Re: FCC ID AUIGMRS1100B
Applicant: Musical Electronics Ltd
Correspondence Reference Number: 24419
731 Confirmation Number: EA542660
Date of Original E-Mail: 11/22/2002

Subject: SAR

In regards to your recent application referenced above we kindly request that you provide the following additional information.

With reference to the FCC E-mail dated 22 Nov 02, following are the responses (in blue).

1) New SAR values and data as follows. The FCC believes the SAR tests performed contain factors that significantly increase measurement uncertainty. Primarily, the large power droop in the device under test produces a dynamic SAR distribution. The SAR measurement system used appears to assume a constant distribution. We suggest that the measured SAR values be scaled up by the drift to establish a conservative SAR value.

To determine the extent of the problem and to optimize SAR measurement please provide support data including power vs time plot, and time length of SAR measurements.

Response: The time length of SAR measurement, Power vs Time plot are provided for EUT using battery only, 6VDC only and battery + 6VDC. The details are on Annex A.1

Than to validate if the scaled SAR values are conservative please perform two additional tests if possible to reduce the effect of power droop.

1) a SAR test using an external power supply to supplement the batteries. Please use shielding and ferrite current dampeners on any wires used.

Response: SAR test were carried out using external power supply to supplement the batteries. Shielding and ferrite current dampeners are used on the wires of the external power supply.

2) A test starting at a time when the power is most stable (based on power vs time data), the SAR value should than be scaled up to full power. Or alternatively, perform shorten/focused scans over the hotspot. Tests in the worst case configuration is considered sufficient.

Response: From the Power Vs Time Plot for Energizer Battery + 6VDC, it can be observed that the power droop after the first 10 minutes is less significant. That is the power is most stable after 10 minutes of continuous transmission.

SAR measurement was carried out in the worst case configuration (Belt Clip Body Worn at Channel 4) after the EUT (using Energizer Battery + 6VDC) has transmitted for 10 minutes.

The SAR values obtained are scaled up to the full power (or initial power). Please refer to Annex A.1.b for results

2) Clarification on the battery type used for testing. Rechargeable? If commercial AA batteries can be used please provide SAR data with several typical manufacturer batteries. Please address the power droop concern mentioned above for each. Data at the worst case SAR configuration is considered sufficient.

Response: Alkaline AA non-rechargeable batteries are used for the SAR measurement. 3 brands of commercial AA batteries are investigated. The 3 brands are Energizer, Panasonic and GP Ultra.

For data for the worst case SAR configuration, please refer to Annex A.2

3) Liquid depths during testing. If available please provide photographs, and Z-axis scan SAR data for the highest SAR test points.

Response: The liquid depth during testing is 15±0.5 cm. Please refer to Annex A.3.a for photograph. The Z-axis SAR scan for the highest SAR test point is also provide (See Annex A.3.b)

4) Description of the probe used for testing including a physical description, calibration information and measurement errors. Please include manufacturer calibration certificates. Per Supplement C Appendix B part II 2.

Response: The description of the probe used for testing is provided in Annex A.4. Manufacturer calibration certificates are also attached.

5) A description of the measurement system and how the SAR measurements are actually performed once setup: include coarse scan, determination of peak SAR location, scans to measure points in 1 gram volume, and procedure to determine SAR value from the measurement points. Per Supplement C Appendix B part II 7 and 8.

Response: A description of the measurement system and how the SAR measurements are actually performed once setup are provided in Annex A.5

6) Manufacturer system validation data. Please also provide forward power used.

Response: The manufacturer system validation data is provided in Annex A.6. The forward power used by manufacturer is 389mW whereas the forward power used by test lab was 250mW. A table with a summary of the normalized SAR values to 1W is also provided.

7) Justification of the SAR results using a 4 mm thick phantom. Supplement C recommends a 2 mm thick phantom. Please provide an analysis of the expected effect on SAR. Please make efforts to obtain a 2 mm thick phantom for future measurements.

Response: **The test lab is in the process of acquiring a 2mm thick phantom for future measurement.** An analysis of the effect of SAR shows that the 4mm phantom could result in a SAR value that is about 5% lower than that of a 2mm SAM phantom. Please see Annex A.7 for details

ANNEX A.1

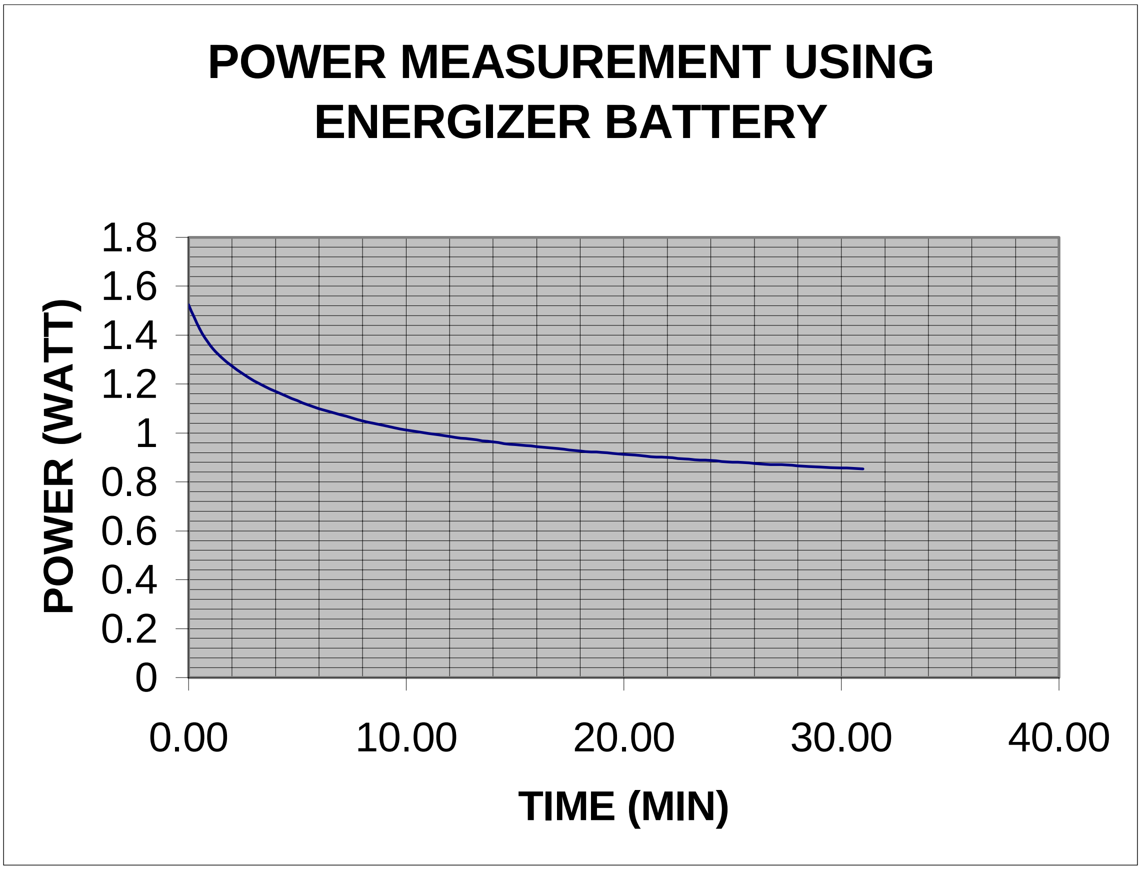
a) **Time Length of Measurement** = 16 min 28 sec

