

SAR Test Report

Test Report No. 15096569S-A-R3

Customer	OM Digital Solutions Corporation
Description of EUT	Wireless LAN/Bluetooth Module
Model Number of EUT	S0123WIFI-PCA ^(*) . Installed into the specified platform)
FCC ID	YSKW123
Test Regulation	FCC 47CFR 2.1093
Test Result	Complied
Issue Date	July 29, 2024
Remarks	-

Representative Test Engineer

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Approved By

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CERTIFICATE 1266.03

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 There is no testing item of "Non-accreditation".

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REVISION HISTORY

Original Test Report No.: 15096569S-A

This report is a revised version of 15096569S-A-R2. 15096569S-A-R2 is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15096569S-A	May 21, 2024	-
-R1	15096569S-A-R1	July 16, 2024	(p5) (2.2) Deleted "Electronic Flash, Wireless Remote controller (Low power than exclusion threshold power) (Refer to 7.2)" in "SAR Accessory" and changed it to "none". (p6(3.1), p7(3.3), p8(3.6.1)) SAR procedure: KDB 447498 D01v06 was changed to KDB 447498 D04v01. (p9) (4.2) SAR Test Exclusion Threshold Power Procedure: KDB 447498 D01v06 was changed to KDB 447498 D04v01 and all comments and tables were replaced. (p13)(7.2) Deleted all comments regarding simultaneous transmission with accessories below the SAR test exclusion threshold power. Verification regarding simultaneous transmission was reported in a separate statement.
-R2	15096569S-A-R2	July 22, 2024	(p5) Corrected zip code 192-33 to 192-0033.
-R3	15096569S-A-R3	July 29, 2024	(p9, 4.2) The table of antenna separation distance and SAR test exclusion threshold power for the product was revised and recalculated with the antenna separation distance set to rounded-down and the power set to rounded-up.

Reference : Abbreviations (Including words undescribed in this report) (R15v240501S07v240507)

A2LA	The American Association for Laboratory Accreditation	JAB	Japan Accreditation Board
AC	Alternating Current	LAN	Local Area Network
AFH	Adaptive Frequency Hopping	LIMS	Laboratory Information Management System
AM	Amplitude Modulation	MCS	Modulation and Coding Scheme
Amp, AMP	Amplifier	MIMO	Multiple Input Multiple Output (Radio)
ANSI	American National Standards Institute	MPE	Maximum Permissible Exposure
Ant, ANT	Antenna	MRA	Mutual Recognition Arrangement
AP	Access Point	MU-MIMO	Multi-User Multiple Input Multiple Output (Radio)
APD	Absorbed Power Density	N/A	Not Applicable, Not Applied
ASK	Amplitude Shift Keying	NII	National Information Infrastructure (Radio)
Atten., ATT	Attenuator	NIST	National Institute of Standards and Technology
AV	Average	NR	New Radio
BPSK	Binary Phase-Shift Keying	NS	Nerve Stimulation
BR	Bluetooth Basic Rate	NSA	Normalized Site Attenuation
BT	Bluetooth	NVLAP	National Voluntary Laboratory Accreditation Program
BT LE	Bluetooth Low Energy	OBW	Occupied Band Width
BW	BandWidth	OFDM	Orthogonal Frequency Division Multiplexing
Cal Int	Calibration Interval	PD	Power Density
CCK	Complementary Code Keying	P/M	Power meter
CDD	Cyclic Delay Diversity	PCB	Printed Circuit Board
CFR	Code of Federal Regulations	PER	Packet Error Rate
Ch., CH	Channel	PHY	Physical Layer
CISPR	Comité International Special des Perturbations Radioélectriques	PK	Peak
CW	Continuous Wave	PN	Pseudo random Noise
DBPSK	Differential BPSK	PRBS	Pseudo-Random Bit Sequence
DC	Direct Current	PSD	Power Spectral Density
D-factor	Distance factor	QAM	Quadrature Amplitude Modulation
DFS	Dynamic Frequency Selection	QP	Quasi-Peak
DQPSK	Differential QPSK	QPSK	Quadrature Phase Shift Keying
DSSS	Direct Sequence Spread Spectrum	RBW	Resolution Band Width
DUT	Device Under Test	RDS	Radio Data System
EDR	Enhanced Data Rate	RE	Radio Equipment
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power	RF	Radio Frequency
EMC	ElectroMagnetic Compatibility	RMS	Root Mean Square
EMI	ElectroMagnetic Interference	RSS	Radio Standards Specifications
EN	European Norm	RU	Resource Unit
ERP, e.r.p.	Effective Radiated Power	Rx	Receiving
ETSI	European Telecommunications Standards Institute	SA, S/A	Spectrum Analyzer
EU	European Union	SAR	Specific Absorption Rate
EUT	Equipment Under Test	SDM	Space Division Multiplexing
Fac.	Factor	SISO	Single Input Single Output (Radio)
FCC	Federal Communications Commission	SG	Signal Generator
FHSS	Frequency Hopping Spread Spectrum	SPLSR	SAR to Peak Location Separation Ratio
FM	Frequency Modulation	SVSWR	Site-Voltage Standing Wave Ratio
Freq.	Frequency	TER	Total Exposure Ratio
FSK	Frequency Shift Keying	TSL	Tissue Simulation Liquid
GFSK	Gaussian Frequency-Shift Keying	T/R	Test Receiver
GNSS	Global Navigation Satellite System	Tx	Transmitting
GPS	Global Positioning System	U-NII	Unlicensed National Information Infrastructure (Radio)
HE	High Efficiency (e.g. IEEE 802.11ax20HE)	URS	Unintentional Radiator(s)
HT	High Throughput (e.g. IEEE 802.11n20HT)	VBW	Video BandWidth
Hori.	Horizontal	Vert.	Vertical
ICES	Interference-Causing Equipment Standard	VHT	Very High Throughput (e.g. IEEE 802.11ac20VHT)
IEC	International Electrotechnical Commission	WLAN	Wireless LAN
IEEE	Institute of Electrical and Electronics Engineers	Wi-Fi, WiFi	Wireless LAN, trademarked by Wi-Fi Alliance
IF	Intermediate Frequency	WPT	Wireless Power Transmit
ILAC	International Laboratory Accreditation Conference		
IPD	Incident Power Density		
ISED	Innovation, Science and Economic Development Canada		
ISO	International Organization for Standardization		

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SECTION 1: Customer information

Company Name	OM Digital Solutions Corporation
Address	49-3 Takakura-machi, Hachioji-shi, Tokyo, 192-0033, Japan
Telephone Number	+81-42-642-3874
Contact Person	Kenichi Aoki

The information provided from the customer is as follows:

- Customer name, Company name, Type of Equipment, Model No., FCC ID on the cover and other relevant pages.
- SECTION 1: Customer information
- SECTION 2: Equipment under test (EUT)
- SECTION 4: Operation of EUT during testing
- Appendix 1: The part of Antenna location information, Description of EUT and Support Equipment

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type	Wireless LAN/Bluetooth Module
Model Number	S0123WIFI-PCA
Serial Number	SS2D070111YN
Rating	DC 3.8 V (3.35 V to 4.2 V), DC 1.8 V (1.782 V to 1.818 V)
Condition of sample	Engineering prototype (Not for sale: The sample is equivalent to mass-produced items.)
Receipt Date of sample	January 19, 2024 (for power measurement) (*. No modification by the Lab.) April 4, 2024 (for SAR test) (*. No modification by the Lab.)
Test Date (SAR)	April 11, 2024

2.2 Product Description

a). This report contains data provided by the customer which can impact the validity of results. UL Japan, Inc. is only responsible for the validity of results after the integration of the data provided by the customer. The data provided by the customer is marked "a)" in the table below.

Radio specification

Equipment type	Transceiver
Frequency of operation	Bluetooth: 2402 MHz ~ 2480 MHz WLAN 2.4 GHz Band: 2412 MHz ~ 2462 MHz
Supported modulations	Bluetooth(BT LE): GFSK WLAN 2.4 GHz band) DSSS) 11b: DBPSK/DQPSK/CCK WLAN 2.4 GHz band) OFDM 11g/n: BPSK/QPSK/16QAM/64QAM
Typical and maximum transmit power	*. The specification of typical and maximum transmit power (which may occur) refer to remarks in below 'Table of Typical power and Maximum tune-up tolerance limit power'. The measured output power (conducted) as SAR reference power refers to section 5 in this report.
Antenna quantity	1 pc.
Antenna type / connector type	PIFA (Planar Inverted F Antenna) / Connector; PCB side: U.FL, Antenna side: soldered
Antenna gain ^{a)} (max. gain)	-2.4 dBi (2.4GHz band) (*.including cable loss)

*. Table of Typical power and Maximum power (= Maximum tune-up tolerance limit power)

Maximum tune-up tolerance limit is conducted burst average power and is defined by a customer as Duty cycle 100% (continuous transmitting).

Band	Channel	Frequency [MHz]	Mode	BW [MHz]	D/R, MCS Index	Typical [dBm]	Max. [dBm]
Bluetooth	0~39	2402~2480	BT LE	2	1 Mbps	7	9
WLAN 2.4GHz	1~11	2412~2462	11b 11g 11n	20	1~11 Mbps 6~54 Mbps MCS0~7	10 10 10	12 12 12

*: The SAR test reference power measurement and the SAR test were applied to the lowest data rate on each operation mode.

*: The EUT do not use the special transmitting technique such as "beam-forming" and "time-space code diversity."

Description of Host Platform

Manufacture	OM Digital Solutions Corporation
Product name	DIGITAL CAMERA
Model number	IM036
Condition of sample	Engineering prototype (Not for sale: The sample is equivalent to mass-produced items.)
Rating	DC 7.2 V (Li-ion Battery, Refer to Appendix 1-2) (*. The SAR test was performed in battery operation.)
SAR Category Identified	Portable device (*. Since EUT may contact to a localized human body during wireless operation, the partial-body SAR (1g) shall be observed.)
Exposure Category	General Population/Uncontrolled Exposure:
SAR Accessory	none

SECTION 3: Maximum SAR value, test specification and procedures

3.1 Summary of Maximum SAR Value

Mode / Band	Highest Reported SAR [W/kg]		
	Partial-body (Flat phantom, Separation 0 mm)	Head (SAM phantom)	Limbs (Flat phantom)
	SAR type: SAR (1g)	SAR type: SAR (1g)	SAR type: SAR (10g)
WLAN 2.4 GHz	0.49	N/A	N/A
Bluetooth	0.19	N/A	N/A
Simultaneous Transmission	N/A (*1)	N/A	N/A

Limit applied: Partial bod 1.6 W/kg (SAR (1g)), for general population/uncontrolled exposure is specified in FCC 47 CFR 2.1093.

