



Bâtiment PONANT, Ave La Pérouse  
Zone du Technopole Brest Iroise, 29280 PLOUZANE.  
☎ : +33 (0)2-98-05-13-34.  
☎ : +33 (0)2-98-05-53-87.

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

**DATE:** 05/04/2008

**REFERENCE:** SN 08/07 EP74

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

**MANUFACTURER:** SATIMO

**SERIAL NUMBER:** SN 08/07 EP74

**CUSTOMER:** CCS

**ORDER :**

**DATE OF CALIBRATION :** 01/05/2008

**WARRANTY :**

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Date

04 MAY 2008

SEAL SATIMO  
Bâtiment PONANT  
Avenue La Pérouse  
Technopole BREST IROISE  
29280 PLOUZANÉ  
TÉL 02 98 05 13 34 - Fax 02 98 05 53 87

COMOSAR PROJECT MANAGER

Date

04 MAY 2008

SEAL SATIMO  
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COMOSAR PROJECT 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=1.384 MΩ Dipole 2: R2=0.992 MΩ Dipole 3: R3=1.784 MΩ
Connector (HIROSE series SR30)	6 wire male (Hirose SR30series)

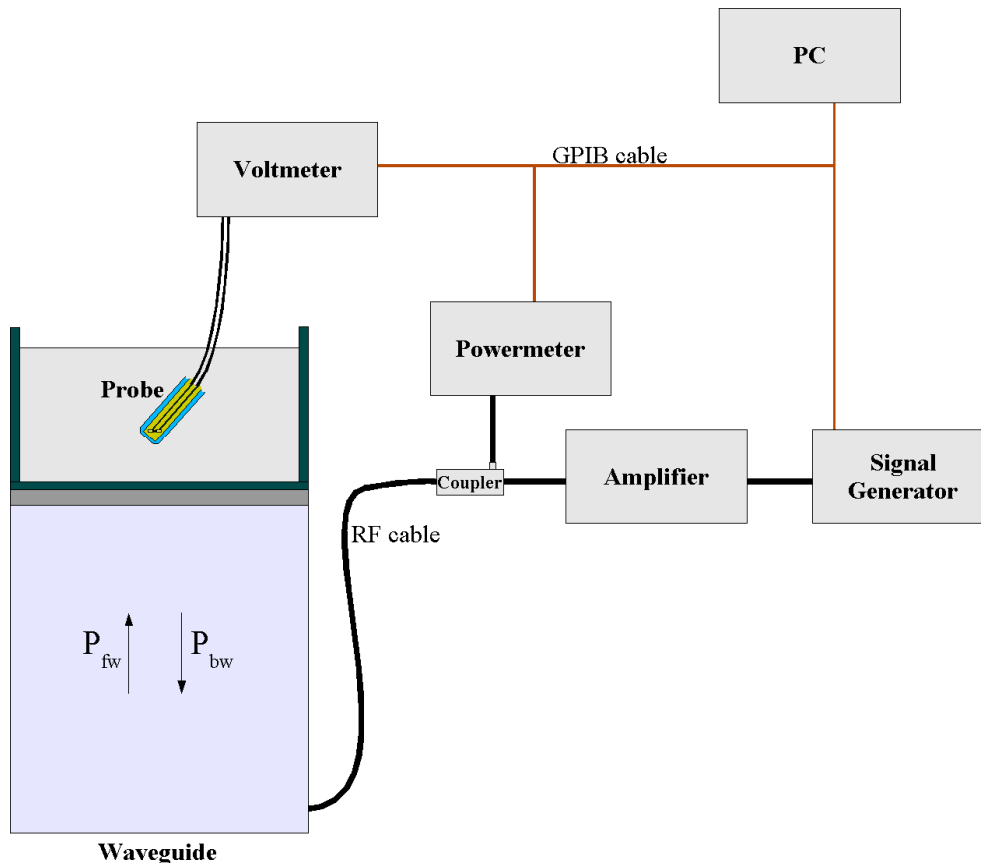
The probe could be checked by measuring the resistance of the three dipoles.

**CALIBRATION TEST EQUIPMENT**

TYPE	IDENTIFICATION
Calibration bench	CALISAR
Voltmeter	Keithley 2000

## 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
- $\delta$  = Skin depth

*Keithley Voltmeter 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



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## 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%
<b>Combined standard uncertainty</b>	B.2.2					2,299%
<b>Expanded uncertainty</b> (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%
<b>Combined standard uncertainty</b>	B.2.2					2,926%
<b>Expanded uncertainty</b> (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%
<b>Combined standard uncertainty</b>						7,721%
<b>Expanded uncertainty</b> (confidence interval of 95%)						15,132%



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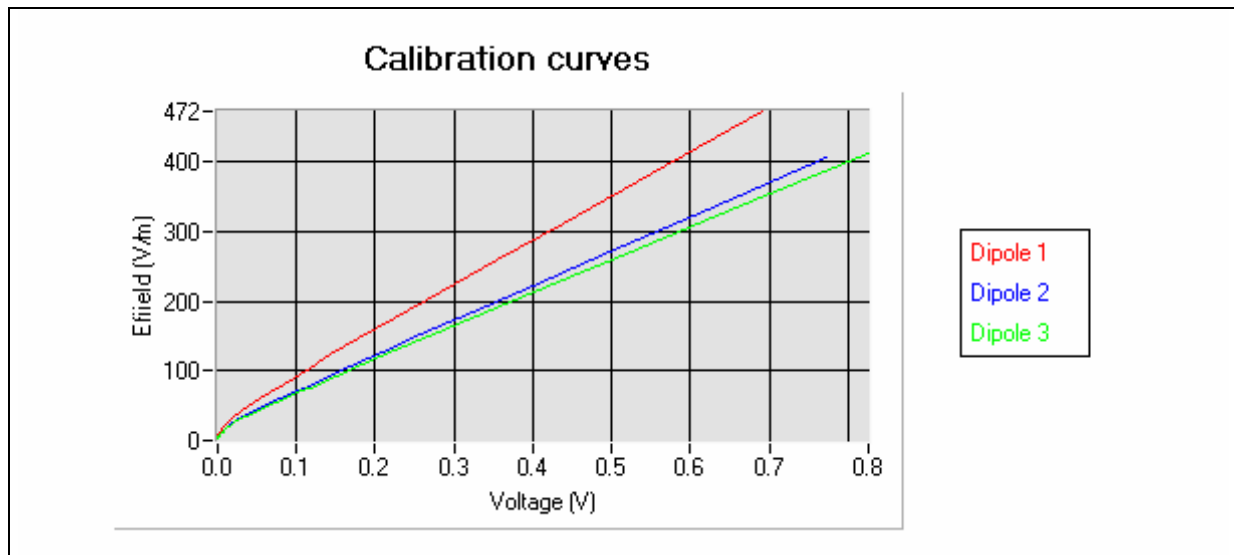
## 1. Calibration at 835.00 MHz

