

DASY5 Validation Report for Head TSL

Date: 07.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1054

Communication System: UID 0 - CW ; Frequency: 750 MHz

Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.91 \text{ S/m}$; $\epsilon_r = 40.9$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.17, 10.17, 10.17); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

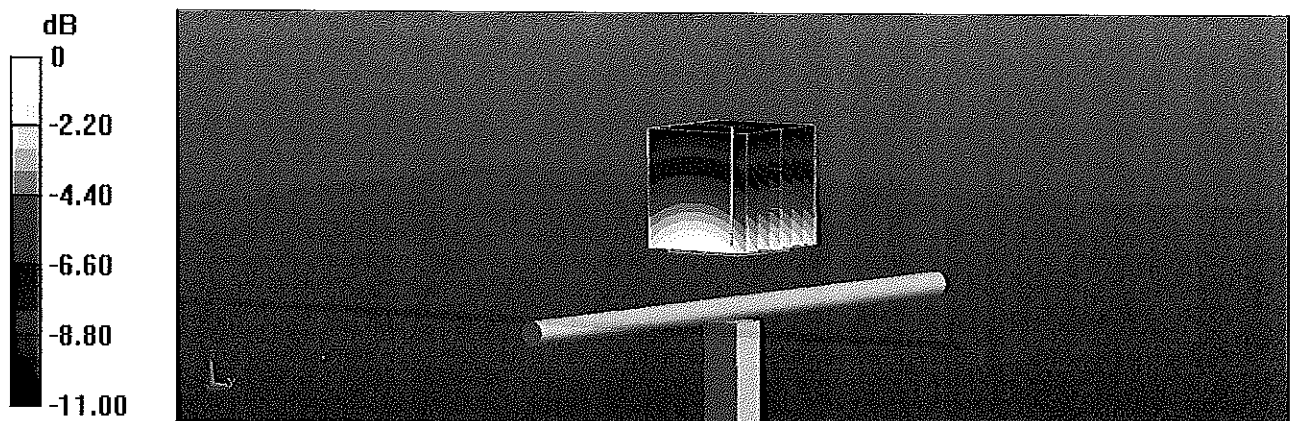
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 59.71 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.21 W/kg

SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.4 W/kg

Maximum value of SAR (measured) = 2.85 W/kg

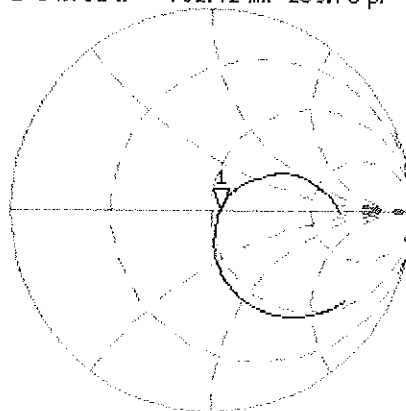


0 dB = 2.85 W/kg = 4.55 dBW/kg

Impedance Measurement Plot for Head TSL

7 Mar 2017 12:25:14
CH1 S11 1 U FS 1: 54.732 Ω -732.42 m Ω 289.73 pF 750.000 000 MHz

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Del
CA



Avg
16

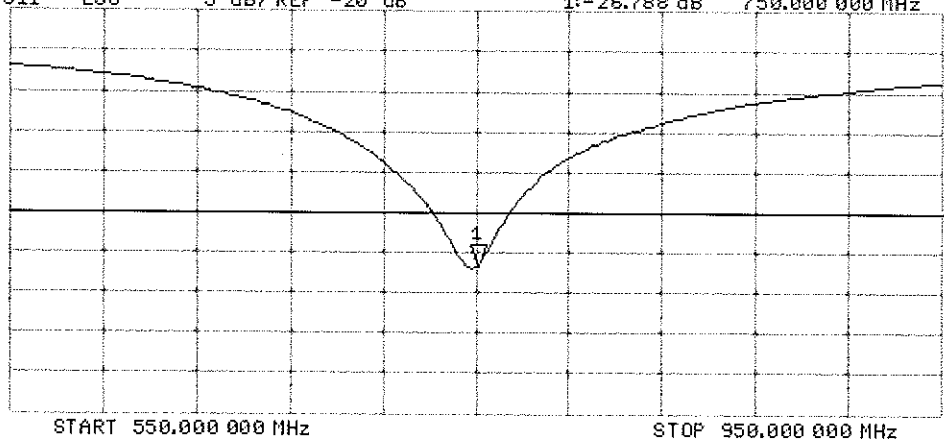
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-26.788 dB 750.000 000 MHz

CA

Avg
16

H1d



DASY5 Validation Report for Body TSL

Date: 07.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1054

Communication System: UID 0 - CW ; Frequency: 750 MHz

Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.99 \text{ S/m}$; $\epsilon_r = 54.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.99, 9.99, 9.99); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

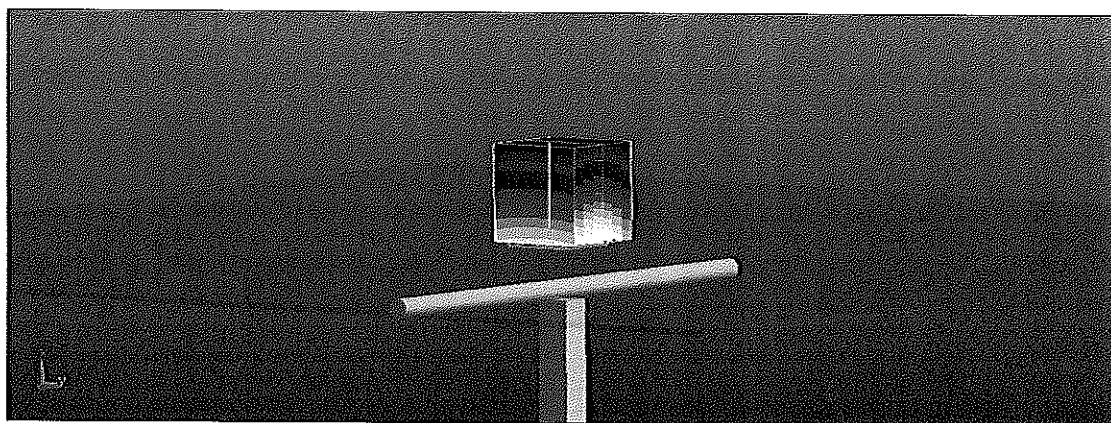
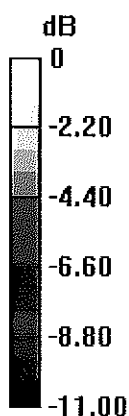
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 57.88 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.31 W/kg

SAR(1 g) = 2.21 W/kg; SAR(10 g) = 1.45 W/kg

Maximum value of SAR (measured) = 2.94 W/kg

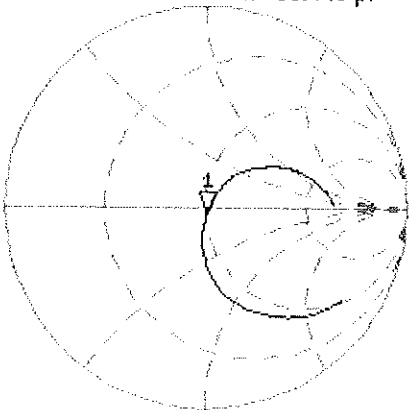


0 dB = 2.94 W/kg = 4.68 dBW/kg

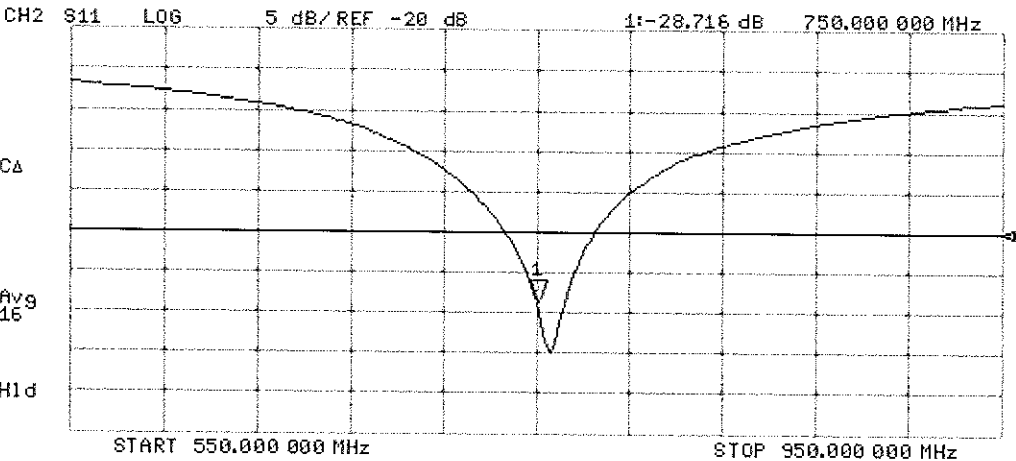
Impedance Measurement Plot for Body TSL

7 Mar 2017 11:51:37
CH1 S11 1 U FS 1: 50.666 Ω -3.6309 Ω 58.445 pF 750.000 000 MHz

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De1
CA



Avg
16
H1d





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D835V2-4d119_Apr17**

CALIBRATION CERTIFICATE

Object **D835V2 - SN:4d119**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

BN ✓
5-3-2017

Calibration date: **April 11, 2017**

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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Claudio Leubler** **Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Signature

Issued: April 12, 2017

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

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 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	40.9 $\pm$ 6 %	0.94 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.46 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.15 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.9 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.42 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.23 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.5 Ω - 4.6 j Ω
Return Loss	- 26.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.1 Ω - 4.2 j Ω
Return Loss	- 27.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.387 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 29, 2010

DASY5 Validation Report for Head TSL

Date: 11.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d119

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

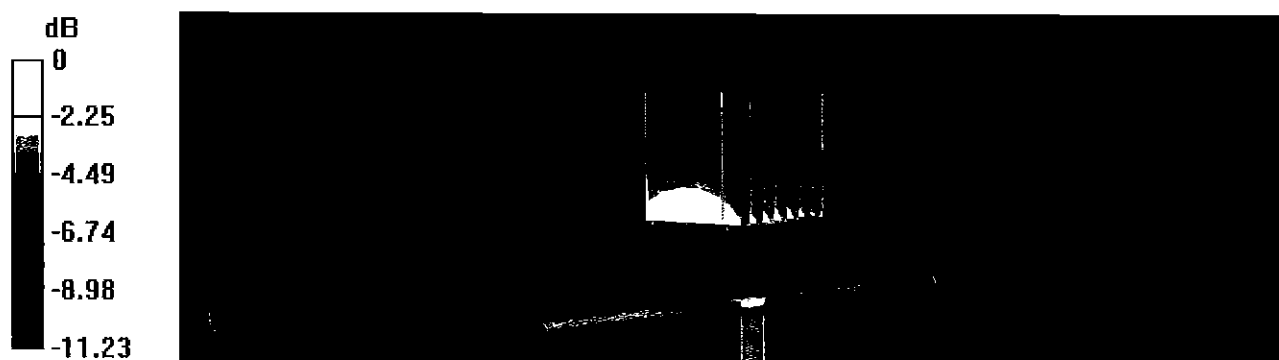
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 62.10 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.65 W/kg

SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.58 W/kg

Maximum value of SAR (measured) = 3.21 W/kg



0 dB = 3.21 W/kg = 5.07 dBW/kg

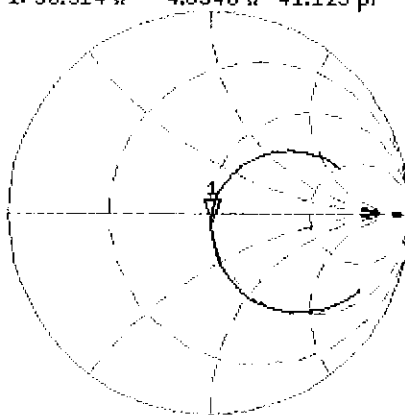
Impedance Measurement Plot for Head TSL

11 Apr 2017 14:25:18
 [CH1] S11 1 U FS 1: 50.514 Ω -4.6348 Ω 41.125 pF 835.000 000 MHz

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 Del
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Avg
 16

H1d

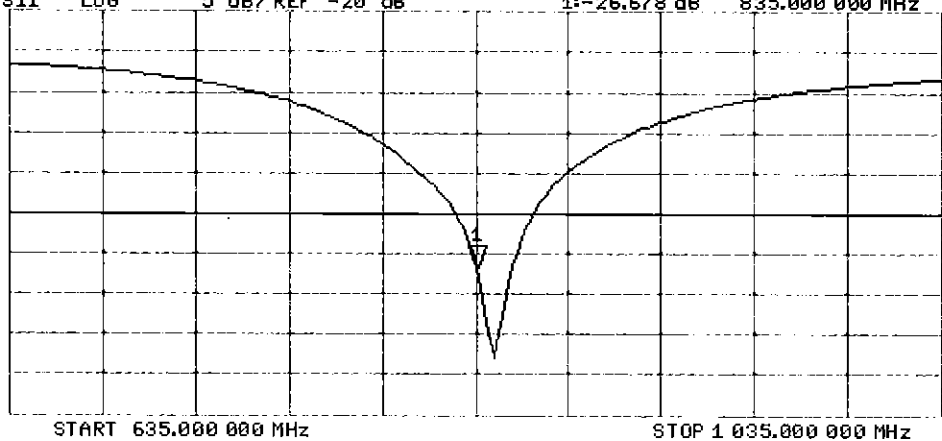


CH2 S11 LOG 5 dB/REF -20 dB 1: -26.678 dB 835.000 000 MHz

CA

Avg
 16

H1d



DASY5 Validation Report for Body TSL

Date: 11.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d119

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 1.01 \text{ S/m}$; $\epsilon_r = 53.9$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

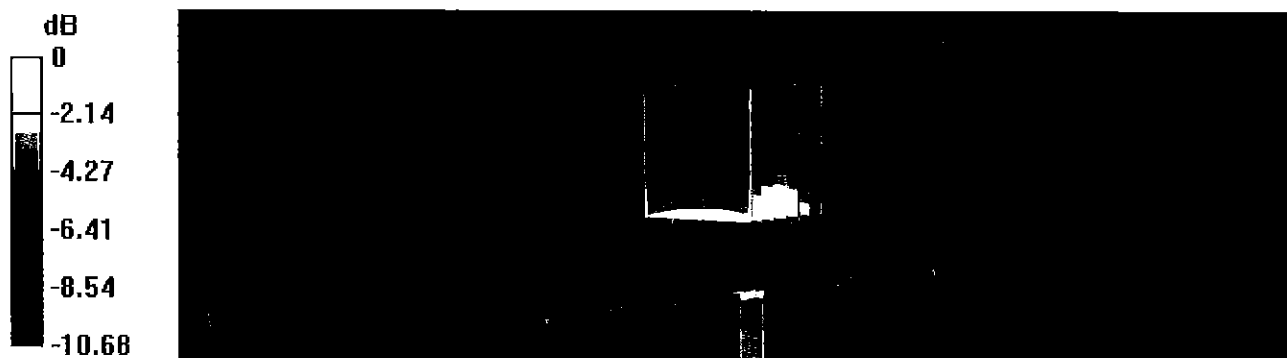
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 59.70 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.64 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.6 W/kg

Maximum value of SAR (measured) = 3.21 W/kg

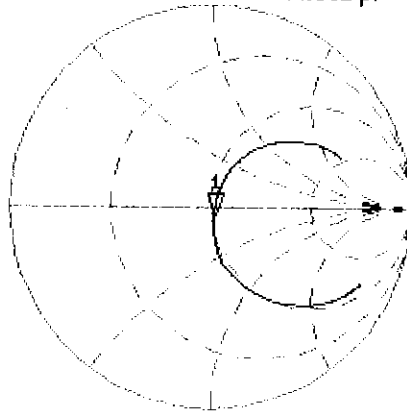


0 dB = 3.21 W/kg = 5.07 dBW/kg

Impedance Measurement Plot for Body TSL

CH1 S11 1 U FS 11 Apr 2017 14:17:40
 1: 51.148 Ω -4.2422 Ω 44.931 pF 835.000 000 MHz

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 Del
 CA



Avg
 16

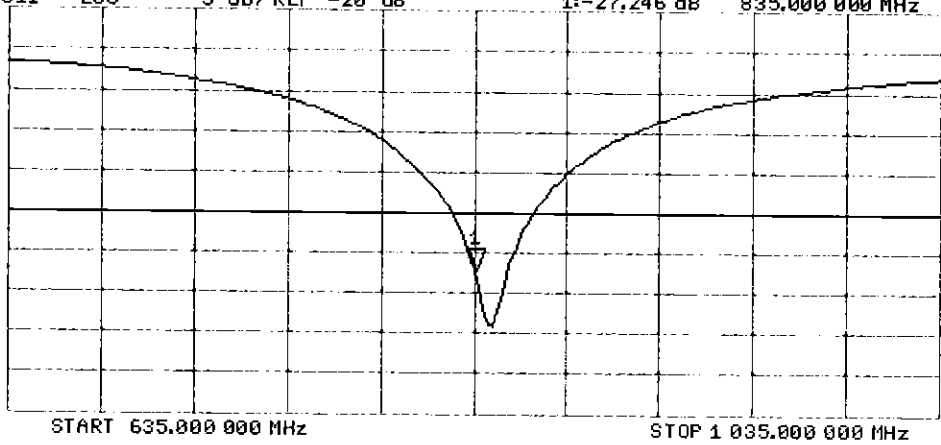
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -27.246 dB 835.000 000 MHz

CA

Avg
 16

H1d





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D835V2-4d132_Jan17**

CALIBRATION CERTIFICATE

Object **D835V2 - SN:4d132**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

BNV
01/26/2017

Calibration date: **January 11, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Jeton Kastrati** **Laboratory Technician**

Signature

[Signature]

Approved by: **Katja Pokovic** **Technical Manager**

[Signature]

Issued: January 12, 2017

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 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	41.4 $\pm$ 6 %	0.92 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.52 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.16 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.0 $\pm$ 6 %	0.99 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.50 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.80 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.64 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.46 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1 Ω - 2.6 j Ω
Return Loss	- 29.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.3 Ω - 6.1 j Ω
Return Loss	- 23.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.386 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 22, 2011

DASY5 Validation Report for Head TSL

Date: 11.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d132

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.92 \text{ S/m}$; $\epsilon_r = 41.4$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

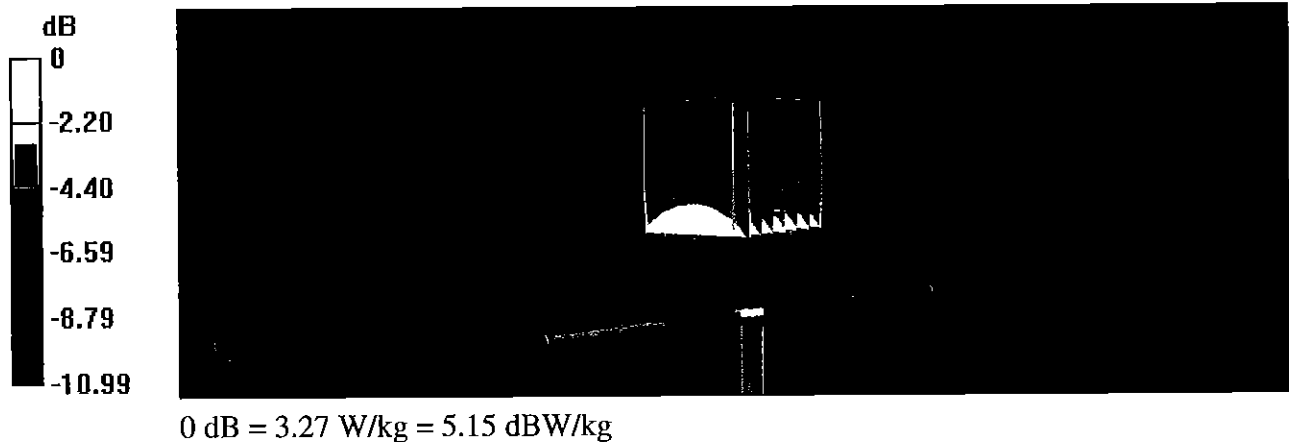
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 62.53 V/m; Power Drift = -0.02 dB

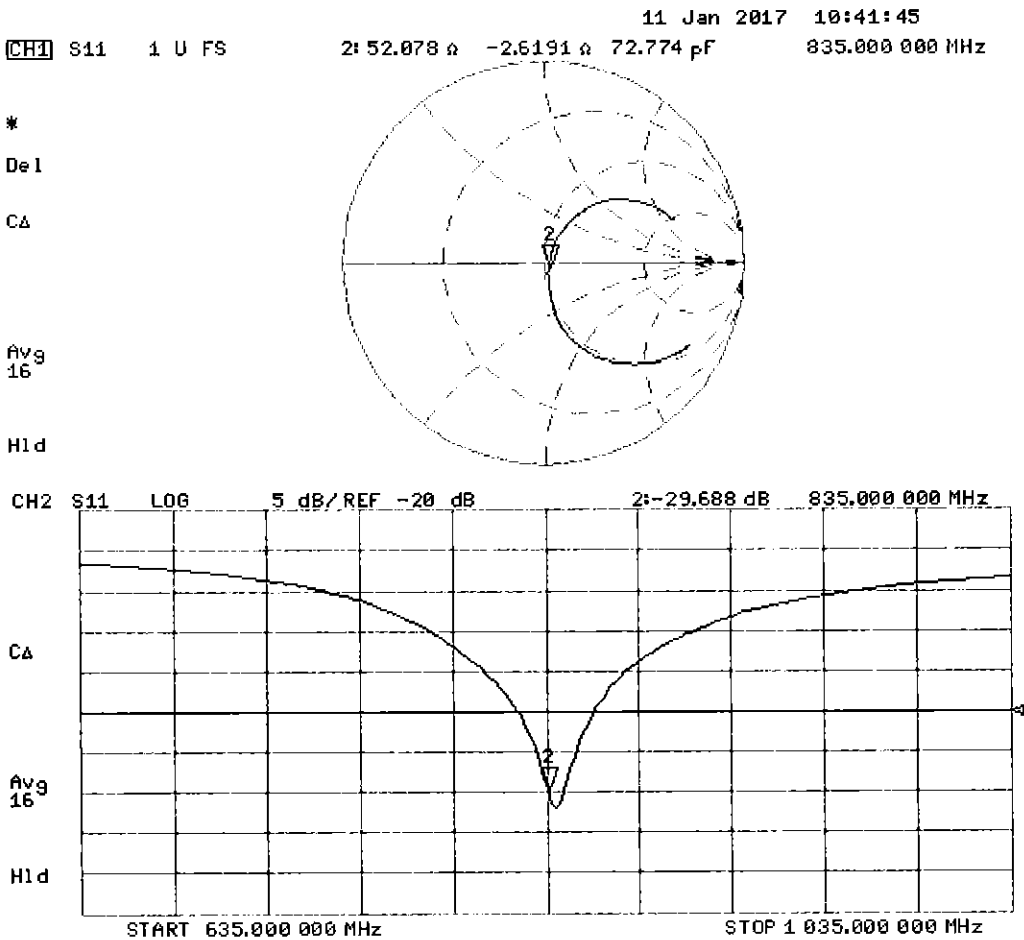
Peak SAR (extrapolated) = 3.69 W/kg

SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (measured) = 3.27 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 10.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d132

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.99 \text{ S/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

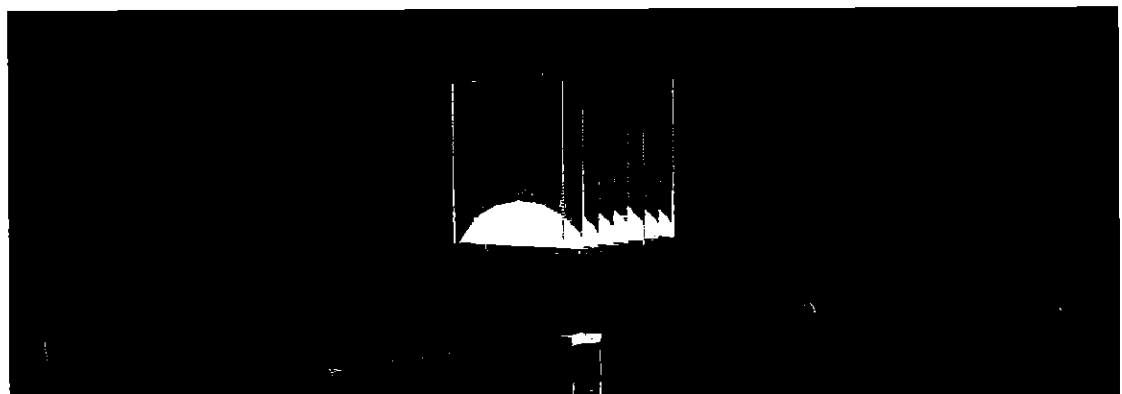
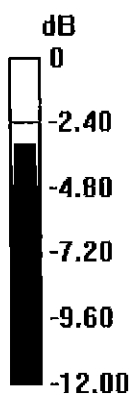
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 61.28 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 3.75 W/kg

