

RF Exposure report



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

Product Type WIFI6E 802.11AX+BT5.2 adapter card
Trade Name Intel® Wi-Fi 6E AX211
Model Number AX211NGW
Company Name ASUSTeK COMPUTER INC.
Company Address 1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan
Standards IEEE/ANSI C95.1-1992, IEEE 1528-2013
FCC ID MSQAX211NG
Date of EUT Receipt Apr. 14, 2022
Date of Test(s) May. 04, 2022 ~ May. 10, 2022
Date of Issue Jun. 23, 2022

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

Remarks:

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

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Signed on behalf of SGS

Clerk / Ruby Ou	PM / Afu Chen	Approved By / John Yeh

Date: Jun. 23, 2022

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TESA2204000049EN	Rev.00	Initial creation of document	Jun. 08, 2022	Ruby Ou	*
TESA2204000049EN	Rev.01	Make hotspots clearer (p. 81-84)	Jun. 23, 2022	Ruby Ou	

Note:

1. The mark " * " is the revised version of the report due to comments submitted by the certification.

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0. Guidance applied

- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- IEC/IEEE 62209-1528:2020
- SPEAG DASY6 System Handbook
- SPEAG DASY6 Application Note
(Interim Procedure for Device Operation at 6GHz-10GHz)
- IEC TR 63170:2018
- IEC 62479:2010
- FCC KDB 865664 D01 v01r04
- FCC KDB 865664 D02 v01r02
- FCC KDB 447498 D01 v06
- FCC KDB 616217 D04 v01r02
- FCC KDB 248227 D01 v02r02

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1. General Information

1.1 Testing Laboratory

SGS Taiwan Ltd. Central RF Lab	
1F, No. 8, Alley 15, Lane 120, Sec. 1, NeiHu Road, Neihu District, Taipei City, 11493, Taiwan.	
FCC Designation Number	TW0029
Tel	+886-2-2299-3279
Fax	+886-2-2298-0488
Internet	http://www.tw.sgs.com/

1.2 Details of Applicant

Company Name	ASUSTeK COMPUTER INC.
Company Address	1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan

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1.3 Description of EUT

Product Type	WIFI6E 802.11AX+BT5.2 adapter card	
Trade Name	Intel® Wi-Fi 6E AX211	
Model Number	AX211NGW	
FCC ID	MSQAX211NG	
Host Information	Product Type: Expertbook Trade Name: ASUS Model Name: B5402FB, B5402FBA, B5402CB, B5402CBA All models are electrically identical, different model names are for marketing purpose.	
Contain Module	Intel / AX211NGW	
Mode of Operation	☒ WLAN802.11 ☒ Bluetooth	
Duty Cycle	WLAN802.11	Refer to page 37-41
	Bluetooth	74.9%
Supported Radios	802.11b/g/n/ax	2.4GHz (2400.0 – 2483.5 MHz)
	802.11a/n/ac/ax	5.2GHz (5150.0 – 5350.0 MHz) 5.6GHz (5470.0 – 5725.0 MHz) 5.8GHz (5725.0 – 5850.0 MHz)
	Bluetooth 5.2	2.4GHz (2400.0 – 2483.5)
	802.11ax	6.0GHz (5925.0 – 7125.0 MHz)

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High-Tek

Summary of Maximum SAR and Power Density Value			
Mode	Highest SAR1g Body (W/kg)	Highest APD (mW/cm ²)	Highest PD (mW/cm ²)
2.4G WLAN	0.87	N/A	N/A
5.2G WLAN	0.68	N/A	N/A
5.3G WLAN	0.64	N/A	N/A
5.6G WLAN	0.77	N/A	N/A
5.8G WLAN	0.97	N/A	N/A
6G WLAN	0.88	0.46	0.44
Bluetooth(GFSK)	0.75	N/A	N/A

PULSE

Summary of Maximum SAR and Power Density Value			
Mode	Highest SAR1g Body (W/kg)	Highest APD (mW/cm ²)	Highest PD (mW/cm ²)
2.4G WLAN	0.91	N/A	N/A
5.2G WLAN	0.54	N/A	N/A
5.3G WLAN	0.52	N/A	N/A
5.6G WLAN	0.68	N/A	N/A
5.8G WLAN	0.81	N/A	N/A
6G WLAN	0.72	0.37	0.35
Bluetooth(GFSK)	0.73	N/A	N/A

Antenna Information

WLAN NB mode																		
Vendor	WLAN Man(PiFA)									High-tek					WLAN Aux(PiFA)			
Antenna	DC33002R600(0AACC022001N)									DC33002R610(0AACC022002N)								
Part Number	DC33002R600(0AACC022001N)									DC33002R610(0AACC022002N)								
Frequency(MHz)	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125
Gain(dBi)	1.81	3.16	3.16	3.91	4.21	4.27	3.63	4.17	3.66	2.69	3.13	3.11	4.14	4.22	4.26	3.72	4.19	3.87
WLAN TB mode																		
Vendor	WLAN Man(PiFA)									High-tek					WLAN Aux(PiFA)			
Antenna	DC33002R600(0AACC022001N)									DC33002R610(0AACC022002N)								
Part Number	DC33002R600(0AACC022001N)									DC33002R610(0AACC022002N)								
Frequency(MHz)	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125
Gain(dBi)	1.16	3.07	3.20	4.06	4.14	3.98	3.25	3.32	3.49	1.16	3.07	3.20	4.06	4.14	3.98	3.25	3.32	3.49
WLAN NB mode																		
Vendor	WLAN Man(PiFA)									PULSE								
Antenna	DC33002R500(TZ2381D)									WLAN Aux(PiFA)								
Part Number	DC33002R500(TZ2381D)									DC33002R510(TZ2381E)								
Frequency(MHz)	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125
Gain(dBi)	1.07	2.81	2.81	3.70	3.77	4.09	2.63	3.46	3.22	1.07	2.81	2.81	3.7	3.77	4.09	2.63	3.46	3.22
WLAN TB mode																		
Vendor	WLAN Man(PiFA)									PULSE								
Antenna	DC33002R500(TZ2381D)									WLAN Aux(PiFA)								
Part Number	DC33002R500(TZ2381D)									DC33002R510(TZ2381E)								
Frequency(MHz)	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125	2400-2500	5150-5250	5250-5350	5470-5725	5725-5850	5925-6425	6425-6525	6525-6875	6875-7125
Gain(dBi)	0.91	2.63	3.06	3.47	3.52	3.54	2.98	3.11	3.07	0.91	2.63	3.06	3.47	3.52	3.54	2.98	3.11	3.07

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WLAN conducted power table:

Notebook mode

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
2.45GHz	802.11b	1	2412	1Mbps	16.00	15.96
		6	2437		16.00	15.98
		11	2462		16.00	15.99
		12	2467		16.00	Not required
		13	2472		16.00	
	802.11g	1	2412	6Mbps	16.00	
		6	2437		16.00	
		11	2462		16.00	
	802.11n20-HT0	1	2412	MCS0	16.00	
		6	2437		16.00	
		11	2462		16.00	
	802.11ax20-HE0	1	2412	MCS0	16.00	
		6	2437		16.00	
		11	2462		16.00	
	802.11n40-HT0	3	2422	MCS0	15.50	
		6	2437		16.00	
		9	2452		15.50	
	802.11ax40-HE0	3	2422	MCS0	15.50	
		6	2437		16.00	
		9	2452		16.00	

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	14.50	Not required
		40	5200		14.50	
		44	5220		14.50	
		48	5240		14.50	
	802.11n20-HT0	36	5180	MCS0	14.50	
		40	5200		14.50	
		44	5220		14.50	
		48	5240		14.50	
	802.11ax20-HE0	36	5180	MCS0	14.50	
		40	5200		14.50	
		44	5220		14.50	
		48	5240		14.50	
	802.11n40-HT0	38	5190	MCS0	14.50	
		46	5230		14.50	
	802.11ax40-HE0	38	5190	MCS0	14.50	
		46	5230		14.50	
	802.11ac80-VHT0	42	5210	MCS0	14.50	
	802.11ax80-HE0	42	5210	MCS0	14.50	
	802.11ac160-VHT0	50	5250	MCS0	14.50	14.49
	802.11ax160-HE0	50	5250	MCS0	14.50	Not required

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	14.50	Not required
		56	5280		14.50	
		60	5300		14.50	
		64	5320		14.50	
	802.11n20-HT0	52	5260	MCS0	14.50	
		56	5280		14.50	
		60	5300		14.50	
		64	5320		14.50	
	802.11ax20-HE0	52	5260	MCS0	14.50	
		56	5280		14.50	
		60	5300		14.50	
		64	5320		14.50	
	802.11n40-HT0	54	5270	MCS0	14.50	
		62	5310		14.50	
	802.11ax40-HE0	54	5270	MCS0	14.50	
		62	5310		14.50	
	802.11ac80-VHT0	58	5290	MCS0	14.50	14.49
	802.11ax80-HE0	58	5290	MCS0	14.50	Not required

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.6GHz	802.11a	100	5500	6Mbps	15.00	Not required
		120	5600		15.00	
		140	5700		15.00	
		144	5720		15.00	
	802.11n20-HT0	100	5500	MCS0	15.00	
		120	5600		15.00	
		140	5700		15.00	
		144	5720		15.00	
	802.11ax20-HE0	100	5500	MCS0	15.00	
		120	5600		15.00	
		140	5700		15.00	
		144	5720		15.00	
	802.11n40-HT0	102	5510	MCS0	15.00	
		118	5590		15.00	
		134	5670		15.00	
		142	5710		15.00	
	802.11ax40-HE0	102	5510	MCS0	15.00	
		118	5590		15.00	
		134	5670		15.00	
		142	5710		15.00	
	802.11ac80-VHT0	106	5530	MCS0	15.00	14.95
		122	5610		15.00	14.93
		138	5690		15.00	14.98
	802.11ax80-HE0	106	5530	MCS0	15.00	Not required
		122	5610		15.00	
		138	5690		15.00	
	802.11ac160-VHT0	114	5570	MCS0	15.00	14.98
	802.11ax160-HE0	114	5570	MCS0	15.00	Not required

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WLAN Main						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.8GHz	802.11a	149	5745	6Mbps	16.50	Not required
		157	5785		16.50	
		165	5825		16.50	
	802.11n20-HT0	149	5745	MCS0	16.50	
		157	5785		16.50	
		165	5825		16.50	
	802.11ax20-HE0	149	5745	MCS0	16.50	
		157	5785		16.50	
		165	5825		16.50	
	802.11n40-HT0	151	5755	MCS0	16.50	
		159	5795		16.50	
	802.11ax40-HE0	151	5755	MCS0	16.50	
		159	5795		16.50	
	802.11ac80-VHT0	155	5775	MCS0	16.50	16.48
	802.11ax80-HE0	155	5775	MCS0	16.50	Not required

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
2.45GHz	802.11b	1	2412	1Mbps	15.50	15.48
		6	2437		15.50	15.44
		11	2462		15.50	15.46
		12	2467		15.50	Not required
		13	2472		15.50	
	802.11g	1	2412	6Mbps	15.50	
		6	2437		15.50	
		11	2462		15.50	
	802.11n20-HT0	1	2412	MCS0	15.50	
		6	2437		15.50	
		11	2462		15.50	
	802.11ax20-HE0	1	2412	MCS0	15.50	
		6	2437		15.50	
		11	2462		15.50	
	802.11n40-HT0	3	2422	MCS0	15.50	
		6	2437		15.50	
		9	2452		15.50	
	802.11ax40-HE0	3	2422	MCS0	15.50	
		6	2437		15.50	
		9	2452		15.50	

