

**APPENDIX 4 : System Validation Dipole (D2450V2,S/N: 713)**

## Schmid & Partner Engineering AG

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

---

### Calibration Certificate

#### 2450 MHz System Validation Dipole

Type:

**D2450V2**

Serial Number:

**713**

Place of Calibration:

**Zurich**

Date of Calibration:

**November 15, 2002**

Calibration Interval:

**24 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:

*D. Vetter*

Approved by:

*Robert Kofe*

---

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

**Schmid & Partner  
Engineering AG**

---

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

---

**DASY**

**Dipole Validation Kit**

**Type: D2450V2**

**Serial: 713**

Manufactured: July 5, 2002  
Calibrated: November 15, 2002

## **1. Measurement Conditions**

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating solution of the following electrical parameters at 2450 MHz:

|                       |                   |            |
|-----------------------|-------------------|------------|
| Relative permittivity | <b>38.0</b>       | $\pm 5\%$  |
| Conductivity          | <b>1.87 mho/m</b> | $\pm 10\%$ |

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was 250mW  $\pm 3\%$ . The results are normalized to 1W input power.

## **2. SAR Measurement with DASY4 System**

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

|                                                    |                  |
|----------------------------------------------------|------------------|
| averaged over 1 cm <sup>3</sup> (1 g) of tissue:   | <b>54.4 mW/g</b> |
| averaged over 10 cm <sup>3</sup> (10 g) of tissue: | <b>24.2 mW/g</b> |

### **3. Dipole impedance and return loss**

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:       **1.158 ns**   (one direction)  
Transmission factor:   **0.997**     (voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 2450 MHz:        $\text{Re}\{Z\} = \mathbf{51.3 \, \Omega}$

$\text{Im}\{Z\} = \mathbf{2.4 \, \Omega}$

Return Loss at 2450 MHz               **- 31.4 dB**

### **4. Measurement Conditions**

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating solution of the following electrical parameters at 2450 MHz:

Relative permittivity               **51.2**        $\pm 5\%$   
Conductivity                       **1.96 mho/m**    $\pm 10\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.5 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was  $250\text{mW} \pm 3 \%$ . The results are normalized to 1W input power.

Date/Time: 11/13/02 21:52:22

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN713\_SN1507\_HSL2450\_131102.da4

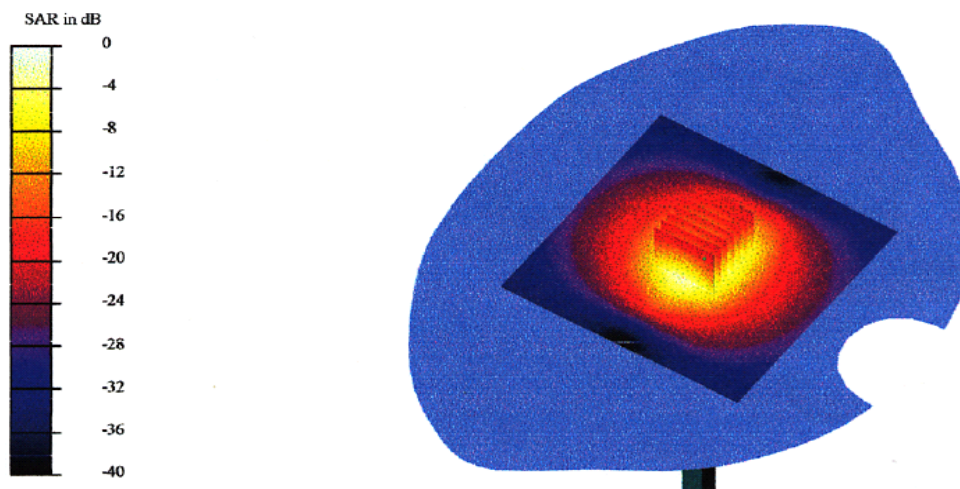
**DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium: HSL 2450 MHz ( $\sigma = 1.87$  mho/m,  $\epsilon = 38.03$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

**Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm  
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm  
Reference Value = 94.4 V/m  
Peak SAR = 29.6 mW/g  
SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.04 mW/g  
Power Drift = 0.01 dB



