2 Composition / Information on ingredients

The Item is composed of the following ingredients:

H_2O	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-methyyl-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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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 ± 2.5% towards the target values of Methanol.

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

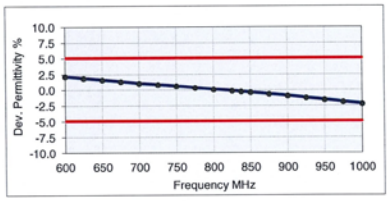
Test Condition

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)

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	57.3	25.02	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



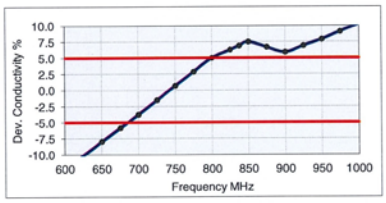


Figure D-2
750MHz Body Tissue Equivalent Matter

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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 ± 2.5% towards the target values of Methanol.

Target Parameters

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

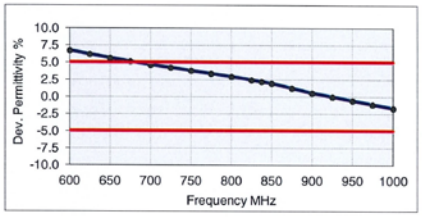
Test Condition

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

Additional Information

TSL Density	1.284 g/cm^3
TSL Heat-capacity	2.701 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-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	8.9
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



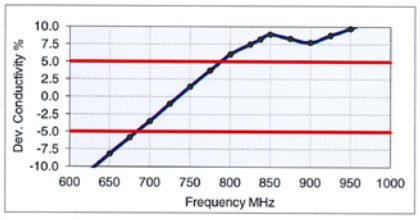


Figure D-3
750MHz Head Tissue Equivalent Matter

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3 Composition / Information on ingredients

The Item is composed of the following ingredients:

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

Safety relevant ingredients:

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

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Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL1900-3800V3)**
Product No.	SL AAH 196 AB (Batch: 170619-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

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

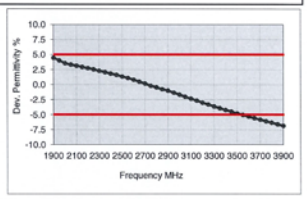
Test Condition

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

Additional Information

TSL Density 1.054 g/cm^3
TSL Heat-capacity 3.389 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	41.8	12.2	1.3	40.0	1.4	4.5	-8.2
1950	41.6	12.3	1.3	40.0	1.4	4.0	-4.6
2000	41.4	12.4	1.4	40.0	1.4	3.6	-1.3
2050	41.2	12.6	1.4	39.9	1.4	3.3	-0.9
2100	41.1	12.7	1.5	39.8	1.5	3.1	-0.6
2150	40.9	12.8	1.5	39.7	1.5	2.9	-0.2
2200	40.7	12.9	1.6	39.6	1.6	2.7	0.2
2250	40.6	13.0	1.6	39.6	1.6	2.5	0.5
2300	40.4	13.2	1.7	39.5	1.7	2.3	1.1
2350	40.2	13.3	1.7	39.4	1.7	2.1	1.5
2400	40.0	13.4	1.8	39.3	1.8	1.8	2.1
2450	39.8	13.5	1.8	39.2	1.8	1.6	2.6
2500	39.7	13.7	1.9	39.1	1.9	1.3	2.6
2550	39.5	13.7	2.0	39.1	1.9	1.1	2.2
2600	39.3	13.9	2.0	39.0	2.0	0.8	2.5
2650	39.1	14.0	2.1	38.9	2.0	0.5	2.6
2700	39.0	14.2	2.1	38.9	2.1	0.2	2.7
2750	38.7	14.3	2.2	38.8	2.1	-0.2	2.6
2800	38.6	14.4	2.2	38.8	2.2	-0.4	2.5
2850	38.4	14.5	2.3	38.7	2.2	-0.8	2.6
2900	38.2	14.6	2.3	38.6	2.3	-1.0	2.6
2950	38.1	14.7	2.4	38.6	2.3	-1.3	2.6
3000	37.9	14.8	2.5	38.5	2.4	-1.7	2.6
3050	37.7	14.8	2.5	38.4	2.5	-2.0	2.8
3100	37.5	14.9	2.6	38.4	2.5	-2.3	2.8
3150	37.3	15.0	2.6	38.3	2.6	-2.6	2.9
3200	37.1	15.1	2.7	38.3	2.6	-3.0	2.9
3250	37.0	15.1	2.7	38.2	2.7	-3.3	3.0
3300	36.8	15.2	2.8	38.2	2.7	-3.6	3.1
3350	36.6	15.3	2.8	38.1	2.8	-3.9	3.2
3400	36.4	15.3	2.9	38.0	2.8	-4.2	3.3
3450	36.3	15.4	3.0	38.0	2.9	-4.5	3.4
3500	36.1	15.5	3.0	37.9	2.9	-4.8	3.5
3550	36.0	15.5	3.1	37.9	3.0	-5.0	3.6
3600	35.8	15.6	3.1	37.8	3.0	-5.3	3.8
3650	35.7	15.7	3.2	37.8	3.1	-5.6	3.7
3700	35.5	15.7	3.2	37.7	3.1	-5.8	3.9
3750	35.4	15.8	3.3	37.6	3.2	-6.1	3.9
3800	35.2	15.9	3.4	37.6	3.2	-6.3	4.1
3850	35.1	15.9	3.4	37.5	3.3	-6.6	4.1