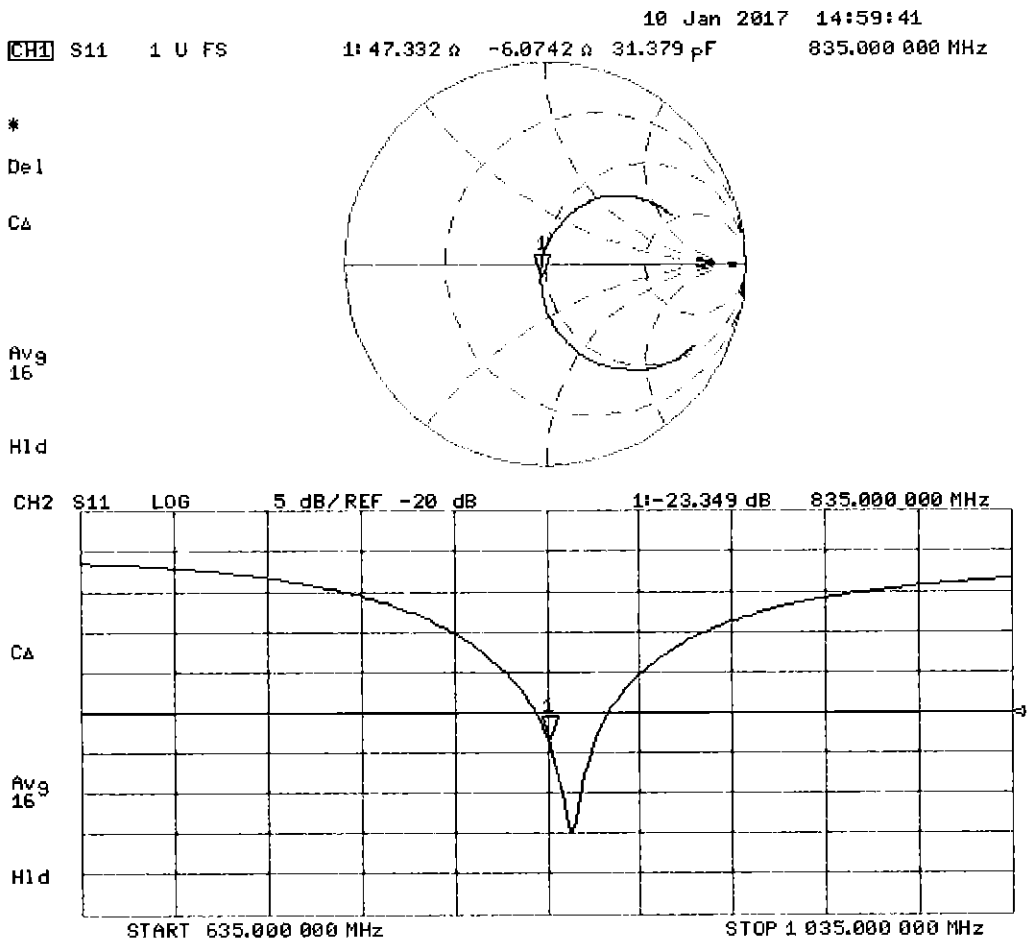
SAR(1 g) = 2.5 W/kg; SAR(10 g) = 1.64 W/kg

Maximum value of SAR (measured) = 3.32 W/kg



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

Impedance Measurement Plot for Body TSL





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D1750V2-1092_May17**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN:1092**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **May 09, 2017**

BN ✓
05-23-2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Claudio Leubler** **Laboratory Technician**

Signature *[Signature]*

Approved by: **Katja Pokovic** **Technical Manager**

[Signature]

Issued: May 11, 2017

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz $\pm$ 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 $\pm$ 0.2) °C	39.0 $\pm$ 6 %	1.36 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.4 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.83 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.3 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.7 $\pm$ 6 %	1.47 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.0 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.93 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	19.8 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.9 Ω - 0.5 j Ω
Return Loss	- 38.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.2 Ω - 0.8 j Ω
Return Loss	- 25.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.217 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 07, 2012

DASY5 Validation Report for Head TSL

Date: 09.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.36$ S/m; $\epsilon_r = 39$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.46, 8.46, 8.46); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

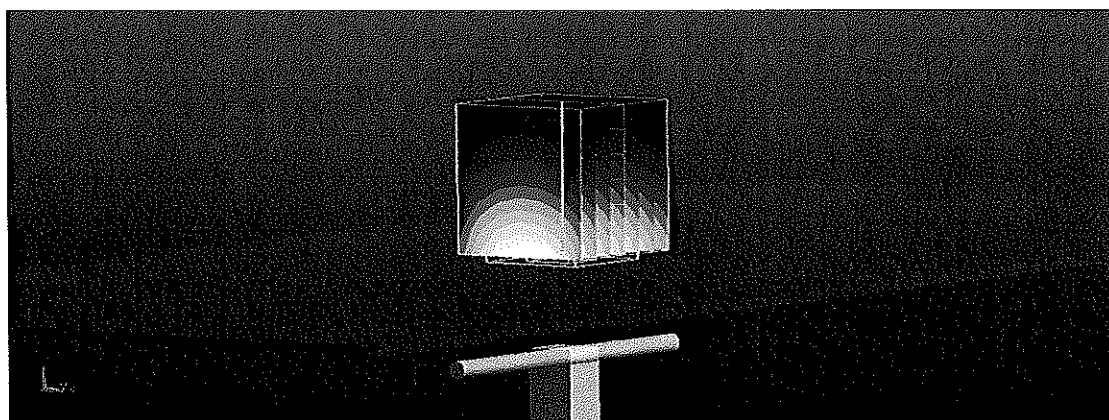
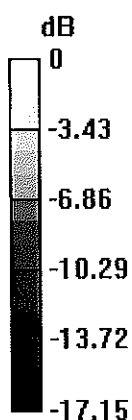
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.6 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 16.5 W/kg

SAR(1 g) = 9.11 W/kg; SAR(10 g) = 4.83 W/kg

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

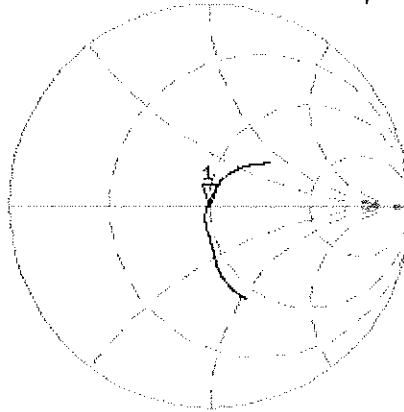


0 dB = 13.8 W/kg = 11.40 dBW/kg

Impedance Measurement Plot for Head TSL

9 May 2017 14:40:22
[CH1] S11 1 U FS 1: 48.926 Ω -480.47 m Ω 189.29 pF 1 750.000 000 MHz

*
Del
CA



Avg
16

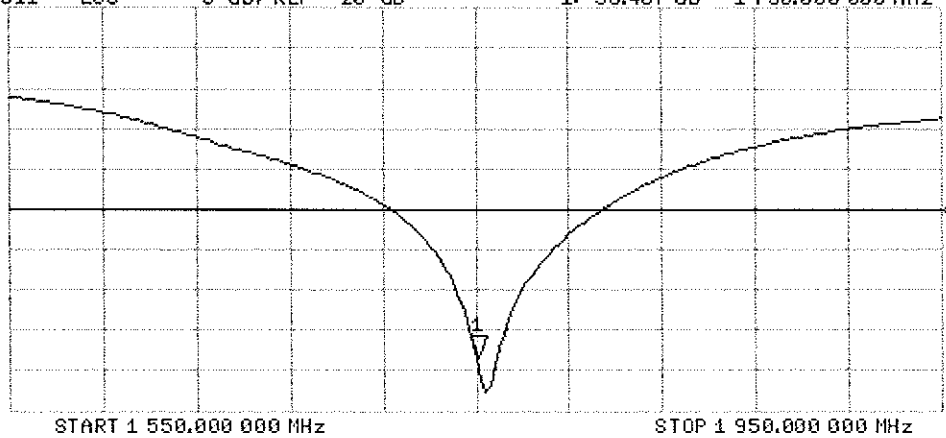
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -38.467 dB 1 750.000 000 MHz

CA

Avg
16

H1d



DASY5 Validation Report for Body TSL

Date: 09.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.47$ S/m; $\epsilon_r = 53.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.25, 8.25, 8.25); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

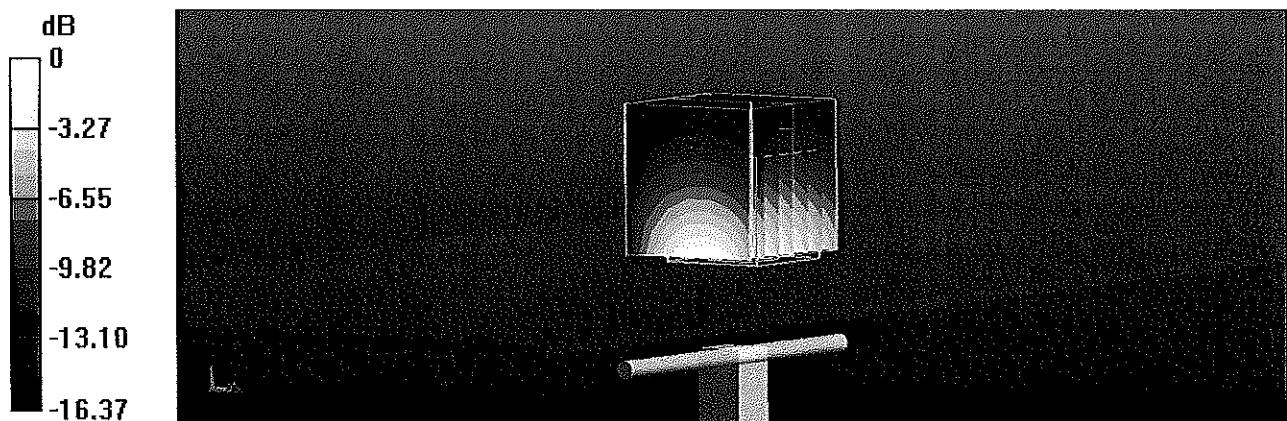
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.81 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 15.8 W/kg

SAR(1 g) = 9.15 W/kg; SAR(10 g) = 4.93 W/kg

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

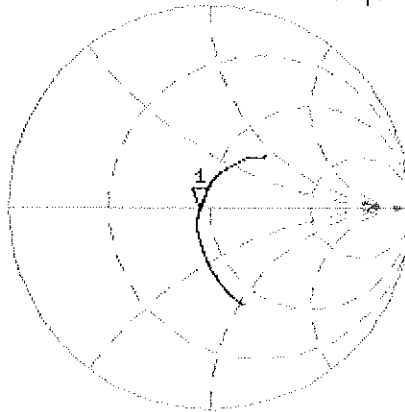


0 dB = 13.1 W/kg = 11.17 dBW/kg

Impedance Measurement Plot for Body TSL

9 May 2017 14:39:51
 [CH1] S11 1 U FS 1: 45.234 Ω -765.63 m Ω 118.79 pF 1 750.000 000 MHz

*
 Del
 CA



Avg
 16

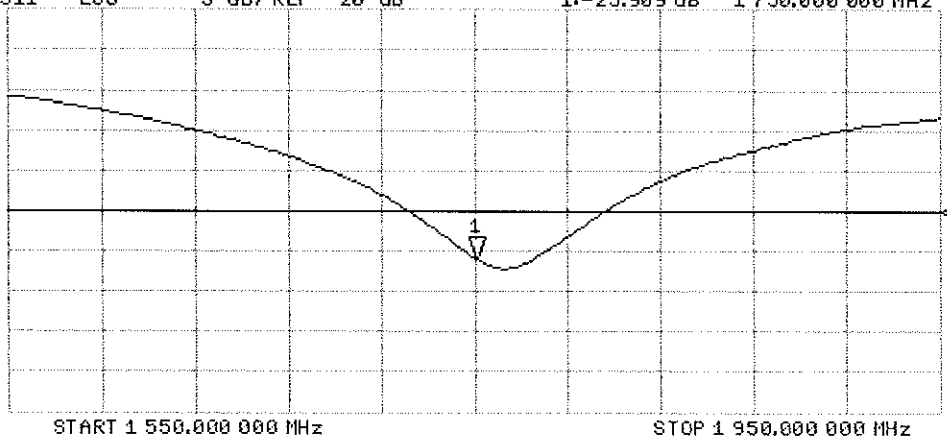
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -25.909 dB 1 750.000 000 MHz

CA

Avg
 16

H1d





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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D1900V2-5d026_May17**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN:5d026**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **May 10, 2017**

BNV
05-23-2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Leif Klysner** **Leif Klysner**
 Name Function
 Laboratory Technician

Approved by: **Katja Pokovic** **Katja Pokovic**
 Name Function
 Technical Manager

Signature

Leif Klysner

Katja Pokovic

Issued: May 12, 2017

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 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 $\pm$ 0.2) °C	41.3 $\pm$ 6 %	1.40 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.75 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.7 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.2 $\pm$ 6 %	1.51 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.34 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.7 \Omega + 8.4 j\Omega$
Return Loss	- 21.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$47.3 \Omega + 8.8 j\Omega$
Return Loss	- 20.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 17, 2002

DASY5 Validation Report for Head TSL

Date: 10.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.4$ S/m; $\epsilon_r = 41.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.0(1444); SEMCAD X 14.6.10(7416)

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

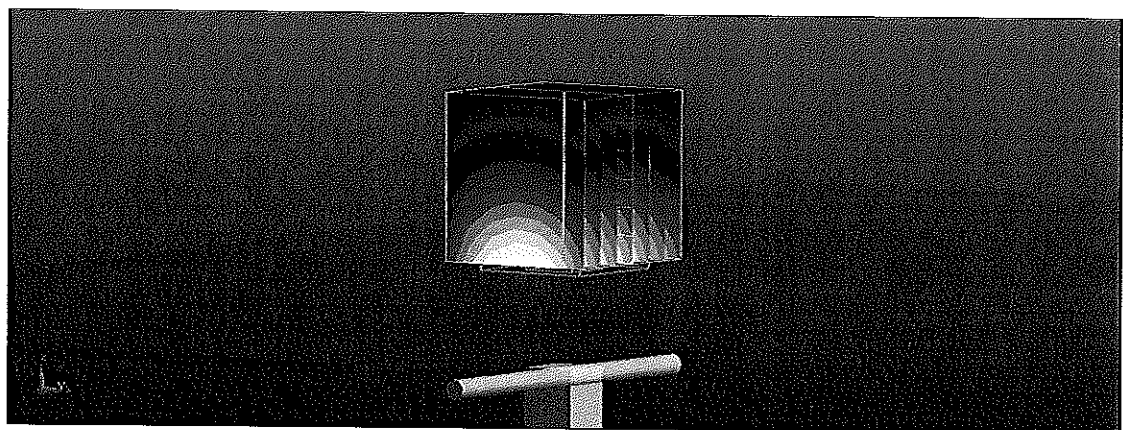
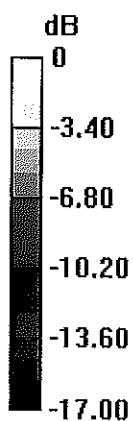
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.4 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 9.75 W/kg; SAR(10 g) = 5.14 W/kg

Maximum value of SAR (measured) = 14.9 W/kg

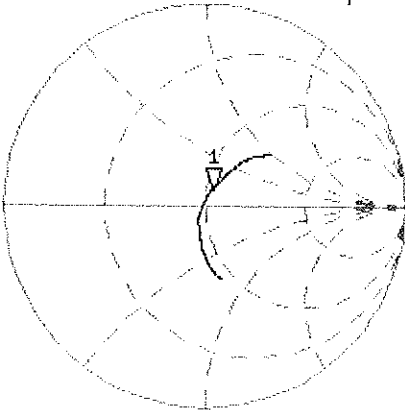


0 dB = 14.9 W/kg = 11.73 dBW/kg

Impedance Measurement Plot for Head TSL

10 May 2017 10:16:29
[CH1] S11 1 U FS 1: 52.662 Ω 8.4414 Ω 707.10 pF 1 900.000 000 MHz

*
De1
CA

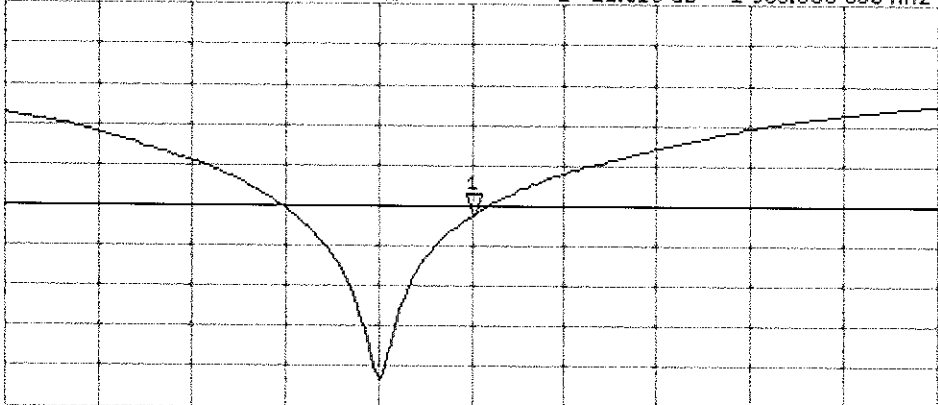


Avg
16
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-21.315 dB 1 900.000 000 MHz

CA

Avg
16
H1d



START 1 700.000 000 MHz STOP 2 100.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 10.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.51$ S/m; $\epsilon_r = 54.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1444); SEMCAD X 14.6.10(7416)

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

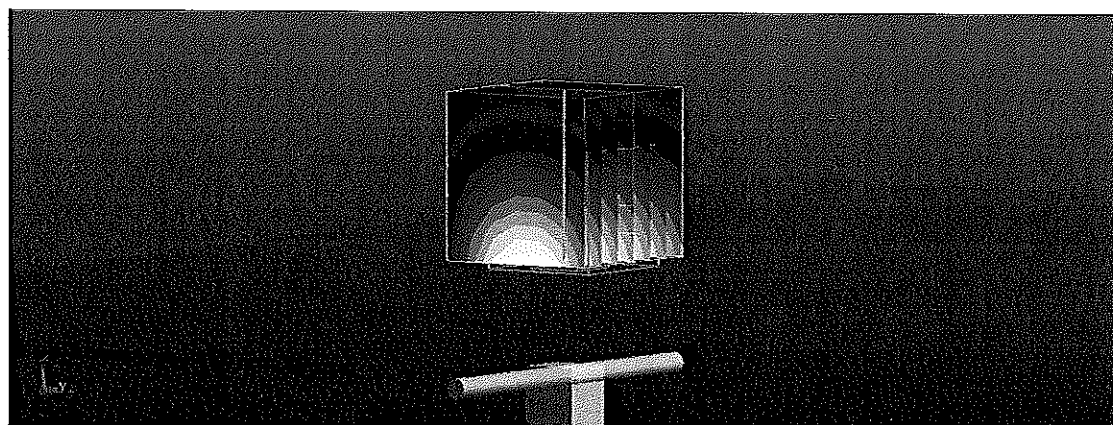
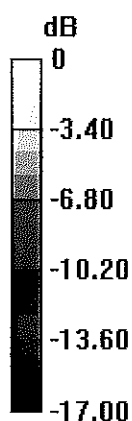
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.9 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 17.7 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.34 W/kg

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

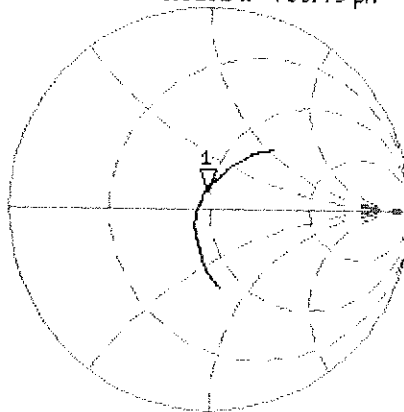


0 dB = 14.5 W/kg = 11.61 dBW/kg

Impedance Measurement Plot for Body TSL

10 May 2017 10:15:44
[CH1] S11 1 U FS 1: 47.309 Ω 8.8281 Ω 739.49 μH 1 900.000 000 MHz

*
De1
CA



Avg
16

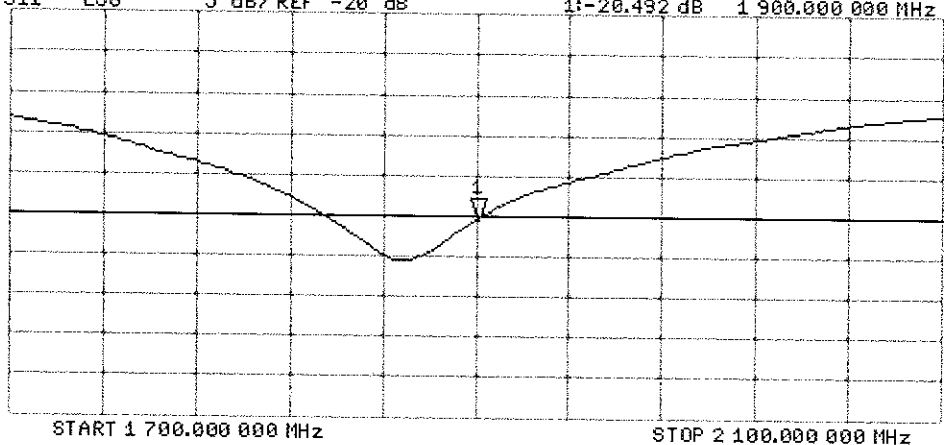
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -20.492 dB 1 900.000 000 MHz

CA

Avg
16

H1d





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **PC Test**

Certificate No: **D1900V2-5d148_Feb17**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN:5d148**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **February 09, 2017**

BN ✓
03/06/2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Claudio Leubler** **Laboratory Technician**

Signature *[Signature]*

Approved by: **Katja Pokovic** **Technical Manager**

[Signature]

Issued: February 10, 2017

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



Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 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 $\pm$ 0.2) °C	40.7 $\pm$ 6 %	1.38 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.9 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.1 $\pm$ 6 %	1.50 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.9 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.33 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.1 Ω + 5.8 j Ω
Return Loss	- 23.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3 Ω + 7.1 j Ω
Return Loss	- 22.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 09.02.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d148

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 40.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

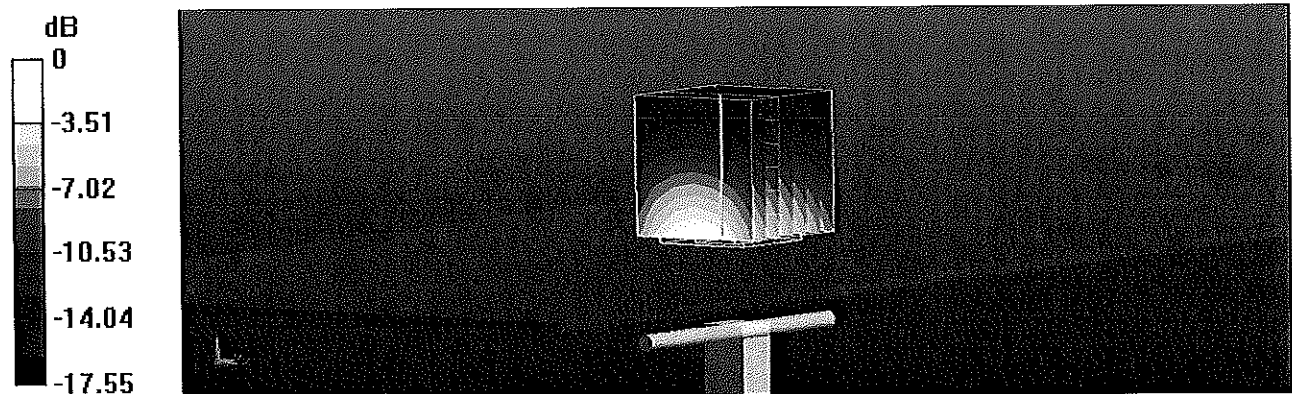
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 108.8 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 19.2 W/kg

SAR(1 g) = 9.93 W/kg; SAR(10 g) = 5.18 W/kg

Maximum value of SAR (measured) = 15.6 W/kg

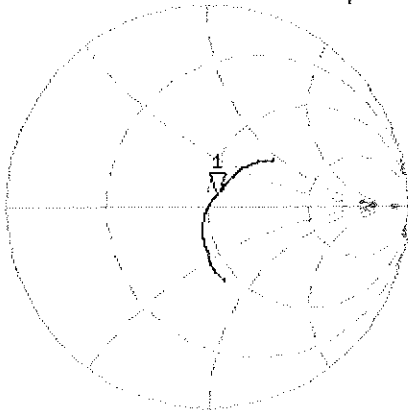


0 dB = 15.6 W/kg = 11.93 dBW/kg

Impedance Measurement Plot for Head TSL

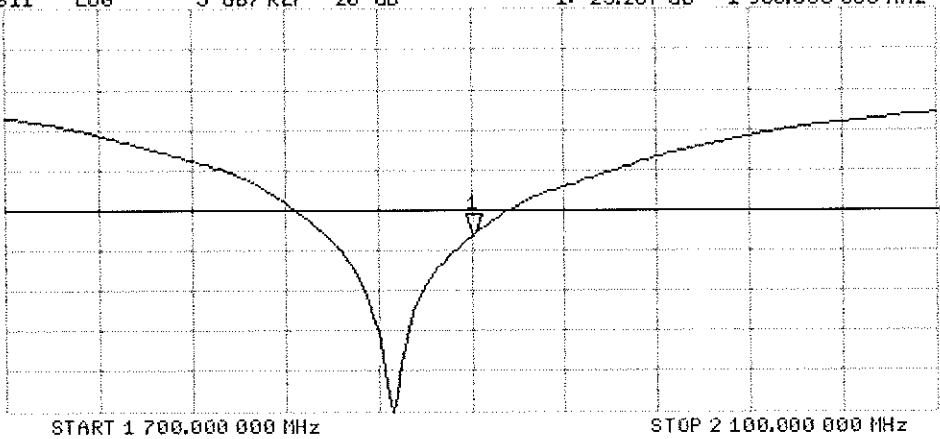
9 Feb 2017 14:46:50
[CH1] S11 1 U FS 1: 54.127 Ω 5.8281 Ω 488.20 μ H 1 900.000 000 MHz

