



# SAR EVALUATION REPORT

For

**Maxon Electronics Australia Pty. Ltd.**

36A Gibson Avenue  
Padstow, NSW 2211, Australia

**FCC ID: Q2FMM-BP3USB**

**Model: MiniMax-USB3-8521**

<b>This Report Concerns:</b> <input checked="" type="checkbox"/> Original Report	<b>Equipment Type:</b> WCDMA/HSDPA 850MHz USB Data Modem
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<b>Report No.:</b>	R0610251-SAR
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## DECLARATION OF COMPLIANCE SAR EVALUATION

Rule Part(s):	CFR 47 2.1093
Test Procedure(s):	FCC OET 65C / IEEE1528 2003
Device Classification:	Licensed Transmitter
Device Type:	USB Data Modem
Modulation:	WCDMA/HSDPA 850 MHz
TX Frequency Range:	824-849 MHz
Max. Conducted Power Tested:	24.8 dBm (834.94 MHz)
Antenna Type(s):	Internal Antenna
Body-Worn Accessories:	None
Face-Head Accessories:	None
<b>Max. SAR Level(s) Measured: 0.747 w/kg (WCDMA/HDPA 850MHz)</b>	

BACL Corp. declares under its sole responsibility that this wireless portable device has been determined to be in compliance for localized specific absorption rate (SAR) for uncontrolled exposure and general population exposure limits specified in EN 50360:2001 and has been tested in accordance with the measurement procedures specified in ANSI IEEE C95.3:2002

All measurements reported herein were performed under my supervision and believed to be accurate to the best of my knowledge. I further attest for the completeness of these measurements and vouch for the qualifications any and all personnel performing such measurements.

The results and statements contained in this report pertain only to the device(s) evaluated.

/signature/



Eric Hong  
Bay Area Compliance Laboratory Corp.



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## REFERENCE, STANDARDS, AND GUILDELINEs

### FCC:

The Report and Order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 "Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

### CE:

The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 2 mW/g as recommended by the EN50360 for an uncontrolled environment. According to the Standard, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in Europe is 2 mW/g average over 10 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

There was no SAR of any concern measured on the device for any of the investigated configurations.

**SAR Limits :***FCC (1g tissue)*

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

*CE (10g tissue)*

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	2.0	10
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

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

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

Population/uncontrolled environments Spatial Peak limit 1.6 w/kg (FCC) & 2.0w/kg (CE) applied to the EUT.

## EUT DESCRIPTION

### Product Description for Equipment Under Test (EUT)

This Bay Area Compliance Laboratories Corp. test report has been prepared on behalf of Maxon Electronics Australia and their product, FCCID:Q2FMM-BP3USB or the EUT (Equipment Under Test) as referred to in the rest of this report. The EUT is an *850 MHz HSDPA USB modem* designed for use with laptop computers. Used in conjunction with included software, the EUT is a data signal transceiver operable from your computer's desktop. The features are listed as below:

- USB 2.0 compatibility
- Superior Range compared with WLAN
- Can be connected to external antenna
- Uses SIM card from GSM carrier

### Mechanical Description

The Maxon Electronics Australia product, FCCID: *FCC ID:Q2FMM-BP3USB*, or the "EUT" as referred to in this report, is a 850 MHz HSDPA USB modem which measures approximately *88 mmL x 31.5 mmW x 8.8 mmH*.

*\* The test data gathered are from typical production sample, serial number: 23100620 provided by the manufacturer.*

### EUT Photo



*Additional photos in Exhibit B*

## DESCRIPTION OF TEST SYSTEM

These measurements were performed with the automated near-field scanning system DASY4 from Schmid & Partner Engineering AG (SPEAG) which is the fourth generation of the system shown in the figure hereinafter:



The system is based on a high precision robot (working range greater than 0.9m), which positions the probes with a positional repeatability of better than  $\pm 0.02\text{mm}$ . Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The SAR measurements were conducted with the dosimetric probe ET3DV6 SN: 1604 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure and found to be better than  $\pm 0.25\text{dB}$ .

