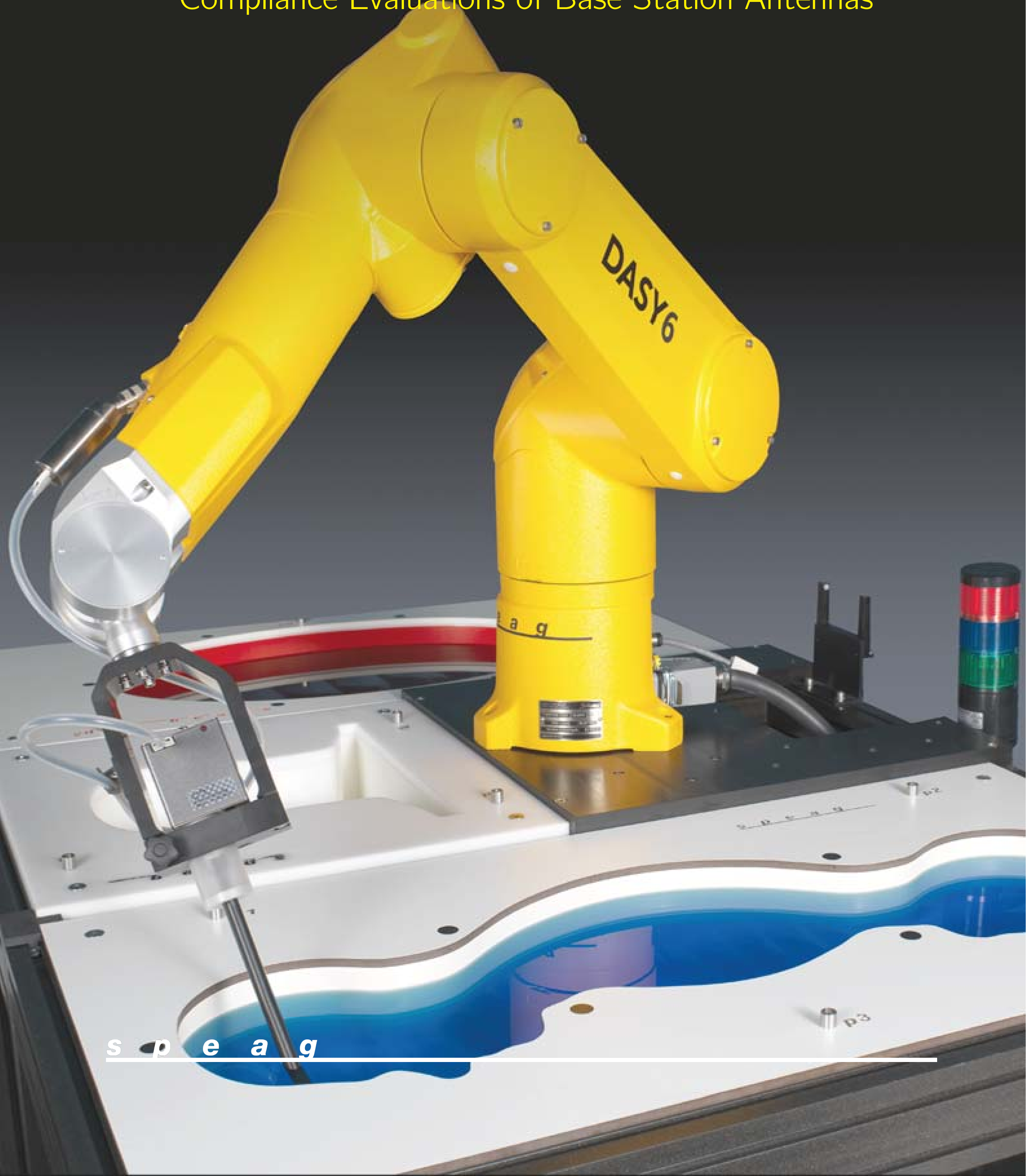
SAR Measurements with cDASY6

APPLICATION NOTE

Compliance Evaluations of Base Station Antennas



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Compliance Evaluations of Base Station Antennas

1 Introduction

The purpose of this application note is to demonstrate how specific absorption rate (SAR) compliance evaluations of base station antennas according to the IEC 62232 standard draft can be performed with cDASY6 V6.6+. A tutorial video is also available to supplement this application note.

