



# SAR Evaluation Report

IN ACCORDANCE WITH THE REQUIREMENTS OF  
FCC REPORT AND ORDER:  
ET DOCKET 93-62, AND OET BULLETIN 65 SUPPLEMENT C

FOR

HANDHELD TERMINAL

MODEL: DT-X10M30URC2

FCC ID: BBQDT-X10M30URC2

REPORT NUMBER: 05I3440-4

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*Prepared for*

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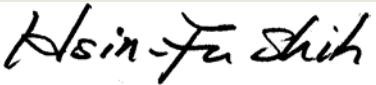
**NVLAP<sup>®</sup>**  
LAB CODE:200065-0

Revision History

| <u>Rev.</u> | <u>Revisions</u>   | <u>Revised By</u> |
|-------------|--|-------------------|
| A           | Initial Issue  | HS                |
| B           | Revised table in page 22 from channel 6 to 11                | HS                |
| C           | Additional SAR test - Alternative battery (model DT-5023BAT) | HS                |

**CERTIFICATE OF COMPLIANCE (SAR EVALUATION)****DATES OF TEST:** June 17, 2005

|                    |  |
|--------------------|--|
| APPLICANT:         | CASIO COMPUTER CO., LTD.                         |
| ADDRESS:           | 6-2, HON-MACHI L-CHOME, SHIBUYA-KU, TOKYO, JAPAN |
| FCC ID:            | BBQDT-X10M30URC2                                 |
| MODEL:             | DT-X10M30URC2                                    |
| DEVICE CATEGORY:   | Portable Device                                  |
| EXPOSURE CATEGORY: | General Population/Uncontrolled Exposure         |

| Handheld Terminal with WLAN and Bluetooth radio module  |  |                                  |                                 |
|---|--|----------------------------------|---------------------------------|
| Test Sample is a:   | Production unit  |                                  |                                 |
| Modulation type:  | <ul style="list-style-type: none"> <li>• Direct Sequence Spread Spectrum (DSSS) for 802.11b</li> <li>• Frequency Hopping Spread Spectrum (FHSS) for Bluetooth module.</li> </ul> |                                  |                                 |
| FCC Rule Parts  | Frequency Range [MHz]  | The Highest SAR Values [1g_mW/g] | Max. Average Power Output [dBm] |
| 47 CFR 15.247   | 2412 - 2462  | 0.153                            | 14.27                           |
| <p>This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC OET 65 Supplement C (Edition 01-01).</p> <p>Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.</p> |  |                                  |                                 |
| Released For CCS By:  |  |                                  |                                 |
|    |  |                                  |                                 |
| Hsin Fu Shih (Sunny Shih)   |  |                                  |                                 |
| COMPLIANCE CERTIFICATION SERVICES   |  |                                  |                                 |

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**1 EQUIPMENT UNDER TEST (EUT) DESCRIPTION**

|  |   |
|--|---|
| Handheld Terminal with WLAN and Bluetooth radio module |   |
| Normal operation:                                      | Handheld and worn on body   |
| Accessory:   | N/A   |
| Earphone/Headset Jack:                                 | N/A   |
| Duty cycle:  | 100% for DSSS & FHSS  |
| Power supply:  | <b>Rechargeable Li-ion battery:</b> <ol style="list-style-type: none"> <li>1. Manufactured by Casio, model DT-5023BAT, Rating 3.7 Vdc, 1550 mA/h.</li> <li>2. Manufactured by Casio, model DT-5025LBAT, Rating 3.7 Vdc, 3400 mA/h.</li> </ol> |

**2 FACILITIES AND ACCREDITATION**

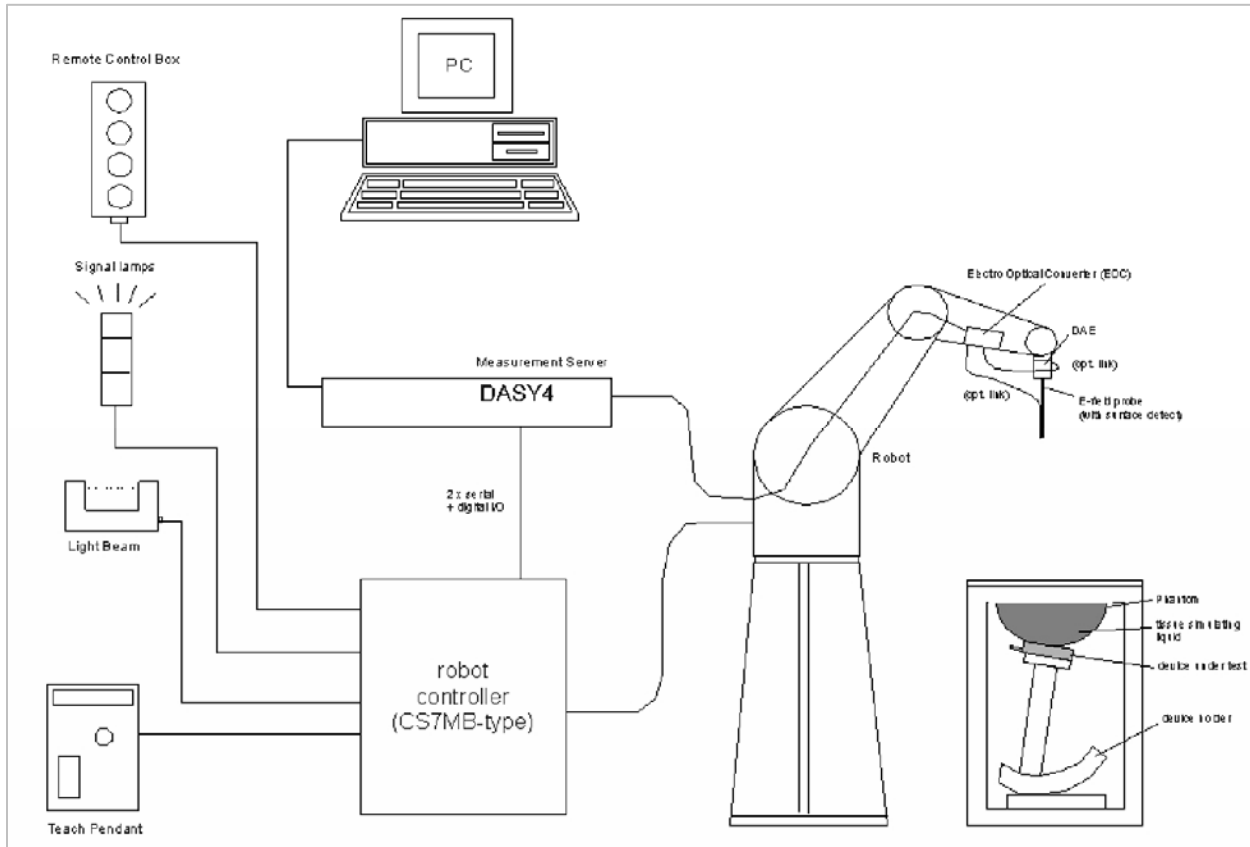
The test sites and measurement facilities used to collect data are located at 561F Monterey Road, Morgan Hill, California, USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."



CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://www.ccsemc.com>.

No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

### 3 SYSTEM DESCRIPTION



#### 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.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote controls 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.
- Validation dipole kits allowing to validate the proper functioning of the system.