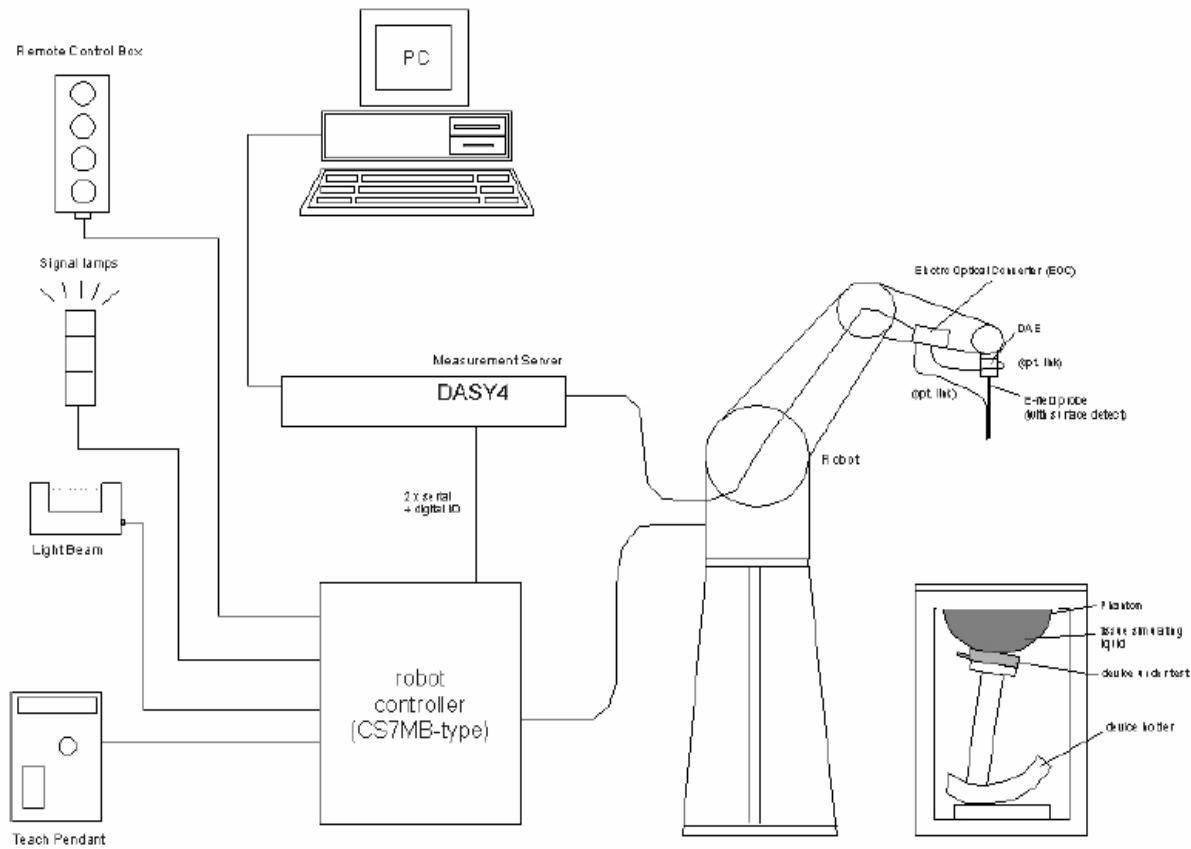
The phantom used was the Generic Twin Phantom". The ear was simulated as a spacer of 4 mm thickness between the earpiece of the phone and the tissue simulating liquid. The Tissue simulation liquid used for each test is in according with the FCC OET65 supplement C as listed below.

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

#### IEEE SCC-34/SC-2 P1528 Recommended Tissue Dielectric Parameters

Frequency (MHz)	Head		Body	
	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

## Measurement System Diagram



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

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.

- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

## System Components

- DASY4 Measurement Server
- Data Acquisition Electronics
- Probes
- Light Beam Unit
- Medium
- SAM Twin Phantom
- Device Holder for SAM Twin Phantom
- System Validation Kits
- Robot

## DASY4 Measurement Server

The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE4 (or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 I/O-board, which is directly connected to the PC/104 bus of the CPU board.



