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TEST REPORT

SPECIFIC ABSORPTION RATE (SAR) EVALUATION REPORT

For Tablet

Model Number: WT9L11P44GD51
Brand Name: VENTURER
Add. Model Number: 100005693
Add. Brand Name: ONN

FCC ID: A2HWT9L11

Prepared for
ALCO Electronics Ltd
11/F Metropole Square, 2 On Yiu St.,Sha Tin, New Territories, Hong Kong

PREPARED AND CHECKED BY:	APPROVED BY:
	Digitally signed by Terry Chan Location: Intertek Testing Services Hong Kong Ltd.
Ricky Xu Assistant Manager Shenzhen UnionTrust Quality and Technology Co., Ltd.	Terry Chan Manager Intertek Testing Services Hong Kong Date: Sep. 12, 2019

TEST REPORT

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TEST REPORT

1. TEST RESULT SUMMARY

Applicant:	ALCO Electronics Ltd
Applicant Address:	11/F Metropole Square, 2 On Yiu St.,Sha Tin, New Territories, Hong Kong
Model:	WT9L11P44GD51
Add. Model:	100005693
Brand Name:	VENTURER
Add. Brand Name:	ONN
Serial Number:	N/A
FCC ID:	A2HWT9L11
Test Device:	Production Unit
Exposure Category:	General Population/Uncontrolled Exposure
Date of Test:	Aug. 30, 2019 to Sep. 05, 2019
Place of Testing:	Shenzhen UnionTrust Quality and Technology Co., Ltd. 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China
Environmental Conditions:	Temperature: +18 to 25°C Humidity 25 to 75%
Test Specification:	ANSI/IEEE C95.1 IEEE Std 1528: 2013 FCC KDB Publication 447498 D01 v06 FCC KDB Publication 865664 D01 v01r04 FCC KDB Publication 865664 D02 v01r02 FCC KDB Publication 248227 D01 v02r02

The maximum spatial peak SAR value for the sample device averaged over 1g was found to be:

Band	Operating Mode	TX Frequency (MHz)	Highest Reported SAR
			Body
2.4GHz WiFi	Data	2412 - 2472	1.19
5.2GHz WiFi	Data	5180 - 5240	1.14
5.3GHz WiFi	Data	5260 - 5320	1.14
5.6GHz WiFi	Data	5500 - 5700	1.17
5.8GHz WiFi	Data	5745 - 5825	1.16
BT	Data	2402 - 2480	N/A

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment / general population exposure limits specified in ANSI/IEEE C95.1.

TEST REPORT

2. GENERAL INFORMATION

2.1. Description of Equipment under test (EUT)

Manufacturer:	ALCO Electronics Ltd
Manufacturer Address:	11/F Metropole Square, 2 On Yiu St.,Sha Tin, New Territories, Hong Kong
Device dimension (L x W) :	292mm x 186mm
Device thickness:	10mm
Antenna Gain:	Band / Ant. A / Ant. B: BT: / ; -0.1 dBi 2.4G WIFI: -0.1 dBi ; 0.2 dBi 5G Band 1: -2.7 dBi ; 2.7 dBi 5G Band 2: -2.4 dBi ; 4.1 dBi 5G Band 3: -0.1 dBi ; 4.3 dBi 5G Band 4: -0.1 dBi ; 4.3 dBi
Operating Configuration(s) / mode:	Body (Data)
Tx Frequency (MHz):	2412MHz to 2472MHz (2.4GHz WiFi) 5180MHz to 5240MHz (5.2GHz WiFi) 5260MHz to 5320MHz (5.3GHz WiFi) 5500MHz to 5700MHz (5.6GHz WiFi) 5745MHz to 5825MHz (5.8GHz WiFi) 2402MHz to 2480MHz (BT)
Duty Cycle*:	2.4GHz 802.11b: 98.26% , BT: 76.80% 5GHz 802.11a: 98.56%, 5GHz 802.11n(HT20): 98.46% 5GHz 802.11n(HT40): 96.91% 5GHz 802.11ac(VHT20): 98.47% 5GHz 802.11ac(VHT40): 96.91% 5GHz 802.11ac(VHT80): 93.99%
H/W Version:	V1.0
S/W Version:	V1.0
Battery Type:	3.7V; 3750mAh; Li-ion Model name: PT2890128-2S Brand name: POW-TECH
Body-worn Accessories:	keyboard

Antenna Gain detail:

Band	Ant. A	Ant. B
BT	/	-0.1 dBi
2.4G WIFI	-0.1 dBi	0.2 dBi
5G Band 1	-2.7 dBi	2.7 dBi
5G Band 2	-2.4 dBi	4.1 dBi
5G Band 3	-0.1 dBi	4.3 dBi
5G Band 4	-0.1 dBi	4.3 dBi

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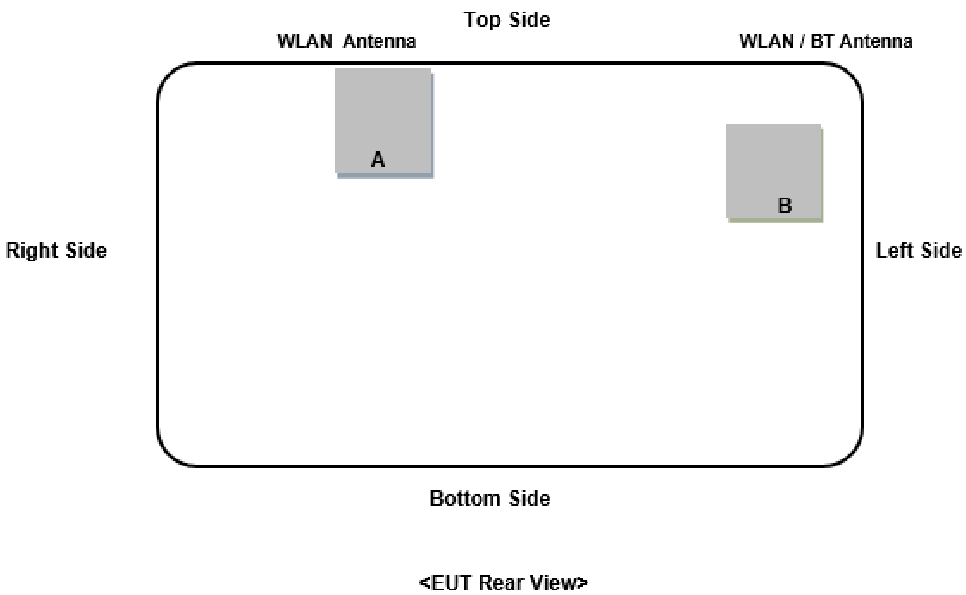
TEST REPORT

2.2. EUT Antenna Locations



Exposure Position	Separation Distance from the Antenna to the Outer Surface	
	A	B
Front	0 mm	0 mm
Back	0 mm	0 mm
Left	187 mm	0 mm
Right	85 mm	279 mm
Top	0 mm	8 mm
Bottom	152 mm	145 mm

Details of antenna specification are shown in separate antenna dimension document.

2.3. Nominal and Maximum Output Power Specifications

The EUT operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498.

For 2.4GHz WiFi

Antenna A

Band	Operating Mode	TX Frequency (MHz)	Output Power Nominal (dBm)	Output Power Maximum (dBm)
2.4GHz	802.11b	2412 - 2472	+14.5	+15.0
2.4GHz	802.11g	2412 - 2472	+13.0	+13.5
2.4GHz	802.11n (HT20)	2412 - 2472	+13.5	+14.0
2.4GHz	802.11n (HT40)	2422 - 2462	+13.0	+13.5

Antenna B

Band	Operating Mode	TX Frequency (MHz)	Output Power Nominal (dBm)	Output Power Maximum (dBm)
2.4GHz	802.11b	2412 - 2472	+15.0	+15.5
2.4GHz	802.11g	2412 - 2472	+14.0	+14.5
2.4GHz	802.11n (HT20)	2412 - 2472	+14.0	+14.5
2.4GHz	802.11n (HT40)	2422 - 2462	+13.5	+14.0

For Bluetooth

Band	Operating Mode	TX Frequency (MHz)	Output Power Nominal (dBm)	Output Power Maximum (dBm)
BR + EDR	GFSK	2402 – 2480	+4.0	+4.5
	π/4DQPSK	2402 – 2480	-2.0	-1.5
	8DPSK	2402 – 2480	-2.0	-1.5
LE	GFSK	2402 – 2480	+1.5	+2.0

For 5.2GHz WiFi

Band	Operating Mode	Output Power A Nominal (dBm)	Output Power A Maximum (dBm)	Output Power B Nominal (dBm)	Output Power B Maximum (dBm)
5.2GHz	802.11a	+13.0	+13.5	+16.0	+16.5
	802.11n HT20	+12.5	+13.0	+16.0	+16.5
	802.11n HT40	+12.5	+13.0	+16.0	+16.5
	802.11ac VHT20	+12.5	+13.0	+16.0	+16.5
	802.11ac VHT40	+12.5	+13.0	+16.0	+16.5
	802.11ac VHT80	+12.0	+12.5	+16.0	+16.5

For 5.3GHz WiFi

Band	Operating Mode	Output Power A Nominal (dBm)	Output Power A Maximum (dBm)	Output Power B Nominal (dBm)	Output Power B Maximum (dBm)
5.3GHz	802.11a	+13.0	+13.5	+16.0	+16.5
	802.11n HT20	+13.0	+13.5	+16.0	+16.5
	802.11n HT40	+12.5	+13.0	+16.0	+16.5
	802.11ac VHT20	+13.0	+13.5	+16.0	+16.5
	802.11ac VHT40	+12.5	+13.0	+16.0	+16.5
	802.11ac VHT80	+12.5	+13.0	+16.0	+16.5

For 5.6GHz WiFi

Band	Operating Mode	Output Power			
		A		B	
		Nominal (dBm)	Maximum (dBm)	Nominal (dBm)	Maximum (dBm)
5.6GHz	802.11a	+13.5	+14.0	+14.5	+15.0
	802.11n HT20	+13.5	+14.0	+14.5	+15.0
	802.11n HT40	+13.5	+14.0	+13.5	+14.0
	802.11ac VHT20	+13.5	+14.0	+14.5	+15.0
	802.11ac VHT40	+13.5	+14.0	+13.5	+14.0
	802.11ac VHT80	+13.0	+13.5	+13.5	+14.0

For 5.8GHz WiFi

Band	Operating Mode	Output Power			
		A		B	
		Nominal (dBm)	Maximum (dBm)	Nominal (dBm)	Maximum (dBm)
5.8GHz	802.11a	+14.0	+14.5	+14.0	+14.5
	802.11n HT20	+14.0	+14.5	+14.0	+14.5
	802.11n HT40	+13.5	+14.0	+13.5	+14.0
	802.11ac VHT20	+14.0	+14.5	+14.0	+14.5
	802.11ac VHT40	+13.5	+14.0	+13.5	+14.0
	802.11ac VHT80	+14.0	+14.5	+14.0	+14.5

TEST REPORT

3. SAR MEASUREMENT SYSTEM DESCRIPTION

SAR is related to the rate at which energy is absorbed per unit mass in object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person’s awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.
The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of given mass density (ρ). The equation description is as below:

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

SAR is expressed in units of Watts per kilogram (W/Kg)
SAR can be obtained using either of the following equations:

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

$$SAR = c_h \left.\frac{dT}{dt}\right|_{t=0}$$

Where

SAR is the specific absorption rate in watts per kilogram;
E is the r.m.s. value of the electric field strength in the tissue in volts per meter;
σ is the conductivity of the tissue in siemens per metre;
ρ is the density of the tissue in kilograms per cubic metre;
c_h is the heat capacity of the tissue in joules per kilogram and Kelvin;

$\frac{dT}{dt}|t=0$ is the initial time derivative of temperature in the tissue in kelvins per second

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

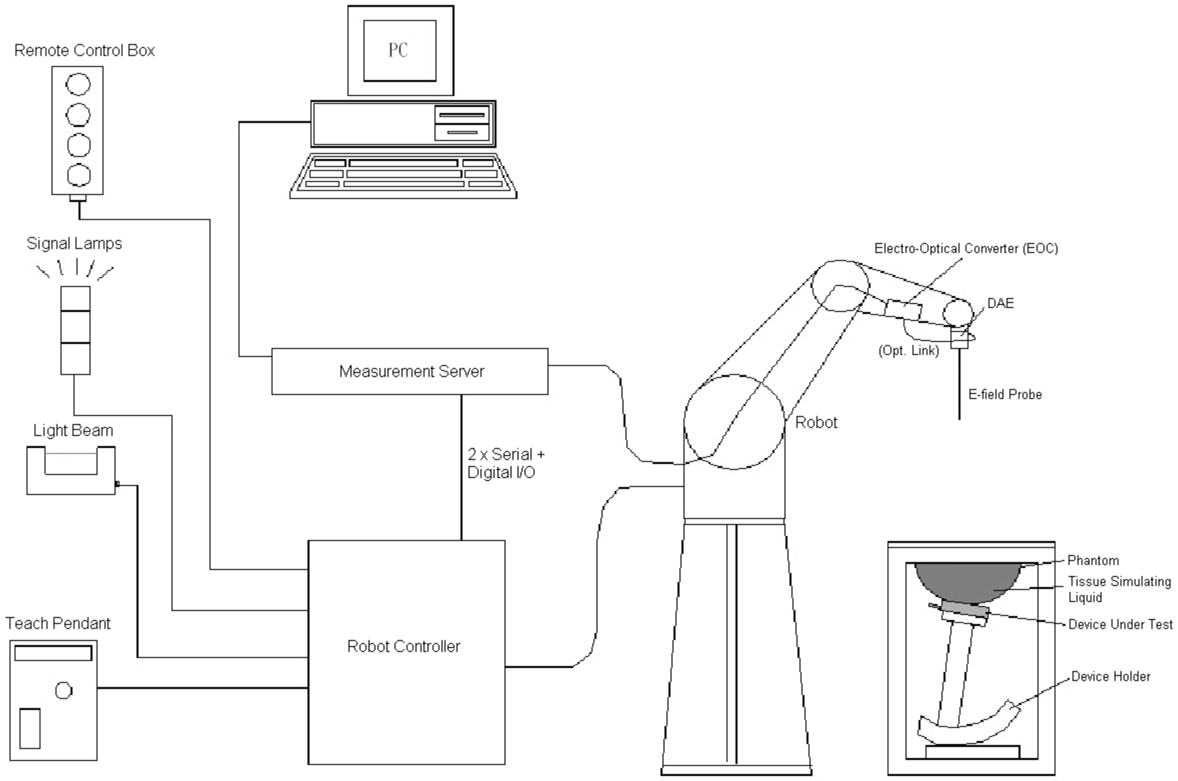


Figure 1: Schematic diagram of the SAR measurement system

TEST REPORT

ROBOT

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli 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)

TEST REPORT

E-FIELD PROBE

The SAR measurement is conducted with the dosimetric probe. 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.

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: ± 0.2 dB
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm

Model	ES3DV3
Construction	Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).
Frequency	10 MHz to 4 GHz Linearity: ± 0.2 dB
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic Range	5 µW/g to 100 mW/g Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm

Data Acquisition Electronics (DAE)

Model	DAE3, DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5µV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm

TEST REPORT

SAM TWIN PHANTOM

Model	Twin SAM
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
Material	Vinylester, glass fiber reinforced (VE-GF)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters

Model	ELI
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.
Material	Vinylester, glass fiber reinforced (VE-GF)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters

TEST REPORT

DEVICE HOLDER

Model	Mounting Device
Construction	In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).
Material	POM

Model	Laptop Extensions Kit
Construction	Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner.
Material	POM, Acrylic glass, Foam

System Validation Dipoles

Model	D-Serial
Construction	Symmetrical dipole with l/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.
Frequency	750 MHz to 5800 MHz
Return Loss	> 20 dB
Power Capability	> 100 W (f < 1GHz), > 40 W (f > 1GHz)

During measurement, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom scanning area is greater than the projection of EUT and antenna.

Area Scan Parameters extracted from KDB 865664

<table>
<tr><td></td><td>$\leq$ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td>Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 mm ± 1 mm</td><td>$\frac{1}{2}\cdot\delta\cdot\ln(2)$ mm ± 0.5 mm</td></tr>
<tr><td>Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>$\leq$ 2 GHz: $\leq$ 15 mm
2 – 3 GHz: $\leq$ 12 mm</td><td>3 – 4 GHz: $\leq$ 12 mm
4 – 6 GHz: $\leq$ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
</table>

When the maximum SAR point has been found, the system will then carry out a zoom (3D) scan centered at that point to determine volume averaged SAR level.

Zoom Scan Parameters extracted from KDB 865664

<table>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>$\leq$ 2 GHz: $\leq$ 8 mm
2 – 3 GHz: $\leq$ 5 mm*</td><td>3 – 4 GHz: $\leq$ 5 mm*
4 – 6 GHz: $\leq$ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>$\leq$ 5 mm</td><td>3 – 4 GHz: $\leq$ 4 mm
4 – 5 GHz: $\leq$ 3 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>$\leq$ 4 mm</td><td>3 – 4 GHz: $\leq$ 3 mm
4 – 5 GHz: $\leq$ 2.5 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5\cdot\Delta z_{Zoom}(n-1)$ mm</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>$\geq$ 30 mm</td><td>3 – 4 GHz: $\geq$ 28 mm
4 – 5 GHz: $\geq$ 25 mm
5 – 6 GHz: $\geq$ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

TEST REPORT

4. TISSUE VERIFICATION

For SAR measurement of field distribution inside phantom, homogeneous tissue simulating liquid as below liquid recipes were filled to a depth of 15cm ± 0.5cm for below 3GHz measurement and of 10cm ± 0.5cm for above 3GHz.

