TEST REPORT

No. I19D00153-SAR01

For

Client:	Doro AB
Production:	2G Clamshell Feature Phone
Model Name:	DFC-0240
Brand Name:	Doro
FCC ID:	WS5DFC0240
Hardware Version:	V01(HW code:3021/3051)
Software Version:	DFC0250_0240_UF290_N_S01A_V01_M190906_SMP
Issued date:	2019-09-29

NOTE

1. The test results in this test report relate only to the devices specified in this report.
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3. KDB has not been approved by A2LA.
4. It has been confirmed with the customer that the Tune-up Power information provided by the customer may affect the validity of the measurement results in this report, and the impact and consequences will be borne by the customer.
5. For the test results, the uncertainty of measurement is not taken into account when judging the compliance with specification, and the results of measurement or the average value of measurement results are taken as the criterion of the compliance with specification directly.

Test Laboratory:
East China Institute of Telecommunications
Add: 7-8F, G Area, No.668, Beijing East Road, Huangpu District, Shanghai, P. R. China
Tel: +86 21 63843300
FAX: +86 21 63843301
E-Mail: welcome@ecit.org.cn

Revision Version

Report Number	Revision	Date	Memo
I19D00153-SAR01	00	2019-09-29	Initial creation of test report

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1. Test Laboratory

1.1. Testing Location

Company Name	East China Institute of Telecommunications
Address	7-8/F., Area G, No.668, Beijing East Road, Shanghai, China
Postal Code	200001
Telephone	+86 21 63843300
Fax	+86 21 63843301

1.2. Testing Environment

Normal Temperature	18℃-25℃
Relative Humidity	25%-75%

1.3. Project Data

Project Leader	Xu Yuting
Testing Start Date	2019-09-27
Testing End Date	2019-09-27

1.4. Signature

Wang Yubin
(Prepared this test report)

Yan Hang
(Reviewed this test report)

Zheng Zhongbin
(Approved this test report)

2. Client Information

2.1. Applicant Information

Company Name	Doro AB
Address	Doro AB, Jörgen Kocksgatan 1B, SE 211 20 MALMÖ, SWEDEN
Telephone	+46 46 280 50 76
Postcode	N/A

2.2. Manufacturer Information

Company Name	Doro AB
Address	Doro AB, Jörgen Kocksgatan 1B, SE 211 20 MALMÖ, SWEDEN
Telephone	+46 46 280 50 76
Postcode	N/A

3. Equipment Under Test (EUT) and Ancillary Equipment (AE)

3.1. About EUT

Description:	2G Clamshell Feature Phone
Model Name:	DFC-0240
Operation Model(s):	GSM1900 BT3.0
Tx Frequency:	1850.2-1909.8MHz (GSM) 2402 – 2480 MHz (BT)
Test device Production Information: GPRS/EGPRS Class Mode: GPRS/ EGPRS Multislot Class:	Production unit B 12
Device Type:	Portable device
Antenna Type:	Embedded antenna
Accessories/Body-worn Configurations:	Battery
Dimensions: Hotspot Mode:	105*55*20mm N/A

3.2. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt
N02	357507100012080 357507100012098	V01(HW code:3021/3051)	DFC0250_0240_UF290_N_S01A_V01_M190906_SMP	2019-09-19
N08	357507100015844 357507100015851	V01(HW code:3021/3051)	DFC0250_0240_UF290_N_S01A_V01_M190906_SMP	2019-09-27

*EUT ID: is used to identify the test sample in the lab internally.

Note: The product has two SIM cards, SIM 1 and SIM 2 does not support simultaneous work, only supports a single transmitter; When SIM 1 is working, SIM 2 will be suspended until SIM 2 is selected. When stop using the SIM 1, SIM 2 would work. SIM1 is the worst case.

The N02 is a primary supply and the N08 is a secondary supply

3.3. Internal Identification of AE used during the test

AE ID*	Description	Type	Manufacturer
BA02	Battery	N/A	N/A
BA08	Battery	N/A	N/A

*AE ID: is used to identify the test sample in the lab internally.

3.4. Difference Between Main supply and Secondary supply

Item	Configure 1	Configure 2
HW code	3021	3051
LCD	LCD SANLONG(28LS124-04)	LCD Holitech(QTB2D8096)
FLASH	Flash GD(GD25LQ128)	Flash DOS(FM25M4AA)
Note: Customer declaration, two configures is the same, except for LCD and FLASH. There are more than one Configure, each one should be applied throughout the compliance test respectively, however, only the worst case (Configure 1) will be recorded in this report.		

Main Supply

Part Name	Model Name	supplier	Remark
ZIF connector	FP270H-025T1DM	JXT	/
Earphone jack	11-0561136-A	LETCON	/
Memory card socket	T11-BB09F150	HRD	/
Micro USB	U11-1B05G252	HRD	/
Battery connector	BAC5540306	VELA	/

Secondary Supply

Part Name	Model Name	supplier	Remark
ZIF connector	4.001A0-025-1R0	HAIWEISI	/
Earphone jack	PH20-0A38F38M JAF00-05382-010101	HRD LCN	/
Micro USB	UBM9250516 UAF95-05254-S135-A	VELA LCN	/
Memory card socket	TFJ1150903	VELA	/
Battery connector	B29-BB03F540 02-032116B	HRD LETCON	/

4. Reference Documents

4.1. Documents supplied by applicant

All technical documents are supplied by the client or manufacturer, which is the basis of testing.

4.2. Reference Documents

The following documents listed in this section are referred for testing.

Reference	Title	Version
ANSI C95.1	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.	**1999**
IEEE 1528	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.	**2013**
KDB648474	Handset SAR	**D04 v01r03**
KDB648474	Wireless Chargers Battery Cover	**D03 v01r04**
KDB248227	802 11 WiFi SAR	**D01 v02r02**
KDB447498	General RF Exposure Guidance	**D01 v06**
KDB865664	SAR Measurement 100 MHz to 6 GHz	**D01 v01r04**
KDB865664	RF Exposure Reporting	**D02 v01r02**
KDB941225	3G SAR Procedures	**D01 v03r01**
KDB941225	SAR for LTE Devices	**D05 v02r05**
KDB941225	Hotspot SAR	**D06 v02r01**
KDB616217	SAR for laptop and tablets	**D04 v01r02**

4.3. Criterion

At frequencies between 100 kHz and 6 GHz, the MPE (Maximum Permissible Exposure) in population/ uncontrolled environments for electromagnetic field strengths may be exceeded if

a) The exposure conditions can be shown by appropriate techniques to produce SARs below 0.08W/kg, as averaged over the whole body, and spatial peak SAR values not exceeding 1.6 W/kg, as averaged over any 1g of tissue (defined as a tissue volume in the shape of a cube), except for the hands, wrists, feet, and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10g of tissue (defined as a tissue volume in the shape of a cube); and

b) The induced currents in the body confirm with the MPE in table 2, Part B in ANSI C95.1-1999.

5. Test Summary and Statement of Compliance

5.1. Test Summary

The maximum results of Specific Absorption Rate (SAR) in standalone mode are as follows.

Table 5.1: Standalone Max. Reported SAR

Band	Reported SAR 1g(W/Kg)	
	Position	
	Head	Body(15mm)
GSM 1900	0.228	0.799

The maximum results of Specific Absorption Rate (SAR) in simultaneous mode are as follows.

Table 5.2: Simultaneous Transmission SAR

Highest Simultaneous Transmission SAR	Highest SAR 1g Body(15mm) (W/Kg)
	0.898

5.2. Statement of Compliance

The **DFC-0240** manufactured by **Doro AB** is a parent model for testing.

ECIT has verified that the compliance of the tested device specified in section 3 of this test report is successfully evaluated according to the procedure and test methods as defined in type certification requirement listed in section 4 of this test report.

For body worn operation mode, this device with any accessory that contained in this report has been tested and the values meet FCC RF exposure guidelines. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

Note: This project has two sets of configured sample N02 (Main supply) and N08 (Secondary supply), among which the N02 sample is the main test, and the N08 sample tests the worst mode of SAR.

6. Specific Absorption Rate (SAR)

6.1. Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an 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.

6.2. SAR Definition

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 a given 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 measurement can be either related to the temperature elevation in tissue by

$$SAR = c\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where:

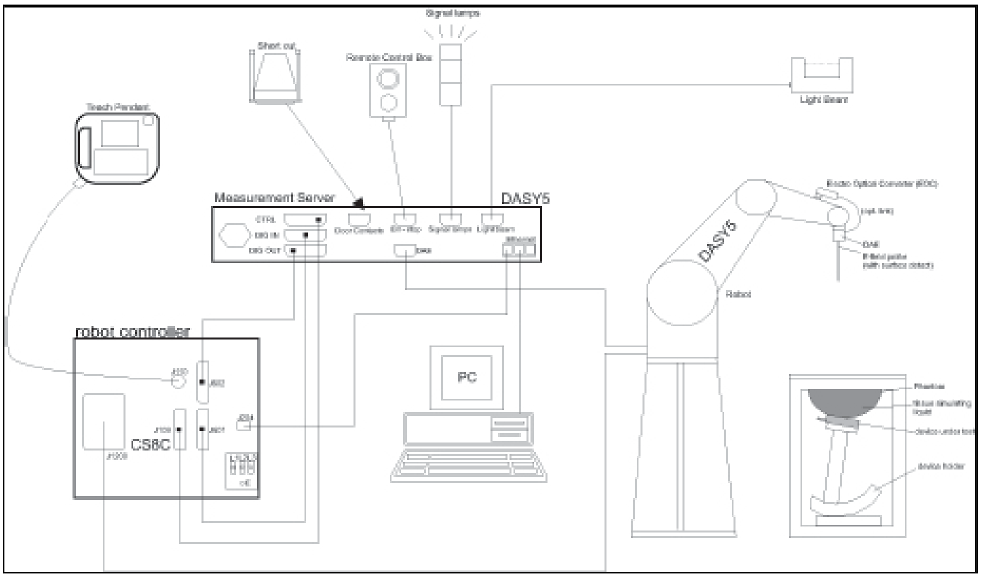
- σ is the conductivity of the tissue
- ρ is the mass density of tissue, which is normally set to 1g/cm^3
- E is the RMS electrical field strength

