

FCC SAR Test Report

Report No. : W7L-P23080026SA01

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Manufacturer : Shanghai Tricheer Technology Co.,Ltd.

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Product : LTE USB Modem

FCC ID : 2ANKMFS040U

Brand : +F

Model No. : FS040U

Standards : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2013
KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02 / KDB 447498 D04 v01
KDB 447498 D02 v02r01 / KDB 941225 D01 v03r01 / KDB 941225 D05 v02r05

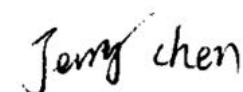
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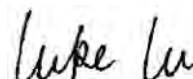
CERTIFICATION: The above equipment have been tested by **BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

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Table of Contents

Release Control Record	3
1. Summary of Maximum SAR Value	4
2. Description of Equipment Under Test	5
3. SAR Measurement System	6
3.1 Definition of Specific Absorption Rate (SAR)	6
3.2 SPEAG DASY System	6
3.2.1 Robot	7
3.2.2 Probes	8
3.2.3 Data Acquisition Electronics (DAE)	8
3.2.4 Phantoms	9
3.2.5 Device Holder	10
3.2.6 System Validation Dipoles	10
3.2.7 Tissue Simulating Liquids	11
3.3 SAR System Verification	13
3.4 SAR Measurement Procedure	14
3.4.1 Area & Zoom Scan Procedure	14
3.4.2 Volume Scan Procedure	14
3.4.3 Power Drift Monitoring	15
3.4.4 Spatial Peak SAR Evaluation	15
3.4.5 SAR Averaged Methods	15
4. SAR Measurement Evaluation	16
4.1 EUT Configuration and Setting	16
4.2 EUT Testing Position	19
4.2.1 Body Exposure Conditions	19
4.3 Tissue Verification	20
4.4 System Verification	20
4.5 Maximum Output Power	21
4.5.1 Maximum Conducted Power	21
4.5.2 Measured Conducted Power Result	21
4.6 SAR Testing Results	25
4.6.1 SAR Test Reduction Considerations	25
4.6.2 SAR Results for Body Exposure Condition (Separation Distance is 0.5 cm Gap)	26
4.6.3 SAR Measurement Variability	27
5. Calibration of Test Equipment	28
6. Measurement Uncertainty	29
7. Information on the Testing Laboratories	30
Appendix A. SAR Plots of System Verification	
Appendix B. SAR Plots of SAR Measurement	
Appendix C. Calibration Certificate for Probe and Dipole	
Appendix D. Photographs of EUT and Setup	

Release Control Record

Report No.	Reason for Change	Date Issued
SA170802W002	Initial release	Sep. 15, 2017
W7L-P23080026SA01	Based on the original product add material manufacturers. The worst case of original report was verified.	Sep. 12, 2023

1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest Reported Body SAR _{1g} (0.5 cm Gap) (W/kg)
TNB	WCDMA V	0.81
	LTE 26	0.79
	LTE 41	1.13

Note:

1. The SAR limit (**Head & Body: SAR_{1g} 1.6 W/kg**) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

2. Description of Equipment Under Test

EUT Type	LTE USB Modem
FCC ID	2ANKMFS040U
Brand Name	+F
Model Name	FS040U
IMEI Code	867826032191520
HW Version	LWDM132A
SW Version	LWDJC02.1.0 M132
Tx Frequency Bands (Unit: MHz)	WCDMA Band V : 826.4 ~ 846.6 LTE Band 26 : 814.7 ~ 848.3 (1.4M), 815.5 ~ 847.5 (3M), 816.5 ~ 846.5 (5M), 819 ~ 844 (10M), 821.5 ~ 841.5 (15M) LTE Band 41 : 2498.5 ~ 2687.5 (5M), 2501 ~ 2685 (10M), 2503.5 ~ 2682.5 (15M), 2506 ~ 2680 (20M)
Uplink Modulations	WCDMA : QPSK LTE : QPSK, 16QAM
Maximum Tune-up Conducted Power (Unit: dBm)	WCDMA Band V : 22.0 LTE Band 26 : 21.5 LTE Band 41 : 21.5
Antenna Type	Fixed Internal Antenna
EUT Stage	Identical Prototype

Note:

1. The above EUT information is declared by the manufacturer and for more detailed features description please refer to the manufacturer's specifications or User's Manual.
2. According to the documentation < Declaration Letter > provided by the manufacturer. Based on the original product add material manufacturers. These changes do not affect the RF performance, so only verify the conducted power and worst case of the original report. (Report No: SA170802W002, FCC ID: 2ANKMFS040U; Issued by: BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD)

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

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.

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 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 the tissue and E is the RMS electrical field strength.

3.2 SPEAG DASY System

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 from the optical into digital electric signal of the DAE and transfers data to the PC.

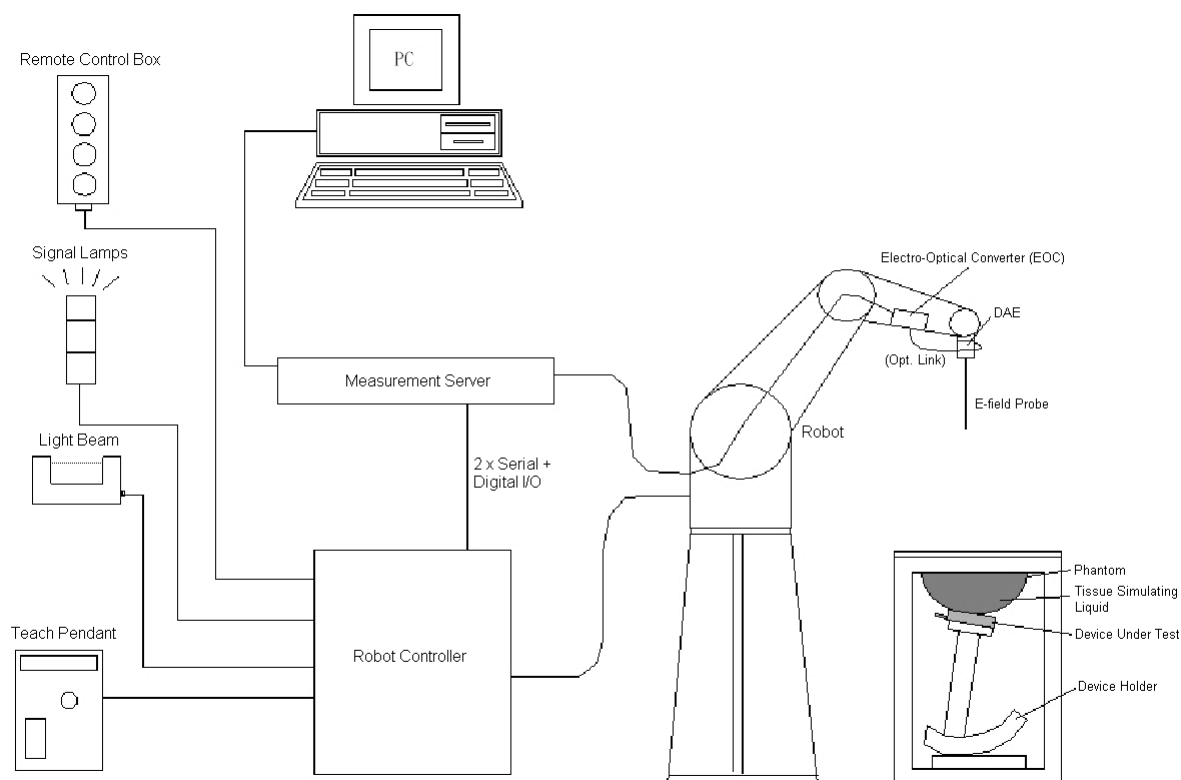


Fig-3.1 DASY System Setup

3.2.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ± 0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



Fig-3.2 DASY5

3.2.2 Probes

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 μ W/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/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 μ W/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	

3.2.3 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	$< 5\mu$ V (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	

3.2.4 Phantoms

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	

3.2.5 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	

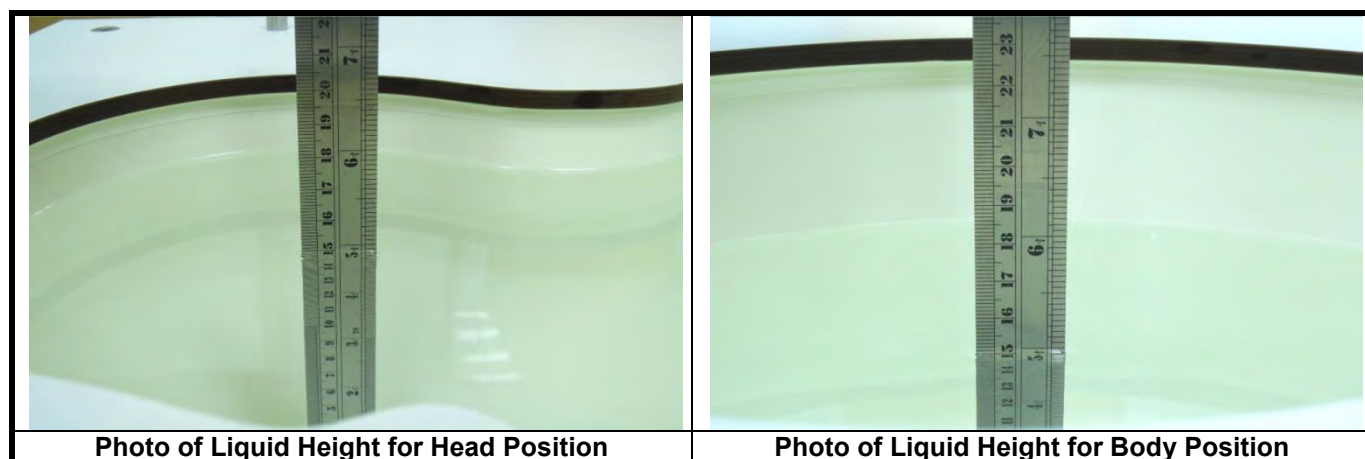
Model	Laptop Extensions Kit	
Construction	Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the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