## 4 SYSTEM COMPONENT

### 4.1 DASY4 MEASUREMENT SERVER



The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

### 4.2 DATA ACQUISITION ELECTRONICS (DAE)

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200M $\Omega$ ; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



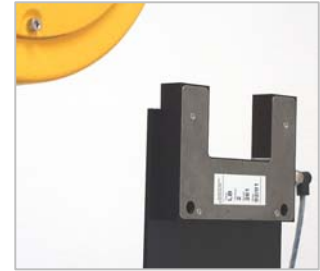
### 4.3 EX3DV3 ISOTROPIC E-FIELD PROBE FOR DOSIMETRIC MEASUREMENTS

- Construction:** Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
- Frequency:** 10 MHz to > 6 GHz; Linearity:  $\pm 0.2$  dB (30 MHz to 3 GHz)
- Directivity:**  $\pm 0.3$  dB in HSL (rotation around probe axis);  $\pm 0.5$  dB in tissue material (rotation normal to probe axis)
- Dynamic Range:** 10  $\mu$ W/g to > 100 mW/g; Linearity:  $\pm 0.2$  dB (noise: typically < 1  $\mu$ W/g)
- Dimensions:** Overall length: 330 mm (Tip: 20 mm)  
Tip diameter: 2.5 mm (Body: 12 mm)  
Typical distance from probe tip to dipole centers: 1 mm
- Application:** High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



#### 4.4 LIGHT BEAM UNIT

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.



#### 4.5 SAM PHANTOM (V4.0)

**Construction:** The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

**Shell Thickness:**  $2 \pm 0.2$  mm

**Filling Volume:** Approx. 25 liters

**Dimensions:** Height: 810mm; Length: 1000mm; Width: 500mm





**4.6 DEVICE HOLDER FOR SAM TWIN PHANTOM**

**Construction:** In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



**4.7 SYSTEM VALIDATION KITS**

**Construction:** Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 450, 900, 1800, 2450, 5800 MHz

**Return loss:** > 20 dB at specified validation position

**Power capability:** > 100 W (f < 1GHz); > 40 W (f > 1GHz)

**Dimensions:** 450V2: dipole length: 270 mm; overall height: 330 mm  
 D900V2: dipole length: 149 mm; overall height: 330 mm  
 D1800V2: dipole length: 72 mm; overall height: 300 mm  
 D835V2: dipole length: 161; overall height: 330  
 D1900V2: dipole length: 68; overall height: 300  
 D2450V2: dipole length: 51.5 mm; overall height: 300 mm D5GHzV2: dipole length: 25.5 mm; overall height: 290 mm

**4.8 COMPOSITION OF INGREDIENTS FOR TISSUE SIMULATING LIQUID**

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

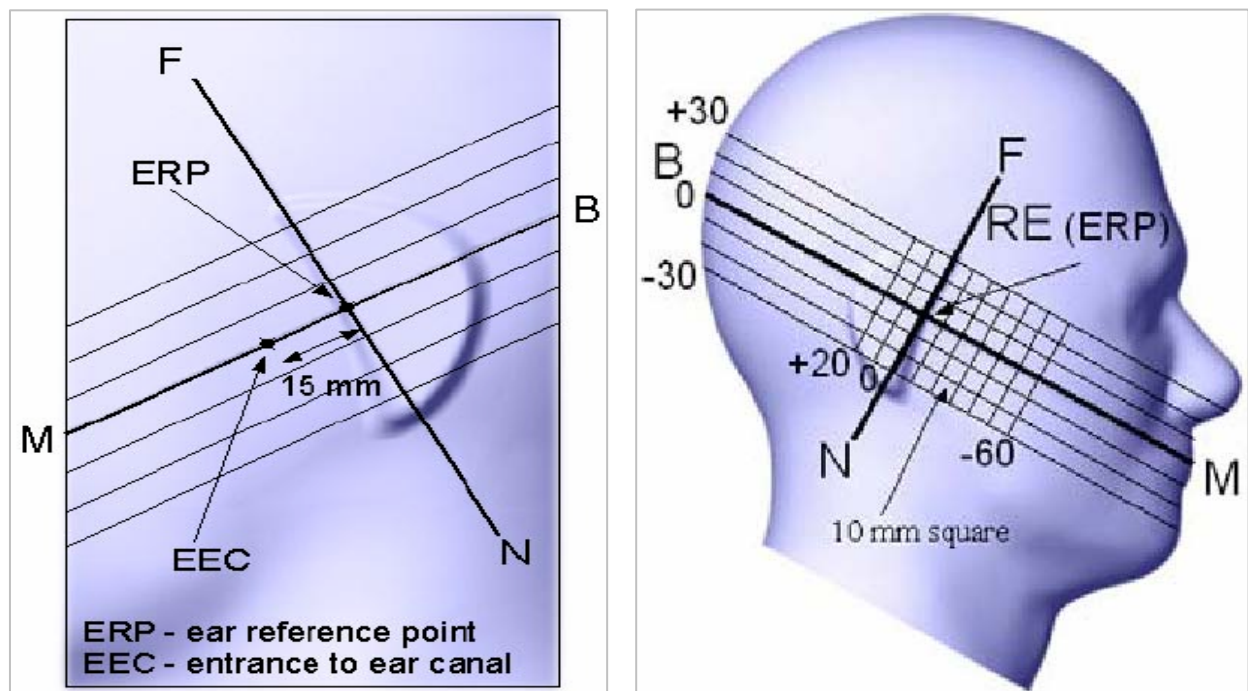
| Ingredients<br>(% by weight) | Frequency (MHz) |       |       |      |       |       |       |      |      |      |
|------------------------------|-----------------|-------|-------|------|-------|-------|-------|------|------|------|
|                              | 450             |       | 835   |      | 915   |       | 1900  |      | 2450 |      |
| Tissue Type                  | Head            | Body  | Head  | Body | Head  | Body  | Head  | Body | Head | Body |
| Water                        | 38.56           | 51.16 | 41.45 | 52.4 | 41.05 | 56.0  | 54.9  | 40.4 | 62.7 | 73.2 |
| Salt (NaCl)                  | 3.95            | 1.49  | 1.45  | 1.4  | 1.35  | 0.76  | 0.18  | 0.5  | 0.5  | 0.04 |
| Sugar                        | 56.32           | 46.78 | 56.0  | 45.0 | 56.5  | 41.76 | 0.0   | 58.0 | 0.0  | 0.0  |
| HEC                          | 0.98            | 0.52  | 1.0   | 1.0  | 1.0   | 1.21  | 0.0   | 1.0  | 0.0  | 0.0  |
| Bactericide                  | 0.19            | 0.05  | 0.1   | 0.1  | 0.1   | 0.27  | 0.0   | 0.1  | 0.0  | 0.0  |
| Triton X-100                 | 0.0             | 0.0   | 0.0   | 0.0  | 0.0   | 0.0   | 0.0   | 0.0  | 36.8 | 0.0  |
| DGBE                         | 0.0             | 0.0   | 0.0   | 0.0  | 0.0   | 0.0   | 44.92 | 0.0  | 0.0  | 26.7 |
| Dielectric Constant          | 43.42           | 58.0  | 42.54 | 56.1 | 42.0  | 56.8  | 39.9  | 54.0 | 39.8 | 52.5 |
| Conductivity (S/m)           | 0.85            | 0.83  | 0.91  | 0.95 | 1.0   | 1.07  | 1.42  | 1.45 | 1.88 | 1.78 |

Salt: 99+% Pure Sodium Chloride                      Sugar: 98+% Pure Sucrose  
 Water: De-ionized, 16 MΩ+ resistivity              HEC: Hydroxyethyl Cellulose  
 DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]  
 Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

## 5 TEST POSITIONS FOR DEVICES OPERATING NEXT TO A PERSON'S EAR

This category includes most wireless handsets with fixed, retractable or internal antennas located toward the top half of the device, with or without a foldout, sliding or similar keypad cover. The handset should have its earpiece located within the upper ¼ of the device, either along the centerline or off-centered, as perceived by its users. This type of handset should be positioned in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point". The "test device reference point" should be located at the same level as the center of the earpiece region. The "vertical centerline" should bisect the front surface of the handset at its top and bottom edges. A "ear reference point" is located on the outer surface of the head phantom on each ear spacer. It is located 1.5 cm above the center of the ear canal entrance in the "phantom reference plane" defined by the three lines joining the center of each "ear reference point" (left and right) and the tip of the mouth.

