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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.9 $\pm$ 6 %	1.38 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.65 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.4 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.6 $\pm$ 6 %	1.47 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.56 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$51.8 \Omega + 6.8 j\Omega$
Return Loss	- 23.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.4 \Omega + 7.8 j\Omega$
Return Loss	- 21.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.170 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 21.02.2019

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.26, 8.26, 8.26) @ 1900 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

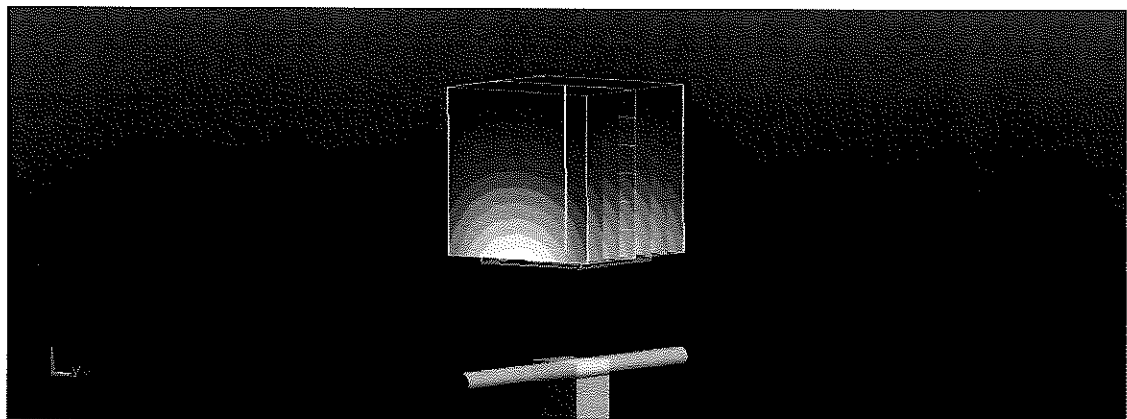
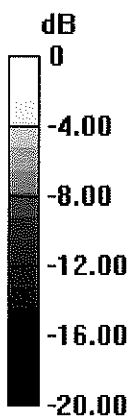
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.4 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 17.8 W/kg

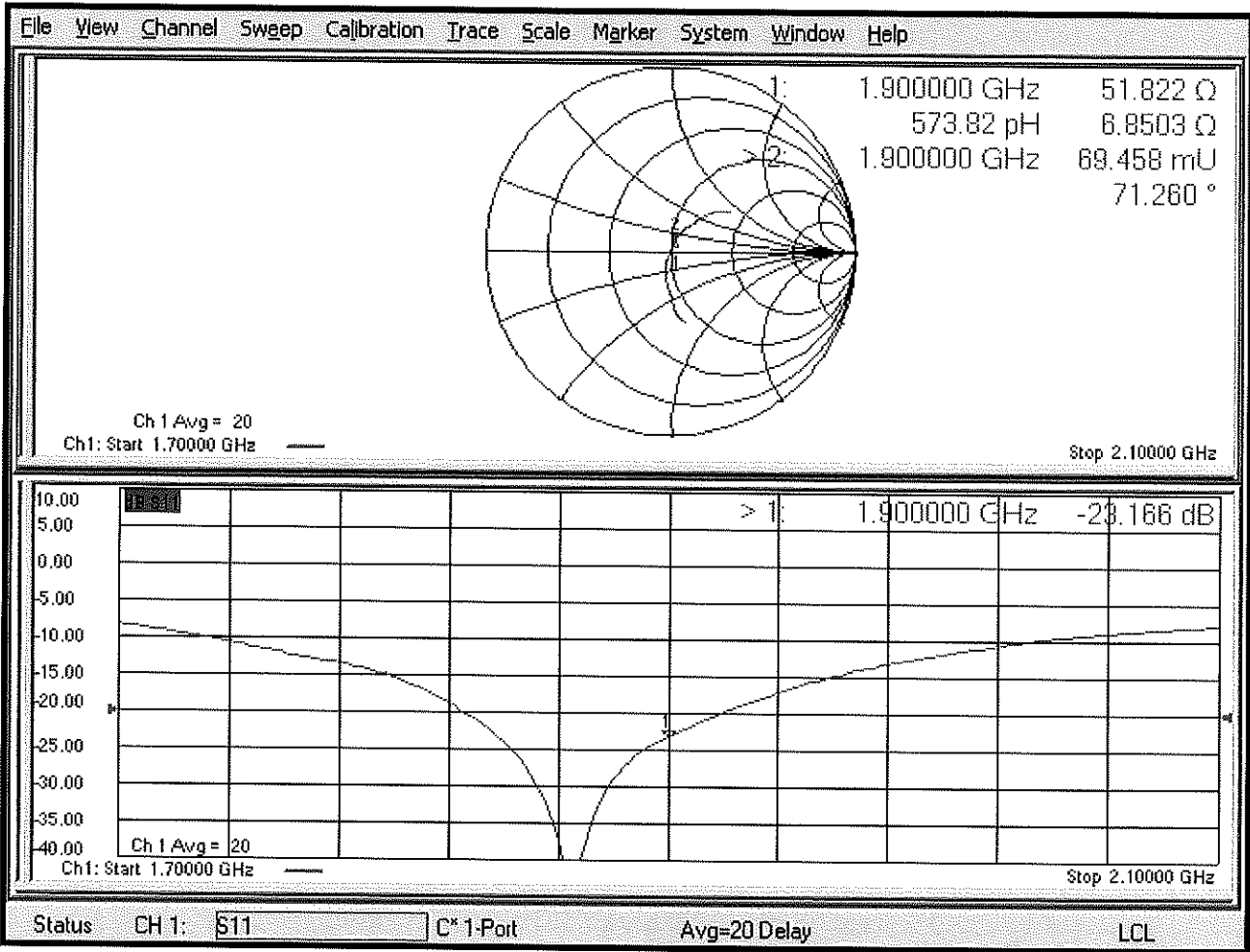
SAR(1 g) = 9.65 W/kg; SAR(10 g) = 5.05 W/kg

