



Annex C

Appendix No.: 1-8581-24-01-17_TR2-A301-R01

Testing Laboratory

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Appendix with Calibration data



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 0108**

Client

CTC Advanced
Saarbrücken, Germany

Certificate No.

MAGPy-8H3D-3079

CALIBRATION CERTIFICATE

Object

MAGPy-8H3D+E3D SN:3079
MAGPy-DAS SN:1023

Calibration procedure(s)

QA CAL-46.v1
Calibration Procedure for MAGPy-8H3D+E3D
Near-field Electric and Magnetic Field Sensor System

Calibration date

October 24, 2023

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
Oscilloscope	SN: 110918	22-Oct-22 (No. 1335.8794K04)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-23 (No. 217-03527)	Apr-24
Type-N mismatch	SN: 310982 / 06327	04-Apr-23 (No. 217-03528)	Apr-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Network Analyzer E5061B	SN: MY49810822	In house check: Nov-22	In house check: Nov-23
TEM Cell	SN: S6029i	In house check: Nov-22	N.A
Plate Capacitor	SN: 6028i	In house check: Nov-22	In house check: Nov-23
Resonator (160kHz)	SN: 6030i	In house check: Nov-22	In house check: Nov-23

	Name	Function	Signature
Calibrated by	Aidonia Georgiadou	Laboratory Engineer	
Approved by	Sven Kühn	Technical Manager	

Issued: October 24, 2023

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



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 0108

Glossary

MAGPy-8H3D-E3D Magnetic Amplitude and Gradient Probe – Eight H-field Sensors, Single E-field sensor
MAGPy-DAS Magnetic Amplitude and Gradient Data Acquisition System

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2013, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", November 2013

Methods Applied and Interpretation of Parameters

- Calibration has been performed after the adjustment of the device.
- *Linearity*: Calibration of the linearity of the field reading over the specified dynamic range at 161.75 kHz. Influence of offset voltage is included in this measurement.
- *Frequency response*: Calibration of the field reading over the specified frequency range from 3.0 kHz to 10.0 MHz.
- Receiving Pattern: Assessed for H-field polarizations ϑ , and $\phi = 0^\circ \dots 360^\circ$; $\vartheta = 90^\circ$, and $\phi = 0^\circ \dots 360^\circ$; for the XYZ sensors (in TEM-Cell at 4 kHz, 40 kHz, 400 kHz and 4 MHz).
- Receiving Pattern: Assessed for E-field polarizations ϑ , and $\phi = 0^\circ \dots 360^\circ$; $\vartheta = 90^\circ$, and $\phi = 0^\circ \dots 360^\circ$; for the XYZ sensor (in parallel plate capacitor at 4 kHz, 40 kHz, 400 kHz and 4 MHz).

Calibration Uncertainty

The calibration uncertainty is 0.7 dB for the H-field readings and 1.06 dB for the E-field readings. The calibration uncertainty is specified over the frequency range from 3.0 kHz to 10.0 MHz and a dynamic range from 0.1 A/m to 3200 A/m and from 0.08 V/m to 2000 V/m respectively.

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%.

Measurement Conditions

Unit Type	MAGPy-8H3D+E3D (SP MGY 303 AA)	3079
	MAGPy-DAS (SE UMS 303 AC)	1023
	MAGPy FPGA Board	WP000009
Adjustment Date	Last MAGPy Adjustment	October 24, 2023
Firmware SW Version	MAGPy Firmware	Ver. 1.00
Backend SW Version	MAGPy Backend	Ver. 1.0.2
Calibration SW Version	MAGACAP	Ver. 1.0

Dynamic Range

Dynamic Range, H-field, Channel 0

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.380	0.370	0.420	0.400	0.390	0.42	0.45	0.46	±1.00
0.540	0.520	0.510	0.560	0.540	0.520	0.32	0.33	0.17	±1.00
0.740	0.710	0.690	0.740	0.740	0.680	0.00	0.36	-0.13	±1.00
0.960	0.930	0.910	0.970	0.960	0.890	0.09	0.28	-0.19	±1.00
1.30	1.26	1.22	1.30	1.28	1.22	0.00	0.14	0.00	±1.00
1.79	1.73	1.68	1.79	1.73	1.69	0.00	0.00	0.05	±1.00
2.38	2.31	2.24	2.39	2.31	2.24	0.04	0.00	0.00	±0.20
3.19	3.09	3.00	3.18	3.09	3.01	-0.03	0.00	0.03	±0.20
4.33	4.20	4.07	4.32	4.20	4.09	-0.02	0.00	0.04	±0.20
5.85	5.67	5.51	5.86	5.70	5.52	0.01	0.05	0.02	±0.20
7.87	7.63	7.40	7.89	7.65	7.42	0.02	0.02	0.02	±0.20
10.5	10.2	9.89	10.5	10.2	9.91	0.00	0.00	0.02	±0.20
14.2	13.8	13.4	14.2	13.8	13.4	0.00	0.00	0.00	±0.20
19.1	18.6	18.0	19.2	18.6	18.1	0.05	0.00	0.05	±0.20
25.9	25.1	24.3	25.9	25.1	24.3	0.00	0.00	0.00	±0.20
34.5	33.5	32.4	34.7	33.6	32.6	0.05	0.03	0.05	±0.20
46.6	45.2	43.9	46.8	45.4	44.0	0.04	0.04	0.02	±0.20
63.0	61.2	59.4	63.4	61.5	59.6	0.05	0.04	0.03	±0.20
86.5	84.0	81.5	86.3	83.8	81.3	-0.02	-0.02	-0.02	±0.20
113	110	107	113	110	106	0.00	0.00	-0.08	±0.20
156	151	147	155	151	146	-0.06	0.00	-0.06	±0.20
216	210	203	215	209	203	-0.04	-0.04	0.00	±0.20
299	290	281	300	285	276	0.03	-0.15	-0.16	±0.20
441	428	415	435	423	410	-0.12	-0.10	-0.11	±0.20
608	590	572	603	587	568	-0.07	-0.04	-0.06	±0.20
905	880	853	908	884	856	0.03	0.04	0.03	±0.20
1370	1330	1290	1390	1350	1310	0.13	0.13	0.13	±0.30
1880	1830	1770	1930	1880	1820	0.23	0.23	0.24	±0.30
3040	2960	2870	3160	3080	2980	0.34	0.35	0.33	±0.50
3670	3570	3470	3820	3730	3620	0.35	0.38	0.37	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0 A/m
- ±0.2dB for applied H-fields ≥ 2.0 A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 1

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.390	0.390	0.380	0.400	0.410	0.420	0.22	0.43	0.87	±1.00
0.540	0.530	0.520	0.540	0.540	0.560	0.00	0.16	0.64	±1.00
0.740	0.720	0.720	0.730	0.720	0.740	-0.12	0.00	0.24	±1.00
0.960	0.940	0.930	0.970	0.940	0.950	0.09	0.00	0.18	±1.00
1.30	1.28	1.26	1.31	1.29	1.29	0.07	0.07	0.20	±1.00
1.78	1.75	1.74	1.79	1.75	1.77	0.05	0.00	0.15	±1.00
2.38	2.34	2.31	2.38	2.36	2.32	0.00	0.07	0.04	±0.20
3.18	3.13	3.10	3.18	3.13	3.12	0.00	0.00	0.06	±0.20
4.32	4.25	4.20	4.33	4.25	4.22	0.02	0.00	0.04	±0.20
5.84	5.74	5.68	5.84	5.76	5.69	0.00	0.03	0.02	±0.20
7.86	7.73	7.64	7.87	7.76	7.65	0.01	0.03	0.01	±0.20
10.5	10.3	10.2	10.5	10.3	10.2	0.00	0.00	0.00	±0.20
14.2	13.9	13.8	14.2	14.0	13.8	0.00	0.06	0.00	±0.20
19.1	18.8	18.6	19.1	18.8	18.6	0.00	0.00	0.00	±0.20
25.8	25.4	25.1	25.8	25.4	25.1	0.00	0.00	0.00	±0.20
34.5	33.9	33.5	34.6	34.0	33.7	0.03	0.03	0.05	±0.20
46.5	45.8	45.3	46.7	45.9	45.5	0.04	0.02	0.04	±0.20
63.0	61.9	61.3	63.3	62.2	61.6	0.04	0.04	0.04	±0.20
86.4	85.1	84.2	86.2	84.8	83.9	-0.02	-0.03	-0.03	±0.20
113	111	110	113	111	110	0.00	0.00	0.00	±0.20
156	153	151	155	153	151	-0.06	0.00	0.00	±0.20
216	212	210	215	212	209	-0.04	0.00	-0.04	±0.20
298	294	290	300	289	285	0.06	-0.15	-0.15	±0.20
441	433	428	434	428	423	-0.14	-0.10	-0.10	±0.20
607	598	591	602	594	586	-0.07	-0.06	-0.07	±0.20
904	890	880	907	895	884	0.03	0.05	0.04	±0.20
1370	1350	1330	1390	1370	1350	0.13	0.13	0.13	±0.30
1880	1850	1830	1930	1910	1880	0.23	0.28	0.23	±0.30
3040	3000	2960	3150	3120	3080	0.31	0.34	0.35	±0.50
3670	3610	3580	3820	3770	3730	0.35	0.38	0.36	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0A/m
- ±0.2dB for applied H-fields ≥ 2.0A/m and < 1000A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000A/m
- ±0.5dB for applied H-fields ≥ 3000A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 2

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.390	0.390	0.410	0.410	0.420	0.21	0.43	0.64	±1.00
0.550	0.530	0.530	0.550	0.550	0.550	0.00	0.32	0.32	±1.00
0.750	0.720	0.720	0.750	0.740	0.730	0.00	0.24	0.12	±1.00
0.970	0.940	0.940	0.990	0.940	0.950	0.18	0.00	0.09	±1.00
1.32	1.27	1.27	1.35	1.26	1.29	0.20	-0.07	0.14	±1.00
1.81	1.75	1.75	1.83	1.74	1.78	0.10	-0.05	0.15	±1.00
2.42	2.33	2.34	2.43	2.34	2.36	0.04	0.04	0.07	±0.20
3.24	3.11	3.12	3.24	3.11	3.13	0.00	0.00	0.03	±0.20
4.39	4.23	4.24	4.39	4.23	4.25	0.00	0.00	0.02	±0.20
5.94	5.72	5.73	5.93	5.71	5.73	-0.01	-0.02	0.00	±0.20
7.99	7.70	7.71	7.99	7.70	7.70	0.00	0.00	-0.01	±0.20
10.7	10.3	10.3	10.7	10.3	10.3	0.00	0.00	0.00	±0.20
14.4	13.9	13.9	14.4	13.9	13.9	0.00	0.00	0.00	±0.20
19.4	18.8	18.8	19.5	18.8	18.8	0.04	0.00	0.00	±0.20
26.3	25.3	25.3	26.3	25.3	25.4	0.00	0.00	0.03	±0.20
35.0	33.8	33.8	35.2	33.9	34.0	0.05	0.03	0.05	±0.20
47.3	45.6	45.7	47.5	45.7	45.9	0.04	0.02	0.04	±0.20
64.0	61.7	61.8	64.3	62.0	62.1	0.04	0.04	0.04	±0.20
87.9	84.8	84.9	87.7	84.5	84.6	-0.02	-0.03	-0.03	±0.20
115	111	111	115	111	111	0.00	0.00	0.00	±0.20
158	152	153	158	152	152	0.00	0.00	-0.06	±0.20
219	211	212	219	211	211	0.00	0.00	-0.04	±0.20
303	293	293	305	288	288	0.06	-0.15	-0.15	±0.20
448	432	432	441	427	427	-0.14	-0.10	-0.10	±0.20
617	595	596	612	592	592	-0.07	-0.04	-0.06	±0.20
919	887	888	923	892	892	0.04	0.05	0.04	±0.20
1390	1340	1340	1410	1370	1360	0.12	0.19	0.13	±0.30
1910	1850	1850	1960	1900	1900	0.22	0.23	0.23	±0.30
3090	2980	2990	3210	3100	3100	0.33	0.34	0.31	±0.50
3730	3600	3610	3880	3760	3770	0.34	0.38	0.38	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0A/m
- ±0.2dB for applied H-fields ≥ 2.0A/m and < 1000A/m
- ±0.3dB for applied H-fields ≥ 1000A/m and < 2000A/m
- ±0.4dB for applied H-fields ≥ 2000A/m and < 3000A/m
- ±0.5dB for applied H-fields ≥ 3000A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 3

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.390	0.380	0.420	0.410	0.390	0.42	0.43	0.23	±1.00
0.550	0.530	0.520	0.550	0.550	0.510	0.00	0.32	-0.17	±1.00
0.750	0.720	0.710	0.750	0.710	0.710	0.00	-0.12	0.00	±1.00
0.980	0.940	0.920	0.980	0.940	0.930	0.00	0.00	0.09	±1.00
1.32	1.28	1.25	1.33	1.28	1.24	0.07	0.00	-0.07	±1.00
1.82	1.76	1.72	1.82	1.74	1.72	0.00	-0.10	0.00	±1.00
2.42	2.34	2.29	2.42	2.35	2.29	0.00	0.04	0.00	±0.20
3.24	3.13	3.06	3.24	3.13	3.07	0.00	0.00	0.03	±0.20
4.40	4.25	4.16	4.39	4.25	4.17	-0.02	0.00	0.02	±0.20
5.95	5.75	5.62	5.95	5.76	5.63	0.00	0.02	0.02	±0.20
8.00	7.74	7.55	8.01	7.76	7.57	0.01	0.02	0.02	±0.20
10.7	10.3	10.1	10.7	10.3	10.1	0.00	0.00	0.00	±0.20
14.4	14.0	13.7	14.4	14.0	13.6	0.00	0.00	-0.06	±0.20
19.5	18.8	18.4	19.5	18.8	18.4	0.00	0.00	0.00	±0.20
26.3	25.4	24.8	26.3	25.4	24.8	0.00	0.00	0.00	±0.20
35.1	33.9	33.1	35.2	34.1	33.3	0.02	0.05	0.05	±0.20
47.4	45.9	44.8	47.5	46.0	44.9	0.02	0.02	0.02	±0.20
64.1	62.0	60.6	64.4	62.3	60.9	0.04	0.04	0.04	±0.20
88.0	85.2	83.2	87.8	84.9	82.9	-0.02	-0.03	-0.03	±0.20
115	111	109	115	111	109	0.00	0.00	0.00	±0.20
158	153	150	158	153	149	0.00	0.00	-0.06	±0.20
220	212	207	219	212	207	-0.04	0.00	0.00	±0.20
304	294	287	305	289	282	0.03	-0.15	-0.15	±0.20
449	434	424	442	429	419	-0.14	-0.10	-0.10	±0.20
618	598	584	613	595	580	-0.07	-0.04	-0.06	±0.20
921	891	870	924	895	874	0.03	0.04	0.04	±0.20
1390	1350	1320	1410	1370	1340	0.12	0.13	0.13	±0.30
1910	1850	1810	1960	1900	1860	0.22	0.23	0.24	±0.30
3100	3000	2930	3210	3090	3040	0.30	0.26	0.32	±0.50
3730	3620	3540	3890	3730	3690	0.36	0.26	0.36	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0 A/m
- ±0.2dB for applied H-fields ≥ 2.0 A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 4

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.390	0.390	0.400	0.400	0.400	0.00	0.22	0.22	±1.00
0.540	0.530	0.520	0.540	0.520	0.530	0.00	-0.17	0.17	±1.00
0.740	0.730	0.720	0.730	0.730	0.720	-0.12	0.00	0.00	±1.00
0.970	0.950	0.940	0.960	0.960	0.940	-0.09	0.09	0.00	±1.00
1.31	1.29	1.27	1.32	1.32	1.27	0.07	0.20	0.00	±1.00
1.80	1.77	1.74	1.79	1.78	1.74	-0.05	0.05	0.00	±1.00
2.40	2.36	2.32	2.40	2.38	2.32	0.00	0.07	0.00	±0.20
3.21	3.16	3.11	3.20	3.17	3.10	-0.03	0.03	-0.03	±0.20
4.36	4.29	4.22	4.36	4.31	4.22	0.00	0.04	0.00	±0.20
5.90	5.80	5.70	5.90	5.82	5.70	0.00	0.03	0.00	±0.20
7.93	7.81	7.66	7.94	7.82	7.66	0.01	0.01	0.00	±0.20
10.6	10.4	10.2	10.6	10.4	10.2	0.00	0.00	0.00	±0.20
14.3	14.1	13.8	14.3	14.1	13.8	0.00	0.00	0.00	±0.20
19.3	19.0	18.7	19.3	19.0	18.7	0.00	0.00	0.00	±0.20
26.1	25.6	25.2	26.1	25.7	25.2	0.00	0.03	0.00	±0.20
34.8	34.2	33.6	35.0	34.4	33.8	0.05	0.05	0.05	±0.20
47.0	46.3	45.4	47.1	46.4	45.6	0.02	0.02	0.04	±0.20
63.5	62.5	61.5	63.9	62.8	61.8	0.05	0.04	0.04	±0.20
87.3	86.0	84.4	87.0	85.7	84.2	-0.03	-0.03	-0.02	±0.20
114	112	110	114	112	110	0.00	0.00	0.00	±0.20
157	155	152	157	154	151	0.00	-0.06	-0.06	±0.20
218	214	210	217	214	210	-0.04	0.00	0.00	±0.20
301	297	291	303	292	286	0.06	-0.15	-0.15	±0.20
445	438	430	438	432	424	-0.14	-0.12	-0.12	±0.20
613	604	593	607	600	589	-0.09	-0.06	-0.06	±0.20
913	899	883	915	903	887	0.02	0.04	0.04	±0.20
1380	1360	1330	1400	1380	1360	0.12	0.13	0.19	±0.30
1900	1870	1840	1950	1920	1890	0.23	0.23	0.23	±0.30
3070	3030	2970	3180	3140	3090	0.31	0.31	0.34	±0.50
3700	3650	3590	3850	3810	3750	0.35	0.37	0.38	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0 A/m
- ±0.2dB for applied H-fields ≥ 2.0 A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 5