*
De1
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-23.287 dB 1 900.000 000 MHz

CA
Avg
16
H1d



DASY5 Validation Report for Body TSL

Date: 09.02.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d148

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.5$ S/m; $\epsilon_r = 54.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

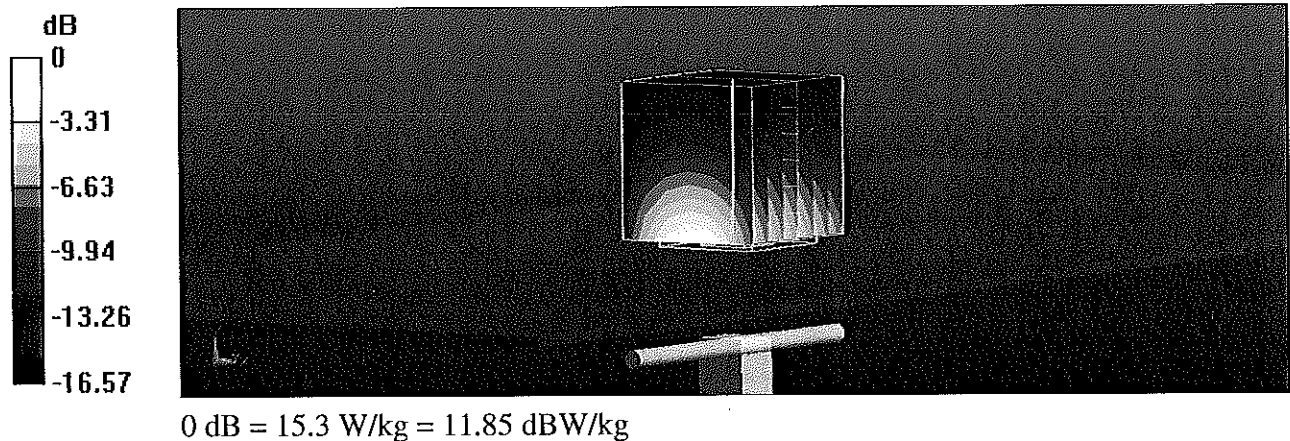
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.3 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 18.1 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.33 W/kg

Maximum value of SAR (measured) = 15.3 W/kg



Impedance Measurement Plot for Body TSL

9 Feb 2017 14:46:18
CH1 S11 1 U FS 1: 48.312 Ω 7.0957 Ω 594.38 μ H 1 900.000 000 MHz

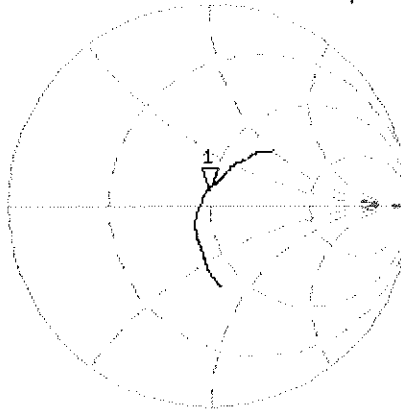
*

De1

CA

Avg
16

H1d

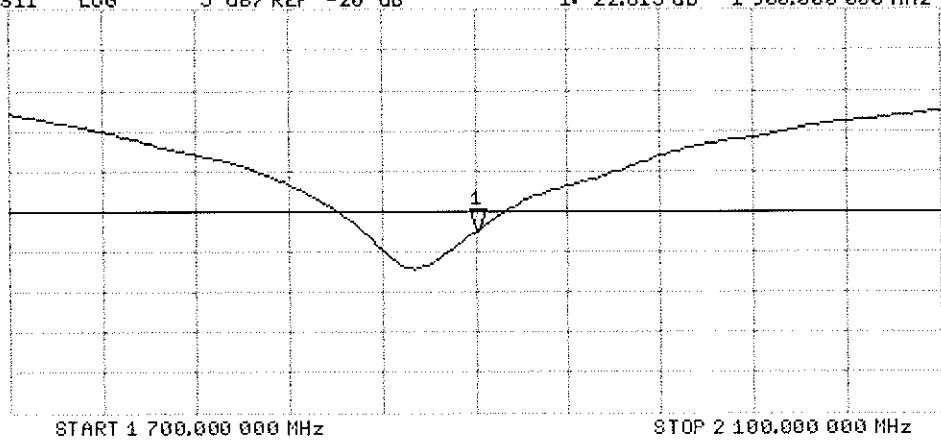


CH2 S11 LOG 5 dB/REF -20 dB 1:-22.615 dB 1 900.000 000 MHz

CA

Avg
16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2300V2-1038_Mar17**

CALIBRATION CERTIFICATE

Object **D2300V2 - SN:1038**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **March 07, 2017**

BN ✓
03-27-2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Johannes Kurikka** Name Function
Laboratory Technician

Signature

Approved by: **Katja Pokovic** Technical Manager

Issued: March 14, 2017

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2300 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	38.4 $\pm$ 6 %	1.71 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	47.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.83 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.9	1.81 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.2 $\pm$ 6 %	1.85 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	47.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.79 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.0 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.7 Ω - 5.1 j Ω
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 Ω - 4.2 j Ω
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.171 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 02, 2013

DASY5 Validation Report for Head TSL

Date: 07.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1038

Communication System: UID 0 - CW ; Frequency: 2300 MHz

Medium parameters used: $f = 2300$ MHz; $\sigma = 1.71$ S/m; $\epsilon_r = 38.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.99, 7.99, 7.99); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

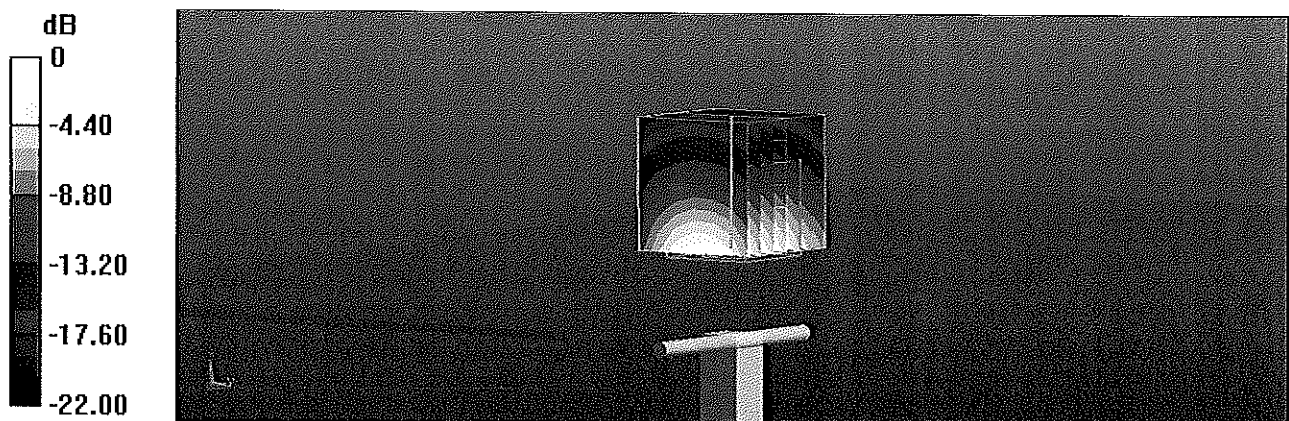
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 111.4 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 23.8 W/kg

SAR(1 g) = 12.1 W/kg; SAR(10 g) = 5.83 W/kg

Maximum value of SAR (measured) = 18.7 W/kg

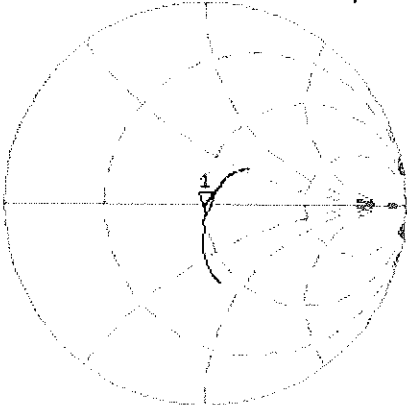


0 dB = 18.7 W/kg = 12.72 dBW/kg

Impedance Measurement Plot for Head TSL

7 Mar 2017 14:54:56
[CH1] S11 1 U FS 1: 49.717 Ω -5.0527 Ω 13.695 pF 2 300.000 000 MHz

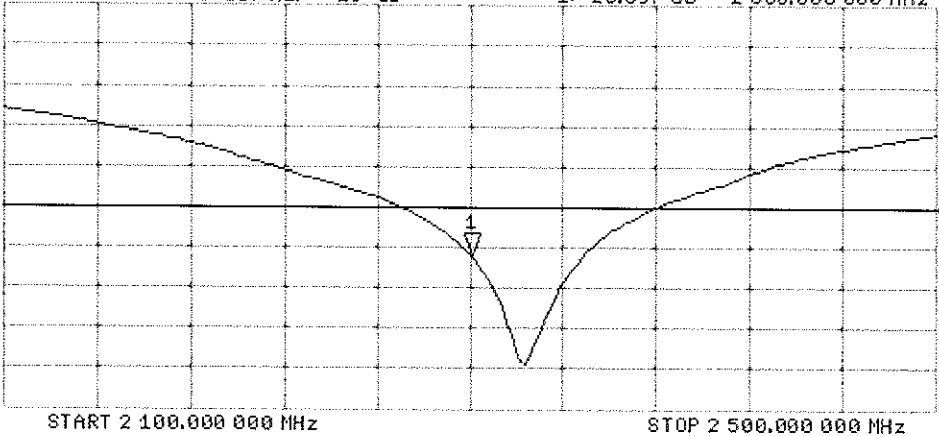
*
De1
Cor



Avg
16
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.897 dB 2 300.000 000 MHz

Cor
Avg
16
H1d



DASY5 Validation Report for Body TSL

Date: 07.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1038

Communication System: UID 0 - CW ; Frequency: 2300 MHz

Medium parameters used: $f = 2300$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.4 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 23.0 W/kg

SAR(1 g) = 12 W/kg; SAR(10 g) = 5.79 W/kg

Maximum value of SAR (measured) = 19.0 W/kg

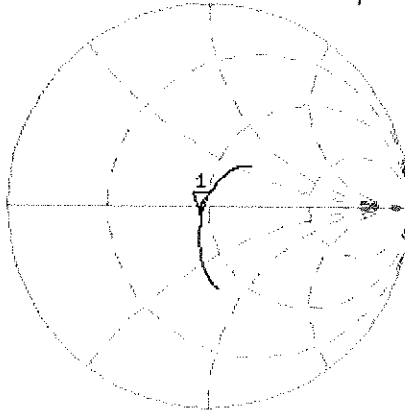


0 dB = 19.0 W/kg = 12.79 dBW/kg

Impedance Measurement Plot for Body TSL

7 Mar 2017 14:53:25
[CH1] S11 1 U FS 1: 45.830 Ω -4.1738 Ω 16.579 pF 2 300.000 000 MHz

*
Del
Cor



Avg
16

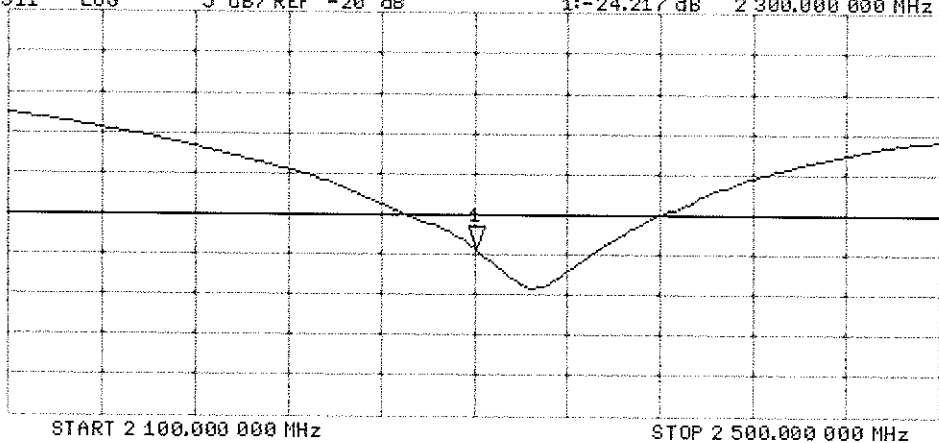
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-24.217 dB 2 300.000 000 MHz

Cor

Avg
16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2450V2-945_May17**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:945**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **May 09, 2017**

BNV
05-23-2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Claudio Leubler** **Laboratory Technician**

Signature *[Signature]*

Approved by: **Katja Pokovic** **Technical Manager**

[Signature]

Issued: May 11, 2017

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

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	37.9 $\pm$ 6 %	1.88 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.4 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.98 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.7 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.3 Ω + 1.8 j Ω
Return Loss	- 25.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.6 Ω + 3.6 j Ω
Return Loss	- 28.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 15, 2014

DASY5 Validation Report for Head TSL

Date: 09.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:945

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.88$ S/m; $\epsilon_r = 37.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

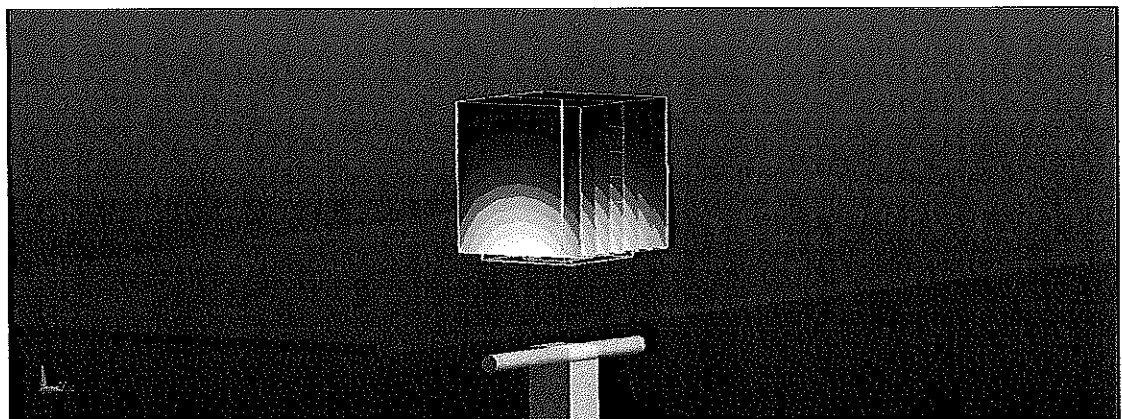
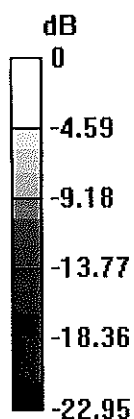
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 114.4 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 27.3 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.08 W/kg

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



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

Impedance Measurement Plot for Head TSL

9 May 2017 12:55:53
 [CH1] S11 1 U FS 1: 55.334 Ω 1.8242 Ω 118.50 μ H 2 450.000 000 MHz

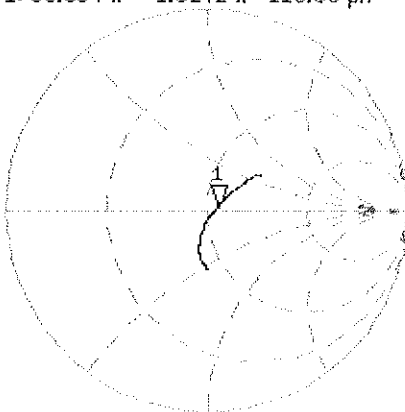
*

De1

CA

Avg
16

H1d

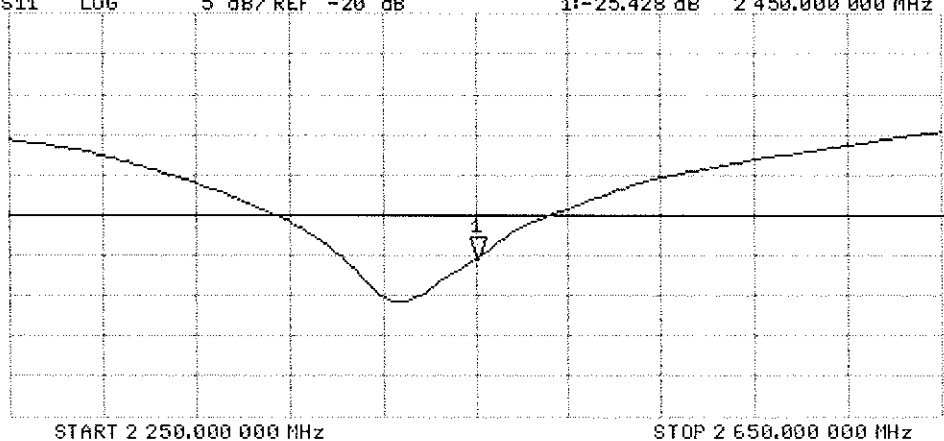


CH2 S11 LOG 5 dB/REF -20 dB 1:-25.428 dB 2 450.000 000 MHz

CA

Avg
16

H1d



DASY5 Validation Report for Body TSL

Date: 09.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:945

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 52.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

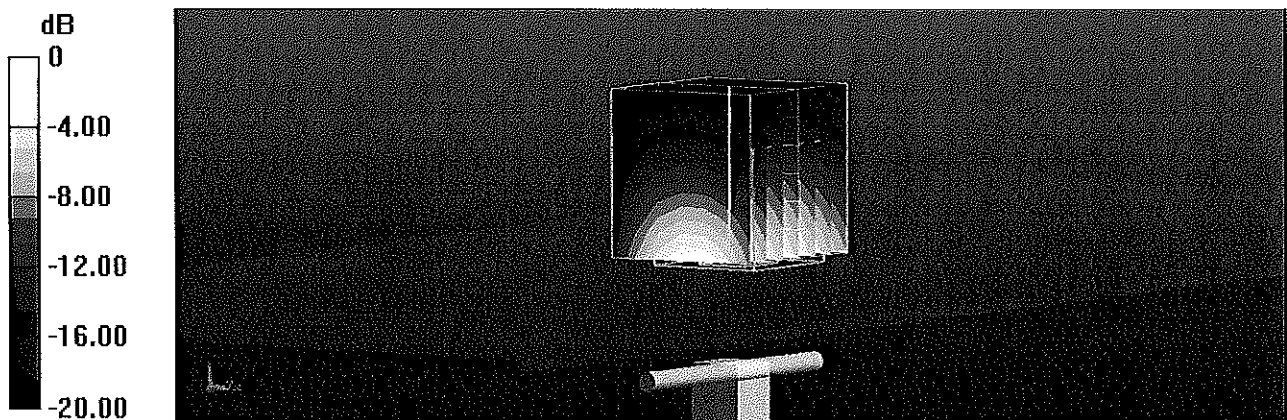
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.8 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 25.3 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.98 W/kg

Maximum value of SAR (measured) = 19.9 W/kg

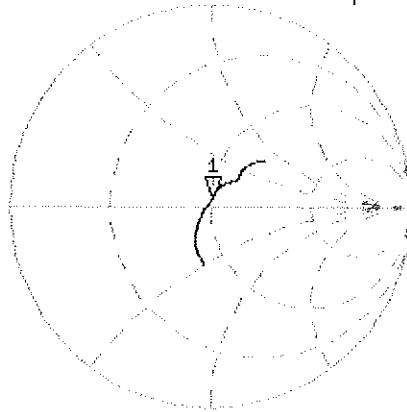


0 dB = 19.9 W/kg = 12.99 dBW/kg

Impedance Measurement Plot for Body TSL

9 May 2017 12:55:22
 CH1 S11 1 U FS 1: 50.646 Ω 3.6074 Ω 234.34 pF 2 450.000 000 MHz

*
 Del
 CA



Avg
 16

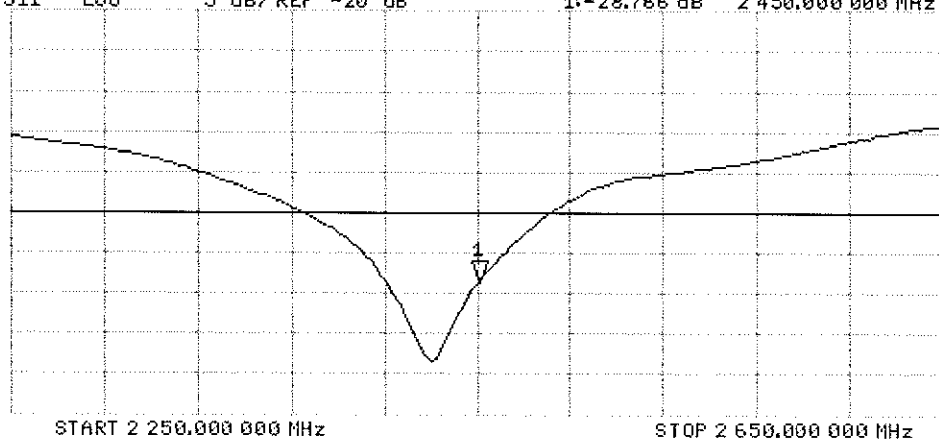
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -28.766 dB 2 450.000 000 MHz

CA

Avg
 16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2450V2-797_Sep16**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:797**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

BNV
09-28-2016

Calibration date: **September 13, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Jeton Kastrati** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature
[Handwritten signatures]

Issued: September 13, 2016

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	37.9 $\pm$ 6 %	1.88 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.6 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.6 $\pm$ 6 %	2.04 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.2 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.8 \Omega + 6.0 j\Omega$
Return Loss	- 23.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$50.8 \Omega + 8.0 j\Omega$
Return Loss	- 22.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 24, 2006

DASY5 Validation Report for Head TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:797

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.88$ S/m; $\epsilon_r = 37.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

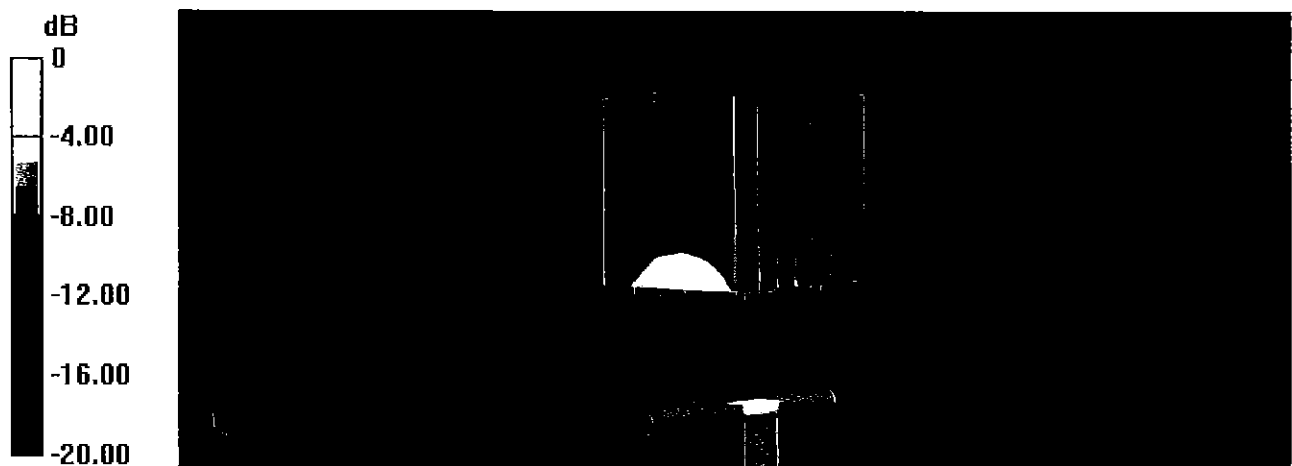
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 113.4 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.26 W/kg

