SAR TEST REPORT

The following samples were submitted and identified on behalf of the client as:

Product Name	Notebook / Tablet Computer
Brand Name	acer
Model No.	N17W1
Prepared for	Acer Incorporated 8F., No. 88, Sec. 1, Xintai 5th Rd., Xizhi, New Taipei City 22181, Taiwan (R.O.C)
Standards	IEEE/ANSI C95.1-1992,IEEE 1528-2013, KDB248227D01v02r02,KDB865664D01v01r04, KDB865664D02v01r02,KDB447498D01v06, KDB616217D04v01r02,
FCC ID	HLZ344A
Date of Receipt	Jun. 16, 2017
Date of Test(s)	Jun. 17, 2017 ~ Jun. 22, 2017
Date of Issue	Sep. 20, 2017

In the configuration tested, the EUT complied with the standards specified above.

Remarks:

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Taiwan Electronic & Communication Laboratory or testing done by SGS Taiwan Electronic & Communication Laboratory in connection with distribution or use of the product described in this report must be approved by SGS Taiwan Electronic & Communication Laboratory in writing.

Signed on behalf of SGS

Engineer	**Supervisor**
Bond Tsai	**John Yeh**
Date: Sep. 20, 2017	**Date: Sep. 20, 2017**

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Revision History

Report Number	Revision	Description	Issue Date
E5/2017/60009	Rev.00	Initial creation of document	Aug. 14, 2017
E5/2017/60009	Rev.01	1st modification	Aug. 16, 2017
E5/2017/60009	Rev.02	2nd modification	Sep. 11, 2017
E5/2017/60009	Rev.03	3rd modification	Sep. 20, 2017

Contents

1. General Information

1.1 Testing Laboratory

SGS Taiwan Ltd. Electronics & Communication Laboratory	
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1.2 Details of Applicant

Company Name	Acer Incorporated
Company Address	8F., No. 88, Sec. 1, Xintai 5th Rd., Xizhi, New Taipei City 22181, Taiwan (R.O.C)

1.3 Description of EUT

Equipment Under Test	Notebook / Tablet Computer	
Marketing Name	SP515-51N, SP515-51GN, NP515-51	
Brand Name	acer	
Model No. of Host	N17W1	
Model No. of BT/WLAN Module	QCNFA344A	
FCC ID	HLZ344A	
Antenna Designation (Maximum Gain)	Main_2.45GHz: -0.02dBi, 5GHz: 0.24dBi Aux_2.45GHz: -1.88dBi, 5GHz: 0.44dBi	
Mode of Operation	☒WLAN802.11 a/b/g/n/ac(20M/40M/80M) ☒Bluetooth	
Duty Cycle	WLAN802.11a/b/g/n/ac (20M/40M/80M)	1
	Bluetooth	1
TX Frequency Range (MHz)	WLAN802.11 b/g/n(20M)	2412 – 2462
	WLAN802.11 n(40M)	2422 – 2452
	WLAN802.11 a/n/ac(20M) 5.2G	5180 – 5240
	WLAN802.11 n/ac(40M) 5.2G	5190 – 5230
	WLAN802.11 ac(80M) 5.2G	5210
	WLAN802.11 a/n/ac(20M) 5.3G	5260 – 5320
	WLAN802.11 n/ac(40M) 5.3G	5270 – 5310
	WLAN802.11 ac(80M) 5.3G	5290
	WLAN802.11 a/n/ac(20M) 5.6G	5500 – 5720
	WLAN802.11 n/ac(40M) 5.6G	5510 – 5710
	WLAN802.11 ac(80M) 5.6G	5530 – 5690

TX Frequency Range (MHz)	WLAN802.11 a/n/ac(20M) 5.8G	5745 – 5825
	WLAN802.11 n/ac(40M) 5.8G	5755 – 5795
	WLAN802.11 ac(80M) 5.8G	5775
	Bluetooth	2402 – 2480
Channel Number (ARFCN)	WLAN802.11 b/g/n(20M)	1 – 11
	WLAN802.11 n(40M)	3 – 9
	WLAN802.11 a/n/ac(20M) 5.2G	36 – 48
	WLAN802.11 n/ac(40M) 5.2G	38 – 46
	WLAN802.11 ac(80M) 5.2G	42
	WLAN802.11 a/n/ac(20M) 5.3G	52 – 64
	WLAN802.11 n/ac(40M) 5.3G	54 – 62
	WLAN802.11 ac(80M) 5.3G	58
	WLAN802.11 a/n/ac(20M) 5.6G	100 – 144
	WLAN802.11 n/ac(40M) 5.6G	102 – 142
	WLAN802.11 ac(80M) 5.6G	106 – 138
	WLAN802.11 a/n/ac(20M) 5.8G	149 – 165
	WLAN802.11 n/ac(40M) 5.8G	151 – 159
	WLAN802.11 ac(80M) 5.8G	155
	Bluetooth	0 – 78

Max. SAR (1 g) (Unit: W/Kg)					
Antenna	Band	Measured	Reported	Channel	Position
Main	WLAN802.11b	1.16	1.16	1	Right side
	WLAN802.11 n(40M) 5.2G	0.46	0.46	46	Top side
	WLAN802.11 n(40M) 5.3G	0.47	0.47	62	Top side
	WLAN802.11 ac(80M) 5.6G	1.04	1.04	106	Right side
	WLAN802.11 n(40M) 5.8G	0.53	0.53	159	Right side
Aux	WLAN802.11b	0.43	0.43	6	Left side
	Bluetooth	0.04	0.04	39	Left side
	WLAN802.11 n(40M) 5.2G	0.57	0.58	46	Left side
	WLAN802.11 n(40M) 5.3G	0.62	0.62	54	Left side
	WLAN802.11 ac(80M) 5.6G	1.09	1.10	122	Left side
	WLAN802.11 n(40M) 5.8G	0.72	0.77	159	Left side

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WLAN802.11 a/b/g/n/ac(20M/40M/80M) conducted power table:

Band \ Antenna	SISO		2TX / 2TX CDD
	Chain 0	Chain 1	Chain0+1
WLAN802.11b	V	V	V
WLAN802.11g	V	V	V
WLAN802.11n(20M)	V	V	V
WLAN802.11n(40M)	V	V	V
WLAN802.11ac	V	V	V
WLAN802.11a	V	V	V
WLAN802.11n(20M) 5G	V	V	V
WLAN802.11n(40M) 5G	V	V	V
WLAN802.11ac(20M) 5G	V	V	V
WLAN802.11ac(40M) 5G	V	V	V
WLAN802.11ac(80M) 5G	V	V	V

Main (Chain 0) - Without power reduction

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	20.50	20.49
		6	2437		20.50	20.33
		11	2462		20.50	20.35
	802.11g	1	2412	6Mbps	18.00	17.95
		6	2437		19.50	19.46
		11	2462		18.00	17.94
	802.11n-HT20	1	2412	MCS0	17.00	16.89
		6	2437		19.50	19.48
		11	2462		16.00	15.99
	802.11n-VHT20	1	2412	MCS0	17.00	16.91
		6	2437		19.50	19.44
		11	2462		16.00	15.90
	802.11n-HT40	3	2422	MCS0	13.00	12.98
		6	2437		18.50	18.40
		9	2452		11.00	10.95
	802.11n-VHT40	3	2422	MCS0	13.00	12.94
		6	2437		18.50	18.42
		9	2452		11.00	10.92

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	15.00	14.75
		40	5200		15.00	14.74
		44	5220		15.00	14.98
		48	5240		15.00	14.79
	802.11n-HT20	36	5180	MCS0	15.00	14.95
		40	5200		15.00	14.89
		44	5220		15.00	14.93
		48	5240		15.00	14.90
	802.11n-VHT20	36	5180	MCS0	15.00	14.85
		40	5200		15.00	14.96
		44	5220		15.00	14.94
		48	5240		15.00	14.88
	802.11n-HT40	38	5190	MCS0	11.50	11.43
		46	5230		14.50	14.46
	802.11n-VHT40	38	5190	MCS0	11.50	11.47
		46	5230		14.50	14.44
	802.11n-VHT80	42	5210	MCS0	10.50	10.38

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	15.00	14.98
		56	5280		15.00	14.97
		60	5300		15.00	14.96
		64	5320		15.00	14.91
	802.11n-HT20	52	5260	MCS0	15.00	14.93
		56	5280		15.00	14.95
		60	5300		15.00	14.90
		64	5320		15.00	14.92
	802.11n-VHT20	52	5260	MCS0	15.00	14.88
		56	5280		15.00	14.96
		60	5300		15.00	14.91
		64	5320		15.00	14.93
	802.11n-HT40	54	5270	MCS0	14.50	14.35
		62	5310		14.00	13.93
	802.11n-VHT40	54	5270	MCS0	14.50	14.48
		62	5310		14.00	13.90
	802.11n-VHT80	58	5290	MCS0	12.00	11.96

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5600 MHz	802.11a	100	5500	6Mbps	15.00	14.88
		120	5600		15.00	14.97
		124	5620		15.00	14.90
		128	5640		15.00	14.92
		140	5700		15.00	14.98
		144	5720		15.00	14.92
	802.11n-HT20	100	5500	MCS0	15.00	14.89
		120	5600		15.00	14.85
		124	5620		15.00	14.79
		128	5640		15.00	14.83
		140	5700		15.00	14.90
		144	5720		15.00	14.85
	802.11n-VHT20	100	5500	MCS0	15.00	14.91
		120	5600		15.00	14.93
		124	5620		15.00	14.88
		128	5640		15.00	14.86
		140	5700		15.00	14.82
		144	5720		15.00	14.81
	802.11n-HT40	102	5510	MCS0	11.50	11.43
		118	5590		14.50	14.44
		126	5630		14.50	14.46
		134	5670		14.50	14.40
		142	5710		14.50	14.32
	802.11n-VHT40	102	5510	MCS0	11.50	11.46
		126	5630		14.50	14.36
		134	5670		14.50	14.33
		142	5710		14.50	14.38
	802.11n-VHT80	106	5530	MCS0	12.00	11.95
		122	5610		14.50	14.48
		138	5690		14.50	14.42

Main Antenna						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5800 MHz	802.11a	149	5745	6Mbps	15.00	14.97
		157	5785		15.00	14.76
		165	5825		15.00	14.96
	802.11n-HT20	149	5745	MCS0	15.00	14.95
		157	5785		15.00	14.93
		165	5825		15.00	14.90
	802.11n-VHT20	149	5745	MCS0	14.50	14.43
		157	5785		15.00	14.85
		165	5825		15.00	14.89
	802.11n-HT40	151	5755	MCS0	11.50	11.40
		159	5795		14.50	14.39
	802.11n-VHT40	151	5755	MCS0	11.50	11.47
		159	5795		14.50	14.41
	802.11n-VHT80	155	5775	MCS0	10.00	9.96

Aux (Chain 1) - Without power reduction

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	20.50	20.49
		6	2437		20.50	20.48
		11	2462		20.50	20.45
	802.11g	1	2412	6Mbps	18.00	17.93
		6	2437		19.50	19.44
		11	2462		18.00	17.92
	802.11n-HT20	1	2412	MCS0	17.00	16.87
		6	2437		19.50	19.46
		11	2462		16.00	15.97
	802.11n-VHT20	1	2412	MCS0	17.00	16.89
		6	2437		19.50	19.42
		11	2462		16.00	15.88
	802.11n-HT40	3	2422	MCS0	13.00	12.96
		6	2437		18.50	18.38
		9	2452		11.00	10.93
	802.11n-VHT40	3	2422	MCS0	13.00	12.92
		6	2437		18.50	18.40
		9	2452		11.00	10.90

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	15.00	14.95
		40	5200		15.00	14.98
		44	5220		15.00	14.73
		48	5240		15.00	14.85
	802.11n-HT20	36	5180	MCS0	15.00	14.92
		40	5200		15.00	14.87
		44	5220		15.00	14.91
		48	5240		15.00	14.88
	802.11n-VHT20	36	5180	MCS0	15.00	14.83
		40	5200		15.00	14.93
		44	5220		15.00	14.92
		48	5240		15.00	14.87
	802.11n-HT40	38	5190	MCS0	11.50	11.41
		46	5230		14.50	14.42
	802.11n-VHT40	38	5190	MCS0	11.50	11.45
		46	5230		14.50	14.42
	802.11n-VHT80	42	5210	MCS0	10.50	10.36

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	15.00	14.98
		56	5280		15.00	14.97
		60	5300		15.00	14.96
		64	5320		15.00	14.93
	802.11n-HT20	52	5260	MCS0	15.00	14.90
		56	5280		15.00	14.92
		60	5300		15.00	14.87
		64	5320		15.00	14.89
	802.11n-VHT20	52	5260	MCS0	15.00	14.85
		56	5280		15.00	14.93
		60	5300		15.00	14.88
		64	5320		15.00	14.90
	802.11n-HT40	54	5270	MCS0	14.50	14.32
		62	5310		14.00	13.90
	802.11n-VHT40	54	5270	MCS0	14.50	14.45
		62	5310		14.00	13.87
	802.11n-VHT80	58	5290	MCS0	12.00	11.93

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5600 MHz	802.11a	100	5500	6Mbps	15.00	14.97
		120	5600		15.00	14.88
		124	5620		15.00	14.92
		128	5640		15.00	14.93
		140	5700		15.00	14.98
		144	5720		15.00	14.91
	802.11n-HT20	100	5500	MCS0	15.00	14.87
		120	5600		15.00	14.83
		124	5620		15.00	14.77
		128	5640		15.00	14.81
		140	5700		15.00	14.88
		144	5720		15.00	14.82
	802.11n-VHT20	100	5500	MCS0	15.00	14.89
		120	5600		15.00	14.91
		124	5620		15.00	14.87
		128	5640		15.00	14.84
		140	5700		15.00	14.80
		144	5720		15.00	14.79
	802.11n-HT40	102	5510	MCS0	11.50	11.41
		118	5590		14.50	14.42
		126	5630		14.50	14.44
		134	5670		14.50	14.38
		142	5710		14.50	14.31
	802.11n-VHT40	102	5510	MCS0	11.50	11.44
		126	5630		14.50	14.33
		134	5670		14.50	14.31
		142	5710		14.50	14.40
	802.11n-VHT80	106	5530	MCS0	12.00	11.92
		122	5610		14.50	14.47
		138	5690		14.50	14.40

Aux Antenna						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5800 MHz	802.11a	149	5745	6Mbps	15.00	14.98
		157	5785		15.00	14.76
		165	5825		15.00	14.90
	802.11n-HT20	149	5745	MCS0	15.00	14.92
		157	5785		15.00	14.90
		165	5825		15.00	14.88
	802.11n-VHT20	149	5745	MCS0	14.50	14.41
		157	5785		15.00	14.84
		165	5825		15.00	14.87
	802.11n-HT40	151	5755	MCS0	11.50	11.42
		159	5795		14.50	14.41
	802.11n-VHT40	151	5755	MCS0	11.50	11.44
		159	5795		14.50	14.42
	802.11n-VHT80	155	5775	MCS0	10.00	9.95

Main (Chain 0) - With power reduction

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	16.50	16.49
		6	2437		16.50	16.48
		11	2462		16.50	16.33
	802.11g	1	2412	6Mbps	16.50	16.45
		6	2437		16.50	16.39
		11	2462		16.50	16.41
	802.11n-HT20	1	2412	MCS0	16.50	16.42
		6	2437		16.50	16.46
		11	2462		16.00	15.95
	802.11n-VHT20	1	2412	MCS0	16.50	16.39
		6	2437		16.50	16.42
		11	2462		16.00	15.88
	802.11n-HT40	3	2422	MCS0	13.00	12.88
		6	2437		16.50	16.45
		9	2452		11.00	10.95
	802.11n-VHT40	3	2422	MCS0	13.00	12.87
		6	2437		16.50	16.42
		9	2452		11.00	10.92

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Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	13.00	12.98
		40	5200		13.00	12.82
		44	5220		13.00	12.95
		48	5240		13.00	12.99
	802.11n-HT20	36	5180	MCS0	13.00	12.95
		40	5200		13.00	12.97
		44	5220		13.00	12.90
		48	5240		13.00	12.91
	802.11n-VHT20	36	5180	MCS0	13.00	12.89
		40	5200		13.00	12.95
		44	5220		13.00	12.98
		48	5240		13.00	12.94
	802.11n-HT40	38	5190	MCS0	11.50	11.34
		46	5230		13.00	12.98
	802.11n-VHT40	38	5190	MCS0	11.50	11.40
		46	5230		13.00	12.94
	802.11n-VHT80	42	5210	MCS0	10.50	10.45

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	13.00	12.96
		56	5280		13.00	12.94
		60	5300		13.00	12.95
		64	5320		13.00	12.90
	802.11n-HT20	52	5260	MCS0	13.00	12.97
		56	5280		13.00	12.92
		60	5300		13.00	12.95
		64	5320		13.00	12.89
	802.11n-VHT20	52	5260	MCS0	13.00	12.93
		56	5280		13.00	12.86
		60	5300		13.00	12.94
		64	5320		13.00	12.91
	802.11n-HT40	54	5270	MCS0	13.00	12.98
		62	5310		13.00	12.99
	802.11n-VHT40	54	5270	MCS0	13.00	12.85
		62	5310		13.00	12.90
	802.11n-VHT80	58	5290	MCS0	12.00	11.89

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Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5600 MHz	802.11a	100	5500	6Mbps	12.00	11.95
		120	5600		12.00	11.96
		124	5620		12.00	11.90
		128	5640		12.00	11.94
		140	5700		12.00	11.93
		144	5720		12.00	11.91
	802.11n-HT20	100	5500	MCS0	12.00	11.90
		120	5600		12.00	11.97
		124	5620		12.00	11.86
		128	5640		12.00	11.89
		140	5700		12.00	11.92
		144	5720		12.00	11.90
	802.11n-VHT20	100	5500	MCS0	12.00	11.87
		120	5600		12.00	11.93
		124	5620		12.00	11.92
		128	5640		12.00	11.96
		140	5700		12.00	11.90
		144	5720		12.00	11.88
	802.11n-HT40	102	5510	MCS0	11.50	11.46
		118	5590		12.00	11.93
		126	5630		12.00	11.97
		134	5670		12.00	11.98
		142	5710		12.00	11.92
	802.11n-VHT40	102	5510	MCS0	11.50	11.40
		126	5630		12.00	11.84
		134	5670		12.00	11.88
		142	5710		12.00	11.86
	802.11n-VHT80	106	5530	MCS0	12.00	11.99
		122	5610		12.00	11.97
		138	5690		12.00	11.95

