Liquid Validation

Instrument	Manufacturer	Model	Calibrated
Network Analyzer	HP	4396B	1 Nov 2002
Dielectric Probe Kit,	Agilent	85070C	Each Use
H_2O, 18 M-Ohm	BACL		Each Use
Probe, SAR 10 kHz - 6 GHz	SPEAG	ES3DV2	9 Oct 2003

Attestation:

I hereby attest that the equipment are suitable for the performance requirements of IEEE P1528/D1.2:2003 and the personnel operating the test equipment and measurements are properly trained to perform the verification of this calibration procedure set forth in IEEE P1528/D1.2:2003.

The validation antenna herein meets the minimum requirements of 20 dB insertion loss

2004-04-12

Hans T. Mellberg
Engineering Manager

Date

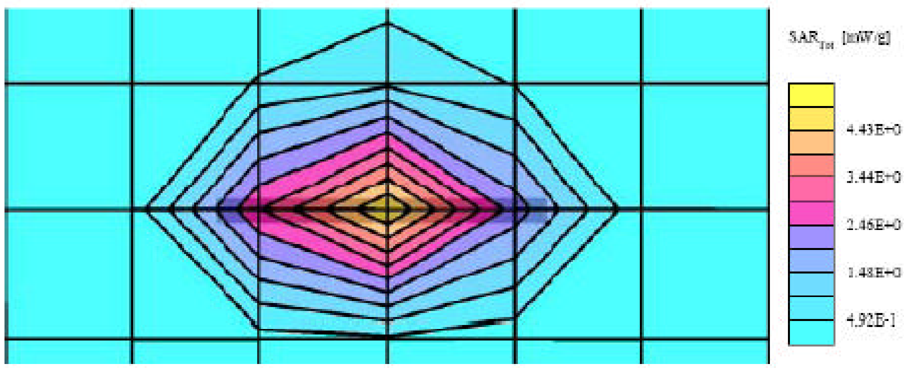
1800 MHz Head Liquid validation Date :12APR2004

Ambient Temp = 23 °C Liquid Temp = 22 °C

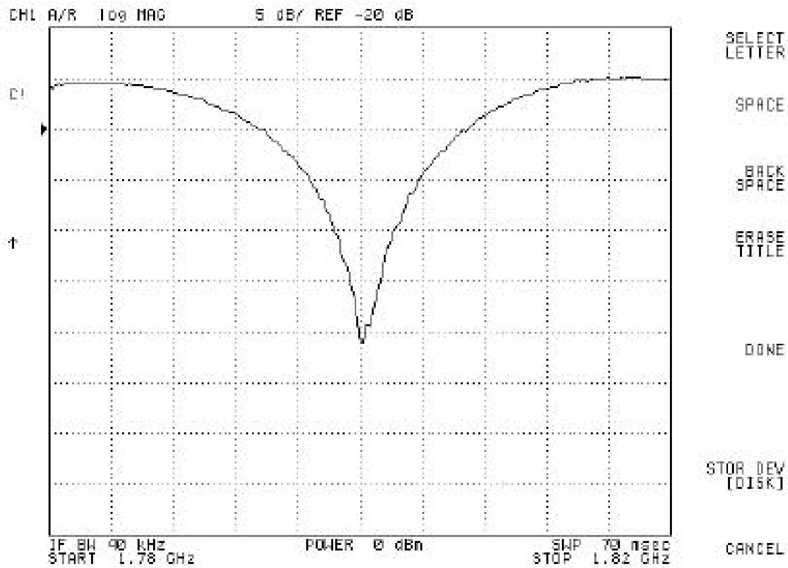
Frequency	**e'**	**e"**	σ ($\sigma = 2\pi f \varepsilon_o \varepsilon''$)
1850000000.0000	38.8246	13.2534	
1852000000.0000	38.7736	13.2429	
1854000000.0000	38.8400	13.2576	
1856000000.0000	38.8463	13.2425	
1858000000.0000	38.8167	13.2672	
1860000000.0000	38.8129	13.2552	
1862000000.0000	38.8118	13.2476	
1864000000.0000	38.7654	13.2345	
1866000000.0000	38.7686	13.2633	
1868000000.0000	38.7997	13.2690	
1870000000.0000	38.7262	13.2308	
1872000000.0000	38.7413	13.2642	
1874000000.0000	38.7458	13.2802	
1876000000.0000	38.7127	13.2833	
1878000000.0000	38.7145	13.2799	
1880000000.0000	38.7380	13.2633	
1882000000.0000	38.7086	13.2820	
1884000000.0000	38.7111	13.2991	
1886000000.0000	38.7184	13.2656	
1888000000.0000	38.7086	13.2724	
1890000000.0000	38.6697	13.2703	
1892000000.0000	38.6773	13.3051	
1894000000.0000	38.6729	13.2817	
1896000000.0000	38.6377	13.2805	
1898000000.0000	38.6113	13.2648	
1900000000.0000	38.6019	13.2714	1.40
1902000000.0000	38.5554	13.2951	
1904000000.0000	38.5535	13.2851	
1906000000.0000	38.5103	13.3424	
1908000000.0000	38.5402	13.3692	
1910000000.0000	38.5162	13.3760	
1912000000.0000	38.4971	13.3857	
1914000000.0000	38.5126	13.3651	
1916000000.0000	38.4920	13.3817	
1918000000.0000	38.5463	13.3665	
1920000000.0000	38.5063	13.3804	
1922000000.0000	38.4973	13.3868	
1924000000.0000	38.5244	13.3470	
1926000000.0000	38.5362	13.3583	
1928000000.0000	38.5352	13.3774	
1930000000.0000	38.5427	13.3676	
1932000000.0000	38.5433	13.3562	
1934000000.0000	38.5374	13.3814	
1936000000.0000	38.5717	13.4048	
1938000000.0000	38.5057	13.4235	
1940000000.0000	38.5314	13.4375	
1942000000.0000	38.5104	13.4338	
1944000000.0000	38.4827	13.4285	
1946000000.0000	38.4545	13.4411	
1948000000.0000	38.4227	13.4385	
1950000000.0000	38.3682	13.4325	

System Validation for 1900 MHz Head Liquid (Ambient Temp = 23 C, Liquid Temp = 22 C, Forward Power = 20.42 dBm, 4/12/2004)

