

**COMOSAR E-Filed probe
Calibration Report**



Ref: CR-280-1-08-SATB-B

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Issue: A

Date: 2012/10/04

COMOSAR E-Filed probe Calibration Report

Prepared By: LUC Jérôme, SATIMO
Project Description: SAR TEST BENCH
Prepared For (End User): Shenzhen Morlab Communication Technology

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**COMOSAR E-Field probe
Calibration Report**



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COMOSAR SEPT ISOTROPIC E-FIELD PROBE CALIBRATION REPORT

DATE: 12/02/2009

REFERENCE: SN 37/08 EP131

OBJECT: COMOSAR SEPT ISOTROPIC E-FIELD PROBE

MANUFACTURER: SATIMO

SERIAL NUMBER: SN 37/08 EP131

CUSTOMER: Shenzhen Morlab Communication Technology

CONTRACT: PF2130108b_SAR_Morlab

DATE OF CALIBRATION: 04/10/2012

WARRANTY:

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Date

04.10.2012

SAR TEAM MANAGER

JCS

SATIMO Bretagne
Technopôle Brest Iroise
Zone du Vernis
225 rue Pierre Rivoalon
29200 BREST

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PRODUCT DESCRIPTION



Frequency Range	100 MHz - 30 GHz
Probe length	330 mm
Length of one dipole	2.0 mm
Maximum external diameter	8 mm
Probe extremity diameter	2.5 mm
Distance between dipoles/probe extremity	1.0 mm
Resistance of the three dipole (at the connector)	Dipole 1: R1=0.1482 MΩ Dipole 2: R2=0.2189 MΩ Dipole 3: R3=0.1968 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

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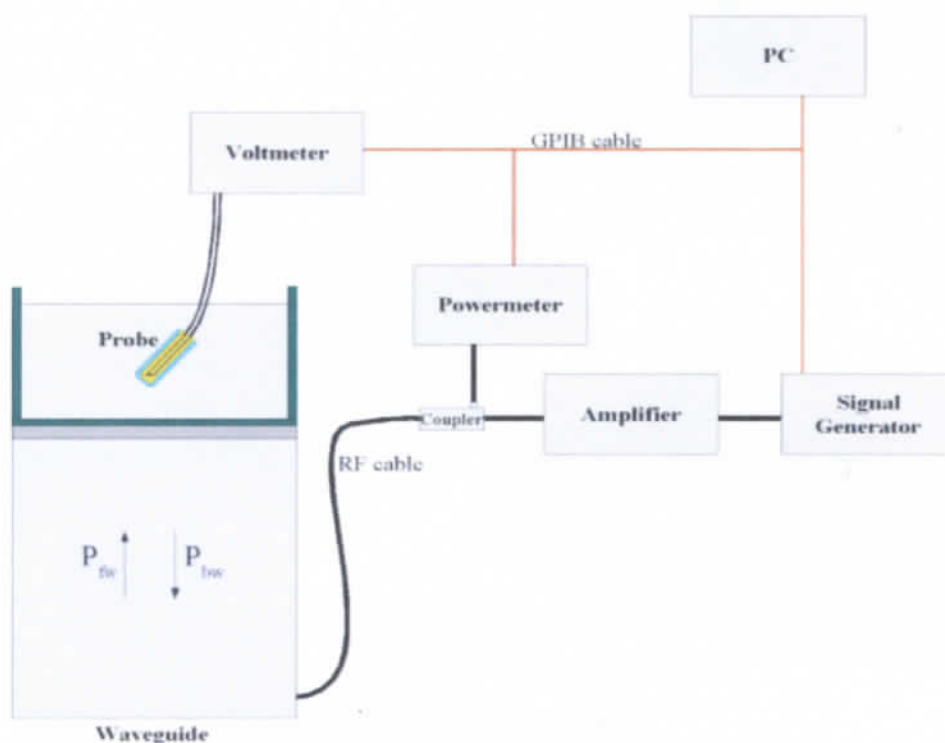
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MEASUREMENT PROCEDURE

Probe calibration is realized, in compliance with CENELEC EN 50361 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 50361 annexe 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

