

Tissue Parameters

Recipe for liquids below 1 GHz:

Water 35-58%

Sugar 40-60%

Salt 0-6%

Hydroxyethyl-cellulose <0.3%

Preventol-D7 0.1-0.7%

Recipe for liquids above 1-3 GHz:

Water 52-75%

DGBE 25-48%

Salt <1.0%

Recipe for liquids 5-6 GHz:

Water 60-80%

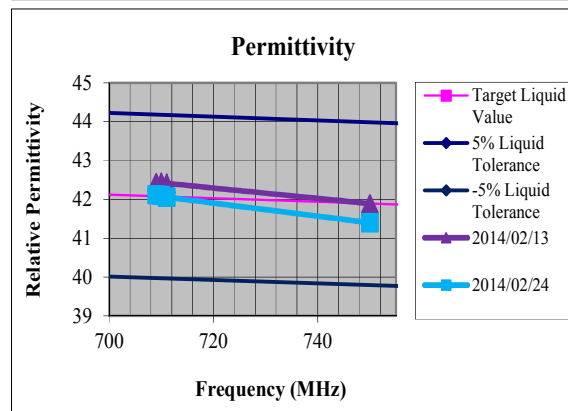
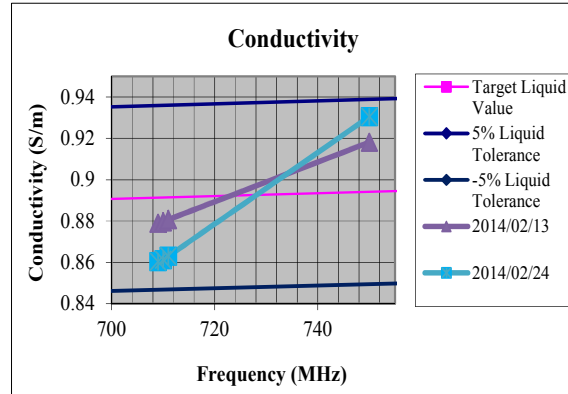
Esters, Emulsifiers, Inhibitors 20-40%

Sodium Chloride 0-1.5%

SAR measurements were made within 24 hours of the measurement of liquid parameters. Relative permittivity and conductivity are within $\pm 5\%$ of the target.

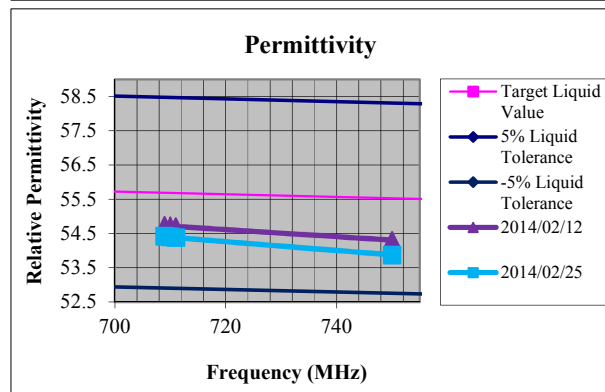
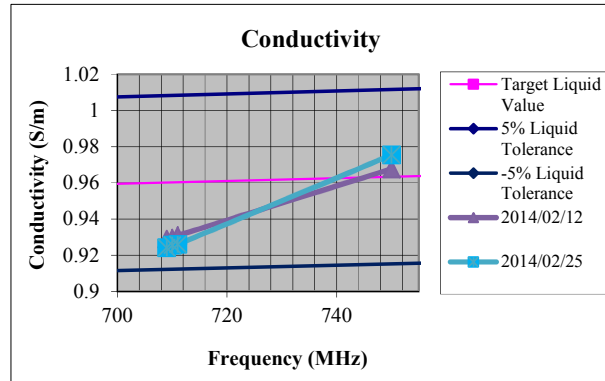
750 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/13	21.3	709	42.4325	0.8789
		710	42.4351	0.8796
		711	42.4141	0.8807
		750	41.8912	0.9181
2014/02/24	20.2	709	42.1197	0.8604
		710	42.1015	0.8613
		711	42.058	0.863
		750	41.3988	0.9305



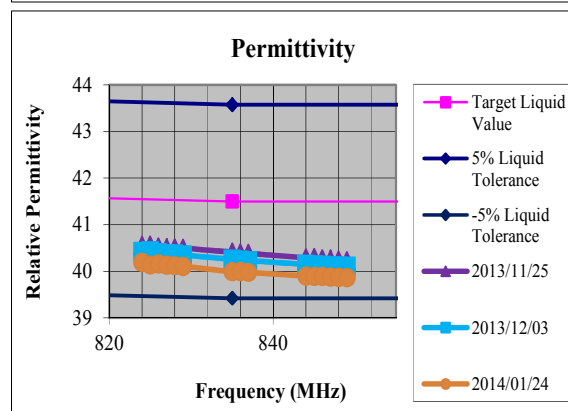
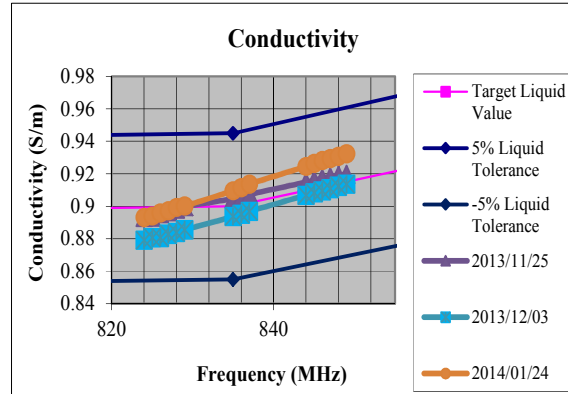
750 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/12	22.1	709	54.741	0.9289
		710	54.7162	0.9294
		711	54.7063	0.9308
		750	54.3064	0.9677
2014/02/25	20.4	709	54.4214	0.9241
		710	54.4017	0.9256
		711	54.3788	0.926
		750	53.876	0.9754



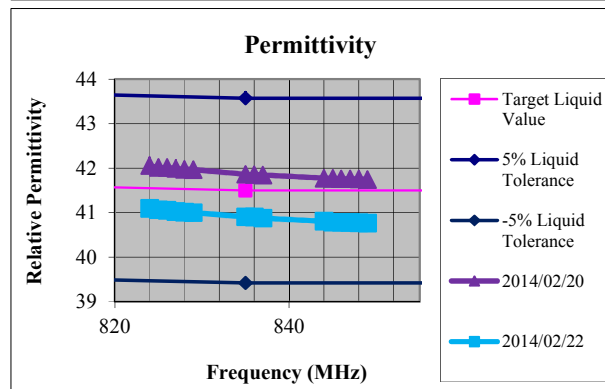
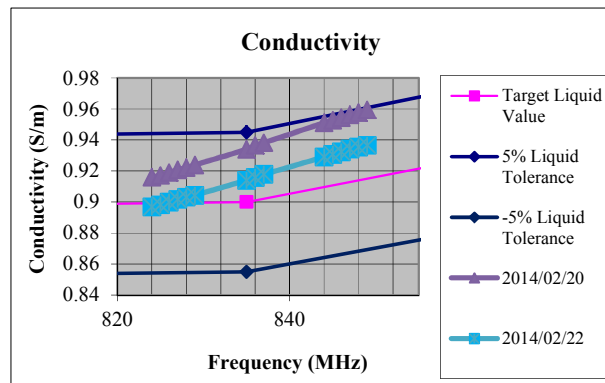
850 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/11/25	21.1	824	40.5587	0.8932
		825	40.5637	0.8934
		826	40.5257	0.8955
		827	40.508	0.8966
		828	40.5023	0.8982
		829	40.4974	0.8998
		835	40.4136	0.9047
		836	40.3943	0.906
		837	40.3859	0.9073
		844	40.2918	0.9149
		845	40.2941	0.9161
		846	40.2696	0.9172
		847	40.2591	0.9181
		848	40.2438	0.9192
		849	40.2264	0.9197
2013/12/03	20.6	824	40.43	0.8791
		825	40.44	0.8807
		826	40.4	0.8807
		827	40.38	0.8828
		828	40.37	0.8839
		829	40.35	0.8855
		835	40.26	0.8937
		836	40.24	0.8951
		837	40.23	0.8969
		844	40.15	0.9068
		845	40.14	0.9083
		846	40.13	0.9095
2014/01/24	20.7	824	40.1955	0.8932
		825	40.1374	0.894
		826	40.1603	0.896
		827	40.135	0.8973
		828	40.1241	0.8994
		829	40.1084	0.9002
		835	39.9946	0.9096
		836	39.9992	0.9116
		837	39.9797	0.9137
		844	39.8995	0.9246
		845	39.8916	0.9264
		846	39.8927	0.9282



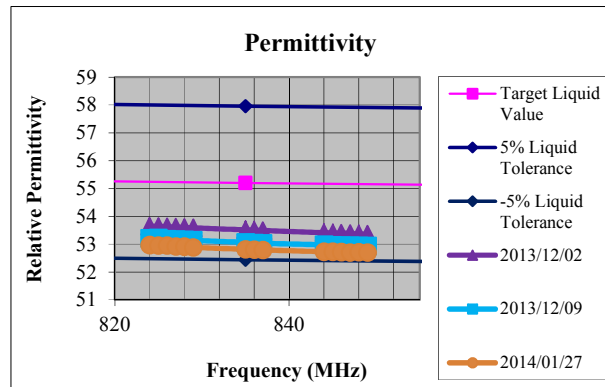
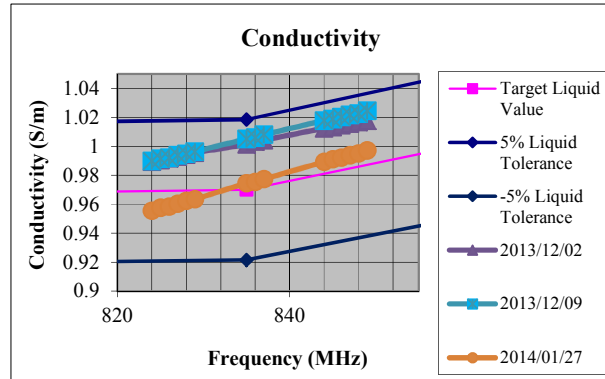
850 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/20	21	824	42.0593	0.916
		825	42.0173	0.9172
		826	42.0192	0.919
		827	41.9949	0.9208
		828	41.975	0.9222
		829	41.9706	0.9239
		835	41.863	0.934
		836	41.8559	0.9366
		837	41.8479	0.9382
		844	41.7784	0.9511
		845	41.778	0.9528
		846	41.7655	0.9545
		847	41.7655	0.9562
		848	41.7596	0.9578
		849	41.7462	0.9595
2014/02/22	20.3	824	41.0974	0.8968
		825	41.0658	0.8982
		826	41.0544	0.9
		827	41.0272	0.9017
		828	41.0147	0.9032
		829	41.0027	0.9044
		835	40.9078	0.9141
		836	40.9041	0.9159
		837	40.8789	0.9178
		844	40.8076	0.9291
		845	40.7877	0.9308
		846	40.7881	0.9324
		847	40.7804	0.9342
		848	40.7735	0.9355
		849	40.7677	0.9366



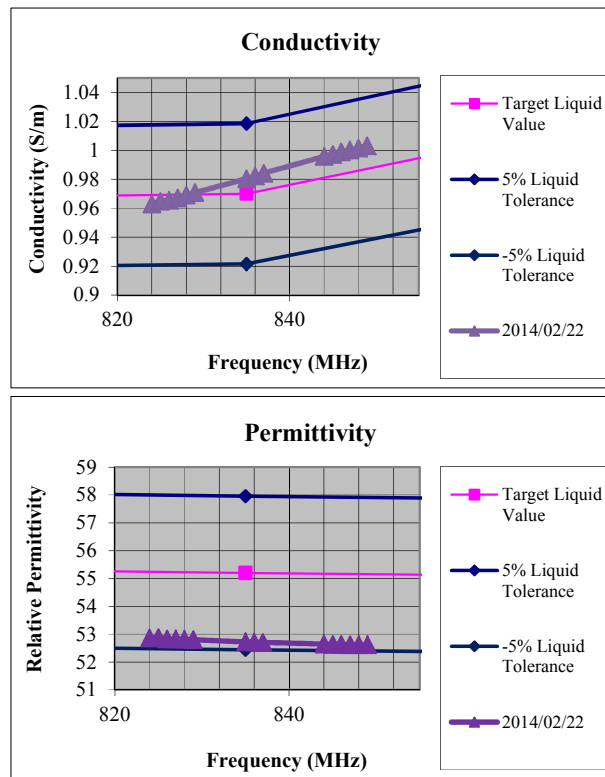
850 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permutivity	Conductivity (S/m)
2013/12/02	20.5	824	53.6481	0.9894
		825	53.6362	0.9906
		826	53.6283	0.9918
		827	53.6132	0.9929
		828	53.5995	0.9943
		829	53.5853	0.9957
		835	53.5143	1.0013
		836	53.5044	1.0034
		837	53.4894	1.0043
		844	53.4118	1.0125
		845	53.401	1.0133
		846	53.3908	1.0146
		847	53.3876	1.0157
		848	53.3666	1.0168
		849	53.3599	1.0177
2013/12/09	20	824	53.2072	0.9898
		825	53.2224	0.9915
		826	53.1771	0.9921
		827	53.1627	0.9939
		828	53.1563	0.9949
		829	53.1378	0.9963
		835	53.0631	1.0051
		836	53.0415	1.006
		837	53.0301	1.0081
		844	52.9755	1.0178
		845	52.957	1.0189
		846	52.9479	1.0203
		847	52.9445	1.0217
		848	52.9313	1.0227
		849	52.929	1.0245
2014/01/27	20.8	824	52.9697	0.9556
		825	52.9468	0.9577
		826	52.9478	0.9584
		827	52.9197	0.9605
		828	52.9098	0.9624
		829	52.8823	0.9635
		835	52.8144	0.9746
		836	52.8019	0.9755
		837	52.7899	0.9774
		844	52.7285	0.9893
		845	52.7262	0.9911
		846	52.7171	0.9923
		847	52.7005	0.9939
		848	52.7096	0.9952
		849	52.7009	0.9972



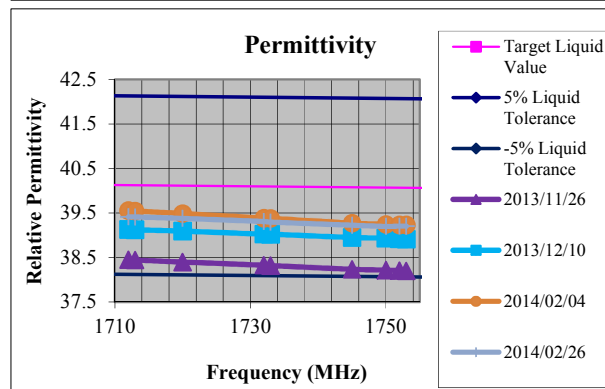
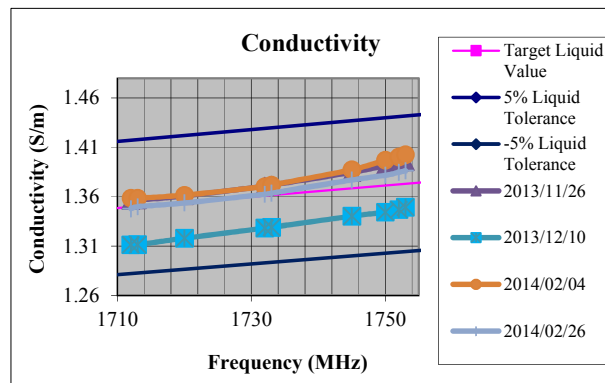
850 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/22	20.9	824	52.8671	0.9628
		825	52.8813	0.9648
		826	52.8297	0.9655
		827	52.8241	0.9671
		828	52.8125	0.9692
		829	52.8018	0.9708
		835	52.7198	0.9804
		836	52.713	0.9823
		837	52.7046	0.9842
		844	52.6445	0.9958
		845	52.6355	0.9971
		846	52.6336	0.9989
		847	52.6264	1.0002
		848	52.6213	1.0015
		849	52.6175	1.0032