Maximum value of SAR (measured) = 21.9 W/kg

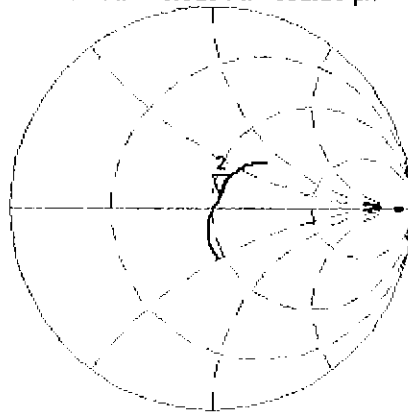


0 dB = 21.9 W/kg = 13.40 dBW/kg

Impedance Measurement Plot for Head TSL

12 Sep 2016 12:42:03
 CH1 S11 1 U FS 2: 53.771 Ω 6.0234 Ω 391.29 μH 2 450.000 000 MHz

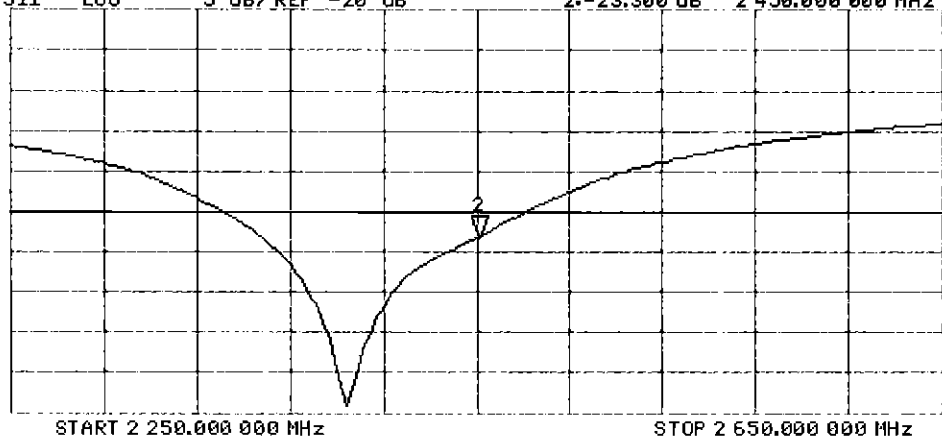
*
 De1
 CA



Avg
 16
 H1 d

CH2 S11 LOG 5 dB/REF -20 dB 2:-23.300 dB 2 450.000 000 MHz

CA
 Avg
 16
 H1 d



DASY5 Validation Report for Body TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:797

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.04$ S/m; $\epsilon_r = 51.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

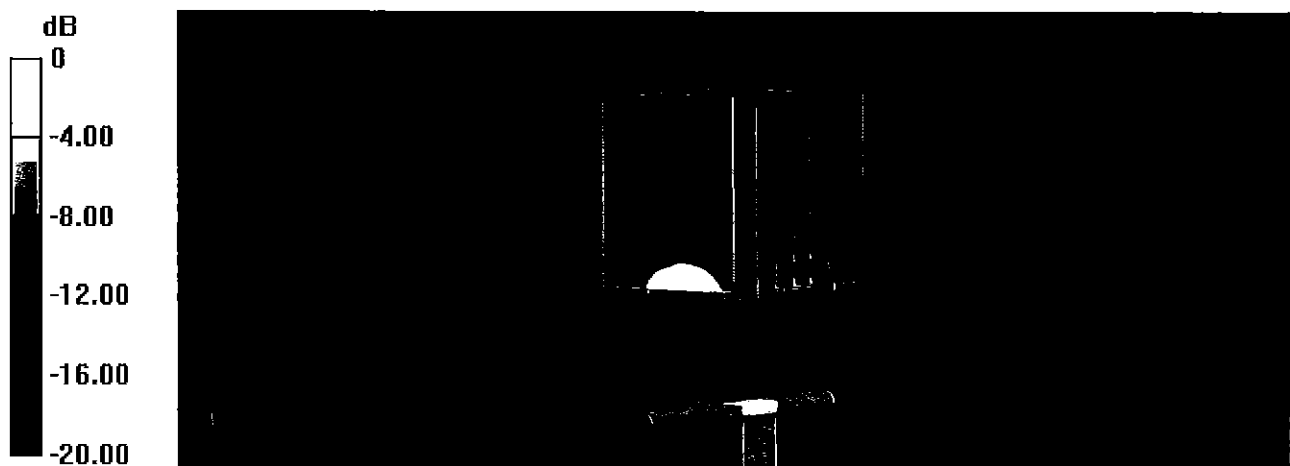
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.5 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 25.6 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.13 W/kg

Maximum value of SAR (measured) = 21.2 W/kg

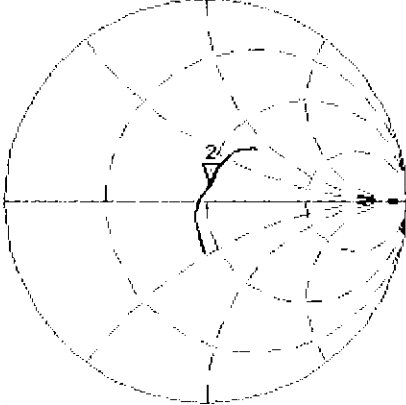


0 dB = 21.2 W/kg = 13.26 dBW/kg

Impedance Measurement Plot for Body TSL

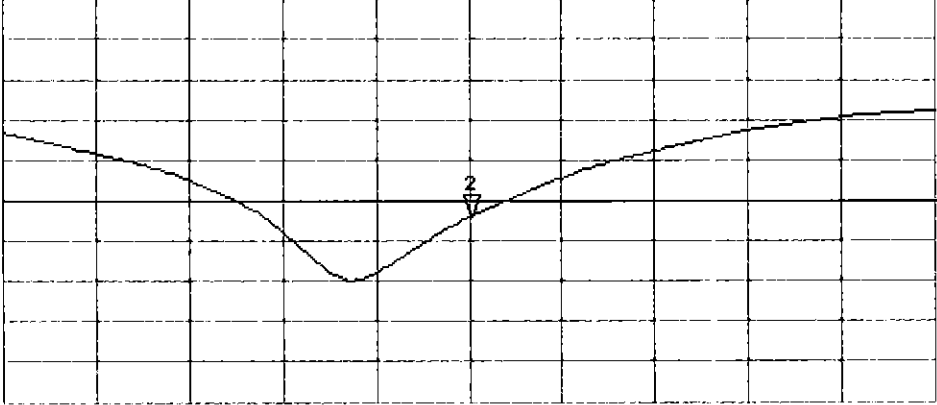
12 Sep 2016 12:40:39
[CH1] S11 1 U FS 2: 50.842 Ω 7.9531 Ω 516.64 μ H 2 450.000 000 MHz

*
De1
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 2:-22.037 dB 2 450.000 000 MHz

CA
Avg
16
H1d



START 2 250.000 000 MHz STOP 2 650.000 000 MHz



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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2600V2-1071_Sep16**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1071**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

BNV
 09-28-2016

Calibration date: **September 13, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Jeton Kastrati** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: September 13, 2016

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz $\pm$ 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	37.3 $\pm$ 6 %	2.05 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.3 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.1 $\pm$ 6 %	2.22 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	54.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.9 Ω - 6.7 j Ω
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.1 Ω - 2.1 j Ω
Return Loss	- 26.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.153 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 17, 2013

DASY5 Validation Report for Head TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1071

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.05$ S/m; $\epsilon_r = 37.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.56, 7.56, 7.56); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.1 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.4 W/kg

SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.45 W/kg

Maximum value of SAR (measured) = 24.6 W/kg

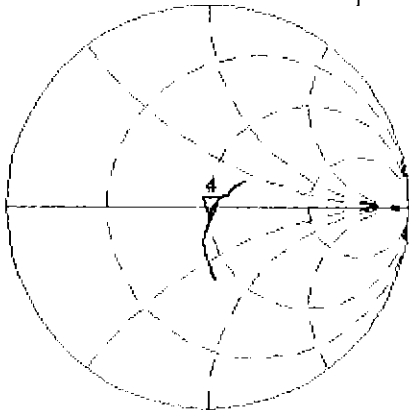


0 dB = 24.6 W/kg = 13.91 dBW/kg

Impedance Measurement Plot for Head TSL

12 Sep 2016 13:13:44
CH1 S11 1 U FS 4: 43.902 Ω -6.6523 Ω 9.2018 pF 2 600.000 000 MHz

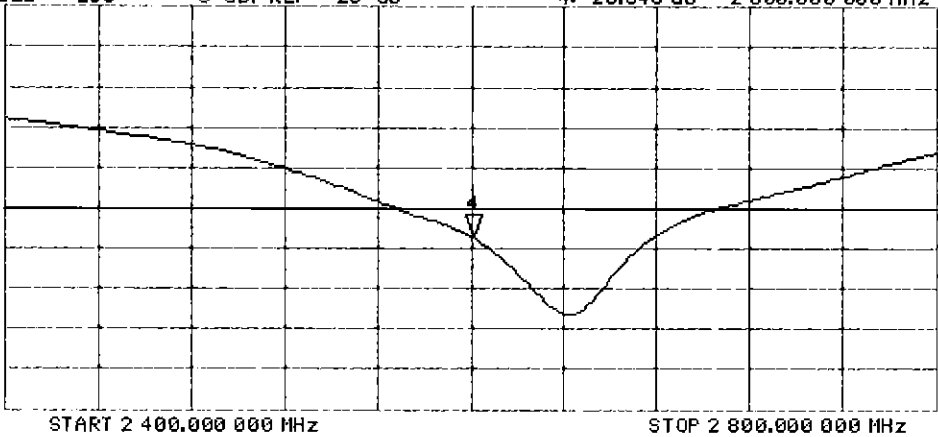
*
De l
CA



Avg
16
H1 d

CH2 S11 LOG 5 dB/ REF -20 dB 4:-23.548 dB 2 600.000 000 MHz

CA
Avg
16
H1 d



DASY5 Validation Report for Body TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1071

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.22$ S/m; $\epsilon_r = 51.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.48, 7.48, 7.48); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.7 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.2 W/kg

Maximum value of SAR (measured) = 23.3 W/kg

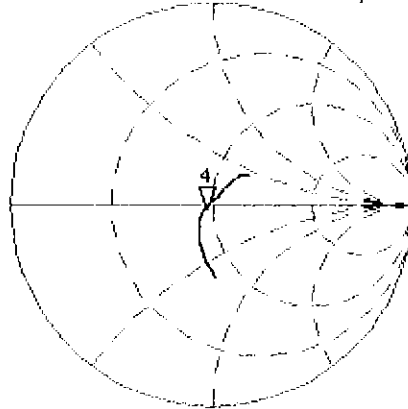


0 dB = 23.3 W/kg = 13.67 dBW/kg

Impedance Measurement Plot for Body TSL

12 Sep 2016 13:13:09
 CH1 S11 1 U FS 4: 46.078 Ω -2.0762 Ω 29.484 pF 2 600.000 000 MHz

*
 De l
 Ca



Avg
 16

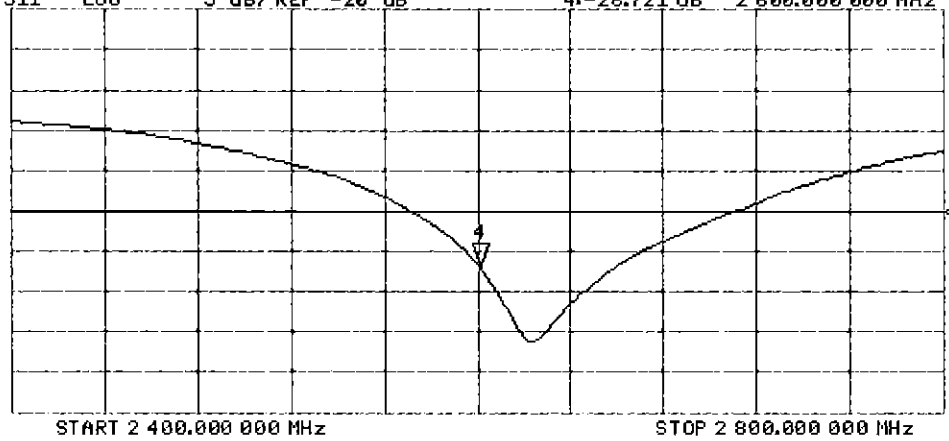
H1 d

CH2 S11 LOG 5 dB/REF -20 dB 4: -26.721 dB 2 600.000 000 MHz

Ca

Avg
 16

H1 d





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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D5GHzV2-1237_Aug16**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1237**

Calibration procedure(s) **QA CAL-22.v2**
Calibration procedure for dipole validation kits between 3-6 GHz

✓PN
8/9/16

Calibration date: **August 02, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 3503	30-Jun-16 (No. EX3-3503_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Claudio Leubler** Name: **Claudio Leubler** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager**

Signature

Issued: August 4, 2016

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Accreditation No.: **SCS 0108**

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

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 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 $\pm$ 0.2) °C	34.4 $\pm$ 6 %	4.52 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.2 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm ³ (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	22.7 W/kg $\pm$ 19.5 % (k=2)

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	33.9 ± 6 %	4.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °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	8.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.3 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg ± 19.5 % (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	33.7 ± 6 %	5.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.2 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.1 ± 6 %	5.42 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.54 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.0 W/kg ± 19.5 % (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	46.5 ± 6 %	5.88 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °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	7.76 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2 ± 6 %	6.11 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	$48.6 \Omega - 2.5 j\Omega$
Return Loss	- 30.7 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$50.9 \Omega + 1.5 j\Omega$
Return Loss	- 35.3 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	$53.8 \Omega + 5.8 j\Omega$
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	$47.0 \Omega - 3.9 j\Omega$
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	$51.5 \Omega + 3.9 j\Omega$
Return Loss	- 27.7 dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	$53.8 \Omega + 0.3 j\Omega$
Return Loss	- 28.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.193 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	May 04, 2015

DASY5 Validation Report for Head TSL

Date: 02.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1237

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.52$ S/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5600$ MHz; $\sigma = 4.86$ S/m; $\epsilon_r = 33.9$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5750$ MHz; $\sigma = 5.02$ S/m; $\epsilon_r = 33.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.42, 5.42, 5.42); Calibrated: 30.06.2016; ConvF(4.89, 4.89, 4.89); Calibrated: 30.06.2016, ConvF(4.85, 4.85, 4.85); Calibrated: 30.06.2016,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 74.10 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 8 W/kg; SAR(10 g) = 2.3 W/kg

Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 73.55 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 32.9 W/kg

SAR(1 g) = 8.43 W/kg; SAR(10 g) = 2.42 W/kg

Maximum value of SAR (measured) = 19.7 W/kg

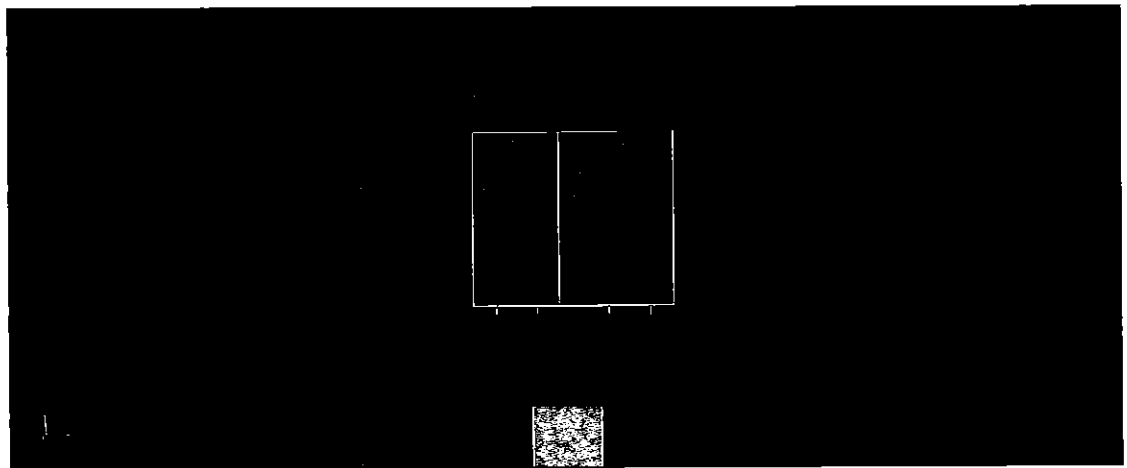
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.23 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 33.6 W/kg

SAR(1 g) = 8.25 W/kg; SAR(10 g) = 2.35 W/kg

Maximum value of SAR (measured) = 18.3 W/kg

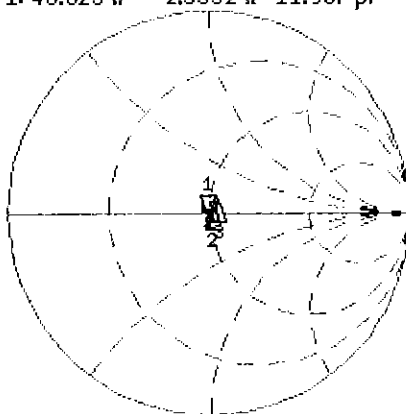


0 dB = 18.3 W/kg = 12.62 dBW/kg

Impedance Measurement Plot for Head TSL

2 Aug 2016 08:52:20
 CH1 S11 1 U FS 1: 48.623 Ω -2.5332 Ω 11.967 pF 5 250.000 000 MHz

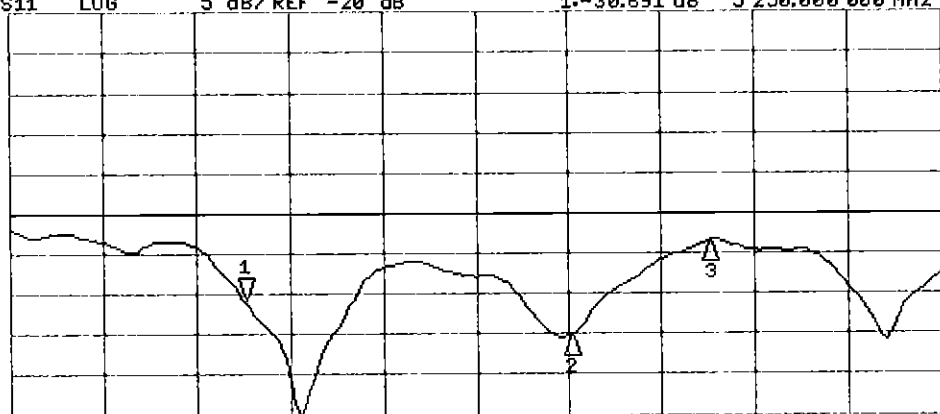
*
 Del
 Cor
 Avg
 16
 H1d



CH1 Markers
 2: 50.867 Ω
 1.4961 Ω
 5.60000 GHz
 3: 53.785 Ω
 5.8164 Ω
 5.75000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -30.691 dB 5 250.000 000 MHz

Cor
 Avg
 16
 H1d



CH2 Markers
 2: -35.297 dB
 5.60000 GHz
 3: -23.501 dB
 5.75000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 02.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1237

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 5.42$ S/m; $\epsilon_r = 47.1$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.88$ S/m; $\epsilon_r = 46.5$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5750$ MHz; $\sigma = 6.11$ S/m; $\epsilon_r = 46.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.85, 4.85, 4.85); Calibrated: 30.06.2016, ConvF(4.35, 4.35, 4.35); Calibrated: 30.06.2016, ConvF(4.3, 4.3, 4.3); Calibrated: 30.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAB4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.19 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 28.4 W/kg

SAR(1 g) = 7.54 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 17.3 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 66.80 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 31.9 W/kg

SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 18.3 W/kg

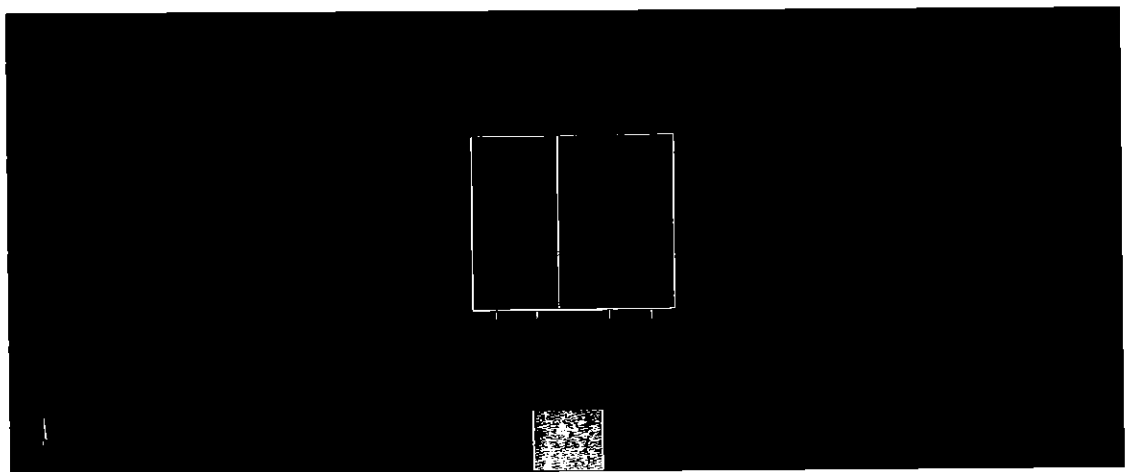
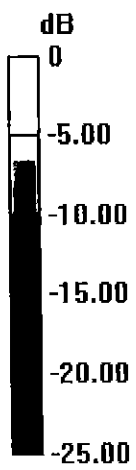
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.31 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 32.6 W/kg

SAR(1 g) = 7.6 W/kg; SAR(10 g) = 2.11 W/kg

Maximum value of SAR (measured) = 18.4 W/kg

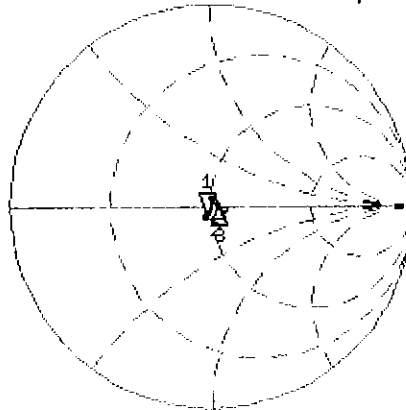


0 dB = 17.3 W/kg = 12.38 dBW/kg

Impedance Measurement Plot for Body TSL

2 Aug 2016 08:49:13
 CH1 S11 1 U FS 1: 46.998 Ω -3.8984 Ω 7.7763 pF 5 250.000 000 MHz

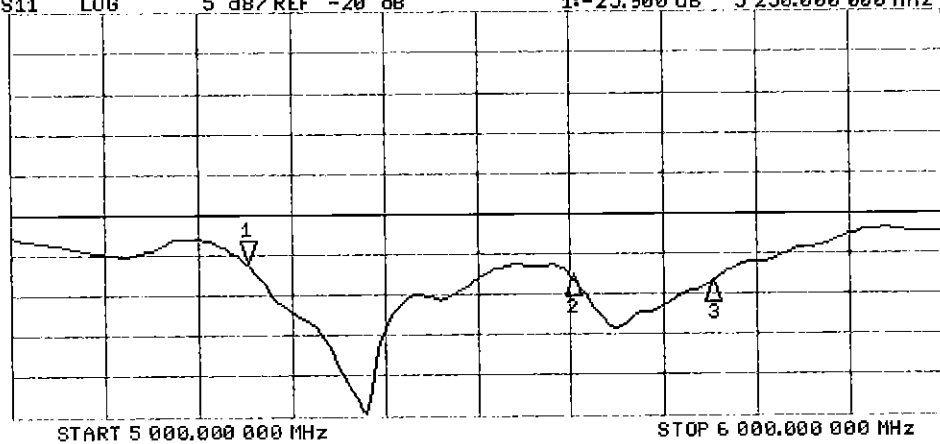
*
 Del
 Cor
 Avg
 16
 H1d



CH1 Markers
 2: 51.525 Ω
 3.8945 Ω
 5.60000 GHz
 3: 53.848 Ω
 0.2930 Ω
 5.75000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.900 dB 5 250.000 000 MHz

Cor
 Avg
 16
 H1d



CH2 Markers
 2:-27.699 dB
 5.60000 GHz
 3:-28.596 dB
 5.75000 GHz



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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D835V2-4d180_May17**

CALIBRATION CERTIFICATE

Object **D835V2 - SN:4d180**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **May 11, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Johannes Kurikka** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

[Handwritten signatures]

Issued: May 11, 2017

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 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	40.8 $\pm$ 6 %	0.94 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.26 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.07 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	55.2 $\pm$ 6 %	0.99 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.61 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.32 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.9 Ω - 5.0 j Ω
Return Loss	- 25.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.7 Ω - 8.6 j Ω
Return Loss	- 20.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.393 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 24, 2014

DASY5 Validation Report for Head TSL

Date: 11.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d180

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.94 \text{ S/m}$; $\epsilon_r = 40.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1444); SEMCAD X 14.6.10(7416)

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

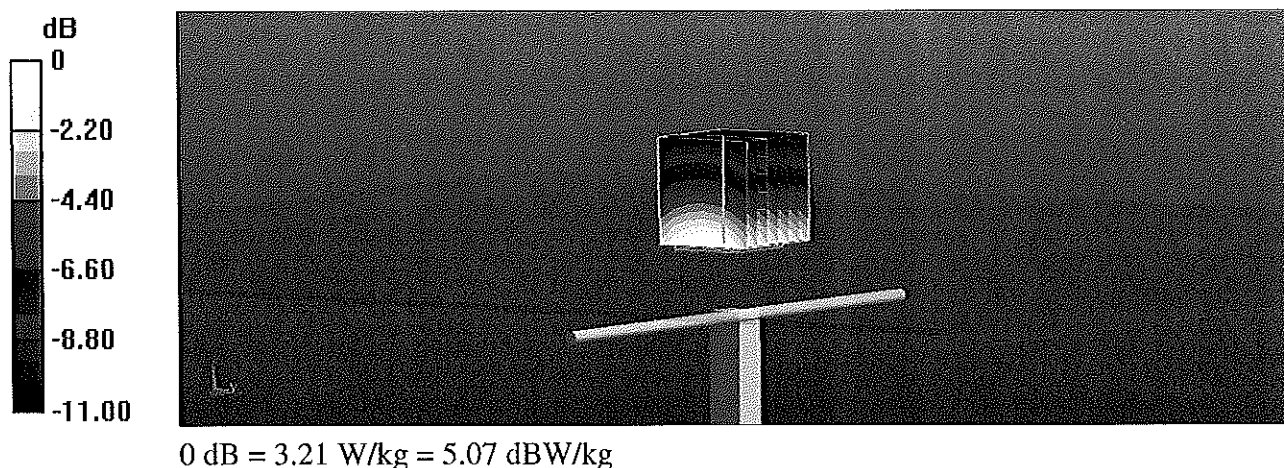
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 62.02 V/m; Power Drift = -0.02 dB