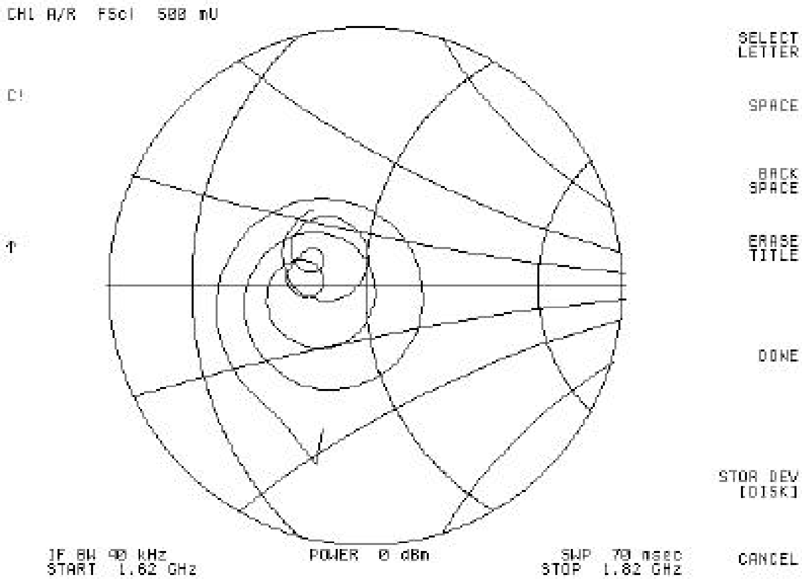
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 1900 MHz
Probe: ES3DV2 - SN3019; ConvF(4.70,4.70,4.70); Crest factor: 1.0; Head Liquid 1900 MHz: σ = 1.40 mho/m ϵ_r = 40.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 4.38 mW/g, SAR (10g): 2.21 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: 0.01 dB



Insertion Loss Plot
S11



Smith Chart


CH1 A/R FScl 500 mU
SELECT LETTER
SPACE
BACK SPACE
ERASE TITLE
DONE
STOR DEV [DISK]
CANCEL
IF BW 90 kHz
START 1.62 GHz
POWER 0 dBm
SWP 70 msec
STOP 1.82 GHz

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

Client Bay Area Comp. Lab (BACL)

CALIBRATION CERTIFICATE

Object(s)	D900V2 - SN:122
Calibration procedure(s)	QA CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	October 3, 2003
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02 (METAS, No. 252-0236)	Oct-03
RF generator R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03

	Name	Function	Signature
Calibrated by:	Judith Mueller	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: October 9, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Schmid & Partner Engineering AG

s p e a g

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DASY

Dipole Validation Kit

Type: D900V2

Serial: 122

Manufactured: July 4, 2001
Calibrated: October 3, 2003

1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **head simulating solution** of the following electrical parameters at 900 MHz:

Relative Dielectricity	**42.3**	± 5%
Conductivity	**0.96 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.6 at 900 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole center to the solution surface. The included distance spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

2. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**10.2 mW/g** ± 16.8 % (k=2)[1]
averaged over 10 cm^3 (10 g) of tissue:	**6.60 mW/g** ± 16.2 % (k=2)[1]

3. Dipole Impedance and Return Loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1.409 ns**	(one direction)
Transmission factor:	**0.983**	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance spacer was in place during impedance measurements.

Feedpoint impedance at 900 MHz:	Re{Z} = **50.8 Ω**
	Im {Z} = **-5.7 Ω**
Return Loss at 900 MHz	**-24.8 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **body simulating solution** of the following electrical parameters at 900 MHz:

Relative Dielectricity	**54.4**	± 5%
Conductivity	**1.04 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.3 at 900 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole center to the solution surface. The included distance spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

5. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**10.7 mW/g** ± 16.8 % (k=2)[2]
averaged over 10 cm^3 (10 g) of tissue:	**6.92 mW/g** ± 16.2 % (k=2)[2]

6. Dipole Impedance and Return Loss

The dipole was positioned at the flat phantom sections according to section 4 and the distance spacer was in place during impedance measurements.

Feedpoint impedance at 900 MHz:	Re{Z} = **47.1 Ω**
	Im {Z} = **-6.7 Ω**
Return Loss at 900 MHz	**-22.6 dB**

7. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

8. Design

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.

9. Power Test

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

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN122

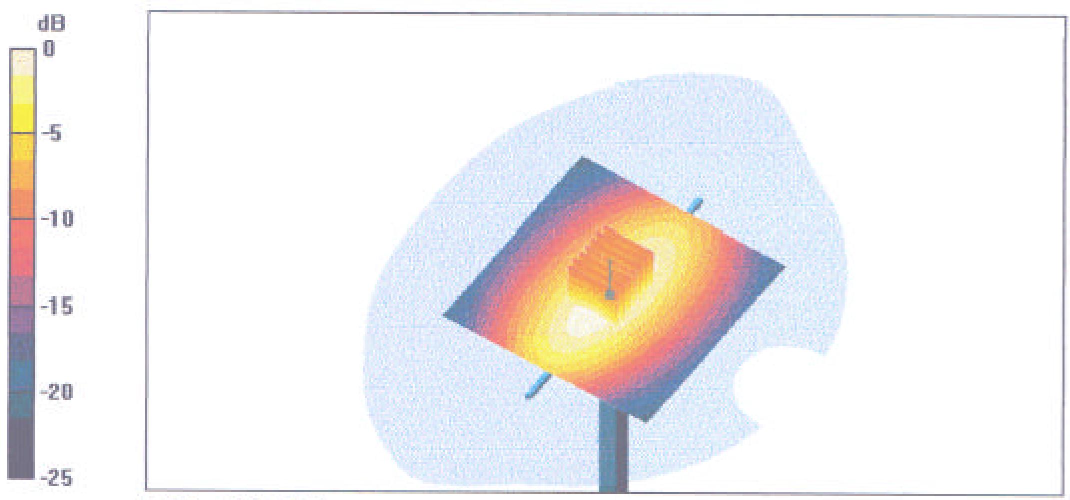
Communication System: CW-900; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: HSL 900 MHz (σ = 0.96 mho/m, ε_r = 42.26, ρ = 1000 kg/m^3)
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

