



No.I19Z61671-SEM01

2600 MHz Dipole Calibration Certificate

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



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Accreditation No.: **SCS 0108**Client **CTTL (Auden)**Certificate No: **D2600V2-1012_Jul19****CALIBRATION CERTIFICATE**

Object **D2600V2 - SN:1012**

Calibration procedure(s) **QA CAL-05.v11**
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz

Calibration date: **July 17, 2019**


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 |
|---------------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP | SN: 104778 | 03-Apr-19 (No. 217-02892/02893) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103244 | 03-Apr-19 (No. 217-02892) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103245 | 03-Apr-19 (No. 217-02893) | Apr-20 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-19 (No. 217-02895) | Apr-20 |
| Reference Probe EX3DV4 | SN: 7349 | 29-May-19 (No. EX3-7349_May19) | May-20 |
| DAE4 | SN: 601 | 30-Apr-19 (No. DAE4-601_Apr19) | Apr-20 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

Calibrated by: **Michael Weber** **Laboratory Technician** 

Approved by: **Katja Pokovic** **Technical Manager** 

Issued: July 17, 2019

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

Certificate No: D2600V2-1012_Jul19

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 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.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. 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 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 | DASY5 | V52.10.2 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2600 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.0 | 1.96 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 37.1 \pm 6 % | 2.02 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|------------------------------|
| SAR measured | 250 mW input power | 14.3 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 55.8 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|------------------------------|
| SAR measured | 250 mW input power | 6.38 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.1 W/kg \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.5 | 2.16 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 50.4 \pm 6 % | 2.20 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|------------------------------|
| SAR measured | 250 mW input power | 14.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 55.0 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|------------------------------|
| SAR measured | 250 mW input power | 6.26 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.8 W/kg \pm 16.5 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.5 Ω - 6.3 j Ω |
| Return Loss | - 23.2 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 43.8 Ω - 4.7 j Ω |
| Return Loss | - 21.6 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.153 ns |
|----------------------------------|----------|

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 |
|-----------------|-------|

DASY5 Validation Report for Head TSL

Date: 16.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1012

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.69, 7.69, 7.69) @ 2600 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

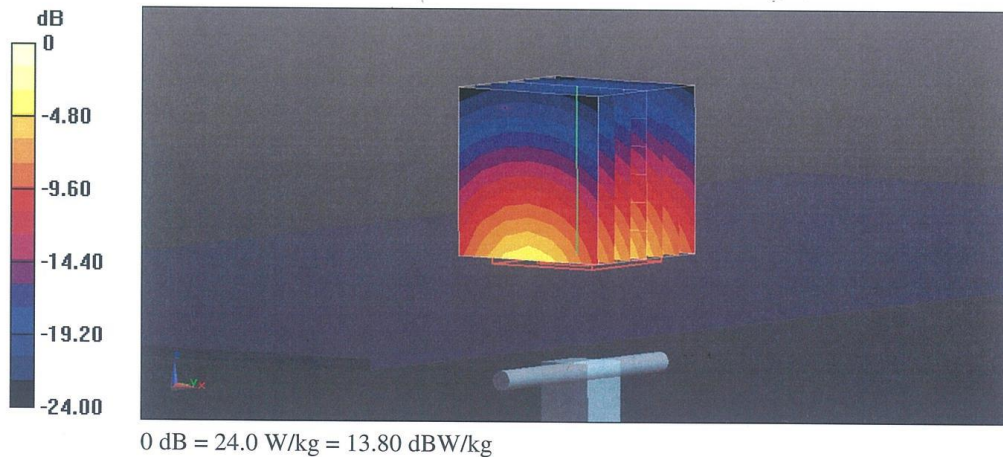
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 118.6 V/m; Power Drift = 0.00 dB