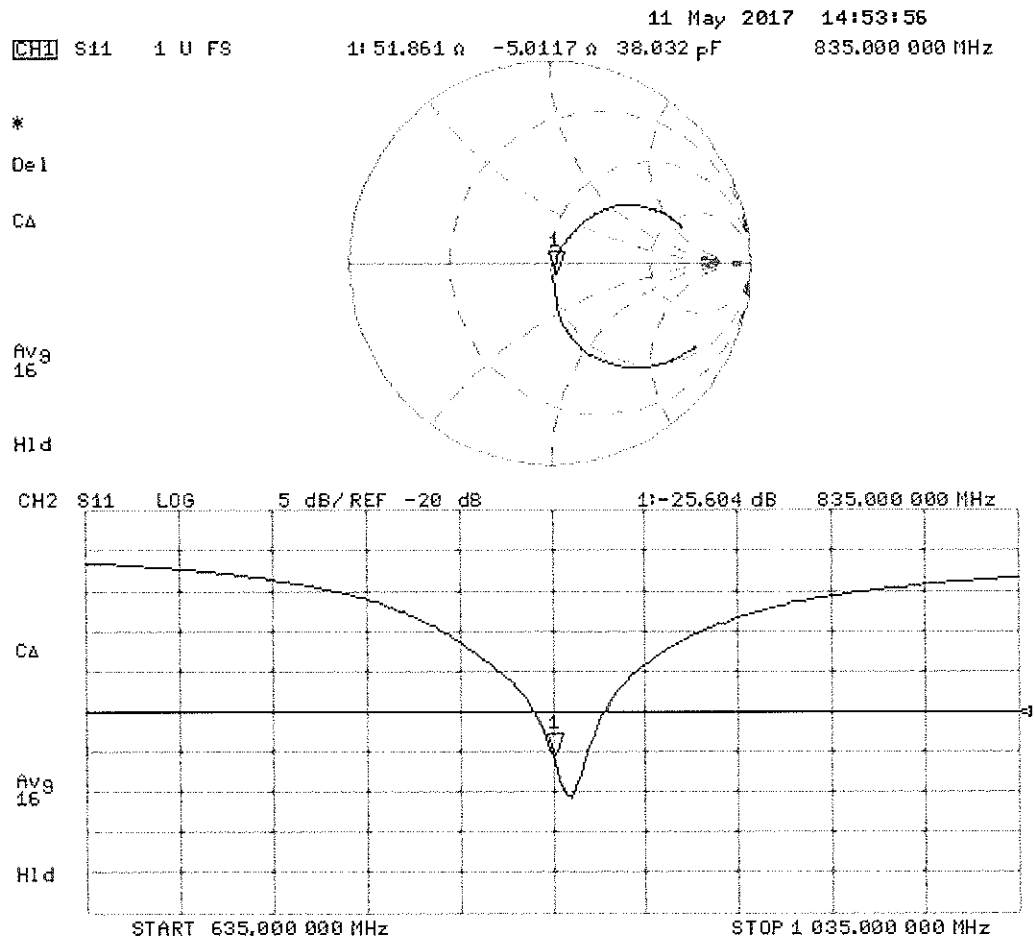
Peak SAR (extrapolated) = 3.58 W/kg

SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (measured) = 3.21 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 11.05.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d180

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.99 \text{ S/m}$; $\epsilon_r = 55.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1444); SEMCAD X 14.6.10(7416)

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

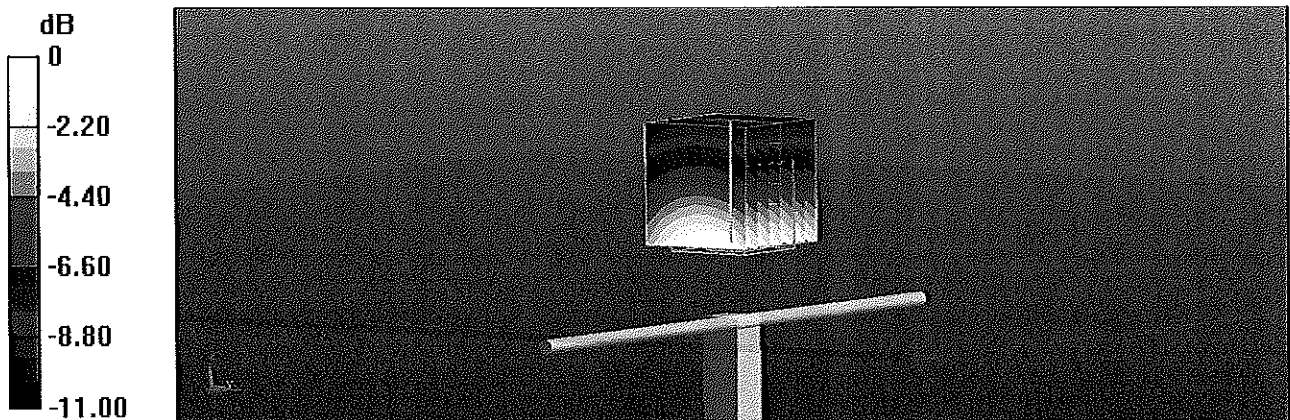
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.10 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.58 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.6 W/kg

Maximum value of SAR (measured) = 3.19 W/kg

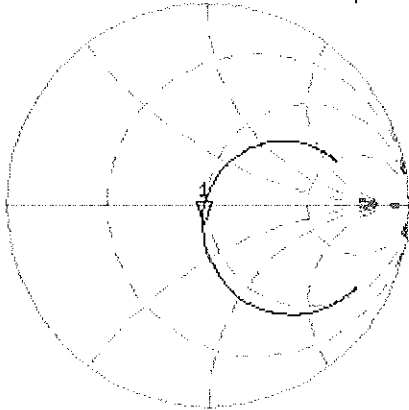


0 dB = 3.19 W/kg = 5.04 dBW/kg

Impedance Measurement Plot for Body TSL

11 May 2017 14:30:26
[CH1] S11 1 U FS 1: 46.727 Ω -8.5898 Ω 22.190 pF 835.000 000 MHz

*
De1
CA



Avg
16

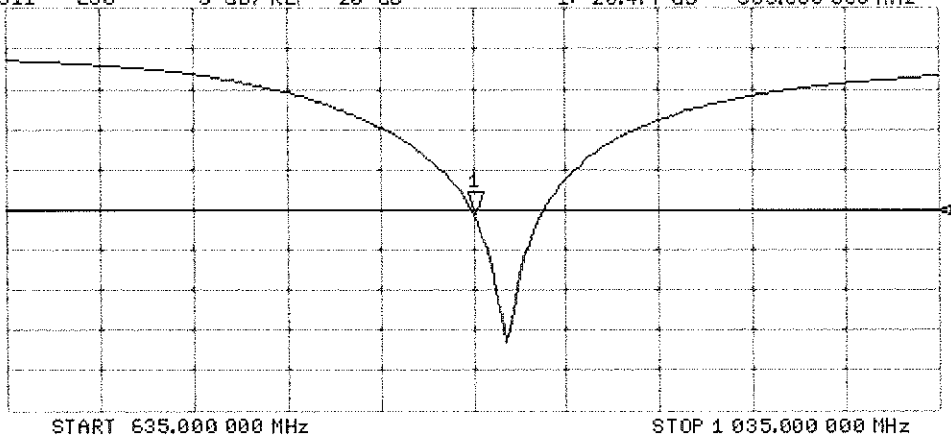
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-20.477 dB 835.000 000 MHz

CA

Avg
16

H1d





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Client **PC Test**

Certificate No: **D2450V2-882_Feb17**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:882**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

BNV
03-01-2017

Calibration date: **February 13, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Jeton Kastrati** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: February 14, 2017

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	37.5 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.6 $\pm$ 6 %	2.02 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.90 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.3 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω + 0.8 j Ω
Return Loss	- 29.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.6 Ω + 2.1 j Ω
Return Loss	- 31.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 06, 2011

DASY5 Validation Report for Head TSL

Date: 10.02.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:882

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.87$ S/m; $\epsilon_r = 37.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

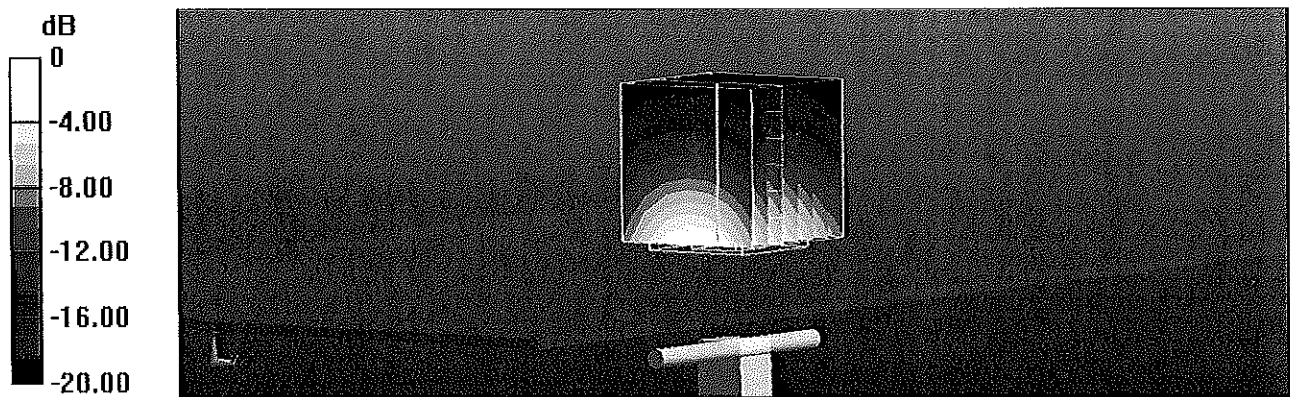
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 112.5 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.1 W/kg

Maximum value of SAR (measured) = 21.8 W/kg

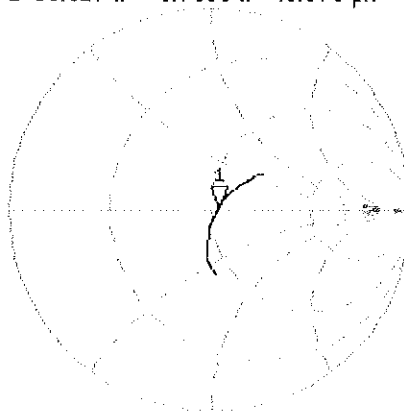


0 dB = 21.8 W/kg = 13.38 dBW/kg

Impedance Measurement Plot for Head TSL

10 Feb 2017 13:03:29
 [CH1] S11 1 U FS 1: 53.527 Ω 0.7539 Ω 48.975 μ H 2 450.000 000 MHz

*
 Del
 CA



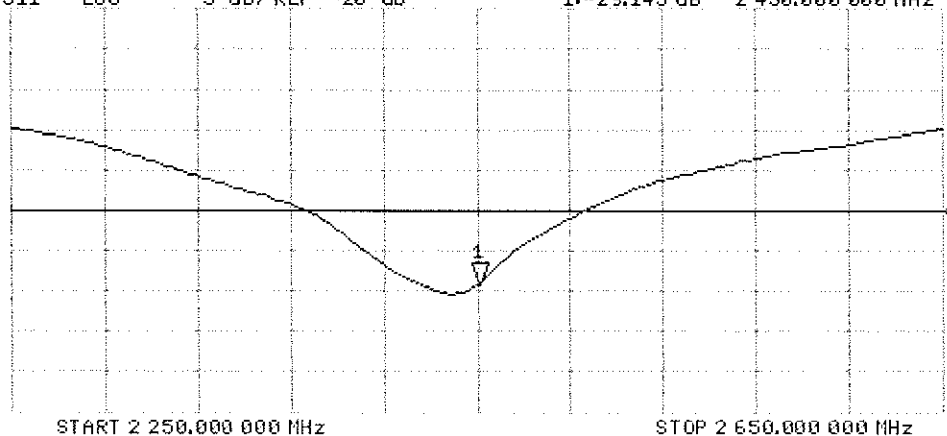
Avg
 16
 H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -29.145 dB 2 450.000 000 MHz

CA

Avg
 16

H1d



DASY5 Validation Report for Body TSL

Date: 13.02.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:882

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 51.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

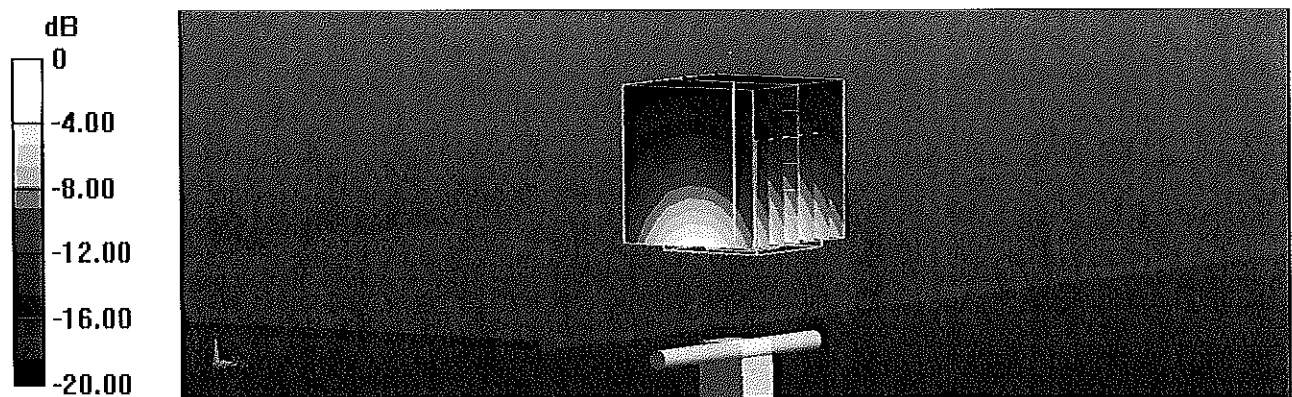
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.6 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 26.2 W/kg

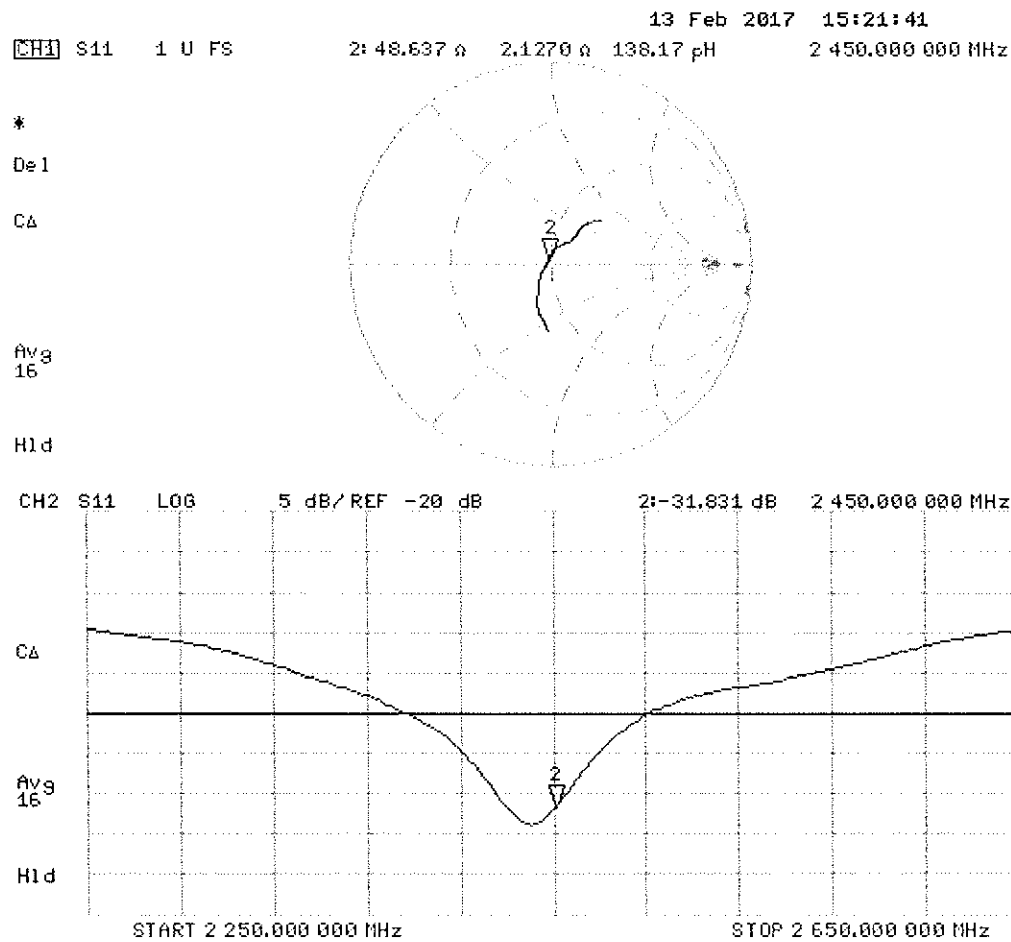
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.9 W/kg

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



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

Impedance Measurement Plot for Body TSL





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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2600V2-1004_Apr17**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1004**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **April 13, 2017**

*BNV
5-3-2017*

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Michael Weber** Name: **Michael Weber** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager**

Signature

[Signature of Michael Weber]

[Signature of Katja Pokovic]

Issued: April 18, 2017

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Accreditation No.: **SCS 0108**

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz $\pm$ 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	37.1 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.7 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.1 $\pm$ 6 %	2.21 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	14.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	55.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.9 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.5 Ω - 5.9 j Ω
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.7 Ω - 4.9 j Ω
Return Loss	- 22.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 23, 2006

DASY5 Validation Report for Head TSL

Date: 13.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1004

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.56, 7.56, 7.56); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

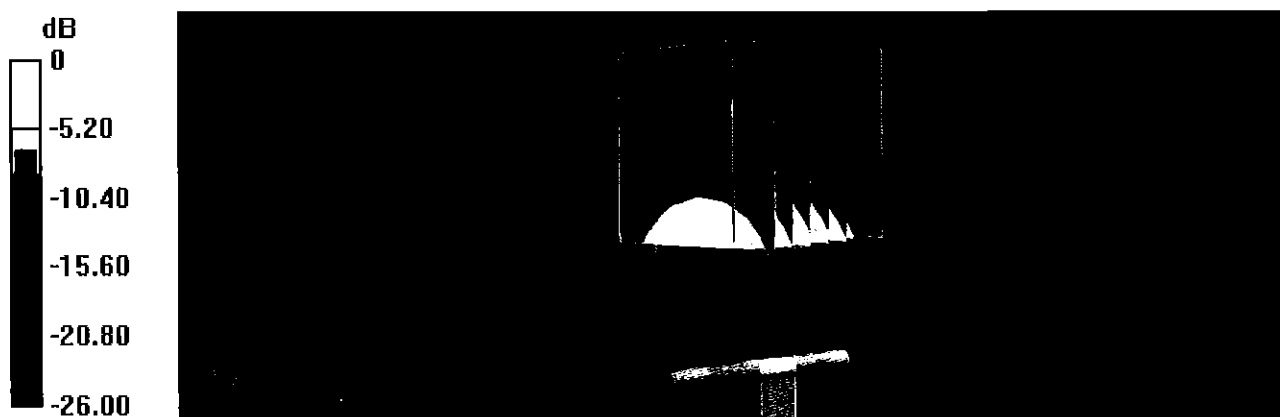
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.4 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 31.2 W/kg

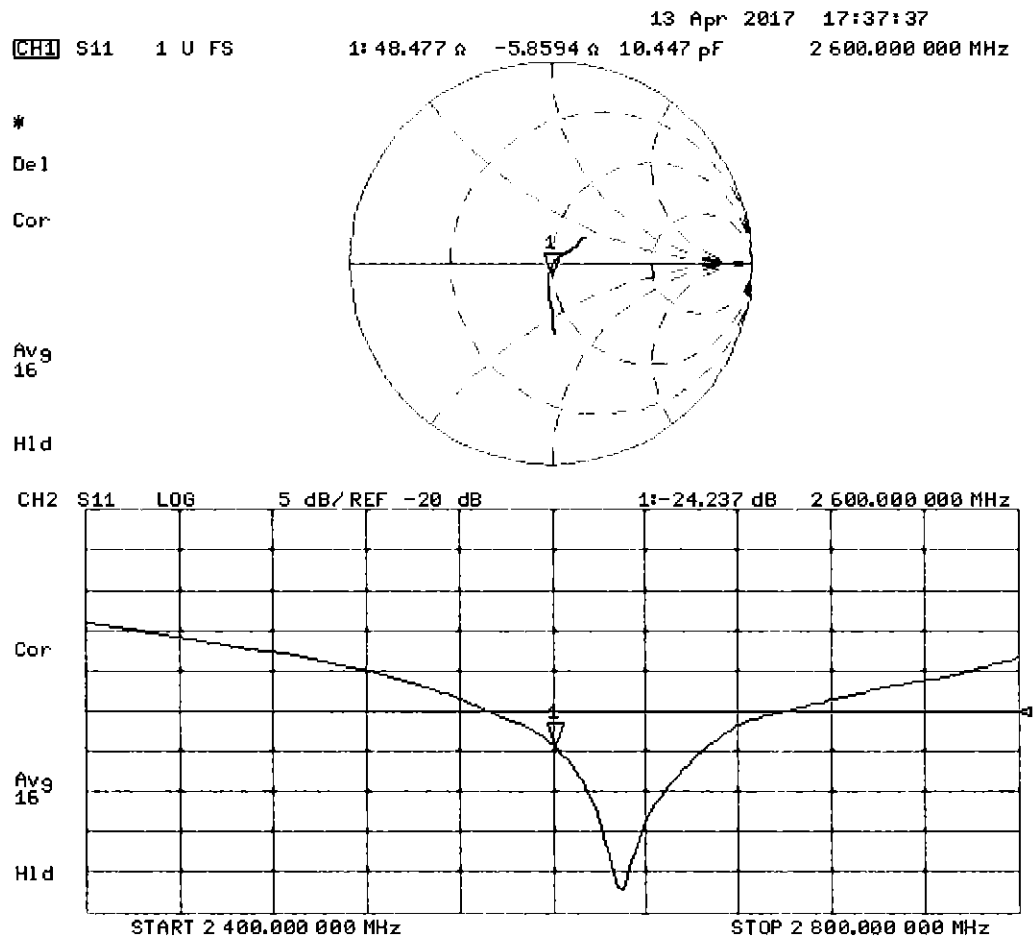
SAR(1 g) = 14.8 W/kg; SAR(10 g) = 6.54 W/kg

Maximum value of SAR (measured) = 24.6 W/kg



0 dB = 24.6 W/kg = 13.91 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 10.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1004

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.21$ S/m; $\epsilon_r = 52.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.48, 7.48, 7.48); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

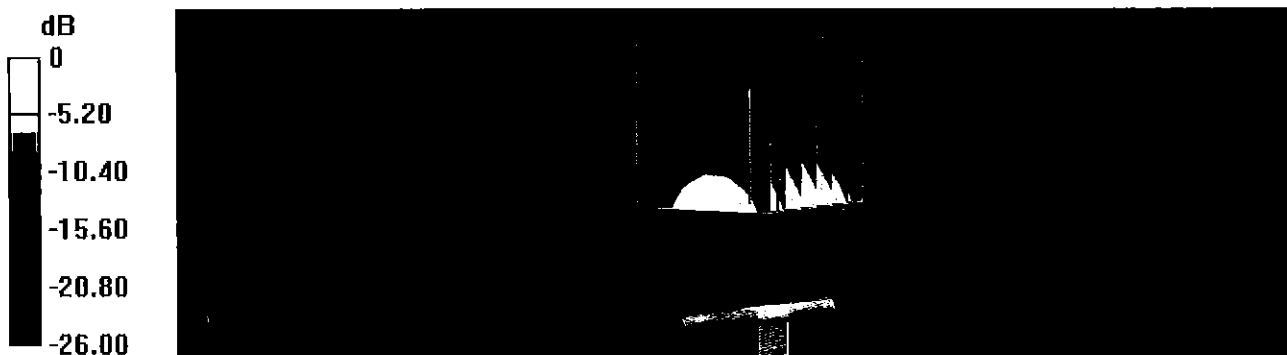
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.3 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 28.2 W/kg

