DASY8 Module SAR

PIA INQUIRY

Usage of Device-Specific Phantoms (V2.2 July 2025)

Revision History

Revision	Date	Author(s)	Description
1.0	13.05.2025	Romain Meyer	Initial version
1.1	27.05.2025	Romain Meyer	Added phantom version number, validation results and uncertainty budget, updated pictures
2.0	12.06.2025	Romain Meyer	The physical phantoms have been modified based on suggestions from the FCC OET Team to include the red line demarcating the measurable area. All future phantoms will feature this line, and the existing ones will be updated accordingly. New images reflecting these changes have been taken and are now included in this version of the report.
2.1	14.06.2025	Romain Meyer	Updated Cover Page.
2.2	11.07.2025	Romain Meyer	Added additional information after FCC approval (Section 2).

PIA Inquiry: Usage of Device-Specific Phantoms, Version 2.2

1 Scope

In this Persistent Inquiry Approval (PIA) submission, we seek acceptance by the US Federal Communications Commission (FCC) of the use of non-standard, device-specific phantoms in specific absorbance rate (SAR) compliance testing when integrated in the DASY8 platform and operated according to software version DASY8 Module SAR V16.4 or higher.[1]

The following specific phantoms are included in this submission:

- **Specific Anthropomorphic Mannequin (SAM) Face-Down Phantom V10+** – for devices used in front of the face, such as goggles and walkie-talkies
- **SAM Head-Stand Phantom V10+** – for transmitters with antennas located on top or at the back of the head, e.g., virtual reality (VR) headsets and helmets
- **Wrist Phantom V10+** – based on the CTIA forearm phantom, for wrist-worn devices, like smartwatches and fitness bands
- **Ankle Phantom V10+** – for wearables positioned on the lower leg, e.g., tracking devices

In alignment with guidance from the TCB Workshop held in April 2025, i.e., the RF Exposure Session, Section 2, we submit this request for PIA authorization to use these phantoms in compliance evaluations via Knowledge Data Base (KDB) inquiry only, removing the need for device-specific Performance Agreements (PAGs).

2 FCC Approval

FCC's approval specifies the following:

> **Note:** *Any applicant for certification that leverages the technology discussed in this PIA will be required to supply the TCBs with a detailed description of the technology such that they will be able to review and establish that it meets the FCC requirements for the PHANTM PAG exemption per KDB 388624-D02. That certification application must also include an attestation document to be filed in the Operational Description of the EAS filings with the KDB inquiry number for the PIA itself; the KDB number is for the FCC to be able to track the PIA information associated with the EAS filing. It is then essential that whoever leverages this PIA would have KDB inquiry number as well.*

For this PIA, the KDB number is *622551*.

[1] The PIA approach was introduced at the Telecommunication Certification Body (TCB) Workshop in April 2025, which allows approval as an alternative to the PHANTM PAG process.

3 Phantom Description and Measurable Area Validation

In this section, we define the phantoms and the measurable area within each phantom, also referred to as the probe trajectory plot in the TCB Workshop presentation.

NOTE: The red line demarcating the measurable area is included on all phantoms shipped after July 2025. Phantoms purchased prior to this date are eligible for a free upgrade.

3.1 SAM Face-Down Phantom V10

The SAM Face-Down Phantom V10 (Figure 1.1) corresponds to the shape and shell definition of the SAM and is defined in IEC/IEEE 62209-1528[1]. The measurable area of the SAM Face-Down Phantom as defined on the phantom and software includes only the head section; the extruded portion is excluded.

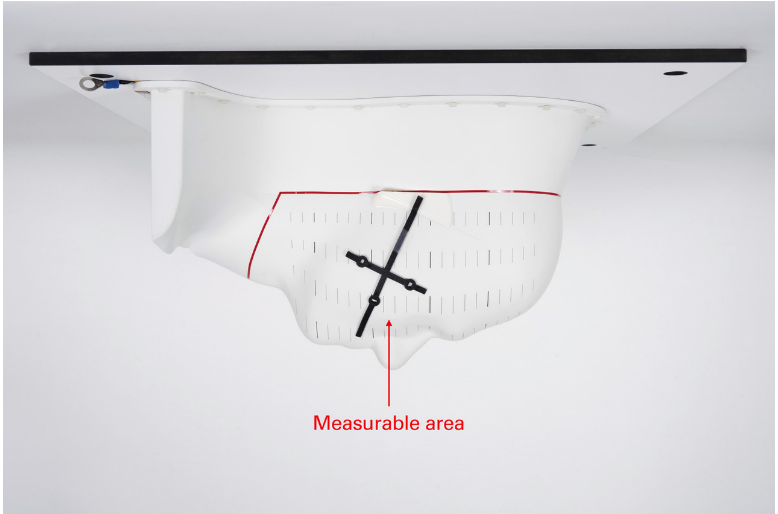


Figure 1.1: Measurable area of the SAM Face-Down Phantom V10.

This region was validated via a surface detection scan of the entire phantom. The yellow points in Figure 1.2 outline the validated area. Measurement points can be interpolated within this boundary.[2]

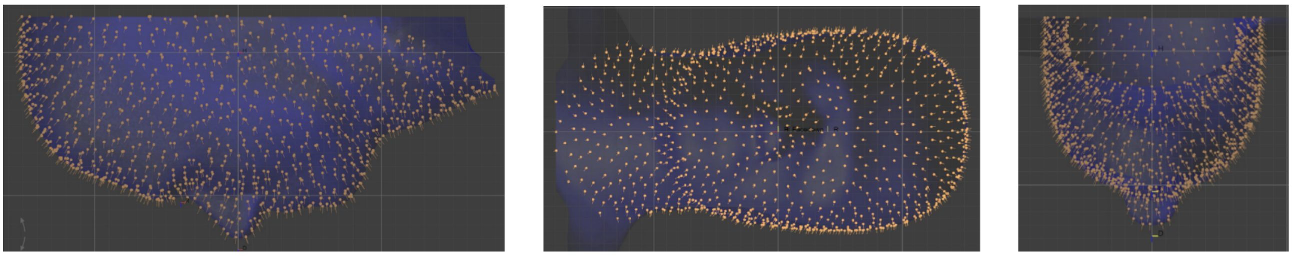


Figure 1.2: Validation of the measurable area of the SAM Face-Down Phantom.

