Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	5.15 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**77.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.1 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	5.20 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.7 ± 6 %	5.43 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**73.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.5 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.1 ± 6 %	5.91 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.69 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.2 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.8 ± 6 %	6.19 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.29 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**72.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.99 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**19.9 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.1	6.06 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	6.26 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5850 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.50 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.5 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	52.3 Ω - 6.9 jΩ
Return Loss	- 23.0 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.7 Ω - 2.4 jΩ
Return Loss	- 25.9 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.0 Ω + 0.5 jΩ
Return Loss	- 24.9 dB

Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	55.5 Ω + 0.6 jΩ
Return Loss	- 25.6 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	52.2 Ω - 4.7 jΩ
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	55.9 Ω - 0.2 jΩ
Return Loss	- 25.1 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.7 Ω + 2.9 jΩ
Return Loss	- 23.3 dB

Antenna Parameters with Body TSL at 5850 MHz

Impedance, transformed to feed point	56.6 Ω + 2.0 jΩ
Return Loss	- 23.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.200 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: 18.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz, Frequency: 5850 MHz
Medium parameters used: f = 5250 MHz; σ = 4.58 S/m; ε_r = 35.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.94 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.15 S/m; ε_r = 35.1; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5850 MHz; σ = 5.20 S/m; ε_r = 35.0; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

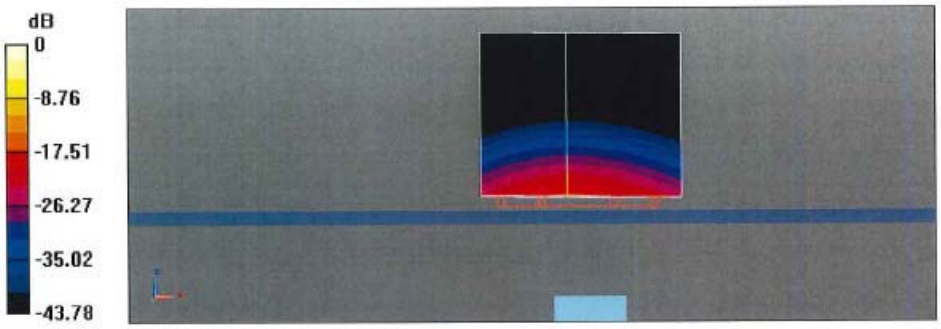
- Probe: EX3DV4 - SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.24 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.0 W/kg
SAR(1 g) = 7.79 W/kg; SAR(10 g) = 2.23 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 71.2%
Maximum value of SAR (measured) = 17.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.85 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 29.5 W/kg
SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.33 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 68.5%
Maximum value of SAR (measured) = 18.9 W/kg

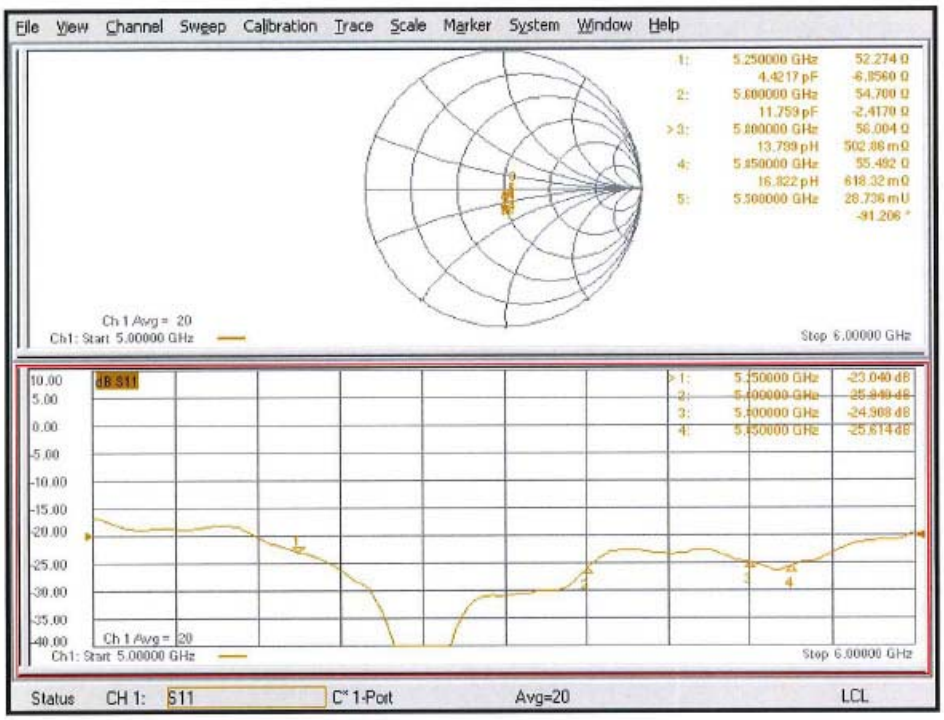
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.63 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 7.80 W/kg; SAR(10 g) = 2.21 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 66.7%
Maximum value of SAR (measured) = 18.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 75.98 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 31.5 W/kg
SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.28 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 66.2%
Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.87 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz, Frequency: 5850 MHz
Medium parameters used: f = 5250 MHz; σ = 5.43 S/m; ε_r = 48.7; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.91 S/m; ε_r = 48.1; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.19 S/m; ε_r = 47.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5850 MHz; σ = 6.26 S/m; ε_r = 47.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

