

Attachment 2. – Dipole Verification Plots

■ Verification Data (750 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 20.0 °C
Test Date: 01/10/2017

DUT: Dipole 750 MHz; Type: D750V3

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.898 \text{ S/m}$; $\epsilon_r = 41.357$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3863; ConvF(10.44, 10.44, 10.44); Calibrated: 2016-07-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2016-01-27
- Phantom: SAM
- Measurement SW: DASY52, Version 52.8 (8);

750MHz Head Verification/Area Scan (7x12x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
Maximum value of SAR (measured) = 0.876 W/kg

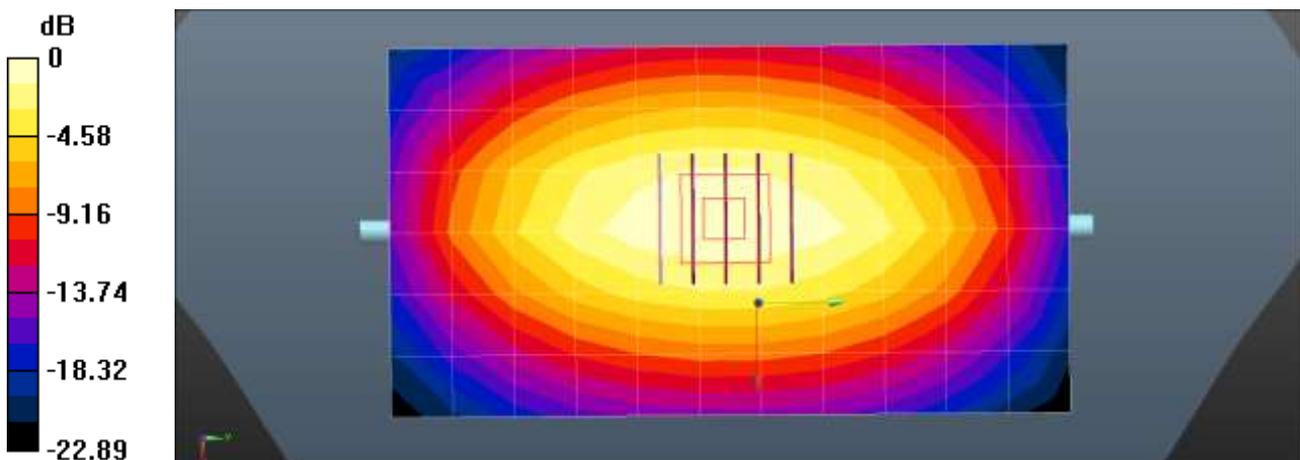
750MHz Head Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 31.63 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 1.27 W/kg

SAR(1 g) = 0.842 W/kg; SAR(10 g) = 0.544 W/kg

Maximum value of SAR (measured) = 0.908 W/kg



0 dB = 0.876 W/kg = -0.58 dBW/kg

■ Verification Data (750 MHz Body)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 20.7 °C
 Test Date: 01/16/2017

DUT: Dipole 750 MHz; Type: D750V3

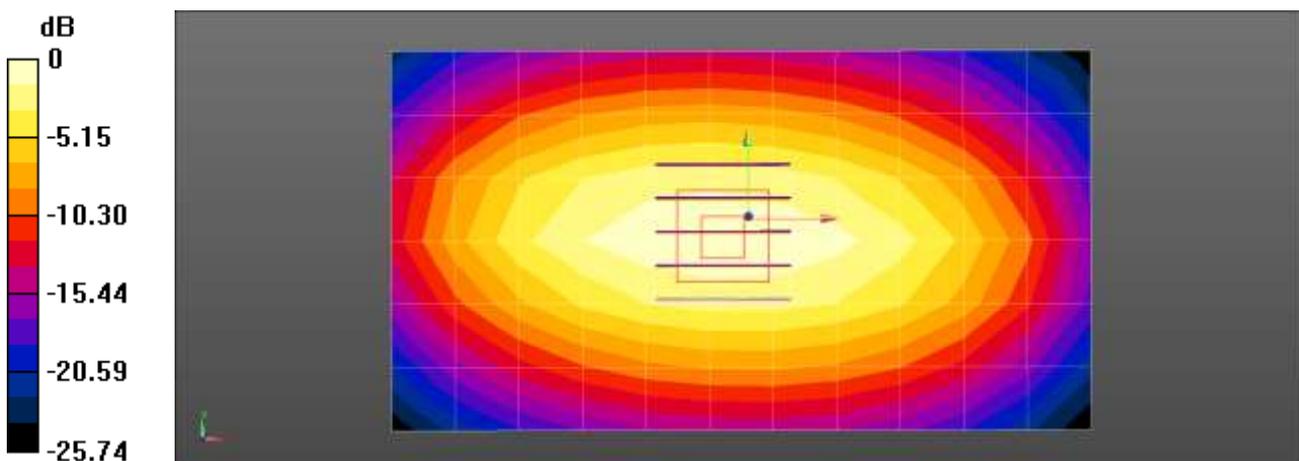
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.998 \text{ S/m}$; $\epsilon_r = 55.466$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(10.5, 10.5, 10.5); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

750MHz Body Verification/Area Scan (12x7x1): Measurement grid: dx=15mm, dy=15mm
 Maximum value of SAR (measured) = 0.914 W/kg

750MHz Body Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
 Reference Value = 30.34 V/m; Power Drift = 0.03 dB
 Peak SAR (extrapolated) = 1.25 W/kg
SAR(1 g) = 0.850 W/kg; SAR(10 g) = 0.555 W/kg
 Maximum value of SAR (measured) = 0.915 W/kg



0 dB = 0.914 W/kg = -0.39 dBW/kg

■ Verification Data (750 MHz Body)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 20.7 °C
 Test Date: 01/16/2017

DUT: Dipole 750 MHz; Type: D750V3

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.956 \text{ S/m}$; $\epsilon_r = 55.553$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(10.5, 10.5, 10.5); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

750 MHz Body Verification/Area Scan (13x8x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
 Maximum value of SAR (measured) = 0.770 W/kg

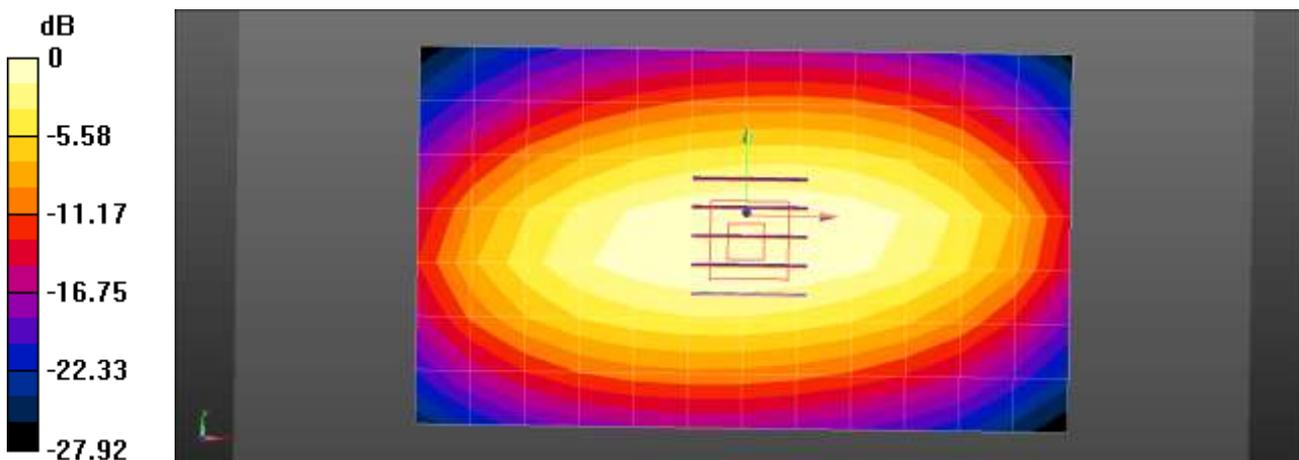
750 MHz Body Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 30.37 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 1.17 W/kg

SAR(1 g) = 0.810 W/kg; SAR(10 g) = 0.541 W/kg

Maximum value of SAR (measured) = 0.870 W/kg



0 dB = 0.770 W/kg = -1.14 dBW/kg

■ **Verification Data (835 MHz Head)**

Test Laboratory: HCT CO., LTD
 Input Power 100 mW (20 dBm)
 Liquid Temp: 20.2 °C
 Test Date: 01/09/2017

DUT: Dipole 835 MHz D835V2; Type: D835V2

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
 Medium parameters used (interpolated): $f = 835 \text{ MHz}$; $\sigma = 0.9 \text{ S/m}$; $\epsilon_r = 42.727$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3863; ConvF(10.03, 10.03, 10.03); Calibrated: 2016-07-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2016-01-27
- Phantom: SAM
- Measurement SW: DASY52, Version 52.8 (8);

835MHz Head Verification/Area Scan (7x13x1): Measurement grid: dx=15mm, dy=15mm
 Maximum value of SAR (measured) = 1.00 W/kg

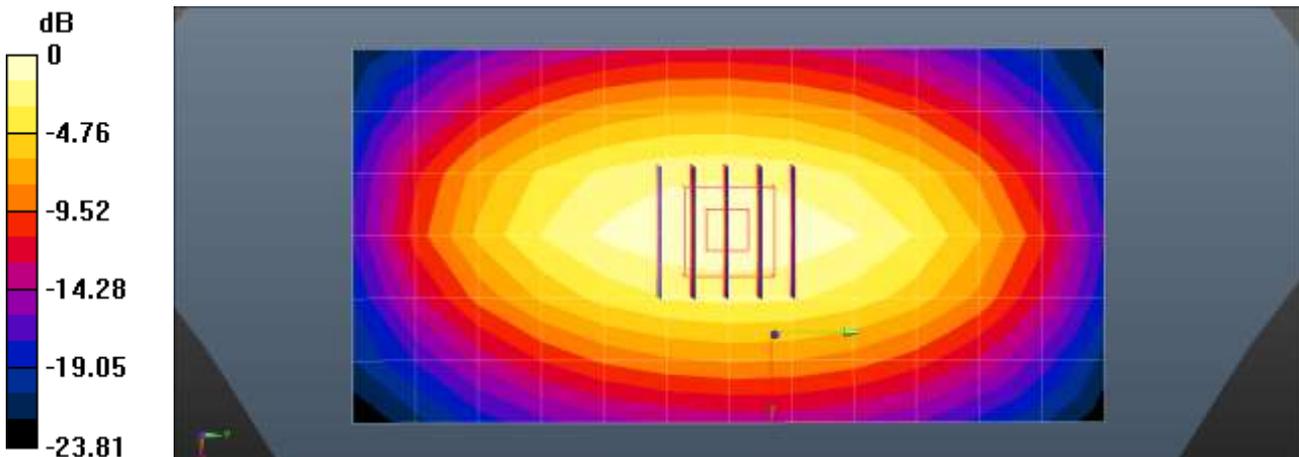
835MHz Head Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 33.50 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 1.40 W/kg

SAR(1 g) = 0.939 W/kg; SAR(10 g) = 0.615 W/kg

Maximum value of SAR (measured) = 1.01 W/kg



0 dB = 1.00 W/kg = 0.01 dBW/kg

■ Verification Data (835 MHz Body)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 20.7 °C
 Test Date: 01/16/2017

DUT: Dipole 835 MHz; Type: D835V2

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
 Medium parameters used (interpolated): $f = 835$ MHz; $\sigma = 0.978$ S/m; $\epsilon_r = 55.437$; $\rho = 1000$ kg/m³
 Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(10.42, 10.42, 10.42); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

835MHz Body Verification/Area Scan (12x7x1): Measurement grid: dx=15mm, dy=15mm
 Maximum value of SAR (measured) = 1.01 W/kg

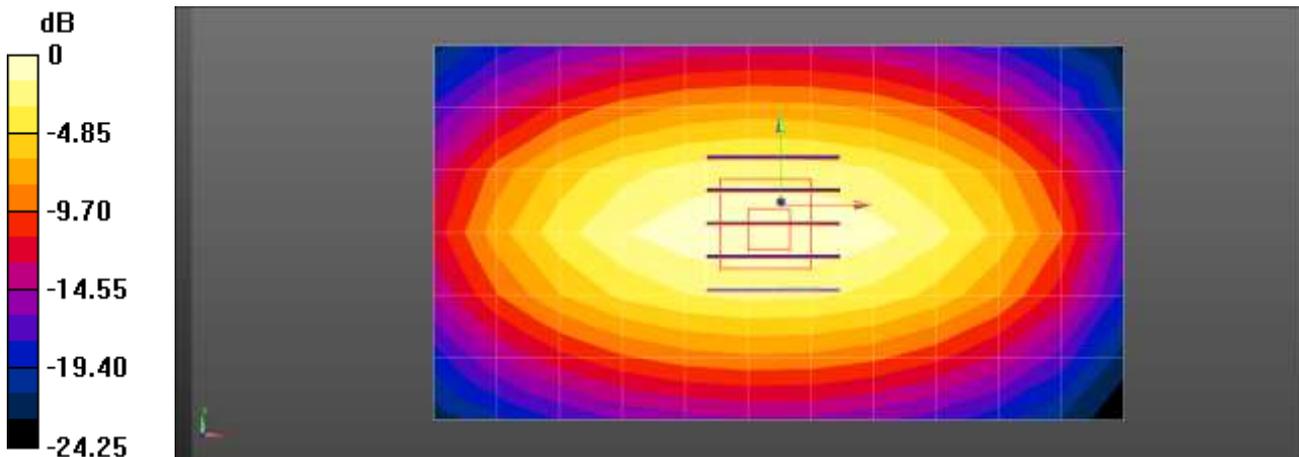
835MHz Body Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 32.21 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 1.41 W/kg

SAR(1 g) = 0.944 W/kg; SAR(10 g) = 0.615 W/kg

Maximum value of SAR (measured) = 1.02 W/kg



0 dB = 1.01 W/kg = 0.05 dBW/kg

■ Verification Data (1800 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 19.1 °C
Test Date: 12/26/2016

DUT: Dipole 1800 MHz; Type: D1800V2

Communication System: UID 0, CW; Frequency: 1800 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1800$ MHz; $\sigma = 1.387$ S/m; $\epsilon_r = 39.708$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(8.75, 8.75, 8.75); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

1800MHz Head Verification/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 3.85 W/kg

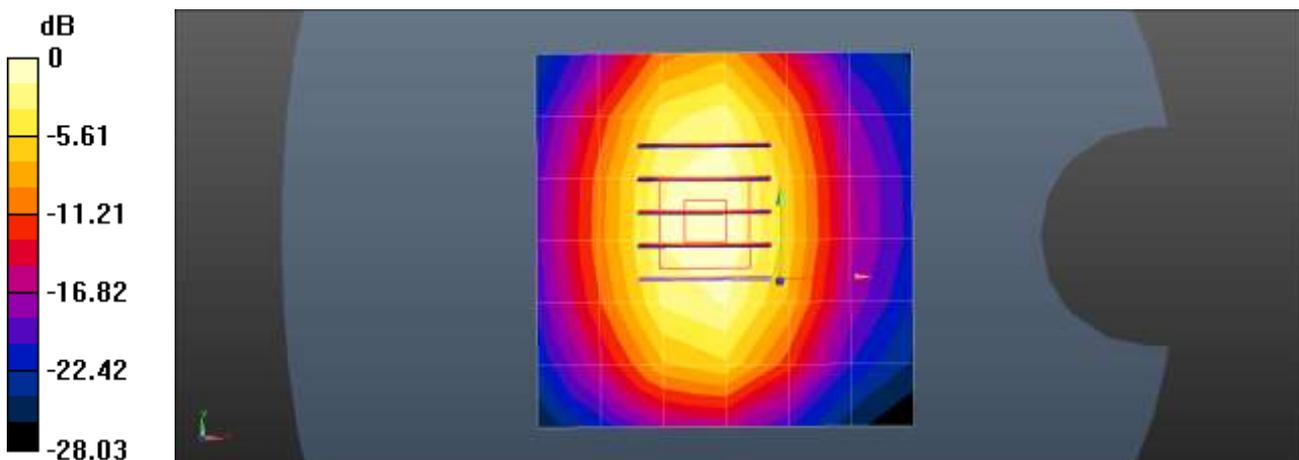
1800MHz Head Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 52.75 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 6.91 W/kg

SAR(1 g) = 3.99 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 4.41 W/kg



0 dB = 3.85 W/kg = 5.86 dBW/kg

■ **Verification Data (1800 MHz Body)**

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 19.3 °C
Test Date: 01/13/2017

DUT: Dipole 1800 MHz; Type: D1800V2

Communication System: UID 0, CW; Frequency: 1800 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1800$ MHz; $\sigma = 1.53$ S/m; $\epsilon_r = 52.316$; $\rho = 1000$ kg/m³
Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(8.37, 8.37, 8.37); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

1800MHz Body Verification/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 5.70 W/kg