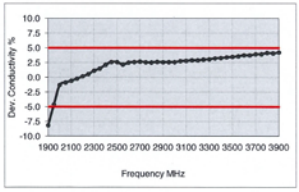


Figure D-5
2.4 GHz Head Tissue Equivalent Matter

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2 Composition / Information on ingredients

The Item is composed of the following ingredients:

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

Figure D-6
Composition of 5 GHz Head Tissue Equivalent Matter

Note: 5 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.

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Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL3500-5800V5)**
Product No.	SL AAH 502 AG (Batch: 170613-1)
Manufacturer	SPEAG

Measurement Method
TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation
Validation results were within ± 2.5% towards the target values of Methanol.

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

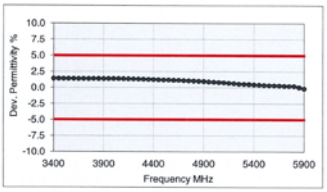
Test Condition

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

Additional Information

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

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	38.6	15.03	2.84	38.0	2.81	1.5	1.1
3500	38.5	15.00	2.92	37.9	2.91	1.5	0.3
3600	38.3	14.98	3.00	37.8	3.02	1.3	-0.5
3700	38.2	14.96	3.08	37.7	3.12	1.3	-1.2
3800	38.1	14.96	3.16	37.6	3.22	1.4	-1.9
3900	38.0	14.95	3.24	37.5	3.32	1.4	-2.5
4000	37.9	14.95	3.33	37.4	3.43	1.5	-2.8
4100	37.8	14.96	3.41	37.2	3.53	1.5	-3.3
4200	37.6	15.00	3.50	37.1	3.63	1.3	-3.6
4300	37.5	15.05	3.60	37.0	3.73	1.3	-3.5
4400	37.4	15.11	3.70	36.9	3.84	1.4	-3.5
4500	37.2	15.18	3.80	36.8	3.94	1.1	-3.5
4600	37.1	15.24	3.90	36.7	4.04	1.2	-3.5
4700	37.0	15.29	4.00	36.6	4.14	1.2	-3.4
4800	36.8	15.35	4.10	36.4	4.25	1.0	-3.4
4850	36.8	15.35	4.14	36.4	4.30	1.1	-3.6
4900	36.7	15.38	4.19	36.3	4.35	1.0	-3.6
4950	36.6	15.39	4.24	36.3	4.40	0.9	-3.6
5000	36.5	15.42	4.29	36.2	4.45	0.8	-3.6
5050	36.5	15.43	4.34	36.2	4.50	0.9	-3.6
5100	36.4	15.46	4.39	36.1	4.55	0.8	-3.6
5150	36.3	15.48	4.43	36.0	4.60	0.7	-3.8
5200	36.2	15.50	4.48	36.0	4.66	0.6	-3.8
5250	36.1	15.53	4.54	35.9	4.71	0.5	-3.5
5300	36.1	15.55	4.58	35.9	4.76	0.6	-3.7
5350	36.0	15.56	4.63	35.8	4.81	0.5	-3.7
5400	35.9	15.57	4.68	35.8	4.86	0.4	-3.7
5450	35.9	15.59	4.73	35.7	4.91	0.6	-3.7
5500	35.8	15.61	4.78	35.6	4.96	0.4	-3.7
5550	35.7	15.65	4.83	35.6	5.01	0.3	-3.7
5600	35.6	15.66	4.88	35.5	5.07	0.2	-3.7
5650	35.6	15.70	4.93	35.5	5.12	0.4	-3.6
5700	35.5	15.72	4.98	35.4	5.17	0.2	-3.6
5750	35.4	15.76	5.04	35.4	5.22	0.1	-3.4
5800	35.4	15.78	5.09	35.3	5.27	0.3	-3.4
5850	35.3	15.81	5.14	35.3	5.34	0.0	-3.7
5900	35.3	15.82	5.19	35.3	5.40	0.0	-3.9



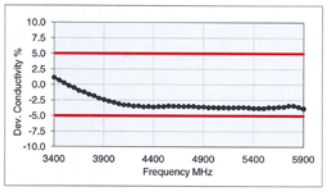


Figure D-7
5 GHz Head Tissue Equivalent Matter

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3 Composition / Information on ingredients

The Item is composed of the following ingredients:

Water	60 – 80%
Esters, Emulsifiers, Inhibitors	20 – 40%
Sodium salt	0 – 1.5%

Figure D-8
Composition of 5 GHz Body Tissue Equivalent Matter

Note: 5 GHz Body 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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Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MBBL3500-5800V5)**
Product No.	SL AAM 501 EA (Batch: 180423-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated DAK probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the KDB 865664 compliance standard.

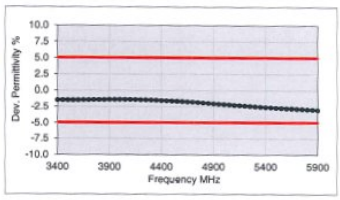
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	25-Apr-18
Operator	WM

