SAR TEST REPORT

Test Report No.: 11947142S-A-R1

Applicant : **UNIVERSAL GLOBAL SCIENTIFIC INDUSTRIAL CO., LTD.**

Type of Equipment : **802.11b/g/n + BT Wireless LAN Module**

Model No. : **WM-BN-BM-26_A**

FCC ID : **COF-WMBNBM26A**

Test Standard : **FCC 47CFR §2.1093**

Test Result : **Complied**

Highest Reported SAR(1g) [W/kg] (DTS band)					Platform		Remarks				
Standalone		Simultaneous transmission	SAR Type	Limit	Type	Model	Wi-F /BLE	Frequency [MHz]	Mode	Output power [dBm]	
Wi-Fi	BLE									Measured	Max.
0.70	**n/a**	Not supported	**Body-touch**	**1.6**	Digital camera	FF170002	Wi-Fi	2437	11b (1Mbps)	14.72	15.5
							BLE	n/a	BLE	n/a	6

*. **Highest reported SAR(1g) across all exposure conditions and on this platform :" 0.70 W/kg (body-worn)."**
*. Since highest reported SAR (1g) on a platform of WM-BN-BM-26_A (EUT) which obtained in accordance with KDB447498 (v06) was kept under 1.2 W/kg, this EUT was approved to operate single-platform (as digital camera).

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by any agency of the Federal Government.
6. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
7. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)

Date of test: October 11, 2017

Test engineer: H. Naka
Hiroshi Naka
Engineer, Consumer Technology Division

Approved by: T. Imamura
Toyokazu Imamura
Leader, Consumer Technology Division

☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
☒ There is no testing item of "Non-accreditation".

JAB Testing RTL02610

REVISION HISTORY

Revision	Test report No.	Date	Page revised	Contents
Original	11947142S-A	November 1, 2017	-	-
R1	11947142S-A-R1	November 15, 2017	Full revision	Reject the Photographs of test setup

*. By issue of new revision report, the report of an old revision becomes invalid.

CONTENTS PAGE

Contents of appendixes

SECTION 1: Customer information

Company Name	UNIVERSAL GLOBAL SCIENTIFIC INDUSTRIAL CO., LTD.
Brand Name	USI
Address	141, Lane 351, Sec.1, Taiping Road., Tsaotuen, Nantou 54261, Taiwan
Telephone Number	+86 49 235 0876
Facsimile Number	+86 49 233 2061
Contact Person	Martin Shih

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

	EUT	Platform
Type of Equipment	802.11b/g/n + BT Wireless LAN Module	Digital Camera
Model Number	WM-BN-BM-26_A	FF170002
Serial Number	E04F43433059	15000073
Condition of EUT	Production model	Engineering prototype (*. Not for sale: This samples is equivalent to mass-produced items.)
Country of Mass-production	China	China
Rating	DC 3.6V from a platform.	DC 7.2V (Li-ion battery operation)
Receipt Date of Sample	October 10, 2017 (*. Power measurement sample.) *. No modification by the Lab. October 11, 2017 (*. SAR test sample) *. No modification by the Lab. (*. The EUT that had been measured the power of SAR test reference, was installed into a platform from the beginning. After power measurement, the EUT was returned to the customer, and the RF wiring was changed to the original antenna line from the antenna conducted power measurement line for SAR test. The EUT was installed into a platform which SAR tested, by the customer.)	
Category Identified	Portable device (*. Since this device may contact and/or very close to a human body during Wi-Fi and BLE operation, the partial-body SAR (1g) shall be observed.)	
Feature of EUT	The EUT is a 802.11b/g/n + BT Wireless LAN Module which installs into the specified platforms.	
SAR Accessory	None	

2.2 Product Description (802.11b/g/n + BT Wireless LAN Module)

Equipment type	Transceiver					
Model number	WM-BN-BM-26_A		FCC ID	COF-WMBNBM26A	IC number	10293A-WMBNBM26A
Serial number	E04F43433059					
Power supply	DC 3.6V from a platform.					
Operation mode	Wi-Fi				Bluetooth (BLE: Low energy)	
Frequency of operation	b/g/n(20HT): 2412 MHz - 2462 MHz				2402 MHz - 2480 MHz	
Number of channel	b/g/n(20HT):11				40	
Channel spacing	b/g/n(20HT): 5 MHz				2MHz	
Bandwidth	b/g/n(20HT): 20 MHz				2MHz	
Type of modulation	DSSS: DBPSK, DQPSK, CCK / OFDM: BPSK, QPSK, 16QAM, 64QAM				FHSS: GFSK	
Antenna type	Chip antenna					
Antenna connector	Not applicable					
Antenna gain (Peak)	3.68 dBi					
Transmit average power [dBm] (*1)	Typical	13.5 (b)	12 (g)	12 (n(20HT))	Typical	4
	Maximum	15.5 (b)	14 (g)	14 (n(20HT))	Maximum	6

*1. The measured transmit average power (conducted) refers to section 6 in this report.

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

*. Wi-Fi and Bluetooth do not transmit simultaneously.

SECTION 3: Test specification, procedures and results

3.1 Test specification

The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992. The device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling in accordance with the following measurement procedures..

KDB 447498 D01 (v06): General RF exposure guidance
KDB 248227 D01 (v02r02): SAR Guidance for IEEE 802.11 (Wi-Fi) transmitters
KDB 865664 D01 (v01r04): SAR measurement 100MHz to 6GHz
IEEE Std. 1528-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

3.2 Exposure limit

Environments of exposure limit	Whole-Body (averaged over the entire body)	Partial-Body (averaged over any 1g of tissue)	Hands, Wrists, Feet and Ankles (averaged over any 10g of tissue)
(A) Limits for Occupational /Controlled Exposure (W/kg)	0.4	8.0	20.0
(B) Limits for General population /Uncontrolled Exposure (W/kg)	0.08	1.6	4.0

***. Occupational/Controlled Environments:** are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).
***. General Population/Uncontrolled Environments:** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

The limit applied in this test report is;

General population / uncontrolled exposure, Partial-Body (averaged over any 1g of tissue) limit: 1.6 W/kg
General population / uncontrolled exposure, Hands (averaged over any 10g of tissue) limit: 4 W/kg

3.3 Procedures and Results

Test Procedure	SAR measurement; KDB 447498, KDB 248227, KDB 865664, IEEE Std.1528		
Category	FCC 47CFR §2.1093 (Portable device)	SAR type	Body touch

Platform / model	Digital camera / FF170002	
Mode / Band (Operation frequency)	Bluetooth ((2402-2480)MHz)	Wi-Fi ((2412-2462)MHz)
Results (Reported SAR(1g))	Complied (lower than Wi-Fi)	Complied
SAR (1g) Limit [W/kg]	1.6	1.6
Reported SAR(1g) value	n/a (*. SAR test was not required)	0.70 W/kg
Measured SAR value	At Bluetooth operation, the SAR test is reduced because the SAR test exclusion judge value are smaller than "3" and "SAR test can be reduced.	0.584 W/kg
Mode, frequency[MHz]		11b(1Mbps), 2437
Duty cycle [%] (scaled factor)		99.8 (×1.00)
Output burst average power [dBm] (max. power, scaled factor)	Maximum power: 6dBm (It is 10dB lower than Wi-Fi in the same antenna.)	14.72 (max.15.5, ×1.20)

Note: UL Japan's SAR Work Procedures No.13-EM-W0429 and 13-EM-W0430. No addition, deviation nor exclusion has been made from standards
*. (Calculating formula) Corrected SAR to max.power (W/kg) = (Measured SAR (W/kg)) × (Duty scaled) × (Tune-up factor)
where; Tune-up factor [-] = 1 / (10 ^ ("Δmax (max.power - burst average power), dB" / 10)), Duty scaled factor [-] = 100(%) / (duty cycle, %)

Test outline: Where this product is built into this platform, it was verified whether multiplatform conditions can be suited in according with section 2) of 5.2.2 in KDB447498 D01 (v06).

Consideration of the test results: **The highest reported SAR (1g) of this platform was kept; ≤ 1.2 W/kg.**
Since highest reported SAR (1g) on this EUT's platform obtained in accordance with KDB447498 D01 (v06) was kept under 1.2 W/kg, this EUT was approved to operate single-platform (as digital camera).

*. Wi-Fi and Bluetooth do not transmit simultaneously.

3.4 Test Location

No.7 shielded room (2.76 m (Width) × 3.76 m (Depth) × 2.4 m (Height)) for SAR testing.

UL Japan, Inc., Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 JAPAN
Telephone number: +81 463 50 6400 / Facsimile number: +81 463 50 6401

3.5 Confirmation before SAR testing

3.5.1 Average power for SAR tests

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. For the SAR test reference, on each operation band, the average output power was measured on the lower/middle/upper channels with the lowest data rate condition.

*. The transmission power was verified that it was within 2dB lower than the maximum power when it was set the rated power. (Clause 4.1, KDB447498 D01 (v06))

Data rate (WM-BN-BM-26_A support the following data rate in each operation mode.)

11b		11g				11n(20HT)						Bluetooth (BLE)	
Modulation	Data rate [Mbps]	Modulation	Data rate [Mbps]	Modulation	Data rate [Mbps]	MCS Index	Spatial Stream	Modulation	MCS Index	Spatial Stream	Modulation	Modulation	Packet type (Data rate)
DBPSK/DSSS	1	BPSK/OFDM	6	16QAM/OFDM	24	MCS0	1	BPSK/OFDM	MCS4	1	16QAM/OFDM	GFSK/FHSS	BLE (1Mbps)
DQPSK/DSSS	2	BPSK/OFDM	9	16QAM/OFDM	36	MCS1	1	QPSK/OFDM	MCS5	1	64QAM/OFDM		
CCK/DSSS	5.5	QPSK/OFDM	12	64QAM/OFDM	48	MCS2	1	QPSK/OFDM	MCS6	1	64QAM/OFDM		
CCK/DSSS	11	QPSK/OFDM	18	64QAM/OFDM	54	MCS3	1	16QAM/OFDM	MCS7	1	64QAM/OFDM		

3.6 Confirmation after SAR testing

It was checked that the power drift [W] is within ±5% in the evaluation procedure of SAR testing. The verification of power drift during the SAR test is that DASY5 system calculates the power drift by measuring the e-filed at the same location at beginning and the end of the scan measurement for each test position.
The result is shown in APPENDIX 1.