3.2.6 System Validation Dipoles

Model	D-Serial	
Construction	Symmetrical dipole with 1/4 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)	

3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528, and KDB 865664 D01 Appendix A. For the body tissue simulating liquids, the dielectric properties are defined in KDB 865664 D01 Appendix A. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Table-3.1 Targets of Tissue Simulating Liquid

Frequency (MHz)	Target Permittivity	Range of $\pm 5\%$	Target Conductivity	Range of $\pm 5\%$
For Head				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53

The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3

3.3 SAR System Verification

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

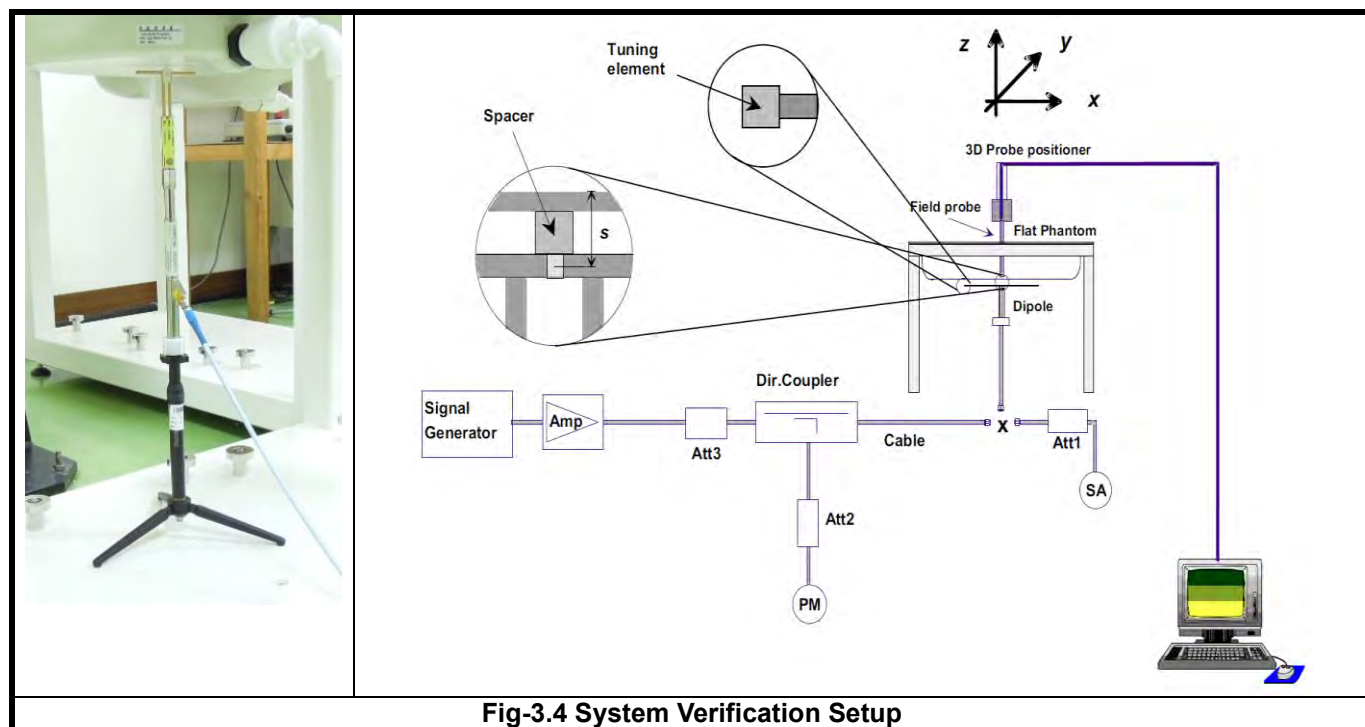


Fig-3.4 System Verification Setup

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

3.4 SAR Measurement Procedure

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
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

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

- (a) Make EUT to transmit maximum output power
- (b) Measure conducted output power through RF cable
- (c) Place the EUT in the specific position of phantom
- (d) Perform SAR testing steps on the DASY system
- (e) Record the SAR value

3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan ($\Delta x, \Delta y$)	<= 15 mm	<= 12 mm	<= 12 mm	<= 10 mm	<= 10 mm
Zoom Scan ($\Delta x, \Delta y$)	<= 8 mm	<= 5 mm	<= 5 mm	<= 4 mm	<= 4 mm
Zoom Scan (Δz)	<= 5 mm	<= 5 mm	<= 4 mm	<= 3 mm	<= 2 mm
Zoom Scan Volume	>= 30 mm	>= 30 mm	>= 28 mm	>= 25 mm	>= 22 mm

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of $\Delta x / \Delta y$ (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

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. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

<Connections between EUT and System Simulator>

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for WCDMA, and Anritsu MT8820C is used for LTE). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

<Considerations Related to WCDMA for Setup and Testing>

Release 5 HSDPA Data Devices

Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1. The 3G SAR test reduction procedure is applied to other HSDPA configurations supported by the Device with HSDPA Sub-test 1 as the primary mode.. HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH / HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors (β_c , β_d), and HS-DPCCH power offset parameters (Δ_{ACK} , Δ_{NACK} , Δ_{CQI}) are set according to values indicated in below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	$\beta_{hs}^{(1)}$	CM (dB) ⁽²⁾	MPR
1	2 / 15	15 / 15	64	2 / 15	4 / 15	0.0	0
2	12 / 15 ⁽³⁾	15 / 15 ⁽³⁾	64	12 / 15 ⁽³⁾	24 / 15	1.0	0
3	15 / 15	8 / 15	64	15 / 8	30 / 15	1.5	0.5
4	15 / 15	4 / 15	64	15 / 4	30 / 15	1.5	0.5

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs} / \beta_c = 30 / 15 \Leftrightarrow \beta_{hs} = 30 / 15 * \beta_c$.

Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15$, $\beta_{hs} / \beta_c = 24 / 15$.

Note 3: For subtest 2 the β_c / β_d ratio of 12 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11 / 15$ and $\beta_d = 15 / 15$.

Release 6 HSPA Data Devices

The 3G SAR test reduction procedure is applied to body SAR with HSDPA Sub-test 1 as the primary mode. Otherwise, body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode. Otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing. Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in below.

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	$\beta_{hs}^{(1)}$	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM ⁽²⁾ (dB)	MPR (dB)	AG ⁽⁴⁾ Index	E-TFCI
1	11 / 15 ⁽³⁾	15 / 15 ⁽³⁾	64	11 / 15 ⁽³⁾	22 / 15	209 / 225	1039 / 225	4	1	1.0	0.0	20	75
2	6 / 15	15 / 15	64	6 / 15	12 / 15	12 / 15	94 / 75	4	1	3.0	2.0	12	67
3	15 / 15	9 / 15	64	15 / 9	30 / 15	30 / 15	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	4	2	2.0	1.0	15	92
4	2 / 15	15 / 15	64	2 / 15	4 / 15	2 / 15	56 / 75	4	1	3.0	2.0	17	71
5	15 / 15 ⁽⁴⁾	15 / 15 ⁽⁴⁾	64	15 / 15 ⁽⁴⁾	30 / 15	24 / 15	134 / 15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs} / \beta_c = 30 / 15 \Leftrightarrow \beta_{hs} = 30 / 15 * \beta_c$.

Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15$, $\beta_{hs} / \beta_c = 24 / 15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the β_c / β_d ratio of 11 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10 / 15$ and $\beta_d = 15 / 15$.

Note 4: For subtest 5 the β_c / β_d ratio of 15 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14 / 15$ and $\beta_d = 15 / 15$.

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6: β_{ed} cannot be set directly; it is set by Absolute Grant Value.

<Considerations Related to LTE for Setup and Testing>

This device contains LTE transmitter which follows 3GPP standards, is category 3, supports both QPSK and 16QAM modulations, and supported LTE band and channel bandwidth is listed in below. The output power was tested per 3GPP TS 36.521-1 maximum transmit procedures for both QPSK and 16QAM modulation. The results please refer to section 4.6 of this report.

