

6.5 Phantom Properties (Size, Shape, Shell Thickness)

The phantom used during the validations was the SAM Phantom model: TP - 1260 from SPEAG. It is a phantom with a single thickness of 2 mm and was filled with the required tissue simulating liquid. The SAM phantom support structures were all non-metallic and spaced more than one device width away in transverse directions.

For SAR testing in the body worn positions an AndreT Flat phantom P 10.1 was used. The phantom thickness is 2.0mm \pm 0.2 mm and was filled with the required tissue simulating liquid. Table below provides a summary of the measured phantom properties. *Refer to Appendix C Part 4, for details of P 10.1 phantom dielectric properties and loss tangent.*

Table: Phantom Properties

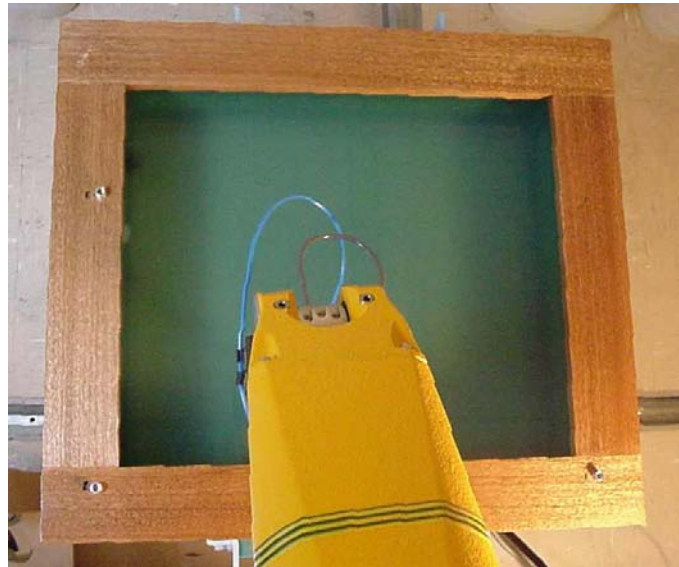
Phantom Properties	Required	Measured
Thickness of flat section	2.0mm \pm 0.2mm (bottom section)	2.12-2.20mm
Dielectric Constant	<5.0	4.603 @ 300MHz (worst-case frequency)
Loss Tangent	<0.05	0.0379 @ 2500MHz (worst-case frequency)

Depth of Phantom	200mm
Length of Flat Section	620mm
Width of Flat Section	540mm

P 10.1 Flat Phantom



P 10.1 Flat Phantom



6.6 Tissue Material Properties

The dielectric parameters of the brain simulating liquid were measured prior to SAR assessment using the HP85070A dielectric probe kit and HP8753ES Network Analyser. The actual dielectric parameters are shown in the following table.

Table: Measured Brain Simulating Liquid Dielectric Values for Validations

Frequency Band	ϵ_r (measured range)	ϵ_r (target)	σ (mho/m) (measured range)	σ (target)	ρ kg/m ³
5200 MHz Brain	36.8	36.0 \pm 5% (34.2 to 37.8)	4.75	4.76 \pm 5% (4.43 to 4.90)	1000
5800 MHz Brain	35.4	35.3 \pm 5% (33.5 to 37.1)	5.31	5.27 \pm 5% (5.01 to 5.53)	1000

NOTE: The brain liquid parameters were within the required tolerances of \pm 5%.

Table: Measured Body Simulating Liquid Dielectric Values for 5200MHz range

Frequency Band	ϵ_r (measured range)	ϵ_r (target)	σ (mho/m) (measured range)	σ (target)	ρ kg/m ³
5180 MHz Muscle	49.0	49.0 \pm 10% (44.1 to 53.9)	5.30	5.3 \pm 10% (4.77 to 5.83)	1000
5260 MHz Muscle	49.0	48.9 \pm 10% (44.01 to 53.8)	5.54	5.4 \pm 10% (4.86 to 5.94)	1000
5320 MHz Muscle	48.6	48.8 \pm 10% (43.9 to 55.3)	5.65	5.4 \pm 10% (4.86 to 5.94)	1000