Maximum value of SAR (measured) = 15.0 W/kg



0 dB = 15.0 W/kg = 11.76 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.02.2019

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.47$ S/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.23, 8.23, 8.23) @ 1900 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

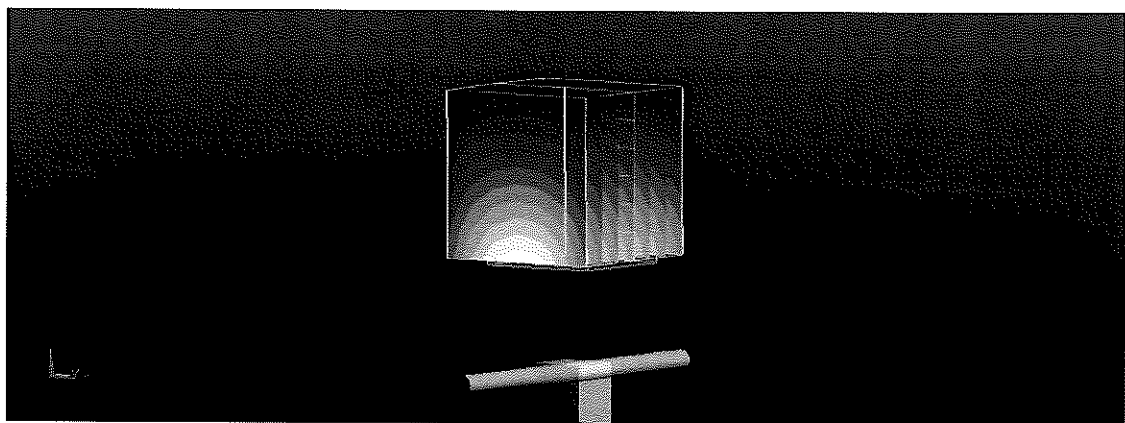
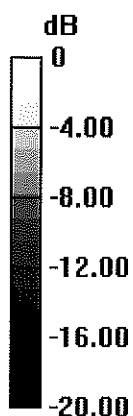
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.7 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.0 W/kg

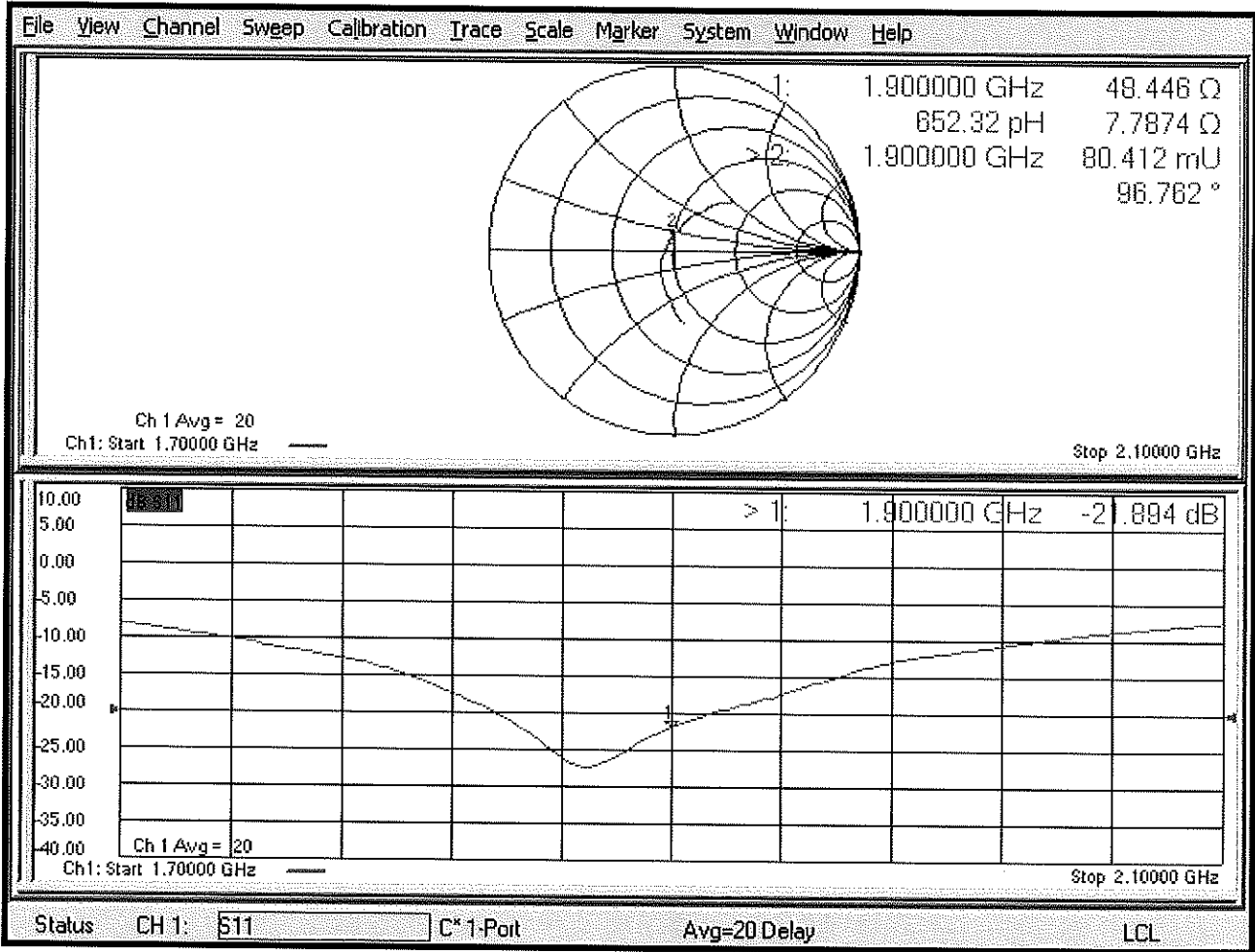
SAR(1 g) = 9.56 W/kg; SAR(10 g) = 5.05 W/kg

Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

Impedance Measurement Plot for Body TSL



APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

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

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

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

Table D-I
Composition of the Tissue Equivalent Matter

Frequency (MHz)	750	750	835	835	1750	1750	1900	1900	2450	2450
Tissue	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Ingredients (% by weight)										
Bactericide	See page 2-3	See page 2	0.1	0.1					See page 4	
DGBE					47	31	44.92	29.44		26.7
HEC			1	1						
NaCl			1.45	0.94	0.4	0.2	0.18	0.39		0.1
Sucrose			57	44.9						
Water			40.45	53.06	52.6	68.8	54.9	70.17		73.2

FCC ID: ZNFX320AA		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 05/21/19 - 06/10/19	DUT Type: Portable Handset			APPENDIX D: Page 1 of 4

2 Composition / Information on ingredients

The item is composed of the following ingredients:

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

Figure D-1
Composition of 750 MHz Head and Body Tissue Equivalent Matter

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

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s p e a g

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Measurement Certificate / Material Test

Item Name	Body Tissue Simulating Liquid (MSL750V2)
Product No.	SL AAM 075 AA (Batch: 170608-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

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

Target Parameters

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

Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	20-Jun-17
Operator	CL

Additional Information

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

f [MHz]	Measured			Target		Diff. to Target [%]	
	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	57.3	26.02	0.84	56.1	0.95	2.2	-12.2
625	57.1	24.67	0.86	56.0	0.95	1.9	-10.1
650	56.8	24.32	0.88	55.9	0.96	1.6	-8.0
675	56.6	24.02	0.90	55.8	0.96	1.3	-5.8
700	56.3	23.71	0.92	55.7	0.96	1.1	-3.8
725	56.1	23.48	0.95	55.6	0.96	0.8	-1.5
750	55.9	23.25	0.97	55.5	0.96	0.6	0.7
775	55.6	23.04	0.99	55.4	0.97	0.3	2.9
800	55.4	22.82	1.02	55.3	0.97	0.1	5.0
825	55.2	22.65	1.04	55.2	0.98	-0.1	6.3
838	55.1	22.56	1.05	55.2	0.98	-0.3	6.9
850	54.9	22.47	1.06	55.2	0.99	-0.4	7.5
875	54.7	22.34	1.09	55.1	1.02	-0.7	6.7
900	54.5	22.21	1.11	55.0	1.05	-0.9	5.9
925	54.3	22.08	1.14	55.0	1.06	-1.3	6.9
950	54.1	21.95	1.16	54.9	1.08	-1.6	7.9
975	53.8	21.86	1.19	54.9	1.09	-1.9	9.1
1000	53.6	21.76	1.21	54.8	1.10	-2.2	10.2

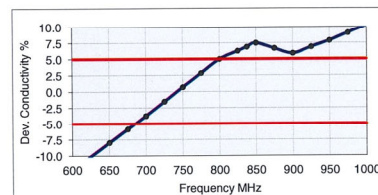
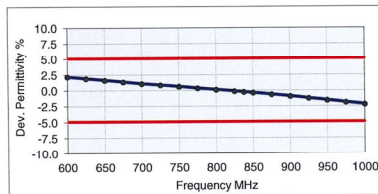


Figure D-2
750MHz Body Tissue Equivalent Matter

FCC ID: ZNFX320AA		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 05/21/19 - 06/10/19	DUT Type: Portable Handset	APPENDIX D: Page 2 of 4		

Measurement Certificate / Material Test

Item Name **Head Tissue Simulating Liquid (HSL750V2)**
 Product No. SL AAH 075 AA (Batch: 170612-4)
 Manufacturer SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

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

Target Parameters

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

Test Condition

Ambient Environment temperatur ($22 \pm 3^\circ\text{C}$ and humidity $< 70\%$).
 TSL Temperature 22°C
 Test Date 20-Jun-17
 Operator CL

