

# SAR TEST REPORT



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

Product Name	Notebook Computer
Marketing Name	SF515-51T, SF515-51TP, SF515-51
Brand Name	acer
Model No.	N18P2
Prepared for	Acer Incorporated
Company Address	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	HLZ9560D2W
Date of Receipt	Sep. 10, 2018
Date of Test(s)	Oct. 02, 2018 ~ Oct. 08, 2018
Date of Issue	Oct. 12, 2018
In the configuration tested, the E	UT 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.

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#### Signed on behalf of SGS

Clerk / Ruby Ou	Engineer / Bond Tsai	Asst. Manager / John Yeh		
Kuby Ou	Bonditsai	John Teh		
		Date: Oct. 12. 2018		

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Report No. : E5/2018/90005 Page: 2 of 105

# **Revision History**

Report Number	Revision	Description	Issue Date
E5/2018/90005	Rev.00	Initial creation of document	Oct. 12, 2018

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# 1. General Information

# 1.1 Testing Laboratory

SGS Taiwan Ltd. Electronics & Communication Laboratory				
No. 2, Keji 1st Rd., Guishan Township, Taoyuan County, 33383, Taiwan				
Tel	+886-2-2299-3279			
Fax	+886-2-2298-0488			
Internet	http://www.tw.sgs.com/			

# **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)

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# **1.3 Description of EUT**

General Information of Host:						
Equipment Under Test	Notebook Computer					
Marketing Name	SF515-51T, SF515-51TP, SF515-51					
Brand Name	acer					
Model No.	N18P2					
FCC ID	HLZ9560D2W					
Mode of Operation	WLAN802.11 a/b/g/n(20M/40M)/ac(	20M/40	)M/80/	′160M)		
Duty Cycle	WLAN802.11 a/b/g/n(20M/40M)/ ac(20M/40M/80M/160M)		1			
	Bluetooth		1			
	WLAN802.11 b/g/n(20M)	2412	_	2472		
	WLAN802.11 n(40M)	2422	_	2462		
	WLAN802.11 a/n(20M)/ac(20M) 5.2G	5180	—	5240		
	WLAN802.11 n(40M)/ac(40M) 5.2G	5190	_	5230		
	WLAN802.11 ac(80M) 5.2G	5210				
	WLAN802.11 ac(160M) 5.2G	5250				
TX Frequency Range	WLAN802.11 a/n(20M)/ac(20M) 5.3G		_	5320		
(MHz)	WLAN802.11 n(40M)/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		
	WLAN802.11 ac(160M) 5.6G		5670			
	WLAN802.11 a/n(20M)/ac(20M) 5.8G		_	5825		
	WLAN802.11 n(40M)/ac(40M) 5.8G	5710	_	5795		
TX Frequency Range (MHz)	WLAN802.11 ac(80M) 5.8G		5775			
	Bluetooth 2402 -			2480		

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	WLAN802.11 b/g/n(20M)	1	_	13
		3	_	
	WLAN802.11 n(40M)		—	11
	WLAN802.11 a/n(20M)/ac(20M) 5.2G	36	—	48
	WLAN802.11 n(40M)/ac(40M) 5.2G	38	—	46
	WLAN802.11 ac(80M) 5.2G		42	
	WLAN802.11 ac(160M) 5.2G		50	
	WLAN802.11 a/n(20M)/ac(20M) 5.3G	52	_	64
	WLAN802.11 n(40M)/ac(40M) 5.3G	54	_	62
Channel Number (ARFCN)	WLAN802.11 ac(80M) 5.3G		58	
	WLAN802.11 a/n/ac(20M) 5.6G		_	144
	WLAN802.11 n/ac(40M) 5.6G	102	_	142
	WLAN802.11 ac(80M) 5.6G	106	_	138
	WLAN802.11 ac(160M) 5.6G		114	
	WLAN802.11 a/n(20M)/ac(20M) 5.8G	149	_	165
	WLAN802.11 n(40M)/ac(40M) 5.8G	151	_	159
	WLAN802.11 ac(80M) 5.8G		155	
	Bluetooth	0	_	78

Vendor	WNC			WNC						
Antenna	Main (PIFA)			Aux (PIFA)						
Part Number	81EAAL15.GKV			81EAAL15.GKU						
Frequency	2.4G	5.2G	5.3G	5.6G	5.8G	2.4G	5.2G	5.3G	5.6G	5.8G
Gain (dBi)	-2.66					-1.57	-1.65	-2.73	-1.82	-1.86

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	Max. SAR (1g) (Unit: W/Kg)						
Antenna	Band	Measured	Reported	Channel	Position		
	WLAN802.11b	0.67	0.67	1	Bottom side		
	WLAN802.11 n(40M) 5.2G	0.77	0.78	46	Bottom side		
Main	WLAN802.11 a 5.3G	0.85	0.86	60	Bottom side		
Main	WLAN802.11 n(40M) 5.3G	0.85	0.86	54	Bottom side		
	WLAN802.11 n(40M) 5.6G	1.11	1.12	134	Bottom side		
	WLAN802.11 n(40M) 5.8G	0.79	0.80	151	Bottom side		
	WLAN802.11b	0.57	0.57	1	Bottom side		
	Bluetooth(GFSK)	0.10	0.16	78	Bottom side		
	WLAN802.11 a 5.2G	0.79	0.79	36	Bottom side		
Aux	WLAN802.11 n(40M) 5.2G	0.81	0.83	46	Bottom side		
Aux	WLAN802.11 a 5.3G	0.84	0.85	60	Bottom side		
	WLAN802.11 n(40M) 5.3G	0.89	0.89	54	Bottom side		
	WLAN802.11 n(40M) 5.6G	0.78	0.78	142	Bottom side		
	WLAN802.11 n(40M) 5.8G	0.79	0.79	151	Bottom side		

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WLAN802.11 a/b/g/n(20M/40M)/ac(20M/40M/80M/160M) conducted power
table:

Antenna	SI	MIMO	
Band	Chain 0	Chain 1	Chain0+1
WLAN802.11b	V	V	-
WLAN802.11g	V	V	-
WLAN802.11n(20M)	V	V	V
WLAN802.11n(40M)	V	V	V
WLAN802.11a	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
WLAN802.11ac(160M) 5G	V	V	V

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# SISO

# Main (Chain 0)

Main Antenna									
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		1	2412		19.00	18.99			
		6	2437		19.00	18.96			
	802.11b	11	2462	1Mbps	19.00	18.95			
		12	2467		18.00	17.93			
		13	2472		14.50	14.46			
		1	2412		18.00	17.97			
		6	2437		19.00	18.93			
	802.11g	10	2457	6Mbps	19.00	18.94			
		11	2462	olviops	16.00	15.97			
		12	2467	-	12.50	12.44			
		13	2472		-7.00	-7.12			
		1	2412		15.00	14.48			
2450 MHz		2	2417		17.00	16.92			
		6	2437		17.00	16.96			
	802.11n20-HT0	10	2457	MCS0	17.00	16.95			
		11	2462		14.50	14.45			
		12	2467		12.50	12.46			
		13	2472		-7.00	-7.09			
		3	2422		13.00	12.97			
		6	2437		13.00	12.95			
		7	2442		14.00	13.96			
	802.11n40-HT0	8	2447	MCS0	12.00	11.96			
		9	2452		11.00	10.92			
		10	2457		6.00	5.92			
		11	2462		1.00	0.88			

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	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		36	5180		18.50	18.47			
	802.11a	40	5200	6Mbps	18.50	18.45			
	002.11a	44	5220	0100003	18.50	18.41			
		48	5240		18.50	18.46			
	802.11n20-HT0	36	5180		16.00	15.98			
		40	5200	MCS0	18.50	18.44			
		44	5220		18.50	18.45			
		48	5240		18.50	18.46			
5.15-5.25 GHz		36	5180		16.00	15.96			
0.10-0.20 0112	802.11ac20-VHT0	40	5200	MCS0	18.50	18.43			
	002.118020-01110	44	5220	10000	18.50	18.41			
		48	5240		18.50	18.44			
	802.11n40-HT0	38	5190	MCS0	13.50	13.43			
	002.11140-1110	46	5230	NIC30	18.50	18.42			
	802.11ac40-VHT0	38	5190	MCS0	13.50	13.48			
	002.118040-01110	46	5230	10000	18.50	18.43			
	802.11ac80-VHT0	42	5210	MCS0	9.00	8.93			
	802.11ac160-VHT0	50	5250	MCS0	13.00	12.95			

Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)		
		52	5260		18.50	18.42		
	802.11a	56	5280	6Mbps	18.50	18.44		
	002.11a	60	5300	olviopa	18.50	18.45		
		64	5320		16.00	15.97		
	802.11n20-HT0	52	5260	MCS0	18.50	18.43		
		56	5280		18.50	18.42		
		60	5300		18.50	18.41		
		64	5320		16.00	15.96		
5.25-5.35 GHz		52	5260		18.50	18.48		
	802.11ac20-VHT0	56	5280	MCS0	18.50	18.38		
	002.118020-01110	60	5300	10000	18.50	18.43		
		64	5320		16.00	15.94		
	802.11n40-HT0	54	5270	MCS0	18.50	18.47		
	002.11140-1110	62	5310	WC30	14.00	13.90		
	802.11ac40-VHT0	54	5270	MCS0	18.50	18.41		
		62	5310	10050	14.00	13.98		
	802.11ac80-VHT0	58	5290	MCS0	11.50	11.46		

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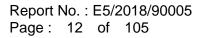


	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		100	5500		18.50	18.42			
		116	5580		18.50	18.48			
	802.11a	120	5600	6Mbpo	18.50	18.47			
	002.11a	124	5620	6Mbps	18.50	18.42			
		128	5640		18.50	18.44			
		140	5700		18.50	18.43			
		100	5500		16.00	15.59			
		116	5580		18.50	18.45			
	000 44+00 UT0	120	5600	MOOO	18.50	18.41			
	802.11n20-HT0	124	5620	MCS0	18.50	18.46			
		128	5640		18.50	18.43			
		140	5700		18.50	18.44			
		100	5500		16.00	15.97			
		116	5580		18.50	18.47			
	000 44 00 \// 170	120	5600	M000	18.50	18.44			
	802.11ac20-VHT0	124	5620	MCS0	18.50	18.37			
		128	5640		18.50	18.41			
5600 MHz		140	5700		18.50	18.39			
		102	5510		13.50	13.47			
		110	5550		17.00	16.93			
	000 44m 40 LITO	118	5590	MCCO	17.00	16.88			
	802.11n40-HT0	126	5630	MCS0	17.00	16.95			
		134	5670		18.50	18.46			
		142	5710		18.50	18.47			
		102	5510		13.50	13.47			
		110	5550		17.00	16.88			
		118	5590	MCS0	17.00	16.85			
	802.11ac40-VHT0	126	5630		17.00	16.87			
		134	5670		18.50	18.42			
		142	5710		18.50	18.44			
		106	5530		11.50	11.43			
	802.11ac80-VHT0	122	5610	MCS0	17.00	16.88			
		138	5690		17.00	16.92			
	802.11ac160-VHT0		5570	MCS0	11.00	10.98			

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Main Antenna									
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		149	5745		18.00	17.95			
	802.11a	153	5765	6Mbps	18.00	17.97			
	002.11a	157	5785	0101005	18.00	17.94			
		165	5825		18.00	17.89			
		149	5745	MCS0	18.00	17.93			
	802.11n20-HT0	153	5765		18.00	17.96			
	002.11120-1110	157	5785		18.00	17.95			
		165	5825		18.00	17.91			
5800 MHz		149	5745		18.00	17.92			
	802.11ac20-VHT0	153	5765	MCS0	18.00	17.95			
	002.118020-0110	157	5785	IVIC30	18.00	17.94			
		165	5825		18.00	17.88			
	902 11p10 UT0	151	5755	MCS0	18.00	17.94			
	802.11n40-HT0	159	5795	IVICSU	18.00	17.98			
	802.11ac40-VHT0	151	5755	MCSO	18.00	17.92			
	002.118040-1010	159	5795	MCS0	18.00	17.95			
	802.11ac80-VHT0	155	5775	MCS0	13.50	13.44			

