



SAR EVALUATION REPORT

Applicant Name:
Motorola Inc
Personal Communications Sector
600 N. U.S. Highway 45
Libertyville, IL 60048-5343 USA

Date of Testing:
11/29/10
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
0Y1011261912.IHD

FCC ID: IHDP56LS1
APPLICANT: MOTOROLA INC

EUT Type: Portable Handset with 5 GHz WLAN
Application Type: SAR Test Report
FCC Rule Part(s): CFR §2.1093; FCC/OET Bulletin 65 Supplement C [June 2001]
FCC Classification: Licensed Transmitter Held to Ear (PCE)
Digital Transmission System (DTS)
Unlicensed Transmitter National Infrastructure (UNII)
Model(s): MB860
Tx Frequency Measured: 5180 - 5320 MHz (WLAN)
5500 - 5825 MHz (WLAN)
Conducted Power: 11.66 dBm 5.2 GHz WLAN
11.48 dBm 5.8 GHz WLAN
Max. SAR Measurement: 0.09 W/kg 5.2 GHz WLAN Body SAR
0.08 W/kg 5.8 GHz WLAN Body SAR
Test Device Serial No.: Pre-Production [S/N: 353648040030974]

This wireless portable device 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 C95.1-1992 and has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001), IEEE 1528-2003 and in applicable Industry Canada Radio Standards Specifications (RSS); for WLAN operations mentioned in this report only.

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 qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

PCTEST certifies that no party to this application has been subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.




Randy Ortanez
President

Report Issued by an Accredited Laboratory

Rapport utfärdad av ett ackrediterat laboratorium



This laboratory is accredited to ISO/IEC 17025
(A2LA accreditation no. 2041.01)



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1 INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

1.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 1-1).

$$SAR = \frac{d}{dt} \left(\frac{dU}{dm} \right) = \frac{d}{dt} \left(\frac{dU}{\rho dV} \right)$$

Figure 1-1
SAR Mathematical Equation



SAR is expressed in units of Watts per Kilogram (W/kg).

$$SAR = \frac{\sigma \cdot E^2}{\rho}$$

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m^3)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

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2 TEST SITE LOCATION

2.1 INTRODUCTION

The map at the right shows the location of the PCTEST LABORATORY in Columbia, Maryland. It is in proximity to the FCC Laboratory, the Baltimore-Washington International (BWI) airport, the city of Baltimore and Washington, DC.

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49' 38" W longitude. The facility is 1.5 miles north of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on January 27, 2006 and Industry Canada.

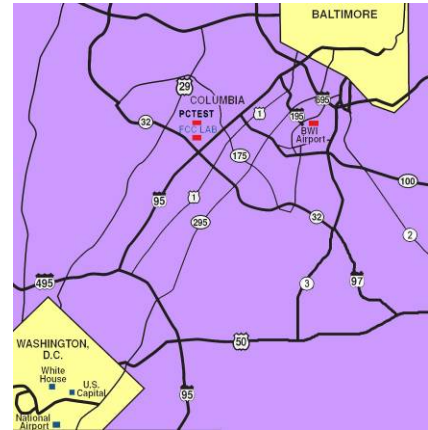
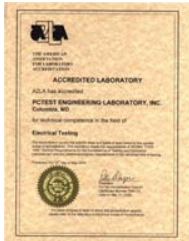


Figure 2-1
Map of the Greater Baltimore and Metropolitan Washington, D.C. area

2.2 Test Facility / Accreditations:

Measurements were performed at an independent accredited PCTEST Engineering Lab located in Columbia, MD 21045, U.S.A.



- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing-Aid Compatibility (HAC), Battery Safety, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST facility is an FCC registered (PCTEST Reg. No. 90864) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (IC-2451).
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and all Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (IC-2451) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS and CDMA, and EvDO mobile phones.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO Data, CDMA 1xRTT Data

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3 SAR MEASUREMENT SETUP

3.1 Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the SAM phantom containing the head or body equivalent material. The robot is a six-axis industrial robot, performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure 3-1).

3.2 System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the SAR Measurement Software DASY4, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, A/D conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal from the DAE and transfers data to the PC card.

3.3 System Electronics

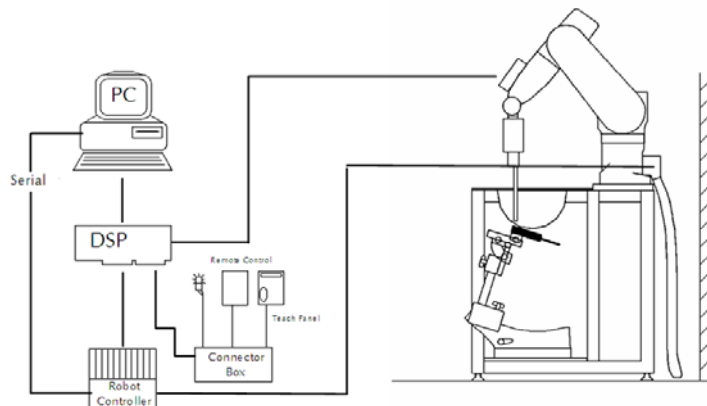




Figure 3-1
SAR Measurement System Setup

The DAE consists of a highly sensitive electrometer-grade auto-zeroing preamplifier, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

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3.4 Automated Test System Specifications

Test Software: SPEAG DASY4 version 4.7 Measurement Software
 Robot: Stäubli Unimation Corp. Robot RX60L
 Repeatability: 0.02 mm
 No. of Axes: 6

Data Acquisition Electronic System (DAE)

Data Converter

Features: Signal Amplifier, multiplexer, A/D converter & control logic
 Software: SEMCAD software
 Connecting Lines: Optical Downlink for data and status info
 Optical upload for commands and clock

PC Interface Card



Function: Link to DAE
 16-bit A/D converter for surface detection system
 Two Serial & Ethernet link to robotics
 Direct emergency stop output for robot

Phantom

Type: SAM Twin Phantom (V4.0)
 Shell Material: Composite
 Thickness: 2.0 ± 0.2 mm



Figure 3-2
SAR Measurement System

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4.1 Probe Measurement System



**Figure 4-1
SAR System**

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration (see Figure 4-3) and optimized for dosimetric evaluation [9]. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber 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

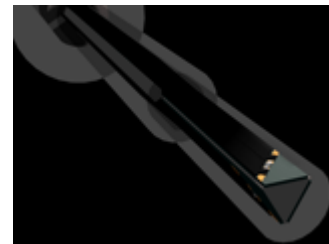
maximum using a 2nd order curve fitting (see Figure 5-1). The approach is stopped at reaching the maximum.

