DASY5 Validation Report for Head TSL

Date: 20.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

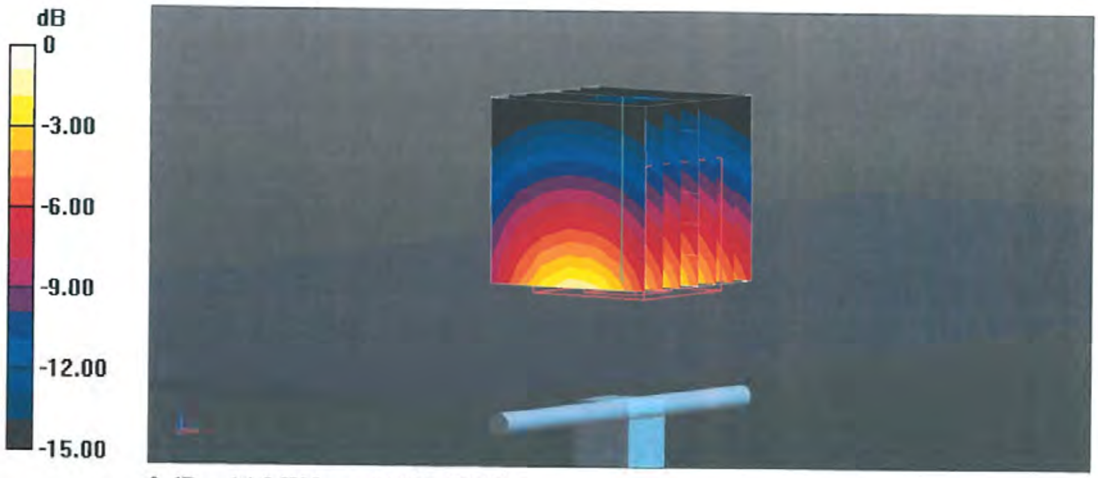
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d029

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.38 S/m; ε_r = 39; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

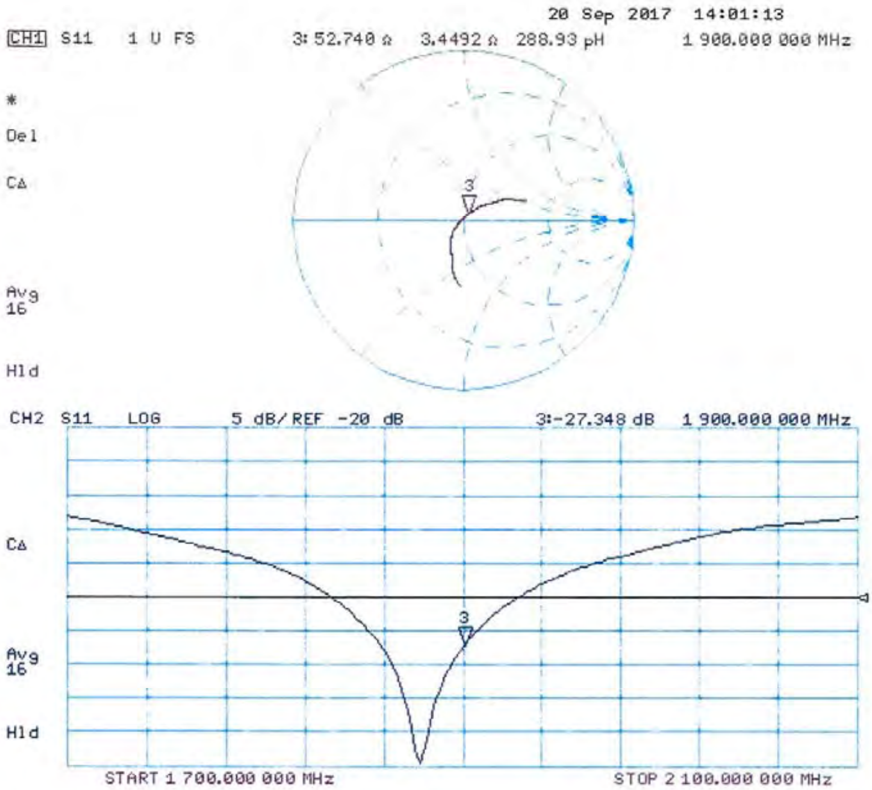
- Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 106.6 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 18.3 W/kg
SAR(1 g) = 9.78 W/kg; SAR(10 g) = 5.13 W/kg
Maximum value of SAR (measured) = 14.8 W/kg



0 dB = 14.8 W/kg = 11.70 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 20.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

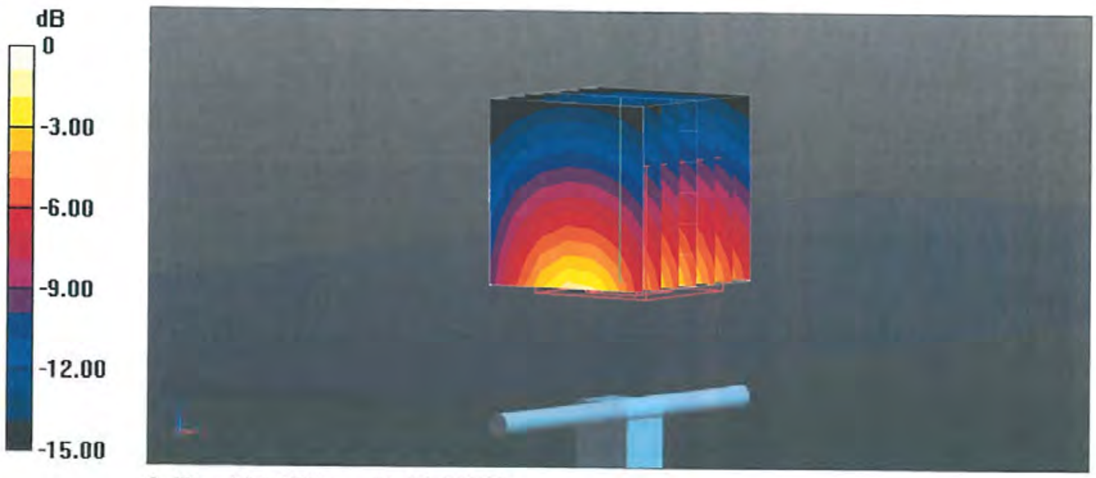
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d029

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.47 S/m; ε_r = 54.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

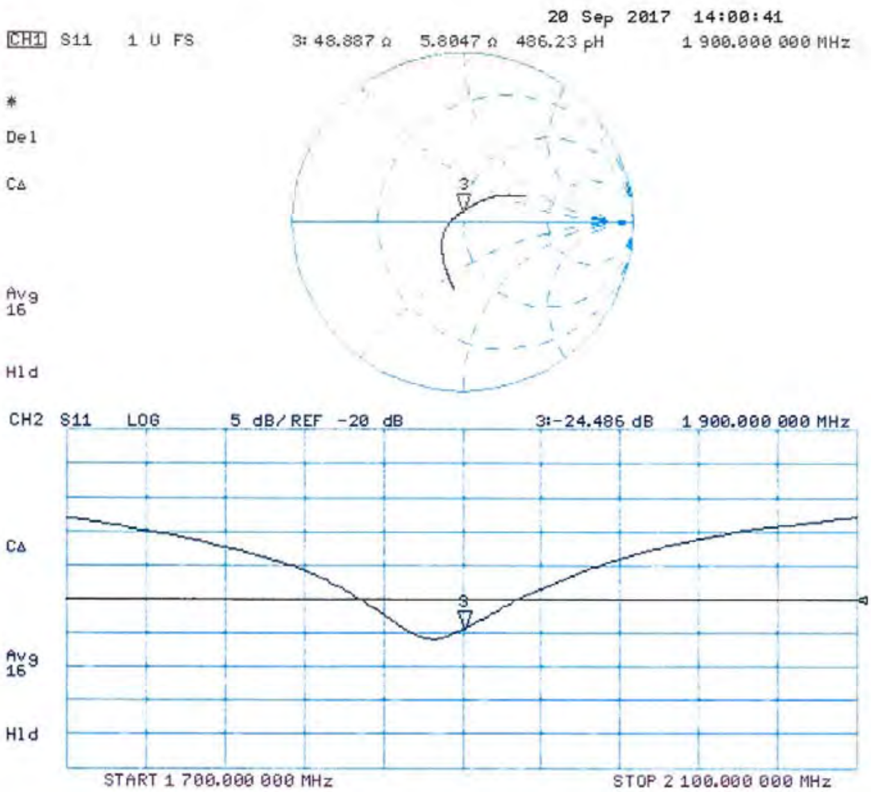
- Probe: EX3DV4 - SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 101.8 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 17.0 W/kg
SAR(1 g) = 9.66 W/kg; SAR(10 g) = 5.15 W/kg
Maximum value of SAR (measured) = 14.1 W/kg



0 dB = 14.1 W/kg = 11.49 dBW/kg

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client DT&C (Dymstec)

Certificate No: D2450V2-726_Sep17

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:726
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 19, 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-May-17 (No. EX3-7349_May17)	May-18
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

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 19, 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:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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 ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.86 mho/m ± 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.5 W/kg ± 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 ± 0.2) °C	51.9 ± 6 %	2.04 mho/m ± 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	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.9 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6 Ω + 4.0 jΩ
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.4 Ω + 6.5 jΩ
Return Loss	- 23.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 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	January 09, 2003

DASY5 Validation Report for Head TSL

Date: 19.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

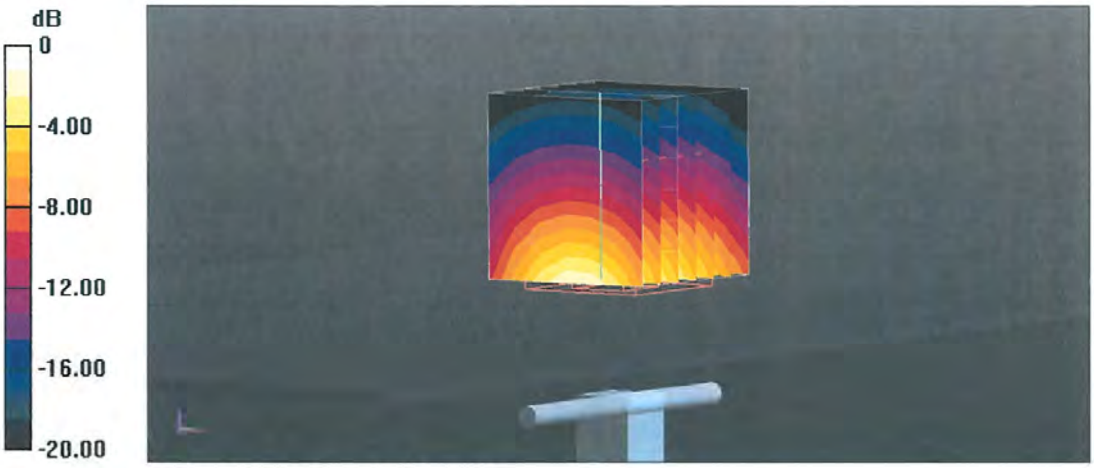
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:726

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ε_r = 37.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

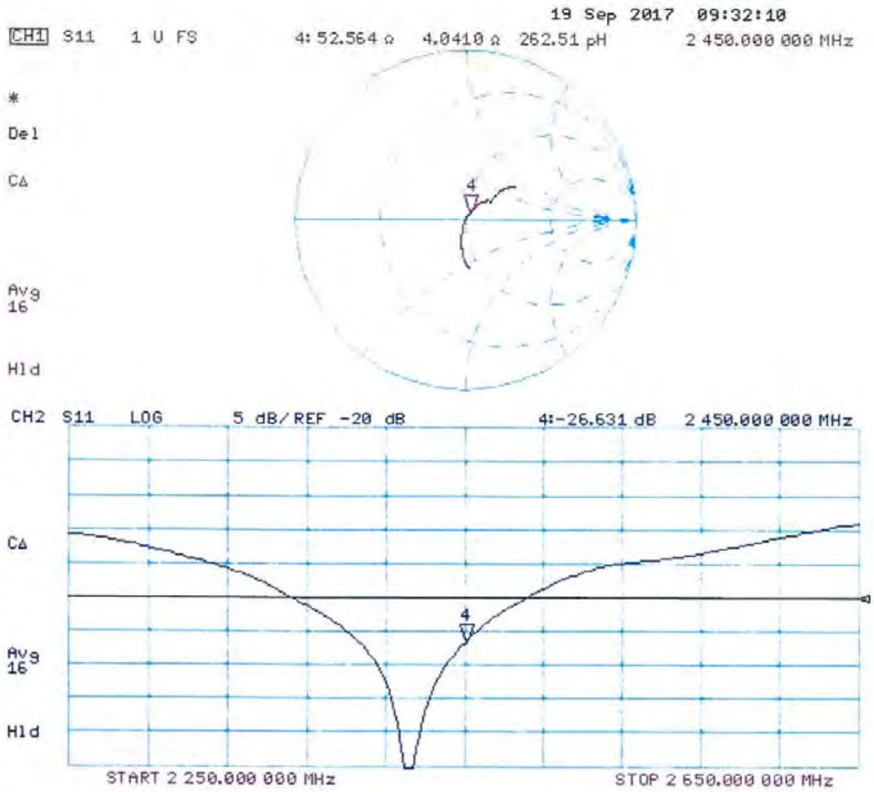
- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 110.8 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 26.9 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.22 W/kg
Maximum value of SAR (measured) = 21.0 W/kg