Test Procedure: Refer to Section 3.2 in this report. In addition:
UL Japan's SAR measurement work procedures No. ULID-003599 (13-EM-W0430).
UL Japan's SAR measurement equipment calibration and inspection work procedures No. ULID-003598 (13-EM-W0429).

*1. WLAN and Bluetooth use same antenna. Therefore, simultaneously transmitted SAR was not considered in this platform standalone base.

For Module approval:

Test outline: Where the EUT is built into this platform, it was verified whether multi-platform conditions can be suited in according with clause 4.2.4 in KDB447498 D04 (v01).

Consideration of the test results:	The highest reported SAR (1g) of this platform was kept; ≤ 0.8 W/kg. <u>Since highest reported SAR (1g) on this EUT's platform obtained in accordance with KDB447498 D04 (v01) was kept under 0.8 W/kg, this EUT was approved to operate multi-platform.</u>
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Conclusion

The SAR test values found for the device are separately below the maximum limit of 1.6 W/kg.

3.2 RF Exposure limit

SAR Exposure Limit (100 kHz ~ 6 GHz)		
	General Population / Uncontrolled Exposure (*1) [W/kg]	Occupational / Controlled Exposure (*2) [W/kg]
Spatial Peak SAR (*3) (Whole Body)	0.08	0.4
Spatial Peak SAR (*4) (Partial-Body, Head or Body)	1.6	8
Spatial Peak SAR (*5) (Hands / Feet / Ankle / Wrist)	4	20

*. For the purpose of this Regulation, FCC has adopted the SAR and RF exposure limits established in FCC 47 CFR 1.1310: Radiofrequency radiation exposure limits.

*1. General Population / Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

*2. Occupational / Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

*3. The Spatial Average value of the SAR averaged over the whole body.

*4. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

*5. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

The limit applied to this device which tested in this report is:

Limit of Spatial Peak SAR (Partial-Body)	1.6 W/kg	General population / uncontrolled exposure
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3.3 Test specification

Standard	Description	Version
47 CFR 2.1093	(Limit) Radiofrequency radiation exposure evaluation: portable devices	-
ANSI/IEEE C95.1	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz	1992
IEEE Std. 1528	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.	2013
KDB 248227 D01	SAR Guidance for IEEE 802.11 (Wi-Fi) transmitters v02r02	v02r02
KDB 447498 D04	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices	v01
KDB 447498 D03	OET Bulletin 65, Supplement C Cross-Reference v01	v01
KDB 865664 D01	SAR measurement 100 MHz to 6 GHz v01r04	v01r04
KDB 865664 D02	RF exposure compliance reporting and documentation considerations v01r02	v01r02

* The measurement uncertainty budget is suggested by IEC/IEEE 62209-1528:2020 and determined by SPEAG, DASY8 Manual for Module SAR. Refer to Appendix3-3 for more details.

In addition to the above, the following information was used, when it is required.:.

TCB workshop, 2016-10	RF Exposure Procedure, DUT Holder Perturbations: When the highest reported SAR of an antenna is > 1.2 W/kg, holder perturbation verification is required for each antenna, using the highest SAR configuration among all applicable frequency bands.
TCB workshop, 2018-04	Expedited Area Scans. (including mother scans)
TCB workshop, 2019-04	RF Exposure Procedure, 802.11ax SAR Testing
TCB workshop, 2019-10	RF Exposure Procedure, Tissue Simulating Liquids (TSL) -FCC has permitted the use of single head tissue simulating liquid specified in IEC 62209 for all SAR tests. -If FCC parameters are used, 5 % tolerance. If IEC parameters, 10 %.

3.4 Addition, deviation and exclusion to the test procedure

No addition, exclusion nor deviation has been made from the test procedure.

3.5 Test Location

UL Japan, Inc., Shonan EMC Lab.

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Telephone number: +81 463 50 6400

* A2LA Certificate Number: 1266.03 (FCC Test Firm Registration Number: 626366, ISED Lab Company Number: 2973D / CAB identifier: JP0001)

Place	Width × Depth × Height (m)	Size of reference ground plane (m) / horizontal conducting plane
No.7 Shielded room	2.76 × 3.76 × 2.4	2.76 × 3.76

3.6 SAR measurement procedure

3.6.1 SAR Definition

SAR is defined as the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). The equation description is shown in right.	$SAR = \frac{d(\frac{dW}{dt} dm)}{dt dm} = \frac{d}{dt} \left(\frac{dW}{\rho * dV} \right)$
SAR measurement can be related to the electrical field in the tissue by the equation in right. SAR is expressed in units of Watts per kilogram (W/kg). Where : σ = conductivity of the tissue (S/m), ρ = mass density of the tissue (kg/m³), E = RMS electric field strength in tissue (V/m)	$SAR = \frac{\sigma E ^2}{\rho}$

3.6.2 Full SAR measurement procedure

The SAR measurement procedures are as follows: (1) The EUT is installed engineering testing software that provides continuous transmitting signal; (2) Measure output power through RF cable and power meter; (3) Set scan area, grid size and other setting on the DASY software; (4) Find out the largest SAR result on these testing positions of each band; (5) Measure SAR results for other channels in worst SAR testing position if the SAR of highest power channel is larger than 0.8 W/kg.

*. According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

Step 1) Power measurement -> SAR: Step 2) Power reference measurement -> Step 3) Area scan -> Step 4) Zoom scan -> Step 5) Power drift measurement

Step 1: Confirmation before SAR testing

Before SAR test, the RF wiring for the sample had been switched to the antenna conducted power measurement line from the antenna line and the average power was measured. This SAR reference power measurement was proceeded with the lowest data rate (which may have the higher time-based average power typically) on each operation mode and on the lower, middle (or near middle), upper and specified channels. The power measurement result is shown in Section 5.

*. The EUT transmission power used SAR test was verified that it was not more than 2 dB lower than the maximum tune-up tolerance limit. (KDB447498 D04 (v01))

Step 2: Power reference measurement

Measured psSAR value at a peak location of Fast Area Scan was used as a reference value for assessing the power drop.

Step 3: Area Scan

(Scan parameters: KDB 865664 D01, IEC/IEEE 62209-1528 (>6GHz))
Area Scans are used to determine the peak location of the measured field before doing a finer measurement around the hotspot. Peak location can be found accurately even on coarse grids using the advanced interpolation routines implemented in DASY8. Area Scans measure a two dimensional volume covering the full device under test area. DASY8 uses Fast Averaged SAR algorithm to compute the 1 g and 10 g of simulated tissue from the Area Scan. DASY8 can either manually or automatically generates Area Scan grid settings based on device dimensions. In automatically case, the scan extent is defined by the device dimensions plus additional 15mm on each side. In manually, the scan covered the entire dimension of the antenna of EUT.

Step 4: Zoom Scan and post-processing

(Scan parameters: KDB 865664 D01, IEC/IEEE 62209-1528 (>6GHz))

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure.

- *. A minimum volume of 30 mm (x) × 30 mm (y) × 30 mm (z) was assessed by "Ratio step" method (*1), for 2.4 GHz band. (Step XY: 5 mm)
- *. A minimum volume of 24 mm (x) × 24 mm (y) × 24 mm (z) was assessed by "Ratio step" method (*1), for 5 GHz band (Step XY: 4 mm).
- *. A minimum volume of 24 mm (x) × 24 mm (y) × 24 mm (z) was assessed by "Ratio step" method (*1), for 6 GHz band (Step XY: 3.4 mm).

When the SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are proceeded for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR. If the zoom scan measured as defined above complies with both of the following criteria. or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed.

- *. The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions and recorded.
- *. The ratio of the SAR at the second measured point to the SAR at the closest measured point at the x-y location of the measured maximum SAR value shall be at least 30 % and recorded.

		$f \leq 3 \text{ GHz}$	$3 \text{ GHz} < f \leq 10 \text{ GHz}$
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		$5 \text{ mm} \pm 1 \text{ mm}$	$1/2 \times \delta \times \ln(2) \text{ mm} \pm 0.5 \text{ mm}$
Maximum probe angle from probe axis to phantom surface normal at the measurement location		$5^\circ \pm 1^\circ$ (flat phantom only) $30^\circ \pm 1^\circ$ (other phantom)	$5^\circ \pm 1^\circ$ (flat phantom only) $30^\circ \pm 1^\circ$ (other phantom)
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$		$\leq 2 \text{ GHz} : \leq 15 \text{ mm}$, $2\text{-}3 \text{ GHz} : \leq 12 \text{ mm}$	$3\text{-}4 \text{ GHz} : \leq 12 \text{ mm}$, $4\text{-}6 \text{ GHz} : \leq 10 \text{ mm}$ $> 6 \text{ GHz} : \leq 60/f \text{ mm}$, or half of the corresponding zoom scan length, whichever is smaller.
Maximum zoom scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.
Maximum zoom scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$		$\leq 2 \text{ GHz} : \leq 8 \text{ mm}$, $2\text{-}3 \text{ GHz} : \leq 5 \text{ mm}$ (*1)	$3\text{-}4 \text{ GHz} : \leq 5 \text{ mm}$ (*1), $4\text{-}6 \text{ GHz} : \leq 4 \text{ mm}$ (*1) $> 6 \text{ GHz} : \leq 24/f \text{ mm}$
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{\text{zoom}}(n)$	$\leq 5 \text{ mm}$	$3\text{-}4 \text{ GHz} : \leq 4 \text{ mm}$, $4\text{-}5 \text{ GHz} : \leq 3 \text{ mm}$, $5\text{-}6 \text{ GHz} : \leq 2 \text{ mm}$ $> 6 \text{ GHz} : \leq 10/f \text{ mm}$
Maximum zoom scan spatial resolution, graded grid	$\Delta z_{\text{zoom}}(1)$: between 1st two points closest to phantom surface $\Delta z_{\text{zoom}}(n>1)$: between subsequent points	$\leq 4 \text{ mm}$	$3\text{-}4 \text{ GHz} : \leq 3 \text{ mm}$, $4\text{-}5 \text{ GHz} : \leq 2.5 \text{ mm}$, $5\text{-}6 \text{ GHz} : \leq 2 \text{ mm}$ $> 6 \text{ GHz} : \leq 12/f \text{ mm}$
Minimum zoom scan volume	x, y, z	$\geq 30 \text{ mm}$	$\leq 1.5 \times \Delta z_{\text{zoom}} (n-1) \text{ mm}$

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEE Std 1528-2013 ($\leq 6 \text{ GHz}$) and IEC/IEEE 62209-1528 ($\leq 10 \text{ GHz}$) for details.