4.2 Probe Specifications



| | |
|--------------------------|---|
| Model(s): | ES3DV2, ES3DV3, EX3DV4 |
| Frequency Range: | 10 MHz – 6.0 GHz (EX3DV4) 10 MHz – 4 GHz (ES3DV3) |
| Calibration: | In head and body simulating tissue at Frequencies from 300 up to 6000MHz |
| Linearity: | ± 0.2 dB (30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB (30 MHz to 4 GHz) for ES3DV3 |
| Dynamic Range: | 10 mW/kg – 100 W/kg |
| Probe Length: | 330 mm |
| Probe Tip Length: | 20 mm |
| Body Diameter: | 12 mm |
| Tip Diameter: | 2.5 mm (3.9mm for ES3DV3) |
| Tip-Center: | 1 mm (2.0 mm for ES3DV3) |
| Application: | SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields |



**Figure 4-2
Near-Field Probe**



**Figure 4-3
Triangular Probe
Configuration**

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5 PROBE CALIBRATION PROCESS

5.1 Dosimetric Assessment Procedure

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm²) using an RF Signal generator, TEM cell, and RF Power Meter.

5.2 Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm².

5.3 Temperature Assessment

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated head tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

where:

- Δt = exposure time (30 seconds),
- C = heat capacity of tissue (brain or muscle),
- ΔT = temperature increase due to RF exposure.

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

where:

- σ = simulated tissue conductivity,
- ρ = Tissue density (1.25 g/cm³ for brain tissue)

SAR is proportional to $\Delta T/\Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. The electric field in the simulated tissue can be used to estimate SAR by equating the thermally derived SAR to that with the E- field component.

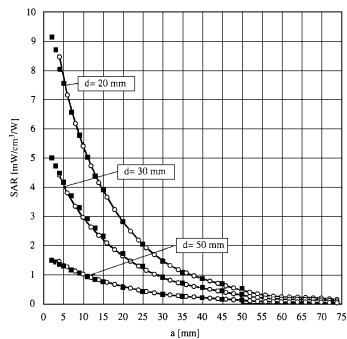


Figure 5-1 E-Field and Temperature measurements at 900MHz [9]

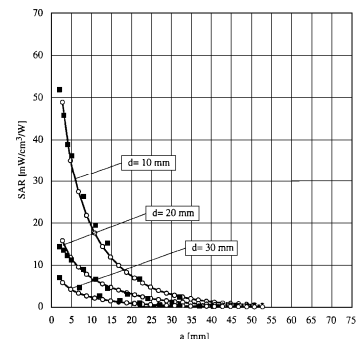




Figure 5-2 E-Field and temperature measurements at 1.9GHz [9]

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6

PHANTOM AND EQUIVALENT TISSUES

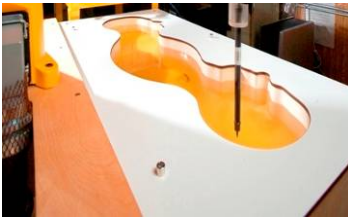
6.1 SAM Phantoms



**Figure 6-1
SAM Phantoms**

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to represent the 90th percentile of the population [12][13]. The phantom enables the dosimetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

6.2 Tissue Simulating Mixture Characterization





**Figure 6-2
SAM Phantom with
Simulating Tissue**

The mixture is characterized to obtain proper dielectric constant (permittivity) and conductivity of the tissue of interest. The tissue dielectric parameters recommended in IEEE 1528 and IEC 62209 have been used as targets for the compositions, and are to match within 5%, per the FCC recommendations.

Table 6-1
Composition of the Tissue Equivalent Matter

| Frequency (MHz) | 5200-5800 |
|---------------------------|-----------|
| Tissue | Body |
| Ingredients (% by weight) | |
| DEGEE | 10.67 |
| Triton X-100 | 10.67 |
| Water | 78.67 |

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7.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm x 15mm.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during testing the 1 gram cube. This fixed point was measured and used as a reference value.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 32mm x 32mm x 30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual for more details):
 - a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 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). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
 - 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 step 2, was re-measured after the zoom scan was complete. If the value deviated by more than 5%, the evaluation was repeated.
5. For 5 GHz testing finer resolution zoom scans were performed as specified by FCC SAR Measurement Requirements for 3 – 6 GHz, KDB pub 865664. The 5 GHz zoom scan requires a minimum volume of 24mm x 24mm x 20mm and 7 x 7 x 11 points.

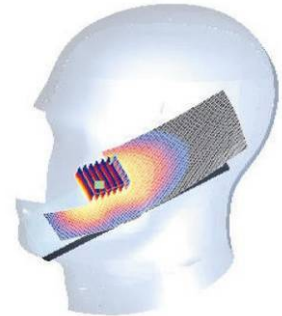




Figure 7-1
Sample SAR Area Scan

7.2 Specific Anthropomorphic Mannequin (SAM) Specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Figure 7-2). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimize reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15 cm.



