1. Tissue Parameters

SAR measurements were made within 24 hours of the measurement of liquid parameters.

850MHz Body Liquid:

Recipe:
The following recipe is provided in percentage by weight.
60.00% Distilled water
35.00% DGBE
5.00% Salt

Date	Frequency (MHz)	Relative Permittivity	Conductivity (S/m)
09/27/10	835	54.15	0.963
09/27/10	836.6	54.13	0.969

1900MHz Body Liquid:

Recipe:
The following recipe is provided in percentage by weight.
69.17% Distilled water
30.29% DGBE
0.44% Salt

Date	Frequency (MHz)	Relative Permittivity	Conductivity (S/m)
09/28/10	1880	51.4	1.552

2. Test Equipment

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Bench top Robot	Mitsubishi supplied by IndexSAR	RV-E2	EA1030108	N/A	N/A
SAM Phantom	Upright shell phantom made by Antennessa digitized and mounted by IndexSAR	SAM	03FT26	04/03	N/A
Flat Phantom	IndexSAR	HeadBox_1	N/A	N/A	N/A
Software	IndexSAR	SARA2 v0.420	N/A	N/A	N/A
850 MHz Body Tissue Simulant	Cetecom Inc.	850 Body	N/A	09/27/2010	N/A
1900 MHz Body Tissue Simulant	Cetecom Inc.	1900 Body	N/A	09/28/10	N/A
850 MHz Dipole	IndexSAR – IEEE 1528 design	IXD-245	081	02/13/2009	02/13/2011
1900 MHz Dipole	IndexSAR – IEEE 1528 design	IXD-188	016	02/13/2009	02/13/2011
Directional coupler	Werlatone	C6529	11249	N/A	N/A
RF Amplifier	Vectawave	VTL5400	N/A	N/A	N/A
SAR Probe	IndexSAR	IXP-050	S/N 0116	10/19/2009	10/19/2010
Dielectric Measurement Kit	IndexSAR	Di-Line	N/A	N/A	N/A

3. Equipment Calibration/Performance Documents:

KDB 450824 states that the return-loss and impedance of dipoles should be measured at least annually to ensure dipoles meed specification. Section 1c) states the return loss should not deviate by more than 20% of the previuos measurement. Section 1d) states the real or imaginary parts of the impedance should not deviate by more than 5 Ω from the previous measurement.

Measurements were made with the dipole against the flat phantom, filled with body liquid for the respective frequency.

835MHz Dipole Serial No 081 was measured on September 20, 2010. The return-loss is -20.577 dB, 0.4% deviation from calibration measurement. The real part impedance is 60.221Ω, 0.421 deviation from the calibration measurement. The imaginary part impedance is 1.3672Ω, 4.88 deviation from the calibration measurement. The 835MHz Dipole is within tolerances stated by KDB 450824.

1880MHz Dipole Serial No 016 was measured on September 20, 1010. The return-loss is -20.892 dB, . The return-loss is 0.2% deviation from calibration measurement. The real part impedance is 42.945Ω, -3.855 deviation from the calibration measurement. The imaginary part impedance is -4.5527, 3.65 deviation from the calibration measurement. The 1880MHz dipole is within tolerances stated by KDB 450824

The following pages are calibration reports for:

- SAR Probe 0116
- 850MHz Dipole Serial No 081
- 1900MHz Dipole Serial No 016

NATIONAL PHYSICAL LABORATORY

Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

Certificate of Calibration

SAR PROBE
IndexSAR
Model: IXP-050
Serial number: 0116

This certificate provides traceability of measurement to recognised national standards, and to the units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, unless permission for the publication of an approved extract has been obtained in writing from the Managing Director. It does not of itself impute to the subject of calibration any attributes beyond those shown by the data contained herein.

FOR:. CETECOM Inc.
411 Dixon Landing Road
Milpitas
California 95035
USA

Order number: PO000000000002096

DESCRIPTION: An IndexSAR isotropic electric field probe for determining specific absorption rates (SAR) in dielectric liquids. The probe has three orthogonal sensors, and the output voltage of the sensors is converted to an optical signal by a meter unit containing an analogue to digital (AD) converter. Probe readings are obtained using software via the RS232 port. The probe was calibrated with IndexSAR amplifier model IXA-010 S/N 036 belonging to NPL.

IDENTIFICATION: The probe is marked with the manufacturer's serial number 0116

MEASUREMENTS COMPLETED ON: 19 October 2009

PREVIOUS NPL CERTIFICATE: None

The reported uncertainty is based on a coverage factor $k = 2$, providing a level of confidence of approximately 95%

Reference : 2009070196

Date of Issue : 19 October 2009

Signed : D G Gentle **(Authorised Signatory)**

Checked by : B. Loader .

Name : Mr D G Gentle **for Managing Director**

MEASUREMENT PROCEDURE

The calibration method is based on establishing a calculable specific absorption rate (SAR) using a matched waveguide cell [1]. The cell has a feed-section and a liquid-filled section separated by a matching window that is designed to minimise reflections at the interface. A TE_{01} mode is launched into the waveguide by means of a N-type-to-waveguide adapter. The power delivered to the liquid is calculated from the forward power and reflection coefficient measured at the input to the cell. At the centre of the cross-section of the waveguide cell, the volume specific absorption rate (SAR^V) in the liquid as a function of distance from the window is given by

$$SAR^V = \frac{4(P_w)}{ab\delta} e^{-2Z/\delta} \qquad (1)$$

where

a = the larger cross-sectional dimension of the waveguide.
b = the smaller cross-sectional dimension of the waveguide.
δ = the skin depth for the liquid in the waveguide.
Z = the distance of the probe's sensors from the liquid to matching window boundary.
P_w = the power delivered to the liquid.