### A. Calibration parameters.

Label	850
Epsilon	42.85
Sigma	0.90 S/m
Temperature	21°C
Cable loss	0.00 dB
Coupler loss	20.50 dB
Waveguide S11	-13.70 dB
Low limit detection	0.81 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E=\sqrt{(e1*e1+e2*e2+e3*e3)}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,691632	472,469639	0,772451	405,957381	0,825739	413,318265
0,549620	382,639655	0,620862	331,578486	0,657416	334,289191
0,437325	311,460548	0,497822	271,113132	0,525764	272,389737
0,355035	259,149501	0,400237	223,048336	0,426258	225,511344
0,282981	213,157505	0,324365	185,558731	0,346218	187,699439
0,225042	175,950719	0,258583	152,904897	0,279404	156,011857
0,179282	146,314486	0,208726	127,994491	0,225173	130,148243
0,143487	122,863947	0,169357	108,156093	0,182466	109,626084
0,116348	104,821349	0,110118	74,665345	0,117682	74,751356
0,076592	74,751356	0,101452	71,222805	0,107071	71,222805
0,070062	71,222805	0,091281	66,775797	0,097406	66,852719
0,062587	66,775797	0,080062	61,463753	0,085597	61,463753
0,054484	61,463753	0,068235	55,222883	0,073138	55,286497
0,045958	55,286497	0,054729	47,766022	0,058604	47,601328
0,036331	47,766022	0,046420	42,915984	0,049834	42,817280
0,030491	42,915984	0,039320	38,647293	0,042261	38,558407
0,025547	38,647293	0,033245	34,843283	0,035822	34,763146
0,021383	34,803192	0,028025	31,449886	0,030264	31,377553
0,017845	31,449886	0,023487	28,354310	0,025434	28,289097
0,014812	28,354310	0,019519	25,504633	0,021165	25,445973
0,012189	25,504633	0,015990	22,783429	0,017391	22,757213
0,009896	22,809674	0,012879	20,212456	0,014045	20,189198
0,007887	20,235740	0,010102	17,705944	0,011048	17,705944
0,006173	17,746760	0,007396	14,983700	0,008121	14,983700
0,004478	15,018241	0,005921	13,338871	0,006474	13,323523
0,003564	13,369621	0,004782	11,929413	0,005221	11,901976
0,002839	11,929413	0,003847	10,693480	0,004214	10,668886
0,002292	10,693480	0,003141	9,607692	0,003401	9,585595
0,001841	9,607692	0,002517	8,642096	0,002762	8,612299
0,001473	8,642096	0,002025	7,755666	0,002246	7,737828
0,001196	7,780188	0,001611	6,936160	0,001778	6,920207
0,000934	6,910083	0,001269	6,153455	0,001380	6,116763
0,000721	6,112095	0,000981	5,415257	0,001067	5,408774
0,000565	5,454082	0,000657	4,492108	0,000732	4,530048
0,000379	4,546725	0,000527	4,050537	0,000571	4,040302
0,000284	4,004745	0,000418	3,639234	0,000453	3,639748
0,000218	3,580233	0,000319	3,220461	0,000357	3,277961
0,000173	3,259245	0,000267	2,976994	0,000274	2,929370
0,000133	2,944692	0,000197	2,613680	0,000211	2,634158
0,000104	2,693771	0,000162	2,411584	0,000162	2,379359
0,000078	2,447029	0,000120	2,144069	0,000114	2,099996
0,000047	2,115554	0,000080	1,853743	0,000080	1,877125
0,000029	1,896684	0,000051	1,610862	0,000048	1,639925



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0,000002	1,510025	0,000024	1,345891	0,000012	1,323188
-0,000001	1,460758	0,000023	1,335068	0,000003	1,231339
-0,000013	1,244341	0,000014	1,233392	-0,000001	1,188240
-0,000021	1,075964	-0,000007	0,954936	-0,000015	1,022525
-0,000027	0,921179	0,000002	1,083076	-0,000025	0,884138
-0,000032	0,784133	-0,000008	0,937569	-0,000033	0,753782
-0,000035	0,675741	-0,000016	0,803009	-0,000039	0,651644
-0,000038	0,573492	-0,000022	0,690529	-0,000043	0,555423
-0,000040	0,489442	-0,000026	0,594816	-0,000047	0,472935
		-0,000029	0,510033		
		-0,000032	0,441176		

Sensitivity in liquid:

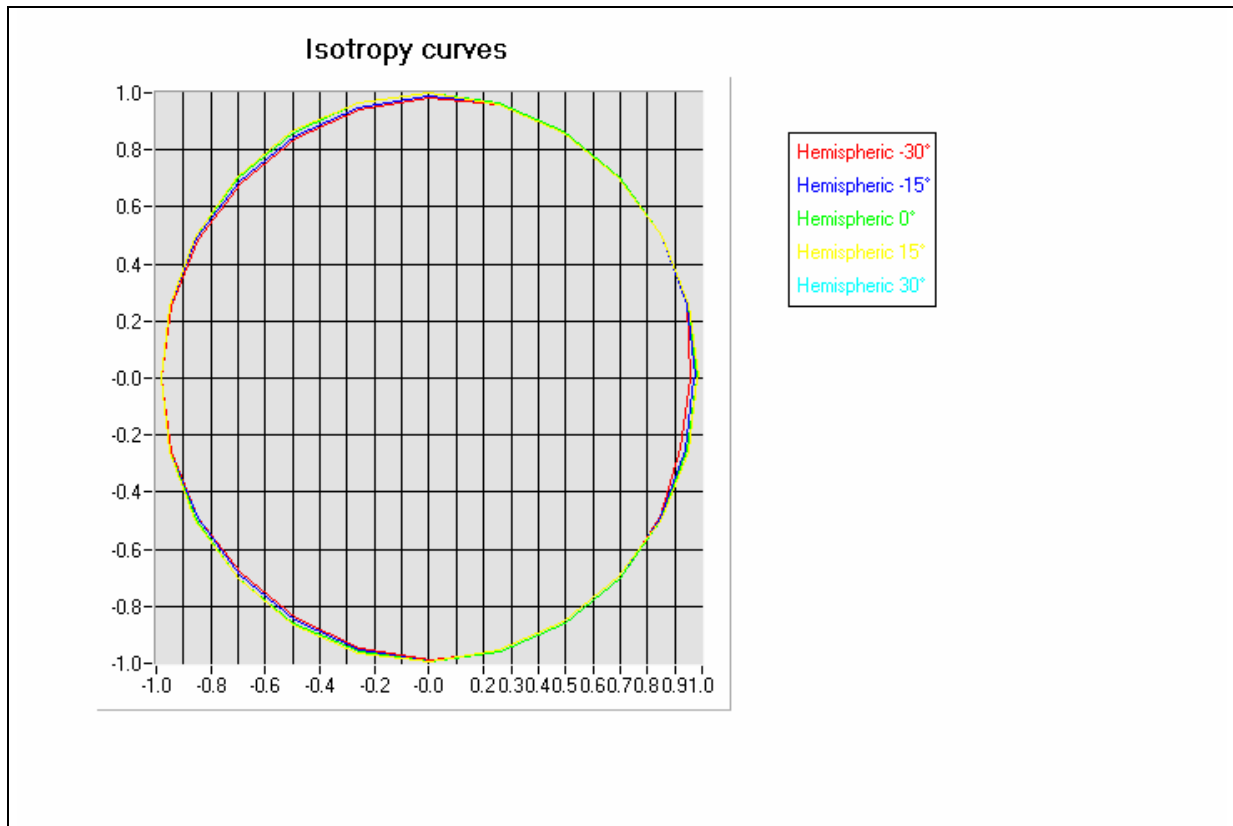
Liquid	$\epsilon$	$\sigma$	CF dipole 1 ( $W.kg^{-1} (mV)^{-1}$ )	CF dipole 2 ( $W.kg^{-1} (mV)^{-1}$ )	CF dipole 3 ( $W.kg^{-1} (mV)^{-1}$ )
Head	42.85	0.90	42.96	25.82	23.62
Body	55.95	0.94	42.01	25.11	22.97



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## B. Isotropy.

- Axial isotropy: 0.08 dB
- Hemispherical isotropy: 0.09 dB



## C. Linearity.

- Linearity: 0.10 dB





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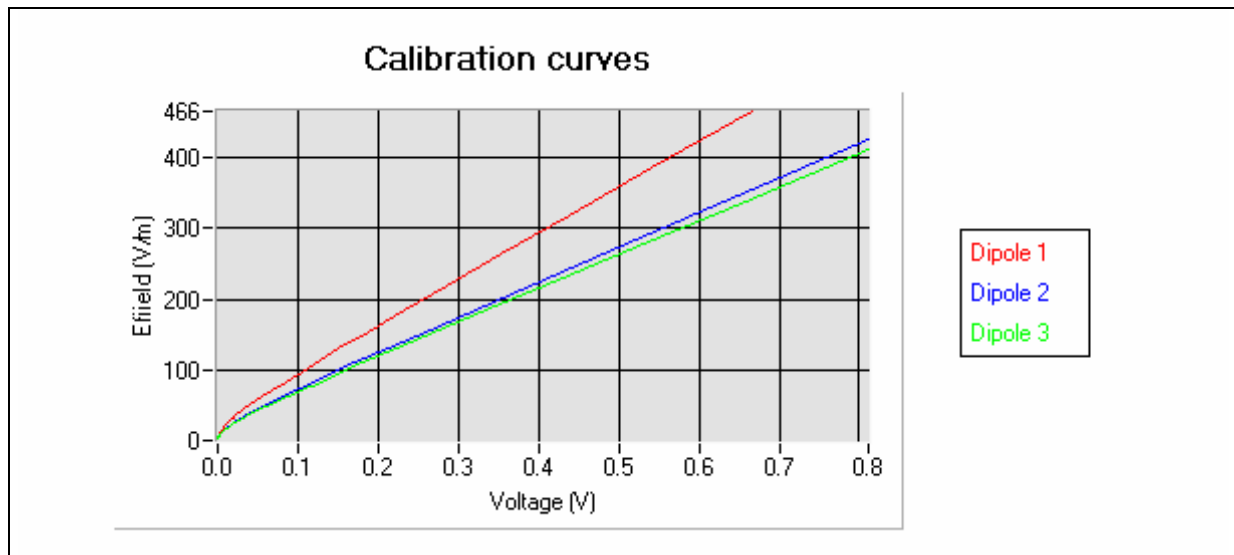
## 2. Calibration at 897.00 MHz