*. DASY5 system calculation Power drift value[dB] =20log(Ea)/(Eb) (where, Before SAR testing: Eb[V/m] / After SAR testing: Ea[V/m])

Limit of power drift[W] = ±5%
Power drift limit (X) [dB] = 10log(P_drift)=10log(1.05/1)=10log(1.05)-10log(1)=0.21dB
from E-filed relations with power.
S=E×H=E^2/η=P/(4×π×r^2) (η: Space impedance) → P=(E^2×4×π×r^2)/η
Therefore, The correlation of power and the E-filed
Power drift limit (X) dB=10log(P_drift)=10log(E_drift)^2=20log(E_drift)
From the above mentioned, **the calculated power drift of DASY5 system must be the less than ±0.21dB.**

3.7 Test setup of EUT and SAR measurement procedure

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

Setup plan	Explanation of SAR test setup plan (*. Refer to Photographs of test setup for test setup photographs which had been tested.)	Wi-Fi D [mm]	Wi-Fi SAR Tested /Reduced	BLE D [mm]	BLE SAR Tested /Reduced	SAR type
Right	A right of a camera was touched to the Flat phantom.	**9.58**	**Tested**	**9.58**	*Reduced*	Body-touch
Right-front	A front portion of right of a camera was touched to the Flat phantom.	**9.58**	**Tested**	**9.58**	*Reduced*	
Front	A point of a right hand grip in the front of a camera was touched to the Flat phantom.	**10.94**	**Tested**	**10.94**	*Reduced*	
Front-right	A front of a camera was tilted to the right direction and touched to the Flat phantom.	**10.94**	**Tested**	**10.94**	*Reduced*	
Front-lens	A front of a camera was tilted to the lens direction and touched to the Flat phantom.	**12.71**	**Tested**	**12.71**	*Reduced*	
Bottom	A bottom of camera is touched to the Flat phantom.	**19.05**	**Tested**	**19.05**	*Reduced*	
Top-Right	(When test is required,) A front-right portion of top of camera is touched to the Flat phantom.	**≈47**	*Reduced*	**≈47**	*Reduced*	
Rear	(When test is required,) A rear of camera (LCD side) was touched to the Flat phantom.	**56.07**	*Reduced*	**56.07**	*Reduced*	
Left	(When test is required,) A left of camera is touched to the Flat phantom.	**123.32**	*Reduced*	**123.32**	*Reduced*	
Rear	(When test is required,) A rear of camera (LCD side) was touched to the Flat phantom.	**56.07**	*Reduced*	**56.07**	*Reduced*	front-of-face

*. **D:** Antenna separation distance. It is the distance from the antenna inside EUT to the outer surface of EUT which an operator may touch.
*. Size of EUT: 9.5mm × 15 mm × 2 mm (maximum thickness)
*. Size of digital camera: 139.8 mm (width) × 97.3 mm (height) × 86.0 mm (depth) (This size is when the lens unit is detached. The convex portion (excluded the view-finder) is not contained in size.)

***. Consideration for SAR evaluation exemption**

KDB 447498 D01 (v06) was taken into consideration to reduce SAR test.

Consideration of SAR test reduction by the antenna separation distance (100MHz~6GHz, ≤50mm)

Mode	Setup Position	Minimum distance [mm]	Minimum distance [mm] (rounded)	Upper frequency [GHz]	Maximum power [dBm]	Maximum power [mW]	Maximum power [mW] (rounded)	Calculation of exclusion (*1)	SAR type	SAR test exclusion: Judge for Exclusion	SAR test exclusion: Standalone SAR test required?	Remarks
BLE	Right, Right-front	9.58	**10**	2.480	6	3.98	**4**	**0.6**	1g	**≤3.0**	Not required	*.SAR test was reduced
	Front, Front-right	10.94	**11**	2.480	6	3.98	**4**	**0.6**	1g	**≤3.0**	Not required	*.SAR test was reduced
	Other positions	>12.71	**>13**	2.480	6	3.98	**4**	**≤0.5**	1g	**≤3.0**	Not required	*.SAR test was reduced
Wi--Fi (b)	Right, Right-front	9.58	**10**	2.462	15.5	35.48	**35**	**5.5**	1g	**≤3.0**	Required	-
	Front, Front-right	10.94	**11**					**5.0**	1g	**≤3.0**	Required	-
	Front-lens	12.71	**13**					**4.2**	1g	**≤3.0**	Required	-
	Bottom	19.05	**19**					**2.9**	1g	**≤3.0**	Not required	*.SAR test was applied.
	Other positions	≥47	**47**					**≤1.2**	1g	**≤3.0**	Not required	*.SAR test was reduced

*1. Parenthesis 1), Clause 4.3.1, KDB 447498 D01 (v06) gives the following formula to calculate the SAR(1g) test exclusion thresholds for 100MHz-6GHz at test separation distance ≤50mm.
[(max.power of channel, including tune-up tolerance, mW) / (min.test separation distance, mm)] × [√f (GHz)] ≤ 3.0 (for SAR(1g)), 7.5(for SAR(10g)) ··· formula (1)
If power is calculated from the upper formula (1);
[SAR(1g) test exclusion thresholds, mW] = 3 × [test separation distance, mm] / [√f (GHz)] ········· formula (2a)

<Conclusion for consideration for SAR test reduction>

1) At Bluetooth operation, the SAR test is reduced because the SAR test exclusion judge value are smaller than "3."
2) At Wi-Fi operation, the SAR setups of "Right", "Right-front", "Front", "Front-right" and "Front-lens" are considered and applied the SAR test in body-liquid, because the SAR test exclusion judge was "test was required."
The SAR setups of "Bottom" is also applied the SAR test in body-liquid even if the SAR test exclusion judge was "test can reduce."
The SAR setups of "Top-right", "Rear" and "Left" are reduced because the SAR test exclusion judge value are smaller than "3."
3) The SAR test of front-of-face (which tested by head liquid) wasn't considered, because the SAR test exclusion judge value was smaller than "3."

By the determined test setup shown above, the SAR test was applied in the following procedures.

Worst SAR search by DSSS mode with a highest measurement output power channel in body liquid.
To confirm the influence to SAR of a frequency, the frequency is changed to all specified channels.
Add SAR test for OFDM mode and BLE mode, if it's necessary.

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

SECTION 4: Operation of EUT during testing

4.1 Operation mode for SAR testing

The EUT has Wireless LAN (IEEE 802.11b, g, n(20HT)) and BLE continuous transmitting modes. For inspection of standalone SAR and simultaneous transmission SAR, the EUT was operated in the following conditions.

Operation mode	BLE	b	g	n(20HT)
Tx band [MHz]	2402~2480	2412~2462		
Bandwidth [MHz]	2	20	20	20
Max.power [dBm]	6	15.5	14	14
Modulation	FHSS	DSSS	OFDM	OFDM
Data rate [Mbps]	1	1	6	MCS0
Tested frequency [MHz]	*.SAR test was reduced (*1)	2412, 2437, 2462	*.SAR test was reduced (*2)	*.SAR test was reduced (*2)

Controlled software	Wi-Fi command: It was used "DSC_JigCommand_WLANBT_e_v08_LX43.csv" command map was installed into the host PC and controlled by HyperFFW. Before the final power measurement, the Wi-Fi output power was adjusted by using "E_WLAN_TXPWR2G4CCK" and the setting power was saved to the EUT. The setting power of Wi-Fi listed in the power table of clause 6.1 as "Power setting (software)."

*1. At Bluetooth operation, the SAR test is reduced because the SAR test exclusion judge value are smaller than "3" and "SAR test can be reduced."
*2. Since the maximum tuned-up power of OFDM mode is 2dB lower than DSSS mode and the estimated highest reported SAR(1g) of OFDM mode is less than 1.2W/kg, the SAR test of OFDM mode is reduced.

SECTION 5: Uncertainty Assessment (SAR measurement)

Uncertainty of SAR measurement (2.4-6GHz) (*.ε&σ: ≤±5%, DAK3.5, Tx: ≈100% duty cycle) (v08)	1g SAR	10g SAR
Combined measurement uncertainty of the measurement system (k=1)	± 13.7%	± 13.6%
Expanded uncertainty (k=2)	± 27.4%	± 27.2%

	Error Description (2.4-6GHz) (v08)	Uncertainty Value	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g)	ui (10g)	Vi, veff
A	Measurement System (DASY5)						(std. uncertainty)	(std. uncertainty)	
1	Probe Calibration Error	±6.55 %	Normal	1	1	1	±6.55 %	±6.55 %	∞
2	Axial isotropy Error	±4.7 %	Rectangular	√3	√0.5	√0.5	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy Error	±9.6 %	Rectangular	√3	√0.5	√0.5	±3.9 %	±3.9 %	∞
4	Linearity Error	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
5	Probe modulation response	±2.4 %	Rectangular	√3	1	1	±1.4 %	±1.4 %	∞
6	Sensitivity Error (detection limit)	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
7	Boundary effects Error	±4.3%	Rectangular	√3	1	1	±2.5 %	±2.5 %	∞
8	Readout Electronics Error(DAE)	±0.3 %	Rectangular	√3	1	1	±0.3 %	±0.3 %	∞
9	Response Time Error	±0.8 %	Normal	1	1	1	±0.8 %	±0.8 %	∞
10	Integration Time Error (≈100% duty cycle)	±0 %	Rectangular	√3	1	1	0 %	0 %	∞
11	RF ambient conditions-noise	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
12	RF ambient conditions-reflections	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
13	Probe positioner mechanical tolerance	±3.3 %	Rectangular	√3	1	1	±1.9 %	±1.9 %	∞
14	Probe Positioning with respect to phantom shell	±6.7 %	Rectangular	√3	1	1	±3.9 %	±3.9 %	∞
15	Max. SAR evaluation (Post-processing)	±4.0 %	Rectangular	√3	1	1	±2.3 %	±2.3 %	∞
B	Test Sample Related								
16	Device Holder or Positioner Tolerance	±3.6 %	Normal	1	1	1	±3.6 %	±3.6 %	5
17	Test Sample Positioning Error	±5.0 %	Normal	1	1	1	±5.0 %	±5.0 %	145
18	Power scaling	±0%	Rectangular	√3	1	1	±0 %	±0 %	∞
19	Drift of output power (measured, <0.2dB)	±2.3%	Rectangular	√3	1	1	±2.9 %	±2.9 %	∞
C	Phantom and Setup								
20	Phantom uncertainty (shape, thickness tolerances)	±7.5 %	Rectangular	√3	1	1	±4.3 %	±4.3 %	∞
21	Algorithm for correcting SAR (e',σ: ≤5%)	±1.2 %	Normal	1	1	0.84	±1.2 %	±0.97 %	∞
22	Measurement Liquid Conductivity Error (DAK3.5)	±3.0 %	Normal	1	0.78	0.71	±2.3 %	±2.1 %	7
23	Measurement Liquid Permittivity Error (DAK3.5)	±3.1 %	Normal	1	0.23	0.26	±0.7 %	±0.8 %	7
24	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.3 %	Rectangular	√3	0.78	0.71	±2.4 %	±2.2 %	∞
25	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.9 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty						±13.7 %	±13.6 %	733
	Expanded Uncertainty (k=2)						±27.4 %	±27.2 %	

*. Table of uncertainties are listed for ISO/IEC 17025.
*. This measurement uncertainty budget is suggested by IEEE Std.1528(2013) and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget). Per KDB 865664 D01 (v01r04) SAR Measurement 100 MHz to 6 GHz Section 2.8.1., when the highest measured SAR(1g) within a frequency band is < 1.5W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std.1528 (2013) is not required in SAR reports submitted for equipment approval.