The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server.

## Data Acquisition Electronics

The data acquisition electronics DAE3 consists of a highly sensitive electrometergrade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.



## Probes

The DASY system can support many different probe types.

**Dosimetric Probes:** These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor ( $\pm 2$  dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

**Free Space Probes:** These are electric and magnetic field probes specially designed for measurements in free space. The z-sensor is aligned to the probe axis and the rotation angle of the x-sensor is specified. This allows the DASY system to automatically align the probe to the measurement grid for field component measurement. The free space probes are generally not calibrated in liquid. (The H-field probes can be used in liquids without any change of parameters.)

**Temperature Probes:** Small and sensitive temperature probes for general use. They use a completely different parameter set and different evaluation procedures. Temperature rise features allow direct SAR evaluations with these probes.

### ET3DV6 Probe Specification

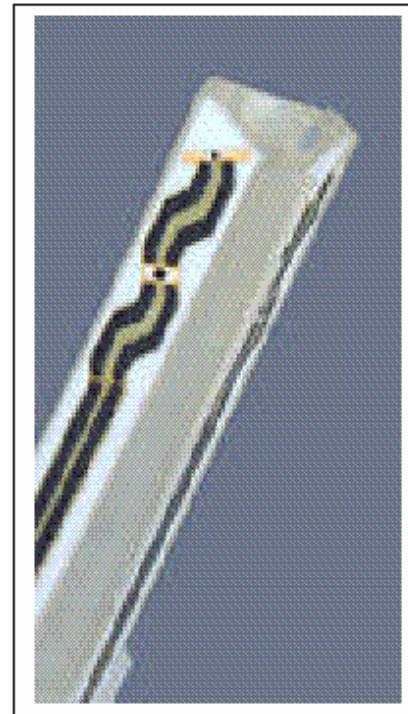
Construction Symmetrical design with triangular core  
 Built-in optical fiber for surface detection System  
 Built-in shielding against static charges  
 Calibration In air from 10 MHz to 2.5 GHz  
 In brain and muscle simulating tissue at  
 Frequencies of 450 MHz, 900 MHz and  
 1.8 GHz (accuracy  $\pm 8\%$ )  
 Frequency 10 MHz to  $> 6$  GHz; Linearity:  $\pm 0.2$  dB  
 (30 MHz to 3 GHz)  
 Directivity  $\pm 0.2$  dB in brain tissue (rotation around  
 probe axis)  
 $\pm 0.4$  dB in brain tissue (rotation normal probe axis)  
 Dynamic 5 mW/g to  $> 100$  mW/g;  
 Range Linearity:  $\pm 0.2$  dB  
 Surface  $\pm 0.2$  mm repeatability in air and clear liquids  
 Detection over diffuse reflecting surfaces.  
 Dimensions Overall length: 330 mm  
 Tip length: 16 mm



Photograph of the probe

Body diameter: 12 mm  
 Tip diameter: 6.8 mm  
 Distance from probe tip to dipole centers: 2.7 mm  
 Application General dosimetric up to 3 GHz  
 Compliance tests of mobile phones  
 Fast automatic scanning in arbitrary phantoms

The SAR measurements were conducted with the dosimetric probe ET3DV6 designed in the classical triangular configuration 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 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 DASY3 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.



**Inside view of  
ET3DV6 E-field Probe**

### **E-Field Probe Calibration Process**

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] 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 are tested.

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 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 then rotated 360 degrees.

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 dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

### **Data Evaluation**

The DASY4 postprocessing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	dcp1

Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	$\sigma$
	- Density	$\rho$

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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 as:

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

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:

$$E - \text{fieldprobes} : \quad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H - \text{fieldprobes} : \quad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $Norm_i$  = sensor sensitivity of channel i (i = x, y, z)  
 $\mu\text{V}/(\text{V}/\text{m})^2$  for E-field probes  
 $ConvF$  = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
 $f$  = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = diode compression point (DASY parameter)

The RSS value of the field components gives the total field strength (Hermitian 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.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

With    SAR = local specific absorption rate in mW/g  
E<sub>tot</sub> = total field strength in V/m  
σ = conductivity in [mho/m] or [Siemens/m]  
ρ = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is normally set to 1, to account for actual brain density rather than the density of the simulation liquid.