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.400	0.400	0.410	0.420	0.420	0.21	0.42	0.42	±1.00
0.550	0.540	0.540	0.540	0.570	0.550	-0.16	0.47	0.16	±1.00
0.750	0.740	0.740	0.750	0.730	0.740	0.00	-0.12	0.00	±1.00
0.980	0.960	0.970	0.990	0.970	0.960	0.09	0.09	-0.09	±1.00
1.32	1.31	1.31	1.33	1.32	1.32	0.07	0.07	0.07	±1.00
1.82	1.79	1.80	1.82	1.79	1.82	0.00	0.00	0.10	±1.00
2.43	2.39	2.40	2.42	2.40	2.42	-0.04	0.04	0.07	±0.20
3.25	3.20	3.21	3.24	3.19	3.22	-0.03	-0.03	0.03	±0.20
4.41	4.35	4.36	4.41	4.34	4.37	0.00	-0.02	0.02	±0.20
5.97	5.87	5.90	5.97	5.88	5.91	0.00	0.01	0.01	±0.20
8.02	7.90	7.93	8.03	7.95	7.96	0.01	0.05	0.03	±0.20
10.7	10.6	10.6	10.7	10.6	10.6	0.00	0.00	0.00	±0.20
14.5	14.3	14.3	14.5	14.3	14.3	0.00	0.00	0.00	±0.20
19.5	19.2	19.3	19.5	19.3	19.3	0.00	0.05	0.00	±0.20
26.4	26.0	26.1	26.4	26.0	26.1	0.00	0.00	0.00	±0.20
35.2	34.7	34.7	35.4	34.8	34.9	0.05	0.02	0.05	±0.20
47.5	46.8	47.0	47.7	47.0	47.1	0.04	0.04	0.02	±0.20
64.3	63.3	63.6	64.6	63.6	63.9	0.04	0.04	0.04	±0.20
88.2	87.0	87.3	88.0	86.8	87.0	-0.02	-0.02	-0.03	±0.20
116	114	114	115	113	114	-0.08	-0.08	0.00	±0.20
159	157	157	158	156	157	-0.05	-0.06	0.00	±0.20
220	217	218	220	217	217	0.00	0.00	-0.04	±0.20
304	300	301	306	295	296	0.06	-0.15	-0.15	±0.20
450	443	444	443	438	439	-0.14	-0.10	-0.10	±0.20
620	611	613	614	607	609	-0.08	-0.06	-0.06	±0.20
923	911	913	925	915	918	0.02	0.04	0.05	±0.20
1400	1380	1380	1420	1400	1400	0.12	0.12	0.12	±0.30
1920	1890	1900	1970	1950	1950	0.22	0.27	0.23	±0.30
3100	3060	3070	3220	3180	3190	0.33	0.33	0.33	±0.50
3740	3690	3710	3900	3850	3880	0.36	0.37	0.39	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0A/m
- ±0.2dB for applied H-fields ≥ 2.0A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 6

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.390	0.400	0.420	0.400	0.400	0.42	0.22	0.00	±1.00
0.540	0.540	0.540	0.550	0.550	0.540	0.16	0.16	0.00	±1.00
0.740	0.730	0.740	0.750	0.760	0.740	0.12	0.35	0.00	±1.00
0.960	0.960	0.970	0.970	0.990	0.980	0.09	0.27	0.09	±1.00
1.31	1.29	1.31	1.32	1.32	1.31	0.07	0.20	0.00	±1.00
1.80	1.78	1.80	1.80	1.79	1.82	0.00	0.05	0.10	±1.00
2.40	2.37	2.40	2.41	2.39	2.43	0.04	0.07	0.11	±0.20
3.21	3.17	3.20	3.21	3.19	3.23	0.00	0.05	0.08	±0.20
4.35	4.31	4.35	4.35	4.30	4.38	0.00	-0.02	0.06	±0.20
5.89	5.83	5.88	5.88	5.83	5.90	-0.01	0.00	0.03	±0.20
7.92	7.84	7.91	7.92	7.85	7.94	0.00	0.01	0.03	±0.20
10.6	10.5	10.6	10.6	10.5	10.6	0.00	0.00	0.00	±0.20
14.3	14.2	14.3	14.3	14.2	14.3	0.00	0.00	0.00	±0.20
19.3	19.1	19.2	19.3	19.1	19.3	0.00	0.00	0.05	±0.20
26.0	25.8	26.0	26.0	25.8	26.0	0.00	0.00	0.00	±0.20
34.7	34.4	34.7	34.9	34.5	34.9	0.05	0.03	0.05	±0.20
46.9	46.5	46.9	47.0	46.6	47.0	0.02	0.02	0.02	±0.20
63.4	62.8	63.4	63.8	63.1	63.7	0.05	0.04	0.04	±0.20
87.1	86.3	87.1	86.9	86.0	86.8	-0.02	-0.03	-0.03	±0.20
114	113	114	114	113	114	0.00	0.00	0.00	±0.20
157	155	157	156	155	156	-0.06	0.00	-0.06	±0.20
217	215	217	217	215	217	0.00	0.00	0.00	±0.20
301	298	300	302	293	295	0.03	-0.15	-0.15	±0.20
444	440	443	437	434	437	-0.14	-0.12	-0.12	±0.20
612	606	611	607	602	607	-0.07	-0.06	-0.06	±0.20
911	903	911	913	907	915	0.02	0.04	0.04	±0.20
1380	1370	1380	1400	1390	1400	0.12	0.13	0.12	±0.30
1890	1880	1890	1940	1930	1950	0.23	0.23	0.27	±0.30
3060	3040	3070	3180	3160	3180	0.33	0.34	0.31	±0.50
3690	3660	3700	3850	3820	3860	0.37	0.37	0.37	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0 A/m
- ±0.2dB for applied H-fields ≥ 2.0 A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, H-field, Channel 7

H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
x	y	z	x	y	z	x	y	z	
0.400	0.390	0.380	0.380	0.410	0.380	-0.45	0.43	0.00	±1.00
0.540	0.530	0.520	0.530	0.550	0.500	-0.16	0.32	-0.34	±1.00
0.740	0.730	0.710	0.740	0.740	0.700	0.00	0.12	-0.12	±1.00
0.960	0.960	0.920	0.980	0.950	0.930	0.18	-0.09	0.09	±1.00
1.31	1.29	1.25	1.32	1.29	1.26	0.07	0.00	0.07	±1.00
1.80	1.78	1.71	1.80	1.78	1.74	0.00	0.00	0.15	±1.00
2.40	2.37	2.29	2.40	2.37	2.31	0.00	0.00	0.08	±0.20
3.21	3.17	3.06	3.21	3.18	3.07	0.00	0.03	0.03	±0.20
4.35	4.31	4.15	4.35	4.33	4.17	0.00	0.04	0.04	±0.20
5.89	5.82	5.61	5.89	5.85	5.63	0.00	0.04	0.03	±0.20
7.92	7.83	7.54	7.92	7.87	7.55	0.00	0.04	0.01	±0.20
10.6	10.5	10.1	10.6	10.5	10.1	0.00	0.00	0.00	±0.20
14.3	14.1	13.6	14.3	14.2	13.6	0.00	0.06	0.00	±0.20
19.3	19.1	18.4	19.2	19.1	18.4	-0.05	0.00	0.00	±0.20
26.0	25.7	24.8	26.0	25.7	24.8	0.00	0.00	0.00	±0.20
34.7	34.4	33.1	34.9	34.5	33.2	0.05	0.03	0.03	±0.20
46.9	46.4	44.7	47.1	46.5	44.9	0.04	0.02	0.04	±0.20
63.4	62.7	60.5	63.8	63.0	60.8	0.05	0.04	0.04	±0.20
87.1	86.2	83.1	86.9	86.0	82.8	-0.02	-0.02	-0.03	±0.20
114	113	109	114	112	108	0.00	-0.08	-0.08	±0.20
157	155	149	156	155	149	-0.06	0.00	0.00	±0.20
217	215	207	217	215	207	0.00	0.00	0.00	±0.20
301	298	287	302	293	282	0.03	-0.15	-0.15	±0.20
444	439	423	437	434	418	-0.14	-0.10	-0.10	±0.20
612	606	583	606	603	579	-0.09	-0.04	-0.06	±0.20
911	902	869	913	907	872	0.02	0.05	0.03	±0.20
1380	1360	1310	1400	1390	1340	0.12	0.19	0.20	±0.30
1890	1880	1810	1940	1930	1860	0.23	0.23	0.24	±0.30
3060	3040	2930	3180	3160	3040	0.33	0.34	0.32	±0.50
3690	3660	3530	3850	3820	3690	0.37	0.37	0.39	±0.50

SPEAG H-field linearity tolerance criteria¹:

- ±1.0dB for applied H-fields < 2.0 A/m
- ±0.2dB for applied H-fields ≥ 2.0 A/m and < 1000 A/m
- ±0.3dB for applied H-fields ≥ 1000 A/m and < 2000 A/m
- ±0.4dB for applied H-fields ≥ 2000 A/m and < 3000 A/m
- ±0.5dB for applied H-fields ≥ 3000 A/m

¹Calibration uncertainty not taken into account (shared risk 50%).

Dynamic Range, E-field, Channel 0

E-field/(V/m) Applied			E-field/(V/m) Reading			Difference/(dB)			Tolerance/(dB)		
x	y	z	x	y	z	x	y	z	x	y	z
0.360	0.210	0.080	0.370	0.210	0.080	0.24	0.00	0.00	±5.00	±5.00	±5.00
0.490	0.290	0.100	0.500	0.310	0.090	0.18	0.58	-0.92	±5.00	±5.00	±5.00
0.680	0.400	0.140	0.680	0.400	0.140	0.00	0.00	0.00	±5.00	±5.00	±5.00
0.880	0.520	0.180	0.890	0.530	0.190	0.10	0.17	0.47	±5.00	±5.00	±5.00
1.19	0.700	0.250	1.19	0.700	0.230	0.00	0.00	-0.72	±5.00	±5.00	±5.00
1.64	0.970	0.340	1.67	0.950	0.350	0.16	-0.18	0.25	±5.00	±5.00	±5.00
2.18	1.29	0.450	2.18	1.28	0.430	0.00	-0.07	-0.39	±1.00	±5.00	±5.00
2.92	1.72	0.610	2.95	1.70	0.600	0.09	-0.10	-0.14	±1.00	±5.00	±5.00
3.97	2.34	0.820	3.98	2.32	0.820	0.02	-0.07	0.00	±1.00	±1.00	±5.00
5.37	3.16	1.11	5.40	3.14	1.08	0.05	-0.06	-0.24	±1.00	±1.00	±5.00
7.22	4.26	1.50	7.27	4.22	1.46	0.06	-0.08	-0.23	±1.00	±1.00	±5.00
9.64	5.68	2.00	9.68	5.65	1.94	0.04	-0.05	-0.26	±1.00	±1.00	±1.00
13.0	7.68	2.70	13.1	7.63	2.60	0.07	-0.06	-0.33	±1.00	±1.00	±1.00
17.6	10.4	3.65	17.6	10.3	3.54	0.00	-0.08	-0.27	±1.00	±1.00	±1.00
23.7	14.0	4.92	23.8	13.9	4.75	0.04	-0.06	-0.31	±1.00	±1.00	±1.00
31.7	18.7	6.57	31.9	18.6	6.41	0.05	-0.05	-0.21	±1.00	±1.00	±1.00
42.8	25.2	8.88	43.0	25.2	8.63	0.04	0.00	-0.25	±1.00	±1.00	±1.00
57.8	34.1	12.0	58.3	34.1	11.7	0.07	0.00	-0.22	±1.00	±1.00	±1.00
79.5	46.9	16.5	79.4	46.5	15.9	-0.01	-0.07	-0.32	±1.00	±1.00	±1.00
104	61.3	21.6	104	60.7	20.9	0.00	-0.09	-0.29	±1.00	±1.00	±1.00
143	84.3	29.7	143	83.5	28.8	0.00	-0.08	-0.27	±1.00	±1.00	±1.00
198	117	41.1	198	116	39.9	0.00	-0.07	-0.26	±1.00	±1.00	±1.00
274	162	56.9	277	162	55.6	0.09	0.00	-0.20	±1.00	±1.00	±1.00
405	239	84.0	391	229	82.5	-0.31	-0.37	-0.16	±1.00	±1.00	±1.00
558	329	116	543	317	114	-0.24	-0.32	-0.15	±1.00	±1.00	±1.00
832	490	172	817	478	172	-0.16	-0.22	0.00	±1.00	±1.00	±1.00
1260	742	261	1250	733	264	-0.07	-0.11	0.10	±1.00	±1.00	±1.00
1730	1020	358	1740	1020	367	0.05	0.00	0.22	±1.00	±1.00	±1.00
2800	1650	580	2850	1670	574	0.15	0.10	-0.09	±1.00	±1.00	±1.00
3370	1990	699	3450	2020	696	0.20	0.13	-0.04	±1.00	±1.00	±1.00

SPEAG E-field linearity tolerance criteria¹:

±5.0dB for applied E-field < 2V/m

±1.0dB for applied E-field ≥ 2V/m

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response

Frequency Response, H-field, Channel 0

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.49	1.48	1.48	0.00	0.00	0.00	±0.3
3200	1.48	1.48	1.48	1.50	1.49	1.50	0.12	0.06	0.12	±0.3
4000	1.47	1.47	1.47	1.47	1.47	1.48	0.00	0.00	0.06	±0.3
5200	1.46	1.46	1.46	1.47	1.47	1.46	0.06	0.06	0.00	±0.3
6600	1.45	1.45	1.45	1.46	1.45	1.46	0.06	0.00	0.06	±0.3
8200	1.44	1.44	1.44	1.45	1.44	1.44	0.06	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.43	1.44	0.00	0.00	0.00	±0.3
10600	4.33	4.30	4.30	4.32	4.31	4.29	-0.02	0.02	-0.02	±0.3
13400	4.35	4.31	4.31	4.36	4.32	4.33	0.02	0.02	0.04	±0.3
17000	4.35	4.30	4.31	4.36	4.30	4.31	0.02	0.00	0.00	±0.3
21400	4.37	4.32	4.33	4.38	4.32	4.33	0.02	0.00	0.00	±0.3
27200	4.37	4.32	4.33	4.37	4.32	4.34	0.00	0.00	0.02	±0.3
34400	4.37	4.33	4.34	4.37	4.33	4.34	0.00	0.00	0.00	±0.3
40000	4.36	4.32	4.33	4.37	4.33	4.33	0.02	0.02	0.00	±0.3
43600	4.35	4.32	4.32	4.36	4.32	4.32	0.02	0.00	0.00	±0.3
55400	4.33	4.30	4.31	4.34	4.31	4.31	0.02	0.02	0.00	±0.3
70000	4.32	4.29	4.30	4.33	4.30	4.30	0.02	0.02	0.00	±0.3
88800	4.31	4.28	4.29	4.32	4.29	4.29	0.02	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.30	4.27	4.28	0.02	0.00	0.02	±0.3
142400	4.27	4.25	4.25	4.28	4.25	4.25	0.02	0.00	0.00	±0.3
161750	4.25	4.23	4.23	4.26	4.23	4.24	0.02	0.00	0.02	±0.3
180400	4.24	4.22	4.22	4.25	4.22	4.22	0.02	0.00	0.00	±0.3
228400	4.21	4.18	4.18	4.22	4.19	4.18	0.02	0.02	0.00	±0.3
289400	4.16	4.14	4.15	4.17	4.15	4.15	0.02	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.13	4.11	4.11	0.02	0.02	0.00	±0.3
400000	4.10	4.08	4.09	4.12	4.09	4.09	0.04	0.02	0.00	±0.3
464000	4.08	4.05	4.06	4.08	4.06	4.06	0.00	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.03	4.02	4.02	0.00	0.02	0.02	±0.3
744200	3.98	3.96	3.96	3.98	3.97	3.96	0.00	0.02	0.00	±0.3
942600	3.96	3.95	3.95	3.97	3.95	3.95	0.02	0.00	0.00	±0.3
1193600	3.93	3.92	3.92	3.94	3.92	3.92	0.02	0.00	0.00	±0.3
1511600	3.92	3.91	3.91	3.93	3.92	3.92	0.02	0.02	0.02	±0.3
1914400	3.90	3.89	3.89	3.91	3.90	3.90	0.02	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.86	0.02	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.81	0.02	0.02	0.02	±0.3
4000000	3.81	3.79	3.79	3.81	3.80	3.80	0.00	0.02	0.02	±0.3
4923800	3.74	3.73	3.73	3.75	3.73	3.73	0.02	0.00	0.00	±0.3
6235400	3.61	3.60	3.60	3.62	3.62	3.60	0.02	0.05	0.00	±0.3
7896400	3.49	3.48	3.48	3.49	3.50	3.48	0.00	0.05	0.00	±0.3
10000000	3.35	3.35	3.35	3.36	3.35	3.36	0.03	0.00	0.03	±0.3

SPEAG H-field frequency response tolerance criteria¹:

±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 1

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.49	1.48	1.49	0.00	0.00	0.06	±0.3
3200	1.48	1.48	1.48	1.50	1.49	1.50	0.12	0.06	0.12	±0.3
4000	1.47	1.47	1.47	1.47	1.47	1.47	0.00	0.00	0.00	±0.3
5200	1.46	1.46	1.46	1.47	1.47	1.46	0.06	0.06	0.00	±0.3
6600	1.45	1.45	1.45	1.46	1.45	1.45	0.06	0.00	0.00	±0.3
8200	1.44	1.44	1.44	1.44	1.44	1.44	0.00	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.44	1.44	0.00	0.06	0.00	±0.3
10600	4.33	4.30	4.30	4.32	4.30	4.33	-0.02	0.00	0.06	±0.3
13400	4.35	4.31	4.31	4.35	4.33	4.32	0.00	0.04	0.02	±0.3
17000	4.35	4.30	4.31	4.36	4.30	4.31	0.02	0.00	0.00	±0.3
21400	4.37	4.32	4.33	4.37	4.33	4.33	0.00	0.02	0.00	±0.3
27200	4.37	4.32	4.33	4.38	4.33	4.33	0.02	0.02	0.00	±0.3
34400	4.37	4.33	4.34	4.37	4.34	4.33	0.00	0.02	-0.02	±0.3
40000	4.36	4.32	4.33	4.37	4.32	4.32	0.02	0.00	-0.02	±0.3
43600	4.35	4.32	4.32	4.35	4.33	4.33	0.00	0.02	0.02	±0.3
55400	4.33	4.30	4.31	4.34	4.31	4.31	0.02	0.02	0.00	±0.3
70000	4.32	4.29	4.30	4.33	4.30	4.30	0.02	0.02	0.00	±0.3
88800	4.31	4.28	4.29	4.32	4.29	4.29	0.02	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.30	4.27	4.27	0.02	0.00	0.00	±0.3
142400	4.27	4.25	4.25	4.28	4.25	4.25	0.02	0.00	0.00	±0.3
161750	4.25	4.23	4.23	4.26	4.24	4.24	0.02	0.02	0.02	±0.3
180400	4.24	4.22	4.22	4.25	4.22	4.23	0.02	0.00	0.02	±0.3
228400	4.21	4.18	4.18	4.22	4.18	4.18	0.02	0.00	0.00	±0.3
289400	4.16	4.14	4.15	4.17	4.15	4.15	0.02	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.13	4.11	4.11	0.02	0.02	0.00	±0.3
400000	4.10	4.08	4.09	4.11	4.09	4.09	0.02	0.02	0.00	±0.3
464000	4.08	4.05	4.06	4.09	4.06	4.06	0.02	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.04	4.01	4.02	0.02	0.00	0.02	±0.3
744200	3.98	3.96	3.96	3.98	3.96	3.96	0.00	0.00	0.00	±0.3
942600	3.96	3.95	3.95	3.97	3.96	3.95	0.02	0.02	0.00	±0.3
1193600	3.93	3.92	3.92	3.95	3.92	3.93	0.04	0.00	0.02	±0.3
1511600	3.92	3.91	3.91	3.93	3.92	3.91	0.02	0.02	0.00	±0.3
1914400	3.90	3.89	3.89	3.92	3.90	3.90	0.04	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.86	0.02	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.80	0.02	0.02	0.00	±0.3
4000000	3.81	3.79	3.79	3.81	3.80	3.79	0.00	0.02	0.00	±0.3
4923800	3.74	3.73	3.73	3.75	3.74	3.73	0.02	0.02	0.00	±0.3
6235400	3.61	3.60	3.60	3.62	3.61	3.60	0.02	0.02	0.00	±0.3
7896400	3.49	3.48	3.48	3.50	3.48	3.48	0.02	0.00	0.00	±0.3
10000000	3.35	3.35	3.35	3.36	3.36	3.35	0.03	0.03	0.00	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 2