b) **Power Vs Time Plot**

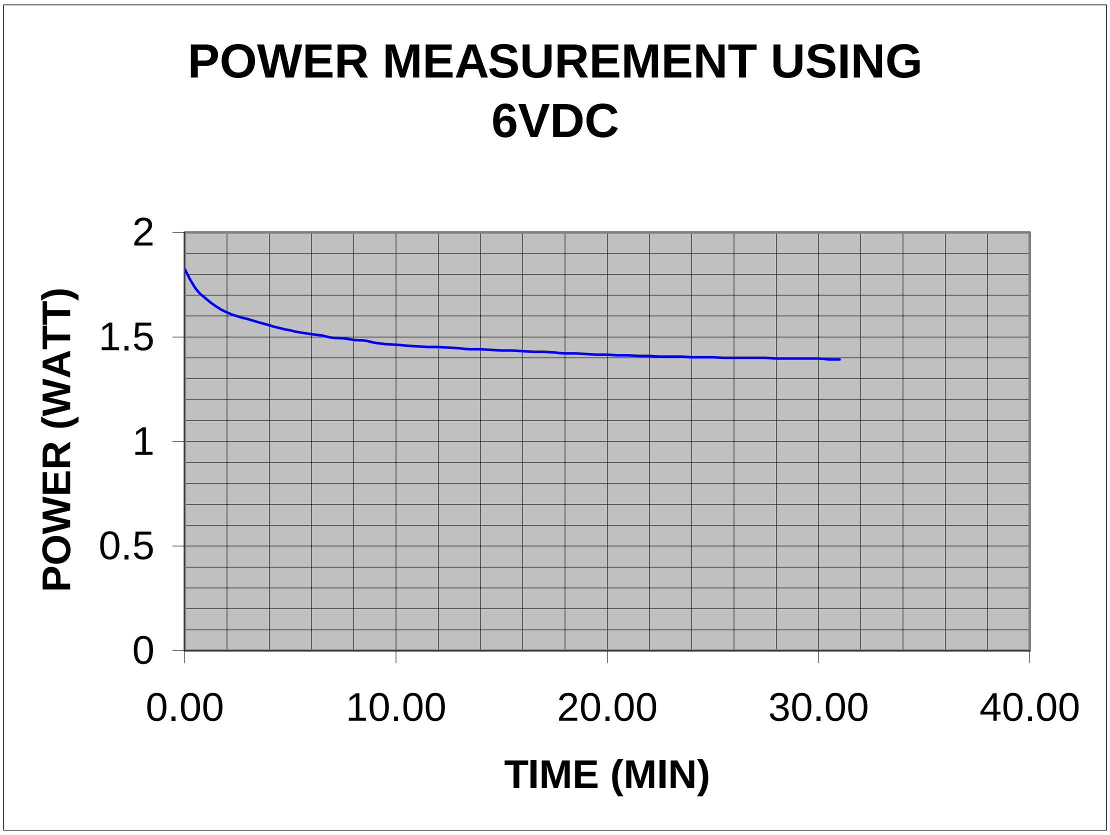
Result Overview

	Energizer Battery only	6VDC only	Energizer Battery + 6VDC	Remarks
Initial Power / W	1.52	1.82	1.83	
Power at 10min / W	1.01	1.46	1.47	Start SAR Test
Power at 20min / W	0.912	1.42	1.42	
Power at 30min / W	0.857	1.40	1.41	End SAR Test

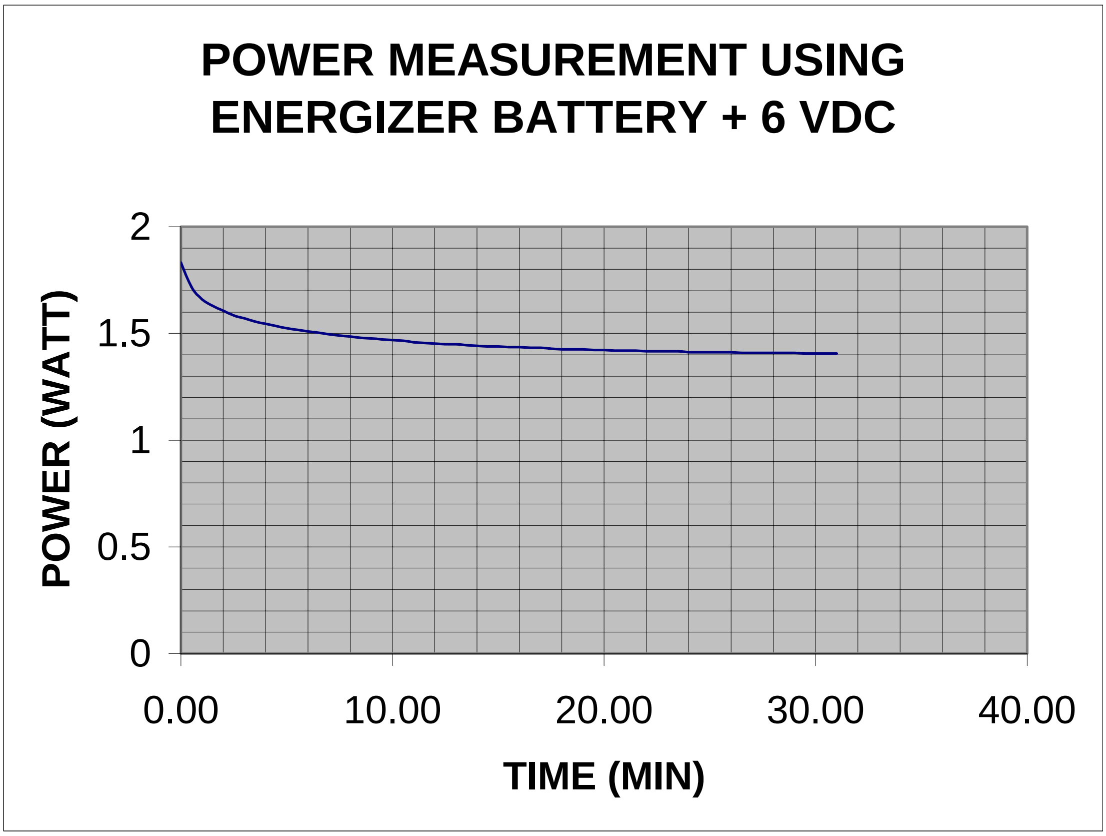
i) Using Energizer Battery only,



ii) Using 6VDC only



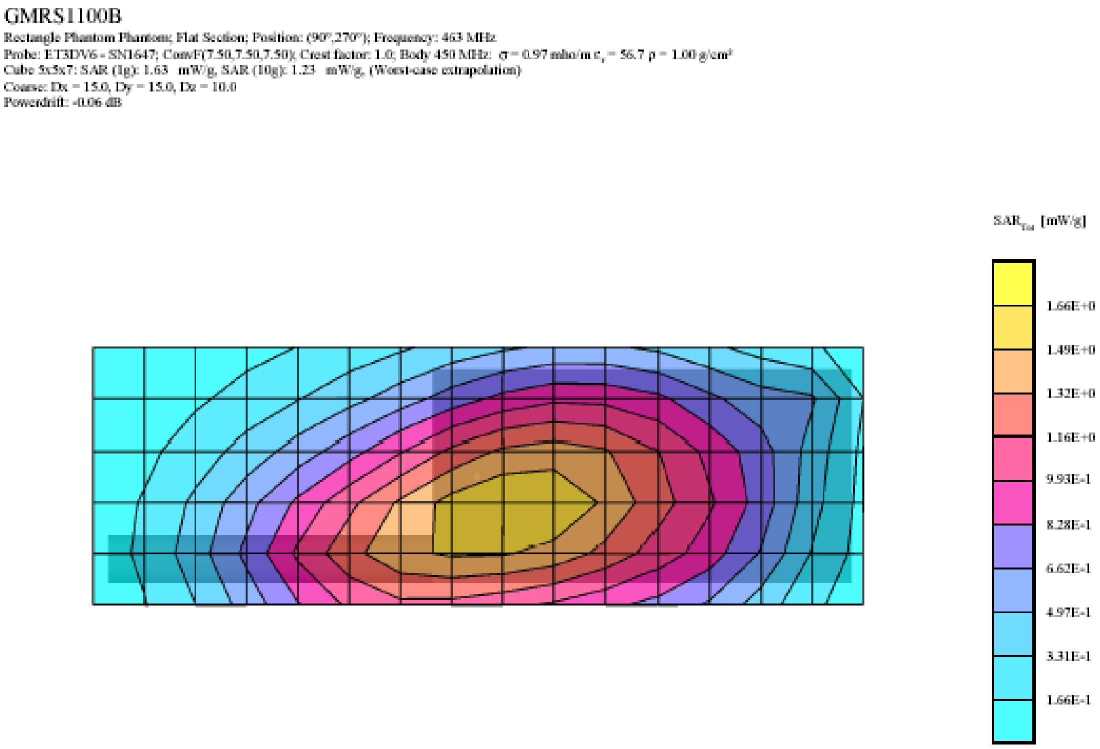
iii) Using Energizer Battery + 6VDC,



From the Power Vs Time Plot for Energizer Battery + 6VDC, it can be observed that the power droop after the first 10 minutes is less significant. That is the power is most stable after 10 minutes of continuous transmission.

SAR measurement was carried out in the worst case configuration (Belt Clip Body Worn at Channel 4) after the EUT (using Energizer Battery + 6VDC) has transmitted for 10 minutes. Shielding and ferrite dampeners are used on the wire of the external power supply.

