



SPORTON LAB.

CD3500V2 – serial no. 1020						
3600 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.6.29	-24.560		47.546		-5.2317	
2023.6.28	-23.797	-3.11	47.349	0.197	-4.8949	-0.3368
2024.6.28	-24.947	1.58	51.354	-3.808	-6.1508	0.9191

CD3500V2 – serial no. 1020						
3950 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.6.29	-18.907		53.237		11.323	
2023.6.28	-17.785	-5.93	53.101	0.136	12.430	-1.107
2024.6.28	-18.356	-2.91	53.703	-0.466	13.079	-1.756

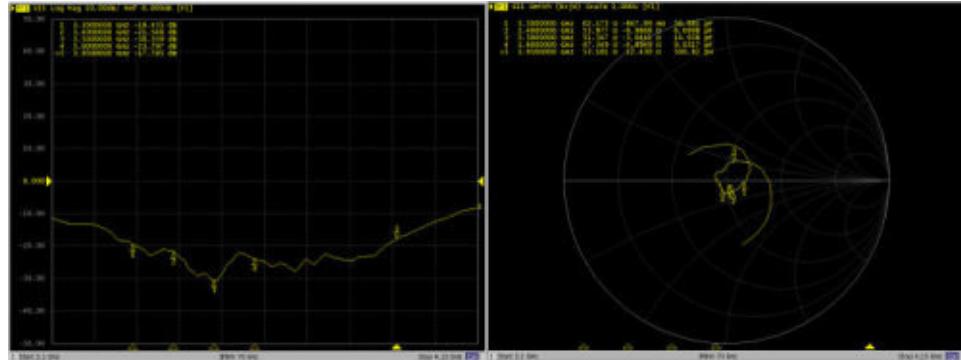
#### <Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration.

Therefore the verification result should support extended calibration.

#### Dipole Verification Data> CD3500V2, serial no. 1020

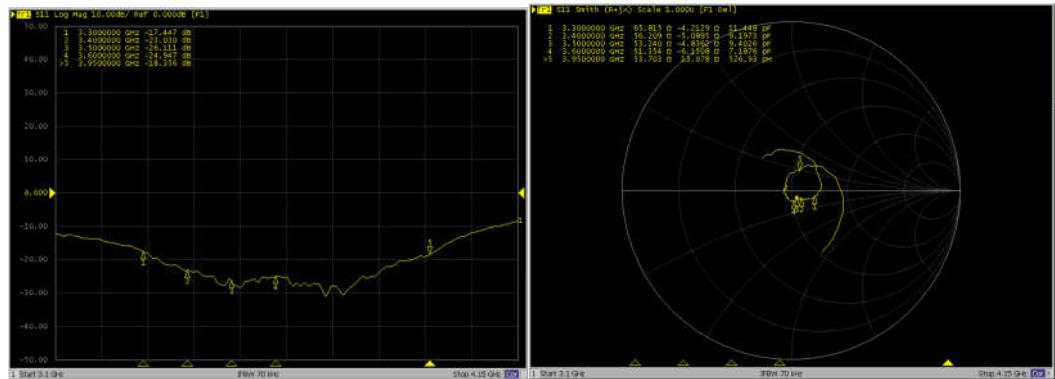
3300MHz -3400MHz -3500MHz -3600MHz -3950MHz – Head – 2023.6.28





SPORTON LAB.

## 3300MHz -3400MHz -3500MHz -3600MHz -3950MHz – Head – 2024.6.28



## IMPORTANT NOTICE

### **USAGE OF THE DAE4**

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange:** The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

**Shipping of the DAE:** Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures:** Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair:** Minor repairs are performed at no extra cost during the calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**DASY Configuration Files:** Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 M $\Omega$  is given in the corresponding configuration file.