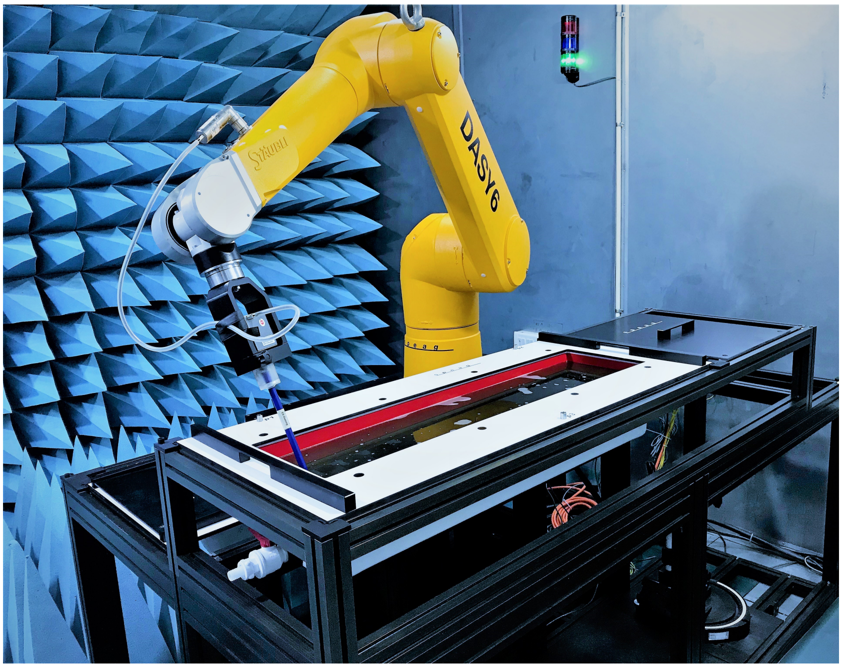


Figure 1.1: BST-C Phantom mounted on a MP6B-TX90XL Platform

2 Hardware Setup

The Base Station Phantom - Adult (BSTP-A) and the Base Station Phantom - Child (BSTP-C) phantoms meet the specifications of IEC 62232. Only TX90XL robots can be used to perform the required evaluations as the reachable range of the TX60L robots is too limited. Each phantom is delivered with a adaptor platform that lifts the phantom higher than the floor and allows a larger range of test distances between the phantom and the antenna under test to be measured.

The hardware setup process consists of three steps: (i) removing the central bar of the frame that separates the two slots[1], (2) mounting the phantom raiser on top of the regular platform, and (iii) installing rubber stoppers

[1] If your platform is missing this feature, please contact SPEAG at support@speag.swiss

to ensure that the phantom position remains steady. Figure 1.1 shows the BSTP-C phantom mounted on the MP6B-TX90XL platform.

Please view this video for more detailed information.

3 Software Setup

First, the base station phantom configuration file is imported into the software inventory. Log in as 'Administrator' in cDASY6 and go to File ≫ Application Preferences ≫ Inventory. Right-click on 'Phantoms' and select 'Add Item', then select the phantom configuration file in the file dialog. In Hardware Setup view, place the Base Station in the platform slot being used and specify the Tissue Simulating Liquid used to fill the phantom.

Next, a mother scan must be performed. Right-click on the Base Station phantom in the 3D view and select 'Perform motherscan' in the context menu.
Note: Mother scans must always be performed with MSTV1 Electronics and TP6V2 probe.

Please view this video for more detailed information.