0 dB = 21.0 W/kg = 13.22 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 19.09.2017

Test Laboratory: SPEAG, Zurich, Switzerland

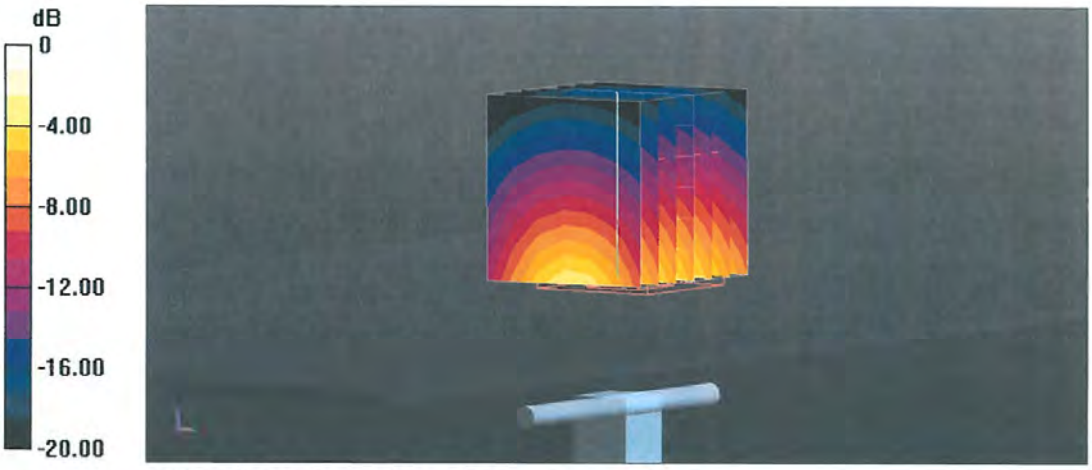
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:726

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ε_r = 51.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

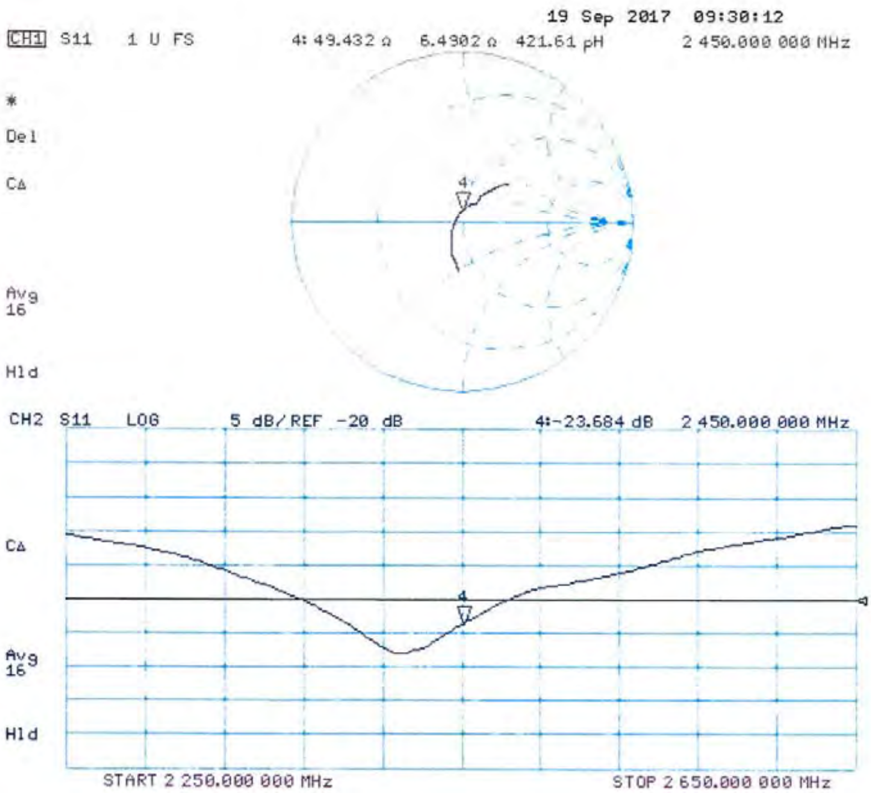
- Probe: EX3DV4 - SN7349; ConvF(8.1, 8.1, 8.1); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 104.9 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 25.4 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.05 W/kg
Maximum value of SAR (measured) = 20.3 W/kg



0 dB = 20.3 W/kg = 13.07 dBW/kg

Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-726_Sep17 Page 8 of 8

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Accreditation No.: SCS 0108

Client DT&C (Dymstec)

Certificate No: D2600V2-1103_Feb18

CALIBRATION CERTIFICATE

Object	D2600V2 - SN:1103
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	February 16, 2018

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (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	30-Dec-17 (No. EX3-7349_Dec17)	Dec-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-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-17)	In house check: Oct-18

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 19, 2018

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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:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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 ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.3 ± 6 %	2.04 mho/m ± 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	**56.4 W/kg ± 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	**25.4 W/kg ± 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 ± 0.2) °C	51.0 ± 6 %	2.22 mho/m ± 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	14.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**55.7 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.29 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**24.9 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.1 Ω - 6.6 jΩ
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.9 Ω - 4.1 jΩ
Return Loss	- 24.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.147 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	January 13, 2015

DASY5 Validation Report for Head TSL

Date: 16.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

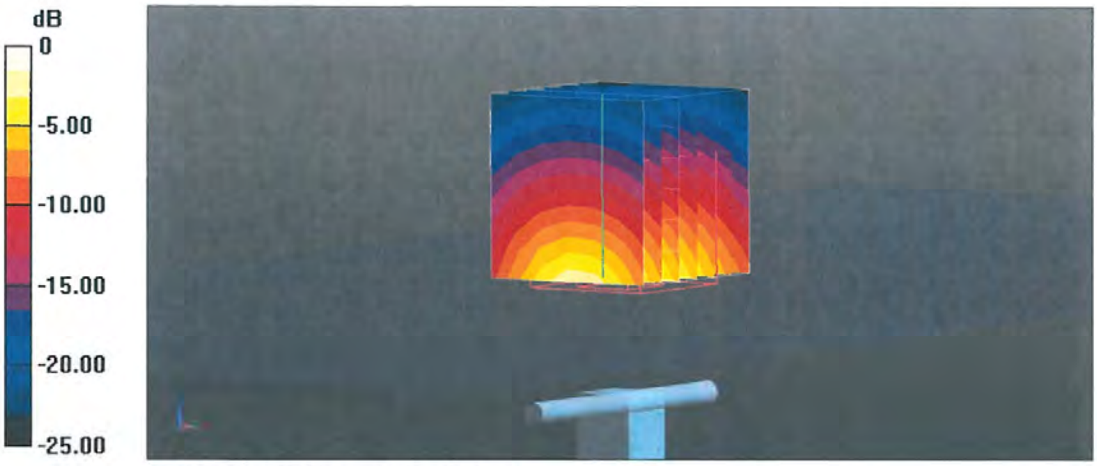
DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1103

Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; σ = 2.04 S/m; ε_r = 37.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

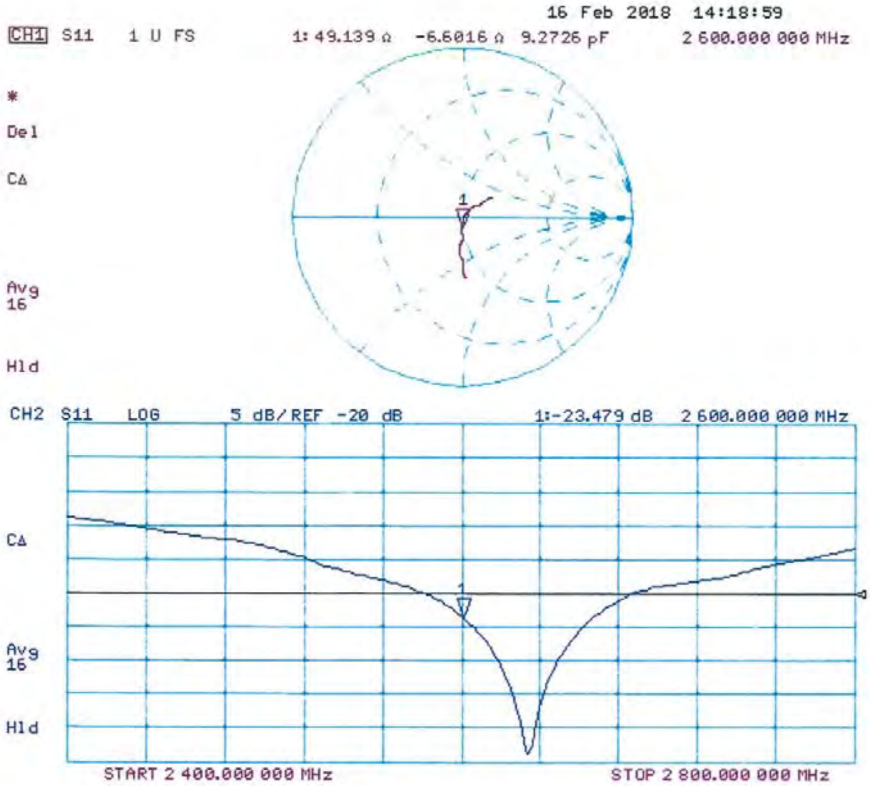
- Probe: EX3DV4 - SN7349; ConvF(7.7, 7.7, 7.7); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 116.0 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 29.2 W/kg
SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.45 W/kg
Maximum value of SAR (measured) = 23.2 W/kg



0 dB = 23.2 W/kg = 13.65 dBW/kg

Impedance Measurement Plot for Head TSL



Certificate No: D2600V2-1103_Feb18 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 16.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1103

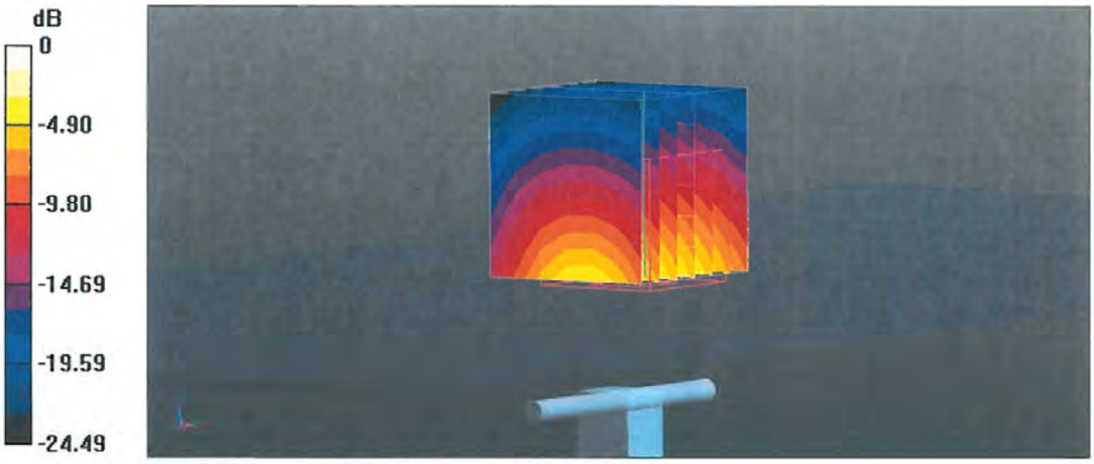
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; $\sigma = 2.22$ S/m; $\varepsilon_r = 51$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.81, 7.81, 7.81); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

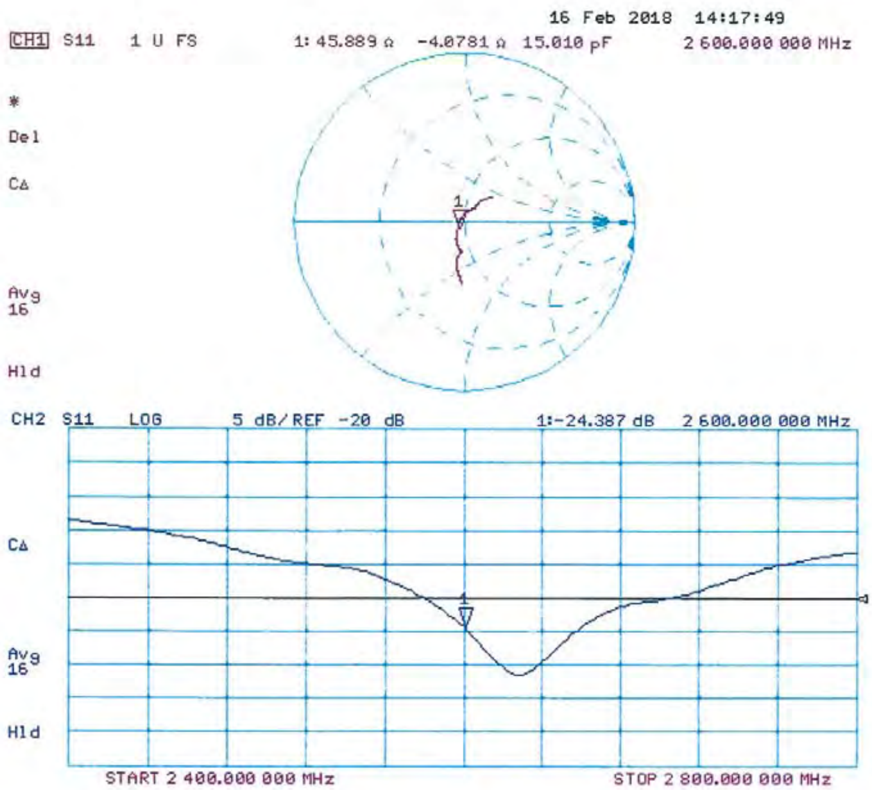
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.4 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 29.7 W/kg
SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.29 W/kg
Maximum value of SAR (measured) = 23.1 W/kg