δ = 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	cl	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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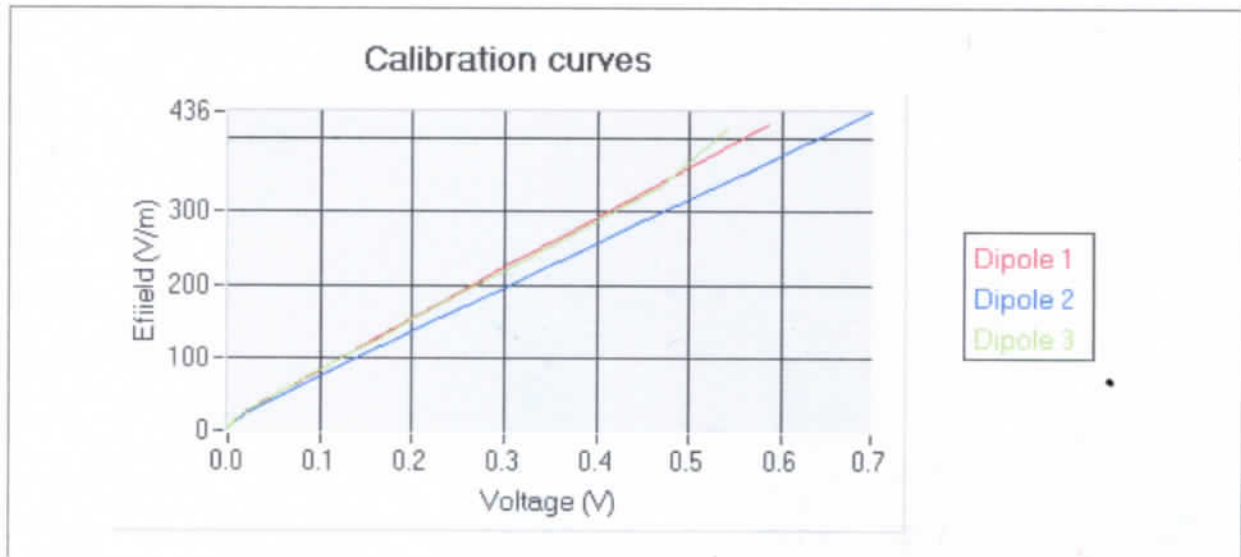
1. Calibration at 5200.00 MHz

A. Calibration parameters.

Frequency	5200.00MHz
Epsilon	HL: 36.0; BL: 49.0
Sigma	HL: 4.66 S/m; BL: 5.30 S/m;
Temperature	21°C
Coupler loss	21.03 dB
S11	-13.50 dB
Low limit detection (CW)	0.72 V/m (0.47 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:

v1	e1	v2	e2	v3	e3
0.671504	419.299857	-0.693489	436.873143	0.542761	412.876502
0.555333	338.949465	-0.553708	352.633111	0.471327	336.343027
0.464494	276.090283	-0.449662	289.899100	0.380396	274.269977
0.390278	224.696643	-0.356435	233.648510	0.307412	224.411485
0.328538	181.896071	-0.284408	190.141051	0.248132	183.871061
0.280049	148.226090	-0.227816	155.902114	0.197282	149.038862
0.241533	121.416762	-0.182842	128.629600	0.159113	122.828894
0.210897	100.018479	-0.144741	105.444922	0.127436	101.001877
0.187378	83.512361	-0.116067	87.911609	0.103041	84.109650
0.168665	70.295219	-0.092680	73.515057	0.083859	70.740129
0.152666	58.894028	-0.074218	62.046443	0.067997	59.584744
0.139416	49.334416	-0.058710	52.292634	0.054923	50.278279
0.129468	42.039602	-0.046176	44.273685	0.044476	42.721001
0.121224	35.868757	-0.036579	37.999230	0.036256	36.651030
0.109355	26.704568	-0.022228	28.275843	0.023842	27.195250
0.105905	23.717145	-0.018286	25.336929	0.020325	24.187121
0.102967	21.257985	-0.014964	22.767105	0.017337	21.661086
0.100518	19.051065	-0.012180	20.649311	0.014846	19.533518
0.098438	17.150496	-0.009822	18.780286	0.012727	17.615362
0.096522	15.328953	-0.007658	16.910019	0.010785	15.722725
0.094853	13.698010	-0.005758	15.239301	0.009054	14.066215
0.093489	12.208979	-0.004231	13.746839	0.007681	12.613645
0.092390	10.956019	-0.003003	12.516899	0.006573	11.376605
0.091519	9.875541	-0.002000	11.373002	0.005669	10.214388
0.090779	8.836132	-0.001169	10.408290	0.004922	9.171383
0.090160	7.837827	-0.000471	9.545066	0.004339	8.311137
0.089626	7.066219	0.000117	8.617620	0.003758	7.403811
0.089185	6.307400	0.000623	7.831656	0.003294	6.588552
0.088800	5.526440	0.001059	6.969345	0.002904	5.803649
0.088623	4.987191	0.001263	6.520520	0.002744	5.321258
0.088391	4.443768	0.001513	5.974590	0.002494	4.774699
0.088204	3.951798	0.001720	5.477959	0.002306	4.289649
0.088074	3.532376	0.001881	5.042548	0.002173	3.876338
0.087957	3.138200	0.002000	4.685423	0.002053	3.467639
0.087865	2.792686	0.002107	4.329134	0.001959	3.125417
0.087792	2.487766	0.002201	3.977986	0.001881	2.804993
0.087736	2.228639	0.002258	3.741053	0.001816	2.506301
0.087669	1.877693	0.002327	3.419879	0.001762	2.227275
0.087628	1.631049	0.002383	3.119052	0.001720	1.982661
0.087595	1.406186	0.002419	2.896878	0.001677	1.695055
0.087560	1.128399	0.002444	2.722989	0.001654	1.518338
0.087558	1.110824	0.002462	2.583815	0.001635	1.354478
0.087537	0.910432	0.002485	2.381308	0.001620	1.208922
0.087524	0.766929	0.002497	2.259637	0.001609	1.089357
0.087520	0.718541	0.002510	2.108561	0.001597	0.940888
0.087508	0.556304	0.002517	2.014934	0.001587	0.795017
0.087504	0.494492	0.002524	1.910789	0.001585	0.762289
0.087498	0.393238	0.002529	1.816713	0.001583	0.727991
0.087493	0.295830	0.002533	1.732115	0.001571	0.467179
0.087490	0.219516	0.002536	1.664228		
0.087488	0.152144				

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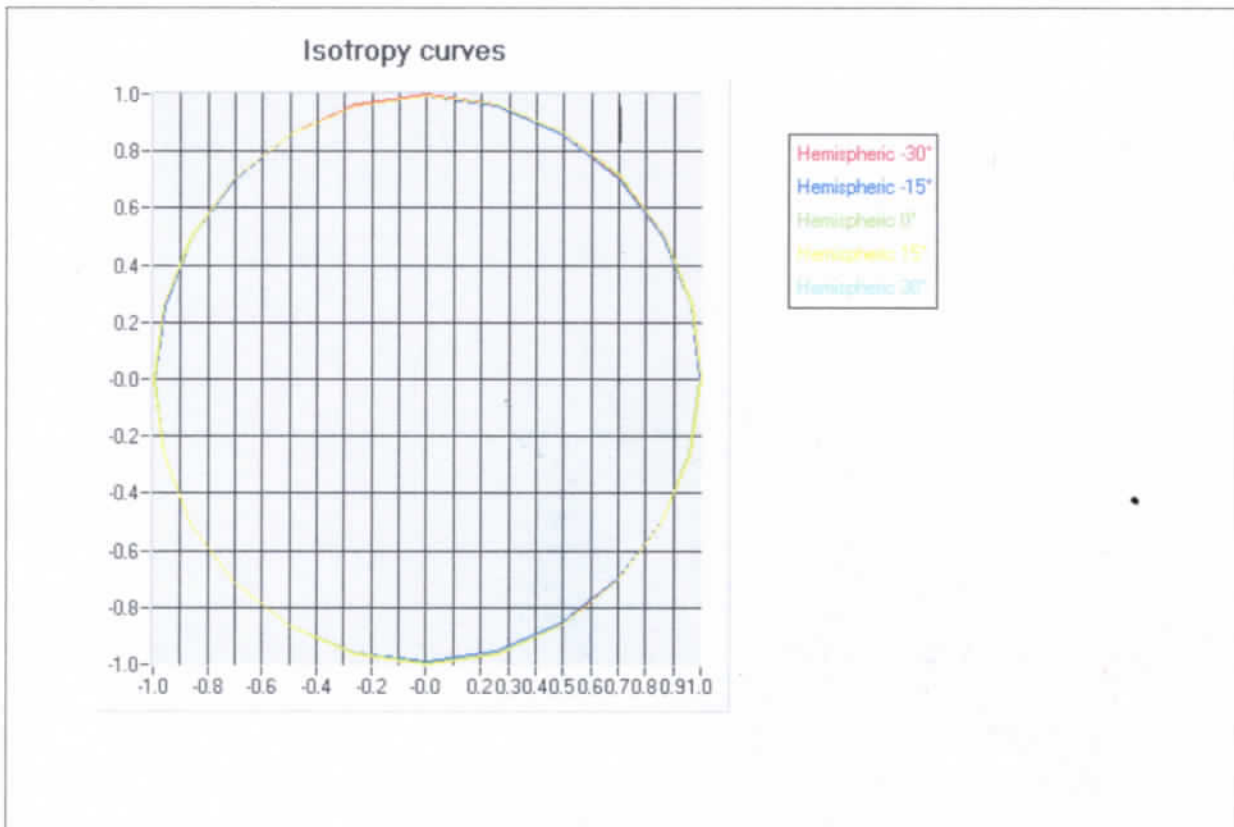
Sensitivity in liquid:

Liquid	ϵ	σ	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	34.57	4.41	32.875	31.275	32.220
Body	48.32	5.01	32.215	31.511	32.178

B. Isotropy.

-Axial isotropy: 0.04 dB

-Hemispherical isotropy: 0.06 dB



C. Linearity.

-Linearity:

0.11 dB

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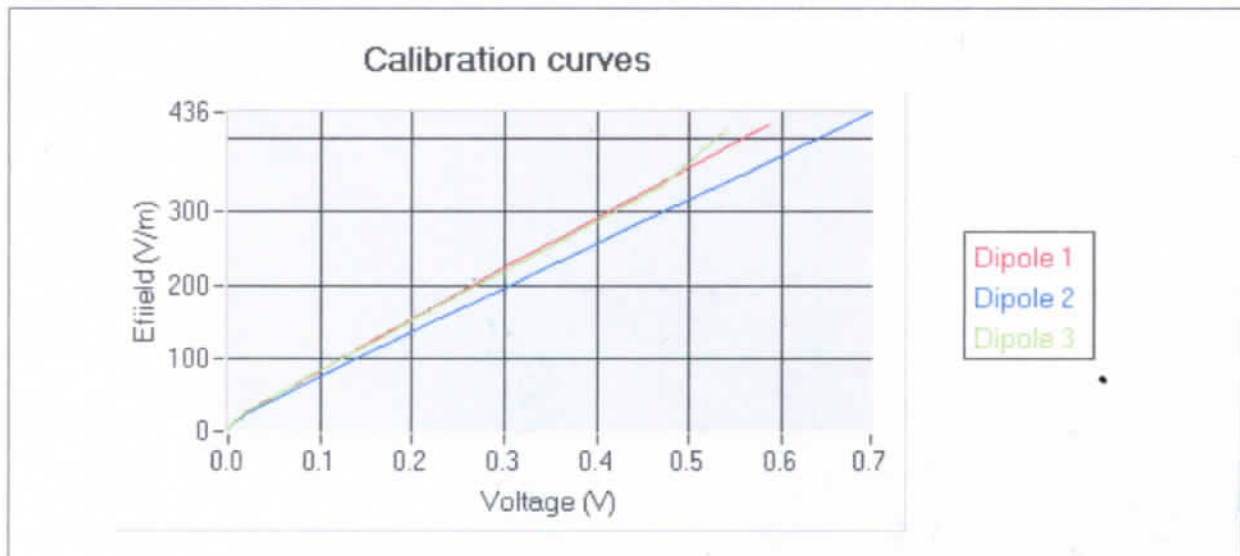
2. Calibration at 5500.00 MHz

A. Calibration parameters.

Frequency	5500.00MHz
Epsilon	HL: 35.6; BL: 48.6
Sigma	HL: 4.96 S/m; BL: 5.65 S/m;
Temperature	21°C
Coupler loss	22.42 dB
S11	-14.56 dB
Low limit detection (CW)	0.72 V/m (0.47 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:

v1	e1	v2	e2	v3	e3
0.611504	419.400057	-0.690279	437.100523	0.543771	413.816415
0.495333	339.049665	-0.550498	352.860491	0.472337	337.282940
0.404494	276.190483	-0.446452	290.126480	0.381406	275.209890
0.330278	224.796843	-0.353225	233.875890	0.308422	225.351398
0.268538	181.996271	-0.281198	190.368431	0.249142	184.810974
0.220049	148.326290	-0.224606	156.129494	0.198292	149.978775
0.181533	121.516962	-0.179632	128.856980	0.160123	123.768807
0.150897	100.118679	-0.141531	105.672302	0.128446	101.941790
0.127378	83.612561	-0.112857	88.138989	0.104051	85.049563
0.108665	70.395419	-0.089470	73.742437	0.084869	71.680042
0.092666	58.994228	-0.071008	62.273823	0.069007	60.524657
0.079416	49.434616	-0.055500	52.520014	0.055933	51.218192
0.069468	42.139802	-0.042966	44.501065	0.045486	43.660914
0.061224	35.968957	-0.033369	38.226610	0.037266	37.590943
0.049355	26.804768	-0.019018	28.503223	0.024852	28.135163
0.045905	23.817345	-0.015076	25.564309	0.021335	25.127034
0.042967	21.358185	-0.011754	22.994485	0.018347	22.600999
0.040518	19.151265	-0.008970	20.876691	0.015856	20.473431
0.038438	17.250696	-0.006612	19.007666	0.013737	18.555275
0.036522	15.429153	-0.004448	17.137399	0.011795	16.662638
0.034853	13.798210	-0.002548	15.466681	0.010064	15.006128
0.033489	12.309179	-0.001021	13.974219	0.008691	13.553558
0.032390	11.056219	0.000207	12.744279	0.007583	12.316518
0.031519	9.975741	0.001210	11.600382	0.006679	11.154301
0.030779	8.936332	0.002041	10.635670	0.005932	10.111296
0.030160	7.938027	0.002739	9.772446	0.005349	9.251050
0.029626	7.166419	0.003327	8.845000	0.004768	8.343724
0.029185	6.407600	0.003833	8.059036	0.004304	7.528465
0.028800	5.626640	0.004269	7.196725	0.003914	6.743562
0.028623	5.087391	0.004473	6.747900	0.003754	6.261171
0.028391	4.543968	0.004723	6.201970	0.003504	5.714612
0.028204	4.051998	0.004930	5.705339	0.003316	5.229562
0.028074	3.632576	0.005091	5.269928	0.003183	4.816251
0.027957	3.238400	0.005210	4.912803	0.003063	4.407552
0.027865	2.892886	0.005317	4.556514	0.002969	4.065330
0.027792	2.587966	0.005411	4.205366	0.002891	3.744906
0.027736	2.328839	0.005468	3.968433	0.002826	3.446214
0.027669	1.977893	0.005537	3.647259	0.002772	3.167188
0.027628	1.731249	0.005593	3.346432	0.002730	2.922574
0.027595	1.506386	0.005629	3.124258	0.002687	2.634968
0.027560	1.228599	0.005654	2.950369	0.002664	2.458251
0.027558	1.211024	0.005672	2.811195	0.002645	2.294391
0.027537	1.010632	0.005695	2.608688	0.002630	2.148835
0.027524	0.867129	0.005707	2.487017	0.002619	2.029270
0.027520	0.818741	0.005720	2.335941	0.002607	1.880801
0.027508	0.656504	0.005727	2.242314	0.002597	1.734930
0.027504	0.594692	0.005734	2.138169	0.002595	1.702202
0.027498	0.493438	0.005739	2.044093	0.002593	1.667904
0.027493	0.396030	0.005743	1.959495	0.002581	
0.027490	0.319716	0.005746	1.891608		
0.027488	0.252344				