4 Measurement Procedure

4.1 Supported Scans

Three different scans are supported for the BSTP-A/-C:

- Fast Scan: used to identify the maximum SAR location to be used as the power reference location in subsequent scans
- Fast Volume Scan: novel reconstruction algorithms are used to make a first assessment of the distribution of both the 1g & 10g-averaged spatial SAR values anywhere in the measured volume and the total absorbed power; the whole-body SAR (wbSAR), easily derived from total absorbed power, is displayed
- Zoom Scan: used to assess peak spatial SAR (psSAR) values within cubic averaging volumes containing 1g and 10g of simulated tissue

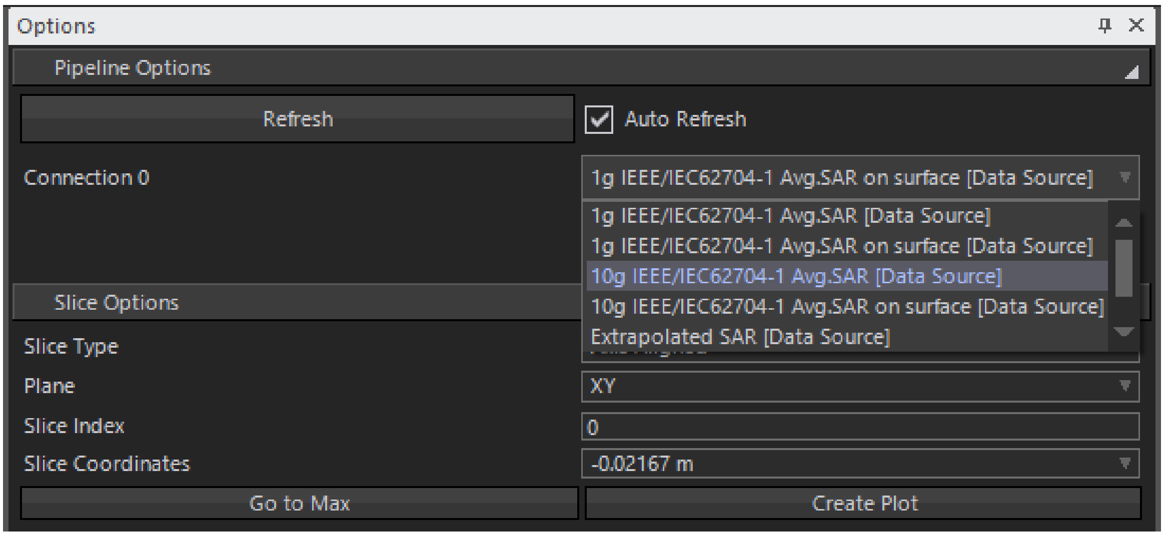


Figure 1.2: Selection of SAR evaluation quantities in cDASY6.6+ via Option View

4.2 Measurement Setup

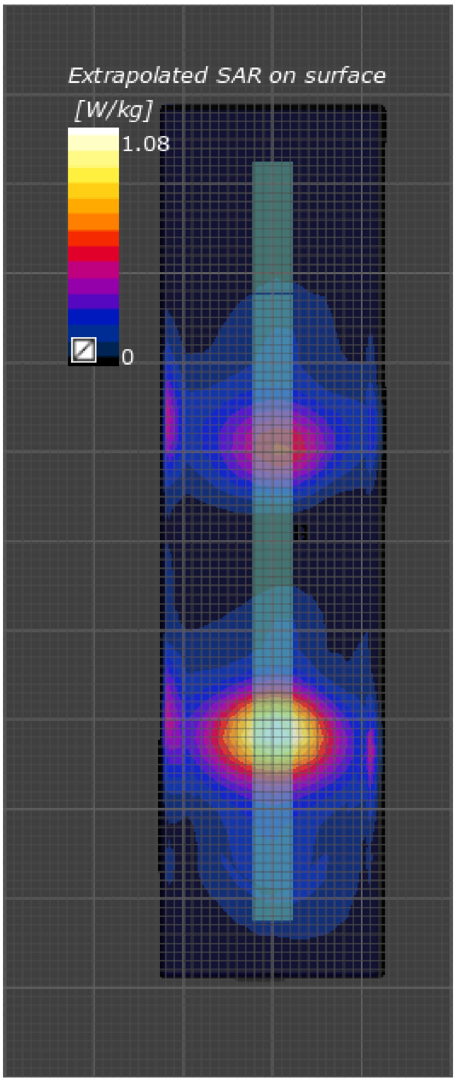
Measurements in base station phantoms can be performed according to the following procedure:

- In Setup mode, Project Setup / Device Settings, specify the characteristics of the devices under test (DUT)
- In Setup mode, Project Setup / Test Conditions view and specify the desired phantom section
- In Setup mode, Project Setup / Communication Systems view, specify the communication system and channel
- In Setup mode, Hardware Setup view, select the probe and Data Acquisition Electronics (DAE) to be used for the measurements and import the TSL parameters
- In Project Overview, select Fast Volume Scan as the area scan variant, and select Whole Phantom Section Grid Extents, so that the entire measurable area of the phantom is measured independently of the DUT dimensions
- In Measurement mode, use the Start button to start the measurements

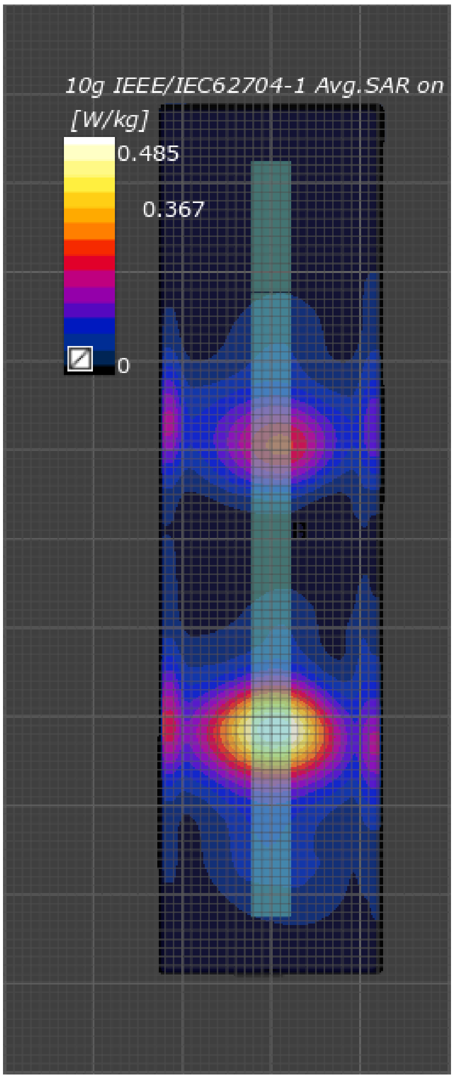
4.3 Post Processing

Fast Volume Scans are used to assess not only the psSAR1g/10g distributions but also the total absorbed power inside the entire phantom. The SAR distributions can be visualized by clicking the icon. The Connection drop down under the Options view is used to select the quantity to be visualized, as shown in Figure 1.2.

Examples of visualizations of SAR and sSAR10g distributions of base station antennas are shown in Figure 1.3



(a) SAR distribution



(b) sSAR10g distribution

Figure 1.3: Examples of distributions displayed in post-processing mode of an omnidirectional base station antenna

The psSAR1g/10g, the total absorbed power, and wbSAR values can be visualized in the Project Overview tree as shown in Figure 1.4. Two correction factors (CF) are computed by the software and taken into consideration in the wbSAR calculation: CF3 is used to account for a possible increase in wbSAR due to a tissue-layering effect, and CF4 is used to compensate for possible bias in the wbSAR obtained for the general public when the large box-shaped phantom is used to assess child exposure configurations. The averaging volume used for the total absorbed power calculation is $1.54\,m \times 0.339\,m \times 0.09\,m$ for the BSTP-A phantom and $0.96\,m \times 0.233\,m \times 0.06\,m$ for the BST-C phantom.

