Date issued: February 17, 2004

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.

Probe ET3DV6

SN:1702

| | |
|------------------|-------------------|
| Manufactured: | July 3, 2002 |
| Last calibrated: | July 29, 2002 |
| Recalibrated: | February 17, 2004 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1702**Sensitivity in Free Space****Diode Compression^A**

| | |
|-------|--|
| NormX | 1.66 $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | 1.71 $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | 1.67 $\mu\text{V}/(\text{V}/\text{m})^2$ |

| | | |
|-------|----|----|
| DCP X | 96 | mV |
| DCP Y | 96 | mV |
| DCP Z | 96 | mV |

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 7.

Boundary Effect**Head 900 MHz Typical SAR gradient: 5 % per mm**

| | | | |
|--|------------------------------|--------|--------|
| Sensor Cener to Phantom Surface Distance | | 3.7 mm | 4.7 mm |
| SAR _{be} [%] | Without Correction Algorithm | 7.5 | 3.9 |
| SAR _{be} [%] | With Correction Algorithm | 0.0 | 0.2 |

Head 1800 MHz Typical SAR gradient: 10 % per mm

| | | | |
|----------------------------|------------------------------|--------|--------|
| Sensor to Surface Distance | | 3.7 mm | 4.7 mm |
| SAR _{be} [%] | Without Correction Algorithm | 11.5 | 8.0 |
| SAR _{be} [%] | With Correction Algorithm | 0.2 | 0.4 |

Sensor Offset

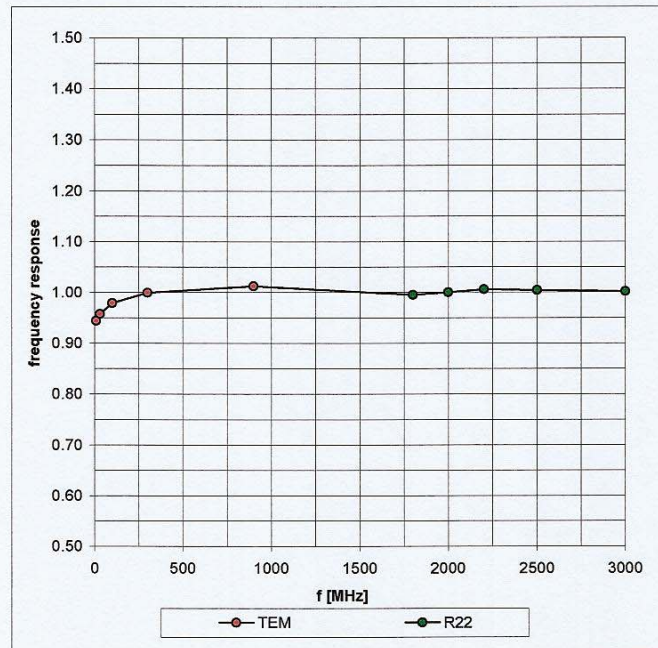
| | |
|----------------------------|--------------|
| Probe Tip to Sensor Center | 2.7 mm |
| Optical Surface Detection | in tolerance |

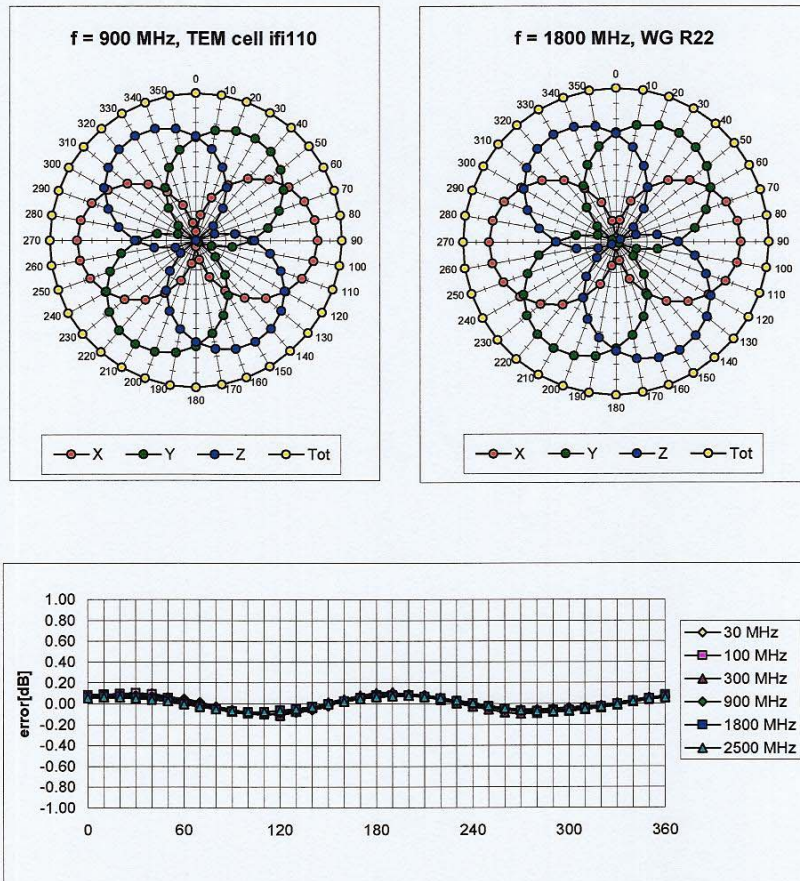
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A numerical linearization parameter; uncertainty not required