Additional Information

TSL Density	0.996 g/cm3
TSL Heat-capacity	3.765 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	e'	e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	50.7	16.46	3.11	51.5	3.20	-1.5	-2.7
3500	50.5	16.50	3.21	51.3	3.31	-1.6	-3.1
3600	50.4	16.56	3.32	51.2	3.43	-1.5	-3.2
3700	50.3	16.63	3.42	51.1	3.55	-1.5	-3.6
3800	50.2	16.72	3.53	50.9	3.66	-1.4	-3.7
3900	50.1	16.81	3.65	50.8	3.78	-1.3	-3.5
4000	49.9	16.93	3.77	50.6	3.90	-1.5	-3.3
4100	49.8	17.05	3.89	50.5	4.01	-1.4	-3.1
4200	49.6	17.18	4.01	50.4	4.13	-1.5	-2.9
4300	49.5	17.32	4.14	50.2	4.25	-1.5	-2.5
4400	49.3	17.46	4.27	50.1	4.37	-1.6	-2.2
4500	49.2	17.59	4.40	50.0	4.48	-1.5	-1.8
4600	49.0	17.73	4.54	49.8	4.60	-1.7	-1.3
4700	48.8	17.86	4.67	49.7	4.72	-1.8	-1.0
4800	48.6	17.99	4.80	49.6	4.83	-1.9	-0.7
4850	48.5	18.05	4.87	49.5	4.89	-2.0	-0.4
4900	48.4	18.11	4.94	49.4	4.95	-2.1	-0.2
4950	48.3	18.17	5.00	49.4	5.01	-2.1	-0.1
5000	48.2	18.23	5.07	49.3	5.07	-2.2	0.1
5050	48.1	18.29	5.14	49.2	5.12	-2.3	0.3
5100	48.0	18.34	5.20	49.2	5.18	-2.3	0.3
5150	47.9	18.39	5.27	49.1	5.24	-2.4	0.6
5200	47.9	18.45	5.34	49.0	5.30	-2.3	0.8
5250	47.8	18.50	5.40	48.9	5.36	-2.3	0.8
5300	47.7	18.56	5.47	48.9	5.42	-2.4	1.0
5350	47.6	18.61	5.54	48.8	5.47	-2.5	1.2
5400	47.5	18.67	5.61	48.7	5.53	-2.5	1.4
5450	47.4	18.72	5.68	48.7	5.59	-2.6	1.6
5500	47.3	18.77	5.74	48.6	5.65	-2.7	1.6
5550	47.2	18.83	5.81	48.5	5.71	-2.8	1.8
5600	47.1	18.88	5.88	48.5	5.77	-2.8	2.0
5650	47.1	18.93	5.95	48.4	5.82	-2.7	2.1
5700	47.0	18.99	6.02	48.3	5.88	-2.8	2.3
5750	46.9	19.04	6.09	48.3	5.94	-2.8	2.5
5800	46.8	19.10	6.16	48.2	6.00	-2.9	2.7
5850	46.7	19.16	6.23	48.1	6.06	-3.0	2.8
5900	46.6	19.22	6.31	48.1	6.12	-3.0	3.2



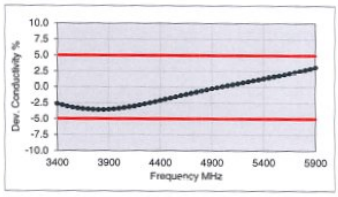


Figure D-9
5 GHz Body Tissue Equivalent Matter

