SAR TEST REPORT

Test item	:	Mobile Phone
Model No.	:	KYL22
Order No.	:	DEMC1309-02848
Date of receipt	:	2013-09-10
Test duration	:	2013-09-28 ~ 2013-10-11
Date of issue	:	2013-10-18
Use of report	:	FCC Original Grant

Applicant : KYOCERA Corporation
2-1-1 Kagahara, Tsuzuki-ku, Yokohama-Shi, Kanagawa 224-8502, Japan

Test laboratory : Digital EMC Co., Ltd.
683-3, Yubang-Dong, Cheoin-Gu, Yongin-Si, Gyeonggi-Do, 449-080, Korea

Test rule part	:	47CFR §2.1093
Test environment	:	See appended test report
Test result	:	☒ Pass ☐ Fail

Tested by:	Witnessed by:	Reviewed by:
Engineer NoKyun, Im	Engineer N/A	Technical Director Harvey Sung

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Test Report Version

Test Report No.	Date	Description
DRTFCC1310-1002	Oct. 18, 2013	Final version for approval

1. DESCRIPTION OF DEVICE

Environmental evaluation measurements of specific absorption rate (SAR) distributions in emulated human head and body tissues exposed to radio frequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).

General Information:

Equipment type	Mobile Phone
FCC ID	JOYKYL22
Equipment model name	KYL22
Equipment add model name	N/A
Equipment serial no.	Identical prototype
Mode(s) of Operation	GSM 850, PCS 1900, WCDMA 850, WCDMA 1900, 2.4 G W-LAN(802.11b/g/n HT20) 5G W-LAN(802.11a/n HT20, HT40/802.11ac VHT20, VHT40, VHT80)
TX Frequency Range	824.2 ~ 848.8 MHz(Cellular Band) / 1850.2 ~ 1909.8 MHz(PCS Band) 826.4 ~ 846.6 MHz(WCDMA FDD V) / 1852.4 ~ 1907.6 MHz(WCDMA FDD II) 2412 ~ 2462 MHz(2.4 G W-LAN) / 5180 ~ 5700 MHz (5 G W-LAN)
RX Frequency Range	869.2 ~ 893.8 MHz(Cellular Band) / 1930.2 ~ 1989.8 MHz(PCS Band) 871.4 ~ 891.6 MHz(WCDMA FDD V) / 1932.4 ~ 1987.6 MHz(WCDMA FDD II) 2412 ~ 2462 MHz(2.4 G W-LAN) / 5180 ~ 5700 MHz (5 G W-LAN)

Equipment Class	Band	Measured Conducted Power [dBm]	Reported SAR 1g SAR (W/kg)		
			Head	Body-worn	Hotspot
PCE	GSM 850	33.0	0.15	0.61	-
PCE	GPRS 850	29.4	**0.31**	1.14	1.14
PCE	PCS 1900	30.0	<0.10	0.44	-
PCE	GPRS 1900	26.0	0.12	**1.23**	**1.23**
PCE	WCDMA 850	22.50	0.16	0.46	0.46
PCE	WCDMA 1900	22.49	0.14	1.09	1.09
DTS	2.4 GHz W-LAN	16.93	0.47	0.24	0.24
NII	5.2 GHz W-LAN	12.26	<0.10	<0.10	-
NII	5.3 GHz W-LAN	12.79	0.13	0.12	-
NII	5.5 GHz W-LAN	14.04	0.29	0.25	-
DSS/DTS	Bluetooth	7.553	N/A		
Simultaneous SAR per KDB 690783 D01v01r02			0.71	**1.48**	1.47

FCC Equipment Class	Licensed Portable Transmitter Held to Ear (PCE)
Date(s) of Tests	2013-09-28 ~ 2013-10-11
Antenna Type	Internal Type Antenna
Functions	● GSM/GPRS(GPRS Class: 12) / EDGE(RX Only) supported * DTM not supported ● BT(2.4GHz) / W-LAN(2.4GHz 802.11b/g/n(HT20)) / W-LAN(5 GHz 802.11a/n HT20, HT40, 802.11ac VHT20, VHT40, VHT80) supported * No simultaneous transmission between BT & WLAN * 5.8 GHz W-LAN(DTS Band) is not supported for this device. ● Simultaneous transmission between GSM, WCDMA voice & WLAN / GPRS, WCDMA & WLAN ● VoIP supported. ● Mobile Hotspot supported. ● WIFI Direct Go is supported for 2.4 GHz WLAN Only.

1.1 Guidance Applied

- FCC OET Bulletin 65 Supplement C [June 2001]
- IEEE 1528-2003
- FCC KDB Publication 941225 D01-D06 (2G/3G and Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r01 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 648474 D04v01r01 (Handset SAR)
- April 2013 TCB Workshop Notes (IEEE 802.11ac)

1.2 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS 850	Voice/Data	824.2 ~ 848.8 MHz
GSM/GPRS 1900	Voice/Data	1850.2 ~ 1909.8 MHz
WCDMA 850	Voice/Data	826.4 ~ 846.6 MHz
WCDMA1900	Voice/Data	1852.4 ~ 1907.6 MHz
2.4 GHz WLAN	Data	2412 ~ 2462 MHz
5.2 GHz WLAN	Data	5180 ~ 5240 MHz
5.3 GHz WLAN	Data	5260 ~ 5320 MHz
5.5 GHz WLAN	Data	5500 ~ 5700 MHz
Bluetooth	Data	2402 ~ 2480 MHz
NFC	Data	13.56 MHz

1.3 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05r01.

Band & Mode		Voice [dBm]	Burst Average GMSK [dBm]			
		1 TX Slot	1 TX Slot	2 TX Slot	3 TX Slot	4 TX Slot
GSM/GPRS 850	Maximum	33.0	33.0	32.0	30.0	29.5
	Nominal	32.0	32.0	31.0	29.0	28.5
GSM/GPRS 1900	Maximum	30.0	30.0	28.7	27.2	26.0
	Nominal	29.0	29.0	27.7	26.2	25.0

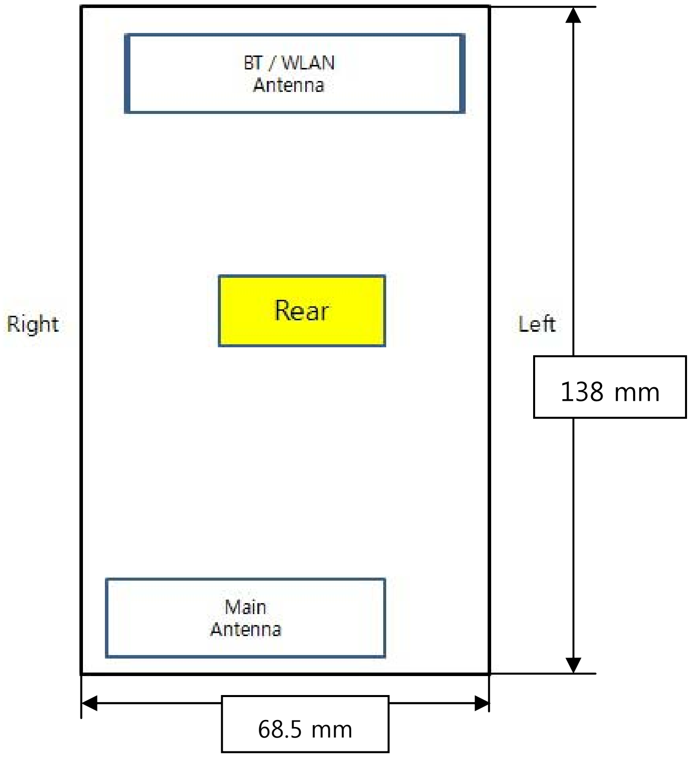
Band & Mode		Modulated Average [dBm]		
		3GPP RMC	3GPP HSDPA	3GPP HSUPA
WCDMA 850	Maximum	22.5	22.5	22.5
	Nominal	21.5	21.5	21.5
WCDMA 1900	Maximum	22.5	22.5	22.5
	Nominal	21.5	21.5	21.5

Band & Mode		**Modulated Average [dBm]**
IEEE 802.11b (2.4 GHz)	Maximum	17.0
	Nominal	15.5
IEEE 802.11g (2.4 GHz)	Maximum	13.5
	Nominal	12.0
IEEE 802.11n (2.4 GHz)	Maximum	13.5
	Nominal	12.0
IEEE 802.11a (5 GHz)	Maximum	14.5
	Nominal	13.0
IEEE 802.11n (5 GHz 20 MHz BW)	Maximum	14.0
	Nominal	12.5
IEEE 802.11n (5 GHz 40 MHz BW)	Maximum	11.5
	Nominal	10.0
IEEE 802.11ac (5 GHz 20 MHz BW)	Maximum	13.8
	Nominal	12.3
IEEE 802.11ac (5 GHz 40 MHz BW)	Maximum	11.2
	Nominal	9.7
IEEE 802.11ac (5 GHz 80 MHz BW)	Maximum	11.6
	Nominal	10.1
Bluetooth	Maximum	8.0
	Nominal	6.5
Bluetooth LE	Maximum	1.5
	Nominal	0.0

1.4 DUT Antenna Locations & SAR Test Configurations

DUT Antenna Locations (Rear Side View):

Note: Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC Filing.