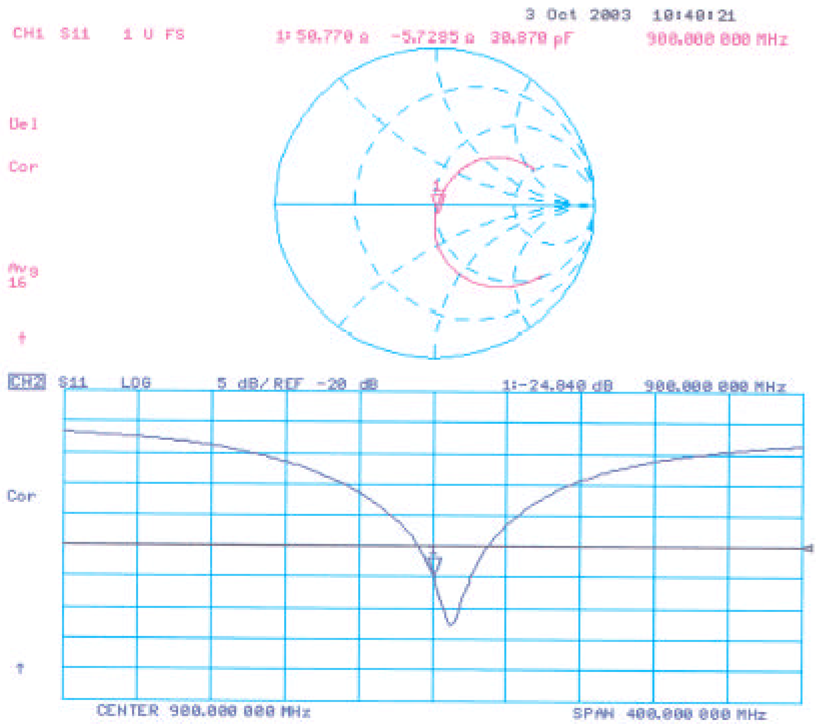
- Probe: ET3DV6 - SN1507; ConvF(6.6, 6.6, 6.6); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- *Electronics: DAE3 - SN411; Calibrated: 1/16/2003*
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.8 Build 60

Pin = 250 mW; d = 15 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 55.6 V/m
Power Drift = 0.003 dB
Maximum value of SAR = 2.75 mW/g

Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 3.81 W/kg
SAR(1 g) = 2.55 mW/g; SAR(10 g) = 1.65 mW/g
Reference Value = 55.6 V/m
Power Drift = 0.003 dB
Maximum value of SAR = 2.76 mW/g



0 dB = 2.76mW/g


3 Oct 2003 10:40:21
CH1 S11 1 U FS
1: 50.770 Ω -5.7285 Ω 30.870 pF 900.000 000 MHz
Del
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF -20 dB 1:-24.040 dB 900.000 000 MHz
Cor
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN122

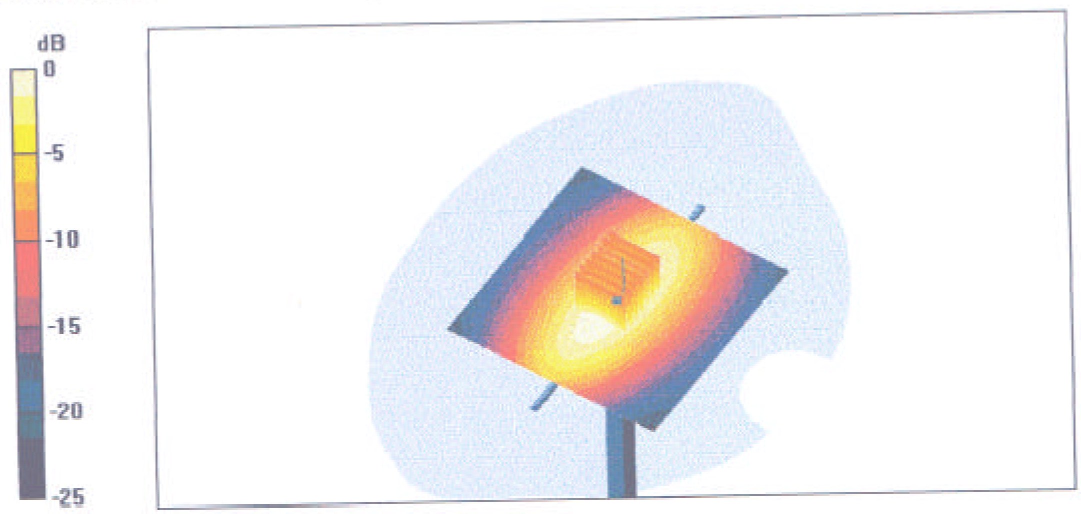
Communication System: CW-900; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: Muscle 900 MHz (σ = 1.04 mho/m, ε_r = 54.38, ρ = 1000 kg/m^3)
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.3, 6.3, 6.3); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: *DAE3 - SN411; Calibrated: 1/16/2003*
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.8 Build 60

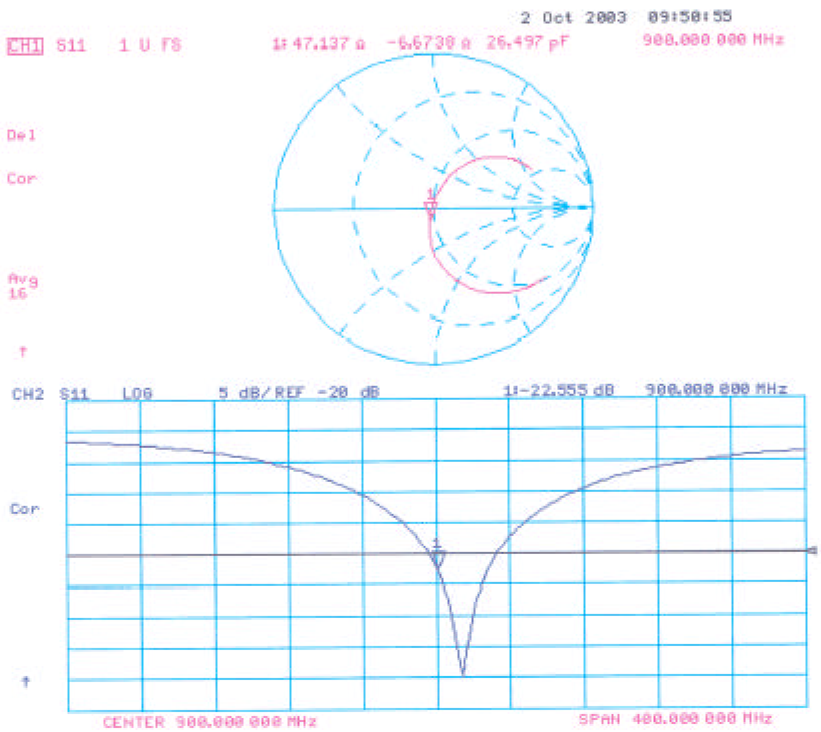
Pin = 250 mW; d = 15 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 55 V/m
Power Drift = 0.0 dB
Maximum value of SAR = 2.87 mW/g

Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 3.92 W/kg
SAR(1 g) = 2.67 mW/g; SAR(10 g) = 1.73 mW/g
Reference Value = 55 V/m
Power Drift = 0.0 dB
Maximum value of SAR = 2.88 mW/g



0 dB = 2.88mW/g

Body


2 Oct 2003 09:50:55
CH1 S11 1 U FS 1: 47.137 Ω -6.6730 Ω 26.497 pF 900.000 000 MHz
Del
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF -20 dB 1:-22.555 dB 900.000 000 MHz
Cor
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz

835 MHZ Body Liquid Validation

frequency	e'	e''
815000000.0000	53.0826	21.5322
815800000.0000	53.0834	21.5254
816600000.0000	53.0398	21.4978
817400000.0000	53.1012	21.4743
818200000.0000	53.0128	21.4624
819000000.0000	53.0067	21.4532
819800000.0000	53.0073	21.4436
820600000.0000	53.0423	21.4274
821400000.0000	53.0154	21.3851
822200000.0000	53.0775	21.3929
823000000.0000	53.0913	21.4047
823800000.0000	52.9638	21.3478
824600000.0000	52.9941	21.2392
825400000.0000	52.9704	21.1584
826200000.0000	53.0071	21.0247
827000000.0000	53.0924	20.9425
827800000.0000	59.8938	20.9532
828600000.0000	59.8754	20.8247
829400000.0000	53.0495	20.7958
830200000.0000	52.8764	20.7126
831000000.0000	52.8287	20.8847
831800000.0000	52.9349	20.9268
832600000.0000	52.9015	21.0149
833400000.0000	52.9046	21.0076
834200000.0000	52.9189	21.1765
835000000.0000	52.9231	21.2374
835800000.0000	52.9278	21.2056
836600000.0000	52.9331	21.1979
837400000.0000	52.9279	21.0314
838200000.0000	52.9257	21.0025
839000000.0000	52.9124	20.9836
839800000.0000	52.8786	20.9875
840600000.0000	52.8258	20.8518
841400000.0000	52.9089	20.8384
842200000.0000	52.9263	20.8631
843000000.0000	52.8715	20.8025
843800000.0000	52.8747	20.7884
844600000.0000	52.8768	20.8397
845400000.0000	52.9111	20.8578
846200000.0000	52.8625	20.8146
847000000.0000	52.8425	20.8601
847800000.0000	52.8334	20.8116
848600000.0000	52.8411	20.8092
849400000.0000	52.8327	20.8014
850200000.0000	52.8058	20.7978
851000000.0000	52.7949	20.7441
851800000.0000	52.7822	20.7227
852600000.0000	52.7758	20.7035
853400000.0000	52.7129	20.7047
854200000.0000	52.7094	20.7139
855000000.0000	52.6843	20.7205

$\sigma = \omega \varepsilon_o \varepsilon'' = 2 \pi f \varepsilon_o \varepsilon'' = 0.9865$

where $f = 835 \times 10^{6}$

$\varepsilon_o = 8.854 \times 10^{-12}$

$\varepsilon'' = 21.2374$

835 MHZ Head Liquid Validation

frequency	e'	e''
815000000.0000	41.4128	19.7719
815800000.0000	41.4475	19.7985
816600000.0000	41.5534	19.6825
817400000.0000	41.6305	19.6921
818200000.0000	41.5963	19.6913
819000000.0000	41.5412	19.6661
819800000.0000	41.4505	19.6257
820600000.0000	41.4033	19.5476
821400000.0000	41.4628	19.5635
822200000.0000	41.4660	19.5947
823000000.0000	41.3284	19.5483
823800000.0000	41.2695	19.5453
824600000.0000	41.2117	19.5215
825400000.0000	41.0976	19.5159
826200000.0000	41.1822	19.5222
827000000.0000	41.2040	19.5370
827800000.0000	41.0765	19.5035
828600000.0000	41.0852	19.4661
829400000.0000	41.2141	19.4487
830200000.0000	41.1935	19.4238
831000000.0000	41.0836	19.4195
831800000.0000	41.0227	19.3943
832600000.0000	41.0294	19.3251
833400000.0000	40.9730	19.3064
834200000.0000	40.9842	19.3147
835000000.0000	40.9758	19.3092
835800000.0000	40.9345	19.3356
836600000.0000	40.9641	19.3624
837400000.0000	40.8997	19.3860
838200000.0000	40.8276	19.3247
839000000.0000	40.8554	19.3599
839800000.0000	40.8659	19.4133
840600000.0000	40.7959	19.4324
841400000.0000	40.7724	19.4424
842200000.0000	40.7841	19.3261
843000000.0000	40.8643	19.3602
843800000.0000	40.9265	19.3260
844600000.0000	40.9658	19.4145
845400000.0000	40.9497	19.4594
846200000.0000	40.8035	19.4156
847000000.0000	40.8221	19.4547
847800000.0000	40.7836	19.4302
848600000.0000	40.8645	19.4949
849400000.0000	40.8226	19.4564
850200000.0000	40.8587	19.4801
851000000.0000	40.9414	19.3443
851800000.0000	40.9123	19.3255
852600000.0000	40.8537	19.3445
853400000.0000	40.8045	19.3775
854200000.0000	40.9265	19.3179
855000000.0000	40.0372	19.3006

$s = w e_o e'' = 2 p f e_o e'' = 0.8969$

where $f = 835 x 10^6$

$e_o = 8.854 \times 10^{-12}$

$e'' = 19.3092$

1900 MHZ Body Liquid Validation

frequency	e'	e''
1850000000.0000	52.6223	14.6815
1852000000.0000	52.6667	14.6854
1854000000.0000	52.6578	14.7023
1856000000.0000	52.6657	14.7514
1858000000.0000	52.6741	14.7987
1860000000.0000	52.7123	14.8772
1862000000.0000	52.7494	14.9301
1864000000.0000	52.7253	14.9187
1866000000.0000	52.7345	14.9413
1868000000.0000	52.7449	14.9264
1870000000.0000	52.7373	14.9021
1872000000.0000	52.7315	14.9165
1874000000.0000	52.7348	14.8921
1876000000.0000	52.7341	14.9036
1878000000.0000	52.7473	14.9275
1880000000.0000	52.7494	14.8987
1882000000.0000	52.7735	14.9025
1884000000.0000	52.7972	14.8941
1886000000.0000	52.7653	14.9088
1888000000.0000	52.7584	14.9240
1890000000.0000	52.7436	14.9101
1892000000.0000	52.7914	14.9118
1894000000.0000	52.7381	14.9051
1896000000.0000	52.7958	14.8532
1898000000.0000	52.7721	14.8797
1900000000.0000	52.7939	14.8889
1902000000.0000	52.7878	14.8665
1904000000.0000	52.7915	14.8854
1906000000.0000	52.8041	14.9028
1908000000.0000	52.7479	14.8945
1910000000.0000	52.7611	14.8824
1912000000.0000	52.8015	14.9152
1914000000.0000	52.8168	14.9478
1916000000.0000	52.8497	14.9537
1918000000.0000	52.7989	14.9428
1920000000.0000	52.8492	14.9812
1922000000.0000	52.8637	14.9724
1924000000.0000	52.8078	14.9654
1926000000.0000	52.8185	14.9567
1928000000.0000	52.7489	14.9253
1930000000.0000	52.7863	14.9395
1932000000.0000	52.7454	14.9578
1934000000.0000	52.7280	14.9084
1936000000.0000	52.7358	14.9297
1938000000.0000	52.7341	14.9623
1940000000.0000	52.6728	14.9584
1942000000.0000	52.6234	14.9415
1944000000.0000	52.6145	14.9194
1946000000.0000	52.6283	14.9387
1948000000.0000	52.5875	14.9141
1950000000.0000	52.5694	14.8974