EUT Supported LTE Band and Channel Bandwidth						
LTE Band	BW 1.4 MHz	BW 3 MHz	BW 5 MHz	BW 10 MHz	BW 15 MHz	BW 20 MHz
26	V	V	V	V	V	
41			V	V	V	V

The LTE maximum power reduction (MPR) in accordance with 3GPP TS 36.101 is active all times during LTE operation. The allowed MPR for the maximum output power is specified in below.

Modulation	Channel Bandwidth / RB Configurations						LTE MPR Setting (dB)
	BW 1.4 MHz	BW 3 MHz	BW 5 MHz	BW 10 MHz	BW 15 MHz	BW 20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	1
16QAM	<= 5	<= 4	<= 8	<= 12	<= 16	<= 18	1
16QAM	> 5	> 4	> 8	> 12	> 16	> 18	2

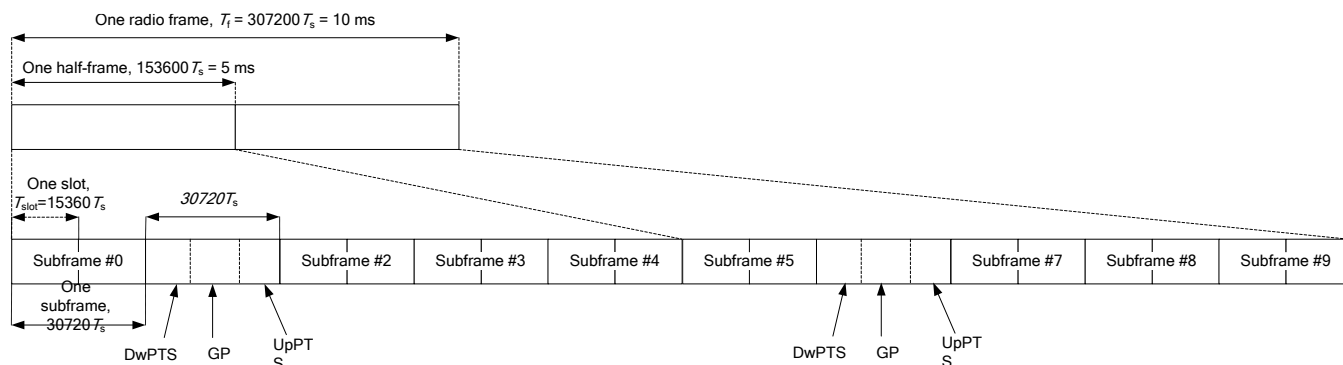
Note: MPR is according to the standard and implemented in the circuit (mandatory).

In addition, the device is compliant with additional maximum power reduction (A-MPR) requirements defined in 3GPP TS 36.101 section 6.2.4 that was disabled for all FCC compliance testing.

During LTE SAR testing, the related parameters of operating band, channel bandwidth, uplink channel number, modulation type, and RB was set in base station simulator. When the EUT has registered and communicated to base station simulator, the simulator set to make EUT transmitting the maximum radiated power.

TDD-LTE Setup Configurations

According to KDB 941225 D05, SAR testing for TDD-LTE device 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 TDD-LTE configurations. The TDD-LTE of this device supports frame structure type 2 defined in 3GPP TS 36.211 section 4.2, and the frame structure configuration can be referred to below.



3GPP TS 36.211 Figure 4.2-1: Frame Structure Type 2

Special Subframe Configuration	Normal Cyclic Prefix in Downlink			Extended Cyclic Prefix in Downlink		
	DwPTS	UpPTS		DwPTS	UpPTS	
		Normal Cyclic Prefix in Uplink	Extended Cyclic Prefix in Uplink		Normal Cyclic Prefix in Uplink	Extended Cyclic Prefix in Uplink
0	6592·Ts	2192·Ts	2560·Ts	7680·Ts	2192·Ts	2560·Ts
1	19760·Ts			20480·Ts		
2	21952·Ts			23040·Ts		
3	24144·Ts			25600·Ts		
4	26336·Ts	4384·Ts	5120·Ts	7680·Ts	4384·Ts	5120·Ts
5	6592·Ts			20480·Ts		
6	19760·Ts			23040·Ts		
7	21952·Ts			12800·Ts		
8	24144·Ts	-	-	-	-	-
9	13168·Ts			-	-	-

3GPP TS 36.211 Table 4.2-1: Configuration of Special Subframe

Uplink-Downlink Configuration	Downlink-to-Uplink Switch-Point Periodicity	Subframe Number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

3GPP TS 36.211 Table 4.2-2: Uplink-Downlink Configurations

The variety of different TD-LTE uplink-downlink configurations allows a network operator to allocate the network's capacity between uplink and downlink traffic to meet the needs of the network. The uplink duty cycle of these seven configurations can readily be computed and shown in below.

UL-DL Configuration	0	1	2	3	4	5	6
Highest Duty-Cycle	63.33%	43.33%	23.33%	31.67%	21.67%	11.67%	53.33%

4.2 EUT Testing Position

4.2.1 Body Exposure Conditions

<Simple Dongle Procedures>

For USB dongle transmitter, according to KDB 447498 D02, SAR evaluation is required for all USB orientations illustrated as below with a device-to-phantom separation distance of 5 mm or less. The typical Horizontal-Up USB connection, found in the majority of host computers, must be tested using an appropriate host computer. A host computer with either Vertical-Front or Vertical-Back USB connection should be used to test one of the vertical USB orientations. If a suitable host computer is not available for testing the Horizontal-Down or the remaining Vertical USB orientation, a high quality USB cable, 12 inches or less, may be used for testing these other orientations.

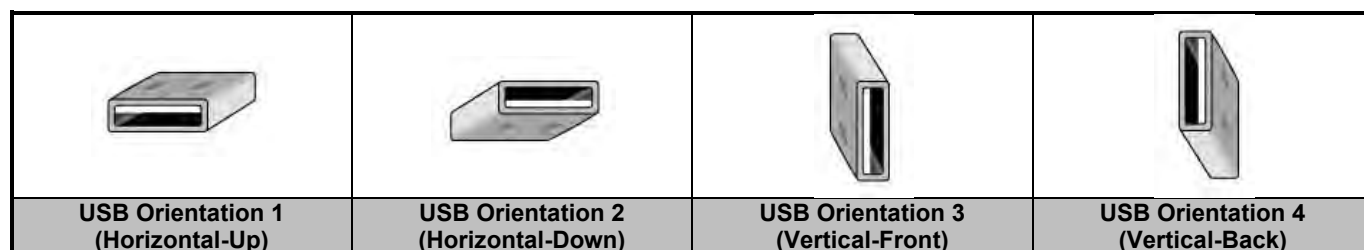


Fig-4.1 Illustration for USB Connector Orientations

4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Test Date	Tissue Type	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity (σ)	Measured Permittivity (ϵ_r)	Target Conductivity (σ)	Target Permittivity (ϵ_r)	Conductivity Deviation (%)	Permittivity Deviation (%)
Sep. 04, 2023	Head	835	22.6	0.914	42.071	0.90	41.50	1.56	1.38
Sep. 05, 2023	Head	2600	22.7	1.895	39.172	1.96	39.00	-3.32	0.44

Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within $\pm 5\%$ of the target values. Liquid temperature during the SAR testing must be within $\pm 2^\circ\text{C}$.

4.4 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N
Sep. 04, 2023	Head	835	9.47	2.36	9.44	-0.32	4d139	3873	1389
Sep. 05, 2023	Head	2600	55.80	12.94	51.76	-7.24	1110	3873	1389

Note:

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

4.5 Maximum Output Power

4.5.1 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

Mode	WCDMA Band V
HSDPA	22.0
HSUPA	21.5

Mode	LTE 26	LTE 41
QPSK / 16QAM	21.5 / 20.5	21.5 / 20.5

4.5.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

Band	WCDMA Band V			3GPP MPR (dB)
Channel	4132	4182	4233	
Frequency (MHz)	826.4	836.4	846.6	
HSDPA Subtest-1	21.53	21.67	21.57	0
HSDPA Subtest-2	21.51	21.61	21.52	0
HSDPA Subtest-3	21.05	21.24	21.14	0.5
HSDPA Subtest-4	21.09	21.23	21.08	0.5
HSUPA Subtest-1	21.10	21.23	21.11	0
HSUPA Subtest-2	20.39	20.53	20.46	2
HSUPA Subtest-3	19.66	19.81	19.73	1
HSUPA Subtest-4	21.07	21.23	21.09	2
HSUPA Subtest-5	21.41	21.42	21.41	0

