

# DC Voltage Measurement

A/D - Converter Resc	lution nominal			
High Range:	1LSB =	6.1µV .	full range =	-100+300 mV
Low Range:	1LSB =	61nV .	full range =	-1+3mV
DASY measurement	parameters: Aut	to Zero Time: 3	3 sec: Measuring	time: 3 sec

<b>Calibration Factors</b>	x	Y	Z
High Range	403.865 ± 0.02% (k=2)	403.595 ± 0.02% (k=2)	403.805 ± 0.02% (k=2)
Low Range	3.95898 ± 1.50% (k=2)	3.98939 ± 1.50% (k=2)	3.96763 ± 1.50% (k=2)

# **Connector Angle**

Connector Angle to be used in DASY system	61.0°±1°
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# Appendix (Additional assessments outside the scope of SCS0108)

# 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	200037.59	1.98	0.00
Channel X + Input	20007.61	1.34	0.01
Channel X - Input	-20004.09	1.79	-0.01
Channel Y + Input	200037.45	1.53	0.00
Channel Y + Input	20002.68	-3.42	-0.02
Channel Y - Input	-20007.17	-1.14	0.01
Channel Z + Input	200037.73	2.17	0.00
Channel Z + Input	20005.72	-0.34	-0.00
Channel Z - Input	-20006.63	-0.49	0.00
Channel Z - Input	-20006.63	-0.49	0.00

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2001.36	-0,15	-0,01
Channel X + Input	201.70	0.16	0.08
Channel X - Input	-198.10	0.49	-0.24
Channel Y + Input	2001.44	0.07	0.00
Channel Y + Input	201.07	+0.21	-0.11
Channel Y - Input	-199.66	-0.98	0.50
Channel Z + Input	2001.52	0.21	0.01
Channel Z + Input	200.81	-0.41	-0,20
Channel Z - Input	-199.00	-0.15	0.07

2. Common mode sensitivity DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-3.95	-5.31
	- 200	5.96	4,97
Channel Y	200	-16.18	-16.25
	- 200	14,41	14.34
Channel Z	200	3.01	2.86
	- 200	-3,93	-4.13

## 3. Channel separation

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200		-0.68	-2.76
Channel Y	200	5.43	-	-0.31
Channel Z	200	10.73	3.29	1

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## 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	16059	17078
Channel Y	15965	16219
Channel Z	15888	13556

# 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	1.40	0.30	2.25	0.35
Channel Y	-0.62	-1.30	0.47	0.33
Channel Z	-0,18	-0.90	0.60	0.31

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

# 7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

## 8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)		Alarm Level (VDC)	
Supply (+ Vcc)	+7.9			
Supply (- Vcc)	-7.6			

# 9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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# **ANNEX H: Probe Calibration Certificate**

Add: No.52 HuaYuanBe	i Road, Haidian Di	strict, Beijin	g. 100191, China	CALIBRATION CNAS L0570
E-mail: ettl@chinattl.com	m http://ww	w.caiet.ac.en	Section 2	1400 (M. 1998) P
Client SA	ICT		Certificate No:	Z22-60124
CALIBRATION	CERTIFIC	CATE		
Object	EX	(3DV4 - S	N : 7621	
Calibration Procedure(s)	ere.	744 004	00	
	Ca	alibration F	-uz Procedures for Dosimetric E-field Probes	
Calibration date:	Ma	ay 06, 202	2	
This selfbastice Octifies			1991 1	
This calibration Certifica	ate documents	the trace	ability to national standards, which real	ize the physical units of
measurements(SI). The	measurements	and the u	incertainties with confidence probability a	re given on the following
pages and are part of the	e certificate.			
All calibrations have be	een conducted	t in the d	closed laboratory facility: environment	temperature(22±3)℃ and
humidity<70%.				
Calibration Equipment us	sed (M&TE crit	ical for cal	libration)	
Calibration Equipment us Primary Standards	sed (M&TE crit ID #	ical for cal	libration) Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
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Certificate No: Z22-60124

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AICT



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#### Glossary:

TSL NORMx,y,z ConvF DCP CF A,B,C,D Polarization Φ Polarization θ

tissue simulating liquid sensitivity in free space sensitivity in TSL / NORMx,y,z diode compression point crest factor (1/duty\_cycle) of the RF signal modulation dependent linearization parameters Φ rotation around probe axis 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<sup>2</sup> -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).