SECTION 6: Confirmation before testing

6.1 SAR reference power measurement (*. Antenna terminal conducted average power)

(Antenna gain (peak): 3.68 dBi)

Mode	Frequency		Data rate	Power Setting (software)	Duty cycle	Duty factor	Duty scaled factor	Measurement Result				Power correction			Power Tune-up?	Remarks
								Time average power		Burst power		Max. power	Δ from max.	Tune-up factor		
	[MHz]	CH	[Mbps]	[-]	[%]	[dB]	[-]	[dBm]	[mW]	[dBm]	[mW]	[dBm]	[dB]	[-]		
BLE	2402	0	1	(fix)	66.5	1.77	×1.50	2.07	1.61	**3.84**	2.42	6.0	-2.16	×1.64	n/a (fix)	(*1)
	2440	19	1	(fix)	66.5	1.77	×1.50	2.61	1.82	**4.38**	2.74	6.0	-1.62	×1.45	n/a (fix)	(*1)
	2480	39	1	(fix)	66.5	1.77	×1.50	3.04	2.01	**4.81**	3.03	6.0	-1.19	×1.32	n/a (fix)	(*1)
11b	2412	1	1	0x0F	99.8	0.01	×1.00	14.59	28.77	**14.60**	28.84	**15.5**	-0.90	×1.23	adjusted	-
	2437	6	1	0x0F	99.8	0.01	×1.00	14.71	29.58	**14.72**	29.65	**15.5**	-0.78	×1.20	adjusted	-
	2462	11	1	0x0F	99.8	0.01	×1.00	14.54	28.44	**14.55**	28.51	**15.5**	-0.95	×1.24	adjusted	-
11g	2412	1	6	0x0D	98.4	0.07	×1.02	12.88	19.41	**12.95**	19.72	14.0	-1.05	×1.27	adjusted	-
	2437	6	6	0x0D	98.4	0.07	×1.02	12.97	19.82	**13.04**	20.14	14.0	-0.96	×1.25	adjusted	-
	2462	11	6	0x0D	98.4	0.07	×1.02	12.77	18.92	**12.84**	19.23	14.0	-1.16	×1.31	adjusted	-
11n (20HT)	2412	1	MCS0	0x0D	98.1	0.08	×1.02	12.53	17.91	**12.61**	18.24	14.0	-1.39	×1.38	adjusted	-
	2437	6	MCS0	0x0D	98.1	0.08	×1.02	12.83	19.19	**12.91**	19.54	14.0	-1.09	×1.29	adjusted	-
	2462	11	MCS0	0x0D	98.1	0.08	×1.02	12.74	18.79	**12.82**	19.14	14.0	-1.18	×1.31	adjusted	-

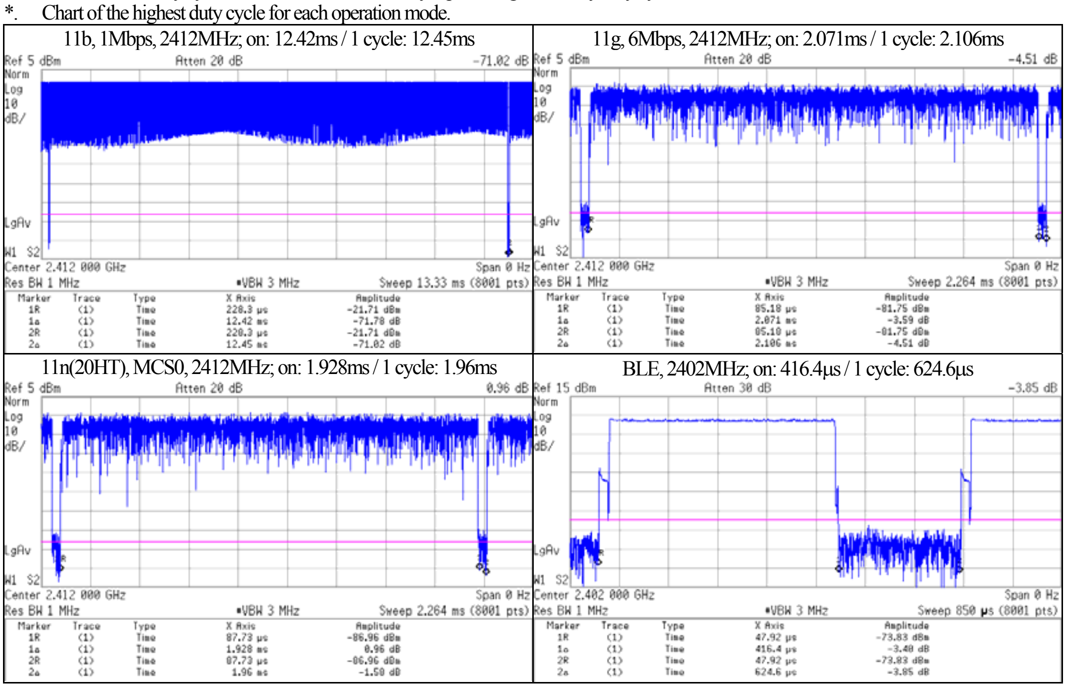
*. [ ] : SAR test was applied. *. xx.xx highlight is shown the higher measured output power in each operation mode, in each band.

*. Preliminary tests were performed in different data rate and data rate associated with the highest power were chosen for full test in following tables.

Data rate (D/R) vs Time average power (dBm)																			
11b (2412MHz)				11g (2412MHz)								11n(20HT) (2412MHz)							
D/R	Duty cycle (%)	Duty factor (dB)	Power	D/R	Duty cycle (%)	Duty factor (dB)	Power	D/R	Duty cycle (%)	Duty factor (dB)	Power	D/R	Duty cycle (%)	Duty factor (dB)	Power	D/R	Duty cycle (%)	Duty factor (dB)	Power
1	99.8	0.01	**14.59**	**6**	98.4	0.07	**12.88**	24	94.1%	0.26	12.39	**MCS0**	98.1	0.08	**12.53**	MCS4	90.8	0.42	12.12
2	99.5	0.02	14.37	9	97.5	0.11	12.87	36	90.9%	0.41	12.23	MCS1	96.6	0.15	12.48	MCS5	88.3	0.54	11.83
5.5	89.9	0.05	14.34	12	97.1	0.13	12.83	48	88.5%	0.53	12.06	MCS2	94.9	0.23	12.45	MCS6	87.9	0.56	11.82
11	97.7	0.10	14.34	18	95.7	0.19	12.56	56	87.5%	0.58	12.00	MCS3	93.3	0.30	12.38	MCS7	86.5	0.63	11.74

*1. The measured duty cycle number of BLE was nearly equal to highest theory duty cycle.

*. Chart of the highest duty cycle for each operation mode.



*. CH: channel, Max: Maximum.

*. Calculating formula: Result-Time average power (dBm) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)
Result-Burst power (dBm) (*.equal to 100% duty cycle) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)+(duty factor, dB)
Duty factor (dB) = 10 × log (100/(duty cycle, %))
Δ form max. (dB) = (Results-Burst power (average, dBm)) - (Max.-specification output power (average, dBm))
Duty scaled factor (Duty cycle correction factor for obtained SAR value) (unit: (-)) = 100(%) / (duty cycle, %)
Tune-up factor (Power tune-up factor for obtained SAR value) (unit: (-)) = 1 / (10 ^ ("Deviation from max., dB" / 10))

*. Date measured: October 10, 2017 / Measured by: Hiroshi Naka / Place: preparation room of No. 7 shielded room. (23 deg.C. / 59 %RH)

*. Uncertainty of antenna port conducted test; Power measurement uncertainty above 1GHz for this test was: (±) 0.72 dB(Average)/(±) 0.85 dB(Peak).

*. Uncertainty of antenna port conducted test; Duty cycle and time measurement: (±) 0.012 %.

SECTION 7: SAR Measurement results

7.1 SAR measurement results

Measurement date: October 11, 2017 Measurement by: Hiroshi Naka

[Liquid measurement]

Frequency [MHz]	Liquid type	Liquid parameters (*a)											ΔSAR Coefficients(*b)		Date measured
		Permittivity (εr) [-]				Conductivity [S/m]				Temp. [deg.C.]	Depth [mm]		ΔSAR	Correction required?	
		Target	Measured Meas.	Measured Δεr [%]	Limit	Target	Measured Meas.	Measured Δσ [%]	Limit				1g [%]		
2412	Body	*52.75*	50.58	-4.1	-5% ≤ εr-meas. ≤ 0%	*1.914*	1.947	+1.7	0% ≤ σ-meas. ≤ +5%	22.0	152		+1.77	not required.	October 11, 2017 before SAR test (*1)
2437		*52.72*	50.48	-4.2		*1.938*	1.980	+2.2					+2.01	not required.	
2462		*52.68*	50.37	-4.4		*1.967*	2.017	+2.6					+2.20	not required.	

[Measured and Reported (Scaled) SAR results]

Mode	Frequency [MHz] (Channel)	Data rate [Mbps]	EUT setup: Position	Gap [mm]	Battery ID	SAR (1g) [W/kg] Max.value of multi-peak: Meas.	ΔSAR [%]	ΔSAR corrected	SAR plot # in Appendix 2-2	Reported SAR (1g) [W/kg]: Duty cycle correction Duty [%]	Duty scaled	Output burst average power correction Meas. [dBm].	Max. [dBm]	Tune-up factor	SAR Corrected (*d)	Remarks
11b	2437(6)	1	Right-front	0	#2	**0.584**	+2.01	n/a (*c)	Plot 1-1	99.8	×1.00	14.72	15.5	×1.20	**0.701**	Higher-Wi-Fi.
	2412(1)				#2	**0.371**	+1.77	n/a (*c)	Plot 2-1	99.8	×1.00	14.60	15.5	×1.23	**0.456**	-
	2462(11)				#2	**0.469**	+2.20	n/a (*c)	Plot 2-2	99.8	×1.00	14.55	15.5	×1.24	**0.582**	-
	2437(6)		Right	0	#1	**0.434**	+2.01	n/a (*c)	Plot 2-3	99.8	×1.00	14.72	15.5	×1.20	**0.521**	-
	2437(6)		Front-right	0	#1	**0.284**	+2.01	n/a (*c)	Plot 2-4	99.8	×1.00	14.72	15.5	×1.20	**0.341**	-
	2437(6)		Front	0	#1	**0.147**	+2.01	n/a (*c)	Plot 2-5	99.8	×1.00	14.72	15.5	×1.20	**0.176**	-
			Front-lens	0	#1	**0.092**	+2.01	n/a (*c)	Plot 2-6	99.8	×1.00	14.72	15.5	×1.20	**0.110**	-
			Bottom	0	#1	**n/a**	+2.01	n/a (*c)	Plot 2-7	*. Since an interpolated maximum SAR value of the area scan was very small and not detected near an antenna, the zoom scan was not performed.						

Notes: *. Gap: It is the separation distance between the nearest position of EUT outer surface and the bottom outer surface of phantom; Battery ID: Battery ID No.#1 and #2 are same. Refer to Photographs of test setup for more detail.; Max.: maximum, Meas.: Measured; n/a: not applied.

*. Calibration frequency of the SAR measurement probe (and used conversion factors)

SAR test frequency	Probe calibration frequency	Validity	Conversion factor	Uncertainty
2412, 2437, 2462 MHz	2450MHz	within ±50MHz of calibration frequency	7.38	±12.0%

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

*a. The target value is a parameter defined in Appendix A of KDB865664 D01 (v01r04), the dielectric parameters suggested for head and body tissue simulating liquid are given at 2000 and 2450MHz. Parameters for the frequencies 2000-2450MHz were obtained using linear interpolation.

*b. Refer to KDB865664 D01 (v01r04), item 2), Clause 2.6; "When nominal tissue dielectric parameters are recorded in the probe calibration data; for example, only target values and tolerance are reported, the measured εr and σ of the liquid used in routine measurements must be: ≤ the target εr and ≥ the target σ values and also within 5% of the required target dielectric parameters."

