

**COMOSAR E-Field probe
Calibration Report**



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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 SEPT ISOTROPIC E-FIELD PROBE CALIBRATION REPORT

DATE: 5/11/2009

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 MAI 2009

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29200 BREST

SAR TEAM MANAGER

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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

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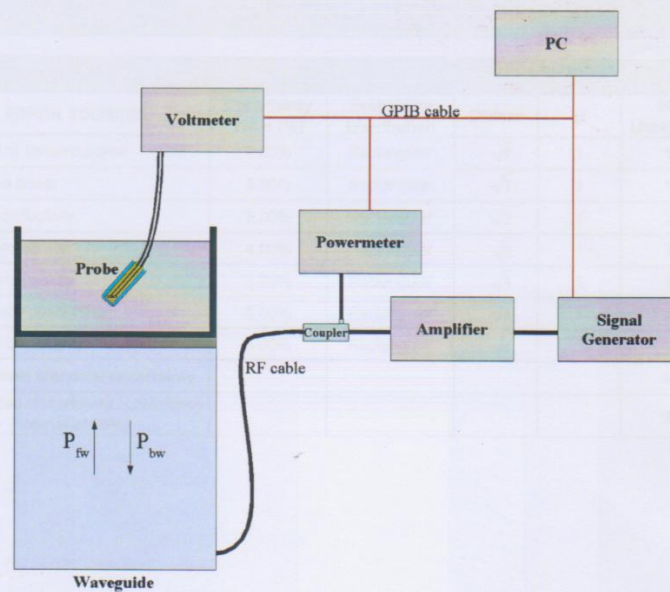
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MEASUREMENT PROCEDURE

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.

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PROBE UNCERTAINTIES

**Calibration report of dosimetric
SATIMO probe**

Uncertainty on calibration system

ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
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%
Combined standard uncertainty					4,761%
Expanded uncertainty (confidence interval of 95%)					9,331%

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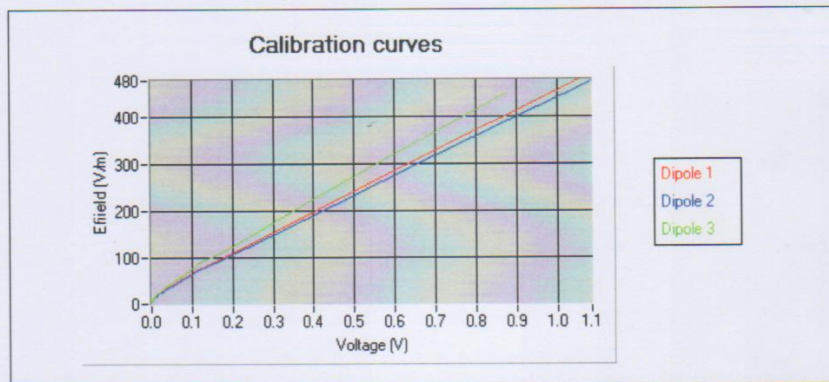
1. Calibration at 835.00 MHz

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.

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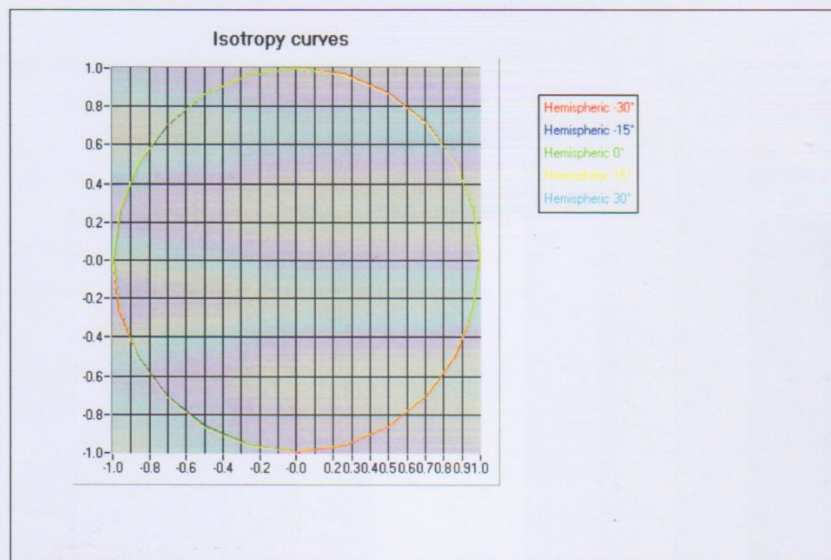
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Calibration coefficients for the three dipoles in CW:

Liquid	Epsilon	Sigma (S/m)	Sensitivity in liquid:		
			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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.04 dB

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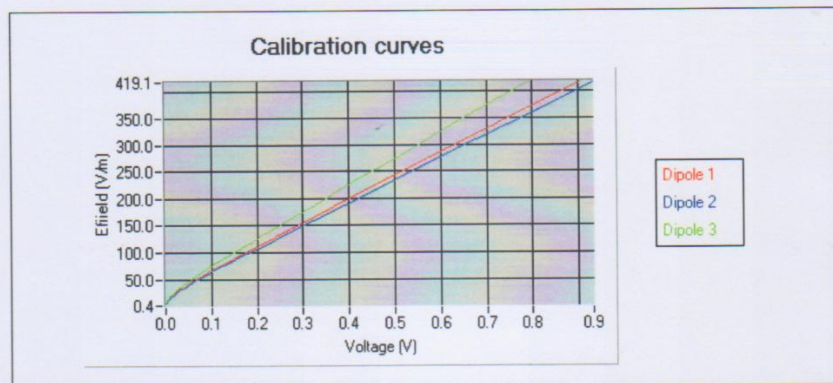
2. Calibration at 897.00 MHz

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.

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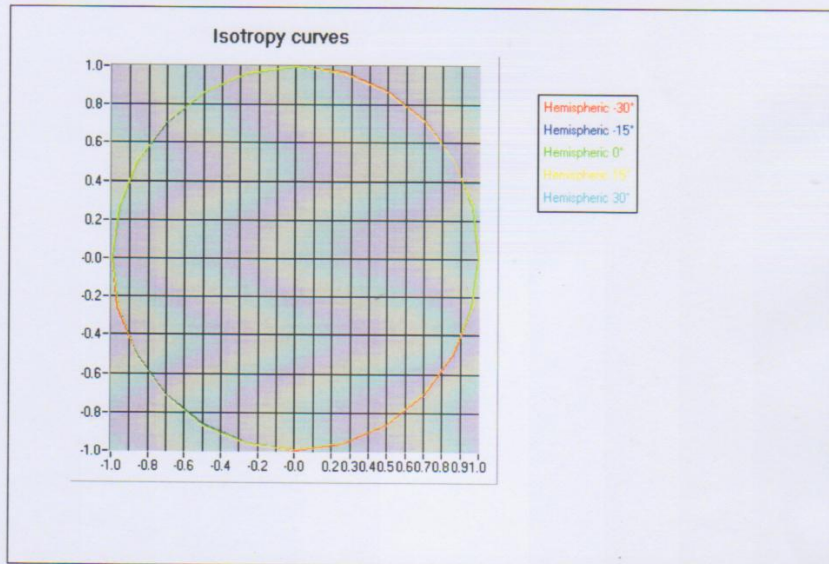
Calibration coefficients for the three dipoles in CW:

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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.04 dB

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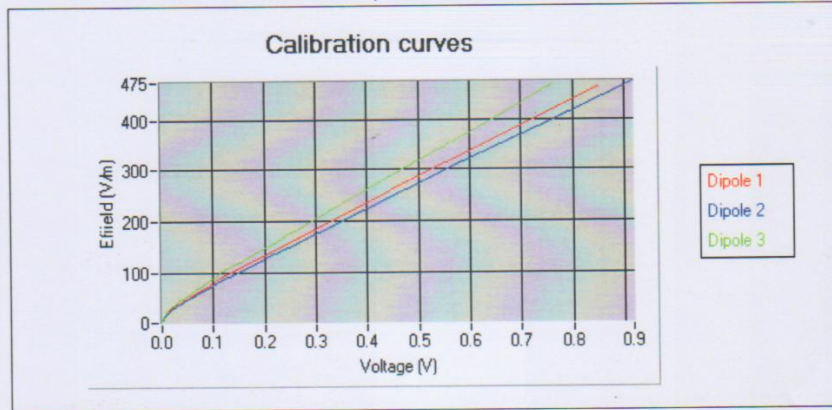
3. Calibration at 1747.00 MHz

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.