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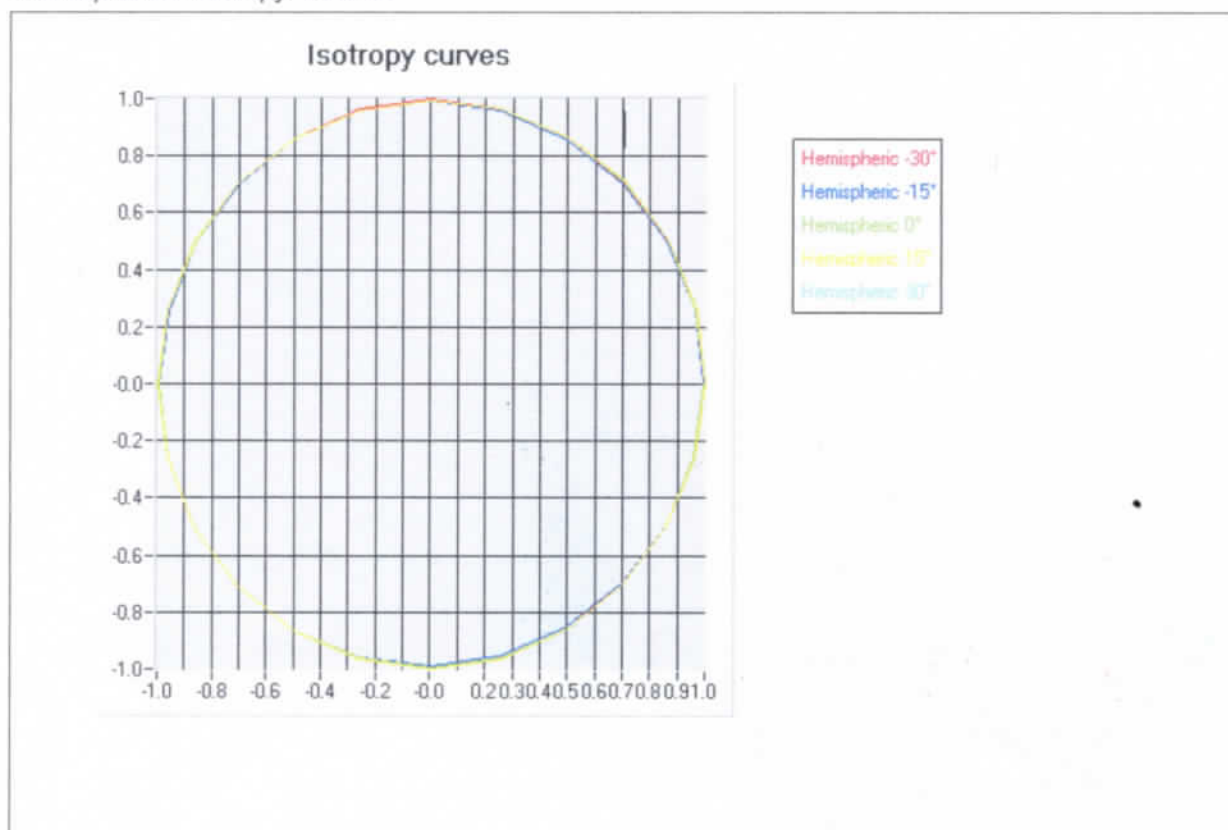
Sensitivity in liquid:

Liquid	ϵ	σ	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	34.93	4.96	35.110	35.007	35.421
Body	48.99	5.77	35.750	35.442	36.117

B. Isotropy.

-Axial isotropy: 0.04 dB

-Hemispherical isotropy: 0.05 dB



C. Linearity.

-Linearity:

0.12 dB

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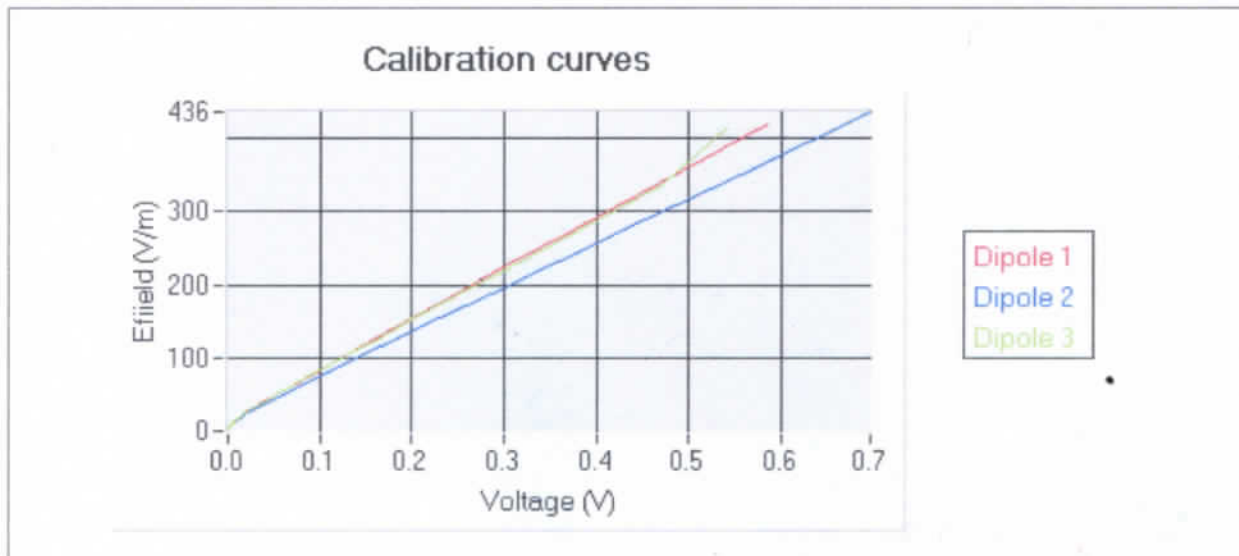
3. Calibration at 5800.00 MHz