$s = w e_o e'' = 2\,p\,f e_o e''=1.5738$

where $f = 1900 \times 10^{6}$

$e_o = 8.854 \times 10^{-12}$

$e'' = 14.8889$

1900 MHZ Head Liquid Validation

frequency	e'	e''
1850000000.0000	39.2324	13.5323
1852000000.0000	39.2019	13.5718
1854000000.0000	39.2123	13.5909
1856000000.0000	39.1351	13.5724
1858000000.0000	39.9516	13.4868
1860000000.0000	39.8657	13.4149
1862000000.0000	39.8143	13.4061
1864000000.0000	39.7847	13.4370
1866000000.0000	39.6472	13.4464
1868000000.0000	39.6594	13.4573
1870000000.0000	39.7015	13.4949
1872000000.0000	39.8042	13.5061
1874000000.0000	39.8790	13.5594
1876000000.0000	39.9131	13.6116
1878000000.0000	40.0130	13.6004
1880000000.0000	40.0043	13.6069
1882000000.0000	39.9634	13.6185
1884000000.0000	39.9367	13.6192
1886000000.0000	39.9854	13.6311
1888000000.0000	39.9917	13.6183
1890000000.0000	40.0218	13.6411
1892000000.0000	40.0162	13.6846
1894000000.0000	40.0097	13.6552
1896000000.0000	39.9903	13.6603
1898000000.0000	40.0075	13.6909
1900000000.0000	40.0041	13.6614
1902000000.0000	39.9968	13.6906
1904000000.0000	40.0106	13.6903
1906000000.0000	39.9986	13.6070
1908000000.0000	39.9871	13.7020
1910000000.0000	39.9756	13.7215
1912000000.0000	40.0184	13.6145
1914000000.0000	39.9626	13.6301
1916000000.0000	40.0114	13.7025
1918000000.0000	39.9981	13.7127
1920000000.0000	39.9909	13.6959
1922000000.0000	39.9926	13.7336
1924000000.0000	39.8742	13.7633
1926000000.0000	39.7421	13.7347
1928000000.0000	39.6548	13.7666
1930000000.0000	39.5587	13.7870
1932000000.0000	39.4662	13.7018
1934000000.0000	39.3103	13.7693
1936000000.0000	39.2381	13.8035
1938000000.0000	39.3257	13.8324
1940000000.0000	39.3132	13.8191
1942000000.0000	39.4204	13.8292
1944000000.0000	39.5063	13.8425
1946000000.0000	39.4979	13.8547
1948000000.0000	39.3149	13.8874
1950000000.0000	39.3538	13.8812

$s = w e_o e'' = 2 p f e_o e'' = 1.4440$

where $f = 1900 \times 10^6$

$e_o = 8.854 \times 10^{-12}$

$e'' = 13.6614$

3 - EUT DESCRIPTION

Applicant:	VeriFone Inc.
Product Description:	Wireless POS Terminal
Product Model Number:	OMNI56XX
FCC ID:	B32OMNI56XXG
Serial Number:	908
Maximum RF Output Power:	33dBm for GSM850
	29.83dBm for GSM1900
RF Exposure environment:	General Population/Uncontrolled
Applicable Standard	FCC CFR 47, Part 22, Part 24
Application Type:	Certification

4 - SYSTEM TEST CONFIGURATION

4.1 Justification

The system was configured for testing in a typical fashion (as normally used by a typical user).

4.2 EUT Exercise Procedure

The EUT exercising program used during SAR testing was designed to exercise the various system components in a manner similar to a typical use.

4.3 Equipment Modifications

No modification(s) were made to ensure that the EUT complies with the applicable limits.

5 – CONDUCTED OUTPUT POWER MEASUREMENTS

5.1 Provision Applicable

According to FCC §22.913 (a), the ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts. According to FCC § 24.232(b), EIRP peak power for mobile/portable stations are limited to 2 watts.

5.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

5.3 Test equipment

Hewlett Packard HP8564E Spectrum Analyzer, Calibration Due Date: 2004-08-25.
Hewlett Packard HP 7470A Plotter, Calibration not required.
A.H. Systems SAS200 Horn Antenna, Calibration Due Date: 2004-08-01
Com-Power AD-100 Dipole Antenna, Calibration Due Date: 2004-09-26

5.4 Test Results

835 MHz

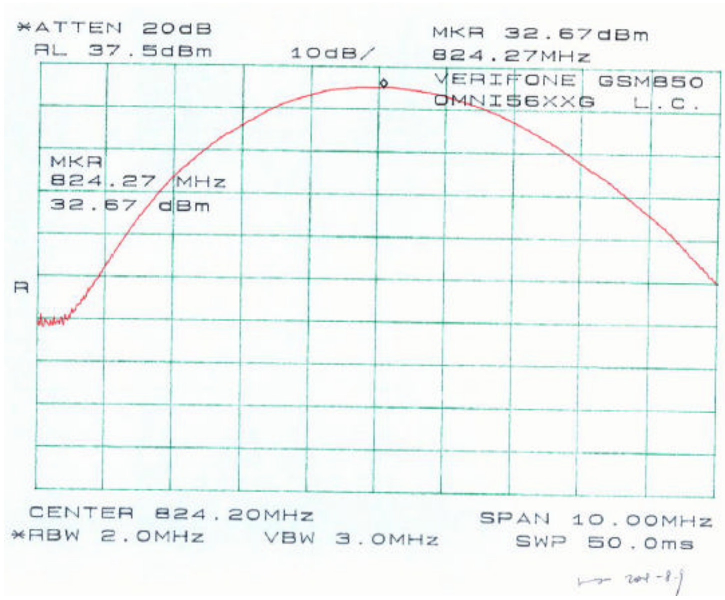
Modulation Type	Channel	Frequency (MHz)	Output Power in dBm	Output Power in W	Limit (W)
GSM	Low	824.20	32.67	1.849	7
	Middle	836.20	33.0	1.995	7
	High	848.80	32.33	1.710	7

1900 MHz

Modulation Type	Channel	Frequency (MHz)	Output Power in dBm	Output Power in W	Limit (W)
GSM	Low	1850.20	29.67	0.927	7
	Middle	1880	29.83	0.962	7
	High	1909.80	29.83	0.962	7

Please refer to the following plots.