SAR Test Configurations:

Mode	Mobile Hotspot Sides for SAR Testing					
	Top	Bottom	Front	Rear	Right	Left
GSM 850	X	O	O	O	O	O
PCS 1900	X	O	O	O	O	O
WCDMA 850	X	O	O	O	O	O
WCDMA 1900	X	O	O	O	O	O
2.4G W-LAN(802.11b/g/n)	O	X	O	O	O	O

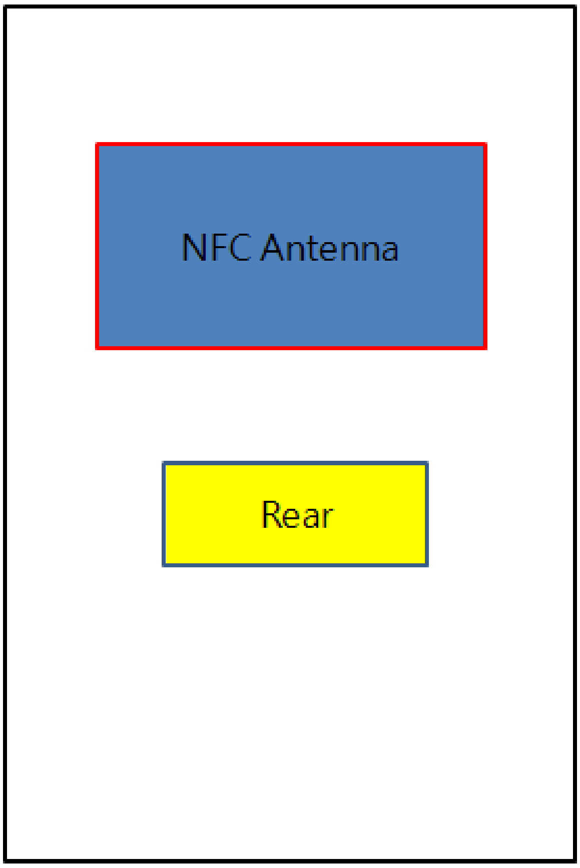
Table 1.1 Mobile Hotspot Sides for SAR Testing

Note:

1. Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v01r01 guidance, page 2. The antenna document shows the distances between the transmit antennas and the edges of the device. When the wireless router mode is enabled, all 5 GHz bands are disabled. Therefore 5 GHz WIFI Wireless Router SAR is not considered in this section.
2. 5 GHz WIFI Direct GO is not supported in the 5 GHz band for this device. WIFI Direct GO is supported in the 2.4 GHz band only. The manufacturer expects 2.4 GHz WIFI Direct GO may be used in a similar manner to wireless router usage. Therefore, 2.4 GHz WIFI Direct GO was evaluated for SAR similarly to wireless router SAR procedures in FCC KDB Publication 941225.

1.5 Near Field Communications (NFC) Antenna

NFC Antenna Locations (Rear Side View):



This DUT has NFC operations. The NFC antenna is integrated into the back cover. Therefore, all SAR tests performed with the device already incorporate the NFC antenna.

1.6 SAR Test Exclusions Applied

(A) WIFI & BT

Since Wireless Router operations are not allowed by the chipset firmware using 5 GHz WIFI, only 2.4 GHz WIFI Hotspot SAR tests and combinations are considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06v01r01.

Per FCC KDB 447498 D01v05r01, the SAR exclusion threshold for distances < 50 mm is defined by the following equation:

$$\frac{Max\ Power\ of\ Channel\ (mW)}{Test\ Separation\ Dist\ (mm)} * \sqrt{Frequency(GHz)} \leq 3.0$$

Based on the maximum conducted power of **Bluetooth** (rounded to the nearest mW) and the antenna to user separation distance, **Bluetooth SAR was not required**; [(6/10)* √2.480] = **<u>1.0</u>** < 3.0.

Based on the maximum conducted power of **Bluetooth LE** (rounded to the nearest mW) and the antenna to user separation distance, **Bluetooth LE SAR was not required**; [(1/10)* √2.480] = **<u>0.2</u>** < 3.0.

Based on the maximum conducted power of **2.4 GHz WIFI** (rounded to the nearest mW) and the antenna to user separation distance, **2.4 GHz WIFI SAR was required**; [(50/10)* √2.437] = **<u>7.8</u>** > 3.0.

Based on the maximum conducted power of **5 GHz WIFI** (rounded to the nearest mW) and the antenna to user separation distance, **5 GHz WIFI SAR was required**; [(28/10)* √5.700] = **<u>6.7</u>** > 3.0.

Per KDB Publication 447498 D01v05r01, the maximum power of the channel was rounded to the nearest mW before calculation.

This device supports 20 MHz and 40 MHz Bandwidths for IEEE 802.11n for 5 GHz WIFI only. IEEE 802.11n was not evaluated for SAR since the average output power of 20 MHz and 40 MHz bandwidths was not more than 0.25 dB higher than the average output power of IEEE 802.11a.

This device supports IEEE 802.11ac with the following features:

a) Up to 80 MHz Bandwidth only
b) No aggregate channel configurations
c) 1 Tx antenna output
d) 256 QAM is supported
e) No new 5 GHz channels

Per April 2013 TCB workshop notes, full SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.

(B) Licensed Transmitter(s)

GSM/GPRS DTM is not supported for US bands. Therefore, the GSM Voice modes in this report do not transmit simultaneously with GPRS Data. And this device is only supported for EDGE Rx.

WCDMA 850 and WCDMA 1900 support HSDPA and HSUPA.

1.7 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

1.8 Device Serial Numbers

Band & Mode	Head Serial Number	Body-Worn Serial Number	Hotspot Serial Number
GSM/GPRS 850	FCC #1	FCC #1	FCC #1
GSM/GPRS 1900	FCC #1	FCC #1	FCC #1
WCDMA 850	FCC #1	FCC #1	FCC #1
WCDMA 1900	FCC #1	FCC #1	FCC #1
2.4 GHz WLAN	FCC #1	FCC #1	FCC #1
5 GHz WLAN	FCC #1	FCC #1	FCC #1

2. INTROCUCTION

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

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency 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. 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*.1-2005 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring 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 National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. 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.

SAR Definition

Specific Absorption Rate (SAR) 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. 2.1)

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

Fig. 2.1 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 relations 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.

3. DESCRIPTION OF TEST EQUIPMENT

3.1 SAR MEASUREMENT SETUP

Measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain 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 Fig. 3.1).

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 Intel Core i7-3770 3.40 GHz desktop computer with Windows NT system and SAR Measurement Software DASY5, 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, AD-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 of the DAE and transfers data to the PC plug-in card.

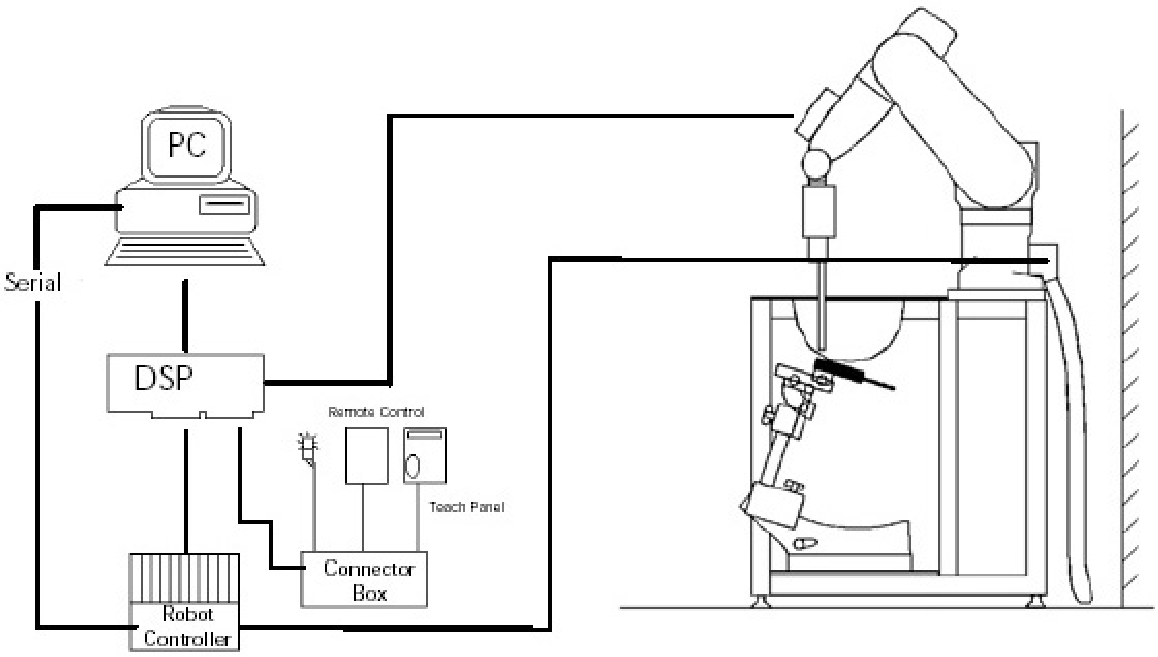


Figure 3.1 SAR Measurement System Setup

The DAE4 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 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. The system is described in detail.

