ETS PRODUCT SERVICE AG

# TEST - REPORT

**SAR Compliance Test Report**

**Test report no.: G0M20703-1258-S-1**

# SAR

ETS
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# 1 General Information

## 1.1 Notes

The purpose of conformity testing is to increase the probability of adherence to the essential requirements or conformity specifications, as appropriate.
The complexity of the technical specifications, however, means that full and thorough testing is impractical for both technical and economic reasons.
Furthermore, there is no guarantee that a test sample which has passed all the relevant tests conforms to a specification.
The existence of the tests nevertheless provides the confidence that the test sample possesses the qualities as maintained and that is performance generally conforms to representative cases of communications equipment.

The test results of this test report relate exclusively to the item tested as specified in 1.5.
The test report may only be reproduced or published in full.
Reproduction or publication of extracts from the report requires the prior written approval of the ETS PRODUCT SERVICE AG.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualification of all persons taking them.

**Tester:**

| | | | |
|---|---|---|---|
| 04.06.2007 | | M. Cersovsky | |
| Date | ETS-Lab. | Name | Signature |

**Technical responsibility for area of testing:**

| | | | |
|---|---|---|---|
| 04.06.2007 | | N. Kaspar | |
| Date | ETS | Name | Signature |

## 1.2 Testing laboratory

### 1.2.1 Location

ETS PRODUCT SERVICE AG
Storkower Straße 38c
D-15526 Reichenwalde b. Berlin
Germany
Telephone : +49 33631 888 00
Fax : +49 33631 888 660

### 1.2.2 Details of accreditation status

**ACCREDITED TESTING LABORATORY**
**DAR-REGISTRATION NUMBER:** DAT-P-201/96

**FCC FILED TEST LABORATORY** REG. NO. 96970

**BLUETOOTH QUALIFICATION TEST FACILITY (BQTF)**
ACCREDITED BY BLUETOOTH QUALIFICATION REVIEW BOARD

**INDUSTRY CANADA FILED TEST LABORATORY REG.** NO. IC 3470

**A2LA ACCREDITED** Certificate Number 1983-01

**Statement:** The tests documented within this report are carried out in accordance with the scope of accreditation of test laboratory ETS Product Service AG.

## 1.3 Details of approval holder

| | |
|---|---|
| Name | : Alcatel Business Systems |
| Street | : 1 Route du Dr A. Schweitzer |
| Town | : Illkirch |
| Country | : France |
| Telephone | : +33 3 90 67 7160 |
| Fax | : +33 3 90 67 6240 |
| Contact | : Mr. Rainier Baltz |
| E-Mail | : |

## 1.4 Manufacturer: (if applicable)

| | |
|---|---|
| Name | : Asteel Electronique |
| Street | : 9 Rue Ampere |
| Town | : Duttlenheim |
| Country | : France |

## 1.5 Application details

| | |
|---|---|
| Date of receipt of application | : 12.03.2007 |
| Date of receipt of test item | : 12.03.2007 |
| Date of test | : 20.03.2007 - 21.03.2007 |

## 1.6 Test item

| | |
|---|---|
| Description of test item | : Radio Base station |
| Type identification | : 4070 EO Brand Name: Alcatel-Lucent |
| Serial number | : without; Identical prototype |
| Device category | : PCB (Licensed Base Station) |

**Technical data**

| | |
|---|---|
| TX Frequency range | : 1921.536 - 1928.448 MHz |
| Max. Conducted RF output power | : PCS 1900 / 20,61 dBm (115,08 mW) |
| Power supply | : 115 V AC |
| Antenna Tx | : integral |
| Antenna RX | : integral |
| Additional information | : ./. |

## 1.7 Test Results

Max. SAR Measurement : 0,00196 W/kg (averaged over 1 gram)

This EUT has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-2003, December 2003.

## 1.8 Test standards

Standards - IEEE Std. 1528-2003, December 2003

FCC Rule Part(s) : - FCC OET Bulletin 65, Supplement C, Edition 01-01

# 2 Technical test

## 2.1 Summary of test results

**Applicable Configuration**

| | |
|---|---|
| Handset (Head) | |
| Handset (Body) | X |
| Headset (Head) | |
| Body Worn Equipment | |

EUT complies with the RF radiation exposure limits of the FCC as shown by the SAR measurement results. These measurements are taken to simulate the RF effects exposure under worst-case conditions. The EUT complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [1]

In case of multiple hotspots the secondary hotspots within 2 dB of the maximum SAR value will be recorded and displayed in the measurement plots. The secondary hotspots with a peak SAR value below 0.5 W/kg will not be measured by the system, due to the high margin to the limits.

