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Tissue Parameters

850MHz Head liquid:

Recipe:
The following recipe is provided in percentage by weight.

49.46%	distilled water
49.46%	DGBE
1.0%	salt
0.1%	bactericide

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

Date	Freq. (MHz)	Rel. Perm.	Condy (S/m)
12/06/2007	835	41.56	0.923
12/06/2007	836.6	41.56	0.922

850MHz Body Liquid:

Recipe:
The following recipe is provided in percentage by weight.

49.8%	distilled water
40.6%	DGBE
8.9%	salt
0.6%	HEC
0.1%	bactericide

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

Date	Freq. (MHz)	Rel. Perm.	Condy (S/m)
12/06/2007	835	55.71	0.986
12/06/2007	836.6	55.72	0.986

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1900MHz Head liquid:

Recipe:
The following recipe is provided in percentage by weight.

54.9%	distilled water
44.92%	DGBE
0.18%	salt
0.1%	bactericide

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

Date	Freq. (MHz)	Rel. Perm.	Condy (S/m)
12/07/2007	1880	40.98	1.390
12/07/2007	1900	41.05	1.411

1900MHz Body Liquid:

Recipe:
The following recipe is provided in percentage by weight.

69.17%	distilled water
30.29%	DGBE
0.44%	salt
0.1%	bactericide

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

Date	Freq. (MHz)	Rel. Perm.	Condy (S/m)
12/07/2007	1880	52.73	1.570

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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 Head Tissue Simulant	Cetecom Inc.	850 Head	N/A	12/06/2007	N/A
850 MHz Body Tissue Simulant	Cetecom Inc.	850 Body	N/A	12/06/2007	N/A
1900 MHz Head Tissue Simulant	Cetecom Inc.	1900 Head	N/A	12/07/2007	N/A
1900 MHz Body Tissue Simulant	Cetecom Inc.	1900 Body	N/A	12/07/2007	N/A
835 MHz Dipole	IndexSAR – IEEE 1528 design	IXDA-083	0016	08/14/2007	08/14/2008
1900 MHz Dipole	IndexSAR – IEEE 1528 design	IXDA-188	0016	08/15/2007	08/15/2008
Directional coupler	Werlatone	C6529	11249	N/A	N/A
RF Amplifier	Vectawave	VTL5400	N/A	N/A	N/A
SAR Probe	IndexSAR	IXP-030	S/N M0024	12/13/2006	12/13/2007
Dielectric Measurement Kit	IndexSAR	Di-Line	N/A	N/A	N/A

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Equipment Calibration/Performance Documents:

Please Note:
(The following pages of Appendix C show calibration documents. These calibration documents are inserted into this appendix. The header information with page numbering scheme is a part of this report and is included on all pages of the report and appendixes. This header is used to track all of the contents of this report.)

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Report No. SN0016_090-180-190-245

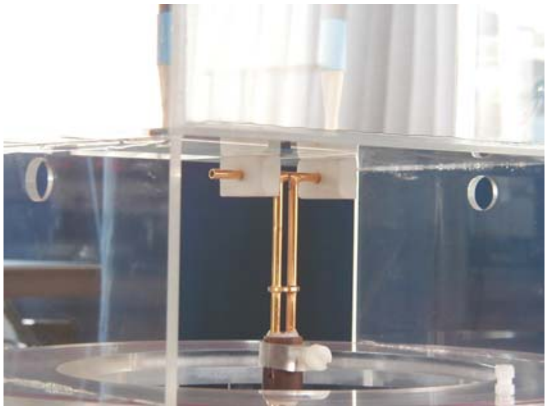
July 1st 2002
Revised 08/16/2007

INDEXSAR
Validation Dipoles
Type IXD-090, IXD-180, IXD-190 & IXD-245

Performance measurements

S/N: 090-0016
S/N: 180-0016
S/N: 245-0016
S/N: 190-0016

MI Manning



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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.

An HP 8753B 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 base of the Indexsar box-phantom used for flat-surface testing and validation checks.

The validation dipoles are supplied with special spacers made form 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. 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 900MHz and below) and the shorter side can be used for tests at 1800MHz 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).

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2. SAR Measurement

SAR validation checks using the dipoles can be performed with the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests may be conducted at a feed power level of 0.25W. However, the actual power level should be recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). The results can then be compared with Table 8.1 in [1]. Brain liquids should be used so that measurement results can be compared with the (computed) reference values tabulated in IEEE 1528.

3. 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 below:

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.