HEAD TISSUE RECIPES

Frequency	Ingredients					
	De-ionized Water	Salt	1,2 propanediol	DGBE	DGMH	Triton X100
450 MHz	33.5%	3.4%	63.1%			
750 MHz	34.2%	1.4%	64.4%			
900 MHz	35.3%	1.0%	63.7%			
1800 MHz	55.2%	0.6%		13.8%		30.4%
1900 MHz	55.3%	0.5%		13.8%		30.4%
2000 MHz	55.3%	0.4%		13.8%		30.5%
2450 MHz	55.7%	0.3%		18.7%		25.3%
5000 MHz	65.3%				17.2%	17.5%

BODY TISSUE RECIPES

Frequency	Ingredients					
	De-ionized Water	Salt	1,2 propanediol	DGBE	DGMH	Triton X100
450 MHz	52.4%	1.9%	45.7%			
750 MHz	55.4%	1.3%	43.3%			
900 MHz	52.9%	1.0%	46.1%			
1800 MHz	70.8%	0.5%		8.7%		20.0%
1900 MHz	70.1%	0.4%		8.9%		20.6%
2000 MHz	70.2%	0.3%		8.6%		20.9%
2450 MHz	70.8%	0.3%		8.7%		20.2%
5000 MHz	76.8%				11.7%	11.5%

TEST REPORT

The head tissue dielectric parameters recommended by the IEEE Std 1528 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. For other head and body tissue parameters, they are recommended by KDB 865664.

Target Frequency (MHz)	head		body	
	εr	σ (S/m)	εr	σ (S/m)
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	1.01	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
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3)

When a transmission band overlaps with one of the target frequencies, the tissue dielectric parameters of the tissue medium at the middle of a device transmission band should be within ±5% of the parameters specified at that target frequency.

TEST REPORT

The dielectric parameters of the liquids were verified prior to the SAR evaluation.

The dielectric parameters were:

Body Liquid

Freq. (MHz)	Temp. (˚C)	ε_r / Relative Permittivity			σ / Conductivity			ρ **(kg/m³)
		measured	Target*	Δ (±5%)	measured	Target*	Δ (±5%)	
2450	22.3	52.889	52.7.0	0.36	2.006	1.95	2.87	1000

* *Target values refer to KDB 865664*
** *Worst-case assumption*

Note:
1. Date of tissue verification measurement: Aug. 30, 2019
2. Ambient temperature: 23.1 deg C
3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

Body Liquid

Freq. (MHz)	Temp. (˚C)	ε_r / Relative Permittivity			σ / Conductivity			ρ **(kg/m³)
		measured	Target*	Δ (±5%)	measured	Target*	Δ (±5%)	
5250	22.2	48.293	48.90	-1.24	5.494	5.36	2.50	1000

* *Target values refer to KDB 865664*
** *Worst-case assumption*

Note:
1. Date of tissue verification measurement: Sep. 04, 2019
2. Ambient temperature: 23.0 deg C
3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

Body Liquid

Freq. (MHz)	Temp. (˚C)	ε_r / Relative Permittivity			σ / Conductivity			ρ **(kg/m³)
		measured	Target*	Δ (±5%)	measured	Target*	Δ (±5%)	
5600	22.0	47.703	48.50	-1.64	5.957	5.77	3.24	1000

* *Target values refer to KDB 865664*
** *Worst-case assumption*

Note:
1. Date of tissue verification measurement: Sep. 03, 2019
2. Ambient temperature: 23.1 deg C
3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

TEST REPORT

Body Liquid

Freq. (MHz)	Temp. (˚C)	ε_r / Relative Permittivity			σ / Conductivity			ρ **(kg/m³)
		measured	Target*	Δ (±5%)	measured	Target*	Δ (±5%)	
5800	22.0	47.400	48.20	-1.66	6.221	6.00	3.68	1000

** Target values refer to KDB 865664*

*** Worst-case assumption*

Note:

1. Date of tissue verification measurement: Sep. 05, 2019

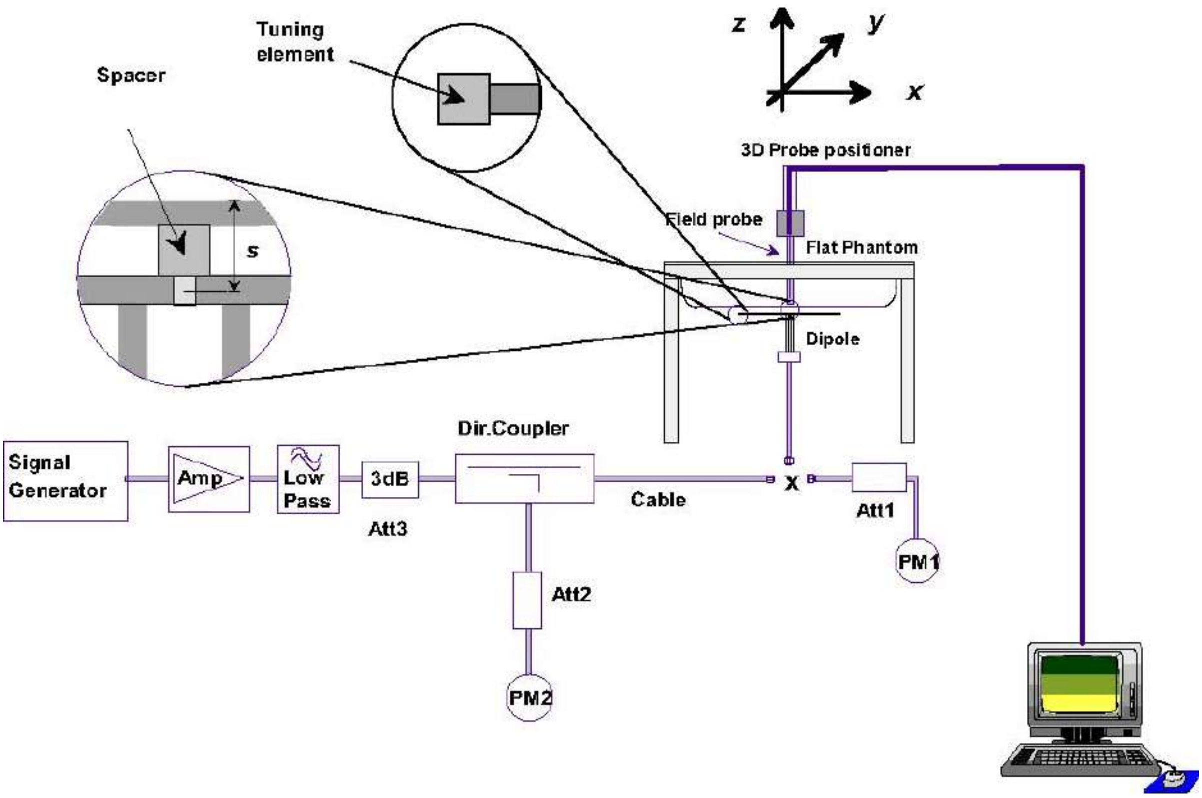
2. Ambient temperature: 23.1 deg C

3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

5. SAR MEASUREMENT SYSTEM VERIFICATION

Each DASY system is equipped with one or more system check kits. These units, together with the predefined measurement procedures within the DASY software, enable user to conduct the system check. System kit includes a dipole, and dipole device holder.

The system check verifies that the system operates within its specifications. It's performed daily or before every SAR measurement. The system check uses normal SAR measurement in the flat section of the phantom with a matched dipole at a specified distance. The system check setup is shown as below.



TEST REPORT

VALIDATION DIPOLE

The dipoles used is based on the IEEE Std 1528, and is complied with mechanical and electrical specifications in line with the requirements of both FCC and KDB requirement.

SYSTEM CHECK RESULTS

Date	Freq. (MHz)	Liquid Type	System Diople	System Verification				
				Serial No.	Target SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Normalized SAR_{1g} (W/kg)	Deviation (±10%)
Aug. 30, 2019	2450	Body	D2450V2	1014	50.50	0.522	52.20	3.37

* the target was quoted from dipole calibration report
* Input power level = 10dBm (10mW)

Date	Freq. (MHz)	Liquid Type	System Diople	System Verification				
				Serial No.	Target SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Normalized SAR_{1g} (W/kg)	Deviation (±10%)
Sep. 04, 2019	5250	Body	D5GHzV2	1280	74.80	7.610	76.10	1.74
Sep. 03, 2019	5600	Body	D5GHzV2	1280	79.20	8.180	81.80	3.28
Sep. 05, 2019	5800	Body	D5GHzV2	1280	74.80	7.450	74.50	-0.40

* the target was quoted from dipole calibration report
* Input power level = 20dBm (0.1W)

SAR_{1g} ambient measured value < 12 mW/kg

Details of System Verification plots are shown in the Appendix A - plot 1, 2, 3, 4.

6. SAR EVALUATION

6.1. Body Exposure Conditions

RF Exposure Conditions	Test Position	Separation Distance	SAR test exclusion
Body	Bottom Surface	0 cm	N/A

Note: The required minimum test separation distance for incorporating transmitters and antennas into laptop computer display is determined with the display screen opened at an angle of 90° to the keyboard compartment

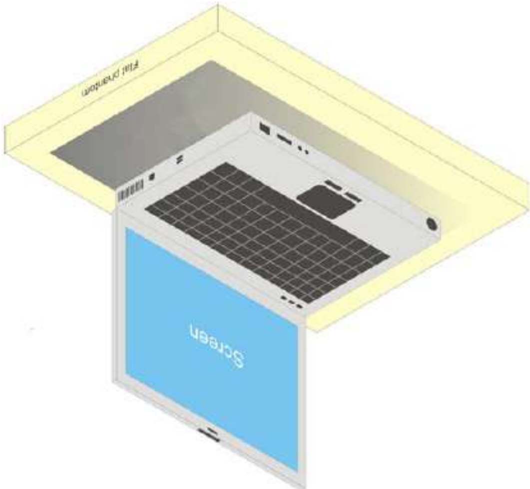


Fig-4.1 Test Positions for Laptop

RF Exposure Conditions	Test Position	Separation Distance	SAR test exclusion
Body	Rear Face	0 cm	Note 4
	Left Side		
	Right Side		
	Top Side		
	Bottom Side		

Note:

1. Exposures from antennas through the front surface of the display section of a tablet are generally limited to the user’s hands. Exposures to hands for typical consumer transmitters used in tablets are not expected to exceed the extremity SAR limit; therefore, SAR evaluation for the front surface of tablet display screens are generally not necessary.
2. When voice mode is supported on a tablet and it is limited to speaker mode or headset operations only, additional SAR testing for this type of voice use is not required.
3. Next to the ear operation is generally not expected for tablets with overall diagonal dimension > 20 cm. However, when next to the ear voice mode is supported, regardless of the overall dimension, phablets must be tested according to the requirements described in KDB Publication 648474 D04.
4. For SAR test exclusion, please refer to section 4.4.

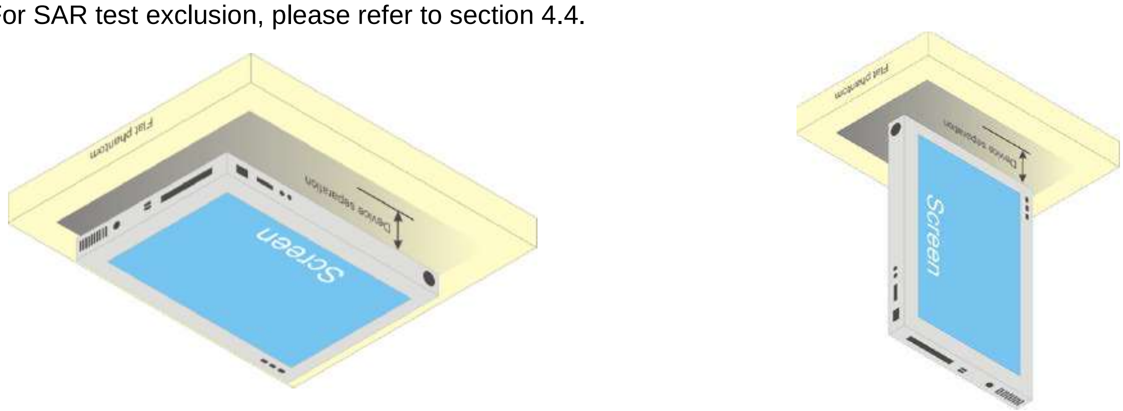


Fig-4.2 Test Positions for Tablet

TEST REPORT

WLAN Configuration and Testing

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01, this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

6.2. RF Output Power Measurements

For 2.4GHz WiFi

Operating Mode / Band		Date Rate	Channel	Freq. (MHz)	Measured Time-averaged Conducted Power (dBm)	
					A	B
802.11b	2.4G	1Mbps	1	2412	13.82	15.14
			6	2437	14.14	14.98
			11	2462	14.46	15.03
			12	2467	14.05	14.91
			13	2472	14.12	15.07
802.11g	2.4G	6Mbps	1	2412	12.22	13.55
			6	2437	12.61	13.49
			11	2462	12.88	13.89
			12	2467	12.96	13.81
			13	2472	13.04	13.85
802.11n (HT20)	2.4G	MCS0	1	2412	11.98	13.45
			6	2437	13.05	13.31
			11	2462	12.55	13.75
			12	2467	12.61	13.71
			13	2472	13.44	13.73
802.11n (HT40)	2.4G	MCS0	3	2422	11.83	13.23
			6	2437	12.88	13.15
			9	2452	13.05	13.06
			10	2457	12.31	13.51
			11	2462	13.19	13.63

For BT

Operating Mode	Band	Channel	Freq. (MHz)	Measured Average Conducted Power (dBm)
BR+EDR (GFSK)	BT	0	2402	3.39
		19	2440	3.81
		39	2480	3.64
BR+EDR (π /4DQPSK)		0	2402	-2.39
		19	2440	-1.89
		39	2480	-2.07
BR+EDR (8DPSK)		0	2402	-2.40
		19	2440	-1.90
		39	2480	-2.08

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Total Quality. Assured.

TEST REPORT

Operating Mode	Band	Channel	Freq. (MHz)	Measured Average Conducted Power (dBm)
LE (GFSK)	BT	0	2402	1.14
		19	2440	1.57
		39	2480	1.38

For 5GHz WiFi

Operating Mode	Band	Channel	Freq. (MHz)	Measured Average Conducted Power (dBm)	
				A	B
802.11a	5.2G	36	5180	12.17	15.87
		40	5200	12.23	16.11
		44	5220	12.73	16.25
		48	5240	12.81	16.13
	5.3G	52	5260	12.72	16.01
		56	5280	12.68	16.14
		60	5300	13.12	16.02
		64	5320	13.15	15.86
	5.6G	100	5500	13.17	13.22
		104	5520	13.08	13.46
		108	5540	13.05	13.51
		112	5560	13.13	13.33
		116	5580	13.14	13.58
		120	5600	13.61	13.49
		124	5620	13.68	13.81
		128	5640	13.79	13.86
		132	5660	13.85	14.35
		136	5680	13.88	14.05
		140	5700	13.89	14.69
	5.8G	149	5745	14.09	14.05
		157	5785	13.66	13.82
		165	5825	13.01	13.42
802.11n (HT20)	5.2G	36	5180	11.95	15.88
		40	5200	12.45	16.18
		44	5220	12.48	16.16
		48	5240	12.56	16.11
	5.3G	52	5260	12.97	15.98
		56	5280	12.89	16.14
		60	5300	12.86	16.04
		64	5320	12.78	15.79
	5.6G	100	5500	12.97	13.24
		104	5520	12.93	13.41

		108	5540	12.96	13.52
		112	5560	12.88	13.39
		116	5580	13.37	13.46
		120	5600	13.44	13.58
		124	5620	13.51	13.68
		128	5640	13.57	13.79
		132	5660	13.65	14.38
		136	5680	13.59	14.09
		140	5700	13.66	14.65
	5.8G	149	5745	13.95	13.99
		157	5785	13.46	13.74
		165	5825	12.86	13.58
802.11n (HT40)	5.2G	38	5190	12.23	15.89
		46	5230	12.31	16.08
	5.3G	54	5270	12.78	16.01
		62	5310	12.73	15.79
	5.6G	102	5510	12.75	13.51
		110	5550	12.68	13.05
		118	5590	13.23	13.56
		126	5630	13.36	13.66
		134	5670	13.45	13.84
	5.8G	151	5755	13.66	13.59
		159	5795	13.11	13.29
802.11ac (VHT20)	5.2G	36	5180	11.89	15.86
		40	5200	12.35	16.26
		44	5220	12.39	16.22
		48	5240	12.51	16.15
	5.3G	52	5260	12.96	16.03
		56	5280	12.88	16.19
		60	5300	12.79	16.07
		64	5320	12.68	15.84
	5.6G	100	5500	12.93	13.13
		104	5520	12.91	13.43
		108	5540	12.86	13.46
		112	5560	12.79	13.41
		116	5580	13.26	13.55
		120	5600	13.31	13.68
		124	5620	13.49	13.79
		128	5640	13.52	13.87
		132	5660	13.44	14.41
		136	5680	13.61	14.11
		140	5700	13.68	14.87
	5.8G	149	5745	13.91	14.02
		157	5785	13.33	13.87
		165	5825	12.77	13.51
802.11ac	5.2G	38	5190	12.15	15.91

TEST REPORT

(VHT40)		46	5230	12.25	16.13
	5.3G	54	5270	12.66	15.85
		62	5310	12.57	15.81
	5.6G	102	5510	12.68	13.47
		110	5550	12.56	13.13
		118	5590	12.21	13.62
		126	5630	12.99	13.79
		134	5670	13.34	13.98
	5.8G	151	5755	13.54	13.58
		159	5795	13.02	13.34
802.11ac (VHT80)	5.2G	42	5210	11.89	15.48
	5.3G	58	5290	12.49	15.65
	5.6G	106	5530	12.11	13.07
		122	5610	13.05	13.58
	5.8G	155	5775	13.45	13.44

Note:
1. Fully charged battery was used for each measurement.
2. There was no power reduction used for any band/mode implemented in this device

TEST REPORT

6.3. Exposure Conditions

Body Exposure Conditions

For 2.4GHz WiFi

Antenna A

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	31.62	N/A
Rear Face	0	10		Test Required
Left Side	187	1466		Excluded
Right Side	85	446		Excluded
Top Side	0	10		Test Required
Bottom	152	1116		Excluded

Antenna B

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	35.48	N/A
Rear Face	0	10		Test Required
Left Side	0	10		Test Required
Right Side	279	2386		Excluded
Top Side	8	10		Test Required
Bottom	145	1046		Excluded

For BT

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	2.82	N/A
Rear Face	0	10		Excluded
Left Side	0	10		Excluded
Right Side	279	2385		Excluded
Top Side	8	10		Excluded
Bottom	145	1045		Excluded

For 5.2GHz WiFi
Antenna A

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	22.39	N/A
Rear Face	0	6.31		Test Required
Left Side	187	1436		Excluded
Right Side	85	416		Excluded
Top Side	0	6.31		Test Required
Bottom	152	1086		Excluded

Antenna B

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	44.67	N/A
Rear Face	0	6.31		Test Required
Left Side	0	6.31		Test Required
Right Side	279	2356		Excluded
Top Side	8	10.23		Test Required
Bottom	145	1016		Excluded

For 5.3GHz WiFi
Antenna A

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	22.39	N/A
Rear Face	0	6.31		Test Required
Left Side	187	1435		Excluded
Right Side	85	415		Excluded
Top Side	0	6.31		Test Required
Bottom	152	1085		Excluded

Antenna B

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	44.67	N/A
Rear Face	0	6.31		Test Required
Left Side	0	6.31		Test Required
Right Side	279	2355		Excluded
Top Side	8	10		Test Required
Bottom	145	1015		Excluded

TEST REPORT

For 5.6GHz WiFi
Antenna A

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	25.12	N/A
Rear Face	0	6.17		Test Required
Left Side	187	1433		Excluded
Right Side	85	413		Excluded
Top Side	0	6.17		Test Required
Bottom	152	1083		Excluded

Antenna B

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	31.62	N/A
Rear Face	0	6.17		Test Required
Left Side	0	6.17		Test Required
Right Side	279	2353		Excluded
Top Side	8	9.77		Test Required
Bottom	145	1013		Excluded

For 5.8GHz WiFi
Antenna A

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	28.18	N/A
Rear Face	0	6.17		Test Required
Left Side	187	1432		Excluded
Right Side	85	412		Excluded
Top Side	0	6.17		Test Required
Bottom	152	1082		Excluded

Antenna B

Test Configurations	Distance to phantom	SAR Exemption limit (mW)	Maximum Time-averaged Conducted power (mW)	SAR Exclusion Result
Front Face	0	N/A	28.18	N/A
Rear Face	0	6.17		Test Required
Left Side	0	6.17		Test Required
Right Side	279	2352		Excluded
Top Side	8	9.77		Test Required
Bottom	145	1012		Excluded

TEST REPORT

6.4. Test Result

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detailed measurement data and plots, which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix B.

