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
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: SCS 0108

Client **UL**
Fremont, USA

Certificate No. **5G-Veri60-1003_Sep23**

CALIBRATION CERTIFICATE

Object	5G Verification Source 60 GHz - SN: 1003
Calibration procedure(s)	QA CAL-45.v4 Calibration procedure for sources in air above 6 GHz
Calibration date:	September 05, 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
Reference Probe EUmmWV3	SN: 9374	22-May-23 (No. EUmm-9374_May23)	May-24
DAE4ip	SN: 1602	05-Jul-23 (No. DAE4ip-1602_Jul23)	Jul-24

Secondary Standards	ID #	Check Date (in house)	Scheduled Check

	Name	Function	Signature
Calibrated by:	Joanna Lleshaj	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	

Issued: September 6, 2023

Glossary

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CW	Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45, Calibration procedure for sources in air above 6 GHz.
- IEC/IEEE 63195-1, "Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz)", May 2022

Methods Applied and Interpretation of Parameters

- *Coordinate System:* z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- *Measurement Conditions: (1) 10 GHz:* The radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. During the measurements, the horn is directly connected to the cable and the antenna ohmic and mismatch losses are determined by far-field measurements. *(2) 30, 45, 60 and 90 GHz*: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- *Horn Positioning:* The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- *E- field distribution:* E field is measured in two x-y-plane (10mm, 10mm + λ/4) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-field-maxima and the averaged (1cm^2 and 4cm^2) power density values at 10mm in front of the horn.
- *Field polarization:* Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

- Local peak E-field (V/m) and average of peak spatial components of the poynting vector (W/m^2) averaged over the surface area of 1 cm^2 and 4cm^2 at the nominal operational frequency of the verification source. Both square and circular averaging results are listed.

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%.

Measurement Conditions

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

DASY Version	DASY8 Module mmWave	V3.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	60 GHz ± 10 MHz	

Calibration Parameters, 60 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	***Prad*[1] *(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m^2)		Uncertainty (k = 2)
				1 cm^2	**4** cm^2	
10 mm	115	**416**	1.27 dB	**350**	**234**	1.28 dB

Distance Horn Aperture to Measured Plane	***Prad*[1] *(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m^2)		Uncertainty (k = 2)
				1 cm^2	**4** cm^2	
10 mm	115	**416**	1.27 dB	**347, 351, 352**	**231, 235, 236**	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	***Prad*[1] *(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m^2)		Uncertainty (k = 2)
				1 cm^2	**4** cm^2	
10 mm	115	**416**	1.27 dB	**354**	**233**	1.28 dB

Distance Horn Aperture to Measured Plane	***Prad*[1] *(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m^2)		Uncertainty (k = 2)
				1 cm^2	**4** cm^2	
10 mm	115	**416**	1.27 dB	**352, 355, 356**	**231, 234, 235**	1.28 dB

Max Power Density

Distance Horn Aperture to Measured Plane	***Prad*[1] *(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Max Power Density Sn, Stot, |Stot| (W/m^2)	Uncertainty (k = 2)
10 mm	115	**416**	1.27 dB	**453, 460, 460**	1.28 dB

[1] Derived from far-field data

DASY Report

Measurement Report for 5G Verification Source 60 GHz, UID 0 -, Channel 60000 (60000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 60 GHz	100.0 x 100.0 x 100.0	SN: 1003	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	60000.0, 60000	1.0

Hardware Setup

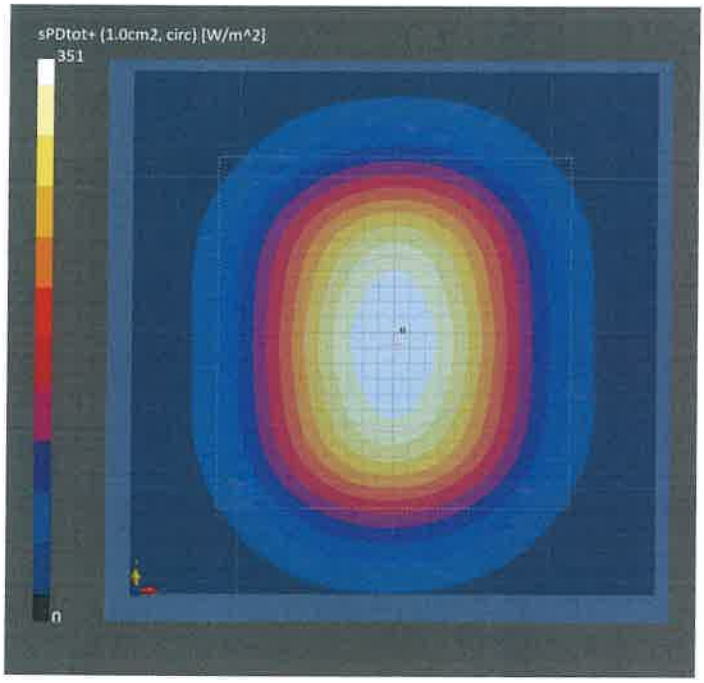
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F55-110GHz, 2023-05-22	DAE4ip Sn1602, 2023-07-05