[2] In the next SAM Face-Down computer-aided design (CAD) model to be released with Module SAR V17.0, the shoulders will be excluded from the measurable area.

3.2 SAM Head-Stand Phantom V10

The SAM Head-Stand Phantom V10 corresponds to the shape and shell definition of SAM as defined in IEC/IEEE 62209-1528[1]. The measurable area of the SAM Head-Stand Phantom includes the entire head section, excluding the extruded portion (Figure 1.3).

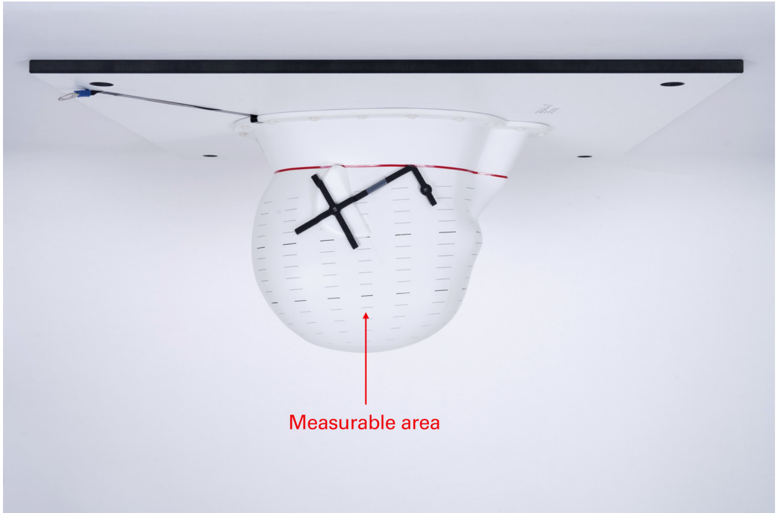


Figure 1.3: Measurable area of the SAM Head-Stand Phantom.

Surface scan validation confirms that the measurable region covers the full head section, as indicated by the yellow dots in Figure 1.4; the actual measurement points can be anywhere within this boundary.

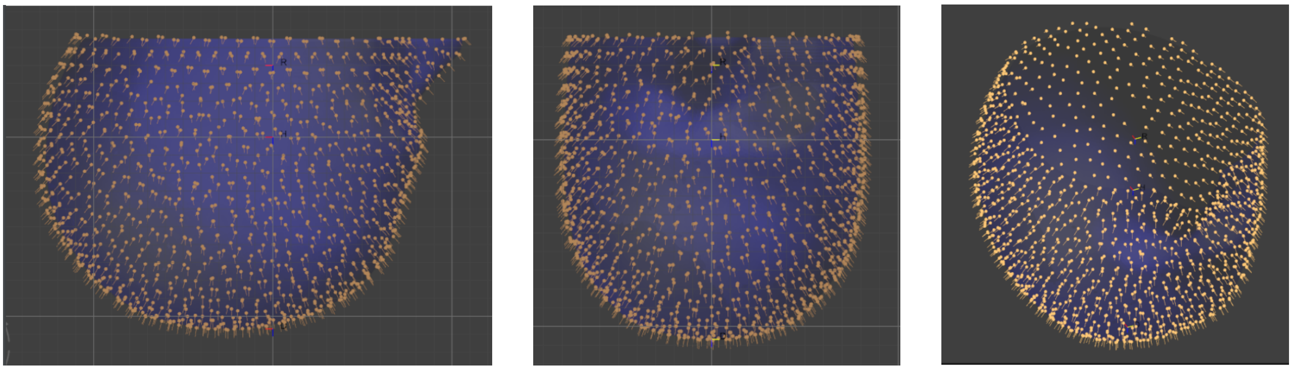


Figure 1.4: Validation of the measurable area of the SAM Head-Stand Phantom.

3.3 Wrist Phantom V10

The Wrist-Phantom V10 as defined by the CTIA[2] has been adopted for the procedure described in IEC/IEEE 62209-1528[1], in which the shell requirements are also defined. The CAD model used by the CTIA was derived from the study of Hand Anthropometry OF U.S. Army Personnel [3]. The measurable area of the Wrist Phantom corresponds to the conical section shown in Figure 1.5.

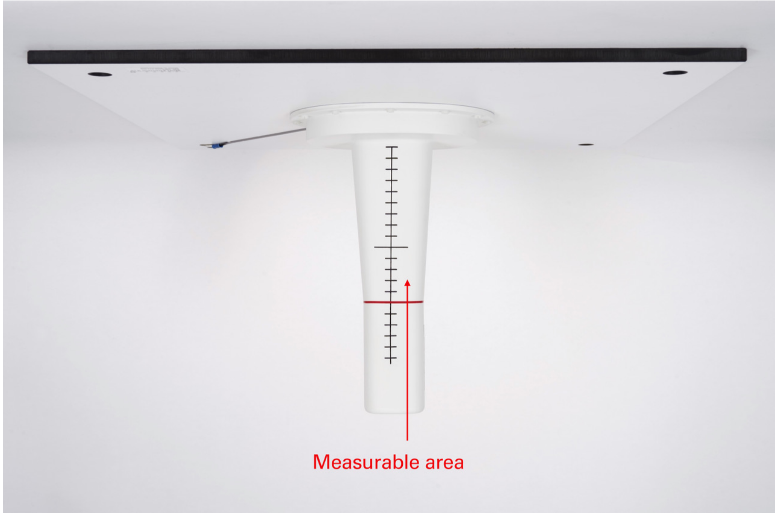


Figure 1.5: Measurable area of the Wrist Phantom.

