

Client

BTL Inc.

Certificate No: Z18-60374

## CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1221

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

Calibration date: September 28, 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 7514    | 27-Aug-18(SPEAG,No.EX3-7514_Aug18)       | Aug-19                |
| DAE4                    | SN 1555    | 20-Aug-18(SPEAG,No.DAE4-1555_Aug18)      | Aug-19                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| 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: September 31, 2018

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



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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| 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.

|                                     |                                                                                              |                                  |
|-------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------|
| <b>DASY Version</b>                 | DASY52                                                                                       | 52.10.1.1476                     |
| <b>Extrapolation</b>                | Advanced Extrapolation                                                                       |                                  |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C                                                                     |                                  |
| <b>Distance Dipole Center - TSL</b> | 10 mm                                                                                        | with Spacer                      |
| <b>Zoom Scan Resolution</b>         | dx, dy = 4 mm, dz = 1.4 mm                                                                   | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>                    | 5200 MHz $\pm$ 1 MHz<br>5300 MHz $\pm$ 1 MHz<br>5600 MHz $\pm$ 1 MHz<br>5800 MHz $\pm$ 1 MHz |                                  |

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 36.0           | 4.66 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 35.1 $\pm$ 6 % | 4.75 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | ----           | ----                 |

## SAR result with Head TSL at 5200 MHz

|                                                               |                    |                                                  |
|---------------------------------------------------------------|--------------------|--------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                  |
| SAR measured                                                  | 100 mW input power | 7.71 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>76.8 mW / g <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                  |
| SAR measured                                                  | 100 mW input power | 2.21 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>22.0 mW / g <math>\pm</math> 24.2 % (k=2)</b> |



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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 | 34.9 ± 6 %   | 4.86 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 <sup>3</sup> (1 g) of Head TSL   | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 7.94 mW / g                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>79.0 mW /g ± 24.4 % (k=2)</b> |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 2.27 mW / g                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>22.6 mW /g ± 24.2 % (k=2)</b> |

### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 35.5         | 5.07 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 34.5 ± 6 %   | 5.19 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 <sup>3</sup> (1 g) of Head TSL   | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 8.07 mW / g                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>80.3 mW /g ± 24.4 % (k=2)</b> |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 2.31 mW / g                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>23.0 mW /g ± 24.2 % (k=2)</b> |



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### 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 | 34.3 ± 6 %   | 5.41 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 <sup>3</sup> (1 g) of Head TSL   | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 7.72 mW / g                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>76.9 mW /g ± 24.4 % (k=2)</b> |
| SAR averaged over 10 cm <sup>3</sup> (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   | <b>21.9 mW /g ± 24.2 % (k=2)</b> |

### 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 | 48.3 ± 6 %   | 5.34 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5200 MHz

|                                                         |                    |                                  |
|---------------------------------------------------------|--------------------|----------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 7.22 mW / g                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>72.0 mW /g ± 24.4 % (k=2)</b> |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                                  |
| SAR measured                                            | 100 mW input power | 2.06 mW / g                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>20.5 mW /g ± 24.2 % (k=2)</b> |



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### 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 | 48.1 ± 6 %   | 5.48 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5300 MHz

|                                                               |                    |                                  |
|---------------------------------------------------------------|--------------------|----------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>   | Condition          |                                  |
| SAR measured                                                  | 100 mW input power | 7.56 mW / g                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>75.4 mW /g ± 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | Condition          |                                  |
| SAR measured                                                  | 100 mW input power | 2.15 mW / g                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>21.4 mW /g ± 24.2 % (k=2)</b> |

### 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 | 47.5 ± 6 %   | 5.88 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5600 MHz

|                                                               |                    |                                  |
|---------------------------------------------------------------|--------------------|----------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>   | Condition          |                                  |
| SAR measured                                                  | 100 mW input power | 7.96 mW / g                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>79.3 mW /g ± 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | Condition          |                                  |
| SAR measured                                                  | 100 mW input power | 2.25 mW / g                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>22.4 mW /g ± 24.2 % (k=2)</b> |



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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 | 47.0 ± 6 %   | 6.18 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 <sup>3</sup> (1 g) of Body TSL   | Condition          |                           |
| SAR measured                                            | 100 mW input power | 7.51 mW / g               |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 74.8 mW /g ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                           |
| SAR measured                                            | 100 mW input power | 2.11 mW / g               |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.0 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 | 52.3Ω - 9.30jΩ |
| Return Loss                          | - 20.6dB       |

### Antenna Parameters with Head TSL at 5300 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 52.9Ω - 1.49jΩ |
| Return Loss                          | - 29.9dB       |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 54.4Ω - 3.77jΩ |
| Return Loss                          | - 25.2dB       |

### Antenna Parameters with Head TSL at 5800 MHz

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.4Ω +3.99jΩ |
| Return Loss                          | - 25.9dB      |

### Antenna Parameters with Body TSL at 5200 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 51.3Ω - 8.42jΩ |
| Return Loss                          | - 21.5dB       |

### Antenna Parameters with Body TSL at 5300 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 51.8Ω + 1.03jΩ |
| Return Loss                          | - 33.7dB       |

### Antenna Parameters with Body TSL at 5600 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 54.6Ω - 2.05jΩ |
| Return Loss                          | - 26.4dB       |