Using Energizer battery + 6VDC,



SAR_1g = 1.63 mW/g

The scaled SAR values can be calculated

Scaled SAR Value = [(Initial Power) / (Power at the end of the test)] * SAR Value

Scaled SAR Value = [(1.83W) / (1.41W)] * (1.63mW/g) = 2.12mW/g

Final SAR with 50% User-based Duty Cycle Consideration
= Scaled SAR Value / Factor of 2
= 2.12mW/g / 2
= 1.06mW/g

ANNEX A.2

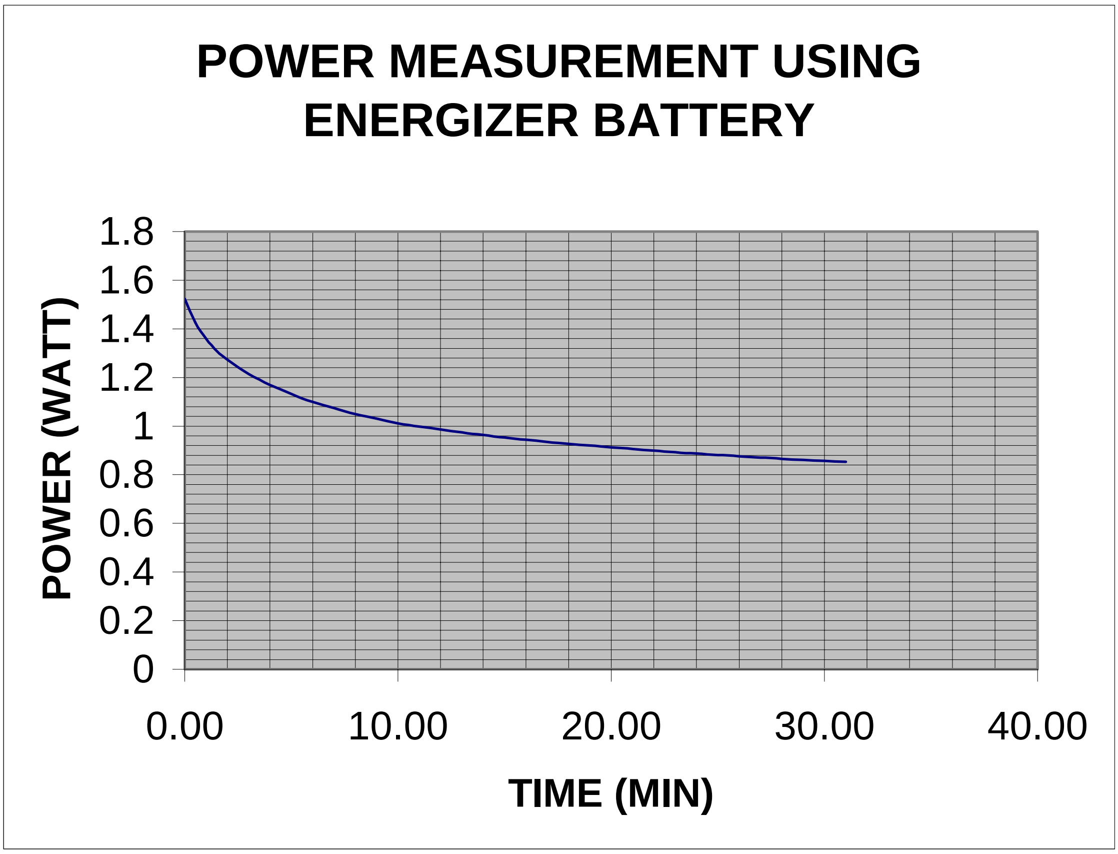
Alkaline AA non-rechargeable batteries are used for the SAR measurement. 3 brands commercial AA batteries are also investigated. They are Energizer, Panasonic and GP Ultra.

a) **Power Vs Time Plots**

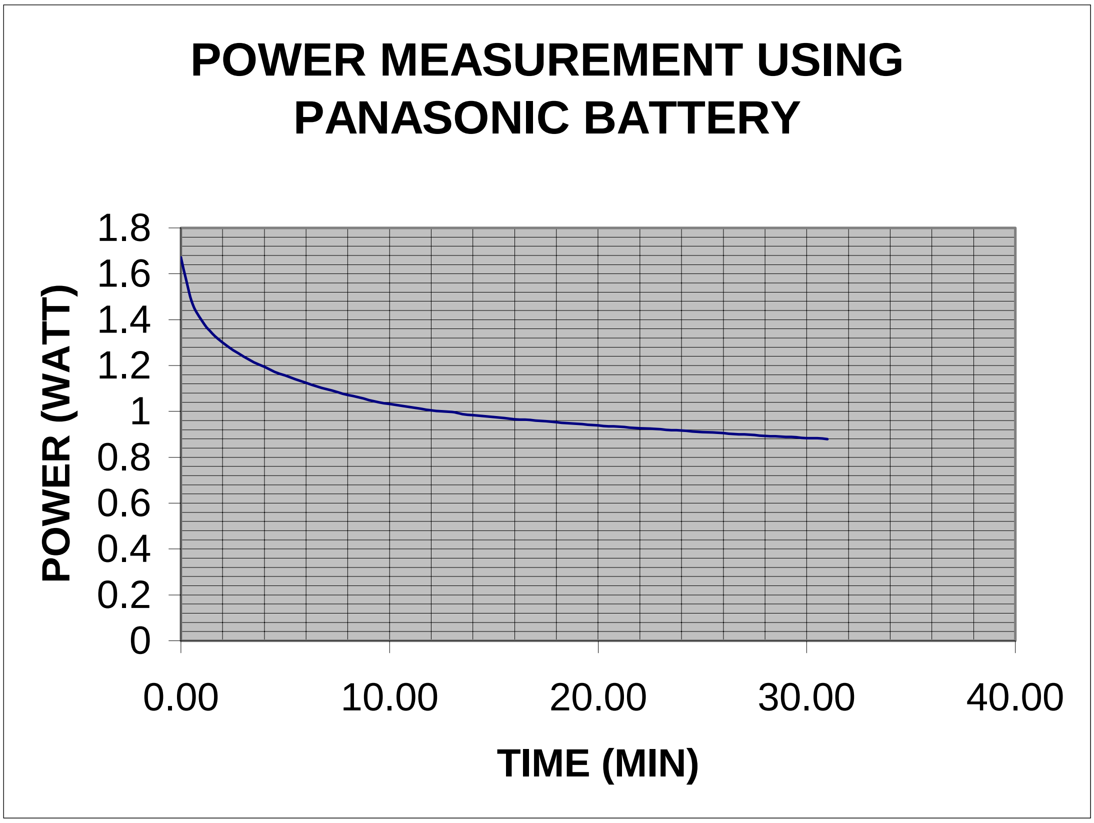
Result Overview

	Energizer Battery Only	Panasonic Battery Only	GP Ultra Battery Only	Remarks
Initial Power / W	1.52	1.67	1.63	
Power at 10min / W	1.01	1.03	1.01	
Power at 20min / W	0.912	0.940	0.893	
Power at 30min / W	0.857	0.883	0.818	

