

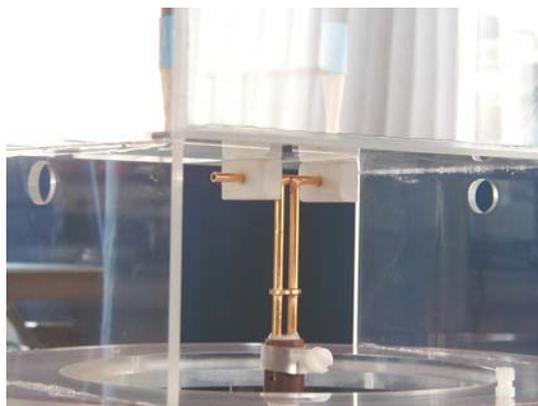


Report No. SN0093\_900  
April 2007

**INDEXSAR**  
**900MHz validation Dipole**  
**Type IXD-090 S/N 0093**

**Performance measurements**

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 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 base 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. 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 1/40<sup>th</sup> 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. Typical SAR Measurement

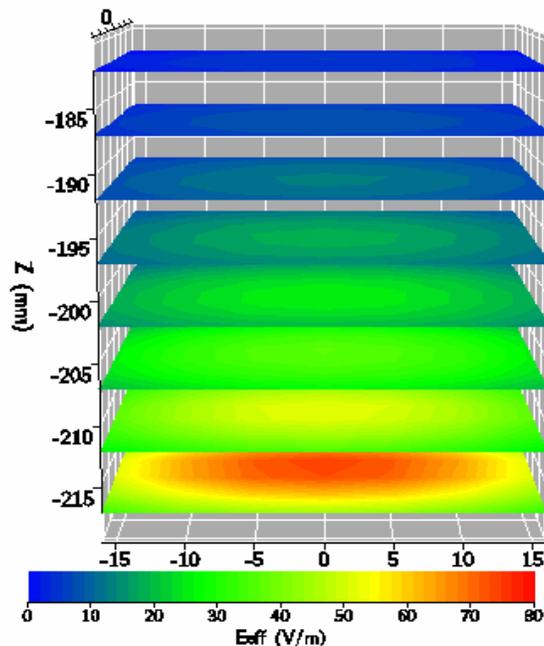
A SAR validation check is performed with the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests are then conducted at a feed power level of approx. 0.25W. The actual power level is recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). The ambient temperature is 21°C +/- 1°C and the relative humidity is around 40% during the measurements.

The phantom is filled with a 900MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 900MHz:

Relative Permittivity	<b>42.5</b>
Conductivity	<b>0.97 S/m</b>

The SARA2 software version VPM2.2 is used with an Indexsar probe previously calibrated using waveguides.

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



The results, normalised to an input power of 1W (forward power) are typically:

Averaged over 1 cm <sup>3</sup> (1g) of tissue	<b>10.55 W/kg</b>
Averaged over 10cm <sup>3</sup> (10g) of tissue	<b>6.80 W/kg</b>

These results can be compared with Table 8.1 in [1]. The agreement is within 10%.



## **4. 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.

## **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, Indexasar 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. References**

[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.



## CALIBRATION CERTIFICATE

# 华东国家计量测试中心 上海市计量测试技术研究院

# 校准证书

委托者  
Customer

基础性能试验中心

委托者地址  
Address of customer

宜山路 716 号

器具名称  
Name of instrument

Dipole

制造厂  
Manufacturer

ANTENNESSA 公司

型号/规格  
Model/Specification

/

器具编号  
No. of instrument

36/05 DIP C20 (850MHz dipole), 36/05 DIP D21 (900MHz dipole),  
36/05 DIP F22 (1800MHz dipole), SN 36/05 DIP G23 (1900MHz  
dipole), 36/05 DIP I24 (2000MHz dipole), SN 36/05 DIP  
J25(2450MHz dipole)

器具准确度  
Instrument accuracy

/

证书批准人  
Approved by

陆福政

(机构校准专用章)

核 验 员  
Checked by

廖 轶

校 准 员  
Calibrated by

朱建刚

校准日期 2007 年 10 月 23 日  
Date for calibrated Year Month Day

投诉电话: 021-50798262  
Tel. for complaint

地址: 上海市张衡路 1500 号(总部) 电话: 021-38839800 传真: 021-50798390 邮编: 201203  
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No. 716 Yishan Road, Shanghai(branch) Tel. Fax. Post Code

未经本院批准, 部分采用本证书内容无效。  
Partly using this certificate will not be admitted unless allowed by SIMT.



