FCC SAR Test Report

FCC ID:FKGU1101

Report No.	:	BTL-FCC SAR-1-2304T012
Equipment	:	802.11a/b/g/n/ac/ax+ BT M.2 form factor
Model Name	:	AX211NGW
Applicant	:	Twinhead International Corporation
Address	:	9F, No. 550, Rueiguang Rd, Neihu,Taipei, Taiwan 11492
Radio Function	:	Bluetooth, WLAN 2.4G, WLAN 5G, WLAN 6E
Standard(s)	:	**KDB447498 D04** Interim General RF Exposure Guidance v01 **KDB248227 D01** 802.11 Wi-Fi SAR v02r02 **KDB865664 D01** SAR measurement 100 MHz to 6 GHz v01r04 **KDB865664 D02** SAR Reporting v01r02 **KDB616217 D04** SAR for laptop and Tablets v01r02 **FCC§2.1093** Radiofrequency radiation exposure evaluation: portable devices **IEEE C95.1:2019** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz. **IEC/IEEE 62209-1528:2020** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528: Human models, instrumentation, and procedures(Frequency range of 4 MHz to 10 GHz)
Date of Receipt	:	Apr. 4, 2023
Date of Test	:	Apr. 28, 2023 ~ May.8, 2023
Issued Date	:	May. 26, 2023

The above equipment has been tested and found in compliance with the requirement of the above standards by BTL Inc.

Prepared by :

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Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **BTL** issued reports.

This report is the confidential property of the client. As a mutual protection to the clients, the public and ourselves, the test report shall not be reproduced, except in full, without our written approval.

BTL's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue.	2023/5/12
R01	Revised Section 2.4 Table UNII-Band	2023/5/26

1. GENERAL INFORMATION

1.1. GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="3">802.11a/b/g/n/ac/ax+ BT M.2 form factor</td></tr>
<tr><td>Model Name</td><td colspan="3">AX211NGW</td></tr>
<tr><td colspan="4">Host device information</td></tr>
<tr><td>Equipment</td><td colspan="3">Tablet</td></tr>
<tr><td>Model Name</td><td colspan="3">U11XXXXXX (X=0-9, A-Z,a-z, Blank)</td></tr>
<tr><td>Trade Name</td><td colspan="3">DURABOOK</td></tr>
<tr><td>Model Difference</td><td colspan="3">Different model distribute to different area.</td></tr>
<tr><td>Power Rating</td><td colspan="3">Brand:FSP TECHNOLOGY INC.
Model:FSP065-RBBN3
Input:100-240Vac, 1.5A 50-60Hz
Output:19Vdc 3.42A</td></tr>
<tr><td>Battery Information</td><td colspan="3">Model Name:X11BA-M
Rated Capacity:7.6VDC/4800mAh/36.48Wh
Rated Voltage:8.7VDC</td></tr>
<tr><td>WIFI+BT Module</td><td colspan="3">AX211NGW</td></tr>
<tr><td rowspan="13">Operation Frequency</td><td>Function</td><td>Band</td><td>Frequency (MHz)</td></tr>
<tr><td rowspan="9">WiFi</td><td>2.4G</td><td>TX : 2412 - 2472 MHz</td></tr>
<tr><td>5G_UNII 1</td><td>TX : 5180 - 5250 MHz</td></tr>
<tr><td>5G_UNII 2a</td><td>TX : 5250 - 5350 MHz</td></tr>
<tr><td>5G_UNII 2c</td><td>TX : 5500 - 5700 MHz</td></tr>
<tr><td>5G_UNII 3</td><td>TX : 5745 - 5825 MHz</td></tr>
<tr><td>6E_UNII 5</td><td>TX : 5925 – 6425 MHz</td></tr>
<tr><td>6E_UNII 6</td><td>TX : 6425 – 6525 MHz</td></tr>
<tr><td>6E_UNII 7</td><td>TX : 6525 – 6875 MHz</td></tr>
<tr><td>6E_UNII 8</td><td>TX : 6875 – 7125 MHz</td></tr>
<tr><td rowspan="3">Bluetooth</td><td>Basic Rate (BR)</td><td>TX : 2402 - 2480 MHz</td></tr>
<tr><td>Enhance Data Rate</td><td>TX : 2402 - 2480 MHz</td></tr>
<tr><td>Bluetooth Low Energy</td><td>TX : 2402 - 2480 MHz</td></tr>
<tr><td>Sample Status</td><td colspan="3">Engineering Sample</td></tr>
<tr><td>EUT Modification(s)</td><td colspan="3">N/A</td></tr>
</table>

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc. The test data, data evaluation, and equipment configuration contained in our test report were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO/IEC 17025 quality assessment standard and technical standard(s).

2. RF EMISSIONS MEASUREMENT

2.1. TEST FACILITY

The test facilities used to collect the test data in this report is **SAR Test room** at the location of No. 68-1, Ln. 169, Sec.2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan.

☒SAR 01 ☐SAR 02 ☐SAR 03

2.2. MEASUREMENT UNCERTAINTY

Uncertainty Budget for Frequency range of 300 MHz to 3 GHz

Error Description	Uncertainty Value (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System								
Probe Calibration	6.0	Normal	1	1	1	± 6.0 %	± 6.0 %	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	1	Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1	Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4	Rectangular	$\sqrt{3}$	1	1	± 1.4 %	± 1.4 %	∞
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8	Rectangular	$\sqrt{3}$	1	1	± 0.5%	± 0.5 %	∞
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3	Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3	Rectangula	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.02	Rectangular	$\sqrt{3}$	1	1	± 0.0 %	± 0.0 %	∞
Probe Positioning	0.4	Rectangular	$\sqrt{3}$	1	1	± 0.2 %	± 0.2 %	∞
Max.SAR Evaluation	2	Rectangular	$\sqrt{3}$	1	1	± 1.2 %	± 1.2 %	∞
Test Sample Related								
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power Drift	5.0	Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup								
Phantom Production Tolerances	6.1	Rectangular	$\sqrt{3}$	1	1	± 3.5 %	± 3.5 %	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	0.84	± 1.9 %	± 1.6 %	
Liquid Conductivity (mea.)	2.5	Rectangular	$\sqrt{3}$	0.78	0.71	± 2.0 %	± 1.8 %	∞
Liquid Permittivity (mea.)	2.5	Rectangular	$\sqrt{3}$	0.26	0.26	± 0.6 %	± 0.7 %	∞
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Standard Uncertainty (K = 1)						± 11.28 %	± 11.19 %	361
Expanded Uncertainty (K = 2)						**± 22.56 %**	**± 22.37 %**	

Uncertainty Budget for Frequency range of 3 GHz to 6 GHz

Error Description	Uncertainty Value (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System								
Probe Calibration	7.00	Normal	1	1	1	± 7.0 %	± 7.00 %	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	2	Rectangular	$\sqrt{3}$	1	1	± 1.2 %	± 1.2 %	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1	Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4	Rectangular	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8	Rectangular	$\sqrt{3}$	1	1	± 0.5%	± 0.5 %	∞
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3	Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3	Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.04	Rectangular	$\sqrt{3}$	1	1	± 0.0 %	± 0.0 %	∞
Probe Positioning	0.8	Rectangular	$\sqrt{3}$	1	1	± 0.5 %	± 0.5 %	∞
Max.SAR Evaluation	4	Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power Drift	5.0	Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup								
Phantom Production Tolerances	6.6	Rectangular	$\sqrt{3}$	1	1	± 3.8 %	± 3.8 %	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	0.84	± 1.9 %	± 1.6 %	
Liquid Conductivity (mea.)	2.5	Rectangular	$\sqrt{3}$	0.78	0.71	± 2.0 %	± 1.8 %	∞
Liquid Permittivity (mea.)	2.5	Rectangular	$\sqrt{3}$	0.26	0.26	± 0.6 %	± 0.7 %	∞
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Standard Uncertainty (K = 1)						± 12.14 %	± 12.06 %	361
Expanded Uncertainty (K = 2)						**± 24.28 %**	**± 24.12 %**	

Uncertainty Budget for Frequency range of 6 GHz to 10 GHz

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System								
Probe Calibration	18.6	Normal	2	1	1	± 9.3 %	± 9.3 %	∞
Probe Calibration Drift	1.7	Rectangular	$\sqrt{3}$	1	1	± 1.0 %	± 1.0 %	∞
Probe Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Broadband Signal	2.8	Rectangular	$\sqrt{3}$	1	1	± 1.6 %	± 1.6 %	∞
Probe Isotropy	7.6	Rectangular	$\sqrt{3}$	1	1	± 4.4 %	± 4.4 %	∞
Other Probe+Electronic	2.4	Normal	1	1	1	± 2.4%	± 2.4%	∞
RF Ambient	1.8	Normal	1	1	1	± 1.8 %	± 1.8 %	∞
Probe Positioning	±0.005mm	Normal	1	0.5	0.5	± 0.25 %	± 0.25 %	∞
Data Processing	3.5	Normal	1	1	1	± 3.5 %	± 3.5 %	∞
Phantom and Device Errors								
Conductivity(meas.)	2.5	Normal	1	0.78	0.71	± 2.0 %	± 1.8 %	∞
Conductivity(temp.)	2.4	Rectangular	$\sqrt{3}$	0.78	0.71	± 1.1 %	± 1.0 %	∞
PhantomPermittivity	14.0	Rectangular	$\sqrt{3}$	0.5	0.5	± 4.0 %	± 4.0 %	∞
Distance DUT - TSL	2.0	Normal	1	2	2	± 4.0 %	± 4.0 %	∞
Device Positioning	1.0	Normal	1	1	1	± 1.0 %	± 1.0 %	145
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %	5
DUT Modulation	2.4	Rectangular	$\sqrt{3}$	1	1	± 1.4 %	± 1.4 %	∞
Time-average SAR	1.7	Rectangular	$\sqrt{3}$	1	1	± 1.0 %	± 1.0 %	∞
DUT drift	2.5	Normal	1	1	1	± 2.5 %	± 2.5 %	∞
Val Antenna Unc.	0	Normal	1	1	1	± 0 %	± 0 %	∞
Unc. Input Power	0	Normal	1	1	1	± 0 %	± 0 %	∞
Correction to the SAR results								
Deviation to Target	1.9	Normal	1	1	0.84	± 1.9 %	± 1.6 %	∞
SAR scaling	0	Rectangular	$\sqrt{3}$	1	1	± 0 %	± 0 %	∞
Combined Standard Uncertainty (K = 1)						± 14.23%	± 14.16%	361
Expanded Uncertainty (K = 2)						**± 28.46 %**	**± 28.32 %**	

