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SAR TEST REPORT

FCC 47 CFR Part 2.1093
Industry Canada RSS-102

RF-Exposure evaluation of portable equipment

Report Reference No. .... :	G0M-1905-8271-TFC093SR-V01
Testing Laboratory .... :	Eurofins Product Service GmbH
Address .... :	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation .... :	ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12092-01-03 ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12092-01-04 DAkkS - Registration number : D-PL-12092-01-03 (ISED) ISED Testing Laboratory site: 3470A-2 DAkkS - Registration number : D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant's name .... :	Leica Geosystems AG
Address .... :	Heinrich Wild Strasse 9435 Heerbrugg SWITZERLAND
Test specification:	
Standard.. :	FCC 47 CFR Part 2 §2.1093 447498 D01 General RF Exposure Guidance v06 IEEE Std. 1528 - 2013 ISED RSS-102 Issue 5
Non-standard test method…………..:	None
Test scope………….. .... :	complete Radio compliance test
Equipment under test (EUT):	
Product description	Imaging Laser Scanner
Model No.	BLK2GO
Additional Model(s)	None
Brand Name(s)	Leica
Hardware version	HW Rev. B
Firmware / Software version	EDM FPGA SW V1.3; Main_FPGA SW V0.4; Alcapone SW V.0.4.8; Android V. 3.1
FCC-ID:	RFD-BLK2GO
IC:	3177A-BLK2GO
Test result	**Passed**

Possible test case verdicts:	
- neither assessed nor tested ....:	N/N
- required by standard but not appl. to test object ....:	N/A
- required by standard but not tested ....:	N/T
- not required by standard for the test object ....:	N/R
- test object does meet the requirement ....:	P (Pass)
- test object does not meet the requirement ....:	F (Fail)

Testing:		
Date of receipt of test item ....:	2019-07-15	
Date (s) of performance of tests ....:	2019-10-21 - 2019-12-05	
Compiled by ....:	Burkhard Pudell	
Tested by (+ signature) ....: (Responsible for Test)	Burkhard Pudell	B. Pudell ....
Approved by (+ signature) ....: (Head of Lab)	Christian Weber	C. Weber ....
Date of issue ....:	2019-12-12	
Total number of pages ....:	160	

General remarks:

The test results presented in this report relate only to the object tested.
The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

Additional comments:

Access Point mode in 2.4 GHz band only. 5 GHz band station mode only.

Version History

Version	Issue Date	Remarks	Revised by
01	2019-12-12	Initial Release	

Eurofins Product Service GmbH
Storkower Str. 38c, D-15526 Reichenwalde, Germany

REPORT INDEX

1 Equipment (Test item) Description

Description	Imaging Laser Scanner	
Model	BLK2GO	
Additional Model(s)	None	
Brand Name(s)	Leica	
Serial number	3630030	
Hardware version	HW Rev. B	
Software / Firmware version	EDM FPGA SW V1.3; Main_FPGA SW V0.4; Alcapone SW V.0.4.8; Android V. 3.1	
PMN	BLK2GO	
HVIN	BLK2GO	
FVIN	EDM FPGA SW V1.3 - MAIN_FGPA SW V0.4 - ALCAPONE SW V0.4.8 - ANDROID V3.1	
HMN	none	
FCC-ID module	PPD-QCNFA324	
IC module	4104A-QCNFA324	
Equipment type	End product	
Prototype or production unit	Production Unit	
Device category	Handset	
Environment	General public	
Radio technologies	WLAN IEEE 802.11a,b,g,n,an,ac / Bluetooth Classic + LE	
Tune-up tolerance	(2.4GHz) ±1.5dB / (5GHz) ±2dB	
Operating frequency ranges	WLAN 2.4G: 2412 - 2462 MHz Bluetooth : 2402 - 2480 MHz WLAN 5GHz UNII-1/-2A: 5170 - 5330 MHz WLAN 5GHz UNII-2C: 5490 - 5710 MHz	
Modulations	WLAN 2.4G: CCK / DSSS / OFDM Bluetooth : GFSK, PI/4-DQPSK, 8-DPSK WLAN 5GHz: BPSK / QPSK / 16-QAM / 64-QAM	
Antenna 0	Type	integrated
	Model	2458N (120-232-01)
	Manufacturer	Wepotec electronic solutions gmbh
	Gain	b, g: -2.9dBi; a: -1.4dBi
Antenna 1	Type	integrated
	Model	2458S (120-233-01)
	Manufacturer	Wepotec electronic solutions gmbh
	Gain	b, g: -3.1dBi; a: -1.6dBi
Power supply	V_{NOM}	7.2 VDC (Lithium Battery)

AC/DC-Adaptor	Model	None
	Vendor	None
	Input	None
	Output	None
Accessories	Charger	
Manufacturer	Leica Geosystems AG Heinrich Wild Strasse 9435 Heerbrugg SWITZERLAND	

1.3 Reference Documents

Document
KDB Publication 447498 : Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Polices
KDB Publication 648474 : SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antennas
KDB Publication 648474 : Review and Approval Policies for SAR Evaluation of Handsets with Multiple Transmitters and Antennas
KDB Publication 865664 : SAR measurement procedures for devices operating between 100 MHz to 6 GHz
KDB Publication 941225: SAR Measurement Procedures for 3G Devices
KDB Publication 941225: 3GPP R6 HSPA and R7 HSPA+ SAR Guidance
KDB Publication 941225: Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE
KDB Publication 941225: SAR Test Consideration for LTE Handsets and Data Modems
KDB Publication 447498 : SAR Measurement Procedures for USB Dongle Transmitters
KDB Publication 248227 : SAR Measurement Procedures for 802.11 a/b/g Transmitters
KDB Publication 450824 : SAR Probe Calibration and System Verification considerations for measurements from 150 MHz to 3 GHz

1.4 Supporting Equipment Used During Testing

Product Type*	Device	Manufacturer	Model No.	Comments
AE	Laptop	DELL	E5530	Control unit

***Note:** Use the following abbreviations:

AE : Auxiliary/Associated Equipment, or

SIM : Simulator (Not Subjected to Test)

CABL : Connecting cables

1.5 Supported standalone operating modes

Mode	Modulation	Frequency range	Duty cycle
BT-BR/LE	GFSK	2402 – 2480 MHz	0.77/0.66
BT-EDR	PI/4-DQPSK	2402 – 2480 MHz	0.77
BT-EDR	8-DPSK	2402 – 2480 MHz	0.77
WLAN 2.4G b	DSSS	2412 – 2462 MHz	1.0
WLAN 2.4G g/n	OFDM	2412 – 2462 MHz	1.0
802.11a/an/ac	OFDM	5170 – 5330 MHz	1.0
802.11a/an/ac	OFDM	5490 – 5710 MHz	1.0

1.6 Conducted Power Values

Bluetooth BR+EDR – Average Output Power			
Antenna port	0		
Frequency [MHz]	Source-base time-average power [dBm]		
	BR (GFSK)	EDR (PI/4-DQPSK)	EDR (8-DPSK)
	DH5	2-DH5	3-DH5
2402	9.0	6.0	6.1
2441	**9.1**	6.8	6.9
2480	8.9	5.8	5.9
Date, Operator:	29.10.2019 , B. Pudell		

Bluetooth Low Energy – Average Output Power	
Antenna port	0
Frequency [MHz]	Source-base time-average power [dBm]
	GFSK
2402	0.8
2440	**1.1**
2480	0.6
Date, Operator:	29.10.2019 , B. Pudell

WLAN 2.4G b – Average Output Power						
Antenna port			0			
Band	Channel	Frequency [MHz]	average power [dBm]			
			Data rate [Mbps]			
			1	2	5.5	11
2.4 GHz	1	2412	**11.7**	11.7	11.6	11.5
	6	2437	11.3	11.2	11.1	11.0
	11	2462	11.5	11.5	11.3	11.2
WLAN 2.4G b – Average Output Power						
Antenna port			1			
Band	Channel	Frequency [MHz]	average power [dBm]			
			Data rate [Mbps]			
			1	2	5.5	11
2.4 GHz	1	2412	**2.4**	2.2	2.0	1.8
	6	2437	1.8	1.7	1.7	1.5
	11	2462	1.8	1.9	1.5	1.4
Date, Operator:			12.11.2019 , B. Pudell			

WLAN 2.4G g – Average Output Power										
Antenna port			0							
Band	Channel	Frequency [MHz]	average power [dBm]							
			Data rate [Mbps]							
			6	9	12	18	24	36	48	54
2.4 GHz	1	2412	**11.3**	11.2	11.2	11.1	10.6	10.3	9.8	9.9
	6	2437	11.0	10.2	10.7	10.5	10.0	10.7	9.4	9.3
	11	2462	11.0	11.0	10.9	10.6	10.2	9.8	9.5	9.5
WLAN 2.4G g – Average Output Power										
Antenna port			1							
Band	Channel	Frequency [MHz]	average power [dBm]							
			Data rate [Mbps]							
			6	9	12	18	24	36	48	54
2.4 GHz	1	2412	1.7	1.7	1.6	1.4	0.9	0.6	0.2	0.2
	6	2437	1.9	1.8	1.7	1.6	0.9	0.9	0.4	0.2
	11	2462	1.8	1.7	1.6	1.4	0.9	0.5	0.2	0.2
Date, Operator:			12.11.2019 , B. Pudell							

WLAN 2.4G n HT20 1SS – Average Output Power											
Antenna port				0							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
2.4 GHz	20	1	2412	**11.0**	10.9	10.7	10.5	10.2	9.9	9.8	9.5
		6	2437	10.7	10.5	10.3	9.8	9.6	9.4	9.2	9.0
		11	2462	10.8	10.6	10.4	10.0	9.6	9.5	9.3	9.1
WLAN 2.4G n HT20 2SS – Average Output Power											
Antenna port				0							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2.4 GHz	20	1	2412	10.9	10.6	10.3	9.9	9.6	9.3	9.0	8.8
		6	2437	10.5	10.2	9.7	9.3	8.9	8.4	8.3	8.2
		11	2462	10.6	10.2	9.9	9.5	9.0	8.7	8.4	8.6
Date. Operator:				12.11.2019 . B. Pudell							

WLAN 2.4G n HT20 1SS – Average Output Power											
Antenna port				1							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
2.4 GHz	20	1	2412	**2.0**	1.8	1.6	1.4	1.1	0.9	0.8	0.7
		6	2437	1.5	1.4	1.2	0.9	0.6	0.4	0.2	0.0
		11	2462	1.5	1.3	1.2	0.9	0.5	0.1	0.0	0.0
WLAN 2.4G n HT20 2SS – Average Output Power											
Antenna port				1							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2.4 GHz	20	1	2412	1.8	1.2	0.9	0.6	0.3	-0.2	-0.3	-0.4
		7	2442	1.4	1.1	0.8	0.3	0.0	-0.6	-0.7	-0.8
		11	2462	1.3	1.0	0.7	0.2	-0.2	-0.5	-0.8	-0.9
Date. Operator:				12.11.2019 . B. Pudell							

WLAN 2.4G n HT40 1SS – Average Output Power											
Antenna port				0							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
2.4 GHz	40	3	2422	**10.7**	10.3	10.0	9.5	9.2	8.7	8.7	8.4
		6	2437	10.4	10.0	9.7	9.2	8.9	8.5	8.3	8.2
		9	2452	10.5	10.1	9.8	9.4	8.9	8.4	8.3	8.3
WLAN 2.4G n HT40 2SS – Average Output Power											
Antenna port				0							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2.4 GHz	40	3	2422	10.3	9.7	9.2	8.7	8.2	7.8	7.9	7.6
		6	2437	10.1	9.4	9.0	8.5	7.8	7.4	7.5	7.2
		9	2452	10.1	9.5	9.1	8.6	8.0	7.6	7.6	7.3
Date. Operator:				12.11.2019 . B. Pudell							

WLAN 2.4G n HT40 1SS – Average Output Power											
Antenna port				1							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
2.4 GHz	40	3	2422	**1.6**	1.3	0.9	0.6	0.1	-0.4	-0.5	-0.6
		6	2437	1.3	1.0	0.6	0.3	-0.2	-0.6	-0.7	-0.8
		9	2452	1.2	0.8	0.5	0.2	-0.4	-0.9	-1.0	-1.1
WLAN 2.4G n HT40 2SS – Average Output Power											
Antenna port				1							
Band	BW [MHz]	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2.4 GHz	40	3	2422	1.21	0.65	0.17	-0.18	-0.77	-1.28	-1.39	-1.48
		6	2437	0.94	0.35	-0.14	-0.68	-1.15	-1.59	-1.67	-1.75
		9	2452	0.78	0.22	-0.29	-0.72	-1.39	-1.75	-1.73	-1.91
Date. Operator:				12.11.2019 . B. Pudell							

IEEE 802.11 a – Average Output Power											
Antenna port				0							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				6	9	12	18	24	36	48	54
20	U-NII 1	36	5180	11.0	11.0	10.8	10.6	10.5	10.5	10.6	10.6
		40	5200	11.2	11.1	11.0	10.7	10.7	10.6	10.7	10.7
		44	5220	11.4	11.4	11.3	11.1	11.0	10.9	10.9	11.0
		48	5240	11.7	11.6	11.5	11.4	11.5	11.5	11.3	11.6
	U-NII 2A	52	5260	11.9	11.8	11.7	11.6	11.4	11.3	11.4	11.4
		56	5280	11.8	11.8	11.8	11.6	11.5	11.4	11.4	11.7
		60	5300	**12.9**	11.9	11.8	11.7	11.6	11.5	11.6	11.6
		64	5320	11.6	11.7	11.6	11.6	11.4	11.3	11.4	11.4
	U-NII 2C	100	5500	12.4	12.3	12.2	12.1	11.8	11.9	11.7	11.9
		104	5520	12.1	12.0	11.9	11.8	11.6	11.5	11.7	11.7
		108	5540	11.6	11.5	11.4	11.2	11.2	11.0	11.2	11.2
		112	5560	11.1	11.1	11.0	10.9	10.6	10.6	10.7	10.7
		116	5580	11.9	11.7	11.7	11.5	11.4	11.3	11.3	11.4
		120	5600	11.4	11.4	11.4	11.0	10.9	10.8	10.9	11.0
		124	5620	11.8	11.7	11.7	11.5	11.4	11.2	11.4	11.4
		128	5640	11.6	11.5	11.2	11.0	11.2	11.1	11.2	11.2
		132	5660	11.8	11.8	11.6	11.5	11.4	11.3	11.4	11.4
		136	5680	12.3	12.3	12.2	12.0	11.8	11.7	11.9	11.8
		140	5700	**12.7**	12.5	12.4	12.3	12.1	12.0	12.2	12.1
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								

IEEE 802.11 a – Average Output Power											
Antenna port				1							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				6	9	12	18	24	36	48	54
20	U-NII 1	36	5180	11.6	11.4	11.5	11.6	11.4	11.4	11.3	11.3
		40	5200	12.0	12.1	12.0	12.1	12.0	11.9	11.9	11.8
		44	5220	12.4	12.4	12.3	12.3	12.2	12.3	12.3	12.3
		48	5240	12.8	12.7	12.8	12.7	12.7	12.6	12.6	12.5
	U-NII 2A	52	5260	13.2	13.1	13.1	13.1	13.0	12.9	13.0	13.0
		56	5280	13.3	13.3	13.2	13.1	13.2	13.1	13.2	13.2
		60	5300	**13.9**	13.8	13.9	13.6	13.4	13.8	13.5	13.7
		64	5320	13.3	13.2	13.2	13.2	13.2	13.1	13.2	13.2
	U-NII 2C	100	5500	13.2	13.1	13.0	13.1	13.2	13.1	13.1	13.1
		104	5520	13.0	13.0	13.0	12.9	12.8	12.8	12.8	12.8
		108	5540	13.1	13.0	13.0	13.0	12.9	13.0	12.9	13.0
		112	5560	12.6	12.7	12.5	12.6	12.4	12.5	12.5	12.5
		116	5580	**13.2**	13.1	13.0	13.1	13.0	13.0	12.9	13.0
		120	5600	12.3	12.1	12.0	12.1	12.1	12.0	12.0	12.0
		124	5620	12.2	12.2	12.1	12.1	12.0	12.1	12.1	12.1
		128	5640	12.2	12.1	12.2	12.1	12.1	12.0	12.1	12.1
		132	5660	12.3	12.2	12.2	12.1	12.2	12.2	12.2	12.2
		136	5680	12.2	12.2	12.1	12.0	11.9	12.0	12.1	12.1
		140	5700	12.1	12.1	12.2	12.2	12.2	12.1	12.1	12.1
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								
Date. Operator:				26.10.2019 . M. Handrik							

