mmWave Rotated Square Validation_Probe SN 9619 SAR 1A

SAR Lab	Tested By	Test Date	Frequency (GHz)	5G Verification Probe SN	Probe Cal. Due Data	5G Verification DAE SN	DAE Cal. Due Date	5G Verification Source SN	Source Cal. Due Data	Measured psPDn (W/m^2) over 4cm^2	Target psPDn (W/m^2) over 4cm^2	Deviation (dB)	Delta ±10 %	Measured psPDtot (W/m^2) over 4cm^2	Target psPDtot (W/m^2) over 4cm^2	Deviation (dB)	Delta ±10 %	Measured psPDmod (W/m^2) over 4cm^2	Target psPDmod (W/m^2) over 4cm^2	Deviation (dB)	Delta ±10 %
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	54.8	55.3	-0.04	-1%	55.1	60.3	-0.39	-9%	55.5	61.1	-0.42	-9%
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	54.8	55.3	-0.04	-1%	55.1	60.3	-0.39	-9%	55.5	61.1	-0.42	-9%
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	53.6	55.3	-0.14	-3%	53.9	60.3	-0.49	-11%	54.3	61.1	-0.51	-11%
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	53.7	55.3	-0.13	-3%	53.9	60.3	-0.49	-11%	54.3	61.1	-0.51	-11%
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	54.6	55.3	-0.06	-1%	54.9	60.3	-0.41	-9%	55.3	61.1	-0.43	-9%
1A	21193	5/3/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	54	55.3	-0.10	-2%	54.2	60.3	-0.46	-10%	54.7	61.1	-0.48	-10%
1A	21193	5/4/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	51.7	55.3	-0.29	-7%	51.9	60.3	-0.65	-14%	52.3	61.1	-0.68	-14%
1A	21193	5/4/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	53.2	55.3	-0.17	-4%	53.4	60.3	-0.53	-11%	53.8	61.1	-0.55	-12%
1A	21193	5/4/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	53.6	55.3	-0.14	-3%	53.9	60.3	-0.49	-11%	54.2	61.1	-0.52	-11%
1A	21193	5/4/2023	10	9619	3/10/2024	1715	1/23/2024	1040	1/19/2024	52.5	55.3	-0.23	-5%	52.8	60.3	-0.58	-12%	53.2	61.1	-0.60	-13%
									Average	**53.7**	55.3	-0.13	-3%	**53.9**	60.3	-0.49	-11%	**54.3**	61.1	-0.51	-11%

psPD Avg (W/m^2) over 4cm^2	**54.0**

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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 **UL USA**

Certificate No: 5G-Veri10-1040_Jan23

CALIBRATION CERTIFICATE

Object	5G Verification Source 10 GHz - SN: 1040
Calibration procedure(s)	QA CAL-45.v4 Calibration procedure for sources in air above 6 GHz
Calibration date:	January 19, 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	2023-01-03(No. EUmmWV3-9374_Jan23)	Jan-24
DAE4ip	SN: 1602	2022-06-27 (No. DAE4ip-1602_Jun22)	Jun-23

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMF100A	SN: 100184	19-May-22 (in house check Nov-22)	In house check: Nov-23
Power sensor R&S NRP18S-10	SN: 101258	31-May-22 (in house check Nov-22)	In house check: Nov-23

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

Issued: February 7, 2023

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

Glossary

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. The forward power is measured prior and after the measurement with a power sensor. 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 + $\lambda/4$) 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	
XY Scan Resolution	dx, dy = 7.5 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	10 GHz ± 10 MHz	

Calibration Parameters, 10 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/m²)		Uncertainty (k = 2)
				1 cm²	**4** cm²	
10 mm	86.1	**163**	1.27 dB	**64.7**	**59.0**	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/m²)		Uncertainty (k = 2)
				1 cm²	**4** cm²	
10 mm	86.1	**163**	1.27 dB	**61.3, 65.9, 66.8**	**55.4, 60.4, 61.2**	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/m²)		Uncertainty (k = 2)
				1 cm²	**4** cm²	
10 mm	86.1	**163**	1.27 dB	**64.7**	**58.9**	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/m²)		Uncertainty (k = 2)
				1 cm²	**4** cm²	
10 mm	86.1	**163**	1.27 dB	**61.3, 65.9, 66.8**	**55.3, 60.3, 61.1**	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/m²)	Uncertainty (k = 2)
10 mm	86.1	**163**	1.27 dB	**63.5, 67.8, 68.8**	1.28 dB

