

## ATTACHMENT S – DIPOLE CALIBRATION DATA

## Schmid & Partner Engineering AG

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### Calibration Certificate

#### 835 MHz System Validation Dipole

Type:

D835V2

Serial Number:

441

Place of Calibration:

Zurich

Date of Calibration:

August 3, 2001

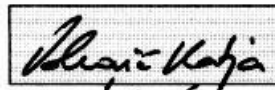
Calibration Interval:

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:



Approved by:



**Schmid & Partner  
Engineering AG**

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# DASY

## Dipole Validation Kit

Type: D835V2

Serial: 441

Manufactured: March 9, 2001  
Calibrated: August 3, 2001

## **1. Measurement Conditions**

The measurements were performed in the flat section of the new generic twin phantom filled with head simulating solution of the following electrical parameters at 835 MHz:

|                        |                   |           |
|------------------------|-------------------|-----------|
| Relative Dielectricity | <b>41.0</b>       | $\pm 5\%$ |
| Conductivity           | <b>0.89 mho/m</b> | $\pm 5\%$ |

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.27 at 900 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 holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.

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

## **2. SAR Measurement**

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 1. The results have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

|  |                   |
|--|-------------------|
| averaged over 1 cm <sup>3</sup> (1 g) of tissue:   | <b>10.64 mW/g</b> |
| averaged over 10 cm <sup>3</sup> (10 g) of tissue: | <b>6.80 mW/g</b>  |

Note: If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well.

### **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>1.390 ns</b> | (one direction)                       |
| Transmission factor: | <b>0.996</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 835 MHz: | <b><math>\text{Re}\{Z\} = 50.0 \Omega</math></b> |
|---------------------------------|--|

|  |  |
|--|--|
|  | <b><math>\text{Im}\{Z\} = -5.4 \Omega</math></b> |
|--|--|

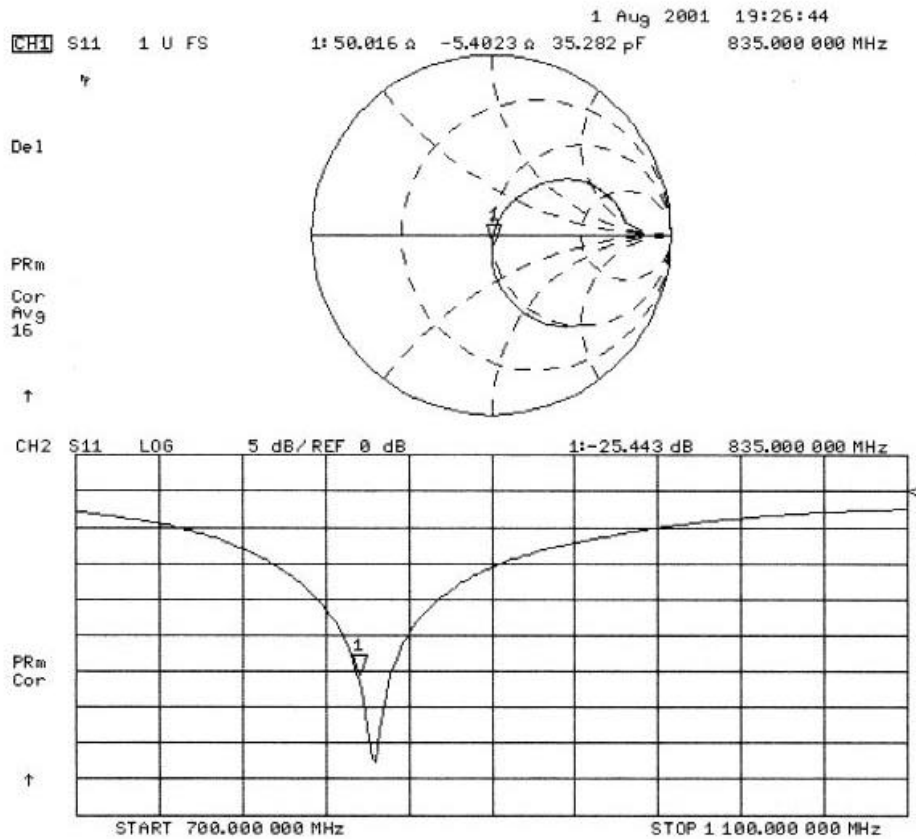
|                        |                 |
|------------------------|-----------------|
| Return Loss at 835 MHz | <b>-25.4 dB</b> |
|------------------------|-----------------|

### **4. Handling**

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.

Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

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

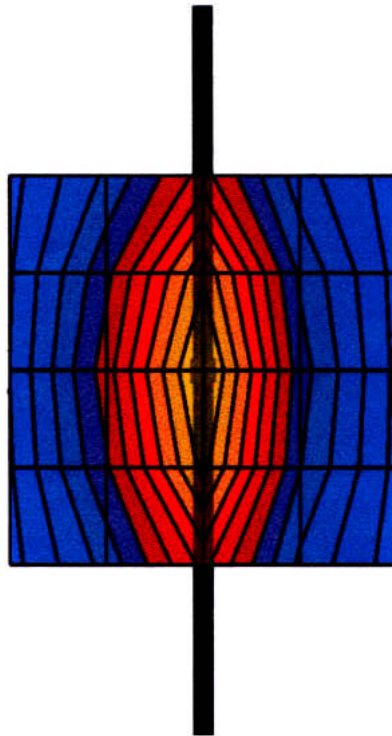




08/01/01

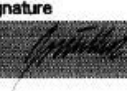

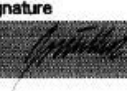

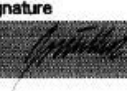

## Validation Dipole D835V2 SN:441, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]  
 SAM Phantom: Flat - SAM Section, Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
 Probe: ET3DV6 - SN1507; ConvF(6,27,6,27) at 900 MHz; IEEE1528 835 MHz;  $\sigma = 0.89$  mho/m  $\epsilon_r = 41.0$   $\rho = 1.00$  g/cm<sup>3</sup>  
 Cubes (2): Peak: 4.25 mW/g  $\pm 0.03$  dB, SAR (1g): 2.66 mW/g  $\pm 0.03$  dB, SAR (10g): 1.70 mW/g  $\pm 0.03$  dB, (Worst-case extrapolation)  
 Penetration depth: 12.0 (10.6, 13.8) [mm]  
 Powerdrift: -0.00 dB



