



## SAR Test Report

Product Name : Barcode Scanner

Model No. : 8680i

FCC ID : HD5-8680B

Applicant : HONEYWELL INTERNATIONAL INC  
Honeywell Safety and Productivity Solutions  
Address : 9680 OLD BAILES RD  
FORT MILL SC 29707-7539,USA

Date of Receipt : Jun. 21, 2019  
Test Date : Jun. 26, 2019 ~ Jul. 08, 2019  
Issued Date : Jul. 08, 2019  
Report No. : 1962139R-HP-US-P03V01  
Report Version : V1.0

The test results relate only to the samples tested.

The test report shall not be reproduced without the written approval of DEKRA Testing and Certification (Suzhou) Co., Ltd.

The measurement result is considered in conformance with the requirement if it is within the prescribed limit, It is not necessary to calculate the uncertainty associated with the measurement result.

This report is not used for social proof in China market.

# Test Report Certification

Issued Date: Jul. 08, 2019

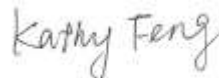
Report No: 1962139R-HP-US-P03V01



Product Name : Barcode Scanner  
Applicant : HONEYWELL INTERNATIONAL INC  
Honeywell Safety and Productivity Solutions  
Address : 9680 OLD BAILES RD FORT MILL SC 29707-7539,USA  
Manufacturer : HONEYWELL INTERNATIONAL INC  
Honeywell Safety and Productivity Solutions  
Address : 9680 OLD BAILES RD FORT MILL SC 29707-7539,USA  
Model No. : 8680i  
FCC ID : HD5-8680B  
EUT Voltage : DC 3.8V  
Applicable Standard : FCC KDB Publication 248227 D01v02r02  
FCC KDB Publication 447498 D01v06  
FCC KDB Publication 865664 D01v01r04  
IEEE Std. 1528-2013  
FCC 47CFR §2.1093  
ANSI C95.1-2005  
Test Result : Max. SAR Measurement (10g)  
2.4G: **0.645** W/kg;  
5G: **0.356** W/kg;  
Simultaneously SAR: **0.729** W/kg  
Performed Location : DEKRA Testing and Certification (Suzhou) Co., Ltd.  
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### History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
1962139R-HP-US-P03V01	V1.0	Initial Issued Report	Jul. 08, 2019

## 1. General Information

### 1.1. EUT Description

Product Name	Barcode Scanner
Model No.	8680i
EUT Voltage	DC 3.8V
<b>WIFI</b>	
Frequency range	For 2.4G 802.11b/g/n(20MHz): 2412 ~ 2462 MHz 802.11n(40MHz): 2422 ~ 2452 MHz For 5GHz 802.11a/n(20MHz): 5150 ~ 5350 MHz, 5470 ~ 5725 MHz, 745 – 5825MHz 802.11n(40MHz): 5190 ~ 5310 MHz, 5510 ~ 5670 MHz, 5755MHz, 5795MHz 802.11 ac(80MHz): 5210 MHz, 5290 MHz, 5530 MHz, 5610MHz, 5775MHz
Channel Number	For 2.4GHz 802.11b/g/n(20MHz): 11 802.11n(40MHz): 7 For 5GHz 802.11a/n(20MHz)/ac(20MHz): 24 802.11n(40MHz)/ac(MHz): 11 802.11ac(80MHz): 5
Type of Modulation	For 2.4GHz DSSS: BPSK,QPSK,CCK OFDM: BPSK, QPSK, 16QAM, 64QAM For 5GHz OFDM-BPSK, QPSK, 16QAM, 64QAM, 128QAM, 256QAM
Data Rate	802.11b: 1/2/5.5/11 Mbps 802.11a/g: 6/9/12/18/24/36/48/54 Mbps 802.11n: up to 150 Mbps 802.11ac: up to 433.3 Mbps
<b>BT</b>	
Version	V3.0/V4.0
Frequency range	2402MHz ~ 2483.5MHz
Channel Number	V3.0: 79

	V4.0: 40
Channel Separation	V3.0: 1MHz V4.0: 2MHz
Type of Modulation	V3.0: GFSK, Pi/4 DQPSK, 8DPSK V4.0: GFSK
Data Rate	V3.0: 1Mbps(GFSK), 2Mbps(Pi/4 DQPSK), 3Mbps(8DPSK) V4.0: 1Mbps

**Channel List****For 2.4GHz Band****IEEE 802.11b/g & IEEE 802.11n(20MHz)**

Working Frequency of Each Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
001	2412 MHz	002	2417 MHz	003	2422 MHz	004	2427 MHz
005	2432 MHz	006	2437 MHz	007	2442 MHz	008	2447 MHz
009	2452 MHz	010	2457 MHz	011	2462 MHz	-	-

**IEEE 802.11n(40MHz)**

Working Frequency of Each Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
003	2422 MHz	004	2427 MHz	005	2432 MHz	006	2437 MHz
007	2442 MHz	008	2447 MHz	009	2452 MHz	-	-

**For 5.0GHz Band****IEEE 802.11a/n(20MHz)/ac(20MHz)**

Working Frequency of Each Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
36	5180 MHz	40	5200 MHz	44	5220 MHz	48	5240 MHz
52	5260 MHz	56	5280 MHz	60	5300 MHz	64	5320 MHz
100	5500 MHz	104	5520 MHz	108	5540 MHz	112	5550 MHz
116	5580 MHz	120	5600 MHz	124	5620 MHz	128	5640 MHz
132	5660 MHz	136	5680 MHz	140	5700 MHz	149	5745 MHz
153	5765 MHz	157	5785 MHz	161	5805 MHz	165	5825MHz

**IEEE 802.11n(40MHz)/ac(40MHz)**

Working Frequency of Each Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz	54	5270 MHz	62	5310 MHz
102	5510 MHz	110	5550 MHz	118	5590 MHz	126	5630 MHz
134	5670 MHz	151	5755 MHz	159	5795 MHz	N/A	N/A

**IEEE 802.11ac(80MHz)**

Working Frequency of Each Channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
42	5210 MHz	58	5290 MHz	106	5530MHz	122	5610 MHz
155	5775 MHz	N/A	N/A	N/A	N/A	N/A	N/A



Bluetooth Working Frequency of Each Channel: (For V4.0)							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
00	2402 MHz	01	2404 MHz	02	2406 MHz	03	2408 MHz
04	2410 MHz	05	2412 MHz	06	2414 MHz	07	2416 MHz
08	2418 MHz	09	2420 MHz	10	2422 MHz	11	2424 MHz
12	2426 MHz	13	2428 MHz	14	2430 MHz	15	2432 MHz
16	2434 MHz	17	2436 MHz	18	2438 MHz	19	2440 MHz
20	2442 MHz	21	2444 MHz	22	2446 MHz	23	2448 MHz
24	2450 MHz	25	2452 MHz	26	2454 MHz	27	2456 MHz
28	2458 MHz	29	2460 MHz	30	2462 MHz	31	2464 MHz
32	2466 MHz	33	2468 MHz	34	2470 MHz	35	2472 MHz
36	2474 MHz	37	2476 MHz	38	2478 MHz	39	2480 MHz

Bluetooth Working Frequency of Each Channel: (For V3.0)							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
00	2402 MHz	01	2403 MHz	02	2404 MHz	03	2405 MHz
04	2406 MHz	05	2407 MHz	06	2408 MHz	07	2409 MHz
08	2410 MHz	09	2411 MHz	10	2412 MHz	11	2413 MHz
12	2414 MHz	13	2415 MHz	14	2416 MHz	15	2417 MHz
16	2418 MHz	17	2419 MHz	18	2420 MHz	19	2421 MHz
20	2422 MHz	21	2423 MHz	22	2424 MHz	23	2425 MHz
24	2426 MHz	25	2427 MHz	26	2428 MHz	27	2429 MHz
28	2430 MHz	29	2431 MHz	30	2432 MHz	31	2433 MHz
32	2434 MHz	33	2435 MHz	34	2436 MHz	35	2437 MHz
36	2438 MHz	37	2439 MHz	38	2440 MHz	39	2441 MHz
40	2442 MHz	41	2443 MHz	42	2444 MHz	43	2445 MHz
44	2446 MHz	45	2447 MHz	46	2448 MHz	47	2449 MHz
48	2450 MHz	49	2451 MHz	50	2452 MHz	51	2453 MHz
52	2454 MHz	53	2455 MHz	54	2456 MHz	55	2457 MHz
56	2458 MHz	57	2459 MHz	58	2460 MHz	59	2461 MHz
60	2462 MHz	61	2463 MHz	62	2464 MHz	63	2465 MHz
64	2466 MHz	65	2467 MHz	66	2468 MHz	67	2469 MHz
68	2470 MHz	69	2471 MHz	70	2472 MHz	71	2473 MHz
72	2474 MHz	73	2475 MHz	74	2476 MHz	75	2477 MHz
76	2478 MHz	77	2479 MHz	78	2480 MHz	N/A	N/A

**Antenna List**

Antenna model / type number .....	N/A		
Antenna serial number .....	N/A		
Antenna Delivery .....	<input checked="" type="checkbox"/>	1TX + 1RX	
	<input type="checkbox"/>	2TX + 2RX	
	<input type="checkbox"/>	Others .....	
Antenna technology.....	<input checked="" type="checkbox"/>	SISO	
	<input type="checkbox"/>	MIMO	<input type="checkbox"/> Basic
			<input type="checkbox"/> CDD
			<input type="checkbox"/> Sectorized
			<input type="checkbox"/> Beam-forming
Antenna Type.....	<input type="checkbox"/>	External	<input type="checkbox"/> Dipole
			<input type="checkbox"/> Sectorized
	<input checked="" type="checkbox"/>	Internal	<input checked="" type="checkbox"/> PIFA
			<input type="checkbox"/> PCB
			<input type="checkbox"/> Others.....
Antenna Gain .....	2.4GHz: 4.3dBi 5GHz: 2.7dBi		
Directional Gain.....	For Power: N/A		
	For PSD: N/A		

## 1.2. Test Environment

Ambient conditions in the laboratory:

Items	Required	Actual
Temperature (°C)	18-25	21.5± 2
Humidity (%RH)	30-70	52

## 1.3. Power Reduction for SAR

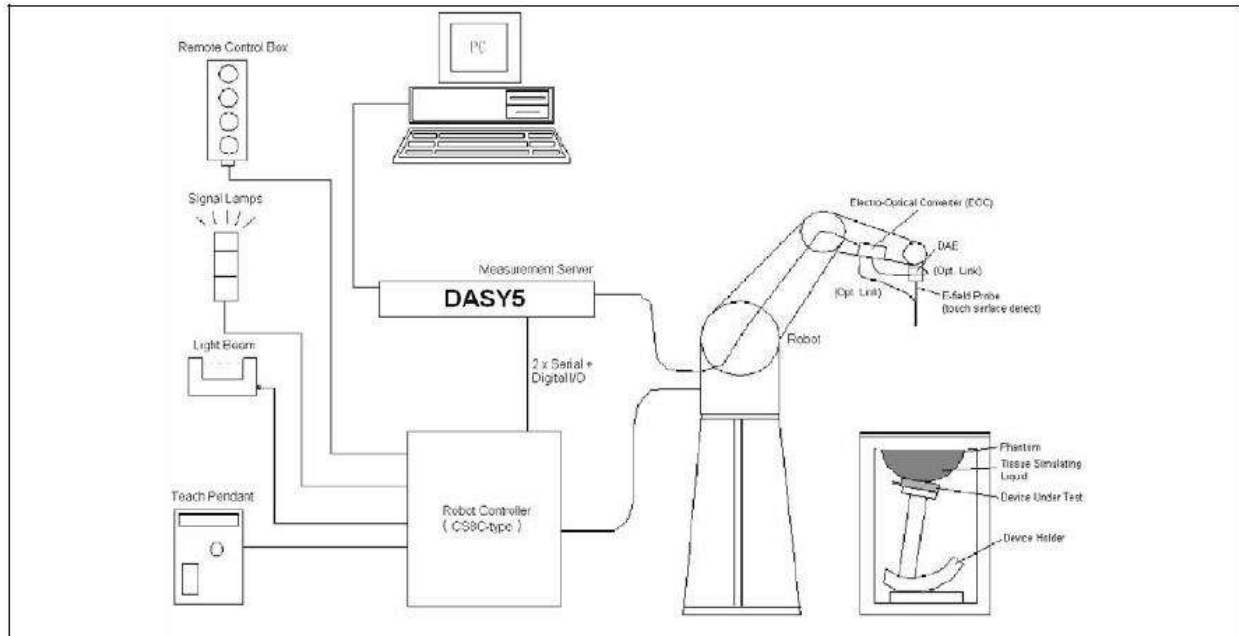
There is no power reduction used for any band/mode implemented in this device for SAR purposes.