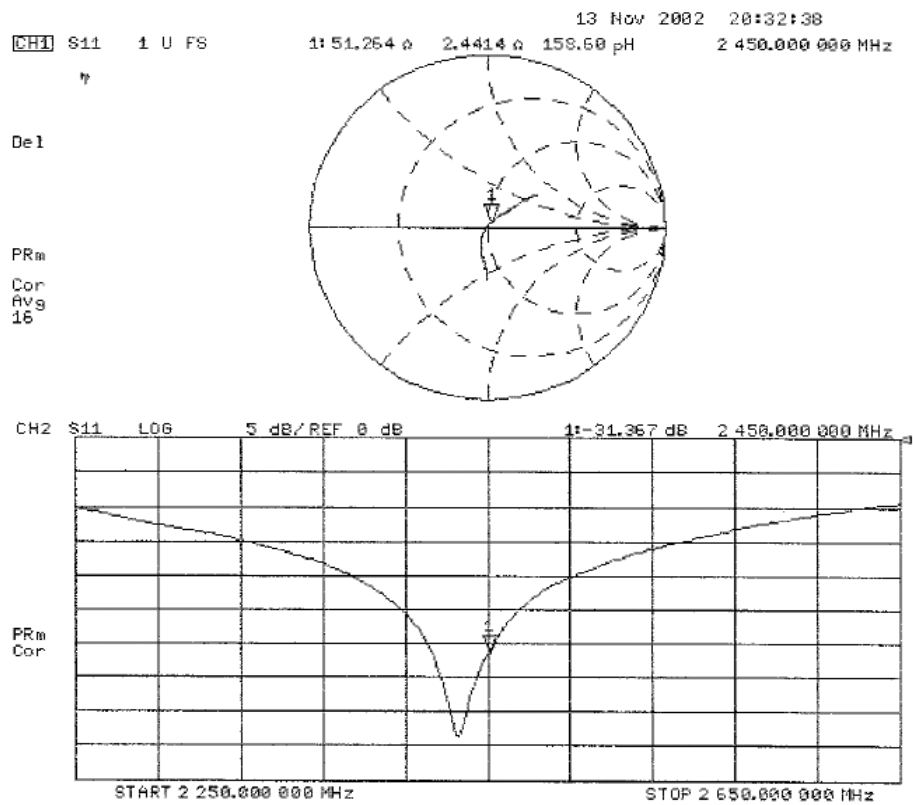
**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124





Date/Time: 11/15/02 14:25:17

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN713\_SN1507\_M2450\_141102.da4

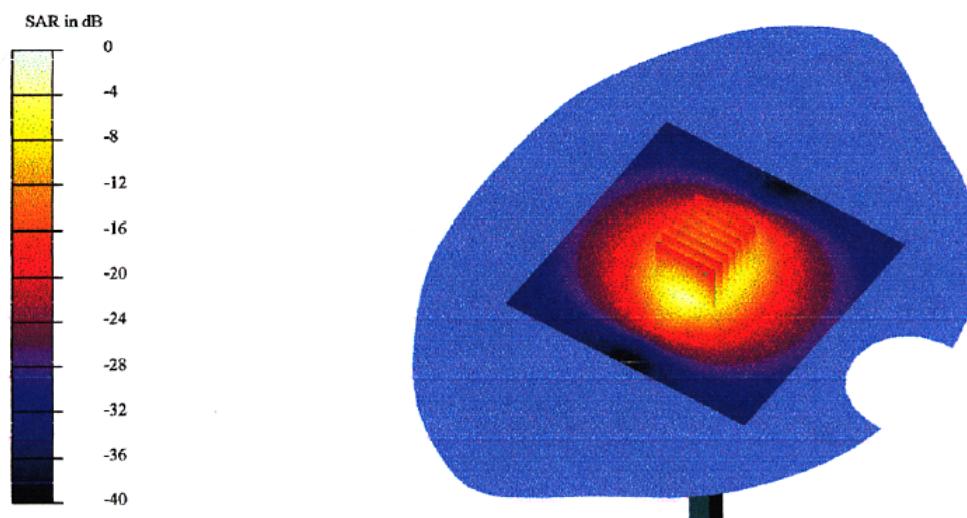
**DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium: Muscle 2450 MHz ( $\sigma = 1.96$  mho/m,  $\epsilon = 51.15$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(4.5, 4.5, 4.5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

**Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm  
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm  
Reference Value = 95.2 V/m  
Peak SAR = 25 mW/g  
SAR(1 g) = 12.9 mW/g; SAR(10 g) = 5.99 mW/g  
Power Drift = 0.02 dB



**UL Apex Co., Ltd.**

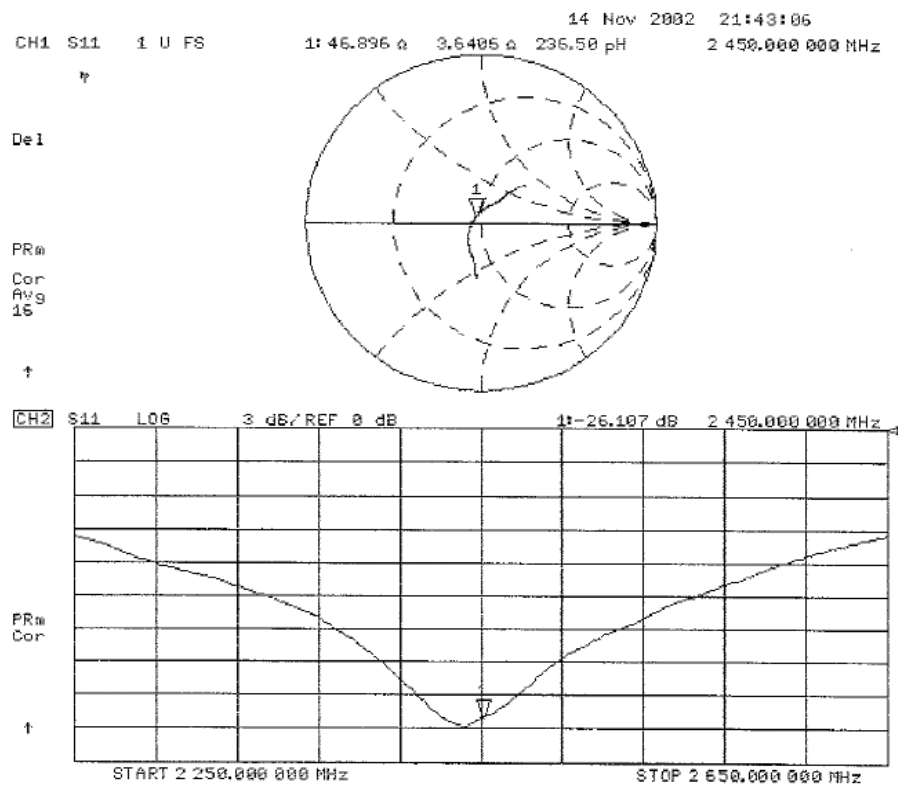
**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124





