



SA à directoire et conseil de surveillance.  
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# **ACCEPTANCE TEST**

## **ANNEX A**

### **PROBE SN01/06 EP45 CALIBRATION**

Prepared By: Mr. LUC Jérôme, ANTENNESSA  
Project Description : SAR TEST BENCH  
Prepared For (End User) : CCS

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COMOSAR SEPT ISOTROPIC E-FIELD PROBE CALIBRATION REPORT

DATE : 06/01/2006

REFERENCE: SN 01/06 EP45

OBJECT : COMOSAR SEPT ISOTROPIC E-FIELD PROBE

MANUFACTURER : ANTENNESSA

SERIAL NUMBER : SN 01/06 EP45

CUSTOMER : CCS

ORDER : PF05120023

DATE OF CALIBRATION : 04/01/2006

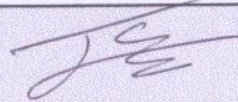
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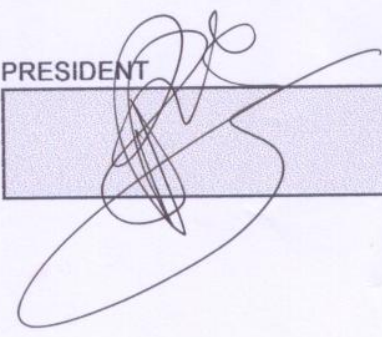
Date

06-01-06  
**ANTENNESSA**  
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SAR TEAM MANAGER



PRESIDENT



## PRODUCT DESCRIPTION



|                                                   |                                                                            |
|---------------------------------------------------|----------------------------------------------------------------------------|
| Frequency Range                                   | 100 MHz - 30 GHz                                                           |
| Probe length                                      | 330 mm                                                                     |
| Length of one dipole                              | 4.5 mm                                                                     |
| Maximum external diameter                         | 8 mm                                                                       |
| Probe extremity diameter                          | 6.5 mm                                                                     |
| Distance between dipoles/probe extremity          | < 2.7 mm                                                                   |
| Resistance of the three dipole (at the connector) | Dipole 1: R1=1.5304 MΩ<br>Dipole 2: R2=1.1400 MΩ<br>Dipole 3: R3=1.6359 MΩ |
| Connector (HIROSE series SR30)                    | 6 wire male (Hirose SR30series)                                            |

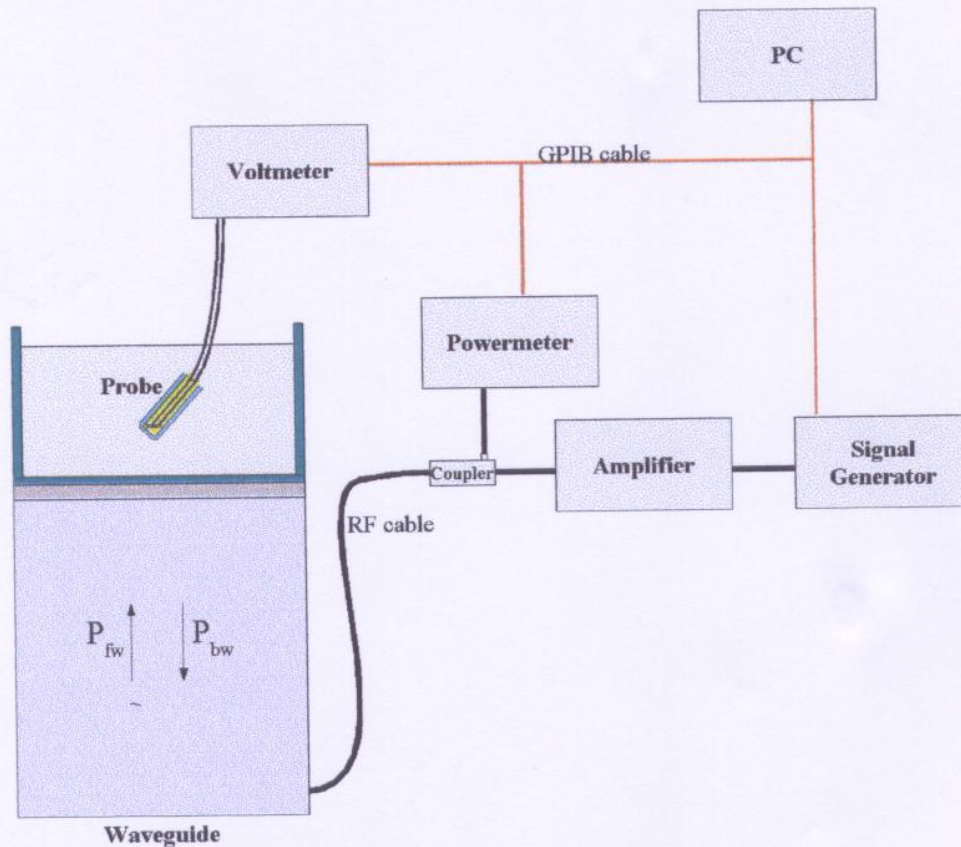
The probe could be checked by measuring the resistance of the three dipoles.