## 1.4. Guidance Documents

- 1) FCC KDB Publication 447498 D01v06 (General SAR Guidance)
- 2) FCC KDB Publication 865664 D01v01r04(SAR measurement 100 MHz to 6 GHz)
- 3) FCC KDB Publication 248227 D01v02r02 (SAR Considerations for 802.11 Devices)
- 4) 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)
- 5) FCC 47CFR §2.1093 Radiofrequency radiation exposure evaluation: portable devices
- 6) ANSI C95.1-2005 - IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

## 2. SAR Measurement System

### 2.1. DASY5 System Description



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

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

### **2.1.1. Applications**

Predefined procedures and evaluations for automated compliance testing with all worldwide standards, e.g., IEEE 1528, OET 65, IEC 62209-1, IEC 62209-2, EN 50360, EN 50383 and others.

### **2.1.2. Area Scans**

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a  $10\text{mm}^2$  step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

### **2.1.3. Zoom Scan (Cube Scan Averaging)**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of  $1000\text{ kg/m}^3$  is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of  $7\times 7\times 7$  (5mmx5mmx5mm) providing a volume of 30mm in the X & Y axis, and 30mm in the Z axis.

### **2.1.4. Uncertainty of Inter-/Extrapolation and Averaging**

In order to evaluate the uncertainty of the interpolation, extrapolation and averaged SAR calculation algorithms of the Postprocessor, DASY5 allows the generation of measurement grids which are artificially predefined by analytically based test functions. Therefore, the grids of area scans and zoom scans can be filled with uncertainty test data, according to the SAR benchmark functions of IEEE 1528. The three analytical functions shown in equations as below are used to describe the possible range of the expected SAR distributions for the tested handsets. The field gradients are covered by the spatially flat distribution f1, the spatially steep distribution f3 and f2 accounts for H-field cancellation on the phantom/tissue surface.

$$f_1(x, y, z) = A e^{-\frac{z}{2a}} \cos^2 \left( \frac{\pi}{2} \frac{\sqrt{x'^2 + y'^2}}{5a} \right)$$

$$f_2(x, y, z) = A e^{-\frac{z}{a}} \frac{a^2}{a^2 + x'^2} \left( 3 - e^{-\frac{2z}{a}} \right) \cos^2 \left( \frac{\pi}{2} \frac{y'}{3a} \right)$$


$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \left( e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

## 2.2. DASY5 E-Field Probe

The SAR measurement is conducted with the dosimetric probe manufactured by SPEAG. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 62209-1, IEC 62209, etc.) under ISO 17025. The calibration data are in Appendix D.

### 2.2.1. Isotropic E-Field Probe Specification

Model	EX3DV4	
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 6 GHz Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)	
Directivity	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 $\mu$ W/g to 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)	
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

### 2.3. Boundary Detection Unit and Probe Mounting Device

The DASY probes use a precise connector and an additional holder for the probe, consisting of a plastic tube and a flexible silicon ring to center the probe. The connector at the DAE is flexibly mounted and held in the default position with magnets and springs. Two switching systems in the connector mount detect frontal and lateral probe collisions and trigger the necessary software response.



### 2.4. DATA Acquisition Electronics (DAE) and Measurement Server

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV Celeron, 128MB chipdisk and 128MB RAM. The necessary circuits for communication with the DAE 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.



## 2.5. Robot

The DASY5 system uses the high precision robots TX90 XL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system, the CS8C robot controller version from Stäubli is used.

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

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



## 2.6. Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.





## 2.7. Device Holder

The DASY5 device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

The DASY5 device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon_r \approx 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



## 2.8. SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- Flat phantom



The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom tip, three reference markers are provided to identify the phantom position with respect to the robot.

### 3. Tissue Simulating Liquid

#### 3.1. The composition of the tissue simulating liquid

INGREDIENT (% Weight)	2450MHz Body	5250MHz Body	5600MHz Body	5750MHz Body
Water	73.2	75.68	75.68	75.68
Salt	0.04	0.43	0.43	0.43
Sugar	0.00	0.00	0.00	0.00
HEC	0.00	0.00	0.00	0.00
Preventol	0.00	0.00	0.00	0.00
DGBE	26.76	4.42	4.42	4.42
Triton X-100	0.00	19.47	19.47	19.47

### 3.2. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using DASY5 Dielectric Probe Kit and Agilent Vector Network Analyzer E5071C

Body Tissue Simulant Measurement				
Frequency [MHz]	Description	Dielectric Parameters		Tissue Temp. [°C]
		$\epsilon_r$	$\sigma$ [s/m]	
2450MHz	Reference result $\pm 5\%$ window	52.7 50.07 to 55.34	1.95 1.85 to 2.05	N/A
	06-26-2019	52.27	1.97	21.0
5250MHz	Reference result $\pm 5\%$ window	49.0 46.55 to 51.45	5.36 5.09 to 5.63	N/A
	07-01-2019	49.39	5.38	21.0
5600MHz	Reference result $\pm 5\%$ window	48.5 46.10 to 50.90	5.77 5.48 to 6.06	N/A
	07-01-2019	48.16	5.84	21.0
5750MHz	Reference result $\pm 5\%$ window	48.3 45.86 to 50.69	5.94 5.65 to 6.24	N/A
	07-01-2019	47.82	6.09	21.0

### 3.3. Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

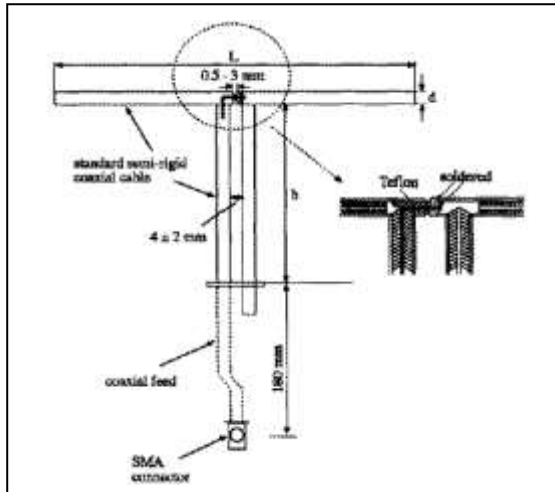
Target Frequency	Head		Body	
(MHz)	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
<b>2450</b>	39.2	1.80	<b>52.7</b>	<b>1.95</b>
3000	38.5	2.40	52.0	2.73
<b>5800</b>	35.3	5.27	<b>48.2</b>	<b>6.00</b>

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

## 4. SAR Measurement Procedure

### 4.1. SAR System Validation

#### 4.1.1. Validation Dipoles



The dipoles used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical specifications for the dipoles.

Frequency	L (mm)	h (mm)	d (mm)
2450MHz	53.5	30.4	3.6
5250MHz	20.6	14.2	3.6
5600MHz	20.6	14.2	3.6
5750MHz	20.6	14.2	3.6

#### 4.1.2. Validation Result

##### System Performance Check at 2450MHz, 5250MHz, 5600MHz and 5750MHz

##### Validation Dipole: D2450V2, SN: 839

Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
2450 MHz	Reference result ± 10% window	50.8 45.72 to 55.88	23.5 21.15 to 25.85	N/A
	06-26-2019	50.8	22.68	21.0

##### Validation Dipole: D5GHzV2, SN: 1078

5250 MHz	Reference result ± 10% window	73.6 66.24 to 80.96	20.9 18.81 to 22.99	N/A
	07-01-2019	72.5	21.1	21.0
5600 MHz	Reference result ± 10% window	77.3 69.57 to 85.03	21.9 19.71 to 24.09	N/A
	07-01-2019	77.8	22.3	21.0
5750 MHz	Reference result ± 10% window	74.4 66.96 to 81.84	20.9 18.81 to 22.99	N/A
	07-01-2019	75.0	21.3	21.0

Note: All SAR values are normalized to 1W forward power.

## 4.2. SAR Measurement Procedure

The DASY 5 calculates SAR using the following equation,

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

$\sigma$ : represents the simulated tissue conductivity

$\rho$ : represents the tissue density

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at  $1\text{mm}^2$ ) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at  $1\text{mm}^3$ ).

### **4.3. SAR Measurement Conditions for 802.11 Device**

#### **4.3.1. Duty Factor Control**

Unless it is permitted by specific KDB procedures or continuous transmission is specifically restricted by the device, the reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

#### **4.3.2. Initial Test Position SAR Test Reduction Procedure**

DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.<sup>16</sup> The initial test position procedure is described in the following:

When the reported SAR of the initial test position is  $\leq 0.4$  W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).

a) When the reported SAR of the initial test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the reported SAR is  $\leq 0.8$  W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.

b) For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.

Additional power measurements may be required for this step, which should be limited to those necessary for identifying the subsequent highest output power channels.



## 5. SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

### Limits for General Population/Uncontrolled Exposure (W/kg)

Type Exposure	Uncontrolled Environment Limit
Spatial Peak SAR (1g cube tissue for brain or body)	<b>1.60 W/kg</b>
Spatial Average SAR (whole body)	<b>0.08 W/kg</b>
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	<b>4.00 W/kg</b>

## 6. Test Equipment List

Instrument	Manufacturer	Model No.	Serial No.	Cali. Due Date
Stäubli Robot TX60L	Stäubli	TX60L	F10/5C90A1/A/01	N/A
Controller	Stäubli	SP1	S-0034	N/A
Dipole Validation Kits	Speag	D2450V2	839	2022.03.24
Dipole Validation Kits	Speag	D5GHzV2	1078	2022.03.21
SAM Twin Phantom	Speag	SAM	TP-1561/1562	N/A
Device Holder	Speag	SD 000 H01 HA	N/A	N/A
Data Acquisition Electronic	Speag	DAE4	1220	2020.04.10
E-Field Probe	Speag	EX3DV4	3710	2020.04.24
SAR Software	Speag	DASY5	V5.2 Build 162	N/A
Power Amplifier	Mini-Circuit	ZVA-183-S+	N657400950	N/A
Directional Coupler	Agilent	778D	20160	N/A
Vector Network	Agilent	E5071C	MY48367267	2020.03.09
Signal Generator	Agilent	E4438C	MY49070163	2020.03.09
Power Meter	Anritsu	ML2495A	0905006	2019.10.14
Wide Bandwidth Sensor	Anritsu	MA2411B	0846014	2019.10.14
Temperature/Humidity Meter	Zhichen	ZC1-2	N/A	2020.04.16
Temperature Meter	OM	N/A	N/N	2020.03.07

## 7. Measurement Uncertainty

<b>DASY5 Uncertainty according to IEEE std. 1528-2013</b>								
Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram / 10 gram.								
Error Description	Uncert. value	Prob. Dist.	Div.	(c <sub>i</sub> ) 1g	(c <sub>i</sub> ) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v <sub>i</sub> ) V <sub>eff</sub>
<b>Measurement System</b>								
Probe Calibration	±6.0%	N	1	1	1	±6.0%	±6.0%	∞
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effects	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.4%	R	$\sqrt{3}$	1	1	±0.2%	±0.2%	∞
Probe Positioning	±2.9%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Max. SAR Eval.	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
<b>Test Sample Related</b>								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
<b>Phantom and Setup</b>								
Phantom Uncertainty	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
Liquid Conductivity (target)	±5.0%	R	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
Liquid Conductivity (meas.)	±2.5%	N	1	0.64	0.43	±1.6%	±1.1%	∞
Liquid Permittivity (target)	±5.0%	R	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
Liquid Permittivity (meas.)	±2.5%	N	1	0.6	0.49	±1.5%	±1.2%	∞
<b>Combined Std. Uncertainty</b>						±11.0%	±10.8%	387
<b>Expanded STD Uncertainty</b>						±22.0%	±21.5%	

<b>DASY5 Uncertainty according to IEEE std. 1528-2013</b>								
Measurement uncertainty for 3 GHz to 6 GHz averaged over 1 gram / 10 gram.								
Error Description	Uncert. value	Prob. Dist.	Div.	(c <sub>i</sub> ) 1g	(c <sub>i</sub> ) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v <sub>i</sub> ) V <sub>eff</sub>
<b>Measurement System</b>								
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%	∞
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effects	±2.0%	R	$\sqrt{3}$	1	1	±1.2%	±1.2%	∞
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Probe Positioning	±9.9%	R	$\sqrt{3}$	1	1	±5.7%	±5.7%	∞
Max. SAR Eval.	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
<b>Test Sample Related</b>								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
<b>Phantom and Setup</b>								
Phantom Uncertainty	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
Liquid Conductivity (target)	±5.0%	R	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
Liquid Conductivity (meas.)	±2.5%	N	1	0.64	0.43	±1.6%	±1.1%	∞
Liquid Permittivity (target)	±5.0%	R	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
Liquid Permittivity (meas.)	±2.5%	N	1	0.6	0.49	±1.5%	±1.2%	∞
<b>Combined Std. Uncertainty</b>						±12.8%	±12.6%	330
<b>Expanded STD Uncertainty</b>						±25.6%	±25.2%	

## 8. Conducted Power Measurement

For 2.4GHz:

Test Mode	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
802.11b	2412	20.06	100	20.5	1.107
	2437	21.88	100	22.0	1.028
	2462	19.83	100	20.0	1.040
802.11g	2412	21.91	99	22.0	1.021
	2437	22.16	99	22.5	1.081
	2462	21.07	99	21.5	1.104
802.11n(20MHz)	2412	22.12	99	22.5	1.072
	2437	22.15	99	23.5	1.084
	2462	21.06	99	21.5	1.107
802.11n(40MHz)	2422	21.77	98	22.0	1.054
	2437	20.25	98	20.5	1.059
	2452	19.32	98	19.5	1.042

For 5GHz:

**Mode 1: Transmit by 802.11a**

Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
36	5180	15.62	98.81	16.0	1.091
44	5220	15.81	98.81	16.0	1.045
48	5240	15.91	98.81	16.0	1.021
52	5260	14.71	98.81	15.0	1.069
60	5300	14.58	98.81	15.0	1.102
64	5320	15.05	98.81	15.5	1.109
100	5500	17.89	98.81	18.0	1.026
114	5580	17.08	98.81	17.5	1.102
140	5700	17.45	98.81	18.0	1.135
149	5745	17.92	98.81	18.0	1.019
157	5785	17.39	98.81	17.5	1.026
165	5825	17.06	98.81	17.5	1.107

**Mode 2: Transmit by 802.11n(20MHz)**

Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
36	5180	15.92	99.29	16.0	1.019
44	5220	16.04	99.29	16.5	1.112
48	5240	15.96	99.29	16.5	1.132
52	5260	14.32	99.29	14.5	1.042
60	5300	14.3	99.29	14.5	1.047
64	5320	14.79	99.29	15.0	1.050
100	5500	17.11	99.29	17.5	1.094
114	5580	16.74	99.29	17.0	1.062
140	5700	16.97	99.29	17.5	1.130
149	5745	18.07	99.29	18.5	1.104
157	5785	17.53	99.29	18.0	1.114
165	5825	18.91	99.29	19.0	1.021

<b>Mode 3: Transmit by 802.11n(40MHz)</b>					
Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
38	5190	11.53	98.28	12.0	1.114
46	5230	11.67	98.28	12.0	1.079
54	5270	13.21	98.28	13.5	1.069
62	5310	13.64	98.28	14.0	1.086
102	5510	13.56	98.28	14.0	1.107
110	5550	12.64	98.28	13.0	1.086
132	5670	11.49	98.28	12.0	1.125
151	5755	18.36	98.28	18.5	1.033
159	5795	19.1	98.28	19.5	1.096
<b>Mode 4: Transmit by 802.11ac(20MHz)</b>					
Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
36	5180	16.03	99.05	16.5	1.114
44	5220	16.17	99.05	16.5	1.079
48	5240	16.08	99.05	16.5	1.102
52	5260	15.04	99.05	15.5	1.112
60	5300	15.45	99.05	16.0	1.135
64	5320	15.62	99.05	16.0	1.091
100	5500	17.75	99.05	18.0	1.059
114	5580	16.55	99.05	17.0	1.109
140	5700	17.17	99.05	17.5	1.079
149	5745	18.04	99.05	18.5	1.112
157	5785	17.53	99.05	18.0	1.114
165	5825	18.9	99.05	19.0	1.023

**Mode 5: Transmit by 802.11ac(40MHz)**

Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
38	5190	11.54	97.57	12.0	1.112
46	5230	11.63	97.57	12.0	1.089
54	5270	13.22	97.57	13.5	1.067
62	5310	13.64	97.57	14.0	1.086
102	5510	13.54	97.57	14.0	1.112
110	5550	12.67	97.57	13.0	1.079
132	5670	11.48	97.57	12.0	1.127
151	5755	11.41	97.57	11.5	1.021
159	5795	12.36	97.57	12.5	1.033

**Mode 6: Transmit by 802.11ac(80MHz)**

Channel No.	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)	Scaling Factor
42	5210	9.56	96.11	10.0	1.107
58	5290	11.97	96.11	12.5	1.130
106	5530	10.78	96.11	11.0	1.052
155	5775	15.02	96.11	15.5	1.117

**For BT**

Test Mode	Frequency (MHz)	Avg. Power (dBm)	Duty cycle (%)	Tune-up Power (dBm)
DH5	2402	5.76	100	6.0
	2441	6.82	100	7.0
	2480	6.33	100	6.5
2DH5	2402	4.56	100	5.0
	2441	5.09	100	5.5
	2480	4.73	100	5.0
3DH5	2402	4.62	100	5.0
	2441	6.68	100	7.0
	2480	5.43	100	6.0
BLE	2402	-0.21	100	0.0
	2440	-0.05	100	0.0
	2480	-0.29	100	0.0



## 9. Test Procedures

### 9.1. SAR Test Results Summary

SAR MEASUREMENT									
Ambient Temperature (°C) : 21.5 ± 2					Relative Humidity (%): 52				
Liquid Temperature (°C) : 21.0 ± 2					Depth of Liquid (cm):>15				
Product:Barcode Scanner									
Frequency: 2412 ~ 2462 MHz									
Test Mode: 802.11b									
Test Position Body (0mm gap)	Antenna Position	Frequency (MHz)	Frame Power (dBm)	Power Drift (<±0.2)	SAR 10g (W/kg)	Scaling Factor	Duty Factor	Scaled SAR 10g (W/kg)	Limit (W/kg)
Bottom	Fixed	2437	21.88	-0.00	0.510	1.028	1.00	0.524	4.0
Test Mode: 802.11g									
Bottom	Fixed	2437	26.42	0.10	0.591	1.081	1.01	0.645	4.0

SAR MEASUREMENT									
Ambient Temperature (°C) : 21.5 ± 2					Relative Humidity (%): 52				
Liquid Temperature (°C) : 21.0 ± 2					Depth of Liquid (cm):>15				
Product: Barcode Scanner									
Frequency: 5180 ~ 5825 MHz									
Test Mode: 802.11a									
Test Position Body (0mm gap)	Antenna Position	Frequency (MHz)	Frame Power (dBm)	Power Drift (<±0.2)	SAR 10g (W/kg)	Scaling Factor	Duty Factor	Scaled SAR 10g (W/kg)	Limit (W/kg)
Bottom	Fixed	5240	15.91	-0.04	0.122	1.021	1.012	0.127	4.0
Bottom	Fixed	5320	15.05	0.04	0.132	1.109	1.012	0.148	4.0
Bottom	Fixed	5500	17.89	-0.19	0.323	1.026	1.012	0.335	4.0
Bottom	Fixed	5745	17.92	-0.19	0.275	1.019	1.012	0.283	4.0
Test Mode: 802.11n(20MHz)									
Bottom	Fixed	5825	18.91	0.05	0.347	1.021	1.007	0.356	4.0

Note 1: \* - repeated at the highest measured SAR according to the FCC KDB 865664

2: When the reported SAR of the initial test position is > 0.4 W/kg, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions are tested.

3: For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

4: While 1-g SAR thresholds are specified in the procedures for SAR test reduction and exclusion, these thresholds should be multiplied by 2.5 when 10-g extremity SAR is considered.

5: The shape of eraphone is irregular, so we used the body phantom which with head tissue to evaluate the six positions of the EUT.

## **9.2. Test position and configuration**

1. Liquid tissue depth was at least 15.0 cm for all frequencies.
2. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
3. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
4. We only evaluated the position towards the limb as the device was designed to use with the wrist.

### 9.3. SAR Test Exclusions Applied

#### Wi-Fi/Bluetooth

Per FCC KDB 447498 D01v06, the SAR exclusion threshold for distances < 50mm is defined by the following equation:

$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Dist (mm)}} * \sqrt{\text{Frequency (GHz)}} \leq 7.5$$

Per FCC KDB 447498 D01v06, the SAR exclusion threshold for distances > 50mm is defined by the following equation:

$$\frac{[\text{Power allowed at numeric threshold for 50 mm in step 1}) + (\text{Test separation distance} - 50 \text{ mm}) * (\text{Frequency (MHz)} / 150)] \text{ mW}}{\text{Test Separation Dist (mm)}} * \sqrt{\text{Frequency (GHz)}}$$

#### The power exclusion threshold :

2.4G Bluetooth Antenna	Separation distances (mm)	Frequency	Tune-up (mW)	Calculated Threshold Value (≤ 7.5 SAR is not required)	Calculated Threshold Value (SAR test exclusion power, mW)	Test SAR (Y/N)
				Separation distances ≤ 50mm	Separation distances > 50mm	
Bottom	5	2441	5.01	1.565	--	N
Bottom	5	2440	1.0	0.312	--	N

## Simultaneous Transmission Analysis

### Estimation SAR of BT

2.4G Bluetooth Antenna	Separation distances(mm)	Tune-up (mW)	Estimation SAR(W/kg)	Test SAR(Y/N)
Bottom	5	5.01	0.084	N
Bottom	5	1.0	0.017	N

Note: Based on the maximum conducted power of Bluetooth and the antenna to use separation distance,

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{\text{(GHz)}}/x}] \text{ W/kg, for test separation distances } \leq 50 \text{ mm;}$

where  $x = 7.5$  for 1-g SAR and  $x = 18.75$  for 10-g SAR.

### Simultaneous Transmission Scenario with Bluetooth

Simult Tx	Configuration	2.4G WLAN SAR (W/kg)	Estimation BT SAR (W/kg)	Estimation BLE SAR (W/kg)	2.4G+BT $\Sigma$ SAR (W/kg)	2.4G+BLE $\Sigma$ SAR (W/kg)
Body	Bottom	0.645	0.084	0.017	0.729	0.662

Simult Tx	Configuration	5G WLAN SAR (W/kg)	Estimation BT SAR (W/kg)	Estimation BLE SAR (W/kg)	5G+BT $\Sigma$ SAR (W/kg)	5G+BLE $\Sigma$ SAR (W/kg)
Body	Bottom	0.356	0.084	0.017	0.440	0.373

## Appendix A. SAR System Validation Data

Date/Time: 26/06/2019

Test Laboratory: DEKRA Lab

System Check body 2450MHz

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2**

Communication System: UID 0, CW; Communication System Band: D2450(2450MHz); Duty Cycle: 1:1;

Frequency: 2450 MHz; Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.97$  S/m;  $\epsilon_r = 52.27$ ;  $\rho = 1000$  kg/m<sup>3</sup>;

Phantom section: Flat Section ; Input Power=250mW

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

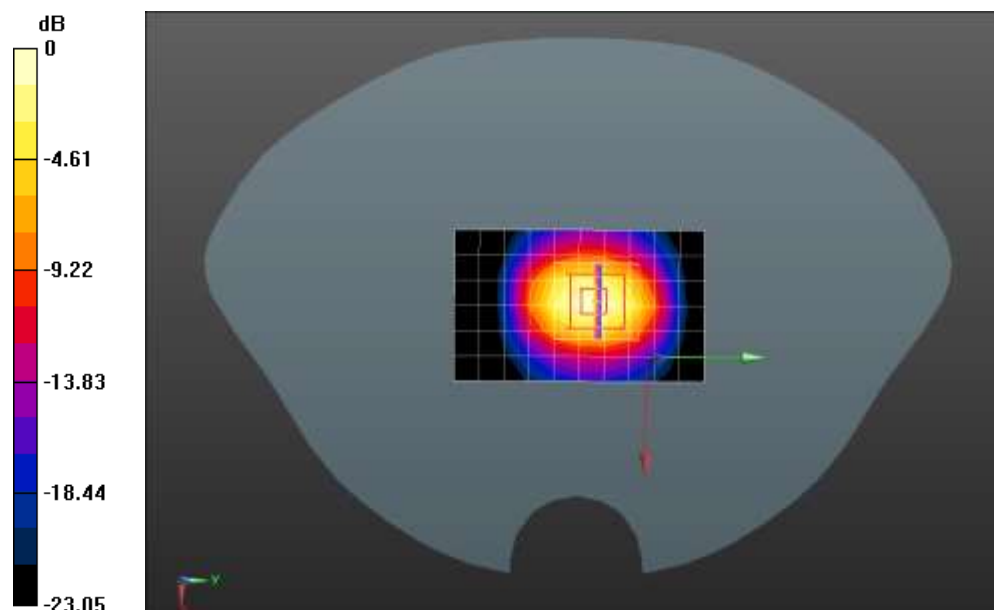
- Probe: EX3DV4 - SN3710; ConvF(7.44, 7.44, 7.44); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/System Check Body 2450MHz/Area Scan (7x11x1):** Measurement grid: dx=10mm, dy=10mm; Maximum value of SAR (measured) = 13.3 W/kg

**Configuration/System Check Body 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm; Reference Value = 81.39 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 27.4 W/kg

**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.67 W/kg;** Maximum value of SAR (measured) = 14.5 W/kg



0 dB = 14.5 W/kg = 11.61 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

System Check Body 5250MHz

**DUT: Dipole D5GHzV2; Type: D5GHzV2**

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1; Frequency: 5250 MHz; Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.38$  S/m;  $\epsilon_r = 49.39$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section; Input Power=100mW

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(4.5, 4.5, 4.5); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