835MHz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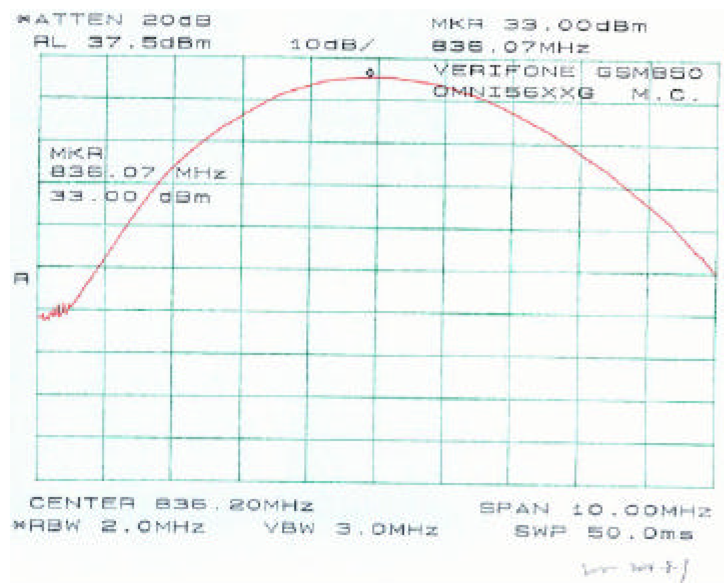
RL 37.5dBm
10dB/
MKR 32.67dBm
824.27MHz
VERIFONE GSM850
OMNI56XXG L.C.
MKR
824.27 MHz
32.67 dBm
A
CENTER 824.20MHz
*RBW 2.0MHz
VBW 3.0MHz
SPAN 10.00MHz
SWP 50.0ms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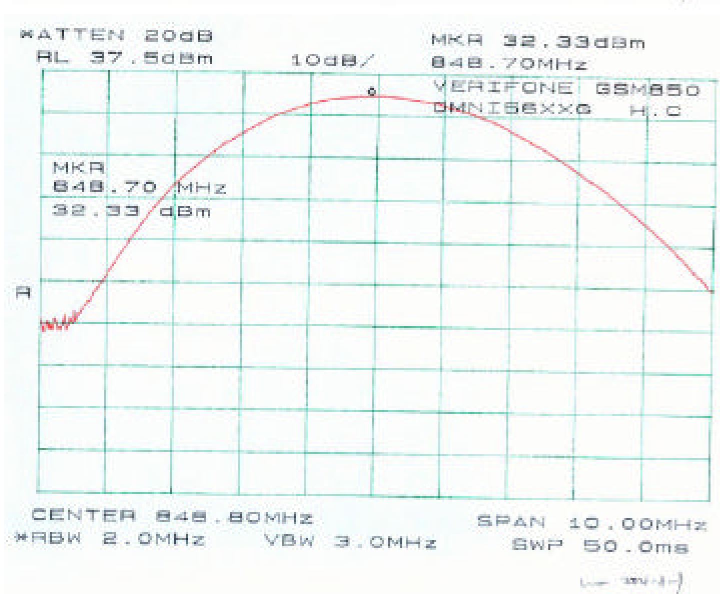
RL 37.5dBm
10dB/
MKR 33.00dBm
836.07MHz
VERIFONE GSM850
OMNI56XXG M.C.
MKR
836.07 MHz
33.00 dBm
A
CENTER 836.20MHz
*RBW 2.0MHz
VBW 3.0MHz
SPAN 10.00MHz
SWP 50.0ms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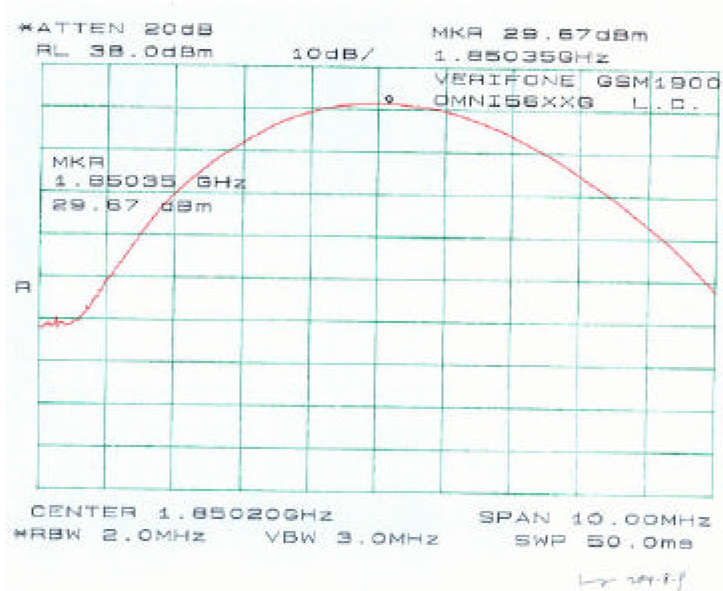
RL 37.5dBm
10dB/
MKR 32.33dBm
848.70MHz
VERIFONE GSM850
OMNI56XXG H.C
MKR
848.70 MHz
32.33 dBm
A
CENTER 848.80MHz
*RBW 2.0MHz
VBW 3.0MHz
SPAN 10.00MHz
SWP 50.0ms