**Important Note:**

**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**

**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the calibration procedure.**

**Important Note:**

**To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.**

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
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Multilateral Agreement for the recognition of calibration certificates

Client **Sporton**  
Shenzhen City

Accreditation No.: **SCS 0108**

Certificate No: **DAE4-715\_Jan24**

## CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BM - SN: 715

Calibration procedure(s) QA CAL-06.v30  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: January 25, 2024

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
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-23 (No:37421)	Aug-24
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001 SE UMS 006 AA 1002	23-Jan-24 (in house check) 23-Jan-24 (in house check)	In house check: Jan-25 In house check: Jan-25

Calibrated by: Name: Dominique Steffen Function: Laboratory Technician

Signature:

Approved by: Name: Sven Kühn Function: Technical Manager

Signature:

Issued: January 25, 2024

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

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**Schmid & Partner**  
**Engineering AG**  
**Zeughausstrasse 43, 8004 Zurich, Switzerland**



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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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB =  $6.1\mu V$ , full range = -100...+300 mVLow 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	$405.105 \pm 0.02\% (k=2)$	$404.650 \pm 0.02\% (k=2)$	$404.469 \pm 0.02\% (k=2)$
Low Range	$3.99033 \pm 1.50\% (k=2)$	$3.97774 \pm 1.50\% (k=2)$	$3.96836 \pm 1.50\% (k=2)$

**Connector Angle**

Connector Angle to be used in DASY system	$203.0^\circ \pm 1^\circ$
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#### **4. AD-Converter Values with inputs shorted**

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

	High Range (LSB)	Low Range (LSB)
<b>Channel X</b>	15783	16054
<b>Channel Y</b>	15995	15951
<b>Channel Z</b>	16466	16344

#### **5. Input Offset Measurement**

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

Input  $10M\Omega$

	Average ( $\mu V$ )	min. Offset ( $\mu V$ )	max. Offset ( $\mu V$ )	Std. Deviation ( $\mu V$ )
<b>Channel X</b>	0.78	-0.24	1.60	0.35
<b>Channel Y</b>	-0.56	-1.30	0.23	0.37
<b>Channel Z</b>	-0.07	-1.14	1.20	0.39

#### **6. Input Offset Current**

Nominal Input circuitry offset current on all channels: <25fA

#### **7. Input Resistance** (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
<b>Channel X</b>	200	200
<b>Channel Y</b>	200	200
<b>Channel Z</b>	200	200

#### **8. Low Battery Alarm Voltage** (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

#### **9. Power Consumption** (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9



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## Glossary

NORM $x,y,z$	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
En	incident E-field orientation normal to probe axis
Ep	incident E-field orientation parallel to probe axis
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ 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 3.1.1, May 2017

## Methods Applied and Interpretation of Parameters:

- $NORMx,y,z$ : Assessed for E-field polarization  $\theta = 0$  for XY sensors and  $\theta = 90$  for Z sensor ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz in R22 waveguide).
- $NORM(f)x,y,z = NORMx,y,z * frequency\_response$  (see Frequency Response Chart).
- $DCPx,y,z$ : DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. 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
- $Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z$ : 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  $NORMx$  (no uncertainty required).

EF3DV3 - SN:4053

September 15, 2023

## Parameters of Probe: EF3DV3 - SN:4053

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ( $k = 2$ )
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	0.73	0.75	1.59	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	101.2	97.6	100.3	$\pm 4.7\%$