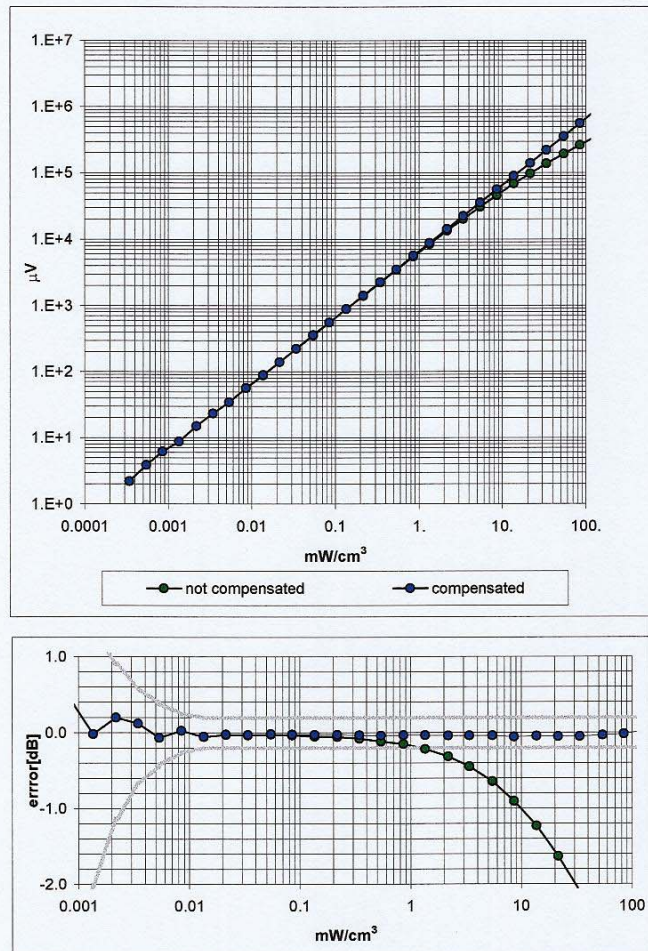
Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



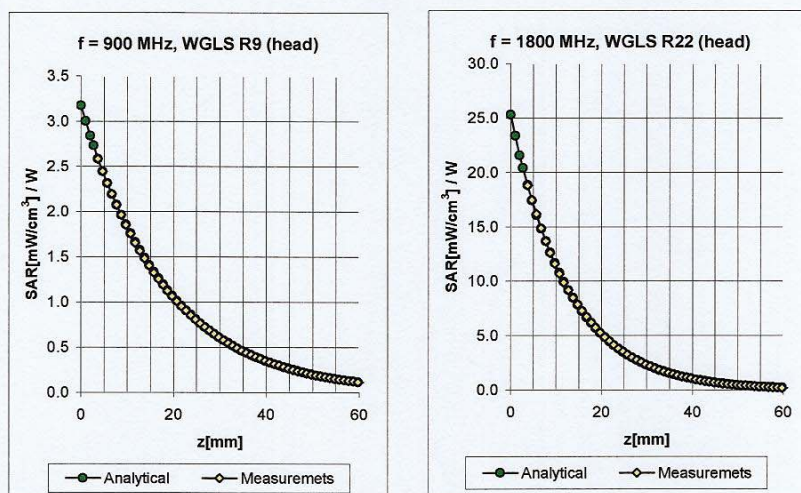
Receiving Pattern (ϕ) , $\theta = 0^\circ$ Axial Isotropy Error $< \pm 0.2$ dB

Dynamic Range f(SAR_{head}) (Waveguide R22)