*1. When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is $\leq 1.4 \text{ W/kg}$, $\leq 8 \text{ mm}$, $\leq 7 \text{ mm}$ and $\leq 5 \text{ mm}$ zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. (KDB 865664 D01)

*. The scan parameters of $> 6 \text{ GHz}$ is defined IEC/IEEE 62209-1528.

Step 5: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same project. The Power Drift Measurement gives the SAR difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. It was checked that the power drift was within $\pm 5\%$ (0.21 dB) in single SAR project run. The verification of power drift during the SAR test shown in SAR plot data of APPENDIX 2.

- *. The most of SAR tests were conservatively performed with test separation distance 0 mm. The phantom bottom thickness is approx. 2mm. Therefore, the distance between the SAR probe tip to the surface of test device which is touched the bottom surface of the phantom is approx. 2.4 mm. Typical distance from probe tip to probe's dipole centers is 1mm.
- *1. "Ratio step" method parameters used; the first measurement point: "1.4 mm" from the phantom surface, the initial z grid separation: "1.5 mm", subsequent graded grid ratio: "1.5" for 2.4 GHz band and the initial z grid separation: "1.4 mm", subsequent graded grid ratio: "1.4" for above 5 GHz. These parameters comply with the requirement of KDB 865664 D01 and recommended by Schmid & Partner Engineering AG (DASY8 manual).

SECTION 4: Operation of EUT during testing

4.1 Operating modes for testing

The EUT has BT LE and IEEE 802.11b/11g/11n20 continuous transmitting modes. The frequency and the modulation used in the SAR testing are shown as a following.

Operation mode	BT LE	11b	11g	11n20	
band	2.4GHz band				
Tx band [MHz]	2402-2480		2412-2462		
Bandwidth [MHz]	1	20	20	20	
Max.power [dBm]	9	12	12	12	
Modulation	GFSK	DSSS	OFDM	OFDM	
D/R [Mbps, MCS#]	1M-PHY	1	6	MCS0	
Frequency tested [MHz]	2402, 2440, 2480	2412, 2437, 2462	n/a (*1)	n/a (*1)	
Controlled software	Test name	Software name	Version	Date	Storage location / Remarks
	Power measurement	Wireless Test	1.00.1	2024-02-05	Driven by connected PC (Refer to Appendix 1-2)
	SAR test	Wireless Test	1.00.1	2024-04-08	Driven by connected PC (Refer to Appendix 1-2)

*. Max.power: Maximum power (tune-up limit power), D/R: Data rate, n/a: SAR test was not applied.

*1. (KDB 248227 D01) Since reported SAR (1g) of DSSS mode which had same output power was enough small, SAR test was only applied DSSS mode.

* OFDM Transmission Mode SAR Test Configuration and Channel Selection Requirements

(KDB 248227 D01, SAR Guidance for Wi-Fi Transmitters) The initial test configuration for 2.4 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 channel bandwidth configurations in a frequency band have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected.

* SAR test reduction considerations

(KDB 248227 D01) For 2.4GHz band, the highest measured maximum output power channel of DSSS was selected for SAR measurement. When the reported SAR is ≤ 0.8 W/kg, no further SAR test is required in this exposure configuration. Otherwise, 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. For OFDM modes (802.11g/n), SAR is not required 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.

4.2 RF exposure conditions (Test exemption)

Antenna separation distances in each test setup plan are shown as follows.

Setup	Explanation of EUT setup (*. Refer to Appendix 1 for test setup photographs.)						D [mm]
Front-Left	The front-left side surface of host platform was touched to the Flat phantom.						1.7
Left	The left side surface of host platform was touched to the Flat phantom.						5.2
Bottom	The bottom side surface of host platform was touched to the Flat phantom.						10.5
Front	The front side surface of host platform was touched to the Flat phantom.						11.6
Rear	The Rear side surface of host platform was touched to the Flat phantom.						34.2
Top	The top side surface of host platform was touched to the Flat phantom.						49.0
Right	The right side surface of host platform was touched to the Flat phantom.						125.1

*: D: Antenna separation distance. It is the distance from the antenna inside device to the outer surface of device which user may touch.

SAR test exemption consideration by KDB 447498 D04 (v01)

Tx mode	Higher Freq. [MHz]	Max. ATP			Antenna			SAR1g based Threshold power (upper row)								Judge of SAR test exemption (lower row)							
		[dBm]	[mW]	Gain [dBi]	ERP [dBm]	[mW]	Front-Left	Left	Bottom	Front	11	34	49	125	Front-Left	Left	Bottom	Front	Rear	Top	Right		
																<5	5	10	11	34	49	125	
BT LE	2480	9	8	-2.4	4.45	3	3 mW	3 mW	10 mW	12 mW	105 mW	210 mW	>218 mW		Test	Test	Exempt	Exempt	Exempt	Exempt	Exempt		
WLAN 2.4 GHz	2462	12	16	-2.4	7.45	6	3 mW	3 mW	10 mW	12 mW	105 mW	210 mW	>219 mW		Test	Test	Test	Test	Exempt	Exempt	Exempt		

*: Power is rounded up to the nearest integer "mW" and antenna separation distance is rounded down to the nearest "mm" before calculation.

*: The table shows the upper frequency which has the maximum power (as "Tune-up limit") in each operation band and, in mode and on the single antenna transmission.

*: (Calculating formula) ERP (dBm) = (max. conducted output power, dBm) + (antenna gain, dBi) - 2.15

<Conclusion for consideration for SAR test reduction>

- 1) The all SAR tests were conservatively performed with test separation distance 0 mm.
- 2) (WLAN operation) "Front-Left", "Left", "Bottom" and "Front" setups are applied the SAR test because near antenna section and/or higher than calculated threshold power. The SAR test of other SAR test setups are reduced, because the SAR test exclusion judge was "test can be reduced".
- 3) (Bluetooth operation) Worst SAR setup of WLAN mode is applied SAR test.

SAR-based thresholds (P_{th} [mW]) shown below table of "Example Power Thresholds [mW]" are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged effective radiated power (ERP), whichever is greater. The SAR-based exemption is calculated by Formula (B.2) in below, applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

Table: Example Power Thresholds [mW] for SAR1g (Bold & Shaded: Listed in Table B.2 of KDB 447498 D04 (v01))																																														
Distance [mm]																																														
Frequency [MHz]	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1900	3	5	6	8	10	12	14	17	20	23	26	29	32	36	40	44	48	52	56	61	66	71	76	81	86	92	98	104	110	116	122	129	136	142	149	157	164	171	179	187	195	203	211	219	228	236
2402	3	4	5	7	9	10	12	15	17	20	22	25	28	32	35	39	42	46	50	55	59	64	68	73	78	84	89	94	100	106	112	118	124	131	138	144	151	158	165	173	180	188	196	204	212	220
2450	3	4	5	7	8	10	12	15	17	19	22	25	28	31	35	38	42	46	50	54	58	63	68	73	78	83	88	94	99	105	111	117	124	130	137	143	150	157	164	172	179	187	195	203	211	219
2462	3	4	5	7	8	10	12	14	17	19	22	25	28	31	35	38	42	46	50	54	58	63	68	73	78	83	88	94	99	105	111	117	123	130	136	143	150	157	164	171	179	187	194	202	210	219
2490	3	4	5	7	8	10	12	14	17	19	22	25	28	31	35	38	42	46	50	54	58	63	67	72	77	82	88	93	99	105	111	117	123	129	136	143	150	157	164	171	179	186	194	202	210	218
3600	2	3	4	5	6	8	10	11	13	16	18	20	23	26	29	32	35	38	42	45	49	53	57	62	66	71	75	80	85	91	96	102	107	113	115	125	132	138	145	151	158	165	173	180	187	195

Calculating formula:

$$P_{th}(mW) = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6.0 \text{ GHz} \end{cases} \quad (B.1)$$

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

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

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

TABLE B.1—THRESHOLDS FOR SINGLE RF-SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source Frequency	Minimum Distance	Threshold ERP
f_1 MHz	f_1 MHz	$\lambda_1/2\pi$
0.3	-	1.34
1.34	-	30
30	-	300
300	-	1500
1500	-	100000
		31.8 mm
		0.5 mm
		19.2 R ²

Subscripts L and H are low and high; λ is wavelength.
From § 1.130(b)(3)(i)(C), modified by adding Minimum Distance columns. R is in meter, f is in MHz.
Upper 2.4GHz: Threshold ERP [W] = $19.2 \times R^2$, at distance: over 40 cm

SECTION 5: Confirmation before testing

5.1 Test reference power measurement

Mode	Frequency		Data rate [Mbps]	Power spec. on each antenna		Duty cycle			Antenna power: Main (Chain 0)				Adjusted power setting? (*1)	
				Typical [dBm]	Max. [dBm]	Duty cycle [%]	Duty cycle [dB]	Scaled factor [Hz]	Set pwr. [Hz]	Burst Ave. [dBm]	ΔMax. [dB]	Tune-up factor [Hz]		
	[MHz]	CH												
BT LE	2402	0	1	-	9	64.9	1.88	1.54	fix	7.12	-1.88	1.54	5.24	No
	2440	19	1	-	9	64.9	1.88	1.54	fix	7.07	-1.93	1.56	5.19	No
	2480	39	1	-	9	64.9	1.88	1.54	fix	7.19	-1.81	1.52	5.31	No
11b	2412	1	1	10	12	100	0.00	1.00	10	10.78	-1.22	1.32	10.78	No
	2437	6	1	10	12	100	0.00	1.00	10	10.68	-1.32	1.35	10.68	No
	2462	11	1	10	12	100	0.00	1.00	10	10.55	-1.45	1.40	10.55	No
11g	2412	1	6	10	12	99.4	0.03	1.01	10	11.50	-0.50	1.12	11.47	No
	2437	6	6	10	12	99.4	0.03	1.01	10	11.50	-0.50	1.12	11.47	No
	2462	11	6	10	12	99.4	0.03	1.01	10	11.48	-0.52	1.13	11.45	No
11n 20HT	2412	1	MCS0	10	12	99.3	0.03	1.01	10	11.44	-0.56	1.14	11.41	No
	2437	6	MCS0	10	12	99.3	0.03	1.01	10	11.35	-0.65	1.16	11.32	No
	2462	11	MCS0	10	12	99.3	0.03	1.01	10	11.23	-0.77	1.19	11.20	No

*1. "Yes": The power setting was adjusted so that measured average power was not more than 2 dB lower than the maximum tune-up tolerance limit.