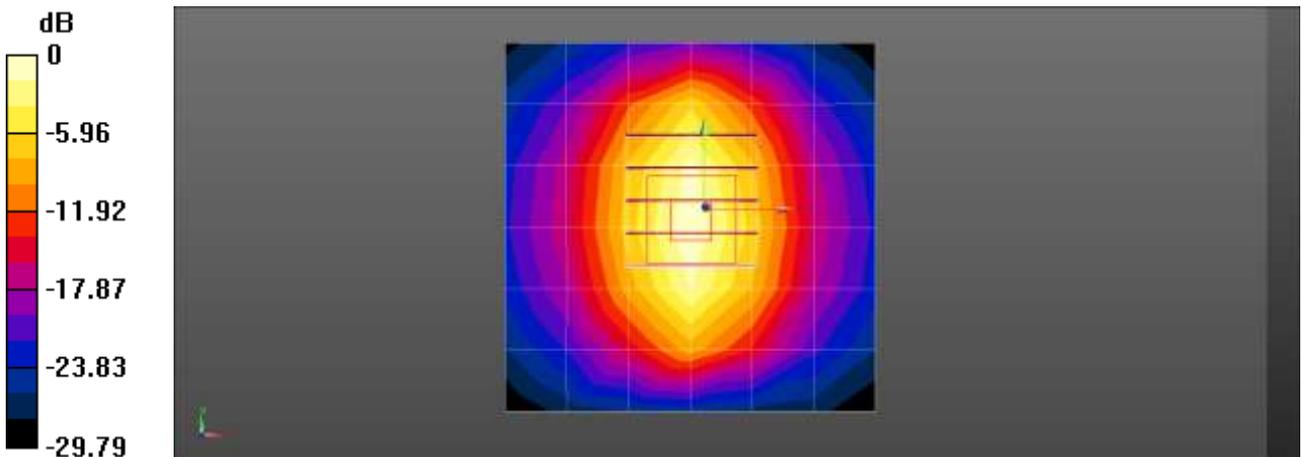
1800MHz Body Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 62.17 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 7.18 W/kg

SAR(1 g) = 3.98 W/kg; SAR(10 g) = 2.07 W/kg

Maximum value of SAR (measured) = 5.59 W/kg



0 dB = 5.70 W/kg = 7.55 dBW/kg

■ Verification Data (1 900 MHz Head)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 19.1 °C
 Test Date: 12/26/2016

DUT: Dipole 1900 MHz; Type: D1900V2

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 1900$ MHz; $\sigma = 1.442$ S/m; $\epsilon_r = 40.424$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(8.41, 8.41, 8.41); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

1900MHz Head Verification/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
 Maximum value of SAR (measured) = 3.24 W/kg

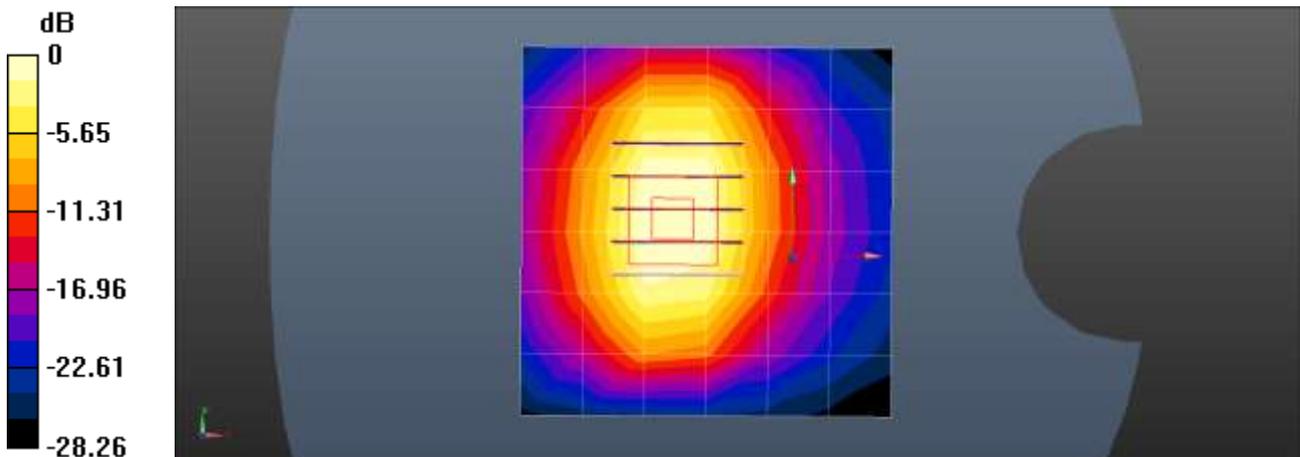
1900MHz Head Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 44.82 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 7.45 W/kg

SAR(1 g) = 3.86 W/kg; SAR(10 g) = 1.95 W/kg

Maximum value of SAR (measured) = 4.30 W/kg



0 dB = 3.24 W/kg = 5.11 dBW/kg

■ Verification Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 21.2 °C
 Test Date: 01/12/2017

DUT: Dipole 1900 MHz; Type: D1900V2

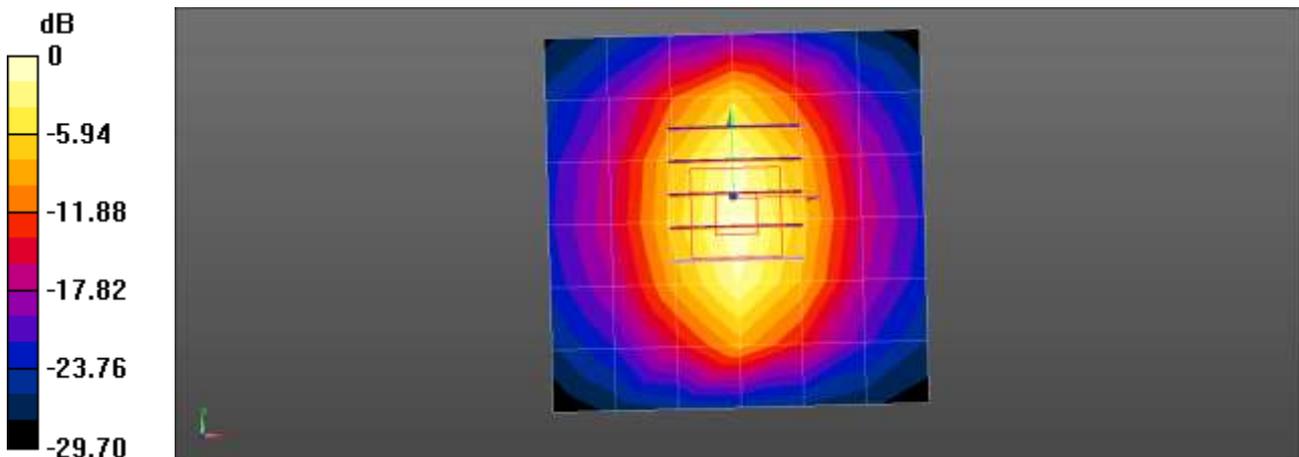
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 1900$ MHz; $\sigma = 1.611$ S/m; $\epsilon_r = 55.335$; $\rho = 1000$ kg/m³
 Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(8.1, 8.1, 8.1); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

1900MHz Body Verification/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
 Maximum value of SAR (measured) = 5.88 W/kg

1900MHz Body Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
 Reference Value = 61.46 V/m; Power Drift = -0.02 dB
 Peak SAR (extrapolated) = 7.50 W/kg
SAR(1 g) = 4.1 W/kg; SAR(10 g) = 2.12 W/kg
 Maximum value of SAR (measured) = 5.78 W/kg



0 dB = 5.88 W/kg = 7.69 dBW/kg

■ Verification Data (2 450 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 19.7 °C
Test Date: 01/19/2017

DUT: Dipole 2450 MHz ; Type: D2450V2

Communication System: UID 0, CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.801$ S/m; $\epsilon_r = 38.75$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(7.54, 7.54, 7.54); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY52, Version 52.8 (8);

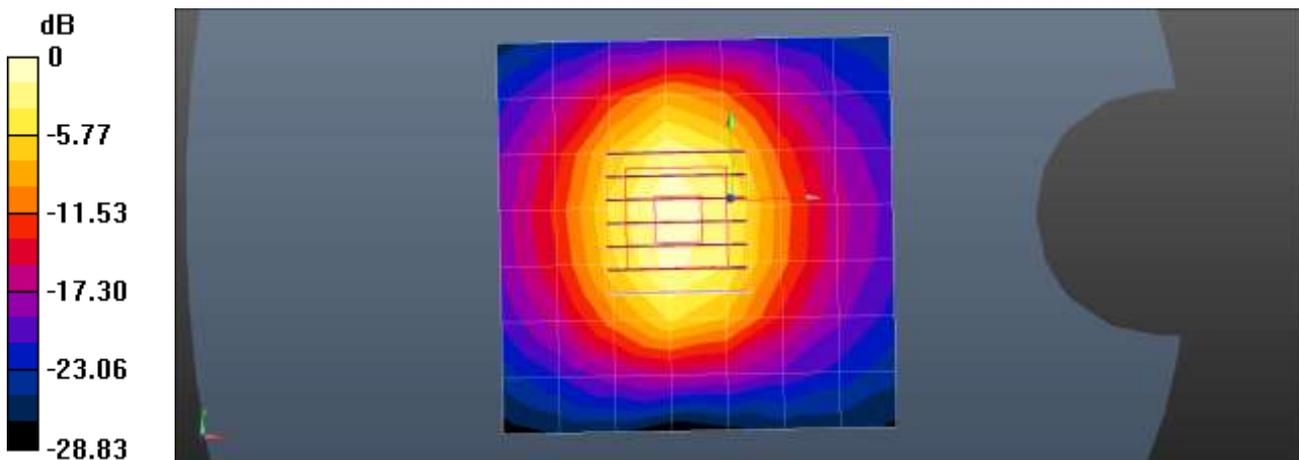
2 450 MHz Head Verification/Area Scan (8x8x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 7.69 W/kg

2 450 MHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 67.58 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 11.3 W/kg

SAR(1 g) = 5.14 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 8.06 W/kg



0 dB = 7.69 W/kg = 8.86 dBW/kg

■ Verification Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 19.7 °C
Test Date: 01/19/2017

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2

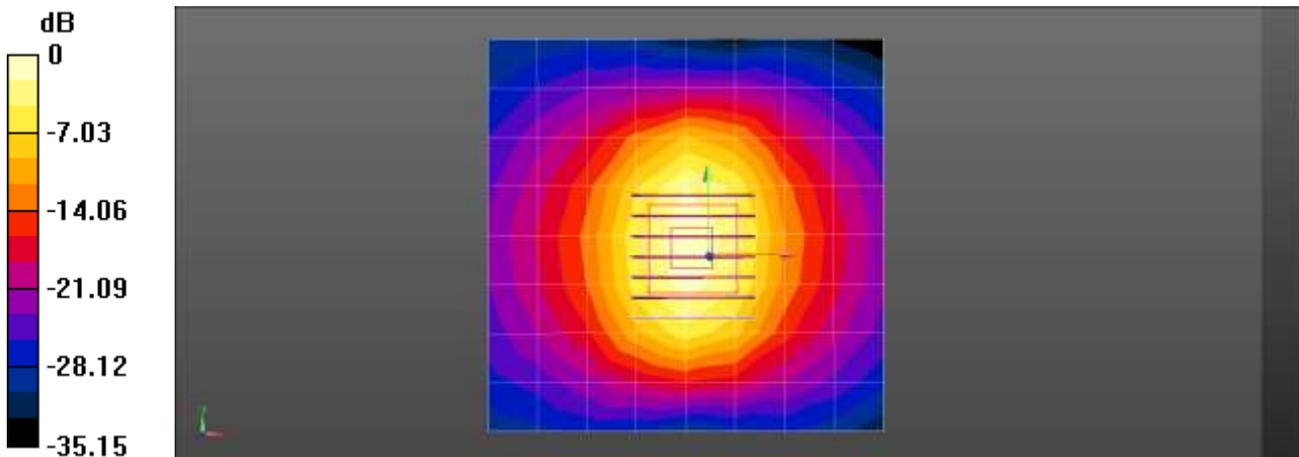
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.936$ S/m; $\epsilon_r = 52.601$; $\rho = 1000$ kg/m³
Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(7.69, 7.69, 7.69); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY52, Version 52.8 (8);

2 450 MHz Body Verification/Area Scan (9x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 5.66 W/kg

2 450 MHz Body Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.09 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 10.0 W/kg
SAR(1 g) = 5.08 W/kg; SAR(10 g) = 2.44 W/kg
Maximum value of SAR (measured) = 6.82 W/kg



0 dB = 5.66 W/kg = 7.53 dBW/kg

■ Verification Data (2 600 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 18.9 °C
Test Date: 01/11/2017

DUT: Dipole 2600MHz; Type: D2600V2

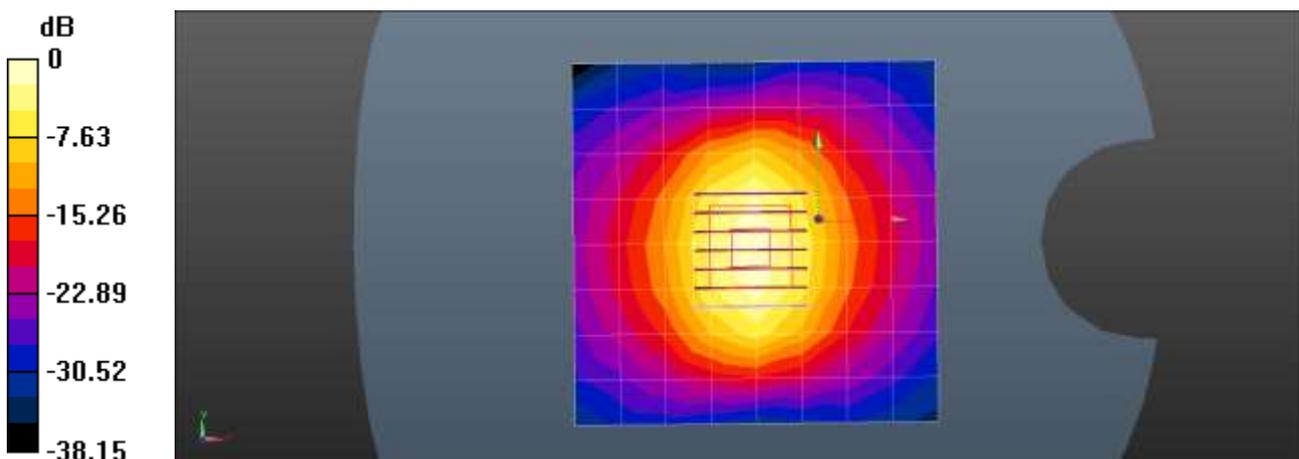
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2600$ MHz; $\sigma = 1.993$ S/m; $\epsilon_r = 38.385$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(7.42, 7.42, 7.42); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

2600MHz Head Verification/Area Scan (9x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 8.96 W/kg

2600MHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.69 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 13.0 W/kg
SAR(1 g) = 5.67 W/kg; SAR(10 g) = 2.5 W/kg
Maximum value of SAR (measured) = 9.09 W/kg



0 dB = 8.96 W/kg = 9.52 dBW/kg

■ Verification Data (2 600 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 18.9 °C
Test Date: 01/11/2017

DUT: Dipole 2600 MHz; Type: D2600V2

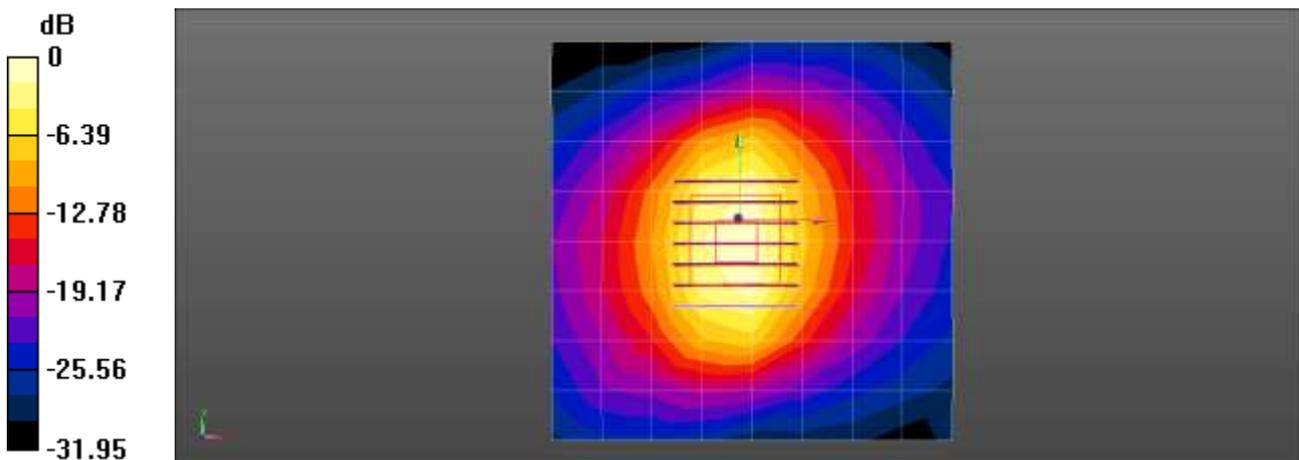
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2600$ MHz; $\sigma = 2.165$ S/m; $\epsilon_r = 50.891$; $\rho = 1000$ kg/m³
Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(7.45, 7.45, 7.45); Calibrated: 2016-09-28;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