3.2 EX3DV4 Probe Specification

Calibration In air from 10 MHz to 6 GHz
In brain and muscle simulating tissue at Frequencies of
450 MHz, 600 MHz, 750 MHz, 835 MHz, 900 MHz, 1750 MHz, 1900 MHz, 2300 MHz,
2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5500 MHz, 5600 MHz, 5800 MHz

Frequency 10 MHz to 6 GHz

Linearity ± 0.2 dB (30 MHz to 6 GHz)

Dynamic 5 μW/g to > 100 mW/g

Range Linearity : ±0.2dB

Dimensions Overall length : 330 mm

Tip length 20 mm

Body diameter 12 mm

Tip diameter 2.5 mm

Distance from probe tip to sensor center 1.0 mm

Application SAR Dosimetry Testing
Compliance tests of mobile phones

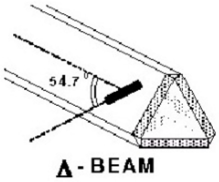


Figure 3.2 Triangular Probe Configurations

Figure 3.3 Probe Thick-Film Technique

DAE System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration(see Fig. 3.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multitier 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 DASY5 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

3.3 Probe Calibration Process

3.3.1 E-Probe Calibration

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees.

Temperature Assessment *

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium, correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent the remits or based temperature probe is used in conjunction with the E-field probe.

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

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to ΔT / Δt , the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

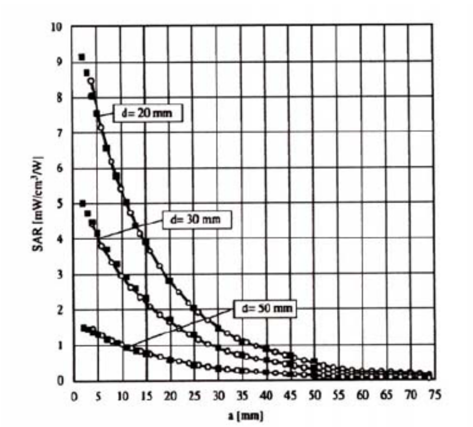


Figure 3.4 E-Field and Temperature Measurements at 900MHz

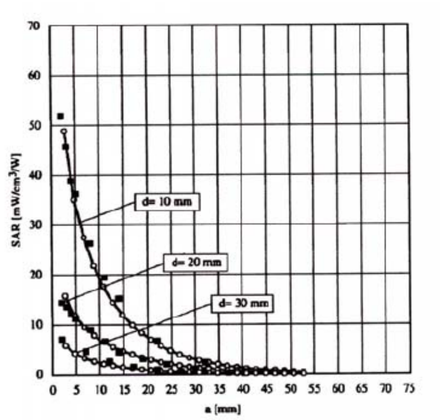


Figure 3.5 E-Field and Temperature Measurements at 1800MHz

3.4 Data Extrapolation

The DASY5 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with V_i = compensated signal of channel i (i=x,y,z)
U_i = input signal of channel i (i=x,y,z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with V_i = compensated signal of channel i (i = x,y,z)
$Norm_i$ = sensor sensitivity of channel i (i = x,y,z) $\mu V/(V/m)^2$ for E-field probes
ConvF = sensitivity of enhancement in solution
E_i = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermetian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in W/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

with P_{pwe} = equivalent power density of a plane wave in W/cm^2
E_{tot} = total electric field strength in V/m

3.5 SAM Twin PHANTOM

The SAM Twin Phantom V5.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. 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 the 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 in the robot. (see Fig. 3.6)

Figure 3.6 SAM Twin Phantom

SAM Twin Phantom Specification:

Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. 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 teaching three points with the robot. Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.
Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet

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 alongthemid-sagittal plane into right and left halves (see Fig. 3.7). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.

Figure 3.7 Sam Twin Phantom shell

3.6 Device Holder for Transmitters

In combination with the Twin SAM Phantom V4.0/V4.0c, V5.0 or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

Figure 3.8 Mounting Device

3.7 Brain & Muscle Simulation Mixture Characterization

The brain and muscle mixtures consist of a viscous gel using hydrox-ethylcellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Harts grove.

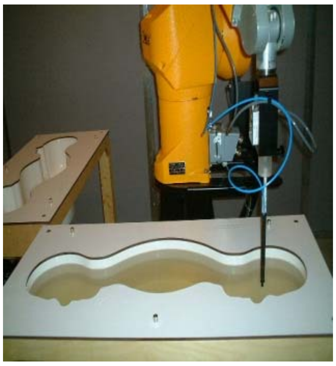


Figure 3.9 Simulated Tissue

Table 3.1 Composition of the Tissue Equivalent Matter

Ingredients (% by weight)	**Frequency (MHz)**							
	835		**1900**		**2450**		**5200 ~ 5800**	
Tissue Type	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**
Water	40.19	50.75	55.24	70.23	71.88	73.40	65.52	80.00
Salt (NaCl)	1.480	0.940	0.310	0.290	0.160	0.060	-	-
Sugar	57.90	48.21	-	-	-	-	-	-
HEC	0.250	-	-	-	-	-	-	-
Bactericide	0.180	0.100	-	-	-	-	-	-
Triton X-100	-	-	-	-	19.97	-	17.24	-
DGBE	-	-	44.45	29.48	7.990	26.54	-	-
Diethylene glycol hexyl ether	-	-	-	-	-	-	17.24	-
Polysorbate (Tween) 80	-	-	-	-	-	-	-	20.00
Target for Dielectric Constant	41.5	55.2	40.0	53.3	39.2	52.7	-	-
Target for Conductivity (S/m)	0.90	0.97	1.40	1.52	1.80	1.95	-	-

Salt:	99 % Pure Sodium Chloride	Sugar:	98 % Pure Sucrose
Water:	De-ionized, 16M 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		

