

ATTACHMENT S – DIPOLE CALIBRATION DATA

DIPOLE ANTENNA for SYSTEM VALIDATION

Description : Validation Dipole Antenna

Model : ES-D-835 (835 MHz)

Manufacturer : EMF Safety Inc.

Serial No : 1012

Manufactured : June 2003

Test Date : February 15, 2005

Tested by : Lee, Seung-Bae *LeeSeungbae*

Approved by : Gimm, Youn-Myoung *Younmyoung*

1. Dipole antenna measurement

1.1 Conditions

The standard dipole antenna have a return loss better than -20 dB (as measured in the test set-up) at the test frequency (see Fig. 1).

- Frequency : 835 MHz
- Network analyzer : HP 8753C
- Flat phantom dimensions (W×L×H) : 360, 300, 190 (mm)
- Flat phantom shell thickness : 2.0 (mm)
- Reference dipole distance S from the liquid : 15 (mm)
- Liquid relative permittivity (ϵ_r) range : $41.5 \pm 5\%$
- Liquid conductivity (σ) range : $0.90 \pm 5\%$ (S/m)

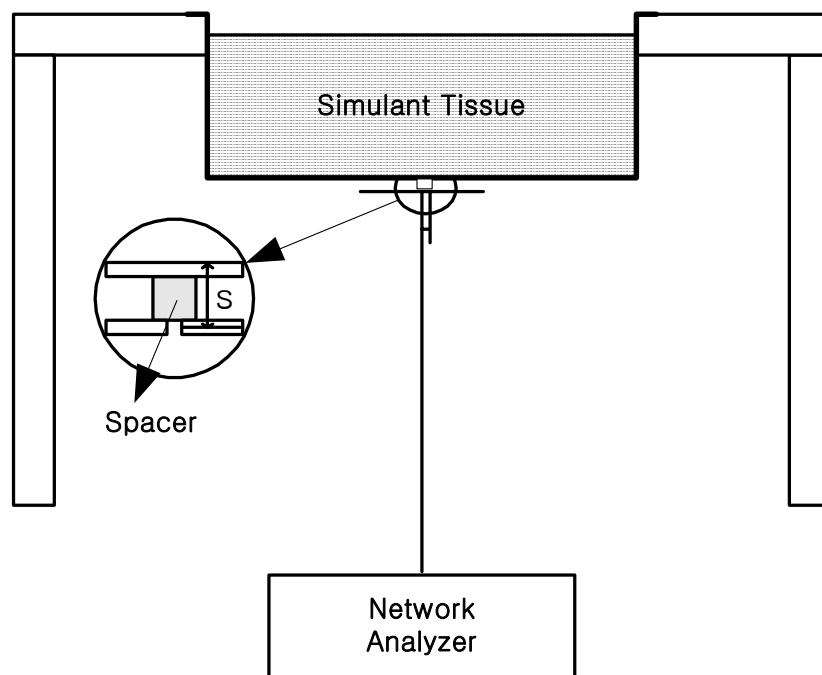