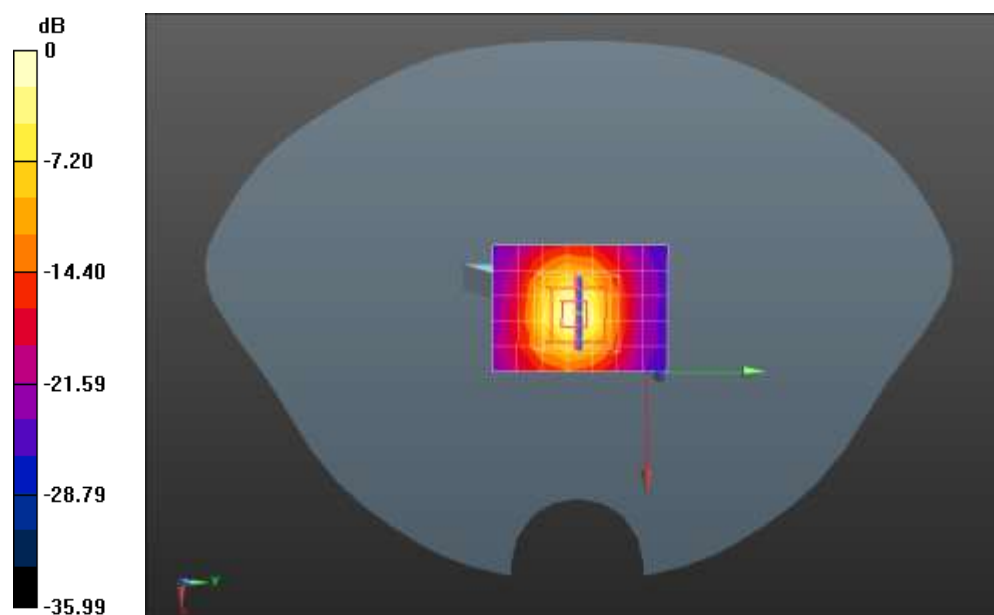
**Configuration/System Check Body 5250MHz/Area Scan (6x8x1):** Measurement grid: dx=10mm, dy=10mm; Maximum value of SAR (measured) = 7.18 W/kg

**Configuration/System Check Body 5250MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm; Reference Value = 38.12 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 52.8 W/kg

**SAR(1 g) = 7.25 W/kg; SAR(10 g) = 2.11 W/kg**

Maximum value of SAR (measured) = 8.72 W/kg



0 dB = 8.72 W/kg = 9.41 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

System Check Body 5600MHz

**DUT: Dipole D5GHzV2; Type: D5GHzV2**

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1; Frequency: 5600 MHz; Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.84$  S/m;  $\epsilon_r = 48.16$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section; Input Power=100mW

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(3.99, 3.99, 3.99); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

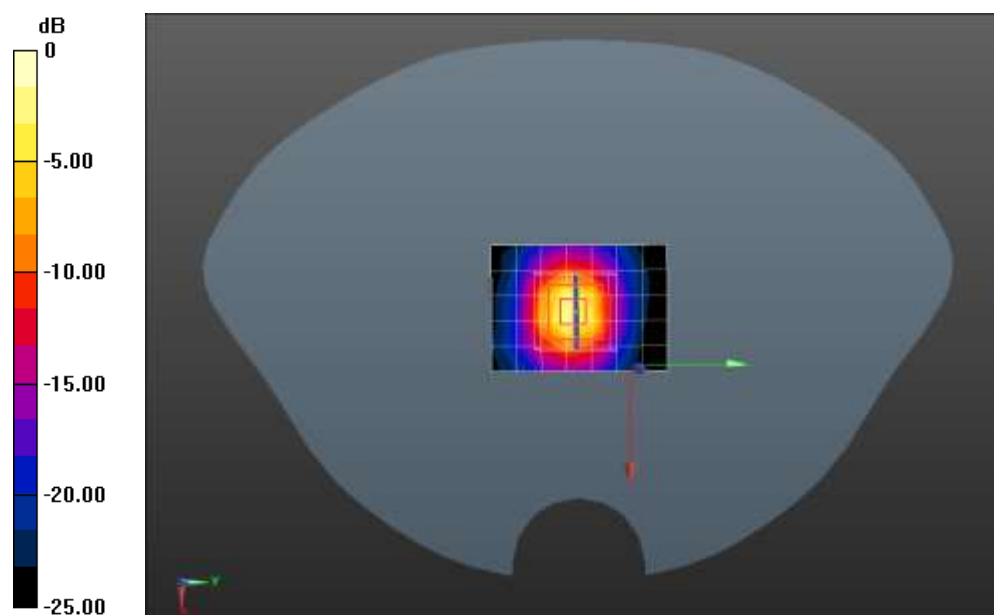
**Configuration/System Check Body 5600MHz/Area Scan (6x8x1):** Measurement grid: dx=10mm, dy=10mm; Maximum value of SAR (measured) = 7.76 W/kg

**Configuration/System Check Body 5600MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm; Reference Value = 36.59 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 27.4 W/kg

**SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.23 W/kg**

Maximum value of SAR (measured) = 10.4 W/kg



0 dB = 10.4 W/kg = 10.17 dBW/kg



Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

System Check Body 5750MHz

**DUT: Dipole D5GHzV2; Type: D5GHzV2**

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1; Frequency: 5750 MHz; Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.09$  S/m;  $\epsilon_r = 47.82$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section; Input Power=100mW

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(4.05, 4.05, 4.05); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

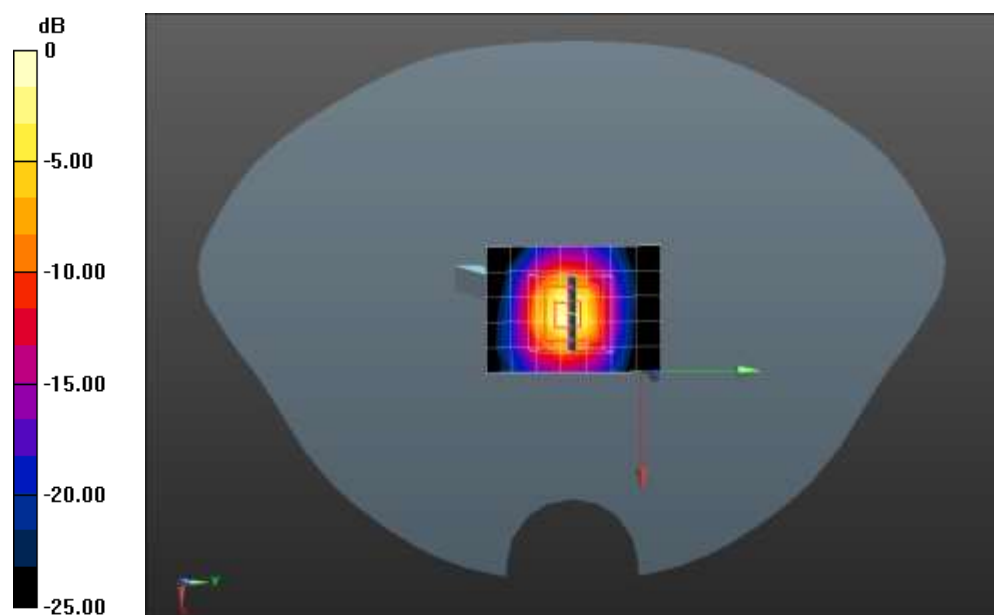
**Configuration/System Check Body 5750MHz/Area Scan (6x8x1):** Measurement grid: dx=10mm, dy=10mm; Maximum value of SAR (measured) = 7.62 W/kg

**Configuration/System Check Body 5750MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm; Reference Value = 37.66 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 26.0 W/kg

**SAR(1 g) = 7.5 W/kg; SAR(10 g) = 2.13 W/kg**

Maximum value of SAR (measured) = 9.57 W/kg



0 dB = 9.57 W/kg = 9.81 dBW/kg

## Appendix B. SAR measurement Data

Date/Time: 26/06/2019

Test Laboratory: DEKRA Lab

802.11b 2437MHz Body Bottom

**DUT: Barcode Scanner; Type: 8680i**

Communication System: UID 0, Wi-Fi (0); Communication System Band: 802.11b; Duty Cycle: 1:1.0;

Frequency: 2437 MHz; Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.96$  S/m;  $\epsilon_r = 52.31$ ;  $\rho = 1000$  kg/m<sup>3</sup> ;

Phantom section: Flat Section ; Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(7.44, 7.44, 7.44); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/802.11b 2437MHz Body-1/Area Scan (7x9x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 1.73 W/kg

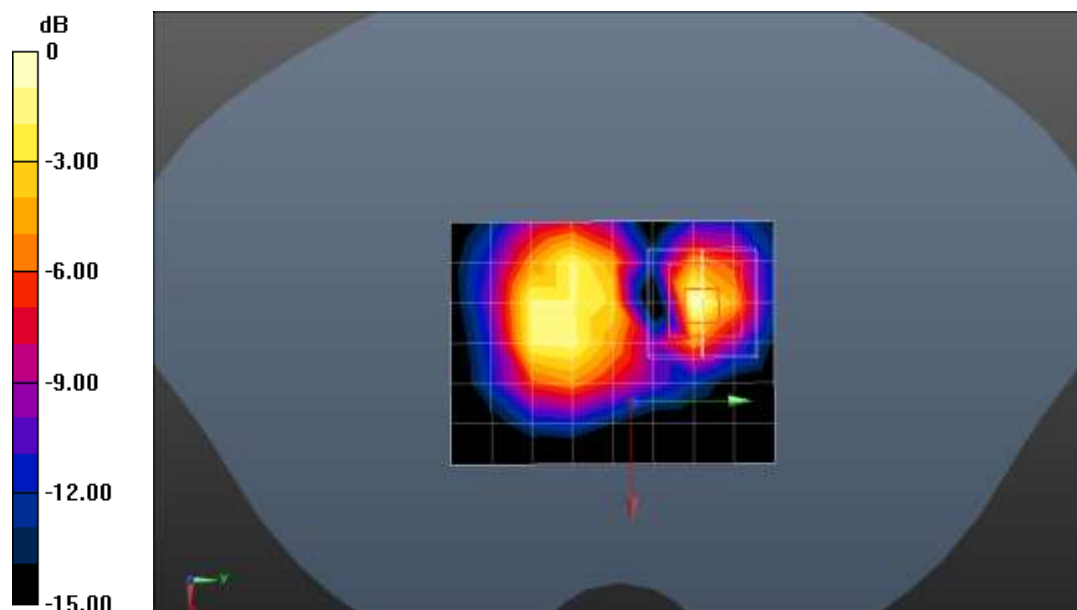
**Configuration/802.11b 2437MHz Body-1/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm,

dy=8mm, dz=5mm; Reference Value = 18.01 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.84 W/kg

**SAR(1 g) = 1.43 W/kg; SAR(10 g) = 0.510 W/kg**

Maximum value of SAR (measured) = 1.77 W/kg



0 dB = 1.77 W/kg = 2.48 dBW/kg

Date/Time: 26/06/2019

Test Laboratory: DEKRA Lab

802.11g 2437MHz Body Bottom

**DUT: Barcode Scanner; Type: 8680i**

Communication System: UID 0, Wi-Fi (0); Communication System Band: 802.11g; Duty Cycle: 1:1.0;

Frequency: 2437 MHz; Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.96$  S/m;  $\epsilon_r = 52.31$ ;  $\rho = 1000$  kg/m<sup>3</sup> ;

Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(7.44, 7.44, 7.44); Calibrated: 25/04/2019;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/802.11g 2437MHz Body 2/Area Scan (7x9x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 1.32 W/kg

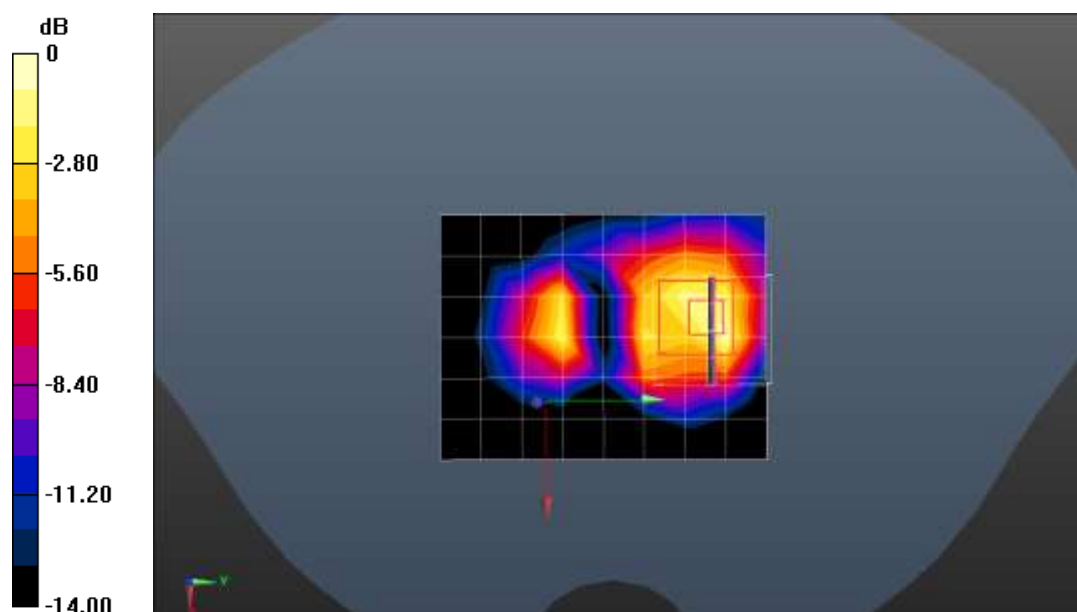
**Configuration/802.11g 2437MHz Body 2/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm,

dy=8mm, dz=5mm; Reference Value = 4.319 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 2.70 W/kg