Uncertainty Budget for psSAR / psAPD Assessments

UncertaintyBudgetforpsSAR/psAPDAssessments

(Frequency band: 6 – 10 GHz range)

Symbol	Error Description	Uncert.	Prob. Dist.	Div.	ci (1g) / (1 cm2)	ci (8 g/10 g) / (4 cm2)	Std. Unc.0(1 g)/ (1 cm2)	Std. Unc. (8 g/10 g) / (4 cm2)
psSAR	Module SAR V16.0 (Table 6.3.3)	±14.23/14.16%	N	1	1	1	±14.23%	±14.16%
PDC	Power Density Conversion	±13.5%	R	$\sqrt{3}$	1	1	±7.8%	±7.8%
u(Δ SAR)	Combined Uncertainty						±15.6%	±15.5 %
U	**Expanded Uncertainty** in dB						±31.2% ±1.2 dB	±31.0% ±1.2 dB

Uncertainty Budget for mmWave

Error Description	Uncertainty Value (±dB)	Probability Distribution	Divisor	Ci	Standard Uncertainty	Vi V_{eff}
Uncertainty terms dependent on the measurement system						
Probe Calibration	0.49	Normal	1	1	±0.49dB	∞
Probe correction	0	Rectangular	$\sqrt{3}$	1	±0dB	∞
Frequency response(BW≤1GHz)	0.20	Rectangular	$\sqrt{3}$	1	±0.12 dB	∞
Sensor cross coupling	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Isotropy	0.50	Rectangular	$\sqrt{3}$	1	±0.29 dB	∞
Linearity	0.20	Rectangular	$\sqrt{3}$	1	±0.12 dB	∞
Probe scattering	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Probe Positioning offset	0.30	Rectangular	$\sqrt{3}$	1	±0.17 dB	∞
Probe Positioning repeatability	0.04	Rectangular	$\sqrt{3}$	1	±0.02 dB	∞
Sensor mechanical offset	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Probe spatial resolution	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Field impedance dependance	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Amplitude and phase drift	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Amplitude and phase noise	0.04	Rectangular	$\sqrt{3}$	1	± 0.02 dB	∞
Measurement area truncation	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Data acquisition	0.03	Normal	1	1	±0.03 dB	∞
Sampling	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Field reconstruction	2.00	Rectangular	$\sqrt{3}$	1	±1.15 dB	∞
Forward transformation	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Power density scaling	-	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Spatial averaging	0.10	Rectangular	$\sqrt{3}$	1	±0.06 dB	∞
System detection limit	0.04	Rectangular	$\sqrt{3}$	1	±0.02 dB	∞
Uncertainty terms dependent on the DUT and environmental factors						
Probe coupling with DUT	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Modulation response	0.40	Rectangular	$\sqrt{3}$	1	± 0.2 dB	∞
Integration time	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Response time	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
Device holder influence	0.10	Rectangular	$\sqrt{3}$	1	± 0.1 dB	∞
DUT alignment	0	Rectangular	$\sqrt{3}$	1	± 0 dB	∞
RF ambient conditions	0.04	Rectangular	$\sqrt{3}$	1	±0.02 dB	∞
Ambient Reflections	0.04	Rectangular	$\sqrt{3}$	1	±0.02 dB	∞
Immunity / secondary reception	0	Rectangular	$\sqrt{3}$	1	±0 dB	∞
Drift of the DUT	0.10	Rectangular	$\sqrt{3}$	1	±0.06 dB	∞
Combined Standard Uncertainty (K = 1)					± 1.34dB	∞
Expanded Uncertainty (K = 2)					**± 2.68dB**	

2.3. WLAN ANTENNA INFORMATION:

Ant.	Brand	Model	Type	Frequency Range (MHz)	Gain (dBi)
Main	WGT	TWU11WIPB01+A	PIFA	2400-2500	-4.24
				5150-5350	-4.99
				5470-5725	-4.60
				5725-5850	-4.59
				5925-6425	-5.19
				6425-6525	-5.19
				6525-6875	-4.85
				6875-7125	-4.85
Aux	WGT	TWU11WIPB02+A	PIFA	2400-2500	-4.27
				5150-5350	-4.53
				5470-5725	-4.48
				5725-5850	-4.88
				5925-6425	-5.00
				6425-6525	-5.00
				6525-6875	-5.20
				6875-7125	-5.20

2.4. THE MAXIMUM SAR-1G VALUES

Band	Mode	Highest Body Reported SAR-1g(W/kg)
FHSS	Bluetooth_DH5	0.048
DTS	Wi-Fi 2.4G	0.943
UNII	5G UNII 1&2a	0.713
	5G UNII 2c	0.608
	5G UNII 3	0.710
	6E UNII 5	0.337
	6E UNII 6	0.351
	6E UNII 7	0.413
	6E UNII 8	0.358

Band	Mode	APD(W/m^2)
6E	6E UNII 7	3.41

Band	Mode	Highest Averaged Power Density(W/m^2)
6E	6E UNII 8	5.135

Note:

1) The device is in compliance with Specific Absorption Rate(SAR)for general population uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:2019/IEEE C95.1:2019, the NCRP Report Number 86 for uncontrolled environment and had been tested in accordance with the measurement methods and procedures specified in IEC/IEEE 62209-1528:2020 .

2.5. LABORATORY ENVIRONMENT

Temperature	Min. = 18ºC, Max. = 25ºC
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2.6. MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1486	May. 31, 2022	1 Year
2	Data Acquisition Electronics	Speag	DAE4	1764	Jan. 03, 2023	1 Year
3	E-field Probe	Speag	EX3DV4	7369	May. 28, 2022	1 Year
4	E-field Probe	Speag	EX3DV4	7781	Dec. 23, 2022	1 Year
5	System Validation Dipole	Speag	D2450V2	973	Feb. 08, 2021	3 Year
6	System Validation Dipole	Speag	D5GHzV2	1221	Feb. 09, 2021	3 Year
7	System Validation Dipole	Speag	D6.5GHzV2	1041	Sep 02, 2021	3 Year
8	E-Field probe	Speag	EUmmWV4	9583	Apr 18, 2023	1 Year
9	5G Verification Source	Speag	5G Verification Source 10GHz	2011	Apr 20, 2023	1 Year
10	ELI4 Phantom	Speag	ELI4 Phantom V8.0	2149	N/A	N/A
11	mmWave Phantom	Speag	QD 015 025 CA	1085	N/A	N/A
12	ENA Network Analyzer	Agilent	E5071C	MY46524658	Mar. 17, 2023	1 Year
13	Signal Generator	R&S	SMR40	100502	Feb. 23, 2023	1 Year
14	Spectrum Analyzer	Agilent	N9010A	MY54200240	Jun. 09, 2022	1 Year
15	Power Meter	Anritsu	ML2495A	1128008	Jun. 1, 2022	1 Year
16	Power Sensor	Anritsu	MA2411B	1126001	Jun. 1, 2022	1 Year
17	Dielectric Probe Kit	Agilent	85070E	2593	N/A	N/A
18	Low pass filter	Mini-Circuits	SLP-2950+	M108294	N/A	N/A
19	Power Amplifier	Mini-Circuits	ZVE-2W-272+	N650001538	N/A	N/A
20	Power Amplifier	Mini-Circuits	ZVE-8G+	N628801631	N/A	N/A
21	Power Amplifier	EMCI	EMC053035	980869	N/A	N/A
22	Thermometer	PA	TA298	h001	Mar. 21, 2023	1 Year
23	Directional Coupler	Woken	50W Coupler	DOM5CIW3E2	N/A	N/A
24	Attenuator	Woken	WATT-518FS-10	N/A	N/A	N/A

Remark:“N/A” denotes no model name, serial No. or calibration specified.

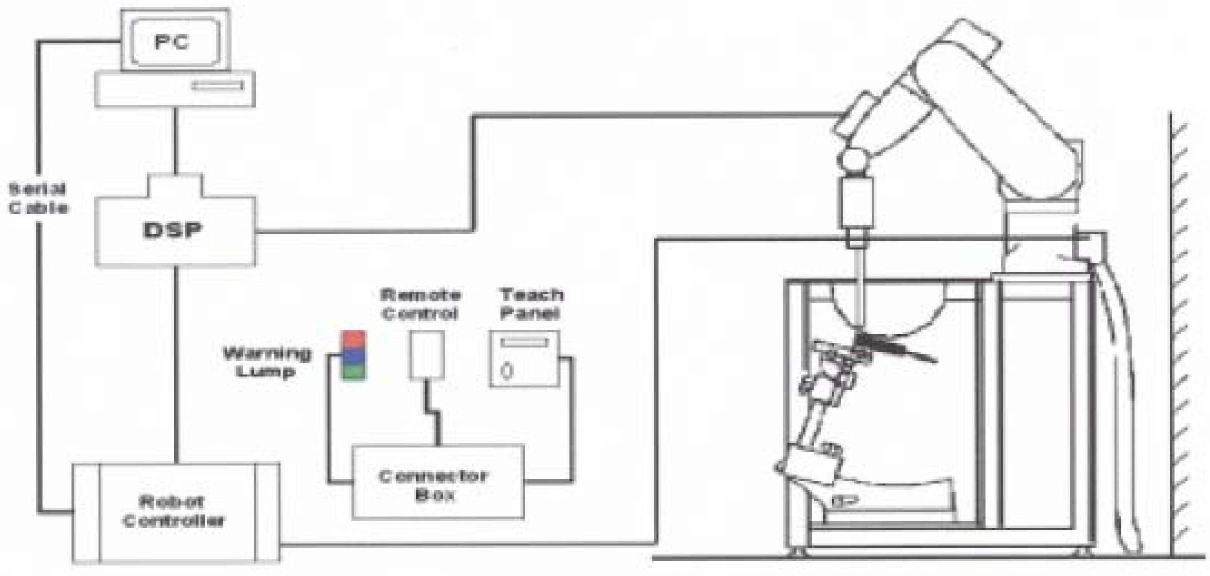
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1. SAR MEASUREMENT SETUP