Fig. 1 Test equipment set-up for return loss measurement

1.2 Mechanical dimensions of dipole antenna

Length (L) : 161.0 mm
Height (h) : 89.8 mm
Diameter (d) : 3.6 mm

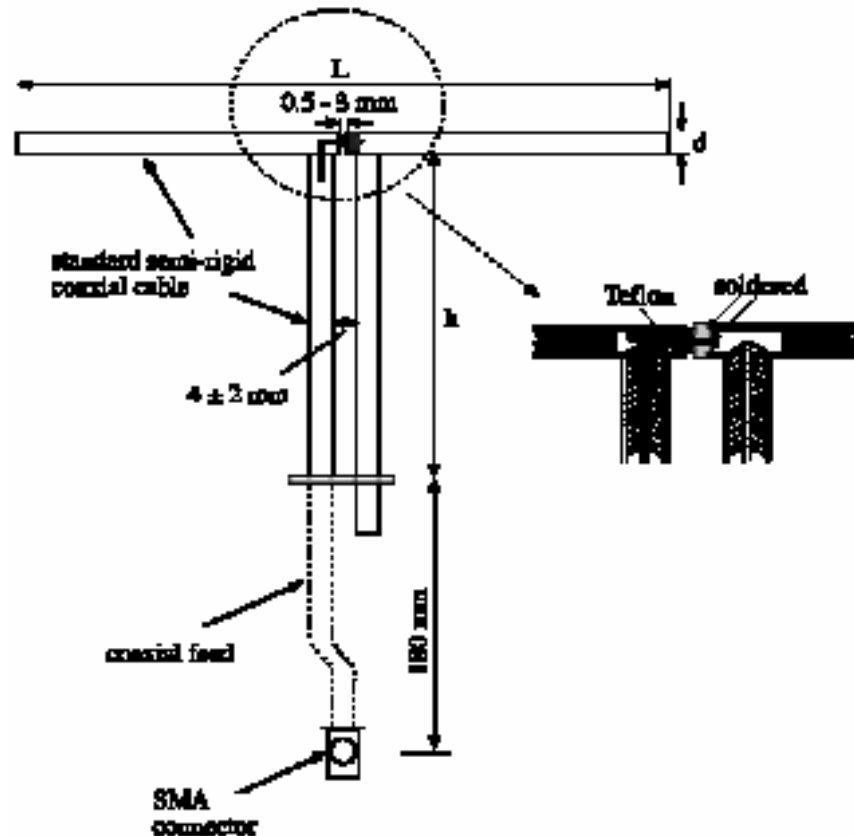


Fig. 2 Reference dipole – basic mechanical parameters.

1.3 Measured dipole antenna impedance and return loss

Feed point impedance	53.24 -j2.8309 Ω
Return loss	27.8 dB

1.4 Data sheets

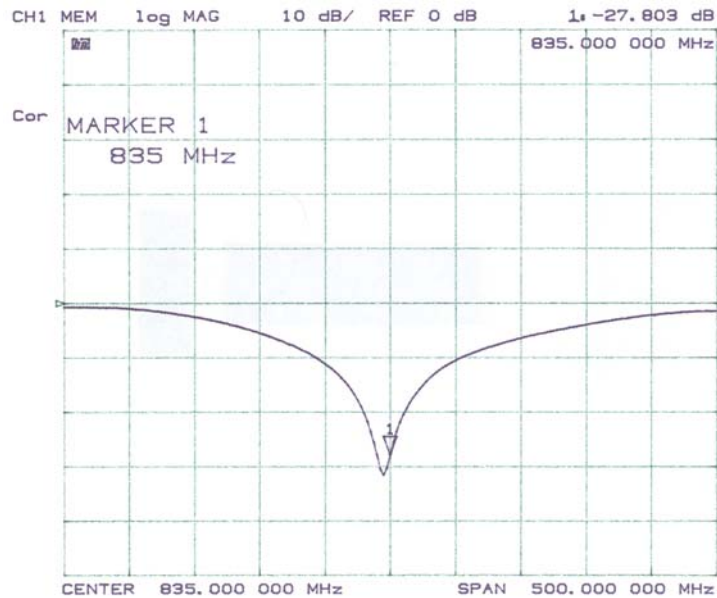


Fig. 3 Return loss test. Mark 1 represents 835 MHz.

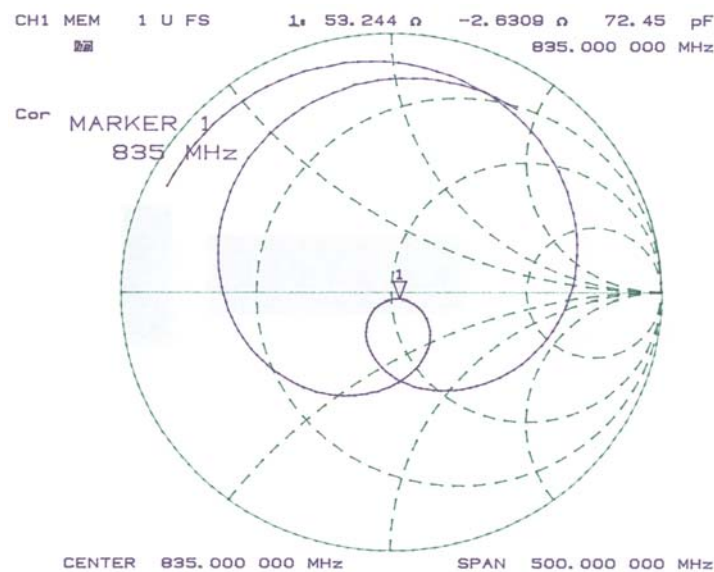


Fig. 4 Feed point impedance at 835 MHz of the dipole

2. SAR measurement set-up

2.1 Environment

- Test set-up at 835 MHz using the dipole antenna (Fig 1)
- Ambient temperature of the laboratory : $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$
- Temperature of the tissue : $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$

