

**COMOSAR E-Field probe  
Calibration Report**



**Ref: CR-131-1-09-SATB-A**

Page: 1/17

Issue: A

Date: 2009/05/11

**COMOSAR E-FIELD PROBE CALIBRATION REPORT**

Prepared By: BUTET Romain, SATIMO

Project Description: COMOSAR E-FIELD PROBE

Prepared For (End User): CCS

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**COMOSAR E-Field probe  
Calibration Report**



**Ref: CR-131-1-09-SATB-A**

Page: 2/17

Issue: A

Date: 2009/05/11

**COMOSAR SEPT ISOTROPIC E-FIELD PROBE CALIBRATION REPORT**

**DATE:** 6/8/2009

**OFFER REFERENCE:** PF.127.1.09.SATB.A

**OBJECT:** COMOSAR SEPT ISOTROPIC E-FIELD PROBE

**MANUFACTURER:** SATIMO

**SERIAL NUMBER:** SN 11/09 EP100

**CUSTOMER:** CCS

**CONTRACT:** B01351

**DATE OF CALIBRATION:** 16/04/2009

**WARRANTY:**

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Date

11/05/2009

SAR TEAM MANAGER

A handwritten signature in black ink, appearing to be "P.A.", written over a rectangular background.

# COMOSAR E-Field probe Calibration Report



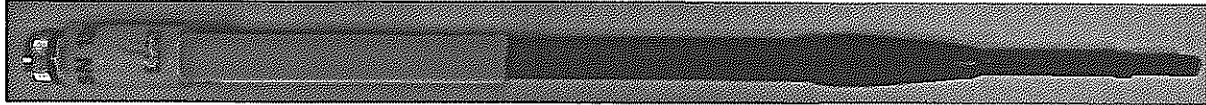
Ref: CR-131-1-09-SATB-A

Page: 3/17

Issue: A

Date: 2009/05/11

## 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=2.5307 MΩ Dipole 2: R2=2.6353 MΩ Dipole 3: R3=2.5471 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	DATE OF CALIBRATION
Calibration bench	CALISAR CALIBRATION SYSTEM V2.0	
Multimeter	Keithley (2000, SN: 1000572)	Date of calibration: 01-07-2008

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

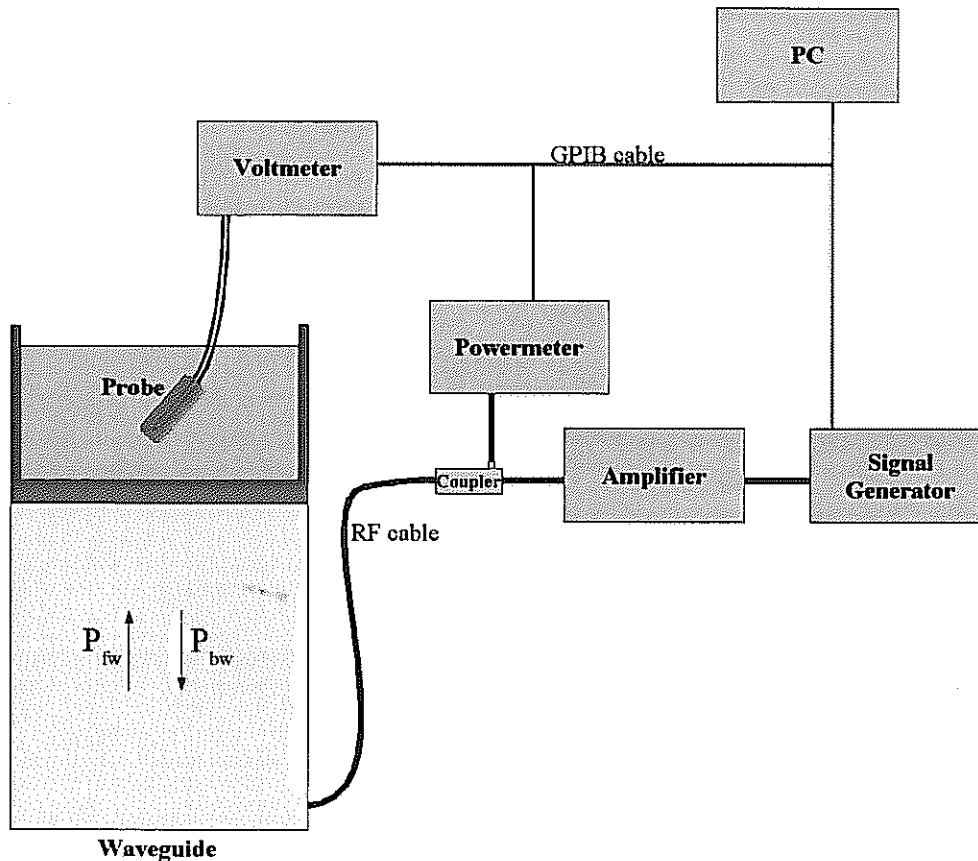
Page: 4/17

Issue: A

Date: 2009/05/11

## MEASUREMENT PROCEDURE

Probe calibration is realized, in compliance with CENELEC EN 50361 and IEEE 1528 std, with CALISAR, SATIMO 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
- d = 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.