Liquids having the properties specified by British and IEEE Standards [2, 3] and FCC guidelines [4] were used for the calibration. The value of δ for the liquid was obtained by measuring the electric field (E) at a number of distances from the matching window. The calibration was for continuous wave (CW) signals, and the axis of the probe was parallel to the direction of propagation of the incident field i.e. end-on to the incident radiation. The probe was rotated about its axis in 15-degree steps, and the ratio of the calibration factors for the three probe sensors X, Y, & Z were optimized to give the best axial isotropy.

The probe was calibrated with the linearisation and air-correction factors enabled. Comparing the measured values of E^2 in the liquid to those calculated for the waveguide cell allows the ratio, *ConvF*, of sensitivity for (E^2_{LIQUID}) / (E^2_{AIR}) to be determined, as required by the probe software.

ENVIRONMENT

Measurements were made in a temperature-controlled laboratory at 22 ± 1°C. The temperature of the liquid used was measured at the beginning and end of each measurement.

UNCERTAINTIES

The estimated uncertainty in calibration for SAR (W kg^{-1}) is ± 10 %. The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%.

This uncertainty is valid when the probe is used in a liquid with the same dielectric properties as those used for the calibration. No estimate is made for the long-term stability of the device calibrated or of the fluids used in the calibration.

When using the probe for SAR testing, additional uncertainties should be added to account for the spherical isotropy of the probe, proximity effects, linearity, and response to pulsed fields. There will be additional uncertainty if the probe is used in liquids having significantly different electrical properties to those used for the calibration. The electrical properties of the liquids will be related to temperature.

RESULTS

Table 1 gives the results for the calibration in liquid and the air factors.

These calibration factors are only correct when the values for sensitivity in free-space, diode compression and sensor offset from the tip of the probe, as set in the probe software, are the same as those given in the Table.

REFERENCES:

[1] Pokovic, KT, T.Schmid and N.Kuster, "Robust set-up for Precise Calibration of E-field probes in Tissue Simulating Liquids at Mobile Phone Frequencies", Proceedings ICECOM 1997, pp 120 – 124, Dubrovnik, Croatia Oct 12-17, 1997.

[2] British Standard BS EN 503361:2001. "Basic standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)".

[3] IEEE Standard 1528-2003 "Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques".

[4] FCC-OET Bulletin 65 (97-01) "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", D. L. Means, K. W. Chan, June 2001.

Table 1
Sensitivity in Liquids.
SAR probe: IXP-050
S/N 0116

Probe settings for calibration		
Sensitivity in free-space[(4)]	**Diode Compression[(1)]**	**Sensor offset from tip of probe[(1)]**
Lin X = 936.77 $(V/m)^2/(V*200)$ Lin Y = 700.45 $(V/m)^2/(V*200)$ Lin Z = 673.31 $(V/m)^2/(V*200)$	DCP_X = 20 (V*200) DCP_Y = 20 (V*200) DCP_Z = 20 (V*200)	2.7 mm

Sensitivity in Liquid.

Calibration frequency (MHz)	Liquid [(2)]			Calibration Factors for E^2_{Liquid} / E^2_{Air}			Axial Isotropy (dB)
	Identifier	ε' [(3)]	σ [(3)] (Sm^{-1})	$ConvF_X$	$ConvF_Y$	$ConvF_Z$	
850	UOB900H-1	41.5	0.95	**0.24**	**0.26**	**0.25**	±0.03
850	TWS900B-1	56.8	0.98	**0.24**	**0.27**	**0.26**	±0.02
900	UOB900H-1	41.2	0.98	**0.24**	**0.26**	**0.26**	±0.03
900	TWS900B-1	56.5	1.01	**0.24**	**0.26**	**0.26**	±0.02
1750	TWS1800H-1	40.0	1.33	**0.30**	**0.29**	**0.30**	±0.02
1750	IndexSAR1850B	53.4	1.47	**0.31**	**0.31**	**0.33**	±0.02
1900	TWS1800H-1	39.4	1.48	**0.31**	**0.31**	**0.32**	±0.02
1900	IndexSAR1850B	52.9	1.61	**0.34**	**0.33**	**0.35**	±0.03
2000	TWS2450H-1	39.9	1.39	**0.31**	**0.31**	**0.33**	±0.03
2000	NPL2450B-1	54.1	1.59	**0.34**	**0.35**	**0.37**	±0.03
2450	TWS2450H-1	37.9	1.84	**0.29**	**0.31**	**0.31**	±0.02
2450	NPL2450B-1	53.1	1.92	**0.38**	**0.37**	**0.39**	±0.04

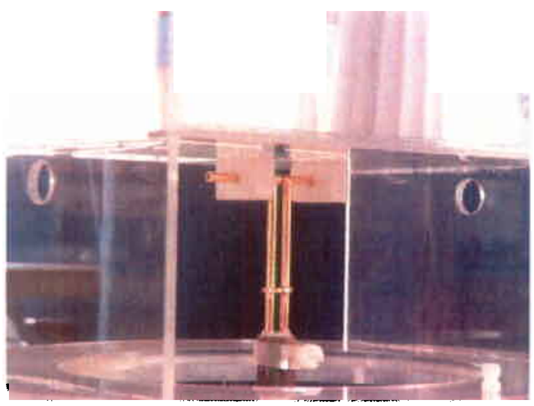
Notes.
(1) The manufacturer supplied these figures.
(2) Head or Muscle Simulating Liquid supplied by NPL.
(3) Measured at NPL at 22 ± 1 °C.
(4) Measured at NPL in a Field Strength of 30 V/m at 900 MHz.