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# Aux (Chain 1)

Aux Antenna									
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		1	2412		19.00	18.97			
		6	2437		19.00	18.94			
	802.11b	11	2462	1Mbps	19.00	18.95			
		12	2467		18.00	17.88			
		13	2472		14.50	14.46			
		1	2412		18.00	17.96			
	802.11g	6	2437	6Mbps	19.00	18.91			
		10	2457		19.00	18.99			
		11	2462	olviops	15.50	15.43			
		12	2467	•	13.00	12.96			
		13	2472		-6.50	-6.55			
		1	2412		15.00	14.93			
2450 MHz		2	2417		17.00	16.93			
		6	2437		17.00	16.91			
	802.11n20-HT0	10	2457	MCS0	17.00	16.94			
		11	2462		14.50	14.42			
		12	2467		13.00	12.97			
		13	2472		-6.50	-6.53			
		3	2422		13.00	12.96			
		6	2437		13.00	12.98			
		7	2442		14.00	13.91			
	802.11n40-HT0	8	2447	MCS0	12.00	11.91			
		9	2452		11.00	10.95			
		10	2457		6.00	5.92			
		11	2462		1.00	0.91			

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Aux Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)		
		36	5180		18.50	18.48		
	802.11a	40	5200	6Mbps	18.50	18.43		
	002.11a	44	5220	0101000	18.50	18.46		
		48	5240		18.50	18.41		
	802.11n20-HT0	36	5180	MCS0	16.00	15.97		
		40	5200		18.50	18.44		
		44	5220	10000	18.50	18.37		
		48	5240		18.50	18.41		
5.15-5.25 GHz		36	5180		16.00	15.98		
5.15-5.25 0112	802.11ac20-VHT0	40	5200	MCS0	18.50	18.43		
	002.118020-01110	44	5220	10000	18.50	18.38		
		48	5240		18.50	18.42		
	802.11n40-HT0	38	5190	MCS0	13.50	13.46		
	002.11140-1110	46	5230	WC30	18.50	18.42		
	802.11ac40-VHT0	38	5190	MCS0	13.50	12.44		
	002.118040-01110	46	5230	10000	18.50	18.41		
	802.11ac80-VHT0	42	5210	MCS0	9.00	8.93		
	802.11ac160-VHT0	50	5250	MCS0	13.00	12.96		

Aux Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)		
		52	5260		18.50	18.46		
	802.11a	56	5280	6Mbps	18.50	18.47		
	002.11a	60	5300	olviopa	18.50	18.48		
		64	5320		15.50	14.44		
	802.11n20-HT0	52	5260		18.50	18.46		
		56	5280	MCS0	18.50	18.44		
		60	5300	MCCO	18.50	18.45		
		64	5320		15.50	15.41		
5.25-5.35 GHz		52	5260		18.50	18.46		
	802.11ac20-VHT0	56	5280	MCS0	18.50	18.38		
	002.118620-01110	60	5300	10000	18.50	18.43		
		64	5320		15.50	15.45		
	802.11n40-HT0	54	5270	MCS0	18.50	18.49		
	002.11140-1110	62	5310	WC30	14.00	13.98		
		54	5270	MCS0	18.50	18.45		
	802.11ac40-VHT0	62	5310	IVIC50	14.00	13.96		
	802.11ac80-VHT0	58	5290	MCS0	11.50	11.43		

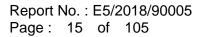
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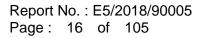
	Aux Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		100	5500		18.00	17.98			
		116	5580		18.50	18.47			
	802.11a	120	5600	GMbpa	18.50	18.44			
	002.11a	124	5620	6Mbps	18.50	18.41			
		128	5640		18.50	18.43			
		140	5700		18.50	18.42			
		100	5500		16.00	15.96			
		116	5580		18.50	18.46			
	802.11n20-HT0	120	5600	MCS0	18.50	18.43			
	002.11120-1110	124	5620	IVIC30	18.50	18.40			
		128	5640		18.50	18.37			
		140	5700		18.50	18.45			
		100	5500		16.00	15.93			
		116	5580		18.50	18.44			
	802.11ac20-VHT0	120	5600	MCS0	18.50	18.38			
	002.118020-01110	124	5620	MC30	18.50	18.43			
5600 MHz		128	5640		18.50	18.39			
5000 1011 12		140	5700		18.50	18.41			
		102	5510		13.50	13.42			
		110	5550		17.00	16.91			
	802.11n40-HT0	118	5590	MCS0	17.00	16.88			
	002.11140-1110	126	5630	10000	17.00	16.93			
		134	5670		18.50	18.48			
		142	5710		18.50	18.49			
		102	5510		13.50	13.48			
		110	5550		17.00	16.95			
	802.11ac40-VHT0	118	5590	MCS0	17.00	16.91			
	002.1100-0-01110	126	5630	10000	17.00	16.93			
		134	5670		18.50	18.40			
		142	5710		18.50	18.43			
		106	5530		11.50	11.43			
	802.11ac80-VHT0	122	5610	MCS0	17.00	16.85			
		138	5690		17.00	16.91			
	802.11ac160-VHT0	114	5570	MCS0	11.00	10.96			

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Aux Antenna									
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		149	5745		17.50	17.43			
	802.11a	153	5765	6Mbps	17.50	17.41			
	002.11a	157	5785	0101005	17.50	17.45			
		165	5825		17.50	17.42			
		149	5745	MCS0	17.50	17.44			
	802.11n20-HT0	153	5765		17.50	17.41			
	002.11120-1110	157	5785		17.50	17.38			
		165	5825		17.50	17.40			
5800 MHz		149	5745		17.50	17.43			
	802.11ac20-VHT0	153	5765	MCS0	17.50	17.50			
	002.118620-01110	157	5785	101030	17.50	17.41			
		165	5825		17.50	17.46			
	802.11n40-HT0	151	5755	MCS0	17.50	17.47			
	ουz.11140-ΠΤU	159	5795	IVICSU	17.50	17.44			
	802.11ac40-VHT0	151	5755	MCSO	17.50	17.43			
	002.118040-1010	159	5795	MCS0	17.50	17.37			
	802.11ac80-VHT0	155	5775	MCS0	13.50	13.44			

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#### MIMO

#### Main (Chain 0)

	•	Main	Antenna			
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
		1	2412		14.50	14.13
		7	2442		17.00	16.70
	802.11n20-HT0	11	2462	HT8	14.00	13.64
		12	2467		11.50	11.28
2450 MHz		13	2472		-9.50	-9.81
		3	2422		12.50	12.48
		7	2442	HT8	14.00	13.55
	802.11n40-HT0	9	2452		9.50	9.20
		10	2457		6.00	5.68
		11	2462		0.50	0.40
		Main	Antenna			
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
	802.11n20-HT0	36	5180	HT8	13.00	12.54
		40	5200		17.50	16.55
		48	5240		17.50	17.28
5.15-5.25 GHz		38	5190		13.00	12.70
	802.11n40-HT0	46	5230	HT8	17.00	16.55
	802.11ac80-VHT0	42	5210	VHT0	8.50	8.05
	802.11ac160-VHT0		5250	VHT0	12.50	12.23
		Main	Antenna	•		
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
		52	5260		15.00	14.60
	802.11n20-HT0	56	5280	HT8	17.00	16.48
		64	5320	-	14.50	14.43
5.25-5.35 GHz		54	5270	1170	17.00	16.97
	802.11n40-HT0	62	5310	HT8	13.00	12.94
	802.11ac80-VHT0	58	5290	VHT0	10.50	10.28

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Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)		
		100	5500		15.50	15.13		
	802.11n20-HT0	120	5600	HT8	14.50	14.44		
	002.11120-010	140	5700	пю	16.50	16.46		
		144	5720		18.00	17.77		
		102	5510		13.00	12.57		
5600 MHz	z 802.11n40-HT0	118	5590	HT8	16.00	15.85		
		134	5670	1110	17.00	16.65		
		142	5710		17.00	16.58		
		106	5530		10.50	10.26		
	802.11ac80-VHT0	122	5610	VHT0	16.00	15.74		
		138	5690		16.50	16.05		
	802.11ac160-VHT0	114	5570	VHT0	10.00	9.86		
		Main	Antenna					
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)		
		149	5745		18.00	17.91		
	802.11n20-HT0	157	5785	HT8	18.00	17.93		
5800 MHz		165	5825		18.00	17.89		
5000 10112	802.11n40-HT0	151	5755	HT8	17.00	16.61		
	оuz.111140-П10	159	5795		16.50	16.25		
	802.11ac80-VHT0	155	5775	VHT0	10.50	10.27		

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# Aux (Chain 1)

Aux Antenna									
Band	Mode	Channel Frequency (MHz) Da		Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		1	2412		14.50	14.24			
		7	2442		17.00	16.60			
	802.11n20-HT0	11	2462	HT8	14.00	13.76			
		12	2467		11.50	11.09			
2450 MHz		13	2472		-9.50	-9.85			
		3	2422		12.50	12.47			
		7	2442		13.50	13.38			
	802.11n40-HT0	9	2452	HT8	9.50	9.10			
		10	2457		6.00	5.73			
		11	2462		0.50	0.20			
		Aux	Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		36	5180		13.00	12.79			
	802.11n20-HT0	40	5200	HT8	17.00	16.83			
		48	5240		18.00	17.71			
5.15-5.25 GHz	000 44 - 40 11T0	38	5190		13.00	12.90			
	802.11n40-HT0	46	5230	HT8	17.00	16.83			
	802.11ac80-VHT0	42	5210	VHT0	8.50	8.12			
	802.11ac160-VHT0	50	5250	VHT0	13.00	12.55			
		Aux	Antenna						
Band	Band Mode		Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		52	5260		15.00	14.82			
	802.11n20-HT0	56	5280	HT8	17.00	16.87			
		64	5320	1	15.00	14.96			
5.25-5.35 GHz		54	5270		17.50	17.37			
	802.11n40-HT0	62	5310	HT8	13.50	13.33			
	802.11ac80-VHT0	58	5290	VHT0	11.00	10.91			

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	Aux Antenna										
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)					
		100	5500		15.50	15.23					
	802.11n20-HT0	120	5600	HT8	15.00	14.98					
		140	5700	1110	17.00	16.85					
		144	5720		18.00	17.66					
		102	5510		13.00	12.79					
5600 MHz	802.11n40-HT0	118	5590	HT8	16.50	16.25					
5000 IVII 12	002.11140-1110	134	5670	1110	17.00	16.71					
		142	5710		17.00	16.77					
		106	5530		11.00	10.89					
	802.11ac80-VHT0	122	5610	VHT0	16.50	16.43					
		138	5690		16.50	16.14					
	802.11ac160-VHT0	114	5570	VHT0	10.50	10.30					

	Aux Antenna										
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)					
	802.11n20-HT0	149	5745		17.50	17.42					
		157	5785	HT8	17.50	17.48					
5800 MHz		165	5825		17.50	17.49					
	802.11n40-HT0	151	5755	HT8	17.00	16.73					
	002.11140-F110	159	5795	пю	16.50	16.03					
	802.11ac80-VHT0	155	5775	VHT0	11.00	10.89					

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#### Bluetooth conducted power table:

Mode	Channel	Frequency	y Average Output Power (dBm)			Max. Rated Avg. Power + Max.		
	Channel	(MHz)	1Mbps	2Mbps	3Mbps	Tolerance (dBm)		
	CH 00	2402	8.54	7.17	7.20			
BR/EDR	CH 39	2441	9.08	7.26	7.24	11.5		
	CH 78	2480	9.54	7.45	7.43			

Mode	Channel	Frequency	Average Output Power (dBm)	Max. Rated Avg. Power + Max.	
MODE	Channel	(MHz)	GFSK	Tolerance (dBm)	
	CH 00	2402	7.85		
LE	CH 19	2440	7.55	9	
	CH 39	2480	8.00		

Mode	lode Channel (MHz)		Average Output Power (dBm)	Max. Rated Avg. Power + Max.	
Mode			GFSK	Tolerance (dBm)	
	CH 00	2402	7.65		
LE 2M	CH 19 2440		7.57	9	
	CH 39	2480	7.98		

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## **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,

#### Laptop mode

Bottom side of keyboard touch against the flat phantom

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Note:

802.11b DSSS SAR Test Requirements:

- 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  $\leq$ 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:

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  $\leq 1.2$  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  $\leq 1.2$ W/kg or all required channels are tested.
- For WLAN Main antennas, 5.2 n(40M) / 5.3 a/5.3 n(40M) / 5.6 n(40M) / 5.8n(40M) is chosen to be the initial test configurations. For WLAN Aux antennas, 5.2 a /5.2 n(40M) / 5.3 a/5.3 n(40M) / 5.6 n(40M) / 5.8n(40M) is chosen to be the initial test configurations.
- 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  $\leq 1.2$  W/kg, SAR is not required for subsequent test configuration.