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	17.50	Not required
		40	5200		17.50	
		44	5220		17.50	
		48	5240		17.50	
	802.11n20-HT0	36	5180	MCS0	17.50	
		40	5200		17.50	
		44	5220		17.50	
		48	5240		17.50	
	802.11ax20-HE0	36	5180	MCS0	17.50	
		40	5200		17.50	
		44	5220		17.50	
		48	5240		17.50	
	802.11n40-HT0	38	5190	MCS0	17.50	
		46	5230		17.50	
	802.11ax40-HE0	38	5190	MCS0	17.50	
		46	5230		17.50	
	802.11ac80-VHT0	42	5210	MCS0	17.50	16.87
	802.11ax80-HE0	42	5210	MCS0	17.50	Not required
	802.11ac160-VHT0	50	5250	MCS0	15.50	
	802.11ax160-HE0	50	5250	MCS0	15.50	

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	17.50	Not required
		56	5280		17.50	
		60	5300		17.50	
		64	5320		17.50	
	802.11n20-HT0	52	5260	MCS0	17.50	
		56	5280		17.50	
		60	5300		17.50	
		64	5320		17.50	
	802.11ax20-HE0	52	5260	MCS0	17.50	
		56	5280		17.50	
		60	5300		17.50	
		64	5320		17.50	
	802.11n40-HT0	54	5270	MCS0	17.50	
		62	5310		17.50	
	802.11ax40-HE0	54	5270	MCS0	17.50	
		62	5310		17.50	
	802.11ac80-VHT0	58	5290	MCS0	17.50	17.47
	802.11ax80-HE0	58	5290	MCS0	17.50	Not required

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Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.6GHz	802.11a	100	5500	6Mbps	17.25	Not required
		120	5600		17.25	
		140	5700		17.25	
		144	5720		17.25	
	802.11n20-HT0	100	5500	MCS0	17.25	
		120	5600		17.25	
		140	5700		17.25	
		144	5720		17.25	
	802.11ax20-HE0	100	5500	MCS0	17.25	
		120	5600		17.25	
		140	5700		17.25	
		144	5720		17.25	
	802.11n40-HT0	102	5510	MCS0	17.25	
		118	5590		17.25	
		134	5670		17.25	
		142	5710		17.25	
	802.11ax40-HE0	102	5510	MCS0	17.25	
		118	5590		17.25	
		134	5670		17.25	
		142	5710		17.25	
	802.11ac80-VHT0	106	5530	MCS0	17.25	17.23
		122	5610		17.25	17.17
		138	5690		17.25	17.24
	802.11ax80-HE0	106	5530	MCS0	17.25	Not required
		122	5610		17.25	
		138	5690		17.25	
	802.11ac160-VHT0	114	5570	MCS0	15.75	
	802.11ax160-HE0	114	5570	MCS0	15.75	

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WLAN Aux						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.8GHz	802.11a	149	5745	6Mbps	17.50	Not required
		157	5785		17.50	
		165	5825		17.50	
	802.11n20-HT0	149	5745	MCS0	17.50	
		157	5785		17.50	
		165	5825		17.50	
	802.11ax20-HE0	149	5745	MCS0	17.50	
		157	5785		17.50	
		165	5825		17.50	
	802.11n40-HT0	151	5755	MCS0	17.50	
		159	5795		17.50	
	802.11ax40-HE0	151	5755	MCS0	17.50	
		159	5795		17.50	
	802.11ac80-VHT0	155	5775	MCS0	17.50	17.48
	802.11ax80-HE0	155	5775	MCS0	17.50	Not required

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Tablet mode

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
2.45GHz	802.11b	1	2412	1Mbps	12.50	12.45
		6	2437		12.50	12.48
		11	2462		12.50	12.46
		12	2467		12.50	Not required
		13	2472		12.50	
	802.11g	1	2412	6Mbps	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11n20-HT0	1	2412	MCS0	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11ax20-HE0	1	2412	MCS0	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11n40-HT0	3	2422	MCS0	12.50	
		6	2437		12.50	
		9	2452		12.50	
	802.11ax40-HE0	3	2422	MCS0	12.50	
		6	2437		12.50	
		9	2452		12.50	

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	10.00	Not required
		40	5200		10.00	
		44	5220		10.00	
		48	5240		10.00	
	802.11n20-HT0	36	5180	MCS0	10.00	
		40	5200		10.00	
		44	5220		10.00	
		48	5240		10.00	
	802.11ax20-HE0	36	5180	MCS0	10.00	
		40	5200		10.00	
		44	5220		10.00	
		48	5240		10.00	
	802.11n40-HT0	38	5190	MCS0	10.00	
		46	5230		10.00	
	802.11ax40-HE0	38	5190	MCS0	10.00	
		46	5230		10.00	
	802.11ac80-VHT0	42	5210	MCS0	10.00	
	802.11ax80-HE0	42	5210	MCS0	10.00	
	802.11ac160-VHT0	50	5250	MCS0	10.00	9.99
	802.11ax160-HE0	50	5250	MCS0	10.00	Not required

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	10.00	Not required
		56	5280		10.00	
		60	5300		10.00	
		64	5320		10.00	
	802.11n20-HT0	52	5260	MCS0	10.00	
		56	5280		10.00	
		60	5300		10.00	
		64	5320		10.00	
	802.11ax20-HE0	52	5260	MCS0	10.00	
		56	5280		10.00	
		60	5300		10.00	
		64	5320		10.00	
	802.11n40-HT0	54	5270	MCS0	10.00	
		62	5310		10.00	
	802.11ax40-HE0	54	5270	MCS0	10.00	
		62	5310		10.00	
	802.11ac80-VHT0	58	5290	MCS0	10.00	9.98
	802.11ax80-HE0	58	5290	MCS0	10.00	Not required

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.6GHz	802.11a	100	5500	6Mbps	9.50	Not required
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11n20-HT0	100	5500	MCS0	9.50	
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11ax20-HE0	100	5500	MCS0	9.50	
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11n40-HT0	102	5510	MCS0	9.50	
		118	5590		9.50	
		134	5670		9.50	
		142	5710		9.50	
	802.11ax40-HE0	102	5510	MCS0	9.50	
		118	5590		9.50	
		134	5670		9.50	
		142	5710		9.50	
	802.11ac80-VHT0	106	5530	MCS0	9.50	9.47
		122	5610		9.50	9.44
		138	5690		9.50	9.49
	802.11ax80-HE0	106	5530	MCS0	9.50	Not required
		122	5610		9.50	
		138	5690		9.50	
	802.11ac160-VHT0	114	5570	MCS0	9.50	9.49
	802.11ax160-HE0	114	5570	MCS0	9.50	Not required

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WLAN Main						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.8GHz	802.11a	149	5745	6Mbps	9.00	Not required
		157	5785		9.00	
		165	5825		9.00	
	802.11n20-HT0	149	5745	MCS0	9.00	
		157	5785		9.00	
		165	5825		9.00	
	802.11ax20-HE0	149	5745	MCS0	9.00	
		157	5785		9.00	
		165	5825		9.00	
	802.11n40-HT0	151	5755	MCS0	9.00	
		159	5795		9.00	
	802.11ax40-HE0	151	5755	MCS0	9.00	
		159	5795		9.00	
	802.11ac80-VHT0	155	5775	MCS0	9.00	8.99
	802.11ax80-HE0	155	5775	MCS0	9.00	Not required

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
2.45GHz	802.11b	1	2412	1Mbps	12.50	12.46
		6	2437		12.50	12.48
		11	2462		12.50	12.46
		12	2467		12.50	Not required
		13	2472		12.50	
	802.11g	1	2412	6Mbps	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11n20-HT0	1	2412	MCS0	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11ax20-HE0	1	2412	MCS0	12.50	
		6	2437		12.50	
		11	2462		12.50	
	802.11n40-HT0	3	2422	MCS0	12.50	
		6	2437		12.50	
		9	2452		12.50	
	802.11ax40-HE0	3	2422	MCS0	12.50	
		6	2437		12.50	
		9	2452		12.50	

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.15-5.25 GHz	802.11a	36	5180	6Mbps	10.50	Not required
		40	5200		10.50	
		44	5220		10.50	
		48	5240		10.50	
	802.11n20-HT0	36	5180	MCS0	10.50	
		40	5200		10.50	
		44	5220		10.50	
		48	5240		10.50	
	802.11ax20-HE0	36	5180	MCS0	10.50	
		40	5200		10.50	
		44	5220		10.50	
		48	5240		10.50	
	802.11n40-HT0	38	5190	MCS0	10.50	
		46	5230		10.50	
	802.11ax40-HE0	38	5190	MCS0	10.50	
		46	5230		10.50	
	802.11ac80-VHT0	42	5210	MCS0	10.50	
	802.11ax80-HE0	42	5210	MCS0	10.50	
	802.11ac160-VHT0	50	5250	MCS0	10.50	10.48
	802.11ax160-HE0	50	5250	MCS0	10.50	Not required

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.25-5.35 GHz	802.11a	52	5260	6Mbps	10.50	Not required
		56	5280		10.50	
		60	5300		10.50	
		64	5320		10.50	
	802.11n20-HT0	52	5260	MCS0	10.50	
		56	5280		10.50	
		60	5300		10.50	
		64	5320		10.50	
	802.11ax20-HE0	52	5260	MCS0	10.50	
		56	5280		10.50	
		60	5300		10.50	
		64	5320		10.50	
	802.11n40-HT0	54	5270	MCS0	10.50	
		62	5310		10.50	
	802.11ax40-HE0	54	5270	MCS0	10.50	
		62	5310		10.50	
	802.11ac80-VHT0	58	5290	MCS0	10.50	10.49
	802.11ax80-HE0	58	5290	MCS0	10.50	Not required

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5.6GHz	802.11a	100	5500	6Mbps	9.50	Not required
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11n20-HT0	100	5500	MCS0	9.50	
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11ax20-HE0	100	5500	MCS0	9.50	
		120	5600		9.50	
		140	5700		9.50	
		144	5720		9.50	
	802.11n40-HT0	102	5510	MCS0	9.50	
		118	5590		9.50	
		134	5670		9.50	
		142	5710		9.50	
	802.11ax40-HE0	102	5510	MCS0	9.50	
		118	5590		9.50	
		134	5670		9.50	
		142	5710		9.50	
	802.11ac80-VHT0	106	5530	MCS0	9.50	9.47
		122	5610		9.50	9.44
		138	5690		9.50	9.49
	802.11ax80-HE0	106	5530	MCS0	9.50	Not required
		122	5610		9.50	
		138	5690		9.50	
	802.11ac160-VHT0	114	5570	MCS0	9.50	9.49
	802.11ax160-HE0	114	5570	MCS0	9.50	Not required