### Calibration Results for Frequency Response (30 MHz – 5.8 GHz)

Frequency MHz	Target E-field (En) V/m	Measured E-field (En) V/m	Deviation E-field (En)	Target E-field (Ep) V/m	Measured E-field (Ep) V/m	Deviation E-field (Ep)	Unc ( $k = 2$ )
30	77.1	76.9	-0.3%	77.1	77.0	-0.1%	$\pm 5.1\%$
100	76.9	77.8	1.2%	77.0	77.9	1.1%	$\pm 5.1\%$
450	77.1	78.3	1.4%	77.2	78.2	1.3%	$\pm 5.1\%$
600	77.1	77.8	0.9%	77.2	77.8	0.7%	$\pm 5.1\%$
750	77.2	77.7	0.6%	77.2	77.5	0.4%	$\pm 5.1\%$
1800	143.2	139.9	-2.3%	143.3	140.2	-2.2%	$\pm 5.1\%$
2000	135.2	129.6	-4.2%	135.1	129.5	-4.1%	$\pm 5.1\%$
2200	127.7	124.5	-2.5%	127.8	125.8	-1.6%	$\pm 5.1\%$
2500	125.4	120.1	-4.3%	125.5	121.2	-3.5%	$\pm 5.1\%$
3000	79.4	76.0	-4.3%	79.5	77.2	-2.9%	$\pm 5.1\%$
3500	255.8	254.6	-0.5%	256.1	252.2	-1.5%	$\pm 5.1\%$
3700	250.0	244.6	-2.2%	249.9	242.9	-2.8%	$\pm 5.1\%$
5200	50.2	50.1	-0.1%	50.1	50.4	0.5%	$\pm 5.1\%$
5500	49.6	48.7	-1.7%	49.6	49.0	-1.2%	$\pm 5.1\%$
5800	48.9	48.0	-1.8%	48.9	47.5	-2.8%	$\pm 5.1\%$

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> Linearization parameter uncertainty for maximum specified field strength.

<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.