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.50	1.48	1.49	0.06	0.00	0.06	±0.3
3200	1.48	1.48	1.48	1.49	1.49	1.50	0.06	0.06	0.12	±0.3
4000	1.47	1.47	1.47	1.47	1.47	1.48	0.00	0.00	0.06	±0.3
5200	1.46	1.46	1.46	1.47	1.47	1.45	0.06	0.06	-0.06	±0.3
6600	1.45	1.45	1.45	1.47	1.45	1.45	0.12	0.00	0.00	±0.3
8200	1.44	1.44	1.44	1.45	1.44	1.44	0.06	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.44	1.44	0.00	0.06	0.00	±0.3
10600	4.33	4.30	4.30	4.33	4.31	4.30	0.00	0.02	0.00	±0.3
13400	4.35	4.31	4.31	4.36	4.30	4.32	0.02	-0.02	0.02	±0.3
17000	4.35	4.30	4.31	4.36	4.31	4.31	0.02	0.02	0.00	±0.3
21400	4.37	4.32	4.33	4.37	4.33	4.34	0.00	0.02	0.02	±0.3
27200	4.37	4.32	4.33	4.37	4.33	4.33	0.00	0.02	0.00	±0.3
34400	4.37	4.33	4.34	4.37	4.33	4.34	0.00	0.00	0.00	±0.3
40000	4.36	4.32	4.33	4.37	4.33	4.33	0.02	0.02	0.00	±0.3
43600	4.35	4.32	4.32	4.35	4.32	4.33	0.00	0.00	0.02	±0.3
55400	4.33	4.30	4.31	4.35	4.31	4.31	0.04	0.02	0.00	±0.3
70000	4.32	4.29	4.30	4.33	4.30	4.31	0.02	0.02	0.02	±0.3
88800	4.31	4.28	4.29	4.31	4.29	4.29	0.00	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.30	4.27	4.27	0.02	0.00	0.00	±0.3
142400	4.27	4.25	4.25	4.28	4.25	4.25	0.02	0.00	0.00	±0.3
161750	4.25	4.23	4.23	4.26	4.24	4.24	0.02	0.02	0.02	±0.3
180400	4.24	4.22	4.22	4.25	4.22	4.22	0.02	0.00	0.00	±0.3
228400	4.21	4.18	4.18	4.22	4.18	4.18	0.02	0.00	0.00	±0.3
289400	4.16	4.14	4.15	4.17	4.15	4.15	0.02	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.13	4.11	4.12	0.02	0.02	0.02	±0.3
400000	4.10	4.08	4.09	4.11	4.10	4.08	0.02	0.04	-0.02	±0.3
464000	4.08	4.05	4.06	4.09	4.06	4.06	0.02	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.03	4.02	4.01	0.00	0.02	0.00	±0.3
744200	3.98	3.96	3.96	3.99	3.97	3.96	0.02	0.02	0.00	±0.3
942600	3.96	3.95	3.95	3.97	3.95	3.95	0.02	0.00	0.00	±0.3
1193600	3.93	3.92	3.92	3.94	3.93	3.93	0.02	0.02	0.02	±0.3
1511600	3.92	3.91	3.91	3.93	3.92	3.91	0.02	0.02	0.00	±0.3
1914400	3.90	3.89	3.89	3.91	3.90	3.90	0.02	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.86	0.02	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.80	0.02	0.02	0.00	±0.3
4000000	3.81	3.79	3.79	3.81	3.80	3.80	0.00	0.02	0.02	±0.3
4923800	3.74	3.73	3.73	3.75	3.74	3.73	0.02	0.02	0.00	±0.3
6235400	3.61	3.60	3.60	3.62	3.60	3.60	0.02	0.00	0.00	±0.3
7896400	3.49	3.48	3.48	3.48	3.49	3.48	-0.02	0.02	0.00	±0.3
10000000	3.35	3.35	3.35	3.35	3.35	3.36	0.00	0.00	0.03	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 3

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.48	1.48	1.49	-0.06	0.00	0.06	±0.3
3200	1.48	1.48	1.48	1.49	1.49	1.51	0.06	0.06	0.17	±0.3
4000	1.47	1.47	1.47	1.47	1.47	1.47	0.00	0.00	0.00	±0.3
5200	1.46	1.46	1.46	1.47	1.47	1.45	0.06	0.06	-0.06	±0.3
6600	1.45	1.45	1.45	1.46	1.45	1.46	0.06	0.00	0.06	±0.3
8200	1.44	1.44	1.44	1.45	1.45	1.45	0.06	0.06	0.06	±0.3
9000	1.44	1.43	1.44	1.43	1.44	1.44	-0.06	0.06	0.00	±0.3
10600	4.33	4.30	4.30	4.34	4.31	4.32	0.02	0.02	0.04	±0.3
13400	4.35	4.31	4.31	4.35	4.30	4.33	0.00	-0.02	0.04	±0.3
17000	4.35	4.30	4.31	4.36	4.29	4.31	0.02	-0.02	0.00	±0.3
21400	4.37	4.32	4.33	4.38	4.34	4.35	0.02	0.04	0.04	±0.3
27200	4.37	4.32	4.33	4.37	4.33	4.32	0.00	0.02	-0.02	±0.3
34400	4.37	4.33	4.34	4.37	4.33	4.35	0.00	0.00	0.02	±0.3
40000	4.36	4.32	4.33	4.37	4.33	4.33	0.02	0.02	0.00	±0.3
43600	4.35	4.32	4.32	4.36	4.33	4.33	0.02	0.02	0.02	±0.3
55400	4.33	4.30	4.31	4.35	4.32	4.32	0.04	0.04	0.02	±0.3
70000	4.32	4.29	4.30	4.32	4.30	4.31	0.00	0.02	0.02	±0.3
88800	4.31	4.28	4.29	4.32	4.28	4.29	0.02	0.00	0.00	±0.3
112400	4.29	4.27	4.27	4.31	4.28	4.28	0.04	0.02	0.02	±0.3
142400	4.27	4.25	4.25	4.29	4.25	4.26	0.04	0.00	0.02	±0.3
161750	4.25	4.23	4.23	4.27	4.24	4.24	0.04	0.02	0.02	±0.3
180400	4.24	4.22	4.22	4.25	4.23	4.23	0.02	0.02	0.02	±0.3
228400	4.21	4.18	4.18	4.22	4.19	4.19	0.02	0.02	0.02	±0.3
289400	4.16	4.14	4.15	4.17	4.15	4.16	0.02	0.02	0.02	±0.3
366400	4.12	4.10	4.11	4.13	4.12	4.12	0.02	0.04	0.02	±0.3
400000	4.10	4.08	4.09	4.11	4.09	4.10	0.02	0.02	0.02	±0.3
464000	4.08	4.05	4.06	4.09	4.06	4.07	0.02	0.02	0.02	±0.3
587800	4.03	4.01	4.01	4.04	4.02	4.02	0.02	0.02	0.02	±0.3
744200	3.98	3.96	3.96	3.99	3.97	3.97	0.02	0.02	0.02	±0.3
942600	3.96	3.95	3.95	3.97	3.96	3.96	0.02	0.02	0.02	±0.3
1193600	3.93	3.92	3.92	3.96	3.92	3.93	0.07	0.00	0.02	±0.3
1511600	3.92	3.91	3.91	3.94	3.92	3.92	0.04	0.02	0.02	±0.3
1914400	3.90	3.89	3.89	3.92	3.90	3.91	0.04	0.02	0.04	±0.3
2424400	3.89	3.88	3.88	3.90	3.89	3.89	0.02	0.02	0.02	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.87	0.02	0.02	0.05	±0.3
3888000	3.81	3.80	3.80	3.83	3.81	3.81	0.05	0.02	0.02	±0.3
4000000	3.81	3.79	3.79	3.81	3.80	3.80	0.00	0.02	0.02	±0.3
4923800	3.74	3.73	3.73	3.74	3.74	3.74	0.00	0.02	0.02	±0.3
6235400	3.61	3.60	3.60	3.62	3.63	3.60	0.02	0.07	0.00	±0.3
7896400	3.49	3.48	3.48	3.49	3.49	3.49	0.00	0.02	0.02	±0.3
10000000	3.35	3.35	3.35	3.36	3.35	3.35	0.03	0.00	0.00	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 4

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.48	1.49	1.47	-0.06	0.06	-0.06	±0.3
3200	1.48	1.48	1.48	1.49	1.50	1.50	0.06	0.12	0.12	±0.3
4000	1.47	1.47	1.47	1.49	1.47	1.47	0.12	0.00	0.00	±0.3
5200	1.46	1.46	1.46	1.47	1.46	1.46	0.06	0.00	0.00	±0.3
6600	1.45	1.45	1.45	1.45	1.45	1.45	0.00	0.00	0.00	±0.3
8200	1.44	1.44	1.44	1.45	1.44	1.44	0.06	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.43	1.44	0.00	0.00	0.00	±0.3
10600	4.33	4.30	4.30	4.33	4.30	4.29	0.00	0.00	-0.02	±0.3
13400	4.35	4.31	4.31	4.36	4.30	4.33	0.02	-0.02	0.04	±0.3
17000	4.35	4.30	4.31	4.34	4.31	4.31	-0.02	0.02	0.00	±0.3
21400	4.37	4.32	4.33	4.37	4.33	4.33	0.00	0.02	0.00	±0.3
27200	4.37	4.32	4.33	4.38	4.32	4.33	0.02	0.00	0.00	±0.3
34400	4.37	4.33	4.34	4.37	4.34	4.34	0.00	0.02	0.00	±0.3
40000	4.36	4.32	4.33	4.37	4.33	4.33	0.02	0.02	0.00	±0.3
43600	4.35	4.32	4.32	4.35	4.32	4.33	0.00	0.00	0.02	±0.3
55400	4.33	4.30	4.31	4.34	4.31	4.31	0.02	0.02	0.00	±0.3
70000	4.32	4.29	4.30	4.32	4.30	4.30	0.00	0.02	0.00	±0.3
88800	4.31	4.28	4.29	4.32	4.29	4.30	0.02	0.02	0.02	±0.3
112400	4.29	4.27	4.27	4.29	4.28	4.27	0.00	0.02	0.00	±0.3
142400	4.27	4.25	4.25	4.28	4.26	4.26	0.02	0.02	0.02	±0.3
161750	4.25	4.23	4.23	4.26	4.23	4.23	0.02	0.00	0.00	±0.3
180400	4.24	4.22	4.22	4.25	4.22	4.23	0.02	0.00	0.02	±0.3
228400	4.21	4.18	4.18	4.22	4.19	4.18	0.02	0.02	0.00	±0.3
289400	4.16	4.14	4.15	4.18	4.15	4.15	0.04	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.13	4.11	4.11	0.02	0.02	0.00	±0.3
400000	4.10	4.08	4.09	4.11	4.09	4.09	0.02	0.02	0.00	±0.3
464000	4.08	4.05	4.06	4.09	4.06	4.06	0.02	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.04	4.02	4.01	0.02	0.02	0.00	±0.3
744200	3.98	3.96	3.96	3.98	3.97	3.97	0.00	0.02	0.02	±0.3
942600	3.96	3.95	3.95	3.97	3.96	3.95	0.02	0.02	0.00	±0.3
1193600	3.93	3.92	3.92	3.94	3.93	3.93	0.02	0.02	0.02	±0.3
1511600	3.92	3.91	3.91	3.94	3.91	3.91	0.04	0.00	0.00	±0.3
1914400	3.90	3.89	3.89	3.91	3.90	3.90	0.02	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.86	0.02	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.81	0.02	0.02	0.02	±0.3
4000000	3.81	3.79	3.79	3.81	3.80	3.80	0.00	0.02	0.02	±0.3
4923800	3.74	3.73	3.73	3.74	3.74	3.74	0.00	0.02	0.02	±0.3
6235400	3.61	3.60	3.60	3.62	3.61	3.60	0.02	0.02	0.00	±0.3
7896400	3.49	3.48	3.48	3.50	3.48	3.48	0.02	0.00	0.00	±0.3
10000000	3.35	3.35	3.35	3.36	3.36	3.34	0.03	0.03	-0.03	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 5

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.49	1.48	1.49	0.00	0.00	0.06	±0.3
3200	1.48	1.48	1.48	1.49	1.49	1.50	0.06	0.06	0.12	±0.3
4000	1.47	1.47	1.47	1.48	1.47	1.48	0.06	0.00	0.06	±0.3
5200	1.46	1.46	1.46	1.47	1.46	1.45	0.06	0.00	-0.06	±0.3
6600	1.45	1.45	1.45	1.46	1.44	1.45	0.06	-0.06	0.00	±0.3
8200	1.44	1.44	1.44	1.45	1.44	1.44	0.06	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.43	1.44	0.00	0.00	0.00	±0.3
10600	4.33	4.30	4.30	4.33	4.32	4.34	0.00	0.04	0.08	±0.3
13400	4.35	4.31	4.31	4.37	4.32	4.30	0.04	0.02	-0.02	±0.3
17000	4.35	4.30	4.31	4.35	4.30	4.31	0.00	0.00	0.00	±0.3
21400	4.37	4.32	4.33	4.38	4.35	4.32	0.02	0.06	-0.02	±0.3
27200	4.37	4.32	4.33	4.38	4.31	4.32	0.02	-0.02	-0.02	±0.3
34400	4.37	4.33	4.34	4.37	4.34	4.33	0.00	0.02	-0.02	±0.3
40000	4.36	4.32	4.33	4.36	4.34	4.33	0.00	0.04	0.00	±0.3
43600	4.35	4.32	4.32	4.35	4.34	4.32	0.00	0.04	0.00	±0.3
55400	4.33	4.30	4.31	4.34	4.30	4.31	0.02	0.00	0.00	±0.3
70000	4.32	4.29	4.30	4.33	4.31	4.30	0.02	0.04	0.00	±0.3
88800	4.31	4.28	4.29	4.32	4.29	4.29	0.02	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.30	4.27	4.27	0.02	0.00	0.00	±0.3
142400	4.27	4.25	4.25	4.28	4.25	4.26	0.02	0.00	0.02	±0.3
161750	4.25	4.23	4.23	4.26	4.23	4.24	0.02	0.00	0.02	±0.3
180400	4.24	4.22	4.22	4.25	4.22	4.23	0.02	0.00	0.02	±0.3
228400	4.21	4.18	4.18	4.22	4.19	4.19	0.02	0.02	0.02	±0.3
289400	4.16	4.14	4.15	4.17	4.15	4.15	0.02	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.13	4.12	4.11	0.02	0.04	0.00	±0.3
400000	4.10	4.08	4.09	4.11	4.09	4.09	0.02	0.02	0.00	±0.3
464000	4.08	4.05	4.06	4.08	4.06	4.06	0.00	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.03	4.02	4.02	0.00	0.02	0.02	±0.3
744200	3.98	3.96	3.96	3.98	3.96	3.97	0.00	0.00	0.02	±0.3
942600	3.96	3.95	3.95	3.97	3.96	3.95	0.02	0.02	0.00	±0.3
1193600	3.93	3.92	3.92	3.95	3.93	3.93	0.04	0.02	0.02	±0.3
1511600	3.92	3.91	3.91	3.93	3.91	3.92	0.02	0.00	0.02	±0.3
1914400	3.90	3.89	3.89	3.91	3.90	3.90	0.02	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.87	3.86	3.86	0.02	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.80	0.02	0.02	0.00	±0.3
4000000	3.81	3.79	3.79	3.81	3.81	3.80	0.00	0.05	0.02	±0.3
4923800	3.74	3.73	3.73	3.74	3.74	3.73	0.00	0.02	0.00	±0.3
6235400	3.61	3.60	3.60	3.62	3.62	3.60	0.02	0.05	0.00	±0.3
7896400	3.49	3.48	3.48	3.49	3.49	3.48	0.00	0.02	0.00	±0.3
10000000	3.35	3.35	3.35	3.35	3.36	3.35	0.00	0.03	0.00	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 6