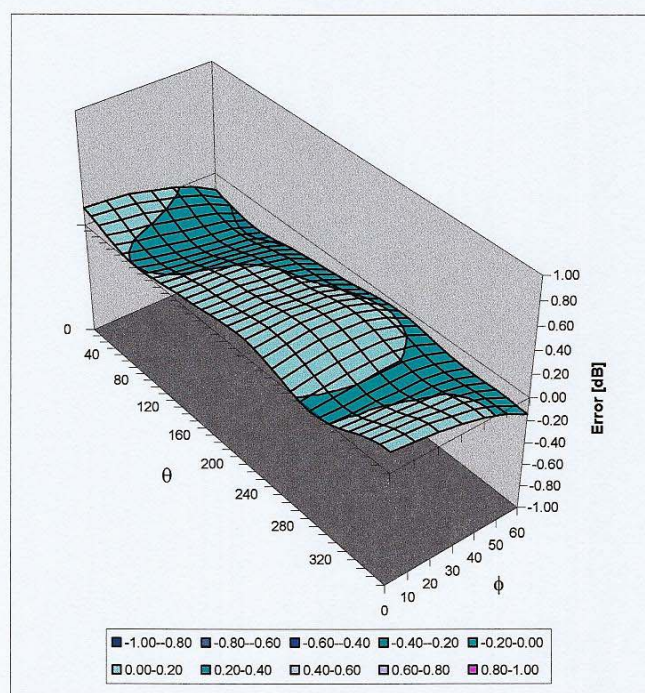
Probe Linearity $< \pm 0.2$ dB

Conversion Factor Assessment



| f [MHz] | Validity [MHz] ^B | Tissue | Permittivity | Conductivity | Alpha | Depth | ConvF | Uncertainty |
|---------|-----------------------------|--------|--------------|--------------|-------|-------|--------------------|-------------|
| 900 | 800-1000 | Head | 41.5 ± 5% | 0.97 ± 5% | 0.58 | 1.74 | 6.52 ± 11.3% (k=2) | |
| 1800 | 1710-1910 | Head | 40.0 ± 5% | 1.40 ± 5% | 0.44 | 2.57 | 5.21 ± 11.7% (k=2) | |
| 2450 | 2400-2500 | Head | 39.2 ± 5% | 1.80 ± 5% | 0.82 | 2.00 | 4.67 ± 9.7% (k=2) | |
| 2450 | 2400-2500 | Body | 52.7 ± 5% | 1.95 ± 5% | 0.95 | 1.82 | 4.19 ± 9.7% (k=2) | |

^B The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

Deviation from Isotropy in HSLError (θ, ϕ), $f = 900$ MHz**Spherical Isotropy Error < ± 0.4 dB**

Additional Conversion Factors

for Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1702

Place of Assessment:

Zurich

Date of Assessment:

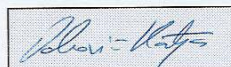
February 20, 2004

Probe Calibration Date:

February 17, 2004

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



Dosimetric E-Field Probe ET3DV6 SN:1702Conversion factor (\pm standard deviation)

| | | | |
|----------|-------|---------------|---|
| 900 MHz | ConvF | $6.3 \pm 8\%$ | $\epsilon_r = 55.0 \pm 5\%$ $\sigma = 1.05 \pm 5\% \text{ mho/m}$ (body tissue) |
| 1800 MHz | ConvF | $4.8 \pm 8\%$ | $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\% \text{ mho/m}$ (body tissue) |
| 1900 MHz | ConvF | $4.6 \pm 8\%$ | $\epsilon_r = 53.2 \pm 5\%$ $\sigma = 1.52 \pm 5\% \text{ mho/m}$ (body tissue) |

Important Note:

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also Section 4.7 of the DASY4 Manual.

Client **Digital EMC (Dymstec)**

CALIBRATION CERTIFICATE

Object(s) **D835V2 - SN:464**

Calibration procedure(s) **QA CAL-05.v2
Calibration procedure for dipole validation kits**

Calibration date: **February 12, 2004**



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 |
|---------------------------|------------|---|------------------------|
| Power meter EPM E442 | GB37480704 | 6-Nov-03 (METAS, No. 252-0254) | Nov-04 |
| Power sensor HP 8481A | US37292783 | 6-Nov-03 (METAS, No. 252-0254) | Nov-04 |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (Agilent, No. 20021018) | Oct-04 |
| RF generator R&S SML-03 | 100698 | 27-Mar-2002 (R&S, No. 20-92389) | In house check: Mar-05 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Nov-03) | In house check: Oct 05 |

| | | | |
|----------------|----------------|---------------------|---|
| | Name | Function | Signature |
| Calibrated by: | Judith Mueller | Technician |  |
| Approved by: | Katja Pokovic | Laboratory Director |  |

Date issued: February 18, 2004

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.