4. Performance Measurement

The dipoles are individually tested at their nominal frequency to ensure that they exhibit a return loss of less than -20dB when used with brain or body liquids.

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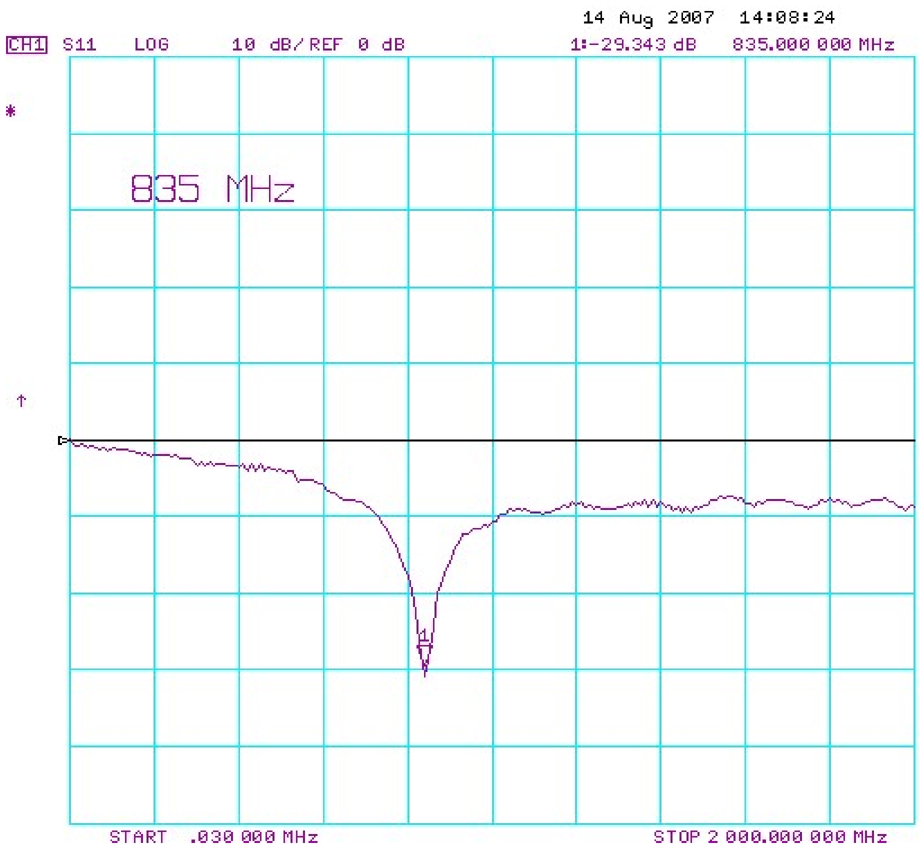
The dipoles are designed to have low return loss ONLY when presented against a lossy-phantom at the specified distance. If the user has a Vector Network Analyser (VNA) it is best to perform a return loss measurement on a specific dipole when it is in a measurement-location against a box phantom. If this is not the case, the return loss should be measured with the dipole positioned at the specified distance from a suitable container of lossy liquid. The distances specified in the standards are 15mm from the lossy liquid (900MHz and below) and 10mm from the liquid (1500MHz and above). The Indexsar foam spacers (described above) should be used to ensure this condition during measurement.

S11 plots for the dipoles with nominal frequencies of 850MHz, 900MHz, 1800MHz, 1900MHz and 2450MHz are shown below.
Please note: The date of verification is show on each plot.