Table: Measured Body Simulating Liquid Dielectric Values for 5800MHz range

Frequency Band	ϵ_r (measured range)	ϵ_r (target)	σ (mho/m) (measured range)	σ (target)	ρ kg/m ³
5745 MHz Muscle	47.9	48.3 \pm 10% (43.47 to 53.13)	6.26	5.9 \pm 10% (5.31 to 6.49)	1000
5785 MHz Muscle	47.8	48.2 \pm 10% (43.38 to 53.02)	6.22	6.0 \pm 10% (5.4 to 6.60)	1000
5825 MHz Muscle	47.3	48.2 \pm 10% (43.38 to 53.02)	6.32	6.0 \pm 10% (5.4 to 6.60)	1000

NOTE: The muscle liquid parameters were within the required tolerances of \pm 10%.



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6.6.1 Liquid Temperature and Humidity

The humidity and dielectric/ambient temperatures were recorded during the assessment of the tissue material dielectric parameters. The difference between the ambient temperature of the liquid during the dielectric measurement and the temperature during tests was less than $|2|^\circ\text{C}$.

Table: Temperature and Humidity recorded for each day

Date	Ambient Temperature ($^\circ\text{C}$)	Liquid Temperature ($^\circ\text{C}$)	Humidity (%)
5 th Dec 07	21.8	21.1	59.0
6 th Dec 07	21.6	21.0	61.0

6.7 Simulated Tissue Composition Used for SAR Test

A low loss clamp was used to position the Tablet underneath the phantom surface. Small pieces of foam were then used to press the Tablet flush against the phantom surface.

Table: Tissue Type: Muscle @ 5600MHz

Volume of Liquid: 60 Litres

EMCT Liquid

Composition
Distilled Water
Salt
Triton X-100

6.8 Device Holder for Laptops and P 10.1 Phantom

A low loss clamp was used to position the Laptop underneath the phantom surface. Small pieces of foam were then used to press the laptop flush against the phantom surface.

Refer to Appendix A for photographs of device positioning



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7.0 SAR MEASUREMENT PROCEDURE USING DASY4

The SAR evaluation was performed with the SPEAG DASY4 system. A summary of the procedure follows:

- a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test, and then again at the end of the test.
- b) The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.0 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm. The actual Area Scan has dimensions of 51 mm x 131 mm surrounding the test device. Based on this data, the area of the maximum absorption is determined by Spline interpolation.
- c) Around this point, a volume of 30 mm x 30 mm x 24 mm is assessed by measuring 7 x 7 x 8 points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:
 - (i) The data at the surface are extrapolated, since the centre of the dipoles is 1.0 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 2.0 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.
 - (ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the "Not a knot"- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.
 - (iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.
 - (iv) The SAR value at the same location as in Step (a) is again measured to evaluate the actual power drift.



8.0 MEASUREMENT UNCERTAINTY

The uncertainty analysis is based on the template listed in the IEEE Std 1528-2003 for both Handset SAR tests and Validation uncertainty. The measurement uncertainty of a specific device is evaluated independently.

Table: Uncertainty Budget for DASY4 Version V4.7 Build 53 – EUT SAR test 5GHz

a	b	c	d	e= f(d,k)	f	g	h=cxf/e	i=cxg/e	k
Uncertainty Component	Sec.	Tol. (%)	Prob. Dist.	Div.	C _i (1g)	C _i (10g)	1g u _i (%)	10g u _i (%)	v _i
Measurement System									
Probe Calibration (k=1) (numerical calibration)	E.2.1	6.8	N	1	1	1	6.8	6.8	∞
Axial Isotropy	E.2.2	4.7	R	1.73	0.707	0.707	1.9	1.9	∞
Hemispherical Isotropy	E.2.2	9.6	R	1.73	0.707	0.707	3.9	3.9	∞
Boundary Effect	E.2.3	2	R	1.73	1	1	1.2	1.2	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	1	N	1	1	1	1.0	1.0	∞
Response Time	E.2.7	0.8	R	1.73	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.73	1	1	1.5	1.5	∞
RF Ambient Conditions	E.6.1	0.075	R	1.73	1	1	0.0	0.0	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.73	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	E.6.3	5.7	R	1.73	1	1	3.3	3.3	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E.5	4	R	1.73	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E.4.2	2.9	N	1	1	1	2.9	2.9	11
Device Holder Uncertainty	E.4.1	3.6	N	1	1	1	3.6	3.6	7
Output Power Variation – SAR Drift Measurement	6.6.2	11.6	R	1.73	1	1	6.7	6.7	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity – Deviation from target values	E.3.2	10	R	1.73	0.64	0.43	3.7	2.5	∞
Liquid Conductivity – Measurement uncertainty	E.3.3	2.5	N	1	0.64	0.43	1.6	1.1	5
Liquid Permittivity – Deviation from target values	E.3.2	10	R	1.73	0.6	0.49	3.5	2.8	∞
Liquid Permittivity – Measurement uncertainty	E.3.3	2.5	N	1	0.6	0.49	1.5	1.2	5
Combined standard Uncertainty			RSS				14.0	13.5	154
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				28.0	27.02	