[1] Assessed ohmic and mismatch loss plus numerical offset: 0.55 dB

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1040	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

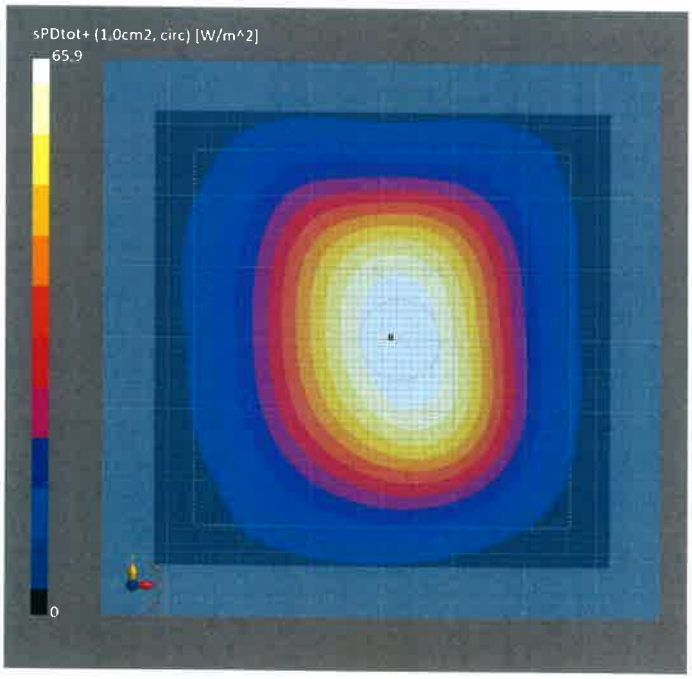
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-01-19, 10:59
Avg. Area [cm²]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	61.3
psPDtot+ [W/m²]	65.9
psPDmod+ [W/m²]	66.8
Max(Sn) [W/m²]	63.5
Max(Stot) [W/m²]	67.8
Max(|Stot|) [W/m²]	68.8
E_{max} [V/m]	163
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1040	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

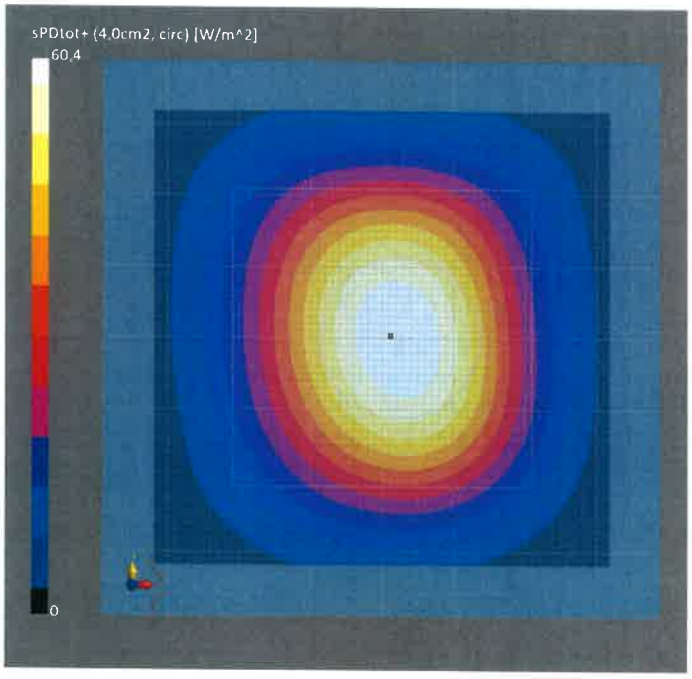
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-01-19, 10:59
Avg. Area [cm²]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	55.4
psPDtot+ [W/m²]	60.4
psPDmod+ [W/m²]	61.2
Max(Sn) [W/m²]	63.5
Max(Stot) [W/m²]	67.8
Max(|Stot|) [W/m²]	68.8
E_{max} [V/m]	163
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1040	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