0 dB = 23.1 W/kg = 13.64 dBW/kg

Impedance Measurement Plot for Body TSL



Calibration Laboratory of
Schmid & Partner
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Zeughausstrasse 43, 8004 Zurich, Switzerland

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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**

Client **DT&C (Dymstec)**

Certificate No: **D5GHzV2-1212_Feb18**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1212
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	February 15, 2018

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (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: 3503	30-Dec-17 (No. EX3-3503_Dec17)	Dec-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-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-17)	In house check: Oct-18

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 21, 2018

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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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:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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 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	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.4 ± 6 %	4.53 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	4.64 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.1 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.0 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**85.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.0 W/kg ± 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	35.8 ± 6 %	4.95 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	8.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	5.16 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.5 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.5 ± 6 %	5.41 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.31 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**72.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.2 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.3 ± 6 %	5.54 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.9 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.9 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	**22.0 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	46.8 ± 6 %	5.95 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	7.94 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	2.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.8 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.4 ± 6 %	6.23 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.8 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.3 Ω - 3.7 jΩ
Return Loss	- 27.8 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	47.8 Ω - 0.1 jΩ
Return Loss	- 33.0 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	46.8 Ω + 1.4 jΩ
Return Loss	- 28.8 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	50.4 Ω + 3.1 jΩ
Return Loss	- 30.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.3 Ω + 3.2 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	47.9 Ω - 3.7 jΩ
Return Loss	- 27.3 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	48.6 Ω + 2.0 jΩ
Return Loss	- 32.0 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	47.4 Ω + 3.1 jΩ
Return Loss	- 27.5 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	50.5 Ω + 4.0 jΩ
Return Loss	- 28.0 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	52.5 Ω + 4.4 jΩ
Return Loss	- 26.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.191 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	November 14, 2014

DASY5 Validation Report for Head TSL

Date: 14.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1212

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.53 S/m; ε_r = 36.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.64 S/m; ε_r = 36.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.84 S/m; ε_r = 36; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.95 S/m; ε_r = 35.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.16 S/m; ε_r = 35.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.75, 5.75, 5.75); Calibrated: 30.12.2017, ConvF(5.5, 5.5, 5.5); Calibrated: 30.12.2017, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2017, ConvF(5.05, 5.05, 5.05); Calibrated: 30.12.2017, ConvF(4.96, 4.96, 4.96); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

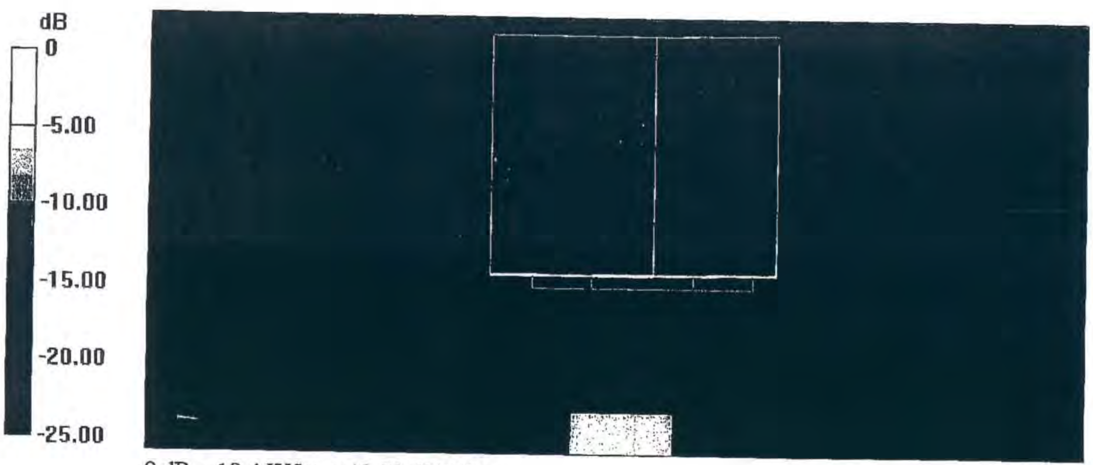
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.98 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 28.5 W/kg
SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 18.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.21 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 29.9 W/kg
SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 18.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.15 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 33.3 W/kg
SAR(1 g) = 8.53 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 20.1 W/kg

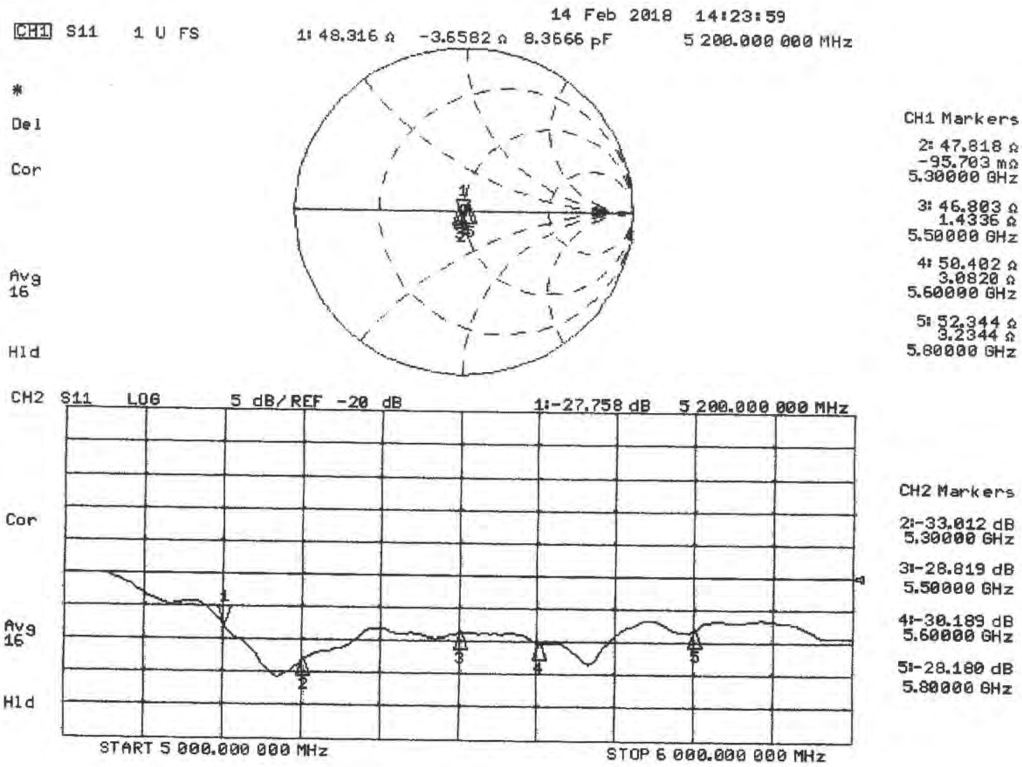
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.01 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 32.2 W/kg
SAR(1 g) = 8.36 W/kg; SAR(10 g) = 2.38 W/kg
Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 70.08 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.24 W/kg
Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.88 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1212

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.41 S/m; ε_r = 47.5; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 5.54 S/m; ε_r = 47.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 5.8 S/m; ε_r = 47; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.95 S/m; ε_r = 46.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.23 S/m; ε_r = 46.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.35, 5.35, 5.35); Calibrated: 30.12.2017, ConvF(5.15, 5.15, 5.15); Calibrated: 30.12.2017, ConvF(4.7, 4.7, 4.7); Calibrated: 30.12.2017, ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2017, ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

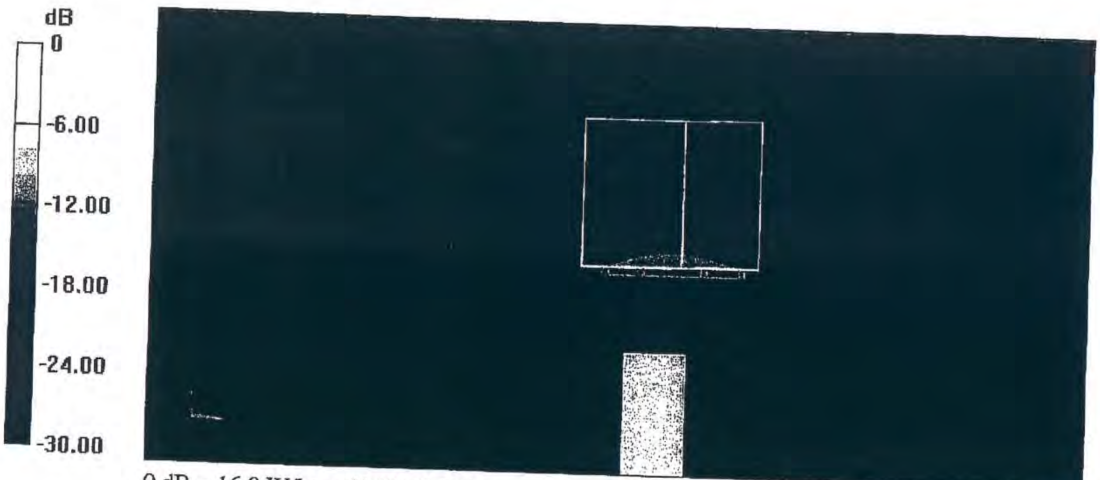
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.59 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 27.2 W/kg
SAR(1 g) = 7.31 W/kg; SAR(10 g) = 2.03 W/kg
Maximum value of SAR (measured) = 16.9 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.99 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 29.6 W/kg
SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.11 W/kg
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.88 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 33.3 W/kg
SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.22 W/kg
Maximum value of SAR (measured) = 19.3 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 = 64.59 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 33.4 W/kg
SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.2 W/kg
Maximum value of SAR (measured) = 19.0 W/kg

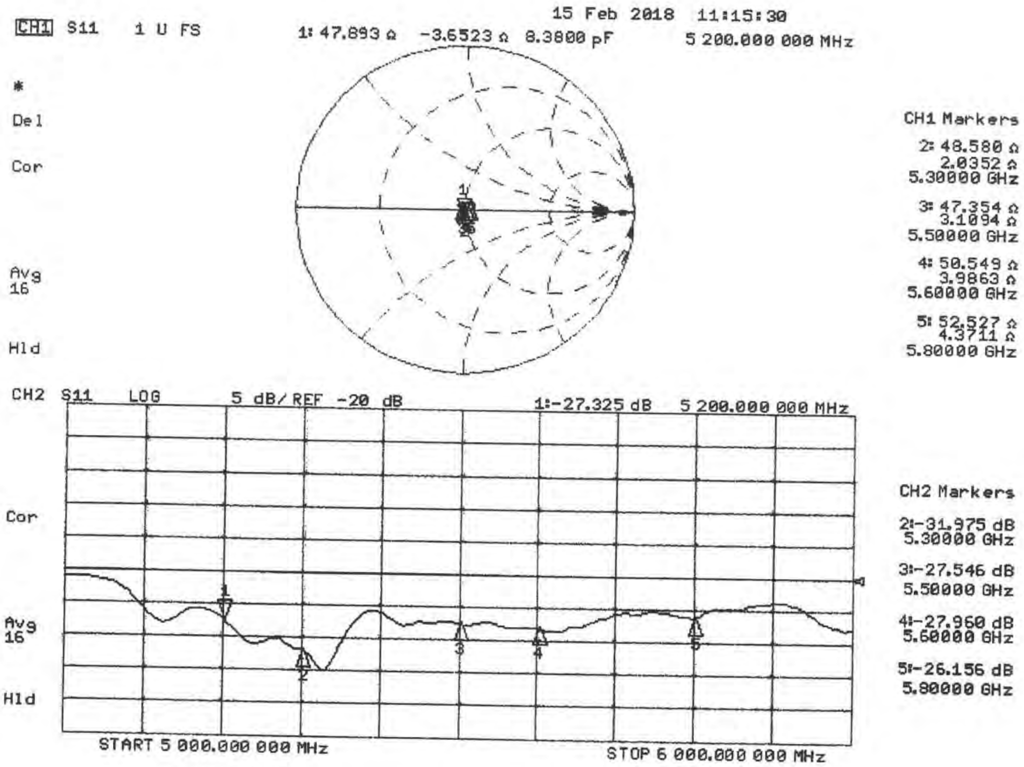
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.42 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 33.2 W/kg
SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.1 W/kg
Maximum value of SAR (measured) = 18.7 W/kg



0 dB = 16.9 W/kg = 12.28 dBW/kg

21/03/2018 18:12 0041442459779 SPEAG PAGE 16/16

Impedance Measurement Plot for Body TSL



Certificate No: D5GHzV2-1212_Feb18 Page 16 of 16

APPENDIX C. – SAR Tissue Specifications

The brain and muscle mixtures consist of a viscous gel using hydrox-ethylcellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Harts grove.