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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. A data acquisition electronic (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.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

3.1.1. TEST SETUP LAYOUT

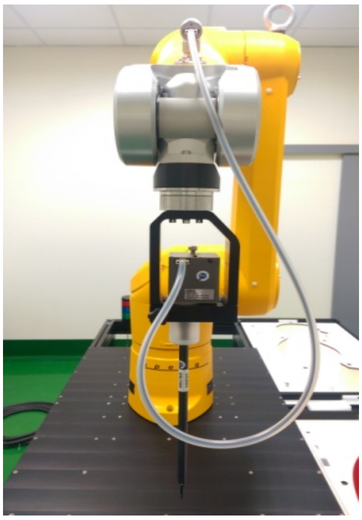


3.2. DASY5 E-FIELD PROBE SYSTEM

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

3.2.1. EX3DV4 PROBE SPECIFICATION

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm



EX3DV4 E-field Probe

3.2.2. E-FIELD PROBE CALIBRATION

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where: Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

Or $$SAR = \frac{|E|^2 \sigma}{\rho}$$

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

3.2.3. OTHER TEST EQUIPMENT

3.2.3.1. DEVICE HOLDER FOR TRANSMITTERS

Construction: Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.) It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

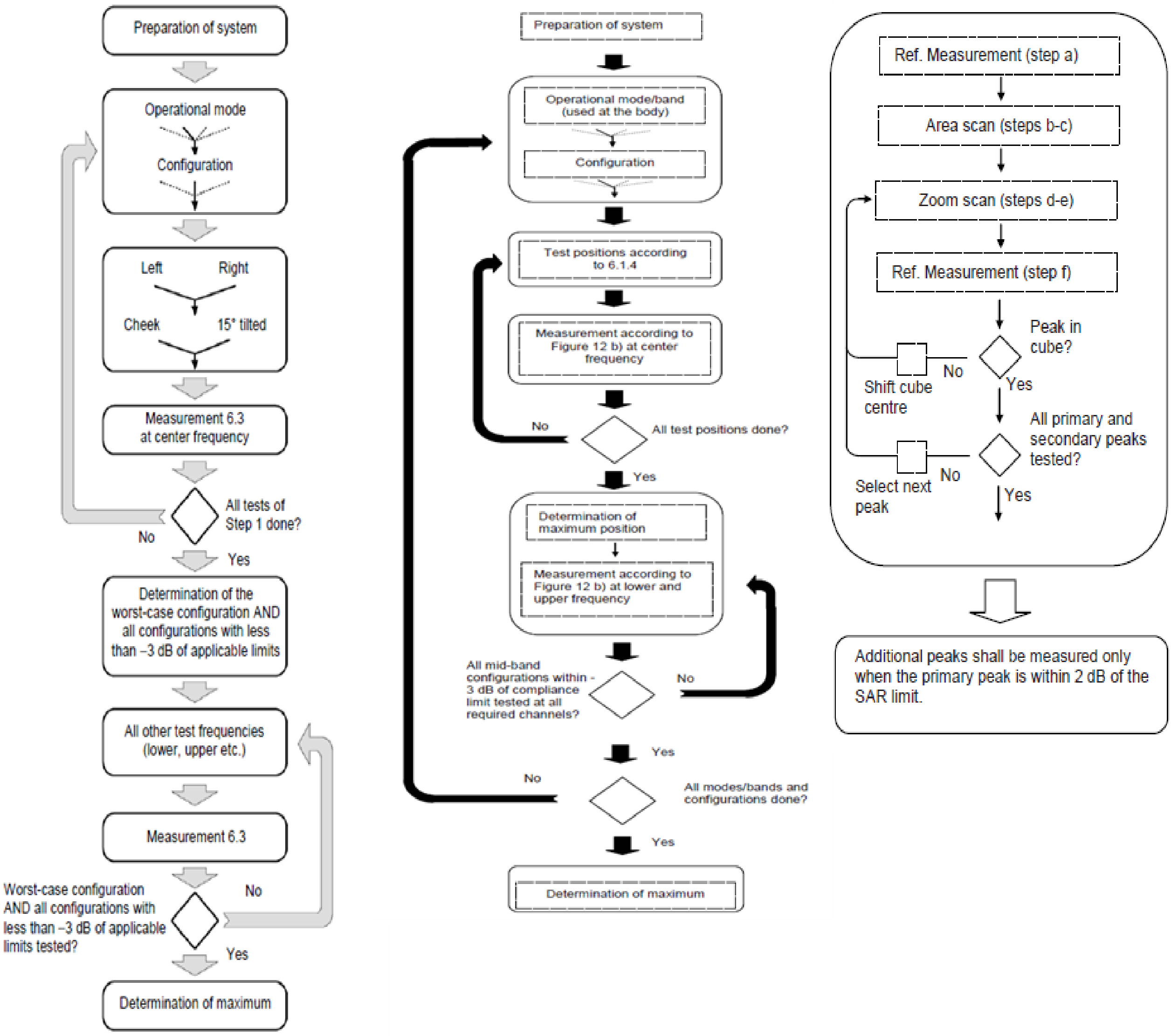
3.2.3.2 PHANTOM

Model	ELI4 Phantom	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Shell Thickness	2±0.1 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Length: 600 mm ; Width: 190mm Height: adjustable feet	
Aailable	Special	

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length:1000mm; Width: 500mm Height: adjustable feet	
Aailable	Special	

3.2.4. SCANNING PROCEDURE

The SAR test against the head and body-worn phantom was carried out as follow:



After an area scan has been done at a fixed distance of 1.4mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEE1528 standard.

This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

3.2.5. DATA STORAGE AND EVALUATION

3.2.5.1 DATA STORAGE

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension “DAE4”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

3.2.6. DATA EVALUATION BY SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	Sensitivity	Normi, a_{i0}, a_{i1}, a_{i2}
	Conversion factor	$ConvF_i$
	Diode compression point	Dcp_i
Device parameters:	Frequency	f
	Crest factor	cf
Media parameters:	Conductivity	
	Density	

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf / dcp_i$$

With	V_i = compensated signal of channel i	(i = x, y, z)
	U_i = input signal of channel i	(i = x, y, z)
	cf = crest factor of exciting field	(DASY parameter)
	dcpi = diode compression point	(DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $Ei = (Vi / Normi \cdot ConvF)^{1/2}$

H-field probes: $Hi = (Vi)^{1/2} \cdot (ai0 + ai1\ f + a_i 2f^2) / f$

With Vi = compensated signal of channel i (i = x, y, z)

$Norm_i$ = sensor sensitivity of channel i (i = x, y, z)
[mV/(V/m)^2] for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$Etot = (EX^2 + EY^2 + EZ^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (Etot)^2 \cdot \sigma / (\rho \cdot 1000)$$

With SAR = local specific absorption rate in mW/g

E_{tot} = total field strength in V/m
= conductivity in [mho/m] or [Siemens/m]
= equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 / 3770 \text{ or } P_{pwe} = H_{tot}^2 \cdot 37.7$$

With P_{pwe} = equivalent power density of a plane wave in mW/cm^2

E_{tot} = total field strength in V/m
H_{tot} = total magnetic field strength in A/m

4. TISSUE-EQUIVALENT LIQUID

4.1. TISSUE-EQUIVALENT LIQUID INGREDIENTS

The liquid is consisted of water, salt and Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. The measured conductivity and relative permittivity should be within ±5% of the target values. The below table shows the detail solution. It’s satisfying the latest tissue dielectric parameters requirements proposed by the IEC 62209.

Composition of the Tissue Equivalent Matter

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
Head 2450	-	45.0	-	0.1	-	-	54.9	-
Head 5G	-	-	-	-	-	17.2	65.5	17.3