Figure 7-2
SAM Twin Phantom Shell

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8.1 EAR REFERENCE POINT

Figure 8-1 shows the front, back and side views of the SAM Twin Phantom. The point “M” is the reference point for the center of the mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 8-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 8-2

Front, back and side view of SAM Twin Phantom Figure 8-2). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

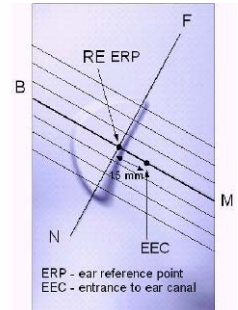


Figure 8-1
Close-Up Side view
of ERP

8.2 HANDSET REFERENCE POINTS

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed 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” (See Figure 8-3). The “test device reference point” was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.



Figure 8-2
Front, back and side view of SAM Twin Phantom

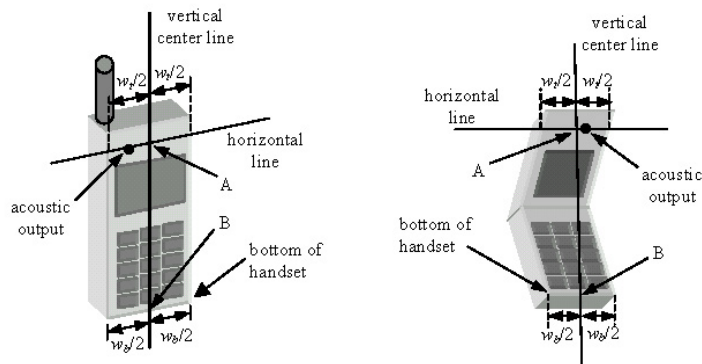




Figure 8-3
Handset Vertical Center & Horizontal Line Reference Points

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9

TEST CONFIGURATION POSITIONS

9.1 Device Holder

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

9.2 Positioning for Cheek/Touch

1. The test device was positioned with the handset 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 9-1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

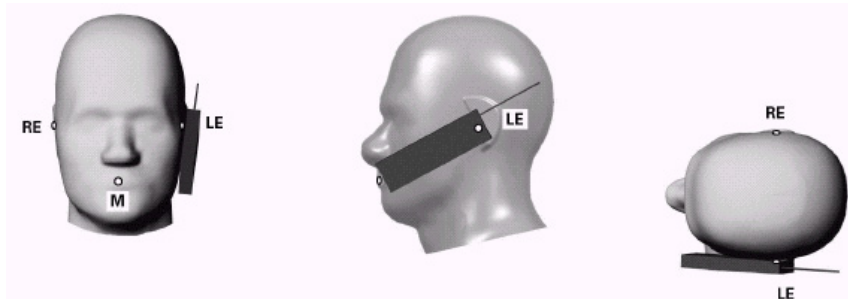




Figure 9-1 Front, Side and Top View of Cheek/Touch Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear (cheek) (See Figure 9-2).

9.3 Positioning for Ear / 15° Tilt

With the test device aligned in the “Cheek/Touch Position”:

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.
2. The phone was then rotated around the horizontal line by 15 degree.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 9-2).

| | | | | |
|-------------------------------|--|---|--|---------------------------------|
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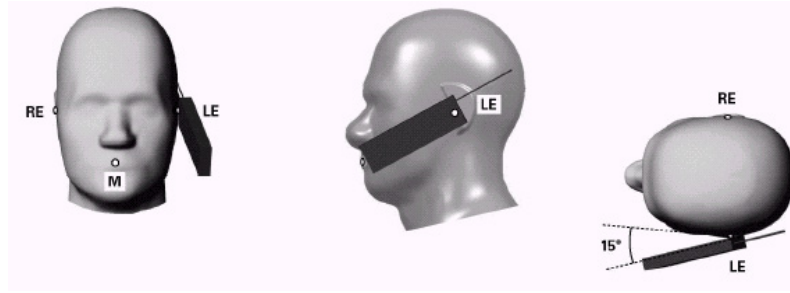


Figure 9-2 Front, Side and Top View of Ear/15° Tilt Position

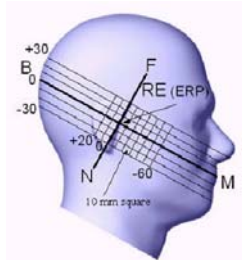


Figure 9-3 Side view w/ relevant markings



Figure 9-4 Body SAR Sample Photo (Not Actual EUT)

9.4 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones. It has been known for some time that there are SAR measurement difficulties in these regions of the SAM phantom. SAR probes are calibrated in tissue equivalent liquids with sufficient separation between the probe sensors and nearby physical boundaries to ensure scattering does not affect probe calibration. When the probe tip is moved into tight regions with multiple boundaries surrounding its sensors, probe calibration and measurement accuracy can become questionable. In addition, these measurement locations often require a probe to be tilted at steep angles, where it may no longer comply with calibration requirements and measurement protocols, or satisfy the required measurement uncertainty. In some situations it is not feasible to tilt the probe or rotate the phantom, as suggested by measurement standards, to conduct these measurements.

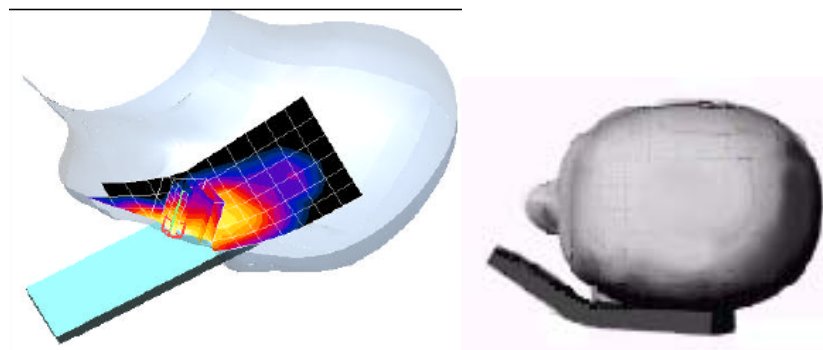




Figure 9-5 SAR Scans near the Jaw/Mouth

In order to ensure there is sufficient conservativeness for ensuring compliance until practical solutions are available, additional measurement considerations are necessary to address these technical difficulties. When measurements are required near the mouth, nose, jaw or similar tight regions of the SAM phantom,