EF3DV3 - SN:4053

September 15, 2023

## Parameters of Probe: EF3DV3 - SN:4053

### Sensor Frequency Model Parameters

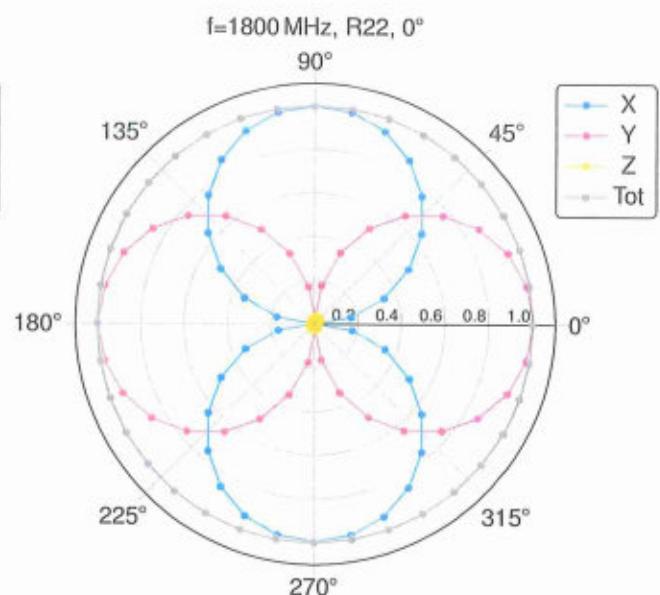
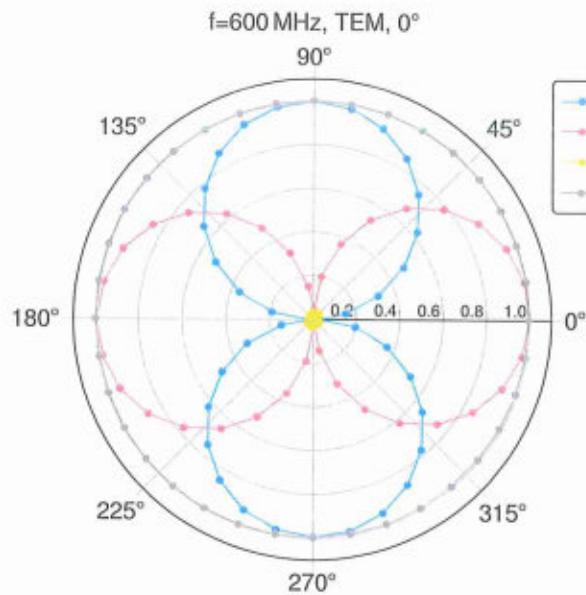
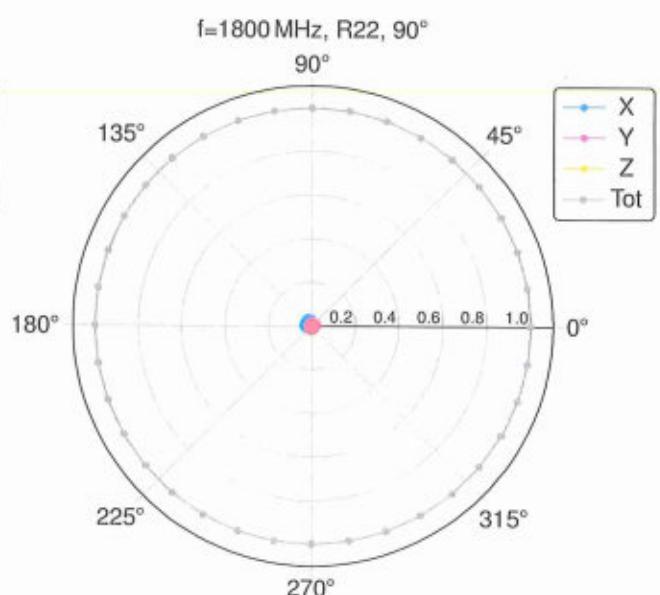
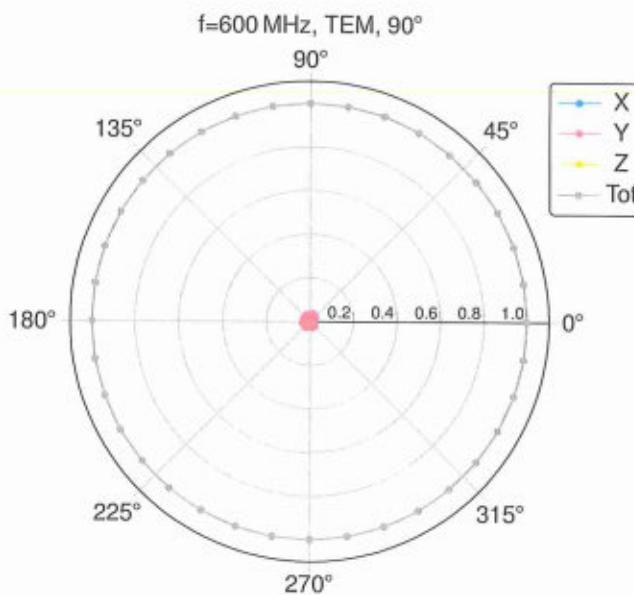
	Sensor X	Sensor Y	Sensor Z
Frequency Corr. (LF)	0.04	-0.07	6.55
Frequency Corr. (HF)	2.82	2.82	2.82