Report No. SN081_0902
13th February 2009

INDEXSAR
835 MHz Validation Dipole
Type IXD-835 S/N 081

Performance measurements

Dr Tony Brinklow



Indexsar, Oakfield House, Cudworth Lane,
Newdigate, Surrey RH5 5BG. UK.
Tel: +44 (0) 1306 632 870 Fax: +44 (0) 1306 631 834
E-mail: enquiries@indexsar.com

1. Measurement Conditions

Measurements were performed using a box-shaped phantom made of PMMA with dimensions designed to meet the accuracy criteria for reasonably-sized phantoms that do not have liquid capacities substantially in excess of the volume of liquid required to fill the Indexsar upright SAM phantoms used for SAR testing of handsets against the ear. The wall thickness was 2mm.

An Anritsu MS4623B vector network analyser was used for the return loss measurements. The dipole was placed in a special holder made of low-permittivity, low-loss materials. This holder enables the dipole to be positioned accurately in the centre of the wall of the Indexsar box-phantom used for flat-surface testing and validation checks.

The validation dipoles are supplied with special spacers made from a low-permittivity, low-loss foam material. These spacers are fitted to the dipole arms to ensure that, when the dipole is offered up to the phantom surface, the spacing between the dipole and the liquid surface is accurately aligned according to the guidance in the relevant standards documentation [1]. The spacers are rectangular with a central hole equal to the dipole arm diameter and dimensioned so that the longer side can be used to ensure a spacing of 15mm from the liquid in the phantom (for tests at 1000MHz and below) and the shorter side can be used for tests at 1000MHz and above to ensure a spacing of 10mm from the liquid in the phantom. The spacers are made on a CNC milling machine with an accuracy of 1/40th mm but they may suffer wear and tear and need to be replaced periodically. The material used is Rohacell, which has a relative permittivity of approx. 1.05 and a negligible loss tangent.

The apparatus supplied by Indexsar for dipole validation tests thus includes:

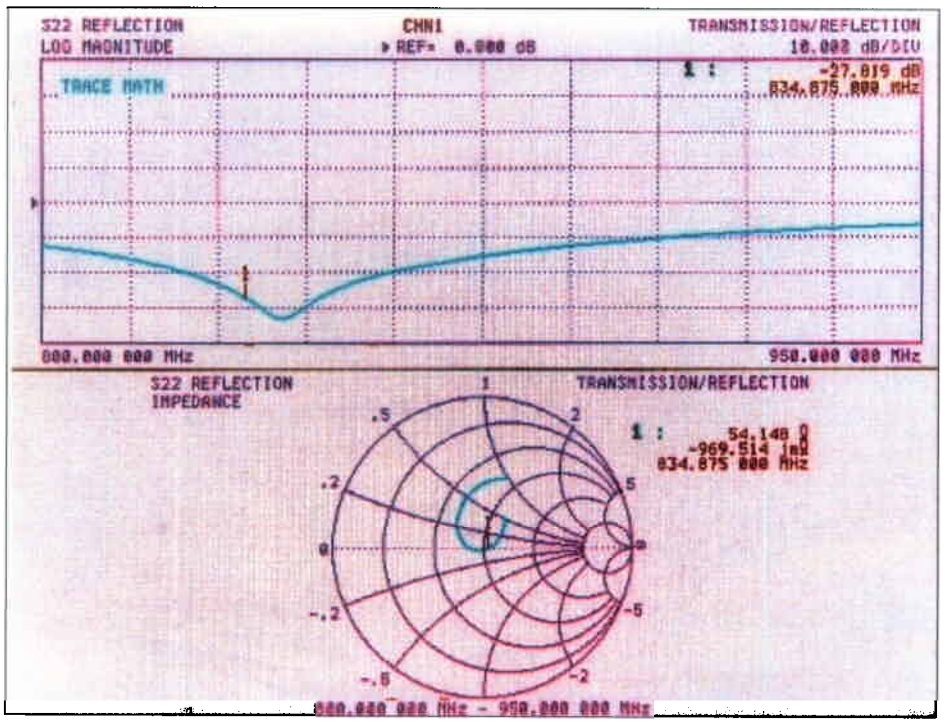
Balanced dipoles for each frequency required are dimensioned according to the guidelines given in IEEE 1528 [1]. The dipoles are made from semi-rigid 50 Ohm co-ax, which is joined by soldering and is gold-plated subsequently. The constructed dipoles are easily deformed, if mis-handled, and periodic checks need to be made of their symmetry.

Rohacell foam spacers designed for presenting the dipoles to 2mm thick PMMA box phantoms. These components also suffer wear and tear and should be replaced when the central hole is a loose-fit on the dipole arms or if the edges are too worn to ensure accurate alignment. The standard spacers are dimensioned for use with 2mm wall thickness (additional spacers are available for 4mm wall thickness).

2. Dipole impedance and return loss

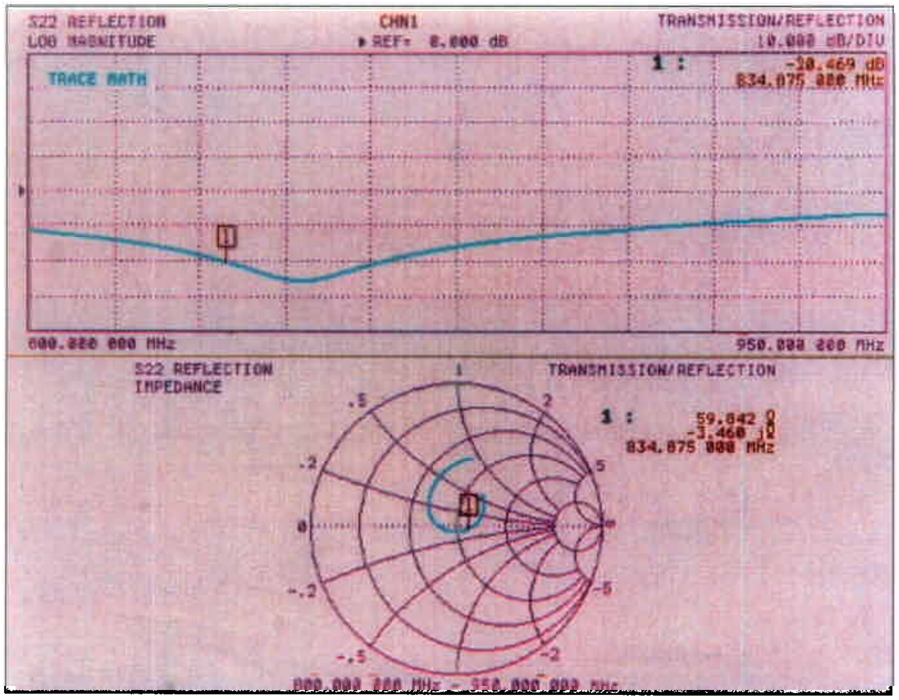
The dipoles are designed to have low return loss ONLY when presented against a lossy-phantom at the specified distance. A Vector Network Analyser (VNA) was used to perform a return loss measurement on the specific dipole when in the measurement-location against the box phantom. The distance was as specified in the standard i.e. 15mm from the liquid (for 835MHz). The Indexsar foam spacers (described above) were used to ensure this condition during measurement.