Validation via surface scan confirmed that the entire conical region is measurable, as indicated by the yellow dots in Figure 1.6.

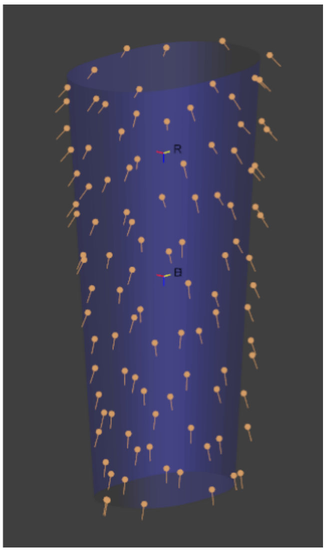


Figure 1.6: Validation of the measurable area of the Wrist Phantom.

3.4 Ankle Phantom V10

The Ankle Phantom V10 shape is compatible with the CTIA-approved over-the-air (OTA) GAPC-V1[2]. The CAD model used by the CTIA was derived from the 1988 Anthropometric Survey of US Army Personnel [4] and is optimized for specific absorption rate (SAR) evaluations of devices, e.g., tracking devices, that operate on or near the lower leg. The measurable area of the Ankle Phantom corresponds to the conical section shown in Figure 1.7.

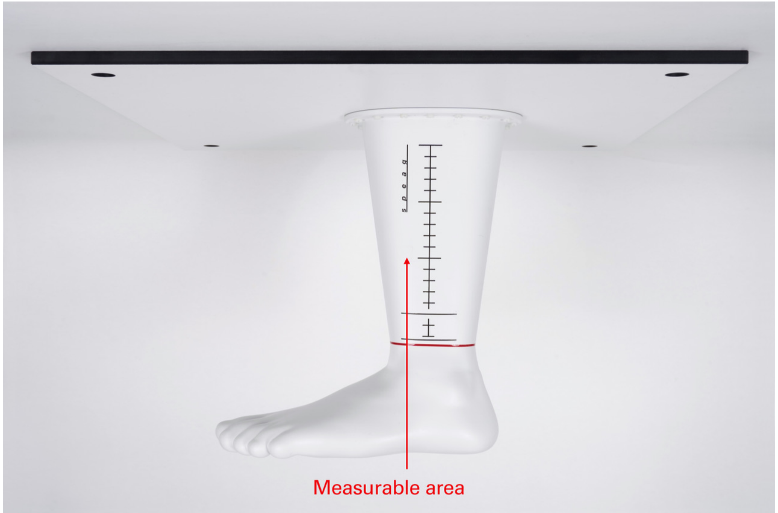


Figure 1.7: Measurable area of the Ankle Phantom.

Validation via surface scan confirmed that the entire conical region as indicated by the yellow dots in Figure 1.8 is measurable.

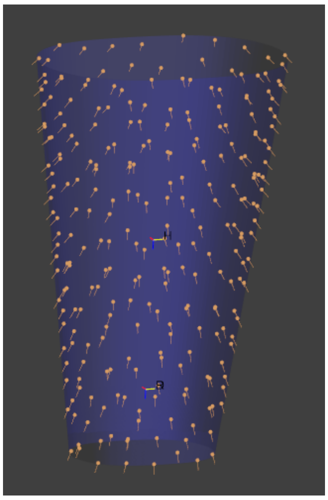


Figure 1.8: Validation of the measurable area of the Ankle Phantom.

4 Device Positioning

The phantoms include surface markings to facilitate reproducible positioning of the devices on the phantoms. Positioning can also be accurately documented through photos and written descriptions to ensure reproducible results.

Figure 1.9 illustrates smart goggles correctly aligned on the Face-Down phantom.

Figure 1.9: Smart goggles positioned on the Face-Down phantom; positioning lines ensure reproducible placement.

Figure 1.10 shows a smart camera correctly aligned on the Head-Stand phantom.

Figure 1.10: Smart camera positioned on the Head-Stand phantom; positioning lines ensure reproducible placement.

Wrist-worn devices, including smart watches and fitness trackers, are positioned on the Wrist Phantom, with a printed ruler used for alignment. This feature improves reproducibility across test setups (Figure 1.11).

Figure 1.11: Smartwatch positioned on the Wrist Phantom aligned via the built-in ruler.

Devices mounted on the lower leg, including electronic tags, are positioned in the same manner as wrist-worn devices, with the printed ruler to ensure accurate alignment.

Figure 1.12: Electronic tag positioned on the Ankle Phantom aligned via the built-in ruler.

5 System Verification

5.1 System Performance Check

System performance checks in device-specific phantoms, as outlined in the IEC/IEEE 62209-1528 [1] standard, are conducted with a flat phantom section provided the same probe, data acquisition electronics, and tissue-simulating liquid are used during the actual measurements in the specific phantom.

5.2 Extended System Performance Check

Checks of system performance may be performed directly in the device-specific phantoms. For SAM-head-derived phantoms, i.e., the SAM Face-Down and SAM Head-Stand phantoms, dedicated positioning masks are provided to ensure accurate placement of validation dipoles (see Figure 1.13). The associated numerical targets for each validation position are defined in the IEC 62209-3 [5] standard.