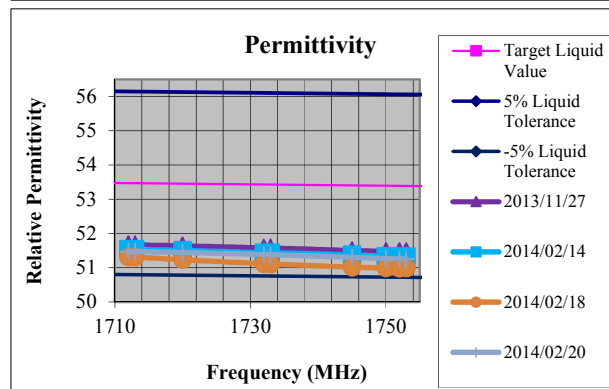
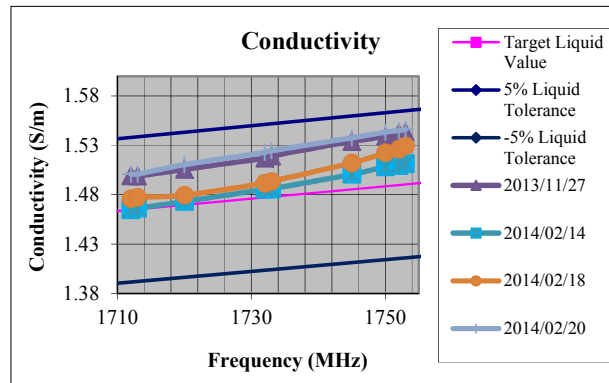
1750 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/11/26	20.3	1712	38.4523	1.3561
		1713	38.444	1.3567
		1720	38.3991	1.3608
		1732	38.3276	1.3707
		1733	38.3194	1.3718
		1745	38.2362	1.3847
		1750	38.2184	1.3916
		1752	38.2056	1.3946
2013/12/10	21.8	1753	38.2	1.3953
		1712	39.1285	1.3113
		1713	39.1229	1.3114
		1720	39.0931	1.3179
		1732	39.0249	1.3282
		1733	39.0241	1.329
		1745	38.9513	1.3403
		1750	38.9352	1.3443
2014/02/04	20.7	1752	38.9218	1.347
		1753	38.9112	1.3493
		1712	39.5557	1.3585
		1713	39.5473	1.3586
		1720	39.4885	1.3616
		1732	39.3843	1.3703
		1733	39.3803	1.3718
		1745	39.2733	1.3874
2014/02/26	20.7	1750	39.2451	1.3971
		1752	39.2318	1.4003
		1753	39.2325	1.4026
		1712	39.4138	1.3478
		1713	39.4125	1.3499
		1720	39.379	1.3537
		1732	39.3099	1.3625
		1733	39.2964	1.3636
		1745	39.2262	1.377
		1750	39.1991	1.3817
		1752	39.2065	1.3847
		1753	39.2042	1.3864



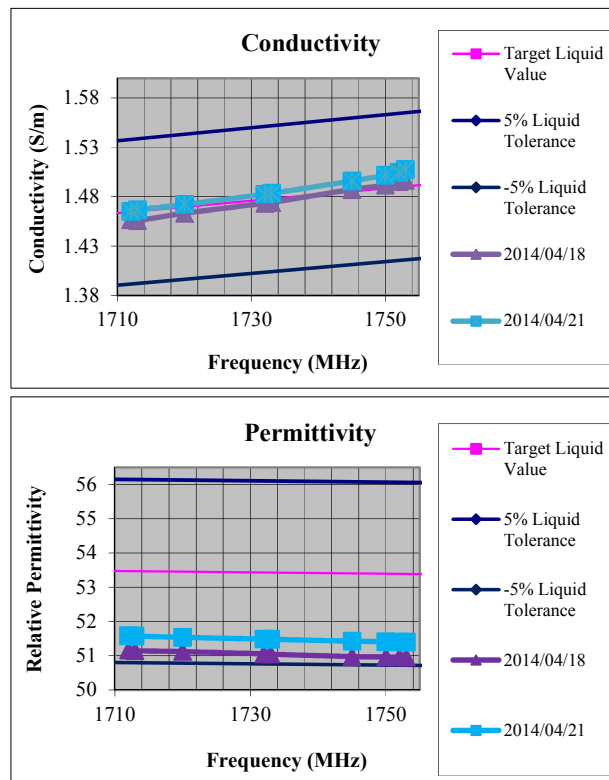
1750 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/11/27	20.4	1712	51.6773	1.4991
		1713	51.6669	1.4989
		1720	51.6402	1.5056
		1732	51.5781	1.517
		1733	51.5746	1.5192
		1745	51.5046	1.534
		1750	51.4775	1.5389
		1752	51.4758	1.5423
		1753	51.4764	1.5432
2014/02/14	21.2	1712	51.5431	1.4648
		1713	51.5383	1.4662
		1720	51.5079	1.4731
		1732	51.4424	1.4854
		1733	51.442	1.486
		1745	51.3768	1.5006
		1750	51.3307	1.5082
		1752	51.3357	1.5096
		1753	51.3299	1.5114
2014/02/18	20.4	1712	51.3108	1.476
		1713	51.3167	1.4775
		1720	51.2343	1.4795
		1732	51.1173	1.4917
		1733	51.1096	1.4936
		1745	51.0202	1.5122
		1750	50.9919	1.5226
		1752	50.988	1.5261
		1753	50.9943	1.5296
2014/02/20	20.9	1712	51.4696	1.5009
		1713	51.4763	1.5008
		1720	51.445	1.5104
		1732	51.3905	1.5229
		1733	51.3829	1.5246
		1745	51.3071	1.5376
		1750	51.2692	1.5434
		1752	51.2605	1.5449
		1753	51.254	1.5463



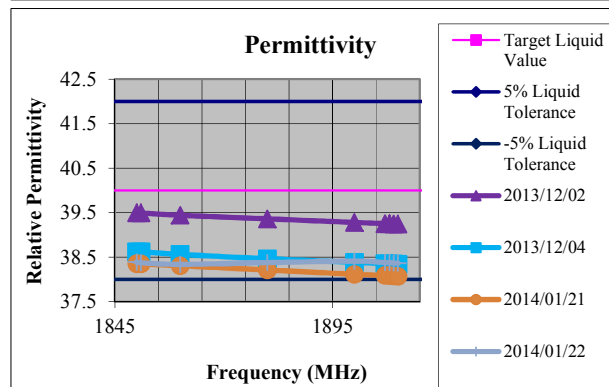
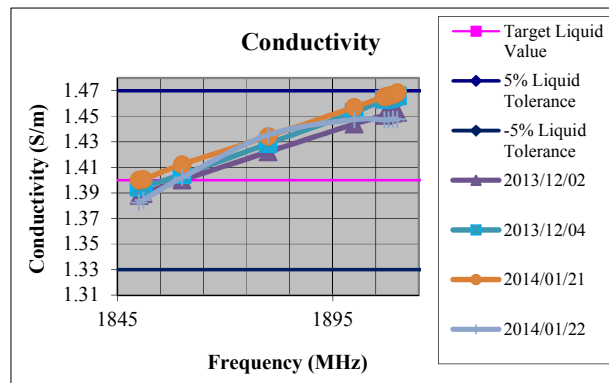
1750 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/04/18	21.9	1712	51.1627	1.4567
		1713	51.1458	1.4558
		1720	51.1217	1.4632
		1732	51.0563	1.4733
		1733	51.046	1.4741
		1745	50.9759	1.4873
		1750	50.9665	1.4916
		1752	50.9651	1.4954
		1753	50.9609	1.4964
2014/04/21	22.3	1712	51.5809	1.465
		1713	51.5759	1.4668
		1720	51.5384	1.4721
		1732	51.4867	1.4825
		1733	51.4809	1.4834
		1745	51.4276	1.4959
		1750	51.4092	1.5017
		1752	51.405	1.5047
		1753	51.4003	1.5076



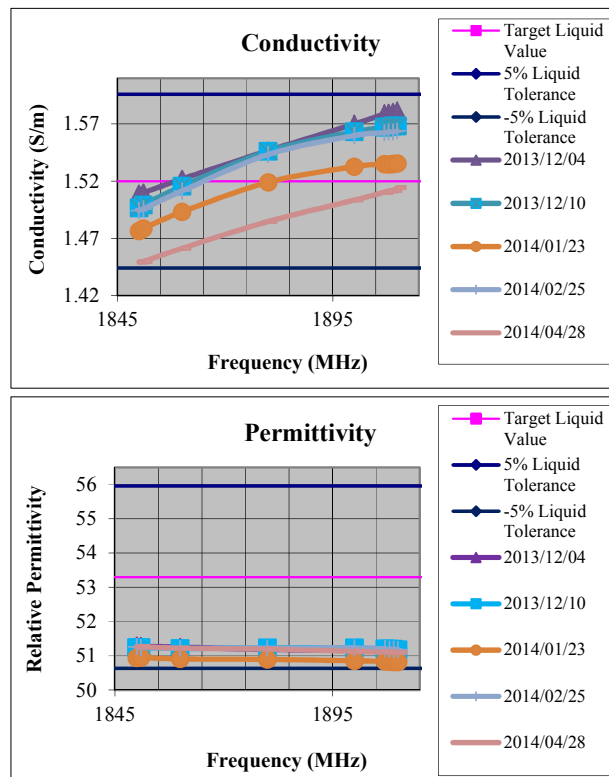
1900 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/12/02	22	1850	39.4947	1.3879
		1851	39.4948	1.3895
		1860	39.443	1.4
		1880	39.3635	1.4221
		1900	39.282	1.4439
		1907	39.2552	1.4507
		1908	39.2521	1.4516
		1909	39.2495	1.4524
		1910	39.246	1.4532
2013/12/04	20.6	1850	38.6219	1.3947
		1851	38.6215	1.395
		1860	38.5644	1.4043
		1880	38.4668	1.4286
		1900	38.3863	1.4531
		1907	38.356	1.4632
		1908	38.3515	1.4638
		1909	38.3479	1.4649
		1910	38.3417	1.466
2014/01/21	20.9	1850	38.357	1.4002
		1851	38.3504	1.4006
		1860	38.3093	1.4123
		1880	38.2147	1.4343
		1900	38.1175	1.4572
		1907	38.0951	1.4653
		1908	38.09	1.466
		1909	38.0791	1.467
		1910	38.0719	1.4687
2014/01/22	22	1850	38.3917	1.3824
		1851	38.3758	1.3844
		1860	38.3405	1.402
		1880	38.3805	1.4354
		1900	38.4137	1.4474
		1907	38.3821	1.4472
		1908	38.3811	1.4473
		1909	38.3738	1.448
		1910	38.3666	1.4474



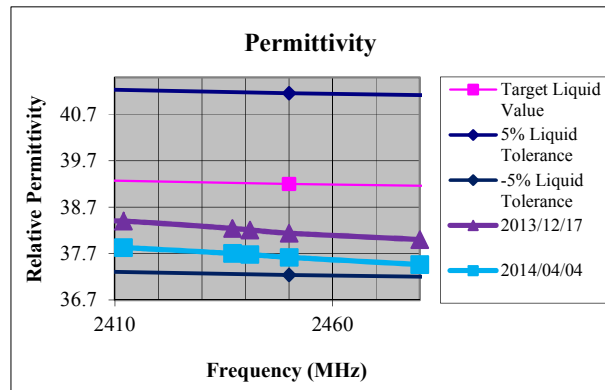
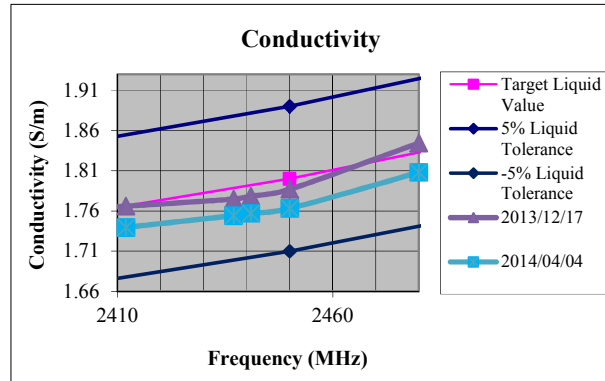
1900 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/12/04	20	1850	51.289	1.509
		1851	51.2831	1.5098
		1860	51.2551	1.5219
		1880	51.1898	1.5466
		1900	51.1566	1.5699
		1907	51.1295	1.5789
		1908	51.1293	1.5794
		1909	51.1257	1.5804
		1910	51.1226	1.5814
2013/12/10	21.6	1850	51.2412	1.4967
		1851	51.2464	1.4991
		1860	51.2148	1.5156
		1880	51.2326	1.5462
		1900	51.2301	1.5632
		1907	51.2029	1.5671
		1908	51.1932	1.5676
		1909	51.193	1.5683
		1910	51.1834	1.5682
2014/01/23	21.9	1850	50.941	1.4763
		1851	50.9542	1.4786
		1860	50.9085	1.4931
		1880	50.8957	1.519
		1900	50.8568	1.5327
		1907	50.8372	1.5349
		1908	50.8263	1.5347
		1909	50.8172	1.535
		1910	50.8162	1.5356
2014/02/25	22	1850	51.2714	1.4943
		1851	51.2451	1.4957
		1860	51.2211	1.5114
		1880	51.2267	1.5433
		1900	51.2318	1.5599
		1907	51.2099	1.5624
		1908	51.1966	1.5632
		1909	51.1981	1.5631
		1910	51.1849	1.564
2014/04/28	21.6	1850	51.2617	1.4493
		1851	51.2734	1.4497
		1860	51.2255	1.4612
		1880	51.1964	1.4847
		1900	51.1287	1.5034
		1907	51.1086	1.5103
		1908	51.108	1.5114
		1909	51.0975	1.5118
		1910	51.093	1.5142



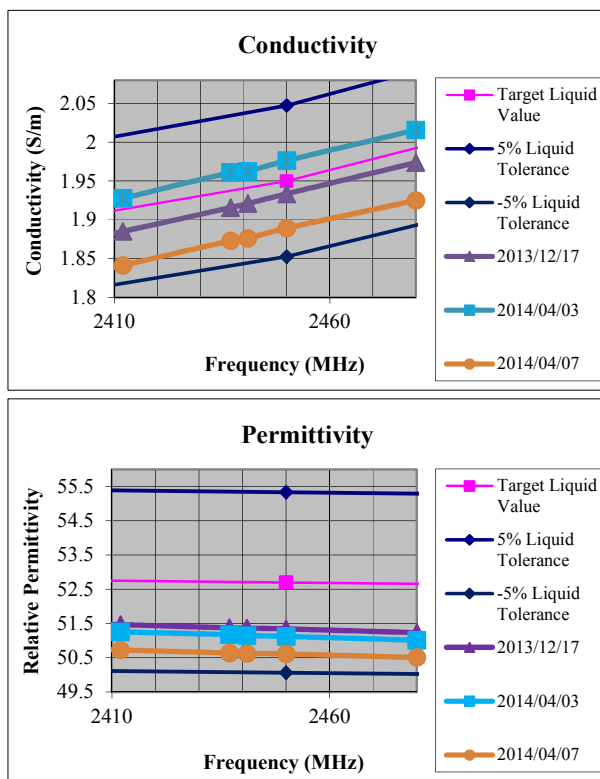
2450 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/12/17	24.65	2402	38.3892	1.7621
		2412	38.4008	1.7659
		2437	38.2444	1.7748
		2441	38.2128	1.7785
		2450	38.1404	1.7869
		2480	38.0053	1.8444
2014/04/04	24.71	2402	37.8358	1.7309
		2412	37.829	1.7394
		2437	37.7043	1.7542
		2441	37.6816	1.757
		2450	37.6202	1.7631
		2480	37.4655	1.808



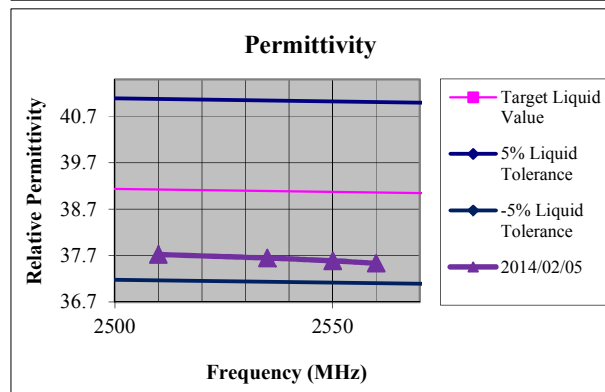
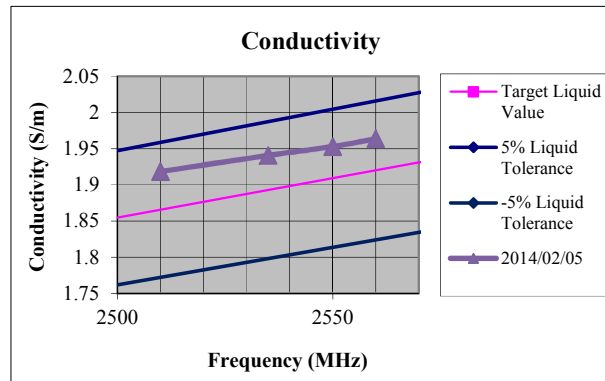
2450 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2013/12/17	23.6	2402	51.4892	1.8728
		2412	51.4681	1.885
		2437	51.3739	1.9158
		2441	51.3663	1.921
		2450	51.3432	1.9336
		2480	51.2328	1.9738
2014/04/03	23.17	2402	51.2816	1.9148
		2412	51.2538	1.9278
		2437	51.1763	1.961
		2441	51.1471	1.9626
		2450	51.1234	1.9763
		2480	51.0128	2.0159
2014/04/07	24.5	2402	50.7533	1.8284
		2412	50.7289	1.8413
		2437	50.6387	1.873
		2441	50.6251	1.8762
		2450	50.6127	1.8893
		2480	50.5083	1.9251