4.2. TISSUE-EQUIVALENT LIQUID PROPERTIES

Dielectric Performance of Tissue Simulating Liquid

Tissue Verification									
Date	Tissue Type	Frequency (MHz)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Limit (%) ±5
2023/5/8	Head	2402	1.79	40.78	1.76	39.29	1.61	3.79	±5
2023/5/8	Head	2412	1.80	40.76	1.77	39.27	1.78	3.78	±5
2023/5/8	Head	2422	1.81	40.73	1.78	39.25	1.98	3.78	±5
2023/5/8	Head	2437	1.83	40.70	1.79	39.22	2.17	3.77	±5
2023/5/8	Head	2441	1.83	40.69	1.79	39.21	2.17	3.77	±5
2023/5/8	Head	2450	1.84	40.66	1.80	39.20	2.24	3.71	±5
2023/5/8	Head	2452	1.84	40.65	1.80	39.19	2.24	3.72	±5
2023/5/8	Head	2457	1.85	40.63	1.81	39.19	2.25	3.66	±5
2023/5/8	Head	2462	1.85	40.60	1.81	39.18	2.26	3.63	±5
2023/5/8	Head	2467	1.86	40.58	1.82	39.17	2.22	3.59	±5
2023/5/8	Head	2472	1.86	40.55	1.82	39.17	2.24	3.53	±5
2023/5/8	Head	2480	1.87	40.51	1.83	39.16	2.23	3.45	±5
2023/5/4	Head	5180	4.60	35.31	4.64	36.02	-0.93	-1.96	±5
2023/5/4	Head	5200	4.61	35.25	4.66	36.00	-0.99	-2.07	±5
2023/5/4	Head	5220	4.65	35.21	4.68	35.98	-0.72	-2.14	±5
2023/5/4	Head	5240	4.68	35.16	4.70	35.96	-0.45	-2.22	±5
2023/5/4	Head	5260	4.70	35.12	4.72	35.94	-0.36	-2.29	±5
2023/5/4	Head	5280	4.72	35.07	4.74	35.92	-0.45	-2.36	±5
2023/5/4	Head	5300	4.73	35.03	4.76	35.90	-0.54	-2.42	±5
2023/5/4	Head	5320	4.76	34.97	4.78	35.88	-0.33	-2.53	±5
2023/5/4	Head	5500	4.97	34.56	4.96	35.60	0.18	-2.93	±5
2023/5/4	Head	5520	4.99	34.50	4.98	35.58	0.24	-3.04	±5
2023/5/4	Head	5540	5.02	34.44	5.00	35.56	0.30	-3.16	±5
2023/5/4	Head	5560	5.04	34.38	5.03	35.54	0.34	-3.25	±5
2023/5/4	Head	5580	5.07	34.34	5.05	35.52	0.35	-3.32	±5
2023/5/4	Head	5600	5.09	34.30	5.07	35.50	0.36	-3.39	±5
2023/5/4	Head	5620	5.11	34.25	5.09	35.48	0.49	-3.47	±5
2023/5/4	Head	5640	5.14	34.20	5.11	35.46	0.61	-3.56	±5
2023/5/4	Head	5660	5.17	34.16	5.13	35.44	0.69	-3.62	±5
2023/5/4	Head	5680	5.19	34.12	5.15	35.42	0.73	-3.66	±5
2023/5/4	Head	5700	5.21	34.09	5.17	35.40	0.76	-3.71	±5
2023/5/4	Head	5720	5.23	34.03	5.19	35.38	0.81	-3.82	±5
2023/5/4	Head	5745	5.26	33.96	5.22	35.35	0.87	-3.94	±5
2023/5/4	Head	5765	5.29	33.92	5.24	35.33	0.97	-4.00	±5
2023/5/4	Head	5785	5.31	33.88	5.26	35.31	1.08	-4.05	±5
2023/5/4	Head	5800	5.33	33.85	5.27	35.30	1.17	-4.10	±5
2023/5/4	Head	5805	5.34	33.84	5.28	35.29	1.17	-4.11	±5
2023/5/4	Head	5825	5.36	33.79	5.30	35.27	1.17	-4.20	±5

Dielectric Performance of Tissue Simulating Liquid

Tissue Verification									
Date	Tissue Type	Frequency (MHz)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Limit (%) ±5
2023/4/28	Head	6000	5.65	36.74	5.48	35.07	3.04	4.75	±5
2023/4/28	Head	6050	5.73	36.68	5.54	35.01	3.45	4.76	±5
2023/4/28	Head	6100	5.78	36.55	5.59	34.95	3.42	4.57	±5
2023/4/28	Head	6150	5.87	36.47	5.65	34.89	3.83	4.53	±5
2023/4/28	Head	6200	5.91	36.38	5.71	34.83	3.56	4.46	±5
2023/4/28	Head	6250	5.99	36.29	5.77	34.77	3.82	4.37	±5
2023/4/28	Head	6300	6.04	36.19	5.83	34.70	3.59	4.30	±5
2023/4/28	Head	6350	6.12	36.11	5.89	34.64	3.92	4.24	±5
2023/4/28	Head	6400	6.16	36.03	5.95	34.58	3.53	4.19	±5
2023/4/28	Head	6450	6.24	35.93	6.01	34.52	3.89	4.08	±5
2023/4/28	Head	6500	6.29	35.87	6.07	34.46	3.56	4.09	±5
2023/4/28	Head	6550	6.37	35.74	6.13	34.40	3.93	3.88	±5
2023/4/28	Head	6600	6.42	35.69	6.19	34.34	3.71	3.94	±5
2023/4/28	Head	6650	6.50	35.54	6.25	34.29	3.95	3.63	±5
2023/4/28	Head	6700	6.56	35.52	6.30	34.23	4.09	3.76	±5
2023/4/28	Head	6750	6.62	35.35	6.36	34.17	4.10	3.46	±5
2023/4/28	Head	6800	6.68	35.33	6.42	34.11	4.11	3.58	±5
2023/4/28	Head	6850	6.74	35.17	6.48	34.05	3.99	3.29	±5
2023/4/28	Head	6900	6.81	35.16	6.53	33.99	4.35	3.44	±5
2023/4/28	Head	6950	6.85	35.00	6.59	33.94	3.96	3.13	±5
2023/4/28	Head	7000	6.94	34.99	6.65	33.88	4.32	3.29	±5

Note:
1)The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2)KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3)The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.
4) According to FCC TCB workshop April, 2019 RF Exposure Procedures Update(Effective February 19,2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEEE 62209-1- for all SAR tests.

5. SYSTEM CHECK

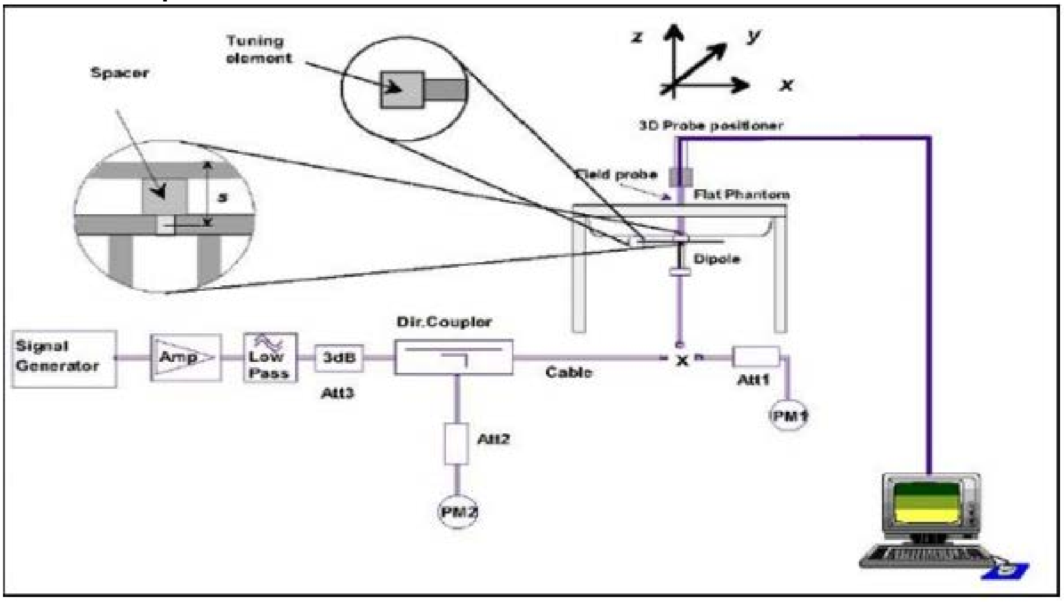
5.1. DESCRIPTION OF SYSTEM CHECK

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulants were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulant, using the dipole validation kit. A power level of 250 mW(below 3GHz) or 100mW(3-6GHz), which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the 6.2.

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system (±10 %).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.

System Check Set-up



5.2. DESCRIPTION OF SYSTEM CHECK

System Check in Tissue Simulating Liquid

The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

Date	System Dipole			Parameters	Target [W/kg]	Measured [W/kg]	Deviation [%]	Limited [%]
	Type	Serial No.	Liquid					
2023/5/8	D2450V2	973	Head	1g SAR	52.5	54.0	2.86	± 10
2023/5/4	D5GHzV2 (5.2GHz)	1221	Head	1g SAR	79.8	85.7	7.39	± 10
2023/5/4	D5GHzV2 (5.3GHz)	1221	Head	1g SAR	81.9	76.2	-6.96	± 10
2023/5/4	D5GHzV2 (5.6GHz)	1221	Head	1g SAR	84.5	87.9	4.02	± 10
2023/5/4	D5GHzV2 (5.8GHz)	1221	Head	1g SAR	81.7	88.5	8.32	± 10
2023/4/28	D6.5GHzV2 (6.5GHz)	1041	Head	1g SAR	289.0	315.0	9.00	± 10

5.3.POWER DENSITY SYSTEM CHECK

System check provides a fast and reliable method to routinely verify that the measurementsystem is operational with no system component failures, including probe defects, drifts ordeviation from target performance requirements. A system check also verifies the repeatabilityof the measurement system before compliance testing.

The measurement of a verification source is started from 5G probe installed and the phantom taught.The verification source is placed on the 5G phantom.Due to the internal distance from thehorn to the outer surface of the verification source, the measurement distance set in the software should be offsetby -4.45 mm; e.g., for measurement of the verification source at 10 mm, the measurement distance set in thesoftware should be 5.55mm (10mm -4.45 mm).

The system check is a complete measurement using simple well-defined reference sources. According to the DASY6 specification in the user's manual and SPEAG's recommendation, the deviation threshold of ±0.66 dB represents the expanded standard uncertainty for system performance check.The system check is successful if the measured results are within±0.66 dB tolerancesto the target value shown in the calibration certificate of the verification source. The instrumentation and procedures usedfor system checkshould ensure the system is ready for performing compliance tests.