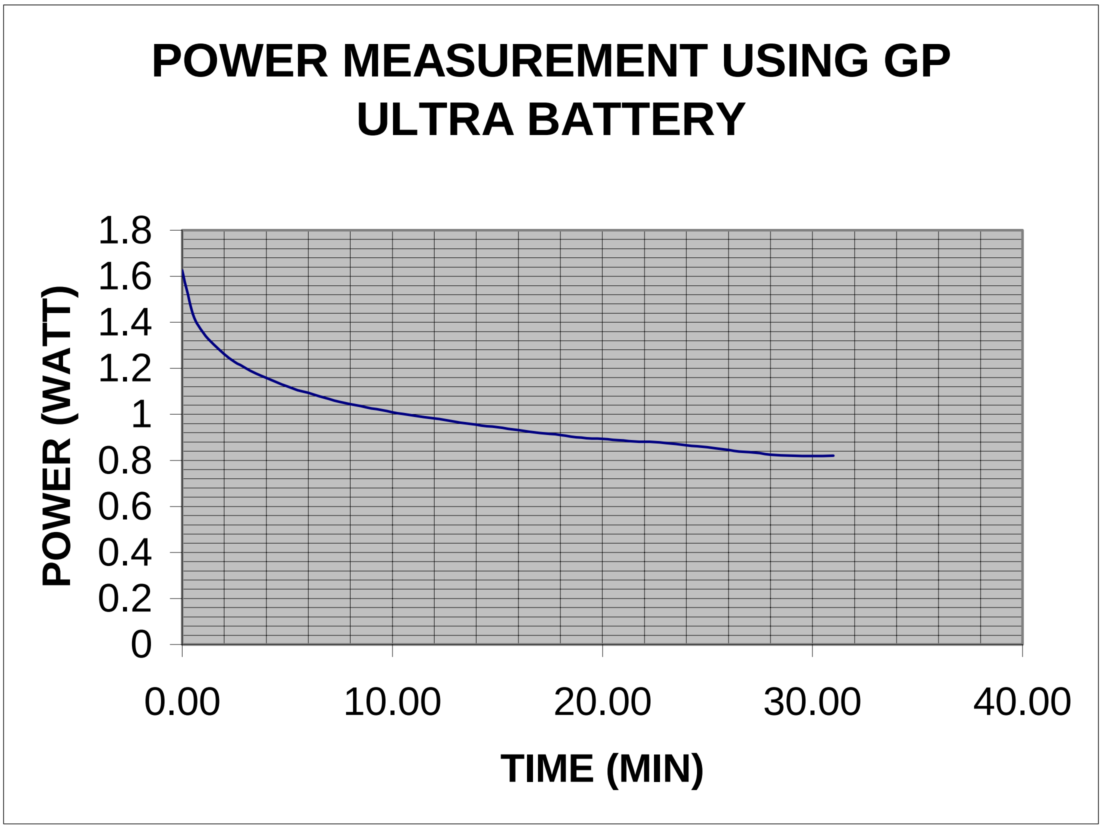
i) Using Energizer Battery only,



ii) Using Panasonic Battery only,

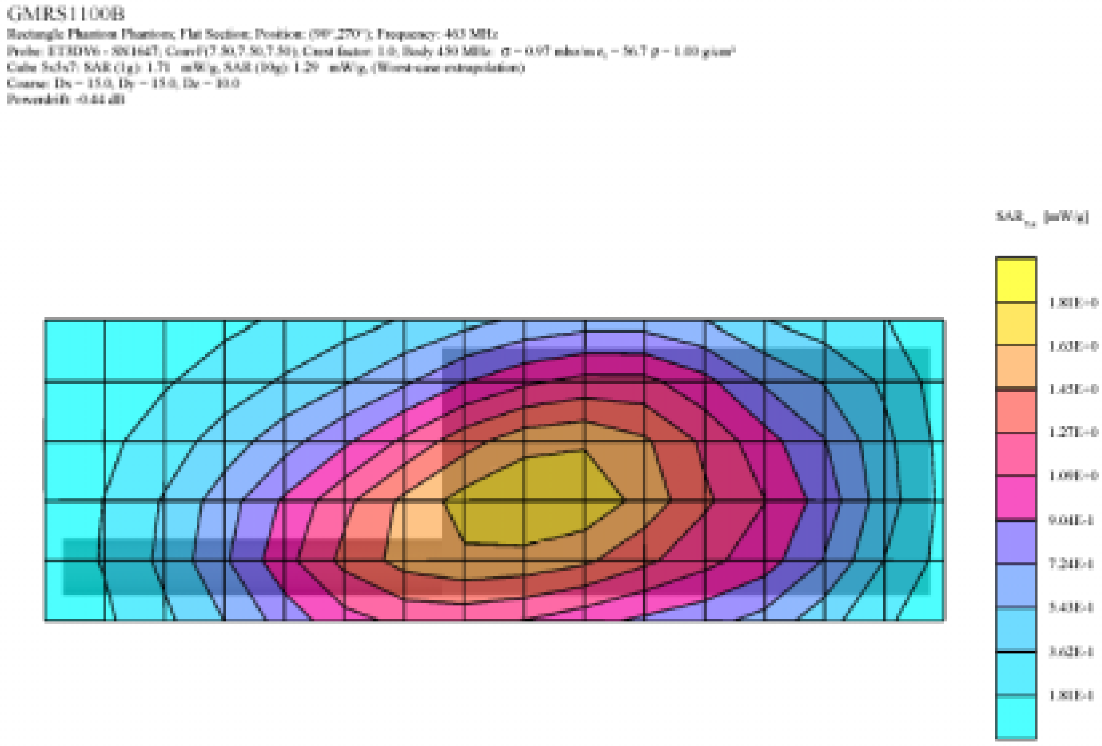


iii) Using GP Ultra Battery only



Even though the power droop is quite significant when measured using the different 3 types of battery, their power droop curve for battery + 6VDC is similar to that of using 6VDC only - See 1(b)(ii). As such, SAR measurement was carried out in the worst case configuration (Belt Clip Body Worn at Channel 4) after the EUT (using Energizer, Panasonic & GP Ultra Battery + 6VDC) has transmitted for 10 minutes. Shielding and ferrite dampeners are used on the wire of the external power supply.

Using Panasonic battery + 6VDC,



SAR_1g = 1.71 mW/g

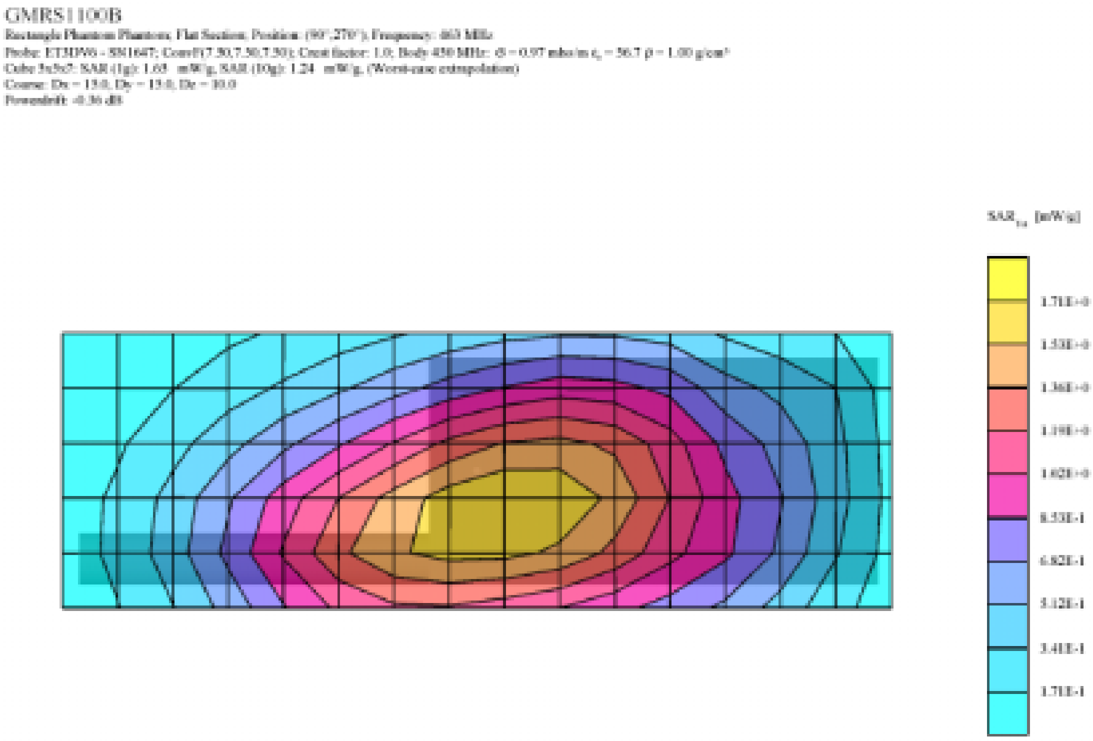
The scaled SAR values can be calculated

Scaled SAR Value = [(Initial Power) / (Power at the end of the test)] * SAR Value

Scaled SAR Value = [(1.82W) / (1.40W)] * (1.71mW/g) = 2.22mW/g

Final SAR with 50% User-based Duty Cycle Consideration
= Scaled SAR Value / Factor of 2
= 2.22mW/g / 2
= 1.11mW/g

Using GP Ultra battery + 6VDC,



SAR_1g = 1.65 mW/g

The scaled SAR values can be calculated

Scaled SAR Value = [(Initial Power) / (Power at the end of the test)] * SAR Value

Scaled SAR Value = [(1.82W) / (1.40W)] * (1.65mW/g) = 2.15mW/g

Final SAR with 50% User-based Duty Cycle Consideration
= Scaled SAR Value / Factor of 2
= 2.15mW/g / 2
= 1.075mW/g