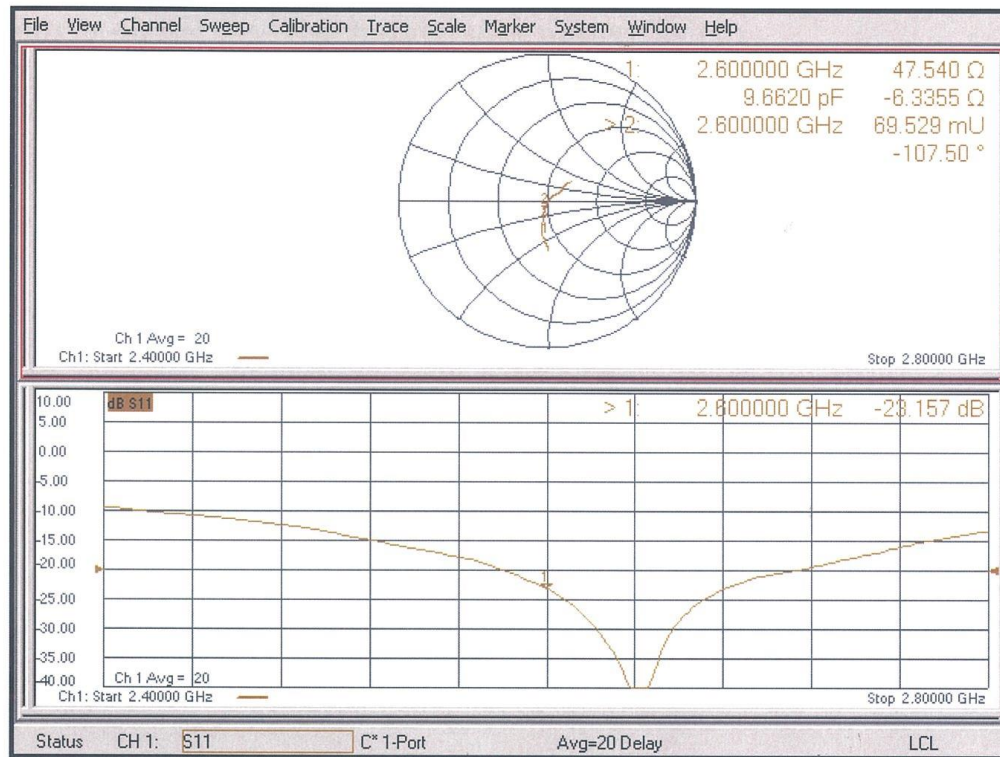
Peak SAR (extrapolated) = 28.8 W/kg

SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.38 W/kg

Maximum value of SAR (measured) = 24.0 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 17.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1012

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600 \text{ MHz}$; $\sigma = 2.2 \text{ S/m}$; $\epsilon_r = 50.4$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.8, 7.8, 7.8) @ 2600 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

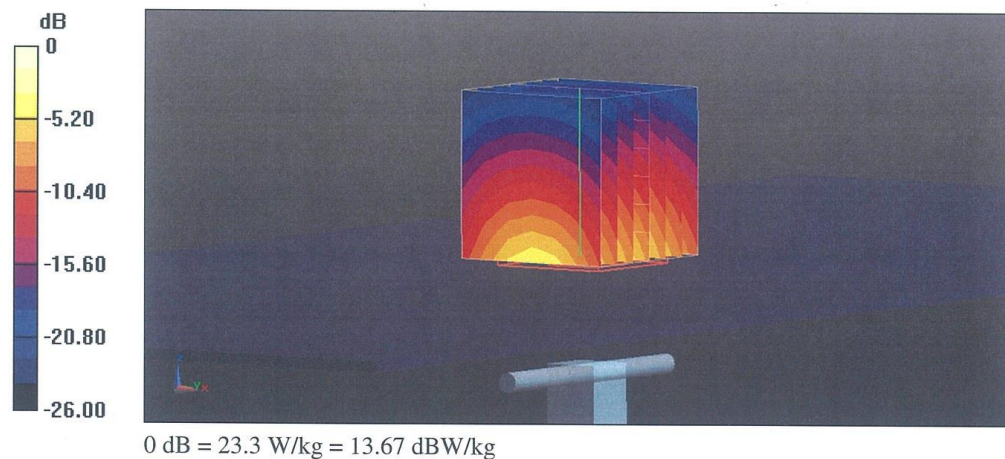
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 110.1 V/m; Power Drift = -0.06 dB