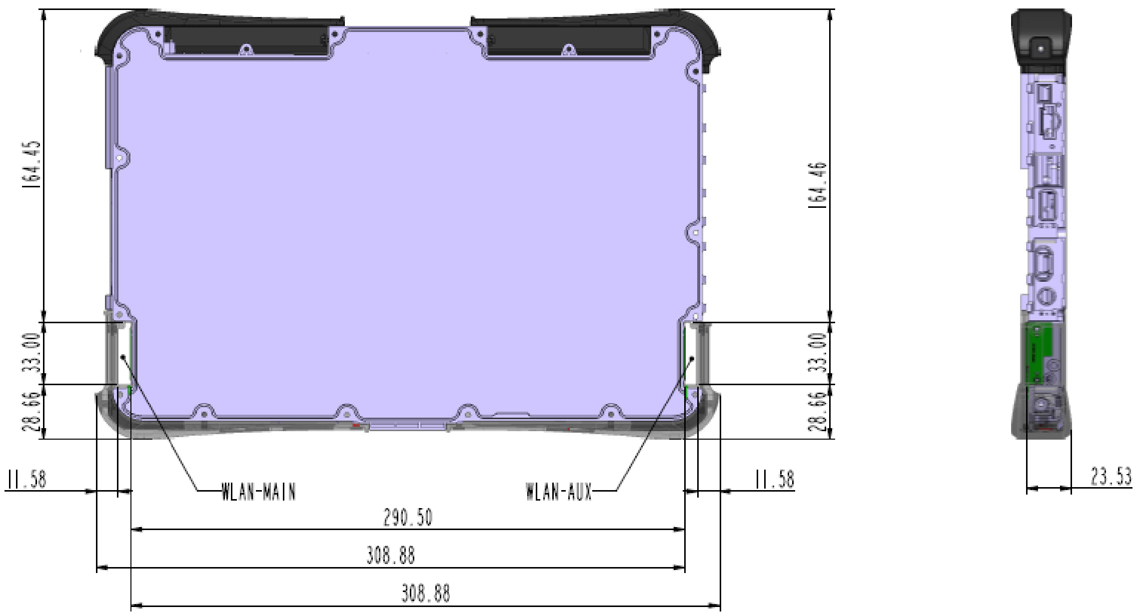
Date	5G Verification Souse			Parameters	Target [W/m^2]	Measured [W/m^2]	Deviation [dB]
	Type	Serial No.	Liquid				
2023/5/5	10G	2011	Head	Avg Power Densuty 4cm^2	171.0	190.0	0.46

6. OPERATIONAL CONDITIONS DURING TEST

6.1. GENERAL DESCRIPTION OF TEST PROCEDURES

Connection to the EUT is established via air interface with base station An, and the EUT is Set to maximum output power by base station. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. The antenna connected to the output of the base station simulator shall be placed at least 50cm away from the EUT. The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the EUT by at least 30dB.

6.2. TEST POSITION ANTENNA LOCATION



6.3. TEST POSITION OF PORTABLE DEVICES

Minimum Separation Distance				
Mode	**Antenna**	**Position**	**Distance (mm)**	**Evaluation Test**
WiFi	Main	Edge1	164.45	NO
		Edge2	308.88	NO
		Edge3	28.66	Yes
		Edge4	11.58	Yes
		Rear	23.53	Yes
	Aux	Edge1	164.46	NO
		Edge2	11.58	Yes
		Edge3	28.66	Yes
		Edge4	308.88	NO
		Rear	23.53	Yes

6.4. TEST POSITION

6.4.1.BODY TEST CONFIGURATION

The SAR Exclusion Threshold in KDB 447498 D04 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an EUT edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned adjacent the phantom and the edge containing the antenna positioned perpendicular to the phantom.

SAR test reduction and exclusion guidance

(1)The SAR exclusion threshold for is defined by the following equation:

$$P_{\mathrm{th}}\ (\mathrm{mW}) = \begin{cases} ERP_{20\ \mathrm{cm}}(d/20\ \mathrm{cm})^{x} & d \le 20\ \mathrm{cm} \\ ERP_{20\ \mathrm{cm}} & 20\ \mathrm{cm} < d \le 40\ \mathrm{cm} \end{cases} \qquad (\mathrm{B.2})$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ \mathrm{cm}}\sqrt{f}}\right)$$

and f is in GHz, d is the separation distance (cm), and $ERP_{20\mathrm{cm}}$ is per Formula (B.1).

Example values shown in Table B.2 are for illustration only.

Table B.2—Example Power Thresholds (mW)

		Distance (mm)									
		5	10	15	20	25	30	35	40	45	50
Frequency (MHz)	300	39	65	88	110	129	148	166	184	201	217
	450	22	44	67	89	112	135	158	180	203	226
	835	9	25	44	66	90	116	145	175	207	240
	1900	3	12	26	44	66	92	122	157	195	236
	2450	3	10	22	38	59	83	111	143	179	219
	3600	2	8	18	32	49	71	96	125	158	195
	5800	1	6	14	25	40	58	80	106	136	169

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
Bluetooth	Aux	Edge1	164.46	2480	10.50	11.22	219	No
Bluetooth	Aux	Edge2	11.58	2480	10.50	11.22	10	Yes
Bluetooth	Aux	Edge3	28.66	2480	10.50	11.22	59	No
Bluetooth	Aux	Edge4	308.88	2480	10.50	11.22	219	No
Bluetooth	Aux	Rear	23.53	2480	10.50	11.22	38	No

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
2.4GHz	Main	Edge1	164.45	2462	21.00	125.89	219	No
2.4GHz	Main	Edge2	308.88	2462	21.00	125.89	10	Yes
2.4GHz	Main	Edge3	28.66	2462	21.00	125.89	59	Yes
2.4GHz	Main	Edge4	11.58	2462	21.00	125.89	219	No
2.4GHz	Main	Rear	23.53	2462	21.00	125.89	38	Yes
2.4GHz	Aux	Edge1	164.46	2462	20.00	100.00	219	No
2.4GHz	Aux	Edge2	11.58	2462	20.00	100.00	10	Yes
2.4GHz	Aux	Edge3	28.66	2462	20.00	100.00	59	Yes
2.4GHz	Aux	Edge4	308.88	2462	20.00	100.00	219	No
2.4GHz	Aux	Rear	23.53	2462	20.00	100.00	38	Yes

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
5.2GHz	Main	Edge1	164.45	5210	15.50	35.48	169	No
5.2GHz	Main	Edge2	308.88	5210	15.50	35.48	169	No
5.2GHz	Main	Edge3	28.66	5210	15.50	35.48	40	No
5.2GHz	Main	Edge4	11.58	5210	15.50	35.48	6	Yes
5.2GHz	Main	Rear	23.53	5210	15.50	35.48	25	Yes
5.2GHz	Aux	Edge1	164.46	5210	17.50	56.23	169	No
5.2GHz	Aux	Edge2	11.58	5210	17.50	56.23	6	Yes
5.2GHz	Aux	Edge3	28.66	5210	17.50	56.23	40	Yes
5.2GHz	Aux	Edge4	308.88	5210	17.50	56.23	169	No
5.2GHz	Aux	Rear	23.53	5210	17.50	56.23	25	Yes

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
5.3GHz	Main	Edge1	164.45	5290	15.50	35.48	169	No
5.3GHz	Main	Edge2	308.88	5290	15.50	35.48	169	No
5.3GHz	Main	Edge3	28.66	5290	15.50	35.48	40	No
5.3GHz	Main	Edge4	11.58	5290	15.50	35.48	6	Yes
5.3GHz	Main	Rear	23.53	5290	15.50	35.48	25	Yes
5.3GHz	Aux	Edge1	164.46	5290	17.50	56.23	169	No
5.3GHz	Aux	Edge2	11.58	5290	17.50	56.23	6	Yes
5.3GHz	Aux	Edge3	28.66	5290	17.50	56.23	40	Yes
5.3GHz	Aux	Edge4	308.88	5290	17.50	56.23	169	No
5.3GHz	Aux	Rear	23.53	5290	17.50	56.23	25	Yes

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
5.6GHz	Main	Edge1	164.45	5530	15.50	35.48	169	No
5.6GHz	Main	Edge2	308.88	5530	15.50	35.48	169	No
5.6GHz	Main	Edge3	28.66	5530	15.50	35.48	40	No
5.6GHz	Main	Edge4	11.58	5530	15.50	35.48	6	Yes
5.6GHz	Main	Rear	23.53	5530	15.50	35.48	25	Yes
5.6GHz	Aux	Edge1	164.46	5530	17.50	56.23	169	No
5.6GHz	Aux	Edge2	11.58	5530	17.50	56.23	6	Yes
5.6GHz	Aux	Edge3	28.66	5530	17.50	56.23	40	Yes
5.6GHz	Aux	Edge4	308.88	5530	17.50	56.23	169	No
5.6GHz	Aux	Rear	23.53	5530	17.50	56.23	25	Yes

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
5.8GHz	Main	Edge1	164.45	5775	15.50	35.48	169	No
5.8GHz	Main	Edge2	308.88	5775	15.50	35.48	169	No
5.8GHz	Main	Edge3	28.66	5775	15.50	35.48	40	No
5.8GHz	Main	Edge4	11.58	5775	15.50	35.48	6	Yes
5.8GHz	Main	Rear	23.53	5775	15.50	35.48	25	Yes
5.8GHz	Aux	Edge1	164.46	5775	17.50	56.23	169	No
5.8GHz	Aux	Edge2	11.58	5775	17.50	56.23	6	Yes
5.8GHz	Aux	Edge3	28.66	5775	17.50	56.23	40	Yes
5.8GHz	Aux	Edge4	308.88	5775	17.50	56.23	169	No
5.8GHz	Aux	Rear	23.53	5775	17.50	56.23	25	Yes

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
6.2GHz	Main	Edge1	164.45	6025	13.50	22.39	169	No
6.2GHz	Main	Edge2	308.88	6025	13.50	22.39	169	No
6.2GHz	Main	Edge3	28.66	6025	13.50	22.39	40	No
6.2GHz	Main	Edge4	11.58	6025	13.50	22.39	6	Yes
6.2GHz	Main	Rear	23.53	6025	13.50	22.39	25	No
6.2GHz	Aux	Edge1	164.46	6025	13.50	22.39	169	No
6.2GHz	Aux	Edge2	11.58	6025	13.50	22.39	6	Yes
6.2GHz	Aux	Edge3	28.66	6025	13.50	22.39	40	No
6.2GHz	Aux	Edge4	308.88	6025	13.50	22.39	169	No
6.2GHz	Aux	Rear	23.53	6025	13.50	22.39	25	No