## **APPENDIX 5 : Dosimetric E-Field Probe Calibration (ET3DV6,S/N: 1685)**

Schmid & Partner Engineering AG

**s p e a g**

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, <http://www.speag.com>

## IMPORTANT NOTICE

### USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

#### Compatible Probes:

- ET3DV6
- ET3DV6R
- ES3DV2
- ER3DV6
- H3DV6

#### Important Note for ET3DV6 Probes:

The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

**s p e a g**

Schmid & Partner Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, <http://www.speag.com>

Schmid & Partner Engineering AG

Technical Note 01.06.15-1

June 2002

---

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

Calibration Laboratory of  
Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client **UL Apex (MTT)**

| CALIBRATION CERTIFICATE                                                                                                                                                                                                        |                                                                     |                                           |                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------|
| Object(s)                                                                                                                                                                                                                      | ET3DV6 - SN:1685                                                    |                                           |                                                                                                    |
| Calibration procedure(s)                                                                                                                                                                                                       | QA CAL-01.v2<br>Calibration procedure for dosimetric E-field probes |                                           |                                                                                                    |
| Calibration date:                                                                                                                                                                                                              | October 10, 2003                                                    |                                           |                                                                                                    |
| Condition of the calibrated item                                                                                                                                                                                               | In Tolerance (according to the specific calibration document)       |                                           |                                                                                                    |
| This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.                                                   |                                                                     |                                           |                                                                                                    |
| All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.                                                                                   |                                                                     |                                           |                                                                                                    |
| Calibration Equipment used (M&TE critical for calibration)                                                                                                                                                                     |                                                                     |                                           |                                                                                                    |
| Model Type                                                                                                                                                                                                                     | ID #                                                                | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration                                                                              |
| Power meter EPM E4419B                                                                                                                                                                                                         | GB41293874                                                          | 2-Apr-03 (METAS, No 252-0250)             | Apr-04                                                                                             |
| Power sensor E4412A                                                                                                                                                                                                            | MY41495277                                                          | 2-Apr-03 (METAS, No 252-0250)             | Apr-04                                                                                             |
| Reference 20 dB Attenuator                                                                                                                                                                                                     | SN: 5086 (20b)                                                      | 3-Apr-03 (METAS No. 251-0340)             | Apr-04                                                                                             |
| Fluke Process Calibrator Type 702                                                                                                                                                                                              | SN: 6295803                                                         | 8-Sep-03 (Sintrel SCS No. E-030020)       | Sep-04                                                                                             |
| Power sensor HP 8481A                                                                                                                                                                                                          | MY41092180                                                          | 18-Sep-02 (Agilent, No. 20020918)         | In house check: Oct 03                                                                             |
| RF generator HP 8684C                                                                                                                                                                                                          | US3642U01700                                                        | 4-Aug-99 (SPEAG, in house check Aug-02)   | In house check: Aug-05                                                                             |
| Network Analyzer HP 8753E                                                                                                                                                                                                      | US37390585                                                          | 18-Oct-01 (Agilent, No. 24BR1033101)      | In house check: Oct 03                                                                             |
| Calibrated by:                                                                                                                                                                                                                 | Name<br>Nico Vetterli                                               | Function<br>Technician                    | Signature<br> |
| Approved by:                                                                                                                                                                                                                   | Name<br>Katja Pokovic                                               | Function<br>Laboratory Director           | Signature<br> |
| Date issued: October 23, 2003                                                                                                                                                                                                  |                                                                     |                                           |                                                                                                    |
| This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed. |                                                                     |                                           |                                                                                                    |

Schmid & Partner Engineering AG

**s p e a g**

---

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, <http://www.speag.com>

# Probe ET3DV6

## SN:1685

|                   |                  |
|-------------------|------------------|
| Manufactured:     | April 3, 2002    |
| Last calibration: | May 10, 2002     |
| Recalibrated:     | October 10, 2003 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

---

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

ET3DV6 SN:1685

October 10, 2003

## DASY - Parameters of Probe: ET3DV6 SN:1685

### Sensitivity in Free Space

|       |                                                 |
|-------|-------------------------------------------------|
| NormX | <b>1.60</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | <b>1.65</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | <b>1.56</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |

### Diode Compression

|       |           |    |
|-------|-----------|----|
| DCP X | <b>95</b> | mV |
| DCP Y | <b>95</b> | mV |
| DCP Z | <b>95</b> | mV |

### Sensitivity in Tissue Simulating Liquid

Head                      **900 MHz**                       $\epsilon_r = 41.5 \pm 5\%$                        $\sigma = 0.97 \pm 5\%$  mho/m  
Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>6.6</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>6.6</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.26</b> |
| ConvF Z | <b>6.6</b> $\pm 9.5\%$ (k=2) | Depth <b>3.07</b> |

Head                      **1800 MHz**                       $\epsilon_r = 40.0 \pm 5\%$                        $\sigma = 1.40 \pm 5\%$  mho/m  
Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>5.2</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>5.2</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.41</b> |
| ConvF Z | <b>5.2</b> $\pm 9.5\%$ (k=2) | Depth <b>2.77</b> |

### Boundary Effect

Head                      **900 MHz**                      Typical SAR gradient: 5 % per mm

|                                                    |             |             |
|----------------------------------------------------|-------------|-------------|
| Probe Tip to Boundary                              | <b>1 mm</b> | <b>2 mm</b> |
| SAR <sub>pe</sub> [%] Without Correction Algorithm | 8.9         | 5.4         |
| SAR <sub>pe</sub> [%] With Correction Algorithm    | 0.4         | 0.5         |

Head                      **1800 MHz**                      Typical SAR gradient: 10 % per mm

|                                                    |             |             |
|----------------------------------------------------|-------------|-------------|
| Probe Tip to Boundary                              | <b>1 mm</b> | <b>2 mm</b> |
| SAR <sub>pe</sub> [%] Without Correction Algorithm | 11.8        | 8.4         |
| SAR <sub>pe</sub> [%] With Correction Algorithm    | 0.4         | 0.2         |

### Sensor Offset

|                            |                                 |    |
|----------------------------|---------------------------------|----|
| Probe Tip to Sensor Center | <b>2.7</b>                      | mm |
| Optical Surface Detection  | <b>1.6 <math>\pm</math> 0.2</b> | mm |