| | | | | |
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area or zoom scans are often unable to fully enclose the peak SAR location as required by IEEE 1528 and Supplement C, due to probe orientation and positioning difficulties. Even when limited measurements are possible, the test results could be questionable due to probe calibration and measurement uncertainty issues. Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document publication 648474. The SAR required in these regions of SAM should be measured using a flat phantom. **Rectangular shaped phones** should be positioned with its bottom edge positioned from the flat phantom with the same distance provided by the cheek touching position using SAM. The ear reference point (ERP, as defined for SAM) of the phone should be positioned ½ cm from the flat phantom shell. **Clam-shell phones** should be positioned with the hinge against a smooth edge of the flat phantom where the upper half of the phone is unfolded and extended beyond the phantom side wall. The lower half of the phone is secured in the test device holder at a fixed distance below the flat phantom determined by the minimum separation along the lower edge of the phone in the cheek touching position using SAM. Any case with substantial variation in separation distance along the lower edge of a clam shell is discussed with the FCC for best-to-use methodology.



The flat phantom data should allow test results to be compared uniformly across measurement systems, until suitable solutions are available in measurement standards to address certain probe calibration and positioning issues, due to implementation differences between horizontal and upright SAM configurations. These flat phantom procedures are only applicable for stand-alone SAR evaluation in tight regions of the SAM phantom, where measurement is not feasible or test results can be questionable due to probe calibration and accessibility issues. Details on device positioning and photos showing how separation distances are determined are included in the SAR report Photographs. SAR for other regions of the head must be evaluated using SAM; therefore, a phone with antennas at different locations may require flat and SAM phantom evaluation for the different antennas.

9.5 Body Holster /Belt Clip Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 9-4). A device with a headset output is tested with a headset connected to the device.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. 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 is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

| | | | | |
|-------------------------------|--|---|--|---------------------------------|
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10 RF EXPOSURE LIMITS

10.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their 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.



10.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). 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.

Table 10-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT <i>General Population</i> (W/kg) or (mW/g) | CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g) |
| SPATIAL PEAK SAR Brain | 1.6 | 8.0 |
| SPATIAL AVERAGE SAR Whole Body | 0.08 | 0.4 |
| SPATIAL PEAK SAR Hands, Feet, Ankles, Wrists | 4.0 | 20 |

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

| | | | | |
|-------------------------------|--|---|--|---------------------------------|
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11 SAR TESTING WITH IEEE 802.11 TRANSMITTERS

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable.

11.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.



11.2 Frequency Channel Configurations [27]

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channels 1, 6 and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band; channels 52 and 64 in the 5.25-5.35 GHz band; channels 104, 116, 124 and 136 in the 5.470-5.725 GHz band; and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 4.9 GHz is tested on channels 1, 10 and 5 or 6, whichever has the higher output power, for 5 MHz channels; channels 11, 15 and 19 for 10 MHz channels; and channels 21 and 25 for 20 MHz channels. These are referred to as the “default test channels”. 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

**Table 11-1
802.11 Test Channels per FCC Requirements**

| Mode | GHz | Channel | Turbo Channel | "Default Test Channels" | | |
|------------|-----------------|---------|----------------|-------------------------|---------|---|
| | | | | §15.247 | UNII | |
| | | | | 802.11b | 802.11g | |
| 802.11 b/g | 2.412 | 1 | | √ | ∇ | |
| | 2.437 | 6 | 6 | √ | ∇ | |
| | 2.462 | 11 | | √ | ∇ | |
| 802.11a | 5.18 | 36 | | | | √ |
| | 5.20 | 40 | 42 (5.21 GHz) | | | * |
| | 5.22 | 44 | | | | * |
| | 5.24 | 48 | 50 (5.25 GHz) | | | √ |
| | 5.26 | 52 | | | | √ |
| | 5.28 | 56 | 58 (5.29 GHz) | | | * |
| | 5.30 | 60 | | | | * |
| | 5.32 | 64 | | | √ | |
| | 5.500 | 100 | Unknown | | | * |
| | 5.520 | 104 | | | | √ |
| | 5.540 | 108 | | | | * |
| | 5.560 | 112 | | | | * |
| | 5.580 | 116 | | | | √ |
| | 5.600 | 120 | | | | * |
| | 5.620 | 124 | | | | √ |
| | 5.640 | 128 | | | | * |
| | 5.660 | 132 | | | | * |
| | 5.680 | 136 | | | | √ |
| | 5.700 | 140 | | | * | |
| | UNII or §15.247 | 5.745 | 149 | | √ | √ |
| 5.765 | | 153 | 152 (5.76 GHz) | | * | * |
| 5.785 | | 157 | | √ | √ | * |
| 5.805 | | 161 | 160 (5.80 GHz) | | * | √ |
| §15.247 | 5.825 | 165 | | √ | | |

| | | | | |
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11.3 RF Conducted Powers

11.3.1 IEEE 802.11a Conducted Powers

| Mode | Freq [MHz] | Channel | Conducted Power [dBm] | | | | | | | |
|---------|---------------|---------|-----------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | Data Rate [Mbps] | | | | | | | |
| | | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11a | 5180 | 36 | 11.22 | 11.27 | 11.32 | 11.06 | 10.85 | 10.98 | 10.82 | 10.81 |
| 802.11a | 5200 | 40 | 11.20 | 11.16 | 11.27 | 10.93 | 10.92 | 10.81 | 10.83 | 10.84 |
| 802.11a | 5220 | 44 | 11.31 | 11.39 | 11.25 | 9.88 | 9.72 | 11.15 | 11.07 | 10.98 |
| 802.11a | 5240 | 48 | 11.31 | 11.22 | 11.36 | 11.10 | 11.09 | 11.08 | 10.99 | 11.03 |
| 802.11a | 5745 | 149 | 11.08 | 11.18 | 11.43 | 9.76 | 9.72 | 10.82 | 11.12 | 10.86 |
| 802.11a | 5765 | 153 | 9.89 | 10.00 | 9.77 | 10.86 | 10.88 | 10.68 | 10.76 | 10.75 |
| 802.11a | 5785 | 157 | 9.67 | 9.76 | 9.69 | 9.56 | 9.46 | 9.65 | 9.54 | 9.53 |
| 802.11a | 5805 | 161 | 9.63 | 9.71 | 9.83 | 9.63 | 9.43 | 9.42 | 9.34 | 9.41 |

