# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 48675**

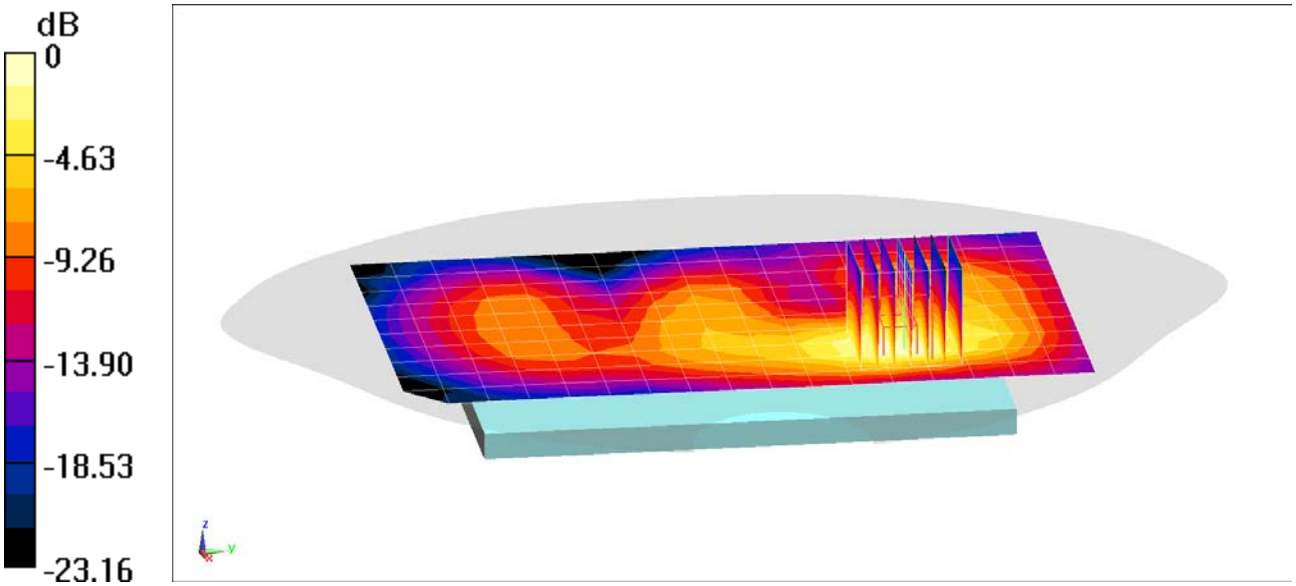
Communication System: UID 0, LTE Band 7; Frequency: 2535 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Body Medium parameters used (interpolated):
f = 2535 MHz; $\sigma$ = 2.145 S/m; $\varepsilon_r$ = 51.254; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-26-2019; Ambient Temp: 22.8°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN7417; ConvF(7.37, 7.37, 7.37) @ 2535 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn665; Calibrated: 2/13/2019
Phantom: LeftTwin-SAM V5.0; Type: QD 000 P40 CD; Serial: TP1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

**Mode: LTE Band 7, Body SAR, Back side, Mid.ch,**
**20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset**

**Area Scan (11x18x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.69 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.461 W/kg
**SAR(1 g) = 0.219 W/kg**




0 dB = 0.363 W/kg = -4.40 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 48675**

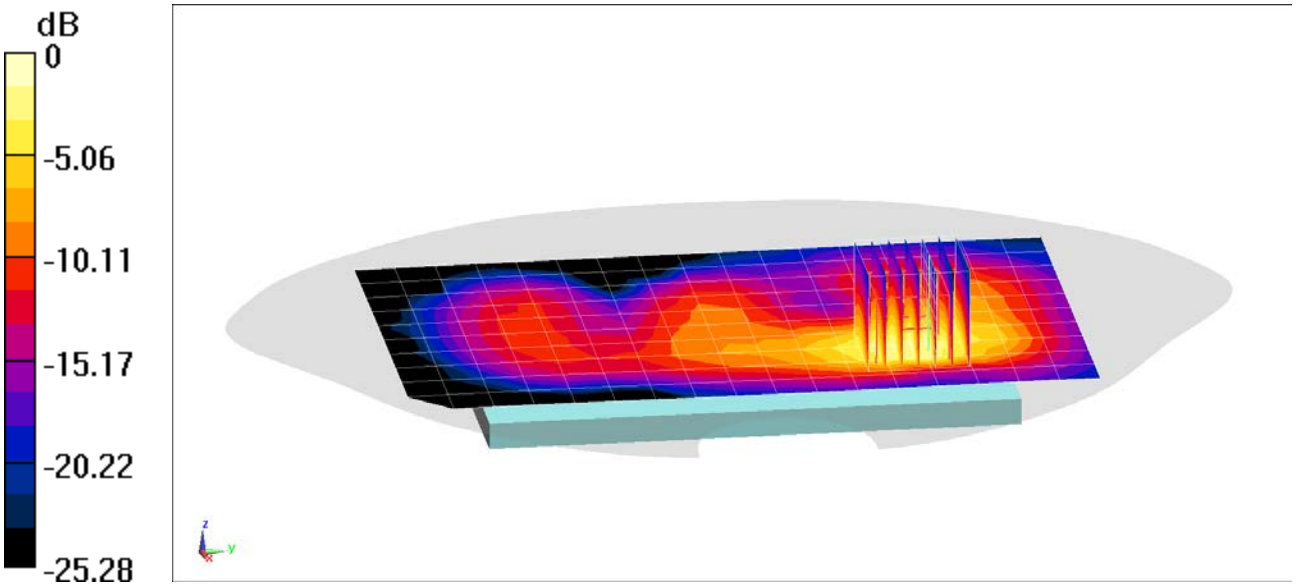
Communication System: UID 0, LTE Band 7; Frequency: 2510 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Body Medium parameters used (interpolated):
f = 2510 MHz; $\sigma$ = 2.115 S/m; $\varepsilon_r$ = 51.331; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-26-2019; Ambient Temp: 22.8°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN7417; ConvF(7.51, 7.51, 7.51) @ 2510 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn665; Calibrated: 2/13/2019
Phantom: LeftTwin-SAM V5.0; Type: QD 000 P40 CD; Serial: TP1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

**Mode: LTE Band 7, Body SAR, Back side, Low.ch,**
**20 MHz Bandwidth, QPSK, 50 RB, 0 RB Offset**

**Area Scan (11x18x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 14.11 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.843 W/kg
**SAR(1 g) = 0.368 W/kg**




0 dB = 0.627 W/kg = -2.03 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 44526**

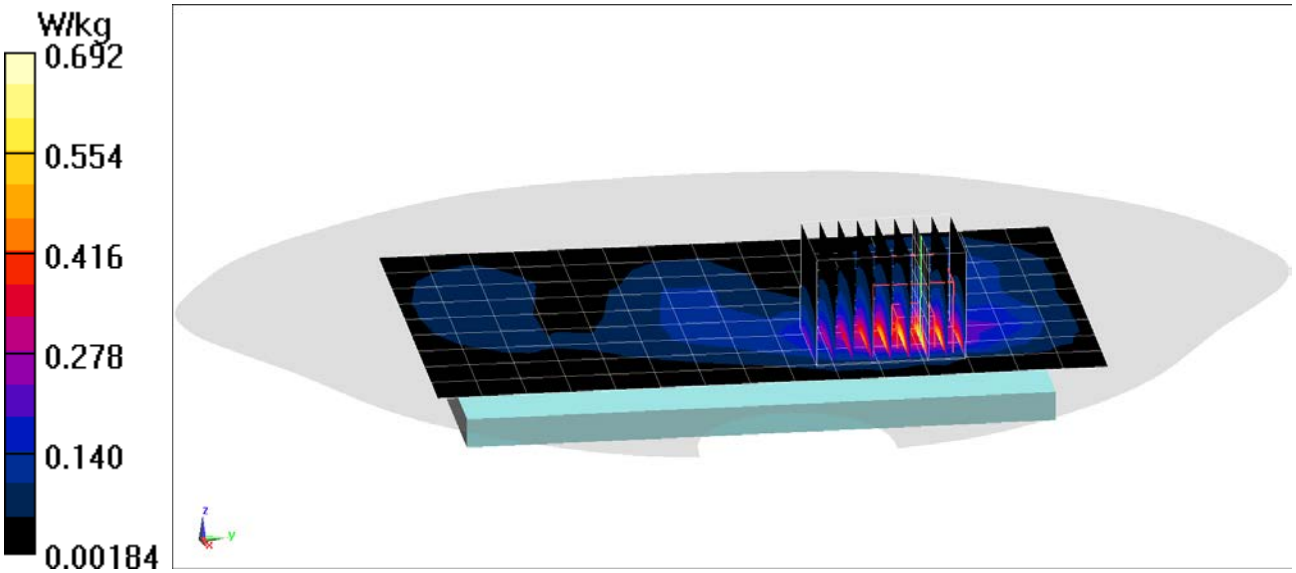
Communication System: UID 0, _LTE Band 41 (Class 2); Frequency: 2549.5 MHz; Duty Cycle: 1:2.31
Medium: 2400-2600 MHz BBBody Medium parameters used:
f = 2550 MHz; $\sigma$ = 2.095 S/m; $\varepsilon_r$ = 52.307; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-16-2019; Ambient Temp: 20.3°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7421; ConvF(7.29, 7.29, 7.29) @ 2549.5 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: LTE Band 41 PC2, Body SAR, Back side, Low-Mid.ch, 20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

**Area Scan (10x16x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x9x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 14.53 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.862 W/kg
**SAR(1 g) = 0.435 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 44526**

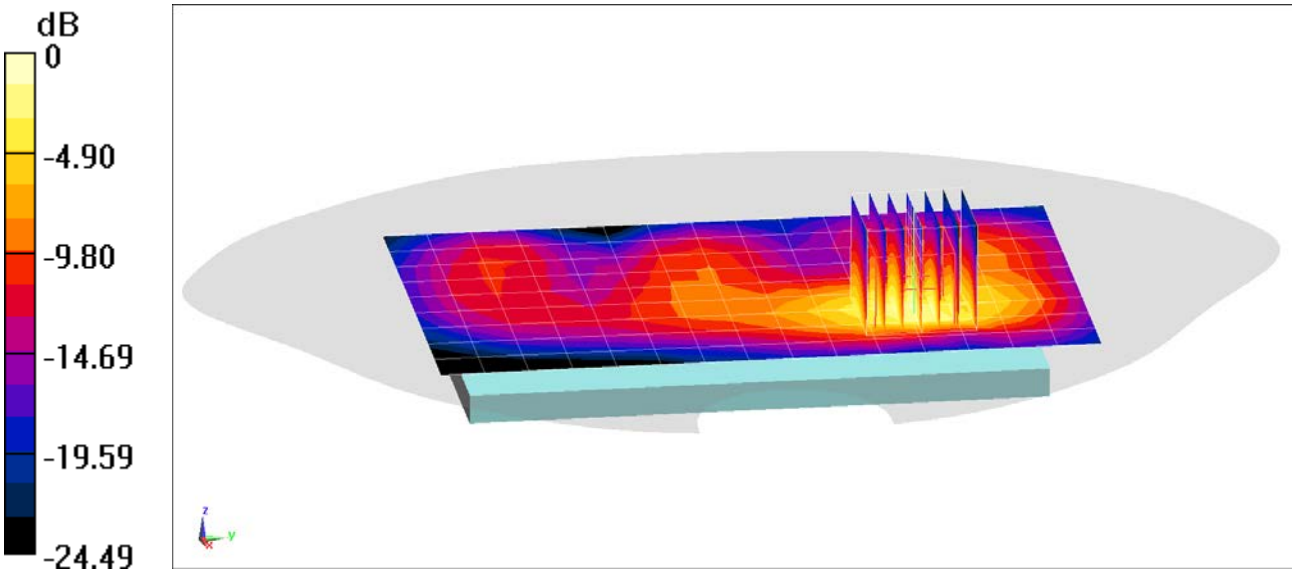
Communication System: UID 0, LTE Band 41; Frequency: 2549.5 MHz; Duty Cycle: 1:1.58
Medium: 2400-2600 MHz BBBody Medium parameters used:
f = 2550 MHz; $\sigma$ = 2.095 S/m; $\varepsilon_r$ = 52.307; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-16-2019; Ambient Temp: 20.3°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7421; ConvF(7.29, 7.29, 7.29) @ 2549.5 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: LTE Band 41 PC3, Body SAR, Back side, Low-Mid.ch, 20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

**Area Scan (10x16x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 21.28 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 1.90 W/kg
**SAR(1 g) = 0.847 W/kg**




0 dB = 1.44 W/kg = 1.58 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

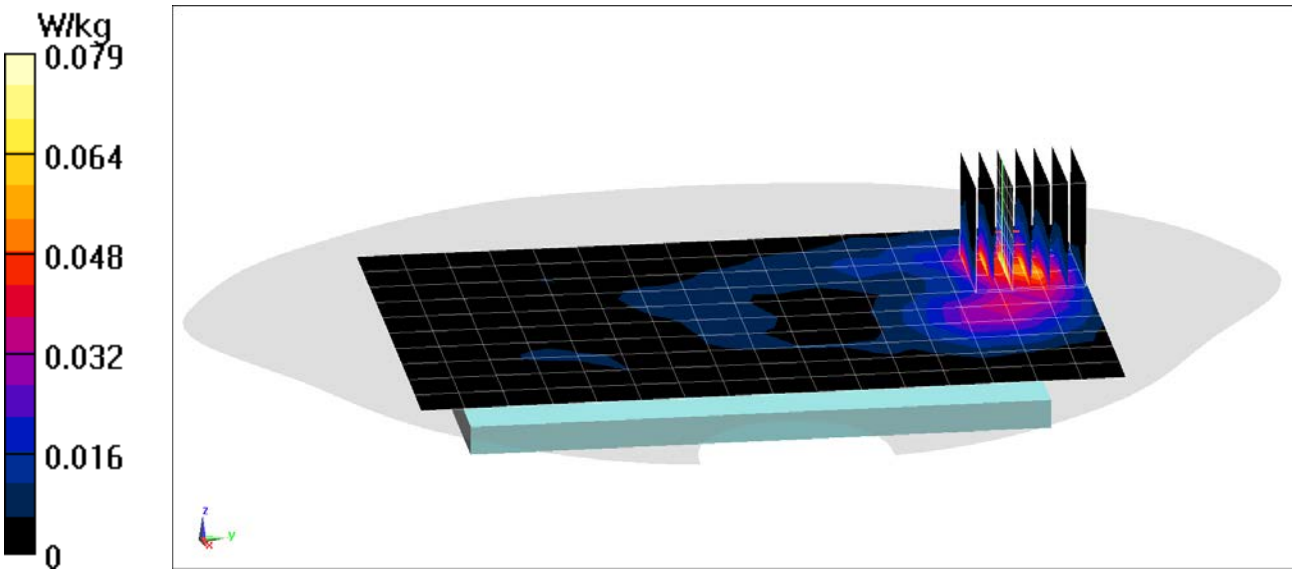
Communication System: UID 0, _IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used (interpolated):
f = 2437 MHz; $\sigma$ = 2.031 S/m; $\varepsilon_r$ = 50.623; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 04-29-2019; Ambient Temp: 22.3°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN7421; ConvF(7.46, 7.46, 7.46) @ 2437 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: IEEE 802.11b, 22 MHz Bandwidth, Body SAR, Ch 6, 1 Mbps, Back Side

**Area Scan (11x17x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.955 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 0.102 W/kg
**SAR(1 g) = 0.047 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

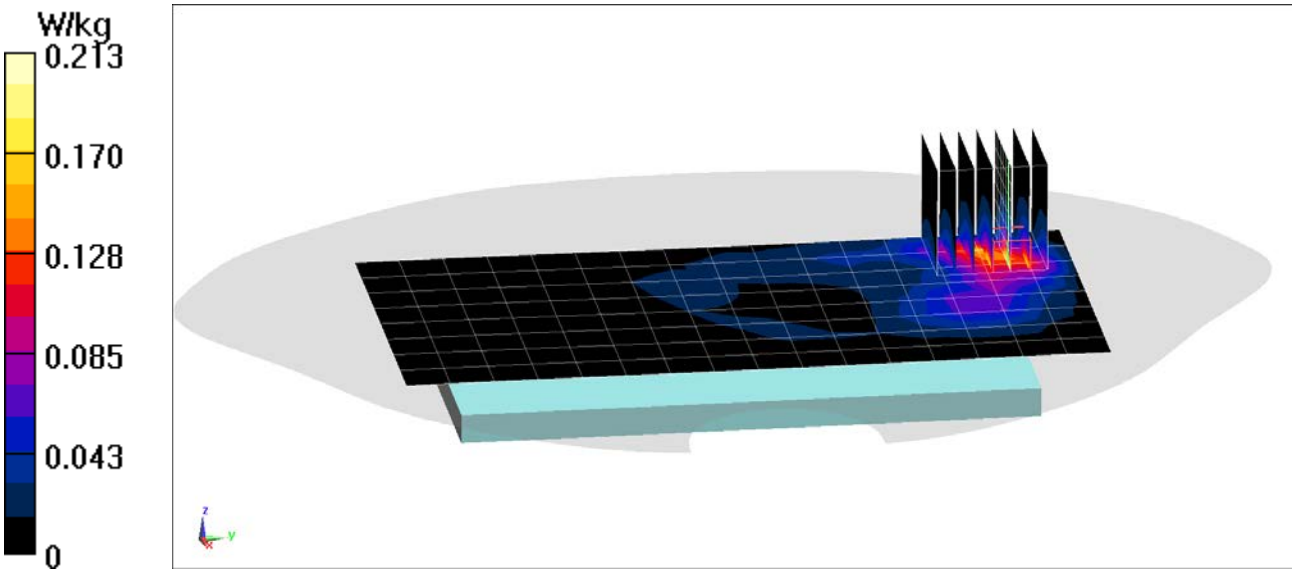
Communication System: UID 0, _IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used (interpolated):
f = 2437 MHz; $\sigma$ = 2.031 S/m; $\varepsilon_r$ = 50.623; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-29-2019; Ambient Temp: 22.3°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN7421; ConvF(7.46, 7.46, 7.46) @ 2437 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: IEEE 802.11b, 22 MHz Bandwidth, Body SAR, Ch 6, 1 Mbps, Back Side

**Area Scan (9x17x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.291 V/m; Power Drift = 0.14 dBm
Peak SAR (extrapolated) = 0.275 W/kg
**SAR(1 g) = 0.121 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

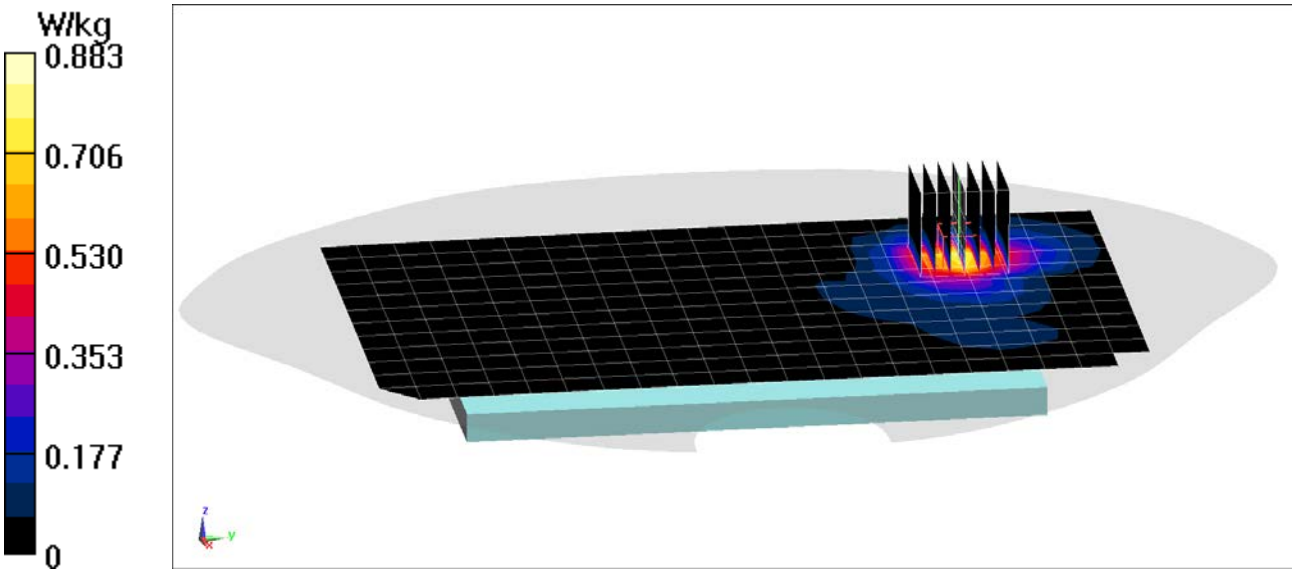
Communication System: UID 0, IEEE 802.11a; Frequency: 5785 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5785 MHz; $\sigma$ = 6.216 S/m; $\varepsilon_r$ = 46.321; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.37, 4.37, 4.37) @ 5785 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: IEEE 802.11a, UNII-3, 20 MHz Bandwidth, Body SAR, Ch 157, 6 Mbps, Back Side

**Area Scan (13x22x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 7.847 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 1.51 W/kg
**SAR(1 g) = 0.360 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

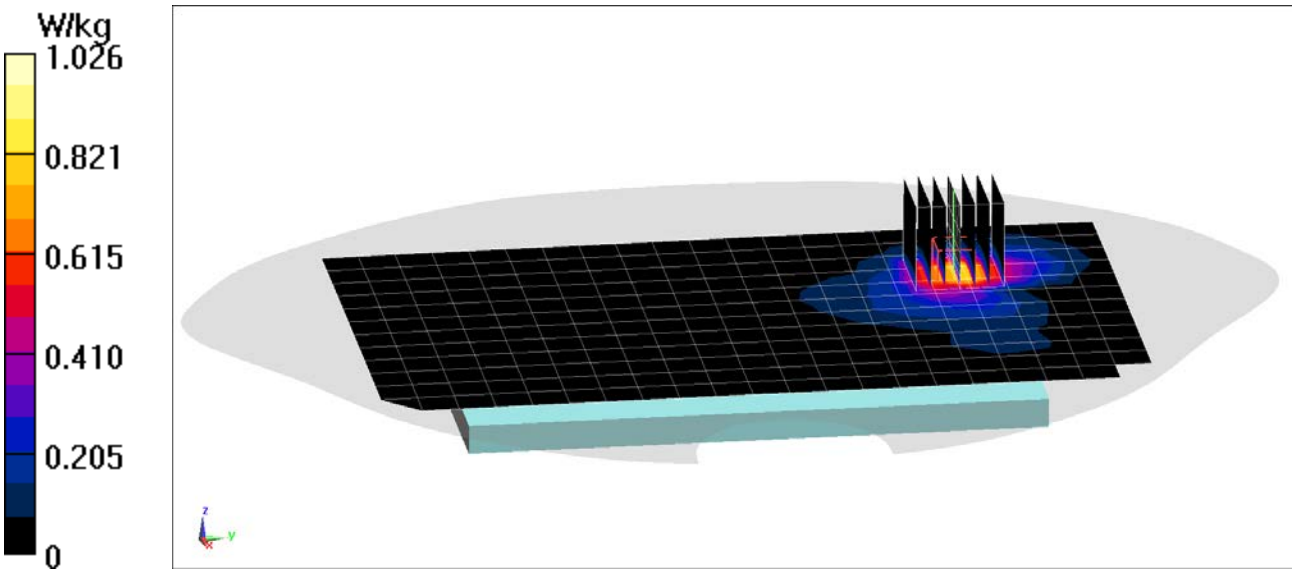
Communication System: UID 0, IEEE 802.11a; Frequency: 5785 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5785 MHz; $\sigma$ = 6.216 S/m; $\varepsilon_r$ = 46.321; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.37, 4.37, 4.37) @ 5785 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: IEEE 802.11a, UNII-3, 20 MHz Bandwidth, Body SAR, Ch 157, 6 Mbps, Back Side

**Area Scan (13x11x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 9.438 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 2.54 W/kg
**SAR(1 g) = 0.618 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

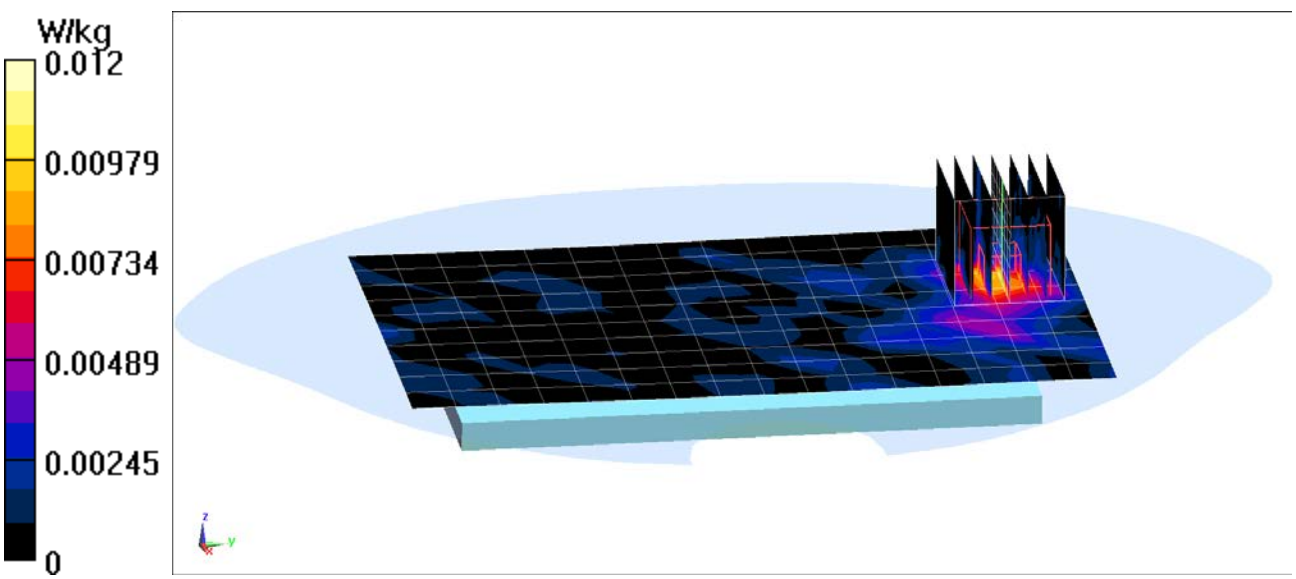
Communication System: UID 0, Bluetooth; Frequency: 2441 MHz; Duty Cycle: 1:1.302
Medium: 2400MHz Body Medium parameters used (interpolated):
f = 2441 MHz; $\sigma$ = 1.982 S/m; $\varepsilon_r$ = 51.448; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-20-2019; Ambient Temp: 20.4°C; Tissue Temp: 19.3°C

Probe: EX3DV4 - SN7427; ConvF(7.47, 7.47, 7.47) @ 2441 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: Bluetooth, Body SAR, Ch 39, 1 Mbps, Back Side

**Area Scan (11x17x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (8x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.029 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.0160 W/kg
**SAR(1 g) = 0.007 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 44526**

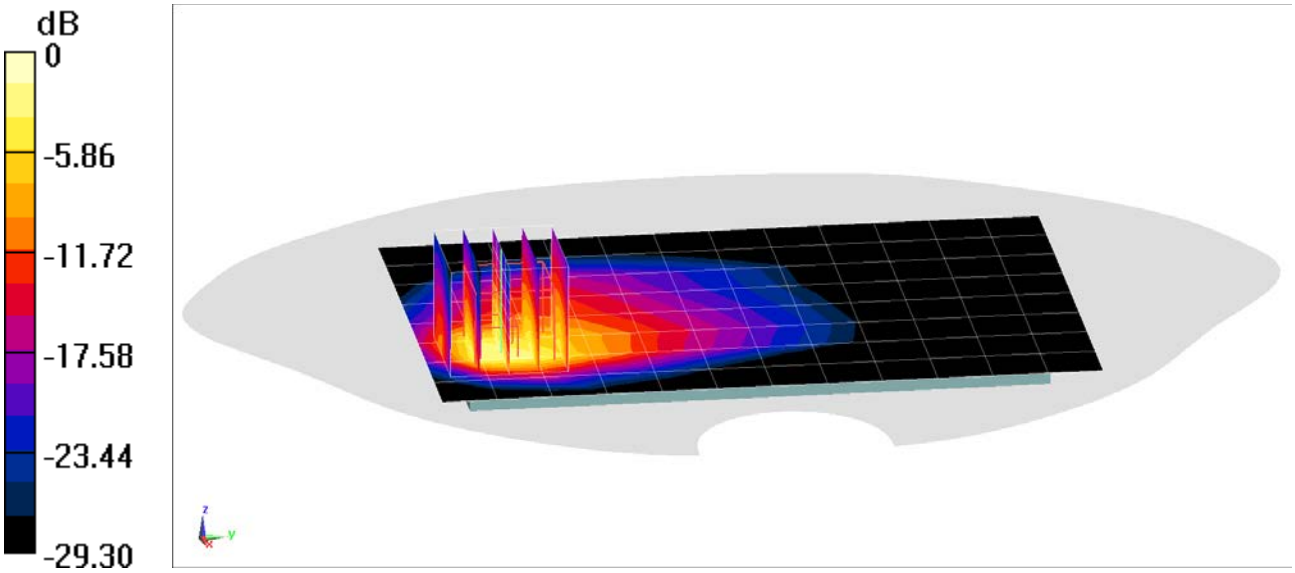
Communication System: UID 0, GSM GPRS; 4 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:2.076
Medium: 1900 Body Medium parameters used:
f = 1880 MHz; $\sigma$ = 1.565 S/m; $\varepsilon_r$ = 51.502; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 05-13-2019; Ambient Temp: 20.9°C; Tissue Temp: 20.3°C

Probe: EX3DV4 - SN7491; ConvF(8.19, 8.19, 8.19) @ 1880 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: GPRS 1900, Phablet SAR, Back side, Mid.ch, 4 Tx Slots

**Area Scan (9x13x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 43.08 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 9.40 W/kg
**SAR(10 g) = 1.2 W/kg**




0 dB = 6.21 W/kg = 7.93 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 36480**

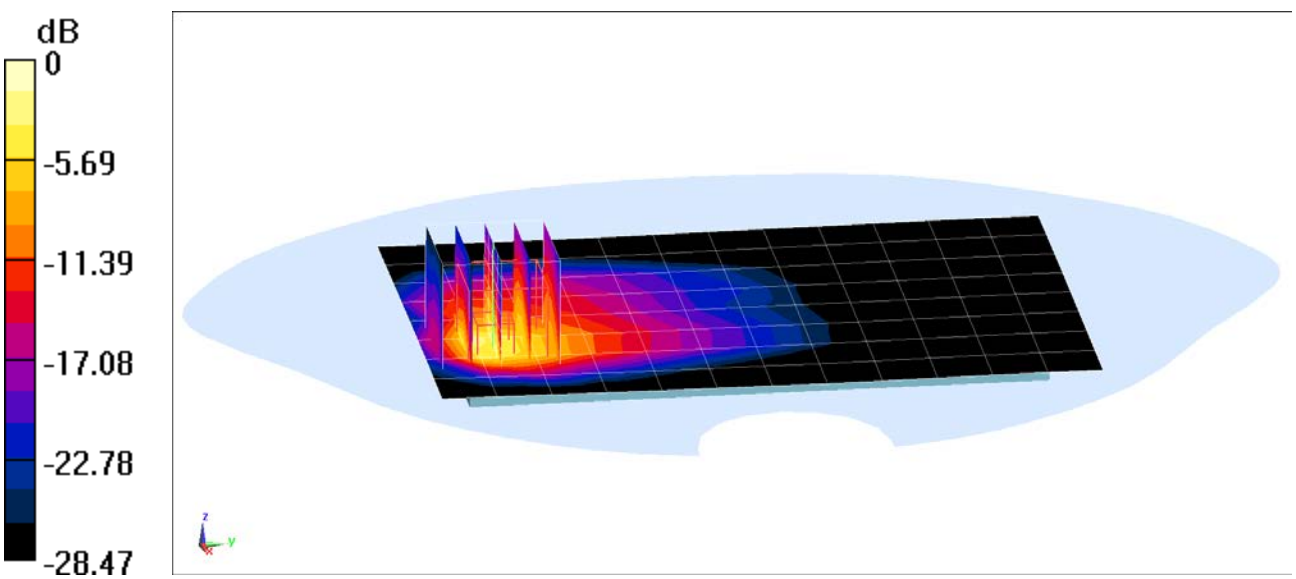
Communication System: UID 0, UMTS; Frequency: 1732.4 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used (interpolated):
f = 1732.4 MHz; $\sigma$ = 1.476 S/m; $\varepsilon_r$ = 52.096; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 05-06-2019; Ambient Temp: 22.5°C; Tissue Temp: 21.1°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1732.4 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: UMTS 1750, Phablet SAR, Back side, Mid.ch

**Area Scan (9x13x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 74.65 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 19.7 W/kg
**SAR(10 g) = 2.45 W/kg**




0 dB = 13.5 W/kg = 11.30 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35854**

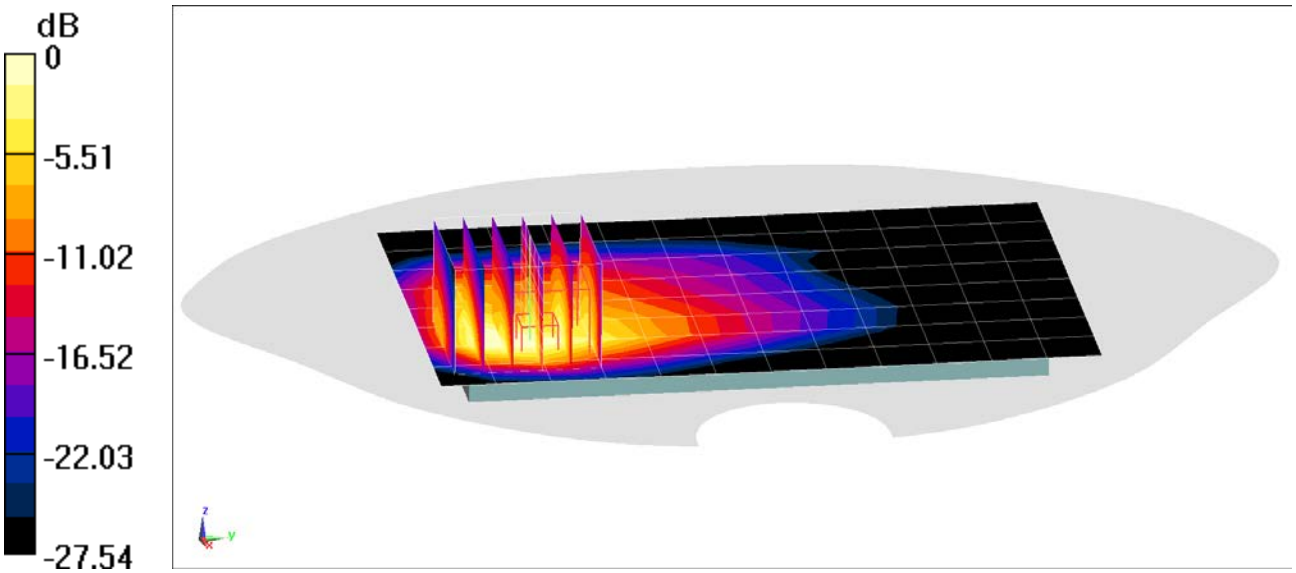
Communication System: UID 0, UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used:
f = 1880 MHz; $\sigma$ = 1.559 S/m; $\varepsilon_r$ = 51.04; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-29-2019; Ambient Temp: 22.9°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79) @ 1880 MHz; Calibrated: 11/19/2018
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1408; Calibrated: 8/14/2018
Phantom: Twin-SAM V8.0; Type: QD 000 P41 Ax; Serial: 1936
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: UMTS 1900, Phablet SAR, Back side, Mid.ch

**Area Scan (9x13x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (6x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 30.22 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 4.99 W/kg
**SAR(10 g) = 1.01 W/kg**




0 dB = 2.83 W/kg = 4.52 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35854**

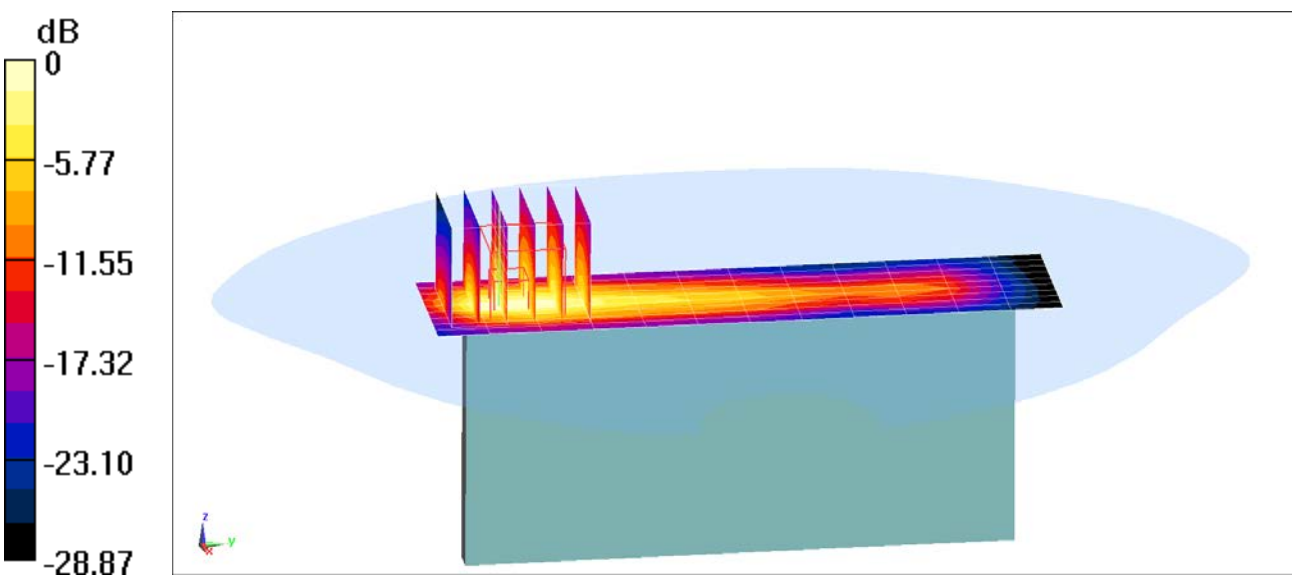
Communication System: UID 0, CDMA; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used:
f = 1880 MHz; $\sigma$ = 1.577 S/m; $\varepsilon_r$ = 50.835; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 05-07-2019; Ambient Temp: 23.5°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3837; ConvF(7.54, 7.54, 7.54) @ 1880 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: PCS EVDO, Phablet SAR, Left Edge, Mid.ch

**Area Scan (10x13x1):** Measurement grid: dx=5mm, dy=15mm
**Zoom Scan (5x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 38.95 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 5.88 W/kg
**SAR(10 g) = 0.978 W/kg**




0 dB = 4.17 W/kg = 6.20 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 44526**

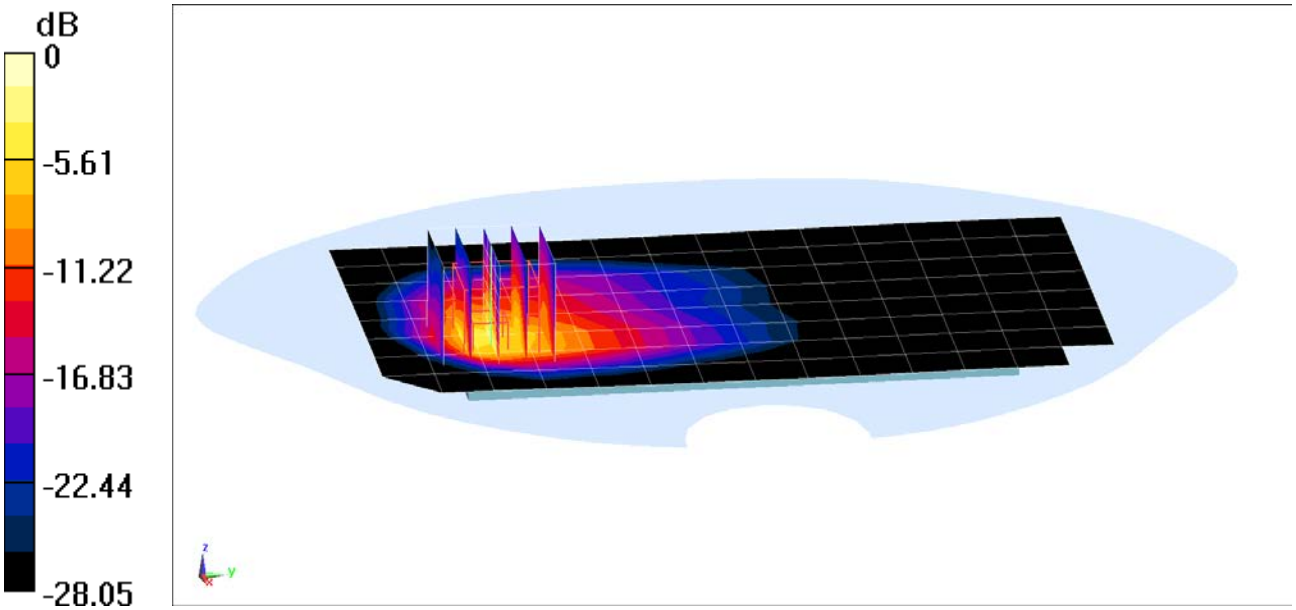
Communication System: UID 0, LTE Band 66 (AWS); Frequency: 1770 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used (interpolated):
f = 1770 MHz; $\sigma$ = 1.5 S/m; $\varepsilon_r$ = 52.175; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 05-13-2019; Ambient Temp: 22.5°C; Tissue Temp: 19.9°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1770 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: LTE Band 66 (AWS), Phablet SAR, Back side, High.ch, 20 MHz Bandwidth, QPSK, 1 RB, 99 RB Offset

**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 74.07 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 18.8 W/kg
**SAR(10 g) = 2.36 W/kg**




0 dB = 13.6 W/kg = 11.34 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35656**

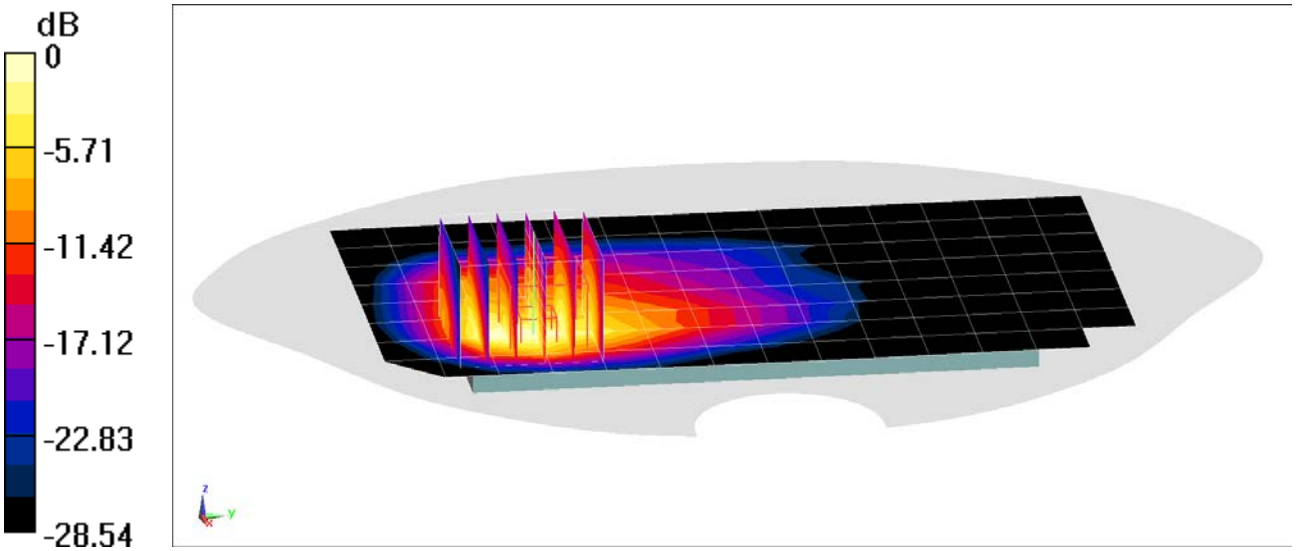
Communication System: UID 0, LTE Band 25 (PCS); Frequency: 1860 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1860 MHz; $\sigma$ = 1.551 S/m; $\varepsilon_r$ = 50.922; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-30-2019; Ambient Temp: 23.6°C; Tissue Temp: 23.4°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79) @ 1860 MHz; Calibrated: 11/19/2018
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1408; Calibrated: 8/14/2018
Phantom: Twin-SAM V8.0; Type: QD 000 P41 Ax; Serial: 1936
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: LTE Band 25 (PCS), Phablet SAR, Back side, Low.ch, 20 MHz Bandwidth, QPSK, 50 RB, 50 RB Offset

**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (6x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 40.08 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 6.93 W/kg
**SAR(10 g) = 1.41 W/kg**




0 dB = 4.23 W/kg = 6.26 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 44526**

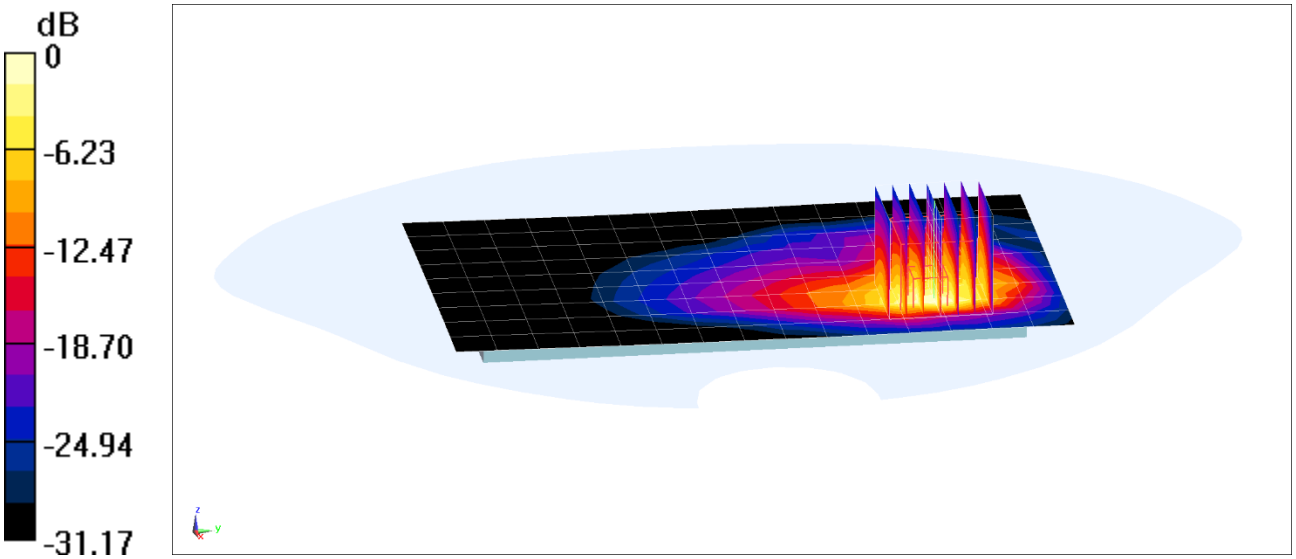
Communication System: UID 0, LTE Band 41; Frequency: 2593 MHz; Duty Cycle: 1:2.31
Medium: 2400-2600 MHz Body Medium parameters used (interpolated):
f = 2593 MHz; $\sigma$ = 2.158 S/m; $\varepsilon_r$ = 50.867; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 06-17-2019; Ambient Temp: 20.2°C; Tissue Temp: 20.2°C

Probe: EX3DV4 - SN7427; ConvF(7.35, 7.35, 7.35) @ 2593 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

**Mode: LTE Band 41 PC2, Body SAR, Back side, Mid.ch,**
**20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset**

**Area Scan (10x16x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x8x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.65 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 27.4 W/kg
**SAR(10 g) = 2.61 W/kg**




0 dB = 13.8 W/kg = 11.40 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMA205U; Type: Portable Handset; Serial: 35912**

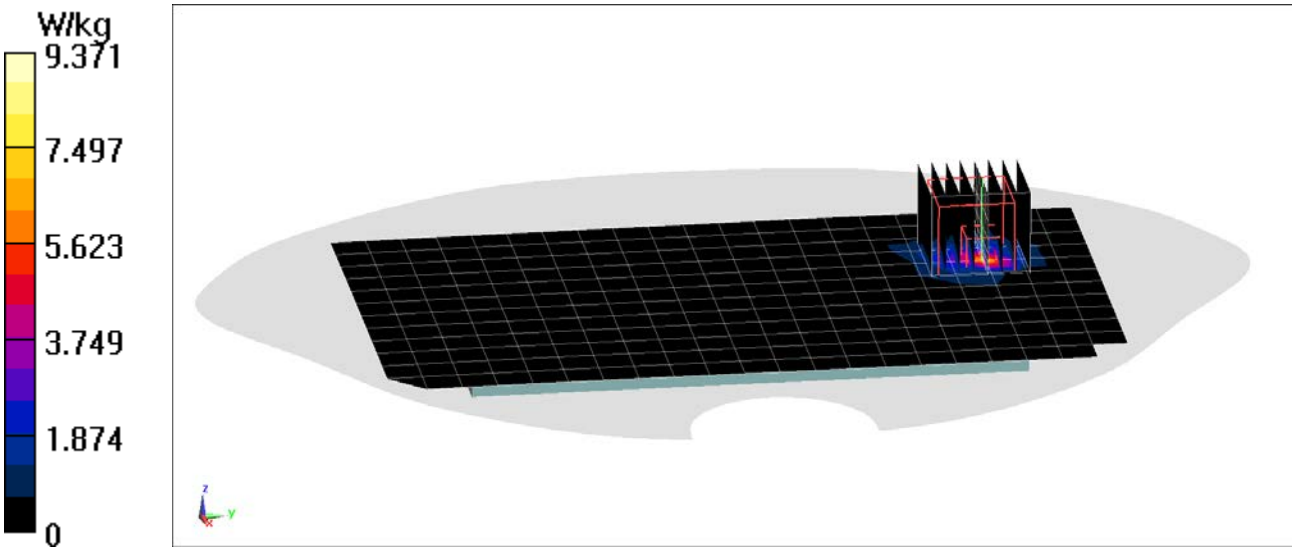
Communication System: UID 0, 802.11a 5.2-5.8 GHz Band; Frequency: 5320 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5320 MHz; $\sigma$ = 5.541 S/m; $\varepsilon_r$ = 47.239; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.82, 4.82, 4.82) @ 5320 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## Mode: IEEE 802.11a, UNII-2A, 20 MHz Bandwidth, Phablet SAR, Ch 64, 6 Mbps, Back Side

**Area Scan (13x22x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 23.70 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 20.3 W/kg
**SAR(10 g) = 0.810 W/kg**



# APPENDIX B: SYSTEM VERIFICATION

© 2019 PCTEST Engineering Laboratory, Inc.

