

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2117
E-mail: emf@caict.ac.cn <http://www.caict.ac.cn>

DASY5 Validation Report for Head TSL

Date: 2022-09-15

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN: 1046

Communication System: UID 0, CW; Frequency: 3700 MHz;

Medium parameters used: $f = 3700$ MHz; $\sigma = 3.111$ S/m; $\epsilon_r = 37.08$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(6.78, 6.78, 6.78) @ 3700 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=3700 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.34 V/m; Power Drift = -0.07 dB

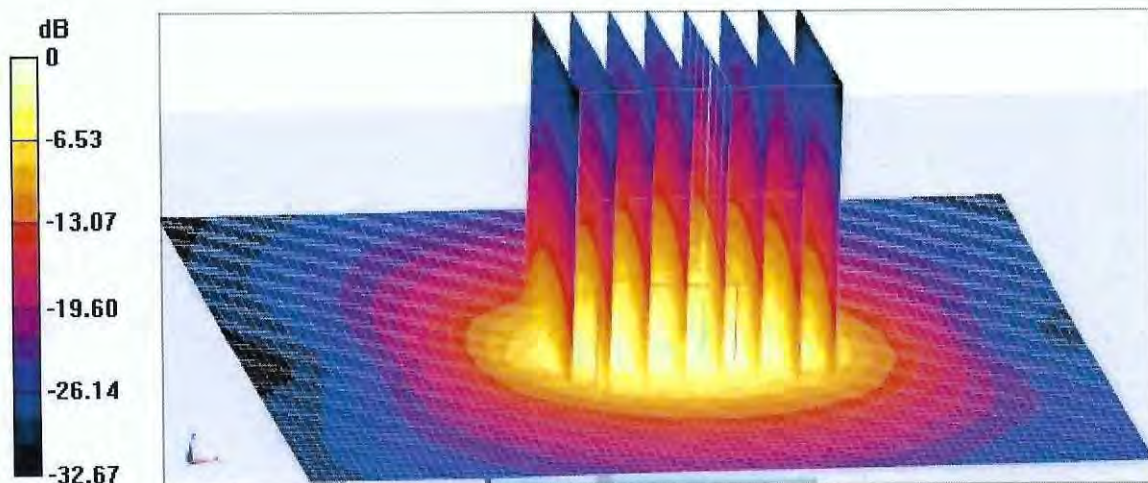
Peak SAR (extrapolated) = 17.6 W/kg

SAR(1 g) = 6.63 W/kg; SAR(10 g) = 2.48 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 75.5%

Maximum value of SAR (measured) = 12.3 W/kg

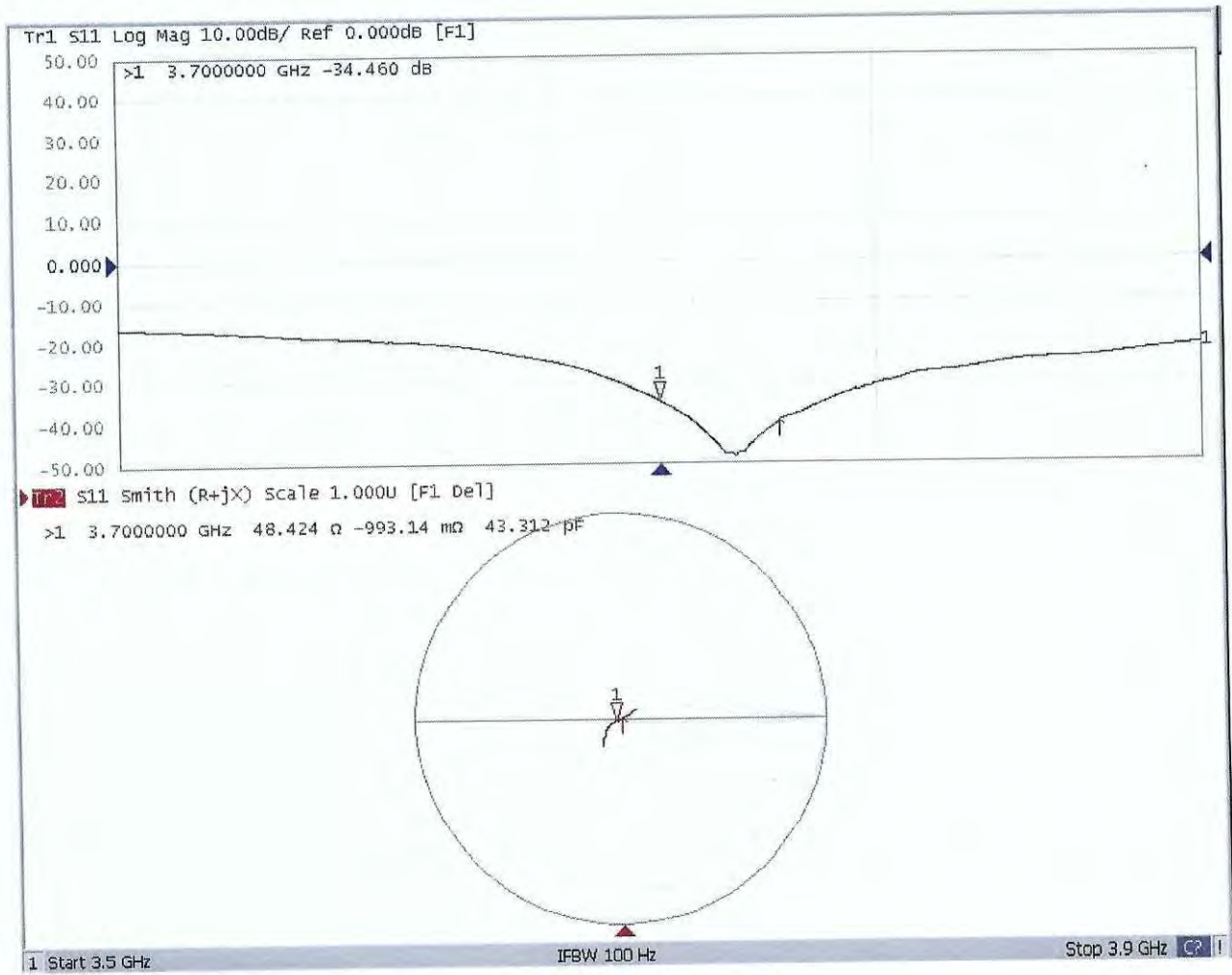


0 dB = 12.3 W/kg = 10.90 dBW/kg



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Impedance Measurement Plot for Head TSL



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Client **SGS**

Certificate No: **Z22-60372**

CALIBRATION CERTIFICATE

Object **D3900V2 - SN: 1026**

Calibration Procedure(s) **FF-Z11-003-01**
Calibration Procedures for dipole validation kits



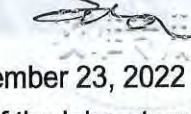
Calibration date: **September 16, 2022**

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|---|-----------------------|
| Power Meter NRP2 | 106277 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Power sensor NRP8S | 104291 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Reference Probe EX3DV4 | SN 7464 | 26-Jan-22(SPEAG,No.EX3-7464_Jan22) | Jan-23 |
| DAE4 | SN 1556 | 12-Jan-22(CTTL-SPEAG,No.Z22-60007) | Jan-23 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 13-Jan-22 (CTTL, No.J22X00409) | Jan-23 |
| Network Analyzer E5071C | MY46110673 | 14-Jan-22 (CTTL, No.J22X00406) | Jan-23 |

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

Issued: September 23, 2022

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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) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- c) 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%.



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Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|-------------------------------------|--------------------------------------|----------------------------------|
| DASY Version | DASY52 | 52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy = 4 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| Frequency | 3900 MHz ± 1 MHz 4100 MHz ± 1 MHz | |

Head TSL parameters at 3900MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 37.5 | 3.32 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 38.0 ± 6 % | 3.31 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Head TSL at 3900MHz

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.65 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 66.7 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.37 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.8 W/kg ± 24.2 % (k=2) |

Head TSL parameters at 4100MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 37.2 | 3.53 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 37.5 ± 6 % | 3.50 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Head TSL at 4100MHz

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.79 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 68.1 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.40 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.0 W/kg ± 24.2 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 3900MHz

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 44.9Ω- 8.03jΩ |
| Return Loss | - 20.0dB |

Antenna Parameters with Head TSL at 4100MHz

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 58.4Ω- 3.87jΩ |
| Return Loss | - 21.4dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.011 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

Additional EUT Data

| | |
|-----------------|-------|
| Manufactured by | SPEAG |
|-----------------|-------|



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DASY5 Validation Report for Head TSL

Date: 2022-09-16

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1026

Communication System: UID 0, CW; Frequency: 3900 MHz; Frequency: 4100 MHz;
Duty Cycle: 1:1

Medium parameters used: $f = 3900$ MHz; $\sigma = 3.31$ S/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 4100$ MHz; $\sigma = 3.498$ S/m; $\epsilon_r = 37.47$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(6.76, 6.76, 6.76) @ 3900 MHz;
ConvF(6.71, 6.71, 6.71) @ 4100 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial:
1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration /Pin=100mW, d=10mm, f=3900 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.50 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 6.65 W/kg; SAR(10 g) = 2.37 W/kg

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 76.4%

Maximum value of SAR (measured) = 12.4 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=4100 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.37 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 18.6 W/kg

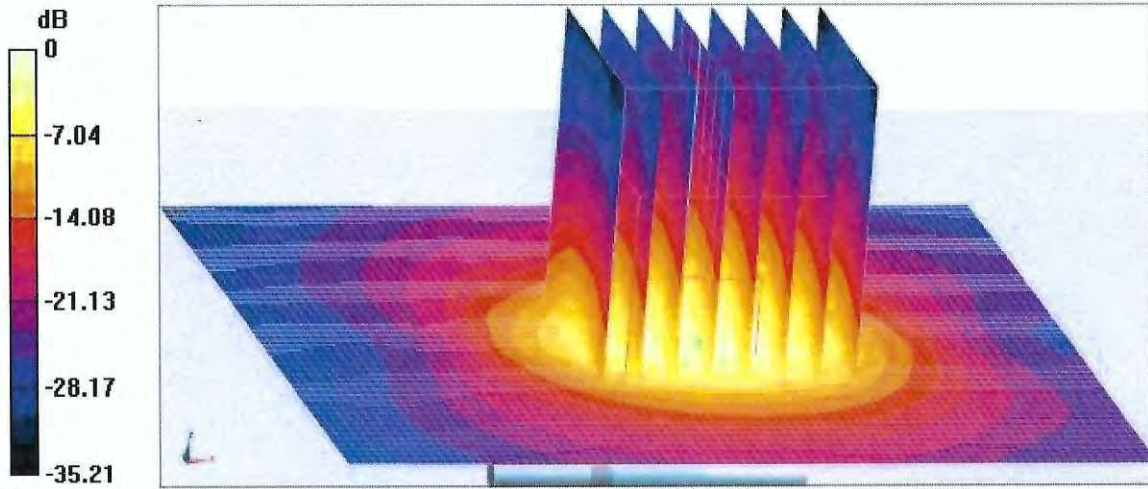
SAR(1 g) = 6.79 W/kg; SAR(10 g) = 2.4 W/kg

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 75.1%

Maximum value of SAR (measured) = 13.1 W/kg

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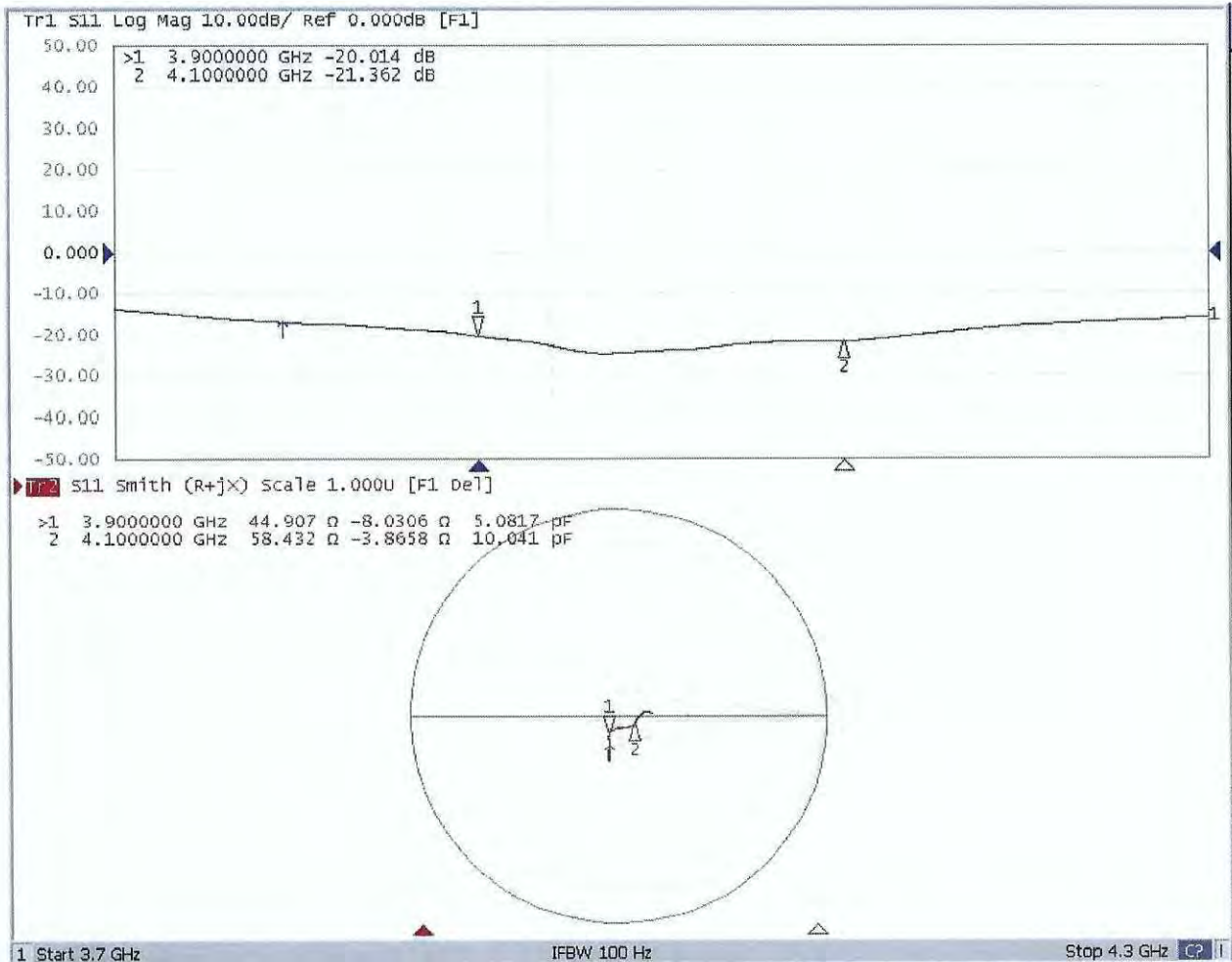


0 dB = 13.1 W/kg = 11.17 dBW/kg



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Impedance Measurement Plot for Head TSL



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Client **SGS**

Certificate No: **Z22-60490**

CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1165

Calibration Procedure(s) FF-Z11-003-01
Calibration Procedures for dipole validation kits

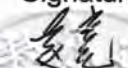

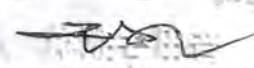
Calibration date: November 1, 2022

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|---|-----------------------|
| Power Meter NRP2 | 106276 | 10-May-22 (CTTL, No.J22X03103) | May-23 |
| Power sensor NRP6A | 101369 | 10-May-22 (CTTL, No.J22X03103) | May-23 |
| Reference Probe EX3DV4 | SN 7464 | 26-Jan-22(SPEAG,No.EX3-7464_Jan22) | Jan-23 |
| DAE4 | SN 1556 | 12-Jan-22(CTTL-SPEAG,No.Z22-60007) | Jan-23 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 13-Jan-22 (CTTL, No. J22X00409) | Jan-23 |
| Network Analyzer E5071C | MY46110673 | 14-Jan-22 (CTTL, No.J22X00406) | Jan-23 |

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

Issued: November 7, 2022

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CALIBRATION LABORATORY



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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:

- IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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



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Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|-------------------------------------|--|----------------------------------|
| DASY Version | DASY52 | 52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy = 4 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| Frequency | 5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz | |

Head TSL parameters at 5250MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.9 | 4.71 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.2 ± 6 % | 4.68 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | — | — |

SAR result with Head TSL at 5250MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.76 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 77.3 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.21 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.1 W/kg ± 24.2 % (k=2) |



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Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.5 | 5.07 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 34.6 ± 6 % | 5.05 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | — | — |

SAR result with Head TSL at 5600MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 8.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 81.3 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.33 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.1 W/kg ± 24.2 % (k=2) |

Head TSL parameters at 5750MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.4 | 5.22 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 34.4 ± 6 % | 5.21 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | — | — |

SAR result with Head TSL at 5750MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.76 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 77.1 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.3 W/kg ± 24.2 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5250MHz

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 49.0Ω- 4.73jΩ |
| Return Loss | - 26.3dB |

Antenna Parameters with Head TSL at 5600MHz

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.5Ω+ 1.12jΩ |
| Return Loss | - 28.9dB |

Antenna Parameters with Head TSL at 5750MHz

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 54.6Ω- 1.85jΩ |
| Return Loss | - 26.5dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.114 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

Additional EUT Data

| | |
|-----------------|-------|
| Manufactured by | SPEAG |
|-----------------|-------|



DASY5 Validation Report for Head TSL

Date: 2022-11-01

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1165

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,
Frequency: 5750 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.677$ S/m; $\epsilon_r = 35.15$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.047$ S/m; $\epsilon_r = 34.56$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5750$ MHz; $\sigma = 5.211$ S/m; $\epsilon_r = 34.35$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

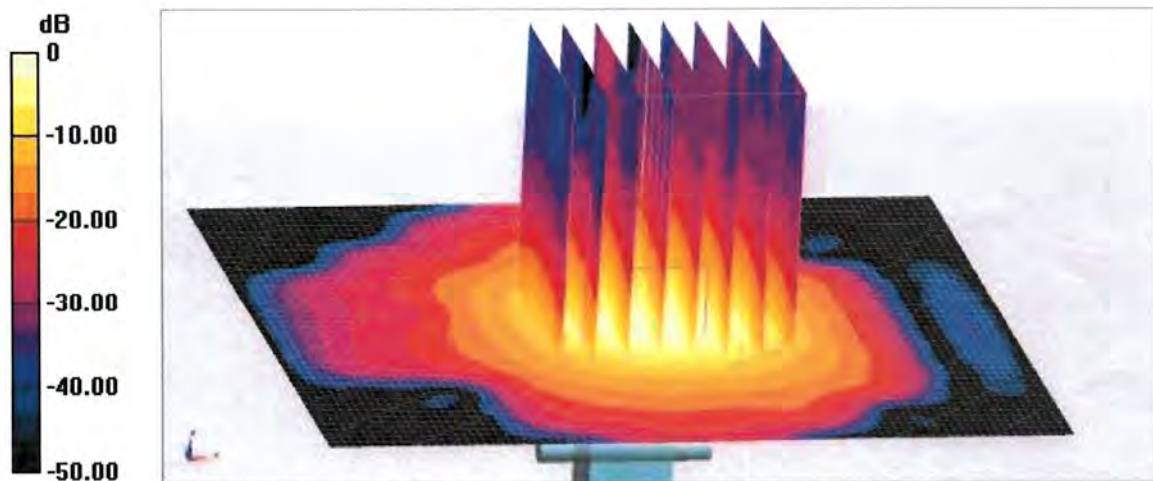
- Probe: EX3DV4 - SN7464; ConvF(5.43, 5.43, 5.43) @ 5250 MHz; ConvF(4.91, 4.91, 4.91) @ 5600 MHz; ConvF(4.85, 4.85, 4.85) @ 5750 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.46 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 31.1 W/kg
SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.22 W/kg
Smallest distance from peaks to all points 3 dB below = 7.5 mm
Ratio of SAR at M2 to SAR at M1 = 65.3%
Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.78 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 35.8 W/kg
SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.33 W/kg
Smallest distance from peaks to all points 3 dB below = 7.5 mm
Ratio of SAR at M2 to SAR at M1 = 62.3%
Maximum value of SAR (measured) = 20.0 W/kg

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Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.99 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 35.9 W/kg
SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.15 W/kg
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 61.4%
Maximum value of SAR (measured) = 19.1 W/kg

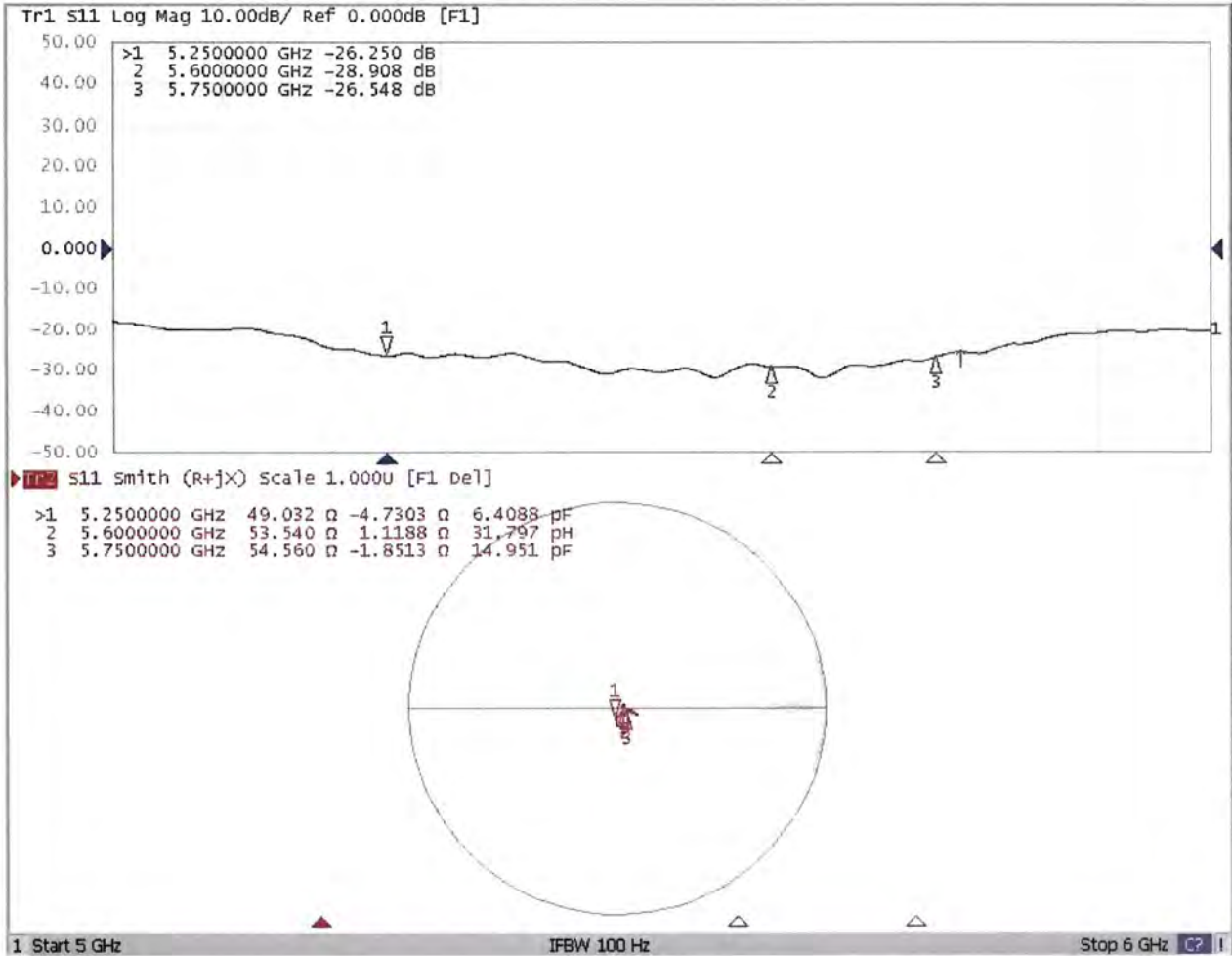


0 dB = 19.1 W/kg = 12.81 dBW/kg



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Impedance Measurement Plot for Head TSL





Accredited by the Swiss Accreditation Service (SAS)
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **SGS
Shenzhen**

Certificate No. **5G-Veri10-2004_Aug24**

CALIBRATION CERTIFICATE

Object **5G Verification Source 10 GHz - SN: 2004**

Calibration procedure(s) **QA CAL-45.v5
Calibration procedure for sources in air above 6 GHz**

Calibration date: **August 20, 2024**

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 |
|----------------------------------|----------------|-----------------------------------|------------------------|
| Reference Probe EUmmWV3 | SN: 9374 | 04-Dec-23 (No. EUmm-9374_Dec23) | Dec-24 |
| DAE4ip | SN: 1602 | 08-Nov-23 (No. DAE4ip-1602_Nov23) | Nov-24 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| RF generator R&S SMF100A | SN: 100184 | 29-Nov-23 (in house check Nov-23) | In house check: Nov-24 |
| Power sensor R&S NRP18S-10 | SN: 101258 | 29-Nov-23 (in house check Nov-23) | In house check: Nov-24 |
| Network Analyzer Keysight E5063A | SN: MY54504221 | 31-Oct-19 (in house check Oct-22) | In house check: Oct-25 |

Calibrated by: **Joanna Lleshaj** Name: **Joanna Lleshaj** Function: **Laboratory Technician**

Approved by: **Sven Kühn** Name: **Sven Kühn** Function: **Technical Manager**

Signature



Issued: August 23, 2024

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Glossary

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45, Calibration procedure for sources in air above 6 GHz.
- IEC/IEEE 63195-1, "Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz)", May 2022

Methods Applied and Interpretation of Parameters

- *Coordinate System:* z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- *Measurement Conditions:* (1) 10 GHz: The radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. The forward power is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly connected to the cable and the antenna ohmic and mismatch losses are determined by far-field measurements. (2) 30, 45, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- *Horn Positioning:* The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- *E-field distribution:* E field is measured in two x-y-plane (10mm, 10mm + $\lambda/4$) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-field-maxima and the averaged (1cm² and 4cm²) power density values at 10mm in front of the horn.
- *Field polarization:* Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

- Local peak E-field (V/m) and average of peak spatial components of the poynting vector (W/m²) averaged over the surface area of 1 cm² and 4cm² at the nominal operational frequency of the verification source. Both square and circular averaging results are listed.

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 | DASY8 Module mmWave | V3.2 |
| Phantom | 5G Phantom | |
| Distance Horn Aperture - plane | 10 mm | |
| Number of measured planes | 2 (10mm, 10mm + $\lambda/4$) | |
| Frequency | 10 GHz \pm 10 MHz | |

Calibration Parameters, 10 GHz

Circular Averaging

| Distance Horn Aperture to Measured Plane | $Prad^1$ (mW) | Max E-field (V/m) | Uncertainty (k = 2) | Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²) | | Uncertainty (k = 2) |
|--|---------------|-------------------|---------------------|--|-------------------|---------------------|
| | | | | 1 cm ² | 4 cm ² | |
| 10 mm | 138 | 295 | 1.27 dB | 231 | 183 | 1.28 dB |

| Distance Horn Aperture to Measured Plane | $Prad^1$ (mW) | Max E-field (V/m) | Uncertainty (k = 2) | Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²) | | Uncertainty (k = 2) |
|--|---------------|-------------------|---------------------|--|-------------------|---------------------|
| | | | | 1 cm ² | 4 cm ² | |
| 10 mm | 138 | 295 | 1.27 dB | 230, 230, 232 | 181, 182, 187 | 1.28 dB |

Square Averaging

| Distance Horn Aperture to Measured Plane | $Prad^1$ (mW) | Max E-field (V/m) | Uncertainty (k = 2) | Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²) | | Uncertainty (k = 2) |
|--|---------------|-------------------|---------------------|--|-------------------|---------------------|
| | | | | 1 cm ² | 4 cm ² | |
| 10 mm | 138 | 295 | 1.27 dB | 231 | 183 | 1.28 dB |

| Distance Horn Aperture to Measured Plane | $Prad^1$ (mW) | Max E-field (V/m) | Uncertainty (k = 2) | Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²) | | Uncertainty (k = 2) |
|--|---------------|-------------------|---------------------|--|-------------------|---------------------|
| | | | | 1 cm ² | 4 cm ² | |
| 10 mm | 138 | 295 | 1.27 dB | 230, 230, 232 | 181, 181, 186 | 1.28 dB |

Max Power Density

| Distance Horn Aperture to Measured Plane | $Prad^1$ (mW) | Max E-field (V/m) | Uncertainty (k = 2) | Max Power Density Sn, Stot, Stot (W/m ²) | Uncertainty (k = 2) |
|--|---------------|-------------------|---------------------|--|---------------------|
| 10 mm | 138 | 295 | 1.27 dB | 250, 250, 250 | 1.28 dB |

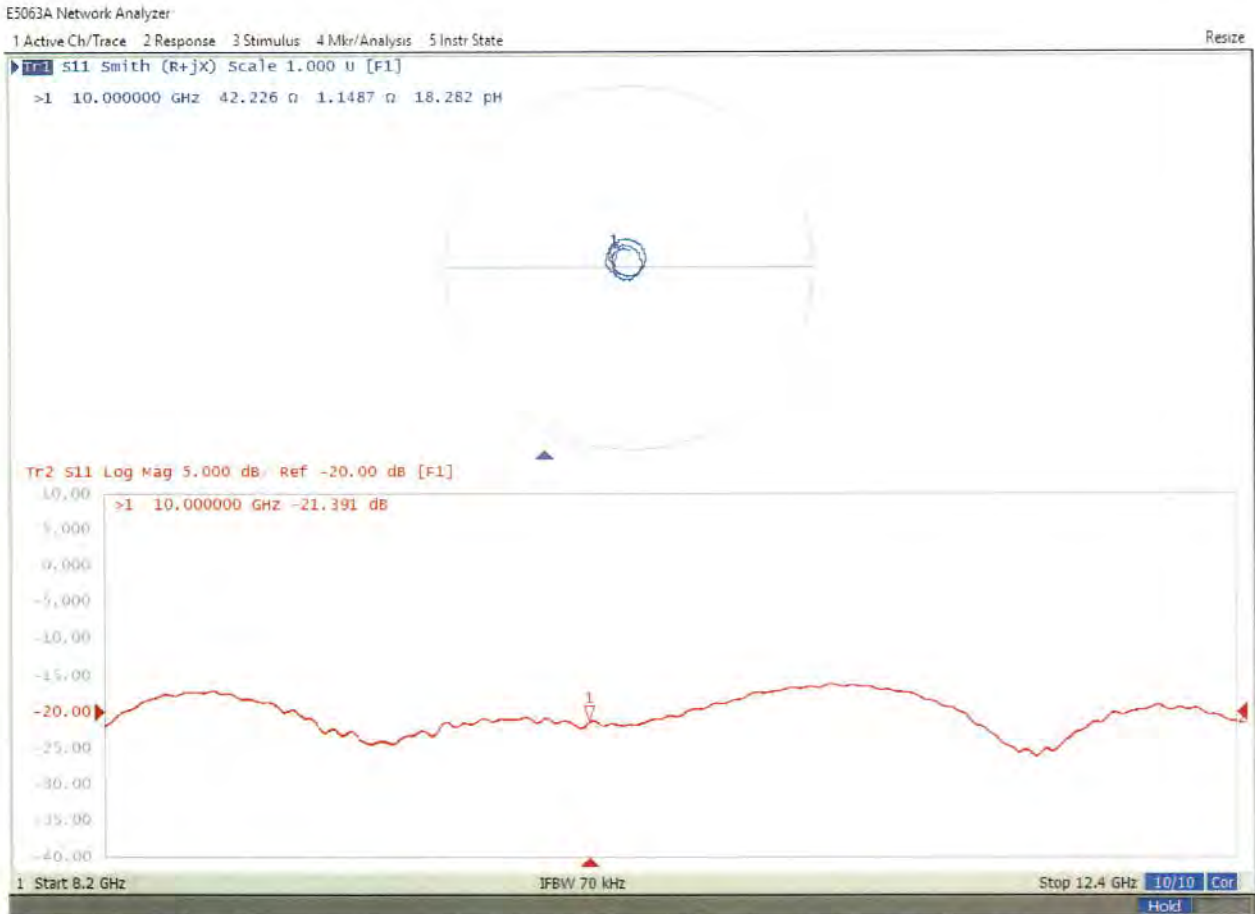
¹ Assessed ohmic and mismatch loss plus numerical offset: 0.60 dB

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

| | |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $42.2 \Omega + 1.1 j\Omega$ |
| Return Loss | - 21.4 dB |

Impedance Measurement Plot



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

| Name, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|-------------------------------|-----------------------|----------|----------|
| 5G Verification Source 10 GHz | 100.0 x 100.0 x 100.0 | SN: 2004 | - |

Exposure Conditions

| Phantom Section | Position, Test Distance [mm] | Band | Group, | Frequency [MHz], Channel Number | Conversion Factor |
|-----------------|------------------------------|-----------------|--------|---------------------------------|-------------------|
| 5G - | 10.0 mm | Validation band | CW | 10000.0, 10000 | 1.0 |

Hardware Setup

| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|-----------------------|--------|---------------------------------------|---------------------------|
| mmWave Phantom - 1002 | Air | EUmmWV3 - SN9374_F1-55GHz, 2023-12-04 | DAE4ip Sn1602, 2023-11-08 |

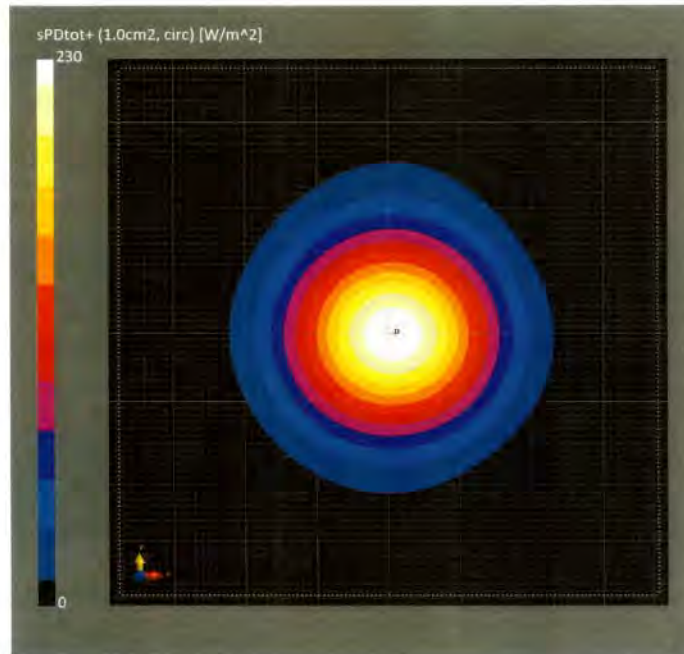
Scan Setup

Sensor Surface [mm]
MAIA

5G Scan
10.0
MAIA not used

Measurement Results

| | 5G Scan |
|---------------------------------|--------------------|
| Date | 2024-08-20, 18:04 |
| Avg. Area [cm ²] | 1.00 |
| Avg. Type | Circular Averaging |
| psPDn+ [W/m ²] | 230 |
| psPDtot+ [W/m ²] | 230 |
| psPDmod+ [W/m ²] | 232 |
| Max(Sn) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| E _{max} [V/m] | 295 |
| Power Drift [dB] | 0.02 |



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

| Name, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|-------------------------------|-----------------------|----------|----------|
| 5G Verification Source 10 GHz | 100.0 x 100.0 x 100.0 | SN: 2004 | - |

Exposure Conditions

| Phantom Section | Position, Test Distance [mm] | Band | Group, | Frequency [MHz], Channel Number | Conversion Factor |
|-----------------|------------------------------|-----------------|--------|---------------------------------|-------------------|
| 5G - | 10.0 mm | Validation band | CW | 10000.0, 10000 | 1.0 |

Hardware Setup

| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|-----------------------|--------|---------------------------------------|---------------------------|
| mmWave Phantom - 1002 | Air | EUmmWV3 - SN9374_F1-55GHz, 2023-12-04 | DAE4ip Sn1602, 2023-11-08 |

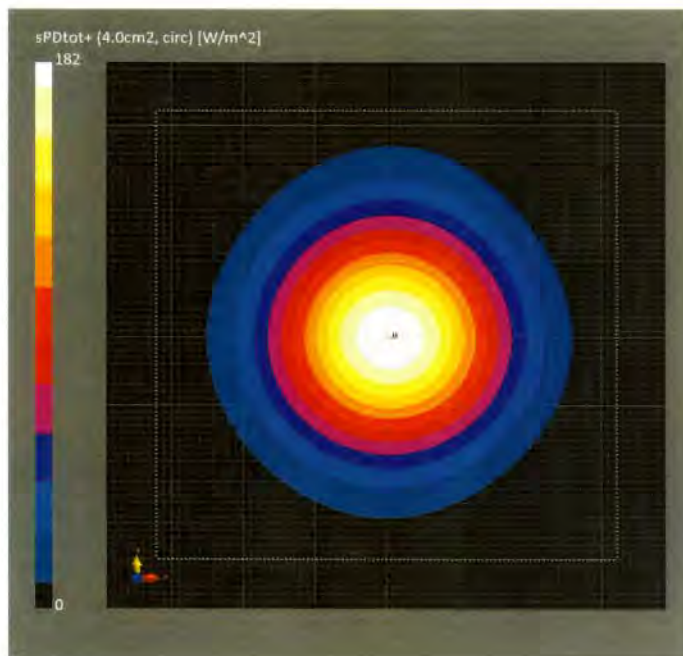
Scan Setup

Sensor Surface [mm]
MAIA

5G Scan
10.0
MAIA not used

Measurement Results

| | 5G Scan |
|---------------------------------|--------------------|
| Date | 2024-08-20, 18:04 |
| Avg. Area [cm ²] | 4.00 |
| Avg. Type | Circular Averaging |
| psPDn+ [W/m ²] | 181 |
| psPDtot+ [W/m ²] | 182 |
| psPDmod+ [W/m ²] | 187 |
| Max(Sn) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| E _{max} [V/m] | 295 |
| Power Drift [dB] | 0.02 |



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

| Name, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|-------------------------------|-----------------------|----------|----------|
| 5G Verification Source 10 GHz | 100.0 x 100.0 x 100.0 | SN: 2004 | - |

Exposure Conditions

| Phantom Section | Position, Test Distance [mm] | Band | Group, | Frequency [MHz], Channel Number | Conversion Factor |
|-----------------|------------------------------|-----------------|--------|---------------------------------|-------------------|
| 5G - | 10.0 mm | Validation band | CW | 10000.0, 10000 | 1.0 |

Hardware Setup

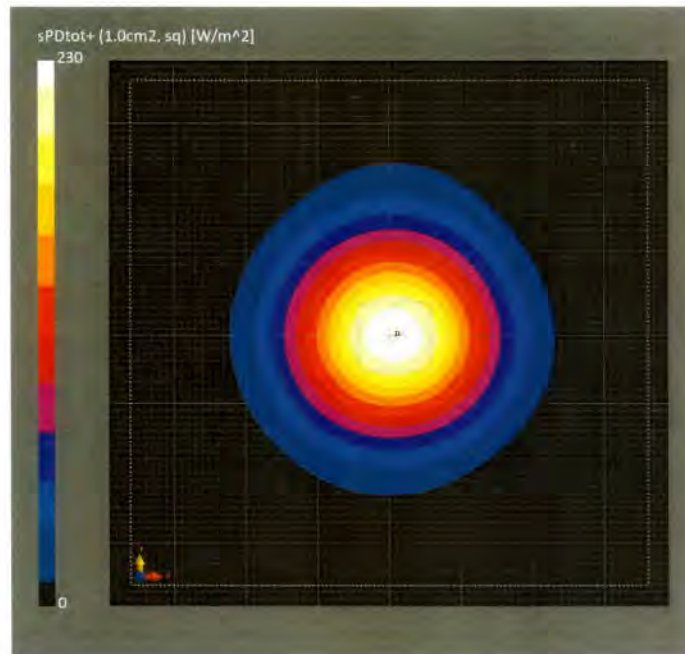
| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|-----------------------|--------|---------------------------------------|---------------------------|
| mmWave Phantom - 1002 | Air | EUmmWV3 - SN9374_F1-55GHz, 2023-12-04 | DAE4ip Sn1602, 2023-11-08 |

Scan Setup

| Sensor Surface [mm] | 5G Scan |
|---------------------|-----------------------|
| MAIA | 10.0 MAIA not used |

Measurement Results

| | 5G Scan |
|---------------------------------|-------------------|
| Date | 2024-08-20, 18:04 |
| Avg. Area [cm ²] | 1.00 |
| Avg. Type | Square Averaging |
| psPDn+ [W/m ²] | 230 |
| psPDtot+ [W/m ²] | 230 |
| psPDmod+ [W/m ²] | 232 |
| Max(Sn) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| E _{max} [V/m] | 295 |
| Power Drift [dB] | 0.02 |



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

| Name, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|-------------------------------|-----------------------|----------|----------|
| 5G Verification Source 10 GHz | 100.0 x 100.0 x 100.0 | SN: 2004 | - |

Exposure Conditions

| Phantom Section | Position, Test Distance [mm] | Band | Group, | Frequency [MHz], Channel Number | Conversion Factor |
|-----------------|------------------------------|-----------------|--------|---------------------------------|-------------------|
| 5G - | 10.0 mm | Validation band | CW | 10000.0, 10000 | 1.0 |

Hardware Setup

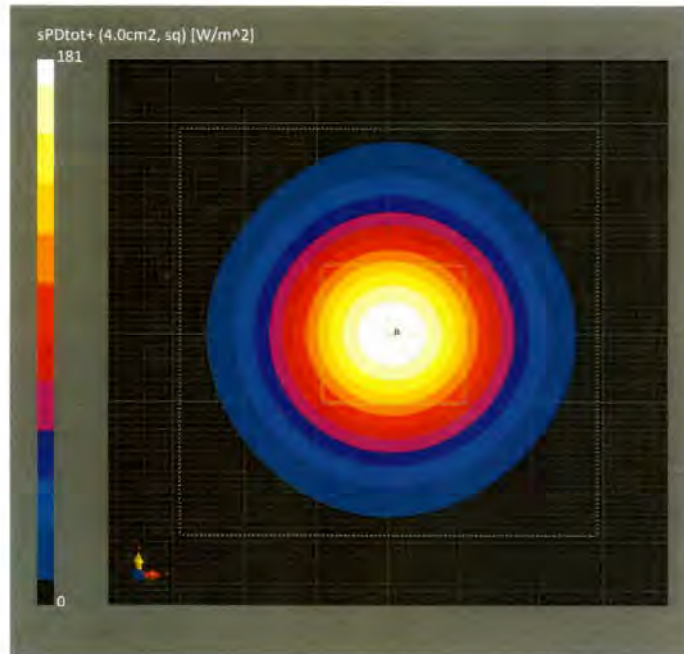
| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|-----------------------|--------|---------------------------------------|---------------------------|
| mmWave Phantom - 1002 | Air | EUmmWV3 - SN9374_F1-55GHz, 2023-12-04 | DAE4ip Sn1602, 2023-11-08 |

Scan Setup

| Sensor Surface [mm] | 5G Scan |
|---------------------|-----------------------|
| MAIA | 10.0 MAIA not used |

Measurement Results

| | 5G Scan |
|---------------------------------|-------------------|
| Date | 2024-08-20, 18:04 |
| Avg. Area [cm ²] | 4.00 |
| Avg. Type | Square Averaging |
| psPDn+ [W/m ²] | 181 |
| psPDtot+ [W/m ²] | 181 |
| psPDmod+ [W/m ²] | 186 |
| Max(Sn) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| Max(Stot) [W/m ²] | 250 |
| E _{max} [V/m] | 295 |
| Power Drift [dB] | 0.02 |



Client : **SGS**

Certificate No: **24J02Z001048**

CALIBRATION CERTIFICATE

Object: DAE4 - SN: 867

Calibration Procedure(s): FF-Z11-002-01
Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: December 31, 2024

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(Calibrated by, Certificate No.) | Scheduled Calibration |
|------------------------|---------|--|-----------------------|
| Process Calibrator 753 | 1971018 | 11-Jun-24 (CTTL, No.24J02X005147) | Jun-25 |

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

Issued: January 02, 2025

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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 = 6.1 μ V, 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 | 406.194 \pm 0.15% (k=2) | 405.646 \pm 0.15% (k=2) | 406.689 \pm 0.15% (k=2) |
| Low Range | 4.00453 \pm 0.7% (k=2) | 3.99658 \pm 0.7% (k=2) | 4.02769 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|-----------------------------------|
| Connector Angle to be used in DASY system | 222 $^{\circ}$ \pm 1 $^{\circ}$ |
|---|-----------------------------------|

Client : **SGS**

Certificate No: **24J02Z000094**

CALIBRATION CERTIFICATE

Object: **DAE4 - SN: 896**

Calibration Procedure(s): **FF-Z11-002-01**
 Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: **March 18, 2024**

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(Calibrated by, Certificate No.) | Scheduled Calibration |
|------------------------|---------|--|-----------------------|
| Process Calibrator 753 | 1971018 | 12-Jun-23 (CTTL, No.J23X05436) | Jun-24 |

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

Issued: March 20, 2024

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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 | 403.759 ± 0.15% (k=2) | 404.293 ± 0.15% (k=2) | 404.210 ± 0.15% (k=2) |
| Low Range | 3.98212 ± 0.7% (k=2) | 4.00285 ± 0.7% (k=2) | 3.97331 ± 0.7% (k=2) |

Connector Angle

| | |
|---|--------------|
| Connector Angle to be used in DASY system | 267.5° ± 1 ° |
|---|--------------|

Client : **SGS**

Certificate No: **24J02Z000160**

CALIBRATION CERTIFICATE

Object **DAE4 - SN: 1663**

Calibration Procedure(s) **FF-Z11-002-01**
 Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: **April 16, 2024**

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 | 12-Jun-23 (CTTL, No.J23X05436) | Jun-24 |

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

Signature



Issued: April 17, 2024

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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 = 6.1 μ V, 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 | 405.056 \pm 0.15% (k=2) | 405.018 \pm 0.15% (k=2) | 404.706 \pm 0.15% (k=2) |
| Low Range | 4.00406 \pm 0.7% (k=2) | 3.98249 \pm 0.7% (k=2) | 4.00701 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|----------------------------------|
| Connector Angle to be used in DASY system | 54 $^{\circ}$ \pm 1 $^{\circ}$ |
|---|----------------------------------|

Client **SGS**

Certificate No: **24J02Z001031**

CALIBRATION CERTIFICATE

Object EX3DV4 - SN : 3789

Calibration Procedure(s) FF-Z11-004-02
Calibration Procedures for Dosimetric E-field Probes



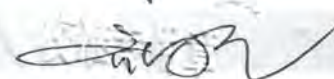
Calibration date: January 15, 2025

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(Calibrated by, Certificate No.) | Scheduled Calibration |
|--------------------------|--------------------|---|-----------------------|
| Power Meter NRP2 | 106277 | 18-Oct-24(CTTL, No.24J02X101459) | Oct-25 |
| Power sensor NRP8S | 104291 | 18-Oct-24(CTTL, No.24J02X101459) | Oct-25 |
| Power sensor NRP8S | 104292 | 18-Oct-24(CTTL, No.24J02X101459) | Oct-25 |
| Reference 10dBAttenuator | 18N50W-10dB | 19-Jan-23(CTTL, No.J23X00212) | Jan-25 |
| Reference 20dBAttenuator | 18N50W-20dB | 19-Jan-23(CTTL, No.J23X00211) | Jan-25 |
| Reference Probe EX3DV4 | SN 7307 | 28-May-24(SPEAG, No.EX-7307_May24) | May-25 |
| DAE4 | SN 771 | 19-Jan-24(SPEAG, No.DAE4-771_Jan24) | Jan-25 |
| DAE4 | SN 1555 | 16-Aug-24(SPEAG, No. DAE4-1555_Aug24) | Aug-25 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGenerator MG3700A | 6201052605 | 12-Jun-24(CTTL, No.24J02X005419) | Jun-25 |
| SignalGenerator APSIN26G | 181-33A6D0700-1959 | 26-Mar-24(CTTL, No.24J02X002468) | Mar-25 |
| Network Analyzer E5071C | MY46110673 | 18-Dec-24(CTTL, No.24J02X103932) | Dec-25 |
| Reference 10dBAttenuator | BT0520 | 11-May-23(CTTL, No.J23X04061) | May-25 |
| Reference 20dBAttenuator | BT0267 | 11-May-23(CTTL, No.J23X04062) | May-25 |
| OCP DAKS | SN 0015 | 09-Oct-24(SPEAG, No. OCP-DAKS-0015_Oct24) | Oct-25 |

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

Issued: January 17, 2025

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Glossary:

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

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

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- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}:** Assessed for E-field polarization $\theta=0$ ($f \leq 900\text{MHz}$ in TEM-cell; $f > 1800\text{MHz}$: waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}:** DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR:** PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,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 $f \leq 800\text{MHz}$) and inside waveguide using analytical field distributions based on power measurements for $f > 800\text{MHz}$. 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 NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from $\pm 50\text{MHz}$ to $\pm 100\text{MHz}$.
- Spherical isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle:** The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



DASY/EASY – Parameters of Probe: EX3DV4 – SN:3789

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|--------------|
| Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.45 | 0.53 | 0.51 | $\pm 10.0\%$ |
| DCP(mV) ^B | 102.5 | 101.2 | 99.3 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 162.8 | $\pm 2.1\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 178.0 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 172.3 | |

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

^A The uncertainties of Norm X, Y, Z do not affect the E²-field uncertainty inside TSL (see Page 4).

^B Numerical linearization parameter: uncertainty not required.

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



DASY/EASY – Parameters of Probe: EX3DV4 – SN:3789

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 | 9.04 | 9.04 | 9.04 | 0.25 | 0.89 | ± 12.7% |
| 835 | 41.5 | 0.90 | 8.64 | 8.64 | 8.64 | 0.10 | 1.42 | ± 12.7% |
| 1450 | 40.5 | 1.20 | 7.90 | 7.90 | 7.90 | 0.13 | 1.27 | ± 12.7% |
| 1750 | 40.1 | 1.37 | 7.71 | 7.71 | 7.71 | 0.19 | 1.10 | ± 12.7% |
| 1900 | 40.0 | 1.40 | 7.38 | 7.38 | 7.38 | 0.19 | 1.18 | ± 12.7% |
| 2300 | 39.5 | 1.67 | 7.20 | 7.20 | 7.20 | 0.65 | 0.66 | ± 12.7% |
| 2450 | 39.2 | 1.80 | 6.98 | 6.98 | 6.98 | 0.62 | 0.70 | ± 12.7% |
| 2600 | 39.0 | 1.96 | 6.80 | 6.80 | 6.80 | 0.65 | 0.68 | ± 12.7% |
| 3300 | 38.2 | 2.71 | 6.49 | 6.49 | 6.49 | 0.54 | 0.85 | ± 13.9% |
| 3500 | 37.9 | 2.91 | 6.40 | 6.40 | 6.40 | 0.35 | 1.15 | ± 13.9% |
| 3700 | 37.7 | 3.12 | 6.15 | 6.15 | 6.15 | 0.35 | 1.30 | ± 13.9% |
| 3900 | 37.5 | 3.32 | 6.16 | 6.16 | 6.16 | 0.35 | 1.45 | ± 13.9% |
| 4100 | 37.2 | 3.53 | 6.22 | 6.22 | 6.22 | 0.40 | 1.15 | ± 13.9% |
| 4400 | 36.9 | 3.84 | 6.03 | 6.03 | 6.03 | 0.40 | 1.25 | ± 13.9% |
| 4600 | 36.7 | 4.04 | 5.98 | 5.98 | 5.98 | 0.50 | 1.10 | ± 13.9% |
| 4800 | 36.4 | 4.25 | 5.93 | 5.93 | 5.93 | 0.50 | 1.15 | ± 13.9% |
| 5250 | 35.9 | 4.71 | 5.11 | 5.11 | 5.11 | 0.45 | 1.40 | ± 13.9% |
| 5600 | 35.5 | 5.07 | 4.53 | 4.53 | 4.53 | 0.55 | 1.22 | ± 13.9% |
| 5750 | 35.4 | 5.22 | 4.67 | 4.67 | 4.67 | 0.55 | 1.22 | ± 13.9% |

^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.

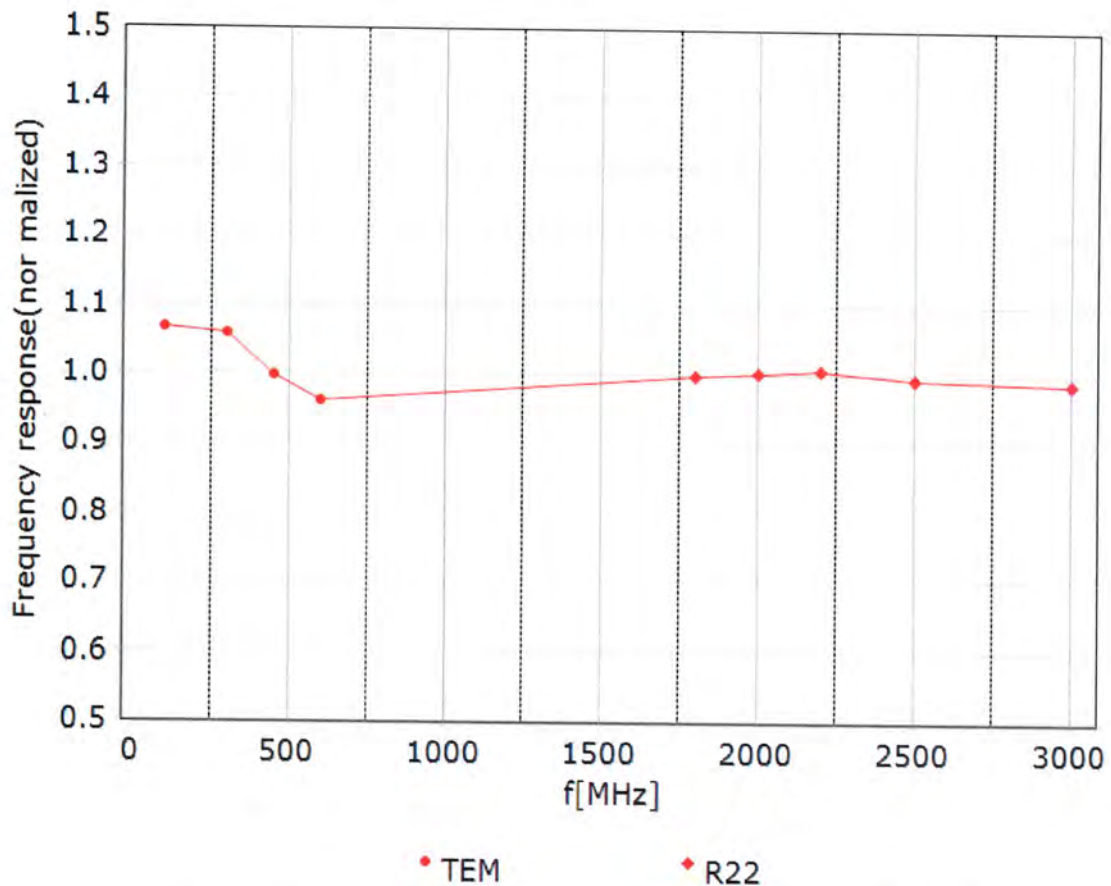
^F At frequency up to 6 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^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)



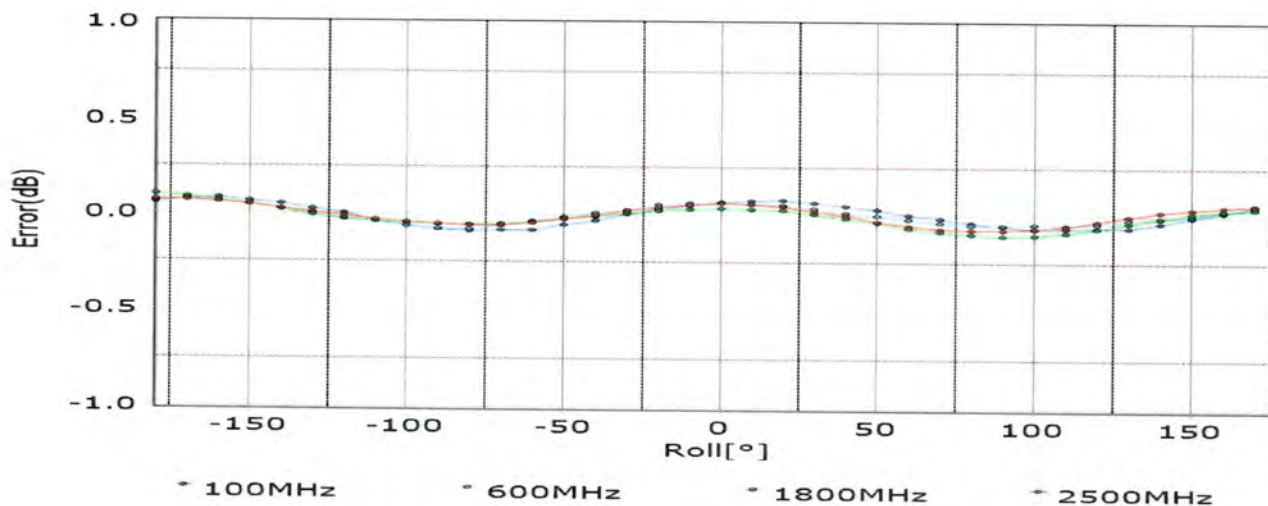
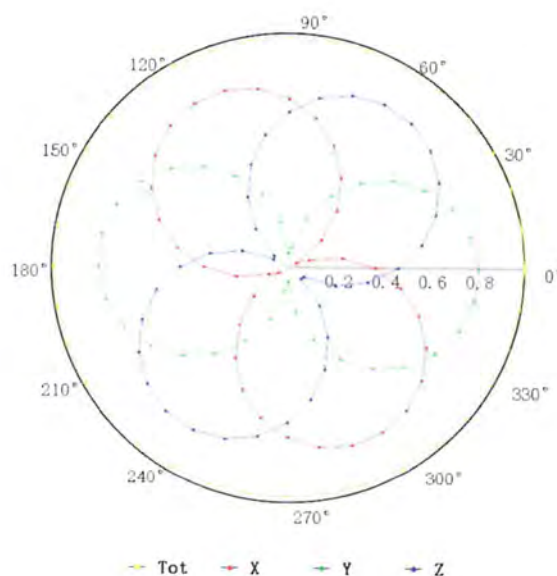
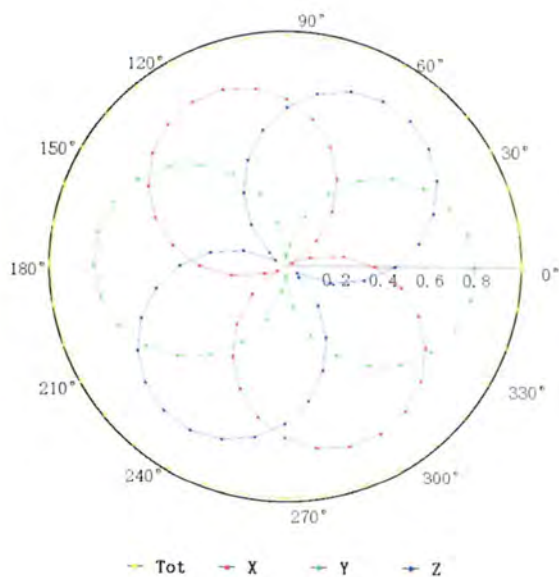
Uncertainty of Frequency Response of E-field: $\pm 7.4\%$ ($k=2$)

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

f=600 MHz, TEM

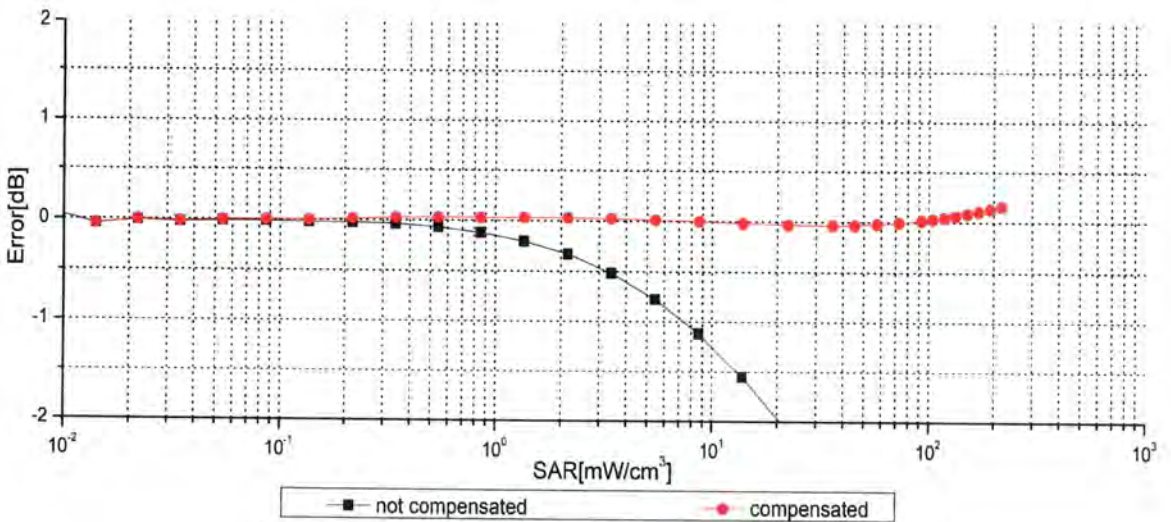
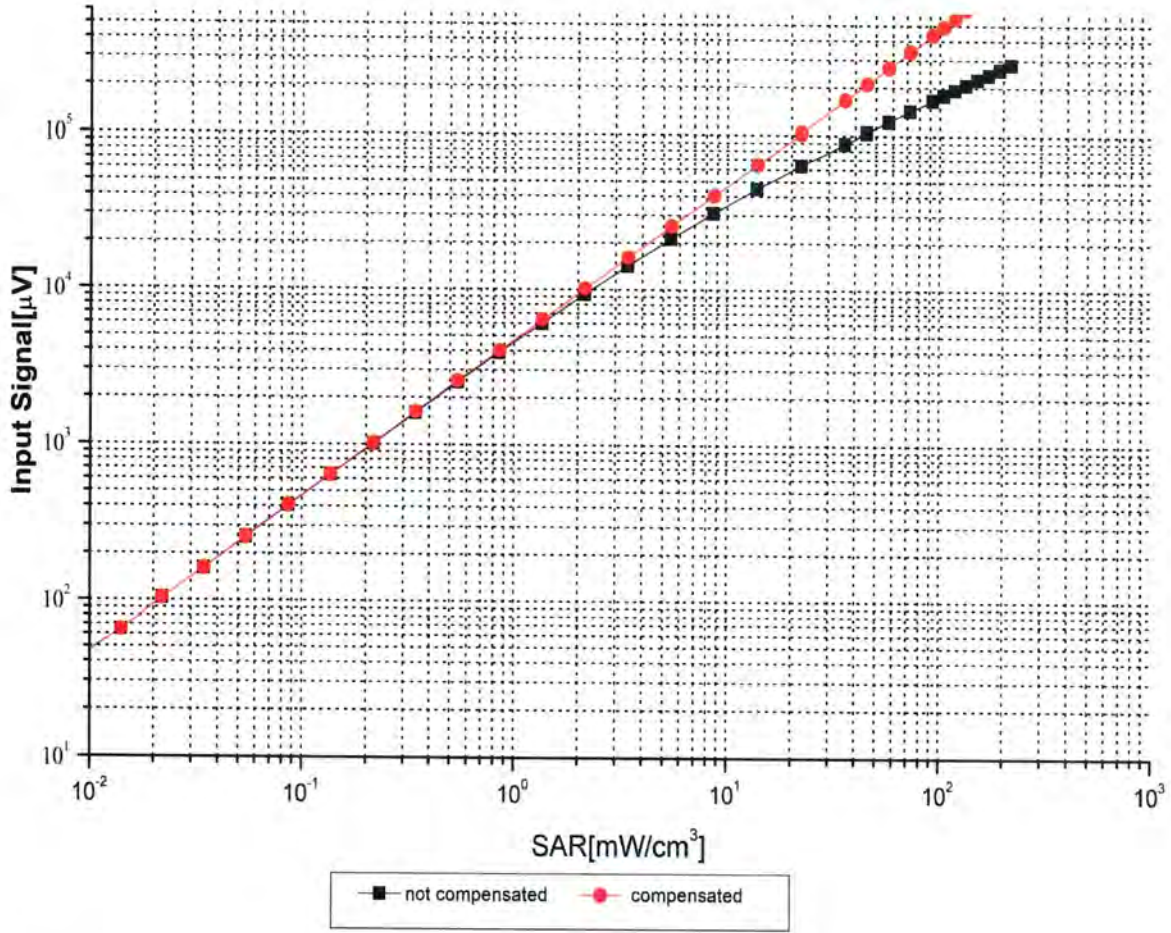
f=1800 MHz, R22



Uncertainty of Axial Isotropy Assessment: $\pm 1.2\%$ ($k=2$)

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Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)



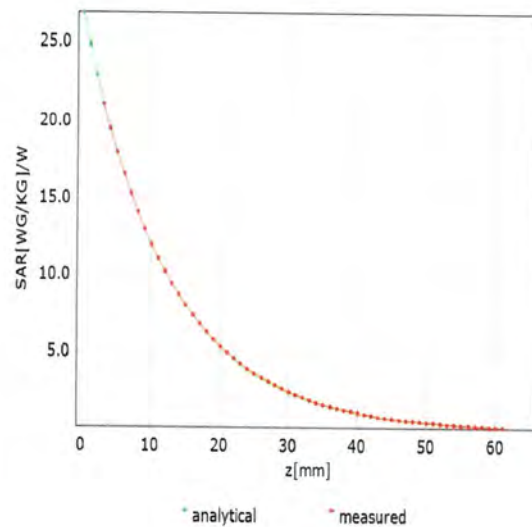
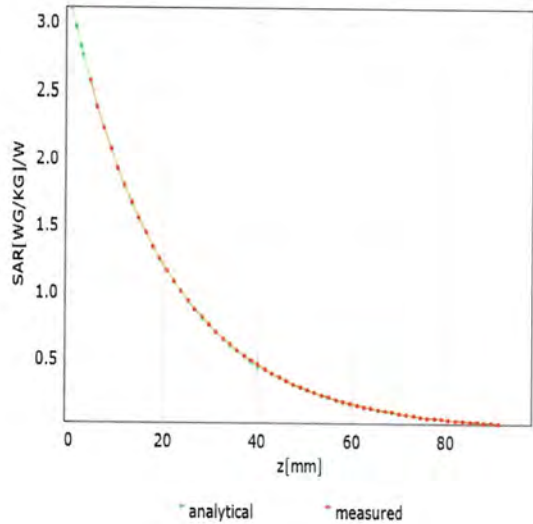
Uncertainty of Linearity Assessment: ±0.9% (k=2)

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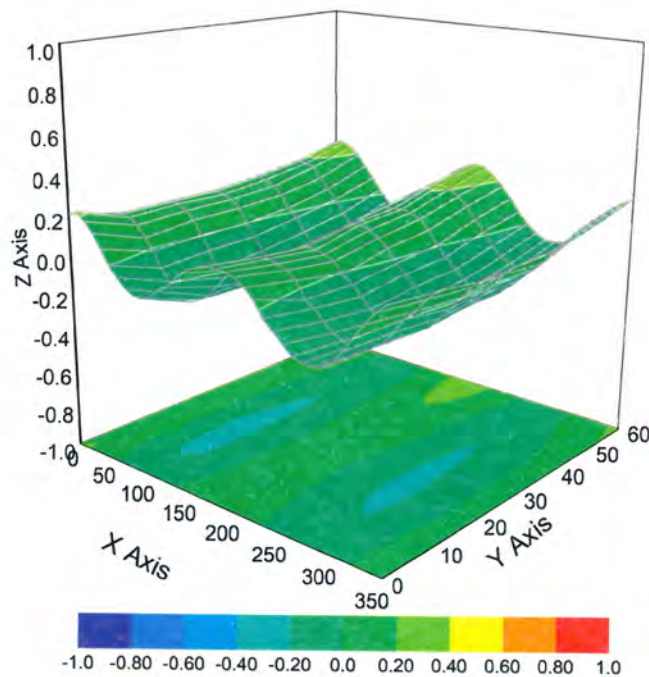
Conversion Factor Assessment

f=750 MHz,WGLS R9(H_convF)

f=1750 MHz,WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: $\pm 3.2\%$ ($k=2$)



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DASY/EASY – Parameters of Probe: EX3DV4 – SN:3789

Other Probe Parameters

| | |
|--|-------------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 45.1 |
| 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 |

Client **SGS**

Certificate No: **24J02Z000365**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN : 7636**

Calibration Procedure(s) **FF-Z11-004-02**
Calibration Procedures for Dosimetric E-field Probes

Calibration date: **July 17, 2024**

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(Calibrated by, Certificate No.) | Scheduled Calibration |
|--------------------------|--------------------|---|-----------------------|
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| Reference 20dBAttenuator | 18N50W-20dB | 19-Jan-23(CTTL, No.J23X00211) | Jan-25 |
| Reference Probe EX3DV4 | SN 7464 | 22-Jan-24(SPEAG, No.EX-7464_Jan24) | Jan-25 |
| DAE4 | SN 1555 | 24-Aug-23(SPEAG, No.DAE4-1555_Aug23) | Aug-24 |
| Reference Probe EX3DV4 | SN 7307 | 28-May-24(SPEAG, No.EX-7307_May24) | May-25 |
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| OCP DAK-12 | SN 1174 | 25-Oct-23(SPEAG, No.OCP-DAK12-1174_Oct23) | Oct-24 |

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

Issued: July 20, 2024

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7636

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|-----------|
| Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.65 | 0.70 | 0.69 | ±10.0% |
| DCP(mV) ^B | 115.1 | 114.0 | 108.9 | |

Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Max Dev. | Max Unc ^E (k=2) |
|-----------|-----------------------------|---|---------|------------------------------|-------|---------|----------|-------------|----------------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 227.7 | ±2.2% | ±4.7% |
| | | Y | 0.0 | 0.0 | 1.0 | | 236.4 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 228.4 | | |
| 10352-AAA | Pulse Waveform (200Hz, 10%) | X | 1.62 | 60.57 | 5.97 | 10.00 | 60 | ±3.6% | ±9.6% |
| | | Y | 1.45 | 60.00 | 5.68 | | 60 | | |
| | | Z | 1.64 | 60.91 | 6.12 | | 60 | | |
| 10353-AAA | Pulse Waveform (200Hz, 20%) | X | 78.00 | 72.00 | 7.00 | 6.99 | 80 | ±3.4% | ±9.6% |
| | | Y | 68.00 | 72.00 | 7.00 | | 80 | | |
| | | Z | 70.00 | 72.00 | 7.00 | | 80 | | |
| 10354-AAA | Pulse Waveform (200Hz, 40%) | X | 0.02 | 135.72 | 1.10 | 3.98 | 95 | ±2.6% | ±9.6% |
| | | Y | 0.01 | 130.45 | 1.02 | | 95 | | |
| | | Z | 0.11 | 142.19 | 1.32 | | 95 | | |
| 10355-AAA | Pulse Waveform (200Hz, 60%) | X | 3.47 | 159.47 | 11.08 | 2.22 | 120 | ±1.6% | ±9.6% |
| | | Y | 0.80 | 159.09 | 17.57 | | 120 | | |
| | | Z | 0.02 | 158.19 | 20.58 | | 120 | | |
| 10387-AAA | QPSK Waveform, 1 MHz | X | 0.41 | 60.00 | 8.47 | 1.00 | 150 | ±4.7% | ±9.6% |
| | | Y | 0.36 | 60.00 | 7.83 | | 150 | | |
| | | Z | 0.44 | 60.02 | 8.58 | | 150 | | |
| 10388-AAA | QPSK Waveform, 10 MHz | X | 1.15 | 63.34 | 11.68 | 0.00 | 150 | ±1.5% | ±9.6% |
| | | Y | 0.92 | 61.33 | 9.82 | | 150 | | |
| | | Z | 1.22 | 63.81 | 12.04 | | 150 | | |
| 10396-AAA | 64-QAM Waveform, 100 kHz | X | 1.83 | 65.98 | 16.99 | 3.01 | 150 | ±0.8% | ±9.6% |
| | | Y | 1.70 | 64.52 | 15.89 | | 150 | | |
| | | Z | 1.66 | 64.19 | 16.26 | | 150 | | |
| 10414-AAA | WLAN CCDF, 64-QAM, 40MHz | X | 3.83 | 65.91 | 14.82 | 0.00 | 150 | ±4.7% | ±9.6% |
| | | Y | 3.63 | 65.78 | 14.47 | | 150 | | |
| | | Z | 3.95 | 66.18 | 15.11 | | 150 | | |

Note: For details on UID parameters see Appendix

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

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

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty 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: 7636

Sensor Model Parameters

| | C1 fF | C2 fF | α V ⁻¹ | T1 ms.V ⁻² | T2 ms.V ⁻¹ | T3 ms | T4 V ⁻² | T5 V ⁻¹ | T6 |
|---|----------|----------|-----------------------------|--------------------------|--------------------------|----------|-----------------------|-----------------------|------|
| X | 10.61 | 74.35 | 31.32 | 0.92 | 0.00 | 4.90 | 0.49 | 0.00 | 1.02 |
| Y | 8.34 | 59.51 | 32.10 | 0.92 | 0.00 | 4.90 | 0.34 | 0.00 | 1.02 |
| Z | 10.84 | 79.01 | 33.55 | 0.92 | 0.00 | 4.90 | 0.00 | 0.03 | 1.02 |

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 127.1 |
| 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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DASY/EASY – Parameters of Probe: EX3DV4 – SN:7636

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 | 10.65 | 10.65 | 10.65 | 0.14 | 1.44 | ± 12.7% |
| 835 | 41.5 | 0.90 | 10.36 | 10.36 | 10.36 | 0.19 | 1.21 | ± 12.7% |
| 1750 | 40.1 | 1.37 | 8.85 | 8.85 | 8.85 | 0.30 | 0.94 | ± 12.7% |
| 1900 | 40.0 | 1.40 | 8.51 | 8.51 | 8.51 | 0.27 | 1.00 | ± 12.7% |
| 2100 | 39.8 | 1.49 | 8.53 | 8.53 | 8.53 | 0.24 | 1.06 | ± 12.7% |
| 2450 | 39.2 | 1.80 | 7.95 | 7.95 | 7.95 | 0.67 | 0.69 | ± 12.7% |
| 2600 | 39.0 | 1.96 | 7.77 | 7.77 | 7.77 | 0.65 | 0.69 | ± 12.7% |
| 3300 | 38.2 | 2.71 | 7.34 | 7.34 | 7.34 | 0.49 | 0.89 | ± 13.9% |
| 3500 | 37.9 | 2.91 | 7.19 | 7.19 | 7.19 | 0.47 | 0.95 | ± 13.9% |
| 3700 | 37.7 | 3.12 | 6.99 | 6.99 | 6.99 | 0.44 | 1.04 | ± 13.9% |
| 3900 | 37.5 | 3.32 | 6.90 | 6.90 | 6.90 | 0.35 | 1.35 | ± 13.9% |
| 4100 | 37.2 | 3.53 | 6.80 | 6.80 | 6.80 | 0.40 | 1.18 | ± 13.9% |
| 5250 | 35.9 | 4.71 | 5.60 | 5.60 | 5.60 | 0.40 | 1.55 | ± 13.9% |
| 5600 | 35.5 | 5.07 | 5.02 | 5.02 | 5.02 | 0.50 | 1.30 | ± 13.9% |
| 5750 | 35.4 | 5.22 | 5.16 | 5.16 | 5.16 | 0.50 | 1.22 | ± 13.9% |

^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.

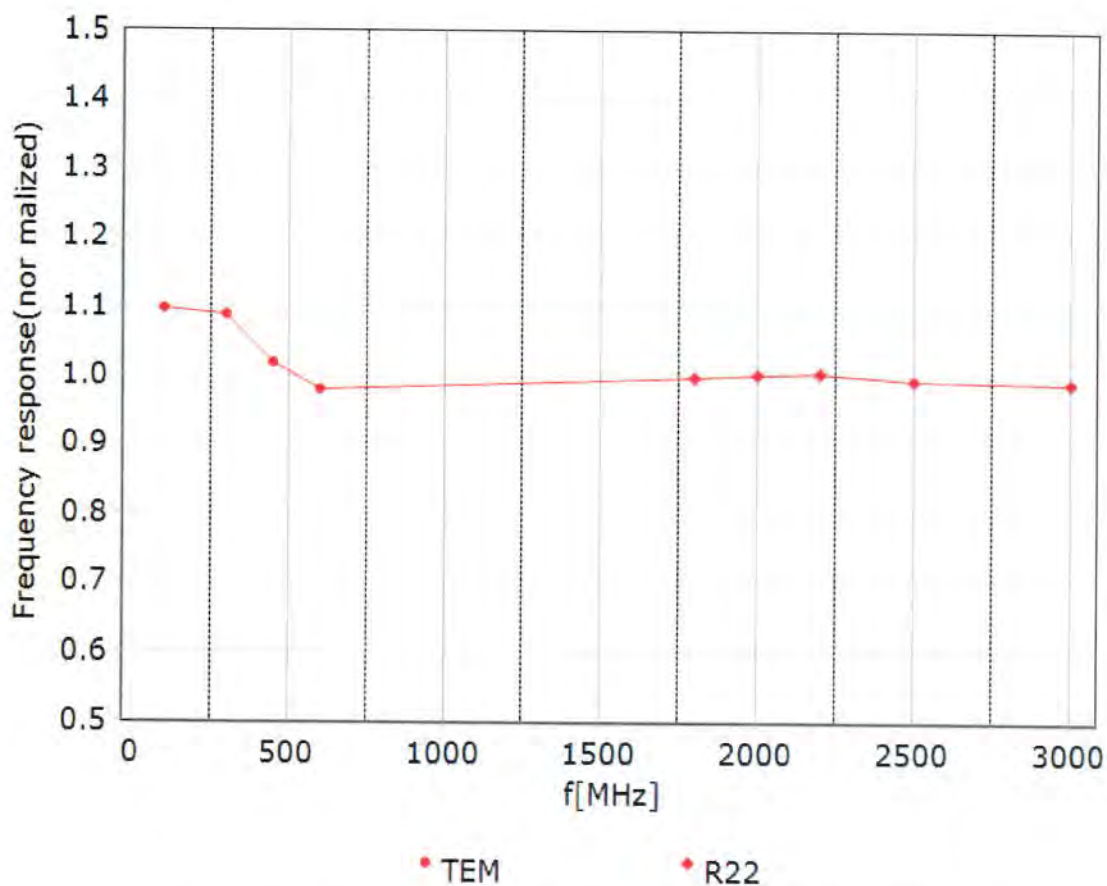
^F At frequency up to 6 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^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)



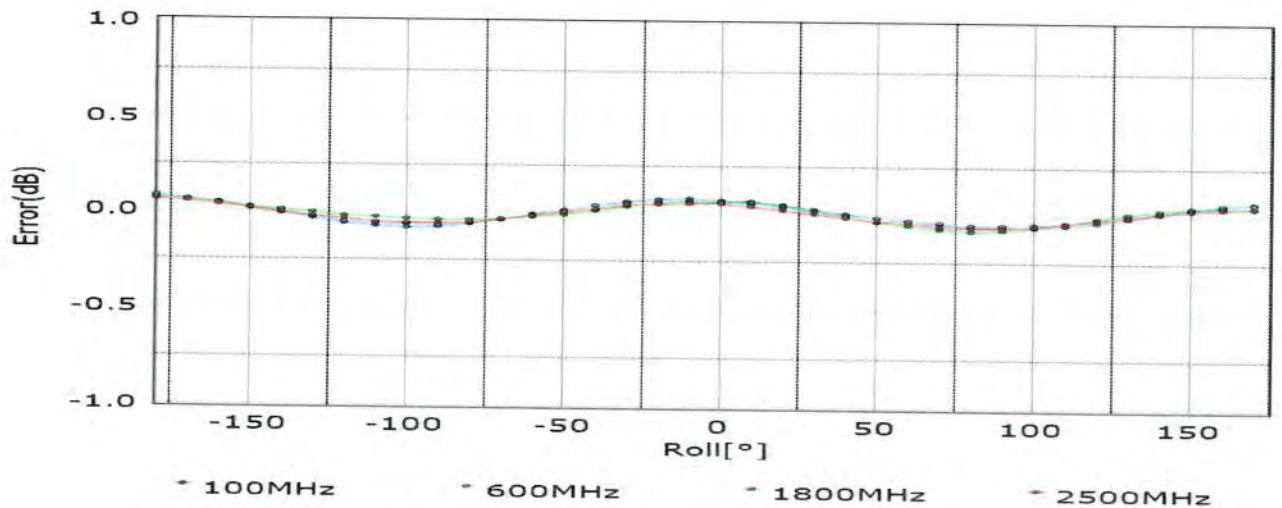
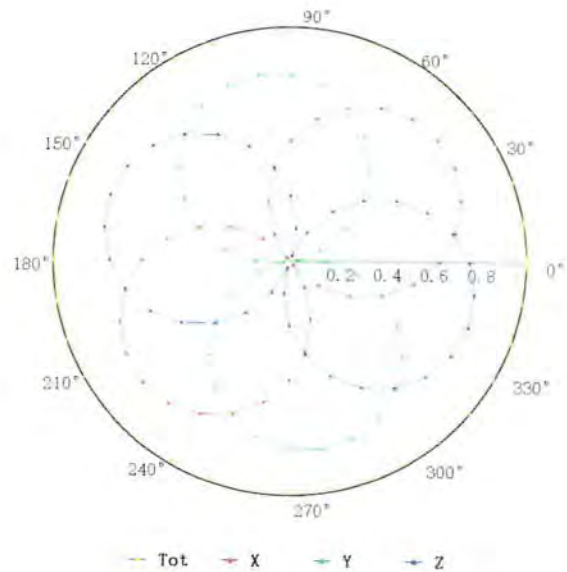
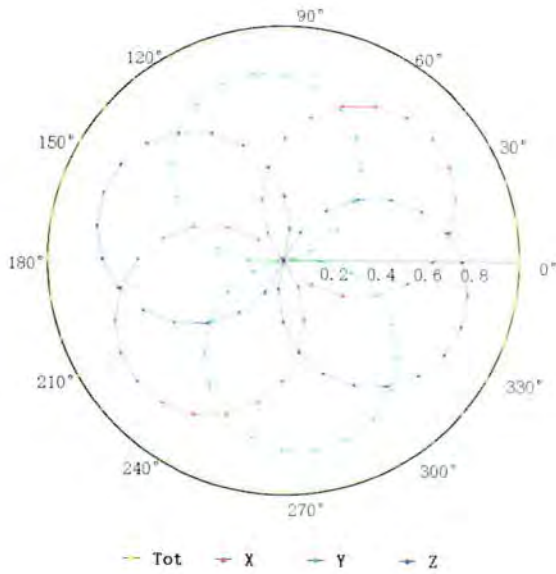
Uncertainty of Frequency Response of E-field: $\pm 7.4\%$ ($k=2$)

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

f=600 MHz, TEM

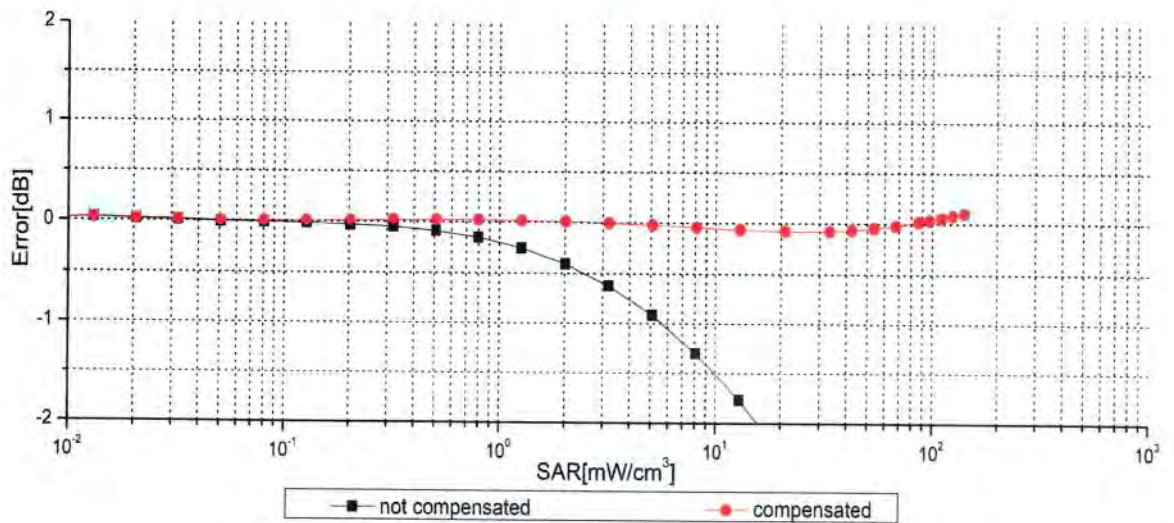
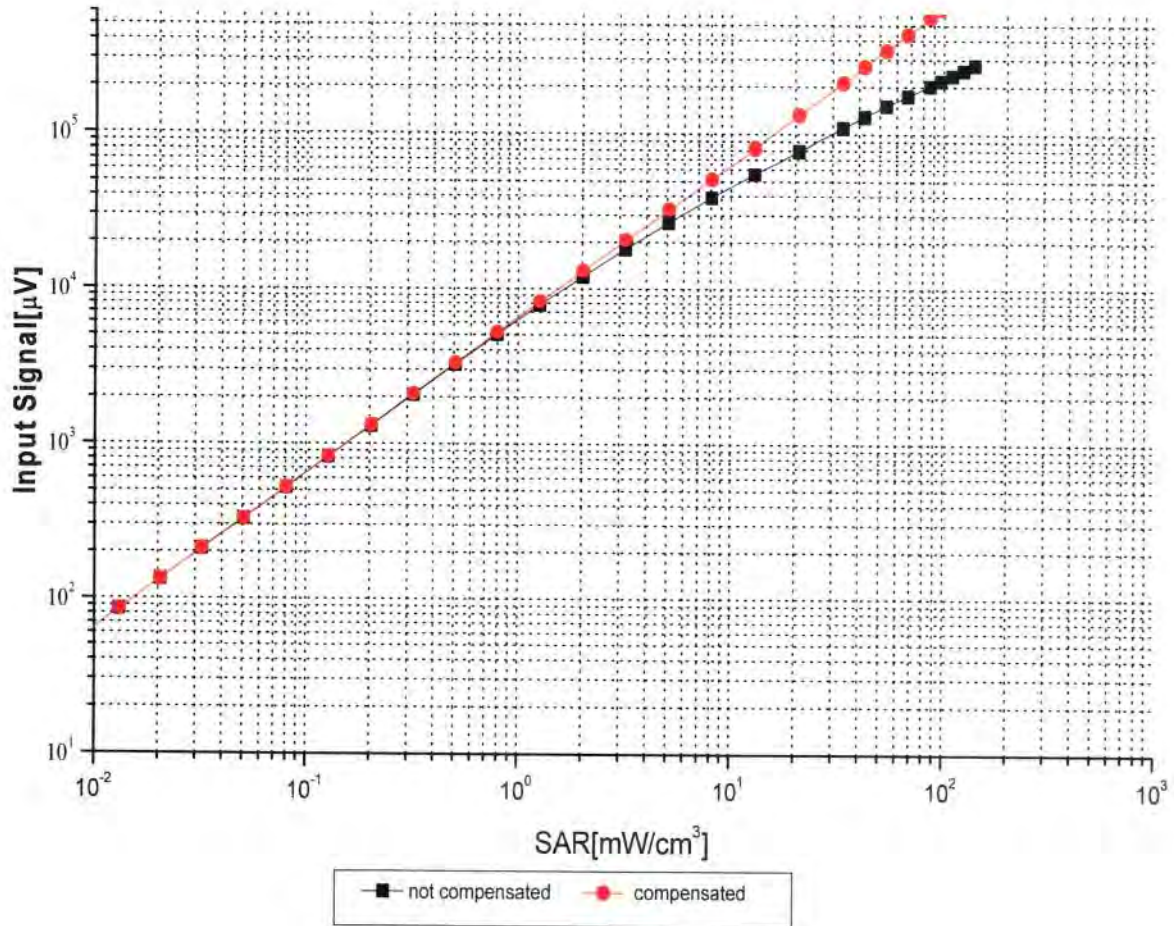
f=1800 MHz, R22



Uncertainty of Axial Isotropy Assessment: $\pm 1.2\%$ ($k=2$)

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Dynamic Range $f(SAR_{head})$ (TEM cell, $f = 900$ MHz)



Uncertainty of Linearity Assessment: $\pm 0.9\%$ ($k=2$)