**COMOSAR E-Field probe  
Calibration Report**



**Ref: CR-131-1-09-SATB-A**

Page: 5/17

Issue: A

Date: 2009/05/11

**PROBE UNCERTAINTIES**

**Calibration report of dosimetric  
SATIMO probe**

**Uncertainty on calibration system**

<b>ERROR SOURCES</b>	<b>Uncertainty value (%)</b>	<b>Probability Distribution</b>	<b>Divisor</b>	<b>ci</b>	<b>Standard Uncertainty (%)</b>
Incident or forward power	3,00%	Rectangular	$\sqrt{3}$	1	1,732%
Reflected power	3,00%	Rectangular	$\sqrt{3}$	1	1,732%
Liquid conductivity	5,00%	Rectangular	$\sqrt{3}$	1	2,887%
Liquid permittivity	4,00%	Rectangular	$\sqrt{3}$	1	2,309%
Field homogeneity	3,00%	Rectangular	$\sqrt{3}$	1	1,732%
Field probe positioning	5,00%	Rectangular	$\sqrt{3}$	1	2,887%
Field probe linearity	3,00%	Rectangular	$\sqrt{3}$	1	1,732%
<b>Combined standard uncertainty</b>					4,761%
<b>Expanded uncertainty (confidence interval of 95%)</b>					9,331%

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 6/17

Issue: A

Date: 2009/05/11

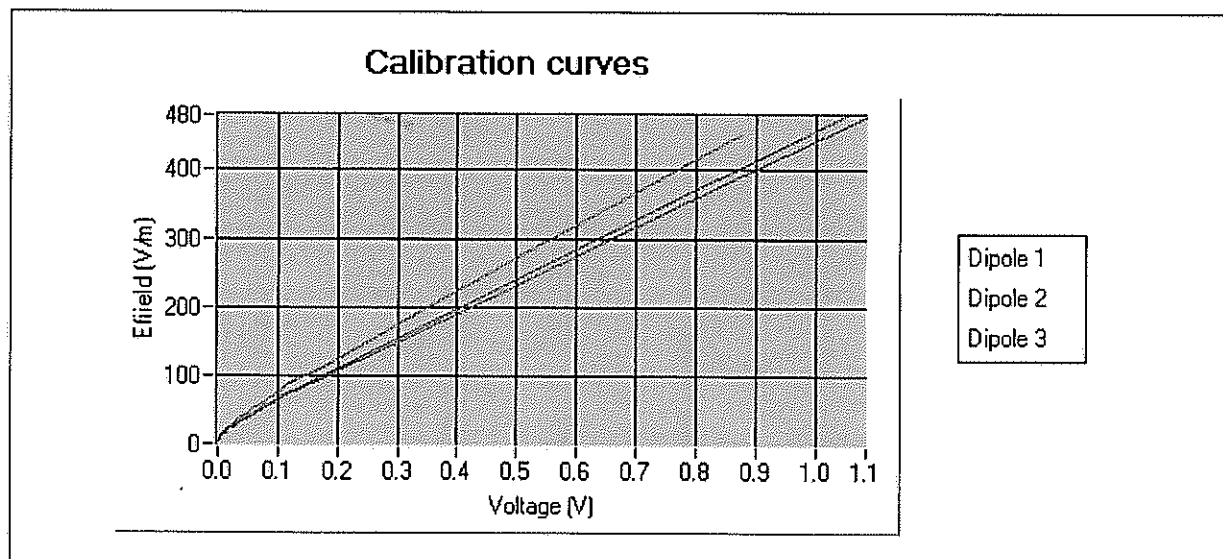
## 1. Calibration at 835.00 MHz

### A. Calibration parameters.

Label	850
Epsilon	41.82
Sigma	0.89 S/m
Temperature	21°C
Cable loss	0.11 dB
Coupler loss	20.50 dB
Waveguide S11	-11.20 dB
Low limit detection	0.824 V/m (0.604 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 7/17

Issue: A

Date: 2009/05/11

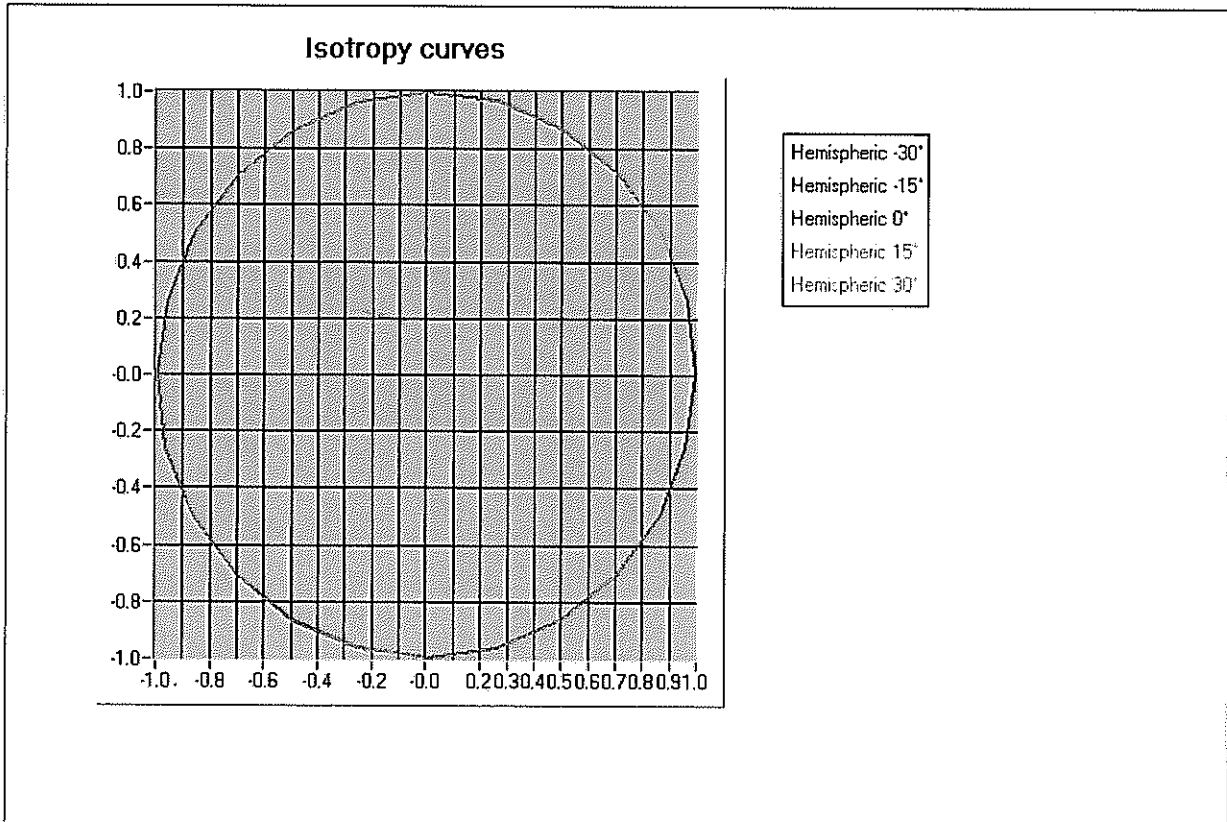
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	41.82	0.89	20.63	20.50	28.35
Body	55.09	0.94	20.01	19.89	27.76