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 750 MHz; Type: D750V3; Serial: 1097**

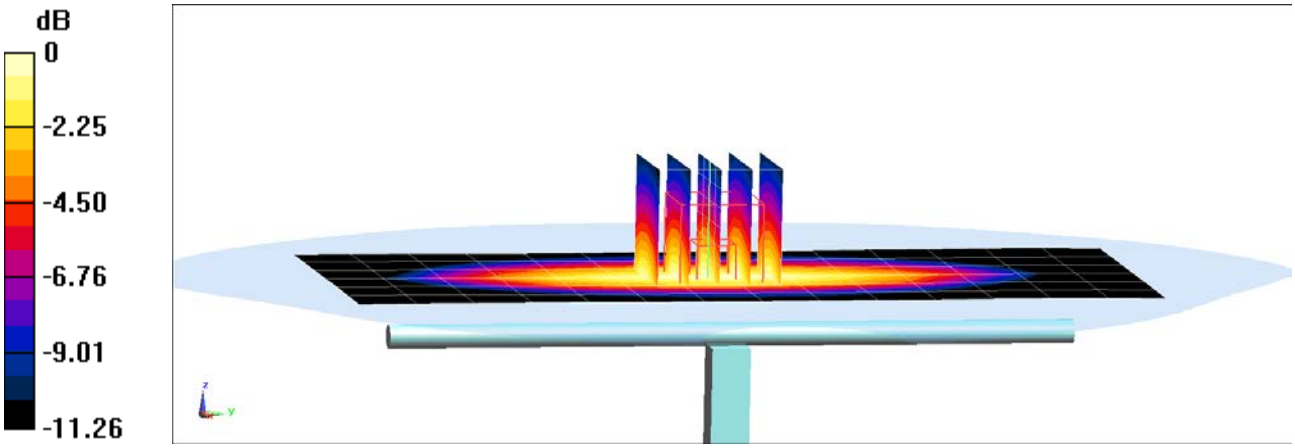
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Head Medium parameters used (interpolated):
f = 750 MHz; $\sigma$ = 0.919 S/m; $\varepsilon_r$ = 41.405; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-02-2019; Ambient Temp: 21.8°C; Tissue Temp: 21.6°C

Probe: EX3DV4 - SN3837; ConvF(9.71, 9.71, 9.71) @ 750 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 750 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 2.65 W/kg
**SAR(1 g) = 1.69 W/kg**
Deviation(1 g) = 2.80%




0 dB = 2.28 W/kg = 3.58 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 750 MHz; Type: D750V3; Serial: 1034**

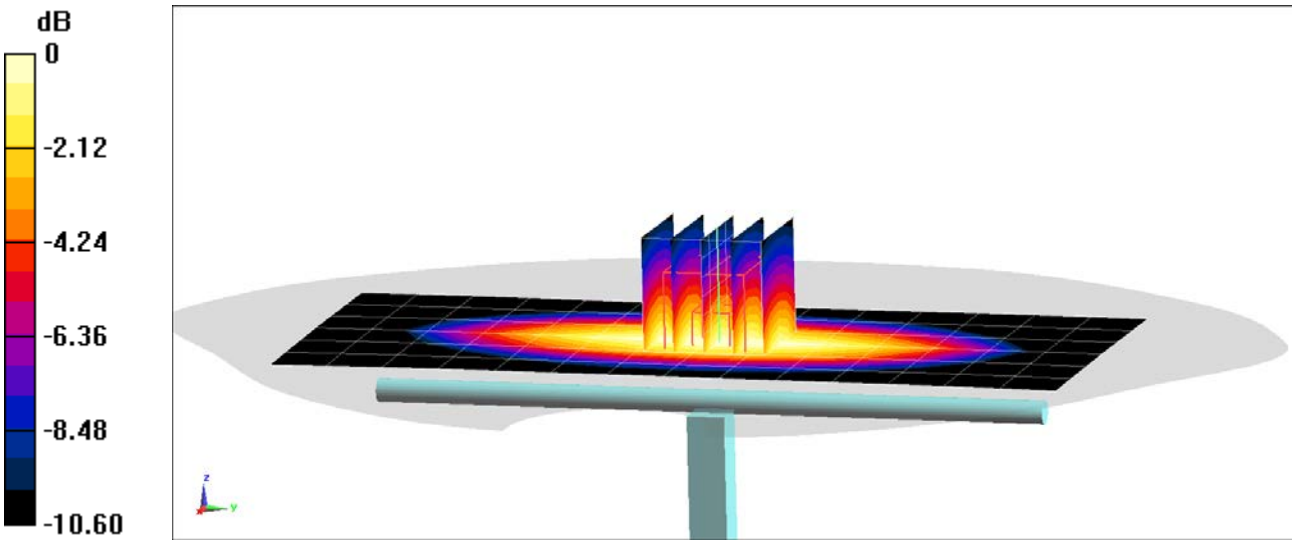
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Head Medium parameters used (interpolated):
f = 750 MHz; $\sigma$ = 0.918 S/m; $\varepsilon_r$ = 41.521; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-07-2019; Ambient Temp: 24.7°C; Tissue Temp: 21.8°C

Probe: EX3DV4 - SN7427; ConvF(10.11, 10.11, 10.11) @ 750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 750 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 2.59 W/kg
**SAR(1 g) = 1.68 W/kg**
Deviation(1 g) = 0.96%




0 dB = 2.27 W/kg = 3.56 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d040**

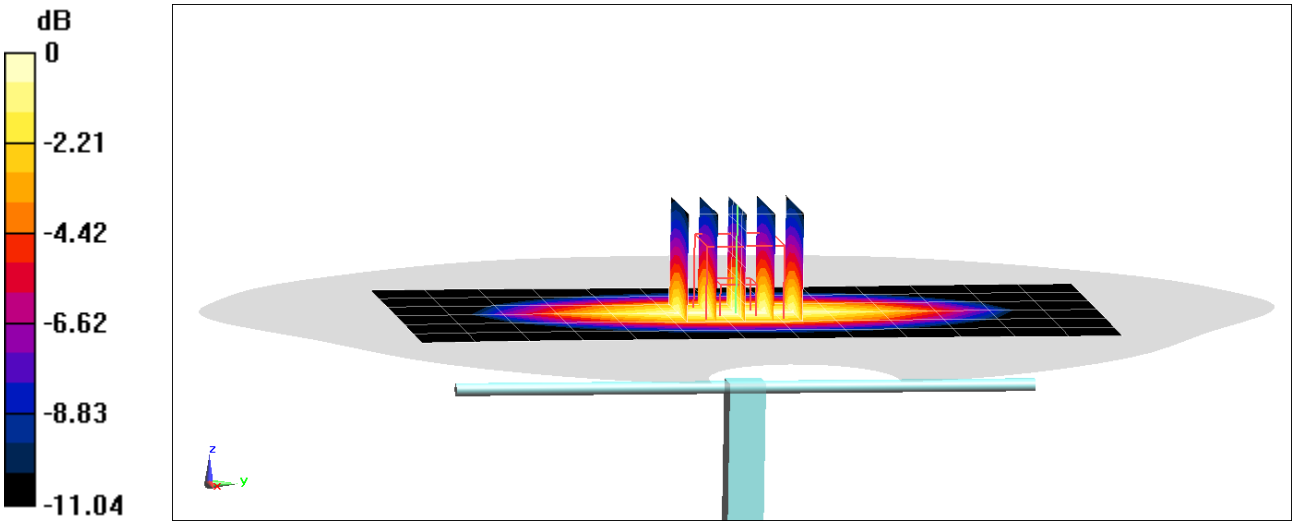
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Head Medium parameters used:
f = 835 MHz; $\sigma$ = 0.918 S/m; $\varepsilon_r$ = 41.131; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-14-2019; Ambient Temp: 21.9°C; Tissue Temp: 20.0°C

Probe: EX3DV4 - SN7427; ConvF(9.92, 9.92, 9.92) @ 835 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 835 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 2.81 W/kg
**SAR(1 g) = 1.83 W/kg**
Deviation(1 g) = -3.28%




0 dB = 2.48 W/kg = 3.94 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 850 MHz; Type: D850V2; Serial: 1009**

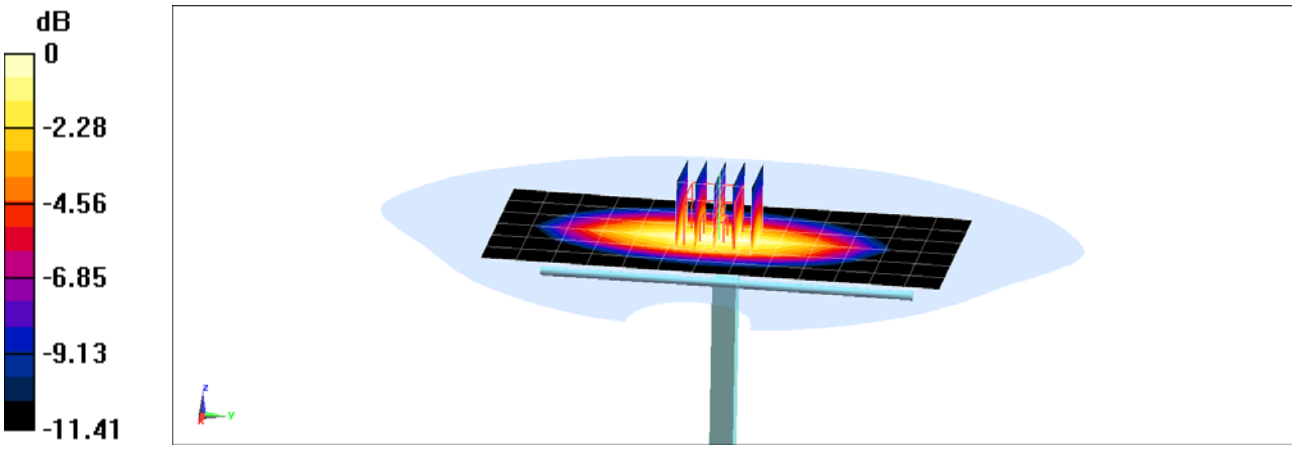
Communication System: UID 0, CW; Frequency: 850 MHz; Duty Cycle: 1:1
Medium: 835 Head Medium parameters used:
f = 850 MHz; $\sigma$ = 0.942 S/m; $\varepsilon_r$ = 41.595; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-06-2019; Ambient Temp: 22.3°C; Tissue Temp: 22.0°C

Probe: EX3DV4 - SN3837; ConvF(9.37, 9.37, 9.37) @ 850 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 850 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 3.27 W/kg
**SAR(1 g) = 2.09 W/kg**
Deviation(1 g) = 4.50%




0 dB = 2.81 W/kg = 4.49 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1092**

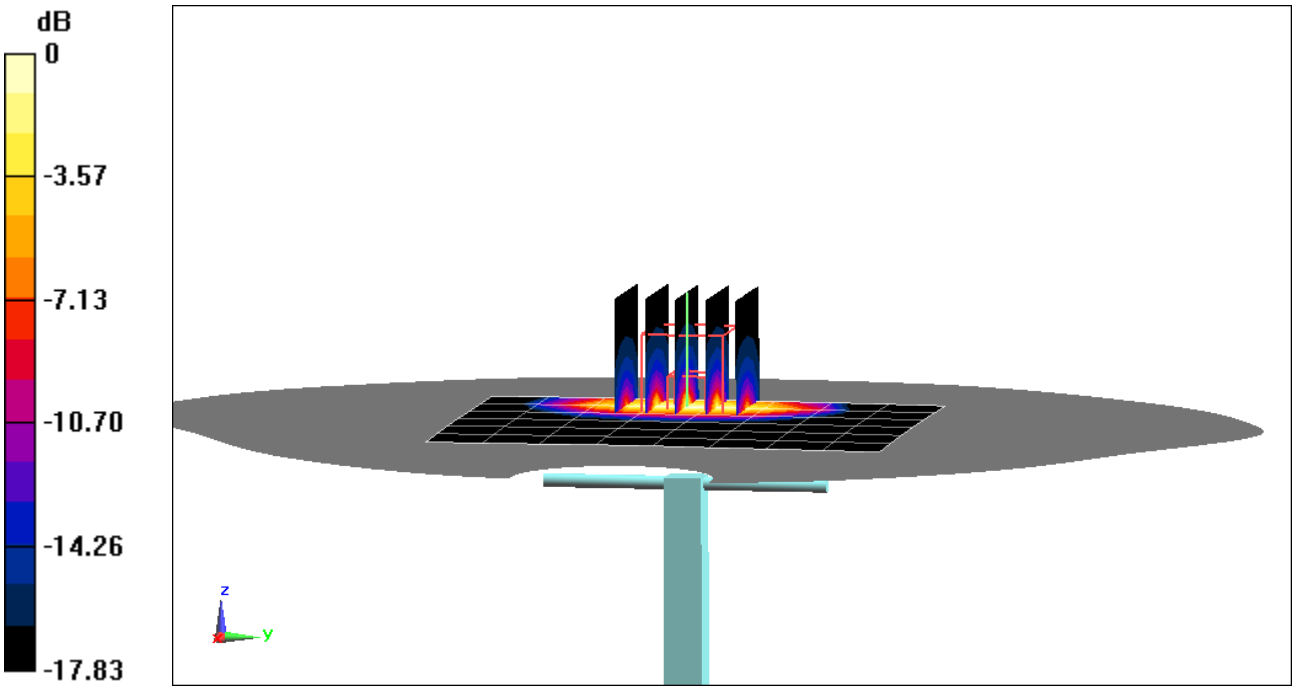
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Head Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.4 S/m; $\varepsilon_r$ = 38.641; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-29-2019; Ambient Temp: 22.1°C; Tissue Temp: 20.5°C

Probe: EX3DV4 - SN7416; ConvF(8.37, 8.37, 8.37) @ 1750 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1402; Calibrated: 7/10/2018
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CA; Serial: 1275
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.93 W/kg
**SAR(1 g) = 3.67 W/kg**
Deviation(1 g) = 1.66%




0 dB = 5.77 W/kg = 7.61 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1083**

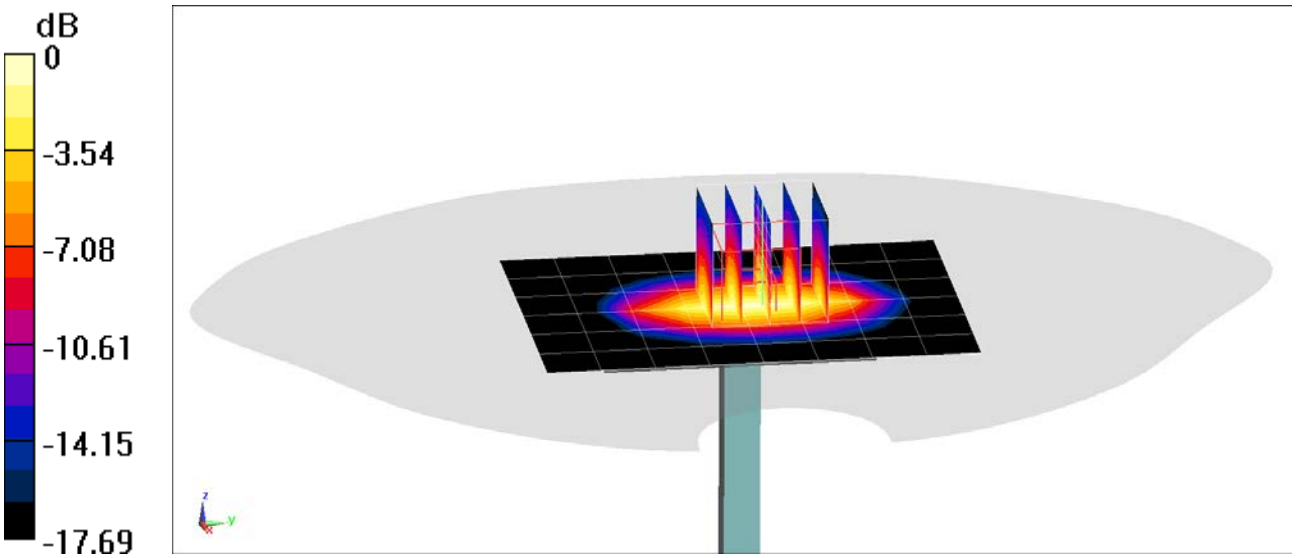
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Head Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.361 S/m; $\varepsilon_r$ = 39.931; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-13-2019; Ambient Temp: 23.5°C; Tissue Temp: 20.3°C

Probe: EX3DV4 - SN7427; ConvF(8.58, 8.58, 8.58) @ 1750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.39 W/kg
**SAR(1 g) = 3.44 W/kg**
Deviation(1 g) = -6.27%




0 dB = 5.35 W/kg = 7.28 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d026**

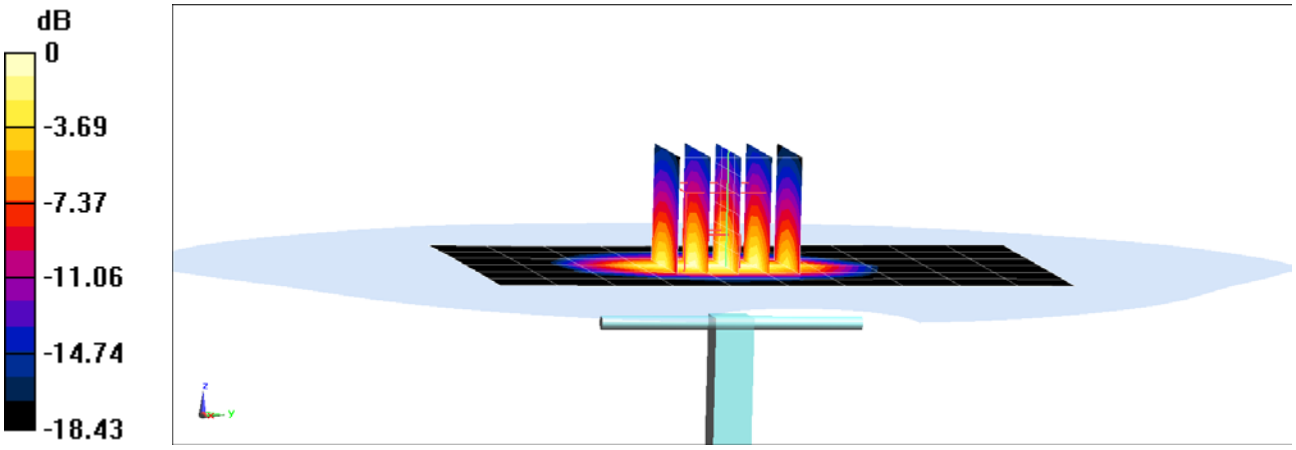
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Head Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.449 S/m; $\varepsilon_r$ = 38.777; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-29-2019; Ambient Temp: 21.9°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN3837; ConvF(7.85, 7.85, 7.85) @ 1900 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.50 W/kg
**SAR(1 g) = 3.87 W/kg**
Deviation(1 g) = -3.73%




0 dB = 5.84 W/kg = 7.66 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d026**

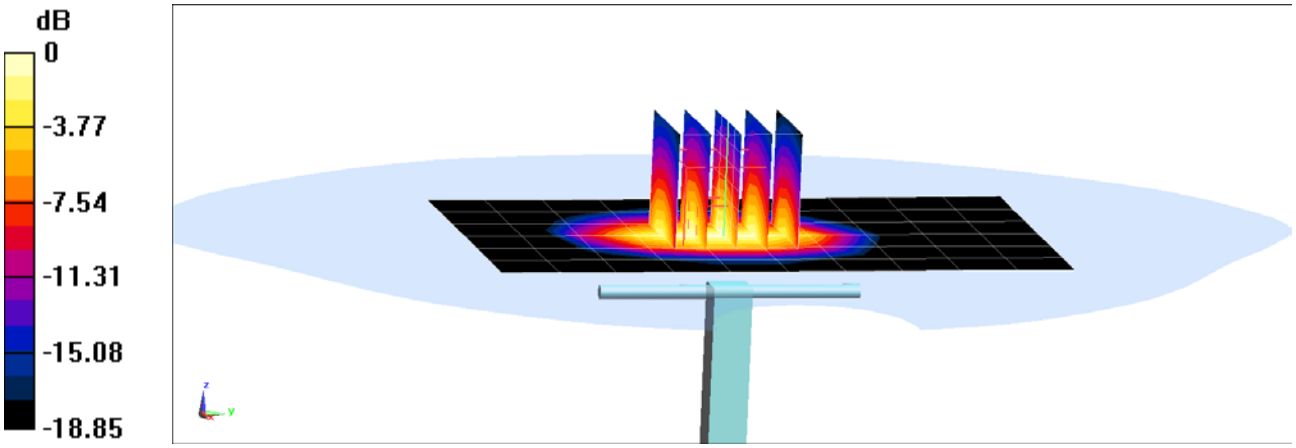
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Head Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.448 S/m; $\varepsilon_r$ = 39.446; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-01-2019; Ambient Temp: 21.5°C; Tissue Temp: 21.0°C

Probe: EX3DV4 - SN3837; ConvF(7.85, 7.85, 7.85) @ 1900 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.46 W/kg
**SAR(1 g) = 3.86 W/kg**
Deviation(1 g) = -3.98%




0 dB = 5.90 W/kg = 7.71 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d180**

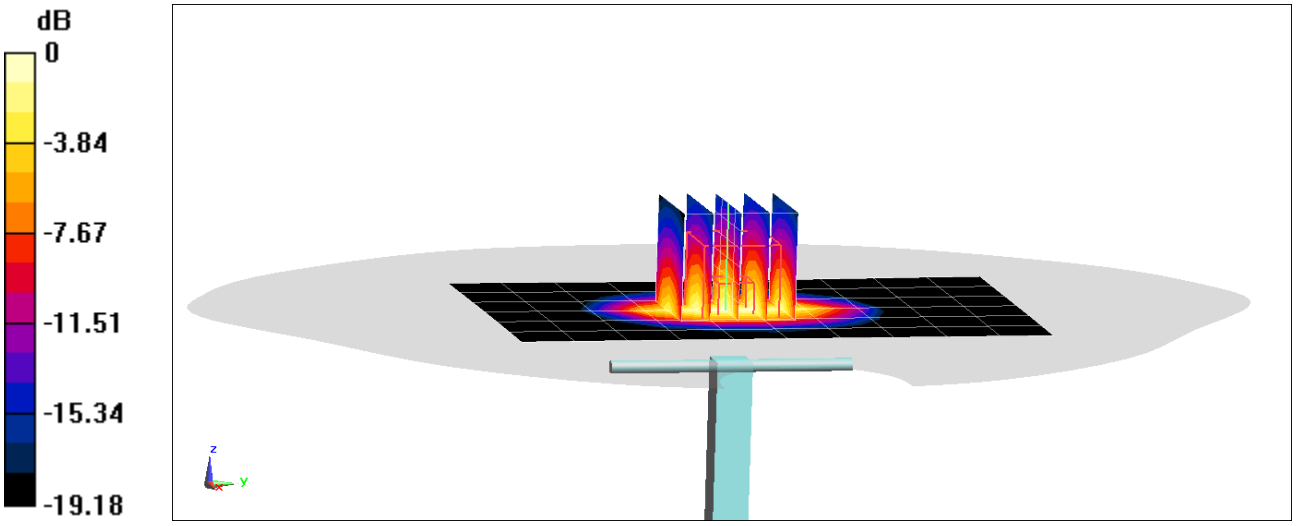
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Head Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.446 S/m; $\varepsilon_r$ = 39.006; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-14-2019; Ambient Temp: 21.7°C; Tissue Temp: 20.0°C

Probe: EX3DV4 - SN7427; ConvF(8.18, 8.18, 8.18) @ 1900 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.90 W/kg
**SAR(1 g) = 4 W/kg**
Deviation(1 g) = 2.04%




0 dB = 6.43 W/kg = 8.08 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 921**

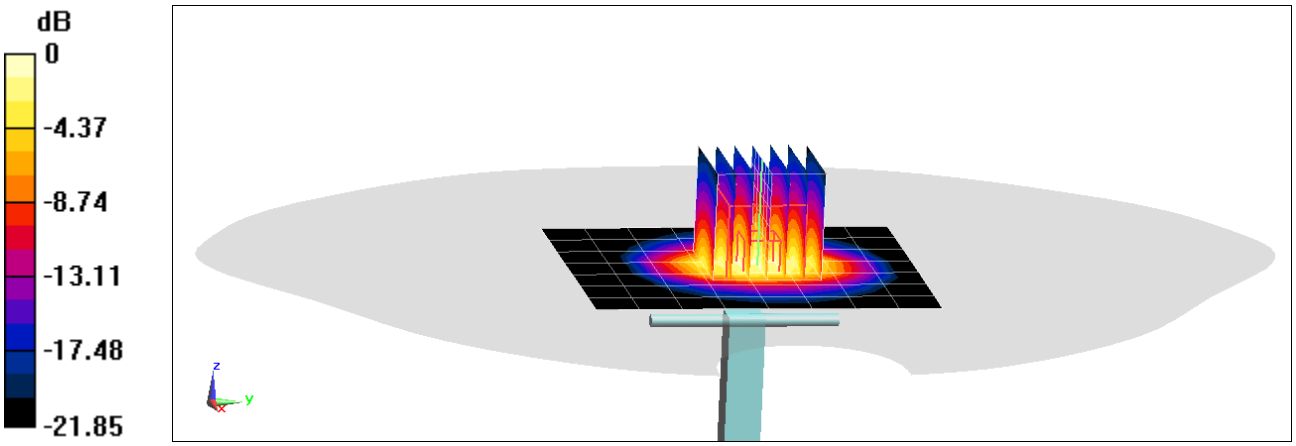
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Head Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.802 S/m; $\varepsilon_r$ = 38.894; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-01-2019; Ambient Temp: 20.9°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN7420; ConvF(7.19, 7.19, 7.19) @ 2450 MHz; Calibrated: 9/18/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1449; Calibrated: 11/12/2018
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CC; Serial: 1596
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.7 W/kg
**SAR(1 g) = 5.63 W/kg**
Deviation(1 g) = 6.03%




0 dB = 9.40 W/kg = 9.73 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 750**

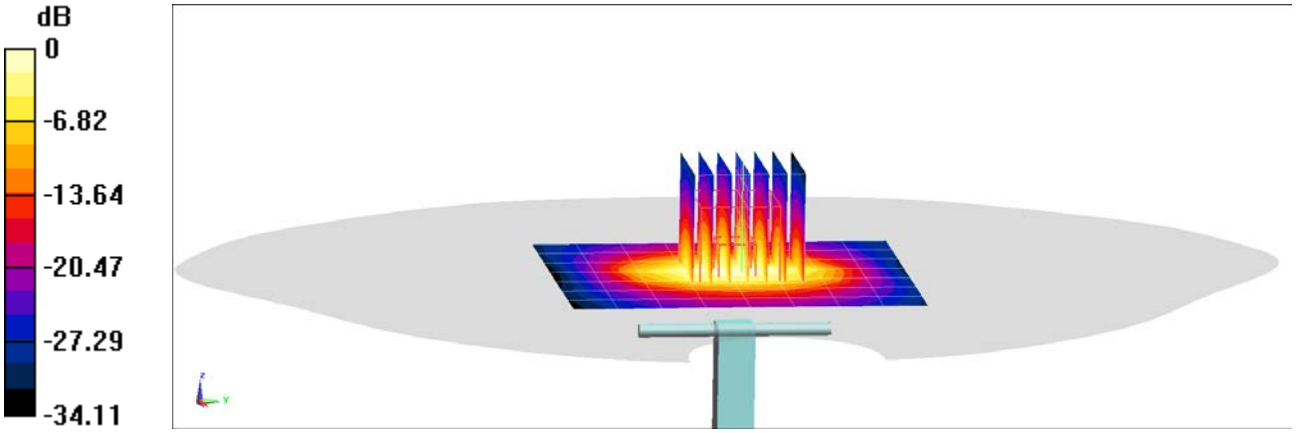
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Head Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.789 S/m; $\varepsilon_r$ = 38.273; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-07-2019; Ambient Temp: 21.1°C; Tissue Temp: 21.5°C

Probe: EX3DV4 - SN7416; ConvF(7.25, 7.25, 7.25) @ 2450 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1402; Calibrated: 7/10/2018
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CA; Serial: 1275
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.4 W/kg
**SAR(1 g) = 5.36 W/kg**
Deviation(1 g) = 0.56%




0 dB = 8.57 W/kg = 9.33 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 921**

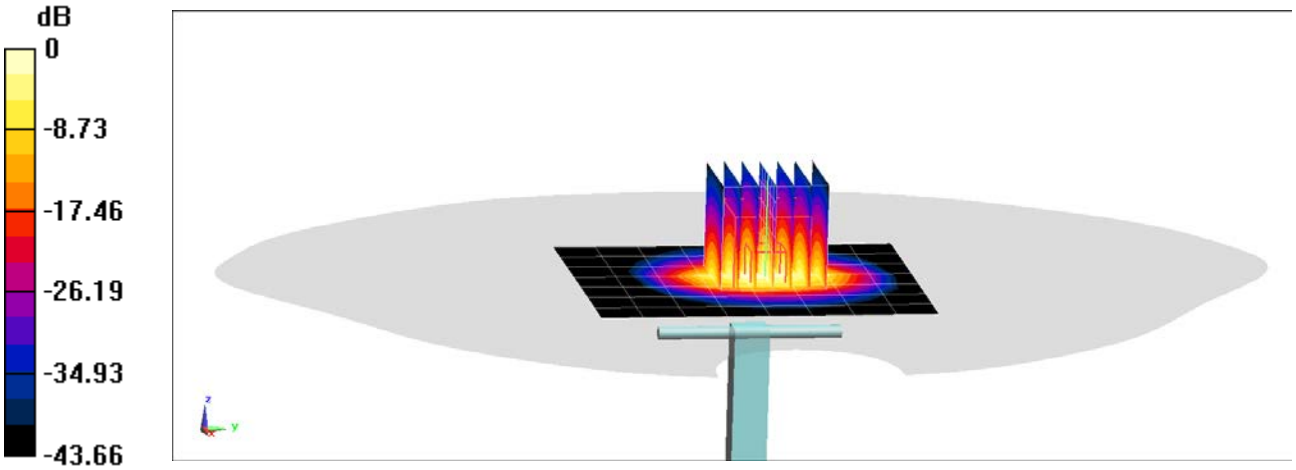
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz Head Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.827 S/m; $\varepsilon_r$ = 38.229; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-14-2019; Ambient Temp: 22.7°C; Tissue Temp: 20.0°C

Probe: EX3DV4 - SN7427; ConvF(7.42, 7.42, 7.42) @ 2450 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 12.0 W/kg
**SAR(1 g) = 5.58 W/kg**
Deviation(1 g) = 5.08%




0 dB = 8.16 W/kg = 9.12 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 797**

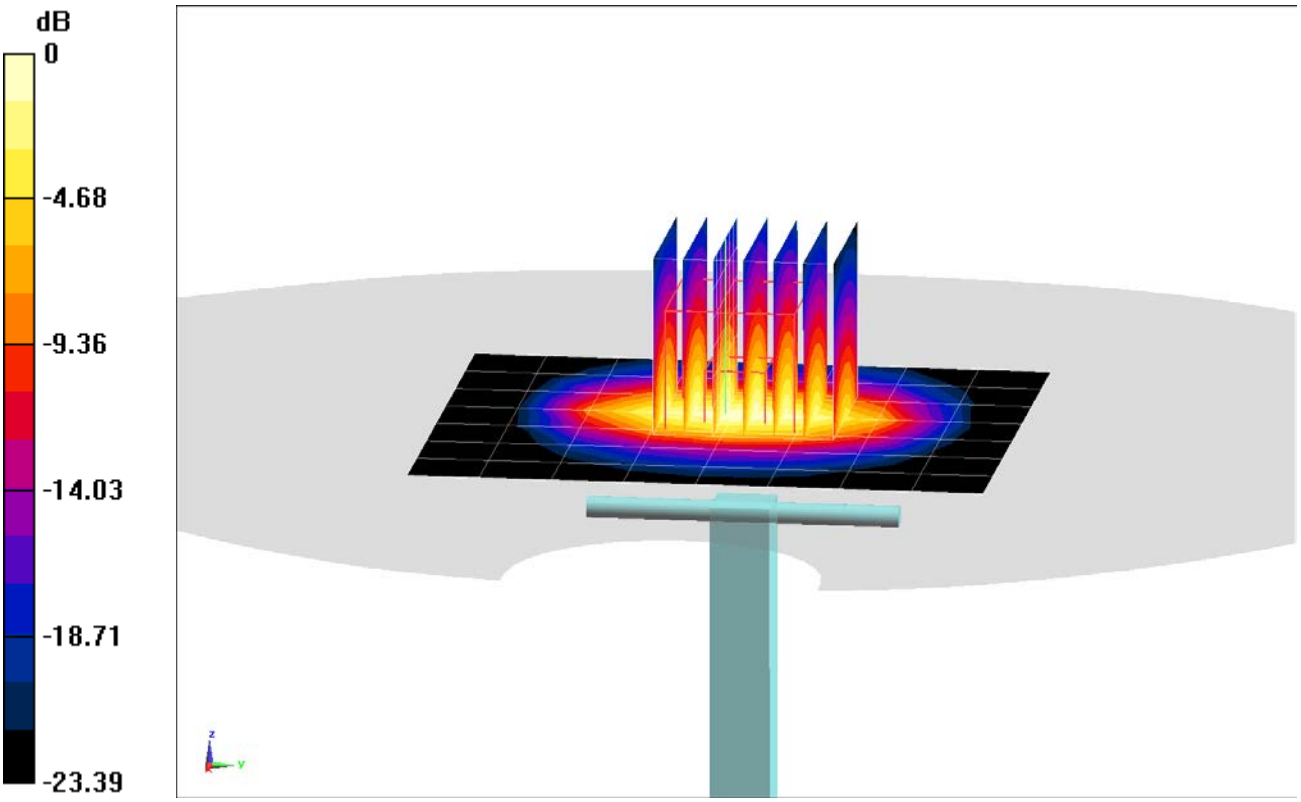
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Head Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.82 S/m; $\varepsilon_r$ = 37.882; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-24-2019; Ambient Temp: 23.2°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(6.46, 6.46, 6.46) @ 2450 MHz; Calibrated: 1/25/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1450; Calibrated: 8/22/2018
Phantom: Twin-SAM V5.0 (30); Type: QD 000 P40 CD; Serial: 1647
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 10.9 W/kg
**SAR(1 g) = 5.05 W/kg**
Deviation(1 g) = -4.17%




0 dB = 8.57 W/kg = 9.33 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1069**

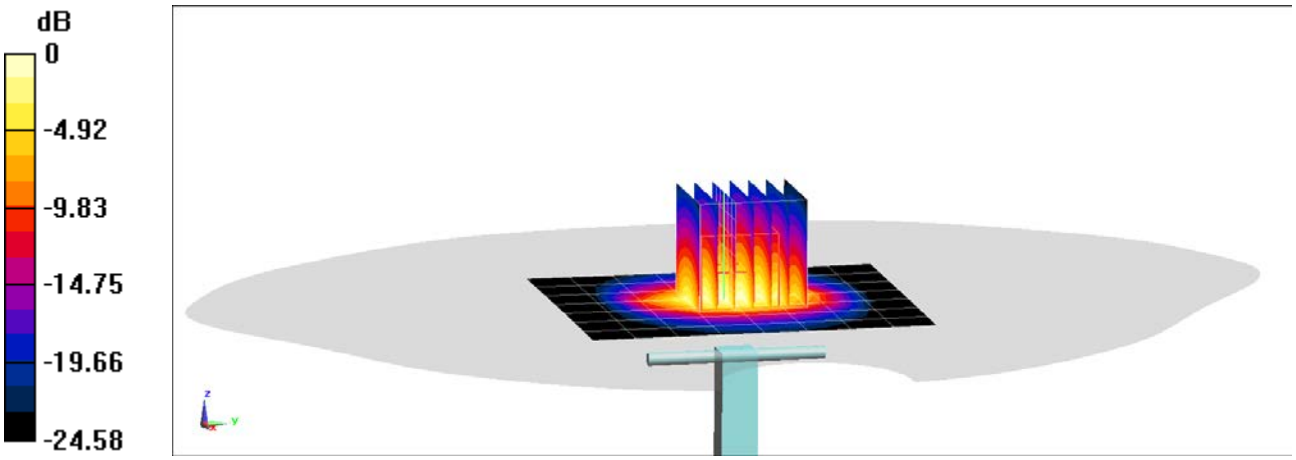
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600MHz Head Medium parameters used:
f = 2600 MHz; $\sigma$ = 1.95 S/m; $\varepsilon_r$ = 37.987; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-14-2019; Ambient Temp: 22.7°C; Tissue Temp: 20.0°C

Probe: EX3DV4 - SN7427; ConvF(7.14, 7.14, 7.14) @ 2600 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2600 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 12.4 W/kg
**SAR(1 g) = 5.79 W/kg**
Deviation(1 g) = 1.76%




0 dB = 9.79 W/kg = 9.91 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1126**

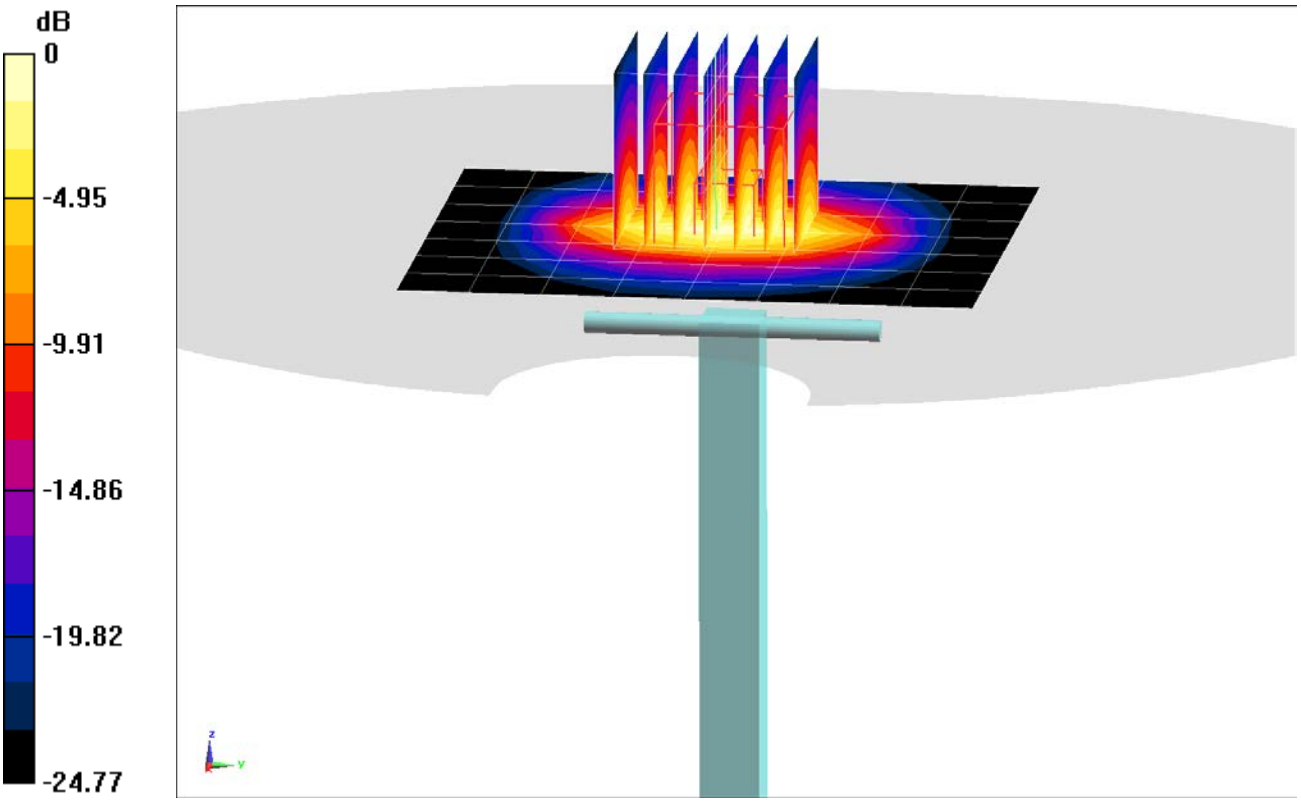
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Head Medium parameters used:
f = 2600 MHz; $\sigma$ = 1.936 S/m; $\varepsilon_r$ = 37.628; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-24-2019; Ambient Temp: 23.2°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(6.25, 6.25, 6.25) @ 2600 MHz; Calibrated: 1/25/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1450; Calibrated: 8/22/2018
Phantom: Twin-SAM V5.0 (30); Type: QD 000 P40 CD; Serial: 1647
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2600 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 12.1 W/kg
**SAR(1 g) = 5.43 W/kg**
Deviation(1 g) = -0.37%




0 dB = 9.32 W/kg = 9.69 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1009**

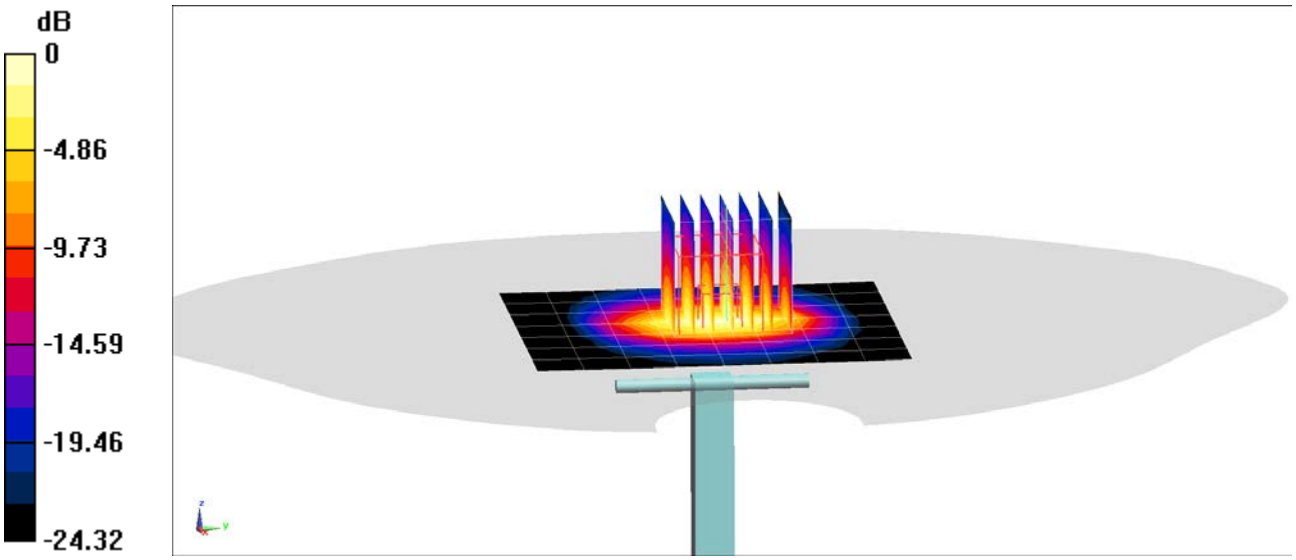
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz Head Medium parameters used:
f = 2600 MHz; $\sigma$ = 1.9 S/m; $\varepsilon_r$ = 37.249; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-28-2019; Ambient Temp: 23.1°C; Tissue Temp: 19.9°C

Probe: EX3DV4 - SN7532; ConvF(7.33, 7.33, 7.33) @ 2600 MHz; Calibrated: 4/12/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn501; Calibrated: 4/17/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CC; Serial: 1179
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2600 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.7 W/kg
**SAR(1 g) = 5.52 W/kg**
Deviation(1 g) = -1.08%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: 1123**

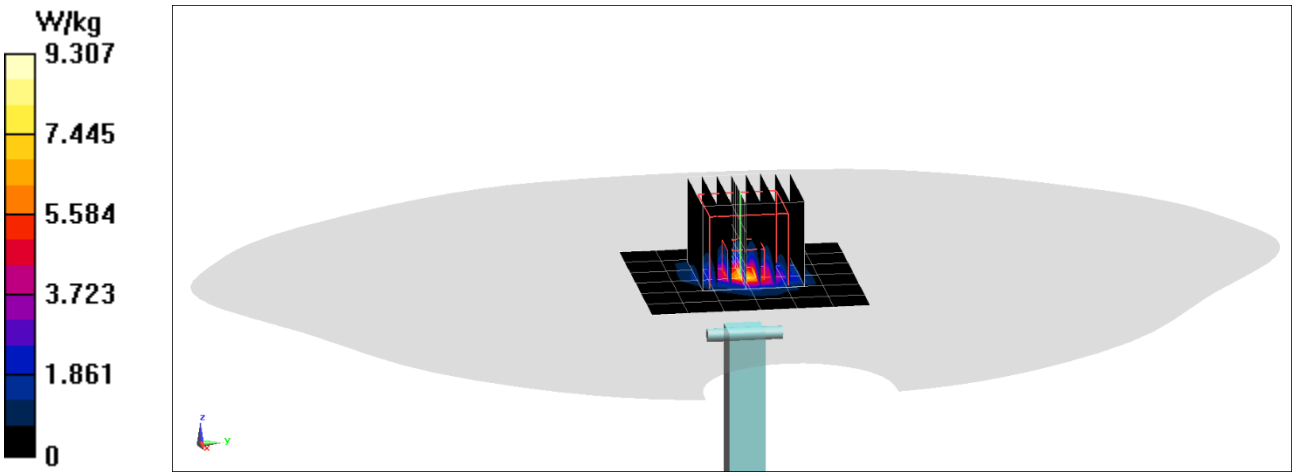
Communication System: UID 0, CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium: 5GHz Head Medium parameters used (interpolated):
f = 5250 MHz; $\sigma$ = 4.558 S/m; $\varepsilon_r$ = 35.059; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-02-2019; Ambient Temp: 21.7°C; Tissue Temp: 21.4°C

Probe: EX3DV4 - SN7491; ConvF(5.62, 5.62, 5.62) @ 5250 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5250 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 15.7 W/kg
**SAR(1 g) = 3.82 W/kg**
Deviation(1 g) = -6.37%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: 1123**

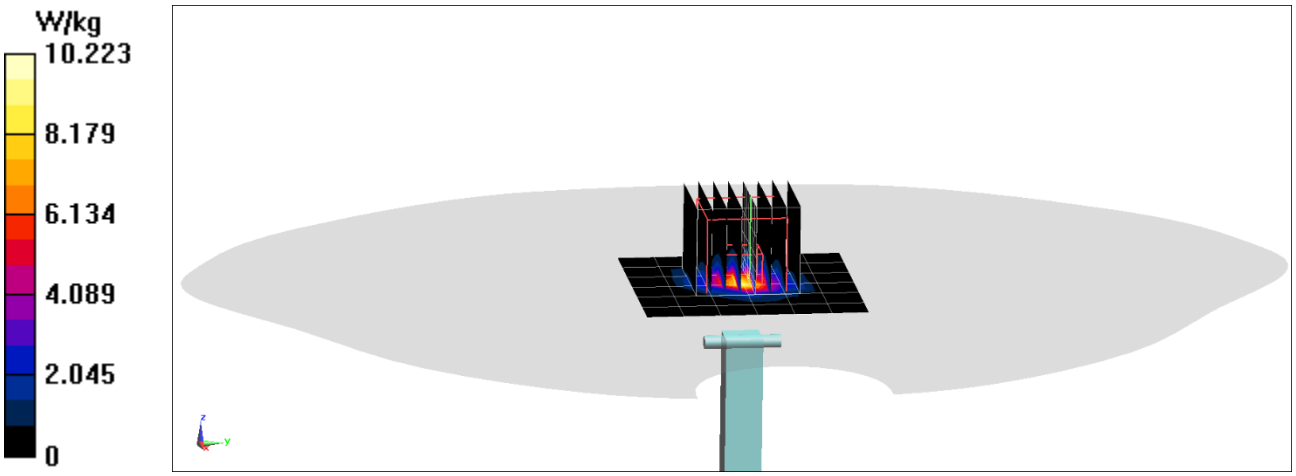
Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium: 5GHz Head Medium parameters used:
f = 5600 MHz; $\sigma$ = 4.946 S/m; $\varepsilon_r$ = 34.446; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-02-2019; Ambient Temp: 21.7°C; Tissue Temp: 21.4°C

Probe: EX3DV4 - SN7491; ConvF(5.05, 5.05, 5.05) @ 5600 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5600 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 18.5 W/kg
**SAR(1 g) = 4.2 W/kg**
Deviation(1 g) = -1.29%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: 1123**

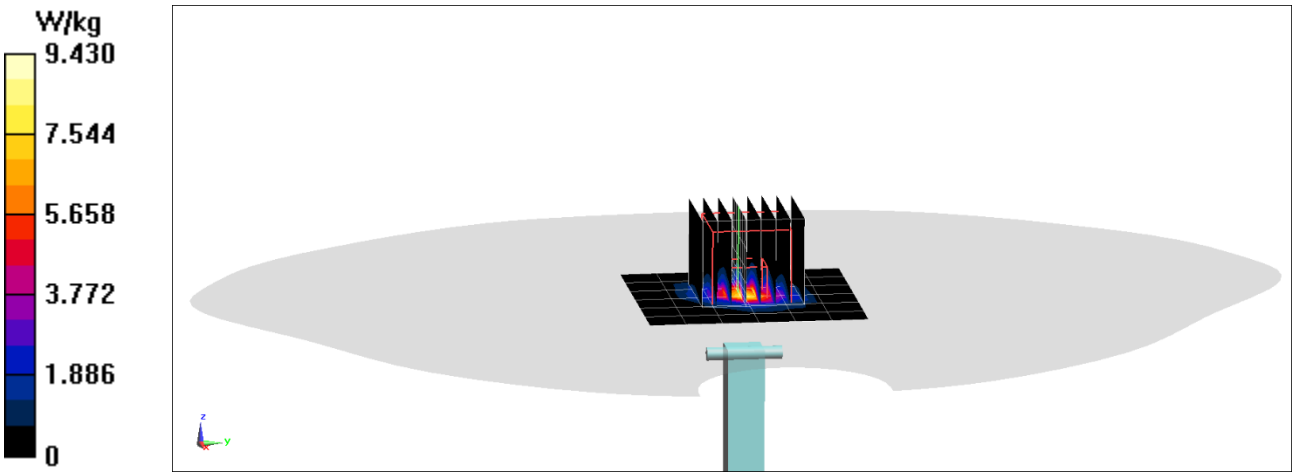
Communication System: UID 0, CW; Frequency: 5750 MHz; Duty Cycle: 1:1
Medium: 5GHz Head Medium parameters used (interpolated):
f = 5750 MHz; $\sigma$ = 5.119 S/m; $\varepsilon_r$ = 34.187; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-02-2019; Ambient Temp: 21.7°C; Tissue Temp: 21.4°C

Probe: EX3DV4 - SN7491; ConvF(5.27, 5.27, 5.27) @ 5750 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5750 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 17.5 W/kg
**SAR(1 g) = 3.79 W/kg**
Deviation(1 g) =-5.96%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 750 MHz; Type: D750V3; Serial: 1034**

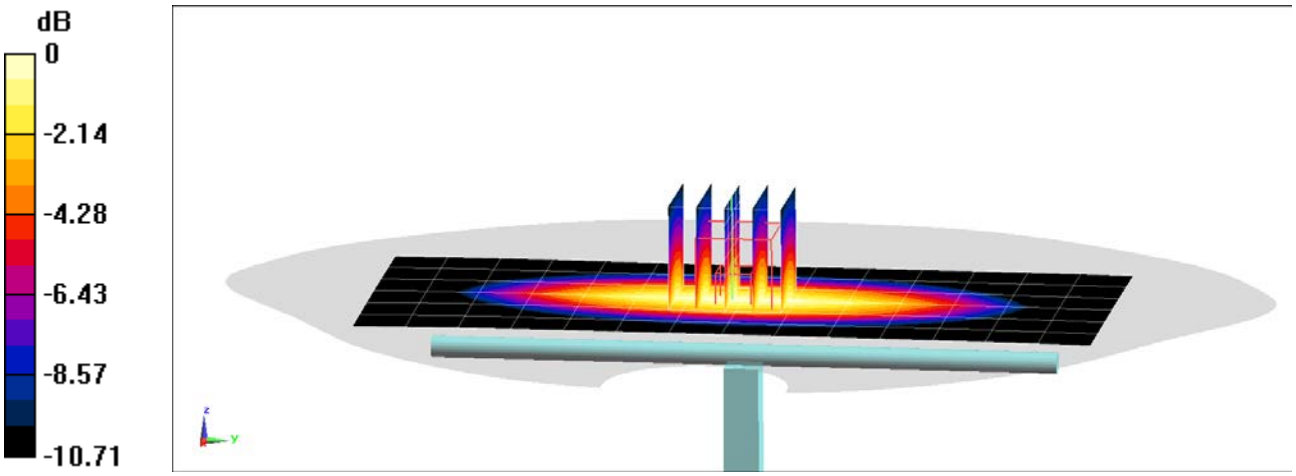
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Body Medium parameters used (interpolated):
f = 750 MHz; $\sigma$ = 0.972 S/m; $\varepsilon_r$ = 53.807; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 04-30-2019; Ambient Temp: 25.0°C; Tissue Temp: 21.6°C

Probe: EX3DV4 - SN7427; ConvF(10.34, 10.34, 10.34) @ 750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 750 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 2.63 W/kg
**SAR(1 g) = 1.65 W/kg**
Deviation(1 g) = -3.73%




0 dB = 2.27 W/kg = 3.56 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 750 MHz; Type: D750V3; Serial: 1034**