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)
			Low CH 26697	Mid CH 26865	High CH 27033		Low CH 26697	Mid CH 26865	High CH 27033	
			814.7 MHz	831.5 MHz	848.3 MHz		814.7 MHz	831.5 MHz	848.3 MHz	
26 / 1.4M	1	0	20.91	21.05	20.67	0	19.41	19.80	19.59	1
	1	2	20.97	21.09	21.02	0	19.47	19.92	19.63	1
	1	5	20.74	21.04	20.68	0	19.34	19.66	19.41	1
	3	0	20.43	20.79	20.55	0	19.65	20.03	19.68	1
	3	1	20.37	20.84	20.57	0	19.50	19.78	19.60	1
	3	3	20.58	20.85	20.60	0	19.72	20.10	19.71	1
	6	0	19.73	19.89	19.63	1	18.79	18.92	18.76	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)
			Low CH 26705	Mid CH 26865	High CH 27025		Low CH 26705	Mid CH 26865	High CH 27025	
			815.5 MHz	831.5 MHz	847.5 MHz		815.5 MHz	831.5 MHz	847.5 MHz	
26 / 3M	1	0	20.88	21.03	20.76	0	19.47	19.90	19.50	1
	1	7	20.85	21.22	20.92	0	19.59	19.83	19.61	1
	1	14	20.74	21.00	20.77	0	19.34	19.70	19.42	1
	8	0	19.49	19.77	19.50	1	18.67	19.01	18.77	2
	8	3	19.43	19.75	19.62	1	18.53	18.89	18.59	2
	8	7	19.49	19.95	19.56	1	18.79	19.01	18.76	2
	15	0	19.65	19.91	19.61	1	18.77	19.05	18.78	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)
			Low CH 26715	Mid CH 26865	High CH 27015		Low CH 26715	Mid CH 26865	High CH 27015	
			816.5 MHz	831.5 MHz	846.5 MHz		816.5 MHz	831.5 MHz	846.5 MHz	
26 / 5M	1	0	20.80	21.12	20.78	0	19.39	19.83	19.46	1
	1	12	20.84	21.16	21.01	0	19.54	19.95	19.66	1
	1	24	20.69	20.98	20.74	0	19.38	19.68	19.37	1
	12	0	19.41	19.84	19.50	1	18.78	18.96	18.73	2
	12	6	19.38	19.71	19.50	1	18.55	18.86	18.63	2
	12	13	19.59	19.96	19.65	1	18.82	19.08	18.65	2
	25	0	19.72	19.84	19.67	1	18.87	18.99	18.79	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)
			Low CH 26740	Mid CH 26865	High CH 26990		Low CH 26740	Mid CH 26865	High CH 26990	
			819.0 MHz	831.5 MHz	844.0 MHz		819.0 MHz	831.5 MHz	844.0 MHz	
26 / 10M	1	0	20.86	21.06	20.78	0	19.44	19.88	19.53	1
	1	24	20.83	21.23	20.96	0	19.51	19.87	19.57	1
	1	49	20.76	20.91	20.72	0	19.37	19.65	19.36	1
	25	0	19.39	19.76	19.41	1	18.68	19.00	18.65	2
	25	12	19.37	19.83	19.50	1	18.54	18.86	18.64	2
	25	25	19.52	19.87	19.65	1	18.76	19.08	18.69	2
	50	0	19.68	19.87	19.62	1	18.87	18.92	18.71	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)
			Low CH 26765	Mid CH 26865	High CH 26965		Low CH 26765	Mid CH 26865	High CH 26965	
			821.5 MHz	831.5 MHz	841.5 MHz		821.5 MHz	831.5 MHz	841.5 MHz	
26 / 15M	1	0	20.94	21.13	20.82	0	19.54	19.95	19.61	1
	1	37	20.98	21.24	21.03	0	19.61	19.97	19.69	1
	1	74	20.77	21.06	20.82	0	19.48	19.77	19.49	1
	36	0	19.54	19.91	19.56	1	18.79	19.06	18.80	2
	36	19	19.52	19.86	19.63	1	18.62	18.92	18.71	2
	36	39	19.62	19.97	19.69	1	18.86	19.14	18.77	2
	75	0	19.77	19.96	19.72	1	18.89	19.07	18.85	2

LTE Band / BW	RB Size	RB Offset	QPSK					3GPP MPR (dB)	16QAM					3GPP MPR (dB)
			L-CH 39675	M-CH 40148	M-CH 40620	M-CH 41093	H-CH 41565		L-CH 39675	M-CH 40148	M-CH 40620	M-CH 41093	H-CH 41565	
			2498.5 MHz	2545.8 MHz	2593.0 MHz	2640.3 MHz	2687.5 MHz		2498.5 MHz	2545.8 MHz	2593.0 MHz	2640.3 MHz	2687.5 MHz	
41 / 5M	1	0	20.51	20.48	20.86	20.93	21.25	0	19.04	19.09	19.48	19.39	19.93	1
	1	12	20.71	20.63	20.95	20.99	21.35	0	19.21	19.28	19.61	19.72	20.07	1
	1	24	20.26	20.35	20.67	20.69	21.13	0	19.05	19.09	19.32	19.40	19.69	1
	12	0	19.38	19.33	19.69	19.73	20.12	1	18.36	18.36	18.73	18.78	19.03	2
	12	6	19.39	19.38	19.65	19.74	20.05	1	18.62	18.65	19.04	19.06	19.36	2
	12	13	19.38	19.26	19.63	19.79	20.10	1	18.62	18.66	18.96	19.04	19.37	2
	25	0	19.35	19.35	19.71	19.81	20.06	1	18.58	18.61	18.93	19.01	19.27	2

LTE Band / BW	RB Size	RB Offset	QPSK					3GPP MPR (dB)	16QAM					3GPP MPR (dB)
			L-CH 39700	M-CH 40160	M-CH 40620	M-CH 41080	H-CH 41540		L-CH 39700	M-CH 40160	M-CH 40620	M-CH 41080	H-CH 41540	
			2501.0 MHz	2547.0 MHz	2593.0 MHz	2639.0 MHz	2685.0 MHz		2501.0 MHz	2547.0 MHz	2593.0 MHz	2639.0 MHz	2685.0 MHz	
41 / 10M	1	0	20.51	20.61	20.91	20.88	21.21	0	19.04	19.01	19.51	19.38	19.90	1
	1	24	20.73	20.63	21.03	21.12	21.36	0	19.24	19.28	19.63	19.81	20.03	1
	1	49	20.27	20.28	20.66	20.68	21.12	0	19.11	19.07	19.40	19.36	19.74	1
	25	0	19.34	19.31	19.79	19.60	20.15	1	18.33	18.33	18.75	18.75	19.11	2
	25	12	19.39	19.37	19.68	19.85	20.14	1	18.56	18.55	19.02	19.08	19.38	2
	25	25	19.42	19.19	19.62	19.74	20.00	1	18.66	18.77	19.03	19.08	19.37	2
	50	0	19.43	19.26	19.65	19.70	19.98	1	18.54	18.51	18.90	18.96	19.38	2

LTE Band / BW	RB Size	RB Offset	QPSK					3GPP MPR (dB)	16QAM					3GPP MPR (dB)
			L-CH 39725	M-CH 40173	M-CH 40620	M-CH 41068	H-CH 41515		L-CH 39725	M-CH 40173	M-CH 40620	M-CH 41068	H-CH 41515	
			2503.5 MHz	2548.3 MHz	2593.0 MHz	2637.8 MHz	2682.5 MHz		2503.5 MHz	2548.3 MHz	2593.0 MHz	2637.8 MHz	2682.5 MHz	
41 / 15M	1	0	20.55	20.53	20.86	20.88	21.22	0	19.04	19.01	19.41	19.47	19.84	1
	1	37	20.66	20.51	21.02	21.08	21.42	0	19.35	19.20	19.63	19.76	20.10	1
	1	74	20.23	20.28	20.60	20.65	21.01	0	19.12	19.03	19.31	19.33	19.77	1
	36	0	19.32	19.21	19.77	19.62	20.14	1	18.34	18.22	18.70	18.71	19.01	2
	36	19	19.42	19.39	19.72	19.84	20.06	1	18.52	18.64	18.95	18.99	19.36	2
	36	39	19.34	19.21	19.63	19.70	19.98	1	18.56	18.63	18.95	18.95	19.41	2
	75	0	19.45	19.25	19.72	19.73	20.08	1	18.55	18.55	18.89	18.97	19.33	2

LTE Band / BW	RB Size	RB Offset	QPSK					3GPP MPR (dB)	16QAM					3GPP MPR (dB)
			L-CH 39750	M-CH 40185	M-CH 40620	M-CH 41055	H-CH 41490		L-CH 39750	M-CH 40185	M-CH 40620	M-CH 41055	H-CH 41490	
			2506.0 MHz	2549.5 MHz	2593.0 MHz	2636.5 MHz	2680.0 MHz		2506.0 MHz	2549.5 MHz	2593.0 MHz	2636.5 MHz	2680.0 MHz	
41 / 20M	1	0	20.66	20.63	20.99	21.03	21.31	0	19.16	19.16	19.56	19.52	19.95	1
	1	50	20.76	20.64	21.08	21.14	21.43	0	19.36	19.34	19.76	19.83	20.14	1
	1	99	20.37	20.39	20.75	20.74	21.14	0	19.17	19.13	19.46	19.46	19.84	1
	50	0	19.46	19.35	19.81	19.75	20.16	1	18.48	18.37	18.82	18.81	19.15	2
	50	25	19.52	19.41	19.75	19.89	20.18	1	18.63	18.68	19.09	19.11	19.43	2
	50	50	19.47	19.31	19.76	19.84	20.13	1	18.69	18.78	19.08	19.10	19.47	2
	100	0	19.46	19.36	19.76	19.82	20.12	1	18.65	18.65	19.03	19.04	19.39	2

4.6 SAR Testing Results

4.6.1 SAR Test Reduction Considerations

<KDB 447498 D04 Interim General RF Exposure Guidance v01>

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

- (1) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- (2) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- (3) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

<KDB 941225 D01, 3G SAR Measurement Procedures>

The mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq 1/4$ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

<KDB 941225 D05, SAR Evaluation Considerations for LTE Devices>

- (1) QPSK with 1 RB and 50% RB allocation

Start with the largest channel bandwidth and measure SAR, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

- (2) 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.