3.8 SAR TEST EQUIPMENT

Table 3.2 Test Equipment Calibration

	Type	Manufacturer	Model	Cal.Date	Next.Cal.Date	S/N
☒	SEMITEC Engineering	SEMITEC	N/A	N/A	N/A	Shield Room
☒	Robot	SCHMID	TX90XL	N/A	N/A	F13/5P9GA1/A/01
☒	Robot Controller	SCHMID	C58C	N/A	N/A	F13/5P9GA1/C/01
☒	Joystick	SCHMID	N/A	N/A	N/A	S-12450905
☒	Intel Core i7-3770 3.40 GHz Windows 7 Professional	N/A	N/A	N/A	N/A	N/A
☒	Probe Alignment Unit LB	N/A	N/A	N/A	N/A	SE UKS 030 AA
☒	Mounting Device	SCHMID	SD000H01HA	N/A	N/A	N/A
☒	Twin SAM Phantom	SCHMID	QD000P40CD	N/A	N/A	1782
☐	Twin SAM Phantom	SCHMID	QD000P40CD	N/A	N/A	1783
☒	Head/Body Equivalent Matter(835MHz)	N/A	N/A	2013-01-01	2014-01-01	N/A
☒	Head/Body Equivalent Matter(1900MHz)	N/A	N/A	2013-01-01	2014-01-01	N/A
☒	Head/Body Equivalent Matter(2450MHz)	N/A	N/A	2013-01-01	2014-01-01	N/A
☒	Head/Body Equivalent Matter(5000MHz)	N/A	N/A	2013-01-01	2014-01-01	N/A
☒	DataAcquisition Electronics	SCHMID	DAE4V1	2013-09-10	2014-09-10	1391
☒	Dosimetric E-Field Probe	SCHMID	EX3DV4	2013-09-10	2014-09-10	3930
☐	Dummy Probe	N/A	N/A	N/A	N/A	N/A
☒	835MHz System Validation Dipole	SCHMID	D835V2	2012-03-14	2014-03-14	464
☒	1900MHz System Validation Dipole	SCHMID	D1900V2	2012-03-16	2014-03-16	5d029
☒	2450MHz System Validation Dipole	SCHMID	D2450V2	2012-03-15	2014-03-15	726
☒	5000MHz System Validation Dipole	SCHMID	D5GHzV2	2013-03-15	2015-03-15	1103
☒	Network Analyzer	Agilent	E5071C	2012-11-02	2013-11-02	MY46106970
☒	Signal Generator	Rohde Schwarz	SMR20	2013-02-28	2014-02-28	101251
☒	Amplifier	EMPOWER	BBS3Q7ELU	2013-09-12	2014-09-12	1020
☒	High Power RF Amplifier	EMPOWER	BBS3Q8CCJ	2012-11-02	2013-11-02	1005
☒	Power Meter	HP	EPM-442A	2013-02-28	2014-02-28	GB37170267
☒	Power Meter	Anritsu	ML2495A	2013-03-06	2014-03-06	1306007
☒	Wide Bandwidth Power Sensor	Anritsu	MA2490A	2013-03-06	2014-03-06	1249001
☒	Power Sensor	HP	8481A	2013-02-28	2014-02-28	3318A96566
☒	Power Sensor	HP	8481A	2013-02-14	2014-02-14	3318A96030
☒	Dual Directional Coupler	Agilent	778D-012	2013-01-08	2014-01-08	50228
☒	Directional Coupler	HP	773D	2013-06-27	2014-06-27	2389A00640
☒	Low Pass Filter 1,5GHz	Micro LAB	LA-15N	2013-01-08	2014-01-08	N/A
☒	Low Pass Filter 3,0GHz	Micro LAB	LA-30N	2013-09-12	2014-09-12	N/A
☒	Low Pass Filter 6,0GHz	Micro LAB	LA-60N	2013-03-12	2014-03-12	03942
☒	Attenuators(3 dB)	Agilent	8491B	2013-06-27	2014-06-27	MY39260700
☒	Attenuators(10 dB)	WEINSCHEL	23-10-34	2013-01-08	2014-01-08	BP4387
☐	Step Attenuator	HP	8494A	2013-09-12	2014-09-12	3308A33341
☒	Dielectric Probe kit	SCHMID	DAK-3.5	2012-12-11	2013-12-11	1092
☒	8960 Series 10 Wireless Comms. Test Set	Agilent	E5515C	2013-02-28	2014-02-28	GB43461134
☒	MXA Signal Analyzer	Agilent	N9020A	2013-09-16	2014-09-16	MY50410163

NOTE: The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Validation measurement is performed by Digital EMC before each test. The brain and muscle simulating material are calibrated by Digital EMC using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material.

3.8.1 Extended Dipole Calibrations

Referring to FCC KDB 865664 D01v01r01 SAR measurement 100 MHz to 6 GHz v01, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
The Justification data of dipole D835V2, SN: 464 / D1900V2, SN: 5d029 / D2450V2, SN: 726 can be found in Table 3.3.

Justification Procedure of Dipole Calibration:

1. Setup a Network Analyzer (Agilent E5071C) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200 MHz around the calibration point.
2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
3. Connect the dipole with the calibrated Network Analyzer.
4. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
5. Record the result and compare with the prior calibration.

Referring to FCC KDB 865664 D01v01r01 SAR measurement 100 MHz to 6 GHz v01, if dipoles are verified in return loss (< -20 dB, within 20 % of prior calibration), and in impedance (with 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

Table 3.3 Justification of the extended calibration Result

D835V2 – Serial No. 464												
Date of Measurement	835 MHz Head						835 MHz Body					
	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2012-03-14 (Calibration)	-32.137		51.215		-2.1855		-25.168		46.469		-3.9863	
2013-03-14 (Measured)	-32.864	**-2.26**	51.758	**-0.543**	-2.2259	**0.040**	-25.295	**-0.50**	46.591	**-0.122**	-3.8298	**-0.1565**
D1900V2 – Serial No. 5d029												
Date of Measurement	1900 MHz Head						1900 MHz Body					
	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2012-03-16 (Calibration)	-30.838		52.887		-0.61914		-25.415		45.633		-2.6895	
2013-03-16 (Measured)	-30.585	**0.82**	52.599	**0.288**	-0.94326	**0.324**	-25.672	**-1.01**	45.569	**0.064**	-2.6244	**-0.0651**
D2450V2 – Serial No. 726												
Date of Measurement	2450 MHz Head						2450 MHz Body					
	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2012-03-15 (Calibration)	-26.011		54.014		3.3145		-26.035		50.006		4.9922	
2013-03-15 (Measured)	-26.244	**-0.90**	54.099	**-0.085**	3.4914	**-0.177**	-26.060	**-0.10**	50.305	**-0.299**	4.9089	**0.0833**

4. TEST SYSTEM SPECIFICATIONS

Automated TEST SYSTEM SPECIFICATIONS:

Positioner

Robot	Stäubli Unimation Corp. Robot Model: TX90XL
Repeatability	0.02 mm
No. of axis	6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor	Intel Core i5-3770
Clock Speed	3.40 GHz
Operating System	Windows 7 Professional
Data Card	DASY5 PC-Board

Data Converter

Features	Signal, multiplexer, A/D converter. & control logic
Software	DASY5
Connecting Lines	Optical downlink for data and status info Optical uplink for commands and clock

PC Interface Card

Function	24 bit (64 MHz) DSP for real time processing Link to DAE 4 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

E-Field Probes

Model	EX3DV4 S/N: 3930
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 6 GHz
Linearity	± 0.2 dB (30 MHz to 6 GHz)

Phantom

Phantom	SAM Twin Phantom (V5.0)
Shell Material	Composite
Thickness	2.0 ± 0.2 mm

Figure 2.2 DASY5 Test System

5. SAR MEASUREMENT PROCEDURE

5.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head or body 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 device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664D01v01(See Table 5.1).

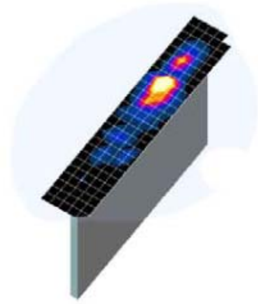


Figure 5.1
Sample SAR Area Scan

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 the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.

3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r01 (See Table 5.1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online 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 2.7mmaway 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 to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

Frequency	Maximum Area Scan Resolution (mm) (Δx_{area}, Δy_{area})	Maximum Zoom Scan Resolution (mm) (Δx_{zoom}, Δy_{zoom})	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
			$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)$*	$\Delta z_{zoom}(n>1)$*	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	$\leq 1.5*\Delta z_{zoom}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	$\leq 1.5*\Delta z_{zoom}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	$\leq 1.5*\Delta z_{zoom}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	$\leq 1.5*\Delta z_{zoom}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	$\leq 1.5*\Delta z_{zoom}(n-1)$	≥ 22

Table 5.1 Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r01

6. DEFINITION OF REFERENCE POINTS

6.1 Ear Reference Point

Figure 6.1 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 ERPs are 15mm posterior to the entrance to the Ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 6.5. 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 6.1). 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.

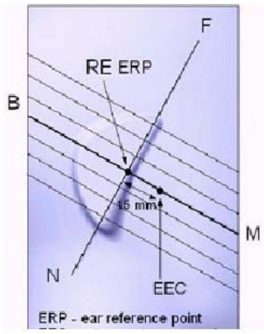


Figure 6.1 Close-up side view of ERP

6.2 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 Fig. 6.3). The "test device reference point" was than 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 it's 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 6.2 Front, back and side view SAM Twin Phantom

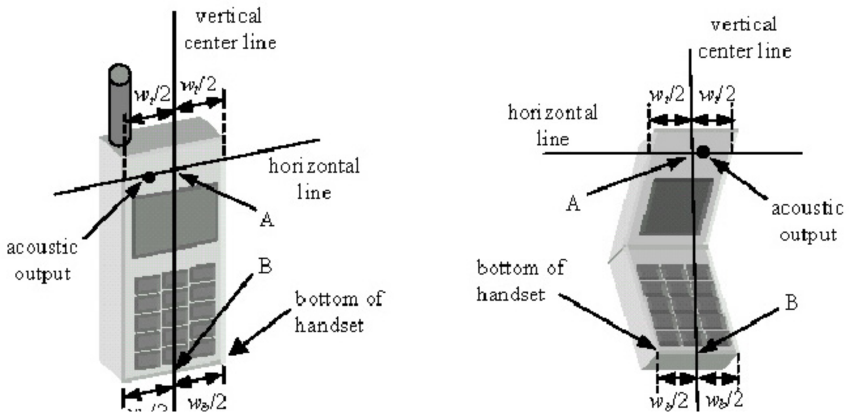


Figure 6.3 Handset Vertical Center & Horizontal Line Reference Points

7. TEST CONFIGURATION POSITIONS FOR HANDSETS

7.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

7.2 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 7.1), 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 7.1 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 hen rotated around the vertical centerline until the phone (horizontal line) was symmetrical was 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 7.2)

7.3 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 15degree.
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 7.3).