Additional Information

TSL Density 1.284 g/cm^3
 TSL Heat-capacity $2.701 \text{ kJ/(kg}^\circ\text{K)}$

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	$\Delta\text{-eps}$	$\Delta\text{-sigma}$
600	45.6	22.97	0.77	42.7	0.88	6.7	-13.1
625	45.2	22.73	0.79	42.6	0.88	6.2	-10.6
650	44.9	22.49	0.81	42.5	0.89	5.6	-8.2
675	44.5	22.27	0.84	42.3	0.89	5.1	-5.8
700	44.2	22.05	0.86	42.2	0.89	4.6	-3.5
725	43.8	21.88	0.88	42.1	0.89	4.2	-1.0
750	43.5	21.72	0.91	41.9	0.89	3.8	1.4
775	43.2	21.55	0.93	41.8	0.90	3.4	3.7
800	42.9	21.38	0.95	41.7	0.90	2.9	6.0
825	42.6	21.24	0.97	41.6	0.91	2.4	7.5
838	42.5	21.17	0.99	41.5	0.91	2.2	8.2
850	42.3	21.09	1.00	41.5	0.92	2.0	8.0
875	42.0	20.98	1.02	41.5	0.94	1.2	8.3
900	41.7	20.87	1.05	41.5	0.97	0.5	7.7
925	41.5	20.76	1.07	41.5	0.98	0.0	8.7
950	41.2	20.64	1.09	41.4	0.99	-0.6	9.7
975	40.9	20.55	1.11	41.4	1.00	-1.1	10.9
1000	40.6	20.46	1.14	41.3	1.01	-1.7	12.1

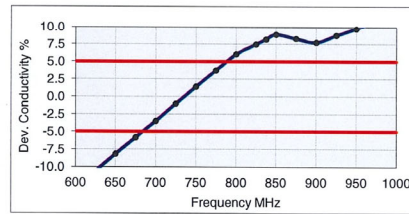
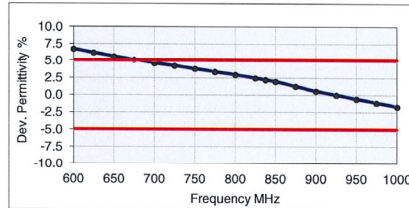


Figure D-3
750MHz Head Tissue Equivalent Matter

FCC ID: ZNFX320AA		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 05/21/19 - 06/10/19	DUT Type: Portable Handset	APPENDIX D: Page 3 of 4		

3 Composition / Information on ingredients

The Item is composed of the following ingredients:

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

Safety relevant ingredients:

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

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

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

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

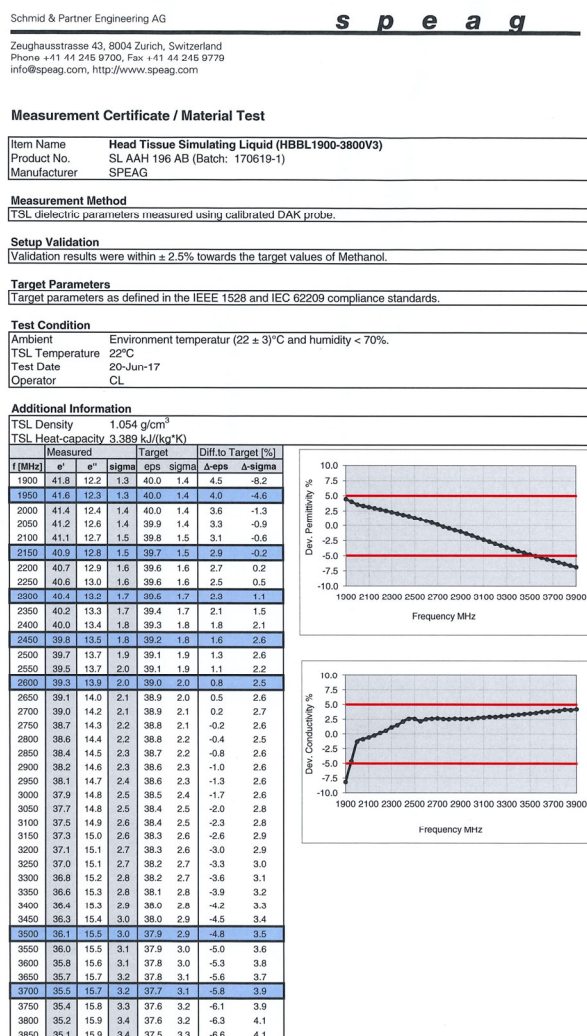


Figure D-5
2.4 GHz Head Tissue Equivalent Matter

FCC ID: ZNFX320AA		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 05/21/19 - 06/10/19	DUT Type: Portable Handset			APPENDIX D: Page 4 of 4