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.49	1.49	1.49	0.00	0.06	0.06	±0.3
3200	1.48	1.48	1.48	1.50	1.50	1.50	0.12	0.12	0.12	±0.3
4000	1.47	1.47	1.47	1.47	1.47	1.48	0.00	0.00	0.06	±0.3
5200	1.46	1.46	1.46	1.47	1.46	1.45	0.06	0.00	-0.06	±0.3
6600	1.45	1.45	1.45	1.46	1.45	1.45	0.06	0.00	0.00	±0.3
8200	1.44	1.44	1.44	1.45	1.44	1.44	0.06	0.00	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.43	1.43	0.00	0.00	-0.06	±0.3
10600	4.33	4.30	4.30	4.36	4.32	4.31	0.06	0.04	0.02	±0.3
13400	4.35	4.31	4.31	4.36	4.31	4.33	0.02	0.00	0.04	±0.3
17000	4.35	4.30	4.31	4.36	4.31	4.32	0.02	0.02	0.02	±0.3
21400	4.37	4.32	4.33	4.38	4.34	4.33	0.02	0.04	0.00	±0.3
27200	4.37	4.32	4.33	4.37	4.32	4.32	0.00	0.00	-0.02	±0.3
34400	4.37	4.33	4.34	4.38	4.33	4.35	0.02	0.00	0.02	±0.3
40000	4.36	4.32	4.33	4.37	4.32	4.33	0.02	0.00	0.00	±0.3
43600	4.35	4.32	4.32	4.37	4.32	4.33	0.04	0.00	0.02	±0.3
55400	4.33	4.30	4.31	4.35	4.31	4.31	0.04	0.02	0.00	±0.3
70000	4.32	4.29	4.30	4.34	4.29	4.30	0.04	0.00	0.00	±0.3
88800	4.31	4.28	4.29	4.32	4.29	4.29	0.02	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.30	4.27	4.28	0.02	0.00	0.02	±0.3
142400	4.27	4.25	4.25	4.29	4.25	4.26	0.04	0.00	0.02	±0.3
161750	4.25	4.23	4.23	4.26	4.24	4.24	0.02	0.02	0.02	±0.3
180400	4.24	4.22	4.22	4.26	4.22	4.23	0.04	0.00	0.02	±0.3
228400	4.21	4.18	4.18	4.23	4.19	4.19	0.04	0.02	0.02	±0.3
289400	4.16	4.14	4.15	4.18	4.15	4.15	0.04	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.14	4.12	4.12	0.04	0.04	0.02	±0.3
400000	4.10	4.08	4.09	4.12	4.09	4.10	0.04	0.02	0.02	±0.3
464000	4.08	4.05	4.06	4.09	4.06	4.07	0.02	0.02	0.02	±0.3
587800	4.03	4.01	4.01	4.04	4.02	4.02	0.02	0.02	0.02	±0.3
744200	3.98	3.96	3.96	3.99	3.97	3.97	0.02	0.02	0.02	±0.3
942600	3.96	3.95	3.95	3.98	3.95	3.96	0.04	0.00	0.02	±0.3
1193600	3.93	3.92	3.92	3.95	3.93	3.93	0.04	0.02	0.02	±0.3
1511600	3.92	3.91	3.91	3.94	3.91	3.92	0.04	0.00	0.02	±0.3
1914400	3.90	3.89	3.89	3.92	3.90	3.90	0.04	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.89	0.02	0.00	0.02	±0.3
3070200	3.86	3.85	3.85	3.88	3.86	3.86	0.04	0.02	0.02	±0.3
3888000	3.81	3.80	3.80	3.83	3.81	3.81	0.05	0.02	0.02	±0.3
4000000	3.81	3.79	3.79	3.82	3.81	3.80	0.02	0.05	0.02	±0.3
4923800	3.74	3.73	3.73	3.75	3.73	3.73	0.02	0.00	0.00	±0.3
6235400	3.61	3.60	3.60	3.62	3.61	3.60	0.02	0.02	0.00	±0.3
7896400	3.49	3.48	3.48	3.50	3.48	3.49	0.02	0.00	0.02	±0.3
10000000	3.35	3.35	3.35	3.35	3.35	3.35	0.00	0.00	0.00	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, H-field, Channel 7

f/(Hz)	H-field/(A/m) Applied			H-field/(A/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	1.49	1.48	1.48	1.49	1.49	1.48	0.00	0.06	0.00	±0.3
3200	1.48	1.48	1.48	1.51	1.50	1.50	0.17	0.12	0.12	±0.3
4000	1.47	1.47	1.47	1.48	1.47	1.47	0.06	0.00	0.00	±0.3
5200	1.46	1.46	1.46	1.47	1.47	1.46	0.06	0.06	0.00	±0.3
6600	1.45	1.45	1.45	1.46	1.45	1.45	0.06	0.00	0.00	±0.3
8200	1.44	1.44	1.44	1.45	1.45	1.44	0.06	0.06	0.00	±0.3
9000	1.44	1.43	1.44	1.44	1.43	1.44	0.00	0.00	0.00	±0.3
10600	4.33	4.30	4.30	4.34	4.29	4.31	0.02	-0.02	0.02	±0.3
13400	4.35	4.31	4.31	4.37	4.32	4.32	0.04	0.02	0.02	±0.3
17000	4.35	4.30	4.31	4.37	4.32	4.31	0.04	0.04	0.00	±0.3
21400	4.37	4.32	4.33	4.40	4.34	4.33	0.06	0.04	0.00	±0.3
27200	4.37	4.32	4.33	4.38	4.33	4.33	0.02	0.02	0.00	±0.3
34400	4.37	4.33	4.34	4.38	4.34	4.33	0.02	0.02	-0.02	±0.3
40000	4.36	4.32	4.33	4.38	4.34	4.33	0.04	0.04	0.00	±0.3
43600	4.35	4.32	4.32	4.36	4.33	4.31	0.02	0.02	-0.02	±0.3
55400	4.33	4.30	4.31	4.35	4.32	4.31	0.04	0.04	0.00	±0.3
70000	4.32	4.29	4.30	4.35	4.30	4.30	0.06	0.02	0.00	±0.3
88800	4.31	4.28	4.29	4.33	4.29	4.29	0.04	0.02	0.00	±0.3
112400	4.29	4.27	4.27	4.31	4.28	4.28	0.04	0.02	0.02	±0.3
142400	4.27	4.25	4.25	4.30	4.26	4.25	0.06	0.02	0.00	±0.3
161750	4.25	4.23	4.23	4.28	4.24	4.24	0.06	0.02	0.02	±0.3
180400	4.24	4.22	4.22	4.27	4.23	4.23	0.06	0.02	0.02	±0.3
228400	4.21	4.18	4.18	4.23	4.19	4.19	0.04	0.02	0.02	±0.3
289400	4.16	4.14	4.15	4.19	4.15	4.15	0.06	0.02	0.00	±0.3
366400	4.12	4.10	4.11	4.14	4.12	4.11	0.04	0.04	0.00	±0.3
400000	4.10	4.08	4.09	4.13	4.10	4.09	0.06	0.04	0.00	±0.3
464000	4.08	4.05	4.06	4.10	4.06	4.06	0.04	0.02	0.00	±0.3
587800	4.03	4.01	4.01	4.04	4.02	4.02	0.02	0.02	0.02	±0.3
744200	3.98	3.96	3.96	3.99	3.97	3.97	0.02	0.02	0.02	±0.3
942600	3.96	3.95	3.95	3.98	3.96	3.96	0.04	0.02	0.02	±0.3
1193600	3.93	3.92	3.92	3.95	3.93	3.93	0.04	0.02	0.02	±0.3
1511600	3.92	3.91	3.91	3.94	3.92	3.92	0.04	0.02	0.02	±0.3
1914400	3.90	3.89	3.89	3.92	3.90	3.90	0.04	0.02	0.02	±0.3
2424400	3.89	3.88	3.88	3.90	3.88	3.88	0.02	0.00	0.00	±0.3
3070200	3.86	3.85	3.85	3.88	3.87	3.87	0.04	0.05	0.05	±0.3
3888000	3.81	3.80	3.80	3.82	3.81	3.81	0.02	0.02	0.02	±0.3
4000000	3.81	3.79	3.79	3.82	3.81	3.80	0.02	0.05	0.02	±0.3
4923800	3.74	3.73	3.73	3.75	3.74	3.74	0.02	0.02	0.02	±0.3
6235400	3.61	3.60	3.60	3.62	3.61	3.60	0.02	0.02	0.00	±0.3
7896400	3.49	3.48	3.48	3.49	3.50	3.48	0.00	0.05	0.00	±0.3
10000000	3.35	3.35	3.35	3.35	3.36	3.36	0.00	0.03	0.03	±0.3

SPEAG H-field frequency response tolerance criteria¹:
±0.3dB for applied H-fields at calibration points from 3kHz to 10MHz

¹ Calibration uncertainty not taken into account (shared risk 50%).

Frequency Response, E-field, Channel 0

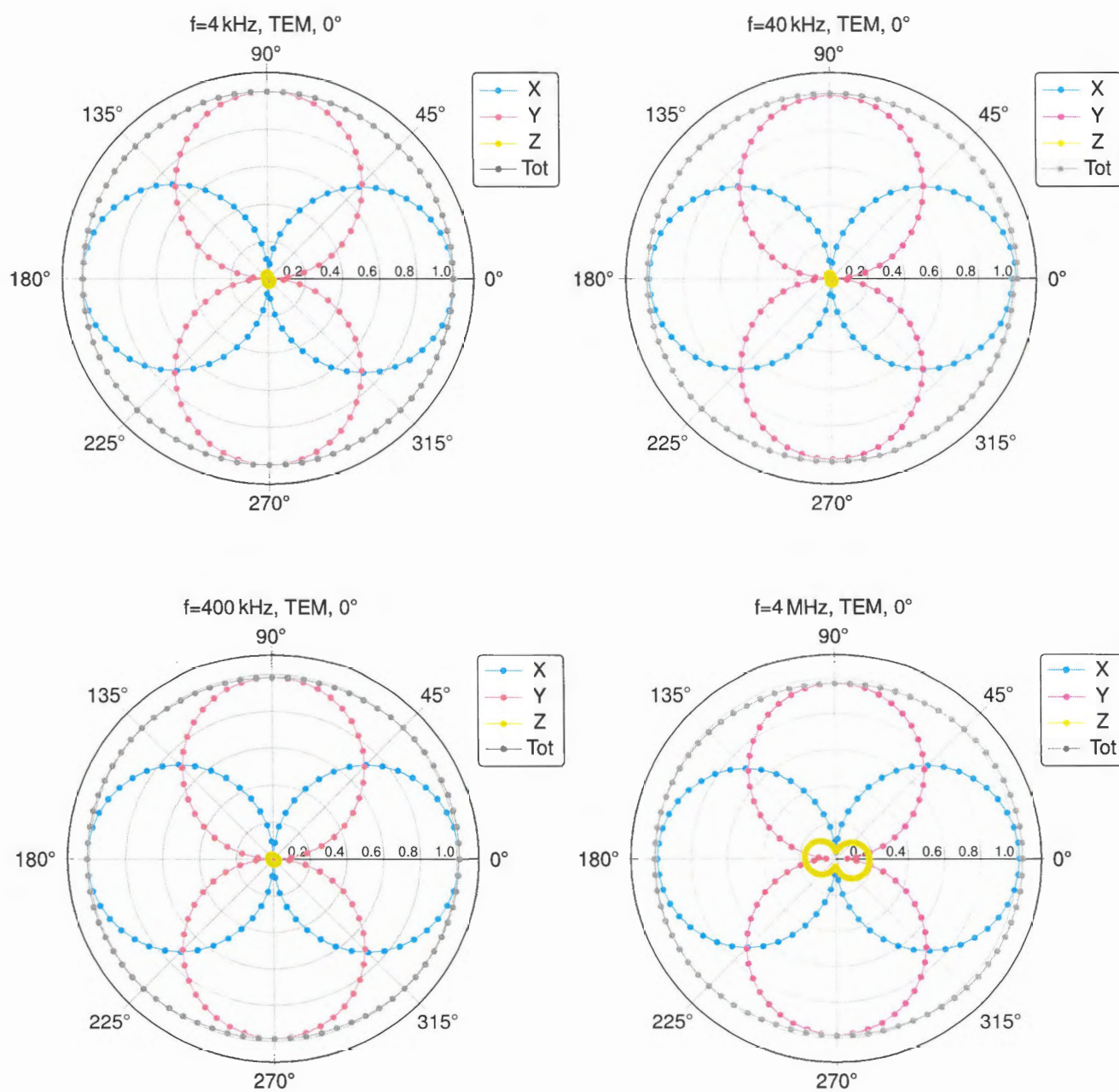
f/(Hz)	E-field/(V/m) Applied			E-field/(V/m) Reading			Difference/(dB)			Tolerance/(dB)
	x	y	z	x	y	z	x	y	z	
3000	165	165	167	165	165	167	0.00	0.00	0.00	±0.3
3200	164	164	171	165	165	170	0.05	0.05	-0.05	±0.3
4000	169	169	163	169	169	163	0.00	0.00	0.00	±0.3
5200	165	165	165	164	165	166	-0.05	0.00	0.05	±0.3
6600	171	171	167	170	171	167	-0.05	0.00	0.00	±0.3
8200	159	159	163	158	159	163	-0.05	0.00	0.00	±0.3
9000	167	167	167	168	168	168	0.05	0.05	0.05	±0.3
10600	168	168	164	168	168	165	0.00	0.00	0.05	±0.3
13400	165	165	165	165	164	166	0.00	-0.05	0.05	±0.3
17000	163	163	166	164	164	166	0.05	0.05	0.00	±0.3
21400	166	166	166	167	167	166	0.05	0.05	0.00	±0.3
27200	164	164	165	164	165	165	0.00	0.05	0.00	±0.3
34400	167	167	164	167	167	165	0.00	0.00	0.05	±0.3
40000	168	168	166	168	168	166	0.00	0.00	0.00	±0.3
43600	167	167	166	167	167	166	0.00	0.00	0.00	±0.3
55400	167	167	167	168	167	167	0.05	0.00	0.00	±0.3
70000	166	166	166	167	166	166	0.05	0.00	0.00	±0.3
88800	167	167	167	168	167	167	0.05	0.00	0.00	±0.3
112400	168	168	168	168	168	168	0.00	0.00	0.00	±0.3
142400	168	168	168	169	169	168	0.05	0.05	0.00	±0.3
161750	168	168	169	169	169	169	0.05	0.05	0.00	±0.3
180400	170	170	169	170	170	169	0.00	0.00	0.00	±0.3
228400	170	170	170	170	170	170	0.00	0.00	0.00	±0.3
289400	171	171	171	172	171	171	0.05	0.00	0.00	±0.3
366400	173	173	172	173	173	172	0.00	0.00	0.00	±0.3
400000	173	173	173	173	173	173	0.00	0.00	0.00	±0.3
464000	174	174	174	174	174	174	0.00	0.00	0.00	±0.3
587800	175	175	175	175	175	175	0.00	0.00	0.00	±0.3
744200	175	175	175	175	175	175	0.00	0.00	0.00	±0.3
942600	176	176	175	176	176	175	0.00	0.00	0.00	±0.3
1193600	176	176	175	176	176	175	0.00	0.00	0.00	±0.3
1511600	175	175	174	175	175	174	0.00	0.00	0.00	±0.3
1914400	174	174	174	175	175	174	0.05	0.05	0.00	±0.3
2424400	174	174	173	174	174	173	0.00	0.00	0.00	±0.3
3070200	174	174	173	174	174	173	0.00	0.00	0.00	±0.3
3888000	174	174	173	174	174	173	0.00	0.00	0.00	±0.3
4000000	174	174	173	174	174	173	0.00	0.00	0.00	±0.3
4923800	175	175	174	175	175	174	0.00	0.00	0.00	±0.3
6235400	177	177	176	177	177	176	0.00	0.00	0.00	±0.3
7896400	182	182	181	182	182	181	0.00	0.00	0.00	±0.3
10000000	191	191	190	191	191	190	0.00	0.00	0.00	±0.3

SPEAG E-field frequency response tolerance criteria¹:
±0.3dB for applied E-fields at calibration points from 3kHz to 10MHz

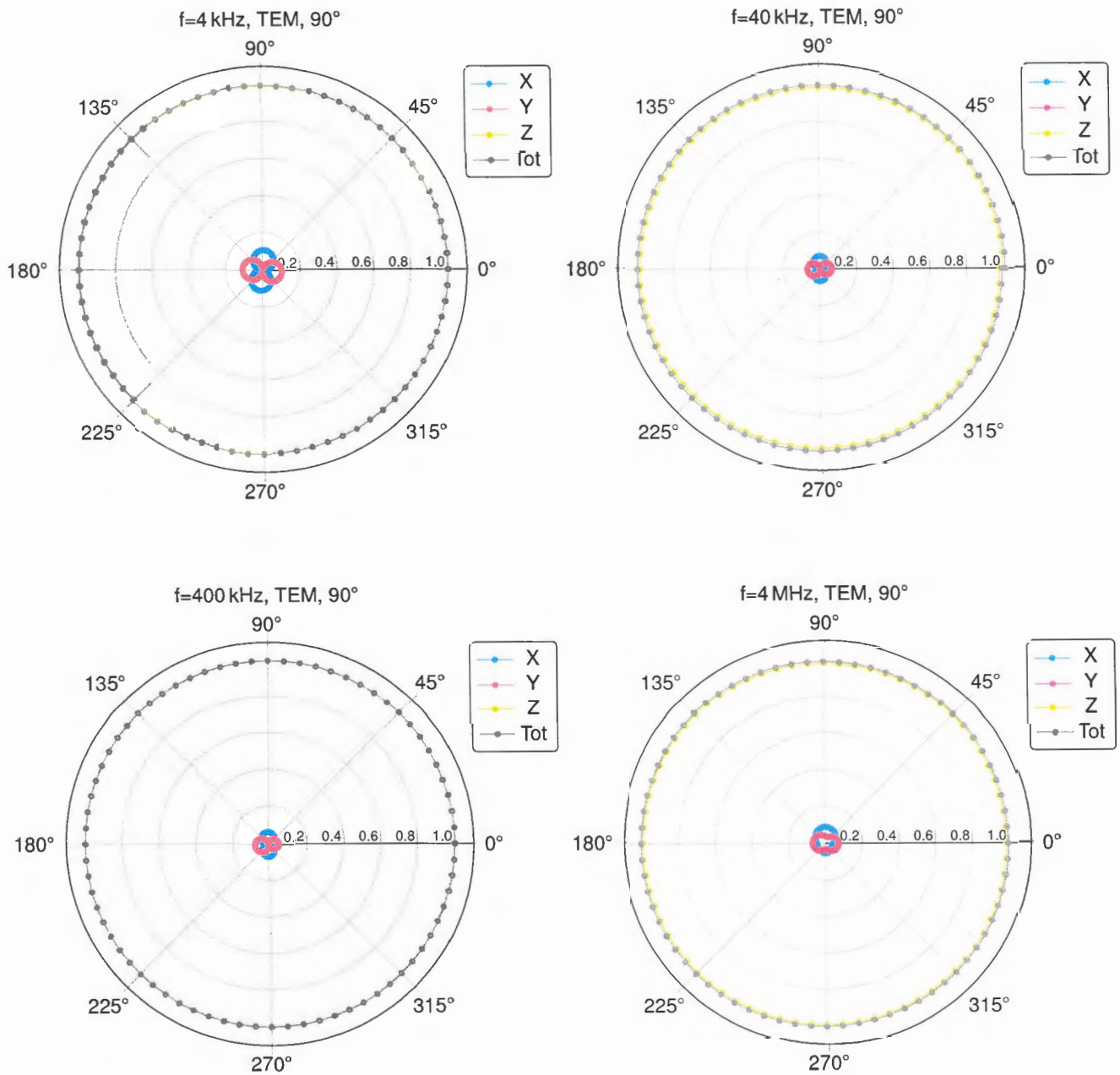
¹ Calibration uncertainty not taken into account (shared risk 50%).