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7. SAR Measurement System Introduction

7.1. Measurement Set-up

The DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:



Picture 7-1 SAR Measurement Set-up

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

7.2. E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using 2^{nd} ord curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:	
Model:	**ES3DV3,EX3DV4**
Frequency Range:	**10MHz — 6GHz(EX3DV4)**
	10MHz — 4GHz(ES3DV3)
Calibration:	**In head and body simulating tissue at frequency from 650MHz to 5900MHz**
Linearity:	**± 0.2 dB(30 MHz to 4 GHz) for ES3DV3** **± 0.2 dB(30 MHz to 6 GHz) for EX3DV4**
Dynamic Range:	**10 mW/kg — 100 W/kg**
Probe Length:	**330 mm**
Probe Tip Length:	**20 mm**
Body Diameter:	**12 mm**
Tip Diameter: **Tip-Center:**	**2.5 mm (3.9 mm for ES3DV3)** **1 mm (2.0mm for ES3DV3)**
Application:	**SAR Dosimetry Testing** **Compliance tests of mobile phones** **Dosimetry in strong gradient fields**

Picture 7-2 Detail of Probe

Picture 7-3 E-field Probe

7.3. E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm^2.

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

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

Where:

Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

7.4. Other Test Equipment

7.4.1. Data Acquisition Electronics (DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

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

Picture 7-4: DAE

7.4.2. Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX90) type 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 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchronal motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Picture 7-5: DASY 5

7.4.3. Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (DASY5: 400 MHz, Intel Celeron), chip disk (DASY5: 128MB), RAM (DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

Picture 7-6: Server for DASY 5

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

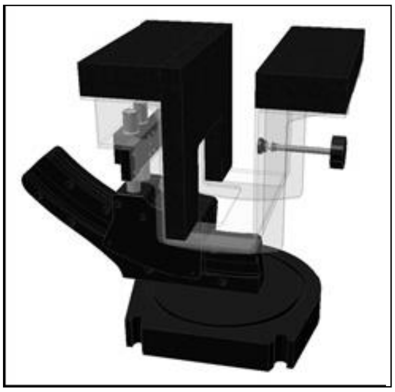
7.4.4. Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.
The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Picture 7-7: Device Holder

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.
The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



Picture 7-8: Laptop Extension Kit

7.4.5. Phantom

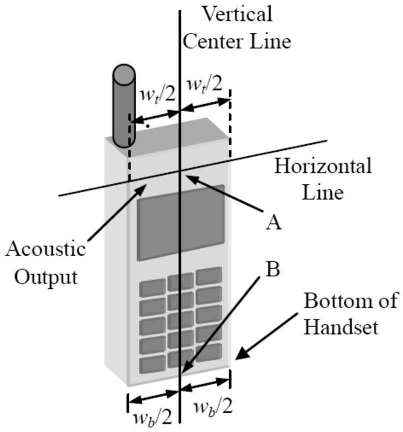
The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to represent the 90th percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness:	2 ± 0.2 mm	
Available:	Special	
Filling Volume:	Approx. 25 liters	
Dimensions:	810 x I000 x 500 mm (H x L x W)	**Picture 7-9: SAM Twin Phantom**

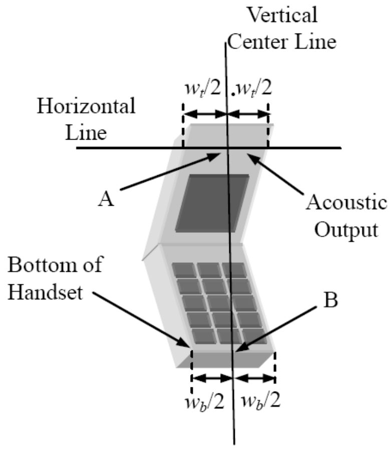
8. Test Position in Relation to the Phantom

8.1. General considerations

This standard specifies two handset test positions against the head phantom – the "cheek" position and the "tilt" position.

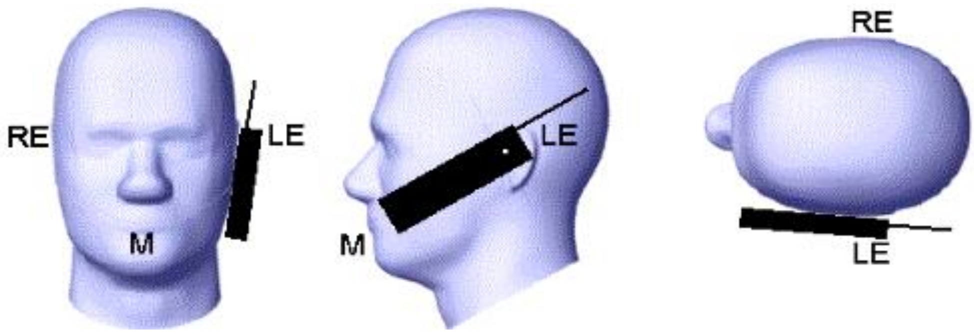


Picture 8-1 Typical "fixed" case handset

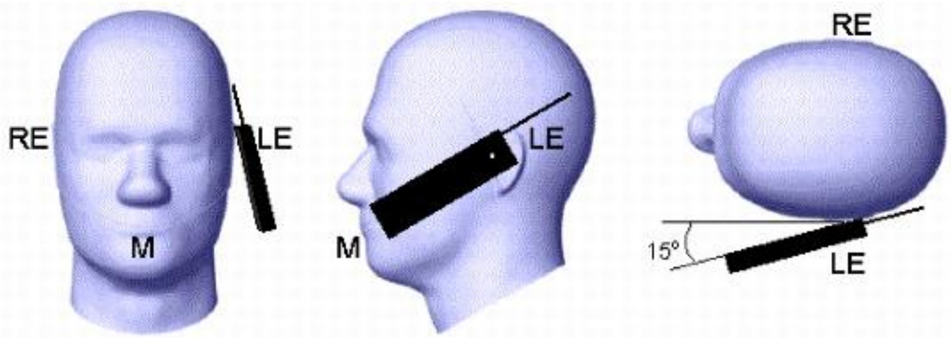


Picture 8-2 Typical "clam-shell" case handset

W_t	Width of the handset at the level of the acoustic
W_b	Width of the bottom of the handset
A	Midpoint of the width W_t of the handset at the level of the acoustic output
B	Midpoint of the width W_b of the bottom of the handset



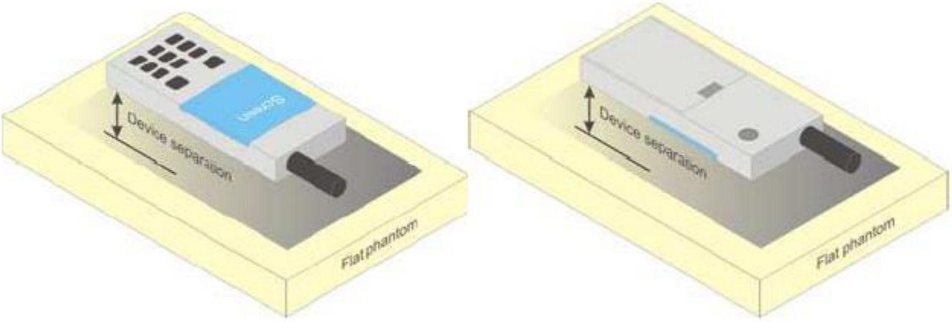
Picture 8-3 Cheek position of the wireless device on the left side of SAM



Picture 8-4 Tilt position of the wireless device on the left side of SAM

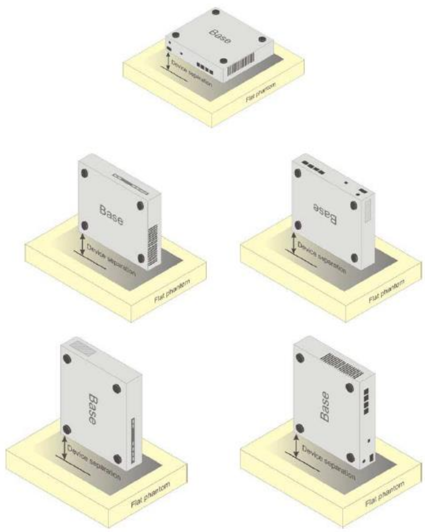
8.2. Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA (personal digital assistant) or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.



Picture 8-5 Test positions for body-worn devices

8.3. Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used. The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions. Tests shall be performed for all antenna positions specified. Picture 8-6 shows positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.	 **Picture 8-6 Test positions for desktop devices**

9. Tissue Simulating Liquids

9.1. Equivalent Tissues Composition

The liquid used for the frequency range of 650-6000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table 9.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table 9.1: Composition of the Head Tissue Equivalent Matter

Frequency (MHz)	835	900	1800	1950	2300	2450	2600	5800
Ingredients (% by weight)								
Water	41.45	40.92	55.242	54.89	56.34	58.79	58.79	65.53
Sugar	56.0	56.5	/	/	/	/	/	
Salt	1.45	1.48	0.306	0.18	0.14	0.06	0.06	
Preventol	0.1	0.1	/	/	/	/	/	
Cellulose	1.0	1.0	/	/	/	/	/	
GlycolMonobutyl	/	/	44.452	44.93	43.52	41.15	41.15	
Diethylenglycol momohexylether	/	/	/	/	/	/	/	17.24
Triton X-100	/	/	/	/	/	/	/	17.23
Dielectric Parameters Target Value	ε=41.5 σ=0.90	ε=41.5 σ=0.97	ε=40.0 σ=1.40	ε=40.0 σ=1.40	ε=39.5 σ=1.67	ε=39.2 σ=1.80	ε=39.0 σ=1.96	ε=35.3 σ=5.27

Table 9.2: Targets for tissue simulating liquid

Frequency (MHz)	Liquid Type	Conductivity (σ)	± 5% Range	Permittivity (ε)	± 5% Range
835	Head	0.90	0.874~0.97	41.5	39.4~43.6
900	Head	0.97	0.92~1.02	41.5	39.4~43.6
1800	Head	1.40	1.33~1.47	40.0	38.0~42.0
1950	Head	1.40	1.33~1.47	40.0	38.0~42.0
2300	Head	1.67	1.59~1.75	39.5	37.5~41.4
2450	Head	1.80	1.71~1.89	39.2	37.2~41.2
2600	Head	1.96	1.86~2.06	39.0	37.5~40.95
5200	Head	4.66	4.43~4.89	35.99	34.19~37.79
5300	Head	4.76	4.52~4.99	35.87	34.08~37.66
5500	Head	4.96	4.71~5.2	35.6	33.82~37.38
5600	Head	5.07	4.82~5.32	35.53	33.75~37.30
5800	Head	5.27	5.01~5.53	35.3	33.54~37.05

Note: Effective February 19, 2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEC 62209-1 for all SAR tests.