IEEE 802.11an HT20 1SS – Average Output Power											
Antenna port				0							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
20	U-NII 1	36	5180	10.8	10.6	10.7	10.4	10.4	10.3	10.5	10.7
		40	5200	10.8	10.7	10.8	10.6	10.5	10.4	10.7	10.8
		44	5220	11.2	11.0	11.1	11.0	10.8	10.7	11.0	11.1
		48	5240	11.4	11.2	11.4	11.1	11.4	10.9	11.5	11.3
	U-NII 2A	52	5260	11.7	11.5	11.6	11.3	11.3	11.2	11.4	11.5
		56	5280	11.3	11.5	11.7	11.4	11.3	11.2	11.4	11.6
		60	5300	**12.2**	11.6	11.8	11.5	11.5	11.4	11.4	11.7
		64	5320	11.6	11.4	11.6	11.3	11.2	11.2	11.3	11.5
	U-NII 2C	100	5500	12.3	11.9	12.3	11.9	11.8	11.7	11.8	12.2
		104	5520	11.9	11.7	11.9	11.6	11.5	11.4	11.6	11.8
		108	5540	11.3	11.2	11.4	11.0	11.0	10.9	11.1	11.3
		112	5560	11.0	10.7	10.9	10.6	10.7	10.6	10.7	10.9
		116	5580	11.6	11.3	11.5	11.3	11.3	11.1	11.4	11.6
		120	5600	11.2	11.1	11.1	10.9	10.8	10.7	10.8	11.2
		124	5620	11.6	11.4	11.6	11.4	11.2	11.1	11.4	11.6
		128	5640	11.4	11.3	11.4	11.1	11.0	10.9	11.1	11.3
		132	5660	11.5	11.4	11.6	11.4	11.2	11.2	11.4	11.5
		136	5680	12.0	11.9	12.1	11.7	11.7	11.6	11.9	12.0
		140	5700	**12.5**	12.2	12.4	12.1	12.1	12.0	12.2	12.4
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								

IEEE 802.11 an HT20 2SS – Average Output Power											
Antenna port				0							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
20	U-NII 1	36	5180	11.1	10.4	10.6	10.7	10.6	10.0	9.8	9.6
		40	5200	11.2	10.4	10.7	10.8	10.7	10.1	9.9	9.7
		44	5220	11.6	10.8	10.9	11.0	11.0	10.4	10.2	10.0
		48	5240	11.8	11.0	11.3	11.3	11.2	10.6	10.4	10.2
	U-NII 2A	52	5260	11.9	11.2	11.5	11.5	11.5	10.9	10.7	10.5
		56	5280	12.1	11.3	11.5	11.6	11.5	10.8	10.6	10.6
		60	5300	12.2	11.4	11.6	11.7	11.6	11.0	10.8	10.7
		64	5320	12.0	11.2	11.5	11.6	11.4	10.7	10.7	10.5
	U-NII 2C	100	5500	12.4	11.8	12.1	12.2	11.9	11.7	11.2	11.1
		104	5520	12.3	11.4	11.7	11.8	11.8	11.0	10.9	10.7
		108	5540	11.7	10.9	11.2	11.2	11.1	10.6	10.3	10.2
		112	5560	11.4	10.6	10.8	10.8	10.8	10.2	10.0	9.8
		116	5580	11.9	11.1	11.5	11.4	11.4	10.9	10.6	10.4
		120	5600	11.6	10.5	11.1	11.1	11.0	10.4	10.1	10.0
		124	5620	12.0	11.1	11.4	11.4	11.5	10.8	10.5	10.5
		128	5640	11.4	10.9	11.2	11.3	11.2	10.6	10.3	10.3
		132	5660	12.0	11.2	11.4	11.6	11.5	10.9	10.6	10.5
		136	5680	12.0	11.6	12.0	12.0	12.0	11.3	11.1	10.9
		140	5700	12.3	12.0	12.2	12.4	12.3	11.7	11.5	11.3
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								
Date. Operator:				18.11.2019 . B. Pudell							

IEEE 802.11 an HT20 1SS – Average Output Power											
Antenna port				1							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
20	U-NII 1	36	5180	11.2	10.9	10.6	10.5	10.5	10.6	10.8	10.7
		40	5200	11.7	11.7	11.7	11.5	11.4	11.4	11.6	11.6
		44	5220	12.1	11.9	11.9	11.6	11.5	11.7	11.8	11.9
		48	5240	12.6	12.5	12.3	12.1	12.0	12.1	12.2	12.3
	U-NII 2A	52	5260	12.8	12.7	12.5	12.5	12.3	12.4	12.5	12.6
		56	5280	13.1	12.9	12.7	12.6	12.3	12.6	12.7	12.7
		60	5300	**13.7**	13.5	13.6	13.1	13.1	13.2	13.2	13.3
		64	5320	13.5	13.3	13.5	13.0	13.0	13.1	13.2	13.2
	U-NII 2C	100	5500	12.9	12.8	12.1	12.6	12.5	12.5	12.6	12.7
		104	5520	12.7	12.5	12.6	12.2	12.1	12.2	12.4	12.4
		108	5540	12.6	12.5	12.4	12.0	12.0	12.2	12.3	12.3
		112	5560	12.1	12.0	11.8	11.8	11.7	11.8	12.0	12.0
		116	5580	**12.8**	12.7	11.5	12.4	12.4	12.5	12.6	12.6
		120	5600	12.6	12.6	11.1	12.3	12.3	12.4	12.5	12.5
		124	5620	12.0	11.8	11.4	11.6	11.5	11.6	11.8	11.8
		128	5640	12.0	11.9	11.2	11.6	11.5	11.5	11.6	11.7
		132	5660	12.1	11.5	11.4	11.2	11.1	11.2	11.3	11.5
		136	5680	12.0	11.9	12.0	11.7	11.6	11.5	11.8	11.8
		140	5700	11.9	12.0	12.2	11.8	11.6	11.7	11.9	11.9
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								

IEEE 802.11 an HT20 2SS – Average Output Power											
Antenna port				1							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
20	U-NII 1	36	5180	11.2	11.1	11.2	11.2	11.4	11.1	11.0	10.7
		40	5200	11.7	11.4	11.3	11.5	11.6	11.3	11.3	11.0
		44	5220	11.9	11.6	11.6	11.7	11.8	11.8	11.4	11.3
		48	5240	12.5	12.2	12.3	12.3	12.5	12.3	12.0	11.9
	U-NII 2A	52	5260	12.9	12.5	12.6	12.7	12.8	12.5	12.4	12.2
		56	5280	13.2	12.8	12.8	12.9	13.0	13.1	12.5	12.4
		60	5300	13.7	13.6	13.7	13.6	13.7	13.7	13.4	13.4
		64	5320	13.4	13.1	13.1	13.2	13.3	13.3	13.0	12.9
	U-NII 2C	100	5500	12.9	12.8	12.8	12.8	12.9	12.8	12.6	12.4
		104	5520	12.6	12.4	12.3	12.4	12.5	12.4	12.2	12.0
		108	5540	12.6	12.4	12.4	12.3	12.5	12.5	12.1	12.0
		112	5560	12.3	12.0	12.0	12.1	12.1	12.1	11.8	11.9
		116	5580	12.9	12.8	12.8	12.6	12.8	12.8	12.6	12.6
		120	5600	12.5	12.5	12.4	12.5	12.5	12.4	12.2	12.0
		124	5620	11.9	12.0	11.9	12.0	12.0	11.9	11.7	11.6
		128	5640	12.0	11.9	11.7	11.9	11.9	11.8	11.8	11.4
		132	5660	12.2	11.9	11.9	12.0	12.1	12.0	11.9	11.6
		136	5680	12.0	11.9	11.9	12.0	12.1	12.0	11.9	11.5
		140	5700	11.8	11.8	11.9	11.8	12.0	11.8	11.6	11.5
	U-NII 3	149	5745								
		153	5765								
		157	5785								
		161	5805								
		165	5825								
Date. Operator:				26.10.2019 . M. Handrik							

IEEE 802.11 an HT40 1SS – Average Output Power											
Antenna port				0							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
40	U-NII 1	38	5190	10.8	10.6	10.5	10.6	10.7	10.6	10.6	10.6
		46	5230	11.5	11.4	11.4	11.4	11.5	11.4	11.4	11.4
	U-NII 2A	54	5270	**12.0**	11.9	11.8	11.7	11.9	11.8	11.8	11.8
		62	5310	11.6	11.2	11.2	11.4	11.5	11.4	11.4	11.4
	U-NII 2C	102	5510	**12.5**	12.3	12.2	12.3	12.3	12.3	12.3	12.3
		110	5550	11.2	11.0	11.1	11.2	11.2	11.1	11.2	11.1
		118	5590	12.3	12.1	11.4	12.4	12.4	12.4	12.4	12.4
		126	5630	11.3	11.0	11.0	11.1	11.2	11.2	11.2	11.2
		134	5670	10.0	10.2	9.9	10.0	10.0	9.9	10.0	10.0
	U-NII 3	151	5755								
		159	5795								

IEEE 802.11 an HT40 2SS – Average Output Power											
Antenna port				0							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
40	U-NII 1	38	5190	10.7	10.6	10.6	10.6	10.7	10.7	10.7	10.7
		46	5230	11.3	11.1	11.1	11.2	11.3	11.2	11.2	11.2
	U-NII 2A	54	5270	11.9	11.7	11.8	11.8	11.8	11.7	11.8	11.8
		62	5310	11.6	11.3	11.4	11.5	11.6	11.5	11.5	11.5
	U-NII 2C	102	5510	12.2	11.9	11.9	11.9	12.0	12.0	12.0	12.0
		110	5550	11.3	11.0	11.0	11.2	11.3	11.2	11.1	11.1
		118	5590	11.7	11.6	11.6	11.6	11.7	11.7	11.7	11.7
		126	5630	10.8	10.7	10.8	10.8	10.8	10.8	10.8	10.8
		134	5670	11.2	10.8	10.8	10.9	11.0	10.9	10.9	10.9
	U-NII 3	151	5755								
		159	5795								
Date. Operator:				20.11.2019 . B. Pudell							

IEEE 802.11 an HT40 1SS – Average Output Power											
Antenna port				1							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
40	U-NII 1	38	5190	10.9	11.5	11.4	11.4	11.5	11.6	11.4	11.5
		46	5230	11.5	12.0	12.0	11.9	11.9	12.0	12.0	12.0
	U-NII 2A	54	5270	12.2	11.9	11.7	11.6	11.9	11.8	11.7	11.8
		62	5310	**12.8**	12.6	12.6	12.6	12.6	12.5	12.6	12.6
	U-NII 2C	102	5510	12.3	12.3	12.0	12.0	12.1	12.2	12.1	12.1
		110	5550	11.9	13.6	13.5	13.6	13.5	13.6	13.6	13.6
		118	5590	**12.5**	12.4	12.3	12.4	12.4	12.3	12.3	12.4
		126	5630	11.3	11.8	11.9	11.9	11.9	11.9	12.0	11.9
		134	5670	11.2	12.0	11.8	11.8	11.9	12.0	11.9	11.9
	U-NII 3	151	5755								
		159	5795								

IEEE 802.11 an HT40 2SS – Average Output Power											
Antenna port				1							
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]							
				Data rate [Mbps]							
				MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
40	U-NII 1	38	5190	10.6	11.4	11.5	11.4	11.5	11.3	11.5	11.5
		46	5230	11.2	12.0	12.0	11.9	11.9	12.0	12.0	12.0
	U-NII 2A	54	5270	12.8	12.5	12.7	12.8	12.8	12.8	12.8	12.8
		62	5310	12.3	12.1	12.2	12.2	12.3	12.3	12.3	12.3
	U-NII 2C	102	5510	11.7	11.9	11.9	12.0	11.9	12.0	12.0	12.0
		110	5550	11.4	12.5	12.4	12.4	12.3	12.4	12.4	12.4
		118	5590	11.9	12.1	12.0	12.1	12.0	12.1	12.3	12.2
		126	5630	11.0	12.0	12.0	11.9	11.9	12.0	12.0	12.0
		134	5670	10.9	11.9	11.9	11.9	11.9	12.0	12.0	12.0
	U-NII 3	151	5755								
		159	5795								
Date. Operator:				20.11.2019 . B. Pudell							

IEEE 802.11 ac VHT20 1SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
20	U-NII 1	36	5180	11.2	11.0	11.1	11.1	10.9	11.0	11.0	11.1	11.0	11.1
		40	5200	11.7	11.2	11.3	11.2	10.3	11.3	11.3	11.3	11.3	11.3
		44	5220	11.1	11.0	11.1	11.0	11.0	11.0	11.0	11.1	11.0	11.1
		48	5240	11.6	11.7	11.7	11.6	11.7	11.7	11.6	11.6	11.6	11.6
	U-NII 2A	52	5260	11.9	11.9	11.9	11.8	11.9	11.8	11.7	11.7	11.7	11.7
		56	5280	12.0	11.8	11.9	11.9	11.9	12.0	12.0	12.0	12.0	12.0
		60	5300	12.2	12.1	12.2	12.1	12.2	**12.3**	12.3	12.1	12.3	12.1
		64	5320	12.1	12.0	12.1	12.0	12.1	12.1	12.1	12.1	12.1	12.1
	U-NII 2C	100	5500	12.3	12.0	12.1	12.1	12.2	12.2	12.2	12.2	12.2	12.2
		104	5520	12.0	12.0	12.1	12.0	12.1	12.1	12.1	12.1	12.1	12.1
		108	5540	11.7	11.5	11.6	11.6	11.7	11.7	11.7	11.7	11.7	11.7
		112	5560	11.2	11.3	11.2	11.3	11.2	11.2	11.3	11.3	11.3	11.3
		116	5580	12.4	12.1	12.3	12.2	12.3	12.1	12.0	12.1	12.0	12.1
		120	5600	11.6	11.5	11.4	11.6	11.5	11.5	11.6	11.6	11.6	11.6
		124	5620	11.8	11.8	12.0	11.9	12.0	12.0	12.0	12.0	12.0	12.0
		128	5640	11.3	11.4	11.3	11.4	11.5	11.4	11.5	11.5	11.5	11.5
		132	5660	11.7	11.9	11.8	11.9	12.0	12.0	12.0	12.0	12.0	12.0
		136	5680	11.9	12.0	12.1	12.0	12.1	12.1	12.2	12.1	12.2	12.1
		140	5700	12.5	12.4	12.5	12.5	12.5	**12.6**	12.5	12.5	12.5	12.5
	U-NII 3	149	5745										
		153	5765										
		157	5785										
		161	5805										
		165	5825										

IEEE 802.11 ac VHT20 2SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
20	U-NII 1	36	5180	11.5	11.3	11.3	11.3	11.5	11.3	11.2	11.3	11.3	11.2
		40	5200	11.2	11.0	11.1	11.1	10.8	11.0	11.0	11.1	11.0	11.0
		44	5220	11.2	11.2	11.3	11.2	10.2	11.3	11.3	11.3	11.3	11.3
		48	5240	11.9	11.6	11.7	11.8	11.8	11.7	11.6	11.7	11.7	11.6
	U-NII 2A	52	5260	11.8	11.7	11.8	11.9	11.9	11.8	11.8	11.8	11.8	11.8
		56	5280	11.9	11.9	11.8	11.8	11.9	11.8	11.9	11.9	11.8	11.9
		60	5300	12.2	12.2	12.2	12.2	12.1	12.2	**12.3**	12.3	12.2	12.3
		64	5320	12.0	12.1	12.0	12.0	12.1	12.0	12.1	12.1	12.0	12.1
	U-NII 2C	100	5500	12.0	12.0	12.2	12.2	12.2	12.2	12.1	12.2	12.2	12.1
		104	5520	12.0	11.9	12.0	12.1	12.1	12.0	12.1	12.1	12.0	12.1
		108	5540	11.7	11.8	11.8	11.9	11.8	11.8	11.9	11.8	11.8	11.9
		112	5560	11.4	11.4	11.2	11.3	11.3	11.4	11.4	11.4	11.4	11.4
		116	5580	12.1	12.0	12.1	12.0	12.2	12.1	12.2	12.3	12.1	12.2
		120	5600	11.7	11.6	11.5	11.6	11.6	11.7	11.7	11.7	11.7	11.7
		124	5620	12.0	12.0	12.1	12.1	12.1	12.0	12.1	12.0	12.0	12.1
		128	5640	11.9	11.7	11.4	11.4	11.6	11.7	11.8	11.8	11.7	11.8
		132	5660	12.0	12.1	12.1	12.2	12.1	12.1	12.2	12.2	12.1	12.2
		136	5680	12.2	12.2	12.3	12.2	12.2	12.3	12.3	12.2	12.3	12.3
		140	5700	**12.5**	12.4	12.5	12.5	12.6	12.6	12.6	12.6	12.6	12.6
	U-NII 3	149	5745										
		153	5765										
		157	5785										
		161	5805										
		165	5825										
Date. Operator:				21.11.2019 . B. Pudell									