Schmid & Partner Engineering AG

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DASY

Dipole Validation Kit

Type: D835V2

Serial: 464

Manufactured: March 27, 2002
Calibrated: February 12, 2004

1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **head simulating solution** of the following electrical parameters at 900 MHz:

| | | |
|------------------------|-------------------|-----------|
| Relative Dielectricity | 42.1 | $\pm 5\%$ |
| Conductivity | 0.89 mho/m | $\pm 5\%$ |

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.3 at 835 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole center to the solution surface. The included distance spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm 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 with DASY4 System

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 and applying the advanced extrapolation are:

| | |
|---|---|
| averaged over 1 cm^3 (1 g) of tissue: | 10.4 mW/g $\pm 16.8\%$ ($k=2$)¹ |
| averaged over 10 cm^3 (10 g) of tissue: | 6.52 mW/g $\pm 16.2\%$ ($k=2$)¹ |

¹ validation uncertainty

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: | 1.381 ns | (one direction) |
| Transmission factor: | 0.989 | (voltage transmission, one direction) |

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

| | |
|---------------------------------|-----------------------------------|
| Feedpoint impedance at 900 MHz: | $\text{Re}\{Z\} = 49.7 \, \Omega$ |
| | $\text{Im}\{Z\} = -0.5 \, \Omega$ |
| Return Loss at 900 MHz | -44.6 dB |

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.

6. Power Test

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN464

Communication System: CW-835; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: HSL 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.89 \text{ mho/m}$; $\epsilon_r = 42.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.3, 6.3, 6.3); Calibrated: 1/23/2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn411; Calibrated: 11/6/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.2 Build 25; Postprocessing SW: SEMCAD, V1.8 Build 98

Pin = 250 mW; d = 15 mm/Area Scan (81x81x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Reference Value = 56.9 V/m

Power Drift = 0.01 dB

Maximum value of SAR = 2.68 mW/g

Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

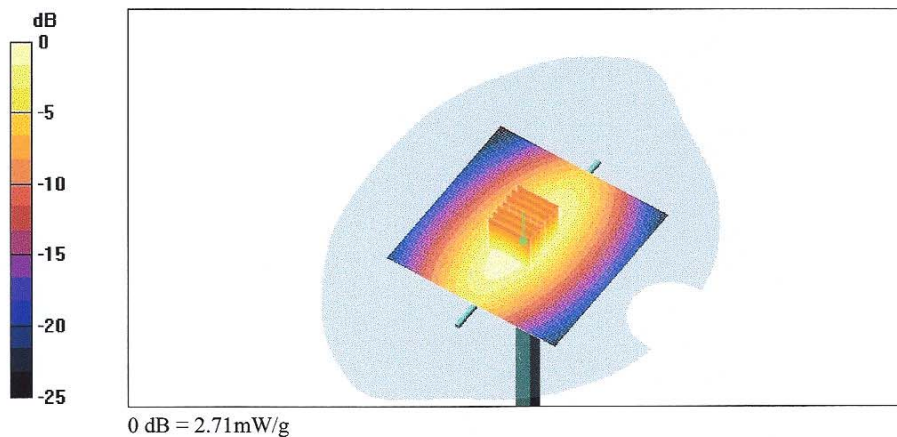
Peak SAR (extrapolated) = 3.83 W/kg

SAR(1 g) = 2.51 mW/g; SAR(10 g) = 1.63 mW/g

Reference Value = 56.9 V/m

Power Drift = 0.01 dB

Maximum value of SAR = 2.71 mW/g



464

CH1 S11 1 U FS 12 Feb 2004 10:40:46
 1: 49.652 Ω -468.75 m Ω 406.62 pF 835.000 000 MHz

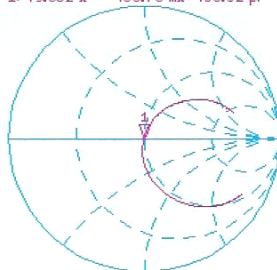
Del

Cor

Avg

16

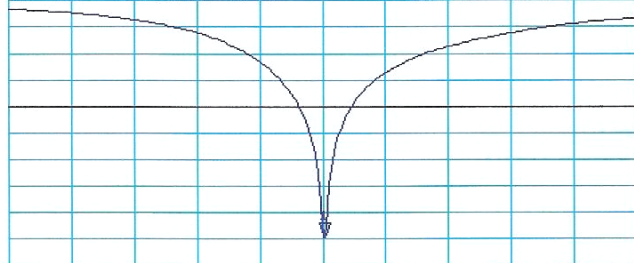
↑



CH2 S11 LOG 5 dB/REF -20 dB 1:-44.553 dB 835.000 000 MHz

Cor

↑



CENTER 835.000 000 MHz

SPAN 400.000 000 MHz