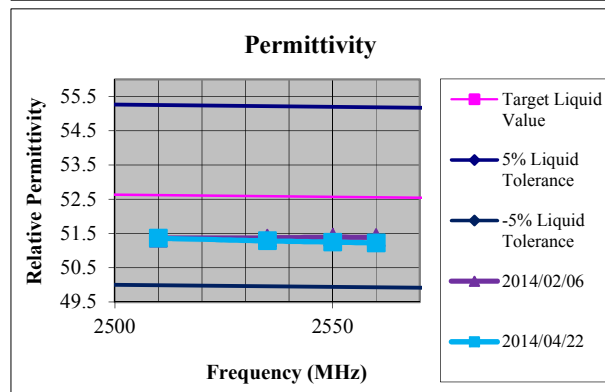
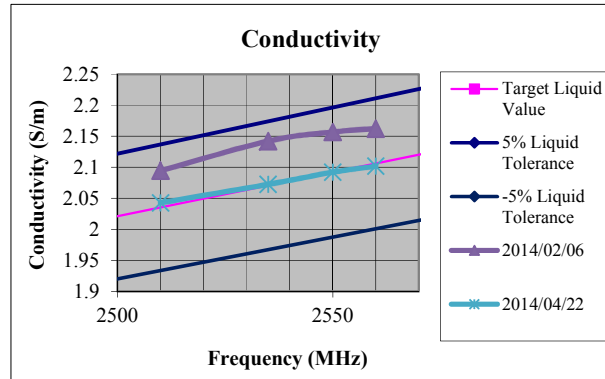
2550 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/05	22.6	2510	37.725	1.9184
		2535	37.649	1.9406
		2550	37.588	1.9529
		2560	37.5356	1.9637



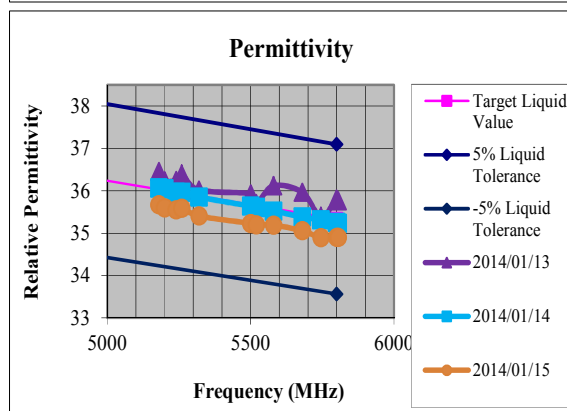
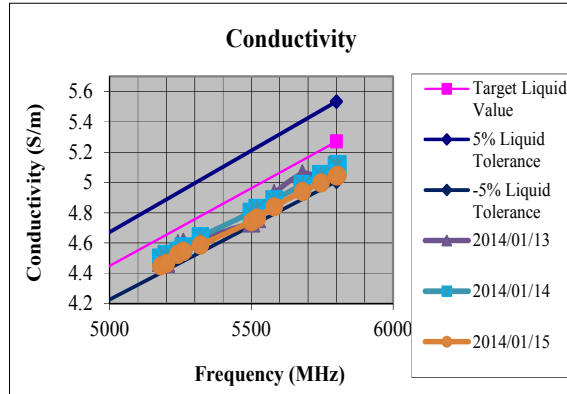
2550 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/06	21.5	2510	51.3662	2.0946
		2535	51.3732	2.1423
		2550	51.3923	2.1569
		2560	51.3863	2.1625
2014/04/22	23.2	2510	51.3635	2.0428
		2535	51.2861	2.0726
		2550	51.2502	2.0921
		2560	51.2245	2.1019



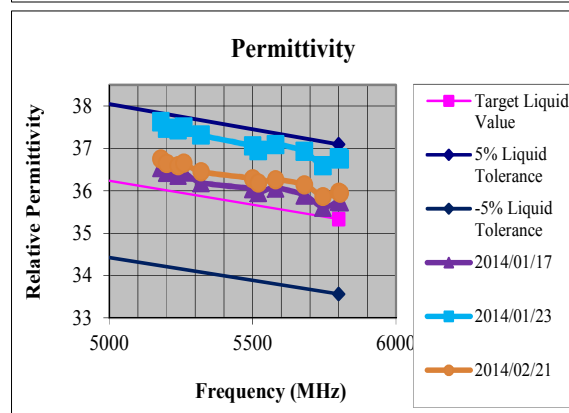
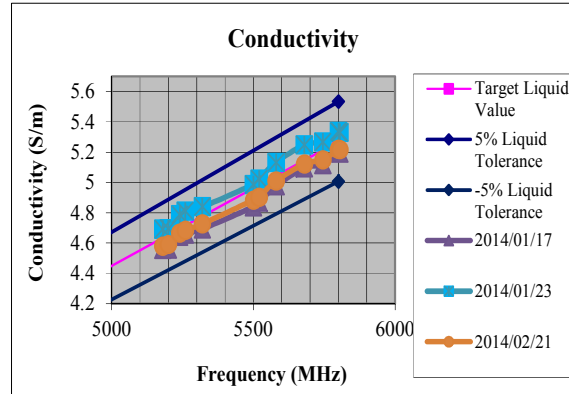
5000 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/01/13	22.7	5180	36.4574	4.473
		5200	36.2374	4.4675
		5240	36.2472	4.5934
		5260	36.3933	4.6048
		5320	36.0192	4.6293
		5500	35.9288	4.7343
		5520	35.6995	4.763
		5580	36.1225	4.9244
		5680	35.9684	5.0571
		5745	35.3953	5.0313
		5800	35.8111	5.1156
		5805	35.768	5.102
2014/01/14	22.14	5180	36.0703	4.5013
		5200	36.049	4.5238
		5240	35.9679	4.5444
		5260	35.9702	4.575
		5320	35.8539	4.641
		5500	35.6403	4.803
		5520	35.6104	4.8271
		5580	35.5251	4.8852
		5680	35.3857	4.9855
		5745	35.3161	5.0505
		5800	35.2549	5.1099
		5805	35.2359	5.117
2014/01/15	21.8	5180	35.6718	4.4497
		5200	35.6025	4.4669
		5240	35.5529	4.5272
		5260	35.5929	4.5464
		5320	35.4069	4.5878
		5500	35.2321	4.7416
		5520	35.1982	4.7662
		5580	35.1913	4.8407
		5680	35.0591	4.941
		5745	34.8965	4.9983
		5800	34.9023	5.0444
		5805	34.9007	5.0466



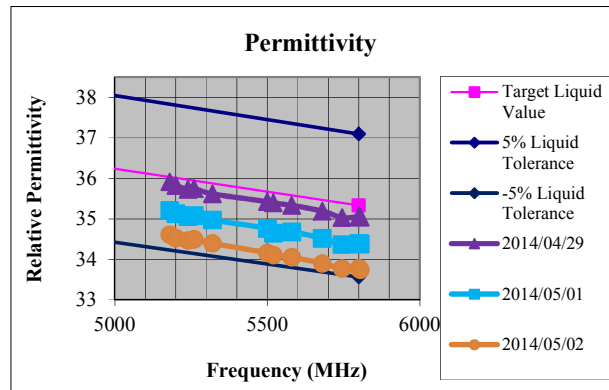
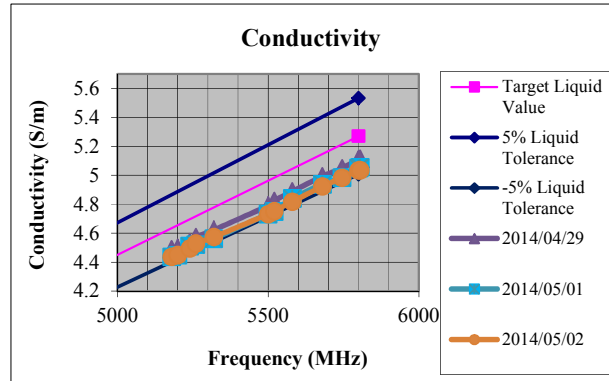
5000 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/01/17	21.5	5180	36.5531	4.5587
		5200	36.436	4.5589
		5240	36.3677	4.6446
		5260	36.4427	4.6596
		5320	36.1964	4.694
		5500	36.0529	4.8395
		5520	35.9606	4.8712
		5580	36.0677	4.9787
		5680	35.8992	5.0971
		5745	35.6138	5.1179
		5800	35.7671	5.1996
		5805	35.7398	5.1941
2014/01/23	21.9	5180	37.6337	4.6917
		5200	37.4754	4.6944
		5240	37.4412	4.7891
		5260	37.5053	4.8118
		5320	37.3168	4.8399
		5500	37.0615	4.987
		5520	36.9514	5.0226
		5580	37.0952	5.1325
		5680	36.9309	5.2484
		5745	36.5942	5.2675
		5800	36.7796	5.3362
		5805	36.7562	5.3308
2014/02/21	20.55	5180	36.754	4.5803
		5200	36.6483	4.5911
		5240	36.5968	4.6658
		5260	36.6564	4.6851
		5320	36.4549	4.7274
		5500	36.2893	4.884
		5520	36.1861	4.903
		5580	36.2639	5.0108
		5680	36.1446	5.1219
		5745	35.8681	5.1502
		5800	35.9737	5.2194
		5805	35.9469	5.2173



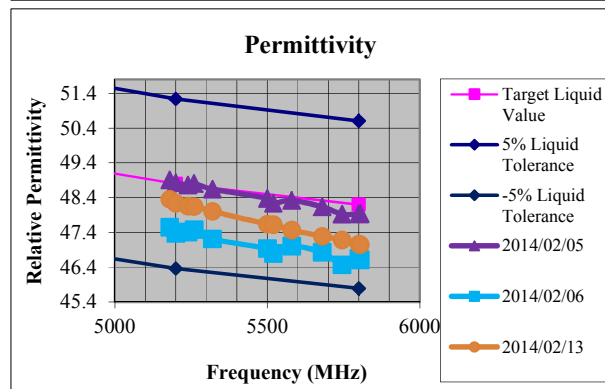
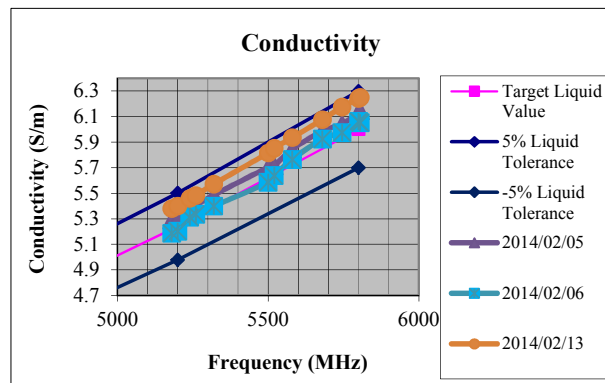
5000 MHz Head Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/04/29	20.8	5180	35.9122	4.4892
		5200	35.8227	4.4972
		5240	35.7308	4.538
		5260	35.7478	4.573
		5320	35.6162	4.623
		5500	35.4243	4.7904
		5520	35.3919	4.8236
		5580	35.3335	4.8896
		5680	35.1922	4.9921
		5745	35.0323	5.0485
		5800	35.0537	5.1116
		5805	35.0405	5.1154
2014/05/01	21.3	5180	35.2101	4.437
		5200	35.123	4.4474
		5240	35.0547	4.5097
		5260	35.0822	4.5206
		5320	34.971	4.5628
		5500	34.763	4.7326
		5520	34.6429	4.749
		5580	34.6737	4.8405
		5680	34.5204	4.9374
		5745	34.3635	4.9846
		5800	34.3975	5.0513
		5805	34.377	5.056
2014/05/02	21.8	5180	34.6119	4.4369
		5200	34.5244	4.4492
		5240	34.4654	4.4945
		5260	34.4957	4.5285
		5320	34.3962	4.574
		5500	34.1594	4.7319
		5520	34.1042	4.7525
		5580	34.0539	4.8176
		5680	33.8974	4.9231
		5745	33.7718	4.9827
		5800	33.7761	5.0342
		5805	33.7409	5.0351



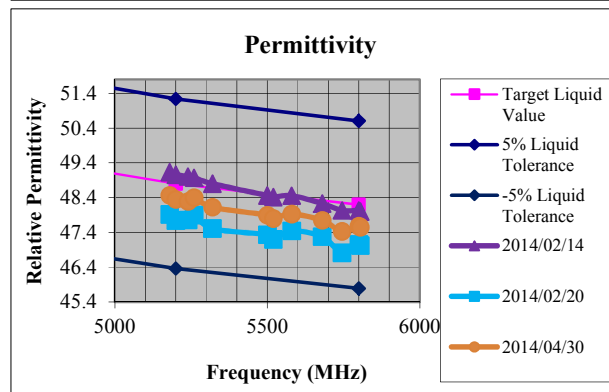
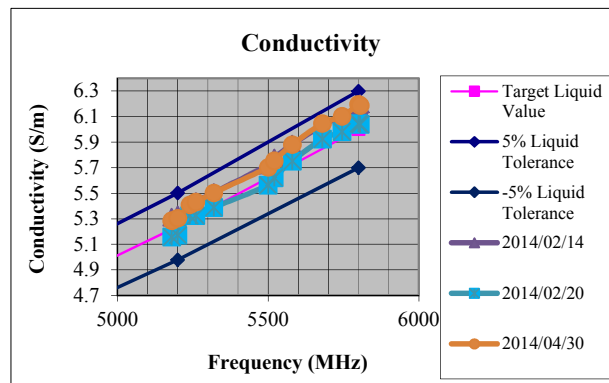
5000 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/05	20.43	5180	48.9146	5.2888
		5200	48.8277	5.3054
		5240	48.7671	5.3746
		5260	48.8095	5.4038
		5320	48.6453	5.4865
		5500	48.3799	5.7023
		5520	48.2387	5.714
		5580	48.3227	5.845
		5680	48.1401	5.987
		5745	47.9282	6.0406
		5800	47.9377	6.1358
		5805	47.9359	6.1475
2014/02/06	20.81	5180	47.5485	5.1856
		5200	47.3708	5.2012
		5240	47.4125	5.3109
		5260	47.4805	5.3352
		5320	47.2131	5.3991
		5500	46.9365	5.5853
		5520	46.7971	5.6374
		5580	47.004	5.7645
		5680	46.8292	5.9248
		5745	46.4689	5.9743
		5800	46.6498	6.0608
		5805	46.6109	6.0508
2014/02/13	20.6	5180	48.3569	5.3793
		5200	48.2397	5.4001
		5240	48.159	5.4593
		5260	48.1482	5.4823
		5320	48.0082	5.5716
		5500	47.6395	5.8156
		5520	47.6237	5.852
		5580	47.4679	5.9356
		5680	47.2931	6.0768
		5745	47.1842	6.1754
		5800	47.0665	6.2424
		5805	47.0481	6.2503



5000 MHz Body Liquid

Date	Temp (°C)	Frequency (MHz)	Relative Permativity	Conductivity (S/m)
2014/02/14	21.2	5180	49.1326	5.3124
		5200	49.0629	5.3316
		5240	49.0098	5.4136
		5260	48.9704	5.4371
		5320	48.8038	5.5057
		5500	48.4627	5.7218
		5520	48.4155	5.7773
		5580	48.4566	5.8831
		5680	48.2328	6.0301
		5745	48.0326	6.1013
		5800	48.0338	6.184
		5805	48.0012	6.199
2014/02/20	21.05	5180	47.9191	5.1571
		5200	47.7435	5.1707
		5240	47.7575	5.3243
		5260	47.8968	5.3231
		5320	47.5108	5.3891
		5500	47.3326	5.5618
		5520	47.1999	5.6205
		5580	47.4452	5.7522
		5680	47.2803	5.9232
		5745	46.8132	5.9814
		5800	47.0517	6.0437
		5805	47.0208	6.0398
2014/04/30	22	5180	48.4682	5.2852
		5200	48.3479	5.304
		5240	48.2936	5.4088
		5260	48.4021	5.4314
		5320	48.1255	5.503
		5500	47.8984	5.7023
		5520	47.8036	5.7537
		5580	47.9278	5.8809
		5680	47.7492	6.0467
		5745	47.432	6.102
		5800	47.583	6.1971
		5805	47.5496	6.187