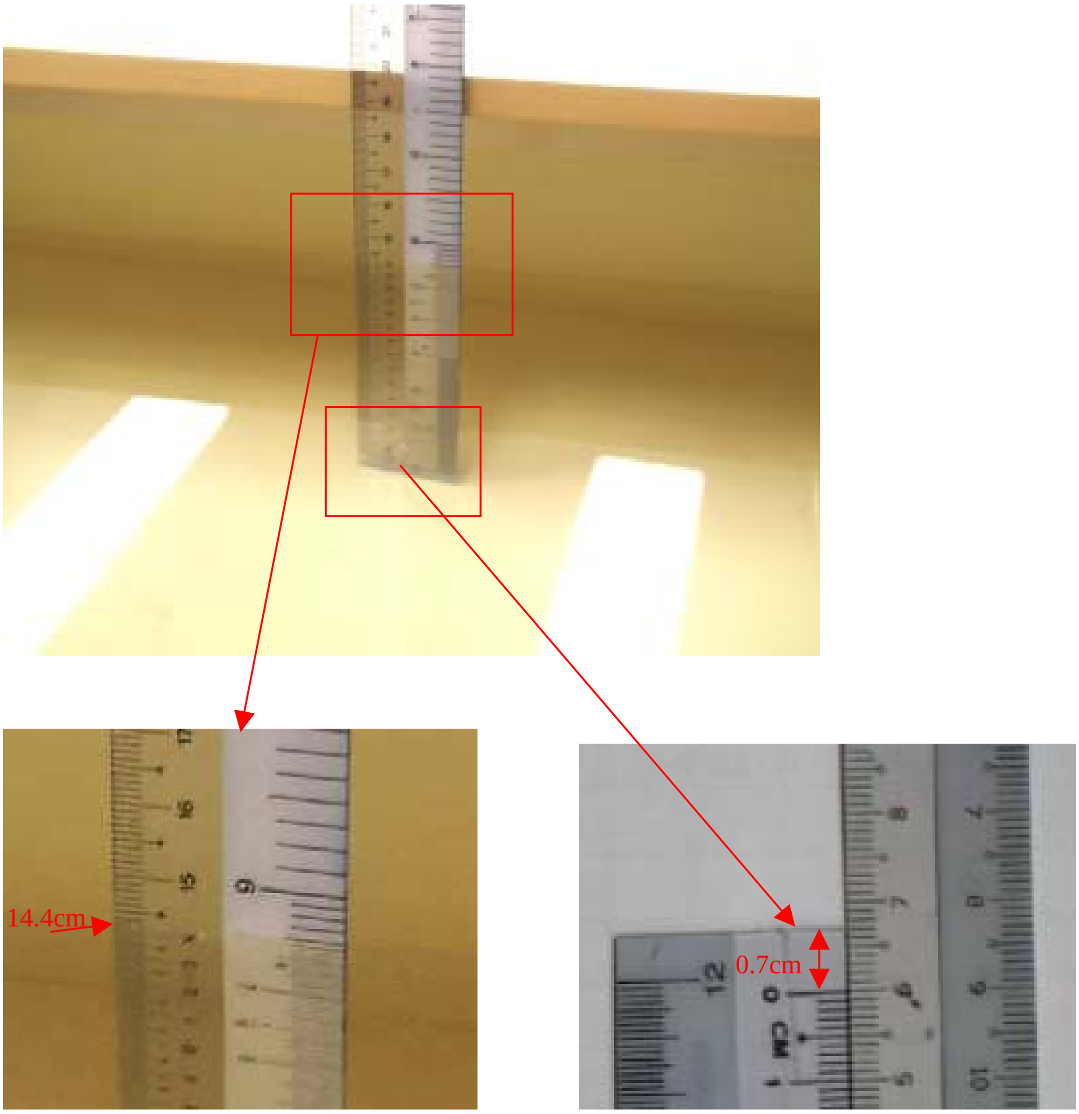
Summary

	Energizer Battery + 6VDC	**Panasonic Battery + 6VDC**	**GP Ultra Battery + 6VDC**	**Remarks**
Initial Power (W)	1.83	1.82	1.82	
Power at End of Test (W)	1.41	1.40	1.40	
Scaled Factor*	1.30	1.30	1.30	
Measured SAR (mW/g)	1.63	1.71	1.65	
Scaled SAR (mW/g)	2.12	2.22	2.15	
Final SAR with 50% User-based Duty Cycle Consideration (mW/g)	**1.06**	**1.11**	**1.075**	Divide by a factor of 2

* Scaled Factor = Initial Power / Power at End of Test (at 30 min)

ANNEX A.3

a) **Liquid Depth** = 15.1 cm (14.4cm + 0.7cm)   [15 ± 0.5cm]



b) Z-axis SAR scan

GMRS1100B

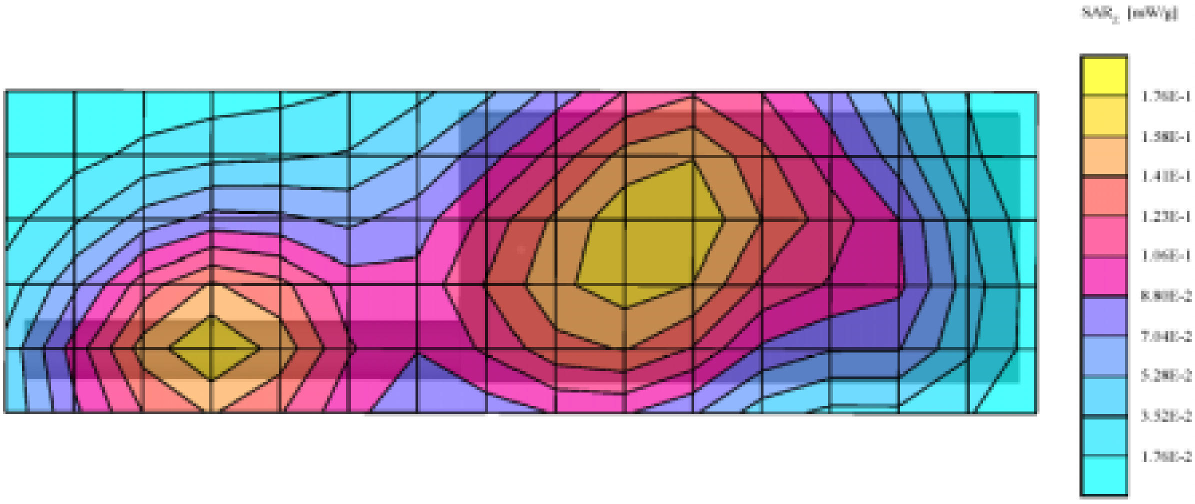
Rectangle Phantom Phantom; Flat Section; Position: (90°,270°); Frequency: 463 MHz

Probe: ET3DV6 - SN1647; ConvF(7.50,7.50,7.50); Crest factor: 1.0; Body 450 MHz: σ = 0.91 mho/m ϵ_r = 55.6 ρ = 1.00 g/cm³

Cube 5x5x7: SAR (1g): 1.20 mW/g, SAR (10g): 0.903 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Powerdrift: -1.51 dB



ANNEX A.4

Probe Description

Probe Description	Isotropic E-Field Probe for Dosimetric Measurements
Manufacturer	SPEAG
Model	ET3DV6
Serial Nos	1647
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvent)
Dimension	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Calibration	Basic Broad Band Calibration in air: 10-2500 MHz Conversion Factors (CF) for HSL 900 and HSL 1800 CF-Calibration for other liquids and frequencies upon request
Frequency	10 MHz to 3 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
Manufacturer Calibration Certificates	See Next Page

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

Dosimetric E-Field Probe

Type:	**ET3DV6**
Serial Number:	**1647**
Place of Calibration:	**Zurich**
Date of Calibration:	**November 26, 2001**
Calibration Interval:	**12 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:

Approved by:

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Telephone +41 1 245 97 00, Fax +41 1 245 97 79

Probe ET3DV6

SN:1647

Manufactured: November 7, 2001
Calibrated: November 26, 2001

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV6 SN:1647

Sensitivity in Free Space

NormX	**1.72**	µV/(V/m)^2
NormY	**1.67**	µV/(V/m)^2
NormZ	**1.73**	µV/(V/m)^2

Diode Compression

DCP X	**99**	mV
DCP Y	**99**	mV
DCP Z	**99**	mV

Sensitivity in Tissue Simulating Liquid

Head **450 MHz** **ε_r = 43.5 ± 5%** **σ = 0.87 ± 10% mho/m**

ConvF X	**7.09**	extrapolated	Boundary effect:	
ConvF Y	**7.09**	extrapolated	Alpha	**0.39**
ConvF Z	**7.09**	extrapolated	Depth	**2.25**

Head **800 - 1000 MHz** **ε_r = 39.0 - 43.5** **σ = 0.80 - 1.10 mho/m**

ConvF X	**6.54**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.54**	± 9.5% (k=2)	Alpha	**0.44**
ConvF Z	**6.54**	± 9.5% (k=2)	Depth	**2.23**

Head **1350 - 1550 MHz** **ε_r = 38.5 - 42.5** **σ = 1.14 - 1.35 mho/m**

ConvF X	**5.65**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.65**	± 9.5% (k=2)	Alpha	**0.38**
ConvF Z	**5.65**	± 9.5% (k=2)	Depth	**3.10**

Head **1700 - 1910 MHz** **ε_r = 39.5 - 41.0** **σ = 1.20 - 1.55 mho/m**

ConvF X	**5.42**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.42**	± 9.5% (k=2)	Alpha	**0.55**
ConvF Z	**5.42**	± 9.5% (k=2)	Depth	**2.19**

Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	~~**1.2**~~ **± 0.2**	mm

1.9 (REFER TO INSTALLATION PROTOCOL)