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
6.5GHz	Main	Edge1	164.45	6505	13.50	22.39	169	No
6.5GHz	Main	Edge2	308.88	6505	13.50	22.39	169	No
6.5GHz	Main	Edge3	28.66	6505	13.50	22.39	40	No
6.5GHz	Main	Edge4	11.58	6505	13.50	22.39	6	Yes
6.5GHz	Main	Rear	23.53	6505	13.50	22.39	25	No
6.5GHz	Aux	Edge1	164.46	6505	13.50	22.39	169	No
6.5GHz	Aux	Edge2	11.58	6505	13.50	22.39	6	Yes
6.5GHz	Aux	Edge3	28.66	6505	13.50	22.39	40	No
6.5GHz	Aux	Edge4	308.88	6505	13.50	22.39	169	No
6.5GHz	Aux	Rear	23.53	6505	13.50	22.39	25	No

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
6.7GHz	Main	Edge1	164.45	6665	13.50	22.39	169	No
6.7GHz	Main	Edge2	308.88	6665	13.50	22.39	169	No
6.7GHz	Main	Edge3	28.66	6665	13.50	22.39	40	No
6.7GHz	Main	Edge4	11.58	6665	13.50	22.39	6	Yes
6.7GHz	Main	Rear	23.53	6665	13.50	22.39	25	No
6.7GHz	Aux	Edge1	164.46	6665	13.50	22.39	169	No
6.7GHz	Aux	Edge2	11.58	6665	13.50	22.39	6	Yes
6.7GHz	Aux	Edge3	28.66	6665	13.50	22.39	40	No
6.7GHz	Aux	Edge4	308.88	6665	13.50	22.39	169	No
6.7GHz	Aux	Rear	23.53	6665	13.50	22.39	25	No

Mode	Ant	Position	Distance (mm)	f (MHz)	Max Power(dBm)	Max Power(mW)	SAR Exclusion threshold(mW)	Test required
7.0GHz	Main	Edge1	164.45	6985	13.50	22.39	169	No
7.0GHz	Main	Edge2	308.88	6985	13.50	22.39	169	No
7.0GHz	Main	Edge3	28.66	6985	13.50	22.39	40	No
7.0GHz	Main	Edge4	11.58	6985	13.50	22.39	6	Yes
7.0GHz	Main	Rear	23.53	6985	13.50	22.39	25	No
7.0GHz	Aux	Edge1	164.46	6985	13.50	22.39	169	No
7.0GHz	Aux	Edge2	11.58	6985	13.50	22.39	6	Yes
7.0GHz	Aux	Edge3	28.66	6985	13.50	22.39	40	No
7.0GHz	Aux	Edge4	308.88	6985	13.50	22.39	169	No
7.0GHz	Aux	Rear	23.53	6985	13.50	22.39	25	No

7. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

7.1. SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 8.2.

7.2. TEST CONFIGURATION

7.2.1. WIFI Test Configuration

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal.

Wi-Fi 2.4GHz Band

Mode	802.11b	802.11g	802.11n20	802.11n40	802.11ax20	802.11ax40
Duty cycle	100%					
Crest factor	1					

Wi-Fi 5GHz Band

Mode	802.11a	802.11n20	802.11n40	802.11 ac80	802.11 ac160
	802.11 ax20	802.11ax40	802.11 ax80	802.11ax160	
Duty cycle	100%				
Crest factor	1				

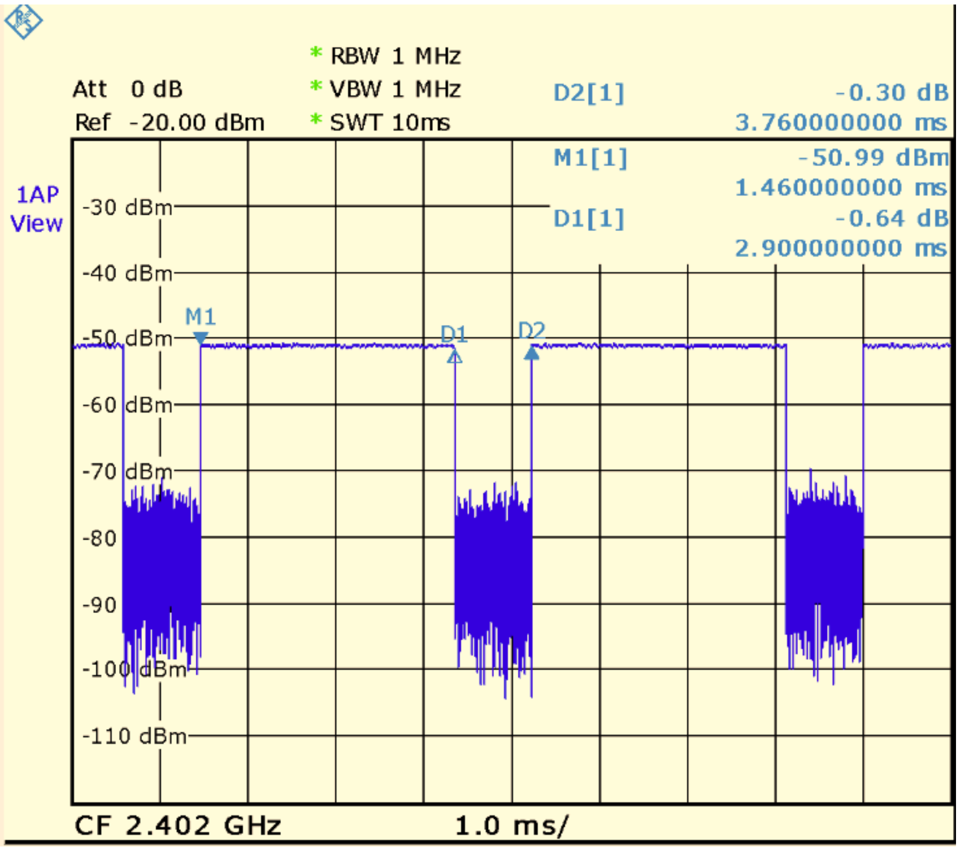
Wi-Fi 6GHz Band

Mode	802.11 ax20	802.11 ax40	802.11 ax80	802.11 ax160
Duty cycle	100%			
Crest factor	1			

For WiFi SAR testing, a communication link is set up with the test mode software for WiFi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The RF signal utilized in SAR measurement has 100% duty cycle and its crest factor is 1. The test procedures in KDB 248227 D01 are applied.

Bluetooth

Mode	Bluetooth DH5	Bluetooth EDR	BLE 1M
Duty cycle	77.13%	77.12%	57.44%
Crest factor	1.30	1.30	1.74



7.2.2. WLAN 2.4G SAR Test Requirements

802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:
1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.
1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

SAR Test Requirements for OFDM configurations

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

7.2.3. WLAN 5G SAR TEST REQUIREMENTS

U-NII-1 and U-NII-2A Band
For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR. When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, both bands are tested independently for SAR.

U-NII-2C, U-NII-3 Bands
The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.
Unless band gap channels are permanently disabled, they must be considered for SAR testing.
To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels.11 When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

7.2.4. OFDM TRANSMISSION MODE AND SAR TEST CHANNEL SELECTION

For the 2.4GHz and 5GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations(for example 802.11a,802.11n and 802.11ac,or 802.11g and 802.11n,with the same channel bandwidth, modulation, and data rate, etc.), the lower order 802.11 mode(i.e.802.11a then 802.11n and 802.11ac,or 802.11g then 802.11n) is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

7.2.5. INITIAL TEST CONFIGURATION PROCEDURE

For OFDM, in both 2.4G and 5GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output powers is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output power will be the initial test configuration. When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurement.

8. CONDUCTED POWER RESULTS

8.1. CONDUCTED POWER MEASUREMENT RESULTS OF BLUETOOTH

Band	Mode	Channel	Frequency (MHz)	Max Power (dBm)	AVG Power (dBm)
DH5	DH5	0	2402	10.50	8.72
		39	2441	10.50	8.65
		78	2480	10.50	8.78
EDR	2DH5	0	2402	9.50	Not Require
		39	2441	9.50	
		78	2480	9.50	
	3DH5	0	2402	9.50	
		39	2441	9.50	
		78	2480	9.50	
BLE	1M	0	2402	9.00	
		19	2440	9.00	
		39	2480	9.00	

8.2. CONDUCTED POWER MEASUREMENTS OF WI-FI 2.4GHZ BAND

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
2.4G	802.11 b	1	2412	1	21.00	20.93	
		6	2437	1	21.00	20.96	
		11	2462	1	21.00	20.90	
	802.11g	1-13	2412-2472	6	21.00	Not Required	
	802.11n20	1-13	2412-2472	HT0	21.00		
	802.11n40	3-9	2422-2462	HT0	21.00		
	802.11ax20	1-13	2412-2472	HE0	21.00		
	802.11ax40	3-9	2422-2462	HE0	21.00		
	802.11b	1	2412	1	20.00		19.94
		6	2437	1	20.00		19.96
		11	2467	1	20.00		19.88
	802.11g	1-13	2412-2472	6	20.00	Not Required	
	802.11n20	1-13	2422-2462	HT0	20.00		
	802.11n40	3-9	2422-2462	HT0	20.00		
	802.11ax20	1-13	2412-2472	HE0	20.00		
	802.11ax40	3-9	2422-2462	HE0	20.00		

Note:

1. As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11g/n20 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2W/kg.

8.3. CONDUCTED POWER MEASUREMENTS OF 5G UNII_1

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_1	802.11a	36-48	5180-5240	6	15.50	Not Required	
	802.11 n20	36-48	5180-5240	HT0	15.50		
	802.11 n40	38-46	5190-5230	HT0	15.50		
	802.11 ax20	36-48	5180-5240	HE0	15.50		
	802.11 ax40	38-46	5190-5230	HE0	15.50		
	802.11 ac80	42	5210	HE0	15.50		
	802.11 ax80	42	5210	HE0	15.50		
UNII_1	802.11a	36-48	5180-5240	6	17.50		
	802.11 n20	36-48	5180-5240	HT0	17.50		
	802.11 n40	38-46	5190-5230	HT0	17.50		
	802.11 ax20	36-48	5180-5240	HE0	17.50		
	802.11 ax40	38-46	5190-5230	HE0	17.50		
	802.11 ac80	42	5210	HE0	17.50		
	802.11 ax80	42	5210	HE0	17.50		

Note:
1. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).

