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Accreditation No.: **SCS 0108**

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Client **BTL**
New Taipei City, Taiwan

Certificate No. **5G-Veri10-2011_Apr23**

CALIBRATION CERTIFICATE

Object **5G Verification Source 10 GHz - SN: 2011**

Calibration procedure(s) **QA CAL-45.v4**
Calibration procedure for sources in air above 6 GHz

Calibration date: **April 20, 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 EUmWV3 DAE4ip	SN: 9374	2023-01-03(No. EUmWV3-9374_Jan23)	Jan-24
	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
Network Analyzer Keysight E5063A	SN: MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25

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

Issued: April 24, 2023

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



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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. 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 (1cm² and 4cm²) 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/m²) averaged over the surface area of 1 cm² and 4cm² 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 + $\lambda/4$)	
Frequency	10 GHz $\pm$ 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	<i>Prad^I</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	217	171	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad^I</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	216, 216, 218	169, 169, 174	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	<i>Prad^I</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	217	170	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad^I</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	216, 216, 218	168, 169, 173	1.28 dB

Max Power Density

Distance Horn Aperture to Measured Plane	<i>Prad^I</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot, Stot (W/m ²)	Uncertainty (k = 2)
10 mm	132	292	1.27 dB	236, 236, 236	1.28 dB

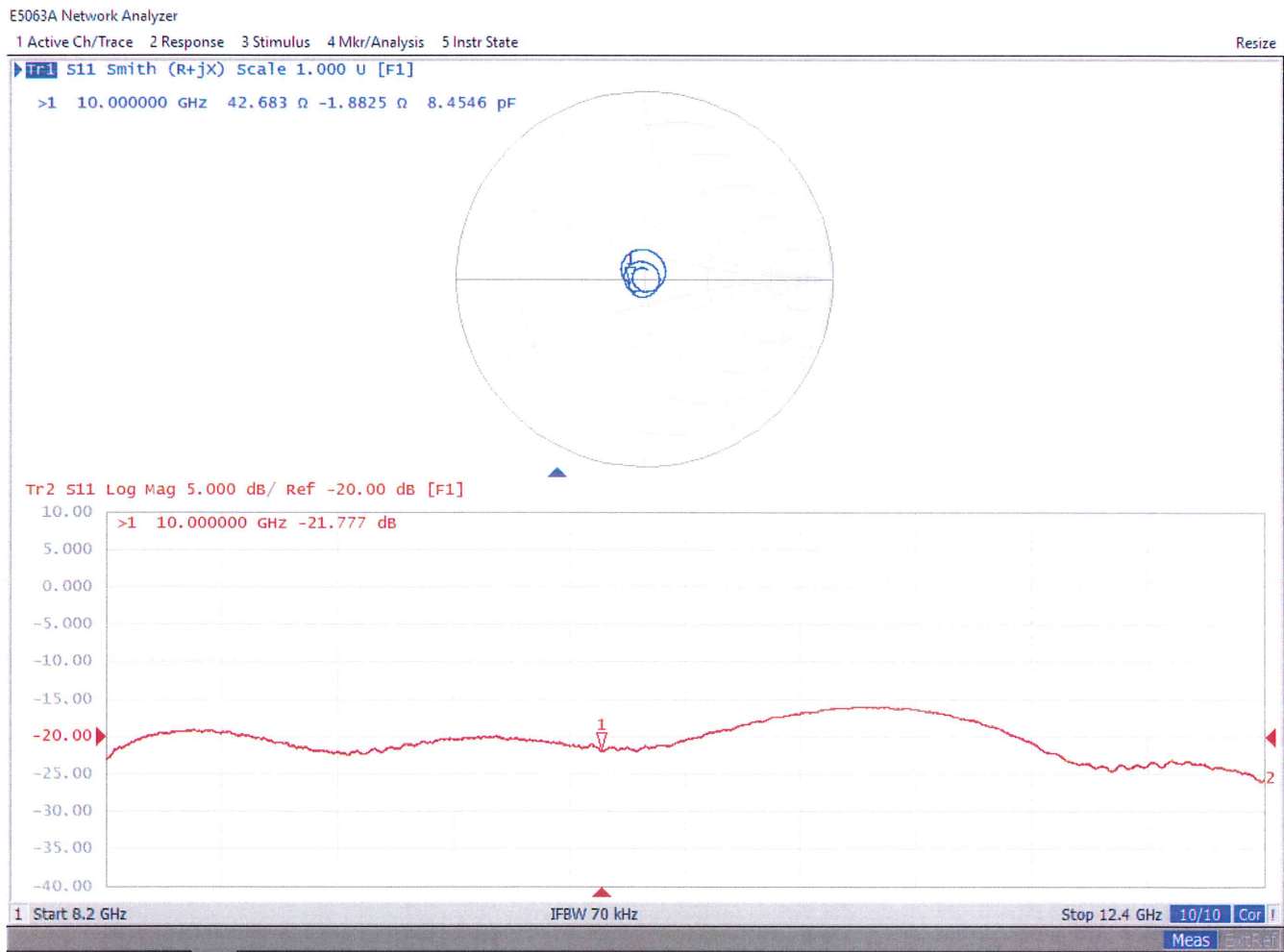
^I Assessed ohmic and mismatch loss plus numerical offset: 0.70 dB