Estimated total measurement uncertainty for the DASY4 measurement system was $\pm 14\%$. The extended uncertainty ($K = 2$) was assessed to be $\pm 28\%$ based on 95% confidence level. The uncertainty is not added to the measurement result.



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Table: Uncertainty Budget for DASY4 Version V4.7 Build 53 – Validation 5GHz

a	b	c	d	e= f(d,k)	f	g	h=cxf/e	i=cxg/e	k
Uncertainty Component	Sec.	Tol. (%)	Prob. Dist.	Div.	C _i (1g)	C _i (10g)	1g u _i (%)	10g u _i (%)	v _i
Measurement System									
Probe Calibration (k=1) (standard calibration)	E.2.1	6.6	N	1	1	1	6.6	6.6	∞
Axial Isotropy	E.2.2	4.7	R	1.73	1	1	2.7	2.7	∞
Hemispherical Isotropy	E.2.2	0	R	1.73	1	1	0.0	0.0	∞
Boundary Effect	E.2.3	2	R	1.73	1	1	1.2	1.2	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	1	N	1	1	1	1.0	1.0	∞
Response Time	E.2.7	0	R	1.73	1	1	0.0	0.0	∞
Integration Time	E.2.8	0	R	1.73	1	1	0.0	0.0	∞
RF Ambient Conditions	E.6.1	0.075	R	1.73	1	1	0.0	0.0	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.73	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	E.6.3	5.7	R	1.73	1	1	3.3	3.3	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E.5	4	R	1.73	1	1	2.3	2.3	∞
Test Sample Related									
Dipole Axis to Liquid distance	E.4.2	2	N	1	1	1	2.0	2.0	11
Output Power Variation – SAR Drift Measurement	6.6.2	4.7	R	1.73	1	1	2.7	2.7	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity – Deviation from target values	E.3.2	5	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity – Measurement uncertainty	E.3.3	2.5	N	1	0.64	0.43	1.6	1.1	5
Liquid Permittivity – Deviation from target values	E.3.2	5	R	1.73	0.6	0.49	1.7	1.4	∞
Liquid Permittivity – Measurement uncertainty	E.3.3	2.5	N	1	0.6	0.49	1.5	1.2	5
Combined standard Uncertainty			RSS				10.3	10.0	154
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				20.5	20.02	

Estimated total measurement uncertainty for the DASY4 measurement system was $\pm 10.3\%$. The extended uncertainty ($K = 2$) was assessed to be $\pm 20.5\%$ based on 95% confidence level. The uncertainty is not added to the measurement result.



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9.0 EQUIPMENT LIST AND CALIBRATION DETAILS