## B. Isotropy.

- Axial isotropy: 0.029 dB
- Hemispherical isotropy: 0.030 dB



## C. Linearity.

- Linearity: 0.04 dB

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 8/17

Issue: A

Date: 2009/05/11

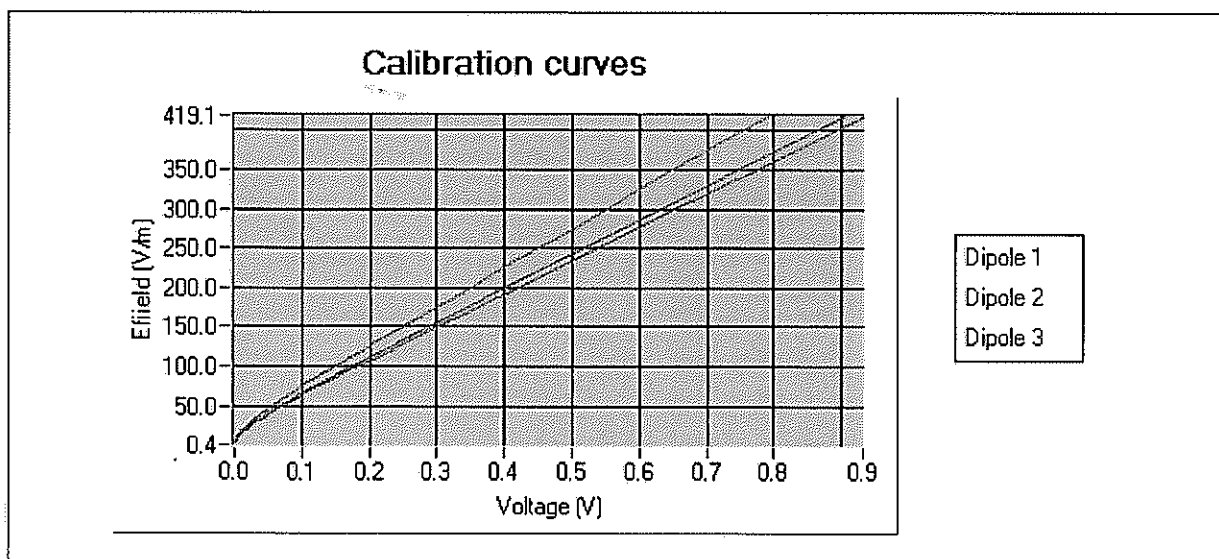
## 2. Calibration at 897.00 MHz

### A. Calibration parameters.

Label	900
Epsilon	41.24
Sigma	0.94 S/m
Temperature	21°C
Cable loss	0.10 dB
Coupler loss	20.27 dB
Waveguide S11	-16.70 dB
Low limit detection	0.795 V/m (0.59 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.



# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 9/17

Issue: A

Date: 2009/05/11

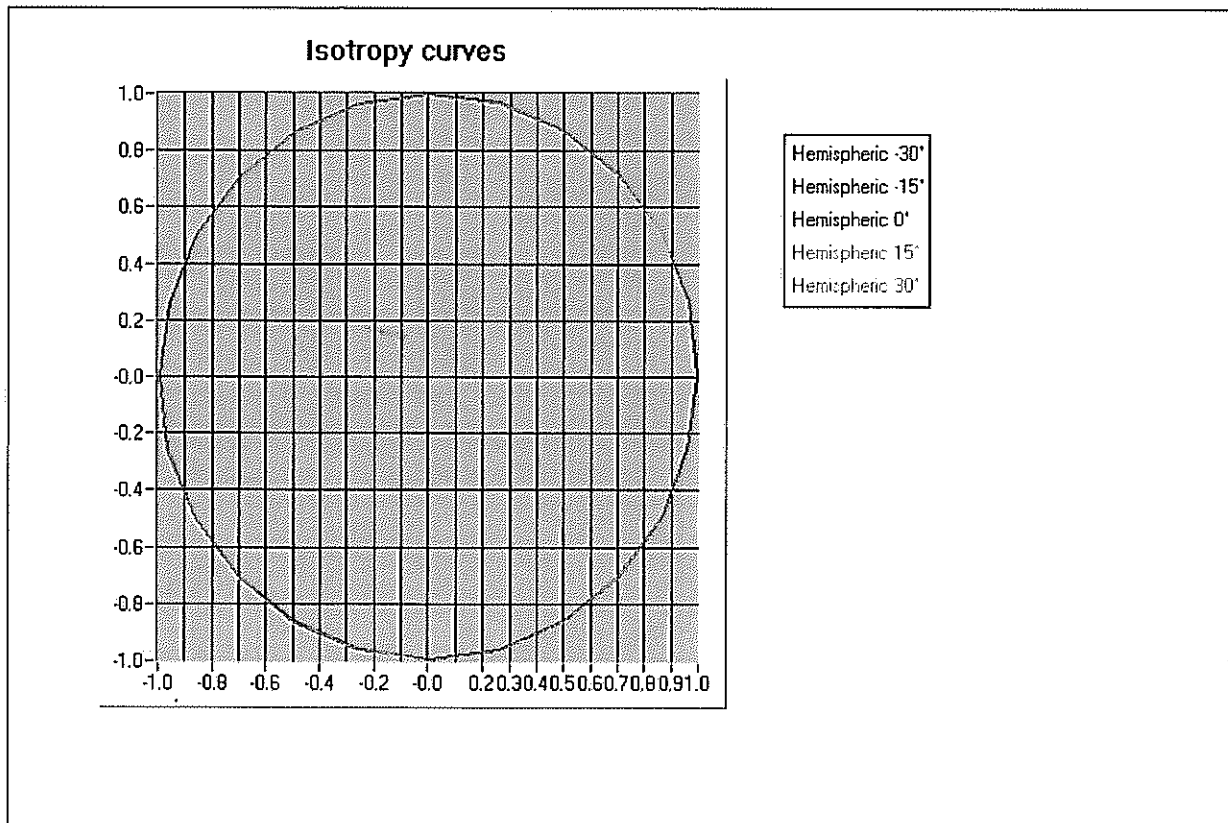
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	41.24	0.94	22.07	22.01	30.17
Body	55.99	1.02	21.56	21.33	29.11

## B. Isotropy.

- Axial isotropy: 0.029 dB
- Hemispherical isotropy: 0.030 dB



## C. Linearity.

- Linearity:

0.04 dB

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 10/17

Issue: A

Date: 2009/05/11

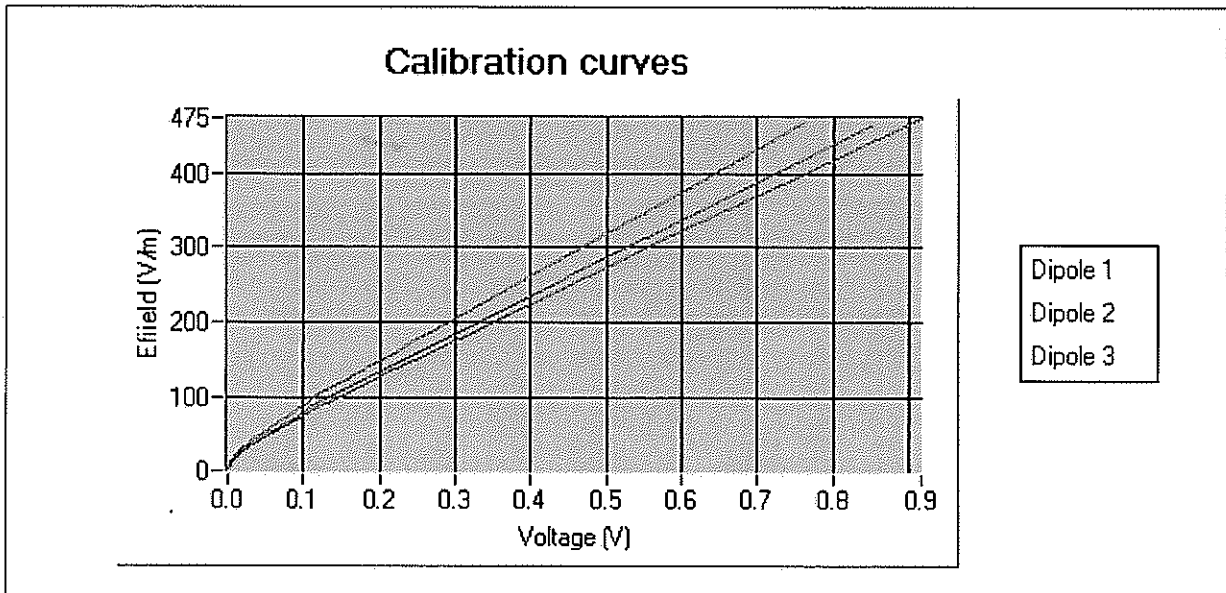
## 3. Calibration at 1747.00 MHz

### A. Calibration parameters.

Label	1800
Epsilon	38.57
Sigma	1.34 S/m
Temperature	21°C
Cable loss	0.18 dB
Coupler loss	20.20 dB
Waveguide S11	-13.15 dB
Low limit detection	0.832 V/m (0.93 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 11/17