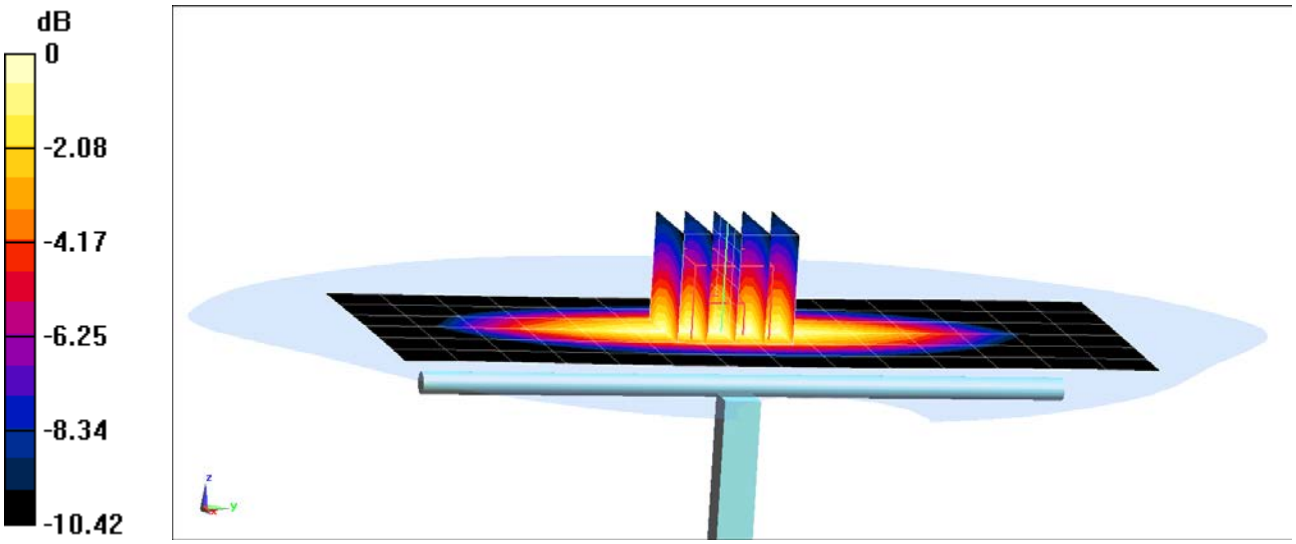
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Body Medium parameters used (interpolated):
f = 750 MHz; $\sigma$ = 0.964 S/m; $\varepsilon_r$ = 54.022; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-06-2019; Ambient Temp: 23.5°C; Tissue Temp: 21.1°C

Probe: EX3DV4 - SN7427; ConvF(10.34, 10.34, 10.34) @ 750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 750 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 2.53 W/kg
**SAR(1 g) = 1.66 W/kg**
Deviation(1 g) = -3.15%




0 dB = 2.23 W/kg = 3.48 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d040**

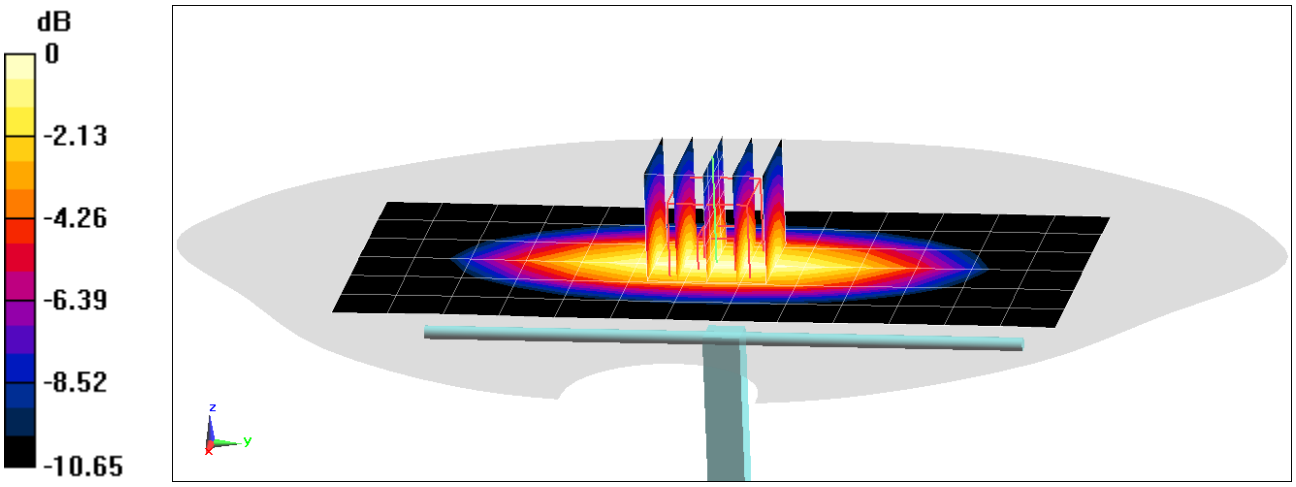
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 835 MHz; $\sigma$ = 0.995 S/m; $\varepsilon_r$ = 53.42; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-01-2019; Ambient Temp: 20.8°C; Tissue Temp: 21.0°C

Probe: EX3DV4 - SN7532; ConvF(10.14, 10.14, 10.14) @ 835 MHz; Calibrated: 4/12/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn501; Calibrated: 4/17/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CC; Serial: 1179
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 835 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 3.07 W/kg
**SAR(1 g) = 2.04 W/kg**
Deviation(1 g) = 6.69%




0 dB = 2.73 W/kg = 4.36 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d040**

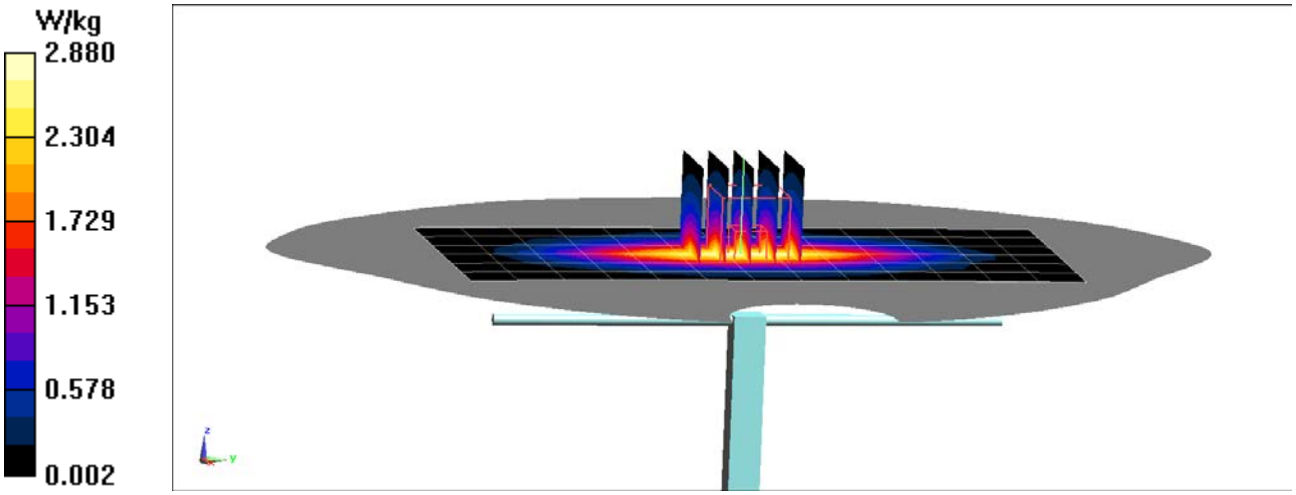
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 835 MHz; $\sigma$ = 0.992 S/m; $\varepsilon_r$ = 53.346; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-06-2019; Ambient Temp: 21.9°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN7416; ConvF(9.4, 9.4, 9.4) @ 835 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1402; Calibrated: 7/10/2018
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CA; Serial: 1275
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 835 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 3.14 W/kg
**SAR(1 g) = 2.03 W/kg**
Deviation(1 g) = 6.17%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d040**

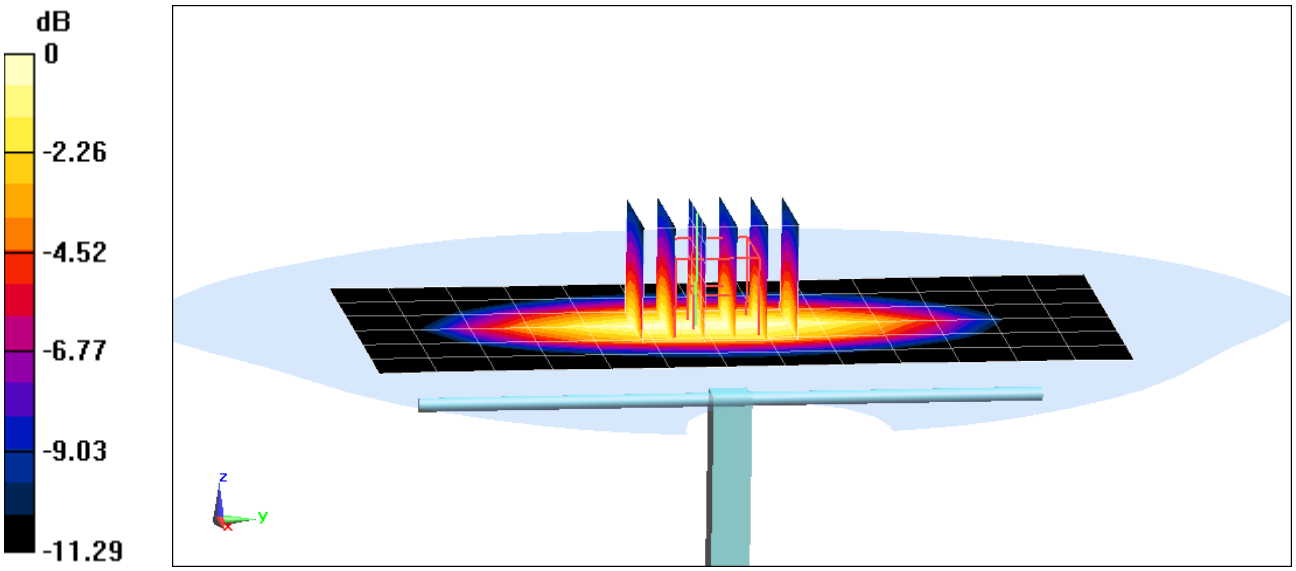
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 835 MHz; $\sigma$ = 1.017 S/m; $\varepsilon_r$ = 53.344; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-09-2019; Ambient Temp: 22.6°C; Tissue Temp: 21.6°C

Probe: EX3DV4 - SN3837; ConvF(9.08, 9.08, 9.08) @ 835 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 835 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 3.24 W/kg
**SAR(1 g) = 2.07 W/kg**
Deviation(1 g) = 8.26%




0 dB = 2.78 W/kg = 4.44 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 850 MHz; Type: D850V2; Serial: 1010**

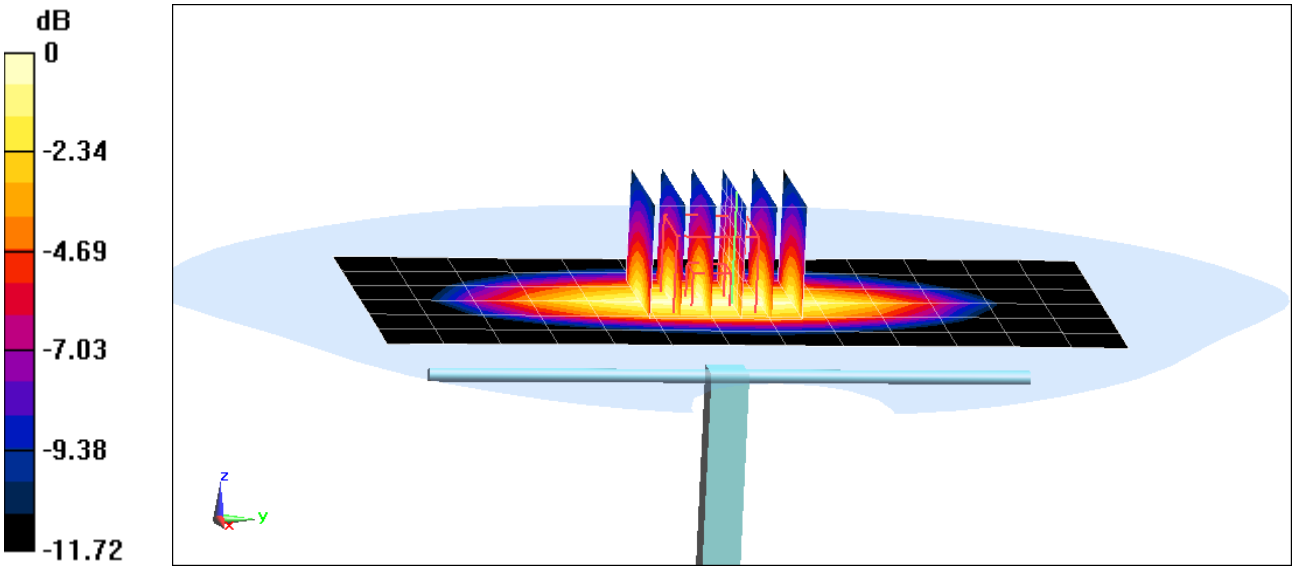
Communication System: UID 0, CW; Frequency: 850 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 850 MHz; $\sigma$ = 0.994 S/m; $\varepsilon_r$ = 52.964; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 05-13-2019; Ambient Temp: 21.3°C; Tissue Temp: 19.9°C

Probe: EX3DV4 - SN3837; ConvF(9.08, 9.08, 9.08) @ 850 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 850 MHz System Verification at 23.0 dBm (200 mW)

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (6x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 3.21 W/kg
**SAR(1 g) = 2.08 W/kg**
Deviation(1 g) = 1.96%




0 dB = 2.74 W/kg = 4.38 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1083**

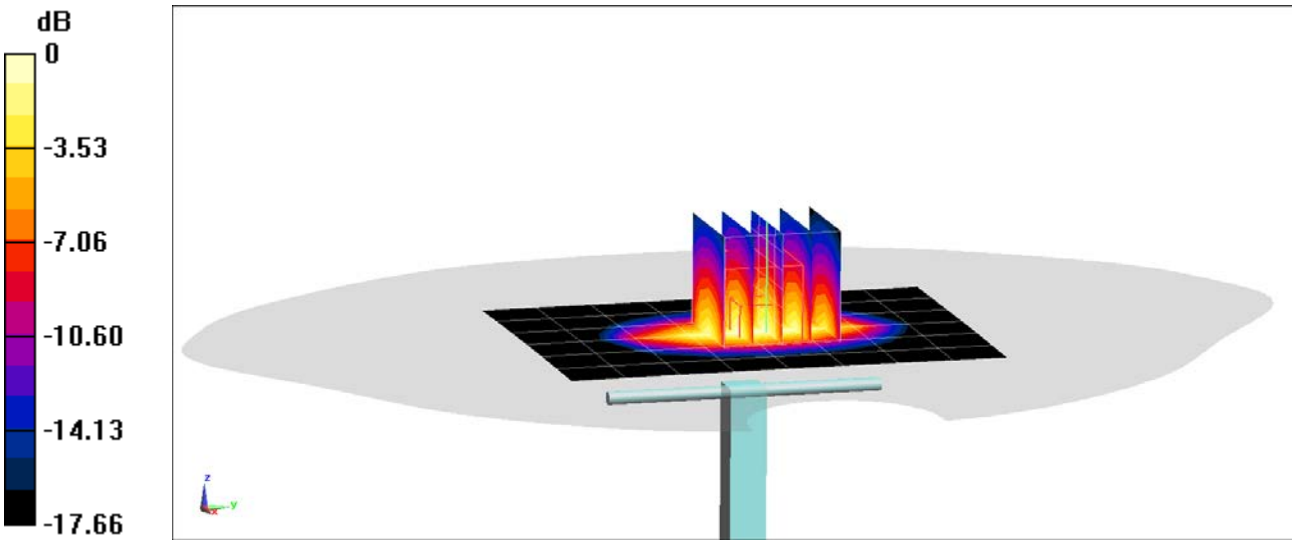
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.509 S/m; $\varepsilon_r$ = 51.746; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-03-2019; Ambient Temp: 22.5°C; Tissue Temp: 19.8°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Sub; Type: QD 000 P40 CC; Serial: 1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.34 W/kg
**SAR(1 g) = 3.5 W/kg**
Deviation(1 g) = -6.17%




0 dB = 5.31 W/kg = 7.25 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1083**

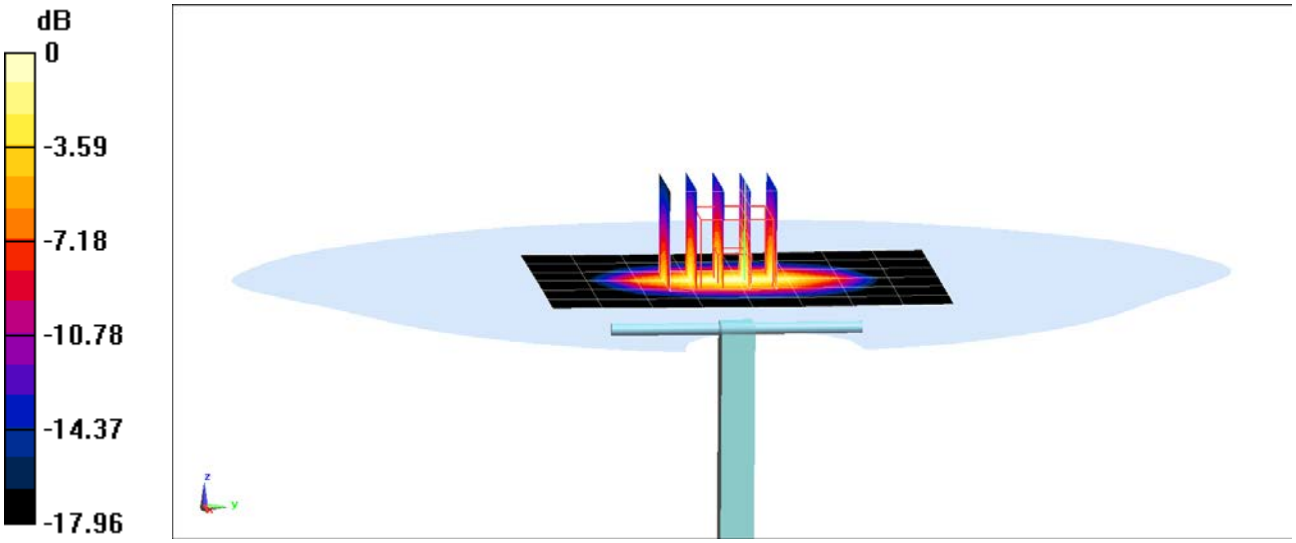
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.489 S/m; $\varepsilon_r$ = 52.068; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-06-2019; Ambient Temp: 22.5°C; Tissue Temp: 21.1°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.86 W/kg
**SAR(1 g) = 3.71 W/kg; SAR(10 g) = 1.97 W/kg**
Deviation(1 g) = -0.54%; Deviation(10 g) = -1.01%




0 dB = 5.67 W/kg = 7.54 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1083**

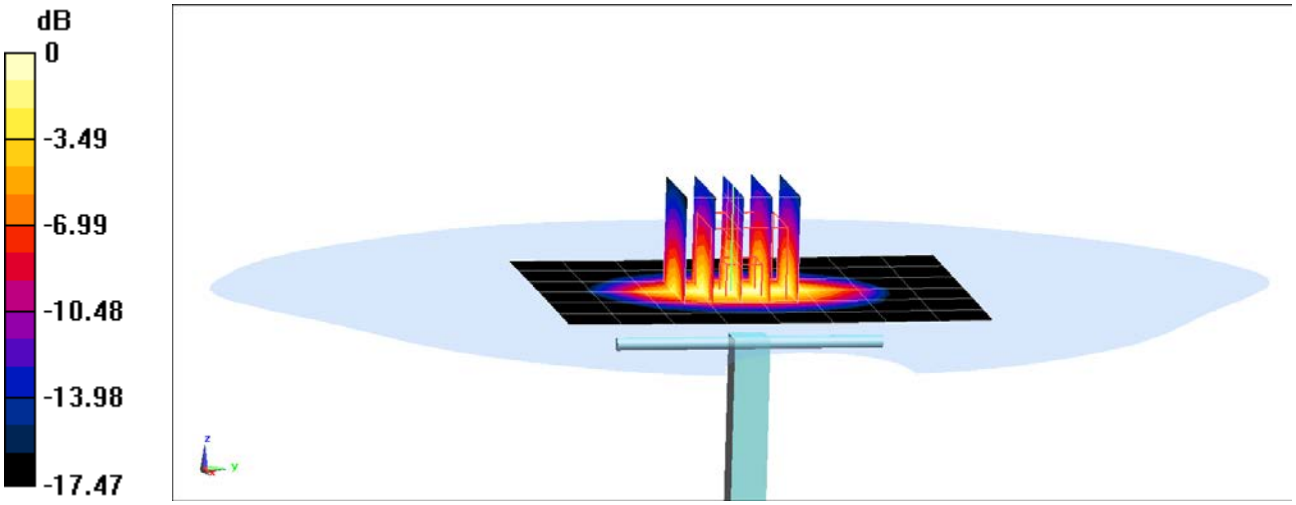
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.505 S/m; $\varepsilon_r$ = 51.99; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-09-2019; Ambient Temp: 21.4°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.73 W/kg
**SAR(1 g) = 3.73 W/kg**
Deviation(1 g) = 0.00%




0 dB = 5.64 W/kg = 7.51 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1083**

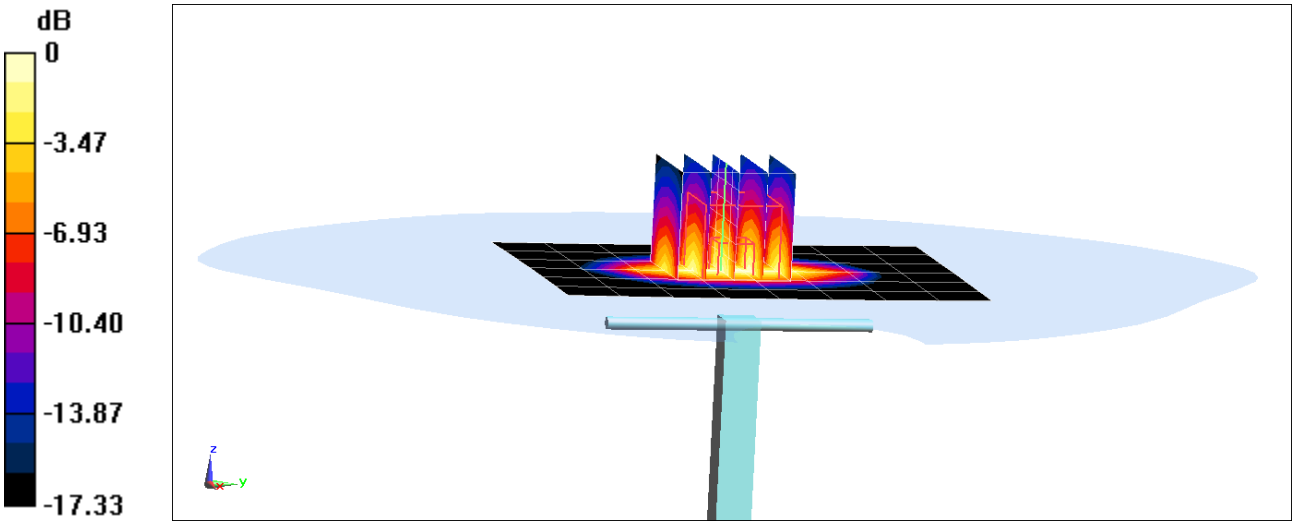
Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used:
f = 1750 MHz; $\sigma$ = 1.486 S/m; $\varepsilon_r$ = 52.199; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-13-2019; Ambient Temp: 22.5°C; Tissue Temp: 19.9°C

Probe: EX3DV4 - SN7427; ConvF(8.14, 8.14, 8.14) @ 1750 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1750 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x9x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 6.44 W/kg
**SAR(10 g) = 1.94 W/kg**
Deviation(10 g) = -2.51%




0 dB = 5.47 W/kg = 7.38 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d181**

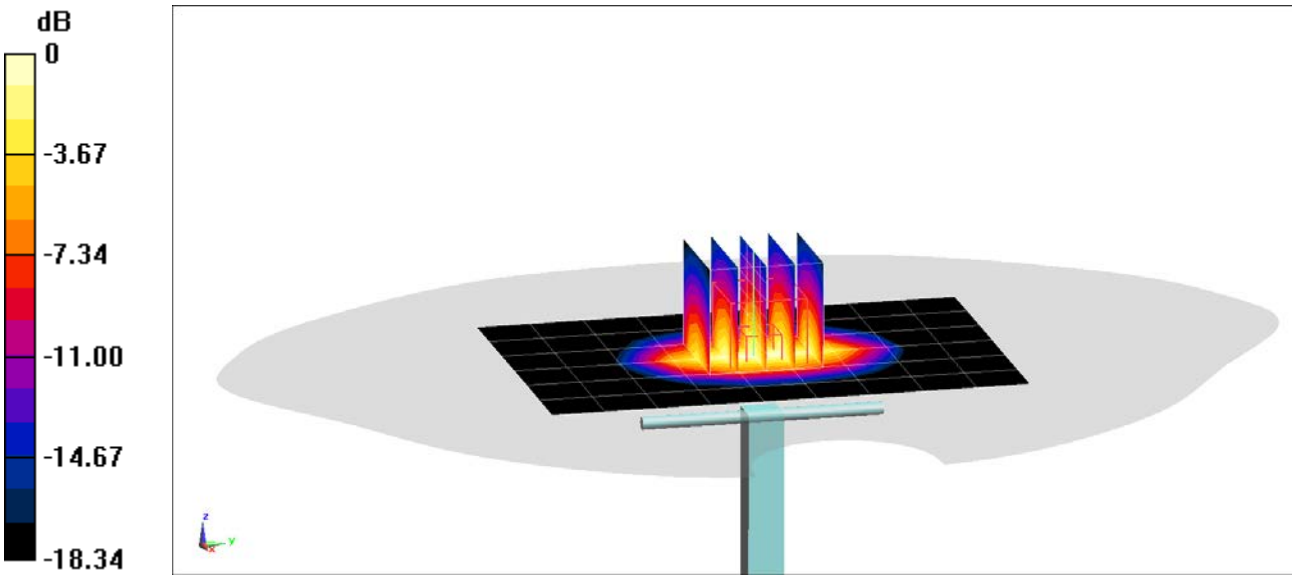
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.576 S/m; $\varepsilon_r$ = 51.009; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-29-2019; Ambient Temp: 22.9°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79) @ 1900 MHz; Calibrated: 11/19/2018
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1408; Calibrated: 8/14/2018
Phantom: Twin-SAM V8.0; Type: QD 000 P41 Ax; Serial: 1936
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.63 W/kg
**SAR(1 g) = 4.23 W/kg; SAR(10 g) = 2.17 W/kg**
Deviation(1 g) = 7.09%; Deviation(10 g) = 3.83%




0 dB = 5.38 W/kg = 7.31 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d180**

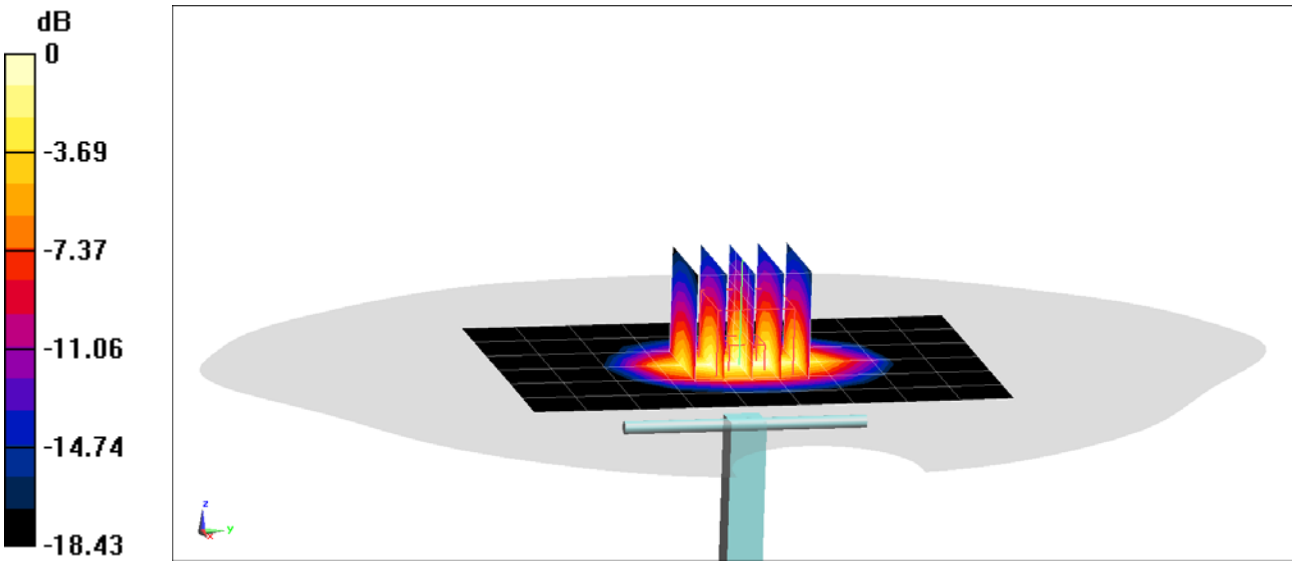
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.584 S/m; $\varepsilon_r$ = 50.828; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-30-2019; Ambient Temp: 23.6°C; Tissue Temp: 23.4°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79) @ 1900 MHz; Calibrated: 11/19/2018
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1408; Calibrated: 8/14/2018
Phantom: Twin-SAM V8.0; Type: QD 000 P41 Ax; Serial: 1936
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.62 W/kg
**SAR(1 g) = 4.23 W/kg; SAR(10 g) = 2.17 W/kg**
Deviation(1 g) = 7.09%; Deviation(10 g) = 3.83%




0 dB = 5.39 W/kg = 7.32 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d180**

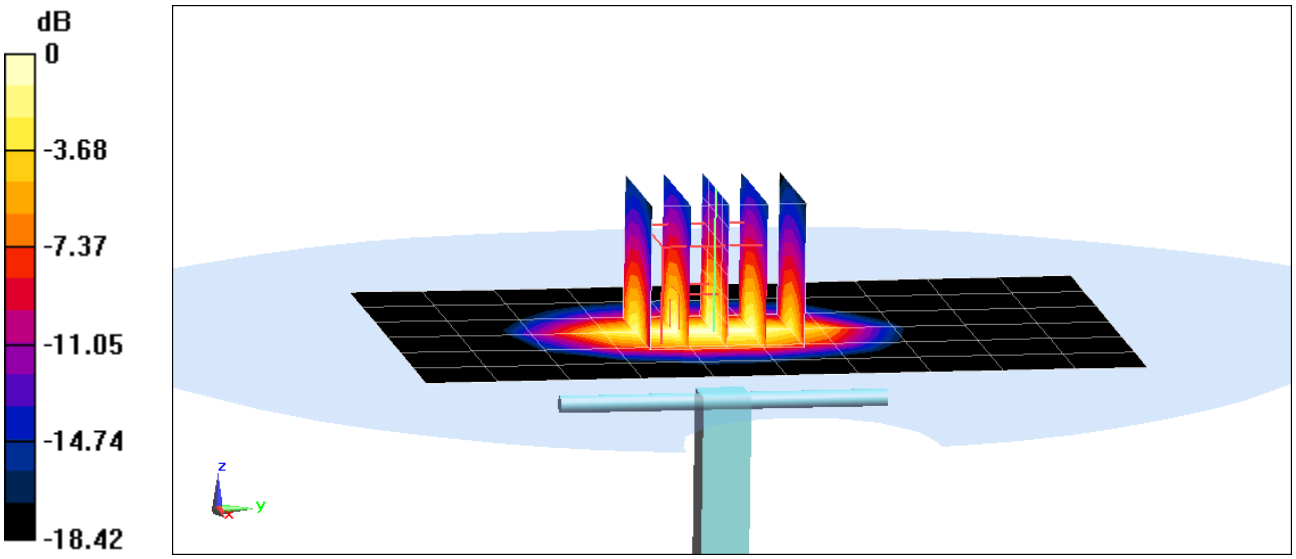
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.589 S/m; $\varepsilon_r$ = 50.814; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-07-2019; Ambient Temp: 23.5°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3837; ConvF(7.54, 7.54, 7.54) @ 1900 MHz; Calibrated: 1/28/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn793; Calibrated: 1/15/2019
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.73 W/kg
**SAR(1 g) = 4.11 W/kg; SAR(10 g) = 2.09 W/kg**
Deviation(1 g) = 4.05%; Deviation(10 g) = 0.00%




0 dB = 6.19 W/kg = 7.92 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d181**

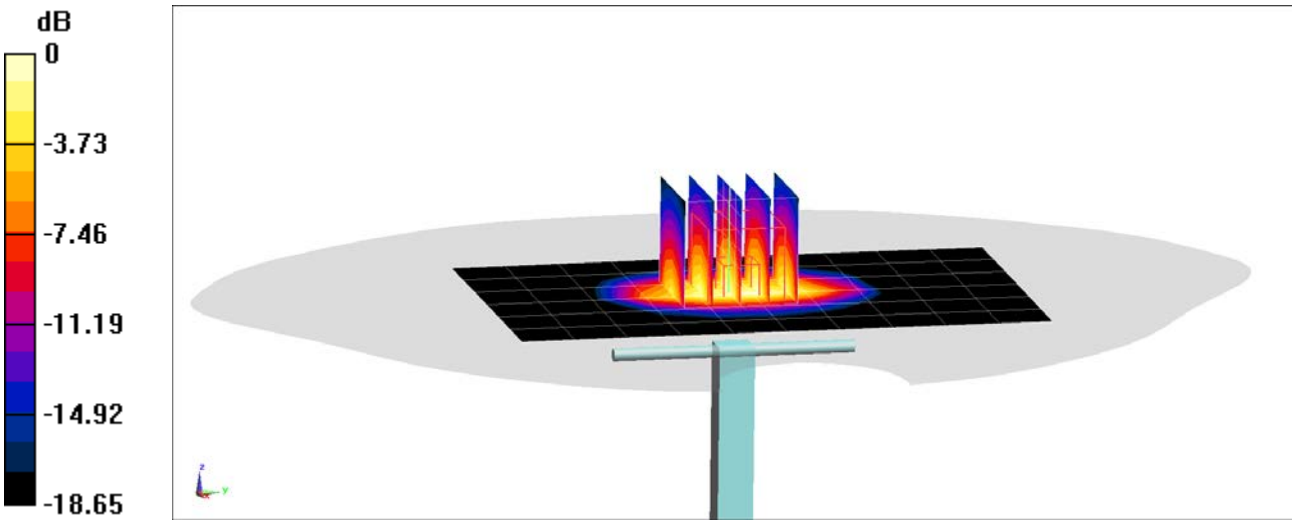
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1900 MHz; $\sigma$ = 1.579 S/m; $\varepsilon_r$ = 51.482; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-13-2019; Ambient Temp: 20.9°C; Tissue Temp: 20.3°C

Probe: EX3DV4 - SN7491; ConvF(8.19, 8.19, 8.19) @ 1900 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 1900 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 7.57 W/kg
**SAR(1 g) = 4.09 W/kg; SAR(10 g) = 2.11 W/kg**
Deviation(1 g) = 3.54%; Deviation(10 g) = 0.96%




0 dB = 6.31 W/kg = 8.00 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 750**

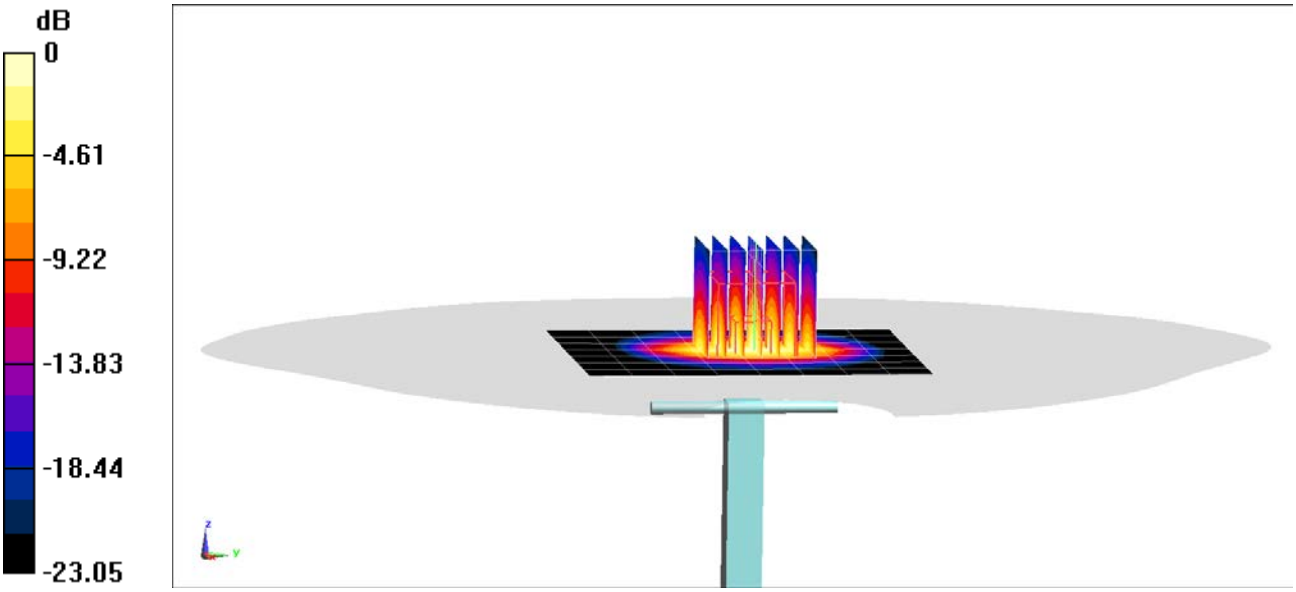
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used:
f = 2450 MHz; $\sigma$ = 2.046 S/m; $\varepsilon_r$ = 50.583; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-29-2019; Ambient Temp: 22.3°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN7421; ConvF(7.46, 7.46, 7.46) @ 2450 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.9 W/kg
**SAR(1 g) = 5.5 W/kg**
Deviation(1 g) = 7.42%




0 dB = 9.42 W/kg = 9.74 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 921**

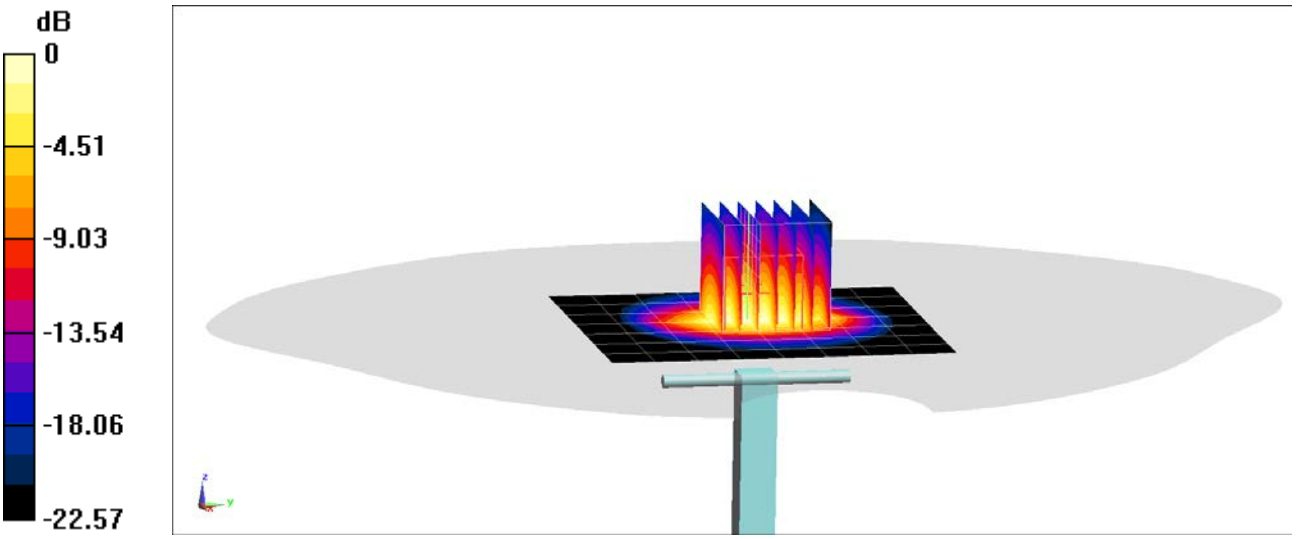
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz BBBody Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.996 S/m; $\varepsilon_r$ = 52.477; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-16-2019; Ambient Temp: 20.3°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7421; ConvF(7.46, 7.46, 7.46) @ 2450 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.3 W/kg
**SAR(1 g) = 5.4 W/kg**
Deviation(1 g) = 6.30%




0 dB = 9.01 W/kg = 9.55 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 921**

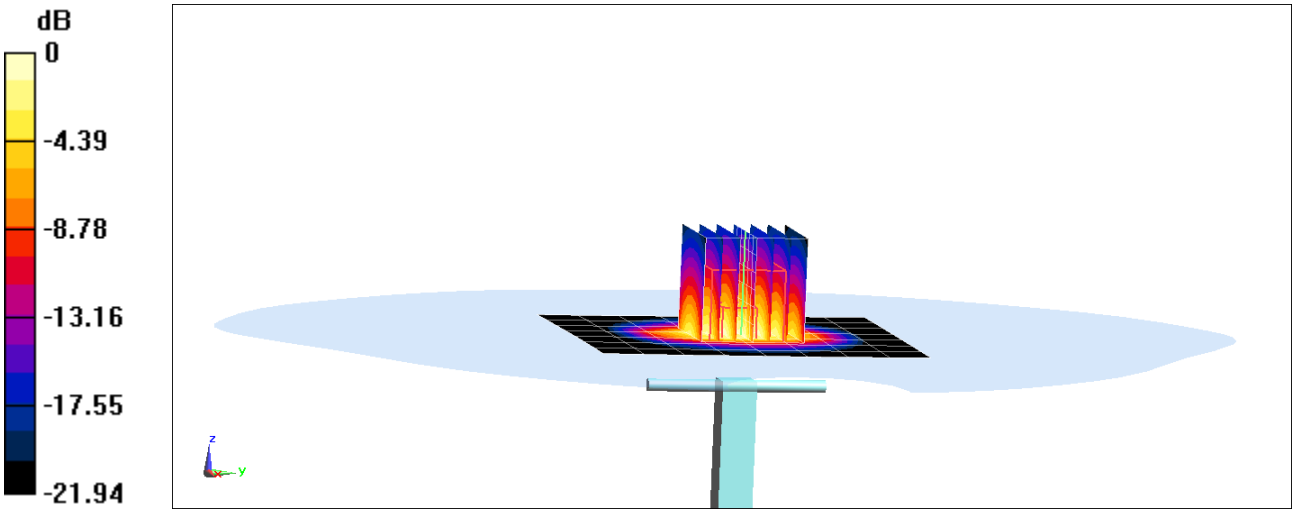
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 MHz Body Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.99 S/m; $\varepsilon_r$ = 51.435; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-20-2019; Ambient Temp: 20.4°C; Tissue Temp: 19.3°C

Probe: EX3DV4 - SN7427; ConvF(7.47, 7.47, 7.47) @ 2450 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.4 W/kg
**SAR(1 g) = 5.32 W/kg**
Deviation(1 g) = 4.72%




0 dB = 8.99 W/kg = 9.54 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 719**

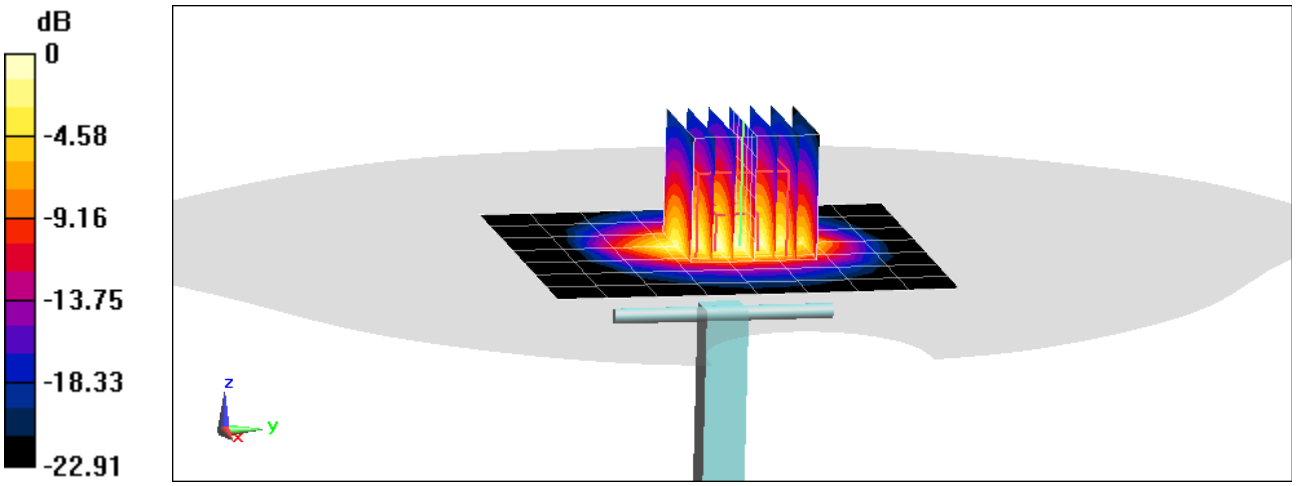
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Body; Medium parameters used:
f = 2450 MHz; $\sigma$ = 2.043 S/m; $\varepsilon_r$ = 51.521; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-26-2019; Ambient Temp: 22.8°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN7417; ConvF(7.51, 7.51, 7.51) @ 2450 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn665; Calibrated: 2/13/2019
Phantom: LeftTwin-SAM V5.0; Type: QD 000 P40 CD; Serial: TP1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.0 W/kg
**SAR(1 g) = 5.19 W/kg**
Deviation(1 g) = 3.59%




0 dB = 8.73 W/kg = 9.41 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 921**

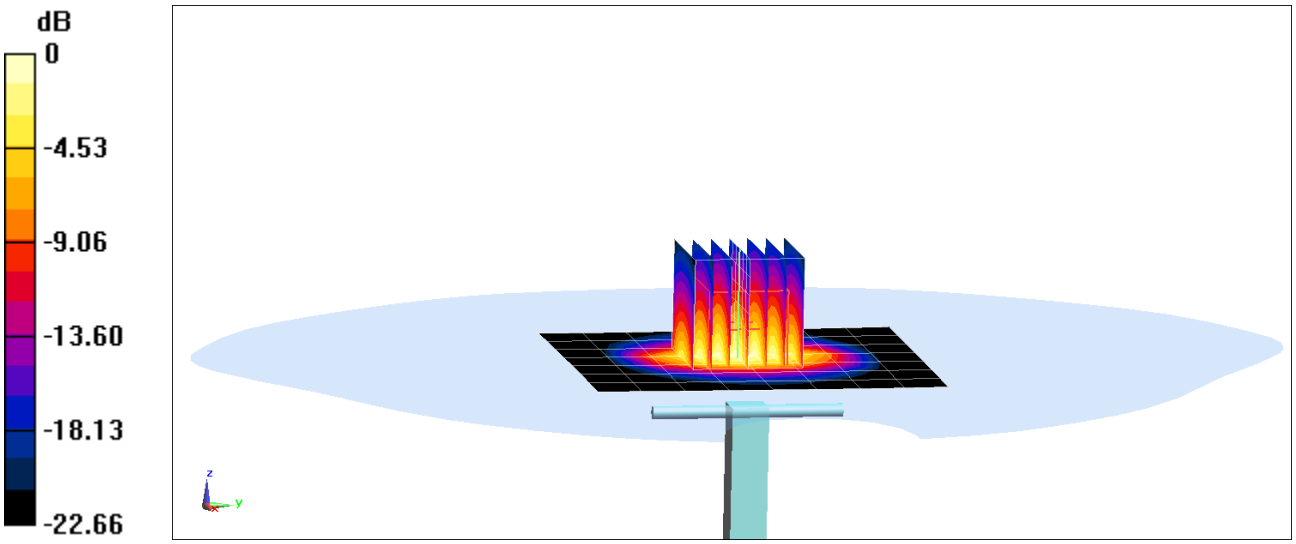
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz Body Medium parameters used:
f = 2450 MHz; $\sigma$ = 2.019 S/m; $\varepsilon_r$ = 51.115; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 06-17-2019; Ambient Temp: 20.2°C; Tissue Temp: 20.2°C

Probe: EX3DV4 - SN7427; ConvF(7.47, 7.47, 7.47) @ 2450 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7470)

## 2450 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.5 W/kg
**SAR(10 g) = 2.48 W/kg**
Deviation(10 g) = 4.20%




0 dB = 9.11 W/kg = 9.60 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1069**

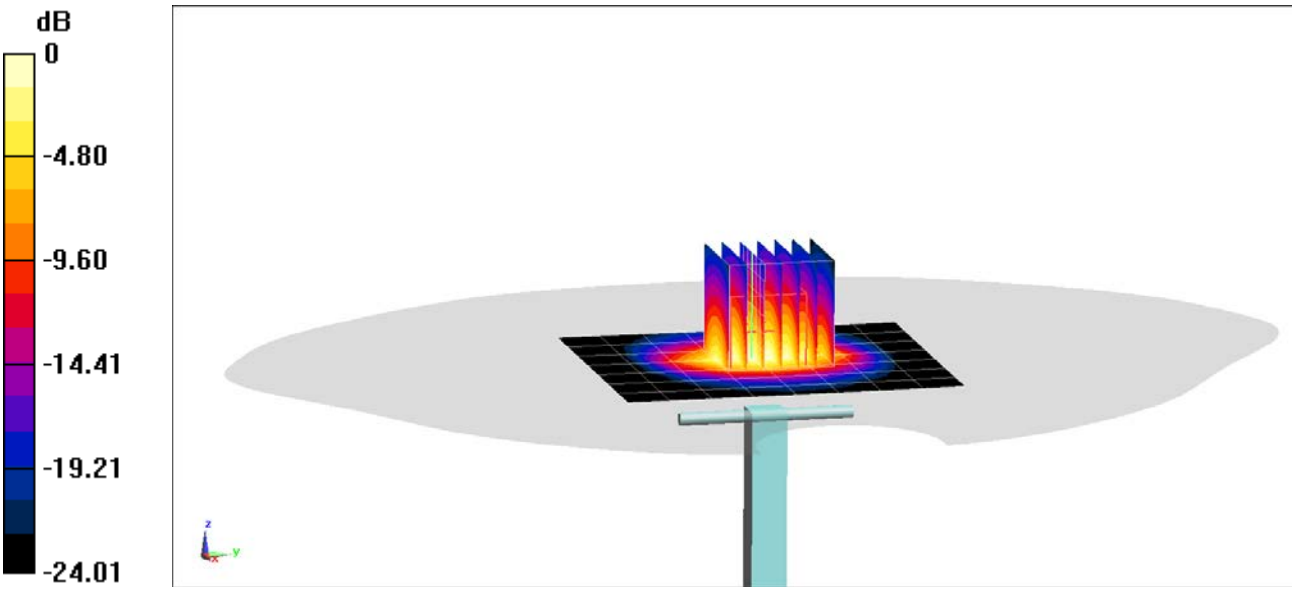
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz BBBody Medium parameters used:
f = 2600 MHz; $\sigma$ = 2.147 S/m; $\varepsilon_r$ = 52.209; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-16-2019; Ambient Temp: 20.3°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7421; ConvF(7.29, 7.29, 7.29) @ 2600 MHz; Calibrated: 3/18/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn604; Calibrated: 3/13/2019
Phantom: Twin-SAM V4.0; Type: QD 000 P40 CD; Serial: 1736
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2600 MHz System Verification at 20.0 dBm (100 mW)\

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 12.0 W/kg
**SAR(1 g) = 5.5 W/kg**
Deviation(1 g) = -0.54%




0 dB = 9.30 W/kg = 9.68 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1004**