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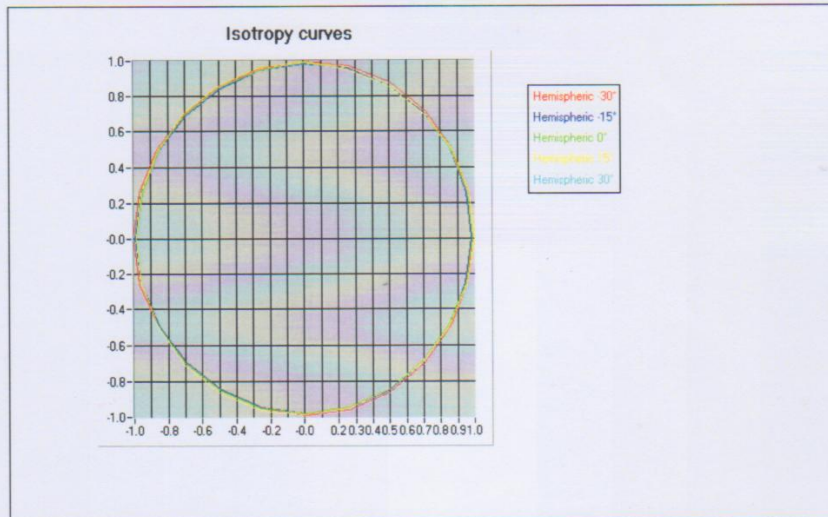
Calibration coefficients for the three dipoles in CW:

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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.03 dB

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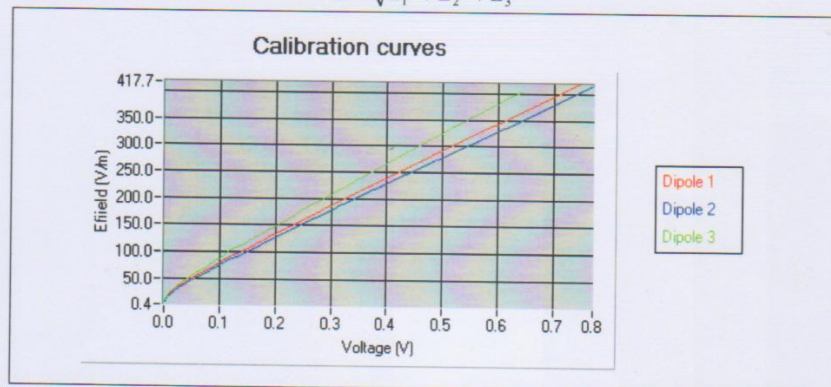
4. Calibration at 1880.00 MHz

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.

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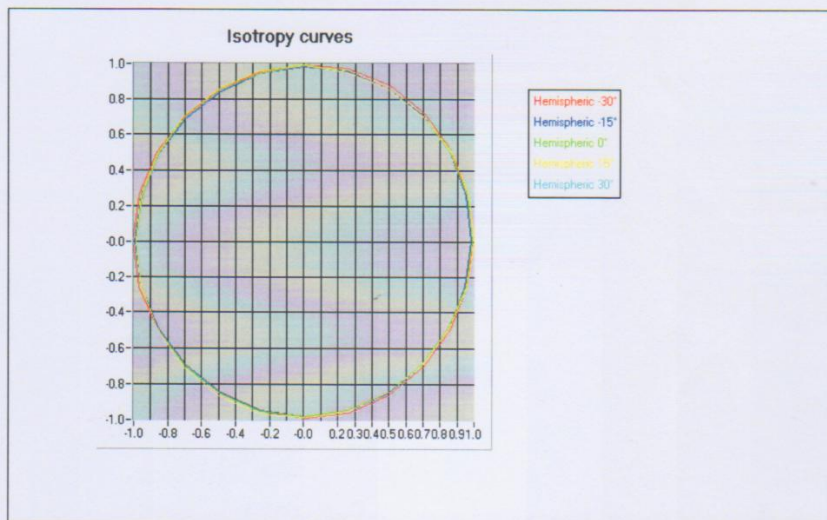
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Calibration coefficients for the three dipoles in CW:

Liquid	Epsilon	Sigma (S/m)	Sensitivity in liquid:		
			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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.03 dB

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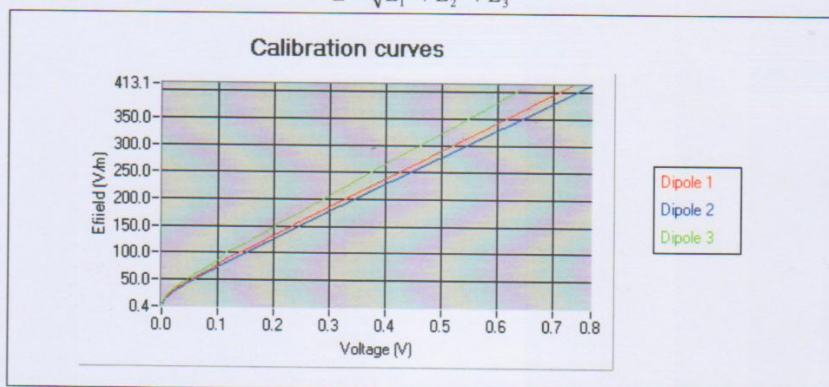
5. Calibration at 1950.00 MHz

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.