2600MHz Body Verification/Area Scan (9x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 7.80 W/kg

2600MHz Body Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 52.28 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 11.9 W/kg
SAR(1 g) = 5.64 W/kg; SAR(10 g) = 2.57 W/kg
Maximum value of SAR (measured) = 8.76 W/kg



0 dB = 7.80 W/kg = 8.92 dBW/kg

■ Verification Data (5.25 GHz Head)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 22.3 °C
Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

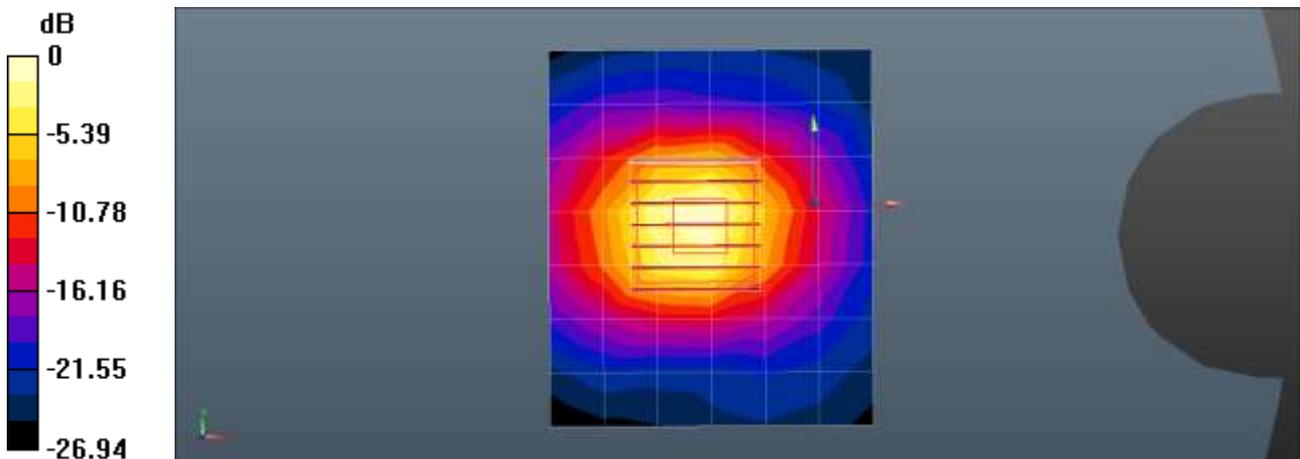
Communication System: UID 0, CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5250$ MHz; $\sigma = 4.631$ S/m; $\epsilon_r = 35.533$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(5.51, 5.51, 5.51); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

5250MHz Head Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 16.8 W/kg

5250MHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm;
Graded Ratio:1.4
Reference Value = 64.87 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 34.5 W/kg
SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 21.0 W/kg



0 dB = 16.8 W/kg = 12.26 dBW/kg

■ Verification Data (5.25 GHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 22.3 °C
Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

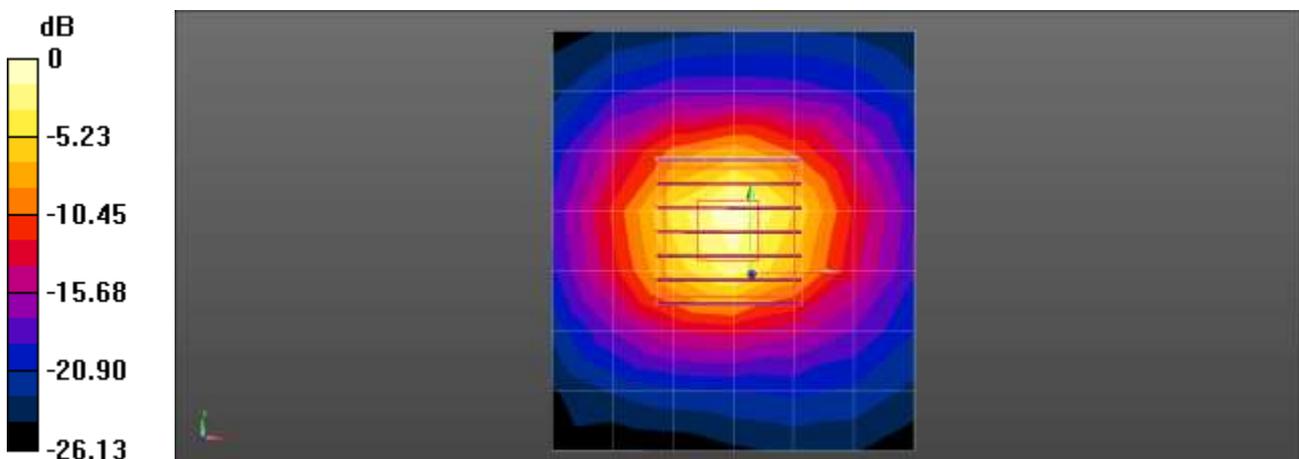
Communication System: UID 0, CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5250$ MHz; $\sigma = 5.206$ S/m; $\epsilon_r = 48.19$; $\rho = 1000$ kg/m³
Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(4.63, 4.63, 4.63); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

5250MHz Body Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 17.6 W/kg

5250MHz Body Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 67.07 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 28.9 W/kg
SAR(1 g) = 7.52 W/kg; SAR(10 g) = 2.17 W/kg
Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 17.6 W/kg = 12.46 dBW/kg

■ Verification Data (5.6 GHz Head)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 22.3 °C
Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

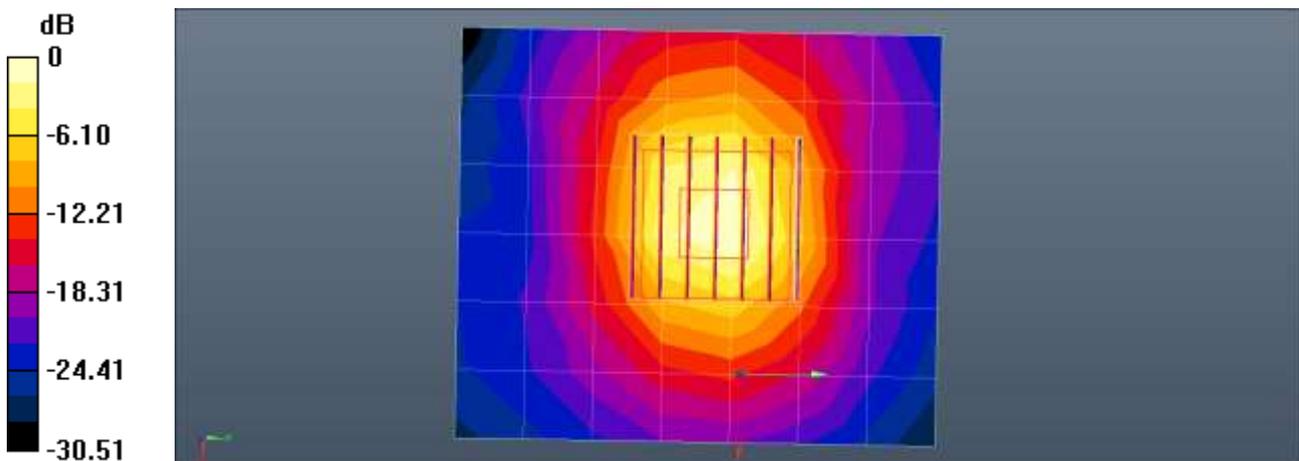
Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.243$ S/m; $\epsilon_r = 36.245$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(4.78, 4.78, 4.78); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

5600MHz Head Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 17.0 W/kg

5600MHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 63.14 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 34.4 W/kg
SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 21.4 W/kg



0 dB = 17.0 W/kg = 12.31 dBW/kg

■ Verification Data (5.6 GHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 22.3 °C
Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

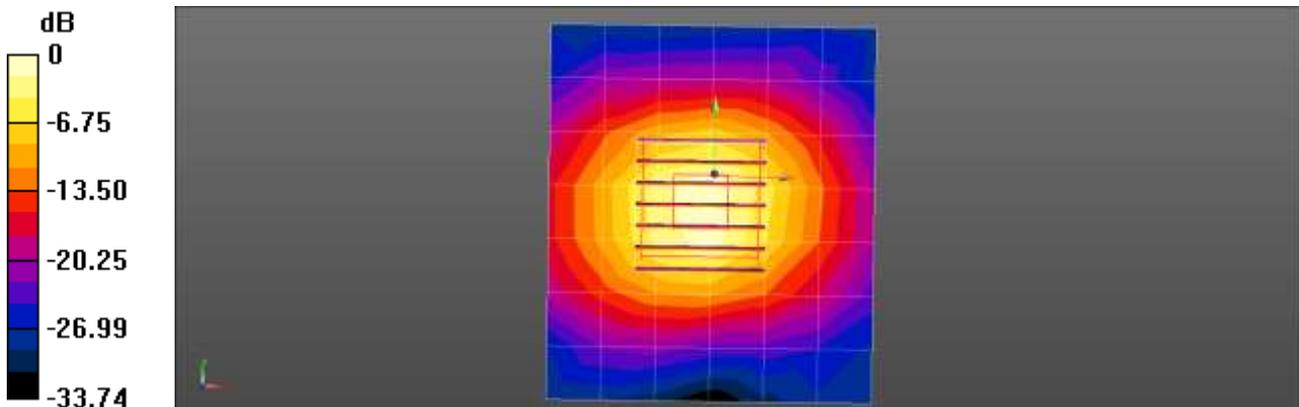
Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.77$ S/m; $\epsilon_r = 47.254$; $\rho = 1000$ kg/m³
Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(3.85, 3.85, 3.85); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

5 600 MHz Body Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 15.5 W/kg

5 600 MHz Body Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 68.13 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 32.8 W/kg
SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 20.3 W/kg



0 dB = 15.5 W/kg = 11.91 dBW/kg

■ **Verification Data (5.75 GHz Head)**

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 22.3 °C
Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

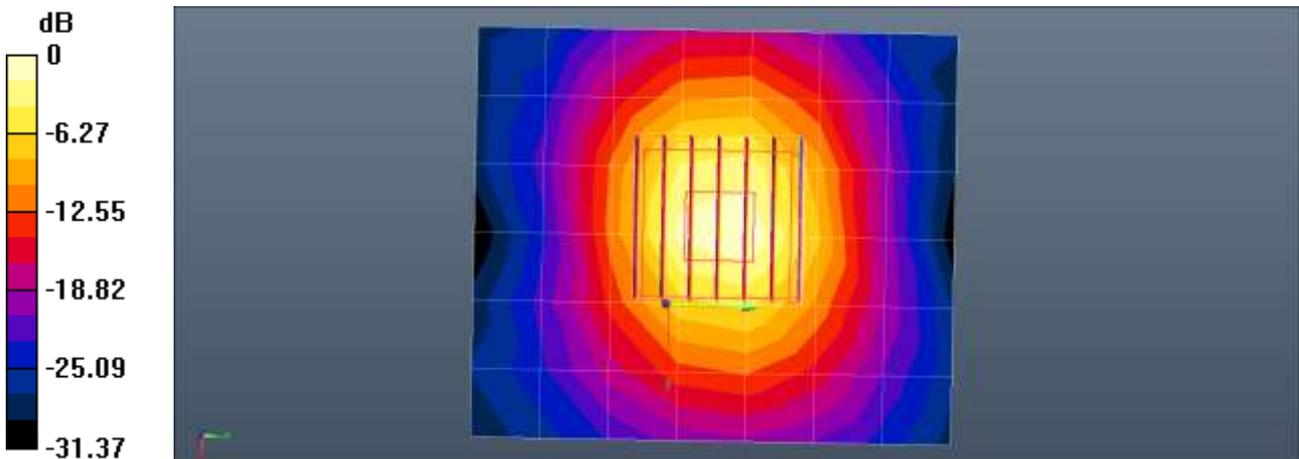
Communication System: UID 0, CW; Frequency: 5750 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5750$ MHz; $\sigma = 5.415$ S/m; $\epsilon_r = 36.855$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(5.04, 5.04, 5.04); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: SAM
- Measurement SW: DASY4, Version 4.7 (80);

5750MHz Head Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 16.0 W/kg

5750MHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 65.50 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 32.6 W/kg
SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 16.0 W/kg = 12.04 dBW/kg

■ **Verification Data (5.75 GHz Body)**

Test Laboratory: HCT CO., LTD
 Input Power 100 mW (20 dBm)
 Liquid Temp: 22.3 °C
 Test Date: 01/17/2017

DUT: Dipole 5GHz; Type: D5000V2

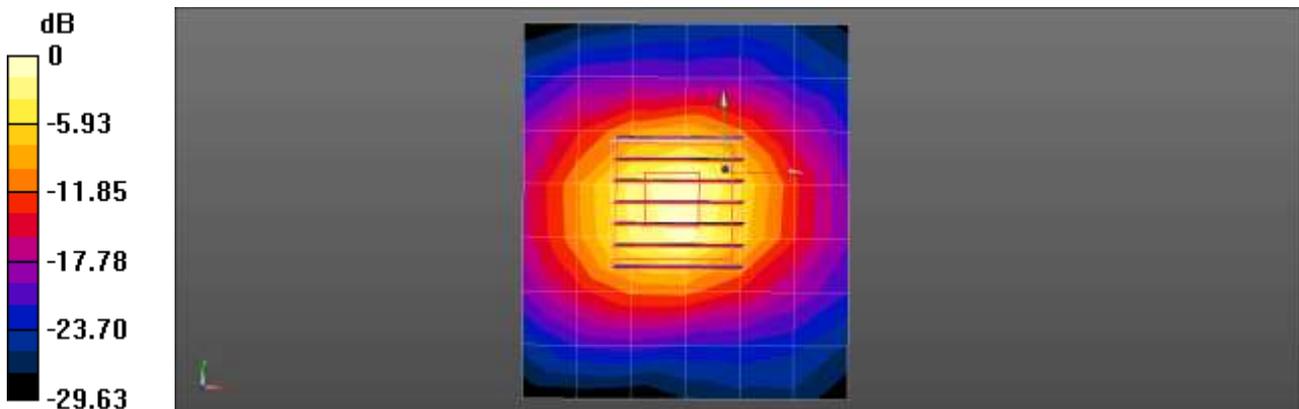
Communication System: UID 0, CW; Frequency: 5750 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 5750$ MHz; $\sigma = 6.026$ S/m; $\epsilon_r = 46.868$; $\rho = 1000$ kg/m³
 Phantom section: Center Section

DASY Configuration:

- Probe: EX3DV4 - SN3903; ConvF(4.13, 4.13, 4.13); Calibrated: 2016-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2016-09-27
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, Version 4.7 (80);

5 750 MHz Body Verification/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
 Maximum value of SAR (measured) = 15.8 W/kg

5 750 MHz Body Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
 Reference Value = 65.90 V/m; Power Drift = -0.02 dB
 Peak SAR (extrapolated) = 32.4 W/kg
SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.16 W/kg
 Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 15.8 W/kg = 11.98 dBW/kg

Attachment 3. – Probe Calibration Data

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **EX3-3863_Jul16**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3863**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,
QA CAL-25.v6
Calibration procedure for dosimetric E-field probes.**

Calibration date: **July 28, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642UD1700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Claudio Leubler** (Name), **Laboratory Technician** (Function), *[Signature]* (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function), *[Signature]* (Signature)

Issued: July 29, 2016

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

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



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Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) 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
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- **NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- **NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- **DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- **PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- **A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- **ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- **Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- **Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3863

July 28, 2016

Probe EX3DV4

SN:3863

Manufactured: February 2, 2012
Calibrated: July 28, 2016

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3863

July 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.35	0.34	0.44	± 10.1 %
DCP (mV) ^B	98.2	101.0	99.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√ μV	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	131.4	±3.0 %
		Y	0.0	0.0	1.0		148.2	
		Z	0.0	0.0	1.0		149.7	

