



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**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528 ED1, "Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-worn wireless communication devices - Part 1528: Human models, instrumentation and procedures (Frequency range of 4 MHz to 10 GHz)", draft 2019

Additional Documentation:

- DASY6 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.
- The absorbed power density (APD):* The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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	DASY6	V6.14
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	$dx, dy = 3.4 \text{ mm}, dz = 1.4 \text{ mm}$	Graded Ratio = 1.4 (Z direction)
Frequency	$6500 \text{ MHz} \pm 1 \text{ MHz}$	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	$(22.0 \pm 0.2) \text{ °C}$	$34.8 \pm 6 \text{ %}$	$6.20 \text{ mho/m} \pm 6 \text{ %}$
Head TSL temperature change during test	$< 0.5 \text{ °C}$	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	293 W/kg ± 24.7 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	5.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg ± 24.4 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.0 Ω - 1.7 $j\Omega$
Return Loss	- 34.1 dB

APD (Absorber Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	293 W/m ²
APD measured	normalized to 1W	2930 W/m ² \pm 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	134 W/m ²
APD measured	normalized to 1W	1340 W/m ² \pm 28.9 % (k=2)

*The reported APD values have been derived using psSAR10g. cDASY6 V6.16+ will use psSAR8g resulting in more accurate estimation of the APD values. The estimated offset is less than - 0.15 dB.

General Antenna Parameters and Design

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
-----------------	-------

DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1021, UID 0 -, Channel 6500 (6500.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
D6.5GHz	16.0 x 6.0 x 300.0	SN: 1021	-

Exposure Conditions

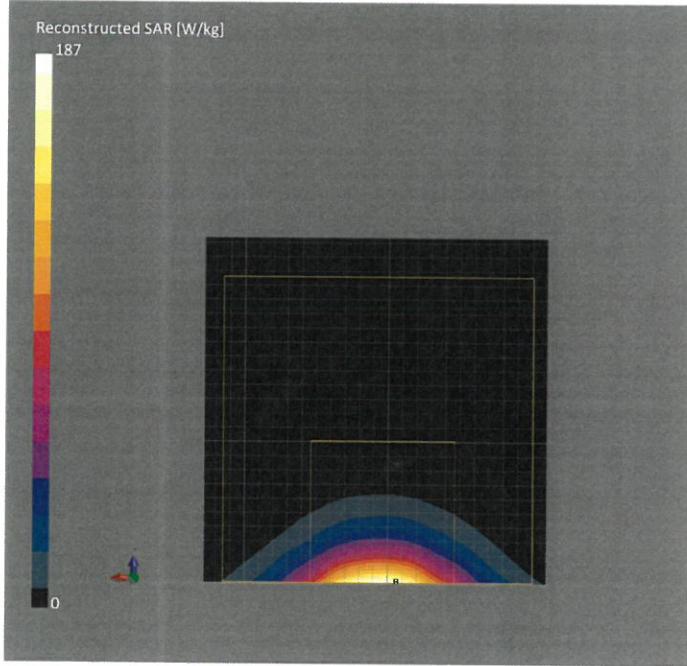
Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.75	6.20	34.8