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WLAN Aux						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
5.8GHz	802.11a	149	5745	6Mbps	8.50	Not required
		157	5785		8.50	
		165	5825		8.50	
	802.11n20-HT0	149	5745	MCS0	8.50	
		157	5785		8.50	
		165	5825		8.50	
	802.11ax20-HE0	149	5745	MCS0	8.50	
		157	5785		8.50	
		165	5825		8.50	
	802.11n40-HT0	151	5755	MCS0	8.50	
		159	5795		8.50	
	802.11ax40-HE0	151	5755	MCS0	8.50	
		159	5795		8.50	
	802.11ac80-VHT0	155	5775	MCS0	8.50	8.48
	802.11ax80-HE0	155	5775	MCS0	8.50	Not required

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WIFI 6E power:

Notebook mode

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-5 6.2GHz	802.11ax20-HE0	1	5955	MCS0	5.00	Not required
		45	6175		5.00	
		93	6415		5.00	
	802.11ax40-HE0	3	5965	MCS0	8.25	
		43	6165		8.25	
		91	6405		8.25	
	802.11ax80-HE0	7	5985	MCS0	10.75	
		39	6145		10.75	
		87	6385		10.75	
	802.11ax160-HE0	15	6025	MCS0	13.50	12.86
		47	6185		13.50	12.83
		79	6345		13.50	12.48

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-6 6.5GHz	802.11ax20-HE0	97	6435	MCS0	5.00	Not required
		105	6475		5.00	
		113	6515		5.00	
	802.11ax40-HE0	99	6445	MCS0	8.25	
		107	6485		8.25	
	802.11ax80-HE0	103	6465	MCS0	10.75	
		119	6545		10.75	
	802.11ax160-HE0	111	6505	MCS0	13.50	13.11

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WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-7 6.7GHz	802.11ax20-HE0	117	6535	MCS0	4.25	Not required
		149	6695		4.25	
		181	6855		4.25	
	802.11ax40-HE0	115	6525	MCS0	8.25	
		147	6685		7.50	
		179	6845		7.50	
	802.11ax80-HE0	135	6625	MCS0	10.00	
		151	6705		10.00	
		167	6785		10.00	
	802.11ax160-HE0	143	6665	MCS0	12.75	12.72
		175	6825		12.75	12.65

WLAN Main						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-8 7.0GHz	802.11ax20-HE0	185	6875	MCS0	4.25	Not required
		209	6995		4.25	
		233	7115		-1.00	
	802.11ax40-HE0	187	6885	MCS0	7.50	
		227	7085		7.50	
	802.11ax80-HE0	183	6865	MCS0	10.00	
		199	6945		10.00	
		215	7025		10.00	
	802.11ax160-HE0	207	6985	MCS0	12.75	12.69

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-5 6.2GHz	802.11ax20-HE0	1	5955	MCS0	5.00	Not required
		45	6175		5.00	
		93	6415		5.00	
	802.11ax40-HE0	3	5965	MCS0	8.25	
		43	6165		8.25	
		91	6405		8.25	
	802.11ax80-HE0	7	5985	MCS0	10.75	
		39	6145		10.75	
		87	6385		10.75	
	802.11ax160-HE0	15	6025	MCS0	13.50	12.97
		47	6185		13.50	12.95
		79	6345		13.50	12.74

WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-6 6.5GHz	802.11ax20-HE0	97	6435	MCS0	5.00	Not required
		105	6475		5.00	
		113	6515		5.00	
	802.11ax40-HE0	99	6445	MCS0	8.25	
		107	6485		8.25	
	802.11ax80-HE0	103	6465	MCS0	10.75	
		119	6545		10.75	
	802.11ax160-HE0	111	6505	MCS0	13.50	13.11

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WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-7 6.7GHz	802.11ax20-HE0	117	6535	MCS0	4.25	Not required
		149	6695		4.25	
		181	6855		4.25	
	802.11ax40-HE0	115	6525	MCS0	8.25	
		147	6685		7.50	
		179	6845		7.50	
	802.11ax80-HE0	135	6625	MCS0	10.00	
		151	6705		10.00	
		167	6785		10.00	
	802.11ax160-HE0	143	6665	MCS0	12.75	12.49
		175	6825		12.75	12.47

WLAN Aux						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-8 7.0GHz	802.11ax20-HE0	185	6875	MCS0	4.25	Not required
		209	6995		4.25	
		233	7115		-1.00	
	802.11ax40-HE0	187	6885	MCS0	7.50	
		227	7085		7.50	
	802.11ax80-HE0	183	6865	MCS0	10.00	
		199	6945		10.00	
		215	7025		10.00	
	802.11ax160-HE0	207	6985	MCS0	12.75	12.74

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Tablet mode

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-5 6.2GHz	802.11ax20-HE0	1	5955	MCS0	5.00	Not required
		45	6175		5.00	
		93	6415		5.00	
	802.11ax40-HE0	3	5965	MCS0	8.25	
		43	6165		8.25	
		91	6405		8.25	
	802.11ax80-HE0	7	5985	MCS0	9.00	
		39	6145		9.00	
		87	6385		9.00	
	802.11ax160-HE0	15	6025	MCS0	9.00	8.92
		47	6185		9.00	8.97
		79	6345		9.00	8.98

WLAN Main						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-6 6.5GHz	802.11ax20-HE0	97	6435	MCS0	5.00	Not required
		105	6475		5.00	
		113	6515		5.00	
	802.11ax40-HE0	99	6445	MCS0	8.25	
		107	6485		8.25	
	802.11ax80-HE0	103	6465	MCS0	9.00	
		119	6545		9.00	
	802.11ax160-HE0	111	6505	MCS0	9.00	8.99

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Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-7 6.7GHz	802.11ax20-HE0	117	6535	MCS0	4.25	Not required
		149	6695		4.25	
		181	6855		4.25	
	802.11ax40-HE0	115	6525	MCS0	8.25	
		147	6685		7.50	
		179	6845		7.50	
	802.11ax80-HE0	135	6625	MCS0	9.00	
		151	6705		9.00	
		167	6785		9.00	
	802.11ax160-HE0	143	6665	MCS0	9.00	8.98
		175	6825		9.00	8.97

WLAN Main						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-8 7.0GHz	802.11ax20-HE0	185	6875	MCS0	4.25	Not required
		209	6995		4.25	
		233	7115		-1.00	
	802.11ax40-HE0	187	6885	MCS0	7.50	
		227	7085		7.50	
	802.11ax80-HE0	183	6865	MCS0	9.00	8.95
		199	6945		8.50	8.46
		215	7025		8.50	8.44
	802.11ax160-HE0	207	6985	MCS0	8.50	Not required

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Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-5 6.2GHz	802.11ax20-HE0	1	5955	MCS0	5.00	Not required
		45	6175		5.00	
		93	6415		5.00	
	802.11ax40-HE0	3	5965	MCS0	8.25	
		43	6165		8.25	
		91	6405		8.25	
	802.11ax80-HE0	7	5985	MCS0	9.00	
		39	6145		9.00	
		87	6385		9.00	
	802.11ax160-HE0	15	6025	MCS0	9.00	8.97
		47	6185		9.00	8.99
		79	6345		9.00	8.98

WLAN Aux						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-6 6.5GHz	802.11ax20-HE0	97	6435	MCS0	5.00	Not required
		105	6475		5.00	
		113	6515		5.00	
	802.11ax40-HE0	99	6445	MCS0	8.25	
		107	6485		8.25	
	802.11ax80-HE0	103	6465	MCS0	9.00	
		119	6545		9.00	
	802.11ax160-HE0	111	6505	MCS0	9.00	8.98

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		149	6695		4.25	
		181	6855		4.25	
	802.11ax40-HE0	115	6525	MCS0	8.25	
		147	6685		7.50	
		179	6845		7.50	
	802.11ax80-HE0	135	6625	MCS0	9.00	
		151	6705		9.00	
		167	6785		9.00	
	802.11ax160-HE0	143	6665	MCS0	9.00	8.99
		175	6825		9.00	8.97

WLAN Aux						
Mode	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
U-NII-8 7.0GHz	802.11ax20-HE0	185	6875	MCS0	4.25	Not required
		209	6995		4.25	
		233	7115		-1.00	
	802.11ax40-HE0	187	6885	MCS0	7.50	8.97
		227	7085		7.50	
	802.11ax80-HE0	183	6865	MCS0	9.00	8.97
		199	6945		8.50	8.44
		215	7025		8.50	8.46
	802.11ax160-HE0	207	6985	MCS0	8.50	Not required

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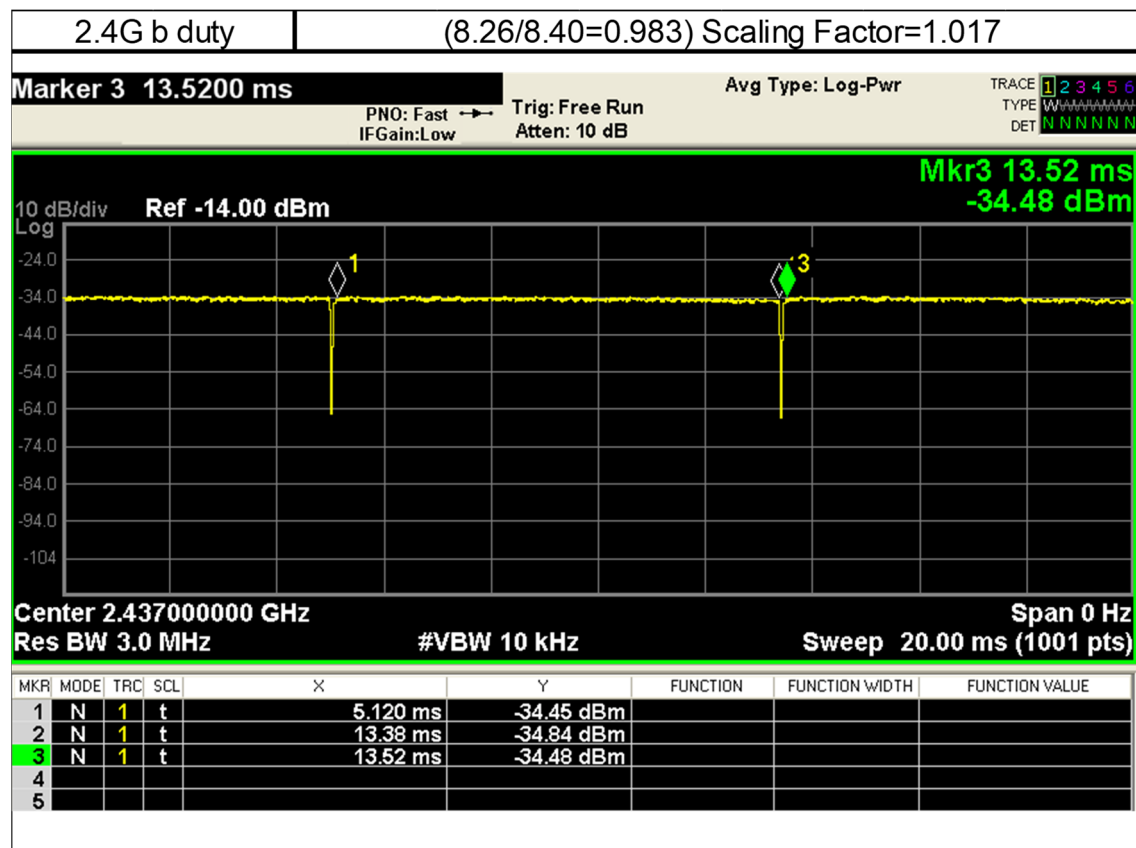
Bluetooth conducted power table:

Mode	Channel	Frequency (MHz)	1Mbps		2Mbps		3Mbps	
			Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
BR/EDR	CH 00	2402	11.00	9.02	7.00	6.94	7.00	6.92
	CH 39	2441		9.11		6.92		6.91
	CH 78	2480		9.21		6.98		6.96

Mode	Channel	Frequency (MHz)	GFSK	
			Max. Rated Avg. Power + Max. Tolerance (dBm)	Average Output Power (dBm)
BLE_1M	CH 00	2402	7	6.79
	CH 19	2440		6.88
	CH 39	2480		6.98
Mode	Channel	Frequency (MHz)	GFSK	
			Max. Rated Avg. Power + Max. Tolerance (dBm)	Average Output Power (dBm)
BLE_2M	CH 00	2402	7	6.45
	CH 19	2440		6.75
	CH 39	2480		6.85

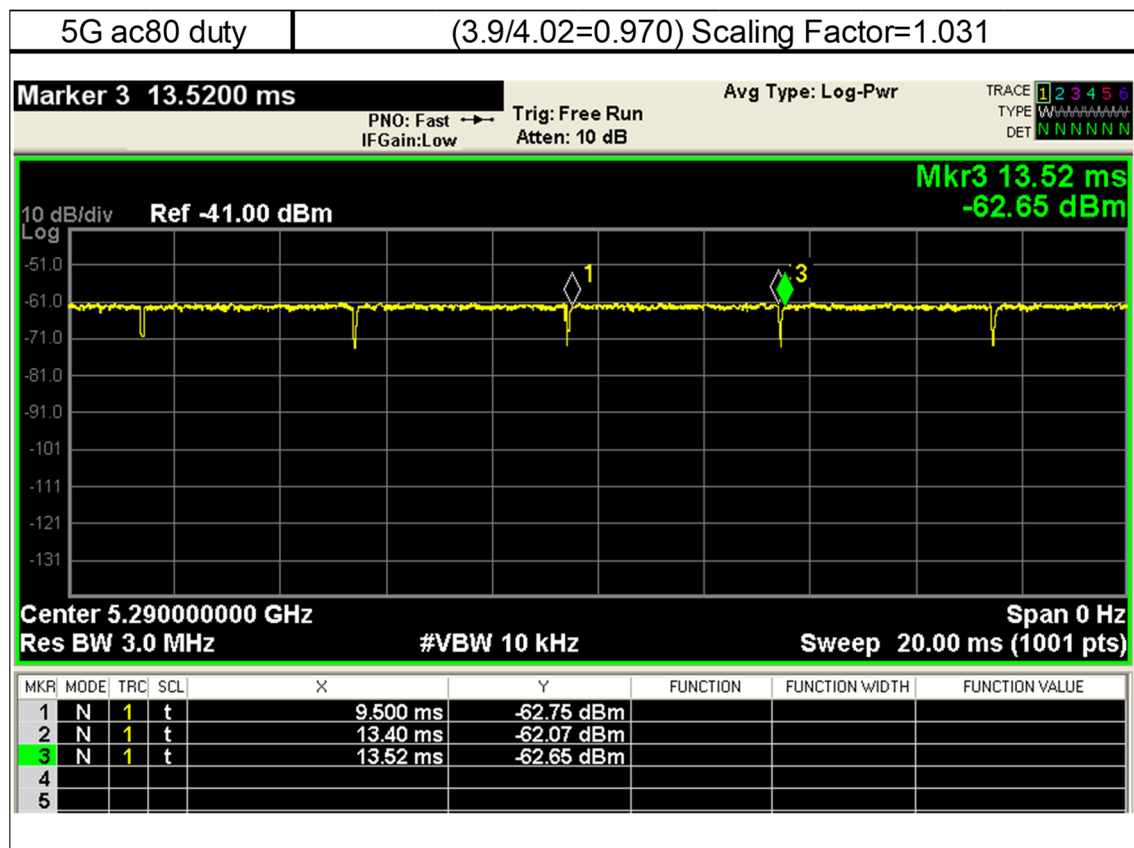
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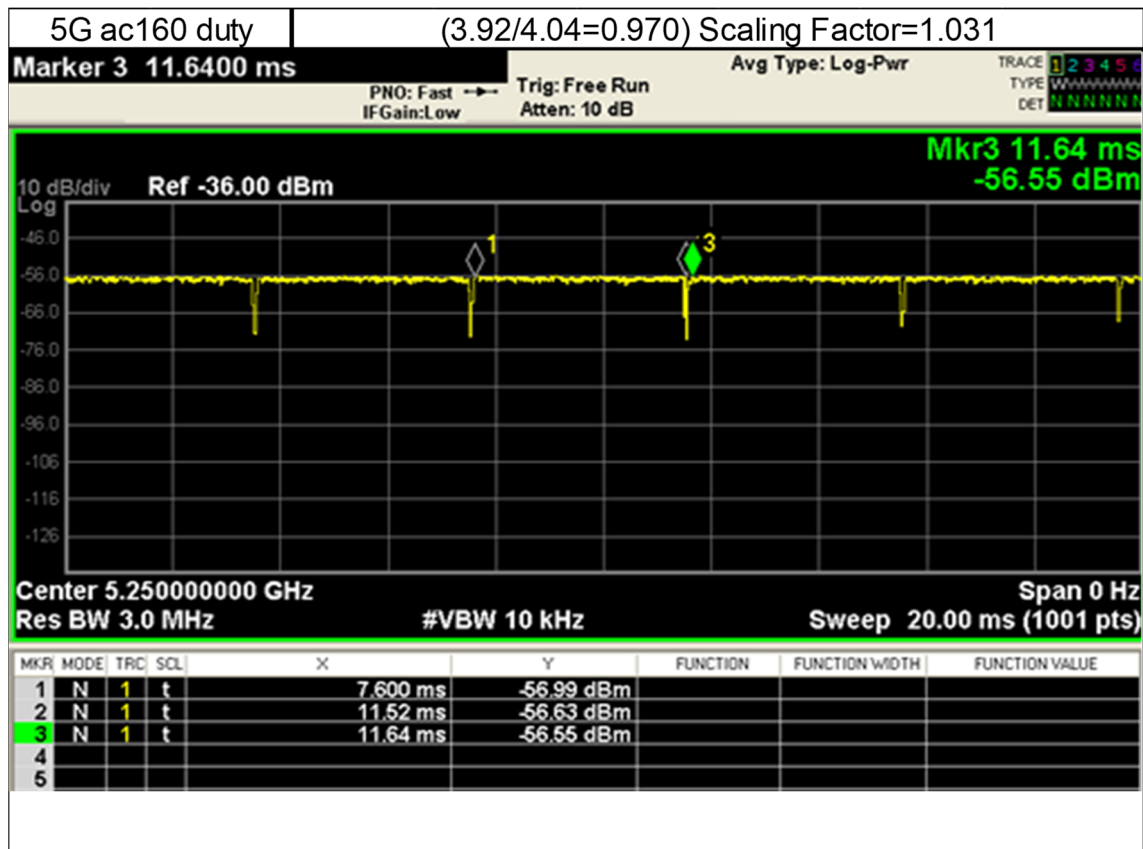
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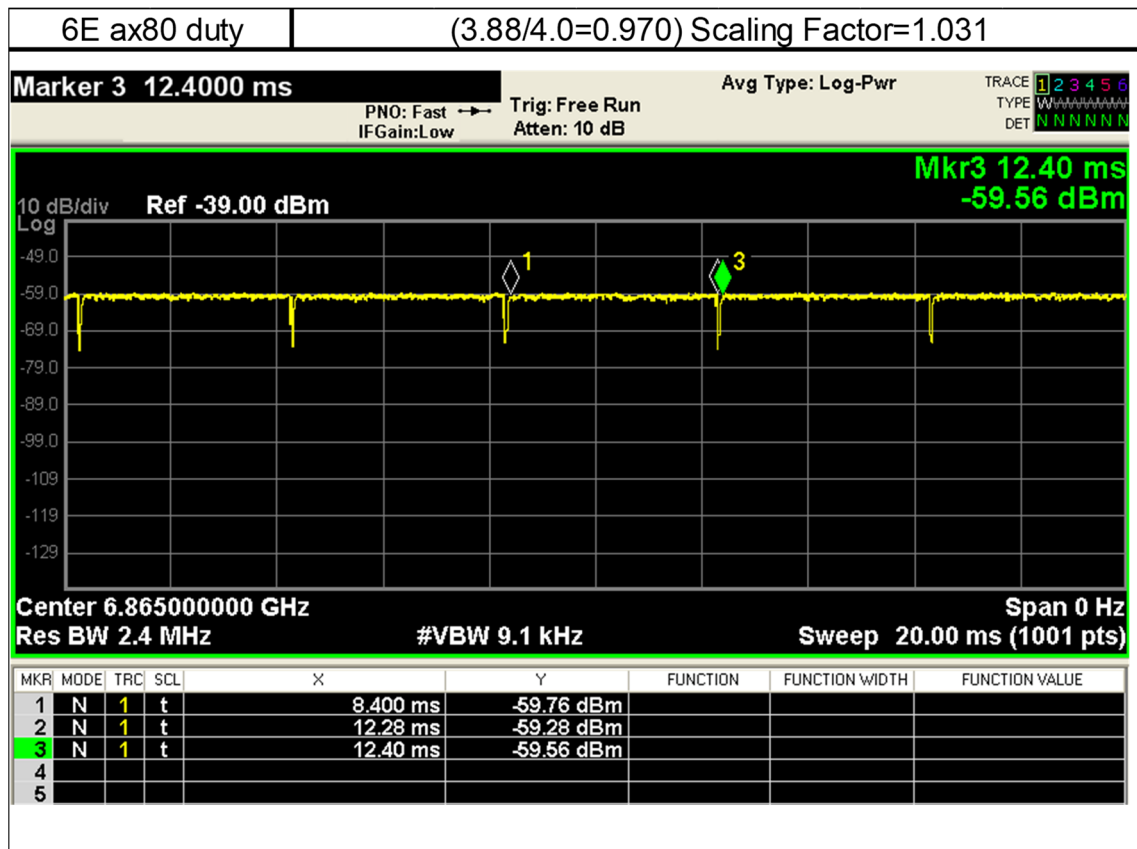
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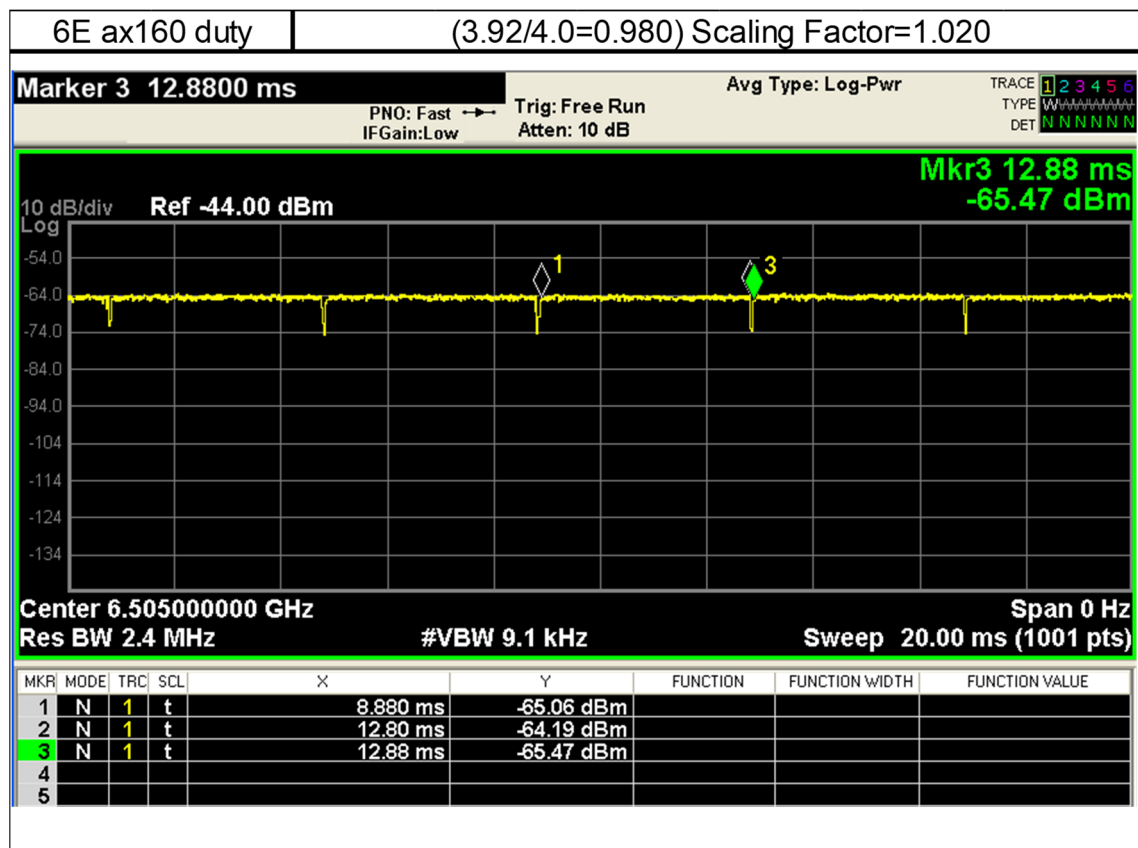
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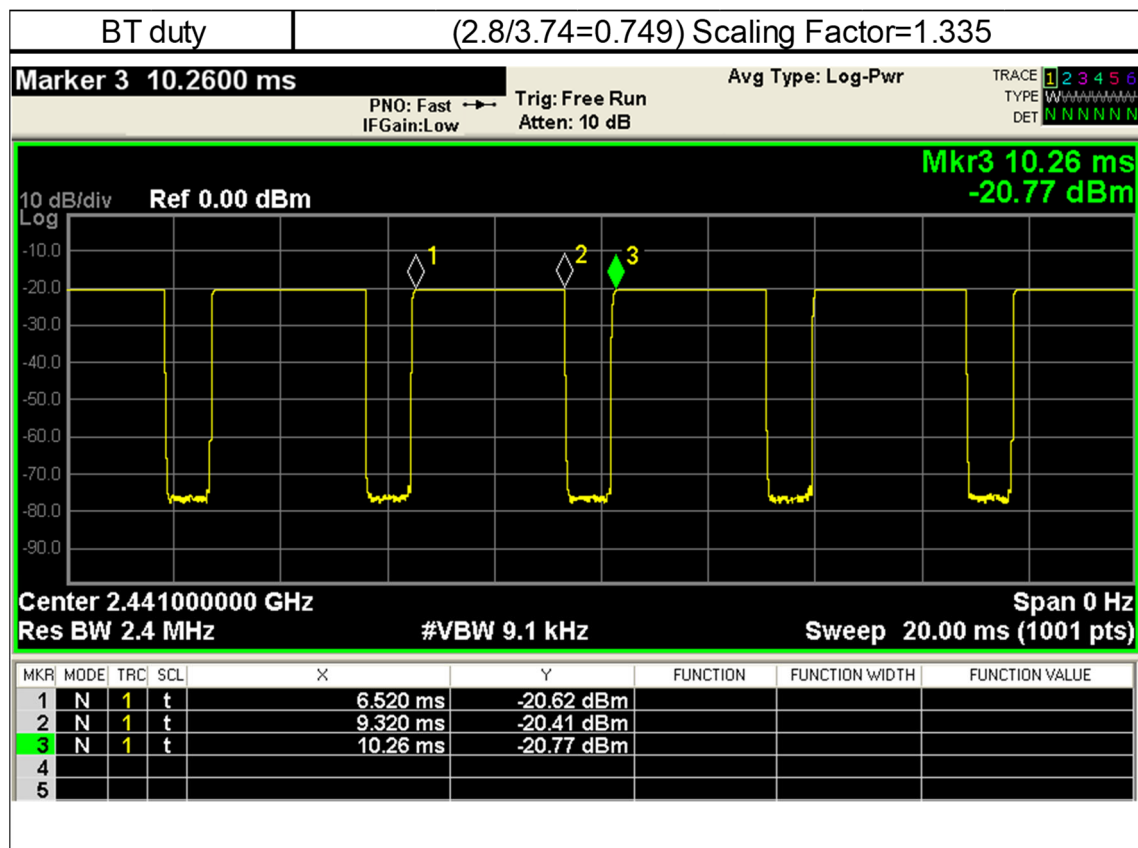
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1.4 Test Environment