*c. Calculating formula: $\Delta SAR(1g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon r = -7.854E\text{-}4 \times f^3 + 9.402E\text{-}3 \times f^2 - 2.742E\text{-}2 \times f - 0.2026$ / $C\sigma = 9.804E\text{-}3 \times f^3 - 8.661E\text{-}2 \times f^2 + 2.981E\text{-}2 \times f + 0.7829$
ΔSAR corrected SAR (1g) (W/kg) = (Meas. SAR(1g) (W/kg)) × (100 - (ΔSAR(%)) / 100

*d. Calculating formula: Reported SAR (1g) (W/kg) = (Measured SAR (1g) (W/kg)) × (Duty scaled) × (Tune-up factor)
Duty scaled = Duty scaled factor: Duty cycle correction factor for obtained SAR value, Duty scaled factor [-] = 100(%) / (duty cycle, %)
Tune-up factor: Power tune-up factor for obtained SAR value, Tune-up factor [-] = 1 / (10 ^ ("Deviation from max., dB" / 10))

Notes: (Clause 5.2, 2.4GHz SAR Procedures, in KDB248227 D01 (v02r02))

5.2.1 802.11b 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 (section 3.1) 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.

5.2.2 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 (section 5.3, including sub-sections). 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.

Notes:

*. SAR test of OFDM mode was reduced, because the estimate reported SAR of OFDM mode was ≤ 1.2 W/kg by using the highest reported SAR of DSSS mode.

OFDM mode	Maximum tune-up tolerance limit: DSSS [dBm]	DSSS [mW] (a)	OFDM [dBm]	OFDM [mW] (b)	OFDM scaled factor [-] (b)/(a)×100	DSSS reported SAR(1g) value: Setup	[W/kg]	Estimated SAR(1g) value: OFDM [W/kg]	Exclusion limit [W/kg]	Standalone SAR test require for OFDM mode?
11g	15.5	35.48	14.0	25.11	0.708	Right-front	0.701	**0.496**	**≤ 1.2**	**No**
n (HT20)	15.5	35.48	14.0	25.11	0.708	Right-front	0.701	**0.496**	**≤ 1.2**	**No**

APPENDIX 1: SAR Measurement data

Appendix 1-1: Evaluation procedure

The SAR evaluation was performed with the following procedure:

Step 1: Measurement of the E-field at a fixed location above the central position of flat phantom was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and suitable horizontal grid spacing of EUT. Based on these data, the area of the maximum absorption was determined by splines interpolation.

Step 3: Around this point found in the Step 2 (area scan), a volume of more than or equal to 30mm(X axis)×30mm(Y axis)×30mm(Z axis) was assessed by measuring 7×7×7 points (or more) under 3GHz and a volume of more than or equal to 28mm(X axis)×28mm(Y axis)×24mm (Z axis) was assessed by measuring 8×8×7 (ratio step method (*1)) points (or more) for 3-6GHz frequency band.
Any additional peaks found in the Step2 which are within 2dB of limit are repeated with this Step3 (Zoom scan).
On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

(1) The data at the surface were extrapolated, since the center of the dipoles is 1mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 2mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

(2) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the "Not a knot"-condition (in x, y and z-directions). The volume was integrated with the trapezoidal-algorithm. One thousand points (10×10×10) were interpolated to calculate the average.

(3) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the E-field at the same location as in Step 1 for the assessment of the power drift.

Step 5: Repeat Step 1-Step 4 with other condition or/and setup of EUT.

*1. Ratio step method parameters used; the first measurement point: "1.4mm" from the phantom surface, the initial grid separation: "1.4mm", subsequent graded grid ratio: "1.4". These parameters comply with the requirement of the KDB 865664 D01 (v01r04) and recommended by Schmid & Partner Engineering AG (DASY5 manual).

Appendix 1-2: SAR measurement data

Worst Reported SAR(1g) Plots

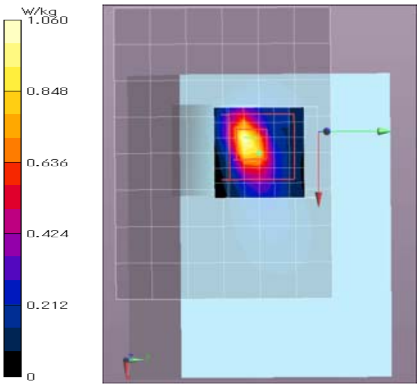
Plot 1-1: Wi-Fi: Right-right & touch, 11b(1Mbps), 2437 MHz->Highest reported SAR(1g) of Wi-Fi

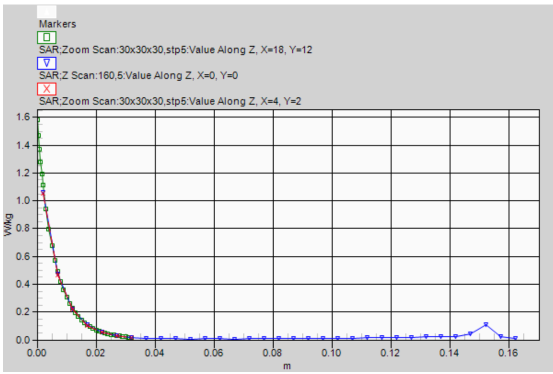
EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section

body-touch/b6,wlan,2437,dsss;right-front-tilt&touch,b(1m)/
Area Scan:96x72,stp12 (9x7x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.812 W/kg
Area Scan:96x72,stp12 (81x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.812 W/kg
Z Scan:160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 1.06 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 20.51 V/m; Power Drift = 0.01 dB; Maximum value of SAR (measured) = 1.06 W/kg; Peak SAR (extrapolated) = 1.58 W/kg
SAR(1 g) = 0.584 W/kg; SAR(10 g) = 0.199 W/kg





Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.2(start)/22.2(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Other SAR test plots

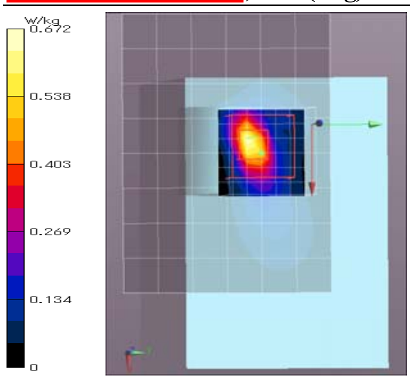
Plot 2-1: Wi-Fi: Right-front & touch, 11b(1Mbps), 2412 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2412 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2412 MHz; σ = 1.947 S/m; ε_r = 50.58; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

body-touch/b7,wlan,2412,dsss;right-front-tilt&touch,b(1m)/
Area Scan:96x72,stp12 (9x7x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.520 W/kg
Area Scan:96x72,stp12 (81x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.520 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 16.58 V/m; Power Drift = 0.00 dB; Maximum value of SAR (measured) = 0.672 W/kg; Peak SAR (extrapolated) = 1.01 W/kg
SAR(1 g) = 0.371 W/kg; SAR(10 g) = 0.127 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.2(start)/22.2(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 1-2: SAR measurement data (cont'd)

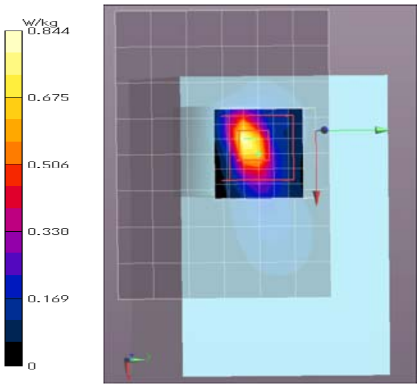
Plot 2-2: Wi-Fi: Right-front & touch, 11b(1Mbps), 2462 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1)**; Frequency: 2462 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2462 MHz; σ = 2.017 S/m; ε_r = 50.37; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

body-touch/b8,wlan,2462,dsss;right-front-tilt&touch,b(1m)/
Area Scan:96x72,stp12 (9x7x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.670 W/kg
Area Scan:96x72,stp12 (81x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.670 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 18.56 V/m; Power Drift = 0.00 dB; Maximum value of SAR (measured) = 0.844 W/kg; Peak SAR (extrapolated) = 1.29 W/kg
SAR(1 g) = 0.469 W/kg; SAR(10 g) = 0.161 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.2(start)/22.2(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

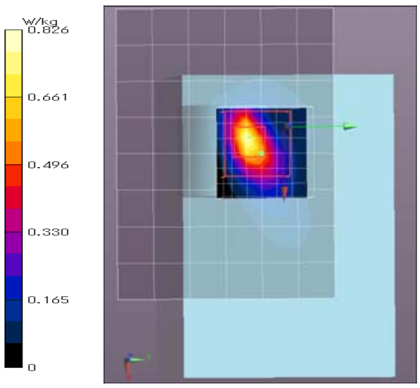
Plot 2-3: Wi-Fi: Right & touch, 11b(1Mbps), 2437 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1)**; Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0 -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section

body-touch/b9,wlan,2437,dsss;right-front(2)&touch,b(1m)/
Area Scan:96x72,stp12 (9x7x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.572 W/kg
Area Scan:96x72,stp12 (81x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.572 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 17.28 V/m; Power Drift = -0.00 dB; Maximum value of SAR (measured) = 0.826 W/kg; Peak SAR (extrapolated) = 1.20 W/kg
SAR(1 g) = 0.434 W/kg; SAR(10 g) = 0.154 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.2(start)/22.1(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 1-2: SAR measurement data (cont'd)

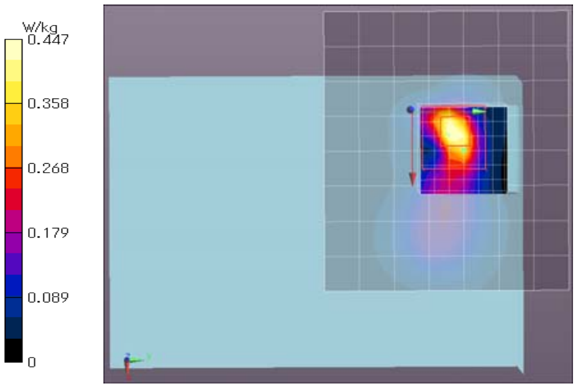
Plot 2-4: Wi-Fi: Front-right & touch, 11b(1Mbps), 2437 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0; -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331); -Electronics: DAE4 Sn554; Calibrated: 2017/05/18

body-touch/b3,wlan,2437,dsss;front-right&touch,b(1m)/
Area Scan:96x84,stp12 (9x8x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.363 W/kg
Area Scan:96x84,stp12 (81x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.363 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 13.73 V/m; Power Drift = 0.03 dB; Maximum value of SAR (measured) = 0.447 W/kg; Peak SAR (extrapolated) = 0.679 W/kg
SAR(1 g) = 0.284 W/kg; SAR(10 g) = 0.105 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.3(start)/22.3(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

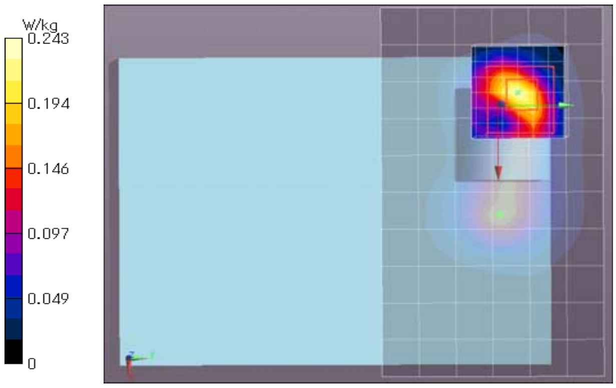
Plot 2-5: Wi-Fi: Front & touch, 11b(1Mbps), 2437 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0; -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331); -Electronics: DAE4 Sn554; Calibrated: 2017/05/18

body-touch/b1,wlan,2437,dsss;front&touch,b(1m)/
Area Scan:120x72,stp12 (11x7x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.170 W/kg
Area Scan:120x72,stp12 (101x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.219 W/kg