Body SAR

Plot No.	Band	Mode	Test Position	Separation Distance (cm)	Ch.	Ant. Status	keyboard	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
2.4GHz WiFi													
	802.11b	-	Rear Face	0	11	A	w/o	15.0	14.46	0.08	0.852	1.13	0.96
	802.11b	-	Top Side	0	11	A	w/o	15.0	14.46	-0.05	0.225	1.13	0.25
	802.11b	-	Rear Face	0	6	A	w/o	15.0	14.14	0.09	0.979	1.22	**1.19**
	802.11b	-	Rear Face	0	1	B	w/o	15.5	15.14	0.08	0.924	1.09	1.00
	802.11b	-	Left Side	0	1	B	w/o	15.5	15.14	0.01	0.233	1.09	0.25
	802.11b	-	Top Side	0	1	B	w/o	15.5	15.14	-0.09	0.112	1.09	0.12
1	802.11b	-	Rear Face	0	13	B	w/o	15.5	15.07	0.05	**0.985**	1.10	1.09
	802.11b	-	Rear Face	0	13	B	w/	15.5	15.07	0.02	0.502	1.10	0.55
	802.11b	-	Rear Face	0	13	B	w/o	15.5	15.07	0.05	0.964	1.10	1.06
5.3GHz WiFi													
2	802.11a	-	Rear Face	0	64	A	w/o	13.5	13.15	0.05	**1.04**	1.08	1.13
	802.11a	-	Top Side	0	64	A	w/o	13.5	13.15	0.05	0.648	1.08	0.70
	802.11a	-	Rear Face	0	60	A	w/o	13.5	13.12	0.04	0.898	1.09	0.98
	802.11ac	VHT80	Rear Face	0	58	B	w/o	16.5	15.65	0.00	0.94	1.22	**1.14**
	802.11ac	VHT80	Left Side	0	58	B	w/o	16.5	15.65	0.05	0.873	1.22	1.06
	802.11ac	VHT80	Top Side	0	58	B	w/o	16.5	15.65	0.03	0.049	1.22	0.06
	802.11a	-	Rear Face	0	64	A	w/	13.5	13.15	0.03	0.361	1.08	0.39
	802.11a	-	Rear Face	0	64	A	w/o	13.5	13.15	0.06	0.993	1.08	1.08
5.6GHz WiFi													
3	802.11n	HT40	Rear Face	0	134	A	w/o	14.0	13.45	0.09	**1.03**	1.14	**1.17**
	802.11n	HT40	Top Side	0	134	A	w/o	14.0	13.45	0.03	0.475	1.14	0.54
	802.11n	HT40	Rear Face	0	126	A	w/o	14.0	13.36	-0.08	1.01	1.16	1.17
	802.11a	-	Rear Face	0	140	B	w/o	15.0	14.69	0.00	0.991	1.07	1.06
	802.11a	-	Left Side	0	140	B	w/o	15.0	14.69	0.09	0.97	1.07	1.04
	802.11a	-	Top Side	0	140	B	w/o	15.0	14.69	0.00	0.071	1.07	0.08
	802.11a	-	Rear Face	0	132	B	w/o	15.0	14.35	-0.05	0.96	1.16	1.11
	802.11a	-	Left Side	0	132	B	w/o	15.0	14.35	0.07	0.95	1.16	1.10
	802.11n	HT40	Rear Face	0	134	A	w/	14.0	13.45	0.02	0.31	1.14	0.35
	802.11n	HT40	Rear Face	0	134	A	w/o	14.0	13.45	0.07	1.03	1.14	1.17
5.8GHz WiFi													
	802.11ac	VHT80	Rear Face	0	155	A	w/o	14.5	13.45	0.08	0.903	1.27	1.15
	802.11ac	VHT80	Top Side	0	155	A	w/o	14.5	13.45	0.09	0.453	1.27	0.58
4	802.11ac	VHT80	Rear Face	0	155	B	w/o	14.5	13.44	0.05	**0.91**	1.28	**1.16**
	802.11ac	VHT80	Left Side	0	155	B	w/o	14.5	13.44	0.12	0.88	1.28	1.12
	802.11ac	VHT80	Top Side	0	155	B	w/o	14.5	13.44	0.03	0.08	1.28	0.10
	802.11ac	VHT80	Rear Face	0	155	B	w/	14.5	13.44	0.00	0.639	1.28	0.82
	802.11ac	VHT80	Rear Face	0	155	B	w/o	14.5	13.44	-0.02	0.86	1.28	1.10

Note:
1. Fully charged batteries were used at the beginning of each SAR measurement.

2. Per KDB 447498, when the maximum output power variation across the required test channels was < 0.5dB, measurement on middle channel was required.

3. Per KDB 447498, if the reported SAR value was ≤ 0.8 W/kg and the transmission band was ≤ 100MHz, SAR testing was not required for the other test channels in the band.

4. Per KDB 865664, repeated measurement was not required when the original highest measured SAR was < 0.8W/kg.

5. There was no power reduction used for any band/mode implemented in this device.

6. This device doesn't support MIMO, and Antenna A and B can't transmit at the same time.

7. This device have keyboard, SAR was tested without keyboard and with keyboard, in SAR result table, w/o means without keyboard, w/ means with keyboard, rear face with 90 degree was test for SAR test with keyboard.

8. SAR repeated measurement procedure:

a. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
b. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
c. If the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20, or when the original or repeated measurement is >= 1.45 W/kg, perform a second repeated measurement.
d. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Band	Mode	Test Position	Ch.	Original Measured SAR-1g (W/kg)	1st Repeated SAR-1g (W/kg)	L/S Ratio	2nd Repeated SAR-1g (W/kg)	L/S Ratio	3rd Repeated SAR-1g (W/kg)	L/S Ratio
Body Exposure Condition										
802.11b	-	Rear Face	13	0.985	0.964	1.02	N/A	N/A	N/A	N/A
802.11a	-	Rear Face	64	1.04	0.993	1.05	N/A	N/A	N/A	N/A
802.11n	HT40	Rear Face	134	1.03	1.03	1.00	N/A	N/A	N/A	N/A
802.11ac	VHT80	Rear Face	155	0.91	0.86	1.06	N/A	N/A	N/A	N/A

6.5. SAR Limits

The following FCC limits (Std. C95.1-1992) for SAR apply to devices operate in General Population/Uncontrolled Exposure and Controlled environment:

GENERAL POPULATION / UNCONTROLLED ENVIRONMENTS:
Defined as location where there is the exposure of individuals who have no knowledge or control of their exposure.

EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Spatial Peak SAR (Head)*	1.60
Spatial Peak SAR (Partial Body)*	1.60
Spatial Peak SAR (Whole Body)*	0.08
Spatial Peak SAR (Hands / Wrists / Feet / Ankles)**	4.00

OCCUPATIONAL / CONTROLLED ENVIRONMENTS:
Defined as location where there is the exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation)

EXPOSURE (Occupational/Controlled Exposure environment)	SAR (W/kg)
Spatial Peak SAR (Head)*	8.00
Spatial Peak SAR (Partial Body)*	8.00
Spatial Peak SAR (Whole Body)*	0.40
Spatial Peak SAR (Hands / Wrists / Feet / Ankles)**	20.00

Notes:

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

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

7. TEST EQUIPMENT LIST

Equipment	Manufacturer	Model No.	SN	Calibration Date	Cal. interval
System Validation Dipole	SPEAG	D2450V2	1014	Jun. 07, 2018	3 Year
System Validation Dipole	SPEAG	D5GHzV2	1280	Jun. 24, 2019	3 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	7506	Jun. 27, 2019	1 Year
Dosimetric E-Field Probe	SPEAG	ES3DV3	3090	Apr. 12, 2019	1 Year
Data Acquisition Electronics	SPEAG	DAE4	662	Apr. 11, 2019	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1557	Jun. 18, 2019	1 Year
ENA Series Network Analyzer	Agilent	8753ES	US39170317	Dec. 12, 2018	1 Year
Dielectric Assessment Kit	SPEAG	DAK-3.5	1056	N/A	N/A
USB/GPIB Interface	Agilent	82357B	N10149	N/A	N/A
Signal Generator	R&S	SMT06	100796	May. 14, 2019	1 Year
Signal Generator	R&S	SMB100A	103718	Dec. 12, 2018	1 Year
POWER METER	R&S	NRP	101293	Dec. 18, 2018	1 Year
Thermometer	Shanghai Gao Zhi Precision Instrument Co., Ltd.	HB6801	120100323	May. 16, 2019	1 Year
Coupler	REBES	TC-05180-10S	161221001	N/A	N/A
Amplifier	Mini-Circuit	ZHL42	QA1252001	N/A	N/A
DC Source	Agilent	66319B	MY43000795	N/A	N/A

TEST REPORT

1. MEASUREMENT UNCERTAINTY

Per FCC KDB 865884, the extensive SAR measurement uncertainty analysis was not required when the highest measured SAR was < 1.5W/kg for all frequency band.

2. E-FIELD PROBE AND DIPOLE ANTENNA CALIBRATION

Probe calibration factors and dipole antenna calibration are included in Appendix C.

TEST REPORT

APPENDIX A – SYSTEM CHECK DATA

Plot #1

Test Laboratory: UnionTrust | Date: 8/30/2019

System Check_B2450

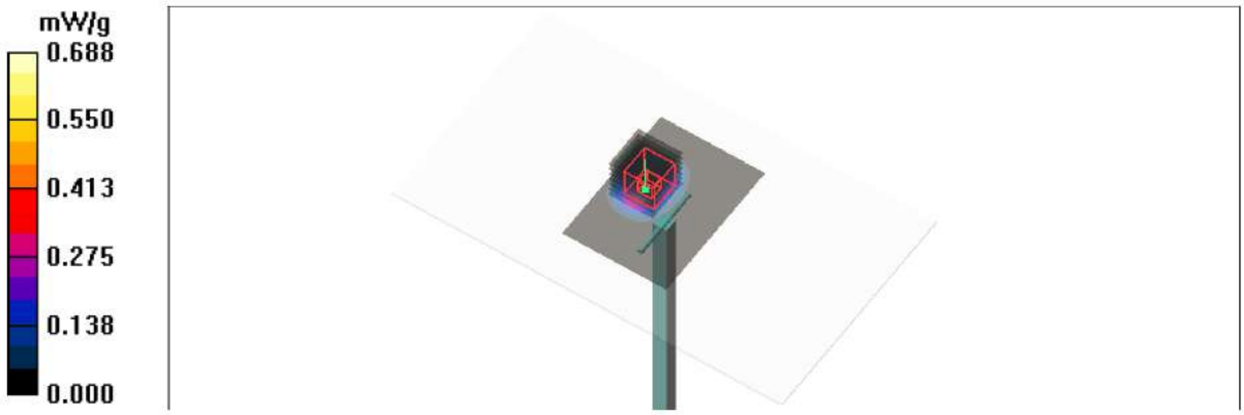
DUT: Dipole 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: B2450 Medium parameters used (extrapolated): f = 2450 MHz; σ = 2.006 mho/m; ε_r = 52.889; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: ES3DV3 - SN3090; ConvF(4.47, 4.47, 4.47); Calibrated: 2019-4-12
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn662; Calibrated: 2019-4-11
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1125
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (51x71x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.688 mW/g

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.17 V/m; Power Drift = 0.020 dB
Peak SAR (extrapolated) = 1.09 W/kg
SAR(1 g) = 0.522 mW/g; SAR(10 g) = 0.242 mW/g
Maximum value of SAR (measured) = 0.679 mW/g



TEST REPORT

Plot #2

Test Laboratory: UnionTrust

Date: 9/4/2019

System Check_B5250

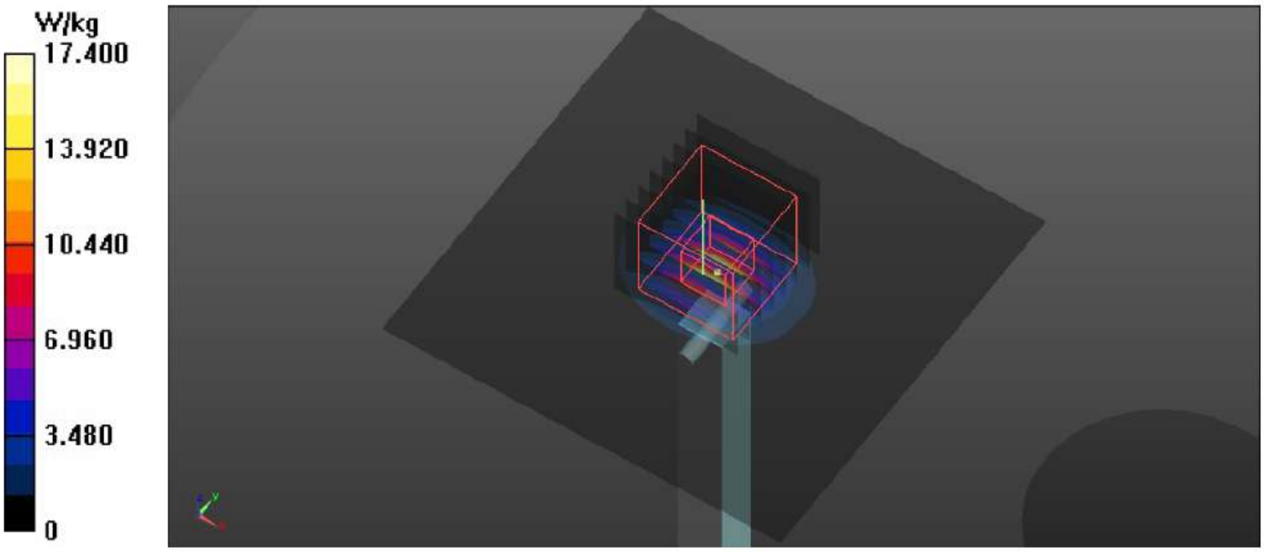
DUT: Dipole D5GHzV2

Communication System: CW; Frequency: 5250 MHz;Duty Cycle: 1:1
Medium: B5G Medium parameters used: f = 5250 MHz; σ = 5.494 S/m; ε_r = 48.293; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(5.03, 5.03, 5.03); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 17.4 W/kg

Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.86 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 28.5 W/kg
SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.18 W/kg
Maximum value of SAR (measured) = 17.5 W/kg



TEST REPORT

Plot #3

Test Laboratory: UnionTrust Date: 9/3/2019

System Check_B5600

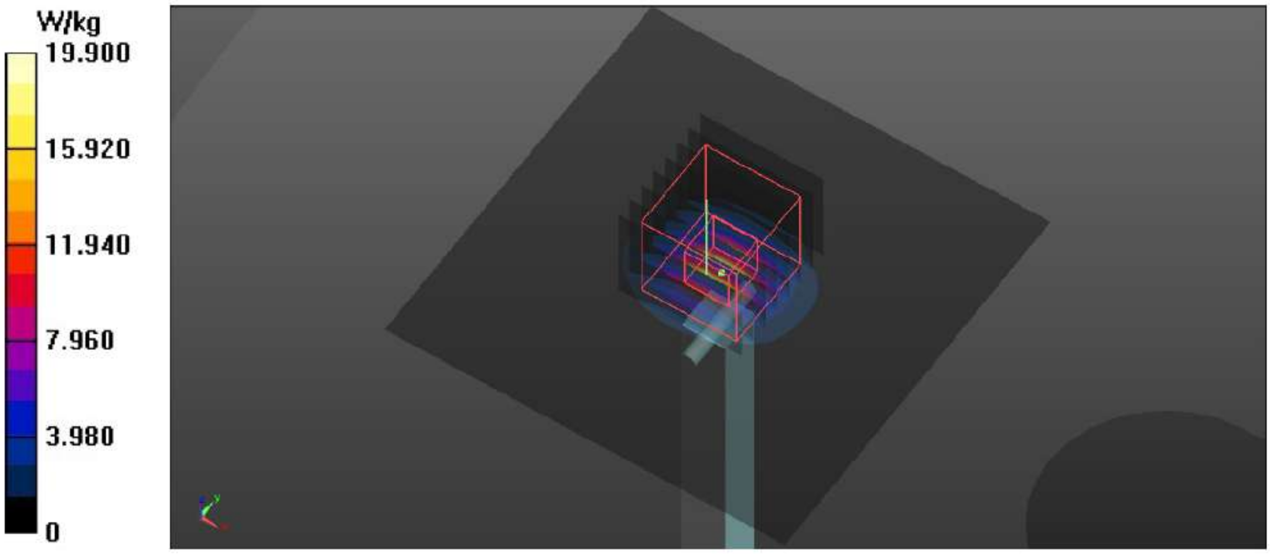
DUT: Dipole D5GHzV2

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: B5G Medium parameters used: f = 5600 MHz; σ = 5.957 S/m; ε_r = 47.703; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(4.34, 4.34, 4.34); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 19.9 W/kg

Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.76 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 33.4 W/kg
SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 19.4 W/kg



TEST REPORT

Plot #4

Test Laboratory: UnionTrust Date: 9/5/2019

System Check_B5800

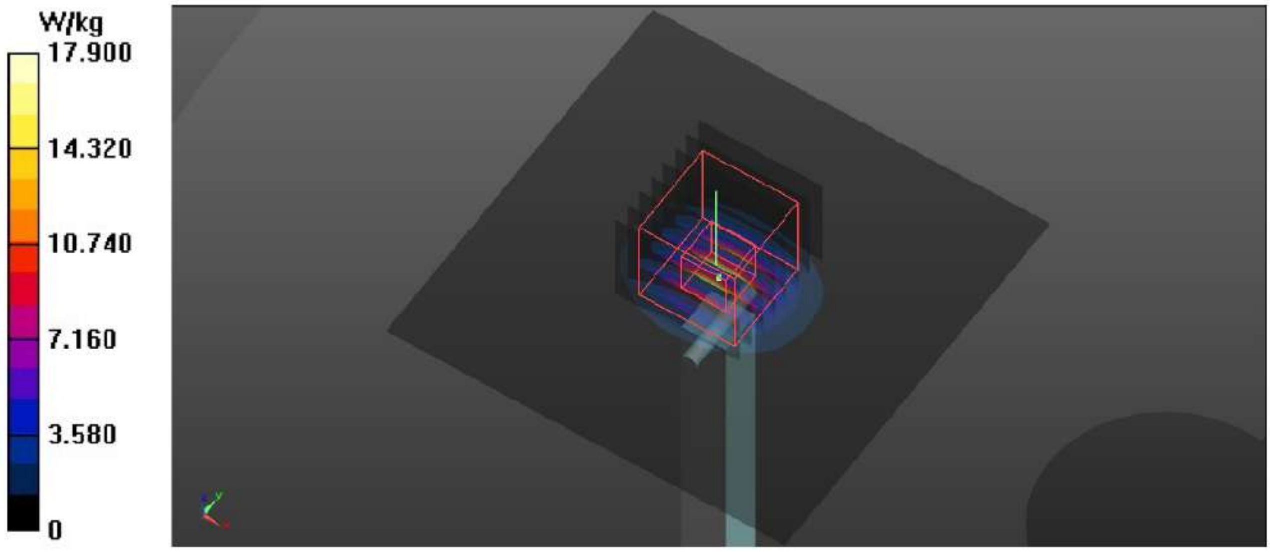
DUT: Dipole D5GHzV2

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium: B5G Medium parameters used: f = 5800 MHz; σ = 6.221 S/m; ε_r = 47.4; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(4.41, 4.41, 4.41); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 17.9 W/kg

Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.13 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 32.1 W/kg
SAR(1 g) = 7.45 W/kg; SAR(10 g) = 2.11 W/kg
Maximum value of SAR (measured) = 17.8 W/kg



TEST REPORT

APPENDIX B – SAR EVALUATION DATA

Test Laboratory: UnionTrust Date: 8/30/2019

P01_802.11b_Rear Face_0mm_13_B

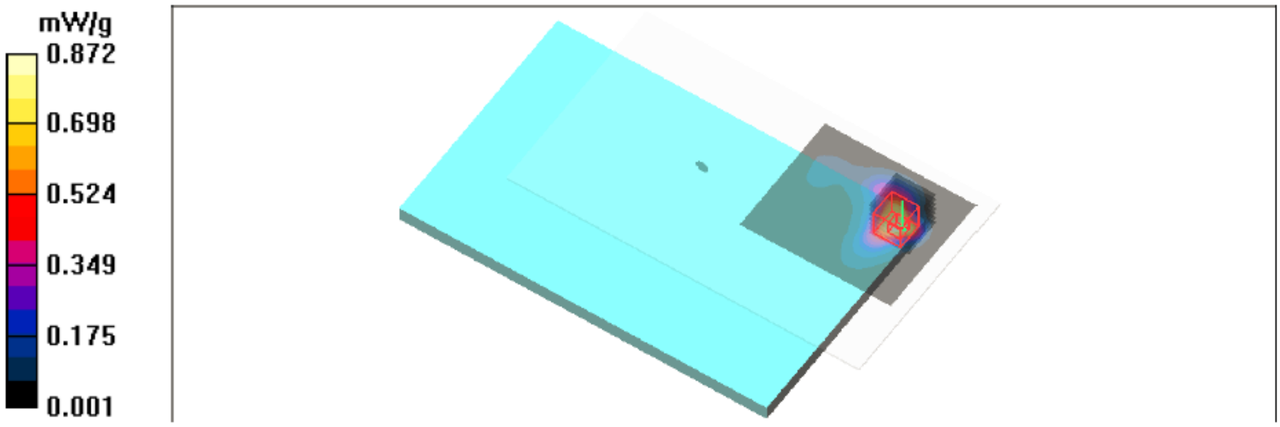
DUT: EUT

Communication System: Wlan 802.11b; Frequency: 2472 MHz;Duty Cycle: 1:1
Medium: B2450 Medium parameters used: f = 2472 MHz; $\sigma = 2.024$ mho/m; $\varepsilon_r = 52.847$; $\rho = 1000$ kg/m^3

DASY4 Configuration:
- Probe: ES3DV3 - SN3090; ConvF(4.47, 4.47, 4.47); Calibrated: 2019-4-12
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn662; Calibrated: 2019-4-11
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1125
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

Test/Area Scan (61x51x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.872 mW/g

Test/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.83 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 2.00 W/kg
SAR(1 g) = 0.985 mW/g; SAR(10 g) = 0.405 mW/g
Maximum value of SAR (measured) = 1.36 mW/g



TEST REPORT

Test Laboratory: UnionTrust

Date: 9/4/2019

P02 802.11a_Rear Face_0cm_Ch64_Antenna A

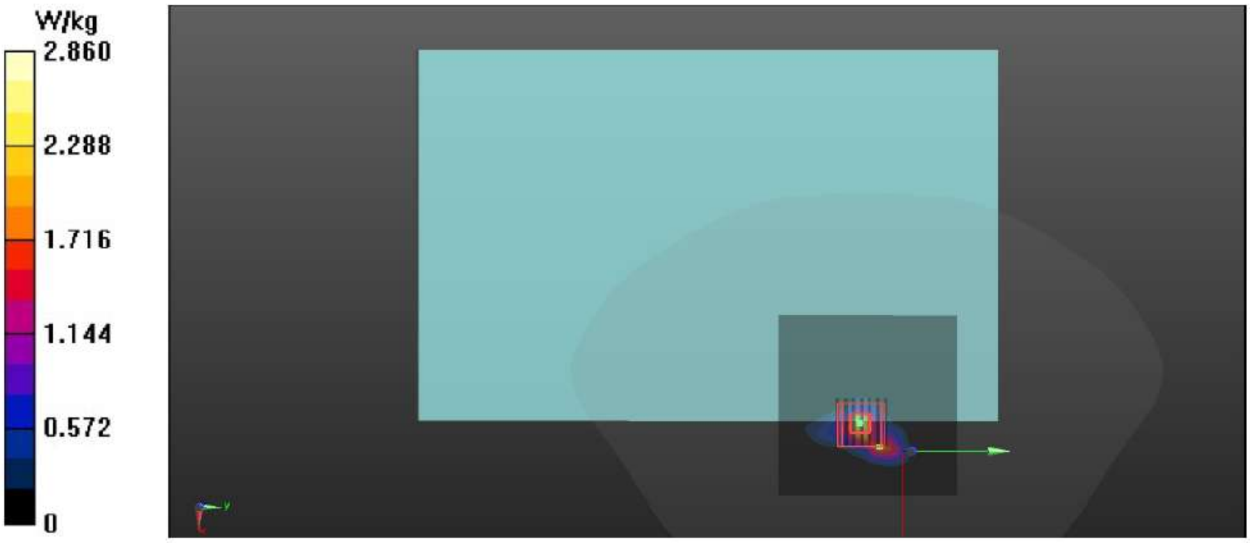
DUT: EUT

Communication System: 802.11a; Frequency: 5320 MHz;Duty Cycle: 1:1
Medium: B5G Medium parameters used: f = 5320 MHz; σ = 5.51 S/m; ε_r = 48.273; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(5.03, 5.03, 5.03); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

- **Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 2.86 W/kg

- **Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 12.39 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 4.72 W/kg
SAR(1 g) = 1.04 W/kg; SAR(10 g) = 0.329 W/kg
Maximum value of SAR (measured) = 2.60 W/kg



TEST REPORT

Test Laboratory: UnionTrust   Date: 9/3/2019

P03 802.11n_HT40_Rear Face_0cm_Ch134_Antenna A

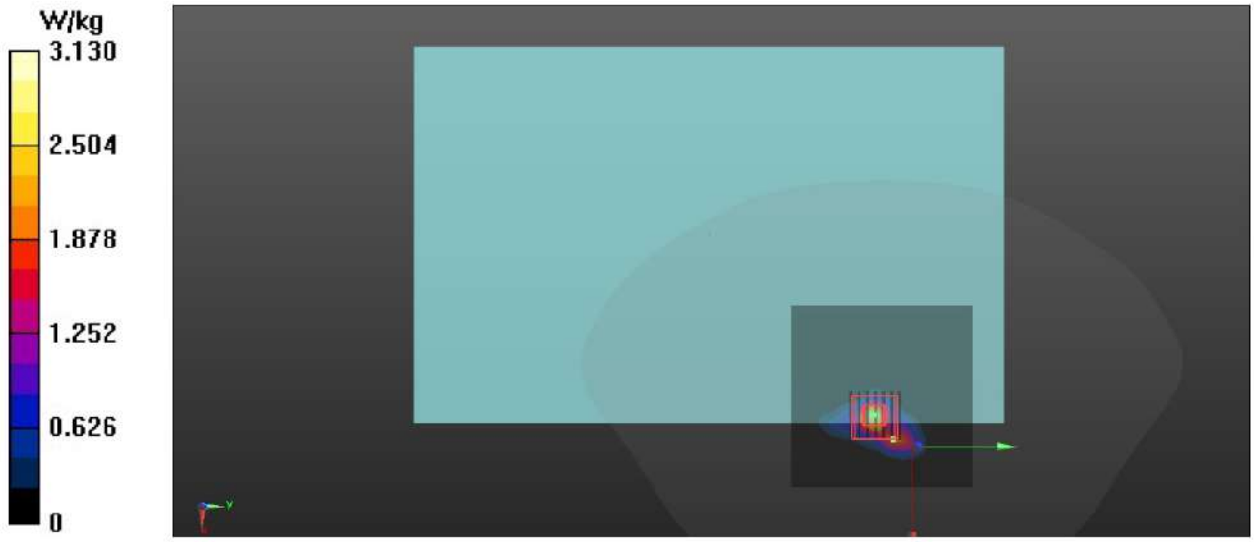
DUT: EUT

Communication System: 802.11n; Frequency: 5670 MHz;Duty Cycle: 1:1.03
Medium: B5G Medium parameters used: f = 5670 MHz; σ = 5.975 S/m; ε_r = 47.684; ρ = 1000 kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(4.34, 4.34, 4.34); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

- **Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 3.13 W/kg

- **Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 13.78 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 7.09 W/kg
SAR(1 g) = 1.03 W/kg; SAR(10 g) = 0.303 W/kg
Maximum value of SAR (measured) = 3.20 W/kg



Test Laboratory: UnionTrust Date: 9/5/2019

P04 802.11ac_VHT80_Rear Face_0cm_Ch155_Antenna B

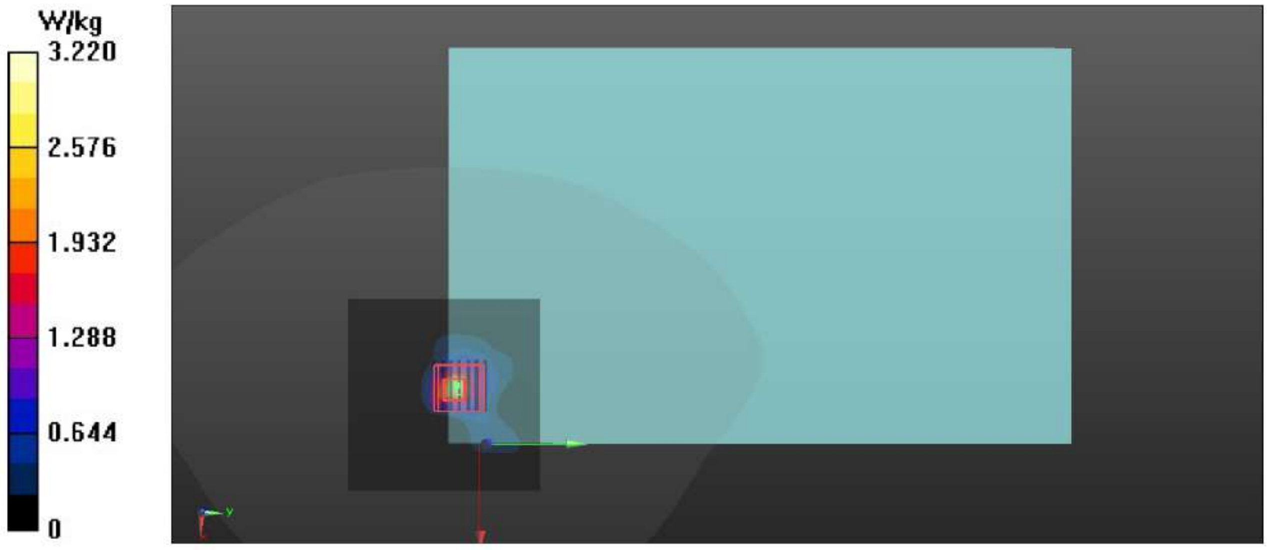
DUT: EUT

Communication System: 802.11ac; Frequency: 5775 MHz;Duty Cycle: 1:1.06
Medium: B5G Medium parameters used: f = 5775 MHz; $\sigma = 6.189$ S/m; $\varepsilon_r = 47.455$; $\rho = 1000$ kg/m^3

DASY4 Configuration:
- Probe: EX3DV4 - SN7506; ConvF(4.41, 4.41, 4.41); Calibrated: 6/27/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1557; Calibrated: 6/18/2019
- Phantom: SAM 2; Type: QD 000 P40 CB; Serial: TP-1376
- ; Postprocessing SW: SEMCAD, V1.8 Build 186

- **Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 3.22 W/kg

- **Zoom Scan (7x7x6)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 13.21 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 5.62 W/kg
SAR(1 g) = 0.91 W/kg; SAR(10 g) = 0.282 W/kg
Maximum value of SAR (measured) = 3.07 W/kg



TEST REPORT

APPENDIX C – E-FIELD PROBE AND DIPOLE ANTENNA CALIBRATION

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国际互认
校准
CALIBRATION
CNAS L0570

Client **UnionTrust** **Certificate No: Z19-60101**

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3090
Calibration Procedure(s)	FF-Z11-004-01 Calibration Procedures for Dosimetric E-field Probes
Calibration date:	April 12, 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	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 14, 2019

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Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "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

c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010

d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the E^2-field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z* frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- *Ax,y,z; Bx,y,z; Cx,y,z;VRx,y,z:*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≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. 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 NORMx,y,z* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from±50MHz to±100MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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Probe ES3DV3

SN: 3090

Calibrated: April 12, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3090

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm(μV/(V/m)^2)^A	1.22	1.35	1.33	±10.0%
DCP(mV)^B	104.2	104.9	104.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	260.9	±2.8%
		Y	0.0	0.0	1.0		280.0	
		Z	0.0	0.0	1.0		276.1	

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

^{A} The uncertainties of Norm X, Y, Z do not affect the E^2-field uncertainty inside TSL (see Page 5 and Page 6).
^{B} Numerical linearization parameter: uncertainty not required.
^{E} Uncertainly 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: ES3DV3 - SN: 3090

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz][C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unct. (k=2)
750	41.9	0.89	6.22	6.22	6.22	0.40	1.45	±12.1%
835	41.5	0.90	6.12	6.12	6.12	0.45	1.45	±12.1%
1750	40.1	1.37	5.36	5.36	5.36	0.65	1.25	±12.1%
1900	40.0	1.40	5.06	5.06	5.06	0.71	1.20	±12.1%
2300	39.5	1.67	4.81	4.81	4.81	0.90	1.08	±12.1%
2450	39.2	1.80	4.57	4.57	4.57	0.90	1.08	±12.1%
2600	39.0	1.96	4.48	4.48	4.48	0.90	1.07	±12.1%

[C] 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.
[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for 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: ES3DV3 - SN: 3090

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz][C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unct. (k=2)
750	55.5	0.96	6.40	6.40	6.40	0.40	1.35	±12.1%
835	55.2	0.97	6.18	6.18	6.18	0.48	1.46	±12.1%
1750	53.4	1.49	4.95	4.95	4.95	0.64	1.30	±12.1%
1900	53.3	1.52	4.79	4.79	4.79	0.65	1.29	±12.1%
2300	52.9	1.81	4.54	4.54	4.54	0.70	1.32	±12.1%
2450	52.7	1.95	4.47	4.47	4.47	0.75	1.30	±12.1%
2600	52.5	2.16	4.24	4.24	4.24	0.80	1.22	±12.1%