Main Antenna						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5800 MHz	802.11a	149	5745	6Mbps	12.00	11.99
		157	5785		12.00	11.96
		165	5825		12.00	11.98
	802.11n-HT20	149	5745	MCS0	12.00	11.95
		157	5785		12.00	11.90
		165	5825		12.00	11.93
	802.11n-VHT20	149	5745	MCS0	12.00	11.91
		157	5785		12.00	11.96
		165	5825		12.00	11.87
	802.11n-HT40	151	5755	MCS0	11.50	11.48
		159	5795		12.00	11.98
	802.11n-VHT40	151	5755	MCS0	11.50	11.45
		159	5795		12.00	11.86
	802.11n-VHT80	155	5775	MCS0	10.00	9.93

Aux (Chain 1) - With power reduction

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	16.50	16.47
		6	2437		16.50	16.49
		11	2462		16.50	16.48
	802.11g	1	2412	6Mbps	16.50	16.43
		6	2437		16.50	16.37
		11	2462		16.50	16.39
	802.11n-HT20	1	2412	MCS0	16.50	16.40
		6	2437		16.50	16.44
		11	2462		16.00	15.96
	802.11n-VHT20	1	2412	MCS0	16.50	16.37
		6	2437		16.50	16.40
		11	2462		16.00	15.86
	802.11n-HT40	3	2422	MCS0	13.00	12.86
		6	2437		16.50	16.43
		9	2452		11.00	10.95
	802.11n-VHT40	3	2422	MCS0	13.00	12.85
		6	2437		16.50	16.40
		9	2452		11.00	10.90

Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	13.00	12.98
		40	5200		13.00	12.97
		44	5220		13.00	12.99
		48	5240		13.00	12.87
	802.11n-HT20	36	5180	MCS0	13.00	12.93
		40	5200		13.00	12.95
		44	5220		13.00	12.88
		48	5240		13.00	12.89
	802.11n-VHT20	36	5180	MCS0	13.00	12.87
		40	5200		13.00	12.93
		44	5220		13.00	12.97
		48	5240		13.00	12.92
	802.11n-HT40	38	5190	MCS0	11.50	11.31
		46	5230		13.00	12.88
	802.11n-VHT40	38	5190	MCS0	11.50	11.38
		46	5230		13.00	12.92
	802.11n-VHT80	42	5210	MCS0	10.50	10.43

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Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	13.00	12.94
		56	5280		13.00	12.92
		60	5300		13.00	12.93
		64	5320		13.00	12.88
	802.11n-HT20	52	5260	MCS0	13.00	12.95
		56	5280		13.00	12.90
		60	5300		13.00	12.93
		64	5320		13.00	12.87
	802.11n-VHT20	52	5260	MCS0	13.00	12.91
		56	5280		13.00	12.84
		60	5300		13.00	12.92
		64	5320		13.00	12.89
	802.11n-HT40	54	5270	MCS0	13.00	12.99
		62	5310		13.00	12.98
	802.11n-VHT40	54	5270	MCS0	13.00	12.83
		62	5310		13.00	12.88
	802.11n-VHT80	58	5290	MCS0	12.00	11.87

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Aux Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5600 MHz	802.11a	100	5500	6Mbps	12.00	11.92
		120	5600		12.00	11.93
		124	5620		12.00	11.87
		128	5640		12.00	11.91
		140	5700		12.00	11.90
		144	5720		12.00	11.85
	802.11n-HT20	100	5500	MCS0	12.00	11.87
		120	5600		12.00	11.94
		124	5620		12.00	11.83
		128	5640		12.00	11.86
		140	5700		12.00	11.89
		144	5720		12.00	11.81
	802.11n-VHT20	100	5500	MCS0	12.00	11.84
		120	5600		12.00	11.90
		124	5620		12.00	11.89
		128	5640		12.00	11.93
		140	5700		12.00	11.87
		144	5720		12.00	11.85
	802.11n-HT40	102	5510	MCS0	11.50	11.43
		118	5590		12.00	11.90
		126	5630		12.00	11.94
		134	5670		12.00	11.95
		142	5710		12.00	11.88
	802.11n-VHT40	102	5510	MCS0	11.50	11.37
		126	5630		12.00	11.81
		134	5670		12.00	11.85
		142	5710		12.00	11.83
	802.11n-VHT80	106	5530	MCS0	12.00	11.98
		122	5610		12.00	11.97
		138	5690		12.00	11.94

Aux Antenna						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
5800 MHz	802.11a	149	5745	6Mbps	12.00	11.94
		157	5785		12.00	11.76
		165	5825		12.00	11.93
	802.11n-HT20	149	5745	MCS0	12.00	11.92
		157	5785		12.00	11.87
		165	5825		12.00	11.90
	802.11n-VHT20	149	5745	MCS0	12.00	11.88
		157	5785		12.00	11.93
		165	5825		12.00	11.84
	802.11n-HT40	151	5755	MCS0	11.50	11.47
		159	5795		12.00	11.73
	802.11n-VHT40	151	5755	MCS0	11.50	11.42
		159	5795		12.00	11.83
	802.11n-VHT80	155	5775	MCS0	10.00	9.91

Bluetooth conducted power table:

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)			Max. Rated Avg. Power + Max. Tolerance
			1Mbps	2Mbps	3Mbps	
BR/EDR	CH 00	2402	4.99	4.52	4.36	7
	CH 39	2441	6.13	5.19	4.66	
	CH 78	2480	5.93	4.92	4.61	

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)	Max. Rated Avg. Power + Max. Tolerance
			GFSK	
LE	CH 00	2402	2.41	4.5
	CH 19	2440	3.81	
	CH 39	2480	3.56	

1.4 Test Environment

Ambient Temperature: 22±2° C
Tissue Simulating Liquid: 22±2° C

1.5 Operation Description

Use chipset specific software to control the EUT, and makes it transmit in maximum power. Measurements are performed respectively on the lowest, middle and highest channels of the operating band(s). The EUT is set to maximum power level during all tests, and at the beginning of each test the battery is fully charged.

EUT was tested as below and confirmed by KDB inquiry

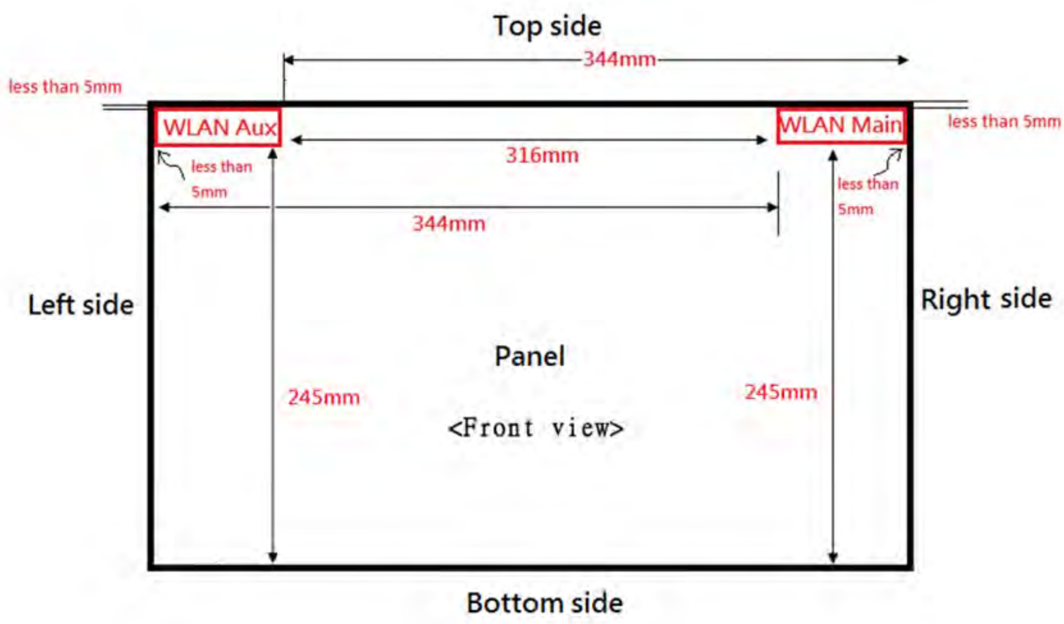
Tablet mode

Back/top/right/left sides_0mm with power reduction

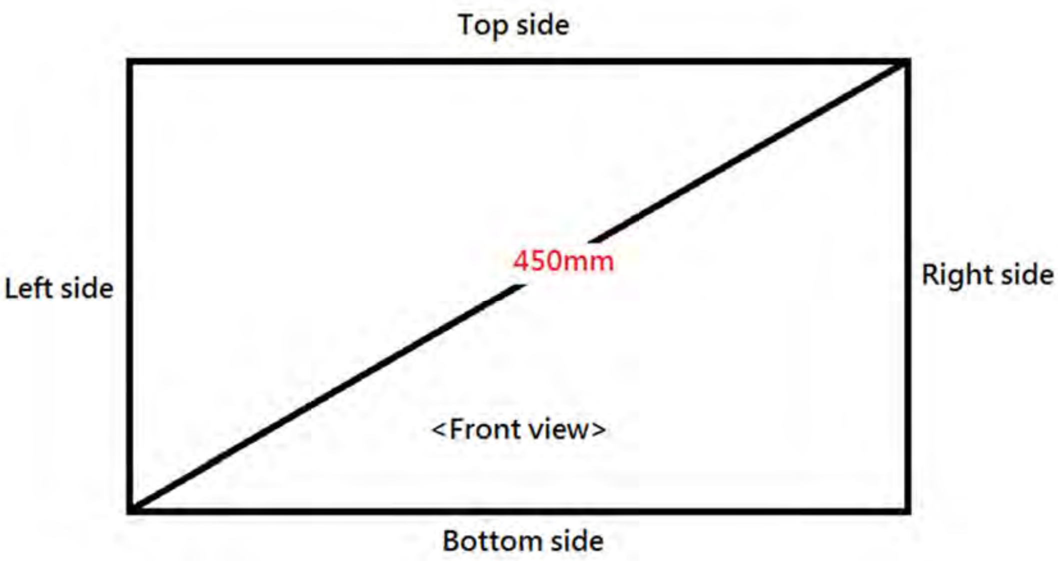
Laptop mode

Laptop mode with normal power is not required for SAR testing since the distance between the antennas and keyboard bottom is larger than 20cm.

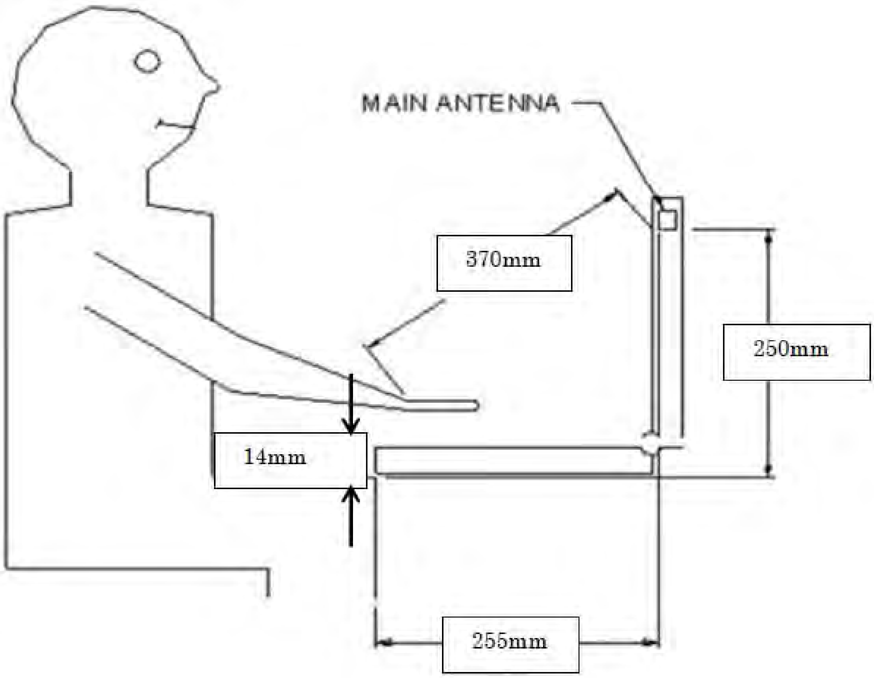
(Based on KDB inquiry, since the levels of power reduction are the same for stand, tent, and tablet modes, the stand and tent positions will be covered by the edge tests of the tablet position. Therefore, the testing of the stand and tent positions are not required.)



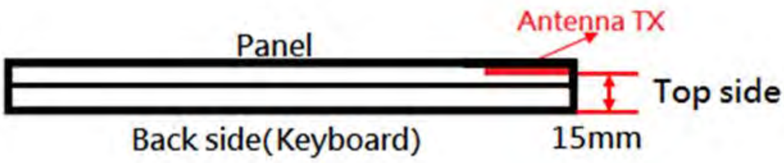
Antenna location (tablet mode)



Diagonal size of the device (tablet mode)



Antenna location (laptop mode)



Antenna location (cross section view of tablet mode)

Note:

802.11b DSSS SAR Test Requirements:

1. SAR is measured for 2.4 GHz 802.11b DSSS mode using the highest measured maximum output power channel, when the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2. When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

802.11g/n OFDM SAR Test Exclusion Requirements:

3. SAR is not required for 802.11g/n since the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Initial Test Configuration:

4. An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band.

5. SAR is measured using the highest measured maximum output power channel. When the reported SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

6. For WLAN Main/Aux antennas, 5.2n(40)/5.3n(40)/5.6ac(80)/5.8n(40) is chosen to be the initial test configurations in tablet mode.

7. Since the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for subsequent test configuration.

8. BT and WLAN Aux use the same antenna path, but they can’t transmit at the same time.

9. According to KDB447498 D01, testing of other required channels is not required when the reported 1-g SAR for the highest output channel is ≤ 0.8 W/kg, when the transmission band is ≤ 100 MHz.
10. According to KDB865664 D01, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is ≥ 0.8 W/kg, repeated that measurement once. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~10% from the 1-g SAR limit)
11. Based on KDB447498D01,

(1) SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances≤ 50 mm are determined by:

$$\frac{\text{Max. tune up power(mW)}}{\text{Min. test separation distance(mm)}} \times \sqrt{f(\text{GHz})} \leq 3$$

When the minimum test separation distance is < 5mm, 5mm is applied to determine SAR test exclusion.

Mode		WLAN Main 2.45GHz	WLAN Main 5GHz
Max. tune-up power(dBm)		16.5	13
Max. tune-up power(mW)		44.668	19.953
Top side	Test separation distance (mm)	less than 5	less than 5
	Calculation value	14.018	9.606
	Require SAR testing?	**YES**	**YES**
Right side	Test separation distance (mm)	less than 5	less than 5
	Calculation value	14.018	9.606
	Require SAR testing?	**YES**	**YES**
Left side	Test separation distance (mm)	344	344
	>20cm	YES	YES
	Require SAR testing?	**NO**	**NO**
Bottom side	Test separation distance (mm)	245	245
	>20cm	YES	YES
	Require SAR testing?	**NO**	**NO**
Back side	Test separation distance (mm)	less than 5	less than 5
	Calculation value	14.018	9.606
	Require SAR testing?	**YES**	**YES**

Mode		WLAN Aux 2.45GHz	WLAN Aux 5GHz	BT
Max. tune-up power(dBm)		16.5	13	7
Max. tune-up power(mW)		44.668	19.953	5.012
Top side	Test separation distance (mm)	less than 5	less than 5	less than 5
	Calculation value	14.018	9.606	1.579
	Require SAR testing?	**YES**	**YES**	**NO**
Right side	Test separation distance (mm)	344	344	344
	>20cm	YES	YES	YES
	Require SAR testing?	**NO**	**NO**	**NO**
Left side	Test separation distance (mm)	less than 5	less than 5	less than 5
	Calculation value	14.018	9.606	1.579
	Require SAR testing?	**YES**	**YES**	**NO**
Bottom side	Test separation distance (mm)	245	245	245
	>20cm	YES	YES	YES
	Require SAR testing?	**NO**	**NO**	**NO**
Back side	Test separation distance (mm)	less than 5	less than 5	less than 5
	Calculation value	14.018	9.606	1.579
	Require SAR testing?	**YES**	**YES**	**NO**

(2) For test separation distances > 50 mm, and the frequency at 100 MHz to 1500MHz, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B of KDB447498 D01.
[(Threshold at 50mm in step1) + (test separation distance-50mm)x($\frac{f(MHz)}{150}$)](mW),

(3) For test separation distances > 50 mm, and the frequency at >1500MHz to 6GHz, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B of KDB447498 D01.

[(Threshold at 50mm in step1) + (test separation distance-50mm)x10](mW),

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1.6 triggering verification for power reduction

The device is a convertible laptop computer with a lid open up to x360 degree. Device modes are defined for different use scenarios. For those device modes under RF exposure concern, the radio power reduction will be triggered. There are the sensors at the lid and the base of laptop, and the sensors can calculate the angle between the screen and the keyboard base, and then reduce the maximum power based on each device mode accordingly.
Also, the G-sensor will calculate the hinge angle for power reduction and its operation is no related the triggering distance and coverage.
When the device is operated at the laptop mode (hinge angle<180 degree), the power reduction will not be triggered, but when the hinge angle > 180 degree, the power reduction will be triggered. Besides, the power reduction is a single fixed level of power reduction, and the power reduction level will be the same with the different hinge angle (different use scenarios, like tent, stand, and tablet modes).
Also, the power reduction will be triggered on WLAN Main & Aux, and the sensor can tell if the device is in stand or tent mode even though the two modes have the same hinge angles between the screen and keyboard base. Stand mode is defined only when the base is placed horizontally.
For the triggering verification, the measured conducted output power is monitored qualitatively to identify the triggering characteristics and recorded quantitatively, versus hinge angle, as similar with the procedures in KDB616217D04.