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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. (εr)	CW VALIDATION			MOD. VALIDATION		
								SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
M	750	11/2/2018	3287	750	Head	0.908	42.190	PASS	PASS	PASS	N/A	N/A	N/A
G	835	8/9/2018	7410	835	Head	0.889	40.915	PASS	PASS	PASS	GMSK	PASS	N/A
M	1750	11/5/2018	3287	1750	Head	1.342	39.217	PASS	PASS	PASS	N/A	N/A	N/A
M	1900	11/5/2018	3287	1900	Head	1.430	39.014	PASS	PASS	PASS	GMSK	PASS	N/A
H	1900	7/16/2018	7409	1900	Head	1.425	40.935	PASS	PASS	PASS	GMSK	PASS	N/A
G	2450	8/7/2018	7410	2450	Head	1.865	39.618	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
I	2450	12/24/2018	7406	2450	Head	1.797	38.399	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
H	5250	7/5/2018	7409	5250	Head	4.492	34.994	PASS	PASS	PASS	OFDM	N/A	PASS
H	5600	7/5/2018	7409	5600	Head	4.839	34.496	PASS	PASS	PASS	OFDM	N/A	PASS
H	5750	7/5/2018	7409	5750	Head	4.995	34.288	PASS	PASS	PASS	OFDM	N/A	PASS
I	750	7/19/2018	7406	750	Body	0.969	53.451	PASS	PASS	PASS	N/A	N/A	N/A
L	750	11/6/2018	7308	750	Body	0.962	53.923	PASS	PASS	PASS	N/A	N/A	N/A
I	835	8/8/2018	7406	835	Body	0.980	53.497	PASS	PASS	PASS	GMSK	PASS	N/A
J	835	9/11/2018	3347	835	Body	0.984	54.197	PASS	PASS	PASS	GMSK	PASS	N/A
J	1750	9/5/2018	3347	1750	Body	1.454	53.515	PASS	PASS	PASS	N/A	N/A	N/A
D	1750	8/15/2018	7357	1750	Body	1.475	51.784	PASS	PASS	PASS	N/A	N/A	N/A
E	1900	12/3/2018	3332	1900	Body	1.518	51.796	PASS	PASS	PASS	GMSK	PASS	N/A
K	2450	4/3/2018	3319	2450	Body	2.043	51.130	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
L	5250	10/29/2018	7308	5250	Body	5.511	48.770	PASS	PASS	PASS	OFDM	N/A	PASS
L	5600	10/29/2018	7308	5600	Body	5.994	48.200	PASS	PASS	PASS	OFDM	N/A	PASS
L	5750	10/29/2018	7308	5750	Body	6.219	47.960	PASS	PASS	PASS	OFDM	N/A	PASS