Figure 1.13: Facedown phantom with the mask mounted for accurate dipole positioning.

For the Wrist phantom, validation dipoles are positioned with the aid of the integrated printed ruler. SAR numerical targets at each validation location have been established by the IT'IS Foundation and are provided in the DASY8 Module SAR System Handbook, Section 7.4.5 [6].

6 Uncertainty Budget

The uncertainty budget for DASY8/6 Module SAR measurements in device-specific phantoms is given in the DASY8 Module SAR System Handbook, Section 6.4 [6] and copied hereunder for convenience.[3]

The uncertainty budget for specific phantoms is described in this Section. The components that differ from regular phantoms are listed in the following:

- *Hemispherical Isotropy:* As it is not guaranteed that the field orientation is dominantly normal to the probe axis for the scanning procedures used in specific phantoms, full tolerance according to hemispherical isotropy must be applied.

- *Probe Positioning:* Even when the surface of the phantom is known with high precision, the uncertainty of the position of the probe tip is conservatively assumed to be doubled compared to normal the probe is almost parallel to the phantom surface due to geometric considerations.

- *Post-Processing:* A larger extrapolation tolerance is expected due to the larger measurement distance from the phantom surface; the uncertainty was estimated on the basis of the steepest decay observed for capacitive sources.

The procedures and uncertainties summarized in Tables 1.3, 1.4 and 1.2 are based on SAR measurement standards, e.g., IEC/IEEE 62209-1528[1]. The uncertainty for measurements in regular phantoms has increased from 23% to 29% ($k = 2$) for specific phantoms.

[3]DASY8 users should always use the uncertainty budget given in the latest version of the DASY8/6 System Handbook.

DASY8 Uncertainty Budget

According to IEC/IEEE 62209-1528[1], Specific Phantoms

(Frequency band: 4 MHz–300 MHz **range)**

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) (1 g)	(c_i) (10 g)	Std. Unc. (1 g)	Std. Unc. (10 g)
Measurement System Errors								
CF	Probe Calibration	±13.3%	N	2	1	1	±6.65%	±6.65%
CF_{drift}	Probe Calibration Drift	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±0.6%	R	$\sqrt{3}$	1	1	±0.3%	±0.3%
ISO	Probe Isotropy	±9.6%	R	$\sqrt{3}$	1	1	±5.5%	±5.5%
DAE	Other Probe+Electronic	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±0.006 mm	N	1	0.04	0.04	±0.20%	±0.20%
DAT	Data Processing	±8.7%	N	1	1	1	±8.7%	±8.7%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±5.4%	R	$\sqrt{3}$	0.78	0.71	±2.4%	±2.2%
EPS	Phantom Permittivity	±14.0%	R	$\sqrt{3}$	0	0	±0.0%	±0.0%
DIS	Distance DUT – TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^{m}	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0.0%	±0.0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0.0%	±0.0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^{p}	±0.0%	R	$\sqrt{3}$	1	1	±0.0%	±0.0%
u(ΔSAR)	Combined Uncertainty						±14.6%	±14.6%
U	**Expanded Uncertainty**						±29.3%	±29.1%

Table 1.2: Worst-case uncertainty budget for DASY8 assessed according to IEC/IEEE 62209-1528[1]. The budget is valid for the frequency range 4 MHz–300 MHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller. All listed error components have v_{eff} equal to ∞. **Footnote details:** ^{m} Sensor Model Calibration (SMC) is a new method for determining the total deviation from linearity. The uncertainty is $\leq$ 2.4% for psSAR1 g/10 g $\leq$2 W/kg, $\leq$ 4.8% for psSAR1 g/10 g $\leq$4 W/kg and $\leq$ 9.6% for psSAR1 g/10 g $\leq$10 W/kg (see modulation calibration parameter uncertainty in the probe calibration certificate); ^{BB} when SPEAG's broad-band liquids (BBL) that have low-temperature coefficients are used; ^{DAK} when SPEAG's high-precision dielectric probe kit (DAK) is applied; ^{p} when power scaling is used, the error item "SAR Scaling" must be adjusted accordingly; ^{val} applies only in cases of validation measurements.

DASY8 Uncertainty Budget

According to IEC/IEEE 62209-1528[1], Specific Phantoms

(Frequency band: 300 MHz–3 GHz **range)**

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) (1 g)	(c_i) (10 g)	Std. Unc. (1 g)	Std. Unc. (10 g)
Measurement System Errors								
CF	Probe Calibration	±13.3%	N	2	1	1	±6.7%	±6.7%
CF_{drift}	Probe Calibration Drift	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±2.8%	R	$\sqrt{3}$	1	1	±1.6%	±1.6%
ISO	Probe Isotropy	±9.6%	R	$\sqrt{3}$	1	1	±5.5%	±5.5%
DAE	Other Probe+Electronic	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±0.006 mm	N	1	0.14	0.14	±0.5%	±0.5%
DAT	Data Processing	±8.7%	N	1	1	1	±8.7%	±8.7%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.3%	R	$\sqrt{3}$	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	$\sqrt{3}$	0	0	±0%	±0%
DIS	Distance DUT – TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^m	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^p	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±14.6%	±14.5%
U	**Expanded Uncertainty**						±29.2%	±29.1%

Table 1.3: Worst-case uncertainty budget for DASY8 assessed according to IEC/IEEE 62209-1528[1]. The budget is valid for the frequency range 300 MHz–3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller. All listed error components have v_{eff} equal to ∞. **Footnote details:** ^{m} SMC is a new method for determining the total deviation from linearity. The uncertainty is $\leq$ 2.4% for psSAR1 g/10 g $\leq$2 W/kg, $\leq$ 4.8% for psSAR1 g/10 g $\leq$4 W/kg and $\leq$ 9.6% for psSAR1 g/10 g $\leq$10 W/kg (see modulation calibration parameter uncertainty in the probe calibration certificate); ^{BB} when SPEAG's broad-band liquids (BBL) that have low-temperature coefficients are used; ^{DAK} when SPEAG's high-precision dielectric probe kit (DAK) is applied; ^{p} when power scaling is used, the error item "SAR Scaling" must be adjusted accordingly; ^{val} applies only in cases of validation measurements.