## 2.2 Test environment

| | |
|---|---|
| Room temperature | : 22.1 - 22.6 ° C |
| Liquid temperature | : 22.0 - 22.3 ° C |
| Relative humidity content | : 20 ... 75 % |
| Air pressure | : 86 ... 103 kPa |
| Details of power supply | : 115 V AC |

## 2.3 Test equipment utilized

| No. | Measurement device: | Type: | Manufacturer: |
|---|---|---|---|
| ETS 0449 | Stäubli Robot | RX90B L | Stäubli |
| ETS 0450 | Stäubli Robot Controller | CS/MBs&p | Stäubli |
| ETS 0451 | DASY 4 Measurement Server | | Schmid & Partner |
| ETS 0452 | Control Pendant | | Stäubli |
| ETS 0453 | Compaq Computer | Pentium IV, 2 GHz, | Schmid & Partner |
| ETS 0454 | Dabu Acquisition Electronics | DAE3V1 | Schmid & Partner |
| ETS 0455 | Dummy Probe | | Schmid & Partner |
| ETS 0456 | Dosimetric E-Field Probe | ET3DV6 | Schmid & Partner |
| ETS 0457 | Dosimetric E-Field Probe | ET3DV6 | Schmid & Partner |
| ETS 0458 | Dosimetric H-Field Probe | H3DV6 | Schmid & Partner |
| ETS 0479 | System Validation Kit | D300V3 | Schmid & Partner |
| ETS 0480 | System Validation Kit | D450V3 | Schmid & Partner |
| ETS 0459 | System Validation Kit | D900V2 | Schmid & Partner |
| ETS 0460 | System Validation Kit | D1800V2 | Schmid & Partner |
| ETS 0461 | System Validation Kit | D1900V2 | Schmid & Partner |
| ETS 0462 | System Validation Kit | D2450V2 | Schmid & Partner |
| ETS 0463 | Probe Alignment Unit | LBV2 | Schmid & Partner |
| ETS 0464 | SAM Twin phantom | V 4.0 | Schmid & Partner |
| ETS 0513 | Flat phantom | V 4.4 | Schmid & Partner |
| ETS 0467 | Oval flat phantom | ELI 4 | Schmid & Partner |
| ETS 0465 | Mounting Device | V 3.1 | Schmid & Partner |
| ETS 0224a | Millivoltmeter | URV 5 | Rohde & Schwarz |
| ETS 0219 | Power sensor | NRV-Z2 | Rohde & Schwarz |
| ETS 0268 | RF signal generator | SMP 02 | Rohde & Schwarz |
| ETS 0322 | Insertion unit | URV5-Z4 | Rohde & Schwarz |
| ETS 0466 | Directional Coupler | HP 87300B | HP |
| ETS 0231 | Radio Communication Tester | CMD65 | Rohde & Schwarz |
| ETS 0484 | Universal Radio Communication Tester | CMU 200 | Rohde & Schwarz |
| ETS 0468 | Network Analyzer 300 kHz to 3 GHz | 8753C | Agilent |
| ETS 0469 | Dielectric Probe Kit | 85070C | Agilent |

## 2.4 Definitions

### 2.4.1 SAR

The specific absorption rate (SAR) is defined as the time derivative of the incremental energy (*dW*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element *(dV)* of a given density ($\rho_t$), expressed in watts per kilogram (W/kg)

$$\text{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho_t dV}\right) = \frac{\sigma}{\rho_t}\left|E_t\right|^2$$

where:

$$\frac{dW}{dt} = \int_v E \cdot J \, dV = \int_v \sigma E^2 dV$$

### 2.4.2 Uncontrolled Exposure

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices. [2]

### 2.4.3 Controlled Exposure

In general, occupational / controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on the risk of potential exposure and instructions on methods to minimize such exposure risks. [2]

## 2.5 Measurement System Description

### 2.5.1 System Setup

Measurements are performed using the DASY4 automated dosimetric assessment system (figure 1) made by Schmid & Partner Engineering AG (SPEAG)in Zurich, Switzerland.


Figure 1

The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- An unit to operate the optical surface detector which is connected to the EOC.
- The Electro-optical converter (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the measurement server.
- The functions of the measurement server is to perform the time critical task such as signal filtering, surveillance of the robot operation, fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows NT.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes (see Application Notes).
- System validation dipoles allowing to validate the proper functioning of the system.