[C] 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.
[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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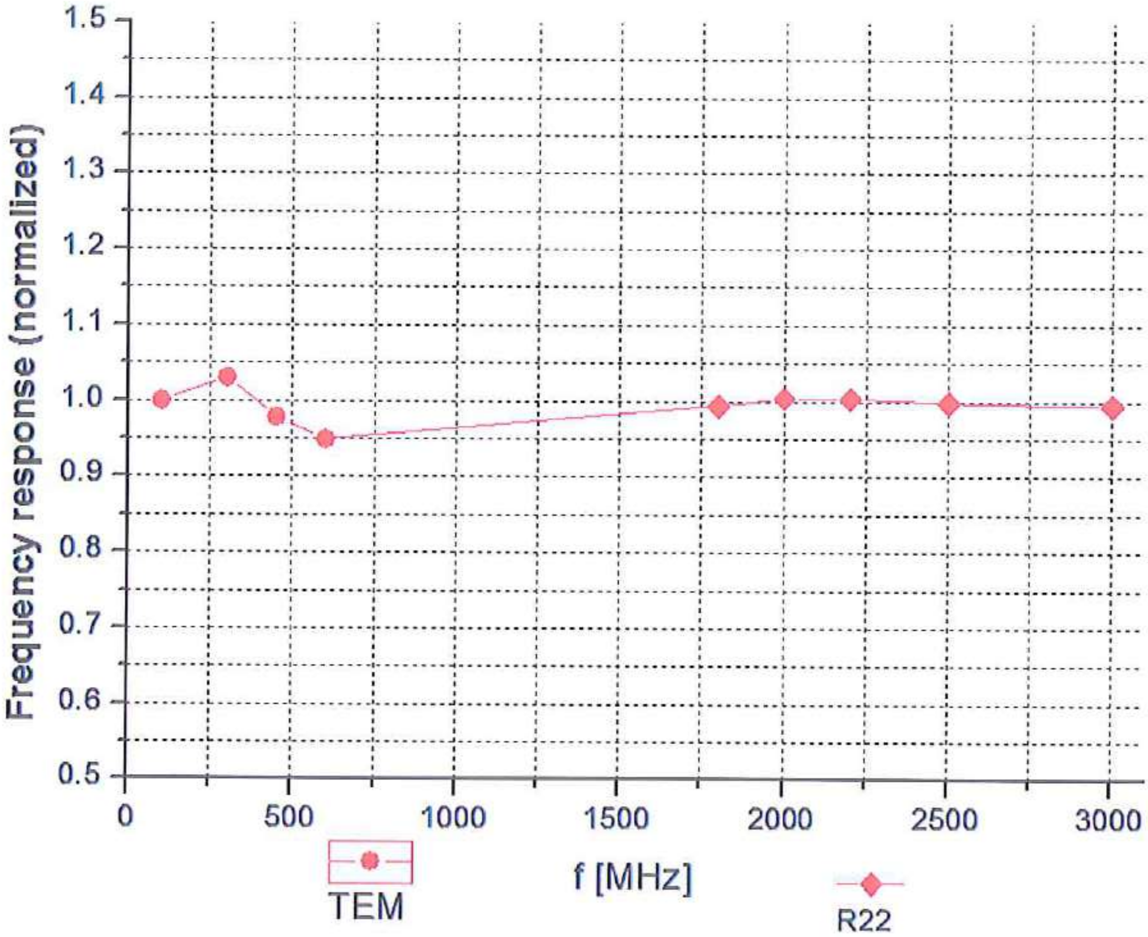
E-mail: cttl@chinattl.com Http://www.chinattl.cn

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



Uncertainty of Frequency Response of E-field: ±7.4% (k=2)

TTL In Collaboration with speag CALIBRATION LABORATORY

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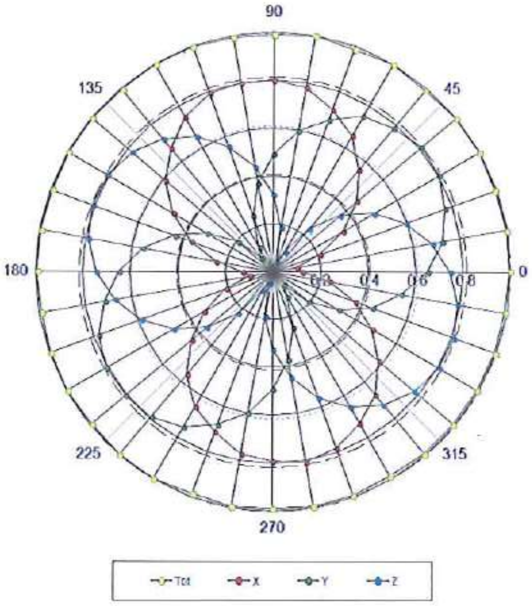
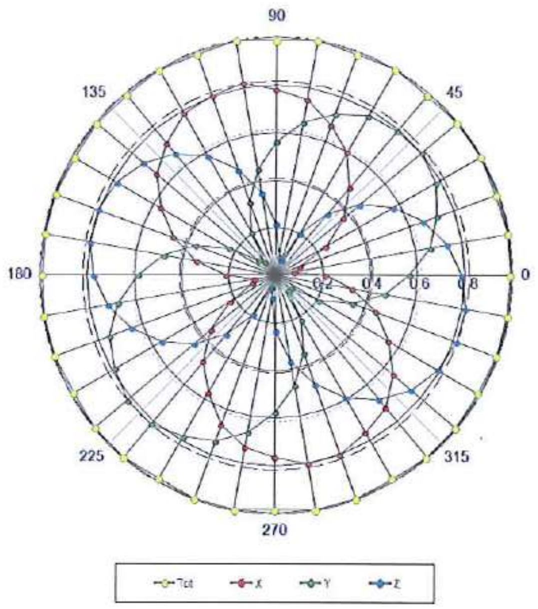
E-mail: cttl@chinattl.com Http://www.chinattl.cn

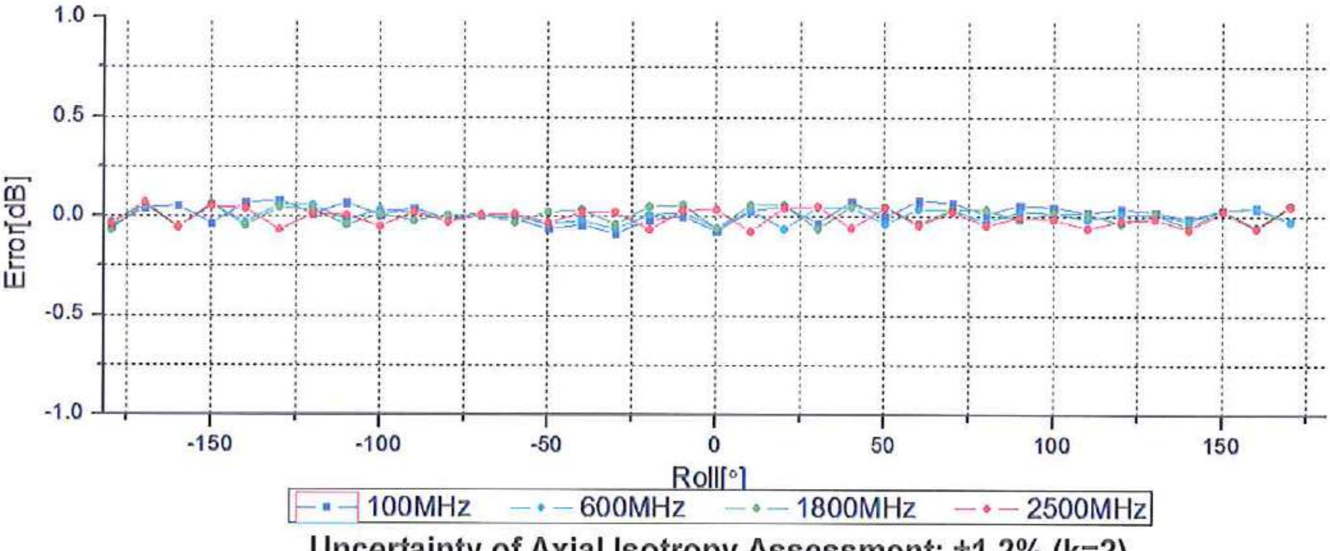
Receiving Pattern (Φ), θ=0°

f=600 MHz, TEM



f=1800 MHz, R22





Uncertainty of Axial Isotropy Assessment: ±1.2% (k=2)

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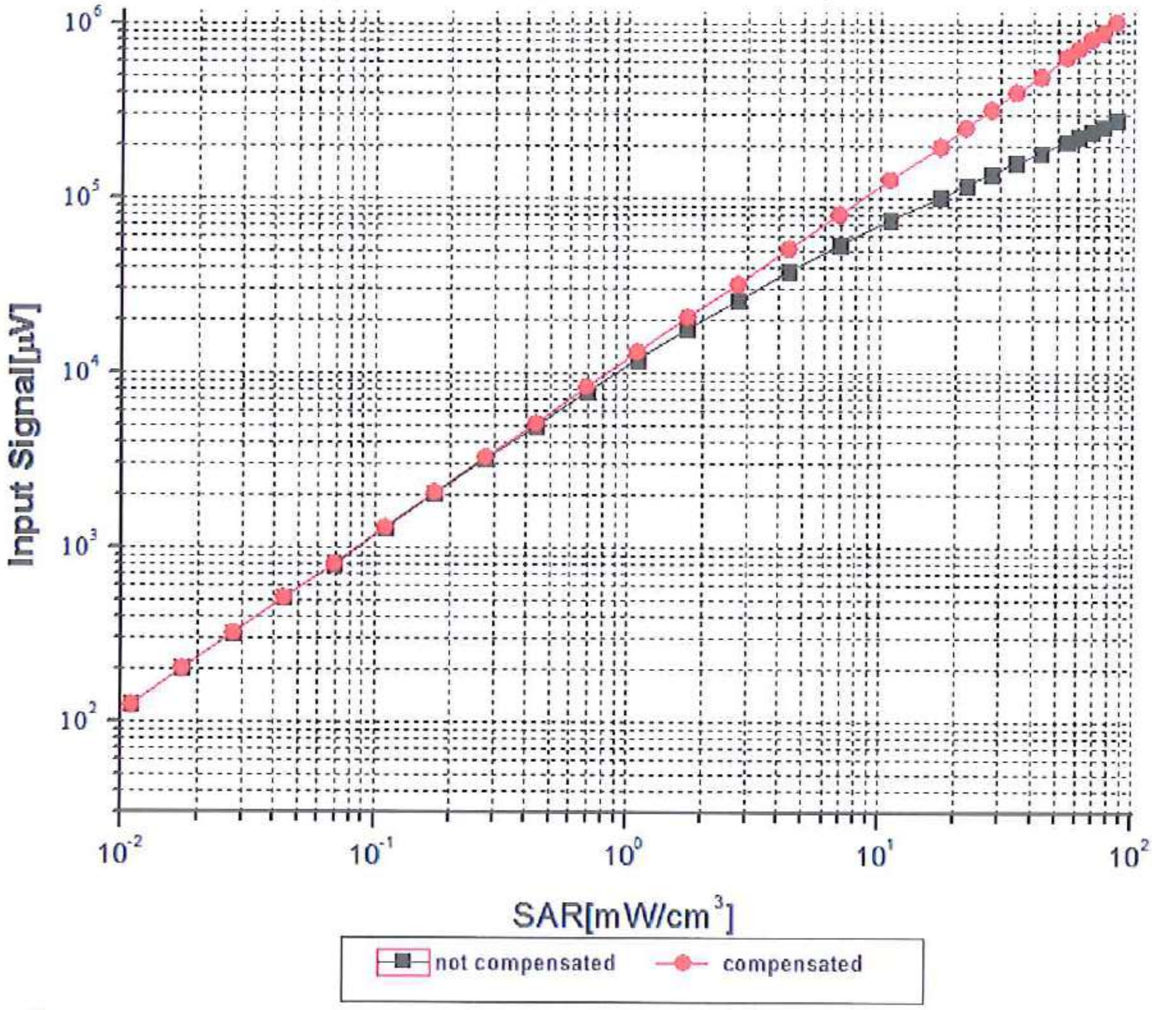
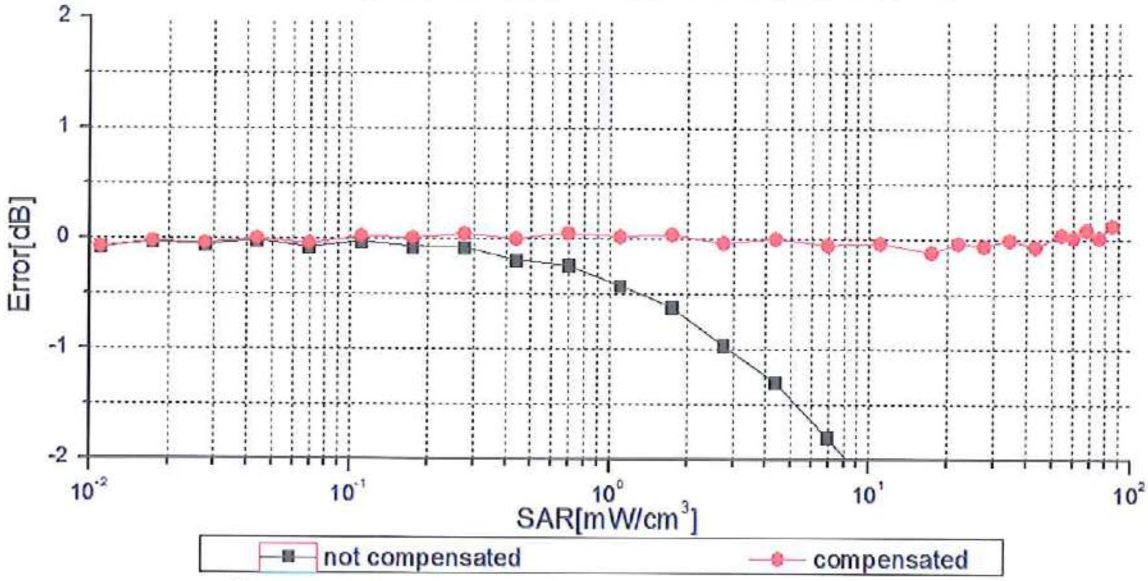
Dynamic Range f(SAR$_{head}$)
(TEM cell, f = 900 MHz)





Uncertainty of Linearity Assessment: ±0.9% (k=2)

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CALIBRATION LABORATORY
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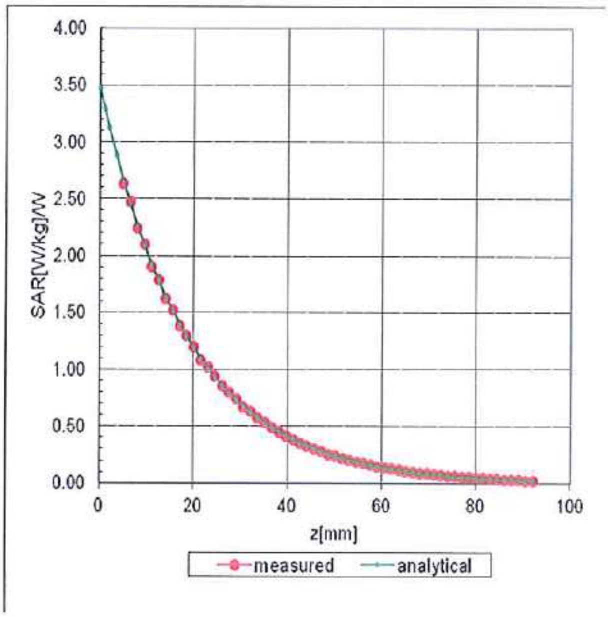
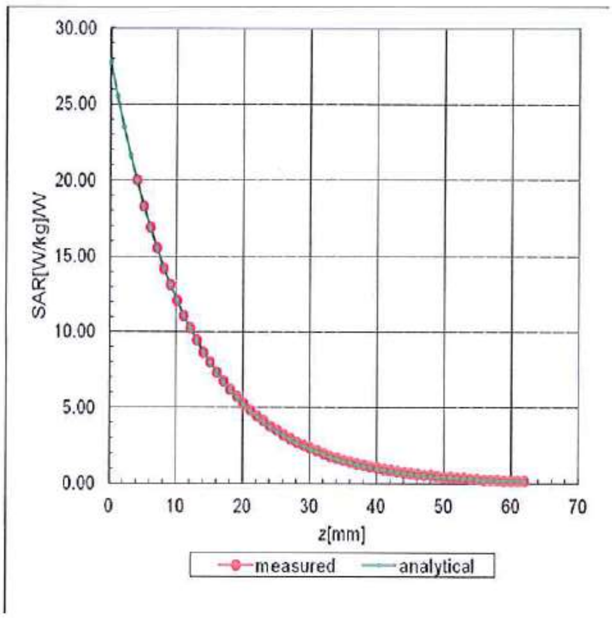
Conversion Factor Assessment

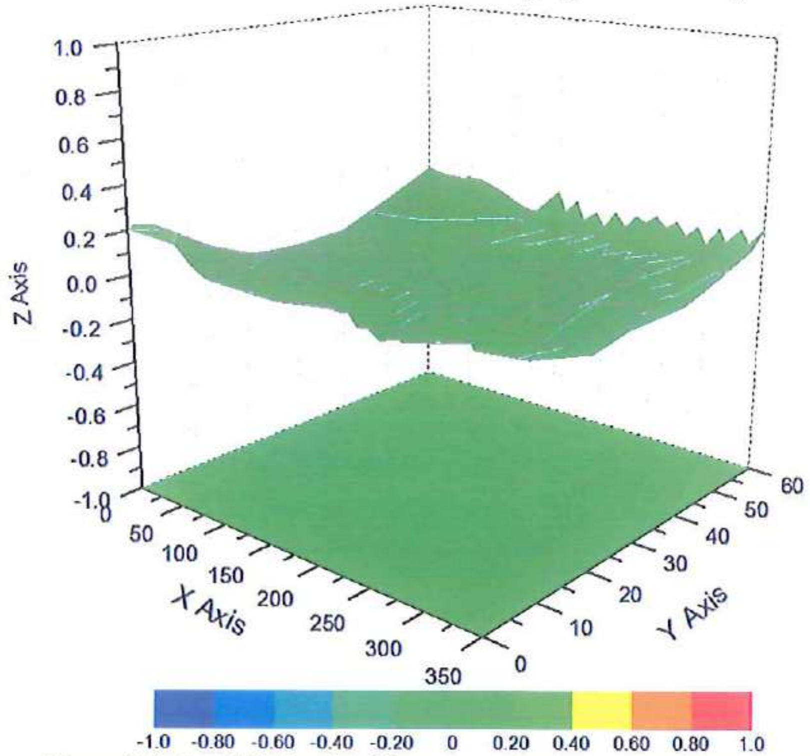
f=835 MHz, WGLS R9(H_convF)



f=1900 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: ±3.2% (K=2)

