**LTE Band 41 Head**
Date: 2019-6-7
Electronics: DAE4 Sn786
Medium: Head 2550MHz
Medium parameters used: f = 2506 MHz; $\sigma$ = 1.899 S/m; $\varepsilon_r$ = 38.524; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_TDD (0) Frequency: 2506 MHz Duty Cycle: 1:1.58
Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

**Left Cheek Middle 1RB_Mid/Area Scan (61x111x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.147 W/kg

**Left Cheek Middle 1RB_Mid/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.470 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.252 W/kg
**SAR(1 g) = 0.148 W/kg; SAR(10 g) = 0.077 W/kg**
Maximum value of SAR (measured) = 0.195 W/kg

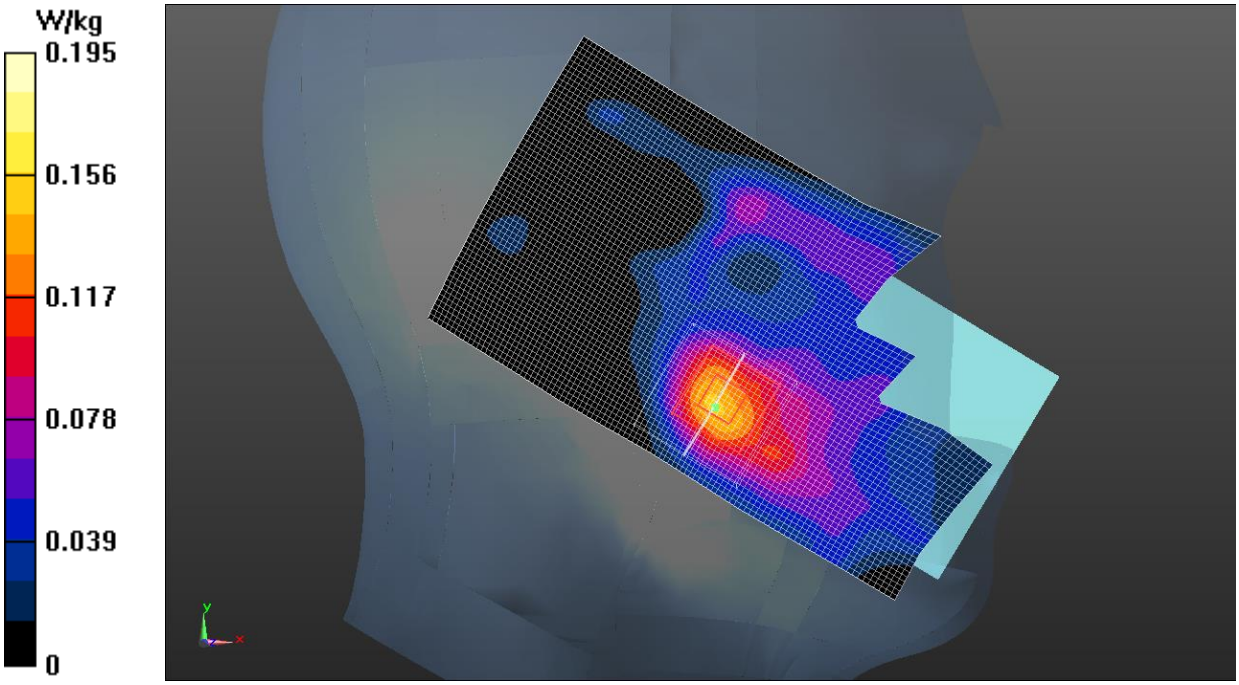


**Fig.31 LTE Band 41**

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**LTE Band 41 Body**
Date: 2019-6-7
Electronics: DAE4 Sn786
Medium: Head 2550MHz
Medium parameters used: f = 2506 MHz; $\sigma$ = 1.899 S/m; $\varepsilon_r$ = 38.524; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_TDD (0) Frequency: 2506 MHz Duty Cycle: 1:1.58
Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

**Rear Side Low 1RB_Mid/Area Scan (61x111x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.574 W/kg

**Rear Side Low 1RB_Mid/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.473 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.625 W/kg
**SAR(1 g) = 0.268 W/kg; SAR(10 g) = 0.184 W/kg**
Maximum value of SAR (measured) = 0.589 W/kg

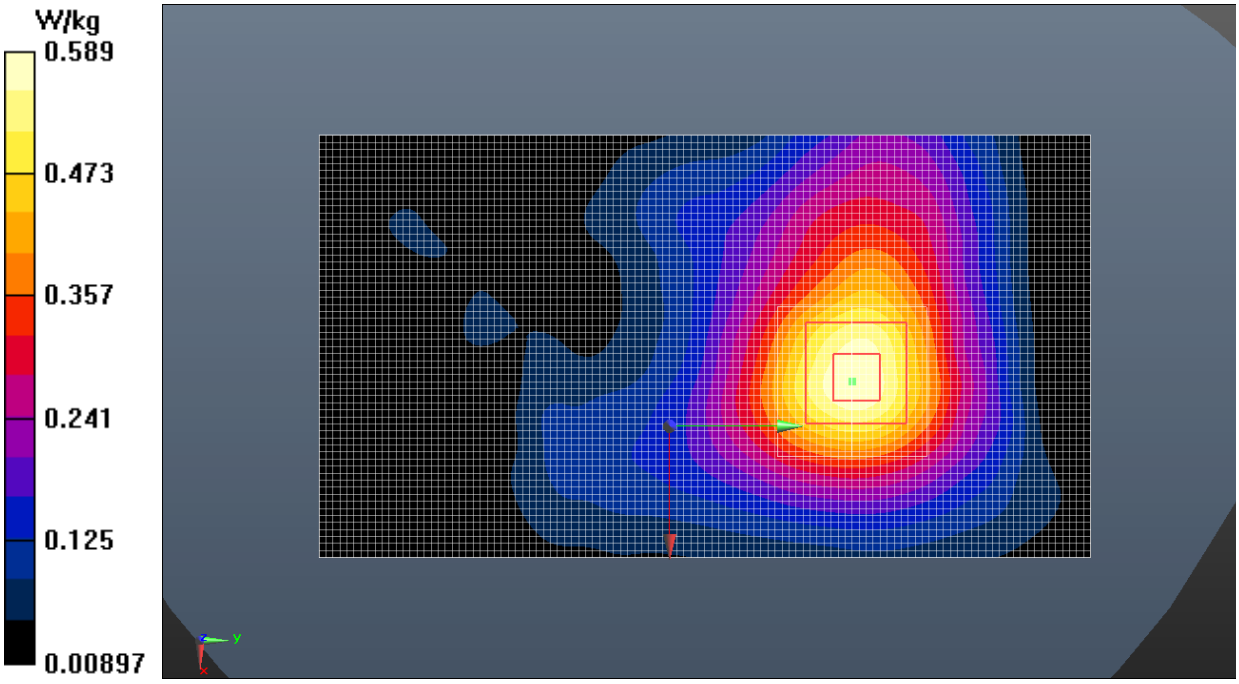


**Fig.32 LTE Band 41**

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**LTE Band 66 Head**
Date: 2019-6-4
Electronics: DAE4 Sn786
Medium: Head 1750MHz
Medium parameters used: f = 1770 MHz; $\sigma$ = 1.379 S/m; $\varepsilon_r$ = 40.273; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_FDD (0) Frequency: 1770 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (8.07, 8.07, 8.07);

**Right Cheek High 1RB_Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.088 W/kg

**Right Cheek High 1RB_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.520 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.121 W/kg
**SAR(1 g) = 0.081 W/kg; SAR(10 g) = 0.051 W/kg**
Maximum value of SAR (measured) = 0.094 W/kg

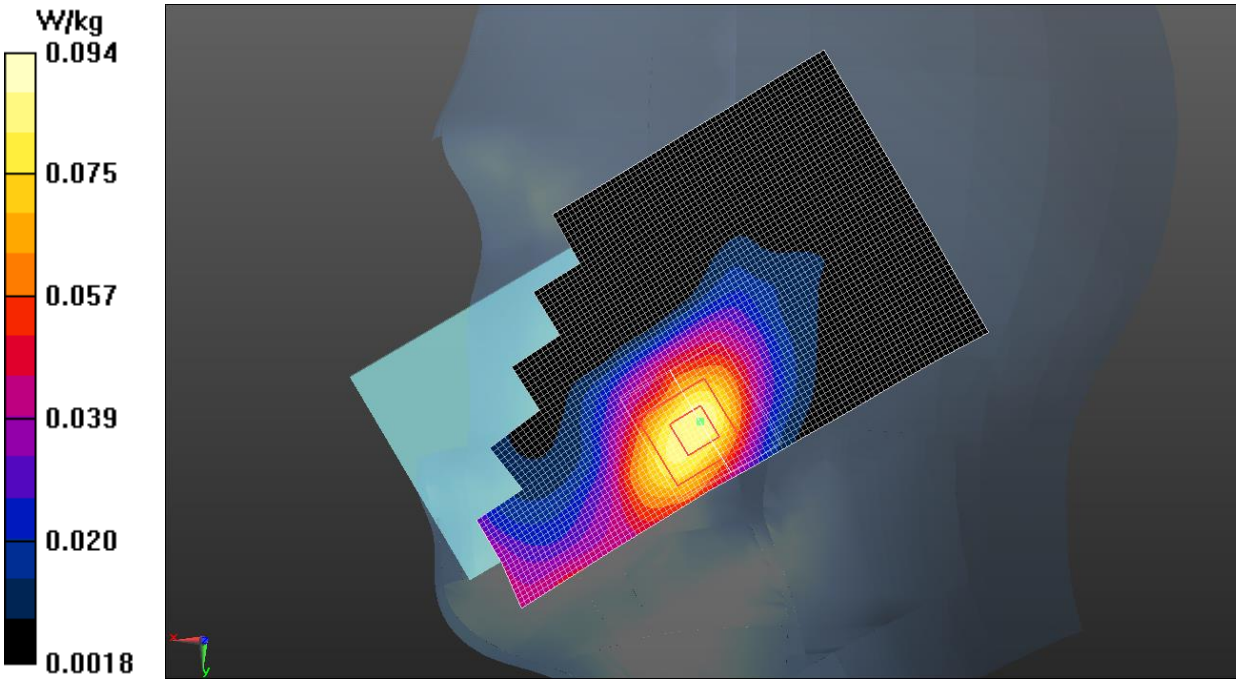


**Fig.33 LTE Band 66**

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**LTE Band 66 Body**
Date: 2019-6-4
Electronics: DAE4 Sn786
Medium: Head 1750MHz
Medium parameters used: f = 1770 MHz; $\sigma$ = 1.379 S/m; $\varepsilon_r$ = 40.273; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_FDD (0) Frequency: 1770 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (8.07, 8.07, 8.07);

**Bottom Side High 1RB_Mid/Area Scan (51x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.851 W/kg

**Bottom Side High 1RB_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 21.45 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 1.14 W/kg
**SAR(1 g) = 0.618 W/kg; SAR(10 g) = 0.307 W/kg**
Maximum value of SAR (measured) = 0.790 W/kg