8.4. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2A

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_2a	802.11a	52-64	5260-5320	6	15.50	Not Required	
	802.11 n20	52-64	5260-5320	HT0	15.50		
	802.11 n40	54-62	5270-5310	HT0	15.50		
	802.11 ac80	58	5290	VHT0	15.50	15.48	
	802.11 ac160	50	5250	VHT0	15.00	Not Required	
	802.11 ax20	52-64	5260-5320	HE0	15.50		
	802.11 ax40	54-62	5270-5310	HE0	15.50		
	802.11 ax80	58	5290	HE0	15.50		
	802.11 ax160	50	5250	HE0	15.25		
UNII_2a	802.11a	52-64	5260-5320	6	17.50	Not Required	
	802.11 n20	52-64	5260-5320	HT0	17.50		
	802.11 n40	54	5270-5310	HT0	17.50		
	802.11 ac80	58	5290	VHT0	17.50		17.46
	802.11 ac160	50	5250	VHT0	17.00	Not Required	
	802.11 ax20	52-64	5260-5320	HE0	17.50		
	802.11 ax40	54-62	5270-5310	HE0	17.50		
	802.11 ax80	58	5290	HE0	17.50		
	802.11 ax160	50	5250	HE0	16.00		

Note:

1. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).
3. Largest channel bandwidth is worse than lowest order modulation.

8.5. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2C

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_2c	802.11a	100-140	5500-5700	6	15.50	Not Required	
	802.11 n20	100-140	5500-5700	HT0	15.50		
	802.11 n40	102-134	5510-5670	HT0	15.50		
	802.11 ac80	106	5530	VHT0	15.50	15.39	
	802.11 ac80	122	5610	VHT0	15.50	15.45	
	802.11 ac80	138	5690	VHT0	15.50	15.38	
	802.11 ac160	114	5570	VHT0	15.50	Not Required	
	802.11 ax20	100-140	5500-5700	HE0	15.50		
	802.11 ax40	100-140	5500-5700	HE0	15.50		
	802.11 ax80	102-134	5510-5670	HE0	15.50		
	802.11 ax160	114	5570	HE0	15.50		
UNII_2c	802.11a	100-140	5500-5700	6	17.50		
	802.11 n20	100-140	5500-5700	HT0	17.50		
	802.11 n40	102-134	5510-5670	HT0	17.50		
	802.11 ac80	106	5530	VHT0	17.50		17.33
	802.11 ac80	122	5610	VHT0	17.50		17.47
	802.11 ac80	138	5690	VHT0	17.50		17.36
	802.11 ac160	114	5570	VHT0	16.25	Not Required	
	802.11 ax20	100-140	5500-5700	HE0	17.50		
	802.11 ax40	100-140	5500-5700	HE0	17.50		
	802.11 ax80	102-134	5510-5670	HE0	17.50		
	802.11 ax160	114	5570	HE0	16.25		

Note:
1. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance,
 in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).
2. Largest channel bandwidth is worse than lowest order modulation.

8.6. CONDUCTED POWER MEASUREMENTS OF 5G UNII_3

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
5.8 UNII_3	802.11a	149-165	5745-5825	6	15.50	Not Required	
	802.11 n20	149-165	5745-5825	HT0	15.50		
	802.11 n40	151~159	5755~5795	HT0	15.50		
	802.11 ac80	155	5775	VHT0	15.50	15.42	
	802.11 ax20	149-165	5745-5825	HE0	15.50	Not Required	
	802.11 ax40	151-159	5755-5795	HE0	15.50		
	802.11 ax80	155	5775	HE0	15.50		
5.8 UNII_3	802.11a	149-165	5745-5825	6	17.50		
	802.11 n20	149-165	5745-5825	HT0	17.50		
	802.11 n40	151~159	5755~5795	HT0	17.50		
	802.11 ac80	155	5775	VHT0	17.50		17.43
	802.11 ax20	149-165	5745-5825	HE0	17.50	Not Required	
	802.11 ax40	151-159	5755-5795	HE0	17.50		
	802.11 ax80	155	5775	HE0	17.50		

Note:
1. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance,
in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).
2. Largest channel bandwidth is worse than lowest order modulation.

8.7. CONDUCTED POWER MEASUREMENTS OF 6E UNII_5

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
6E UNII_5	802.11 ax20	1 - 93	5955 -6415	HE0	7.00	Not Required	
	802.11 ax40	3 - 91	5965 - 6405	HE0	10.00		
	802.11 ax80	7 - 87	5985 - 6385	HE0	13.00		
	802.11 ax160	15	6025	HE0	13.50	13.32	
	802.11 ax160	47	6185	HE0	13.50	13.45	
	802.11 ax160	79	6345	HE0	13.50	13.39	
	802.11 ax20	1 - 93	5955 -6415	HE0	7.00	Not Required	
	802.11 ax40	3 - 91	5965 - 6405	HE0	10.00		
	802.11 ax80	7 - 87	5985 - 6385	HE0	13.00		
	802.11 ax160	15	6025	HE0	13.50		13.38
	802.11 ax160	47	6185	HE0	13.50		13.47
	802.11 ax160	79	6345	HE0	13.50		13.36

8.8. CONDUCTED POWER MEASUREMENTS OF 6E UNII_6

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
6E UNII 6	802.11 ax20	97 - 113	6435 - 6515	HE0	7.00	Not Required	
	802.11 ax40	99 -107	6445- 6485	HE0	10.00		
	802.11 ax80	103-119	6465-6545	HE0	13.00		
	802.11 ax160	111	6505	HE0	13.50	13.41	
	802.11 ax20	97 - 113	6435 - 6515	HE0	7.00	Not Required	
	802.11 ax40	99 -107	6445- 6485	HE0	10.00		
	802.11 ax80	103-119	6465-6545	HE0	13.00		
	802.11 ax160	111	6505	HE0	13.50		13.45

8.9. CONDUCTED POWER MEASUREMENTS OF 6E UNII_7

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
6E UNII 7	802.11 ax20	117 - 181	6535 - 6855	HE0	7.00	Not Required	
	802.11 ax40	115 - 179	6525 - 6845	HE0	10.00		
	802.11 ax80	135-167	6625-6785	HE0	13.00		
	802.11 ax160	143	6665	HE0	13.50	13.44	
	802.11 ax160	175	6825	HE0	13.50	13.40	
	802.11 ax20	117 - 181	6535 - 6855	HE0	7.00	Not Required	
	802.11 ax40	115 - 179	6525 - 6845	HE0	10.00		
	802.11 ax80	135-167	6625-6785	HE0	13.00		
	802.11 ax160	143	6665	HE0	13.50		13.46
	802.11 ax160	175	6825	HE0	13.50		13.42

8.10. CONDUCTED POWER MEASUREMENTS OF 6E UNII_8

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
6E UNII 8	802.11 ax20	185-233	6875-7115	HE0	7.00	Not Required	
	802.11 ax40	187-227	6885-7085	HE0	10.00		
	802.11 ax80	199-215	6945-7025	HE0	13.00		
	802.11 ax160	207	6985	HE0	13.50	13.47	
	802.11 ax20	185-233	6875-7115	HE0	7.00	Not Required	
	802.11 ax40	187-227	6885-7085	HE0	10.00		
	802.11 ax80	199-215	6945-7025	HE0	13.00		
	802.11 ax160	207	6985	HE0	13.50		13.48

8.11. SAR TEST RESULTS

General Notes:

1. Per KDB447498 D04, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
2. Per KDB447498 D04, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:≤0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is≤100 MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
3. Per KDB865664 D01,for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/kg, only one repeated measurement is required.

WLAN Notes:

1. For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated(peak) SAR is used as the initial test position. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 for 2.4GHz WIFI single transmission chain operations, the highest measured maximum output power Channel for DSSS was selected for SAR measurement. SAR for OFDM modes(2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section7.1.4 for more information.
3. Justification for test configurations for WLAN per KDB Publication 248227 for 5GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed power. Other transmission mode was not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than1.2W/kg. See Section 7.1.4 for more information.

WLAN PD Note:

1. The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
2. Absorbed power density (APD) using a 4cm2 averaging area is reported based on SAR measurements.
3. Power density was calculated by repeated E-field measurements on two measurement planes separated by λ/4.
4. 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.
5. Per FCC guidance and equipment manufacturer guidance, power density results were scaled according to IEC 62479:2010 for the portion of the measurement uncertainty > 30%. Total expanded uncertainty of 2.68 dB (85.4%) was used to determine the psPD measurement scaling factor.
6. The measurement procedure consists of measuring the PDinc at two different distances: 2 mm (compliance distance) and λ/5. The grid extents should be large enough to fully capture the transmitted energy. The grid step should be fine enough to demonstrate that the integrated Power Density iPDn fulfill the criterion described below. Since iPD ratio between the two distances is ≥ -1dB, the grid step (0.0625) was sufficient for determining compliance at d=2mm.

$$10 \cdot log_{10} \frac{iPD_n(2mm)}{iPD_n(\lambda/5)} \geq -1$$

9. SAR TEST RESULTS

9.1. BODY SAR TEST RESULTS

SAR test results of Bluetooth

Mode	Channel	Test Position	Ant	Max Tune-up (dBm)	AVG Power (dBm)	Area Scan SAR 1g	SAR 1g	Duty Cycel %	Duty Factor	Reported SAR 1g	Note
Bluetooth_DH5	78	Rear	Aux	10.50	8.78	0.006	0.001	77.13%	1.30	0.002	
	78	Edge 2	Aux	10.50	8.78	0.043	0.025	77.13%	1.30	**0.048**	
	78	Edge 3	Aux	10.50	8.78	0.005	0.003	77.13%	1.30	0.005	