DASY8 Uncertainty Budget

According to IEC/IEEE 62209-1528[1], Specific Phantoms

(Frequency band: 3 GHz–6 GHz **range)**

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) (1 g)	(c_i) (10 g)	Std. Unc. (1 g)	Std. Unc. (10 g)
Measurement System Errors								
CF	Probe Calibration	±13.1%	N	2	1	1	±6.55%	±6.55%
CF_{drift}	Probe Calibration Drift	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
ISO	Probe Isotropy	±9.6%	R	$\sqrt{3}$	1	1	±5.5%	±5.5%
DAE	Other Probe+Electronic	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±0.005 mm	N	1	0.29	0.29	±0.8%	±0.8%
DAT	Data Processing	±8.7%	N	1	1	1	±8.7%	±8.7%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.4%	R	$\sqrt{3}$	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	$\sqrt{3}$	0.25	0.25	±2.0%	±2.0%
DIS	Distance DUT – TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^{m}	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^{p}	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±14.7%	±14.6%
U	**Expanded Uncertainty**						±29.4%	±29.3%

Table 1.4: Worst-case uncertainty budget for DASY8 assessed according to IEC/IEEE 62209-1528[1]. The budget is valid for the frequency range 3 GHz–6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller. All listed error components have v_{eff} equal to ∞.

Footnote details: ^{m} SMC is a new method for determining the total deviation from linearity. The uncertainty is $\leq$ 2.4% for psSAR1 g/10 g $\leq$2 W/kg, $\leq$ 4.8% for psSAR1 g/10 g $\leq$4 W/kg and $\leq$ 9.6% for psSAR1 g/10 g $\leq$10 W/kg (see modulation calibration parameter uncertainty in the probe calibration certificate); ^{BB} when SPEAG's broad-band liquids (BBL) that have low-temperature coefficients are used; ^{DAK} when SPEAG's high-precision dielectric probe kit (DAK) is applied; ^{p} when power scaling is used, the error item "SAR Scaling" must be adjusted accordingly; ^{val} applies only in cases of validation measurements.

7 Validation of DASY8 Module SAR Measurement Accuracy in Specific Phantoms

The purpose of this section is to validate on a system level that the implementation is correct for all of the specific phantoms listed, that the system check as described in 5.1 is sufficient to verify that the system operates within the stated performance specifications, and that the measurement uncertainty budget is applicable. This section is an extract from Section 7.4 of the System Manual [6].

7.1 Verification for Probe Angles at up to 70° from the Phantom Surface Normal

To assess the reliability of probe positioning and the extrapolation algorithm when the probe is not normal to the phantom surface, a special validation phantom, shown in Figure 1.14, has been built to support the validation measurements based on standard system validation dipoles for measurements at different probe inclination angles. In this validation, probes angles of 20°, 60°, and 70° are used and the results are compared with the numerical SAR targets. The measurement results, summarized in Table 1.5, show a maximum deviation of 0.34 dB, which is well within the measurement uncertainty specified in Section 6.

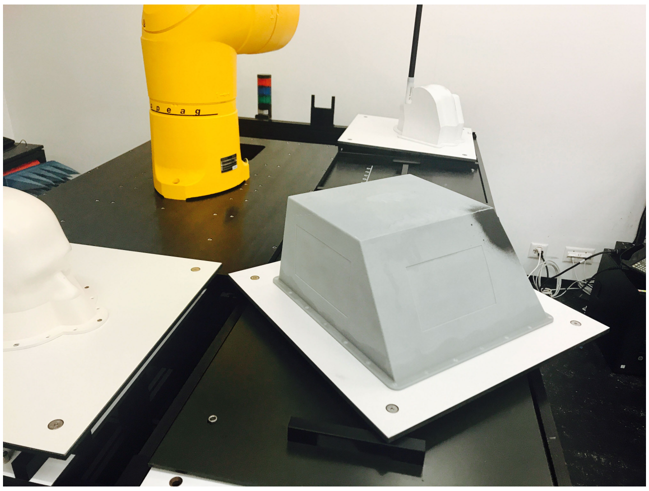


Figure 1.14: The special validation phantom with different inclination planes for system verification checks; the shell thickness at the center of the field on each gray side is 2 ± 0.1 mm). This simulation is used to verify the implemented measurement procedures and extrapolation for any specific phantoms.

Angle	Frequency	Measured [W/Kg]		Target [W/Kg]		Deviation [dB]	
[°]	[MHz]	1 g	10 g	1 g	10 g	1 g	10 g
20	900	10.1	6.64	11.1	7.17	−0.40	−0.33
60	900	10.9	7.15	11.1	7.17	−0.08	0.00
70	900	11.4	7.43	11.1	7.17	0.12	0.16
20	5800	68.6	19.8	74.1	20.5	−0.34	−0.15
60	5800	77.3	22.1	74.1	20.5	0.18	0.33
70	5800	74.6	21.6	74.1	20.5	0.03	0.23

Table 1.5: Summary of the measurement results for deviations from the surface normal of up to 70°. All values are normalized to 1 W forward power.