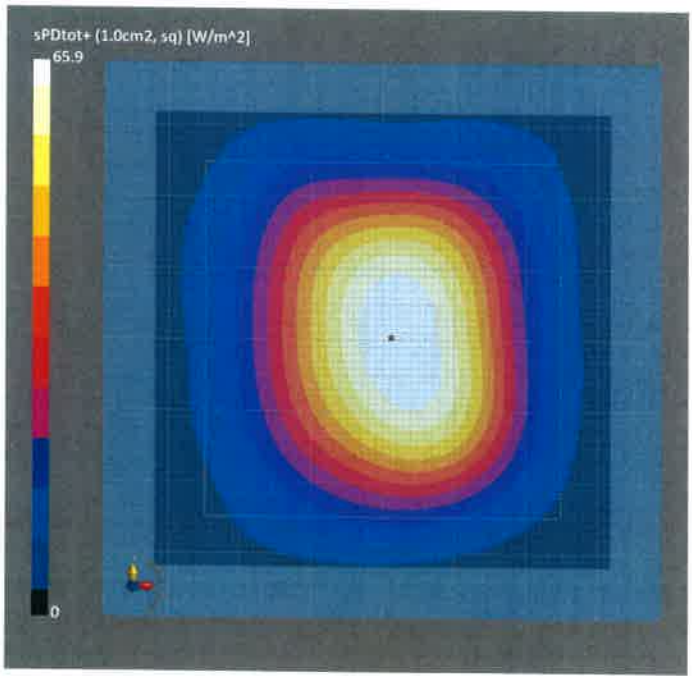
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-01-19, 10:59
Avg. Area [cm²]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	61.3
psPDtot+ [W/m²]	65.9
psPDmod+ [W/m²]	66.8
Max(Sn) [W/m²]	63.5
Max(Stot) [W/m²]	67.8
Max(|Stot|) [W/m²]	68.8
E_{max} [V/m]	163
Power Drift [dB]	-0.00



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1040	-

Exposure Conditions

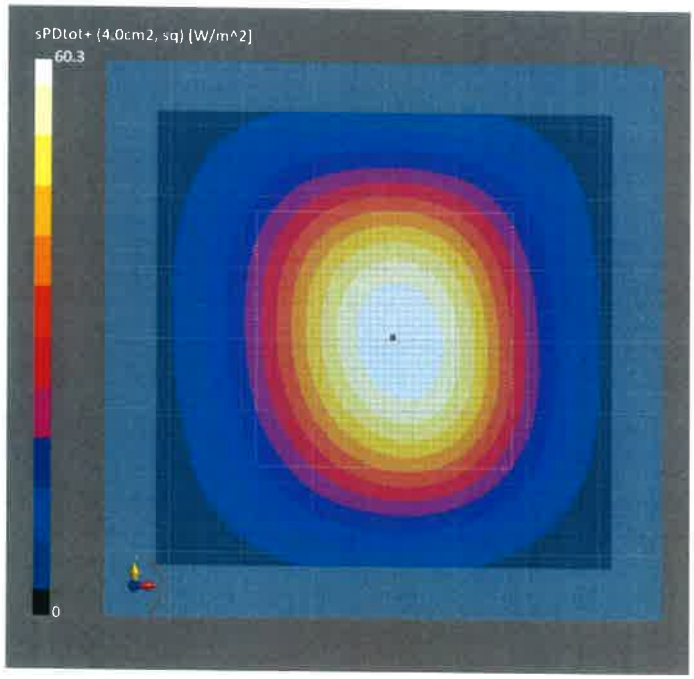
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-01-19, 10:59
Avg. Area [cm²]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	55.3
psPDtot+ [W/m²]	60.3
psPDmod+ [W/m²]	61.1
Max(Sn) [W/m²]	63.5
Max(Stot) [W/m²]	67.8
Max(|Stot|) [W/m²]	68.8
E_{max} [V/m]	163
Power Drift [dB]	-0.00