APPENDIX E: SAR SYSTEM VALIDATION

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

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

Table E-1
SAR System Validation Summary – 1g

SAR System	Freq. (MHz)	Date	Probe SN	Probe Cal Point		Cond. (σ)	Perm. (ϵ_r)	CW VALIDATION			MOD. VALIDATION		
								SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
D	750	4/12/2019	3914	750	Head	0.903	42.785	PASS	PASS	PASS	N/A	N/A	N/A
H	835	7/13/2018	7409	835	Head	0.932	43.227	PASS	PASS	PASS	GMSK	PASS	N/A
E	1750	2/6/2019	3589	1750	Head	1.363	41.670	PASS	PASS	PASS	N/A	N/A	N/A
L	1900	5/22/2019	7308	1900	Head	1.450	38.200	PASS	PASS	PASS	GMSK	PASS	N/A
E	2450	2/5/2019	3589	2450	Head	1.825	39.836	PASS	PASS	PASS	D	PASS	PASS
I	750	5/16/2019	7357	750	Body	0.937	56.547	PASS	PASS	PASS	N/A	N/A	N/A
J	835	3/10/2019	7488	835	Body	0.988	53.868	PASS	PASS	PASS	GMSK	PASS	N/A
D	1750	4/29/2019	3914	1750	Body	1.529	51.886	PASS	PASS	PASS	N/A	N/A	N/A
G	1900	8/10/2018	7410	1900	Body	1.567	52.239	PASS	PASS	PASS	GMSK	PASS	N/A
E	1900	2/5/2019	3589	1900	Body	1.584	54.248	PASS	PASS	PASS	GMSK	PASS	N/A
K	2450	3/6/2019	7417	2450	Body	2.039	50.670	PASS	PASS	PASS	D	PASS	PASS

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

FCC ID: ZNFX320AA		SAR EVALUATION REPORT		Approved by: Quality Manager
Test Dates: 05/21/19 - 06/10/19	DUT Type: Portable Handset			APPENDIX E: Page 1 of 1

APPENDIX G: DOWNLINK LTE CA RF CONDUCTED POWERS

1.1 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 DLCA Test Reduction Methodology:

- The supported combinations were arranged by the number of component carriers in columns.
- 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).
- 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.
- Only subsets that have the exact same components as a superset were excluded for measurement.
- 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.
- Both inter-band and intra-band downlink carrier aggregation scenarios were considered.
- Downlink CA combinations for SISO operations were measured independently, per May 2017 TCBC Workshop notes.