SAR(1 g) = 14 W/kg; SAR(10 g) = 6.26 W/kg

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

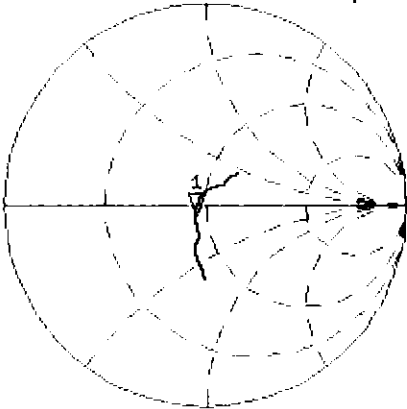


0 dB = 22.0 W/kg = 13.42 dBW/kg

Impedance Measurement Plot for Body TSL

10 Apr 2017 14:58:52
CH1 S11 1 U FS 1: 44.701 Ω -4.8926 Ω 12.511 pF 2 600.000 000 MHz

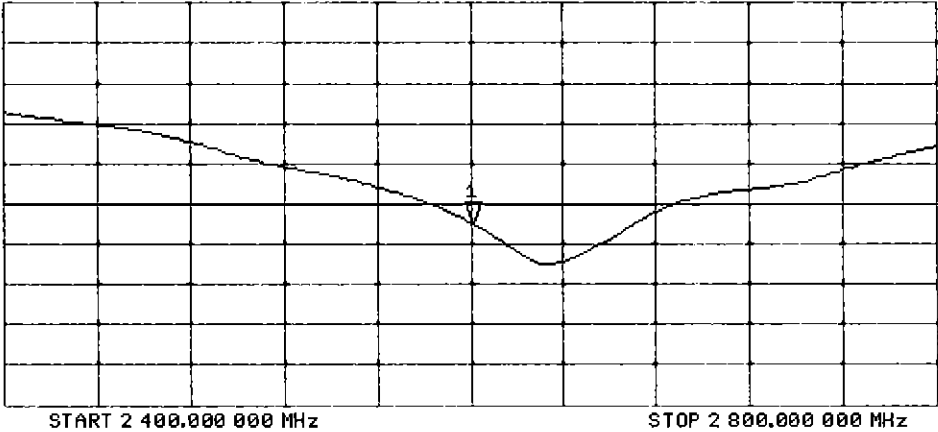
*
De1
CA



Av9
16
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-22.378 dB 2 600.000 000 MHz

CA
Av9
16
H1d





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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D5GHzV2-1123_Mar17**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1123**

Calibration procedure(s) **QA CAL-22.v2**
Calibration procedure for dipole validation kits between 3-6 GHz

BNV
03-27-2017

Calibration date: **March 09, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 3503	31-Dec-16 (No. EX3-3503_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Johannes Kurikka** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

[Handwritten signature]
[Handwritten signature]

Issued: March 10, 2017

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Accreditation No.: **SCS 0108**

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

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 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 $\pm$ 0.2) °C	34.9 $\pm$ 6 %	4.57 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.98 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.3 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg $\pm$ 19.5 % (k=2)

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 $\pm$ 0.2) °C	34.4 $\pm$ 6 %	4.92 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °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	8.49 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.2 W / kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg $\pm$ 19.5 % (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	34.2 ± 6 %	5.07 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.1 ± 6 %	5.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.61 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg ± 19.5 % (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	47.5 ± 6 %	5.99 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °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	7.91 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	78.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.2 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.65 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	51.6 Ω - 5.7 j Ω
Return Loss	- 24.7 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.9 Ω - 0.7 j Ω
Return Loss	- 25.1 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.7 Ω + 1.2 j Ω
Return Loss	- 23.9 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	51.8 Ω - 3.8 j Ω
Return Loss	- 27.7 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.2 Ω + 1.4 j Ω
Return Loss	- 22.3 dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	57.3 Ω + 3.7 j Ω
Return Loss	- 22.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.205 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 08.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1123

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 4.57$ S/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.92$ S/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 5.07$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.58, 5.58, 5.58); Calibrated: 31.12.2016, ConvF(5.09, 5.09, 5.09); Calibrated: 31.12.2016, ConvF(5.02, 5.02, 5.02); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.62 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 29.9 W/kg

SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.47 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 34.1 W/kg

SAR(1 g) = 8.49 W/kg; SAR(10 g) = 2.42 W/kg

Maximum value of SAR (measured) = 19.8 W/kg

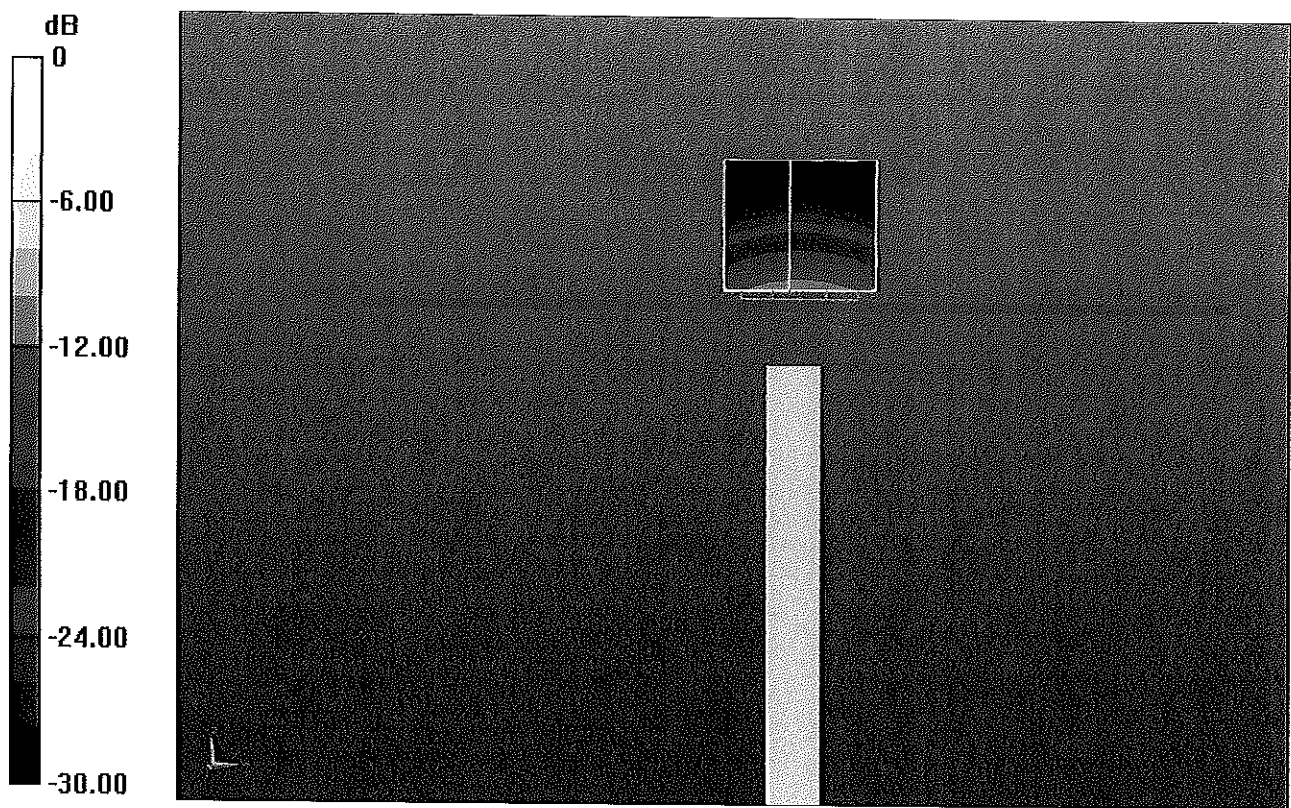
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.34 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 34.6 W/kg

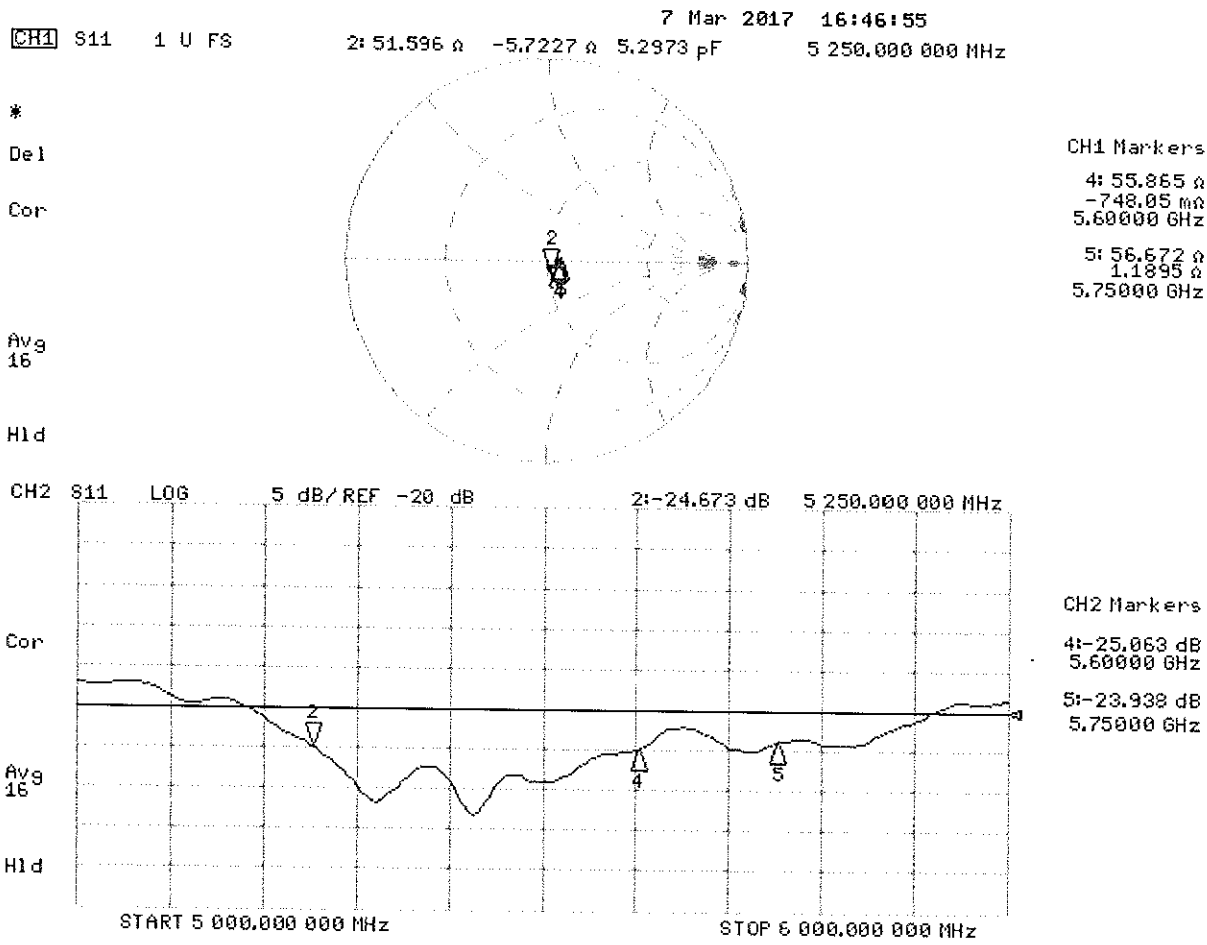
SAR(1 g) = 8.3 W/kg; SAR(10 g) = 2.35 W/kg

Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 18.3 W/kg = 12.62 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 09.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1123

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 5.52$ S/m; $\epsilon_r = 48.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.99$ S/m; $\epsilon_r = 47.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 6.21$ S/m; $\epsilon_r = 47.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.14, 5.14, 5.14); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 31.12.2016, ConvF(4.52, 4.52, 4.52); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.40 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 29.1 W/kg

SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.14 W/kg

Maximum value of SAR (measured) = 17.5 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.91 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 33.2 W/kg

SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.22 W/kg

Maximum value of SAR (measured) = 18.7 W/kg

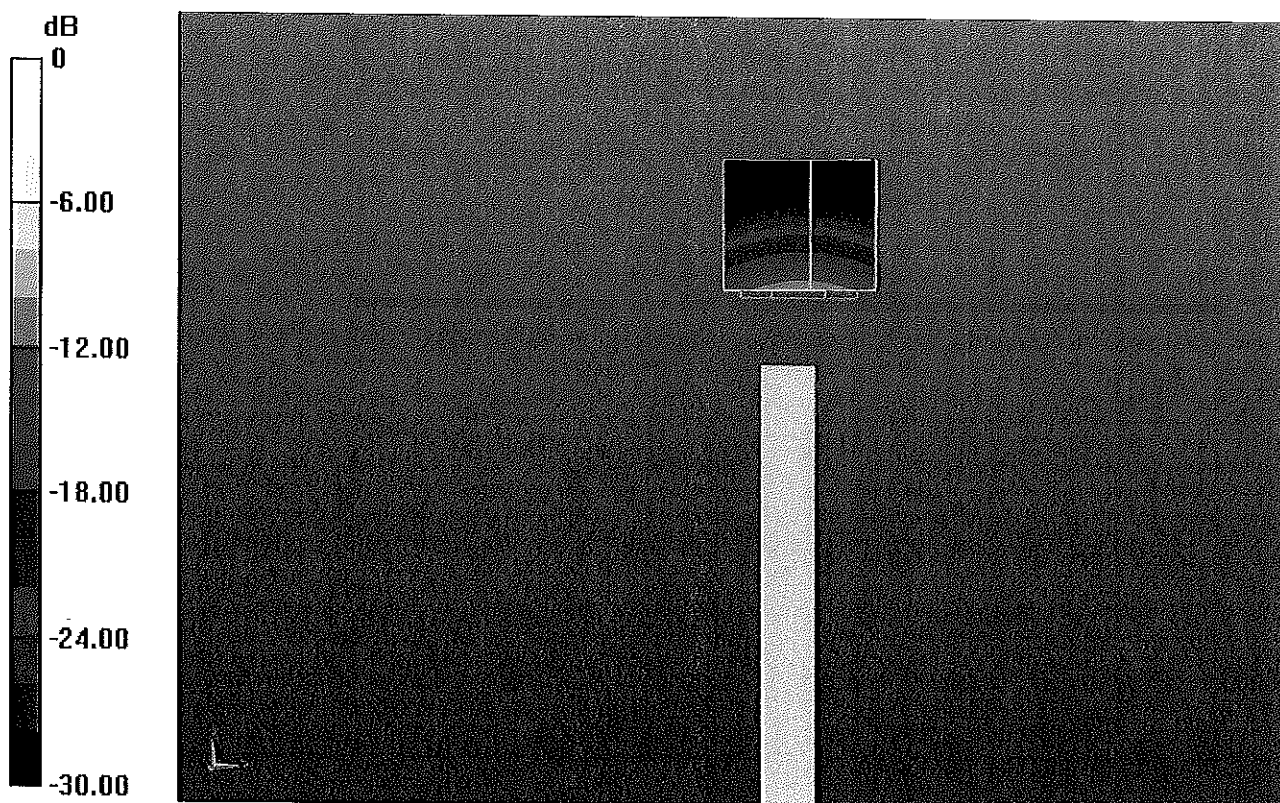
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.25 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 33.4 W/kg

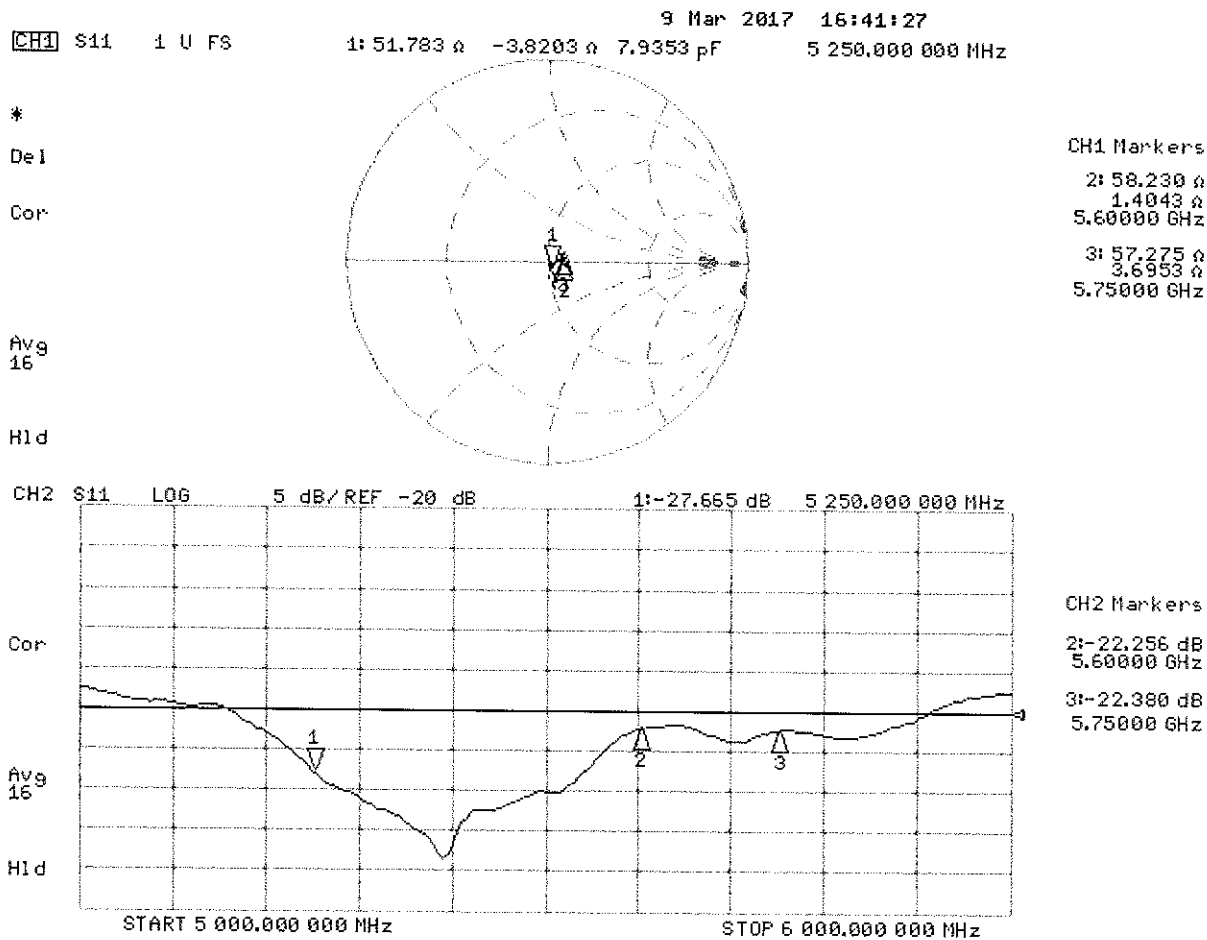
SAR(1 g) = 7.65 W/kg; SAR(10 g) = 2.14 W/kg

Maximum value of SAR (measured) = 18.3 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

Impedance Measurement Plot for Body TSL



APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity ϵ' can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

Table D-I
Composition of the Tissue Equivalent Matter

Frequency (MHz)	750	750	835	835	1750	1750	1900	1900	2300-2600	2300-2600	5200-5800	5200-5800
Tissue	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Ingredients (% by weight)												
Bactericide	See page 2-3	See page 2	0.1	0.1					See page 4	26.7	See page 5	
DGBE					47	31	44.92	29.44				
HEC			1	1								
NaCl			1.45	0.94	0.4	0.2	0.18	0.39				
Sucrose			57	44.9								20
Polysorbate (Tween) 80												80
Water			40.45	53.06	52.6	68.8	54.9	70.17		73.2		

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset			APPENDIX D: Page 1 of 5

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

H ₂ O	Water, 35 – 58%
Sucrose	Sugar, white, refined, 40 – 60%
NaCl	Sodium Chloride, 0 – 6%
Hydroxyethyl-cellulose	Medium Viscosity (CAS# 9004-62-0), <0.3%
Preventol-D7	Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone, 0.1 – 0.7%
Relevant for safety; Refer to the respective Safety Data Sheet*.	

Figure D-1

Composition of 750 MHz Head and Body Tissue Equivalent Matter

Note: 750MHz liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	Body Tissue Simulating Liquid (MSL750V2)
Product No.	SL AAM 075 AA (Batch: 150518-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

Validation results were within $\pm 2.5\%$ towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient	Environment temperatur (22 $\pm$ 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	20-Apr-16
Operator	WM

Additional Information

TSL Density	1.212 g/cm ³
TSL Heat-capacity	3.006 kJ/(kg*K)

f [MHz]	Measured			Target			Diff. to Target [%]	
	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma	
600	57.2	24.76	0.83	56.1	0.95	2.0	-13.2	
625	57.0	24.43	0.85	56.0	0.95	1.7	-11.0	
650	56.7	24.11	0.87	55.9	0.96	1.4	-8.8	
675	56.4	23.82	0.89	55.8	0.96	1.1	-6.6	
700	56.1	23.53	0.92	55.7	0.96	0.7	-4.5	
725	55.9	23.32	0.94	55.6	0.96	0.5	-2.2	
750	55.7	23.12	0.96	55.5	0.96	0.2	0.1	
775	55.4	22.93	0.99	55.4	0.97	-0.1	2.4	
800	55.1	22.73	1.01	55.3	0.97	-0.4	4.6	
825	54.9	22.59	1.04	55.2	0.98	-0.7	6.0	
838	54.8	22.52	1.05	55.2	0.98	-0.8	6.7	
850	54.6	22.45	1.06	55.2	0.99	-0.9	7.4	
875	54.4	22.32	1.09	55.1	1.02	-1.2	6.6	
900	54.1	22.19	1.11	55.0	1.05	-1.6	5.8	
925	53.9	22.09	1.14	55.0	1.06	-1.9	6.9	
950	53.7	21.98	1.16	54.9	1.08	-2.2	8.0	
975	53.5	21.91	1.19	54.9	1.09	-2.6	9.3	
1000	53.2	21.83	1.21	54.8	1.10	-2.9	10.6	

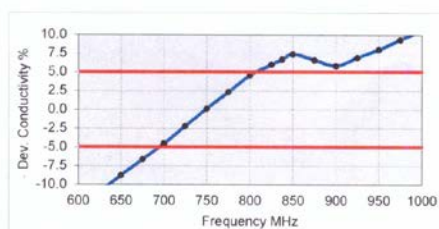
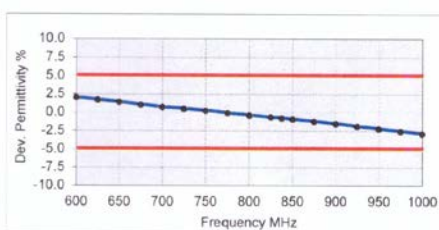


Figure D-2
750MHz Body Tissue Equivalent Matter

FCC ID: ZNFV30A		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset	APPENDIX D: Page 2 of 5		
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Measurement Certificate / Material Test

Item Name	Head Tissue Simulating Liquid (HSL750V2)
Product No.	SL AAH 075 AB (Batch: 160322-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

Validation results were within $\pm 2.5\%$ towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient Environment temperatur (22 ± 3)°C and humidity < 70%.
 TSL Temperature 22°C
 Test Date 23-Mar-16
 Operator WM

Additional Information

TSL Density 1.284 g/cm³
 TSL Heat-capacity 2.701 kJ/(kg*K)

f [MHz]	Measured			Target		Diff.to Target [%]	
	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	44.9	22.60	0.75	42.7	0.88	5.1	-14.4
625	44.5	22.37	0.78	42.6	0.88	4.5	-12.0
650	44.2	22.13	0.80	42.5	0.89	4.0	-9.6
675	43.8	21.90	0.82	42.3	0.89	3.4	-7.4
700	43.4	21.67	0.84	42.2	0.89	2.8	-5.1
725	43.1	21.52	0.87	42.1	0.89	2.4	-2.6
750	42.8	21.37	0.89	41.9	0.89	2.0	-0.2
775	42.4	21.21	0.91	41.8	0.90	1.5	2.1
800	42.1	21.04	0.94	41.7	0.90	0.9	4.4
825	41.8	20.92	0.96	41.6	0.91	0.5	5.9
838	41.6	20.86	0.97	41.5	0.91	0.2	6.6
850	41.5	20.79	0.98	41.5	0.92	0.0	7.3
875	41.2	20.68	1.01	41.5	0.94	-0.7	6.7
900	40.9	20.56	1.03	41.5	0.97	-1.5	6.1
925	40.6	20.48	1.05	41.5	0.98	-2.0	7.3
950	40.3	20.39	1.08	41.4	0.99	-2.6	8.3
975	40.1	20.29	1.10	41.4	1.00	-3.2	9.5
1000	39.8	20.20	1.12	41.3	1.01	-3.7	10.7

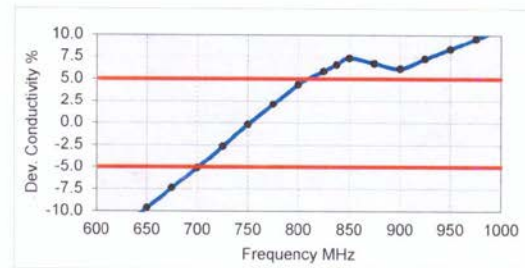
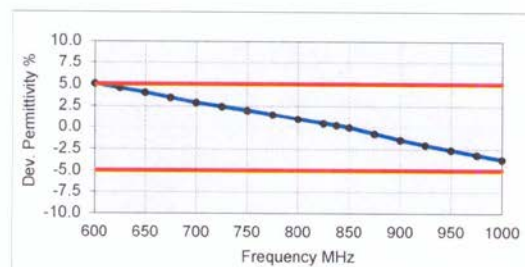


Figure D-3
750MHz Head Tissue Equivalent Matter

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset			APPENDIX D: Page 3 of 5
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3 Composition / Information on ingredients

The Item is composed of the following ingredients:

Water	50 – 73 %	
Non-ionic detergents	25 – 50 %	polyoxyethylenesorbitan monolaurate
NaCl	0 – 2 %	
Preservative	0.05 – 0.1 %	Preventol-D7

Safety relevant ingredients:

CAS-No. 55965-84-9	< 0.1 %	aqueous preparation, containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone
CAS-No. 9005-64-5	< 50 %	polyoxyethylenesorbitan monolaurate

According to international guidelines, the product is not a dangerous mixture and therefore not required to be marked by symbols.