The impedance was measured at the SMA-connector with the network analyser. The following parameters were measured against Head fluid:



Dipole impedance at 835 MHz	Re{Z} = **54.1 Ω** Im{Z} = **-0.9 Ω**
Return loss at 835MHz	**-27.8 dB**

The measurements were also repeated against 835MHz Body fluid:



Dipole impedance at 835 MHz   Re{Z} = **59.8 Ω**
Im{Z} = **-3.5 Ω**

Return loss at 835MHz   **-20.5 dB**

3. SAR Validation Measurement in Brain Fluid

SAR validation checks have been performed using the dipole and the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests were then conducted at a feed power level of approx. 0.25W. The actual power level was recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). A correction factor was also applied to account for transmission loss arising from the dipole's reflection coefficient.

The ambient temperature was 21°C +/- 1°C and the relative humidity was around 35% during the measurements.

The phantom was filled with a 835MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 835MHz at the measurement temperature:

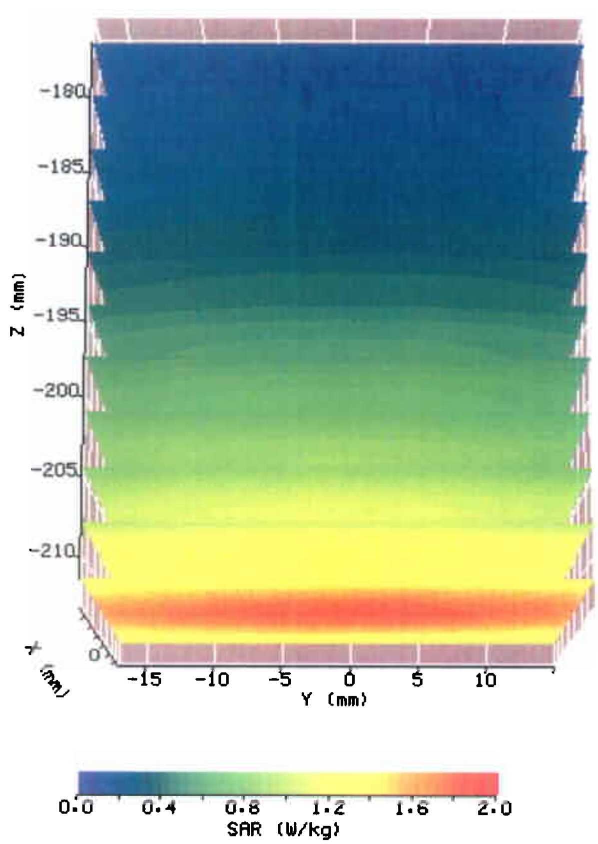
Relative Permittivity	**40.85**	**(Target: 41.5)**
Conductivity	**0.90 S/m**	**(Target: 0.90 S/m)**

SAR specification EN62209-2(2007) [ref 2], in which the validation method is described, specifies how to adjust measured 1g & 10g volume-averaged SAR values to take into account the difference between the fluid's actual, and target, electrical properties. The correction factors for this combination of properties at 835MHz equals:

1g: -0.1%
10g: -0.03%

The SARA2 software version 2.54 VPM was used with Indexsar IXP_050 probe Serial Number 0127 previously calibrated using waveguides.

The 3D measurement made using the dipole at the bottom of the phantom box is shown below:



SAR measurement standard 62209-1 [ref 2] tabulates the volume-averaged 1g and 10g SAR values over a range of frequencies up to 3000MHz. The following values are listed for 835MHz:

	SAR values (W/kg) (Normalised to 1W feed power)
1g SAR	9.5
10g SAR	6.2

The validation results, also normalised to an input power of 1W (forward power) were:

	Measured SAR values (W/kg) (Normalised to 1W feed power)	% Deviation from Standard
1g SAR	9.44	-0.7%
10g SAR	6.24	+0.6%

4. SAR Measurement in Body Fluid

SAR validation checks are only defined in the standard against brain simulant fluid. Nonetheless, it is possible to measure the effective volume-averaged SAR values against body fluid, simply to provide a reference value.

The ambient temperature was 21°C +/- 1°C and the relative humidity was around 32% during the measurements.