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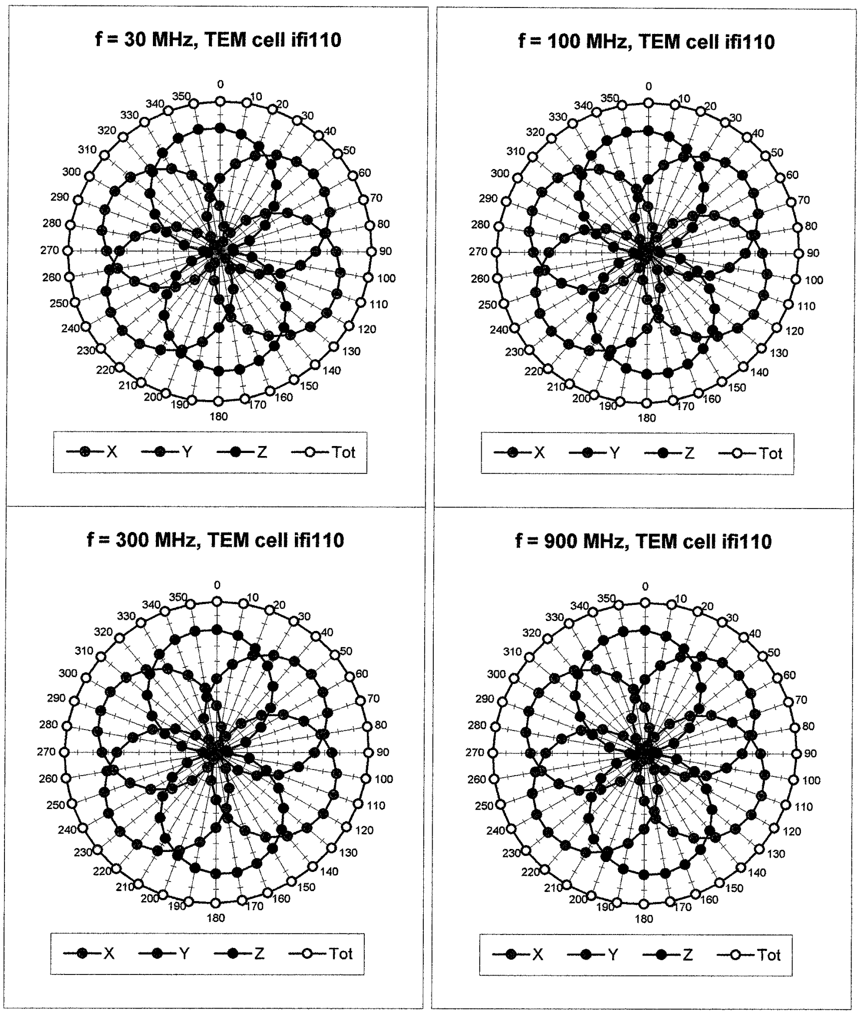
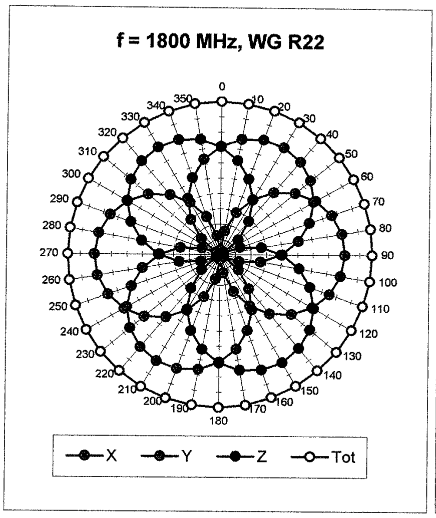
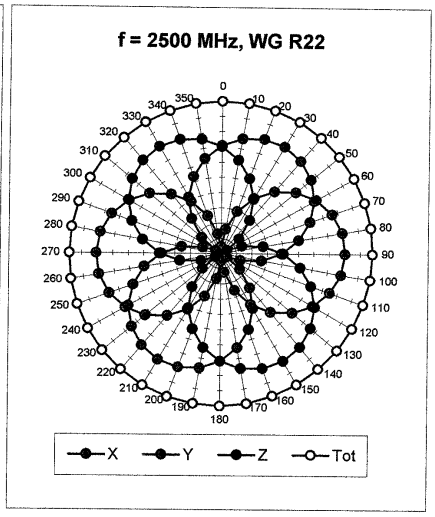
Receiving Pattern (ϕ), θ = 0°

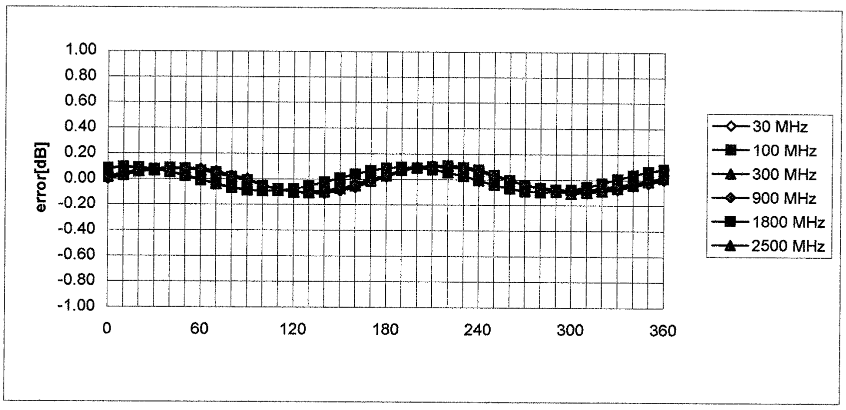


ET3DV6 SN:1647



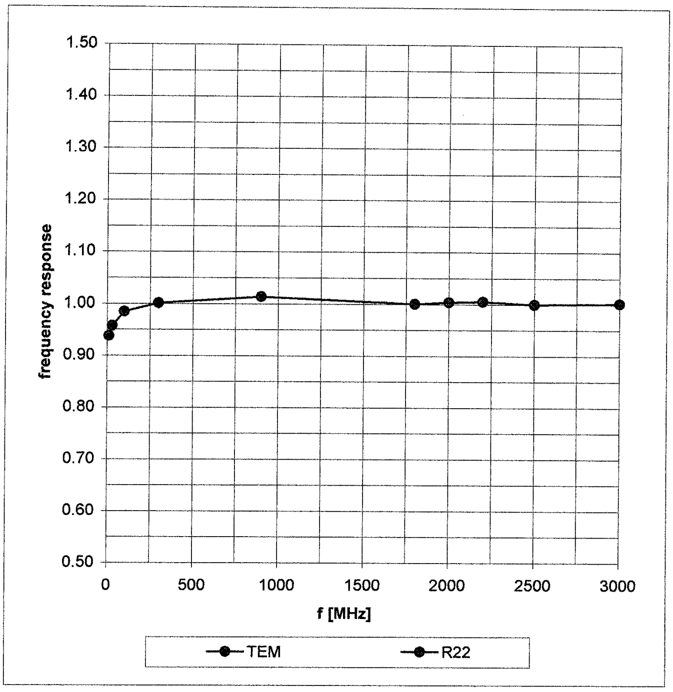


Isotropy Error (ϕ), θ = 0°



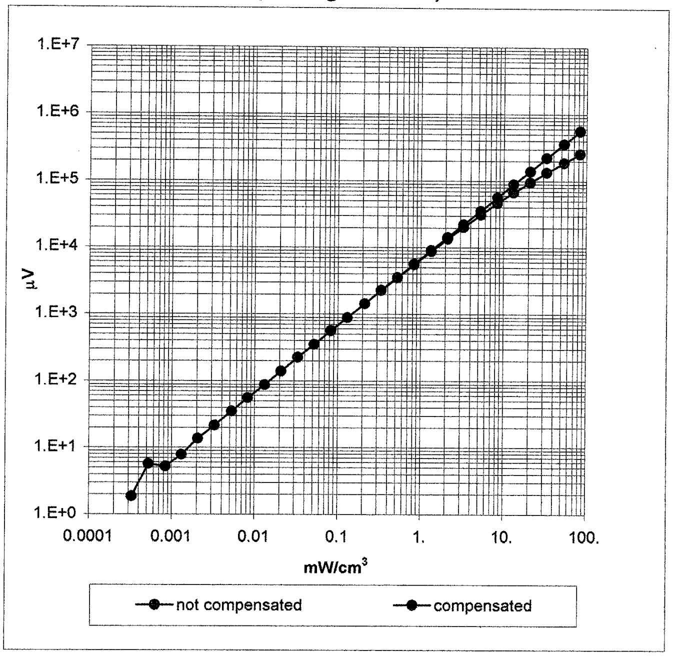
Frequency Response of E-Field

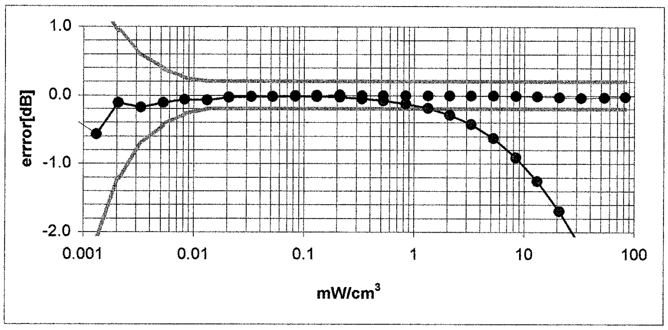
(TEM-Cell:ifi110, Waveguide R22)



