Application note:
Procedure for testing wireless modules in laptops
and
**devices held against the body**

Introduction

For SAR testing handsets of designed to be held against the head, detailed test procedures are defined in both the EN50361 and draft IEEE1528 standards. However, for testing other devices that may be used close to other parts of the body, agreed test methods do not yet exist. It is, however, common practice to test them against the flat side of a suitable phantom the dimensions of which are chosen in relation to the test frequency and the dimensions of the wireless unit being tested. Examples of such items are laptops with wireless modules included, PDAs, etc.

To test such items with the SARA2 system, it is easiest to utilise the vertical side of a suitable rectangular phantom, although the bottom of such phantoms can also be used.

The box phantom is made from two different thicknesses of Perspex. The inside dimensions of the box phantom are as follows: 200mm x 200mm x 150mm. The base of the box is 2mm thick and the sides are all 4mm thick. It is mounted on a similar rotation bearing to the SAM phantoms and allows the same 360° of rotation.
The shape of the box phantom has been digitised and a head shape file has been created so that the SARA2 system will recognise the box phantom wall positions in the same way that it accounts for the shape of the shell of a digitised head phantom. The head shape file that is created is an Excel file that contains a series of angular, height and radial data that make up the shape of the box phantom. When the Excel file is opened in the SARA2 software, the digital shape of the box phantom is displayed.
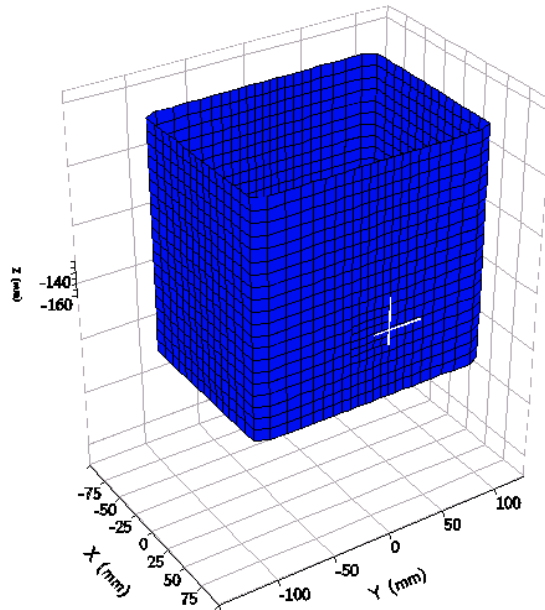
Digitised box shape displayed in SARA2 software

Since the shape of the box phantom shape is recognised by the SARA2 software, a standard head scan can take place – i.e. an area scan followed by a 3D (zoom) scan.

The following procedure should be used for tests at the side of the box:
1. Remove the SAM head phantom and put the box phantom in its place. Fill the box phantom with the appropriate liquid.
2. Attach the foam platform in place of the phone holder so that the platform is touching the side of the box phantom.
3. Position the laptop so that the wireless communication device is central against the box.
4. In the SARA2 software, select the box phantom shape from the drop down menu. Adjust other variables accordingly i.e. Probe cal, Conductivity.
5. Select the area scan icon from the tool bar and enter the limits of the scan. Because of the size of the box, this will limit the scan in height and depth to +/- 100mm.
6. With the desired limits entered, proceed with the 2D area scan.
7. As with testing in a head shape, when the area scan has finished you will be asked to proceed with a 3D zoom scan.

Properties of supporting materials

The specially developed platform that allows testing of wireless communications in laptops against the box phantom is made of a special foam material called Rohacell. This foam is made from expanded plastic based on PMI (polymethacrylimide), with properties close to those of air. This type of material although very light, is also very strong and rigid. The main advantage of this material is that it has minimal effect on the RF radiation of the device.

The properties of Rohacell foam are listed below:

Material name: Rohm Rohacell 51 IG PMI rigid foam

| Density Kg/m^3	52	
Frequency GHz	**Dielectric Constant**	**Loss tangent**
2.5	1.057	<0.0002
5.0	1.065	0.0008
10.0	1.067	0.0041
26.5	1.048	0.0135

Test conditions: 23°C

Measured by: Seavey Engineering Associates Inc. Report 9335-700

Digitising the outline of the part of the device under test

It is helpful to the user if the edge of the laptop and the wireless comms. device are digitised for the SARA2 software so that the scan results can be mapped on the outline shape so that maximum and minimum radiation points can be easily identified. Digitising can be done using a software program (phonedig.exe) available from IndexSAR.

A photo of the DUT is loaded into the program. An outline is then drawn around the main features. This outline is then used in the SARA2 software to show the relationship between the SAR distribution and the shape of the device.
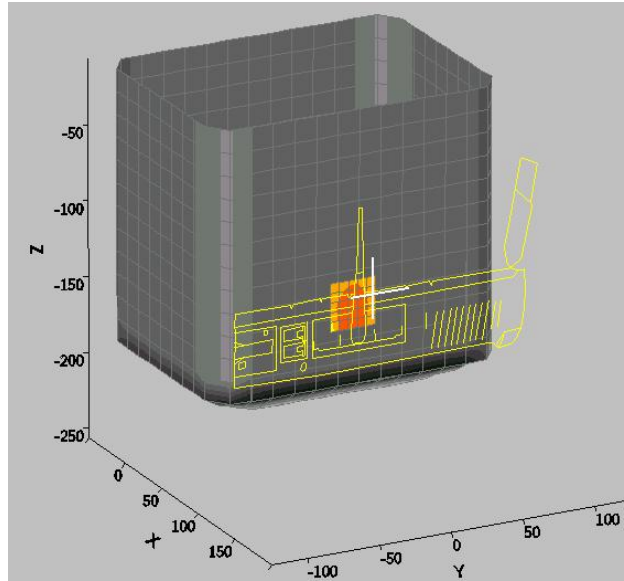
Outline shape of laptop with wireless comms. Device against box phantom in SARA2 software

Tests underneath the phantom

The Box phantom is mainly used with the source underneath the box for validation purposes with a balanced dipole. However, it can also be used for testing handsets, other wireless devices and accessories. The procedure is as follows:

1. Place the device centrally underneath the phantom with the side that would come into contact with the body, placed flat against the bottom of the box.
2. Care needs to be taken to determine the test height of the lowest scan plane to be used for testing. This procedure is the same as that used for validation tests. It is recommended that the lowest data plane is such that the sensors are at a height of 8mm above the inside surface of the phantom box.
3. Care must be taken to ensure that the coordinates entered into the unconstrained window are in head coordinates (origin above head) and are not in the robot coordinates (origin at base of robot) used in the robot control window.
4. The unconstrained mode of testing is then used to zoom scan a select cube volume at the bottom of the box.