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- 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  $\leq$  0.8 W/kg, when the transmission band is  $\leq$  100 MHz.
- 10. According to KDB865664 D01, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is  $\geq$  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  $\geq$  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:

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

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

(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) $\times$ 10](mW),

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#### 1.6 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=  $\sigma$  (|Ei|<sup>2</sup>)/  $\rho$  where  $\sigma$  and  $\rho$  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.

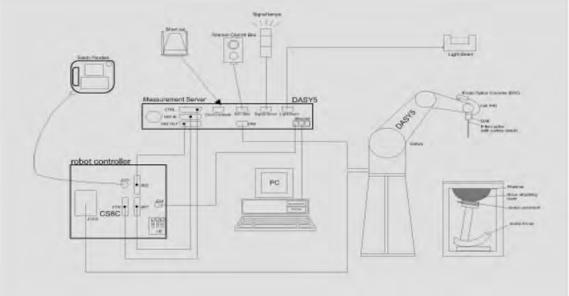


Fig. a The block diagram of SAR system

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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.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The device holder for handheld mobile phones. 10.
- 11. Tissue simulating liquid mixed according to the given recipes.
- 12. Validation dipole kits allowing to validate the proper functioning of the system.

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# **1.7 System Components**

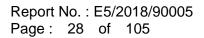
# **EX3DV4 E-Field Probe**

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	$10 \mu\text{W/g}$ to > 100 mW/g
Range	Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/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	2 ± 0.2 mm
Thickness	
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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## **1.8 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  $\geq$  15 cm  $\pm$  5 mm (frequency  $\leq$  3 GHz) or  $\geq$  10 cm  $\pm$  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.

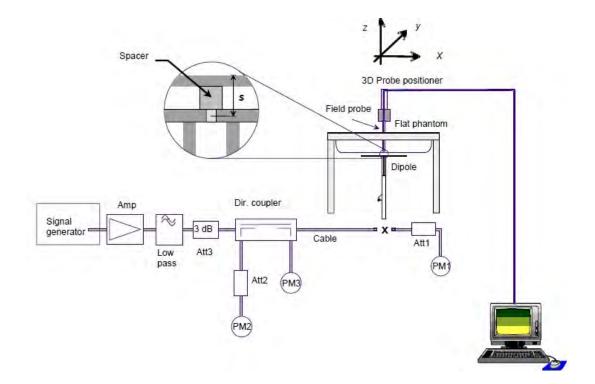


Fig. b The block diagram of system verification

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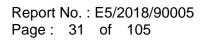
Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D2450V2	727	2450	Body	50.8	12.5	50	-1.57%	Oct. 02, 2018
	1023	5200	Body	70.9	7.44	74.4	4.94%	Oct. 03, 2018
D5GHzV2		5300	Body	72.9	7.76	77.6	6.45%	Oct. 04, 2018
DOGHZVZ	1023	5600	Body	77.6	8.08	80.8	4.12%	Oct. 05, 2018
		5800	Body	74.1	7.75	77.5	4.59%	Oct. 08, 2018

Table 1. Results of system validation

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# 1.9 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this Head-simulant fluid were measured by using the Agilent Model 85070E Dielectric Probe (rates frequency band 200 MHz to 20 GHz) 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  $\geq 15$  cm  $\pm 5$ mm (Frequency  $\leq$ 3G) or  $\geq$  10 cm  $\pm$  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 ɛr	% dev σ
		2412	52.751	1.914	53.927	1.853	-2.23%	3.15%
		2437	52.717	1.938	53.903	1.877	-2.25%	3.12%
	Oct, 02. 2018	2450	52.700	1.950	53.859	1.889	-2.20%	3.12%
		2462	52.685	1.967	53.865	1.906	-2.24%	3.12%
		2480	52.669	1.984	53.855	1.908	-2.25%	3.83%
	Oct, 03. 2018	5180	49.041	5.276	49.924	5.166	-1.80%	2.09%
		5200	49.014	5.299	49.921	5.189	-1.85%	2.08%
Dedu		5230	48.974	5.334	49.880	5.224	-1.85%	2.06%
Body	Oct 04 2018	5270	48.919	5.381	49.775	5.265	-1.75%	2.15%
	Oct, 04. 2018	5300	48.879	5.416	49.783	5.301	-1.85%	2.12%
	0 + 05 2010	5600	48.471	5.766	49.344	5.648	-1.80%	2.06%
	Oct, 05. 2018	5670	48.376	5.848	49.247	5.727	-1.80%	2.08%
		5710	48.322	5.895	47.119	5.804	2.49%	1.55%
	Oct 09 2019	5755	48.261	5.947	47.098	5.872	2.41%	1.27%
	Oct, 08. 2018	5795	48.207	5.994	46.982	5.901	2.54%	1.55%
		5800	48.200	6.000	47.019	5.908	2.45%	1.53%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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

# The composition of the tissue simulating liquid:

#### 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

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# 1.10 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

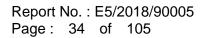
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interpolation to get all points within the measured volume. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. If the highest 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.

# 1.11 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:

#### 1.11.1 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  $\sigma$  is the conductivity,  $\rho$  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  $\rho$ ), there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed  $\pm 5\%$ .
- 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  $\pm 5\%$  (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].

# 1.11.2 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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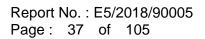
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#### **1.12 Test Standards and Limits**

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.

- Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the (1) 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).
- Occupational/Controlled limits apply when persons are exposed as a (2) 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.
- Limits for General Population/Uncontrolled exposure: 0.08 W/kg as (3) 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

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	0	AR over 1g /kg)	Plot page
		()		(1011 122)	Tolerance (dBm)	(dBm)		Measured	Reported	page
	Bottom side	0	1	2412	19.00	18.99	100.23%	0.666	0.668	45
WLAN802.11 b	Bottom side	0	6	2437	19.00	18.96	100.93%	0.642	0.648	-
	Bottom side	0	11	2462	19.00	18.95	101.16%	0.646	0.653	-
WLAN802.11 n(40M) 5.2G	Bottom side	0	46	5230	17.50	17.42	101.86%	0.766	0.780	46
WLAN802.11 a 5.3G	Bottom side	0	60	5300	17.50	17.45	101.16%	0.853	0.863	47
WLAN002.11 a 5.3G	Bottom side*	0	60	5300	17.50	17.45	101.16%	0.844	0.854	-
WILLANDOO 44 - (40N0 5 00	Bottom side	0	54	5270	17.50	17.47	100.69%	0.852	0.858	48
WLAN802.11 n(40M) 5.3G	Bottom side*	0	54	5270	17.50	17.47	100.69%	0.839	0.845	-
	Bottom side	0	134	5670	17.50	17.46	100.93%	1.110	1.120	49
WLAN802.11 n(40M) 5.6G	Bottom side*	0	134	5670	17.50	17.46	100.93%	1.080	1.090	-
	Bottom side	0	142	5710	17.50	17.47	100.69%	1.010	1.017	-
	Bottom side	0	151	5755	17.00	16.94	101.39%	0.793	0.804	50
WLAN802.11 n(40M) 5.8G	Bottom side*	0	151	5755	17.00	16.94	101.39%	0.781	0.792	-
	Bottom side	0	159	5795	17.00	16.98	100.46%	0.796	0.800	-

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

#### WLAN Aux Antenna

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	U U	AR over 1g /kg)	Plot page
		()		(	Tolerance (dBm)	(dBm)		Measured	Reported	P3-
WLAN802.11 b	Bottom side	0	1	2412	19.00	18.97	100.69%	0.567	0.571	51
Bluetooth (GFSK)	Bottom side	0	78	2480	11.50	9.54	157.04%	0.101	0.159	52
WLAN802.11 a 5.2G	Bottom side	0	36	5180	17.50	17.48	100.46%	0.788	0.792	53
WLAN802.11 n(40M) 5.2G	Bottom side	0	46	5230	17.50	17.42	101.86%	0.810	0.825	54
WLANOUZ.TT N(4010) 5.2G	Bottom side*	0	46	5230	17.50	17.42	101.86%	0.798	0.813	-
WLAN802.11 a 5.3G	Bottom side	0	60	5300	17.50	17.48	100.46%	0.841	0.845	55
WLAN002.11 a 5.50	Bottom side*	0	60	5300	17.50	17.48	100.46%	0.832	0.836	-
WLAN802.11 n(40M) 5.3G	Bottom side	0	54	5270	17.50	17.49	100.23%	0.889	0.891	56
WLANOUZ. IT 11(4010) 5.3G	Bottom side*	0	54	5270	17.50	17.49	100.23%	0.881	0.883	-
WLAN802.11 n(40M) 5.6G	Bottom side	0	142	5710	17.50	17.49	100.23%	0.775	0.777	57
WLAN802.11 n(40M) 5.8G	Bottom side	0	151	5755	16.50	16.47	100.69%	0.785	0.790	58

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

Note:  $\frac{\text{reported SAR}}{\text{measured SAR}} = \frac{P2(mW)}{P1(mW)} = 10^{\left(\frac{P2-P1}{10}\right)(dBm)}$ Scaling = Reported SAR = measured SAR \* (scaling) Where P2 is maximum specified power, P1 is measured conducted power

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# 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.