9.2. Dielectric Performance of TSL

Table 9.3: Dielectric Performance of Head Tissue Simulating Liquid

Tissue Simulating Liquid								
Frequency (MHz)	Head(Standard)		Temperature	Date	Test Result		Deviation (%)	
	Permittivity ε	Conductivity σ			Permittivity ε	Conductivity σ	Permittivity ε	Conductivity σ
1900	40.00	1.40	22.5	2019-09-27	41.831	1.342	4.58%	-4.14%

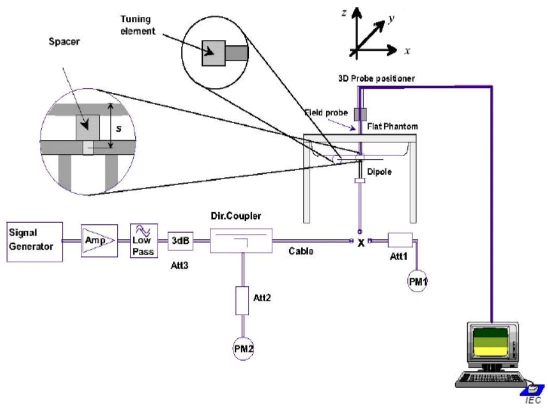
10. System Validation

10.1. System Validation

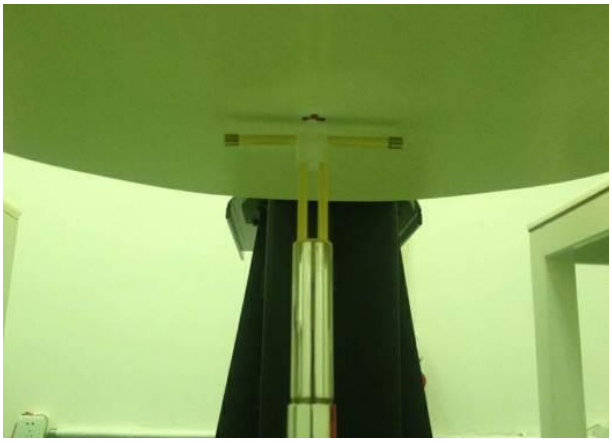
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

10.2. System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 10-1 Setup for System Evaluation



Picture 10-2. Setup for Dipole

10.3. System Validation Result

Table 10.1: System Validation Result of SAR

SAR System Validation								
Frequency (MHz)	Target Value (w/kg)		Temperature	Date	Test Result (w/kg)		Deviation (%)	
	10g	1g			10g	1g	10g	1g
1900	21.1	40.5	22.5	2019-09-27	21.72	42.4	2.94%	4.69%
Note: The input power level is equivalent to 1w								

11. Measurement Procedures

11.1. Test Steps

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

(a) Power reference measurement

The reference and drift jobs are useful for monitoring the power drift of the device under test in the batch process. Both jobs measure the electric field strength at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

(b) Area scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought up, grid was at to 15mm * 15mm and can be edited by users.

(c) Zoom scan

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1g and 10g of simulated tissue. The default zoom scan measures 5 * 5 * 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly.

(d) Power drift measurement

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same setting. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under within a batch process. In the properties of the drift job, the user can specify a limit for the drift and have DASY software stop the measurements if this limit is exceeded. This ensures that the power drift during one measurement is within 5%.

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit it maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Measure SAR results for Middle channel or the highest power channel on each testing position
(e) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg
(f) Record the SAR value

11.2. Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1g and 10g.

The DASY system allows evaluations that combine measured data and robot positions, such as:

a) Maximum Search

During a maximum search, global and local maximum searches are automatically performed in 2D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2dB of the global maxima for all SAR distributions.

b) Extrapolation

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5*5*5 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10 cubes.

c) Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosi-metric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx So + Sb * \exp\left(-\frac{z}{a}\right) * \cos\left(\pi\frac{z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probe (a≪ λ), the cos-term can be omitted. Factors Sb (parameter Alpha in the DASY software) and a (parameter Delta in the DASY software) ard assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- ➢ The boundary curvature is small
- ➢ The probe axis is angled less than 30_to the boundary normal
- ➢ The distance between probe and boundary is larger than 25% of the probe diameter
- ➢ The probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

11.3. General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

Table 11.1: Test Resolution Requirement

<table>
<tr><th colspan="3">Items</th><th>≤3GHz</th><th>>3GHz</th></tr>
<tr><td colspan="3">Maximum Distance</td><td>5mm ±1mm</td><td>$\frac{1}{2} * \delta * \ln(2)$ mm ±0.5mm</td></tr>
<tr><td colspan="3">Maximum probe angle</td><td>30±1°</td><td>20±1°</td></tr>
<tr><td colspan="3" rowspan="3">Maximum Area Scan spatial resolution:
Δx_{Area} , Δy_{Area}</td><td>≤2GHz: ≤15mm</td><td>3-4GHz: ≤12mm</td></tr>
<tr><td>2-3GHz: ≤12mm</td><td>4-6GHz: ≤10mm</td></tr>
<tr><td colspan="2">when the x or y dimension of the device , in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the device with at least one measurement point on the device</td></tr>
<tr><td colspan="3" rowspan="2">Maximum Zoom Scan spatial resolution:
Δx_{Zoom} , Δy_{Zoom}</td><td>≤2GHz: ≤8mm</td><td>3-4GHz: ≤5mm</td></tr>
<tr><td>2-3GHz: ≤5mm</td><td>4-6GHz: ≤4mm</td></tr>
<tr><td rowspan="3">maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: Δz_{Zoom}(n)</td><td>≤5mm</td><td>3-4GHz: ≤4mm
4-5GHz: ≤3mm
5-6GHz: ≤2mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>Δz_{Zoom}(1): between 1st two points closest to phantom surface</td><td>≤4mm</td><td>3-4GHz: ≤3mm
4-5GHz: ≤2.5mm
5-6GHz: ≤2mm</td></tr>
<tr><td>Δz_{Zoom}(n >1) between subsequent points</td><td colspan="2">≤1.5*</td></tr>
<tr><td>minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥30mm</td><td>3-4GHz: ≥28mm
4-5GHz: ≥25mm
5-6GHz: ≥22mm</td></tr>
<tr><td colspan="5">Notes:
δ is the penetration depth of a plane-wave at normal incidence to the tissue medium in IEEE 1528-2013.
When Zoom Scan is required and reported SAR from the Area Scan based 1-g SAR estimation procedure of KDB publication 447498 is ≤1.4 W/kg, ≤8mm for 2GHz-3GHz, ≤7mm for 3GHz-4GHz, ≤5mm for 4GHz-6GHz Zoom Scan resolution may be applied.</td></tr>
</table>

11.4. WCDMA Measurement Procedures

The following procedures are applicable to WCDMA handsets operating under 3GPP Release99, Release 5 and Release 6. The default test configuration is to measure SAR with an established radio link between the DUT and a communication test set using a 12.2kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH & DPDCHn), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Both uplink and downlink should be configured with the same RMC or AMR, when required. SAR for Release 5 HSDPA and Release 6 HSPA are measured using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified according to applicable versions of 3GPP TS 34.121 and SAR must be measured according to these maximum output conditions. When Maximum Power Reduction (MPR) is not implemented according to Cubic Metric (CM) requirements for Release 6 HSPA, the following procedures do not apply.

Table 11.2: HSDPA setting for Release 5

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs}	CM (dB)	MPR (dB)
1	2/15	15/15	64	2/15	4/15	1.5	0.5
2	12/15	15/15	64	12/15	24/25	2.0	1
3	15/15	8/15	64	15/8	30/15	2.0	1
4	15/15	4/15	64	15/4	30/15	2.0	1

Table 11.3: HSUPA setting for Release 6

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs}	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (dB)	MPR (dB)	AG Index	E-TFCI
1	11/15	15/15	64	11/15	22/15	209/225	1039/225	4	1	2.0	1.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	12/15	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	3.0	2.0	15	92
4	2/15	15/15	64	2/15	4/15	4/15	56/75	4	1	2.0	1.0	17	71
5	15/15	15/15	64	15/15	24/15	30/15	134/15	4	1	2.0	1.0	21	81

Note:

A KDB inquiry is required to address test and approval requirements when the maximum output power measured in HS-DPCCH Sub-test 2 – 4 is higher than Sub-test 1.

A KDB inquiry is required to determine test and approval requirements when the maximum output power measured in E-DCH Sub-test 2 – 4 is higher than Sub-test 5.

11.5. LTE Measurement Procedure

SAR tests for LTE are performed with a base station simulator. Closed loop power control was used so the UE transmits with maximum output power during SAR testing.

1. Per KDB 941225 D05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
2. 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
3. For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is ＞ 1.45 W/kg, the remaining required test channels must also be tested.
4. 16QAM/64QAM output power for each RB allocation configuration is ＞ not $\frac{1}{2}$dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; 16QAM/64QAM SAR testing is not required.
5. Smaller bandwidth output power for each RB allocation configuration is ＞not $\frac{1}{2}$dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; smaller bandwidth SAR testing is not required.
6. For LTE B12 / B26 the maximum bandwidth does not support three non-overlapping channels, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.
7. LTE band 17 / 2 / 5 / 38 / 4 SAR test was covered by Band 12 / 25 / 26 / 41 / 66; according to TCB workshop, SAR test for overlapping LTE bands can be reduced if

a. The maximum output power, including tolerance, for the smaller band is ≤ the larger band to qualify for the SAR test exclusion.

b. The channel bandwidth and other operating parameters for the smaller band are fully supported by the larger band.