IEEE 802.11 ac VHT20 1SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
20	U-NII 1	36	5180	11.4	11.4	11.4	11.4	11.3	11.3	11.4	11.4	11.4	11.4
		40	5200	11.7	11.6	11.8	11.8	11.7	11.8	11.8	11.8	11.8	11.8
		44	5220	12.1	12.1	12.1	12.0	12.0	12.0	12.0	12.1	12.0	12.1
		48	5240	12.5	12.6	12.7	12.5	12.5	12.6	12.6	12.6	12.6	12.6
	U-NII 2A	52	5260	12.9	12.8	12.9	12.9	12.9	12.8	12.9	12.9	12.9	12.9
		56	5280	13.1	13.2	13.1	13.1	13.2	13.1	13.2	13.2	13.2	13.2
		60	5300	**13.8**	13.8	13.7	13.8	13.8	13.7	13.7	13.7	13.7	13.7
		64	5320	13.4	13.2	13.3	13.3	13.3	13.4	13.4	13.4	13.4	13.4
	U-NII 2C	100	5500	13.2	12.9	12.8	12.9	13.0	13.0	13.0	13.0	13.0	13.0
		104	5520	12.7	12.7	12.7	12.8	12.7	12.6	12.8	12.7	12.8	12.7
		108	5540	12.7	12.7	12.7	12.8	12.7	12.6	12.8	12.7	12.8	12.7
		112	5560	12.3	12.4	12.3	12.4	12.4	12.3	12.4	12.4	12.4	12.4
		116	5580	**13.0**	12.9	12.8	12.9	13.0	13.0	13.0	13.0	13.0	13.0
		120	5600	12.5	12.4	12.5	12.4	12.4	12.4	12.5	12.5	12.5	12.5
		124	5620	12.0	11.9	12.0	11.9	11.9	12.0	12.0	12.0	12.0	12.0
		128	5640	12.2	12.1	12.1	12.2	12.2	12.2	12.1	12.2	12.1	12.2
		132	5660	12.2	12.2	12.1	12.2	12.2	12.1	12.2	12.2	12.2	12.2
		136	5680	11.9	12.0	12.0	12.0	11.9	12.0	12.0	12.0	12.0	12.0
		140	5700	11.8	11.8	11.7	11.8	11.8	11.9	11.9	11.9	11.9	11.9
	U-NII 3	149	5745										
		153	5765										
		157	5785										
		161	5805										
		165	5825										

IEEE 802.11 ac VHT20 2SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
20	U-NII 1	36	5180	11.3	11.3	11.4	11.4	11.3	11.4	11.2	11.3	11.4	11.2
		40	5200	11.8	11.9	11.8	11.8	11.8	11.8	11.9	11.8	11.8	11.9
		44	5220	12.2	12.2	12.1	12.1	12.1	12.1	12.1	12.0	12.1	12.1
		48	5240	12.7	12.7	12.7	12.7	12.6	12.6	12.7	12.7	12.6	12.7
	U-NII 2A	52	5260	12.9	13.0	12.8	12.9	13.0	12.8	12.9	12.9	12.8	12.9
		56	5280	13.3	13.2	13.2	13.2	13.2	13.1	13.2	13.2	13.1	13.2
		60	5300	13.5	13.3	13.5	13.5	13.6	13.5	13.7	13.7	13.5	13.7
		64	5320	13.3	13.3	13.2	13.3	13.3	13.3	13.2	13.3	13.3	13.2
	U-NII 2C	100	5500	13.1	13.2	13.2	12.9	13.1	12.9	13.0	13.1	12.9	13.0
		104	5520	12.9	12.7	12.7	12.8	12.7	12.6	12.8	12.7	12.6	12.8
		108	5540	12.9	12.7	12.7	12.8	12.7	12.6	12.8	12.7	12.6	12.8
		112	5560	12.3	12.3	12.4	12.4	12.3	12.3	12.4	12.4	12.3	12.4
		116	5580	12.9	12.8	12.8	12.9	12.9	13.0	13.0	13.0	13.0	13.0
		120	5600	12.7	12.6	12.5	12.4	12.5	12.6	12.6	12.6	12.6	12.6
		124	5620	12.0	12.0	12.0	12.1	12.1	12.1	12.1	12.1	12.1	12.1
		128	5640	12.3	12.2	12.3	12.2	12.1	12.3	12.3	12.3	12.3	12.3
		132	5660	12.4	12.4	12.3	12.3	12.4	12.4	12.4	12.4	12.4	12.4
		136	5680	12.2	12.2	12.2	12.2	12.1	12.2	12.3	12.3	12.2	12.3
		140	5700	12.0	11.9	11.8	11.9	11.0	12.0	12.0	12.1	12.0	12.0
	U-NII 3	149	5745										
		153	5765										
		157	5785										
		161	5805										
		165	5825										
Date. Operator:				21.11.2019 . B. Pudell									

IEEE 802.11 ac VHT40 1SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
40	U-NII 1	38	5190	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6
		46	5230	11.3	11.2	11.3	11.2	11.3	11.3	11.3	11.3	11.3	11.3
	U-NII 2A	54	5270	**12.3**	12.1	12.0	11.9	12.1	12.1	12.2	12.2	12.2	12.2
		62	5310	11.9	11.9	11.9	11.8	12.0	12.0	12.0	12.0	12.0	12.0
	U-NII 2C	102	5510	**12.3**	12.1	11.9	11.9	12.0	12.0	12.0	12.0	12.0	12.0
		110	5550	11.2	11.3	11.3	11.4	11.3	11.4	11.4	11.4	11.4	11.4
		118	5590	11.6	11.6	11.6	11.7	11.8	11.8	11.8	11.8	11.8	11.8
		126	5630	10.9	10.9	11.0	11.1	11.0	11.1	11.1	10.9	11.1	10.9
		134	5670	12.1	12.1	12.1	12.1	12.0	12.1	12.1	12.1	12.1	12.1
	U-NII 3	151	5755										
		159	5795										

IEEE 802.11 ac VHT40 2SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
40	U-NII 1	38	5190	10.8	10.8	10.7	10.6	10.7	10.7	10.6	10.7	10.7	10.6
		46	5230	11.3	11.2	11.2	11.1	11.1	11.2	11.2	11.2	11.2	11.2
	U-NII 2A	54	5270	12.2	12.1	12.0	11.9	12.0	12.0	12.0	12.0	12.0	12.0
		62	5310	11.9	11.9	11.8	11.8	12.0	12.0	12.0	12.0	12.0	12.0
	U-NII 2C	102	5510	12.2	12.1	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
		110	5550	11.6	11.5	11.4	11.4	11.4	11.4	11.4	11.5	11.4	11.4
		118	5590	11.7	11.9	11.6	11.7	11.6	11.7	11.7	11.9	11.7	11.7
		126	5630	11.0	11.0	11.1	11.0	10.9	11.0	11.1	11.1	11.0	11.1
		134	5670	12.1	12.0	12.1	12.0	12.1	12.1	12.1	12.1	12.1	12.1
	U-NII 3	151	5755										
		159	5795										

Date. Operator: 20.11.2019 . B. Pudell

IEEE 802.11 ac VHT40 1SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
40	U-NII 1	38	5190	11.6	11.6	11.5	11.5	11.6	11.6	11.6	11.6	11.6	11.6
		46	5230	12.1	12.1	12.1	12.1	12.1	12.2	12.2	12.2	12.2	12.2
	U-NII 2A	54	5270	**13.3**	13.1	13.2	13.2	13.3	13.2	13.2	13.2	13.2	13.2
		62	5310	13.0	12.9	13.0	12.9	13.0	13.1	13.1	13.1	13.1	13.1
	U-NII 2C	102	5510	12.8	12.6	12.7	12.7	12.8	12.7	12.8	12.8	12.8	12.8
		110	5550	12.3	12.4	12.3	12.3	12.4	12.5	12.4	12.4	12.4	12.4
		118	5590	**12.8**	12.6	12.8	12.7	12.6	12.7	12.6	12.6	12.6	12.6
		126	5630	12.0	11.9	12.1	12.0	12.0	12.0	12.1	12.1	12.1	12.1
		134	5670	12.3	12.1	12.2	12.3	12.3	12.3	12.2	12.3	12.2	12.3
	U-NII 3	151	5755										
		159	5795										

IEEE 802.11 ac VHT40 2SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
40	U-NII 1	38	5190	11.7	11.7	11.6	11.6	11.5	11.6	11.6	11.7	11.5	11.6
		46	5230	12.1	12.2	12.2	12.1	12.1	12.2	12.1	12.2	12.1	12.2
	U-NII 2A	54	5270	13.0	13.0	13.1	13.0	13.0	13.1	13.1	13.1	13.0	13.1
		62	5310	12.8	12.7	12.8	12.9	12.8	12.7	12.8	12.7	12.8	12.7
	U-NII 2C	102	5510	12.8	12.7	12.8	12.7	12.8	12.8	12.8	12.8	12.8	12.8
		110	5550	12.4	12.4	12.4	12.3	12.4	12.4	12.4	12.4	12.4	12.4
		118	5590	12.7	12.7	12.7	12.7	12.5	12.6	12.7	12.6	12.5	12.6
		126	5630	12.2	12.2	12.1	12.2	12.2	12.1	12.1	12.1	12.2	12.1
		134	5670	12.3	12.2	12.3	12.3	12.2	12.3	12.3	12.3	12.2	12.3
	U-NII 3	151	5755										
		159	5795										
Date. Operator:				20.11.2019 . B. Pudell									

IEEE 802.11 ac VHT80 1SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
80	U-NII 1	42	5210	10.7	10.6	10.7	10.9	10.9	11.0	11.0	10.9	11.0	10.9
	U-NII 2A	58	5290	**12.1**	11.9	12.0	12.1	12.1	12.1	12.0	12.0	12.0	12.0
	U-NII 2C	106	5530	**11.8**	11.5	11.5	11.7	11.8	11.8	11.8	11.8	11.8	11.8
		122	5610	11.1	11.0	10.8	11.0	11.1	11.1	11.0	11.2	11.0	11.2
	U-NII 3	155	5775										

IEEE 802.11 ac VHT80 2SS – Average Output Power													
Antenna port				0									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
80	U-NII 1	42	5210	11.1	11.1	10.9	10.9	11.0	11.0	10.9	11.0	11.0	11.0
	U-NII 2A	58	5290	12.0	12.1	11.9	11.9	11.9	12.0	12.0	12.0	11.9	12.0
	U-NII 2C	106	5530	11.7	11.6	11.5	11.6	11.5	11.6	11.7	11.7	11.5	11.6
		122	5610	11.0	11.1	11.0	10.9	11.1	11.1	11.1	11.1	11.1	11.1
	U-NII 3	155	5775										
Date. Operator:				20.11.2019 . B. Pudell									

IEEE 802.11 ac VHT80 1SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
80	U-NII 1	42	5210	11.8	11.7	11.8	11.9	12.0	11.9	12.0	12.1	12.0	12.1
	U-NII 2A	58	5290	**13.2**	13.1	13.0	13.0	13.1	13.1	13.1	13.1	13.1	13.1
	U-NII 2C	106	5530	**12.7**	12.6	12.6	12.7	12.6	12.7	12.7	12.7	12.7	12.7
		122	5610	12.5	12.3	12.3	12.2	12.2	12.3	12.2	12.3	12.2	12.3
	U-NII 3	155	5775										

IEEE 802.11 ac VHT80 2SS – Average Output Power													
Antenna port				1									
BW [MHz]	Band	Ch.	Frequency [MHz]	Source-base time-average power [dBm]									
				Data rate [Mbps]									
				MCS 0	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5	MCS 6	MCS 7	MCS 8	MCS 9
80	U-NII 1	42	5210	12.1	12.1	12.1	12.0	12.1	12.1	12.0	12.0	12.1	12.1
	U-NII 2A	58	5290	13.1	13.1	13.0	13.0	13.1	13.0	13.1	13.1	13.1	13.0
	U-NII 2C	106	5530	12.7	12.6	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
		122	5610	12.4	12.5	12.5	12.4	12.3	12.2	12.3	12.3	12.3	12.2
	U-NII 3	155	5775										
Date. Operator:				20.11.2019 . B. Pudell									

1.7 Standalone Operational Mode Test Exclusion for FCC

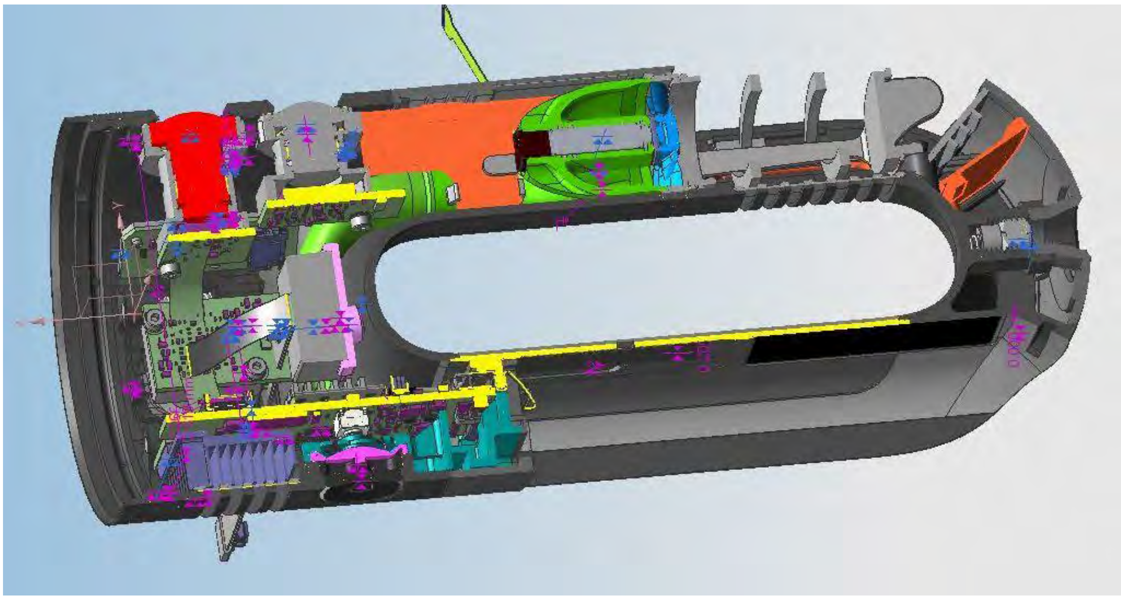
According to KDB 447498 D01 v05r02 for standalone SAR evaluation the test exclusion power condition is given by

$$\frac{\max Power.mW}{test\ distance.mm} \cdot \sqrt{f_{GHz}} \leq 3.0$$

for test separation distance ≤ 50mm. For test separation distances > 50mm. the SAR test exclusion threshold is:

$$P_{TH}[mW] = Power\ allowed\ at\ numeric\ threshold\ for\ 50mm + (test\ distance.mm - 50mm) \cdot \frac{f[MHz]}{150} \quad . \quad 100\ MHz < f < 1500\ MHz$$

$$P_{TH}[mW] = Power\ allowed\ at\ numeric\ threshold\ for\ 50mm + (test\ distance.mm - 50mm) \cdot 10 \quad . \quad 1500\ MHz < f < 6\ GHz$$

Antenna position


Antenna 0 : orange (great) below sensors
Antenna 1 : orange (small) 45° at grip

SAR Test Exclusion FCC

Mode	Pmax + tune-up [mW]	Antenna	Region	EUT Edge											
				Front		Back		Left		Right		Top		Bottom	
				Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]
BT – BR	11	0	FCC	**3**	**10**	77	366	40	77	40	77	160	1196	120	796
BT – LE	2	0	FCC	3	10	77	366	40	77	40	77	160	1196	120	796
WLAN 2.4G b	21	0	FCC	**3**	**10**	77	366	40	77	40	77	160	1196	120	796
WLAN 2.4G g	20	0	FCC	**3**	**10**	77	366	40	77	40	77	160	1196	120	796
WLAN 2.4G n2	18	0	FCC	**3**	**10**	77	366	40	77	40	77	160	1196	120	796
WLAN 2.4G n4	17	0	FCC	**3**	**10**	77	366	40	77	40	77	160	1196	120	796
IEEE 802.11a	31	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11an2	31	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11an4	28	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11ac2	29	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11ac4	27	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11ac8	26	0	FCC	**3**	**6**	77	333	40	51	40	51	160	1163	120	763
IEEE 802.11b	2.1	1	FCC	18	35	62	216	40	77	40	77	270	2296	10	19
IEEE 802.11g	2.0	1	FCC	18	35	62	216	40	77	40	77	270	2296	10	19
IEEE 802.11n2	2.1	1	FCC	18	35	62	216	40	77	40	77	270	2296	10	19
IEEE 802.11n4	2.0	1	FCC	18	35	62	216	40	77	40	77	270	2296	10	19
IEEE 802.11a	39	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**
IEEE 802.11an2	37	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**

IEEE 802.11an4	30	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**
IEEE 802.11ac2	38	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**
IEEE 802.11ac4	34	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**
IEEE 802.11ac8	33	1	FCC	**18**	**23**	62	183	40	51	40	51	270	2263	**10**	**12**

SAR Test Exclusion FCC

Mode	Pmax + tune-up [mW]	Antenna	Region	EUT Edge											
				ANT1-45 deg		ANT1 Flat-Grip-Left		ANT1 Flat-Grip-Right		reserved		reserved			
				Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]		
WLAN 2.4G b	2.1	1	FCC	2	10	20	38	20	38						
WLAN 2.4G g	2.0	1	FCC	2	10	20	38	20	38						
WLAN 2.4G n2	2.1	1	FCC	2	10	20	38	20	38						
WLAN 2.4G n4	2.0	1	FCC	2	10	20	38	20	38						
IEEE 802.11a	39	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						
IEEE 802.11an2	37	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						
IEEE 802.11an4	30	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						
IEEE 802.11ac2	38	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						
IEEE 802.11ac4	34	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						
IEEE 802.11ac8	33	1	FCC	**2**	**6**	**20**	**25**	**20**	**25**						

Comments: All bold Threshold values are above the limit and have to be measured
WLAN 5GHz – the max channel frequency (5700 MHz) is used for SAR test exclusion power threshold as strongest requirement.