Dynamic Range f(SAR_{brain})

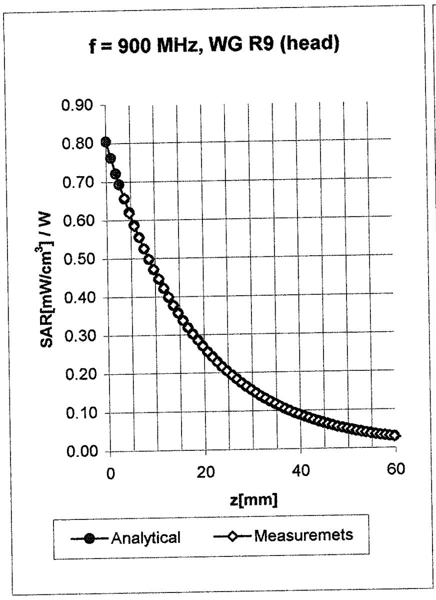
(Waveguide R22)

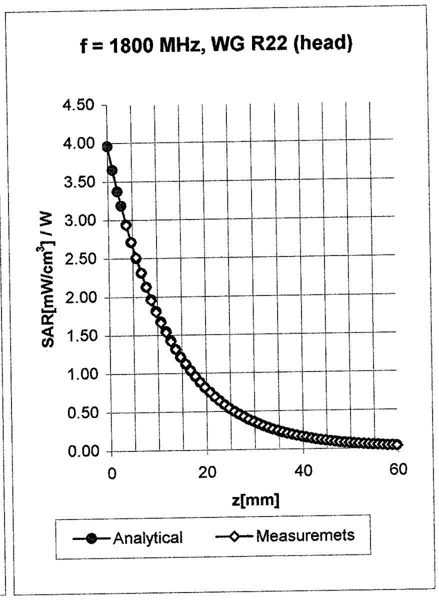




ET3DV6 SN:1647

Conversion Factor Assessment

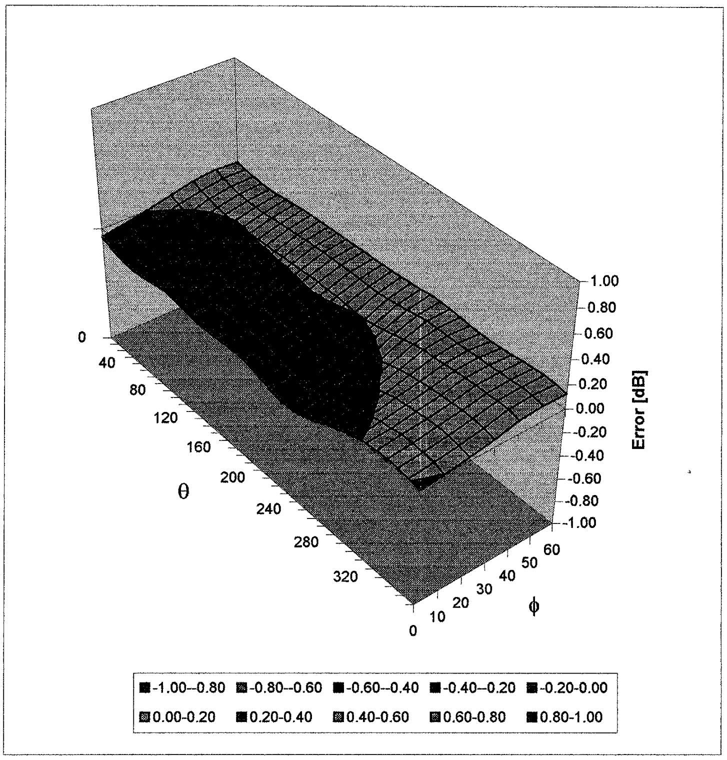




Head	**800 - 1000 MHz**		**ε_r = 39.0 - 43.5**	**σ = 0.80 - 1.10 mho/m**	
	ConvF X	**6.54**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**6.54**	± 9.5% (k=2)	Alpha	**0.44**
	ConvF Z	**6.54**	± 9.5% (k=2)	Depth	**2.23**
Head	**1350 - 1550 MHz**		**ε_r = 38.5 - 42.5**	**σ = 1.14 - 1.35 mho/m**	
	ConvF X	**5.65**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**5.65**	± 9.5% (k=2)	Alpha	**0.38**
	ConvF Z	**5.65**	± 9.5% (k=2)	Depth	**3.10**
Head	**1700 - 1910 MHz**		**ε_r = 39.5 - 41.0**	**σ = 1.20 - 1.55 mho/m**	
	ConvF X	**5.42**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**5.42**	± 9.5% (k=2)	Alpha	**0.55**
	ConvF Z	**5.42**	± 9.5% (k=2)	Depth	**2.19**

Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



Dosimetric E-Field Probe ET3DV6 SN:1647

Conversion factor (± standard deviation)

450 MHz	ConvF	**7.5 ± 8%**	**ε_r = 56.7 ± 5%** **σ = 0.94 ± 5% mho/m** Body tissue
900 MHz	ConvF	**6.3 ± 8%**	**ε_r = 55.0 ± 5%** **σ = 1.05 ± 5% mho/m** Body tissue
1800 MHz	ConvF	**5.0 ± 8%**	**ε_r = 53.3 ± 5%** **σ = 1.52 ± 5% mho/m** Body tissue

ANNEX A.5

Measurement System Description

These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG).

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 ±0.02mm.

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 (length ≈ 300 mm) to the data acquisition unit.

The SAR measurements were conducted with the dosimetric probe ET3DV5 SN:1647 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

The probe has been calibrated with an accuracy of better than ±10%. The spherical isotropy was evaluated and found to be better than ±0.25 dB.

The evaluation was performed the with following procedure:
Step 1: Measurement of the SAR value at a fixed location was used as a reference value for assessing the power drop.

Step 2: The SAR distribution was measured at a distance of 3.9mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm x 15 mm. Based on this 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 with 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. 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 straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were 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-directions). 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.

