

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

<b>DASY Version</b>	DASY5	V52.8.8
<b>Phantom</b>	HAC Test Arch	
<b>Distance Dipole Top - Probe Center</b>	15 mm	
<b>Scan resolution</b>	dx, dy = 5 mm	
<b>Frequency</b>	1880 MHz $\pm$ 1 MHz	
<b>Input power drift</b>	< 0.05 dB	

## Maximum Field values at 1880 MHz

<b>E-field 15 mm above dipole surface</b>	<b>condition</b>	<b>Interpolated maximum</b>
Maximum measured above high end	100 mW input power	91.4 V/m = 39.22 dBV/m
Maximum measured above low end	100 mW input power	90.1 V/m = 39.09 dBV/m
Averaged maximum above arm	100 mW input power	<b>90.7 V/m <math>\pm</math> 12.8 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters

<b>Frequency</b>	<b>Return Loss</b>	<b>Impedance</b>
1730 MHz	36.7 dB	50.2 $\Omega$ - 1.5 j $\Omega$
1880 MHz	18.2 dB	51.1 $\Omega$ + 12.5 j $\Omega$
1900 MHz	18.6 dB	54.3 $\Omega$ + 11.6 j $\Omega$
1950 MHz	22.9 dB	55.3 $\Omega$ + 5.3 j $\Omega$
2000 MHz	19.6 dB	50.6 $\Omega$ + 10.6 j $\Omega$

### 3.2 Antenna Design and Handling

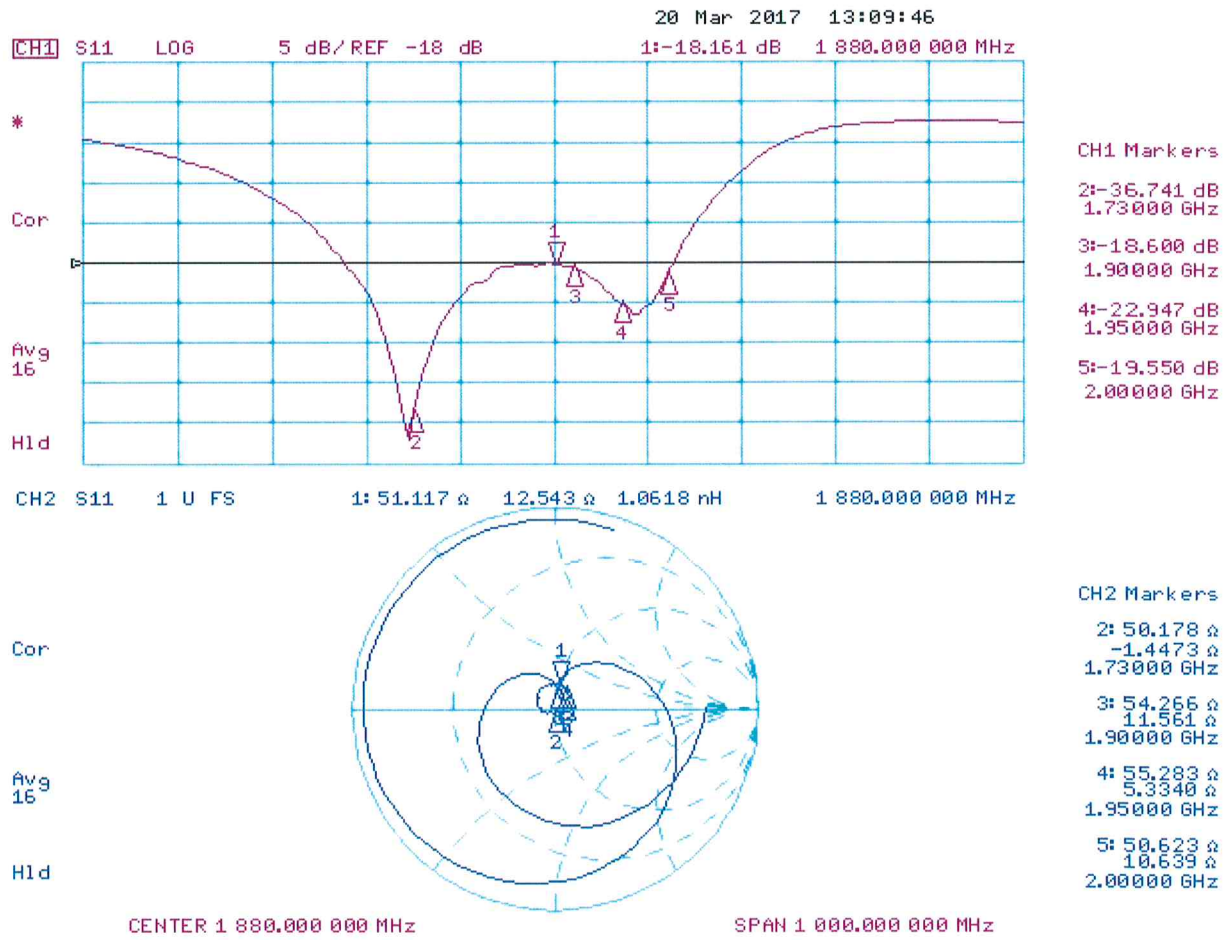
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