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3863

July 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^h (mm)	Unc (k=2)
150	52.3	0.76	12.59	12.59	12.59	0.00	1.00	± 13.3 %
300	45.3	0.87	11.75	11.75	11.75	0.11	1.20	± 13.3 %
450	43.5	0.87	10.84	10.84	10.84	0.20	1.25	± 13.3 %
750	41.9	0.89	10.44	10.44	10.44	0.36	1.03	± 12.0 %
835	41.5	0.90	10.03	10.03	10.03	0.48	0.83	± 12.0 %
900	41.5	0.97	9.81	9.81	9.81	0.28	1.11	± 12.0 %
1450	40.5	1.20	8.84	8.84	8.84	0.32	0.80	± 12.0 %
1750	40.1	1.37	8.65	8.65	8.65	0.28	0.97	± 12.0 %
1900	40.0	1.40	8.38	8.38	8.38	0.33	0.80	± 12.0 %
1950	40.0	1.40	8.00	8.00	8.00	0.33	0.80	± 12.0 %
2300	39.5	1.67	7.84	7.84	7.84	0.30	0.80	± 12.0 %
2450	39.2	1.80	7.42	7.42	7.42	0.39	0.80	± 12.0 %
2600	39.0	1.96	7.17	7.17	7.17	0.41	0.81	± 12.0 %
5250	35.9	4.71	5.01	5.01	5.01	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.85	4.85	4.85	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.92	4.92	4.92	0.45	1.80	± 13.1 %

^c Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^h Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4--SN:3863

July 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^h (mm)	Unc (k=2)
150	61.9	0.80	12.11	12.11	12.11	0.00	1.00	± 13.3 %
300	58.2	0.92	11.56	11.56	11.56	0.05	1.20	± 13.3 %
450	56.7	0.94	11.24	11.24	11.24	0.09	1.25	± 13.3 %
750	55.5	0.96	9.98	9.98	9.98	0.48	0.82	± 12.0 %
835	55.2	0.97	9.73	9.73	9.73	0.48	0.80	± 12.0 %
1750	53.4	1.49	8.17	8.17	8.17	0.40	0.83	± 12.0 %
1900	53.3	1.52	7.83	7.83	7.83	0.39	0.83	± 12.0 %
2450	52.7	1.95	7.45	7.45	7.45	0.38	0.80	± 12.0 %
2600	52.5	2.16	7.24	7.24	7.24	0.32	0.80	± 12.0 %
5250	48.9	5.36	4.49	4.49	4.49	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.77	3.77	3.77	0.55	1.90	± 13.1 %
5750	48.3	5.94	4.19	4.19	4.19	0.55	1.90	± 13.1 %

^c Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

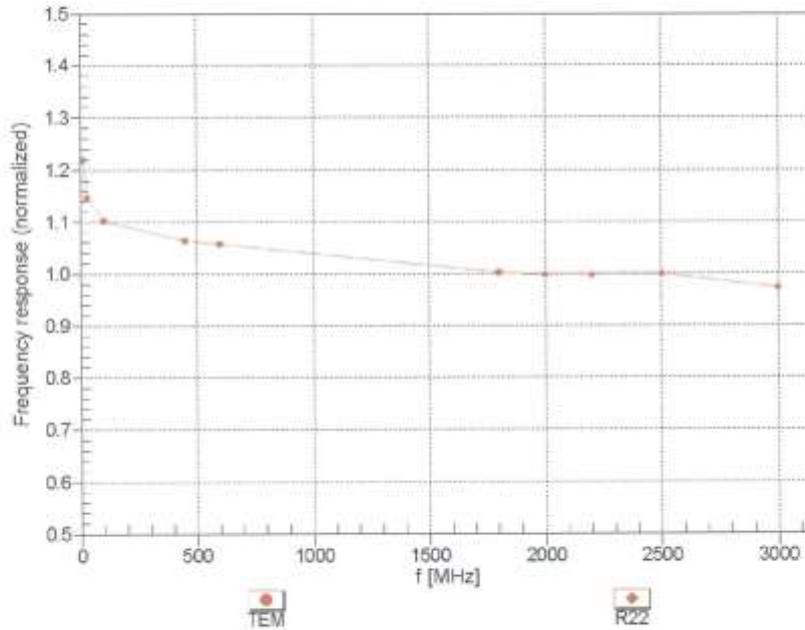
^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^h Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4-SN:3863

July 28, 2016

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

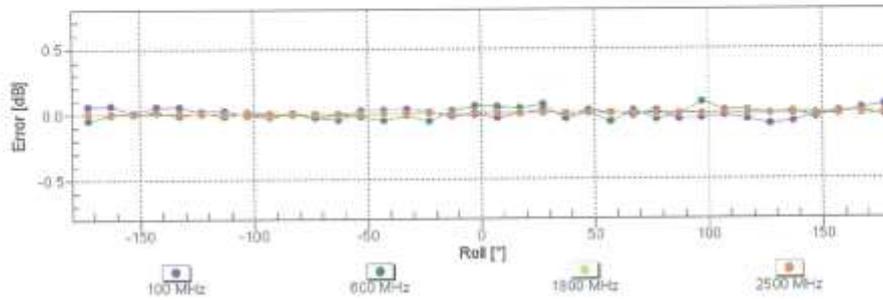
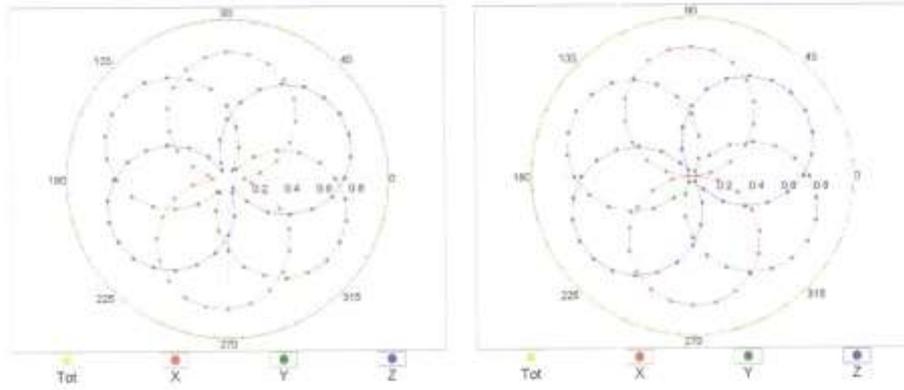
EX3DV4- SN:3863

July 28, 2016

Receiving Pattern (ϕ), $\theta = 0^\circ$

f=600 MHz,TEM

f=1800 MHz,R22

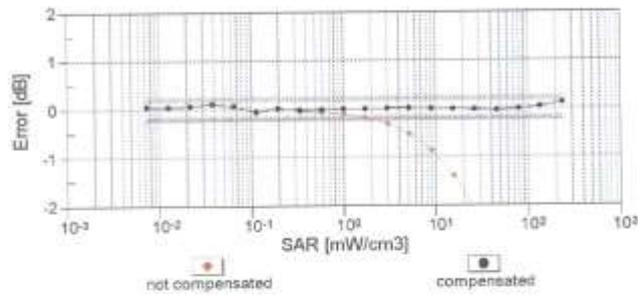
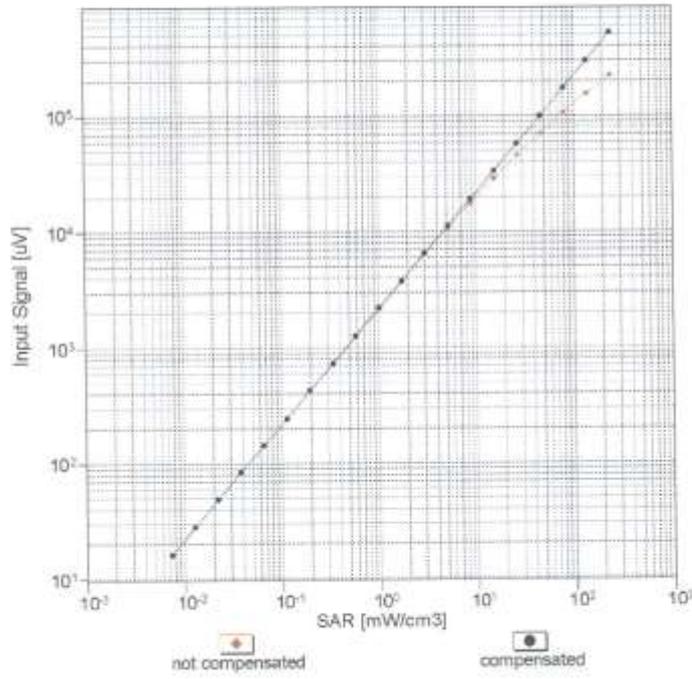


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EX3DV4- SN:3863

July 28, 2016

Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

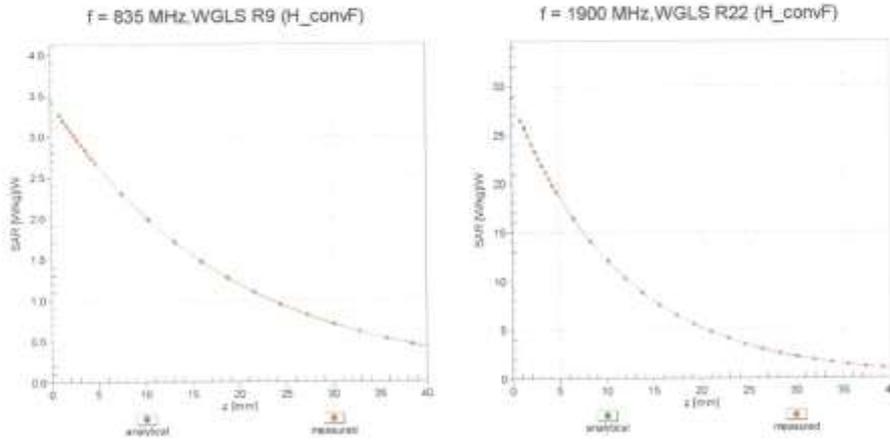


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

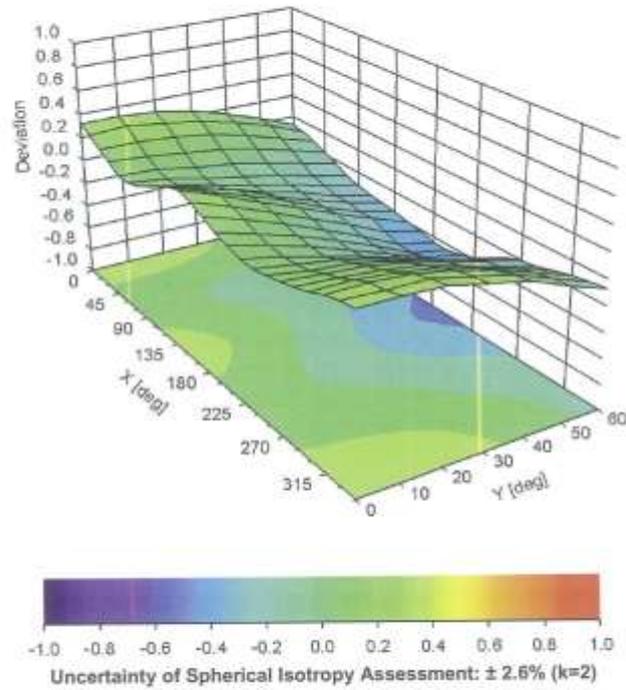
EX3DV4- SN:3863

July 28, 2016

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



EX3DV4- SN:3863

July 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	107.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

**Calibration Laboratory of
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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **EX3-3903_Sep16**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3903**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,
QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 28, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02286)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 55277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013, Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660, Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E44199	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-09 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 28, 2016

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1526-2013, "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
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3903

September 28, 2016

Probe EX3DV4

SN:3903

Manufactured: September 4, 2012
Calibrated: September 28, 2016

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3903

September 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3903

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.39	0.36	0.53	± 10.1 %
DCP (mV) ^B	102.5	106.2	103.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	174.0	±3.5 %
		Y	0.0	0.0	1.0		184.6	
		Z	0.0	0.0	1.0		194.4	

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3903

September 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3903

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^H (mm)	Unc (k=2)
150	52.3	0.76	13.42	13.42	13.42	0.00	1.00	± 13.3 %
300	45.3	0.87	12.68	12.68	12.68	0.10	1.10	± 13.3 %
450	43.5	0.87	11.00	11.00	11.00	0.20	1.25	± 13.3 %
750	41.9	0.89	11.35	11.35	11.35	0.33	1.14	± 12.0 %
835	41.5	0.90	10.72	10.72	10.72	0.51	0.80	± 12.0 %
900	41.5	0.97	10.30	10.30	10.30	0.35	1.01	± 12.0 %
1450	40.5	1.20	8.76	8.76	8.76	0.39	0.80	± 12.0 %
1750	40.1	1.37	8.75	8.75	8.75	0.28	0.85	± 12.0 %
1900	40.0	1.40	8.41	8.41	8.41	0.28	0.84	± 12.0 %
1950	40.0	1.40	8.22	8.22	8.22	0.32	0.80	± 12.0 %
2300	39.5	1.67	8.01	8.01	8.01	0.32	0.80	± 12.0 %
2450	39.2	1.80	7.54	7.54	7.54	0.31	0.84	± 12.0 %
2600	39.0	1.96	7.42	7.42	7.42	0.31	0.86	± 12.0 %
5250	35.9	4.71	5.51	5.51	5.51	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.78	4.78	4.78	0.45	1.80	± 13.1 %
5750	35.4	5.22	5.04	5.04	5.04	0.45	1.80	± 13.1 %

^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^H Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3903

September 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3903

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^H (mm)	Unc (k=2)
150	61.9	0.80	13.33	13.33	13.33	0.00	1.00	± 13.3 %
300	58.2	0.92	12.07	12.07	12.07	0.08	1.10	± 13.3 %
450	56.7	0.94	11.95	11.95	11.95	0.10	1.20	± 13.3 %
750	55.5	0.96	10.50	10.50	10.50	0.29	1.13	± 12.0 %
835	55.2	0.97	10.42	10.42	10.42	0.55	0.80	± 12.0 %
1750	53.4	1.49	8.37	8.37	8.37	0.35	0.91	± 12.0 %
1900	53.3	1.52	8.10	8.10	8.10	0.37	0.80	± 12.0 %
2450	52.7	1.95	7.69	7.69	7.69	0.33	0.85	± 12.0 %
2600	52.5	2.16	7.45	7.45	7.45	0.33	0.90	± 12.0 %
5250	48.9	5.36	4.63	4.63	4.63	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.85	3.85	3.85	0.60	1.90	± 13.1 %
5750	48.3	5.94	4.13	4.13	4.13	0.60	1.90	± 13.1 %

^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

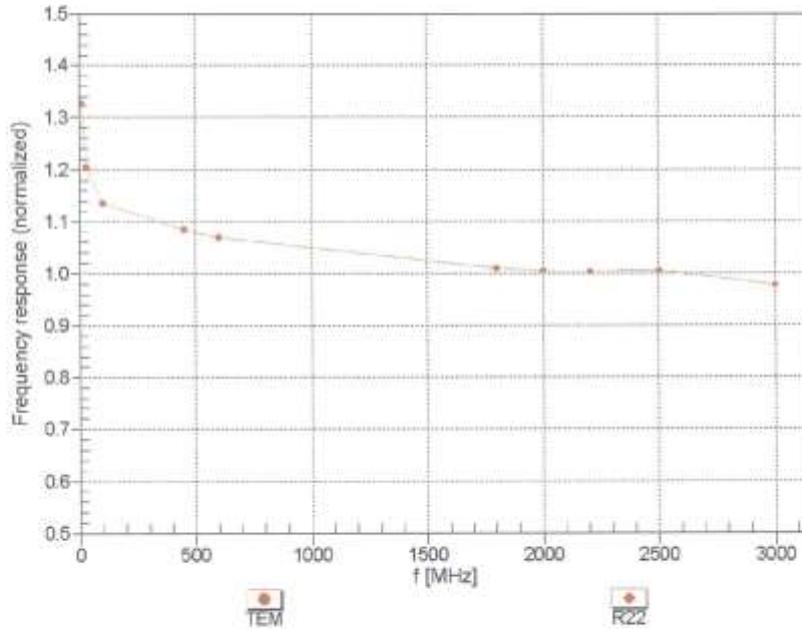
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^H Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3903

September 28, 2016

Frequency Response of E-Field (TEM-Cell:if1110 EXX, Waveguide: R22)

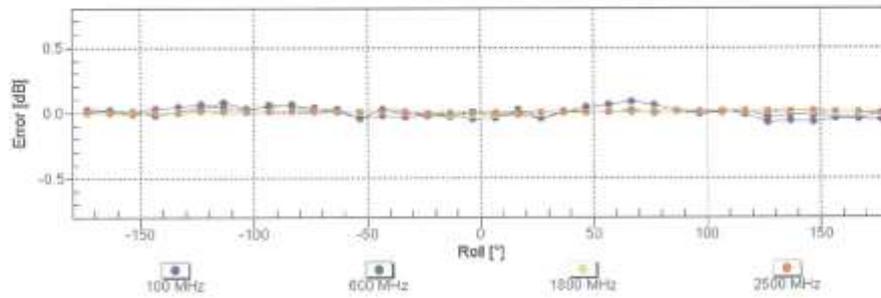
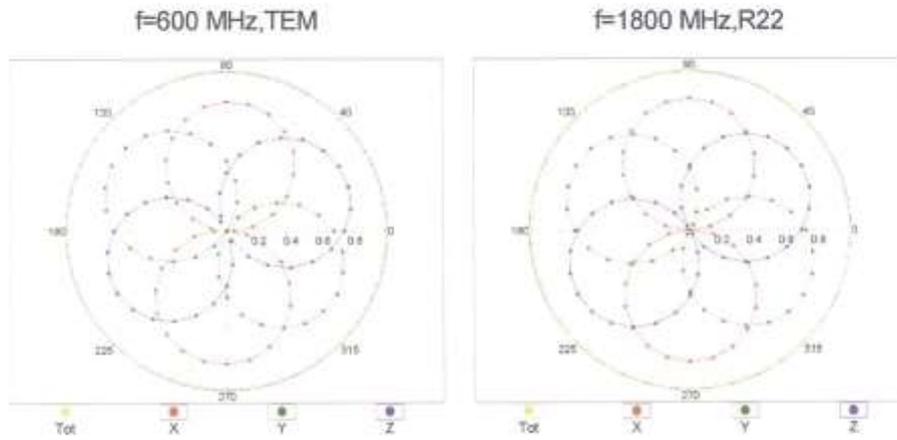