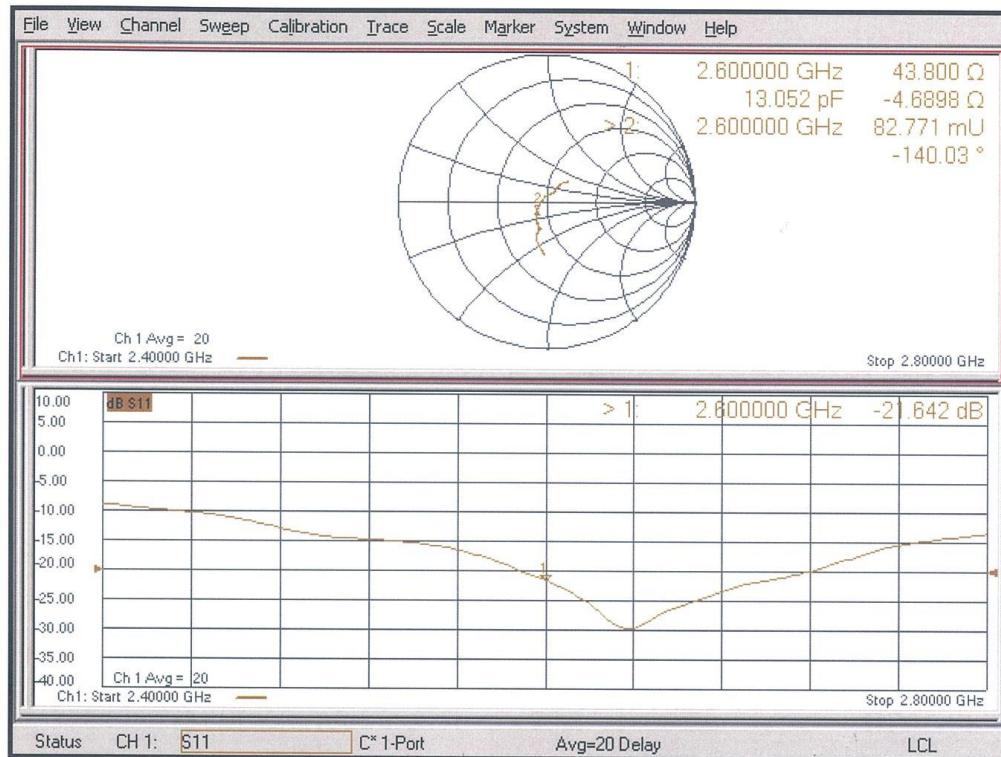
Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 14 W/kg; SAR(10 g) = 6.26 W/kg

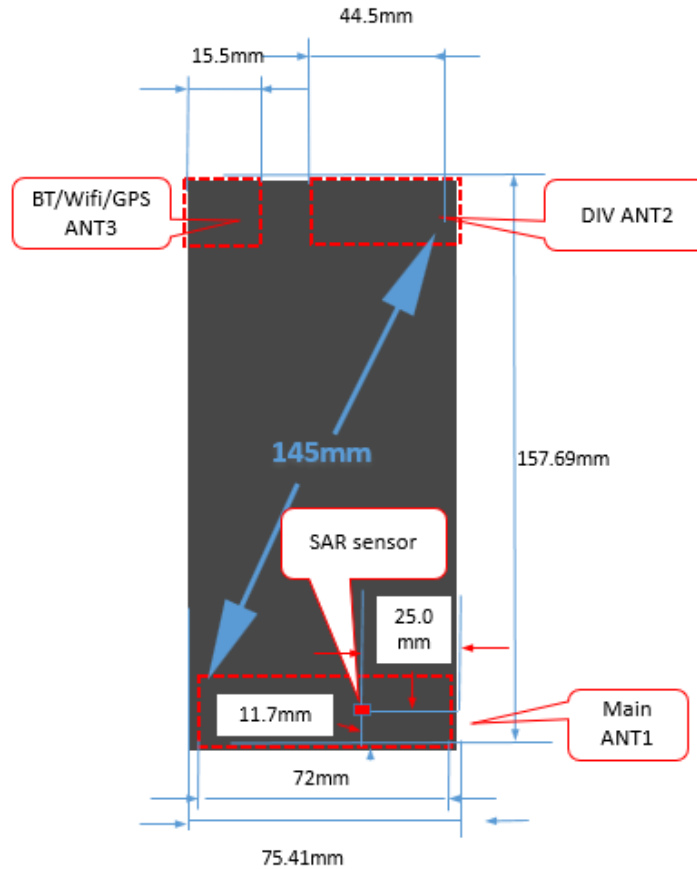
Maximum value of SAR (measured) = 23.3 W/kg



Impedance Measurement Plot for Body TSL



ANNEX I Sensor Triggering Data Summary



| SAR Sensor Detect | Near | Far |
|-------------------|--------------------|-----------------|
| back | $\leq 18\text{mm}$ | $> 18\text{mm}$ |
| front | $\leq 12\text{mm}$ | $> 12\text{mm}$ |
| bottom | $\leq 18\text{mm}$ | $> 18\text{mm}$ |

According to the above description, this device was tested by the manufacturer to determine the SAR sensor triggering distances for the rear, left edge and top edge of the device. The measured power state within $\pm 5\text{mm}$ of the triggering points (or until touching the phantom) is included for rear and each applicable edge.

To ensure all production units are compliant it is necessary to test SAR at a distance 1mm less than the smallest distance from the device and SAR phantom with the device at maximum output power without power reduction.