Scan Setup

	5G Scan
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-09-05, 12:20
Avg. Area [cm²]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	347
psPDtot+ [W/m²]	351
psPDmod+ [W/m²]	352
Max(Sn) [W/m²]	453
Max(Stot) [W/m²]	460
Max(|Stot|) [W/m²]	460
E_{max} [V/m]	416
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 60 GHz, UID 0 -, Channel 60000 (60000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 60 GHz	100.0 x 100.0 x 100.0	SN: 1003	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	60000.0, 60000	1.0

Hardware Setup

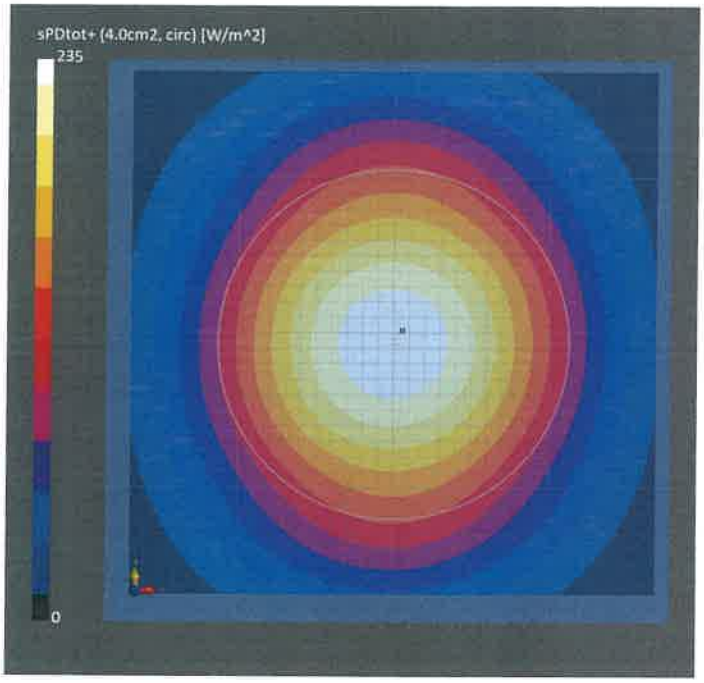
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F55-110GHz, 2023-05-22	DAE4ip Sn1602, 2023-07-05

Scan Setup

	5G Scan
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-09-05, 12:20
Avg. Area [cm²]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	231
psPDtot+ [W/m²]	235
psPDmod+ [W/m²]	236
Max(Sn) [W/m²]	453
Max(Stot) [W/m²]	460
Max(|Stot|) [W/m²]	460
E_{max} [V/m]	416
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 60 GHz, UID 0 -, Channel 60000 (60000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 60 GHz	100.0 x 100.0 x 100.0	SN: 1003	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	60000.0, 60000	1.0

Hardware Setup

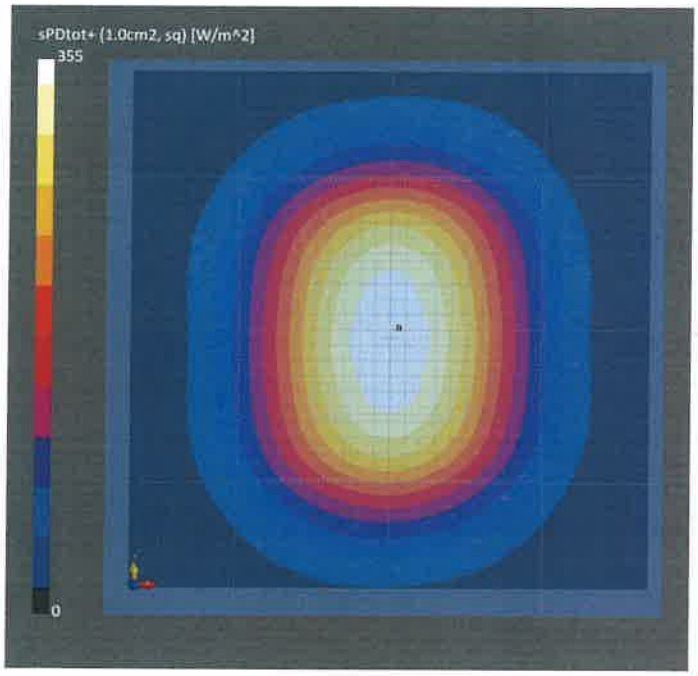
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F55-110GHz, 2023-05-22	DAE4ip Sn1602, 2023-07-05

Scan Setup

	5G Scan
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-09-05, 12:20
Avg. Area [cm²]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	352
psPDtot+ [W/m²]	355
psPDmod+ [W/m²]	356
Max(Sn) [W/m²]	453
Max(Stot) [W/m²]	460
Max(|Stot|) [W/m²]	460
E_{max} [V/m]	416
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 60 GHz, UID 0 -, Channel 60000 (60000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 60 GHz	100.0 x 100.0 x 100.0	SN: 1003	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	60000.0, 60000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
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Scan Setup

	5G Scan
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-09-05, 12:20
Avg. Area [cm²]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	231
psPDtot+ [W/m²]	234
psPDmod+ [W/m²]	235
Max(Sn) [W/m²]	453
Max(Stot) [W/m²]	460
Max(|Stot|) [W/m²]	460
E_{max} [V/m]	416
Power Drift [dB]	-0.00