### 2.5.2 Phantom Description

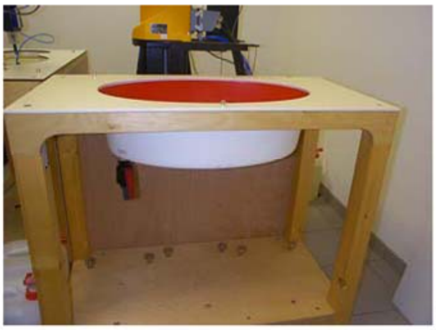

(Figure 2.1)

The SAM twin phantom V4.0 (figure 2.1) is a fiberglass shell phantom with 2 mm shell thickness. It has three measurement areas:

- Left hand
- Right hand
- Flat phantom


(Figure 2.2)

The FLATPHANTOM V4 (figure 2.2) is a phantom for dosimetric evaluations of body mounted usage and system performance check for the frequency up to 3 GHz.


(Figure 2.3)

The Oval flat phantom (ELI 4) (figure 2.3) is a fiberglass shell phantom with 2 mm thickness.

The phantom is integrated in a wooden table.
The bottom plate of the table contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is necessary if two phantoms are used (e.g., for different liquids).

A cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible.

On the phantom top, three reference markers are provided to identify the phantom positions with respect to the robot.

### 2.5.3 Tissue Simulating Liquids

The parameters of the tissue simulating liquid strongly influence the SAR. The parameters for the different frequencies are defined in the corresponding compliance standards (e.g., EN 50361, IEEE P1528-2003.

Tissue dielectric properties

| | Head | | Body | |
|---|---|---|---|---|
| **Frequency (MHz)** | **Relative Dielectric Constant ($\varepsilon_r$)** | **Conductivity ($\sigma$) (S/m)** | **Relative Dielectric Constant ($\varepsilon_r$)** | **Conductivity ($\sigma$) (S/m)** |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1800 | 40.0 | 1.40 | 53.3 | 1.52 |
| 1900 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |

### 2.5.4 Device Holder

The DASY device holder (figure 3.1 and 3.2) is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The rotation centers for both scales is the ear opening. Thus the device needs no repositioning when changing the angles.

Figure 3.1

Figure 3.2

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\varepsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

### 2.5.5 Probes

The SAR measurements were conducted with the dosimetric probe ET3DV6 (figure 4), designed in the classical triangular configuration and optimized for dosimetric evaluation. [3] The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

Figure 4

Probe Specifications

| | |
|---|---|
| Calibration: | In air from 10 MHz to 2.5 GHz<br>In brain and muscle simulating tissue at Frequencies of 835 MHz, 900 MHz, 1800 MHz, 1900 MHz and 2450 MHz<br>Calibration certificates please find attached. |
| Frequency: | 10 MHz to > 3 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz) |
| Directivity: | ± 0.2 dB in HSL (rotation around probe axis)<br>± 0.4 dB in HSL (rotation normal probe axis) |
| Dynamic Range: | 5 µW/g to > 100 mW/g; |
| Linearity: | ± 0.2 dB |
| Dimensions: | Overall length: 330 m<br>Tip length: 16 mm<br>Body diameter: 12 mm<br>Tip diameter: 6.8 mm<br>Distance from probe tip to dipole centers: 2.7 mm |
| Application: | General dosimetry up to 3 GHz<br>Compliance tests of mobile phones<br>Fast automatic scanning in arbitrary phantoms |

## 2.6 Test System Specification

**Positioner**

| | |
|---|---|
| Robot: | Stäubli Animation Corp. Robot Model: RX90B L |
| Repeatability: | 0.02 mm |
| No. of axis: | 6 |

**Data Acquisition Electronic (DAE) System**
**Cell Controller**

| | |
|---|---|
| Processor: | Pentium IV |
| Clock Speed: | 2.0 GHz |
| Operating System: | Windows 2000 |
| Data Card: | DASY4 PC-Board |
| Data Converter | |
| Features: | Signal Amplifier, multiplexer, A/D converter, & control logic |
| Software: | DASY4 software |
| Connecting Lines: | Optical downlink for data and status info.<br>Optical uplink for commands and clock |

**PC Interface Card**

| | |
|---|---|
| Function: | 24 bit (64 MHz) DSP for real time processing<br>Link to DAE3<br>16 bit A/D converter for surface detection system<br>serial link to robot<br>direct emergency stop output for robot |

**E-Field Probes**

| | |
|---|---|
| Model: | ET3DV6 SN1711 |
| Construction: | Triangular core fiber optic detection system |
| Frequency: | 10 MHz to 6 GHz |
| Linearity: | ± 0.2 dB (30 MHz to 3 GHz) |