Date. Operator:	22.11.2019 . B. Pudell

1.8 Standalone Operational Mode Exemption limits for IC

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW
Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

1.9 SAR value estimation for multi-transmitter evaluation

According to KDB 447498 D01 v05r02 for standalone SAR evaluation the estimated SAR is given by

$$\frac{\max Power\ (including\ tune\ up\ tolerance).mW}{min.test\ separation\ distance.mm} \cdot \sqrt{\frac{f_{GHz}}{x}} \leq 0.4\frac{W}{kg}$$

x=7.5 for 1-g SAR. and x=18.75 for 10-g SAR. for test separation ≤ 50mm.

For test separation distance > 50mm. the estimated SAR value is 0.4 W/kg

SAR Test Exclusion ISED

Mode	Pmax + Gain + tune-up [mW]	Antenna	Region	EUT Edge											
				Front		Back		Left		Right		Top		Bottom	
				Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]
BT – BR	12	0	ISED	**3**	**4**	77	>309	40	173	40	173	160	>309	120	>309
BT – LE	2	0	ISED	3	4	77	>309	40	173	40	173	160	>309	120	>309
WLAN 2.4G b	21	0	ISED	**3**	**4**	77	>309	40	173	40	173	160	>309	120	>309
WLAN 2.4G g	20	0	ISED	**3**	**4**	77	>309	40	173	40	173	160	>309	120	>309
WLAN 2.4G n2	18	0	ISED	**3**	**4**	77	>309	40	173	40	173	160	>309	120	>309
WLAN 2.4G n4	17	0	ISED	**3**	**4**	77	>309	40	173	40	173	160	>309	120	>309
IEEE 802.11a	31	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
IEEE 802.11an2	31	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
IEEE 802.11an4	28	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
IEEE 802.11ac2	29	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
IEEE 802.11ac4	27	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
IEEE 802.11ac8	26	0	ISED	**3**	**1**	77	>106	40	85	40	85	160	>106	120	>106
WLAN 2.4G b	2.1	1	ISED	18	35	62	216	40	77	40	77	270	>309	10	19
WLAN 2.4G g	2.0	1	ISED	18	35	62	216	40	77	40	77	270	>309	10	19
WLAN 2.4G n2	2.1	1	ISED	18	35	62	216	40	77	40	77	270	>309	10	19
WLAN 2.4G n4	2.0	1	ISED	18	35	62	216	40	77	40	77	270	>309	10	19
IEEE 802.11a	39	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**
IEEE 802.11an2	37	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**
IEEE 802.11an4	30	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**

IEEE 802.11ac2	38	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**
IEEE 802.11ac4	34	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**
IEEE 802.11ac8	33	1	ISED	**18**	**22**	62	>106	40	85	40	85	270	>106	**10**	**6**

SAR Test Exclusion ISED

Mode	Pmax + tune-up [mW]	Antenna	Region	EUT Edge									
				ANT1-45 deg		ANT1 Flat-Grip-Left		ANT1 Flat-Grip-Right		reserved		reserved	
				Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]	Antenna distance to user [mm]	SAR Test Exclusion Threshold [mW]
WLAN 2.4G b	2.1	1	ISED	2	4	20	30	20	30				
WLAN 2.4G g	2.0	1	ISED	2	4	20	30	20	30				
WLAN 2.4G n2	2.1	1	ISED	2	4	20	30	20	30				
WLAN 2.4G n4	2.0	1	ISED	2	4	20	30	20	30				
IEEE 802.11a	39	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				
IEEE 802.11an2	37	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				
IEEE 802.11an4	30	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				
IEEE 802.11ac2	38	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				
IEEE 802.11ac4	34	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				
IEEE 802.11ac8	33	1	ISED	**2**	**1**	**20**	**28**	**20**	**28**				

Comments: All bold Threshold values are above the limit and have to be measured
WLAN 5GHz – the max channel frequency (5700 MHz) is used for SAR test exclusion power threshold as strongest requirement.

Date. Operator:	22.11.2019 . B. Pudell

1.10 Supported concurrent (multi-transmitter) operating modes

	Bluetooth BR/LE	WLAN 802.11b/g/n	WLAN 802.11a/n/ac
Bluetooth BR/LE	N/A	N/A	N/A
WLAN 802.11b/g/n	N/A	N/A	N/A
WLAN 802.11a/n/ac	N/A	N/A	N/A

1.11 Supported use cases

Use case	Distance to human body	corresponding test configuration
EUT placed at human body	0-5 mm (worst case)	body-worn device

1.12 Radio Test Modes

Mode	Settings
BT-BR	Mode = TX testmode Modulation = GFSK (DH5) Output Power max = QRCT Power setting 9 Air interface = Antenna 0
BT-LE	Mode = TX testmode Modulation = GFSK Output Power max = no QRCT Power setting Air interface = Antenna 0
WLAN 2.4G b	Mode = TX testmode Modulation = DBPSK (1 Mbps) Duty cycle = 99% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 0 + Antenna 1
WLAN 2.4G g	Mode = TX testmode Modulation = BPSK (6 Mbps) Duty cycle = 95% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 0 + Antenna 1
WLAN 2.4G n2	Mode = TX testmode Modulation = BPSK (HT20_MCS0) Duty cycle = 95% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 1 + Antenna 2

IEEE 802.11a	Mode = TX testmode Modulation = BPSK (6 Mbps) Duty cycle = 95% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 1 + Antenna 2
IEEE 802.11an2	Mode = TX testmode Modulation = BPSK (HT20_MCS0) Duty cycle = 95% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 1 + Antenna 2
IEEE 802.11ac2	Mode = TX testmode Modulation = BPSK (VHT20_MCS0) Duty cycle = 95% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 1 + Antenna 2
IEEE 802.11ac22	Mode = TX testmode Modulation = BPSK (VHT20_MCS5) Duty cycle = 73% Output Power max = QRCT Power setting 12 Spatial Streams= 1 Air interface = Antenna 1 + Antenna 2
Remarks: result of SAR test exclusion	

1.13 Test Positions

Position	Description
FLAT-FRONT	EUT front side touching the phantom.
FLAT-LEFT	EUT left side touching the phantom.
FLAT-RIGHT	EUT right side touching the phantom.
ANT1-45	EUT GRIP angled by 45° touching the phantom.
Remarks: result of SAR test exclusion	

1.14 Test Equipment Used During Testing

SAR Measurement					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Stäubli Robot	Stäubli	RX90B L	EF00271	functional test	functional test
Stäubli Robot Controller	Stäubli	CS7MB	EF00272	functional test	functional test
DASY 5 Measurement Server	Schmid & Partner		EF00273	functional test	functional test
Control Pendant	Stäubli		EF00274	functional test	functional test
Dell Computer	Schmid & Partner	Intel	EF00275	functional test	functional test
Data Acquisition Electronics	Schmid & Partner	DAE3V1	EF00276	2019-09	2020-09
Dosimetric E-Field Probe	Schmid & Partner	EX3DV4	EF00826	2019-09	2020-09
System Validation Kit	Schmid & Partner	D2450V2	EF00284	2018-09	2021-09
System Validation Kit	Schmid & Partner	D5GHzV2	EF00827	2018-09	2021-09
Flat phantom	Schmid & Partner	V 4.4	EF00328	no calibration required	no calibration required
Oval flat phantom	Schmid & Partner	ELI 4	EF00289	functional test	functional test
Mounting Device	Schmid & Partner	V 3.1	EF00287	functional test	functional test
Millivoltmeter	Rohde & Schwarz	URV 5	EF00126	2019-07	2022-07
Power sensor	Rohde & Schwarz	NRV-Z2	EF00125	2019-07	2021-07
RF signal generator	Rohde & Schwarz	SMP 02	EF00165	2019-07	2021-07
Insertion unit	Rohde & Schwarz	URV5-Z4	EF00322	2019-07	2021-07
Directional Coupler	HP	HP 87300B	EF00288	functional test	functional test
Network Analyzer 300 kHz to 3 GHz	Agilent	8752C	EF00140	2019-07	2020-07
Network Analyzer 10 MHz to 40 GHz	Rohde & Schwarz	ZNB40	EF01065	2019-07	2020-07
Dielectric Probe Kit	Agilent	85070C	EF00291	functional test	functional test
Dielectric Probe Kit	SPEAG	DAK-3.5	EF00945	2019-09	2020-09
DAK Measurement Software	SPEAG	DAKS	EF00965	functional test	functional test
Thermometer	LKM electronic GmbH	DTM3000	EF00967	2019-01	2020-01

2 Result Summary

447498 D01 General RF Exposure Guidance. RSS-102					
Product Specific Standard Section	**Requirement – Test**	**Reference Method**	**Maximum SAR [W/kg]**	**Result**	**Remarks**
447498 D01 General RF Exposure Guidance RSS-102 Section 3	Single-band conformity	KDB Publication 447498 KDB Publication 248227 KDB Publication 865664	**1.11**	PASS	
447498 D01 General RF Exposure Guidance RSS-102 Section 3	Multi-band conformity	KDB Publication 447498 KDB Publication 648474 KDB Publication 865664	N/A	N/R	No concurrent transmission modes
Remarks:					

TEST SUMMARY

Frequency Band	Maximum Reported SAR (W/kg)	
	Body-worn	Limbs
Bluetooth	0.79	0.29
WI-FI (2.4GHz)	1.09	0.42
WI-FI (5GHz)	1.11	0.45
SAR Limited (W/kg)	1.6	4.0

3 Definitions

The specific absorption rate (SAR) is defined as the time derivative of the incremental energy (*dW*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element *(dV*) of a given density (ρ_t). expressed in watts per kilogram (W/kg)

$$SAR = d/dt\ (dW/dm) = d/dt\ (dW/\rho_t dV) = \sigma/\rho_t\ |E_t|^2$$

where

$$dW/dt = \int_V E\ J\ dV = \int_V \sigma E^2\ dV$$

3.1 Controlled Exposure

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example. in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category and the general population/uncontrolled exposure limits apply to these devices.

3.2 Uncontrolled Exposure

In general. occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment. who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits. but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate. warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on the risk of potential exposure and instructions on methods to minimize such exposure risks.

3.3 Localized SAR

Compliance with the localized SAR limits is demonstrated using the head and trunk limit because this SAR limit is only half the limbs limit value. The values are obtained by SAR measurements according to EN 62209-2.

4 Localized SAR Measurement Equipment

The measurements were performed with Dasy5 automated near-field scanning system comprised of high precision robot. robot controller. computer. e-field probe. probe alignment unit. phantoms. non-conductive phone positioned and software extension.

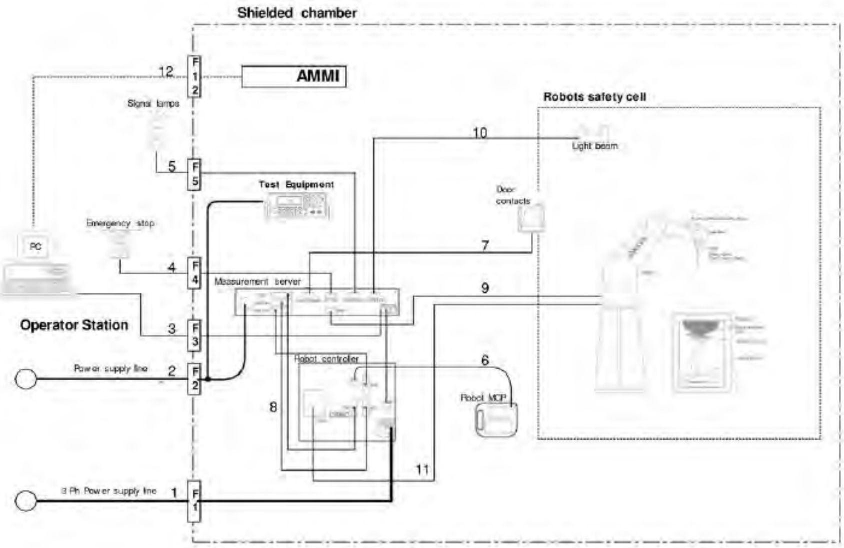
4.1 Complete SAR DASY5 Measurement System

Measurements are performed using the DASY5 automated assessment system made by Schmid & Partner Engineering AG (SPEAG) in Zurich. Switzerland.

DASY 5 SAR Measurement Setup

The following Diagram show the elements involved in the measurement setup.

DASY 5 SAR Measurement Diagram



The DASY5 system for performing compliance tests consists of the following items:

DASY5 SAR Measurement System	
Device	Description:
RX90BL	A standard high precision 6-axis robot (Stäubli RX family) with controller. teach pendant and software.
Probe Alignment Unit	A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
Teach Pendant	The Manual Control Pendant (MCP). also called the manual teach pendant. is the user interface to the robot. In DASY. it is used for certain installation and teach procedures
Signal Lamps	External warning lamp which indicates when the robot arm is powered-on and if the robot is under software control or in manual mode (controlled with the teach pendant).
DAE	The 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.
E-Field Probes	Isotropic E-Field probe optimized and calibrated for E-field measurements in free space.
EOC	The electro-optical converter (EOC) performs the conversion between optical and electrical signals
Measurement Server	The functions of the measurement server is to perform the time critical task such as signal filtering. surveillance of the robot operation. fast movement interrupts.
Control Computer	A computer operating Windows 2000 or Windows NT with DASY 4 Software.
Control Software	DASY4 and SEMCAD post processing Software
SAM Twin Phantom	The SAM twin phantom enabling testing left-hand and right-hand usage.
Flat Phantom	Flat Phantom (only for body-mounted transceivers operating below 800 MHz).
Tissue simulating liquid	Tissue simulating liquid mixed according to the given recipes.
Device Holder	The device holder for handheld mobile phones.
System Validation Dipoles	System validation dipoles allowing to validate the proper functioning of the system.

4.2 Robot Arm

The DASY5 system uses the high precision robots RX90BL type out of the newer series from Stäubli SA (France).

The RX robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

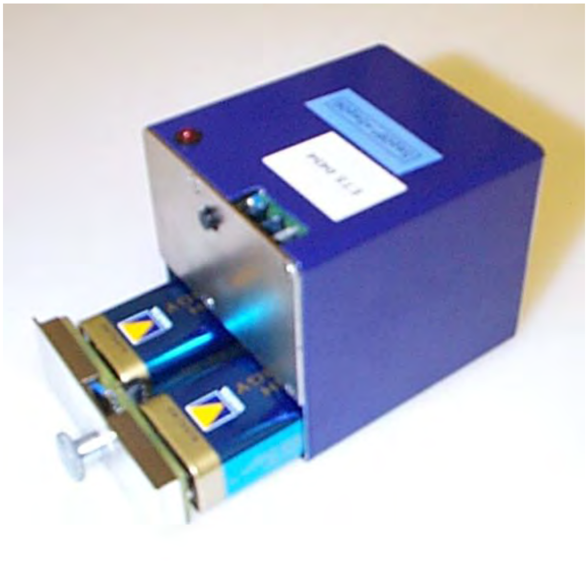
Robot arm

4.3 Data Acquisition Electronics

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing. a channel and gain-switching multiplexer. a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.

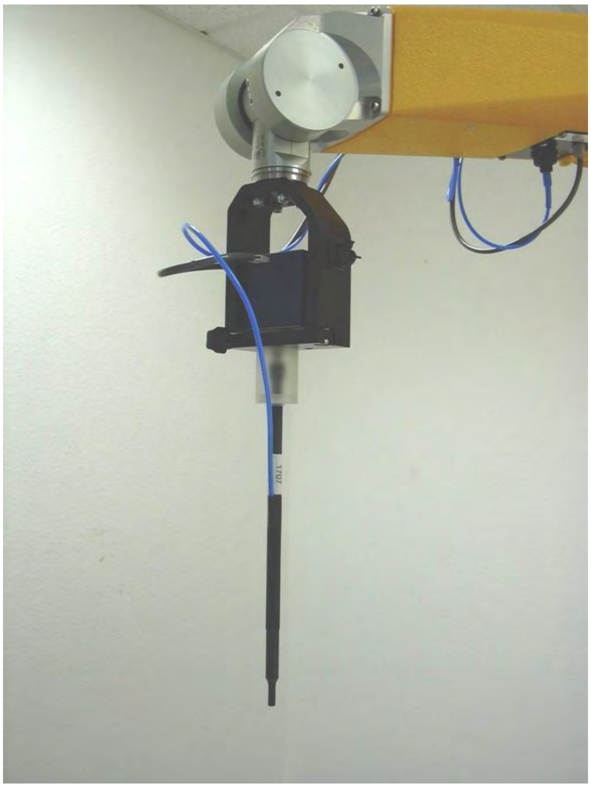
Data Acquisition Electronics



4.4 Isotropic E-Field Probe ≤ 3 GHz

Probe Specifications

Isotropic E-Field Probe ET3DV6



Construction:

One dipole parallel. two dipoles normal to probe axis built-in shielding against static charges.

Calibration:

In air from 10 MHz to 2.5 GHz.
In brain and muscle simulating tissue at Frequencies of 835MHz. 900MHz. 1800MHz. 1900 MHz and 2450 MHz

Frequency:

10MHz to > 3GHz.
Linearity ±0.2dB (30MHz to 3GHz)

Directivity:

±0.2dB in HSL (rotation around probe axis)
±0.4dB in HSL (rotation normal to probe axis)

Dynamic Range:

5µW/g to > 100mW/g

Linearity:

±0.2dB

Dimensions:

Overall Length: 330mm (Tip: 16mm).
Tip Diameter: 6.8mm (Body: 12mm).
Distance from probe tip to dipole centers: 2.7mm

Application:

General dosimetry up to 3 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms

4.5 Isotropic E-Field Probe ≤ 6 GHz

Probe Specifications

Construction:

One dipole parallel. two dipoles normal to probe axis built-in shielding against static charges.