7.2 Validation in the SAM Head Derived Phantoms

The validations in SAM Head derived phantoms, i.e., the Face-Down and Head-Stand Phantoms, are performed according to the validation points described in the IEC 62209-3 [5] standard. The locations of the nine points are shown in Figure 1.15.

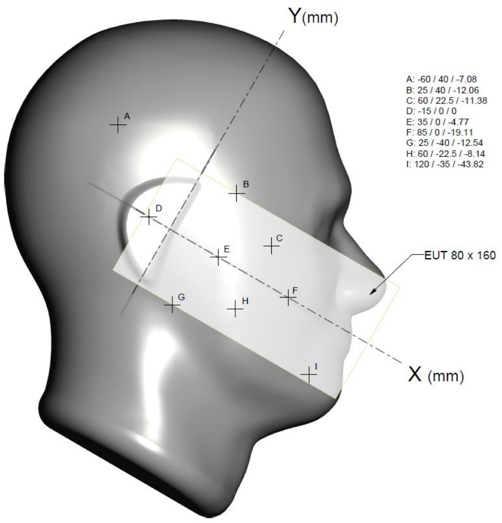
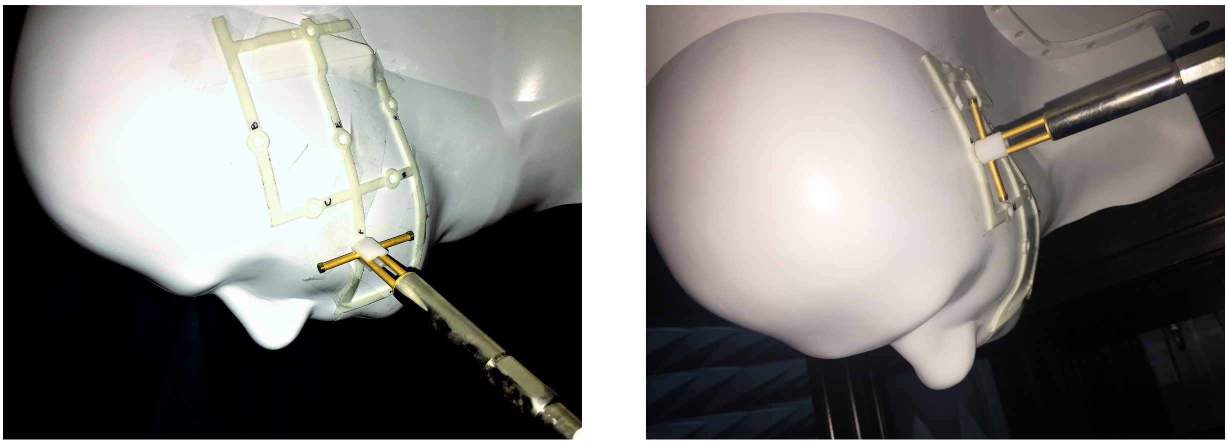


Figure 1.15: Validation points on the SAM Right Head Phantom

7.2.1 Validation in the SAM Face-Down Phantom

The measurement procedure for the SAM Face-Down Phantom has been validated according to the relevant test positions defined for the Validation Mask in IEC 62209-3 [5] to position the dipoles at the Face-Down Phantom. Figure 1.16 below shows examples of two of the tested dipole positions.

Table 1.6 provides a comparison between the measured SAR values and the numerical targets.



(a) Point F

(b) Point B

Figure 1.16: Test positions on Face-Down Phantom at points F (left) and B (right).

7.2.2 Validation in the SAM Head-Stand Phantom

The measurement procedures for the SAM Head-Stand Phantom have been validated according to the relevant test positions defined in IEC 62209-3 [5].

Point	Freq [MHz]	Rot [°]	d [mm]	Meas [W/kg] 1 g	Meas [W/kg] 10 g	Target [W/kg] 1 g	Target [W/kg] 10 g	Dev [dB] 1 g	Dev [dB] 10 g	Probe Angle [°] Max	Probe Angle [°] Avg
C	900	90	15	9.86	6.42	11.2	7.25	−0.54	−0.52	40.0	31.1
E	900	90	15	9.98	6.54	10.9	7.06	−0.37	−0.33	55.0	48.3
H	900	90	15	9.68	6.32	11.1	7.21	−0.60	−0.57	60.0	47.4
I	900	0	15	9.52	6.17	11.1	7.20	−0.66	−0.67	35.0	26.5
I	900	90	15	10.7	7.04	9.26	6.03	0.63	0.67	35.0	26.4
C	1750	90	10	35.5	18.8	39.3	20.5	−0.44	−0.38	40.0	32.8
E	1750	90	10	34.9	18.6	37.9	19.9	−0.36	−0.30	55.0	49.2
H	1750	90	10	35.3	18.7	39.6	20.6	−0.51	−0.42	60.0	46.4
I	1750	90	10	30.6	16.4	34.4	17.9	−0.50	−0.39	35.0	24.4
F	1950	90	10	46.4	24.0	42.2	21.5	0.39	0.47	35.0	24.9
B	2450	0	10	49.5	23.1	54.0	25.1	−0.38	−0.35	45.0	39.3
B	2450	90	10	49.1	22.9	53.8	24.3	−0.40	−0.25	50.0	40.6
C	2450	0	10	48.9	22.7	52.8	24.4	−0.33	−0.32	40.0	31.5
C	2450	90	10	52.7	24.3	54.8	24.8	−0.17	−0.09	40.0	32.2
E	2450	0	10	48.5	22.9	51.8	23.9	−0.29	−0.19	55.0	48.8
E	2450	90	10	50.7	23.7	51.8	24.0	−0.09	−0.05	55.0	48.5
F	2450	0	10	51.7	23.9	53.2	24.0	−0.13	−0.01	35.0	25.0
F	2450	90	10	56.5	26.4	54.8	24.9	0.14	0.25	35.0	25.0
H	2450	0	10	48.3	22.3	51.4	23.5	−0.27	−0.23	60.0	51.1
H	2450	90	10	53.7	24.5	56.0	27.5	−0.18	−0.51	60.0	47.8
I	2450	0	10	59.1	27.9	56.0	26.0	0.23	0.31	40.0	26.7
I	2450	90	10	47.1	21.9	53.0	24.0	−0.51	−0.39	35.0	24.3
G	5800	90	25	14.1	5.29	15.9	5.97	−0.52	−0.53	55.0	48.9
I	5800	90	25	18.0	6.31	15.6	5.73	0.62	0.42	60.0	45.4

