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Accreditation No.: **SCS 0108**

Client **UL Korea (Dymstec)**

Certificate No: **5G-Veri30-1047_Feb20**

CALIBRATION CERTIFICATE

Object **5G Verification Source 30 GHz - SN: 1047**

Calibration procedure(s) **QA CAL-45.v2
Calibration procedure for sources in air above 6 GHz**

Calibration date: **February 26, 2020**

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	SN: 9374	31-Dec-19 (No. EUmWV3-9374_Dec19)	Dec-20
DAE4ip	SN: 1602	01-Oct-19 (No. DAE4ip-1602_Oct19)	Oct-20

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

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 27, 2020

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-45-5Gsources
- 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 forward power to the horn antenna 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 (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 peak values of the total and normal component of the poynting vector $|\text{Re}\{S\}|$ and $n \cdot \text{Re}\{S\}$ averaged over the surface area of 1 cm² ($pS_{\text{tot} \text{avg} 1 \text{cm}^2}$ and $pS_{n \text{avg} 1 \text{cm}^2}$) and 4cm² ($pS_{\text{tot} \text{avg} 4 \text{cm}^2}$ and $pS_{n \text{avg} 4 \text{cm}^2}$) at the nominal operational frequency of the verification source.

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	V2.0
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	dx, dy = 2.5 mm	
Number of measured planes	2 (10mm, 10mm + $\lambda/4$)	
Frequency	30 GHz \pm 10 MHz	

Calibration Parameters, 30 GHz

Distance Horn Aperture to Measured Plane	<i>Prad</i> ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density n.Re{S}, Re{S} (W/m ²)		Uncertainty (k = 2)
				1 cm ²	4 cm ²	
10 mm	61.9	186	1.27 dB	79.3, 80.0	69.9, 70.8	1.28 dB

¹ derived from far-field data

DASY Report

Measurement Report for 5G Verification Source 30 GHz, UID 0 -, Channel 30000 (30000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 30 GHz	100.0 x 100.0 x 100.0	SN: 1047	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	30000.0, 30000	1.0

Hardware Setup

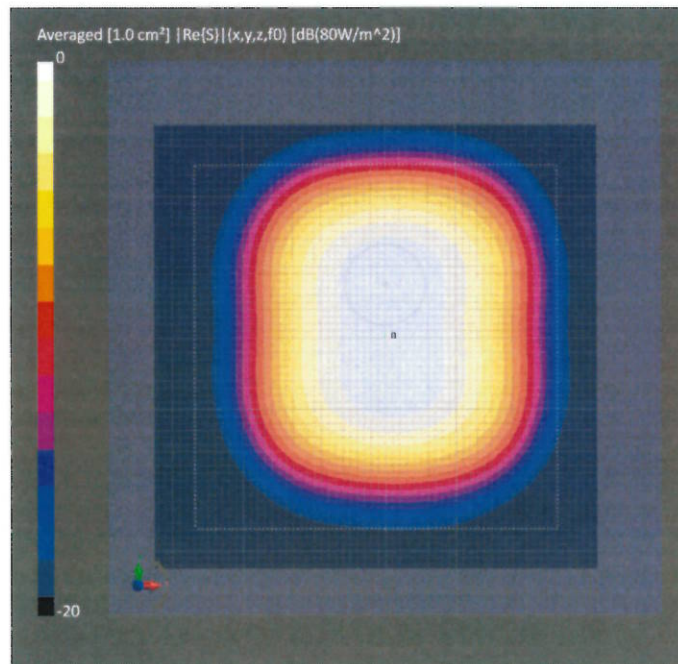
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-78GHz, 2019-12-31	DAE4ip Sn1602, 2019-10-01

Scan Setup

	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2020-02-26, 11:45
Avg. Area [cm ²]	1.00
pS _{tot} avg [W/m ²]	80.0
pS _n avg [W/m ²]	79.3
E _{peak} [V/m]	186
Power Drift [dB]	-0.07



Appendix: Source Evaluation for Relative System Check

Measurement Equipment

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

Item	ID#	Cal Date (Certificate No.)
Probe EUmmWV4	SN: 9431	26-Feb-20

Measurement Conditions

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

DASY Version	cDASY6 Module mmWave	V2.0
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	dx, dy = 2.5 mm	
Number of measured planes	2 (10mm, 10mm + $\lambda/4$)	
Frequency	30 GHz \pm 10 MHz	

Calibration Parameters, 30 GHz

Distance Horn Aperture to Measured Plane	<i>Prad¹</i> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density $n \cdot \text{Re}\{S\}, \text{Re}\{S\} $ (W/m ²)		Uncertainty (k = 2)
				1 cm ²	4 cm ²	
10 mm	61.9	181	1.27 dB	74.8, 75.9	65.5, 66.7	1.28 dB

¹ derived from far-field data

Appendix: DASY Report

Measurement Report for 5G Verification Source 30 GHz, UID 0 -, Channel 30000 (30000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 30 GHz	100.0 x 100.0 x 100.0	SN: 1047	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	30000.0, 30000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUMmWV4 - SN9431_F1-78GHz, 2020-02-26	DAE4 Sn908, 2019-12-30

Scan Setup

	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2020-02-25, 16:49
Avg. Area [cm ²]	1.00
pS _{tot} avg [W/m ²]	75.9
pS _n avg [W/m ²]	74.8
E _{peak} [V/m]	181
Power Drift [dB]	0.04