### A. Calibration parameters.

Label	900
Epsilon	42.33
Sigma	0.95 S/m
Temperature	21°C
Cable loss	0.00 dB
Coupler loss	20.30 dB
Waveguide S11	-13.40 dB
Low limit detection	0.78 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E=\sqrt{(e1*e1+e2*e2+e3*e3)}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,665706	465,714150	0,810449	426,787300	0,811412	412,225759
0,540789	384,894554	0,649435	347,501876	0,657697	339,052008
0,439489	319,232472	0,519900	283,620686	0,531720	279,003081
0,354044	263,697494	0,418086	233,299182	0,431709	231,240434
0,286572	219,674327	0,332186	190,705403	0,346780	190,567737
0,232092	183,938723	0,264490	156,977610	0,275348	156,216203
0,188352	155,039264	0,212735	131,021705	0,222775	130,786340
0,151283	130,301982	0,171466	110,142000	0,180830	110,342367
0,120242	109,296622	0,110498	76,788839	0,118093	76,877296
0,077028	76,788839	0,102786	73,501821	0,108188	73,501821
0,071126	73,501821	0,093211	68,991899	0,099556	69,150942
0,064143	69,150942	0,082352	63,649955	0,088081	63,723276
0,056208	63,796683	0,070459	57,318934	0,075491	57,451067
0,047622	57,451067	0,057468	49,922704	0,061647	49,980213
0,038267	49,980213	0,048841	44,853682	0,052545	44,957081
0,032197	44,957081	0,041437	40,438785	0,044700	40,485369
0,027014	40,485369	0,035129	36,500440	0,037945	36,542487
0,022666	36,542487	0,029733	32,983603	0,032226	33,021599
0,019001	33,021599	0,024966	29,771320	0,027105	29,805615
0,015786	29,805615	0,020794	26,779231	0,022663	26,810079
0,013037	26,840963	0,017086	23,977180	0,018684	24,032453
0,010638	24,032453	0,013808	21,296003	0,015124	21,345095
0,008506	21,345095	0,010877	18,698127	0,011936	18,741231
0,006635	18,741231	0,007938	15,768780	0,008715	15,786945
0,004799	15,786945	0,006355	14,021617	0,006979	14,053940
0,003819	14,053940	0,005114	12,540016	0,005635	12,554462
0,003040	12,554462	0,004124	11,227888	0,004549	11,253771
0,002455	11,240823	0,003342	10,099459	0,003696	10,111093
0,001980	10,099459	0,002702	9,073986	0,003003	9,084439
0,001588	9,077673	0,002190	8,152637	0,002411	8,134499
0,001271	8,151397	0,001729	7,255009	0,001935	7,310548
0,001023	7,345754	0,001364	6,464579	0,001523	6,513770
0,000779	6,455718	0,001062	5,728715	0,001141	5,675944
0,000599	5,710908	0,000733	4,800352	0,000786	4,767109
0,000387	4,684193	0,000579	4,297435	0,000608	4,238686
0,000322	4,320803	0,000434	3,762965	0,000469	3,774953
0,000248	3,865738	0,000352	3,423980	0,000367	3,394595
0,000174	3,349405	0,000278	3,086268	0,000316	3,187441
0,000141	3,091469	0,000213	2,755696	0,000241	2,855632
0,000096	2,700319	0,000170	2,513226	0,000176	2,533149
0,000075	2,496900	0,000132	2,277565	0,000108	2,144493
0,000059	2,330025	0,000090	1,984806	0,000091	2,035768
0,000032	2,017361	0,000059	1,737362	0,000041	1,675587
0,000011	1,735665	0,000024	1,406611	0,000011	1,416169
-0,000006	1,473326	0,000011	1,261870	-0,000009	1,215330
-0,000017	1,264369	-0,000004	1,075672	-0,000023	1,044719
-0,000025	1,087811	-0,000014	0,926687	-0,000034	0,889038
-0,000031	0,938743	-0,000021	0,801349	-0,000042	0,766932



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-0,000036	0,803565	-0,000027	0,682548	-0,000048	0,659378
-0,000039	0,694300	-0,000031	0,584326	-0,000052	0,567002
-0,000042	0,590051	-0,000034	0,505336	-0,000055	0,486289
-0,000044	0,508815	-0,000036	0,428867		
-0,000045	0,440610				

Sensitivity in liquid:

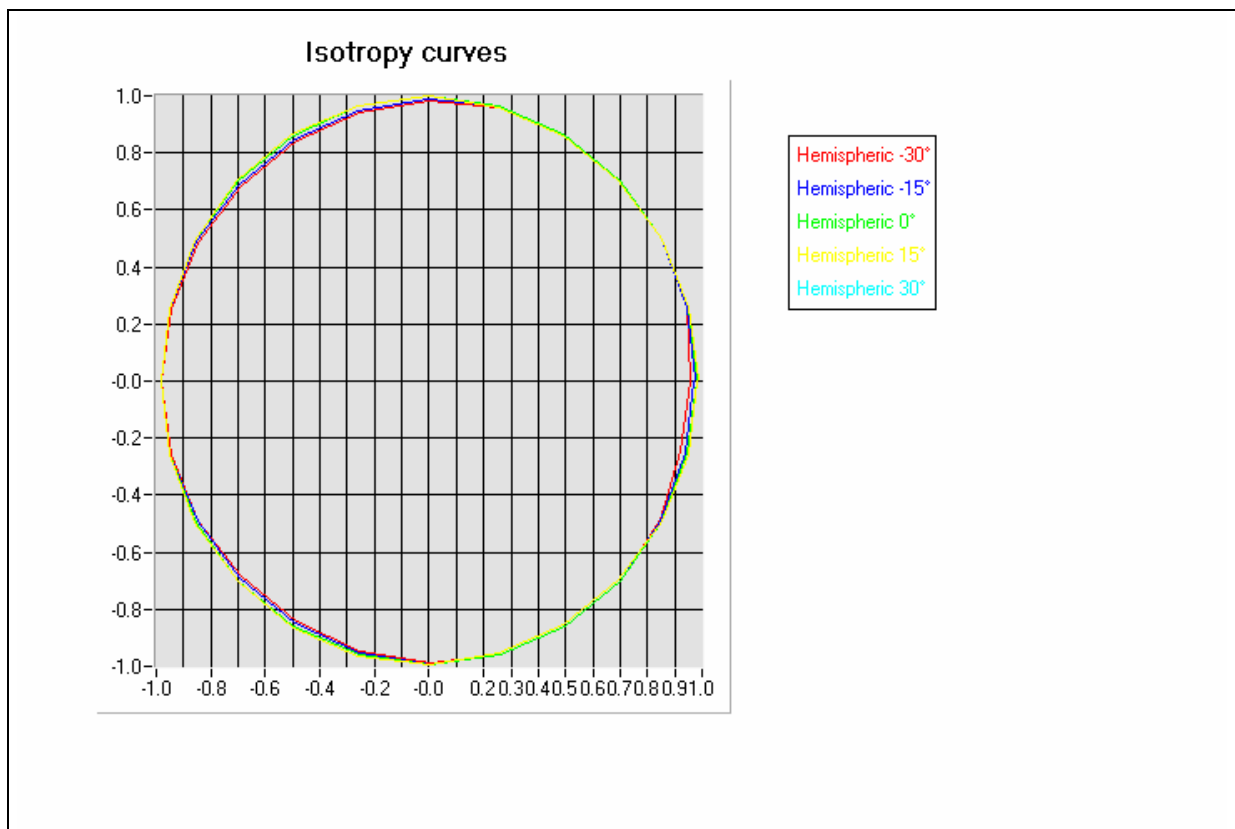
Liquid	$\epsilon$	$\sigma$	CF dipole 1 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 2 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 3 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )
Head	42.33	0.95	44.78	26.10	24.28
Body	56.33	1.05	44.03	25.55	23.69



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## B. Isotropy.