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Impedance, transformed to feed point	42.7 Ω - 1.9 j Ω
Return Loss	- 21.8 dB

Impedance Measurement Plot



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: 2011	-

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

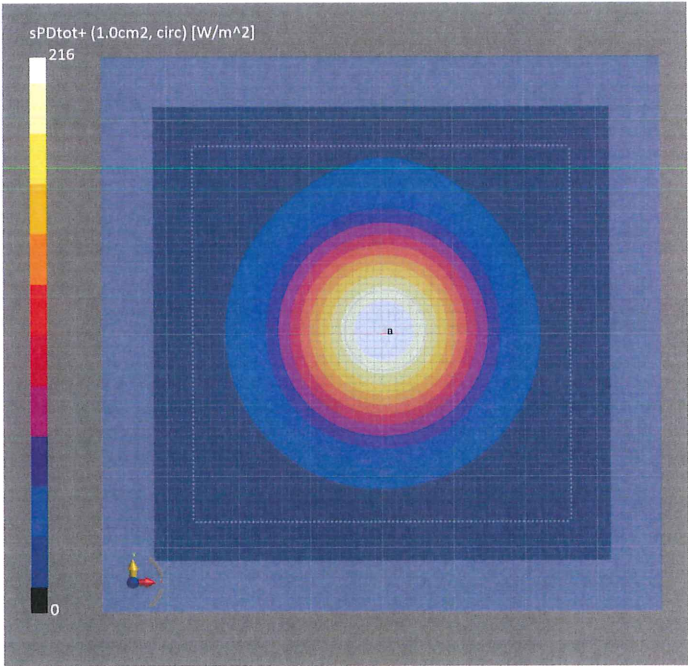
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-13, 15:58
Avg. Area [cm²]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	216
psPDtot+ [W/m²]	216
psPDmod+ [W/m²]	218
Max(Sn) [W/m²]	236
Max(Stot) [W/m²]	236
Max(Stot) [W/m²]	236
E _{max} [V/m]	292
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 100.0	SN: 2011	-

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

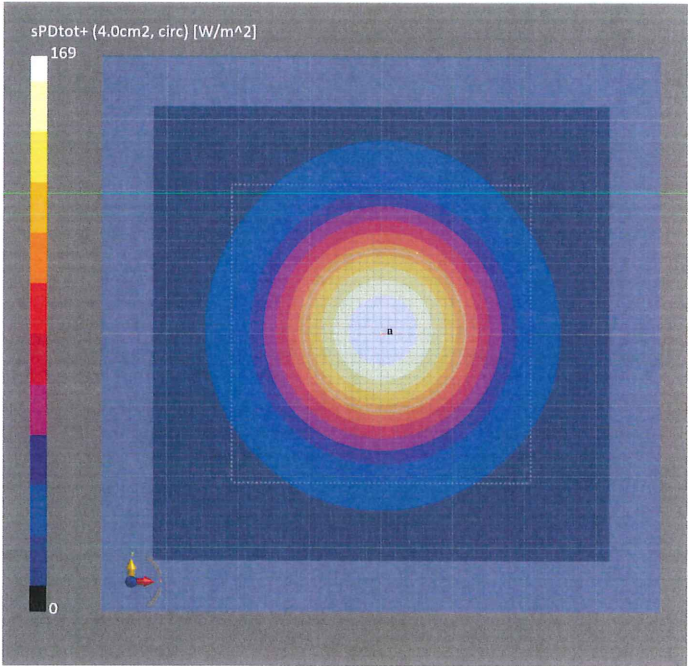
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-13, 15:58
Avg. Area [cm²]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	169
psPDtot+ [W/m²]	169
psPDmod+ [W/m²]	174
Max(Sn) [W/m²]	236
Max(Stot) [W/m²]	236
Max(Stot) [W/m²]	236
E _{max} [V/m]	292
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 100.0	SN: 2011	-