Table 1 – Example of Exclusion Table for SISO Configurations

Table 1: Approved Contract Documents (ACDs) by Measurement & Payment Schedule						Table 2: Approved Contract Documents (ACDs) by Measurement & Payment Schedule						Table 3: Approved Contract Documents (ACDs) by Measurement & Payment Schedule					
Index	DOC	Approved Contract Document (Title)		Revision	Completely Covered by Measurement & Payment Schedule	Index	DOC	Approved Contract Document (Title)		Revision	Completely Covered by Measurement & Payment Schedule	Index	DOC	Approved Contract Document (Title)		Revision	Completely Covered by Measurement & Payment Schedule
Doc 46	CA-24	CA-24-001	CA-24-001-001	1.00	Yes	Doc 47	CA-24	CA-24-002	CA-24-002-001	1.00	Yes	Doc 48	CA-24	CA-24-003	CA-24-003-001	1.00	Yes
Doc 47	CA-24	CA-24-002	CA-24-002-001	1.00	Yes	Doc 49	CA-24	CA-24-004	CA-24-004-001	1.00	Yes	Doc 50	CA-24	CA-24-005	CA-24-005-001	1.00	Yes
Doc 48	CA-24	CA-24-003	CA-24-003-001	1.00	Yes	Doc 51	CA-24	CA-24-006	CA-24-006-001	1.00	Yes	Doc 52	CA-24	CA-24-007	CA-24-007-001	1.00	Yes
Doc 49	CA-24	CA-24-004	CA-24-004-001	1.00	Yes	Doc 53	CA-24	CA-24-008	CA-24-008-001	1.00	Yes	Doc 54	CA-24	CA-24-009	CA-24-009-001	1.00	Yes
Doc 50	CA-24	CA-24-005	CA-24-005-001	1.00	Yes	Doc 55	CA-24	CA-24-010	CA-24-010-001	1.00	Yes	Doc 56	CA-24	CA-24-011	CA-24-011-001	1.00	Yes
Doc 51	CA-24	CA-24-006	CA-24-006-001	1.00	Yes	Doc 57	CA-24	CA-24-012	CA-24-012-001	1.00	Yes	Doc 58	CA-24	CA-24-013	CA-24-013-001	1.00	Yes
Doc 52	CA-24	CA-24-007	CA-24-007-001	1.00	Yes	Doc 59	CA-24	CA-24-014	CA-24-014-001	1.00	Yes	Doc 59	CA-24	CA-24-014	CA-24-014-001	1.00	Yes
Doc 53	CA-24	CA-24-008	CA-24-008-001	1.00	Yes	Doc 60	CA-24	CA-24-015	CA-24-015-001	1.00	Yes	Doc 60	CA-24	CA-24-015	CA-24-015-001	1.00	Yes
Doc 54	CA-24	CA-24-009	CA-24-009-001	1.00	Yes	Doc 61	CA-24	CA-24-016	CA-24-016-001	1.00	Yes	Doc 61	CA-24	CA-24-016	CA-24-016-001	1.00	Yes
Doc 55	CA-24	CA-24-010	CA-24-010-001	1.00	Yes	Doc 62	CA-24	CA-24-017	CA-24-017-001	1.00	Yes	Doc 62	CA-24	CA-24-017	CA-24-017-001	1.00	Yes
Doc 56	CA-24	CA-24-011	CA-24-011-001	1.00	Yes	Doc 63	CA-24	CA-24-018	CA-24-018-001	1.00	Yes	Doc 63	CA-24	CA-24-018	CA-24-018-001	1.00	Yes
Doc 57	CA-24	CA-24-012	CA-24-012-001	1.00	Yes	Doc 64	CA-24	CA-24-019	CA-24-019-001	1.00	Yes	Doc 64	CA-24	CA-24-019	CA-24-019-001	1.00	Yes
Doc 58	CA-24	CA-24-013	CA-24-013-001	1.00	Yes	Doc 65	CA-24	CA-24-020	CA-24-020-001	1.00	Yes	Doc 65	CA-24	CA-24-020	CA-24-020-001	1.00	Yes
Doc 59	CA-24	CA-24-014	CA-24-014-001	1.00	Yes	Doc 66	CA-24	CA-24-021	CA-24-021-001	1.00	Yes	Doc 66	CA-24	CA-24-021	CA-24-021-001	1.00	Yes
Doc 60	CA-24	CA-24-015	CA-24-015-001	1.00	Yes	Doc 67	CA-24	CA-24-022	CA-24-022-001	1.00	Yes	Doc 67	CA-24	CA-24-022	CA-24-022-001	1.00	Yes
Doc 61	CA-24	CA-24-016	CA-24-016-001	1.00	Yes	Doc 68	CA-24	CA-24-023	CA-24-023-001	1.00	Yes	Doc 68	CA-24	CA-24-023	CA-24-023-001	1.00	Yes
Doc 62	CA-24	CA-24-017	CA-24-017-001	1.00	Yes	Doc 69	CA-24	CA-24-024	CA-24-024-001	1.00	Yes	Doc 69	CA-24	CA-24-024	CA-24-024-001	1.00	Yes
Doc 63	CA-24	CA-24-018	CA-24-018-001	1.00	Yes	Doc 70	CA-24	CA-24-025	CA-24-025-001	1.00	Yes	Doc 70	CA-24	CA-24-025	CA-24-025-001	1.00	Yes
Doc 64	CA-24	CA-24-019	CA-24-019-001	1.00	Yes	Doc 71	CA-24	CA-24-026	CA-24-026-001	1.00	Yes	Doc 71	CA-24	CA-24-026	CA-24-026-001	1.00	Yes
Doc 65	CA-24	CA-24-020	CA-24-020-001	1.00	Yes	Doc 72	CA-24	CA-24-027	CA-24-027-001	1.00	Yes	Doc 72	CA-24	CA-24-027	CA-24-027-001	1.00	Yes
Doc 66	CA-24	CA-24-021	CA-24-021-001	1.00	Yes	Doc 73	CA-24	CA-24-028	CA-24-028-001	1.00	Yes	Doc 73	CA-24	CA-24-028	CA-24-028-001	1.00	Yes
Doc 67	CA-24	CA-24-022	CA-24-022-001	1.00	Yes	Doc 74	CA-24	CA-24-029	CA-24-029-001	1.00	Yes	Doc 74	CA-24	CA-24-029	CA-24-029-001	1.00	Yes
Doc 68	CA-24	CA-24-023	CA-24-023-001	1.00	Yes	Doc 75	CA-24	CA-24-030	CA-24-030-001	1.00	Yes	Doc 75	CA-24	CA-24-030	CA-24-030-001	1.00	Yes
Doc 69	CA-24	CA-24-024	CA-24-024-001	1.00	Yes	Doc 76	CA-24	CA-24-031	CA-24-031-001	1.00	Yes	Doc 76	CA-24	CA-24-031	CA-24-031-001	1.00	Yes
Doc 70	CA-24	CA-24-025	CA-24-025-001	1.00	Yes	Doc 77	CA-24	CA-24-032	CA-24-032-001	1.00	Yes	Doc 77	CA-24	CA-24-032	CA-24-032-001	1.00	Yes
Doc 71	CA-24	CA-24-026	CA-24-026-001	1.00	Yes	Doc 78	CA-24	CA-24-033	CA-24-033-001	1.00	Yes	Doc 78	CA-24	CA-24-033	CA-24-033-001	1.00	Yes
Doc 72	CA-24	CA-24-027	CA-24-027-001	1.00	Yes	Doc 79	CA-24	CA-24-034	CA-24-034-001	1.00	Yes	Doc 79	CA-24	CA-24-034	CA-24-034-001	1.00	Yes
Doc 73	CA-24	CA-24-028	CA-24-028-001	1.00	Yes	Doc 80	CA-24	CA-24-035	CA-24-035-001	1.00	Yes	Doc 80	CA-24	CA-24-035	CA-24-035-001	1.00	Yes
Doc 74	CA-24	CA-24-029	CA-24-029-001	1.00	Yes	Doc 81	CA-24	CA-24-036	CA-24-036-001	1.00	Yes	Doc 81	CA-24	CA-24-036	CA-24-036-001	1.00	Yes