- Axial isotropy: 0.08 dB
- Hemispherical isotropy: 0.09 dB



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

## C. Linearity.

- Linearity: 0.10 dB



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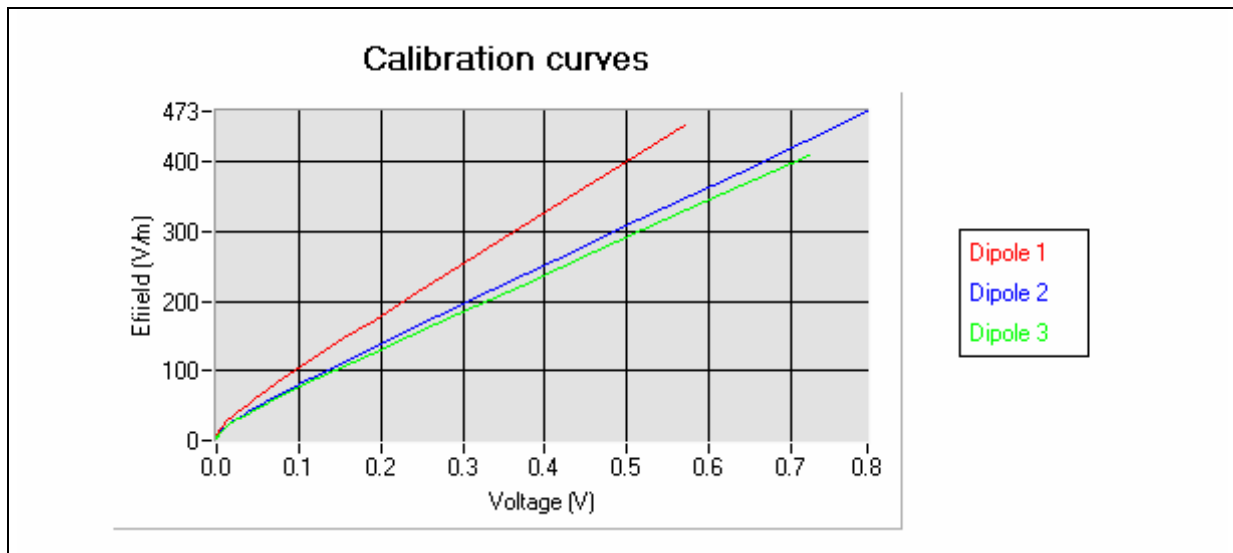
### 3. Calibration at 1747.00 MHz

#### A. Calibration parameters.

Label	1800
Epsilon	38.47
Sigma	1.27 S/m
Temperature	21°C
Cable loss	0.00 dB
Coupler loss	20.18 dB
Waveguide S11	-13.10 dB
Low limit detection	0.79 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E=\sqrt{(e1*e1+e2*e2+e3*e3)}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,570159	454,293234	0,793185	473,147314	0,721893	410,039855
0,460154	373,160321	0,635366	384,425275	0,573698	331,134299
0,369498	306,169332	0,514367	316,324158	0,459716	270,357451
0,297011	252,454068	0,414053	259,771394	0,370994	222,952315
0,237094	207,872549	0,335191	215,206069	0,294440	181,924913
0,192713	174,665175	0,270310	178,416230	0,235103	149,981916
0,155416	146,548115	0,218846	149,094844	0,187414	124,147596
0,125492	123,756028	0,176546	124,835376	0,122819	88,900273
0,080839	88,797982	0,114803	88,900273	0,104066	80,984722
0,070906	80,891538	0,100748	81,078013	0,094016	73,435000
0,061543	73,350503	0,088681	73,350503	0,083000	66,359499
0,053072	66,283144	0,077136	66,435942	0,072073	60,103962
0,045601	60,034805	0,066880	60,103962	0,061346	53,691198
0,038306	53,629419	0,056766	53,691198	0,050255	46,870878
0,030878	46,816948	0,046364	46,870878	0,041175	41,105799
0,024916	41,105799	0,037914	41,153151	0,033839	36,341521
0,020169	36,299704	0,031060	36,341521	0,027880	32,277738
0,016397	32,240598	0,025510	32,277738	0,022970	28,734463
0,013330	28,734463	0,020964	28,734463	0,018957	25,698223
0,010851	25,668654	0,017251	25,698223	0,015635	23,009284
0,008857	23,009284	0,014206	23,035790	0,012869	20,672981
0,007245	20,672981	0,011681	20,696795	0,010623	18,616717
0,005927	18,616717	0,009618	18,616717	0,008642	16,649573
0,004774	16,649573	0,007806	16,649573	0,006674	14,534601
0,003642	14,534601	0,006026	14,534601	0,005193	12,761540
0,002819	12,746857	0,004690	12,776240	0,004078	11,269459
0,002204	11,269459	0,003684	11,282442	0,003234	10,009286
0,001725	10,020817	0,002915	10,020817	0,002565	8,931061
0,001362	8,902166	0,002318	8,931061	0,002060	7,996558
0,001082	7,979127	0,001865	7,996558	0,001639	7,165960
0,000866	7,186516	0,001480	7,155475	0,001324	6,472146
0,000692	6,477875	0,001200	6,469667	0,001060	5,827379
0,000549	5,831370	0,000966	5,835021	0,000802	5,119400
0,000411	5,130803	0,000730	5,115820	0,000587	4,444080
0,000310	4,550215	0,000545	4,471884	0,000432	3,885072
0,000226	4,003728	0,000409	3,931809	0,000330	3,468399
0,000156	3,483435	0,000310	3,486440	0,000253	3,117175
0,000104	3,039820	0,000236	3,112188	0,000185	2,770221
0,000075	2,761638	0,000170	2,735534	0,000129	2,447843
0,000040	2,383041	0,000131	2,486288	0,000096	2,236212
0,000024	2,188260	0,000097	2,246546	0,000070	2,054173
0,000013	2,043607	0,000070	2,036153	0,000045	1,862431
-0,000002	1,827997	0,000049	1,856098	0,000019	1,639400
-0,000018	1,564266	0,000021	1,584512	0,000005	1,505684
-0,000030	1,332010	0,000001	1,357657	-0,000016	1,283825
-0,000039	1,139349	-0,000014	1,164576	-0,000031	1,090682
-0,000045	0,985683	-0,000024	0,996555	-0,000041	0,935894
-0,000049	0,851579	-0,000032	0,862679	-0,000049	0,809308



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-0,000052	0,731933	-0,000038	0,745570	-0,000054	0,693172
-0,000055	0,621221	-0,000042	0,643679	-0,000059	0,591308
-0,000057	0,532537	-0,000045	0,553958	-0,000062	0,510125
-0,000058	0,454794	-0,000047	0,475392	-0,000064	0,436585

Sensitivity in liquid:

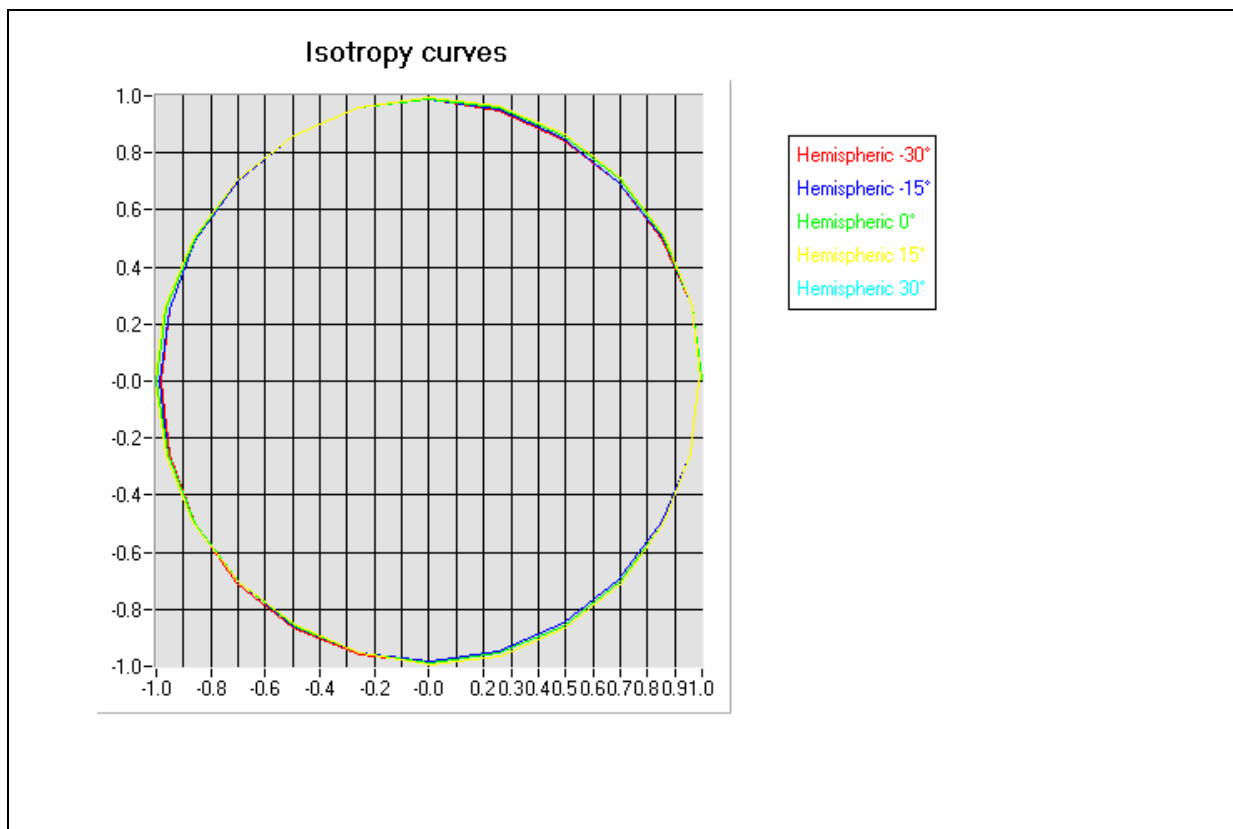
Liquid	$\epsilon$	$\sigma$	CF dipole 1 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 2 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 3 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )
Head	38.47	1.27	56.41	33.29	29.79
Body	54.31	1.47	57.02	33.98	30.25



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## B. Isotropy.

- Axial isotropy: 0.08 dB
- Hemispherical isotropy: 0.12 dB



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

## C. Linearity.

- Linearity: 0.13dB





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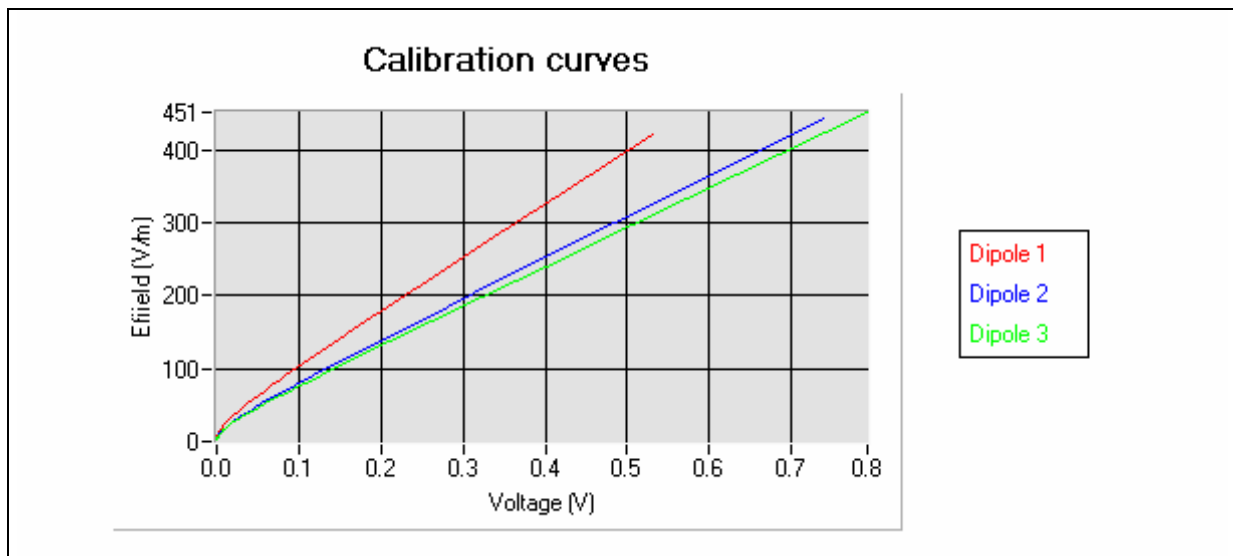
## 4. Calibration at 1880.00 MHz

### A. Calibration parameters.

Label	1900
Epsilon	38.22
Sigma	1.35 S/m
Temperature	21°C
Cable loss	0.00 dB
Coupler loss	20.13 dB
Waveguide S11	-29.23 dB
Low limit detection	0.79 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E = \sqrt{e_1 \cdot e_1 + e_2 \cdot e_2 + e_3 \cdot e_3}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,529809	421,189214	0,738169	442,897549	0,792274	450,886437
0,424640	344,222761	0,598731	364,275971	0,634458	366,118127
0,338295	280,886982	0,483509	299,229473	0,504978	296,490196
0,272073	232,149840	0,385295	243,681963	0,401271	240,624598
0,216150	190,794926	0,312949	202,657085	0,323177	198,451479
0,174812	160,022350	0,248912	166,205932	0,261662	165,116922
0,141210	134,787822	0,201907	139,305880	0,210633	137,330435
0,090821	95,977362	0,127941	96,087924	0,136503	95,977362
0,083431	90,296063	0,118038	90,296063	0,126013	90,296063
0,075266	83,978634	0,106291	84,075375	0,114452	83,978634
0,066756	77,209157	0,095518	77,298099	0,100873	77,209157
0,058294	70,334566	0,084032	70,415588	0,090128	70,415588
0,050447	63,851162	0,073344	63,851162	0,078779	63,851162
0,043484	57,832080	0,063826	57,898700	0,068664	57,832080
0,037029	52,139733	0,054906	52,199797	0,059171	52,199797
0,029804	45,516496	0,044766	45,621421	0,048406	45,621421
0,024020	39,963988	0,036563	40,010025	0,039648	40,056114
0,019425	35,291393	0,029906	35,332048	0,032537	35,332048
0,015767	31,345039	0,024578	31,381147	0,026779	31,381147
0,012805	27,936295	0,020191	27,968476	0,022063	27,968476
0,010423	24,955645	0,016609	24,984393	0,018162	24,984393
0,008500	22,344405	0,013660	22,395915	0,014973	22,395915
0,006955	20,075613	0,011227	20,121892	0,012341	20,121892
0,005689	18,078767	0,009242	18,120443	0,010182	18,120443
0,004608	16,224406	0,007542	16,261807	0,008306	16,243096
0,003532	14,163442	0,005821	14,179758	0,006415	14,179758
0,002740	12,435659	0,004514	12,449984	0,005002	12,449984
0,002138	10,994330	0,003555	10,994330	0,003930	10,994330
0,001686	9,764923	0,002798	9,764923	0,003109	9,776172
0,001334	8,713022	0,002236	8,713022	0,002462	8,713022
0,001068	7,800022	0,001793	7,792356	0,001968	7,792356
0,000851	6,999852	0,001441	7,002368	0,001596	7,002905
0,000672	6,263330	0,001158	6,303258	0,001263	6,259729
0,000552	5,716686	0,000931	5,680639	0,001042	5,713391
0,000397	4,921547	0,000685	4,917697	0,000758	4,923080
0,000301	4,356901	0,000526	4,354018	0,000578	4,348436
0,000212	3,758399	0,000383	3,775860	0,000422	3,780404
0,000158	3,343442	0,000287	3,331912	0,000316	3,339754
0,000121	3,026448	0,000209	2,921953	0,000246	3,013640
0,000089	2,722690	0,000177	2,736052	0,000190	2,724791
0,000056	2,368992	0,000119	2,362105	0,000136	2,413740
0,000039	2,164342	0,000097	2,203727	0,000099	2,175081
0,000022	1,938202	0,000071	2,000450	0,000067	1,945201
0,000008	1,729914	0,000052	1,837737	0,000046	1,778266
0,000004	1,665625	0,000033	1,659143	0,000029	1,630658
-0,000010	1,416306	0,000000	1,291534	0,000002	1,363771
-0,000019	1,226054	-0,000013	1,111845	-0,000016	1,157488
-0,000027	1,043085	-0,000023	0,950480	-0,000028	0,992248