Table 1.6: Summary of the validation measurements performed in the SAM Face-Down Phantom with the measurement points defined in the Annex D of the IEC 62209-3 [5]. The uncertainty of the target values have been specified as 0.4 dB ($k = 2$). All values are normalized to 1 W forward power. The maximum deviation of 0.67 dB is well within the combined uncertainty of target values and the measurement uncertainty.

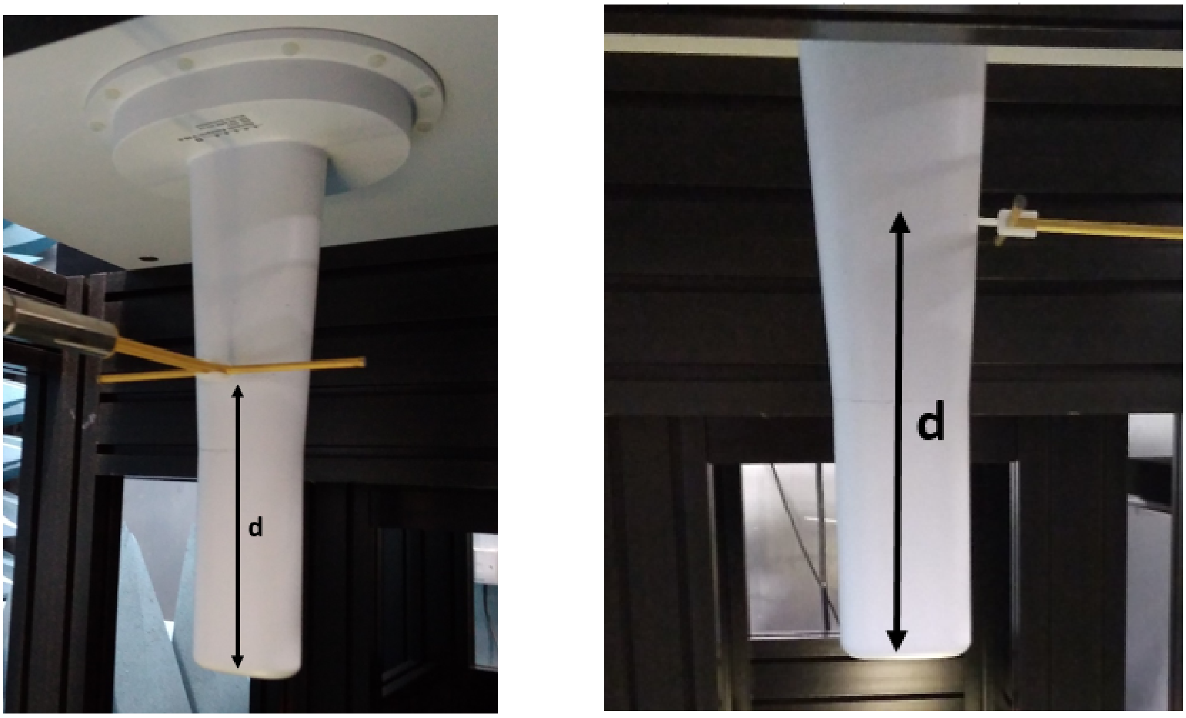
Table 1.7 summarizes the comparison between measured SAR values and the numerical targets.

Point	Freq [MHz]	Rot [°]	d [mm]	Meas [W/kg] 1 g	Meas [W/kg] 10 g	Target [W/kg] 1 g	Target [W/kg] 10 g	Dev [dB] 1 g	Dev [dB] 10 g	Probe Angle [°] Max	Probe Angle [°] Avg
A	835	90	15	9.04	5.89	9.00	6.02	0.02	−0.09	45.0	38.1
B	835	90	15	9.52	6.25	9.70	6.37	−0.08	−0.09	45.0	41.4
C	900	90	15	11.3	7.22	11.2	7.25	0.06	−0.02	50.0	39.9
A	1950	90	10	45.8	23.8	41.0	21.1	0.48	0.52	45.0	36.4
B	1950	90	10	46.2	23.8	41.7	21.2	0.44	0.51	45.0	41.4
B	1950	90	5	75.6	34.8	77.2	34.2	−0.09	0.07	45.0	41.9
A	2450	0	10	60.9	27.9	54.6	24.6	0.47	0.55	45.0	39.9
B	2450	90	10	60.1	27.7	53.8	24.3	0.48	0.57	45.0	41.8
C	2450	90	10	51.0	23.5	54.8	24.9	−0.31	−0.25	45.0	39.6
C	5800	90	25	19.0	6.78	17.1	5.97	0.45	0.55	40.0	39.4

Table 1.7: Summary of validation measurements performed in the SAM Head-Stand Phantom with the measurement points defined in Annex D of the of the IEC 62209-3 [5]. The uncertainty of the target values have been specified as 0.4 dB ($k = 2$). All values are normalized to 1 W forward power. The maximum deviation of 0.57 dB is well within the combined uncertainty of target values and the measurement uncertainty.