Ambient Temperature: $22 \pm 2^\circ \text{C}$

Tissue Simulating Liquid: $22 \pm 2^\circ \text{C}$

1.5 Operation Description

1. An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band.
2. SAR is measured using the highest measured maximum output power channel. When the reported SAR of the initial test configuration is $> 0.8 \text{ W/kg}$, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is $\leq 1.2 \text{ W/kg}$ or all required channels are tested.
3. Since the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is $\leq 1.2 \text{ W/kg}$, SAR is not required for subsequent test configuration.
4. Per 201904 TCBC workshops, general principles of FCC KDB Publication 248227 D01 can be applied to determine the SAR Initial Test Configurations and test reduction for 802.11ax SAR testing.
5. In applying the test guidance, the IEEE 802.11 mode with the maximum output power (out of all modes) should be considered for testing. For modes with the same maximum output power, the guidance from section 5.3.2 a) of FCC KDB Publication 248227 D01 should be applied, with 802.11ax being considered as the highest 802.11 mode for the appropriate frequency bands
6. According to KDB865664 D01, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is $\geq 0.8 \text{ W/kg}$, repeated that measurement once. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is $\geq 1.45 \text{ W/kg}$ ($\sim 10\%$ from the 1-g SAR limit)
7. WIFI 6E of the device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools.
8. Per October 2020 & April 2021 TCB Workshop Interim procedures and FCC guidance, start instead with a minimum of 5 test channels across the full band, then adapt and apply conducted power and SAR test reduction procedures of KDB Pub. 248227 v02r02.
9. WIFI 6E SAR is measured by using 6-7GHz parameters per IEC/IEEE62209-1528:2020 and report also estimated absorbed PD (for reference purposes only, not specifically for compliance).

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.
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10. For the highest SAR test configurations also measure incident PD (total) using mmW near-field probe and total-field/power-density reconstruction method.
11. The PD test was performed with a 2 mm separation between probe sensor and EUT surface.
12. According to October 2020 TCB Workshop Interim procedures, power density results were scaled according to IEC 62479:2010 for the portion of the measurement uncertainty > 30%. Total expanded uncertainty of 2.67 dB (85%) was used to determine the psPD measurement scaling factor.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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1.6 Operating modes validation by power measurement

The device is a convertible laptop computer with predefined single fixed power to each device modes.

For the operating modes validation, the measured conducted output power is monitored qualitatively to identify the triggering characteristics and recorded quantitatively.

Device Mode	Lid Open Angle description Lid Close → Laptop → Tablet	Lid Open Angle description Tablet → Laptop → Lid Close	Mode Reported to OS for WLAN
Lid Close	$0^{\circ} \leq \text{Lid angle} < 12.5^{\circ}$ (GMR Sensor Trigger)	$0^{\circ} \leq \text{Lid angle} < 12.5^{\circ}$ (GMR Sensor Trigger)	Standby
Laptop	$12.5^{\circ} \leq \text{Lid angle} < 200^{\circ}$ (G-Sensor Trigger)	$12.5^{\circ} \leq \text{Lid angle} < 160^{\circ}$ (G-Sensor Trigger)	Notebook
Tablet	$200^{\circ} \leq \text{Lid angle} \leq 360^{\circ}$ (G-Sensor Trigger)	$160^{\circ} \leq \text{Lid angle} \leq 360^{\circ}$ (G-Sensor Trigger)	Non-notebook

1.6.1 Results and conclusion

The measured output power versus lid angle is tabulated in the following table based on the guidance from 2019-11 TCB workshop, and the triggering verification complies with the device mode / power level declared by the manufacturer.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.
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Operating mode validation by power measurement