IXD-085

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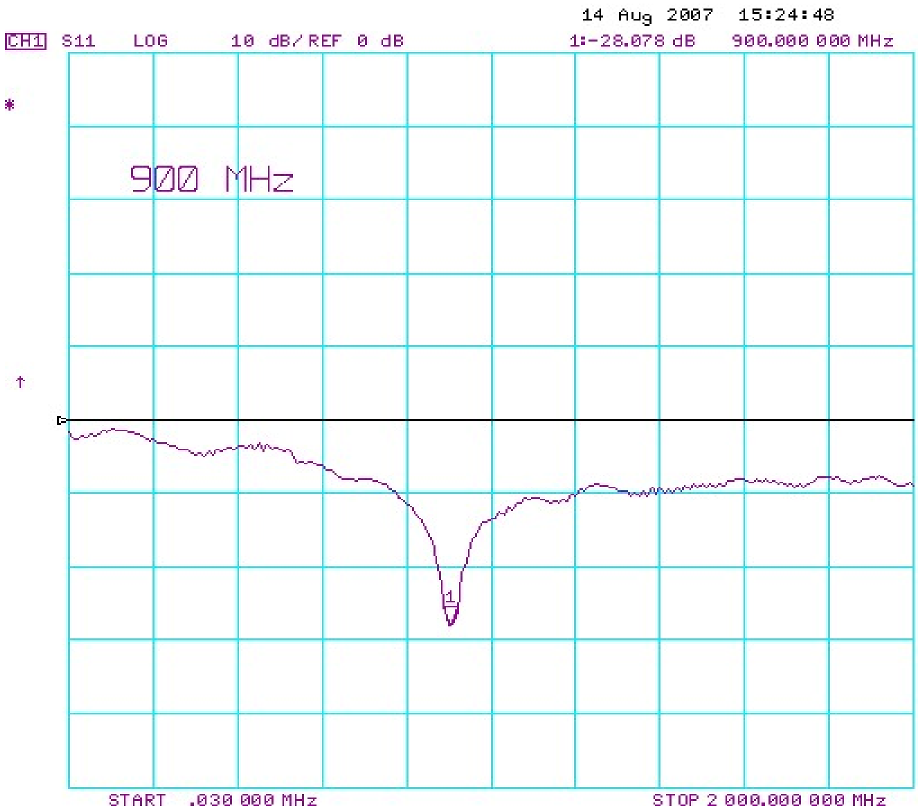
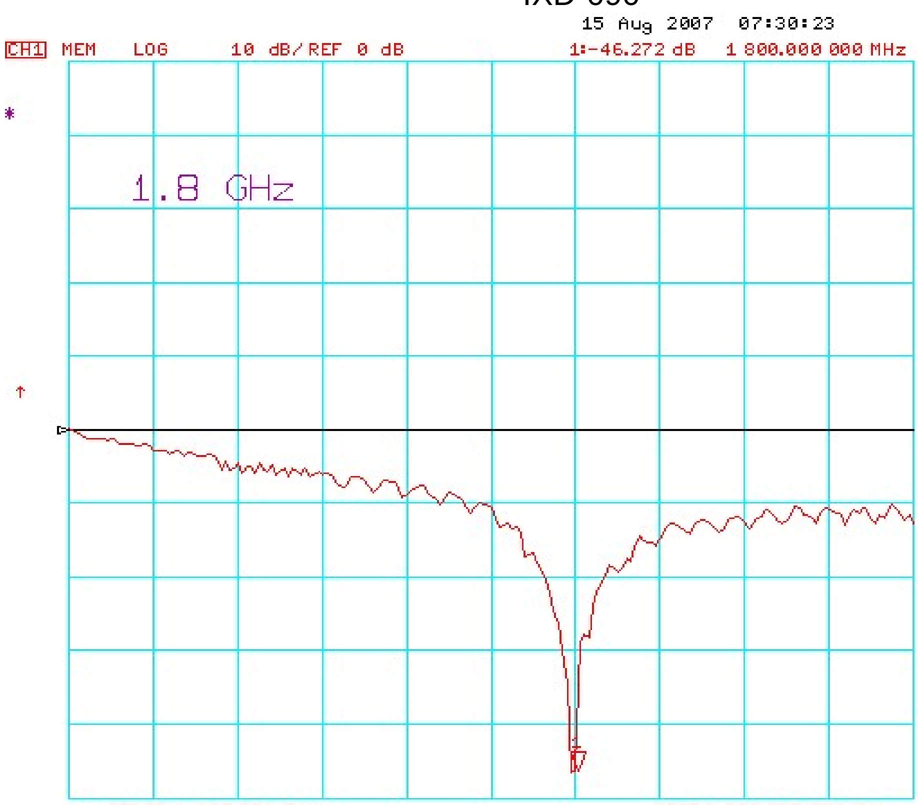