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4- SN:3903

September 28, 2016

Receiving Pattern (ϕ), $\theta = 0^\circ$

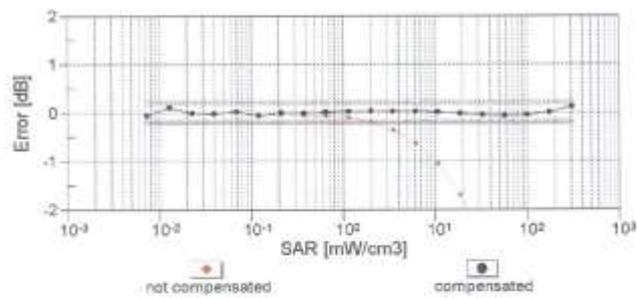
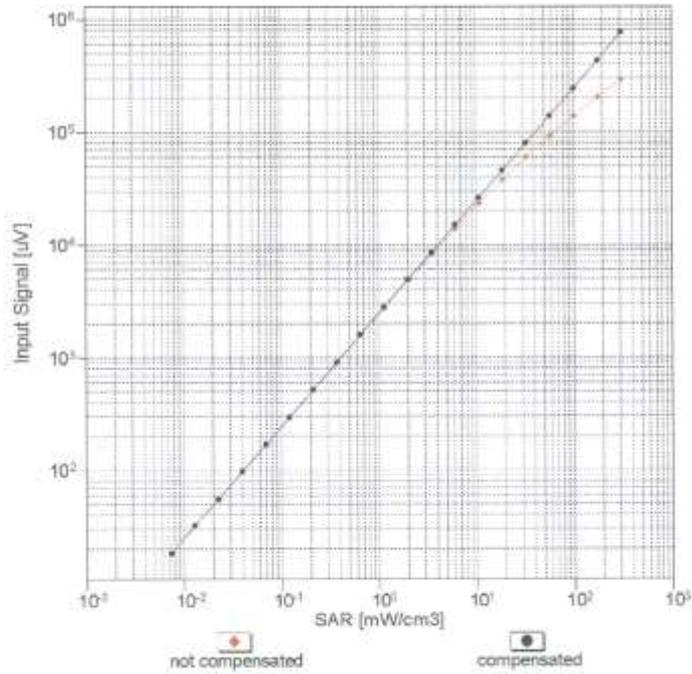


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:3903

September 28, 2016

Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

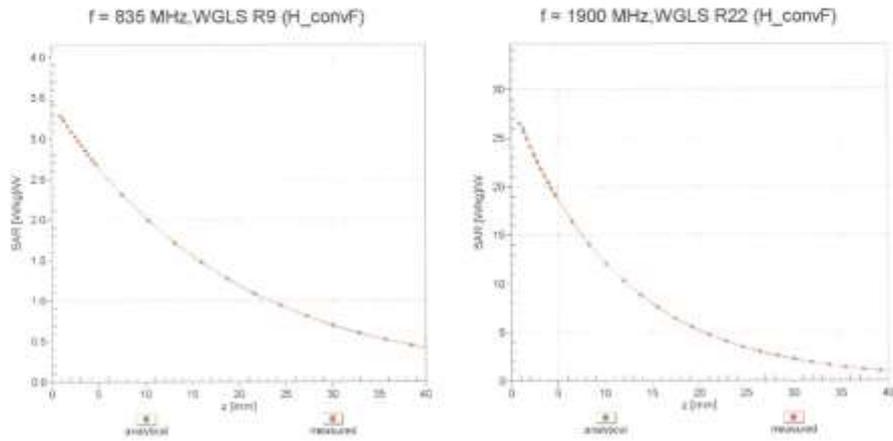


Uncertainty of Linearity Assessment: ± 0,6% (k=2)

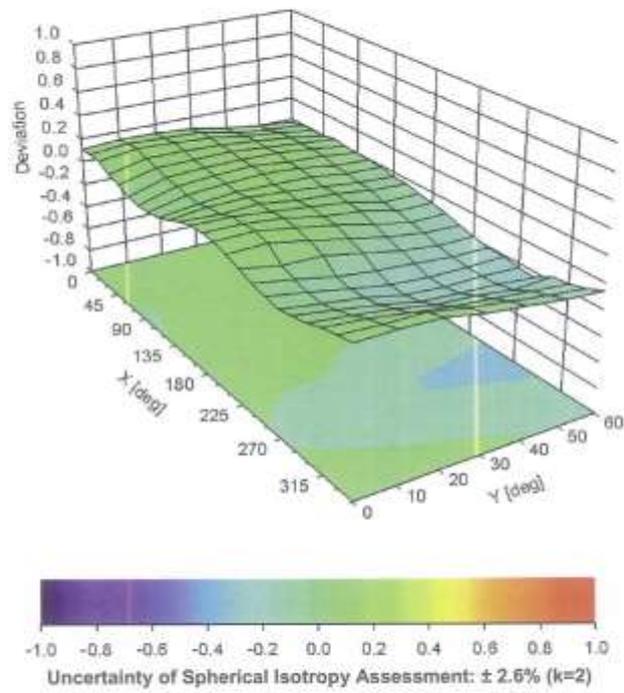
EX3DV4-SN:3903

September 28, 2016

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



EX3DV4- SN:3903

September 28, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3903

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-33.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Attachment 4. – Dipole Calibration Data

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Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D750V3-1014_Jul16**

CALIBRATION CERTIFICATE

Object **D750V3 - SN:1014**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **July 22, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	16-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Claudio Leubler** (Name) / **Laboratory Technician** (Function) / *[Signature]* (Signature)

Approved by: **Katja Pokovic** (Name) / **Technical Manager** (Function) / *[Signature]* (Signature)

Issued: July 26, 2016

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.91 mho/m ± 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	2.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.29 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.46 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.1 ± 6 %	0.99 mho/m ± 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	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.74 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.72 W/kg ± 16.5 % (k=2)

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

Impedance, transformed to feed point	54.7 Ω + 2.2 j Ω
Return Loss	- 26.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 Ω - 0.8 j Ω
Return Loss	- 41.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.033 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
Manufactured on	March 22, 2010

DASY5 Validation Report for Head TSL

Date: 21.07.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:1014

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 0.91$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

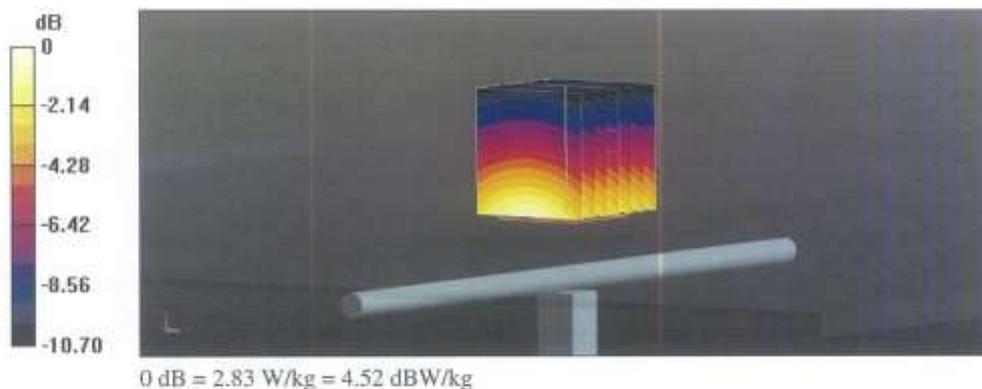
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.75 V/m; Power Drift = 0.01 dB

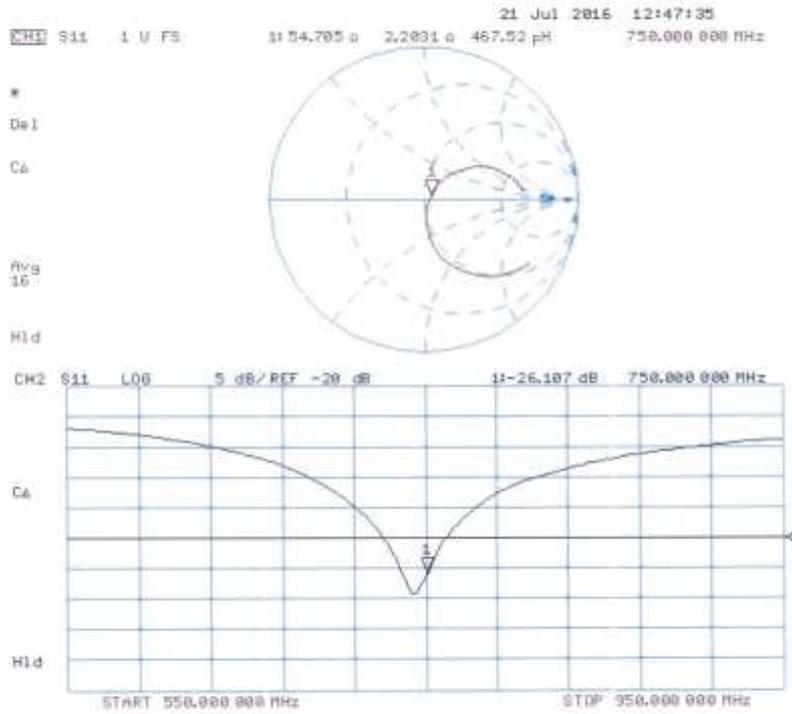
Peak SAR (extrapolated) = 3.19 W/kg

SAR(1 g) = 2.12 W/kg; SAR(10 g) = 1.39 W/kg

Maximum value of SAR (measured) = 2.83 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 22.07.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:1014

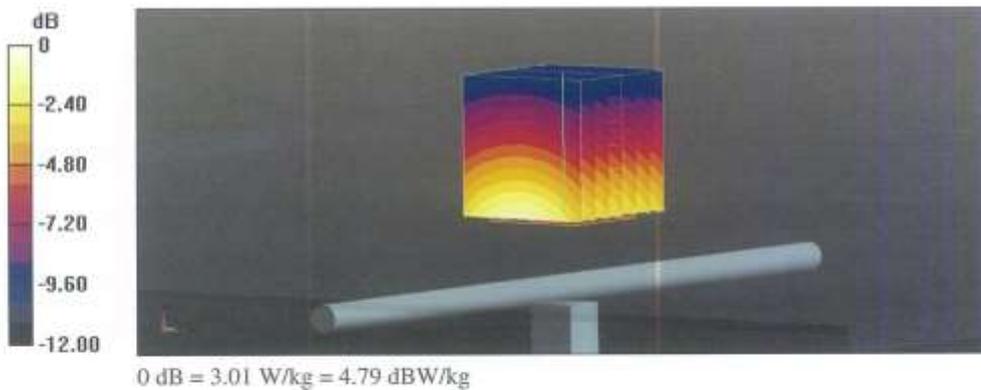
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: $f = 750$ MHz; $\sigma = 0.99$ S/m; $\epsilon_r = 55.1$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

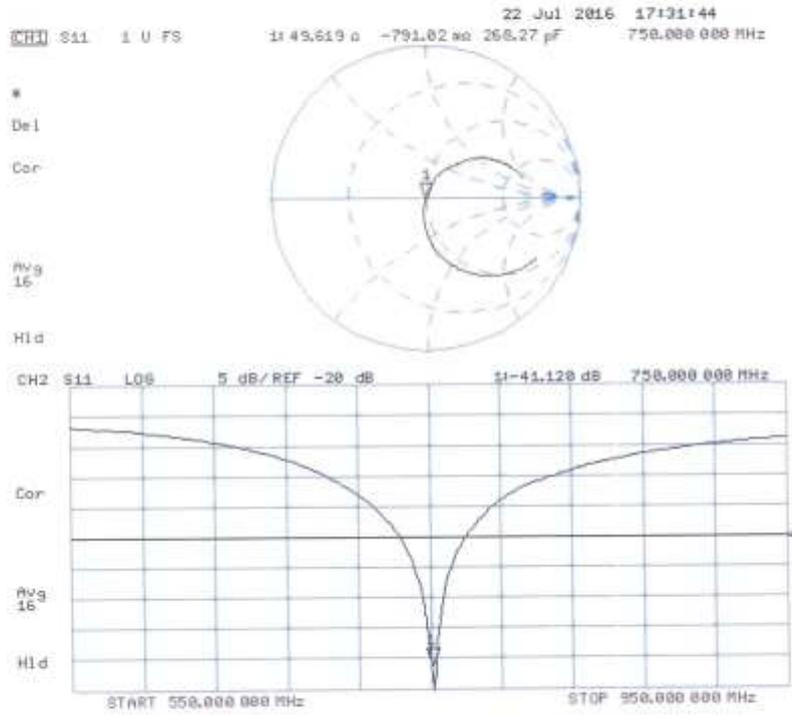
- Probe: EX3DV4 - SN7349; ConvF(9.99, 9.99, 9.99); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.48 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.42 W/kg
SAR(1 g) = 2.24 W/kg; SAR(10 g) = 1.46 W/kg
Maximum value of SAR (measured) = 3.01 W/kg



Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D835V2-441_Nov16**

CALIBRATION CERTIFICATE			
Object	D835V2 - SN:441		
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	November 16, 2016		
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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	09-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	09-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17
Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature
			Issued: November 17, 2016
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.94 mho/m ± 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	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.38 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.11 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.2 ± 6 %	1.01 mho/m ± 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	2.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.62 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.63 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.37 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 1.8 $\mu\Omega$
Return Loss	- 34.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.0 Ω - 4.6 $\mu\Omega$
Return Loss	- 24.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.369 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
Manufactured on	March 09, 2001

DASY5 Validation Report for Head TSL

Date: 16.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:441

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.94 \text{ S/m}$; $\epsilon_r = 40.9$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

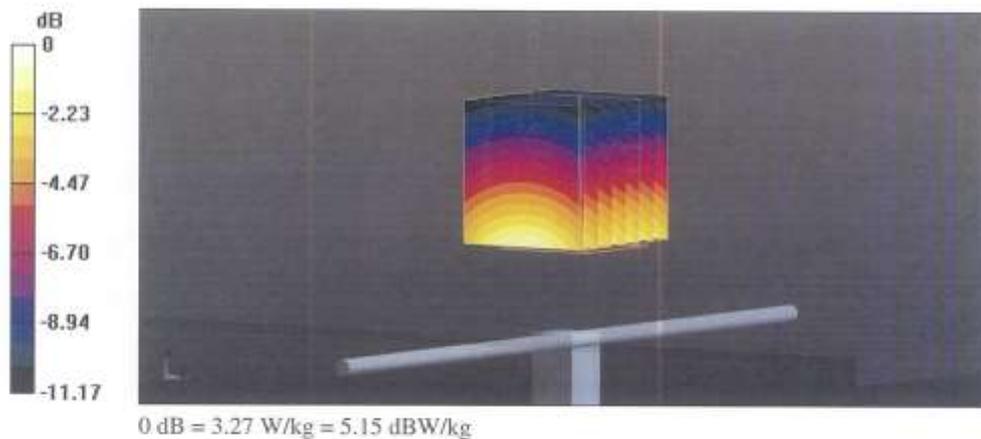
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 61.83 V/m; Power Drift = -0.02 dB