- (3) Higher order modulations

SAR is required only when the highest maximum output power for the configuration in the higher order modulation is $> 1/2$ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

- (4) Other channel bandwidth

SAR is required when the highest maximum output power of the smaller channel bandwidth is $> 1/2$ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

4.6.2 SAR Results for Body Exposure Condition (Separation Distance is 0.5 cm Gap)

Plot No.	Band	Mode	Test Position	Ch.	EUT Status (Degree)	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (dB)	Measured SAR-1g (W/kg)	Tune-up Scaling Factor	Scaled SAR-1g (W/kg)
	WCDMA V	HSDPA Subtest-1	Horizontal Up	4233	180	22	21.57	-0.03	0.727	1.104	0.80
P01	WCDMA V	HSDPA Subtest-1	Horizontal Up	4132	180	22	21.53	0.01	0.728	1.114	0.81
	WCDMA V	HSDPA Subtest-1	Horizontal Up	4182	180	22	21.67	-0.09	0.725	1.079	0.78

Plot No.	Band	Mode	Test Position	Ch.	EUT Status (Degree)	RB#	RB Offset	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (dB)	Measured SAR-1g (W/kg)	Tune-up Scaling Factor	Scaled SAR-1g (W/kg)
P02	LTE 26	QPSK15M	Horizontal Up	26865	180	1	37	21.5	21.24	-0.04	0.745	1.062	0.79

Plot No.	Band	Mode	Test Position	Ch.	EUT Status (Degree)	RB#	RB Offset	Duty Cycle %	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (dB)	Measured SAR-1g (W/kg)	Duty Cycle Scaling Factor	Tune-up Scaling Factor	Scaled SAR-1g (W/kg)
P03	LTE 41	QPSK20M	Horizontal Down	39750	180	1	50	62.9	21.5	20.76	0.04	0.948	1.006	1.186	1.13
	LTE 41	QPSK20M	Horizontal Down	40185	180	1	50	62.9	21.5	20.64	-0.07	0.914	1.006	1.219	1.12
	LTE 41	QPSK20M	Horizontal Down	40620	180	1	50	62.9	21.5	21.08	0.07	0.993	1.006	1.102	1.10
	LTE 41	QPSK20M	Horizontal Down	41055	180	1	50	62.9	21.5	21.14	0.05	0.871	1.006	1.086	0.95
	LTE 41	QPSK20M	Horizontal Down	41490	180	1	50	62.9	21.5	21.43	0.09	1.070	1.006	1.016	1.09

4.6.3 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was 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. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10 , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3. 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.
4. 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.	EUT Status (Degree)	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
LTE 41	QPSK20M	Horizontal Down	41490	180	1.070	1.050	1.02	N/A	N/A	N/A	N/A

Test Engineer : Dennis Ye

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SPEAG	D835V2	4d139	Sep. 17, 2021	3 Years
System Validation Dipole	SPEAG	D2600V2	1110	Sep. 16, 2021	3 Years
Data Acquisition Electronics	SPEAG	DAE4	1389	Nov. 09, 2023	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	3873	Aug. 22, 2023	1 Year
Dielectric Probe Kit	SPEAG	DAK-3.5	1076	Aug. 17, 2023	1 Year
Radio Communication Analyzer	ANRITSU	MT8820C	6201465426	Feb. 14, 2023	1 Year
Wireless Communication Test Set	Agilent	E5515C	MY50260600	May. 10, 2023	1 Year
ENA Series Network Analyzer	Agilent	E5071C	MY46214638	May. 10, 2023	1 Year
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510355	May. 10, 2023	1 Year
MXG Analog Signal Generator	KEYSIGHT	N5183A	MY50143024	Feb. 14, 2023	1 Year
Power Meter	Agilent	N1914A	MY52180044	Feb. 15, 2023	1 Year
Power Sensor	Agilent	E9304A H18	MY52050011	Feb. 15, 2023	1 Year
Power Meter	ANRITSU	ML2495A	1506002	Feb. 14, 2023	1 Year
Power Sensor	ANRITSU	MA2411B	1339352	Feb. 14, 2023	1 Year
Temp. & Humi. Recorder	HUATO	A2000TH	HE20107684	May. 09, 2023	1 Year
Electronic Thermometer	YONGFA	YF-160A	120100323	May. 10, 2023	1 Year
Coupler	Woken	0110A056020-10	COM27RW1A3	May. 10, 2023	1 Year

Note:

- Referring to KDB 865664 D01 v01r04, the dipole calibration interval can be extended to 3 years with justification. The dipole are also not physically damaged, or repaired during the interval. The dipole justification can be found in appendix C.
The return loss is $< -20\text{dB}$, within 20% of prior calibration, the impedance is with 5ohm of prior calibration.

6. Measurement Uncertainty

DASY5 Uncertainty Budget								
Error Description	Uncertainty Value (±%)	Probability	Divisor	(Ci) 1g	(Ci) 10g	Standard Uncertainty (1g) (±%)	Standard Uncertainty (10g) (±%)	(Vi) Veff
Measurement System								
Probe Calibration	6.0	N	1	1	1	6.0	6.0	∞
Axial Isotropy	4.7	R	1.732	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	R	1.732	0.7	0.7	3.9	3.9	∞
Boundary Effects	1.0	R	1.732	1	1	0.6	0.6	∞
Linearity	4.7	R	1.732	1	1	2.7	2.7	∞
System Detection Limits	1.0	R	1.732	1	1	0.6	0.6	∞
Modulation Response	3.2	R	1.732	1	1	1.8	1.8	∞
Readout Electronics	0.3	N	1	1	1	0.3	0.3	∞
Response Time	0.0	R	1.732	1	1	0.0	0.0	∞
Integration Time	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Noise	3.0	R	1.732	1	1	1.7	1.7	∞
RF Ambient Reflections	3.0	R	1.732	1	1	1.7	1.7	∞
Probe Positioner	0.4	R	1.732	1	1	0.2	0.2	∞
Probe Positioning	2.9	R	1.732	1	1	1.7	1.7	∞
Max. SAR Eval.	2.0	R	1.732	1	1	1.2	1.2	∞
Test Sample Related								
Device Positioning	3.0	N	1	1	1	3.0	3.0	35
Device Holder	3.6	N	1	1	1	3.6	3.6	12
Power Drift	5.0	R	1.732	1	1	2.9	2.9	∞
Power Scaling	0.0	R	1.732	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty	6.1	R	1.732	1	1	3.5	3.5	∞
SAR correction	0.0	R	1.732	1	0.84	0.0	0.0	∞
Liquid Conductivity Repeatability	0.2	N	1	0.78	0.71	0.1	0.1	5
Liquid Conductivity (target)	5.0	R	1.732	0.78	0.71	2.3	2.0	∞
Liquid Conductivity (mea.)	2.5	R	1.732	0.78	0.71	1.1	1.0	∞
Temp. unc. - Conductivity	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity Repeatability	0.15	N	1	0.23	0.26	0.0	0.0	5
Liquid Permittivity (target)	5.0	R	1.732	0.23	0.26	0.7	0.8	∞
Liquid Permittivity (mea.)	2.5	R	1.732	0.23	0.26	0.3	0.4	∞
Temp. unc. - Permittivity	0.83	R	1.732	0.23	0.26	0.1	0.1	∞
Combined Std. Uncertainty						11.4%	11.4%	1013
Coverage Factor for 95 %						K=2	K=2	
Expanded STD Uncertainty						22.9%	22.7%	

Uncertainty budget for frequency range 300 MHz to 3 GHz

7. Information on the Testing Laboratories

We, BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD., were founded in 2015 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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Email: customerservice.sw@cn.bureauveritas.com

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The road map of all our labs can be found in our web site also.