**Phantom**

| | |
|---|---|
| Phantom 1: | Oval flat phantom (ELI 4) |
| Shell Material: | Fiberglass |
| Thickness: | 2.0 ± 0.2 mm |
| Phantom 2: | Flat Phantom (V4.4) |
| Shell Material: | Fiberglass |
| Thickness: | 6.0 ± 0.2 mm |
| Phantom 3: | SAM Twin Phantom (V4.0) |
| Shell Material: | Fiberglass |
| Thickness: | 2.0 ± 0.2 mm |

## 2.7 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed location point was measured and used as a reference value.
2. The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 10mm x 10mm.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 30 mm x 30 mm x 30 mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 5 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:
   a. The data at the surface was extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm [4]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
   b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions) [4] [5]. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as procedure # 1, was re-measured. If the value changed by more than 5 %, the evaluation is repeated.

## 2.8 Reference Points

### 2.8.1 Ear Reference Points

Figure 5.1 shows the front, back and side vies of SAM. The point "M" is the reference point for the center of mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5.2. The plane passing through the two ear reference points and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 5.3). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the N-F line, the ear is truncated as illustrated in Figure 5.2. The ear truncation is introduced to avoid the handset from touching the ear lobe, which can cause unstable handset positioning at the cheek. [6]


Figure 5.1

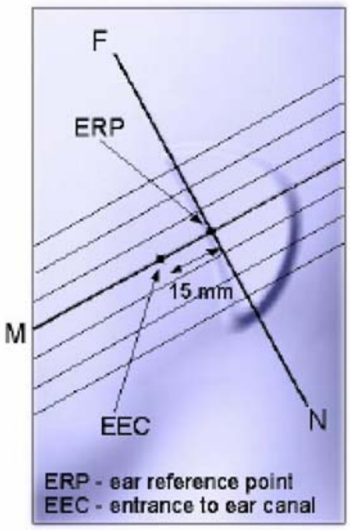



Figure 5.2

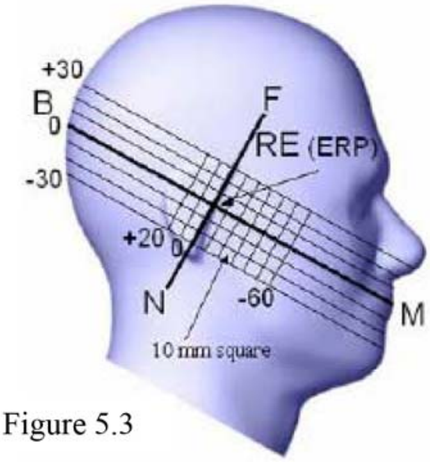



Figure 5.3

### 2.8.2 Handset Reference Points

Two imaginary lines on the handset were defined: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width *wt* of the handset at the level of the acoustic output (point A on Figures 6.1 and 6.2), and the midpoint of the width *wb* of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 6.1). The two lines intersect at point A. For many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. The vertical centerline is not necessarily parallel to the front face of the handset (see Figure 6.2), especially for clamshell handsets, handsets with flip pieces, and other irregularly-shaped handsets. [6]