Doc 75	CA-24	CA-24-030	CA-24-030-001	1.00	Yes	Doc 82	CA-24	CA-24-037	CA-24-037-001	1.00	Yes	Doc 82	CA-24	CA-24-037	CA-24-037-001	1.00	Yes
Doc 76	CA-24	CA-24-031	CA-24-031-001	1.00	Yes	Doc 83	CA-24	CA-24-038	CA-24-038-001	1.00	Yes	Doc 83	CA-24	CA-24-038	CA-24-038-001	1.00	Yes
Doc 77	CA-24	CA-24-032	CA-24-032-001	1.00	Yes	Doc 84	CA-24	CA-24-039	CA-24-039-001	1.00	Yes	Doc 84	CA-24	CA-24-039	CA-24-039-001	1.00	Yes
Doc 78	CA-24	CA-24-033	CA-24-033-001	1.00	Yes	Doc 85	CA-24	CA-24-040	CA-24-040-001	1.00	Yes	Doc 85	CA-24	CA-24-040	CA-24-040-001	1.00	Yes
Doc 79	CA-24	CA-24-034	CA-24-034-001	1.00	Yes	Doc 86	CA-24	CA-24-041	CA-24-041-001	1.00	Yes	Doc 86	CA-24	CA-24-041	CA-24-041-001	1.00	Yes
Doc 80	CA-24	CA-24-035	CA-24-035-001	1.00	Yes	Doc 87	CA-24	CA-24-042	CA-24-042-001	1.00	Yes	Doc 87	CA-24	CA-24-042	CA-24-042-001	1.00	Yes
Doc 81	CA-24	CA-24-036	CA-24-036-001	1.00	Yes	Doc 88	CA-24	CA-24-043	CA-24-043-001	1.00	Yes	Doc 88	CA-24	CA-24-043	CA-24-043-001	1.00	Yes
Doc 82	CA-24	CA-24-037	CA-24-037-001	1.00	Yes	Doc 89	CA-24	CA-24-044	CA-24-044-001	1.00	Yes	Doc 89	CA-24	CA-24-044	CA-24-044-001	1.00	Yes
Doc 83	CA-24	CA-24-038	CA-24-038-001	1.00	Yes	Doc 90	CA-24	CA-24-045	CA-24-045-001	1.00	Yes	Doc 90	CA-24	CA-24-045	CA-24-045-001	1.00	Yes
Doc 84	CA-24	CA-24-039	CA-24-039-001	1.00	Yes	Doc 91	CA-24	CA-24-046	CA-24-046-001	1.00	Yes	Doc 91	CA-24	CA-24-046	CA-24-046-001	1.00	Yes
Doc 85	CA-24	CA-24-040	CA-24-040-001	1.00	Yes	Doc 92	CA-24	CA-24-047	CA-24-047-001	1.00	Yes	Doc 92	CA-24	CA-24-047	CA-24-047-001	1.00	Yes
Doc 86	CA-24	CA-24-041	CA-24-041-001	1.00	Yes	Doc 93	CA-24	CA-24-048	CA-24-048-001	1.00	Yes	Doc 93	CA-24	CA-24-048	CA-24-048-001	1.00	Yes
Doc 87	CA-24	CA-24-042	CA-24-042-001	1.00	Yes	Doc 94	CA-24	CA-24-049	CA-24-049-001	1.00	Yes	Doc 94	CA-24	CA-24-049	CA-24-049-001	1.00	Yes
Doc 88	CA-24	CA-24-043	CA-24-043-001	1.00	Yes	Doc 95	CA-24	CA-24-050	CA-24-050-001	1.00	Yes	Doc 95	CA-24	CA-24-050	CA-24-050-001	1.00	Yes
Doc 89	CA-24	CA-24-044	CA-24-044-001	1.00	Yes	Doc 96	CA-24	CA-24-051	CA-24-051-001	1.00	Yes	Doc 96	CA-24	CA-24-051	CA-24-051-001	1.00	Yes
Doc 90	CA-24	CA-24-045	CA-24-045-001	1.00	Yes	Doc 97	CA-24	CA-24-052	CA-24-052-001	1.00	Yes	Doc 97	CA-24	CA-24-052	CA-24-052-001	1.00	Yes
Doc 91	CA-24	CA-24-046	CA-24-046-001	1.00	Yes	Doc 98	CA-24	CA-24-053	CA-24-053-001	1.00	Yes	Doc 98	CA-24	CA-24-053	CA-24-053-001	1.00	Yes
Doc 92	CA-24	CA-24-047	CA-24-047-001	1.00	Yes	Doc 99	CA-24	CA-24-054	CA-24-054-001	1.00	Yes	Doc 99	CA-24	CA-24-054	CA-24-054-001	1.00	Yes
Doc 93	CA-24	CA-24-048	CA-24-048-001	1.00	Yes	Doc 100	CA-24	CA-24-055	CA-24-055-001	1.00	Yes	Doc 100	CA-24	CA-24-055	CA-24-055-001	1.00	Yes
Doc 94	CA-24	CA-24-049	CA-24-049-001	1.00	Yes	Doc 101	CA-24	CA-24-056	CA-24-056-001	1.00	Yes	Doc 101	CA-24	CA-24-056	CA-24-056-001	1.00	Yes
Doc 95	CA-24	CA-24-050	CA-24-050-001	1.00	Yes	Doc 102	CA-24	CA-24-057	CA-24-057-001	1.00	Yes	Doc 102	CA-24	CA-24-057	CA-24-057-001	1.00	Yes
Doc 96	CA-24	CA-24-051	CA-24-051-001	1.00	Yes	Doc 103	CA-24	CA-24-058	CA-24-058-001	1.00	Yes	Doc 103	CA-24	CA-24-058	CA-24-058-001	1.00	Yes
Doc 97	CA-24	CA-24-052	CA-24-052-001	1.00	Yes	Doc 104	CA-24	CA-24-059	CA-24-059-001	1.00	Yes	Doc 104	CA-24	CA-24-059	CA-24-059-001	1.00	Yes
Doc 98	CA-24	CA-24-053	CA-24-053-001	1.00	Yes	Doc 105	CA-24	CA-24-060	CA-24-060-001	1.00	Yes	Doc 105	CA-24	CA-24-060	CA-24-060-001	1.00	Yes
Doc 99	CA-24	CA-24-054	CA-24-054-001	1.00	Yes	Doc 106	CA-24	CA-24-061	CA-24-061-001	1.00	Yes	Doc 106	CA-24	CA-24-061	CA-24-061-001	1.00	Yes
Doc 100	CA-24	CA-24-055	CA-24-055-001	1.00	Yes	Doc 107	CA-24	CA-24-062	CA-24-062-001	1.00	Yes	Doc 107	CA-24	CA-24-062	CA-24-062-001	1.00	Yes
Doc 101	CA-24	CA-24-056	CA-24-056-001	1.00	Yes	Doc 108	CA-24	CA-24-063	CA-24-063-001	1.00	Yes	Doc 108	CA-24	CA-24-063	CA-24-063-001	1.00	Yes
Doc 102	CA-24	CA-24-057	CA-24-057-001	1.00	Yes	Doc 109	CA-24	CA-24-064	CA-24-064-001	1.00	Yes	Doc 109	CA-24	CA-24-064	CA-24-064-001	1.00	Yes
Doc 103	CA-24	CA-24-058	CA-24-058-001	1.00	Yes	Doc 110	CA-24	CA-24-065	CA-24-065-001	1.00	Yes	Doc 110	CA-24	CA-24-065	CA-24-065-001	1.00	Yes
Doc 104	CA-24	CA-24-059	CA-24-059-001	1.00	Yes	Doc 111	CA-24	CA-24-066	CA-24-066-001	1.00	Yes	Doc 111	CA-24	CA-24-066	CA-24-066-001	1.00	Yes
Doc 105	CA-24	CA-24-060	CA-24-060-001	1.00	Yes	Doc 112	CA-24	CA-24-067	CA-24-067-001	1.00	Yes	Doc 112	CA-24	CA-24-067	CA-24-067-001	1.00	Yes
Doc 106	CA-24	CA-24-061	CA-24-061-001	1.00	Yes	Doc 113	CA-24	CA-24-068	CA-24-068-001	1.00	Yes	Doc 113	CA-24	CA-24-068	CA-24-068-001	1.00	Yes
Doc 107	CA-24	CA-24-062	CA-24-062-001	1.00	Yes	Doc 114	CA-24	CA-24-069	CA-24-069-001	1.00	Yes	Doc 114	CA-24	CA-24-069	CA-24-069-001	1.00	Yes
Doc 108	CA-24	CA-24-063	CA-24-063-001	1.00	Yes	Doc 115	CA-24	CA-24-070	CA-24-070-001	1.00	Yes	Doc 115	CA-24	CA-2			