---END---

Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

System Check_HSL835_20230904

DUT: Dipole:835 MHz;Type:D835V2

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1

Medium: HSL835_0904 Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.914 \text{ S/m}$; $\epsilon_r = 42.071$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature : 23.2°C ; Liquid Temperature : 22.6°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(9.94, 9.14, 8.98) @ 835 MHz; Calibrated: 2023/08/22
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1389; Calibrated: 2022/11/09
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:1781
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=250mW/Area Scan (61x111x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 3.03 W/kg

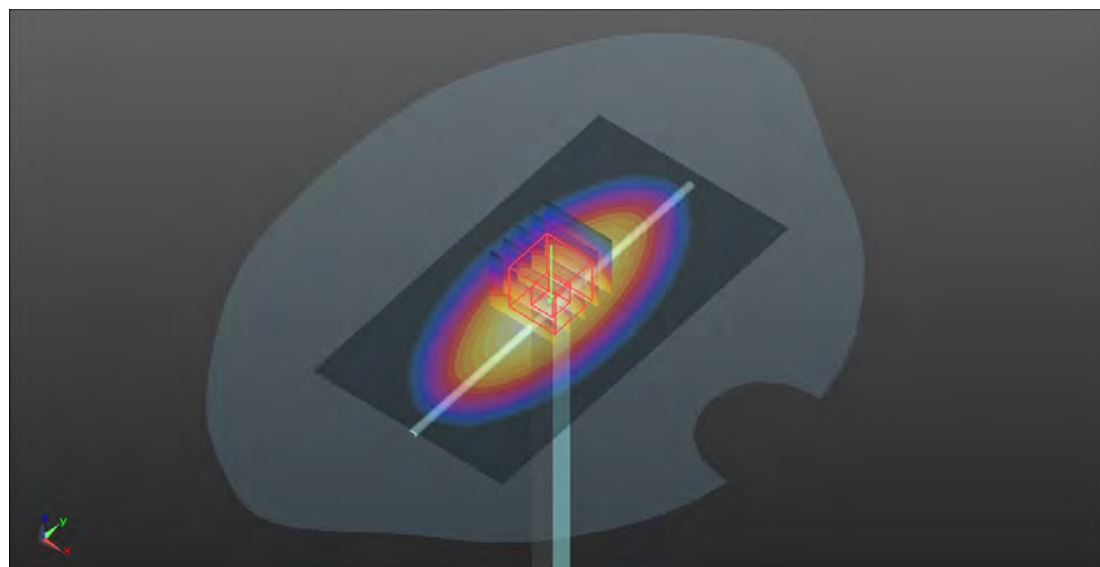
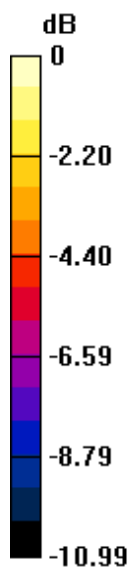
Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 59.01 V/m ; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 3.55 W/kg

SAR(1 g) = 2.36 W/kg ; SAR(10 g) = 1.53 W/kg

Maximum value of SAR (measured) = 3.01 W/kg



0 dB = 3.01 W/kg

System Check_HSL2600_20230905

DUT: Dipole:2600 MHz;Type:D2600V2

Communication System: CW; Frequency: 2600 MHz;Duty Cycle: 1:1

Medium: HSL2600_09054 Medium parameters used: $f = 2600$ MHz; $\sigma = 1.895$ S/m; $\epsilon_r = 39.172$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.6°C; Liquid Temperature : 22.7°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.52, 7.57, 7.43) @ 2600 MHz; Calibrated: 2023/08/22
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1389; Calibrated: 2022/11/09
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:1781
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=250mW/Area Scan (61x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 18.5 W/kg

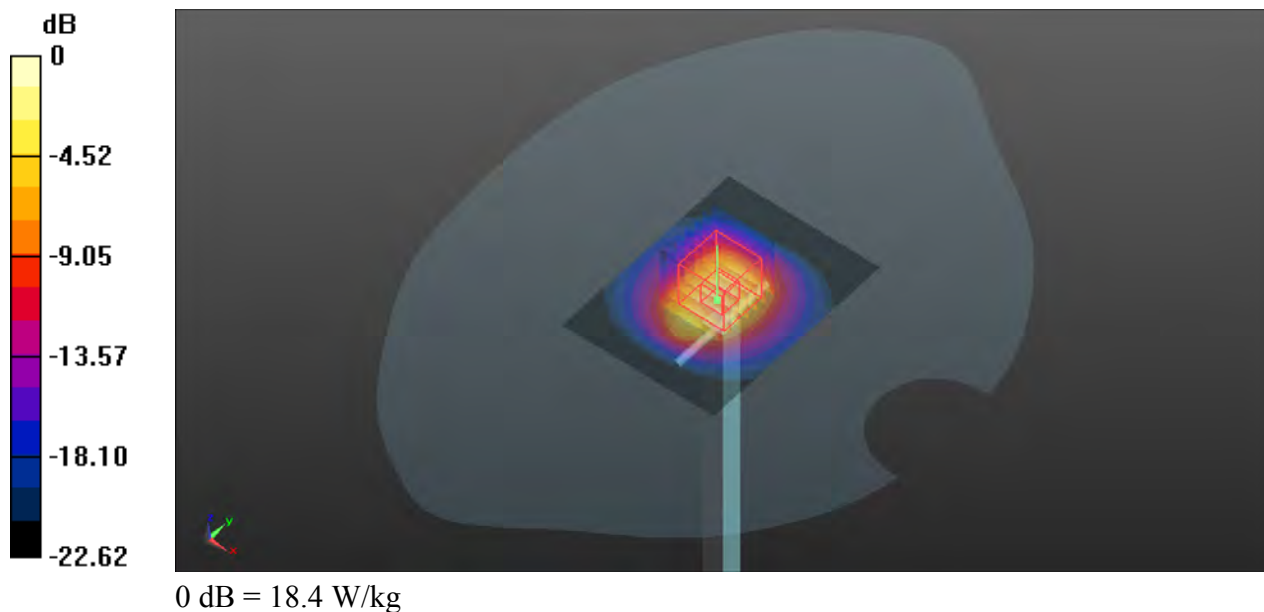
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.9 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 24.8 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.87 W/kg

Maximum value of SAR (measured) = 18.4 W/kg



Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

P01 WCDMA V_RMC12.2K_Horizontal Up_0.5cm_Ch4132

Communication System: WCDMA; Frequency: 826.4 MHz; Duty Cycle: 1:1

Medium: HSL835_0904 Medium parameters used: $f = 826.4$ MHz; $\sigma = 0.911$ S/m; $\epsilon_r = 42.095$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2°C; Liquid Temperature : 22.6°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(9.94, 9.14, 8.98) @ 826.4 MHz; Calibrated: 2023/08/22
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1389; Calibrated: 2022/11/09
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:1781
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

- **Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.818 W/kg

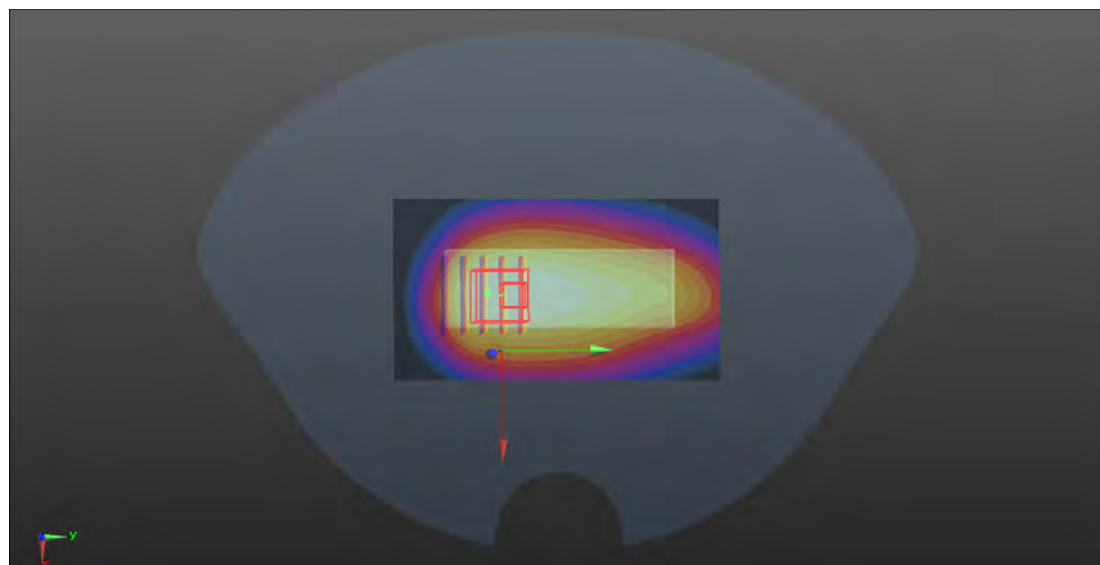
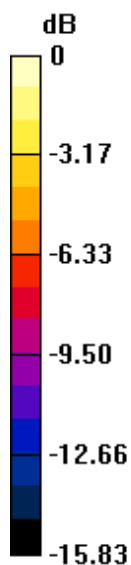
- **Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 28.02 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 1.06 W/kg