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#### 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:

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

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  $\leq$  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

No.	Conditions	Position	Max. WLAN Main	Max. WLAN Aux	SAR Sum	SPLSR
1	2.4 GHz WLAN Main + WLAN Aux	Bottom side	0.668	0.571	1.239	ΣSAR<1.6, Not required

#### **5 GHz WLAN MIMO**

No.	Conditions	Position	Max. WLAN Main	Max. WLAN Aux	SAR Sum	SPLSR
2	5 GHz WLAN Main + WLAN Aux	Bottom side	1.120	0.891	2.011	Analyzed as below

#### **5 GHz WLAN MIMO**

Conditions	Position	SAR Value	Coc	ordinates (	(cm)	ΣSAR (W/kg)	Peak Location Separation	SPLSR	Simultaneous Transmission
		(W/kg)	х	У	z	(W/Kg)	Distance (mm)		SAR Test
Main	Bottom	1.12	11.34	0.42	-0.169	2.011	89.81	0.032	SPLSR<0.04,
Aux	side	0.891	11.22	9.40	-0.117	2.011	09.01	0.032	Not required
	_								
			0	WLAN	MAI	N	WLAN	AUX	
									_
					4				

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#### **BT+ 2.4GHz WLAN Main**

No.	Conditions	Position	Max. WLAN Main	BT	SAR Sum	SPLSR
3	2.4 GHz WLAN Main + BT	Bottom side	0.668	0.159	0.827	ΣSAR<1.6, Not required

#### **BT+ 5GHz WLAN Main**

No.	Conditions	Position	Max. WLAN Main	BT	SAR Sum	SPLSR
4	5 GHz WLAN Main + BT	Bottom side	1.120	0.159	1.279	ΣSAR<1.6, Not required

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# 4. Instruments List

Manufacturer	Device	Туре	Serial number	Date of last calibration	Date of next calibration
SPEAG	Dosimetric E-Field Probe	EX3DV4	3831	Jan.23,2018	Jan.22,2019
SPEAG	System Validation	D2450V2	727	Apr.24,2018	Apr.23,2019
SFEAG	Dipole	D5GHzV2	1023	Jan.25,2018	Jan.24,2019
SPEAG	Data acquisition Electronics	DAE4	547	Mar.16,2018	Mar.15,2019
SPEAG	Software	DASY 52 V52.10.1	N/A		Calibration not required
SPEAG	Phantom	ELI	N/A	Calibration not required	Calibration not required
Agilent	Network Analyzer	E5071C	MY46107530	Feb.26,2018	Feb.25,2019
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilent	Dual-directional	772D	MY52180142	Jul.04,2018	Jul.03,2019
Aglient	coupler	778D	MY52180302	Jul.05,2018	Jul.04,2019
Agilent	Signal Generator	N5181A	MY50144143	Mar.15,2018	Mar.14,2019
Agilent	Power Meter	E4417A	MY52240003	Dec.21,2017	Dec.20,2018
Agilent	Power Sensor	E9301H	MY52200003	Dec.21,2017	Dec.20,2018
			MY52200004	Dec.21,2017	Dec.20,2018
Changzhou Xinwang	Digital thermometer	DTM-303A	TP130077	Mar.09,2018	Mar.08,2019

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## 5. Measurements

Date: 2018/10/2

### WLAN 802.11b Body Bottom side CH 1 Main 0mm

Communication System: WLAN 2.45G; Frequency: 2412 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2412 MHz;  $\sigma$  = 1.853 S/m;  $\epsilon_r$  = 53.927;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

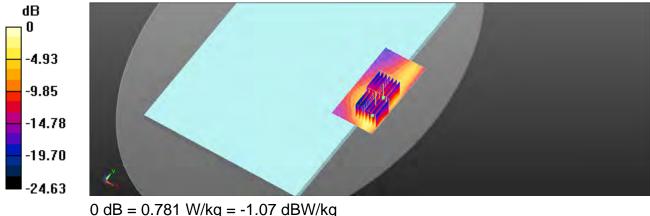
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.26, 7.26, 7.26); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16 •
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (51x101x1): Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.931 W/kg

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 1.2410 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 1.53 W/kg SAR(1 g) = 0.666 W/kg; SAR(10 g) = 0.311 W/kgMaximum value of SAR (measured) = 1.07 W/kg Zoom Scan (7x7x7)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 1.0093 V/m: Power Drift = 0.01 dB Peak SAR (extrapolated) = 1.09 W/kg SAR(1 g) = 0.468 W/kg; SAR(10 g) = 0.232 W/kg

Maximum value of SAR (measured) = 0.781 W/kg



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Date: 2018/10/3

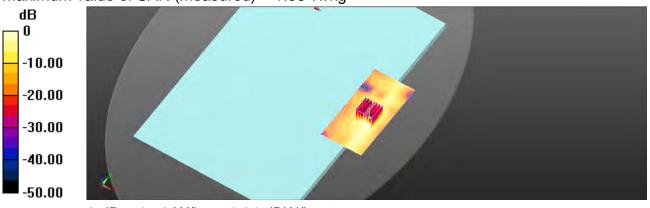
#### WLAN 802.11n(40M) 5.2G\_Body\_Bottom side\_CH 46\_Mian\_0mm

Communication System: WLAN 5G; Frequency: 5230 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5230 MHz;  $\sigma$  = 5.224 S/m;  $\epsilon_r$  = 49.88;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

- **DASY5** Configuration:
  - Probe: EX3DV4 SN3831; ConvF(4.56, 4.56, 4.56); Calibrated: 2018/1/23
  - Sensor-Surface: 2mm (Mechanical Surface Detection)
  - Electronics: DAE4 Sn547; Calibrated: 2018/3/16
  - Phantom: ELI
  - DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.40 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 1.4230 V/m: Power Drift = 0.01 dB Peak SAR (extrapolated) = 3.43 W/kg SAR(1 g) = 0.766 W/kg; SAR(10 g) = 0.232 W/kg Maximum value of SAR (measured) = 1.56 W/kg



0 dB = 1.56 W/kg = 1.94 dBW/kg

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Date: 2018/10/4

### WLAN 802.11a 5.3G\_Body\_Bottom side\_CH 60\_Main\_0mm

Communication System: WLAN 5G; Frequency: 5300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5300 MHz;  $\sigma$  = 5.301 S/m;  $\epsilon_r$  = 49.783;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

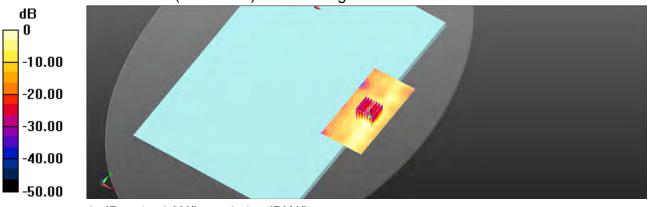
Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.39, 4.39, 4.39); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.57 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 1.6850 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.97 W/kg SAR(1 g) = 0.853 W/kg; SAR(10 g) = 0.261 W/kg Maximum value of SAR (measured) = 1.76 W/kg



0 dB = 1.76 W/kg = 2.45 dBW/kg

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Report No. : E5/2018/90005 Page: 48 of 105

Date: 2018/10/4

### WLAN 802.11n(40M) 5.3G\_Body\_Bottom side\_CH 54\_Main\_0mm

Communication System: WLAN 5G; Frequency: 5270 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5270 MHz;  $\sigma$  = 5.265 S/m;  $\epsilon_r$  = 49.775;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

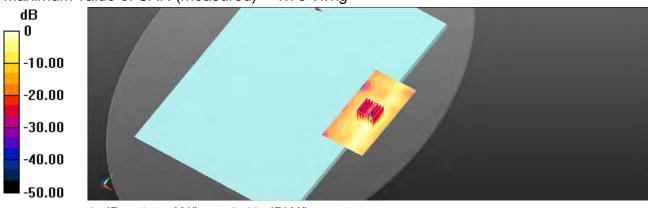
Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.39, 4.39, 4.39); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.55 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 1.6290 V/m: Power Drift = 0.09 dB Peak SAR (extrapolated) = 3.91 W/kg SAR(1 g) = 0.852 W/kg; SAR(10 g) = 0.259 W/kg Maximum value of SAR (measured) = 1.75 W/kg



0 dB = 1.75 W/kg = 2.43 dBW/kg

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Date: 2018/10/5

#### WLAN 802.11n(40M) 5.6G\_Body\_Bottom side\_CH 134\_Main\_0mm

Communication System: WLAN 5G; Frequency: 5670 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5670 MHz;  $\sigma$  = 5.727 S/m;  $\epsilon_r$  = 49.247;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

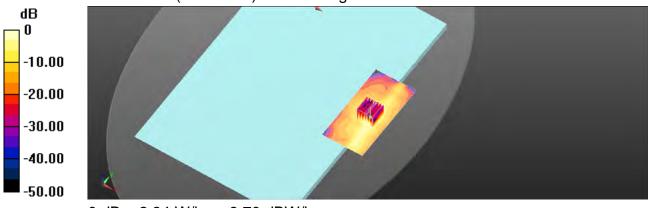
Ambient temperature: 22.1°C; Liquid temperature: 21.7°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(3.92, 3.92, 3.92); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 2.10 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 2.2240 V/m: Power Drift = 0.01 dB Peak SAR (extrapolated) = 5.53 W/kg SAR(1 g) = 1.11 W/kg; SAR(10 g) = 0.316 W/kg Maximum value of SAR (measured) = 2.34 W/kg



0 dB = 2.34 W/kg = 3.70 dBW/kg

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Date: 2018/10/8

#### WLAN 802.11n(40M) 5.8G\_Body\_Bottom side\_CH 151\_Main\_0mm

Communication System: WLAN 5G; Frequency: 5755 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5755 MHz;  $\sigma$  = 5.872 S/m;  $\epsilon_r$  = 47.098;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

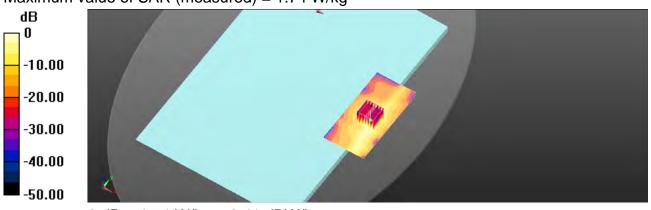
Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.17, 4.17, 4.17); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.50 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 1.4760 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 4.02 W/kg SAR(1 g) = 0.793 W/kg; SAR(10 g) = 0.223 W/kg Maximum value of SAR (measured) = 1.74 W/kg



0 dB = 1.74 W/kg = 2.41 dBW/kg

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Date: 2018/10/2

### WLAN 802.11b\_Body\_Bottom side\_CH 1\_Aux\_0mm

Communication System: WLAN 2.45G; Frequency: 2412 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2412 MHz;  $\sigma$  = 1.853 S/m;  $\epsilon_r$  = 53.927;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.26, 7.26, 7.26); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (51x101x1): Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.915 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 1.0120 V/m: Power Drift = 0.07 dB

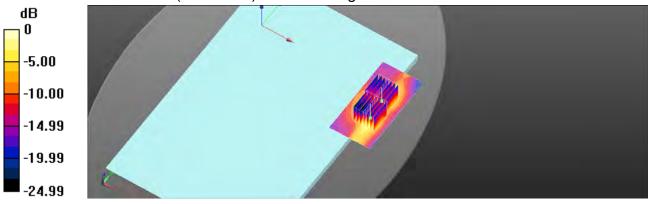
Peak SAR (extrapolated) = 1.30 W/kg

SAR(1 g) = 0.567 W/kg; SAR(10 g) = 0.267 W/kg

Maximum value of SAR (measured) = 0.911 W/kg

**Zoom Scan (7x7x7)/Cube 1:** Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 0.8573 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 1.08 W/kg SAR(1 g) = 0.476 W/kg; SAR(10 g) = 0.223 W/kg

Maximum value of SAR (measured) = 0.712 W/kg



0 dB = 0.911 W/kg = -0.41 dBW/kg

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Date: 2018/10/2

### Bluetooth(GFSK)\_Bottom side\_CH 78\_Aux\_0mm

Communication System: WLAN 2.45G; Frequency: 2480 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2480 MHz;  $\sigma$  = 1.908 S/m;  $\epsilon_r$  = 53.855;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

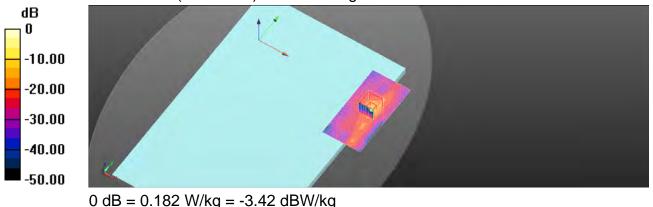
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.26, 7.26, 7.26); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (51x101x1): Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.185 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 0.2241 V/m: Power Drift = 0.07 dB Peak SAR (extrapolated) = 0.253 W/kg SAR(1 g) = 0.101 W/kg; SAR(10 g) = 0.053 W/kg