## Light Beam Unit

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

## Medium

### Parameters

The parameters of the tissue simulating liquid strongly influence the SAR in the liquid. The parameters for the different frequencies are defined in the corresponding compliance standards (e.g., EN 50361, IEEE 1528-2003).

### Parameter measurements

Several measurement systems are available for measuring the dielectric parameters of liquids:

- The open coax test method (e.g., HP85070 dielectric probe kit) is easy to use, but has only moderate accuracy. It is calibrated with open, short, and deionized water and the calibrations a critical process.
- The transmission line method (e.g., model 1500T from DAMASKOS, INC.) measures the transmission and reflection in a liquid filled high precision line. It needs standard two port calibration and is probably more accurate than the open coax method.
- The reflection line method measures the reflection in a liquid filled shorted precision line. The method is not suitable for these liquids because of its low sensitivity.
- The slotted line method scans the field magnitude and phase along a liquid filled line. The evaluation is straight forward and only needs a simple response calibration. The method is very accurate, but can only be used in high loss liquids and at frequencies above 100 to 200MHz. Cleaning the line can be tedious.

## SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left hand
- Right hand
- Flat phantom

The phantom table comes in two sizes: A 100 x 50 x 85 cm (L x W x H) table for use with free standing robots (DASY4 professional system option) or as a second phantom and a 100 x 75 x 85 cm (L x W x H) table with reinforcements for table mounted robots (DASY4 compact system option).

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is necessary if two phantoms are used (e.g., for different liquids) A white cover is provided to tap the phantom during  $\sigma$ -periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.



The phantom can be used with the following tissue simulating liquids:

- Water-sugar based liquids can be left permanently in the phantom. Always cover the liquid if the system is not used, otherwise the parameters will change due to water evaporation.
- Glycol based liquids should be used with care. As glycol is a softener for most plastics, the liquid should be taken out of the phantom and the phantom should be dried when the system is not used (desirable at least once a week).
- Do not use other organic solvents without previously testing the phantom resistiveness.

## Device Holder for SAM Twin Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source in 5mm distance, a positioning uncertainty of  $\pm 0.5\text{mm}$  would produce a SAR uncertainty of  $\pm 20\%$ . An accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions, in which the devices must be measured, are defined by the standards.

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



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

## System Validation Kits

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. For that purpose a well defined SAR distribution in the flat section of the SAM twin phantom is produced.

System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder. Dipoles are available for the variety of frequencies between 300MHz and 6 GHz (dipoles for other frequencies or media and other calibration conditions are available upon request).

The dipoles are highly symmetric and matched at the center frequency for the specified liquid and distance to the flat phantom (or flat section of the SAM-twin phantom). The accurate distance between the liquid surface and the dipole center is achieved with a distance holder that snaps on the dipole.

## Robot

The DASY4 system uses the high precision industrial robots RX60L, RX90 and RX90L, as well as the RX60BL and RX90BL types out of the newer series from Staubli SA (France). The RX robot series offers many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance-free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (the closed metallic construction shields against motor control fields)

For the newly delivered DASY4 systems as well as for the older DASY3 systems delivered since 1999, the CS7MB robot controller version from Staubli is used. Previously delivered systems have either a CS7 or CS7M controller; the differences to the CS7MB are mainly in the hardware, but some procedures in the robot software from Staubli are also not completely the same. The following descriptions about robot hard- and software correspond to CS7MB controller with software version 13.1 (edit S5). The actual commands, procedures and configurations, also including details in hardware, might differ if an older robot controller is in use. In this case please also refer to the Staubli manuals for further information.