Calibration:

In air from 10 MHz to 6 GHz.
In brain and muscle simulating tissue at Frequencies of 5200. 5500. 5800

Frequency:

10MHz to 6GHz.
Linearity ±0.2dB (30MHz to 6GHz)

Directivity:

±0.3dB in HSL (rotation around probe axis)
±0.5dB in tissue material (rotation normal to probe axis)

Dynamic Range:

10µW/g to > 100mW/g

Linearity:

±0.2dB

Dimensions:

Overall Length: 337mm (Tip: 20mm).
Tip Diameter: 2.5mm (Body: 12mm).
Distance from probe tip to dipole centers: 1mm

Application:

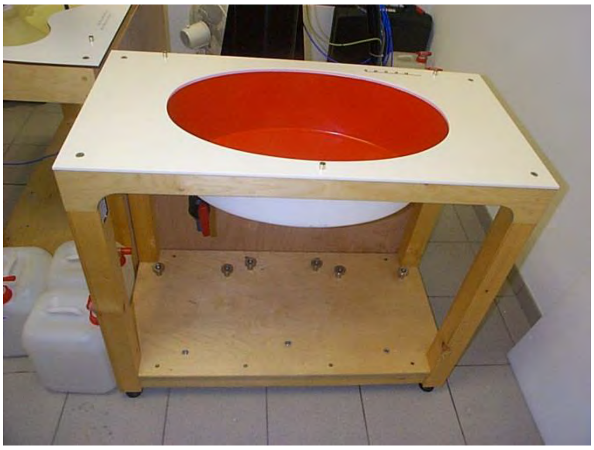
General dosimetry up to 6 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms

Isotropic E-Field Probe EX3DV4

4.6 Test phantom and positioner

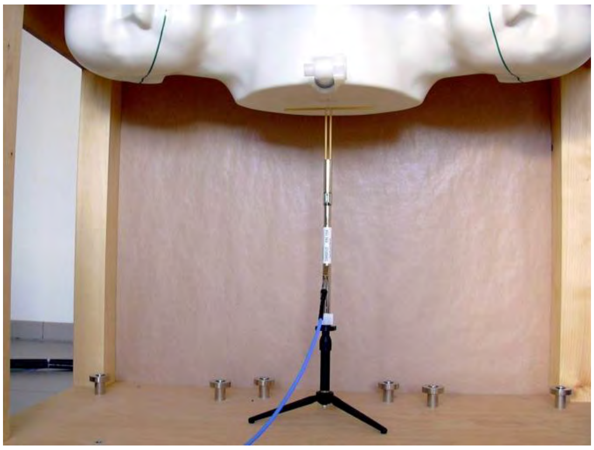
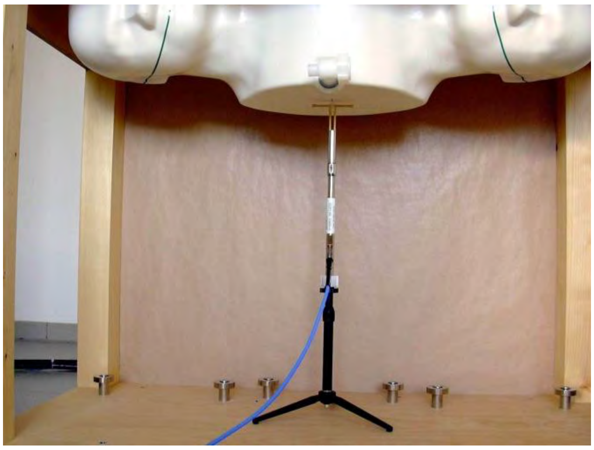
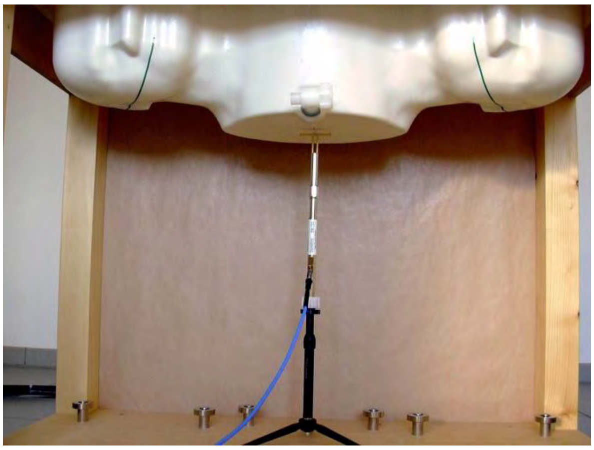
The positioner and test phantoms are manufactured by SPEAG. The test phantoms are used for all tests i.e. for both validation testing and device testing. The positioner and test phantom conforms to the requirements of EN 62209 and IEEE 1528.

The SPEAG device holder was used to position the test device in all tests whilst a tripod was used to position the validation dipoles in the test arch.

Probe Positioner	SAM Twin Phantom
	
ELI4 phantom	**Flat phantom**
	

4.7 System Validation Dipoles

A set of calibration dipoles (D900V2. D1900V2. D2450V2. D5GHzV2) is included as a part of the SAR measurement setup. These are used for the validation of the test setup after its installation and prior to the EUT measurements. The calibration dipole is placed in the position normally occupied by the EUT. All calibration dipoles have the same height which allows an exact fitting below the center point of the test phantom. The dipole center is 10mm below the surface of the test phantom.

900MHz Dipole	1900MHz Dipole
	
2450MHz Dipole	**5000MHz Dipole**
	

5 Single-band SAR Measurement

After successful completion of the tissue and system verification the SAR values of the EUT are measured according to the following description.

5.1 General measurement description

The measurement is performed for each frequency band of the device. If the width of the transmit frequency band exceeds 1% of its center frequency. than the channels at the lowest and highest frequencies should also be tested. Furthermore. if the width of the transmit band exceeds 10% of its center frequency the following formula is used to determine the number of channels:

$$N_C = 2 \cdot \text{roundup}[10 \cdot (f_{high} - f_{low})/f_c] + 1$$

First the device is tested on the center channel of each frequency band used by the device. An operation mode and configuration with maximum transmit power is established. If battery operated equipment is used. the batteries are fully charged.

SAR measurements are performed using the steps outlined in the next section for all relevant operational modes. EUT configurations and measurement positions.

For the condition (position. configuration. operational mode) that provides the highest spatial-average SAR value on the center channel. the other channels are also tested.

Additionally all other conditions where the spatial-average SAR value is within 3dB of the SAR limit are also tested on all determined test frequencies.

5.2 SAR measurement description

First the local SAR value at a test point within 10mm or less in normal direction from the inner surface of the phantom is measured. This SAR value is used to determine the measurement drift during SAR measurement.

Next an area scan is performed over an area larger than the projection of the EUT with antenna on the surface of the phantom with a spatial grid step of 10mm.

From the scanned SAR distribution the position of maximum SAR value is identified as well as any local SAR maxima within 2dB of the maximum value that are not within the zoom scan volume. (The additional peaks are only measured when the primary peak is within 2dB of the SAR limit.)

The zoom-scan volume constructed on the peak SAR position is scanned with a grid step of 5mm. The measured data are extracted and the local SAR value for each measurement point is calculated. The measured values are interpolated over a fine-mesh within the scan volume and the average SAR value over 10g mass is calculated.

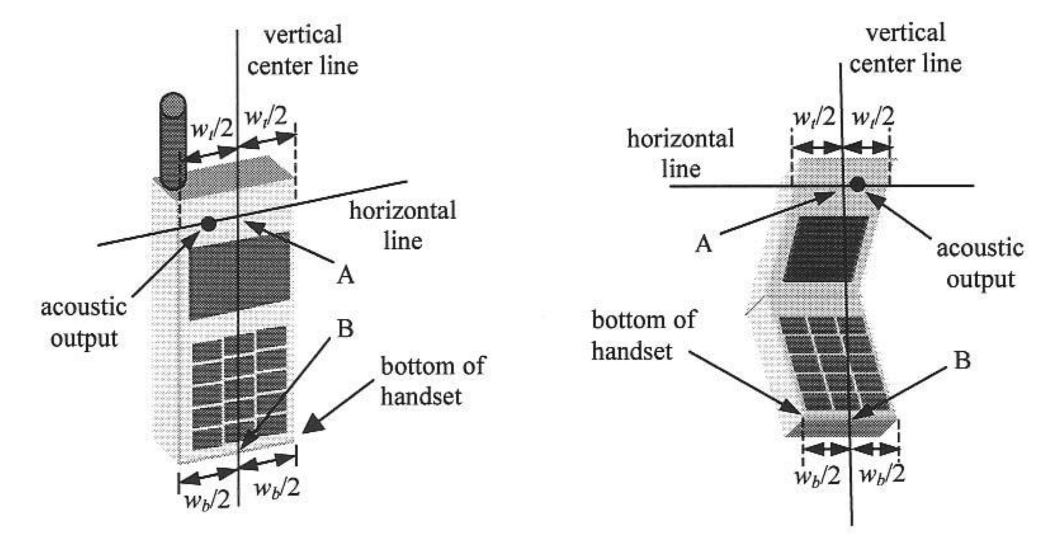
At the end of the measurement the reference point measured at the beginning of the measurement is measured again and from the difference the drift is calculated.

5.3 Reference lines and points for Handsets

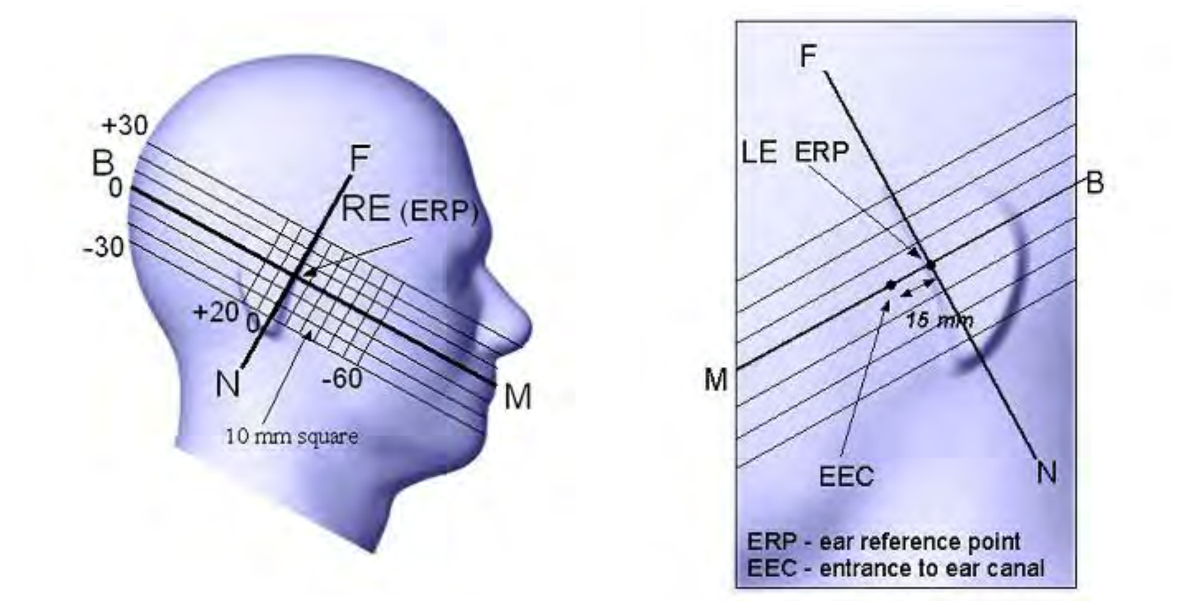
For all measurement positions of the EUT. the EUT has to be place in a specific orientation with respect to the phantom. The orientation of the EUT relative to the phantom is defined by reference lines and points.

According to IEEE 1528. the reference lines and points shall be positioned at the EUT as shown in the following figure.

Reference lines and points on EUT acc. to IEEE 1528



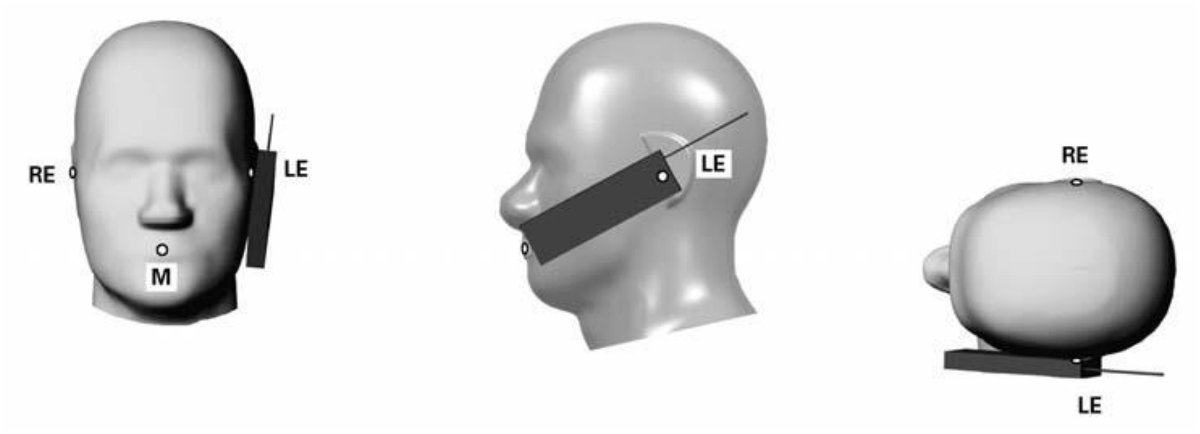
Reference lines and points on human head acc. to IEEE 1528



5.4 Test positions relative to the Head

Cheek position

Cheek positions according to IEEE 1528

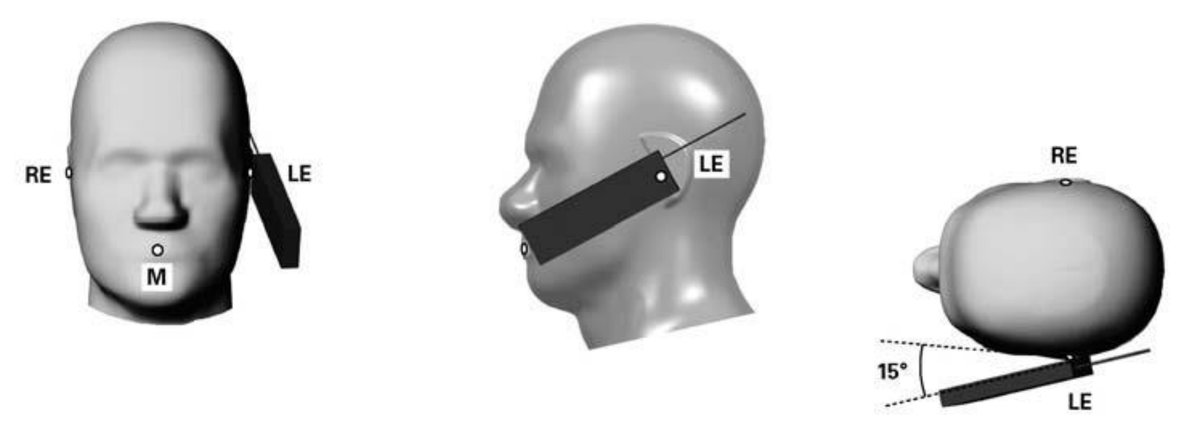


The handset is positioned close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure). such that the plane defined by the vertical centerline and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom. Next the handset is translated towards the phantom along the line passing through RE and LE until handset point A touches the pinna at the ERP.

While the handset is maintained in this plane. it is rotated around the LE-RE line until the vertical centerline is in the plane normal to the plane containing B-M and N-F lines. i.e.. the Reference Plane.
Then it is rotated around the vertical centerline until the handset (horizontal line) is parallel to the N-F line. While the vertical centerline is maintained in the Reference Plane. point A is kept on the line passing through RE and LE. and the handset is maintained in contact with the pinna. the handset is rotated about the N-F line until any point on the handset is in contact with a phantom point below the pinna on the cheek.

Tilt position

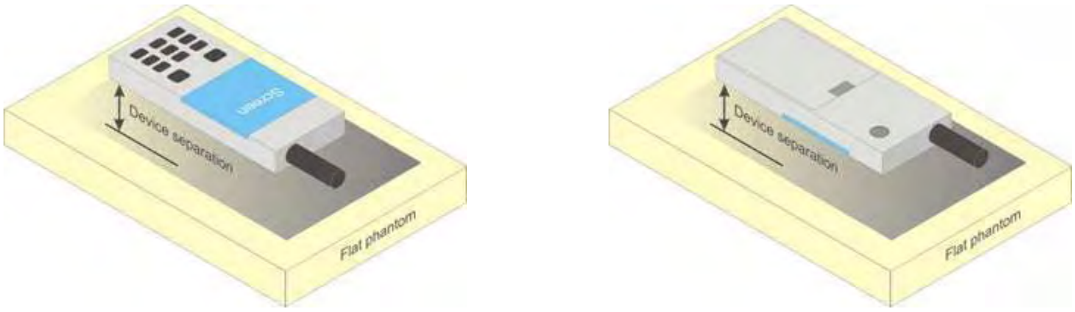
Tilt positions according to IEEE 1528



First the EUT is placed in the cheek position. Next the handset is moved away from the pinna along the line passing through RE and LE far enough to allow a rotation of the handset away from the cheek by 15°. Then the handset is rotated around the horizontal line by 15°.