Antenna	Operation mode	Lid angle	802.11b	802.11ac(80M) 5.2G	802.11ac(80M) 5.3G	802.11ac(80M) 5.6G	802.11ac(80M) 5.8G	U-NII-5 802.11ax(160M)	U-NII-6 802.11ax(160M)	U-NII-7 802.11ax(160M)	U-NII-8 802.11ax(160M)
Main	Lid close	0°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Laptop	20°	15.90	14.45	14.45	14.91	16.48	12.76	13.07	12.62	12.63
		15°	15.90	14.45	14.45	14.89	16.41	12.79	13.08	12.63	12.69
		10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		11°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Lid close	12°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		13°	15.93	14.48	14.46	14.98	16.43	12.79	13.07	12.68	12.65
	Laptop	14°	15.93	14.46	14.46	14.89	16.42	12.85	13.02	12.64	12.66
		15°	15.90	14.45	14.43	14.92	16.40	12.76	13.08	12.66	12.60
		16°	15.91	14.44	14.46	14.89	16.44	12.81	13.09	12.65	12.69
		17°	15.98	14.39	14.40	14.91	16.38	12.80	13.03	12.70	12.60
		18°	15.92	14.44	14.45	14.93	16.39	12.77	13.10	12.65	12.64
		19°	15.98	14.45	14.41	14.92	16.48	12.86	13.09	12.70	12.61
		20°	15.93	14.41	14.47	14.89	16.44	12.84	13.03	12.65	12.59
		30°	15.90	14.46	14.44	14.96	16.48	12.78	13.11	12.71	12.69
		40°	15.96	14.41	14.43	14.91	16.44	12.80	13.06	12.64	12.60
		50°	15.95	14.47	14.45	14.94	16.46	12.84	13.04	12.66	12.68
		60°	15.97	14.47	14.44	14.88	16.39	12.78	13.07	12.70	12.59
		70°	15.91	14.43	14.49	14.92	16.42	12.83	13.04	12.64	12.65
		80°	15.97	14.49	14.42	14.97	16.41	12.86	13.03	12.65	12.68
		90°	15.89	14.47	14.48	14.92	16.45	12.80	13.02	12.69	12.63
		100°	15.90	14.48	14.44	14.88	16.43	12.79	13.02	12.70	12.66
		110°	15.91	14.45	14.44	14.91	16.42	12.83	13.06	12.70	12.65
		120°	15.99	14.47	14.48	14.88	16.41	12.82	13.11	12.66	12.68
		130°	15.89	14.44	14.42	14.96	16.46	12.78	13.03	12.68	12.67
		140°	15.89	14.39	14.46	14.91	16.38	12.81	13.08	12.68	12.60
		150°	15.90	14.46	14.43	14.93	16.41	12.77	13.05	12.70	12.65
		160°	15.94	14.49	14.42	14.92	16.39	12.84	13.11	12.68	12.62
		170°	15.98	14.48	14.39	14.93	16.45	12.86	13.07	12.70	12.59
		180°	15.97	14.47	14.47	14.96	16.43	12.83	13.11	12.62	12.68
		190°	15.92	14.44	14.45	14.93	16.39	12.81	13.01	12.63	12.61
	Table	200°	12.41	9.97	9.94	9.44	8.98	8.90	8.91	8.98	8.95
		195°	15.97	14.43	14.41	14.91	16.40	12.81	13.09	12.66	12.67
	Laptop	196°	15.94	14.41	14.44	14.92	16.47	12.85	13.11	12.62	12.67
		197°	15.99	14.47	14.39	14.92	16.48	12.80	13.03	12.64	12.65
		198°	15.91	14.41	14.40	14.90	16.45	12.79	13.06	12.72	12.62
		199°	15.97	14.43	14.49	14.88	16.40	12.79	13.08	12.67	12.59
		200°	12.48	9.94	9.92	9.47	8.92	8.90	8.93	8.95	8.92
		201°	12.38	9.99	9.95	9.40	8.92	8.92	8.91	8.94	8.95
		202°	12.41	9.92	9.92	9.48	8.98	8.94	8.92	8.95	8.93
		203°	12.46	9.91	9.96	9.42	8.97	8.89	8.89	8.98	8.85
		204°	12.41	9.92	9.90	9.42	8.94	8.95	8.89	8.96	8.87
		205°	12.40	9.97	9.48	9.46	8.98	8.97	8.93	8.97	8.94
	Table	206°	12.43	9.92	9.91	9.41	8.94	8.93	8.99	8.91	8.87
		207°	12.41	9.97	9.95	9.41	8.96	8.90	8.98	8.96	8.94
		208°	12.47	9.91	9.89	9.39	8.92	8.89	8.95	8.96	8.89
		209°	12.43	9.94	9.96	9.49	8.93	8.91	8.98	8.97	8.86
		210°	12.39	9.94	9.88	9.39	8.92	8.93	8.95	8.89	8.93
		220°	12.44	9.91	9.94	9.42	8.90	8.98	8.97	8.92	8.88
		230°	12.48	9.90	9.96	9.45	8.90	8.90	8.90	8.93	8.95
		240°	12.41	9.89	9.93	9.47	8.96	8.88	8.98	8.88	8.95
		250°	12.39	9.95	9.89	9.49	8.89	8.92	8.91	8.97	8.85
		260°	12.41	9.92	9.88	9.45	8.97	8.90	8.90	8.90	8.91
		270°	12.42	9.98	9.98	9.46	8.96	8.96	8.95	8.89	8.95
		280°	12.41	9.96	9.90	9.43	8.90	8.98	8.93	8.95	8.94
		290°	12.48	9.94	9.92	9.48	8.97	8.88	8.95	8.97	8.85
		300°	12.46	9.91	9.98	9.42	8.95	8.96	8.96	8.92	8.90
		310°	12.38	9.92	9.98	9.39	8.96	8.97	8.89	8.97	8.95
		320°	12.38	9.92	9.93	9.46	8.95	8.92	8.97	8.96	8.89
		330°	12.45	9.96	9.96	9.41	8.92	8.96	8.96	8.89	8.92
		340°	12.46	9.97	9.97	9.49	8.97	8.94	8.94	8.88	8.89
		350°	12.44	9.93	9.92	9.48	8.98	8.89	8.90	8.95	8.86
		360°	12.38	9.94	9.93	9.47	8.91	8.88	8.91	8.89	8.89
		350°	12.41	9.89	9.93	9.44	8.94	8.91	8.95	8.97	8.91
		340°	12.48	9.98	9.98	9.44	8.90	8.92	8.93	8.97	8.88
		330°	12.45	9.96	9.97	9.43	8.93	8.94	8.93	8.92	8.91
		320°	12.38	9.93	9.98	9.44	8.93	8.94	8.94	8.89	8.87
		310°	12.47	9.98	9.92	9.45	8.91	8.90	8.95	8.90	8.86
		300°	12.41	9.97	9.95	9.49	8.90	8.96	8.98	8.98	8.89
		290°	12.43	9.96	9.89	9.48	8.96	8.97	8.89	8.97	8.95
		280°	12.46	9.93	9.41	9.41	8.95	8.94	8.95	8.94	8.96
		270°	12.48	9.90	9.96	9.46	8.89	8.96	8.90	8.88	8.94
	Table	260°	12.42	9.94	9.92	9.42	8.99	8.96	8.91	8.88	8.92
		250°	12.39	9.93	9.89	9.41	8.95	8.88	8.95	8.92	8.85
		240°	12.39	9.97	9.96	9.43	8.98	8.95	8.89	8.92	8.87
		230°	12.45	9.97	9.98	9.42	8.95	8.89	8.95	8.97	8.87
		220°	12.47	9.90	9.96	9.47	8.95	8.89	8.95	8.89	8.88
		210°	12.41	9.89	9.88	9.44	8.91	8.95	8.89	8.98	8.88
		200°	12.38	9.90	9.96	9.49	8.91	8.88	8.91	8.91	8.87
		190°	12.40	9.94	9.94	9.41	8.94	8.90	8.90	8.92	8.94
		180°	12.48	9.94	9.92	9.41	8.94	8.91	8.99	8.88	8.86
		170°	12.45	9.91	9.94	9.41	8.96	8.89	8.98	8.88	8.88
	Laptop	160°	12.45	9.96	9.89	9.46	8.99	8.92	8.98	8.90	8.94
		150°	15.98	14.41	14.48	14.96	16.38	12.82	13.10	12.66	12.67
		155°	15.91	14.48	14.42	14.89	16.40	12.83	13.03	12.72	12.64
	Table	160°	12.40	9.98	9.88	9.39	8.95	8.93	8.93	8.90	8.86
		159°	15.89	14.42	14.49	14.90	16.38	12.82	13.10	12.67	12.63
		158°	15.95	14.44	14.47	14.95	16.45	12.82	13.04	12.68	12.63
		157°	15.91	14.47	14.41	14.91	16.46	12.80	13.07	12.65	12.64
		156°	15.96	14.48	14.49	14.91	16.38	12.81	13.05	12.70	12.63
		155°	15.95	14.47	14.45	14.97	16.39	12.83	13.05	12.71	12.67
		154°	15.98	14.49	14.47	14.90	16.47	12.82	13.09	12.64	12.64
	Laptop	153°	15.90	14.47	14.49	14.96	16.48	12.82	13.05	12.67	12.68
		152°	15.90	14.40	14.44	14.88	16.40	12.86	13.10	12.70	12.66
		151°	15.89	14.43	14.40	14.92	16.44	12.85	13.06	12.70	12.66
		150°	15.91	14.44	14.46	14.89	16.39	12.81	13.10	12.67	12.66
		140°	15.91	14.46	14.40	14.94	16.38	12.84	13.07	12.69	12.65
		130°	15.91	14.43	14.43	14.91	16.38	12.76	13.04	12.64	12.65
		120°	15.93	14.49	14.44	14.98	16.46	12.80	13.11	12.65	12.60
		110°	15.99	14.49	14.40	14.93	16.47	12.76	13.10	12.62	12.62
		100°	15.95	14.39	14.41	14.88	16.44	12.77	13.04	12.63	12.60
		90°	15.93	14.47	14.45	14.92	16.38	12.85	13.04	12.66	12.67
		80°	15.89	14.42	14.40	14.93	16.48	12.86	13.11	12.65	12.67
		70°	15.89	14.46	14.49	14.90	16.46	12.76	13.02		
60°	15.90	14.42	14.41	14.89	16.42	12.86	13.05	12.66	12.64		
50°	15.98	14.43	14.43	14.91	16.47	12.84	13.11	12.69	12.68		
40°	15.91	14.47	14.43	14.97	16.43	12.83	13.01	12.68	12.59		
30°	15.96	14.48	14.43	14.98	16.39	12.79	13.02	12.68	12.65		
20°	15.93	14.49	14.47	14.88	16.39	12.76	13.03	12.67	12.66		
Lid close	10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	15°	15.94	14.45	14.44	14.90	16.40	12.82	13.02	12.63	12.62	
Laptop	14°	15.89	14.39	14.43	14.97	16.43	12.80	13.03	12.68	12.66	
	13°	15.91	14.42	14.43	14.95	16.39	12.85	13.02	12.70	12.68	
Lid close	12°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	11°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	0°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	0°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