Table E-2
SAR System Validation Summary – 10g

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE CAL. POINT		COND. (σ)	PERM. (εr)	CW VALIDATION			MOD. VALIDATION		
								SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
D	1750	8/15/2018	7357	1750	Body	1.475	51.784	PASS	PASS	PASS	N/A	N/A	N/A
E	1900	12/3/2018	3332	1900	Body	1.518	51.796	PASS	PASS	PASS	GMSK	PASS	N/A
L	5250	10/29/2018	7308	5250	Body	5.511	48.770	PASS	PASS	PASS	OFDM	N/A	PASS
L	5600	10/29/2018	7308	5600	Body	5.994	48.200	PASS	PASS	PASS	OFDM	N/A	PASS
L	5750	10/29/2018	7308	5750	Body	6.219	47.960	PASS	PASS	PASS	OFDM	N/A	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.

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APPENDIX G POWER REDUCTION VERIFICATION

Per the May 2017 TCBC Workshop Notes, demonstration of proper functioning of the power reduction mechanisms is required to support the corresponding SAR configurations. The verification process was divided into two parts: (1) evaluation of output power levels for individual or multiple triggering mechanisms and (2) evaluation of the triggering distances for proximity-based sensors.

G.1 Power Verification Procedure

The power verification was performed according to the following procedure:

1. A base station simulator was used to establish a conducted RF connection and the output power was monitored. The power measurements were confirmed to be within expected tolerances for all states before and after a power reduction mechanism was triggered.

2. Step 1 was repeated for all relevant modes and frequency bands for the mechanism being investigated.

3. Steps 1 and 2 were repeated for all individual power reduction mechanisms and combinations thereof. For the combination cases, one mechanism was switched to a 'triggered' state at a time; powers were confirmed to be within tolerances after each additional mechanism was activated.

G.2 Distance Verification Procedure

The distance verification procedure was performed according to the following procedure:

1. A base station simulator was used to establish an RF connection and to monitor the power levels. The device being tested was placed below the relevant section of the phantom with the relevant side or edge of the device facing toward the phantom.

2. The device was moved toward and away from the phantom to determine the distance at which the mechanism triggers and the output power is reduced, per KDB Publication 616217 D04v01r02 and FCC Guidance. Each applicable test position was evaluated. The distances were confirmed to be the same or larger (more conservative) than the minimum distances provided by the manufacturer.

3. Steps 1 and 2 were repeated for low, mid, and high bands, as appropriate (see note below Table G-2 for more details).

4. Steps 1 through 3 were repeated for all distance-based power reduction mechanisms.

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G.3 Main Antenna Verification Summary

Table G-1
Power Measurement Verification for Main Antenna

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
		Un-triggered (Max)	Mechanism #1 (Reduced)
Grip	UMTS 1750	24.62	23.23
Grip	UMTS 1900	24.28	23.04
Grip	PCS CDMA	24.16	22.89
Grip	LTE FDD Band 4	24.31	23.01
Grip	LTE FDD Band 66	24.38	23.12
Grip	LTE FDD Band 2	24.09	22.84