The phantom was filled with a 835MHz body liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 835MHz at the measurement temperature:

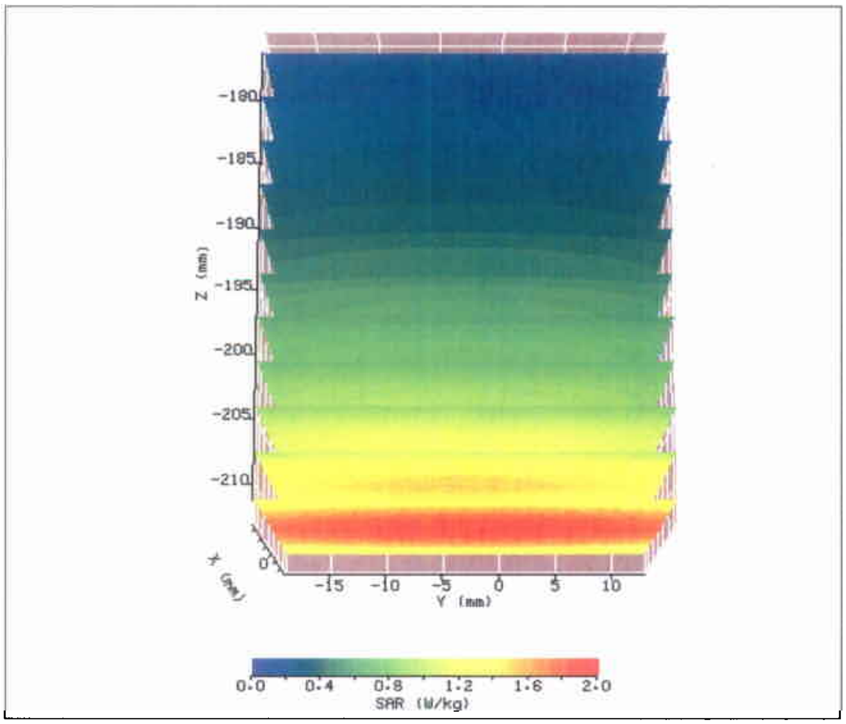
Relative Permittivity	**55.91**	**(Target: 55.2)**
Conductivity	**0.99 S/m**	**(Target: 0.97 S/m)**

The correction factors for this combination of properties at 835MHz equals:

1g: -1.1%
10g: -0.9%

The SARA2 software version 2.54 VPM was used with Indexsar IXP_050 probe Serial Number 0127 previously calibrated using waveguides.

The 3D measurement made using the dipole at the bottom of the phantom box is shown below:



The validation results, also normalised to an input power of 1W (forward power) were:

	Measured SAR values (W/kg) (Normalised to 1W feed power)	% Deviation from Standard
1g SAR	9.78	N/A
10g SAR	6.48	N/A

5. Dipole handling

The dipoles are made from standard, copper-sheathed coaxial cable. In assembly, the sections are joined using ordinary soft-soldering. This is necessary to avoid excessive heat input in manufacture, which would destroy the polythene dielectric used for the cable. The consequence of the construction material and the assembly technique is that the dipoles are fragile and can be deformed by rough handling. Conversely, they can be straightened quite easily as described in this report.

If a dipole is suspected of being deformed, a normal workshop lathe can be used as an alignment jig to restore the symmetry. To do this, the dipole is first placed in the headstock of the lathe (centred on the plastic or brass spacers) and the headstock is rotated by hand (do NOT use the motor). A marker (lathe tool or similar) is brought up close to the end of one dipole arm and then the headstock is rotated by 0.5 rev. to check the opposing arm. If they are not balanced, judicious deformation of the arms can be used to restore the symmetry.

If a dipole has a failed solder joint, the dipole can be fixed down in such a way that the arms are co-linear and the joint re-soldered with a reasonably-powerful electrical soldering iron. Do not use gas soldering irons. After such a repair, electrical tests must be performed as described below.

Please note that, because of their construction, the dipoles are short-circuited for DC signals.

6. Tuning the dipole

The dipole dimensions are based on calculations that assumed specific liquid dielectric properties. If the liquid dielectric properties are somewhat different, the dipole tuning will also vary. A pragmatic way of accounting for variations in liquid properties is to 'tune' the dipole (by applying minor variations to its effective length). For this purpose, Indexsar can supply short brass tube lengths to extend the length of the dipole and thus 'tune' the dipole. It cannot be made shorter without removing a bit from the arm. An alternative way to tune the dipole is to use copper shielding tape to extend the effective length of the dipole. Do both arms equally.

It should be possible to tune a dipole as described, whilst in place in the measurement position as long as the user has access to a VNA for determining the return loss.

7. References

[1] IEEE Std 1528-2003. IEEE recommended practice for determining the peak spatial-average specific absorption rate (SAR) in the human body due to wireless communications devices: Measurement Techniques – Description.

[2] BS EN 62209-1:2006 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)

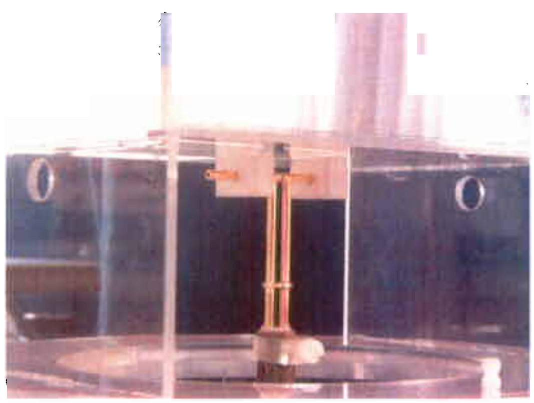
[3] BS EN 62209-2:2007 Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices - Human models, Instrumentation, and Procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

Report No. SN016_0902
13th February 2009

INDEXSAR
1880 MHz Validation Dipole
Type IXDA-188 S/N 016

Performance measurements

Dr Tony Brinklow



Indexsar, Oakfield House, Cudworth Lane,
Newdigate, Surrey RH5 5BG. UK.
Tel: +44 (0) 1306 632 870 Fax: +44 (0) 1306 631 834
E-mail: enquiries@indexsar.com

1. Measurement Conditions

Measurements were performed using a box-shaped phantom made of PMMA with dimensions designed to meet the accuracy criteria for reasonably-sized phantoms that do not have liquid capacities substantially in excess of the volume of liquid required to fill the Indexsar upright SAM phantoms used for SAR testing of handsets against the ear. The wall thickness was 2mm.