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

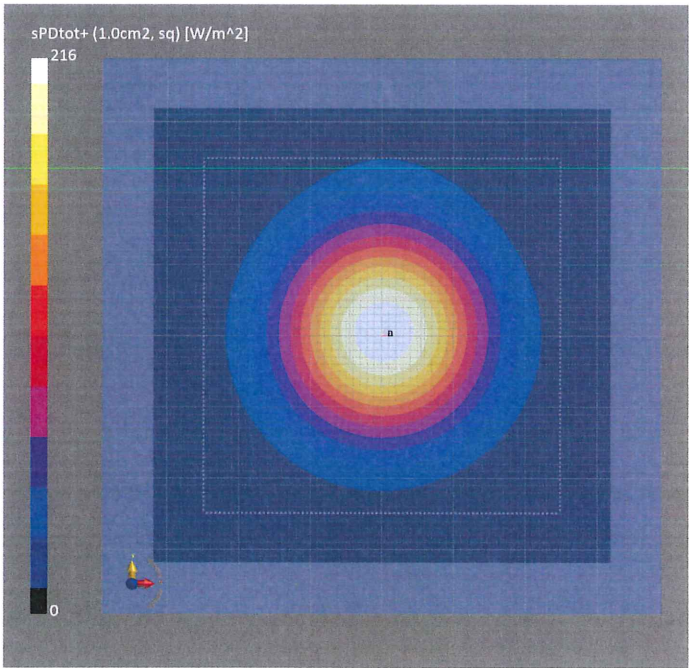
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-13, 15:58
Avg. Area [cm²]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	216
psPDtot+ [W/m²]	216
psPDmod+ [W/m²]	218
Max(Sn) [W/m²]	236
Max(Stot) [W/m²]	236
Max(Stot) [W/m²]	236
E _{max} [V/m]	292
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 100.0	SN: 2011	-

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

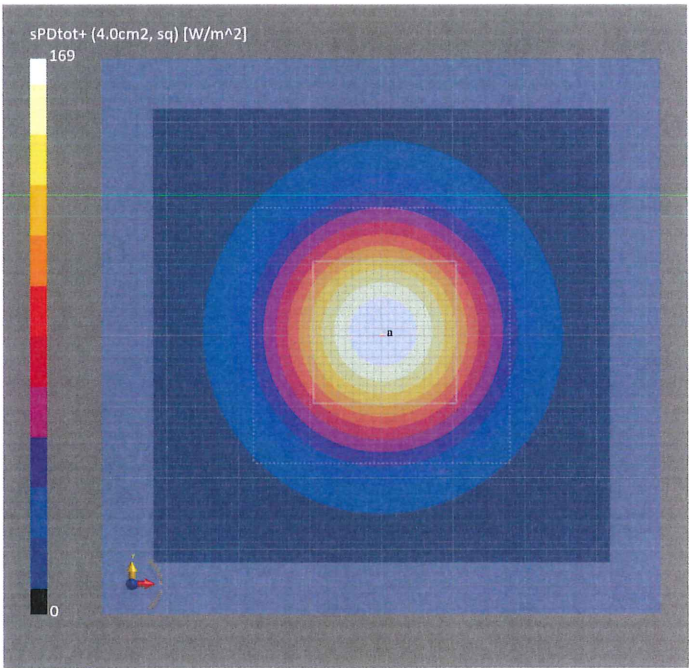
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-13, 15:58
Avg. Area [cm²]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	168
psPDtot+ [W/m²]	169
psPDmod+ [W/m²]	173
Max(Sn) [W/m²]	236
Max(Stot) [W/m²]	236
Max(Stot) [W/m²]	236
E _{max} [V/m]	292
Power Drift [dB]	0.00



Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	<i>Prad</i>¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	219	171	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad</i>¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	218, 218, 220	169, 170, 175	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	<i>Prad</i>¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	219	170	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad</i>¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1 cm²	4 cm²	
10 mm	132	292	1.27 dB	218, 218, 220	168, 169, 174	1.28 dB

Max Power Density

Distance Horn Aperture to Measured Plane	<i>Prad</i>¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot, Stot (W/m ²)	Uncertainty (k = 2)
10 mm	132	292	1.27 dB	239, 239, 239	1.28 dB

¹ Assessed ohmic and mismatch loss plus numerical offset: 0.70 dB

Appendix: Source Evaluation for Relative System Check

Measurement Equipment

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

Item	ID#	Certificate No.
Probe EUmmWV4	SN: 9583	EUmm-9583_Apr23

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 + $\lambda/4$)	
Frequency	10 GHz $\pm$ 10 MHz	