Figure 3.9 Simulated Tissue

Table C.1 Composition of the Tissue Equivalent Matter

Ingredients (% by weight)	Frequency (MHz)							
	835		1900		2450		5200 ~ 5800	
Tissue Type	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**
Water	40.19	50.75	55.24	70.23	71.88	73.40	65.52	80.00
Salt (NaCl)	1.480	0.940	0.310	0.290	0.160	0.060	-	-
Sugar	57.90	48.21	-	-	-	-	-	-
HEC	0.250	-	-	-	-	-	-	-
Bactericide	0.180	0.100	-	-	-	-	-	-
Triton X-100	-	-	-	-	19.97	-	17.24	-
DGBE	-	-	44.45	29.48	7.990	26.54	-	-
Diethylene glycol hexyl ether	-	-	-	-	-	-	17.24	-
Polysorbate (Tween) 80	-	-	-	-	-	-		20.00
Target for Dielectric Constant	41.5	55.2	40.0	53.3	39.2	52.7	-	-
Target for Conductivity (S/m)	0.90	0.97	1.40	1.52	1.80	1.95	-	-

Salt: 99 % Pure Sodium Chloride Sugar: 98 % Pure Sucrose

Water: De-ionized, 16M resistivity HEC: Hydroxyethyl Cellulose

DGBE: 99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]

Triton X-100(ultra pure): Polyethylene glycol mono[4-(1,1,3,3-tetramethylbutyl)phenyl] ether

Table C.2 HSL/MSL750 (Head and Body liquids for 700 – 800 MHz)

Item	Head Tissue Simulation Liquids HSL750 Muscle (body) Tissue Simulation Liquids MSL750
Type No	SL AAH 075, SL AAM 075
Manufacturer	SPEAG
The item is composed of the following ingredients:	
H^2O	Water, 35 – 58%
Sucrose	Sucrose, 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-methyyl-3(2H)-isothiazolone, 0.1 – 0.6%

Table C.3 HSL/MSL1750 (Head and Body liquids for 1700 – 1800 MHz)

Item	Head Tissue Simulation Liquids HSL1750 Muscle (body) Tissue Simulation Liquids MSL1750
Type No	SL AAH 175, SL AAM 175
Manufacturer	SPEAG
The item is composed of the following ingredients:	
H^2O	Water, 52 – 75%
C8H18O3	Diethylene glycol monobutyl ether (DGBE), 25 – 48%
NaCl	Sodium Chloride, < 1.0%

APPENDIX D. – SAR SYSTEM VALIDATION

SAR System Validation

Per FCC KDB 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 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 D.1 SAR System Validation Summary

SAR System	Freq. [MHz]	Date	Probe SN	Probe Type	Probe CAL. Point		PERM.	COND.	CW Validation			MOD. Validation		
							(εr)	(σ)	Sensi-tivity	Probe Linearity	Probe Isortopy	MOD. Type	Duty Factor	PAR
D	750	2018.04.09	3328	ES3DV3	750	Head	41.251	0.885	PASS	PASS	PASS	N/A	N/A	N/A
D	835	2018.04.10	3328	ES3DV3	835	Head	41.212	0.876	PASS	PASS	PASS	GMSK	PASS	N/A
D	1800	2018.04.11	3328	ES3DV3	1800	Head	41.115	1.443	PASS	PASS	PASS	N/A	N/A	N/A
D	1900	2018.04.12	3328	ES3DV3	1900	Head	41.051	1.414	PASS	PASS	PASS	GMSK	PASS	N/A
C	2450	2018.06.21	3866	EX3DV4	2450	Head	38.885	1.764	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
D	2600	2018.04.16	3328	ES3DV3	2600	Head	38.889	1.955	PASS	PASS	PASS	TDD	PASS	N/A
C	5200	2018.06.12	3866	EX3DV4	5200	Head	35.442	4.715	PASS	PASS	PASS	OFDM	N/A	PASS
C	5300	2018.06.12	3866	EX3DV4	5300	Head	35.216	4.815	PASS	PASS	PASS	OFDM	N/A	PASS
C	5500	2018.06.13	3866	EX3DV4	5500	Head	35.056	5.015	PASS	PASS	PASS	OFDM	N/A	PASS
C	5600	2018.06.13	3866	EX3DV4	5600	Head	34.915	5.212	PASS	PASS	PASS	OFDM	N/A	PASS
C	5800	2018.06.14	3866	EX3DV4	5800	Head	34.826	5.336	PASS	PASS	PASS	OFDM	N/A	PASS
D	750	2018.04.09	3328	ES3DV3	750	Body	54.332	0.981	PASS	PASS	PASS	N/A	N/A	N/A
D	835	2018.04.10	3328	ES3DV3	835	Body	54.168	0.977	PASS	PASS	PASS	GMSK	PASS	N/A
D	1800	2018.04.11	3328	ES3DV3	1800	Body	52.164	1.524	PASS	PASS	PASS	N/A	N/A	N/A
D	1900	2018.04.12	3328	ES3DV3	1900	Body	52.006	1.544	PASS	PASS	PASS	GMSK	PASS	N/A
C	2450	2018.06.21	3866	EX3DV4	2450	Body	51.664	2.015	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
D	2600	2018.04.16	3328	ES3DV3	2600	Body	51.056	2.211	PASS	PASS	PASS	TDD	PASS	N/A
C	5200	2018.06.12	3866	EX3DV4	5200	Body	48.884	5.446	PASS	PASS	PASS	OFDM	N/A	PASS
C	5300	2018.06.12	3866	EX3DV4	5300	Body	48.226	5.516	PASS	PASS	PASS	OFDM	N/A	PASS
C	5500	2018.06.13	3866	EX3DV4	5500	Body	47.886	5.779	PASS	PASS	PASS	OFDM	N/A	PASS
C	5600	2018.06.13	3866	EX3DV4	5600	Body	47.514	5.836	PASS	PASS	PASS	OFDM	N/A	PASS
C	5800	2018.06.14	3866	EX3DV4	5800	Body	47.224	6.223	PASS	PASS	PASS	OFDM	N/A	PASS

NOTE: While the probes have been calibrated for both a 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 KDB 865664.

APPENDIX E. – LTE Band 7 Phablet SAR Evaluation with proximity sensor enabled

E.1. Reduced LTE Band 7 Nominal and Maximum Output Power Spec and Conducted Powers

Band & Mode		Modulated Average [dBm]
LTE Band 7	Maximum	23.7
	Nominal	23.2

Table E.1.1 Nominal and Maximum Output Power Spec (Reduced Conducted Powers – Proximity Sensor Triggering Active)

LTE Band 7 Conducted Power– 20 MHz Bandwidth							
Modulation	RB Size	RB Offset	Low Channel 20850 (2510.0 MHz)	Mid Channel 21100 (2535.0 MHz)	High Channel 21350 (2560.0 MHz)	MPR Allowed Per 3GPP(dB)	MPR (dB)
			Conducted Power (dBm)				
QPSK	1	0	23.61	23.58	23.61	0	0
	1	50	23.56	23.62	23.60		
	1	**99**	23.63	23.63	23.66		
	50	0	23.44	23.45	23.48	0-1	0
	50	25	23.46	23.47	23.47		
	50	**50**	23.50	23.52	23.53		
	100	0	23.49	23.51	23.48	0-1	0
16QAM	1	0	23.55	23.52	23.56	0-1	0
	1	50	23.54	23.53	23.54		
	1	99	23.59	23.54	23.59		
	50	0	22.42	22.52	22.44	0-2	1
	50	25	22.58	22.52	22.48		
	50	50	22.59	22.55	22.52		
	100	0	22.50	22.51	22.38	0-2	1
64QAM	1	0	22.47	22.51	22.51	0-2	1
	1	50	22.55	22.51	22.53		
	1	99	22.56	22.55	22.56		
	50	0	21.39	21.56	21.45	0-3	2
	50	25	21.54	21.52	21.45		
	50	50	21.56	21.53	21.47		
	100	0	21.48	21.52	21.41	0-3	2

Table E.1.2 LTE Conducted Power

LTE Band 7 Conducted Power– 15 MHz Bandwidth							
Modulation	RB Size	RB Offset	Low Channel 20825 (2507.5 MHz)	Mid Channel 21100 (2535.0 MHz)	High Channel 21375 (2562.5 MHz)	MPR Allowed Per 3GPP(dB)	MPR (dB)
			Conducted Power (dBm)				
QPSK	1	0	23.55	23.57	23.58	0	0
	1	36	23.60	23.60	23.50		
	1	74	23.64	23.61	23.38		
	36	0	23.40	23.53	23.40	0-1	0
	36	18	23.59	23.52	23.46		
	36	37	23.60	23.53	23.45		
	75	0	23.55	23.48	23.42	0-1	0
16QAM	1	0	23.52	23.55	23.55	0-1	0
	1	36	23.55	23.56	23.47		
	1	74	23.53	23.57	23.36		
	36	0	22.43	22.51	22.39	0-2	1
	36	18	22.59	22.52	22.45		
	36	37	22.53	22.56	22.41		
	75	0	22.54	22.49	22.39	0-2	1
64QAM	1	0	22.47	22.57	22.57	0-2	1
	1	36	22.51	22.55	22.57		
	1	74	22.55	22.59	22.51		
	36	0	21.42	21.53	21.52	0-3	2
	36	18	21.56	21.57	21.57		
	36	37	21.53	21.57	21.56		
	75	0	21.50	21.48	21.47	0-3	2

Table E.1.3 LTE Conducted Power

LTE Band 7 Conducted Power– 10 MHz Bandwidth							
Modulation	RB Size	RB Offset	Low Channel	Mid Channel	High Channel	MPR Allowed Per 3GPP(dB)	MPR (dB)
			20800 (2505.0 MHz)	21100 (2535.0 MHz)	21400 (2565.0 MHz)		
			Conducted Power (dBm)				
QPSK	1	0	23.60	23.59	23.55	0	0
	1	25	23.62	23.57	23.58		
	1	49	23.60	23.65	23.53		
	25	0	23.55	23.54	23.50	0-1	0
	25	12	23.49	23.55	23.52		
	25	25	23.59	23.54	23.52		
	50	0	23.47	23.48	23.46	0-1	0
16QAM	1	0	23.55	23.54	23.54	0-1	0
	1	25	23.56	23.53	23.55		
	1	49	23.53	23.56	23.51		
	25	0	22.52	22.54	22.52	0-2	1
	25	12	22.43	22.52	22.51		
	25	25	22.56	22.53	22.52		
	50	0	22.59	22.45	22.46	0-2	1
64QAM	1	0	22.54	22.54	22.54	0-2	1
	1	25	22.57	22.54	22.52		
	1	49	22.57	22.57	22.56		
	25	0	21.48	21.55	21.53	0-3	2
	25	12	21.46	21.52	21.52		
	25	25	21.54	21.52	21.54		
	50	0	21.52	21.48	21.49	0-3	2

Table E.1.4 LTE Conducted Power

LTE Band 7 Conducted Power– 5 MHz Bandwidth							
Modulation	RB Size	RB Offset	Low Channel	Mid Channel	High Channel	MPR Allowed Per 3GPP(dB)	MPR (dB)
			20775 (2502.5 MHz)	21100 (2535.0 MHz)	21425 (2567.5 MHz)		
			Conducted Power (dBm)				
QPSK	1	0	23.54	23.55	23.63	0	0
	1	12	23.56	23.61	23.64		
	1	24	23.44	23.62	23.65		
	12	0	23.56	23.55	23.58	0-1	0
	12	6	23.59	23.53	23.56		
	12	13	23.47	23.52	23.51		
	25	0	23.50	23.48	23.50	0-1	0
16QAM	1	0	23.52	23.51	23.53	0-1	0
	1	12	23.55	23.57	23.56		
	1	24	23.43	23.58	23.54		
	12	0	22.54	22.57	22.54	0-2	1
	12	6	22.56	22.54	22.58		
	12	13	22.50	22.53	22.53		
	25	0	22.51	22.50	22.54	0-2	1
64QAM	1	0	22.55	22.54	22.52	0-2	1
	1	12	22.57	22.57	22.52		
	1	24	22.52	22.54	22.53		
	12	0	21.53	21.55	21.57	0-3	2
	12	6	21.56	21.54	21.60		
	12	13	21.49	21.54	21.57		
	25	0	21.46	21.44	21.50	0-3	2

Table E.1.5 LTE Conducted Power

E.2. Reduced LTE Band 7 DL Carrier Aggregation Conducted Powers

- **Below downlink CA configurations were determined based on Manufacturer's information.**

Table E.2.1 CA BW Class

Class	ATBC		Maximum number of CC
	$N_{RB.agg}$	MHz	
A	N ≤ 100	20	1
B	25 < N ≤ 100	20	2
C	100 < N ≤ 200	40	2
D	200 < N ≤ 300	60	3
E	300 < N ≤ 400	80	4
F	400 < N ≤ 500	100	5
I	700 < N ≤ 800	160	8

Table E.2.2 Exclusion Table for LTE DL CA (2CC)

Index	2CC	Supported Channel Bandwidth [MHz]		Restriction	Completely Covered by Measurement Superset
		CC1	CC2		
2CC #1	CA_4A-7A (0)	5, 10	5, 10, 15, 20		No
2CC #2	CA_4A-7A (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #3	CA_5A-7A (0)	1.4, 3, 5, 10	10, 15, 20		No
2CC #4	CA_5A-7A (1)	5, 10	10, 15, 20		No
2CC #5	CA_7A-7A (0)	5, 10, 15, 20	10, 15, 20		No
2CC #6	CA_7A-7A (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #7	CA_7A-7A (2)	5, 10, 15, 20	5, 10		No
2CC #8	CA_7A-7A (3)	10, 15, 20	10, 15, 20		No
2CC #9	CA_7B (0)	15	5		No
2CC #10	CA_7C (0)	15, 20	15, 20		No
2CC #11	CA_7C (1)	10, 15, 20	10, 15, 20		No
2CC #12	CA_7C (2)	15, 20	10, 15, 20		No

Note: Only yellow highlighted cells need power measurement.