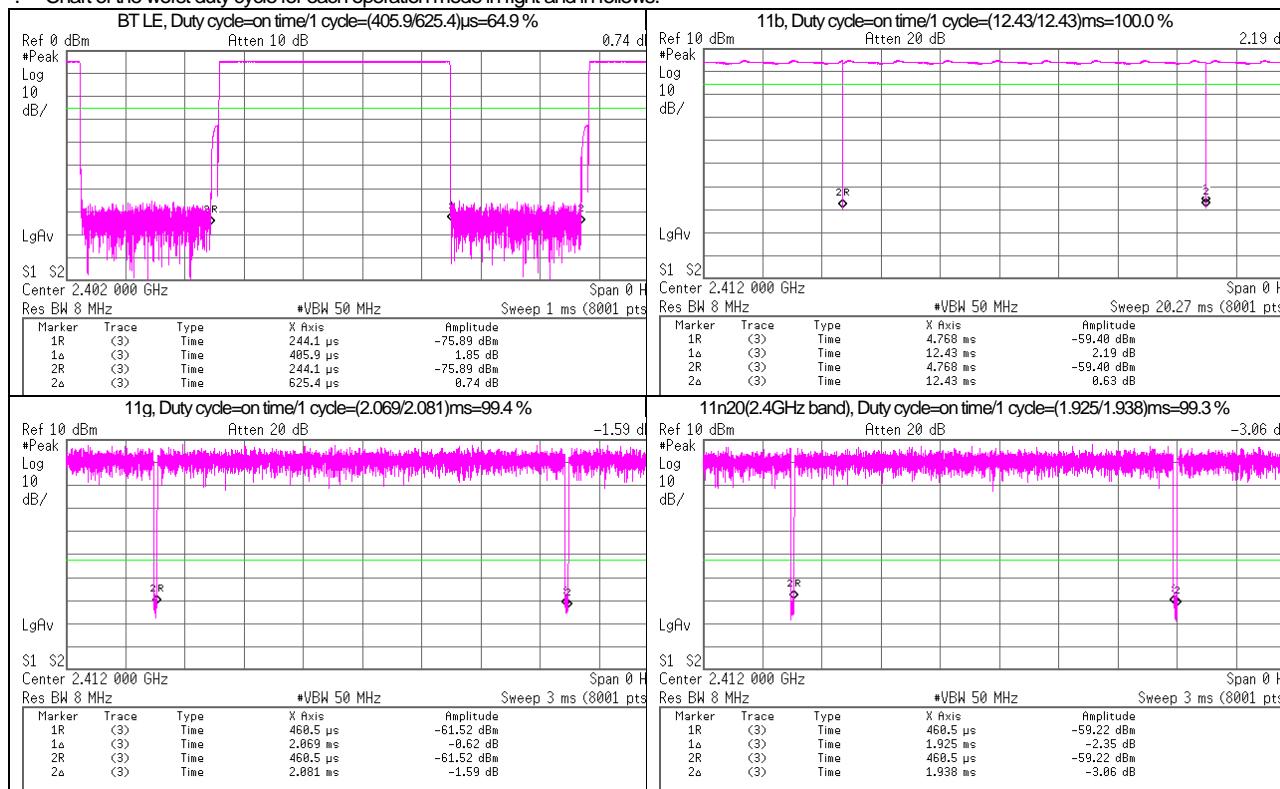
*. CH: Channel; Power spec.: Power specification; Max.: Maximum; Set pwr.: Setting power by tested software; Burst Ave.: Measured burst average power; Time Ave.: Measured time-based average power.

*. Calculating formula: Time average power (dBm) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)
Burst power (dBm) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)+(duty factor, dB)
Duty cycle: (duty cycle, %) = (Tx on time) / (1 cycle time) × 100, Duty factor (dBm) = 10 × log (100/(duty cycle, %))
Duty cycle scaled factor: Duty cycle correction factor for obtained SAR value, Duty scaled factor [-] = 100(%) / (duty cycle, %)
ΔMax. (Deviation from max.power, dB) = (Burst power measured (average, dBm)) - (Max.tune-up limit power (average, dBm))
Tune-up factor: Power tune-up factor for obtained SAR value, Tune-up factor [-] = 1 / (10 ^ ("Deviation from max., dB" / 10))

*. Date measured: February 5, 2024 / Measured by: H. Naka / Place: Preparation room of No. 7 shield room. (21 deg.C/ 31 %RH)

*. Uncertainty of antenna port conducted test; (±) 0.81 dB (Average power), (±) 0.27 % (duty cycle).

*. Chart of the worst duty cycle for each operation mode in right and in follows.



SECTION 6: Tissue simulating liquid

6.1 Liquid measurement

Frequency [MHz]	Liquid type	Liquid Temp. [deg.C]	Liquid depth of phantom [mm]	Liquid parameters									ΔSAR Coefficients (*a)			Date measured		
				Target value	Permittivity (ϵ_r) [-]			Conductivity [S/m]			Target value	Interpolated?			ΔSAR			
					Measured	Value	$\Delta\epsilon_r$ [%]	Limit [%]	Measured	Value		$\Delta\sigma$ [%]	Limit [%]	Δend, >48hrs.	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Yes	1g [%]	10g [%]
2450 (*2)	Head	22.5	150	39.2	39.11	-0.2	10	begin	1.80	1.840	2.2	10	begin	<input type="checkbox"/>	1.1	0.6	no	2024-04-11, before SAR test.
2402	Head			39.29	39.20	-0.2	10	begin	1.757	1.799	2.4	10	begin	<input type="checkbox"/>	1.2	0.7	no	
2412	Head			39.27	39.18	-0.2	10	begin	1.766	1.808	2.4	10	begin	<input type="checkbox"/>	1.2	0.7	no	
2437	Head			39.22	39.13	-0.2	10	begin	1.788	1.829	2.3	10	begin	<input type="checkbox"/>	1.2	0.6	no	
2440	Head			39.22	39.13	-0.2	10	begin	1.791	1.831	2.2	10	begin	<input type="checkbox"/>	1.1	0.6	no	
2462	Head			39.19	39.10	-0.2	10	begin	1.813	1.848	1.9	10	begin	<input type="checkbox"/>	1.0	0.5	no	
2480	Head			39.16	39.07	-0.2	10	begin	1.833	1.862	1.6	10	begin	<input type="checkbox"/>	0.8	0.4	no	

*1. "begin": SAR test has ended within 24 hours from the liquid parameter measurement, "< 48 hrs.". Since SAR test has ended within 48 hours (2 days) from the liquid parameter measurement and a change in the liquid temperature was within 1 degree, liquid parameters measured on first day were used on next day continuously. "value (%)": Since the SAR test series took longer than 48 hours, the liquid parameters were measured on every 48 hours period and on the date which was end of test series. Since the difference of liquid parameters between the beginning and next measurement was smaller than 5%, the liquid parameters measured in beginning were used until end of each test series.

Calculating formula: " $\Delta\text{end}(>48 \text{ hrs.}) (\%)$ " = $\{(\text{dielectric properties, end of test series}) / (\text{dielectric properties, beginning of test series}) - 1\} \times 100$

*2. This frequency was for system check.

*. The dielectric parameters were checked prior to assessment using the DAK-3.5 dielectric probe kit.

*. The target values refers to clause 6.2 of this report.

*a. The coefficients in below are parameters defined in IEEE Std.1528

(Calculating formula, 4 MHz-6 GHz): $\Delta\text{SAR}(1g) = C_{\epsilon_r} \times \Delta\epsilon_r + C_{\sigma} \times \Delta\sigma$, $C_{\epsilon_r} = 7.854E-4 \times f^3 + 9.402E-3 \times f^2 - 2.742E-2 \times f - 0.2026 / C_{\sigma} = 9.804E-3 \times f^3 - 8.661E-2 \times f^2 + 2.981E-2 \times f + 0.7829$

$\Delta\text{SAR}(10g) = C_{\epsilon_r} \times \Delta\epsilon_r + C_{\sigma} \times \Delta\sigma$, $C_{\epsilon_r} = 3.456 \times 10^{-3} \times f^3 - 3.531 \times 10^{-2} \times f^2 + 7.675 \times 10^{-2} \times f - 0.1860 / C_{\sigma} = 4.479 \times 10^{-3} \times f^3 - 3.1586 \times 10^{-2} \times f^2 - 0.1972 \times f + 0.7717$

Since the calculated ΔSAR values of the tested liquid had shown positive correction, the measured SAR was not converted by ΔSAR correction conservatively.

(Calculating formula): ΔSAR corrected SAR (W/kg) = (Measured SAR (W/kg)) $\times (100 - (\Delta\text{SAR}(\%))) / 100$

6.2 Target of tissue simulating liquid

Nominal dielectric values of the tissue simulating liquids in the phantom are listed in the following table. (Appendix A, KDB 865664 v01r04)

Target Frequency (MHz)	Head		Body		Target Frequency (MHz)	Head		Body	
	ϵ_r	$\sigma(\text{S/m})$	ϵ_r	$\sigma(\text{S/m})$		ϵ_r	$\sigma(\text{S/m})$	ϵ_r	$\sigma(\text{S/m})$
1800~2000	40.0	1.40	53.3	1.52	3000	38.5	2.40	52.0	2.73
2450	39.2	1.80	52.7	1.95	5800	35.3	5.27	48.2	6.00

* For other frequencies, the target nominal dielectric values shall be obtained by linear interpolation between the higher and lower tabulated figures.

v. 2000, vol. 48, no. 11, pp. 1988-1995.