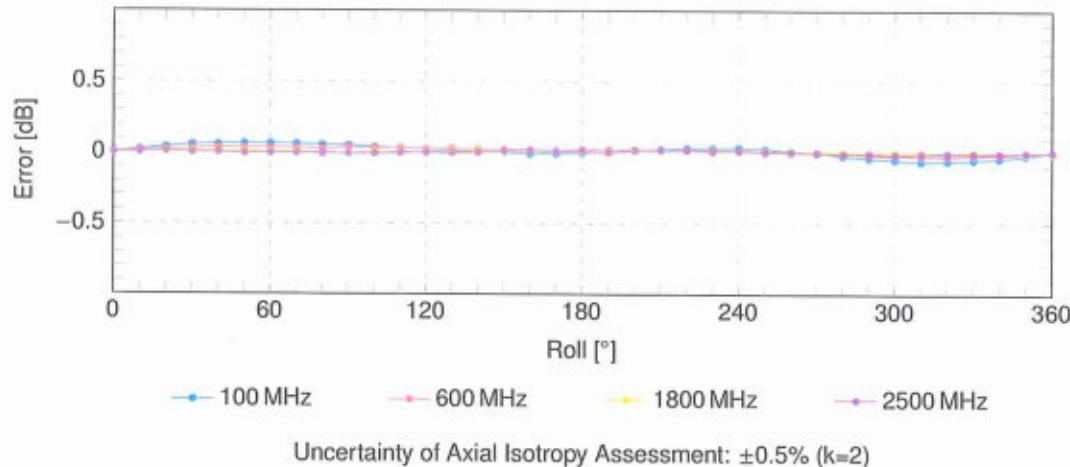
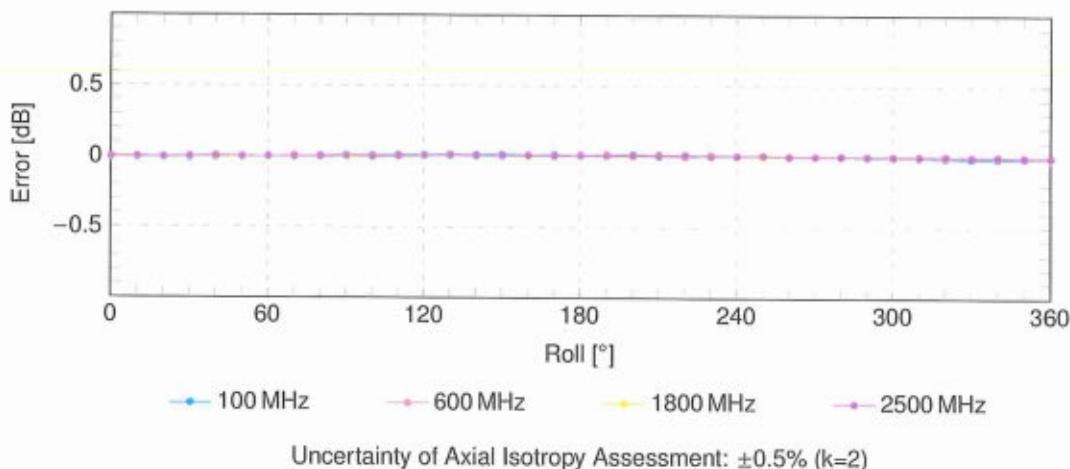
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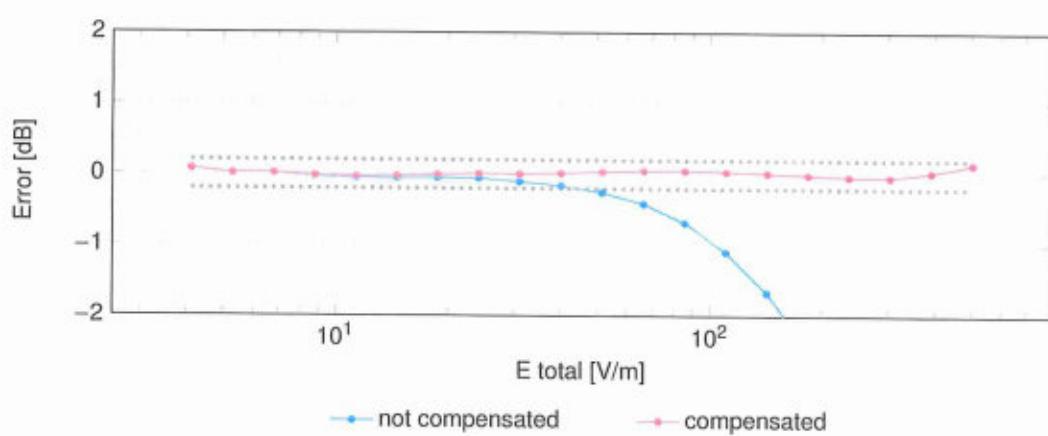
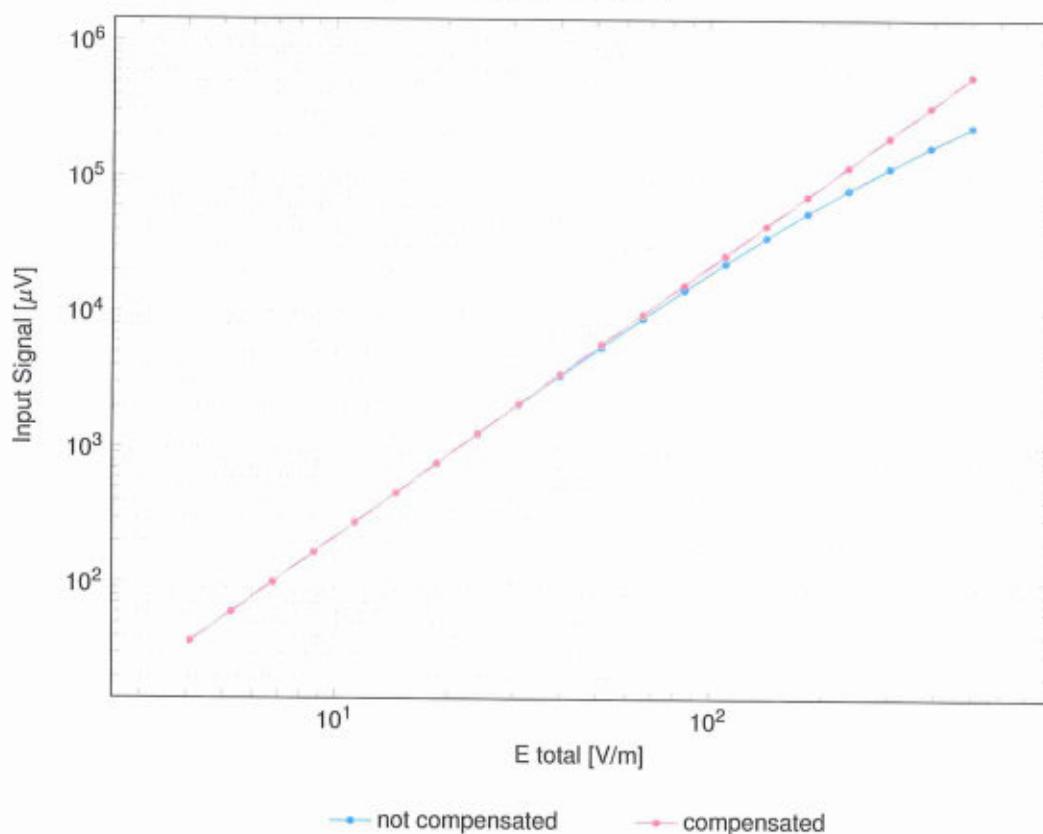
	C1 fF	C2 fF	$\alpha$ V $^{-1}$	T1 ms V $^{-2}$	T2 ms V $^{-1}$	T3 ms	T4 V $^{-2}$	T5 V $^{-1}$	T6
x	33.7	216.67	35.11	5.62	0.28	4.94	1.33	0.00	1.00
y	57.1	374.83	36.47	12.87	0.70	5.02	1.28	0.27	1.01
z	8.5	55.04	35.18	4.33	0.00	4.95	0.46	0.00	1.00