2.2 Probe

Model	ET20
Serial No.	04OCT-0038
Calibrated	January 6, 2005
Conversion factor	5.11
DCP (mV)	Ch1 = 110, Ch2 = 110, Ch3 = 110
Sensor sensitivity [$\mu\text{V}/(\text{V}/\text{m})^2$]	Ch1 = 0.669, Ch2 = 0.768, Ch3 = 0.756

2.3 Flat phantom

Flat phantom dimension (W×L×H)	360 × 300 × 190 [mm]
Flat phantom shell thickness	2.0 [mm]
Electrical characteristic at 800 MHz	$\epsilon_r = 4.254$, $\tan \delta = 0.033$

2.4 Dipole antenna

Dipole antenna dimension (L×h×d)	161.0 × 89.8 × 3.6[mm]
Dipole to phantom (S)	15 [mm]
Return loss	27.8 dB

2.5 Head tissue

Permittivity range	41.5 ±5 %
Conductivity range (S/m)	0.90 ±5 %

2.6 Test input power to the dipole

Forward power to the dipole antenna	250 mW (24 dBm)
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3. SAR measurement for system validation

- Test set-up in Fig. 5
- SAR measurement with system model ESSAY-3 of EMF Safety Inc.
- Reference

IEEE Std 1528-200X ; DRAFT Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications. Devices : Experimental Techniques

- The results are for the normalized 1 W input power the dipole antenna.

. Result

	Measured	Target value	Difference from target value
1 g SAR	9.676 W/kg	9.5 W/kg	+ 1.8 %
10 g SAR	6.244 W/kg	6.2 W/kg	+ 0.7 %

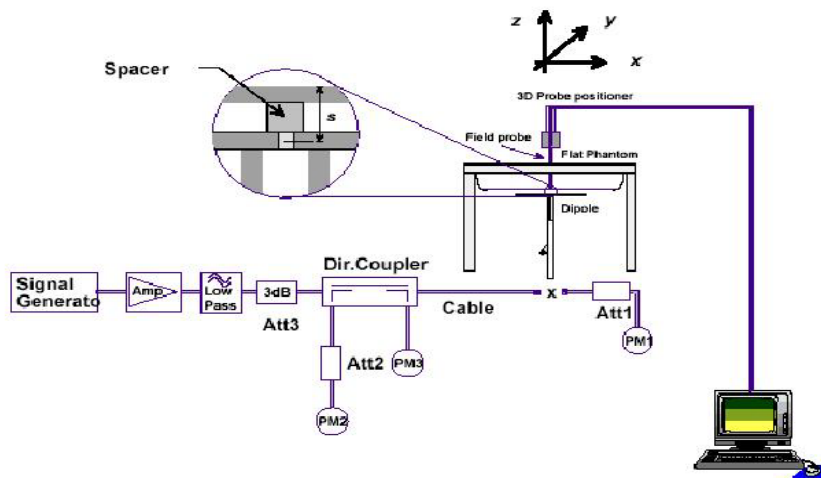


Fig. 5 System validation measurement set-up

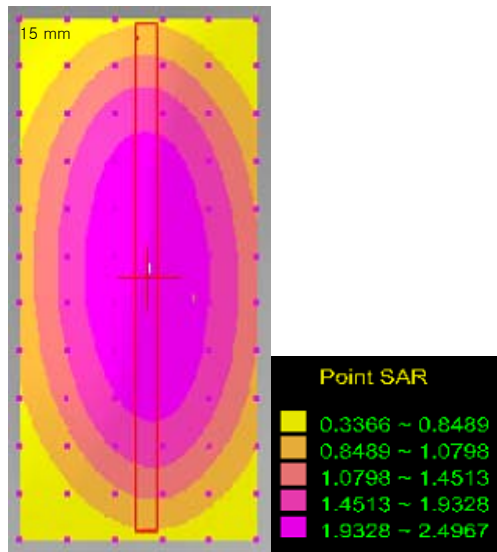


Fig. 6 E-field contour above the dipole antenna in the liquid with 250 mW input power.