A. Calibration parameters.

Frequency	5800.00MHz
Epsilon	HL: 35.3; BL: 48.2
Sigma	HL: 5.27 S/m; BL: 6.00 S/m;
Temperature	21°C
Coupler loss	23.67 dB
S11	-12.37 dB
Low limit detection (CW)	0.72 V/m (0.47 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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v1	e1	v2	e2	v3	e3
0.699004	419.142057	-0.687709	438.351643	0.545341	413.862202
0.582833	338.791665	-0.547928	354.111611	0.473907	337.328727
0.491994	275.932483	-0.443882	291.377600	0.382976	275.255677
0.417778	224.538843	-0.350655	235.127010	0.309992	225.397185
0.356038	181.738271	-0.278628	191.619551	0.250712	184.856761
0.307549	148.068290	-0.222036	157.380614	0.199862	150.024562
0.269033	121.258962	-0.177062	130.108100	0.161693	123.814594
0.238397	99.860679	-0.138961	106.923422	0.130016	101.987577
0.214878	83.354561	-0.110287	89.390109	0.105621	85.095350
0.196165	70.137419	-0.086900	74.993557	0.086439	71.725829
0.180166	58.736228	-0.068438	63.524943	0.070577	60.570444
0.166916	49.176616	-0.052930	53.771134	0.057503	51.263979
0.156968	41.881802	-0.040396	45.752185	0.047056	43.706701
0.148724	35.710957	-0.030799	39.477730	0.038836	37.636730
0.136855	26.546768	-0.016448	29.754343	0.026422	28.180950
0.133405	23.559345	-0.012506	26.815429	0.022905	25.172821
0.130467	21.100185	-0.009184	24.245605	0.019917	22.646786
0.128018	18.893265	-0.006400	22.127811	0.017426	20.519218
0.125938	16.992696	-0.004042	20.258786	0.015307	18.601062
0.124022	15.171153	-0.001878	18.388519	0.013365	16.708425
0.122353	13.540210	0.000022	16.717801	0.011634	15.051915
0.120989	12.051179	0.001549	15.225339	0.010261	13.599345
0.119890	10.798219	0.002777	13.995399	0.009153	12.362305
0.119019	9.717741	0.003780	12.851502	0.008249	11.200088
0.118279	8.678332	0.004611	11.886790	0.007502	10.157083
0.117660	7.680027	0.005309	11.023566	0.006919	9.296837
0.117126	6.908419	0.005897	10.096120	0.006338	8.389511
0.116685	6.149600	0.006403	9.310156	0.005874	7.574252
0.116300	5.368640	0.006839	8.447845	0.005484	6.789349
0.116123	4.829391	0.007043	7.999020	0.005324	6.306958
0.115891	4.285968	0.007293	7.453090	0.005074	5.760399
0.115704	3.793998	0.007500	6.956459	0.004886	5.275349
0.115574	3.374576	0.007661	6.521048	0.004753	4.862038
0.115457	2.980400	0.007780	6.163923	0.004633	4.453339
0.115365	2.634886	0.007887	5.807634	0.004539	4.111117
0.115292	2.329966	0.007981	5.456486	0.004461	3.790693
0.115236	2.070839	0.008038	5.219553	0.004396	3.492001
0.115169	1.719893	0.008107	4.898379	0.004342	3.212975
0.115128	1.473249	0.008163	4.597552	0.004300	2.968361
0.115095	1.248386	0.008199	4.375378	0.004257	2.680755
0.115060	0.970599	0.008224	4.201489	0.004234	2.504038
0.115058	0.953024	0.008242	4.062315	0.004215	2.340178
0.115037	0.752632	0.008265	3.859808	0.004200	2.194622
0.115024	0.609129	0.008277	3.738137	0.004189	2.075057
0.115020	0.560741	0.008290	3.587061	0.004177	1.926588
0.115008	0.398504	0.008297	3.493434	0.004167	1.780717
0.115004	0.336692	0.008304	3.389289	0.004165	1.747989
0.114998	0.235438	0.008309	3.295213	0.004163	1.713691
0.114993	0.138030	0.008313	3.210615	0.004151	0.045787
0.114990	0.061716	0.008316	3.142728		
0.114988	-0.005656				