Table G-2
Distance Measurement Verification for Main Antenna

Mechanism(s)	Test Condition	Band	Distance Measurements (mm)		Minimum Distance per Manufacturer (mm)
			Moving Toward	Moving Away	
Grip	Body - Back Side	Mid	3	5	3
Grip	Body - Front Side	Mid	5	7	5
Grip	Body - Bottom Edge	Mid	5	7	5

*Note: Mid band refers to: PCS CDMA (BC1), UMTS B2/4, LTE B2/4/66

G.4 WIFI Verification Summary

Table G-3
Power Measurement Verification WIFI

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	802.11b	21.26	16.08
Held-to-Ear	802.11g	20.87	16.24
Held-to-Ear	802.11n (2.4GHz)	20.11	15.96
Held-to-Ear	802.11a	18.97	12.29
Held-to-Ear	802.11n (5GHz, 20MHz BW)	15.53	12.51
Held-to-Ear	802.11ac (20MHz BW)	15.29	12.62
Held-to-Ear	802.11n (5GHz, 40MHz BW)	14.48	12.28
Held-to-Ear	802.11ac (40MHz BW)	14.73	11.23

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APPENDIX H: DOWNLINK LTE CA RF CONDUCTED POWERS

1.1 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 KBD 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.

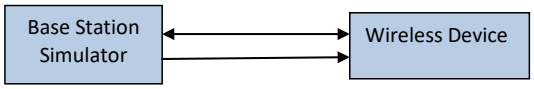

Figure 1
DL CA Power Measurement Setup

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1.2 Downlink Carrier Aggregation RF Conducted Powers

1.2.1 LTE Band 71 as PCC

Table 1
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_2A-71A	LTE B71	10	133297	680.5	QPSK	1	49	68761	634.5	LTE B2	20	900	1960	25.17	25.17
CA_4A-71A	LTE B71	10	133297	680.5	QPSK	1	49	68761	634.5	LTE B4	20	2175	2132.5	25.13	25.17
CA_66A-71A	LTE B71	10	133297	680.5	QPSK	1	49	68761	634.5	LTE B66	20	66786	2145	25.18	25.17

1.2.2 LTE Band 12 as PCC

Table 2
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_2A-12A	LTE B12	3	23165	714.5	QPSK	1	0	5165	744.5	LTE B2	20	900	1960	25.18	25.14
CA_4A-12A	LTE B12	3	23165	714.5	QPSK	1	0	5165	744.5	LTE B4	20	2175	2132.5	25.12	25.14
CA_12A-66A	LTE B12	3	23165	714.5	QPSK	1	0	5165	744.5	LTE B66	20	66786	2145	25.08	25.14

1.2.3 LTE Band 5 as PCC

Table 3
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_2A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	LTE B2	20	900	1960	25.13	25.10
CA_4A-5A	LTE B5	10	20525	836.5	QPSK	1	25	2525	881.5	LTE B4	20	2175	2132.5	25.06	25.10

1.2.4 LTE Band 4 as PCC

Table 4
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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-4A	LTE B4	20	20050	1720	QPSK	1	50	2050	2120	LTE B4	20	2300	2145	24.67	24.70
CA_2A-4A	LTE B4	20	20050	1720	QPSK	1	50	2050	2120	LTE B2	20	900	1960	24.66	24.70
CA_4A-5A	LTE B4	20	20050	1720	QPSK	1	50	2050	2120	LTE B5	10	2525	881.5	24.63	24.70
CA_4A-12A	LTE B4	20	20050	1720	QPSK	1	50	2050	2120	LTE B12	10	5095	737.5	24.67	24.70
CA_4A-71A	LTE B4	20	20050	1720	QPSK	1	50	2050	2120	LTE B71	20	68761	634.5	24.68	24.70