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DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3090

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	1.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	10mm
Tip Diameter	4mm
Probe Tip to Sensor X Calibration Point	2mm
Probe Tip to Sensor Y Calibration Point	2mm
Probe Tip to Sensor Z Calibration Point	2mm
Recommended Measurement Distance from Surface	3mm

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

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

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

Accreditation No.: SCS 0108

Client TuV-CN (Auden)

Certificate No: EX3-7506_Jun19

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7506

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: June 27, 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 (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 660	19-Dec-18 (No. DAE4-660_Dec18)	Dec-19
Reference Probe ES3DV2	SN: 3013	31-Dec-18 (No. ES3-3013_Dec18)	Dec-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Manu Seitz	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 27, 2019

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7506

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.56	0.41	0.51	± 10.1 %
DCP (mV)[B]	98.9	94.1	97.4	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.9	±3.3 %	± 4.7 %
		Y	0.0	0.0	1.0		143.5		
		Z	0.0	0.0	1.0		142.2		

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7506

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	60
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7506

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	43.5	0.87	11.26	11.26	11.26	0.11	1.20	± 13.3 %
750	41.9	0.89	10.49	10.49	10.49	0.61	0.80	± 12.0 %
835	41.5	0.90	10.23	10.23	10.23	0.53	0.81	± 12.0 %
900	41.5	0.97	10.02	10.02	10.02	0.44	0.94	± 12.0 %
1750	40.1	1.37	8.93	8.93	8.93	0.32	0.90	± 12.0 %
1900	40.0	1.40	8.57	8.57	8.57	0.35	0.86	± 12.0 %
2000	40.0	1.40	8.46	8.46	8.46	0.33	0.86	± 12.0 %
2300	39.5	1.67	8.07	8.07	8.07	0.32	0.88	± 12.0 %
2450	39.2	1.80	7.85	7.85	7.85	0.32	0.99	± 12.0 %
2600	39.0	1.96	7.59	7.59	7.59	0.34	0.96	± 12.0 %
3500	37.9	2.91	6.91	6.91	6.91	0.30	1.30	± 13.1 %
3700	37.7	3.12	6.90	6.90	6.90	0.30	1.30	± 13.1 %
5250	35.9	4.71	5.40	5.40	5.40	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.92	4.92	4.92	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.05	5.05	5.05	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7506

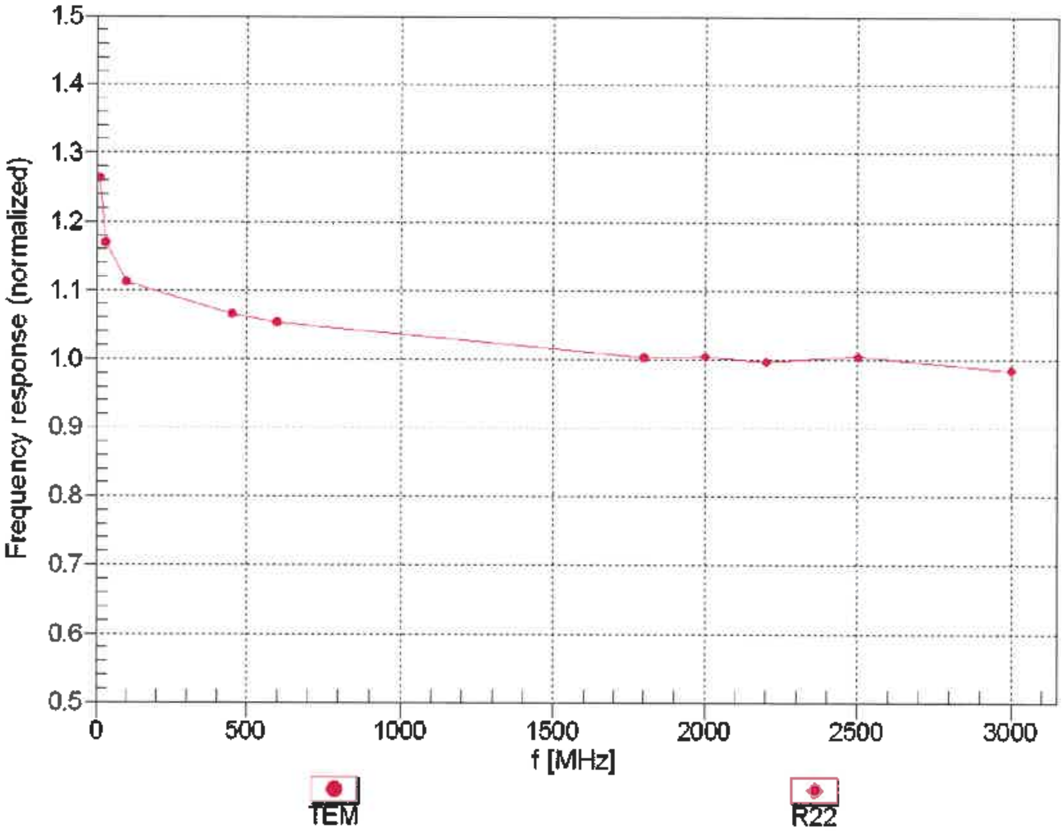
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	56.7	0.94	10.85	10.85	10.85	0.08	1.20	± 13.3 %
750	55.5	0.96	10.44	10.44	10.44	0.50	0.80	± 12.0 %
835	55.2	0.97	10.18	10.18	10.18	0.47	0.80	± 12.0 %
900	55.0	1.05	10.02	10.02	10.02	0.48	0.80	± 12.0 %
1750	53.4	1.49	8.48	8.48	8.48	0.37	0.90	± 12.0 %
1900	53.3	1.52	8.06	8.06	8.06	0.42	0.86	± 12.0 %
2000	53.3	1.52	7.97	7.97	7.97	0.42	0.86	± 12.0 %
2300	52.9	1.81	7.86	7.86	7.86	0.43	0.90	± 12.0 %
2450	52.7	1.95	7.67	7.67	7.67	0.37	0.96	± 12.0 %
2600	52.5	2.16	7.58	7.58	7.58	0.33	0.96	± 12.0 %
3500	51.3	3.31	6.68	6.68	6.68	0.40	1.30	± 13.1 %
3700	51.0	3.55	6.66	6.66	6.66	0.40	1.30	± 13.1 %
5250	48.9	5.36	5.03	5.03	5.03	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.34	4.34	4.34	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.41	4.41	4.41	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field

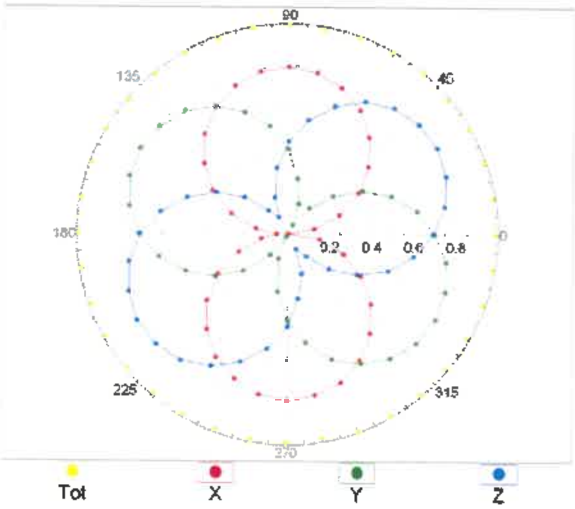
(TEM-Cell:ifi110 EXX, Waveguide: R22)



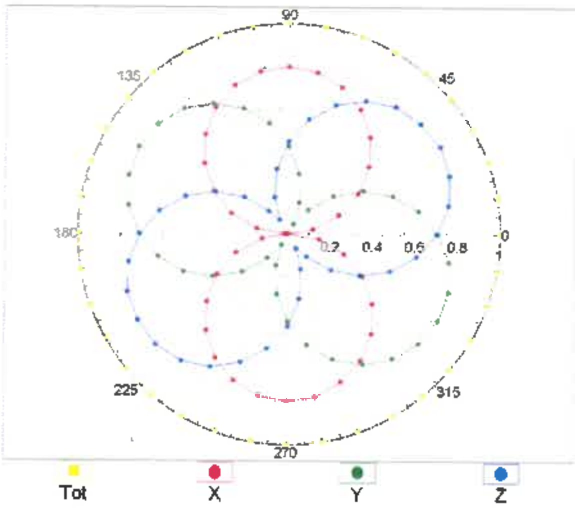
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

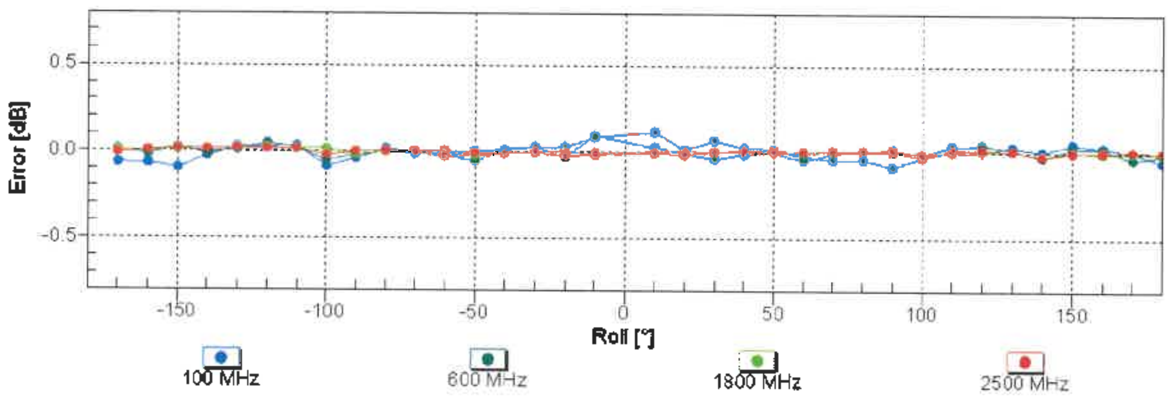
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



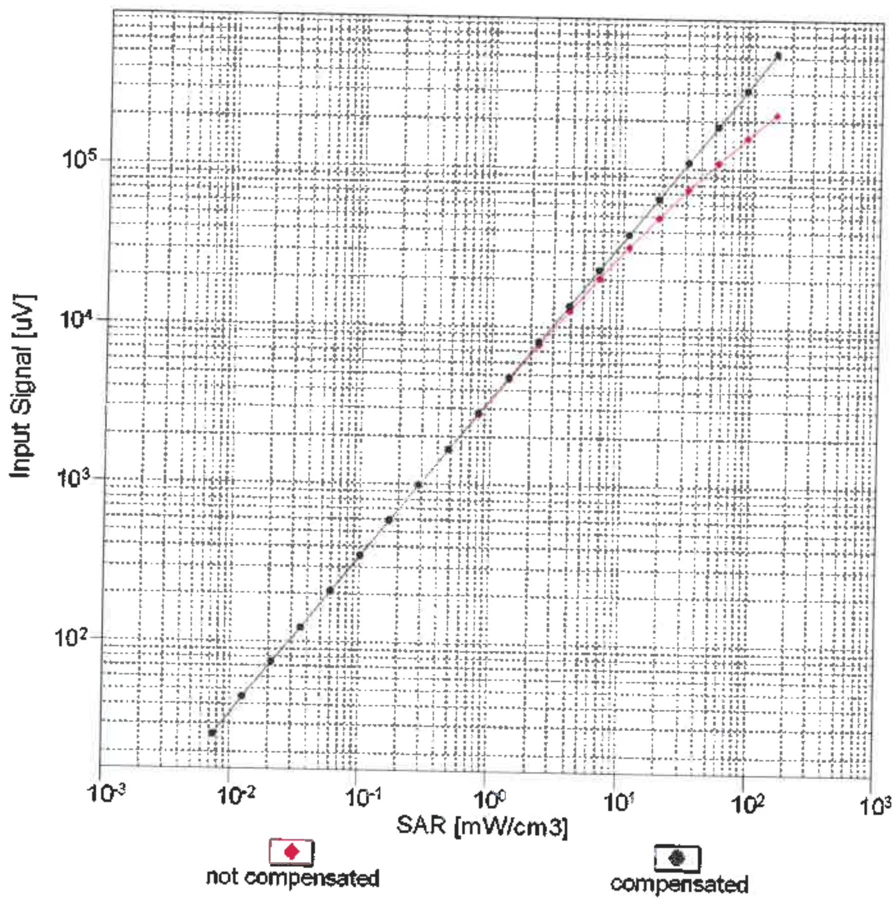
f=1800 MHz,R22

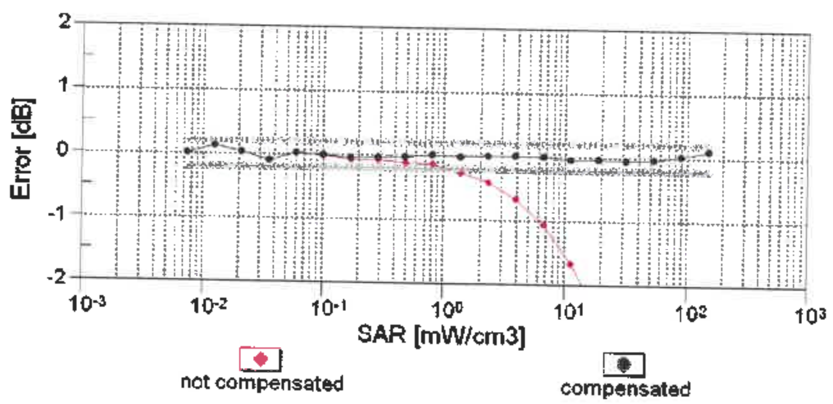




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

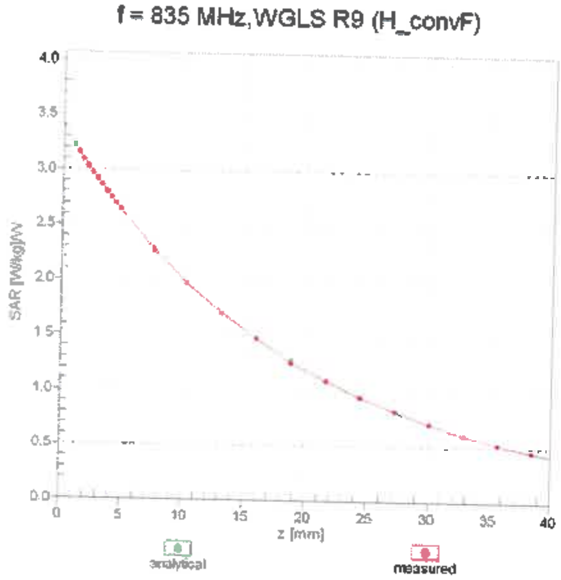
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

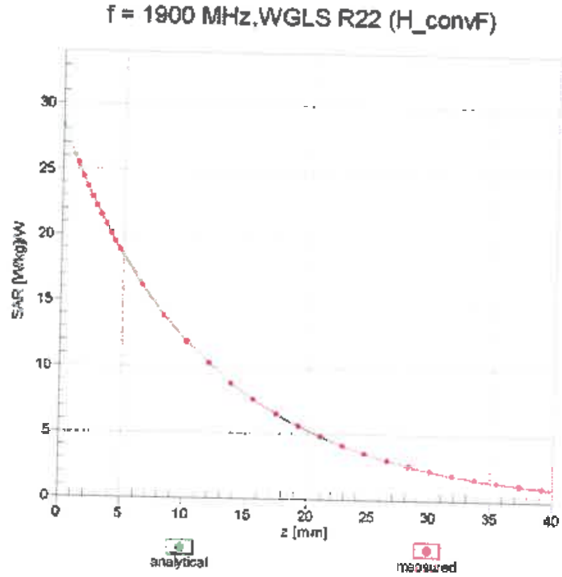




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

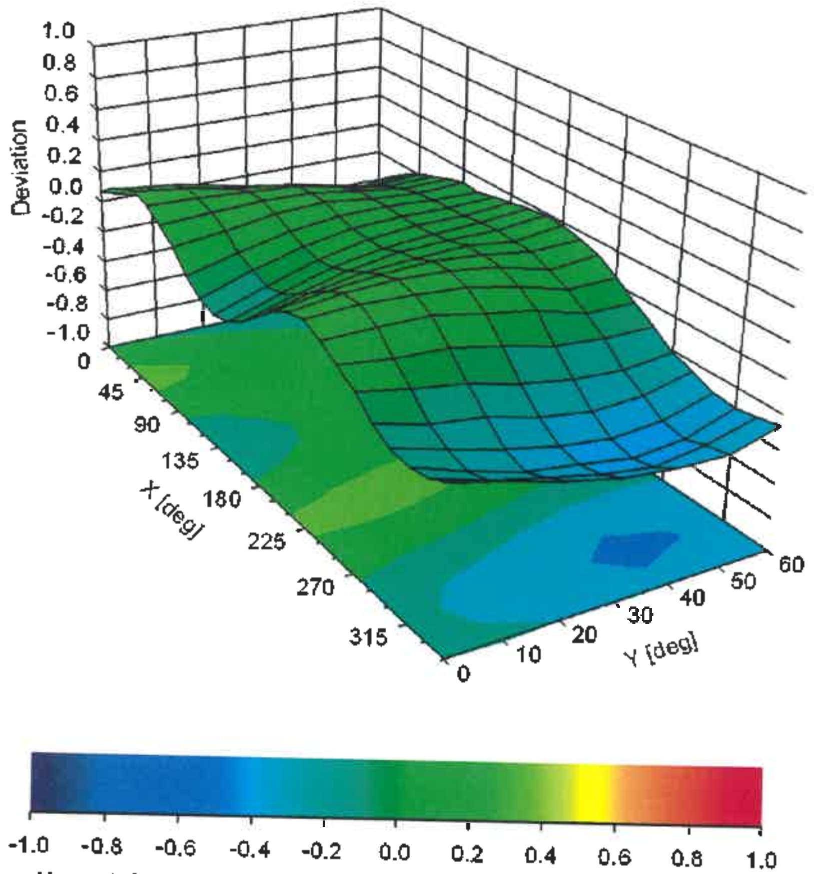
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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