Zoom Scan:30x30x30,stp5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 11.33 V/m; Power Drift = -0.12 dB; Maximum value of SAR (measured) = 0.243 W/kg; Peak SAR (extrapolated) = 0.328 W/kg
SAR(1 g) = 0.147 W/kg; SAR(10 g) = 0.061 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.1(start)/22.2(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 1-2: SAR measurement data (cont'd)

Plot 2-6: Wi-Fi: Front-lens & touch, 11b(1Mbps), 2437 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)

Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**

Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3

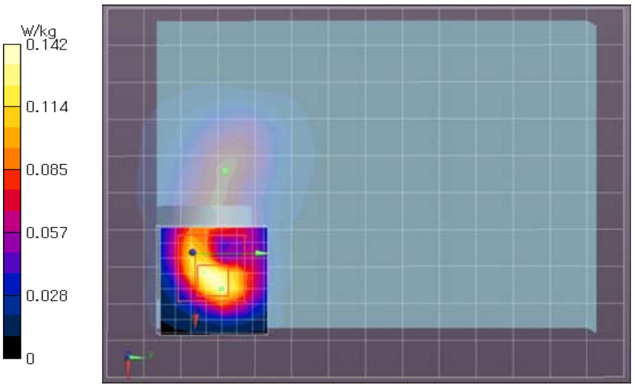
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0 -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section

body-touch/b2,wlan,2437,dsss;front-lens-tilt&touch,b(1m)/
Area Scan:120x168,stp12 (11x15x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.0986 W/kg
Area Scan:120x168,stp12 (101x141x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.115 W/kg

Zoom Scan:30x30x30,stp5 (8x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 8.519 V/m; Power Drift = 0.07 dB; Maximum value of SAR (measured) = 0.142 W/kg; Peak SAR (extrapolated) = 0.205 W/kg

SAR(1 g) = 0.092 W/kg; SAR(10 g) = 0.041 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.2(start)/22.3(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Plot 2-7: Wi-Fi: Bottom & touch, 11b(1Mbps), 2437 MHz

EUT: WLAN/BLE module in Digital camera; Type: WM-BN-BM-26_A (camera:FF170002); Serial: E04F43433059 (camera:15000073)

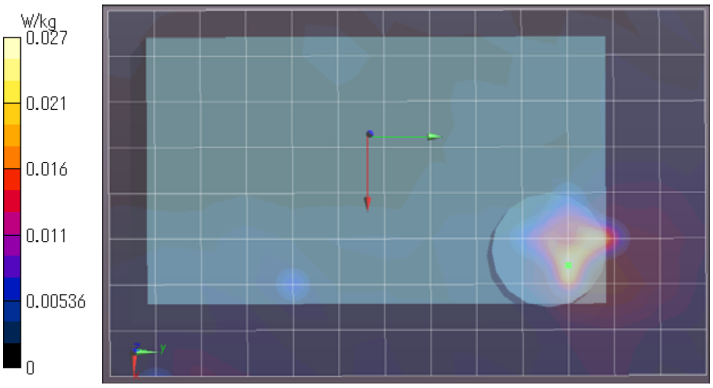
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**

Medium: M2450(1710); Medium parameters used: f = 2437 MHz; σ = 1.98 S/m; ε_r = 50.48; ρ = 1000 kg/m^3

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0 -Electronics: DAE4 Sn554; Calibrated: 2017/05/18
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section

body-touch/b13,wlan,2437,dsss;bottom&touch,b(1m)/
Area:96x156,12 (9x14x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.0161 W/kg
Area:96x156,12 (81x131x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.0268 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (23~24) deg.C. / (50~60) %RH,
*. liquid temperature: 22.1(start)/22.1(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

APPENDIX 2: Test instruments

Appendix 2-1: Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
KPM-08	Power meter	Anritsu	ML2495A	6K00003356	AT	2017/09/19 * 12
KPSS-04	Power sensor	Anritsu	MA2411B	012088	AT	2017/09/19 * 12
KAT10-S3	Attenuator	Agilent	8490D 010	50924	AT	2016/12/21 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	AT	2017/03/07 * 12
KDC-01	Regulated DC Power supply	Kikusui	PAN35-10A	DE001677	AT	Pre Check

*. AT (antenna terminal conducted power measurement) was measured October 10, 2017. (Refer to Section 6 in this report.)

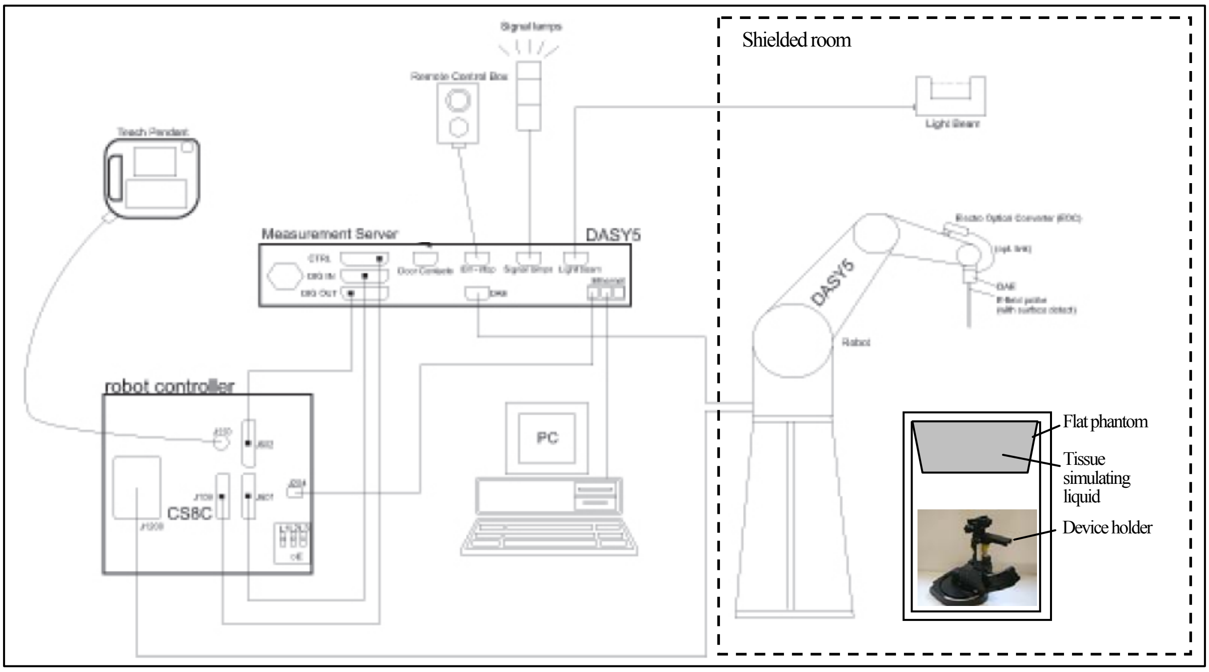
Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
COTS-SSAR-02	DASY52	Schmid&Partner Engineering AG	DASY52(ver.52.8.8(1222))	-	SAR	-
COTS-SSEP-02	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK(ver1.10.317.11)	-	SAR	-
SSAR-02	SAR measurement system	Schmid&Partner Engineering AG	DASY5	1324	SAR	Pre Check
SSRBT-02	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F12/5L2QA1/A/01	SAR	2017/09/28 * 12
KDAE-R01	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	554	SAR	2017/05/18 * 12
SPB-02	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3907	SAR	2017/02/27 * 12
KSDA-01	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	822	SAR	2017/01/11 * 12
KPFL-01	Flat Phantom	Schmid&Partner Engineering AG	Oval flat phantom ELI 4.0	1059	SAR	2017/08/25 * 12
SSNA-01	Network Analyzer	Agilent	8753ES	US39171777	SAR	2016/12/15 * 12
SEPP-02	Dielectric probe	Schmid&Partner Engineering AG	DAK3.5	1129	SAR	2017/08/08 * 12
KSG-08	Signal Generator	Rohde & Schwarz	SMT06	100763	SAR	2107/08/23 * 12
KPA-12	RF Power Amplifier	MILMEGA	AS2560-50	1018582	SAR	Pre Check
KCPL-07	Directional Coupler	Pulsar Microwave Corp.	CCS30-B26	0621	SAR	Pre Check
KPM-06	Power Meter	Rohde & Schwarz	NRVD	101599	SAR	2017/09/19 * 12
KIU-08	Power sensor	Rohde & Schwarz	NRV-Z4	100372	SAR	2017/09/19 * 12
KIU-09	Power sensor	Rohde & Schwarz	NRV-Z4	100371	SAR	2017/09/19 * 12
KAT10-P1	Attenuator	Weinschel	24-10-34	BY5927	SAR	2016/12/21 * 12
KPM-05	Power meter	Agilent	E4417A	GB41290718	SAR	2017/05/08 * 12
KPSS-01	Power sensor	Agilent	E9327A	US40440544	SAR	2017/05/08 * 12
SAT20-SAR1	Attenuator	TME	SFA-01AXPJ-20	-	SAR	2016/12/21 * 12
SCC-SAR2	Coaxial Cable	HUBER+SUHNER	SF104A/11PC3542/11N451/4M	MY699/4A	SAR	Pre Check
KRU-01	Ruler(300mm)	Shinwa	13134	-	SAR	2017/02/02 * 12
KRU-02	Ruler(150mm,L)	Shinwa	12103	-	SAR	2017/02/02 * 12
KRU-05	Ruler(100x50mm,L)	Shinwa	12101	-	SAR	2017/05/23 * 12
KOS-13	Digtal thermometer	HANNA	Checktemp-2	KOS-13	SAR	2016/12/13 * 12
KOS-14	Thermo-Hygrometer data logger	SATO KEIRYOKI	SK-L200THIIα / SK-LTHIIα-2	015246/08169	SAR	2016/12/13 * 12
SOS-11	Humidity Indicator	A&D	AD-5681	4063424	SAR	2016/12/13 * 12
SOS-12	Digtal thermometer	HANNA	Checktemp-4	SOS-12	SAR	2017/02/21 * 12
SOS-SAR1	Digtal thermometer	LKMelectonic	DTM3000	3171	SAR	2016/10/28 * 12
SSA-04	Spectrum Analyzer	Advantest	R3272	101100994	SAR(moni.)	Pre Check
KSDH-01	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	2017/09/28 * 12
SWTR-03	DI water	MonotaRo	34557433	-	SAR	Pre Check
SALC-01	Primepure Ethanol	Kanto Chemical Co., Inc.	14032-79	-	SAR	Pre Check
KSLM245-01	Tissue simulation liqud (2450MHz,body)	Schmid&Partner Engineering AG	MSL2450V2	SL AAM 245 BA	SAR	Pre Check

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

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

Appendix 2-2: Configuration and peripherals

These measurements were performed with the automated near-field scanning system DASY5 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 ± 0.02 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.