IXD-090



IXD-180

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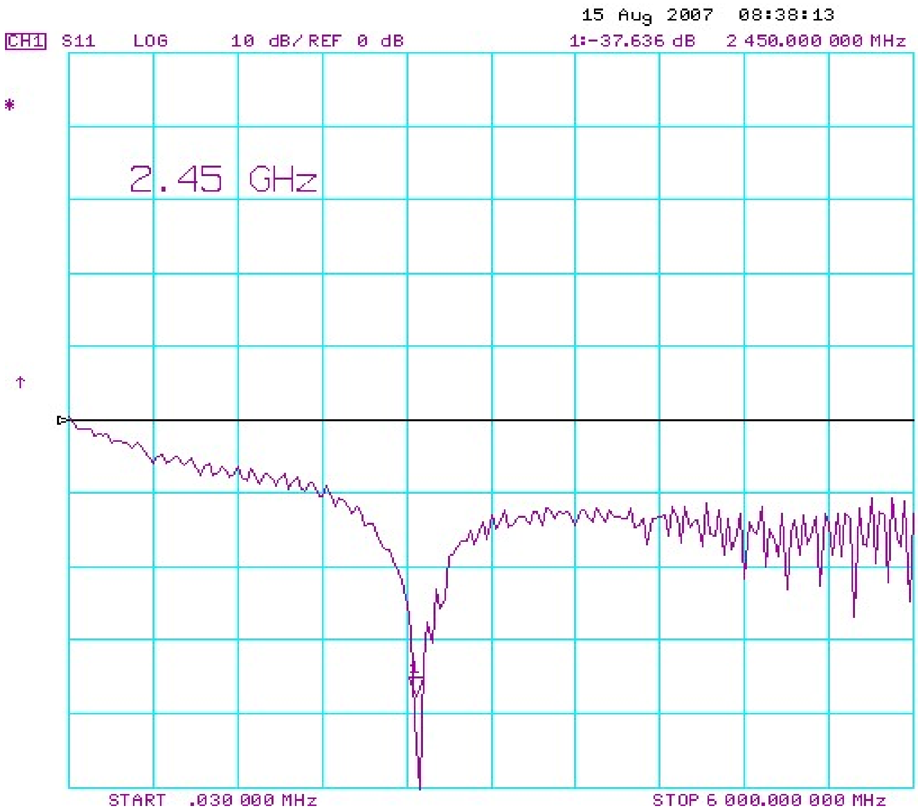
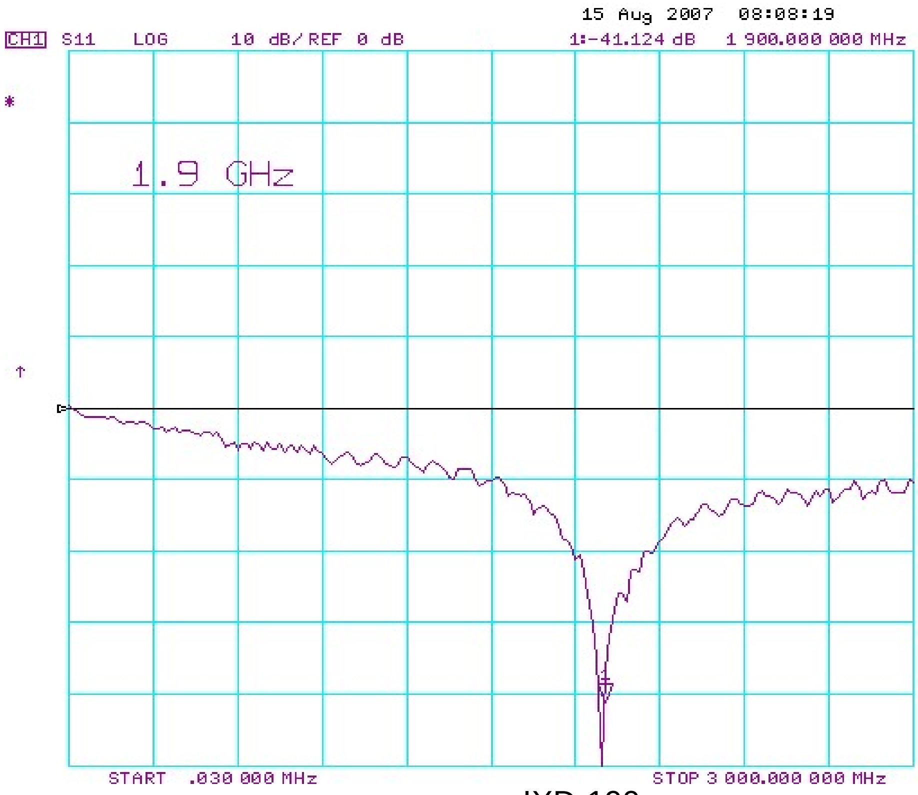


IXD-245



IXD-190

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5. 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.

6. Reference

[1] Draft recommended practice for determining the peak spatial-average specific absorption rate (SAR) in the human body due to wireless communications devices: Experimental Techniques.