Probe orientation optimisation for testing at the side of upright phantoms

Indexsar IXP-050 probe S/N 0177

28/03/06

This procedure is defined in Indexsar Application Note 2006 No. 003 dated (18/03/2006). The present Report should be read in conjunction with the full calibration report for this probe - IMMERSIBLE SAR PROBE CALIBRATION REPORT Part Number: IXP – 050 S/N 0177 March 2006.

Explanation of procedure

System Validation procedures recommended in EN50361 and IEEE1528 require SAR measurements to be made using a dipole placed at the flat, bottom surface of a liquid-filled phantom of 2mm wall thickness. In this simplified test set-up, SAM phantom influences are avoided and the test limits the source polarisation to the plane normal to the probe axis. This is also the source polarisation direction used for calibration of the probes in liquid-filled waveguides, so the system validation check should confirm the probe calibration parameters.

The equivalent validation geometry for an upright phantom is a horizontally-aligned dipole placed at the vertical side of a box phantom, when the source polarisation is direction is also normal to the probe axis.

Additional uncertainties are introduced in the subsequent testing of handsets. These include the anatomical shaping of the phantom and the possibility that the wireless source has an arbitrary, and possibly unknown, polarisation direction with respect to the phantom and probe.

When a dipole is used under a box phantom, the validation source is only tested in the plane of the normal to the probe axis but, for a test at the side of the phantom, the source polarisation can be rotated with respect to the probe axis direction. This configuration therefore tests the system response to a broad range of polarisation directions and tests the full spherical isotropy behaviour of the SAR probe. It is not possible to make a similar check if the probe is vertical in a box with the source polarisation tangential to the phantom bottom.

Upright phantom uncertainty assessments make allowance for this full isotropy range, but the results of a validation check are expected to be variable within this range of spherical isotropy.

In this Report, additional calibration measurements have been made, which enable the isotropy range for testing at the side to be characterised and optimised. To minimise the uncertainty range, the SAR conversion factor is set to the mid point of the isotropy range.

Additional calibration test procedure

The dipole is set up and presented to the surface in the same manner as used for the normal validation tests. The facility is presented by the upright holder to position the dipole horizontally, vertically and at intermediate angles.

The probe is configured as shown in Figure 1. With a box phantom shape loaded into the SARA2 software, the probe is positioned at the point on the phantom centerline at dipole height. The probe is then moved (in constrained mode) until the tip is at a point 70mm in the X direction.

The first step involves measurement of the rotational isotropy of the probe in the configuration of Figure 1. The probe is first aligned to rotate smoothly about the center of the probe tip. The rotational isotropy is measured in 10 degree steps using a facility in the SARA2 software both with the dipole horizontal and with the dipole vertical. The two data sets are compared as in Figure 2.

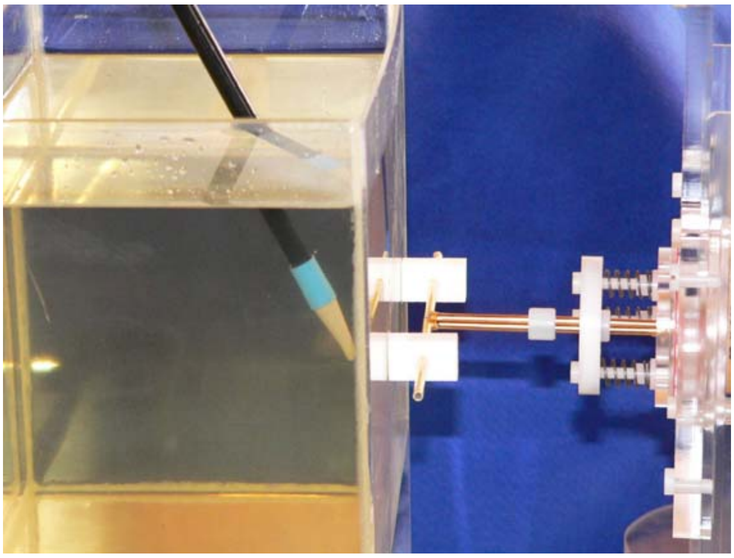

Figure 1: Showing the optional upright validation configuration with the probe angled against the side of a flat phantom of 2mm wall thickness.