Table E.2.3 LTE Band 7 as PCC

PCC										SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_4A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B4	10	2175	2132.5	23.62	23.66
CA_4A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B4	20	2175	2132.5	23.64	23.66
CA_5A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B5	10	2525	881.5	23.61	23.66
CA_5A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B5	10	2525	881.5	23.61	23.66
CA_7A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	23.60	23.66
CA_7A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	23.60	23.66
CA_7A-7A (2)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	10	2850	2630.0	23.58	23.66
CA_7A-7A (3)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	23.60	23.66
CA_7B (0)	LTE B7	15	20825	2507.5	QPSK	1	74	2825	2627.5	LTE B7	5	2918	2636.8	23.60	23.64
CA_7C (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	23.57	23.66
CA_7C (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	23.57	23.66
CA_7C (2)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	23.57	23.66

Note(s):
1. The device only supports downlink Carrier Aggregation. Uplink Carrier Aggregation is not supported. The DL carrier aggregation powers were measured according to the April 2018 TCB Workshop Notes (LTE Carrier Aggregation). Per Fall 2017 TCB Workshop Notes (LTE Carrier Aggregation) and FCC KDB Publication 941225 D05Av01r02, no further power measurements and SAR measurements are required for DL 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.
2. For downlink carrier aggregation combinations, PCC uplink channel was selected based on section C.3)b)ii) of KDB 941225 D05Av01r02.

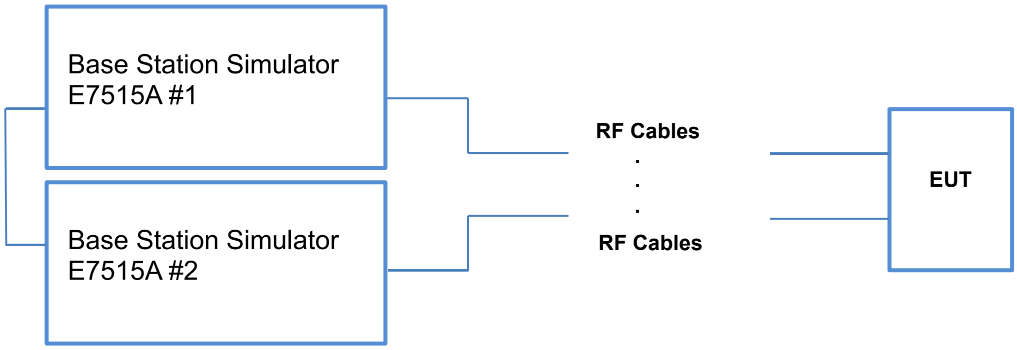


Figure E.2.1 DL 4CA Power Measurement Setup

E.3. LTE Band 7 Cap Sensor (proximity sensor) Power Measurement, Triggering Distance

- Power reduction and Proximity Sensor information of ZNFQ850FA

(1) Power reduction by proximity (capacitance) sensing: **LTE B7 only**

a) A proximity sensor for power reduction is implemented in this device to address RF exposure compliance about SAR requirement for protection of the human body.

(2) Proximity sensor detection area:

a) All proximity sensor pads are combined with the primary antenna pattern, therefore, they occupy the same area as the primary antenna.

b) The primary antenna and the proximity sensor pads are collocated and the peak SAR location is overlapping with the sensors, therefore do not need to measure proximity sensor coverage according to the KDB 616217 D04v01r02, section 6.3.

c) Power reduction mechanism is implemented in this device

i) Bottom surface, Front surface, Rear surface

d) The proximity sensor is triggered at the following distances when:

i) The bottom surface of the device is 6 mm for the trigger from the phantom.

ii) The front surface of the device is 3 mm for the trigger from the phantom.

iii) The rear surface of the device is 4 mm for the trigger from the phantom.

iv) Other surfaces (Right/Left edges) will be tested with the maximum powers.

e) When a certain object or human body approaches the DUT, if the measured capacitance is higher than certain capacitance, proximity sensor is triggered and power is reduced as follows.

Table E.3.1 LTE Band 7 Proximity Sensor power information

Band	Proximity sensor state	Maximum	Power (dBm)	Normal	Power (dBm)
LTE B7	Inactive (Far)	Maximum	24.7	Normal	24.2
	Active (Near)	Maximum	23.7	Normal	23.2

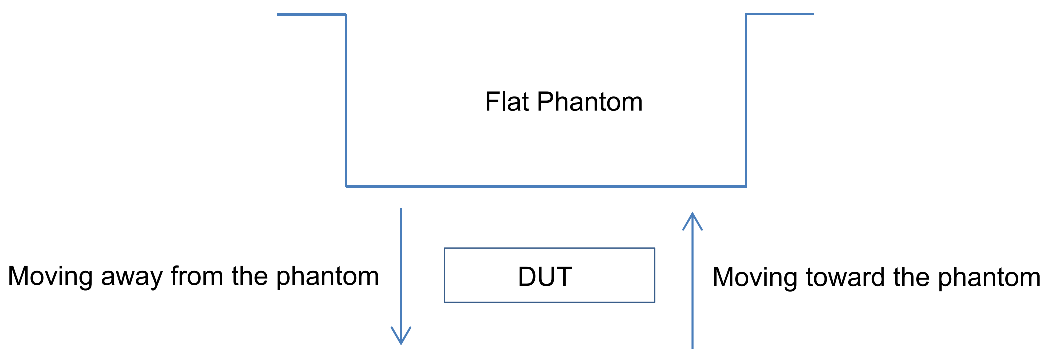


Figure E.3.1 Proximity Sensor Triggering Distance Assessment

- Cap Sensor Power Measurement and Triggering Distance

As per the KDB616217 D04v01r02, section 6.2 and two parts power verification procedure is used to determine the triggering distances.

Using this procedure the most conservative sensor triggering distance was measured and SAR measurement distance is determined (The most conservative sensor triggering distance – 1 mm for each applicable sides and edges).

(1) Proximity sensor status table when DUT is moving towards/ moving away the phantom (Bottom)

Moving toward the phantom					Moving away from the phantom					Final SAR Measurement Distance (mm)
Dist. to the DUT (mm)	Capacitive Sensor Status (Bot. surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	Dist. to the DUT (mm)	Capacitive Sensor Status (Bot. surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	
26	Inactive (Far)	24.67	6	5	18	Inactive (Far)	24.67	6	5	5
23	Inactive (Far)				17	Inactive (Far)				
20	Inactive (Far)				16	Inactive (Far)				
17	Inactive (Far)				15	Inactive (Far)				
14	Inactive (Far)				14	Inactive (Far)				
11	Inactive (Far)				13	Inactive (Far)				
8	Inactive (Far)				12	Inactive (Far)				
7	Inactive (Far)				11	Inactive (Far)				
6	Active (Near)	23.66			10	Inactive (Far)				
5	Active (Near)				9	Inactive (Far)				
4	Active (Near)				8	Inactive (Far)				
3	Active (Near)				7	Inactive (Far)				
2	Active (Near)				6	Active (Near)	23.66			
1	Active (Near)				3	Active (Near)				
0	Active (Near)				0	Active (Near)				

(2) Proximity sensor status table when DUT is moving towards/ moving away the phantom (Front)

Moving toward the phantom					Moving away from the phantom					Final SAR Measurement Distance (mm)
Dist. to the DUT (mm)	Capacitive Sensor Status (Front surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	Dist. to the DUT (mm)	Capacitive Sensor Status (Front surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	
23	Inactive (Far)	24.67	3	2	13	Inactive (Far)	24.67	3	2	2
20	Inactive (Far)				12	Inactive (Far)				
17	Inactive (Far)				11	Inactive (Far)				
14	Inactive (Far)				10	Inactive (Far)				
11	Inactive (Far)				9	Inactive (Far)				
8	Inactive (Far)				8	Inactive (Far)				
5	Inactive (Far)				7	Inactive (Far)				
4	Inactive (Far)				6	Inactive (Far)				
3	Active (Near)	23.66			5	Inactive (Far)				
2	Active (Near)				4	Inactive (Far)				
1	Active (Near)				3	Active (Near)	23.66			
0	Active (Near)				0	Active (Near)				

(3) Proximity sensor status table when DUT is moving towards/ moving away the phantom (Rear)

Moving toward the phantom					Moving away from the phantom					Final SAR meas. Dist. (mm)
Dist. to the DUT (mm)	Capacitive Sensor Status (Rear surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	Dist. to the DUT (mm)	Capacitive Sensor Status (Rear surface)	LTE Band 7 Cond. Power (dBm)	Trigg. dist. (mm)	SAR meas. Dist. (mm)	
24	Inactive (Far)	24.67	4	3	14	Inactive (Far)	24.67	4	3	3
21	Inactive (Far)				13	Inactive (Far)				
18	Inactive (Far)				12	Inactive (Far)				
15	Inactive (Far)				11	Inactive (Far)				
12	Inactive (Far)				10	Inactive (Far)				
9	Inactive (Far)				9	Inactive (Far)				
6	Inactive (Far)				8	Inactive (Far)				
5	Inactive (Far)				7	Inactive (Far)				
4	Active (Near)	23.66			6	Inactive (Far)				
3	Active (Near)				5	Inactive (Far)				
2	Active (Near)				4	Active (Near)	23.66			
1	Active (Near)				3	Active (Near)				
0	Active (Near)				0	Active (Near)				

- Cap Sensor SAR Test Plan for ZNFQ850FA

The smallest separation distance determined by the sensor triggering and sensor coverage for normal and/or tilt positions in KDB 616217 D04v01r02 section 6.2, 6.3 and 6.4 for front, back surface and edge triggering conditions, minus 1 mm, must be used as the test separation distance for SAR testing.

(1) The proximity sensor SAR will tested at the following distances when:

a) The **bottom surface** will be tested with the **maximum powers** of the device is **5 mm** from the phantom.

b) The **front surface** will be tested with the **maximum powers** of the device is **2 mm** from the phantom.

c) The **rear surface** will be tested with the **maximum powers** of the device is **3 mm** from the phantom.

d) **Other surfaces** (Left/Right edges) will be tested with the **maximum powers** of the device is **0 mm** from the phantom.

e) The **bottom surface** will be tested with the **reduction powers** of the device is **0 mm** from the phantom.

f) The **front surface** will be tested with the **reduction powers** of the device is **0 mm** from the phantom.

g) The **rear surface** will be tested with the **reduction powers** of the device is **0 mm** from the phantom.

Per FCC KDB Publication 616217 D04v01r02, this device was tested by test lab(DT&C) to determine the proximity sensor triggering distances for all applicable sides and edges of the device. The measured output power at distances within ± 5 mm of the triggering points (or until touching the phantom) is included for rear and front sides and each applicable edge per Step i) in Section 6.2 of the KDB. The technical descriptions in the filing contain the complete set of triggering data required by Section 6 of FCC Publication 616217 D04v01r02.

To ensure all production units are compliant, it is necessary to test SAR at a distance 1 mm less than the smallest distance between the device and SAR phantom (determined from the sensor triggering tests according to FCC KDB 616217 D04v01r02) with the device at the maximum output power (without power reduction). These SAR tests are included in addition to the SAR tests for the device touching the SAR phantom (at the reduced output power level).

The operational description contains information explaining how this device remains compliant in the event of a sensor malfunction.