Hardware Setup

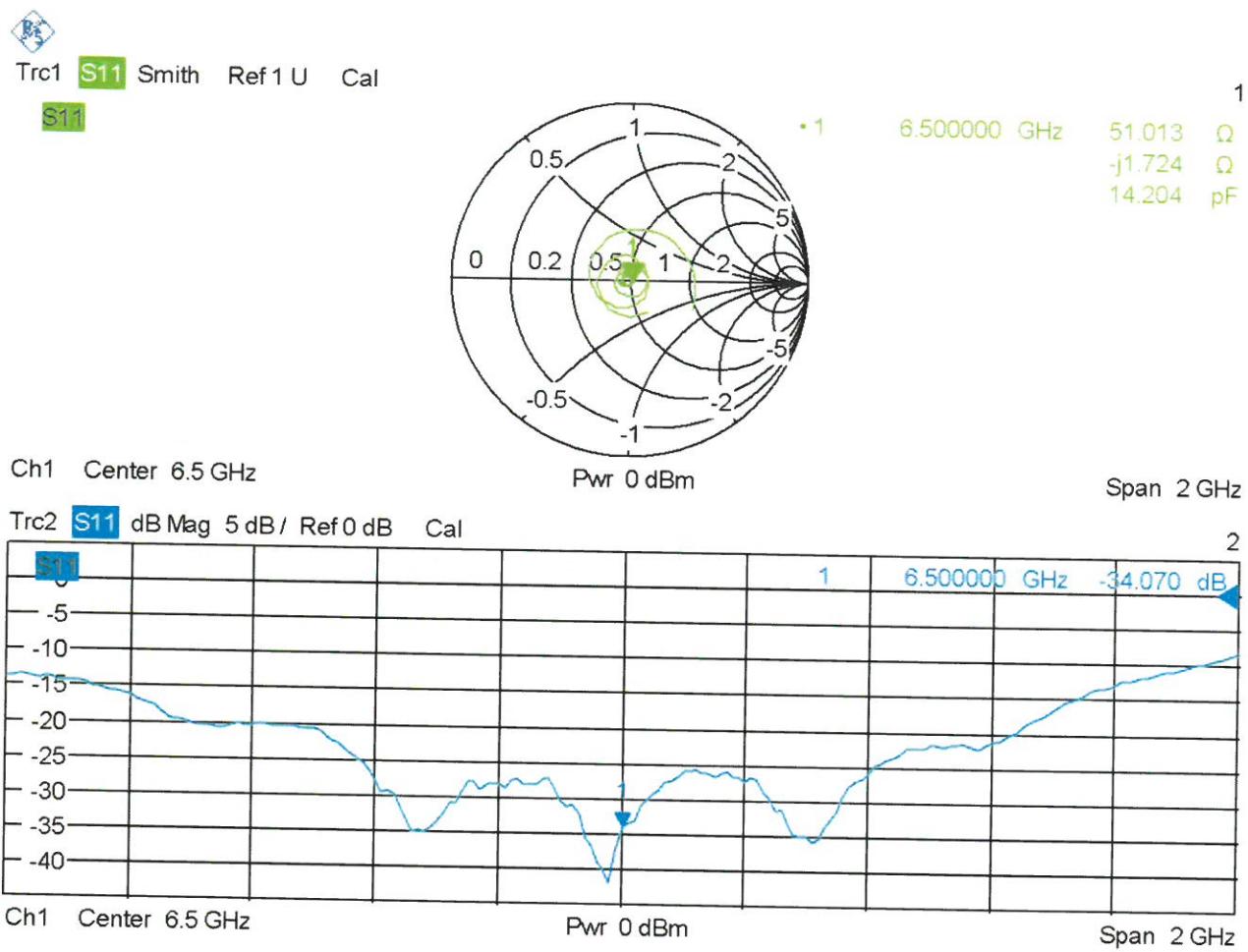
Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2020-12-30	DAE4 Sn908, 2020-08-14

Scan Setup

	Zoom Scan	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0	Date
Grid Steps [mm]	3.4 x 3.4 x 1.4	psSAR1g [W/Kg]
Sensor Surface [mm]	1.4	psSAR10g [W/Kg]
Graded Grid	Yes	Power Drift [dB]
Grading Ratio	1.4	Power Scaling
MAIA	N/A	Scaling Factor [dB]
Surface Detection	VMS + 6p	TSL Correction
Scan Method	Measured	M2/M1 [%]
		Dist 3dB Peak [mm]



Impedance Measurement Plot for Head TSL





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

Client **Dekra-TW (Auden)**

Accreditation No.: **SCS 0108**

Certificate No: **5G-Veri10-2006_May22**

CALIBRATION CERTIFICATE

Object **5G Verification Source 10 GHz - SN: 2006**

Calibration procedure(s) **QA CAL-45.v3**
 Calibration procedure for sources in air above 6 GHz