Table: SPEAG DASY4 Version V4.7 Build 53

Equipment Type	Manufacturer	Model Number	Serial Number	Calibration Due	Used For this Test?
Robot - Six Axes	Staubli	RX90BL	N/A	Not Applicable	Yes
Robot Remote Control	SPEAG	CS7MB	RX90B	Not Applicable	Yes
SAM Phantom	SPEAG	N/A	1260	Not Applicable	Yes
SAM Phantom	SPEAG	N/A	1060	Not Applicable	No
Flat Phantom	AndreT	10.1	P 10.1	Not Applicable	Yes
Flat Phantom	AndreT	9.1	P 9.1	Not Applicable	No
Flat Phantom	SPEAG	PO1A 6mm	1003	Not Applicable	No
Data Acquisition Electronics	SPEAG	DAE3 V1	359	12-July-2007	Yes
Data Acquisition Electronics	SPEAG	DAE3 V1	442	13-Aug-2007	No
Probe E-Field - Dummy	SPEAG	DP1	N/A	Not Applicable	No
Probe E-Field	SPEAG	ET3DV6	1380	12-Dec-2007	No
Probe E-Field	SPEAG	ET3DV6	1377	14-July-2007	No
Probe E-Field	SPEAG	ES3DV6	3029	Not Used	No
Probe E-Field	SPEAG	EX3DV4	3563	14-July-2007	Yes
Antenna Dipole 300 MHz	SPEAG	D300V2	1005	26-Oct-2007	No
Antenna Dipole 450 MHz	SPEAG	D450V2	1009	14-Dec-2008	No
Antenna Dipole 900 MHz	SPEAG	D900V2	047	6-July-2008	No
Antenna Dipole 1640 MHz	SPEAG	D1640V2	314	30-June-2008	No
Antenna Dipole 1800 MHz	SPEAG	D1800V2	242	3-July-2008	No
Antenna Dipole 1950 MHz	SPEAG	D1950V3	1113	5-March-2009	No
Antenna Dipole 2450 MHz	SPEAG	D2450V2	724	13-Dec-2008	No
Antenna Dipole 3500 MHz	SPEAG	D3500V2	1002	1-July-2007	No
Antenna Dipole 5600 MHz	SPEAG	D5GHzV2	1008	27-Oct-2007	Yes
RF Amplifier	EIN	603L	N/A	Not Applicable	No
RF Amplifier	Mini-Circuits	ZHL-42	N/A	Not Applicable	No
RF Amplifier	Mini-Circuits	ZVE-8G	N/A	Not Applicable	Yes
Synthesized signal generator	Hewlett Packard	ESG-D3000A	GB37420238	*In Test	No
RF Power Meter Dual	Hewlett Packard	437B	3125012786	30-May-2007	Yes
RF Power Sensor 0.01 - 18 GHz	Hewlett Packard	8481H	1545A01634	30-May-2007	Yes
RF Power Meter Dual	Gigatronics	8542B	1830125	18-April-2007	Yes
RF Power Sensor	Gigatronics	80301A	1828805	18-April-2007	Yes
RF Power Meter Dual	Hewlett Packard	435A	1733A05847	*In Test	Yes
RF Power Sensor	Hewlett Packard	8482A	2349A10114	*In Test	Yes
Network Analyser	Hewlett Packard	8714B	GB3510035	31-Aug-2007	No
Network Analyser	Hewlett Packard	8753ES	JP39240130	02-Oct-2008	Yes
Dual Directional Coupler	Hewlett Packard	778D	1144 04700	*In Test	No
Dual Directional Coupler	NARDA	3022	75453	*In Test	Yes

* Calibrated during the test for the relevant parameters.



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10.0 OET BULLETIN 65 – SUPPLEMENT C TEST METHOD

Notebooks should be evaluated in normal use positions, typical for lap-held bottom-face only. However the number of positions will depend on the number of configurations the laptop can be operated in. The “RYUGA” can be used in either a conventional laptop position (see Appendix A1) or a Tablet configuration. The antenna location in the “RYUGA” is closest to the top of the screen when used in a conventional laptop configuration and due to the separation distances involved between the phantom and the laptop antenna, testing is not required in this position.

10.1 Positions

10.1.1 “Edge On” Position Definition (0mm spacing)

The device was tested in the (2.00 mm) flat section of the AndreT phantom for the “Edge On” position. The Antenna edge of the Transceiver was placed underneath the flat section of the phantom and suspended until the edge touched the phantom. *Refer to Appendix A for photos of measurement positions.*

10.2 List of All Test Cases (Antenna In/Out, Test Frequencies, User Modes)

The device has a fixed antenna. Depending on the measured SAR level up to three test channels with the test sample operating at maximum power, as specified in section 4.0 were recorded. The following table represents the matrix used to determine what testing was required. The worst case result was verified with the Bluetooth transmitting at full power in co-transmission with the WLAN.

Table: Testing configurations

Phantom Configuration	*Device Mode	Antenna	Test Configurations		
			Channel (Low)	Channel (Middle)	Channel (High)
Edge On	OFDM 5.2GHz	A		X	
	OFDM 5.8GHz	A		X	

Legend

X	Testing Required in this configuration
	Testing required in this configuration only if SAR of middle channel is more than 3dB below the SAR limit or it is the worst case.