## TESTING EQUIPMENT

### Equipments List & Calibration Info

Type / Model	Cal. Due Date	S/N:
DASY4 Professional Dosimetric System	N/A	N/A
Robot RX60L	N/A	CS7MBSP / 467
Robot Controller	N/A	F01/5J72A1/A/01
Dell Computer Demension 3000	N/A	N/A
SPEAG EDC3	N/A	N/A
SPEAG DAE3	2006-10-18*	456
DASY4 Measurement Server	N/A	1176
SPEAG E-Field Probe ET3DV6	2007-5-2	1604
Antenna, Dipole, D900V2	2007-6-16	122
Antenna, Diapole, D-1800-S-1	2007-6-28	BCL-049
SPEAG Generic Twin Phantom	N/A	N/A
SPEAG Light Alignment Sensor	N/A	278
Brain Equivalent Matter (900/1800MHz)	N/A	N/A
Muscle Equivalent Matter (900/1800MHz)	N/A	N/A
Robot Table	N/A	N/A
Phone Holder	N/A	N/A
Phantom Cover	N/A	N/A
Agilent, Spectrum Analyzer 8565EC	2007-11-6	2240A01930
Microwave Amp. 8349A	N/A	2644A02662
Power Meter Agilent E4419B	2007-9-13	MY4121511
Power Sensor Agilent E4412A	2007-10-12	MY41497252
Agilent, Wireless Communications Test Set 8960 Series 10	2007-8-8	E5515C
Dielectric Probe Kit HP85070A	N/A	US99360201
HP, Microwave Frequency Counter 5342A	2006-12-12	2232A06383
Amplifier, ST181-20	N/A	E012-0101
Antenna, Horn SAS-200/571	2007-4-20	A052704

\*Please see speag Evaluation Report featured the Appendix of this test report for verification of calibration succeeding the listed due date.

## SAR MEASUREMENT SYSTEM VERIFICATION

### System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 10\%$ . The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

#### IEEE P1528 recommended reference value for head

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (above feed point)	Local SAR at surface (v=2cm offset from feed point)
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	14.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2000	41.1	21.1	74.6	6.5
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

#### Validation Dipole SAR Reference Test Result for Body (835 MHz)

Validation Measurement	SAR @ 1W Input averaged over 1g	SAR @ 1W Input averaged over 10g
Test 1	7.71	4.91
Test 2	7.98	5.08
Test 3	7.94	5.09
Test 4	7.98	5.06
Test 5	7.84	5.08
Test 6	7.71	4.91
Test 7	7.71	5.08
Test 8	7.97	5.09
Test 9	7.95	5.06
Test 10	7.84	5.01
Average	7.86	5.04

## EUT TEST STRATEGY AND METHODOLOGY

### SAR Evaluation Procedure

The evaluation was performed with the following procedure:

**Step 1:** Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop.

**Step 2:** The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 20 mm x 20 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

**Step 3:** Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

1. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm [11]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
2. The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three onedimensional splines with the "Not a knot"-condition (in x, y and z-directions) [11], [12]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
3. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

**Step 4:** Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

## CONCLUSION

This page summarizes the results of the performed dosimetric evaluation. The plots with the corresponding SAR distributions, which reveal information about the location of the maximum SAR with respect to the device could be found in Appendix E.

### SAR Test Data

#### Environmental Conditions

Ambient Temperature:	21° C
Relative Humidity:	70%
ATM Pressure:	1022 mbar

\* Testing was performed by Eric Hong on 2006-10-.

EUT position	Freq (MHz)	Output Power (mw)*	Phantom	Measured (mW/1g)	Limit (mw/1g)	Plot #
Dell Laptop with DUT Back touching to the flat phantom	834.94	302	Flat	0.659	1.6	1
IBM Laptop with DUT Back touching to the flat phantom	834.94	302	Flat	0.747	1.6	2
Acer Laptop with DUT Back touching to the flat phantom	834.94	302	Flat	0.708	1.6	3

Note: \*TX PDM Set at 333 for the Output Power

## APPENDIX A – MEASUREMENT UNCERTAINTY

The uncertainty budget has been determined for the DASY4 measurement system and is given in the following Table.