Antenna	Operation mode	Lid angle	802.11b	802.11ac(80M) 5.2G	802.11ac(80M) 5.3G	802.11ac(80M) 5.6G	802.11ac(80M) 5.8G	U-NII-5 802.11ax(160M)	U-NII-6802.11ax(160M)	U-NII-7802.11ax(160M)	U-NII-8802.11ax(160M)	
	Lid close	0°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	Laptop	10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		20°	15.48	16.79	17.40	17.23	17.47	12.96	13.01	12.43	12.74	
		15°	15.42	16.77	17.45	17.15	17.45	12.94	13.05	12.44	12.67	
	Lid close	10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		11°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		12°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		13°	15.44	16.78	17.40	17.24	17.41	12.95	13.07	12.47	12.68	
		14°	15.47	16.85	17.43	17.21	17.40	12.95	13.02	12.43	12.69	
		15°	15.47	16.80	17.37	17.18	17.44	12.91	13.07	12.47	12.69	
16°		15.48	16.83	17.39	17.17	17.45	12.97	13.08	12.43	12.73		
17°		15.48	16.80	17.43	17.16	17.40	12.90	13.10	12.42	12.72		
18°		15.39	16.80	17.45	17.16	17.44	12.96	13.05	12.45	12.64		
19°		15.40	16.77	17.45	17.22	17.40	12.88	13.06	12.42	12.69		
Laptop	20°	15.47	16.83	17.38	17.17	17.47	12.91	13.08	12.48	12.71		
	30°	15.44	16.80	17.45	17.18	17.44	12.96	13.03	12.41	12.74		
	40°	15.42	16.84	17.45	17.23	17.44	12.92	13.04	12.46	12.70		
	50°	15.42	16.81	17.41	17.20	17.46	12.88	13.11	12.48	12.64		
	60°	15.48	16.85	17.45	17.23	17.41	12.97	13.11	12.49	12.67		
	70°	15.39	16.84	17.46	17.22	17.44	12.96	13.06	12.42	12.73		
	80°	15.48	16.85	17.41	17.20	17.47	12.97	13.07	12.42	12.71		
	90°	15.42	16.83	17.40	17.22	17.40	12.95	13.10	12.44	12.67		
	100°	15.46	16.81	17.43	17.22	17.38	12.90	13.01	12.42	12.70		
	110°	15.48	16.87	17.37	17.18	17.44	12.95	13.01	12.42	12.71		
	Laptop	120°	15.45	16.83	17.42	17.22	17.43	12.94	13.05	12.40	12.73	
		130°	15.44	16.82	17.42	17.23	17.38	12.90	13.06	12.48	12.64	
		140°	15.48	16.77	17.41	17.18	17.38	12.97	13.09	12.40	12.73	
	150°	15.44	16.85	17.45	17.21	17.44	12.89	13.08	12.42	12.69		
	160°	15.42	16.84	17.42	17.19	17.44	12.95	13.04	12.39	12.64		
	170°	15.43	16.85	17.46	17.16	17.44	12.96	13.03	12.45	12.70		
	180°	15.42	16.80	17.37	17.18	17.47	12.96	13.02	12.44	12.68		
	190°	15.38	16.82	17.38	17.14	17.41	12.91	13.01	12.42	12.68		
	200°	12.41	10.39	10.42	9.47	8.48	8.97	8.90	8.94	8.97		
		Laptop	195°	15.48	16.81	17.37	17.23	17.44	12.88	13.07	12.39	12.67
196°			15.41	16.80	17.41	17.16	17.48	12.95	13.09	12.39	12.74	
197°			15.48	16.79	17.44	17.17	17.41	12.91	13.02	12.46	12.67	
198°		15.48	16.87	17.37	17.22	17.47	12.93	13.08	12.45	12.73		
199°		15.48	16.84	17.43	17.23	17.47	12.88	13.11	12.45	12.72		
Table		200°	12.38	10.38	10.41	9.42	8.41	8.91	8.91	8.91	8.89	
		201°	12.41	10.43	10.42	9.42	8.46	8.98	8.94	8.98	8.92	
		202°	12.43	10.46	10.44	9.45	8.42	8.99	8.92	8.98	8.96	
		203°	12.39	10.46	10.45	9.43	8.45	8.90	8.94	8.91	8.97	
		204°	12.38	10.39	10.48	9.47	8.46	8.99	8.97	8.99	8.87	
	205°	12.38	10.44	10.43	9.39	8.48	8.92	8.89	8.91	8.93		
	206°	12.43	10.43	10.45	9.39	8.47	8.95	8.95	8.98	8.87		
	207°	12.38	10.46	10.41	9.47	8.48	8.99	8.95	8.92	8.96		
	208°	12.38	10.48	10.39	9.42	8.41	8.97	8.95	8.90	8.90		
	209°	12.42	10.47	10.44	9.44	8.41	8.97	8.92	8.95	8.87		
	Table	210°	12.39	10.38	10.48	9.44	8.42	8.91	8.91	8.90	8.97	
		220°	12.43	10.40	10.43	9.43	8.46	8.96	8.94	8.94	8.94	
		230°	12.44	10.43	10.43	9.45	8.38	8.93	8.96	8.91	8.94	
	240°	12.45	10.48	10.42	9.45	8.43	8.94	8.98	8.89	8.87		
	250°	12.48	10.45	10.40	9.42	8.46	8.92	8.98	8.98	8.87		
	260°	12.47	10.43	10.43	9.43	8.47	8.97	8.98	8.97	8.89		
	270°	12.41	10.39	10.45	9.41	8.41	8.98	8.98	8.98	8.87		
	280°	12.47	10.46	10.40	9.40	8.40	8.93	8.95	8.90	8.95		
	290°	12.38	10.41	10.44	9.41	8.46	8.95	8.88	8.99	8.88		
	300°	12.45	10.40	10.41	9.49	8.45	8.90	8.88	8.93	8.92		
	Table	310°	12.39	10.43	10.40	9.44	8.38	8.91	8.91	8.97	8.87	
		320°	12.42	10.41	10.48	9.45	8.43	8.92	8.92	8.94	8.89	
		330°	12.41	10.43	10.40	9.43	8.45	8.94	8.94	8.96	8.93	
	340°	12.38	10.44	10.39	9.46	8.39	8.89	8.89	8.96	8.89		
	350°	12.41	10.46	10.47	9.39	8.45	8.97	8.92	8.93	8.89		
	360°	12.38	10.47	10.42	9.48	8.43	8.91	8.85	8.91	8.83		
	350°	12.42	10.45	10.45	9.45	8.38	8.90	8.89	8.94	8.89		
	340°	12.44	10.43	10.44	9.42	8.44	8.96	8.94	8.92	8.87		
	330°	12.38	10.39	10.48	9.47	8.40	8.99	8.98	8.96	8.95		
	320°	12.43	10.39	10.45	9.39	8.44	8.90	8.90	8.95	8.90		
310°	12.48	10.42	10.47	9.43	8.46	8.93	8.97	8.97	8.94			
	Table	300°	12.48	10.44	10.41	9.46	8.39	8.94	8.94	8.94	8.88	
		290°	12.41	10.41	10.49	9.40	8.47	8.91	8.95	8.93	8.88	
		280°	12.44	10.40	10.43	9.41	8.45	8.91	8.90	8.95	8.91	
	270°	12.47	10.41	10.45	9.46	8.40	8.99	8.97	8.98	8.91		
	260°	12.46	10.42	10.43	9.44	8.47	8.99	8.89	8.91	8.96		
	250°	12.39	10.41	10.48	9.46	8.46	8.98	8.88	8.94	8.92		
	240°	12.44	10.45	10.41	9.43	8.43	8.92	8.98	8.96	8.89		
	230°	12.42	10.41	10.46	9.41	8.44	8.95	8.94	8.93	8.91		
	220°	12.48	10.46	10.44	9.42	8.39	8.96	8.88	8.94	8.96		
	210°	12.39	10.46	10.41	9.49	8.47	8.99	8.90	8.97	8.87		
	Table	200°	12.45	10.38	10.41	9.49	8.48	8.99	8.92	8.89	8.90	
		190°	12.38	10.39	10.40	9.47	8.45	8.93	8.95	8.95	8.89	
		180°	12.47	10.47	10.43	9.47	8.42	8.90	8.91	8.91	8.92	
	170°	12.42	10.40	10.45	9.44	8.46	8.93	8.91	8.97	8.91		
	160°	12.46	10.41	10.47	9.43	8.39	8.94	8.98	8.91	8.92		
	150°	15.38	16.77	17.41	17.14	17.46	12.92	13.08	12.49	12.67		
	155°	15.47	16.87	17.43	17.19	17.38	12.92	13.10	12.44	12.65		
		Table	160°	12.41	10.44	10.39	9.44	8.41	8.88	8.93	8.96	8.96
			159°	15.44	16.77	17.44	17.20	17.40	12.90	13.09	12.42	12.69
			158°	15.42	16.79	17.39	17.23	17.41	12.87	13.05	12.49	12.65
157°		15.38	16.79	17.40	17.14	17.45	12.89	13.11	12.47	12.65		
156°		15.44	16.77	17.41	17.21	17.46	12.93	13.09	12.40	12.68		
155°		15.38	16.83	17.45	17.21	17.39	12.94	13.03	12.49	12.71		
154°		15.42	16.83	17.43	17.19	17.45	12.97	13.11	12.48	12.72		
153°		15.45	16.80	17.38	17.14	17.39	12.92	13.10	12.43	12.74		
152°		15.44	16.86	17.47	17.18	17.42	12.88	13.04	12.39	12.68		
151°		15.40	16.84	17.46	17.14	17.40	12.87	13.04	12.39	12.71		
	Laptop	150°	15.43	16.78	17.38	17.18	17.45	12.92	13.05	12.39	12.64	
		140°	15.43	16.84	17.47	17.16	17.46	12.87	13.06	12.42	12.65	
		130°	15.43	16.82	17.39	17.16	17.43	12.90	13.10	12.45	12.70	
	120°	15.44	16.87	17.40	17.18	17.47	12.90	13.07	12.45	12.71		
	110°	15.41	16.85	17.40	17.17	17.47	12.92	13.04	12.39	12.72		
	100°	15.44	16.79	17.42	17.16	17.43	12.90	13.10	12.39	12.70		
	90°	15.42	16.82	17.46	17.20	17.42	12.91	13.11	12.43	12.66		
	80°	15.40	16.80	17.40	17.18	17.38	12.91	13.06	12.46	12.73		
	70°	15.44	16.82	17.43	17.15	17.43	12.97	13.07	12.42	12.68		
	60°	15.38	16.79	17.41	17.23	17.39	12.88	13.08	12.41	12.70		
	Laptop	50°	15.44	16.79	17.40	17.18	17.48	12.91	13.02	12.41	12.73	
		40°	15.39	16.77	17.46	17.20	17.48	12.96	13.04	12.47	12.65	
		30°	15.44	16.87	17.43	17.18	17.38	12.91	13.06	12.46	12.73	
	20°	15.38	16.84	17.46	17.20	17.40	12.92	13.07	12.45	12.72		
	10°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
	Laptop	15°	15.48	16.84	17.40	17.21	17.44	12.90	13.03	12.43	12.74	
		14°	15.40	16.85	17.40	17.21	17.41	12.93	13.05	12.45	12.68	
		13°	15.40	16.81	17.37	17.14	17.41	12.96	13.01	12.49	12.73	
	Lid close	12°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
		11°	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
10°		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		

1.7 EUT Testing Position

For laptop PC, according to KDB 616217 D04, SAR evaluation is required for the bottom surface of the keyboard. This EUT was tested in the base of EUT directly against the flat phantom. The required minimum test separation distance for incorporating transmitters and antennas into laptop computer display is determined with the display screen opened at an angle of 90° to the keyboard compartment.

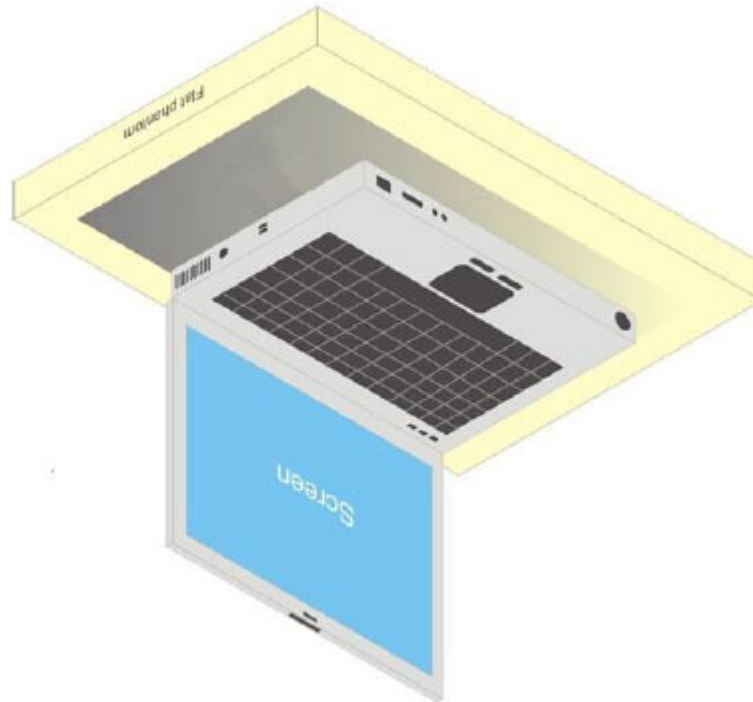


Illustration for Laptop Setup

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For full-size tablet, according to KDB 616217 D04, SAR evaluation is required for back surface and edges of the devices. The back surface and edges of the tablet are tested with the tablet touching the phantom. Exposures from antennas through the front surface of the display section of a tablet are generally limited to the user's hands. Exposures to hands for typical consumer transmitters used in tablets are not expected to exceed the extremity SAR limit; therefore, SAR evaluation for the front surface of tablet display screens are generally not necessary. When voice mode is supported on a tablet and it is limited to speaker mode or headset operations only, additional SAR testing for this type of voice use is not required.