LTE Carrier Aggregation Conducted Power (Downlink)

According to KDB941225 D05A v01r02, Uplink maximum output power measurement with downlink carrier aggregation active should be measured, using the highest output channel measured without downlink carrier aggregation, to confirm that uplink maximum output power with downlink carrier aggregation active remains within the specified tune-up tolerance limits and not more than ¼ dB higher than the maximum output measured without downlink carrier aggregation active.

LTE TDD Considerations

According to KDB 941225 D05 SAR for LTE Devices, for Time-Division Duplex (TDD) systems, SAR must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP LTE TDD configurations.

SAR was tested with the highest transmission duty factor (63.33%) using Uplink-downlink configuration 0 and Special sub-frame configuration 7.

LTE TDD Band 41 supports 3GPP TS 36.211 section 4.2 for Type 2 Frame Structure and Table 4.2-2 for uplink-downlink configurations and Table 4.2-1 for Special sub-frame configurations.

Table 11.4 Calculated Duty Cycle for LTE TDD

Uplink-Downlink Configuration		Sub-frame Number										Calculated
0	Periodicity	1	2	3	4	5	6	7	8	9	10	Duty Cycle (%)
0	5 ms	D	S	U	U	U	D	S	U	U	U	63.33
1	5 ms	D	S	U	U	D	D	S	U	U	D	43.33
2	5 ms	D	S	U	D	D	D	S	U	D	D	23.33
3	10 ms	D	S	U	U	U	D	D	D	D	D	31.67
4	10 ms	D	S	U	U	D	D	D	D	D	D	21.67
5	10 ms	D	S	U	D	D	D	D	D	D	D	11.67
6	5 ms	D	S	U	U	U	D	S	U	U	D	53.33

Example for Calculated Duty Cycle for Uplink-Downlink Configuration 0:
Calculated Duty Cycle = (5120 × Ts × 2 + 6 ms) / 10ms = 63.33%
Where
Ts = 1/(15000 x 2048) seconds

11.6. Bluetooth & WiFi Measurement Procedures

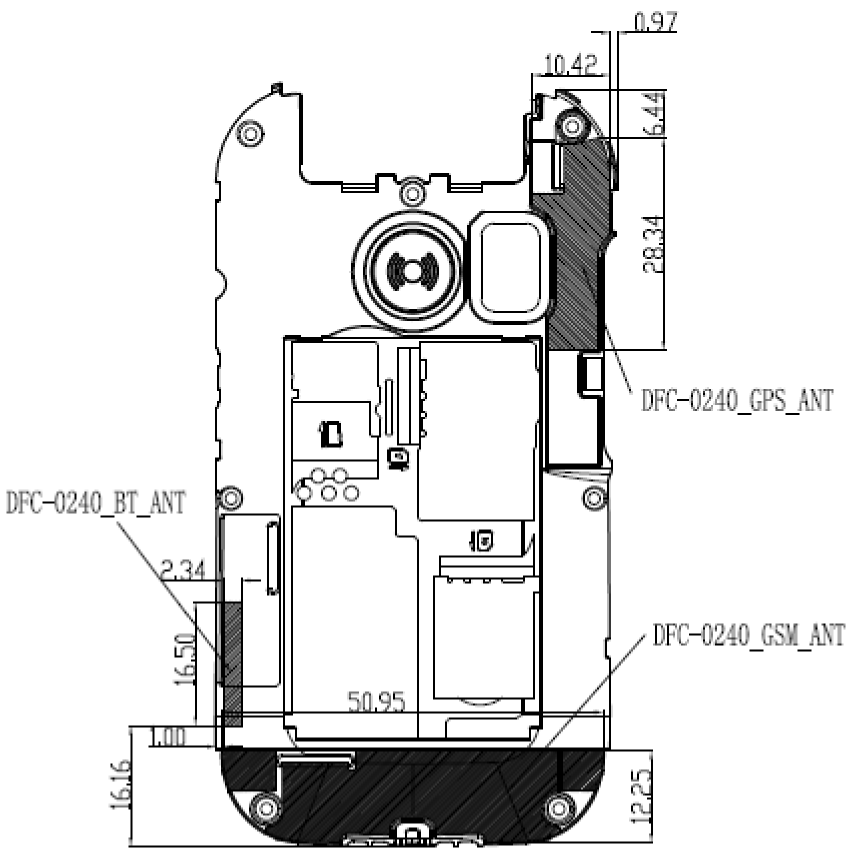
Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.
Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

12. Simultaneous Transmission SAR Considerations

12.1. Reference Document

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

12.2. Antenna Separation Distances



Picture 12-1 Antenna Locations

12.3. SAR Measurement Positions

According to the KDB941225 D06 Hot Spot SAR v01, the edges with less than 2.5 cm distance to the antennas need to be tested for SAR.

Table 12.1: SAR measurement Positions

Antenna Mode	Front	Back	Left	Right	Top	Bottom
2/3/4G	Yes	Yes	Yes	Yes	No	Yes
BT/WiFi	Yes	Yes	No	Yes	Yes	No

12.4. Low Power Transmitters SAR Consideration

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation for low power transmitters is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.
The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} * \sqrt{\text{Frequency (GHz)}} \leqslant 3.0$$

Where

- Frequency(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

According to the KDB447498 appendix A, the SAR test exclusion threshold for 2450MHz at 5mm test separation distances is 10mW. That means the transmitters with tune-up power below 10mW are excluded for SAR measurement.

12.5. Simultaneous Transmission Analysis

KDB 447498 D01 General RF Exposure Guidance introduces a new formula for calculating the SPLSR (SAR to Peak Location Ratio) between pairs of simultaneously transmitting antennas:

$$\text{SPLSR} = \sqrt{(\text{SAR1} + \text{SAR2})^3}/\text{Ri}$$

Where

- SAR1 is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition.
- SAR2 is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first.
- Ri is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location , based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of

$$(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2$$

In order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$\sqrt{(SAR1 + SAR2)^3}/Ri < 0.04$$

12.6. Simultaneous Transmission Table

Table 12.2: Simultaneous Transmission Configurations

Items	Capable Transmit Configurations
1	GSM/EGPRS/EDGE + BT
Note: For the DUT, the BT modules a single antenna. GSM modules a single antenna. So we can get above combination that can transmit signal simultaneously.	

13. Conducted Output Power

13.1. GSM Measurement result

Table 13.1: The conducted power measurement results for GSM1900

GSM			GSM1900							
Model	Modulation	Time Slot	Tune up (dBm)	Measure Power(dBm)			Devision Factor(dB)	Average Power(dBm)		
				512	661	810		512	661	810
GSM	GMSK	1 Tx	30	29.37	29.23	29.07	-9.03	20.34	20.2	20.04
GPRS	GMSK	1 Tx	30	29.46	29.34	29.18	-9.03	20.43	20.31	20.15
		2 Tx	29	28.65	28.62	28.55	-6.02	22.63	22.6	22.53
		3 Tx	27	26.47	26.52	26.53	-4.26	22.21	22.26	22.27
		4 Tx	26	25.37	25.43	25.65	-3.01	22.36	22.42	**22.64**

NOTES:

1) Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.03dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.02dB

3TX-slots = 3 transmit time slots out of 8 time slots=> conducted power divided by (8/3) => -4.26dB

4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.01dB

According to the conducted power as above, the body measurements are performed with 4Txslots for GSM1900.

13.2. BT Measurement result

Table 13.2: The conducted power for Bluetooth

BlueTooth		BT					
Mode	Channel	DH1		2DH1		3DH1	
		Tune up	Output Power	Tune up	Output Power	Tune up	Output Power
BT3.0	0	8.5	7.67	7	6.39	7	6.36
	39	8.5	8.04	7	6.7	7	6.74
	78	8.5	7.94	7	6.6	7	6.64

NOTE: According to KDB447498 D01 BT standalone SAR are not required, because maximum average output power is less than 10mW.

Evaluation=2.23 ＜ 3.0

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion:

$$SAR = \frac{P(Max. Power\ of\ channel, including\ tuneup\ tolerance, mW)}{D(Min. test\ separation\ distance,\ mm)} * \frac{\sqrt{frequency(GHz)}}{x}$$

Where

- D (Min, test separation distances, mm) is always set to 50 mm for Head SAR evaluation
- Frequency(GHz) is the center frequency in GHz
- where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR

Therefor

- SAR head value of BT is 0.297 W/Kg where D is set to 5mm
- SAR body value of BT is 0.099 W/Kg for 1g where D is set to 15mm

14. SAR Measurement Result

14.1. Standalone SAR Test Result

Table 14.1: SAR Values for GSM1900

Test Position	Cover Type	Mode	Channel	Frequency (MHz)	Measured power (dBm)	Tune-up (dBm)	Power Drift (dB)	Limit of 1gSAR 1.6 W/kg (mW/g)			Figure No.
								Measured SAR1g	Scaling Factor	Report SAR1g	
Head SAR											
Left Touch	Standard	GSM1900	661	1880	29.23	30	0.160	0.191	1.19	**0.228**	**1**
Left Tilt 15°	Standard	GSM1900	661	1880	29.23	30	0.100	0.038	1.19	0.045	**/**
Right Touch	Standard	GSM1900	661	1880	29.23	30	-0.190	0.152	1.19	0.181	**/**
Right Tilt 15°	Standard	GSM1900	661	1880	29.23	30	-0.140	0.064	1.19	0.076	**/**
Body SAR (Worn 15mm)											
Front Side	Close	GPRS 4TS	661	1880	25.43	26	-0.090	0.122	1.14	0.139	**/**
Back Side	Close	GPRS 4TS	661	1880	25.43	26	0.090	0.426	1.14	0.486	**/**
Back Side	Open	GPRS 4TS	661	1880	25.43	26	0.130	0.625	1.14	0.713	**/**
Back Side	SIM2	GPRS 4TS	661	1880	25.43	26	0.080	0.701	1.14	**0.799**	**2**
Back Side	Second Supply	GPRS 4TS	661	1880	25.43	26	0.080	0.649	1.14	0.740	**/**

14.2. Simultaneous SAR Evaluation

Table 14.2 Simultaneous transmission SAR

Simultaneous multi-band transmission					
Test Position			WWAN	2.4GHz	SUM
			2G	BT	
Head	Left	Touch	0.228	0.297	0.525
		Tilt 15°	0.045	0.297	0.342
	Right	Touch	0.181	0.297	0.478
		Tilt 15°	0.076	0.297	0.373
Body Close (15mm)	Front Side		0.139	0.099	0.238
	Back Side		0.486	0.099	0.585
Body Open (15mm)	Back Side		0.799	0.099	0.898

According to the above table, the sum of reported SAR values for GSM and BT<1.6W/kg. So the simultaneous transmission SAR is not required for BT transmitter.

