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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

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 **SGS**
Shenzhen

Certificate No. **EUmm-9533_Aug23**

CALIBRATION CERTIFICATE

Object	EUmmWV4 - SN:9533
Calibration procedure(s)	QA CAL-02.v9, QA CAL-25.v8, QA CAL-42.v3 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date	August 18, 2023

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 sensor NRP110T	SN: 101244	12-Apr-23 (No. 0001A300692178)	Apr-24
Spectrum analyzer FSV40	SN: 101832	23-Jan-23 (No. 4030-315005314)	Jan-24
Ref. Probe EUmmWV3	SN: 9374	22-May-23 (No. EUmm-9374_May23)	May-24
DAE4ip	SN: 1662	13-Feb-23 (No. DAE4ip-1662_Feb23)	Feb-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Generator APSIN26G	SN: 669	28-Mar-17 (in house check May-23)	In house check: May-24
Generator Agilent E8251A	SN: US41140111	28-Mar-17 (in house check May-23)	In house check: May-24

	Name	Function	Signature
Calibrated by	Leif Klysner	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: August 25, 2023

Glossary

NORMx,y	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 φ	φ rotation around probe axis
Polarization ϑ	ϑ 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
Sensor Angles	sensor deviation from the probe axis, used to calculate the field orientation and polarization
$\vec{k}$	is the wave propagation direction

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). For frequencies > 6 GHz, the far field in front of waveguide horn antennas is measured for a set of frequencies in various waveguide bands up to 110 GHz.
- *DCPx,y*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
  Note: As the field is measured with a diode detector sensor, it is warrantied that the probe response is linear (E^2) below the documented lowest calibrated value.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- The frequency sensor model parameters are determined prior to calibration based on a frequency sweep (sensor model involving resistors R, R_p, inductance L and capacitors C, C_p).
- *Ax,y; Bx,y; Cx,y; Dx,y; VRx,y: 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.
- *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).
- *Equivalent Sensor Angle*: The two probe sensors are mounted in the same plane at different angles. The angles are assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide / horn setup.

Parameters of Probe: EUmmWV4 - SN:9533

Basic Calibration Parameters

	Sensor X	Sensor Y	Unc ($k = 2$)
Norm (μV/(V/m)^2)	0.01837	0.01951	±10.1%
DCP (mV) [B]	105.0	105.0	±4.7%
Equivalent Sensor Angle	-61.3	36.1	

Calibration Results for Frequency Response (750 MHz – 110 GHz)

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc ($k = 2$) dB
0.75	77.2	−0.13	−0.32	±0.43
1.8	140.4	−0.02	−0.03	±0.43
2.0	133.0	0.11	0.13	±0.43
2.2	124.8	−0.06	−0.03	±0.43
2.5	123.0	0.08	0.14	±0.43
3.5	256.2	−0.09	−0.11	±0.43
3.7	249.8	0.08	0.04	±0.43
6.6	74.7	0.20	−0.22	±0.98
8.0	67.2	0.03	−0.10	±0.98
10.0	66.2	−0.03	0.02	±0.98
15.0	51.2	0.03	0.04	±0.98
26.6	112.6	0.19	0.13	±0.98
30.0	121.9	0.08	0.06	±0.98
35.0	121.3	0.04	0.10	±0.98
40.0	102.3	0.07	0.18	±0.98
50.0	61.5	0.40	0.32	±0.98
55.0	75.9	−0.06	−0.03	±0.98
60.0	80.5	−0.01	−0.01	±0.98
65.0	77.1	0.09	0.02	±0.98
70.0	74.3	0.14	0.06	±0.98
75.0	74.8	0.05	0.04	±0.98
75.0	96.6	0.02	0.05	±0.98
80.0	95.4	−0.11	−0.03	±0.98
85.0	58.0	−0.06	−0.07	±0.98
90.0	84.0	−0.00	−0.01	±0.98
92.0	83.9	0.02	0.03	±0.98
95.0	76.2	0.03	0.01	±0.98
97.0	69.1	0.04	0.02	±0.98
100.0	66.9	0.11	0.12	±0.98
105.0	67.2	−0.18	−0.12	±0.98
110.0	78.1	0.06	0.02	±0.98

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%.

[B] Linearization parameter uncertainty for maximum specified field strength.