11.3.2 IEEE 802.11n Conducted Powers

| Mode | Freq [MHz] | Channel | Conducted Power [dBm] | | | | | | | |
|---------|---------------|---------|-----------------------|-------|-------|-------|-------|-------|-------|------|
| | | | Data Rate [Mbps] | | | | | | | |
| | | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | 5180 | 36 | 11.05 | 10.97 | 10.67 | 10.76 | 10.78 | 10.69 | 10.80 | 8.39 |
| 802.11n | 5200 | 40 | 11.17 | 11.09 | 10.72 | 10.74 | 10.88 | 10.83 | 10.82 | 8.63 |
| 802.11n | 5220 | 44 | 11.05 | 11.21 | 10.94 | 10.93 | 10.87 | 10.88 | 10.87 | 8.69 |
| 802.11n | 5240 | 48 | 11.31 | 11.09 | 10.86 | 11.00 | 10.98 | 10.93 | 10.88 | 8.71 |
| 802.11n | 5745 | 149 | 10.87 | 10.84 | 10.62 | 10.81 | 10.86 | 10.85 | 10.61 | 8.72 |
| 802.11n | 5765 | 153 | 10.76 | 10.77 | 10.61 | 10.65 | 10.50 | 10.76 | 10.79 | 8.43 |
| 802.11n | 5785 | 157 | 10.80 | 10.69 | 10.64 | 10.59 | 10.74 | 10.65 | 10.75 | 8.61 |
| 802.11n | 5805 | 161 | 11.02 | 10.99 | 10.64 | 10.63 | 10.66 | 10.74 | 10.51 | 8.62 |

| Mode | Freq [MHz] | Channel | Conducted Power [dBm] | | | | | | | |
|---------|---------------|---------|-----------------------|-------|-------|-------|-------|-------|-------|------|
| | | | Data Rate [Mbps] | | | | | | | |
| | | | 7.2 | 14.4 | 21.7 | 28.9 | 43.3 | 57.8 | 65.0 | 72.2 |
| 802.11n | 5180 | 36 | 11.66 | 11.31 | 11.63 | 10.85 | 10.98 | 11.04 | 10.84 | 8.50 |
| 802.11n | 5200 | 40 | 11.12 | 10.97 | 10.75 | 10.94 | 10.86 | 10.82 | 10.81 | 8.56 |
| 802.11n | 5220 | 44 | 11.13 | 11.15 | 10.87 | 10.94 | 10.99 | 10.87 | 10.95 | 8.50 |
| 802.11n | 5240 | 48 | 11.17 | 11.14 | 10.96 | 11.04 | 11.13 | 11.00 | 11.00 | 8.73 |
| 802.11n | 5745 | 149 | 11.48 | 10.73 | 10.56 | 10.86 | 10.87 | 10.83 | 10.86 | 8.72 |
| 802.11n | 5765 | 153 | 10.95 | 10.87 | 10.63 | 10.79 | 10.70 | 10.69 | 10.72 | 8.43 |
| 802.11n | 5785 | 157 | 10.94 | 10.84 | 10.49 | 10.59 | 10.69 | 10.72 | 10.70 | 8.43 |
| 802.11n | 5805 | 161 | 10.92 | 10.82 | 10.59 | 10.65 | 10.67 | 10.72 | 10.75 | 8.32 |



Figure 11-1
Power Measurement Setup

| | | | | |
|-------------------------------|--|---|----------|---------------------------------|
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12 SYSTEM VERIFICATION

12.1 Tissue Verification

**Table 12-1
Measured Tissue Properties**

| Calibrated for Tests Performed | Tissue Type | Measured Frequency (MHz) | Measured Conductivity, σ (S/m) | Measured Dielectric Constant, ϵ | TARGET Conductivity, σ (S/m) | TARGET Dielectric Constant, ϵ | % dev σ | % dev ϵ |
|--------------------------------|-------------|--------------------------|---------------------------------------|--|-------------------------------------|--|----------------|------------------|
| 11/29/2010 | 5200B-5800B | 5170 | 5.105 | 48.00 | 5.26 | 49.06 | -3.02% | -2.15% |
| | | 5210 | 5.101 | 47.81 | 5.31 | 49.00 | -3.95% | -2.43% |
| | | 5250 | 5.260 | 47.84 | 5.36 | 48.95 | -1.83% | -2.26% |
| | | 5270 | 5.277 | 47.97 | 5.38 | 48.92 | -1.93% | -1.94% |
| | | 5310 | 5.297 | 47.68 | 5.43 | 48.87 | -2.41% | -2.43% |
| | | 5350 | 5.415 | 47.48 | 5.47 | 48.81 | -1.01% | -2.73% |
| | | 5470 | 5.499 | 47.25 | 5.62 | 48.65 | -2.07% | -2.87% |
| | | 5510 | 5.592 | 47.16 | 5.66 | 48.59 | -1.22% | -2.95% |
| | | 5550 | 5.654 | 47.03 | 5.71 | 48.54 | -0.95% | -3.11% |
| | | 5570 | 5.692 | 46.90 | 5.73 | 48.51 | -0.68% | -3.32% |
| | | 5610 | 5.768 | 46.77 | 5.78 | 48.46 | -0.17% | -3.48% |
| | | 5650 | 5.813 | 46.71 | 5.83 | 48.40 | -0.21% | -3.50% |
| | | 5670 | 5.889 | 46.71 | 5.85 | 48.38 | 0.70% | -3.44% |
| | | 5710 | 5.933 | 46.74 | 5.90 | 48.32 | 0.64% | -3.27% |
| | | 5750 | 6.023 | 46.40 | 5.94 | 48.27 | 1.36% | -3.87% |
| | | 5770 | 6.086 | 46.37 | 5.97 | 48.24 | 2.03% | -3.88% |
| 5810 | 6.053 | 46.53 | 6.01 | 48.19 | 0.68% | -3.44% | | |
| 5850 | 6.122 | 46.11 | 6.06 | 48.13 | 1.06% | -4.20% | | |

Note: KDB Publication 450824 was ensured to be applied for probe calibration frequencies greater than or equal to 50 MHz of the DUT frequencies.