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-0,000032	0,899809	-0,000031	0,811234	-0,000037	0,847393
-0,000036	0,775098	-0,000036	0,693110	-0,000043	0,723593
-0,000039	0,665743	-0,000040	0,588244	-0,000048	0,618670
-0,000041	0,574709	-0,000043	0,506953	-0,000051	0,528446
-0,000042	0,491321	-0,000045	0,434342	-0,000054	0,450006

Sensitivity in liquid:

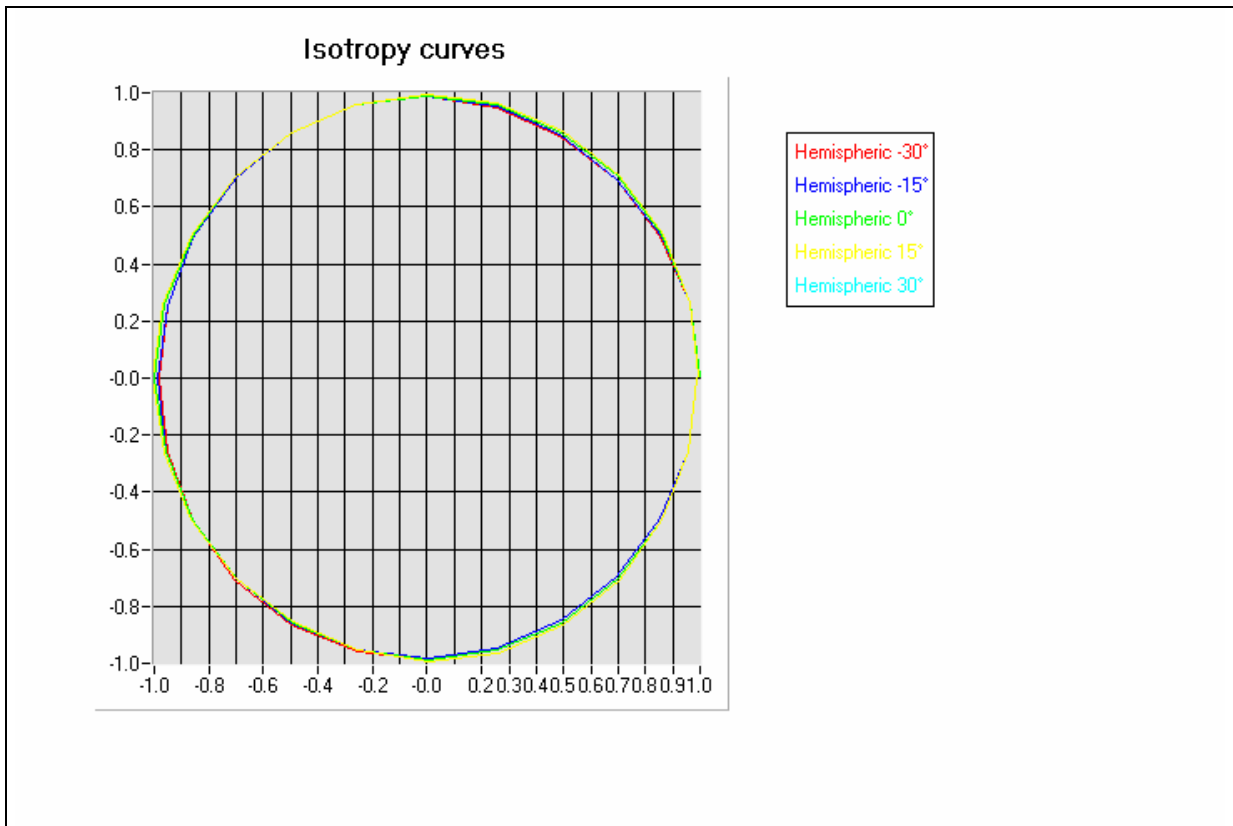
Liquid	$\epsilon$	$\sigma$	CF dipole 1 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 2 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 3 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )
Head	38.22	1.35	55.42	33.34	30.29
Body	54.66	1.49	55.99	34.03	30.89



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## B. Isotropy.

- Axial isotropy: 0.09 dB
- Hemispherical isotropy: 0.12 dB



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

## C. Linearity.

- Linearity: 0.12 dB



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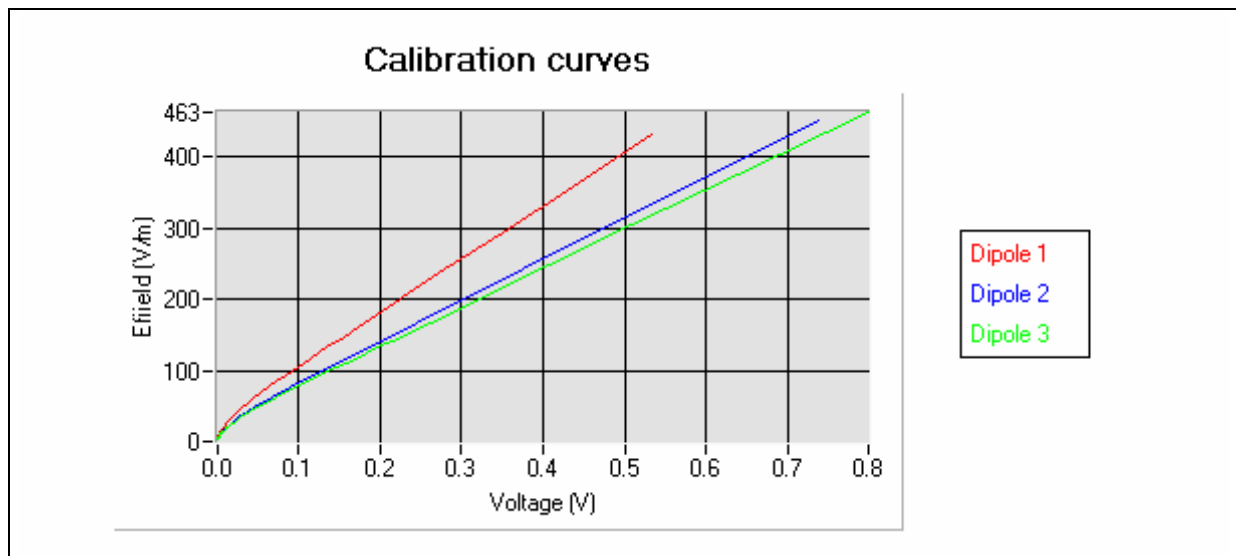
## 5. Calibration at 1950.00 MHz