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

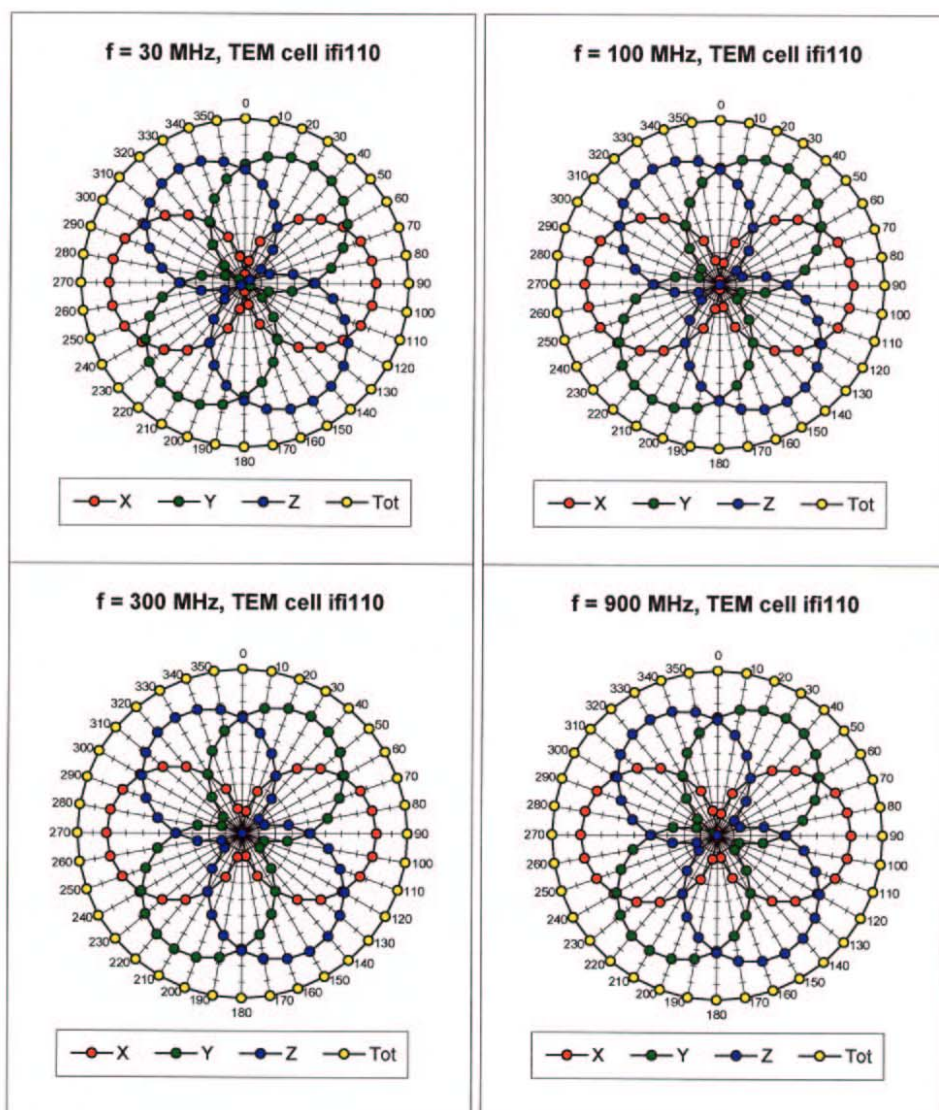
Facsimile: +81 596 24 8124



ET3DV6 SN:1685

October 10, 2003

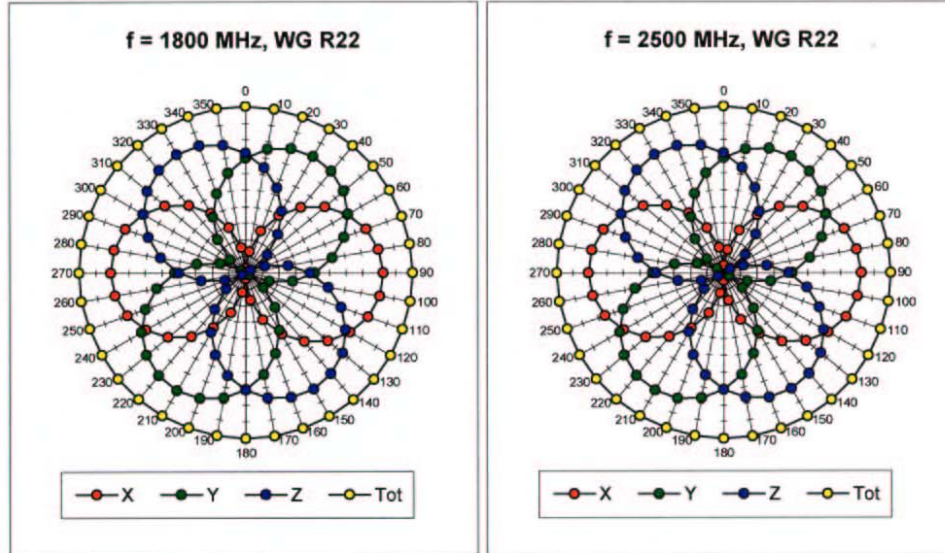
## Receiving Pattern ( $\phi, \theta = 0^\circ$ )



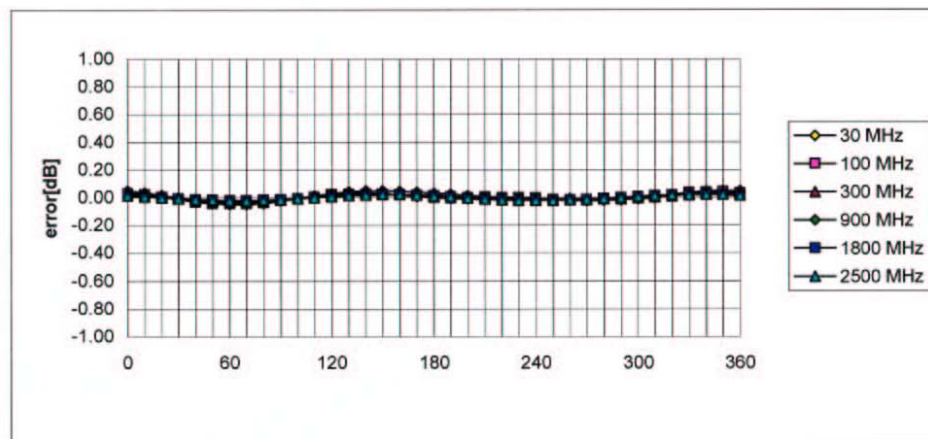


ET3DV6 SN:1685

October 10, 2003



### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$

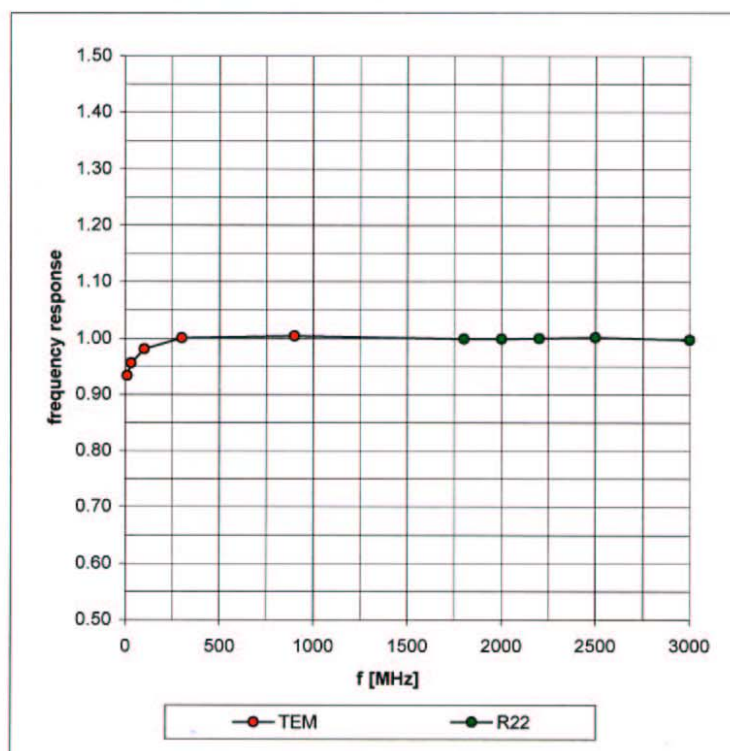


ET3DV6 SN:1685

October 10, 2003

## Frequency Response of E-Field

( TEM-Cell:ifi110, Waveguide R22)