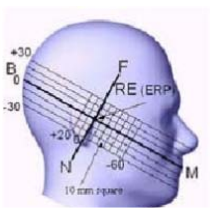


Figure 7.2 Side view w/relevant markings

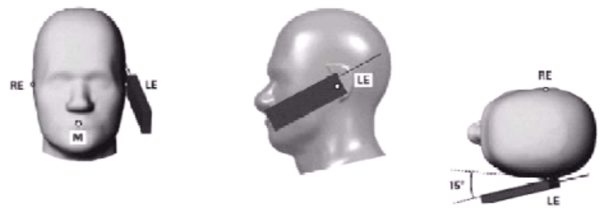


Figure 7.3 Front, Side and Top View of Ear/15°Position

7.4 Body-Worn Accessory Configurations

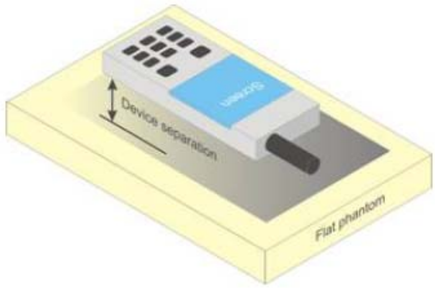


Figure 6.7 Sample Body-Worn Diagram

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 6.7). Per FCC KDB Publication 648474 D04v01r01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v05r01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

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.

7.5 Extremity Exposure Configurations

Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1-g body and 10-g extremity SAR Exclusion Thresholds found in KDB Publication 447498 D01v05r01 should be applied to determine SAR test requirements.

Per KDB Publication 447498 D01v05r01, Cell phones (handsets) are not normally designed to be used on extremities or operated in extremity only exposure conditions. The maximum output power levels of handsets generally do not require extremity SAR testing to show compliance. Therefore, extremity SAR was not evaluated for this device.

7.6 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06v01r01 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 cm) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes.

Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05r01 publication procedures. The “Portable Hotspot” feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

8. RF EXPOSURE LIMITS

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.

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 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 8.1.SAR Human Exposure Specified in ANSI/IEEE C95.1-2005

	HUMAN EXPOSURE LIMITS	
	General Public Exposure (W/kg) or (mW/g)	Occupational Exposure (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Brain)	1.60	8.00
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.40
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.00	20.0

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.

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

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).

9. FCC MEASUREMENT PROCEDURES

Power measurements were performed using a base station simulator under digital average power.

9.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05r01, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. The highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

9.2 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB Publication 941225 D01v02r02 "SAR Measurement Procedures for 3G Devices" v02, October 2007.

The device was placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. Devices under test were evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device was tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviated by more than 5%, the SAR test and drift measurements were repeated.

9.3 SAR Measurement Conditions for WCDMA(UMTS)

9.3.1 Output Power Verification

Maximum output power is measured on the High, Middle and Low channels for each applicable transmission band according to the general descriptions in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all "1s".

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in section 5.2 of 3GPP TS 34.121 (release 5), using the appropriate RMC with TPC (transmit power control) set to all "1s" or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HS-DPCCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

9.3.2 Head SAR Measurements for Handsets

SAR for head exposure configurations is measured using the 12.2 kbps RMC with TPC bits configured to all "1s". SAR in AMR configurations is not required when the maximum average output of each RF channel for 12.2 kbps AMR is less than 0.25 dB higher than that measured in 2.2 kbps RMC. Otherwise, SAR is measured on the maximum output channel in 12.2 AMR with a 3.4 kbps SRB (signaling radio bearer) using the exposure configuration that resulted in the highest SAR for that RF channel in the 12.2 kbps RMC mode.

9.3.3 Body SAR Measurements

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits all “1s”.

9.3.4 SAR Measurements for Handsets with Rel 5 HSDPA

Body SAR for HSDPA is not required for handsets with HSDPA capabilities when the maximum average output power of each RF channel with HSDPA active is less than 0.25 dB higher than that measured without HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is ≤ 75% of the SAR limit. Otherwise, SAR is measured for HSDPA, using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration measured in 12.2 kbps RMC without HSDPA, on the maximum output channel with the body exposure configuration that resulted in the highest SAR in 12.2 kbps RMC mode for that RF channel.

The H-set used in FRC for HSDPA should be configured according to the UE category of a test device. The number of HS-DSCH/HSPDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the applicable H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the FRC for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 2 ms to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors of βc=9 and βd=15, and power offset parameters of ∆ACK= ∆NACK =5 and ∆CQI=2 is used. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the FRC.

Sub-Test	β_c	β_d	β_d *(SF)*	β_c/β_d	β_{HS} *(Note1, Note 2)*	CM (dB) *(Note 3)*	MPR (dB) *(Note 3)*
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 *(Note 4)*	15/15 *(Note 4)*	64	12/15 *(Note 4)*	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Note 1: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 8 ⇔ $A_{hs} = \beta_{hs}/\beta_c$ = 30/15 ⇔ β_{hs} = 30/15 * β_c.
Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, Δ_{ACK} and Δ_{NACK} = 8 (A_{hs} = 30/15) with β_{hs} = 30/15 * β_c, and Δ_{CQI} = 7 (A_{hs} = 24/15) with β_{hs} = 24/15 * β_c.
Note 3: CM = 1 for β_c/β_d =12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Figure 9.1 Table C.10.1.4 of TS 234.121-1

9.3.4 SAR Measurements for Handsets with Rel 6 HSUPA

Body SAR for HSUPA is not required when the maximum average output of each RF channel with HSUPA/HSDPA active is less than 0.25 dB higher than as measured without HSUPA/HSDPA using 12.2 kbps RMC and maximum SAR for 12.2 kbps RMC is ≤ 75 % of the SAR limit. Otherwise SAR is measured on the maximum output channel for the body exposure configuration produced highest SAR in 12.2 kbps RMC for that RF channel, using the additional procedures under “Release 6 HSPA data devices”

Head SAR for VOIP operations under HSPA is not required when maximum average output of each RF channel with HSPA is less than 0.25 dB higher than as measured using 12.2 kbps RMC. Otherwise SAR is measured using same HSPA configuration as used for body SAR.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM(2) (dB)	MPR (dB)	AG(4) Index	E-TFCI
1	11/15(3)	15/15(3)	64	11/15(3)	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}: 47/15 β_{ed2}: 47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15(4)	15/15(4)	64	15/15(4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 8 ⇔ $A_{hs} = \beta_{hs}/\beta_c$ = 30/15 ⇔ β_{hs} = 30/15 * β_c.
Note 2: CM = 1 for β_c/β_d =12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH, DPCCH, HS- DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
Note 3: For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to β_c = 10/15 and β_d = 15/15.
Note 4: For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to β_c = 14/15 and β_d = 15/15.
Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.
Note 6: β_{ed} can not be set directly; it is set by Absolute Grant Value.

9.4 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g/n /ac 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. See KDB Publication 248227 D01v01r02 for more details.

9.4.1 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.

9.4.2 Frequency Channel Configurations

For 2.4 GHz, the highest average RF output power channel between the low, mid and high channel at the lowest data rate was selected for SAR evaluation in 802.11b mode. 802.11g/n modes and higher data rates for 802.11b were additionally evaluated for SAR if the output power of the respective mode was 0.25 dB or higher than the powers of the SAR configurations tested in the 802.11b mode.

For 5 GHz, the highest average RF output power channel across the default test channels at the lowest data rate was selected for SAR evaluation in 802.11a. When the adjacent channels are higher in power then the default channels, these “required channels” were considered instead of the default channels for SAR testing. 802.11n modes and higher data rates for 802.11a/n were evaluated only if the respective mode was 0.25 dB or higher than the 802.11a mode. 802.11ac SAR was evaluated for highest 802.11a configuration in each 5 GHz band and each exposure condition. 802.11ac modes were additionally evaluated for SAR if the output power for the respective mode was more than 0.25 dB higher than powers of 802.11a modes.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg and if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.