E.4. Tissue Verification

MEASURED TISSUE PARAMETERS										
Date(s)	**Tissue Type**	**Ambient Temp.[°C]**	**Liquid Temp.[°C]**	**Measured Frequency [MHz]**	**Target Dielectric Constant, εr**	**Target Conductivity, σ (S/m)**	**Measured Dielectric Constant, εr**	**Measured Conductivity, σ (S/m)**	**Er Deviation [%]**	**σ Deviation [%]**
Aug. 20. 2018	2600 Body	20.2	20.9	2510.0	52.624	2.035	50.626	1.995	-3.80	-1.97
				2535.0	52.592	2.071	50.566	2.024	-3.85	-2.27
				2560.0	52.560	2.106	50.510	2.055	-3.90	-2.42
				2600.0	52.509	2.163	50.411	2.100	-4.00	-2.91

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB 865664 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

Measurement Procedure for Tissue verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the sample which 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 , for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\varepsilon_r'\varepsilon_0)^{1/2}]}{r}d\phi' d\rho' d\rho$$

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 $j = \sqrt{-1}$.

E.5. Test System Verification

Prior to assessment, the system is verified to the ± 10 % of the specifications at using the SAR Dipole kit(s). (Graphic Plots Attached)

Table E.5.1 System Verification Results (10g)

SYSTEM DIPOLE VERIFICATION TARGET & MEASURED											
SAR System #	Freq. [MHz]	SAR Dipole kits	Date(s)	Tissue Type	Ambient Temp. [°C]	Liquid Temp. [°C]	Probe S/N	Input Power (mW)	1 W Target SAR_{10g} (W/kg)	Measured SAR_{10g} (W/kg)	1 W Normalized SAR_{10g} (W/kg)	Deviation [%]
D	2600	D2600V2, SN: 1103	Aug. 20. 2018	Body	20.2	20.9	3328	100	24.9	2.56	25.60	2.81

Note1 : System Verification was measured with input 100 mW and normalized to 1W.
Note2 : Full system validation status and results can be found in Attachment 3.

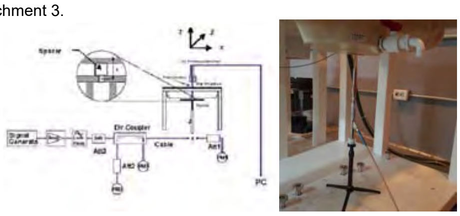


Figure E.5.1 Dipole Verification Test Setup Diagram & Photo

E.6. Standalone Phablet SAR Results

MEASUREMENT RESULTS																	
FREQUENCY		Mode/ Band	BW [MHz]	Max Allowed Power [dBm]	Cond. PWR [dBm]	Drift Power [dB]	MPR	Position	Device Serial Number	Mod.	RB Size	RB Offs.	Duty Cycle	10g SAR (W/kg)	Scaling Factor	10g Scaled SAR (W/kg)	Plots #
MHz	Ch																
2560.0	21350	LTE B7	20	24.70	24.67	-0.120	0	5 mm [Bottom]	FCC #1	QPSK	1	99	1:1	0.778	1.007	0.783	
2560.0	21350	LTE B7	20	23.70	23.62	-0.040	1	5 mm [Bottom]	FCC #1	QPSK	50	50	1:1	0.606	1.019	0.618	
2560.0	21350	LTE B7	20	24.70	24.67	0.020	0	2 mm [Front]	FCC #1	QPSK	1	99	1:1	0.688	1.007	0.693	
2560.0	21350	LTE B7	20	23.70	23.62	0.000	1	2 mm [Front]	FCC #1	QPSK	50	50	1:1	0.508	1.019	0.518	
2560.0	21350	LTE B7	20	24.70	24.67	0.090	0	3 mm [Rear]	FCC #1	QPSK	1	99	1:1	1.350	1.007	1.359	
2560.0	21350	LTE B7	20	23.70	23.62	0.110	1	3 mm [Rear]	FCC #1	QPSK	50	50	1:1	1.070	1.019	1.090	
2560.0	21350	LTE B7	20	24.70	24.67	0.100	0	0 mm [Right]	FCC #1	QPSK	1	99	1:1	0.128	1.007	0.129	
2560.0	21350	LTE B7	20	23.70	23.62	0.090	1	0 mm [Right]	FCC #1	QPSK	50	50	1:1	0.106	1.019	0.108	
2560.0	21350	LTE B7	20	24.70	24.67	0.040	0	0 mm [Left]	FCC #1	QPSK	1	99	1:1	0.181	1.007	0.182	
2560.0	21350	LTE B7	20	23.70	23.62	0.060	1	0 mm [Left]	FCC #1	QPSK	50	50	1:1	0.141	1.019	0.144	
2560.0	21350	LTE B7	20	23.70	23.66	-0.150	0	0 mm [Bottom]	FCC #1	QPSK	1	99	1:1	1.450	1.009	1.463	
2560.0	21350	LTE B7	20	23.70	23.53	0.080	0	0 mm [Bottom]	FCC #1	QPSK	50	50	1:1	1.400	1.040	1.456	
2560.0	21350	LTE B7	20	23.70	23.66	0.000	0	0 mm [Front]	FCC #1	QPSK	1	99	1:1	1.130	1.009	1.140	
2560.0	21350	LTE B7	20	23.70	23.53	0.170	0	0 mm [Front]	FCC #1	QPSK	50	50	1:1	1.050	1.040	1.092	
2560.0	21350	LTE B7	20	23.70	23.66	0.050	0	0 mm [Rear]	FCC #1	QPSK	1	99	1:1	1.870	1.009	1.887	
2560.0	21350	LTE B7	20	23.70	23.53	-0.140	0	0 mm [Rear]	FCC #1	QPSK	50	50	1:1	1.850	1.040	**1.924**	A74
2560.0	21350	LTE B7	20	23.70	23.53	-0.120	0	0 mm [Rear]	FCC #1	QPSK	50	50	1:1	1.850	1.040	1.924	
ANSI / IEEE C95.1-1992– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure									Phablet 4.0 W/kg (mW/g) averaged over 10 gram								

Note(s):
1. Blue entries represent SIM2 measurements.

E.7. Phablet SAR Simultaneous Transmission Analysis with proximity sensor enabled

Table E.7.1 Simultaneous Transmission Scenario : 4G + 5.3 GHz W-LAN Ant.1 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.3G W-LAN Ant.1 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.023	0.023
		Bottom	1.463	-	1.463
		Front	1.140	0.202	1.342
		Rear	1.924	0.262	**2.186**
		Right	0.129	-	0.129
		Left	0.182	0.023	0.205

Table E.7.2 Simultaneous Transmission Scenario : 4G + 5.3 GHz W-LAN Ant.2 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.3G W-LAN Ant.2 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.005	0.005
		Bottom	1.463	-	1.463
		Front	1.140	0.012	1.152
		Rear	1.924	1.271	**3.195**
		Right	0.129	-	0.129
		Left	0.182	0.234	0.416

Table E.7.3 Simultaneous Transmission Scenario : 4G + 5.3 GHz W-LAN MIMO (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.3G W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.023	0.023
		Bottom	1.463	-	1.463
		Front	1.140	0.184	1.324
		Rear	**1.924**	**1.306**	**3.230**
		Right	0.129	-	0.129
		Left	0.182	0.258	0.440

Table E.7.4 Simultaneous Transmission Scenario : 4G with 5.6 GHz W-LAN Ant.1 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.6G W-LAN Ant.1 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.017	0.017
		Bottom	1.463	-	1.463
		Front	1.140	0.252	1.392
		Rear	1.924	0.263	**2.187**
		Right	0.129	-	0.129
		Left	0.182	0.020	0.202

Table E.7.5 Simultaneous Transmission Scenario : 4G + 5.6 GHz W-LAN Ant.2 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.6G W-LAN Ant.2 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.005	0.005
		Bottom	1.463	-	1.463
		Front	1.140	0.046	1.186
		Rear	1.924	1.253	**3.177**
		Right	0.129	-	0.129
		Left	0.182	0.283	0.465

Table E.7.6 Simultaneous Transmission Scenario : 4G + 5.6 GHz W-LAN MIMO (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.6G W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.026	0.026
		Bottom	1.463	-	1.463
		Front	1.140	0.234	1.374
		Rear	1.924	1.259	**3.183**
		Right	0.129	-	0.129
		Left	0.182	0.291	0.473

Table E.7.7 Simultaneous Transmission Scenario : 4G + 5.8 GHz W-LAN Ant.1 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.8G W-LAN Ant.1 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.028	0.028
		Bottom	1.463	-	1.463
		Front	1.140	0.242	1.382
		Rear	1.924	0.298	**2.222**
		Right	0.129	-	0.129
		Left	0.182	0.027	0.209

Table E.7.8 Simultaneous Transmission Scenario : 4G + 5.8 GHz W-LAN Ant.2 (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.8G W-LAN Ant.2 SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.005	0.005
		Bottom	1.463	-	1.463
		Front	1.140	0.049	1.189
		Rear	1.924	1.022	**2.946**
		Right	0.129	-	0.129
		Left	0.182	0.228	0.410

Table E.7.9 Simultaneous Transmission Scenario : 4G + 5.8 GHz W-LAN MIMO (Phablet at 0 mm)

Exposure Condition	Mode	Configuration	4G SAR (W/kg)	5.8G W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)
			1	2	1+2
Phablet SAR	LTE Band 7	Top	-	0.033	0.033
		Bottom	1.463	-	1.463
		Front	1.140	0.217	1.357
		Rear	1.924	1.016	**2.940**
		Right	0.129	-	0.129
		Left	0.182	0.233	0.415

E.8. Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528-2013 Section 6.3.4.1.2.

APPENDIX F. – Downlink LTE CA RF Conducted Powers

F.1 LTE Downlink Only Carrier Aggregation Test Reduction Methodology

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number of component carriers (CCs) supported by the product implementation. Per April 2018 TCBC Workshop Notes, the following test reduction methodology was applied to determine the combinations required for conducted power measurements.

LTE DL CA Test Reduction Methodology:

(1) Test supported combinations were arranged by the number of component carriers in columns.
(2) Any limitations on the PCC or SCC for each combination were identified alongside the combination (e.g. CA_2A-2A-4A-12A, but B12 can only be configured as a SCC).
(3) Power measurements were performed for “supersets” (LTE CA combinations with multiple components carriers) and any “subsets” (LTE CA combinations with fewer component carriers) that were not completely covered by the supersets.
(4) Only subsets that have the exact same components as a superset were excluded for measurement.
(5) When there were certain restrictions on component carriers that existed in the superset that were not applied for the subset, the subset configuration was additionally evaluated.
(6) Both inter-band and intra-band downlink carrier aggregation scenarios were considered.

Index	[illegible]	Supported Channel Bandwidth (MHz)		Restriction	Completely Covered by Measurement Superset
		PCC	SCC		
2CC #1	CA_2C	5, 10, 15, 20	5, 10, 15, 20		3CC #4
2CC #2	CA_2A-5A	5, 10, 15, 20	5, 10		4CC #1
2CC #3	CA_2A-12A	5, 10, 15, 20	5, 10		3CC #3
2CC #4	CA_2A-13A	5, 10, 15, 20	10		3CC #9
2CC #5	CA_2A-17A	5, 10	5, 10		No
2CC #6	CA_2A-30A	5, 10, 15, 20	5, 10		3CC #14
2CC #8	CA_2A-66A (2)	5, 10, 15, 20	5, 10, 15, 20		5CC #1
2CC #9	CA_2A-71A	5, 10, 15, 20	5, 10, 15, 20		3CC #10
2CC #10	CA_4A-4A	5, 10, 15, 20	5, 10, 15, 20		3CC #6
2CC #11	CA_4A-5A (1)	5, 10, 15, 20	5, 10		4CC #1
2CC #12	CA_4A-12A (4)	5, 10, 15, 20	5, 10		3CC #8
2CC #13	CA_4A-13A	5, 10, 15, 20	10		3CC #9
2CC #14	CA_4A-17A	5, 10	5, 10	B17 SCC Only	No
2CC #15	CA_5B	5, 10	5, 10		5CC #1
2CC #16	CA_5A-25A	5, 10	5, 10, 15, 20		No
2CC #17	CA_7C	15, 20	15, 20		No
2CC #18	CA_7A-7A (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #19	CA_7A-12A	5, 10, 15, 20	5, 10		3CC #12
2CC #20	CA_12B	5	5, 10		3CC #13
2CC #21	CA_12A-25A	5, 10	5, 10, 15, 20		No
2CC #22	CA_12A-30A	5, 10	5, 10		3CC #14
2CC #23	CA_41A-41A (1)	5, 10, 15, 20	5, 10, 15, 20		No