---

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

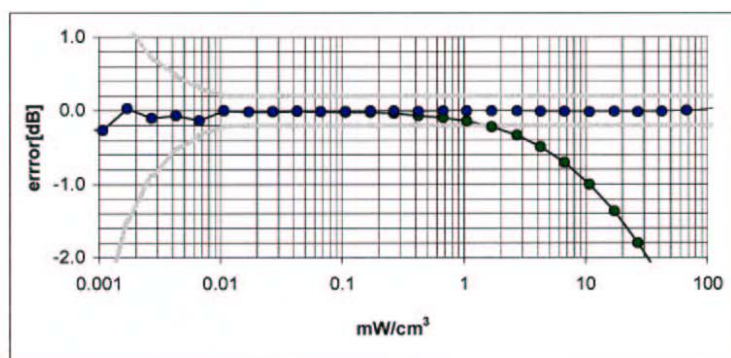
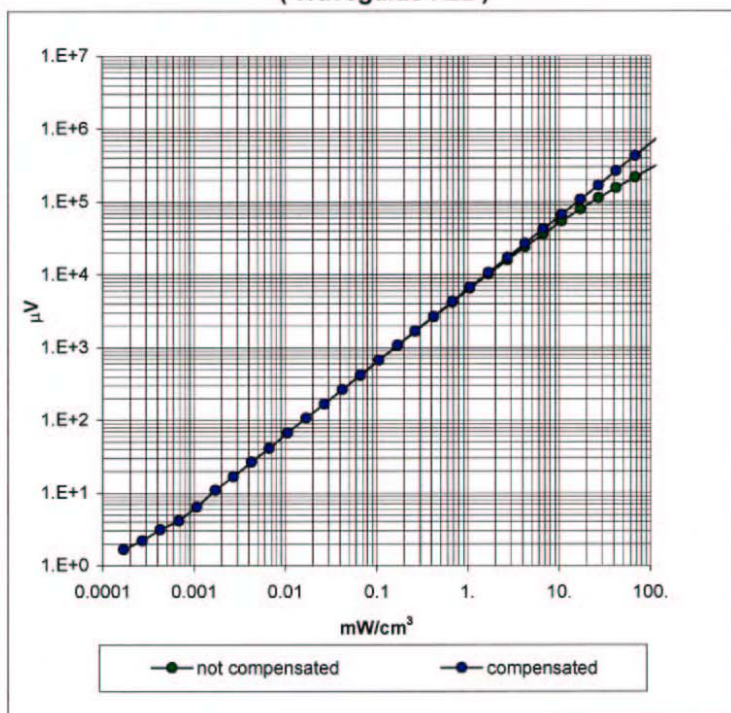
Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

ET3DV6 SN:1685

October 10, 2003

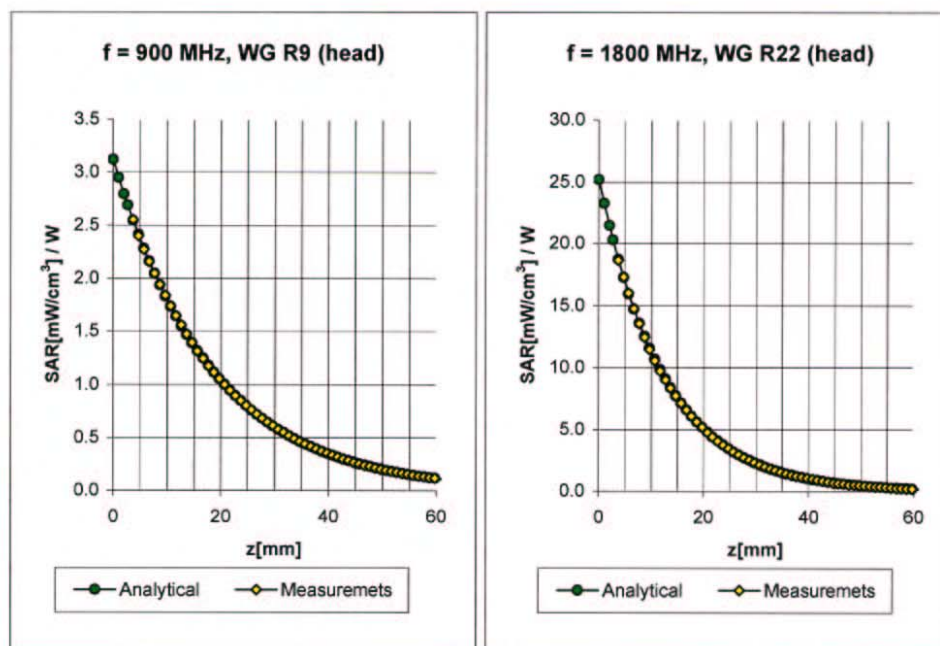
### Dynamic Range f(SAR<sub>brain</sub>) (Waveguide R22)