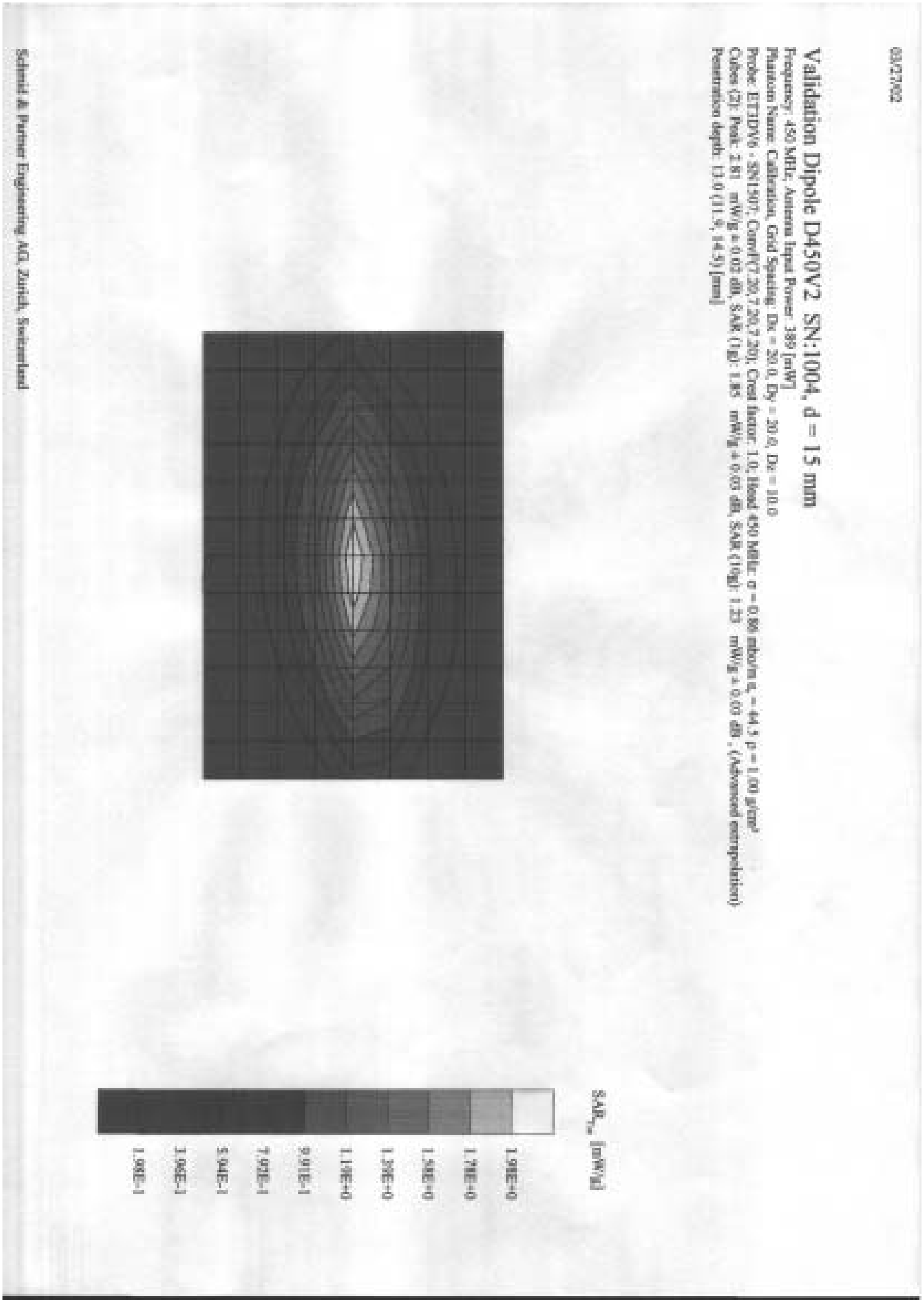
ANNEX A.6

System Validation Data - Summary

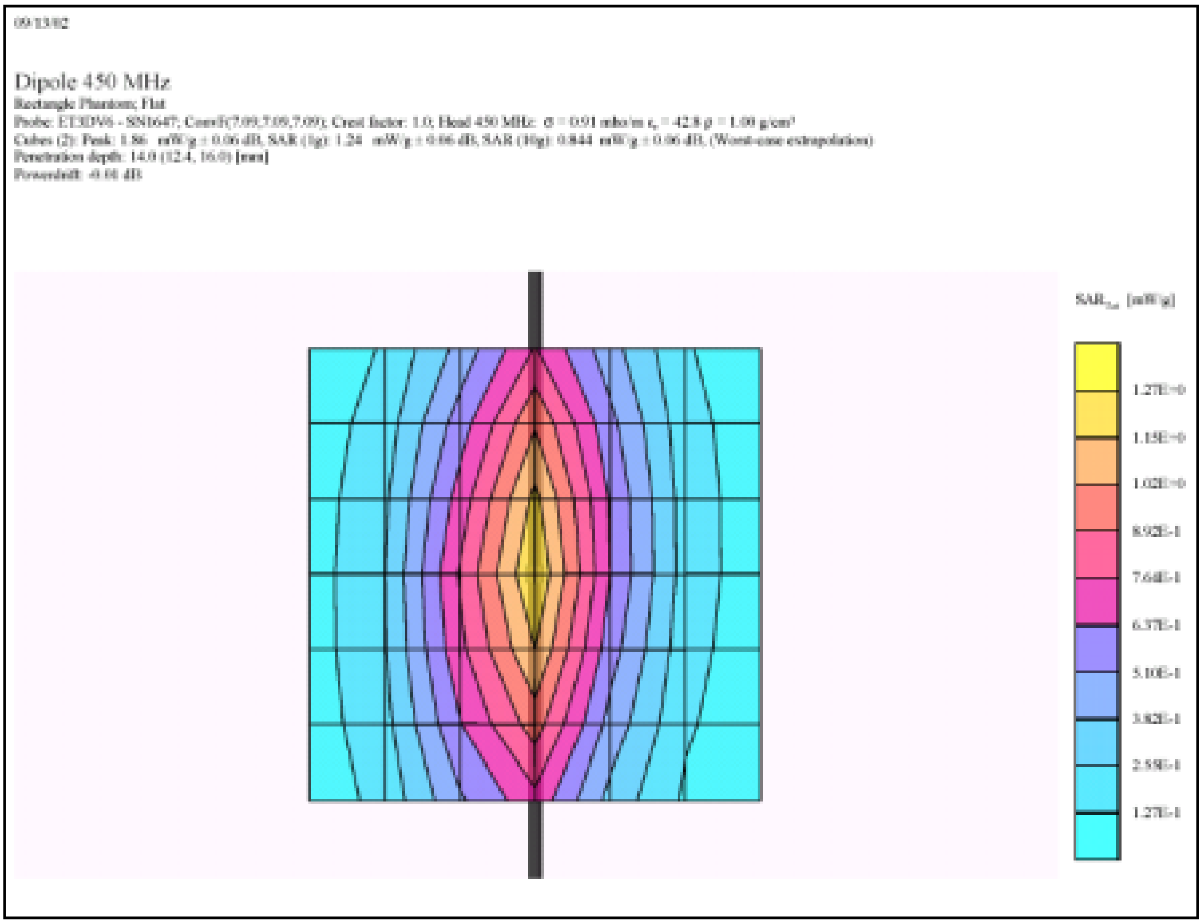
	Manufacturer	**Test Lab**	**Theoretical Value**
Forward Power Used (mW)	389	250	1000
Peak SAR (mW/g)	2.81	1.86	7.2
Normalised* Peak SAR (mW/g)	***7.22***	***7.44***	***7.2***
SAR (1g) (mW/g)	1.85	1.24	4.9
Normalised* SAR (1g) (mW/g)	***4.76***	***4.96***	***4.9***
SAR (10g) (mW/g)	1.23	0.844	3.3
Normalised* SAR (10g) (mW/g)	***3.16***	***3.38***	***3.3***

* To 1000mW (Forward Power)

a) Manufacturer System Validation Data
Forward Power Used = 389mW



b) Test Lab System Validation Data
Forward Power Used = 250mW



ANNEX A.7

Justification of SAR result using a 4mm thick phantom.

a) **Test Lab is in the process of acquiring a 2mm thick phantom for future measurements.**

b) Below is an analysis of the expected effect on SAR for the 4mm thick phantom.

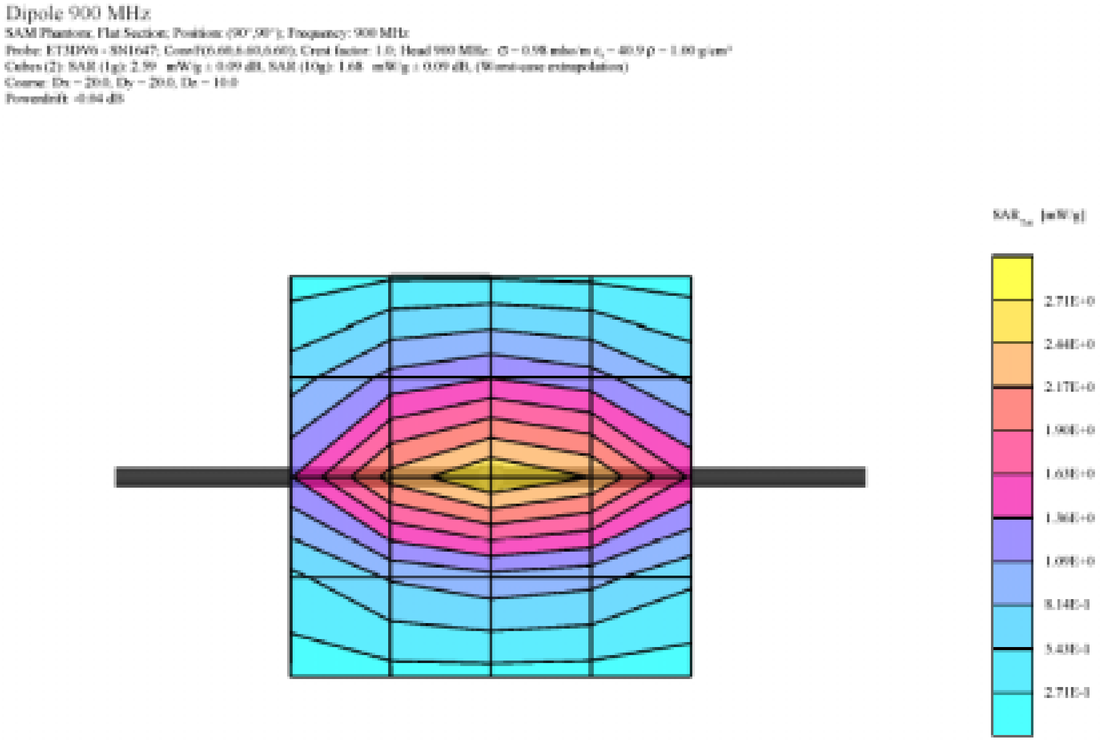
(1) A comparison testing was carried out using the 4mm thick phantom and the SAM (2mm thick) phantom. As the SAM phantom is suitable for measurement for frequency > 800MHz, the comparison testing was carried out at 900MHz using the flat section of both phantoms.

Below is the summary of the comparison testing.

	SAM Phantom (2mm)	**4mm Phantom**	**Differences**
Using 900MHz Dipole (Forward Power = 250mW)	2.59mW/g*	2.45mW/g*	-5.4%

* SAR_1g

(i) Using 900MHz Dipole (Forward Power = 250mW) – SAM Phantom



(ii) Using 900MHz Dipole (Forward Power = 250mW) – 4mm Phantom