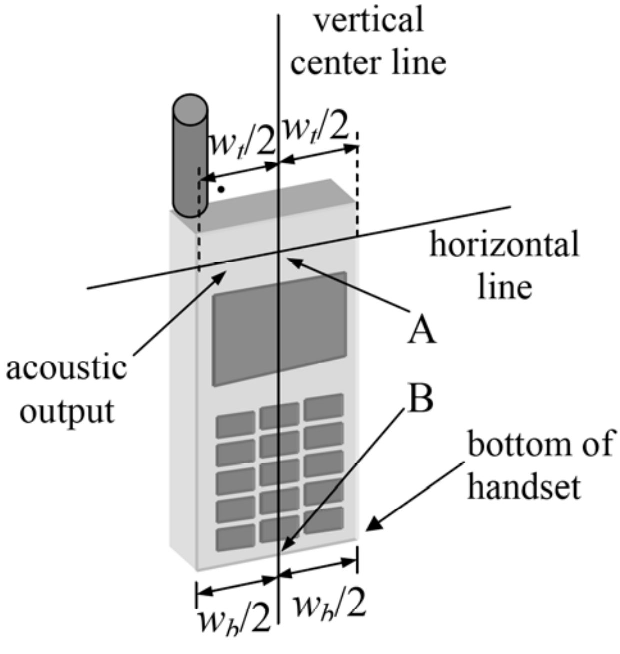



Figure 6.1

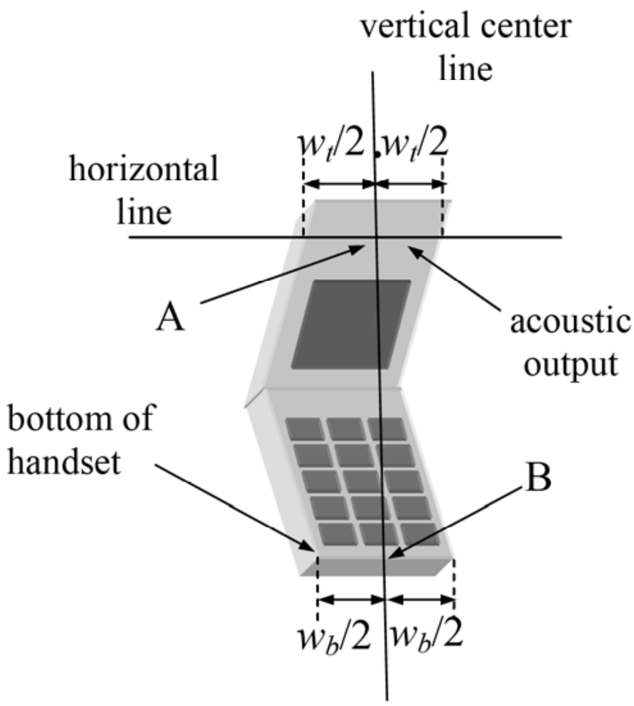



Figure 6.2

## 2.9 Test Positions

### 2.9.1 "Cheek" / "Touch" Position

The EUT was positioned close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 7), such that the plane defined by the vertical center line and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.
The EUT was translated towards the phantom along the line passing through RE and LE until the handset touches the pinna.
While maintaining the handset in this plane, the EUT was rotated it around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (called the reference plane).
The EUT was rotated around the vertical centerline until the handset (horizontal line) was symmetrical with respect to the line NF.
While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the handset contact with the pinna, the EUT was rotated about the line NF until any point on the handset was in contact with a phantom point below the pinna (cheek). [6] See Figure 7.

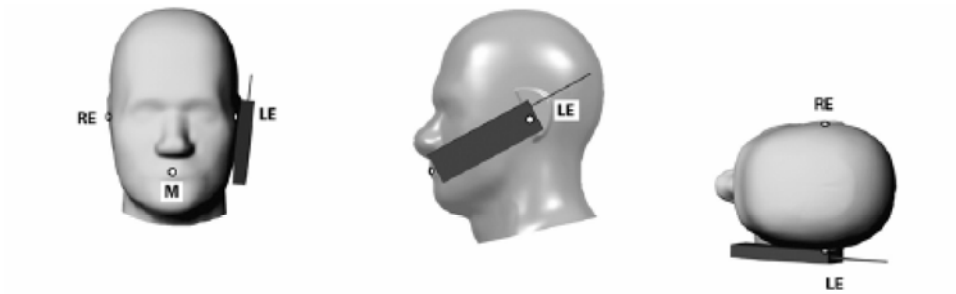



Figure 7

### 2.9.2 "Tilted" Position

The EUT was in "cheek position".
While maintaining the orientation of the handset move the handset away from the pinna along the line passing through RE and LE in order to enable a rotation of the handset by 15 degrees.
The EUT was rotated around the horizontal line by 15 degrees.
While maintaining the orientation of the handset, the EUT was moved towards the phantom on a line passing through RE and LE until any part of the handset touched the ear. The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna (e.g., the antenna with the back of the phantom head), the angle of the handset would be reduced. In this case, the tilted position is obtained if any part of the handset was in contact with the pinna as well as a second part of the handset was in contact with the phantom (e.g., the antenna with the back of the head). [6] See Figure 8.

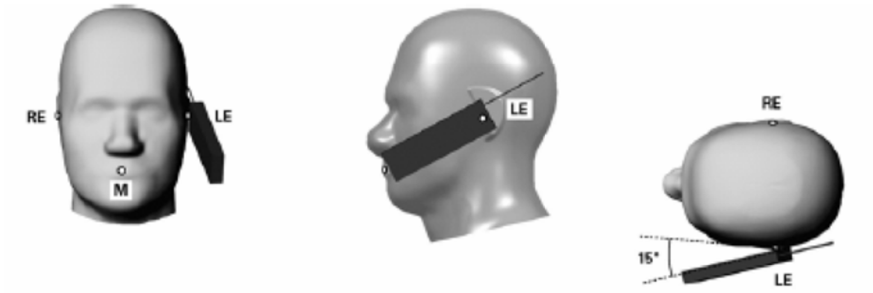



Figure 8