SAR(1 g) = 0.728 W/kg; SAR(10 g) = 0.459 W/kg

Maximum value of SAR (measured) = 0.778 W/kg



0 dB = 0.778 W/kg

P02 LTE 26_QPSK15M_Horizontal Up_0.5cm_Ch26865_1RB_OS37

Communication System: LTE; Frequency: 831.5 MHz; Duty Cycle: 1:1

Medium: HSL835_0904 Medium parameters used: $f = 831.5$ MHz; $\sigma = 0.913$ S/m; $\epsilon_r = 42.082$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2°C; Liquid Temperature : 22.6°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(9.94, 9.14, 8.98) @ 831.5 MHz; Calibrated: 2023/08/22
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1389; Calibrated: 2022/11/09
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:1781
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

- **Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.854 W/kg

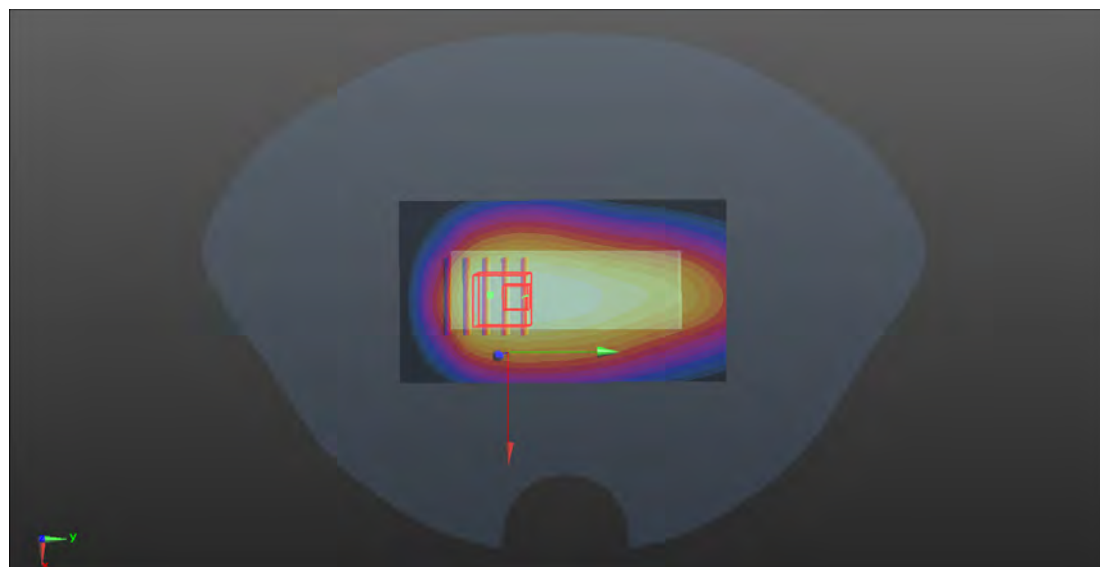
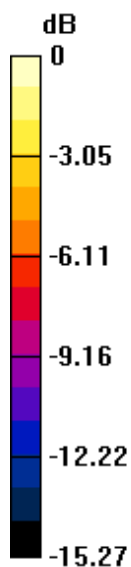
- **Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 29.09 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 1.07 W/kg

SAR(1 g) = 0.745 W/kg; SAR(10 g) = 0.473 W/kg

Maximum value of SAR (measured) = 0.800 W/kg



0 dB = 0.800 W/kg

P03 LTE 41_QPSK20M_Horizontal Down_0.5cm_Ch39750_1RB_OS50

Communication System: LTE TDD; Frequency: 2506 MHz; Duty Cycle: 1:1.59

Medium: HSL2600_0905 Medium parameters used: $f = 2506$ MHz; $\sigma = 1.822$ S/m; $\epsilon_r = 39.297$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.6°C; Liquid Temperature : 22.7°C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.52, 7.57, 7.43) @ 2506 MHz; Calibrated: 2023/08/22
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1389; Calibrated: 2022/11/09
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:1781
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

- **Area Scan (51x111x1):** Interpolated grid: $dx=1.200$ mm, $dy=1.200$ mm

Maximum value of SAR (interpolated) = 1.58 W/kg

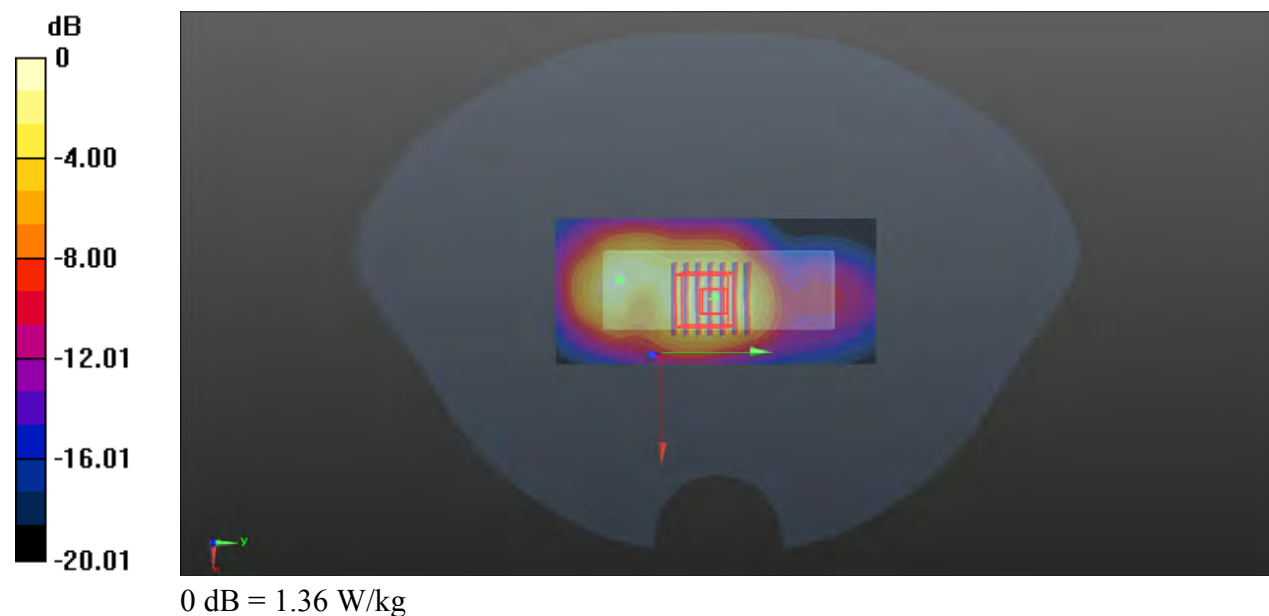
- **Zoom Scan (7x7x7)/Cube 0:** Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 25.08 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 2.24 W/kg

SAR(1 g) = 0.948 W/kg; SAR(10 g) = 0.563 W/kg

Maximum value of SAR (measured) = 1.36 W/kg





Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.



In Collaboration with
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CALIBRATION LABORATORY



中国认可
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CNAS L0570

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

Client

B.V.ADT

Certificate No: **Z21-60333**

CALIBRATION CERTIFICATE

Object

D835V2 - SN: 4d139

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

September 17, 2021

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Power sensor NRP8S	104291	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Reference Probe EX3DV4	SN 7517	03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Feb-22
DAE4	SN 1556	15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Jan-22
Secondary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-21 (CTTL, No.J21X00593)	Jan-22
NetworkAnalyzer E5071C	MY46110673	14-Jan-21 (CTTL, No.J21X00232)	Jan-22

	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: September 22, 2021

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



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Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.2 $\pm$ 6 %	0.91 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.47 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.15 W/kg $\pm$ 18.7 % (k=2)



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.4Ω- 2.93jΩ
Return Loss	- 29.9dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.302 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: 09.17.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d139

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835$ MHz; $\sigma = 0.91$ S/m; $\epsilon_r = 41.23$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7517; ConvF(9.81, 9.81, 9.81) @ 835 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 58.58 V/m; Power Drift = 0.00 dB