Isotropy H-Field

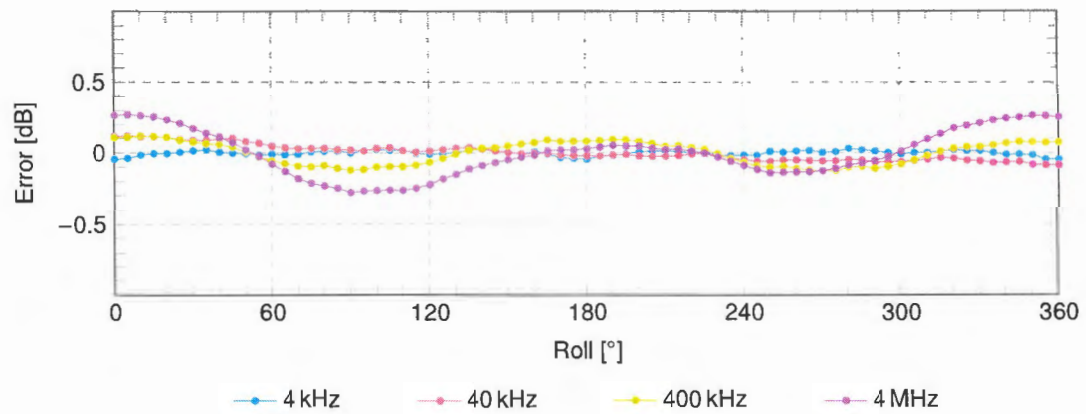
H-Field Receiving Pattern (ϕ), $\vartheta = 0^\circ$



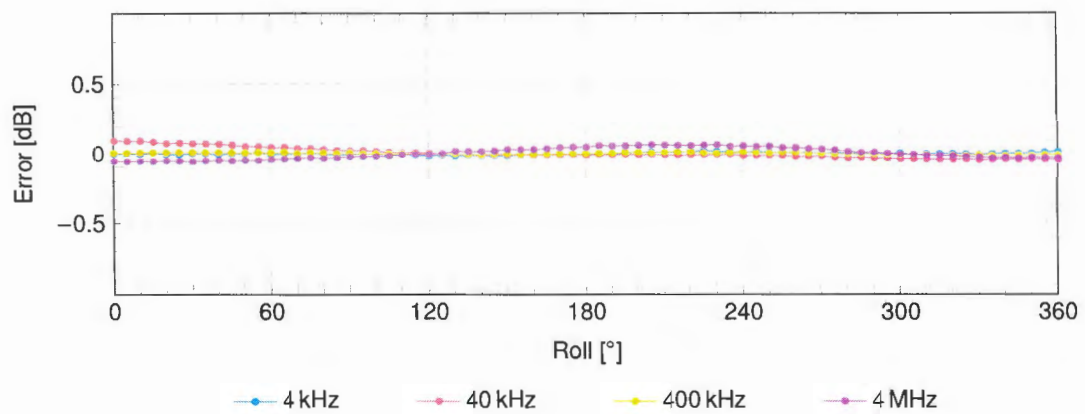
H-Field Receiving Pattern (ϕ), $\vartheta = 90^\circ$



H-Field Receiving Pattern (ϕ), $\vartheta = 0^\circ$



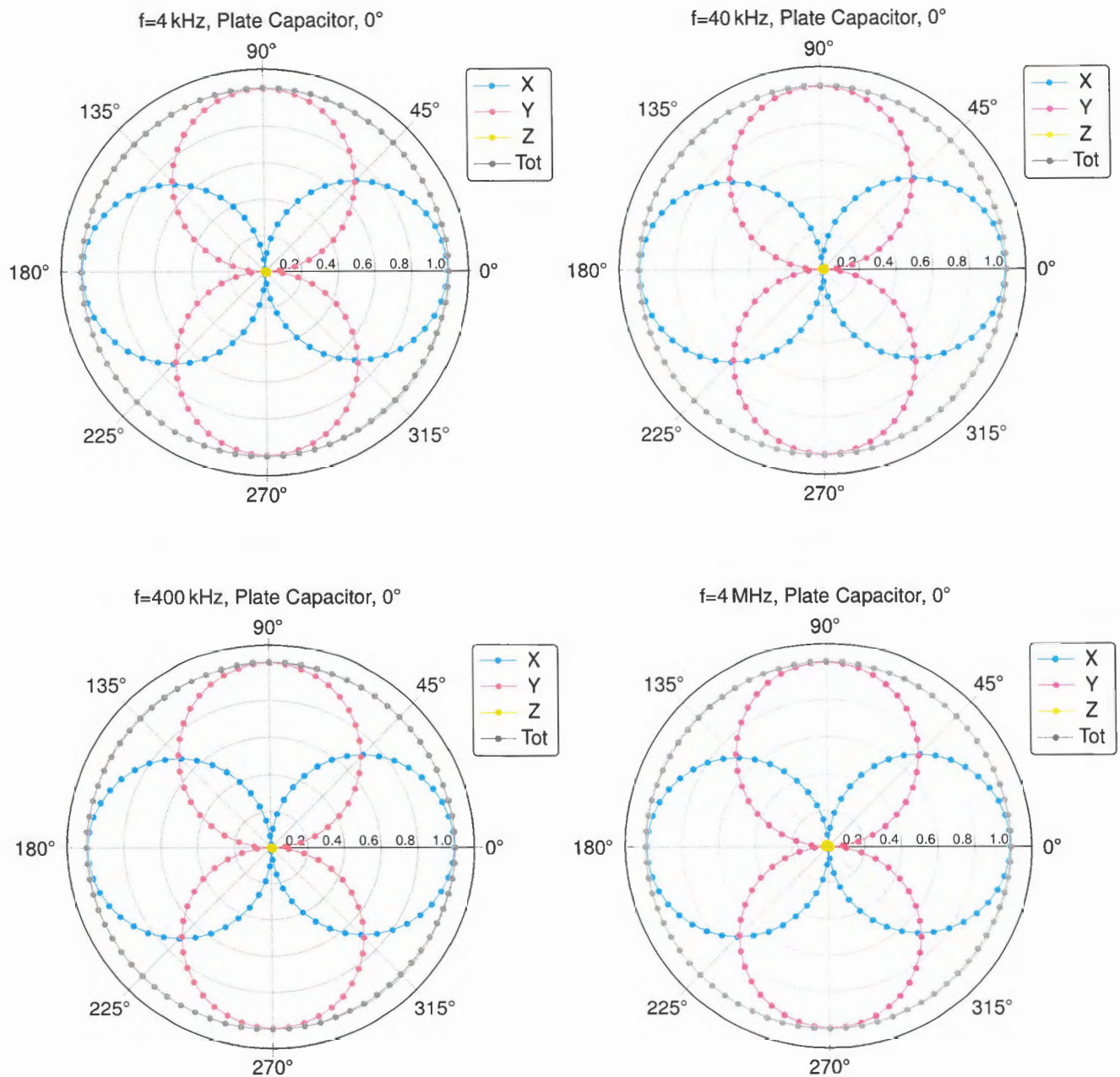
H-Field Receiving Pattern (ϕ), $\vartheta = 90^\circ$



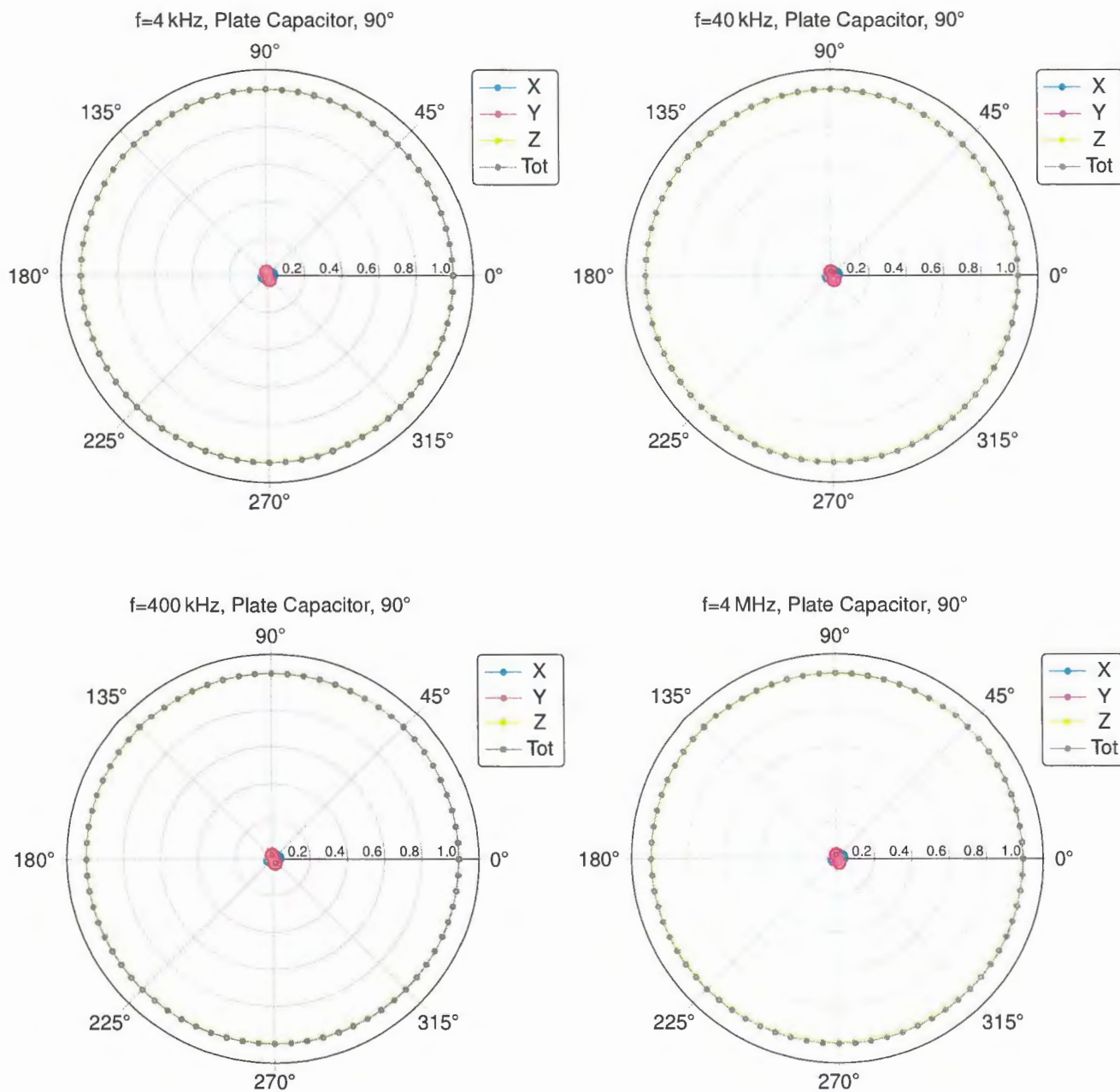
SPEAG axial deviation from the ideal response tolerance for H-field: ± 0.6 dB

Isotropy E-Field

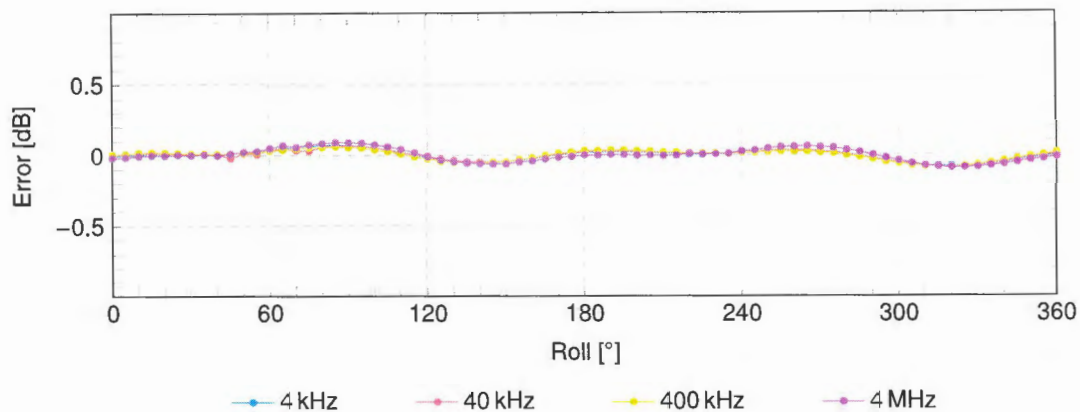
E-Field Receiving Pattern (ϕ), $\vartheta = 0^\circ$



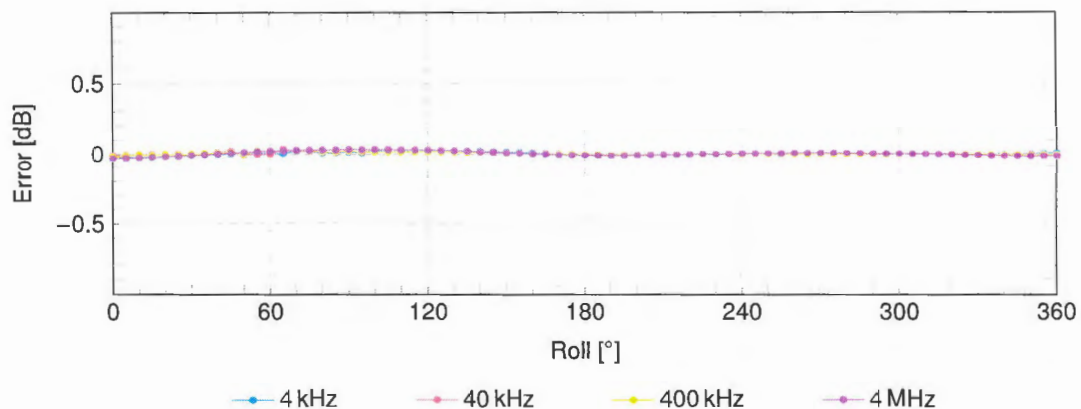
E-Field Receiving Pattern (ϕ), $\vartheta = 90^\circ$



E-Field Receiving Pattern (ϕ), $\vartheta = 0^\circ$



E-Field Receiving Pattern (ϕ), $\vartheta = 90^\circ$



SPEAG axial deviation from the ideal response tolerance for E-field: ± 0.8 dB

Client **CTC Advanced**
Saarbrücken, Germany

Certificate No: **V-Coil50/400-1021_Nov23**

CALIBRATION CERTIFICATE

Object **V-Coil50/400 - SN: 1021**

Calibration procedure(s) **QA CAL-47.v2**
Calibration Procedure for WPT Verification & Validation Sources

Calibration date: **November 2, 2023**

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
MAGPy-8H3D+E3D/DAS	SN: 3065/3056	06-Apr-23 (MAGPy-8H3D+E3D-3065)	Apr-24

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
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	Name	Function	Signature
Calibrated by:	Jingtian Xi	Project Leader	
Approved by:	Sven Kühn	Technical Manager	

Issued: November 3, 2023

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

Glossary:

WPT	wireless power transfer
V&V	verification & validation

Calibration is Performed According to the Following Standards:

- Internal procedure QA CAL-47 Calibration procedure for WPT verification & validation sources from 3 kHz to 10 MHz
- IEC/IEEE 63164, "Assessment methods of the human exposure to electric and magnetic fields from wireless power transfer systems – Models, instrumentation, measurement and computational methods and procedures (Frequency range 3 kHz to 30 MHz)", draft standard, 2023

Additional Documentation:

- a) cDASY6/DASY8 Module WPT Manual

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* The V&V source is switched on for at least 30 minutes.
- *Source Positioning:* The V&V source is placed in the center of the UniPV1 phantom such that the source surface is parallel to phantom surface. The probe location used for DUT teaching is the top center of the coil (marked on the source casing). The probe distance is verified using mechanical gauges placed on the source surface.
- *H-field distribution:* H-field is measured in the volume above the V&V source in a rectilinear grid with a uniform grid step of 7.33 mm.

Calibrated Quantity

- Local peak H-field at d mm

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%.

Measurement Conditions

Software version	cDASY6 Module WPT	2.2.0
	Notebook GUI	2.2.0
	Sim4Life	7.2.4
Scan setup	Grid dimensions	x: 169 mm, y: 169 mm, z: 36.7 mm
	Grid resolutions	dx, dy, dz: 7.33 mm
Distance (relative to source surface)	0 mm	
Frequency	400 kHz	

Calibrated Quantities

Distance (relative to source surface) (mm)	Peak H-field (A/m)	Uncertainty (k=2) (dB)
0	280	1.13

Appendix (Additional assessments outside the scope of SCS 0108)

Peak values of induced fields¹

Distance (relative to source surface) (mm)	Induced peak current density, 1cm ² area avg. (A/m ²)	Induced peak E-field (V/m)		peak spatial SAR (mW/kg)	
		2mm cube avg.	5mm line avg.	1g avg.	10g avg.
0	2.79	4.42	4.53	7.67	3.79

Voltage measurement

Total voltage (V)	Voltages at harmonics (dBc)
0.4133	Highest harmonic: -21.76 2 nd highest harmonic: -31.64

¹ determined for a virtual half-space phantom with tissue properties $\epsilon_r = 55$, $\sigma = 0.75$ S/m, $\rho = 1000$ kg/m³

Measurement report

cDASY6 Module WPT Measurement Report

Device under test

Info:
V-Coil50/400

Serial number:
1021

Scenario:
source calibration

Tool info

DASY software version:
cDASY6 Module WPT 2.2.0.3801

Probe model, serial no. and configuration date:
MAGPy-8H3D+E3Dv2, WP000030, 2023/06/16

Software version:
2.0.39, backend: 0.9.2

Scan info

Center location:
x: -9.27 mm, y: 71.92 mm, z: 85.67 mm

Dimensions:
x: 80.7 mm, y: 80.7 mm, z: 36.7 mm

Resolution:
x: 7.33 mm, y: 7.33 mm, z: 7.33 mm

Completed on:
2023/11/02 18:51:36

Measurement results

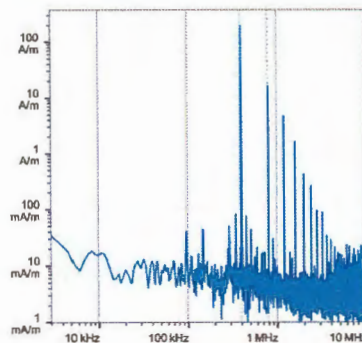
Maximum H-field [RMS]:
MAGNITUDE: 142.78 A/m
x: 27.99 A/m, y: 19.03 A/m, z: 138.71 A/m

Maximum H-field location relative to DUT:
x: 3.67 mm, y: 3.67 mm, z: 8.00 mm

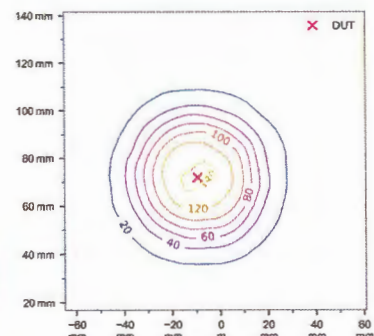
Distance to -20.0 dB boundary:
36.67 mm

Offset relative to DUT:
x: 0.00 m, y: 0.00 m, z: 500.00 μ m

H-field magnitude [RMS] at maximum location



H-field magnitude [RMS] at lowest plane



Incident fields, and induced quantities in the anatomical model (f = 400.00 kHz, $\sigma = 0.750$ S/m, tissue density = 1,000 kg/m³)