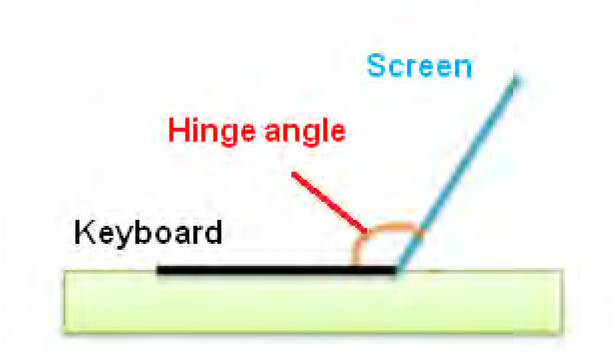

Illustration of hinge angle

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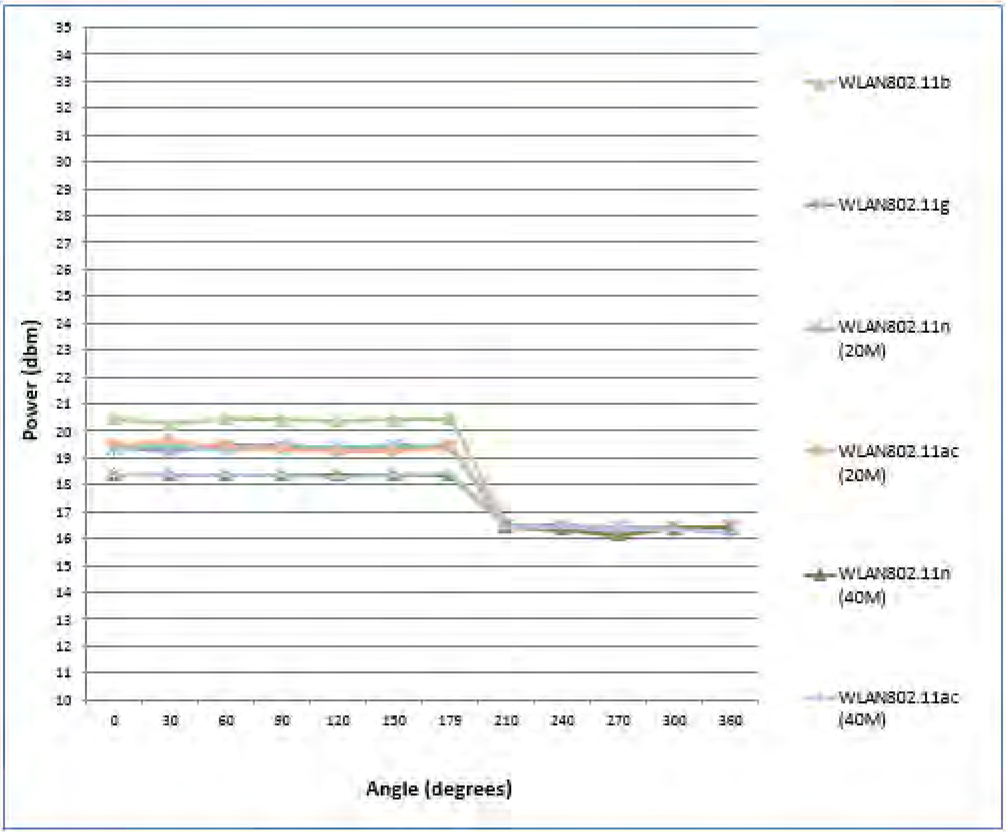
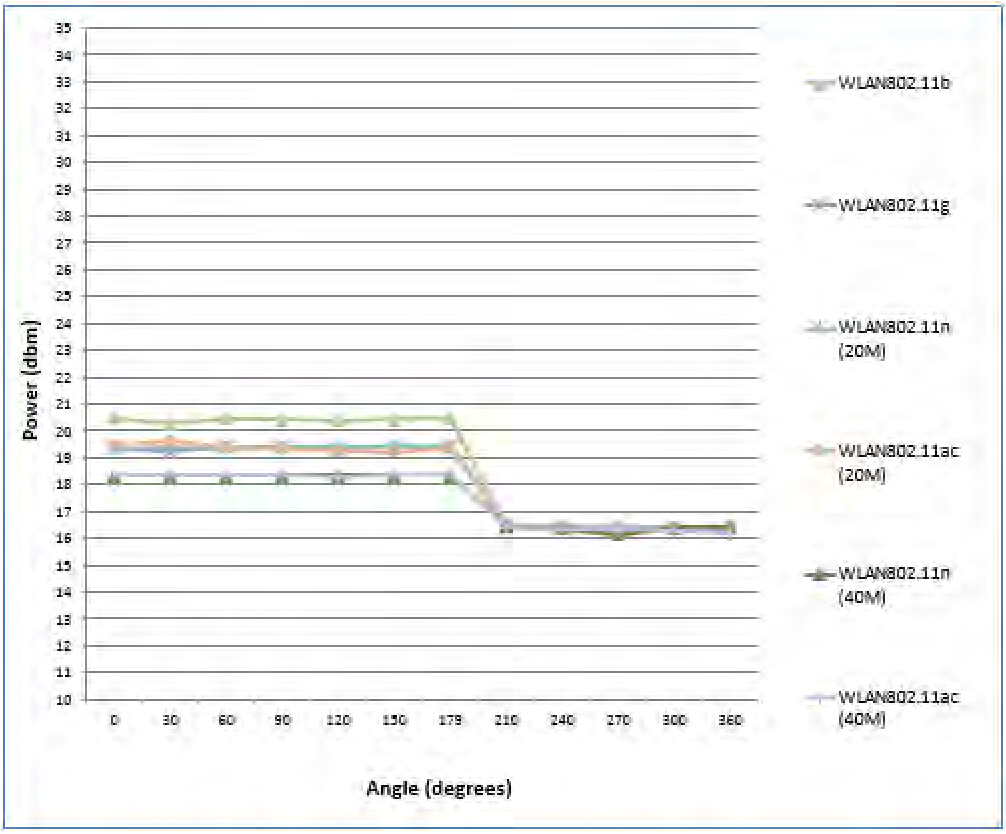
1.6.1 Results and conclusion

The measured output power versus hinge angle is tabulated in the following table, and the triggering verification complies with the device mode / power level declared by the manufacturer.

2.4G Main



2.4G Aux



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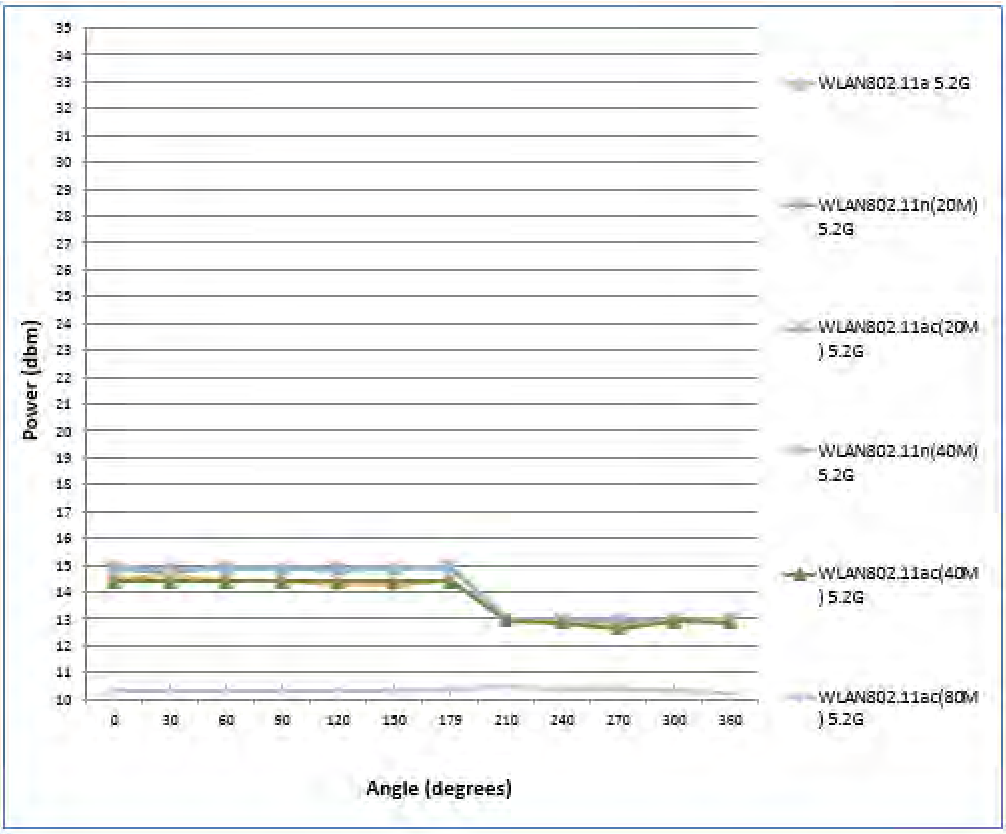
5.2G Main



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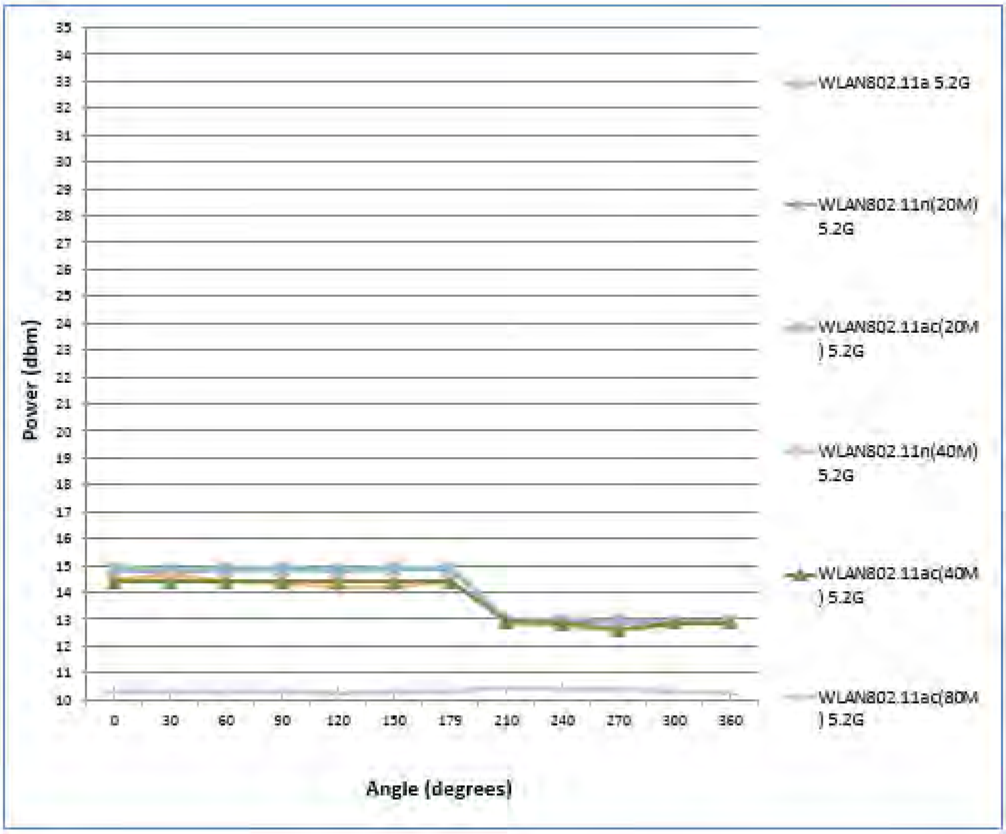
5.2G Aux



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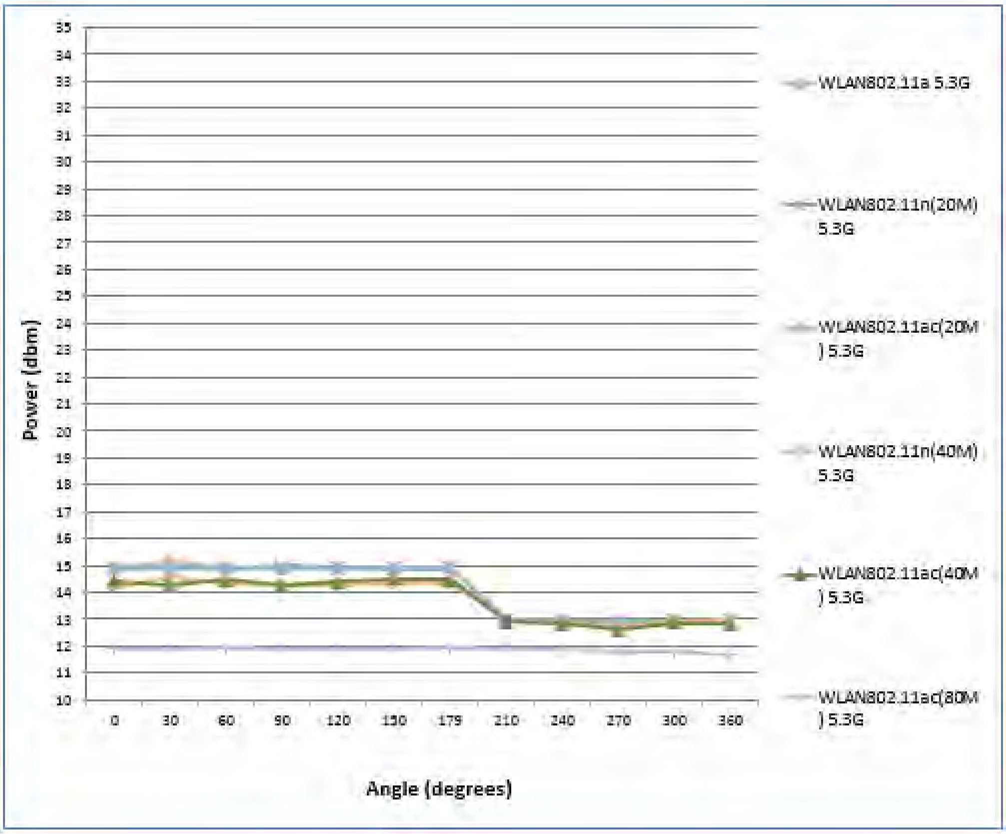
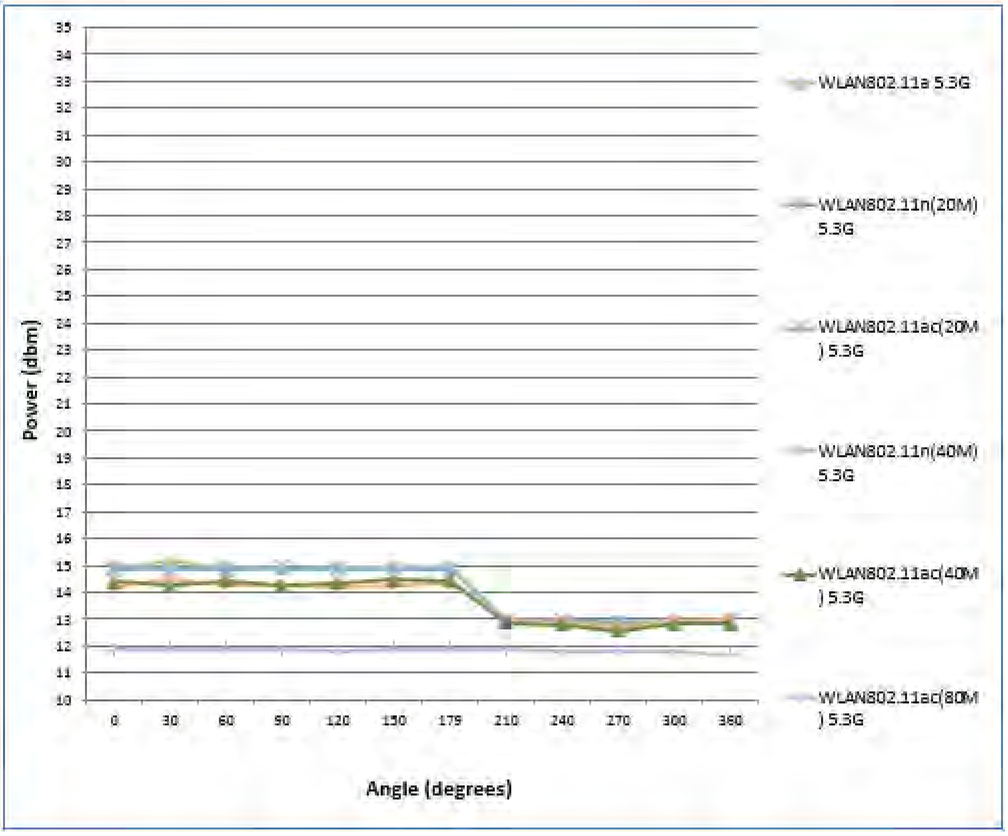
5.3G Main


Power (dbm)
Angle (degrees)
WLAN802.11a 5.3G
WLAN802.11n(20M) 5.3G
WLAN802.11ac(20M) 5.3G
WLAN802.11n(40M) 5.3G
WLAN802.11ac(40M) 5.3G
WLAN802.11ac(80M) 5.3G

5.3G Aux



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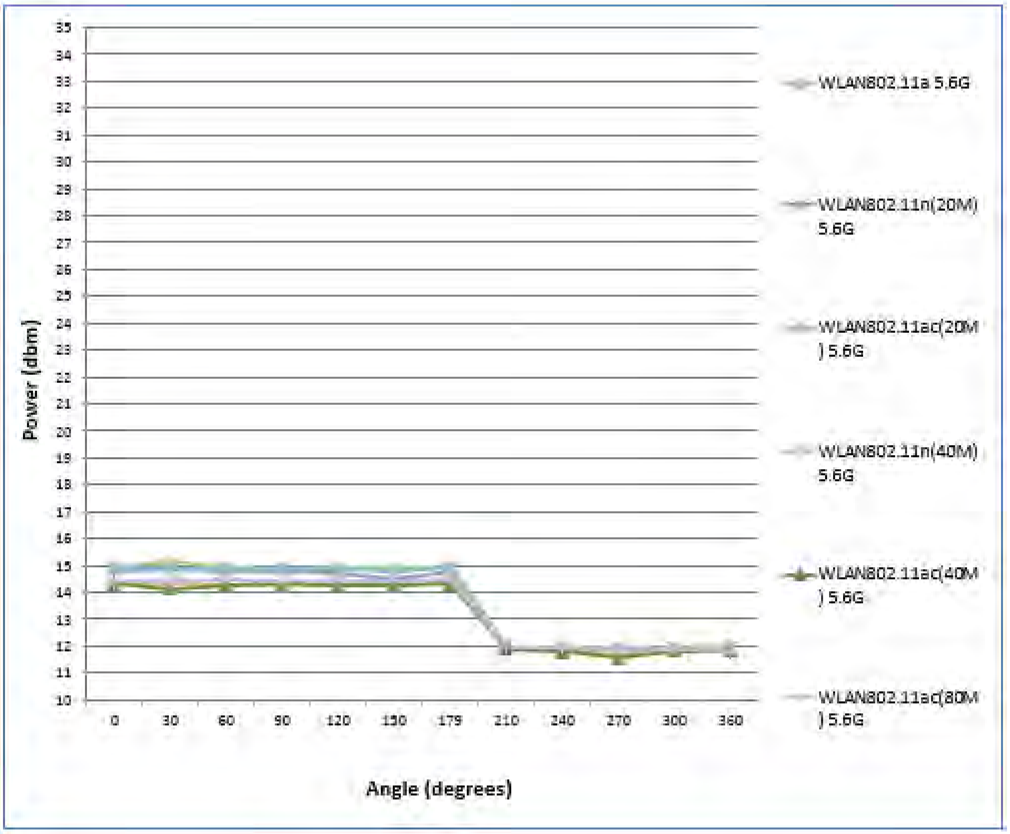
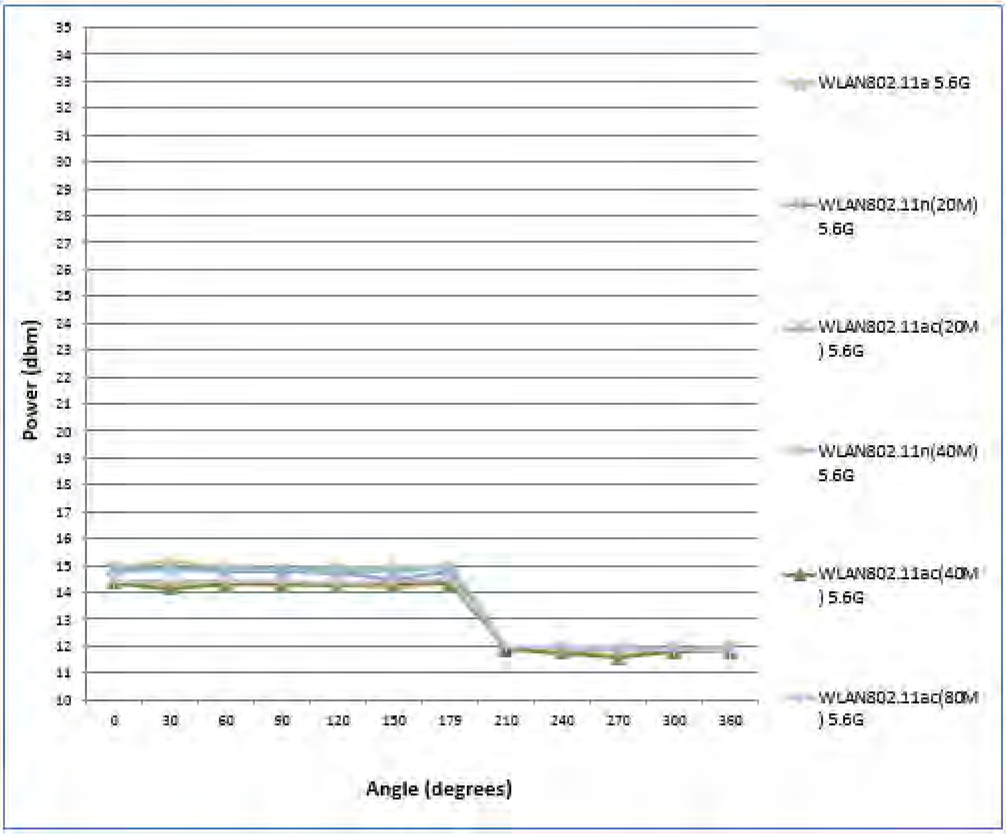
5.6G Main