10. RF CONDUCTED POWERS

10.1 GSM Conducted Powers

Band	Channel	Maximum Burst-Averaged Output Power (dBm)				
		Voice	GPRS/EDGE (GMSK) Data			
		GSM CS 1 Slot	GPRS 1 TX Slot	GPRS 2 TX Slot	GPRS 3 TX Slot	GPRS 4 TX Slot
GSM 850	128	33.0	33.0	31.9	30.0	29.4
	190	33.0	33.0	31.9	30.0	29.4
	251	33.0	32.9	31.8	29.9	29.5
PCS 1900	512	30.0	30.0	28.7	27.2	26.0
	661	30.0	30.0	28.7	27.1	26.0
	810	29.9	29.8	28.7	27.1	25.9
Band	**Channel**	**Calculated Maximum Frame-Averaged Output Power (dBm)**				
		Voice	**GPRS/EDGE (GMSK) Data**			
		GSM CS 1 Slot	**GPRS 1 TX Slot**	**GPRS 2 TX Slot**	**GPRS 3 TX Slot**	**GPRS 4 TX Slot**
GSM 850	128	23.97	23.97	25.88	25.74	**26.39**
	190	23.97	23.97	25.88	25.74	**26.39**
	251	23.97	23.87	25.78	25.64	**26.49**
PCS 1900	512	20.97	20.97	22.68	22.94	**22.99**
	661	20.97	20.97	22.68	22.84	**22.89**
	810	20.87	20.77	22.68	22.84	**22.99**

Table 10.1 The power was measured by E5515C

Note:

1. Both burst-averaged and calculated frame-averaged powers are included. Frame-averaged power was calculated from the measured burst-averaged power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
2. The bolded GPRS modes were selected according to the highest frame-averaged output power table according to KDB 941225 D03v01.
3. GPRS/EDGE (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our Investigation has shown that CS1 - CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.
4. This device does not support EDGE. (EDGE RX only)

GSM Class: B
GPRS Multislot class: 12 (max 4 TX Uplink slots)
DTM Multislot Class: N/A

Figure 10.1 Power Measurement Setup

10.2 WCDMA Conducted Powers

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band (dBm)			PCS Band (dBm)			3GPP MPR (dB)
			4132	4183	4233	9262	9400	9538	
99	WCDMA	12.2 kbps RMC	22.47	22.50	22.46	22.45	22.49	22.41	-
99		12.2 kbps AMR	22.46	22.48	22.41	22.41	22.48	22.39	-
5	HSDPA	Subtest 1	22.43	22.45	22.39	22.41	22.46	22.38	0
5		Subtest 2	22.43	22.44	22.38	22.40	22.40	22.35	0
5		Subtest 3	21.94	21.95	21.93	21.99	21.94	21.91	0.5
5		Subtest 4	21.91	21.95	21.92	21.97	21.93	21.89	0.5
6	HSUPA	Subtest 1	22.41	22.43	22.37	22.39	22.42	22.33	0
6		Subtest 2	20.42	20.43	20.39	20.49	20.45	20.39	2
6		Subtest 3	21.48	21.45	21.41	21.45	21.46	21.39	1
6		Subtest 4	20.41	20.41	20.38	20.45	20.43	20.39	2
6		Subtest 5	22.40	22.41	22.39	22.38	22.40	22.31	0

Table 10.2 The power was measured by E5515C

WCDMA SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02r02. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

This device does not support DC-HSDPA.

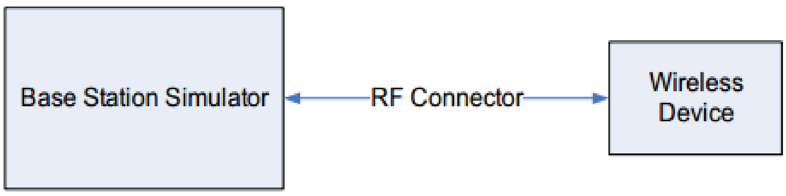


Figure 10.2 Power Measurement Setup

10.3 WLAN Conducted Powers

Mode	Freq. (MHz)	Channel	802.11b (2.4 GHz) Conducted Power (dBm) Data Rate (Mbps) 1	2	5.5	11
802.11b	2412	1	16.77	16.76	16.72	16.71
	2437	6	**16.93**	16.87	16.85	16.80
	2462	11	16.65	16.57	16.56	16.59

Table 10.3 IEEE 802.11b Average RF Power

Mode	Freq. (MHz)	Channel	802.11g (2.4 GHz) Conducted Power (dBm) Data Rate (Mbps) 6	9	12	18	24	36	48	54
802.11g	2412	1	13.12	12.97	12.97	12.95	12.92	12.89	12.83	12.80
	2437	6	13.35	13.23	13.22	13.16	13.11	13.07	12.96	13.01
	2462	11	13.07	13.00	12.96	12.96	12.94	12.89	12.90	12.80

Table 10.4 IEEE 802.11g Average RF Power

Mode	Freq. (MHz)	Channel	802.11n HT20 (2.4 GHz) Conducted Power (dBm) Data Rate (Mbps) 6.5	13	19.5	26	39	52	58.5	65
802.11n (HT-20)	2412	1	12.98	12.96	12.89	12.91	12.86	12.89	12.83	12.87
	2437	6	13.26	13.25	13.22	13.15	13.13	13.17	12.99	12.96
	2462	11	12.71	12.66	12.67	12.54	12.51	12.50	12.41	12.40

Table 10.5 IEEE 802.11n Average RF Power

Mode	Mode	Freq. (MHz)	Channel	802.11a (5 GHz) Conducted Power (dBm)							
				Data Rate (Mbps)							
				6	9	12	18	24	36	48	54
802.11a	5.2 G	5180	36	12.24	12.21	12.20	12.18	12.05	12.03	12.03	12.00
		5200	40	**12.26**	12.21	12.19	12.14	12.11	12.10	12.10	12.05
		5220	44	12.19	12.16	11.96	12.01	11.98	11.89	11.81	11.80
		5240	48	12.20	12.17	12.13	12.06	12.00	11.98	11.95	11.91
	5.3 G	5260	52	**12.79**	12.77	12.72	12.68	12.68	12.63	12.56	12.54
		5280	56	12.44	12.36	12.23	12.19	12.21	12.13	12.02	11.98
		5300	60	12.64	12.62	12.60	12.56	12.54	12.47	12.41	12.37
		5320	64	12.45	12.42	12.40	12.32	12.29	12.20	12.12	12.07
	5.5 G	5500	100	13.92	13.86	13.83	13.77	13.70	13.64	13.60	13.57
		5520	104	13.88	13.81	13.76	13.61	13.61	13.49	13.41	13.45
		5540	108	13.85	13.79	13.70	13.58	13.51	13.40	13.38	13.35
		5560	112	13.75	13.69	13.66	13.53	13.53	13.38	13.35	13.33
		5580	116	14.03	13.96	13.89	13.84	13.82	13.71	13.65	13.64
		5660	132	13.69	13.65	13.61	13.54	13.58	13.61	13.54	13.48
		5680	136	13.61	13.59	13.58	13.43	13.45	13.43	13.39	13.38
		5700	140	**14.04**	13.96	13.92	13.85	13.83	13.72	13.68	13.64

Table 10.6 IEEE 802.11a Average RF Power

Mode	Mode	Freq. (MHz)	Channel	802.11n HT20 (5 GHz) Conducted Power (dBm)							
				Data Rate (Mbps)							
				6.5	13	19.5	26	39	52	58.5	65
802.11n (HT-20)	5.2 G	5180	36	12.23	12.18	12.10	12.09	12.05	12.01	11.98	11.88
		5200	40	11.96	11.94	11.86	11.81	11.82	11.80	11.72	11.69
		5220	44	11.91	11.88	11.76	11.75	11.73	11.75	11.68	11.65
		5240	48	12.20	12.11	12.09	12.11	12.10	12.06	12.08	12.01
	5.3 G	5260	52	12.27	12.25	12.23	12.22	12.21	12.15	12.05	11.99
		5280	56	12.21	12.18	12.15	12.15	12.10	12.09	12.01	11.90
		5300	60	12.49	12.45	12.40	12.36	12.30	12.22	12.16	12.11
		5320	64	12.37	12.33	12.27	12.28	12.27	12.19	12.10	12.01
	5.5 G	5500	100	13.86	13.83	13.76	13.66	13.62	13.54	13.46	13.46
		5520	104	13.68	13.65	13.61	13.57	13.55	13.40	13.38	13.24
		5540	108	13.65	13.61	13.58	13.51	13.50	13.39	13.31	13.21
		5560	112	13.66	13.61	13.59	13.50	13.42	13.41	13.28	13.18
		5580	116	13.94	13.92	13.88	13.81	13.81	13.75	13.67	13.64
		5660	132	13.51	13.50	13.38	13.39	13.33	13.29	13.23	13.19
		5680	136	13.49	13.45	13.46	13.41	13.41	13.35	13.30	13.11
		5700	140	13.97	13.94	13.87	13.78	13.74	13.70	13.61	13.63