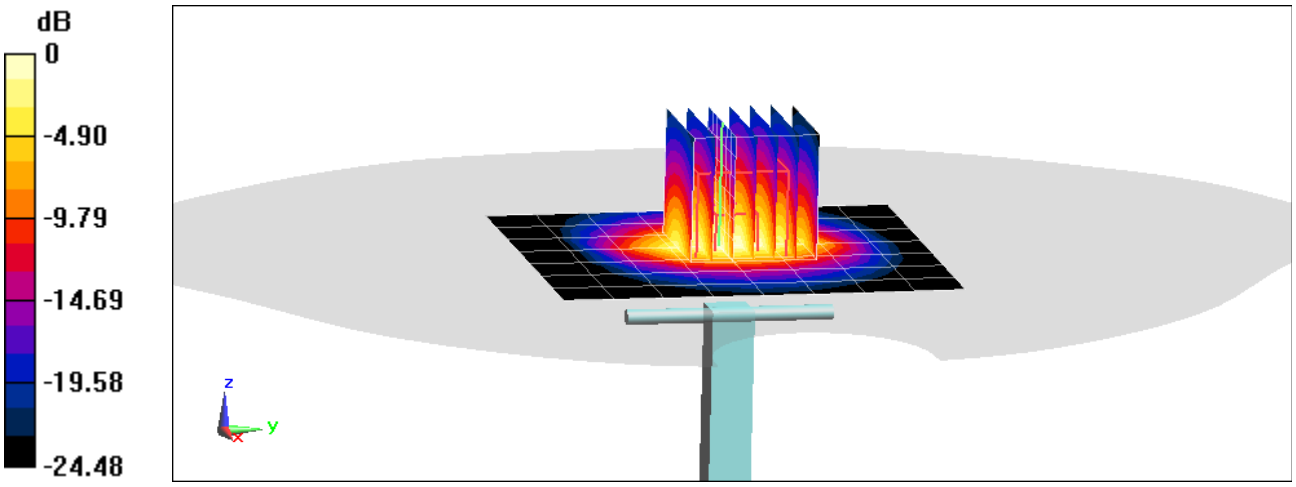
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600 Body; Medium parameters used:
f = 2600 MHz; $\sigma$ = 2.223 S/m; $\varepsilon_r$ = 51.046; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-26-2019; Ambient Temp: 22.8°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN7417; ConvF(7.37, 7.37, 7.37) @ 2600 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn665; Calibrated: 2/13/2019
Phantom: LeftTwin-SAM V5.0; Type: QD 000 P40 CD; Serial: TP1375
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 2600 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 11.9 W/kg
**SAR(1 g) = 5.36 W/kg**
Deviation(1 g) = -2.19%




0 dB = 9.20 W/kg = 9.64 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: 1069**

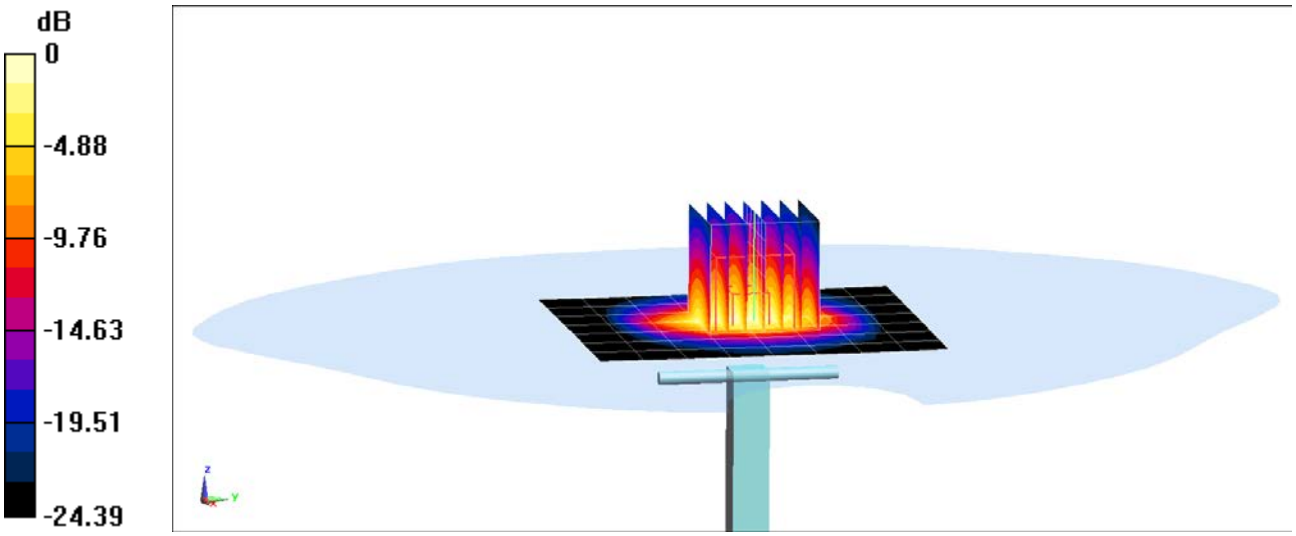
Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium: 2400-2600 MHz Body Medium parameters used:
f = 2600 MHz; $\sigma$ = 2.165 S/m; $\varepsilon_r$ = 50.852; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 06-17-2019; Ambient Temp: 20.2°C; Tissue Temp: 20.2°C

Probe: EX3DV4 - SN7427; ConvF(7.35, 7.35, 7.35) @ 2600 MHz; Calibrated: 2/19/2019
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1403; Calibrated: 2/13/2019
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1406
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7470)

## 2600 MHz System Verification at 20.0 dBm (100 mW)

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 12.0 W/kg
**SAR(10 g) = 2.39 W/kg**
Deviation(10 g) = -3.63%




0 dB = 9.37 W/kg = 9.72 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1123**

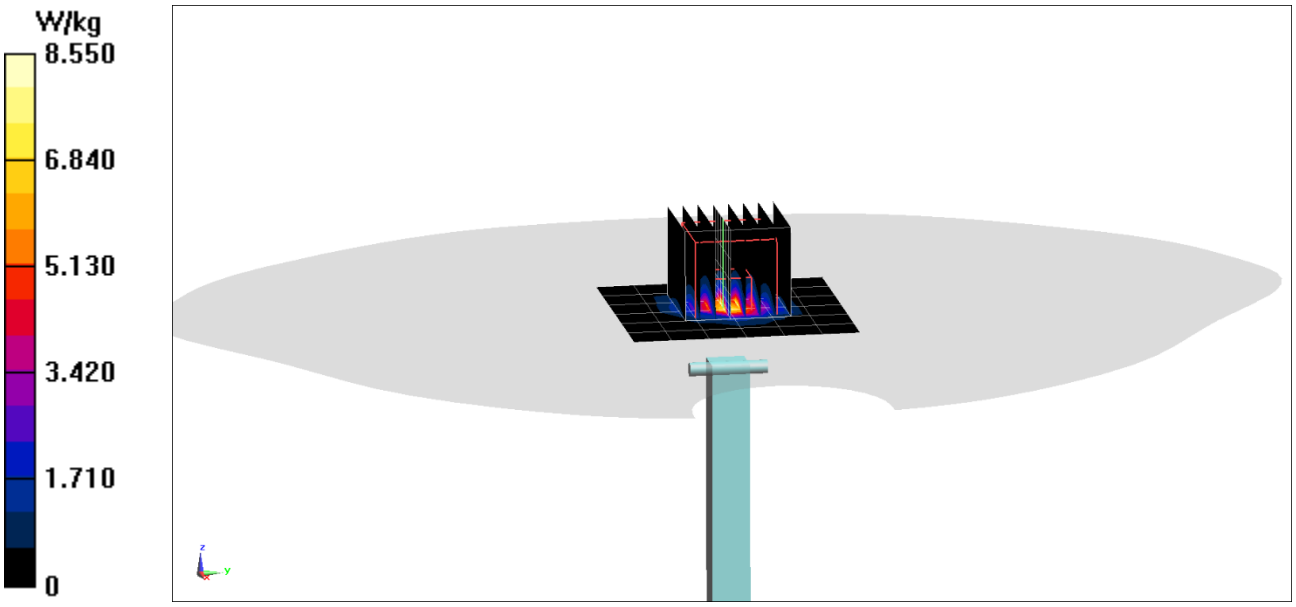
Communication System: UID 0, CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used (interpolated):
f = 5250 MHz; $\sigma$ = 5.434 S/m; $\varepsilon_r$ = 47.362; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.82, 4.82, 4.82) @ 5250 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5250 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 15.0 W/kg
**SAR(1 g) = 3.66 W/kg; SAR(10 g) = 1.02 W/kg**
Deviation(1 g) = -1.08%; Deviation(10 g) = -0.97%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1123**

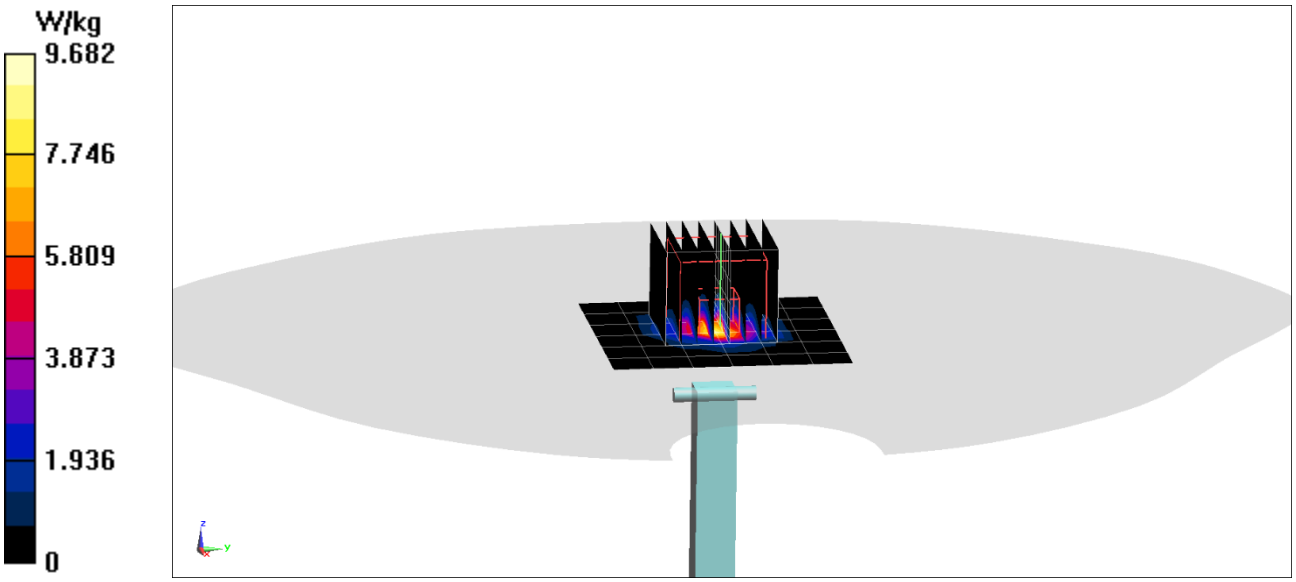
Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5600 MHz; $\sigma$ = 5.951 S/m; $\varepsilon_r$ = 46.684; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.19, 4.19, 4.19) @ 5600 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5600 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 17.3 W/kg
**SAR(1 g) = 3.83 W/kg; SAR(10 g) = 1.06 W/kg**
Deviation(1 g) = -1.29%; Deviation(10 g) = -2.30%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1123**

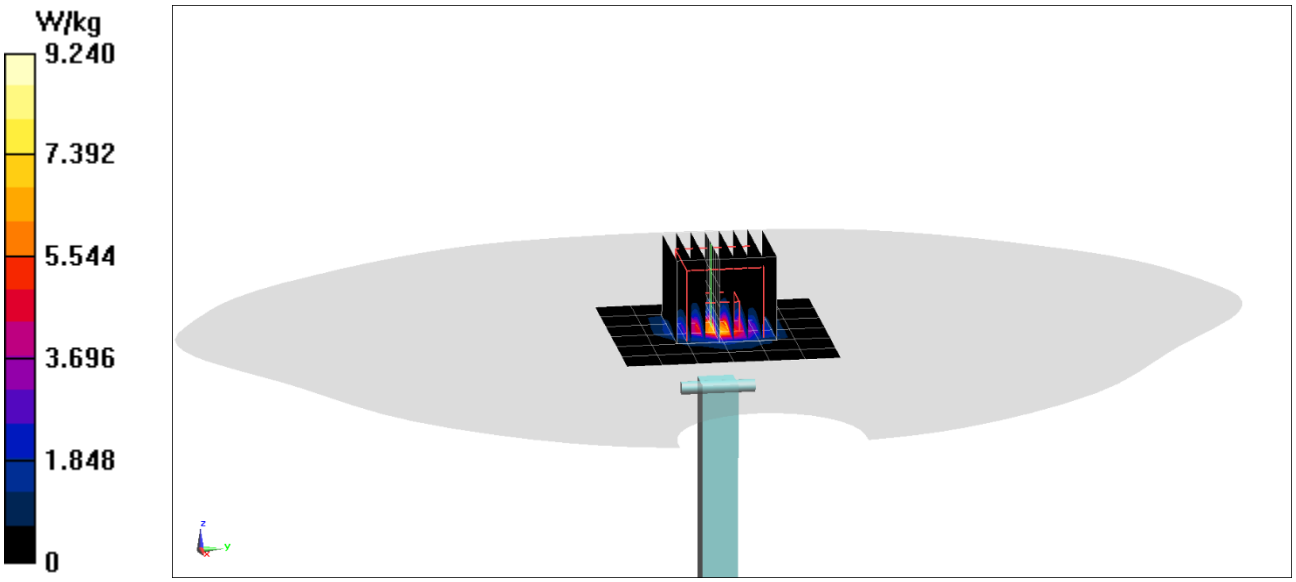
Communication System: UID 0, CW; Frequency: 5750 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used (interpolated):
f = 5750 MHz; $\sigma$ = 6.142 S/m; $\varepsilon_r$ = 46.337; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 05-06-2019; Ambient Temp: 21.5°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN7491; ConvF(4.37, 4.37, 4.37) @ 5750 MHz; Calibrated: 7/20/2018
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 10/18/2018
Phantom: Twin-SAM V8.0_Left; Type: QD 000 P41 AA; Serial: 1935
Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

## 5750 MHz System Verification at 17.0 dBm (50 mW)

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Peak SAR (extrapolated) = 17.4 W/kg
**SAR(1 g) = 3.66 W/kg; SAR(10 g) = 1.02 W/kg**
Deviation(1 g) = -2.01%; Deviation(10 g) = -1.92%



# APPENDIX C: PROBE CALIBRATION

© 2019 PCTEST Engineering Laboratory, Inc.

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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** PC Test

**Certificate No: D750V3-1097_Sep17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D750V3 - SN:1097 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | September 08, 2017 |

SC ✓ 10/03/2017

SC ✓ 9/8/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

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

Issued: September 8, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 41.2 ± 6 % | 0.90 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 | 2.08 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **8.22 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.36 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **5.39 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 | 55.5 ± 6 % | 0.96 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 | 2.14 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **8.56 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.42 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **5.68 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 | 54.4 Ω - 0.6 jΩ |
| Return Loss | - 27.5 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.0 Ω - 3.6 jΩ |
| Return Loss | - 28.8 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.034 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 | July 05, 2013 |

## DASY5 Validation Report for Head TSL

Date: 08.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1097**

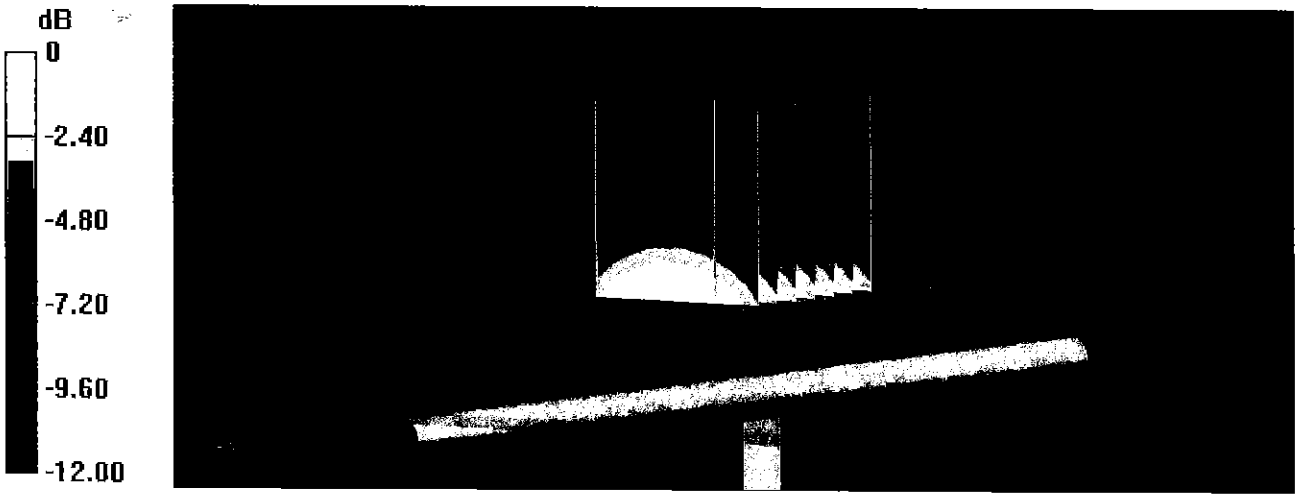
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma$ = 0.9 S/m; $\varepsilon_r$ = 41.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.49, 10.49, 10.49); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

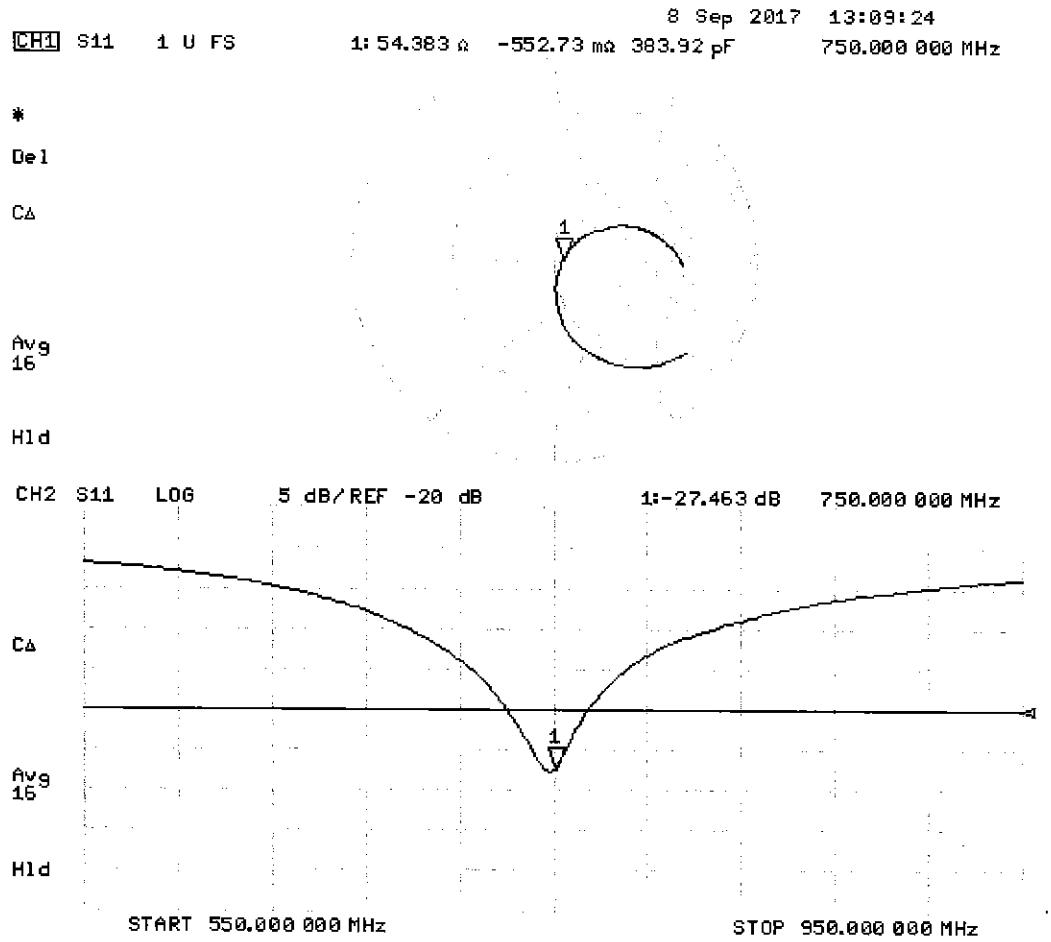
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 58.59 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 3.19 W/kg
**SAR(1 g) = 2.08 W/kg; SAR(10 g) = 1.36 W/kg**
Maximum value of SAR (measured) = 2.80 W/kg




0 dB = 2.80 W/kg = 4.47 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 08.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1097**

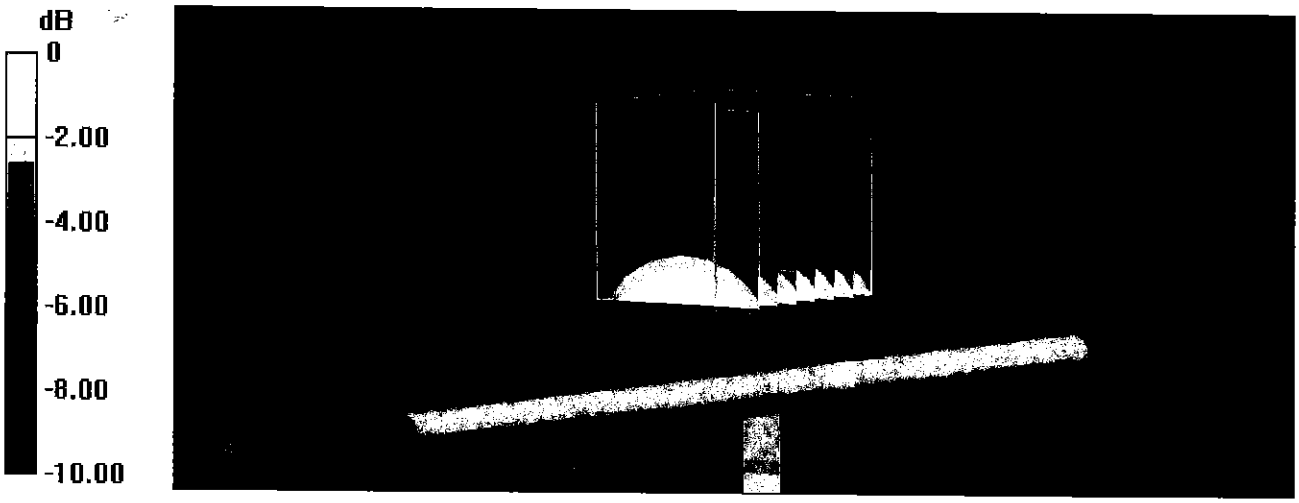
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma$ = 0.96 S/m; $\varepsilon_r$ = 55.5; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.35, 10.35, 10.35); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

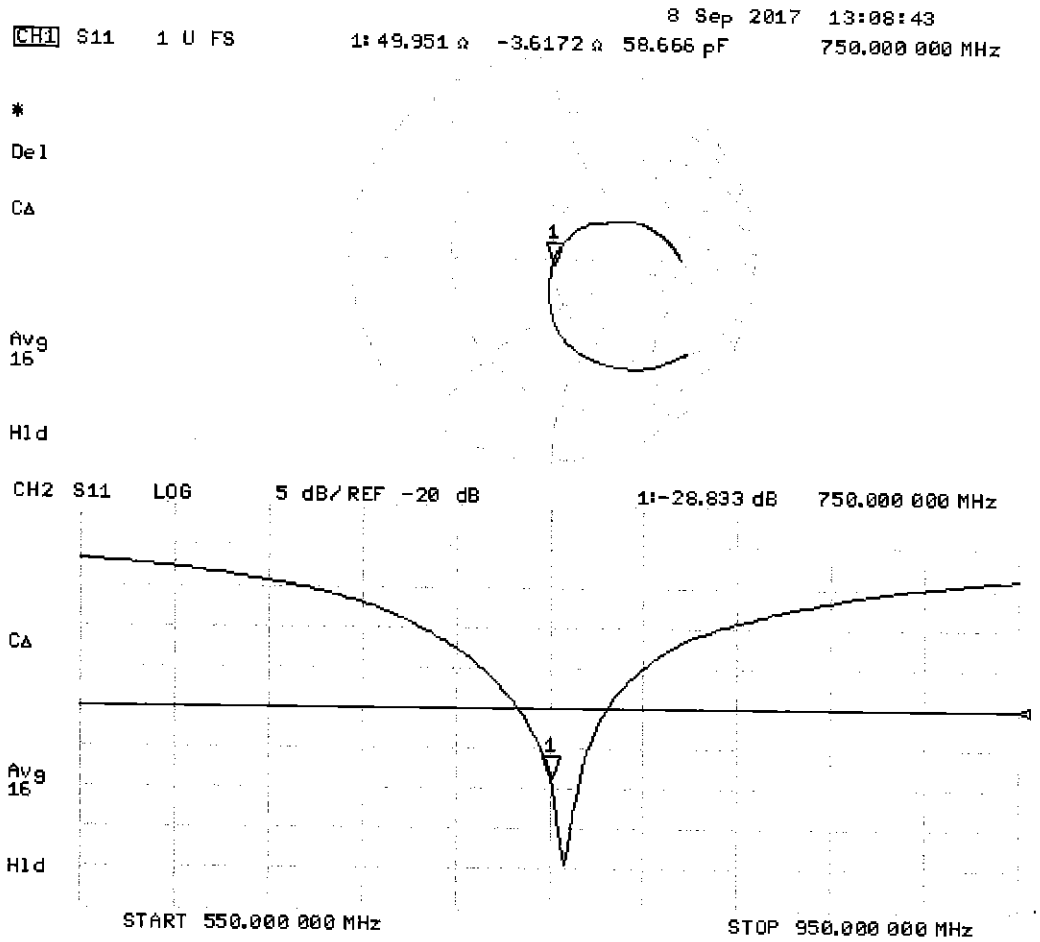
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.96 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 3.16 W/kg
**SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.42 W/kg**
Maximum value of SAR (measured) = 2.81 W/kg




0 dB = 2.81 W/kg = 4.49 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D750V3 – SN: 1097

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: September 08, 2018

Description: SAR Validation Dipole at 750 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 5/15/2018 | Annual | 5/15/2019 | 1070 |
| SPEAG | ES3DV3 | SAR Probe | 9/18/2017 | Annual | 9/18/2018 | 3287 |
| SPEAG | DAE4 | Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1533 |
| SPEAG | EX3DV4 | SAR Probe | 7/20/2018 | Annual | 7/20/2019 | 7416 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/18/2018 | Annual | 1/18/2019 | 793 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Team Lead Engineer | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

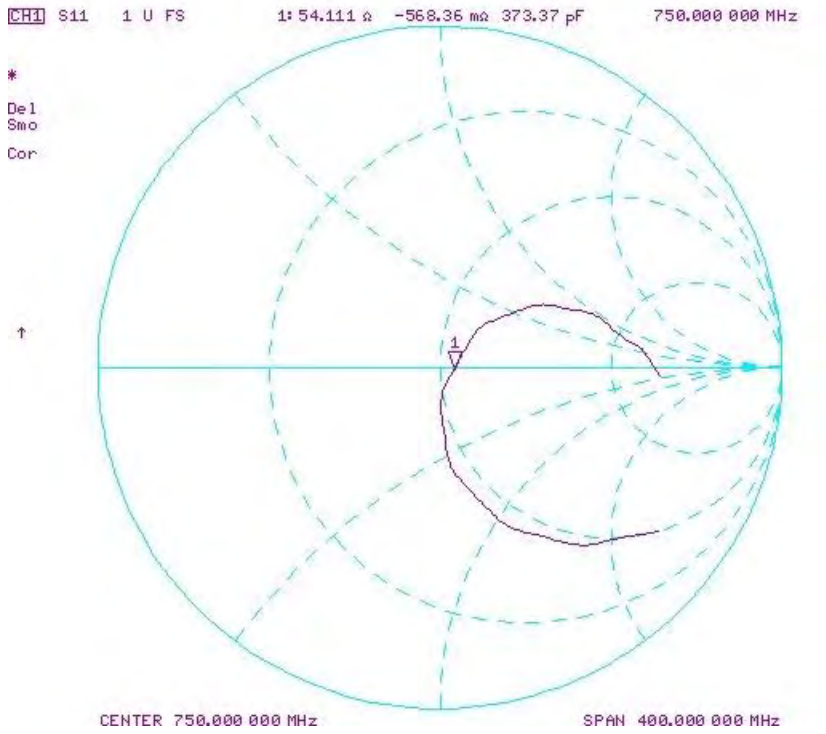
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

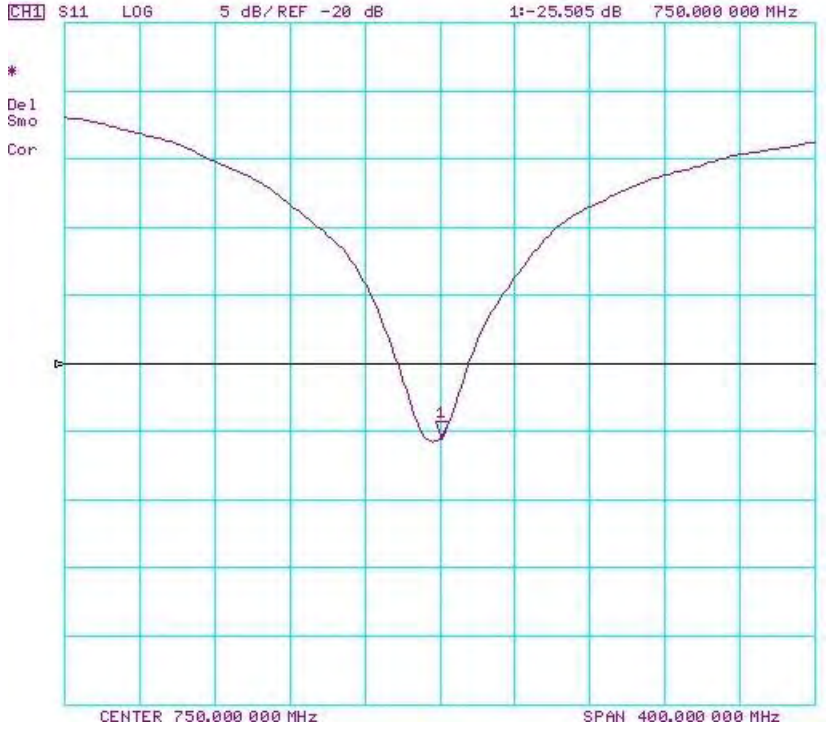
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 23.0 dBm | Measured Head SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 23.0 dBm | Measured Head SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/8/2017 | 9/8/2018 | 1.034 | 1.644 | 1.7 | 3.41% | 1.078 | 1.12 | 3.90% | 54.4 | 54.1 | 0.3 | -0.6 | -0.6 | 0 | -27.5 | -25.5 | 7.30% | PASS |

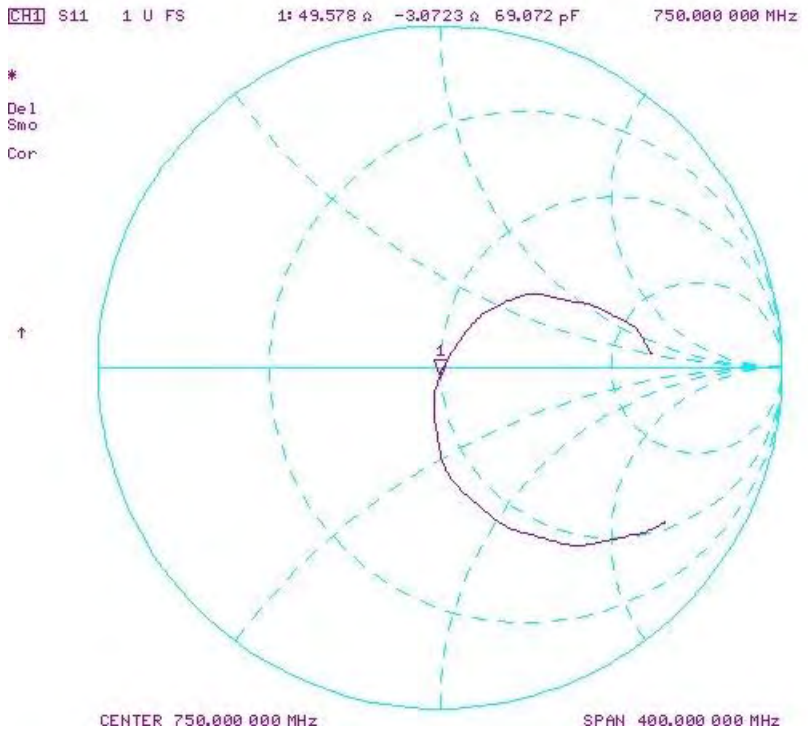
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 23.0 dBm | Measured Body SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 23.0 dBm | Measured Body SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/8/2017 | 9/8/2018 | 1.034 | 1.712 | 1.78 | 3.97% | 1.136 | 1.17 | 2.99% | 50 | 49.6 | 0.4 | -3.6 | -3.1 | 0.5 | -28.8 | -30.3 | -5.20% | PASS |

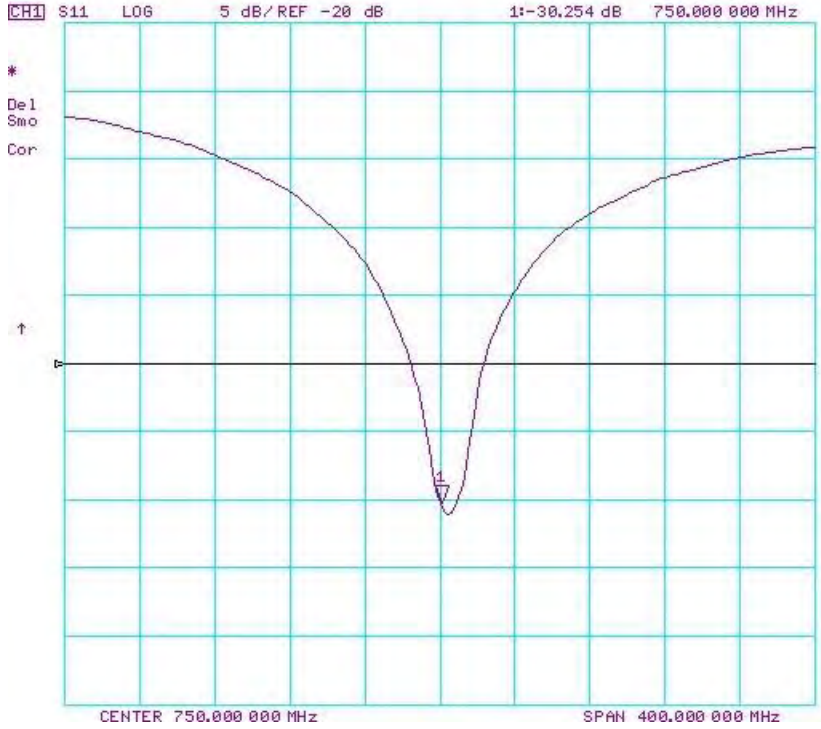
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** PC Test

**Certificate No: D750V3-1034_May18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D750V3 - SN:1034 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | May 18, 2018 |

SC ✓
5/31/2018

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 26-Oct-17 (No. DAE4-601_Oct17) | Oct-18 |

| 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-17) | In house check: Oct-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Manu Seitz | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: May 22, 2018

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.1 |
| **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 | 41.0 ± 6 % | 0.89 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.09 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **8.32 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.36 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **5.42 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 | 54.7 ± 6 % | 0.96 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.15 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **8.57 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.42 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **5.67 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 | 55.3 Ω + 0.0 jΩ |
| Return Loss | - 26.0 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.0 Ω - 3.2 jΩ |
| Return Loss | - 29.8 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.034 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 | July 06, 2011 |

## DASY5 Validation Report for Head TSL

Date: 17.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1034**

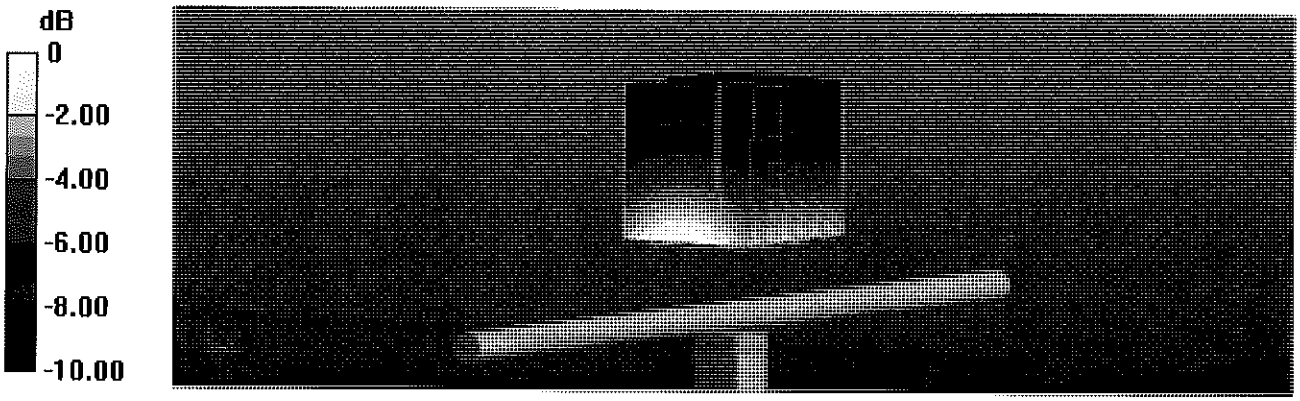
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma$ = 0.89 S/m; $\varepsilon_r$ = 41; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.22, 10.22, 10.22) @ 750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

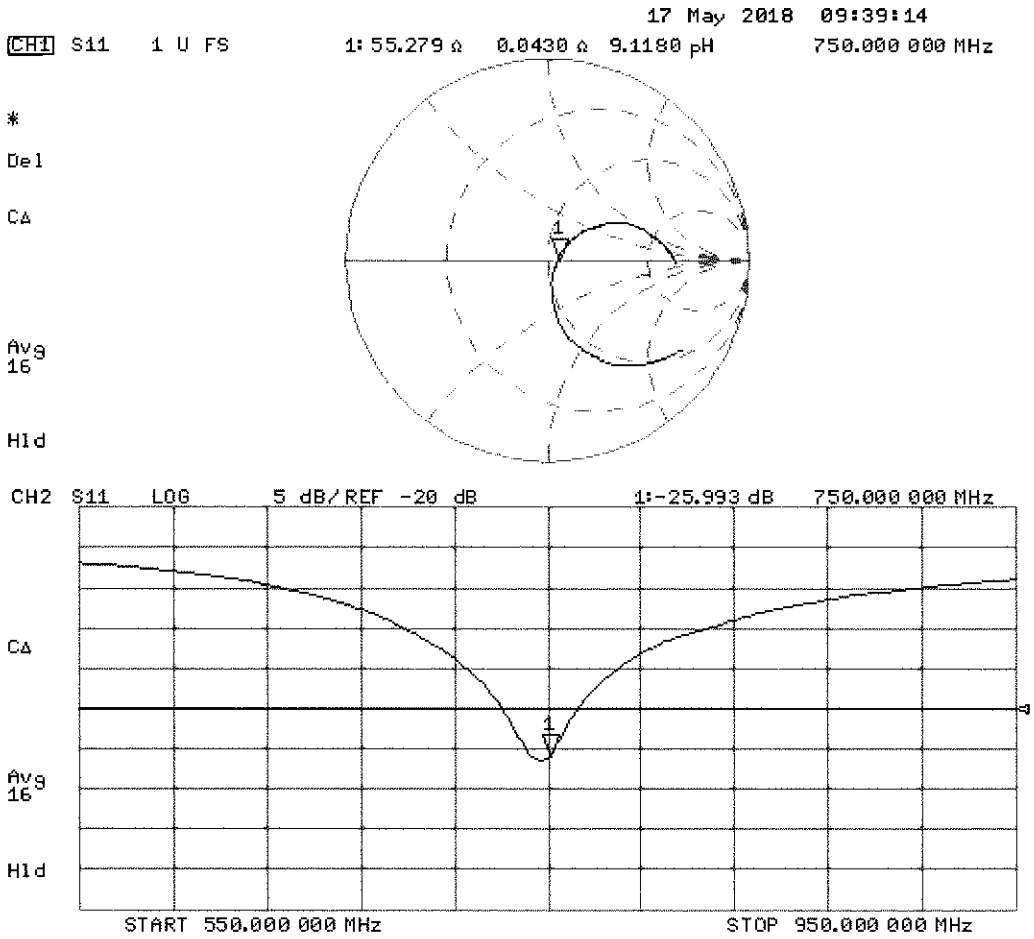
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 59.66 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 3.18 W/kg
**SAR(1 g) = 2.09 W/kg; SAR(10 g) = 1.36 W/kg**
Maximum value of SAR (measured) = 2.82 W/kg




0 dB = 2.82 W/kg = 4.50 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 18.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1034**

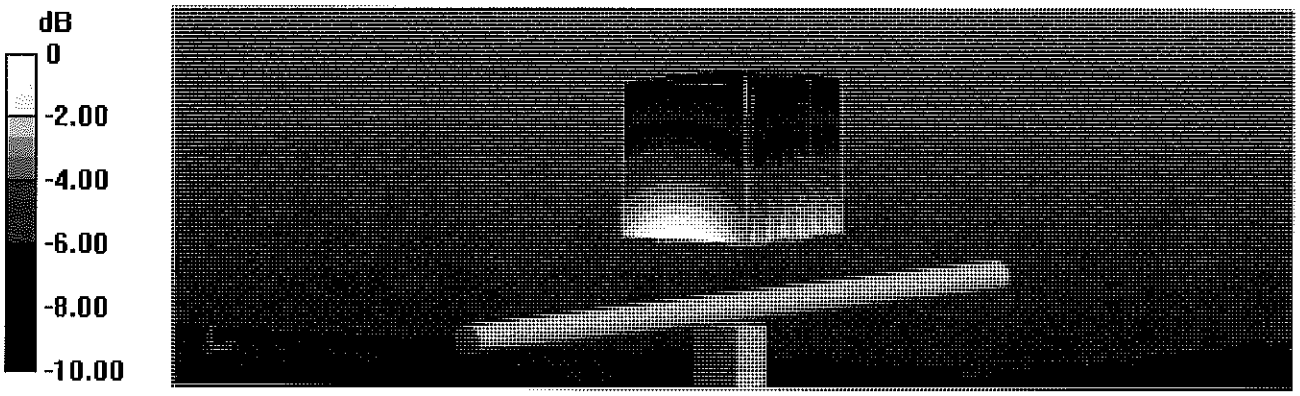
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma$ = 0.96 S/m; $\varepsilon_r$ = 54.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.19, 10.19, 10.19) @ 750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

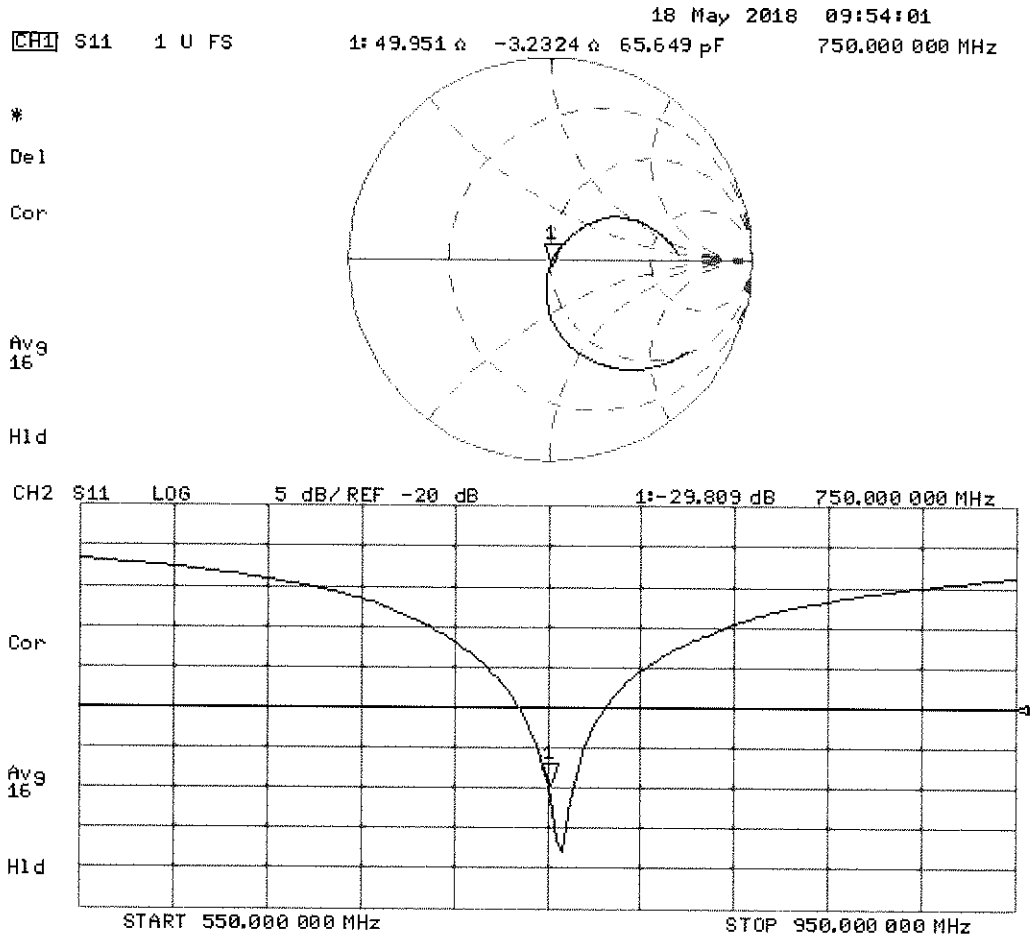
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.60 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.16 W/kg
**SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.42 W/kg**
Maximum value of SAR (measured) = 2.83 W/kg




0 dB = 2.83 W/kg = 4.52 dBW/kg

## Impedance Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D835V2-4d040_Jun17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D835V2 - SN:4d040 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | June 13, 2017 |

BNV 8/3/2017
SC ✓ 6/1/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Johannes Kurikka | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 15, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 41.0 ± 6 % | 0.93 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (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 | **9.46 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.56 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 | 54.7 ± 6 % | 1.00 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.45 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **9.56 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.60 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.28 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 | 49.8 Ω - 4.4 jΩ |
| Return Loss | - 27.0 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 46.4 Ω - 6.5 jΩ |
| Return Loss | - 22.3 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.391 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 | September 20, 2005 |

## DASY5 Validation Report for Head TSL

Date: 13.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d040**

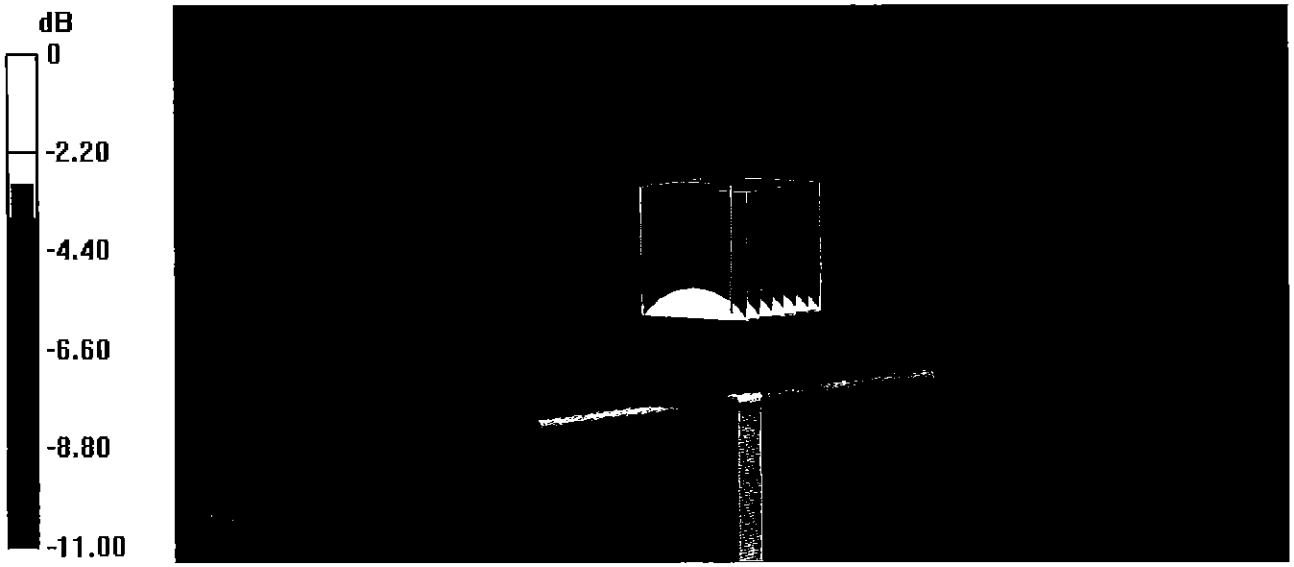
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 0.93 S/m; $\varepsilon_r$ = 41; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

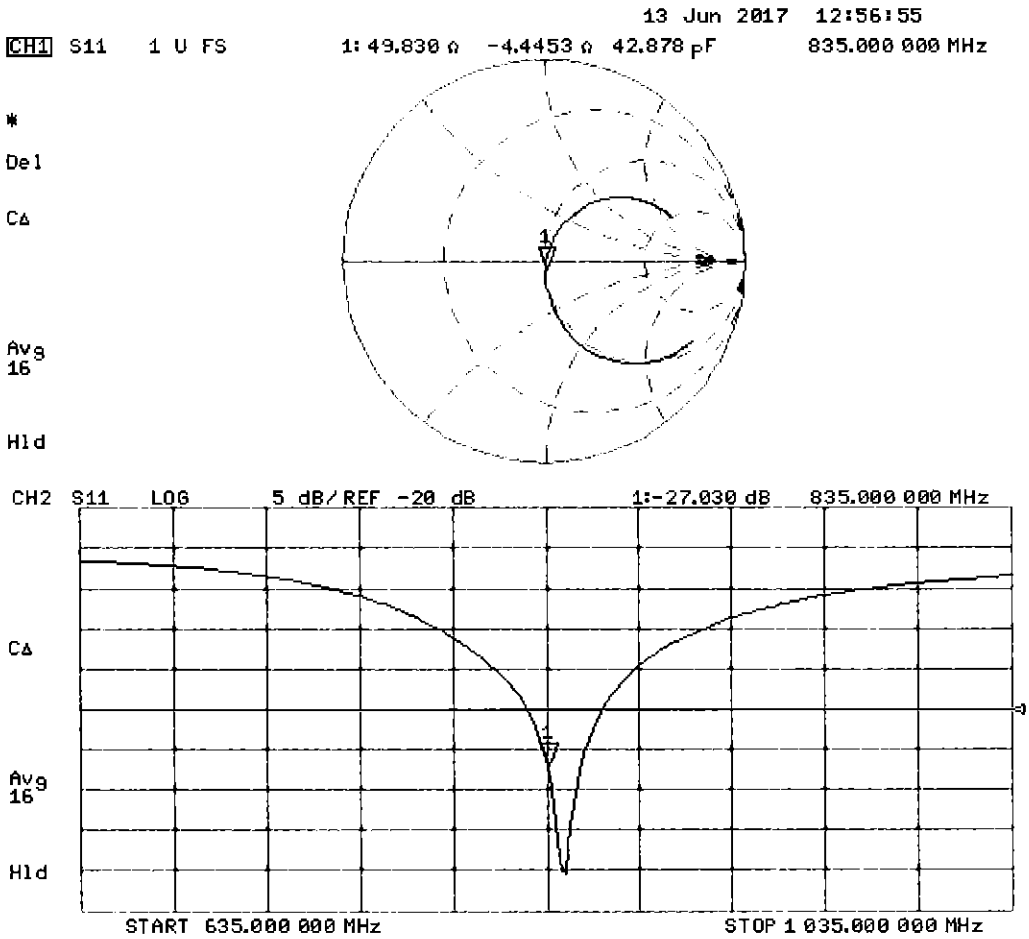
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 62.24 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.79 W/kg
**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.56 W/kg**
Maximum value of SAR (measured) = 3.32 W/kg




0 dB = 3.32 W/kg = 5.21 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 12.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d040**

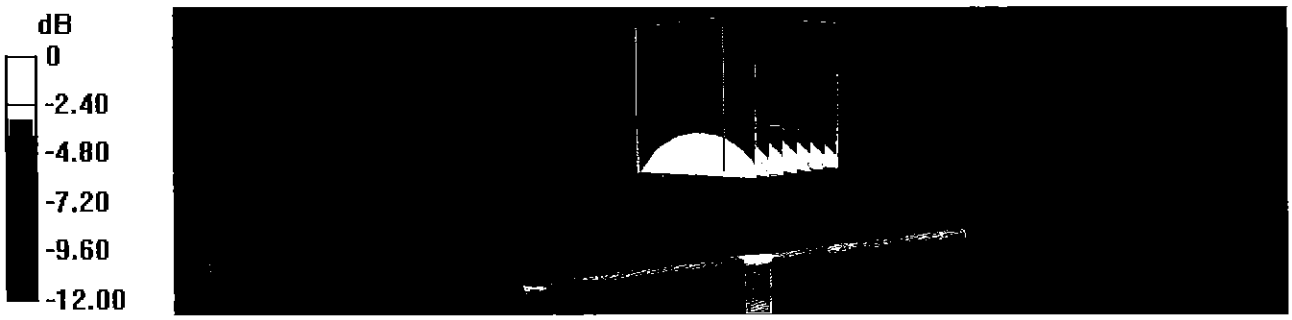
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 1 S/m; $\varepsilon_r$ = 54.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.2, 10.2, 10.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