Certificate No:Z22-60124

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN:7621

# **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm(µV/(V/m) <sup>2</sup> ) <sup>A</sup>	0.71	0.71	0.56	±10.0%
DCP(mV) <sup>B</sup>	111.7	111.8	115.7	

# Modulation Calibration Parameters

UID	Communication System Name		A dB	B dBõV	C	D dB	VR mV	Unc <sup>E</sup> ( <i>k</i> =2)
0	CW	X	0.0	0.0	1.0	0.00	210.8	±3.5%
		Y	0.0	0.0	1.0		218.6	
		Z	0.0	0.0	1.0		190.8	

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

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 4).

 <sup>B</sup> Numerical linearization parameter: uncertainty not required.
 <sup>E</sup> 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:7621

#### Relative Conductivity Depth<sup>G</sup> Unct. f [MHz]<sup>C</sup> ConvF X ConvF Y ConvF Z Alpha<sup>G</sup> Permittivity F (S/m) F (mm) (k=2) 750 41.9 0.89 11.12 11.12 11.12 0.18 1.14 ±12.1% 900 41.5 0.97 10.68 10.68 10.68 0.14 1.14 ±12.1% 1450 40.5 1.20 9.65 9.65 9.65 0.21 0.91 ±12.1% 1750 40.1 1.37 9.22 9.22 9.22 0.31 0.90 ±12.1% 1900 40.0 1.40 8.90 8.90 8.90 0.35 0.84 ±12.1% 2100 39.8 1.49 8.95 8.95 8.95 0.23 1.13 $\pm 12.1\%$ 2300 39.5 1.67 8.60 8.60 8.60 0.44 0.78 $\pm 12.1\%$ 2450 39.2 1.80 8.17 8.17 0.49 8.17 0.78 $\pm 12.1\%$ 2600 39.0 1.96 7.93 0.51 7.93 7.93 0.75 $\pm 12.1\%$ 3300 38.2 2.71 7.74 7.74 7.74 0.45 0.92 $\pm 13.3\%$ 3500 37.9 2.91 7.56 7.56 7.56 0.44 1.00 +13.3% 3700 37.7 3.12 7.18 0.38 7.18 7.18 1.05 $\pm 13.3\%$ 3900 37.5 3.32 7.26 0.35 7 26 7 26 1.35 +13.3% 4100 37.2 3.53 0.25 7.21 7.21 7.21 1.30 $\pm 13.3\%$ 4400 36.9 3.84 7.01 7.01 7.01 0.25 1.55 $\pm 13.3\%$ 4600 36 7 4.04 6.90 6.90 6.90 0.30 1.72 ±13.3% 4800 36.4 4 25 6.79 6.79 6.79 0.30 1.85 ±13.3% 4950 36.3 4.40 6.44 6.44 6.44 0.30 1.80 $\pm 13.3\%$ 5250 35.9 4.71 5 98 5 98 5.98 0.35 1.63 $\pm 13.3\%$ 5600 35.5 5.07 5.47 5.47 5.47 0.40 1.55 ±13.3% 5750 35.4 5.22 5.40 5.40 5.40 0.40 1.55 ±13.3%

# Calibration Parameter Determined in Head Tissue Simulating Media

<sup>c</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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



Uncertainty of Frequency Response of E-field: ±7.4% (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:7621

### **Other Probe Parameters** Sensor Arrangement Triangular Connector Angle (°) 95.4 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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# ANNEX I: Dipole Calibration Certificate

# 750MHz Dipole

Add: No.52 Hua YuanBei Ro	start disconcerner accession of		
Tel: +86-10-62304633-2117	http://www.enie	ALC: COS	
Client SAIC	T	Certificate No: Z2	2-60333
CALIBRATION CE	ERTIFICAT	E	1.5
Object	D750V	3 - SN: 1163	
Calibration Procedure(s)		000.04	
	Calibra	-003-01 tion Procedures for dipole validation kits	
Calibration data:		22 2022	
Janutanun uate.	August	22, 2022	
measurements (SI). The me bages and are part of the ce	asurements and ertificate.	the uncertainties with confidence probability	are given on the following
measurements (SI). The me pages and are part of the ce All calibrations have been humidity<70%. Calibration Equipment used	easurements and ertificate. conducted in t (M&TE critical fo	the uncertainties with confidence probability he closed laboratory facility: environment or calibration)	are given on the following temperature (22±3)°C and
measurements (SI). The me bages and are part of the ce All calibrations have been humidity<70%. Calibration Equipment used	conducted in t (M&TE critical fo	the uncertainties with confidence probability he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.)	are given on the followin temperature (22±3)°C an Scheduled Calibration
neasurements (SI). The me bages and are part of the ce ful calibrations have been humidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2	Conducted in t (M&TE critical for ID # 106277	the uncertainties with confidence probability he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326)	are given on the followin temperature (22±3)°C an Scheduled Calibration Sep-22
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# Glossary:

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) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

c) 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	750 MHz ±1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	42.0	0.90 mho/m
Measured Head TSL parameters	(22.0 ±0.2) °C	41.3 ±6 %	0.90 mho/m ±6 %
Head TSL temperature change during test	<1.0 °C		(s <del>quer</del>

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.48 W/kg ± 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.62 W/kg ±18.7 % (k=2)

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

#### Antenna Parameters with Head TSL

50.0Ω- 4.06jΩ	
- 27.8dB	
	50.0Ω- 4.06jΩ - 27.8dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	0.941 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

Manufactured by	SPEAG	









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# DASY5 Validation Report for Head TSL

Date: 2022-08-22

Test Laboratory: CTTL, Beijing, China **DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1163** Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 750 MHz;  $\sigma = 0.902$  S/m;  $\varepsilon_r = 41.26$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Right Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration:

- Probe: EX3DV4 SN7464; ConvF(10.26, 10.26, 10.26) @ 750 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

```
Reference Value = 55.49 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.17 W/kg
SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.42 W/kg
Smallest distance from peaks to all points 3 dB below = 21.2 mm
Ratio of SAR at M2 to SAR at M1 = 67.5%
Maximum value of SAR (measured) = 2.84 W/kg
```



0 dB = 2.84 W/kg = 4.53 dBW/kg

Certificate No: Z22-60333

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# 835MHz Dipole

Client SAICT CALIBRATION CE Object Calibration Procedure(s) Calibration date: This calibration Certificate do measurements (SI). The measurements	RTIFICAT D835V/ FF-Z11 Calibra Octobe	Certificate No: Z2 E 2 - SN: 4d057 -003-01 tion Procedures for dipole validation kits	1-60355
CALIBRATION CE Object Calibration Procedure(s) Calibration date: This calibration Certificate do measurements (SI). The mea	RTIFICAT D836V2 FF-Z11 Calibra Octobe	E 2 - SN: 4d057 -003-01 tion Procedures for dipole validation kits	
Object Calibration Procedure(s) Calibration date: This calibration Certificate do measurements (SI). The mea	D835V/ FF-Z11 Calibra Octobe	2 - SN: 4d057 -003-01 tion Procedures for dipole validation kits	
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Calibration date: This calibration Certificate do measurements (SI). The mea:	Calibra	tion Procedures for dipole validation kits	
Calibration date: This calibration Certificate do neasurements (SI). The mea:	Octobe		
This calibration Certificate do neasurements (SI). The mea		r 18, 2021	
uumidity<70%. Calibration Equipment used (I Primary Standards	M&TE critical fo ID # 106277	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326)	Scheduled Calibration Sep-22
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	104291 SN 7517	24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG, No.Z21-60001)	Sep-22 Feb-22
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4	104291 SN 7517 SN 1556	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Sep-22 Feb-22 Jan-22
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards	104291 SN 7517 SN 1556 ID #	03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.)	Sep-22 Feb-22 Jan-22 Scheduled Calibration
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	104291 SN 7517 SN 1556 ID# MY49071430 MY46110673	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	104291 SN 7517 SN 1556 ID # MY49071430 MY46110673	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	104291 SN 7517 SN 1556 ID# MY49071430 MY46110673 Name	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232) Function	Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22 Signature
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	104291 SN 7517 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232) Function SAR Test Engineer	Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22 Signature
Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	104291 SN 7517 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing Lin Hao	24-Sep-21 (CTTL, No.321X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232) Function SAR Test Engineer SAR Test Engineer	Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22 Signature

Certificate No: Z21-60355 Page 1 of 6







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#### Glossary: TSL

ConvF

N/A

tissue simulating liquid sensitivity in TSL / NORMx,y,z 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	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 ± 1 MHz	

Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	1999	( ) and (

## 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	9.64 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.29 W/kg ± 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	49.8Ω- 4.19jΩ	
Return Loss	- 27.5dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.301 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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Certificate No: Z21-60355