The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies (per IEEE 1528 6.6.1.2). The SAR test plots may slightly differ from the table above since the DASY software rounds to three significant digits.

12.2 Measurement Procedure for Tissue verification

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity, for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r\epsilon_0)^{1/2}]}{r} d\phi'd\rho'd\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho' \cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

| | | | | |
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12.3 Justification for Extended SAR Dipole Calibrations

Usage of SAR dipoles calibrated less than 2 years ago but more than 1 year ago were confirmed in maintaining return loss (< - 20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB Publication 450824:

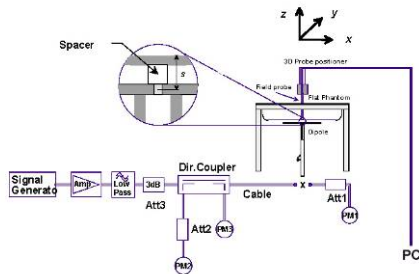
| D5GHzV2 SN: 1007 5500MHz | | | | |
|--------------------------|------------------|------------|------------------------|----------------|
| Date of Measurement | Return Loss (dB) | Δ % | Impedance (Ω) | $\Delta\Omega$ |
| 8/19/2009 | -35.2 | | 49.7 | |
| 8/19/2010 | -31.5 | -10.5% | 48.4 | -1.3 |

12.4 Test System Verification

Prior to assessment, the system is verified to $\pm 10\%$ of the manufacturer SAR measurement on the reference dipole at the time of calibration.

**Table 12-2
System Verification Results**

| System Verification TARGET & MEASURED | | | | | | | | | | |
|--|----------------|------------------|-----------------|------------------------|-----------|-------------|-----------------------------------|-------------------------------------|---|---------------|
| Date: | Amb. Temp (°C) | Liquid Temp (°C) | Input Power (W) | Tissue Frequency (MHz) | Dipole SN | Tissue Type | Measured SAR _{1g} (W/kg) | 1 W Target SAR _{1g} (W/kg) | 1 W Normalized SAR _{1g} (W/kg) | Deviation (%) |
| 11/29/2010 | 23.5 | 22.3 | 0.025 | 5200 | 1007 | Body | 1.93 | 78.900 | 77.20 | -2.15% |
| 11/29/2010 | 23.7 | 21.9 | 0.025 | 5800 | 1007 | Body | 1.95 | 72.300 | 78.00 | 7.88% |



**Figure 12-1
System Verification Setup Diagram**



**Figure 12-2
System Verification Setup Photo**

| | | | | |
|-------------------------------|--|---|----------|---------------------------------|
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13 SAR DATA SUMMARY

**Table 13-1
5.2 GHz SAR Results**

| MEASUREMENT RESULTS | | | | | | | | | | | |
|---|-----|--------------|---------|--------------|-------|----------|---|--------------|------------------|-------|----------|
| FREQUENCY | | Mode | Service | C_Power[dBm] | | Position | Spacing | Battery Type | Data Rate (Mbps) | Side | SAR (1g) |
| MHz | Ch. | | | Start | End | | | | | | (W/kg) |
| 5220 | 44 | 5.2 GHz WLAN | 802.11a | 11.31 | 11.37 | Body | 2.5 cm | Standard | 6 | back | 0.037 |
| 5240 | 48 | 5.2 GHz WLAN | 801.11a | 11.31 | 11.25 | Body | 2.5 cm | Standard | 6 | back | 0.036 |
| 5220 | 44 | 5.2 GHz WLAN | 802.11a | 11.31 | 11.37 | Body | 2.5 cm | Standard | 6 | front | 0.018 |
| 5240 | 48 | 5.2 GHz WLAN | 801.11a | 11.31 | 11.22 | Body | 2.5 cm | Standard | 6 | front | 0.012 |
| 5220 | 44 | 5.2 GHz WLAN | 802.11a | 11.31 | 11.25 | Body | 1.0 cm | Standard | 6 | back | 0.051 |
| 5240 | 48 | 5.2 GHz WLAN | 801.11a | 11.31 | 11.28 | Body | 1.0 cm | Standard | 6 | back | 0.087 |
| 5220 | 44 | 5.2 GHz WLAN | 802.11a | 11.31 | 11.38 | Body | 1.0 cm | Standard | 6 | front | 0.019 |
| 5240 | 48 | 5.2 GHz WLAN | 801.11a | 11.31 | 11.38 | Body | 1.0 cm | Standard | 6 | front | 0.023 |
| 5220 | 44 | 5.2 GHz WLAN | 802.11a | 11.31 | 11.52 | Body | 1.0 cm | Standard | 6 | right | 0.056 |
| 5240 | 48 | 5.2 GHz WLAN | 801.11a | 11.31 | 11.39 | Body | 1.0 cm | Standard | 6 | right | 0.062 |
| 5180 | 36 | 5.2 GHz WLAN | 802.11n | 11.66 | 11.72 | Body | 2.5 cm | Standard | 7.22 | back | 0.029 |
| 5180 | 36 | 5.2 GHz WLAN | 802.11n | 11.66 | 11.59 | Body | 2.5 cm | Standard | 7.22 | front | 0.020 |
| 5180 | 36 | 5.2 GHz WLAN | 802.11n | 11.66 | 11.72 | Body | 1.0 cm | Standard | 7.22 | back | 0.072 |
| 5180 | 36 | 5.2 GHz WLAN | 802.11n | 11.66 | 11.73 | Body | 1.0 cm | Standard | 7.22 | front | 0.028 |
| 5180 | 36 | 5.2 GHz WLAN | 802.11n | 11.66 | 11.66 | Body | 1.0 cm | Standard | 7.22 | right | 0.049 |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population | | | | | | | Body 1.6 W/kg (mW/g) averaged over 1 gram | | | | |