Table 5
Reduced Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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-4A	LTE B4	20	20050	1720	QPSK	50	25	2050	2120	LTE B4	20	2300	2145	23.48	23.50
CA_2A-4A	LTE B4	20	20050	1720	QPSK	50	25	2050	2120	LTE B2	20	900	1960	23.42	23.50
CA_4A-5A	LTE B4	20	20050	1720	QPSK	50	25	2050	2120	LTE B5	10	2525	881.5	23.45	23.50
CA_4A-12A	LTE B4	20	20050	1720	QPSK	50	25	2050	2120	LTE B12	10	5095	737.5	23.46	23.50
CA_4A-71A	LTE B4	20	20050	1720	QPSK	50	25	2050	2120	LTE B71	20	68761	634.5	23.45	23.50

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1.2.5 LTE Band 66 as PCC

Table 6
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_66A-66A	LTE B66	20	132072	1720	QPSK	1	50	66536	2120	LTE B66	20	67236	2190	24.61	24.70
CA_66B	LTE B66	5	132647	1777.5	QPSK	1	0	67111	2177.5	LTE B66	15	67018	2168.2	24.67	24.70
CA_66C	LTE B66	20	132072	1720	QPSK	1	50	66536	2120	LTE B66	20	66734	2139.8	24.69	24.70
CA_2A-66A	LTE B66	20	132072	1720	QPSK	1	50	66536	2120	LTE B2	20	900	1960	24.69	24.70
CA_12A-66A	LTE B66	20	132072	1720	QPSK	1	50	66536	2120	LTE B12	10	5095	737.5	24.49	24.70
CA_66A-71A	LTE B66	20	132072	1720	QPSK	1	50	66536	2120	LTE B71	20	68761	634.5	24.60	24.70

Table 7
Reduced Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_66A-66A	LTE B66	20	132072	1720	QPSK	50	25	66536	2120	LTE B66	20	67236	2190	23.44	23.50
CA_66B	LTE B66	15	132047	1717.5	QPSK	1	36	66511	2117.5	LTE B66	5	66604	2126.8	23.49	23.50
CA_66C	LTE B66	20	132072	1720	QPSK	50	25	66536	2120	LTE B66	20	66734	2139.8	23.44	23.50
CA_2A-66A	LTE B66	20	132072	1720	QPSK	50	25	66536	2120	LTE B2	20	900	1960	23.38	23.50
CA_12A-66A	LTE B66	20	132072	1720	QPSK	50	25	66536	2120	LTE B12	10	5095	737.5	23.40	23.50
CA_66A-71A	LTE B66	20	132072	1720	QPSK	50	25	66536	2120	LTE B71	20	68761	634.5	23.47	23.50

1.2.6 LTE Band 2 as PCC

Table 8
Maximum Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_2A-2A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B2	20	700	1940	24.38	24.35
CA_2A-4A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B4	20	2175	2132.5	24.40	24.35
CA_2A-5A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B5	10	2525	881.5	24.35	24.35
CA_2A-12A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B12	10	5095	737.5	24.31	24.35
CA_2A-66A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B66	20	66786	2145	24.30	24.35
CA_2A-71A	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B71	20	68761	634.5	24.28	24.35
CA_2C	LTE B2	15	18900	1880	QPSK	1	0	900	1960	LTE B2	20	729	1942.9	24.39	24.35

Table 9
Reduced Output Powers

	PCC									SCC				Power	
Combination	PCC Band	PCC BW [MHz]	PCC (UL) Channel	PCC (UL) Freq. [MHz]	Modulation	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_2A-2A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B2	20	700	1940	23.10	23.20
CA_2A-4A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B4	20	2175	2132.5	23.13	23.20
CA_2A-5A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B5	10	2525	881.5	23.20	23.20
CA_2A-12A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B12	10	5095	737.5	23.09	23.20
CA_2A-66A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B66	20	66786	2145	23.18	23.20
CA_2A-71A	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B71	20	68761	634.5	23.13	23.20
CA_2C	LTE B2	20	18900	1880	QPSK	50	0	900	1960	LTE B2	20	702	1940.2	23.18	23.20

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