Issue: A

Date: 2009/05/11

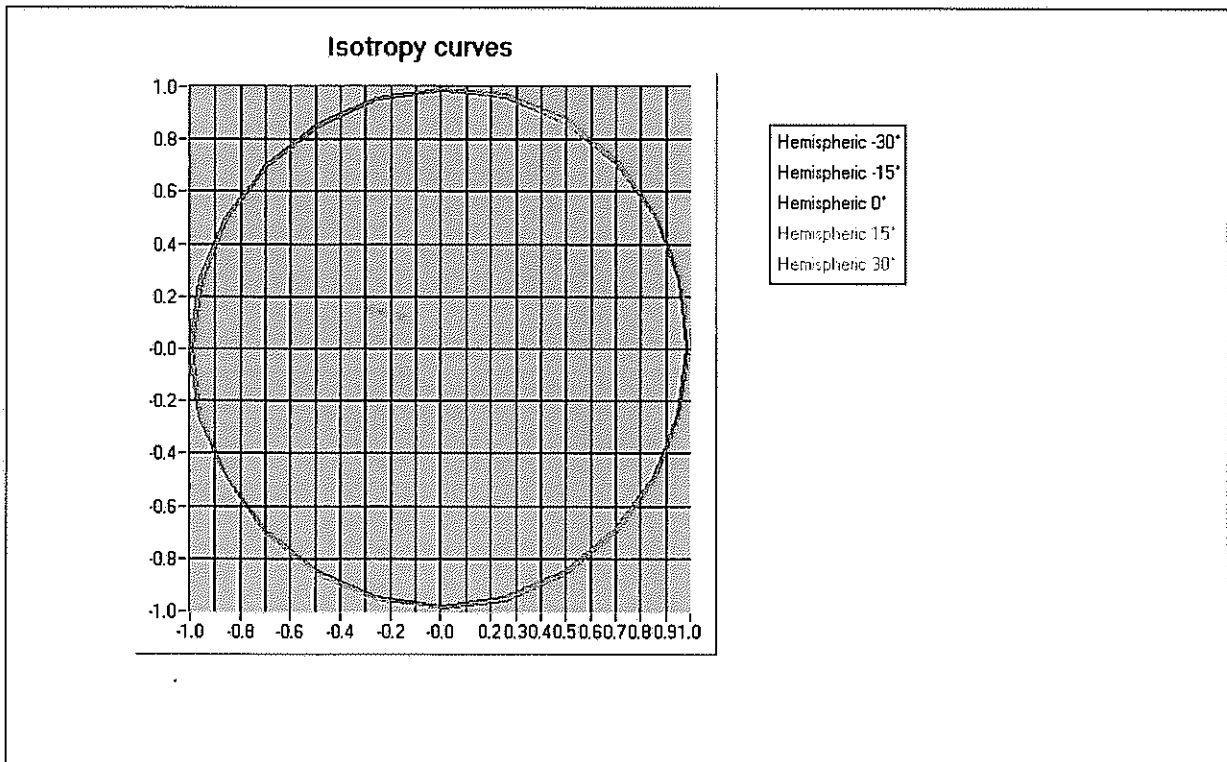
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	38.57	1.34	37.12	38.57	50.40
Body	51.99	1.49	36.65	37.99	49.65

## B. Isotropy.

- Axial isotropy: 0.050 dB
- Hemispherical isotropy: 0.076 dB



## C. Linearity.

- Linearity: 0.03 dB

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 12/17

Issue: A

Date: 2009/05/11

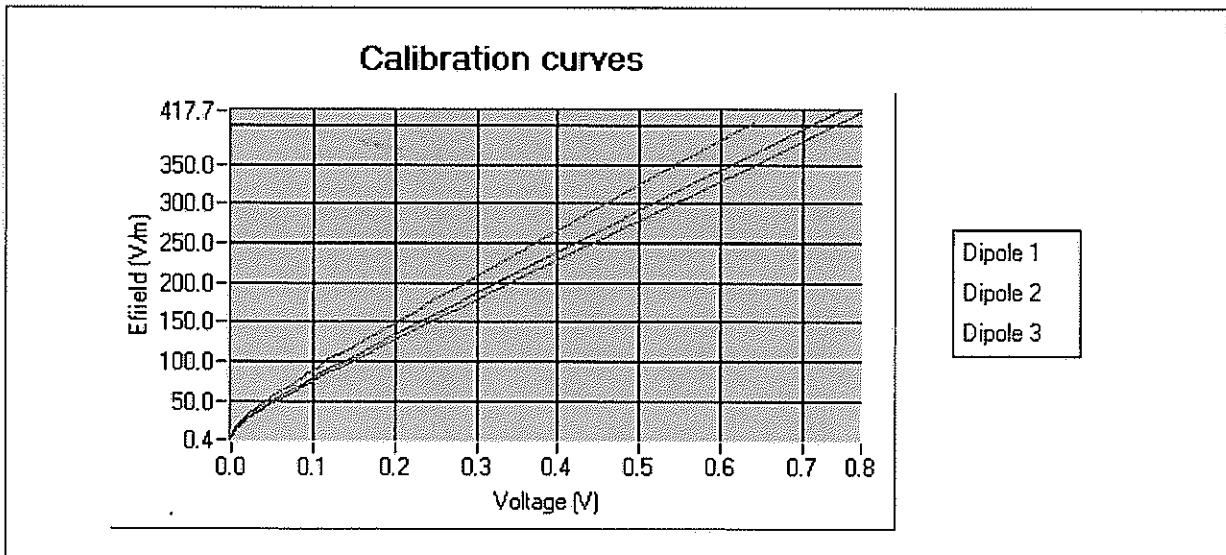
## 4. Calibration at 1880.00 MHz

### A. Calibration parameters.

Label	1900
Epsilon	38.34
Sigma	1.45 S/m
Temperature	21°C
Cable loss	0.18 dB
Coupler loss	21.15 dB
Waveguide S11	-26.90 dB
Low limit detection	0.796 V/m (0.92 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 13/17