The handset is moved towards the phantom on the line passing through RE and LE until any part of the handset touches the ear. The tilt position is obtained when the contact point is on the pinna. See Figure. If contact occurs at any location other than the pinna. e.g.. the antenna at the back of the phantom head. the angle of the handset should be reduced. In this case. the tilt position is obtained if any point on the handset is in contact with the pinna and a second point on the handset is in contact with the phantom. e.g.. the antenna with the back of the head

5.5 Test positions relative to the human body

Body positions according to IEEE 1528


In body worn configuration the device is positioned parallel to the phantom surface with either top or bottom side of the EUT facing against the phantom.

The separation distance of the EUT is selected according to the use case of the EUT (e.g. with belt clip or holster).

5.6 Measurement Uncertainty

Measurement Uncertainty according to IEEE 1528							
Error Description	**Uncertainty Value**	**Probability Distribution**	**Div.**	**c_i (1g)**	**c_i (10g)**	**Std. Unc. 1g**	**Std. Unc. 10g**
Measurement System							
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
Modulation Response	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%
Boundary effects	±2.0%	R	$\sqrt{3}$	1	1	±1.2%	±1.2%
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
Probe Positioner	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Probe Positioning	±6.7%	R	$\sqrt{3}$	1	1	±3.9%	±3.9%
Post processing	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%
Test Sample Related							
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
Test Sample Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%
Power Scaling	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%
Phantom and Setup Related							
Phantom Uncertainty	±7.9%	R	$\sqrt{3}$	1	1	±4.6%	±4.6%
SAR correction	±1.9%	R	$\sqrt{3}$	1	0.84	±1.1%	±0.9%
Liquid conductivity (measured)	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
Liquid permittivity (measured)	±2.5%	N	1	0.26	0.26	±0.1%	±0.1%
Temperature uncertainty - Conductivity	±5.2%	R	$\sqrt{3}$	0.78	0.71	±2.3%	±2.1%
Temperature uncertainty - Permittivity	±0.8%	R	$\sqrt{3}$	0.23	0.26	±0.1%	±0.1%
Combined Standard Uncertainty						±12.8%	±12.7%
Expanded Standard Uncertainty						**±25.6%**	**±25.4%**

Measurement Uncertainty according to EN 62209-1							
Error Description	**Uncertainty Value**	**Probability Distribution**	**Div.**	**c_i (1g)**	**c_i (10g)**	**Std. Unc. 1g**	**Std. Unc. 10g**
Measurement System							
Probe Calibration	±6.0%	N	1	1	1	±6.0%	±6.0%
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%
Boundary effects	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
Probe Positioner	±0.4%	R	$\sqrt{3}$	1	1	±0.2%	±0.2%
Probe Positioning	±2.9%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
Max. SAR Evaluation	±2.0%	R	$\sqrt{3}$	1	1	±1.2%	±1.2%
Test Sample Related							
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%
Power Scaling	±0%	R	$\sqrt{3}$	1	1	±0.0%	±0.0%
Phantom and Setup Related							
Phantom Uncertainty	±6.1%	R	$\sqrt{3}$	1	1	±3.5%	±3.5%
SAR correction	±1.9%	R	$\sqrt{3}$	1	0.84	±1.1%	±0.9%
Liquid conductivity (measured)	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
Liquid permittivity (measured)	±2.5%	N	1	0.26	0.26	±0.6%	±0.7%
Temperature uncertainty - Conductivity	±5.2%	R	$\sqrt{3}$	0.78	0.71	±2.3%	±2.1%
Temperature uncertainty - Permittivity	±0.8%	R	$\sqrt{3}$	0.23	0.26	±0.1%	±0.1%
Combined Standard Uncertainty						±11.4%	±11.3%
Expanded Standard Uncertainty						**±22.9%**	**±22.7%**

Measurement Uncertainty according to EN 62209-2							
Error Description	**Uncertainty Value**	**Probability Distribution**	**Div.**	**c_i (1g)**	**c_i (10g)**	**Std. Unc. 1g**	**Std. Unc. 10g**
Measurement System							
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
Modulation Response	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%
Boundary effects	±2.0%	R	$\sqrt{3}$	1	1	±1.2%	±1.2%
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
Probe Positioner	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Probe Positioning	±6.7%	R	$\sqrt{3}$	1	1	±3.9%	±3.9%
Post processing	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%
Test Sample Related							
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
Test Sample Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%
Power Scaling	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%
Phantom and Setup Related							
Phantom Uncertainty	±7.9%	R	$\sqrt{3}$	1	1	±4.6%	±4.6%
SAR correction	±1.9%	R	$\sqrt{3}$	1	0.84	±1.1%	±0.9%
Liquid conductivity (measured)	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
Liquid permittivity (measured)	±2.5%	N	1	0.26	0.26	±0.1%	±0.1%
Temperature uncertainty - Conductivity	±5.2%	R	$\sqrt{3}$	0.78	0.71	±2.3%	±2.1%
Temperature uncertainty - Permittivity	±0.8%	R	$\sqrt{3}$	0.23	0.26	±0.1%	±0.1%
Combined Standard Uncertainty						±12.8%	±12.7%
Expanded Standard Uncertainty						**±25.6%**	**±25.4%**

6 Test Conditions and Results

6.1 Recipes for Tissue Simulating Liquids

Body Tissue Simulating Liquids					
Ingredient	M 450-B weight (%)	M 900-B weight (%)	M 1800-B weight (%)	M 1950-A weight (%)	M 2450-B weight (%)
Water	46.21	50.75	70.17	69.79	68.64
Sugar	51.17	48.21			
Cellulose	0.18				
Salt	2.34		0.39	0.2	
Preventol	0.08	0.1			
DGBE			29.44	30	31.37
Head Tissue Simulating Liquids					
Ingredient	HSL 450-A weight (%)	HSL 900-B weight (%)	HSL 1800-F weight (%)	HSL 1950-B weight (%)	HSL 2450-B weight (%)
Water	38.91	40.29	55.24	55.41	55
Sugar	56.93	57.9			
Cellulose	0.25	0.24			
Salt	3.79	1.38	0.31	0.08	
Preventol	0.12	0.18			
DGBE			44.45	44.51	45

Water: deionized water. resistivity ≥ 16 MΩ
Sugar: refined white sugar
Salt: pure NaCl
Cellulose: Hydroxyethyl-cellulose
Preservative: Preventol D-7
DGBE: Diethylenglycol-monobuthyl ether

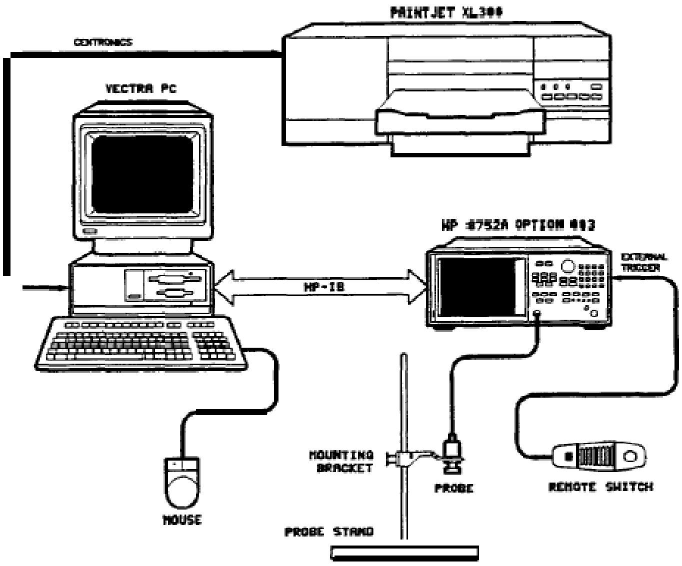
The parameters for the different frequencies are defined in the corresponding compliance standards (e.g.. IEEE 1528-2003. IEC 62209-1)

The HBBL3-6GHz and MBBL 3-6 GHz liquids are direct from Speag.

6.2 Test Conditions and Results – Tissue Validation

Tissue Validation acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102					Verdict: PASS
Test according to measurement reference	Reference Method				
	865664 D01 SAR Measurement 100 MHz to 6 GHz				
Target Values					
Frequency [MHz]	Head		Body		Permitted tolerance [%]
	Relative dielectric constant ε_r	Conductivity σ [S/m]	Relative dielectric constant ε_r	Conductivity σ [S/m]	
150	52.3	0.76	61.9	0.80	≤ ±5
300	45.3	0.87	58.2	0.92	≤ ±5
450	43.5	0.87	56.7	0.94	≤ ±5
835	41.5	0.90	55.2	0.97	≤ ±5
900	41.5	0.97	55.0	1.05	≤ ±5
915	41.5	0.98	55.0	1.06	≤ ±5
1450	40.5	1.20	54.0	1.30	≤ ±5
1610	40.3	1.29	53.8	1.40	≤ ±5
1800 – 2000	40.0	1.40	53.3	1.52	≤ ±5
2450	39.2	1.80	52.7	1.95	≤ ±5
3000	38.5	2.40	52.0	2.73	≤ ±5
5200	36.0	4.66	49.0	5.30	≤ ±5
5500	35.6	4.96	48.6	5.65	≤ ±5
5800	35.3	5.27	48.2	6.00	≤ ±5

Test setup



Test procedure

1. The dielectric probe kit is calibrated using the standards air. short circuit and deionized water
2. The tissue simulating liquid is measured using the dielectric probe
3. Target values are compared to the measurement values and deviations are determined

TISSUE VALIDATION									
Room Temperature [°C]					22.9				
Tissue	Freq. [MHz]	Measured ε_r	Target ε_r *	Δ ε_r [%] **	Measured σ [S/m]	Target σ [S/m] *	Δ σ [%] **	Operator	Date
MSL-2450	2450	52.49	52.70	-0.40	2.011	1.95	3.13	B. Pudell	07.11.2019
MSL-2450	2402	52.48	52.76	-0.53	1.918	1.90	0.95	B. Pudell	07.11.2019
MSL-2450	2441	52.52	52.71	-0.36	1.996	1.94	2.89	B. Pudell	07.11.2019
MSL-2450	2480	52.44	52.66	-0.42	2.069	1.99	3.97	B. Pudell	07.11.2019
MSL-2450	2450	52.59	52.70	-0.21	2.014	1.95	3.28	B. Pudell	12.11.2019
MSL-2450	2412	52.65	52.75	-0.19	1.949	1.91	2.04	B. Pudell	12.11.2019
MSL-2450	2437	52.60	52.72	-0.23	1.994	1.94	2.78	B. Pudell	12.11.2019
MSL-2450	2462	52.56	52.68	-0.23	2.032	1.97	3.15	B. Pudell	12.11.2019
MSL-3.4-6GHZ	5200	47.80	49.00	-2.45	5.45	5.30	2.83	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5260	47.83	48.93	-2.25	5.39	5.37	0.37	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5300	48.34	48.88	-1.10	5.46	5.42	0.74	B. Pudell	20.11.2019

MSL-3.4-6GHZ	5500	47.56	48.60	-2.14	5.79	5.65	2.48	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5580	47.55	48.50	-1.96	5.88	5.74	2.44	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5600	47.57	48.47	-1.86	5.89	5.77	2.08	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5700	47.28	48.34	-2.19	6.03	5.88	2.56	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5800	47.11	48.20	-2.26	6.06	6.00	0.01	B. Pudell	20.11.2019
MSL-3.4-6GHZ	5200	47.58	49.00	-2.90	5.33	5.30	0.57	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5260	47.71	48.93	-2.08	5.39	5.37	0.37	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5300	48.29	48.88	-1.21	5.53	5.42	2.03	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5500	48.11	48.60	-1.01	5.75	5.65	1.77	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5580	47.51	48.50	-2.04	5.83	5.74	1.57	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5600	47.54	48.47	-1.92	5.87	5.77	1.73	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5700	47.35	48.34	-2.05	5.96	5.88	1.36	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5800	48.21	48.20	0.02	6.10	6.00	1.67	B. Pudell	25.11.2019
MSL-3.4-6GHZ	5200	47.63	49.00	-2.80	5.35	5.30	0.94	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5260	47.75	48.93	-2.41	5.41	5.37	0.74	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5300	48.39	48.88	-1.00	5.54	5.42	2.21	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5500	48.26	48.60	-0.70	5.78	5.65	2.30	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5580	47.58	48.50	-1.90	5.82	5.74	1.39	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5600	47.64	48.47	-1.71	5.85	5.77	1.39	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5700	47.51	48.34	-1.72	5.91	5.88	0.51	B. Pudell	29.11.2019
MSL-3.4-6GHZ	5800	48.32	48.20	2.49	6.07	6.00	1.17	B. Pudell	29.11.2019

* The target tissue dielectric properties of the corresponding basic SAR measurement standard apply
** The deviation has to be 5% or lower

6.3 Test Conditions and Results – System Validation

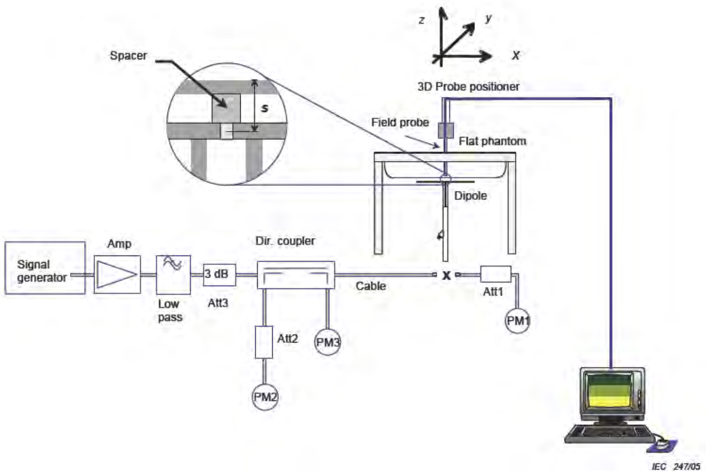
System Validation acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102	Verdict: PASS
Test according to measurement reference	Reference Method
	865664 D01 SAR Measurement 100 MHz to 6 GHz / IEEE 1528
Test frequency range	Tested frequencies
	2450 / 5200 / 5500 / 5800 MHz
Test mode	unmodulated CW

Target Values

Frequency [MHz]	Target SAR value [W/kg (1g)]	Permitted tolerance [%]
2450	12.73 @ 250mW	≤ ±10
5200	7.41 @ 100mW	≤ ±10
5500	8.12 @ 100mW	≤ ±10
5800	7.71 @ 100mW	≤ ±10

The target reference values are taken from the calibration sheets (see annex)

Test setup



Test procedure

1. The dipole antenna input power is set to 250mW
2. The reference dipole is positioned under the phantom
3. With the dipole antenna powered the SAR value is measured
4. The measured SAR values are compared to the target SAR values

SYSTEM VALIDATION – 1g									
Room Temperature [°C]					22.9				
TSL	Validation Dipole	Measurement Phantom	Validation Frequency [MHz]	Input Power [mW]	Measured SAR (1g) [W/kg]	Target SAR (1g) [W/kg] *	Δ SAR (1g) [%] **	Operator	Date
MSL-2450	D2450V2	ELI 4	2450	250 mW	12.8	12.73	0.55	B. Pudell	07.11.2019
MSL-2450	D2450V2	ELI 4	2450	250 mW	12.9	12.73	1.33	B. Pudell	12.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5200	100 mW	7.58	7.41	2.29	B. Pudell	20.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5500	100 mW	8.15	8.12	3.69	B. Pudell	20.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5800	100 mW	7.78	7.71	0.91	B. Pudell	20.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5200	100 mW	7.29	7.41	-1.62	B. Pudell	25.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5500	100 mW	8.07	8.12	-0.62	B. Pudell	25.11.2019
MSL-3.4-6GHZ	D5GHzV2	ELI 4	5800	100 mW	7.46	7.71	-3.24	B. Pudell	25.11.2019

* See calibration documents of system validation dipole
** The deviation has to be 10% or lower

6.4 Test Conditions and Results – Standalone SAR Measurement

Standalone SAR acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102		**Verdict: PASS**
Test according to measurement reference	Reference Method	
	865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102 Issue 5	
Room temperature	22.5 – 24.5 °C	
Liquid depth	15.5 cm	
Environment	general public	
Limits		
Region	Occupational SAR values [W/kg]	General public SAR values [W/kg]
Whole body average SAR	0.4	0.08
Localized SAR (Head and trunk) SAR averaging mass = 1g	8	1.6
Localized SAR (Limbs) SAR averaging mass = 10g	20	4