14.3. SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Table 14.3: SAR Measurement Variability (1g)

Frequency		Configuration	Test Position	Original SAR (W/kg)	First Repeated SAR (W/kg)	The Ratio
MHz	Ch.					
--	--	--	--	--	--	--

Note: According to the KDB 865664 D01 repeated measurement is not required when the original highest measured SAR is < 0.8 W/kg.

15. Test Equipment Utilized

Table 15.1 SAR Test System Equipment List

Item	Instrument Name	Type	Serial Number	Manufacturer	Cal. Date	Cal. interval
1	Network analyzer	N5242A	MY51221755	Agilent	2018-12-17	1 year
2	Power meter	NRVD	102257	RS	2019-5-10	1 year
3	Power sensor	NRV-Z5	100241			
			100644			
4	Signal Generator	E4438C	MY49072044	Agilent	2019-5-10	1 Year
5	Amplifier	NTWPA-0086010F	12023024	rflight	No Calibration Requested	
6	Coupler	778D	MY4825551	Agilent	2019-5-10	1 year
7	BTS	E5515C	MY50266468	Agilent	2018-12-17	1 year
8	E-field Probe	EX3DV4	7401	SPEAG	2019-1-5	1 year
9	DAE	SPEAG DAE4	1244	SPEAG	2018-12-13	1 year
10	Dipole Validation Kit	SPEAG D1900V2	5d151	SPEAG	2017-12-6	3 year

16. Measurement Uncertainty

Table 16.1 Measurement Uncertainty Evaluation for SAR test

Uncertainty Factors	Unc. value, ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std.Unc. ±%,1g	Std.Unc. ±%,10g	V_i V_{eff}
Measurement System								
Probe Calibration	6	N	1	1	1	6	6	∞
Axial Isotropy	0.5	R	√3	0.7	0.7	0.2	0.2	∞
Hemispherical Isotropy	2.6	R	√3	0.7	0.7	1.1	1.1	∞
Boundary Effects	0.8	R	√3	1	1	0.5	0.5	∞
Linearity	0.6	R	√3	1	1	0.3	0.3	∞
System Detection Limits	1	R	√3	1	1	0.6	0.6	∞
Readout Electronics	0.7	N	1	1	1	0.7	0.7	∞
Response Time	0	R	√3	1	1	0	0	∞
Integration Time	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	3	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	3	R	√3	1	1	1.7	1.7	∞
Probe Positioner	1.5	R	√3	1	1	0.9	0.9	∞
Probe Positioning	2.9	R	√3	1	1	1.7	1.7	∞
Max. SAR Eval.	1	R	√3	1	1	0.6	0.6	∞
Test Sample Related								
Device Positioning	2.9	N	1	1	1	2.9	2.9	145
Device Holder	3.6	N	1	1	1	3.6	3.6	5
Phantom and Setup								
Phantom Uncertainty	4	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity (target)	5	R	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (meas.)	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid Permittivity (target)	5	R	√3	0.6	0.49	1.7	1.4	∞
Liquid Permittivity (meas.)	2.5	N	1	0.6	0.49	1.5	1.2	∞
Combined Std. Uncertainty		RSS				**±9.27%**	**±9.07%**	
Expanded Std. Uncertainty		k=2				**±18.53%**	**±18.14%**	

Table 16.2 Measurement Uncertainty Evaluation for System Validation

Uncertainty Factors	Unc. value, ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std.Unc. ±%,1g	Std.Unc. ±%,10g	V_i V_{eff}
Measurement System								
Probe Calibration	6	N	1	1	1	6	6	∞
Axial Isotropy	0.5	R	√3	0.7	0.7	0.2	0.2	∞
Hemispherical Isotropy	2.6	R	√3	0.7	0.7	1.1	1.1	∞
Boundary Effects	0.8	R	√3	1	1	0.5	0.5	∞
Linearity	0.6	R	√3	1	1	0.3	0.3	∞
System Detection Limits	1	R	√3	1	1	0.6	0.6	∞
Readout Electronics	0.7	N	1	1	1	0.7	0.7	∞
Response Time	0	R	√3	1	1	0	0	∞
Integration Time	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	3	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	3	R	√3	1	1	1.7	1.7	∞
Probe Positioner	1.5	R	√3	1	1	0.9	0.9	∞
Probe Positioning	2.9	R	√3	1	1	1.7	1.7	∞
Max. SAR Eval.	1	R	√3	1	1	0.6	0.6	∞
Diople								
Power Drift	5	R	√3	1	1	2.9	2.9	∞
Dipole Positioning	2	N	1	1	1	2	2	∞
Dipole Input Power	5	N	1	1	1	5	5	∞
Phantom and Setup								
Phantom Uncertainty	4	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity (target)	5	R	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (meas.)	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid Permittivity (target)	5	R	√3	0.6	0.49	1.7	1.4	∞
Liquid Permittivity (meas.)	2.5	N	1	0.6	0.49	1.5	1.2	∞
Combined Std. Uncertainty		RSS				**±11.2%**	**±10.9%**	387
Expanded Std. Uncertainty		k=2				**±22.4%**	**±21.8%**	

Table 16.3 Measurement Uncertainty Evaluation for Fast SAR test

Uncertainty Factors	Unc. value, ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std.Unc. ±%,1g	Std.Unc. ±%,10g	Vi veff
Measurement System								
Probe Calibration	6	N	1	1	1	6	6	∞
Axial Isotropy	0.5	R	√3	0.7	0.7	0.2	0.2	∞
Hemispherical Isotropy	2.6	R	√3	1	1	1.5	1.5	∞
Boundary Effects	0.8	R	√3	0.7	0.7	0.32	0.32	∞
Linearity	0.6	R	√3	1	1	0.35	0.35	∞
System Detection Limits	1	R	√3	1	1	0.58	0.58	∞
Readout Electronics	0.7	R	√3	1	1	0.4	0.4	∞
Response Time	0	N	1	1	1	0	0	∞
Integration Time	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	3	R	√3	1	1	1.73	1.73	∞
RF Ambient Reflections	3	R	√3	1	1	1.73	1.73	∞
Probe Positioner	1.5	R	√3	1	1	0.87	0.87	∞
Probe Positioning	2.9	R	√3	1	1	1.67	1.67	∞
Max. SAR Eval.	1	R	√3	1	1	0.58	0.58	∞
Fast SAR z-Approximation	7	R	√3	1	1	4.04	4.04	∞
Test sample Related								
Test sample Positioning	2.9	N	1	1	1	2.9	2.9	145
Device Holder Uncertainty	3.6	N	1	1	1	3.6	3.6	5
Phantom and Tissue Parameters								
Phantom Uncertainty	4	R	√3	1	1	2.31	2.31	∞
Liquid Conductivity (target)	5	R	√3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (meas)	2.5	N	1	0.64	0.43	0.92	0.62	∞
Liquid Permittivity (target)	5	R	√3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (meas)	2.5	N	1	0.6	0.49	0.87	0.71	∞
Combined Std. Uncertainty		RSS				**±10.11%**	**±9.93%**	
Expanded Std. Uncertainty		k=2				**±20.22%**	**±19.86%**	

END OF REPORT BODY

ANNEX A. Graph Results

Fig.1 GSM 1900 Left Cheek Middle

Date/Time: 2019/9/27
Electronics: DAE4 Sn1244
Medium parameters used: f = 1880 MHz; σ = 1.323 S/m; ε_r = 41.918; ρ = 1000 kg/m^3
Ambient Temperature:22.5°C Liquid Temperature:22.5°C
Communication System: GSM Professional 1900MHz; Frequency: 1880 MHz; Duty Cycle: 1:8.3
Probe: EX3DV4 - SN7401ConvF(8.21, 8.21, 8.21); Calibrated: 1/15/2019
GSM 1900 Left Cheek Middle/Area Scan (121x51x1):
Measurement grid: dx=10 mm, dy=10 mm
Maximum value of SAR (Measurement) = 0.209 W/kg
GSM 1900 Left Cheek Middle/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.930 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 0.343 W/kg
SAR(1 g) = 0.191 W/kg; SAR(10 g) = 0.101 W/kg
Maximum of SAR (measured) = 0.280 W/kg