Test Equipment

SAR1 Lab

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Robot	Staubli	TX90	F10/5D3NA 1/A/01	N/A	N/A
SAM Twin Phantom	SPEAG	SM 000 T01 DA	1592	N/A	N/A
Elliptical Phantom	SPEAG	QD OVA 001 BB	1092	N/A	N/A
Software	SPEAG	Dasy52.6.2.482	N/A	N/A	N/A
Device Holder	SPEAG	SD 000H01	N/A	N/A	N/A

SAR 3 Lab

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Robot	Staubli	TX90	F11/5G2MA 1/C/01	N/A	N/A
SAM Twin Phantom	SPEAG	SM 000 T01 DA	1637	N/A	N/A
SAM Twin Phantom	SPEAG	SM 000 T01 DA	1638	N/A	N/A
Elliptical Phantom	SPEAG	QD OVA 001 BB	1124	N/A	N/A
Software	SPEAG	Dasy52.6.2.482	N/A	N/A	N/A
Device Holder	SPEAG	SD 000H01	N/A	N/A	N/A

SAR 4 Lab

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Robot	Staubli	TX90	F11/5GW9A 1/A/01	N/A	N/A
SAM Twin Phantom	SPEAG	SM 000 T01 DA	1639	N/A	N/A
SAM Twin Phantom	SPEAG	SM 000 T01 DA	1640	N/A	N/A
Elliptical Phantom	SPEAG	QD OVA 001 BB	1125	N/A	N/A
Software	SPEAG	Dasy52.6.2.482	N/A	N/A	N/A
Device Holder	SPEAG	SD 000H01	N/A	N/A	N/A

Shared Equipment

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
750 MHz Head Tissue Simulant	SPEAG	HSL 750	110524-3	2014/02/13 – 2014/02/24	N/A
750 MHz Body Tissue Simulant	SPEAG	MSL 750	110526-1	2014/02/12 – 2014/02/25	N/A
900 MHz Head Tissue Simulant	SPEAG	HSL 900	100922-1	2013/11/25 – 2014/02/22	N/A
900 MHz Body Tissue Simulant	SPEAG	MSL 900	110614-1	2013/12/02 – 2013/12/09	N/A
900 MHz Body Tissue Simulant	SPEAG	MSL 900	110518-7	2014/01/27 – 2014/02/22	N/A
1750 MHz Head Tissue Simulant	SPEAG	HSL 1750	100907-4	2013/11/26 – 2014/02/26	N/A
1750 MHz Body Tissue Simulant	SPEAG	MSL 1750	100824-2	2013/11/27 – 2014/04/21	N/A
1900 MHz Head Tissue Simulant	SPEAG	HSL 1900	110530-2	2013/12/02 – 2013/12/04	N/A
1900 MHz Head Tissue Simulant	SPEAG	HSL 1900	100907-3	1/21/2014 – 2014/01/22	N/A
1900 MHz Body Tissue Simulant	SPEAG	MSL 1900	110615-4	2013/12/04 – 2013/12/10	N/A
1900 MHz Body Tissue Simulant	SPEAG	MSL 1900	110530-3	2014/01/23 – 2014/02/25	N/A
1900 MHz Body Tissue Simulant	SPEAG	MSL 1900	100824-3	2014/04/28	N/A
2450 MHz Head Tissue Simulant	SPEAG	HSL 2450	110531-2	2013/12/17 – 2014/04/04	N/A
2450 MHz Body Tissue Simulant	SPEAG	MSL 2450	110530-1	2013/12/17 -	N/A
2450 MHz Body Tissue Simulant	SPEAG	MSL 2450	100824-5	2014/04/03 – 2014/04/07	N/A
2550 MHz Head Tissue Simulant	SPEAG	HBBL 1900-3800	130605-2	2014/02/05	N/A
2550 MHz Body Tissue Simulant	SPEAG	MBBL 1900-3800	130604-1	2014/02/06 – 2014/04/22	N/A
5000 MHz Head Tissue Simulant	SPEAG	HSL 501	100901-1	2014/01/13 – 2014/05/02	N/A
5000 MHz Body Tissue Simulant	SPEAG	MSL 501	100823-1	2014/02/05 – 2014/05/01	N/A
750 MHz Dipole	SPEAG	D750V3	1090	2013/06/06	2014/06/06
835 MHz Dipole	SPEAG	D835V2	4d113	2012/11/05	2013/11/05
835 MHz Dipole	SPEAG	D835V2	4d155	2013/06/06	2014/06/06
1750 MHz Dipole	SPEAG	D1750V2	1045	2012/11/08	2013/11/08
1750 MHz Dipole	SPEAG	D1750V2	1094	2013/06/06	2014/06/06
1900 MHz Dipole	SPEAG	D1900V2	5d135	2012/11/06	2013/11/06
1900 MHz Dipole	SPEAG	D1900V2	5d172	2013/06/10	2014/06/10
2450 MHz Dipole	SPEAG	D2450V2	911	2013/06/07	2014/06/07
2550 MHz Dipole	SPEAG	D2550V2	1009	2013/06/07	2014/06/07
5000 MHz Dipole	SPEAG	D5GHzV2	1096	2012/11/13	2013/11/13
5000 MHz Dipole	SPEAG	D5GHzV2	1096	2014/04/15	2015/04/15
5000 MHz Dipole	SPEAG	D5GHzV2	1154	2013/06/04	2014/06/04

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Data Acquisition Electronics	SPEAG	DAE4	1233	2012/11/06	2014/03/16
Data Acquisition Electronics	SPEAG	DAE4	1233	2014/03/17	2015/03/17
Data Acquisition Electronics	SPEAG	DAE4	1265	2013/06/11	2014/01/28
Data Acquisition Electronics	SPEAG	DAE4	1265	2014/01/29	2015/01/29
Data Acquisition Electronics	SPEAG	DAE4	1266	2013/08/15	2014/08/15
Data Acquisition Electronics	SPEAG	DAE4	1375	2013/06/10	2014/06/10
SAR Probe	SPEAG	ES3DV3	3260	2013/06/19	2014/03/18
SAR Probe	SPEAG	ES3DV3	3260	2014/03/19	2015/03/19
SAR Probe	SPEAG	ES3DV3	3323	2013/06/12	2014/06/12
SAR Probe	SPEAG	EX3DV4	3739	2014/03/18	2015/03/18
SAR Probe	SPEAG	EX3DV4	3771	2013/06/14	2014/03/17
SAR Probe	SPEAG	EX3DV4	3771	2014/03/18	2015/03/18
Network Analyzer	Agilent	FieldFox N9923A	MY51491621	2013/06/21	2014/06/21
Directional coupler	Werlatone	C6529	11249	N/A	N/A
RF Amplifier	Vectawave	VTL5400	N/A	N/A	N/A
Dielectric Measurement Kit	SPEAG	DAK-3.5	1023	2013/08/13	2014/08/13
Synthesized CW Generator	Agilent	8371213	US37101255	N/A	N/A
Power Meter	Agilent	E4419B	MY45101996	2013/06/03	2015/06/03
Power Sensor	Agilent	E9300A	MY41498484	2013/06/04	2015/06/04
Power Sensor	Agilent	E9300A	MY41498492	2013/06/04	2015/06/04
Radio Communications Tester	Rohde & Schwarz	CMU 200	101821	2013/06	2015/06
Radio Communications Tester	Rohde & Schwarz	CMU 200	109879	2013/06	2015/06
Radio Communications Tester	Rohde & Schwarz	CMU 200	110759	2013/06	2015/06
Radio Communications Tester	Rohde & Schwarz	CMW500	109825	2013/06	2015/06

NOTES:

1. Calibrations with calibration due dates before May 2, 2014 are not used after the calibration due date.

Equipment Calibration/Performance Documents:

Attached:

SAR Probe ES3DV3 Calibration Report

SAR Probe EX3DV4 Calibration Report

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **ES3-3260_Jun13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3260**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4**
Calibration procedure for dosimetric E-field probes

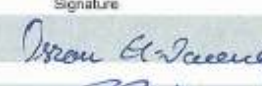
Calibration date: **June 19, 2013**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&E critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	in house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	in house check: Oct-13

	Name	Function	Signature
Calibrated by:	Israa El-Nasouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: June 19, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

ES3DV3 – SN:3260

June 19, 2013

Probe ES3DV3

SN:3260

Manufactured: January 25, 2010
Calibrated: June 19, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

ES3DV3- SN:3260

June 19, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V/m})^2$) ^A	1.28	1.36	1.17	$\pm 10.1 \%$
DCP (mV) ^B	102.5	102.9	101.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	160.4	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		167.4	
		Z	0.0	0.0	1.0		159.1	
10011- CAA	UMTS-FDD (WCDMA)	X	3.32	66.9	18.5	2.91	129.2	$\pm 0.9 \%$
		Y	3.48	68.0	19.1		133.6	
		Z	3.37	67.2	18.7		127.3	
10012- CAA	IEEE 802.11b WIFI 2.4 GHz (DSSS, 1 Mbps)	X	3.63	71.8	20.2	1.67	132.6	$\pm 0.7 \%$
		Y	3.41	71.0	19.8		135.8	
		Z	3.56	71.5	20.1		131.1	
10021- DAA	GSM-FDD (TDMA, GMSK)	X	27.70	99.4	29.0	9.39	128.0	$\pm 1.4 \%$
		Y	24.74	98.2	28.1		115.2	
		Z	26.19	99.6	29.1		114.0	
10024- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	39.94	99.6	26.2	6.56	147.9	$\pm 1.7 \%$
		Y	39.52	99.6	25.7		143.3	
		Z	38.75	99.9	26.2		132.6	
10027- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	53.95	99.9	24.4	4.80	104.7	$\pm 1.9 \%$
		Y	54.17	100.0	24.1		106.3	
		Z	48.16	100.0	24.7		144.1	
10028- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	48.51	99.8	23.9	3.55	108.4	$\pm 1.9 \%$
		Y	65.79	99.8	22.7		109.9	
		Z	46.79	99.8	23.9		102.2	
10080- CAB	CDMA2000 (1xEV-DO, 153.6 kbps)	X	4.45	66.6	18.9	4.22	129.6	$\pm 0.7 \%$
		Y	4.52	67.0	19.0		138.0	
		Z	4.42	66.4	18.6		124.4	
10081- CAA	CDMA2000 (1xRTT, RC3)	X	3.99	66.1	18.6	3.97	126.6	$\pm 0.7 \%$
		Y	4.11	66.8	18.9		134.9	
		Z	4.04	66.3	18.7		121.7	
10100- CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.78	68.7	20.5	5.67	145.1	$\pm 1.2 \%$
		Y	6.13	66.3	19.1		108.4	
		Z	6.70	68.4	20.3		139.2	
10106- CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.66	68.3	20.4	5.60	142.9	$\pm 1.2 \%$
		Y	6.06	66.0	19.0		107.8	
		Z	6.57	67.9	20.2		136.7	

ES3DV3- SN:3260

June 19, 2013

10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.31	67.6	20.1	5.75	139.4	±1.2 %
		Y	5.80	65.6	18.9		106.0	
		Z	6.24	67.2	19.9		133.9	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.16	66.9	19.8	5.73	123.1	±0.9 %
		Y	5.16	67.0	19.8		130.4	
		Z	5.12	66.7	19.8		118.2	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.17	66.9	19.9	5.72	122.8	±0.9 %
		Y	5.13	66.9	19.8		130.1	
		Z	5.18	67.0	19.9		118.9	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.68	68.3	20.4	5.81	142.7	±1.2 %
		Y	6.11	66.1	19.1		107.3	
		Z	6.60	67.9	20.2		143.5	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^a The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 6 and 7).

^b Numerical linearization parameter: uncertainty not required.

^c Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ES3DV3- SN:3260

June 19, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.59	6.59	6.59	0.48	1.48	± 12.0 %
835	41.5	0.90	6.33	6.33	6.33	0.73	1.15	± 12.0 %
900	41.5	0.97	6.29	6.29	6.29	0.50	1.36	± 12.0 %
1750	40.1	1.37	5.47	5.47	5.47	0.60	1.29	± 12.0 %
1900	40.0	1.40	5.32	5.32	5.32	0.65	1.28	± 12.0 %
1950	40.0	1.40	5.16	5.16	5.16	0.80	1.17	± 12.0 %
2300	39.5	1.67	4.82	4.82	4.82	0.73	1.22	± 12.0 %
2450	39.2	1.80	4.50	4.50	4.50	0.76	1.28	± 12.0 %
2550	39.1	1.91	4.36	4.36	4.36	0.80	1.24	± 12.0 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ES3DV3- SN:3260

June 19, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.41	6.41	6.41	0.80	1.17	± 12.0 %
835	55.2	0.97	6.29	6.29	6.29	0.45	1.56	± 12.0 %
900	55.0	1.05	6.20	6.20	6.20	0.34	1.90	± 12.0 %
1750	53.4	1.49	5.10	5.10	5.10	0.47	1.66	± 12.0 %
1900	53.3	1.52	4.85	4.85	4.85	0.45	1.67	± 12.0 %
1950	53.3	1.52	4.99	4.99	4.99	0.58	1.43	± 12.0 %
2300	52.9	1.81	4.54	4.54	4.54	0.67	1.35	± 12.0 %
2450	52.7	1.95	4.34	4.34	4.34	0.68	1.14	± 12.0 %
2550	52.6	2.09	4.28	4.28	4.28	0.66	1.16	± 12.0 %

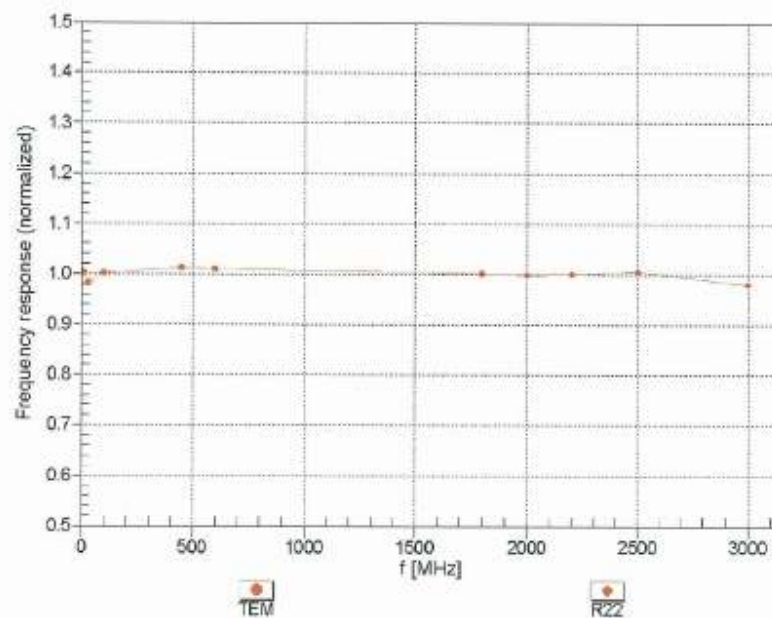
^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ES3DV3- SN:3260