An Anritsu MS4623B vector network analyser was used for the return loss measurements. The dipole was placed in a special holder made of low-permittivity, low-loss materials. This holder enables the dipole to be positioned accurately in the centre of the wall of the Indexsar box-phantom used for flat-surface testing and validation checks.

The validation dipoles are supplied with special spacers made from a low-permittivity, low-loss foam material. These spacers are fitted to the dipole arms to ensure that, when the dipole is offered up to the phantom surface, the spacing between the dipole and the liquid surface is accurately aligned according to the guidance in the relevant standards documentation [1]. The spacers are rectangular with a central hole equal to the dipole arm diameter and dimensioned so that the longer side can be used to ensure a spacing of 15mm from the liquid in the phantom (for tests at 1000MHz and below) and the shorter side can be used for tests at 1000MHz and above to ensure a spacing of 10mm from the liquid in the phantom. The spacers are made on a CNC milling machine with an accuracy of 1/40th mm but they may suffer wear and tear and need to be replaced periodically. The material used is Rohacell, which has a relative permittivity of approx. 1.05 and a negligible loss tangent.

The apparatus supplied by Indexsar for dipole validation tests thus includes:

Balanced dipoles for each frequency required are dimensioned according to the guidelines given in IEEE 1528 [1]. The dipoles are made from semi-rigid 50 Ohm co-ax, which is joined by soldering and is gold-plated subsequently. The constructed dipoles are easily deformed, if mis-handled, and periodic checks need to be made of their symmetry.

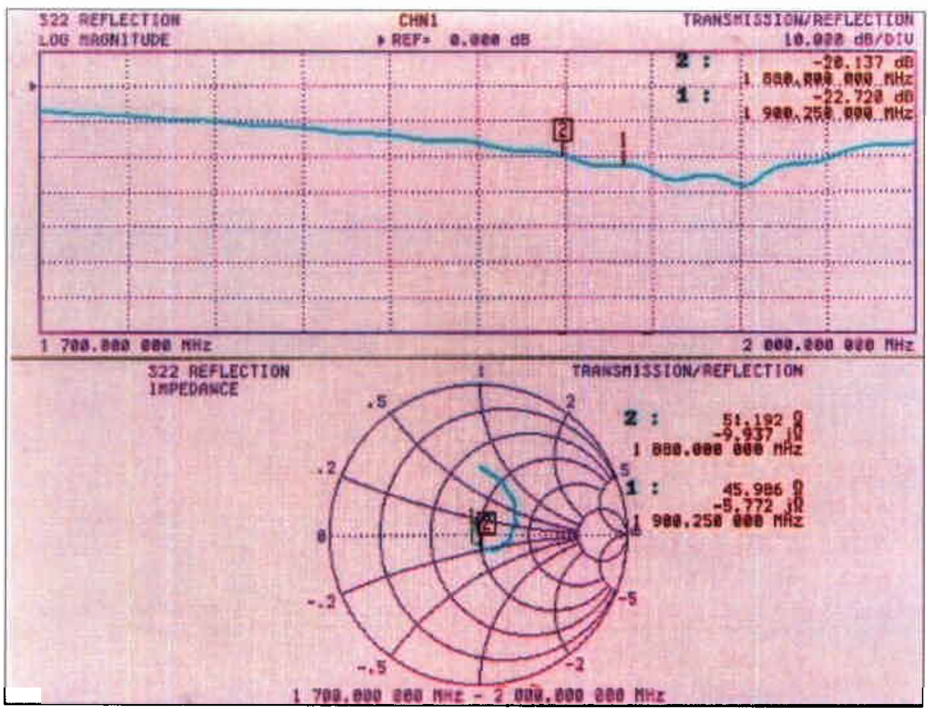
Rohacell foam spacers designed for presenting the dipoles to 2mm thick PMMA box phantoms. These components also suffer wear and tear and should be replaced when the central hole is a loose-fit on the dipole arms or if the edges are too worn to ensure accurate alignment. The standard spacers are dimensioned for use with 2mm wall thickness (additional spacers are available for 4mm wall thickness).

2. Dipole impedance and return loss

The customer advised that although the dipole-under-test was designed as an 1880MHz air dipole (model IXDA-188), in practice it is used as a SAR dipole. Consequently, this report concentrates on the dipole's 1900MHz performance relative to the 1900MHz reference values.

The dipoles are designed to have low return loss ONLY when presented against a lossy-phantom at the specified distance. A Vector Network Analyser (VNA) was used to perform a return loss measurement on the specific dipole when in the measurement-location against the box phantom. The distance was as specified in the standard i.e. 10mm from the liquid (for 1900MHz). The Indexsar foam spacers (described above) were used to ensure this condition during measurement.