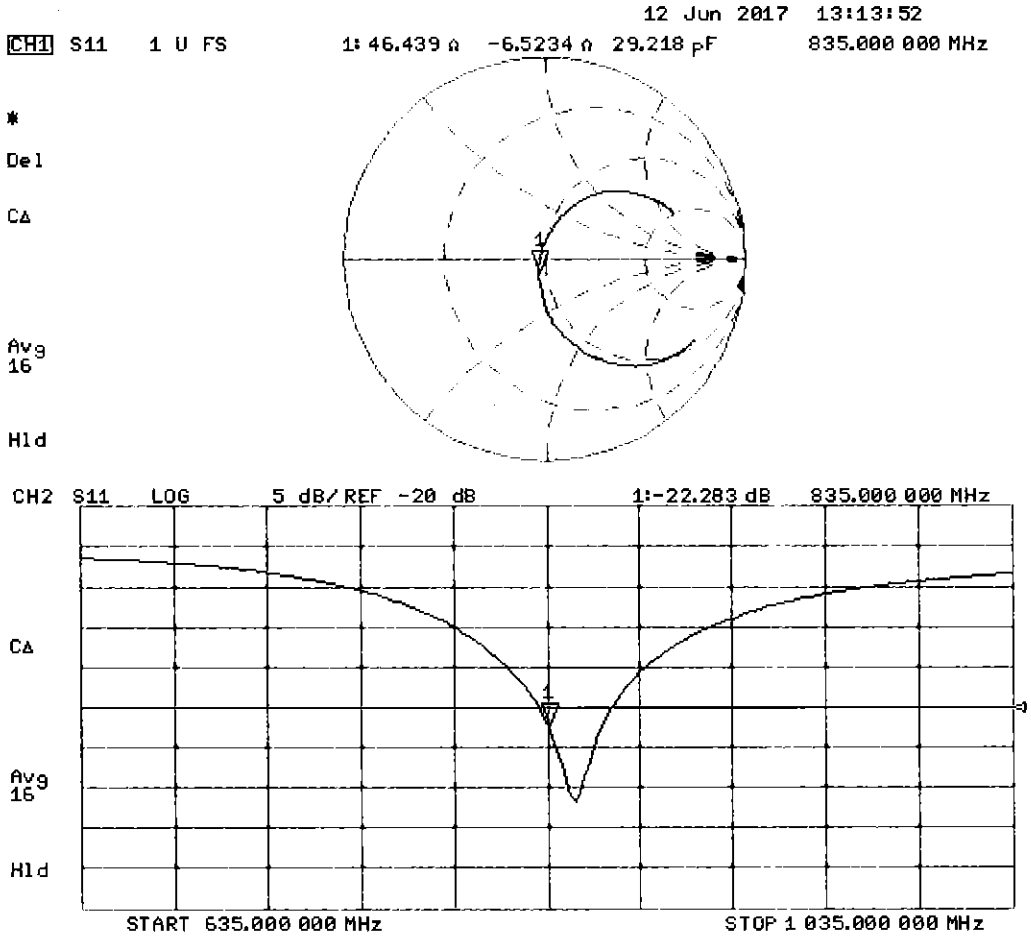
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 59.95 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.72 W/kg
**SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.6 W/kg**
Maximum value of SAR (measured) = 3.26 W/kg




0 dB = 3.26 W/kg = 5.13 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D835V2 – SN: 4d040

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: June 01, 2018

Description: SAR Validation Dipole at 835 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/1/2017 | Annual | 6/1/2018 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2208-6 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAKS-3.5 | Portable DAK | 9/5/2017 | Annual | 9/5/2018 | 1045 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3131 |
| SPEAG | EX3DV4 | SAR Probe | 1/26/2018 | Annual | 1/26/2019 | 7490 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 604 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1532 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Biomedical Engineer II | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

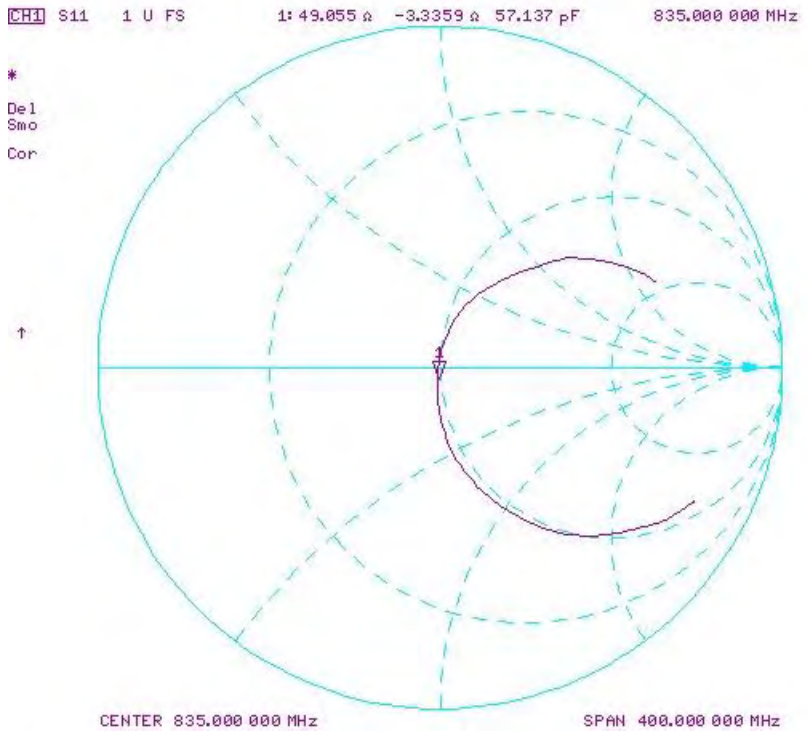
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

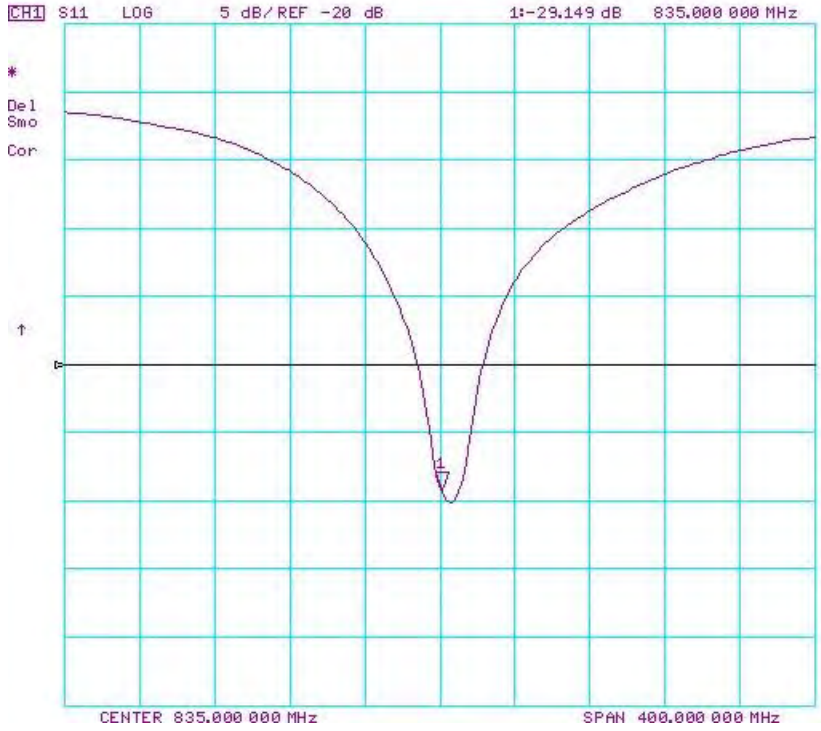
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 23.0 dBm | Measured Head SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 23.0 dBm | Measured Head SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/13/2017 | 6/1/2018 | 1.391 | 1.892 | 1.99 | 5.18% | 1.222 | 1.3 | 6.38% | 49.8 | 49.1 | 0.7 | -4.4 | -3.3 | 1.1 | -27 | -29.1 | -7.80% | PASS |

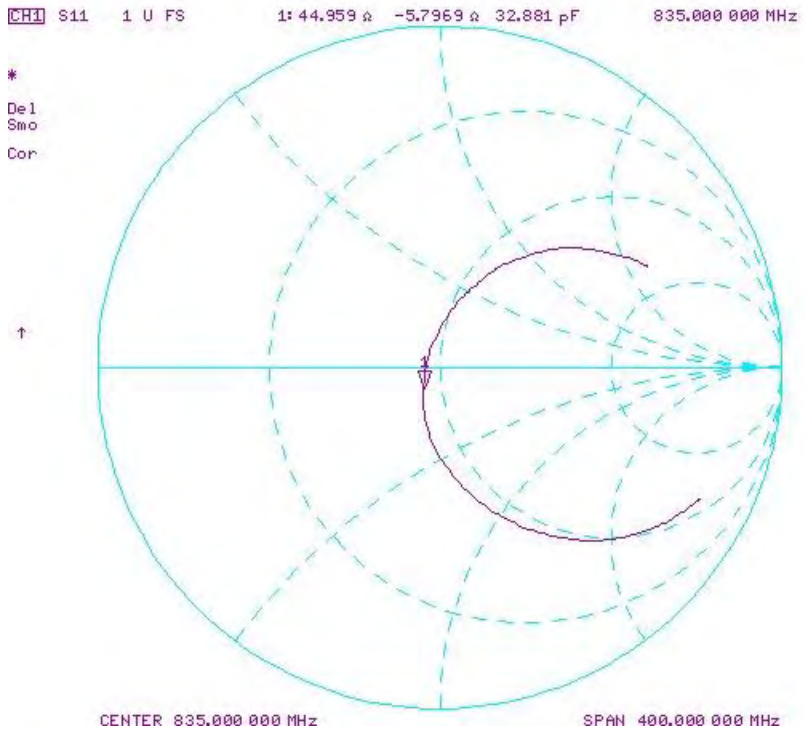
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 23.0 dBm | Measured Body SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 23.0 dBm | Measured Body SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/13/2017 | 6/1/2018 | 1.391 | 1.912 | 1.9 | -0.63% | 1.256 | 1.26 | 0.32% | 46.4 | 45 | 1.4 | -6.5 | -5.8 | 0.7 | -22.3 | -22.5 | -0.90% | PASS |

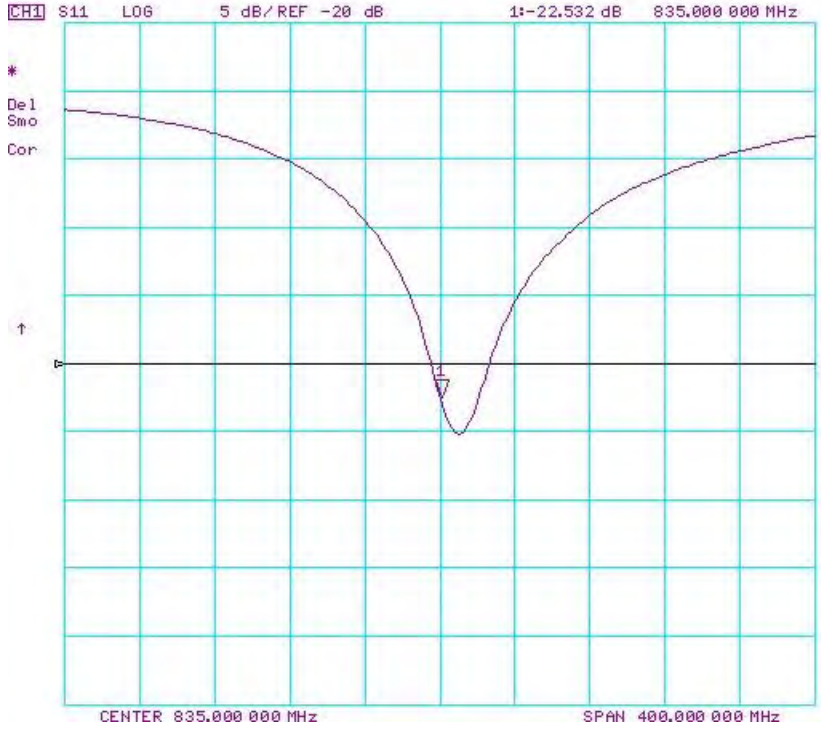
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D850V2-1009_Aug17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D850V2 - SN:1009 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 16, 2017 |

8/27/17
PM
8/4/18
SC ✓

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 tempereture (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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Johannes Kurikka | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 17, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 850 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 | 0.92 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 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.56 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **10.0 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.66 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **6.54 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 | 0.99 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 54.7 ± 6 % | 1.02 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.53 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **9.88 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.65 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.48 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 - 2.5 jΩ |
| Return Loss | - 29.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.5 Ω - 7.3 jΩ |
| Return Loss | - 22.1 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.438 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 | September 04, 2012 |

## DASY5 Validation Report for Head TSL

Date: 16.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 850 MHz; Type: D850V2; Serial: D850V2 - SN:1009**

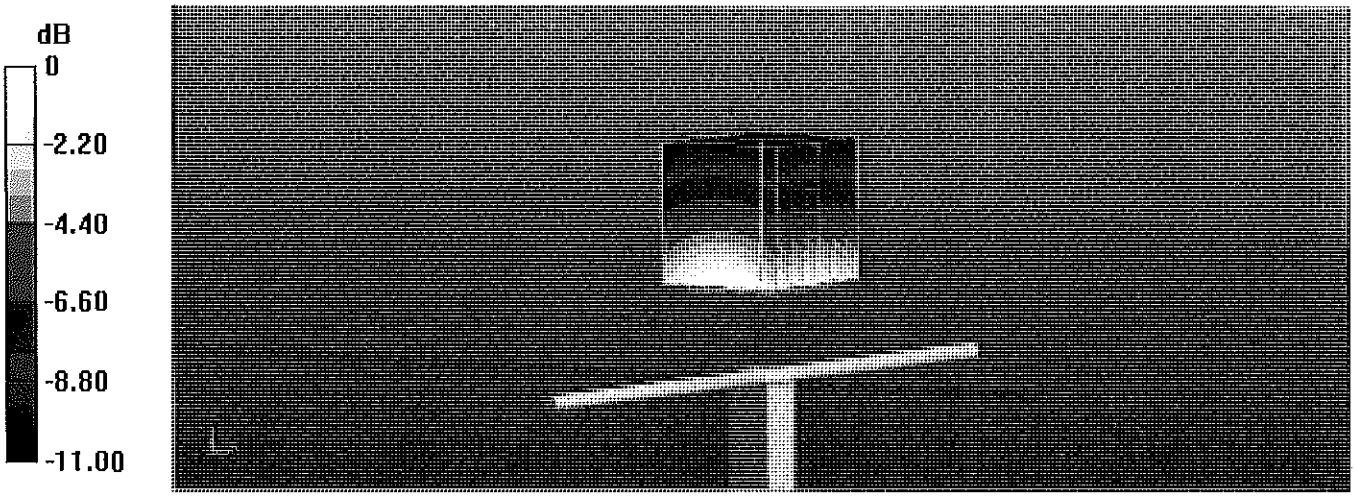
Communication System: UID 0 - CW; Frequency: 850 MHz
Medium parameters used: f = 850 MHz; $\sigma$ = 0.94 S/m; $\varepsilon_r$ = 40.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.93, 9.93, 9.93); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

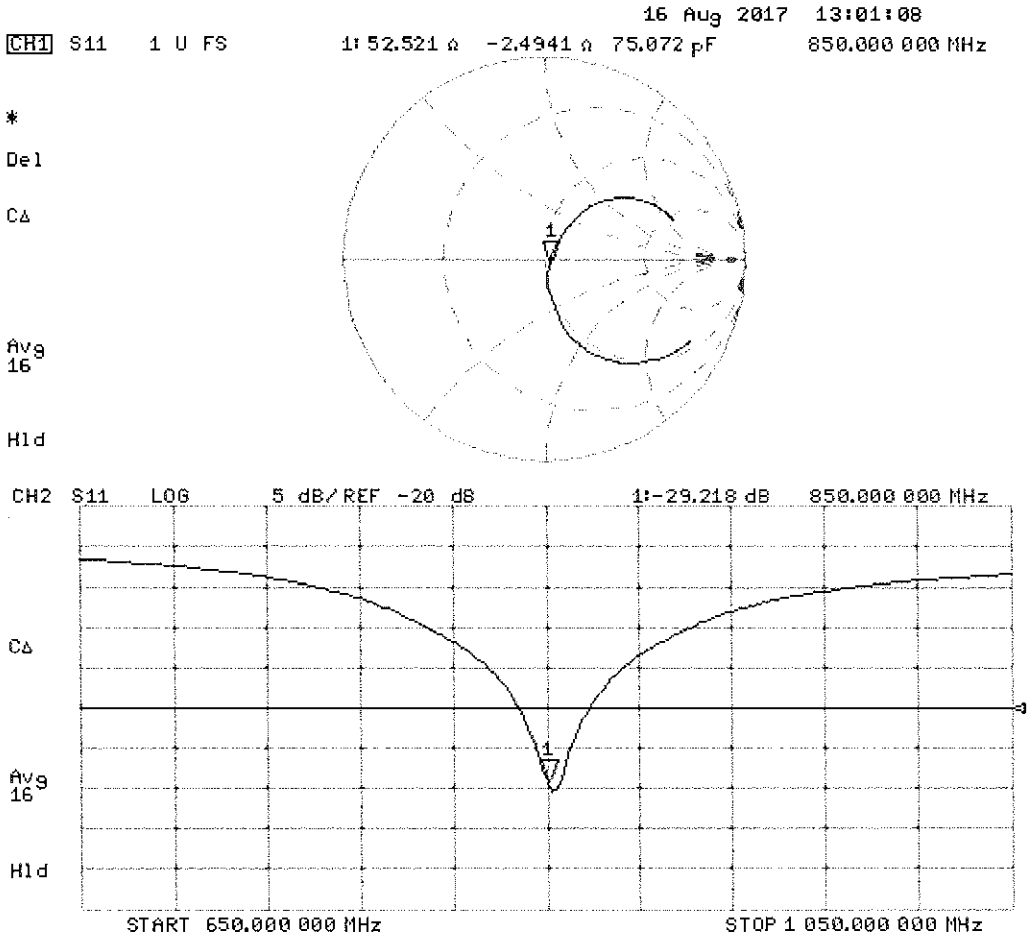
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.35 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 3.86 W/kg
**SAR(1 g) = 2.56 W/kg; SAR(10 g) = 1.66 W/kg**
Maximum value of SAR (measured) = 3.43 W/kg




0 dB = 3.43 W/kg = 5.35 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 16.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 850 MHz; Type: D850V2; Serial: D850V2 - SN:1009**

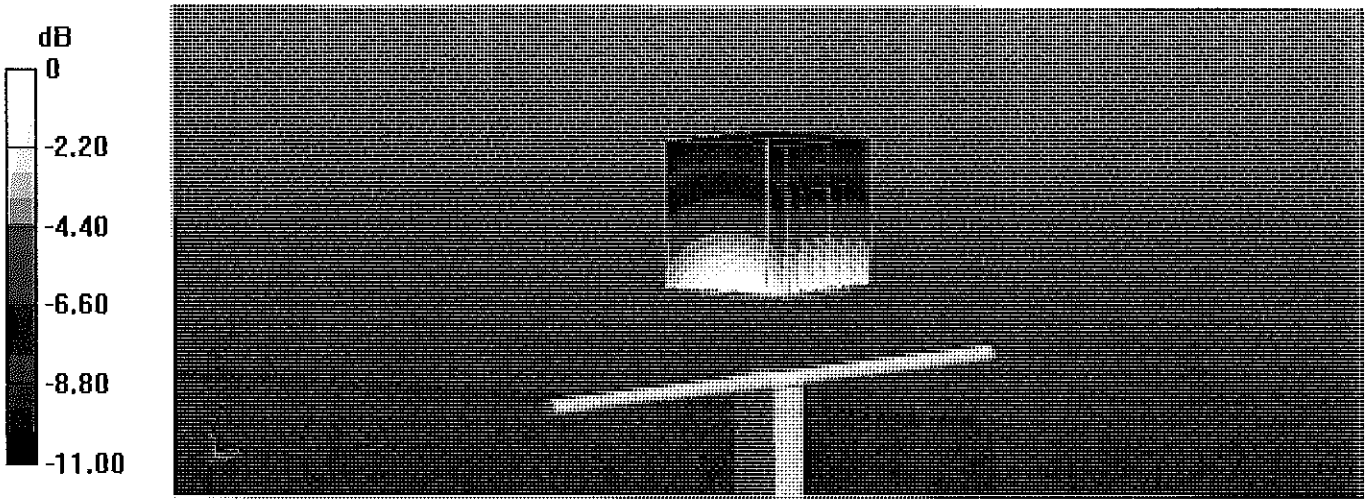
Communication System: UID 0 - CW; Frequency: 850 MHz
Medium parameters used: f = 850 MHz; $\sigma$ = 1.02 S/m; $\varepsilon_r$ = 54.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.11, 10.11, 10.11); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

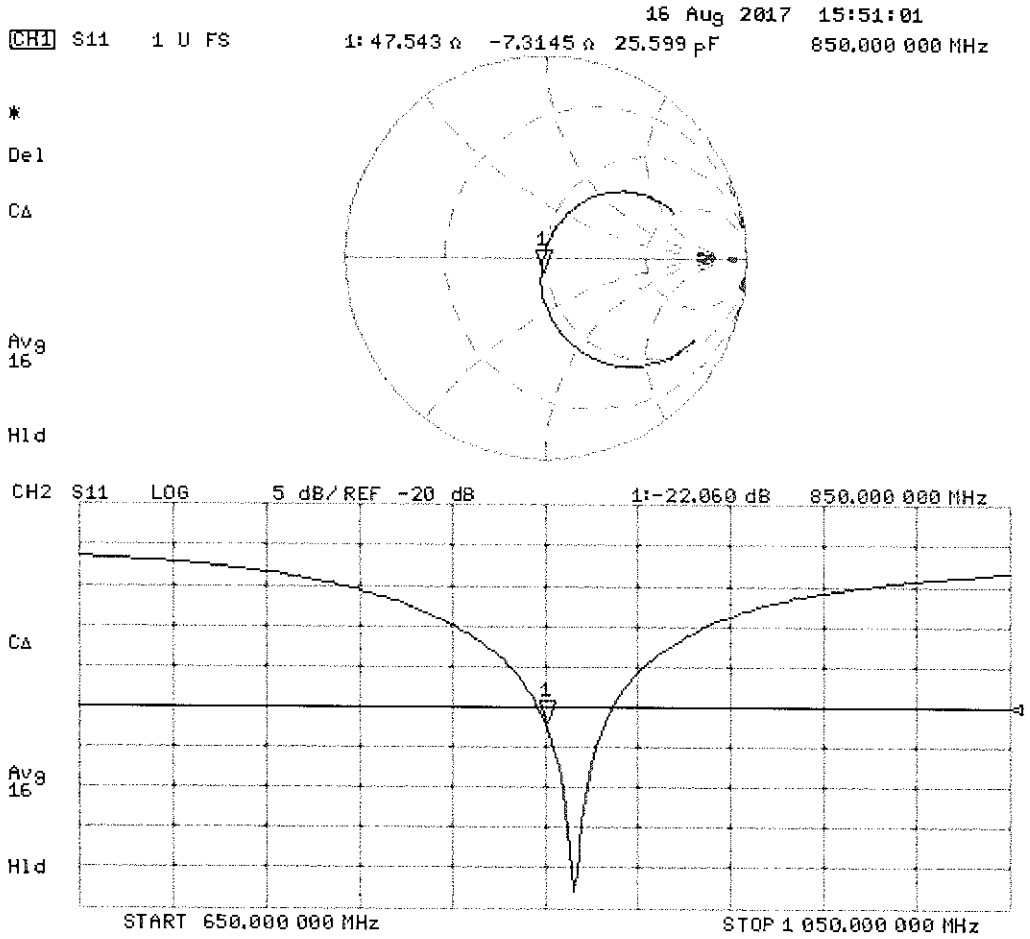
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 60.51 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 3.80 W/kg
**SAR(1 g) = 2.53 W/kg; SAR(10 g) = 1.65 W/kg**
Maximum value of SAR (measured) = 3.35 W/kg




0 dB = 3.35 W/kg = 5.25 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D850V2 – SN: 1009

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: August 02, 2018

Description: SAR Validation Dipole at 850 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2208-6 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAKS-3.5 | Portable DAK | 9/5/2017 | Annual | 9/5/2018 | 1045 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3131 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 604 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Biomedical Engineer II | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

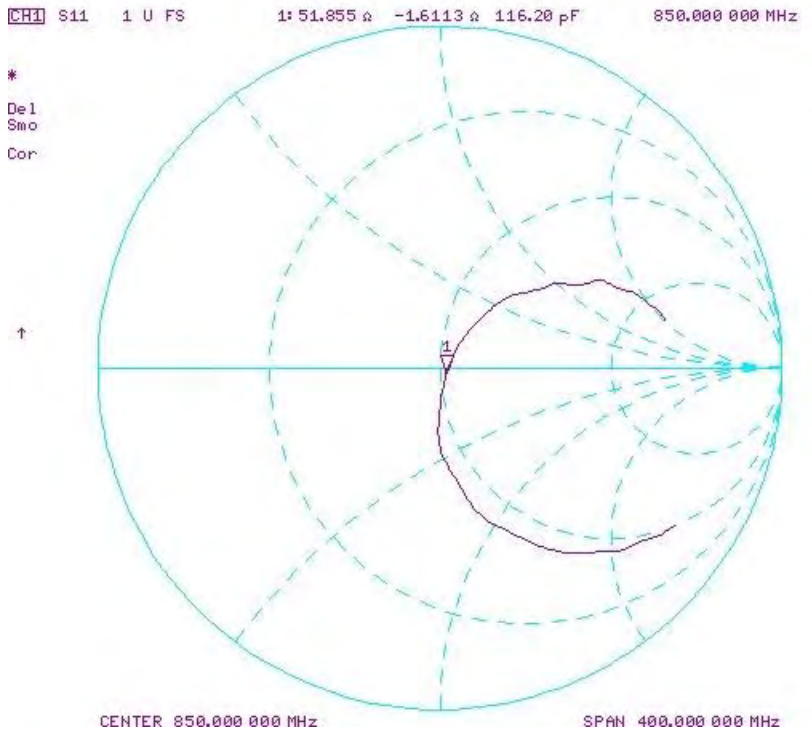
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

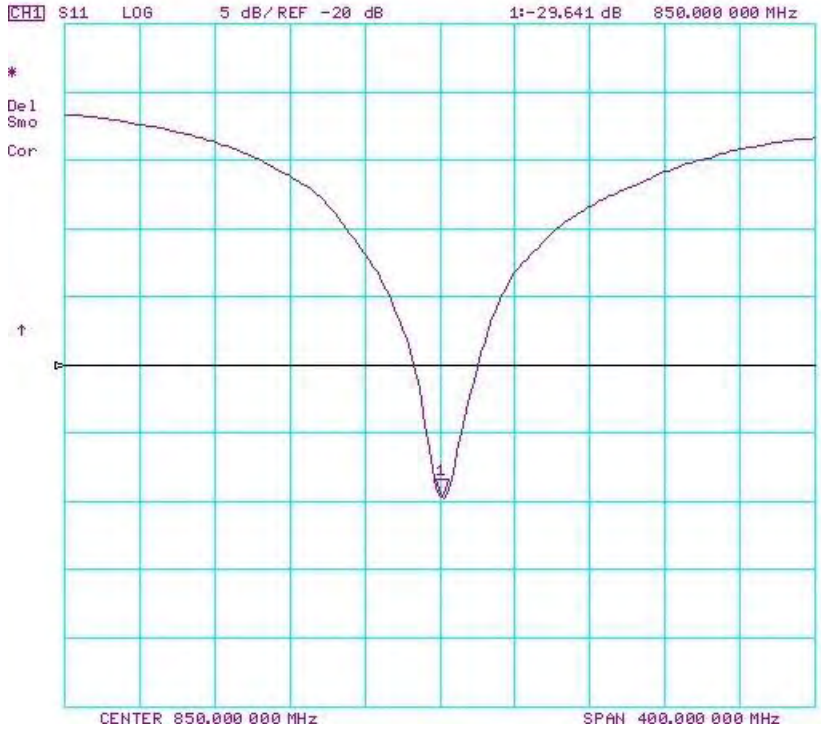
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 23.0 dBm | Measured Head SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 23.0 dBm | Measured Head SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/16/2017 | 8/2/2018 | 1.438 | 2 | 1.93 | -3.50% | 1.308 | 1.25 | -4.43% | 52.5 | 51.9 | 0.6 | -2.5 | -1.6 | 0.9 | -29.2 | -29.6 | -1.40% | PASS |

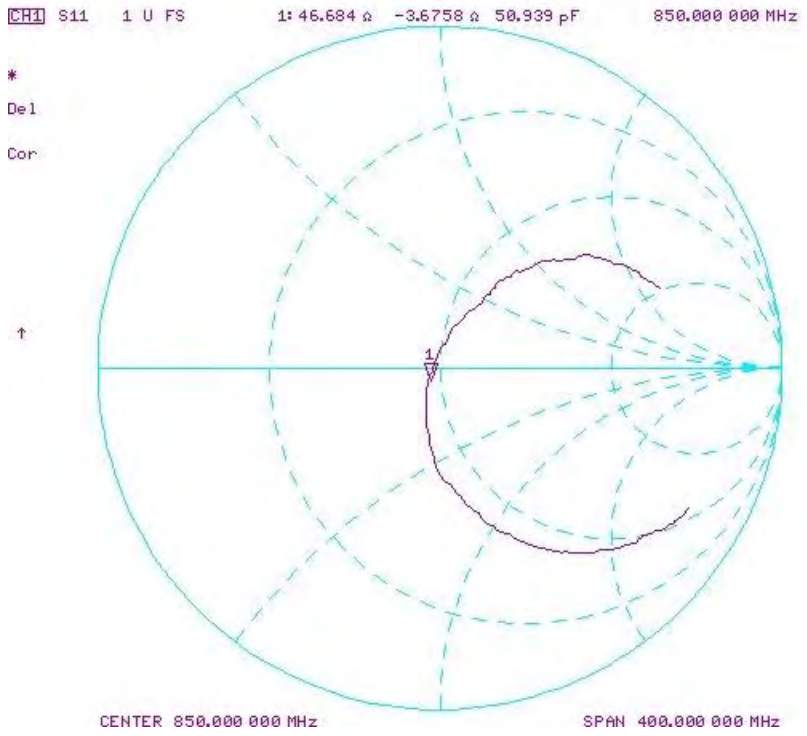
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 23.0 dBm | Measured Body SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 23.0 dBm | Measured Body SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/16/2017 | 8/2/2018 | 1.438 | 1.976 | 2.07 | 4.76% | 1.296 | 1.36 | 4.94% | 47.5 | 46.7 | 0.8 | -7.3 | -3.7 | 3.6 | -22.1 | -26 | -17.60% | PASS |

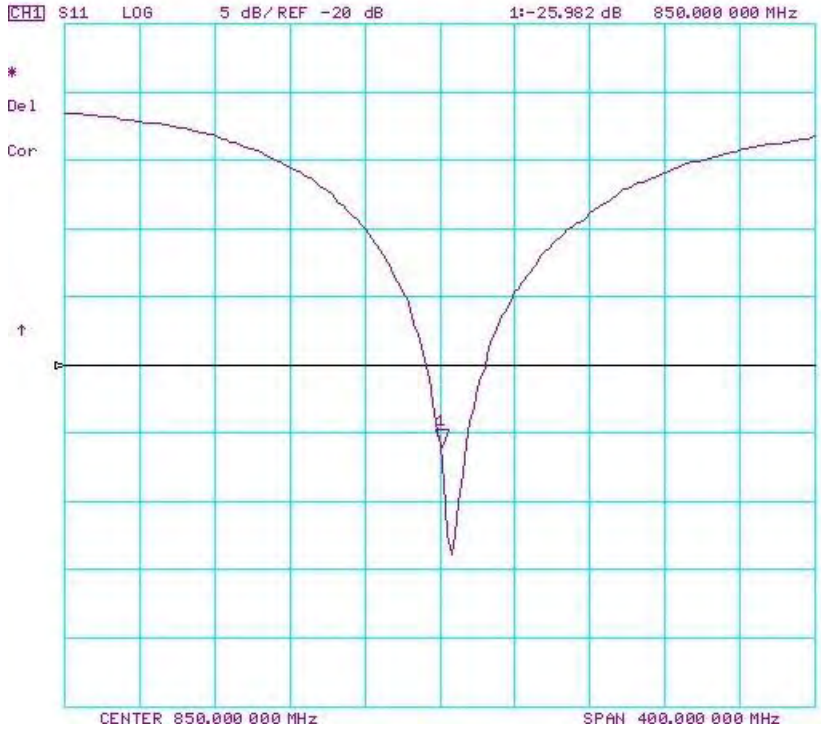
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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 **PC Test**

**Certificate No: D850V2-1010_Sep17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D850V2 - SN:1010 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | September 08, 2017 |

SC ✓ 10/03/2017

SC ✓ 9/8/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

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

Issued: September 8, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 850 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 | 0.92 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 | 2.53 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **9.93 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.63 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **6.42 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 | 0.99 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 55.3 ± 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 | 2.55 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **10.2 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.67 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.68 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 | 50.2 Ω - 3.1 jΩ |
| Return Loss | - 30.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 46.6 Ω - 5.8 jΩ |
| Return Loss | - 23.2 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.432 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 | September 04, 2012 |

## DASY5 Validation Report for Head TSL

Date: 08.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 850 MHz; Type: D850V2; Serial: D850V2 - SN:1010**

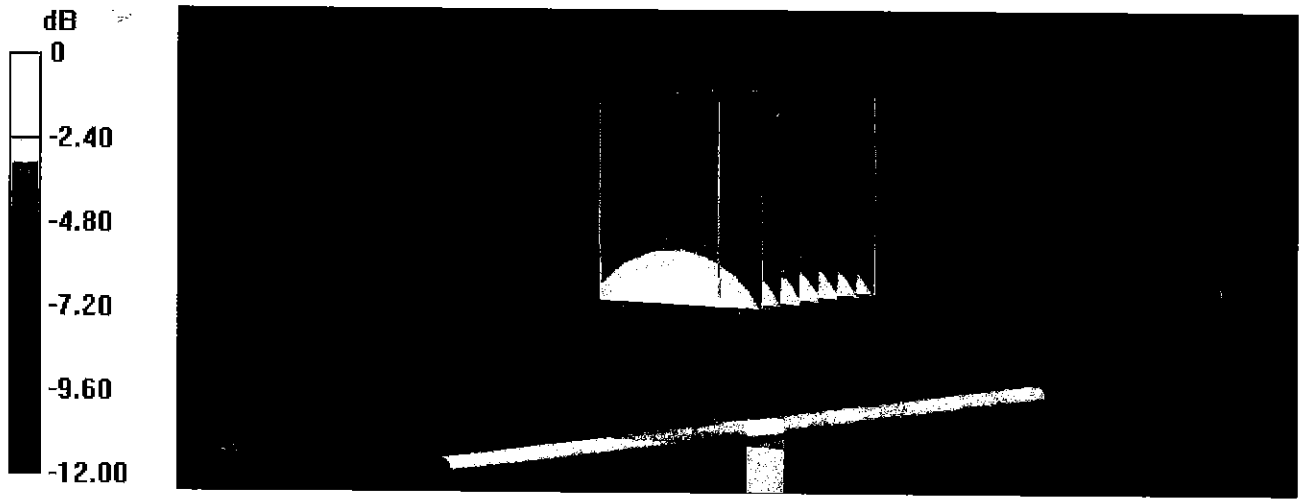
Communication System: UID 0 - CW; Frequency: 850 MHz
Medium parameters used: f = 850 MHz; $\sigma$ = 0.94 S/m; $\varepsilon_r$ = 40.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.93, 9.93, 9.93); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

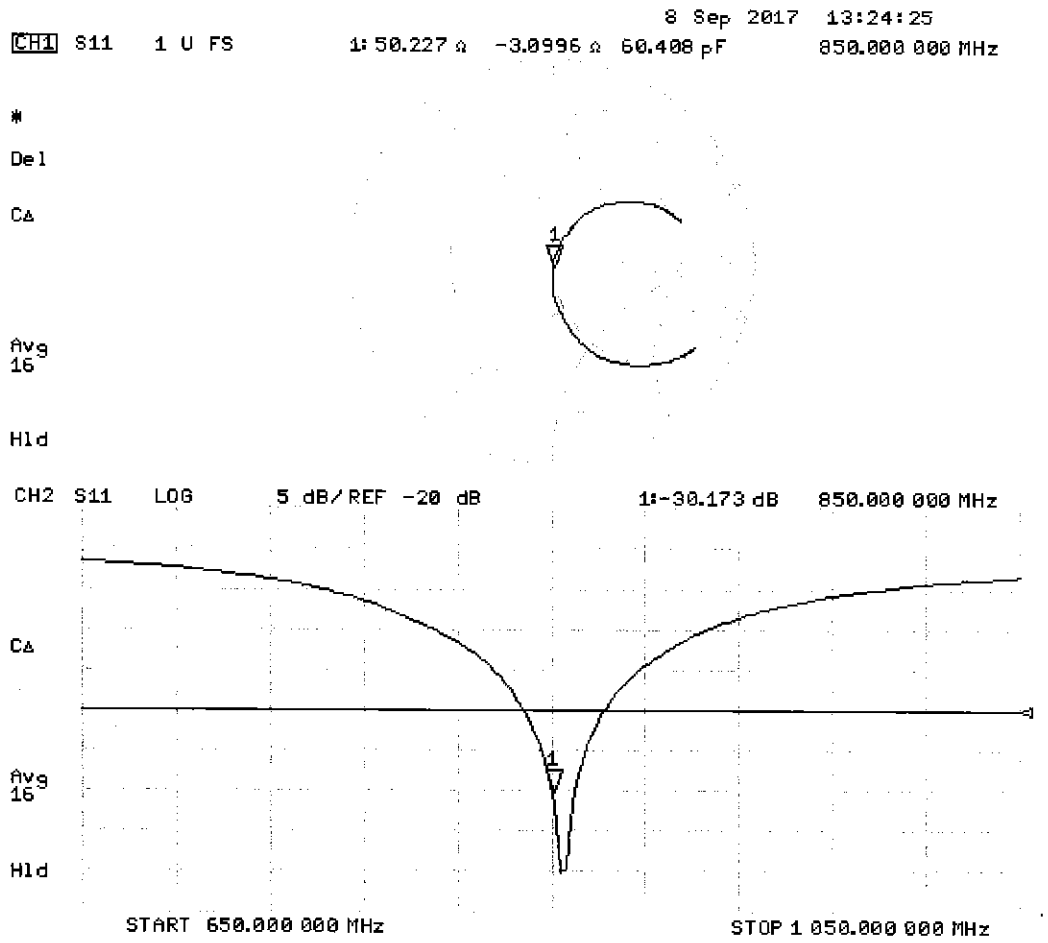
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.32 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.85 W/kg
**SAR(1 g) = 2.53 W/kg; SAR(10 g) = 1.63 W/kg**
Maximum value of SAR (measured) = 3.41 W/kg




0 dB = 3.41 W/kg = 5.33 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 08.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 850 MHz; Type: D850V2; Serial: D850V2 - SN:1010**

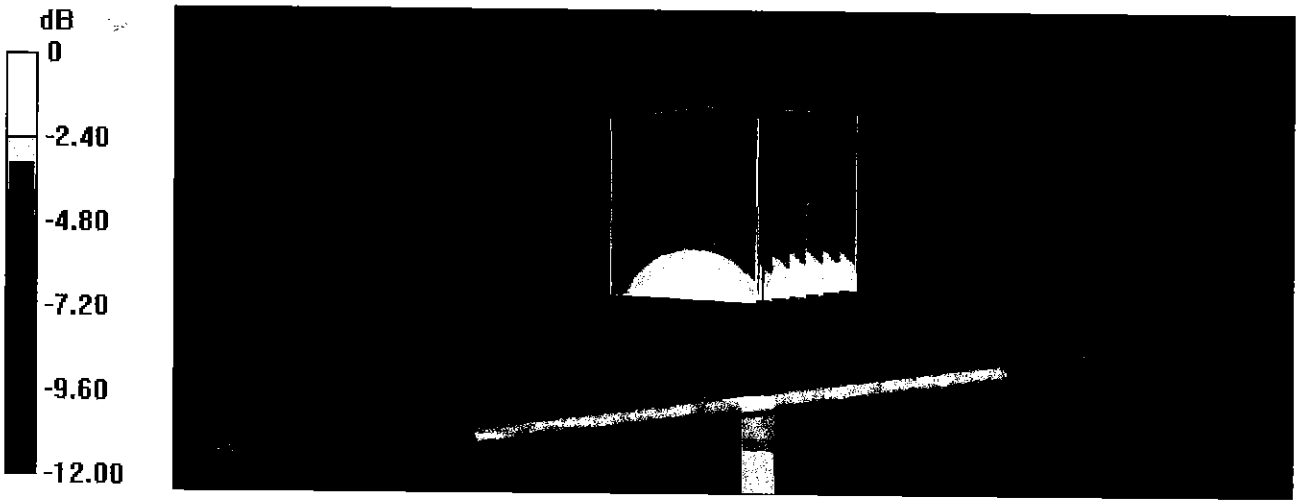
Communication System: UID 0 - CW; Frequency: 850 MHz
Medium parameters used: f = 850 MHz; $\sigma$ = 0.99 S/m; $\varepsilon_r$ = 55.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.11, 10.11, 10.11); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

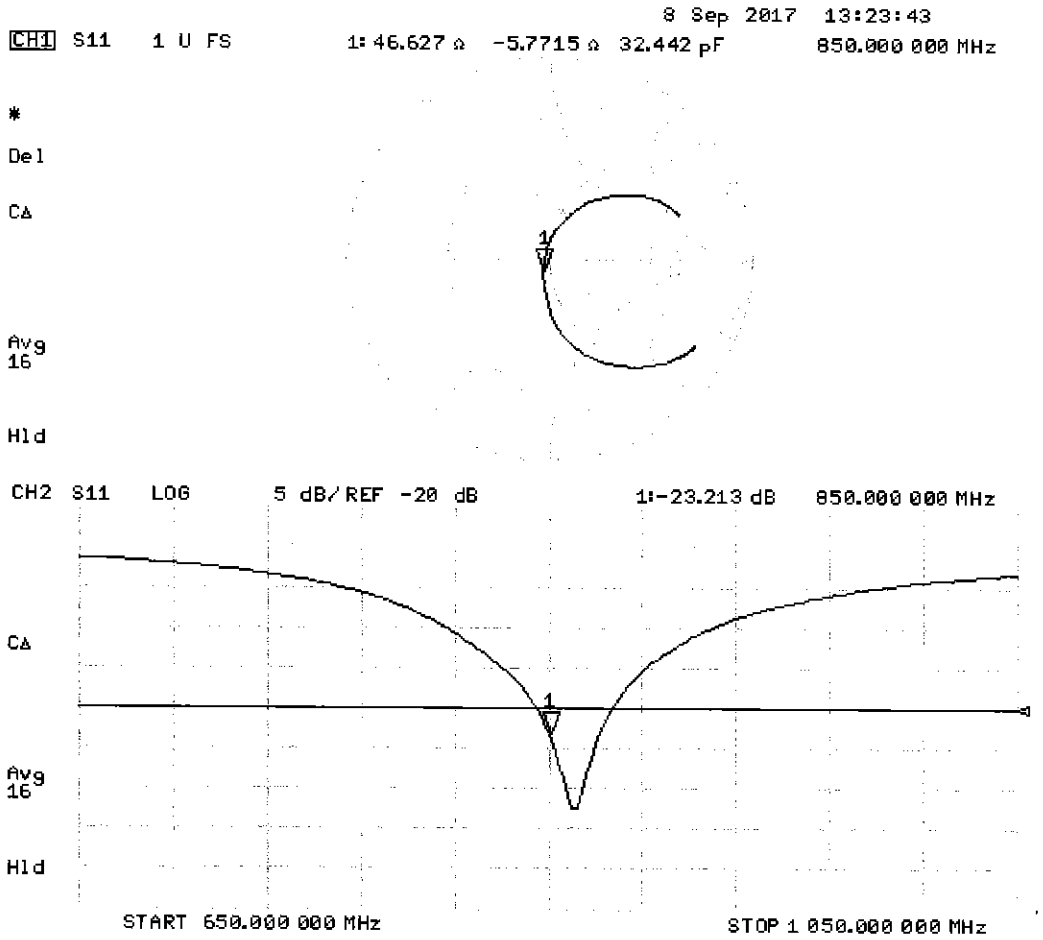
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 61.09 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 3.79 W/kg
**SAR(1 g) = 2.55 W/kg; SAR(10 g) = 1.67 W/kg**
Maximum value of SAR (measured) = 3.36 W/kg




0 dB = 3.36 W/kg = 5.26 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D850V2 – SN: 1010

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: September 08, 2018

Description: SAR Validation Dipole at 850 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 5/15/2018 | Annual | 5/15/2019 | 1070 |
| SPEAG | ES3DV3 | SAR Probe | 9/18/2017 | Annual | 9/18/2018 | 3287 |
| SPEAG | DAE4 | Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1533 |
| SPEAG | EX3DV4 | SAR Probe | 1/26/2018 | Annual | 1/26/2019 | 7490 |
| SPEAG | DAE4 | Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1532 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Team Lead Engineer | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

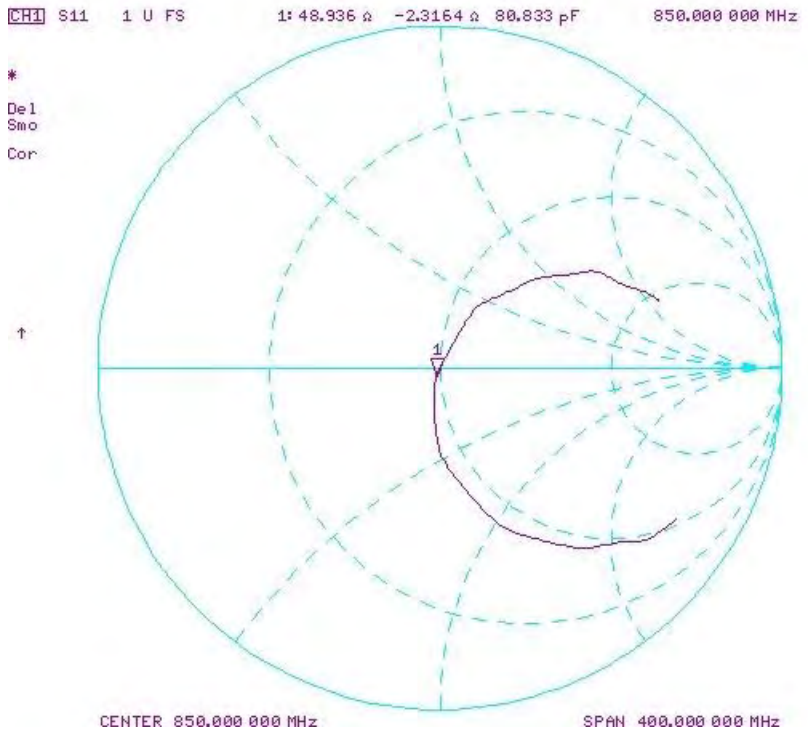
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

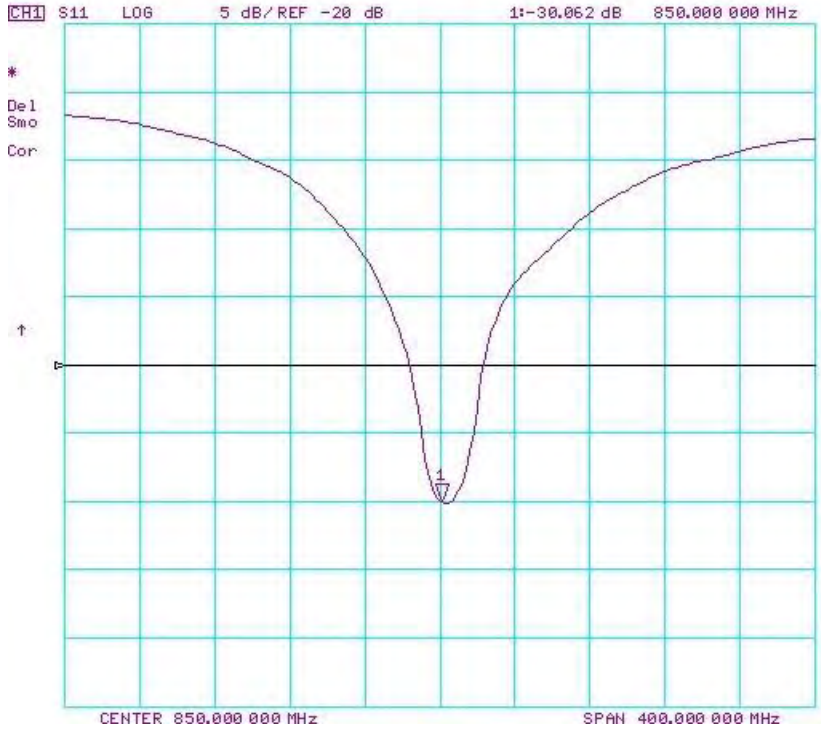
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 23.0 dBm | Measured Head SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 23.0 dBm | Measured Head SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/8/2017 | 9/8/2018 | 1.432 | 1.986 | 2.01 | 1.21% | 1.284 | 1.31 | 2.02% | 50.2 | 48.9 | 1.3 | -3.1 | -2.3 | 0.8 | -30.2 | -30.1 | 0.30% | PASS |

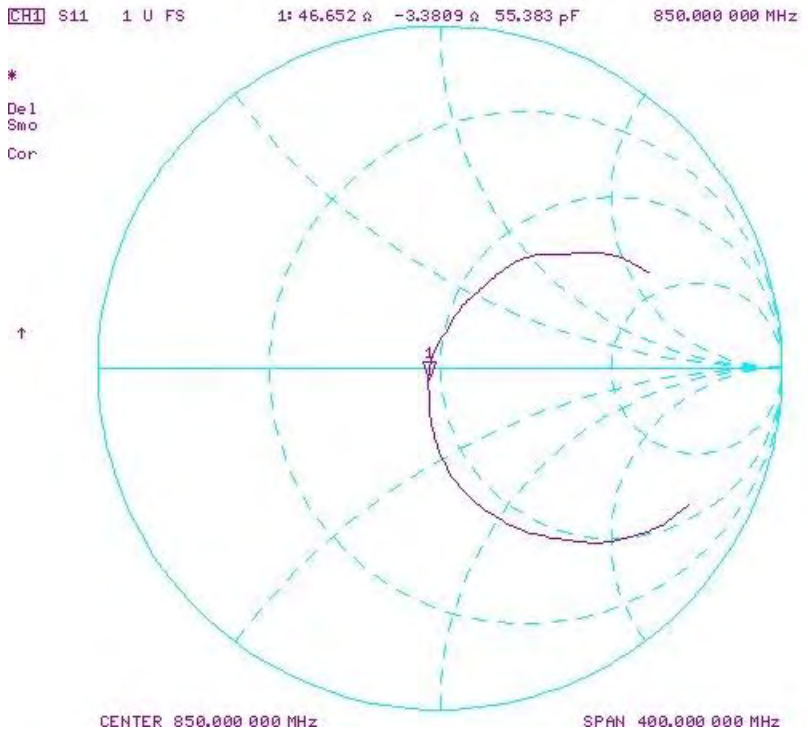
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 23.0 dBm | Measured Body SAR (1g) W/kg @ 23.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 23.0 dBm | Measured Body SAR (10g) W/kg @ 23.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/8/2017 | 9/8/2017 | 1.432 | 2.04 | 2.01 | -1.47% | 1.336 | 1.32 | -1.20% | 46.6 | 46.7 | 0.1 | -5.8 | -3.4 | 2.4 | -23.2 | -25.8 | -11.20% | PASS |