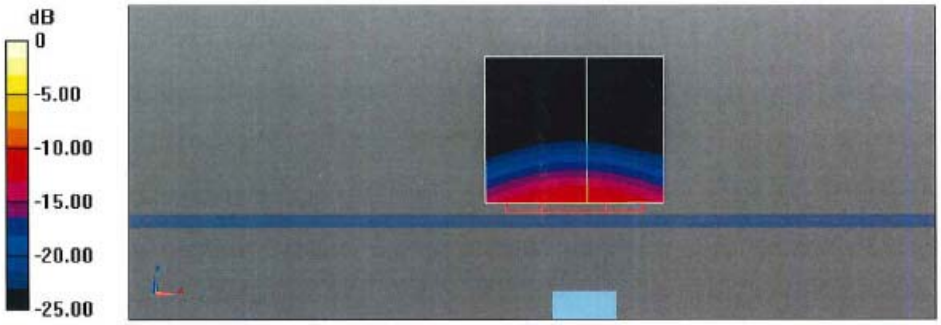
- Probe: EX3DV4 - SN3503; ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.79, 4.79, 4.79) @ 5600 MHz, ConvF(4.62, 4.62, 4.62) @ 5800 MHz, ConvF(4.61, 4.61, 4.61) @ 5850 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.20 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 7.38 W/kg; SAR(10 g) = 2.05 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 68.2%
Maximum value of SAR (measured) = 16.9 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.24 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.12 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 64.6%
Maximum value of SAR (measured) = 18.4 W/kg

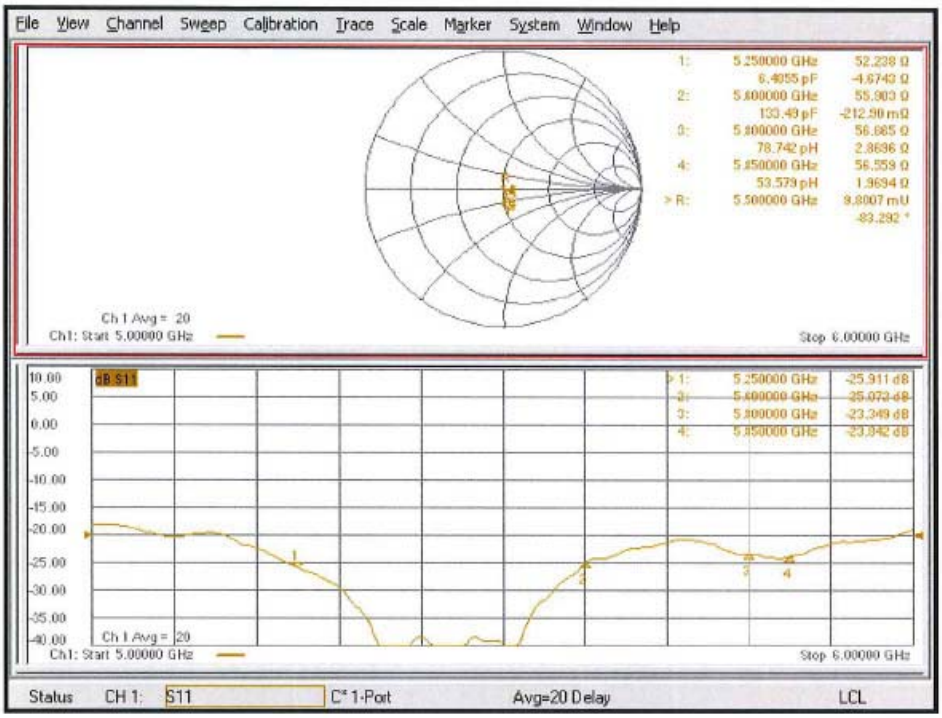
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.49 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 30.8 W/kg
SAR(1 g) = 7.29 W/kg; SAR(10 g) = 1.99 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 64%
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.50 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 32.6 W/kg
SAR(1 g) = 7.50 W/kg; SAR(10 g) = 2.05 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 63.2%
Maximum value of SAR (measured) = 18.3 W/kg



0 dB = 18.4 W/kg = 12.65 dBW/kg

Impedance Measurement Plot for Body TSL



Certificate No: D5GHzV2-1020_Nov21 Page 14 of 14

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System check uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents and is given in the following Table.