Maximum value of SAR (measured) = 0.182 W/kg



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Date: 2018/10/3

#### WLAN 802.11a 5.2G\_Body\_Bottom side\_CH 36\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5180 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5180 MHz;  $\sigma$  = 5.166 S/m;  $\epsilon_r$  = 49.924;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

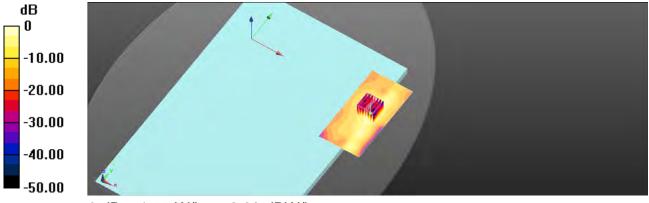
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.56, 4.56, 4.56); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.32 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0.1120 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 3.07 W/kg SAR(1 g) = 0.788 W/kg; SAR(10 g) = 0.213 W/ka

Maximum value of SAR (measured) = 1.57 W/kg



0 dB = 1.57 W/kg = 2.03 dBW/kg

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Date: 2018/10/3

### WLAN 802.11n(40M) 5.2G\_Body\_Bottom side\_CH 46\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5230 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5230 MHz;  $\sigma$  = 5.224 S/m;  $\epsilon_r$  = 49.88;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

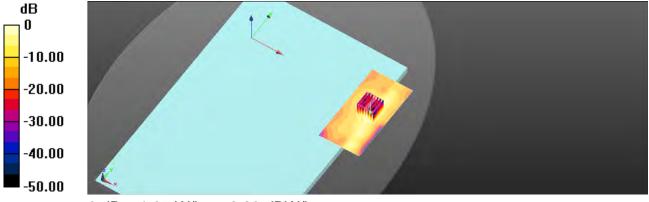
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.56, 4.56, 4.56); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.56 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0.1120 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.57 W/kg SAR(1 g) = 0.810 W/kg; SAR(10 g) = 0.243 W/ka

Maximum value of SAR (measured) = 1.67 W/kg



0 dB = 1.67 W/kg = 2.23 dBW/kg

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Date: 2018/10/4

### WLAN 802.11a 5.3G\_Body\_Bottom side\_CH 60\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5300 MHz;  $\sigma$  = 5.301 S/m;  $\epsilon_r$  = 49.783;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

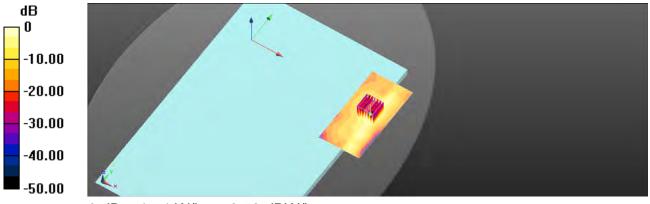
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.39, 4.39, 4.39); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.59 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0.1682 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 3.77 W/kg SAR(1 g) = 0.841 W/kg; SAR(10 g) = 0.252 W/ka

Maximum value of SAR (measured) = 1.74 W/kg



0 dB = 1.74 W/kg = 2.58 dBW/kg

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Date: 2018/10/4

### WLAN 802.11n(40M) 5.3G\_Body\_Bottom side\_CH 54\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5270 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5270 MHz;  $\sigma$  = 5.265 S/m;  $\epsilon_r$  = 49.775;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

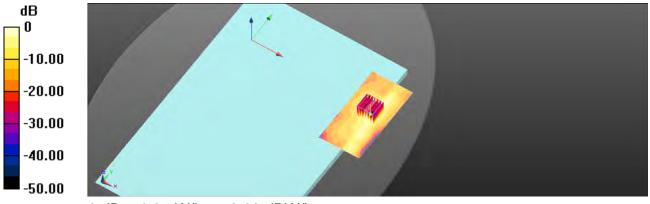
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.39, 4.39, 4.39); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.70 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0.1623 V/m: Power Drift = 0.01 dB Peak SAR (extrapolated) = 4.01 W/kg SAR(1 g) = 0.889 W/kg; SAR(10 g) = 0.267 W/ka

Maximum value of SAR (measured) = 1.85 W/kg



0 dB = 1.85 W/kg = 2.68 dBW/kg

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Date: 2018/10/5

### WLAN 802.11n(40M) 5.6G\_Body\_Bottom side\_CH 142\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5710 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5710 MHz;  $\sigma$  = 5.804 S/m;  $\epsilon_r$  = 47.119;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

Ambient temperature: 22.1°C; Liquid temperature: 21.7°C

**DASY5** Configuration:

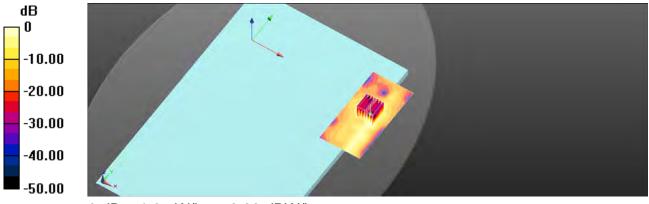
- Probe: EX3DV4 SN3831; ConvF(3.92, 3.92, 3.92); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.59 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0 V/m: Power Drift = 0.01 dB Peak SAR (extrapolated) = 3.82 W/kg

SAR(1 g) = 0.775 W/kg; SAR(10 g) = 0.231 W/ka

Maximum value of SAR (measured) = 1.67 W/kg



0 dB = 1.67 W/kg = 2.23 dBW/kg

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### WLAN 802.11n(40M) 5.8G\_Body\_Bottom side\_CH 151\_Aux\_0mm

Communication System: WLAN 5G; Frequency: 5755 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5755 MHz;  $\sigma$  = 5.872 S/m;  $\epsilon_r$  = 47.098;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.17, 4.17, 4.17); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

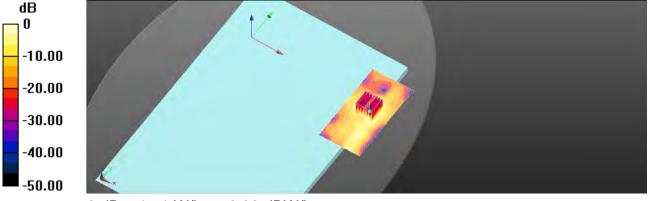
Area Scan (61x121x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 1.66 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 0 V/m: Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.87 W/kg

SAR(1 g) = 0.785 W/kg; SAR(10 g) = 0.234 W/ka

Maximum value of SAR (measured) = 1.71 W/kg



0 dB = 1.71 W/kg = 2.32 dBW/kg

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# 6. SAR System Performance Verification

Date: 2018/10/2

### Dipole 2450 MHz SN:727

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.889 S/m;  $\epsilon_r$  = 53.859;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

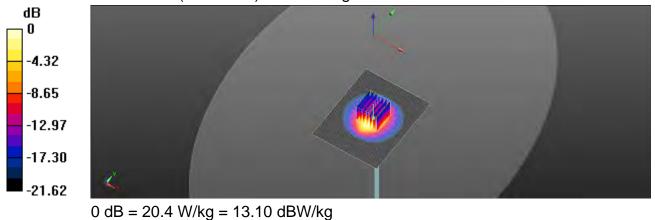
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.26, 7.26, 7.26); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16 •
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (81x101x1): Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 20.7 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 99.63 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 27.3 W/kg SAR(1 g) = 12.5 W/kg; SAR(10 g) = 6.04 W/kg

Maximum value of SAR (measured) = 20.4 W/kg



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### Dipole 5200 MHz SN:1023

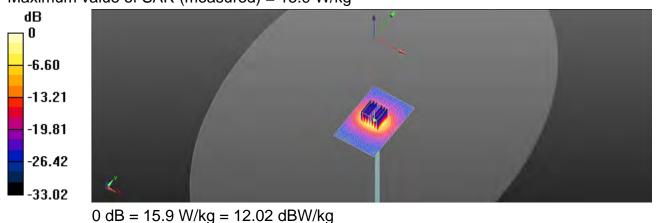
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5200 MHz;  $\sigma$  = 5.189 S/m;  $\epsilon_r$  = 49.921;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.56, 4.56, 4.56); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x91x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 15.9 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 55.86 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 30.6 W/kg SAR(1 g) = 7.44 W/kg; SAR(10 g) = 2.02 W/kg Maximum value of SAR (measured) = 15.9 W/kg



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### Dipole 5300 MHz SN:1023

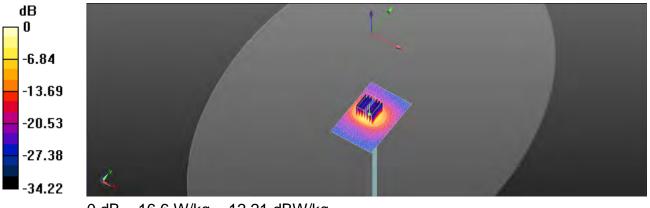
Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5300 MHz;  $\sigma$  = 5.3 S/m;  $\epsilon$ r = 49.783;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.39, 4.39, 4.39); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x91x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 16.2 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 47.62 V/m: Power Drift = -0.07 dB Peak SAR (extrapolated) = 32.4 W/kg SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.16 W/kg Maximum value of SAR (measured) = 16.6 W/kg



0 dB = 16.6 W/kg = 12.21 dBW/kg

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### Dipole 5600 MHz SN:1023

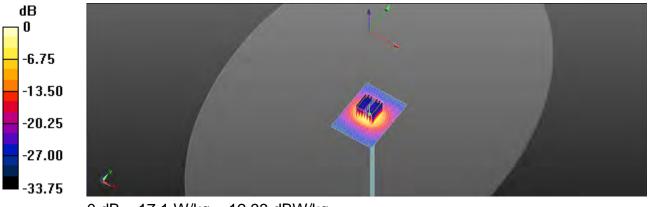
Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.648 S/m;  $\epsilon_r$  = 49.344;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.7°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(3.92, 3.92, 3.92); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x81x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 17.3 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 58.75 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 33.8 W/kg SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.24 W/kg Maximum value of SAR (measured) = 17.1 W/kg



0 dB = 17.1 W/kg = 12.33 dBW/kg

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### Dipole 5800 MHz SN:1023

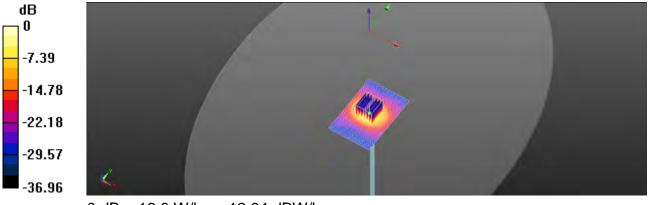
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.908 S/m;  $\epsilon_r$  = 47.019;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.17, 4.17, 4.17); Calibrated: 2018/1/23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn547; Calibrated: 2018/3/16
- Phantom: ELI
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Area Scan (61x91x1): Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 16.0 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 54.00 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 32.9 W/kg SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.19 W/kg Maximum value of SAR (measured) = 16.0 W/kg



0 dB = 16.0 W/kg = 12.04 dBW/kg

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# 7. DAE & Probe Calibration Certificate

	ch, Switzerland		C Service suisse d'etalonnage Servizio svizzero di tarstura S Swiss Calibration Service
conditied by the Swiss Accredit the Swiss Accreditation Servic Aultilateral Agreement for the r	oe is one of the signatorie	s to the EA	itation No.: SCS 0108
Client SGS (Auden)		Certilic	min No: DAE4-547_Mar18
CALIBRATION (	CERTIFICATE		
Object	DAE4 - SD 000 D	004 BM - SN: 547	
Calibration procedure(s)	QA CAL-06.v29 Galibration proces	dure for the data acquisition	electronics (DAE)
Calibration dete:	March 16, 2018		
The measurements and the unce All calibrations have been condu	ettainlies with confidence pr	onal standards, which realize the phys robability are given on the following pa y lectility: emirronment temperature. (22	ges and are part of the certificate.
The measurements and the uno All calibrations have been condu Calibration Equipment used (M& Primary Standards	ettainties with confidence pr otad in the closed laborator TE critical for calibration)	obability are given on the following part y leadily: environment temperature (22 Cal Data (Cartificate No.)	ges and are part of the certificate. ( ± 3)°C and humidity < 70%. Schedulod Calibration
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithlay Multimeter Type 2001	entainties with confidence pr cted in the closed laborator TE critical for calibration)	robability and given on the following pay	ges and are part of the certificate. $\pm 30^{\circ}\mathrm{C}$ and humidity $< 70\%$ .
The measurements and the unce All calibrations have been condu Calibration Equipment used (M8 Primary Standards Keithley Multimeter Type 2001 Secondary Standards	ID # ID # ID #	robability and given on the following pail y lacility: emirorment temperature. (22 Cal Date (Cartificate No.) 31-Aug-17 (No:21082) Check Date (in house)	ges and are part of the certificate. ± 30°C and humidity < 70%. <u>Scheduled Calibration</u> Aug-18 Scheduled Check.
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accrutitation No.: SCS 0108

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#### Glossary

DAE Connector andle

data acquisition electronics 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 Ofiset 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**

High Range:	1LS8 =	5.1nV	full range =	100+300 mV
Low Range:	1LSB -	6TnV.		