June 19, 2013

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

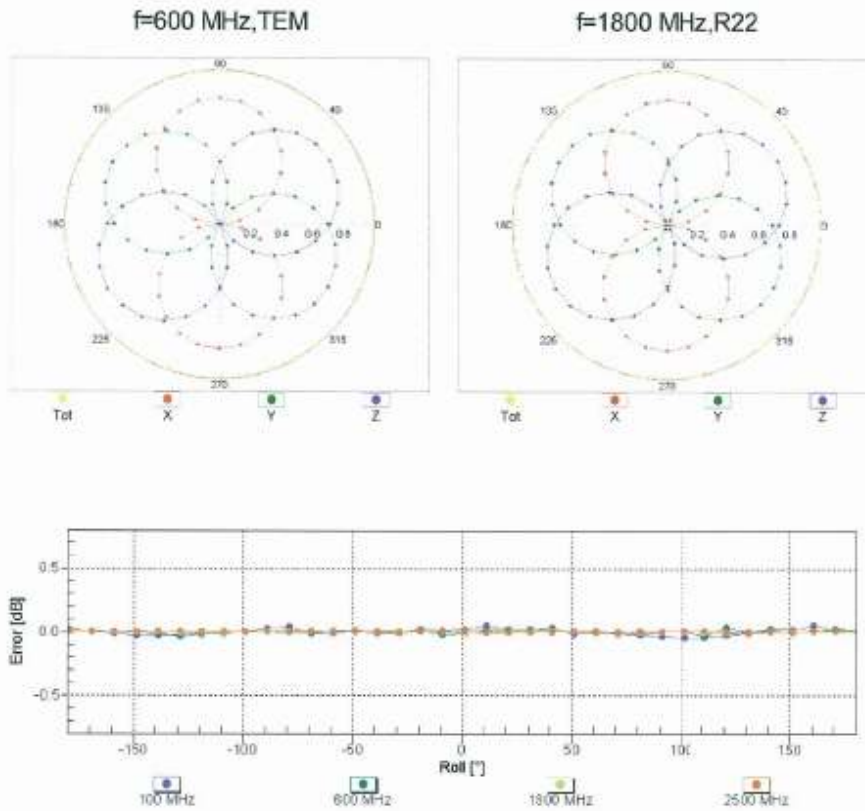


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

ES3DV3- SN:3260

June 19, 2013

Receiving Pattern (ϕ), $\theta = 0^\circ$

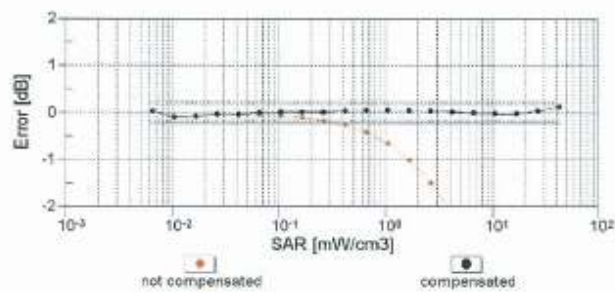
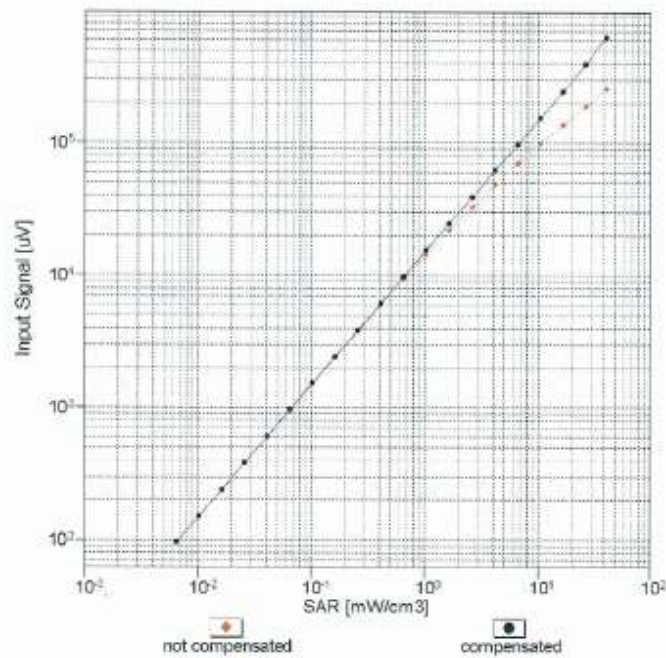


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

ES3DV3- SN:3260

June 19, 2013

Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

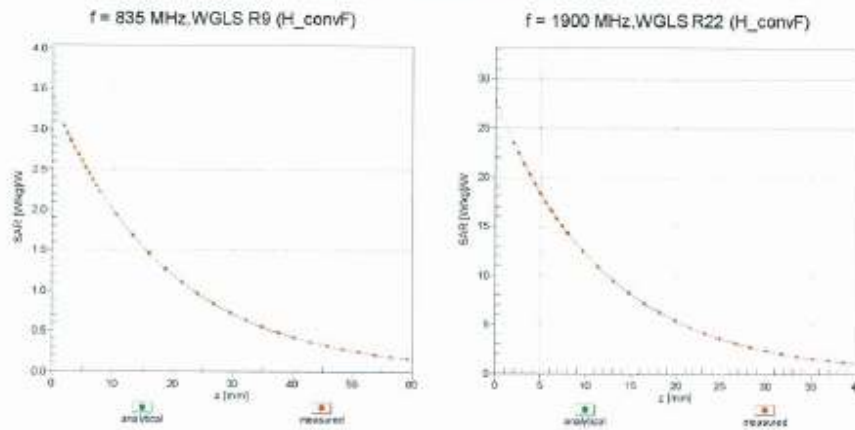


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

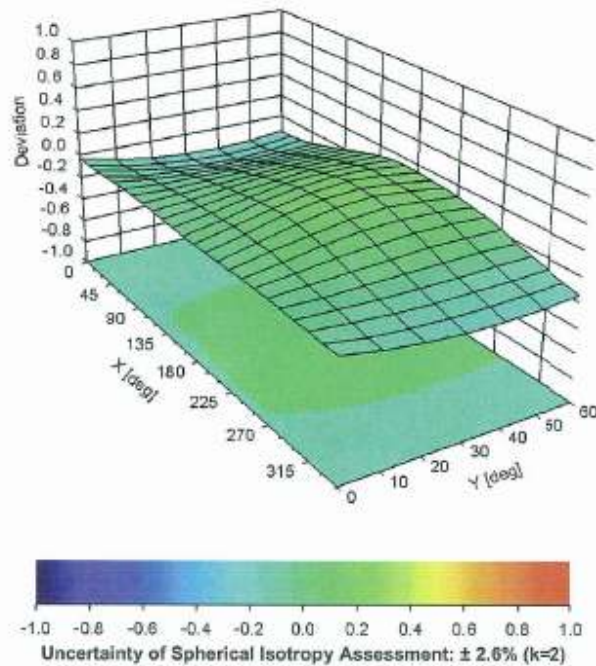
ES3DV3- SN:3260

June 19, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), f = 900 MHz



ES3DV3- SN:3260

June 18, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-68.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland



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C Service suisse d'étalonnage
S Servizio svizzero di taratura
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Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **ES3-3260_Mar14**

CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3260**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6**
Calibration procedure for dosimetric E-field probes

Calibration date: **March 19, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3542U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature 
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature 
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Issued: March 20, 2014

Calibration Laboratory of
Schmid & Partner
Engineering AG
 Zeughausstrasse 43, 8004 Zurich, Switzerland



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S Servizio svizzero di taratura
S Swiss Calibration Service

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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization ϕ	ϕ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

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- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: In a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

ES3DV3 – SN:3260

March 19, 2014

Probe ES3DV3

SN:3260

Manufactured: January 25, 2010

Calibrated: March 19, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

ES3DV3- SN:3260

March 19, 2014

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^{2/A}$)	1.30	1.37	1.18	$\pm 10.1 \%$
DCP (mV) ^B	104.8	102.1	104.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu V}$	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	211.8	$\pm 3.3 \%$
		Y	0.0	0.0	1.0		195.7	
		Z	0.0	0.0	1.0		208.8	
10011-CAB	UMTS-FDD (WCDMA)	X	3.31	67.4	18.8	2.91	127.8	$\pm 0.7 \%$
		Y	3.40	67.4	18.7		134.6	
		Z	3.34	67.6	18.8		145.4	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	30.39	99.4	28.9	9.39	135.6	$\pm 1.9 \%$
		Y	28.56	99.7	28.9		131.2	
		Z	29.91	99.6	28.7		119.9	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	44.86	99.9	26.3	6.56	123.6	$\pm 1.4 \%$
		Y	44.01	99.9	25.9		126.4	
		Z	42.79	99.7	26.1		147.0	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	53.01	99.7	24.7	4.80	130.0	$\pm 1.7 \%$
		Y	50.58	99.6	24.5		137.2	
		Z	52.62	99.6	24.4		123.5	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	59.40	99.6	23.5	3.55	137.7	$\pm 1.7 \%$
		Y	59.13	99.9	23.3		140.0	
		Z	56.71	99.7	23.4		126.5	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	4.12	67.1	19.1	3.97	149.5	$\pm 0.7 \%$
		Y	4.00	66.0	18.4		131.8	
		Z	4.09	67.0	19.1		146.9	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.60	68.2	20.1	5.67	144.1	$\pm 1.2 \%$
		Y	6.35	67.0	19.4		125.9	
		Z	6.59	68.2	20.1		141.7	
10103-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	12.38	77.7	26.5	9.29	127.9	$\pm 3.0 \%$
		Y	12.64	78.8	27.1		136.2	
		Z	12.27	78.1	26.9		122.6	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.50	67.8	20.0	5.80	142.8	$\pm 1.2 \%$
		Y	6.34	66.9	19.5		128.4	
		Z	6.47	67.7	20.0		140.9	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	11.69	76.9	26.3	9.28	122.6	$\pm 3.3 \%$
		Y	11.83	77.7	26.7		130.6	
		Z	13.11	80.6	28.1		149.4	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.18	67.2	19.7	5.75	139.6	$\pm 1.4 \%$
		Y	6.25	67.2	19.7		146.4	
		Z	6.11	67.0	19.6		138.3	

ES3DV3- SN:3260

March 19, 2014

10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.19	67.1	19.8	5.73	143.7	±1.2 %
		Y	5.26	67.3	19.9		149.8	
		Z	5.20	67.2	19.9		143.3	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	13.41	86.4	30.9	9.21	138.5	±3.3 %
		Y	10.53	80.4	28.2		121.8	
		Z	12.56	85.1	30.3		139.6	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.20	67.1	19.9	5.72	139.5	±1.2 %
		Y	5.10	66.5	19.5		130.7	
		Z	5.14	66.9	19.8		139.8	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.44	67.5	19.9	5.81	136.9	±1.2 %
		Y	6.34	66.9	19.5		127.4	
		Z	6.44	67.6	19.9		140.9	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.64	66.9	18.3	3.76	131.9	±0.7 %
		Y	4.81	67.4	18.5		143.6	
		Z	4.68	67.1	18.4		135.2	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of Norm(X,Y,Z) do not affect the E²-field uncertainty inside TSL (see Pages 6 and 7).

^B Numerical linearization parameter; uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ES3DV3 - SN:3260

March 19, 2014

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^a (mm)	Unct. (k=2)
750	41.9	0.89	6.47	6.47	6.47	0.80	1.12	± 12.0 %
835	41.5	0.90	6.25	6.25	6.25	0.31	1.77	± 12.0 %
900	41.5	0.97	6.19	6.19	6.19	0.57	1.31	± 12.0 %
1750	40.1	1.37	5.49	5.49	5.49	0.41	1.64	± 12.0 %
1900	40.0	1.40	5.47	5.47	5.47	0.80	1.16	± 12.0 %
1950	40.0	1.40	5.28	5.28	5.28	0.65	1.32	± 12.0 %
2300	39.5	1.67	4.88	4.88	4.88	0.80	1.30	± 12.0 %
2450	39.2	1.80	4.56	4.56	4.56	0.80	1.24	± 12.0 %
2550	39.1	1.91	4.41	4.41	4.41	0.71	1.36	± 12.0 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

ES3DV3- SN:3260

March 19, 2014

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.22	6.22	6.22	0.34	1.88	± 12.0 %
835	55.2	0.97	6.14	6.14	6.14	0.37	1.79	± 12.0 %
900	55.0	1.05	6.02	6.02	6.02	0.56	1.38	± 12.0 %
1750	53.4	1.49	4.90	4.90	4.90	0.56	1.48	± 12.0 %
1900	53.3	1.52	4.69	4.69	4.69	0.60	1.45	± 12.0 %
1950	53.3	1.52	4.81	4.81	4.81	0.54	1.58	± 12.0 %
2300	52.9	1.81	4.42	4.42	4.42	0.80	1.22	± 12.0 %
2450	52.7	1.95	4.26	4.26	4.26	0.68	1.12	± 12.0 %
2550	52.6	2.09	4.15	4.15	4.15	0.80	1.01	± 12.0 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

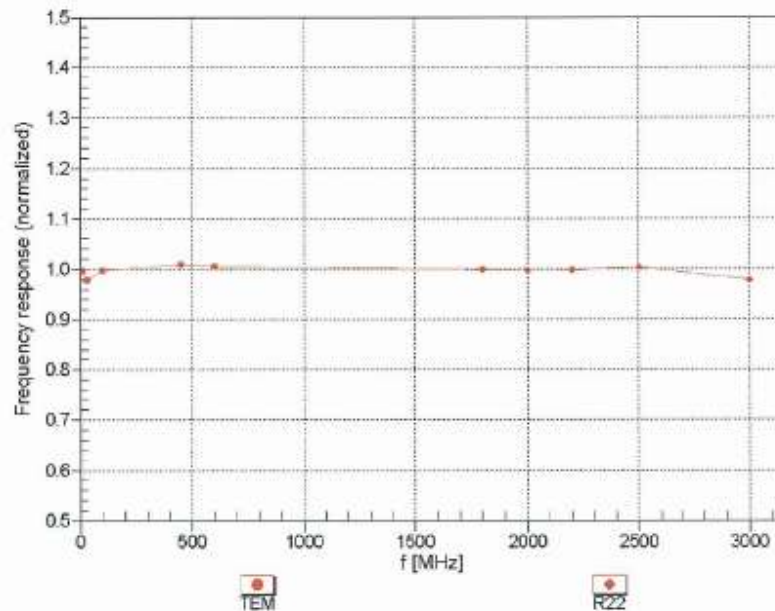
^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

ES3DV3- SN:3260

March 19, 2014

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

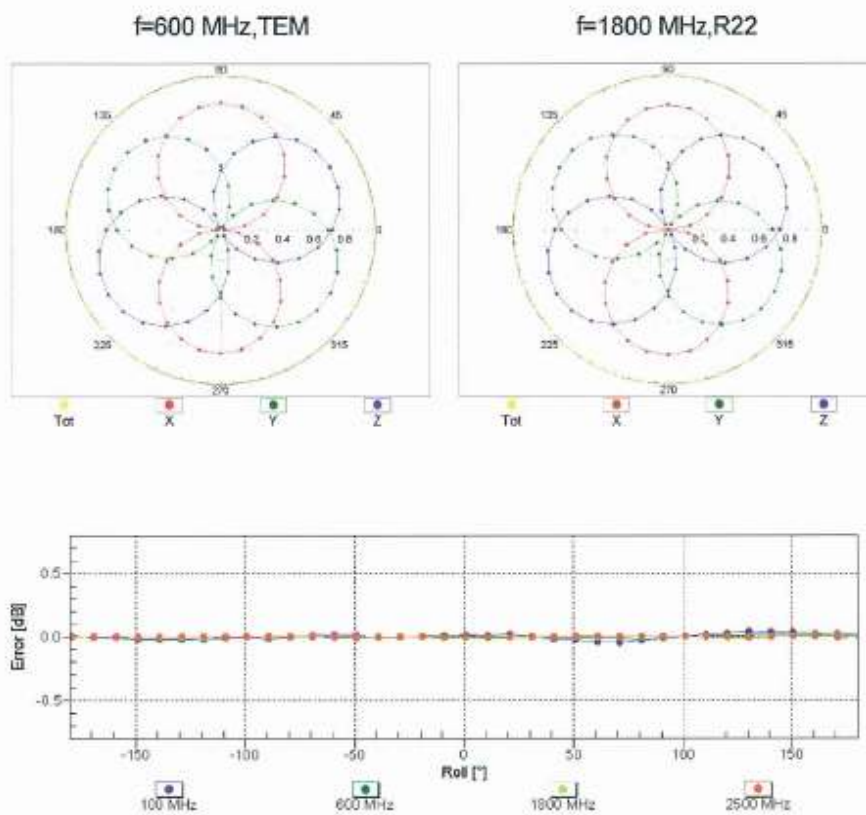


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

ES3DV3- SN:3260

March 19, 2014

Receiving Pattern (ϕ), $\theta = 0^\circ$

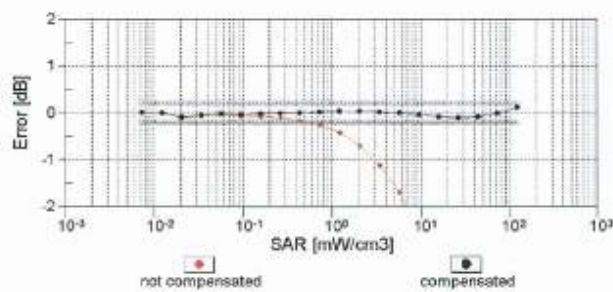
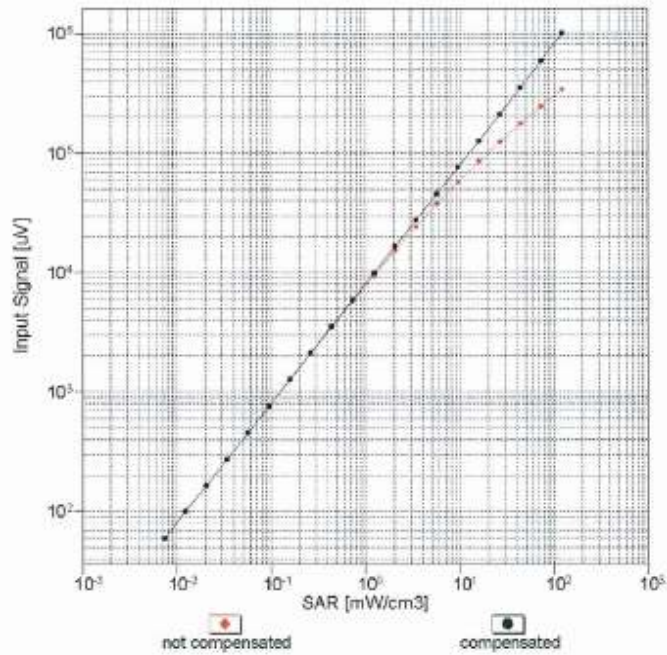