# Impedance Measurement Plot



# DASY5 E-field Result

Date: 17.03.2017

Test Laboratory: SPEAG Lab2

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1062**

Communication System: UID 0 - CW ; Frequency: 1880 MHz

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 30.12.2016;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 02.09.2016
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):**

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 160.8 V/m; Power Drift = 0.01 dB

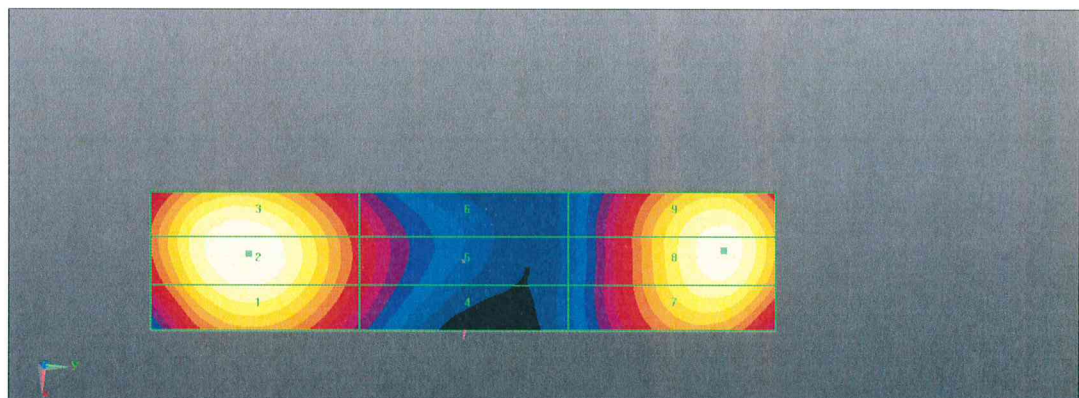
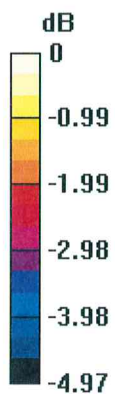
Applied MIF = 0.00 dB

RF audio interference level = 39.22 dBV/m

**Emission category: M2**

MIF scaled E-field

Grid 1 M2 38.94 dBV/m	Grid 2 M2 39.22 dBV/m	Grid 3 M2 39.15 dBV/m
Grid 4 M2 36.86 dBV/m	Grid 5 M2 37.05 dBV/m	Grid 6 M2 36.96 dBV/m
Grid 7 M2 38.81 dBV/m	Grid 8 M2 39.09 dBV/m	Grid 9 M2 39.05 dBV/m



0 dB = 91.45 V/m = 39.22 dBV/m



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Client : **Sporton International INC**

Certificate No: **Z17-97153**

## CALIBRATION CERTIFICATE

Object **DAE4 - SN: 1326**

Calibration Procedure(s) **FF-Z11-002-01**  
**Calibration Procedure for the Data Acquisition Electronics (DAEx)**