6.3 Simulated tissue composition

Liquid type	Head	Control No.	SSLHV6-01	Model No. / Product No.	HBBL600-10000V6 / SL AAH U16 BC
Ingredient: Mixture [%]	Water: >77, Ethanol: <5.2, Sodium petroleum sulfonate: <2.9, Hexylene Glycol: <2.9, alkoxylated alcohol (>C ₁₆): <2.0				
Tolerance specification				± 10%	
Temperature gradients [% / deg.C]	permittivity: -0.19 / conductivity: -0.57 (at 2.6 GHz), permittivity: +0.31 / conductivity: -1.43 (at 5.5 GHz) (*)				
Manufacture	Schmid & Partner Engineering AG	Note: *. speag_920-SLAxxy-E_1.12.15CL (Maintenance of tissue simulating liquid)			

SECTION 7: Measurement results

7.1 Measurement results

Test setup		Mode and Frequency		Duty cycle		Power correction			SAR results [W/kg] (Max.value of multi-peak)					SAR plot # in Appx. 2	Setup photo# in Appx. 1-3	Memo	
Test position	Gap [mm]	Mode (D/R)	[MHz]	CH	Duty [%]	Duty scaled factor	Max. tune-up limit [dBm]	Measured conducted [dBm]	Power scaled (tune-up) factor	Measured SAR	ΔSAR [%]	ΔSAR corrected	Reported SAR (*b)	SAR type	Limit		
Mark with ^{***} is the initial mod																	
Front-Left	0	11b (1Mbps)	2412	1	100	1.00	12	10.78	1.32	0.330	Positive	N/A(*a)	0.436	1g	1.6	-	P1
Front-Left	0	11b (1Mbps)	2437	6	100	1.00	12	10.68	1.36	0.303	Positive	N/A(*a)	0.412	1g	1.6	-	P1
Front-Left	0	11b (1Mbps)	2462*	11	100	1.00	12	10.55	1.40	0.349	Positive	N/A(*a)	0.489	1g	1.6	1	P1
Left	0	11b (1Mbps)	2412	1	100	1.00	12	10.78	1.32	0.118	Positive	N/A(*a)	0.156	1g	1.6	-	P2
Left	0	11b (1Mbps)	2437	6	100	1.00	12	10.68	1.36	0.134	Positive	N/A(*a)	0.182	1g	1.6	-	P2
Left	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.134	Positive	N/A(*a)	0.188	1g	1.6	-	P2
Bottom	0	11b (1Mbps)	2412	1	100	1.00	12	10.78	1.32	0.023	Positive	N/A(*a)	0.030	1g	1.6	-	P3
Bottom	0	11b (1Mbps)	2437	6	100	1.00	12	10.68	1.36	0.023	Positive	N/A(*a)	0.031	1g	1.6	-	P3
Bottom	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.026	Positive	N/A(*a)	0.036	1g	1.6	-	P3
Right	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.004	Positive	N/A(*a)	0.006	1g	1.6	-	P4
Front	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.017	Positive	N/A(*a)	0.024	1g	1.6	-	P5
Top	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.010	Positive	N/A(*a)	0.014	1g	1.6	-	P6
Rear	0	11b (1Mbps)	2462	11	100	1.00	12	10.55	1.40	0.004	Positive	N/A(*a)	0.006	1g	1.6	-	P7
Front-Left	0	BT LE (1Mbps)	2402	0	64.9	1.54	9	7.12	1.54	0.061	Positive	N/A(*a)	0.145	1g	1.6	-	P1
Front-Left	0	BT LE (1Mbps)	2440	19	64.9	1.54	9	7.07	1.56	0.076	Positive	N/A(*a)	0.183	1g	1.6	-	P1
Front-Left	0	BT LE (1Mbps)	2480	39	64.9	1.54	9	7.19	1.52	0.080	Positive	N/A(*a)	0.187	1g	1.6	-	P1

*. The highest Reported (scaled) SARs are marked with yellow marker (xxx), respectively.

*. ANT: Antenna, Appx. Appendix, Max.: maximum.; n/a: not applied. Gap: It is the separation distance between the host platform surface and the bottom outer surface of phantom.

*. Before SAR test, the battery of host device was full charged.

*. During SAR test, the radiated power is always monitored by Spectrum Analyzer.

*. (KDB 248227 D01) 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 of OFDM mode was reduced.

OFDM mode	Maximum tune-up tolerance limit			OFDM scaled factor [-] (b)/(a)×100	DSSS worst reported SAR (1g) value		Estimated SAR value: OFDM [W/kg]	Exclusion limit [W/kg]	Standalone SAR test of OFDM mode require?		
	DSSS [dBm]	OFDM [dBm]	OFDM [mW] (a)		OFDM [mW] (b)	(b)/(a)×100	Setup	[W/kg]			
11g	12	15.8	12	15.8	1.00		Front-left	0.489	0.489	≤ 1.2	No
11n20	12	15.8	12	15.8	1.00		Front-left	0.489	0.489	≤ 1.2	No

a. Since the calculated ΔSAR values of the tested liquid had shown positive correction, the measured SAR was not converted by ΔSAR correction.

Calculating formula: $\Delta\text{SAR} \text{ corrected SAR (W/kg)} = (\text{Measured SAR (W/kg)}) \times (100 - (\Delta\text{SAR}(\%))) / 100$

b. Calculating formula: $\text{Reported (Scaled) SAR (W/kg)} = (\text{Measured SAR (W/kg)}) \times (\text{Duty scaled factor}) \times (\text{Power scaled factor})$

where, Duty scaled factor [-] = $100\% / (\text{measured duty cycle, \%})$, Power scaled factor [-] = $10^{((\text{Max.tune-up limit power, dBm}) - (\text{Measured conducted power, dBm})) / 10)}$

c. Calibration frequency of the SAR measurement probe (and used conversion factors for each frequency.)

The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

Liquid	SAR test frequency	Probe calibration frequency	Validity	Conversion factor	Uncertainty
Head	(2402, 2412, 2437, 2440, 2462, 2480) MHz	2450 MHz	within ± 50 MHz of calibration frequency	6.83, 7.07, 6.68	$\pm 12.0\%$

7.2 Simultaneous transmission evaluation

Result: Simultaneous transmission is not existed on this host device alone. (*1)

*1. WLAN and Bluetooth use same antenna. Therefore, simultaneously transmission (WLAN+BT) of IM036 alone is not existed.

7.3 Measurement Variability (Repeated measurement requirement)

Result: Since all the measured SAR are less than 0.8 W/kg (SAR(1g)), the repeated measurement is not required.

7.4 Device holder (D/H) perturbation verification (SAR)

Result: Since all the reported (scaled) SAR are less than 1.2 W/kg (SAR(1g)), the additional “device holder perturbation verification” measurement is not considered.

7.5 Requirements on the Uncertainty Evaluation

Decision Rule

Uncertainty is not included.
 Uncertainty is included.

*: The highest measured SAR(1g) is less than 1.5 W/kg and the highest measured SAR(10g) is less than 3.75 W/kg. Therefore, per KDB Publication 865664 DO1, the extended measurement uncertainty analysis described in IEEE 1528 is not required.

APPENDIX 2: Measurement data

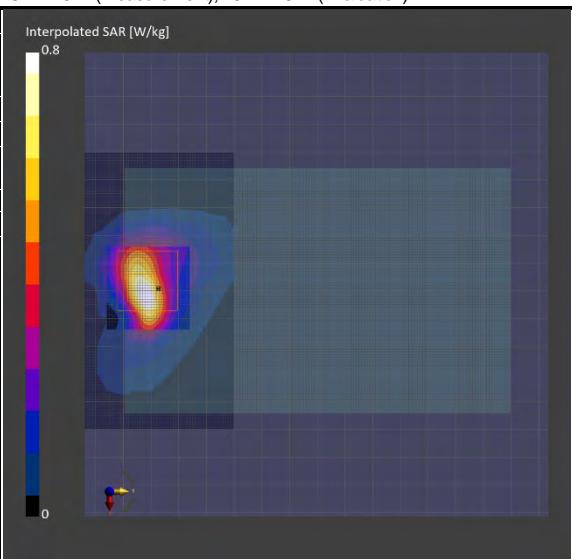
Appendix 2-1: Plot(s) of Worst Reported Value

Plot 1: SAR1g) Fron-Left, 11b(1Mbps), 2462 MHz

EUT: Wireless LAN/Bluetooth Module (in Digital Camera) ; Model: S0123-WIFI (Camera: IM036); Serial:SS2D070111YN (Camera: PP1-148)
Mode: 11b(1Mbps)(UID: 0 (CW)) ; Frequency: 2462 MHz ; Test Distance: 0.00 mm
TSL parameters used: Head(v6) ; f= 2462 MHz; Conductivity: 1.848 S/m; Permittivity: 39.10

DASY8 Configuration: - Electronics: DAE4 - SN626 (Calibrated: 2024-01-09) / - Phantom: ELI V8.0 (20deg probe tilt) ; Serial: 2161 ; Phantom section: Flat - Probe: EX3DV4 - SN3907(Calibrated: 2024-01-15); ConvF: (6.83, 7.07, 6.68) / - Software: 16.2.4.2524 (Measurement); 16.2.4.2524 (Evaluation)

Scan Setup		Measurement Results			
Setup items	Area Scan	Zoom Scan	Meas. Items	Area Scan	Zoom Scan
Grid Extents [mm]	100.0x60.0	30.0x 30.0 x30.0	psSAR 1g [W/kg]	0.344	0.349
Grid Steps [mm]	10.0x10.0	5.0x 5.0 x1.5	psSAR 10g [W/kg]	0.156	0.156
Sensor Surface [mm]	3.0	1.4	Power Drift [dB]	-0.00	-0.02
Graded Grid	N/A	Yes	Power Scaling	Disabled	Disabled
Grading Ratio	N/A	1.5	Scaling Factor [dB]	N/A	N/A
MAIA monitored	Y	Y	TSL Correction	No correction	No correction
Surface Detection	VMS + 6p	VMS + 6p	M2/M1 [%]	N/A	75.9
Scan Method	Measured	Measured	Dist 3dB Peak [mm]	N/A	6.5



Remarks: *. Date tested: 2024-04-11; Tested by: Hiroshi Naka; Tested place: No.7 shielded room; Ambient: 22.4 deg.C. / 76 %RH; Liquid depth: 150 mm;
*. Liquid temperature: 22.0 deg.C. \pm 0.5 deg.C. (22.0 deg.C., in check); *. Red cubic: big=SAR(10g) / small=SAR(1g)
*. Project file name: Measurement Group: 15096569_240404_s0123+dc_om-dig.d8sar-4/11-3,11b,2462,front-left

APPENDIX 3: Test instruments

Appendix 3-1: Equipment used

Test Name	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Interval (Month)
AT	191844	Thermo-Hygrometer	CUSTOM, Inc	CTH-201	-	2023/08/03	12
AT	169910	Power Meter	Keysight Technologies Inc	8990B	MY51000448	2023/09/28	12
AT	169911	Power sensor	Keysight Technologies Inc	N1923A	MY57270004	2023/09/28	12
AT	145137	Attenuator	Keysight Technologies Inc	8493C-010	74865	2023/10/11	12
AT	160899	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46185516	2024/02/07	12
AT	145175	Coaxial Cable	Suher	SUCOFLEX 102	31600/2	2023/12/08	12

*. AT was measured 2024-02-05. (Refer to Section 5 in this report.)