Table 10.7 IEEE 802.11n Average RF Power - 20 MHz Bandwidth

Mode	Mode	Freq. (MHz)	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm)							
				Data Rate (Mbps)							
				13.5	27	40.5	54	81	108	121.5	135
802.11n (HT-40)	5.2 G	5190	38	10.89	10.82	10.79	10.76	10.67	10.57	10.49	10.40
		5230	46	10.97	10.89	10.83	10.77	10.74	10.68	10.60	10.53
	5.3 G	5270	54	11.15	11.05	11.03	10.96	10.94	10.87	10.78	10.72
		5310	62	11.21	11.20	11.10	11.08	11.01	10.96	10.86	10.81
	5.5 G	5510	102	11.06	11.00	10.92	10.86	10.82	10.83	10.76	10.70
		5550	110	11.13	11.06	11.02	11.04	10.96	10.87	10.81	10.73
		5670	134	11.16	11.06	11.04	10.95	10.89	10.87	10.82	10.78

Table 10.8 IEEE 802.11n Average RF Power - 40 MHz Bandwidth

Mode	Mode	Freq. (MHz)	Channel	802.11ac VHT20 (5 GHz) Conducted Power (dBm)
				Data Rate (Mbps)
				78
802.11ac (VHT-20)	5.2 G	5180	36	11.75
		5200	40	11.51
		5220	44	11.49
		5240	48	11.77
	5.3 G	5260	52	11.81
		5280	56	11.89
		5300	60	12.04
		5320	64	11.91
	5.5 G	5500	100	13.39
		5520	104	13.15
		5540	108	13.10
		5560	112	13.08
		5580	116	13.50
		5660	132	13.12
		5680	136	13.01
		5700	140	13.49

Table 10.9 IEEE 802.11ac Average RF Power - 20 MHz Bandwidth

Mode	Mode	Freq. (MHz)	Channel	802.11ac VHT40 (5 GHz) Conducted Power (dBm)	
				Data Rate (Mbps)	
				162	180
802.11ac (VHT-40)	5.2 G	5190	38	10.35	10.31
		5230	46	10.50	10.45
	5.3 G	5270	54	10.70	10.68
		5310	62	10.79	10.73
	5.5 G	5510	102	10.66	10.64
		5550	110	10.68	10.65
		5670	134	10.70	10.68

Table 10.10 IEEE 802.11n Average RF Power - 40 MHz Bandwidth

Mode	Mode	Freq.	Channel	802.11ac VHT80 (5 GHz) Conducted Power (dBm)									
				Data Rate (Mbps)									
		(MHz)		29.3	58.5	87.8	117	175.5	234	263.3	292.5	351	390
802.11ac (VHT-80)	5.2 G	5210	42	**11.29**	11.28	11.23	11.21	11.14	11.12	11.03	11.01	10.91	10.82
	5.3 G	5290	58	**11.57**	11.47	11.40	11.34	11.27	11.21	11.23	11.21	11.14	11.10
	5.5 G	5530	106	**11.57**	11.55	11.52	11.47	11.40	11.32	11.32	11.28	11.29	11.20

Table 10.11 IEEE 802.11n Average RF Power - 80 MHz Bandwidth

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 / April 2013 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes(including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- Full SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The average output powers for 802.11ac - 20MHz (VHT20) and 802.11ac - 40 MHz (VHT40) modes are equivalent to the 802.11n - 20 MHz (HT20) and 802.11n - 40 MHz (HT40). Therefore, no additional measurements were required for the lower bandwidth for 802.11ac.
- The underlined data rate and channel above were tested for SAR.

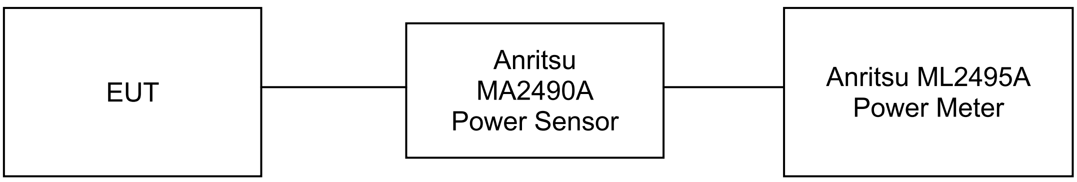


Figure 10.3 Power Measurement Setup for Bandwidths < 50 MHz

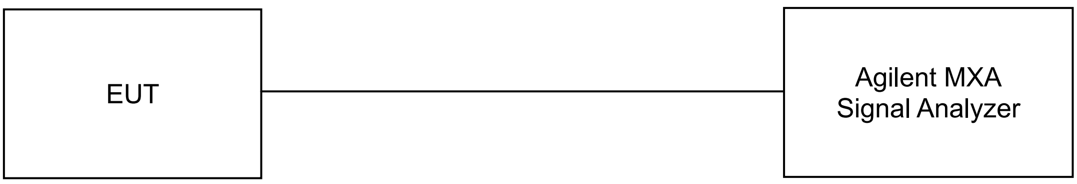


Figure 10.4 Power Measurement Setup for Bandwidths > 50 MHz

10.4 Bluetooth Conducted Powers

Channel	Frequency	Output Power (1Mbps)		Output power (2Mbps)		Output power (3Mbps)	
	(MHz)	(dBm)	(mW)	(dBm)	(mW)	(dBm)	(mW)
Low	2402	7.396	5.490	6.057	4.034	6.059	4.036
Mid	2441	6.429	4.394	5.417	3.481	5.430	3.491
High	**2480**	**7.553**	**5.692**	6.201	4.170	6.202	4.171

Table 10.12 Bluetooth Average RF Power

Channel	Frequency	Output Power (LE)	
	(MHz)	(dBm)	(mW)
Low	2402	-0.759	0.840
Mid	2441	-1.394	0.725
High	**2480**	**-0.340**	**0.925**

Table 10.13 Bluetooth Average RF Power

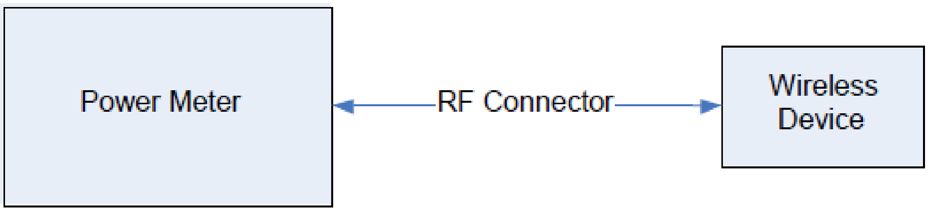


Figure 10.4 Power Measurement Setup

11. SYSTEM VERIFICATION

11.1 Tissue Verification

MEASURED TISSUE PARAMETERS										
Date(s)	Tissue Type	Ambient Temp.[°C]	Liquid Temp.[°C]	Measured Frequency [MHz]	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	Er Deviation [%]	σ Deviation [%]
Sep. 28. 2013	835 Head	21.8	22.5	824.2	41.551	0.899	40.440	0.903	-2.67	0.44
				835.0	41.500	0.900	40.376	0.907	-2.71	0.78
				836.6	41.500	0.902	40.362	0.908	-2.74	0.67
				848.8	41.500	0.915	40.290	0.913	-2.92	-0.22
Oct. 05. 2013	835 Body	22.1	22.4	824.2	55.240	0.969	53.700	0.972	-2.79	0.31
				835.0	55.200	0.970	53.604	0.983	-2.89	1.34
				836.6	55.195	0.972	53.586	0.985	-2.92	1.34
				848.8	55.158	0.987	53.464	0.997	-3.07	1.01
Sep. 30. 2013	835 Head	22.2	22.4	826.4	41.540	0.899	40.414	0.904	-2.71	0.56
				835.0	41.500	0.900	40.356	0.909	-2.76	1.00
				836.6	41.500	0.902	40.346	0.910	-2.78	0.89
				846.6	41.500	0.912	40.283	0.915	-2.93	0.33
Sep. 30. 2013	835 Body	22.2	22.4	826.4	55.230	0.969	54.023	0.978	-2.19	0.93
				835.0	55.200	0.970	53.942	0.987	-2.28	1.75
				836.6	55.195	0.972	53.921	0.988	-2.31	1.65
				846.6	55.160	0.984	53.819	0.998	-2.43	1.42
Oct. 01. 2013	1900 Head	22.4	22.6	1850.2	40.000	1.400	40.647	1.381	1.62	-1.36
				1880.0	40.000	1.400	40.602	1.404	1.50	0.29
				1900.0	40.000	1.400	40.570	1.419	1.43	1.36
				1909.8	40.000	1.400	40.553	1.427	1.38	1.93
Oct. 07. 2013	1900 Body	21.8	22.1	1850.2	53.300	1.520	55.133	1.482	3.44	-2.50
				1880.0	53.300	1.520	55.059	1.512	3.30	-0.53
				1900.0	53.300	1.520	55.004	1.532	3.20	0.79
				1909.8	53.300	1.520	54.977	1.541	3.15	1.38
Oct. 02. 2013	1900 Head	22.2	22.7	1852.4	40.000	1.400	40.629	1.382	1.57	-1.29
				1880.0	40.000	1.400	40.590	1.403	1.48	0.21
				1900.0	40.000	1.400	40.559	1.418	1.40	1.29
				1907.6	40.000	1.400	40.546	1.425	1.37	1.79
Oct. 02. 2013	1900 Body	22.2	22.7	1852.4	53.300	1.520	54.525	1.482	2.30	-2.50
				1880.0	53.300	1.520	54.461	1.510	2.18	-0.66
				1900.0	53.300	1.520	54.410	1.530	2.08	0.66
				1907.6	53.300	1.520	54.390	1.537	2.05	1.12
Oct. 04. 2013	2450 Head	21.9	22.3	2412	39.268	1.766	39.139	1.799	-0.33	1.87
				2437	39.223	1.788	39.063	1.821	-0.41	1.85
				2450	39.200	1.800	39.026	1.833	-0.44	1.83
				2462	39.184	1.813	38.994	1.844	-0.48	1.71
Oct. 04. 2013	2450 Body	21.9	22.3	2412	52.751	1.914	51.040	1.885	-3.24	-1.52
				2437	52.717	1.938	50.933	1.902	-3.38	-1.86
				2450	52.700	1.950	50.885	1.913	-3.44	-1.90
				2462	52.685	1.967	50.859	1.923	-3.47	-2.24