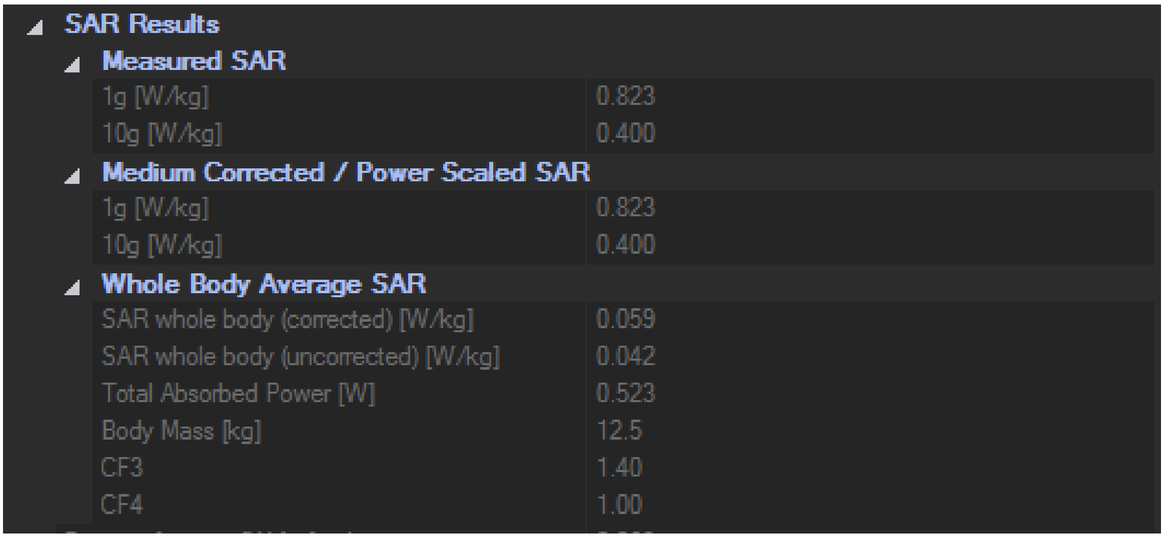


Figure 1.4: Window displaying the evaluated psSAR1g/10g, total absorbed power, and wbSAR values for a given base station antenna

The compliance of base station antennas can be easily demonstrated with cDASY6 V6.6, as all required SAR quantities are already provided in the software. The user must perform measurements at several antenna-TSL distances to determine the compliance distance for a given transmitting power.

5 System Check or Verification

The system check or verification is performed by placing the dipoles at the nominal distance with the appropriate spacer positioned in the center of the phantom oriented parallel to the long axis of the phantom, with the power setup as recommended in the DASY6 manual (Section 4.10.3 – System Check Procedure). A full fast whole-volume scan should be performed and, if requested by the regulators, a zoom scan should also be performed (Section 4.11.8 – System Validation). SAR results should be compared with the target values provided in Table 1.1. The difference may not be larger than the specified uncertainties of the assessments for psSAR1g, psSAR10g, and wbSAR.

	psSAR [W/kg]		wbSAR [W/kg]		
Frequency [MHz]	1 g	10 g	BST-C	BST-A	ELI
300	2.85	1.94	0.073	0.021	0.073
450	4.58	3.06	0.073	0.021	0.074
750	8.49	5.55	0.070	0.020	0.070
835	9.56	6.22	0.069	0.019	0.068
900	10.9	6.99	0.068	0.019	0.068
1450	29.0	16.0	0.068	0.019	0.068
1800	38.4	20.1	0.064	0.017	0.064
1900	39.7	20.5	0.062	0.017	0.062
1950	40.5	20.9	0.062	0.017	0.062
2000	41.1	21.1	0.061	0.017	0.061
2450	52.4	24.0	0.055	0.015	0.055
2585	55.9	24.4	0.052	0.014	0.052
2600	55.3	24.6	0.052	0.014	0.052
3000	63.8	25.7	0.046	0.013	0.046
3500	67.1	25.0	0.039	0.011	0.040
3700	67.4	24.2	0.038	0.010	0.038
5000	77.9	22.1	0.028	0.008	0.028
5200	76.5	21.6	0.027	0.007	0.027
5500	83.3	23.4	0.025	0.007	0.025
5800	78.0	21.9	0.024	0.007	0.024

Table 1.1: Numerical SAR targets for the reference dipoles; all values are normalized to a forward power of 1 W. The wbSAR targets are given for the BST-C, BST-A, and ELI phantoms.