Calibration date: **May 02, 2022**

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 $(22 \pm 3)^\circ\text{C}$ 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	2021-12-21(No. EUmmWV3-9374_Dec21)	Dec-22
DAE4ip	SN: 1602	2021-06-25 (No. DAE4ip-1602_Jun21)	Jun-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check

Calibrated by: Name **Leif Klysner** Function **Laboratory Technician** Signature

Approved by: Name **Sven Kühn** Function **Deputy Manager** Signature

Issued: May 2, 2022

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



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**

Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45-5Gsources
- IEC TR 63170 ED1, "Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz", January 2018

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 1cm^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	cDASY6 Module mmWave	V3.0
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	$dx, dy = 7.5 \text{ mm}$	
Number of measured planes	2 (10mm, 10mm + $\lambda/4$)	
Frequency	$10 \text{ GHz} \pm 10 \text{ MHz}$	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	P_{rad}^1 (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density		Uncertainty (k = 2)
				Avg (psPDn+, psPDTot+, psPDmod+) (W/m ²)		
10 mm	124	263	1.27 dB	180	146	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	P_{rad}^1 (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density		Uncertainty (k = 2)
				Avg (psPDn+, psPDTot+, psPDmod+) (W/m ²)		
10 mm	124	263	1.27 dB	181	147	1.28 dB

¹ Assessed ohmic and mismatch loss plus numerical offset: 0.95 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 100.0	SN: 2006	-

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, 2021-12-21	DAE4ip Sn1602, 2021-06-25

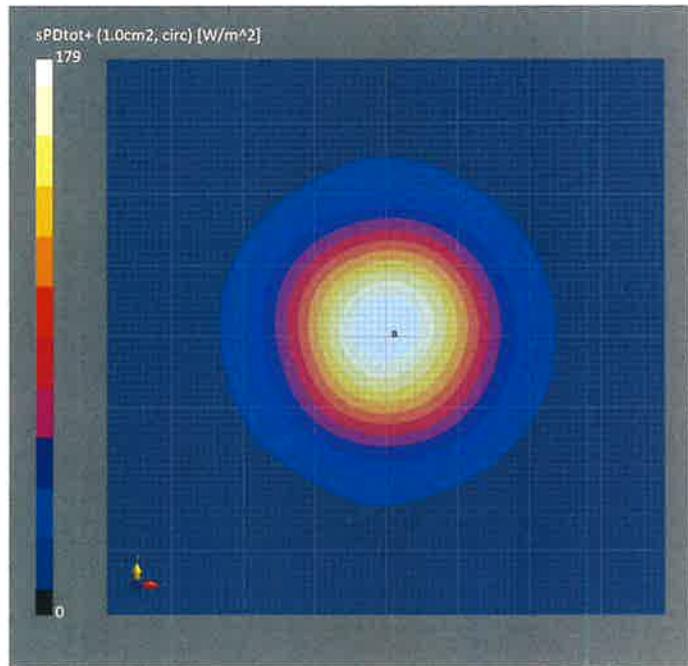
Scan Setup

Grid Extents [mm]	5G Scan
Grid Steps [lambda]	120.0 x 120.0
Sensor Surface [mm]	0.25 x 0.25
MAIA	10.0

MAIA not used

Measurement Results

5G Scan
2022-05-02, 16:18
1.00
179
179
181
263
-0.02



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 100.0	SN: 2006	-

Exposure Conditions

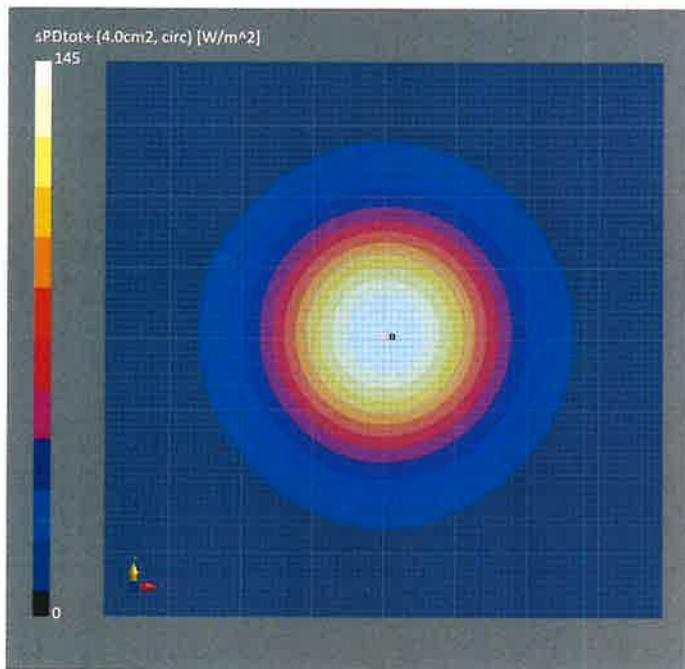
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2021-12-21	DAE4ip Sn1602, 2021-06-25