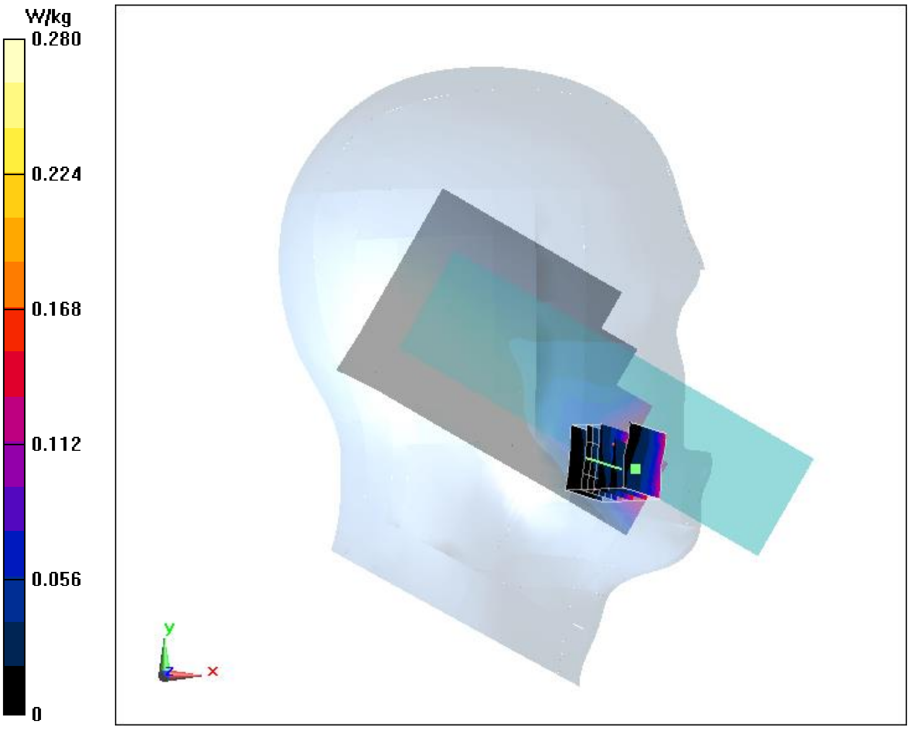
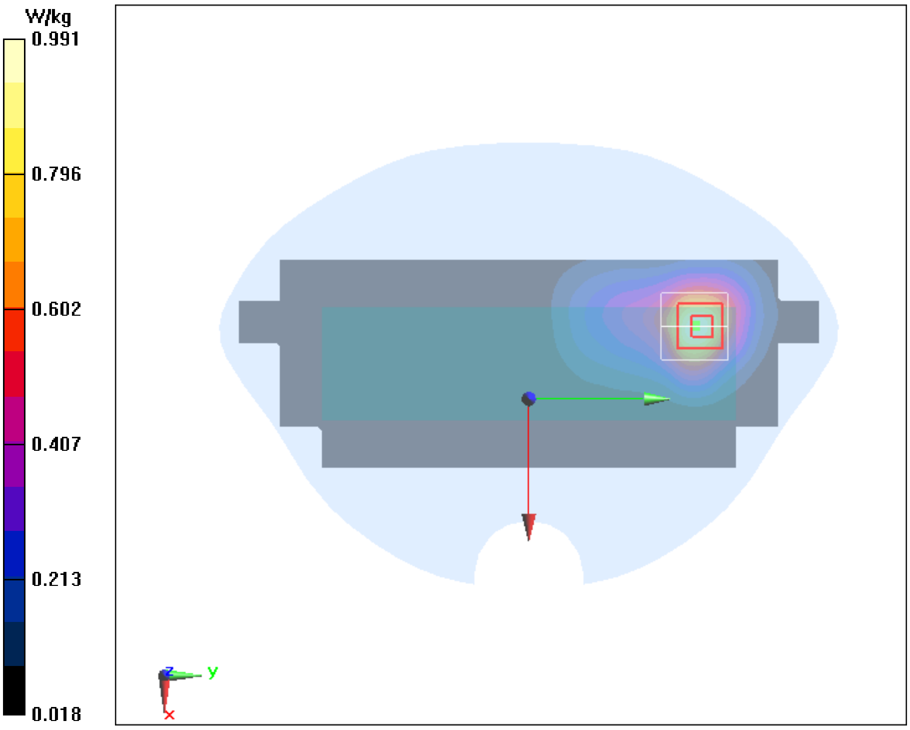


Fig.2 GPRS 1900 4TS Ground Mode Middle 15mm

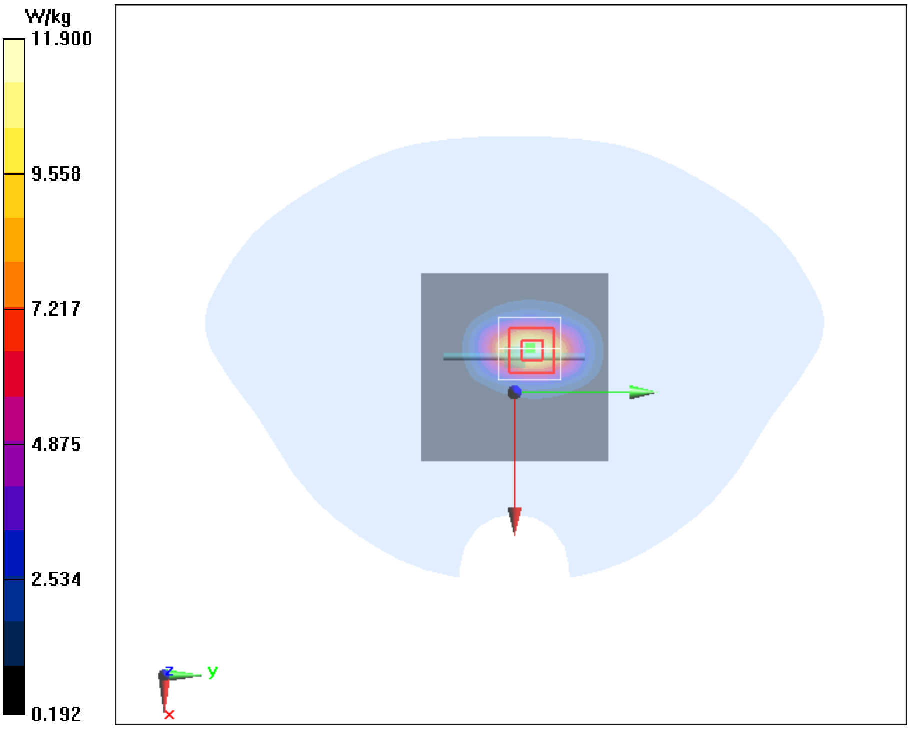
Date/Time: 2019/9/27
Electronics: DAE4 Sn1244
Medium parameters used: f = 1880 MHz; σ = 1.323 S/m; ε_r = 41.918; ρ = 1000 kg/m^3
Ambient Temperature:22.5°C Liquid Temperature:22.5°C
Communication System: GSM 1900MHz GPRS 4TS (0); Frequency: 1880 MHz; Duty Cycle: 1:2
Probe: EX3DV4 - SN7401ConvF(8.21, 8.21, 8.21); Calibrated: 1/15/2019
GPRS 1900 4TS Ground Mode Middle 15mm /Area Scan (51x141x1):
Measurement grid: dx=10 mm, dy=10 mm
Maximum value of SAR (Measurement) = 0.996 W/kg
GPRS 1900 4TS Ground Mode Middle 15mm /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.799 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 1.22 W/kg
SAR(1 g) = 0.701 W/kg; SAR(10 g) = 0.397 W/kg
Maximum value of SAR (measured) = 0.991 W/kg



ANNEX B. System Validation Plot

1900MHz

Date/Time: 2019/9/27
Electronics: DAE4 Sn1244
Medium parameters used: f = 1900 MHz; σ = 1.342 S/m; ε_r = 41.831; ρ = 1000 kg/m^3
Ambient Temperature:22.5°C Liquid Temperature:22.5°C
Communication System: CW 1900MHz; Frequency: 1900 MHz; Duty Cycle: 1:1
Probe: EX3DV4 - SN7401ConvF(8.21, 8.21, 8.21); Calibrated: 1/15/2019
System Validation /Area Scan (61x61x1):
Measurement grid: dx=10 mm, dy=10 mm
Maximum value of SAR (Measurement) = 12.4 W/kg
System Validation /Zoom Scan (7x7x7) (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.83 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 20.2 W/kg
SAR(1 g) = 10.6 W/kg; SAR(10 g) = 5.43 W/kg
Maximum value of SAR (measured) = 11.9 W/kg



ANNEX C. Calibration Certification

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CNAS 中国认可 国际互认 校准 CALIBRATION CNAS L0570

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

Client : ECIT

Certificate No: Z18-60529

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 1244
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	December 03, 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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	20-Jun-18 (CTTL, No.J18X05034)	June-19

	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: December 05, 2018

Certificate No: Z18-60529 Page 1 of 3

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Glossary:

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

Methods Applied and Interpretation of Parameters:

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

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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

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

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

Calibration Factors	X	Y	Z
High Range	403.818 ± 0.15% (k=2)	403.555 ± 0.15% (k=2)	404.470 ± 0.15% (k=2)
Low Range	3.95395 ± 0.7% (k=2)	3.97087 ± 0.7% (k=2)	3.97994 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	22.5° ± 1 °

Certificate No: Z18-60529 Page 3 of 3

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Client CTTL-SH Certificate No: Z18-60557

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7401
Calibration Procedure(s)	FF-Z11-004-01 Calibration Procedures for Dosimetric E-field Probes
Calibration date:	January 15, 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)	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-18 (CTTL, No.J18X00561)	Jan -19

	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: January 17, 2019

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

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 EX3DV4

SN: 7401

Calibrated: January 15, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7401

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm(μV/(V/m)²)[A]	0.37	0.45	0.33	±10.0%
DCP(mV)[B]	103.9	100.2	102.8	

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	141.7	±3.0%
		Y	0.0	0.0	1.0		162.9	
		Z	0.0	0.0	1.0		135.6	

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: EX3DV4 – SN: 7401

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	10.42	10.42	10.42	0.09	1.32	±12.1%
835	41.5	0.90	10.07	10.07	10.07	0.18	1.17	±12.1%
900	41.5	0.97	10.17	10.17	10.17	0.12	1.31	±12.1%
1750	40.1	1.37	8.69	8.69	8.69	0.22	1.11	±12.1%
1900	40.0	1.40	8.21	8.21	8.21	0.34	0.84	±12.1%
2000	40.0	1.40	8.20	8.20	8.20	0.26	0.95	±12.1%
2300	39.5	1.67	8.10	8.10	8.10	0.60	0.71	±12.1%
2450	39.2	1.80	7.69	7.69	7.69	0.58	0.73	±12.1%
2600	39.0	1.96	7.55	7.55	7.55	0.60	0.71	±12.1%
5250	35.9	4.71	5.82	5.82	5.82	0.40	1.20	±13.3%
5600	35.5	5.07	5.20	5.20	5.20	0.40	1.30	±13.3%
5750	35.4	5.22	5.25	5.25	5.25	0.45	1.30	±13.3%