Distance [mm]	Peak incident fields H _{inc} [A/m, rms]	Peak E _{ind} [V/m, rms]			Peak J _{ind} [A/m ² , rms]	psSAR [mW/kg]		H-field extent -20 dB radius [mm]	Errors		
		Cube avg.	Local	Line avg.		1g avg.	10g avg.		Sign	Vector potential	Boundary effect
0.0	280.0	4.42	4.54	4.53	2.79	7.67	3.79	38.7	1%	8%	23%

Standard compliance evaluation (with multi-frequency enhancement, total field evaluation)

Distance [mm]	ICNIRP 2010/2020 [dB]			ICNIRP 1998 [dB]			IEEE 2019 [dB]			FCC [dB]			HC Code 6 [dB]		
	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak J _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR
0.0	27.2	-19.8	-27.2	43.7	13.1	-27.2	9.8	-23.4	-27.2	44.7	-19.8	-23.2	43.7	-19.6	-23.2

Standard compliance evaluation (coverage factor-adjusted) (with multi-frequency enhancement, total field evaluation)

Distance [mm]	ICNIRP 2010/2020 [dB]			ICNIRP 1998 [dB]			IEEE 2019 [dB]			FCC [dB]			HC Code 6 [dB]		
	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak J _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR	Peak H _{inc}	Peak E _{ind}	psSAR
0.0	27.2	-6.7	-27.2	43.7	13.1	-27.2	9.8	-15.2	-27.2	44.7	-6.7	-23.2	43.7	-3.6	-23.2

Coverage factors: $W_{E_{ind}, \text{code avg.}} = [5.381]$, $W_{E_{ext}, \text{line avg.}} = [2.949]$

Document generated at 2023/11/02 18:56:24, simulation performed at 2023/11/02 18:53:41 using Sim4Life version 7.2.4.14019

Appendix to Test Report No.: 1-8581-24-01-17_TR2-R01 (SAR)

Testing Laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
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**Appendix with Calibration data, Phantom certificate and system check
information for SAR from 30 MHz to 6 GHz**

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2 Calibration report “Probe EX3DV4” – SN: 7566

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



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S Servizio svizzero di taratura
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Cetecom Advanced**
Saarbrücken, Germany

Certificate No. **EX-7566_Aug24**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7566**

Calibration procedure(s) **QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6,
QA CAL-25.v8
Calibration procedure for dosimetric E-field probes**

Calibration date **August 12, 2024**

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 NRP2	SN: 104778	26-Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
OCP DAK-3.5 (weighted)	SN: 1249	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	26-Mar-24 (No. 217-04046)	Mar-25
DAE4	SN: 660	23-Feb-24 (No. DAE4-660_Feb24)	Feb-25
Reference Probe EX3DV4	SN: 7349	03-Jun-24 (No. EX3-7349_Jun24)	Jun-25

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-24)	in house check: Jun-26
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-24)	in house check: Jun-26
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-24)	in house check: Jun-26
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-24)	in house check: Jun-26
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	in house check: Oct-24

	Name	Function	Signature
Calibrated by	Krešimir Franjić	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: August 12, 2024			

**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

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 ψ	ψ 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:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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. 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:7566

August 12, 2024

Parameters of Probe: EX3DV4 - SN:7566**Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.66	0.48	0.54	$\pm 10.1\%$
DCP (mV) ^B	101.2	101.4	101.7	$\pm 4.7\%$

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc ^E k = 2
0	CW	X	0.00	0.00	1.00	0.00	118.3	$\pm 2.4\%$	$\pm 4.7\%$
		Y	0.00	0.00	1.00		144.9		
		Z	0.00	0.00	1.00		131.4		
10352	Pulse Waveform (200Hz, 10%)	X	20.00	93.70	22.40	10.00	60.0	$\pm 2.9\%$	$\pm 9.6\%$
		Y	20.00	88.15	18.93		60.0		
		Z	20.00	93.82	22.06		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	20.00	94.73	21.96	6.99	80.0	$\pm 1.4\%$	$\pm 9.6\%$
		Y	20.00	89.52	18.61		80.0		
		Z	20.00	97.68	22.85		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	20.00	98.17	22.38	3.98	95.0	$\pm 1.2\%$	$\pm 9.6\%$
		Y	20.00	93.80	19.51		95.0		
		Z	20.00	103.73	24.29		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	20.00	102.36	23.10	2.22	120.0	$\pm 1.1\%$	$\pm 9.6\%$
		Y	20.00	101.25	21.87		120.0		
		Z	20.00	108.91	25.25		120.0		
10387	QPSK Waveform, 1 MHz	X	1.66	64.65	14.22	1.00	150.0	$\pm 2.0\%$	$\pm 9.6\%$
		Y	1.65	66.77	15.19		150.0		
		Z	1.61	64.58	14.08		150.0		
10388	QPSK Waveform, 10 MHz	X	2.15	66.64	14.84	0.00	150.0	$\pm 1.1\%$	$\pm 9.6\%$
		Y	2.17	67.86	15.80		150.0		
		Z	2.10	66.46	14.76		150.0		
10396	64-QAM Waveform, 100 kHz	X	2.93	69.77	18.26	3.01	150.0	$\pm 0.8\%$	$\pm 9.6\%$
		Y	2.62	70.07	18.87		150.0		
		Z	2.76	69.01	17.94		150.0		
10399	64-QAM Waveform, 40 MHz	X	3.51	66.68	15.40	0.00	150.0	$\pm 0.9\%$	$\pm 9.6\%$
		Y	3.47	67.05	15.60		150.0		
		Z	3.47	66.55	15.35		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	4.74	64.80	14.98	0.00	150.0	$\pm 1.9\%$	$\pm 9.6\%$
		Y	4.78	65.66	15.57		150.0		
		Z	4.91	65.50	15.36		150.0		

Note: For details on UID parameters see Appendix

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 E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Linearization parameter uncertainty for maximum specified field strength.

^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:7566

August 12, 2024

Parameters of Probe: EX3DV4 - SN:7566**Sensor Model Parameters**

	C1 fF	C2 fF	α V^{-1}	T1 $ms V^{-2}$	T2 $ms V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
x	51.8	384.31	34.98	19.96	0.04	5.10	1.28	0.25	1.01
y	38.3	283.87	35.09	15.62	0.00	5.04	1.63	0.02	1.01
z	48.8	364.87	35.47	11.25	0.04	5.09	1.08	0.26	1.01

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-70.5°
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	1.4 mm

Note: Measurement distance from surface can be increased to 3–4 mm for an Area Scan job.

EX3DV4 - SN:7566

August 12, 2024

Parameters of Probe: EX3DV4 - SN:7566**Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) ^C	Relative Permittivity ^F	Conductivity ^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc ^H (k = 2)
750	41.9	0.89	10.31	10.08	9.25	0.35	1.27	±11.0%
850	41.5	0.92	10.03	9.81	9.01	0.35	1.27	±11.0%
900	41.5	0.97	9.95	9.73	8.93	0.35	1.27	±11.0%
1750	40.1	1.37	8.41	8.22	7.55	0.35	1.27	±11.0%
1900	40.0	1.40	8.13	7.95	7.30	0.35	1.27	±11.0%
2450	39.2	1.80	7.67	7.50	6.89	0.35	1.27	±11.0%
2600	39.0	1.96	7.74	7.57	6.95	0.35	1.27	±11.0%
3300	38.2	2.71	6.82	6.67	6.12	0.34	1.27	±13.1%
3500	37.9	2.91	6.89	6.74	6.19	0.34	1.27	±13.1%
3700	37.7	3.12	6.89	6.74	6.18	0.34	1.27	±13.1%
3900	37.5	3.32	6.72	6.57	6.04	0.34	1.27	±13.1%
5200	36.0	4.66	5.62	5.50	5.05	0.31	1.39	±13.1%
5300	35.9	4.76	5.63	5.51	5.06	0.30	1.38	±13.1%
5500	35.6	4.96	5.26	5.15	4.72	0.28	1.36	±13.1%
5600	35.5	5.07	5.07	4.96	4.55	0.27	1.35	±13.1%
5800	35.3	5.27	5.06	4.95	4.54	0.26	1.34	±13.1%

^C Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ±10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4–9 MHz, and ConvF assessed at 13 MHz is 9–19 MHz. Above 5 GHz frequency validity can be extended to ±110 MHz.

^F The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10% if SAR correction is applied.

^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.

^H The stated uncertainty is the total calibration uncertainty (k = 2) of Norm ConvF. This is equivalent to the uncertainty component with the symbol CF in Table 9 of IEC/IEEE 62209-1528:2020.

EX3DV4 - SN:7566

August 12, 2024

Parameters of Probe: EX3DV4 - SN:7566**Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) ^C	Relative Permittivity ^F	Conductivity ^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc ^H (k = 2)
6500	34.5	6.07	5.52	5.40	4.96	0.20	1.27	±18.6%

^C Frequency validity at 6.5 GHz is ± 600 MHz, and ± 700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than $\pm 10\%$ from the target values (typically better than $\pm 6\%$) and are valid for TSL with deviations of up to $\pm 10\%$.

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than $\pm 1\%$ for frequencies below 3 GHz; below $\pm 2\%$ for frequencies between 3–6 GHz; and below $\pm 4\%$ for frequencies between 6–10 GHz at any distance larger than half the probe tip diameter from the boundary.

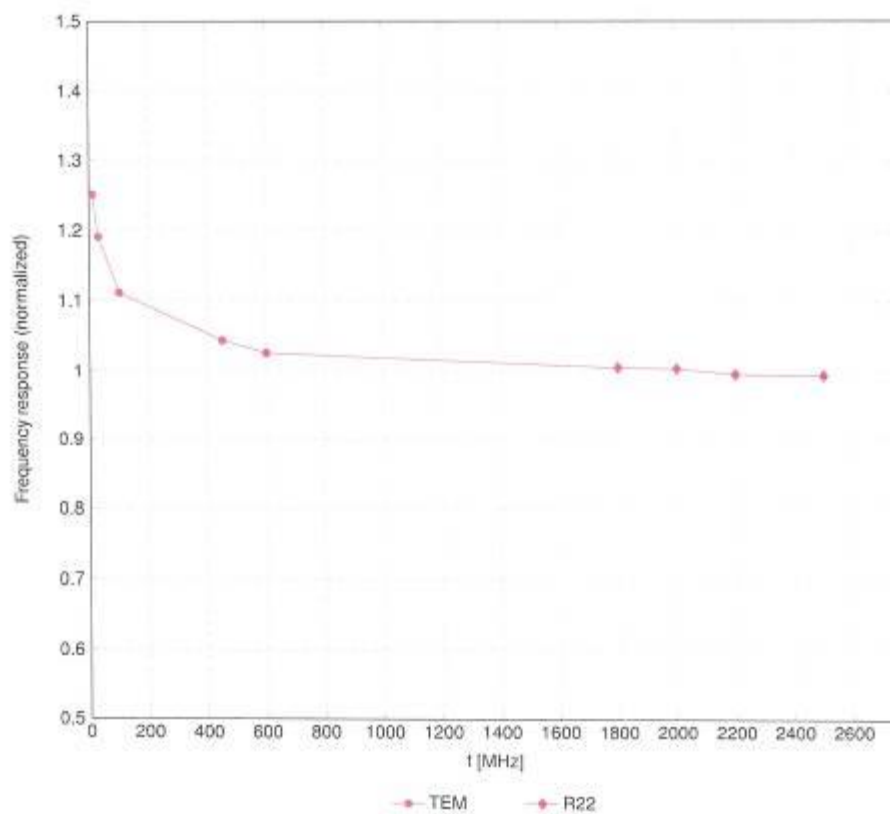
^H The stated uncertainty is the total calibration uncertainty (k = 2) of Norm ConvF. This is equivalent to the uncertainty component with the symbol CF in Table 9 of IEC/IEEE 62209-1528:2020.

EX3DV4 - SN:7566

August 12, 2024

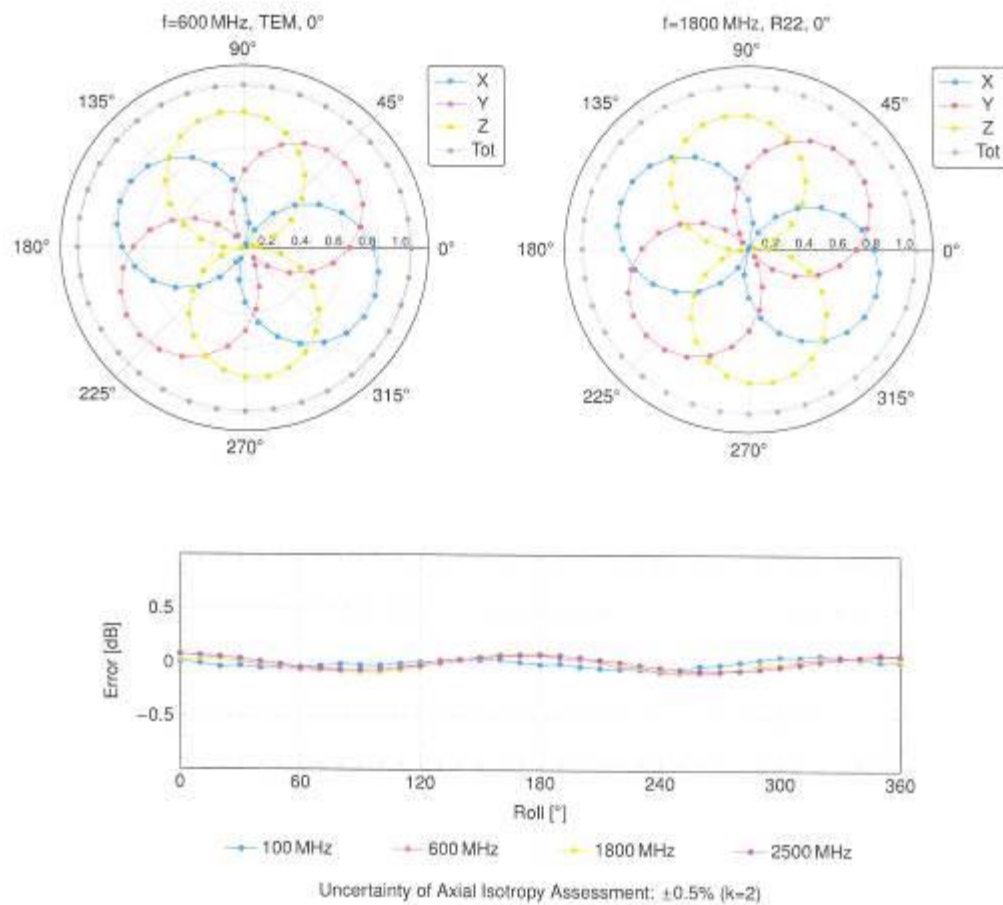
Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide:R22)

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

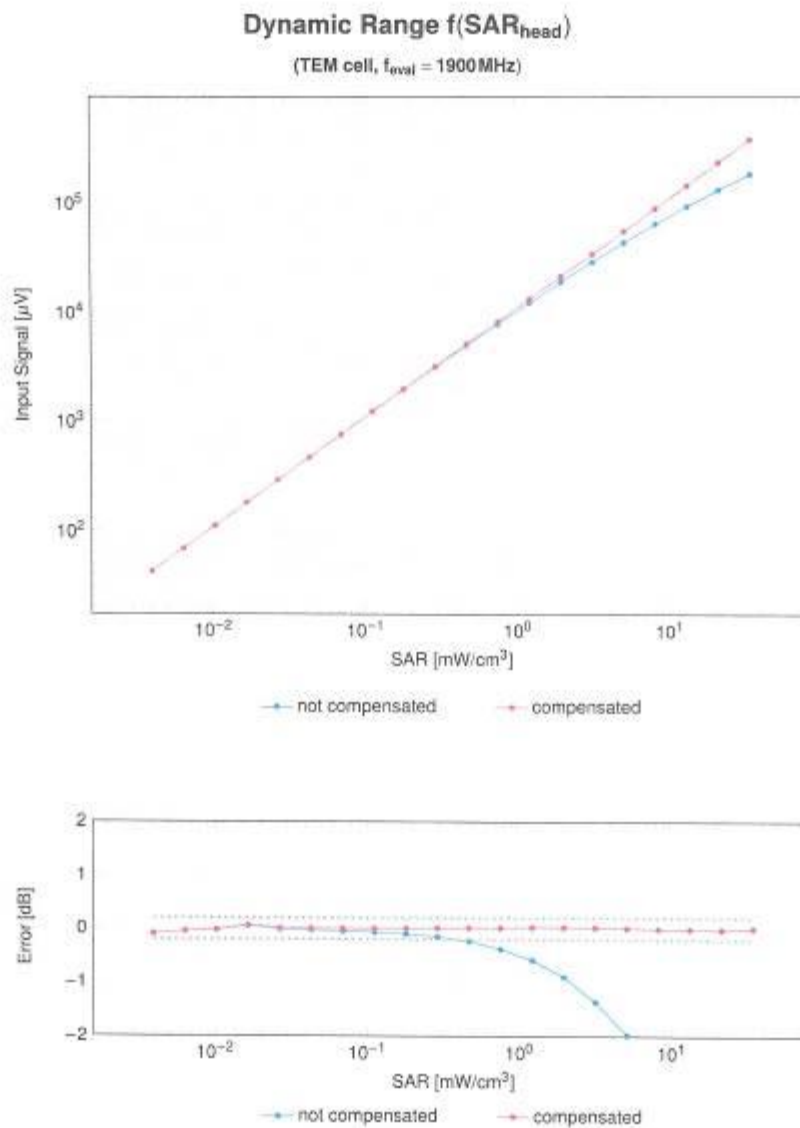
EX3DV4 - SN:7566

August 12, 2024

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

EX3DV4 - SN:7566

August 12, 2024

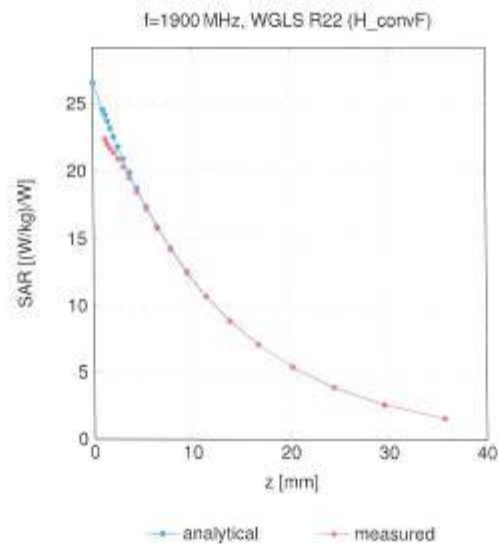


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

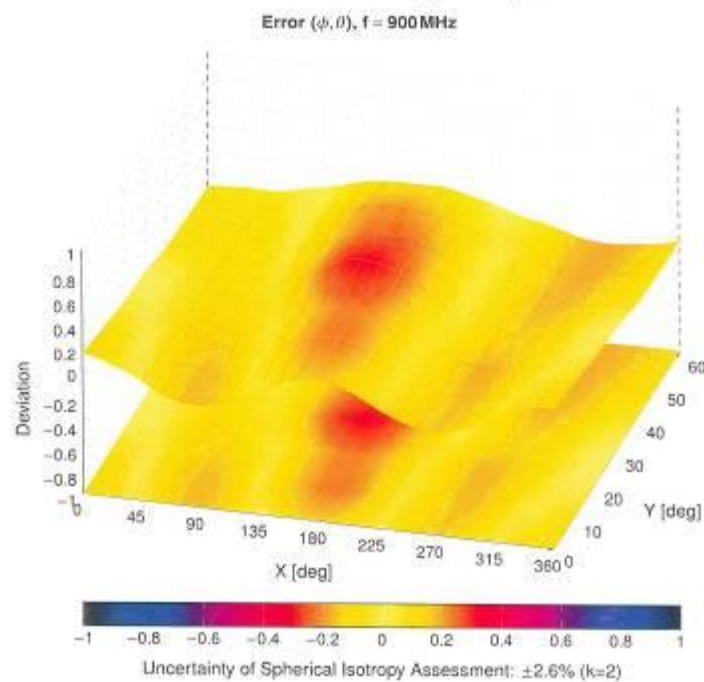
EX3DV4 - SN:7566

August 12, 2024

Conversion Factor Assessment



Deviation from Isotropy in Liquid



3 Calibration report "2450 MHz System validation dipole"

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client: **CTC advanced GmbH**