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

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

Accreditation No.: SCS 0108

Client TüV China (Auden)

Certificate No: D2450V2-1014_Jun18

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:1014
Calibration procedure(s)	QA CAL-05.v10 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	June 07, 2018

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Reference Probe EX3DV4	SN: 7349	30-Dec-17 (No. EX3-7349_Dec17)	Dec-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18

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

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

Issued: June 7, 2018

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.2 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.3 ± 6 %	2.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.8 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.0 Ω + 3.3 jΩ
Return Loss	- 24.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.8 Ω + 4.1 jΩ
Return Loss	- 27.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.144 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 17, 2017

DASY5 Validation Report for Head TSL

Date: 07.06.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1014

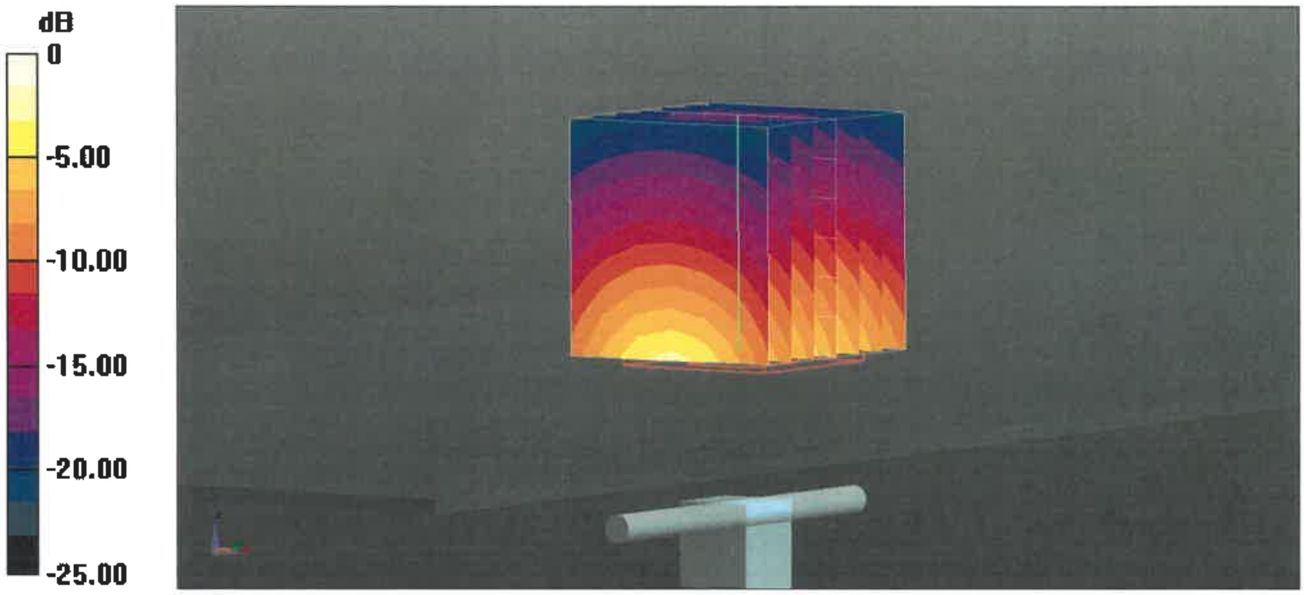
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma = 1.85$ S/m; $\varepsilon_r = 38.2$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

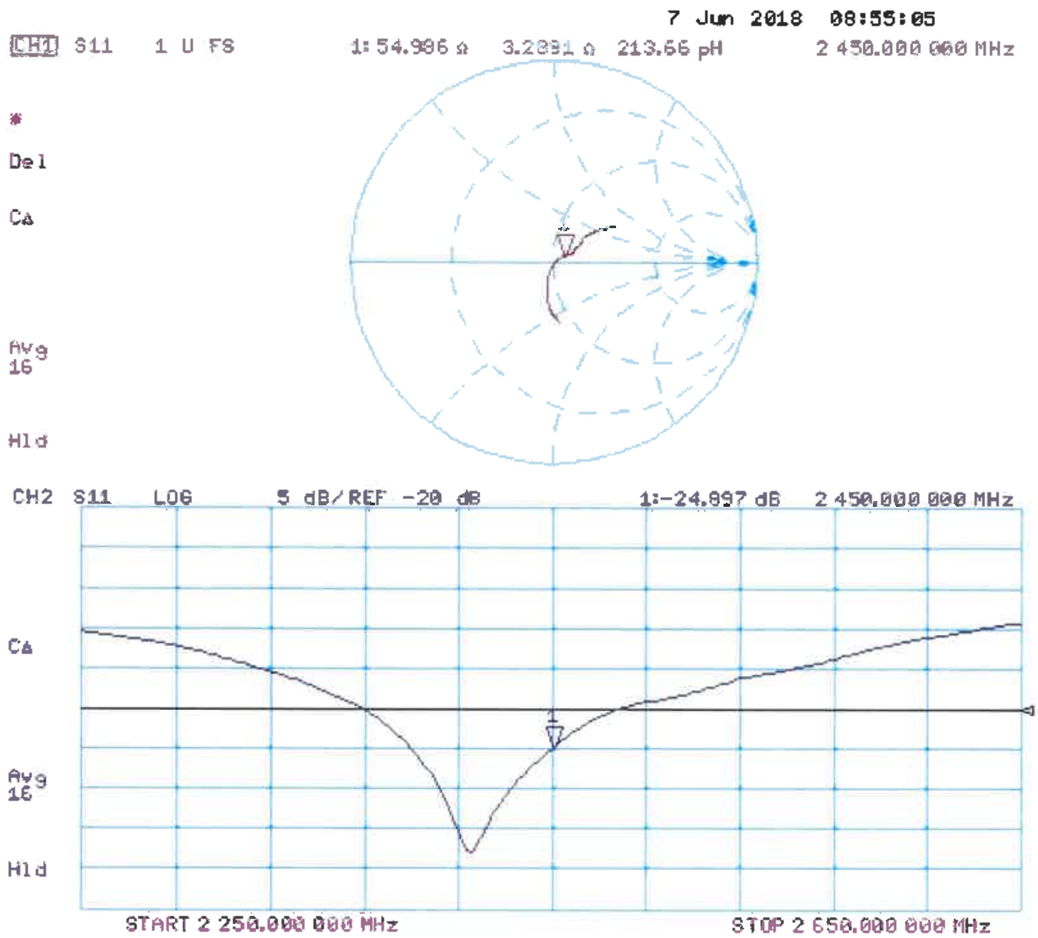
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 115.1 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 25.9 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.09 W/kg
Maximum value of SAR (measured) = 21.5 W/kg



0 dB = 21.5 W/kg = 13.32 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 07.06.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1014

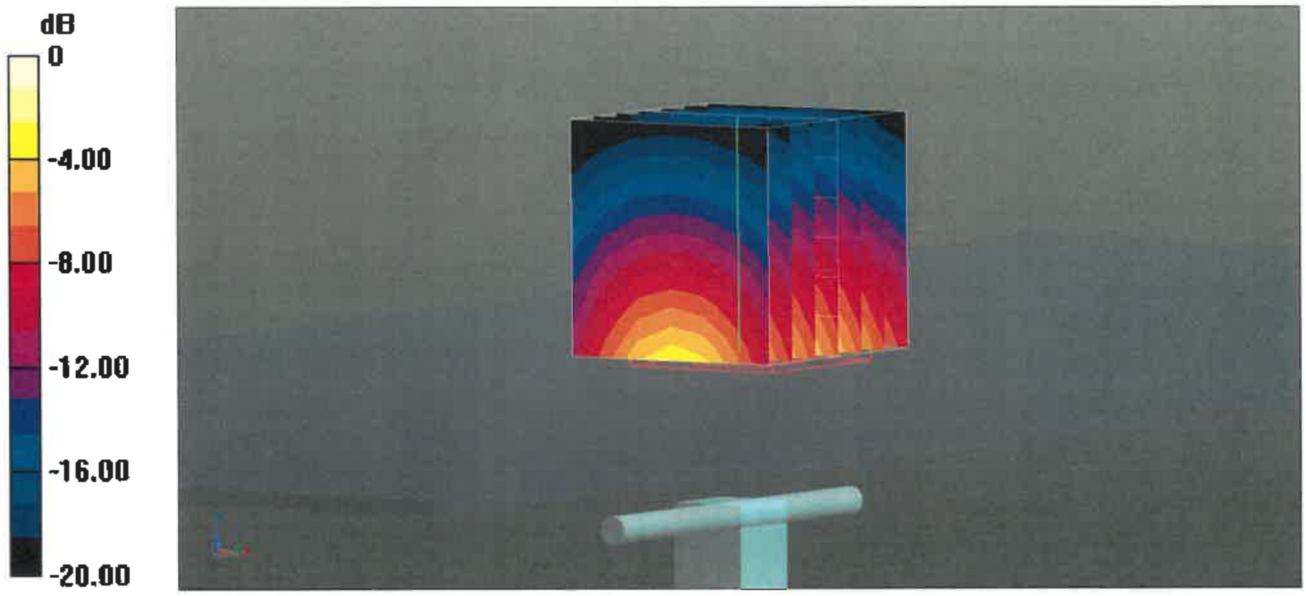
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.03 S/m; ε_r = 52.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.01, 8.01, 8.01) @ 2450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

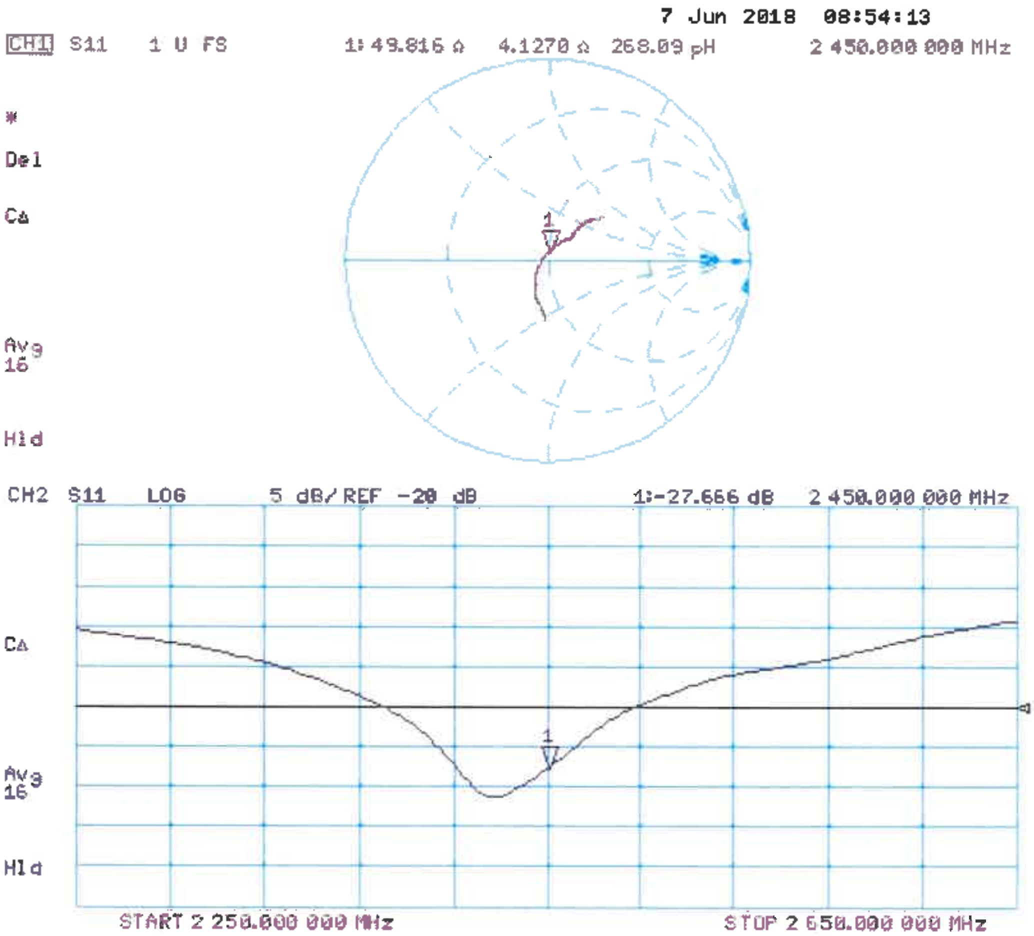
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.4 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 25.5 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.02 W/kg
Maximum value of SAR (measured) = 21.0 W/kg



0 dB = 21.0 W/kg = 13.22 dBW/kg

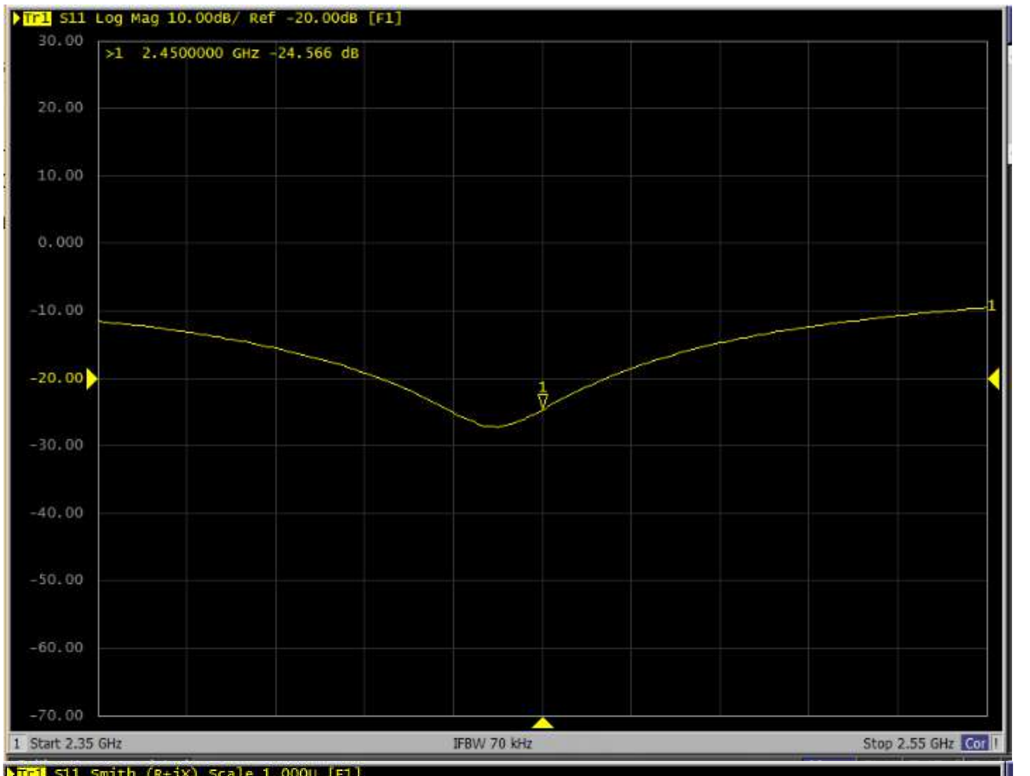
Impedance Measurement Plot for Body TSL

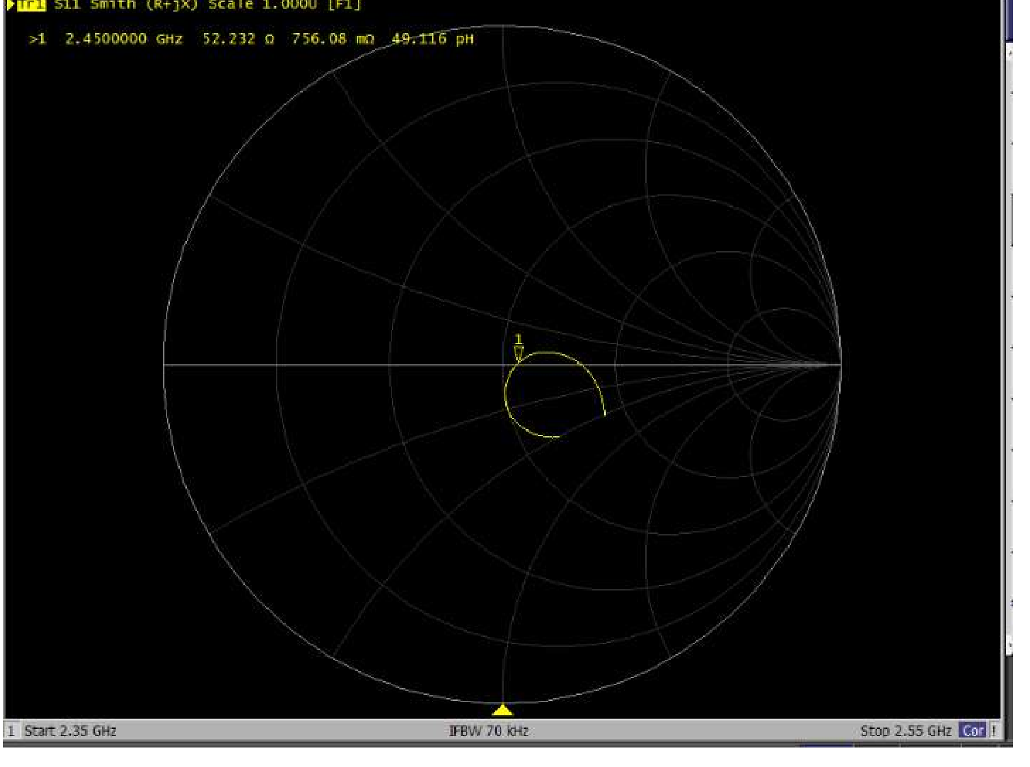


Justification for Extended SAR Dipole Calibrations

Dipole	Date of Measurement	Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)
Head 2450 MHz	Jun. 07, 2018	-24.9	-	55	-
	Apr. 17, 2019	-24.6	-1.20	52.2	-2.8

Note: The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification results meet the requirement of extended calibration.