4. List of used equipments

Description	Manufacturer	Model / Serial No.	Date of Cal.	Calibration by / Certificate No.
Signal Generator	Wiltron	68347B / 534006	2004/07/02	HCT / C-2004-14074
Power Meter	HP	436A / 1803A04211	2004/07/01	HCT / C-2004-14069
Power Meter	HP	436A / 2709A26102	2004/07/01	HCT / C-2004-14071
Power Sensor	HP	8481A / 2702A52736	2004/06/29	HCT / C2004-14070
Power Sensor	HP	8482A / 2235A07171	2004/06/29	HCT / C-2004-14072
Dual Directional Coupler	HP	778D / 13472	2004/07/01	HCT / C-2004-14073
Network Analyzer	HP	8753C / 2901A00795	2004/07/01	HCT / C-2004-14068

5. Data sheet of the system validation

SAR Measurement Report

SAR TEST DATA SUMMARY

Simulant Liquid :	Head	Ambient Temperature (°C) :	23
Dielectric Constant :	41.5	Relative Humidity (%) :	26
Conductivity (S/m) :	0.9		
Phantom Model :	Flat	Place of Measurement :	EMF Safety
Test Date :	14-Feb-05	Measuring Equipment :	ESSAY-III

DUT	Probe
Model	Model
Power (dBm) :	ET20-04 OCT-0038
Frequency (MHz) :	Offset (mm) :
Serial No.	Conversion Factor :
Antenna ES-D-835	Duty Factor :
24	2.1
835	5.11
1012	1

Reference Point SAR(W/kg) in Medium

Before Scanning :	2.63608	After Scanning :	2.61178	Drit :	-0.922 %
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Measurement Result (W/kg)

Averaged 1g SAR :	2.419	Averaged 10g SAR :	1.561
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Notes :

DIPOLE ANTENNA for SYSTEM VALIDATION

Description : Validation Dipole Antenna

Model Type : ES-D-1900 (1900 MHz)

Manufacturer : EMF Safety Inc.

Serial No : 1005

Manufactured : June 2003

Test Date : February 15, 2005

Tested by : Lee, Seung-Bae *Lee Seungbae*

Approved by : Gimm, Youn-Myoung *Younmyoung*

1. Dipole antenna measurement

1.1 Conditions

The standard dipole antenna have a return loss better than -20 dB (as measured in the test set-up) at the test frequency (see Fig. 1).

- Frequency : 1900 MHz
- Network analyzer : HP 8753C
- Flat phantom dimensions (W×L×H) : 360 × 300 × 190 (mm)
- Flat phantom shell thickness : 2.0 (mm)
- Reference dipole distance S from the liquid : 10 (mm)
- Liquid relative permittivity (ϵ_r) range : $40.0 \pm 5\%$
- Liquid conductivity (σ) range : $1.40 \pm 5\%$ (S/m)