A handset should be initially positioned with the earpiece region pressed against the ear spacer of a head phantom. For the SCC-34/SC-2 head phantom, the device should be positioned parallel to the "N-F" line defined along the base of the ear spacer that contains the "ear reference point". For interim head phantoms, the device should be positioned parallel to the cheek for maximum RF energy coupling. The "test device reference point" is aligned to the "ear reference point" on the head phantom and the "vertical centerline" is aligned to the "phantom reference plane". This is called the "initial ear position". While maintaining these three alignments, the body of the handset is gradually adjusted to each of the following positions for evaluating SAR:



## 5.1 CHEEK/TOUCH POSITION

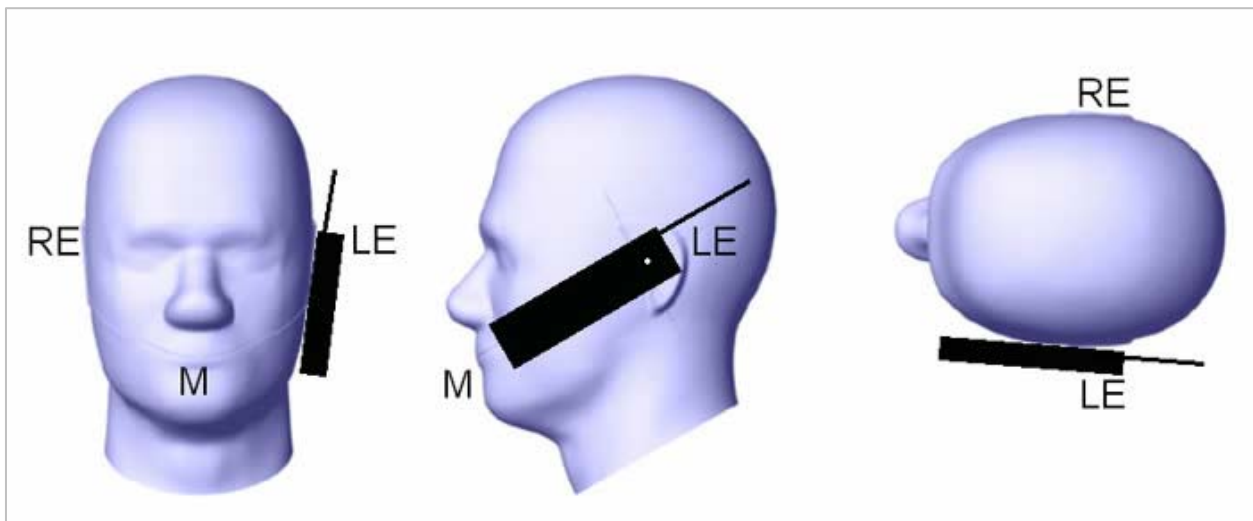
The device is brought toward the mouth of the head phantom by pivoting against the “ear reference point” or along the “N-F” line for the SCC-34/SC-2 head phantom.

This test position is established:

- i. When any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom.
- ii. (or) When any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.

For existing head phantoms – when the handset loses contact with the phantom at the pivoting point, rotation should continue until the device touches the cheek of the phantom or breaks its last contact from the ear spacer.

Cheek / Touch Position



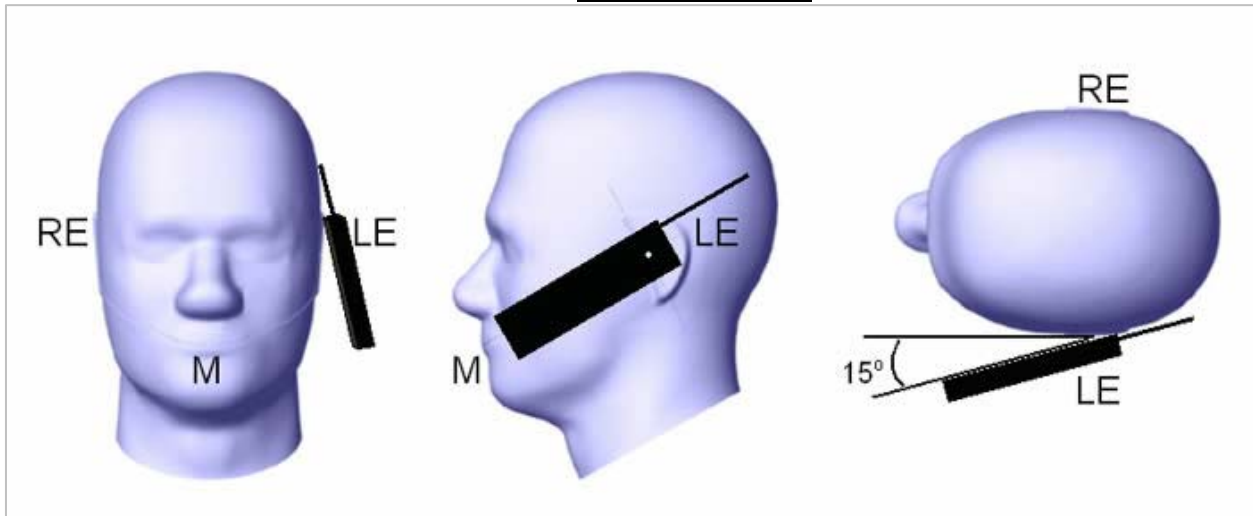
## 5.2 EAR/TILT POSITION

With the handset aligned in the “Cheek/Touch Position”:

- i. If the earpiece of the handset is not in full contact with the phantom’s ear spacer (in the “Cheek/Touch position”) and the peak SAR location for the “Cheek/Touch” position is located at the ear spacer region or corresponds to the earpiece region of the handset, the device should be returned to the “initial ear position” by rotating it away from the mouth until the earpiece is in full contact with the ear spacer.
- ii. (otherwise) The handset should be moved (translated) away from the cheek perpendicular to the line passes through both “ear reference points” (note: one of these ear reference points may not physically exist on a split head model) for approximate 2-3 cm. While it is in this position, the device handset is tilted away from the mouth with respect to the “test device reference point” until the inside angle between the vertical centerline on the front surface of the phone and the horizontal line passing through the ear reference point is by  $15^\circ$ . After the tilt, it is then moved (translated) back toward the head perpendicular to the line passes through both “ear reference points” until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than  $15^\circ$  so that the device and its antenna would touch the phantom simultaneously. This test position may require a device holder or positioner to achieve the translation and tilting with acceptable positioning repeatability.