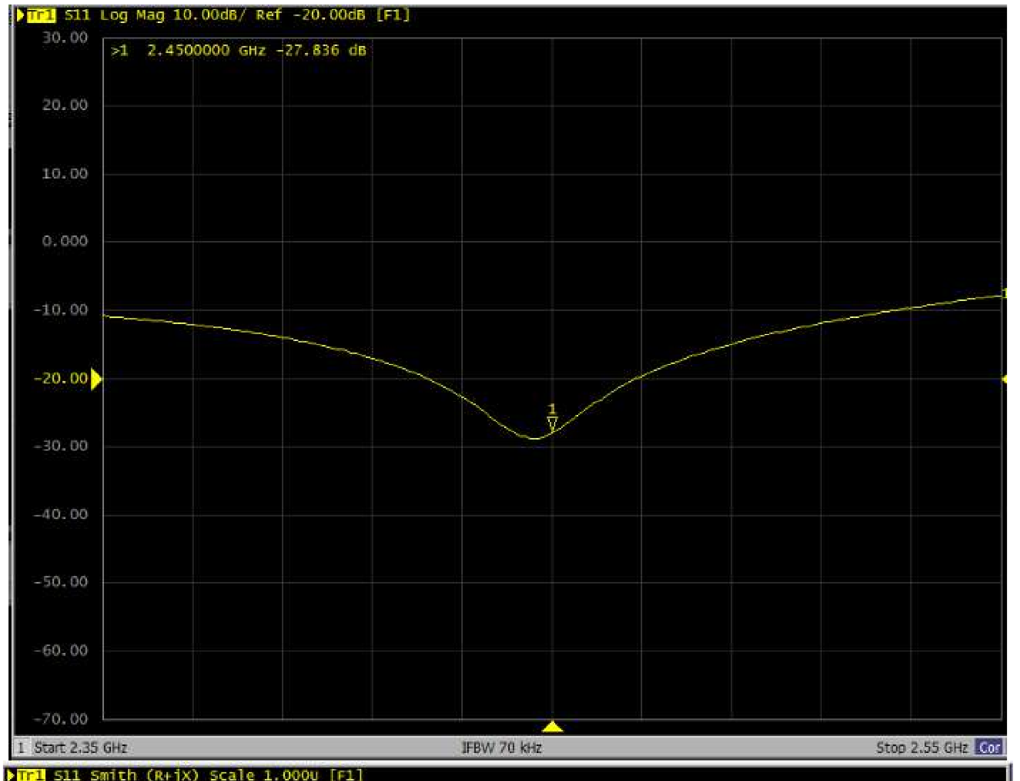


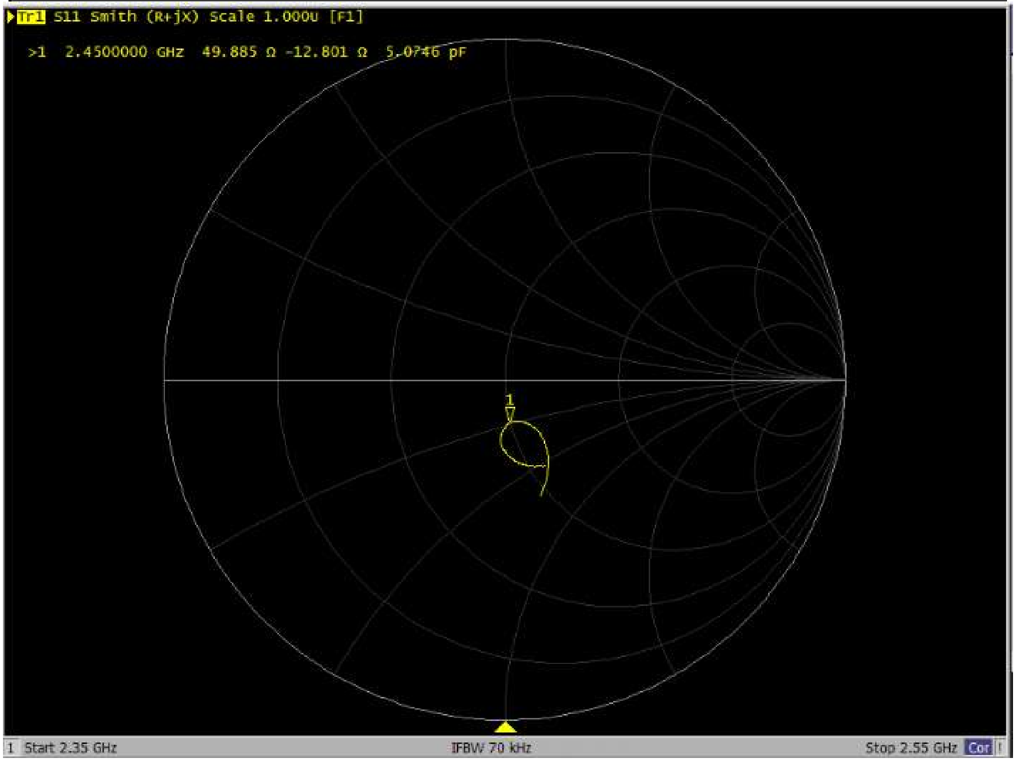


Justification for Extended SAR Dipole Calibrations

Dipole	Date of Measurement	Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)
Body 2450 MHz	Jun. 07, 2018	-27.7	-	49.8	-
	Apr. 17, 2019	-27.8	0.36	49.9	0.1

Note: The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification results meet the requirement of extended calibration.





Calibration Laboratory of
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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client TuV-CN (Auden)

Certificate No: D5GHzV2-1280_Jun19

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1280
Calibration procedure(s)	QA CAL-22.v4 Calibration Procedure for SAR Validation Sources between 3-6 GHz
Calibration date:	June 24, 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 (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	Mar-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

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

Issued: June 24, 2019

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

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

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 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 ± 0.2) °C	35.4 ± 6 %	4.52 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °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	7.96 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

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	34.9 ± 6 %	4.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	5.08 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.04 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

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	47.5 ± 6 %	5.49 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.9 W/kg ± 19.5 % (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	46.8 ± 6 %	5.97 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.19 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.2 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.5 ± 6 %	6.25 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.9 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	49.0 Ω - 4.4 jΩ
Return Loss	- 26.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	51.6 Ω + 2.1 jΩ
Return Loss	- 31.7 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.4 Ω + 5.0 jΩ
Return Loss	- 25.3 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	49.0 Ω - 2.2 jΩ
Return Loss	- 32.1 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	52.5 Ω + 2.6 jΩ
Return Loss	- 29.0 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	52.9 Ω + 5.7 jΩ
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.188 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

DASY5 Validation Report for Head TSL

Date: 21.06.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1280

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5250 MHz; σ = 4.52 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.88 S/m; ε_r = 34.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.08 S/m; ε_r = 34.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.4, 5.4, 5.4) @ 5250 MHz, ConvF(4.95, 4.95, 4.95) @ 5600 MHz, ConvF(4.96, 4.96, 4.96) @ 5800 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

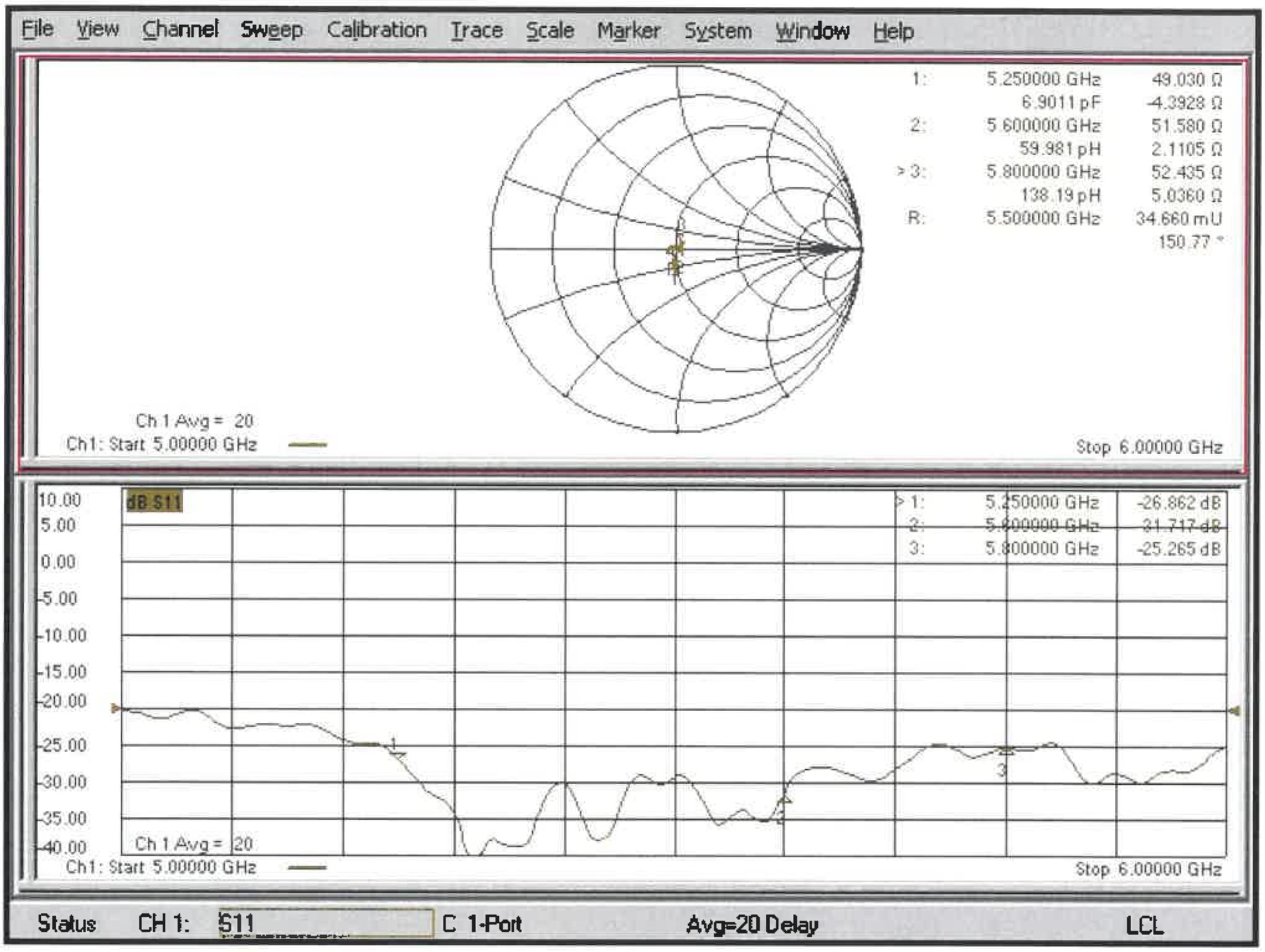
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.91 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.30 W/kg
Maximum value of SAR (measured) = 17.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 75.18 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 31.0 W/kg
SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 19.6 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.67 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 31.7 W/kg
SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.27 W/kg
Maximum value of SAR (measured) = 19.2 W/kg

0 dB = 17.0 W/kg = 12.31 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.06.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1280

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5250 MHz; σ = 5.49 S/m; ε_r = 47.5; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.97 S/m; ε_r = 46.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.25 S/m; ε_r = 46.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

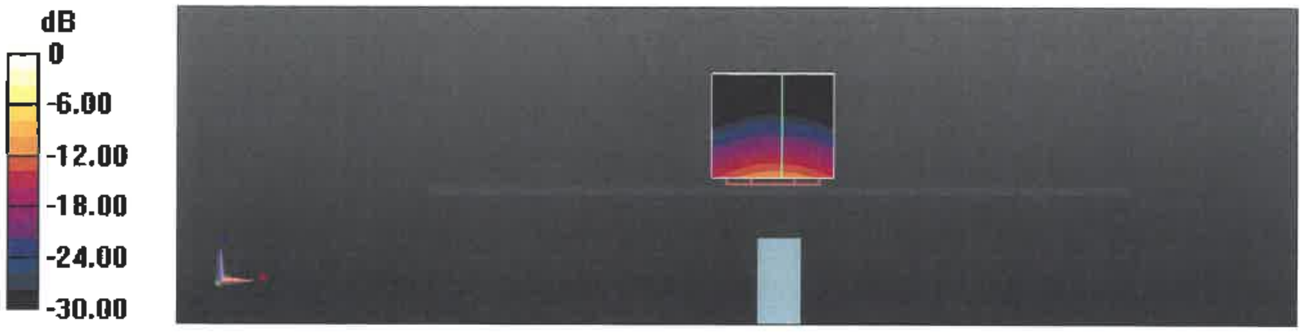
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.74, 4.74, 4.74) @ 5600 MHz, ConvF(4.62, 4.62, 4.62) @ 5800 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.87 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 28.5 W/kg
SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.06 W/kg
Maximum value of SAR (measured) = 17.3 W/kg

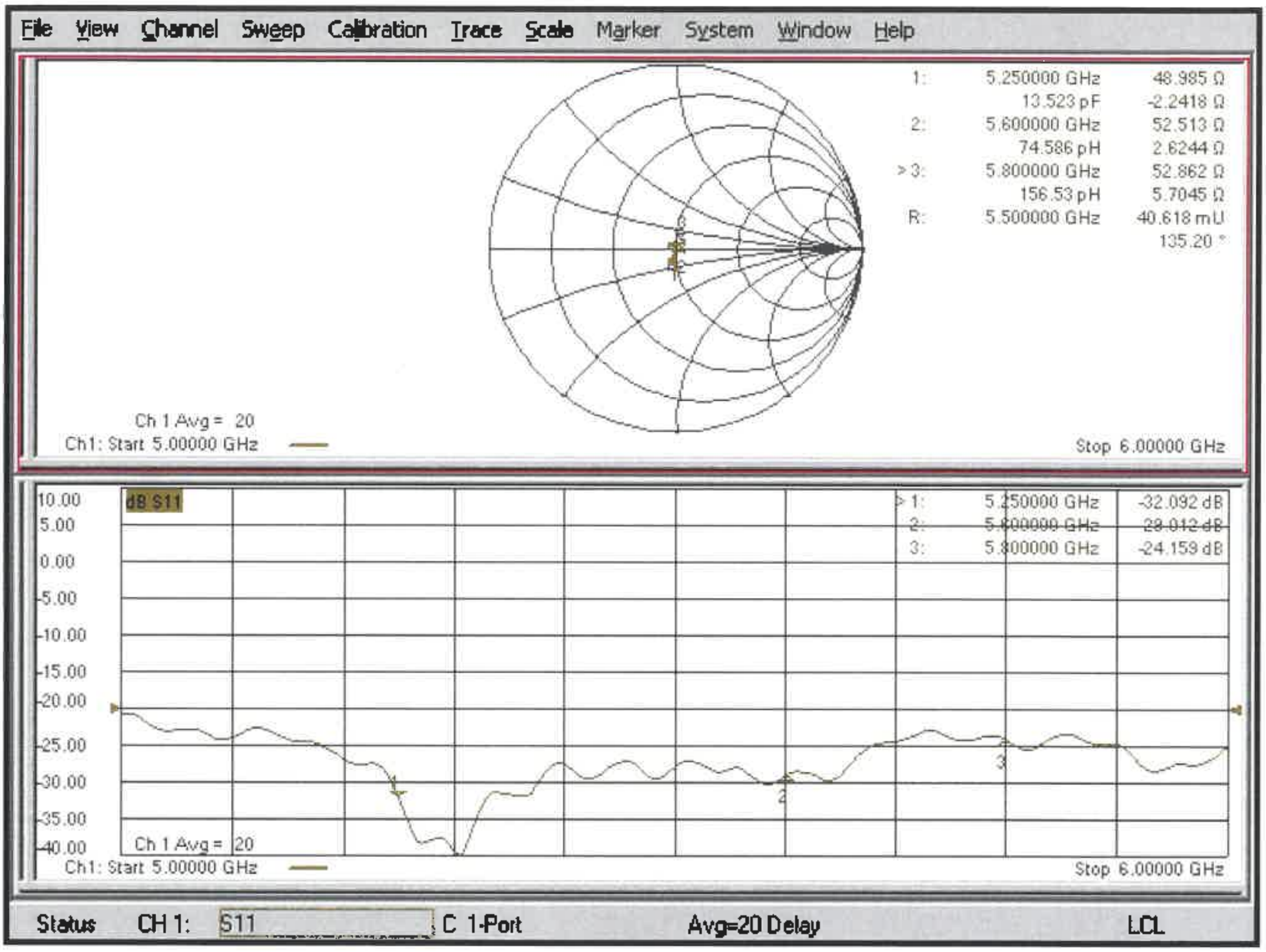
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.69 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 33.1 W/kg
SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.19 W/kg
Maximum value of SAR (measured) = 19.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.87 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.06 W/kg
Maximum value of SAR (measured) = 18.2 W/kg



0 dB = 17.3 W/kg = 12.39 dBW/kg

Impedance Measurement Plot for Body TSL



TEST REPORT

APPENDIX D – SAR SYSTEM VALIDATION

Per KDB 865664, SAR system validation status should be documented to confirm measurement accuracy. SAR measurement systems are validated according to procedures in KDB 865664. The validation status is documented according to the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters. When multiple SAR system is used, the validation status of each SAR system is needed to be documented separately according to the associated system components.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters are shown as below.

Date	Probe S/N	Tested Freq. (MHz)	Tissue Type	Perm	Cond	CW Validation			Mod. Validation		
						Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	Peak to average power ratio
Apr. 19, 2019	3090	2450	Body	2.020	50.710	Pass	Pass	Pass	OFDM	N/A	Pass
Jul. 28, 2019	7506	5250	Body	5.244	49.380	Pass	Pass	Pass	OFDM	N/A	Pass
Jul. 28, 2019	7506	5600	Body	5.582	49.220	Pass	Pass	Pass	OFDM	N/A	Pass
Jul. 28, 2019	7506	5800	Body	5.851	48.640	Pass	Pass	Pass	OFDM	N/A	Pass