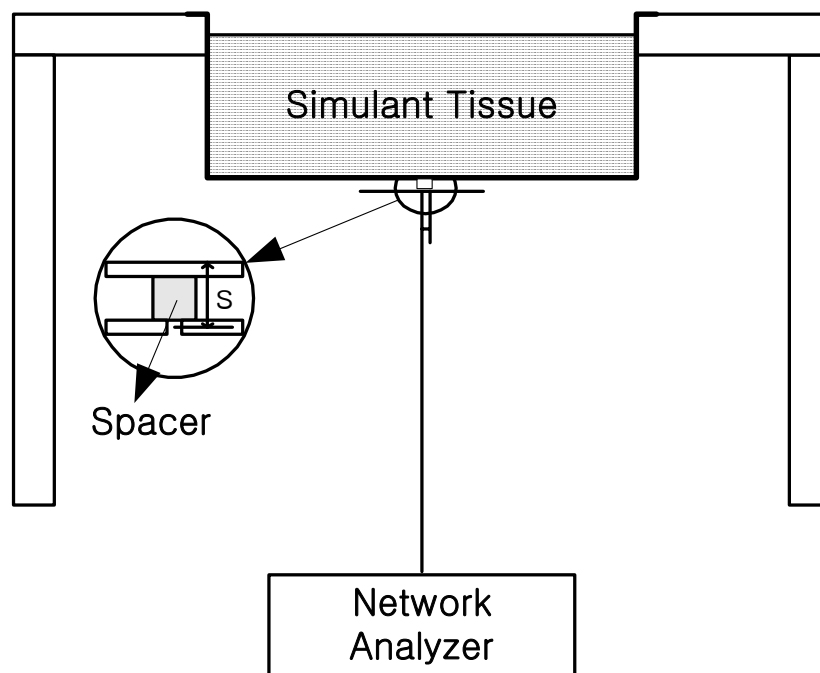


Fig. 1 Test equipment set-up for return loss measurement

1.2 Mechanical dimensions

Length (L) : 68.0 mm
Height (h) : 39.5 mm
Diameter (d) : 3.6 mm

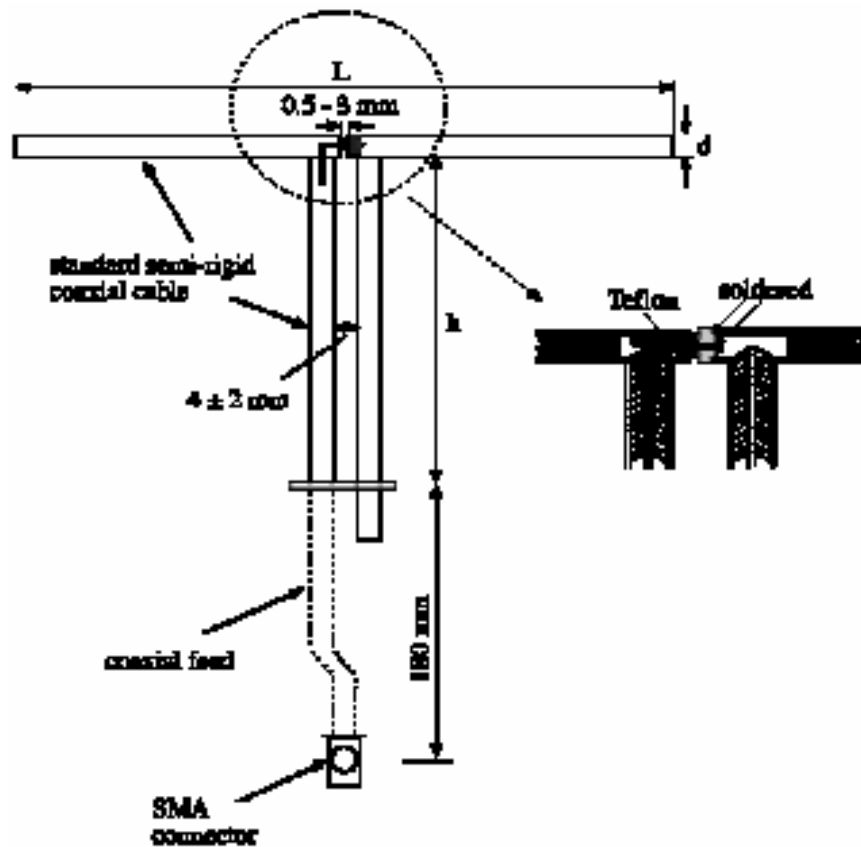


Fig. 2 Reference dipole – basic mechanical parameters.