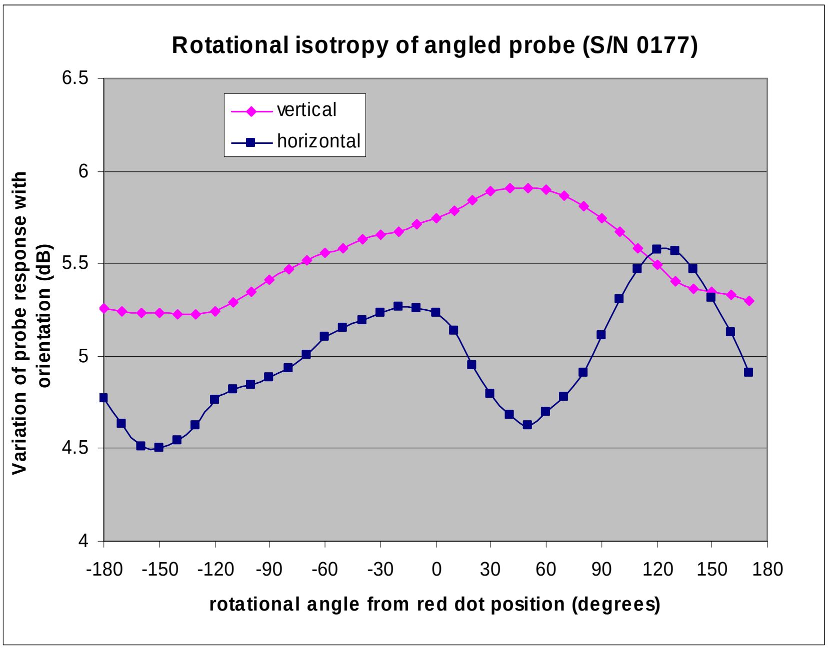

Figure 2: Comparing the probe response to both vertical and horizontal source polarization directions at varying probe presentation angles for Probe IXP-050 S/N 0177.

The behaviour exhibited by the probe as shown by the data in Figure 2 is consistent with findings from a detailed study of probe directivity [1]. By inspection of the data as illustrated in Figure 2, it is possible to find preferred presentation angles for an individual probe, where the variation between horizontal and vertical are least. From Figure 2, a rotation angle of 130 degrees was selected to optimize the response to both horizontal and vertical source orientations.

To facilitate the positioning of the probe in the SARA2 robot in this position, a green dot has been machined into the probe connector. This green dot should be aligned with the positive X-axis of the robot (directly away from the robot). With this probe presentation angle, the probe is then aligned using normal SARA2 procedures at the right height and centered on the central laser spot.

Following probe re-alignment, a sequence of 2D/3D scans are conducted at the side of the box phantom. With Probe S/N 0177 validation scans were performed in both horizontal and vertical orientations as shown in Table 1.

The table shows the average deviation of the results at all the probe orientation angles tested. This figure should be within 10% to be in line with normal validation procedure recommendations.

Table 1: Variation from reference values for 1g and 10g validation scans done at side of upright phantom at 900MHz

Dipole presentation angle (degrees from horizontal)	1g SAR result for 250mW input power (W/kg)	10g SAR result for 250mW input power (W/kg)	Ratio of measured value to reference value (1g)	Ratio of measured value to reference value (10g)
Horizontal	2.688	1.824	0.97	1.06
Vertical	2.851	1.961	1.097	1.137
		Average deviation	**7%**	**10%**

Table 2: 900MHz calibration factors form probe S/N 0177 with Conversion Factor adjusted by 0.08 dB to equalize the isotropy variation about the mean

Calibration factor	177_900SIDE	X	Y	Z
Sensor radius (mm)	1.25			
Angle of X channel to zero (degrees)	143			
BC alpha factor	0.52			
BC depth factor (mm)	3.0			
DCP (V*200)		20	20	20
ConvF Upright	**0.291**			
ConvF Normal	0.287			
Channel sensitivity factors		417	368	414

Reference

[1] MI Manning, 'SAR probe directivity as influenced by boundary proximity, probe tilt angle and probe size', IndexSAR report IXS 0228, February 2005.

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