SAR test results of 2.4G WiFi

Mode	Channel	Test Position	Ant	Max Tune-up (dBm)	AVG Power (dBm)	Area Scan SAR 1g	SAR 1g	Reported SAR 1g	Note
802.11b	6	Edge 3	Main	21.00	20.96	0.161	0.163	0.165	
	6	Edge 4	Main	21.00	20.96	0.615	0.587	**0.592**	
	6	Rear	Main	21.00	20.96	0.183	0.186	0.188	
802.11b	6	Edge 2	Aux	20.00	19.96	0.909	0.882	0.890	
	6	Edge 3	Aux	20.00	19.96	0.251	0.252	0.254	
	6	Rear	Aux	20.00	19.96	0.300	0.299	0.302	
	1	Edge 2	Aux	20.00	19.94	0.884	0.875	0.887	1
	11	Edge 2	Aux	20.00	19.88	0.921	0.917	**0.943**	1
	11	Edge 2	Aux	20.00	19.88	0.895	0.903	0.928	2

Note:
1. Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
2.Repeated measurements are required only when the measured SAR is ≥0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04)
Original SAR = 0.917 W/kg, therefore second times repeat SAR is required.
Repeat SAR = 0.903 W/kg < 1.45W/kg
SAR variation= -1.55% < 20%

SAR test results of 5G WiFi

Band	Mode	Channel	Test Position	Ant	Max Tune-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
5G UNII 1&2a	802.11 ac80	58	Rear	Main	15.50	15.48	0.024	0.040	0.040	
		58	Edge 4	Main	15.50	15.48	0.069	0.070	**0.070**	
	802.11 ac80	58	Rear	Aux	17.50	17.46	0..242	0.256	0.258	
		58	Edge 2	Aux	17.50	17.46	0.680	0.706	**0.713**	
		58	Edge 3	Aux	17.50	17.46	0.163	0.186	0.188	
5G UNII 2C	802.11 ac80	122	Rear	Main	15.50	15.45	0.027	0.051	0.051	
		122	Edge 4	Main	15.50	15.45	0.159	0.163	**0.165**	
	802.11 ac80	122	Rear	Aux	17.50	17.47	0.300	0.331	0.333	
		122	Edge 2	Aux	17.50	17.47	0.533	0.604	**0.608**	
		122	Edge 3	Aux	17.50	17.47	0.115	0.158	0.159	
5G UNII 3	802.11 ac80	155	Rear	Main	15.50	15.42	0.066	0.081	0.083	
		155	Edge 4	Main	15.50	15.42	0.165	0.174	**0.176**	
	802.11 ac80	155	Rear	Aux	17.50	17.43	0.437	0.385	0.391	
		155	Edge 2	Aux	17.50	17.43	0.536	0.699	**0.710**	
		155	Edge 3	Aux	17.50	17.43	0.086	0.121	0.123	

SAR test results of 6E WiFi

Band	Mode	Channel	Test Position	Ant	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	APD (W/m2)
6E UNII 5	802.11 ax160	47	Edge 4	Main	13.50	13.45	0.089	0.099	**0.100**	0.80
	802.11 ax160	47	Edge 2	Aux	13.50	13.47	0.305	0.335	**0.337**	2.88
6E UNII 6	802.11 ax160	111	Edge 4	Main	13.50	13.41	0.098	0.098	**0.100**	0.82
	802.11 ax160	111	Edge 2	Aux	13.50	13.45	0.326	0.347	**0.351**	2.97
6E UNII 7	802.11 ax160	143	Edge 4	Main	13.50	13.44	0.062	0.063	0.064	0.48
	802.11 ax160	175	Edge 4		13.50	13.40	0.060	0.066	**0.068**	0.47
	802.11 ax160	143	Edge 2	Aux	13.50	13.46	0.365	0.349	0.352	2.99
	802.11 ax160	175	Edge 2		13.50	13.42	0.394	0.405	**0.413**	3.41
6E UNII 8	802.11 ax160	207	Edge 4	Main	13.50	13.47	0.040	0.048	**0.048**	0.32
	802.11 ax160	207	Edge 2	Aux	13.50	13.48	0.355	0.356	**0.358**	2.95

Power Density results of 6E WiFi

Band	Mode	Channel	Test Position	Gap (mm)	Ant	Max une-up (dBm)	AVG Power (dBm)	Grid Step	iPDn	iPD ratio (≥ -1)	Averaging Area cm^2	Avg-Total Power Density W/m^2
6E UNII5	802.11 ax160	47	Bottom	2mm	Main	13.50	13.47	0.0625	1.93	1.46212121	4.000	1.920
6E UNII5	802.11 ax160	47	Bottom	10mm	Main	13.50	13.47	0.25	1.32		4.000	0.556
6E UNII8	802.11 ax160	207	Bottom	2mm	Aux	13.50	13.48	0.0625	2.63	2.26831150	4.000	3.290
6E UNII8	802.11 ax160	207	Bottom	8.6mm	Aux	13.50	13.48	0.25	1.56		4.000	1.160

Band	Mode	Channel	Test Position	Gap (mm)	Ant	Max une-up (dBm)	AVG Power (dBm)	Grid Step	Scaling Factor for Measurement Uncertainty	Averaging Area cm^2	Avg-Total Power Density W/m^2	Scaling Total Power Density
6E UNII 5	802.11 ax160	47	Edge 2	2mm	Aux	13.50	13.47	0.0625	1.5535	4.000	1.920	3.003
6E UNII 6	802.11 ax160	111	Edge 2	2mm	Aux	13.50	13.45	0.0625	1.5535	4.000	1.690	2.656
6E UNII 7	802.11 ax160	143	Edge 2	2mm	Aux	13.50	13.46	0.0625	1.5535	4.000	2.320	3.637
6E UNII 7	802.11 ax160	175	Edge 2	2mm	Aux	13.50	13.42	0.0625	1.5535	4.000	3.150	4.985
6E UNII 8	802.11 ax160	207	Edge 2	2mm	Aux	13.50	13.48	0.0625	1.5535	4.000	3.290	5.135

Note:
We reference TCB workshop April 2021 to test Power Density.

10. SIMULTANEOUS TRANSMISSION CONDITIONS

10.1. STAND-ALONE SAR TEST EXCLUSION

SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions, including network hand-offs, is greater than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis.

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration
1	WLAN 2.4G(Main)+BT
2	RLAN 5G(Main)+BT
3	WLAN 6G(Maim)+BT
4	WLAN 2.4G(Main)+ WLAN 2.4G(Aux)
5	RLAN 5G(Main)+ RLAN 5G(Aux)
6	WLAN 6G(Main)+ WLAN 6G(Aux)

10.2. SIMULTANEOUS TRANSMISSION CONDITIONS

KDB 447498 D04 Interim General RF Exposure Guidance v01, introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

$SPLSR = (SAR_1 + SAR_2)^{1.5} / R_i$
Where:

SAR_1 is the highest Reported or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest Reported or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

R_i is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

A new threshold of 0.04 is also introduced in the KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:
$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$

10.3. ABOUT BT/WIFI

SAR1g(W/kg) \ Test Position	Rear	Edge 2	Edge 3	Edge 4
WLAN 2.4G WiFi_Main	0.188		0.165	0.592
WLAN 2.4G WiFi_Aux	0.302	0.943	0.254	
UNII_1 & 2a WiFi_Main	0.040			0.070
UNII_1 & 2a WiFi_Aux	0.258	0.713	0.188	
UNII_2c WiFi_Main	0.051			0.165
UNII_2c WiFi_Aux	0.333	0.608	0.159	
UNII_3 WiFi_Main	0.083			0.176
UNII_3 WiFi_Aux	0.391	0.710	0.123	
UNII_5 WiFi_Main				0.100
UNII_5 WiFi_Aux		0.337		
UNII_6 WiFi_Main				0.100
UNII_6 WiFi_Aux		0.351		
UNII_7 WiFi_Main				0.068
UNII_7 WiFi_Aux		0.413		
UNII_8 WiFi_Main				0.048
UNII_8 WiFi_Aux		0.358		
Bluetooth_DH5	0.002	0.048	0.005	
WLAN2.4G_Main+WLAN 2.4G_Aux MAX∑SAR1g	0.490	0.943	0.419	0.592
WLAN_Main+BT_Aux MAX∑SAR1g	0.190	0.048	0.170	0.592
RLAN 5G_Main+ RLAN 5G_Aux MAX∑SAR1g	0.474	0.713	0.188	0.176
Wi-Fi 6E_Main+ Wi-Fi 6E_Aux MAX∑SAR1g		0.413		0.100

Note:

1. MAX. ΣSAR_{1g} = 0.943 W/Kg<1.6 W/Kg, so Peak location SAR are not required.

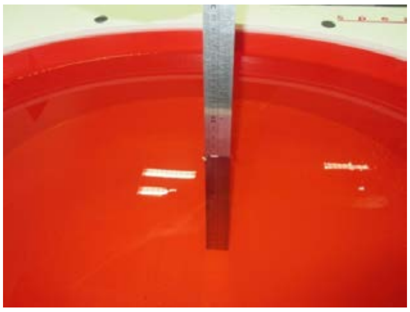
11. TEST LAYOUT

Specific Absorption Rate Test Layout

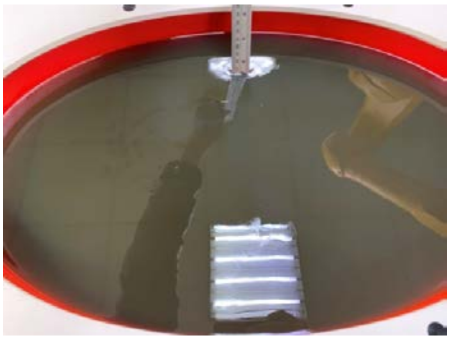
Liquid depth in the flat Phantom (≥15cm depth)

HSL(2450MHz)

HSL(5GHz)



HSL(6.5GHz)



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2304T012_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2304T012_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2304T012_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2304T012_Appendix D.)

End of Test Report