Power (dbm)
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
0
30
60
90
120
150
179
210
240
270
300
360
Angle (degrees)
WLAN802.11a 5.6G
WLAN802.11n(20M) 5.6G
WLAN802.11ac(20M) 5.6G
WLAN802.11n(40M) 5.6G
WLAN802.11ac(40M) 5.6G
WLAN802.11ac(80M) 5.6G

5.6G Aux



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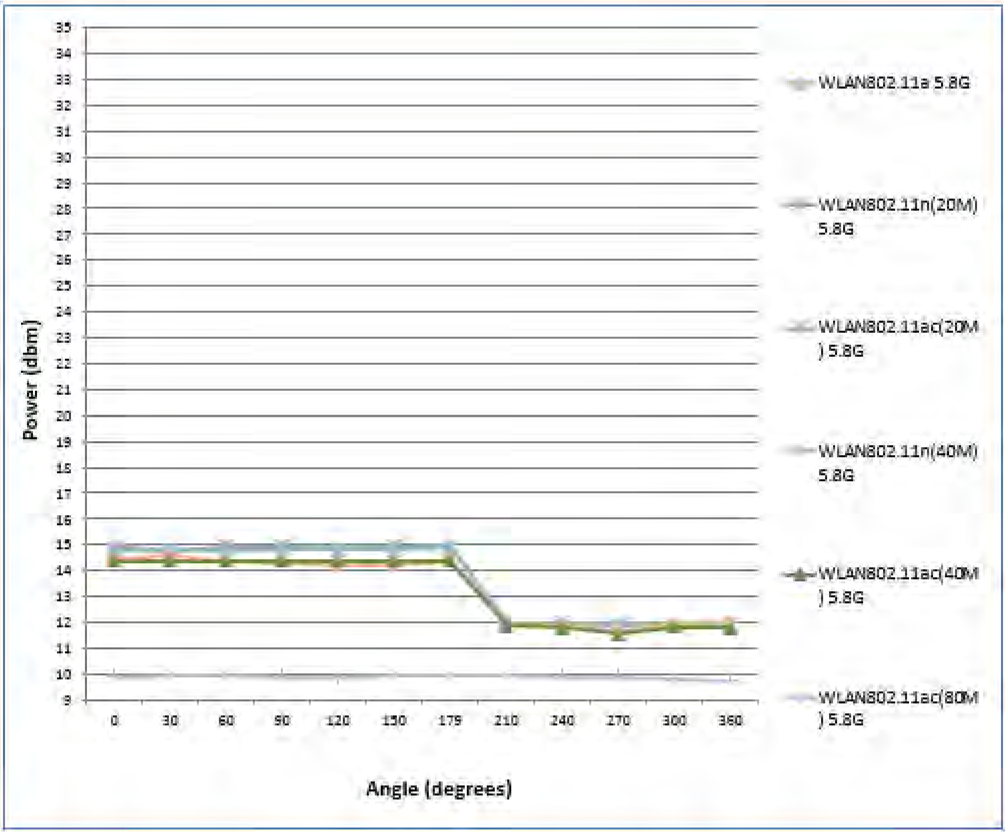
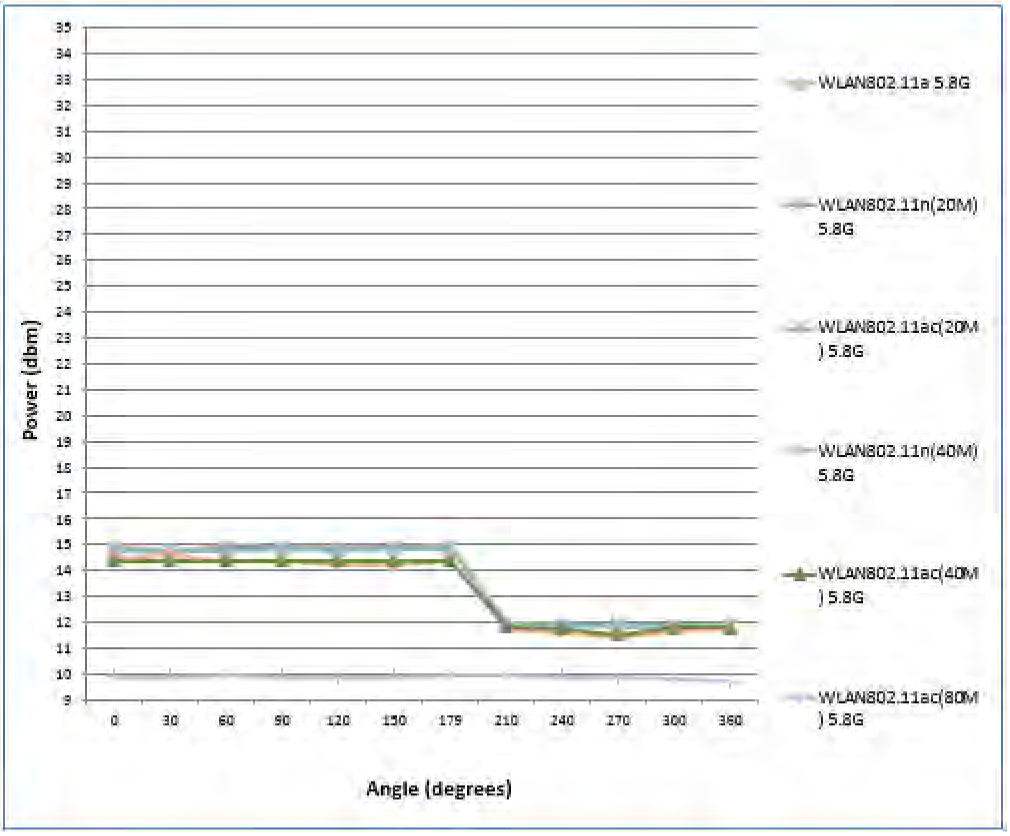
5.8 Main


Power (dbm)
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
0
30
60
90
120
150
179
210
240
270
300
360
Angle (degrees)
WLAN802.11a 5.8G
WLAN802.11n(20M) 5.8G
WLAN802.11ac(20M) 5.8G
WLAN802.11n(40M) 5.8G
WLAN802.11ac(40M) 5.8G
WLAN802.11ac(80M) 5.8G

5.8G Aux



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1.7 The SAR Measurement System

A block diagram of the SAR measurement System is given in Fig. a. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 5 professional system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= σ ($|Ei|^2$)/ ρ where σ and ρ are the conductivity and mass density of the tissue-simulant.

The DASY 5 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage intissue simulating liquid. The probe is equipped with an optical surface detector system.
3. A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

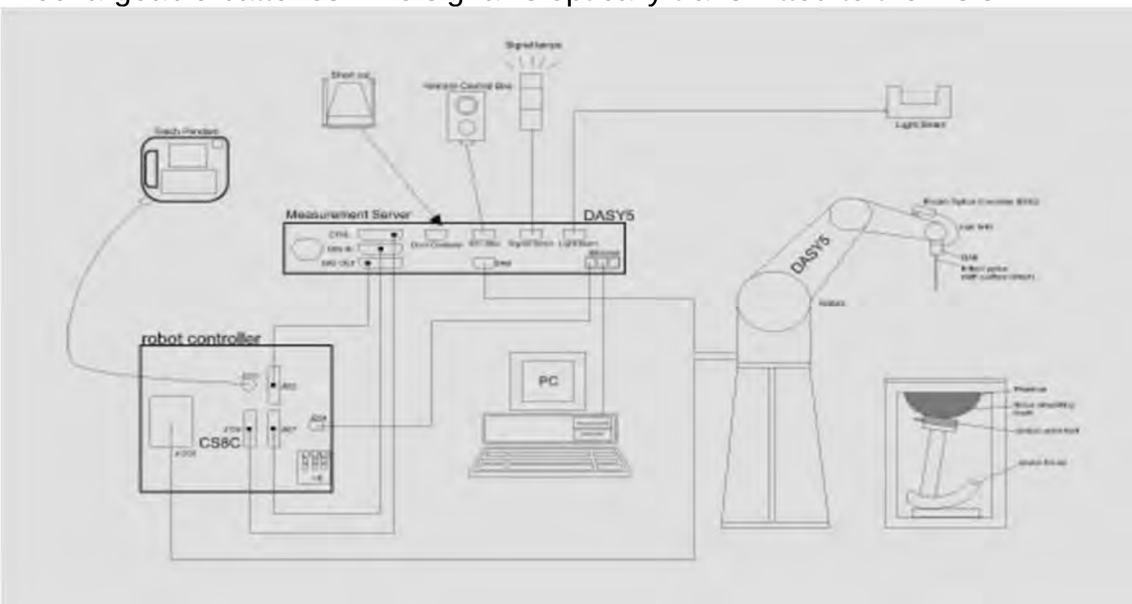

Fig. a The block diagram of SAR system

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4. The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
5. The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
6. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
7. A computer operating Windows 7.
8. DASY 5 software.
9. Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
10. The SAM twin phantom enabling testing left-hand and right-hand usage.
11. The device holder for handheld mobile phones.
12. Tissue simulating liquid mixed according to the given recipes.
13. Validation dipole kits allowing to validate the proper functioning of the system.

1.8 System Components

EX3DV4 E-Field Probe

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 2450/5200/5300/5600/5800 MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Tip diameter: 2.5 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

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PHANTOM

Model	ELI	
Construction	The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	

DEVICE HOLDER

Construction	The device holder (Supporter) for Notebook is made by POM (polyoxymethylene resin) , which is non-metal and non-conductive. The height can be adjusted to fit varies kind of notebooks.	 Device Holder

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1.9 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. These tests were done at 2450/5200/5300/5600/5800 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1 (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

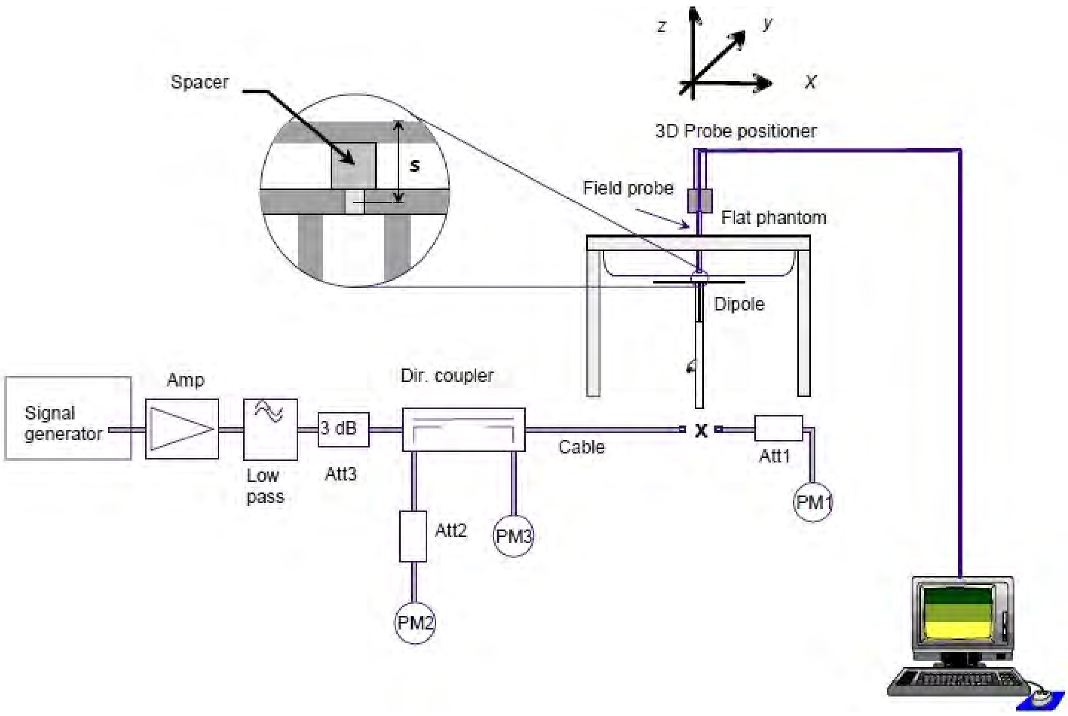

Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D2450V2	727	2450	Body	50.6	13.00	52.00	2.77%	Jun. 18, 2017
D5GHzV2	1023	5200	Body	72.8	7.39	73.90	1.51%	Jun. 20, 2017
		5300	Body	76.1	7.57	75.70	-0.53%	Jun. 22, 2017
		5600	Body	79.6	8.16	81.60	2.51%	Jun. 22, 2017
		5800	Body	75.9	7.35	73.50	-3.16%	Jun. 17, 2017

Table 1. Results of system validation

1.10 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this body-simulant fluid were measured by using the Schmid & Partner Engineering AG Model DAKS Dielectric Probe Kit in conjunction with Network Analyzer. All dielectric parameters of tissue simulates were measured within 24 hours of SAR measurements. The measured conductivity and permittivity are all within ± 5% of the target values.

The depth of the tissue simulant in the flat section of the phantom was ≥ 15 cm ± 5 mm (Frequency ≤3G) or ≥ 10 cm ± 5 mm (Frequency >3G) during all tests. (Fig. 2)

Tissue Type	Measurement Date	Measured Frequency (MHz)	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	% dev εr	% dev σ
Body	Jun. 18, 2017	2402	52.764	1.904	53.962	1.928	-2.27%	-1.26%
		2412	52.751	1.914	53.959	1.940	-2.29%	-1.37%
		2437	52.717	1.938	53.863	1.971	-2.17%	-1.72%
		2441	52.712	1.941	53.827	1.978	-2.12%	-1.91%
		2450	52.700	1.950	53.850	1.992	-2.18%	-2.15%
		2462	52.685	1.967	53.807	2.005	-2.13%	-1.93%
		2480	52.662	1.993	53.762	2.026	-2.09%	-1.66%
	Jun. 20, 2017	5180	49.041	5.276	49.231	5.072	-0.39%	3.87%
		5190	49.028	5.288	49.216	5.082	-0.38%	3.90%
		5200	49.014	5.299	49.135	5.092	-0.25%	3.91%
		5220	48.987	5.323	49.109	5.102	-0.25%	4.15%
		5230	48.974	5.334	49.012	5.137	-0.08%	3.70%
		5240	48.960	5.346	49.000	5.145	-0.08%	3.76%
	Jun. 22, 2017	5260	48.933	5.369	48.900	5.174	0.07%	3.64%
		5270	48.919	5.381	48.894	5.207	0.05%	3.23%
		5280	48.906	5.393	48.875	5.206	0.06%	3.46%
		5300	48.879	5.416	48.830	5.246	0.10%	3.14%
		5310	48.865	5.428	48.766	5.252	0.20%	3.24%
		5320	48.851	5.439	48.741	5.271	0.23%	3.10%
	Jun. 22, 2017	5500	48.607	5.650	48.211	5.569	0.81%	1.43%
		5530	48.566	5.685	48.093	5.596	0.97%	1.56%
		5600	48.471	5.766	47.891	5.730	1.20%	0.63%
		5610	48.458	5.778	47.842	5.739	1.27%	0.68%
		5690	48.349	5.872	47.598	5.893	1.55%	-0.37%
		5700	48.336	5.883	47.541	5.888	1.64%	-0.08%
	Jun. 17, 2017	5745	48.275	5.936	47.431	5.962	1.75%	-0.44%
		5755	48.261	5.947	47.409	5.972	1.77%	-0.41%
		5785	48.220	5.982	47.257	6.038	2.00%	-0.93%
		5795	48.207	5.994	47.247	6.051	1.99%	-0.95%
		5800	48.200	6.000	47.259	6.052	1.95%	-0.87%
		5825	48.166	6.029	47.232	6.091	1.94%	-1.03%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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The composition of the tissue simulating liquid:

Frequency (MHz)	Mode	Ingredient						Total amount
		DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	
2450M	Body	301.7ml	698.3ml	—	—	—	—	1.0L(Kg)

Body Simulating Liquids for 5 GHz, Manufactured by SPEAG:

Ingredients	Water	Esters, Emulsifiers, Inhibitors	Sodium and Salt
(% by weight)	60-80	20-40	0-1.5

Table 3. Recipes for Tissue Simulating Liquid

1.11 Evaluation Procedures

The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1g and 10g.

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within –2 dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5mm.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7x7x7 scans. The routines are verified and optimized for the grid dimensions used in these cube measurements.

The measured volume of 30x30x30mm contains about 30g of tissue.