Calibration date: **September 15, 2017**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: September 18, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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### **Glossary:**

DAE data acquisition electronics  
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

### **Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



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### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.898 $\pm$ 0.15% (k=2)	405.241 $\pm$ 0.15% (k=2)	404.618 $\pm$ 0.15% (k=2)
Low Range	3.98840 $\pm$ 0.7% (k=2)	3.99650 $\pm$ 0.7% (k=2)	3.99854 $\pm$ 0.7% (k=2)

### Connector Angle

Connector Angle to be used in DASY system	41.5° $\pm$ 1°
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Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton-KS (Auden)**

Certificate No: **ER3-2476\_Nov16**

## CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2476**

Calibration procedure(s) **QA CAL-02.v8, QA CAL-25.v6  
Calibration procedure for E-field probes optimized for close near field  
evaluations in air**

Calibration date: **November 23, 2016**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ER3DV6	SN: 2328	14-Oct-16 (No. ER3-2328_Oct16)	Oct-17
DAE4	SN: 789	11-Nov-16 (No. DAE4-789_Nov16)	Nov-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: November 25, 2016

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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Multilateral Agreement for the recognition of calibration certificates

### Glossary:

NORM <sub>x,y,z</sub>	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

### Calibration is Performed According to the Following Standards:

- IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- CTIA Test Plan for Hearing Aid Compatibility, Rev 3.0, November 2013

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  for XY sensors and  $\vartheta = 90$  for Z sensor ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart).
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- Spherical isotropy (3D deviation from isotropy)**: in a locally homogeneous field realized using an open waveguide setup.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



# Probe ER3DV6

## SN:2476

Manufactured: March 31, 2009  
Calibrated: November 23, 2016

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

## DASY/EASY - Parameters of Probe: ER3DV6 - SN:2476

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	1.87	1.64	2.15	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	99.9	100.2	101.5	