Calibration Factors	Х	¥	Z
High Range	403.254 ± 0.02% (k=2)	403.158 ± 0.02% (k=2)	402.803 ± 0.02% (k=2)
		3.90484 ± 1.50% (k=2)	

#### **Connector Angle**

Connector Angle to be used in DASY system	90.5°±1°
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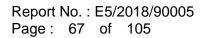
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#### Appendix (Additional assessments outside the scope of SCS0108)

#### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	200032.85	-2.13	-0.00
Channel X + Input	20008.76	3.21	0.02
Channel X - Input	-20000.69	4.51	-0.02
Channel Y + Input	200033.55	-4.13	-0.00
Channel Y + Input	20003.79	-1,78	-0.01
Channel Y - Input	-20005.44	-1.22	0.01
Channel Z + Input	200031.86	-3.06	-0.00
Channel Z + Input	20006.10	0.58	0.00
Channel Z - Input	-20003.99	1.29	-0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2001.72	0.18	0,07
Channel X + Input	201,65	0.01	0.01
Channel X - Input	-198.51	-0.28	0.14
Channel Y + Input	2001.34	-0.09	-0,00
Channel Y + Input	200,96	-0.70	-0.35
Channel Y - Input	-199.61	-1.33	0.67
Channel Z + Input	2001,33	-0.06	-0.00
Channel Z + Input	200.08	-1.48	-0.74
Channel Z - Input	-200,26	-1.91	0.96

#### 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	-3.69	-5.17
	+ 200	5.60	4.08
Channel Y	200	-0.50	-1,15
	- 200	0.25	-0,51
Channel Z	200	5.51	5.17
1	- 200	-7.82	-8.28

#### 3. Channel separation

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200		3.20	-2.58
Channel Y	200	9.59	-	3.91
Channel Z	200	5.09	7.98	1

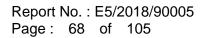
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#### 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	16363	15273
Channel Y	16469	16100
Channel Z	16083	17048

#### 5. Input Offset Measurement

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

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-1,57	-2.25	-0.71	0.35
Channel Y	0.27	-0.91	1.98	0,42
Channel 2	0.12	-1.25	1.42	0.47

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25(A

#### 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 (- Vec)	-0.01	-8	-9

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Dbjerd	EX3DV4 - SN:383	1	
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Selibration date:	January 23, 2018		
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Calibration Laboratory of Schmid & Partner Engineering AG ughausstrasse 43, 6004 Zurich, Switzerland Ze



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titation No.: SCS 0108

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Multilateral Agreement for the recognition of cellbration certificates Glossary:

ISL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,v,z
DCP	blode compression point
CF	crest factor (1/duty cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization o	e rotation around probe axis
Potarization 9	9 rotation around an axis that is in the plane normal to probe exis (at measurement center), i.e., 9 = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the rotiol coordinate system

#### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement
- b)
- Techniques", June 2013 IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016 IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wheless communication devices
- C) used in close proximity to the human body (frequency range of 30 MHz to 0 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 8 = 0 (f ≤ 900 MHz in TEM-cell; I > 1800 MHz; R22 waveguide). NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not affect the E<sup>2</sup>-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 t > 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 NORMs, 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 MH<sub>2</sub>
- Spherical isotropy (3D deviation from isotropy), in a field of low gradients realized using a flat phantom exposed by a patch enterna. 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 NORMs (no uncertainty required).

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EX3DV4 - SN:3831

January 23, 2018

# Probe EX3DV4

# SN:3831

Manufactured: Calibrated:

September 6, 2011 January 23, 2018

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

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EX3DV4- SN:3831

January 23, 2018

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor 2	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	0.43	0.41	0.42	± 10.1 %
DCP (mV) <sup>#</sup>	100.3	106.6	101.4	- 1911 14

#### Modulation Calibration Parameters

uio	Communication System Name		A dB	B dBõV	c	D dB	VR mV	Unc <sup>t</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	176.5	±35%
-		Y	0.0	0.0	1.0		196.9	-
		Z	0.0	0.0	1.0		196.8	

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%.

The uncertainties of Norm X,Y,Z do set affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 8). Numerical integration parameter uncertainty not required Uncertainty e determined using the max, deviation from linear response applying rectanguar distribution and is expressed for the square of the field welk in

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EX3DV4- SN:3831

January 23, 2018

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

f (MHz) <sup>c</sup>	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>Q</sup> (mm)	Unc (k=2)
750	41.9	0.89	9.55	9.55	9.55	0,32	1.00	± 12.0 %
835	41.5	0.90	9.10	9,10	9.10	0.29	1.04	± 12.0 %
900	41.5	0.97	9.00	9.00	9,00	D,40	0.85	±12.0 %
1750	40.1	1.37	8.09	8.09	8.09	0.37	0.80	± 12.0 %
1900	40.0	1.40	7.78	7.78	7.78	0,34	0.84	± 12.0 %
2000	40.0	1.40	7.79	7.79	7.79	0.27	0.84	±12,0 %
2300	39.5	1.67	7.50	7.50	7.50	0,32	0.80	± 12.0 %
2450	39.2	1.60	7.16	7.16	7.16	0.38	0.84	± 12.0.%
2600	39.0	1.96	6.95	6.95	6.95	0.38	0.82	112.0 %
3500	37.9	2.91	6.64	6.64	6.64	0.30	1.20	± 13.1 %
5200	36.0	4.66	4.86	4.86	4.86	0.35	1.60	±13.1 %
5300	35.9	4,76	4.65	4.65	4.65	0.35	1.80	±13.1 %
5600	35.5	5.07	4.49	4.49	4,49	0.40	1.80	±13.1 %
5800	35.3	5.27	4.50	4.50	4.50	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Head Tissue Simulating Media

<sup>5</sup> Prequency 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 ConvE uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz to ± 50, ADV to and 70 MHz for ConvE assessments at 30, 64, 128, 150 and 200 MHz respectively. Above 5 GHz frequency validity below 300 MHz to ± 10, bHz. The uncertainty for the indicated frequency band. Frequency validity below 300 MHz to ± 10, bHz. The uncertainty is a be extended to ± 110 MHz. The uncertainty is a set of the indicated frequency band in the indicated frequency validity can be extended to ± 10% of figure compensation formula is applied to measure of the transmission of the test of the indicated frequency and the test of the indicated the set of the indicated frequency validity of tissue parameters (c and e) is restricted to ± 5%. The uncertainty is the FSS of the ConvE meeting for indicated target before the set of the test of the indicated they detected the set of the indicated there are been set of the set of

diameter from the boundary

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EX30V4- SN:3831

January 23, 2018

f (MHz) <sup>G</sup>	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha <sup>9</sup>	Depth <sup>®</sup> (mm)	Unc (k=2)
750	55.5	0.96	9.39	9.39	9,39	0.34	1.00	± 12.0 %
835	55.2	0.97	9.18	9.18	9.18	0.39	0.85	= 12.0 %
900	55.0	1.05	9.13	9,13	9.13	0.32	0.96	±12.0 %
1750	53.4	1.49	7.65	7.85	7.65	0.32	0.85	±12.0 9
1900	53,3	1.52	7.35	7.35	7.35	0.38	0.81	# 12.0 9
2000	53.3	1.52	7.51	7.51	7.51	0.36	0.80	± 12.0 %
2300	52.9	1.81	7.29	7.29	7.29	0.36	88.0	± 12.0 9
2450	52.7	1.95	7.26	7.26	7.28	0.34	0,88	± 12.0 9
2600	52.5	2.16	6,95	6.95	6.95	0.25	0.99	± 12.0 9
3500	51.3	3.31	6.60	6.60	6.60	0.30	1.20	# 13.1 9
5200	49.0	5.30	4.56	4,56	4,56	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.39	4.39	4.39	0.35	1.90	± 13.1 9
5600	48.5	5.77	3.92	3.92	3.92	0.40	1.90	±13.1 9
5800	48.2	6.00	4.17	4.17	4.17	0.40	1.90	±13.1 9

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

<sup>6</sup> Frequency validity above 300 kHz of ± 100 MHz only applies for DASY v4.4 and higher (see Prope 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the CorvE uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 22, 40, 50 and 70 MHz for CorvE assessments at 50, 64, 128, 150 and 220 MHz respectively. Above 5 EHz trequency validity and be extended to ± 10 MHz. The validity of the uncertainty is the extended to ± 10 MHz. The validity of the corvE assessments at 50, 64, 128, 150 and 220 MHz respectively. Above 5 EHz trequency validity and the uncertainty for the respectively. Above 5 EHz trequency validity on the extended to ± 110 MHz. The validity of issue parameters (is and or) a restricted to ± 5%. The uncertainty is the RSS of the CorvE insertion is uncertainty for indicated target insue parameters.