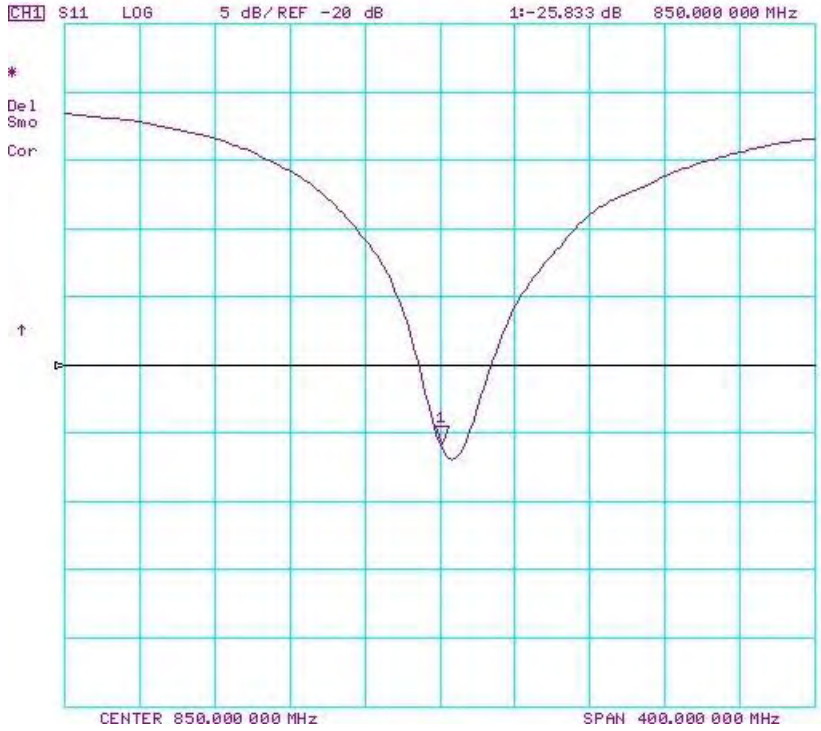
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D1750V2-1092_May18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1750V2 - SN:1092 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | May 15, 2018 |

SC ✓
5/31/2018

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 26-Oct-17 (No. DAE4-601_Oct17) | Oct-18 |

| 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-17) | In house check: Oct-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Manu Seitz | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: May 17, 2018

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.1 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1750 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.1 | 1.37 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.0 ± 6 % | 1.34 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 8.95 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **36.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 4.73 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **19.0 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 | 53.4 | 1.49 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.2 ± 6 % | 1.46 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 8.99 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **36.4 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 4.81 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **19.4 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 | 49.2 Ω - 1.0 jΩ |
| Return Loss | - 37.8 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 44.8 Ω - 0.6 jΩ |
| Return Loss | - 25.2 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.217 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 07, 2012 |

## DASY5 Validation Report for Head TSL

Date: 15.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1092**

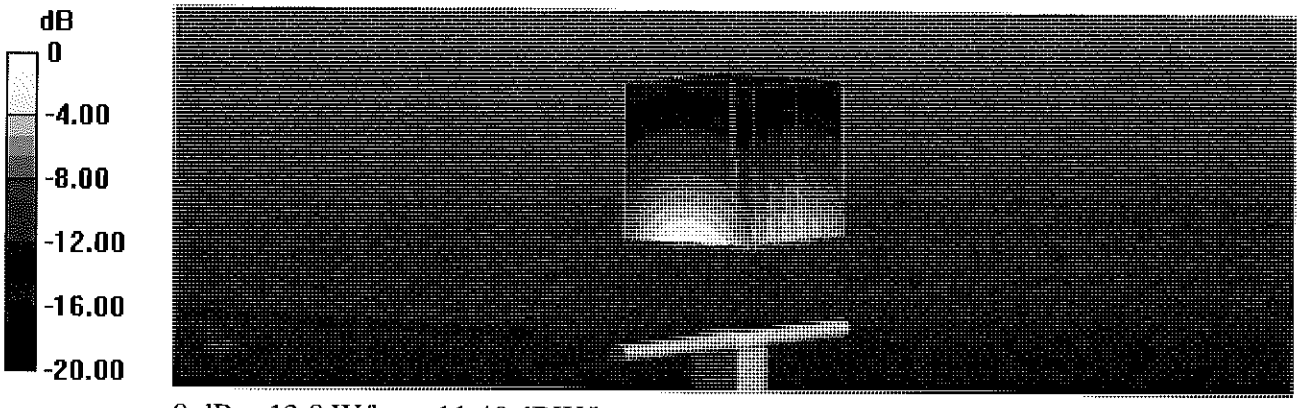
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.34 S/m; $\varepsilon_r$ = 39; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.5, 8.5, 8.5) @ 1750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

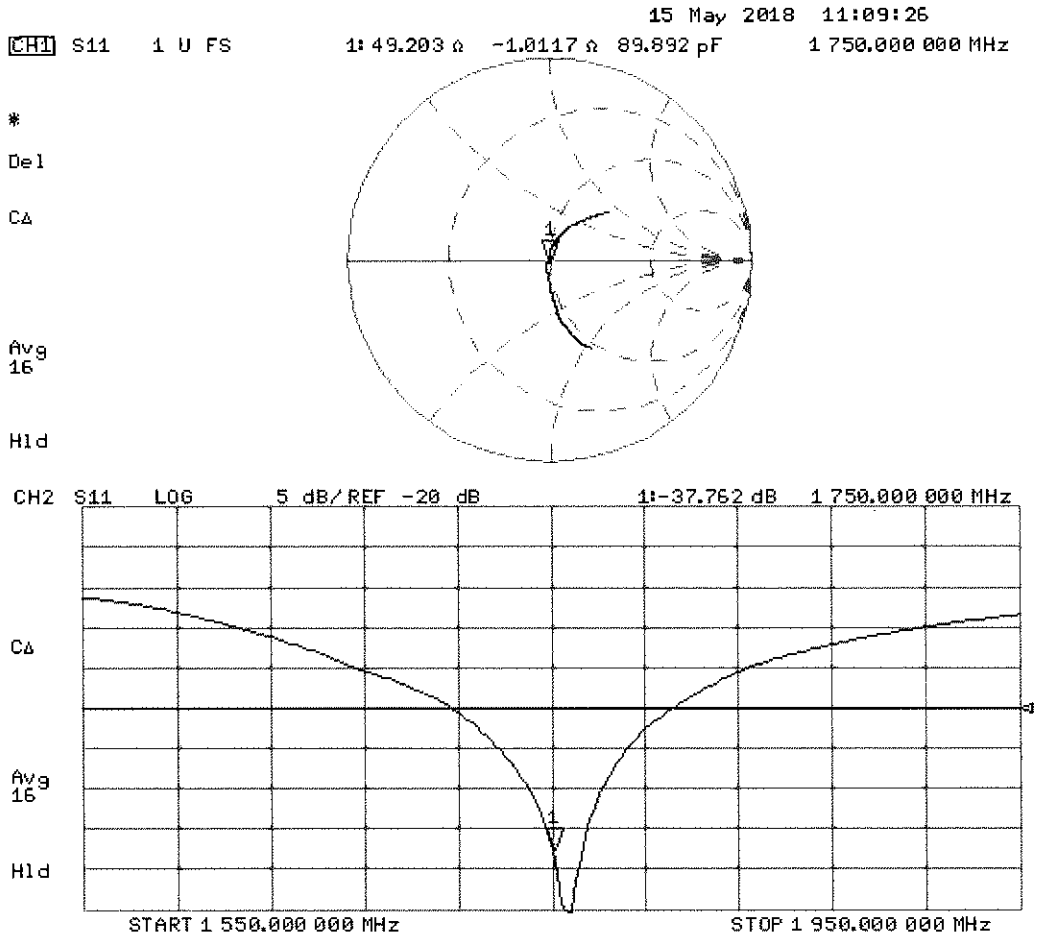
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 106.8 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 16.3 W/kg
**SAR(1 g) = 8.95 W/kg; SAR(10 g) = 4.73 W/kg**
Maximum value of SAR (measured) = 13.8 W/kg




0 dB = 13.8 W/kg = 11.40 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 15.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1092**

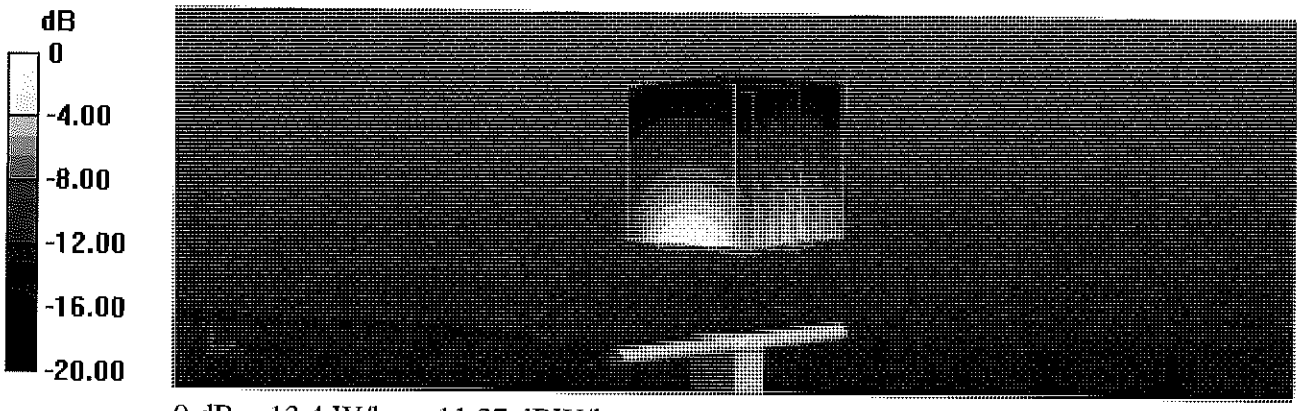
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.46 S/m; $\varepsilon_r$ = 53.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.35, 8.35, 8.35) @ 1750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

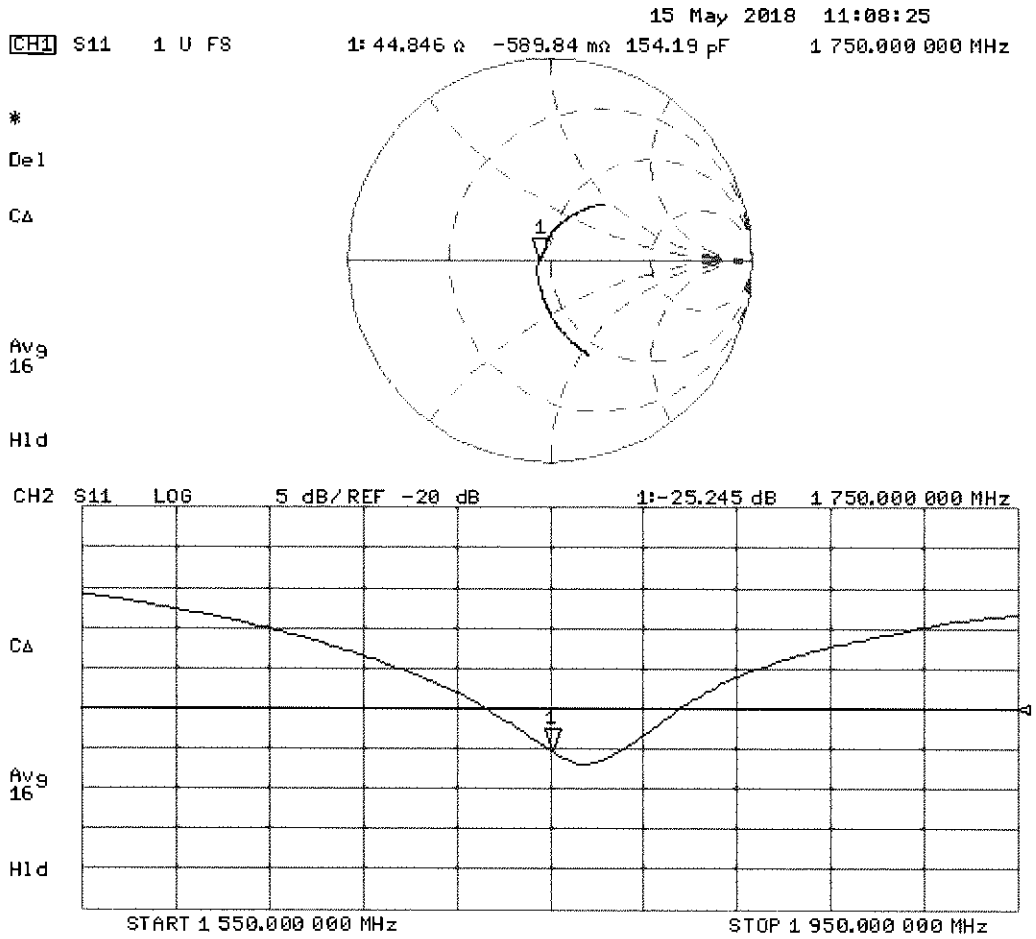
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.4 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 15.8 W/kg
**SAR(1 g) = 8.99 W/kg; SAR(10 g) = 4.81 W/kg**
Maximum value of SAR (measured) = 13.4 W/kg




0 dB = 13.4 W/kg = 11.27 dBW/kg

## Impedance Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D1750V2-1083_Jun17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1750V2 - SN: 1083 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | June 09, 2017 |

BNV ✓ 8/3/2017
SCV ✓ 6/1/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 13, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1750 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.1 | 1.37 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.2 ± 6 % | 1.36 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **36.7 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 4.83 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **19.3 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 | 53.4 | 1.49 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.2 ± 6 % | 1.47 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.26 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **37.3 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 4.95 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 | 51.1 Ω - 1.2 jΩ |
| Return Loss | - 35.8 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 46.8 Ω - 1.2 jΩ |
| Return Loss | - 29.1 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.218 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 | January 19, 2011 |

## DASY5 Validation Report for Head TSL

Date: 08.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1083**

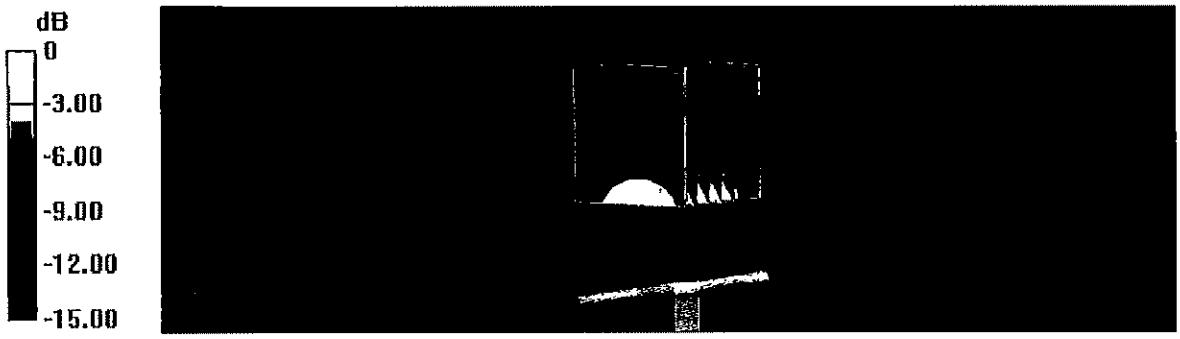
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.36 S/m; $\varepsilon_r$ = 39.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.73, 8.73, 8.73); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

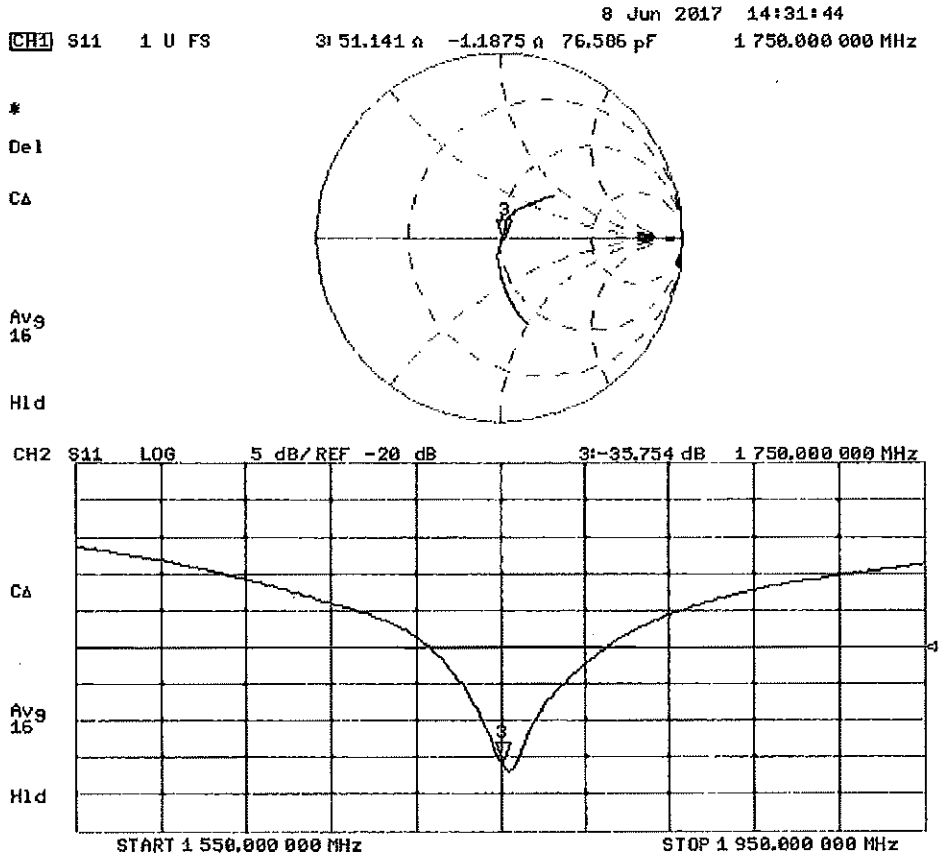
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 103.2 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 17.2 W/kg
**SAR(1 g) = 9.17 W/kg; SAR(10 g) = 4.83 W/kg**
Maximum value of SAR (measured) = 13.7 W/kg




0 dB = 13.7 W/kg = 11.37 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 09.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1083**

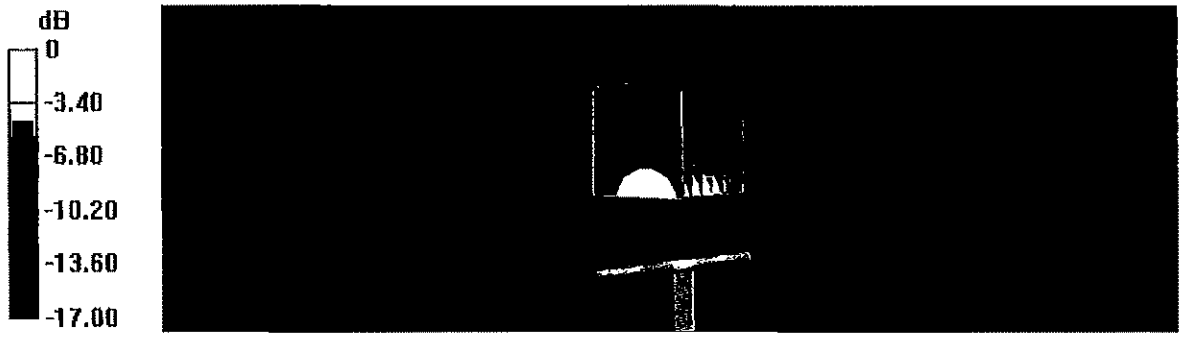
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.47 S/m; $\varepsilon_r$ = 53.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.46, 8.46, 8.46); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

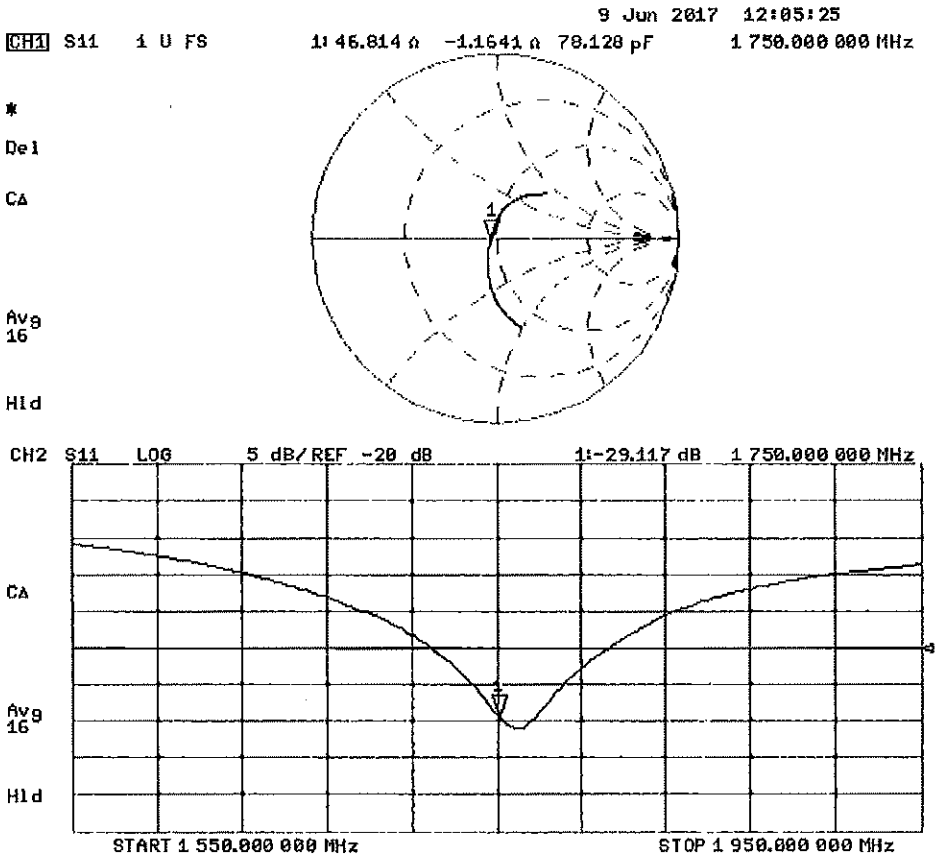
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.81 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 16.2 W/kg
**SAR(1 g) = 9.26 W/kg; SAR(10 g) = 4.95 W/kg**
Maximum value of SAR (measured) = 13.2 W/kg




0 dB = 13.2 W/kg = 11.21 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object: D1750V2 – SN: 1083

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: June 01, 2018

Description: SAR Validation Dipole at 1750 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/1/2017 | Annual | 6/1/2018 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAKS-3.5 | Portable DAK | 9/5/2017 | Annual | 9/5/2018 | 1045 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3131 |
| SPEAG | EX3DV4 | SAR Probe | 1/26/2018 | Annual | 1/26/2019 | 7490 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 604 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1532 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Biomedical Engineer II | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

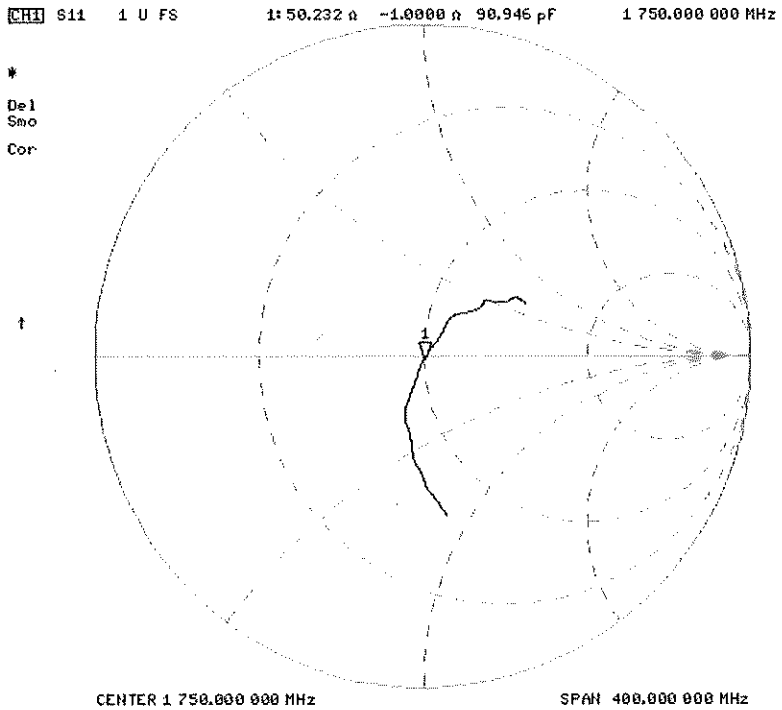
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

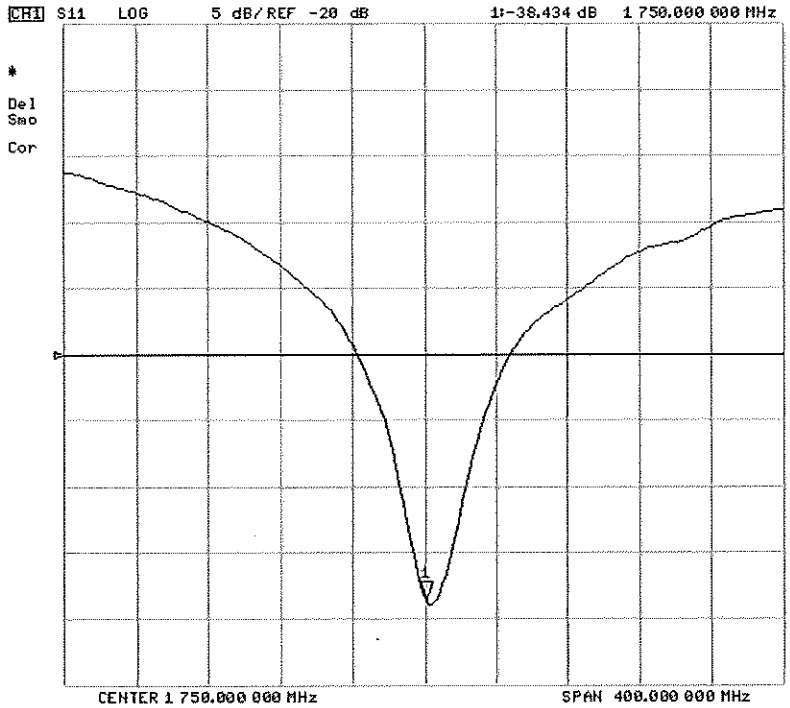
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/9/2017 | 6/1/2018 | 1.218 | 3.67 | 3.67 | 0.00% | 1.93 | 1.93 | 0.00% | 51.1 | 50.2 | 0.9 | -1.2 | -1 | 0.2 | -35.8 | -38.4 | -7.50% | PASS |

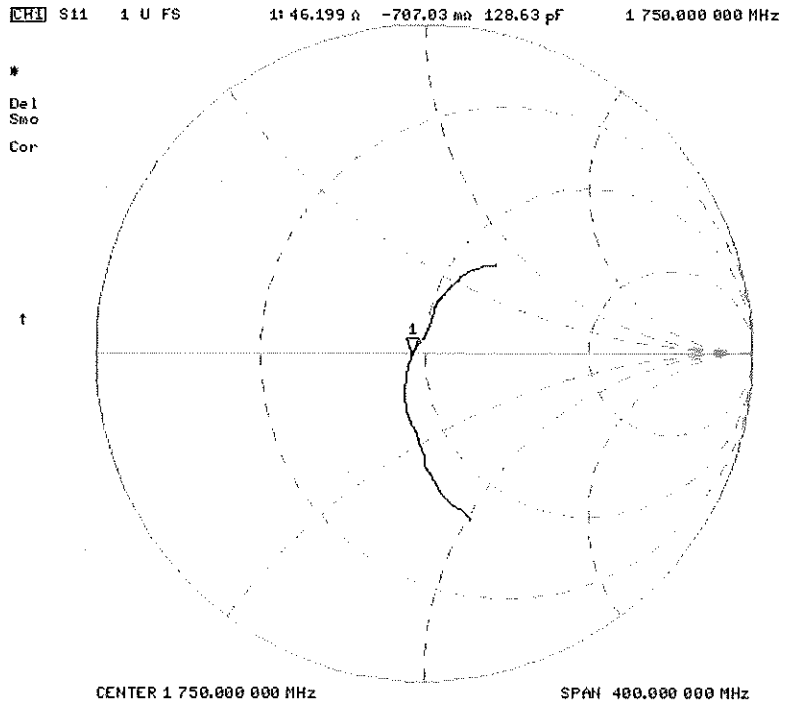
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/9/2017 | 6/1/2018 | 1.218 | 3.73 | 3.53 | -5.36% | 1.99 | 1.88 | -5.53% | 46.6 | 46.2 | 0.6 | -1.2 | -0.7 | 0.5 | -29.1 | -28 | 3.70% | PASS |

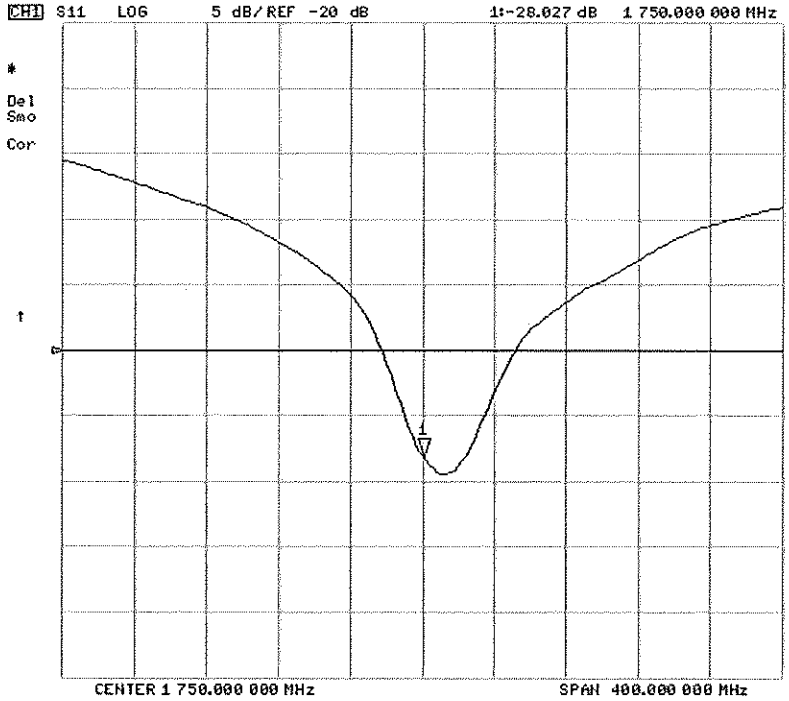
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D1900V2-5d026_May18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN:5d026 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | May 14, 2018 |

SC ✓
5/31/2018

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 26-Oct-17 (No. DAE4-601_Oct17) | Oct-18 |

| 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-17) | In house check: Oct-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: May 14, 2018

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.1 |
| **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 | 41.2 ± 6 % | 1.35 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 | 9.78 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **40.2 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.19 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.1 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 | 55.3 ± 6 % | 1.46 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 | 9.65 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.9 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.19 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.2 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 | 53.0 Ω + 8.0 jΩ |
| Return Loss | - 21.6 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.1 Ω + 7.4 jΩ |
| Return Loss | - 21.8 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.199 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 17, 2002 |

## DASY5 Validation Report for Head TSL

Date: 14.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d026**

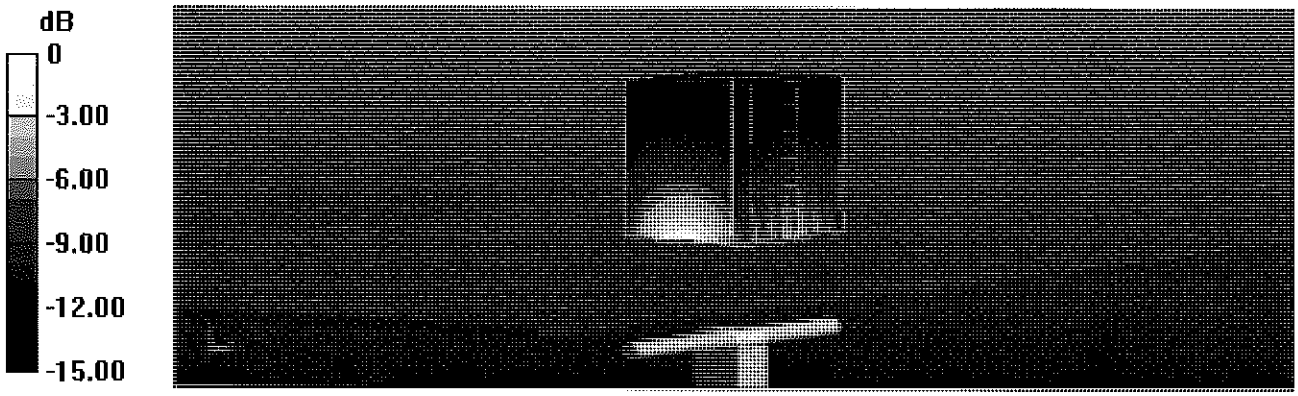
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.35 S/m; $\varepsilon_r$ = 41.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.18, 8.18, 8.18) @ 1900 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

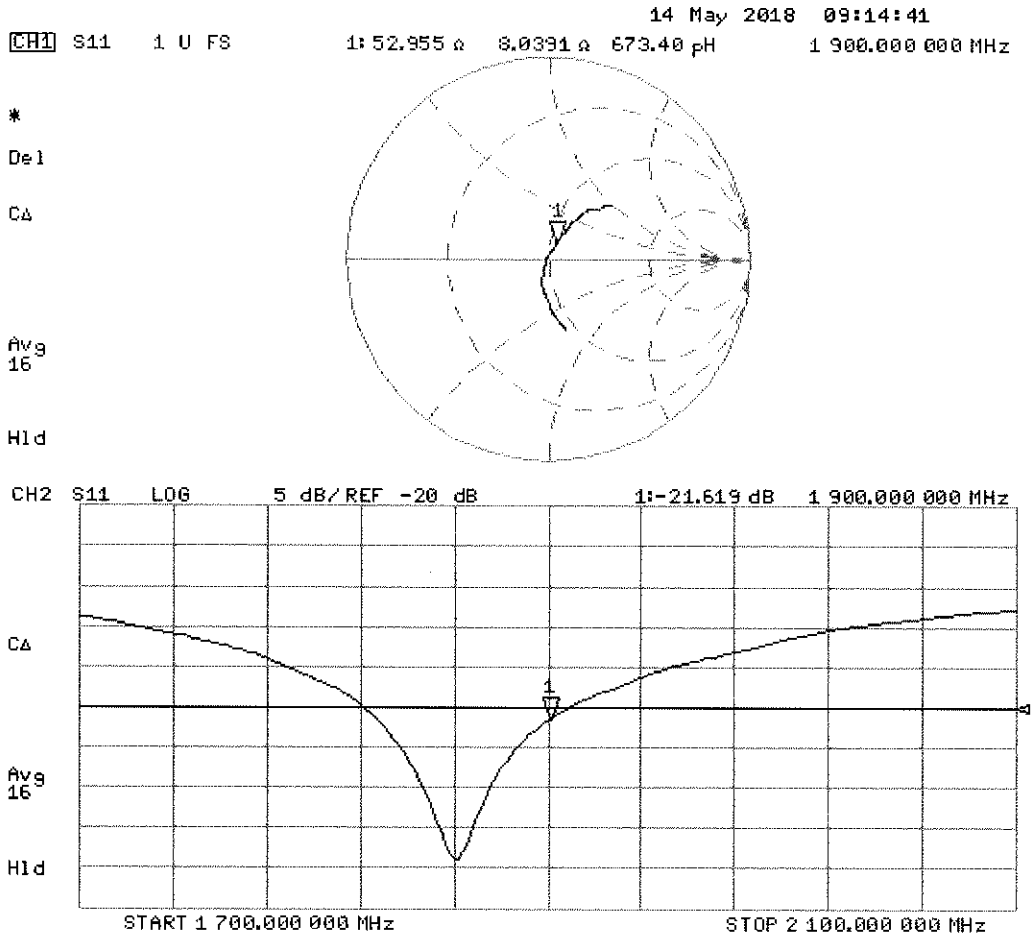
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 109.9 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 17.8 W/kg
**SAR(1 g) = 9.78 W/kg; SAR(10 g) = 5.19 W/kg**
Maximum value of SAR (measured) = 15.0 W/kg




0 dB = 15.0 W/kg = 11.76 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 14.05.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d026**

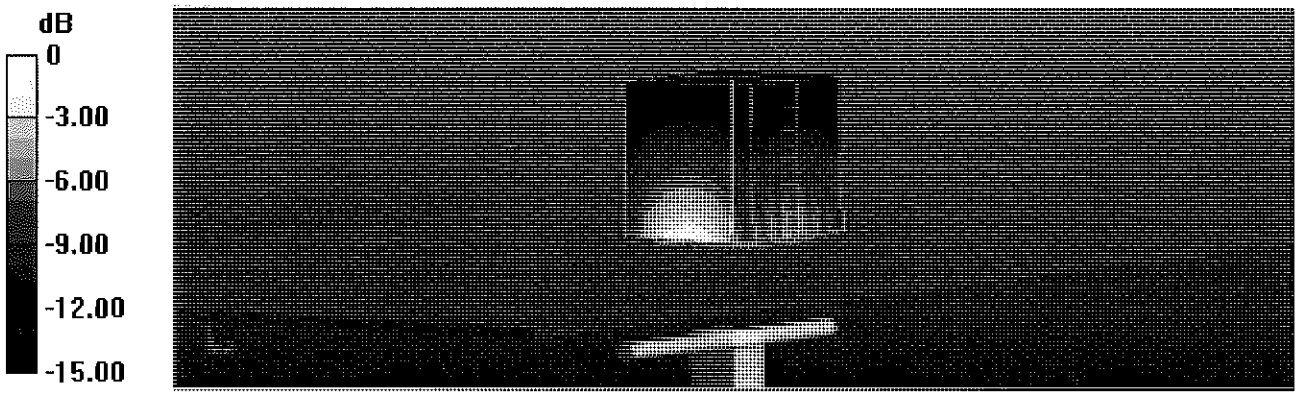
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.46 S/m; $\varepsilon_r$ = 55.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.15, 8.15, 8.15) @ 1900 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

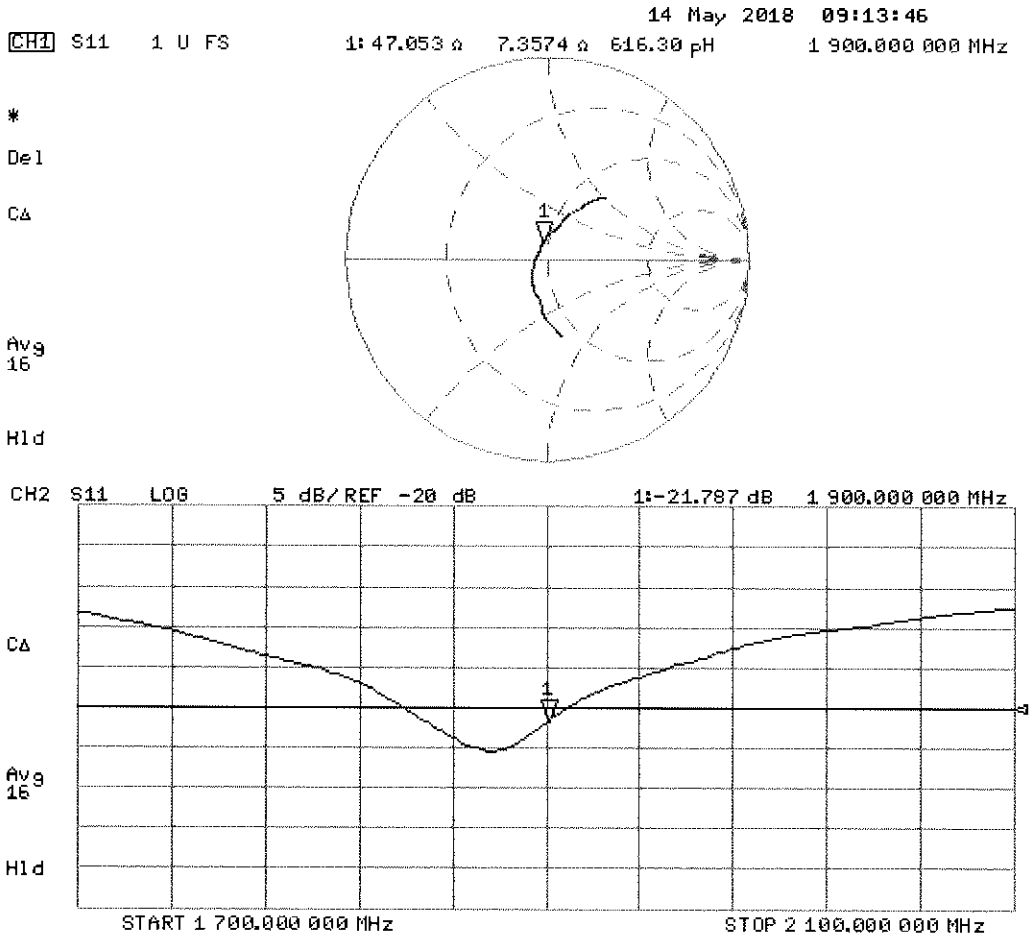
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.5 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 16.7 W/kg
**SAR(1 g) = 9.65 W/kg; SAR(10 g) = 5.19 W/kg**
Maximum value of SAR (measured) = 14.4 W/kg




0 dB = 14.4 W/kg = 11.58 dBW/kg

## Impedance Measurement Plot for Body TSL



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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S 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 **PC Test**

Certificate No: **D1900V2-5d180_Aug17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN:5d180 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 16, 2017 |

PMV 8/27/17 SCV 8/1/18

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Johannes Kurikka | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 16, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 40.6 ± 6 % | 1.36 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 | 9.60 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **39.2 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.09 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.6 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 | 54.1 ± 6 % | 1.48 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 | 9.68 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.17 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 | 54.0 Ω + 5.7 jΩ |
| Return Loss | - 23.5 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.6 Ω + 6.5 jΩ |
| Return Loss | - 23.7 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.203 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 | August 23, 2013 |

## DASY5 Validation Report for Head TSL

Date: 16.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d180**

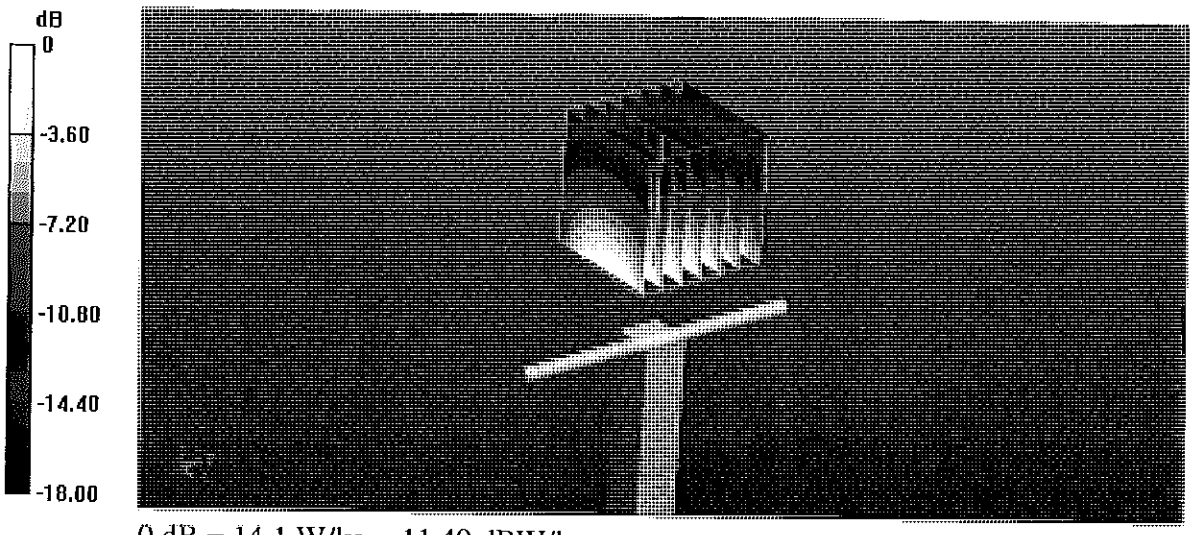
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.36 S/m; $\varepsilon_r$ = 40.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

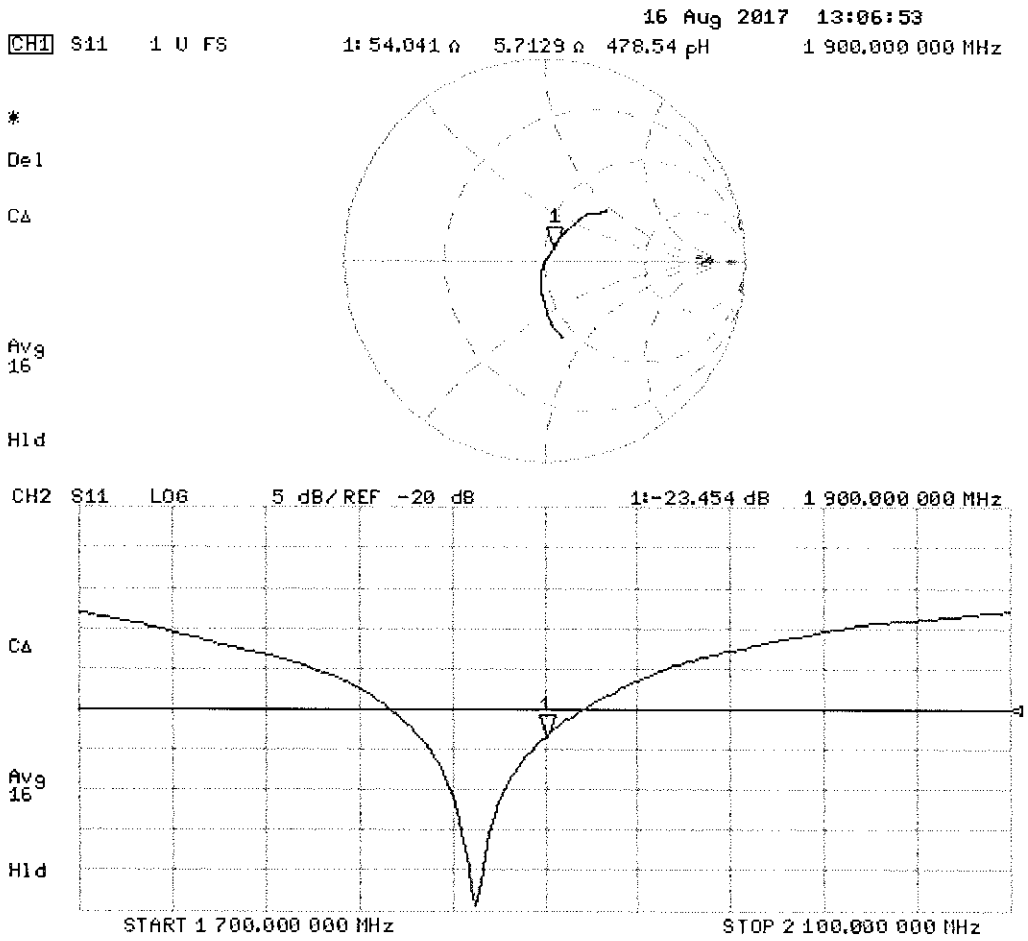
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 103.7 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 17.6 W/kg
**SAR(1 g) = 9.6 W/kg; SAR(10 g) = 5.09 W/kg**
Maximum value of SAR (measured) = 14.1 W/kg




0 dB = 14.1 W/kg = 11.49 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 16.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d180**

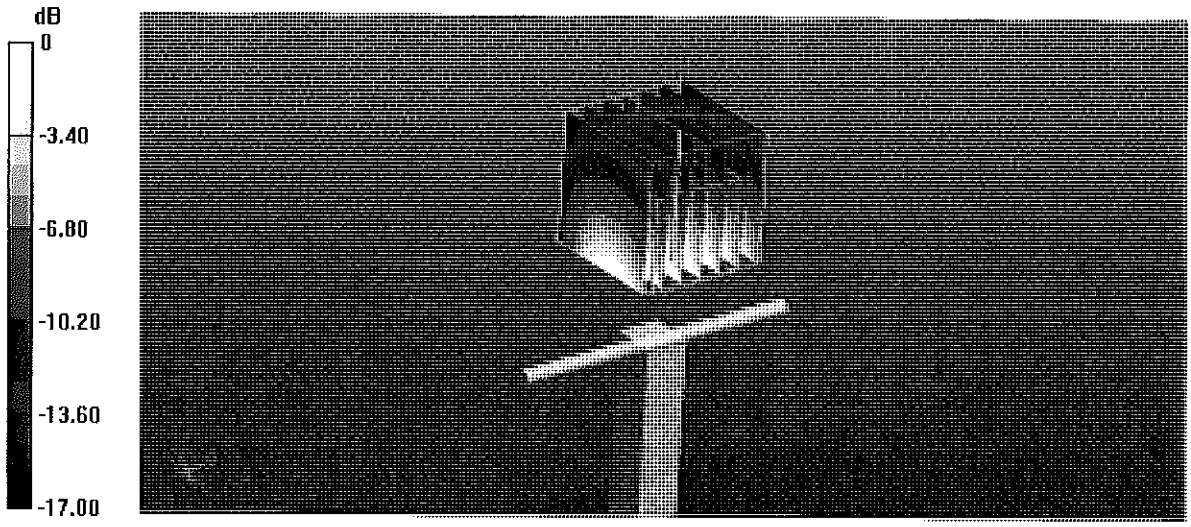
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.48 S/m; $\varepsilon_r$ = 54.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

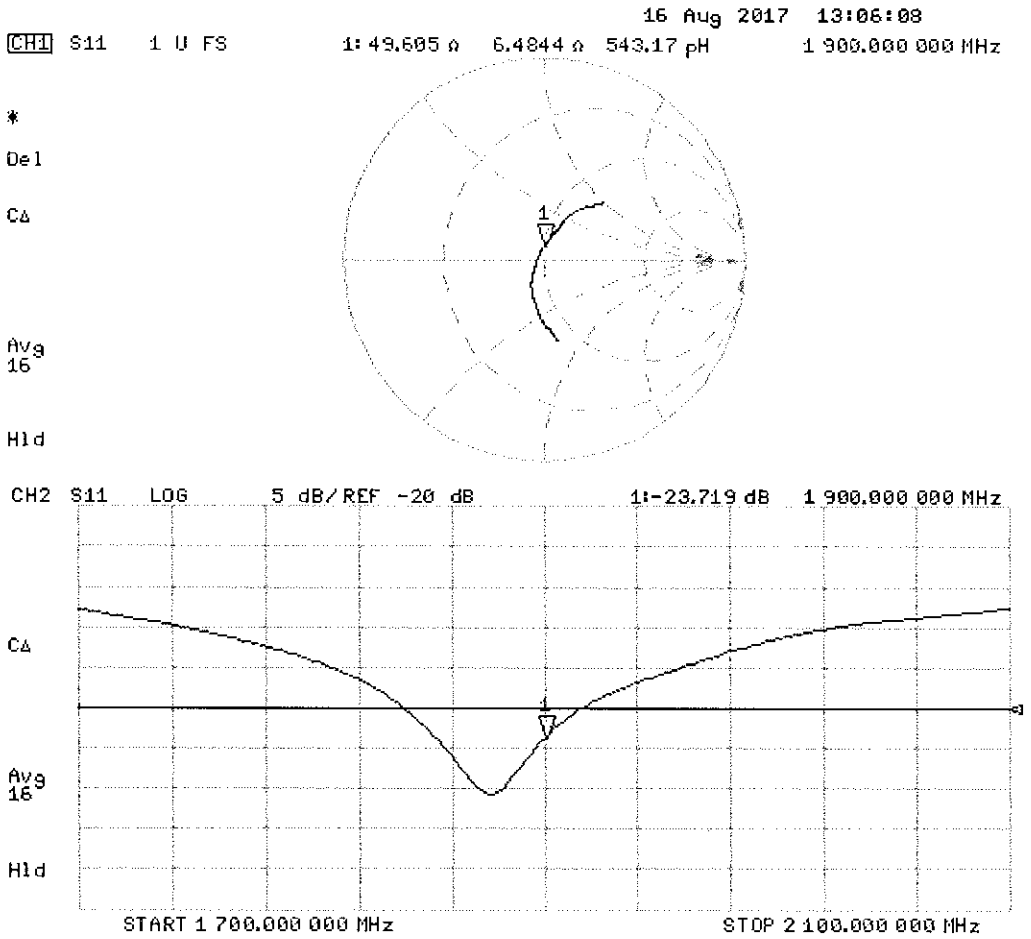
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.33 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 16.9 W/kg
**SAR(1 g) = 9.68 W/kg; SAR(10 g) = 5.17 W/kg**
Maximum value of SAR (measured) = 14.1 W/kg