Figure D-4
Composition of 2.4 GHz Head Tissue Equivalent Matter

Note: 2.4 GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	Head Tissue Simulating Liquid (HBBL1900-3800V3)
Product No.	SL AAH 196 AB (Batch: 160330-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

Validation results were within $\pm 2.5\%$ towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	30-Mar-16
Operator	WM

Additional Information

TSL Density 1.054 g/cm³

TSL Heat-capacity 3.389 kJ/(kg·K)

f [MHz]	ε'	ε''	σ [S/m]	Target ε'	Target ε''	Δ-ε'	Δ-ε''
1900	40.7	12.3	1.3	40.0	1.4	1.7	-6.9
1950	40.5	12.5	1.4	40.0	1.4	1.2	-3.3
2000	40.3	12.6	1.4	40.0	1.4	0.8	0.1
2050	40.1	12.7	1.5	39.9	1.4	0.6	0.5
2100	39.9	12.9	1.5	39.8	1.5	0.3	0.9
2150	39.8	13.0	1.6	39.7	1.5	-0.1	1.2
2200	39.6	13.1	1.6	39.6	1.6	-0.2	1.7
2250	39.4	13.2	1.7	39.6	1.6	-0.3	2.0
2300	39.2	13.3	1.7	39.5	1.7	-0.6	2.4
2350	39.1	13.5	1.8	39.4	1.7	-0.8	2.9
2400	38.9	13.6	1.8	39.3	1.8	-1.0	3.4
2450	38.7	13.7	1.9	39.2	1.8	-1.2	4.0
2500	38.5	13.8	1.9	39.1	1.9	-1.5	3.9
2550	38.3	13.9	2.0	39.1	1.9	-1.9	3.5
2600	38.2	14.1	2.0	39.0	2.0	-2.2	3.8
2650	37.9	14.2	2.1	38.9	2.0	-2.6	3.8
2700	37.8	14.3	2.2	38.9	2.1	-2.8	3.9
2750	37.5	14.4	2.2	38.8	2.1	-3.3	3.6
2800	37.4	14.5	2.3	38.8	2.2	-3.6	3.6
2850	37.2	14.6	2.3	38.7	2.2	-3.9	3.7
2900	37.0	14.7	2.4	38.6	2.3	-4.1	3.8
2950	36.8	14.8	2.4	38.6	2.3	-4.5	3.7
3000	36.6	14.9	2.5	38.5	2.4	-4.8	3.6
3050	36.4	15.0	2.5	38.4	2.5	-5.2	3.8
3100	36.2	15.1	2.6	38.4	2.5	-5.6	3.8
3150	36.1	15.2	2.7	38.3	2.6	-5.9	4.0
3200	35.9	15.2	2.7	38.3	2.6	-6.2	3.9
3250	35.7	15.3	2.8	38.2	2.7	-6.6	4.1
3300	35.5	15.3	2.8	38.2	2.7	-6.9	4.0
3350	35.4	15.4	2.9	38.1	2.8	-7.2	4.2
3400	35.2	15.5	2.9	38.0	2.8	-7.5	4.1
3450	35.0	15.5	3.0	38.0	2.9	-7.8	4.2
3500	34.9	15.6	3.0	37.9	2.9	-8.1	4.2
3550	34.7	15.6	3.1	37.9	3.0	-8.4	4.2
3600	34.5	15.7	3.1	37.8	3.0	-8.7	4.4
3650	34.4	15.8	3.2	37.8	3.1	-9.0	4.3
3700	34.2	15.8	3.3	37.7	3.1	-9.3	4.5
3750	34.1	15.9	3.3	37.6	3.2	-9.5	4.4
3800	33.9	15.9	3.4	37.6	3.2	-9.9	4.7
3850	33.7	16.0	3.4	37.5	3.3	-10.1	4.7

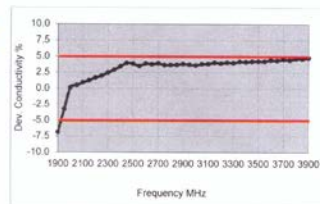
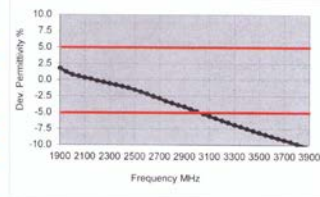


Figure D-5
2.4 GHz Head Tissue Equivalent Matter

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset			APPENDIX D: Page 4 of 5

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

Water	50 – 65%
Mineral oil	10 – 30%
Emulsifiers	8 – 25%
Sodium salt	0 – 1.5%

Figure D-6

Composition of 5 GHz Head Tissue Equivalent Matter

Note: 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	Head Tissue Simulating Liquid (HBBL3500-5800V5)
Product No.	SL AAH 502 AG (Batch: 160331-2)
Manufacturer	SPEAG

Measurement Method	
TSL dielectric parameters measured using calibrated DAK probe.	

Setup Validation	
Validation results were within $\pm 2.5\%$ towards the target values of Methanol.	

Target Parameters	
Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.	

Test Condition	
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	4-Apr-16
Operator	WM

Additional Information	
TSL Density	0.985 g/cm ³
TSL Heat-capacity	3.383 kJ/(kg*K)

	Measured				Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma	
3400	39.0	15.12	2.86	38.0	2.81	2.5	1.8	
3500	38.8	15.09	2.94	37.9	2.91	2.3	0.9	
3600	38.7	15.08	3.02	37.8	3.02	2.3	0.2	
3700	38.6	15.08	3.10	37.7	3.12	2.4	-0.6	
3800	38.4	15.07	3.19	37.6	3.22	2.2	-0.9	
3900	38.3	15.09	3.27	37.5	3.32	2.2	-1.6	
4000	38.2	15.10	3.36	37.4	3.43	2.3	-1.9	
4100	38.1	15.13	3.45	37.2	3.53	2.3	-2.2	
4200	38.0	15.18	3.55	37.1	3.63	2.3	-2.2	
4300	37.8	15.22	3.64	37.0	3.73	2.1	-2.5	
4400	37.7	15.29	3.74	36.9	3.84	2.2	-2.5	
4500	37.6	15.34	3.84	36.8	3.94	2.2	-2.5	
4600	37.4	15.41	3.94	36.7	4.04	2.0	-2.5	
4700	37.3	15.47	4.05	36.6	4.14	2.0	-2.2	
4800	37.1	15.53	4.15	36.4	4.25	1.8	-2.2	
4850	37.1	15.57	4.20	36.4	4.30	2.0	-2.2	
4900	37.0	15.60	4.25	36.3	4.35	1.8	-2.2	
4950	36.9	15.62	4.30	36.3	4.40	1.7	-2.2	
5000	36.8	15.66	4.35	36.2	4.45	1.6	-2.2	
5050	36.8	15.68	4.40	36.2	4.50	1.8	-2.2	
5100	36.7	15.73	4.46	36.1	4.55	1.7	-2.0	
5150	36.6	15.75	4.51	36.0	4.60	1.5	-2.0	
5200	36.5	15.78	4.57	36.0	4.66	1.4	-1.8	
5250	36.4	15.80	4.62	35.9	4.71	1.3	-1.8	
5300	36.4	15.84	4.67	35.9	4.76	1.5	-1.8	
5350	36.3	15.85	4.72	35.8	4.81	1.4	-1.8	
5400	36.2	15.88	4.77	35.8	4.86	1.2	-1.9	
5450	36.2	15.90	4.82	35.7	4.91	1.4	-1.9	
5500	36.1	15.91	4.87	35.6	4.96	1.3	-1.9	
5550	36.0	15.95	4.93	35.6	5.01	1.2	-1.7	
5600	35.9	15.99	4.98	35.5	5.07	1.0	-1.7	
5650	35.9	16.02	5.04	35.5	5.12	1.2	-1.5	
5700	35.8	16.05	5.09	35.4	5.17	1.1	-1.5	
5750	35.7	16.09	5.15	35.4	5.22	1.0	-1.3	
5800	35.7	16.10	5.20	35.3	5.27	1.1	-1.3	
5850	35.6	16.14	5.25	35.3	5.34	0.8	-1.6	
5900	35.5	16.15	5.30	35.3	5.40	0.6	-1.9	

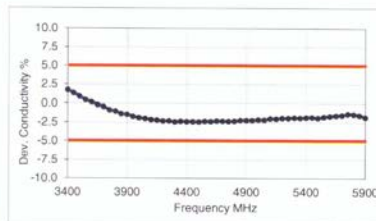
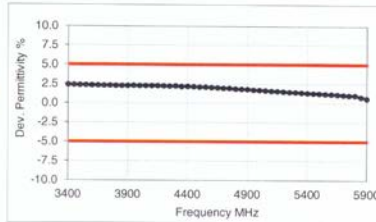


Figure D-7

5GHz Head Tissue Equivalent Matter

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset	APPENDIX D: Page 5 of 5		

APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB Publication 865664 D02v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table E-I
SAR System Validation Summary – 1g

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE TYPE	PROBE CAL. POINT	COND.	PERM.	CW VALIDATION			MOD. VALIDATION		
						(σ)	(ε _r)	SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
J	750	6/21/2017	3209	ES3DV3	750	Head	0.868	39.874	PASS	PASS	PASS	N/A	N/A
K	835	5/2/2017	7406	EX3DV4	835	Head	0.896	40.478	PASS	PASS	PASS	GMSK	PASS
H	1750	3/22/2017	3318	ES3DV3	1750	Head	1.338	38.950	PASS	PASS	PASS	N/A	N/A
H	1900	3/13/2017	3318	ES3DV3	1900	Head	1.441	39.998	PASS	PASS	PASS	GMSK	PASS
J	1900	6/5/2017	3209	ES3DV3	1900	Head	1.456	39.187	PASS	PASS	PASS	GMSK	PASS
I	2300	6/1/2017	3213	ES3DV3	2300	Head	1.698	40.843	PASS	PASS	PASS	N/A	N/A
H	2450	4/27/2017	3318	ES3DV3	2450	Head	1.882	38.945	PASS	PASS	PASS	OFDM/TDD	PASS
I	2450	6/1/2017	3213	ES3DV3	2450	Head	1.876	40.253	PASS	PASS	PASS	OFDM/TDD	PASS
I	2600	6/1/2017	3213	ES3DV3	2600	Head	2.059	39.650	PASS	PASS	PASS	TDD	PASS
H	5250	6/10/2017	3914	EX3DV4	5250	Head	4.580	35.029	PASS	PASS	PASS	OFDM	N/A
H	5600	6/10/2017	3914	EX3DV4	5600	Head	4.940	34.501	PASS	PASS	PASS	OFDM	N/A
H	5750	6/10/2017	3914	EX3DV4	5750	Head	5.103	34.300	PASS	PASS	PASS	OFDM	N/A
K	750	5/3/2017	7406	EX3DV4	750	Body	0.952	53.745	PASS	PASS	PASS	N/A	N/A
E	835	4/4/2017	3319	ES3DV3	835	Body	0.954	53.125	PASS	PASS	PASS	GMSK	PASS
I	835	4/24/2017	3213	ES3DV3	835	Body	0.991	53.903	PASS	PASS	PASS	GMSK	PASS
K	1750	5/1/2017	7406	EX3DV4	1750	Body	1.514	51.685	PASS	PASS	PASS	N/A	N/A
J	1750	6/5/2017	3209	ES3DV3	1750	Body	1.474	51.981	PASS	PASS	PASS	N/A	N/A
J	1900	6/15/2017	3209	ES3DV3	1900	Body	1.552	52.203	PASS	PASS	PASS	GMSK	PASS
G	2300	9/27/2016	3287	ES3DV3	2300	Body	1.818	51.466	PASS	PASS	PASS	N/A	N/A
G	2450	9/28/2016	3287	ES3DV3	2450	Body	2.030	50.891	PASS	PASS	PASS	OFDM/TDD	PASS
G	2600	9/27/2016	3287	ES3DV3	2600	Body	2.236	50.316	PASS	PASS	PASS	TDD	PASS
D	5250	2/2/2017	3589	EX3DV4	5250	Body	5.422	47.823	PASS	PASS	PASS	OFDM	N/A
D	5600	2/2/2017	3589	EX3DV4	5600	Body	5.882	47.193	PASS	PASS	PASS	OFDM	N/A
D	5750	2/2/2017	3589	EX3DV4	5750	Body	6.117	46.985	PASS	PASS	PASS	OFDM	N/A

Table E-II
SAR System Validation Summary – 10g

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE TYPE	PROBE CAL. POINT	COND.	PERM.	CW VALIDATION			MOD. VALIDATION		
						(σ)	(ε _r)	SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
D	5250	2/2/2017	3589	EX3DV4	5250	Body	5.422	47.823	PASS	PASS	PASS	OFDM	N/A
D	5600	2/2/2017	3589	EX3DV4	5600	Body	5.882	47.193	PASS	PASS	PASS	OFDM	N/A
D	5750	2/2/2017	3589	EX3DV4	5750	Body	6.117	46.985	PASS	PASS	PASS	OFDM	N/A

NOTE: While the probes have been calibrated for both CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04 for scenarios when CW probe calibrations are used with other signal types. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to FCC KDB Publication 865664 D01

FCC ID: ZNFV30A		SAR EVALUATION REPORT		Approved by: Quality Manager
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APPENDIX G: WIFI POWER REDUCTION VERIFICATION

This device was tested by the test lab to verify power reduction in WIFI power levels when audio is routed through the ear-piece of the device.

G1. Test Procedure

The following procedure was utilized to verify power reduction in normal operating conditions:

1. The WIFI antenna of the DUT is connected via a conducted connection to a CMW500 with WIFI signaling and measurement functions.
2. A WIFI data transmission is initiated and WIFI power is measured by the CMW500.
3. The DUT is connected via a radiated connection to a second CMW500 and a speech call is initiated, simultaneously with the WIFI data transmission.
4. Audio is verified to be routed through the held-to-ear speaker and the WIFI power is measured. The speakerphone is toggled on and off to ensure power reduction is reactivated when audio is restored to the held-to-ear speaker.
5. The WIFI powers are measured and compared to the reduced power levels to verify the WIFI power reduction mechanism.
6. Repeat for each WIFI mode (e.g. 802.11b, 802.11g, etc...) supported by the DUT.

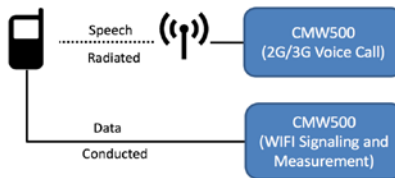


Figure 1 – Verification of WIFI Power Reduction

G2. Verification Data Summary

The WIFI power reduction mechanism was verified under the above test procedures and conditions. The maximum and reduced WIFI power levels were within the tune-up range.

Table 1 – Data Summary of Power Reduction

FCC ID	IMEI	Antenna	Mode	Channel	Target Max Power (dBm)	Measured Power (dBm)	Target Reduced Power (dBm)	Measured Power (dBm)
ZNFV30A	15532	1	802.11b	6	18.00	18.91	16.00	16.95
		1	802.11g	6	17.00	17.96	16.00	16.65
		2	802.11b	6	17.50	18.20	16.00	16.02
		2	802.11g	6	17.00	16.86	16.00	15.73

Maximum Allowed Output Power: Target Power +1 dB

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Test Dates: 07/24/17 - 08/10/17	DUT Type: Portable Handset			APPENDIX G: Page 1 of 1

APPENDIX H: CONDUCTED POWERS FOR 4X4 DL MIMO

This device supports downlink 4x4 MIMO operations for LTE Bands 66, 4, 2 only. Uplink transmission is limited to a single output stream. Power measurements were performed with downlink 4x4 MIMO active for the configuration with highest measured maximum conducted power with 4x4 downlink MIMO inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

Per FCC Guidance, SAR for downlink 4x4 MIMO was not needed since the maximum average output power in 4x4 downlink MIMO mode was not > 0.25 dB higher than the maximum output power with downlink 4x4 MIMO inactive. When carrier aggregation is applicable, power measurements were performed with the downlink carrier aggregation and 4x4 DL MIMO active for the configuration with highest measured maximum conducted power with downlink carrier aggregation inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

Note: Per FCC guidance LTE Band 66 SISO powers were used to select measurement configurations for LTE Band 4 and LTE Band 25 SISO powers were used to select measurement configurations for LTE Band 2.

H.1 Single Carrier 4x4 Downlink MIMO

Table H-1
Additional Maximum Output Powers

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
4	5	20375	1752.5	QPSK	1	0	24.7	24.70	24.2
66	5	132647	1777.5	QPSK	1	0	24.7	24.70	24.2
2	20	19100	1900	QPSK	1	50	24.69	24.70	24.2

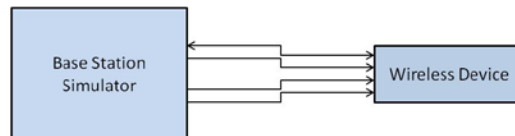


Figure H-1
Power Measurement Setup

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
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H.2 Carrier Aggregation Scenarios with 2 Component Carriers with 4x4 Downlink MIMO

Table H-2
LTE Band 12 Additional Maximum Output Powers – 2 Component Carriers

	PCC										SCC					Power	
Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-12A (1)	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	25.15	25.50
CA 4A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B4	10	2175	2132.5	4x4 MIMO	25.14	25.50
CA 12A-66A (2)	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	25.12	25.50

Table H-3
LTE Band 17 Additional Maximum Output Powers – 2 Component Carriers

	PCC										SCC					Power	
Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-17A	LTE B17	10	23790	710	QPSK	1	25	5790	740	2x2 MIMO	LTE B2	10	900	1960	4x4 MIMO	25.11	25.50
CA 4A-17A	LTE B17	10	23790	710	QPSK	1	25	5790	740	2x2 MIMO	LTE B4	10	2175	2132.5	4x4 MIMO	25.08	25.50

Table H-4
LTE Band 13 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC					DL Antenna Configuration	SCC				DL Antenna Configuration	Power	
						PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	SCC Band		SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	LTE Tx.Power with DL CA Enabled (dBm)		LTE Single Carrier Tx Power (dBm)	
CA 2A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	25.14	25.47	
CA 4A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	25.10	25.47	
CA 13A-66A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	25.12	25.47	

Table H-5
LTE Band 5 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC							SCC				Power			
			PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	25.23	25.50
CA 4A-5A (1)	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	25.29	25.50
CA 5A-66A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	25.29	25.50

Table H-6
LTE Band 66 Additional Maximum Output Powers – 2 Component Carriers

PCC										SCC					Power		
Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-66A (2)	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	24.68	24.70
CA 2A-66A (2)	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	24.69	24.70
CA 2A-66A (2)	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	4x4 MIMO	24.65	24.70
CA 5A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.67	24.70
CA 12A-66A (2)	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.69	24.70
CA 13A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.62	24.70
CA 29A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.70	24.70
CA 30A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.68	24.70
CA 66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B66	15	67018	2168.2	4x4 MIMO	24.70	24.70
CA 66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B66	20	66994	2165.8	4x4 MIMO	24.68	24.70
CA 66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.63	24.70
CA 66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B66	5	66461	2112.5	4x4 MIMO	24.68	24.70

FCC ID: ZNFV30A	 SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset		APPENDIX H: Page 2 of 6

Table H-7
LTE Band 4 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC										SCC					Power	
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-4A (2)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	24.70	24.70
CA 2A-4A (2)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	24.63	24.70
CA 2A-4A (2)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	4x4 MIMO	24.64	24.70
CA 4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	24.68	24.70
CA 4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	24.67	24.70
CA 4A-5A (1)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.65	24.70
CA 4A-7A (1)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B7	20	3100	2655	2x2 MIMO	24.65	24.70
CA 4A-12A (1)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.69	24.70
CA 4A-13A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.70	24.70
CA 4A-17A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B17	10	5790	740	2x2 MIMO	24.70	24.70
CA 4A-29A (2)	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.68	24.70
CA 4A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.67	24.70

Table H-8
LTE Band 2 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC										SCC					Power	
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-2A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	24.68	24.70
CA 2A-2A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	4x4 MIMO	24.65	24.70
CA 2A-4A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	24.65	24.70
CA 2A-4A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	24.68	24.70
CA 2A-4A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	24.67	24.70
CA 2A-5A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.69	24.70
CA 2A-12A (1)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.67	24.70
CA 2A-13A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.66	24.70
CA 2A-17A	LTE B2	10	19150	1905	QPSK	1	25	1150	1985	4x4 MIMO	LTE B17	10	5790	740	2x2 MIMO	24.69	24.67
CA 2A-29A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.69	24.70
CA 2A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.68	24.70
CA 2A-66A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.67	24.70
CA 2A-66A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	24.69	24.70
CA 2A-66A (2)	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B66	20	66786	2145	4x4 MIMO	24.66	24.70

Table H-9
LTE Band 30 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC										SCC					Power	
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-30A	LTE B30	10	27710	2310	QPSK	1	25	9820	2355	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	25.13	25.20
CA 4A-30A	LTE B30	10	27710	2310	QPSK	1	25	9820	2355	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	25.14	25.20
CA 30A-66A	LTE B30	10	27710	2310	QPSK	1	25	9820	2355	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	25.17	25.20

Table H-10
LTE Band 7 Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC										SCC					Power	
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 4A-7A (1)	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	23.60	23.60

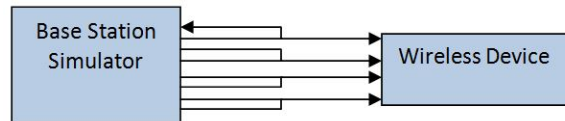


Figure H-2
Power Measurement Setup

FCC ID: ZNFV30A	PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset	APPENDIX H: Page 3 of 6		

H.3 Carrier Aggregation Scenarios with 3 Component Carriers with 4x4 Downlink MIMO

Table H-11
LTE Band 12 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC				PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 1				SCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 2				SCC (DL) Frequency [MHz]	DL Antenna Configuration	Power	
				Modulation	PCC UL RB	PCC UL RB Offset	PCC (UL) Channel			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-2A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	5	900	1960	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO		25.46	25.50
CA 2A-4A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO		25.49	25.50
CA 2A-4A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO		25.50	25.50
CA 2A-12A-30A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO		25.45	25.50
CA 2A-12A-66A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO		25.50	25.50
CA 2A-12A-66A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO		25.48	25.50
CA 4A-4A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B4	5	2175	2132.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO		25.50	25.50
CA 4A-7A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B7	20	3100	2655	2x2 MIMO		25.49	25.50
CA 4A-12A-30A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO		25.45	25.50
CA 12A-66A-66A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	2x2 MIMO	LTE B66	5	66786	2145	4x4 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO		25.48	25.50

Table H-12
LTE Band 13 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC				PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 1				SCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 2				SCC (DL) Frequency [MHz]	DL Antenna Configuration	Power	
				Modulation	PCC UL RB	PCC UL RB Offset	PCC (UL) Channel			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-2A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	5	900	1960	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO		25.20	25.47
CA 2A-4A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO		25.19	25.47
CA 2A-4A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO		25.20	25.47
CA 2A-13A-66A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO		25.26	25.47
CA 2A-13A-66A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO		25.29	25.47
CA 4A-4A-13A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B4	5	2175	2132.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO		25.16	25.47
CA 13A-66A-66A	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B66	5	66786	2145	4x4 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO		25.27	25.47
CA 13A-66B	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B66	15	66786	2145	4x4 MIMO	LTE B66	5	66694	2165.8	2x2 MIMO		25.35	25.47
CA 13A-66C	LTE B13	10	23230	782	QPSK	1	25	5230	751	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	LTE B66	20	66994	2164.8	4x4 MIMO		25.39	25.47

Table H-13
LTE Band 5 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC				PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 1				SCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 2				SCC (DL) Frequency [MHz]	DL Antenna Configuration	Power	
				Modulation	PCC UL RB	PCC UL RB Offset	PCC (UL) Channel			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]			LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-2A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	5	900	1960	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO		25.48	25.50
CA 2A-4A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO		25.49	25.50
CA 2A-4A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO		25.50	25.50
CA 2A-5A-30A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO		25.38	25.50
CA 2A-5A-66A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO		25.50	25.50
CA 2A-5A-66A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO		25.49	25.50
CA 4A-4A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B4	5	2175	2132.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO		25.50	25.50
CA 4A-5A-30A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO		25.35	25.50
CA 5A-10A-66B	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B10	10	9820	2355	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO		25.40	25.50
CA 5A-66B	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B66	15	66786	2145	4x4 MIMO	LTE B66	5	66693	2135.7	2x2 MIMO		25.47	25.50
CA 5A-66C	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	LTE B66	20	66994	2164.8	4x4 MIMO		25.50	25.50
CA 5A-66A-66A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	2x2 MIMO	LTE B66	5	66786	2145	4x4 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO		25.49	25.50