**SIMT**

No. L0134

校准证书编号: 2007F33-10-001389

Calibrated certificate series No.

国家法定计量检定机构计量授权证书号(中心/院): (国)法计(2002)01039号/(2002)01019号

The number of the Certificate of Metrological Authorization to The Legal Metrological Verification Institution is No. (2002) 01039 / No. (2002) 01019

中国实验室国家认可委员会(CNAL)实验室认可证书号: No.L0134

The number of the certificate accredited by CNAL is No.L0134

本次校准所依据的技术规范(代号、名称):

Reference documents for the calibration (code, name)

IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head form Wireless Communications Devices: Measure Techniques", December 2003

CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields form mobile phones (300 MHz - 3 GHz)", July 2001

Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

本次校准所使用的主要计量标准器具:

Main measurement standards used in this calibration

名称/型号 Name/Model	编号 Number	证书编号/有效期限 Certificate No./Due date	测量范围/准确度 Measuring range/accuracy
矢量网络分析仪 ZVB 8	容-027-27	2007F31-10-001767 2008.06.27	300 kHz to 8 GHz, 频率分辨率: 100 μHz, 测量时间: < 8 ms, 测量带宽: 1 Hz to 500 kHz

以上计量标准器具的量值溯源至国家基准。

Quantity values of above measurement standards used in this calibration are traced to those of the national primary standards in the P.R. China.

校准地点及环境条件:

Location and environmental condition for the calibration

地点: 上海市计量测试技术研究院

Location

温度: 21.8-22.2 °C; 湿度: 43 %RH; 其它: /

Ambient temperature

Relative humidity

Others

本次校准结果的扩展不确定度:

Expanded uncertainty

/

校准结果/说明:

Results of calibration and additional explanation

参见校准结果/说明

校准规范要求:

Return Loss must be less than -20dB

符合校准规范要求

本证书提供的结果仅对本次被校的器具有效。

The data are valid only for the instrument(s).

校准证书续页专用

Continued page of calibration certificate

**校准结果/说明 (续页):**

Results of calibration and additional explanation (continued page)

**1. Calibration procedure:**

Return Loss is measured with the dipole mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis. During calibration, The flat phantom is filled with the liquid whose parameters are calibrated relative to different frequency.

**2. Calibration Conditions:****A. The spacer from Dipole center to TSL:**

Distance Dipole Center - TSL	Frequency
15mm±0.2mm with spacer	900MHz, 850MHz
10mm±0.2mm with spacer	1800MHz, 1900 MHz, 2000MHz, 2450 MHz

**B. Head TSL parameters:**

The following parameters and calculation were applied.

Head TSL temperature change is well controlled to be within 22±0.2°C during test.

Frequency	Nominal Head TSL Parameters (Permittivity/ Conductivity)	Measurement Head TSL parameters (Permittivity/ Conductivity)
850 MHz	42.53/0.94	41.97/0.96
900 MHz	42.00/0.99	41.20/0.97
1800 MHz	40.00/1.38	39.71/1.36
1900 MHz	40.00/1.40	39.65/1.37
2000 MHz	40.00/1.40	39.15/1.39
2450 MHz	39.00/1.84	38.56/1.82

**C. Body TSL parameters:**

The following parameters and calculation were applied.

Body TSL temperature change is well controlled to be within 22±0.2°C during test.

Frequency	Nominal Body TSL Parameters (Permittivity/ Conductivity)	Measurement Body TSL parameters (Permittivity/ Conductivity)
850 MHz	55.20/0.97	50.91/0.93
900 MHz	55.00/1.05	54.63/1.04
1800 MHz	53.30/1.52	51.39/1.53
1900 MHz	53.30/1.52	51.98/1.52
2000 MHz	53.30/1.52	51.58/1.51
2450 MHz	52.70/1.95	/



校准结果/说明 (续页):

Results of calibration and additional explanation (continued page)

3. Measurement Results:

Frequency	Return Loss with Head TSL	Return Loss with Body TSL
850 MHz Dipole	-28.06 dB	-27.15 dB
900 MHz Dipole	-23.17 dB	-22.19 dB
1800 MHz Dipole	-21.14 dB	-21.08 dB
1900 MHz Dipole	-22.43 dB	-21.56 dB
2000 MHz Dipole	-22.71 dB	-21.25 dB
2450 MHz Dipole	-37.56 dB	/

备注: /

校准结果内容结束