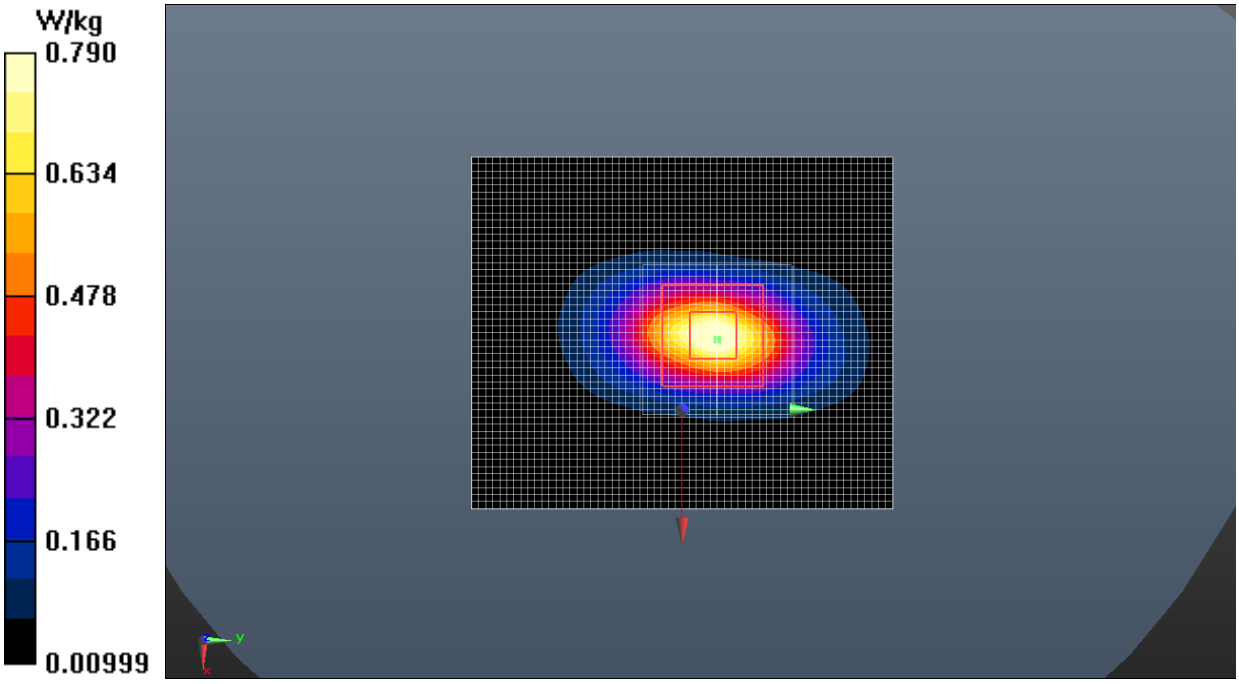


**Fig.34 LTE Band 66**

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**LTE Band 71 Head**
Date: 2019-6-2
Electronics: DAE4 Sn786
Medium: Head 750MHz
Medium parameters used (extrapolated): f = 673 MHz; $\sigma$ = 0.888 S/m; $\varepsilon_r$ = 41.443; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_FDD (0) Frequency: 673 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

**Left Cheek Low 1RB_Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.034 W/kg

**Left Cheek Low 1RB_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.749 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 0.045 W/kg
**SAR(1 g) = 0.032 W/kg; SAR(10 g) = 0.023 W/kg**
Maximum value of SAR (measured) = 0.036 W/kg

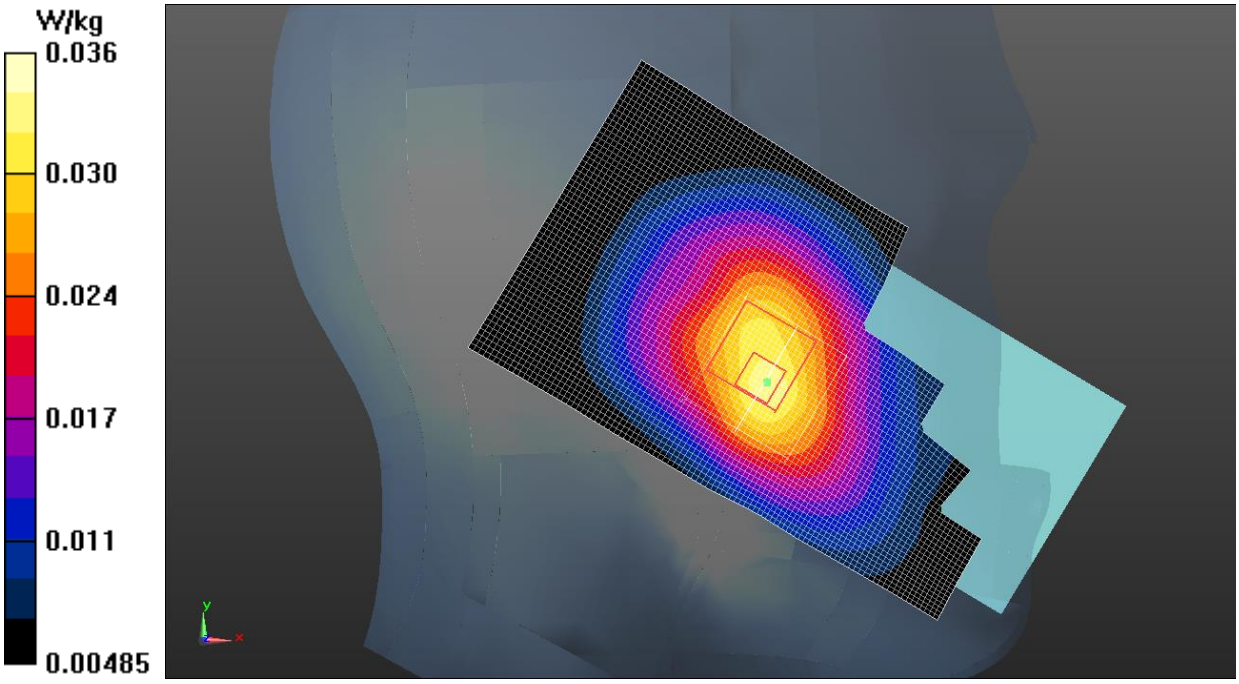


**Fig.35 LTE Band 71**

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**LTE Band 71 Body**
Date: 2019-6-2
Electronics: DAE4 Sn786
Medium: Head 750MHz
Medium parameters used (extrapolated): f = 673 MHz; $\sigma$ = 0.888 S/m; $\varepsilon_r$ = 41.443; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, LTE_FDD (0) Frequency: 673 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

**Front Side Low 1RB_Mid/Area Scan (61x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.0396 W/kg

**Front Side Low 1RB_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 6.104 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 0.0800 W/kg
**SAR(1 g) = 0.045 W/kg; SAR(10 g) = 0.029 W/kg**
Maximum value of SAR (measured) = 0.0527 W/kg

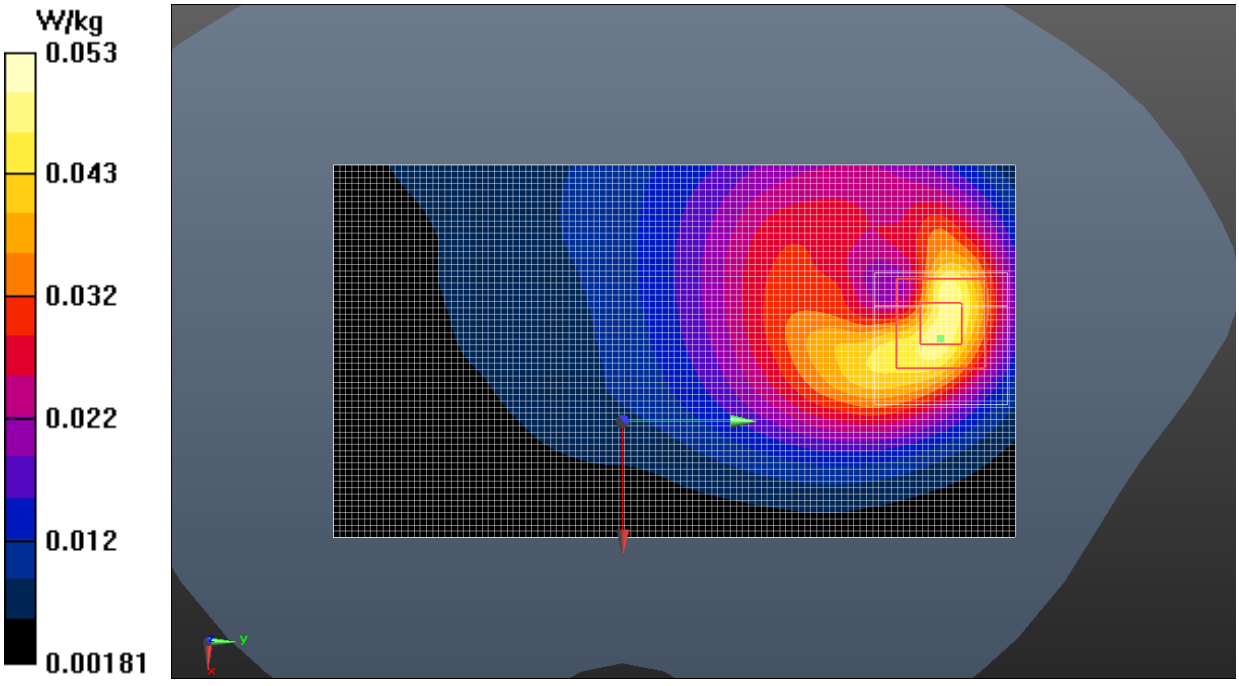


**Fig.36 LTE Band 71**

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**Wi-Fi 2.4G Head**
Date: 2019-6-17
Electronics: DAE4 Sn786
Medium: Head 2450MHz
Medium parameters used (interpolated): f = 2437 MHz; $\sigma$ = 1.808 S/m; $\varepsilon_r$ = 38.185; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, WiFi (0) Frequency: 2437 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

**Left Cheek Middle/Area Scan (61x61x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.08 W/kg

**Left Cheek Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 13.49 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 2.03 W/kg
**SAR(1 g) = 0.879 W/kg; SAR(10 g) = 0.380 W/kg**
Maximum value of SAR (measured) = 1.41 W/kg

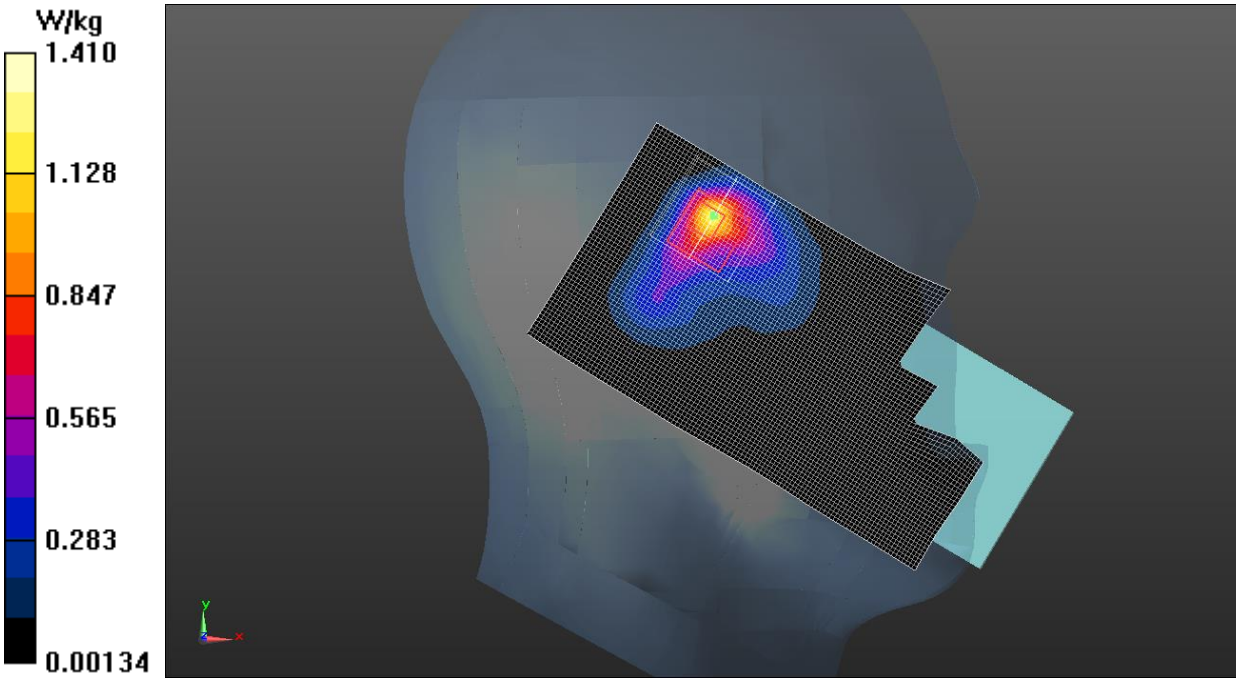


**Fig.37 Wi-Fi 2.4G**

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**Wi-Fi 2.4G Body**
Date: 2019-6-17
Electronics: DAE4 Sn786
Medium: Head 2450MHz
Medium parameters used: f = 2462 MHz; $\sigma$ = 1.838 S/m; $\varepsilon_r$ = 38.093; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C
Communication System: UID 0, WiFi (0) Frequency: 2462 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