0 dB = 14.1 W/kg = 11.49 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D1900V2 – SN: 5d180

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: August 01, 2018

Description: SAR Validation Dipole at 1900 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAKS-3.5 | Portable DAK | 9/5/2017 | Annual | 9/5/2018 | 1045 |
| SPEAG | ES3DV3 | SAR Probe | 2/13/2018 | Annual | 2/13/2019 | 3329 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 2/8/2018 | Annual | 2/8/2019 | 1403 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Biomedical Engineer II | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

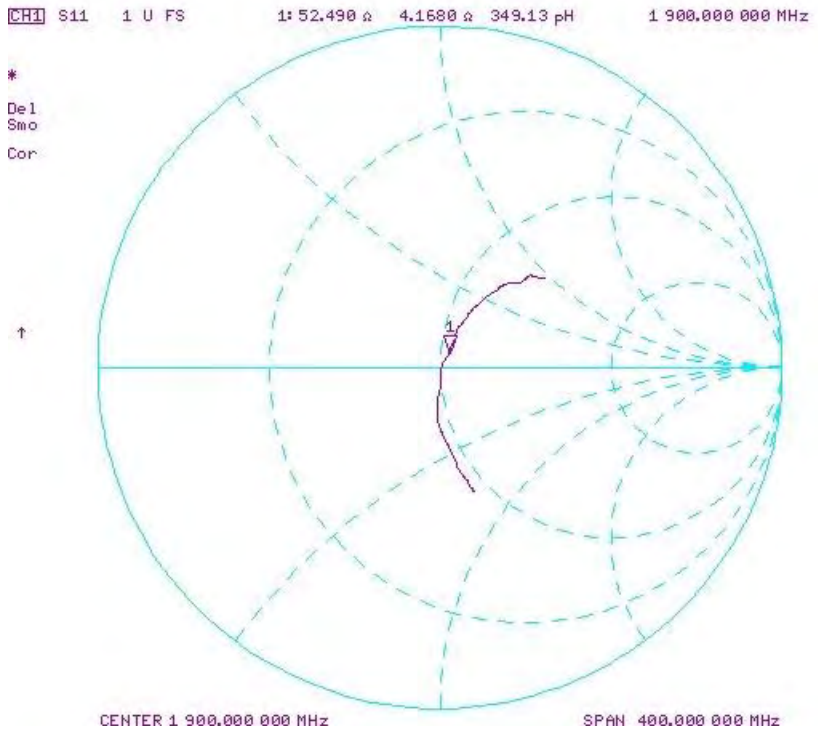
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

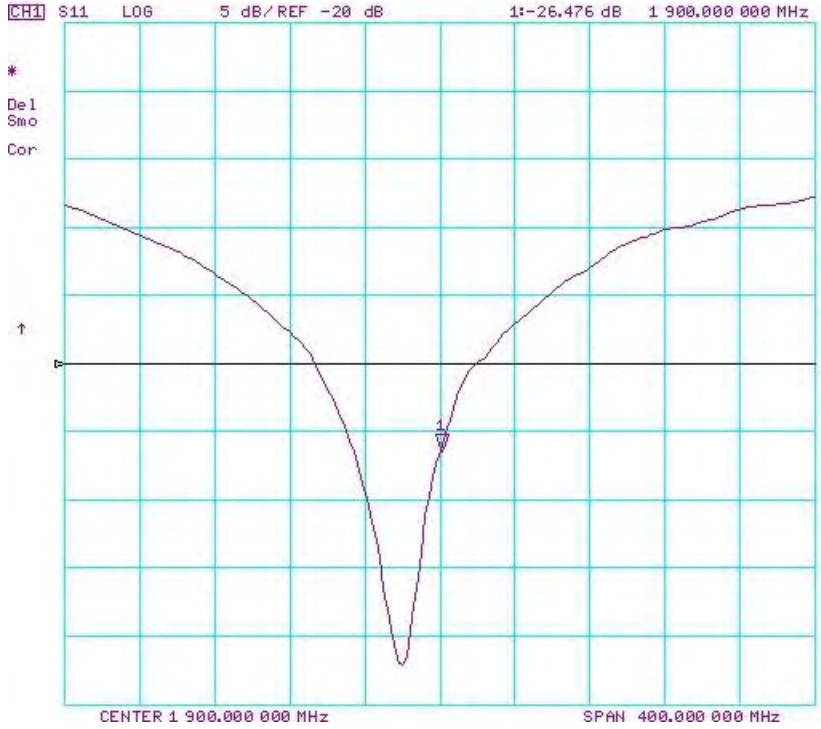
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/16/2017 | 8/1/2018 | 1.203 | 3.92 | 3.81 | -2.81% | 2.06 | 1.97 | -4.37% | 54 | 52.5 | 1.5 | 5.7 | 4.2 | 1.5 | -23.5 | -26.5 | -12.80% | PASS |

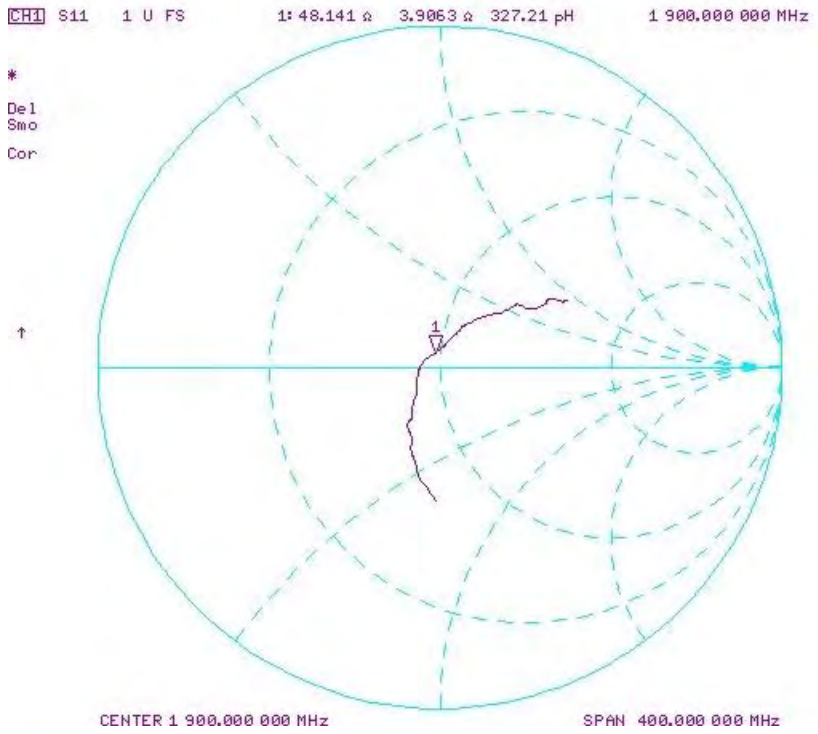
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/16/2017 | 8/1/2018 | 1.203 | 3.95 | 4.29 | 8.61% | 2.09 | 2.21 | 5.74% | 49.6 | 48.1 | 1.5 | 6.5 | 3.9 | 2.6 | -23.7 | -26.7 | -12.70% | PASS |

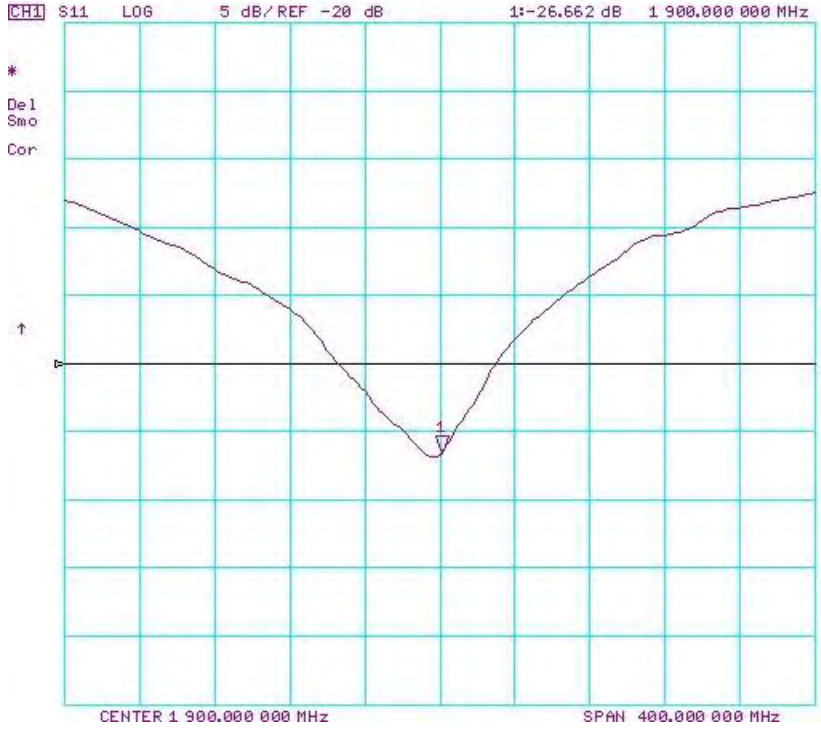
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** PC Test

**Certificate No: D1900V2-5d181_Sep17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN:5d181 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | September 07, 2017 |

SC ✓ 10/03/2017

SC ✓ 9/7/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: September 7, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 39.0 ± 6 % | 1.38 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 | 9.85 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **39.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.6 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 | 54.3 ± 6 % | 1.47 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 | 9.65 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.14 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 | 53.7 Ω + 4.6 jΩ |
| Return Loss | - 24.9 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.2 Ω + 5.6 jΩ |
| Return Loss | - 24.8 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.200 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | August 23, 2013 |

## DASY5 Validation Report for Head TSL

Date: 07.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d181**

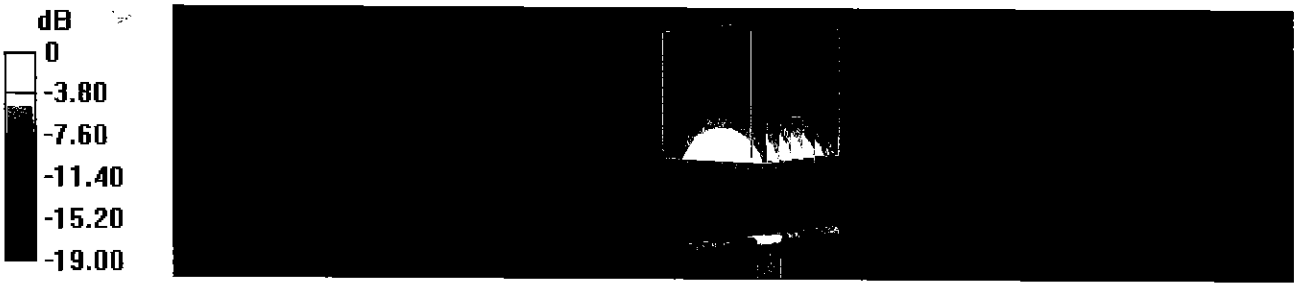
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.38 S/m; $\varepsilon_r$ = 39; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

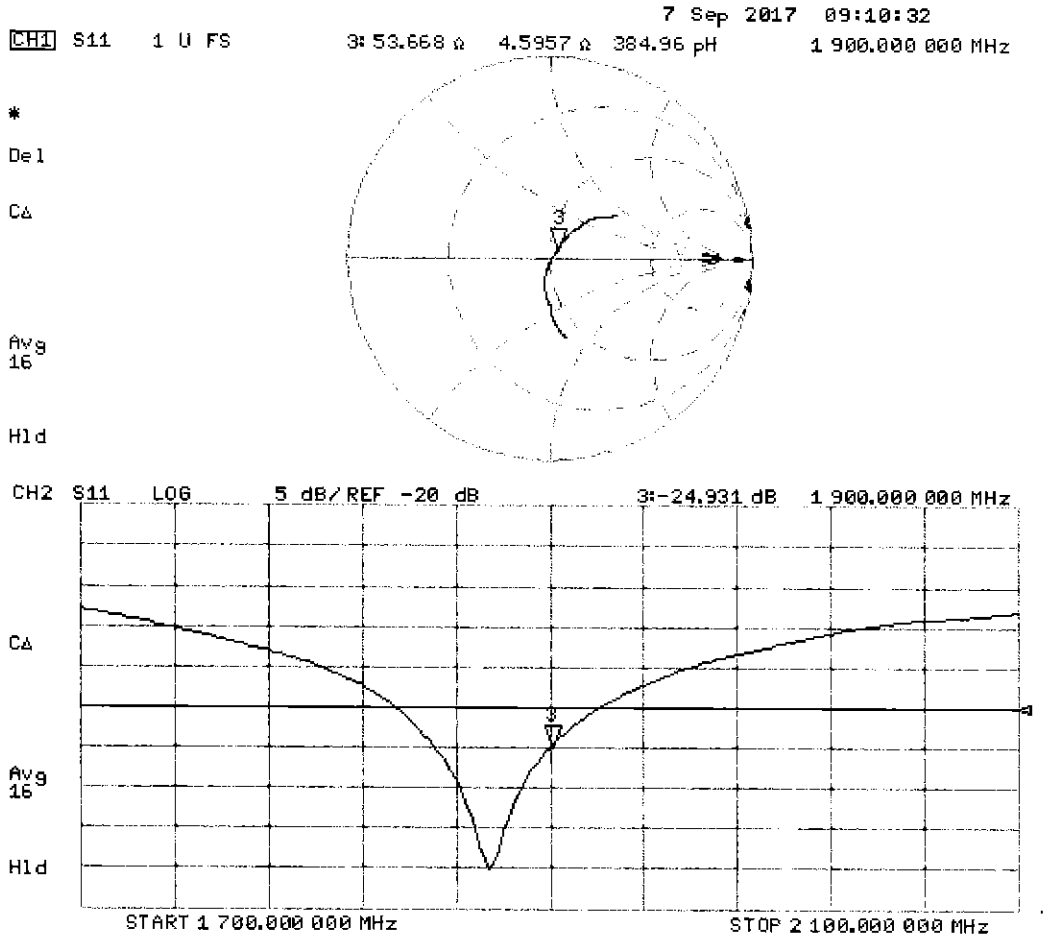
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 106.8 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 18.5 W/kg
**SAR(1 g) = 9.85 W/kg; SAR(10 g) = 5.15 W/kg**
Maximum value of SAR (measured) = 14.8 W/kg




0 dB = 14.8 W/kg = 11.70 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 07.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d181**

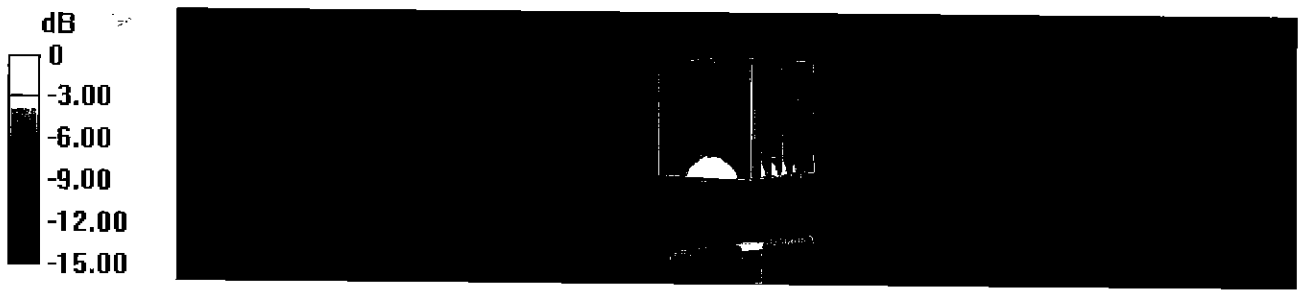
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.47 S/m; $\varepsilon_r$ = 54.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

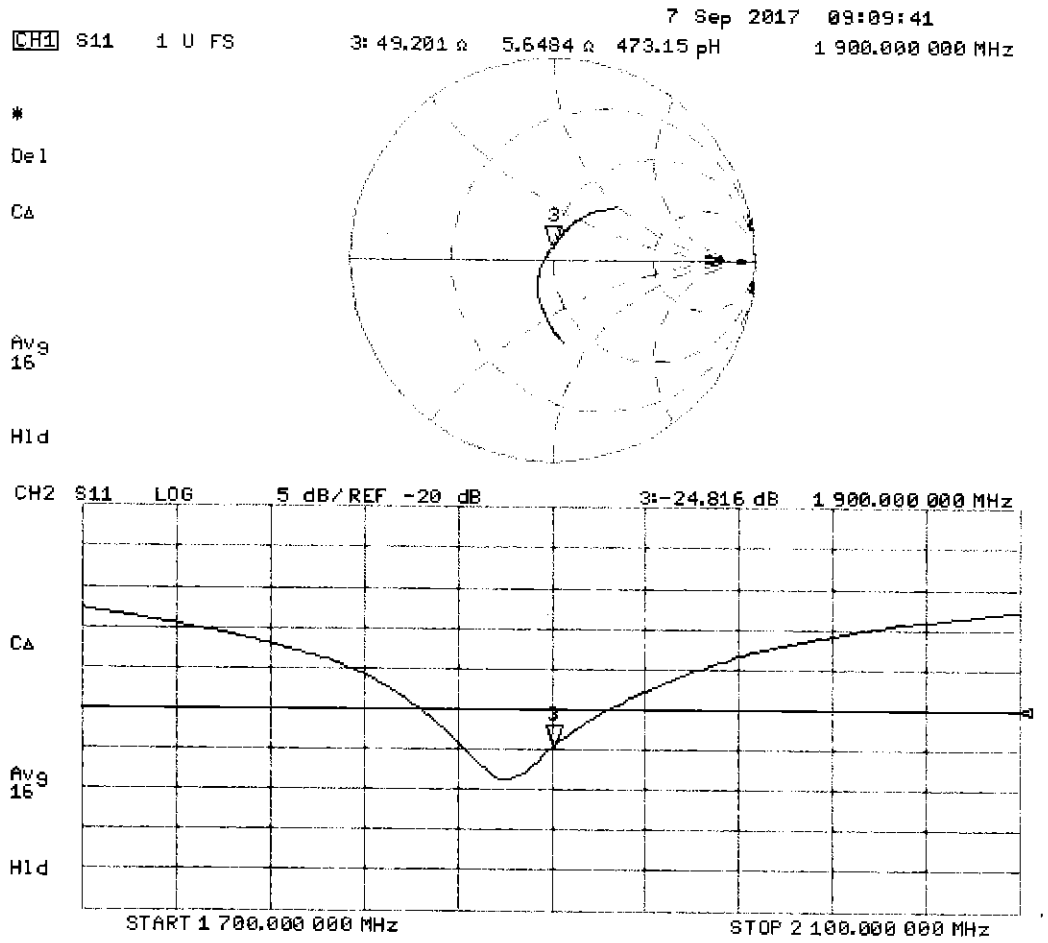
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.4 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 17.0 W/kg
**SAR(1 g) = 9.65 W/kg; SAR(10 g) = 5.14 W/kg**
Maximum value of SAR (measured) = 13.8 W/kg




0 dB = 13.8 W/kg = 11.40 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D1900V2 – SN: 5d181

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: September 07, 2018

Description: SAR Validation Dipole at 1900 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 5/15/2018 | Annual | 5/15/2019 | 1070 |
| SPEAG | ES3DV3 | SAR Probe | 9/18/2017 | Annual | 9/18/2018 | 3287 |
| SPEAG | DAE4 | Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1533 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3131 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 604 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Team Lead Engineer | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

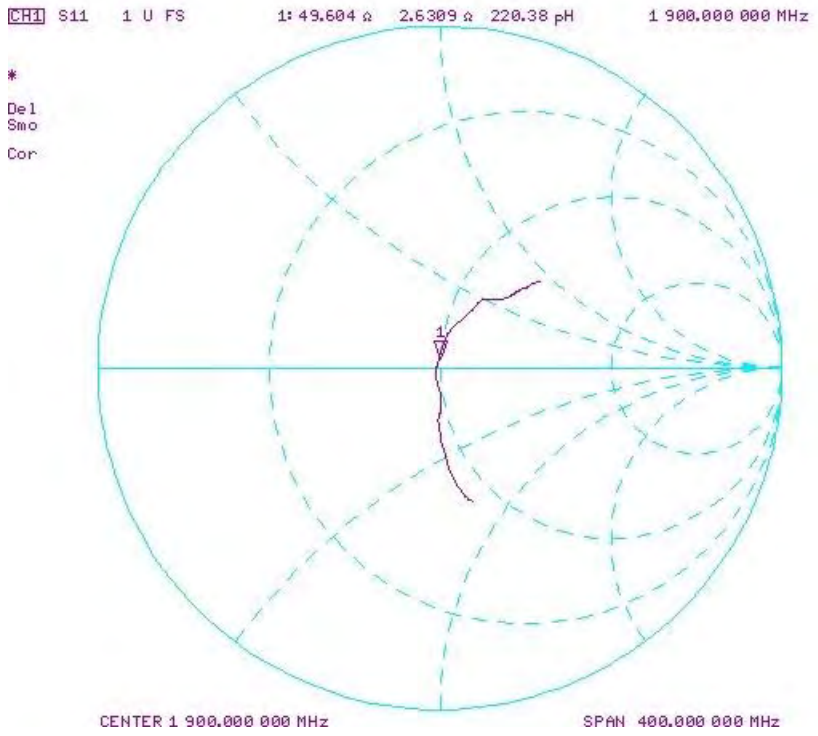
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

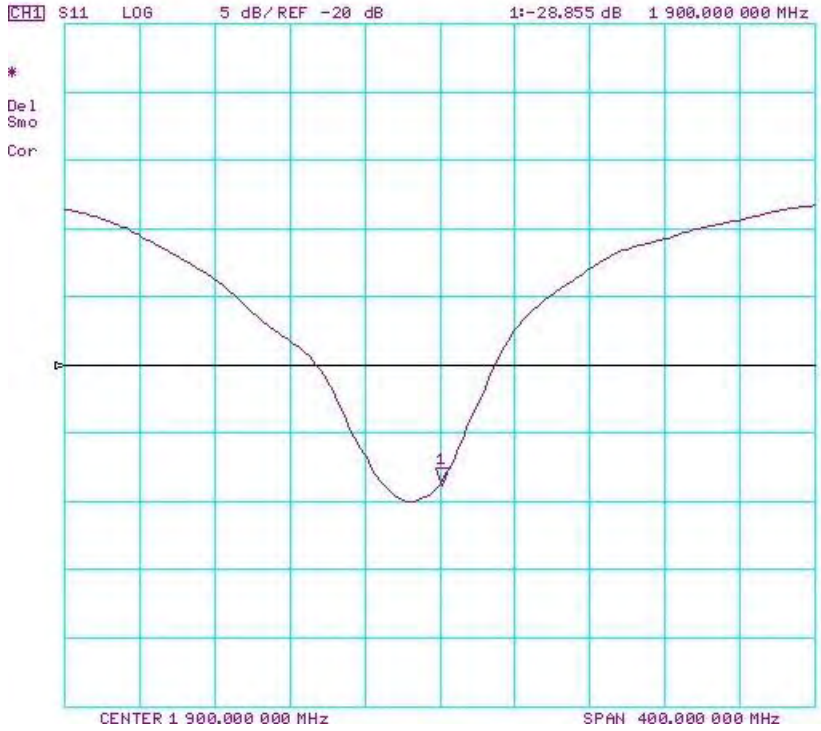
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/7/2017 | 9/7/2018 | 1.2 | 3.95 | 3.99 | 1.01% | 2.06 | 2.07 | 0.49% | 53.7 | 49.6 | 4.1 | 4.6 | 2.6 | 2 | -24.9 | -28.9 | -16.10% | PASS |

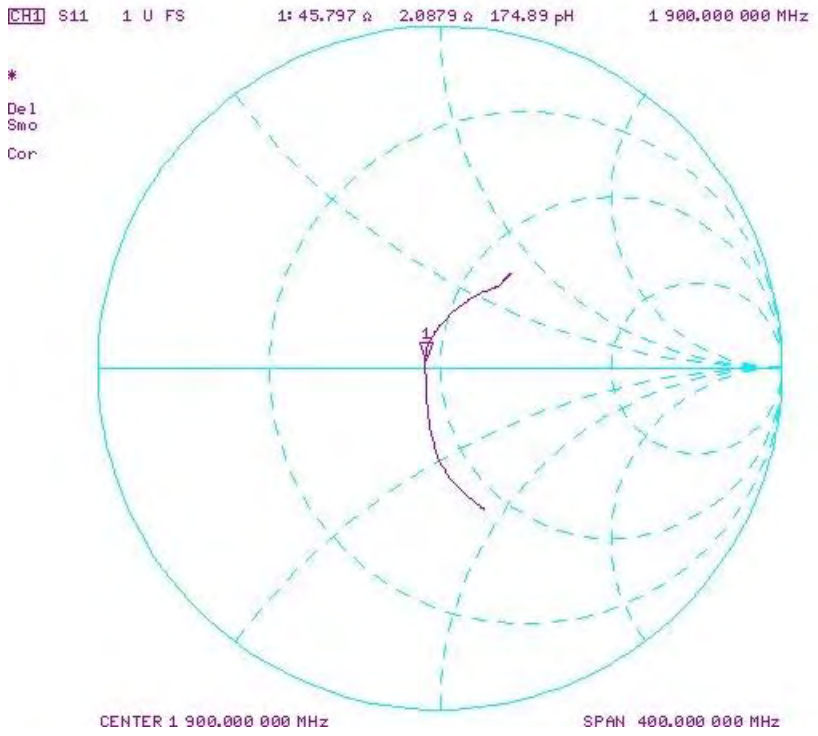
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/7/2017 | 9/7/2018 | 1.2 | 3.95 | 4.13 | 4.56% | 2.09 | 2.14 | 2.39% | 49.2 | 45.8 | 3.4 | 5.6 | 2.1 | 3.5 | -24.8 | -24.7 | 0.40% | PASS |

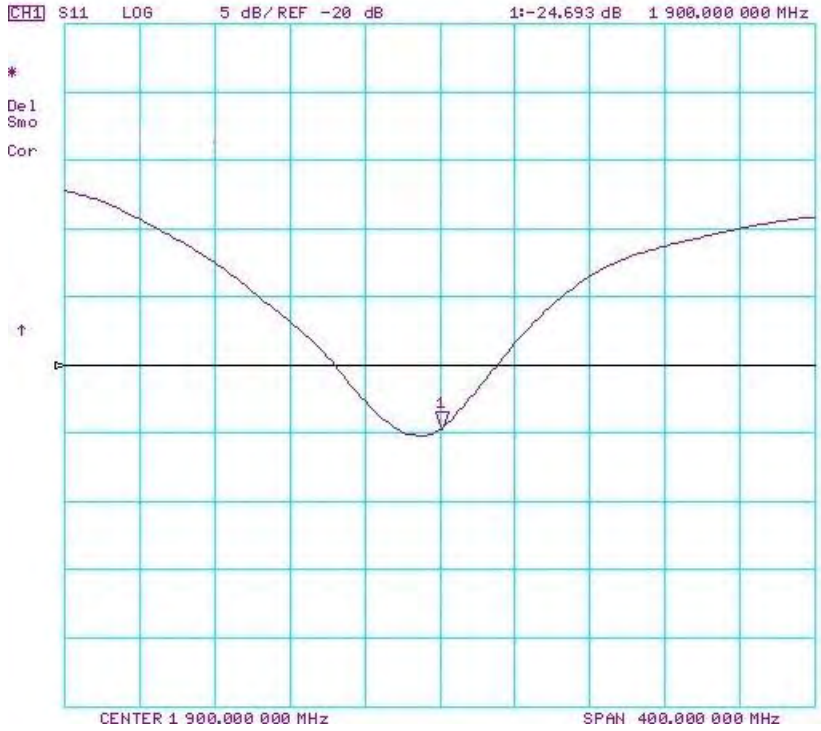
Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** PC Test

**Certificate No: D2450V2-921_Nov18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN:921 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | November 12, 2018 |

SC ✓ 12/11/2018

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 04-Oct-18 (No. DAE4-601_Oct18) | Oct-19 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Manu Seitz | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 12, 2018

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.2 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 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 | 37.9 ± 6 % | 1.86 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.6 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **53.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.28 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.8 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 | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 51.4 ± 6 % | 2.02 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **50.8 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.03 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.8 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 + 6.5 jΩ |
| Return Loss | - 22.3 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.7 Ω + 7.8 jΩ |
| Return Loss | - 22.2 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.157 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 | September 26, 2013 |

## DASY5 Validation Report for Head TSL

Date: 12.11.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:921**

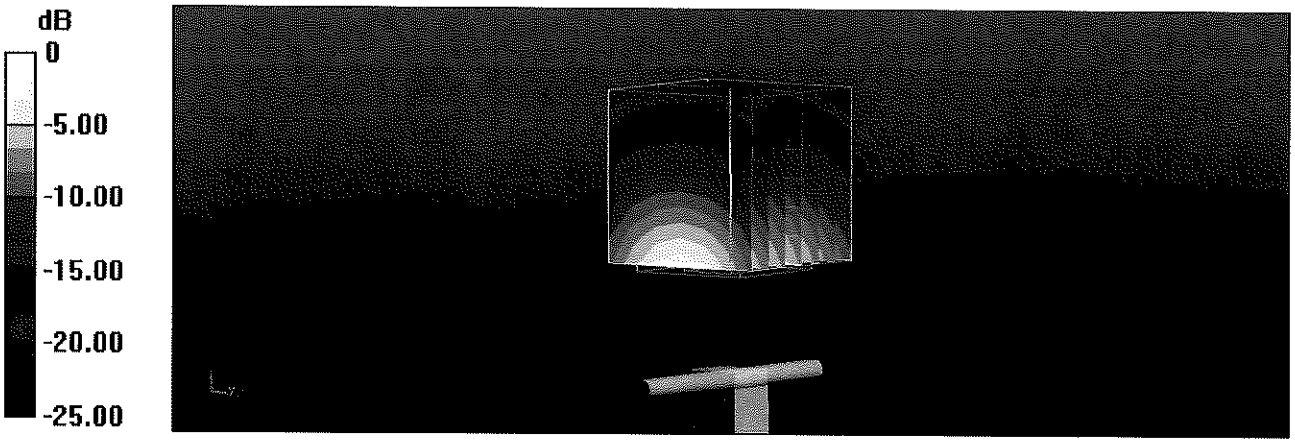
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.86 S/m; $\varepsilon_r$ = 37.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

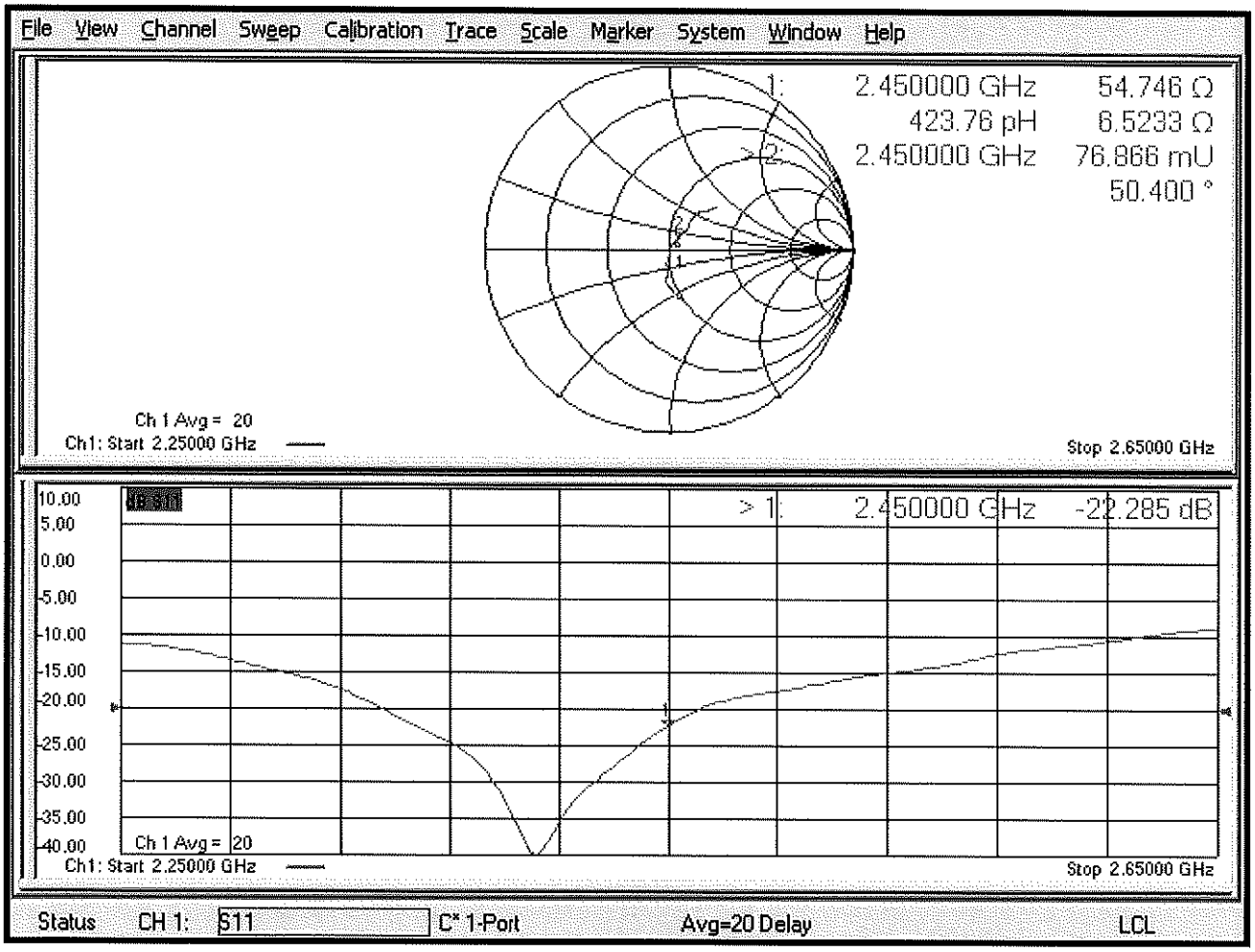
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 117.7 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 27.4 W/kg
**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.28 W/kg**
Maximum value of SAR (measured) = 22.4 W/kg




0 dB = 22.4 W/kg = 13.50 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 12.11.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:921**

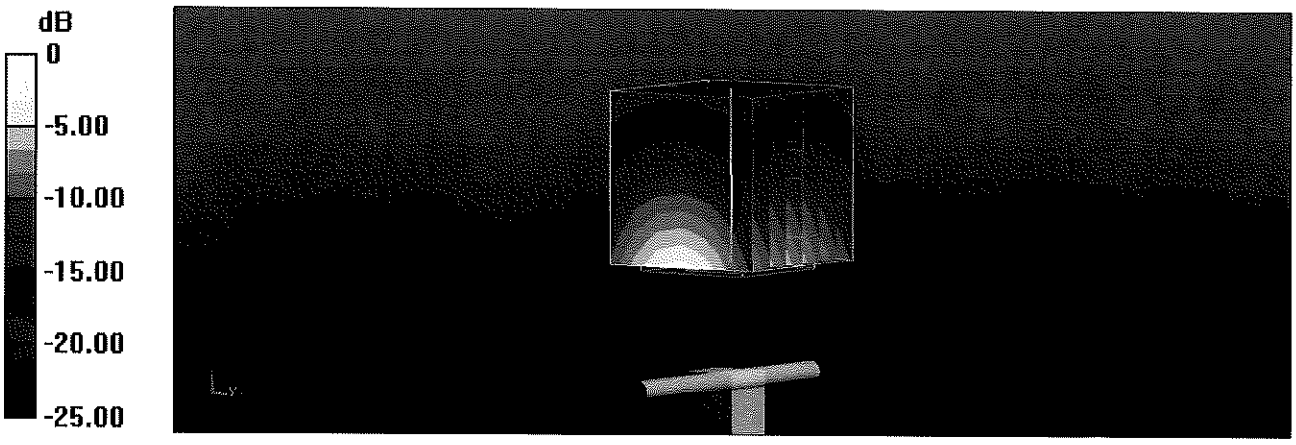
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.02 S/m; $\varepsilon_r$ = 51.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.01, 8.01, 8.01) @ 2450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

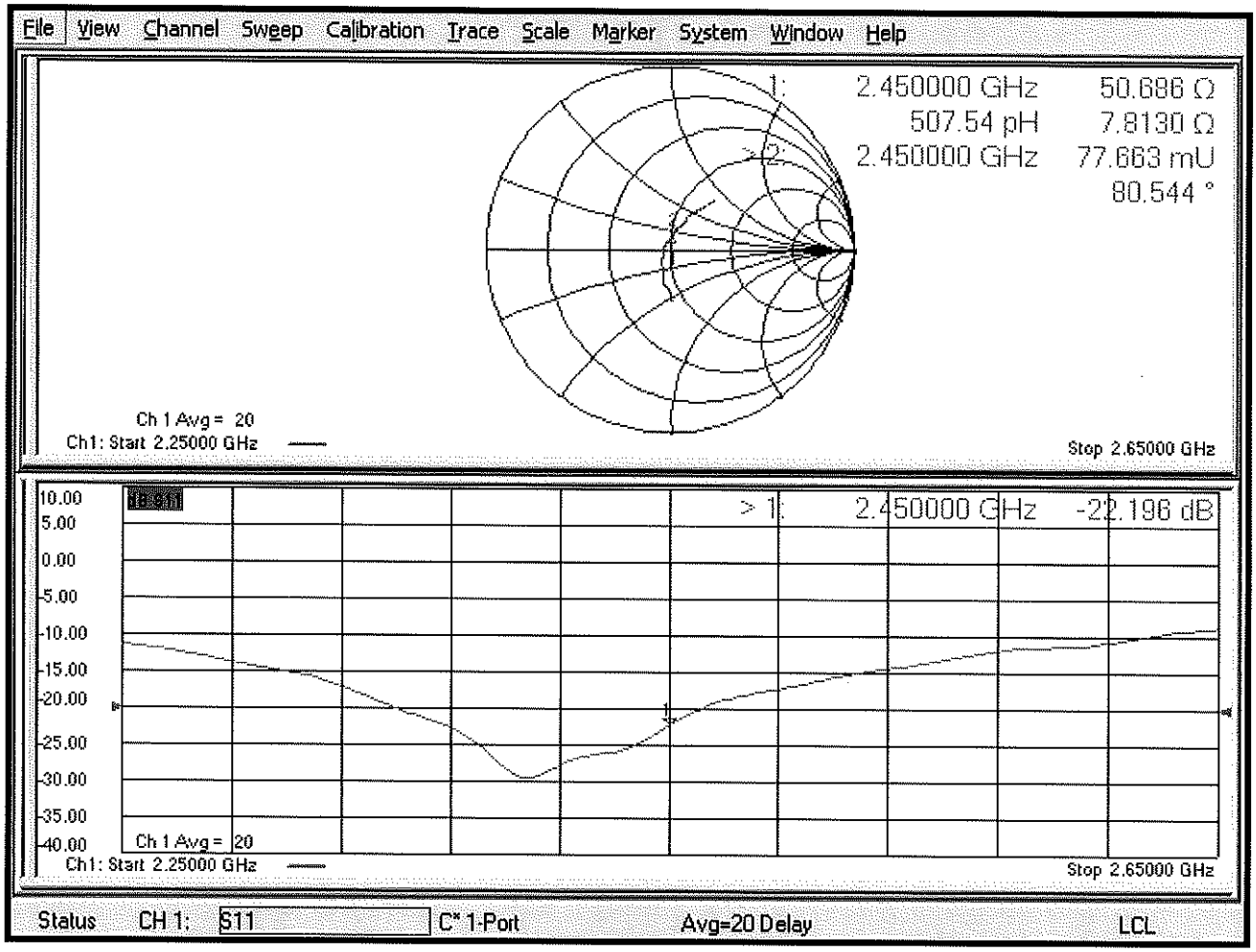
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.6 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.1 W/kg
**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg**
Maximum value of SAR (measured) = 21.3 W/kg




0 dB = 21.3 W/kg = 13.28 dBW/kg

## Impedance Measurement Plot for Body TSL



Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

**CUSTOMER COPY**

# DIPOLE REPAIR REPORT – SPEAG Production Center

| | | | |
|---|---|---|---|
| **PRODUCT** | **D2450V2 Dipole** | | |
| **SERIAL Nr.:** | **SN: 921** | **IN DATE:** | **8-Nov-2018** |
| **CUSTOMER:** | **PC Test** | | |

| **DIPOLE REPAIR MATERIAL** | **WORK DESCRIPTION** | | | | | | **WORKING TIME (h)** | |
|---|---|---|---|---|---|---|---|---|
| Dipole Arm | fixed | X | exchanged | O | ..... | O | 0.50 | hours |
| Dipole Connector | fixed | O | exchanged | O | ..... | O | | hours |
| Gold Plating | fixed | O | exchanged | O | ..... | O | | hours |
| Housing | fixed | O | exchanged | O | ..... | O | | hours |
| Disassemble/clean | fixed | O | exchanged | O | ..... | | | hours |
| .....: | fixed | O | exchanged | O | ..... | | | hours |
| .....: | fixed | O | exchanged | O | ..... | | | hours |
| Analysis: | | | | | | | 0.50 | hours |
| Final Assembly: | | | | | | | 0.50 | hours |
| **Total hours** | | | | | | | 1.50 | hours |

**COMMENTS:**

The dipole was returned for calibration. Receiving inspection found the dipole arms and both feed-lines were strongly bent. In order to re-establish full functionality, the dipole arms and feed-lines were straightened. The connector was cleaned as well. The dipole will be newly calibrated after this repair.

| | | | |
|---|---|---|---|
| **CONDUCTED BY:** | | **APPROVED BY:** | |
| **DATE:** | 09.11.2018 | **DATE:** | 09.11.2018 |

**REPAIR COST:**

| | | USD | Euro |
|---|---|---|---|
| MATERIAL COST: | | O | O |
| REPAIR: | | O | O |

| | | | |
|---|---|---|---|
| **TOTAL COST:** | **No cost** | **QUOTATION #:** | |

**APPROVED BY:**

**DATE:** 09.11.2018

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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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 **PC Test**

Certificate No: **D2450V2-750_Jun17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN:750 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | June 07, 2017 |

BN 8/3/2017
SC 6/1/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-Dec-16 (No. EX3-7349_Dec16) | Dec-17 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Johannes Kurikka | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 9, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 37.9 ± 6 % | 1.85 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.6 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **53.3 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.29 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.8 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 | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 52.2 ± 6 % | 2.04 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.1 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **51.2 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.13 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **24.2 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 | 53.7 Ω + 5.8 jΩ |
| Return Loss | - 23.5 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.7 Ω + 6.7 jΩ |
| Return Loss | - 23.5 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.155 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 01, 2003 |

## DASY5 Validation Report for Head TSL

Date: 07.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750**

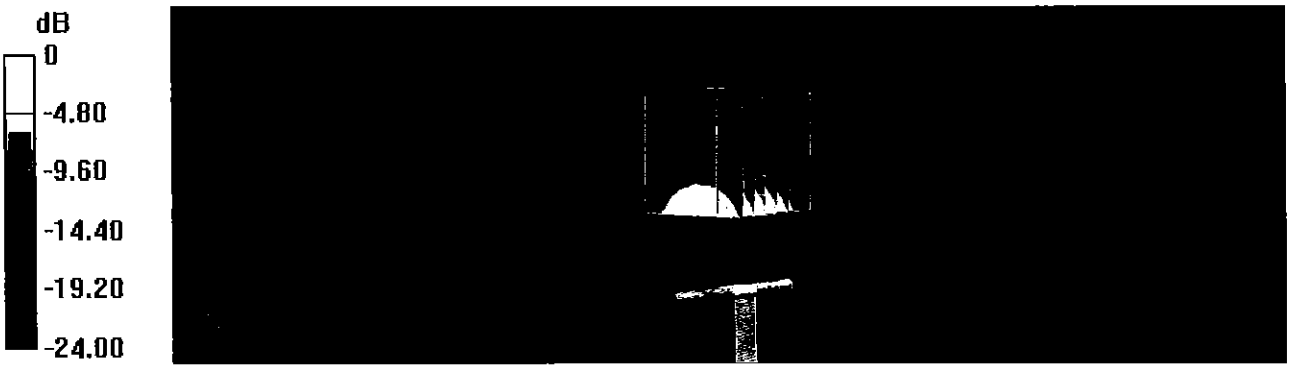
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.85 S/m; $\varepsilon_r$ = 37.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

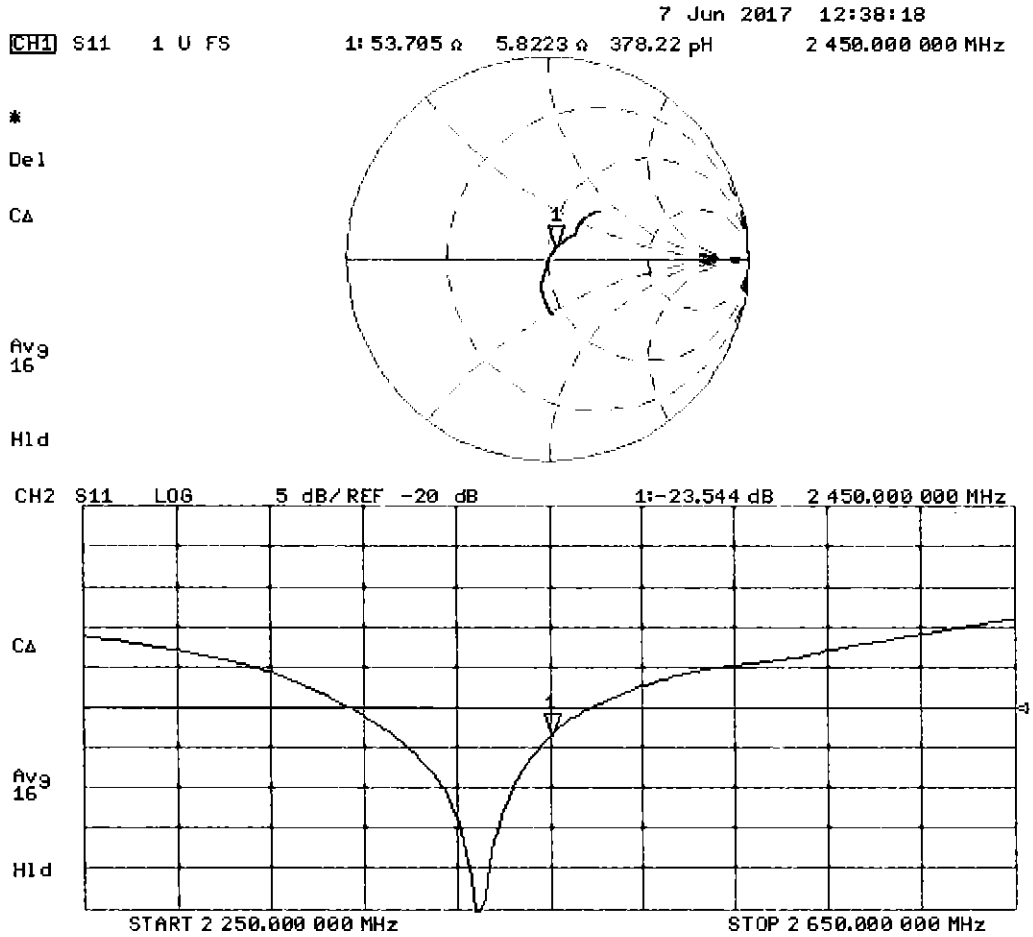
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 113.7 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 27.9 W/kg
**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.29 W/kg**
Maximum value of SAR (measured) = 22.0 W/kg




0 dB = 22.0 W/kg = 13.42 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 07.06.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750**

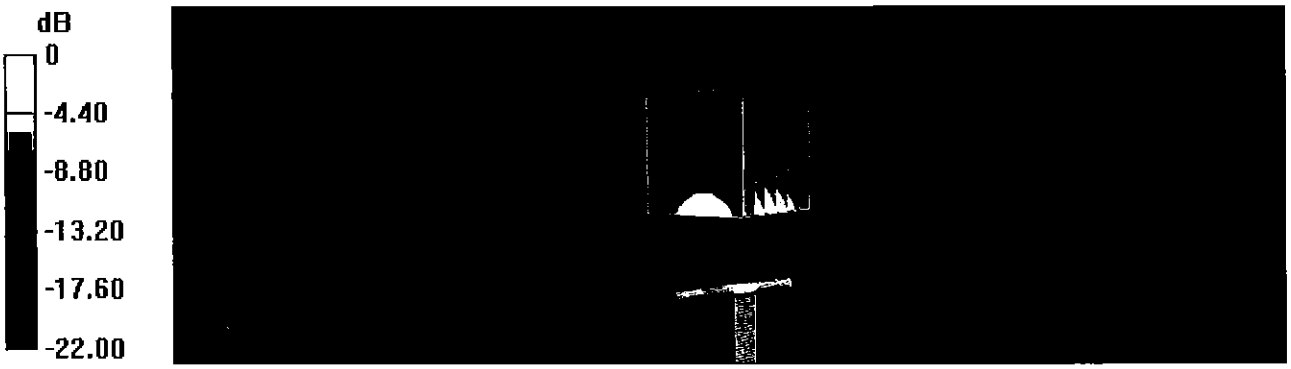
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.04 S/m; $\varepsilon_r$ = 52.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.1, 8.1, 8.1); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

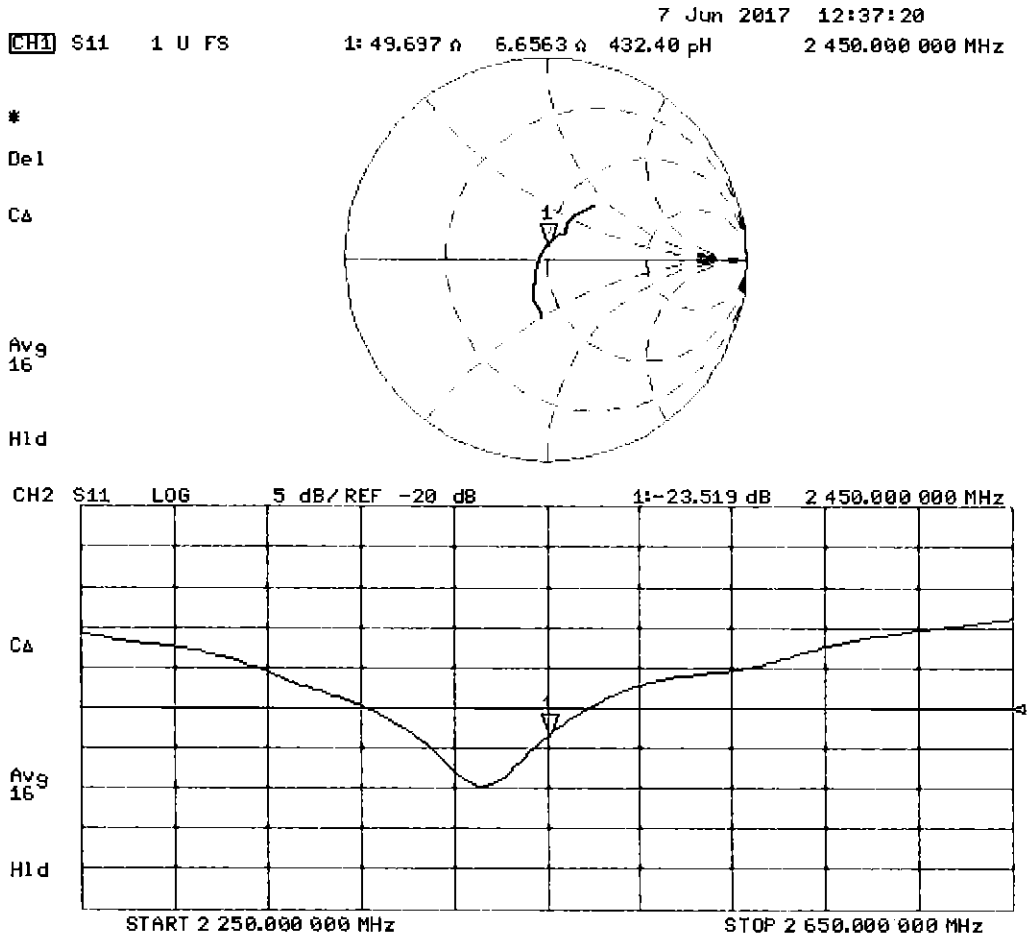
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 103.3 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 26.0 W/kg
**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.13 W/kg**
Maximum value of SAR (measured) = 20.5 W/kg




0 dB = 20.5 W/kg = 13.12 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D2450V2 – SN: 750