SINGLE TRANSMITTER SAR EVALUATION – 1g											
Room Temperature [°C]						22.9					
Mode	Position	TSL	Phant.	Ch.	Freq. [MHz]	Power Drift [dB]	Measured SAR (1g) [W/kg]	Power Scaling Factor*	Reported SAR (1g) [W/kg] **	Operator	Date
BT-BR	Flat-Front	MSL-2450	ELI 4	39	2441	-0.10	0.566	1.40	0.79	B. Pudell	07.11.2019
BT-LE	Flat-Front	MSL-2450	ELI 4	19	2440	-0.06	0.064	1.40	0.09	B. Pudell	07.11.2019
IEEE 802.11b	Flat-Front	MSL-2450	ELI 4	1	2412	0.04	0.779	1.40	1.09	B. Pudell	12.11.2019
IEEE 802.11b	Flat-Left	MSL-2450	ELI 4	1	2412	-0.17	0.03	1.40	0.04	B. Pudell	12.11.2019
IEEE 802.11b	Flat-Rght	MSL-2450	ELI 4	1	2412	-	noise	1.40	noise	B. Pudell	12.11.2019
IEEE 802.11b	Flat-Front	MSL-2450	ELI 4	6	2437	-0.02	0.717	1.40	1.00	B. Pudell	13.11.2019
IEEE 802.11b	Flat-Front	MSL-2450	ELI 4	11	2462	-0.13	0.699	1.40	0.98	B. Pudell	13.11.2019
IEEE 802.11g	Flat-Front	MSL-2450	ELI 4	1	2412	-0.15	0.669	1.40	0.94	B. Pudell	13.11.2019
IEEE 802.11g	Flat-Front	MSL-2450	ELI 4	6	2437	-0.14	0.626	1.40	0.88	B. Pudell	13.11.2019

IEEE 802.11g	Flat-Front	MSL-2450	ELI 4	11	2462	-0.12	0.632	1.40	0.88	B. Pudell	13.11.2019
IEEE 802.11n21	Flat-Front	MSL-2450	ELI 4	1	2412	-0.18	0.606	1.40	0.85	B. Pudell	13.11.2019
IEEE 802.11n21	Flat-Front	MSL-2450	ELI 4	6	2437	-0.16	0.573	1.40	0.80	B. Pudell	13.11.2019
IEEE 802.11n21	Flat-Front	MSL-2450	ELI 4	11	2462	-0.15	0.576	1.40	0.81	B. Pudell	13.11.2019
IEEE 802.11b	Flat_ ANT1-45	MSL-2450	ELI 4	1	2412	-0.00	0.386	1.40	0.54	B. Pudell	13.11.2019
IEEE 802.11g	Flat_ ANT1-45	MSL-2450	ELI 4	1	2412	0.14	0.360	1.40	0.50	B. Pudell	13.11.2019
IEEE 802.11a	Flat-Front	MSL-5200	ELI 4	52	5260	0.06	0.71	1.56	**1.11**	B. Pudell	21.11.2019
IEEE 802.11a	Flat-Left	MSL-5200	ELI 4	52	5260	-	noise	1.56	noise	B. Pudell	25.11.2019
IEEE 802.11a	Flat-Right	MSL-5200	ELI 4	52	5260	-	noise	1.56	noise	B. Pudell	25.11.2019
IEEE 802.11a	Flat-Front	MSL-5200	ELI 4	60	5300	-0.15	0.69	1.56	1.08	B. Pudell	21.11.2019
IEEE 802.11a	Flat-Front	MSL-5500	ELI 4	100	5500	0.19	0.43	1.56	0.67	B. Pudell	21.11.2019
IEEE 802.11a	Flat-Front	MSL-5500	ELI 4	116	5580	0.15	0.50	1.56	0.78	B. Pudell	21.11.2019
IEEE 802.11a	Flat-Front	MSL-5500	ELI 4	124	5600	0.03	0.52	1.56	0.81	B. Pudell	21.11.2019
IEEE 802.11a	Flat-Front	MSL-5800	ELI 4	140	5700	0.06	0.57	1.56	0.89	B. Pudell	21.11.2019
IEEE 802.11an2	Flat-Front	MSL-5200	ELI 4	52	5260	-0.06	0.61	1.56	0.95	B. Pudell	21.11.2019
IEEE 802.11an2	Flat-Front	MSL-5200	ELI 4	60	5300	-0.06	0.62	1.56	0.97	B. Pudell	21.11.2019
IEEE 802.11an2	Flat-Front	MSL-5500	ELI 4	100	5500	0.17	0.39	1.56	0.61	B. Pudell	22.11.2019
IEEE 802.11an2	Flat-Front	MSL-5500	ELI 4	116	5580	0.04	0.46	1.56	0.72	B. Pudell	22.11.2019
IEEE 802.11an2	Flat-Front	MSL-5500	ELI 4	124	5600	-0.17	0.50	1.56	0.78	B. Pudell	22.11.2019
IEEE 802.11an2	Flat-Front	MSL-5800	ELI 4	140	5700	-0.19	0.54	1.56	0.84	B. Pudell	21.11.2019
IEEE 802.11ac2	Flat-Front	MSL-5200	ELI 4	52	5260	0.16	0.48	1.56	0.75	B. Pudell	27.11.2019
IEEE 802.11ac22	Flat-Front	MSL-5200	ELI 4	60	5300	-0.10	0.49	1.56	0.76	B. Pudell	27.11.2019

IEEE 802.11ac2	Flat-Front	MSL-5500	ELI 4	116	5580	0.03	0.48	1.56	0.75	B. Pudell	27.11.2019
IEEE 802.11ac22	Flat-Front	MSL-5800	ELI 4	140	5700	-0.19	0.44	1.56	0.69	B. Pudell	27.11.2019
IEEE 802.11a	ANT1-45	MSL-5200	ELI 4	52	5260	-0.02	0.22	1.56	0.34	B. Pudell	28.11.2019
IEEE 802.11a	ANT1-45	MSL-5200	ELI 4	60	5300	-0.19	0.20	1.56	0.31	B. Pudell	29.11.2019
IEEE 802.11a	ANT1-45	MSL-5500	ELI 4	116	5580	0.11	0.13	1.56	0.20	B. Pudell	29.11.2019
IEEE 802.11a	ANT1-45	MSL-5800	ELI 4	140	5700	0.00	0.091	1.56	0.14	B. Pudell	29.11.2019
* Scaling factor = Max. conducted power (including tune up tolerance) [mW]/ measured conducted power [mW] ** Reported SAR = Measured SAR * Scaling Factor											

According to KDB 865664 D02 v01r01 only the SAR plots for the highest SAR results for each EUT configuration and operating condition are given in the "SAR Results" part of the report.

Calculation Scaling factor for 2.4GHz frequency range:
$P_{max\ cond.}$: WLAN 2.4GHz b = 11.7 dBm
Tune-up tolerance : 1.5 dB

Calculation Scaling factor for 5 GHz frequency range:
$P_{max\ cond.}$: WLAN 5GHz a = 13.9 dBm
Tune-up tolerance : 2.0 dB

6.5 Test Conditions and Results – Multi-transmitter SAR Result

None

ANNEX A Calibration Documents

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

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

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

Accreditation No.: SCS 0108

Client **Eurofins**

Certificate No: DAE3-522_Sep19

CALIBRATION CERTIFICATE

Object: DAE3 - SD 000 D03 AA - SN: 522

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

Calibration date: September 11, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Sep-19 (No:25949)	Sep-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-19 (in house check)	In house check: Jan-20
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-19 (in house check)	In house check: Jan-20

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: September 11, 2019

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	full range =	-100...+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1.......+3mV

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

Calibration Factors	X	Y	Z
High Range	404.466 ± 0.02% (k=2)	404.137 ± 0.02% (k=2)	404.986 ± 0.02% (k=2)
Low Range	3.95998 ± 1.50% (k=2)	3.94027 ± 1.50% (k=2)	3.99746 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	327.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.62	-2.59	-0.00
Channel X	+ Input	20008.76	2.53	0.01
Channel X	- Input	-20003.81	2.10	-0.01
Channel Y	+ Input	200040.05	-0.17	-0.00
Channel Y	+ Input	20005.09	-1.06	-0.01
Channel Y	- Input	-20006.72	-0.61	0.00
Channel Z	+ Input	200037.47	-1.41	-0.00
Channel Z	+ Input	20005.33	-0.80	-0.00
Channel Z	- Input	-20006.69	-0.55	0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2002.34	0.91	0.05
Channel X	+ Input	201.04	-0.31	-0.15
Channel X	- Input	-198.29	0.24	-0.12
Channel Y	+ Input	2001.93	0.70	0.03
Channel Y	+ Input	201.25	0.14	0.07
Channel Y	- Input	-198.96	-0.23	0.12
Channel Z	+ Input	2001.67	0.44	0.02
Channel Z	+ Input	200.99	-0.14	-0.07
Channel Z	- Input	-199.81	-1.20	0.60

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	-3.87	-4.98
	- 200	6.29	4.56
Channel Y	200	0.53	-0.36
	- 200	-1.17	-0.60
Channel Z	200	15.87	16.15
	- 200	-17.32	-18.14

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.36	-4.25
Channel Y	200	7.64	-	1.04
Channel Z	200	9.49	5.41	-

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	15761	16023
Channel Y	15720	15278
Channel Z	16038	14273

5. Input Offset Measurement

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

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.18	-1.44	1.89	0.62
Channel Y	-0.82	-2.10	0.64	0.55
Channel Z	0.99	-0.48	2.49	0.60

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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

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IMPORTANT NOTICE

USAGE OF THE DAE3

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exa ct values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:
Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:
Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:
To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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Engineering AG
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Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **Eurofins**

Certificate No: **EX3-3893_Sep19**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3893
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	September 20, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 660	19-Dec-18 (No. DAE4-660_Dec18)	Dec-19
Reference Probe ES3DV2	SN: 3013	31-Dec-18 (No. ES3-3013_Dec18)	Dec-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

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

Issued: September 21, 2019

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, ", "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"

Methods Applied and Interpretation of Parameters:

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.53	0.42	0.32	± 10.1 %
DCP (mV)[B]	100.7	98.1	100.7	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	150.9	±2.7 %	± 4.7 %
		Y	0.0	0.0	1.0		145.5		
		Z	0.0	0.0	1.0		143.9		

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-22.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
300	45.3	0.87	12.27	12.27	12.27	0.08	1.20	± 13.3 %
450	43.5	0.87	11.38	11.38	11.38	0.16	1.20	± 13.3 %
750	41.9	0.89	10.42	10.42	10.42	0.51	0.80	± 12.0 %
900	41.5	0.97	9.83	9.83	9.83	0.54	0.80	± 12.0 %
1750	40.1	1.37	9.03	9.03	9.03	0.36	0.86	± 12.0 %
1810	40.0	1.40	8.67	8.67	8.67	0.33	0.86	± 12.0 %
1950	40.0	1.40	8.26	8.26	8.26	0.38	0.86	± 12.0 %
2150	39.7	1.53	8.16	8.16	8.16	0.31	0.86	± 12.0 %
2450	39.2	1.80	7.67	7.67	7.67	0.40	0.90	± 12.0 %
2600	39.0	1.96	7.53	7.53	7.53	0.39	0.90	± 12.0 %
5200	36.0	4.66	5.09	5.09	5.09	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.95	4.95	4.95	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.80	4.80	4.80	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

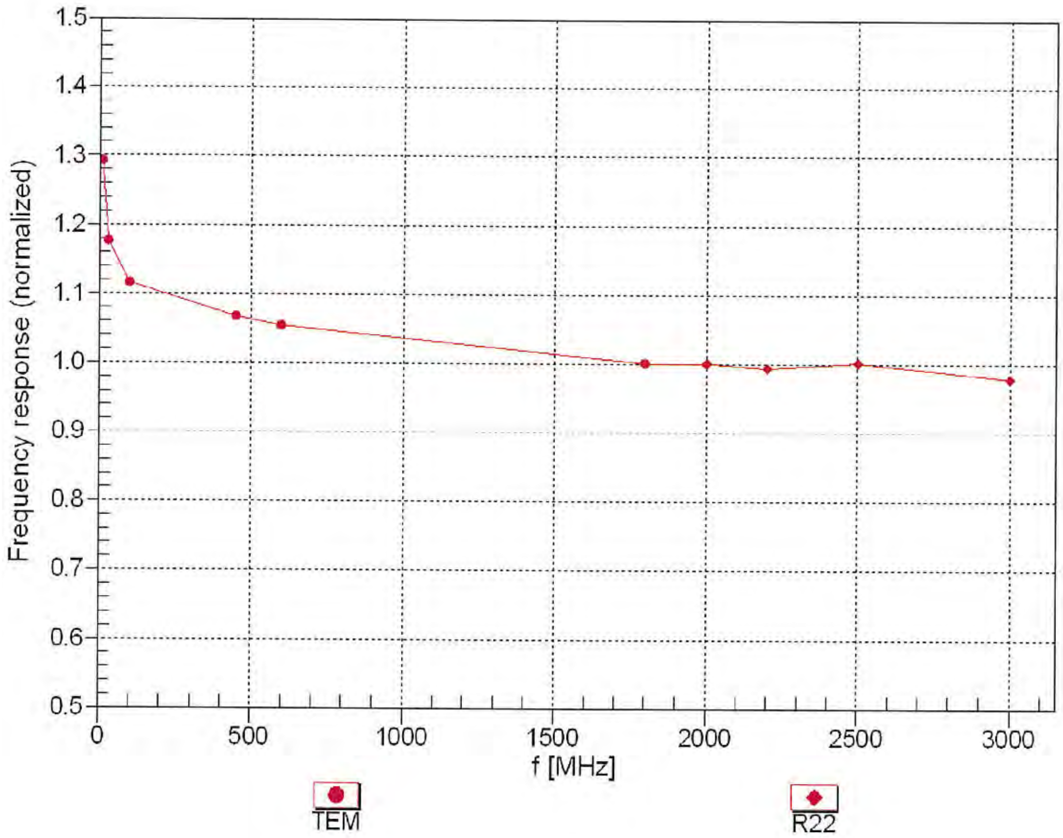
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
300	58.2	0.92	12.02	12.02	12.02	0.08	1.20	± 13.3 %
450	56.7	0.94	11.60	11.60	11.60	0.09	1.20	± 13.3 %
750	55.5	0.96	10.28	10.28	10.28	0.43	0.88	± 12.0 %
900	55.0	1.05	9.92	9.92	9.92	0.48	0.80	± 12.0 %
1750	53.4	1.49	8.61	8.61	8.61	0.22	0.86	± 12.0 %
1810	53.3	1.52	8.32	8.32	8.32	0.37	0.86	± 12.0 %
1950	53.3	1.52	8.15	8.15	8.15	0.39	0.86	± 12.0 %
2150	53.1	1.66	8.13	8.13	8.13	0.37	0.86	± 12.0 %
2450	52.7	1.95	7.79	7.79	7.79	0.35	0.90	± 12.0 %
2600	52.5	2.16	7.64	7.64	7.64	0.25	0.90	± 12.0 %
5200	49.0	5.30	4.56	4.56	4.56	0.50	1.90	± 13.1 %
5500	48.6	5.65	4.18	4.18	4.18	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.14	4.14	4.14	0.50	1.90	± 13.1 %

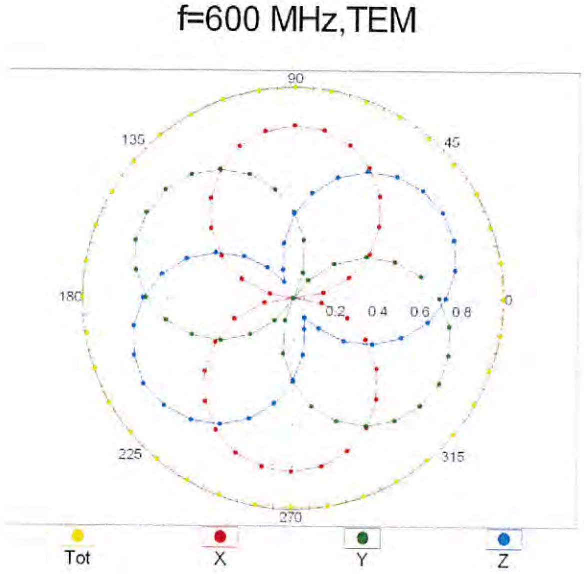
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

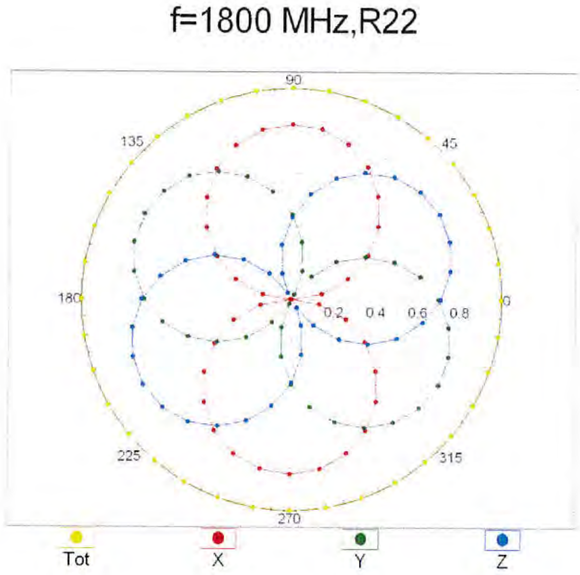
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)