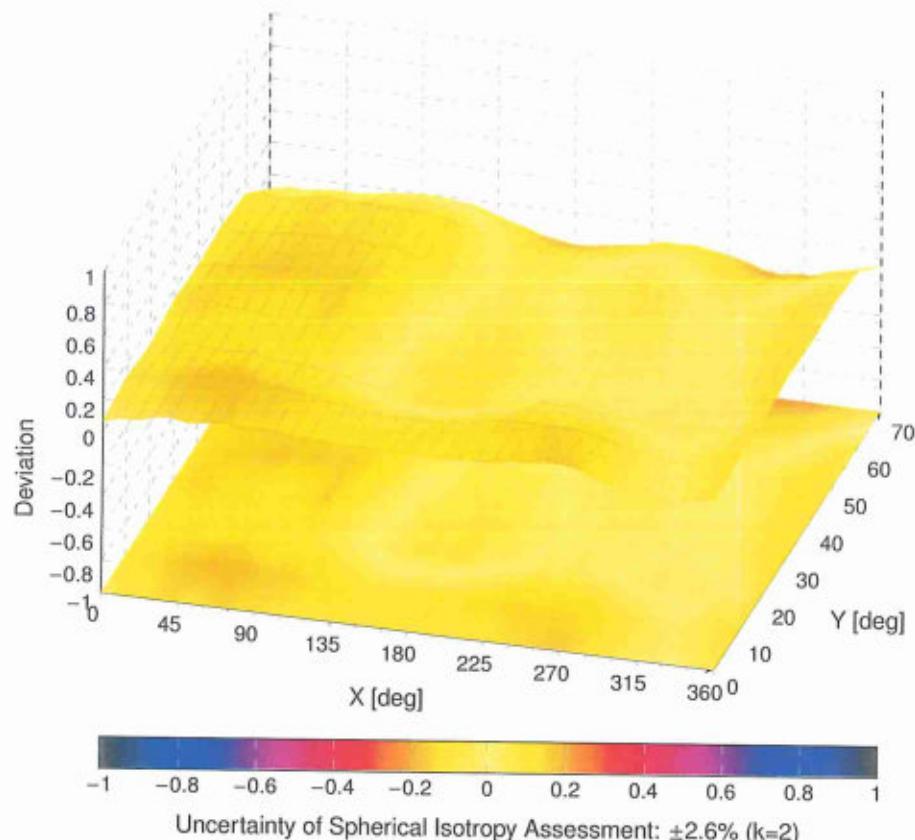
### Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle	168.4°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	12 mm
Tip Length	25 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm
Probe Tip to Sensor Z Calibration Point	1.5 mm

**Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$** **Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$** 

**Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$** **Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$** 

**Dynamic Range f(E-field)**(TEM cell,  $f_{eval} = 900$  MHz)Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

**Deviation from Isotropy in Air**Error ( $\phi, \theta$ ),  $f = 900\text{ MHz}$ 























UID	Rev	Communication System Name	Group	PAR (dB)	Unc <sup>E</sup> k = 2
10983	AAA	5G NR DL (CP-OFDM, TM 3.1, 40 MHz, 64-QAM, 15 kHz)	5G NR FR1 TDD	9.31	$\pm 9.6$
10984	AAA	5G NR DL (CP-OFDM, TM 3.1, 50 MHz, 64-QAM, 15 kHz)	5G NR FR1 TDD	9.42	$\pm 9.6$
10985	AAA	5G NR DL (CP-OFDM, TM 3.1, 40 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.54	$\pm 9.6$
10986	AAA	5G NR DL (CP-OFDM, TM 3.1, 50 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.50	$\pm 9.6$
10987	AAA	5G NR DL (CP-OFDM, TM 3.1, 60 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.53	$\pm 9.6$
10988	AAA	5G NR DL (CP-OFDM, TM 3.1, 70 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.38	$\pm 9.6$
10989	AAA	5G NR DL (CP-OFDM, TM 3.1, 80 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.33	$\pm 9.6$
10990	AAA	5G NR DL (CP-OFDM, TM 3.1, 90 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	9.52	$\pm 9.6$
11003	AAA	5G NR DL (CP-OFDM, TM 3.1, 30 MHz, 64-QAM, 15 kHz)	5G NR FR1 TDD	10.24	$\pm 9.6$
11004	AAA	5G NR DL (CP-OFDM, TM 3.1, 30 MHz, 64-QAM, 30 kHz)	5G NR FR1 TDD	10.73	$\pm 9.6$
11005	AAA	5G NR DL (CP-OFDM, TM 3.1, 25 MHz, 64-QAM, 15 kHz)	5G NR FR1 FDD	8.70	$\pm 9.6$
11006	AAA	5G NR DL (CP-OFDM, TM 3.1, 30 MHz, 64-QAM, 15 kHz)	5G NR FR1 FDD	8.55	$\pm 9.6$
11007	AAA	5G NR DL (CP-OFDM, TM 3.1, 40 MHz, 64-QAM, 15 kHz)	5G NR FR1 FDD	8.46	$\pm 9.6$
11008	AAA	5G NR DL (CP-OFDM, TM 3.1, 50 MHz, 64-QAM, 15 kHz)	5G NR FR1 FDD	8.51	$\pm 9.6$
11009	AAA	5G NR DL (CP-OFDM, TM 3.1, 25 MHz, 64-QAM, 30 kHz)	5G NR FR1 FDD	8.76	$\pm 9.6$
11010	AAA	5G NR DL (CP-OFDM, TM 3.1, 30 MHz, 64-QAM, 30 kHz)	5G NR FR1 FDD	8.95	$\pm 9.6$
11011	AAA	5G NR DL (CP-OFDM, TM 3.1, 40 MHz, 64-QAM, 30 kHz)	5G NR FR1 FDD	8.96	$\pm 9.6$
11012	AAA	5G NR DL (CP-OFDM, TM 3.1, 50 MHz, 64-QAM, 30 kHz)	5G NR FR1 FDD	8.68	$\pm 9.6$
11013	AAA	IEEE 802.11be (320 MHz, MCS1, 99pc duty cycle)	WLAN	8.47	$\pm 9.6$
11014	AAA	IEEE 802.11be (320 MHz, MCS2, 99pc duty cycle)	WLAN	8.45	$\pm 9.6$
11015	AAA	IEEE 802.11be (320 MHz, MCS3, 99pc duty cycle)	WLAN	8.44	$\pm 9.6$
11016	AAA	IEEE 802.11be (320 MHz, MCS4, 99pc duty cycle)	WLAN	8.44	$\pm 9.6$
11017	AAA	IEEE 802.11be (320 MHz, MCS5, 99pc duty cycle)	WLAN	8.41	$\pm 9.6$
11018	AAA	IEEE 802.11be (320 MHz, MCS6, 99pc duty cycle)	WLAN	8.40	$\pm 9.6$
11019	AAA	IEEE 802.11be (320 MHz, MCS7, 99pc duty cycle)	WLAN	8.29	$\pm 9.6$
11020	AAA	IEEE 802.11be (320 MHz, MCS8, 99pc duty cycle)	WLAN	8.27	$\pm 9.6$
11021	AAA	IEEE 802.11be (320 MHz, MCS9, 99pc duty cycle)	WLAN	8.46	$\pm 9.6$
11022	AAA	IEEE 802.11be (320 MHz, MCS10, 99pc duty cycle)	WLAN	8.36	$\pm 9.6$
11023	AAA	IEEE 802.11be (320 MHz, MCS11, 99pc duty cycle)	WLAN	8.09	$\pm 9.6$
11024	AAA	IEEE 802.11be (320 MHz, MCS12, 99pc duty cycle)	WLAN	8.42	$\pm 9.6$
11025	AAA	IEEE 802.11be (320 MHz, MCS13, 99pc duty cycle)	WLAN	8.37	$\pm 9.6$
11026	AAA	IEEE 802.11be (320 MHz, MCS0, 99pc duty cycle)	WLAN	8.39	$\pm 9.6$

<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.