Test Name	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Interval (Month)
SAR	224031	DASY8 Module SAR/APD soft	Schmid & Partner Engineering AG	ver.16.2.4.2524	9-2506F07D	-	-
SAR	144886	Dielectric assessment kit soft	Schmid & Partner Engineering AG	DAK ver.3.0.6.14	9-0EE103A4	-	-
SAR	224020	DASY8 PC	Hewlett Packard	HP Z4 G4 Workstation	CZC1198G21	-	-
SAR	225155	Mounting Platform	Schmid & Partner Engineering AG	MP8E-TX2-60L Basic	-	-	-
SAR	224032	6-axis Robot	Schmid & Partner Engineering AG	TX2-60L spe	F/22/0033789/A/001	2023/08/29	12
SAR	224023	Robot Controller	Schmid & Partner Engineering AG	CS9spe-TX2-60	F/22/0033789/C/001	-	-
SAR	224025	Measurement Server	Schmid & Partner Engineering AG	DASY8 Measurement Server	10042	2024/02/01	12
SAR	224026	Electro-Optical Converter	Schmid & Partner Engineering AG	EOC8-60	1027	-	-
SAR	224027	Light Beam Unit	Schmid & Partner Engineering AG	LIGHTBEAM-85	2069	-	-
SAR	227155	SP2 Manual Control Pendant	Schmid & Partner Engineering AG	D21144507 C	22066839	-	-
SAR	144944	Data Acquisition Electronics	Schmid & Partner Engineering AG	DAE4	626	2024/01/09	12
SAR	146235	Dosimetric E-Field Probe	Schmid & Partner Engineering AG	EX3DV4	3907	2024/01/15	12
SAR	224034	Flat Phantom	Schmid & Partner Engineering AG	ELI V8.0	2161	2023/08/21	12
SAR	145596	Device holder	Schmid & Partner Engineering AG	Mounting device for transmitter	-	2023/08/29	12
SAR	224028	Modulation & Audio Interference Analyzer	Schmid & Partner Engineering AG	MAIA	1582	-	-
SAR	145090	Dipole Antenna	Schmid & Partner Engineering AG	D2450V2	822	2024/01/05	12
SAR	230872	RF Power Source	Schmid & Partner Engineering AG	POWERSOURCE1	4300	2024/01/03	12
SAR	145500	Dielectric probe	Schmid & Partner Engineering AG	DAK3.5	1129	2024/01/16	12
SAR	146258	Network Analyzer	Keysight Technologies Inc	3753ES	US39171777	2023/10/05	12
SAR	145106	Ruler(150mm,L)	SHINWA	12103	-	2024/02/26	12
SAR	145086	Ruler(300mm)	SHINWA	13134	-	2024/02/26	12
SAR	145087	Ruler(100x50mm,L)	SHINWA	12101	-	2024/02/26	12
SAR	150560	Ruler(150mm)	SHINWA	14001	-	2024/02/26	12
SAR	144986	Thermo-Hygrometer data logger	SATO KEIRYOKI	SK-L200THIIa/SK-LTHIIa-2	015246/08169	2023/08/04	12
SAR	201967	Digital thermometer	HANNA	Checktemp-4	A01440226111	2023/08/04	12
SAR	201968	Digital thermometer	HANNA	Checktemp-4	A01310946111	2023/08/04	12
SAR	191844	Thermo-Hygrometer	CUSTOM, Inc	CTH-201	-	2023/08/03	12
SAR	146176	Spectrum Analyzer	ADVANTEST	R3272	101100994	-	-
SAR	146185	DI water	MonotaRo	34557433	-	-	-
SAR	146112	Primepure Ethanol	Kanto Chemical Co, Inc.	14032-79	-	-	-
SAR	207714	Head Tissue Simulating Liquid	Schmid & Partner Engineering AG	HBBL600-10000V/6	SL AAH U16 BC	-	-

*. SAR test was performed 2024-04-11.

The expiration date of calibration is the end of the expired month.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chain of calibrations.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

*. Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.

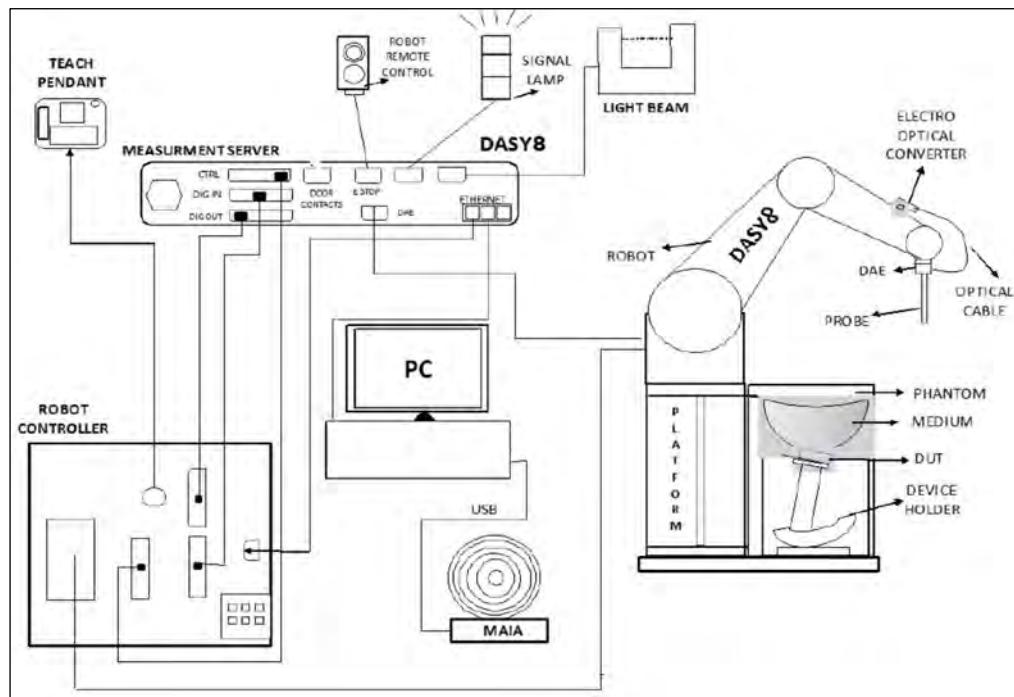
[Test Item] SAR: Specific Absorption Rate, AT: Antenna terminal conducted power

*. LIMSID: 146112, the parameters of primepure Ethanol (as reference liquid) used for the simulated tissue parameter confirmation was defined the NPL Report MAT23 (<http://www.npl.co.uk/content/copublication/4295>)

Appendix 3-2: Measurement System

Appendix 3-2-1: SAR Measurement System

These measurements were performed with the automated near-field scanning system DASY8 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot, which positions the probes with a positional repeatability of better than ± 0.03 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the dosimetry probes EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.



The DASY8 SAR/APD system for performing compliance tests consist of the following items:

- 6-axis robotic arm (Stäubli TX2-60L) for positioning the probe
- Mounting Platform for keeping the phantoms at a fixed location relative to the robot
- Measurement Server for handling all time-critical tasks, such as measurement data acquisition and supervision of safety features
- EOC (Electrical to Optical Converter) for converting the optical signal from the DAE to electrical before being transmitted to the measurement server
- LB (Light-Beam unit) for probe alignment (measurement of the exact probe length and eccentricity)
- SAR probe (EX3DV4 probes) for measuring the E-field distribution in the phantom. The SAR distribution and the psSAR (peak spatial averaged SAR) are derived from the E-field measurement.
- SAR phantom that represents a physical model with an equivalent human anatomy. A Specific Anthropomorphic Mannequin (SAM) head is usually used for handheld devices, and a Flat phantom is used for body-worn devices.
- TSL (Tissue Simulating Liquid) representing the dielectric properties of used tissue, e.g. Head Simulating Liquid, HSL.
- DAE (Data Acquisition Electronics) for reading the probe voltages and transmitting it to the DASY8 PC.
- Device Holder for positioning the DUT beneath the phantom.
- MAIA (Modulation and Interference Analyzer) for confirming the accuracy of the probe linearization parameters
- Operator PC for running the DASY8 software to define/execute the measurements
- System validation kits for system check/validation purposes.

Platforms

The platform is a multi-phantom support structure made of a wood and epoxy composite ($\epsilon = 3.3$ and loss tangent $\delta < 0.07$). It is a strong and rigid structure transparent to electric and magnetic fields (nonmetallic components).

TX2-60L robot, CS9 robot controller

•Number of Axes : 6 •Repeatability : ± 0.03 mm •Manufacture : Stäubli

DASY8 Measurement server

The DASY8 Measurement Server handles all time critical tasks such as acquisition of measurement data, detection of phantom surface, control of robot movements, supervision of safety features.
•Manufacture : Schmid & Partner Engineering AG

Data Acquisition Electronic (DAE)

The DAE is used to acquire the probe sensor voltages and transfer them to the DASY8 Measurement Server, and to report mechanical surface detection and probe collisions. The DAE consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter, and a command decoder with a control logic unit. Transmission to the DASY8 Measurement Server is accomplished through an optical downlink for data and status information and an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts used for mechanical surface detection and probe collision detection.