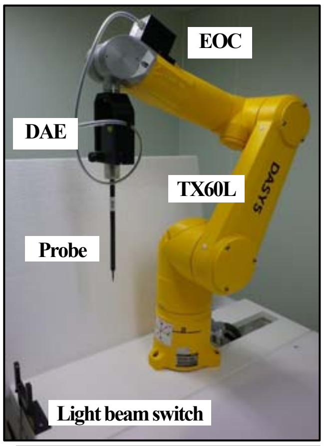
The DASY5 system for performing compliance tests consist of the following items:

1	A standard high precision 6-axis robot (Stäubli TX/RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
2	An isotropic field probe optimized and calibrated for the targeted measurement.
3	A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4	The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
5	The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
6	The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
7	A computer running Win7 professional operating system and the DASY5 software.
8	R Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
9	The phantom.
10	The device holder for EUT. (low-loss dielectric palette) (*. when it was used.)
11	Tissue simulating liquid mixed according to the given recipes.
12	Validation dipole kits allowing to validate the proper functioning of the system.

Appendix 2-3: Test system specification

TX60 Lspeag robot/CS8Cspeag-TX60 robot controller

•Number of Axes : 6 •Repeatability : ±0.02mm
•Manufacture : Stäubli Unimation Corp.



DASY5 Measurement server

•Features : The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV Celeron, 128MB chip-disk and 128MB RAM. The necessary circuits for communication with the DAE4 electronics box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY5 I/O board, which is directly connected to the PC/104 bus of the CPU board.
•Calibration : No calibration required.
•Manufacture : Schmid & Partner Engineering AG

Data Acquisition Electronic (DAE)

•Features : Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY5 embedded system (fully remote controlled). 2 step probe touch detector for mechanical surface detection and emergency robot stop (not in -R version)
•Measurement Range : 1μV to > 200mV (16bit resolution and 2 range settings: 4mV, 400mV)
•Input Offset voltage : < 1μV (with auto zero)
•Input Resistance : 200MΩ
•Battery Power : > 10hr of operation (with two 9V battery)
•Manufacture : Schmid & Partner Engineering AG

Electro-Optical Converter (EOC61)

•Manufacture : Schmid & Partner Engineering AG

Light Beam Switch (LB5/80)

•Manufacture : Schmid & Partner Engineering AG

SAR measurement software

•Item : Dosimetric Assessment System DASY5
•Software version : DASY52, V8.2 B969
•Manufacture : Schmid & Partner Engineering AG

E-Field Probe

•Model : <u>**EX3DV4 (serial number: 3907)**</u>
•Construction : Symmetrical design with triangular core.
Built-in shielding against static charges.
PEEK enclosure material (resistant to organic solvents, e.g., DGBE).
•Frequency : 10MHz to 6GHz, Linearity: ±0.2 dB (30MHz to 6GHz)
•Conversion Factors : 2.45, 5.2, 5.25, 5.5, 5.6, 5.75, 5.8 GHz (Head)
: 2.45, 5.25, 5.6, 5.75 GHz (Body)
•Directivity : ±0.3 dB in HSL (rotation around probe axis)
±0.5 dB in tissue material (rotation normal to probe axis)
•Dynamic Range : 10μW/g to > 100 mW/g; Linearity: ±0.2 dB (noise: typically < 1μW/g)
•Dimension : Overall length: 330mm (Tip: 20mm)
Tip diameter: 2.5mm (Body: 12mm)
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

Phantom

•Type : <u>**ELI 4.0 oval flat phantom**</u>
•Shell Material : Fiberglass •Shell Thickness : Bottom plate: 2 ±0.2mm
•Dimensions : Bottom elliptical: 600×400mm, Depth: 190mm (Volume: Approx. 30 liters)
•Manufacture : Schmid & Partner Engineering AG

Device Holder

☒ Urethane foam
☒ KSDH-01: In combination with the ELI4, 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 : POM •Manufacture : Schmid & Partner Engineering AG

Appendix 2-4: Simulated tissue composition and parameter confirmation

Liquid type	Body
Control No.	KSLM245-01
Model No. / Product No.	MSL2450V2 / SL AAM 245 BA
Ingredient: Mixture(%)	Water: 52-75%, DGBE: 25-48%, NaCl: <1.0%
Manufacture	Schmid & Partner Engineering AG

*. The dielectric parameters were checked prior to assessment using the DAK3.5 dielectric probe kit.

Measured date	Freq. [MHz]	Liquid type	Ambient [deg.C.] /[%RH]	Liquid temp. [deg.C.]	Liquid Depth [mm]	Liquid parameters (*a)								ΔSAR	
						Permittivity (εr) [-]				Conductivity [S/m]				(1g) [%] (*b)	(10g) [%] (*b)
						Target	Measured Meas.	Measured Δεr[%]	Limit	Target	Measured Meas.	Measured Δσ[%]	Limit		
October 11, 2017	2450	Body	23.6/53	22.0	(152)	***52.7***	50.41	-4.4	±5%	***1.95***	1.996	+2.4	±5%	+2.12	+1.31

*a. The target value is a parameter defined in Appendix A of KDB865664 D01 (v01r04), the dielectric parameters are given at 2000, 2450 and 3000MHz. Parameters for the frequencies between 2000-3000MHz were obtained using linear interpolation.

Standard														
f (MHz)	Head Tissue εr [-]	Head Tissue σ [S/m]	Body Tissue εr [-]	Body Tissue σ [S/m]	f (MHz)	Head Tissue εr [-]	Head Tissue σ [S/m]	Body Tissue εr [-]	Body Tissue σ [S/m]	f (MHz)	Head Tissue εr [-]	Head Tissue σ [S/m]	Body Tissue εr [-]	Body Tissue σ [S/m]
(1800-)2000	**40.0**	**1.40**	**53.3**	**1.52**	2450	**39.2**	**1.80**	**52.7**	**1.95**	3000	**38.5**	**2.40**	**52.0**	**2.73**

*b. The coefficients are parameters defined in IEEE Std. 1528-2013.

$\Delta SAR(1g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon r = -7.854E\text{-}4 \times f^3 + 9.402E\text{-}3 \times f^2 - 2.742E\text{-}2 \times f - 0.2026$ / $C\sigma = 9.804E\text{-}3 \times f^3 - 8.661E\text{-}2 \times f^2 + 2.981E\text{-}2 \times f + 0.7829$

$\Delta SAR(10g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon r = 3.456 \times 10^{-3} \times f^3 - 3.531 \times 10^{-2} \times f^2 + 7.675 \times 10^{-2} \times f - 0.1860$ / $C\sigma = 4.479 \times 10^{-3} \times f^3 - 1.586 \times 10^{-2} \times f^2 - 0.1972 \times f + 0.7717$

Appendix 2-5: Daily 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 ±10%. The Daily check results are in the table below.

Daily check results																					
Date	Freq. [MHz]	Liquid Type	Daily check target & measured																		
			SAR (1g) [W/kg] (*d)									SAR (10g) [W/kg] (*d)									
			Meas. (*c)	ΔSAR-correct	1W scaled	Target Cal. (*e)	Target STD (*f)	Deviation Cal. [%]	Deviation STD [%]	Limit [%]	Pass ?	Meas. (*c)	ΔSAR-correct	1W scaled	Target Cal. (*e)	Target STD (*f)	Deviation Cal. [%]	Deviation STD [%]	Limit [%]	Pass ?
October 11, 2017	2450	Body	13.1	12.82	51.28	49.6	n/a	+3.4	n/a	±10	Pass	6.09	6.01	24.04	23.3	n/a	+3.2	n/a	±10	Pass

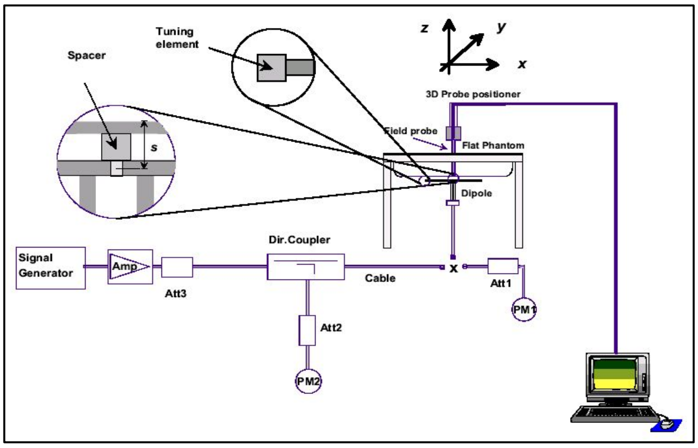
*. Calculating formula: ΔSAR corrected SAR (1g,10g) (W/kg) = (Measured SAR(1g,10g) (W/kg)) × (100 - (ΔSAR(%)) / 100

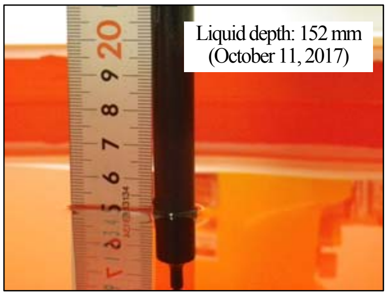
*c. The "Measured" SAR value is obtained at 250 mW for 2450MHz, and at 100 mW for 5GHz band.

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

*e. The target value is a parameter defined in the calibration data sheet of D2450V2 (sn:822) dipole calibrated by Schmid & Partner Engineering AG (Certification No. D2450V2-822_Jan17, the data sheet was filed in this report).

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





Test setup for the system performance check

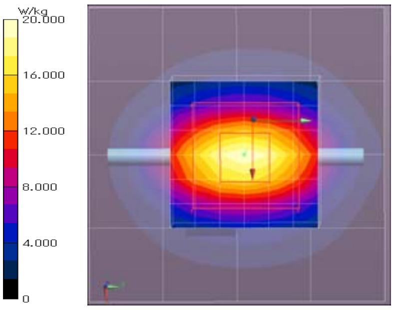
Appendix 2-6: Daily check measurement data

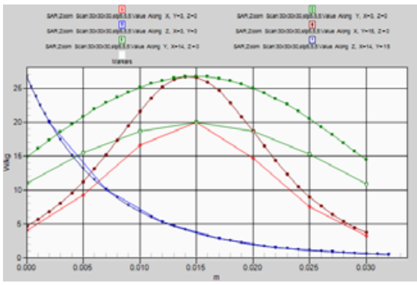
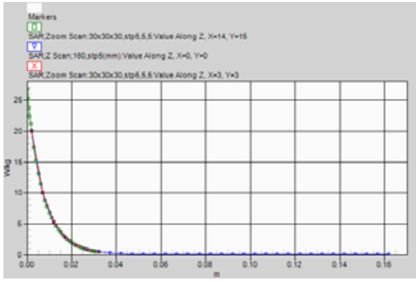
EUT: Dipole(2.45GHz)(sn822); Type: D2450V2; Serial: 822; Forward conducted power: 250mW
Communication System: CW (*. UID:0; Frame Length in ms: 0; PAR: 0; PMF: 1)**; Frequency: 2450 MHz; Crest Factor: 1.0**
Medium: M2450(1710); Medium parameters used: f = 2450 MHz; σ = 1.996 S/m; ε_r = 50.41; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3907; ConvF(7.38, 7.38, 7.38); Calibrated: 2017/02/27; -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331) -Electronics: DAE4 Sn554; Calibrated: 2017/05/18

Area Scan:60x60,stp15 (5x5x1): Measurement grid: dx=15mm, dy=15mm; Maximum value of SAR (measured) = 19.8 W/kg
Area Scan:60x60,stp15 (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm; Maximum value of SAR (interpolated) = 19.9 W/kg
Z Scan;160,stp5(mm) (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 20.0 W/kg