**Top Side High/Area Scan (41x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.285 W/kg

**Top Side High/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.276 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.391 W/kg
**SAR(1 g) = 0.205 W/kg; SAR(10 g) = 0.106 W/kg**
Maximum value of SAR (measured) = 0.297 W/kg

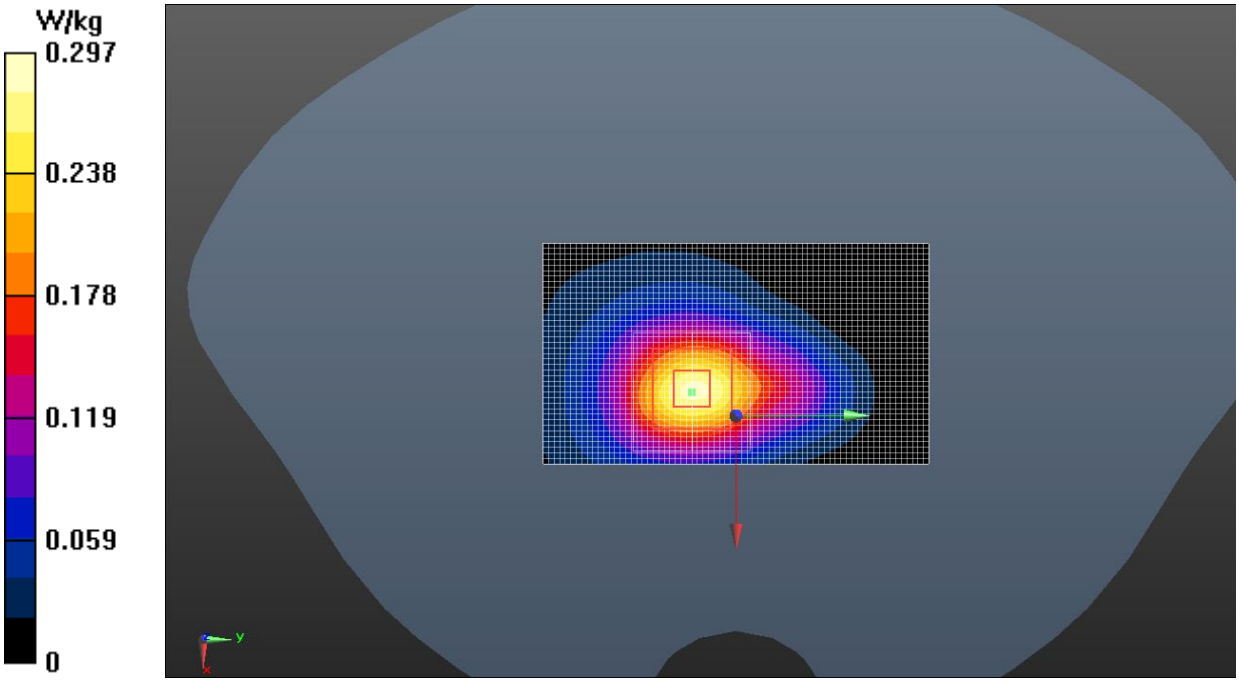


**Fig.38 Wi-Fi 2.4G**

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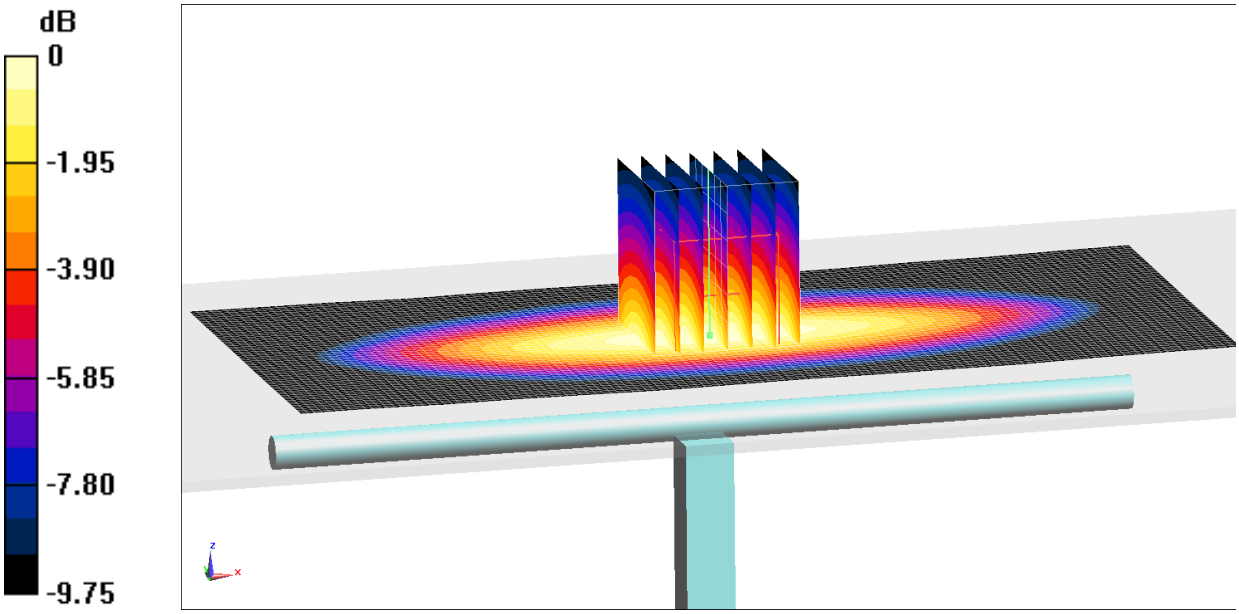
# ANNEX B SystemVerification Results

**750MHz**
Date: 2019-6-2
Electronics: DAE4 Sn786
Medium: Head 750MHz
Medium parameters used: f = 750 MHz; σ = 0.916 S/m; εr = 41.162.; ρ = 1000 kg/m3
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

**System Validation /Area Scan (81x191x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 58.616 V/m; Power Drift = 0.02 dB
**SAR(1 g) = 2.12 W/kg; SAR(10 g) = 1.38 W/kg**
Maximum value of SAR (interpolated) = 2.28 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 58.616 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 2.77 W/kg
**SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.40 W/kg**
Maximum value of SAR (measured) = 2.31 W/kg




0 dB = 2.31 W/kg = 3.64 dB W/kg

**Fig.B.1. Validation 750MHz 250mW**

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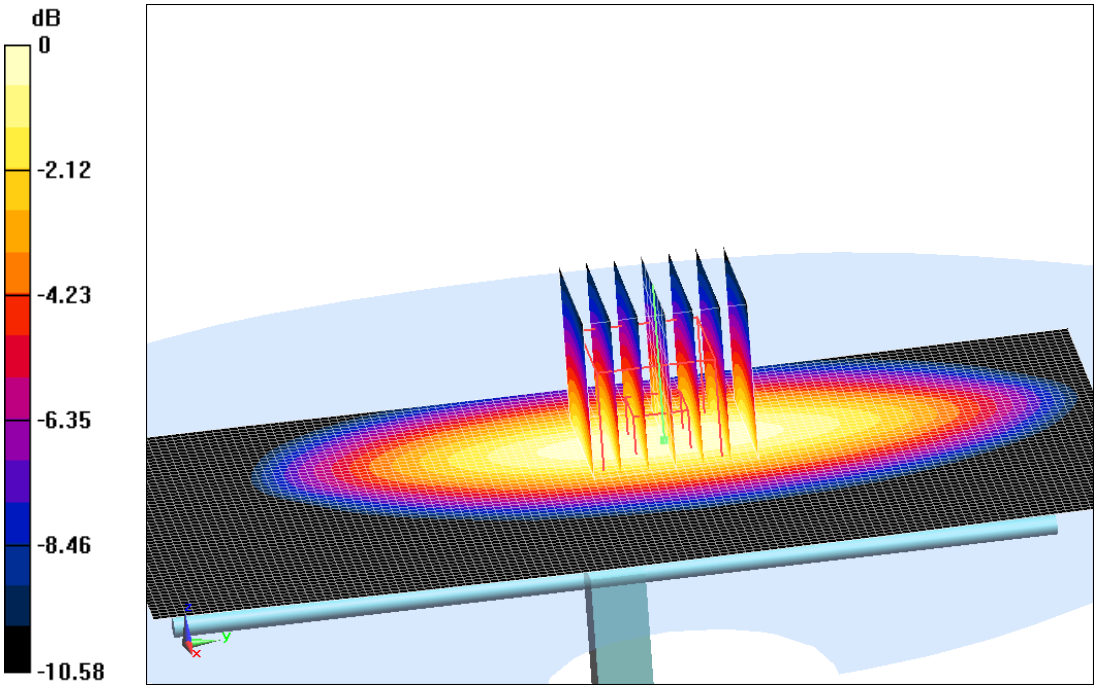
**835MHz**
Date: 2019-5-30
Electronics: DAE4 Sn786
Medium: Head 835MHz
Medium parameters used: f = 835 MHz; $\sigma$ =0.915 S/m; $\varepsilon r$ = 40.441; $\rho$ = 1000 kg/$m^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

**System Validation /Area Scan (81x161x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 60.203 V/m; Power Drift = -0.09 dB
**SAR(1 g) = 2.49 W/kg; SAR(10 g) = 1.60 W/kg**
Maximum value of SAR (interpolated) = 2.61 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 60.203 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 3.16 W/kg
**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.59 W/kg**
Maximum value of SAR (measured) = 2.58 W/kg




0 dB = 2.58 W/kg = 4.12 dB W/kg

**Fig.B.2. Validation 835MHz 250mW**

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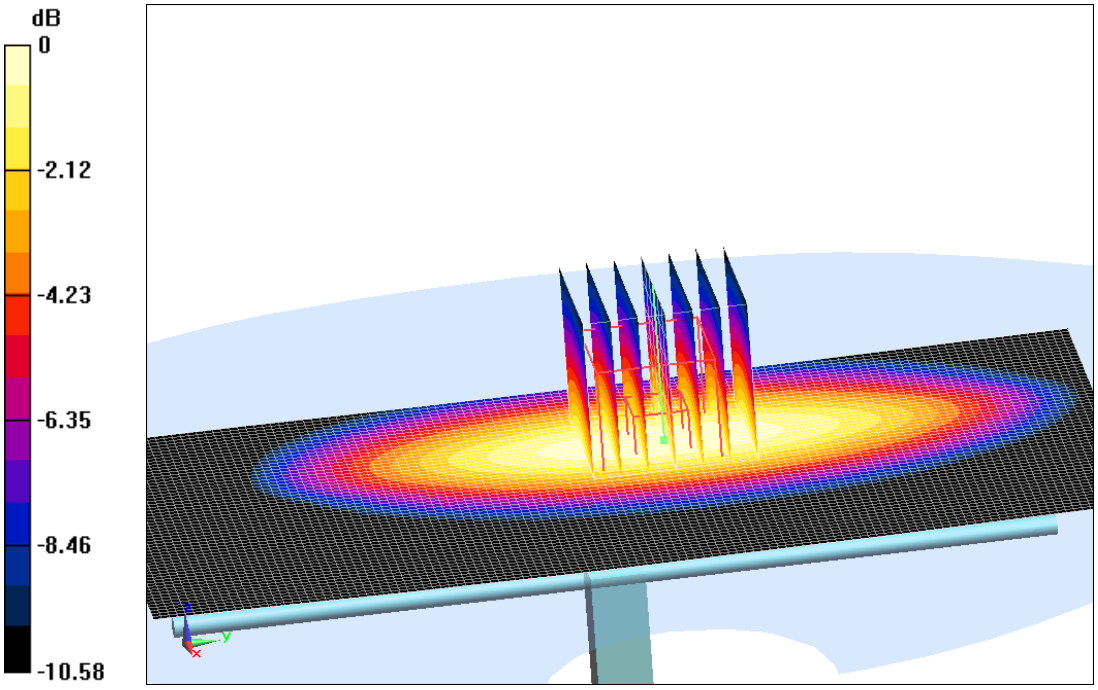
**835MHz**
Date: 2019-5-31
Electronics: DAE4 Sn786
Medium: Head 835MHz
Medium parameters used: f = 835 MHz; $\sigma$ =0.923 S/m; $\varepsilon r$ = 40.258; $\rho$ = 1000 kg/$m^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

**System Validation /Area Scan (81x161x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 61.242 V/m; Power Drift = 0.05 dB
**SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.60 W/kg**
Maximum value of SAR (interpolated) = 2.62 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 61.242 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 3.25 W/kg
**SAR(1 g) = 2.49 W/kg; SAR(10 g) = 1.61 W/kg**
Maximum value of SAR (measured) = 2.66 W/kg




0 dB = 2.66 W/kg = 4.25 dB W/kg

**Fig.B.3. Validation 835MHz 250mW**

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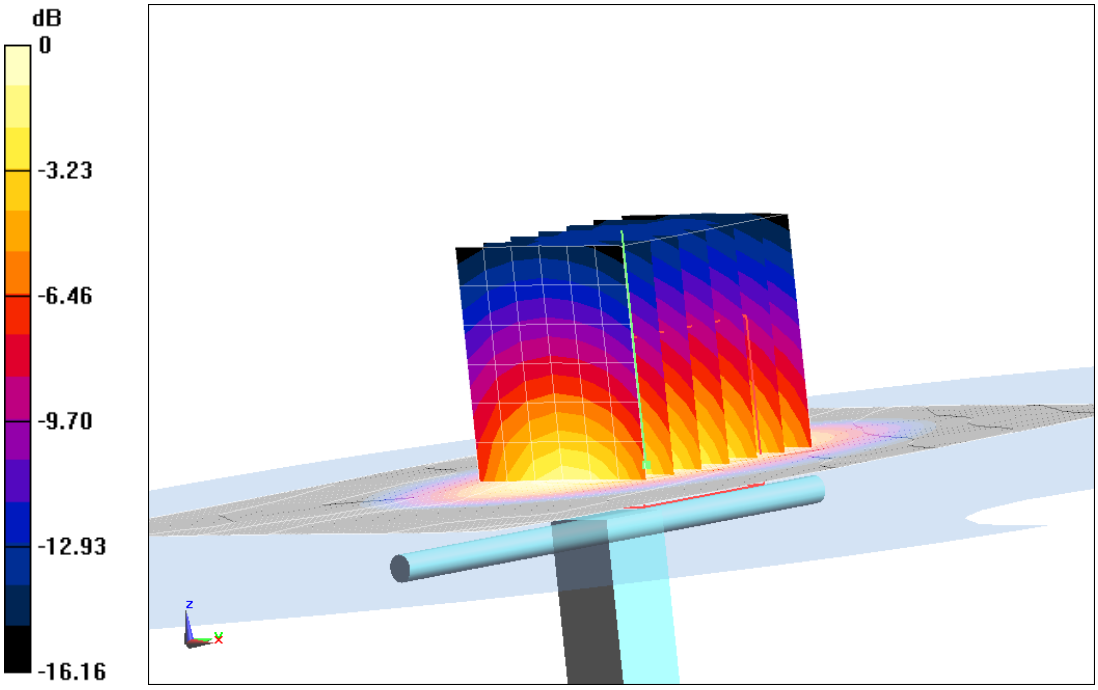
**1750MHz**
Date: 2019-6-4
Electronics: DAE4 Sn786
Medium: Head 1750MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.361 S/m; $\varepsilon_r$ = 40.334; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 1750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (8.07, 8.07, 8.07);

**System Validation/Area Scan (61x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 77.815 V/m; Power Drift = -0.11 dB
**SAR(1 g) = 9.02 W/kg; SAR(10 g) = 4.86 W/kg**
Maximum value of SAR (interpolated) = 11.2 W/kg

**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 77.815 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 17.3 W/kg
**SAR(1 g) = 8.85 W/kg; SAR(10 g) = 4.80 W/kg**
Maximum value of SAR (measured) = 11.0 W/kg




0 dB = 11.0 W/kg = 10.41 dB W/kg

**Fig.B.4. Validation 1750MHz 250mW**

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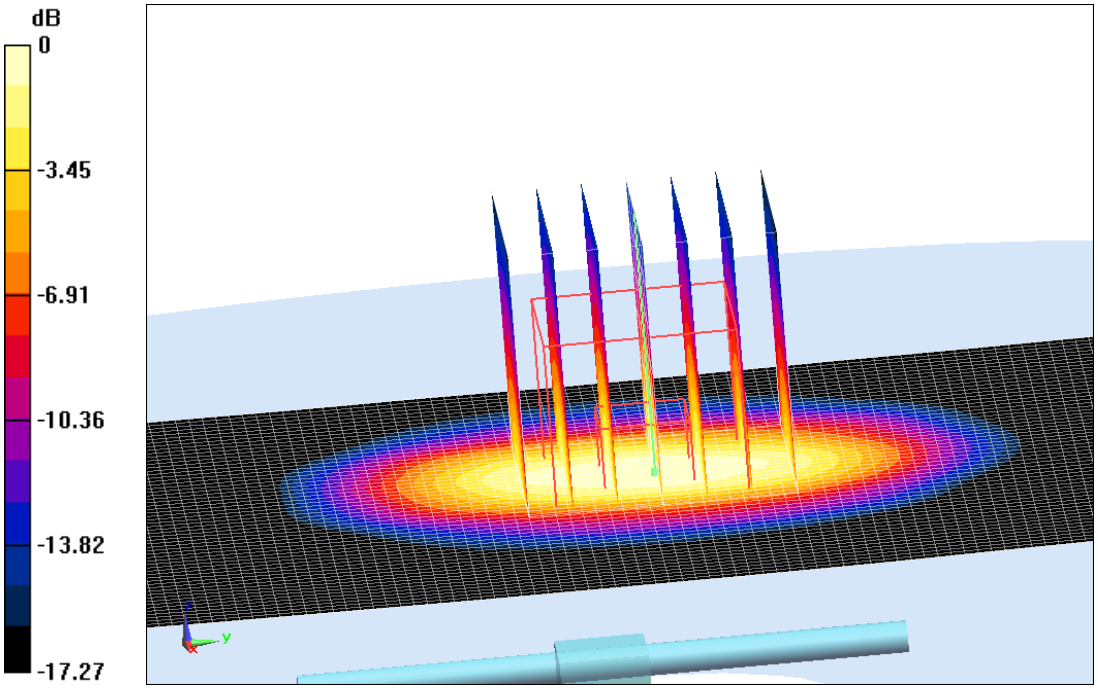
**1900MHz**
Date: 2019-6-19
Electronics: DAE4 Sn786
Medium: Head 1900MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.384 S/m; $\varepsilon_r$ = 40.452; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.63, 7.63, 7.63);

**System Validation /Area Scan (81x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 89.521 V/m; Power Drift = -0.05 dB
**SAR(1 g) = 9.92 W/kg; SAR(10 g) = 5.16 W/kg**
Maximum value of SAR (interpolated) = 12.4 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.521 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 20.2 W/kg
**SAR(1 g) = 9.77 W/kg; SAR(10 g) = 5.13 W/kg**
Maximum value of SAR (measured) = 12.1 W/kg




0 dB = 12.1 W/kg = 10.83 dB W/kg

**Fig.B.5. Validation 1900MHz 250mW**

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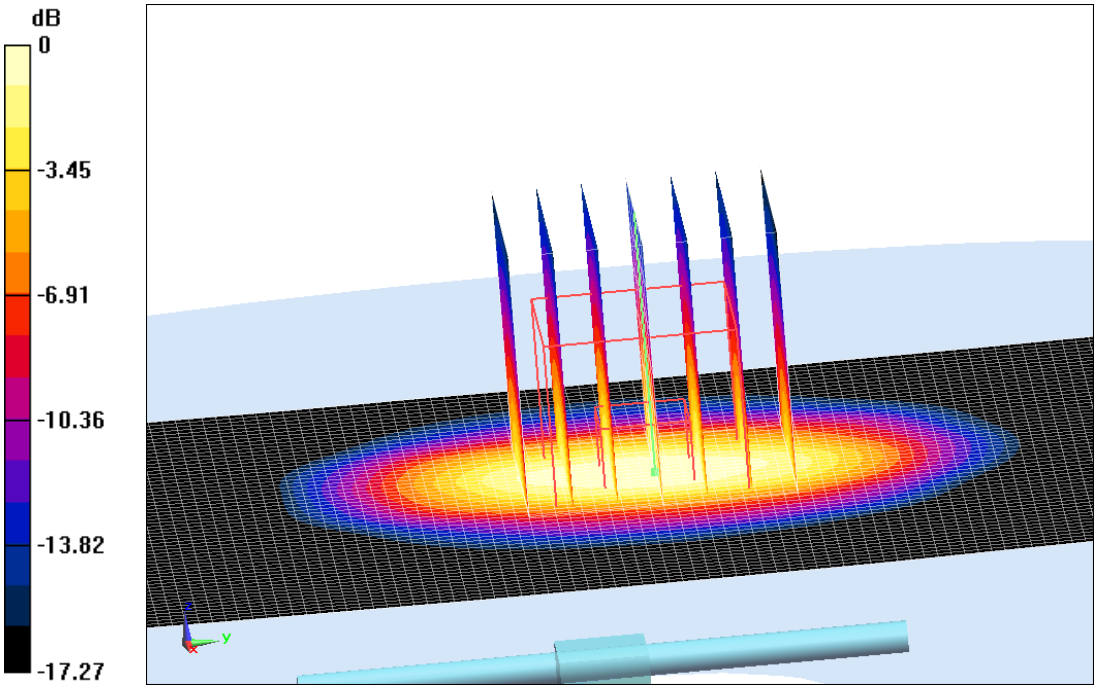
**1900MHz**
Date: 2019-6-20
Electronics: DAE4 Sn786
Medium: Head 1900MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.395 S/m; $\varepsilon_r$ = 40.266; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.63, 7.63, 7.63);

**System Validation /Area Scan (81x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 90.448 V/m; Power Drift = -0.06 dB
**SAR(1 g) = 10.0 W/kg; SAR(10 g) = 5.20 W/kg**
Maximum value of SAR (interpolated) = 12.8 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.448 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 21.1 W/kg
**SAR(1 g) = 9.83 W/kg; SAR(10 g) = 5.16 W/kg**
Maximum value of SAR (measured) = 12.6 W/kg




0 dB = 12.6 W/kg = 11.00 dB W/kg

**Fig.B.6. Validation 1900MHz 250mW**

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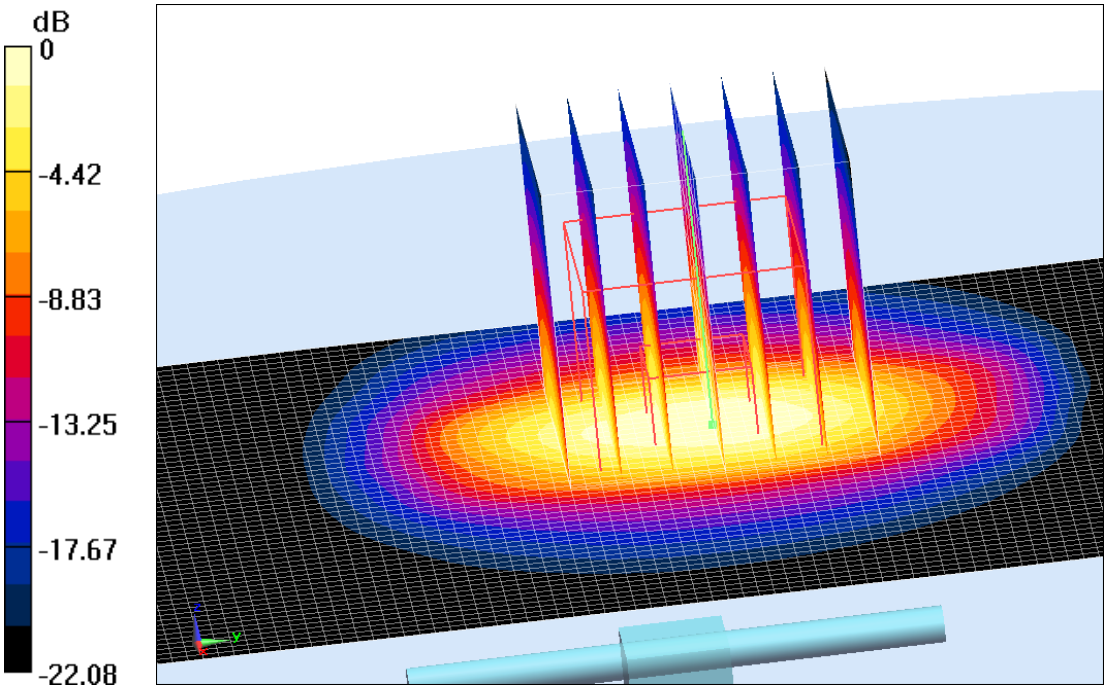
**2450MHz**
Date: 2019-6-17
Electronics: DAE4 Sn786
Medium: Head 2450MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.823 S/m; $\varepsilon_r$ = 38.142; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

**System Validation /Area Scan (61x81x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 91.905 V/m; Power Drift = -0.10 dB
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.13 W/kg**
Maximum value of SAR (interpolated) = 15.1 W/kg

**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 91.905 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 25.8 W/kg
**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.08 W/kg**
Maximum value of SAR (measured) = 15.4 W/kg




0 dB = 15.4 W/kg = 11.88 dB W/kg

**Fig.B.7. Validation 2450MHz 250mW**

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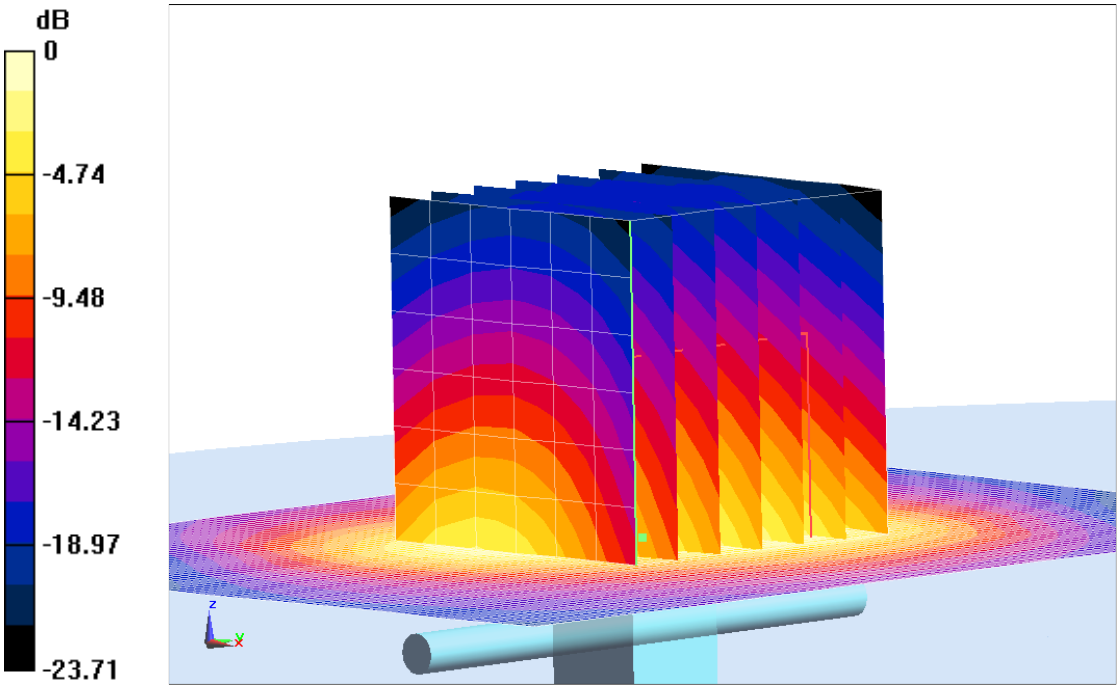
**2550 MHz**
Date: 2019-6-7
Electronics: DAE4 Sn786
Medium: Head 2550MHz
Medium parameters used: f = 2550 MHz; $\sigma$ = 1.951 S/m; $\varepsilon_r$ = 38.363; $\rho$ = 1000 kg/m$^3$
Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C
Communication System: CW_TMC Frequency: 2550 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.12, 7.12, 7.12);

**System Validation/Area Scan (61x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 92.426 V/m; Power Drift = 0.08 dB
**SAR(1 g) = 14.7 W/kg; SAR(10 g) = 6.66 W/kg**
Maximum value of SAR (interpolated) = 16.1 W/kg

**System Validation/Zoom Scan (7x7x7)/Cube0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 92.426 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 31.3 W/kg
**SAR(1 g) = 14.9 W/kg; SAR(10 g) = 6.72 W/kg**
Maximum value of SAR (measured) = 16.3 W/kg




0 dB = 16.3 W/kg = 12.12 dB W/kg

**Fig.B.8. validation 2550MHz 250mW**

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The SAR system verification must be required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR.

**Table B.1 Comparison between area scan and zoom scan for system verification**

| Band (MHz) | Position | Area scan (1g) | Zoom scan (1g) | Drift (%) |
|---|---|---|---|---|
| 750 | Head | 2.12 | 2.15 | 1.42 |
| 835 | Head | 2.49 | 2.47 | -0.80 |
| 835 | Head | 2.46 | 2.49 | 1.22 |
| 1750 | Head | 9.02 | 8.85 | -1.88 |
| 1900 | Head | 9.92 | 9.77 | -1.51 |
| 1900 | Head | 10.0 | 9.83 | -1.70 |
| 2450 | Head | 13.3 | 13.2 | -0.75 |
| 2550 | Head | 14.7 | 14.9 | 1.36 |

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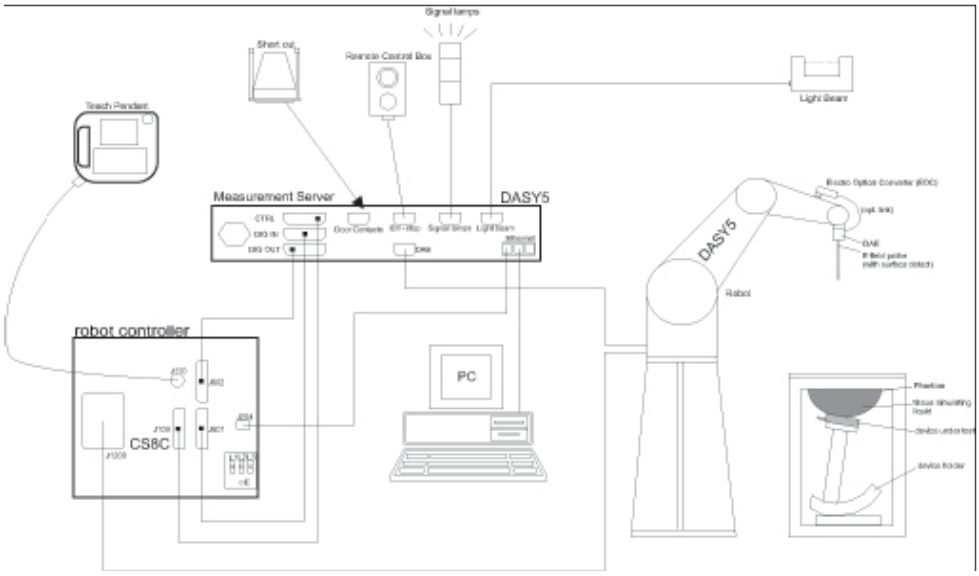
# ANNEX C SAR Measurement Setup

## C.1 Measurement Set-up

DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:




**Picture C.1 SAR Lab Test Measurement Set-up**

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as
- warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

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## C.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection durning a software approach and looks for the maximum using 2$^{nd}$ord curve fitting. The approach is stopped at reaching the maximum.

**Probe Specifications:**

**Model:** ES3DV3, EX3DV4
**Frequency** 10MHz — 6.0GHz(EX3DV4)
**Range:** 10MHz — 4GHz(ES3DV3)
**Calibration:** In head and body simulating tissue at Frequencies from 835 up to 5800MHz
**Linearity:** ± 0.2 dB(30 MHz to 6 GHz) for EX3DV4
± 0.2 dB(30 MHz to 4 GHz) for ES3DV3
**Dynamic Range:** 10 mW/kg — 100W/kg
**Probe Length:** 330 mm
**Probe Tip**
**Length:** 20 mm
**Body Diameter:** 12 mm
**Tip Diameter:** 2.5 mm (3.9 mm for ES3DV3)
**Tip-Center:** 1 mm (2.0mm for ES3DV3)
**Application:** SAR Dosimetry Testing
Compliance tests of mobile phones
Dosimetry in strong gradient fields

**Picture C.2 Near-field Probe**

**Picture C.3 E-field Probe**

## C.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm$^2$) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or

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other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ $cm^2$.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/$m^3$).