The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D

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interpolation to get all points within the measured volume. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

1.12 Probe Calibration Procedures

For the calibration of E-field probes in lossy liquids, an electric field with an accurately known field strength must be produced within the measured liquid. For standardization purposes it would be desirable if all measurements which are necessary to assess the correct field strength would be traceable to standardized measurement procedures. In the following two different calibration techniques are summarized:

1.12.1 Transfer Calibration with Temperature Probes

In lossy liquids the specific absorption rate (SAR) is related both to the electric field (E) and the temperature gradient ($\delta T / \delta t$) in the liquid.

$$SAR = C \frac{\delta T}{\delta t},$$

whereby σ is the conductivity, ρ the density and c the heat capacity of the liquid.

Hence, the electric field in lossy liquid can be measured indirectly by measuring the temperature gradient in the liquid. Non-disturbing temperature probes (optical probes or thermistor probes with resistive lines) with high spatial resolution (<1-2 mm) and fast reaction time (<1 s) are available and can be easily calibrated with high precision [1]. The setup and the exciting source have no influence on the calibration; only the relative positioning uncertainties of the standard temperature probe and the E-field probe to be calibrated must be considered. However, several problems limit the available accuracy of probe calibrations with temperature probes:

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- The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept small.
- The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
- The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures (~ 2% for c; much better for ρ) , there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed ±5%.
- Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

Considering these problems, the possible accuracy of the calibration of E-field probes with temperature gradient measurements in a carefully designed setup is about ±10% (RSS) [2]. Recently, a setup which is a combination of the waveguide techniques and the thermal measurements was presented in [3]. The estimated uncertainty of the setup is ±5% (RSS) when the same liquid is used for the calibration and for actual measurements and ±7-9% (RSS) when not, which is in good agreement with the estimates given in [2].

1.12.2 Calibration with Analytical Fields

In this method a technical setup is used in which the field can be calculated analytically from measurements of other physical magnitudes (e.g., input power). This corresponds to the standard field method for probe calibration in air; however, there is no standard defined for fields in lossy liquids.
When using calculated fields in lossy liquids for probe calibration, several points must be considered in the assessment of the uncertainty:

- The setup must enable accurate determination of the incident power.
- The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
- Due to the small wavelength in liquids with high permittivity, even small

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setups might be above the resonant cutoff frequencies. The field distribution in the setup must be carefully checked for conformity with the theoretical field distribution.

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1. N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
2. K. Meier, M. Burkhardt, T. Schmid, and N. Kuster, \Broadband calibration of E-field probes in lossy media", *IEEE Transactions on Microwave Theory and Techniques*, vol. 44, no. 10, pp. 1954{1962, Oct. 1996.
3. K. Jokela, P. Hyysalo, and L. Puranen, \Calibration of specific absorption rate (SAR) probes in waveguide at 900 MHz", *IEEE Transactions on Instrumentation and Measurements*, vol. 47, no. 2, pp. 432{438, Apr. 1998.

1.13 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (''SAR'') in Section 4.2 of ''IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,'' ANSI/IEEE C95.1, By the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in ''Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields,'' NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube).

(2) Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(3) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not

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exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section. (Table 4.)

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR (Brain)	1.60 W/kg	8.00 W/kg
Spatial Average SAR (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 W/kg	20.00 W/kg

Table 4. RF exposure limits

Notes:
1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

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2. Summary of Results

WLAN Main Antenna (Tablet mode)

Antenna	Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 1g (W/kg)		Plot page
									Measured	Reported	
Main	WLAN802.11 b	Back sdie	0	1	2412	16.5	16.49	100.23%	0.149	0.149	-
		Top side	0	1	2412	16.5	16.49	100.23%	0.706	0.708	-
		Right side	0	1	2412	16.5	16.49	100.23%	1.160	1.163	66
		Right side*	0	1	2412	16.5	16.49	100.23%	1.150	1.153	-
		Right side	0	6	2437	16.5	16.48	100.46%	1.060	1.065	-
		Right side	0	11	2462	16.5	16.33	103.99%	1.020	1.061	-
	WLAN802.11 n(40M) 5.2G	Back sdie	0	46	5230	13	12.98	100.46%	0.024	0.024	-
		Top side	0	46	5230	13	12.98	100.46%	0.461	0.463	67
		Right side	0	46	5230	13	12.98	100.46%	0.425	0.427	-
	WLAN802.11 n(40M) 5.3G	Back sdie	0	62	5310	13	12.99	100.23%	0.018	0.018	-
		Top side	0	62	5310	13	12.99	100.23%	0.471	0.472	68
		Right side	0	62	5310	13	12.99	100.23%	0.303	0.304	-
	WLAN802.11 ac(80M) 5.6G	Back sdie	0	106	5530	12	11.99	100.23%	0.047	0.047	-
		Top side	0	106	5530	12	11.99	100.23%	0.592	0.593	-
		Right side	0	106	5530	12	11.99	100.23%	1.040	1.042	69
		Right side*	0	106	5530	12	11.99	100.23%	1.020	1.022	-
		Right side	0	122	5610	12	11.97	100.69%	0.895	0.901	-
	WLAN802.11 n(40M) 5.8G	Back sdie	0	159	5795	12	11.98	100.46%	0.016	0.016	-
		Top side	0	159	5795	12	11.98	100.46%	0.452	0.454	-
		Right side	0	159	5795	12	11.98	100.46%	0.528	0.530	70

* - repeated at the highest SAR measurement according to the KDB 865664 D01

WLAN Aux Antenna (Tablet mode)

Antenna	Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 1g (W/kg)		Plot page
									Measured	Reported	
Aux	WLAN802.11 b	Back sdie	0	6	2437	16.5	16.49	100.23%	0.121	0.121	-
		Top side	0	6	2437	16.5	16.49	100.23%	0.343	0.344	-
		Left side	0	6	2437	16.5	16.49	100.23%	0.427	0.428	71
	Bluetooth (GFSK)	Back sdie	0	39	2441	7	6.13	122.18%	0.011	0.014	-
		Top side	0	39	2441	7	6.13	122.18%	0.031	0.038	-
		Left side	0	39	2441	7	6.13	122.18%	0.036	0.044	72
	WLAN802.11 n(40M) 5.2G	Back sdie	0	46	5230	13	12.88	102.80%	0.020	0.021	-
		Top side	0	46	5230	13	12.88	102.80%	0.225	0.231	-
		Left side	0	46	5230	13	12.88	102.80%	0.568	0.584	73
	WLAN802.11 n(40M) 5.3G	Back sdie	0	54	5270	13	12.99	100.23%	0.027	0.027	-
		Top side	0	54	5270	13	12.99	100.23%	0.363	0.364	-
		Left side	0	54	5270	13	12.99	100.23%	0.622	0.623	74
	WLAN802.11 ac(80M) 5.6G	Back sdie	0	106	5530	12	11.98	100.46%	0.042	0.042	-
		Top side	0	106	5530	12	11.98	100.46%	0.557	0.560	-
		Left side	0	106	5530	12	11.98	100.46%	1.080	1.085	-
		Left side	0	122	5610	12	11.97	100.69%	1.090	1.098	75
		Left side*	0	122	5610	12	11.97	100.69%	1.080	1.087	-
	WLAN802.11 n(40M) 5.8G	Back sdie	0	159	5795	12	11.73	106.41%	0.018	0.019	-
		Top side	0	159	5795	12	11.73	106.41%	0.347	0.369	-
		Left side	0	159	5795	12	11.73	106.41%	0.719	0.765	76

* - repeated at the highest SAR measurement according to the KDB 865664 D01

Note:

$$\text{Scaling} = \frac{\text{reported SAR}}{\text{measured SAR}} = \frac{\text{P2(mW)}}{\text{P1(mW)}} = 10^{\left(\frac{P2-P1}{10}\right)(\text{dBm})}$$

Reported SAR = measured SAR * (scaling)

Where P2 is maximum specified power, P1 is measured conducted power

3. Simultaneous Transmission Analysis

Simultaneous Transmission Scenarios:

Simultaneous Transmit Configurations	Body
2.4GHz WLAN MIMO	Yes
5GHz WLAN MIMO	Yes
BT + 2.4GHz WLAN Main	Yes
BT + 5GHz WLAN Main	Yes

Note:
1. Bluetooth and WLAN Aux share the same antenna path, and BT can transmit with WLAN Main simultaneously.
2. For 2.4/5GHz WLAN Main and Aux antennas, the maximum output power of each antenna during simultaneous transmission is the same with that used in standalone transmission, and we used the sum of 1-g SAR provision in KDB447498D01 to exclude the simultaneous transmitted SAR measurement.

3.1 Estimated SAR calculation

According to KDB447498 D01v06 – When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$$\text{Estimated SAR} = \frac{\text{Max. tune up power (mW)}}{\text{Min. test separation distance(mm)}} \times \frac{\sqrt{\text{f(GHz)}}}{7.5}$$

If the minimum test separation distance is < 5mm, a distance of 5mm is used for estimated SAR calculation. When the test separation distance is >50mm, the 0.4W/kg is used for SAR-1g.

3.2 SPLSR evaluation and analysis

Per KDB447498D01, when the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR sum to peak location separation ratio(SPLSR).

The simultaneous transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion.

The ratio is determined by **(SAR1 + SAR2)^1.5/Ri**, rounded to two decimal digits, and must be **≤ 0.04** for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

SAR1 and SAR2 are the highest reported or estimated SAR for each antenna in the pair, and Ri is the separation distance between the peak SAR locations for the antenna pair in mm.

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna.

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2.4 GHz WLAN MIMO (Tablet Mode)

No.	Conditions	Position	Max. WLAN Main	Max. WLAN Aux	SAR Sum	SPLSR
1	2.4 GHz WLAN Main + WLAN Aux	Back side	0.149	0.121	0.270	ΣSAR<1.6, Not required
		Top side	0.708	0.344	1.052	ΣSAR<1.6, Not required
		Right side	1.163	-	-	ΣSAR<1.6, Not required
		Left side	-	0.428	-	ΣSAR<1.6, Not required

5 GHz WLAN MIMO (Tablet Mode)

No.	Conditions	Position	Max. WLAN Main	Max. WLAN Aux	SAR Sum	SPLSR
2	5 GHz WLAN Main + WLAN Aux	Back side	0.047	0.042	0.089	ΣSAR<1.6, Not required
		Top side	0.593	0.560	1.153	ΣSAR<1.6, Not required
		Right side	1.042	-	-	ΣSAR<1.6, Not required
		Left side	-	1.098	-	ΣSAR<1.6, Not required

2.4GHz WLAN Main + BT (Tablet Mode)

No.	Conditions	Position	Max. WLAN Main	BT	SAR Sum	SPLSR
3	2.4 GHz WLAN Main + BT	Back side	0.149	0.014	0.163	ΣSAR<1.6, Not required
		Top side	0.708	0.038	0.746	ΣSAR<1.6, Not required
		Right side	1.163	-	-	ΣSAR<1.6, Not required
		Left side	-	0.044	-	ΣSAR<1.6, Not required

5GHz WLAN Main + BT (Tablet Mode)

No.	Conditions	Position	Max. WLAN Main	BT	SAR Sum	SPLSR
4	5 GHz WLAN Main + BT	Back side	0.047	0.014	0.061	ΣSAR<1.6, Not required
		Top side	0.593	0.038	0.631	ΣSAR<1.6, Not required
		Right side	1.042	-	-	ΣSAR<1.6, Not required
		Left side	-	0.044	-	ΣSAR<1.6, Not required

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4. Instruments List

Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Dosimetric E-Field Probe	EX3DV4	3770	Apr.27,2017	Apr.26,2018
SPEAG	System Validation Dipole	D2450V2	727	Apr.21,2017	Apr.20,2018
		D5GHzV2	1023	Jan.20,2017	Jan.19,2018
SPEAG	Data acquisition Electronics	DAE4	856	Apr.28,2017	Apr.27,2018
SPEAG	Software	DASY 52 V52.8.8	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	ELI	N/A	Calibration not required	Calibration not required
Agilent	Vector Network Analyzer and Vector Reflect meter	DAKS VNA R140	0040513	Jan.24,2017	Jan.23,2018
Agilent	Dielectric Probe Kit	DAKS-3.5	1053	Jan.24,2017	Jan.23,2018
Agilent	Dual-directional coupler	772D	MY52180142	Apr.13,2017	Apr.12,2018
Agilent	RF Signal Generator	N5181A	MY50144143	Mar.01,2017	Feb.28,2018
Agilent	Power Meter	E4417A	MY52240003	Oct.17,2016	Oct.16,2017
Agilent	Power Sensor	E9301H	MY52200003	Oct.17,2016	Oct.16,2017
			MY52200004	Oct.17,2016	Oct.16,2017
TECPEL	Digital thermometer	DTM-303A	TP130077	Mar.17,2017	Mar.16,2018

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5. Measurements

Date: 2017/7/18

WLAN 802.11b_Body_Right side_CH 1_Main_0mm

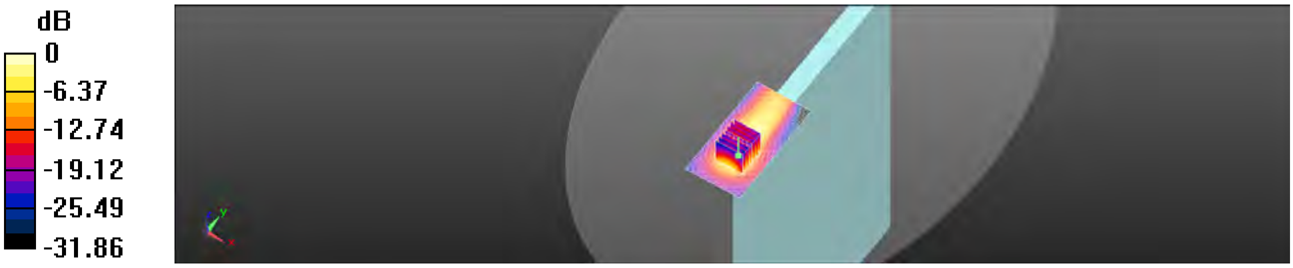
Communication System: WLAN 2.4G; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.94 S/m; ε_r = 53.959; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.9°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(7.47, 7.47, 7.47); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Head/Area Scan (51x101x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 1.93 W/kg

Configuration/Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.375 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 2.68 W/kg
SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.465 W/kg
Maximum value of SAR (measured) = 1.81 W/kg



0 dB = 1.81 W/kg = 2.58 dBW/kg

Date: 2017/7/20

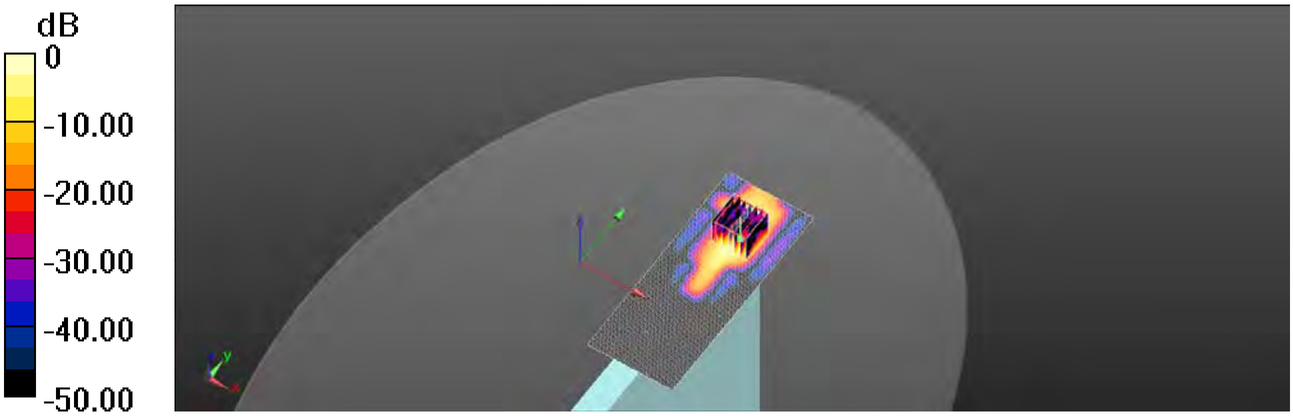
WLAN 802.11n(40M) 5.2G_Body_Top side_CH 46_Main_0mm
Communication System: WLAN 5G; Frequency: 5230 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5230 MHz; σ = 5.137 S/m; ε_r = 49.012; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (61x151x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 0.928 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.114 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 2.51 W/kg
SAR(1 g) = 0.461 W/kg; SAR(10 g) = 0.114 W/kg
Maximum value of SAR (measured) = 1.10 W/kg



0 dB = 1.10 W/kg = 0.41 dBW/kg

Date: 2017/7/22

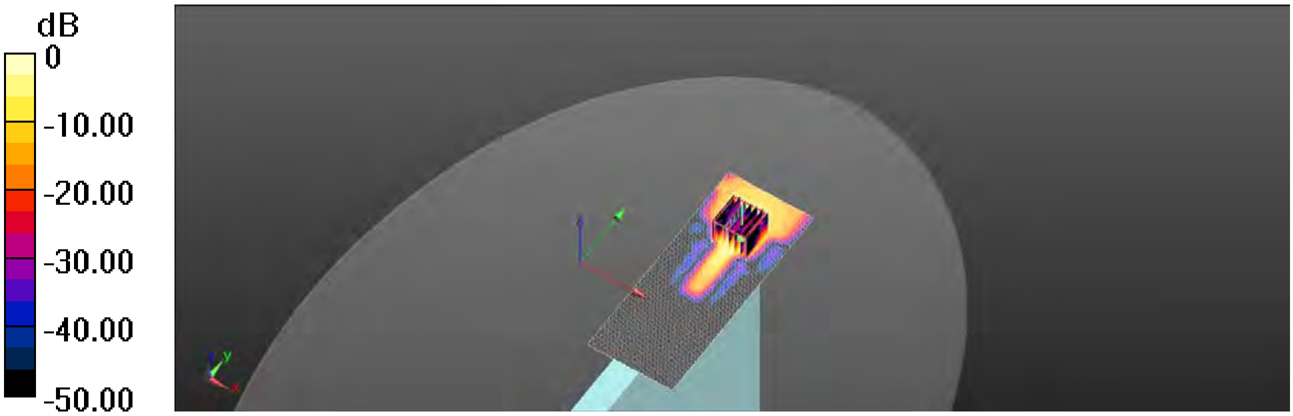
WLAN 802.11n(40M) 5.3G_Body_Top side_CH 62_Main_0mm
Communication System: WLAN 5G; Frequency: 5310 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5310 MHz; σ = 5.252 S/m; ε_r = 48.766; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 22.2°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (61x151x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.09 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.441 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 2.90 W/kg
SAR(1 g) = 0.471 W/kg; SAR(10 g) = 0.130 W/kg
Maximum value of SAR (measured) = 1.17 W/kg