1900MHz


*ATTEN 20dB
RL 38.0dBm
10dB/
MKR 29.67dBm
1.85035GHz
VERIFONE GSM1900
OMNI56XXG L.C.
MKR
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A
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SPAN 10.00MHz
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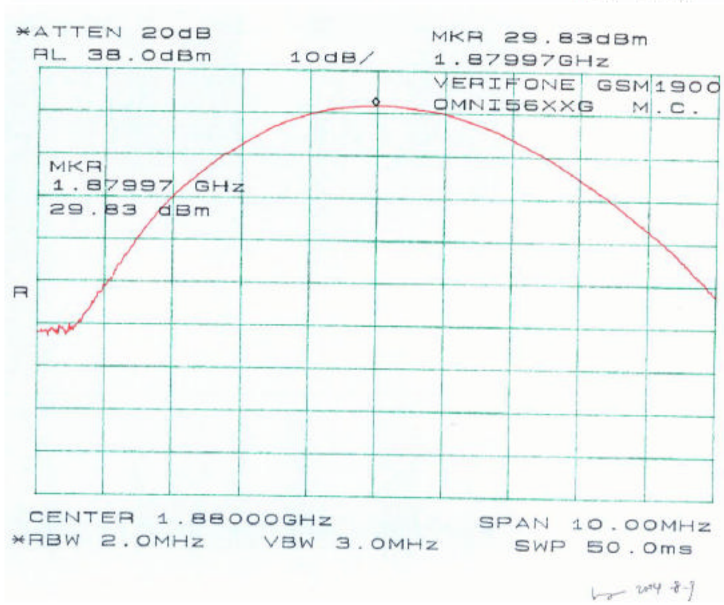
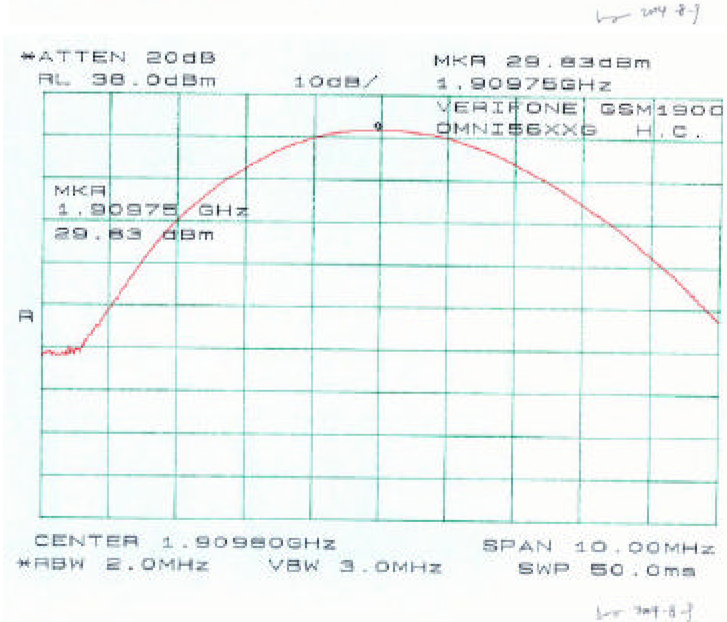
VBW 3.0MHz
SWP 50.0ms


*ATTEN 20dB
RL 38.0dBm
10dB/
MKR 29.83dBm
1.87997GHz
VERIFONE GSM1900
OMNI56XXG M.C.
MKR
1.87997 GHz
29.83 dBm
A
CENTER 1.88000GHz
SPAN 10.00MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms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10dB/
MKR 29.83dBm
1.90975GHz
VERIFONE GSM1900
OMNI56XXG H.C.
MKR
1.90975 GHz
29.83 dBm
A
CENTER 1.90980GHz
SPAN 10.00MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms

6 - DOSIMETRIC ASSESSMENT SETUP

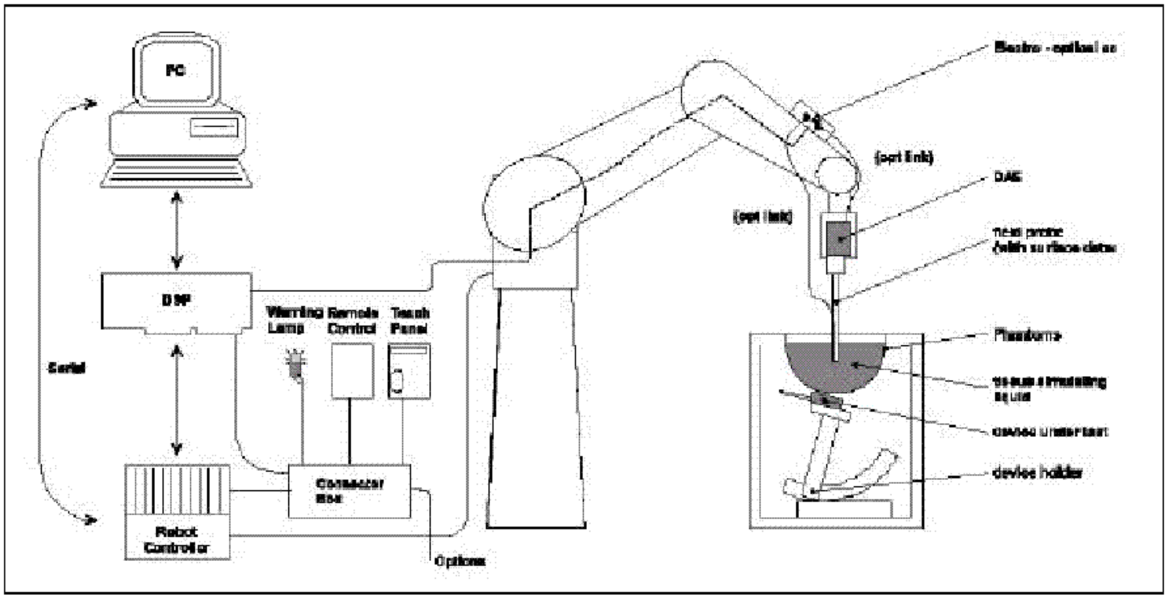
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than ±0.02mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The system is described in detail in [3].

The SAR measurements were conducted with the dosimetric probe ET3DV6 SN: 1577 (manufactured by SPEAG), designed in the classical triangular configuration [3] and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ±0.25dB.

The phantom used was the \Generic Twin Phantom” described in [4]. The ear was simulated as a spacer of 4 mm thickness between the earpiece of the phone and the tissue simulating liquid. The Tissue simulation liquid used for each test is in according with the FCC OET65 supplement C as listed below.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (s/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

6.1 Measurement System Diagram



The DASY3 system for performing compliance tests consist of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
5. A unit to operate the optical surface detector, which is connected to the EOC. The Electro-optical coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the PC plug-in card. The functions of the PC plug-in card based on a DSP is to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.
6. A computer operating Windows 95 or larger
7. DASY3 software
8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling testing left-hand and right-hand usage.
10. The device holder for handheld EUT.
11. Tissue simulating liquid mixed according to the given recipes (see Application Note).
12. System validation dipoles to validate the proper functioning of the system.

6.2. System Components

ES3DV2 Probe Specification

Photograph of the probe

Construction: Symmetrical design with triangular core
Interleafed sensors
Built-in shielding against static charges
PEEK enclosure material (resistant to organic solvents, e.g., glycol)

Calibration: In air from 10 MHz to 3 GHz
In brain and muscle simulating tissue at frequencies of 450 MHz, 900 MHz and 1.8 GHz (accuracy ± 8%)
Calibratin for other liquids and frequencies upon request

Frequency: 10 MHz to > 6GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.2 dB in brain tissue (rotation around probe axis)
± 0.3 dB in brain tissue (rotation normal to probe axis)

Dynamic Range: 5µW/g to > 100 mW/g; Linearity: ± 0.2 dB

Dimensions: Overall length: 330 mm
Tip length: 20 mm
Body diameter: 12 mm
Tip diameter: 3.9 mm
Distance from probe tip to dipole centers: 2.7 mm

Application: General dosimetry up to 5 GHz
Dosimetry in strong gradient fields
Compliance tests of mobile phones

The SAR measurements were conducted with the dosimetric probe ET3DV2 designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY3 software reads the reflection during a software approach and looks for the maximum using a 2 nd order fitting. The approach is stopped when reaching the maximum.