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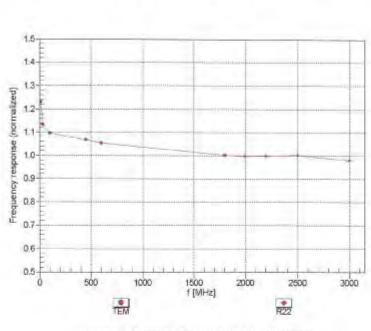
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EX3DV4- SN:3831

January 23, 2018



## 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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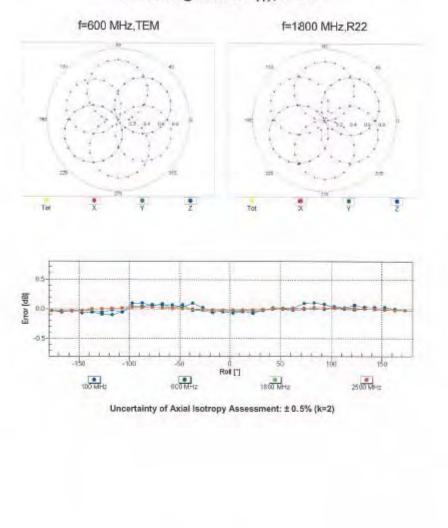
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EX3DV4- SN:3831

January 23, 2018



Receiving Pattern ( $\phi$ ),  $\vartheta = 0^{\circ}$ 

Certificate No: EX3-3831\_Jan18

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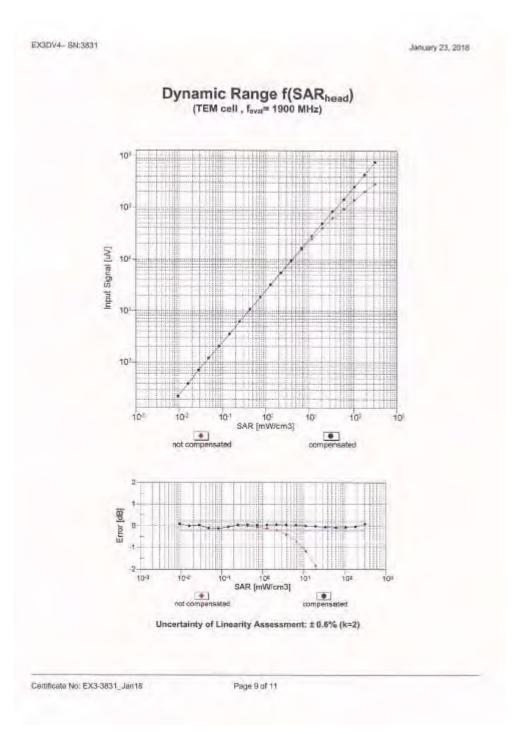
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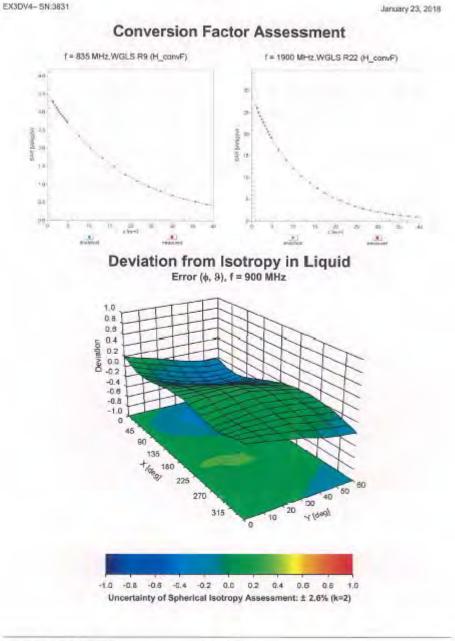
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EXEDV4- SN JIL11

January 23, 2018

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-17.1
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 Diaméter	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 mim
Recommended Measurement Distance from Surface	1.4 mm

Certificale No. EX3-3831\_Jan18

Rage 11 01 11

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# 8. Uncertainty Budget

A	с	D	е		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%	00
lsotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	œ
lsotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	œ
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	8
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	80
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	80
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	80
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	80
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	00
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	œ
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	œ
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	œ
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	œ
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	œ
Probe Positioning with respect to phantom shell	2.90%	R	√3	1.732	1	1	1.67%	1.67%	œ
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	80
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	80
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%	80
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	œ
Liquid permittivity (mea.)	2.54%	N	1	1	0.64	0.43	1.63%	1.09%	М
Liquid Conductivity (mea.)	2.15%	Ν	1	1	0.6	0.49	1.29%	1.05%	М
Combined standard uncertainty		RSS					11.90%	11.80%	
Expant uncertainty (95% confidence interval), K=2							23.80%	23.61%	

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

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A	с	D	е		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%	Ν	1	1	1	1	6.00%	6.00%	~
lsotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	~
lsotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	$\infty$
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%	Ν	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%	$\infty$
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	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	~
Test Sample related									
Test sample positioning	2.90%	Ν	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	Ν	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%	$\infty$
Liquid permittivity (mea.)	2.25%	N	1	1	0.64	0.43	1.44%	0.97%	М
Liquid Conductivity (mea.)	3.83%	N	1	1	0.6	0.49	2.30%	1.88%	М
Combined standard uncertainty		RSS					11.74%	11.60%	
Expant uncertainty (95% confidence interval), K=2							23.47%	23.20%	

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

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## 9. Phantom Description

Schmid & Partner Engineering AG

s а D e a

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 $\leq 0.05$ , at $f \leq 6$ GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material Compatibility with tissue resistivity 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

\*\*

- OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
   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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nd & Barther Engineering AG bayestrassa 43, 8004 Kulch, Shiteriar 8/441 44/25-9708 Fext-44 44/55 9779

Doc No 881 - QD OVA 002 A - A

Page 1(1)

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## **10. System Validation from Original Equipment Supplier**

Engineering AG ghausstrasse 43, 8004 Zurict	n, Switzerland		C Service suisse d'étaionnage Servizio svizzero di taratura S Swiss Calibration Service		
coordinate by the Swise According to Swise Accordination Service ultilateral Agreement for the re	is one of the signatorie	- Action Self	Accredibilition No.: SCS 0108		
lient SGS-TW (Aude	n)	Certificate	No: D2450V2-727_Apr18		
CALIBRATION C	ERTIFICATE				
Deject	D2450V2 - SN:73	27			
Calibration proceedure(s)	QA CAL-05.v10 Calibration proce	dure for dipole validation kits a	above 700 MHz		
Calibration date:	April 24, 2018				
		onal standards, which realize the physica robability are given on the following pages			
and a second state in the second state of the	cted in the closed laborato	ry facility: environment temperature (22 ±	37°C and humidity < 70%		
		and for an arrange of a			
Calibration Equipment used (M&)	TE onlical for calibration)				
Calibration Equipment used (M&1 Primary Standards	TE critical for calibration)	Cal Data (Cettingale No.)	Screduled Calibration		
Calibration Equipment used (M&1 Primisry Standards Power mater NRP	TE onlical for calibration)	Cal Data (Cestificate No.) D4-Apr-18 (No. 217-02672/02673)	Schedured Calibration Apr-19		
Calibration Equipment used (M&1 Primary Standards Power mater (MRP Power sensor NRP-291	TE ontical for cellibration) ID & SN: 104778 SN: 103244	Cal Data (Certificate No.) 04-Apr-18 (No. 217-03672/00673) 04-Apr-18 (No. 217-03672)	Scredured Calbration Apr-19 Apr-19		
Calibration Equipment used (M&1 Primisry Standards Power mater NRP Power sensor NRP-291 Power sensor NRP-291	7E ontical for calibration) ID # SN: 104779 SN: 103244 SN: 103245	Cal Data (Cettificale No.) D4-Apr-16 (No. 217-02672/02673) O4-Apr-16 (No. 217-02672) O4-Apr-16 (No. 217-02672)	Screedured Calibration Apr-19 Apr-19 Apr-19		
Calibration Equipment used (M&1 Primary Standards Power mater NRP Power sensor NRP-Z91 Reference 20 dB Attenuator	TE onlical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 5058 (20K)	Cal Data (Certificate No.) D4-Apr-16 (No. 217-02672/02673) D4-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682)	Scredured Calbration Apr-19 Apr-19		
Calibration Equipment used (M81 Inmery Standards Power mater MRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination	7E ontical for calibration) ID # SN: 104779 SN: 103244 SN: 103245	Cal Data (Cettificale No.) D4-Apr-16 (No. 217-02672/02673) O4-Apr-16 (No. 217-02672) O4-Apr-16 (No. 217-02672)	Scheduled Calibration Apr-19 Apr-19 Apr-19 Apr-19		
Calibration Equipment used (M&1 Primary Standards Power mater MRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Paterance Probe EX30V4	TE onlical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 5047.2 / 06327	Cal Data (CentRoste No.) 04-Apr-18 (No. 217-02672/02673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-0262) 04-Apr-18 (No. 217-0262)	Scredued Calbration Apr-19 Apr-18 Apr-19 Apr-19 Apr-19		
Calibration Equipment used (M&1 Primary Standards Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-M mismatch combination Reference Probe EX3DV4 DAE4	TE ontical for calibration) ID # SN: 104778 SN: 103244 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	Cal Data (Certificate No.) 04-Apr-18 (No. 217-02672/CC673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EK3-Y349_Dec17)	Schedured Calibration Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Doc-18		
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Calibration Equipment used (M81 Primary Standards Prever motor MRP Power sensor NRP-201 Power sensor NRP-201 Reterance 20 dB Attenuator Type-N mismatch combination Raterance Probe EX30V4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 0481A	TE ontical for calibration) ID # SN: 104778 SN: 103244 SN: 103244 SN: 103245 SN: 5058 (20K) SN: 5058 (20K) SN: 5058 (20K) ID # SN: GB37450704	Cal Data (Certificate No.) 04-Apr-16 (No. 217-02672/02673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EX3-7349_Dec17) 25-Oct-17 (No. DAE4-601_Dct17) Dhock Date (in house) 07-Oct-15 (in house check Oct-16)	Schedured Calibration Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Scheduled Check In fouse check: Oct-18		
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Calibration Laboratory of Schmid & Partner



ac-MR/

Sanweizerischer Kallbrierdi s Service suisse d'étalormagé C Servizio evizzoro di tarabura Swiss Calibration Service

Accreditation No.: SCS 0108

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 caliberation coefficience Glossary:

TSL

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

#### Calibration is Performed According to the Following Standards:

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

#### Additional Documentation:

e) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

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#### Measurement Conditions

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

DASY Version	DASYS	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	da, 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	38.3 ± 8 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>5</sup> (1 g) of Head TSL	Condition	
SAR measured	250 m/W input power	13,3 W/kg.
SAR for nominal Head TSL parameters	hormalized to 1W	52.1 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	8.16 W/kg

#### **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 %	2.01 mhc/m = 6 %
Body TSL temperature change during test	< 0,5 °C	_	

#### SAR result with Body TSL

SAR sveraged over 1 cm <sup>2</sup> (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	50.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Bbdy TSL SAR measured	condition 250 mW input power	6.00 W/kg

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#### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.2 Ω + 2.7 JΩ	
Return Loss	= 25.1 dB	

#### Antenna Parameters with Body TSL

Impledance, transformed to lead point	51.2 Q + 5.8 Q
Fietum Loss	- 25.0 dB

#### General Antenna Parameters and Design

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

The dipole is made of standard semingid 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 capaare 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 both or the soldered connections rear 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: 24.04.2018

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;  $\sigma = 1.86 \text{ S/m}$ ;  $\epsilon_t = 38.3$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

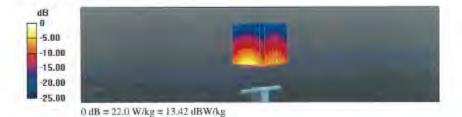
DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.88, 7.88, 7.88); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017 .
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001 ٠
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid; dx=5mm, dy=5mm, dz=5mm

Reference Value = 116.0 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 26.7 W/kg SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.16 W/kg

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



Centificate No: D2450V2-727\_April8

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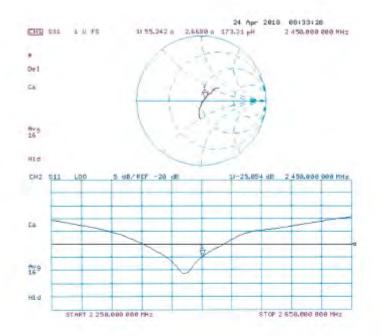
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#### Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-727\_Apr18

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#### **DASY5 Validation Report for Body TSL**

Date: 24.04.2018

Test Laboratory: SPEAG, Zurich, Switzerland

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

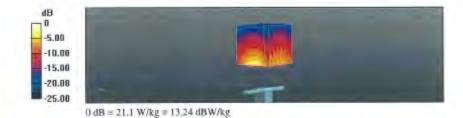
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.01$  S/m;  $v_r = 52.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.01, 8.01, 8.01); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 108.4 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 25.5 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6 W/kg Maximum value of SAR (measured) = 21.1 W/kg