MEASURED TISSUE PARAMETERS										
Date(s)	**Tissue Type**	**Ambient Temp.[°C]**	**Liquid Temp.[°C]**	**Measured Frequency [MHz]**	**Target Dielectric Constant, εr**	**Target Conductivity, σ (S/m)**	**Measured Dielectric Constant, εr**	**Measured Conductivity, σ (S/m)**	**Er Deviation [%]**	**σ Deviation [%]**
Oct. 08. 2013	5 GHz Head	21.9	22.4	5200	36.000	4.660	36.892	4.703	2.48	0.92
				5210	35.980	4.667	36.879	4.716	2.50	1.05
				5300	35.900	4.760	36.705	4.818	2.24	1.22
				5500	35.600	4.960	36.359	5.055	2.13	1.92
				5600	35.500	5.070	36.178	5.176	1.91	2.09
				5800	35.300	5.270	35.803	5.415	1.42	2.75
Oct. 08. 2013	5 GHz Body	21.9	22.4	5200	49.000	5.300	48.382	5.194	-1.26	-2.00
				5210	48.980	5.312	48.366	5.207	-1.25	-1.98
				5300	48.900	5.420	48.210	5.327	-1.41	-1.72
				5500	48.600	5.650	47.854	5.597	-1.53	-0.94
				5600	48.500	5.770	47.663	5.734	-1.73	-0.62
				5800	48.200	6.000	47.326	6.014	-1.81	0.23
Oct. 10. 2013	5 GHz Head	22.0	22.5	5200	36.000	4.660	36.787	4.697	2.19	0.79
				5260	35.900	4.720	36.672	4.768	2.15	1.02
				5290	35.900	4.760	36.627	4.800	2.03	0.84
				5300	35.900	4.760	36.599	4.811	1.95	1.07
				5500	35.600	4.960	36.257	5.048	1.85	1.77
				5600	35.500	5.070	36.077	5.169	1.63	1.95
				5800	35.300	5.270	35.701	5.408	1.14	2.62
Oct. 10. 2013	5 GHz Body	22.0	22.5	5200	49.000	5.300	48.354	5.195	-1.32	-1.98
				5260	48.900	5.372	48.241	5.277	-1.35	-1.77
				5290	48.900	5.408	48.203	5.315	-1.43	-1.72
				5300	48.900	5.420	48.179	5.329	-1.47	-1.68
				5500	48.600	5.650	47.822	5.598	-1.60	-0.92
				5600	48.500	5.770	47.636	5.735	-1.78	-0.61
				5800	48.200	6.000	47.297	6.015	-1.87	0.25
Oct. 11. 2013	5 GHz Head	22.3	22.7	5200	36.000	4.660	35.336	4.507	-1.84	-3.28
				5300	35.900	4.760	35.167	4.621	-2.04	-2.92
				5500	35.600	4.960	34.838	4.852	-2.14	-2.18
				5530	35.570	4.991	34.774	4.888	-2.24	-2.06
				5600	35.500	5.070	34.662	4.971	-2.36	-1.95
				5700	35.400	5.170	34.481	5.087	-2.60	-1.61
				5800	35.300	5.270	34.305	5.202	-2.82	-1.29
Oct. 11. 2013	5 GHz Body	22.3	22.7	5200	49.000	5.300	48.401	5.197	-1.22	-1.94
				5300	48.900	5.420	48.230	5.331	-1.37	-1.64
				5500	48.600	5.650	47.873	5.600	-1.50	-0.88
				5530	48.570	5.686	47.808	5.644	-1.57	-0.74
				5600	48.500	5.770	47.685	5.738	-1.68	-0.55
				5700	48.300	5.880	47.517	5.874	-1.62	-0.10
				5800	48.200	6.000	47.351	6.019	-1.76	0.32

Tissue Verification Note:

Note: The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per IEEE 1528 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

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):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r'\varepsilon_0)^{1/2}\right]}{r} d\phi' d\rho' d\rho$$

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 $j = \sqrt{-1}$.

11.2 Test System Verification

Prior to assessment, the system is verified to the± 10 % of the specifications at 835 MHz, 1900 MHz, 2450 MHz and 5 GHz by using the SAR Dipole kit(s). (Graphic Plots Attached)

SYSTEM DIPOLE VERIFICATION TARGET & MEASURED												
SAR System #	Freq. [MHz]	SAR Dipole kits	Date(s)	Liquid	Ambient Temp.[°C]	Liquid Temp.[°C]	Probe S/N	Input Power (mW)	1 W Target SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	1 W Normalized SAR_{1g} (W/kg)	Deviation [%]
E	835	D835V2, SN:464	Sep. 28. 2013	Head	21.8	22.5	3930	250	9.40	2.40	9.60	2.13
E	835	D835V2, SN:464	Oct. 05. 2013	Body	22.1	22.4	3930	250	9.53	2.22	8.88	-6.82
E	835	D835V2, SN:464	Sep. 30. 2013	Head	22.2	22.4	3930	250	9.40	2.31	9.24	-1.70
E	835	D835V2, SN:464	Sep. 30. 2013	Body	22.2	22.4	3930	250	9.53	2.25	9.00	-5.56
E	1900	D1900V2, SN:5d029	Oct. 01. 2013	Head	22.4	22.6	3930	250	38.4	9.13	36.52	-4.90
E	1900	D1900V2, SN:5d029	Oct. 07. 2013	Body	21.8	22.1	3930	250	39.6	10.6	42.40	7.07
E	1900	D1900V2, SN:5d029	Oct. 02. 2013	Head	22.2	22.7	3930	250	38.4	8.92	35.68	-7.08
E	1900	D1900V2, SN:5d029	Oct. 02. 2013	Body	22.2	22.7	3930	250	39.6	9.26	37.04	-6.46
E	2450	D2450V2, SN:726	Oct. 04. 2013	Head	21.9	22.3	3930	250	52.0	12.6	50.40	-3.08
E	2450	D2450V2, SN:726	Oct. 04. 2013	Body	21.9	22.3	3930	250	50.2	12.4	49.60	-1.20
E	5200	D5GHzV2, SN: 1103	Oct. 08. 2013	Head	21.9	22.4	3930	100	81.1	7.70	77.00	-5.06
E	5300	D5GHzV2, SN: 1103					3930	100	82.5	8.54	85.40	3.52
E	5500	D5GHzV2, SN: 1103					3930	100	85.3	8.27	82.70	-3.05
E	5600	D5GHzV2, SN: 1103					3930	100	84.5	8.13	81.30	-3.79
E	5800	D5GHzV2, SN: 1103					3930	100	80.5	8.01	80.10	-0.50
E	5200	D5GHzV2, SN: 1103	Oct. 08. 2013	Body	21.9	22.4	3930	100	74.7	7.54	75.40	0.94
E	5300	D5GHzV2, SN: 1103					3930	100	76.0	7.57	75.70	-0.39
E	5500	D5GHzV2, SN: 1103					3930	100	80.0	8.10	81.00	1.25
E	5600	D5GHzV2, SN: 1103					3930	100	81.3	8.38	83.80	3.08
E	5800	D5GHzV2, SN: 1103					3930	100	75.5	7.98	79.80	5.70