If a device is also designed to transmit with its keypad cover closed for operating in the head position, such positions should also be considered in the SAR evaluation. The device should be tested on the left and right side of the head phantom in the “Cheek/Touch” and “Ear/Tilt” positions. When applicable, each configuration should be tested with the antenna in its fully extended and fully retracted positions. These test configurations should be tested at the high, middle and low frequency channels of each operating mode; for example, AMPS, CDMA, and TDMA. If the SAR measured at the middle channel for each test configuration (left, right, Cheek/Touch, Tile/Ear, extended and retracted) is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s). If the transmission band of the test device is less than 10 MHz, testing at the high and low frequency channels is optional.

Ear/Tilt  $15^\circ$  Position



## 6 TEST POSITIONS FOR BODY-WORN AND OTHER SIMILAR CONFIGURATIONS

With the belt-clips or holsters

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do.

When multiple accessories

When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., the same metallic belt-clip used with different holsters with no other metallic components), only the accessory that dictates the closest spacing to the body must be tested.

Without the belt-clips or holsters

Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.

Transmitter that is designed to operate in front of a person's face (face-held)

Transmitters that are designed to operate in front of a person's face, in push-to-talk configurations, should be tested for SAR compliance with the front of the device positioned at 2.5 cm from a flat phantom. Frontal face-phantoms are typically not recommended because of the potential of higher E-field probe boundary-effects errors in the non-smooth regions of these face phantoms, such as the nose, lips and eyes etc. For devices that are carried next to the body, such as shoulder, waist or chest-worn transmitters, SAR compliance should be tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in normal use configurations.

With neck-strap or lanyard

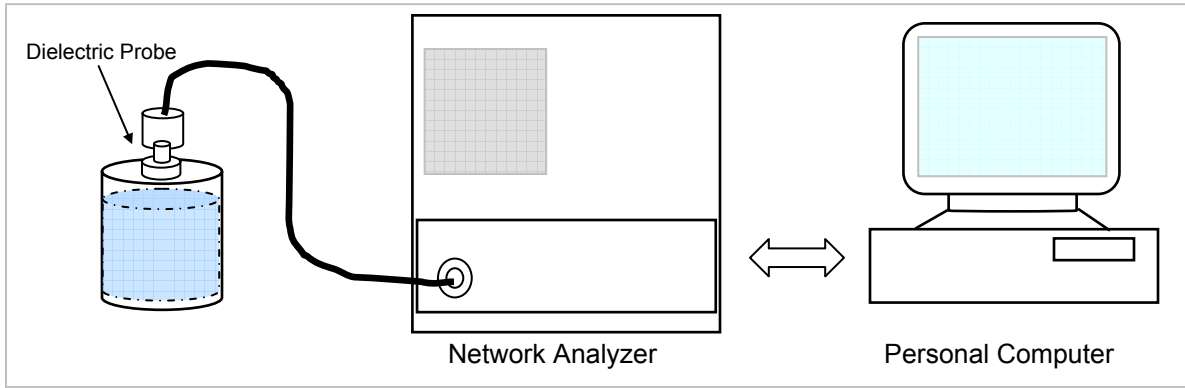
SAR data is requested for cellphones designed to be used with a headset while worn next to the body using a neck-strap or lanyard; device should be tested with front and back sides in contact with a flat phantom

Lap-held

SAR is tested for a lap-held position with the bottom of the computer in direct contact against a flat phantom.

**7 SIMULATING LIQUID PARAMETERS CHECK**

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within  $\pm 5\%$  of the values given in the table below.



Set-up for liquid parameters check

**Reference Values of Tissue Dielectric Parameters for Head and Body Phantom**

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE Standard 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

| Target Frequency (MHz) | Head         |                | Body         |                |
|------------------------|--------------|----------------|--------------|----------------|
|                        | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150                    | 52.3         | 0.76           | 61.9         | 0.80           |
| 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           |
| 915                    | 41.5         | 0.98           | 55.0         | 1.06           |
| 1450                   | 40.5         | 1.20           | 54.0         | 1.30           |
| 1610                   | 40.3         | 1.29           | 53.8         | 1.40           |
| 1800 – 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           |
| 5800                   | 35.3         | 5.27           | 48.2         | 6.00           |

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

**7.1 SIMULATING LIQUID PARAMETER CHECK RESULT**

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2450 MHz

Room Ambient Temperature =24°C; Relative humidity = 40%

Measured by: James Lee

| Simulating Liquid |            |            | Parameters |                            | Target | Measured | Deviation (%) | Limit (%) |
|-------------------|------------|------------|------------|----------------------------|--------|----------|---------------|-----------|
| f (MHz)           | Temp. (°C) | Depth (cm) | e''        | Relative Permittivity (e') |        |          |               |           |
| 2450              | 23         | 15         |            | Relative Permittivity (e') | 52.7   | 51.9731  | -1.38         | ± 5       |
|                   |            |            | 14.7964    | Conductivity (σ)           | 1.95   | 2.01670  | 3.42          | ± 5       |

Liquid Check

Ambient temperature: 24.0 deg. C; Liquid temperature: 23.0 deg C

June 17, 2005 10:22 PM

| Frequency   | e'      | e''     |
|-------------|---------|---------|
| 2400000000. | 52.1783 | 14.5822 |
| 2410000000. | 52.1537 | 14.5932 |
| 2420000000. | 52.1212 | 14.6147 |
| 2430000000. | 52.0692 | 14.6765 |
| 2440000000. | 52.0288 | 14.7282 |
| 2450000000. | 51.9731 | 14.7964 |
| 2460000000. | 51.9628 | 14.8571 |
| 2470000000. | 51.9362 | 14.9393 |
| 2480000000. | 51.9167 | 15.0285 |
| 2490000000. | 51.8586 | 15.0805 |
| 2500000000. | 51.7973 | 15.0727 |

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 e'' = 2 \pi f \epsilon_0 e''$$

where  $f = \text{target } f * 10^6$

$$\epsilon_0 = 8.854 * 10^{-12}$$

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2450 MHz

Room Ambient Temperature =24°C; Relative humidity = 45%

Measured by: Anson Lu

| Simulating Liquid |            |            | Parameters |                            | Target | Measured | Deviation (%) | Limit (%) |
|-------------------|------------|------------|------------|----------------------------|--------|----------|---------------|-----------|
| f (MHz)           | Temp. (°C) | Depth (cm) | e''        | Relative Permittivity (e') |        |          |               |           |
| 2450              | 23         | 15         |            | Relative Permittivity (e') | 52.7   | 51.6941  | -1.91         | ± 5       |
|                   |            |            | 14.4713    | Conductivity (σ)           | 1.95   | 1.97239  | 1.15          | ± 5       |

Liquid Check

Ambient temperature: 24.0 deg. C; Liquid temperature: 23.0 deg C

July 05, 2005 09:25 AM

| Frequency   | e'      | e''     |
|-------------|---------|---------|
| 2400000000. | 51.8511 | 14.2719 |
| 2410000000. | 51.8274 | 14.2941 |
| 2420000000. | 51.7885 | 14.3509 |
| 2430000000. | 51.7535 | 14.3885 |
| 2440000000. | 51.7267 | 14.4314 |
| 2450000000. | 51.6941 | 14.4713 |
| 2460000000. | 51.6468 | 14.5191 |
| 2470000000. | 51.6297 | 14.5745 |
| 2480000000. | 51.5903 | 14.6289 |
| 2490000000. | 51.5375 | 14.6598 |
| 2500000000. | 51.5056 | 14.6910 |

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 e'' = 2 \pi f \epsilon_0 e''$$

where  $f = \text{target } f * 10^6$

$$\epsilon_0 = 8.854 * 10^{-12}$$



## 8 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of  $\pm 10\%$ .

### System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4 system with an Isotropic E-Field Probe EX3DV4-SN: 3552 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
- Special 5 x 5 x 7 fine cube was chosen for cube integration(dx=dy=7.5mm; dz=5mm).
- Distance between probe sensors and phantom surface was set to 2.5 mm.
- The dipole input power (forward power) was 250 mW $\pm 3\%$ .
- The results are normalized to 1 W input power.