**SAR(1 g) = 1.31 W/kg; SAR(10 g) = 0.591 W/kg**

Maximum value of SAR (measured) = 1.52 W/kg



0 dB = 1.52 W/kg = 1.82 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

802.11a 5240MHz Body Bottom

DUT: Barcode Scanner; Type: 8616

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1.0; Frequency: 5240 MHz; Medium parameters used:  $f = 5240$  MHz;  $\sigma = 5.37$  S/m;  $\epsilon_r = 49.42$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(4.5, 4.5, 4.5); Calibrated: 25/04/2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

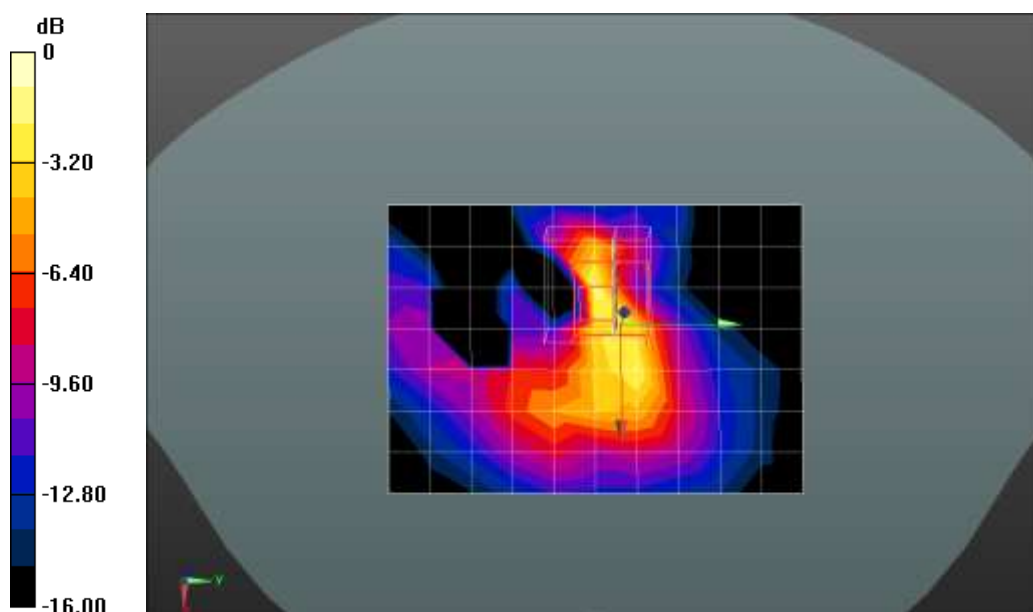
**Configuration/802.11ac 5240MHz Body-Bottom/Area Scan (8x11x1):** Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.867 W/kg

**Configuration/802.11ac 5240MHz Body-Bottom/Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=2mm; Reference Value = 5.445 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 3.20 W/kg

**SAR(1 g) = 0.455 W/kg; SAR(10 g) = 0.122 W/kg**

Maximum value of SAR (measured) = 1.27 W/kg



0 dB = 1.27 W/kg = 1.04 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

802.11a 5320MHz Body Bottom

DUT: Barcode Scanner; Type: 8616

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1.0; Frequency: 5320 MHz; Medium parameters used:  $f = 5320$  MHz;  $\sigma = 4.81$  S/m;  $\epsilon_r = 37.26$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(5.12, 5.12, 5.12); Calibrated: 25/04/2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

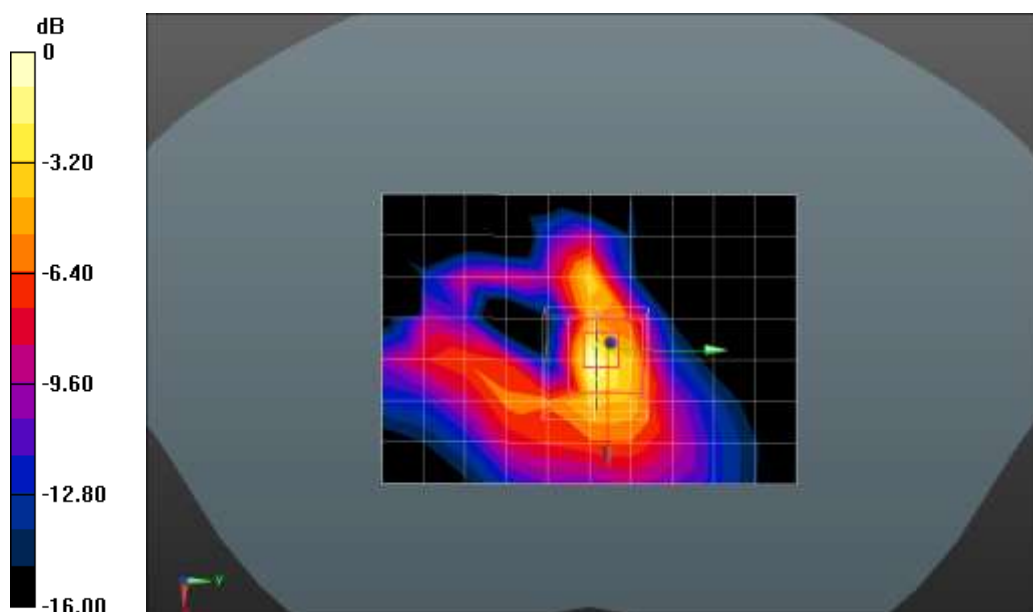
**Configuration/802.11ac 5320MHz Body-Bottom/Area Scan (8x11x1):** Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.782 W/kg

**Configuration/802.11ac 5320MHz Body-Bottom/Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=2mm; Reference Value = 10.01 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 1.68 W/kg

**SAR(1 g) = 0.449 W/kg; SAR(10 g) = 0.132 W/kg**

Maximum value of SAR (measured) = 0.905 W/kg



0 dB = 0.905 W/kg = -0.43 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

802.11a 5500MHz Body Bottom

DUT: Barcode Scanner; Type: 8616

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1.0; Frequency: 5500 MHz; Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.7$  S/m;  $\epsilon_r = 48.51$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(3.99, 3.99, 3.99); Calibrated: 25/04/2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

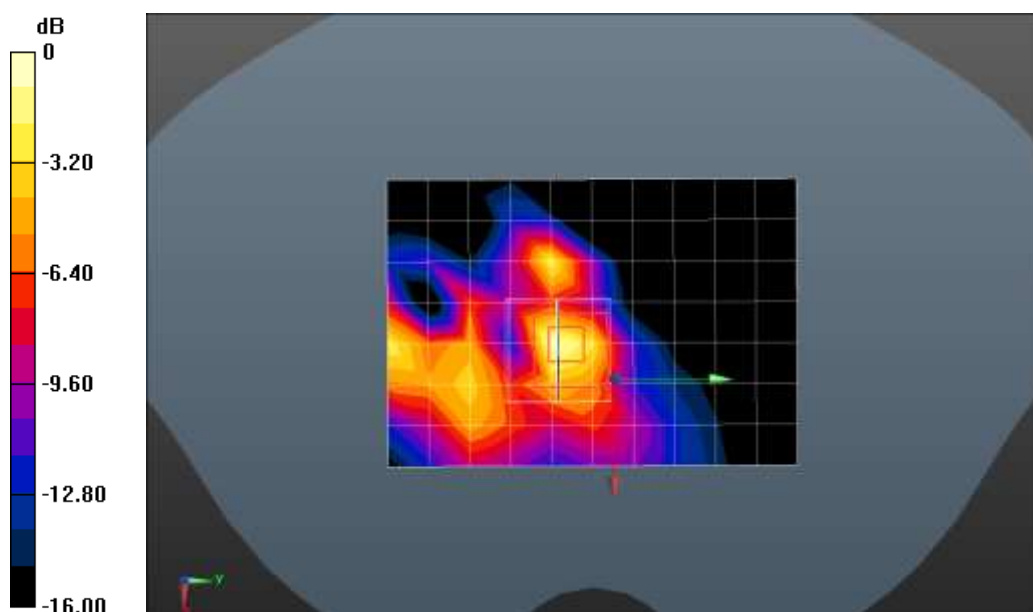
**Configuration/802.11ac 5320MHz Body-Bottom/Area Scan (8x11x1):** Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 2.08 W/kg

**Configuration/802.11ac 5320MHz Body-Bottom/Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=2mm; Reference Value = 10.40 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 4.88 W/kg

**SAR(1 g) = 1.19 W/kg; SAR(10 g) = 0.323 W/kg**

Maximum value of SAR (measured) = 2.21 W/kg



0 dB = 2.21 W/kg = 3.44 dBW/kg

Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

802.11a 5745MHz Body Bottom

DUT: Barcode Scanner; Type: 8616

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1.0; Frequency: 5745 MHz; Medium parameters used:  $f = 5745$  MHz;  $\sigma = 6.09$  S/m;  $\epsilon_r = 47.84$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(4.05, 4.05, 4.05); Calibrated: 25/04/2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

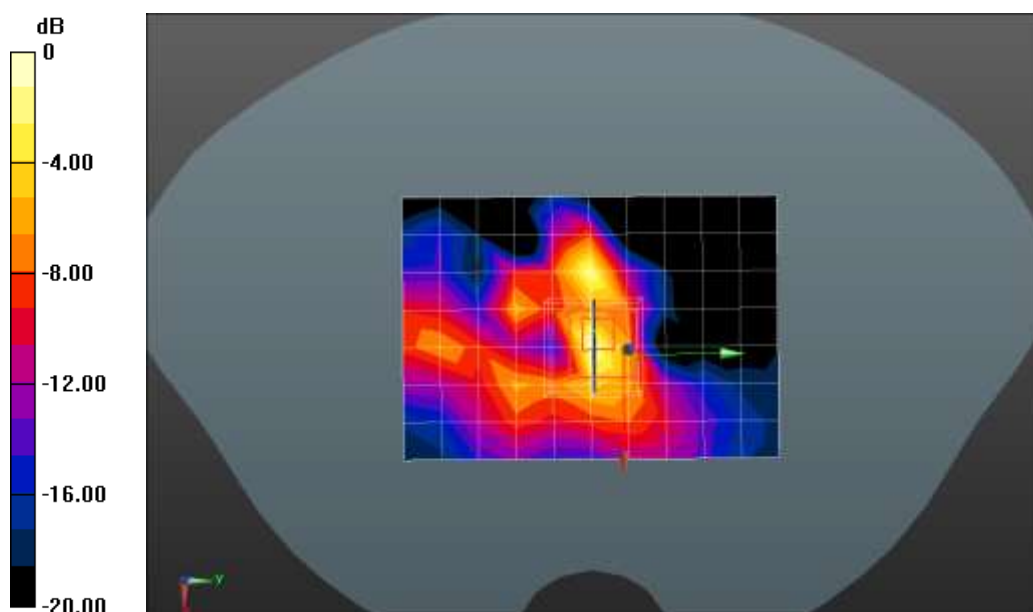
**Configuration/802.11ac 5745MHz Body-Bottom/Area Scan (8x11x1):** Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 1.94 W/kg

**Configuration/802.11ac 5745MHz Body-Bottom/Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=2mm; Reference Value = 14.81 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 4.72 W/kg

**SAR(1 g) = 1.07 W/kg; SAR(10 g) = 0.275 W/kg**

Maximum value of SAR (measured) = 2.32 W/kg



0 dB = 2.32 W/kg = 3.65 dBW/kg



Date/Time: 01/07/2019

Test Laboratory: DEKRA Lab

802.11n20 5825MHz Bottom

**DUT: Barcode Scanner; Type: 8616**

Communication System: UID 0, CW (0); Communication System Band: 5GHz(5000.0-6000.0MHz); Duty Cycle: 1:1.0; Frequency: 5825 MHz; Medium parameters used:  $f = 5825$  MHz;  $\sigma = 6.17$  S/m;  $\epsilon_r = 47.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(4.05, 4.05, 4.05); Calibrated: 25/04/2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 11/04/2019
- Phantom: SAM2; Type: SAM; Serial: TP1562
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