### Modulation Calibration Parameters

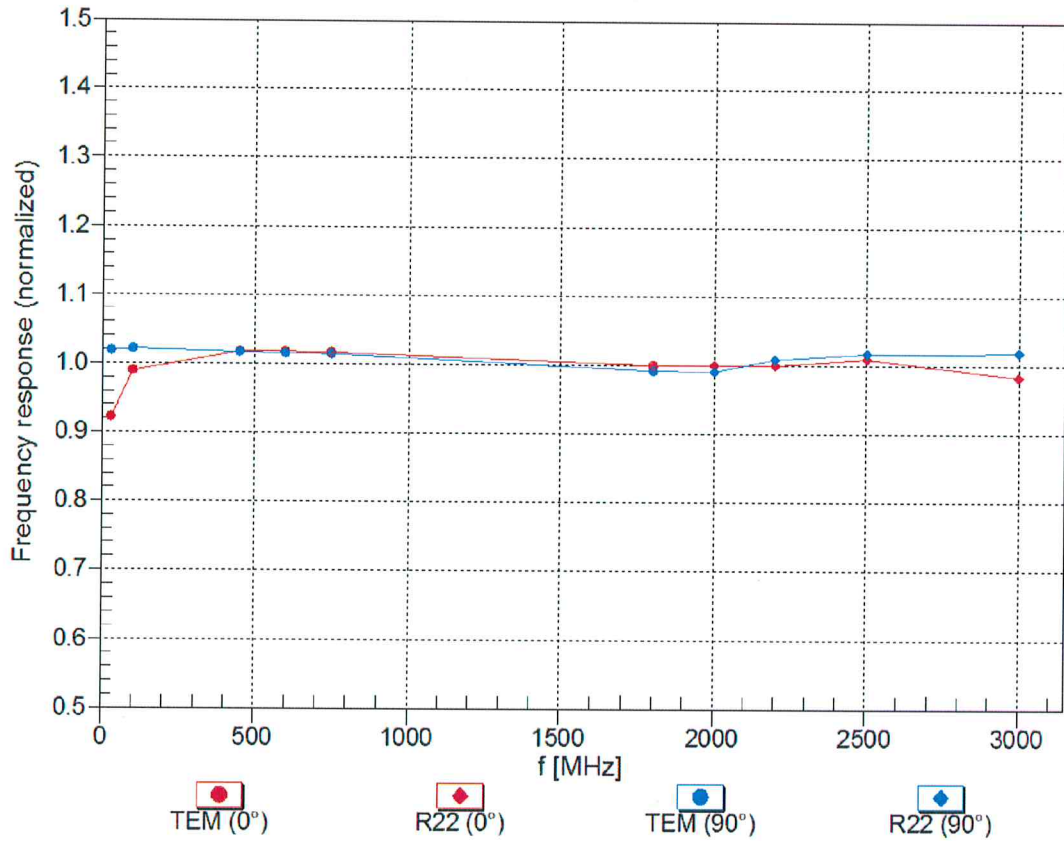
UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	183.4	$\pm 3.3 \%$
		Y	0.0	0.0	1.0		208.3	
		Z	0.0	0.0	1.0		231.9	
10011-CAB	UMTS-FDD (WCDMA)	X	3.33	67.4	19.0	2.91	149.1	$\pm 0.7 \%$
		Y	3.26	67.0	18.9		125.3	
		Z	3.27	67.3	19.1		140.4	
10021-DAC	GSM-FDD (TDMA, GMSK)	X	17.50	100.0	28.4	9.39	137.1	$\pm 1.7 \%$
		Y	16.60	99.2	28.5		115.1	
		Z	22.35	99.5	29.0		112.3	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.65	66.5	19.1	4.57	111.6	$\pm 0.9 \%$
		Y	4.75	66.7	19.3		128.0	
		Z	4.83	67.3	19.6		143.5	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.99	66.6	19.1	3.97	148.4	$\pm 0.7 \%$
		Y	3.93	66.2	18.9		123.3	
		Z	3.95	66.6	19.1		137.5	
10295-AAB	CDMA2000, RC1, SO3, 1/8th Rate 25 fr.	X	14.10	99.6	41.9	12.49	86.6	$\pm 1.9 \%$
		Y	13.03	95.0	39.3		101.1	
		Z	18.07	99.9	39.6		93.9	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

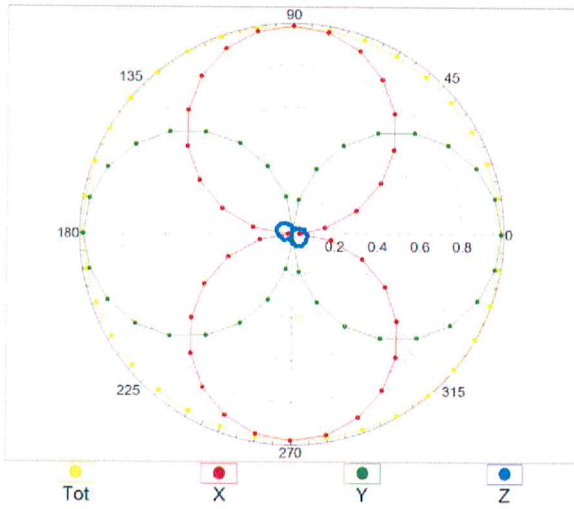
### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



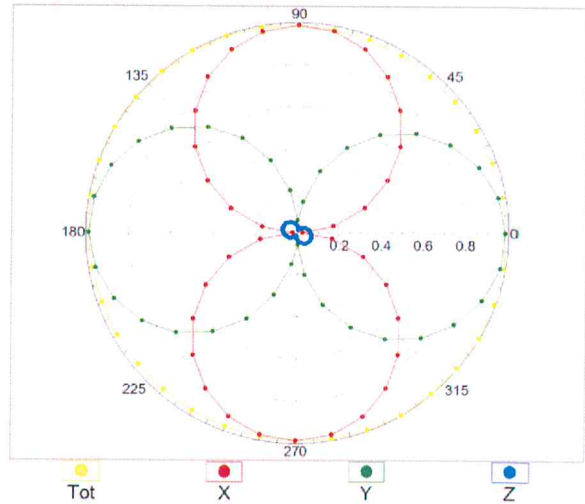
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz, TEM,  $0^\circ$