Issue: A

Date: 2009/05/11

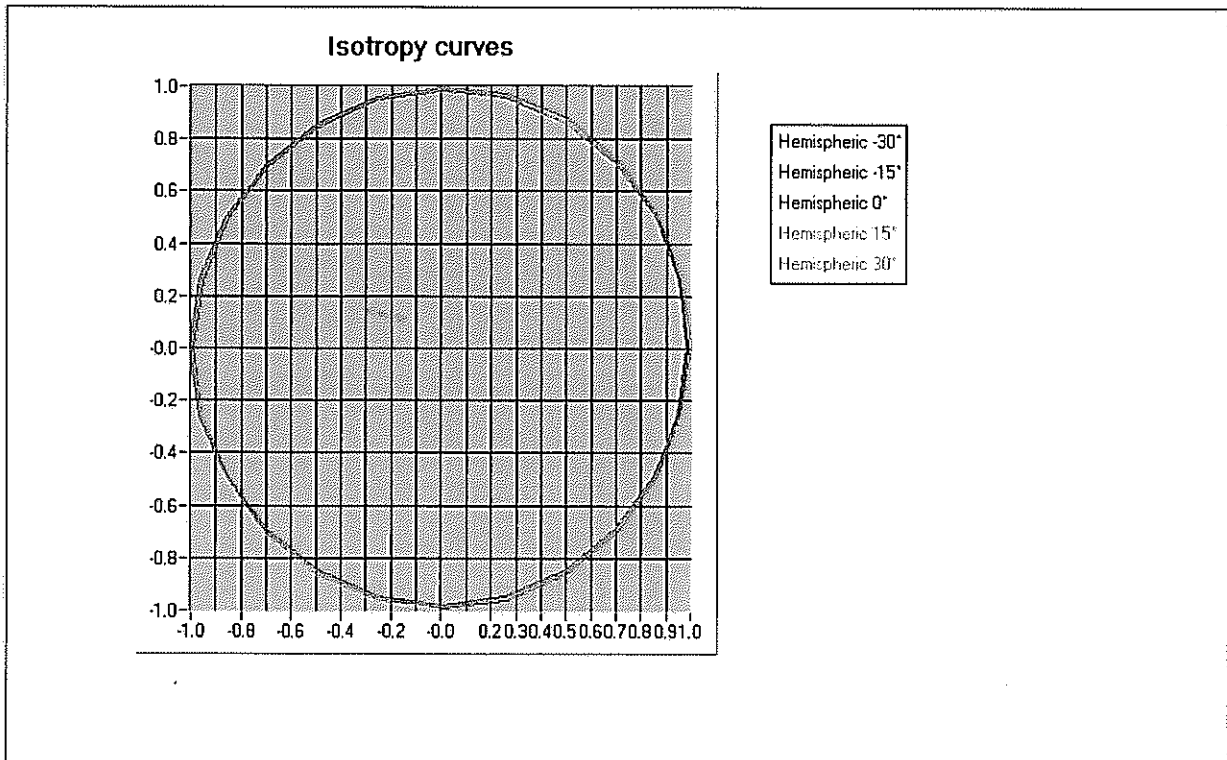
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	38.34	1.45	41.07	42.36	55.46
Body	52.13	1.50	40.41	41.11	54.77

## B. Isotropy.

- Axial isotropy: 0.050 dB
- Hemispherical isotropy: 0.076 dB



## C. Linearity.

- Linearity: 0.03 dB

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 14/17

Issue: A

Date: 2009/05/11

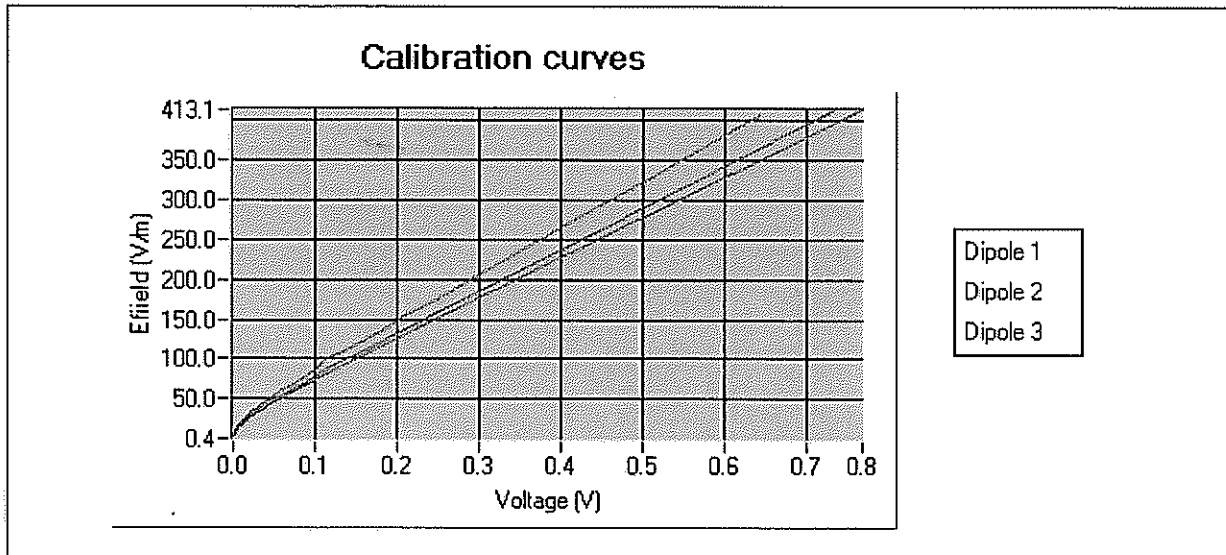
## 5. Calibration at 1950.00 MHz

### A. Calibration parameters.

Label	2000
Epsilon	38.19
Sigma	1.47 S/m
Temperature	21°C
Cable loss	0.19 dB
Coupler loss	20.10 dB
Waveguide S11	-30.10 dB
Low limit detection	0.787 V/m (0.94 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 15/17

Issue: A

Date: 2009/05/11

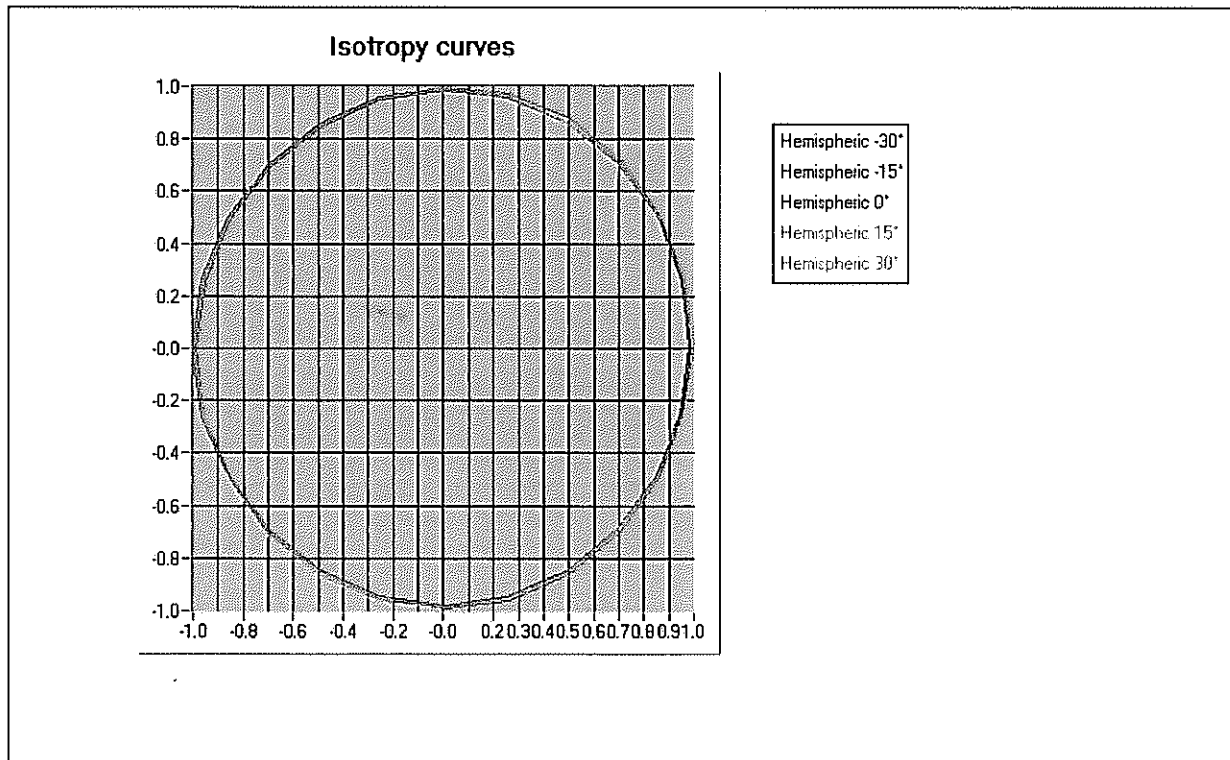
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	38.19	1.46	41.92	43.16	56.44
Body	54.05	1.52	41.01	42.41	55.66

## B. Isotropy.

- Axial isotropy: 0.050 dB
- Hemispherical isotropy: 0.076 dB



## C. Linearity.

- Linearity: 0.03 dB

# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 16/17

Issue: A

Date: 2009/05/11

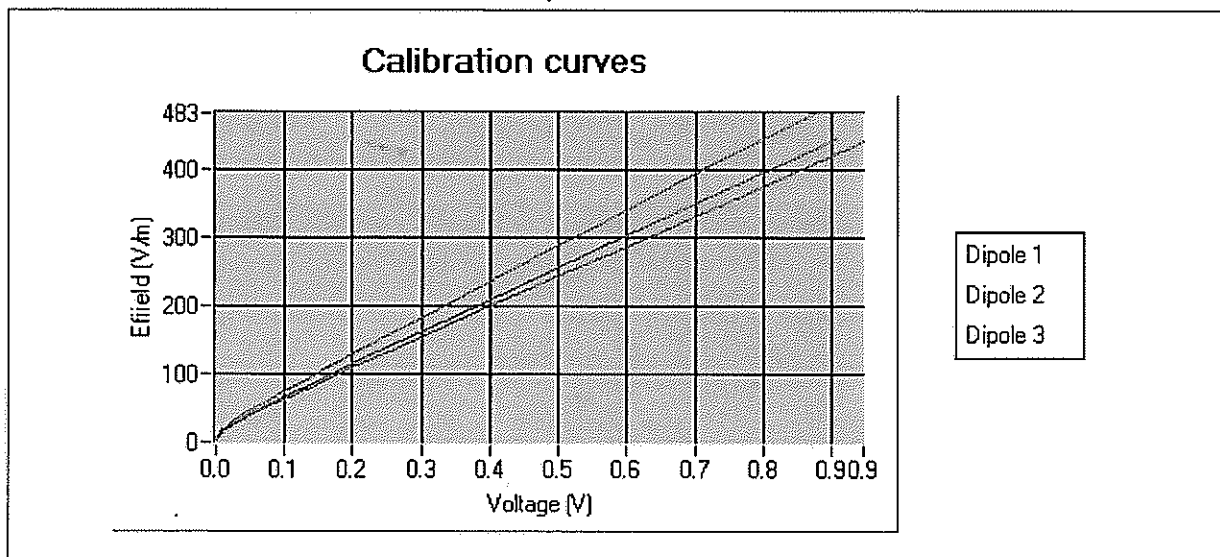
## 6. Calibration at 2450.00 MHz

### A. Calibration parameters.

Label	2450
Epsilon	37.44
Sigma	1.75 S/m
Temperature	21°C
Cable loss	0.20 dB
Coupler loss	21.50 dB
Waveguide S11	-13.65 dB
Low limit detection	0.793 V/m (1.09 mW/kg)

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 represent the calibration curves linearization by curve segment in CW signal.



# COMOSAR E-Field probe Calibration Report



Ref: CR-131-1-09-SATB-A

Page: 17/17

Issue: A

Date: 2009/05/11

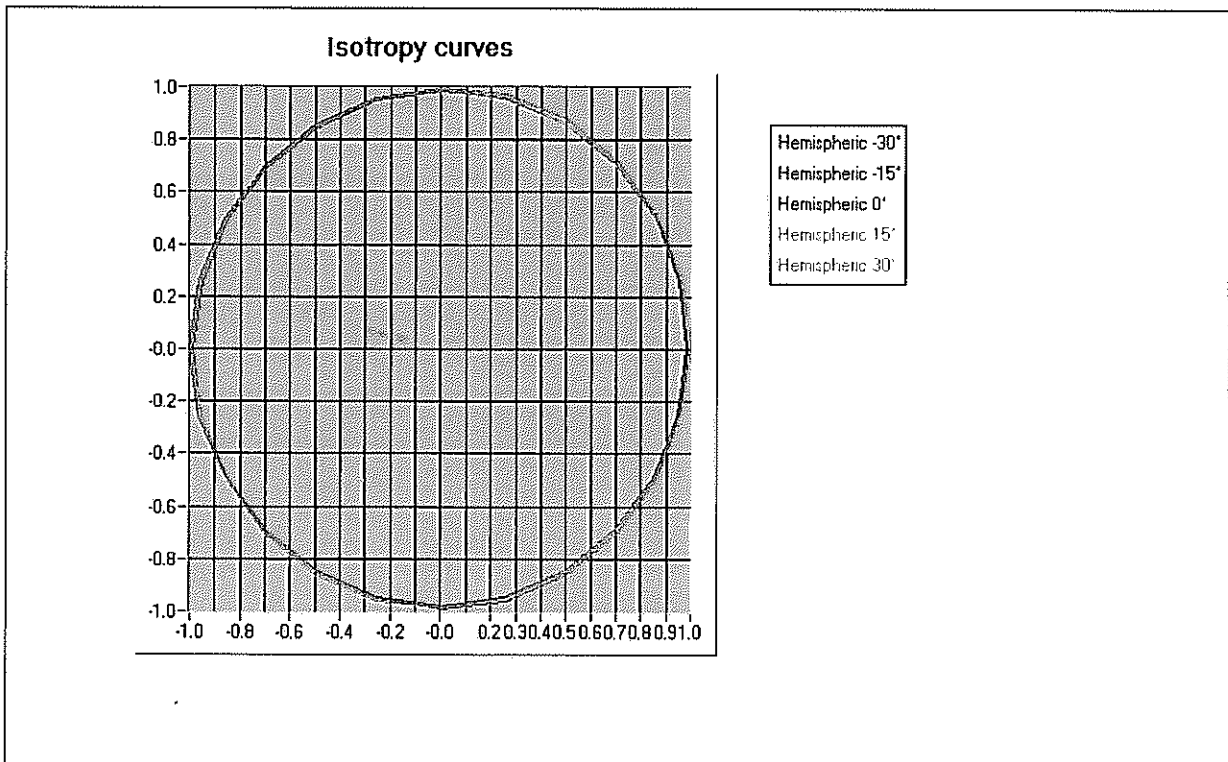
Calibration coefficients for the three dipoles in CW:

Sensitivity in liquid:

Liquid	Epsilon	Sigma (S/m)	CF dipole 1 (W.kg-1 (mV)-1)	CF dipole 2 (W.kg-1 (mV)-1)	CF dipole 3 (W.kg-1 (mV)-1)
Head	37.44	1.75	51.19	53.87	70.49
Body	53.70	1.96	50.36	52.99	69.77

## B. Isotropy.

- Axial isotropy: 0.050 dB
- Hemispherical isotropy: 0.076 dB



## C. Linearity.

- Linearity: 0.03 dB