•Measurement Range : 1 μ V to > 200 mV (2 range settings: 4 mV (low), 400 mV (high))
•Input Offset voltage : < 1 μ V (with auto zero) •Input Resistance : 200 M Ω
•Battery operation : > 10 hrs. (with two rechargeable 9 V battery)
•Manufacture : Schmid & Partner Engineering AG

Electro-Optical Converter (EOC8-TX2-60L)

The Electrical to Optical Converter (EOC8) supports as data exchange between the DAE and the measurement server (optical connector) and data acquisition based on Ethernet protocol.
•Manufacture : Schmid & Partner Engineering AG



Light Beam Switch

The light beam unit allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm, as well as the probe length and the horizontal probe offset, are measured. The software then corrects all movements within the measurement jobs, such that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

•Manufacture : Schmid & Partner Engineering AG



SAR measurement software

•Software version : Refer to Appendix 3-1 (Equipment used) •Manufacture : Schmid & Partner Engineering AG

E-Field Probe

•Model : EX3DV4 •Frequency : 4 MHz to 10 GHz, Linearity: ± 0.2 dB (30 MHz to 10 GHz)
•Construction : Symmetrical design with triangular core, Built-in shielding against static charges, PEEK enclosure material (resistant to organic solvents, e.g., DGBE).
•CF : Refer to calibration data of Appendix. (CF: Conversion Factors)
•Directivity : ± 0.1 dB in TSL (rotation around probe axis) / ± 0.3 dB in TSL (rotation normal to probe axis)
•Dynamic Range : 10 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 μ W/g)
•Dimension : Overall length: 330 mm (Tip: 20 mm) / Tip diameter: 2.5 mm (Body: 12 mm)
Typical distance from probe tip to dipole centers: 1mm
•Application : High precision dosimetric measurement in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6GHz with precision of better 30%.
•Manufacture : Schmid & Partner Engineering AG



ELI Phantom

The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices in the frequency range of 4 MHz to 10 GHz. ELI is fully compatible with the IEC/IEEE 62209-1528 standard and all known tissue simulating liquids.

ELI V8.0 phantom shell has optimized pretension in the bottom surface during production, such that the phantom is more robust and with reduced sagging.

•Model Number : ELI V8.0 flat phantom •Shell Material : Vinyl ester, fiberglass reinforced (VE-GF)
•Shell Thickness : 2.0 ± 0.2 mm (bottom plate) •Dimensions : 600 mm \times 400 mm (oval) (volume: Approx. 30 liters)
•Manufacture : Schmid & Partner Engineering AG



Device Holder, Laptop holder, support material

Accurate device positioning is crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards. The device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles. The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

- Device holder: In combination with the ELI phantom, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Transmitter devices can be easily and accurately positioned. The low-loss dielectric urethane foam was used for the mounting section of device holder.
- Material : Polyoxymethylene (POM) •Manufacture: Schmid & Partner Engineering AG
- Laptop holder: A simple but effective and easy-to-use extension for the Mounting Device; facilitates testing of larger devices (e.g., laptops, cameras, etc.) according to IEC 62209-2.
- Material : Polyoxymethylene (POM), PET-G, Foam•Manufacture: Schmid & Partner Engineering AG
- Support form: Urethane foam



Data storage and evaluation (post processing)

The uplink signal transmitted by the DUT is measured inside the TSL by the probe, which is accurately positioned at a precisely known distance and with a normal orientation with respect to the phantom surface. The dipole / loop sensors at the probe tips pick up the signal and generate a voltage, which is measured by the voltmeter inside the DAE. The DAE returns digital values, which are converted to an optical signal and transmitted via the EOC to the measurement server. The data is finally transferred to the DASY8 software for further post processing. In addition, the DASY8 software periodically requests a measurement with short-circuited inputs from the DAE to compensate the amplifier offset and drift. This procedure is called DAE zeroing.

The operator has access to the following low level measurement settings:

- the integration time is the voltage acquisition time at each measurement point. It is typically 0.5 s.
- the zeroing period indicates how often the DAE zeroing is performed.

In parallel, the MAIA measures the characteristics of the uplink signal via the air interface and sends this information to the DASY8 software, which compares them to the communication system defined by the operator. A warning is issued if any difference is detected.

The measurement data is now acquired and can be post processed to compute the psSAR1g /8g/10g.

The measured voltages are not directly proportional to SAR and must be linearized. The formulas below are based on [1] (*1).

The measured voltage is first linearized using the (a, b, c, d) set of parameters specific to the communication system and sensor:

$$V_{compi} = U_i + U_i^2 \cdot \frac{10^{10}}{d_{cp_i}}$$

with	V_{compi}	= compensated voltage of channel i (μ V)	$(i = x,y,z)$
	U_i	= input voltage of channel i (μ V)	$(i = x,y,z)$
	d	= PMR factor d (dB)	(Probe parameter)
	d_{cp_i}	= diode compression point of channel i (μ V)	(Probe parameter, $i = x,y,z$)

$$V_{compi\ dB\sqrt{\mu V}} = 10 \cdot \log_{10}(V_{compi})$$

$$corr_i = a_i \cdot e^{-\frac{b_i - 10 \log_{10}(V_{compi})}{c_i}}$$

with	$corr_i$	= correction factor of channel i (dB)	$(i = x,y,z)$
	$V_{compi\ dB\sqrt{\mu V}}$	= compensated voltage of channel i ($\text{dB}\sqrt{\mu V}$)	$(i = x,y,z)$
	a_i	= PMR factor a of channel i (dB)	(Probe parameter, $i = x,y,z$)
	b_i	= PMR factor b of channel i ($\text{dB}\sqrt{\mu V}$)	(Probe parameter, $i = x,y,z$)
	c_i	= PMR factor c of channel i (-)	(Probe parameter, $i = x,y,z$)

The voltage $V_{i\ dB\sqrt{\mu V}}$ is the linearized voltage in $\text{dB}\sqrt{\mu V}$:

$$V_{i\ dB\sqrt{\mu V}} = V_{compi\ dB\sqrt{\mu V}} - corr_i$$

with	$V_{i\ dB\sqrt{\mu V}}$	= linearized voltage of channel i ($\text{dB}\sqrt{\mu V}$)	$(i = x,y,z)$
	$V_{compi\ dB\sqrt{\mu V}}$	= compensated voltage of channel i ($\text{dB}\sqrt{\mu V}$)	$(i = x,y,z)$
	$Corr_i$	= PMR factor a of channel i (dB)	$(i = x,y,z)$

Finally, the linearized voltage is converted in μ V:

$$V_i = 10^{\frac{V_{i\ dB\sqrt{\mu V}}}{10}}$$

with	V_i	= linearized voltage of channel i (μ V)	$(i = x,y,z)$
	$V_{compi\ dB\sqrt{\mu V}}$	= linearized voltage of channel i ($\text{dB}\sqrt{\mu V}$)	$(i = x,y,z)$

The Field data for each channel are calculated using the linearized voltage:

$$\text{E-fieldprobes: } E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with	V_i	= linearized voltage of channel i in μ V	$(i = x,y,z)$
	$Norm_i$	= sensor sensitivity of channel i in μ V/(V/m)2 for E-field Probes	$(i = x,y,z)$
	$ConvF$	= sensitivity enhancement in solution	
	E_i	= electric field strength of channel i in V/m	$(i = x,y,z)$

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

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The E-field data value is used to calculate SAR :

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with	SAR	= local specific absorption rate in mW/g
	E_{tot}	= total field strength in V/m
	σ	= conductivity in [Ω/m] or [S/m]
	ρ	= equivalent tissue density in g/cm^3

Note: The resulting linearized voltage is only approximated because the probe UID is used 0 (CW) for the test signal in this test report.

(*1) [1] Jagadish Nadakuduti, Sven Kuehn, Marcel Fehr, Mark Douglas Katja Pokovic and Niels Kuster, "The Effect of Diode Response of electromagnetic Field Probes for the Measurements of Complex Signals." IEEE Transactions on Electromagnetic Compatibility, vol. 54, pp. 1195–1204, Dec. 2012.

Appendix 3-2-2: SAR system check results

*. Prior to the SAR assessment of EUT, the Daily check was performed to test whether the SAR system was operating within its target of $\pm 10\%$. The Daily check results are in the table below.

Daily check results (*. Abbreviations: F: Frequency, Meas.: Measured, Cal.: Calibration value, STD: Standard value, Dev.: Deviation)																					
Liquid type: Head	F [MHz]	Δ SAR		Pin [dBm]	SAR (1g) [W/kg] (*b)				SAR (10g) [W/kg] (*b)				Meas. (°c)	1W scaled	Target (°c)	Deviation [%]	Meas. (°c)	1W scaled	Target (°c)	Deviation [%]	Dev. Limit [%]
		1g [%]	10g [%]		Meas. (*a)	1W scaled	Cal. (°d)	STD [%]	Cal. (°d)	STD [%]	Cal. (°c)	STD [%]									
2024-04-11	2450	1.1	0.6	17.01	2.61	51.38	53.4	52.4	3.8	-1.9	1.22	24.15	25	24	-3.4	0.6	≤ 10				

*a. The Measured SAR/ value is obtained at 17 dBm setting of POWER SOURCE1 (LIMS ID#230872, S/N: 4300) calibrated by Schmid & Partner Engineering AG, the data sheet was filed in this report.

*b. The measured SAR value of Daily check was compensated for tissue dielectric deviations (Δ SAR) and scaled to 1W of output power in order to compare with the manufacturer's calibration target value which was normalized.

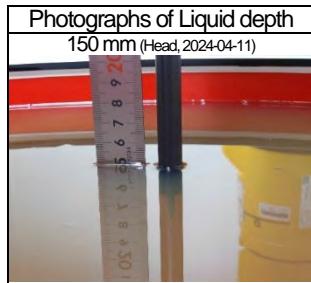
$$\Delta\text{SAR} \text{ corrected SAR (1g) (W/kg)} = (\text{Measured SAR(1g) (W/kg)}) \times (100 - (\Delta\text{SAR1g}(\%))) / 100$$

$$\Delta\text{SAR} \text{ corrected SAR (10g,8g) (W/kg)} = (\text{Measured SAR(10g,8g) (W/kg)}) \times (100 - (\Delta\text{SAR10g}(\%))) / 100$$

*c. The target value is a parameter defined in the calibration data sheet of D2450V2 (sn:822) dipole antenna calibrated by Schmid & Partner Engineering AG, the data sheet was filed in this report.

*d. The target value (normalized to 1W) is defined in IEEE Std.1528.