### A. Calibration parameters.

Label	2000
Epsilon	38.21
Sigma	1.42 S/m
Temperature	21°C
Cable loss	0.00 dB
Coupler loss	20.07 dB
Waveguide S11	-36.66 dB
Low limit detection	0.81 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E=\sqrt{(e1*e1+e2*e2+e3*e3)}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,534425	431,091500	0,737803	451,051257	0,799998	463,436357
0,430476	354,221932	0,586704	364,502368	0,639440	375,856970
0,349783	294,408346	0,467143	295,916666	0,508056	304,101193
0,279435	242,084421	0,375502	243,234093	0,406240	248,390230
0,180175	166,687020	0,245613	166,687020	0,260530	166,687020
0,155350	148,389026	0,213053	148,389026	0,226312	148,389026
0,133334	131,795865	0,184015	131,795865	0,195741	131,795865
0,114461	117,328031	0,158993	117,328031	0,169311	117,193030
0,097953	104,568719	0,137185	104,568719	0,146349	104,568719
0,083979	93,519416	0,118571	93,519416	0,126685	93,519416
0,072097	83,927017	0,102685	83,830448	0,108562	83,830448
0,061842	75,492148	0,088837	75,405285	0,095234	75,405285
0,053034	68,061542	0,076898	68,061542	0,082584	68,061542
0,045561	61,574627	0,066595	61,503777	0,071642	61,503777
0,036785	53,752886	0,054567	53,752886	0,058850	53,691037
0,029852	47,195630	0,044849	47,249998	0,048450	47,195630
0,024263	41,725523	0,036960	41,725523	0,039985	41,725523
0,019821	37,102382	0,030530	37,102382	0,033152	37,059691
0,016195	33,067532	0,025227	33,067532	0,027466	33,067532
0,013283	29,607503	0,020888	29,607503	0,022801	29,607503
0,010883	26,570626	0,017294	26,570626	0,018924	26,570626
0,008965	23,900214	0,014319	23,927745	0,015711	23,900214
0,007373	21,572565	0,011888	21,572565	0,013034	21,572565
0,006262	19,787995	0,010120	19,787995	0,011110	19,787995
0,004806	17,274353	0,007853	17,274353	0,008648	17,274353
0,003741	15,167073	0,006125	15,167073	0,006751	15,167073
0,002912	13,393738	0,004823	13,409166	0,005310	13,393738
0,002304	11,909727	0,003828	11,909727	0,004214	11,896023
0,001823	10,614556	0,003041	10,626783	0,003366	10,614556
0,001447	9,482197	0,002453	9,503899	0,002690	9,492963
0,001162	8,543363	0,001975	8,538897	0,002168	8,529072
0,000937	7,721968	0,001581	7,689566	0,001739	7,664934
0,000743	6,936084	0,001281	6,930230	0,001404	6,924571
0,000555	6,078323	0,000977	6,093630	0,001070	6,097574
0,000414	5,345426	0,000737	5,341386	0,000799	5,333148
0,000292	4,618370	0,000562	4,717856	0,000603	4,703485
0,000219	4,122460	0,000428	4,177969	0,000452	4,153797
0,000160	3,673053	0,000319	3,680859	0,000353	3,749925
0,000120	3,334090	0,000241	3,279191	0,000263	3,340664
0,000087	3,025996	0,000196	3,023282	0,000192	2,978382
0,000044	2,569700	0,000137	2,650584	0,000142	2,694178
0,000037	2,487510	0,000116	2,504581	0,000099	2,423248
0,000023	2,314389	0,000080	2,232182	0,000066	2,192738
0,000012	2,168693	0,000053	2,003727	0,000045	2,032483
-0,000010	1,841430	0,000034	1,825907	0,000009	1,723435
-0,000024	1,594396	0,000010	1,572814	-0,000009	1,545913
-0,000036	1,359673	-0,000002	1,429562	-0,000028	1,333385
-0,000044	1,173558	-0,000017	1,223543	-0,000043	1,139152



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-0,000050	1,009988	-0,000028	1,052775	-0,000054	0,968528
-0,000055	0,865391	-0,000037	0,896000	-0,000062	0,827294
-0,000058	0,741183	-0,000042	0,771116	-0,000067	0,710292
-0,000060	0,640408	-0,000047	0,663189	-0,000072	0,610988
-0,000062	0,549927	-0,000050	0,568953	-0,000075	0,524565
-0,000064	0,466964	-0,000052	0,491462	-0,000077	0,448757

Sensitivity in liquid:

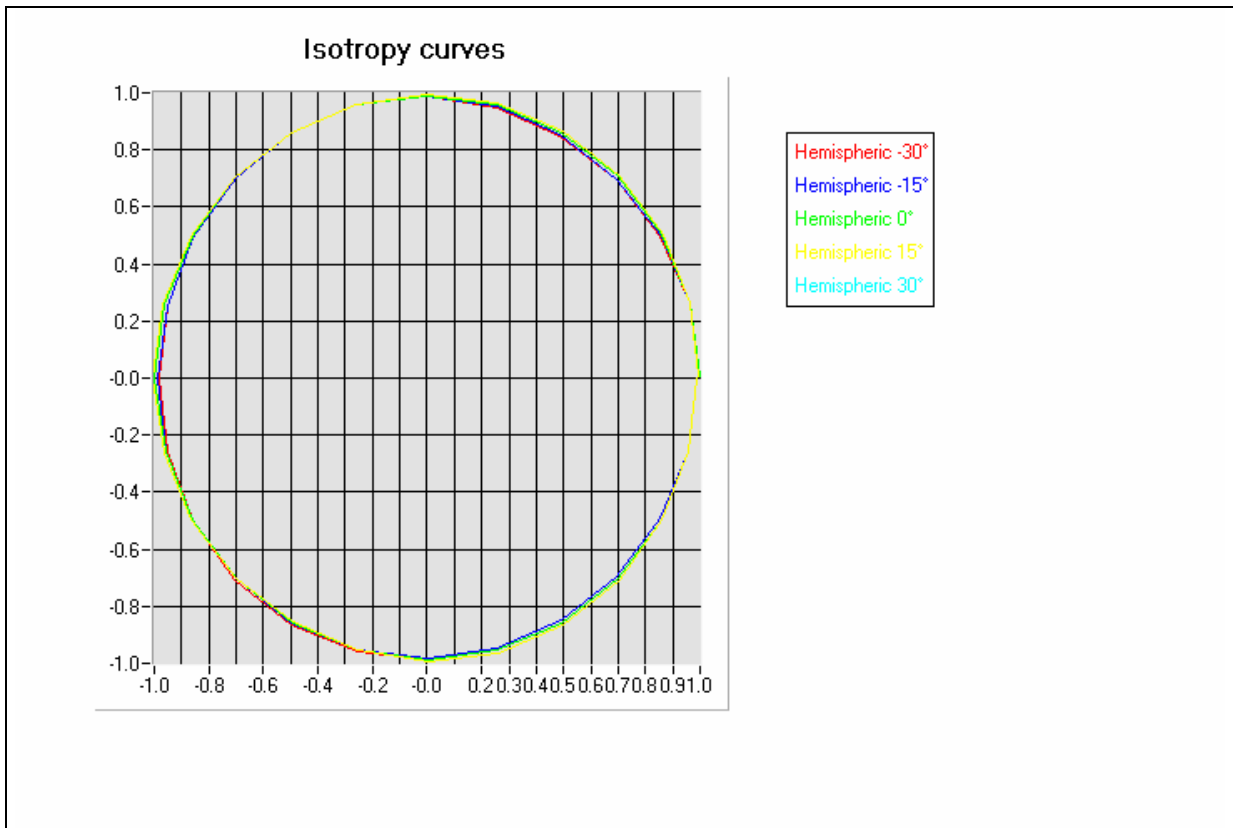
Liquid	$\epsilon$	$\sigma$	CF dipole 1 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 2 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 3 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )
Head	38.21	1.42	57.24	34.64	31.45
Body	55.02	1.48	58.01	34.16	31.99



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## B. Isotropy.

- Axial isotropy: 0.09 dB
- Hemispherical isotropy: 0.11 dB



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

## C. Linearity.

- Linearity: 0.14 dB





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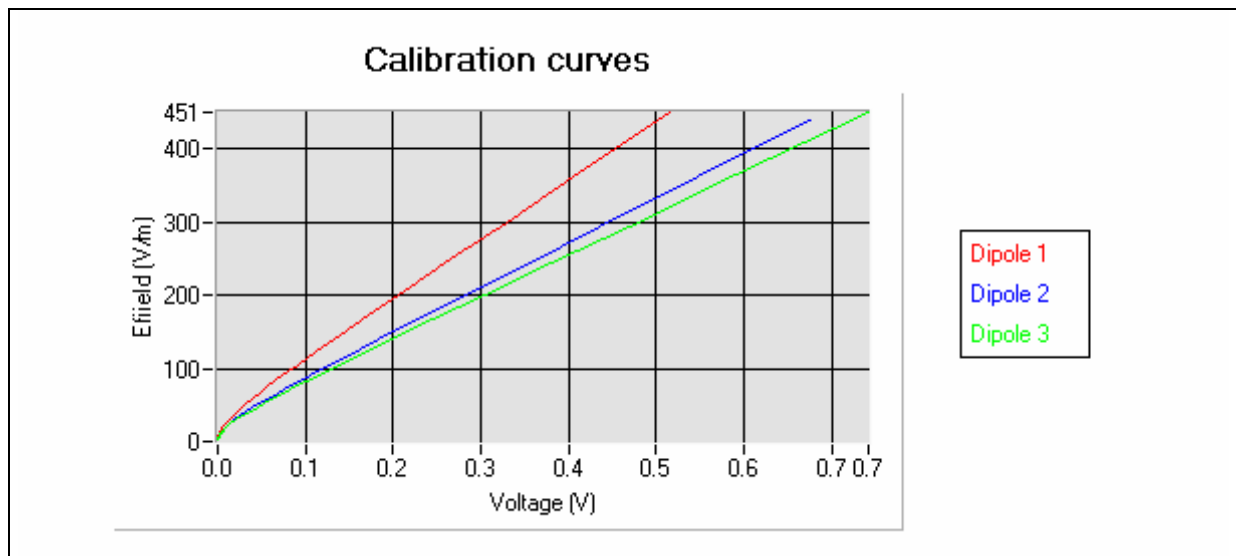
## 6. Calibration at 2450.00 MHz

### A. Calibration parameters.

Label	2450
Epsilon	38.59
Sigma	1.71 S/m
Temperature	21 °C
Cable loss	0.00 dB
Coupler loss	21.50 dB
Waveguide S11	-14.70 dB
Low limit detection	0.76 V/m

Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain E-field value using the formula:

$$E=\sqrt{(e1*e1+e2*e2+e3*e3)}$$



The following tables represent the linearization of calibration curves by curve segment in CW signal.