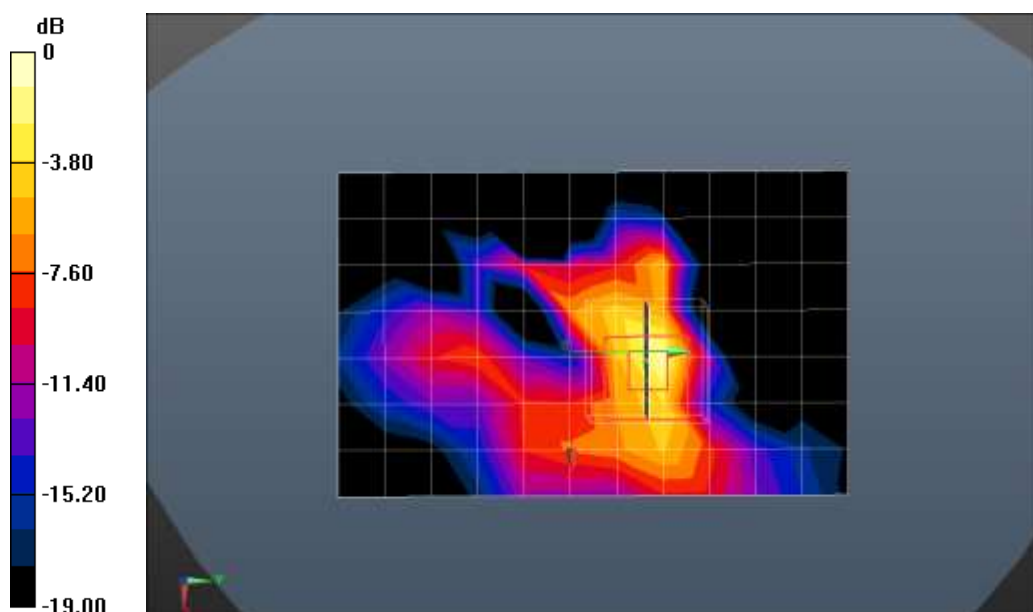
**Configuration/802.11n20 5825MHz Body-Bottom/Area Scan (8x12x1):** Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 1.85 W/kg

**Configuration/802.11n20 5825MHz Body-Bottom/Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=2mm; Reference Value = 2.531 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 4.25 W/kg

**SAR(1 g) = 1.175 W/kg; SAR(10 g) = 0.347 W/kg**

Maximum value of SAR (measured) = 2.19 W/kg



0 dB = 2.19 W/kg = 3.40 dBW/kg



## Appendix C. Probe Calibration Data



In Collaboration with  
**s p e a g**  
CALIBRATION LABORATORY



中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504  
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Client

Dekra-CN

Certificate No: Z19-60114

### CALIBRATION CERTIFICATE

Object

EX3DV4 - SN:3710

Calibration Procedure(s)

FF-Z11-004-01

Calibration Procedures for Dosimetric E-field Probes

Calibration date:

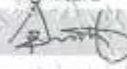
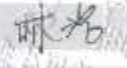

April 25, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101547	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101548	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Reference10dBAttenuator	18N50W-10dB	09-Feb-18(CTTL, No.J18X01133)	Feb-20
Reference20dBAttenuator	18N50W-20dB	09-Feb-18(CTTL, No.J18X01132)	Feb-20
Reference Probe EX3DV4	SN 7514	27-Aug-18(SPEAG, No.EX3-7514_Aug18/2)	Aug-19
DAE4	SN 1555	20-Aug-18(SPEAG, No.DAE4-1555_Aug18)	Aug -19
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	21-Jun-18 (CTTL, No.J18X05033)	Jun-19
Network Analyzer E5071C	MY46110673	24-Jan-19 (CTTL, No.J19X00547)	Jan -20

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: April 27, 2019

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: Z19-60114

Page 1 of 11



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504  
 E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization $\Phi$	$\Phi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), $\theta=0$ 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:

- 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
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>:** Assessed for E-field polarization  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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 (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.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>:** A,B,C 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  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* 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  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- 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 NORM<sub>x</sub> (no uncertainty required).



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# Probe EX3DV4

## SN: 3710

Calibrated: April 25, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3710

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.37	0.41	0.49	±10.0%
DCP(mV) <sup>B</sup>	102.9	103.3	102.1	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\mu\text{V}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	136.4	±2.3%
		Y	0.0	0.0	1.0		146.9	
		Z	0.0	0.0	1.0		162.0	

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%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5 and Page 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.





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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3710

### Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] <sup>c</sup>	Relative Permittivity <sup>f</sup>	Conductivity (S/m) <sup>f</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>g</sup>	Depth <sup>g</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.65	9.65	9.65	0.10	1.50	± 12.1%
835	41.5	0.90	9.29	9.29	9.29	0.15	1.38	± 12.1%
900	41.5	0.97	9.20	9.20	9.20	0.17	1.16	± 12.1%
1810	40.0	1.40	7.95	7.95	7.95	0.25	1.02	± 12.1%
1900	40.0	1.40	7.78	7.78	7.78	0.26	1.00	± 12.1%
2450	39.2	1.80	7.26	7.26	7.26	0.57	0.72	± 12.1%
2600	39.0	1.96	7.12	7.12	7.12	0.66	0.69	± 12.1%
3500	37.9	2.91	6.80	6.80	6.80	0.60	0.90	± 13.3%
5250	35.9	4.71	5.12	5.12	5.12	0.45	1.60	± 13.3%
5600	35.5	5.07	4.64	4.64	4.64	0.45	1.52	± 13.3%
5750	35.4	5.22	4.71	4.71	4.71	0.50	1.45	± 13.3%

<sup>c</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of 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.

<sup>f</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>g</sup> 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3710

### Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.63	9.63	9.63	0.40	0.80	±12.1%
835	55.2	0.97	9.30	9.30	9.30	0.18	1.41	±12.1%
900	55.0	1.05	9.28	9.28	9.28	0.22	1.20	±12.1%
1810	53.3	1.52	7.63	7.63	7.63	0.18	1.23	±12.1%
1900	53.3	1.52	7.65	7.65	7.65	0.20	1.20	±12.1%
2450	52.7	1.95	7.44	7.44	7.44	0.60	0.75	±12.1%
2600	52.5	2.16	7.20	7.20	7.20	0.69	0.70	±12.1%
3500	51.3	3.31	6.54	6.54	6.54	0.55	1.03	±13.3%
5250	48.9	5.36	4.50	4.50	4.50	0.50	1.70	±13.3%
5600	48.5	5.77	3.99	3.99	3.99	0.55	1.68	±13.3%
5750	48.3	5.94	4.05	4.05	4.05	0.55	1.63	±13.3%

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of 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.

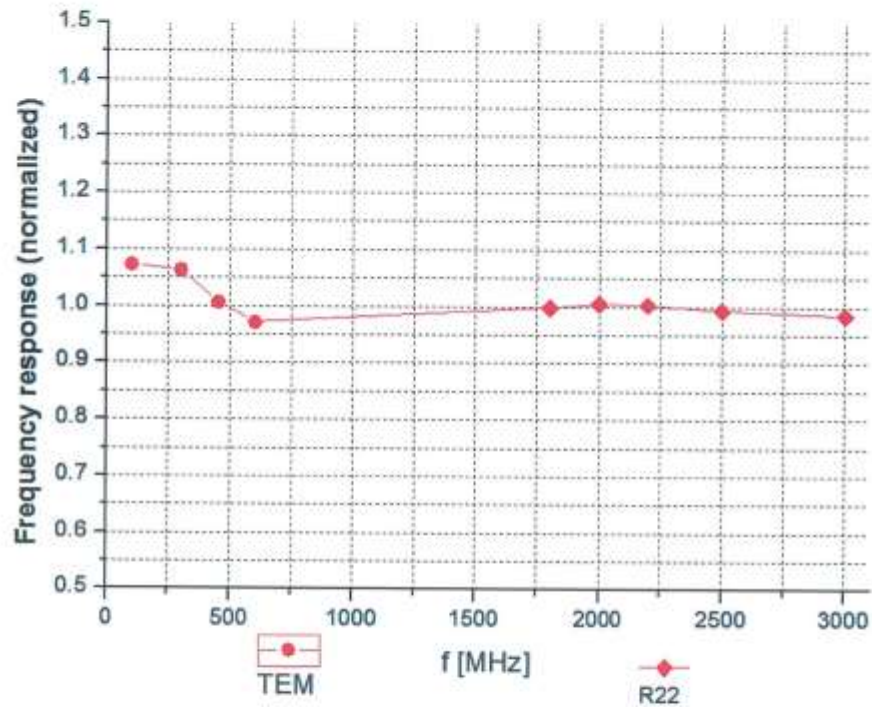
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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



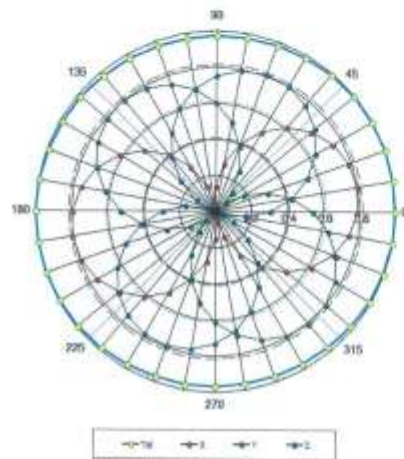
Uncertainty of Frequency Response of E-field:  $\pm 7.4\%$  ( $k=2$ )



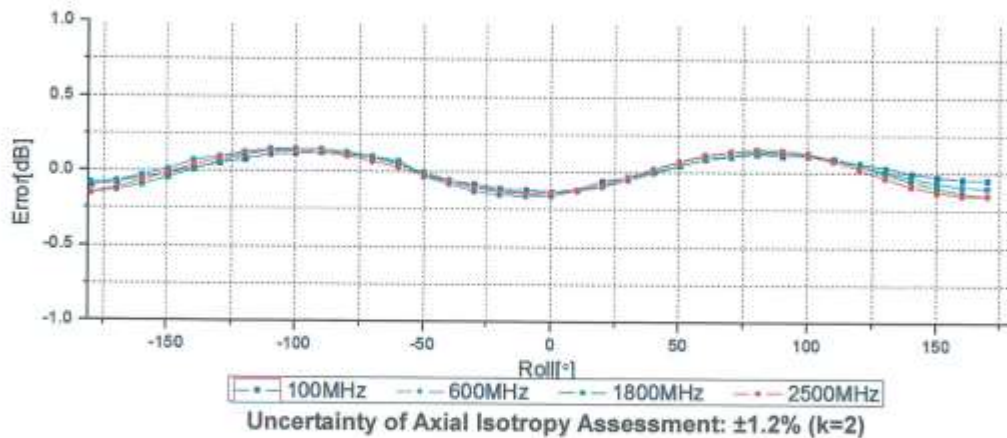
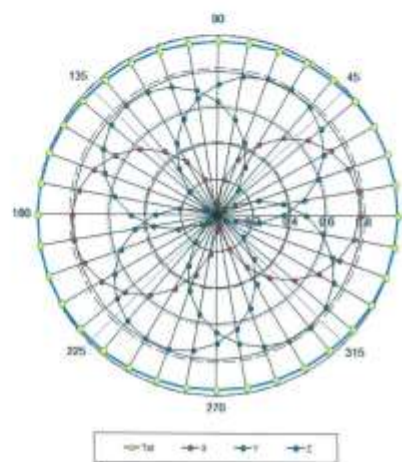
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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**