Appendix 3-2-3: SAR system check measurement data

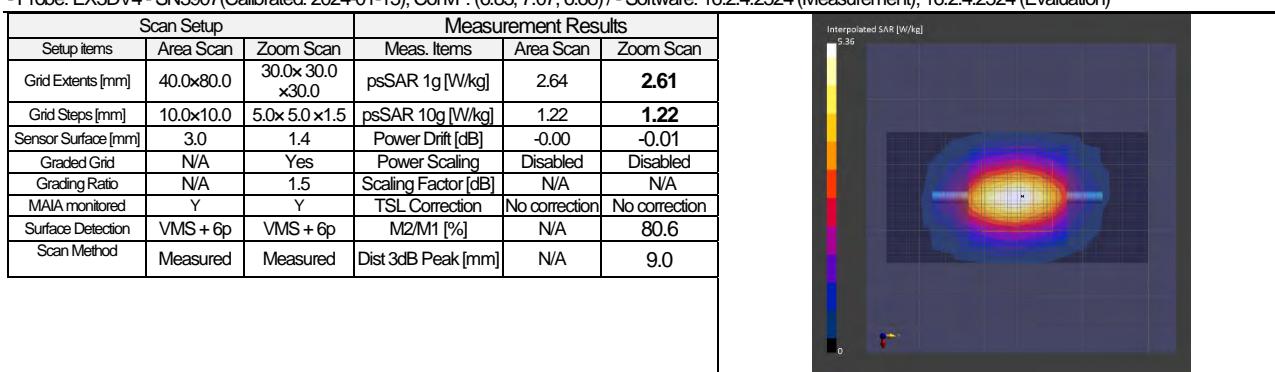


EUT: Dipole(2.4GHz) ; Model: D2450V2 ; Serial: 822; Input power: 17 dBm setting of PS1

Mode: CW (UID: 0 (CW)) ; Frequency: 2450.0MHz ; Test Distance: 10 mm

TSL parameters used: Head(v6) ; f= 2450 MHz; Conductivity: 1.840 S/m; Permittivity: 39.11

DASY8 Configuration: - Electronics: DAE4 - SN626 (Calibrated: 2024-01-09) / - Phantom: ELI V8.0 (20deg probe tilt) ; Serial: 2161 ; Phantom section: Flat - Probe: EX3DV4 - SN3907 (Calibrated: 2024-01-15); ConvF: (6.83, 7.07, 6.68) / - Software: 16.2.4.2524 (Measurement); 16.2.4.2524 (Evaluation)



Remarks: *. Date tested: 2024-04-11; Tested by: Hiroshi Naka; Tested place: No.7 shielded room; Ambient: 21.6 deg.C. / 70 %RH; Liquid depth: 150 mm;

*. Liquid temperature: 22.0 deg.C. \pm 0.5 deg.C. (22.0 deg.C., in check); *. Red cubic: big=SAR(10g) / small=SAR(1g)

*. Project file name-Measurement Group: 15096569_240404_s0123+dc_om-dig.d8sar-4/11,daily,2.45g

Appendix 3-3: Measurement Uncertainty

Uncertainty of SAR measurement (2.4 GHz ~ 6 GHz) (* liquid: head(v6), DAK-3.5, Wi-Fi(BT) (v11r05))							1g SAR	10g SAR
Symbol	Error Description	Uncertainty (Unc.)	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g) (Std. Unc.)	ui (10g) (Std. Unc.)
Measurement System (DASY8)								
CF	Probe Calibration (EX3DV4) (*.HSL-10%)	± 14.0 %	Normal	2	1	1	± 7.0 %	± 7.0 %
CFdrift	Probe Calibration Drift	± 1.7 %	Rectangular	√3	1	1	± 1.0 %	± 1.0 %
LIN	Probe Linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
BBS	Broadband Signal	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
ISO1	Probe Isotropy	± 7.6 %	Rectangular	√3	1	1	± 4.4 %	± 4.4 %
DAE	Data Acquisition	± 1.2 %	Normal	1	1	1	± 1.2 %	± 1.2 %
AMB	RF Ambient (noise&refraction) (< 12uW/g)	± 1.0 %	Normal	1	1	1	± 1.0 %	± 1.0 %
Δsys	Probe Positioning	± 0.5 %	Normal	1	0.33	0.33	± 0.2 %	± 0.2 %
DAT	Data Processing	± 2.3 %	Normal	1	1	1	± 2.3 %	± 2.3 %
Phantom and Device Error								
LIQ(σ)	Conductivity (measured) (DAK-3.5)	± 5.0 %	Normal	2	0.78	0.71	± 2.0 %	± 1.8 %
LIQ(T ₀)	Conductivity (temperature) (≤ 2 deg.C.)	± 2.4 %	Rectangular	√3	0.78	0.71	± 1.1 %	± 1.0 %
EPS	Phantom Permittivity (liquid to antenna: ≥ 5 mm)	± 14.0 %	Rectangular	√3	0.25	0.25	± 2.0 %	± 2.0 %
DIS	Distance EUT-TSL	± 2.7 %	Normal	1	2	2	± 5.4 %	± 5.4 %
Dxyz	Test Sample positioning	± 1.8 %	Normal	1	1	1	± 5.0 %	± 5.0 %
H	Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %
MOD	EUT Modulation	± 2.4 %	Rectangular	√3	1	1	± 1.4 %	± 1.4 %
TAS	Time-average SAR	± 0.0 %	Rectangular	√3	1	1	± 0.0 %	± 0.0 %
RFdrift	Drift of output power (measured, < 0.2 dB)	± 4.7 %	Normal	2	1	1	± 2.4 %	± 2.4 %
Correction to the SAR results								
C(e,σ)	Deviation to Target (e,σ: ≤ 10 %, IEC head)	± 1.9 %	Normal	1	1	0.84	± 1.9 %	± 1.6 %
C(R)	SAR Scaling	± 0 %	Rectangular	√3	1	1	± 0.0 %	± 0.0 %
u(ΔSAR)	(SAR: 2.4 GHz-6 GHz) Combined Standard Uncertainty						RSS	± 12.3 %
U	(SAR: 2.4 GHz-6 GHz) Expanded Uncertainty						k=2	± 24.6 %

*: This uncertainty budget is suggested by IEC/IEEE 62209-1528 and determined by SPEAG, DASY8 Module SAR Manual, 2022-08 (Chapter 6.3, DASY8 Uncertainty Budget for Hand-held/Body-worn Devices, Frequency band: 300 MHz - 3 GHz range and 3 GHz – 6 GHz range). All listed error components have v_{eff} equal to ∞ .

Uncertainty of SAR daily check (2.4 GHz ~ 6 GHz) (* liquid: head(v6), DAK-3.5, CW) (v11r05)							1g SAR	10g SAR
Symbol	Error Description	Uncertainty (Unc.)	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g) (Std. Unc.)	ui (10g) (Std. Unc.)
Measurement System (DASY8)								
CF	Probe Calibration (EX3DV4) (*.HSL-5%)	± 14.0 %	Normal	2	1	1	± 7.0 %	± 7.0 %
CFdrift	Probe Calibration Drift	± 1.7 %	Rectangular	√3	1	1	± 1.0 %	± 1.0 %
LIN	Probe Linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
ISO2	Probe Isotropy	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
DAE	Data Acquisition	± 1.2 %	Normal	1	1	1	± 1.2 %	± 1.2 %
AMB	RF Ambient (noise&refraction) (< 12uW/g)	± 1.0 %	Normal	1	1	1	± 1.0 %	± 1.0 %
Δsys	Probe Positioning	± 0.5 %	Normal	1	0.33	0.33	± 0.2 %	± 0.2 %
DAT	Data Processing	± 2.3 %	Normal	1	1	1	± 2.3 %	± 2.3 %
Phantom and Device Error								
LIQ(σ)	Conductivity (measured) (DAK-3.5)	± 5.0 %	Normal	2	0.78	0.71	± 2.0 %	± 1.8 %
LIQ(T ₀)	Conductivity (temperature) (≤ 2 deg.C.)	± 2.4 %	Rectangular	√3	0.78	0.71	± 1.1 %	± 1.0 %
EPS	Phantom Permittivity (liquid to antenna: ≥ 5 mm)	± 14.0 %	Rectangular	√3	0.25	0.25	± 2.0 %	± 2.0 %
VAL	Validation antenna uncertainty	± 5.5 %	Rectangular	√3	1	1	± 3.2 %	± 3.2 %
Pin	Uncertainty in accepted power	± 2.5 %	Normal	2	1	1	± 1.3 %	± 1.3 %
DIS	Distance EUT-TSL	± 2.0 %	Normal	1	2	2	± 4.0 %	± 4.0 %
Dxyz	Test Sample positioning	± 1.0 %	Normal	1	1	1	± 1.0 %	± 1.0 %
RFdrift	Drift of output power (measured, < 0.1 dB)	± 2.3 %	Rectangular	√3	1	1	± 1.3 %	± 1.3 %
Correction to the SAR results								
C(e,σ)	Deviation to Target (e,σ: ≤ 10 %, IEC head)	± 1.9 %	Normal	1	1	0.84	± 1.9 %	± 1.6 %
u(ΔSAR)	(SAR daily check: 2.4 GHz-6 GHz) Combined Standard Uncertainty						RSS	± 10.8 %
U	(SAR daily check: 2.4 GHz-6 GHz) Expanded Uncertainty						k=2	± 21.6 %

*: This uncertainty budget is suggested by IEC/IEEE 62209-1528:2020 and determined by SPEAG, DASY8 Module SAR Manual, 2022-08 (Chapter 6.2, DASY8 Uncertainty Budget for System Verification, Frequency band: 300 MHz - 6 GHz range). All listed error components have v_{eff} equal to ∞ .

- *: Table of uncertainties are listed for ISO/IEC 17025.
- *: Although this standard determines only the limit value of uncertainty, there is no applicable rule of uncertainty in this. Therefore, the results are derived depending on whether or not laboratory uncertainty is applied.

Appendix 3-4: Calibration certificates

LIMS ID	Description	Type/Model	Serial Number	Manufacture	Calibration Certificate	Note
146235	Dosimetric E-Field Probe	EX3DV4	3907	SPEAG		-
145090	Dipole Antenna (2.45 GHz)	D2450V2	822	SPEAG		*1
230872	RF Power Source	POWERSOURCE1	4300	SPEAG		-

*1: As stated on page 2 of the certificate, the calibration was performed in accordance with the latest standard IEC/IEEE 62209-1528. Therefore, the reported SAR values are valid for any system that complies with IEC/IEEE 62209-1528 including all new versions of DASY such as DASY6 and DASY8.

-End of report-