### Reference SAR Values

The reference SAR values were using measurement results indicated in the dipole calibration document (See attached dipole certificate).

| f (MHz) | Head Tissue       |                    | Body Tissue       |                    |
|---------|-------------------|--------------------|-------------------|--------------------|
|         | SAR <sub>1g</sub> | SAR <sub>10g</sub> | SAR <sub>1g</sub> | SAR <sub>10g</sub> |
| 2450    | 52.0              | 23.8               | 54.8              | 25.4               |

### 8.1 SYSTEM PERFORMANCE CHECK RESULT

#### @ System Validation Dipole: D2450V2 SN: 748

Date: June 17, 2005

Ambient Temperature = 24°C, Relative humidity = 40%

Measured by: James Lee

| Body Simulating Liquid |            |            | M <sub>measured</sub> |                   | Target <sub>1g</sub> | Deviation[%] | Limit [%] |
|------------------------|------------|------------|-----------------------|-------------------|----------------------|--------------|-----------|
| f (MHz)                | Temp. [°C] | Depth [cm] | 1g                    | Normalized to 1 W |                      |              |           |
| 2450                   | 23         | 15         | 12.6                  | 50.4              | 54.8                 | -8.03        | $\pm 10$  |

Date: July 05, 2005

Ambient Temperature = 24°C, Relative humidity = 45%

Measured by: Anson Lu

| Body Simulating Liquid |            |            | M <sub>measured</sub> |                   | Target <sub>1g</sub> | Deviation[%] | Limit [%] |
|------------------------|------------|------------|-----------------------|-------------------|----------------------|--------------|-----------|
| f (MHz)                | Temp. [°C] | Depth [cm] | 1g                    | Normalized to 1 W |                      |              |           |
| 2450                   | 23         | 15         | 12.7                  | 50.8              | 54.8                 | -7.30        | $\pm 10$  |

## 9 SAR MEASUREMENT PROCEDURE

A summary of the procedure follows:

- a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test, and then again at the end of the test.
- b) The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.5 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.
- c) Around this point, a volume of X=Y=Z=30 mm is assessed by measuring 5 x 5 x 7 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:
  - (i) The data at the surface are extrapolated, since the centre of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.
  - (ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are 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-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.
  - (iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.
  - (iv) The SAR value at the same location as in Step (a) is again measured to evaluate the actual power drift.

## **DASY4 SAR MEASUREMENT PROCEDURE**

### **Step 1: Power Reference Measurement**

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 1.2 mm for an EX3DV3 probe type).

### **Step 2: Area Scan**

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

### **Step 3: Zoom Scan**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 5 x 5 x 7 mm points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

### **Step 4: Power drift measurement**

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

### **Step 5: Z-Scan**

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

**10 CONDUCTED POWER**

The cable assembly insertion loss of 11dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

**802.11b**

| Ch | f (MHz) | Rate (Mbps) | Conducted Power     |
|----|---------|-------------|---------------------|
|    |         |             | Average Power (dBm) |
| 1  | 2412    | 1           | 14.14               |
| 6  | 2437    | 1           | 14.27               |
| 11 | 2462    | 1           | 14.20               |

The cable assembly insertion loss of 1dB was entered as an offset in the power meter to allow for direct reading of power.

**Bluetooth**

| Ch | f (MHz) | Conducted Power     |
|----|---------|---------------------|
|    |         | Average Power (dBm) |
| 0  | 2402    | -4.68               |
| 38 | 2441    | -6.21               |
| 79 | 2480    | -8.80               |

**11 SAR TEST SUMMARY**

**11.1 Test Position 1 – With the Back side of the EUT in direct contact against a flat phantom**



**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5025LBAT)**

| Separation. distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
|                           | 1       | 2412    |                    |                   |                        |              |
| 0                         | 6       | 2437    | 0.00663            | -0.147            | 0.007                  | 1.6          |
|                           | 11      | 2462    |                    |                   |                        |              |

**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5023BAT)**

| Separation. distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
|                           | 1       | 2412    |                    |                   |                        |              |
| 0                         | 6       | 2437    | 0.011              | -0.151            | 0.011                  | 1.6          |
|                           | 11      | 2462    |                    |                   |                        |              |

Notes:

- 1) The exact method of extrapolation is  $measured\ SAR \times 10^{(-drift/10)}$ . The SAR reported at the end of the measurement process by the DASY4 measurement system can be scaled up by the measured drift to determine the SAR at the beginning of the measurement process.
- 2) The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, thus testing at low & high channel is optional.
- 3) Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

**11.2 Test Position 2 – With the Front side of the EUT in direct contact against a flat phantom**



**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5025LBAT)**

| Separation. distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
|                           | 1       | 2412    |                    |                   |                        |              |
| 0                         | 6       | 2437    | 0.035              | -0.146            | 0.036                  | 1.6          |
|                           | 11      | 2462    |                    |                   |                        |              |

**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5023BAT)**

| Separation. distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
|                           | 1       | 2412    |                    |                   |                        |              |
| 0                         | 6       | 2437    | 0.034              | -0.143            | 0.035                  | 1.6          |
|                           | 11      | 2462    |                    |                   |                        |              |

Notes:

- 1) The exact method of extrapolation is  $measured\ SAR \times 10^{(-drift/10)}$ . The SAR reported at the end of the measurement process by the DASY4 measurement system can be scaled up by the measured drift to determine the SAR at the beginning of the measurement process.
- 2) The SAR measured at the low channel (highest power) for this configuration is at least 3 dB lower than SAR limit, thus testing at middle & high channel is optional.
- 3) Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

**11.3 Test Position 3 – With the Right side of the EUT in direct contact against a flat phantom**



**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5025LBAT)**

| Separation. distance (mm) | Channel | f (MHz)            | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|--------------------|--------------------|-------------------|------------------------|--------------|
| 0                         | 1       | 2412               | 0.117              | -0.132            | 0.121                  | 1.6          |
| 0                         | 6       | 2437               | 0.121              | -0.109            | 0.124                  | 1.6          |
| 0                         | 11      | 2462               | 0.148              | -0.151            | 0.153                  | 1.6          |
| 0                         | 11      | 2462 <sup>1)</sup> | 0.146              | -0.113            | 0.150                  | 1.6          |

**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5023BAT)**

| Separation. distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|---------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
|                           | 1       | 2412    |                    |                   |                        |              |
| 0                         | 6       | 2437    | 0.112              | -0.165            | 0.116                  | 1.6          |
| 0                         | 11      | 2462    | 0.134              | -0.168            | 0.139                  | 1.6          |

Notes:

- 1) The Co-located SAR measurement result with the 802.11b radio module and Bluetooth radio module (Transmitting simultaneously).
- 2) The exact method of extrapolation is measured SAR x 10<sup>^(-drift/10)</sup>. The SAR reported at the end of the measurement process by the DASY4 measurement system can be scaled up by the measured drift to determine the SAR at the beginning of the measurement process.
- 3) The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, thus testing at low & high channel is optional.
- 4) Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

**11.4 Test Position 4 – With the Left side of the EUT in direct contact against a flat phantom**



**802.11b (1 Mbps), 100% duty cycle (with battery model DT-5025LBAT)**

| Separation distance (mm) | Channel | f (MHz) | Measured 1g (mW/g) | Power Drift (dBm) | Extrapolated 1g (mW/g) | Limit (mW/g) |
|--------------------------|---------|---------|--------------------|-------------------|------------------------|--------------|
| 0                        | 0       | 2402    | 0.019              | -0.198            | 0.020                  | 1.6          |
| 0                        | 39      | 2441    |                    |                   | 0.000                  | 1.6          |
| 0                        | 78      | 2480    |                    |                   | 0.000                  | 1.6          |

Notes:

- 1) The exact method of extrapolation is  $measured\ SAR \times 10^{(-drift/10)}$ . The SAR reported at the end of the measurement process by the DASY4 measurement system can be scaled up by the measured drift to determine the SAR at the beginning of the measurement process.
- 2) The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, thus testing at low & high channel is optional.
- 3) Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.