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

**Client**      **Hyundai CT (Dymstec)**

| CALIBRATION CERTIFICATE   |  |   |                        |      |          |           |                               |            |   |                            |                     |   |
|---|--|---|------------------------|------|----------|-----------|-------------------------------|------------|---|----------------------------|---------------------|---|
| Object(s)   | D1900V2 - SN:5d032   |   |                        |      |          |           |                               |            |   |                            |                     |   |
| Calibration procedure(s)  | QA CAL-05.v2<br>Calibration procedure for dipole validation kits |   |                        |      |          |           |                               |            |   |                            |                     |   |
| Calibration date:   | May 12, 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 R&S SML-03   | 100698   | 27-Mar-2002 (R&S, No. 20-92389)   | In house check: Mar-05 |      |          |           |                               |            |   |                            |                     |   |
| Power sensor HP 8481A   | MY41092317   | 18-Oct-02 (Agilent, No. 20021018)   | Oct-04                 |      |          |           |                               |            |   |                            |                     |   |
| Power sensor HP 8481A   | US37292783   | 30-Oct-02 (METAS, No. 252-0236)   | Oct-03                 |      |          |           |                               |            |   |                            |                     |   |
| Power meter EPM E442  | GB37480704   | 30-Oct-02 (METAS, No. 252-0236)   | Oct-03                 |      |          |           |                               |            |   |                            |                     |   |
| Network Analyzer HP 8753E   | US38432426   | 3-May-00 (Agilent, No. 8702K064602)   | In house check: May 03 |      |          |           |                               |            |   |                            |                     |   |
| <table border="1"> <thead> <tr> <th>Name</th> <th>Function</th> <th>Signature</th> </tr> </thead> <tbody> <tr> <td>Calibrated by: Judith Mueller</td> <td>Technician</td> <td></td> </tr> <tr> <td>Approved by: Katja Pekovic</td> <td>Laboratory Director</td> <td></td> </tr> </tbody> </table> |  |   |                        | Name | Function | Signature | Calibrated by: Judith Mueller | Technician |  | Approved by: Katja Pekovic | Laboratory Director |  |
| Name  | Function   | Signature   |                        |      |          |           |                               |            |   |                            |                     |   |
| Calibrated by: Judith Mueller   | Technician   |  |                        |      |          |           |                               |            |   |                            |                     |   |
| Approved by: Katja Pekovic  | Laboratory Director  |  |                        |      |          |           |                               |            |   |                            |                     |   |
| Date issued: May 13, 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.  |  |   |                        |      |          |           |                               |            |   |                            |                     |   |



Schmid & Partner Engineering AG

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# DASY

## Dipole Validation Kit

Type: D1900V2

Serial: 5d032

Manufactured: March 17, 2003

Calibrated: May 12, 2003

## **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 1900 MHz:

|                        |                   |           |
|------------------------|-------------------|-----------|
| Relative Dielectricity | <b>38.8</b>       | $\pm 5\%$ |
| Conductivity           | <b>1.44 mho/m</b> | $\pm 5\%$ |

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.2 at 1900 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 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 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 $1 \text{ cm}^3$ (1 g) of tissue:   | <b>42.0 mW/g <math>\pm 16.8 \%</math> (k=2)<sup>1</sup></b> |
| averaged over $10 \text{ cm}^3$ (10 g) of tissue: | <b>21.6 mW/g <math>\pm 16.2 \%</math> (k=2)<sup>1</sup></b> |

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<sup>1</sup> 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:       **1.195 ns**   (one direction)  
Transmission factor:   **0.980**     (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 1900 MHz:        $\text{Re}\{Z\} = 50.5 \Omega$

$\text{Im}\{Z\} = 3.2 \Omega$

Return Loss at 1900 MHz               **-29.9 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.

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: 05/12/03 20:36:30

Test Laboratory: SPEAG, Zurich, Switzerland

File Name: SNSd032\_SN1507\_HSL1900\_120503.da4**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN5d032****Program: Dipole Calibration**

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: HSL 1900 MHz ( $\sigma = 1.44 \text{ mho/m}$ ,  $\epsilon_r = 38.8$ ,  $\rho = 1000 \text{ kg/m}^3$ )

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5.2, 5.2, 5.2); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1); Measurement grid: dx=15mm, dy=15mm**

Reference Value = 94.9 V/m

Power Drift = 0.06 dB

Maximum value of SAR = 11.6 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0; Measurement grid: dx=5mm, dy=5mm, dz=5mm**

Peak SAR (extrapolated) = 18.4 W/kg

SAR(1 g) = 10.5 mW/g; SAR(10 g) = 5.39 mW/g

Reference Value = 94.9 V/m

Power Drift = 0.06 dB

Maximum value of SAR = 11.8 mW/g