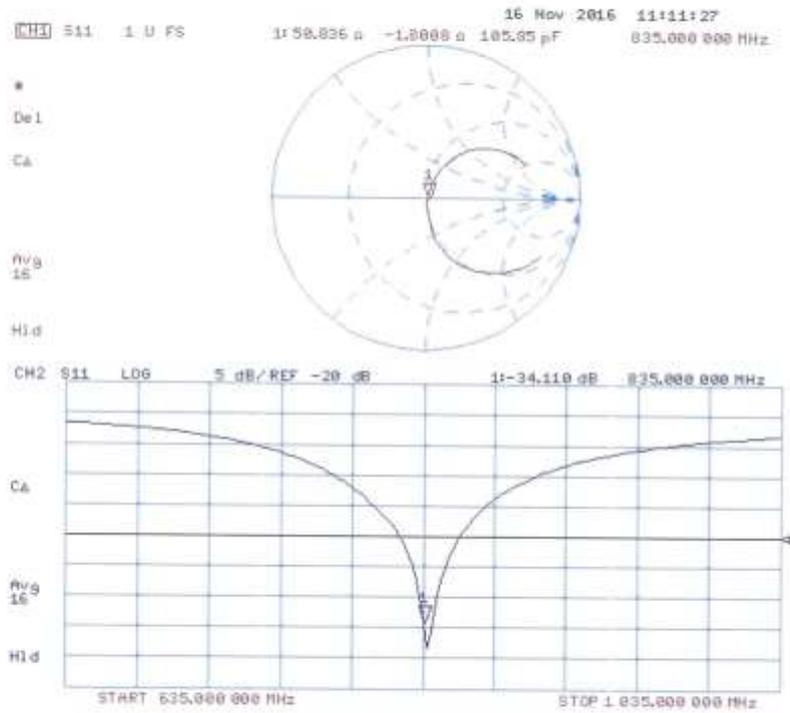
Peak SAR (extrapolated) = 3.67 W/kg

SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.57 W/kg

Maximum value of SAR (measured) = 3.27 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:441

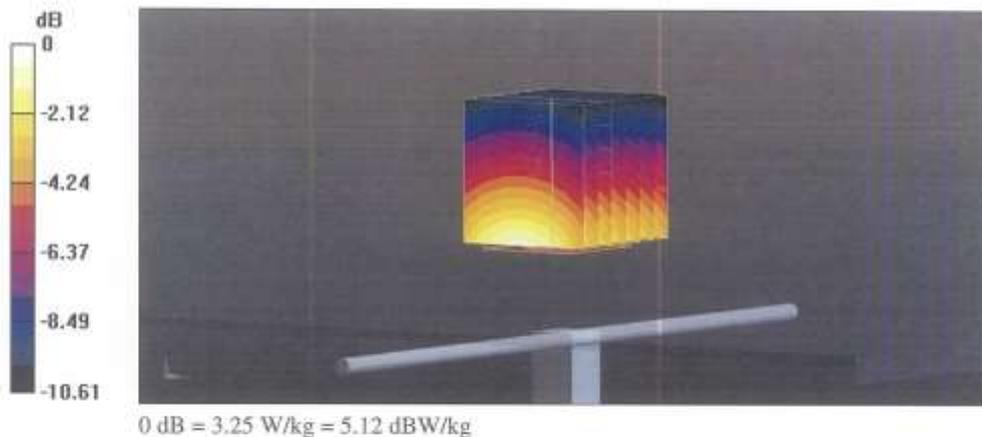
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 1.01 \text{ S/m}$; $\epsilon_r = 55.2$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

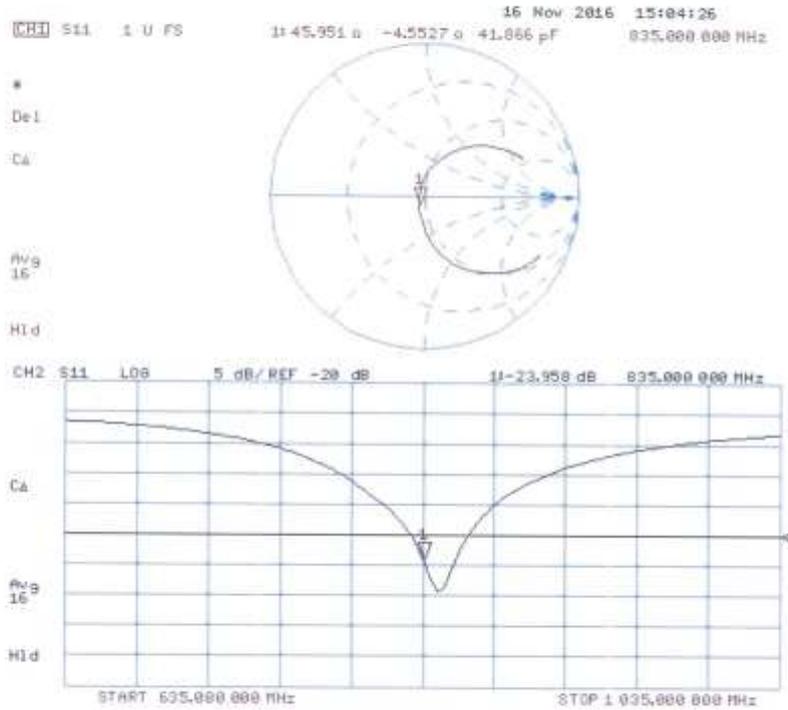
- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 59.90 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 3.61 W/kg
SAR(1 g) = 2.48 W/kg; SAR(10 g) = 1.63 W/kg
Maximum value of SAR (measured) = 3.25 W/kg



Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D1800V2-2d007_Nov16**

CALIBRATION CERTIFICATE

Object: **D1800V2 - SN:2d007**

Calibration procedure(s): **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

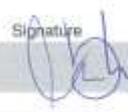
Calibration date: **November 16, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292793	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RIF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Claudio Leubler** (Name), **Laboratory Technician** (Function),  (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function),  (Signature)

Issued: November 17, 2016

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Accreditation No.: SCS 0108

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1800 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.1 ± 6 %	1.39 mho/m ± 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	9.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	37.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.8 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.6 ± 6 %	1.52 mho/m ± 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	9.39 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.6 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.97 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	19.9 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.2 Ω - 8.4 j Ω
Return Loss	- 20.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	43.9 Ω - 6.2 j Ω
Return Loss	- 20.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 ns
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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
Manufactured on	July 23, 2001

DASY5 Validation Report for Head TSL

Date: 15.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d007

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used: $f = 1800$ MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.26, 8.26, 8.26); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

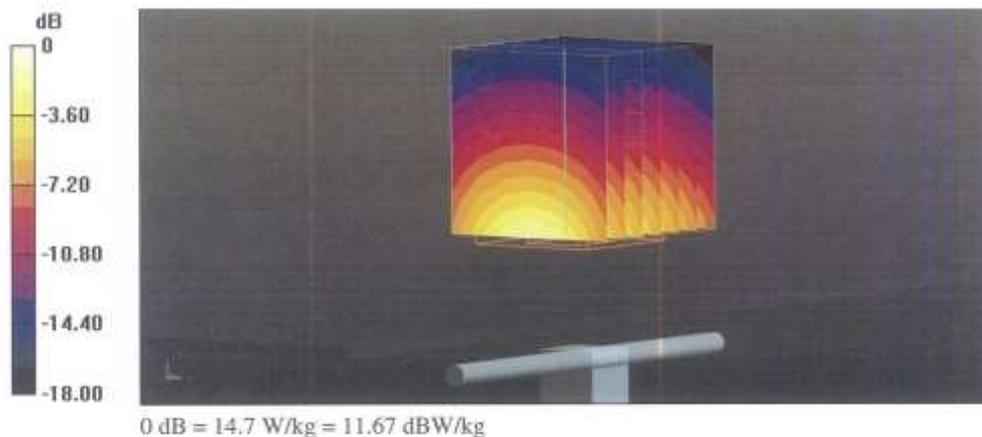
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.8 V/m; Power Drift = -0.04 dB

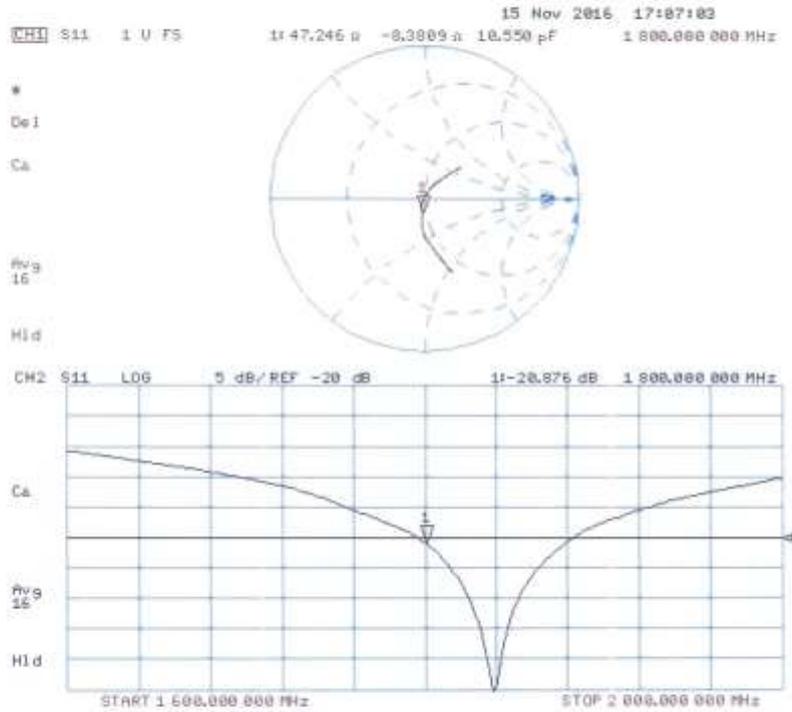
Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 9.47 W/kg; SAR(10 g) = 4.95 W/kg

Maximum value of SAR (measured) = 14.7 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d007

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used: $f = 1800$ MHz; $\sigma = 1.52$ S/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.17, 8.17, 8.17); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

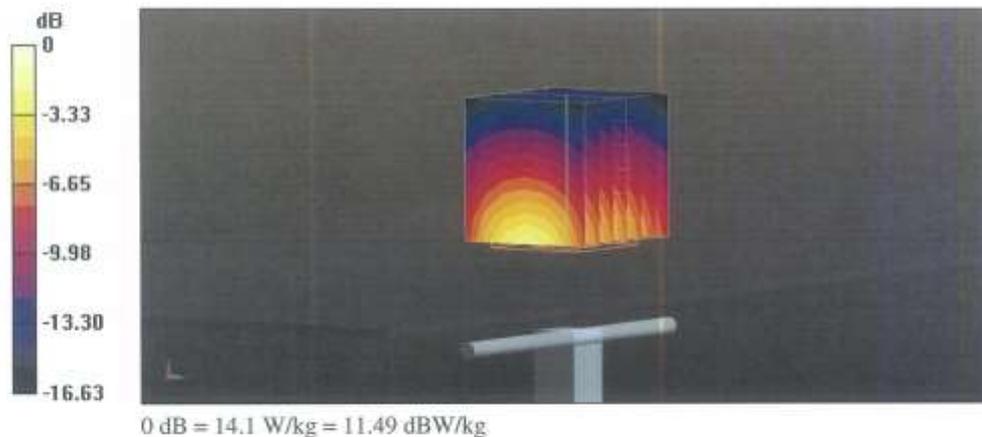
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.5 V/m; Power Drift = -0.03 dB

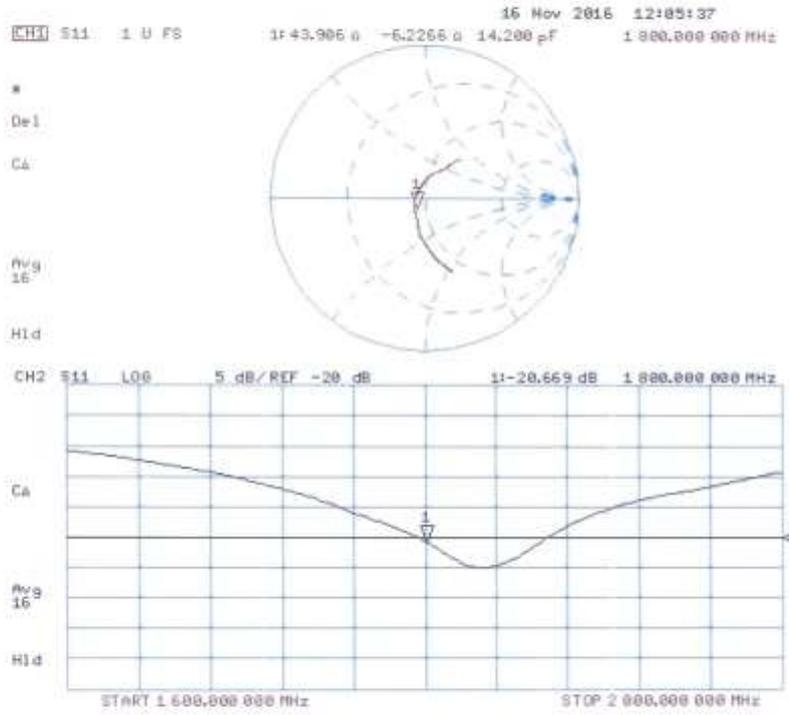
Peak SAR (extrapolated) = 16.3 W/kg

SAR(1 g) = 9.39 W/kg; SAR(10 g) = 4.97 W/kg

Maximum value of SAR (measured) = 14.1 W/kg



Impedance Measurement Plot for Body TSL



**Calibration Laboratory of
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Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D1900V2-5d061_Apr16**

CALIBRATION CERTIFICATE

Object: **D1900V2 - SN: 5d061**

Calibration procedure(s): **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **April 25, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX30V4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 26, 2016.

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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:

- a) 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
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- e) 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.0 ± 6 %	1.37 mho/m ± 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	9.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	38.6 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.01 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.2 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.9 ± 6 %	1.49 mho/m ± 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	9.82 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.5 Ω + 7.7 j Ω
Return Loss	-22.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.9 Ω + 8.5 j Ω
Return Loss	-21.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.192 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
Manufactured on	December 10, 2004

DASY5 Validation Report for Head TSL

Date: 25.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d061

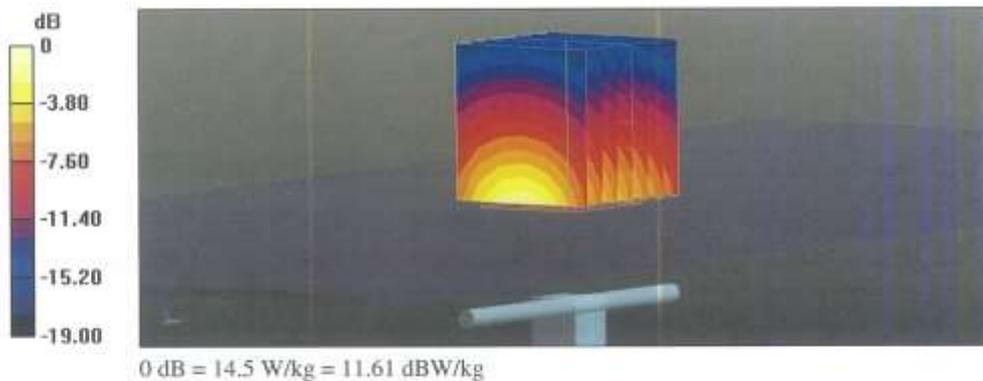
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.37$ S/m; $\epsilon_r = 40$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

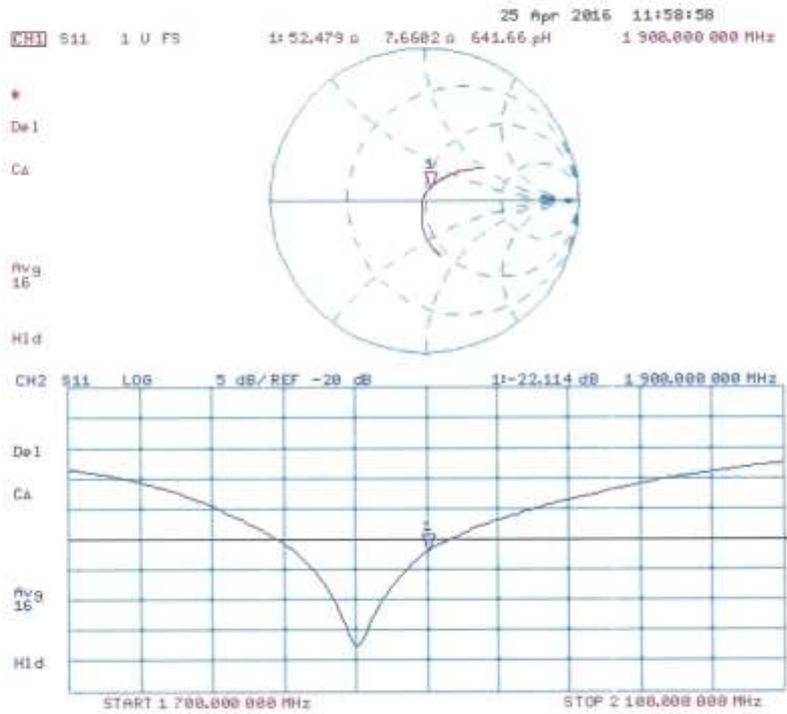
- Probe: EX3DV4 - SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 107.4 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 17.2 W/kg
SAR(1 g) = 9.53 W/kg; SAR(10 g) = 5.01 W/kg
Maximum value of SAR (measured) = 14.5 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 25.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d061