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

ES3DV3- SN:3260

March 19, 2014

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)

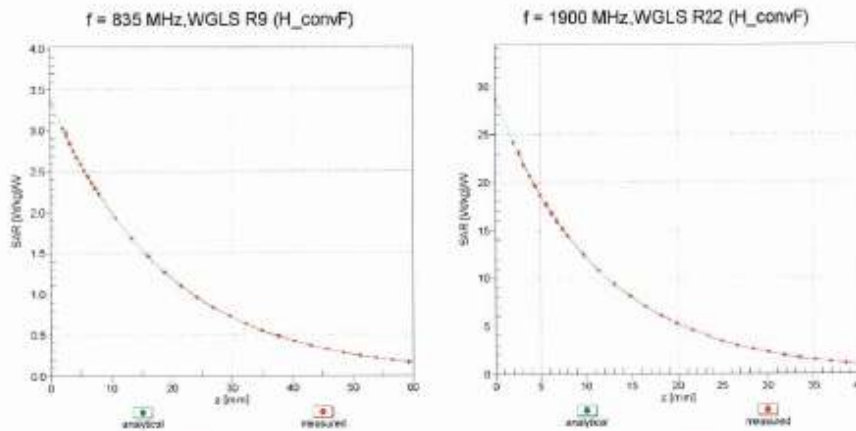


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

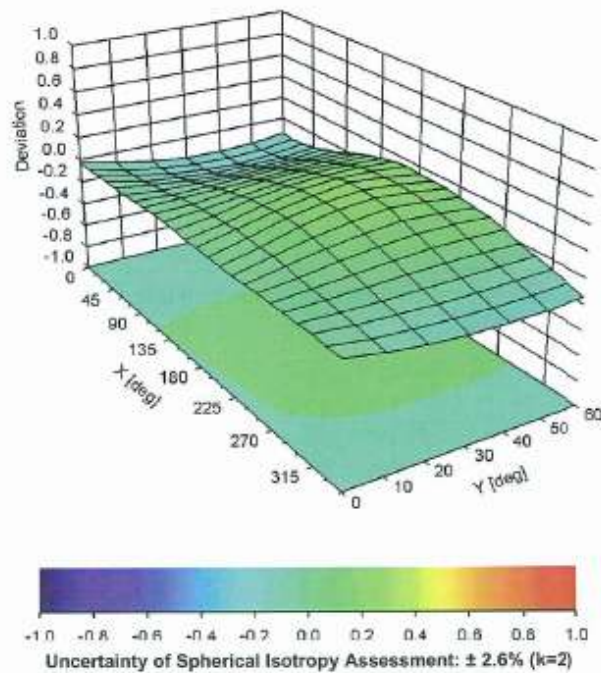
ES3DV3- SN:3260

March 19, 2014

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), f = 900 MHz



ES3DV3-SN:3260

March 19, 2014

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3260**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-79.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

**Calibration Laboratory of
Schmid & Partner
Engineering AG**
Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **ES3-3323_Jun13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3323**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **June 12, 2013**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: June 12, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Calibration Laboratory of
Schmid & Partner
Engineering AG
 Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
$NORM_{x,y,z}$	sensitivity in free space
$ConvF$	sensitivity in TSL / $NORM_{x,y,z}$
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- $NORM_{x,y,z}$: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). $NORM_{x,y,z}$ are only intermediate values, i.e., the uncertainties of $NORM_{x,y,z}$ does not affect the E^2 -field uncertainty inside TSL (see below $ConvF$).
- $NORM(f)_{x,y,z} = NORM_{x,y,z} \cdot frequency_response$ (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of $ConvF$.
- $DCP_{x,y,z}$: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- $A_{x,y,z}$; $B_{x,y,z}$; $C_{x,y,z}$; $D_{x,y,z}$; $VR_{x,y,z}$: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- $ConvF$ and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to $NORM_{x,y,z} \cdot ConvF$ whereby the uncertainty corresponds to that given for $ConvF$. A frequency dependent $ConvF$ is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical Isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

ES3DV3 - SN:3323

June 12, 2013

Probe ES3DV3

SN:3323

Manufactured: January 10, 2012
Calibrated: June 12, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

ES3DV3- SN:3323

June 12, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3323

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.12	1.12	0.77	$\pm 10.1 \%$
DCP (mV) ^B	104.9	106.5	101.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.2	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		194.2	
		Z	0.0	0.0	1.0		152.6	
10011- CAA	UMTS-FDD (WCDMA)	X	3.22	66.3	18.0	2.91	114.8	$\pm 0.5 \%$
		Y	3.12	66.3	18.0		112.3	
		Z	3.15	65.3	17.2		123.8	
10012- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	3.00	68.3	18.2	1.87	117.5	$\pm 0.5 \%$
		Y	3.24	70.3	19.1		114.1	
		Z	2.84	66.6	17.0		125.4	
10021- DAA	GSM-FDD (TDMA, GMSK)	X	21.19	94.6	26.6	9.39	145.5	$\pm 1.7 \%$
		Y	29.76	99.6	27.6		142.9	
		Z	13.12	87.2	24.0		136.8	
10024- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	45.18	99.6	25.0	6.56	111.0	$\pm 1.4 \%$
		Y	50.15	99.8	24.5		111.8	
		Z	26.31	94.6	24.1		116.2	
10027- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	52.37	99.1	23.5	4.80	121.7	$\pm 1.4 \%$
		Y	67.49	99.8	22.9		122.2	
		Z	11.90	82.8	19.1		128.2	
10028- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	62.99	99.9	22.7	3.55	132.7	$\pm 1.9 \%$
		Y	76.36	99.6	21.9		128.9	
		Z	18.38	87.2	19.4		136.0	
10080- CAA	CDMA2000 (1xEV-DO, 153.6 kbps)	X	4.27	66.0	18.3	4.22	112.4	$\pm 0.7 \%$
		Y	4.20	66.1	18.3		110.5	
		Z	4.17	65.1	17.6		117.3	
10091- CAA	CDMA2000 (1xRTT, RC3)	X	3.83	65.4	18.0	3.37	110.3	$\pm 0.7 \%$
		Y	3.72	65.2	17.9		108.2	
		Z	3.78	64.6	17.3		115.2	
10100- CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.30	67.0	19.3	5.37	124.4	$\pm 1.2 \%$
		Y	6.25	67.1	19.4		122.2	
		Z	6.41	66.9	19.1		130.9	
10103- CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	10.92	75.7	25.5	9.29	122.3	$\pm 2.7 \%$
		Y	11.01	76.5	26.2		117.5	
		Z	10.27	73.8	24.5		126.9	

ES3DV3- SN.3323

June 12, 2013

10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.23	66.7	19.2	5.80	124.3	±1.4 %
		Y	6.19	66.9	19.4		121.5	
		Z	6.33	66.7	19.1		130.3	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	10.40	75.1	25.4	9.28	118.5	±2.7 %
		Y	10.61	76.4	26.3		113.8	
		Z	9.79	73.3	24.4		123.1	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	5.95	66.3	19.0	5.75	121.7	±1.4 %
		Y	5.89	66.4	19.2		119.7	
		Z	6.04	66.2	18.9		127.3	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.19	67.5	19.9	5.73	148.4	±0.9 %
		Y	5.16	67.6	20.2		146.1	
		Z	4.76	65.2	18.5		110.4	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	9.80	79.7	27.7	9.21	126.5	±2.5 %
		Y	11.35	84.7	30.3		131.0	
		Z	8.91	77.3	26.6		137.1	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.14	67.2	19.8	5.72	143.0	±0.9 %
		Y	5.08	67.5	20.0		140.2	
		Z	4.76	65.2	18.6		110.6	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.18	66.5	19.1	5.81	119.1	±1.4 %
		Y	6.14	66.6	19.3		117.2	
		Z	6.37	66.7	19.2		130.4	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^a The uncertainties of NormX,Y,Z do not affect the E^2 field uncertainty inside TSL (see Pages 6 and 7).

^b Numerical linearization parameter: uncertainty not required.

^c Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ES3DV3- SN:3323

June 12, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3323

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.57	6.57	6.57	0.37	1.65	± 12.0 %
835	41.5	0.90	6.28	6.28	6.28	0.23	2.18	± 12.0 %
900	41.5	0.97	6.22	6.22	6.22	0.49	1.41	± 12.0 %
1750	40.1	1.37	5.24	5.24	5.24	0.80	1.13	± 12.0 %
1900	40.0	1.40	5.04	5.04	5.04	0.51	1.46	± 12.0 %
1950	40.0	1.40	4.87	4.87	4.87	0.80	1.17	± 12.0 %
2300	39.5	1.67	4.76	4.76	4.76	0.54	1.52	± 12.0 %
2450	39.2	1.80	4.48	4.48	4.48	0.63	1.44	± 12.0 %
2550	39.1	1.91	4.28	4.28	4.28	0.80	1.24	± 12.0 %

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ES3DV3- SN:3323

June 12, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3323

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.45	6.45	6.45	0.42	1.64	± 12.0 %
835	55.2	0.97	6.39	6.39	6.39	0.58	1.37	± 12.0 %
900	55.0	1.05	6.30	6.30	6.30	0.40	1.67	± 12.0 %
1750	53.4	1.49	5.01	5.01	5.01	0.65	1.36	± 12.0 %
1900	53.3	1.52	4.77	4.77	4.77	0.80	1.28	± 12.0 %
1950	53.3	1.52	4.86	4.86	4.86	0.60	1.47	± 12.0 %
2300	52.9	1.81	4.51	4.51	4.51	0.80	1.23	± 12.0 %
2450	52.7	1.95	4.31	4.31	4.31	0.80	1.10	± 12.0 %
2550	52.6	2.09	4.23	4.23	4.23	0.74	1.09	± 12.0 %

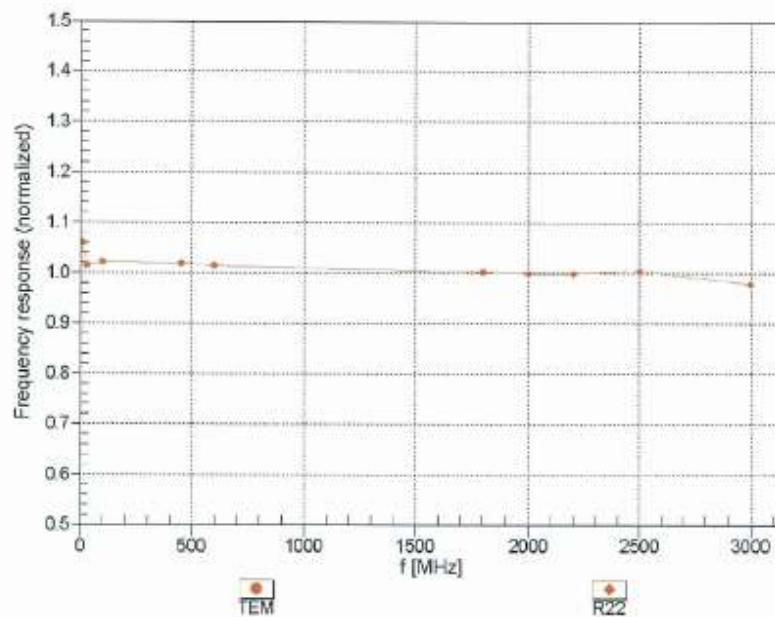
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ES3DV3- SN:3323

June 12, 2013

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

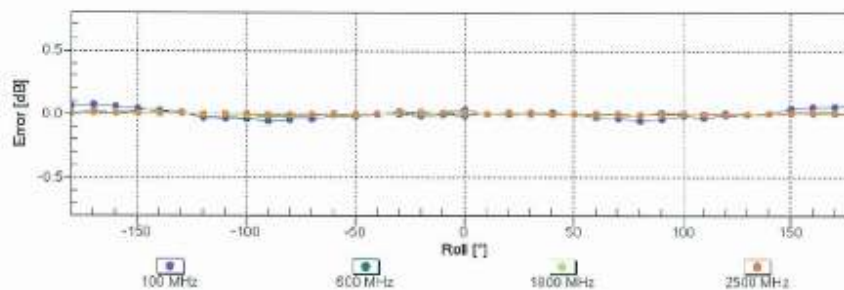
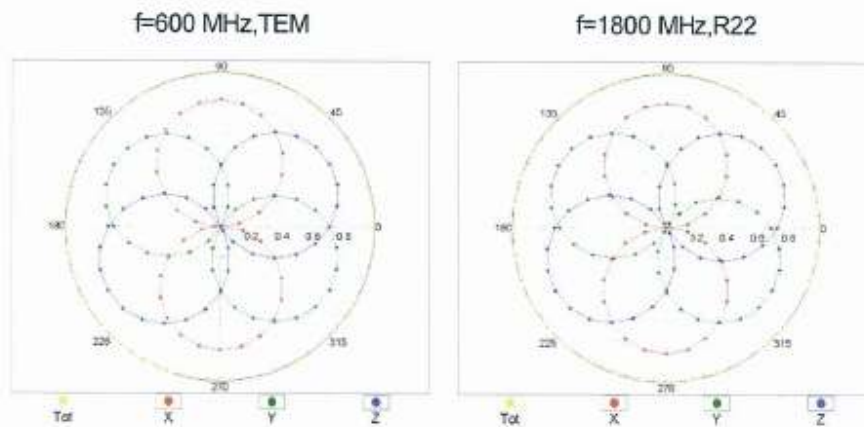


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

ES3DV3- SN:3323

June 12, 2013

Receiving Pattern (ϕ), $\theta = 0^\circ$

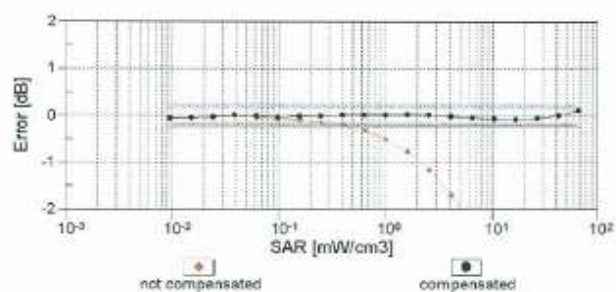
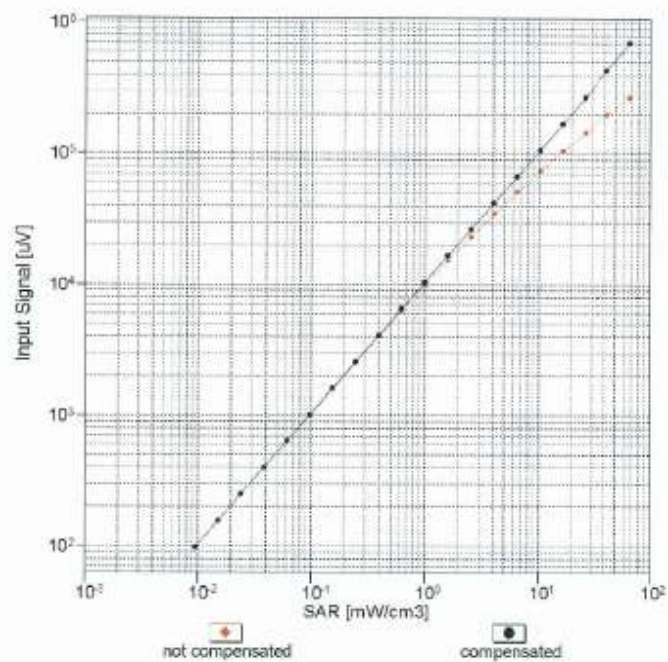


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

ES3DV3- SN:3323

June 12, 2013

Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)