## CALIBRATION TEST EQUIPMENT

| TYPE              | IDENTIFICATION |
|-------------------|----------------|
| Calibration bench | CALISAR        |
| Multimeter        | Keithley 2000  |

## MEASUREMENT PROCEDURE

Probe calibration is realized, in compliance with CENELEC EN 50361 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 50361 annexe technique using reference guide at the five frequencies.



$$SAR = \frac{4(P_{fw} - P_{bw})}{ab\delta} \cos^2\left(\pi \frac{y}{a}\right) e^{-(2z/\delta)}$$

Where :

- $P_{fw}$  = Forward Power
- $P_{bw}$  = Backward Power
- $a$  and  $b$  = Waveguide dimensions
- $\delta$  = Skin depth

Keithley configuration:

Rate = Medium; Filter = ON; RDGS=10; FILTER TYPE =MOVING AVERAGE; RANGE AUTO

After each calibration, a SAR measurement is performed on a validation dipole and compared with a NPL calibrated probe, to verify it.

PROBE UNCERTAINTIES

Calibration report of dosimetric Antennessa  
probe

Uncertainty analysis for the evaluation of reference antenna gain

| ERROR SOURCES                                     | Description (Section) | Uncertainty value (%) | Probability Distribution | Divisor    | ci | Standard Uncertainty (%) |
|---------------------------------------------------|-----------------------|-----------------------|--------------------------|------------|----|--------------------------|
| Incident Power                                    | B.2.2                 | 0,20%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,115%                   |
| Reflection coefficients                           | B.2.2                 | 0,75%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,433%                   |
| Distance                                          | B.2.2                 | 2,50%                 | Rectangular              | $\sqrt{3}$ | 1  | 1,443%                   |
| Liquid Permittivity                               | B.2.2                 | 3,00%                 | Rectangular              | $\sqrt{3}$ | 1  | 1,732%                   |
| Combined standard uncertainty                     | B.2.2                 |                       |                          |            |    | 2,299%                   |
| Expanded uncertainty (confidence interval of 95%) | B.2.2                 |                       |                          |            |    | 4,506%                   |

Uncertainty analysis for the technique using reference antennas

| ERROR SOURCES                                     | Description (Section) | Uncertainty value (%) | Probability Distribution | Divisor    | ci | Standard Uncertainty (%) |
|---------------------------------------------------|-----------------------|-----------------------|--------------------------|------------|----|--------------------------|
| Incident Power                                    | B.2.2                 | 0,20%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,200%                   |
| Reflection coefficients                           | B.2.2                 | 0,75%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,433%                   |
| Antenna Gain                                      | B.2.2                 | 2,50%                 | Normal                   | 1          | 1  | 2,500%                   |
| Liquid Permittivity                               | B.2.2                 | 3,00%                 | Rectangular              | $\sqrt{3}$ | 0  | 1,732%                   |
| Probe Positioning                                 | B.2.2                 | 2,50%                 | Rectangular              | $\sqrt{3}$ | 1  | 1,443%                   |
| Combined standard uncertainty                     | B.2.2                 |                       |                          |            |    | 2,926%                   |
| Expanded uncertainty (confidence interval of 95%) | B.2.2                 |                       |                          |            |    | 5,735%                   |