Zoom Scan:30x30x30,stp5,5,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 101.1 V/m; Power Drift = -0.00 dB; Maximum value of SAR (measured) = 20.0 W/kg; Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.09 W/kg



Remarks: *. Date tested: 2017/10/11; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 152 mm; Position: distance of dipole to phantom: 8mm (10mm to liquid); ambient: 23.6 deg.C. / 55 %RH,
*. liquid temperature: 22.1(start)/22.1(end)/22.1(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-7: Daily check uncertainty

Uncertainty of daily check (2.4~6GHz) (*.ε&σ tolerance: ≤±5%, DAK3.5, CW) (v08)	1g SAR	10g SAR
Combined measurement uncertainty of the measurement system (k=1)	± 11.0 %	± 10.9 %
Expanded uncertainty (k=2)	± 22.1 %	± 21.8 %

	Error Description (v08)	Uncertainty Value	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g)	ui (10g)	Vi, veff
A	Measurement System (DASY5)						(std. uncertainty)	(std. uncertainty)	
1	Probe Calibration Error	±6.55 %	Normal	1	1	1	±6.55 %	±6.55 %	∞
2	Axial isotropy error	±4.7 %	Rectangular	√3	√0.5	√0.5	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy error	±9.6 %	Rectangular	√3	0	0	0 %	0 %	∞
4	Probe linearity	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
5	Probe modulation response (CW)	±0.0 %	Rectangular	√3	1	1	0 %	0 %	∞
6	System detection limit	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
7	Boundary effects	±4.8 %	Rectangular	√3	1	1	±2.8 %	±2.8 %	∞
8	System readout electronics (DAE)	±0.3 %	Normal	1	1	1	±0.3 %	±0.3 %	∞
9	Response Time Error (<5ms/100ms wait)	±0.0 %	Rectangular	√3	1	1	0 %	0 %	∞
10	Integration Time Error (CW)	±0.0 %	Rectangular	√3	1	1	0 %	0 %	∞
11	RF ambient conditions-noise	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
12	RF ambient conditions-reflections	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
13	Probe positioner mechanical tolerance	±3.3 %	Rectangular	√3	1	1	±1.9 %	±1.9 %	∞
14	Probe positioning with respect to phantom shell	±6.7 %	Rectangular	√3	1	1	±3.9 %	±3.9 %	∞
15	Max. SAR evaluation (Post-processing)	±4.0 %	Rectangular	√3	1	1	±2.3 %	±2.3 %	∞
B	Test Sample Related								
16	Deviation of the experimental source	±3.5 %	Normal	1	1	1	±3.5 %	±3.5 %	∞
17	Dipole to liquid distance (10mm±0.2mm,<2deg.)	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2 %	∞
18	Drift of output power (measured, <0.2dB)	±2.3 %	Rectangular	√3	1	1	±1.3 %	±1.3 %	∞
C	Phantom and Setup								
19	Phantom uncertainty	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2%	∞
20	Algorithm for correcting SAR (e',σ: ≤5%)	±1.2 %	Normal	1	1	0.84	±1.2 %	±0.97 %	∞
21	Liquid conductivity (meas.) (DAK3.5)	±3.0 %	Normal	1	0.78	0.71	±2.3 %	±2.1 %	∞
22	Liquid permittivity (meas.) (DAK3.5)	±3.1 %	Normal	1	0.23	0.26	±0.7 %	±0.8 %	∞
23	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.3 %	Rectangular	√3	0.78	0.71	±2.4 %	±2.2 %	∞
24	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.9 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty						±11.0 %	±10.9 %	
	Expanded Uncertainty (k=2)						±22.1 %	±21.8 %	

*. This measurement uncertainty budget is suggested by IEEE Std. 1528(2013) and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget).

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4)

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

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

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

Accreditation No.: **SCS 0108**

Client **UL Japan (Vitec)**

Certificate No: **EX3-3907_Feb17**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3907
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	February 27, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 27, 2017

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

Probe EX3DV4

SN:3907

Manufactured:	September 4, 2012
Repaired:	February 15, 2017
Calibrated:	February 27, 2017

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

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.45	0.57	0.54	± 10.1 %
DCP (mV)[B]	98.9	100.0	99.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	133.5	±2.7 %
		Y	0.0	0.0	1.0		150.0	
		Z	0.0	0.0	1.0		144.5	

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

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

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
2450	39.2	1.80	7.37	7.37	7.37	0.35	0.82	± 12.0 %
5200	36.0	4.66	5.56	5.56	5.56	0.30	1.80	± 13.1 %
5250	35.9	4.71	5.45	5.45	5.45	0.30	1.80	± 13.1 %
5500	35.6	4.96	5.03	5.03	5.03	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.69	4.69	4.69	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.80	4.80	4.80	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.81	4.81	4.81	0.40	1.80	± 13.1 %

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

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Calibration Parameter Determined in Body Tissue Simulating Media

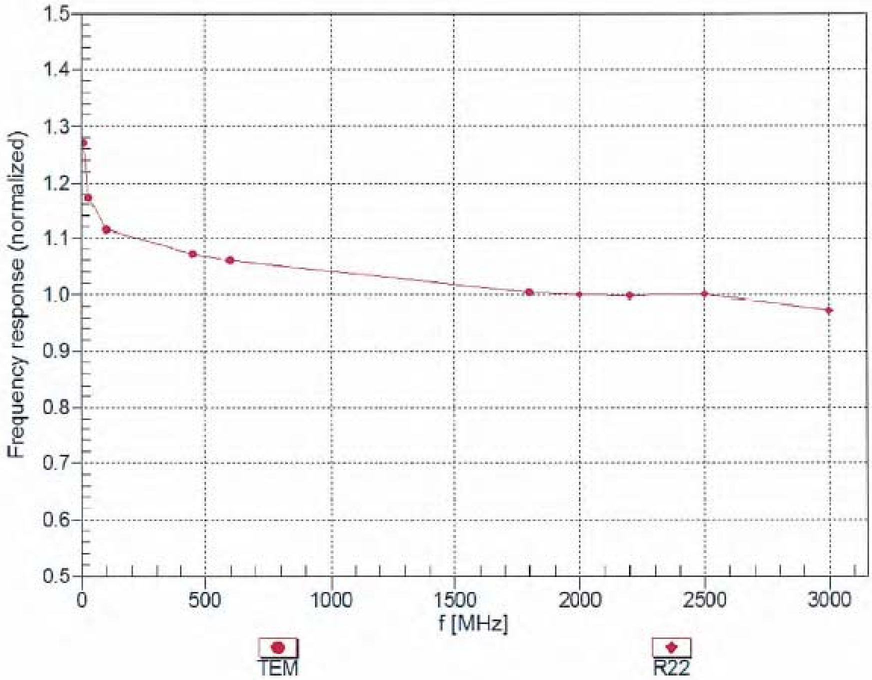
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
2450	52.7	1.95	7.38	7.38	7.38	0.36	0.85	± 12.0 %
5250	48.9	5.36	4.65	4.65	4.65	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.78	3.78	3.78	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.13	4.13	4.13	0.50	1.90	± 13.1 %

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

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

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



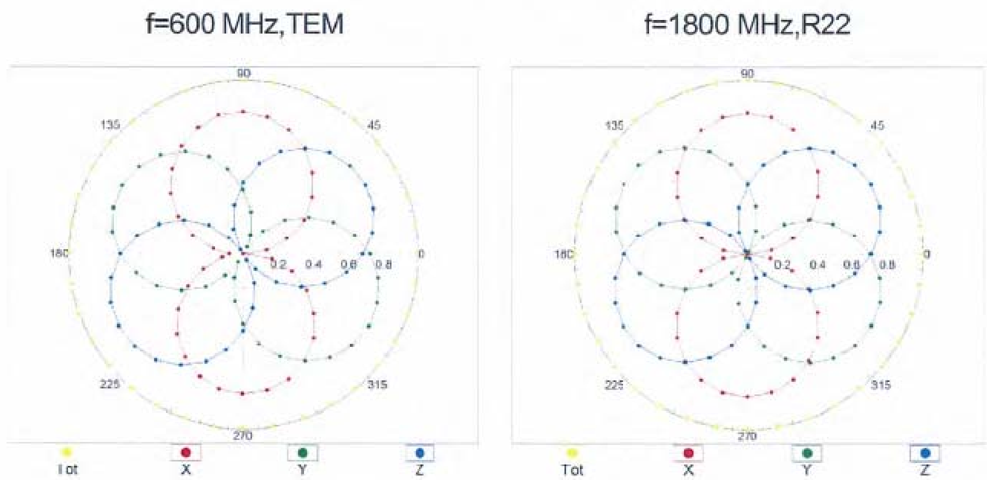
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

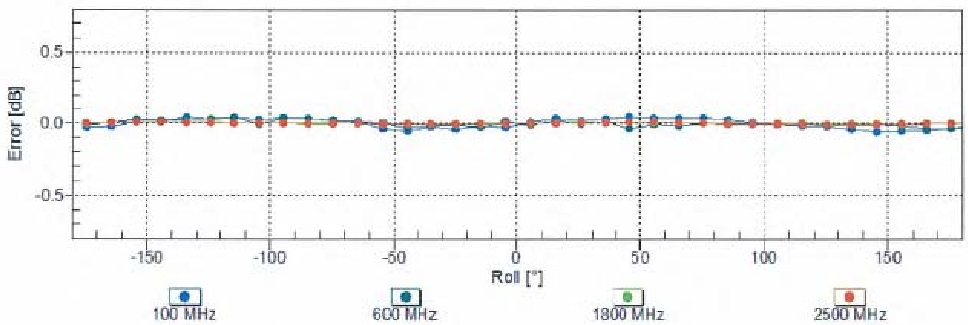
UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3907 February 27, 2017

Receiving Pattern (ϕ), ϑ = 0°





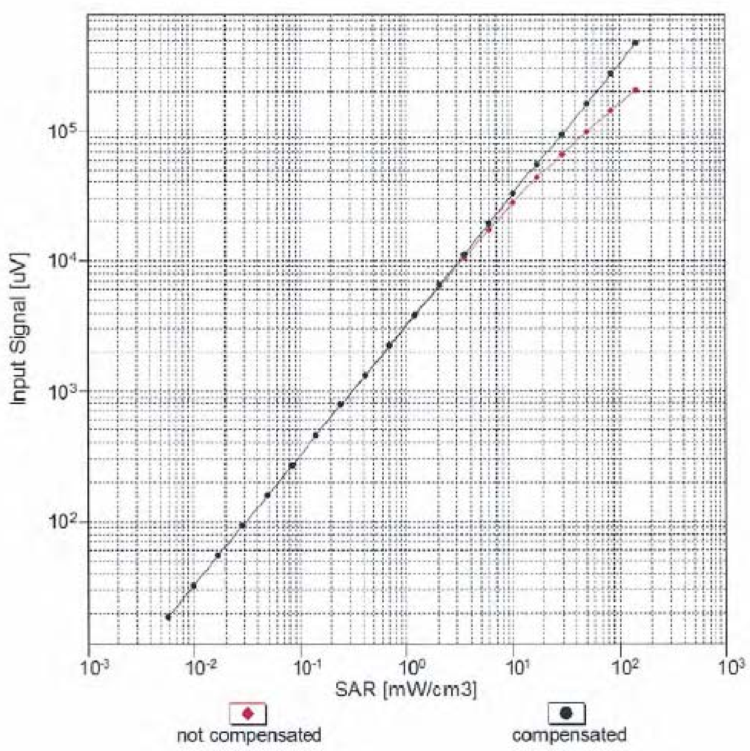
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