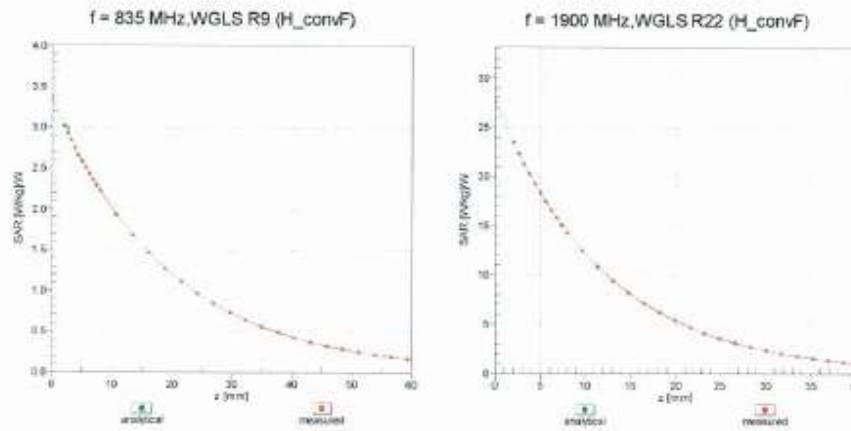


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

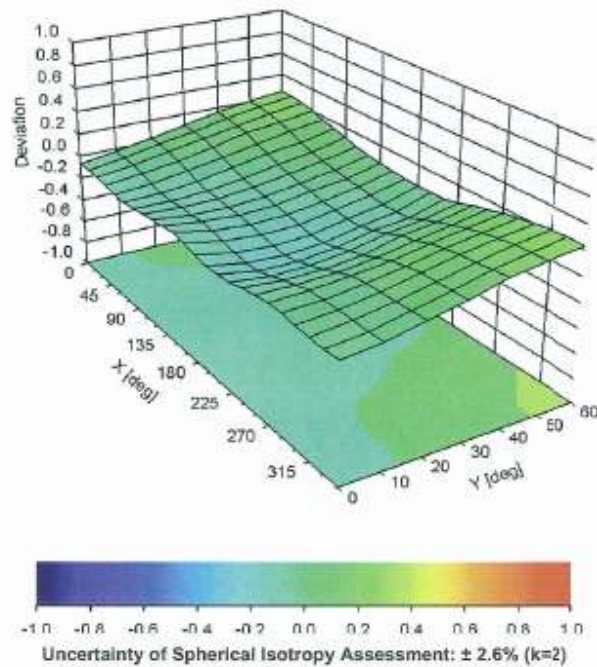
ES3DV3- SN:3323

June 12, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), f = 900 MHz



ES3DV3- SN:3323

June 12, 2013

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3323**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-29.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **EX3-3739_Mar14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3739**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

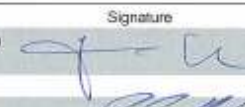
Calibration date: **March 18, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: 35054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: 35277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: 35129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Jelon Kastrati	Laboratory Technician	
Approved by:	Keja Pokovic	Technical Manager	
			Issued: March 20, 2014
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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3739

March 18, 2014

Probe EX3DV4

SN:3739

Manufactured: February 15, 2010

Calibrated: March 18, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3739

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3739

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.37	0.48	0.28	± 10.1 %
DCP (mV) ^B	101.5	101.8	107.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	157.0	±3.3 %
		Y	0.0	0.0	1.0		157.2	
		Z	0.0	0.0	1.0		136.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4 - SN:3739

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3739

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^d (mm)	Unct. (k=2)
2450	39.2	1.80	7.23	7.23	7.23	0.39	0.76	± 12.0 %
5200	36.0	4.66	5.04	5.04	5.04	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.79	4.79	4.79	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.76	4.76	4.76	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.51	4.51	4.51	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.59	4.59	4.59	0.40	1.80	± 13.1 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3739

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3739

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unct. (k=2)
2450	52.7	1.95	7.18	7.18	7.18	0.73	0.57	± 12.0 %
5200	49.0	5.30	4.55	4.55	4.55	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.35	4.35	4.35	0.45	1.90	± 13.1 %
5500	48.6	5.65	4.00	4.00	4.00	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.85	3.85	3.85	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.08	4.08	4.08	0.50	1.90	± 13.1 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

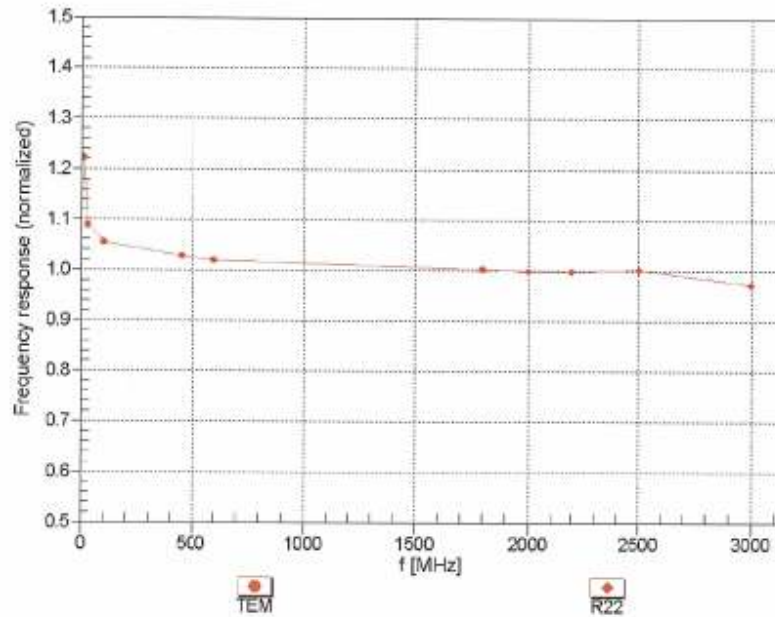
^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3739

March 18, 2014

Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)

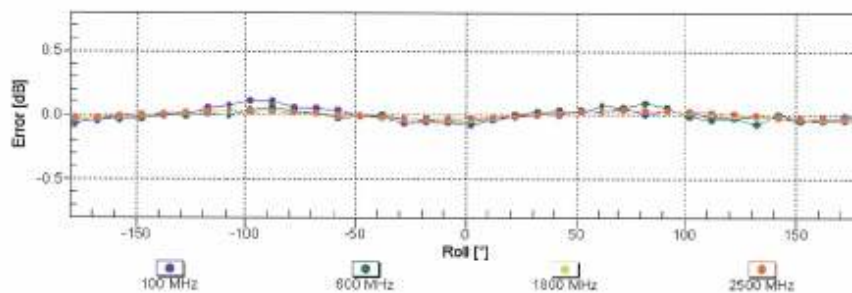
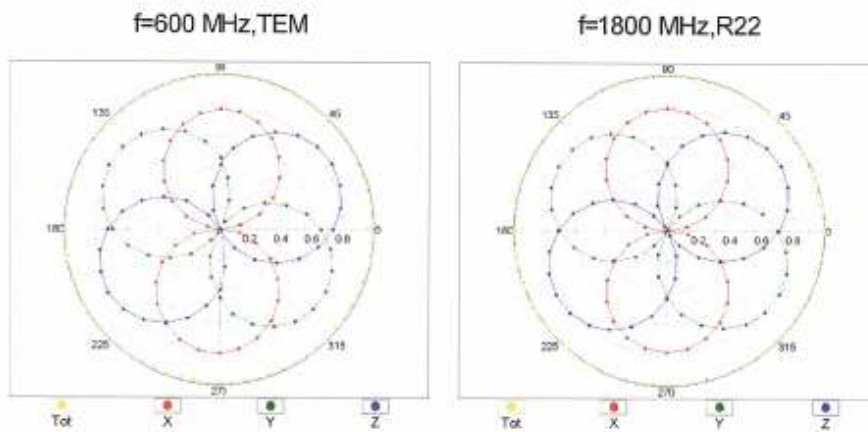


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3739

March 18, 2014

Receiving Pattern (ϕ), $\theta = 0^\circ$

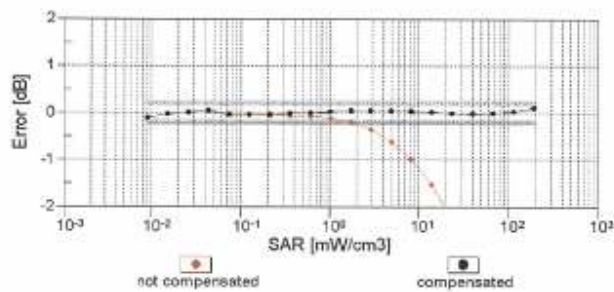
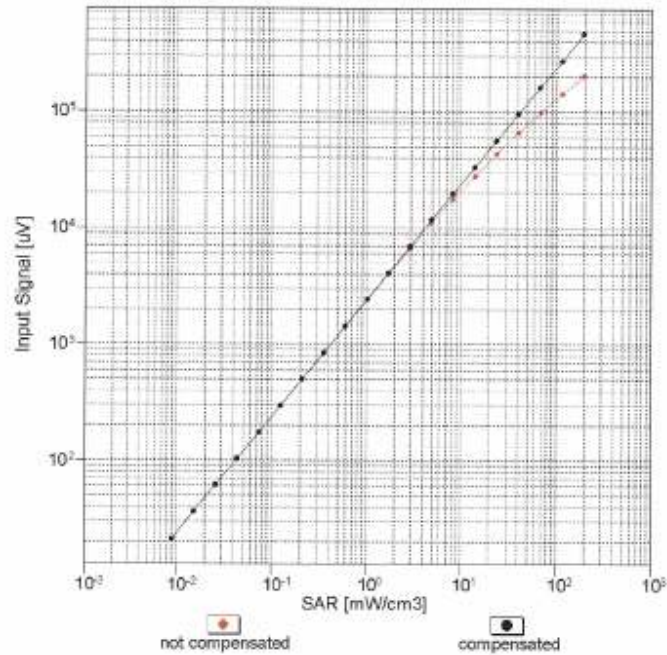


Uncertainty of Axial Isotropy Assessment: $\pm 1.5\%$ ($k=2$)

EX3DV4- SN:3739

March 18, 2014

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)

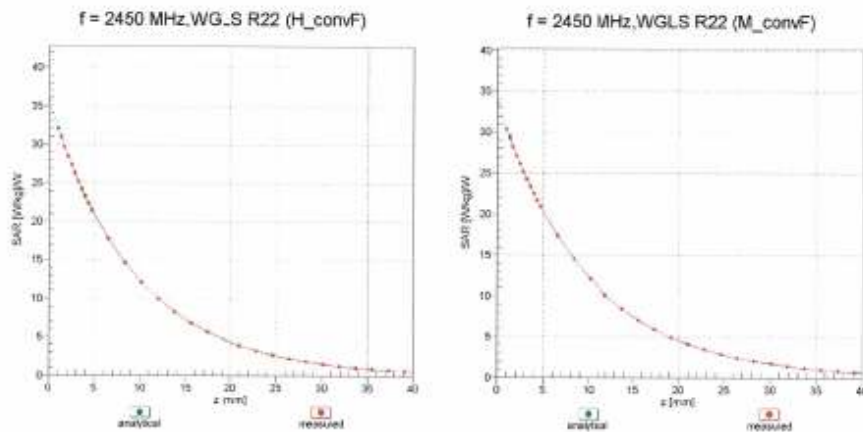


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

EX3DV4- SN:3739

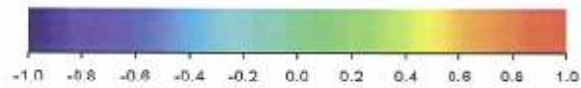
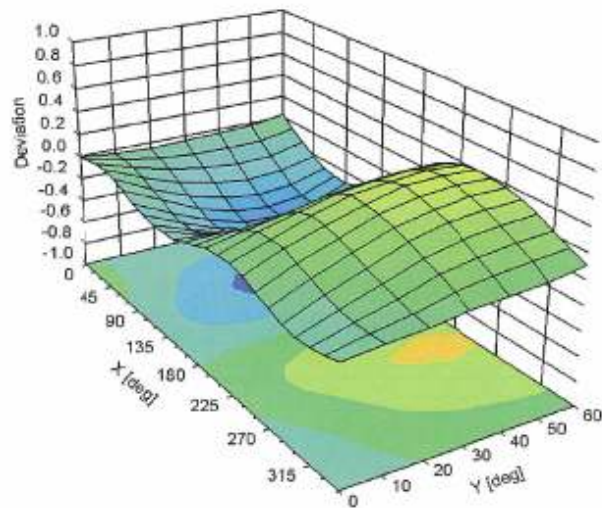
March 18, 2014

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), $f = 900 \text{ MHz}$



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)

EX3DV4- SN:3739

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3739**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-127.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **EX3-3771_Jun13**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3771**

Calibration procedure(s): **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4**
Calibration procedure for dosimetric E-field probes

Calibration date: **June 14, 2013**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30x)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	29-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name Israa El-Nazouq	Function Laboratory Technician	Signature 
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature 

Issued: June 15, 2013

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Accreditation No.: **SCS 108**

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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical Isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

EX3DV4 – SN:3771

June 14, 2013

Probe EX3DV4

SN:3771

Manufactured: March 29, 2011
Calibrated: June 14, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3771

June 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.56	0.56	0.58	$\pm 10.1 \%$
DCP (mV) ^B	98.9	100.7	95.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.30	172.1	$\pm 3.3 \%$
		Y	0.0	0.0	1.0		169.7	
		Z	0.0	0.0	1.0		173.6	
10062- CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	10.29	68.8	21.5	8.36	128.0	$\pm 2.5 \%$
		Y	10.43	69.6	22.2		135.2	
		Z	10.42	69.1	21.7		133.4	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of NormX, Y, Z do not affect the E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3771

June 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
5200	36.0	4.66	5.22	5.22	5.22	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.99	4.99	4.99	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.88	4.88	4.88	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.79	4.79	4.79	0.30	1.80	± 13.1 %
5800	35.3	5.27	4.56	4.56	4.56	0.40	1.80	± 13.1 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), also it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3771

June 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
5200	49.0	5.30	4.59	4.59	4.59	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.45	4.45	4.45	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.06	4.06	4.06	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.96	3.96	3.96	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.27	4.27	4.27	0.45	1.90	± 13.1 %

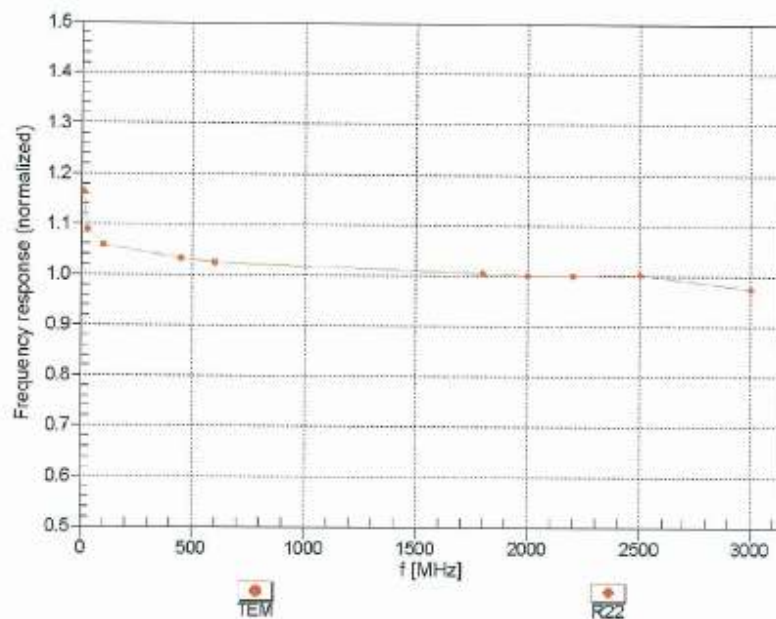
^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3771