Index	[illegible]	Supported Channel Bandwidth (MHz)			Restriction	Completely Covered by Measurement Superset
		PCC	SCC1	SCC2		
3CC #1	CA_2A-2A-4A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		4CC #1
3CC #2	CA_2A-2A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10		4CC #1
3CC #3	CA_2A-2A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10		No
3CC #4	CA_2C-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #5	CA_2A-2A-71A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #6	CA_2A-4A-4A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #7	CA_2A-4A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10		4CC #1
3CC #8	CA_2A-4A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10		No
3CC #9	CA_2A-4A-13A	5, 10, 15, 20	5, 10, 15, 20	10		No
3CC #10	CA_2A-4A-71A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #11	CA_2A-5B	5, 10, 15, 20	5, 10	5, 10		4CC #5
3CC #12	CA_2A-7A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10		No
3CC #13	CA_2A-12B	5, 10, 15, 20	5	5, 10		No
3CC #14	CA_2A-12A-30A	5, 10, 15, 20	5, 10	5, 10		No
3CC #15	CA_4A-4A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10		No
3CC #16	CA_5B-30A	5, 10	5, 10	5, 10		5CC #1
3CC #17	CA_5B-66A	5, 10	5, 10	5, 10, 15, 20		5CC #1
3CC #18	CA_5A-30A-66A	5, 10	5, 10	5, 10, 15, 20		4CC #9
3CC #19	CA_12A-66C	5, 10	5, 10, 15, 20	5, 10, 15, 20		No
3CC #20	CA_30A-66A-66A	5, 10	5, 10, 15, 20	5, 10, 15, 20		4CC #9
3CC #21	CA_41D	10, 15, 20	10, 15, 20	10, 15, 20		No
3CC #22	CA_41A-41C	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #23	CA_66D	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No
3CC #24	CA_66A-66C	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No

Index	[illegible]	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset
		PCC	SCC1	SCC2	SCC3		
4CC #1	CA_2A-2A-4A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		No
4CC #2	CA_2A-2A-4A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10	B12 SCC Only	No
4CC #3	CA_2A-2A-5A-30A	5, 10, 15, 20	5, 10, 15, 20	5, 10	5, 10		No
4CC #4	CA_2A-2A-5A-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10	5, 10, 15, 20		No
4CC #5	CA_2A-5B-30A	5, 10, 15, 20	5, 10	5, 10	5, 10		5CC #1
4CC #6	CA_2A-5B-66A	5, 10, 15, 20	5, 10	5, 10	5, 10, 15, 20		5CC #1
4CC #7	CA_5B-30A-66A	5, 10	5, 10	5, 10	5, 10		5CC #1
4CC #8	CA_5B-66A-66A	5, 10	5, 10	5, 10, 15, 20	5, 10, 15, 20		5CC #2
4CC #9	CA_5A-30A-66A-66A	5, 10	5, 10	5, 10, 15, 20	5, 10, 15, 20		No
4CC #10	CA_41E	15, 20	15, 20	15, 20	20		No

Index	[illegible]	Supported Channel Bandwidth (MHz)					Restriction	Completely Covered by Measurement Superset
		PCC	SCC1	SCC2	SCC3	SCC4		
5CC #1	CA_2A-5B-30A-66A	5, 10, 15, 20	5, 10	5, 10	5, 10	5, 10, 15, 20		No
5CC #2	CA_2A-5B-66A-66A	5, 10, 15, 20	5, 10	5, 10	5, 10, 15, 20	5, 10, 15, 20		No

Table F.1.1 Example of Exclusion Table for LTE DL CA

F.2 LTE Downlink Only Carrier Aggregation Test Selection and Setup

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number of component carriers (CCs) supported by the product implementation. For those configurations required by April 2018 TCBC Workshop Notes, conducted power measurements with LTE Carrier Aggregation (CA) (downlink only) active are made in accordance to KDB Publication 941225 D05Av01r02. The RRC connection is only handled by one cell, the primary component carrier (PCC) for downlink and uplink communications. After making a data connection to the PCC, the UE device adds secondary component carrier(s) (SCC) on the downlink only. All uplink communications and acknowledgements remain identical to specifications when downlink carrier aggregation is inactive on the PCC. 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.

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.

General PCC and SCC configuration selection procedure

PCC uplink channel, channel bandwidth, modulation and RB configurations were selected based on section C)3)b)ii) of KDB 941225 D05v01r02. The downlink PCC channel was paired with the selected PCC uplink channel according to normal configurations without carrier aggregation.

To maximize aggregation bandwidth, highest channel bandwidth available for that CA combination was selected for SCC. For inter-band CA, the SCC downlink channels were selected near the middle of their transmission bands. For contiguous intra-band CA, 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 non-contiguous intra-band CA, the downlink channel spacing between the component carriers was set to be larger than the nominal channel spacing and provided maximum separation between the component carriers.

All selected PCC and SCC(s) remained fully within the uplink/downlink transmission band of the respective component carrier.

When a device supports LTE capabilities with overlapping transmission frequency ranges, the standalone powers from the band with a larger transmission frequency range can be used to select measurement configurations for the band with the fully covered transmission frequency range.

F.3 LTE DL Carrier Aggregation Conducted Powers

- **Below downlink CA configurations were determined based on Manufacturer's information.**

Table F.3.1 CA BW Class

Class	ATBC		Maximum number of CC
	$N_{RB.agg}$	MHz	
A	N ≤ 100	20	1
B	25 < N ≤ 100	20	2
C	100 < N ≤ 200	40	2
D	200 < N ≤ 300	60	3
E	300 < N ≤ 400	80	4
F	400 < N ≤ 500	100	5
I	700 < N ≤ 800	160	8

Table F.3.2 Exclusion Table for LTE DL CA (2CC)

Index	2CC	Supported Channel Bandwidth [MHz]		Restriction	Completely Covered by Measurement Superset
		CC1	CC2		
2CC #1	CA_4A-5A (0)	5, 10	5, 10		No
2CC #2	CA_4A-5A (1)	5, 10, 15, 20	5, 10		No
2CC #3	CA_4A-7A (0)	5, 10	5, 10, 15, 20		No
2CC #4	CA_4A-7A (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #5	CA_4A-12A(0)	1.4, 3, 5, 10	5, 10		No
2CC #6	CA_4A-12A(1)	1.4, 3, 5, 10, 15, 20	5, 10		No
2CC #7	CA_4A-12A(2)	5, 10, 15, 20	3, 5, 10		No
2CC #8	CA_4A-12A(3)	5, 10	5, 10		No
2CC #9	CA_4A-12A(4)	5, 10, 15, 20	5, 10		No
2CC #10	CA_4A-12A(5)	5, 10, 15	5		No
2CC #11	CA_4A-17A (0)	5, 10	5, 10		No
2CC #12	CA_5A-7A (0)	1.4, 3, 5, 10	10, 15, 20		No
2CC #13	CA_5A-7A (1)	5, 10	10, 15, 20		No
2CC #14	CA_7A-7A (0)	5, 10, 15, 20	10, 15, 20		No
2CC #15	CA_7A-7A (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #16	CA_7A-7A (2)	5, 10, 15, 20	5, 10		No
2CC #17	CA_7A-7A (3)	10, 15, 20	10, 15, 20		No
2CC #18	CA_7B (0)	15	5		No
2CC #19	CA_7C (0)	15, 20	15, 20		No
2CC #20	CA_7C (1)	10, 15, 20	10, 15, 20		No
2CC #21	CA_7C (2)	15, 20	10, 15, 20		No
2CC #22	CA_12A-66A (0)	5, 10	1.4, 3, 5, 10		No
2CC #23	CA_12A-66A (1)	5, 10	1.4, 3, 5, 10, 15, 20		No
2CC #24	CA_12A-66A (2)	3, 5, 10	5, 10, 15, 20		No
2CC #25	CA_12A-66A (3)	5, 10	5, 10		No
2CC #26	CA_12A-66A (4)	5, 10	5, 10, 15, 20		No
2CC #27	CA_12A-66A (5)	5	5, 10, 15		No
2CC #28	CA_41C (0)	10, 15, 20	10, 15, 20		No
2CC #29	CA_41C (1)	5, 10, 15, 20	5, 10, 15, 20		No
2CC #30	CA_41C (2)	10, 15, 20	10, 15, 20		No
2CC #31	CA_41C (3)	10, 20	20		No
2CC #32	CA_66A-66A (0)	5, 10, 15, 20	5, 10, 15, 20		3CC #1
2CC #33	CA_66B (0)	5, 10, 15	5, 10, 15		No
2CC #34	CA_66C (0)	5, 10, 15, 20	5, 10, 15, 20		No

Note: Only yellow highlighted cells need power measurement.

Table F.3.3 Exclusion Table for LTE DL CA (3CC)

Index	3CC	Supported Channel Bandwidth [MHz]			Restriction	Completely Covered by Measurement Superset
		CC1	CC2	CC3		
3CC #1	CA_12A-66A-66A (0)	5, 10	5, 10, 15, 20	5, 10, 15, 20		No
3CC #2	CA_41D (0)	10, 15, 20	10, 15, 20	10, 15, 20		No

Note: Only yellow highlighted cells need power measurement.

Table F.3.4 LTE Band 4 as PCC

PCC										SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_4A-5A (0)	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B5	10	2525	881.5	23.64	23.69
CA_4A-5A (1)	LTE B4	20	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B5	10	2525	881.5	23.66	23.68
CA_4A-7A (0)	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B7	20	3100	2655.0	23.63	23.69
CA_4A-7A (1)	LTE B4	20	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B7	20	3100	2655.0	23.65	23.68
CA_4A-12A (0)	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	23.65	23.69
CA_4A-12A (1)	LTE B4	20	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	23.64	23.68
CA_4A-12A (2)	LTE B4	20	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	23.64	23.68
CA_4A-12A (3)	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	23.65	23.69
CA_4A-12A (4)	LTE B4	20	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	23.64	23.68
CA_4A-12A (5)	LTE B4	15	20175	1732.5	QPSK	1	99	2175	2132.5	LTE B12	5	5095	737.5	23.63	23.69
CA_4A-17A (0)	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B17	10	5790	740.0	23.63	23.69

Table F.3.5 LTE Band 5 as PCC

PCC										SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_5A-7A (0)	LTE B5	10	20525	836.5	QPSK	1	0	2525	881.5	LTE B7	20	3100	2655.0	25.13	25.15
CA_5A-7A (1)	LTE B5	10	20525	836.5	QPSK	1	0	2525	881.5	LTE B7	20	3100	2655.0	25.13	25.15
CA_4A-5A (0)	LTE B5	10	20525	836.5	QPSK	1	0	2525	881.5	LTE B4	10	2175	2132.5	25.11	25.15
CA_4A-5A (1)	LTE B5	10	20525	836.5	QPSK	1	0	2525	881.5	LTE B4	20	2175	2132.5	25.12	25.15

Table F.3.6 LTE Band 7 as PCC

PCC										SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_4A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B4	10	2175	2132.5	24.64	24.67
CA_4A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B4	20	2175	2132.5	24.65	24.67
CA_5A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B5	10	2525	881.5	24.63	24.67
CA_5A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B5	10	2525	881.5	24.63	24.67
CA_7A-7A (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	24.61	24.67
CA_7A-7A (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	24.61	24.67
CA_7A-7A (2)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	10	2800	2625.0	24.60	24.67
CA_7A-7A (3)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	2850	2630.0	24.61	24.67
CA_7B (0)	LTE B7	15	21100	2535.0	QPSK	1	36	3100	2655.0	LTE B7	5	3193	2664.3	24.61	24.63
CA_7C (0)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	24.58	24.67
CA_7C (1)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	24.58	24.67
CA_7C (2)	LTE B7	20	21350	2560.0	QPSK	1	99	3350	2680.0	LTE B7	20	3152	2660.2	24.58	24.67

Table F.3.7 LTE Band 12 as PCC

PCC										SCC				SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_4A-12A (0)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B4	10	2175	2132.5	-	-	-	-	25.09	25.12
CA_4A-12A (1)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B4	20	2175	2132.5	-	-	-	-	25.10	25.12
CA_4A-12A (2)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B4	20	2175	2132.5	-	-	-	-	25.10	25.12
CA_4A-12A (3)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B4	10	2175	2132.5	-	-	-	-	25.09	25.12
CA_4A-12A (4)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B4	20	2175	2132.5	-	-	-	-	25.10	25.12
CA_4A-12A (5)	LTE B12	5	23155	713.5	QPSK	1	12	5155	743.5	LTE B4	15	2175	2132.5	-	-	-	-	25.08	25.12
CA_12A-66A (0)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	10	66786	2145.0	-	-	-	-	25.06	25.12
CA_12A-66A (1)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	20	66786	2145.0	-	-	-	-	25.08	25.12
CA_12A-66A (2)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	20	66786	2145.0	-	-	-	-	25.08	25.12
CA_12A-66A (3)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	10	66786	2145.0	-	-	-	-	25.06	25.12
CA_12A-66A (4)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	20	66786	2145.0	-	-	-	-	25.08	25.12
CA_12A-66A (5)	LTE B12	5	23155	713.5	QPSK	1	12	5155	743.5	LTE B66	15	66786	2145.0	-	-	-	-	25.07	25.12
CA_12A-66A-66A (0)	LTE B12	10	23095	707.5	QPSK	1	49	5095	737.5	LTE B66	20	66786	2145.0	LTE B66	20	67036	2170.0	25.06	25.12

Table F.3.8 LTE Band 17 as PCC

PCC										SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_4A-17A (0)	LTE B17	10	23790	710.0	QPSK	1	49	5790	740.0	LTE B4	10	2175	2132.5	25.16	25.23