1.3 Dipole antenna impedance and return loss

Feed point impedance	$49.16 + j3.804 \Omega$
Return loss	28.1 dB

1.4 Data sheets

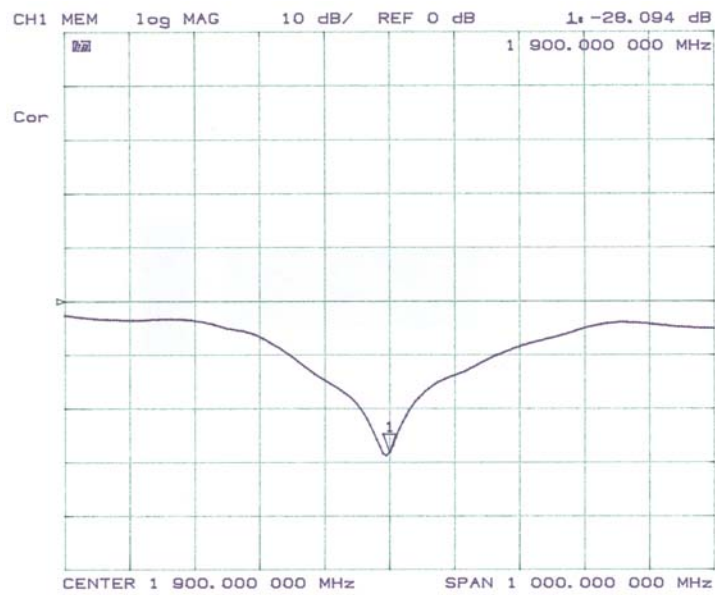


Fig. 3 Return loss test. Mark 1 represents 1,900 MHz

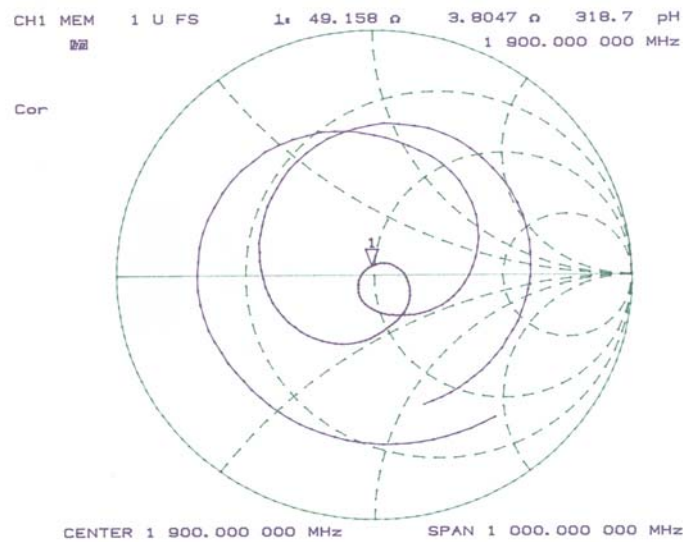


Fig. 4 Feed point impedance at 1,900 MHz of the dipole

2. SAR measurement set-up

2.1 Environment

- Test set-up at 1900 MHz using the dipole antenna (Fig 1)
- Ambient temperature of the laboratory : $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$
- Temperature of the tissue : $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$

2.2 Probe

Model	ET20
Serial No.	04OCT-0038
Calibrated	January 6, 2005
Conversion factor	4.53
DCP (mV)	Ch1 = 110, Ch2 = 110, Ch3 = 110
Sensor sensitivity [$\mu\text{V}/(\text{V}/\text{m})^2$]	Ch1 = 0.669, Ch2 = 0.768, Ch3 = 0.756

2.3 Flat phantom

Flat phantom dimension (W×L×H)	$360 \times 300 \times 190$ [mm]
Flat phantom shell thickness	2.0 [mm]
Electrical characteristic at 1900 MHz	$\epsilon_r = 4.167$, $\tan \delta = 0.029$

2.4 Dipole antenna

Dipole antenna dimension (L×h×d)	$68.0 \times 39.5 \times 3.6$ [mm]
Dipole to phantom (S)	10 [mm]
Return loss	28.1 dB

2.5 Head tissue

Permittivity range	$40 \pm 5\%$
Conductivity range (S/m)	$1.4 \pm 5\%$

2.6 Test input power to the dipole

Forward power to the dipole antenna	250 mW (24 dBm)
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3. SAR measurement for system validation

- Test set-up in Fig. 5
- SAR measurement with system model ESSAY-3 of EMF Safety Inc.
- Reference

IEEE Std 1528-200X ; DRAFT Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices : Experimental Techniques

- The results are for the normalized 1 W input power the dipole antenna.