7.3 Validation in the Wrist Phantom

Figure 1.17 shows a dipole positioned at two different test positions.



(a) Point N (wide side)

(b) Point R (narrow side)

Figure 1.17: Test positions on the Wrist Phantom: point N on the wide side of the wrist and point R on the narrow side of the wrist

Table 1.8 summarizes the comparison between the measured SAR values and the numerical targets.

Point	Freq	Rot	*d*	Meas [W/Kg]		Target [W/Kg]		Dev [dB]		Probe Angle [°]	
(170 mm)	[MHz]	[°]	[mm]	1 g	10 g	1 g	10 g	1 g	10 g	Max	Avg
N (ws)	900	0	15	8.48	5.57	7.30	5.10	0.65	0.38	75.0	47.8
R (ns)	900	0	15	4.60	3.40	4.70	3.20	−0.15	0.17	80.0	64.6
N (ws)	1750	0	10	32.2	17.7	36.0	18.9	−0.48	−0.28	75.0	48.3
Q (ns)	1750	90	10	46.4	23.4	44.4	22.8	0.19	0.12	75.0	49.9
R (ns)	1750	0	10	22.6	11.9	25.1	13.0	−0.46	−0.38	80.0	62.6
N (ws)	2450	0	10	53.4	25.6	53.5	24.2	−0.01	0.24	75.0	49.3
Q (ns)	2450	90	10	64.0	26.8	62.1	26.8	0.13	0.01	80.0	62.4
R (ns)	2450	0	10	38.3	16.5	41.3	17.6	−0.33	−0.28	80.0	61.6
N (ws)	5800	0	10	84.8	22.6	78.0	21.9	0.36	0.14	80.0	61.8
N (ws)	6500	90	5	304	59.0	305	52.5	−0.01	0.51	80.0	61.8

Table 1.8: Summary of validation measurements performed on the wide side (ws) and narrow side (ns) of the Wrist Phantom. The uncertainty of the target values have been specified as 0.4 dB ($k = 2$). All Values are normalized to 1 W forward power. The maximum deviation of 0.65 dB is well within the combined uncertainty of target values and the measurement uncertainty. Note: the orientation at 90° is parallel to the axis of the wrist.

7.4 Validation in the Ankle Phantom

The measurement procedures for the Ankle Phantom have been validated at reference point R as shown in Figure 1.18 for four frequencies defined in IEC 62209-3 [5].

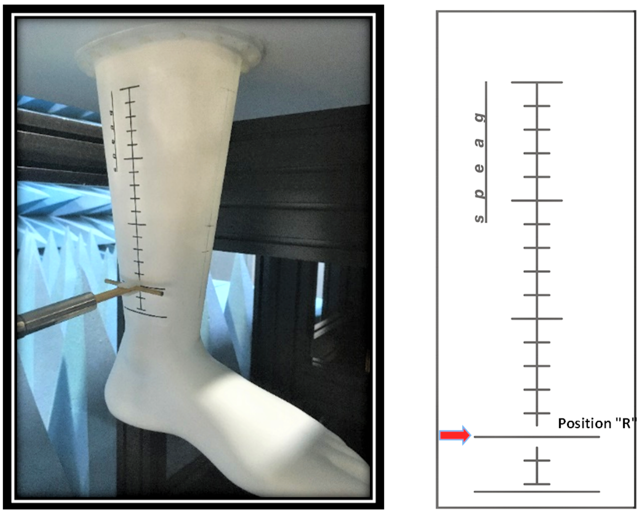


Figure 1.18: System check at point R of the Ankle Phantom

The validation results are summarized in Table 1.9.

Point	Freq [MHz]	Orient.	d [mm]	Measured [W/kg]		Target [W/kg]		Deviation [dB]	
				1 g	10 g	1 g	10 g	1 g	10 g
R	900	0	15	7.76	5.12	8.1	5.4	−0.20	−0.26
R	1750	0	10	36.8	19.8	38.6	20.2	−0.21	−0.10
R	2450	0	10	52.0	24.68	56.8	26.1	−0.38	−0.24
R	5800	0	10	68.0	17.96	72.9	20.5	−0.30	−0.57

Table 1.9: Summary of validation measurements performed on the Ankle phantom. The uncertainty of the target values have been specified as 0.4 dB ($k = 2$). All values are normalized to 1 W forward power. The maximum deviation of 0.57 dB is well within the combined uncertainty of target values (0.4 dB), and the measurement uncertainty of 1.1 dB equals 1.2 dB ($k = 2$).

8 Conclusions

The usage of the specific phantoms in DASY8 as well as the required system checks, the uncertainty budgets, and the comprehensive validations are described. The integration of the specific phantoms in DASY8 is according to guidance described in IEC/IEEE 62209-1528[1].

Bibliography

[1] IEC/IEEE 62209-1528, *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: Human Models, Instrumentation and Procedures (Frequency Range of 4 MHz to 10 GHz)*. IEC/IEEE, October 2020, standard No. IEC/IEEE 62209-1528:2020.

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[4] Claire C. Gordon et.al., *Anthropometric Survey of U.S. Army Personnel: Summary Statistics, Interim Report for 1988*. Army Natick Research Development and Engineering Center, 1989.

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[6] SPEAG, *DASY8 Module SAR System Handbook*. SPEAG, May 2024.