Certificate No: D2450V2-727 April8

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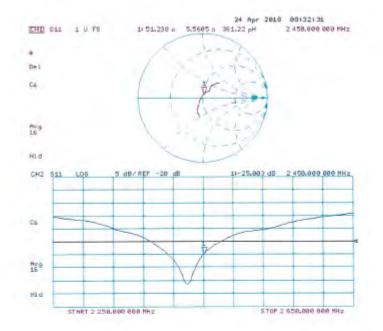
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#### Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-727\_Apr18

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coredited by the Swiss Accredit he Swiss Accreditation Servic builtiatoral Agreement for the r	e is one of the signatories	s to the EA	preditation No.: SCS 0108
lient SGS-TW (Aud	an)	Certificate No	D5GHzV2-1023_Jan18
CALIBRATION	CERTIFICATE		
Object	D5GHzV2 - SN:1	023	-
Calibration procedure(s)	QA CAL-22.v2 Calibration proce	dure for dipole validation kits bat	ween 3-6 GHz
Calibration date:	January 25, 2018		
All calibrations have been condu	icted in the closed laborato	could standards, which realize the physical un robability are phren on the following peages an ry facility, ecwironment temperature ( $22 \pm 3$ )*	ed any part of the certificate.
All calibrations have been condu Galibration Equipment used (Mil	icted in the closed laborato	robability are phren on the following pages an ry facility: environment temperature (22 ± 3)* Call Date (Certificate No.)	d ere part of the certificate. C and humidity = 70%. Scheduled Calibration
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All calibrations have been conde Calibration Equipment used (M& Primery Standards Power sensor NRP, 251 Power sensor NRP, 251 Referance 20 dB Alternator	ID A BN: 103244 SN: 103245 SN: 5058 (20k)	robability are given on the following pages or ry facility: environment temperature (22 = 3)** Call Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	d ere part of the certificate. C and humidity # 70%. Boheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18
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All calibrations have been condu Calibration Equitorment used (Mé Primury Standards Power sensor NRP-Z01 Power sensor NRP-Z01 Power sensor NRP-Z01 Reformance 20 dB Attenuation Type-N mismatch combination Reference Probe EX3DV4	ID A BN: 103244 SN: 103245 SN: 5058 (20k)	robability are given on the following pages or ry facility: environment temperature (22 = 3)** Call Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	d ere part of the certificate. C and humidity # 70%. Boheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18
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All calibrations have been conde Calibration Equipment used (M8 Primery Standards Power sensor NRP-251 Power sensor NRP-251 Reformance 20 dB Alternation Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	ID # ID # SN: 103244 SN: 103244 SN: 103244 SN: 103244 SN: 103245 SN: 504727 06327 SN: 504727 06327 SN: 3503	robability are phren on the following peges an ry (actiny, environment temperature (22 = 3)** Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 30-Dec-17 (No. 217-02528)	d ere part of the certificate. C and humidity = 70%. Boheduled Calibration Apr-18 Apr-18 Apr-18 Apr-16 Apr-16 Dac-18 Oct-18
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All calibrations have been conde Calibration Equipment used (Md Primury Standards Power meter NRP Power sensor NRP-201 Power sensor NRP-201 Power sensor NRP-201 Power sensor NRP-201 Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 6481A HT generator R8S 5MT-06	ID # ID # EN: 104778 SN: 103244 SN: 103244 SN: 103244 SN: 103245 SN: 50472 / 05327 SN: 3503 SN: 601 ID # SN: 6837480704 SN: 0537262783 SN: 100672 SN: 100672 SN: US37380985	Instability are phren on the following pages and ry (actiny, environment temperature (22 = 3)**           Cal Date (Certificate No.)           04-Apr-17 (No. 217-02521/02522)           04-Apr-17 (No. 217-02521)           07-Apr-17 (No. 217-02521)           07-Apr-17 (No. 217-02521)           07-Apr-17 (No. 217-02529)           07-Apr-17 (No. 217-02529)           09-Dec-17 (No. 217-02529)           07-Apr-17 (No. 217-02529)           07-Oct-15 (In house)           07-Oct-15 (In house check Oct-16)           07-Oct-15 (In house check Oct-16)           07-Oct-15 (In house check Oct-16)           19-Jun-15 (In house check Oct-16)           19-Oct-01 (In house check Oct-17)	d ere part of the certificate. C and humidity = 70%. Apr-18 Apr-18 Apr-18 Apr-18 Apr-16 Dac-18 Oct-18 Oct-18 Scheduled Check In flouse check: Oct-18 in flouse check: Oct-18
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## Report No. : E5/2018/90005 Page: 92 of 105

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



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Accreditation No.: SCS 0108

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## Glossary:

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

#### Calibration is Performed According to the Following Standards:

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

Certificate No: D5GHzV2-1023\_Jan18

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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 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 mha/m
Measured Head TSL parameters	(22.0±0.2) °C	36.3 ± 6 %	4.50 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.72 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.3 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>8</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition	2.22 W/kg

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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	36.2 ± 6 %	4.60 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 <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.9 W / kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2,32 W/kg
		2.32 W/kg 23.2 W/kg ± 19.5 % (ke2

#### Head TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	35.8±6%	4.90 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.19 W/kg
SAR for nominal Head TSL perameters	normalized to 1W	81,9 W/kg = 19,9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.34 W/kg

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#### Head TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35:3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5±6%	5,11 mho/m ± 8 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.90 W/kg
SAR for nominal Head TSL parameters.	normalized to 1W	79.0 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.25 W/kg

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#### Body TSL parameters at 5200 MHz

	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	47.3 ± 6 %	5.41 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	-

#### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	70.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.00 W/kg

#### Body TSL parameters at 5300 MHz

	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	47.1±6%	5.54 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	-

## SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.34 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	72.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2,06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.4 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 mha/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.6±6%	5.94 mha/m ± 6 %
Body TSL temperature change during lesi	< 0.5 °C	-	

#### SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>9</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.6 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2 19 W/kp
		2 19 W/kg 21.7 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mhaim
Measured Body TSL parameters	(22.0 ± 0.2) °C	45.2 ± 6 %	6.22 mha/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	-

#### SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7,46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.1 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2,07 W/kg

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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	50,1 Ω - 8,1 jΩ	
Return Loss	- 21.9 dB	

## Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.5 Q - 2.3 jQ
Return Loss	- 32,7 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.9 Ω - 0.7  Ω	
Return Loss	- 28.4 dB	

#### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed its feed point	55.3 II + 2.6  II
Hetum Loss	- 25.1 dB

## Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to leed point	49.8 (7 - 5.9 (2
Return Loss	- 23.2 dB

## Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to leed point	50,9 Ω · 0.9 jΩ	
Return Loss	- 37.9 dB	

## Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.0 Ω + 0.5 JΩ
Return Loss	- 24.9 dB

## Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to leed point	56.6.Ω + 2.3 jΩ
Return Loss	- 23.7 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' parsigraph. 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 time feedpoint may be damaged.

#### Additional EUT Data

Menufactured by	SPEAG
Manufactured on	February 05, 2004

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### **DASY5 Validation Report for Head TSL**

Date: 25.01.2018

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;  $\sigma = 4.5 \text{ S/m}$ ;  $\epsilon_s = 36.3$ ;  $\rho = 1000 \text{ kg/m}^4$ . Medium parameters used: f = 5300 MHz;  $\sigma = 4.6$  S/m;  $r_c = 36.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5600 MFiz; a = 4.9 S/m; r, = 35.8: p = 1000 kg/m2 Medium parameters used: f = 5800 MHz;  $\sigma = 5.11$  S/m;  $\epsilon_r = 35.5$ ;  $\rho = 1000$  kg/m Phantom section: Flat Section

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

DASY52 Configuration:

- Prope: EX3DV4 SN3503; ConvF(5.75, 5.75, 5.75), Calibrated: 30.12.2017. ConvF(5.5, 5.5, 5.5); Calibrated: 30.12.2017; ConvF(5.05, 5.05, 5.05); Calibrated: 30.12.2017; ConvF(4.96, 4.96, 4.96); Calibrated; 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electromics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52,10.0(1446); SEMCAD X 14.6.10(7417) .

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MH<sub>2</sub>/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.47 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 27.5 W/kg SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.22 W/kg Maximum value of SAR (measured) = 17.7 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=L4mm Reference Value = 74.63 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 29.6 W/kg SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.32 W/kg Maximum value of SAR (measured) = 18.6 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 = 70.79 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 31.5 W/kg SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.34 W/kg Maximum value of SAR (measured) = 19.6 W/kg

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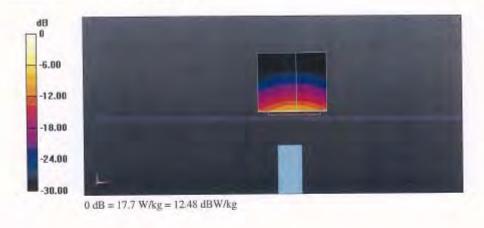
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Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.22 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 31.2 W/kg SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.25 W/kg Maximum value of SAR (measured) = 19.0 W/kg



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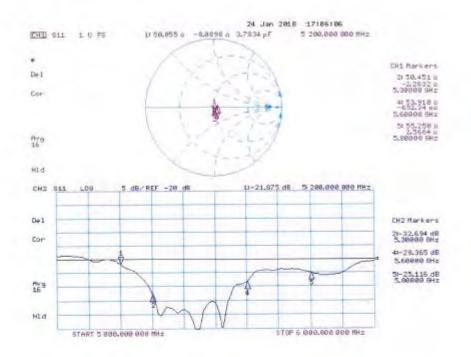
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## Impedance Measurement Plot for Head TSL



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#### DASY5 Validation Report for Body TSL

Date: 23.01.2018

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;  $\sigma = 5.41 \text{ S/m}$ ;  $\epsilon_r = 47.3$ ;  $p = 1000 \text{ kg/m}^3$ . Medium parameters used: f = 5300 MHz; σ = 5.54 S/m; ε<sub>r</sub> = 47.1; ρ = 1000 kg/m<sup>3</sup> Medium parameters used: f = 5600 MHz; a = 5.94 S/m; er = 46.6; p = 1000 kg/m<sup>3</sup>. Medium parameters used: f = 5800 MHz;  $\sigma = 6.22$  S/m;  $r_r = 46.2$ ; p = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration.

- Probe; EX3DV4 SN3503; ConvF(5.35, 5.35, 5.35); Calibrated: 30 12,2017. ConvF(5.15, 5.15, 5.15); Calibrated; 30,12,2017, ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2017, ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Senal: 1002
- DASY52 52, 10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 66.00 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 26.4 W/kg SAR(1 g) = 7.14 W/kg; SAR(10 g) = 2 W/kg Maximum value of SAR (measured) = 16.8 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 = 65.19 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 28.4 W/kg SAR(1 g) - 7.34 W/kg; SAR(10 g) = 2.06 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 = 66.21 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 32.8 W/kg SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.19 W/kg Maximum value of SAR (measured) = 19.1 W/kg

Certilicate No: D5GHzV2-1023 Jan18

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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 = 64.05 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 32.3 W/kg SAR(1 g) = 7.46 W/kg; SAR(10 g) = 2.07 W/kg Maximum value of SAR (measured) = 18.8 W/kg



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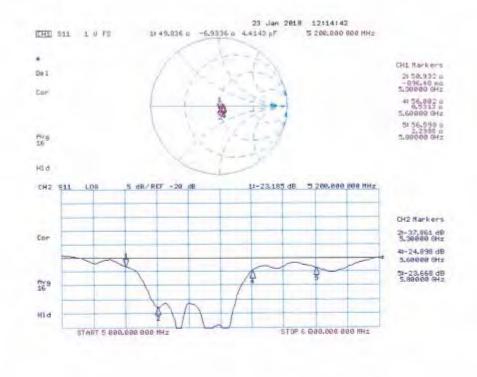
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#### Impedance Measurement Plot for Body TSL



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## - End of report -

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