### DASY4 Uncertainty Budget According to IEEE 1528 [1]

Error Description	Uncertainty value	Prob. Dist.	Div.	$(c_i)$ 1g	$(c_i)$ 10g	Std. Unc. (1g)	Std. Unc. (10g)	$(v_i)$ $v_{eff}$
<b>Measurement System</b>								
Probe Calibration	±5.9 %	N	1	1	1	±5.9 %	±5.9 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
<b>Test Sample Related</b>								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
<b>Phantom and Setup</b>								
Phantom Uncertainty	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Liquid Conductivity (target)	±5.0 %	R	$\sqrt{3}$	0.64	0.43	±1.8 %	±1.2 %	∞
Liquid Conductivity (meas.)	±2.5 %	N	1	0.64	0.43	±1.6 %	±1.1 %	∞
Liquid Permittivity (target)	±5.0 %	R	$\sqrt{3}$	0.6	0.49	±1.7 %	±1.4 %	∞
Liquid Permittivity (meas.)	±2.5 %	N	1	0.6	0.49	±1.5 %	±1.2 %	∞
Combined Std. Uncertainty						±10.8 %	±10.6 %	330
Expanded STD Uncertainty						±21.6 %	±21.1 %	

**DASY4 Uncertainty Budget**  
According to CENELEC EN 50361 [2]

Error Description	Uncertainty value	Prob. Dist.	Div.	$(c_i)$ 1g	$(c_i)$ 10g	Std. Unc. (1g)	Std. Unc. (10g)	$(v_i)$ $v_{eff}$
<b>Measurement Equipment</b>								
Probe Calibration	$\pm 5.9\%$	N	1	1	1	$\pm 5.9\%$	$\pm 5.9\%$	$\infty$
Axial Isotropy	$\pm 4.7\%$	R	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	$\infty$
Spherical Isotropy	$\pm 9.6\%$	R	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	$\infty$
Probe Linearity	$\pm 4.7\%$	R	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
Detection Limit	$\pm 1.0\%$	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Boundary Effects	$\pm 1.0\%$	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Readout Electronics	$\pm 0.3\%$	N	1	1	1	$\pm 0.3\%$	$\pm 0.3\%$	$\infty$
Response Time	$\pm 0.8\%$	N	1	1	1	$\pm 0.8\%$	$\pm 0.8\%$	$\infty$
Noise	$\pm 0\%$	N	1	1	1	$\pm 0\%$	$\pm 0\%$	$\infty$
Integration Time	$\pm 2.6\%$	N	1	1	1	$\pm 2.6\%$	$\pm 2.6\%$	$\infty$
<b>Mechanical Constraints</b>								
Scanning System	$\pm 0.4\%$	R	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	$\infty$
Phantom Shell	$\pm 4.0\%$	R	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	$\infty$
Probe Positioning	$\pm 2.9\%$	R	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
Device Positioning	$\pm 2.9\%$	N	1	1	1	$\pm 2.9\%$	$\pm 2.9\%$	145
<b>Physical Parameters</b>								
Liquid Conductivity (target)	$\pm 5.0\%$	R	$\sqrt{3}$	0.7	0.5	$\pm 2.0\%$	$\pm 1.4\%$	$\infty$
Liquid Conductivity (meas.)	$\pm 4.3\%$	R	$\sqrt{3}$	0.7	0.5	$\pm 1.7\%$	$\pm 1.2\%$	$\infty$
Liquid Permittivity (target)	$\pm 5.0\%$	R	$\sqrt{3}$	0.6	0.5	$\pm 1.7\%$	$\pm 1.4\%$	$\infty$
Liquid Permittivity (meas.)	$\pm 4.3\%$	R	$\sqrt{3}$	0.6	0.5	$\pm 1.5\%$	$\pm 1.2\%$	$\infty$
Power Drift	$\pm 5.0\%$	R	$\sqrt{3}$	1	1	$\pm 2.9\%$	$\pm 2.9\%$	$\infty$
RF Ambient Conditions	$\pm 3.0\%$	R	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
<b>Post-Processing</b>								
Extrap. and Integration	$\pm 1.0\%$	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Combined Std. Uncertainty						$\pm 10.9\%$	$\pm 10.6\%$	18125
<b>Expanded Std. Uncertainty</b>						<b><math>\pm 21.7\%</math></b>	<b><math>\pm 12.1\%</math></b>	