12 PHOTO

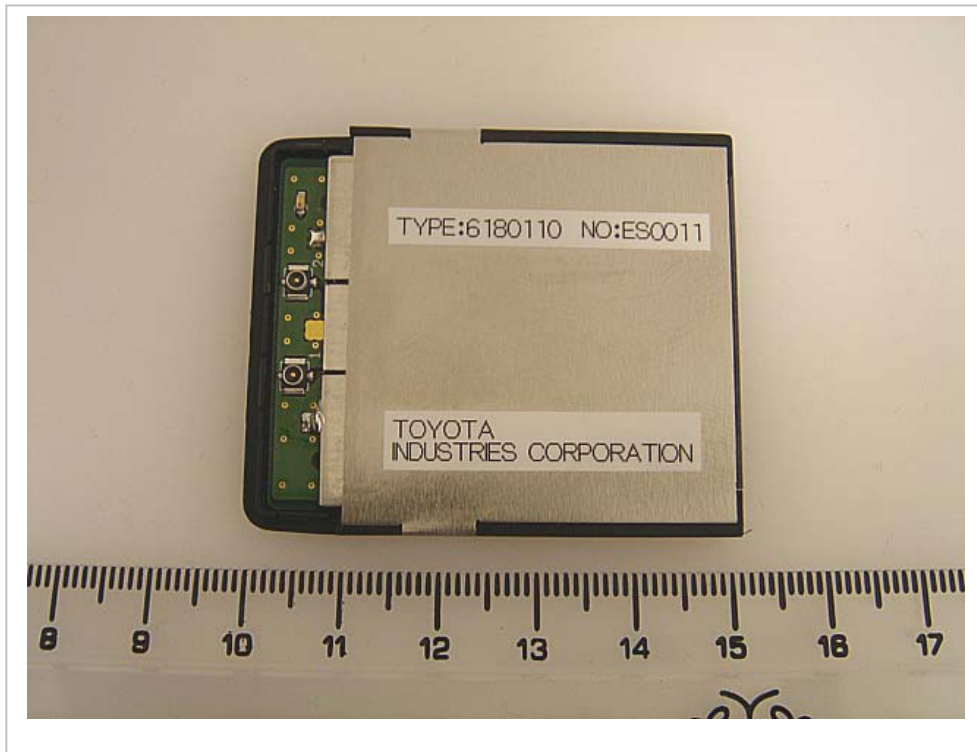


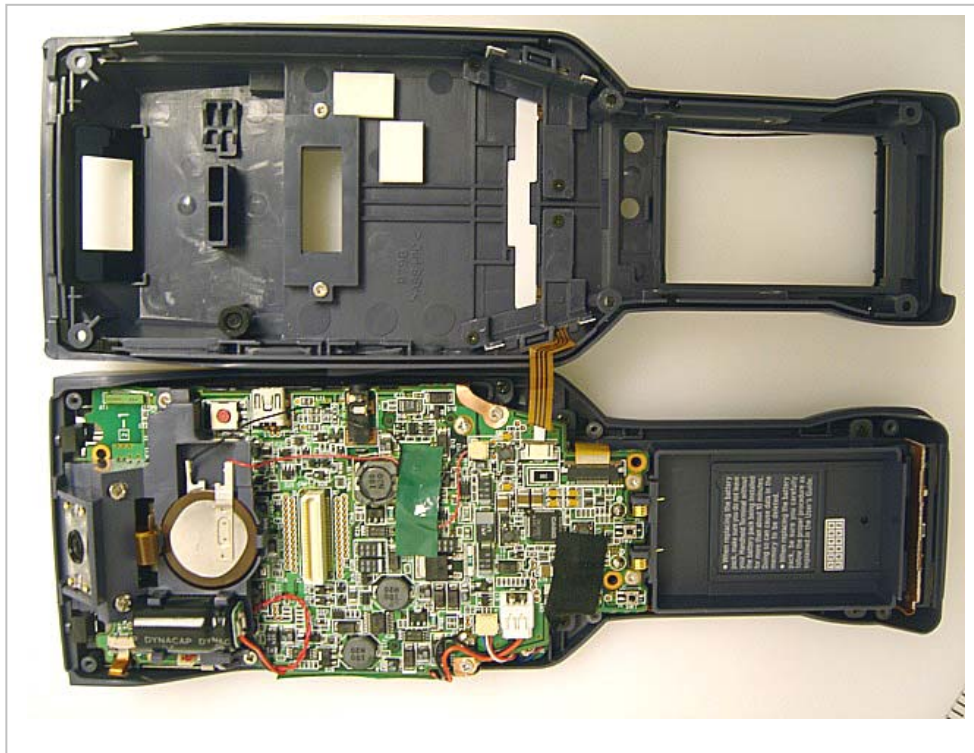
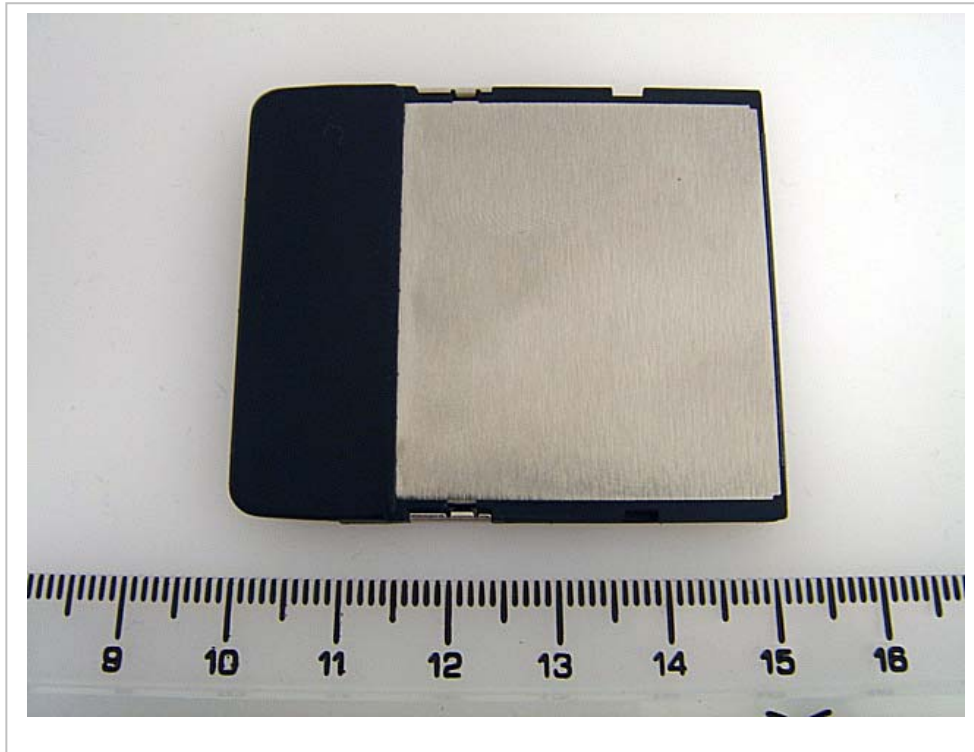
**With battery model DT-5025LBAT**