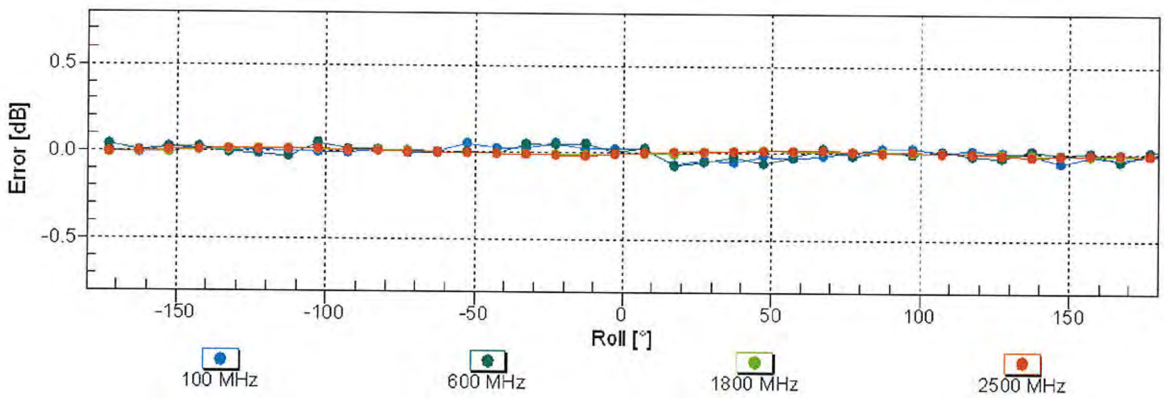


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), $\vartheta = 0°$

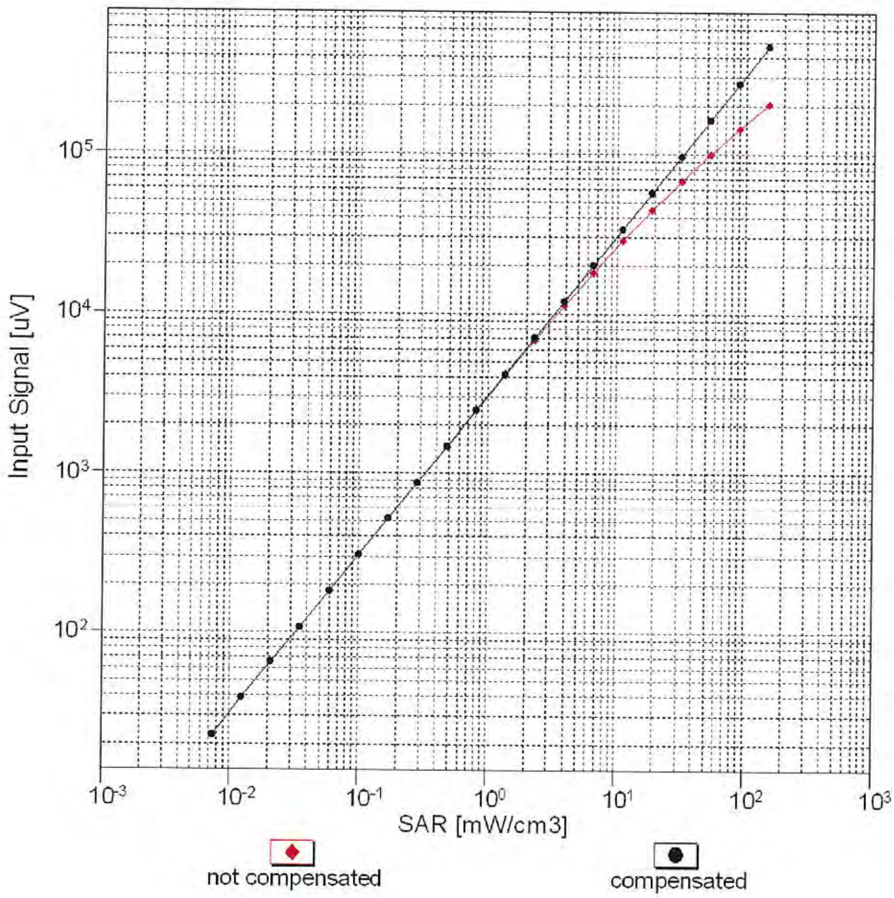


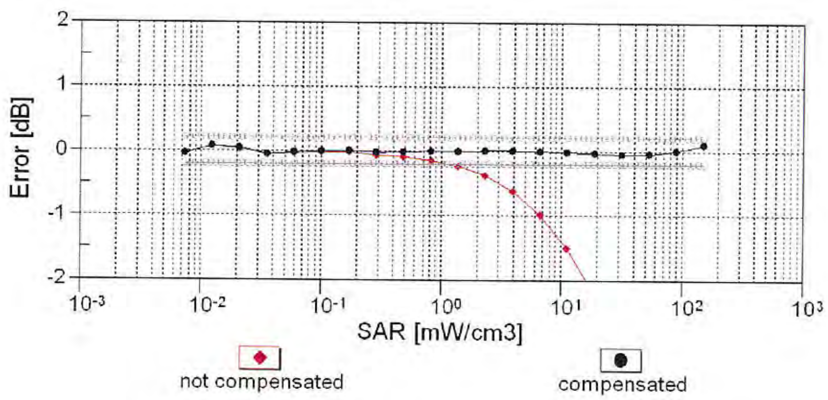




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR$_{head}$)
(TEM cell , f_{eval}= 1900 MHz)

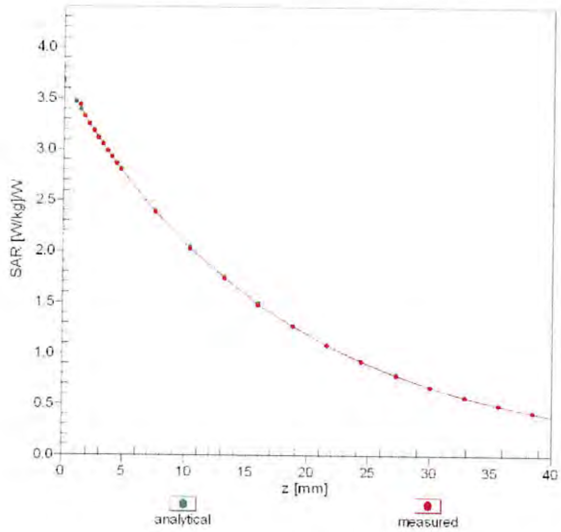




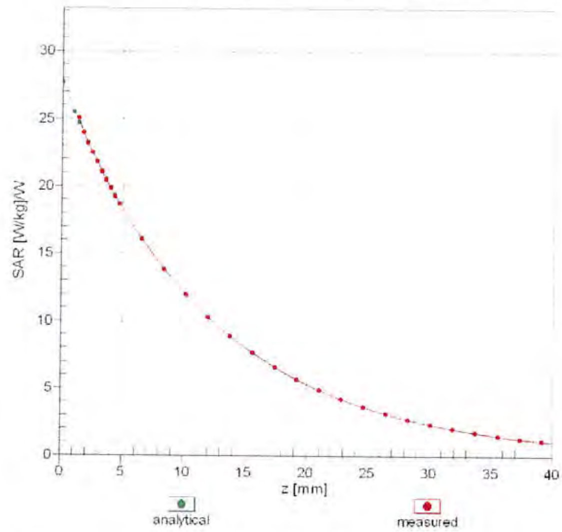
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

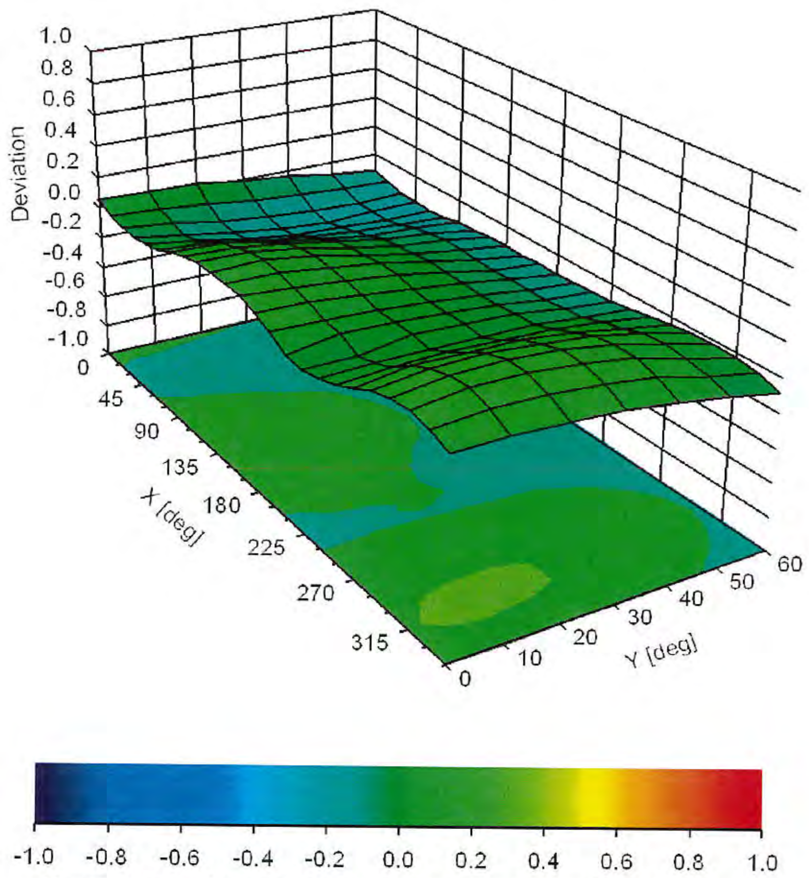


f = 1810 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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

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

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

Accreditation No.: SCS 0108

Client **Eurofins**

Certificate No: D2450V2-722_Sep18

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:722
Calibration procedure(s)	QA CAL-05.v10 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 04, 2018

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Reference Probe EX3DV4	SN: 7349	30-Dec-17 (No. EX3-7349_Dec17)	Dec-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-17)	In house check: Oct-18

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

Issued: September 4, 2018

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.4 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.8 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**24.0 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.5 Ω + 8.9 jΩ
Return Loss	- 20.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 Ω + 10.9 jΩ
Return Loss	- 18.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 16, 2002

Date: 04.09.2018

Test Laboratory: SPEAG, Zurich, Switzerland

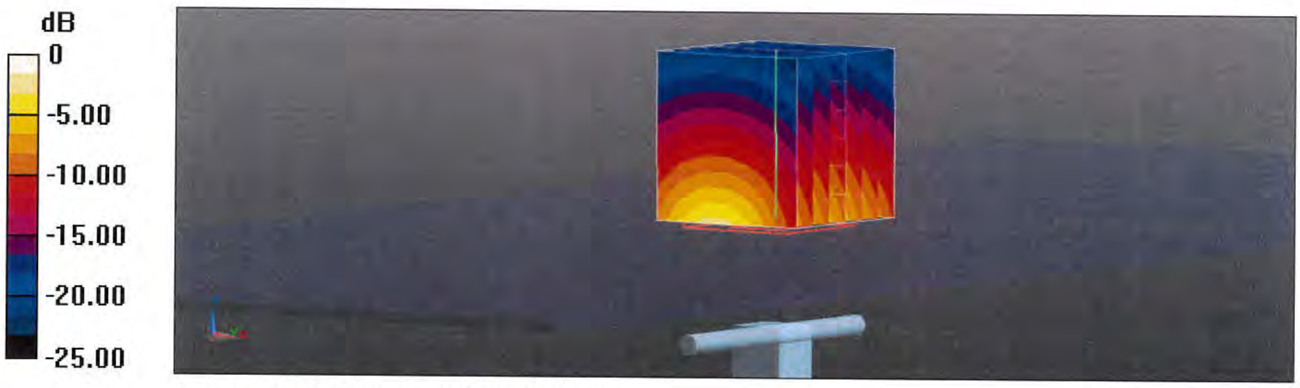
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:722

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ε_r = 37.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

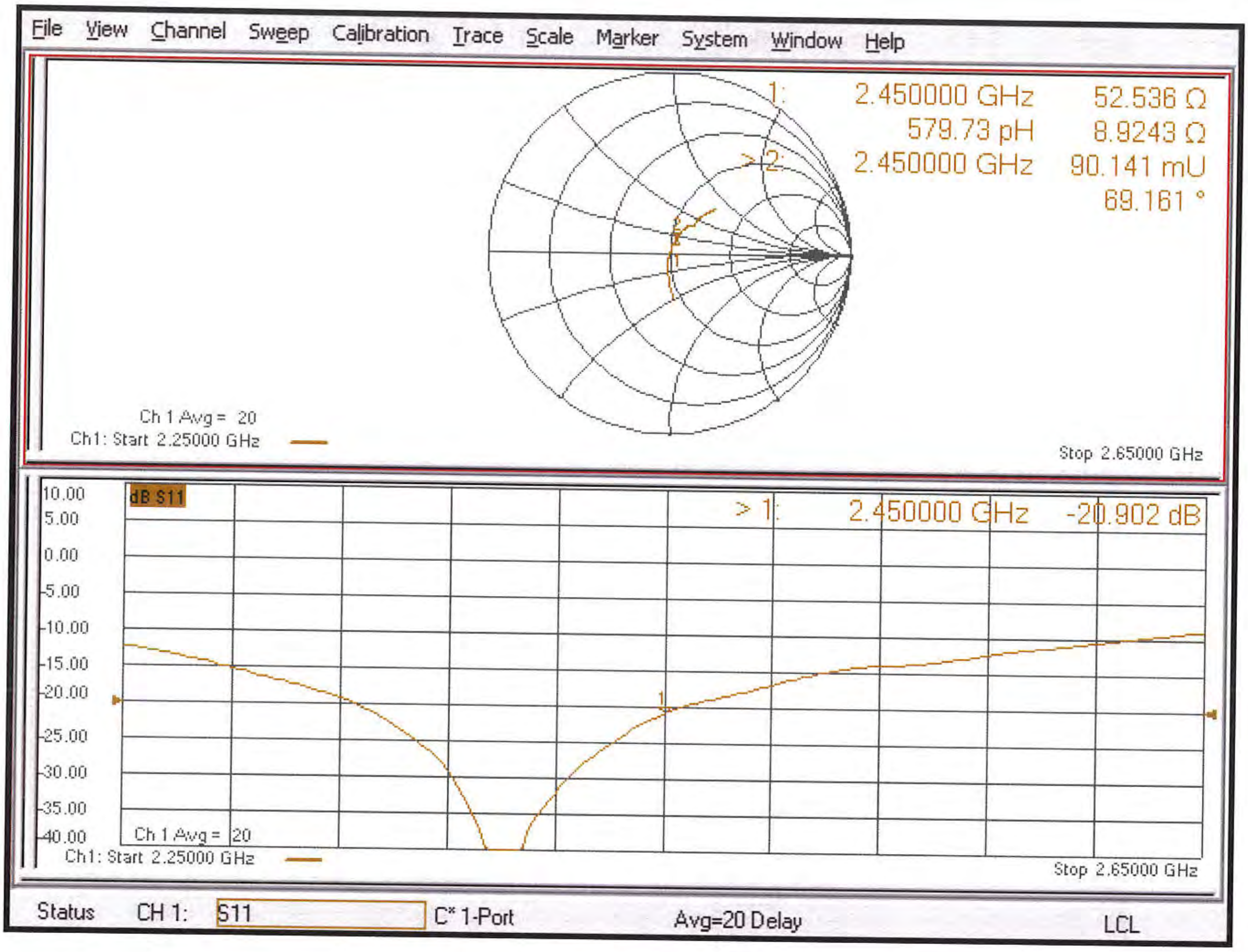
- Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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 = 113.8 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.19 W/kg
Maximum value of SAR (measured) = 21.0 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 04.09.2018

Test Laboratory: SPEAG, Zurich, Switzerland

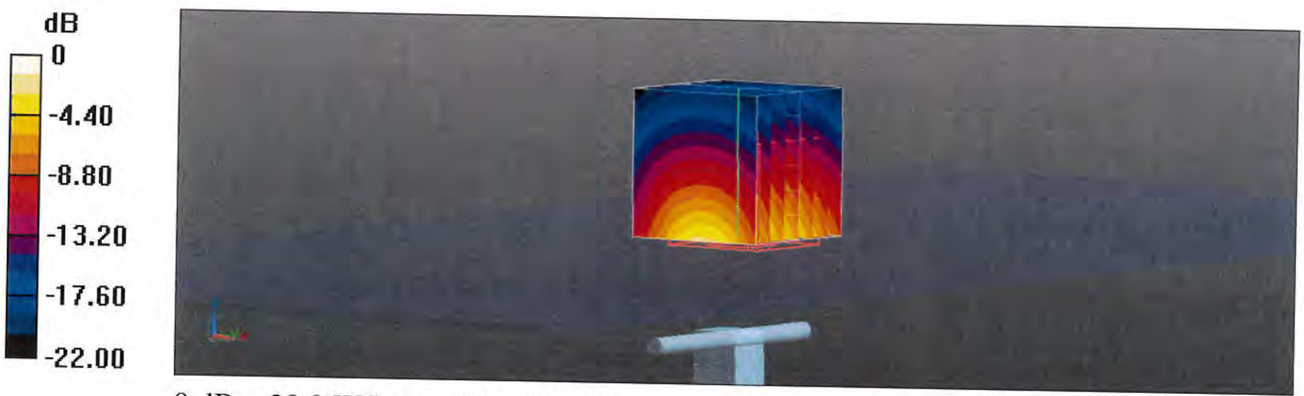
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:722

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 51.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.01, 8.01, 8.01) @ 2450 MHz; 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 52.10.1(1476); SEMCAD X 14.6.11(7439)

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 = 107.4 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 25.8 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.08 W/kg
Maximum value of SAR (measured) = 20.9 W/kg



0 dB = 20.9 W/kg = 13.20 dBW/kg

Impedance Measurement Plot for Body TSL