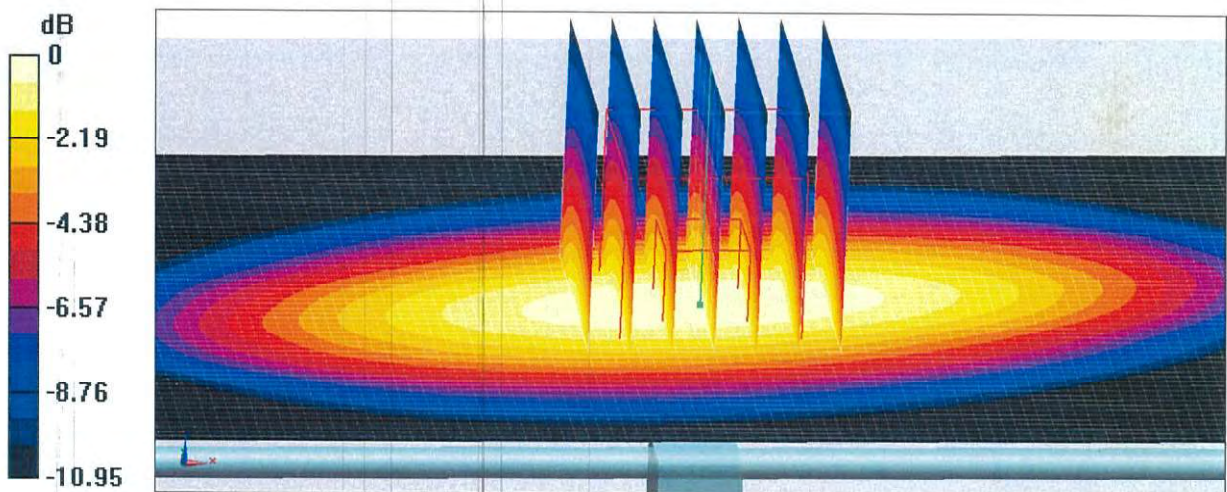
Peak SAR (extrapolated) = 3.75 W/kg

SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.55 W/kg

Smallest distance from peaks to all points 3 dB below = 17.5 mm

Ratio of SAR at M2 to SAR at M1 = 63.9%

Maximum value of SAR (measured) = 3.27 W/kg



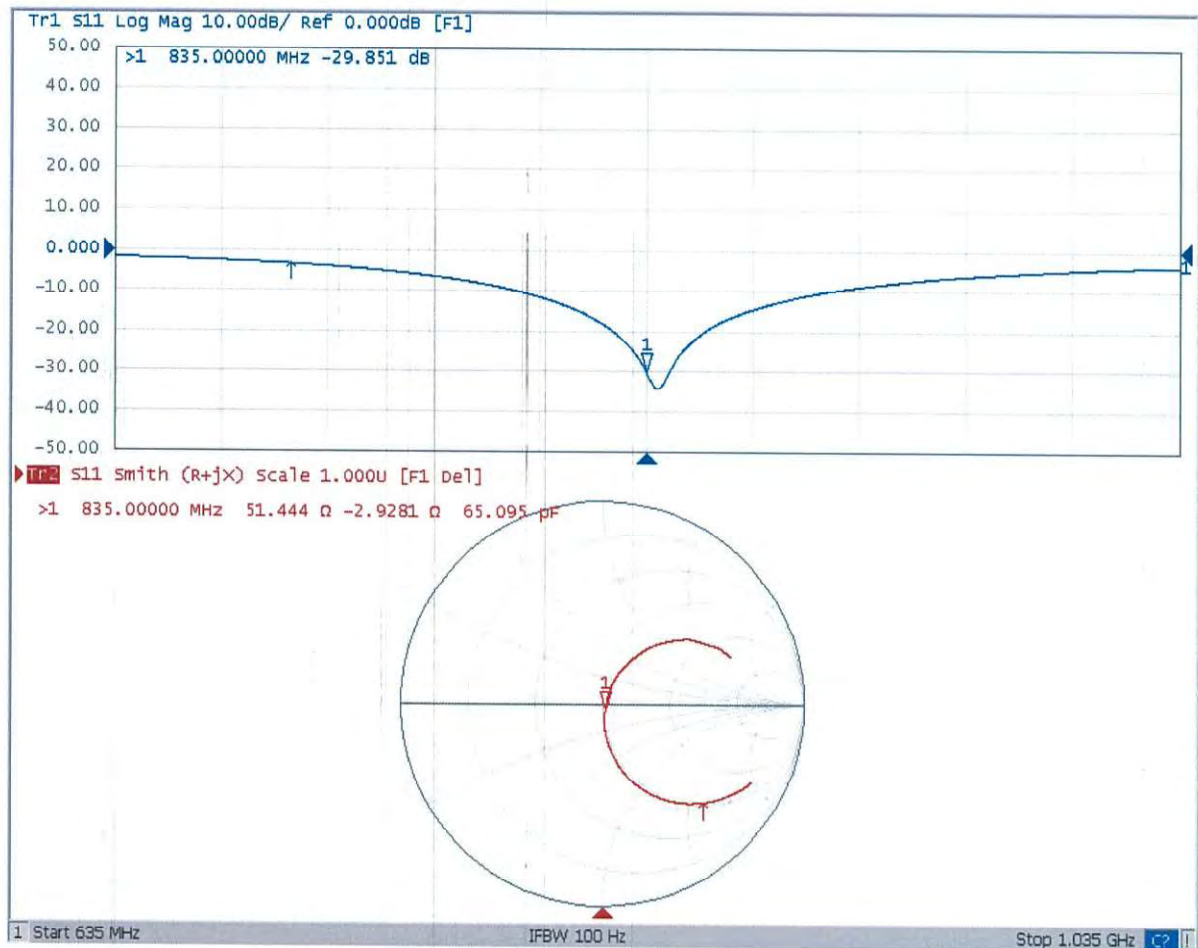
0 dB = 3.27 W/kg = 5.15 dBW/kg



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Impedance Measurement Plot for Head TSL



D835V2 - SN: 4d139 Extended Dipole Calibrations

Referring to KDB 865664 D01, if dipoles are verified in return loss ($< -20\text{dB}$, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

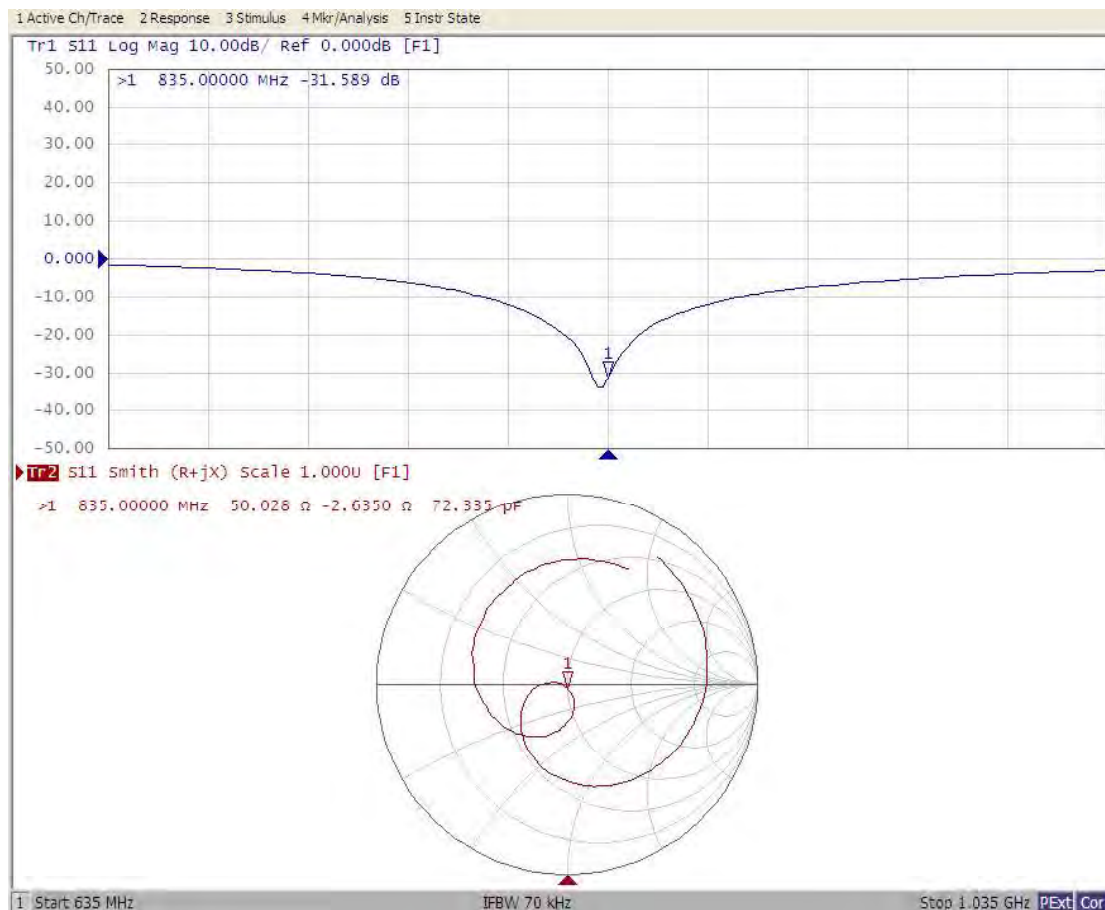
D835V2 - SN: 4d139						
835 Head						
Date of Measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2021.09.17	-29.8		51.4		-2.9	
2022.09.17	-31.6	-6.0	50.0	-1.4	-2.6	0.3

<Justification of the extended calibration>

The return loss is $< -20\text{dB}$, within 20% of prior calibration, and the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Dipole Verification Data>

Head 835MHz _2022.0917





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Client

B.V.ADT

Certificate No: **Z21-60339**

CALIBRATION CERTIFICATE

Object

D2600V2 - SN: 1110

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

September 16, 2021

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Power sensor NRP8S	104291	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Reference Probe EX3DV4	SN 7517	03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Feb-22
DAE4	SN 1556	15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Jan-22
Secondary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-21 (CTTL, No.J21X00593)	Jan-22
Network Analyzer E5071C	MY46110673	14-Jan-21 (CTTL, No.J21X00232)	Jan-22

	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: September 21, 2021

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



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Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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