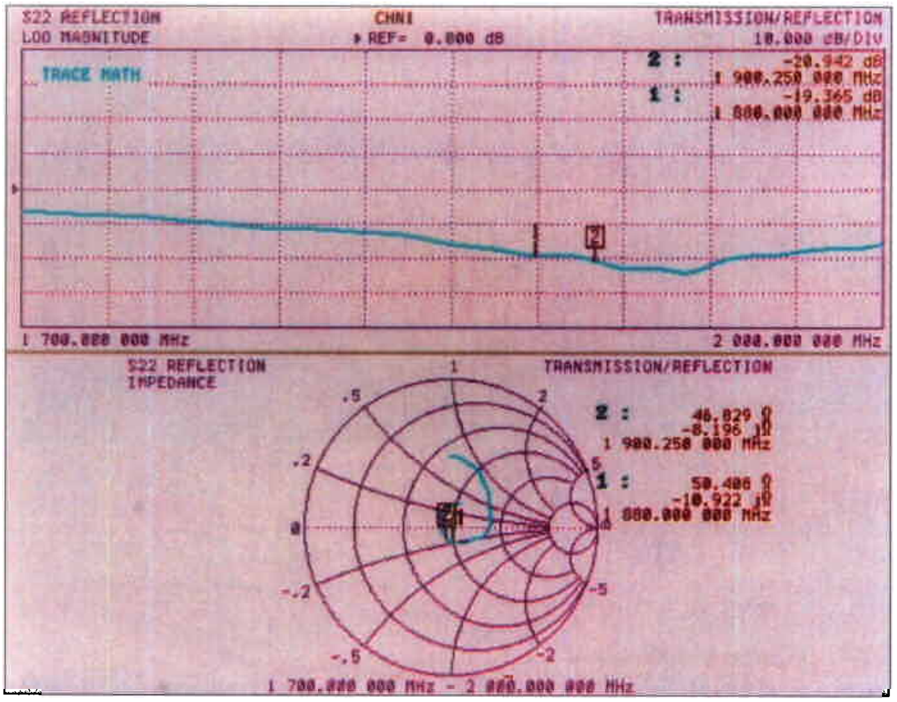
The impedance was measured at the SMA-connector with the network analyser. The following parameters were measured against Head fluid:



Dipole impedance at 1900 MHz	Re{Z} = **46.0 Ω**
Im{Z} = **-5.8 Ω**

Return loss at 1900MHz	**-22.7 dB**

The measurements were also repeated against 1900MHz Body fluid:



Dipole impedance at 1900 MHz Re{Z} = **46.8 Ω**
Im{Z} = **-8.2 Ω**

Return loss at 1900MHz **-20.9 dB**

3. SAR Validation Measurement in Brain Fluid

SAR validation checks have been performed using the dipole and the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests were then conducted at a feed power level of approx. 0.25W. The actual power level was recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). A correction factor was also applied to account for transmission loss arising from the dipole's reflection coefficient.

The ambient temperature was 21°C +/- 1°C and the relative humidity was around 35% during the measurements.

The phantom was filled with a 1900MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 1900MHz at the measurement temperature:

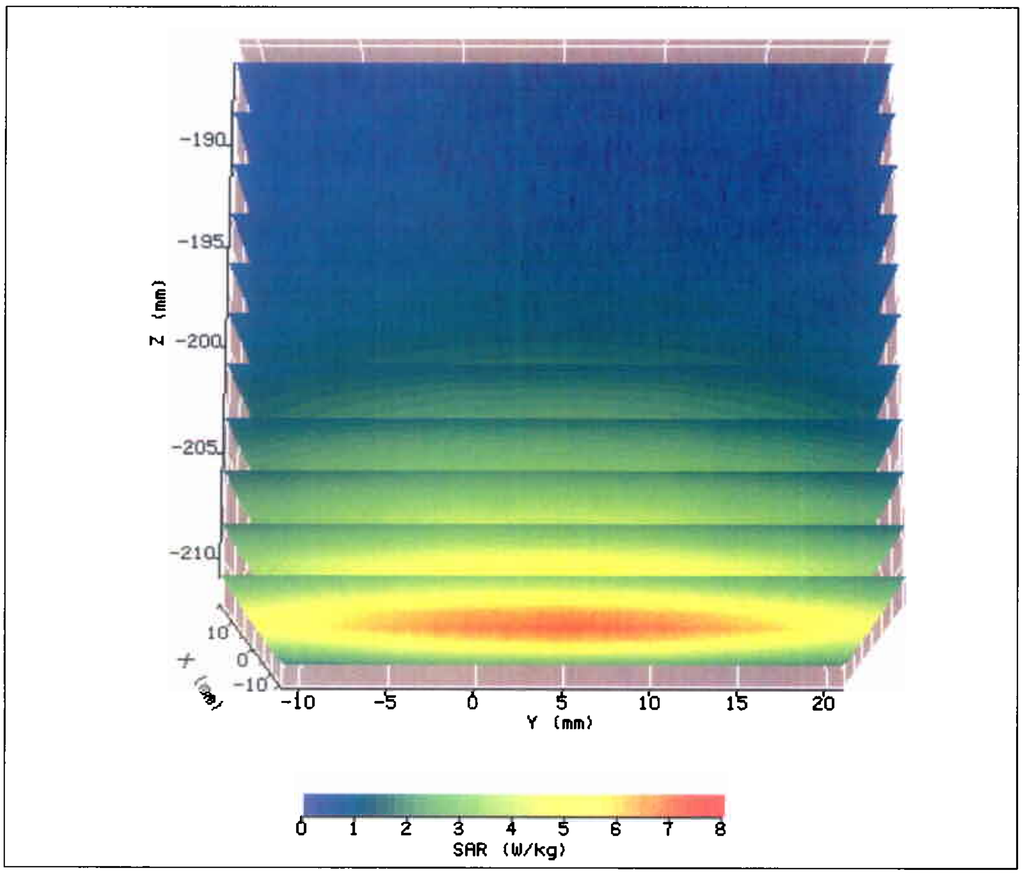
Relative Permittivity	**39.10**	**(Target: 40.0)**
Conductivity	**1.52 S/m**	**(Target: 1.40 S/m)**

SAR specification EN62209-2(2007) [ref 2], in which the validation method is described, specifies how to adjust measured 1g & 10g volume-averaged SAR values to take into account the difference between the fluid's actual and target electrical properties. The correction factors for this combination of properties at 1900MHz equals:

1g: -5.3%
10g: -3.4%

The SARA2 software version 2.54 VPM was used with Indexsar IXP_050 probe Serial Number 0127 previously calibrated using waveguides.