June 14, 2013

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

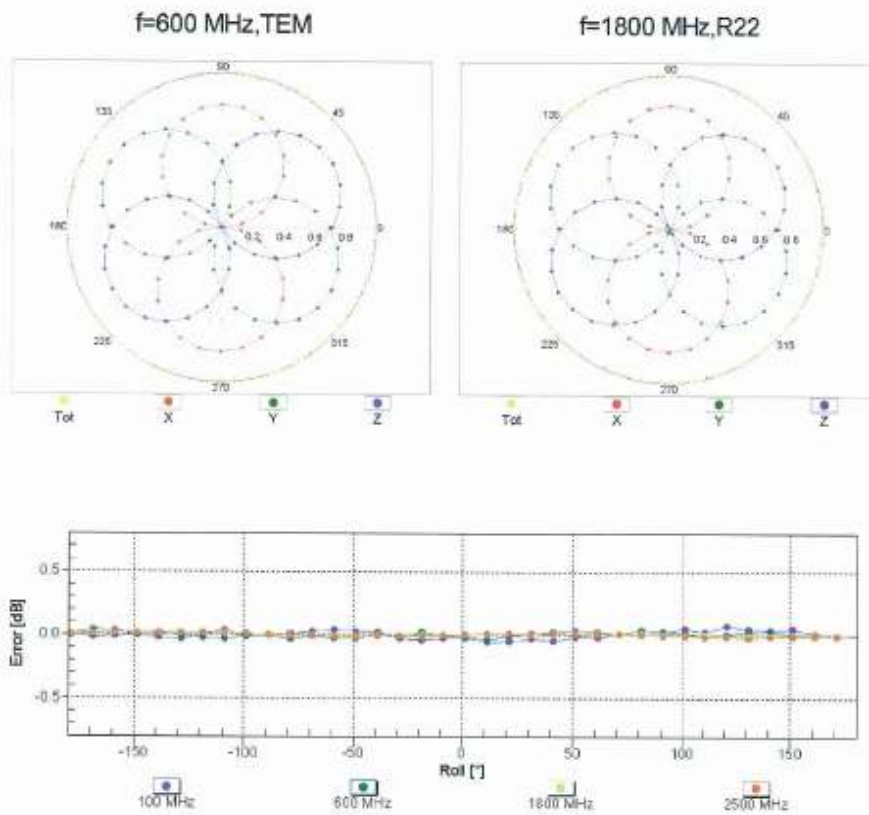


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3771

June 14, 2013

Receiving Pattern (ϕ), $\theta = 0^\circ$

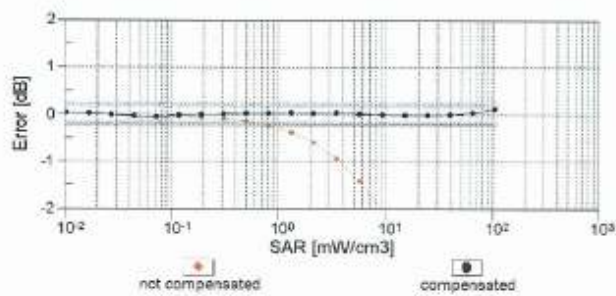
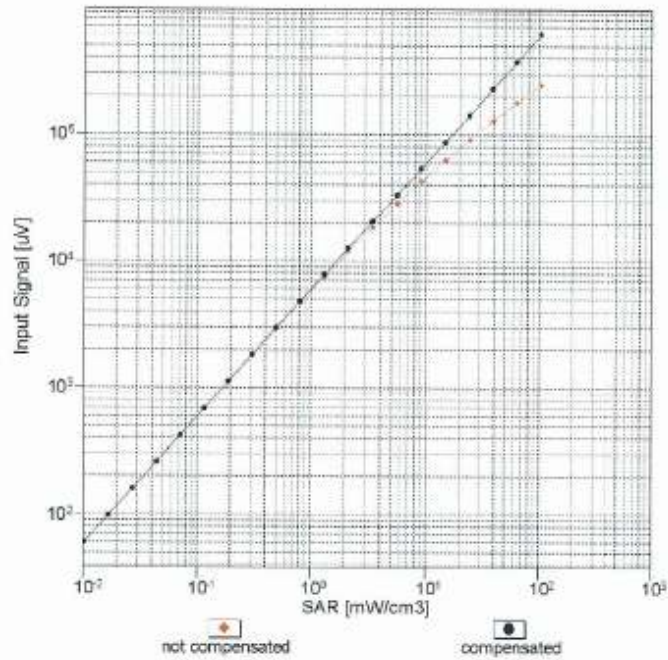


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:3771

June 14, 2013

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$)

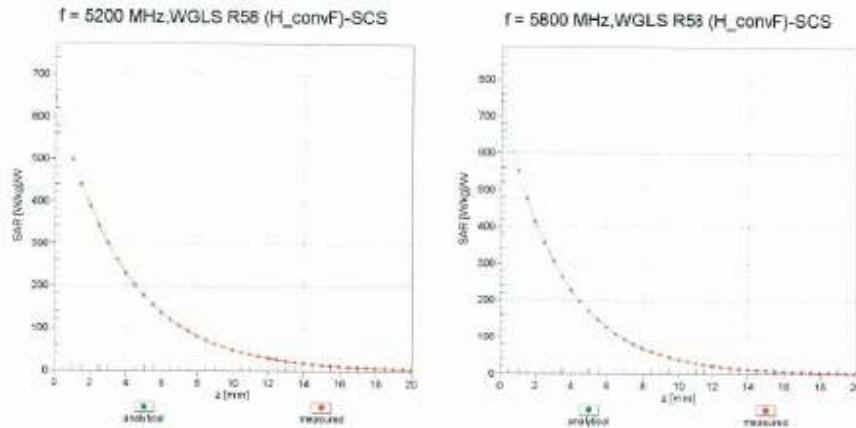


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

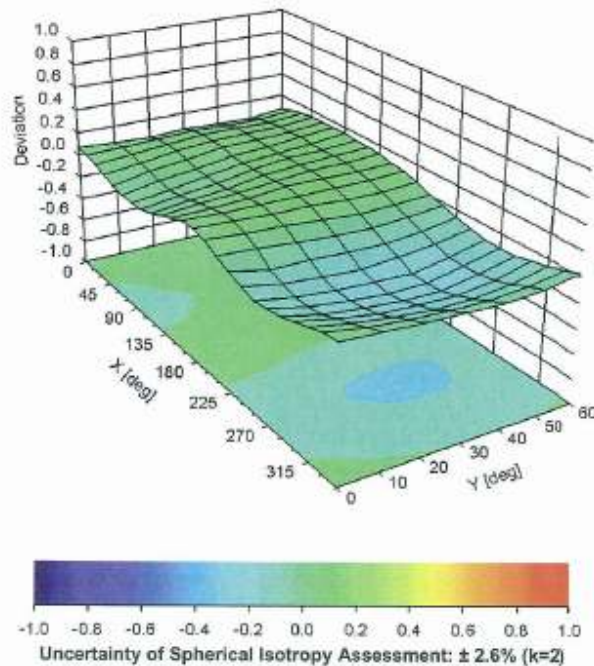
EX3DV4-- SN:3771

June 14, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900 \text{ MHz}$



EX3DV4- SN:3771

June 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-98.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

**Calibration Laboratory of
Schmid & Partner
Engineering AG**
Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **EX3-3771_Mar14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3771**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

Calibration date: **March 18, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: 35054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: 35277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: 35129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 360	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3542U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Jeron Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: March 20, 2014			

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Calibration Laboratory of
Schmid & Partner
Engineering AG
 Zeughausstrasse 43, 8004 Zurich, Switzerland



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S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the effect of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3771

March 18, 2014

Probe EX3DV4

SN:3771

Manufactured: March 29, 2011

Calibrated: March 18, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3771

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.56	0.56	0.58	$\pm 10.1 \%$
DCP (mV) ^B	96.9	99.4	94.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	150.6	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		154.3	
		Z	0.0	0.0	1.0		153.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3771

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth (mm) ^g	Unct. (k=2)
2450	39.2	1.80	7.21	7.21	7.21	0.31	0.89	± 12.0 %
5200	36.0	4.66	5.02	5.02	5.02	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.86	4.86	4.86	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.73	4.73	4.73	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.53	4.53	4.53	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.57	4.57	4.57	0.40	1.80	± 13.1 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3771

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unct. (k=2)
2450	52.7	1.95	7.21	7.21	7.21	0.70	0.61	± 12.0 %
5200	49.0	5.30	4.72	4.72	4.72	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.53	4.53	4.53	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.24	4.24	4.24	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.96	3.96	3.96	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.25	4.25	4.25	0.50	1.90	± 13.1 %

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

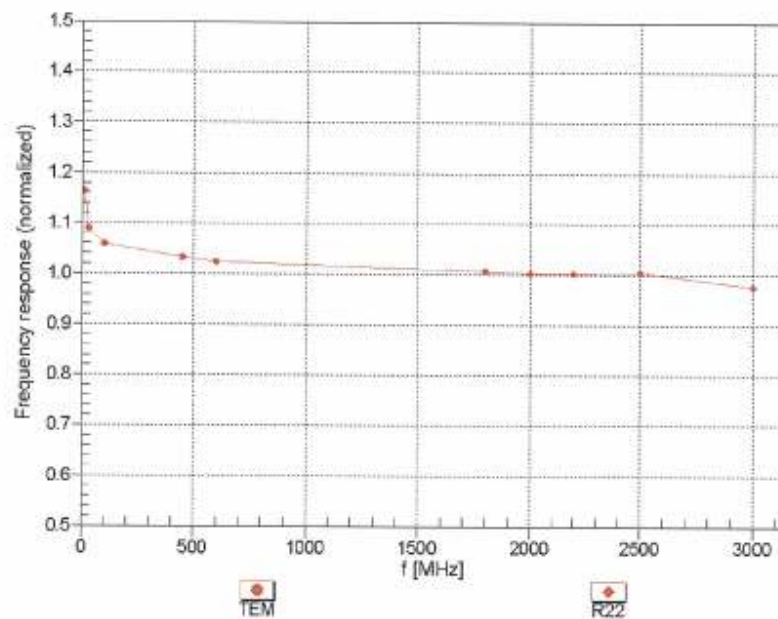
^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3771

March 18, 2014

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

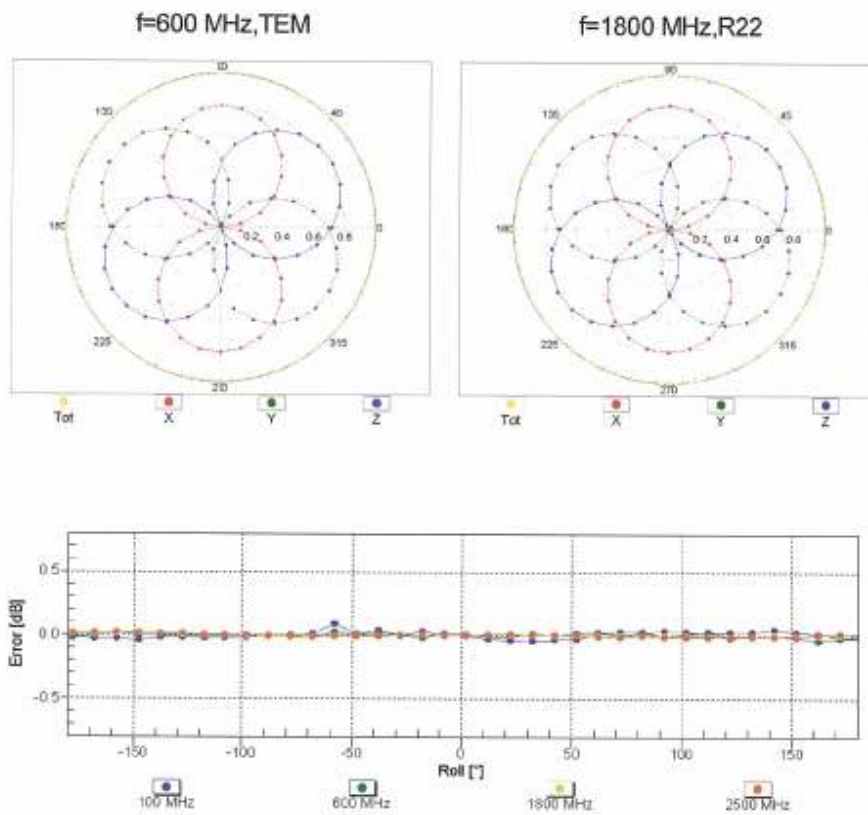


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4-SN:3771

March 18, 2014

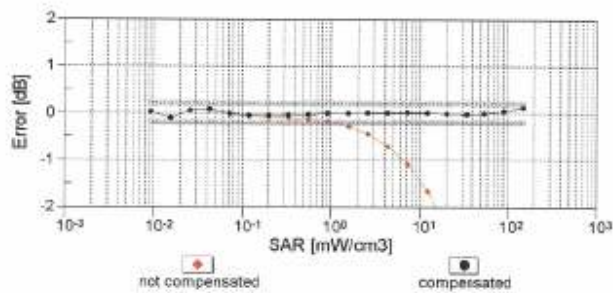
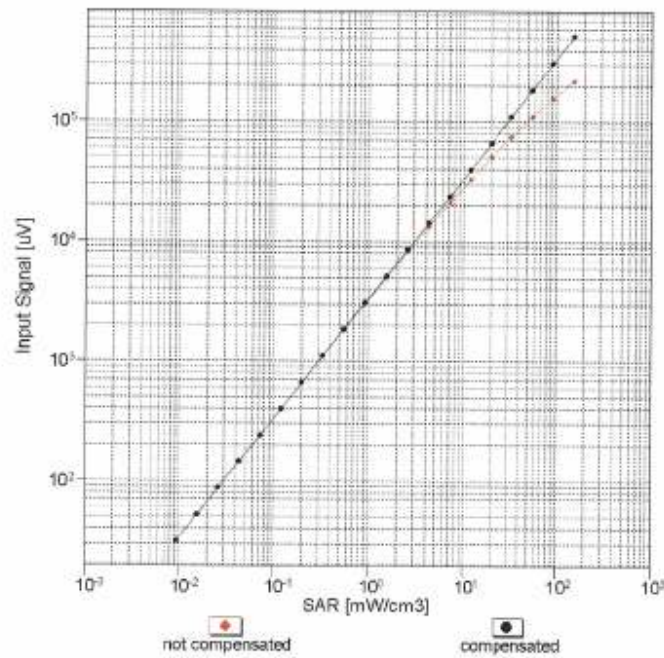
Receiving Pattern (ϕ), $\theta = 0^\circ$



EX3DV4-SN:3771

March 18, 2014

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)

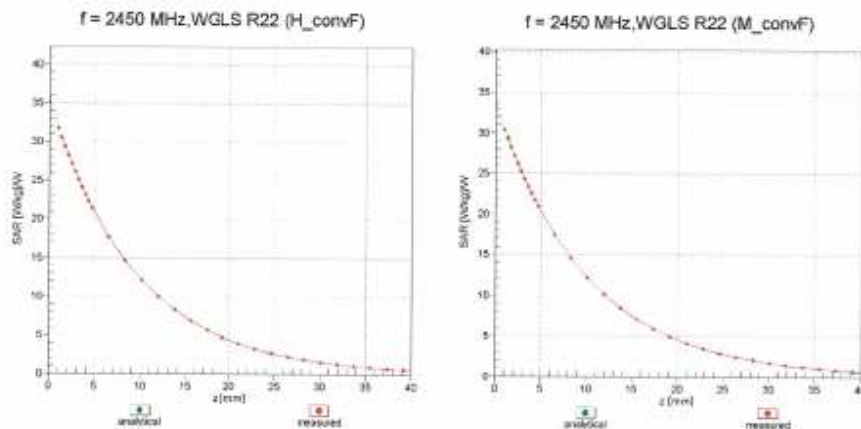


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

EX3DV4- SN:3771

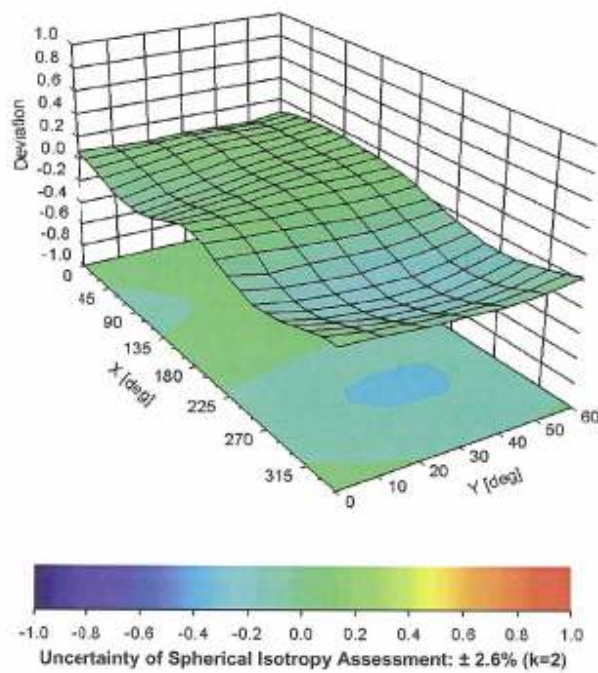
March 18, 2014

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), $f = 900 \text{ MHz}$



EX3DV4- SN:3771

March 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3771**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-97.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm