

Test Laboratory: BTL Inc.

Date: 2020/11/26

System Check_H750_1126**DUT: Dipole 750 MHz D750V3;SN:1095;**

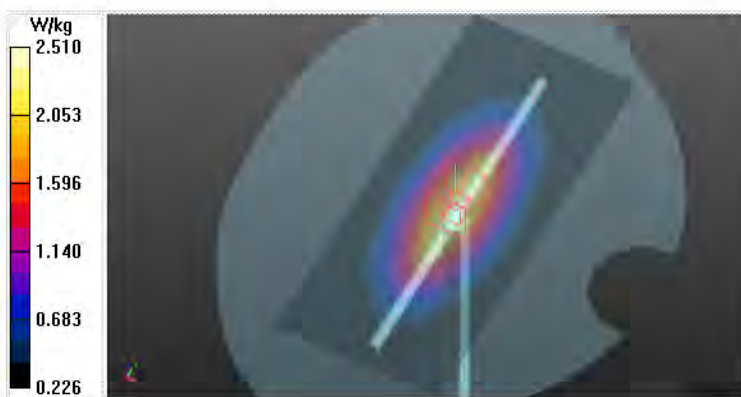
Communication System: UID 0, CW (0); Frequency: 750 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 750$ MHz; $\sigma = 0.889$ S/m; $\epsilon_r = 43.005$; $\rho = 1000$ kg/m³
Ambient Temperature: 23.1 °C; Liquid Temperature: 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(10.44, 10.44, 10.44) @ 750 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (7x15x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 2.51 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 54.53 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.26 W/kg
SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.41 W/kg
Maximum value of SAR (measured) = 2.51 W/kg



Calibrator

Seven Lu

Approver:

Herbert Lin



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CNAS L0570

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Client **BTL Inc .**

Certificate No: **Z21-60217**

CALIBRATION CERTIFICATE

Object **D750V3 - SN: 1095**

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

Calibration date: **June 1, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 26-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 6, 2021

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 750 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 42.0 | 0.90 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 42.0 ± 6 % | 0.88 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 2.13 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 8.59 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 1.39 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 5.60 W/kg ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.7Ω- 1.50jΩ |
| Return Loss | - 28.2dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 0.940 ns |
|----------------------------------|----------|

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

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

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.01.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1095

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 750$ MHz; $\sigma = 0.881$ S/m; $\epsilon_r = 42.02$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(10, 10, 10) @ 750 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.56 V/m; Power Drift = -0.08 dB

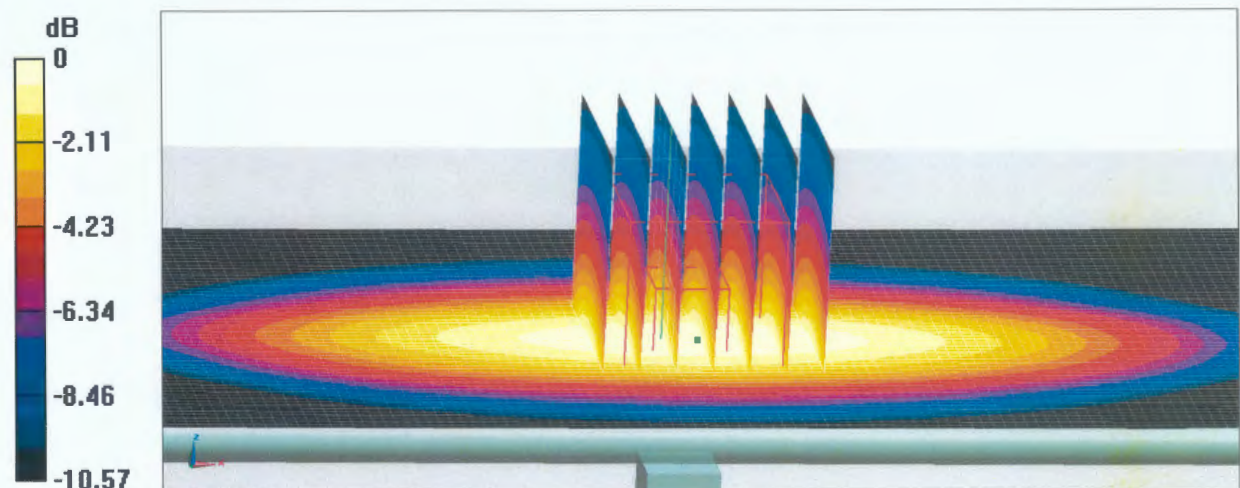
Peak SAR (extrapolated) = 3.36 W/kg

SAR(1 g) = 2.13 W/kg; SAR(10 g) = 1.39 W/kg

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid

Ratio of SAR at M2 to SAR at M1 = 63.3%

Maximum value of SAR (measured) = 2.91 W/kg

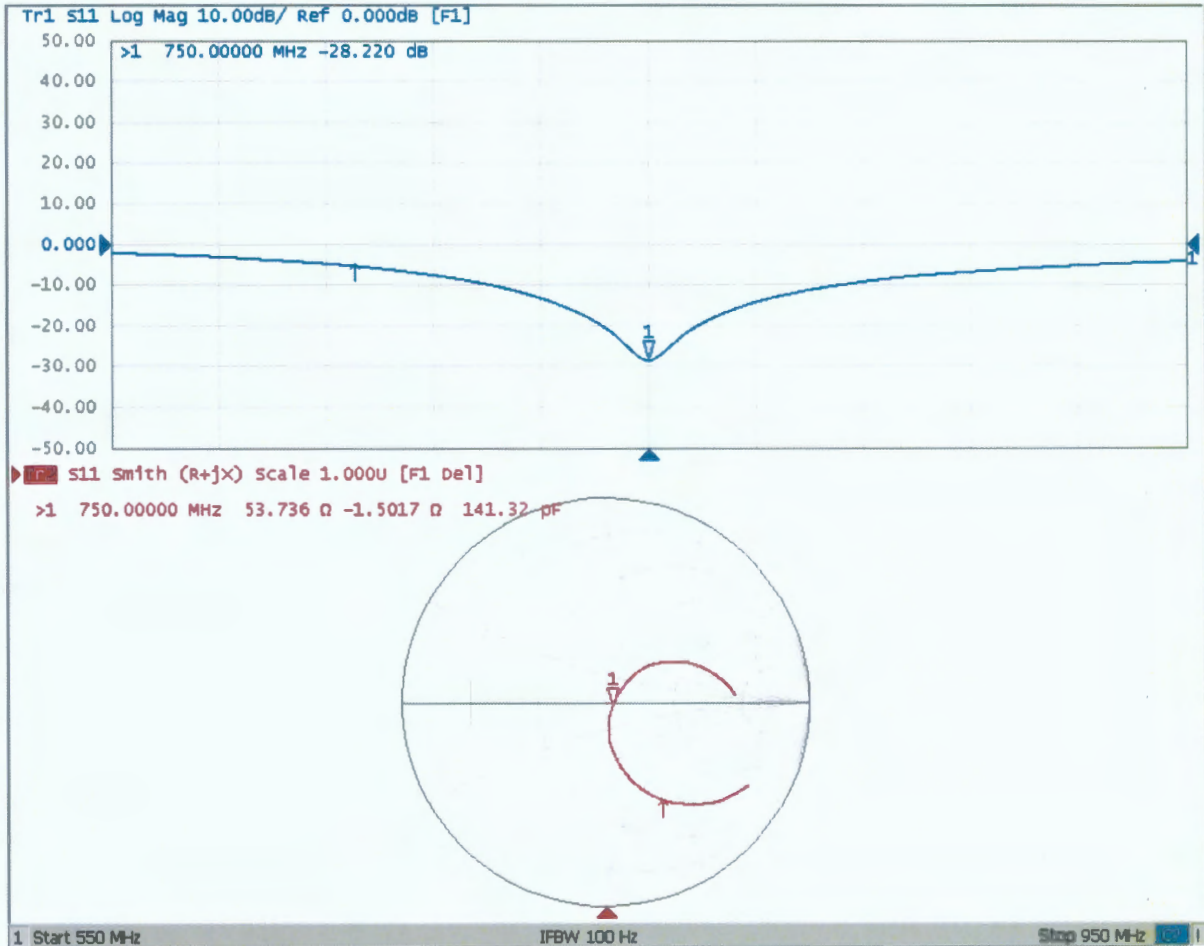


0 dB = 2.91 W/kg = 4.64 dBW/kg



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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60177**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d160**

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

Calibration date: **June 5, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRV-Z5 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Reference Probe EX3DV4 | SN 7464 | 12-Sep-17(SPEAG,No.EX3-7464_Sep17) | Sep-18 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| NetworkAnalyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 11, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 835 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 41.5 | 0.90 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 42.1 \pm 6 % | 0.87 mho/m \pm 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|--|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 2.25 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 9.23 mW / g \pm 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 1.47 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 6.00 mW / g \pm 18.7 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 55.2 | 0.97 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 55.2 \pm 6 % | 0.99 mho/m \pm 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL

| | | |
|---|--------------------|--|
| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 2.42 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 9.53 mW / g \pm 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 1.57 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 6.20 mW / g \pm 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 51.0Ω- 3.97jΩ |
| Return Loss | - 27.9dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 46.4Ω- 4.96jΩ |
| Return Loss | - 23.9dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.308 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.04.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d160

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.874 \text{ S/m}$; $\epsilon_r = 42.13$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(10.28, 10.28, 10.28) @ 835 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

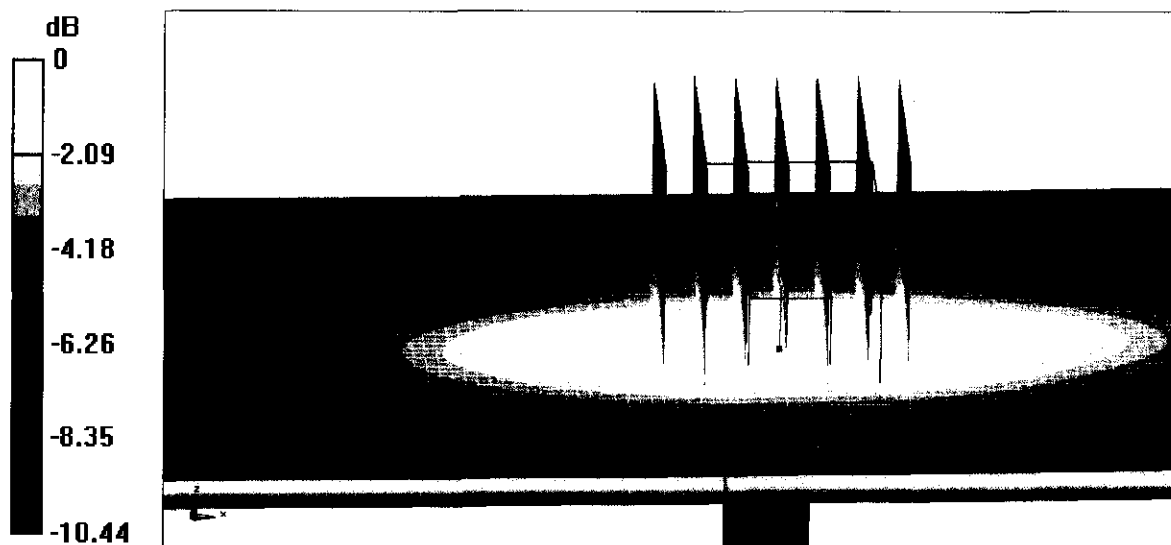
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 56.53 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.44 W/kg

SAR(1 g) = 2.25 W/kg; SAR(10 g) = 1.47 W/kg

Maximum value of SAR (measured) = 3.03 W/kg

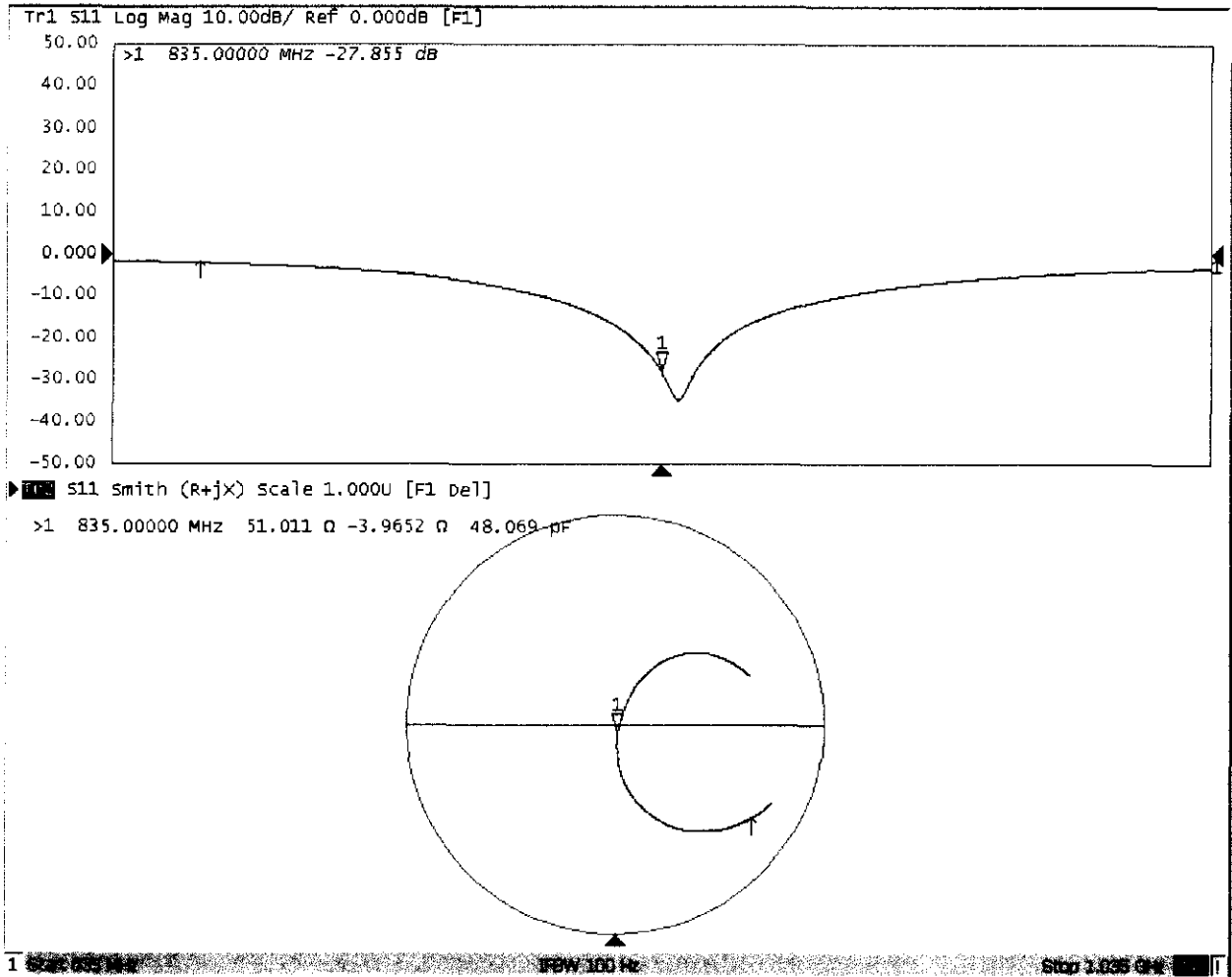


0 dB = 3.03 W/kg = 4.81 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.04.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d160

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.99 \text{ S/m}$; $\epsilon_r = 55.15$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(10.21, 10.21, 10.21) @ 835 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

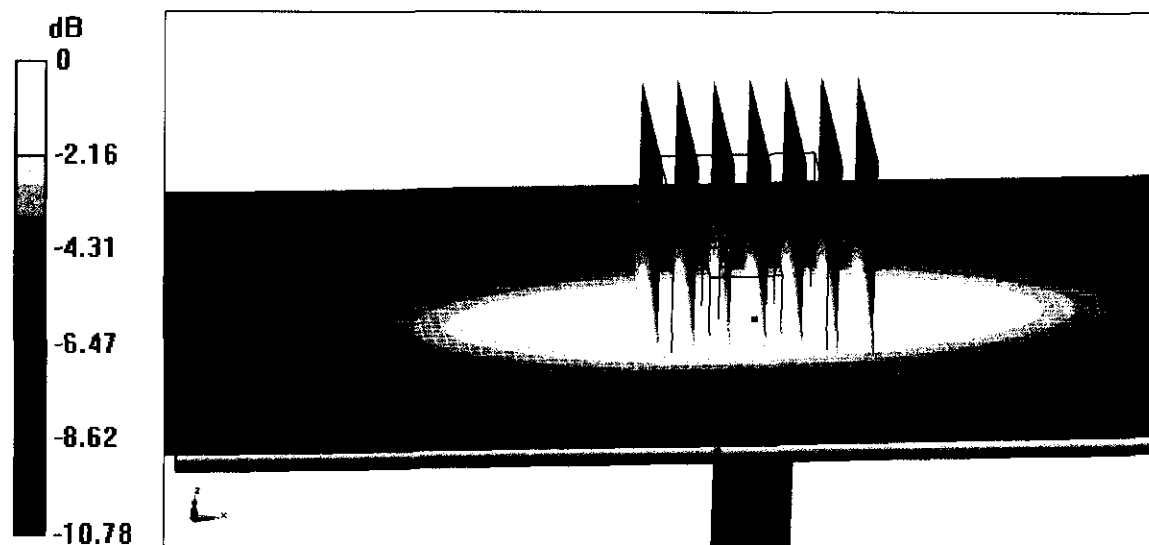
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 55.82 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.76 W/kg

SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.57 W/kg

Maximum value of SAR (measured) = 3.29 W/kg

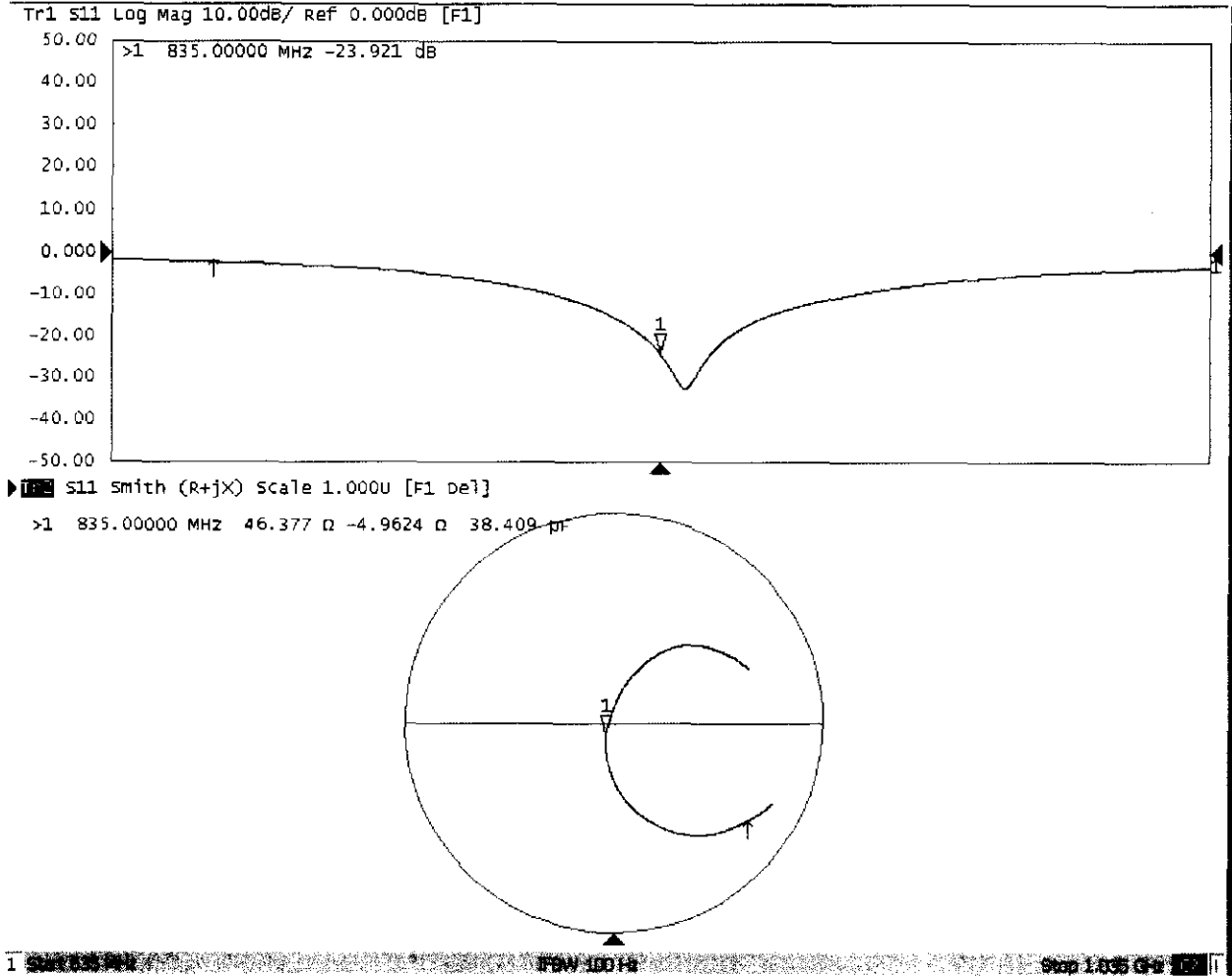


0 dB = 3.29 W/kg = 5.17 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|--------------|------------------|--------------|
| Asset No. : | E-437 | Model No. : | D835V2 | Serial No. : | 4d160 |
| Environmental | 23.2°C, 51 % | Original Cal. Date : | June 5, 2018 | Next Cal. Date : | June 5, 2021 |

Standard List

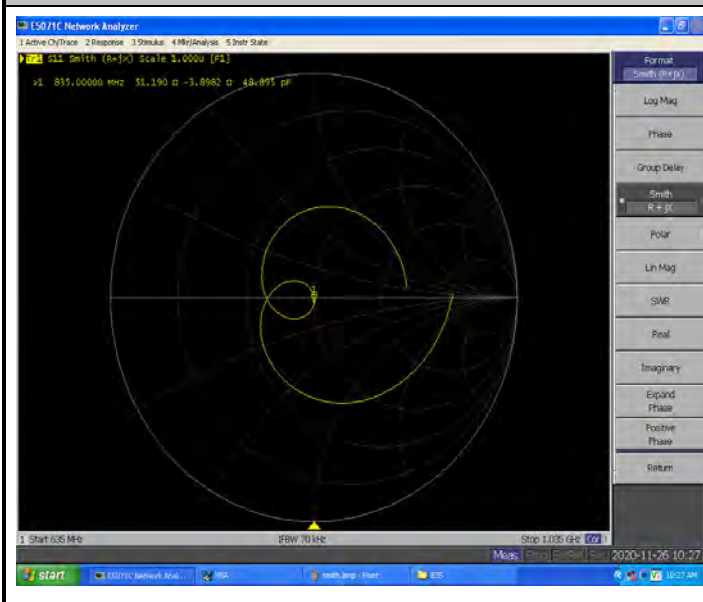
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

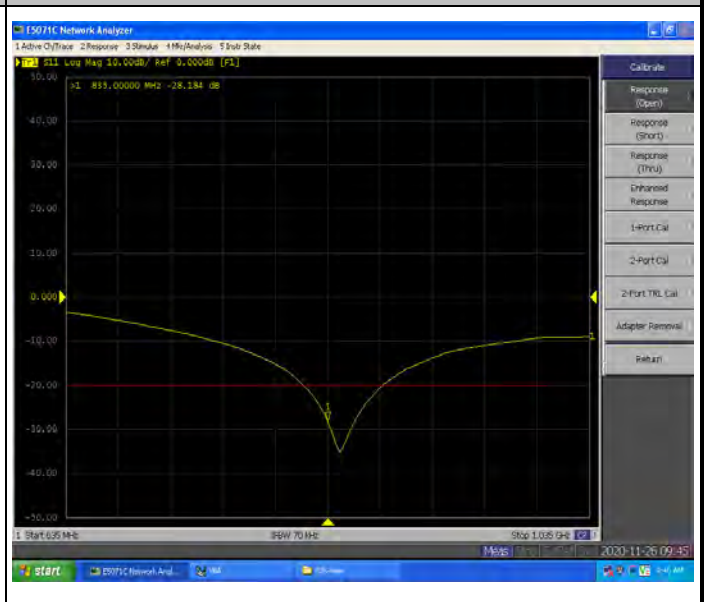
| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organization : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|--------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | N/A | March 10, 2020 |
| DC Source meter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A056010-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Thermometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

| Model No | For Head Tissue | | | | |
|----------|--------------------------------------|----------------------|------------------------|-----------|--------|
| | Item | Original Cal. Result | Verified on 2020/11/26 | Deviation | Result |
| D835V2 | Impedance, transformed to feed point | 51.0Ω-3.97jΩ | 51.2Ω-3.90jΩ | <5Ω | Pass |
| | Return Loss(dB) | -27.9 | -28.184 | 1.0% | Pass |
| | SAR Value for 1g(mW/g) | 2.25 | 2.31 | 2.7% | Pass |
| | SAR Value for 10g(mW/g) | 1.47 | 1.52 | 3.4% | Pass |

Impedance Test-Head



Return Loss-Head



Test Laboratory: BTL Inc

Date: 2020/11/26

System Check_H835_1126**DUT: Dipole 835 MHz D835V2;SN:4d160;**

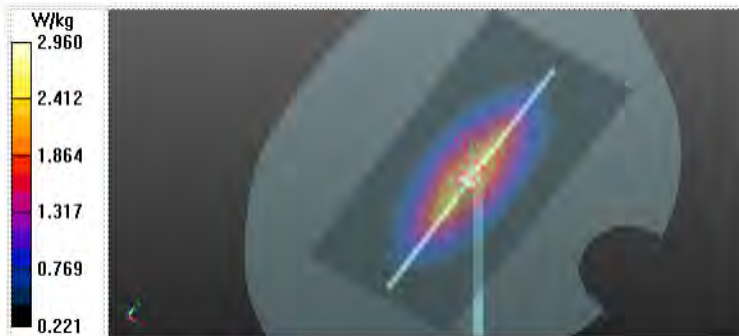
Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 835$ MHz; $\sigma = 0.939$ S/m; $\epsilon_r = 40.843$; $\rho = 1000$ kg/m³
Ambient Temperature: 23.1 °C; Liquid Temperature: 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(10.06, 10.06, 10.06) @ 835 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (7x13x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 2.94 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 57.29 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 4.01 W/kg
SAR(1 g) = 2.31 W/kg; SAR(10 g) = 1.52 W/kg
Maximum value of SAR (measured) = 2.96 W/kg



Calibrator:

Seven Lu

Approver:

Herbert Lin



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Client **BTL Inc .**

Certificate No: **Z21-60218**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d160**

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

Calibration date: **June 1, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 26-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 6, 2021

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 835 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 41.5 | 0.90 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 41.4 ± 6 % | 0.89 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 2.37 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 9.52 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 1.53 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 6.14 W/kg ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 50.9Ω- 5.07jΩ |
| Return Loss | - 25.8dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.350 ns |
|----------------------------------|----------|

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

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

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.01.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d160

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.894 \text{ S/m}$; $\epsilon_r = 41.44$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(10, 10, 10) @ 835 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 56.07 V/m; Power Drift = -0.04 dB

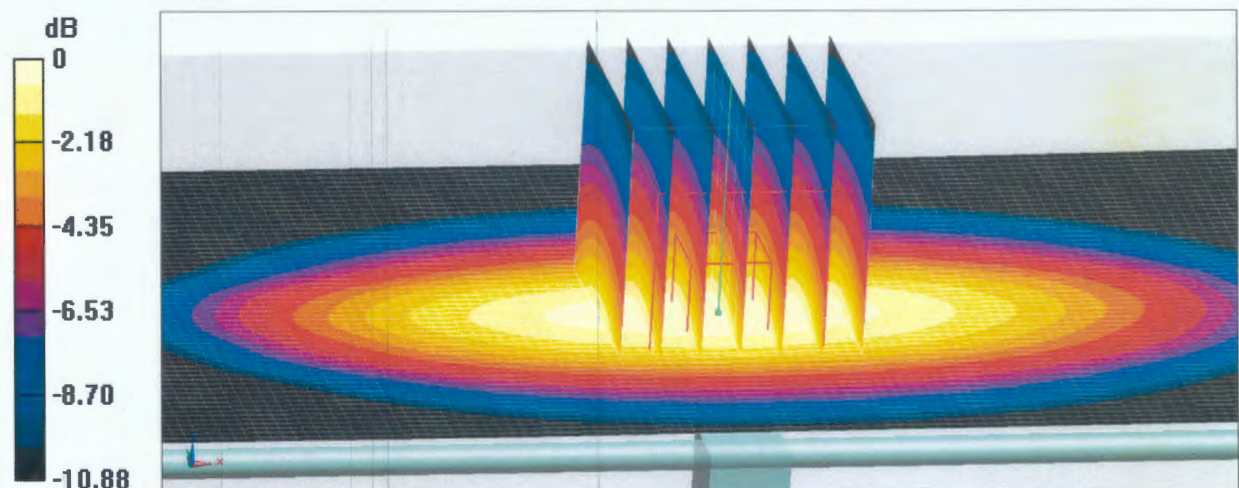
Peak SAR (extrapolated) = 3.79 W/kg

SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.53 W/kg

Smallest distance from peaks to all points 3 dB below = 20.6 mm

Ratio of SAR at M2 to SAR at M1 = 62.6%

Maximum value of SAR (measured) = 3.26 W/kg

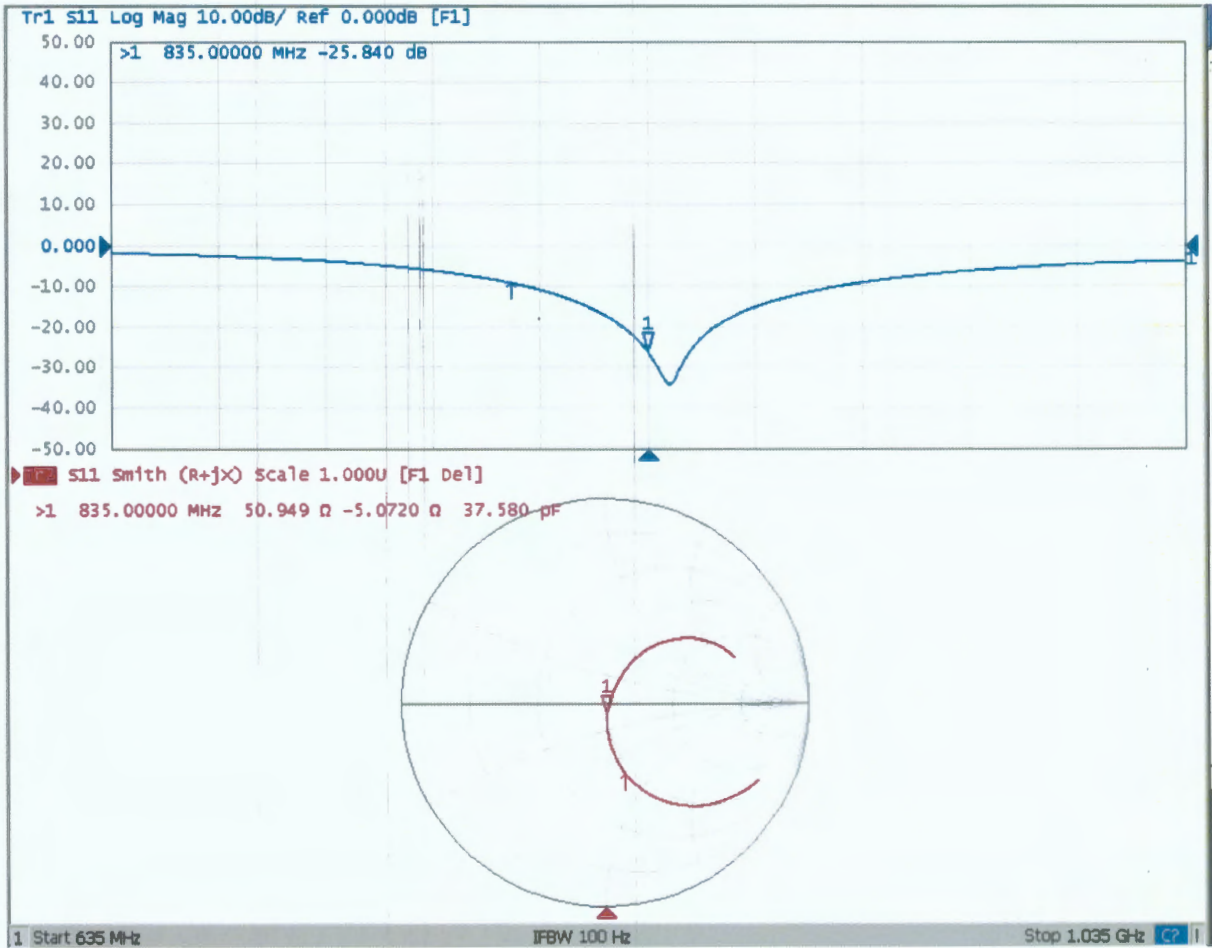


0 dB = 3.26 W/kg = 5.13 dBW/kg



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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60179**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1101**

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

Calibration date: **June 7, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRV-Z5 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Reference Probe EX3DV4 | SN 7464 | 12-Sep-17(SPEAG,No.EX3-7464_Sep17) | Sep-18 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| NetworkAnalyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 11, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1750 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.1 | 1.37 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 41.2 ± 6 % | 1.33 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Head TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 9.04 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 37.0 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 4.90 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 19.9 mW / g ± 18.7 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 53.4 | 1.49 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 52.0 ± 6 % | 1.53 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Body TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 9.57 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 37.4 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 5.11 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.1 mW / g ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 49.8Ω- 2.69 jΩ |
| Return Loss | - 31.4 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 46.3Ω- 2.68 jΩ |
| Return Loss | - 26.5 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.085 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.07.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1101

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.332$ S/m; $\epsilon_r = 41.23$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.7, 8.7, 8.7) @ 1750 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

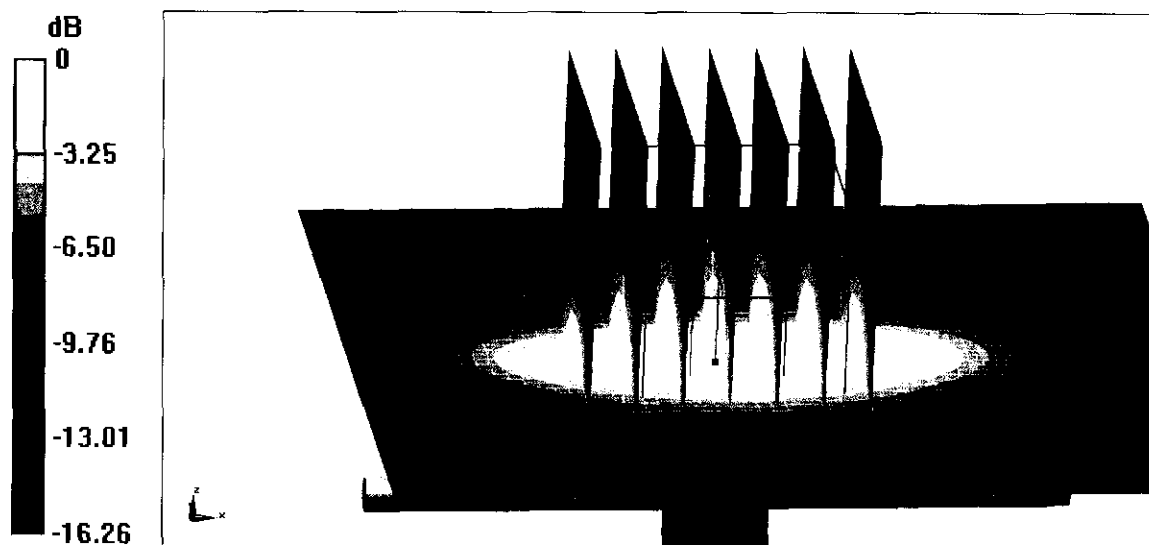
$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 96.28 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 16.5 W/kg

SAR(1 g) = 9.04 W/kg; SAR(10 g) = 4.9 W/kg

Maximum value of SAR (measured) = 13.8 W/kg

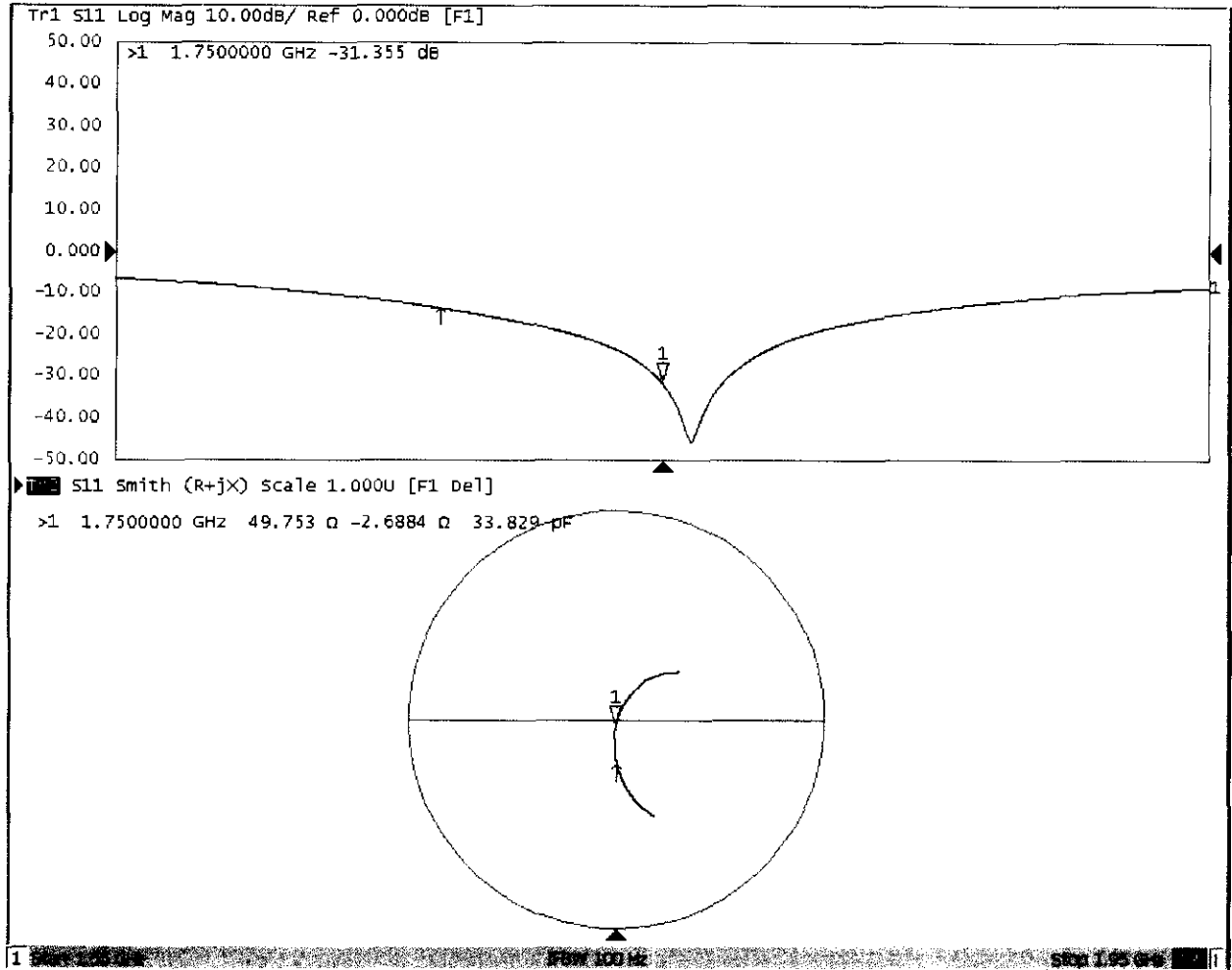


0 dB = 13.8 W/kg = 11.40 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.06.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1101

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.533$ S/m; $\epsilon_r = 51.99$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.6, 8.6, 8.6) @ 1750 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

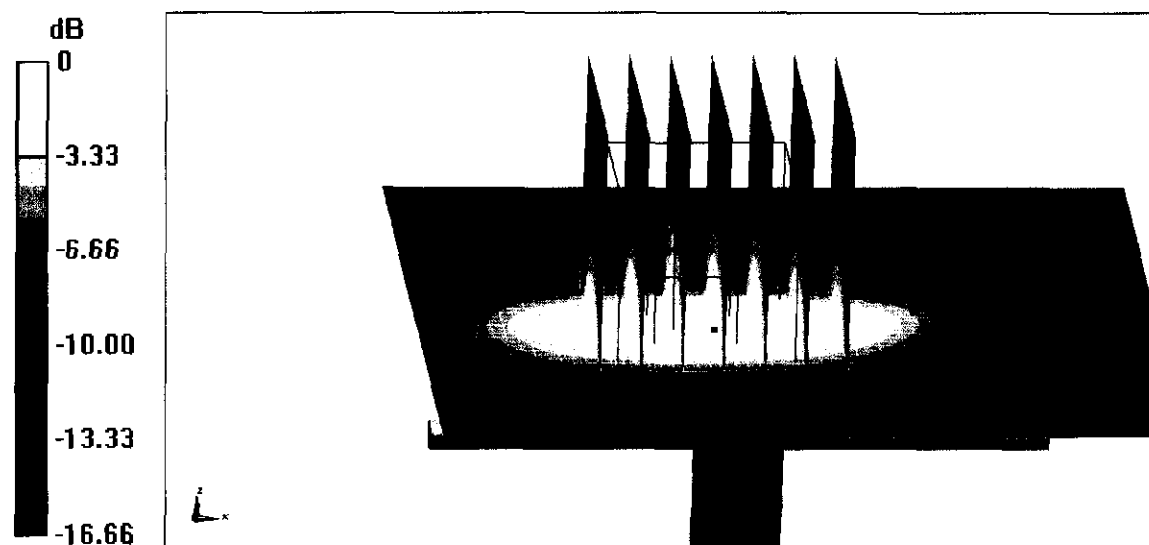
$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 82.09 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.3 W/kg

SAR(1 g) = 9.57 W/kg; SAR(10 g) = 5.11 W/kg

Maximum value of SAR (measured) = 14.6 W/kg

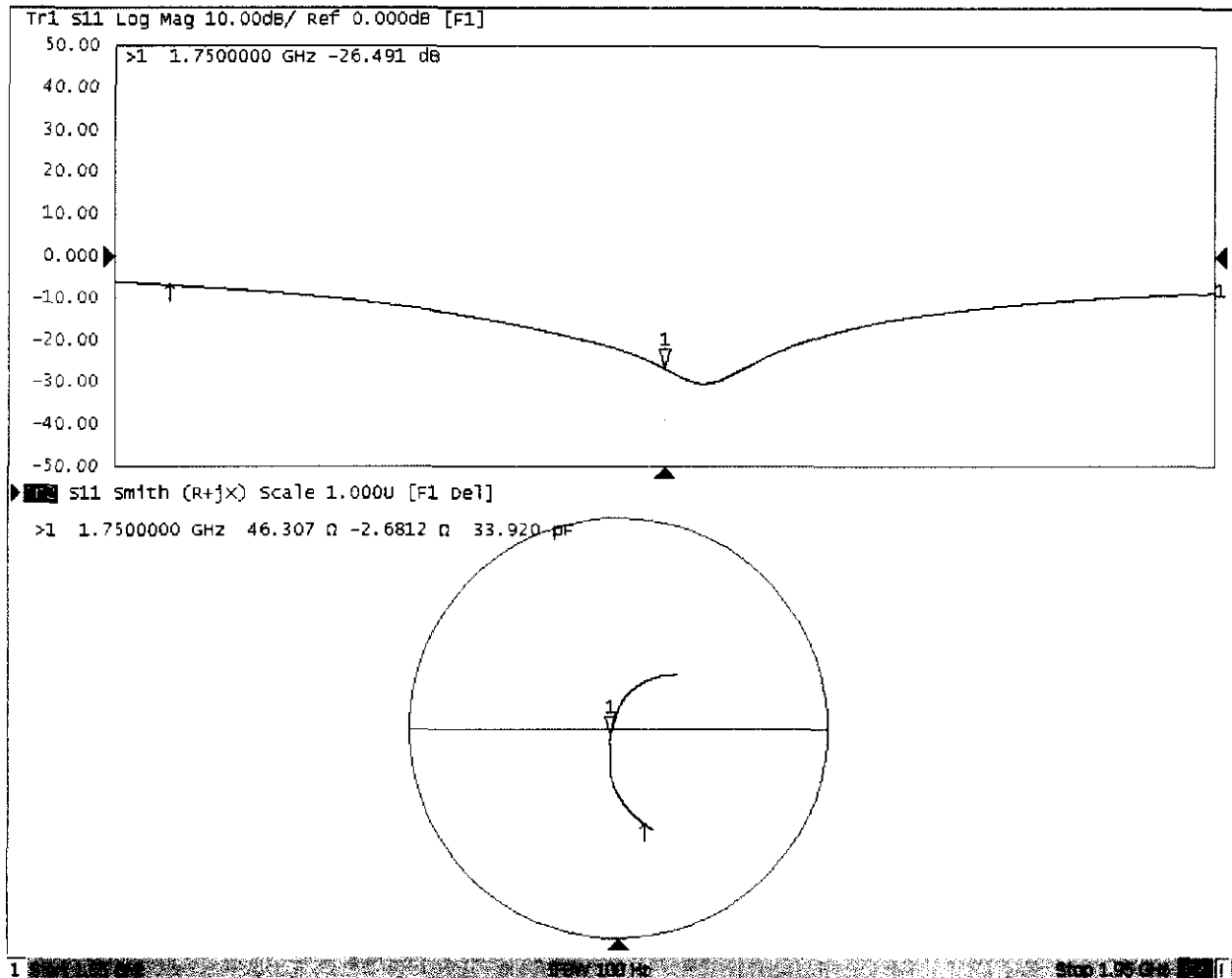


0 dB = 14.6 W/kg = 11.64 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|--------------|------------------|--------------|
| Asset No. : | E-438 | Model No. : | D1750V2 | Serial No. : | 1101 |
| Environmental | 22.9°C, 51 % | Original Cal. Date : | June 7, 2018 | Next Cal. Date : | June 7, 2021 |

Standard List

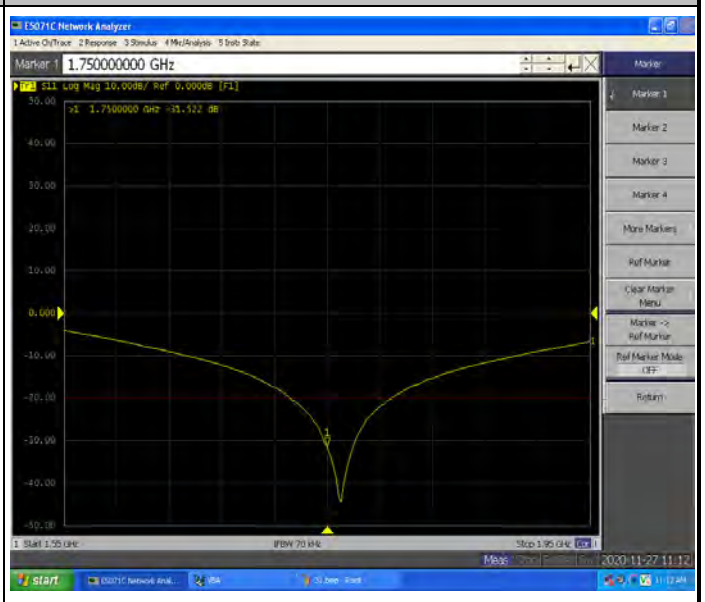
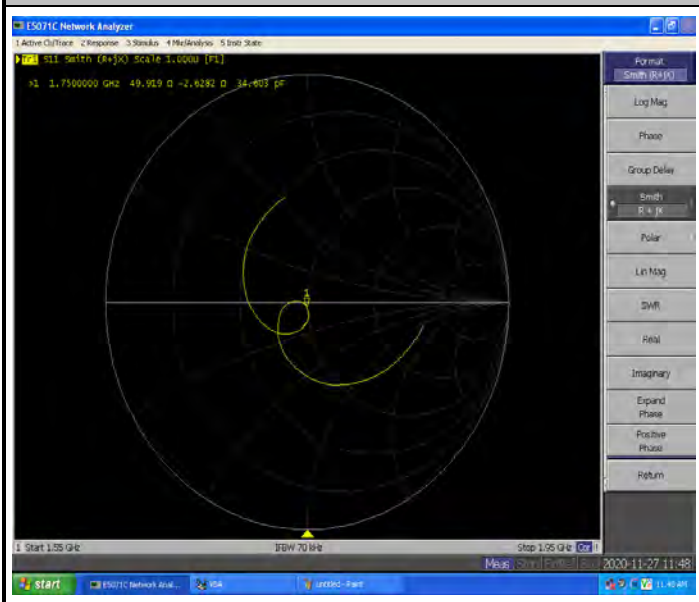
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organization : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|--------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | N/A | March 10, 2020 |
| DC Source metter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A056010-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Thermometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

| Model No | For Head Tissue | | | | |
|----------|--------------------------------------|----------------------|------------------------|-----------|--------|
| | Item | Original Cal. Result | Verified on 2020/11/27 | Deviation | Result |
| D1750V2 | Impedance, transformed to feed point | 49.8Ω-2.69jΩ | 49.9Ω-2.63jΩ | <5Ω | Pass |
| | Return Loss(dB) | -31.4 | -31.522 | 0.4% | Pass |
| | SAR Value for 1g(mW/g) | 9.04 | 9.47 | 4.8% | Pass |
| | SAR Value for 10g(mW/g) | 4.9 | 5.08 | 3.7% | Pass |

| Impedance Test-Head | Return Loss-Head |
|---------------------|------------------|
|---------------------|------------------|



Validation Report for Head TSL

Test Laboratory: BTL Inc.

Date: 2020/11/27

System Check_H1750_1127

DUT: Dipole 1750 MHz D1750V2; SN:1101;

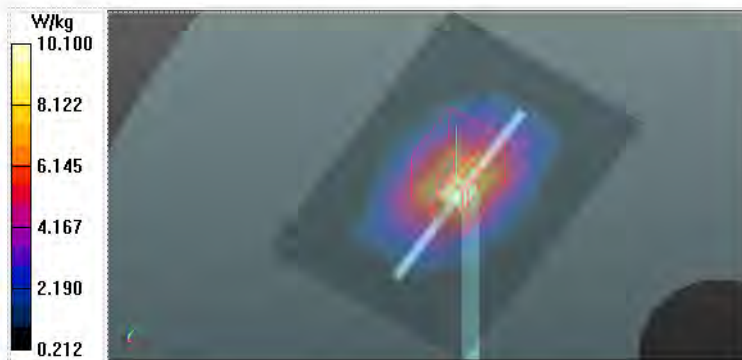
Communication System: UID 0, CW (0); Frequency: 1750 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1750$ MHz; $\sigma = 1.386$ S/m; $\epsilon_r = 39.696$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(8.56, 8.56, 8.56) @ 1750 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x8x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 9.70 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 93.83 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 17.1 W/kg
SAR(1 g) = 9.47 W/kg; SAR(10 g) = 5.08 W/kg
Maximum value of SAR (measured) = 10.1 W/kg



Calibrator:

Seven Lu

Approver:

Herbert Lin



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Client **BTL Inc .**

Certificate No: **Z21-60220**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1101**

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

Calibration date: **June 1, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 26-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 6, 2021

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1750 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.1 | 1.37 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 40.5 ± 6 % | 1.36 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 9.04 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 36.4 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 4.69 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 18.9 W/kg ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 47.8Ω- 2.01jΩ |
| Return Loss | - 30.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.124 ns |
|----------------------------------|----------|

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

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

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.01.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1101

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.358$ S/m; $\epsilon_r = 40.5$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(8.22, 8.22, 8.22) @ 1750 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 93.22 V/m; Power Drift = -0.04 dB

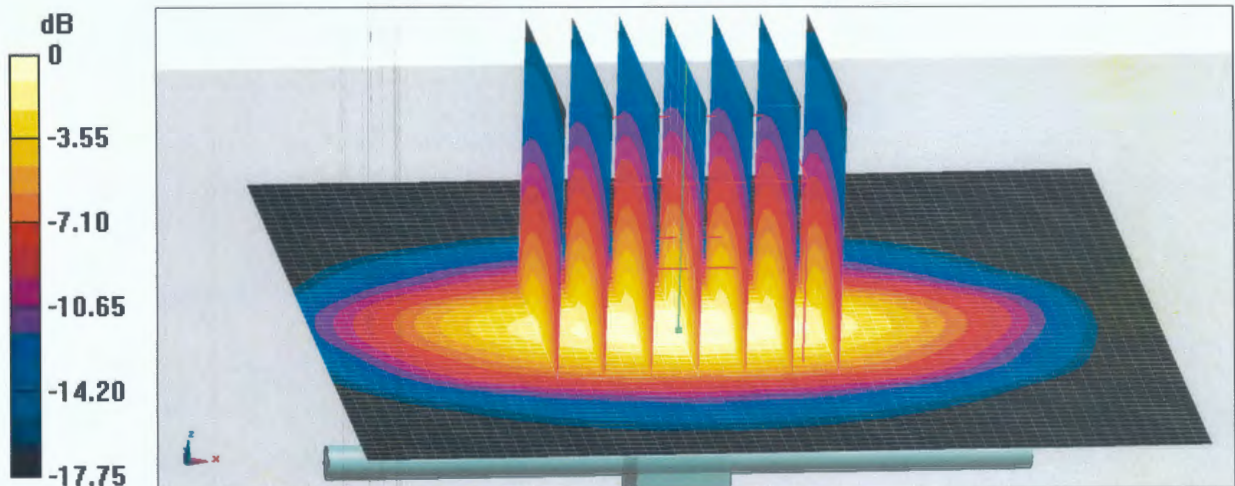
Peak SAR (extrapolated) = 17.6 W/kg

SAR(1 g) = 9.04 W/kg; SAR(10 g) = 4.69 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 51.3%

Maximum value of SAR (measured) = 14.5 W/kg

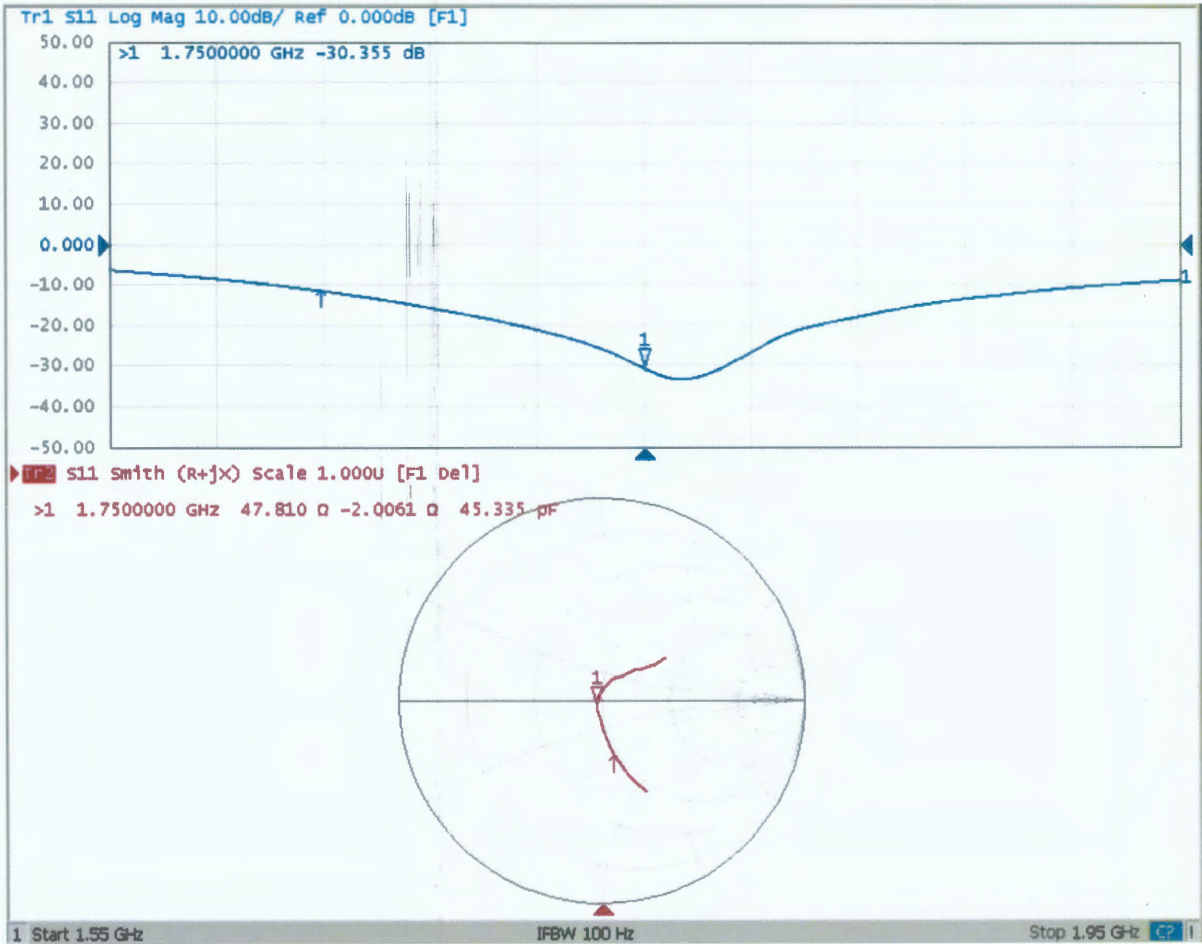


0 dB = 14.5 W/kg = 11.61 dBW/kg



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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60180**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d179**

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

Calibration date: **June 7, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRV-Z5 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Reference Probe EX3DV4 | SN 7464 | 12-Sep-17(SPEAG,No.EX3-7464_Sep17) | Sep-18 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| NetworkAnalyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 11, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1900 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.0 | 1.40 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 41.2 ± 6 % | 1.44 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Head TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 9.96 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 39.5 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 5.21 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 20.7 mW / g ± 18.7 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 53.3 | 1.52 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 51.8 ± 6 % | 1.57 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Body TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 10.2 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 39.8 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 5.29 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.8 mW / g ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 50.9Ω+ 3.19jΩ |
| Return Loss | - 29.7dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 47.2Ω+ 3.99jΩ |
| Return Loss | - 26.0dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.065 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.06.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d179

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.438$ S/m; $\epsilon_r = 41.15$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.39, 8.39, 8.39) @ 1900 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

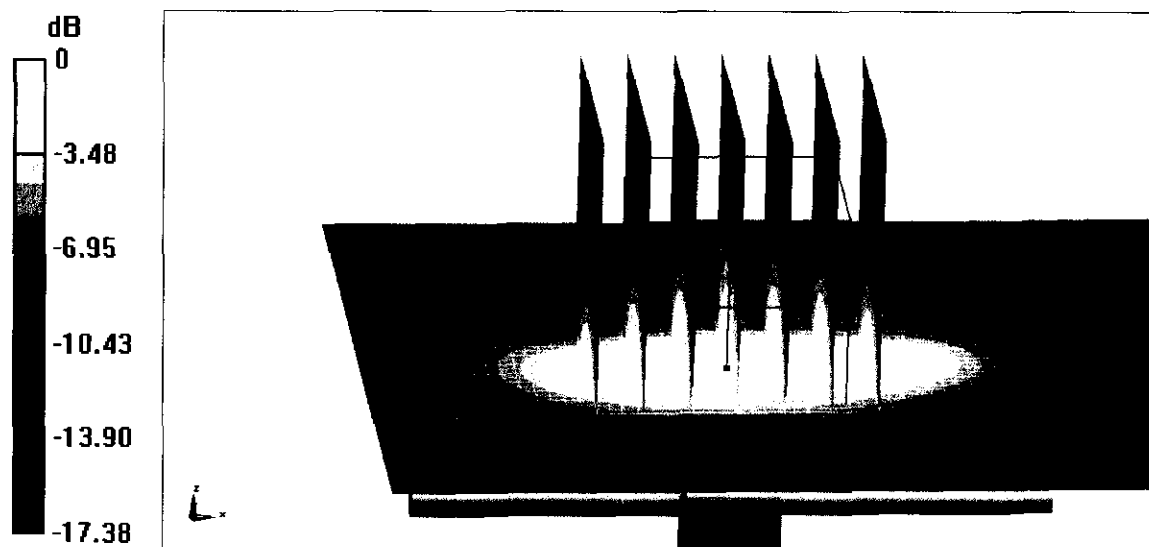
$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 95.41 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 18.8 W/kg

SAR(1 g) = 9.96 W/kg; SAR(10 g) = 5.21 W/kg

Maximum value of SAR (measured) = 15.5 W/kg

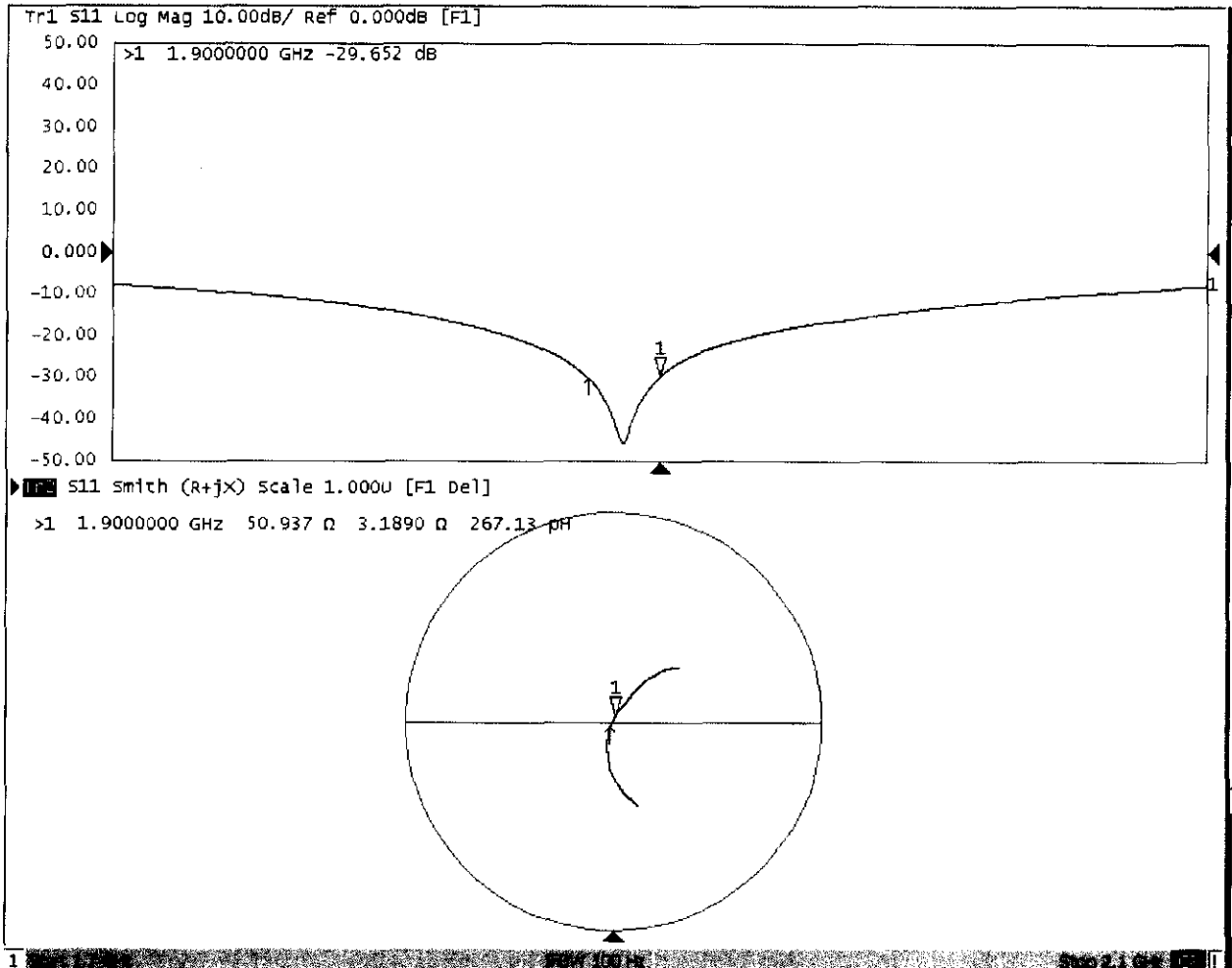


0 dB = 15.5 W/kg = 11.90 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.06.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d179

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.565$ S/m; $\epsilon_r = 51.75$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.32, 8.32, 8.32) @ 1900 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439))

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

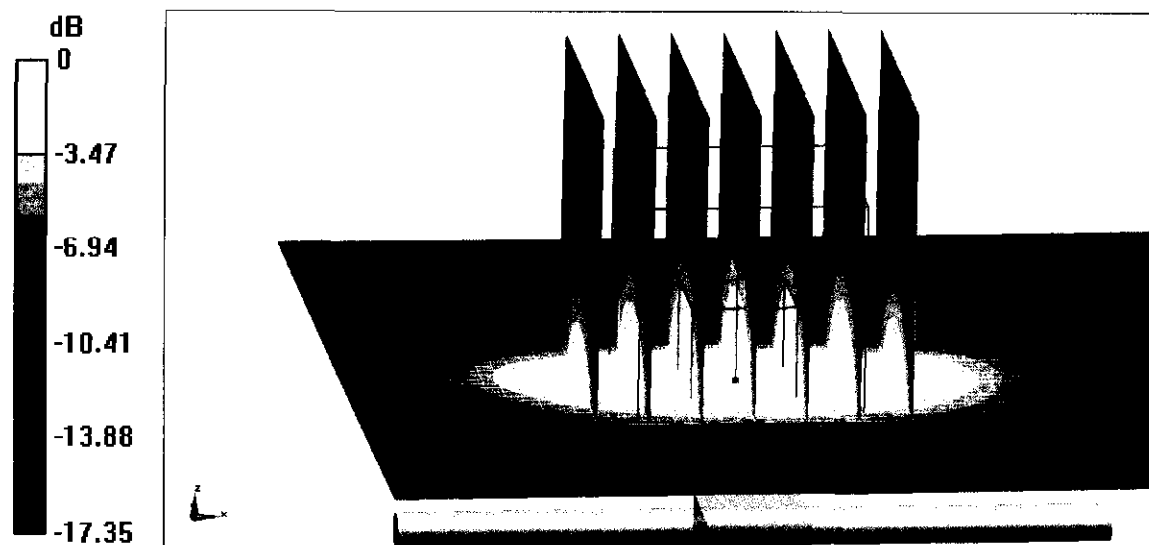
$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 87.58 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 19.1 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.29 W/kg

Maximum value of SAR (measured) = 15.9 W/kg

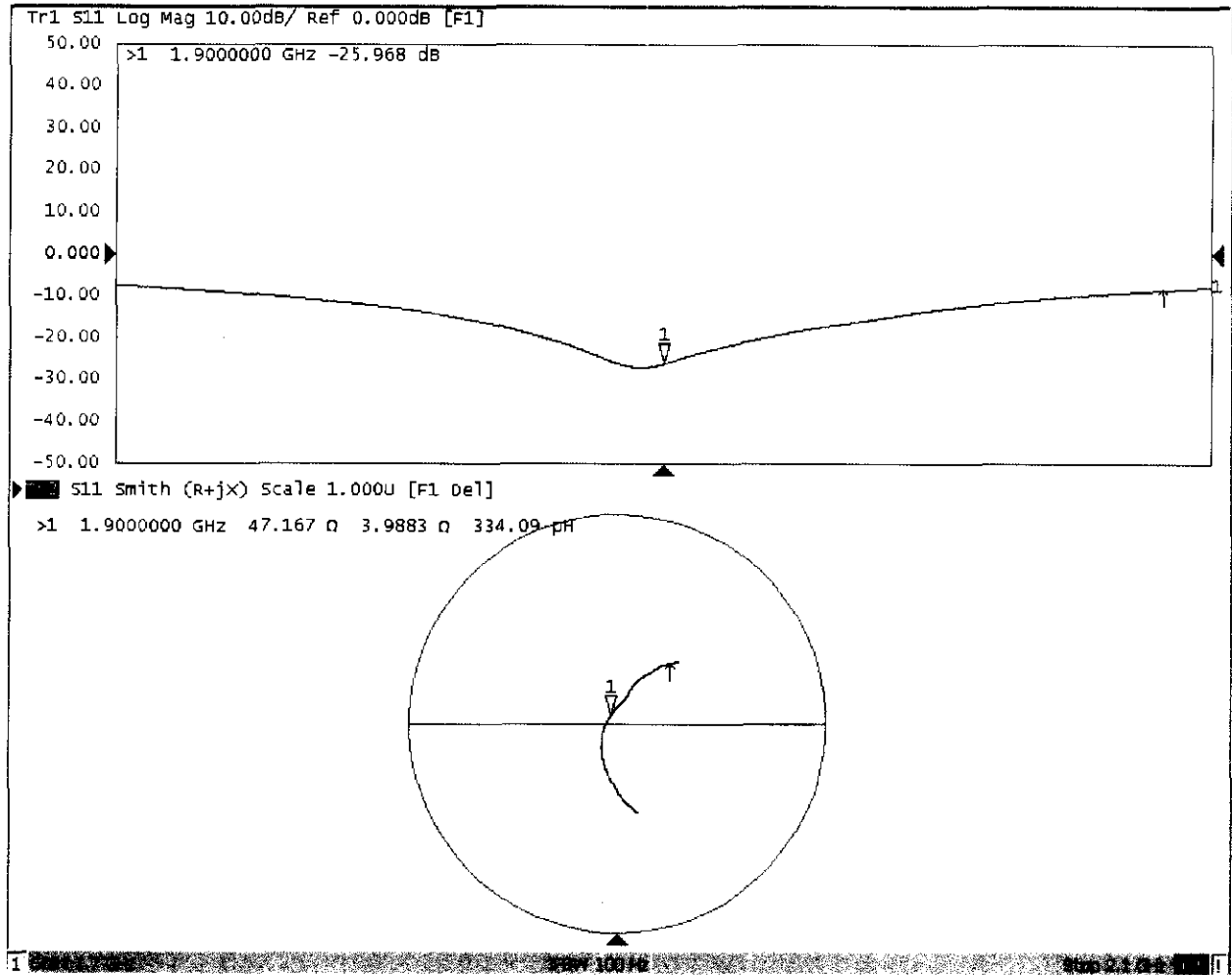


0 dB = 15.9 W/kg = 12.01 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|--------------|------------------|--------------|
| Asset No. : | E-431 | Model No. : | D1900V2 | Serial No. : | 5d179 |
| Environmental | 23.1°C, 52 % | Original Cal. Date : | June 7, 2018 | Next Cal. Date : | June 7, 2021 |

Standard List

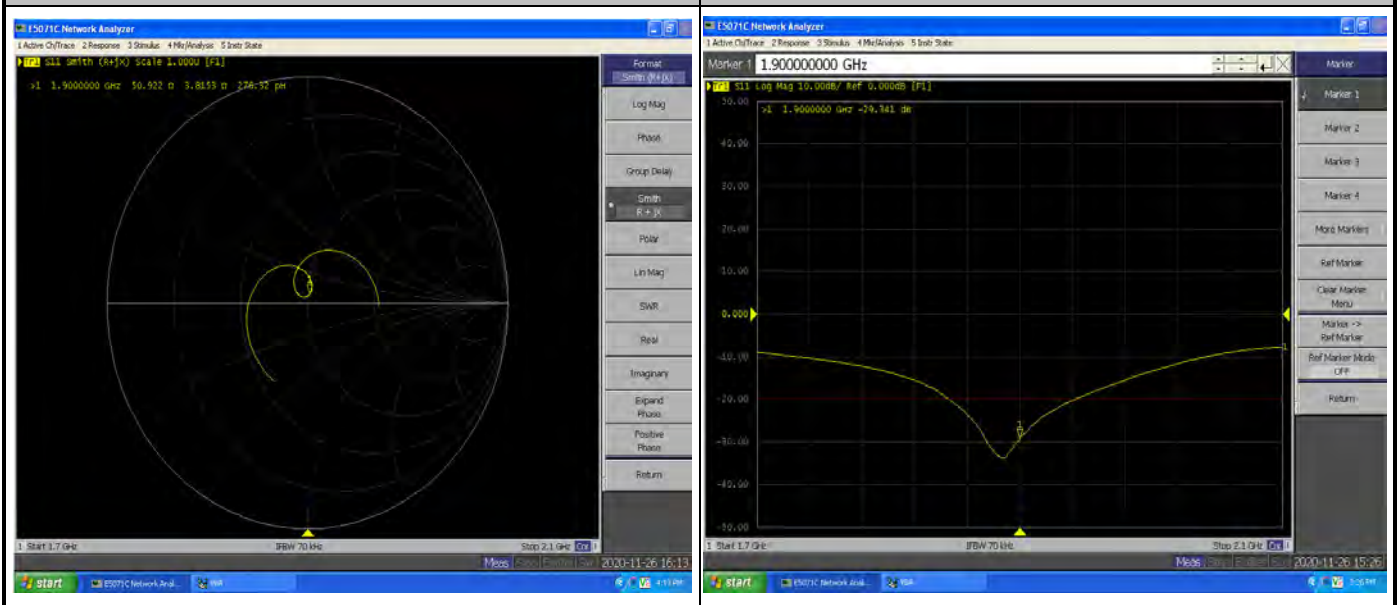
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organization : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|--------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | N/A | March 10, 2020 |
| DC Source metter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A05601O-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Themometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

| Model No | For Head Tissue | | | | |
|----------|--------------------------------------|----------------------|------------------------|-----------|--------|
| | Item | Original Cal. Result | Verified on 2020/11/26 | Deviation | Result |
| D1900V2 | Impedance, transformed to feed point | 50.9Ω+3.19jΩ | 50.9Ω+3.82jΩ | <5Ω | Pass |
| | Return Loss(dB) | -29.7 | -29.341 | -1.2% | Pass |
| | SAR Value for 1g(mW/g) | 9.96 | 9.74 | -2.2% | Pass |
| | SAR Value for 10g(mW/g) | 5.21 | 5.16 | -1.0% | Pass |

| Impedance Test-Head | Return Loss-Head |
|---------------------|------------------|
|---------------------|------------------|



Test Laboratory: BTL Inc.

Date: 2020/11/26

System Check_H1900_1126

DUT: Dipole 1900 MHz D1900V2;SN:5d179;

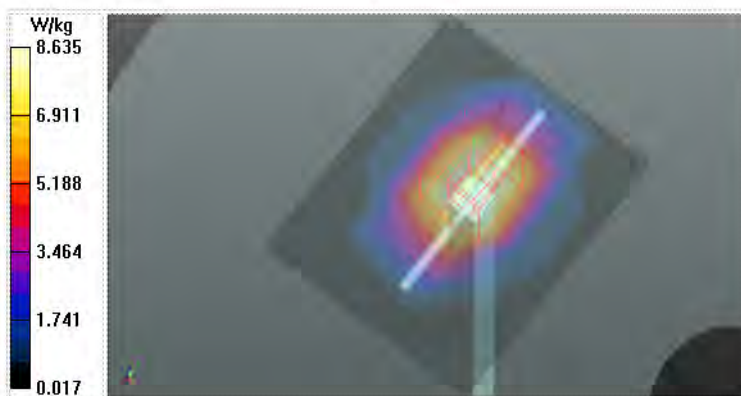
Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.333$ S/m; $\epsilon_r = 39.836$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(8.22, 8.22, 8.22) @ 1900 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x7x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 8.63 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 97.59 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 17.3 W/kg
SAR(1 g) = 9.74 W/kg; SAR(10 g) = 5.16 W/kg
Maximum value of SAR (measured) = 12.3 W/kg



Calibrator:

Seven Lu

Approver:

Herbert Lin



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Client **BTL Inc .**

Certificate No: **Z21-60221**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d179**

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

Calibration date: **May 31, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 26-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 6, 2021

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lossary:

| | |
|-------|--|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM _{x,y,z} |
| N/A | not applicable or not measured |

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1900 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.0 | 1.40 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 40.3 ± 6 % | 1.38 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 9.79 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 39.6 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 4.97 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 20.0 W/kg ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 52.8Ω+ 2.66jΩ |
| Return Loss | - 28.4dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.105 ns |
|----------------------------------|----------|

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

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

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 05.31.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d179

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 40.25$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.96, 7.96, 7.96) @ 1900 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 93.89 V/m; Power Drift = -0.09 dB

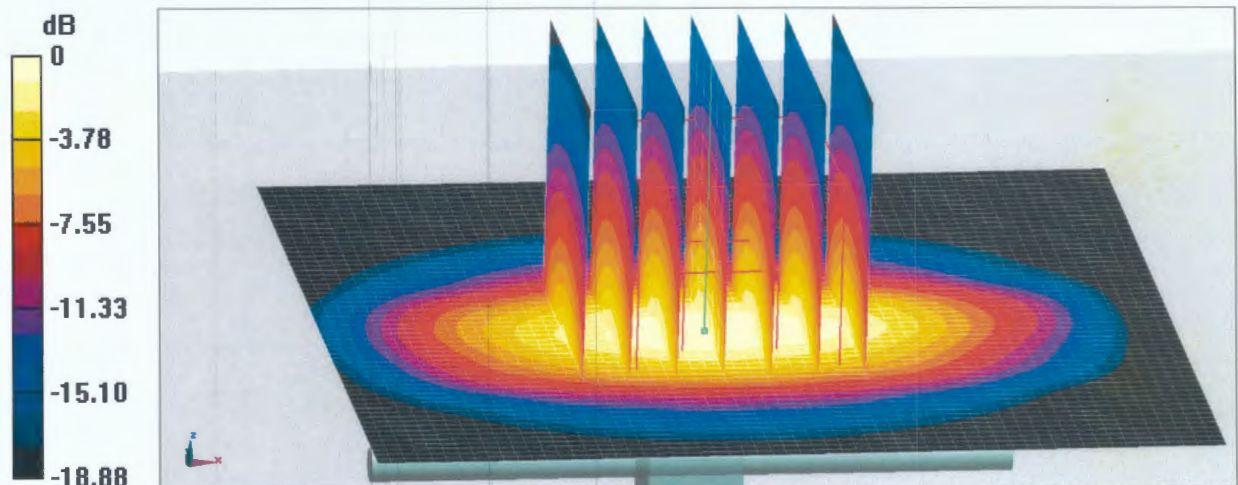
Peak SAR (extrapolated) = 19.3 W/kg

SAR(1 g) = 9.79 W/kg; SAR(10 g) = 4.97 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 50.5%

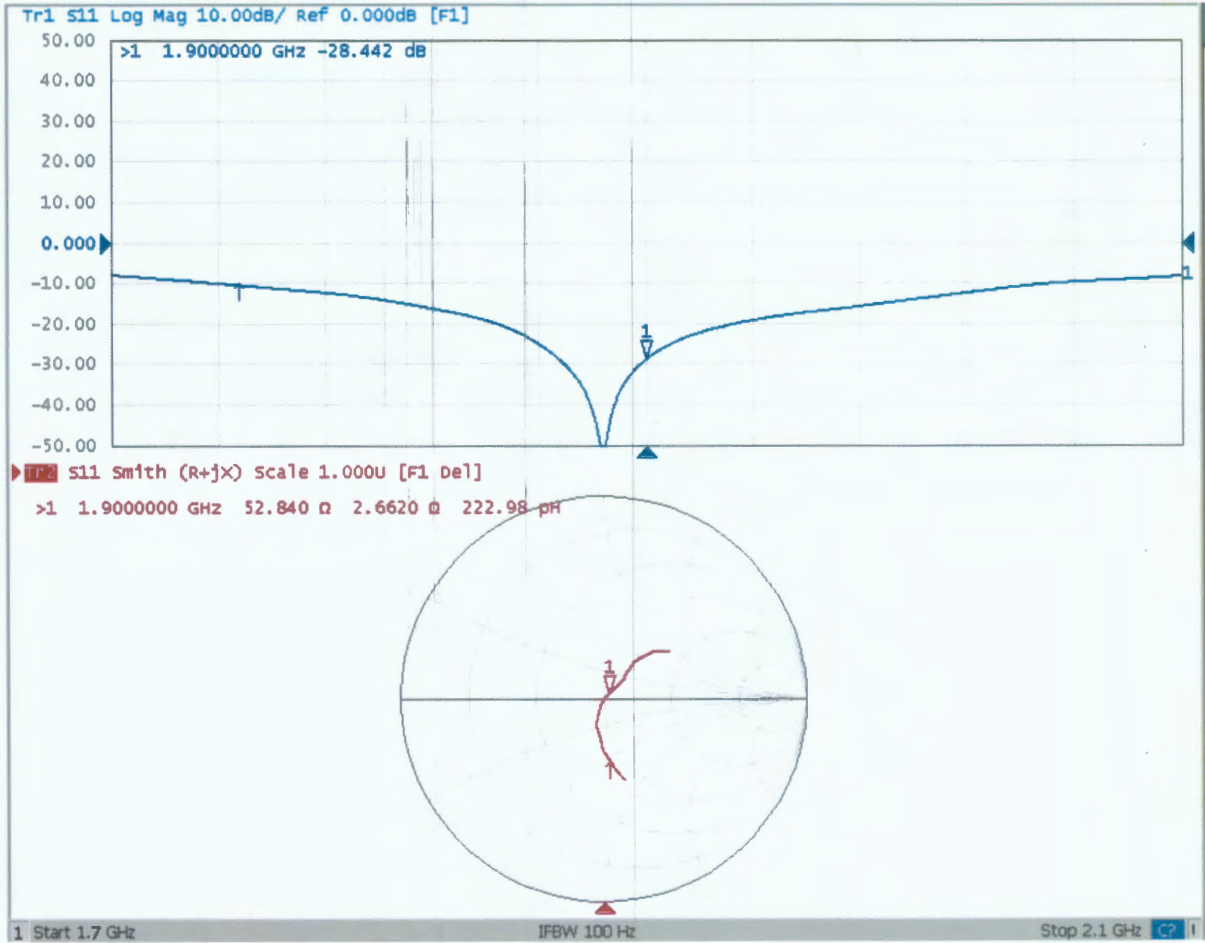
Maximum value of SAR (measured) = 15.7 W/kg





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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60183**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 919**

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

Calibration date: **June 11, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRV-Z5 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Reference Probe EX3DV4 | SN 7464 | 12-Sep-17(SPEAG,No.EX3-7464_Sep17) | Sep-18 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| NetworkAnalyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 13, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 40.4 ± 6 % | 1.85 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Head TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 13.1 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 52.1 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 6.17 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.6 mW / g ± 18.7 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.7 | 1.95 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 54.1 ± 6 % | 1.98 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | --- | --- |

SAR result with Body TSL

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 12.7 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 50.8 mW / g ± 18.8 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 5.93 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 23.7 mW / g ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.0Ω+ 2.85jΩ |
| Return Loss | - 27.9dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 49.9Ω+ 4.74jΩ |
| Return Loss | - 26.5dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.022 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.11.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 919

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 40.36$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(7.89, 7.89, 7.89) @ 2450 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

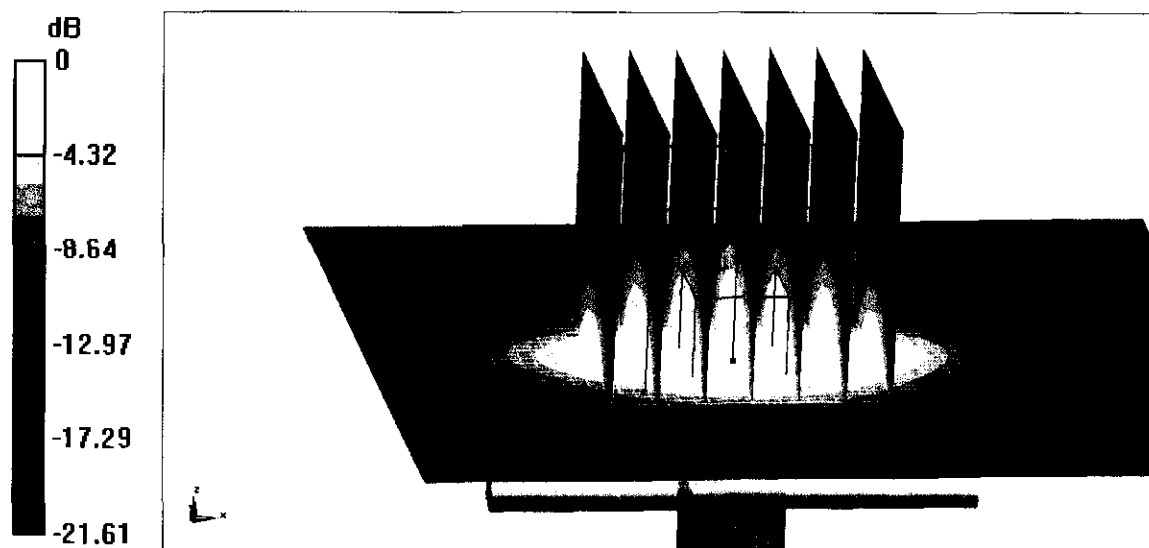
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.2 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.17 W/kg

Maximum value of SAR (measured) = 22.0 W/kg



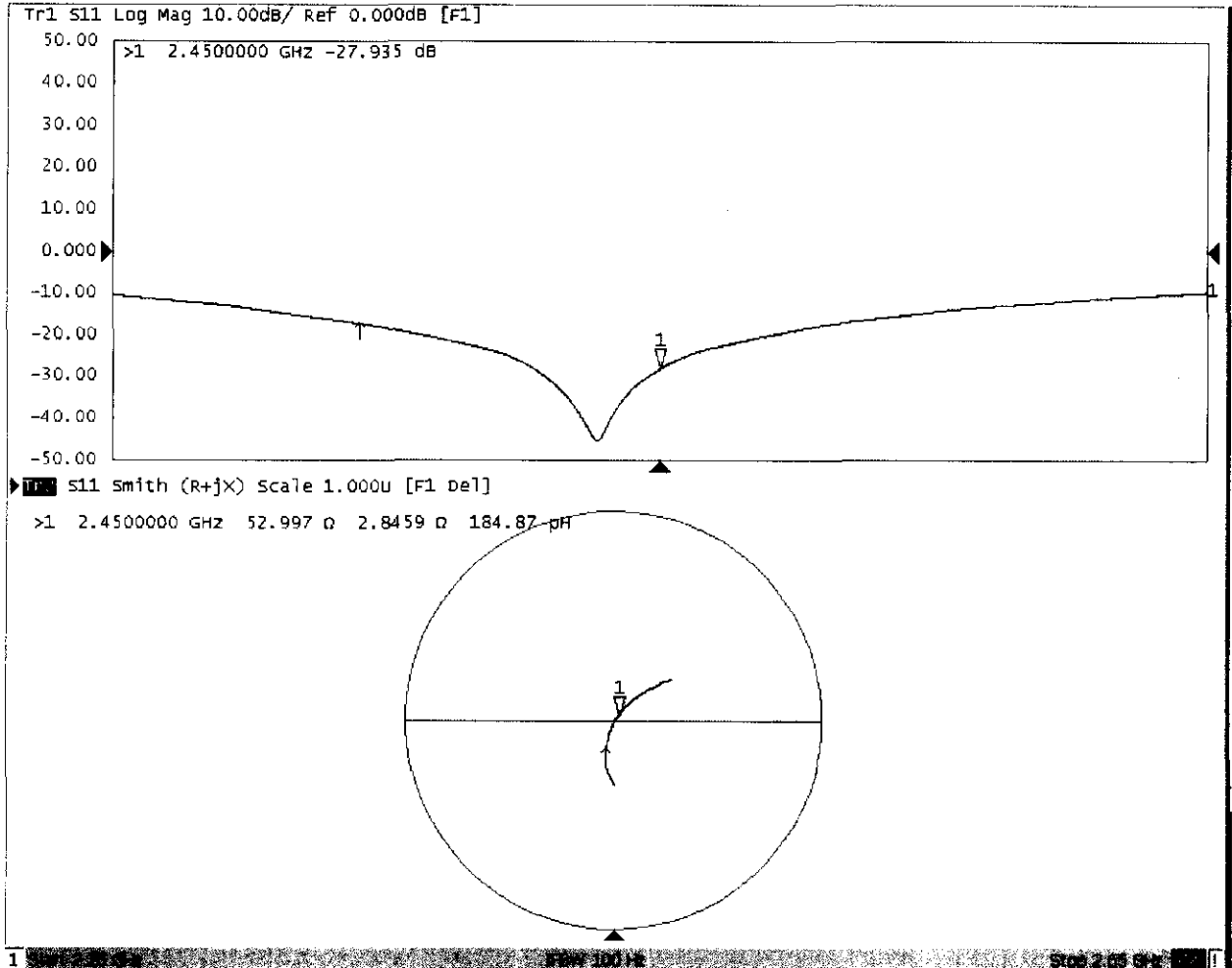
0 dB = 22.0 W/kg = 13.42 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.08.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 919

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.977$ S/m; $\epsilon_r = 54.12$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.09, 8.09, 8.09) @ 2450 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

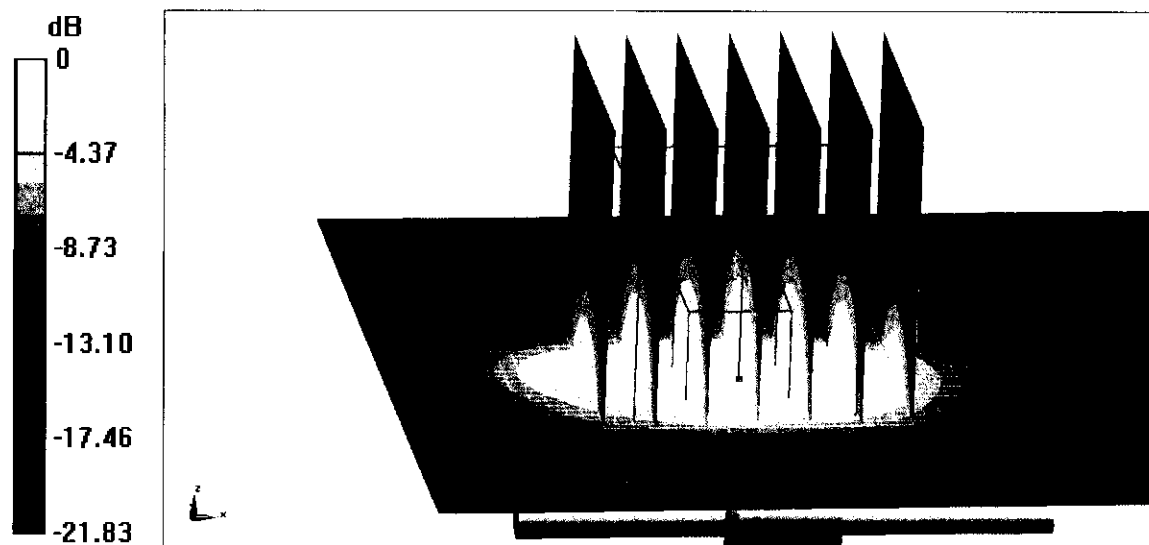
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 81.30 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 26.0 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.93 W/kg

Maximum value of SAR (measured) = 20.8 W/kg



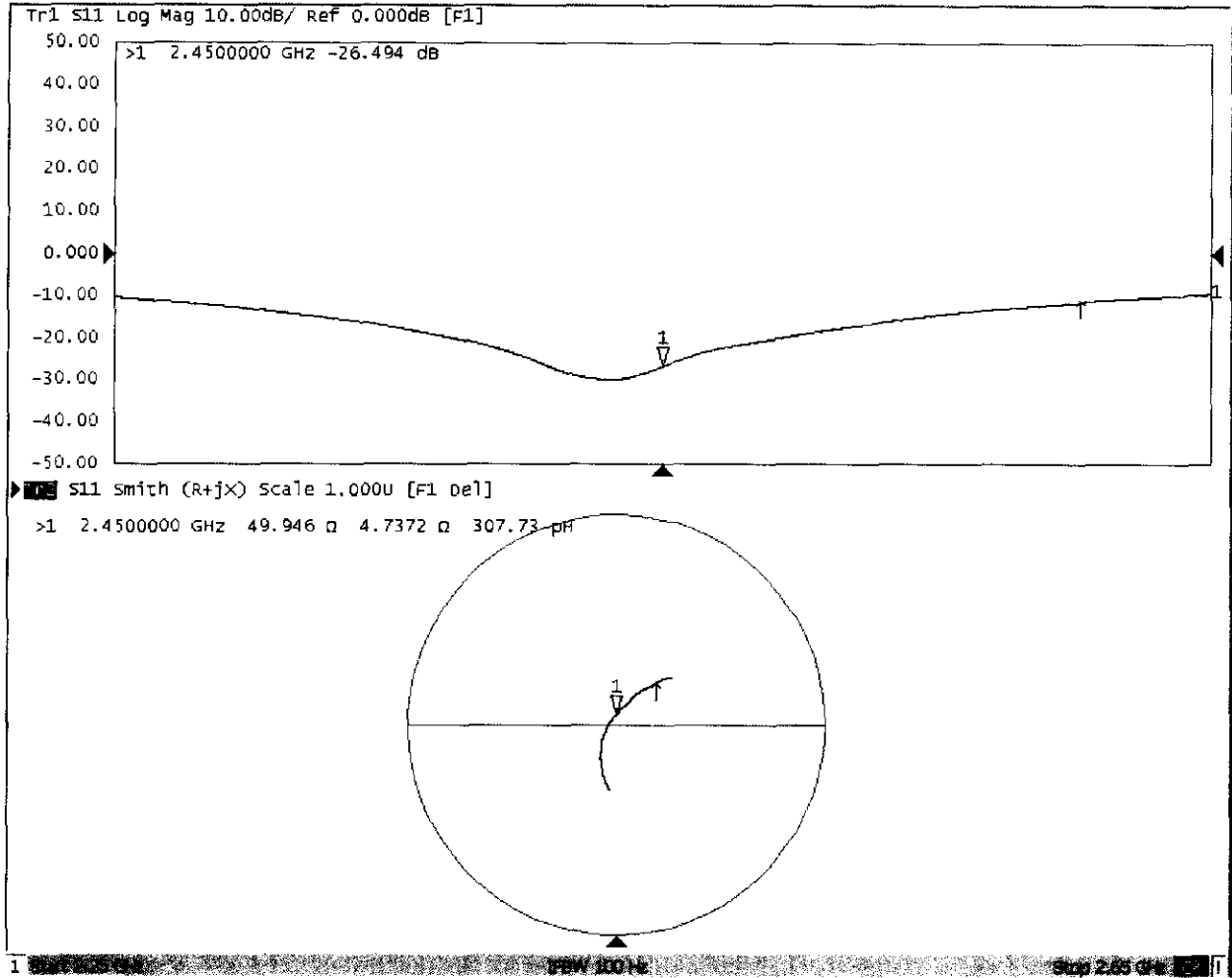
0 dB = 20.8 W/kg = 13.18 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|---------------|------------------|---------------|
| Asset No. : | E-434 | Model No. : | D2450V2 | Serial No. : | 919 |
| Environmental | 22.9°C, 52 % | Original Cal. Date : | June 11, 2018 | Next Cal. Date : | June 11, 2021 |

Standard List

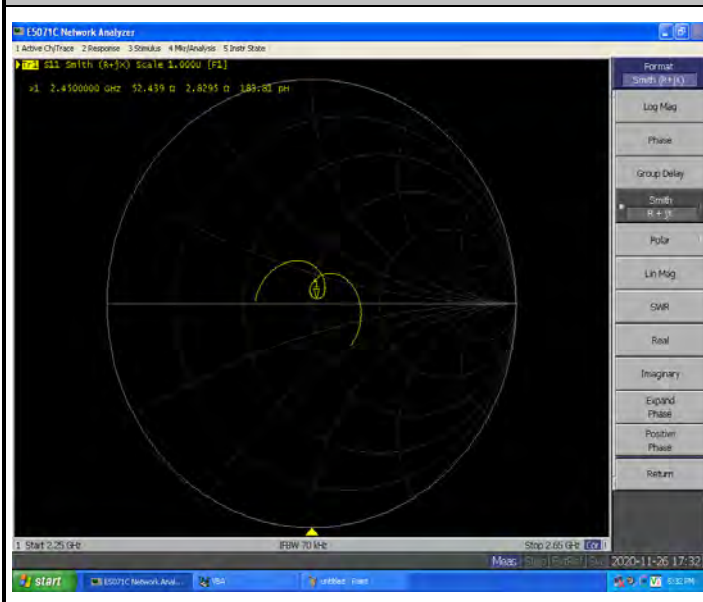
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

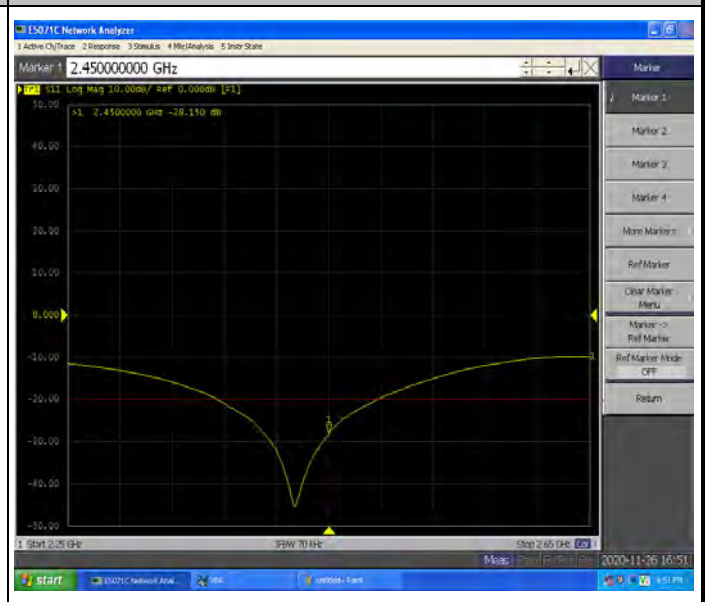
| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organization : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|--------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | N/A | March 10, 2020 |
| DC Source metter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A05601O-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Thermometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

| Model No | For Head Tissue | | | | |
|----------|--------------------------------------|----------------------|------------------------|-----------|--------|
| | Item | Original Cal. Result | Verified on 2020/11/26 | Deviation | Result |
| D2450V2 | Impedance, transformed to feed point | 53Ω+2.85jΩ | 52.4Ω+2.83jΩ | <5Ω | Pass |
| | Return Loss(dB) | -27.9 | -28.15 | 0.9% | Pass |
| | SAR Value for 1g(mW/g) | 13.1 | 13.6 | 3.8% | Pass |
| | SAR Value for 10g(mW/g) | 6.17 | 6.18 | 0.2% | Pass |

Impedance Test-Head



Return Loss-Head



Test Laboratory: BTL Inc.

Date: 2020/11/26

System Check_H2450_1126**DUT: Dipole 2450 MHz D2450V2; SN:919;**

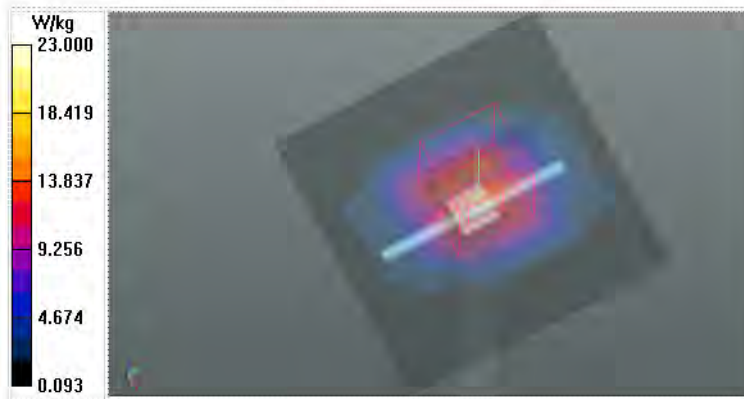
Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2450$ MHz; $\sigma = 1.82$ S/m; $\epsilon_r = 38.48$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(7.56, 7.56, 7.56) @ 2450 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 14.1 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 116.6 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 28.3 W/kg
SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.18 W/kg
Maximum value of SAR (measured) = 23.0 W/kg

Calibrator: *Seven Lu*Approver: *Herbert Liu*



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Client **BTL Inc.**

Certificate No: **Z21-60224**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 919**

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

Calibration date: **May 28, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 6-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 8-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 2, 2021

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 38.8 ± 6 % | 1.81 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 13.1 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 52.1 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 5.95 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.7 W/kg ± 18.7 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 55.6Ω+ 2.17jΩ |
| Return Loss | - 24.8dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.070 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 05.28.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 919

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ S/m; $\epsilon_r = 38.82$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.45, 7.45, 7.45) @ 2450 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.10 V/m; Power Drift = -0.09 dB

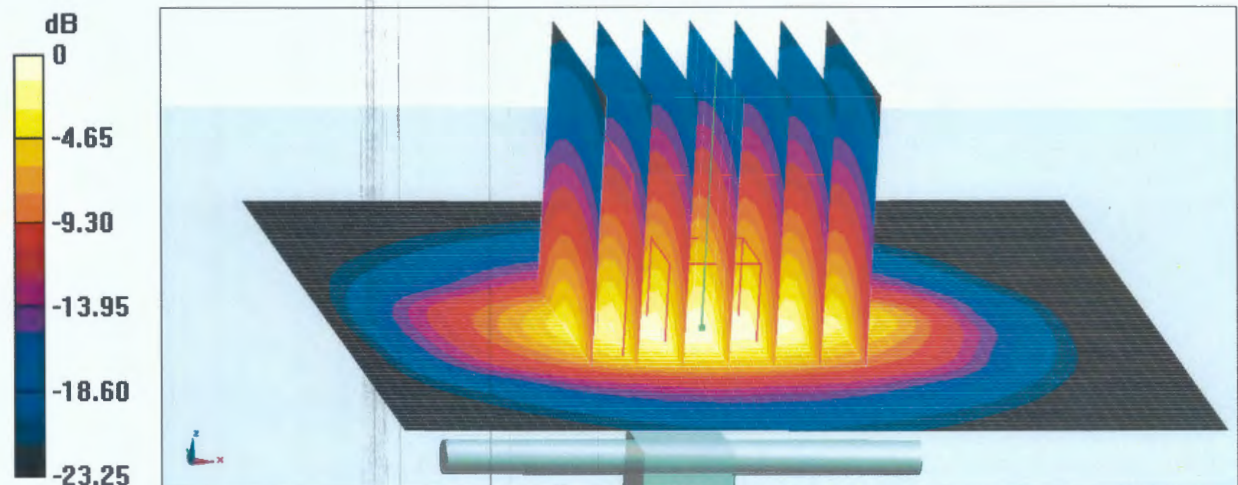
Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 5.95 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 45.9%

Maximum value of SAR (measured) = 22.6 W/kg



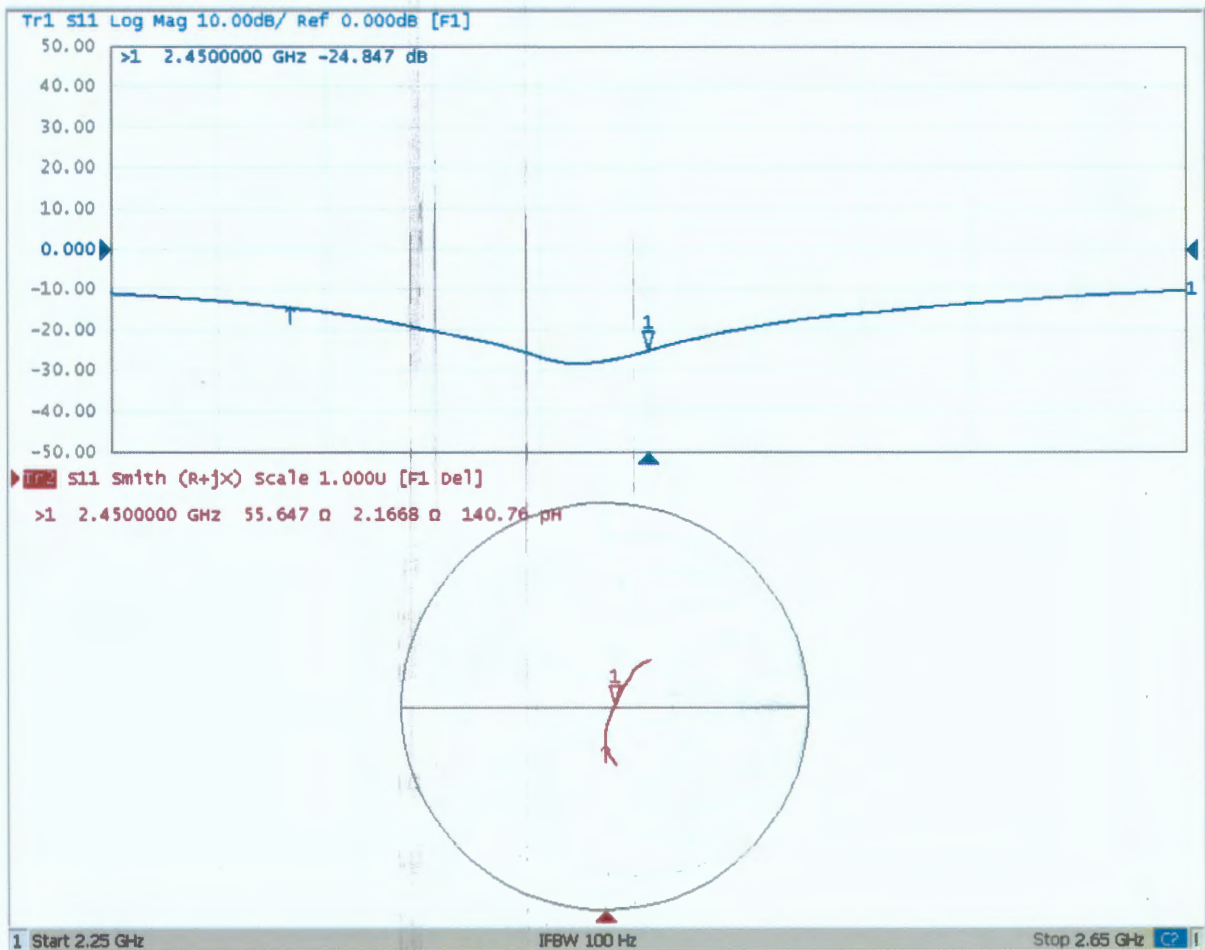
0 dB = 22.6 W/kg = 13.54 dBW/kg



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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60184**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN: 1067**

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

Calibration date: **June 11, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRV-Z5 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Reference Probe EX3DV4 | SN 7464 | 12-Sep-17(SPEAG,No.EX3-7464_Sep17) | Sep-18 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| Network Analyzer E5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 13, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2600 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.0 | 1.96 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 39.9 \pm 6 % | 2.01 mho/m \pm 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|--|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 14.1 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 56.1 mW / g \pm 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 6.33 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.3 mW / g \pm 18.7 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.5 | 2.16 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 54.0 \pm 6 % | 2.16 mho/m \pm 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL

| | | |
|---|--------------------|--|
| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 13.7 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 55.2 mW / g \pm 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 6.11 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.6 mW / g \pm 18.7 % (k=2) |



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Appendix(Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 47.5Ω- 6.92jΩ |
| Return Loss | - 22.5dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 43.8Ω- 5.59jΩ |
| Return Loss | - 21.1dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.012 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.11.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1067

Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.01$ S/m; $\epsilon_r = 39.93$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(7.76, 7.76, 7.76) @ 2600 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

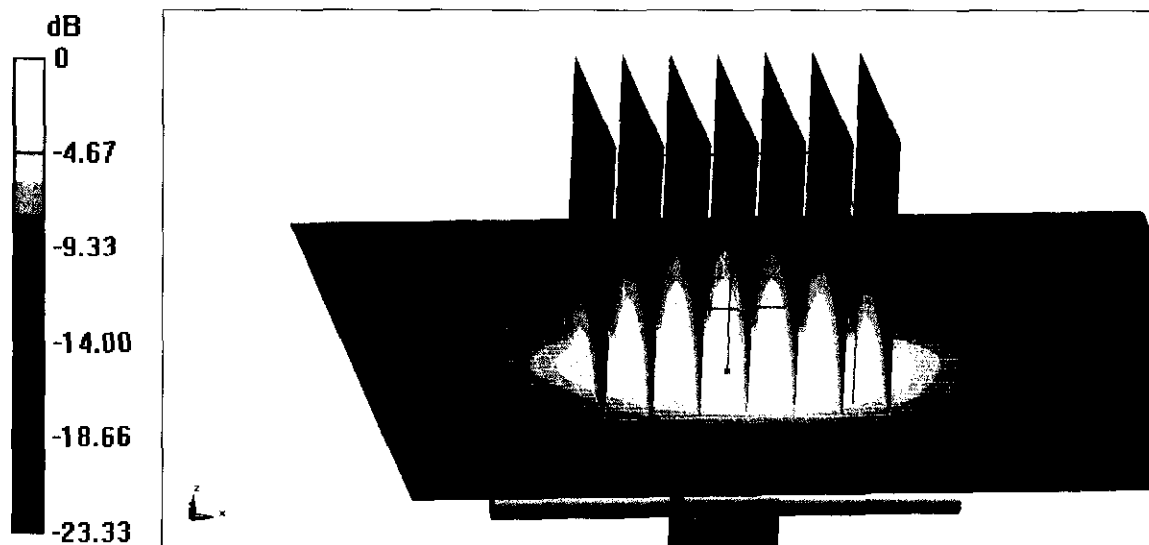
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.20 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.3 W/kg

SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.33 W/kg

Maximum value of SAR (measured) = 24.2 W/kg

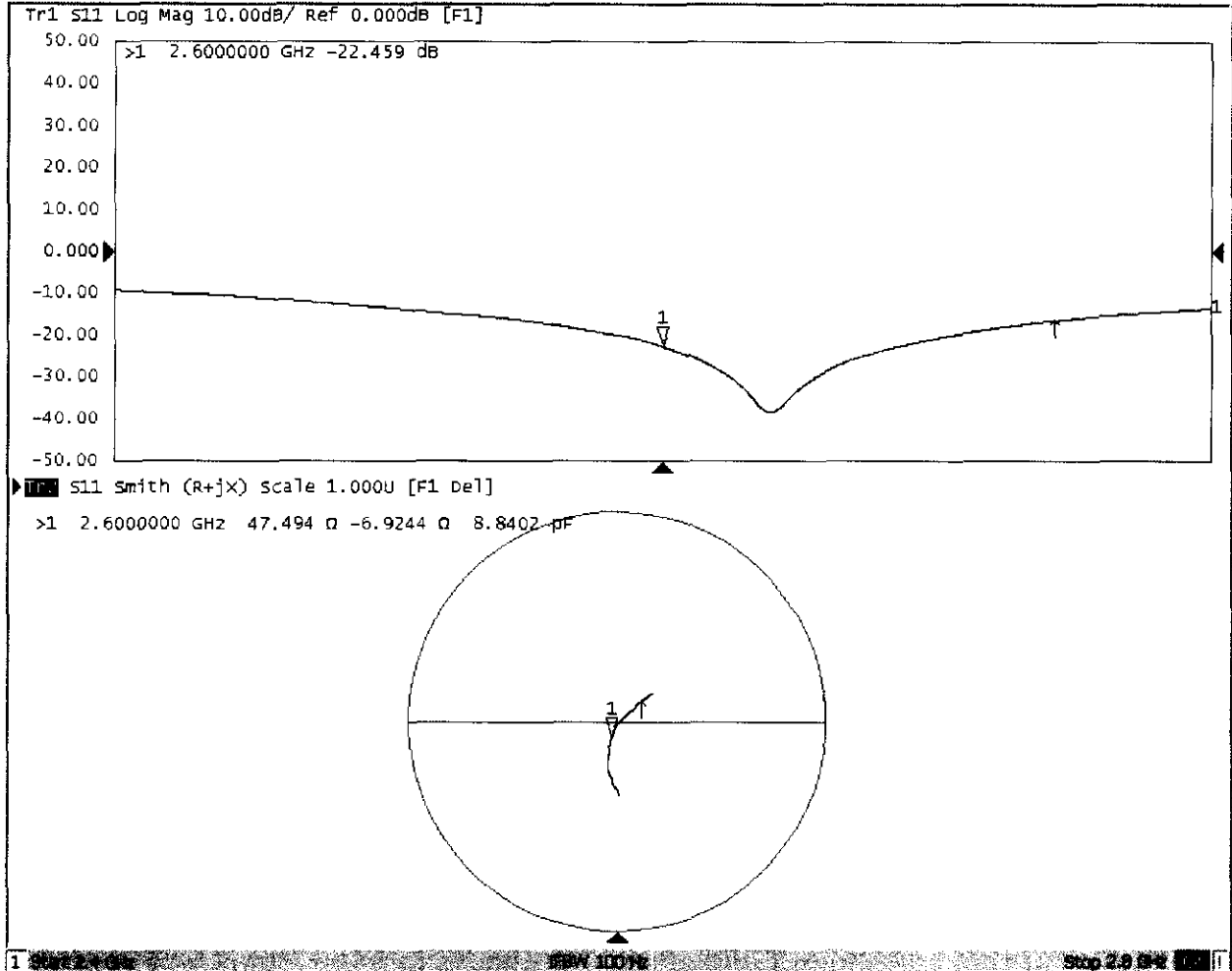


0 dB = 24.2 W/kg = 13.84 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.08.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1067

Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.157$ S/m; $\epsilon_r = 54.01$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

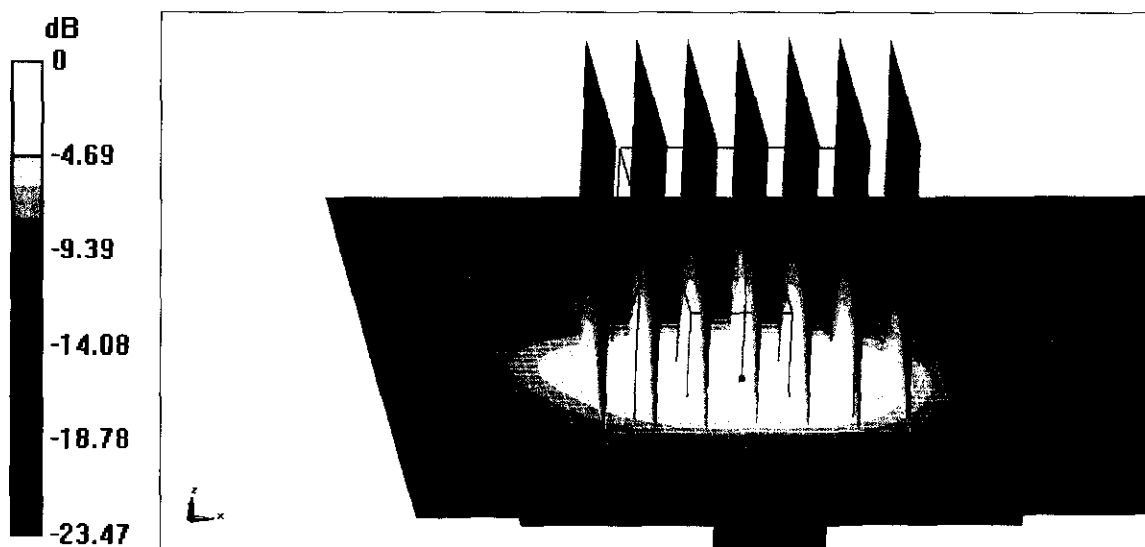
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 78.44 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.11 W/kg

Maximum value of SAR (measured) = 23.5 W/kg



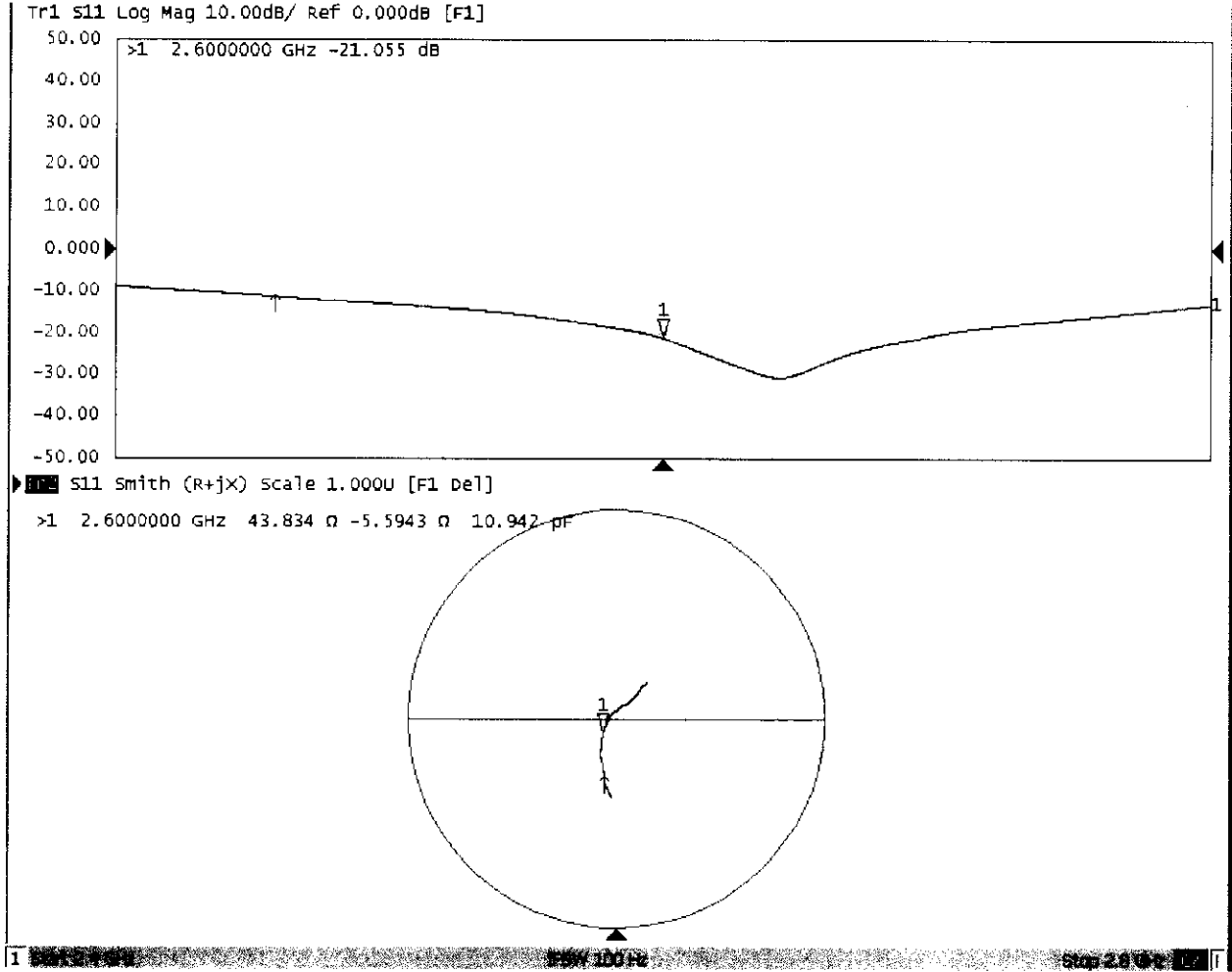
0 dB = 23.5 W/kg = 13.71 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|---------------|------------------|---------------|
| Asset No. : | E-435 | Model No. : | D2600V2 | Serial No. : | 1067 |
| Environmental | 23.1°C, 48 % | Original Cal. Date : | June 11, 2018 | Next Cal. Date : | June 11, 2021 |

Standard List

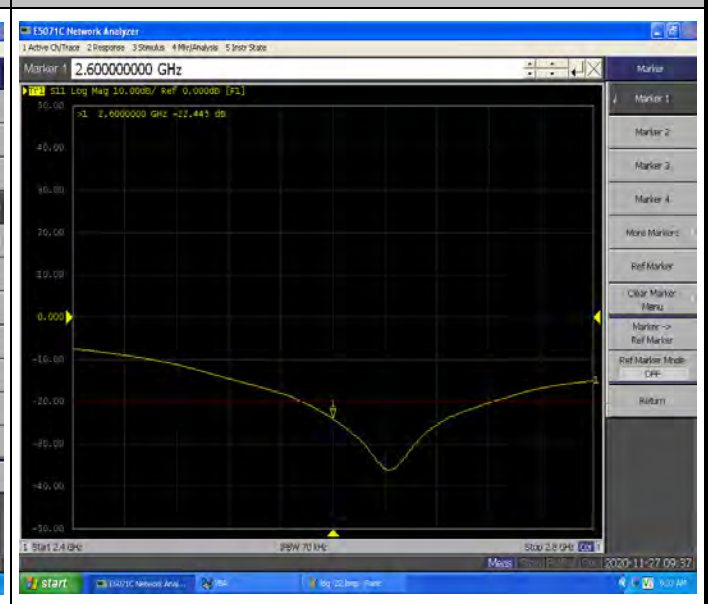
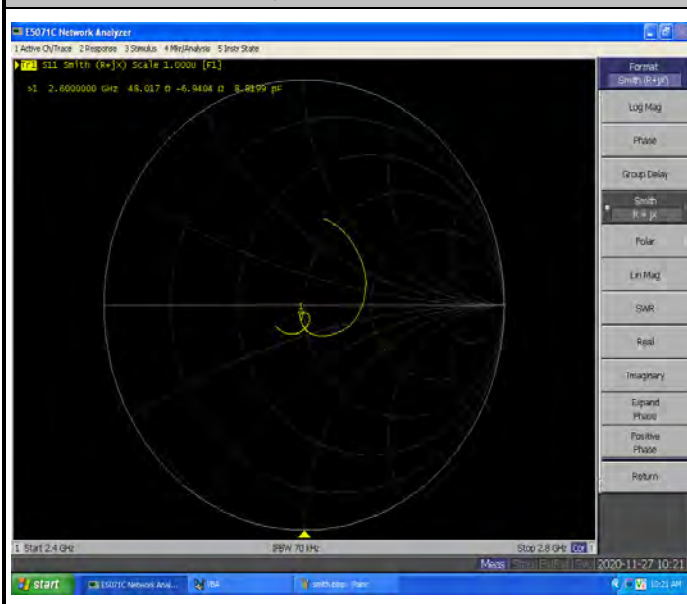
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organizati on : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|---------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | N/A | March 10, 2020 |
| DC Source metter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A05601O-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Themometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

| Model No | For Head Tissue | | | | |
|----------|--------------------------------------|----------------------|------------------------|-----------|--------|
| | Item | Originak Cal. Result | Verified on 2020/11/27 | Deviation | Result |
| D2600V2 | Impedance, transformed to feed point | 47.5Ω-6.92jΩ | 48.0Ω-6.94jΩ | <5Ω | Pass |
| | Return Loss(dB) | -22.5 | -22.445 | -0.2% | Pass |
| | SAR Value for 1g(mW/g) | 14.1 | 13.9 | -1.4% | Pass |
| | SAR Value for 10g(mW/g) | 6.33 | 6.08 | -3.9% | Pass |

| Impedance Test-Head | Return Loss-Head |
|---------------------|------------------|
|---------------------|------------------|



Test Laboratory: BTL, Inc

Date: 2020/11/27

System Check_H2600_1127**DUT: Dipole 2600 MHz D2600V2; SN:1067;**

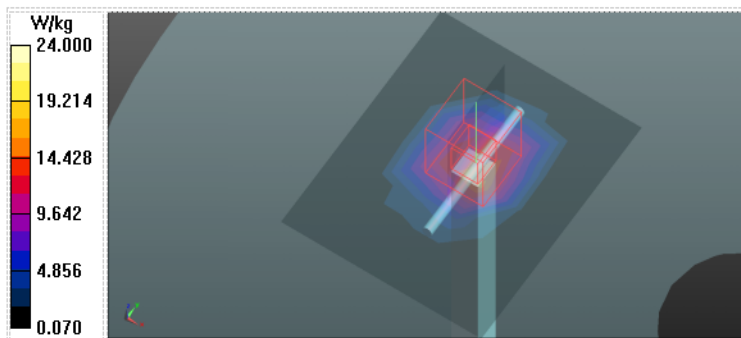
Communication System: UID 0, CW (0); Frequency: 2600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2600$ MHz; $\sigma = 1.915$ S/m; $\epsilon_r = 37.876$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(7.37, 7.37, 7.37) @ 2600 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x7x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 14.9 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
Reference Value = 116.5 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 30.1 W/kg
SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.08 W/kg
Maximum value of SAR (measured) = 24.0 W/kg



Calibrator:

Seven Lu

Approver:

Herbert Liu



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Client **BTL Inc .**

Certificate No: **Z21-60225**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN: 1067**

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

Calibration date: **May 28, 2021**

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Reference Probe EX3DV4 | SN 3846 | 26-Apr-21(CTTL-SPEAG,No.Z21-60084) | Apr-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| Network Analyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 2, 2021

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2600 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.0 | 1.96 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 39.3 ± 6 % | 1.96 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 14.2 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 56.9 W/kg ± 18.8 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 6.22 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.9 W/kg ± 18.7 % (k=2) |



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Appendix(Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 48.9Ω- 6.74jΩ |
| Return Loss | - 23.2dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.057 ns |
|----------------------------------|----------|

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

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

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 05.28.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1067

Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 1.957$ S/m; $\epsilon_r = 39.33$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.3, 7.3, 7.3) @ 2600 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.7 V/m; Power Drift = -0.07 dB

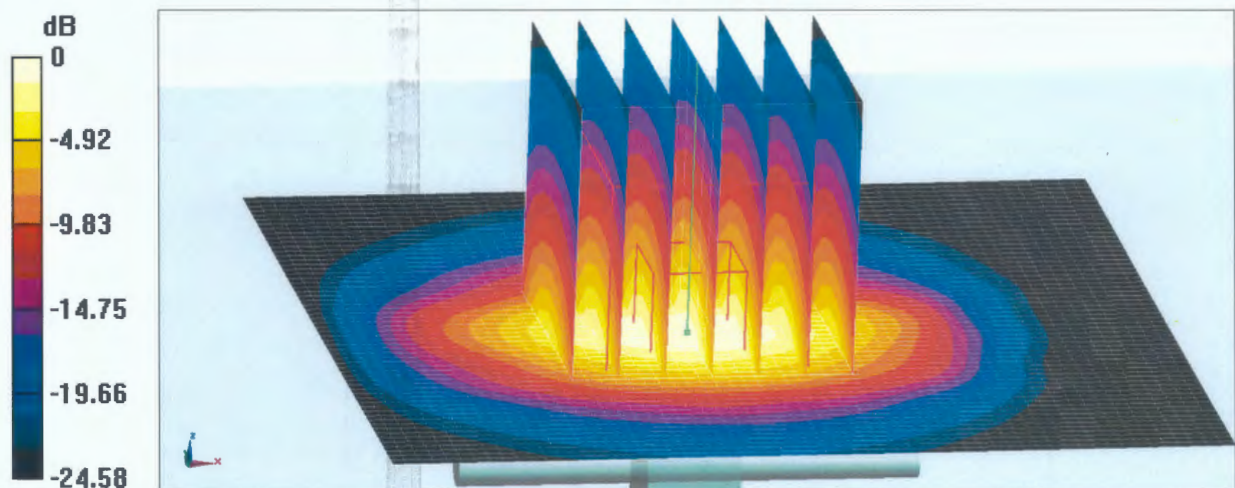
Peak SAR (extrapolated) = 31.6 W/kg

SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.22 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 44.5%

Maximum value of SAR (measured) = 24.7 W/kg

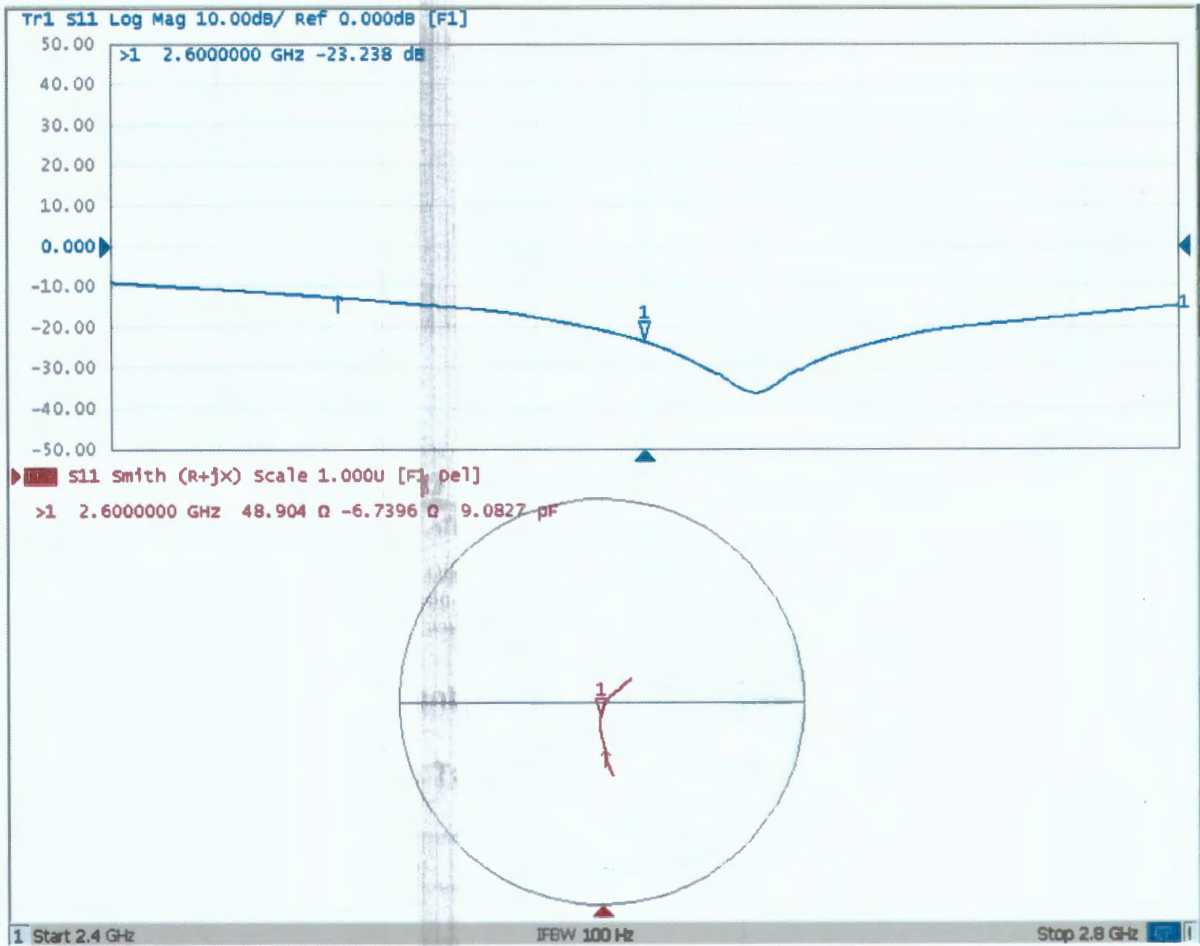


0 dB = 24.7 W/kg = 13.93 dBW/kg



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Impedance Measurement Plot for Head TSL





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Client **BTL Inc .**

Certificate No: **Z18-60185**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1160**

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

Calibration date: **June 20, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-----------------------|---------|--|-----------------------|
| Power Meter NRP2 | 102083 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| Power sensor NRP-Z91 | 100542 | 01-Nov-17 (CTTL, No.J17X08756) | Oct-18 |
| ReferenceProbe EX3DV4 | SN 3846 | 25-Jan-18(SPEAG,No.EX3-3846_Jan18) | Jan-19 |
| DAE4 | SN 1525 | 02-Oct-17(SPEAG,No.DAE4-1525_Oct17) | Oct-18 |
| DAE4 | SN 777 | 15-Dec-17(SPEAG,No.DAE4-777_Dec17) | Dec-18 |

| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560) | Jan-19 |
| NetworkAnalyzerE5071C | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561) | Jan-19 |

| | 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: June 23, 2018

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | 52.10.1.1476 |
| 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 | 5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz | |

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 36.0 | 4.66 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 36.6 ± 6 % | 4.63 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5200 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.50 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 75.3 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.16 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.7 mW / g ± 24.2 % (k=2) |



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Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.9 | 4.76 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 36.3 ± 6 % | 4.75 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5300 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.66 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 76.8 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.20 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.1 mW / g ± 24.2 % (k=2) |

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.6 | 4.96 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.6 ± 6 % | 4.94 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5500 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 8.08 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 80.8 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.30 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.0 mW / g ± 24.2 % (k=2) |



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Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.5 | 5.07 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.8 ± 6 % | 4.98 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5600 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.85 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 78.6 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.25 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.5 mW / g ± 24.2 % (k=2) |

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.3 | 5.27 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.6 ± 6 % | 5.24 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5800 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.78 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 77.9 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.21 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.1 mW / g ± 24.2 % (k=2) |



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Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 49.0 | 5.30 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 48.8 ± 6 % | 5.32 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL at 5200 MHz

| | | |
|---|--------------------|-----------------------------------|
| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 6.99 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 69.8 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 1.92 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 19.2 mW / g ± 24.2 % (k=2) |

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 48.9 | 5.42 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 48.4 ± 6 % | 5.38 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL at 5300 MHz

| | | |
|---|--------------------|-----------------------------------|
| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 7.25 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 72.3 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 2.04 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.3 mW / g ± 24.2 % (k=2) |



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Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 48.6 | 5.65 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 48.4 ± 6 % | 5.56 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL at 5500 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 7.63 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 76.2 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 2.13 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.3 mW / g ± 24.2 % (k=2) |

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 48.5 | 5.77 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 48.1 ± 6 % | 5.80 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL at 5600 MHz

| | | |
|---|--------------------|----------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 7.78 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 77.7 mW / g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 2.14 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.4 mW / g ± 24.2 % (k=2) |



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Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 48.2 | 6.00 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 48.0 ± 6 % | 6.07 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Body TSL at 5800 MHz

| | | |
|---|--------------------|---------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 7.66 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 76.6 mW /g ± 24.4 % (k=2) |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | Condition | |
| SAR measured | 100 mW input power | 2.15 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.5 mW /g ± 24.2 % (k=2) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.5 Ω - 8.96j Ω |
| Return Loss | - 20.7dB |

Antenna Parameters with Head TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.1 Ω - 3.00j Ω |
| Return Loss | - 30.5dB |

Antenna Parameters with Head TSL at 5500 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.4 Ω - 5.39j Ω |
| Return Loss | - 25.2dB |

Antenna Parameters with Head TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.5 Ω - 2.95j Ω |
| Return Loss | - 22.5dB |

Antenna Parameters with Head TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.5 Ω - 1.38j Ω |
| Return Loss | - 26.9dB |

Antenna Parameters with Body TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.1 Ω - 7.52j Ω |
| Return Loss | - 22.1dB |

Antenna Parameters with Body TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.3 Ω - 2.06j Ω |
| Return Loss | - 33.1dB |



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Antenna Parameters with Body TSL at 5500 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.9 Ω - 4.94j Ω |
| Return Loss | - 26.1dB |

Antenna Parameters with Body TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 58.5 Ω - 0.79j Ω |
| Return Loss | - 22.1dB |

Antenna Parameters with Body TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.3 Ω + 0.12j Ω |
| Return Loss | - 27.6dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.065 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



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DASY5 Validation Report for Head TSL

Date: 06.20.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1160

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz,
Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz,

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.633$ S/m; $\epsilon_r = 36.62$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5300$ MHz; $\sigma = 4.754$ S/m; $\epsilon_r = 36.31$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5500$ MHz; $\sigma = 4.942$ S/m; $\epsilon_r = 35.58$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5600$ MHz; $\sigma = 4.984$ S/m; $\epsilon_r = 35.81$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5800$ MHz; $\sigma = 5.241$ S/m; $\epsilon_r = 35.58$; $\rho = 1000$ kg/m³,

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(5.57, 5.57, 5.57) @ 5200 MHz; Calibrated: 1/25/2018, ConvF(5.34, 5.34, 5.34) @ 5300 MHz; Calibrated: 1/25/2018, ConvF(4.91, 4.91, 4.91) @ 5500 MHz; Calibrated: 1/25/2018, ConvF(4.73, 4.73, 4.73) @ 5600 MHz; Calibrated: 1/25/2018, ConvF(4.9, 4.9, 4.9) @ 5800 MHz; Calibrated: 1/25/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 12/15/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.38 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 7.5 W/kg; SAR(10 g) = 2.16 W/kg
Maximum value of SAR (measured) = 17.8 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.70 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 33.3 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.2 W/kg
Maximum value of SAR (measured) = 18.4 W/kg



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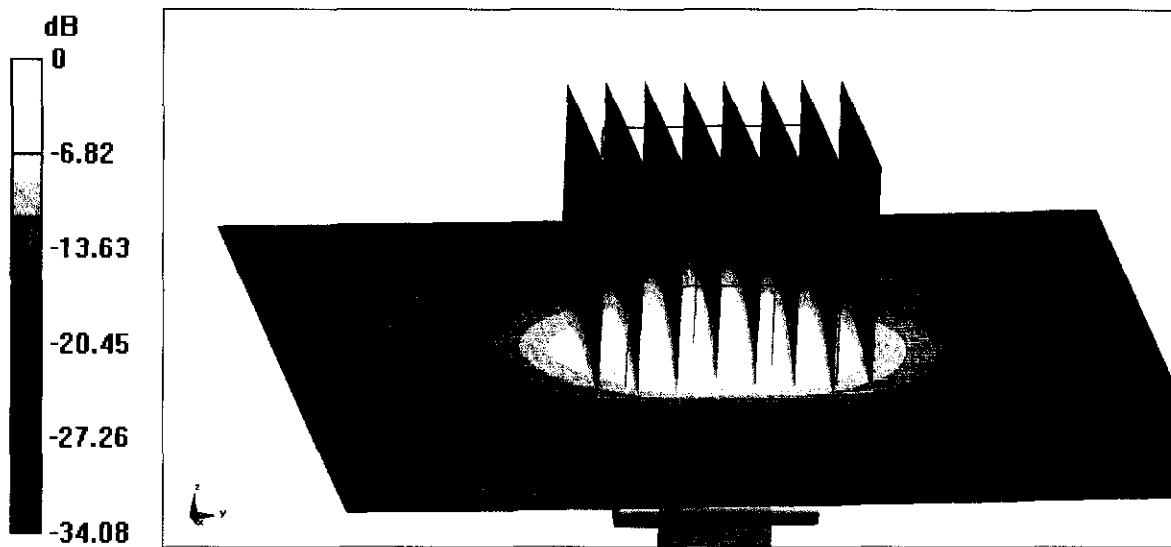
E-mail: cttl@chinattl.com

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Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.94 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 36.4 W/kg
SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.3 W/kg
Maximum value of SAR (measured) = 19.4 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 = 65.08 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 35.7 W/kg
SAR(1 g) = 7.85 W/kg; SAR(10 g) = 2.25 W/kg
Maximum value of SAR (measured) = 18.9 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.16 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 37.2 W/kg
SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 19.1 W/kg

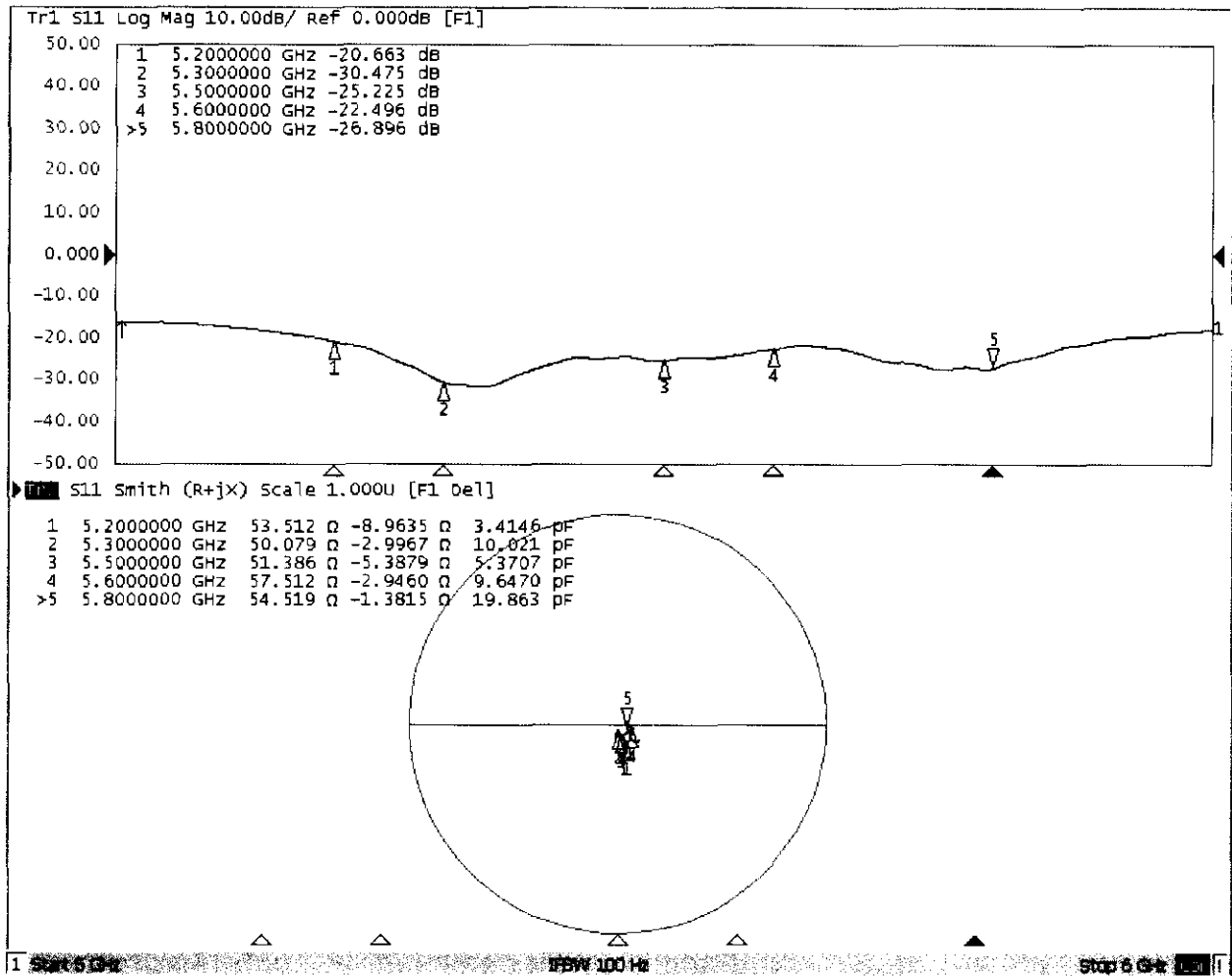


0 dB = 19.1 W/kg = 12.81 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 06.19.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1160

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz,
Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz,

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.317$ S/m; $\epsilon_r = 48.78$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5300$ MHz; $\sigma = 5.381$ S/m; $\epsilon_r = 48.35$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5500$ MHz; $\sigma = 5.56$ S/m; $\epsilon_r = 48.36$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.795$ S/m; $\epsilon_r = 48.14$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5800$ MHz; $\sigma = 6.065$ S/m; $\epsilon_r = 48.03$; $\rho = 1000$ kg/m³,

Phantom section: Left Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(5.15, 5.15, 5.15) @ 5200 MHz; Calibrated: 1/25/2018, ConvF(5.04, 5.04, 5.04) @ 5300 MHz; Calibrated: 1/25/2018, ConvF(4.46, 4.46, 4.46) @ 5500 MHz; Calibrated: 1/25/2018, ConvF(4.36, 4.36, 4.36) @ 5600 MHz; Calibrated: 1/25/2018, ConvF(4.51, 4.51, 4.51) @ 5800 MHz; Calibrated: 1/25/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Electronics: DAE4 Sn777; Calibrated: 12/15/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 62.32 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 31.6 W/kg

SAR(1 g) = 6.99 W/kg; SAR(10 g) = 1.92 W/kg

Maximum value of SAR (measured) = 16.7 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 56.59 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 33.3 W/kg

SAR(1 g) = 7.25 W/kg; SAR(10 g) = 2.04 W/kg

Maximum value of SAR (measured) = 18.2 W/kg



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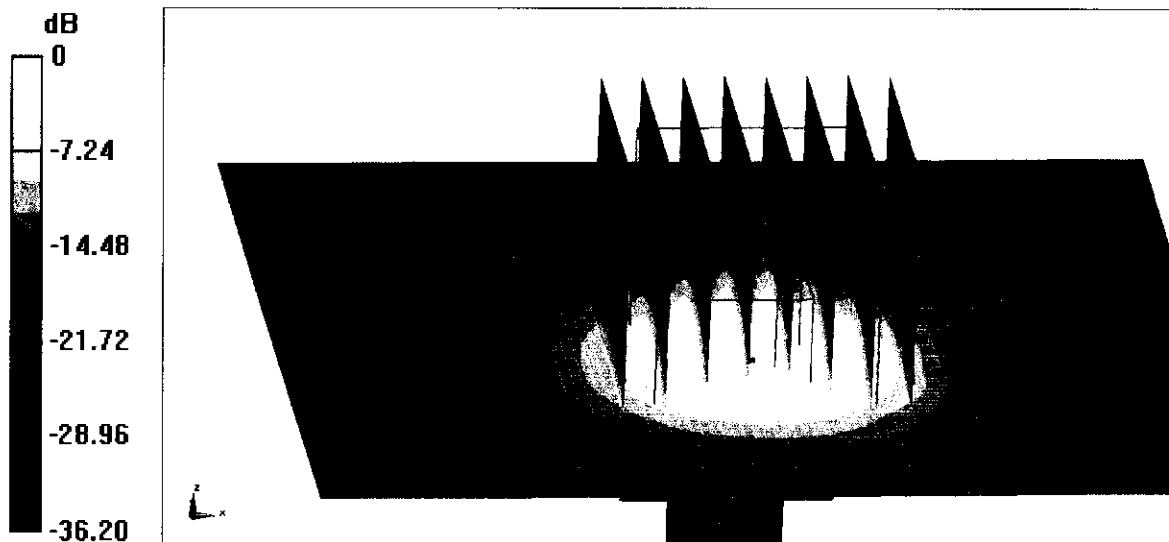
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Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.72 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 35.6 W/kg
SAR(1 g) = 7.63 W/kg; SAR(10 g) = 2.13 W/kg
Maximum value of SAR (measured) = 19.2 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 = 57.49 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 37.4 W/kg
SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.14 W/kg
Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 41.04 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 36.5 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 18.8 W/kg

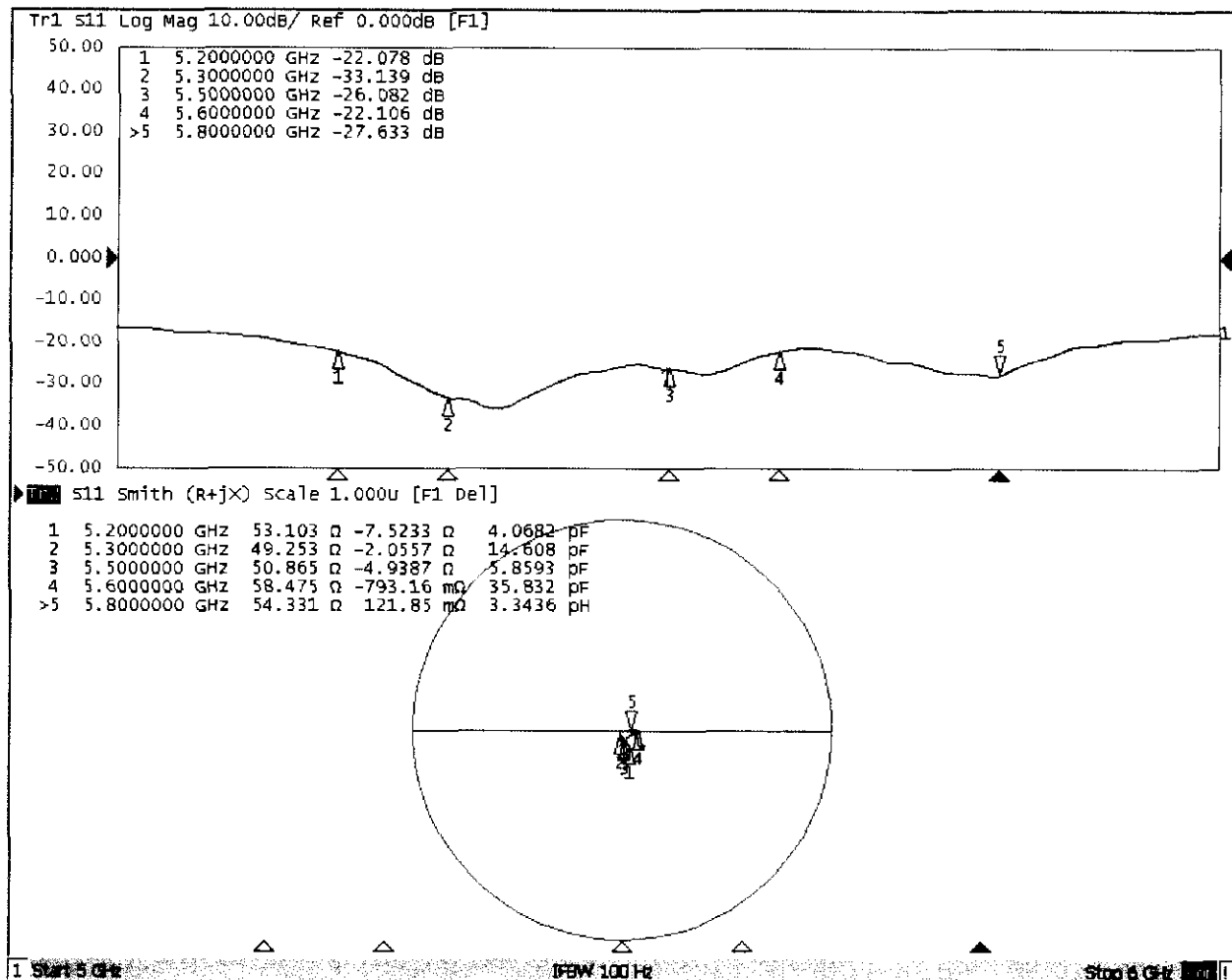


0 dB = 18.8 W/kg = 12.74 dBW/kg



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Impedance Measurement Plot for Body TSL





Dipole Internal Calibration Record

| | | | | | |
|---------------|--------------|----------------------|---------------|------------------|---------------|
| Asset No. : | E-436 | Model No. : | D5GHzV2 | Serial No. : | 1160 |
| Environmental | 23.1°C, 50 % | Original Cal. Date : | June 20, 2018 | Next Cal. Date : | June 20, 2021 |

Standard List

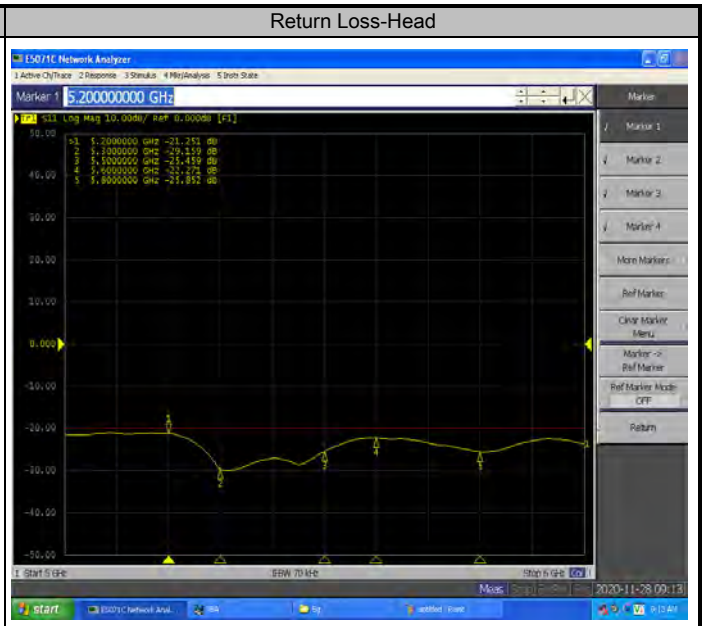
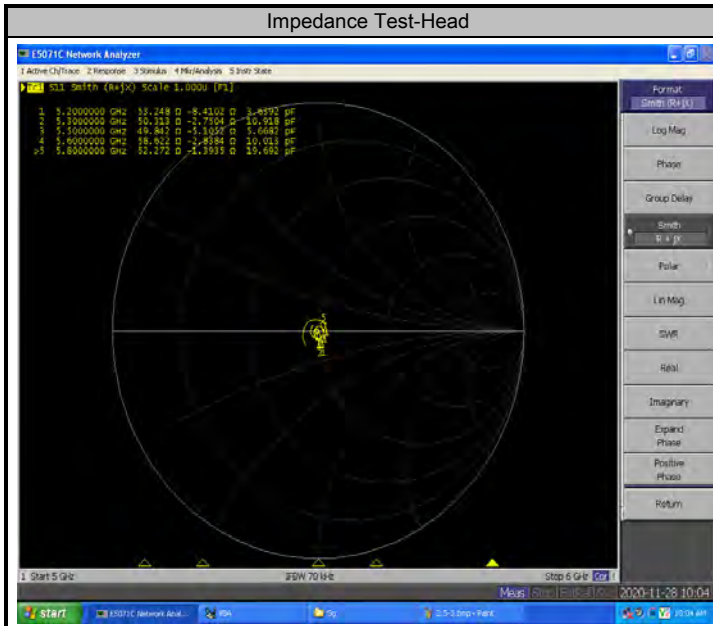
| | | |
|---|--------------------|--|
| 1 | IEEE Std 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013 |
| 2 | IEC 62209-2 | Procedure to determine the 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 |
| 3 | KDB865664 | SAR Measurement Requirements for 100 MHz to 6 GHz |

Equipment Information

| Equipment : | Manufacturer : | Model No. : | Serial No. : | Cal.Organization : | Cal. Date : |
|---------------------------|----------------|----------------|--------------------|--------------------|-------------------|
| Power Amplifier | Mini-Circuits | ZVE-8G+ | 520701341 | N/A | March 10, 2020 |
| DC Source metter | Iteck | IT6154 | 006104126768201001 | N/A | July 25, 2020 |
| Signal Analyzer | R&S | FSV7 | 103120 | N/A | July 25, 2020 |
| Vector Network Analyzer | Anritsu | MS46522B | 1538101 | N/A | July 25, 2020 |
| Signal Generator | R&S | SMF100A | 101214 | N/A | February 29, 2020 |
| Smart Power Sensor | R&S | NRP-Z21 | 102209 | N/A | March 7, 2020 |
| Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| Directional Coupler | Woken | TS-PCC0M-05 | 107090019 | N/A | March 1, 2020 |
| Coupler | Woken | 0110A05601O-10 | COM5BNW1A2 | N/A | March 1, 2020 |
| Digital Themometer | LKM | DTM3000 | 3519 | N/A | July 2, 2020 |

For Head Tissue

| Model No | Item | Originak Cal. Result | Verified on 2020/11/28 | Deviation | Result |
|-----------------|--------------------------------------|----------------------|------------------------|-----------|--------|
| D5GHzV2(5.2GHz) | Impedance, transformed to feed point | 53.5Ω-8.96jΩ | 53.2Ω-8.41jΩ | <5Ω | Pass |
| | Return Loss(dB) | -20.7 | -21.251 | 2.7% | Pass |
| | SAR Value for 1g(mW/g) | 7.5 | 7.57 | 0.9% | Pass |
| | SAR Value for 10g(mW/g) | 2.16 | 2.2 | 1.9% | Pass |
| D5GHzV2(5.3GHz) | Impedance, transformed to feed point | 50.1Ω-3jΩ | 50.3Ω-2.75jΩ | <5Ω | Pass |
| | Return Loss(dB) | -30.5 | -29.159 | -4.4% | Pass |
| | SAR Value for 1g(mW/g) | 7.66 | 7.67 | 0.1% | Pass |
| | SAR Value for 10g(mW/g) | 2.2 | 2.15 | -2.3% | Pass |
| D5GHzV2(5.5GHz) | Impedance, transformed to feed point | 51.4Ω-5.39jΩ | 49.8Ω-5.10jΩ | <5Ω | Pass |
| | Return Loss(dB) | -25.2 | -25.459 | 1.0% | Pass |
| | SAR Value for 1g(mW/g) | 8.08 | 8.15 | 0.9% | Pass |
| | SAR Value for 10g(mW/g) | 2.3 | 2.27 | -1.3% | Pass |
| D5GHzV2(5.6GHz) | Impedance, transformed to feed point | 57.5Ω-2.95jΩ | 58.6Ω-2.84jΩ | <5Ω | Pass |
| | Return Loss(dB) | -22.5 | -22.271 | -1.0% | Pass |
| | SAR Value for 1g(mW/g) | 7.85 | 8.23 | 4.8% | Pass |
| | SAR Value for 10g(mW/g) | 2.25 | 2.3 | 2.2% | Pass |
| D5GHzV2(5.8GHz) | Impedance, transformed to feed point | 54.5Ω-1.38jΩ | 52.3Ω-1.40jΩ | <5Ω | Pass |
| | Return Loss(dB) | -26.9 | -25.852 | -3.9% | Pass |
| | SAR Value for 1g(mW/g) | 7.78 | 7.48 | -3.9% | Pass |
| | SAR Value for 10g(mW/g) | 2.21 | 2.12 | -4.1% | Pass |



Validation Report for Head TSL of 5.2GHz

Test Laboratory: BTL Inc. Date: 2020/11/28

System Check_H5200_1128

DUT: Dipole D5GHzV2;SN:1160;

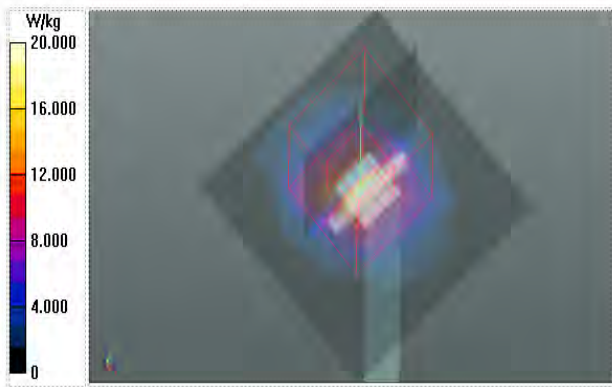
Communication System: UID 0, CW (0); Frequency: 5200 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 5200$ MHz; $\sigma = 4.514$ S/m; $\epsilon_r = 35.539$; $\rho = 1000$ kg/m³
 Ambient Temperature: 23.1 °C; Liquid Temperature: 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(5.56, 5.56, 5.56) @ 5200 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 23.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
 Maximum value of SAR (measured) = 14.4 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=2$ mm
 Reference Value = 70.19 V/m; Power Drift = 0.01 dB
 Peak SAR (extrapolated) = 37.0 W/kg
SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.2 W/kg
 Maximum value of SAR (measured) = 20.0 W/kg



Validation Report for Head TSL of 5.3GHz

Test Laboratory: BTL Inc. Date: 2020/11/28

System Check_H5300_1128

DUT: Dipole D5GHzV2;SN:1160;

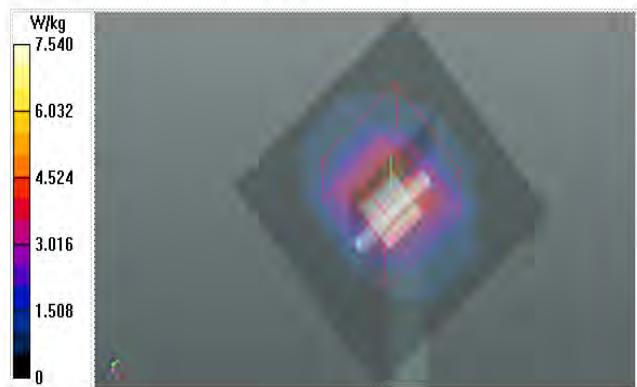
Communication System: UID 0, CW (0); Frequency: 5300 MHz; Duty Cycle: 1:1
 Medium parameters used (interpolated): $f = 5300$ MHz; $\sigma = 4.62$ S/m; $\epsilon_r = 35.321$; $\rho = 1000$ kg/m³
 Ambient Temperature: 23.1 °C; Liquid Temperature: 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(5.25, 5.25, 5.25) @ 5300 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 23.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
 Maximum value of SAR (measured) = 4.69 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=2$ mm
 Reference Value = 40.80 V/m; Power Drift = -0.01 dB
 Peak SAR (extrapolated) = 39.8 W/kg
SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.15 W/kg
 Maximum value of SAR (measured) = 7.54 W/kg



Validation Report for Head TSL of 5.5GHz

Validation Report for Head TSL of 5.6GHz

Test Laboratory: BTL Inc

Date: 2020/11/28

System Check_H5500_1128

DUT: Dipole D5GHzV2; SN:1160;

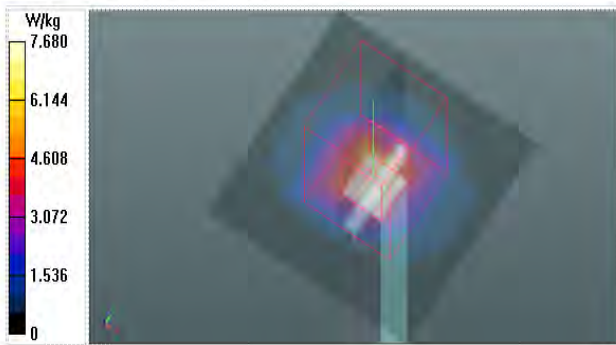
Communication System: UID 0, CW (0); Frequency: 5500 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 5500$ MHz; $\sigma = 5.036$ S/m; $\epsilon_r = 35.48$; $\rho = 1000$ kg/m³
 Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(4.97, 4.97, 4.97) @ 5500 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 23.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
 Maximum value of SAR (measured) = 4.81 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=2$ mm
 Reference Value = 39.43 V/m; Power Drift = 0.02 dB
 Peak SAR (extrapolated) = 45.0 W/kg
SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.27 W/kg
 Maximum value of SAR (measured) = 7.68 W/kg



Test Laboratory: BTL Inc

Date: 2020/11/28

System Check_H5600_1128

DUT: Dipole D5GHzV2; SN:1160;

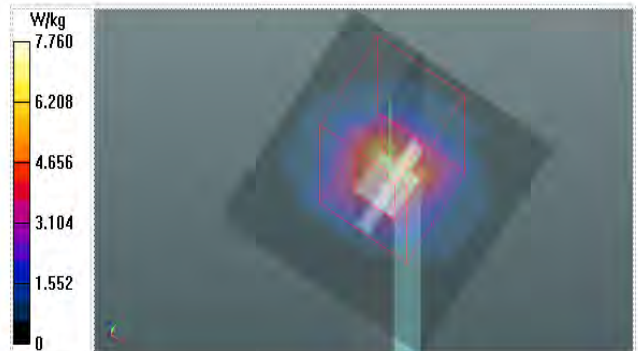
Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 5600$ MHz; $\sigma = 5.156$ S/m; $\epsilon_r = 35.266$; $\rho = 1000$ kg/m³
 Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(4.82, 4.82, 4.82) @ 5600 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 23.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
 Maximum value of SAR (measured) = 5.67 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=2$ mm
 Reference Value = 38.73 V/m; Power Drift = 0.07 dB
 Peak SAR (extrapolated) = 44.9 W/kg
SAR(1 g) = 8.23 W/kg; SAR(10 g) = 2.3 W/kg
 Maximum value of SAR (measured) = 7.76 W/kg



Validation Report for Head TSL of 5.8GHz

Test Laboratory: BTL Inc.

Date: 2020/11/28

System Check_H5800_1128

DUT: Dipole D5GHzV2;SN:1160;

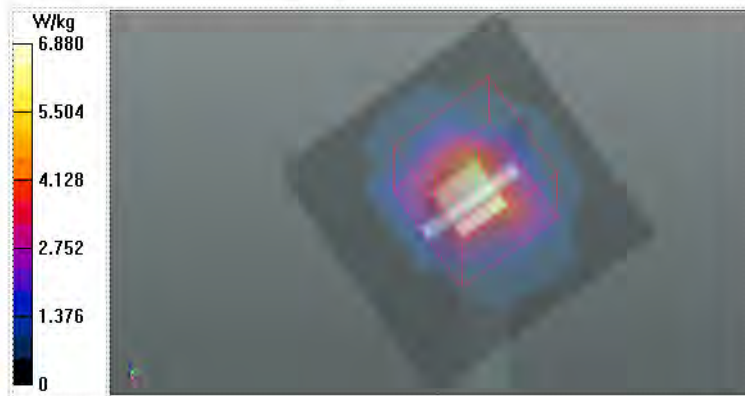
Communication System: UID 0, CW (0); Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5800$ MHz; $\sigma = 5.19$ S/m; $\epsilon_r = 34.169$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.1 °C; Liquid Temperature : 22.3 °C

DASY Configuration:

- Probe: EX3DV4 - SN7544; ConvF(4.8, 4.8, 4.8) @ 5800 MHz; Calibrated: 2020/10/29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 1.0, 23.0$
- Electronics: DAE4 Sn1390; Calibrated: 2020/11/6
- Phantom: SAM Left v5.0; Type: Twin SAM; Serial: TP:1896
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Area Scan (6x6x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 4.95 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=2$ mm
Reference Value = 35.90 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 42.9 W/kg
SAR(1 g) = 7.48 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 6.88 W/kg



Calibrator: *Seven Lu*

Approver: *Herbert Lin*



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Client

BTL Inc.

Certificate No:

Z21-60226

CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1160

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

Calibration date: May 27, 2021

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 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| Power sensor NRP8S | 104291 | 23-Sep-20 (CTTL, No.J20X08336) | Sep-21 |
| ReferenceProbe EX3DV4 | SN 3617 | 27-Jan-21(SPEAG,No.EX3-3617_Jan21) | Jan-22 |
| DAE4 | SN 777 | 08-Jan-21(CTTL-SPEAG,No.Z21-60003) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzerE5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | 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: June 2, 2021

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



Glossary:

| | |
|-------|--|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM _{x,y,z} |
| N/A | not applicable or not measured |

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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 | V52.10.4 |
| 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 5250 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.9 | 4.71 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 36.3 ± 6 % | 4.68 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5250 MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.78 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 78.0 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.23 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.4 W/kg ± 24.2 % (k=2) |



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Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.5 | 5.07 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.7 ± 6 % | 5.06 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5600 MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 8.05 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 80.6 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.30 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.0 W/kg ± 24.2 % (k=2) |

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.4 | 5.22 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.5 ± 6 % | 5.22 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL at 5750 MHz

| | | |
|---|--------------------|---------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 7.65 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 76.5 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm³ (10 g) of Head TSL | Condition | |
| SAR measured | 100 mW input power | 2.16 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.6 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 5250 MHz

| | |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 48.9Ω - 6.08jΩ |
| Return Loss | - 24.1dB |

Antenna Parameters with Head TSL at 5600 MHz

| | |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 54.2Ω - 1.85jΩ |
| Return Loss | - 27.1dB |

Antenna Parameters with Head TSL at 5750 MHz

| | |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 53.1Ω - 1.51jΩ |
| Return Loss | - 29.6dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.105 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

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



DASY5 Validation Report for Head TSL

Date: 05.27.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1160

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

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.683$ S/m; $\epsilon_r = 36.33$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.061$ S/m; $\epsilon_r = 35.72$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5750$ MHz; $\sigma = 5.224$ S/m; $\epsilon_r = 35.5$; $\rho = 1000$ kg/m³,

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(5.4, 5.4, 5.4) @ 5250 MHz; ConvF(5, 5, 5) @ 5600 MHz; ConvF(5.12, 5.12, 5.12) @ 5750 MHz; Calibrated: 2021-01-27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

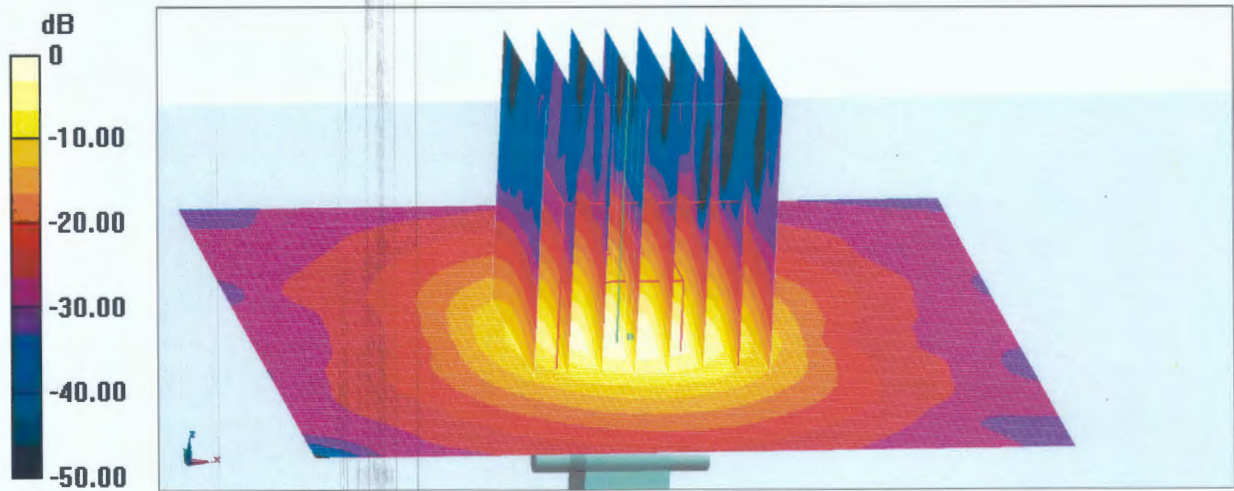
Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.64 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 31.7 W/kg
SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.23 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 64.8%
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 = 66.46 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 35.6 W/kg
SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.3 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 62.4%
Maximum value of SAR (measured) = 19.7 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 = 64.41 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 35.0 W/kg
SAR(1 g) = 7.65 W/kg; SAR(10 g) = 2.16 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 61.4%
Maximum value of SAR (measured) = 18.6 W/kg**



0 dB = 18.6 W/kg = 12.70 dBW/kg



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Impedance Measurement Plot for Head TSL