6 Recommended Workflow

For compliance, performance of the following steps to determine the minimal safe distance from a base station antenna operated at frequencies f_1, f_2,... f_n, is recommended:

- Perform a system check valid for the frequency bands f_1, f_2,... f_n of the antenna under test; refer to Table 1.1 to choose the best test frequency for each operating frequency of the antenna
- Perform dosimetric evaluations (Fast Volume Scan setting) for f_1, f_2,... f_n at minimal (e.g., 0 mm, i.e., with the antenna touching the medium), intermediate (e.g., 200 mm and 400 mm), and maximal (e.g., 600 mm) distances to obtain the wbSAR and 1g and 10g psSAR values for each distance tested
- Compare the wbSAR and psSAR values results to threshold values for the antenna to find the smallest distance for each frequency at which the values exceed compliance; the smallest distance that exceeds compliance and the largest distance that satisfies compliance bracket the minimal safe distance
- Repeat dosimetric evaluations at all frequencies at distance steps intermediate between the distance at which the wbSAR and psSAR values exceeded compliance and the next largest distance previously measured (i.e., a distance found to be compliant) to determine refined bracketing distances at which the values exceed and satisfy compliance
- Continue to repeat dosimetric evaluations at all frequencies to obtain more refined estimates of bracketing values for non-compliant and compliant distances, until the distance that satisfies compliance differs by less that 30% from that determined in the previous step

The distance for each frequency determined in the final round of dosimetric evaluations at which the wbSAR and 1g and 10g psSAR values satisfy compliance thresholds is the minimal safe distance.

7 Uncertainty

The uncertainty budgets stated for body-worn devices in the DASY6 manual, are also directly applicable for the base-station phantom.

8 System Validation

The validation procedure consists of measuring the psSAR1g, psSAR10g, and the total absorbed power. The wbSAR is derived from the total absorbed power on the basis of a mass of 12.5 kg. Table 1.2 summarizes the validation results performed at three different frequencies. For 2600 MHz, the validation was performed at test distances of 10 and 25 mm. Also, a test was performed with two dipoles (1900 MHz and 1950 MHz) separated by 400 mm. In this case, both the psSAR1g and psSAR10g targets correspond to the 1950 MHz targets. The total absorbed power target corresponds to the sum of the 1900 MHz and 1950 MHz targets. The quantities reported are the results of Fast Volume Scans.

		Measured [W/kg]			Target [W/kg]			Deviation [dB]		
Frequency [MHz]	d [mm]	1g	10g	WB	1g	10g	WB	1g	10g	WB
750	15	8.08	5.10	0.070	8.49	5.55	0.073	-0.21	-0.37	-0.18
1900 / 1950	10	39.2	20.0	0.113	40.5	20.9	0.123	-0.14	-0.19	-0.37
2600	10	56.5	25.5	0.052	55.3	24.6	0.052	0.10	0.16	0.00
2600	25	6.41	3.68	0.018	6.91	3.68	0.016	-0.33	-0.34	-0.40

Table 1.2: Summary of validation results for the psSAR1g (1g), psSAR10g (10g), and wbSAR (WB). A mass of 12.5 kg was used. All values are normalized to 1 W input power. Note that the maximum deviation is 0.37 dB, which is well within the uncertainty budget.

9 Conclusions

This application note describes how easily compliance of base station antennas can be demonstrated with cDASY6 . The proposed measurement procedure has been validated with reference dipoles. The maximum deviation across the psSAR1g/10g and wbSAR is 0.37 dB, which is well within the uncertainty budget. In the next cDASY6 6.8 release, a smarter sampling of the measurement grid will be implemented, and points with negligible SAR values will be ignored, which reduces measurement times in most cases by several factors.