We tested the power and got the different proximity sensor triggering distances for rear, left edge and top edge. But the manufacturer has declared 16mm (rear/bottom) / 11mm (front) are the most

conservative triggering distance for main antenna. Therefore base on the most conservative triggering distances as above, additional SAR measurements were required at 15mm (rear/bottom) / 10mm (front) for main antenna.

Rear of main antenna

Moving device toward the phantom:

| The power state | | | | | | | | | | | |
|-----------------|--------|--------|--------|--------|--------|-----|-----|-----|-----|-----|-----|
| Distance [mm] | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 |
| Main antenna | Normal | Normal | Normal | Normal | Normal | Low | Low | Low | Low | Low | Low |

Moving device away from the phantom:

| The power state | | | | | | | | | | | |
|-----------------|-----|-----|-----|-----|-----|-----|--------|--------|--------|--------|--------|
| Distance [mm] | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| Main antenna | Low | Low | Low | Low | Low | Low | Normal | Normal | Normal | Normal | Normal |

Bottom Edge of main antenna

Moving device toward the phantom:

| The power state | | | | | | | | | | | |
|-----------------|--------|--------|--------|--------|--------|-----|-----|-----|-----|-----|-----|
| Distance [mm] | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 |
| Main antenna | Normal | Normal | Normal | Normal | Normal | Low | Low | Low | Low | Low | Low |

Moving device away from the phantom:

| The power state | | | | | | | | | | | |
|-----------------|-----|-----|-----|-----|-----|-----|--------|--------|--------|--------|--------|
| Distance [mm] | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| Main antenna | Low | Low | Low | Low | Low | Low | Normal | Normal | Normal | Normal | Normal |

Front Edge of main antenna

Moving device toward the phantom:

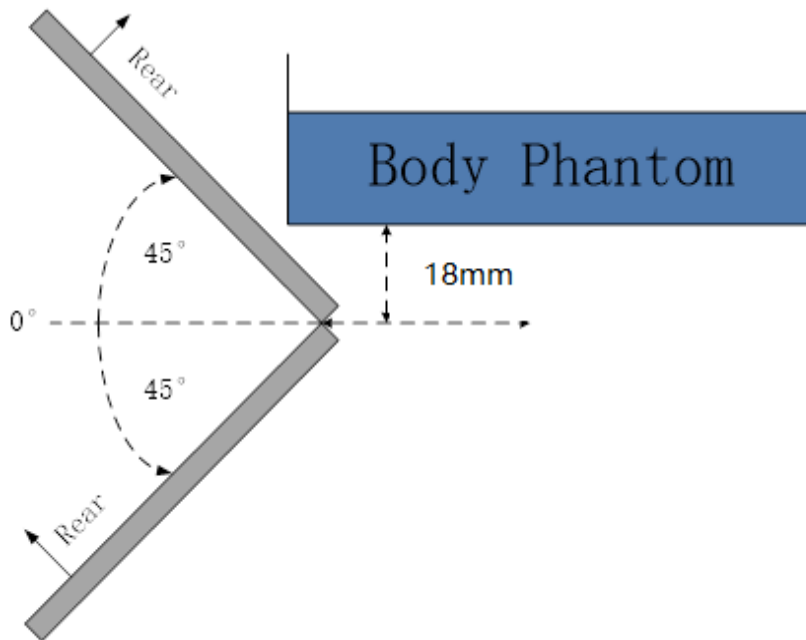
| The power state | | | | | | | | | | | |
|-----------------|--------|--------|--------|--------|--------|-----|-----|-----|-----|-----|-----|
| Distance [mm] | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 |
| Main antenna | Normal | Normal | Normal | Normal | Normal | Low | Low | Low | Low | Low | Low |

Moving device away from the phantom:

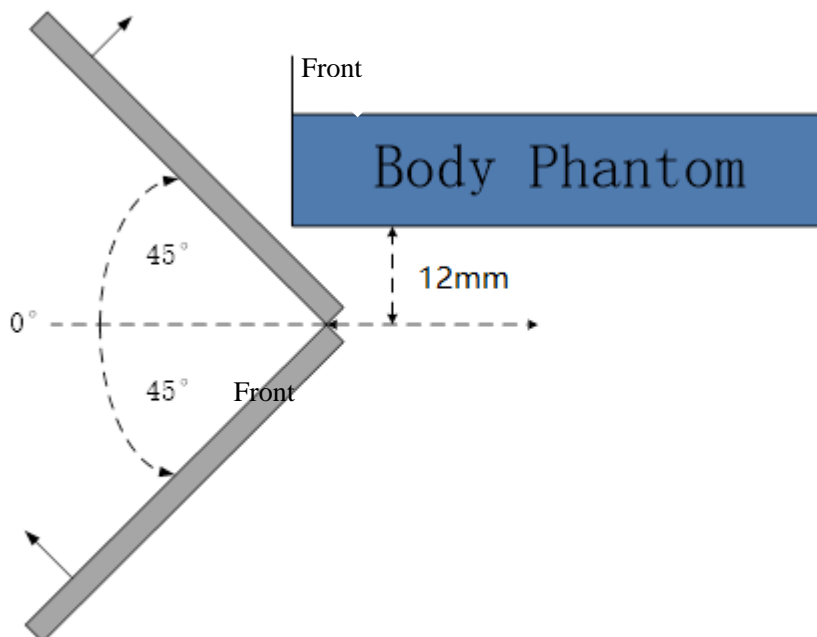
| The power state | | | | | | | | | | | |
|-----------------|-----|-----|-----|-----|-----|-----|--------|--------|--------|--------|--------|
| Distance [mm] | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Main antenna | Low | Low | Low | Low | Low | Low | Normal | Normal | Normal | Normal | Normal |

The influence of table tilt angles to proximity sensor triggering is determined by positioning each edge that contains a transmitting antenna, perpendicular to the flat phantom, at the smallest sensor triggering test distance by rotating the device around the edge next to the phantom in $\leq 10^\circ$

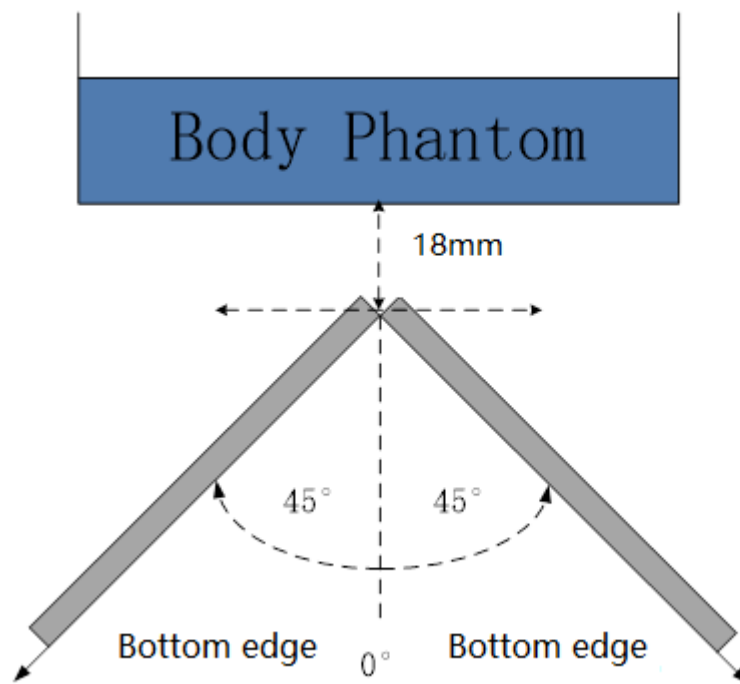
increments until the tablet is $\pm 45^\circ$ or more from the vertical position at 0° .



The Rear evaluation



The Front edge evaluation



The bottom edge evaluation

Based on the above evaluation, we come to the conclusion that the sensor triggering is not released and normal maximum output power is not restored within the $\pm 45^\circ$ range at the smallest sensor triggering test distance declared by manufacturer.

ANNEX J Accreditation Certificate

| | | | | |
|---|---|--|---|--|
| <p>United States Department of Commerce National Institute of Standards and Technology</p> <p>NVLAP[®]</p> <hr/> <p>Certificate of Accreditation to ISO/IEC 17025:2005</p> <hr/> <p>NVLAP LAB CODE: 600118-0</p> <p>Telecommunication Technology Labs, CAICT Beijing China</p> <p><i>is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:</i></p> <p>Electromagnetic Compatibility & Telecommunications</p> <p><i>This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).</i></p> <table><tr><td><p>2019-09-26 through 2020-09-30</p><hr/><p>Effective Dates</p></td><td></td><td><p></p><hr/><p>For the National Voluntary Laboratory Accreditation Program</p></td></tr></table> | | <p>2019-09-26 through 2020-09-30</p> <hr/> <p>Effective Dates</p> |  | <p></p> <hr/> <p>For the National Voluntary Laboratory Accreditation Program</p> |
| <p>2019-09-26 through 2020-09-30</p> <hr/> <p>Effective Dates</p> |  | <p></p> <hr/> <p>For the National Voluntary Laboratory Accreditation Program</p> | | |