Repeatability Budget for System Check

<0.3 – 3 GHz range Body>

Error Description	Uncertainty value ± %		Probability distribution	divisor	(ci) 1 g	(ci) 10 g	Standard Uncertainty (1 g)		Standard Uncertainty (10 g)		vi or veff
Measurement System											
Probe calibration	±	1.8	Normal	1	1	1	±	1.8	±	1.8	∞
Axial isotropy of the probe	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Spherical isotropy of the probe	±	0.0	Rectangular	√3	1	0	±	0.0	±	0.0	∞
Boundary effects	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe linearity	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Detection limit	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Modulation response	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Readout electronics	±	0.0	Normal	1	1	1	±	0.0	±	0.0	∞
Response time	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Integration time	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
RF ambient Noise	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
RF ambient Reflections	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe Positioner	±	0.02	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe positioning	±	0.4	Rectangular	√3	1	1	±	0.2	±	0.2	∞
Max.SAR Eval.	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Dipole Related											
Dev. of experimental dipole	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Dipole Axis to Liquid Distance	±	2.0	Rectangular	√3	1	1	±	1.2	±	1.2	∞
Input power and SAR drift meas.	±	3.4	Rectangular	√3	1	1	±	2.0	±	2.0	∞
Phantom and Setup											
Phantom uncertainty	±	4.0	Rectangular	√3	1	1	±	2.3	±	2.3	∞
SAR correction	±	1.9	Rectangular	√3	1	0.84	±	1.1	±	0.9	∞
Liquid conductivity (meas.)	±	5.0	Normal	1	0.78	0.71	+	3.9	+	3.6	∞
Liquid permittivity (meas.)	±	5.0	Normal	1	0.26	0.26	-	1.3	-	1.3	∞
Temp. unc. - Conductivity	±	3.4	Rectangular	√3	0.78	0.71	±	1.5	±	1.4	∞
Temp. unc. - Permittivity	±	0.4	Rectangular	√3	0.23	0.26	±	0.1	±	0.1	∞
Combined Standard Uncertainty							±	**5.856**	±	**5.562**	
Expanded Uncertainty (k=2)							±	**11.7**	±	**11.1**	

Table of uncertainties are listed for ISO/IEC 17025.

<3 – 6 GHz range Body >

Error Description	Uncertainty value ± %		Probability distribution	divisor	(ci) 1 g	(ci) 10 g	Standard Uncertainty (1 g)		Standard Uncertainty (10 g)		vi or veff
Measurement System											
Probe calibration	±	1.8	Normal	1	1	1	±	1.8	±	1.8	∞
Axial isotropy of the probe	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Spherical isotropy of the probe	±	0.0	Rectangular	√3	1	0	±	0.0	±	0.0	∞
Boundary effects	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe linearity	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Detection limit	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Modulation response	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Readout electronics	±	0.0	Normal	1	1	1	±	0.0	±	0.0	∞
Response time	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Integration time	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
RF ambient Noise	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
RF ambient Reflections	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe Positioner	±	0.04	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Probe positioning	±	0.8	Rectangular	√3	1	1	±	0.5	±	0.5	∞
Max.SAR Eval.	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Test Sample Related											
Dev. of experimental dipole	±	0.0	Rectangular	√3	1	1	±	0.0	±	0.0	∞
Dipole Axis to Liquid Distance	±	2.0	Rectangular	√3	1	1	±	1.2	±	1.2	∞
Input power and SAR drift meas.	±	3.4	Rectangular	√3	1	1	±	2.0	±	2.0	∞
Phantom and Setup											
Phantom uncertainty	±	4.0	Rectangular	√3	1	1	±	2.3	±	2.3	∞
SAR correction	±	1.9	Rectangular	√3	1	0.84	±	1.1	±	0.9	∞
Liquid conductivity (meas.)	±	5.0	Normal	1	0.78	0.71	+	3.9	+	3.6	∞
Liquid permittivity (meas.)	±	5.0	Normal	1	0.26	0.26	-	1.3	-	1.3	∞
Temp. unc. - Conductivity	±	3.4	Rectangular	√3	0.78	0.71	±	1.5	±	1.4	∞
Temp. unc. - Permittivity	±	0.4	Rectangular	√3	0.23	0.26	±	0.1	±	0.1	∞
Combined Standard Uncertainty							±	**5.870**	±	**5.576**	
Expanded Uncertainty (k=2)							±	**11.7**	±	**11.2**	

Table of uncertainties are listed for ISO/IEC 17025.