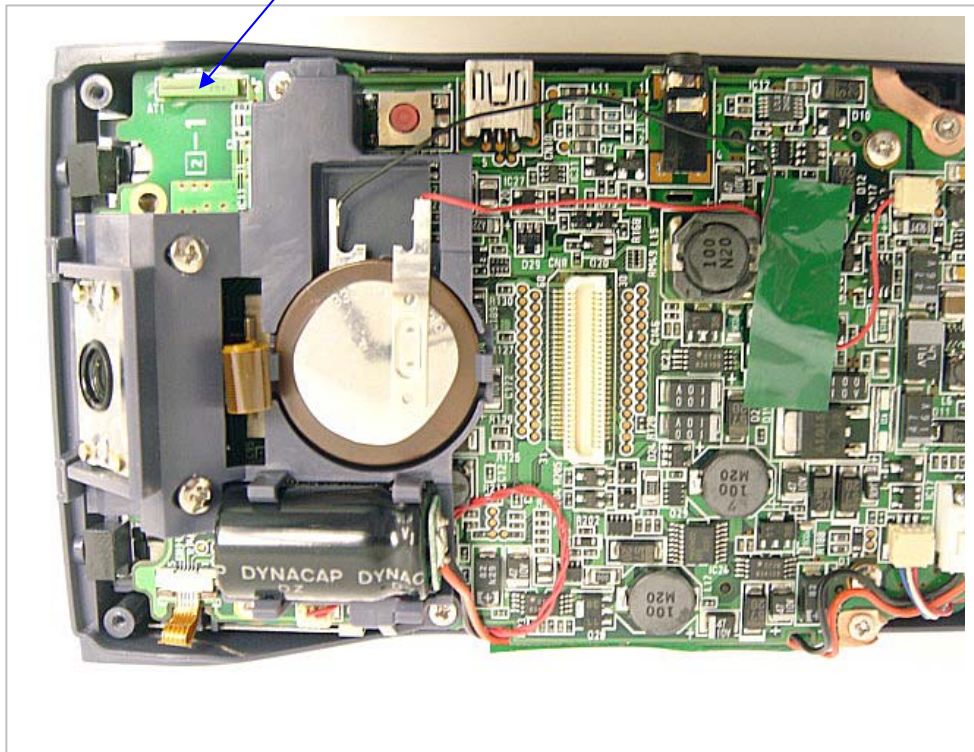
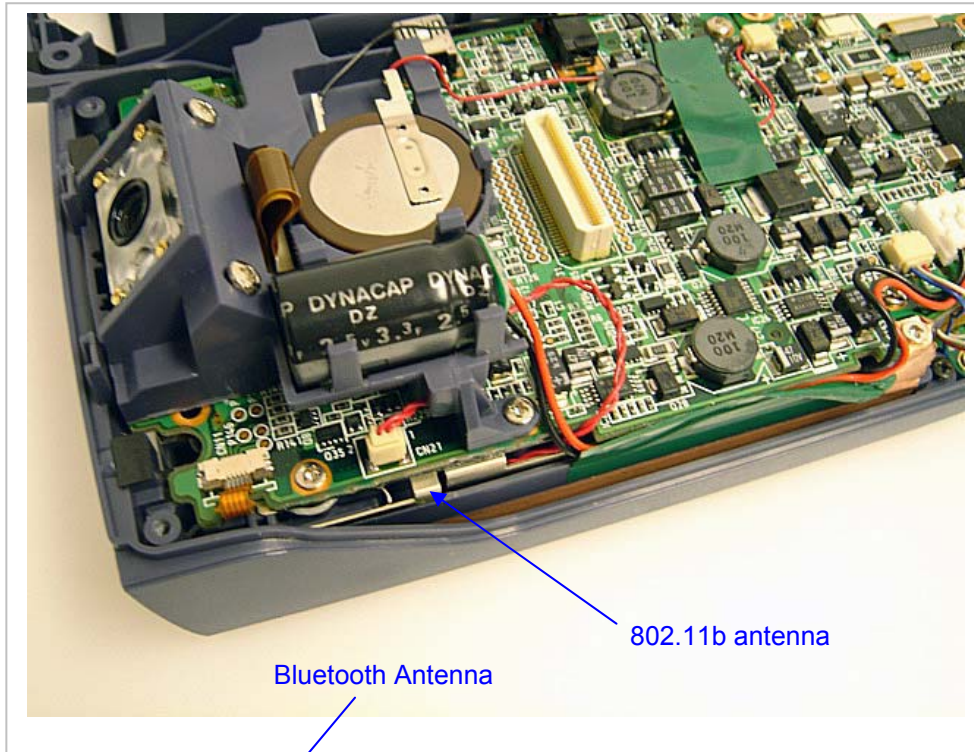