[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: EX3DV4 – SN: 7401

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	10.56	10.56	10.56	0.40	0.80	±12.1%
835	55.2	0.97	10.21	10.21	10.21	0.16	1.45	±12.1%
900	55.0	1.05	10.25	10.25	10.25	0.21	1.19	±12.1%
1750	53.4	1.49	8.38	8.38	8.38	0.21	1.13	±12.1%
1900	53.3	1.52	8.06	8.06	8.06	0.22	1.15	±12.1%
2000	53.3	1.52	8.06	8.06	8.06	0.22	1.16	±12.1%
2300	52.9	1.81	7.97	7.97	7.97	0.63	0.76	±12.1%
2450	52.7	1.95	7.67	7.67	7.67	0.36	1.17	±12.1%
2600	52.5	2.16	7.59	7.59	7.59	0.48	0.88	±12.1%
5250	48.9	5.36	5.26	5.26	5.26	0.45	1.90	±13.3%
5600	48.5	5.77	4.66	4.66	4.66	0.50	1.85	±13.3%
5750	48.3	5.94	4.69	4.69	4.69	0.56	1.45	±13.3%

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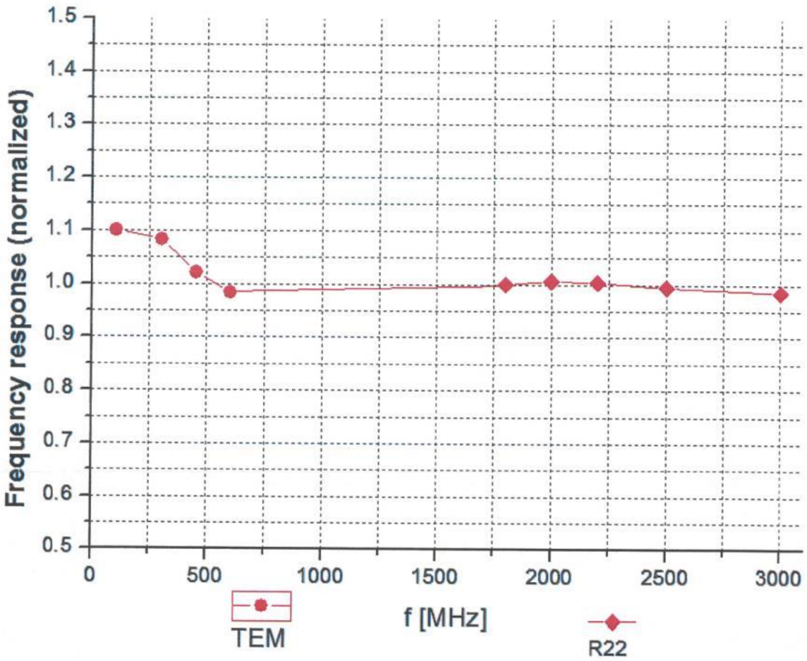
Frequency Response of E-Field
(TEM-Cell: ifi110 EXX, Waveguide: R22)



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

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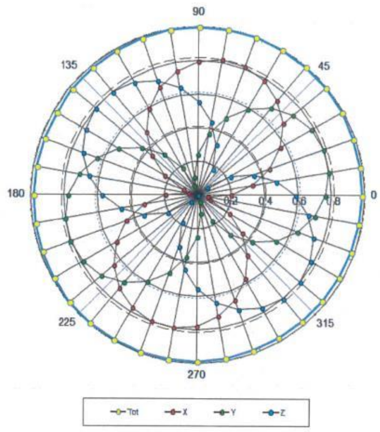
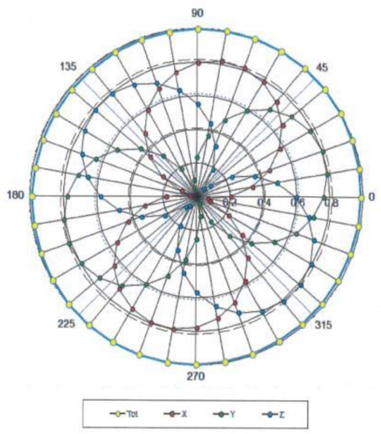
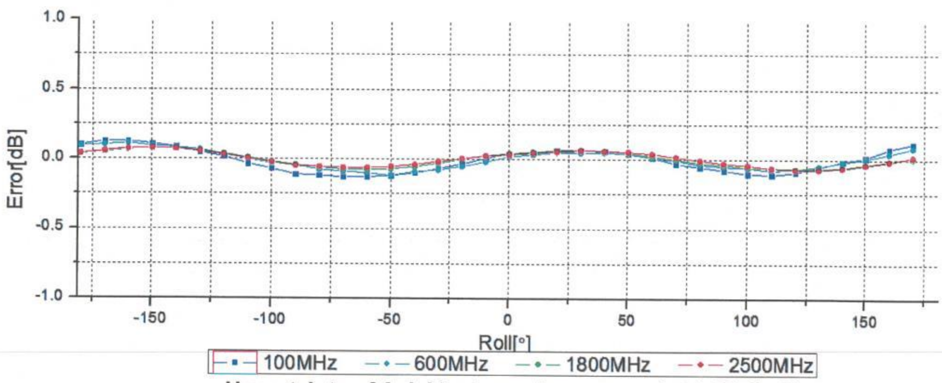
Receiving Pattern (Φ), θ=0°

f=600 MHz, TEM **f=1800 MHz, R22**







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

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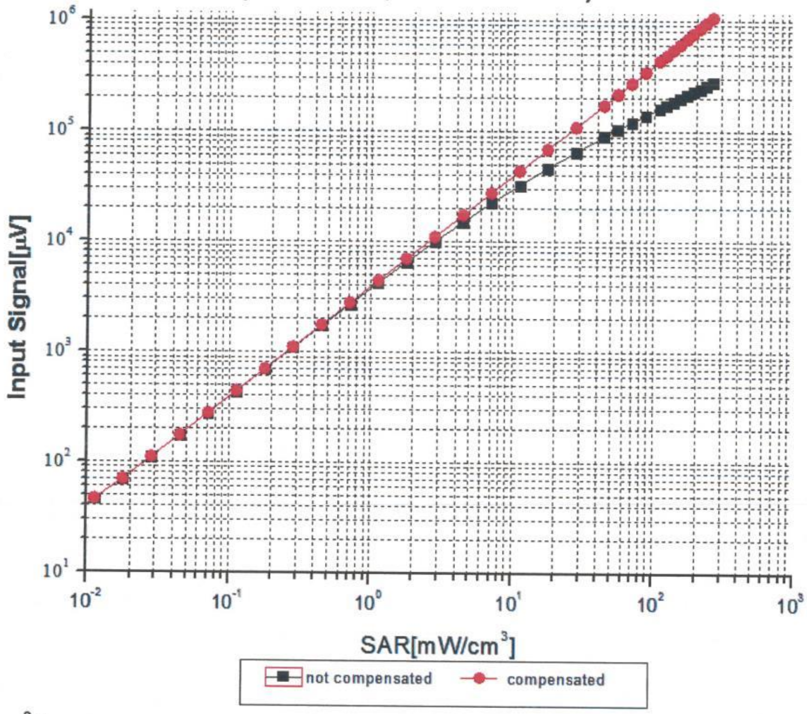
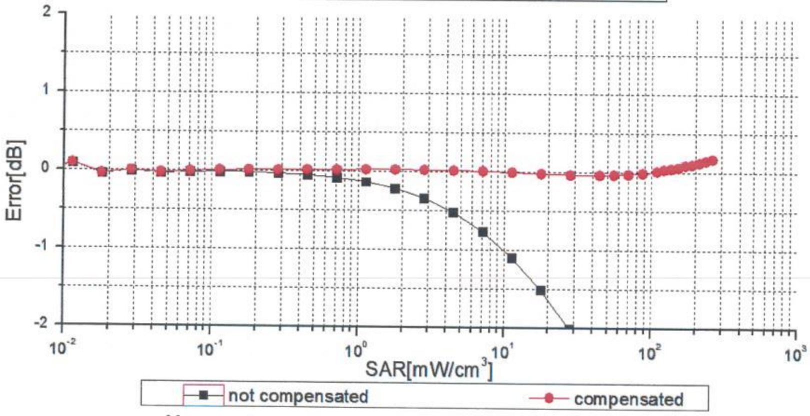
Dynamic Range f(SAR$_{head}$)
(TEM cell, f = 900 MHz)





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

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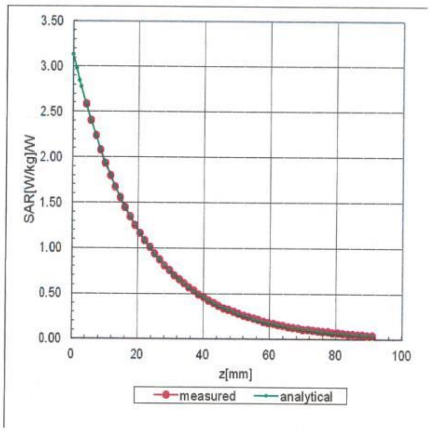
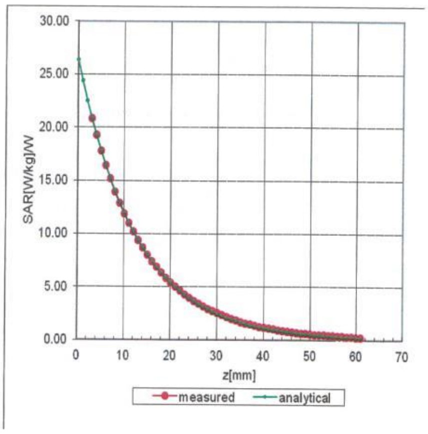
Conversion Factor Assessment

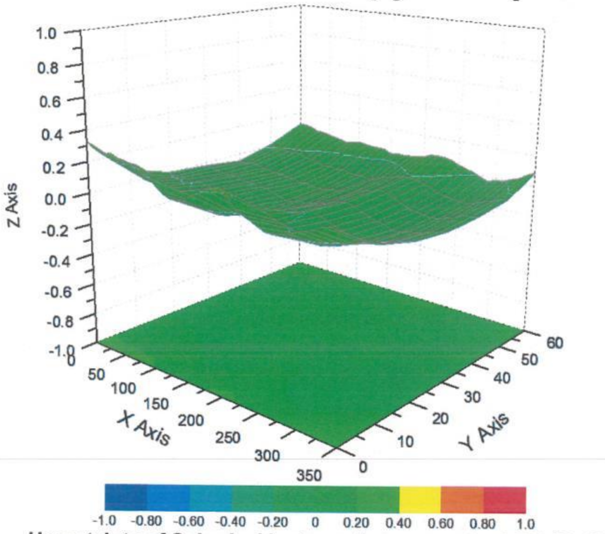
f=750 MHz, WGLS R9(H_convF)



f=1750 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: EX3DV4 – SN: 7401

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	151.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

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Client CTTL-CQ Certificate No: Z17-97253

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d151
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits
Calibration date:	December 6, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRVD	102196	02-Mar-17 (CTTL, No.J17X01254)	Mar-18
Power sensor NRV-Z5	100596	02-Mar-17 (CTTL, No.J17X01254)	Mar-18
Reference Probe EX3DV4	SN 3617	23-Jan-17(SPEAG,No.EX3-3617_Jan17)	Jan-18
DAE3	SN 536	09-Oct-17(CTTL-SPEAG,No.Z17-97198)	Oct-18
Secondary Standards	**ID #**	**Cal Date(Calibrated by, Certificate No.)**	**Scheduled Calibration**
Signal Generator E4438C	MY49071430	13-Jan-17 (CTTL, No.J17X00286)	Jan-18
Network Analyzer E5071C	MY46110673	13-Jan-17 (CTTL, No.J17X00285)	Jan-18

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

Issued: December 10, 2017

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lossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORMx,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 assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
d) KDB865664, 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%.