Table H-14
LTE Band 66 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC				DL				SCC 1				SCC 2				Power		
				Modulation	PCC UL# RB	PCC UL RB Offset	PCC (UL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configurat on	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configurat on	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configurat on	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)	
CA 2A-2A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	5	900	1960	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	24.69	24.70
CA 2A-2A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	5	900	1960	2x2 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	24.70	24.70
CA 2A-5A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.70	24.70
CA 2A-5A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.70	24.70
CA 2A-12A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.68	24.70
CA 2A-12A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.68	24.70
CA 2A-13A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.70	24.70
CA 2A-13A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.67	24.70
CA 2A-66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	15	67018	2168.2	2x2 MIMO	24.69	24.70
CA 2A-66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	20	66994	2165.8	4x4 MIMO	24.70	24.70
CA 2A-66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	20	66994	2165.8	2x2 MIMO	24.68	24.70
CA 2A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.68	24.70
CA 2A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.70	24.70
CA 2A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.67	24.70
CA 5A-30A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.60	24.70
CA 5A-66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B66	15	67018	2168.2	4x4 MIMO	24.67	24.70
CA 5A-66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B66	20	66994	2165.8	4x4 MIMO	24.68	24.70
CA 5A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.66	24.70
CA 5A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.70	24.70
CA 12A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.70	24.70
CA 12A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.68	24.70
CA 13A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.69	24.70
CA 13A-66A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.66	24.70
CA 13A-66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	15	67018	2168.2	4x4 MIMO	24.69	24.70
CA 13A-66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	20	66994	2165.8	4x4 MIMO	24.70	24.70
CA 66A-66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B66	20	66578	2124.2	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.60	24.70
CA 66C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B66	20	66994	2165.8	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.59	24.70
CA 66A-66C	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B66	20	66578	2124.2	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.60	24.70
CA 66C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	2x2 MIMO	LTE B66	20	66994	2165.8	2x2 MIMO	LTE B66	5	66461	2112.5	2x2 MIMO	24.58	24.70

Table H-15
LTE Band 4 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC				DL Antenna Configuration	SCC 1				DL Antenna Configuration	SCC 2				DL Antenna Configuration	Power		LTE Single Carrier Tx Power (dBm)
						PCC UL RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)	
CA 2A-4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	24.65	24.70	
CA 2A-4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	24.68	24.70	
CA 2A-4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	24.68	24.70	
CA 2A-4A-5A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.70	24.70	
CA 2A-4A-5A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.68	24.70	
CA 2A-4A-12A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.67	24.70	
CA 2A-4A-12A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.70	24.70	
CA 2A-4A-13A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.65	24.70	
CA 2A-4A-13A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.70	24.70	
CA 2A-4A-7A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B7	20	3100	2655	2x2 MIMO	24.69	24.70	
CA 2A-4A-29A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.66	24.70	
CA 2A-4A-29A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.70	24.70	
CA 2A-4A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	20	900	1960	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.68	24.70	
CA 2A-4A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.69	24.70	
CA 4A-4A-5A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.70	24.70	
CA 4A-4A-5A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.70	24.70	
CA 4A-4A-12A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.69	24.70	
CA 4A-4A-12A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.70	24.70	
CA 4A-4A-13A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.68	24.70	
CA 4A-4A-13A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.70	24.70	
CA 4A-4A-29A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.65	24.70	
CA 4A-4A-29A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B4	5	1975	2112.5	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.70	24.70	
CA 4A-5A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.68	24.70	
CA 4A-7A-7A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B7	5	3100	2655	2x2 MIMO	LTE B7	5	2775	2622.5	2x2 MIMO	24.70	24.70	
CA 4A-7A-12A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B7	20	3100	2655	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.70	24.70	
CA 4A-12A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.69	24.70	
CA 4A-29A-30A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.70	24.70	
CA 2A-4A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B4	5	1975	2112.5	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	24.59	24.70	
CA 2A-2A-4A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	2x2 MIMO	LTE B2	5	900	1960	2x2 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	24.62	24.70	

Table H-16
LTE Band 2 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC				DL Antenna Configuration	SCC 1				DL Antenna Configuration	SCC 2				DL Antenna Configuration	Power		LTE Single Carrier Tx Power (dBm)
						PCC UL RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)	
CA 2A-2A-5A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.66	24.70	
CA 2A-2A-5A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.65	24.70	
CA 2A-2A-12A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.66	24.70	
CA 2A-2A-12A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.65	24.70	
CA 2A-2A-13A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.67	24.70	
CA 2A-2A-13A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.67	24.70	
CA 2A-2A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.66	24.70	
CA 2A-2A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.65	24.70	
CA 2A-2A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	24.70	24.70	
CA 2A-4A-4A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	5	2175	2132.5	2x2 MIMO	LTE B4	5	2375	2152.5	2x2 MIMO	24.70	24.70	
CA 2A-4A-4A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	5	2175	2132.5	4x4 MIMO	LTE B4	5	2375	2152.5	2x2 MIMO	24.69	24.70	
CA 2A-4A-5A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.69	24.70	
CA 2A-4A-5A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	24.65	24.70	
CA 2A-4A-12A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.60	24.70	
CA 2A-4A-12A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	24.68	24.70	
CA 2A-4A-13A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.65	24.70	
CA 2A-4A-13A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	24.66	24.70	
CA 2A-4A-7A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B7	20	3100	2655	2x2 MIMO	24.68	24.70	
CA 2A-4A-29A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.67	24.70	
CA 2A-4A-29A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	24.69	24.70	
CA 2A-4A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.67	24.70	
CA 2A-4A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.68	24.70	
CA 2A-5A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.64	24.70	
CA 2A-5A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B5	10	2525	881.5	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.70	24.70	
CA 2A-12A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.65	24.70	
CA 2A-12A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.65	24.70	
CA 2A-12A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	24.69	24.70	
CA 2A-13A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO	24.68	24.70	
CA 2A-13A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B13	10	5230	751	2x2 MIMO	LTE B66	20	66786	2145	4x4 MIMO	24.70	24.70	
CA 2A-29A-30A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B29	10	9715	722.5	2x2 MIMO	LTE B30	10	9820	2355	2x2 MIMO	24.70	24.70	
CA 2A-66B	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B66	15	66786	2145	2x2 MIMO	LTE B66	5	66879	2154.3	4x4 MIMO	24.70	24.70	
CA 2A-66B	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	15	66786	2145	2x2 MIMO	LTE B66	5	66879	2154.3	4x4 MIMO	24.69	24.70	
CA 2A-66C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	20	66786	2145	2x2 MIMO	LTE B66	20	66984	2164.8	4x4 MIMO	24.68	24.70	
CA 2A-66C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B66	20	66786	2145	2x2 MIMO	LTE B66	20	66984	2164.8	4x4 MIMO	24.69	24.70	
CA 2A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	5	66786	2145	2x2 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO	24.69	24.70	
CA 2A-66A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	5	66786	2145	2x2 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO	24.69	24.70	
CA 2A-66A-66A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B66	5	66786	2145	2x2 MIMO	LTE B66	5	67311	2197.5	2x2 MIMO	24.70	24.70	
CA 2A-4A-4A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B4	5	2175	2132.5	2x2 MIMO	LTE B4	5	2375	2152.5	2x2 MIMO	24.61	24.70	
CA 2A-2A-4A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	2x2 MIMO	LTE B2	5	625	1932.5	2x2 MIMO	LTE B4	20	2175	2132.5	2x2 MIMO	24.59	24.70	

Table H-18
LTE Band 7 Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC					PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 1				DL Antenna Configuration	SCC 2				DL Antenna Configuration	Power	
				PCC (UL) Frequency [MHz]	Modulation	PCC UL RB	PCC UL RB Offset	PCC (DL) Channel			SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]		LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-4A-7A	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	2x2 MIMO	LTE B2	20	900	1960	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	23.50	23.60
CA 4A-7A-7A	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B7	5	2775	2622.5	2x2 MIMO	23.46	23.60
CA 4A-7A-12A	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	2x2 MIMO	LTE B4	20	2175	2132.5	4x4 MIMO	LTE B12	10	5095	737.5	2x2 MIMO	23.47	23.60

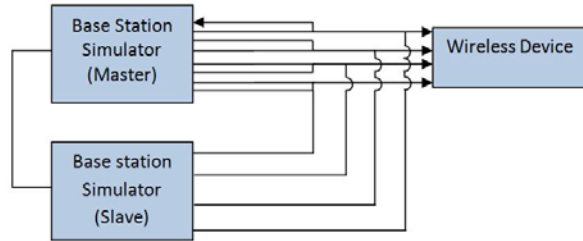


Figure H-3
Power Measurement Setup

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset	APPENDIX H: Page 6 of 6		

APPENDIX I: CONDUCTED POWERS FOR LAA

This device supports LAA with downlink carrier aggregation only for B46. All uplink communications and acknowledgements on the PCC remain identical to specifications when downlink carrier aggregation is inactive.

Per FCC Guidance and KDB Publication 941225 D05A v01r02, for every supported combination, additional conducted output powers are measured with the downlink carrier aggregation active for the configuration with highest measured maximum conducted power with downlink carrier aggregation inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

The PCC uplink channel was selected based on section C)3)b)ii) of KDB 941225 D05 V01r02. The downlink PCC channel was paired with the selected PCC uplink channel according to normal configurations without carrier aggregation per 3GPP requirements. The SCC downlink channels were selected near the middle of their transmission bands. For contiguous intra-band carriers, the downlink channel spacing between the component carriers was set to multiple of 300 kHz less than the nominal channel spacing defined in section 5.4.1A of 3GPP TS 36.521. For LAA operations, each Band 46 sub-band was evaluated independently due to the wide downlink bandwidth.

Per FCC KDB Publication 941225 D05Av01r02, no SAR measurements are required for carrier aggregation configurations when the average output power with downlink only carrier aggregation active is not more than 0.25 dB higher than the average output power with downlink only carrier aggregation inactive.

Per FCC guidance, LTE Band 66 standalone powers were used to select measurement configurations for LTE Band 4 and LTE Band 25 standalone powers were used to select measurement configurations for LTE Band 2.

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT	 LG	Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset			APPENDIX I: Page 1 of 4

I.1 Downlink LAA Additional Conducted Powers

Table I-1
Additional Maximum Output Powers – 2 Component Carriers

	PCC								SCC				Power		
Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA_2A-46 _A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _A	20	47290	5200	24.60	24.70
CA_2A-46 _B	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _B	20	48290	5300	24.57	24.70
CA_2A-46 _C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	51290	5600	24.53	24.70
CA_2A-46 _D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _D	20	53140	5785	24.50	24.70
CA_4A-46 _A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _A	20	47290	5200	24.62	24.70
CA_4A-46 _B	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _B	20	48290	5300	24.61	24.70
CA_4A-46 _C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	51290	5600	24.68	24.70
CA_4A-46 _D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _D	20	53140	5785	24.68	24.70
CA_46 _A -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _A	20	47290	5200	24.56	24.70
CA_46 _B -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _B	20	48290	5300	24.60	24.70
CA_46 _C -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	51290	5600	24.67	24.70
CA_46 _D -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _D	20	53140	5785	24.62	24.70
CA_13A-46 _A	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _A	20	47290	5200	25.23	25.47
CA_13A-46 _B	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _B	20	48290	5300	25.29	25.47
CA_13A-46 _C	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _C	20	51290	5600	25.32	25.47
CA_13A-46 _D	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _D	20	53140	5785	25.28	25.47
CA_7A-46 _A	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _A	20	47290	5200	23.62	23.60
CA_7A-46 _B	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _B	20	48290	5300	23.63	23.60
CA_7A-46 _C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	51290	5600	23.65	23.60
CA_7A-46 _D	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _D	20	53140	5785	23.64	23.60

Table I-4
Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC									SCC 1			SCC 2			Power			
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA_2A-46 _C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	47290	5200	LTE B46 _C	20	47488	5219.8	24.59	24.70
CA_2A-46 _C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	48290	5300	LTE B46 _C	20	48488	5319.8	24.61	24.70
CA_2A-46 _C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	51290	5600	LTE B46 _C	20	51488	5619.8	24.57	24.70
CA_2A-46 _C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	53140	5785	LTE B46 _C	20	53338	5804.8	24.55	24.70
CA_2A-46 _A -46 _A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46 _C	20	47090	5180	LTE B46 _C	20	53540	5825	24.44	24.70
CA_4A-46 _C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	47290	5200	LTE B46 _C	20	47488	5219.8	24.63	24.70
CA_4A-46 _C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	48290	5300	LTE B46 _C	20	48488	5319.8	24.60	24.70
CA_4A-46 _C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	51290	5600	LTE B46 _C	20	51488	5619.8	24.65	24.70
CA_4A-46 _C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	53140	5785	LTE B46 _C	20	53338	5804.8	24.67	24.70
CA_4A-46 _A -46 _A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46 _C	20	47090	5180	LTE B46 _C	20	53540	5825	24.64	24.70
CA_46 _C -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	47290	5200	LTE B46 _C	20	47488	5219.8	24.61	24.70
CA_46 _C -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	48290	5300	LTE B46 _C	20	48488	5319.8	24.60	24.70
CA_46 _C -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	51290	5600	LTE B46 _C	20	51488	5619.8	24.65	24.70
CA_46 _C -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	53140	5785	LTE B46 _C	20	53338	5804.8	24.64	24.70
CA_46 _A -46 _B -66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46 _C	20	47090	5180	LTE B46 _C	20	53540	5825	24.64	24.70
CA_13A-46 _C	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _C	20	47290	5200	LTE B46 _C	20	47488	5219.8	25.31	25.47
CA_13A-46 _C	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _C	20	48290	5300	LTE B46 _C	20	48488	5319.8	25.32	25.47
CA_13A-46 _C	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _C	20	51290	5600	LTE B46 _C	20	51488	5619.8	25.30	25.47
CA_13A-46 _C	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46 _C	20	53140	5785	LTE B46 _C	20	53338	5804.8	25.31	25.47
CA_7A-46 _C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	47290	5200	LTE B46 _C	20	47488	5219.8	23.63	23.60
CA_7A-46 _C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	48290	5300	LTE B46 _C	20	48488	5319.8	23.62	23.60
CA_7A-46 _C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	51290	5600	LTE B46 _C	20	51488	5619.8	23.65	23.60
CA_7A-46 _C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	53140	5785	LTE B46 _C	20	53338	5804.8	23.63	23.60
CA_7A-46 _A -46 _A	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46 _C	20	47090	5180	LTE B46 _C	20	53540	5825	23.64	23.60

FCC ID: ZNFV30A		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset	APPENDIX I: Page 2 of 4		

Table I-2
Additional Maximum Output Powers – 4 Component Carriers

Combination	PCC Band	PCC					SCC 1					SCC 2					SCC 3					Power	
		PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	PCC UL RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46	20	47290	5200	LTE B46	20	47488	5219.8	LTE B46	20	47092	5180.2	24.58	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46	20	48290	5300	LTE B46	20	48488	5319.8	LTE B46	20	48092	5280.2	24.54	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46	20	51290	5600	LTE B46	20	51488	5619.8	LTE B46	20	51092	5580.2	24.55	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46	20	53140	5785	LTE B46	20	53338	5804.8	LTE B46	20	52942	5765.2	24.57	24.70
CA 2A-46A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	LTE B46	20	47090	5180	LTE B46	20	53540	5825	LTE B46	20	53342	5805.2	24.48	24.70
CA 13A-46D	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46	20	47290	5200	LTE B46	20	47488	5219.8	LTE B46	20	47092	5180.2	25.33	25.47
CA 13A-46D	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46	20	48290	5300	LTE B46	20	48488	5319.8	LTE B46	20	48092	5280.2	25.32	25.47
CA 13A-46D	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46	20	51290	5600	LTE B46	20	51488	5619.8	LTE B46	20	51092	5580.2	25.34	25.47
CA 13A-46D	LTE B13	10	23230	782	QPSK	1	25	5230	751	LTE B46	20	53140	5785	LTE B46	20	53338	5804.8	LTE B46	20	52942	5765.2	25.32	25.47
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46	20	47290	5200	LTE B46	20	47488	5219.8	LTE B46	20	47092	5180.2	24.60	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46	20	48290	5300	LTE B46	20	48488	5319.8	LTE B46	20	48092	5280.2	24.60	24.70
CA 4A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46	20	51290	5600	LTE B46	20	51488	5619.8	LTE B46	20	51092	5580.2	24.68	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46	20	53140	5785	LTE B46	20	53338	5804.8	LTE B46	20	52942	5765.2	24.70	24.70
CA 4A-46A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	LTE B46	20	47090	5180	LTE B46	20	53540	5825	LTE B46	20	53342	5805.2	24.65	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46	20	47290	5200	LTE B46	20	47488	5219.8	LTE B46	20	47092	5180.2	24.63	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46	20	48290	5300	LTE B46	20	48488	5319.8	LTE B46	20	48092	5280.2	24.62	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46	20	51290	5600	LTE B46	20	51488	5619.8	LTE B46	20	51092	5580.2	24.68	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46	20	53140	5785	LTE B46	20	53338	5804.8	LTE B46	20	52942	5765.2	24.61	24.70
CA 46A-46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B46	20	47090	5180	LTE B46	20	53540	5825	LTE B46	20	53342	5805.2	24.60	24.70
CA 7A-46D	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46	20	47290	5200	LTE B46	20	47488	5219.8	LTE B46	20	47092	5180.2	23.62	23.60
CA 7A-46D	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46	20	48290	5300	LTE B46	20	48488	5319.8	LTE B46	20	48092	5280.2	23.64	23.60
CA 7A-46D	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46	20	51290	5600	LTE B46	20	51488	5619.8	LTE B46	20	51092	5580.2	23.59	23.60
CA 7A-46D	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46	20	53140	5785	LTE B46	20	53338	5804.8	LTE B46	20	52942	5765.2	23.60	23.60
CA 7A-46A-46C	LTE B7	20	21100	2535	QPSK	1	0	3100	2655	LTE B46	20	47090	5180	LTE B46	20	53540	5825	LTE B46	20	53342	5805.2	23.60	23.60

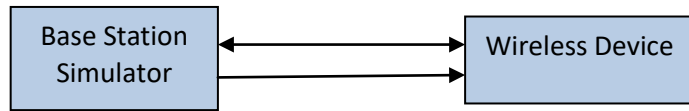


Figure I-3
Power Measurement Setup

FCC ID: ZNFV30A	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT	 LG	Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset			APPENDIX I: Page 3 of 4

I.2 Downlink 4x4 MIMO LAA Additional Conducted Powers

Table I-3
Additional Maximum Output Powers – 2 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	PCC					DL Antenna Configuration	SCC					Power	
					Modulation	PCC UL# RB	PCC UL# RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]		SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-46A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46A	20	47290	5200	2x2 MIMO	24.60	24.70
CA 2A-46A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46A	20	48290	5300	2x2 MIMO	24.64	24.70
CA 2A-46A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46A	20	51290	5600	2x2 MIMO	24.68	24.70
CA 2A-46A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46A	20	53140	5785	2x2 MIMO	24.61	24.70
CA 4A-46A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46A	20	47290	5200	2x2 MIMO	24.56	24.70
CA 4A-46A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46A	20	48290	5300	2x2 MIMO	24.54	24.70
CA 4A-46A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46A	20	51290	5600	2x2 MIMO	24.62	24.70
CA 4A-46A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46A	20	53140	5785	2x2 MIMO	24.55	24.70
CA 46A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46A	20	47290	5200	2x2 MIMO	24.57	24.70
CA 46A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46A	20	48290	5300	2x2 MIMO	24.55	24.70
CA 46A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46A	20	51290	5600	2x2 MIMO	24.54	24.70
CA 46A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46A	20	53140	5785	2x2 MIMO	24.56	24.70

Table I-4
Additional Maximum Output Powers – 3 Component Carriers

Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL# RB Offset	PCC (DL) Channel	PCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC 1					SCC 2					Power	
											SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	SCC Band	SCC Bandwidth [MHz]	SCC (DL) Channel	SCC (DL) Frequency [MHz]	DL Antenna Configuration	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46C	20	47290	5200	2x2 MIMO	LTE B46C	20	47488	5219.8	2x2 MIMO	24.62	24.70
CA 2A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46C	20	48290	5300	2x2 MIMO	LTE B46C	20	48488	5319.8	2x2 MIMO	24.63	24.70
CA 2A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46C	20	51290	5600	2x2 MIMO	LTE B46C	20	51488	5619.8	2x2 MIMO	24.66	24.70
CA 2A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46C	20	53140	5785	2x2 MIMO	LTE B46C	20	53338	5804.8	2x2 MIMO	24.66	24.70
CA 2A-46A-46A	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46C	20	47090	5180	2x2 MIMO	LTE B46C	20	53540	5825	2x2 MIMO	24.64	24.70
CA 4A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46C	20	47290	5200	2x2 MIMO	LTE B46C	20	47488	5219.8	2x2 MIMO	24.57	24.70
CA 4A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46C	20	48290	5300	2x2 MIMO	LTE B46C	20	48488	5319.8	2x2 MIMO	24.55	24.70
CA 4A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46C	20	51290	5600	2x2 MIMO	LTE B46C	20	51488	5619.8	2x2 MIMO	24.59	24.70
CA 4A-46A-46A	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46C	20	53140	5785	2x2 MIMO	LTE B46C	20	53338	5804.8	2x2 MIMO	24.56	24.70
CA 46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46C	20	47290	5200	2x2 MIMO	LTE B46C	20	47488	5219.8	2x2 MIMO	24.56	24.70
CA 46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46C	20	48290	5300	2x2 MIMO	LTE B46C	20	48488	5319.8	2x2 MIMO	24.53	24.70
CA 46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46C	20	51290	5600	2x2 MIMO	LTE B46C	20	51488	5619.8	2x2 MIMO	24.59	24.70
CA 46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46C	20	53140	5785	2x2 MIMO	LTE B46C	20	53338	5804.8	2x2 MIMO	24.54	24.70
CA 46A-46A-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46C	20	47090	5180	2x2 MIMO	LTE B46C	20	53540	5825	2x2 MIMO	24.60	24.70

Table I-5
Additional Maximum Output Powers – 4 Component Carriers

Combination	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL# RB Offset	PCC (DL) Ch.	PCC (DL) Freq. [MHz]	DL Ant. Config.	SCC 1					SCC 2					SCC 3					Power	
											SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46D	20	47290	5200	2x2 MIMO	LTE B46D	20	47488	5219.8	2x2 MIMO	LTE B46D	20	47092	5180.2	2x2 MIMO	24.61	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46D	20	48290	5300	2x2 MIMO	LTE B46D	20	48488	5319.8	2x2 MIMO	LTE B46D	20	48092	5280.2	2x2 MIMO	24.66	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46D	20	51290	5600	2x2 MIMO	LTE B46D	20	51488	5619.8	2x2 MIMO	LTE B46D	20	51092	5580.2	2x2 MIMO	24.66	24.70
CA 2A-46D	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46D	20	53140	5785	2x2 MIMO	LTE B46D	20	53338	5804.8	2x2 MIMO	LTE B46D	20	52942	5765.2	2x2 MIMO	24.67	24.70
CA 2A-46A-46C	LTE B2	20	19100	1900	QPSK	1	50	1100	1980	4x4 MIMO	LTE B46D	20	47090	5180	2x2 MIMO	LTE B46D	20	53540	5825	2x2 MIMO	LTE B46D	20	53342	5805.2	2x2 MIMO	24.60	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46D	20	47290	5200	2x2 MIMO	LTE B46D	20	47488	5219.8	2x2 MIMO	LTE B46D	20	47092	5180.2	2x2 MIMO	24.56	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46D	20	48290	5300	2x2 MIMO	LTE B46D	20	48488	5319.8	2x2 MIMO	LTE B46D	20	48092	5280.2	2x2 MIMO	24.54	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46D	20	51290	5600	2x2 MIMO	LTE B46D	20	51488	5619.8	2x2 MIMO	LTE B46D	20	51092	5580.2	2x2 MIMO	24.58	24.70
CA 4A-46D	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46D	20	53140	5785	2x2 MIMO	LTE B46D	20	53338	5804.8	2x2 MIMO	LTE B46D	20	52942	5765.2	2x2 MIMO	24.56	24.70
CA 4A-46A-46C	LTE B4	5	20375	1752.5	QPSK	1	0	2375	2152.5	4x4 MIMO	LTE B46D	20	47090	5180	2x2 MIMO	LTE B46D	20	53540	5825	2x2 MIMO	LTE B46D	20	53342	5805.2	2x2 MIMO	24.59	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46D	20	47290	5200	2x2 MIMO	LTE B46D	20	47488	5219.8	2x2 MIMO	LTE B46D	20	47092	5180.2	2x2 MIMO	24.55	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46D	20	48290	5300	2x2 MIMO	LTE B46D	20	48488	5319.8	2x2 MIMO	LTE B46D	20	48092	5280.2	2x2 MIMO	24.54	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46D	20	51290	5600	2x2 MIMO	LTE B46D	20	51488	5619.8	2x2 MIMO	LTE B46D	20	51092	5580.2	2x2 MIMO	24.57	24.70
CA 46D-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46D	20	53140	5785	2x2 MIMO	LTE B46D	20	53338	5804.8	2x2 MIMO	LTE B46D	20	52942	5765.2	2x2 MIMO	24.53	24.70
CA 46A-46C-66A	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	4x4 MIMO	LTE B46D	20	47090	5180	2x2 MIMO	LTE B46D	20	53540	5825	2x2 MIMO	LTE B46D	20	53342	5805.2	2x2 MIMO	24.59	24.70

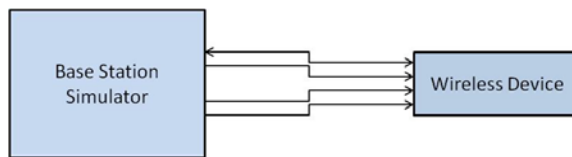


Figure I-4
Power Measurement Setup

FCC ID: ZNFV30A		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 07/24/17 – 08/10/17	DUT Type: Portable Handset			APPENDIX I: Page 4 of 4