Appendix: 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: 2011	-

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

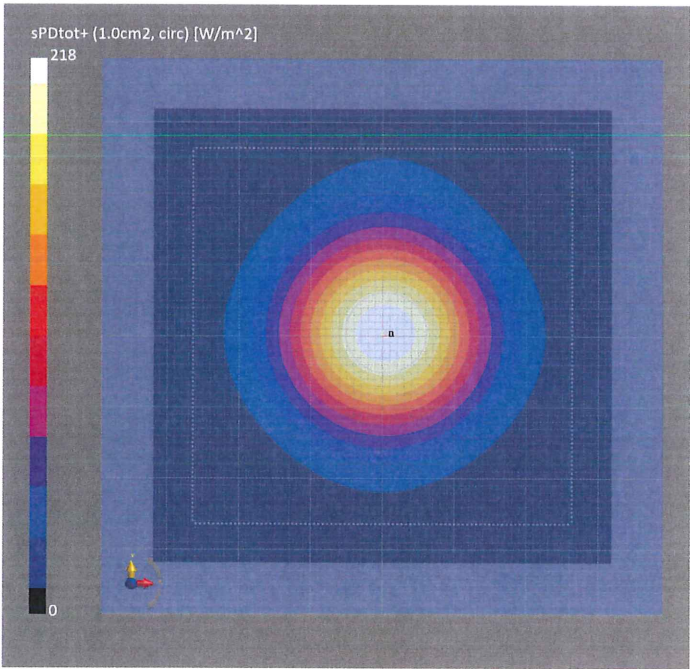
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV4 - SN9583_F1-55GHz, 2023-04-18	DAE4 Sn1215, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-20, 13:31
Avg. Area [cm²]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	218
psPDtot+ [W/m²]	218
psPDmod+ [W/m²]	220
Max(Sn) [W/m²]	239
Max(Stot) [W/m²]	239
Max(Stot) [W/m²]	239
E _{max} [V/m]	292
Power Drift [dB]	0.01



Appendix: 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: 2011	-

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

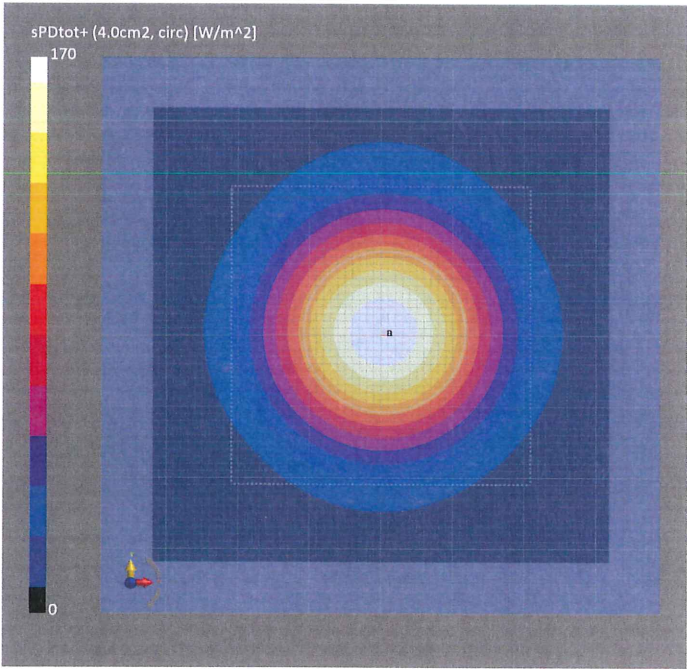
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV4 - SN9583_F1-55GHz, 2023-04-18	DAE4 Sn1215, 2022-06-27

Scan Setup

Sensor Surface [mm]	5G Scan
MAIA	10.0 MAIA not used

Measurement Results

	5G Scan
Date	2023-04-20, 13:31
Avg. Area [cm²]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m²]	169
psPDtot+ [W/m²]	170
psPDmod+ [W/m²]	175
Max(Sn) [W/m²]	239
Max(Stot) [W/m²]	239
Max(Stot) [W/m²]	239
E _{max} [V/m]	292
Power Drift [dB]	0.01



Appendix: 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: 2011	-

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	EUmmWV4 - SN9583_F1-55GHz, 2023-04-18	DAE4 Sn1215, 2022-06-27

Scan Setup

	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2023-04-20, 13:31
Avg. Area [cm²]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m²]	218
psPDtot+ [W/m²]	218
psPDmod+ [W/m²]	220
Max(Sn) [W/m²]	239
Max(Stot) [W/m²]	239
Max(Stot) [W/m²]	239
E _{max} [V/m]	292
Power Drift [dB]	0.01