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Measurement Conditions

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

DASY Version	DASY52	52.10.0.1446
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.4 ± 6 %	1.41 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**40.5 mW /g ± 18.8 % (k=2)**
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.30 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**21.1 mW /g ± 18.7 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.9 ± 6 %	1.54 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**40.4 mW /g ± 18.8 % (k=2)**
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.34 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**21.2 mW /g ± 18.7 % (k=2)**

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.8Ω+ 5.34jΩ
Return Loss	- 25.2dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3Ω+ 5.41jΩ
Return Loss	- 24.8dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.057 ns

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

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

Additional EUT Data

Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL Date: 12.06.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d151

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: f = 1900 MHz; σ = 1.409 S/m; εr = 39.36; ρ = 1000 kg/m3

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(8.26, 8.26, 8.26); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 10/9/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

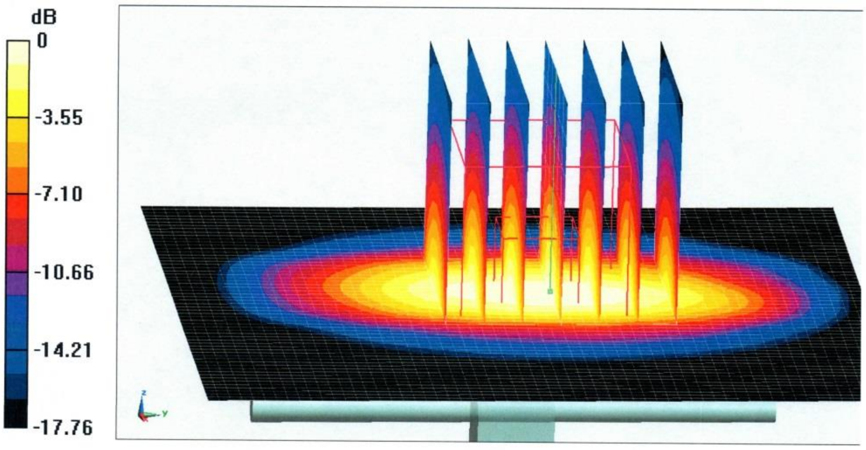
System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.8 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 19.3 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.3 W/kg

Maximum value of SAR (measured) = 15.9 W/kg



0 dB = 15.9 W/kg = 12.01 dBW/kg

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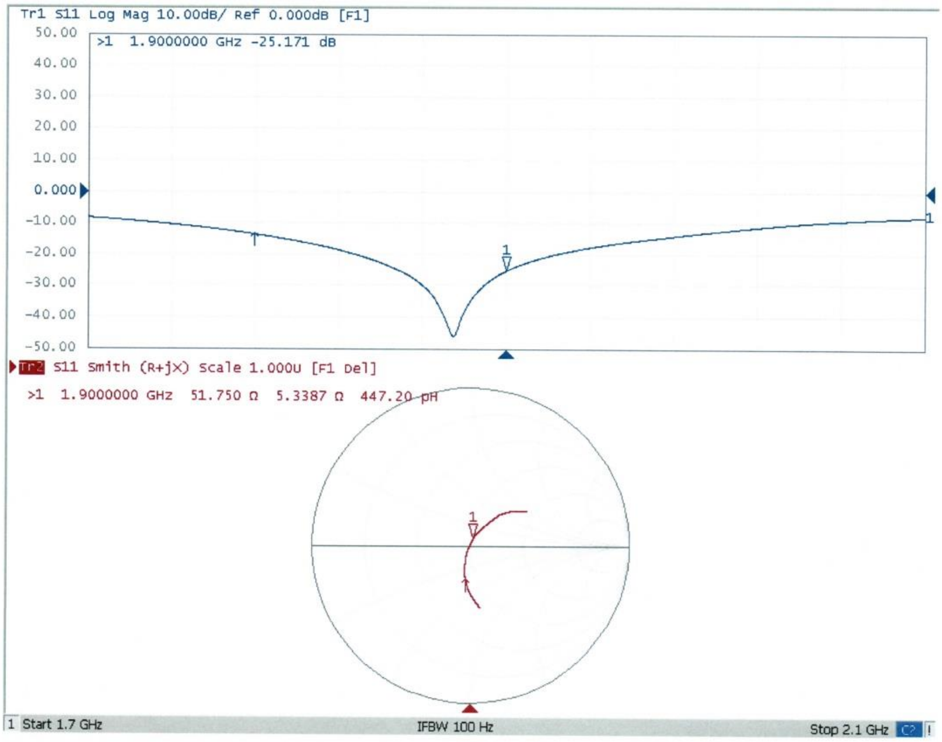
Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL Date: 12.06.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d151

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: f = 1900 MHz; σ = 1.542 S/m; ε_r = 52.89; ρ = 1000 kg/m^3

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.95, 7.95, 7.95); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 10/9/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

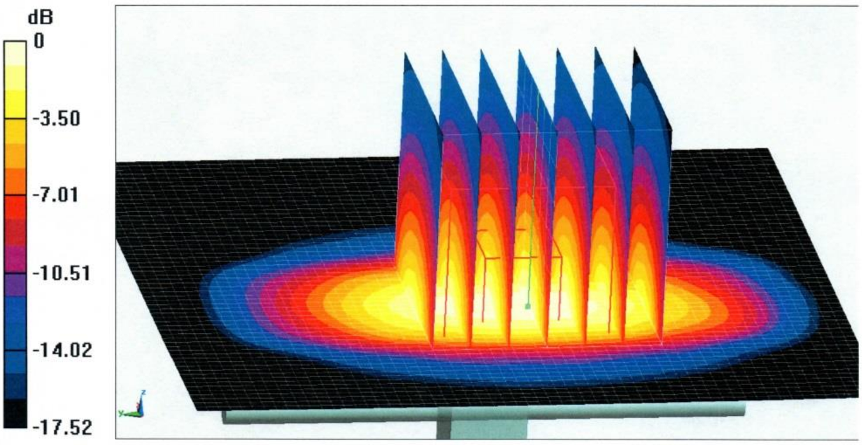
System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.74 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 18.7 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.34 W/kg

Maximum value of SAR (measured) = 15.8 W/kg



0 dB = 15.8 W/kg = 11.99 dBW/kg

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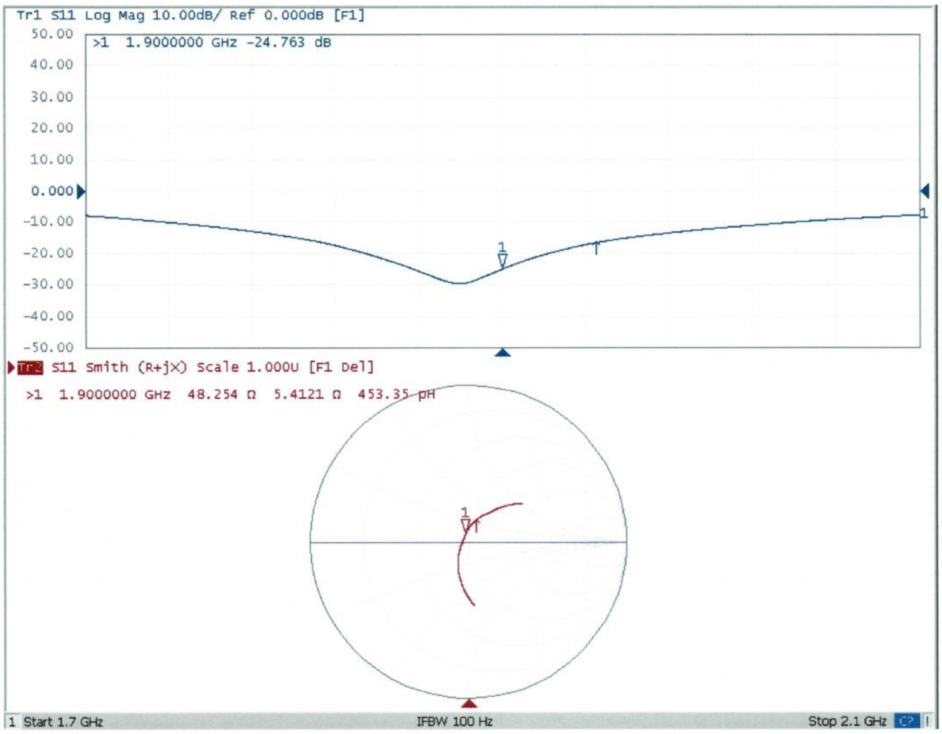
Impedance Measurement Plot for Body TSL



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ANNEX D. Accreditation Certification

Accredited Laboratory

A2LA has accredited

EAST CHINA INSTITUTE OF TELECOMMUNICATIONS

Shanghai, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 6th day of May 2019.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3682.01
Valid to February 28, 2021

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

************End of the Report************