The 3D measurement made using the dipole at the bottom of the phantom box is shown below:



SAR measurement standard 62209-1 [ref 2] tabulates the volume-averaged 1g and 10g SAR values over a range of frequencies up to 3000MHz. The following values are listed for 1900MHz:

	Target SAR values (W/kg) (Normalised to 1W feed power)
1g SAR	39.7
10g SAR	20.5

The validation results, also normalised to an input power of 1W (forward power) were:

	Measured SAR values (W/kg) (Normalised to 1W feed power)	% Deviation from Standard
1g SAR	38.3	-3.6%
10g SAR	20.2	-1.6%

4. SAR Measurement in Body Fluid

SAR validation checks are only defined in the standard against brain simulant fluid. Nonetheless, it is possible to measure the effective volume-averaged SAR values against body fluid, simply to provide a reference value.

The ambient temperature was 21°C +/- 1°C and the relative humidity was around 32% during the measurements.

The phantom was filled with a 1900MHz body liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 1900MHz at the measurement temperature:

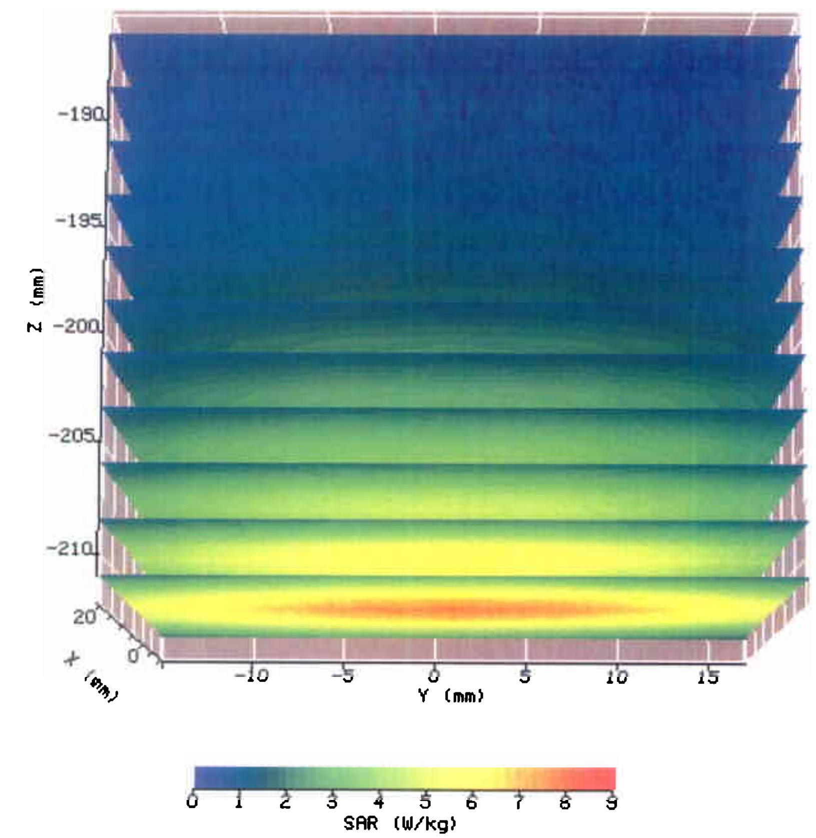
Relative Permittivity	**54.05**	**(Target: 53.3)**
Conductivity	**1.55 S/m**	**(Target: 1.52 S/m)**

The correction factors for this combination of properties at 1900MHz equals:

1g: -0.9%
10g: -0.6%

The SARA2 software version 2.54 VPM was used with Indexsar IXP_050 probe Serial Number 0127 previously calibrated using waveguides.

The 3D measurement made using the dipole at the bottom of the phantom box is shown below:



The validation results, also normalised to an input power of 1W (forward power) were:

	Measured SAR values (W/kg) (Normalised to 1W feed power)	% Deviation from Standard
1g SAR	40.35	N/A
10g SAR	21.76	N/A

5. Dipole handling

The dipoles are made from standard, copper-sheathed coaxial cable. In assembly, the sections are joined using ordinary soft-soldering. This is necessary to avoid excessive heat input in manufacture, which would destroy the polythene dielectric used for the cable. The consequence of the construction material and the assembly technique is that the dipoles are fragile and can be deformed by rough handling. Conversely, they can be straightened quite easily as described in this report.

If a dipole is suspected of being deformed, a normal workshop lathe can be used as an alignment jig to restore the symmetry. To do this, the dipole is first placed in the headstock of the lathe (centred on the plastic or brass spacers) and the headstock is rotated by hand (do NOT use the motor). A marker (lathe tool or similar) is brought up close to the end of one dipole arm and then the headstock is rotated by 0.5 rev. to check the opposing arm. If they are not balanced, judicious deformation of the arms can be used to restore the symmetry.

If a dipole has a failed solder joint, the dipole can be fixed down in such a way that the arms are co-linear and the joint re-soldered with a reasonably-powerful electrical soldering iron. Do not use gas soldering irons. After such a repair, electrical tests must be performed as described below.

Please note that, because of their construction, the dipoles are short-circuited for DC signals.

6. Tuning the dipole

The dipole dimensions are based on calculations that assumed specific liquid dielectric properties. If the liquid dielectric properties are somewhat different, the dipole tuning will also vary. A pragmatic way of accounting for variations in liquid properties is to 'tune' the dipole (by applying minor variations to its effective length). For this purpose, Indexsar can supply short brass tube lengths to extend the length of the dipole and thus 'tune' the dipole. It cannot be made shorter without removing a bit from the arm. An alternative way to tune the dipole is to use copper shielding tape to extend the effective length of the dipole. Do both arms equally.

It should be possible to tune a dipole as described, whilst in place in the measurement position as long as the user has access to a VNA for determining the return loss.

7. References

[1] IEEE Std 1528-2003. IEEE recommended practice for determining the peak spatial-average specific absorption rate (SAR) in the human body due to wireless communications devices: Measurement Techniques – Description.

[2] BS EN 62209-1:2006 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)

[3] BS EN 62209-2:2007 Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices - Human models, Instrumentation, and Procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)