## C.4 Other Test Equipment

### C.4.1 Data Acquisition Electronics (DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

**PictureC.4: DAE**

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### C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

**Picture C.5 DASY 5**

### C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5:128MB), RAM (DASY5:128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

**Picture C.6 Server for DASY 5**

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### C.4.4 Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss

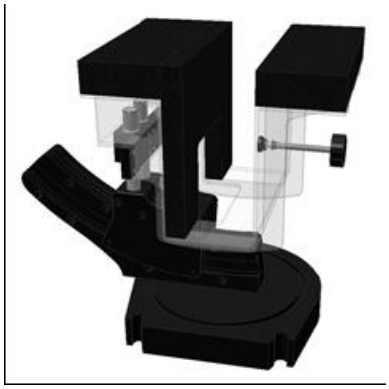
POM material having the following dielectric

parameters: relative permittivity $\varepsilon$ =3 and loss tangent $\delta$ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.

**Picture C.7-1: Device Holder**



**Picture C.7-2: Laptop Extension Kit**

### C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90$^{th}$ percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

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| | |
|---|---|
| Shell Thickness: | 2 ± 0. 2 mm |
| Filling Volume: | Approx. 25 liters |
| Dimensions: | 810 x l000 x 500 mm (H x L x W) |
| Available: | Special |

**Picture C.8: SAM Twin Phantom**

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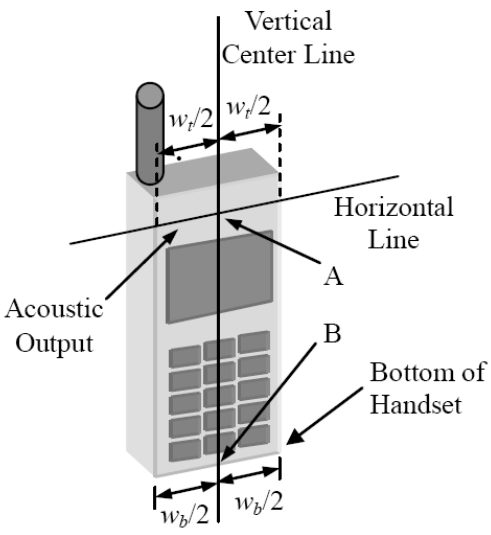
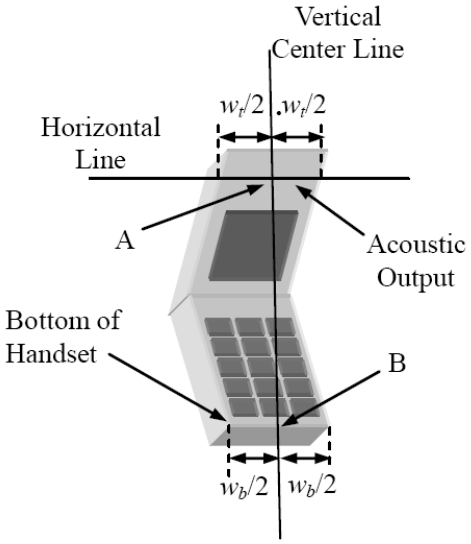
# ANNEX D Position of the wireless device in relation to the phantom

## D.1 General considerations

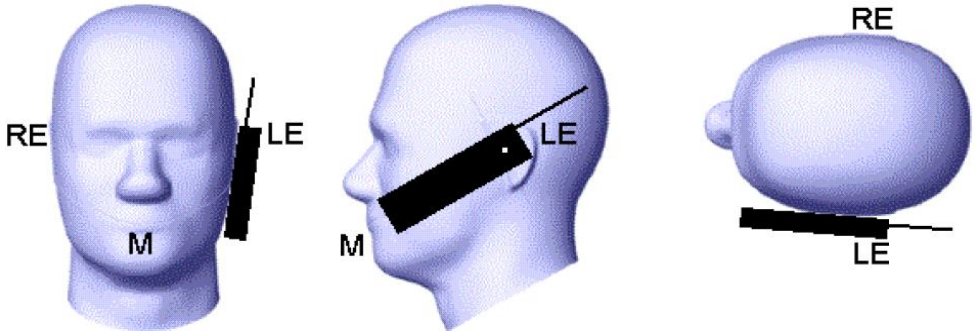
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.




| | |
|---|---|
| $w_t$ | Width of the handset at the level of the acoustic |
| $w_b$ | Width of the bottom of the handset |
| A | Midpoint of the width $w_t$ of the handset at the level of the acoustic output |
| B | Midpoint of the width $w_b$ of the bottom of the handset |

**Picture D.1-a Typical “fixed” case handset** **Picture D.1-b Typical “clam-shell” case handset**




**Picture D.2 Cheek position of the wireless device on the left side of SAM**

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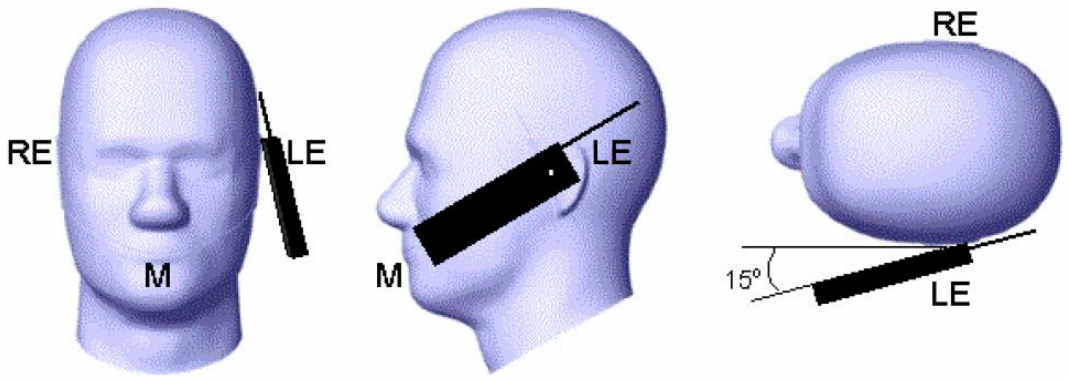
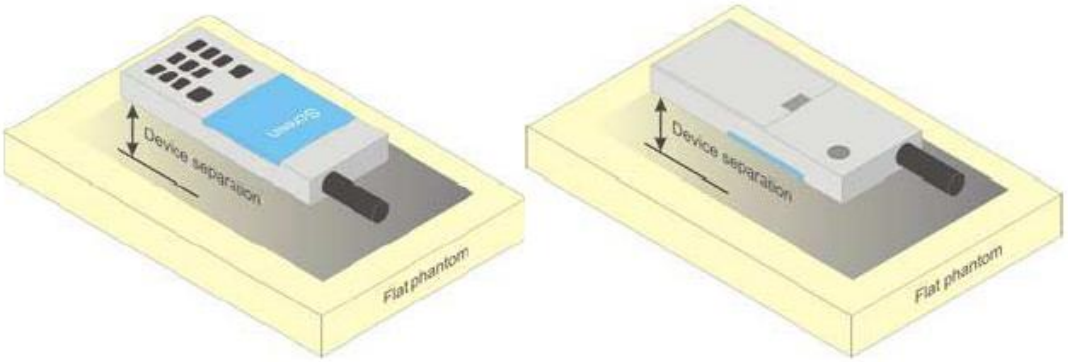



**Picture D.3 Tilt position of the wireless device on the left side of SAM**

## D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.




**Picture D.4 Test positions for body-worn devices**

## D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.

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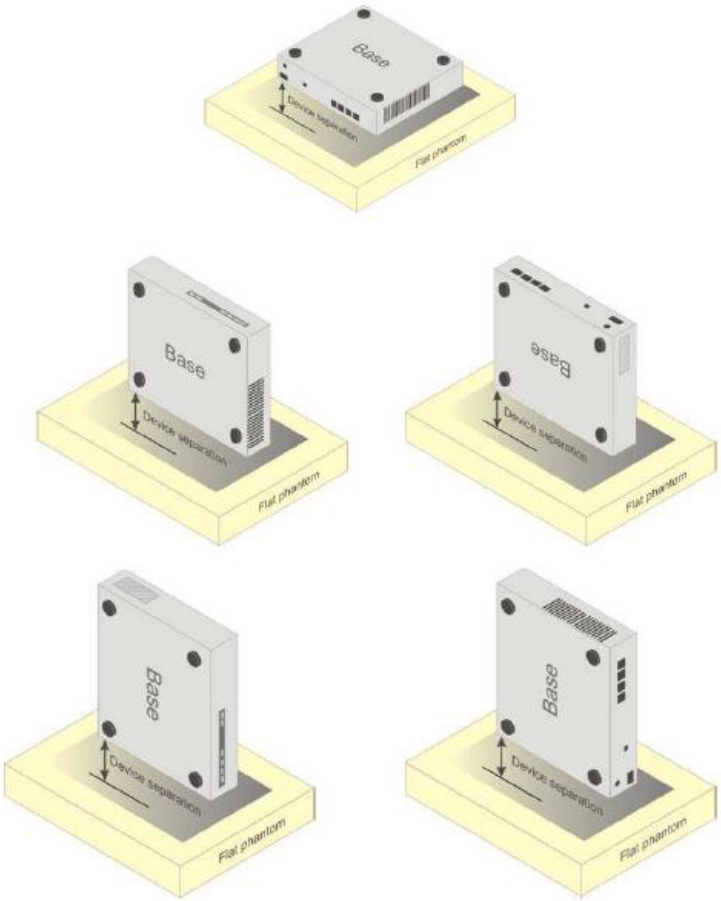


**Picture D.5 Test positions for desktop devices**

## D.4 DUT Setup Photos

**Picture D.6**

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# ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 700-6000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

**Table E.1: Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 835 Head | 835 Body | 1900 Head | 1900 Body | 2450 Head | 2450 Body | 5800 Head | 5800 Body |
|---|---|---|---|---|---|---|---|---|
| Ingredients (% by weight) | | | | | | | | |
| Water | 41.45 | 52.5 | 55.242 | 69.91 | 58.79 | 72.60 | 65.53 | 65.53 |
| Sugar | 56.0 | 45.0 | \ | \ | \ | \ | \ | \ |
| Salt | 1.45 | 1.4 | 0.306 | 0.13 | 0.06 | 0.18 | \ | \ |
| Preventol | 0.1 | 0.1 | \ | \ | \ | \ | \ | \ |
| Cellulose | 1.0 | 1.0 | \ | \ | \ | \ | \ | \ |
| Glycol Monobutyl | \ | \ | 44.452 | 29.96 | 41.15 | 27.22 | \ | \ |
| Diethylenglycol monohexylether | \ | \ | \ | \ | \ | \ | 17.24 | 17.24 |
| Triton X-100 | \ | \ | \ | \ | \ | \ | 17.24 | 17.24 |
| Dielectric Parameters Target Value | ε=41.5 σ=0.90 | ε=55.2 σ=0.97 | ε=40.0 σ=1.40 | ε=53.3 σ=1.52 | ε=39.2 σ=1.80 | ε=52.7 σ=1.95 | ε=35.3 σ=5.27 | ε=48.2 σ=6.00 |