Certificate No.: **D2450V2-710_May22**

CALIBRATION CERTIFICATE

Object: **D2450V2 - SN:710**

Calibration procedure(s): **QA CAL-05.v11
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **May 11, 2022**

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 NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: B49394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	02-May-22 (No. DAE4-601_May22)	May-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-G5	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41090477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

Calibrated by:	Name: Aldonis Georgiadou	Function: Laboratory Technician	Signature: 
Approved by:	Name: Sven Kuhn	Function: Technical Manager	Signature: 

Issued: May 12, 2022

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

Certificate No.: D2450V2-710_May22

Page 1 of 8

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Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:** This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1:

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	38.2 $\pm$ 6 %	1.85 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	—	—

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.8 W/kg $\pm$ 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.1 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.5 $\pm$ 6 %	2.02 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	—	—

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.6 W/kg $\pm$ 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.95 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	$52.8 \Omega + 3.7 j\Omega$
Return Loss	- 26.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$49.3 \Omega + 4.3 j\Omega$
Return Loss	- 27.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:710

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 38.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 116.1 V/m; Power Drift = 0.02 dB

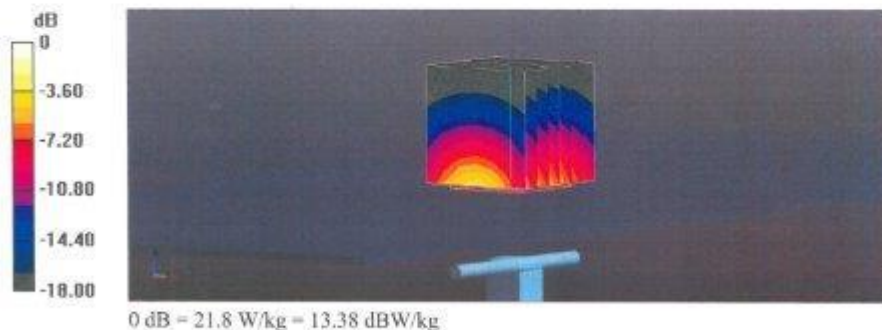
Peak SAR (extrapolated) = 26.3 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.09 W/kg

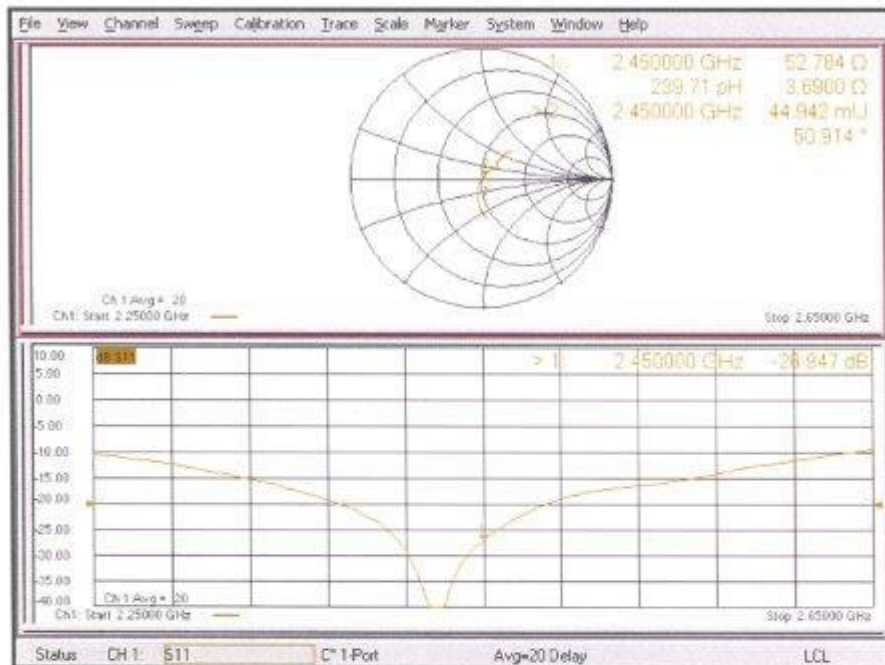
Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 50%

Maximum value of SAR (measured) = 21.8 W/kg

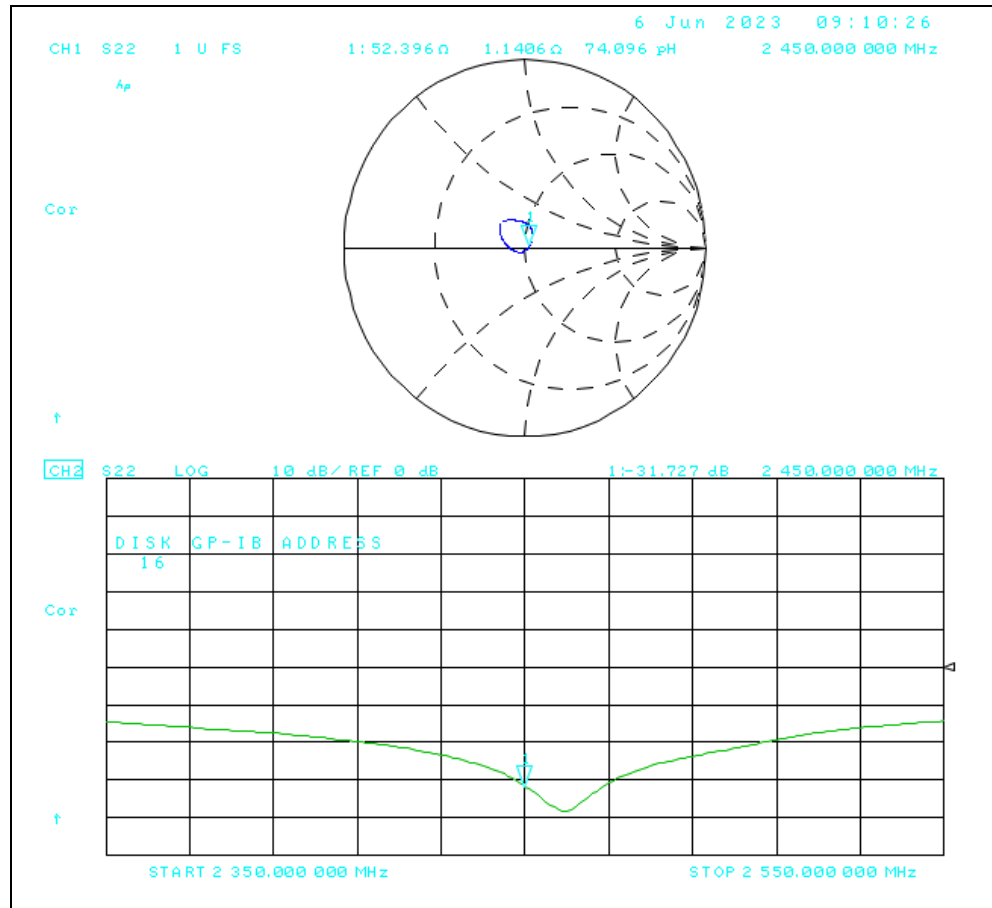


Impedance Measurement Plot for Head TSL



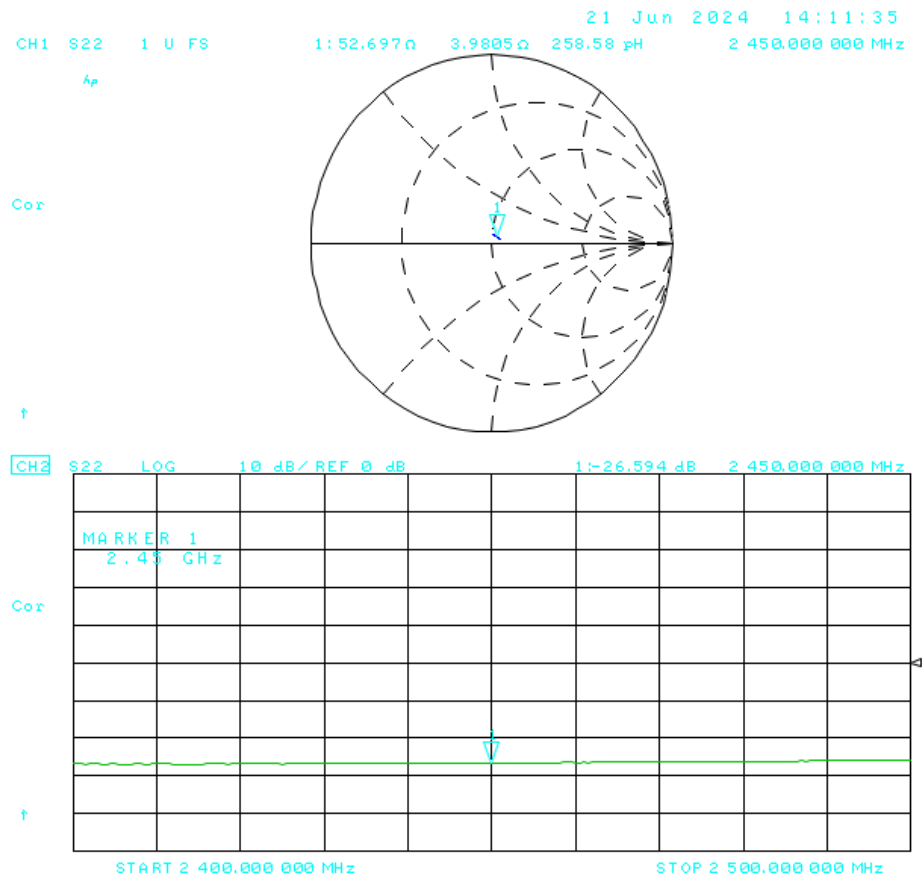
Antenna Parameters with Head TSL

	From cal. data	Measured 2023-06-06
Impedance; transformed to feed point	52.8 Ω + 3.7 j Ω	52.4 Ω + 1.1 j Ω
Return Loss	-26.9 dB	-31.7 dB



Antenna Parameters with Head TSL

	From cal. data	Measured 2024-06-21
Impedance; transformed to feed point	$52.8\Omega + 3.7j\Omega$	$52.7\Omega + 3.9j\Omega$
Return Loss	-26.9dB	-26.6dB



DASY5 Validation Report for Body TSL

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:710

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 51.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.8 V/m; Power Drift = -0.06 dB

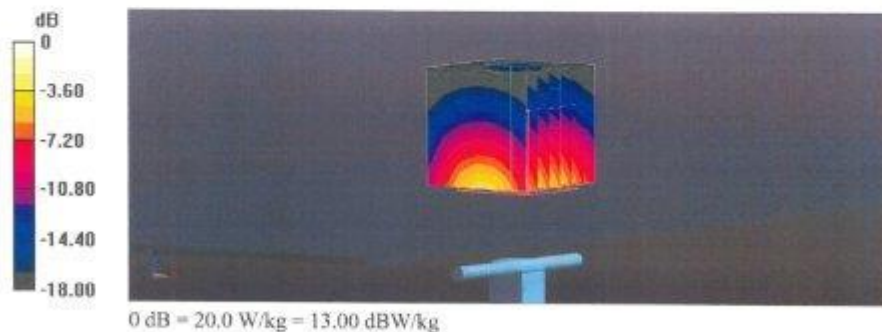
Peak SAR (extrapolated) = 24.0 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.95 W/kg

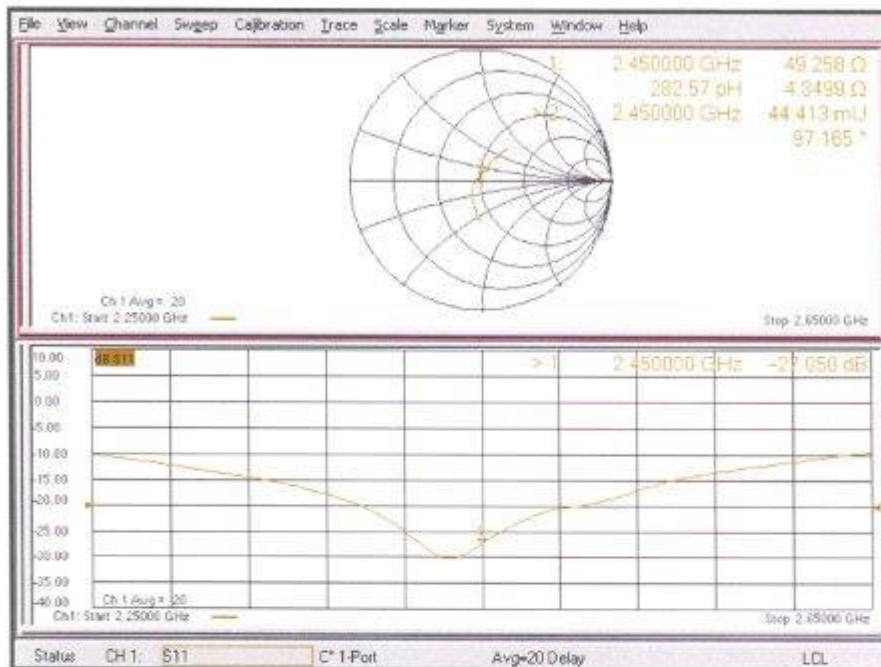
Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 54.1%

Maximum value of SAR (measured) = 20.0 W/kg



Impedance Measurement Plot for Body TSL



4 Calibration certificate of Data Acquisition Unit (DAE) – SN: 1387

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



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

Accreditation No.: **SCS 0108**

Client **Cetecom Advanced**
Saarbrücken - Germany

Certificate No: **DAE4-1387_Aug24**

CALIBRATION CERTIFICATE

Object: **DAE4 - SD 000 D04 BM - SN: 1387**

Calibration procedure(s): **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **August 08, 2024**

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
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-23 (No:37421)	Aug-24
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-24 (in house check)	In house check: Jan-25
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-24 (in house check)	In house check: Jan-25

Calibrated by: **Name**
Adrian Gehring **Function**
Laboratory Technician

Approved by: **Sven Kühn** **Technical Manager**

Signature



Issued: August 8, 2024

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

5 Certificate of "SAM Twin Phantom V4.0, V5.0, V8.0"

Schmid & Partner Engineering AG

s p e a g

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Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Certificate of Conformity / First Article Inspection

Item	SAM Twin Phantom V4.0 and V5.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the pre-series QD 000 P40 A, # TP-1001, on the series first article QD 000 P40 B # TP-1006. Certain parameters are retested on series items.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File *	First article, Samples
Material thickness of shell	2mm +/- 0.2mm in flat section, other locations: +/- 0.2mm with respect to CAD file	in flat section, in the cheek area	First article, Samples, TP-1314 ff.
Material thickness at ERP	6mm +/- 0.2mm at ERP		First article, All items
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05 , at $f \leq 6$ GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids.	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	< 1% for filling height up to 155 mm	Prototypes, Sample testing

* The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

** Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

- [1] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
- [2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- [3] IEC 62209-1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", 2005-02-18
- [4] IEC 62209-2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", 2010-03-30

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of **hand-held** SAR measurements and system performance checks as specified in [1 – 4] and further standards.

Date 25.07.2011

Signature / Stamp

s p e a g

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Doc No 881 – QD 000 P40 C – H

Page 1 (1)

Schmid & Partner Engineering AG

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Certificate of Conformity / First Article Inspection

Item	SAM Twin Phantom V8.0
Type No	QD 000 P41 A
Series No	TP-1912 and higher
Manufacturer	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the pre-series QD 000 P40 A, # TP-1001, on the series first article QD 000 P40 B # TP-1006. Certain parameters are retested on series items.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File *	First article, Samples
Material thickness of shell	2mm +/- 0.2mm in flat section, other locations: +/- 0.2mm with respect to CAD file	in flat section, in the cheek area	First article, Samples, TP-1314 ff.
Material thickness at ERP	6mm +/- 0.2mm at ERP		First article, All items
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05 , at $f \leq 6$ GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids.	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	< 1% for filling height up to 155 mm	Prototypes, Sample testing

* The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

** Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

- [1] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- [2] IEEE 1528-2013, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, June 2013"
- [3] IEC 62209-1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine 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
- [4] IEC 62209-2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of **hand-held** SAR measurements and system performance checks as specified in [1 – 4] and further standards.

Date

10.06.2015

Signature / Stamp


s p e a g

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Doc No 881 – QD 000 P41 A – A

Page 1 (1)

6 Certificate of "ELI Phantom V8.0"

Schmid & Partner Engineering AG

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Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI v8.0
Type No	QD OVA 004 A
Series No	2048 and higher
Manufacturer	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the prototype units QD OVA 001 A, pre-series units QD OVA 001 B as well as on some series units QD OVA 001 B, QD OVA 003 A and QD OVA 004A.