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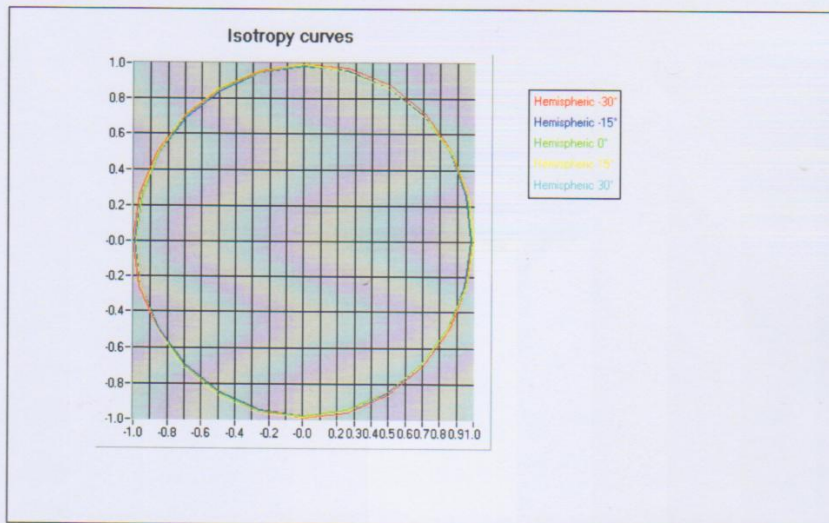
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Calibration coefficients for the three dipoles in CW:

Liquid	Epsilon	Sigma (S/m)	Sensitivity in liquid:		
			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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.03 dB

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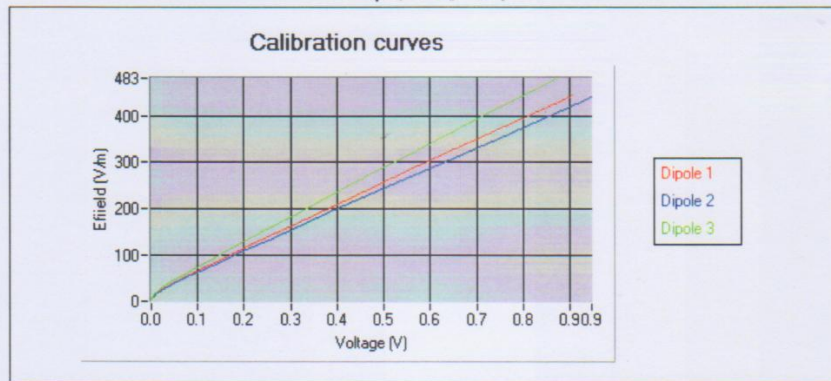
6. Calibration at 2450.00 MHz

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.

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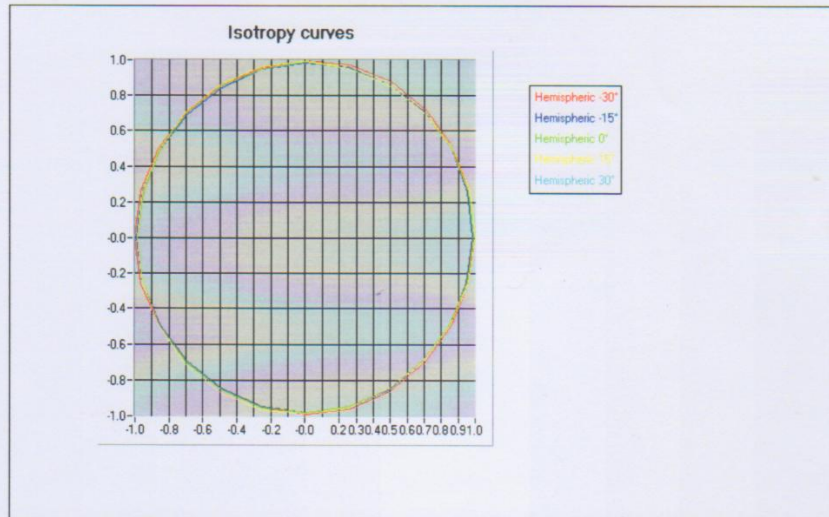
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Calibration coefficients for the three dipoles in CW:

Liquid	Epsilon	Sigma (S/m)	Sensitivity in liquid:		
			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

B. Isotropy.

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



C. Linearity.

- Linearity: 0.03 dB