ET3DV6 SN:1685

October 10, 2003

## Conversion Factor Assessment



Head 900 MHz  $\epsilon_r = 41.5 \pm 5\%$   $\sigma = 0.97 \pm 5\%$  mho/m

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>6.6</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>6.6</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.26</b> |
| ConvF Z | <b>6.6</b> $\pm 9.5\%$ (k=2) | Depth <b>3.07</b> |

Head 1800 MHz  $\epsilon_r = 40.0 \pm 5\%$   $\sigma = 1.40 \pm 5\%$  mho/m

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>5.2</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>5.2</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.41</b> |
| ConvF Z | <b>5.2</b> $\pm 9.5\%$ (k=2) | Depth <b>2.77</b> |

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

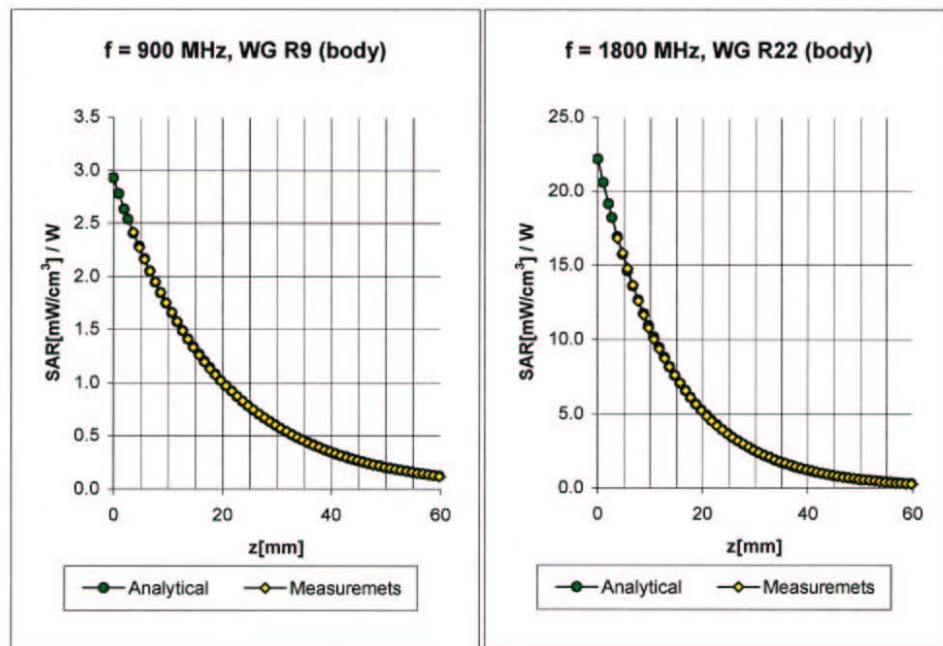
Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

ET3DV6 SN:1685

October 10, 2003

## Conversion Factor Assessment



Body 900 MHz  $\epsilon_r = 55.0 \pm 5\%$   $\sigma = 1.05 \pm 5\%$  mho/m

Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>6.4</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>6.4</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.27</b> |
| ConvF Z | <b>6.4</b> $\pm 9.5\%$ (k=2) | Depth <b>3.22</b> |

Body 1800 MHz  $\epsilon_r = 53.3 \pm 5\%$   $\sigma = 1.52 \pm 5\%$  mho/m

Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

|         |                              |                   |
|---------|------------------------------|-------------------|
| ConvF X | <b>4.7</b> $\pm 9.5\%$ (k=2) | Boundary effect:  |
| ConvF Y | <b>4.7</b> $\pm 9.5\%$ (k=2) | Alpha <b>0.48</b> |
| ConvF Z | <b>4.7</b> $\pm 9.5\%$ (k=2) | Depth <b>2.94</b> |