10.3 FCC RF Exposure Limits for Occupational/ Controlled Exposure

Spatial Peak SAR Limits For:

Partial-Body:	8.0 mW/g (averaged over any 1g cube of tissue)
Hands, Wrists, Feet and Ankles:	20.0 mW/g (averaged over 10g cube of tissue)

10.4 FCC RF Exposure Limits for Un-controlled/Non-occupational

Spatial Peak SAR Limits For:

Partial-Body:	1.6 mW/g (averaged over any 1g cube of tissue)
Hands, Wrists, Feet and Ankles:	4.0 mW/g (averaged over 10g cube of tissue)



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11.0 SAR MEASUREMENT RESULTS

The SAR values averaged over 1g tissue masses were determined for the sample device for all test configurations listed in section 7.2.

11.1 GHz Band SAR Results

Table: SAR MEASUREMENT RESULTS Lower Band – OFDM Mode

Test Position	Plot No.	Ant	Bit rate Mode (Mbps)	Channel Bandwidth (MHz)	Test Channel	Test Freq (MHz)	Measured 1g SAR Results (mW/g)	Measured Drift (dB)
Edge On	1	A	6	-	36	5180	0.04	-0.45
	2	A	6	-	52	5240	0.04	0.17
	3	A	6	-	64	5320	0.05	0.44
Edge On w/ Extended Battery	4	A	6	-	64	5320	0.06	-0.39
Edge On with Bluetooth On	5	A	6	-	64	5320	0.02	0.48

NOTE: The measurement uncertainty of 28% for 5GHz testing is not added to the result.

*This plot was used for identifying the “hotspot” only.

The highest SAR level recorded in the 5.2 GHz band was 0.06 mW/g as evaluated in a 1g cube of averaging mass. This value was obtained in Edge On position with extended battery in OFDM mode, utilizing channel 64 (5320MHz) and antenna A. The Bluetooth was ON at the Frequency of 2441 MHz.

Table: SAR MEASUREMENT RESULTS Upper Band – OFDM Mode

Test Position	Plot No.	Ant	Bit rate Mode (Mbps)	Channel Bandwidth (MHz)	Test Channel	Test Freq (MHz)	Measured 1g SAR Results (mW/g)	Measured Drift (dB)
Edge On	6	A	6	-	149	5745	0.12	0.47
	7	A	6	-	157	5785	0.12	0.16
	8	A	6	-	165	5805	0.11	0.43
Edge On w/ Extended Battery	9	A	6	-	157	5785	0.03	-0.03
Edge On with Bluetooth On	10	A	6	-	157	5785	0.12	-0.20

NOTE: The measurement uncertainty of 28% for 5GHz testing is not added to the result.

*This plot was used for identifying the “hotspot” only.

The highest SAR level recorded in the 5.8 GHz band was 0.12 mW/g as evaluated in a 1g cube of averaging mass. This value was obtained in Edge On position in OFDM mode, utilizing channel 157 (5785MHz) and antenna A. The Bluetooth was ON at the Frequency of 2441 MHz.



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12.0 COMPLIANCE STATEMENT

The Fujitsu Tablet PC, Model: P1620 with INTEL Mini-PCI Wireless LAN Module (ATHEROS 802.11a/b/g/n), Model: AR5BxB6 & TAIYO YUDEN Bluetooth Module, Model: EYTF3CS FT was found to comply with the FCC and RSS-102 SAR requirements.

The highest SAR level recorded was 0.12 mW/g for a 1g cube. This value was measured at 5785 MHz (channel 157) in the “Edge On” position in OFDM modulation mode at the antenna A. The Bluetooth was ON at the Frequency of 2441 MHz. This was below the limit of 1.6 mW/g for uncontrolled exposure, even taking into account the measurement uncertainty of 28 %.



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APPENDIX A1 TEST SAMPLE PHOTOGRAPHS

P1620 Host - Conventional Laptop Configuration



P1620 Host - Tablet Front



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APPENDIX A2 TEST SAMPLE PHOTOGRAPHS

Battery 1



Battery 2



Model: AR5BxB6 – WLAN Module



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