0 dB = 1.17 W/kg = 0.68 dBW/kg

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Date: 2017/7/22

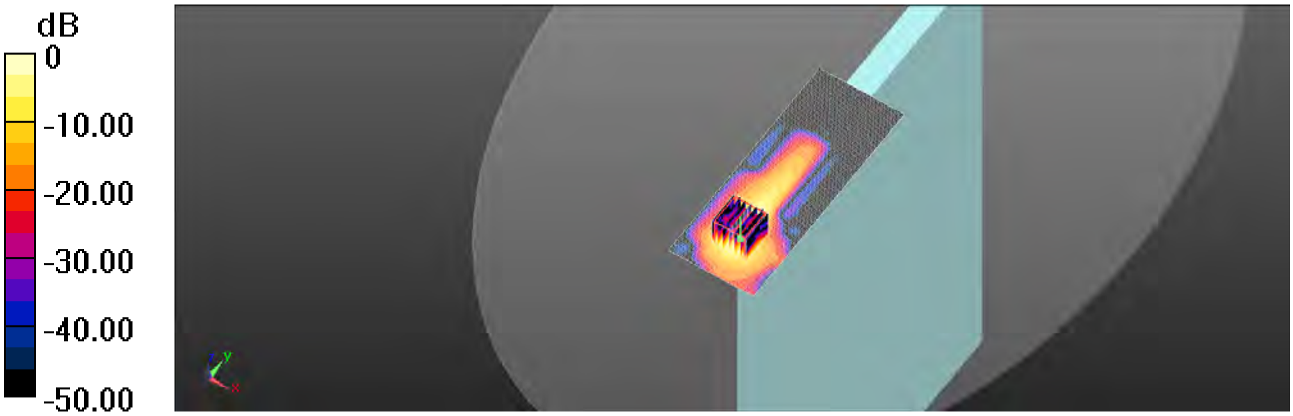
WLAN 802.11ac(80M) 5.6G_Body_Right side_CH 106_Main_0mm
Communication System: WLAN 5G; Frequency: 5530 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5530 MHz; σ = 5.596 S/m; ε_r = 48.093; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.7°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(3.98, 3.98, 3.98); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (61x161x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 2.75 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 1.173 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 6.37 W/kg
SAR(1 g) = 1.04 W/kg; SAR(10 g) = 0.250 W/kg
Maximum value of SAR (measured) = 2.56 W/kg



0 dB = 2.56 W/kg = 4.08 dBW/kg

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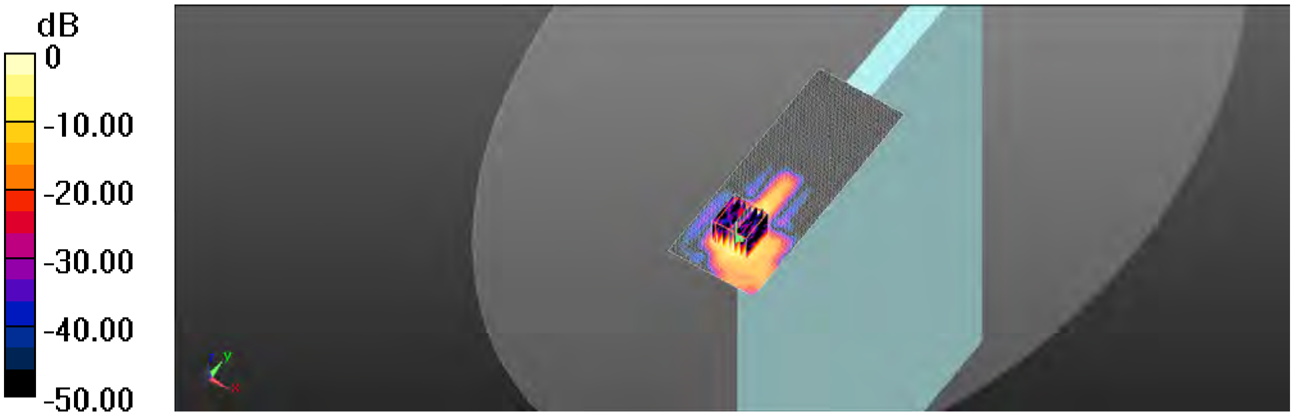
Date: 2017/7/17

WLAN 802.11n(40M) 5.8G_Body_Right side_CH 159_Main_0mm
Communication System: WLAN 5G; Frequency: 5795 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5795 MHz; σ = 6.051 S/m; ε_r = 47.247; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.8°C; Liquid temperature: 22.0°C

DASY5 Configuration:
- Probe: EX3DV4 - SN3770; ConvF(4.38, 4.38, 4.38); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (61x161x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.53 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.091 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 4.07 W/kg
SAR(1 g) = 0.528 W/kg; SAR(10 g) = 0.107 W/kg
Maximum value of SAR (measured) = 1.51 W/kg



0 dB = 1.51 W/kg = 1.79 dBW/kg

Date: 2017/7/18

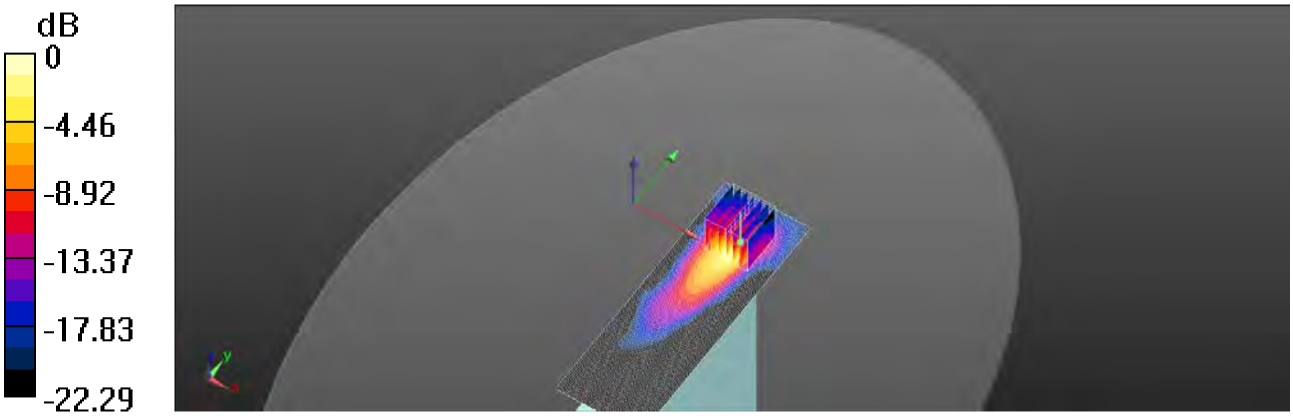
WLAN 802.11b_Body_Left side_CH 6_Aux_0mm
Communication System: WLAN 2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 1.971 S/m; ε_r = 53.863; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.9°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(7.47, 7.47, 7.47); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (51x151x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 0.648 W/kg

Configuration/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.886 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 1.06 W/kg
SAR(1 g) = 0.427 W/kg; SAR(10 g) = 0.184 W/kg
Maximum value of SAR (measured) = 0.699 W/kg



0 dB = 0.699 W/kg = -1.56 dBW/kg

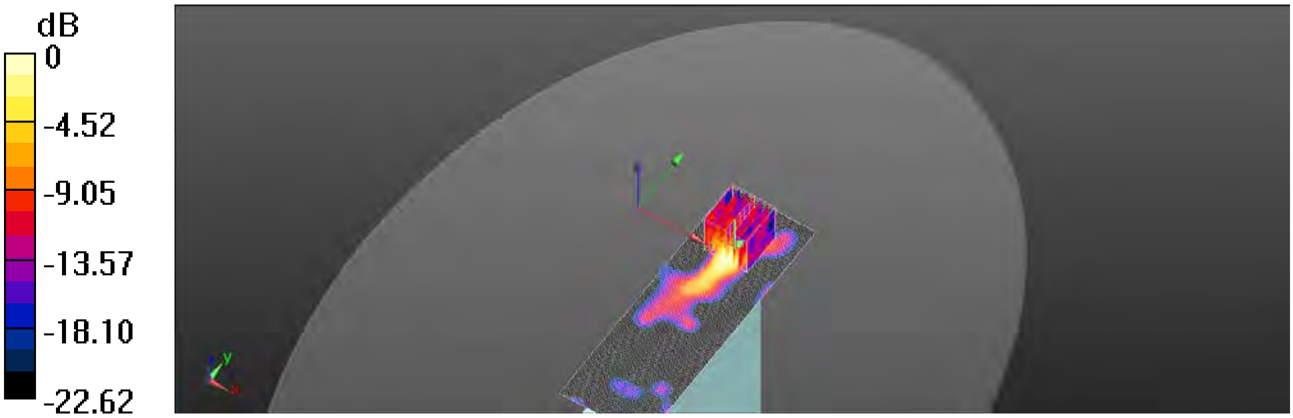
Date: 2017/7/18

Bluetooth (GFSK)_Body_Left side_CH 39_Aux_0mm
Communication System: Bluetooth; Frequency: 2441 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2441 MHz; σ = 1.978 S/m; ε_r = 53.827; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.9°C; Liquid temperature: 22.1°C

DASY5 Configuration:
- Probe: EX3DV4 - SN3770; ConvF(7.47, 7.47, 7.47); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (51x151x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 0.0746 W/kg

Configuration/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.574 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.0860 W/kg
SAR(1 g) = 0.036 W/kg; SAR(10 g) = 0.016 W/kg
Maximum value of SAR (measured) = 0.0584 W/kg



0 dB = 0.0584 W/kg = -12.34 dBW/kg

Date: 2017/7/20

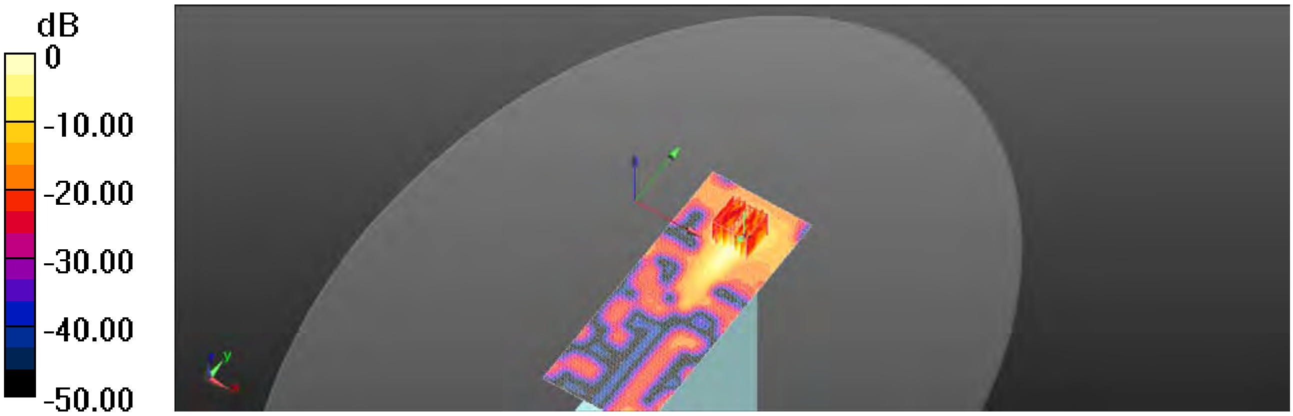
WLAN 802.11n(40M) 5.2G_Body_Left side_CH 46_Aux_0mm
Communication System: WLAN 5G; Frequency: 5230 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5230 MHz; σ = 5.137 S/m; ε_r = 49.012; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (71x181x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.32 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.743 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 3.51 W/kg
SAR(1 g) = 0.568 W/kg; SAR(10 g) = 0.142 W/kg
Maximum value of SAR (measured) = 1.36 W/kg



0 dB = 1.36 W/kg = 1.34 dBW/kg

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Date: 2017/7/22

WLAN 802.11n(40M) 5.3G_Body_Left side_CH 54_Aux_0mm

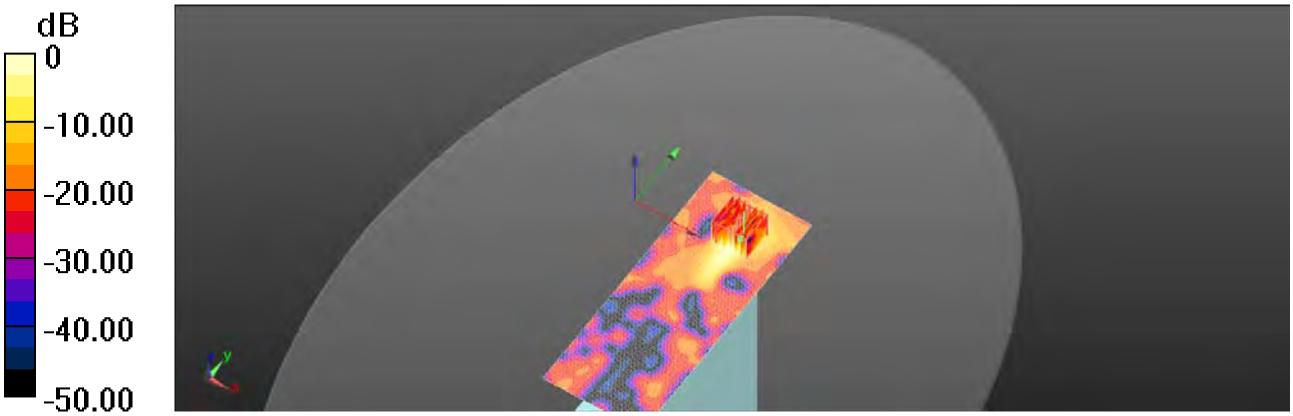
Communication System: WLAN 5G; Frequency: 5270 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5270 MHz; σ = 5.207 S/m; ε_r = 48.894; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 22.2°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (71x181x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.46 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.684 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 3.81 W/kg
SAR(1 g) = 0.622 W/kg; SAR(10 g) = 0.152 W/kg
Maximum value of SAR (measured) = 1.47 W/kg



0 dB = 1.47 W/kg = 1.67 dBW/kg

Date: 2017/7/22

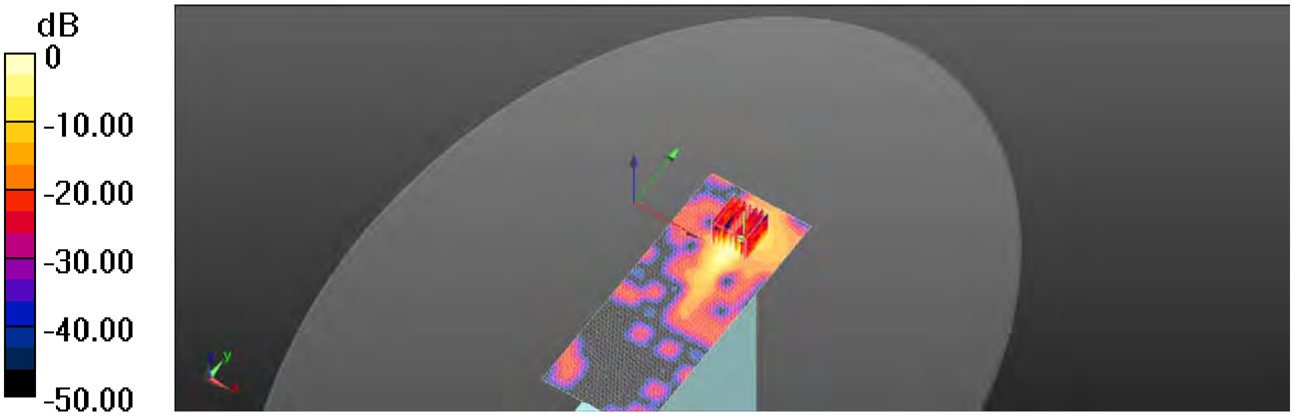
WLAN 802.11ac(80M) 5.6G_Body_Left side_CH 122_Aux_0mm
Communication System: WLAN 5G; Frequency: 5610 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5610 MHz; σ = 5.739 S/m; ε_r = 47.842; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.7°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(3.98, 3.98, 3.98); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (71x181x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 2.71 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.649 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 7.37 W/kg
SAR(1 g) = 1.09 W/kg; SAR(10 g) = 0.252 W/kg
Maximum value of SAR (measured) = 2.86 W/kg



0 dB = 2.86 W/kg = 4.56 dBW/kg

Date: 2017/7/17

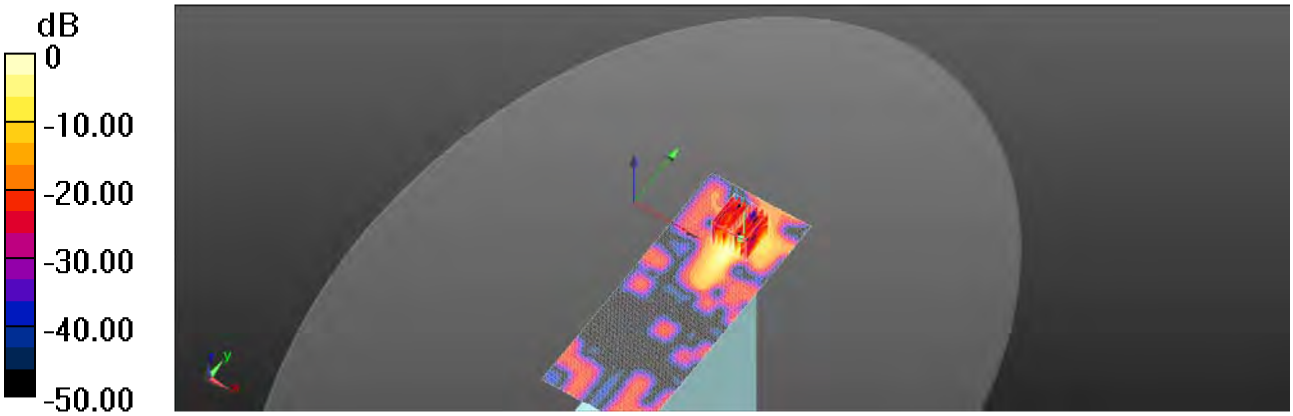
WLAN 802.11n(40M) 5.8G_Body_Left side_CH 159_Aux_0mm
Communication System: WLAN 5G; Frequency: 5795 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5795 MHz; σ = 6.051 S/m; ε_r = 47.247; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.8°C; Liquid temperature: 22.0°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.38, 4.38, 4.38); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Body/Area Scan (71x181x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.86 W/kg

Configuration/Body/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.337 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 5.06 W/kg
SAR(1 g) = 0.719 W/kg; SAR(10 g) = 0.160 W/kg
Maximum value of SAR (measured) = 1.88 W/kg