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

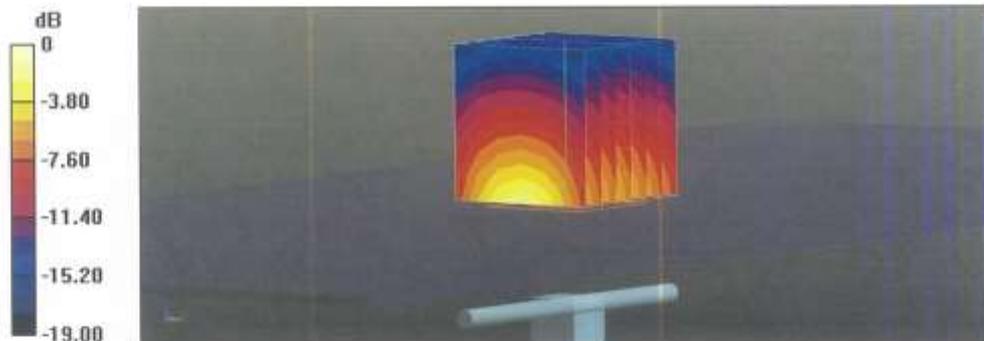
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.3 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.3 W/kg

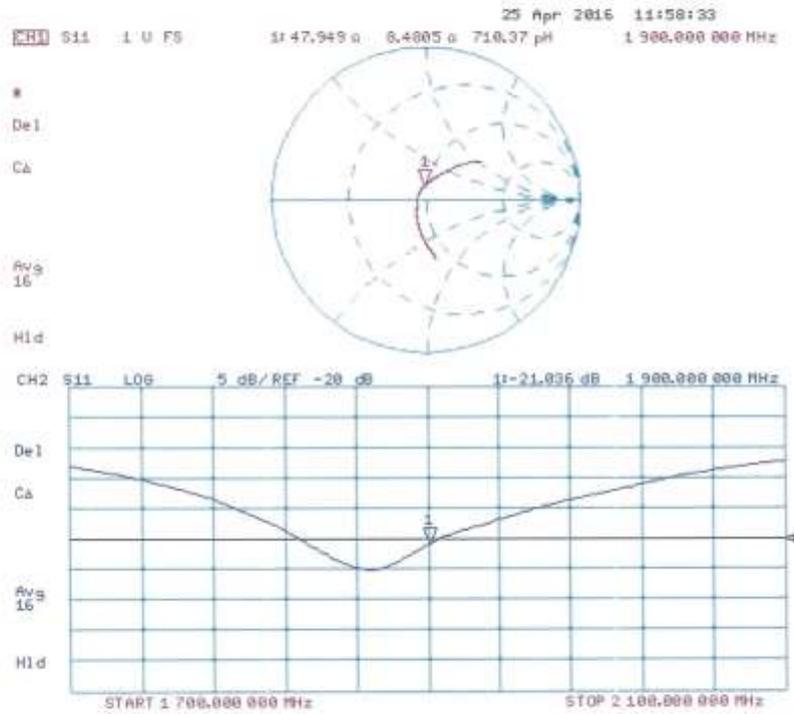
SAR(1 g) = 9.82 W/kg; SAR(10 g) = 5.2 W/kg

Maximum value of SAR (measured) = 14.9 W/kg



0 dB = 14.9 W/kg = 11.73 dBW/kg

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client **HCT (Dymstec)**

Certificate No: D2450V2-965_Apr16

CALIBRATION CERTIFICATE

Object: D2450V2 - SN: 965

Calibration procedure(s): QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: April 19, 2016

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	16-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 20, 2016

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.0 ± 6 %	1.83 mho/m ± 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	12.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	50.6 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.7 ± 6 %	1.98 mho/m ± 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	12.4 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.2 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.78 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.0 W/kg ± 16.5 % (k=2)

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

Impedance, transformed to feed point	54.6 Ω + 3.8 j Ω
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.0 Ω + 5.9 j Ω
Return Loss	- 24.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.162 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
Manufactured on	November 19, 2014

DASY5 Validation Report for Head TSL

Date: 19.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 965

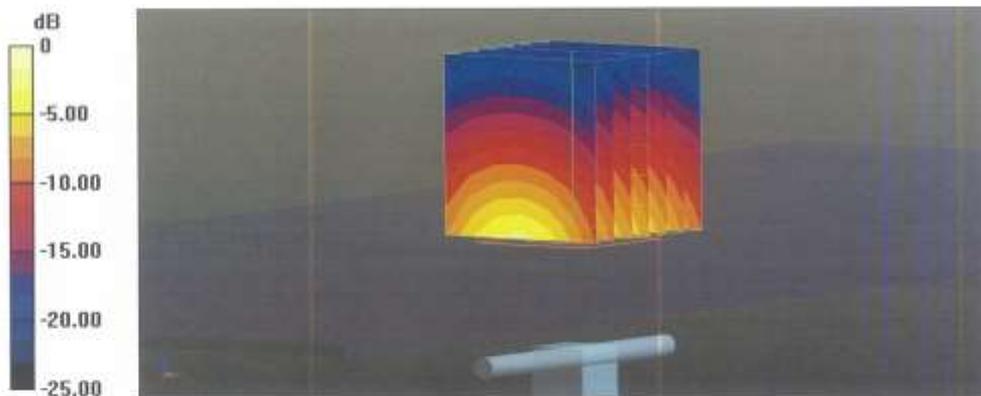
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 40$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

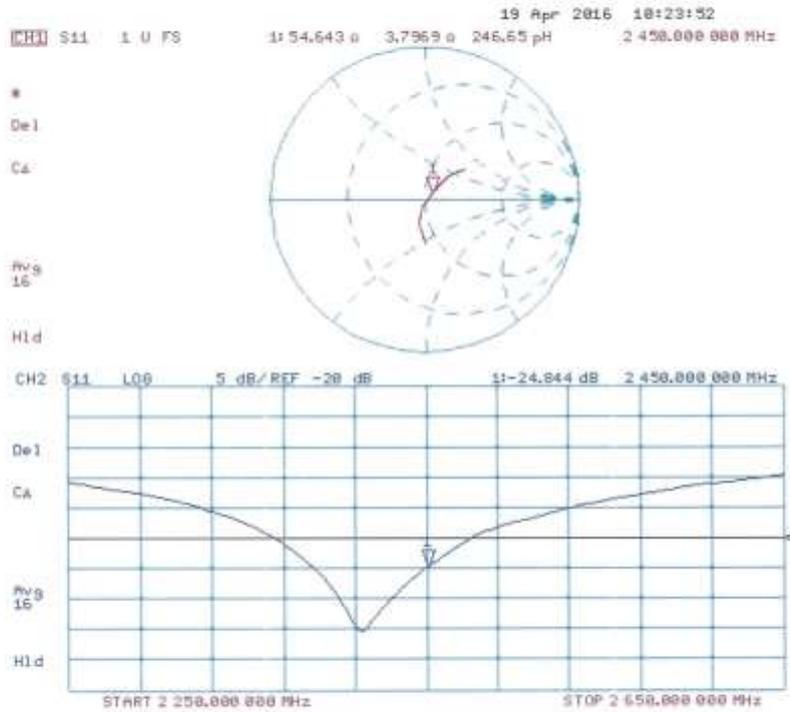
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 112.4 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 25.6 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.89 W/kg
Maximum value of SAR (measured) = 20.7 W/kg



0 dB = 20.7 W/kg = 13.16 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 19.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 965

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.98$ S/m; $\epsilon_r = 52.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

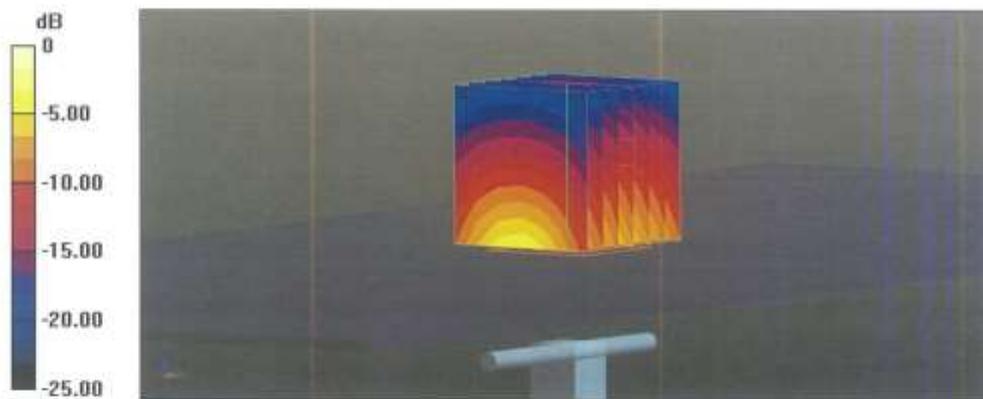
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.7 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 24.7 W/kg

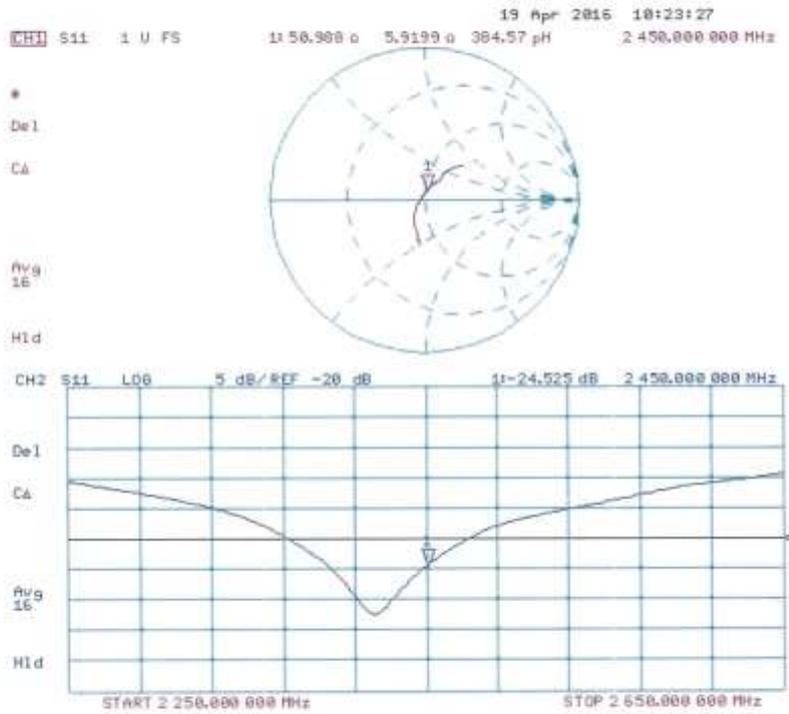
SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.78 W/kg

Maximum value of SAR (measured) = 20.0 W/kg



0 dB = 20.0 W/kg = 13.01 dBW/kg

Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D2600V2-1106_Feb16**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN: 1106**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **February 18, 2016**

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 EPM-442A	GB37480704	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 18, 2016

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Accreditation No.: SCS 0108

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:

- a) 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
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- e) 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	V52.8.8
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 ± 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 ± 0.2) °C	38.1 ± 6 %	2.01 mho/m ± 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	14.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.1 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg ± 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 ± 0.2) °C	52.5 ± 6 %	2.18 mho/m ± 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	13.4 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	53.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.94 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.7 W/kg ± 16.5 % (k=2)

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

Impedance, transformed to feed point	49.5 Ω - 7.3 $\mu\Omega$
Return Loss	- 22.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.8 Ω - 6.0 $\mu\Omega$
Return Loss	- 21.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1,150 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
Manufactured on	February 18, 2015

DASY5 Validation Report for Head TSL

Date: 18.02.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1106

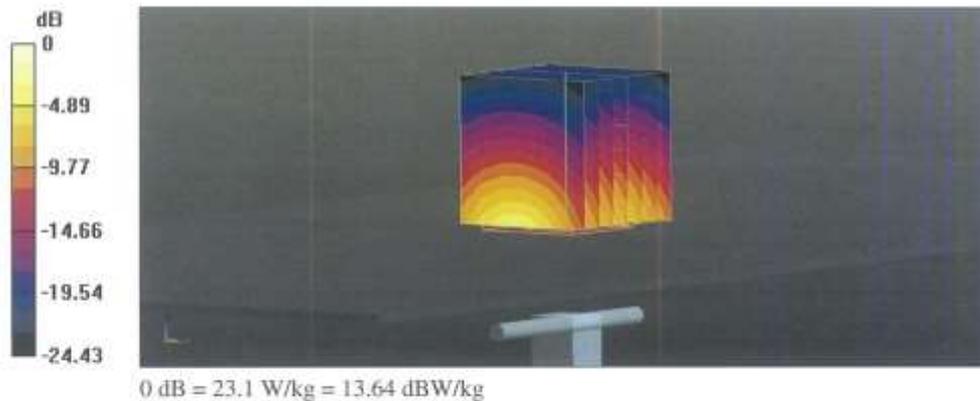
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: $f = 2600$ MHz; $\sigma = 2.01$ S/m; $\epsilon_r = 38.1$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

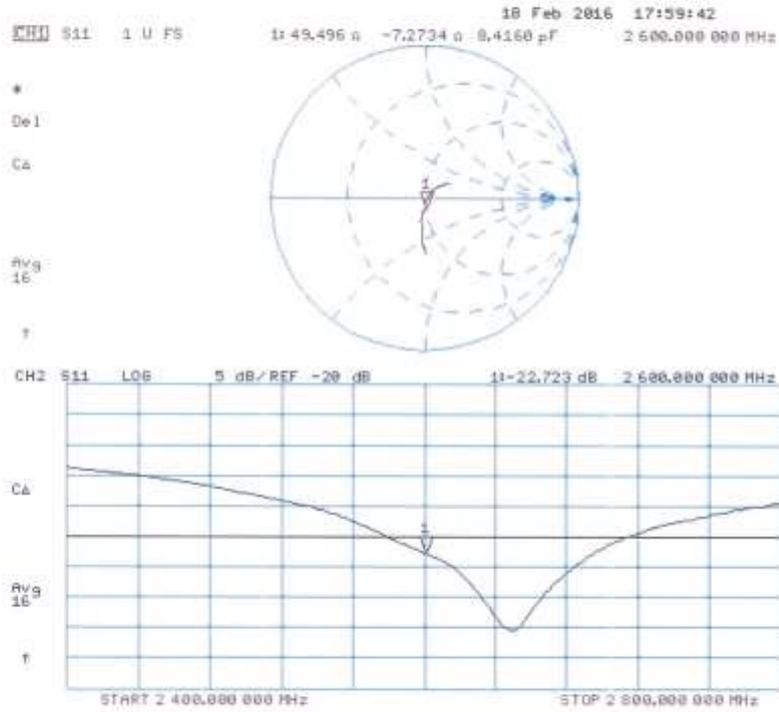
- Probe: EX3DV4 - SN7349; ConvF(7.49, 7.49, 7.49); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 113.4 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 29.4 W/kg
SAR(1 g) = 14 W/kg; SAR(10 g) = 6.19 W/kg
Maximum value of SAR (measured) = 23.1 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 18.02.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1106

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

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.18$ S/m; $\epsilon_r = 52.5$; $\rho = 1000$ kg/m³.