**f=1800 MHz, R22**

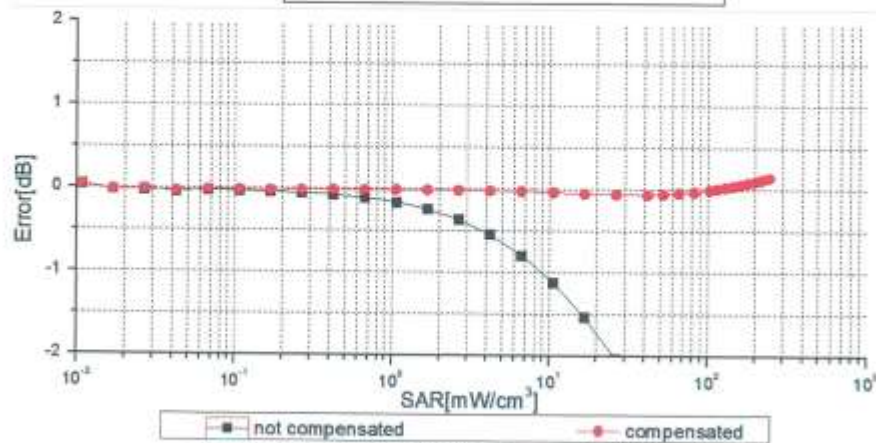
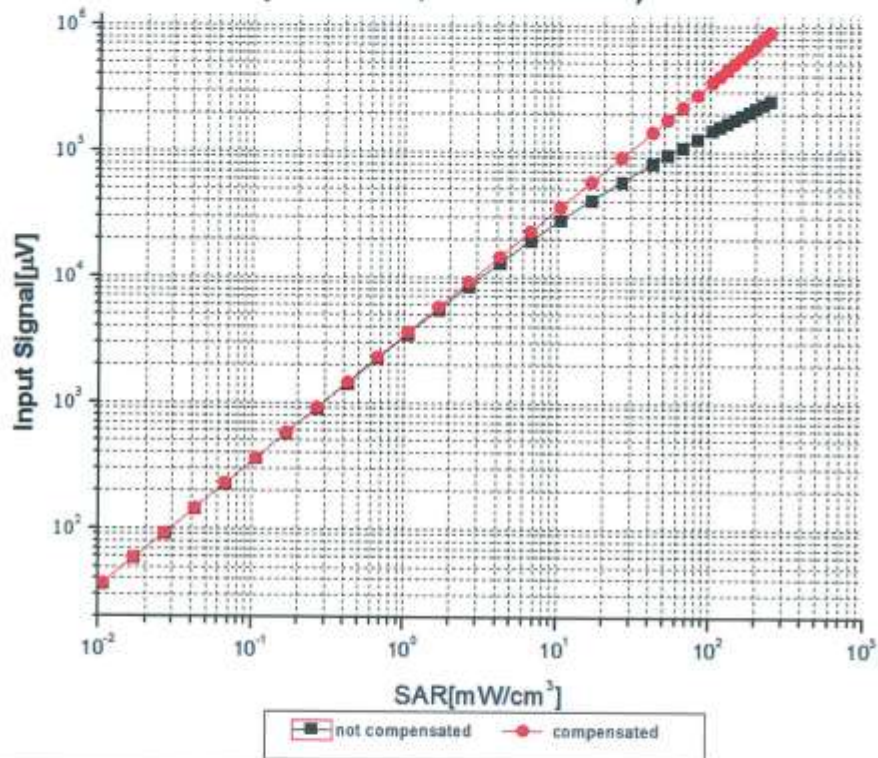






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### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$ )



Uncertainty of Linearity Assessment:  $\pm 0.9\%$  ( $k=2$ )

Certificate No: Z19-60114

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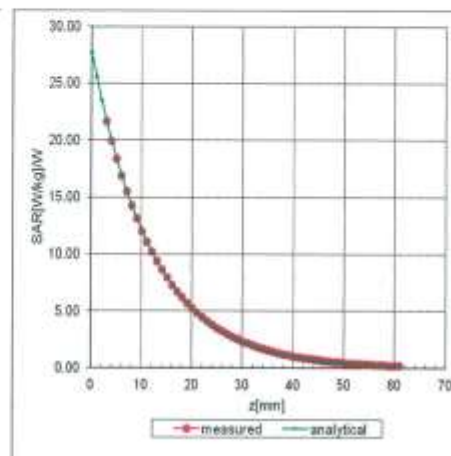
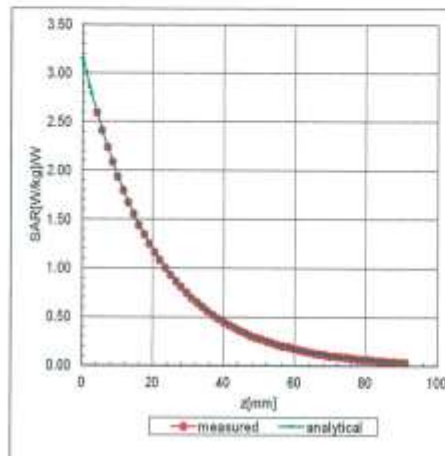


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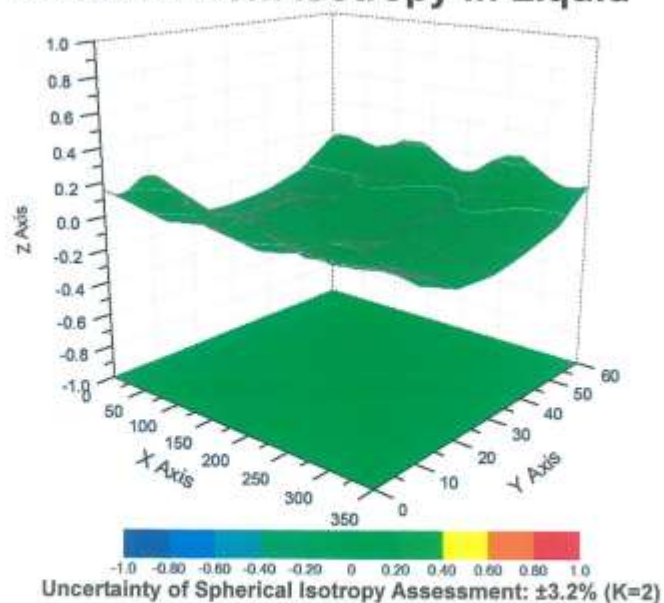
## Conversion Factor Assessment

f=750 MHz, WGLS R9(H\_convF)

f=1810 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid









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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3710

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	81.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

## Appendix D. Dipole Calibration Data


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中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

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Client **Dekra-CN** Certificate No: **Z19-60093**

### CALIBRATION CERTIFICATE

Object: **D2450V2 - SN: 839**

Calibration Procedure(s): **FF-Z11-003-01**  
 Calibration Procedures for dipole validation kits

Calibration date: **March 25, 2019**

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

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




Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
Power sensor NRP8S	104291	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
Reference Probe EX3DV4	SN 3617	31-Jan-19(SPEAG,No.EX3-3617_Jan19)	Jan-20
DAE4	SN 1331	06-Feb-19(SPEAG,No.DAE4-1331_Feb19)	Feb-20

Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-19 (CTTL, No.J19X00336)	Jan-20
NetworkAnalyzer E5071C	MY46110673	24-Jan-19 (CTTL, No.J19X00547)	Jan-20

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 28, 2019

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.





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**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

- 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
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

- 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%.



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### Measurement Conditions

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

DASY Version	DASY52	52.10.2.1495
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	39.6 $\pm$ 6 %	1.84 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	---	---

### SAR result with Head TSL

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.2 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg $\pm$ 18.7 % (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 $\pm$ 0.2) °C	53.8 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	---	---

### SAR result with Body TSL

SAR averaged over 1 $cm^3$ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.8 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.89 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.5 W/kg $\pm$ 18.7 % (k=2)



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#### Appendix (Additional assessments outside the scope of CNAS L0570)

##### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.3Ω+ 4.84 jΩ
Return Loss	- 24.9dB

##### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.5Ω+ 6.02 jΩ
Return Loss	- 24.3dB

##### General Antenna Parameters and Design

Electrical Delay (one direction)	1.026 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
-----------------	-------



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#### DASY5 Validation Report for Head TSL

Date: 03.25.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 839**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.841$  S/m;  $\epsilon_r = 39.63$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.62, 7.62, 7.62) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

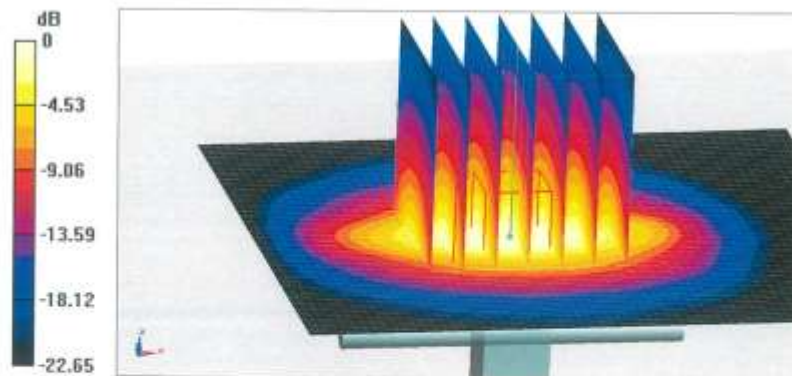
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.8 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.6 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.92 W/kg**

Maximum value of SAR (measured) = 22.0 W/kg



0 dB = 22.0 W/kg = 13.42 dBW/kg

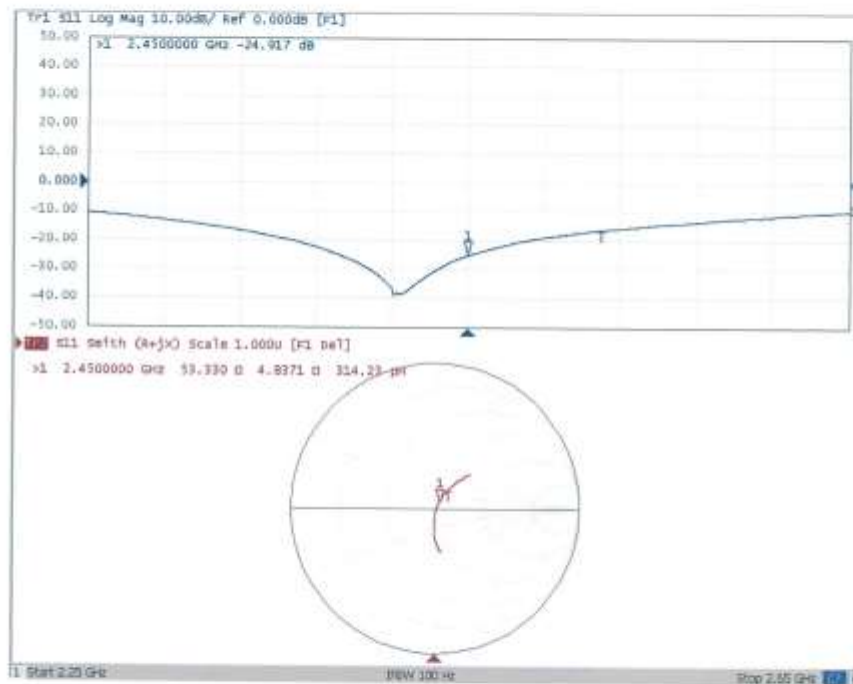




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### Impedance Measurement Plot for Head TSL





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#### DASY5 Validation Report for Body TSL

Date: 03.25.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 839**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.003$  S/m;  $\epsilon_r = 53.78$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.79, 7.79, 7.79) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

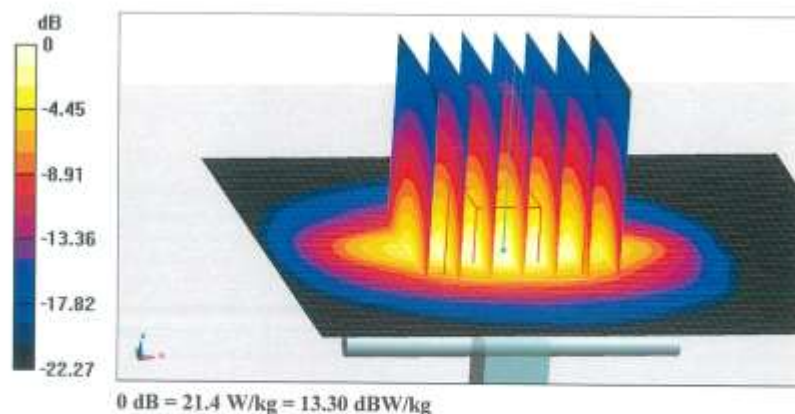
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.90 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.89 W/kg

Maximum value of SAR (measured) = 21.4 W/kg

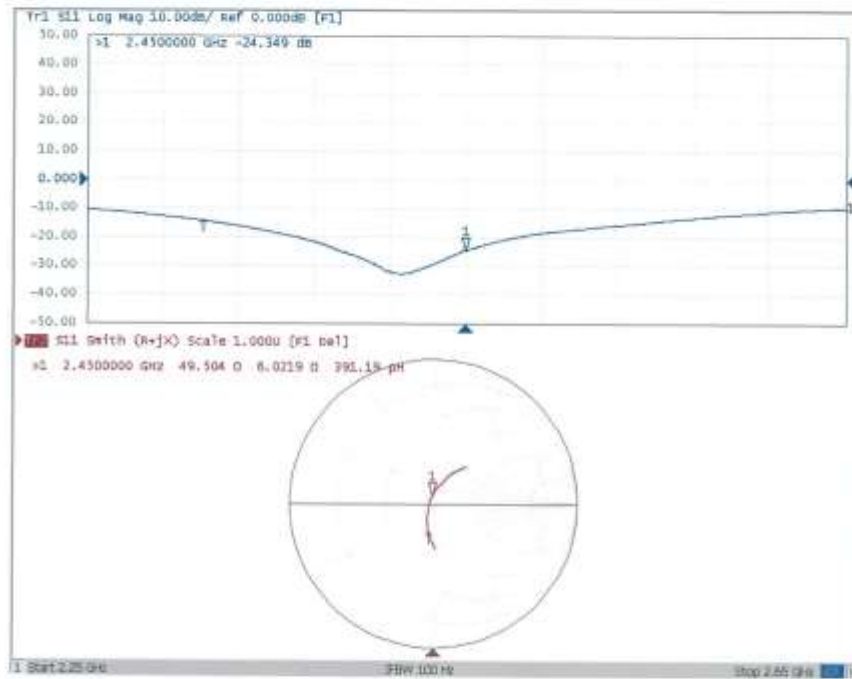




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### Impedance Measurement Plot for Body TSL





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CNAS L0570

Client

Dekra-CN

Certificate No: Z19-60096

## CALIBRATION CERTIFICATE

Object: D5GHzV2 - SN: 1078

Calibration Procedure(s): FF-Z11-003-01  
Calibration Procedures for dipole validation kits

Calibration date: March 22, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
Power sensor NRP8S	104291	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
ReferenceProbe EX3DV4	SN 7514	27-Aug-18(SPEAG,No.EX3-7514_Aug18/2)	Aug-19
DAE4	SN 1331	06-Feb-19(SPEAG,No.DAE4-1331_Feb19)	Feb-20
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-19 (CTTL, No.J19X00336)	Jan-20
NetworkAnalyzerE5071C	MY46110673	24-Jan-19 (CTTL, No.J19X00547)	Jan-20

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 26, 2019

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: Z19-60096

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#### Glossary:

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

#### Calibration is Performed According to the Following Standards:

- 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
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### Additional Documentation:

- 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%.