Scan Setup

	5G Scan	5G Scan
Grid Extents [mm]	120.0 x 120.0	2022-05-02, 16:18
Grid Steps [λ]	0.25 x 0.25	4.00
Sensor Surface [mm]	10.0	145
MAIA	MAIA not used	145
	psPDtot+ [W/m ²]	148
	psPDmod+ [W/m ²]	263
	E _{max} [V/m]	-0.02
	Power Drift [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 100.0	SN: 2006	

Exposure Conditions

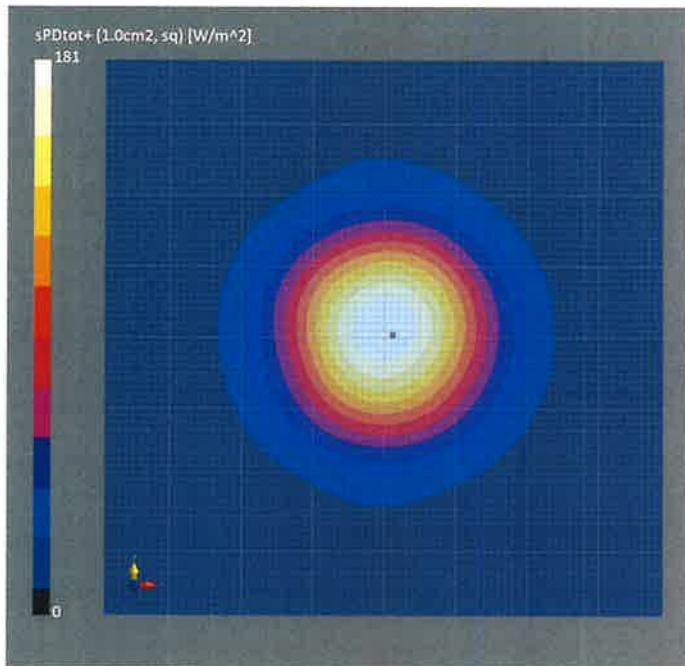
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2021-12-21	DAE4ip Sn1602, 2021-06-25

Scan Setup

	5G Scan	5G Scan
Grid Extents [mm]	120.0 x 120.0	2022-05-02, 16:18
Grid Steps [lambda]	0.25 x 0.25	1.00
Sensor Surface [mm]	10.0	181
MAIA	MAIA not used	181
	Date	182
	Avg. Area [cm ²]	182
	psPDn+ [W/m ²]	263
	psPDtot+ [W/m ²]	-0.02
	psPDmod+ [W/m ²]	
	E _{max} [V/m]	
	Power Drift [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 100.0	SN: 2006	-

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	EUmmWW3 - SN9374_F1-55GHz, 2021-12-21	DAE4ip Sn1602, 2021-06-25

Scan Setup

	5G Scan	5G Scan
Grid Extents [mm]	120.0 x 120.0	2022-05-02, 16:18
Grid Steps [lambda]	0.25 x 0.25	4.00
Sensor Surface [mm]	10.0	146
MAIA	MAIA not used	146
	Date	149
	Avg. Area [cm ²]	263
	psPDn+ [W/m ²]	-0.02
	psPDtot+ [W/m ²]	
	psPDmod+ [W/m ²]	
	E _{max} [V/m]	
	Power Drift [dB]	