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: June 01, 2018

Description: SAR Validation Dipole at 2450 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/1/2017 | Annual | 6/1/2018 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAKS-3.5 | Portable DAK | 9/5/2017 | Annual | 9/5/2018 | 1045 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3131 |
| SPEAG | EX3DV4 | SAR Probe | 1/26/2018 | Annual | 1/26/2019 | 7490 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 604 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1532 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Biomedical Engineer II | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

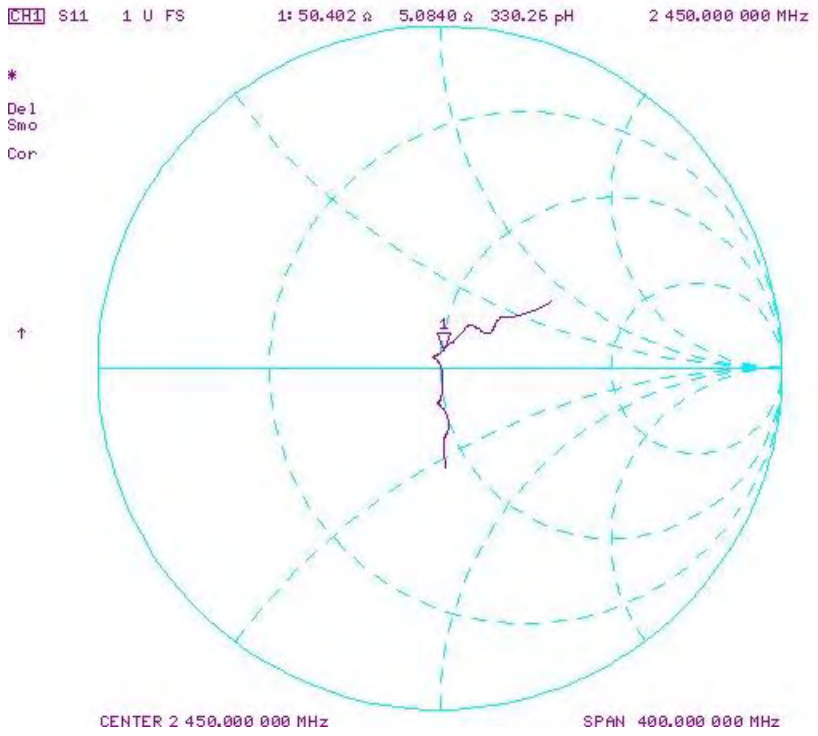
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

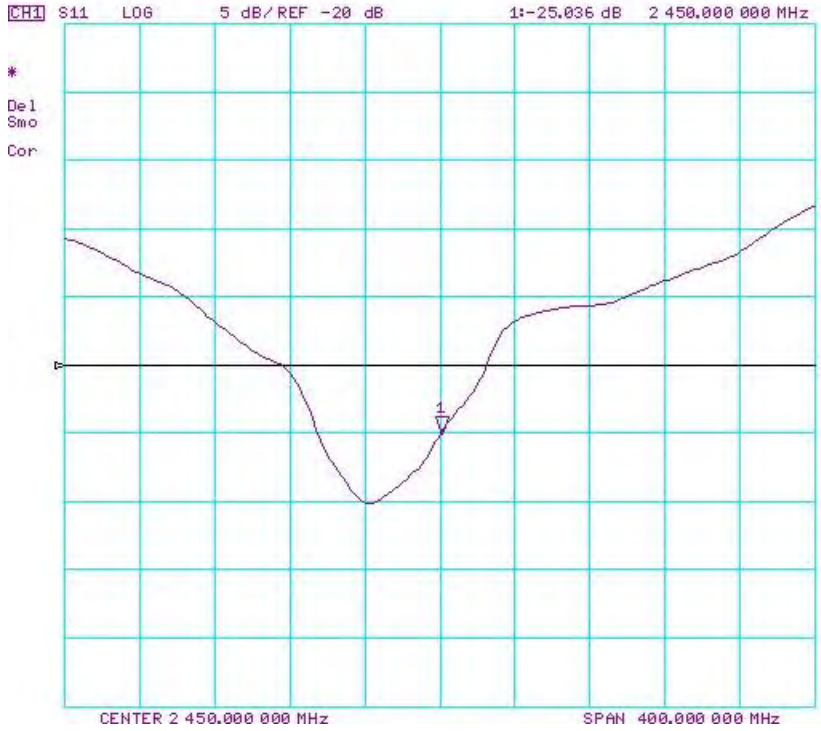
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/7/2017 | 6/1/2018 | 1.155 | 5.33 | 5.54 | 3.94% | 2.48 | 2.51 | 1.21% | 53.7 | 50.4 | 3.3 | 5.8 | 5.1 | 0.7 | -23.5 | -25 | -6.40% | PASS |

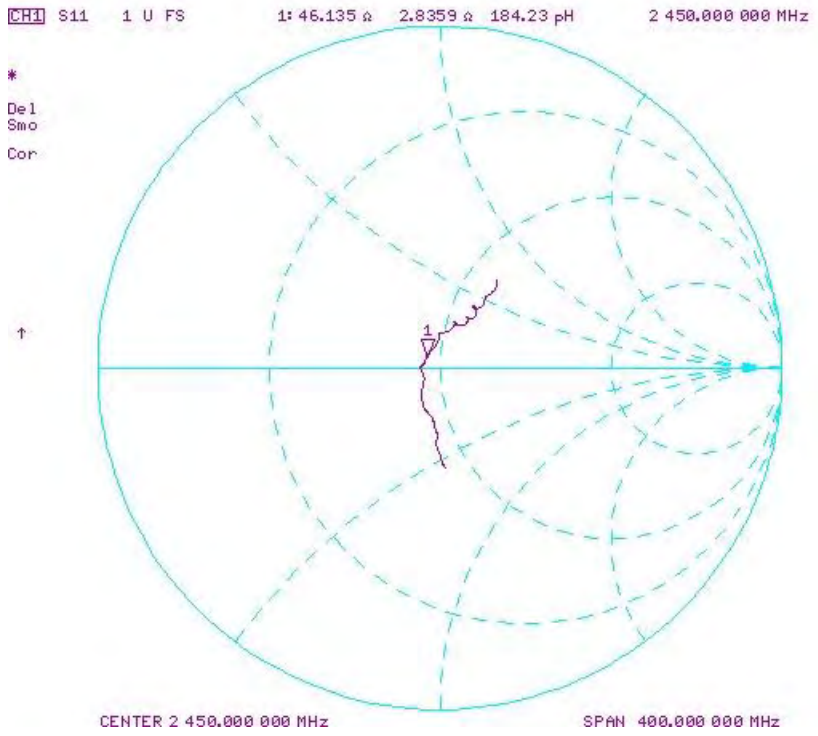
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/7/2017 | 6/1/2018 | 1.155 | 5.12 | 4.9 | -4.30% | 2.42 | 2.23 | -7.85% | 49.7 | 46.1 | 3.6 | 6.7 | 2.8 | 3.9 | -23.5 | -24.5 | -4.30% | PASS |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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 **PC Test**

Certificate No: **D2450V2-719_Aug17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN:719 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 17, 2017 |

PM ✓
8/27/17
Extended
BN ✓
7/19/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M. Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 17, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 37.8 ± 6 % | 1.86 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.3 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **51.9 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.3 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 | 51.9 ± 6 % | 2.03 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 12.8 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **50.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.00 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 | 55.7 Ω + 7.0 jΩ |
| Return Loss | - 21.4 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.4 Ω + 8.1 jΩ |
| Return Loss | - 21.8 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 | September 10, 2002 |

## DASY5 Validation Report for Head TSL

Date: 17.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

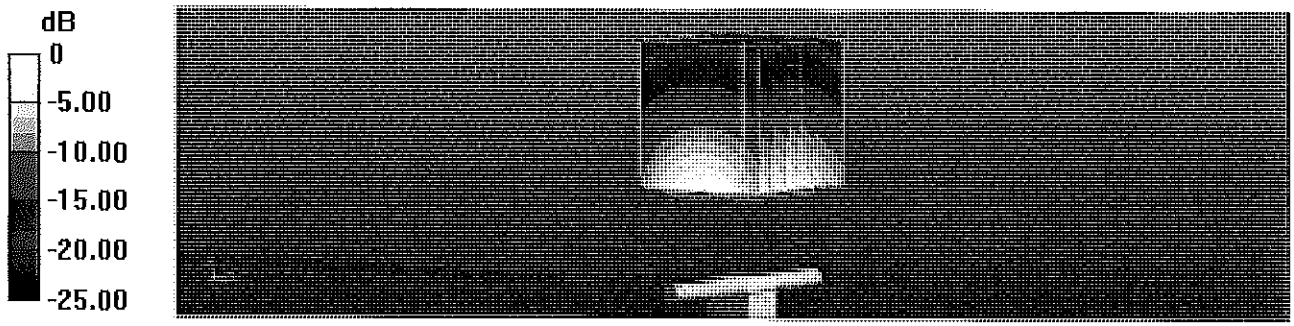
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.86 S/m; $\varepsilon_r$ = 37.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

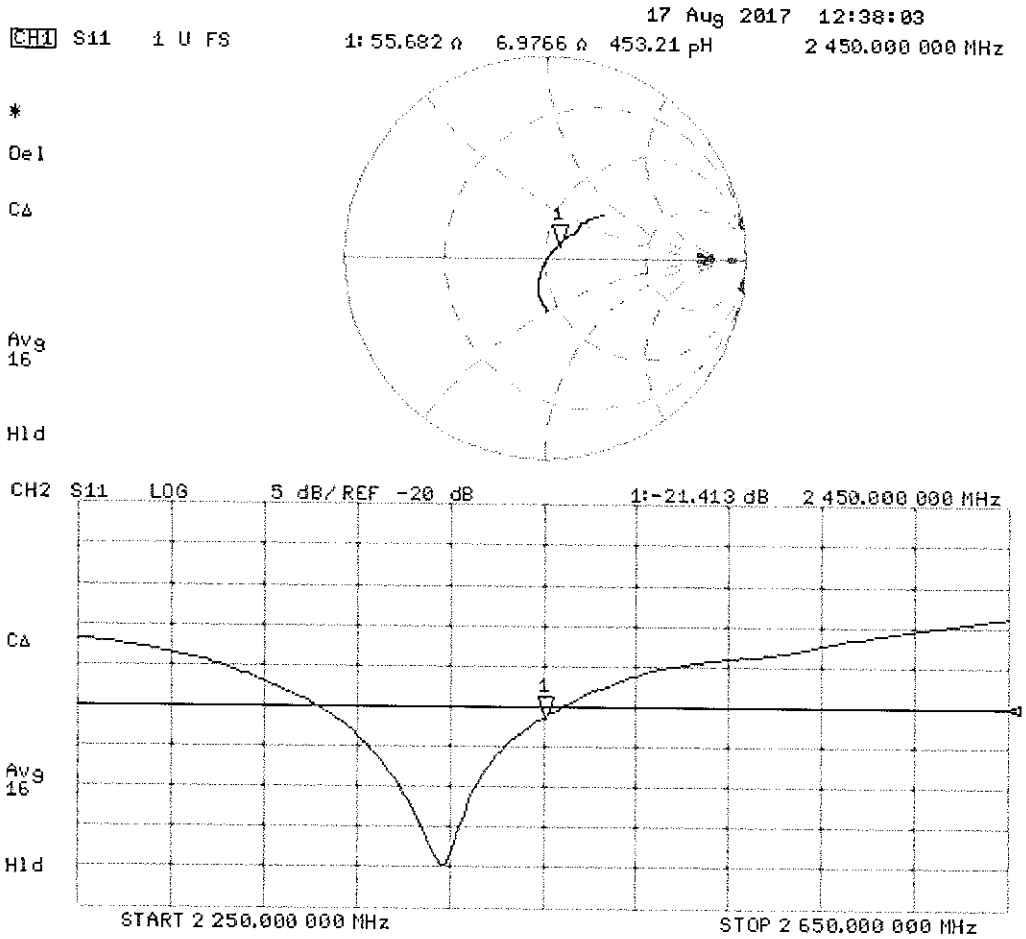
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 112.8 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 26.9 W/kg
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.15 W/kg**
Maximum value of SAR (measured) = 21.6 W/kg




0 dB = 21.6 W/kg = 13.34 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 17.08.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

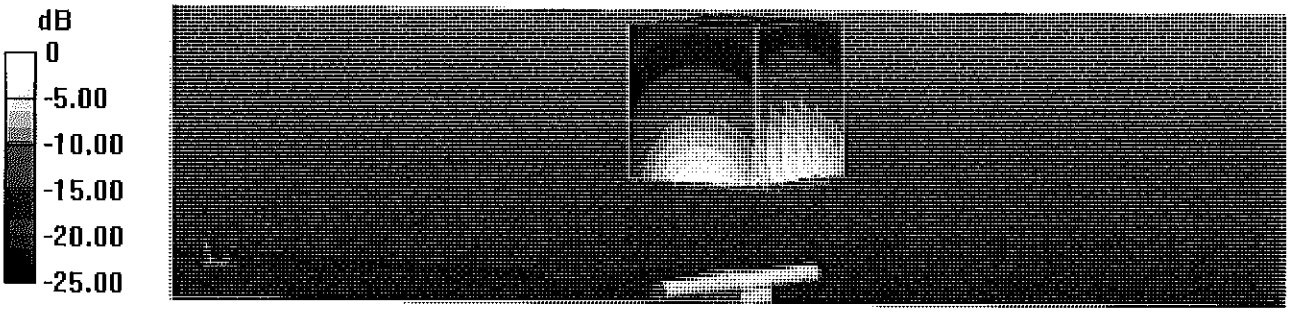
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 51.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.1, 8.1, 8.1); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

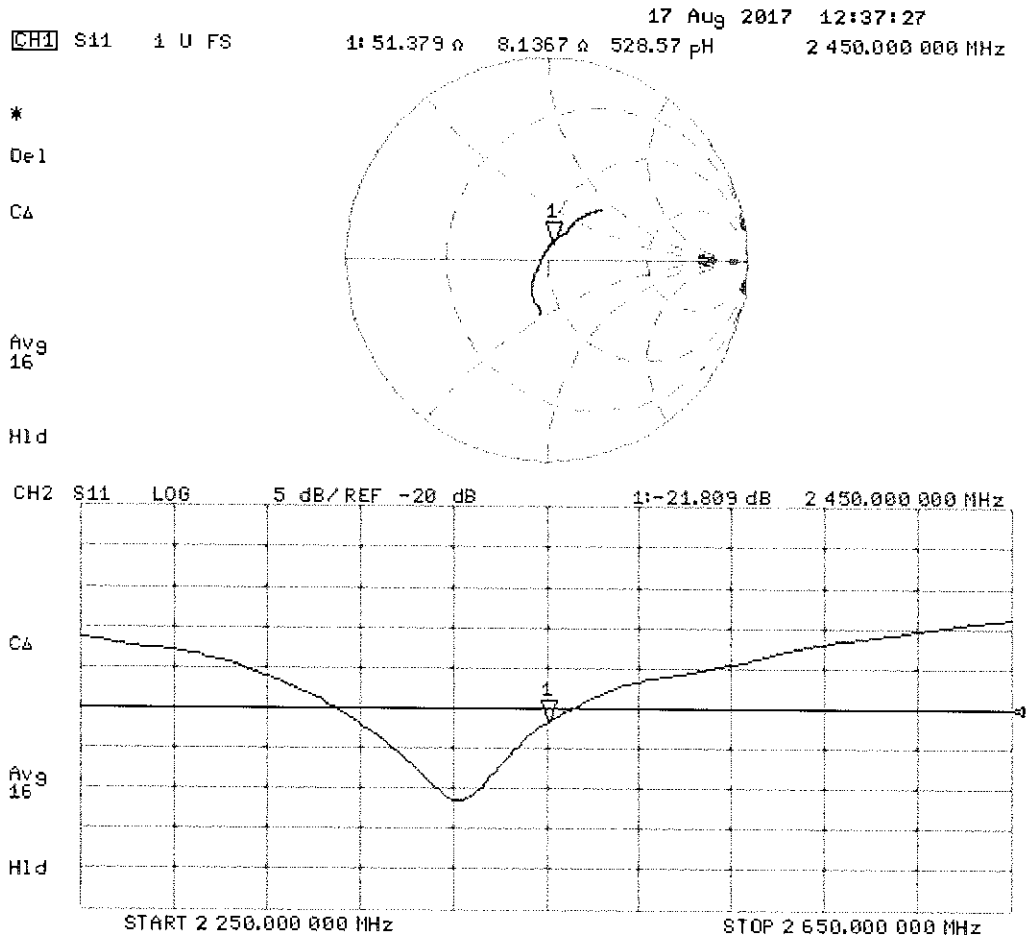
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 103.0 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 25.2 W/kg
**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 6 W/kg**
Maximum value of SAR (measured) = 19.8 W/kg




0 dB = 19.8 W/kg = 12.97 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D2450V2 – SN: 719

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: 07/18/2018

Description: SAR Validation Dipole at 2450 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | E4438C | ESG Vector Signal Generator | 3/24/2017 | Biennial | 3/24/2019 | MY42082385 |
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 433971 |
| Anritsu | ML2495A | Power Meter | 11/28/2017 | Annual | 11/28/2018 | 1039008 |
| Anritsu | MA2411B | Pulse Power Sensor | 3/2/2018 | Annual | 3/2/2019 | 1207364 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Control Company | 4040 | Therm./Clock/Humidity Monitor | 3/31/2017 | Biennial | 3/31/2019 | 170232394 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 5/2/2017 | Biennial | 5/2/2019 | 170330156 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/7/2018 | Annual | 3/7/2019 | 1368 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 8/9/2017 | Annual | 8/9/2018 | 1323 |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 9/12/2017 | Annual | 9/12/2018 | 1091 |
| SPEAG | ES3DV3 | SAR Probe | 3/13/2018 | Annual | 3/13/2019 | 3319 |
| SPEAG | ES3DV3 | SAR Probe | 8/14/2017 | Annual | 8/14/2018 | 3332 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Brodie Halbfoster | Test Engineer | BRODIE HALBFOSTER |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | KOK |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

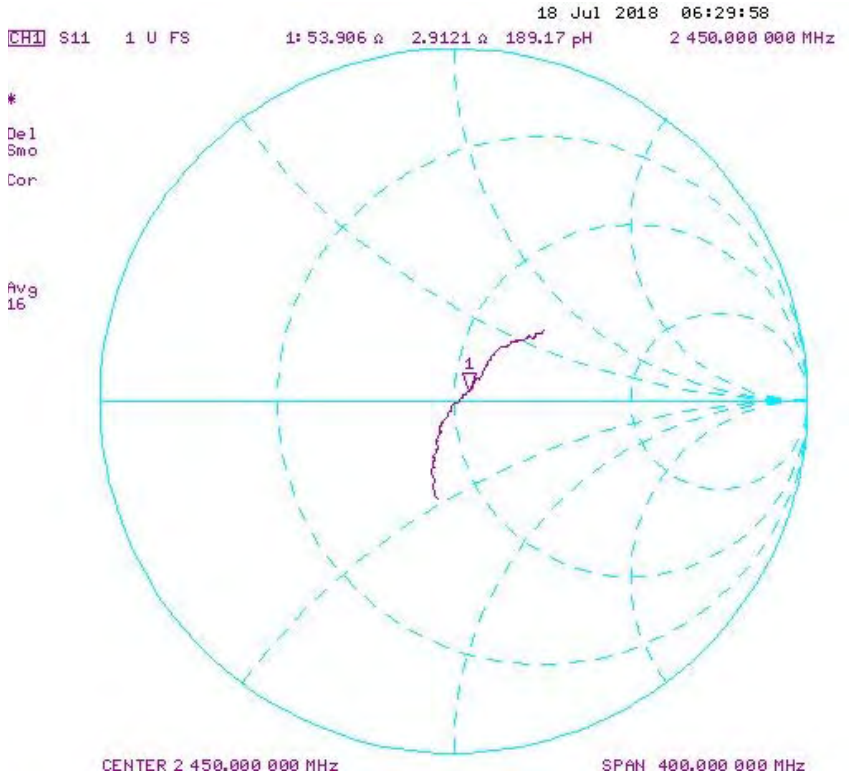
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

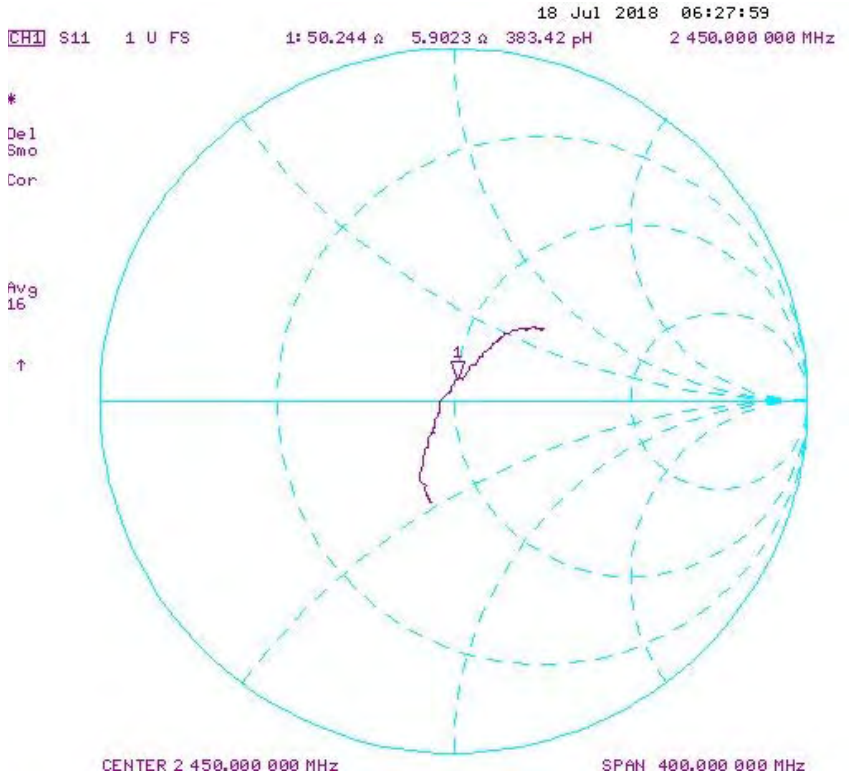
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/17/2017 | 7/18/2018 | 1.150 | 5.19 | 5.46 | 5.20% | 2.43 | 2.51 | 3.29% | 55.7 | 53.9 | 1.8 | 7.0 | 2.9 | 4.1 | -21.4 | -25.4 | -18.70% | PASS |

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/17/2017 | 7/18/2018 | 1.150 | 5.01 | 5.19 | 3.59% | 2.37 | 2.38 | 0.42% | 51.4 | 50.2 | 1.2 | 8.1 | 5.9 | 2.2 | -21.8 | -24.6 | -12.80% | PASS |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D2600V2-1069_Sep17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2600V2 - SN:1069 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | September 11, 2017 |

SCV 10/03/2017

SCV 9/10/2018

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 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |

| 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 |

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

Issued: September 11, 2017

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.0 |
| **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 | 37.2 ± 6 % | 2.03 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 14.6 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **56.9 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.45 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **25.4 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 | 51.4 ± 6 % | 2.23 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 14.1 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **55.3 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.26 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **24.8 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.1 Ω - 6.1 jΩ |
| Return Loss | - 24.1 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 46.2 Ω - 4.7 jΩ |
| Return Loss | - 24.1 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.152 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 | July 17, 2013 |

## DASY5 Validation Report for Head TSL

Date: 11.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1069**

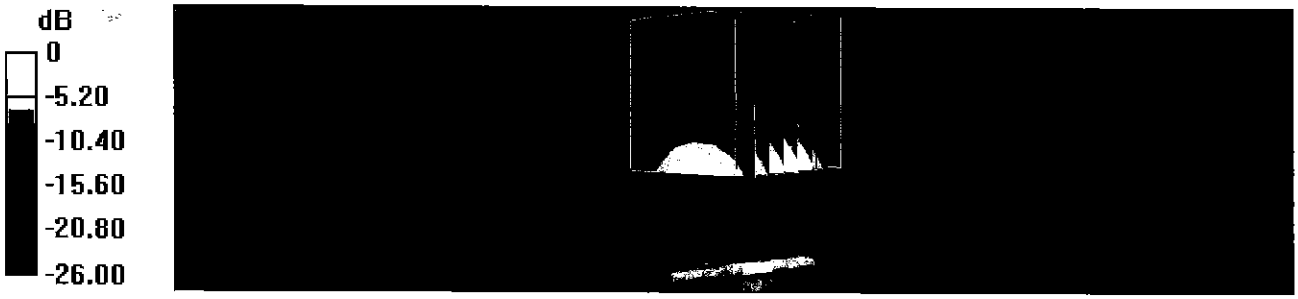
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 37.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

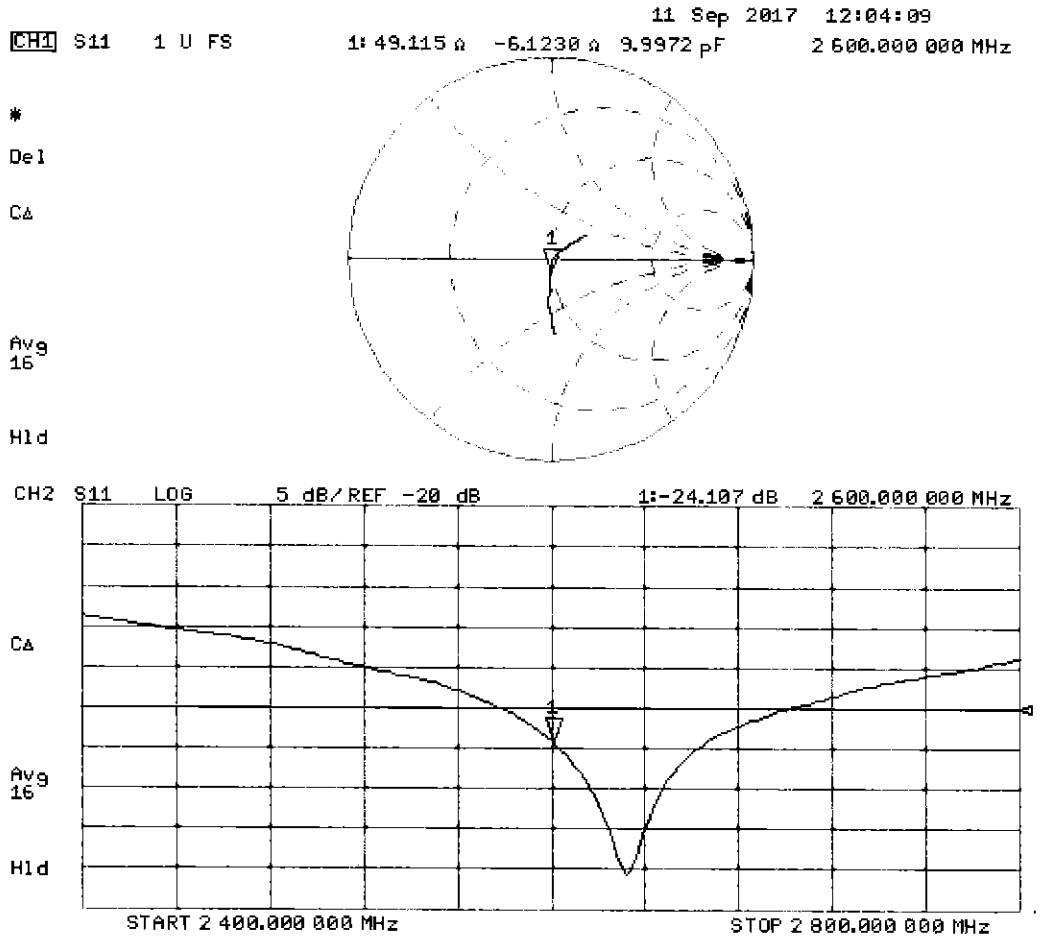
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 115.4 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 31.2 W/kg
**SAR(1 g) = 14.6 W/kg; SAR(10 g) = 6.45 W/kg**
Maximum value of SAR (measured) = 24.5 W/kg




0 dB = 24.5 W/kg = 13.89 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 11.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1069**

Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; $\sigma$ = 2.23 S/m; $\varepsilon_r$ = 51.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

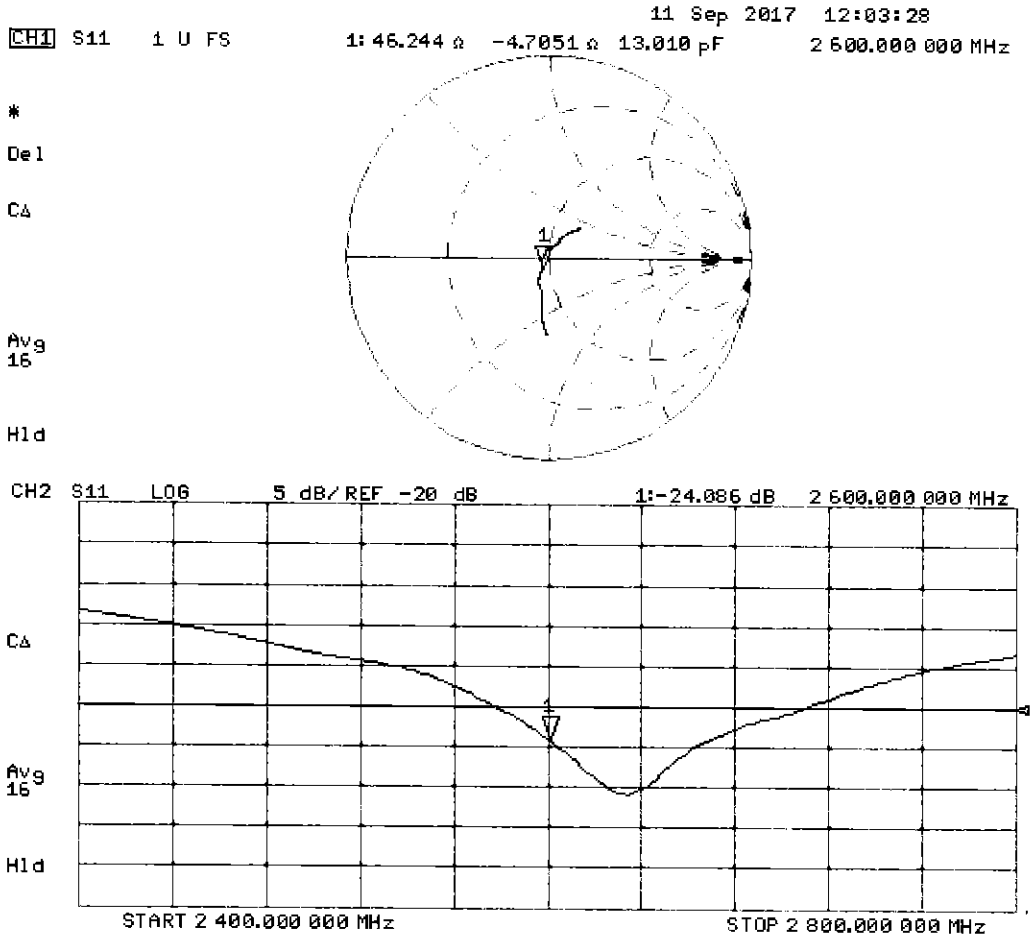
- Probe: EX3DV4 - SN7349; ConvF(7.94, 7.94, 7.94); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

### 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 = 105.7 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 29.9 W/kg
**SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.26 W/kg**
Maximum value of SAR (measured) = 22.9 W/kg

0 dB = 22.9 W/kg = 13.60 dBW/kg

## Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object D2600V2 – SN: 1069

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: September 10, 2018

Description: SAR Validation Dipole at 2600 MHz.

Calibration Equipment used:

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8753ES | S-Parameter Network Analyzer | 9/14/2017 | Annual | 9/14/2018 | US39170118 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/19/2018 | Annual | 3/19/2019 | US46240505 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 343972 |
| Anritsu | ML2496A | Power Meter | 10/9/2017 | Annual | 10/9/2018 | 1138001 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/15/2017 | Annual | 11/15/2018 | 1339007 |
| Anritsu | MA2411B | Pulse Power Sensor | 11/22/2017 | Annual | 11/22/2018 | 1339008 |
| Control Company | 4040 | Temperature / Humidity Monitor | 2/28/2018 | Biennial | 2/28/2020 | 150761911 |
| Control Company | 4352 | Ultra Long Stem Thermometer | 2/14/2017 | Biennial | 2/14/2019 | 170112507 |
| Keysight | 772D | Dual Directional Coupler | CBT | N/A | CBT | MY52180215 |
| Keysight Technologies | 85033E | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 6/4/2018 | Annual | 6/4/2019 | MY53401181 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE5011-1 | Torque Wrench | 7/19/2017 | Biennial | 7/19/2019 | N/A |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 5/15/2018 | Annual | 5/15/2019 | 1070 |
| SPEAG | ES3DV3 | SAR Probe | 9/18/2017 | Annual | 9/18/2018 | 3287 |
| SPEAG | DAE4 | Data Acquisition Electronics | 1/26/2018 | Annual | 1/26/2019 | 1533 |
| SPEAG | ES3DV3 | SAR Probe | 4/12/2018 | Annual | 4/12/2019 | 3275 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 4/12/2018 | Annual | 4/12/2019 | 501 |

Measurement Uncertainty = ±23% (k=2)

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated By: | Sangmin Cha | Team Lead Engineer | |
| Approved By: | Kaitlin O'Keefe | Senior Technical Manager | |

# DIPOLE CALIBRATION EXTENSION

Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

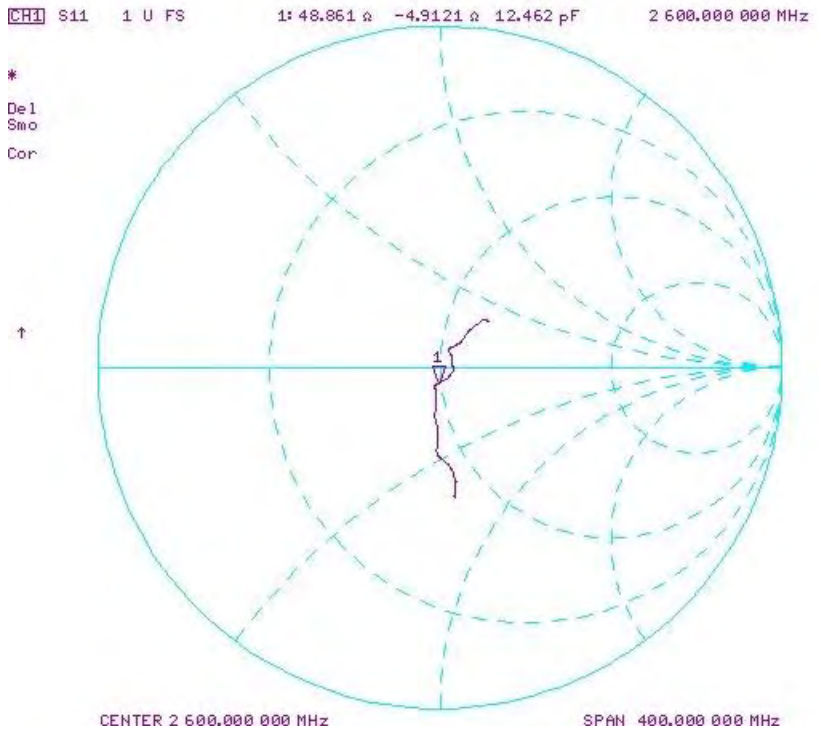
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

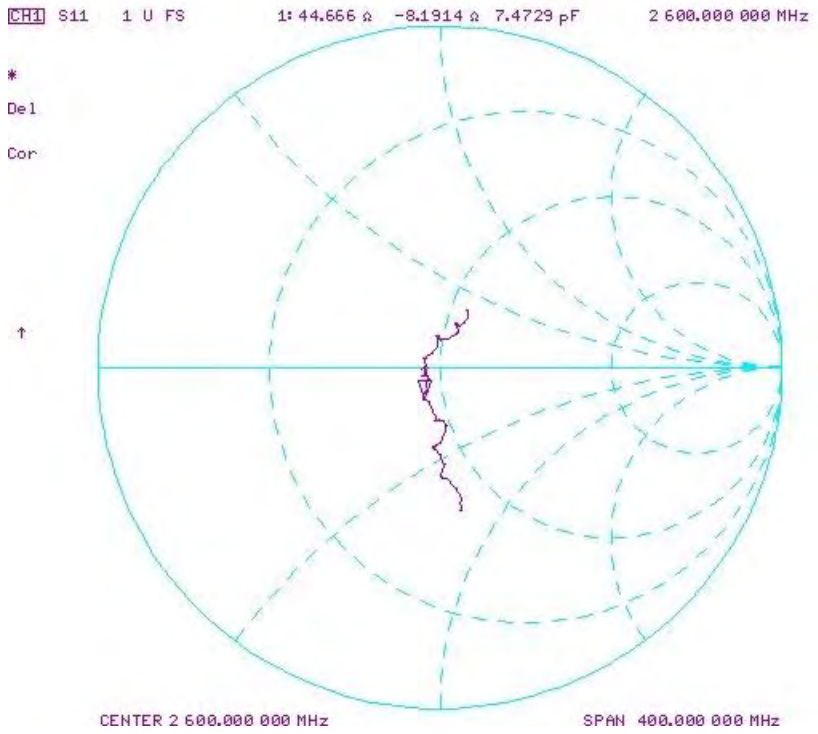
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Head (Ohm) Real | Measured Impedance Head (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Head (Ohm) Imaginary | Measured Impedance Head (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/11/2017 | 9/10/2018 | 1.152 | 5.69 | 5.52 | -2.99% | 2.54 | 2.51 | -1.18% | 49.1 | 48.9 | 0.2 | -6.1 | -4.9 | 1.2 | -24.1 | -25.8 | -7.10% | PASS |

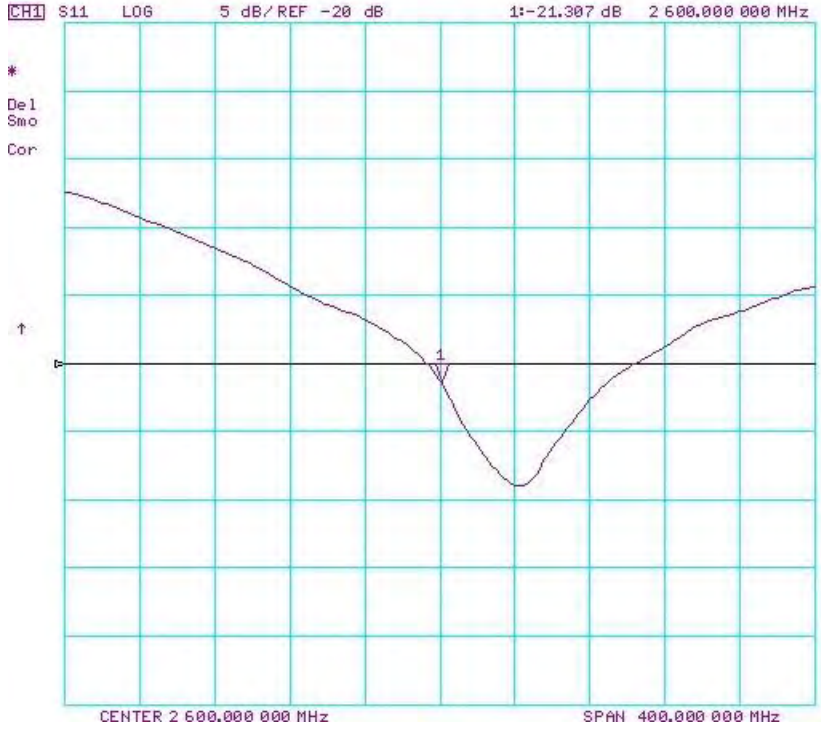
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/11/2017 | 9/10/2018 | 1.152 | 5.53 | 5.28 | -4.52% | 2.48 | 2.35 | -5.24% | 46.2 | 44.7 | 1.5 | -4.7 | -8.2 | 3.5 | -24.1 | -21.3 | 11.60% | PASS |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** **PC Test**

**Certificate No: D2600V2-1126_Aug18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2600V2 - SN:1126 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 13, 2018 |

BN ✓
09-06/2018

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 26-Oct-17 (No. DAE4-601_Oct17) | Oct-18 |

| 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 Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-17) | In house check: Oct-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 13, 2018

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

## 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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 | V52.10.1 |
| **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 | 37.1 ± 6 % | 2.03 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (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 | **54.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.25 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.6 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 | 51.3 ± 6 % | 2.20 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.7 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **54.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.15 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **24.4 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 | 48.3 Ω - 8.0 jΩ |
| Return Loss | - 21.6 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 44.7 Ω - 5.8 jΩ |
| Return Loss | - 21.7 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.154 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 | October 22, 2015 |

## DASY5 Validation Report for Head TSL

Date: 13.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1126**

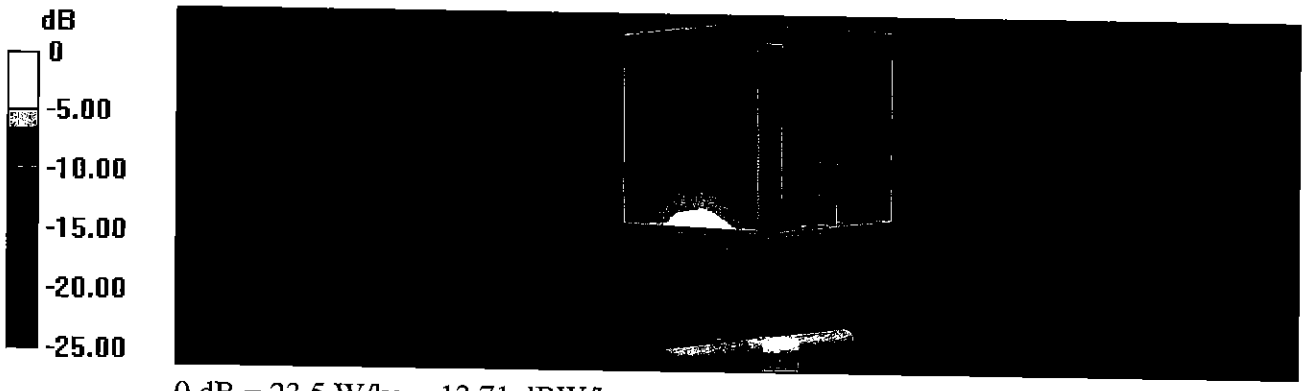
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 37.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.7, 7.7, 7.7) @ 2600 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

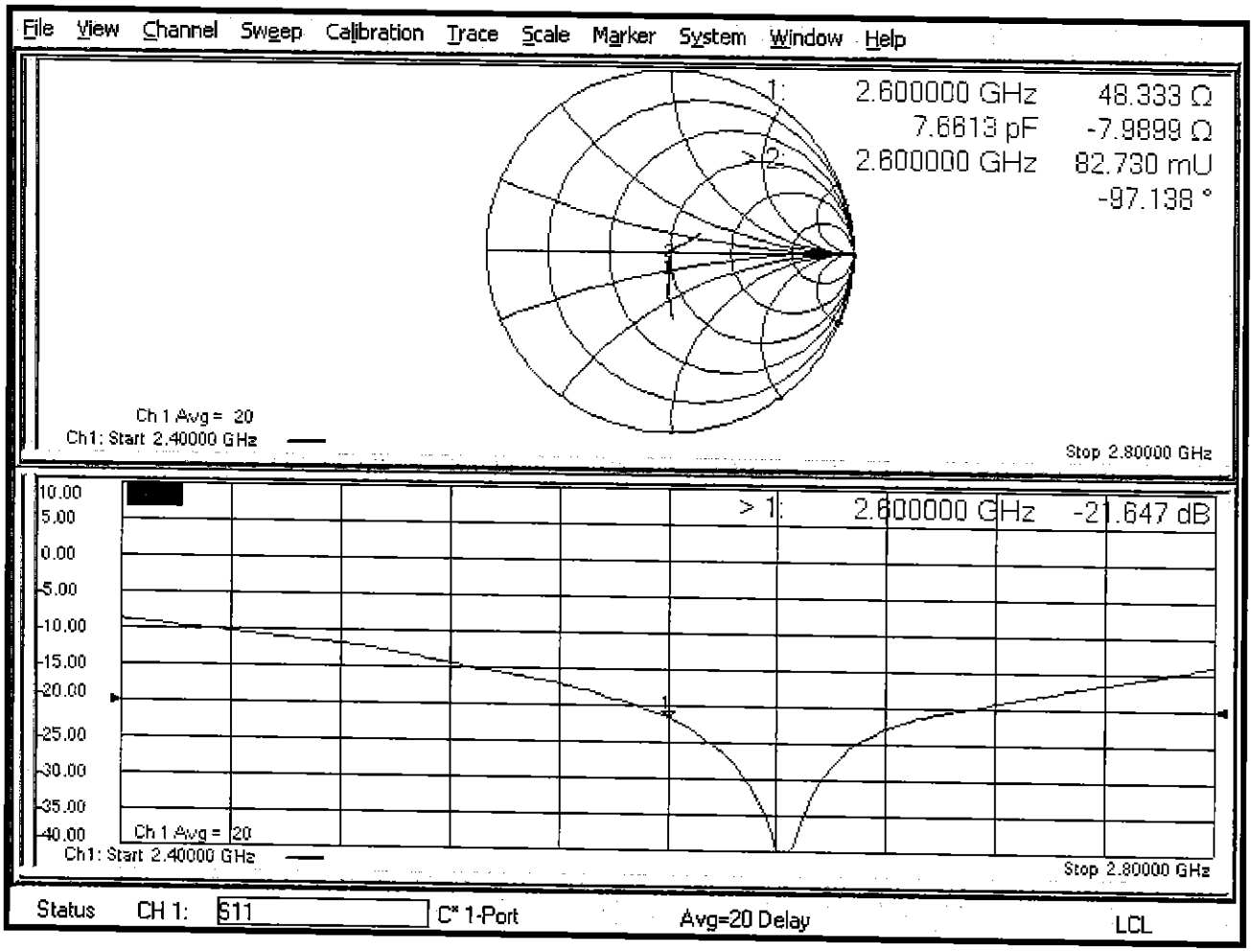
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 117.1 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 28.0 W/kg
**SAR(1 g) = 14 W/kg; SAR(10 g) = 6.25 W/kg**
Maximum value of SAR (measured) = 23.5 W/kg




0 dB = 23.5 W/kg = 13.71 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 13.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1126**

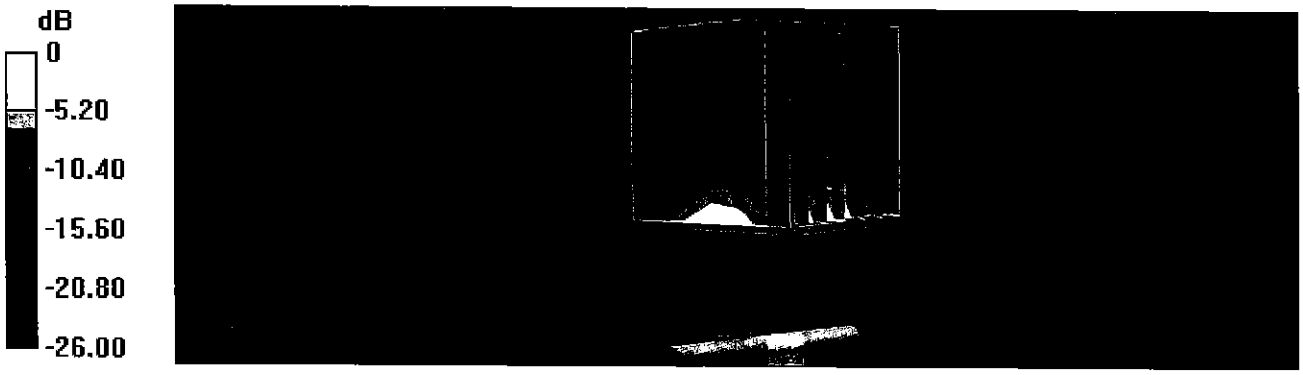
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; $\sigma$ = 2.2 S/m; $\varepsilon_r$ = 51.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.81, 7.81, 7.81) @ 2600 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

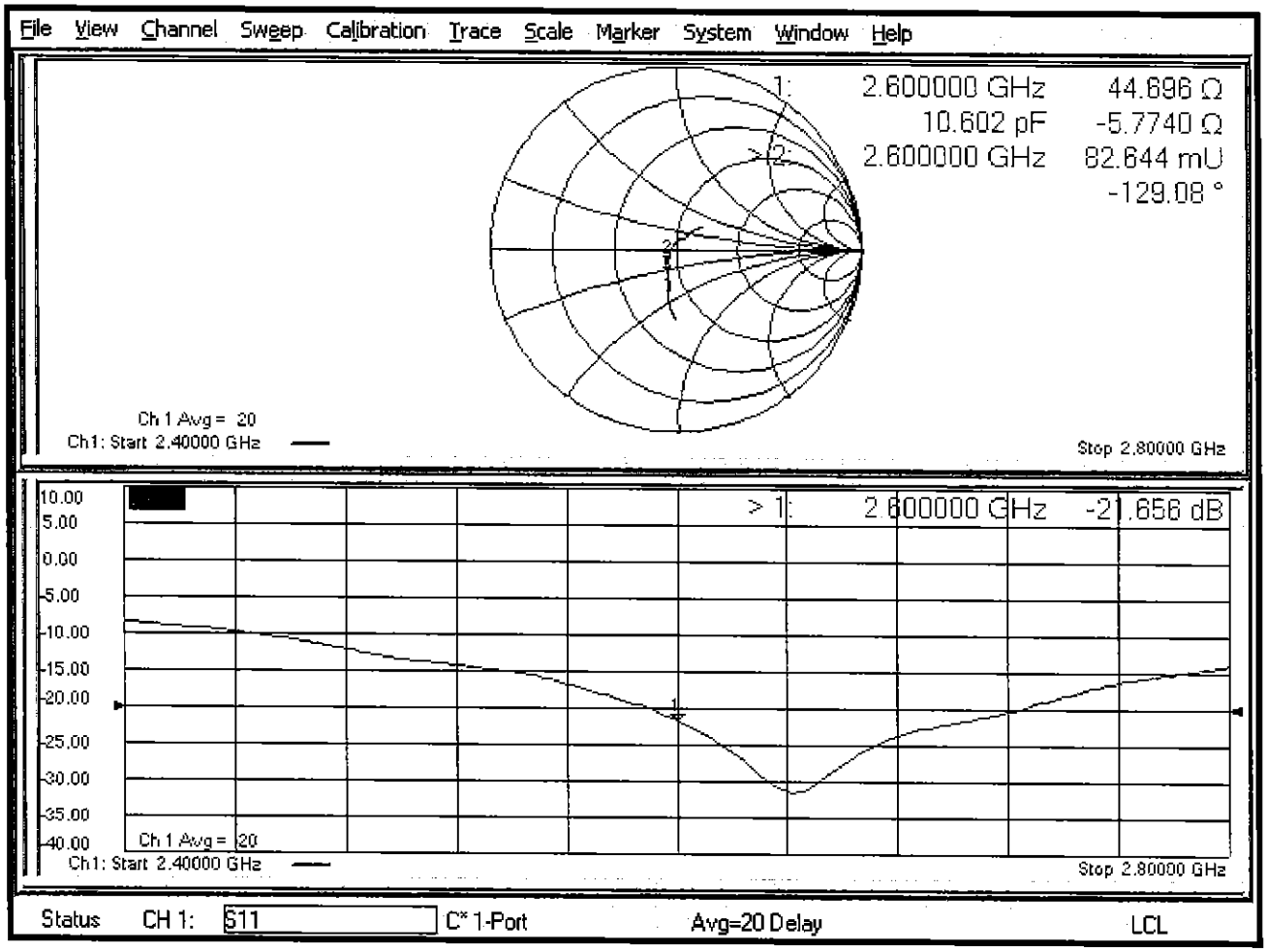
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.2 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 28.0 W/kg
**SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.15 W/kg**
Maximum value of SAR (measured) = 22.4 W/kg




0 dB = 22.4 W/kg = 13.50 dBW/kg

## Impedance Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** 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** PC Test

**Certificate No: D2600V2-1009_Jun18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2600V2 - SN:1009 |
| Calibration procedure(s) | QA CAL-05.v10<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | June 19, 2018 |

SC ✓ 6/28/18

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 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 30-Dec-17 (No. EX3-7349_Dec17) | Dec-18 |
| DAE4 | SN: 601 | 26-Oct-17 (No. DAE4-601_Oct17) | Oct-18 |

| 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-17) | In house check: Oct-18 |

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

Issued: June 21, 2018

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