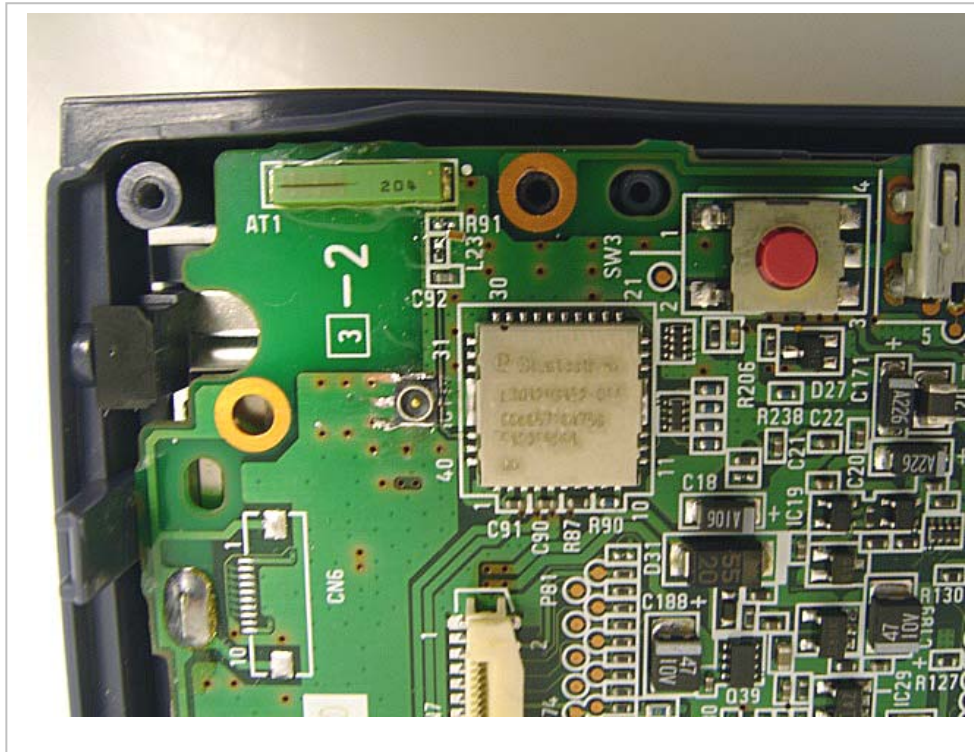
**With battery model DT-5023BAT**











**13 MEASUREMENT UNCERTAINTY**

| Uncertainty component  | Tol. (±%) | Probe Dist. | Div.  | Ci (1g) | Ci (10g) | Std. Unc.(±%) |         |
|--|-----------|-------------|-------|---------|----------|---------------|---------|
|  |           |             |       |         |          | Ui (1g)       | Ui(10g) |
| <b>Measurement System</b>  |           |             |       |         |          |               |         |
| Probe Calibration  | 4.80      | N           | 1     | 1       | 1        | 4.80          | 4.80    |
| Axial Isotropy   | 4.70      | R           | 1.732 | 0.707   | 0.707    | 1.92          | 1.92    |
| Hemispherical Isotropy   | 9.60      | R           | 1.732 | 0.707   | 0.707    | 3.92          | 3.92    |
| Boundary Effects   | 1.00      | R           | 1.732 | 1       | 1        | 0.58          | 0.58    |
| Linearity  | 4.70      | R           | 1.732 | 1       | 1        | 2.71          | 2.71    |
| System Detection Limits  | 1.00      | R           | 1.732 | 1       | 1        | 0.58          | 0.58    |
| Readout Electronics  | 1.00      | N           | 1     | 1       | 1        | 1.00          | 1.00    |
| Response Time  | 0.80      | R           | 1.732 | 1       | 1        | 0.46          | 0.46    |
| Integration Time   | 2.60      | R           | 1.732 | 1       | 1        | 1.50          | 1.50    |
| RF Ambient Conditions - Noise  | 1.59      | R           | 1.732 | 1       | 1        | 0.92          | 0.92    |
| RF Ambient Conditions - Reflections  | 0.00      | R           | 1.732 | 1       | 1        | 0.00          | 0.00    |
| Probe Positioner Mechanical Tolerance  | 0.40      | R           | 1.732 | 1       | 1        | 0.23          | 0.23    |
| Probe Positioning With Respect to Phantom Shell                                  | 2.90      | R           | 1.732 | 1       | 1        | 1.67          | 1.67    |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 3.90      | R           | 1.732 | 1       | 1        | 2.25          | 2.25    |
| <b>Test sample Related</b>   |           |             |       |         |          |               |         |
| Test Sample Positioning  | 1.10      | N           | 1     | 1       | 1        | 1.10          | 1.10    |
| Device Holder Uncertainty  | 3.60      | N           | 1     | 1       | 1        | 3.60          | 3.60    |
| Power and SAR Drift Measurement  | 5.00      | R           | 1.732 | 1       | 1        | 2.89          | 2.89    |
| <b>Phantom and Tissue Parameters</b>   |           |             |       |         |          |               |         |
| Phantom Uncertainty  | 4.00      | R           | 1.732 | 1       | 1        | 2.31          | 2.31    |
| Liquid Conductivity - Target   | 5.00      | R           | 1.732 | 0.64    | 0.43     | 1.85          | 1.24    |
| Liquid Conductivity - Meas.  | 8.60      | N           | 1     | 0.64    | 0.43     | 5.50          | 3.70    |
| Liquid Permittivity - Target   | 5.00      | R           | 1.732 | 0.6     | 0.49     | 1.73          | 1.41    |
| Liquid Permittivity - Meas.  | 3.30      | N           | 1     | 0.6     | 0.49     | 1.98          | 1.62    |
| <b>Combined Standard Uncertainty</b>   |           |             | RSS   |         |          | 11.44         | 10.49   |
| <b>Expanded Uncertainty (95% Confidence Interval)</b>                            |           |             | K=2   |         |          | 22.87         | 20.98   |
| Notes for table  |           |             |       |         |          |               |         |
| 1. Tol. - tolerance in influence quantity  |           |             |       |         |          |               |         |
| 2. N - Nomal   |           |             |       |         |          |               |         |
| 3. R - Rectangular   |           |             |       |         |          |               |         |
| 4. Div. - Divisor used to obtain standard uncertainty                            |           |             |       |         |          |               |         |
| 5. Ci - is te sensitivity coefficient  |           |             |       |         |          |               |         |



**14 EQUIPMENT LIST & CALIBRATION**

| <u>Name of Equipment</u>     | <u>Manufacturer</u> | <u>Type/Model</u> | <u>Serial Number</u> | <u>Cal. Due date</u>        |
|------------------------------|---------------------|-------------------|----------------------|-----------------------------|
| Robot - Six Axes             | Stäubli             | RX90BL            | N/A                  | N/A                         |
| Robot Remote Control         | Stäubli             | CS7MB             | 3403-91535           | N/A                         |
| DASY4 Measurement Server     | SPEAG               | SEUMS001BA        | 1041                 | N/A                         |
| Probe Alignment Unit         | SPEAG               | LB (V2)           | 261                  | N/A                         |
| S-Parameter Network Analyzer | Agilent             | 8753ES-6          | US39173569           | 8/19/05                     |
| Electronic Probe kit         | Hewlett Packard     | 85070C            | N/A                  | N/A                         |
| E-Field Probe                | SPEAG               | EX3DV4            | 3552                 | 3/19/06                     |
| Thermometer                  | ERTCO               | 639-1             | 8402                 | 10/13/2005                  |
| Thermometer                  | ERTCO               | 639-1             | 8404                 | 10/21/2005                  |
| Thermometer                  | ERTCO               | 637-1             | 8661                 | 10/21/2005                  |
| SAM Phantom (SAM1)           | SPEAG               | TP-1185           | QD000P40CA           | N/A                         |
| SAM Phantom (SAM2)           | SPEAG               | TP-1015           | N/A                  | N/A                         |
| Data Acquisition Electronics | SPEAG               | DAE3 V1           | 500                  | 2/7/06                      |
| System Validation Dipole     | SPEAG               | D2450V2           | 748                  | 5/14/06                     |
| System Validation Dipole     | SPEAG               | D5GHzV2           | 1003                 | 10/5/05                     |
| Signal General               | R&H                 | SMP 04            | DE34210              | 6/2/06                      |
| Power Meter                  | Giga-tronics        | 8651A             | 8651404              | 9/16/05                     |
| Power Sensor                 | Giga-tronics        | 80701A            | 1834588              | 9/16/05                     |
| Amplifier                    | Mini-Circuits       | ZVE-8G            | 0360                 | N/A                         |
| Amplifier                    | Mini-Circuits       | ZHL-42W           | D072701-5            | N/A                         |
| Radio Communication Tester   | Rohde & Schwarz     | CMU 200           | 838114/032           | 12/17/06                    |
| Simulating Liquid            | CCS                 | M2450             | N/A                  | within 24 hrs of first test |

**15 ATTACHMENT**

| <b>No.</b> | <b>Contents</b>  | <b>No. of page (s)</b> |
|------------|--|------------------------|
| 1          | System Performance Check Plot                          | 2                      |
| 1-1        | System Performance Check Plot_ 7-5-05                  | 2                      |
| 2          | SAR Test Plot  | 8                      |
| 2-1        | SAR Test Plot _7-5-05                                  | 4                      |
| 3          | Certificate of E-filed Probe EX3DV4 SN 3552            | 10                     |
| 4          | Certificate of System Validation Dipole D2450V2 SN 748 | 9                      |

**END OF REPORT**