0 dB = 1.88 W/kg = 2.74 dBW/kg

6. SAR System Performance Verification

Date: 2017/7/18

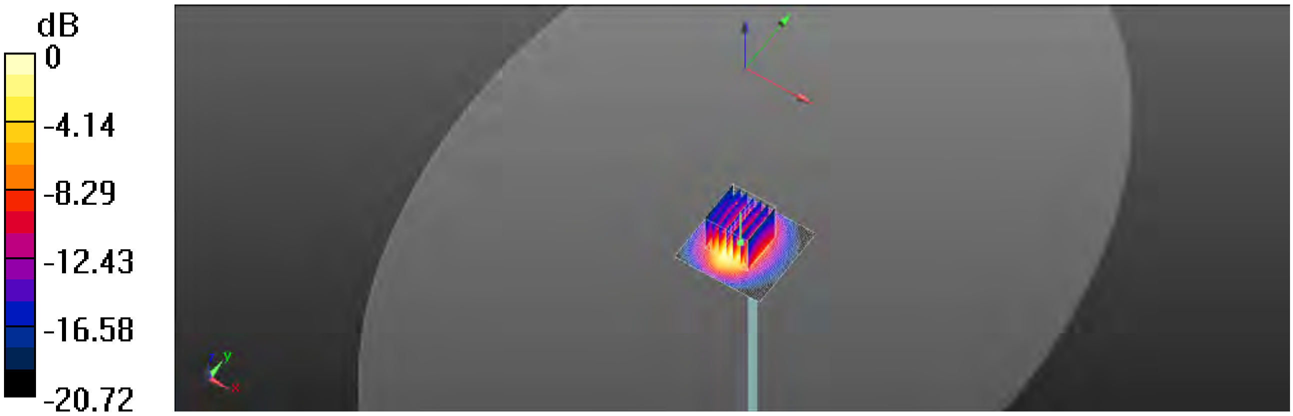
Dipole 2450 MHz_SN:727
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.992 S/m; ε_r = 53.85; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.9°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(7.47, 7.47, 7.47); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Pin=250mW/Area Scan (51x51x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 20.6 W/kg

Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.57 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 26.0 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.07 W/kg
Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg

Date: 2017/7/20

Dipole 5200 MHz_SN:1023

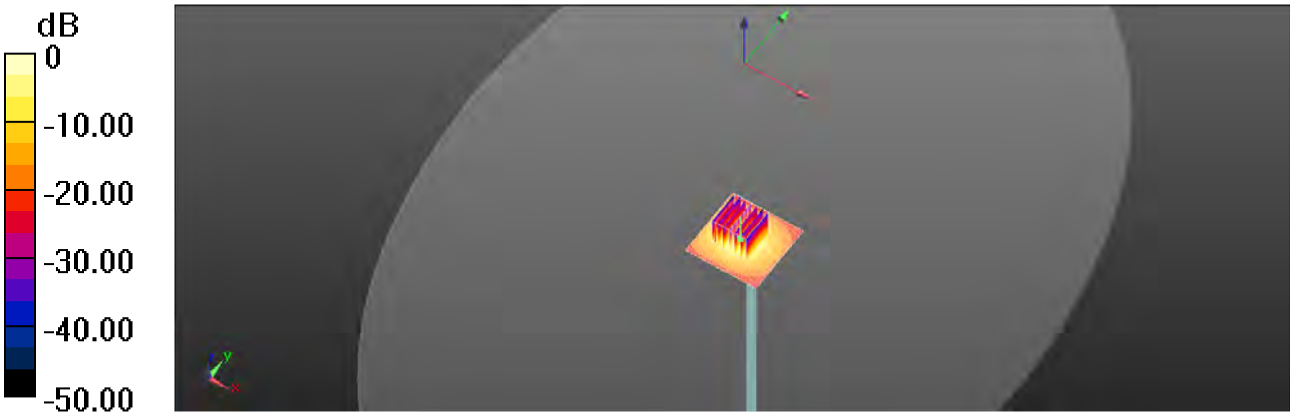
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.092 S/m; ε_r = 49.135; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Pin=100mW/Area Scan (51x51x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 15.6 W/kg

Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 56.33 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 31.5 W/kg
SAR(1 g) = 7.39 W/kg; SAR(10 g) = 2.06 W/kg
Maximum value of SAR (measured) = 15.8 W/kg



0 dB = 15.8 W/kg = 11.99 dBW/kg

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Date: 2017/7/22

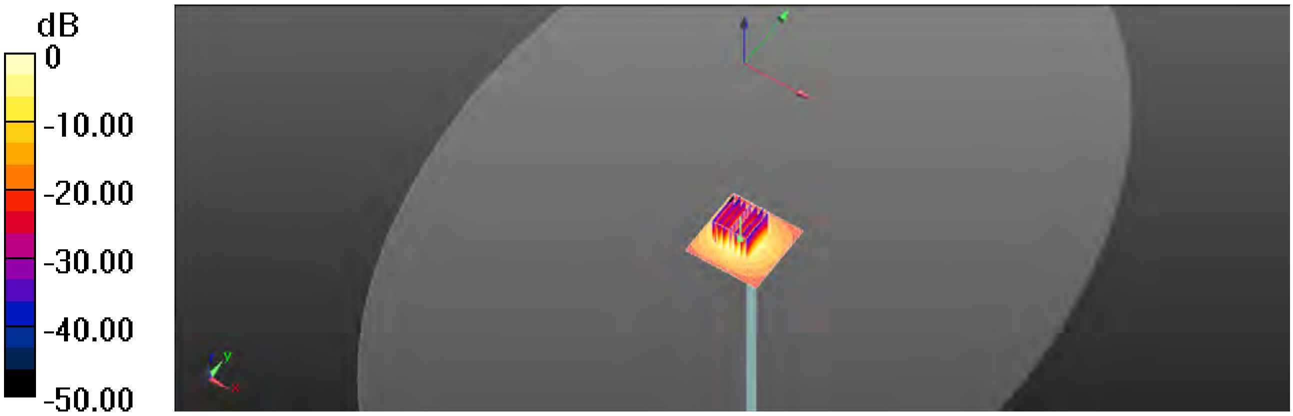
Dipole 5300 MHz_SN:1023
Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5300 MHz; σ = 5.246 S/m; ε_r = 48.83; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.2°C; Liquid temperature: 22.0°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.61, 4.61, 4.61); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Pin=100mW/Area Scan (51x51x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 16.1 W/kg

Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 56.31 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.09 W/kg
Maximum value of SAR (measured) = 16.3 W/kg



0 dB = 16.3 W/kg = 12.12 dBW/kg

Date: 2017/7/22

Dipole 5600 MHz_SN:1023

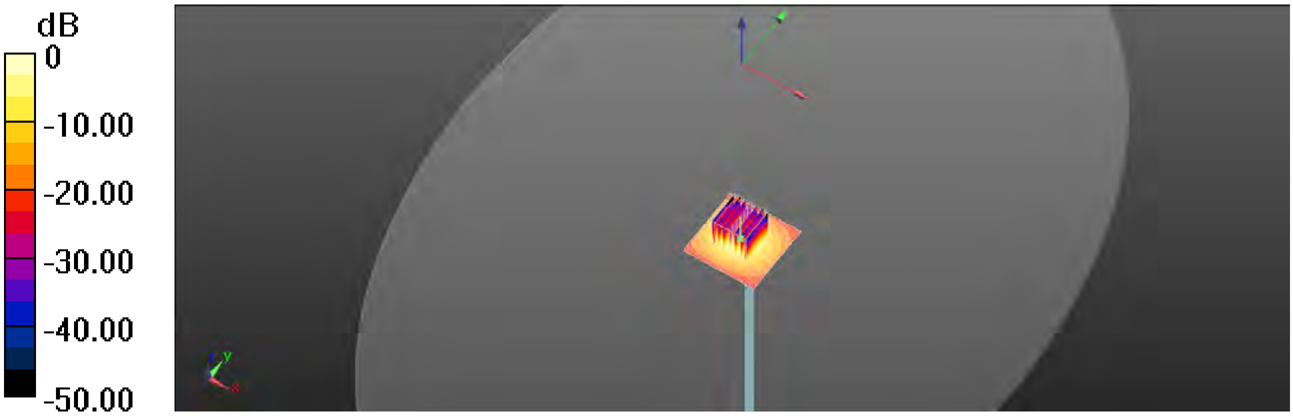
Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5600 MHz; σ = 5.73 S/m; ε_r = 47.891; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.7°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(3.98, 3.98, 3.98); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Pin=100mW/Area Scan (51x51x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 17.8 W/kg

Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 58.80 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 36.7 W/kg
SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.24 W/kg
Maximum value of SAR (measured) = 17.6 W/kg



0 dB = 17.6 W/kg = 12.46 dBW/kg

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Date: 2017/7/17

Dipole 5800 MHz_SN:1023

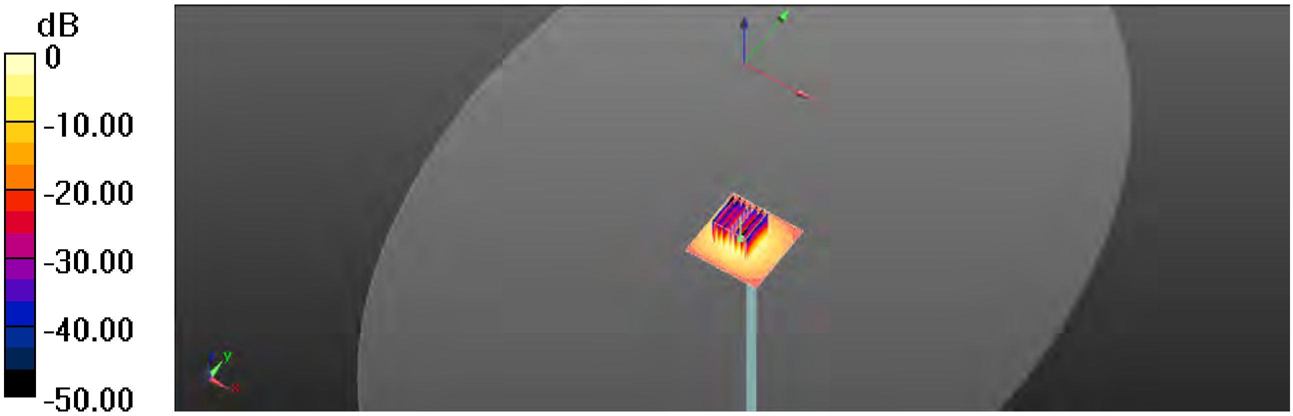
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.052 S/m; ε_r = 47.259; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.8°C; Liquid temperature: 22.0°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3770; ConvF(4.38, 4.38, 4.38); Calibrated: 2017/4/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2017/4/28
- Phantom: Body
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Pin=100mW/Area Scan (51x51x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 16.0 W/kg

Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 53.80 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 7.35 W/kg; SAR(10 g) = 2.04 W/kg
Maximum value of SAR (measured) = 15.7 W/kg



0 dB = 15.7 W/kg = 11.96 dBW/kg

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7. DAE & Probe Calibration Certificate

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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Client SGS - TW (Auden)

Certificate No: DAE4-856_Apr17

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 856

Calibration procedure(s): QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: April 28, 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
Keithley Multimeter Type 2001	SN: 0810278	09-Sep-16 (No:19065)	Sep-17
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Technician	A. Gehr
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V. [signature]

Issued: April 28, 2017

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

Certificate No: DAE4-856_Apr17 Page 1 of 5

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Accreditation No.: SCS 0108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.433 ± 0.02% (k=2)	404.548 ± 0.02% (k=2)	403.875 ± 0.02% (k=2)
Low Range	3.97691 ± 1.50% (k=2)	3.97761 ± 1.50% (k=2)	3.97820 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	265.0 ° ± 1 °

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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199990.20	-3.22	-0.00
Channel X	+ Input	19998.56	-2.48	-0.01
Channel X	- Input	-20000.93	0.14	-0.00
Channel Y	+ Input	199991.93	-1.72	-0.00
Channel Y	+ Input	19997.38	-3.74	-0.02
Channel Y	- Input	-20002.46	-1.42	0.01
Channel Z	+ Input	199994.32	0.88	0.00
Channel Z	+ Input	19998.13	-2.80	-0.01
Channel Z	- Input	-20002.06	-0.83	0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.92	0.26	0.01
Channel X	+ Input	201.31	0.06	0.03
Channel X	- Input	-198.68	0.02	-0.01
Channel Y	+ Input	2000.75	-0.08	-0.00
Channel Y	+ Input	200.81	-0.45	-0.22
Channel Y	- Input	-199.12	-0.55	0.28
Channel Z	+ Input	2001.03	0.18	0.01
Channel Z	+ Input	200.28	-0.96	-0.47
Channel Z	- Input	-199.73	-1.15	0.58

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-15.65	-16.66
	- 200	17.23	15.98
Channel Y	200	-1.72	-2.19
	- 200	0.71	0.50
Channel Z	200	10.75	10.48
	- 200	-13.09	-13.42

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	2.87	-2.63
Channel Y	200	7.31	-	2.81
Channel Z	200	8.33	5.08	-

Certificate No: DAE4-656_Apr17 Page 4 of 5

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16228	16854
Channel Y	15953	17971
Channel Z	15877	17010

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.28	-0.37	1.30	0.27
Channel Y	0.02	-1.04	0.89	0.39
Channel Z	-1.00	-1.74	0.18	0.38

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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Accreditation No.: **SCS 0108**

Client **SGS-TW (Auden)**

Certificate No: **EX3-3770_Apr17**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3770
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date	April 27, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-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	Claudio Leubler	Laboratory Technician	
Approved by	Katja Pokovic	Technical Manager	

Issued: May 1, 2017

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

Certificate No: EX3-3770_Apr17 Page 1 of 11

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

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

Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
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"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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Probe EX3DV4

SN:3770

Manufactured: July 6, 2010
Calibrated: April 27, 2017

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3770

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.30	0.59	0.39	± 10.1 %
DCP (mV)[B]	105.5	99.9	100.3	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	194.4	±2.7 %
		Y	0.0	0.0	1.0		177.5	
		Z	0.0	0.0	1.0		188.0	

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%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3770

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	43.5	0.87	11.41	11.41	11.41	0.14	1.20	± 13.3 %
750	41.9	0.89	10.17	10.17	10.17	0.51	0.80	± 12.0 %
835	41.5	0.90	9.71	9.71	9.71	0.38	0.90	± 12.0 %
900	41.5	0.97	9.52	9.52	9.52	0.42	0.84	± 12.0 %
1750	40.1	1.37	8.49	8.49	8.49	0.36	0.84	± 12.0 %
1900	40.0	1.40	8.08	8.08	8.08	0.42	0.80	± 12.0 %
2000	40.0	1.40	8.13	8.13	8.13	0.41	0.80	± 12.0 %
2300	39.5	1.67	7.90	7.90	7.90	0.37	0.84	± 12.0 %
2450	39.2	1.80	7.46	7.46	7.46	0.43	0.80	± 12.0 %
2600	39.0	1.96	7.18	7.18	7.18	0.32	0.96	± 12.0 %
5250	35.9	4.71	5.37	5.37	5.37	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.88	4.88	4.88	0.40	1.80	± 13.1 %
5750	35.4	5.22	5.25	5.25	5.25	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3770

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	56.7	0.94	10.64	10.64	10.64	0.09	1.20	± 13.3 %
750	55.6	0.96	9.96	9.96	9.96	0.52	0.80	± 12.0 %
835	55.2	0.97	9.65	9.65	9.65	0.39	0.91	± 12.0 %
900	55.0	1.05	9.59	9.59	9.59	0.39	0.90	± 12.0 %
1750	53.4	1.49	8.43	8.43	8.43	0.41	0.80	± 12.0 %
1900	53.3	1.52	8.12	8.12	8.12	0.23	1.12	± 12.0 %
2000	53.3	1.52	8.00	8.00	8.00	0.43	0.80	± 12.0 %
2300	52.9	1.81	7.68	7.68	7.68	0.37	0.80	± 12.0 %
2450	52.7	1.95	7.47	7.47	7.47	0.35	0.86	± 12.0 %
2600	52.5	2.16	7.17	7.17	7.17	0.28	0.99	± 12.0 %
5250	48.9	5.36	4.61	4.61	4.61	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.98	3.98	3.98	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.38	4.38	4.38	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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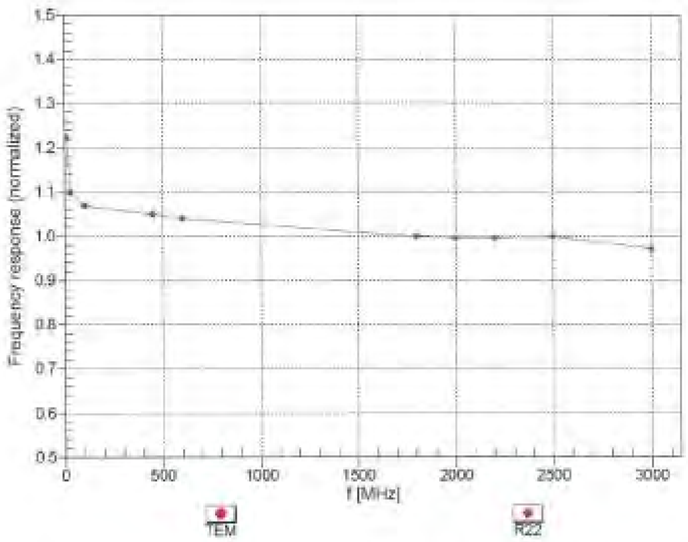
EX3DV4– SN:3770 April 27, 2017

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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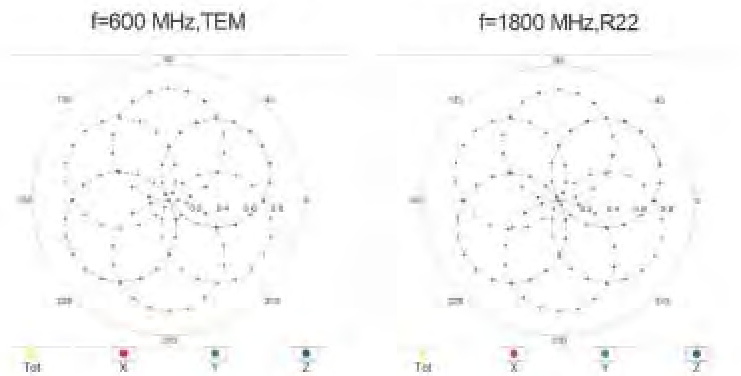
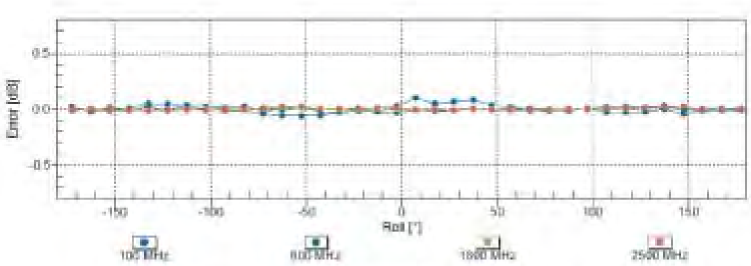
Receiving Pattern (ϕ), ϑ = 0°





Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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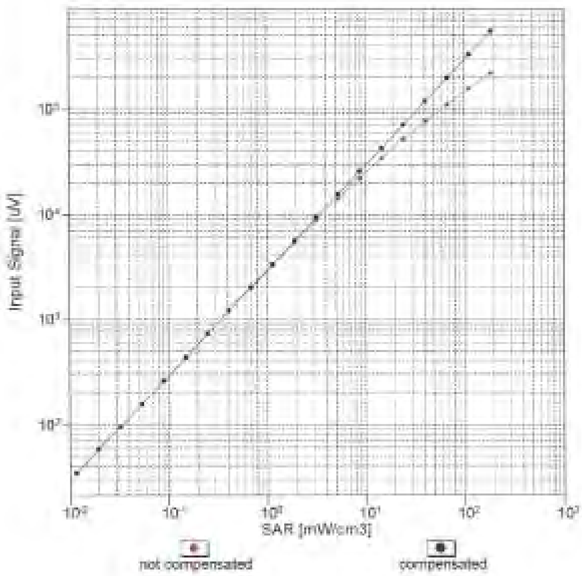
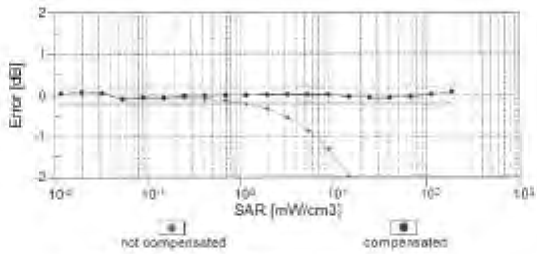
Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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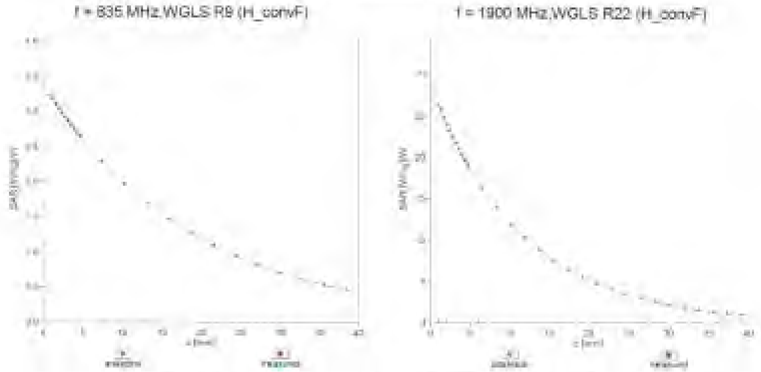
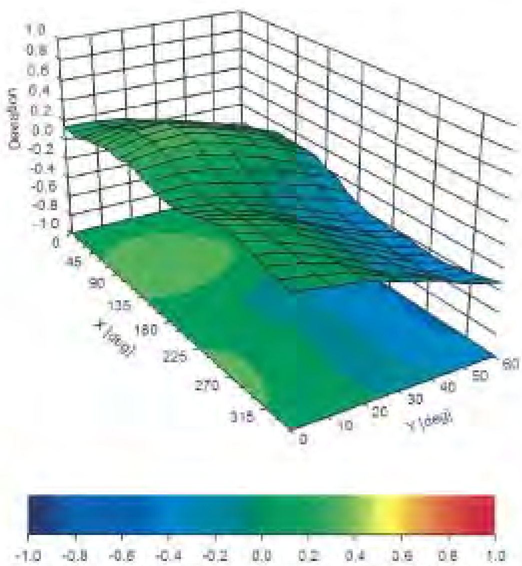
EX3DV4– SN:3770 April 27, 2017

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3770

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-32.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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8. Uncertainty Budget

Measurement Uncertainty evaluation template for DUT SAR test (3-6G)

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	∞
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	∞
Isotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	√3	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.00%	N	1	1	0.64	0.43	1.28%	0.86%	M
Liquid Conductivity (mea.)	4.15%	N	1	1	0.6	0.49	2.49%	2.03%	M
Liquid conductivity σ – temperature uncertainty	2.60%	R	√3	1.732	0.78	0.71	1.17%	1.07%	∞
Liquid permittivity ε – temperature uncertainty	1.80%	R	√3	1.732	0.23	0.26	0.24%	0.27%	∞
Combined standard uncertainty		RSS					12.05%	11.91%	
Expant uncertainty (95% confidence interval), K=2							24.09%	23.83%	

Measurement Uncertainty evaluation template for DUT SAR test (0.3-3G)

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.00%	N	1	1	1	1	6.00%	6.00%	∞
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	∞
Isotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	√3	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.29%	N	1	1	0.64	0.43	1.47%	0.98%	M
Liquid Conductivity (mea.)	2.15%	N	1	1	0.6	0.49	1.29%	1.05%	M
Liquid conductivity σ – temperature uncertainty	2.60%	R	√3	1.732	0.78	0.71	1.17%	1.07%	∞
Liquid permittivity ε – temperature uncertainty	1.80%	R	√3	1.732	0.23	0.26	0.24%	0.27%	∞
Combined standard uncertainty		RSS					11.58%	11.50%	
Expant uncertainty (95% confidence interval), K=2							23.17%	23.00%	

9. Phantom Description

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 5.0
Type No	QD OVA 002 A
Series No	1108 and higher
Manufacturer	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests
Complete tests were made on the prototype units QD OVA 001 A, pre-series units QD OVA 001 B as well as on some series units QD OVA 001 B. Some tests are made on all series units QD OVA 002 A.

Test	Requirement	Details	Units tested
Shape	Internal dimensions, depth and sagging are compatible with standards	Bottom elliptical 600 x 400 mm, Depth 190 mm, dimension compliant with [1] for f > 375 MHz	Prototypes
Material thickness	Bottom: 2.0mm +/- 0.2mm	dimension compliant with [3] for f > 800 MHz	all
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05, at f ≤ 6 GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids .	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	within tolerance for filling height up to 155 mm	Prototypes, samples

** Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

[1] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
[2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
[3] IEC 62209–1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", 2005-02-18
[4] IEC 62209–2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 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)", 2010-03-30

Conformity
Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of body-worn SAR measurements and system performance checks as specified in [1 – 4] and further standards.

Date 25.7.2011

Signature / Stamp

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Doc No 881 – QD OVA 002 A - A Page 1 (1)

10. System Validation from Original Equipment Supplier

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

ilac-MRA

S Schweizerischer Kalibrierdienst
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S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client SGS -TW (Auden)

Certificate No: D2450V2-727_Apr17

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 727
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	April 21, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	[signature]
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: April 21, 2017

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

Certificate No: D2450V2-727_Apr17 Page 1 of 8

Calibration Laboratory of
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S Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
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%.

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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	37.7 ± 6 %	1.87 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	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.3 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	52.5 ± 6 %	2.03 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	**50.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.01 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.8 W/kg ± 16.5 % (k=2)**

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.3 Ω + 2.1 jΩ
Return Loss	- 24.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.1 Ω + 4.1 jΩ
Return Loss	- 27.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 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

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DASY5 Validation Report for Head TSL

Date: 21.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

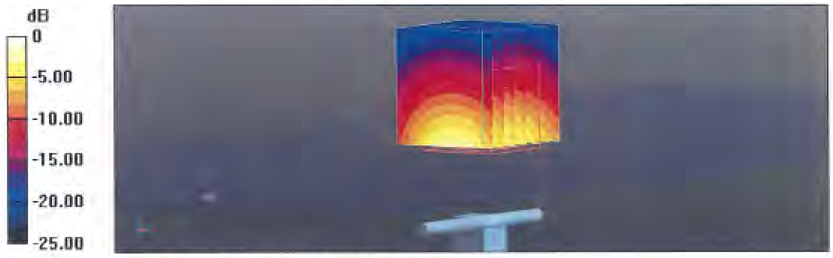
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ε_r = 37.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

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

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 109.8 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 27.3 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.18 W/kg
Maximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg = 13.24 dBW/kg

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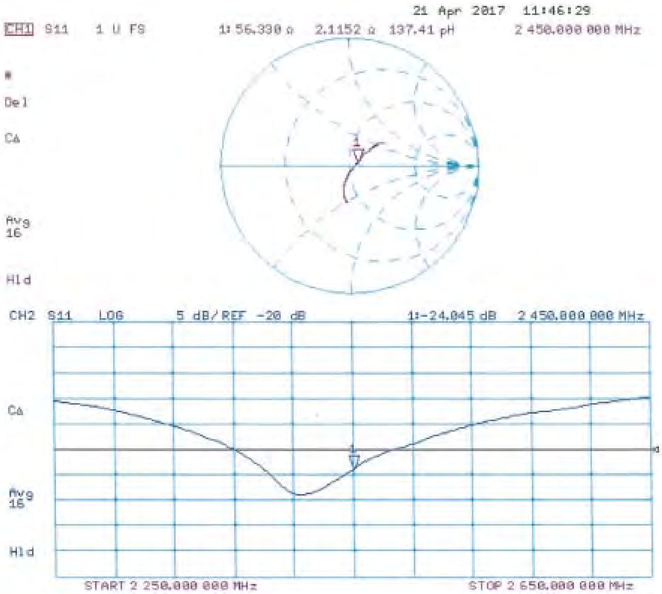
Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 21.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

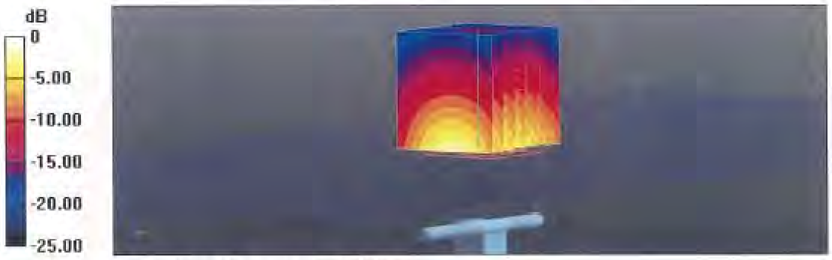
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.03 S/m; ε_r = 52.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

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

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.0 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 25.4 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.01 W/kg
Maximum value of SAR (measured) = 20.0 W/kg



0 dB = 20.0 W/kg = 13.01 dBW/kg

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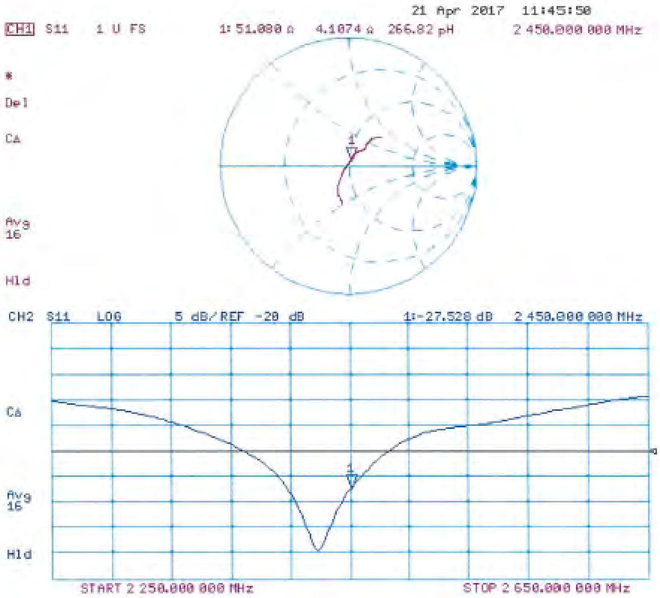
Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-727_Apr17 Page 8 of 8

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Accreditation No.: **SCS 0108**

Client **SGS-TW (Auden)**

Certificate No: **D5GHzV2-1023_Jan17**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1023
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	January 20, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 3503	31-Dec-16 (No. EX3-3503_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

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

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

Issued: January 24, 2017

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

Certificate No: D5GHzV2-1023_Jan17 Page 1 of 15

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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 62209-2, "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
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 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	35.4 ± 6 %	4.45 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	7.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**75.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.5 W/kg ± 19.5 % (k=2)**

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Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	4.55 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	8.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.8 W / kg ± 19.9 % (k=2)**

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

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	4.85 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	8.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

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Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	5.05 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	7.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**77.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.0 W/kg ± 19.5 % (k=2)**

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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 %	5.36 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	7.32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**72.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.3 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 %	5.50 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	7.66 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 19.5 % (k=2)**

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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	46.6 ± 6 %	5.90 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	——	——

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.4 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	46.3 ± 6 %	6.17 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	——	——

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.64 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.1 W/kg ± 19.5 % (k=2)**

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.6 Ω - 6.7 jΩ
Return Loss	- 23.4 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	49.0 Ω - 1.8 jΩ
Return Loss	- 33.5 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.1 Ω - 0.2 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.4 Ω + 2.8 jΩ
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	48.9 Ω - 7.0 jΩ
Return Loss	- 22.9 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	51.0 Ω - 1.0 jΩ
Return Loss	- 37.0 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	55.6 Ω + 1.5 jΩ
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.6 Ω + 2.7 jΩ
Return Loss	- 23.6 dB

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General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 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	February 05, 2004

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DASY5 Validation Report for Head TSL

Date: 20.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1023

Communication System: UID 0 - CW;
Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.45 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.55 S/m; ε_r = 35.2; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.85 S/m; ε_r = 34.7; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.05 S/m; ε_r = 34.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.76, 5.76, 5.76); Calibrated: 31.12.2016, ConvF(5.35, 5.35, 5.35); Calibrated: 31.12.2016, ConvF(5.09, 5.09, 5.09); Calibrated: 31.12.2016, ConvF(5.01, 5.01, 5.01); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 70.58 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 27.6 W/kg
SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.16 W/kg
Maximum value of SAR (measured) = 17.4 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 = 73.01 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 31.6 W/kg
SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.35 W/kg
Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.94 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 33.2 W/kg
SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.33 W/kg
Maximum value of SAR (measured) = 19.8 W/kg

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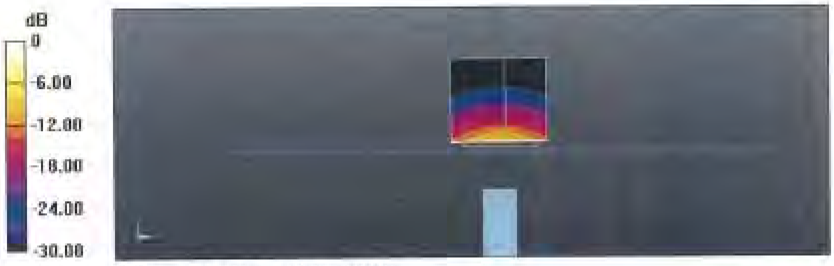
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 69.84 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 32.7 W/kg
SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.22 W/kg
Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg

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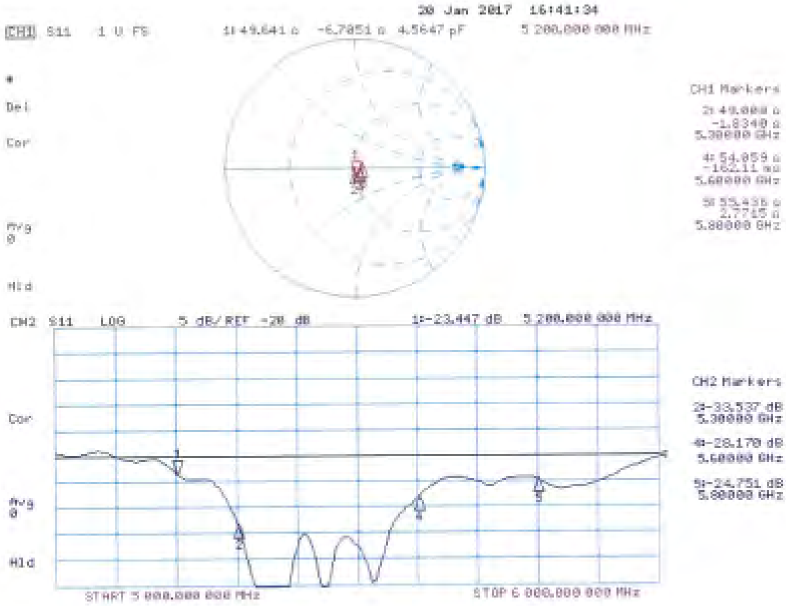
Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 19.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1023

Communication System: UID 0 - CW;
Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.36 S/m; ε_r = 47.5; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 5.5 S/m; ε_r = 47.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.9 S/m; ε_r = 46.6; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.17 S/m; ε_r = 46.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.29, 5.29, 5.29); Calibrated: 31.12.2016, ConvF(5.04, 5.04, 5.04); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 31.12.2016, ConvF(4.48, 4.48, 4.48); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.54 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 28.1 W/kg
SAR(1 g) = 7.32 W/kg; SAR(10 g) = 2.05 W/kg
Maximum value of SAR (measured) = 16.6 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 = 66.93 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 30.1 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 17.6 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 = 67.09 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 33.7 W/kg
SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 18.9 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 = 65.14 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 34.0 W/kg
SAR(1 g) = 7.64 W/kg; SAR(10 g) = 2.13 W/kg
Maximum value of SAR (measured) = 18.3 W/kg

0 dB = 16.6 W/kg = 12.20 dBW/kg

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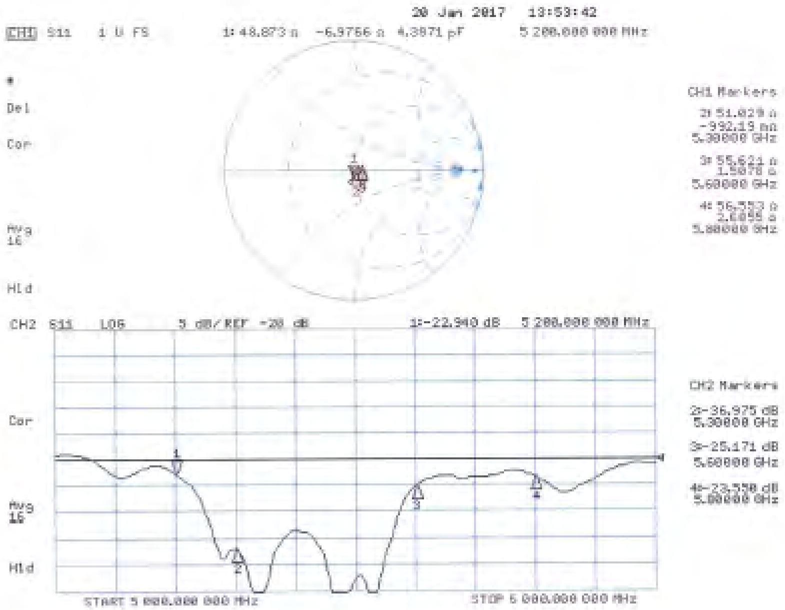
Impedance Measurement Plot for Body TSL



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- End of 1st part of report -