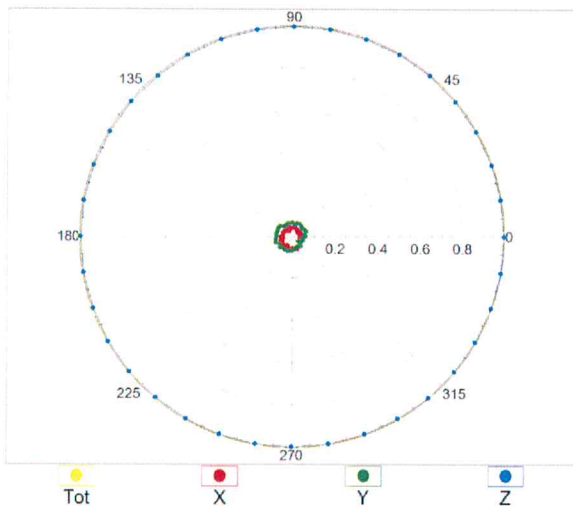


f=2500 MHz, R22,  $0^\circ$

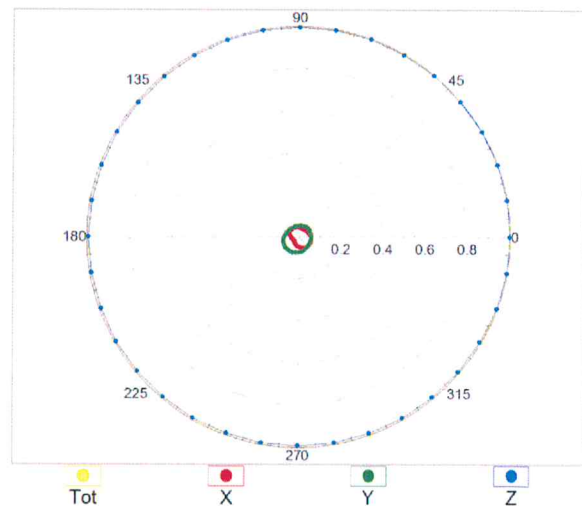


### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$

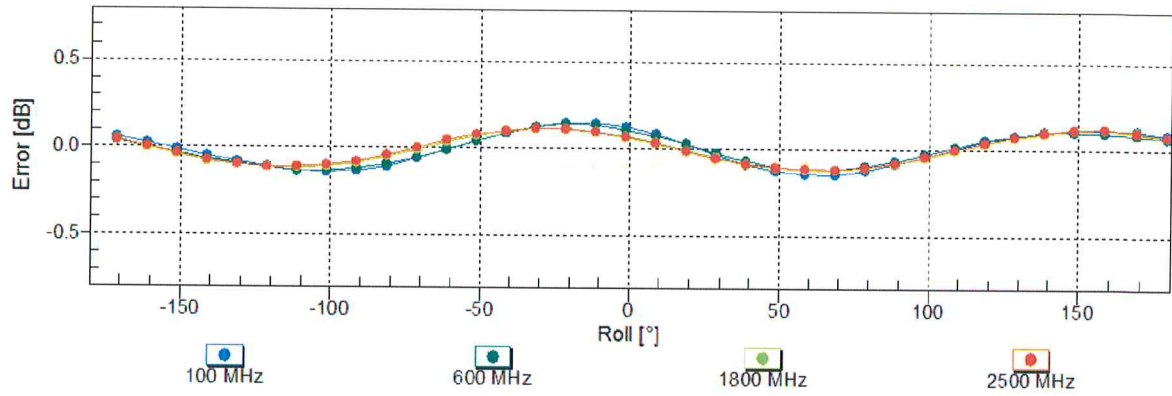
f=600 MHz, TEM,  $90^\circ$