**Note: There is a little adjustment respectively for 750, 1800, 2600, 5200, 5300, and 5600, based on the recipe of closest frequency in table E.1**

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# ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

**Table F.1: System Validation**

| Probe SN. | Liquid name | Validation date | Frequency point | Status (OK or Not) |
|---|---|---|---|---|
| 3633 | Head 750MHz | 2019-03-02 | 750 MHz | OK |
| 3633 | Head 835MHz | 2019-03-02 | 835 MHz | OK |
| 3633 | Head 1750MHz | 2019-03-02 | 1800 MHz | OK |
| 3633 | Head 1900MHz | 2019-03-02 | 1900 MHz | OK |
| 3633 | Head 2450MHz | 2019-03-02 | 2450 MHz | OK |
| 3633 | Head 2550MHz | 2019-03-02 | 2550 MHz | OK |
| 3633 | Head 5200MHz | 2019-03-02 | 5200 MHz | OK |
| 3633 | Head 5300MHz | 2019-03-02 | 5300 MHz | OK |
| 3633 | Head 5600MHz | 2019-03-02 | 5600 MHz | OK |
| 3633 | Head 5800MHz | 2019-03-02 | 5800 MHz | OK |
| 3633 | Body 750MHz | 2019-03-03 | 750 MHz | OK |
| 3633 | Body 835MHz | 2019-03-03 | 835 MHz | OK |
| 3633 | Body 1750MHz | 2019-03-03 | 1800 MHz | OK |
| 3633 | Body 1900MHz | 2019-03-03 | 1900 MHz | OK |
| 3633 | Body 2450MHz | 2019-03-03 | 2450 MHz | OK |
| 3633 | Body 2550MHz | 2019-03-03 | 5200 MHz | OK |
| 3633 | Body 5200MHz | 2019-03-03 | 5200 MHz | OK |
| 3633 | Body 5300MHz | 2019-03-03 | 5300 MHz | OK |
| 3633 | Body 5600MHz | 2019-03-03 | 5600 MHz | OK |
| 3633 | Body 5800MHz | 2019-03-03 | 5800 MHz | OK |

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# ANNEX G LTE Band 41 Power Class 2 and Power Class 3 Linearity

This device supports Power Class 2 and Power Class 3 operations for LTE Band 41. The highest available duty cycle for Power Class 2 operations is 43.3 % using UL-DL configuration 1. Per May 2017 TCB Workshop Notes based on the device behavior, all SAR tests were performed using Power Class 3. SAR with Power Class 2 at the highest power and available duty factor was additionally performed for the Power Class 3 configuration with the highest SAR for each exposure condition. The linearity between the Power Class 2 and Power Class 3 SAR results and the respective frame averaged powers was calculated to determine that the results were linear. When ULCA is active, the device does not supports Power Class 2. Per May 2017 TCB Workshop, no additional SAR measurements were required since the linearity between power classes was < 10% and all reported SAR values were < 1.4 W/kg for 1g and < 3.5 W/kg for 10g.

LTE Band 41 SAR testing with power class 2 at the highest power and available duty factor was additionally performed for the power class 3 configuration with the highest SAR for each exposure condition.

**Table G.1 LTE Band 41 Single Carrier Head Linearity Data**

| / | LTE Band 41 PC3 | LTE Band 41 PC2 |
|---|---|---|
| Maximum Tune up Power (dBm) | 24.0 | 26.5 |
| Reported 1g SAR (W/kg) | 0.15 | 0.17 |
| Duty Cycle | 63.30% | 43.30% |
| Frame Averaged (mW) | 159.00 | 193.41 |
| Linearity SAR (W/kg) | 0.182 | |
| % deviation from expected linearity | | -6.83% |

**Table G.2 LTE Band 41 Single Carrier Hotspot Linearity Data**

| / | LTE Band 41 PC3 | LTE Band 41 PC2 |
|---|---|---|
| Maximum Tune up Power (dBm) | 21.0 | 23.5 |
| Reported 1g SAR (W/kg) | 0.12 | 0.14 |
| Duty Cycle | 63.30% | 43.30% |
| Frame Averaged (mW) | 79.69 | 96.94 |
| Linearity SAR (W/kg) | 0.146 | |
| % deviation from expected linearity | | -4.09% |

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**Table G.3 LTE Band 41 Single Carrier Body-Worn Linearity Data**

| / | LTE Band 41 PC3 | LTE Band 41 PC2 |
|---|---|---|
| Maximum Tune up Power (dBm) | 24.0 | 26.5 |
| Reported 1g SAR (W/kg) | 0.24 | 0.31 |
| Duty Cycle | 63.30% | 43.30% |
| Frame Averaged (mW) | 159.00 | 193.41 |
| Linearity SAR (W/kg) | 0.292 | |
| % deviation from expected linearity | | 6.19% |

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# ANNEX H DAE Calibration Certificate

## DAE4 SN: 786 Calibration Certificate

In Collaboration with speag CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

中国认可 国际互认 校准 CALIBRATION CNAS L0570

Client : CTTL(South Branch) Certificate No: Z19-60016

### CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 786 |
| Calibration Procedure(s) | FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | January 11, 2019 |

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Process Calibrator 753 | 1971018 | 20-Jun-18 (CTTL, No.J18X05034) | June-19 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: January 14, 2019

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



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E-mail: cttl@chinattl.com Http://www.chinattl.cn

**Glossary:**

| | |
|---|---|
| DAE | data acquisition electronics |
| Connector angle | information used in DASY system to align probe sensor X to the robot coordinate system. |

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



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## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV
Low Range: 1LSB = 61nV , full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 404.064 ± 0.15% (k=2) | 404.247 ± 0.15% (k=2) | 404.629 ± 0.15% (k=2) |
| Low Range | 3.97273 ± 0.7% (k=2) | 3.97435 ± 0.7% (k=2) | 3.95858 ± 0.7% (k=2) |

## Connector Angle

| Connector Angle to be used in DASY system | 229.5° ± 1 ° |
|---|---|



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# ANNEX I Probe Calibration Certificate

## Probe EX3DV4-SN: 3633 Calibration Certificate

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CALIBRATION LABORATORY
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Client CTTL(South Branch) Certificate No: Z19-60033

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3633 |
| Calibration Procedure(s) | FF-Z11-004-01<br>Calibration Procedures for Dosimetric E-field Probes |
| Calibration date: | February 26, 2019 |

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRP2 | 101919 | 20-Jun-18 (CTTL, No.J18X05032) | Jun-19 |
| Power sensor NRP-Z91 | 101547 | 20-Jun-18 (CTTL, No.J18X05032) | Jun-19 |
| Power sensor NRP-Z91 | 101548 | 20-Jun-18 (CTTL, No.J18X05032) | Jun-19 |
| Reference10dBAttenuator | 18N50W-10dB | 09-Feb-18(CTTL, No.J18X01133) | Feb-20 |
| Reference20dBAttenuator | 18N50W-20dB | 09-Feb-18(CTTL, No.J18X01132) | Feb-20 |
| Reference Probe EX3DV4 | SN 7514 | 27-Aug-18(SPEAG,No.EX3-7514_Aug18/2) | Aug-19 |
| DAE4 | SN 1555 | 20-Aug-18(SPEAG, No.DAE4-1555_Aug18) | Aug -19 |
| **Secondary Standards** | **ID #** | **Cal Date(Calibrated by, Certificate No.)** | **Scheduled Calibration** |
| SignalGeneratorMG3700A | 6201052605 | 21-Jun-18 (CTTL, No.J18X05033) | Jun-19 |
| Network Analyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan -19 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: February 28, 2019

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**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "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"

**Methods Applied and Interpretation of Parameters:**

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z* frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- *Ax,y,z; Bx,y,z; Cx,y,z;VRx,y,z:*A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx,y,z* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from±50MHz to±100MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).



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# Probe EX3DV4

## SN: 3633

Calibrated: February 26, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm(μV/(V/m)²)[A] | 0.39 | 0.37 | 0.39 | ±10.0% |
| DCP(mV)[B] | 97.3 | 98.8 | 98.6 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 144.3 | ±2.0% |
| | | Y | 0.0 | 0.0 | 1.0 | | 145.2 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 147.9 | |

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X, Y, Z do not affect the $E^2$-field uncertainty inside TSL (see Page 5 and Page 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 9.51 | 9.51 | 9.51 | 0.09 | 1.70 | ±12.1% |
| 900 | 41.5 | 0.97 | 9.27 | 9.27 | 9.27 | 0.27 | 0.92 | ±12.1% |
| 1640 | 40.3 | 1.29 | 8.16 | 8.16 | 8.16 | 0.21 | 1.06 | ±12.1% |
| 1750 | 40.1 | 1.37 | 8.07 | 8.07 | 8.07 | 0.26 | 1.00 | ±12.1% |
| 1900 | 40.0 | 1.40 | 7.63 | 7.63 | 7.63 | 0.24 | 1.07 | ±12.1% |
| 2100 | 39.8 | 1.49 | 7.60 | 7.60 | 7.60 | 0.25 | 1.02 | ±12.1% |
| 2300 | 39.5 | 1.67 | 7.60 | 7.60 | 7.60 | 0.61 | 0.69 | ±12.1% |
| 2450 | 39.2 | 1.80 | 7.33 | 7.33 | 7.33 | 0.61 | 0.70 | ±12.1% |
| 2600 | 39.0 | 1.96 | 7.12 | 7.12 | 7.12 | 0.47 | 0.99 | ±12.1% |
| 3500 | 37.9 | 2.91 | 6.74 | 6.74 | 6.74 | 0.62 | 0.86 | ±13.3% |
| 3700 | 37.7 | 3.12 | 6.47 | 6.47 | 6.47 | 0.58 | 0.88 | ±13.3% |
| 5250 | 35.9 | 4.71 | 5.42 | 5.42 | 5.42 | 0.45 | 1.15 | ±13.3% |
| 5600 | 35.5 | 5.07 | 4.72 | 4.72 | 4.72 | 0.45 | 1.30 | ±13.3% |
| 5750 | 35.4 | 5.22 | 4.73 | 4.73 | 4.73 | 0.45 | 1.30 | ±13.3% |

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

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

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



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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 9.56 | 9.56 | 9.56 | 0.40 | 0.80 | ±12.1% |
| 900 | 55.0 | 1.05 | 9.25 | 9.25 | 9.25 | 0.20 | 1.24 | ±12.1% |
| 1640 | 53.8 | 1.40 | 7.90 | 7.90 | 7.90 | 0.22 | 1.14 | ±12.1% |
| 1750 | 53.4 | 1.49 | 7.93 | 7.93 | 7.93 | 0.20 | 1.16 | ±12.1% |
| 1900 | 53.3 | 1.52 | 7.67 | 7.67 | 7.67 | 0.21 | 1.20 | ±12.1% |
| 2100 | 53.2 | 1.62 | 7.56 | 7.56 | 7.56 | 0.22 | 1.18 | ±12.1% |
| 2300 | 52.9 | 1.81 | 7.48 | 7.48 | 7.48 | 0.55 | 0.80 | ±12.1% |
| 2450 | 52.7 | 1.95 | 7.40 | 7.40 | 7.40 | 0.62 | 0.76 | ±12.1% |
| 2600 | 52.5 | 2.16 | 7.21 | 7.21 | 7.21 | 0.69 | 0.70 | ±12.1% |
| 3500 | 51.3 | 3.31 | 6.45 | 6.45 | 6.45 | 0.50 | 1.15 | ±13.3% |
| 3700 | 51.0 | 3.55 | 6.37 | 6.37 | 6.37 | 0.52 | 1.05 | ±13.3% |
| 5250 | 48.9 | 5.36 | 5.03 | 5.03 | 5.03 | 0.55 | 1.30 | ±13.3% |
| 5600 | 48.5 | 5.77 | 4.19 | 4.19 | 4.19 | 0.55 | 1.50 | ±13.3% |
| 5750 | 48.3 | 5.94 | 4.29 | 4.29 | 4.29 | 0.55 | 1.30 | ±13.3% |