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Batteries are fully charged for all readings. Standard battery was used.
4. Tissue parameters and temperatures are listed on the SAR plots.
5. Liquid tissue depth is was at least 15.0 cm.
6. Device was tested using a fixed spacing.
7. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate was selected for WLAN for SAR evaluation. Other IEEE 802.11 modes (including 802.11n), were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding highest output power channel in the lowest data rate IEEE 802.11b mode per channel.
8. WLAN transmission was verified using a spectrum analyzer.



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**Table 13-2
5.8 GHz Body SAR Results**

| MEASUREMENT RESULTS | | | | | | | | | | | |
|---|-----|--------------|---------|--------------|-------|----------|-----------------------------|--------------|------------------|-------|--------|
| FREQUENCY | | Mode | Service | C_Power[dBm] | | Position | Spacing | Battery Type | Data Rate (Mbps) | Side | SAR |
| MHz | Ch. | | | Start | End | | | | | | (W/kg) |
| 5745 | 149 | 5.8 GHz WLAN | 802.11a | 11.08 | 11.01 | Body | 2.5 cm | Standard | 6 | back | 0.049 |
| 5745 | 149 | 5.8 GHz WLAN | 801.11a | 11.43 | 11.42 | Body | 2.5 cm | Standard | 12 | back | 0.049 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11a | 11.08 | 11.13 | Body | 2.5 cm | Standard | 6 | front | 0.011 |
| 5745 | 149 | 5.8 GHz WLAN | 801.11a | 11.43 | 11.35 | Body | 2.5 cm | Standard | 12 | front | 0.023 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11a | 11.08 | 11.05 | Body | 1.0 cm | Standard | 6 | back | 0.074 |
| 5745 | 149 | 5.8 GHz WLAN | 801.11a | 11.43 | 11.48 | Body | 1.0 cm | Standard | 12 | back | 0.072 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11a | 11.08 | 11.16 | Body | 1.0 cm | Standard | 6 | front | 0.039 |
| 5745 | 149 | 5.8 GHz WLAN | 801.11a | 11.43 | 11.50 | Body | 1.0 cm | Standard | 12 | front | 0.030 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11a | 11.08 | 11.18 | Body | 1.0 cm | Standard | 6 | right | 0.063 |
| 5745 | 149 | 5.8 GHz WLAN | 801.11a | 11.43 | 11.52 | Body | 1.0 cm | Standard | 12 | right | 0.066 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11n | 11.48 | 11.39 | Body | 2.5 cm | Standard | 7.2 | back | 0.043 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11n | 11.48 | 11.56 | Body | 2.5 cm | Standard | 7.2 | front | 0.027 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11n | 11.48 | 11.47 | Body | 1.0 cm | Standard | 7.2 | back | 0.066 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11n | 11.48 | 11.57 | Body | 1.0 cm | Standard | 7.2 | front | 0.032 |
| 5745 | 149 | 5.8 GHz WLAN | 802.11n | 11.48 | 11.55 | Body | 1.0 cm | Standard | 7.2 | right | 0.082 |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT | | | | | | | Body | | | | |
| Spatial Peak | | | | | | | 1.6 W/kg (mW/g) | | | | |
| Uncontrolled Exposure/General Population | | | | | | | averaged over 1 gram | | | | |

Notes:



1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Batteries are fully charged for all readings. Standard battery was used.
4. Tissue parameters and temperatures are listed on the SAR plots.
5. Liquid tissue depth is was at least 15.0 cm.
6. Device was tested using a fixed spacing.
7. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate was selected for WLAN for SAR evaluation. Other IEEE 802.11 modes (including 802.11n), were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding highest output power channel in the lowest data rate IEEE 802.11b mode per channel.
8. WLAN transmission was verified using a spectrum analyzer.