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### Measurement Conditions

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

DASY Version	DASY52	52.10.2.1495
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz	

### Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.8 $\pm$ 6 %	4.65 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

### SAR result with Head TSL at 5250 MHz

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.60 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	75.5 W/kg $\pm$ 24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.6 W/kg $\pm$ 24.2 % (k=2)



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#### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	5.06 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

#### SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.7 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.0 W/kg ± 24.2 % (k=2)

#### Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	5.24 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.90 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.6 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 24.2 % (k=2)



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#### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.2 ± 6 %	5.45 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	---	---

#### SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.6 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 24.2 % (k=2)

#### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.6 ± 6 %	5.91 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	---	---

#### SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.75 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.3 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.9 W/kg ± 24.2 % (k=2)





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#### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.2 ± 6 %	6.11 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	---	----

#### SAR result with Body TSL at 5750 MHz

SAR averaged over 1 $cm^3$ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.4 W/kg ± 24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 24.2 % (k=2)



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	52.1Ω - 4.23jΩ
Return Loss	- 26.7dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	59.2Ω - 3.00jΩ
Return Loss	- 21.1dB

### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	51.9Ω + 2.48jΩ
Return Loss	- 30.3dB

### Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	50.7Ω - 3.30jΩ
Return Loss	- 29.5dB

### Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.8Ω - 1.83jΩ
Return Loss	- 21.7dB

### Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	53.0Ω + 4.58jΩ
Return Loss	- 25.5dB



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#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.062 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

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**DASY5 Validation Report for Head TSL**

Date: 03.20.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1078**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,  
Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.652$  S/m;  $\epsilon_r = 34.84$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.063$  S/m;  $\epsilon_r = 34.48$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.236$  S/m;  $\epsilon_r = 34.35$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Center Section

**DASY5 Configuration:**

- Probe: EX3DV4 - SN7514; ConvF(5.02, 5.02, 5.02) @ 5250 MHz; Calibrated: 8/27/2018, ConvF(4.41, 4.41, 4.41) @ 5600 MHz; Calibrated: 8/27/2018, ConvF(4.47, 4.47, 4.47) @ 5750 MHz; Calibrated: 8/27/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.01 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 31.1 W/kg

**SAR(1 g) = 7.6 W/kg; SAR(10 g) = 2.18 W/kg**

Maximum value of SAR (measured) = 17.8 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.43 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 35.7 W/kg

**SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.32 W/kg**

Maximum value of SAR (measured) = 19.5 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.10 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 36.7 W/kg

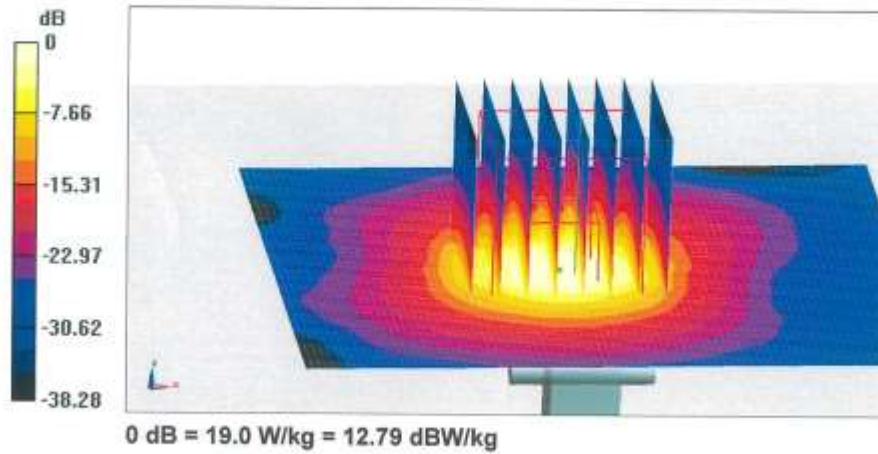
**SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.26 W/kg**

Maximum value of SAR (measured) = 19.0 W/kg



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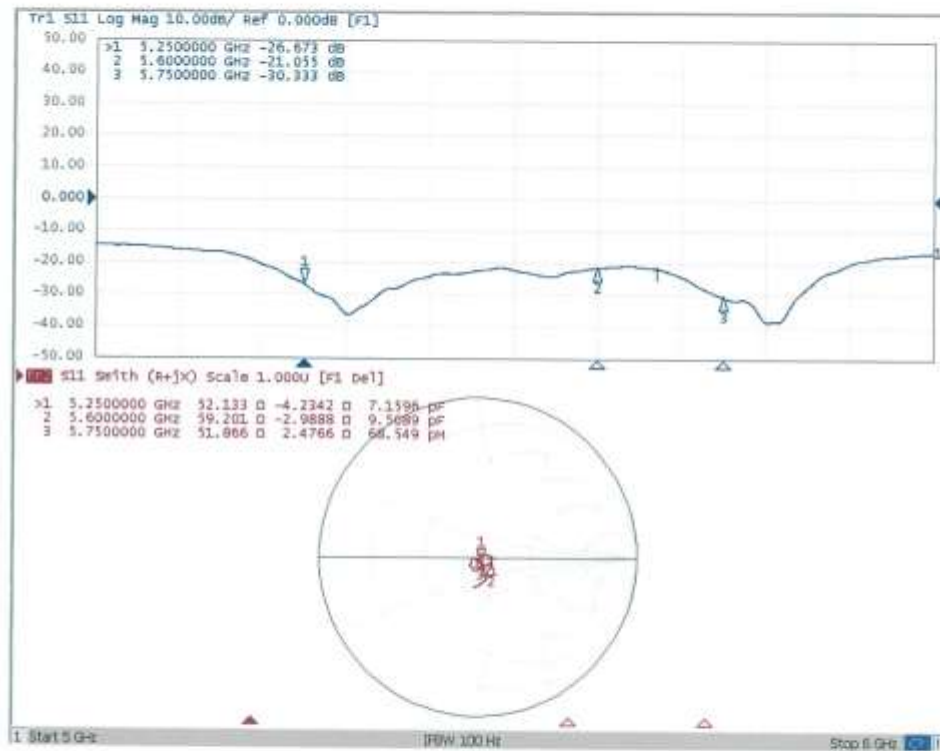




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### Impedance Measurement Plot for Head TSL







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#### DASY5 Validation Report for Body TSL

Date: 03.21.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1078**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.446$  S/m;  $\epsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.906$  S/m;  $\epsilon_r = 47.56$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.107$  S/m;  $\epsilon_r = 47.22$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

#### DASY5 Configuration:

- Probe: EX3DV4 - SN7514; ConvF(4.54, 4.54, 4.54) @ 5250 MHz; Calibrated: 8/27/2018, ConvF(4, 4, 4) @ 5600 MHz; Calibrated: 8/27/2018, ConvF(3.98, 3.98, 3.98) @ 5750 MHz; Calibrated: 8/27/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

#### Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 59.53 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 29.8 W/kg

**SAR(1 g) = 7.38 W/kg; SAR(10 g) = 2.1 W/kg**

Maximum value of SAR (measured) = 17.1 W/kg

#### Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.54 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 34.1 W/kg

**SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.2 W/kg**

Maximum value of SAR (measured) = 18.9 W/kg

#### Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 60.01 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 34.6 W/kg

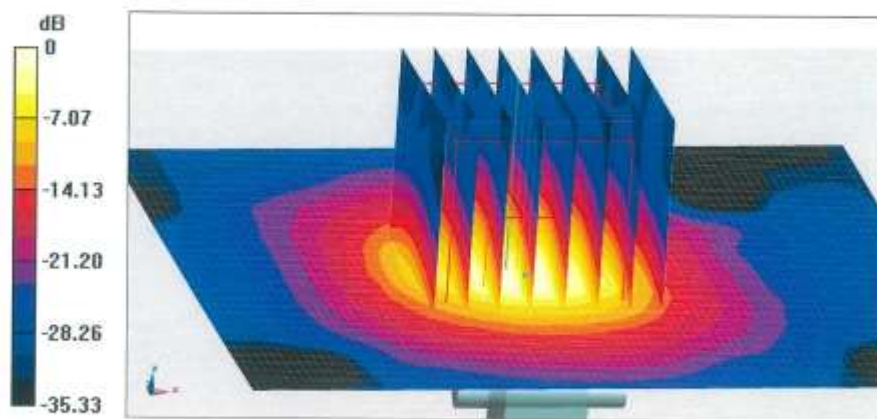
**SAR(1 g) = 7.46 W/kg; SAR(10 g) = 2.1 W/kg**

Maximum value of SAR (measured) = 19.0 W/kg



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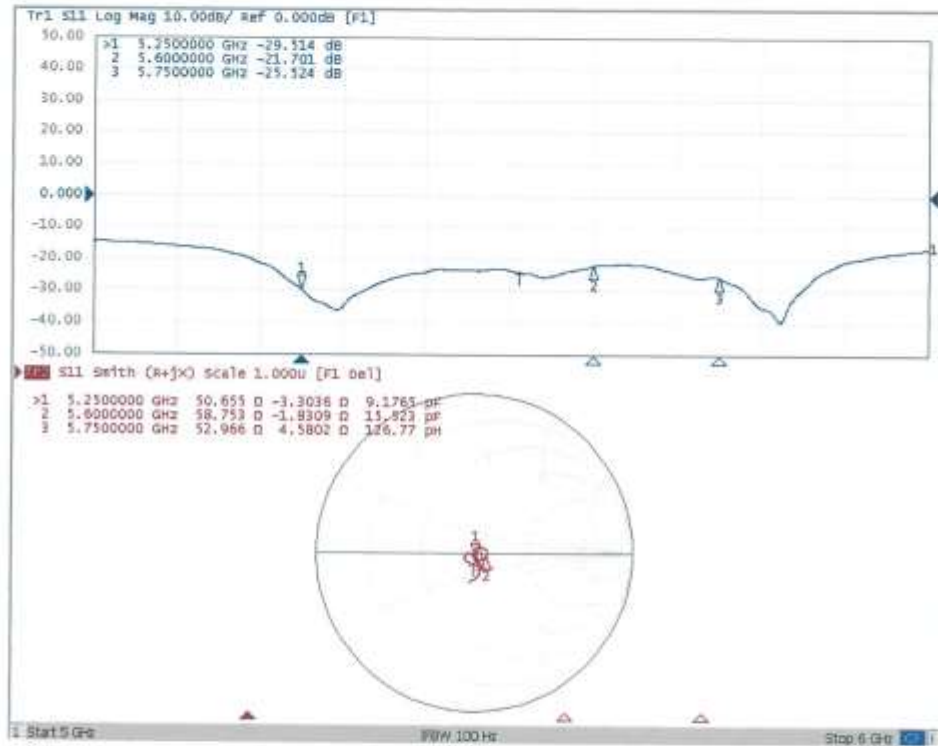
0 dB = 19.0 W/kg = 12.79 dBW/kg





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### Impedance Measurement Plot for Body TSL



## Appendix E. DAE Calibration Data



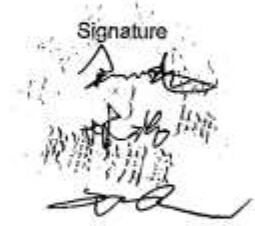
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Client : **Dekra-CN**Certificate No: **Z19-60115**

CALIBRATION CERTIFICATE			
Object	DAE4 - SN: 1220		
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)		
Calibration date:	April 11, 2019		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	20-Jun-18 (CTTL, No.J18X05034)	June-19
Calibrated by:	Name Yu Zongying	Function SAR Test Engineer	Signature 
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	
Issued: April 13, 2019			
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Certificate No: Z19-60115

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**Glossary:**

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

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



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### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	405.134 $\pm$ 0.15% (k=2)	404.854 $\pm$ 0.15% (k=2)	404.085 $\pm$ 0.15% (k=2)
Low Range	3.97713 $\pm$ 0.7% (k=2)	3.99438 $\pm$ 0.7% (k=2)	3.98563 $\pm$ 0.7% (k=2)

### Connector Angle

Connector Angle to be used in DASY system	177° $\pm$ 1°
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