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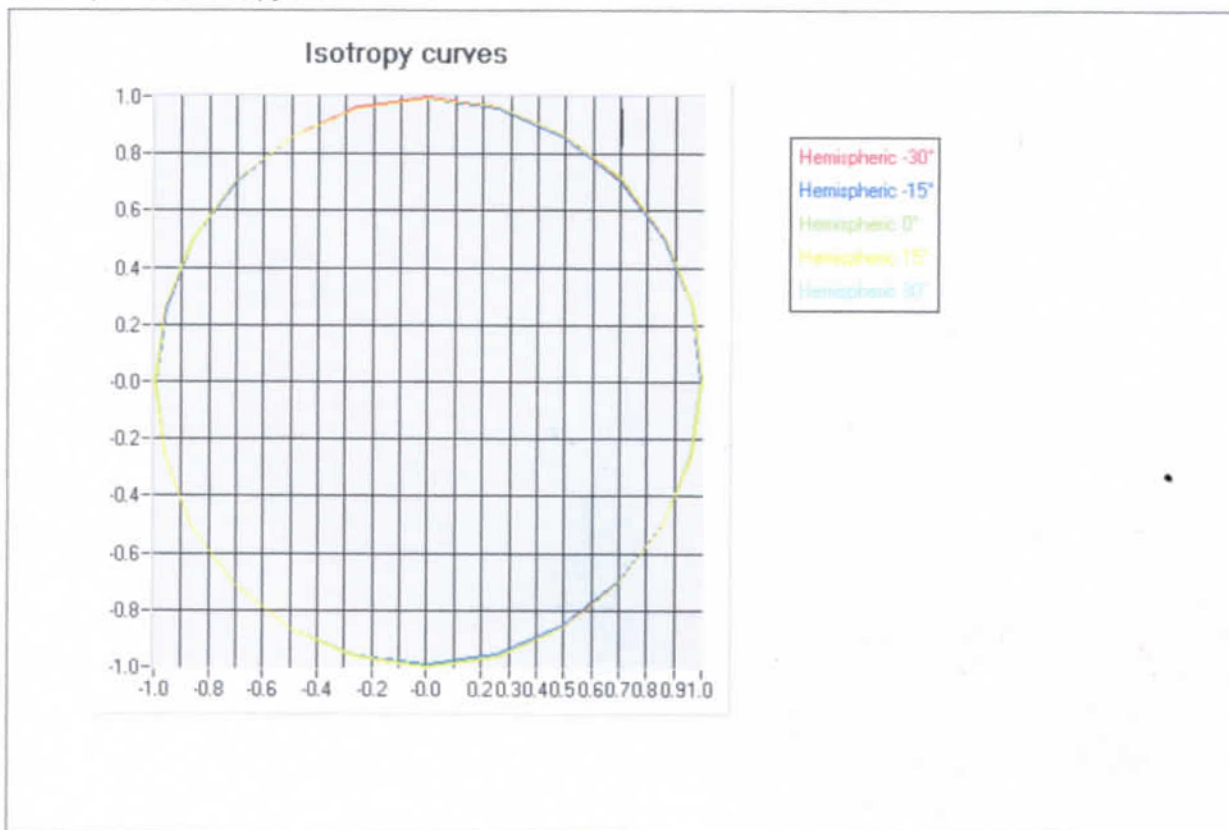
Sensitivity in liquid:

Liquid	ϵ	σ	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	33.69	5.42	36.142	34.568	35.420
Body	49.56	6.11	36.745	34.115	36.174

B. Isotropy.

-Axial isotropy: 0.06 dB

-Hemispherical isotropy: 0.06 dB



C. Linearity.

-Linearity:

0.13 dB