Table F.3.8 LTE Band 41 as PCC

PCC										SCC				SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_41C (0)	LTE B41	20	40620	2593.0	QPSK	1	0	40620	2593.0	LTE B41	20	40818	2612.8	-	-	-	-	23.75	23.77
CA_41C (1)	LTE B41	20	40620	2593.0	QPSK	1	0	40620	2593.0	LTE B41	20	40818	2612.8	-	-	-	-	23.75	23.77
CA_41C (2)	LTE B41	20	40620	2593.0	QPSK	1	0	40620	2593.0	LTE B41	20	40818	2612.8	-	-	-	-	23.75	23.77
CA_41C (3)	LTE B41	20	40620	2593.0	QPSK	1	0	40620	2593.0	LTE B41	20	40818	2612.8	-	-	-	-	23.75	23.77
CA_41D (0)	LTE B41	20	40620	2593.0	QPSK	1	0	40620	2593.0	LTE B41	20	40818	2612.8	LTE B41	20	41016	2632.6	23.73	23.77

Table F.3.9 LTE Band 66 as PCC

PCC										SCC				SCC				Power	
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)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	SCC Band	SCC BW (MHz)	SCC (DL) CH.	SCC (DL) Freq. (MHz)	LTE Tx. Power with DL CA Enabled (dBm)	LTE Single Carrier Tx. Power (dBm)
CA_12A-66A (0)	LTE B66	10	132622	1775.0	QPSK	1	0	67086	2175.0	LTE B12	10	5095	737.5	-	-	-	-	23.35	23.37
CA_12A-66A (1)	LTE B66	20	132572	1770.0	QPSK	1	0	67036	2170.0	LTE B12	10	5095	737.5	-	-	-	-	23.60	23.62
CA_12A-66A (2)	LTE B66	20	132572	1770.0	QPSK	1	0	67036	2170.0	LTE B12	10	5095	737.5	-	-	-	-	23.60	23.62
CA_12A-66A (3)	LTE B66	10	132622	1775.0	QPSK	1	0	67086	2170.0	LTE B12	10	5095	737.5	-	-	-	-	23.35	23.37
CA_12A-66A (4)	LTE B66	20	132572	1770.0	QPSK	1	0	67036	2170.0	LTE B12	10	5095	737.5	-	-	-	-	23.60	23.62
CA_12A-66A (5)	LTE B66	15	132047	1717.5	QPSK	1	74	66511	2117.5	LTE B12	5	5095	737.5	-	-	-	-	23.25	23.29
CA_12A-66A-66A (0)	LTE B66	20	132572	1770.0	QPSK	1	0	67036	2170.0	LTE B66	20	66536	2120.0	LTE B12	10	5095	737.5	23.58	23.62
CA_66B (0)	LTE B66	15	132047	1717.5	QPSK	1	74	66511	2117.5	LTE B66	5	66604	2126.8	-	-	-	-	23.25	23.29
CA_66C (0)	LTE B66	20	132572	1770.0	QPSK	1	0	67036	2170.0	LTE B66	20	66838	2150.2	-	-	-	-	23.55	23.62

Note(s):
1. The device only supports downlink Carrier Aggregation. Uplink Carrier Aggregation is not supported. The DL carrier aggregation powers were measured according to the April 2018 TCB Workshop Notes (LTE Carrier Aggregation). Per Fall 2017 TCB Workshop Notes (LTE Carrier Aggregation) and FCC KDB Publication 941225 D05Av01r02, no further power measurements and SAR measurements are required for DL 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.
2. For downlink carrier aggregation combinations, PCC uplink channel was selected based on section C.3)b)ii) of KDB 941225 D05Av01r02.

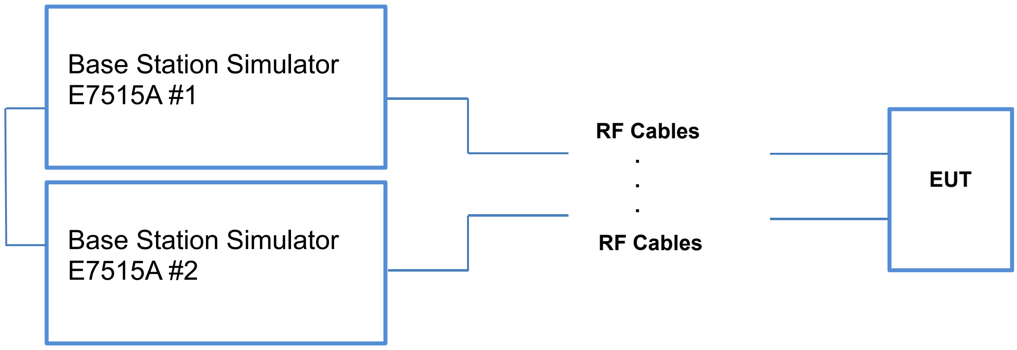


Figure F.3.1 DL 4CA Power Measurement Setup

F.4 64QAM uplink : Applying KDB inquiry # 331653

According to the Response to Inquiry to FCC (KDB Inquiry Tracking Number: 331653), the SAR Power Measurement Plan is as follows.

(1) Per KDB 941225 D05 V02r05, we'll measure conducted powers per Section 5.1 for all uplink modulations (QPSK, 16QAM, 64QAM) and include in the test report.

(2) From these power measurements, we will apply the procedures in Section 5.2.4 ("Higher Order Modulations") to determine SAR test reduction for 16QAM and 64QAM test cases.

APPENDIX G. – Description of Test Equipment

G.1 SAR Measurement Setup

Measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. G.1.1).

A cell controller system contains the power supply, robot controller each pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the Intel Core i7-3770 3.40 GHz desktop computer with Windows 7 system and SAR Measurement Software DASY5,A/D interface card, monitor, mouse, and keyboard. The Staubli Robotis connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

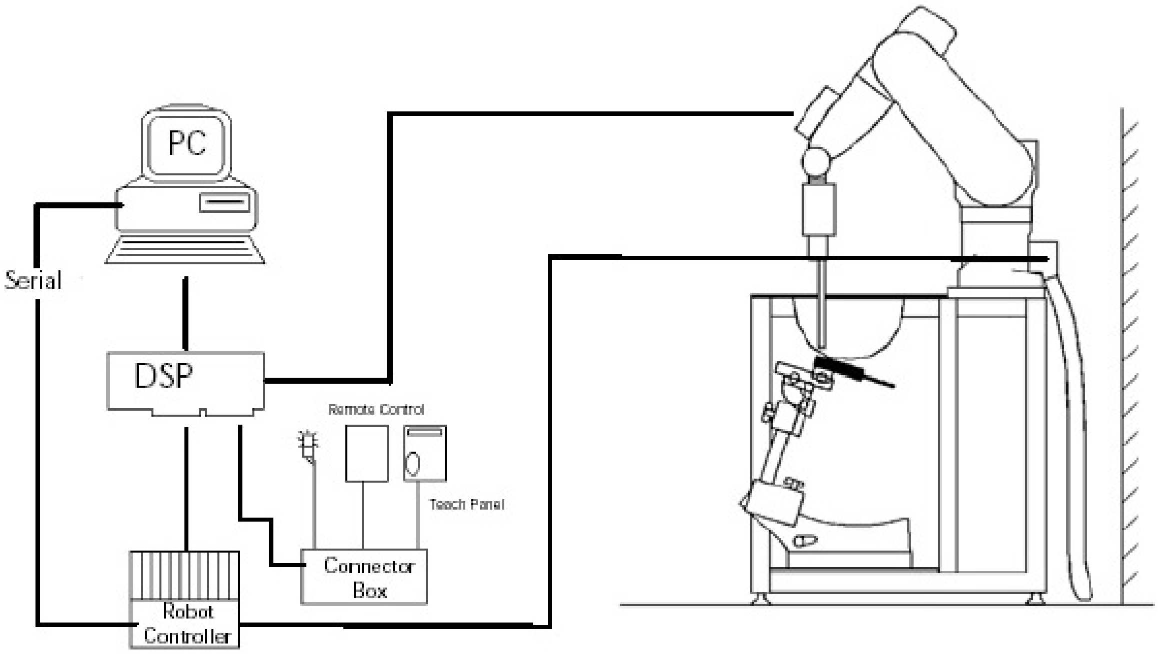


Figure G.1.1 SAR Measurement System Setup

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail.

G.2 Probe Specification

Calibration	In air from 10 MHz to 4 GHz/10 MHz to 6 GHz In brain and muscle simulating tissue at Frequencies of 750 MHz, 835 MHz, 900 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz / 750 MHz, 835 MHz, 900 MHz, 1750 MHz, 1900 MHz, 2300 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5500 MHz, 5600 MHz, 5800 MHz	
Frequency	10 MHz to 4 GHz/10 MHz to 6 GHz	
Linearity	± 0.2 dB(30 MHz to 4 GHz/30 MHz to 6 GHz)	
Dynamic	10 μW/g to > 100 mW/g	
Range	Linearity :	±0.2dB
Dimensions	Overall length :	337 mm
Tip length	20 mm	
Body diameter	12 mm	
Tip diameter	3.9 mm/2.5 mm	
Distance from probe tip to sensor center	2.0 mm/1.0 mm	
Application	SAR Dosimetry Testing Compliance tests of mobile phones	

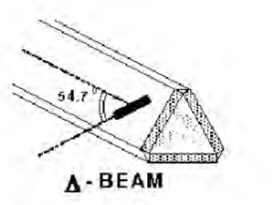


Figure G.2.1 Triangular Probe Configurations

Figure G.2.2 Probe Thick-Film Technique

DAE System

The SAR measurements were conducted with the dosimetric probe ES3DV3 and EX3DV4, designed in the classical triangular configuration(see G.2.1) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multitier line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

G.3 E-Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees.

Temperature Assessment *

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

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to ΔT / Δt , the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

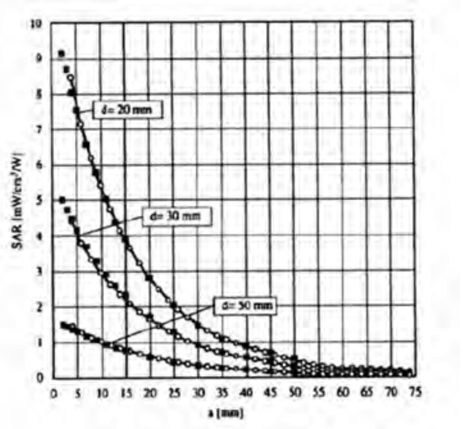


Figure G.3.1 E-Field and Temperature Measurements at 900MHz

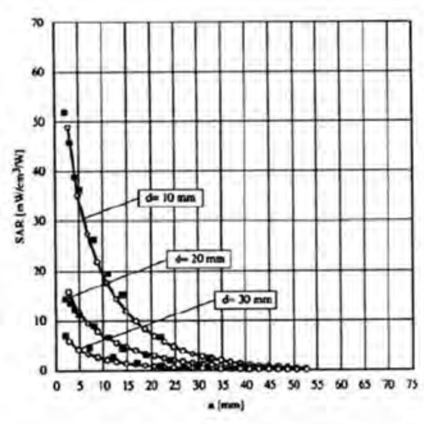


Figure G.3.2 E-Field and Temperature Measurements at 1800MHz

G.4 Data Extrapolation

The DASY5 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with
V_i = compensated signal of channel i (i=x,y,z)
U_i = input signal of channel i (i=x,y,z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with
V_i = compensated signal of channel i (i = x,y,z)
$Norm_i$ = sensor sensitivity of channel i (i = x,y,z) $\mu V/(V/m)^2$ for E-field probes
ConvF = sensitivity of enhancement in solution
E_i = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermetian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with
SAR = local specific absorption rate in W/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

with
P_{pwe} = equivalent power density of a plane wave in W/cm^2
E_{tot} = total electric field strength in V/m

G.5 SAM Twin Phantom

The SAM Twin Phantom V5.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid.

Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. (see Fig. G.5.1)

Figure G.5.1 SAM Twin Phantom

SAM Twin Phantom Specification:

Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.
Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet

Specific Anthropomorphic Mannequin (SAM) Specifications:

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Fig. G.5.2). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.

Figure G.5.2 Sam Twin Phantom shell

G.6 Device Holder for Transmitters

In combination with the Twin SAM Phantom V4.0/V4.0c, V5.0 or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).
Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

Figure G.6.1 Mounting Device

G.7 Automated Test System Specifications

Positioner

Robot	Stäubli Unimation Corp. Robot Model: TX90XL
Repeatability	0.02 mm
No. of axis	6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor	Intel Core i7-3770
Clock Speed	3.40 GHz
Operating System	Windows 7 Professional
Data Card	DASY5 PC-Board

Data Converter

Features	Signal, multiplexer, A/D converter. & control logic
Software	DASY5
Connecting Lines	Optical downlink for data and status info Optical uplink for commands and clock

PC Interface Card

Function	24 bit (64 MHz) DSP for real time processing Link to DAE 4 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

E-Field Probes

Model	ES3DV3 S/N: 3328/ EX3DV4 S/N: 3866
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 4 GHz/10 MHz to 6 GHz
Linearity	± 0.2 dB (30 MHz to 4 GHz/30 MHz to 6 GHz)

Phantom

Phantom	SAM Twin Phantom (V5.0)
Shell Material	Composite
Thickness	2.0 ± 0.2 mm

Figure G.7.1 DASY5 Test System