Test	Requirement	Details	Units tested
Shape	Internal dimensions, depth and sagging are compatible with standards	Bottom elliptical 600 x 400 mm, Depth 190 mm, dimension compliant with [1] for $f > 375$ MHz	Prototypes
Material thickness	Bottom: 2.0mm +/- 0.2mm	dimension compliant with [3] for $f > 800$ MHz	all
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05 , at $f \leq 6$ GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids .	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	within tolerance for filling height up to 155 mm	Prototypes, samples

** Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

- [1] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- [2] IEEE 1528-2013, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, June 2013"
- [3] IEC 62209-1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine 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
- [4] IEC 62209-2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of **body-worn** SAR measurements and system performance checks as specified in [1 – 4] and further standards.

Date 10.06.2016

s p e a g

Signature / Stamp

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7 Application Note System Performance Check

7.1 Purpose of system performance check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check is performed prior to any usage of the system in order to guarantee reproducible results.

The measurement of the Specific Absorption Rate (SAR) is a complicated task and the result depends on the proper functioning of many components and the correct settings of many parameters. Faulty results due to drift, failures or incorrect parameters might not be recognized, since they often look similar in distribution to the correct ones. The Dosimetric Assessment System DASY incorporates a system performance check procedure to test the proper functioning of the system. The system performance check uses normal SAR measurements in a simplified setup (the flat section of the SAM Twin Phantom) with a well characterized source (a matched dipole at a specified distance). This setup was selected to give a high sensitivity to all parameters that might fail or vary over time (e.g., probe, liquid parameters, and software settings) and a low sensitivity to external effects inherent in the system (e.g., positioning uncertainty of the device holder). The system performance check does not replace the calibration of the components. The accuracy of the system performance check is not sufficient for calibration purposes. It is possible to calculate the field quite accurately in this simple setup; however, due to the open field situation some factors (e.g., laboratory reflections) cannot be accounted for. Calibrations in the flat phantom are possible with transfer calibration methods, using either temperature probes or calibrated E-field probes. The system performance check also does not test the system performance for arbitrary field situations encountered during real measurements of mobile phones. These checks are performed at SPEAG by testing the components under various conditions (e.g., spherical isotropy measurements in liquid, linearity measurements, temperature variations, etc.), the results of which are used for an error estimation of the system. The system performance check will indicate situations where the system uncertainty is exceeded due to drift or failure.

7.2 System Performance check procedure

Preparation

The conductivity should be measured before the validation and the measured liquid parameters must be entered in the software. If the measured values differ from targeted values in the dipole document, the liquid composition should be adjusted. If the validation is performed with slightly different (measured) liquid parameters, the expected SAR will also be different. See the application note about SAR sensitivities for an estimate of possible SAR deviations. Note that the liquid parameters are temperature dependent with approximately – 0.5% decrease in permittivity and + 1% increase in conductivity for a temperature decrease of 1° C. The dipole must be placed beneath the flat phantom section of the Generic Twin Phantom with the correct distance holder in place. The distance holder should touch the phantom surface with a light pressure at the reference marking (little hole) and be oriented parallel to the long side of the phantom. Accurate positioning is not necessary, since the system will search for the peak SAR location, except that the dipole arms should be parallel to the surface. The device holder for mobile phones can be left in place but should be rotated away from the dipole. The forward power into the dipole at the dipole SMA connector should be determined as accurately as possible. The actual dipole input power level can be between 20mW and several watts. The result can later be normalized to any power level. It is strongly recommended to note the actually used power level in the „comment“-window of the measurement file; otherwise you lose this crucial information for later reference.

System Performance Check

The DASY installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks, so you must save the finished validation under a different name. The validation document requires the Generic Twin Phantom, so this phantom must be properly installed in your system. (You can create your own measurement procedures by opening a new document or editing an existing document file). Before you start the validation, you just have to tell the system with which components (probe, medium, and device) you are performing the validation; the system will take care of all parameters. After the validation, which will take about 20 minutes, the results of each task are displayed in the document window. Selecting all measured tasks and opening the predefined "validation" graphic format displays all necessary information for validation. A description of the different measurement tasks in the predefined document is given below, together with the information that can be deduced from their results:

- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the amplifier output power. If it is too high (above $\pm 0.1\text{dB}$) the validation should be repeated; some amplifiers have very high drift during warm-up. A stable amplifier gives drift results in the DASY system below $\pm 0.02\text{ dB}$.
- The „area scan“ measures the SAR above the dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The proposed scan uses large grid spacing for faster measurement; due to the symmetric field the peak detection is reliable. If a finer graphic is desired, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result.
- The zoom scan job measures the field in a volume around the peak SAR value assessed in the previous „area“ scan (for more information see the application note on SAR evaluation).

If the validation measurements give reasonable results, the peak 1g and 10g spatial SAR values averaged between the two cubes and normalized to 1W dipole input power give the reference data for comparisons. The next section analyzes the expected uncertainties of these values. Section 6 describes some additional checks for further information or troubleshooting.

7.3 Uncertainty Budget

Please note that in the following Tables, the tolerance of the following uncertainty components depends on the actual equipment and setup at the user location and need to be either assessed or verified on-site by the end user of the DASY system:

- RF ambient conditions
- Dipole Axis to Liquid Distance
- Input power and SAR drift measurement
- Liquid permittivity - measurement uncertainty
- Liquid conductivity - measurement uncertainty

Note: All errors are given in percent of SAR, so 0.1 dB corresponds to 2.3%. The field error would be half of that. The liquid parameter assessment give the targeted values from the dipole document. All errors are given in percent of SAR, so 0.1dB corresponds to 2.3%. The field error would be half of that.

System validation DASY 5/8 and cDASY6

In the tables below, the system validation uncertainty with respect to the analytically assessed SAR value of a dipole source as given in the IEC/IEEE 62209-1528 standard is given. This uncertainty is smaller than the expected uncertainty for mobile phone measurements due to the simplified setup and the symmetric field distribution.

DASY 5 - Uncertainty Budget for System Validation for the 0.3 - 6 GHz range								
Source of uncertainty	Uncertainty Value	Probability Distribution	Divisor	c _i	c _i	Standard Uncertainty		v _i ² or
				(1g)	(10g)	± %, (1g)	± %, (10g)	v _{eff}
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %	∞
Boundary effects	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Integration time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
RF ambient conditions	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Dipole Related								
Dev. of exp. dipole	± 5.5 %	Rectangular	√ 3	1	1	± 3.2 %	± 3.2 %	∞
Dipole Axis to Liquid Dist.	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Input power & SAR drift	± 3.4 %	Rectangular	√ 3	1	1	± 2.0 %	± 2.0 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Normal	1	0.78	0.71	± 3.9 %	± 3.6 %	∞
Liquid permittivity (meas.)	± 5.0 %	Normal	1	0.26	0.26	± 1.3 %	± 1.3 %	∞
Temp. unc. - Conductivity	± 1.7 %	Rectangular	√ 3	0.78	0.71	± 0.8 %	± 0.7 %	∞
Temp. unc. - Permittivity	± 0.3 %	Rectangular	√ 3	0.23	0.26	± 0.0 %	± 0.0 %	∞
Combined Uncertainty						± 10.7 %	± 10.6 %	330
Expanded Std. Uncertainty						± 21.4 %	± 21.1 %	

Table 1: Measurement uncertainties of the System Validation with DASY5 (0.3-6GHz).

The RF ambient noise uncertainty has been reduced to ±1.0, considering input power levels are ≥ 250mW.

cDASY 6 - Uncertainty Budget for System Validation for the 0.3 - 6 GHz range

Source of uncertainty	Uncertainty Value	Probability Distribution	Divisor	c _i	c _i	Standard Uncertainty		v _i ² or v _{eff}
				(1g)	(10g)	± %, (1g)	± %, (10g)	
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %	∞
Boundary effects	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Integration time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
RF Ambient Noise	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
RF Ambient Reflections	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe positioner	± 0.04 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Probe positioning	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Max. SAR evaluation	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Dipole Related								
Dev. of exp. dipole	± 5.5 %	Rectangular	√ 3	1	1	± 3.2 %	± 3.2 %	∞
Dipole Axis to Liquid Dist.	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Input power & SAR drift	± 3.4 %	Rectangular	√ 3	1	1	± 2.0 %	± 2.0 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
SAR correction	± 1.9 %	Normal	1	1	0.84	± 1.9 %	± 1.6 %	∞
Liquid conductivity (meas.) ^{DAK}	± 2.5 %	Normal	1	0.78	0.71	± 2.0 %	± 1.8 %	∞
Liquid permittivity (meas.) ^{DAK}	± 2.5 %	Normal	1	0.23	0.26	± 0.6 %	± 0.7 %	∞
Temp. unc. - Conductivity ^{BB}	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. unc. - Permittivity ^{BB}	± 0.4 %	Rectangular	√ 3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 9.5 %	± 9.4 %	
Expanded Std. Uncertainty						± 19.0 %	± 18.8 %	

Table 2: Uncertainties of a system validation with cDASY6 (0.3-6GHz).

The RF ambient noise uncertainty has been reduced to ± 1.0 , considering input power levels are $\geq 250\text{mW}$.

Footnote details:

^{BB} if SPEAG's broad-band liquids (BBL) are used that have low temperature coefficients;

^{DAK} if SPEAG's high precision dielectric probe kit (DAK) is applied.

Uncertainty Budget for System Validation (Frequency band: 300MHz - 6GHz range) with DASY8 System								
Symbol	Error Description	Uncertainty Value	Probability Distribution	Divisor	C _i	C _i	Standard Uncertainty	
					(1g)	(10g)	± %, (1g)	± %, (10g)
Measurement System Errors								
CF	Probe Calibration Repeat.	± 13.1 %	Normal	2	1	1	± 9.3 %	± 9.3 %
CFdrift	Probe Calibration Drift	± 1.7 %	Rectangular	√ 3	1	1	± 1.0 %	± 1.0 %
LIN	Probe linearity	± 4.7 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
BBS	Broadband Signal	± 0.0 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
ISO	Probe Isotropy (axial)	± 4.7 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
DAE	Data Acquisition	± 0.3 %	Normal	1	0	0	± 0.0 %	± 0.0 %
AMB	RF Ambient	± 0.6 %	Normal	1	0	0	± 0.0 %	± 0.0 %
Δ _{sys}	Probe Positioning	± 0.5 %	Normal	1	0.29	0.29	± 0.1 %	± 0.1 %
DAT	Data Processing	± 0.0 %	Normal	1	1	1	± 0.0 %	± 0.0 %
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.) ^{DAK}	± 2.5 %	Normal	1	0.78	0.71	± 2.0 %	± 1.8 %
LIQ(Tσ)	Conductivity (temp.) ^{BB}	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %
EPS	Phantom Permittivity	± 14.0 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
DIS	Distance DUT - TSL	± 1.3 %	Normal	1	2	2	± 2.6 %	± 2.6 %
MOD	DUT Modulationm	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %
TAS	Time-average SAR	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %
VAL	Validation antenna	± 3.2 %	Normal	1	1	1	± 3.2 %	± 3.2 %
P _{in}	Accepted power	± 2.0 %	Normal	1	1	1	± 2.0 %	± 2.0 %
Correction to the SAR results								
C(ε, σ)	Deviation to Target	± 1.9 %	Normal	1	1	0.84	± 1.9 %	± 1.6 %
u(ΔSAR)	Combined Uncertainty						± 10.8 %	± 10.7 %
U	Expanded Uncertainty						± 21.7 %	± 21.5 %

Table 6.2.1: Uncertainty of a system validation with DASY8 system (300MHz - 6 GHz).

The RF ambient noise uncertainty has been reduced to ± 1.0 , considering input power levels are $\geq 250\text{mW}$.
All listed error components have *veff* equal to ∞ .

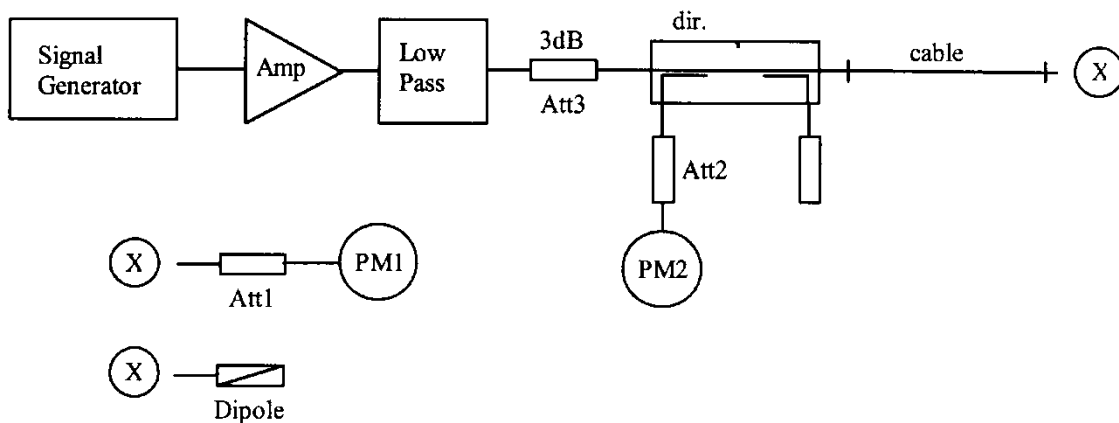
Footnote details:

^{BB} if SPEAG's broad-band liquids (BBL) are used that have low temperature coefficients;

^{DAK} if SPEAG's high precision dielectric probe kit (DAK) is applied.

7.4 Power set-up for validation

The uncertainty of the dipole input power is a significant contribution to the absolute uncertainty and the expected deviation in interlaboratory comparisons. The values in Section 2 for a typical and a sophisticated setup are just average values. Refer to the manual of the power meter and the detector head for the evaluation of the uncertainty in your system. The uncertainty also depends on the source matching and the general setup. Below follows the description of a recommended setup and procedures to increase the accuracy of the power reading:



The figure shows the recommended setup. The PM1 (incl. Att1) measures the forward power at the location of the validation dipole connector. The signal generator is adjusted for the desired forward power at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow a setting in 0.01dB steps, the remaining difference at PM2 must be noted and considered in the normalization of the validation results. The requirements for the components are:

- The signal generator and amplifier should be stable (after warm-up). The forward power to the dipole should be above 10mW to avoid the influence of measurement noise. If the signal generator can deliver 15dBm or more, an amplifier is not necessary. Some high power amplifiers should not be operated at a level far below their maximum output power level (e.g. a 100W power amplifier operated at 250mW output can be quite noisy). An attenuator between the signal generator and amplifier is recommended to protect the amplifier input.
- The low pass filter after the amplifier reduces the effect of harmonics and noise from the amplifier. For most amplifiers in normal operation the filter is not necessary.
- The attenuator after the amplifier improves the source matching and the accuracy of the power head. (See power meter manual.) It can also be used also to make the amplifier operate at its optimal output level for noise and stability. In a setup without directional coupler, this attenuator should be at least 10dB.
- The directional coupler (recommended ³ 20dB) is used to monitor the forward power and adjust the signal generator output for constant forward power. A medium quality coupler is sufficient because the loads (dipole and power head) are well matched. (If the setup is used for reflective loads, a high quality coupler with respect to directivity and output matching is necessary to avoid additional errors.)
- The power meter PM2 should have a low drift and a resolution of 0.01dBm, but otherwise its accuracy has no impact on the power setting. Calibration is not required.
- The cable between the coupler and dipole must be of high quality, without large attenuation and phase changes when it is moved. Otherwise, the power meter head PM1 should be brought to the location of the dipole for measuring.
- The power meter PM1 and attenuator Att1 must be high quality components. They should be calibrated, preferably together. The attenuator (³10dB) improves the accuracy of the power reading. (Some higher power heads come with a built-in calibrated attenuator.) The exact attenuation of the attenuator at the frequency used must be known; many attenuators are up to 0.2dB off from the specified value.

- Use the same power level for the power setup with power meter PM1 as for the actual measurement to avoid linearity and range switching errors in the power meter PM2. If the validation is performed at various power levels, do the power setting procedure at each level.
- The dipole must be connected directly to the cable at location “X”. If the power meter has a different connector system, use high quality couplers. Preferably, use the couplers at the attenuator Att1 and calibrate the attenuator with the coupler.
- Always remember: We are measuring power, so 1% is equivalent to 0.04dB.

7.5 Laboratory reflection

In near-field situations, the absorption is predominantly caused by induction effects from the magnetic near-field. The absorption from reflected fields in the laboratory is negligible. On the other hand, the magnetic field around the dipole depends on the currents and therefore on the feed point impedance. The feed point impedance of the dipole is mainly determined from the proximity of the absorbing phantom, but reflections in the laboratory can change the impedance slightly. A 1% increase in the real part of the feed point impedance will produce approximately a 1% decrease in the SAR for the same forward power. The possible influence of laboratory reflections should be investigated during installation. The validation setup is suitable for this check, since the validation is sensitive to laboratory reflections. The same tests can be performed with a mobile phone, but most phones are less sensitive to reflections due to the shorter distance to the phantom. The fastest way to check for reflection effects is to position the probe in the phantom above the feed point and start a continuous field measurement in the DASY multi-meter window. Placing absorbers in front of possible reflectors (e.g. on the ground near the dipole or in front of a metallic robot socket) will reveal their influence immediately. A 10dB absorber (e.g. ferrite tiles or flat absorber mats) is probably sufficient, as the influence of the reflections is small anyway. If you place the absorber too near the dipole, the absorber itself will interact with the reactive near-field. Instead of measuring the SAR, it is also possible to monitor the dipole impedance with a network analyzer for reflection effects. The network analyzer must be calibrated at the SMA connector and the electrical delay (two times the forward delay in the dipole document) must be set in the NWA for comparisons with the reflection data in the dipole document. If the absorber has a significant influence on the results, the absorber should be left in place for validation or measurements. The reference data in the dipole document are produced in a low reflection environment.

7.6 Additional system checks

While the validation gives a good check of the DASY system components, it does not include all parameters necessary for real phone measurements (e.g. device modulation or device positioning). For system validation (repeatability) or comparisons between laboratories a reference device can be useful. This can be any mobile phone with a stable output power (preferably a device whose output power can be set through the keyboard). For comparisons, the same device should be sent around, since the SAR variations between samples can be large. Several measurement possibilities in the DASY software allow additional tests of the performance of the DASY system and components. These tests can be useful to localize component failures:

- The validation can be performed at different power levels to check the noise level or the correct compensation of the diode compression in the probe.
- If a pulsed signal with high peak power levels is fed to the dipole, the performance of the diode compression compensation can be tested. The correct crest factor parameter in the DASY software must be set (see manual). The system should give the same SAR output for the same averaged input power.
- The probe isotropy can be checked with a 1D-probe rotation scan above the feed point. The automatic probe alignment procedure must be passed through for accurate probe rotation movements (optional DASY feature with a robot-mounted light beam unit). Otherwise the probe tip might move on a small circle during rotation, producing some additional isotropy errors in gradient fields.