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1.2 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 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 maximum 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. All bands required for SAR testing per FCC KDB procedures were considered. Based on the measured maximum powers below, no additional SAR tests were required for DLCA SAR configurations.

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 D05 V01r02. The downlink PCC channel was paired with the selected PCC uplink channel according to normal configurations without carrier aggregation.
- To maximize aggregated 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.

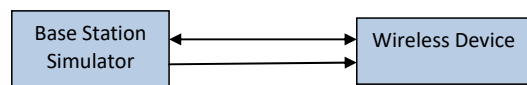


Figure 1
DL CA Power Measurement Setup

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1.3 Downlink Carrier Aggregation RF Conducted Powers

1.3.1 LTE Band 12 as PCC

Table 1
Maximum Output Powers

Combination	PCC									SCC 1				Power	
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-12A (2)	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	LTE B2	10	900	1960	25.30	25.30
CA 4A-12A	LTE B12	10	23095	707.5	QPSK	1	25	5095	737.5	LTE B4	10	2175	2132.5	25.05	25.30

1.3.2 LTE Band 5 as PCC

Table 2
Maximum Output Powers

Combination	PCC									SCC 1				Power	
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-5A (1)	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	LTE B2	10	900	1960	24.48	25.10
CA 4A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	LTE B4	10	2175	2132.5	25.12	25.10

1.3.3 LTE Band 4 as PCC

Table 3
Maximum Output Powers

Combination	PCC									SCC 1				Power	
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 4A-5A	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B5	10	2525	881.5	24.69	24.80
CA 4A-12A	LTE B4	10	20175	1732.5	QPSK	1	0	2175	2132.5	LTE B12	10	5095	737.5	24.56	24.80

1.3.4 LTE Band 2 as PCC

Table 4
Maximum Output Powers

Combination	PCC									SCC 1				Power	
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 2A-5A (1)	LTE B2	10	18900	1880	QPSK	1	25	900	1960	LTE B5	10	2525	881.5	24.18	24.80
CA 2A-12A (2)	LTE B2	10	18900	1880	QPSK	1	25	900	1960	LTE B12	10	5095	737.5	24.08	24.80

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