. Result

	Measured	Target value	Difference from target value
1 g SAR	40.384 W/kg	39.7 W/kg	+ 1.7 %
10 g SAR	20.232 W/kg	20.5 W/kg	- 1.3 %

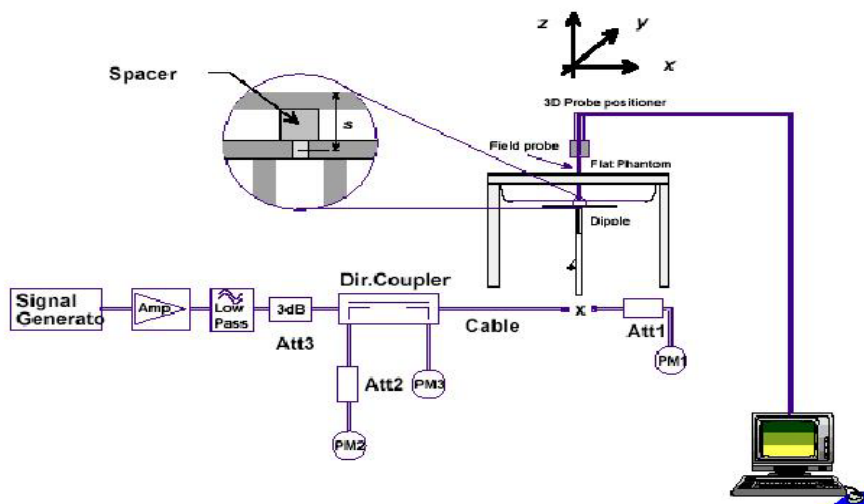


Fig. 5 System validation measurement set-up

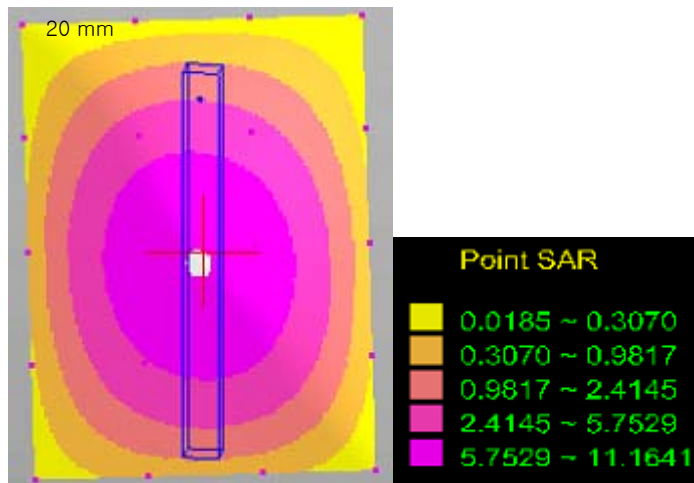


Fig. 6 E-field contour above the dipole antenna in the liquid with 250 mW input power.

4. List of used equipments

Description	Manufacturer	Model / Serial No.	Date of Cal.	Calibration by / Certificate No.
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Power Meter	HP	436A / 1803A04211	2004/07/01	HCT / C-2004-14069
Power Meter	HP	436A / 2709A26102	2004/07/01	HCT / C-2004-14071
Power Sensor	HP	8481A / 2702A52736	2004/06/29	HCT / C2004-14070
Power Sensor	HP	8482A / 2235A07171	2004/06/29	HCT / C-2004-14072
Dual Directional Coupler	HP	778D / 13472	2004/07/01	HCT / C-2004-14073
Network Analyzer	HP	8753C / 2901A00795	2004/07/01	HCT / C-2004-14068

5. Data sheet of the system validation

SAR Measurement Report

SAR TEST DATA SUMMARY

Simulant Liquid :	Head	Ambient Temperature (°C) :	23
Dielectric Constant :	38.5	Relative Humidity (%) :	25
Conductivity (S/m) :	1.4		
Phantom Model :	Flat	Place of Measurement :	EMF Safety
Test Date :	14-Feb-05	Measuring Equipment :	ESSAY-III

<u>DUT</u>		<u>Probe</u>	
Model	Antenna ES-D-1900	Model	ET20-04 OCT-0038
Power (dBm) :	24	Offset (mm) :	2.1
Frequency (MHz) :	1900	Conversion Factor :	4.53
Serial No.	1005	Duty Factor :	1

Reference Point SAR(W/kg) in Medium

Before Scanning :	12.60044	After Scanning :	12.68026	Drit :	+0.633 %
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Measurement Result (W/kg)

Averaged 1g SAR :	10.096	Averaged 10g SAR :	5.058
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Notes :