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

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

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



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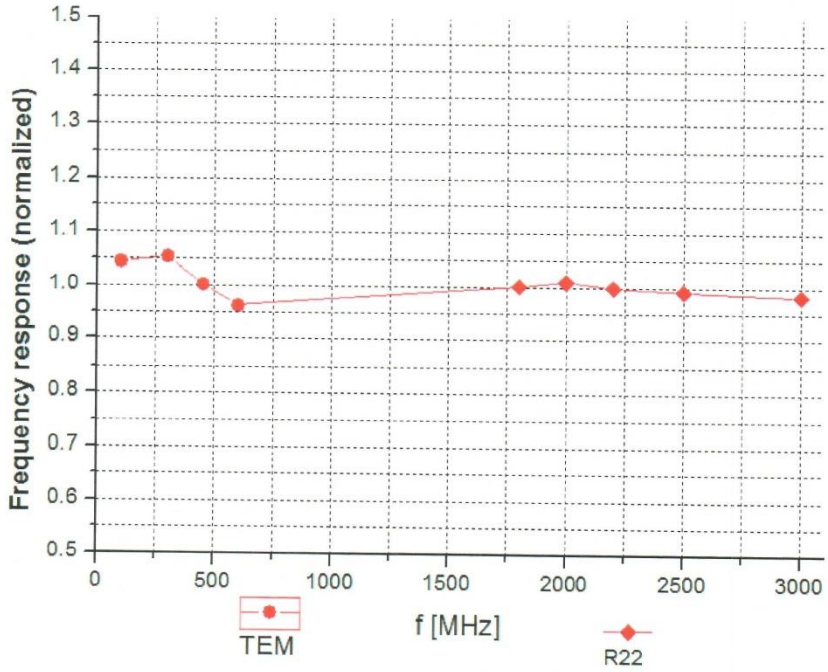
## Frequency Response of E-Field
## (TEM-Cell: ifi110 EXX, Waveguide: R22)




**Uncertainty of Frequency Response of E-field: ±7.4% (k=2)**



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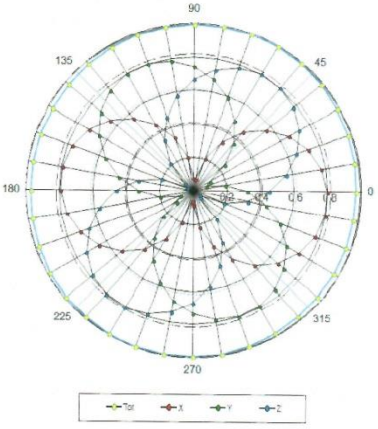
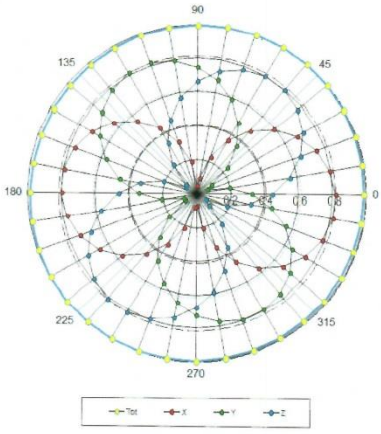
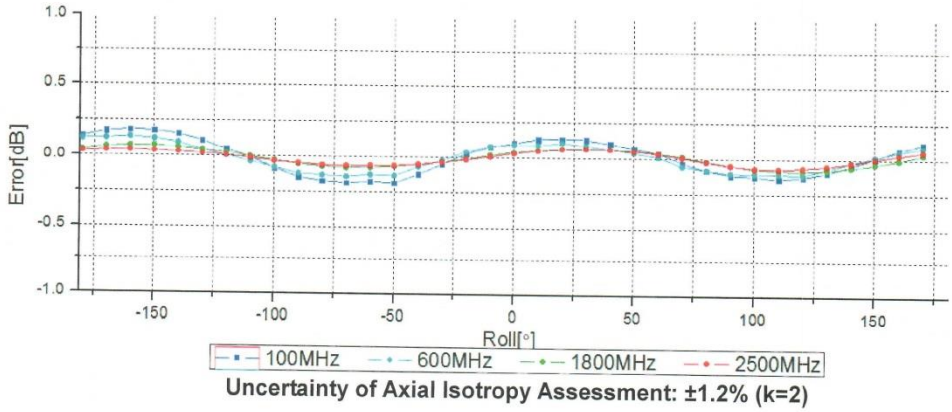
## Receiving Pattern (Φ), θ=0°

**f=600 MHz, TEM**




**f=1800 MHz, R22**




**Uncertainty of Axial Isotropy Assessment: ±1.2% (k=2)**



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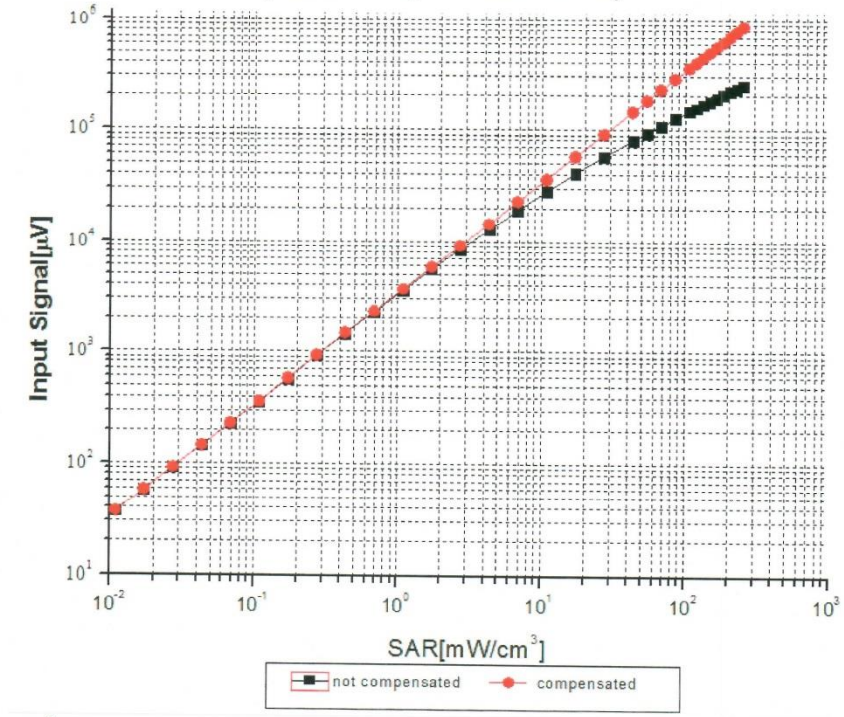
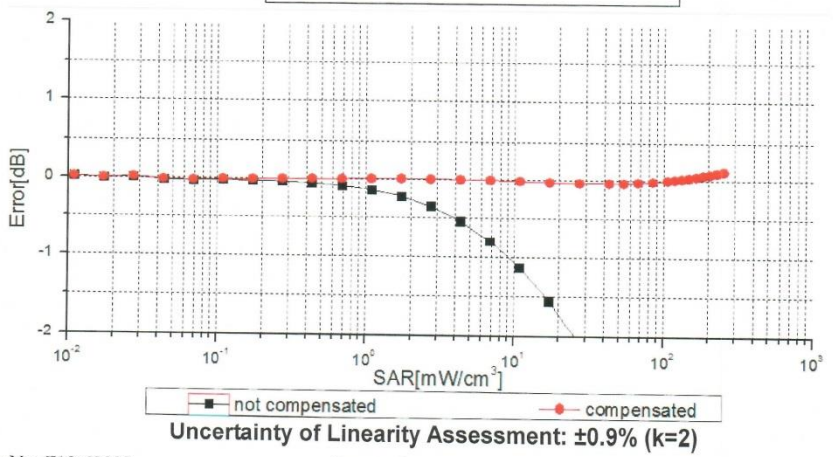
## Dynamic Range f(SAR$_{head}$)
## (TEM cell, f = 900 MHz)




**Uncertainty of Linearity Assessment: ±0.9% (k=2)**



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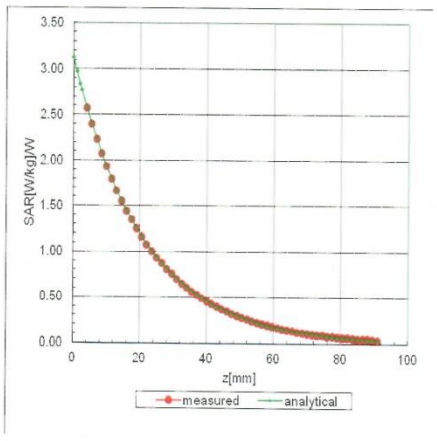
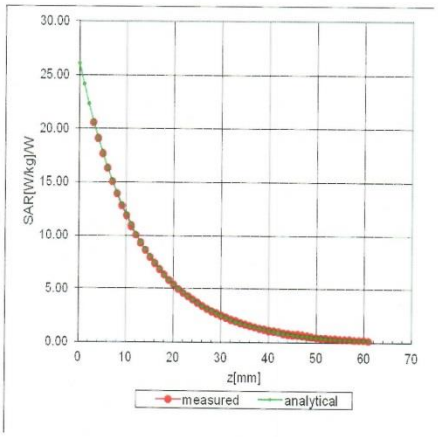
## Conversion Factor Assessment

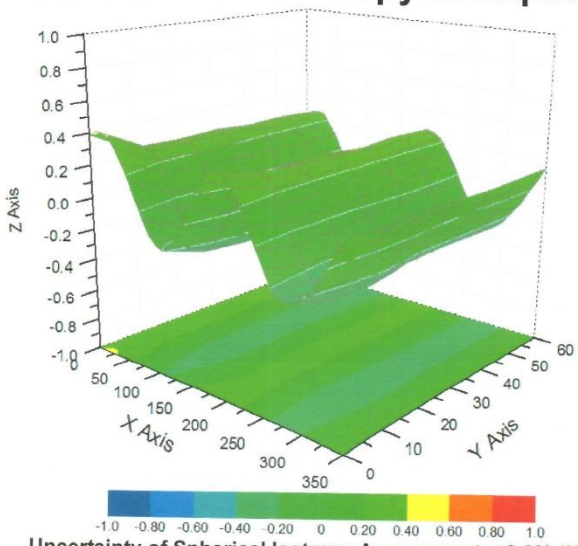
f=750 MHz, WGLS R9(H_convF)




f=1750 MHz, WGLS R22(H_convF)




## Deviation from Isotropy in Liquid




Uncertainty of Spherical Isotropy Assessment: ±3.2% (K=2)



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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 72.2 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disable |
| Probe Overall Length | 337mm |
| Probe Body Diameter | 10mm |
| Tip Length | 9mm |
| Tip Diameter | 2.5mm |
| Probe Tip to Sensor X Calibration Point | 1mm |
| Probe Tip to Sensor Y Calibration Point | 1mm |
| Probe Tip to Sensor Z Calibration Point | 1mm |
| Recommended Measurement Distance from Surface | 1.4mm |



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