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.6, 7.6, 7.6); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

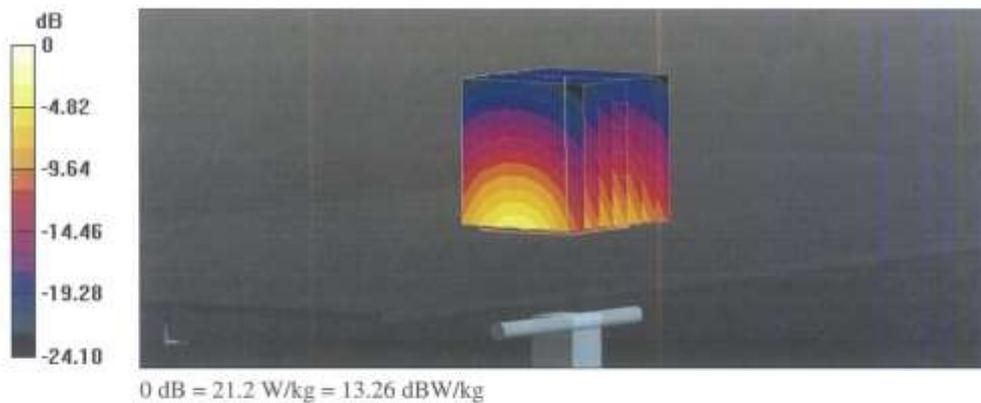
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.1 V/m; Power Drift = 0.05 dB

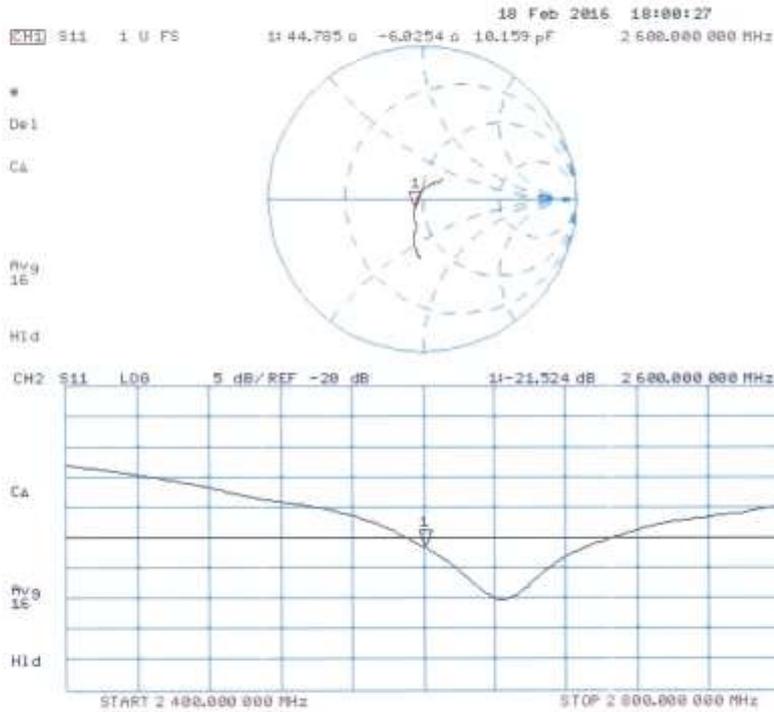
Peak SAR (extrapolated) = 27.7 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 5.94 W/kg

Maximum value of SAR (measured) = 21.2 W/kg



Impedance Measurement Plot for Body TSL



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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **D5GHzV2-1107_Jan16**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1107**

Calibration procedure(s) **QA CAL-22.v2
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **January 29, 2016**

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 EPM-442A	GB37480704	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 3503	31-Dec-15 (No. EX3-3503_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Name: Michael Weber, Function: Laboratory Technician, Signature: M. Weber**

Approved by: **Name: Katja Pokovic, Function: Technical Manager, Signature: [Handwritten]**

Issued: January 29, 2016

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

**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: **SCS 0108**

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:

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- d) 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	4.55 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.5 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (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	21.9 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	47.0 ± 6 %	5.44 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 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	46.4 ± 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 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.95 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	78.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5750 MHz

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	46.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.1 ± 6 %	6.12 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.55 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (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	21.0 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	55.2 Ω - 7.3 j Ω
Return Loss	- 21.5 dB

Antenna Parameters with Head TSL at 5600 MHz

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

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.8 Ω + 0.7 j Ω
Return Loss	- 23.8 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	48.5 Ω - 7.3 j Ω
Return Loss	- 22.4 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	55.3 Ω - 3.9 j Ω
Return Loss	- 24.1 dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	55.2 Ω - 4.4 j Ω
Return Loss	- 23.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 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
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 28.01.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1107

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 4.55$ S/m; $\epsilon_r = 35.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.9$ S/m; $\epsilon_r = 34.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 5.05$ S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.53, 5.53, 5.53); Calibrated: 31.12.2015, ConvF(4.99, 4.99, 4.99); Calibrated: 31.12.2015, ConvF(4.95, 4.95, 4.95); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 72.04 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 28.7 W/kg

SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 18.4 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 = 71.71 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 31.8 W/kg

SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.33 W/kg

Maximum value of SAR (measured) = 19.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

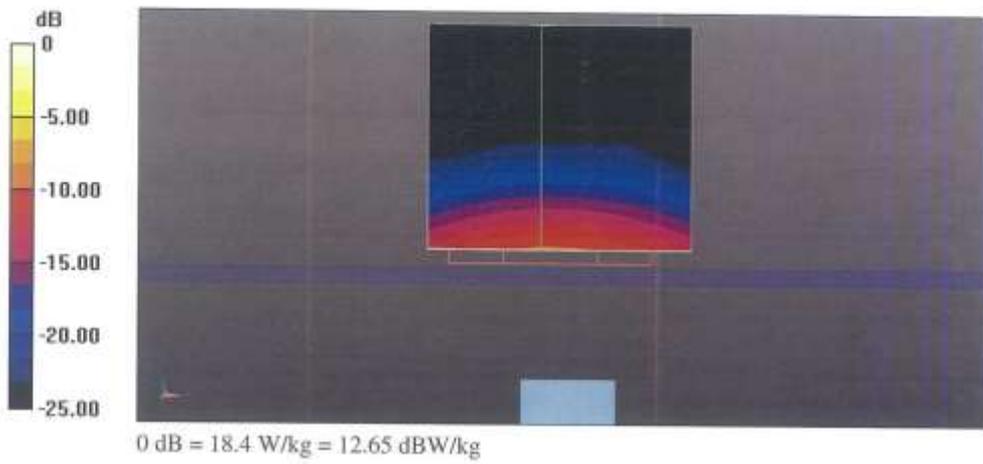
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.35 V/m; Power Drift = 0.03 dB

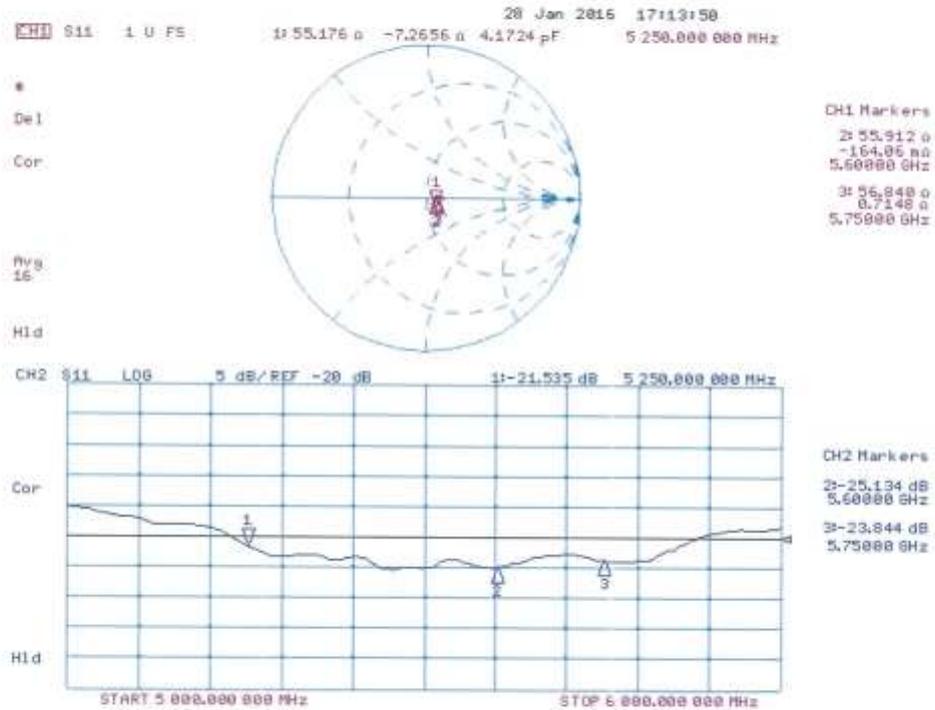
Peak SAR (extrapolated) = 31.7 W/kg

SAR(1 g) = 7.73 W/kg; SAR(10 g) = 2.21 W/kg

Maximum value of SAR (measured) = 19.0 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 29.01.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1107

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 5.44$ S/m; $\epsilon_r = 47$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.91$ S/m; $\epsilon_r = 46.4$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 6.12$ S/m; $\epsilon_r = 46.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.85, 4.85, 4.85); Calibrated: 31.12.2015, ConvF(4.35, 4.35, 4.35); Calibrated: 31.12.2015, ConvF(4.3, 4.3, 4.3); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 66.57 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 7.46 W/kg; SAR(10 g) = 2.11 W/kg

Maximum value of SAR (measured) = 17.0 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 = 67.15 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 32.5 W/kg

SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 18.8 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

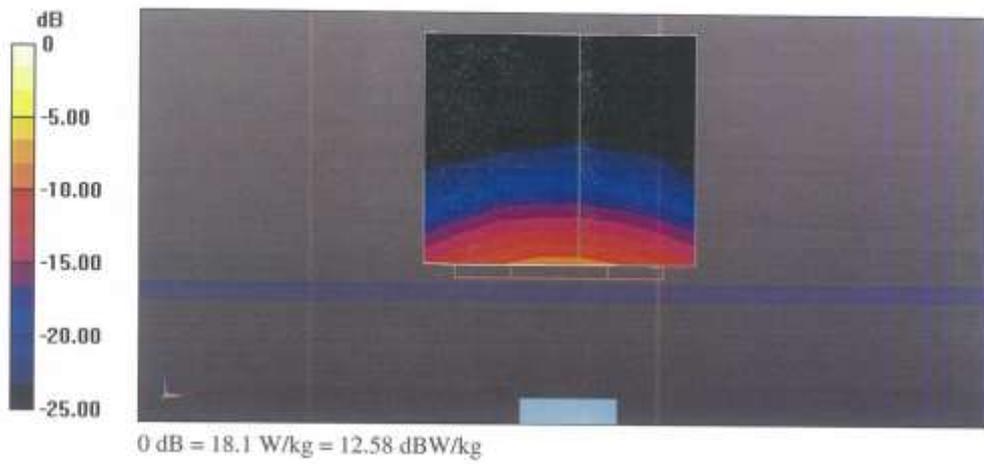
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.88 V/m; Power Drift = 0.02 dB

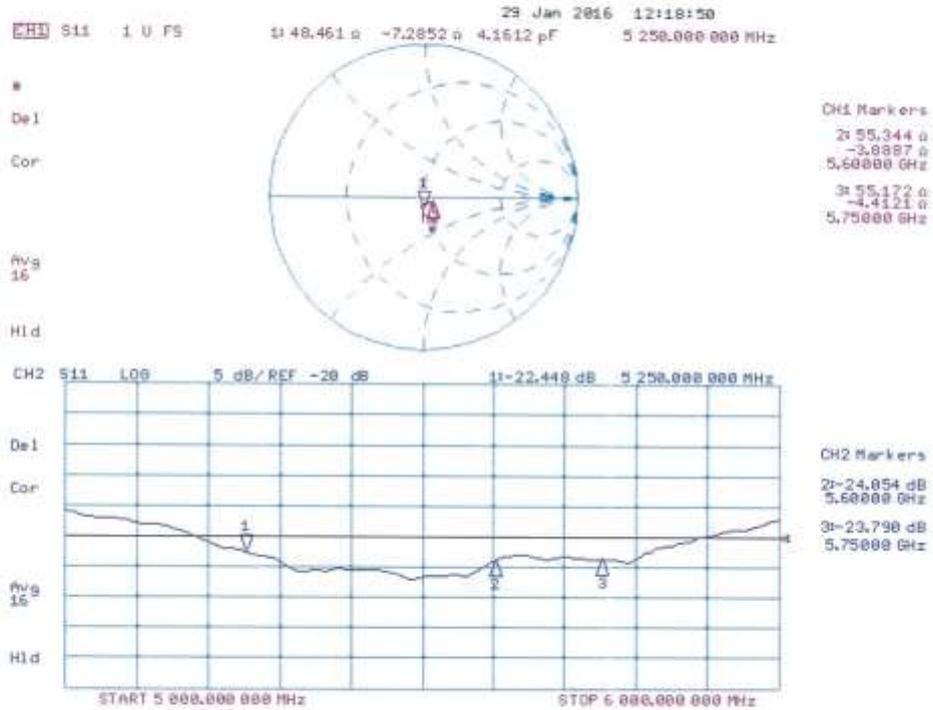
Peak SAR (extrapolated) = 32.2 W/kg

SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 18.1 W/kg



Impedance Measurement Plot for Body TSL



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s p e a g

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Certificate of conformity / First Article Inspection

Item	Triple Modular Flat Phantom V5.1
Type No	QD 000 P51 C
Series No	1100 and higher
Manufacturer / Origin	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

The sub-units of item 1100 are identified with the designation 1100/1, 1100/2 and 1100/3. Tests were conducted on all 3 sub-units of this phantom.

Test	Requirement	Details	Units tested
Material thickness	Compliant with the standard requirements.	2 mm +/- 0.2 mm 30 points over the bottom area	all
Material parameters	Dielectric parameters for required frequencies	200 MHz – 6 GHz - Relative permittivity 3 - 5 Loss tangent < 0.05.	Material sample
Material resistivity	The material is compatible with the liquids defined in the standards if handled and cleaned according to the instructions.	DGBE based simulating liquids, Observe Technical Note for material compatibility.	Material Samples
Shape	Internal dimensions	Internal height: > 175 mm Bottom internal length: 280 mm Bottom internal width: 175 mm Nominal filling height: 155 mm Nominal volume: 9.2 l	Pre-series, design
Sagging	Depending on standard	No initial sagging (negative preshaped, change < 0.5 mm)	1100/2

Standards

- [1] IEEE 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- [2] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [3] IEC 62209 – 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures, Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", March 2010
- [4] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Conformity

Based on the dimensions and sample tests above, we certify that this item is in compliance with the standards [1] to [4] for frequencies > 700 MHz, if operated according to the specific requirements.

Date 16.07.2015

Signature / Stamp

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Attachment 5. – SAR Tissue Characterization

The brain and muscle mixtures consist of a viscous gel using hydrox-ethyl cellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove.

Ingredients (% by weight)	Frequency (MHz)									
	750		835		1 900		2 450 – 2 700		5 200 - 5 800	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	41.1	51.7	40.45	53.06	54.9	70.17	71.88	73.2	65.52	78.66
Salt (NaCl)	1.4	0.9	1.45	0.94	0.18	0.39	0.16	0.1	0.0	0.0
Sugar	57.0	47.2	57.0	44.9	0.0	0	0.0	0.0	0.0	0.0
HEC	0.2	0	1.0	1.0	0.0	0	0.0	0.0	0.0	0.0
Bactericide	0.2	0.1	0.1	0.1	0.0	0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	19.97	0.0	17.24	10.67
DGBE	0.0	0.0	0.0	0.0	44.92	29.44	7.99	26.7	0.0	0.0
Diethylene glycol hexyl ether	-	-	-	-	-	-	-	-	-	-

Salt: 99 % Pure Sodium Chloride Sugar: 98 % Pure Sucrose
 Water: De-ionized, 16M resistivity HEC: Hydroxyethyl Cellulose
 DGBE: 99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]
 Triton X-100(ultra pure): Polyethylene glycol mono[4-(1,1,3,3-tetramethylbutyl)phenyl] ether

Composition of the Tissue Equivalent Matter

Attachment 6. – SAR SYSTEM VALIDATION

Per FCC KCB 865664 D02v01r02, SAR system validation status should be document to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2013 and FCC KDB 865664 D01v01r04. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

SAR System No.	Probe	Probe Type	Probe Calibration Point		Dipole	Date	Dielectric Parameters		CW Validation			Modulation Validation		
							Measured Permittivity	Measured Conductivity	Sensitivity	Probe Linearity	Probe Isotropy	MOD. Type	Duty Factor	PAR
1	3863	EX3DV4	Head	750	1014	2016.08.08	42	0.88	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Body	750	1014	2016.10.11	55.6	0.97	PASS	PASS	PASS	N/A	N/A	N/A
1	3863	EX3DV4	Head	835	441	2016.11.24	41.5	0.89	PASS	PASS	PASS	N/A	N/A	N/A
1	3863	EX3DV4	Head	835	441	2016.11.24	41.5	0.89	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Body	835	441	2016.11.25	55.4	0.98	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Body	835	441	2016.11.25	55.4	0.98	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Head	1800	2d007	2016.11.24	40.1	1.41	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Head	1800	2d007	2016.11.24	40.1	1.41	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Body	1800	2d007	2016.11.25	53.3	1.5	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Body	1800	2d007	2016.11.25	53.3	1.5	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Head	1900	5d061	2016.10.10	40.3	1.39	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Head	1900	5d061	2016.10.10	40.3	1.39	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Body	1900	5d061	2016.10.11	53.7	1.53	PASS	PASS	PASS	GMSK	PASS	N/A
5	3903	EX3DV4	Body	1900	5d061	2016.10.11	53.7	1.53	PASS	PASS	PASS	N/A	N/A	N/A
5	3903	EX3DV4	Head	2450	965	2016.10.10	39.4	1.82	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Body	2450	965	2016.10.11	52.5	1.97	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Head	2600	1106	2016.10.10	39.2	1.97	PASS	PASS	PASS	NA	N/A	NA
5	3903	EX3DV4	Body	2600	1106	2016.10.11	52.7	2.15	PASS	PASS	PASS	NA	N/A	NA
5	3903	EX3DV4	Head	5250	1107	2016.10.10	36	4.7	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Head	5600	1107	2016.10.10	35.8	5.04	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Head	5750	1107	2016.10.10	35.3	5.25	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Body	5250	1107	2016.10.11	48.3	5.4	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Body	5600	1107	2016.10.11	48.7	5.78	PASS	PASS	PASS	OFDM	N/A	PASS
5	3903	EX3DV4	Body	5750	1107	2016.10.11	48.5	5.95	PASS	PASS	PASS	OFDM	N/A	PASS

SAR System Validation Summary 1g

Note;

All measurement were performed using probes calibrated for CW signal only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04. SAR system were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664 D01v01r04.