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Calibration coefficients for the three dipoles in CW in Head Liquid:

v1	e1	v2	e2	v3	e3
0,515625	449,294640	0,676349	440,467121	0,742339	450,608367
0,412769	366,940956	0,548041	362,538522	0,590630	364,352274
0,329117	299,801694	0,435956	294,354038	0,468929	295,053758
0,266670	249,511541	0,351850	243,070371	0,380690	244,701522
0,213517	206,501698	0,281214	199,855036	0,303582	200,567558
0,171296	172,105532	0,225482	165,592392	0,244680	166,705463
0,138846	145,428362	0,183037	139,327528	0,197851	139,622583
0,112251	123,304481	0,147395	117,077681	0,158817	116,861388
0,091138	105,468010	0,117935	98,461424	0,126506	97,801112
0,073208	90,015130	0,093777	82,939661	0,101131	82,596985
0,058128	76,668364	0,075657	71,048214	0,081518	70,611257
0,047030	66,521704	0,061074	61,228571	0,065474	60,561207
0,038175	58,121529	0,048976	52,817151	0,053131	52,593274
0,030799	50,813522	0,039502	45,971301	0,042842	45,708936
0,024930	44,698062	0,032006	40,310109	0,034668	40,002842
0,020265	39,556619	0,025878	35,442793	0,028127	35,210731
0,016110	34,673539	0,016536	27,333989	0,018220	27,333989
0,010491	27,333989	0,013240	24,138098	0,014655	24,138098
0,008358	24,165904	0,010553	21,315868	0,011675	21,315868
0,006599	21,340423	0,008464	18,932285	0,009357	18,932285
0,005265	18,954095	0,006810	16,873418	0,007538	16,873418
0,004209	16,892853	0,005510	15,107863	0,006093	15,107863
0,003379	15,064805	0,004462	13,558232	0,004945	13,558232
0,002737	13,581202	0,003623	12,209645	0,004035	12,209645
0,002217	12,248507	0,002957	11,020545	0,003264	11,007863
0,001797	11,055435	0,001949	8,926949	0,002163	8,926949
0,001177	9,009979	0,001884	8,784217	0,002043	8,784217
0,001136	8,858080	0,001429	7,712640	0,001582	7,719746
0,000856	7,741451	0,001110	6,806506	0,001219	6,825167
0,000656	6,833038	0,000867	6,060847	0,000935	6,033495
0,000506	6,063057	0,000685	5,435784	0,000741	5,426714
0,000399	5,447701	0,000534	4,856505	0,000556	4,776817
0,000301	4,815601	0,000417	4,354997	0,000431	4,282221
0,000232	4,315360	0,000324	3,910750	0,000360	3,973972
0,000180	3,896155	0,000257	3,556477	0,000289	3,639711
0,000128	3,426034	0,000161	2,976247	0,000168	2,985014
0,000065	2,750858	0,000139	2,826552	0,000147	2,856146
0,000035	2,365475	0,000105	2,578165	0,000079	2,391682
0,000013	2,028751	0,000060	2,206841	0,000070	2,323261
-0,000003	1,745864	0,000041	2,029766	0,000043	2,104695
-0,000015	1,506784	0,000027	1,888696	0,000019	1,889305
-0,000024	1,303495	0,000005	1,642717	0,000004	1,741208
-0,000031	1,111268	-0,000002	1,556319	-0,000017	1,506882
-0,000036	0,949907	-0,000018	1,335812	-0,000034	1,287641
-0,000039	0,813084	-0,000031	1,137100	-0,000046	1,110854
-0,000042	0,696402	-0,000039	0,977685	-0,000055	0,959722
-0,000044	0,592435	-0,000045	0,845533	-0,000061	0,829151
-0,000045	0,505653	-0,000050	0,724896	-0,000066	0,711492



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-0,000046	0,434170	-0,000054	0,620208	-0,000070	0,603730
		-0,000056	0,527348	-0,000073	0,514851
		-0,000058	0,449920	-0,000075	0,439809

Sensitivity in liquid:

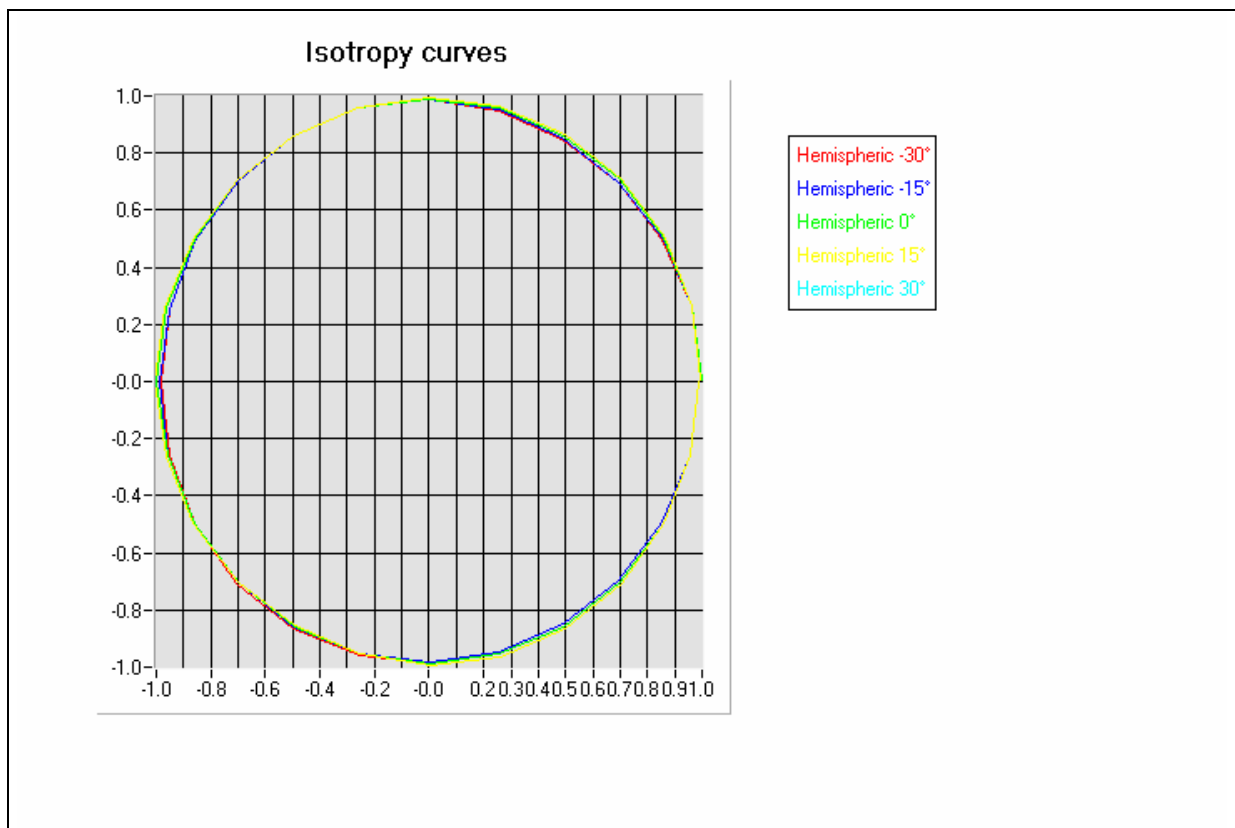
Liquid	$\epsilon$	$\sigma$	CF dipole 1 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 2 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )	CF dipole 3 (W.kg <sup>-1</sup> (mV) <sup>-1</sup> )
Head	38.59	1.71	66.22	38.80	34.19
Body	53.63	1.87	66.76	39.11	34.71



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## B. Isotropy.

- Axial isotropy: 0.10 dB
- Hemispherical isotropy: 0.11 dB



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

## C. Linearity.

- Linearity: 0.13 dB