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

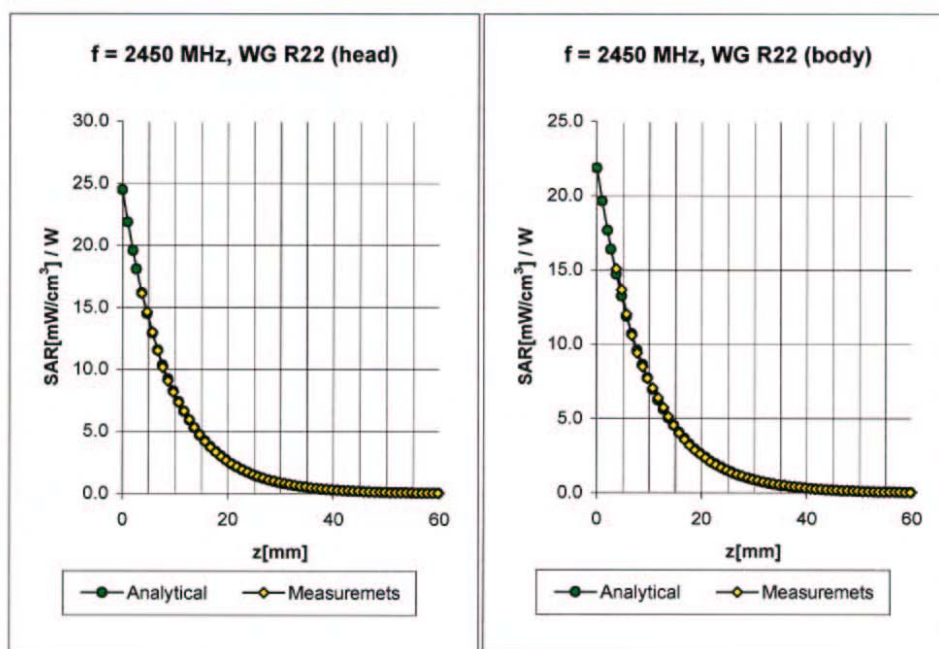
Facsimile: +81 596 24 8124



ET3DV6 SN:1685

October 10, 2003

## Conversion Factor Assessment



|                                                                                                |                              |                             |                                       |
|------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|---------------------------------------|
| <b>Head</b>                                                                                    | <b>2450 MHz</b>              | $\epsilon_r = 39.2 \pm 5\%$ | $\sigma = 1.80 \pm 5\% \text{ mho/m}$ |
| Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X |                              |                             |                                       |
| ConvF X                                                                                        | <b>4.7</b> $\pm 9.5\%$ (k=2) | Boundary effect:            |                                       |
| ConvF Y                                                                                        | <b>4.7</b> $\pm 9.5\%$ (k=2) | Alpha                       | <b>0.78</b>                           |
| ConvF Z                                                                                        | <b>4.7</b> $\pm 9.5\%$ (k=2) | Depth                       | <b>2.04</b>                           |
| <b>Body</b>                                                                                    | <b>2450 MHz</b>              | $\epsilon_r = 52.7 \pm 5\%$ | $\sigma = 1.95 \pm 5\% \text{ mho/m}$ |
| Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C      |                              |                             |                                       |
| ConvF X                                                                                        | <b>4.3</b> $\pm 9.5\%$ (k=2) | Boundary effect:            |                                       |
| ConvF Y                                                                                        | <b>4.3</b> $\pm 9.5\%$ (k=2) | Alpha                       | <b>0.80</b>                           |
| ConvF Z                                                                                        | <b>4.3</b> $\pm 9.5\%$ (k=2) | Depth                       | <b>1.89</b>                           |

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124

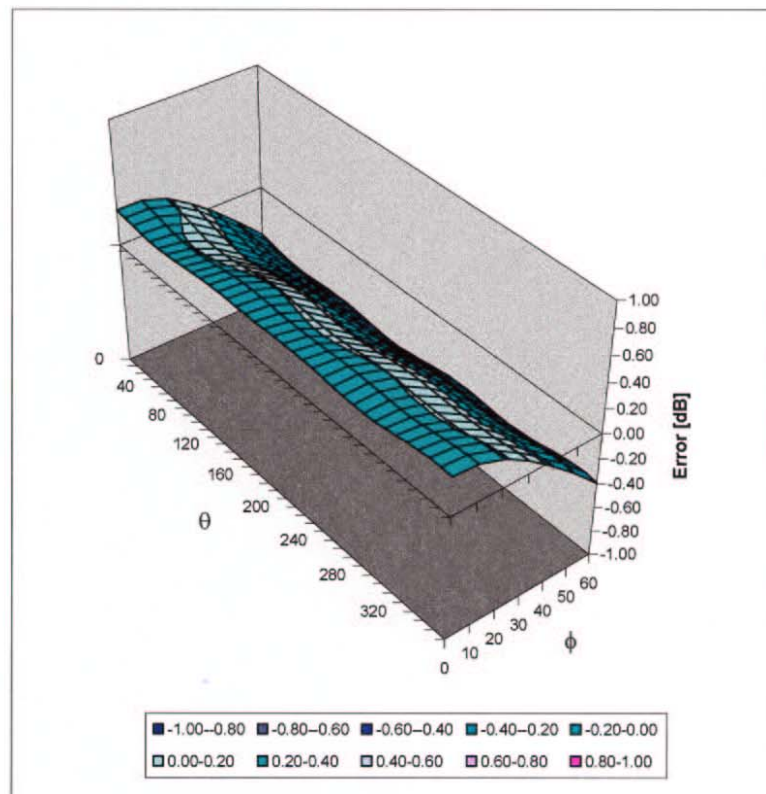


ET3DV6 SN:1685

October 10, 2003

## Deviation from Isotropy in HSL

Error ( $\theta\phi$ ),  $f = 900$  MHz



---

**UL Apex Co., Ltd.**

**Head Office EMC Lab.**

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8116

Facsimile: +81 596 24 8124