f=2500 MHz, R22,  $90^\circ$

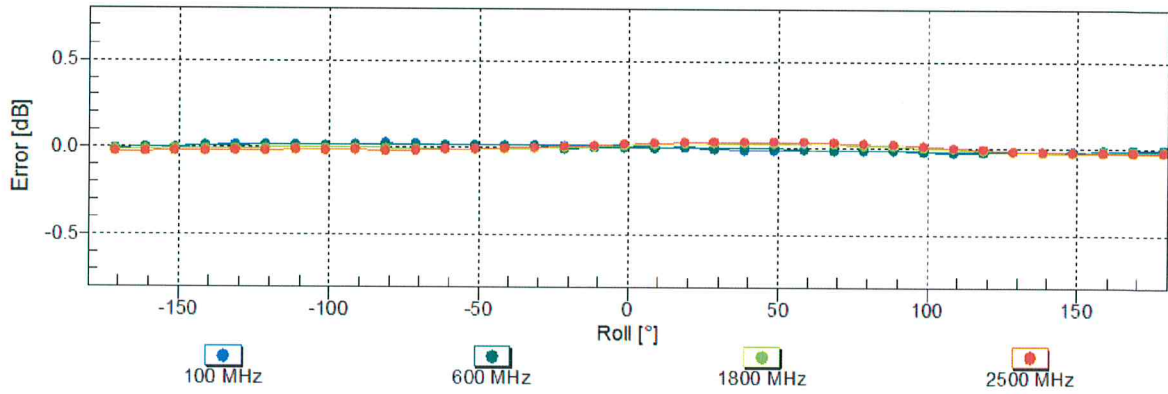


### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



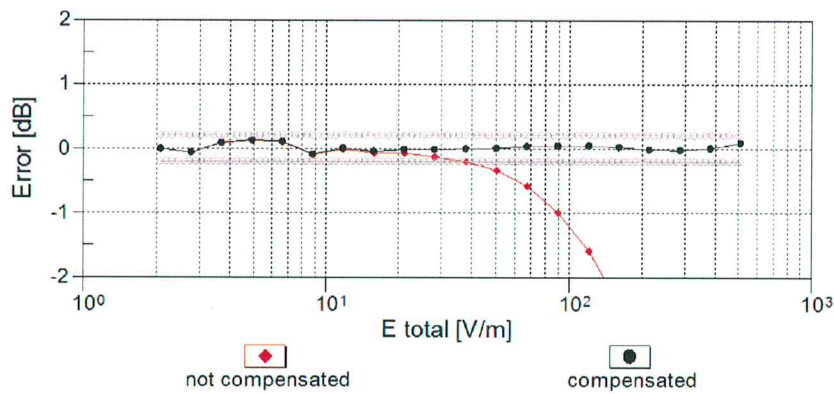
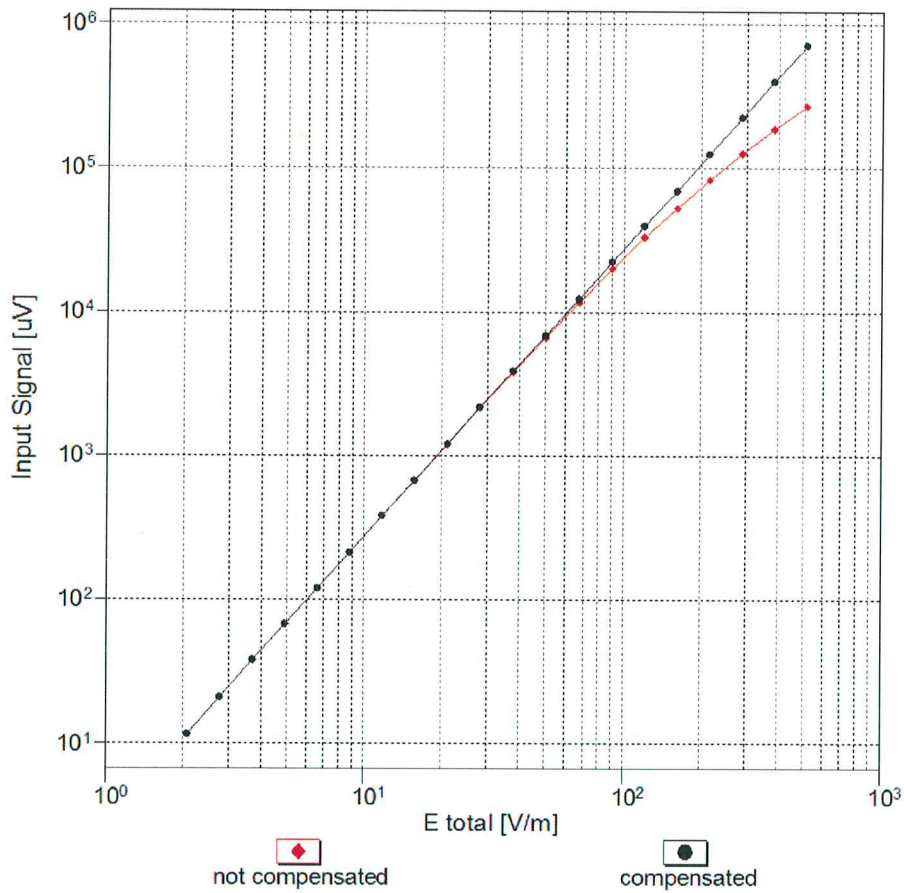
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$



Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

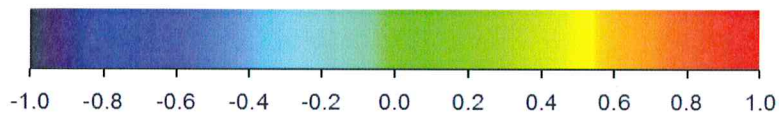
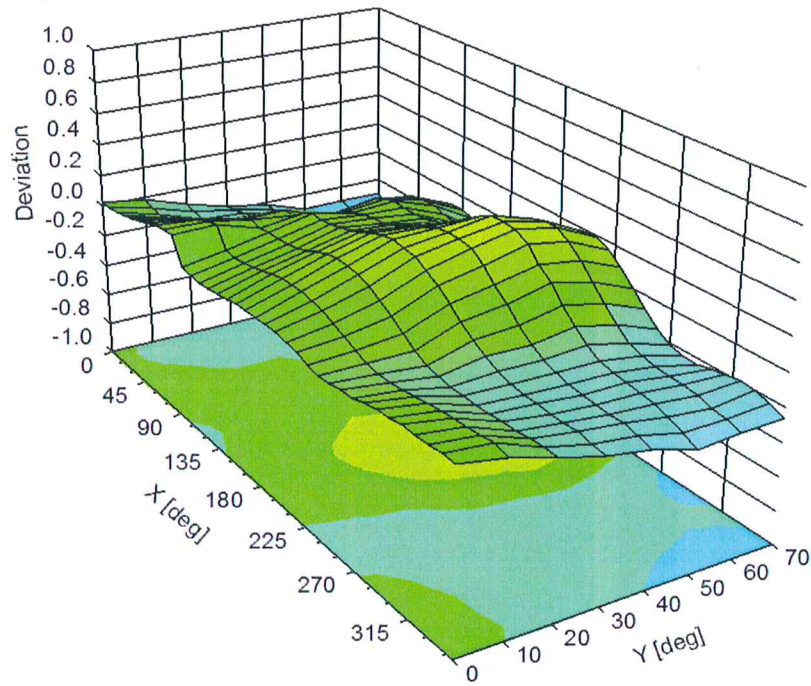
### Dynamic Range f(E-field) (TEM cell , f = 900 MHz)



Uncertainty of Linearity Assessment: ± 0.6% (k=2)

# Deviation from Isotropy in Air

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



**Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )**

## DASY/EASY - Parameters of Probe: ER3DV6 - SN:2476

### Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	18.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	8 mm
Probe Tip to Sensor X Calibration Point	2.5 mm
Probe Tip to Sensor Y Calibration Point	2.5 mm
Probe Tip to Sensor Z Calibration Point	2.5 mm