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14 EQUIPMENT LIST

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|--------------------|-------------|-----------------------------------|------------|--------------|-----------|---------------|
| Agilent | 85070B | Dielectric Probe Kit | 8/22/2010 | Annual | 8/22/2011 | US33020316 |
| Agilent | 8648D | (9kHz-4GHz) Signal Generator | 10/11/2010 | Annual | ##### | 3613A00315 |
| Agilent | 8753E | (30kHz-6GHz) Network Analyzer | 3/31/2010 | Annual | 3/31/2011 | JP38020182 |
| Agilent | E5515C | Wireless Communications Test Set | 10/11/2010 | Annual | ##### | GB46110872 |
| Agilent | E5515C | Wireless Communications Test Set | 10/11/2010 | Annual | ##### | GB46310798 |
| Agilent | E5515C | Wireless Communications Test Set | 8/12/2010 | Annual | 8/12/2011 | GB41450275 |
| Agilent | E8257D | (250kHz-20GHz) Signal Generator | 3/30/2010 | Annual | 3/30/2011 | MY45470194 |
| Gigatronics | 80701A | (0.05-18GHz) Power Sensor | 10/11/2010 | Annual | ##### | 1833460 |
| Gigatronics | 8651A | Universal Power Meter | 10/11/2010 | Annual | ##### | 8650319 |
| Index SAR | IXTL-010 | Dielectric Measurement Kit | N/A | | N/A | N/A |
| Index SAR | IXTL-030 | 30MM TEM line for 6 GHz | N/A | | N/A | N/A |
| Rohde & Schwarz | CMU200 | Base Station Simulator | 6/21/2010 | Annual | 6/21/2011 | 833855/0010 |
| Rohde & Schwarz | NRV-Z32 | Peak Power Sensor (100uW-2W) | 12/5/2008 | Biennial | 12/5/2010 | 100155 |
| Rohde & Schwarz | NRV-Z33 | Peak Power Sensor (1mW-20W) | 12/5/2008 | Biennial | 12/5/2010 | 100004 |
| SPEAG | D1450V2 | 1450 MHz SAR Dipole | 5/20/2009 | Biennial | 5/20/2011 | 1025 |
| SPEAG | D1765V2 | 1765 MHz SAR Dipole | 5/19/2009 | Biennial | 5/19/2011 | 1008 |
| SPEAG | D1900V2 | 1900 MHz SAR Dipole | 1/20/2009 | Biennial | 1/20/2011 | 502 |
| SPEAG | D1900V2 | 1900 MHz SAR Dipole | 8/18/2009 | Biennial | 8/18/2011 | 5d080 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 8/27/2009 | Biennial | 8/27/2011 | 719 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 1/8/2009 | Biennial | 1/8/2011 | 797 |
| SPEAG | D2600V2 | 2600 MHz SAR Dipole | 8/12/2009 | Biennial | 8/12/2011 | 1004 |
| SPEAG | D5GHzV2 | 5 GHz SAR Dipole | 8/19/2009 | Biennial | 8/19/2011 | 1007 |
| SPEAG | D5GHzV2 | 5 GHz SAR Dipole | 1/15/2009 | Biennial | 1/15/2011 | 1057 |
| SPEAG | D835V2 | 835 MHz SAR Dipole | 1/19/2009 | Biennial | 1/19/2011 | 4d047 |
| SPEAG | D835V2 | 835 MHz SAR Dipole | 8/24/2009 | Biennial | 8/24/2011 | 4d026 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/22/2010 | Annual | 3/22/2011 | 704 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 4/21/2010 | Annual | 4/21/2011 | 665 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/22/2010 | Annual | 1/22/2011 | 649 |
| SPEAG | ES3DV2 | SAR Probe | 9/21/2010 | Annual | 9/21/2011 | 3022 |
| SPEAG | EX3DV4 | SAR Probe | 8/19/2010 | Annual | 8/19/2011 | 3561 |
| SPEAG | EX3DV4 | SAR Probe | 1/26/2010 | Annual | 1/26/2011 | 3550 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 7/8/2010 | Annual | 7/8/2011 | 859 |
| SPEAG | D750V3 | 750 MHz Dipole | 8/19/2010 | Biennial | 8/19/2012 | 1003 |
| SPEAG | ES3DV3 | SAR Probe | 3/16/2010 | Annual | 3/16/2011 | 3213 |
| SPEAG | ES3DV3 | SAR Probe | 4/20/2010 | Annual | 4/20/2011 | 3209 |
| Rohde & Schwarz | SMIQ03B | Signal Generator | 4/1/2010 | Annual | 4/1/2011 | DE27259 |
| SPEAG | D1640V2 | 1640 MHz Dipole | 8/17/2010 | Biennial | 8/17/2012 | 321 |
| Rohde & Schwarz | CMW500 | LTE Radio Communication Tester | 8/30/2010 | Annual | 8/30/2011 | 100976 |
| Anritsu | MA2481A | Power Sensor | 12/2/2009 | Annual | 12/2/2010 | 5318 |
| Anritsu | MA2481A | Power Sensor | 12/3/2009 | Annual | 12/3/2010 | 5442 |
| Anritsu | ML2438A | Power Meter | 12/3/2009 | Annual | 12/3/2010 | 1190013 |
| Anritsu | ML2438A | Power Meter | 12/3/2009 | Annual | 12/3/2010 | 98150041 |
| Agilent | 8648D | Signal Generator | 4/1/2010 | Annual | 4/1/2011 | 3629U00687 |
| Anritsu | ML2438A | Power Meter | 12/3/2009 | Annual | 12/3/2010 | 1070030 |
| Anritsu | MA2481A | Power Sensor | 12/2/2009 | Annual | 12/2/2010 | 5821 |
| Anritsu | MA2481A | Power Sensor | 12/3/2009 | Annual | 12/3/2010 | 8013 |
| Anritsu | MA2481A | Power Sensor | 12/3/2009 | Annual | 12/3/2010 | 2400 |
| Apriel | ALS-PR-DIEL | Dielectric Probe Kit | N/A | | N/A | 260-00959 |
| Agilent | E5515C | Wireless Communications Tester | 4/14/2010 | Annual | 4/14/2011 | US41140256 |
| SPEAG | ES3DV3 | SAR Probe | 2/10/2010 | Annual | 2/10/2011 | 3173 |
| Amplifier Research | 5S1G4 | 5W, 800MHz-4.2GHz | N/A | | | 17042 |

Justification for 2-year calibration cycle for SAR dipoles is found in Section 12.3.



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15 MEASUREMENT UNCERTAINTIES

Applicable for 5.2 to 5.8 GHz.

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|----------------------|---------------|----------------|--------------|-----------------------|--------------------------|--------------------------------|----------------------------------|----------------|
| Uncertainty Component | IEEE 1528 Sec. | Tol. (± %) | Prob. Dist. | Div. | c _i 1gm | c _i 10 gms | 1gm u _i (± %) | 10gms u _i (± %) | v _i |
| Measurement System | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.6 | N | 1 | 1.0 | 1.0 | 6.6 | 6.6 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| Test Sample Related | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| Phantom & Tissue Parameters | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| Combined Standard Uncertainty (k=1) | | | | RSS | | | 12.4 | 12.0 | 299 |
| Expanded Uncertainty (95% CONFIDENCE LEVEL) | | | | k=2 | | | 24.7 | 24.0 | |

The above measurement uncertainties are according to IEEE Std. 1528-2003



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16 CONCLUSION

16.1 Measurement Conclusion



The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada for the 5 GHz WLAN operations only, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested. The test results in this report do not demonstrate compliance with the other capabilities of this EUT.

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 various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]



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