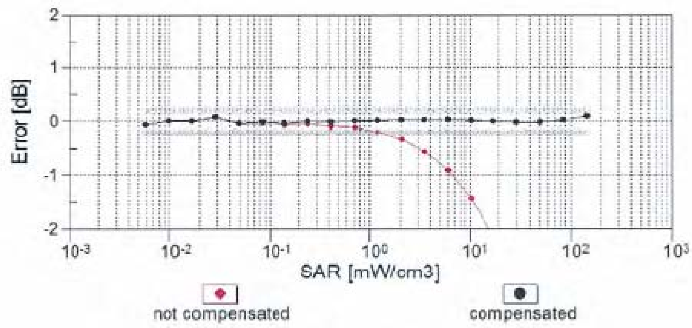
UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3907 February 27, 2017

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





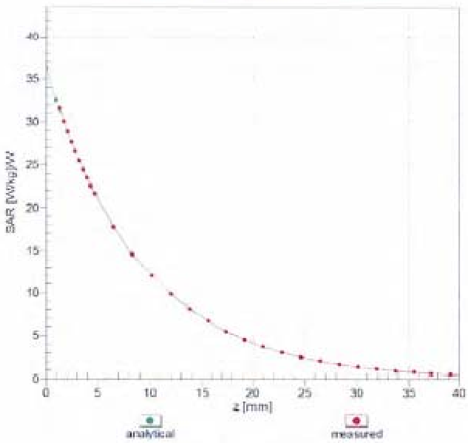
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

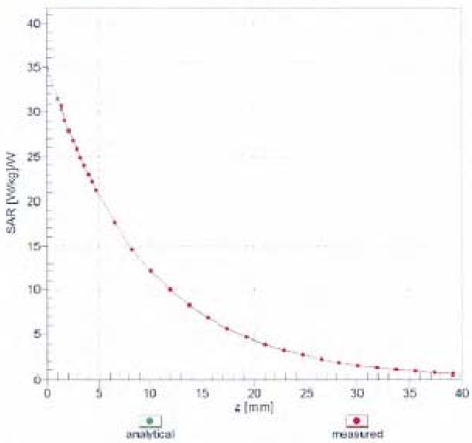
Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

Conversion Factor Assessment

f = 2450 MHz,WGLS R22 (H_convF)

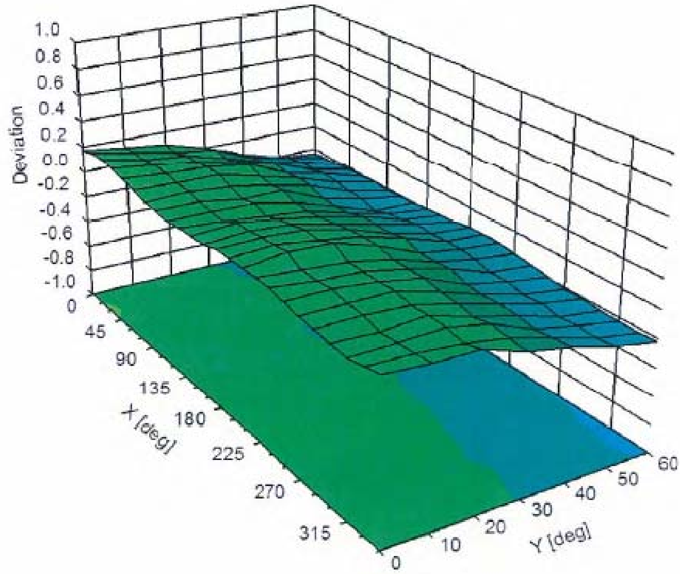


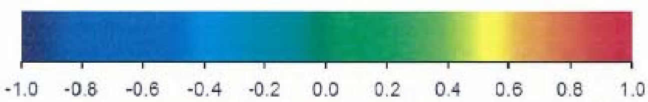
f = 2450 MHz,WGLS R22 (M_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

Appendix 2-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	45.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2)

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

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

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

Accreditation No.: **SCS 0108**

Client **UL Japan Shonan (Vitec)**

Certificate No: **D2450V2-822_Jan17**

CALIBRATION CERTIFICATE

Object: D2450V2 - SN:822

Calibration procedure(s): QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: January 11, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 13, 2017

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.0 ± 6 %	1.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.0 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

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

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.88 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.3 W/kg ± 16.5 % (k=2)**

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.4 Ω + 5.1 jΩ
Return Loss	- 23.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.6 Ω + 5.9 jΩ
Return Loss	- 24.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 11, 2008

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Head TSL

Date: 10.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

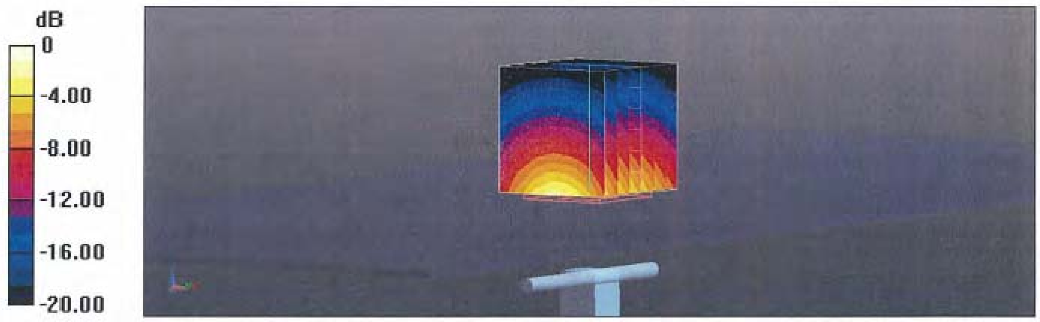
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.88 S/m; ε_r = 38; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 112.9 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 26.9 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.09 W/kg
Maximum value of SAR (measured) = 21.6 W/kg

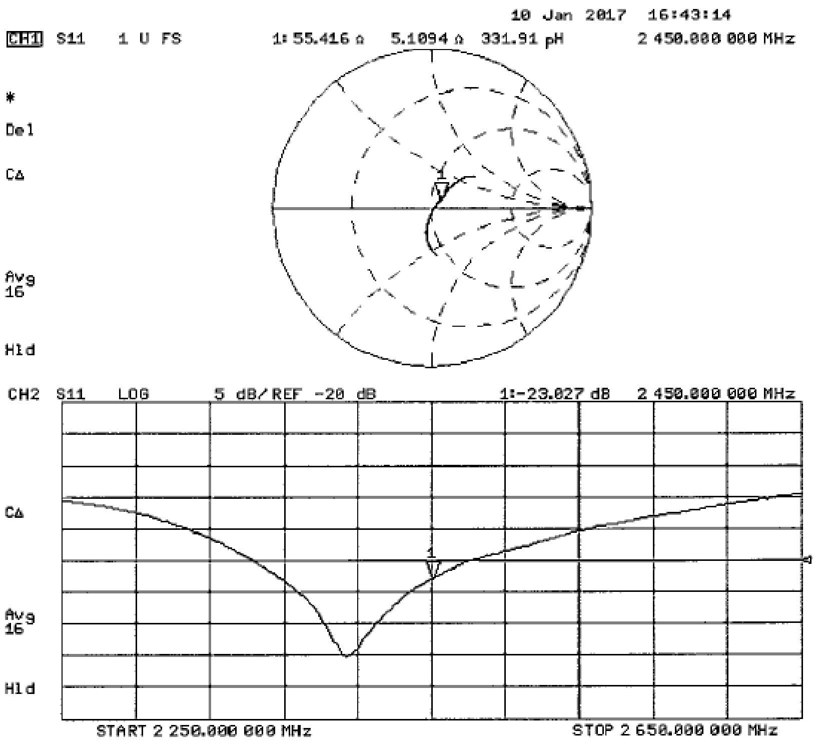


0 dB = 21.6 W/kg = 13.34 dBW/kg

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Head TSL



UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Body TSL

Date: 11.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

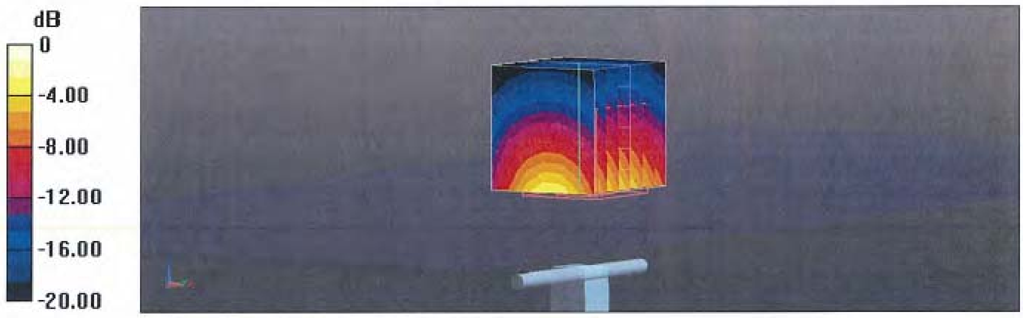
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 52.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.9 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 25.5 W/kg
SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.88 W/kg
Maximum value of SAR (measured) = 20.1 W/kg

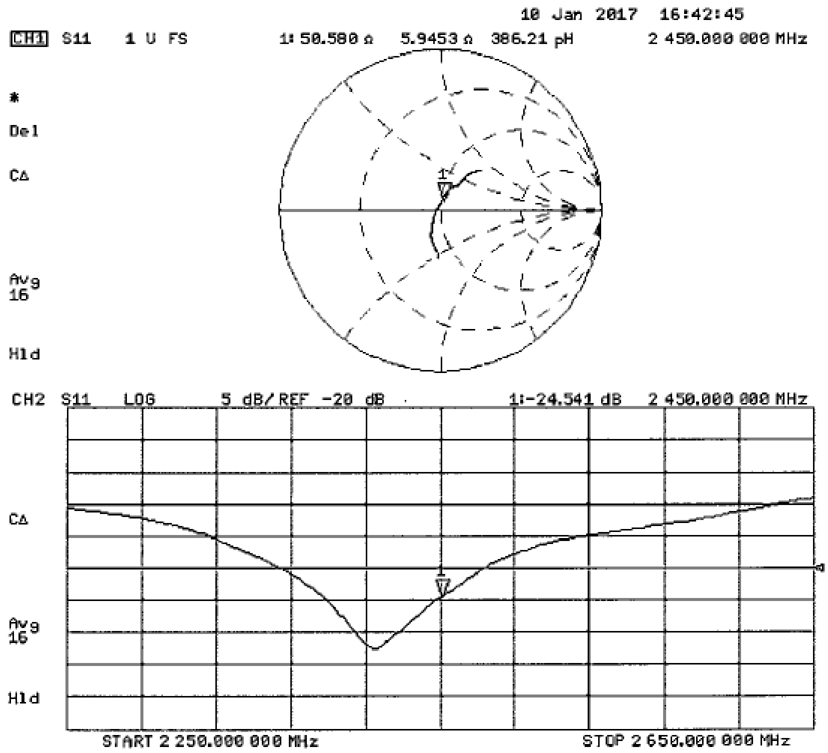


0 dB = 20.1 W/kg = 13.03 dBW/kg

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401

Appendix 2-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Body TSL



UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
Telephone: +81 463 50 6400 / Facsimile: +81 463 50 6401