Inside view of ES3DV2 E-field Probe

E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a waveguide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

Data Evaluation

The DASY3 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe Parameter:	-Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	-Conversion Factor	ConvFi
	-Diode compression point	Dcp_i
Device parameter:	-Frequency	f
	-Crest Factor	cf
Media parameter:	-Conductivity	s
	-Density	?

These parameters must be set correctly in the software. They can either be found in the component documents or be imported into the software from the configuration files issued for the DASY3 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$Vi = Ui + (Ui)^2 \, cf / dcp_i$$

With Vi = compensated signal of channel i (i =x, y, z)
Ui = input signal of channel i (i =x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

H-field probes: $$H_i = \sqrt{Vi} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

With Vi = compensated signal of channel i (i =x, y, z)
$Norm_i$ = sensor sensitivity of channel i (i =x, y, z)
µV/ (V/m)^2 for E-field probes
ConF = sensitivity enhancement in solution
a_{ij} = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strenggy of channel i in V/m
H_i = diode compression point (DASY parameter)

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \text{Square Root } [(E_x)^2 + (E_y)^2 + (E_z)^2]$$

The primary field data are used to calculate the derived field units.

$$SAR = (E_{tot})^2 ?s /(? ?1000)$$

With SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
s = conductivity in [mho/m] or [Siemens/m]
? = equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

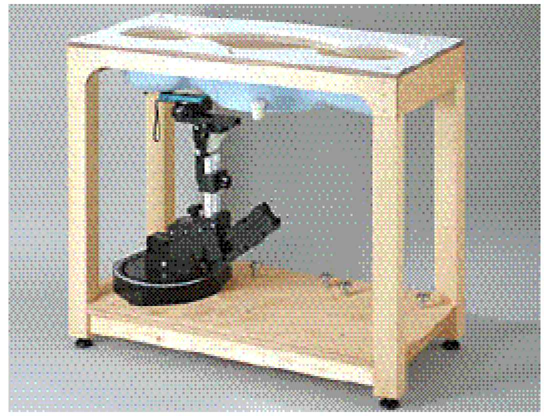
The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = (E_{tot})^2 / 3770 \text{ or } P_{pwe} = (H_{tot})2 ? 37.7$$

With P_{pwe} = equivalent power density of a plane wave in mW/cm3
E_{tot} = total electric filed strength in V/m
H_{tot} = total magnetic filed strength in V/m

Generic Twin Phantom

The Generic Twin Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allows the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.
Shell Thickness 2 ± 0.1 mm
Filling Volume Approx. 20 liters
Dimensions 810 x 1000 x 500 mm (H x L x W)

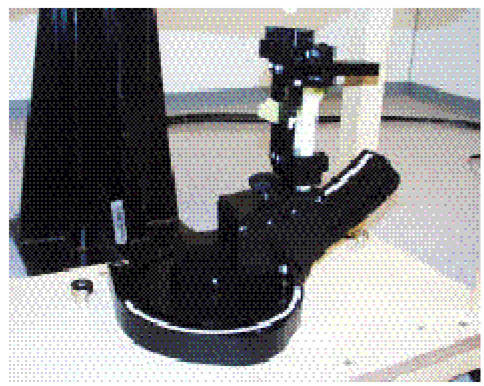


Generic Twin Phantom

Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



Device Holder

6.3 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [13] and the NIST1297 [14] documents and is given in the following Table.

Measurement Uncertainty Analysis per IEEE P1528-2002								
Description	Section	Reported Variance (%)	Probability Distribution type	Divisor	Ci (1g)	Ui (1g)	Vi	welc/satt series term
Probe Calibration	E.2.1	4.80	N	1	1	4.80	1.00E+09	5.30842E-07
Axial isotropy	E.2.2	4.70	R	1.732	0.707107	1.92	1.00E+09	1.35563E-08
Hemispherical isotropy	E.2.2	9.60	R	1.732	0.707107	3.92	1.00E+09	2.35957E-07
Boundary effects	E.2.3	8.30	R	1.732	1	4.79	1.00E+09	5.27377E-07
Linearity	E.2.4	4.70	R	1.732	1	2.71	1.00E+09	5.4225E-08
System Detection Limit	E.2.5	1.00	R	1.732	1	0.58	1.00E+09	1.11124E-10
Readout Electronics	E.2.6	0.00	N	1	1	0.00	1.00E+09	0
Response time	E.2.7	0.00	R	1.732	1	0.00	1.00E+09	0
Integration time	E.2.8	0.00	R	1.732	1	0.00	1.00E+09	0
RF Ambient conditions	E.6.1	3.00	R	1.732	1	1.73	1.00E+09	9.00106E-09
Probe positioning mechanical tolerance	E.6.2	0.40	R	1.732	1	0.23	1.00E+09	2.84478E-12
Probe positioning wrt phantom shell	E.6.3	2.90	R	1.732	1	1.67	1.00E+09	7.8596E-09
Extra/inter-polation & integration algorithmsfor max SAR evaluation	E.5.2	3.90	R	1.732	1	2.25	1.00E+09	2.57079E-08
Test sample positioning	8, E.4.2	6.00	R	1.732	1	3.46	1.00E+09	1.44017E-07
Device holder distance tolerance	E.4.1	5.00	N	1	1	5.00	1.00E+09	0.000000625
Output power and SAR drift measurement	8, E.6.6.2	5.00	R	1.732	1	2.89	1.00E+09	6.94526E-08
Phantom uncertainty, shell thickness tolerance	E.3.1	4.00	R	1.732	1	2.31	1.00E+09	2.84478E-08
Liquid conductivity, deviation from target values	E.3.2	5.00	R	1.732	0.64	1.85	1.00E+09	1.16522E-08
Liquid conductivity, measurement uncertainty	E.3.3	5.00	N	1	0.64	3.20	5	20.97152
Liquid permitivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09
Liquid permitiv ity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2
								689
Probe isotropy sensitivity coefficient	0.5							
Combined Standard Uncertainty						12.65	%	
Expanded Uncertainty, 95% confidence		k=	2.004			25.34	%	

7 - EVALUATION PROCEDURE

7.1 Body SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location within an anthropomorphic torso simulation shell was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of the torso was measured at the required distance from the inner surface of the shell. The area covered the entire dimension of the EUT and the horizontal grid spacing was 20 mm x 20 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

Step 3: Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

1. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm [11]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

2. The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one dimensional splines with the “Not a knot"-condition (in x, y and z-directions) [11], [12]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

3. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.