Uncertainty on measurement system

| ERROR SOURCES                                     | Description (Section) | Uncertainty value (%) | Probability Distribution | Divisor    | ci | Standard Uncertainty (%) |
|---------------------------------------------------|-----------------------|-----------------------|--------------------------|------------|----|--------------------------|
| Probe Calibration                                 | 7.2.1.                | 5,73%                 | Normal                   | 1          | 1  | 5,735%                   |
| Axial Isotropy                                    | 7.2.1.                | 5,00%                 |                          |            |    |                          |
| Hemispherical Isotropy                            | 7.2.1.                | 10,00%                |                          |            |    |                          |
| Total Isotropy                                    | 7.2.1.                | 7,50%                 | Rectangular              | $\sqrt{3}$ | 1  | 4,330%                   |
| Linearity                                         | 7.2.1.                | 4,60%                 | Rectangular              | $\sqrt{3}$ | 1  | 2,656%                   |
| Detection Limits                                  | 7.2.1.                | 0,50%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,289%                   |
| Boundary Effect                                   | 7.2.1.                | 0,50%                 | Rectangular              | $\sqrt{3}$ | 1  | 0,289%                   |
| Readout Electronics                               | 7.2.1.                | 0,02%                 | Normal                   | 1          | 1  | 0,020%                   |
| Response Time                                     | 7.2.1.                | 0,50%                 | Normal                   | 1          | 1  | 0,500%                   |
| Noise                                             | 7.2.1.                | 0,50%                 | Normal                   | 1          | 1  | 0,500%                   |
| Integration Time                                  | 7.2.1.                | 0,50%                 | Normal                   | 1          | 1  | 0,500%                   |
| Combined standard uncertainty                     |                       |                       |                          |            |    | 7,721%                   |
| Expanded uncertainty (confidence interval of 95%) |                       |                       |                          |            |    | 15,132%                  |

**CALIBRATION @ 2450 MHz**

**Calibration parameters**

| Label                    | Bluetooth2450 |
|--------------------------|---------------|
| Epsilon                  | 38.59         |
| Sigma                    | 1.71 S/m      |
| Temperature              | 21 °C         |
| Cable loss               | 3.30 dB       |
| Coupler loss             | 21.50 dB      |
| Waveguide S11            | -11.70 dB     |
| Low limit detection (CW) | 2.16 V/m      |

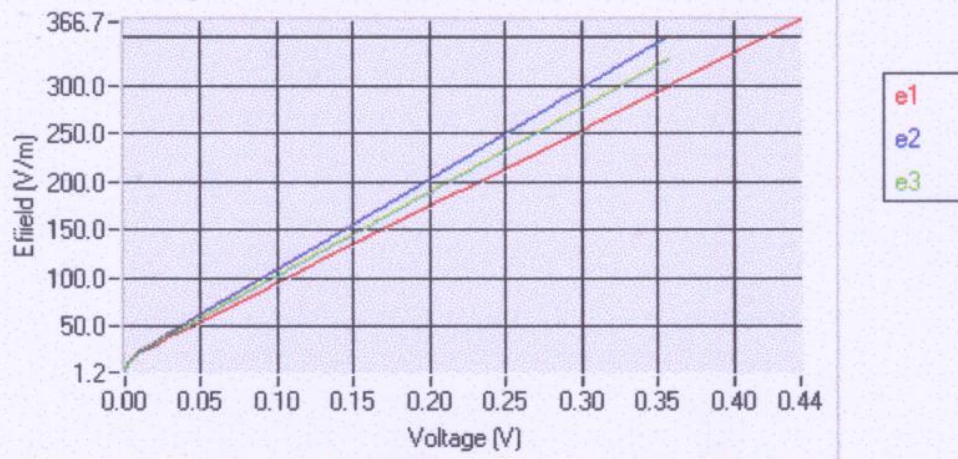
**Calibration curves**

Calibration curves  $e_i = f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:  $E = \sqrt{e_1^2 + e_2^2 + e_3^2}$

The following tables show the calibration curves linearisation by curve segment in CW and TDMA signal. TDMA coefficients have been calculated from CW coefficients using the formula:

$$E_{tdma}(V) = 1/8 * (E_{cw}(V * 8))$$

**Calibration curves**

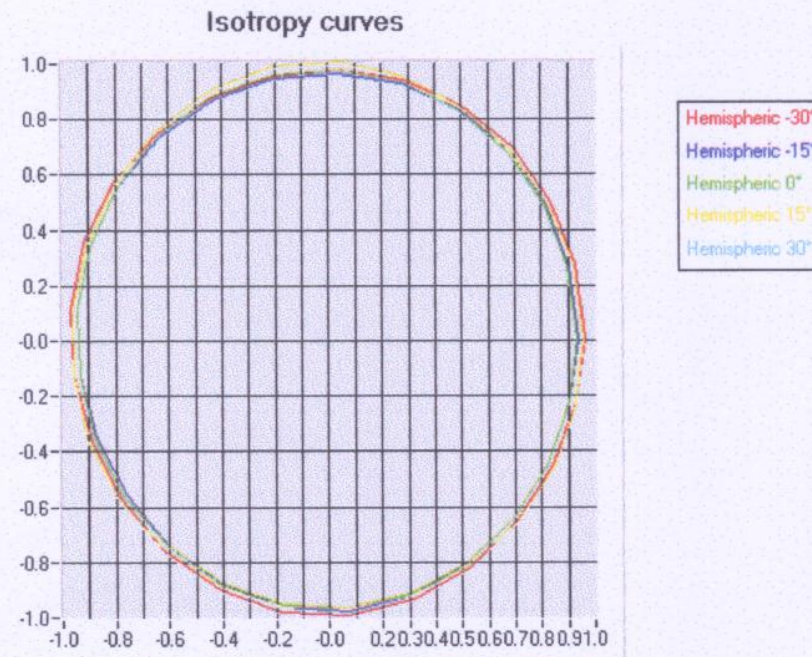


**Calibration coefficients for the three dipoles in CW:**

| v1        | e1         | v2        | e2         | v3        | e3         |
|-----------|------------|-----------|------------|-----------|------------|
| 0.331523  | 306.842468 | 0.326012  | 354.721771 | 0.326263  | 332.115631 |
| 0.252046  | 237.077667 | 0.246535  | 272.237000 | 0.275022  | 282.456696 |
| 0.190897  | 183.399857 | 0.185386  | 208.772293 | 0.228393  | 237.266754 |
| 0.123124  | 123.908760 | 0.117613  | 138.434387 | 0.151276  | 162.529892 |
| 0.032362  | 44.210320  | 0.026851  | 44.210320  | 0.066804  | 80.665092  |
| 0.026892  | 39.493320  | 0.022182  | 39.447880  | 0.029269  | 44.261246  |
| 0.022100  | 35.198460  | 0.018172  | 35.198460  | 0.024259  | 39.493320  |
| 0.017775  | 31.047285  | 0.014543  | 31.011562  | 0.019922  | 35.198460  |
| 0.013999  | 27.165873  | 0.011410  | 27.165873  | 0.015993  | 31.047285  |
| 0.011090  | 23.934462  | 0.009013  | 23.934462  | 0.012569  | 27.197166  |
| 0.008847  | 21.184765  | 0.007149  | 21.184765  | 0.009933  | 23.934462  |
| 0.007091  | 18.859217  | 0.005723  | 18.859217  | 0.007907  | 21.184765  |
| 0.005693  | 16.847042  | 0.004586  | 16.847042  | 0.006339  | 18.859217  |
| 0.004596  | 15.101624  | 0.003700  | 15.101624  | 0.005074  | 16.847042  |
| 0.003721  | 13.568244  | 0.002992  | 13.568244  | 0.004102  | 15.101624  |
| 0.002989  | 12.218662  | 0.002423  | 12.218662  | 0.003310  | 13.568244  |
| 0.002437  | 11.028683  | 0.001965  | 11.028683  | 0.002689  | 12.218662  |
| 0.001946  | 9.920273   | 0.001592  | 9.920273   | 0.002177  | 11.028683  |
| 0.001485  | 8.680079   | 0.001185  | 8.680079   | 0.001754  | 9.920273   |
| 0.001111  | 7.629984   | 0.000891  | 7.638774   | 0.001320  | 8.680079   |
| 0.000865  | 6.753419   | 0.000685  | 6.753419   | 0.000993  | 7.629984   |
| 0.000649  | 6.005147   | 0.000517  | 6.005147   | 0.000755  | 6.745648   |
| 0.000471  | 5.364430   | 0.000388  | 5.364430   | 0.000564  | 6.005147   |
| 0.000355  | 4.808655   | 0.000308  | 4.808655   | 0.000433  | 5.358259   |
| 0.000263  | 4.320397   | 0.000232  | 4.320397   | 0.000299  | 4.808655   |
| 0.000191  | 3.890663   | 0.000175  | 3.895145   | 0.000241  | 4.315425   |
| 0.000126  | 3.519846   | 0.000121  | 3.515796   | 0.000169  | 3.890663   |
| 0.000081  | 3.173391   | 0.000075  | 3.177047   | 0.000121  | 3.511751   |
| 0.000042  | 2.776666   | 0.000040  | 2.783066   | 0.000079  | 3.177047   |
| 0.000018  | 2.449197   | -0.000017 | 2.112706   | 0.000039  | 2.776666   |
| 0.000001  | 2.495896   | -0.000030 | 1.923197   | -0.000012 | 2.446378   |
| -0.000012 | 2.371874   | -0.000032 | 1.891552   | -0.000029 | 2.169821   |
| -0.000014 | 2.351701   | -0.000059 | 1.409006   | -0.000042 | 2.006022   |
| -0.000041 | 2.067210   | 0.000000  | 0.000000   | -0.000044 | 1.978931   |
| -0.000116 | 0.882160   | 0.000000  | 0.000000   | -0.000113 | 0.513818   |

**Isotropy:**

- Axial isotropy: 0.13 dB
- Hemispherical isotropy: 0.23 dB



$E\text{-field } E \text{ (V/m)} = f(\phi, \theta)$