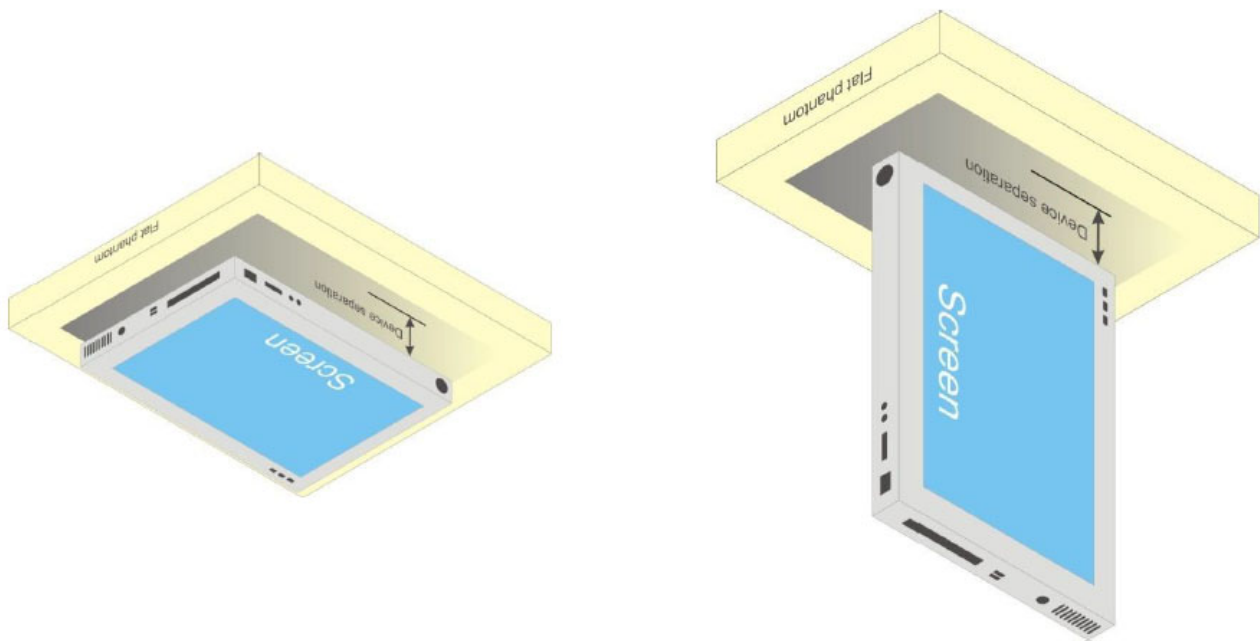


Illustration for Tablet Setup

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1.8 Evaluation Procedures

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

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

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

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

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

The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30x30x30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is

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the moved around until the highest averaged SAR is found.

If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

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1.9 Probe Calibration Procedures

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

1.9.1 Transfer Calibration with Temperature Probes

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

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

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

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

1. The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept

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small.

2. The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
3. The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures ($\sim 2\%$ for c ; much better for ρ), there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed $\pm 5\%$.
4. Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

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

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1.9.2 Calibration with Analytical Fields

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

When using calculated fields in lossy liquids for probe calibration, several points must be considered in the assessment of the uncertainty:

1. The setup must enable accurate determination of the incident power.
2. The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
3. Due to the small wavelength in liquids with high permittivity, even small setups might be above the resonant cutoff frequencies. The field distribution in the setup must be carefully checked for conformity with the theoretical field distribution.

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- (3) K. Jokela, P. Hyysalo, and L. Puranen, "Calibration of specific absorption rate (SAR) probes in waveguide at 900 MHz", *IEEE Transactions on Instrumentation and Measurements*, vol. 47, no. 2, pp. 432-438, Apr. 1998.

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1.10 SAR System Description and Setup

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

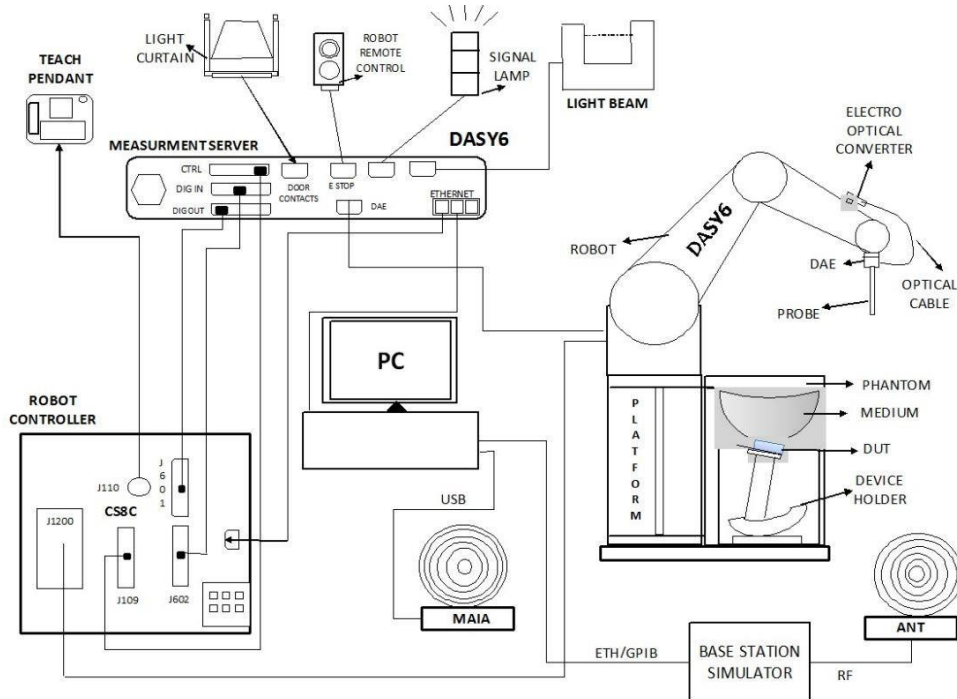


Fig. a A block diagram of the SAR measurement system

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to

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the measurement server.

- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Windows 10 and the DASY6 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

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1.10.1 Power density measurement system

DASY6 system

Power density measurements for mmWave frequencies were performed using SPEAG DASY6 with cDASY6 5G module. The DASY6 included a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the 5G phantom cover.

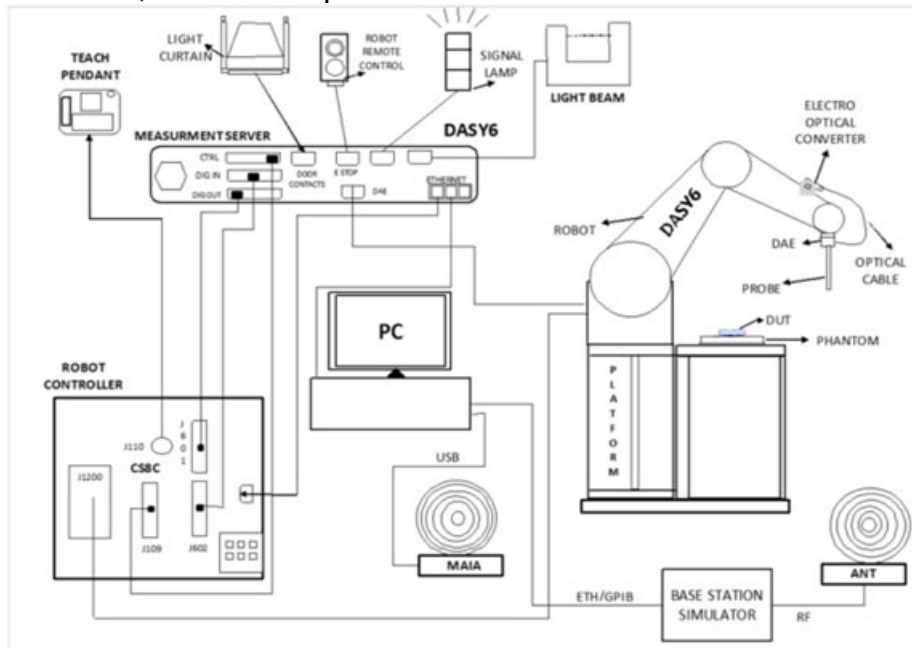


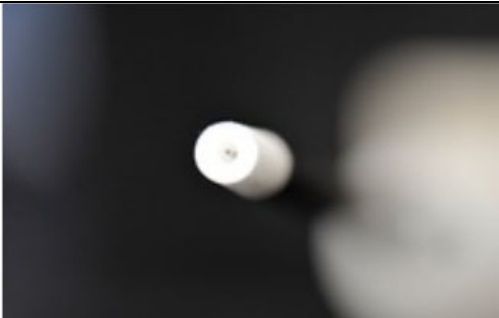
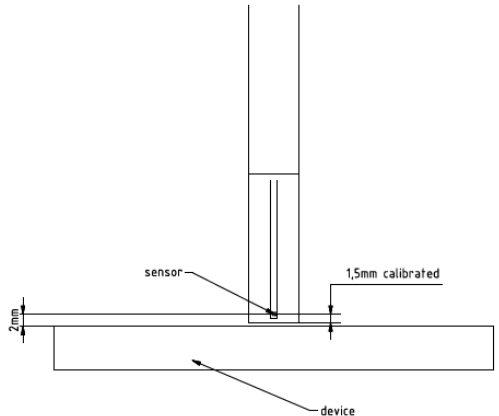
Fig-2.1 SPEAG DASY6 system

EUmmWVx probe

The EUmmWVx probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. The design entails two small 0.8mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9mm wide and 0.12mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields. The probe consist of two sensors with different angles (1 and 2) arranged in the same plane in the probe axis. Three or more measurements of the two sensors are taken for different probe rotational angles to derive the amplitude and polarization information. The probe design allows measurements at distances as small as 2mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm. The exact distance is calibrated.

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	Two dipoles optimally arranged to obtain pseudo-vector information. Minimum 3 measurements/ point, 120° rotated around probe axis. Sensors (0.8mm length) printed on glass substrate protected by high density foam. Low perturbation of the measured field. Requires positioner which can do accurate probe rotation.
Frequency Range	750 MHz – 110 GHz
Dynamic Range	< 20 V/m – 10,000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm (DASY6)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm. Sensor displacement to probe's calibration point: < 0.3 mm
Applications 	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space). Power density, H-field and far-field analysis using total field reconstruction (cDASY6 5G module required)
Compatibility	cDASY6 + 5G-Module SW1.0 and higher

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