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Date: 10.18.2021

### **DASY5 Validation Report for Head TSL** Test Laboratory: CTTL, Beijing, China DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d057 Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium parameters used: f = 835 MHz; $\sigma = 0.886$ S/m; $\varepsilon_r = 40.9$ ; $\rho = 1000$ kg/m<sup>3</sup> 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 (7501)

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

```
Reference Value - 58.86 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.68 W/kg
SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.56 W/kg
Smallest distance from peaks to all points 3 dB below = 18 mm
Ratio of SAR at M2 to SAR at M1 = 64.9%
Maximum value of SAR (measured) = 3.23 W/kg
```



0 dB = 3.23 W/kg = 5.09 dBW/kg

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Impedance Measurement Plot for Head TSL



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# 1750MHz Dipole

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CALIBRATION CI	ERTIFICAT	E	
Object	D1750	V2 - SN: 1152	
Calibration Procedure(s)	EE 744	002.04	
	Calibra	-003-01 tion Procedures for dinole validation kits	
Collibration date:			
campration date:	August	22, 2022	
All calibrations have been humidity<70%. Calibration Equipment used	conducted in t	he closed laboratory facility: environment or calibration)	temperature (22±3)°C and
All calibrations have been humidity<70%. Calibration Equipment used Primary Standards	Conducted in t (M&TE critical for ID #	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.)	temperature (22±3)°C and
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2	Conducted in t (M&TE critical for ID # 106277	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326)	temperature (22±3)°C an Scheduled Calibration Sep-22
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S	conducted in t (M&TE critical for ID # 106277 104291	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326)	temperature (22±3)°C an Scheduled Calibration Sep-22 Sep-22
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	conducted in t (M&TE critical for ID # 106277 104291 SN 7464 SN 7464	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22)	temperature (22±3)°C an Scheduled Calibration Sep-22 Sep-22 Jan-23
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4	Conducted in t (M&TE critical for ID # 106277 104291 SN 7464 SN 1556	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007)	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards	conducted in t (M&TE critical for 106277 104291 SN 7464 SN 1556 ID #	he closed laboratory facility: environment or calibration) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.)	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration
All calibrations have been humidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	conducted in t (M&TE critical for 106277 104291 SN 7464 SN 1556 ID # MY49071430	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409)	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	conducted in t (M&TE critical for 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406)	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
All calibrations have been humidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	conducted in t (M&TE critical for 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22 (SPEAG,No.EX3-7464_Jan22) 12-Jan-22 (CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	conducted in t (M&TE critical fo ID # 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
All calibrations have been numidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	conducted in t (M&TE critical fo 1D # 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
All calibrations have been humidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C Calibrated by: Reviewed by:	conducted in t (M&TE critical for 1D # 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing Lin Hao	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer SAR Test Engineer	Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
All calibrations have been humidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C Calibrated by: Reviewed by: Approved by:	conducted in t (M&TE critical for 10 # 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing Lin Hao Qi Dianyuan	he closed laboratory facility: environment or calibration) Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer SAR Test Engineer SAR Project Leader	temperature (22±3)°C and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23

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### Glossary:

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) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

c) 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	52.10.4
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	1750 MHz ±1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.3 ±6 %	1.41 mho/m ±6 %
Head TSL temperature change during test	<1.0 °C		

## SAR result with Head TSL

Condition	
250 mW input power	9.18 W/kg
normalized to 1W	36.3 W/kg ±18.8 % (k=2)
Condition	
250 mW input power	4.94 W/kg
normalized to 1W	19.6 W/kg ± 18.7 % (k=2)
	Condition 250 mW Input power normalized to 1W Condition 250 mW input power normalized to 1W

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.9Ω- 0.71jΩ	
Retum Loss	- 32.8dB	

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.120 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

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Manufactured by		SPEAG	
ficate No: Z22-60335	Page 4 of 6		









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# DASY5 Validation Report for Head TSL

Date: 2022-08-22

Test Laboratory: CTTL, Beijing, China **DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1152** Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1750 MHz;  $\sigma = 1.408$  S/m;  $\varepsilon_r = 41.28$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Right Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration:

- Probe: EX3DV4 SN7464; ConvF(8.52, 8.52, 8.52) @ 1750 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

```
Reference Value = 91.44 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 16.5 W/kg
SAR(1 g) = 9.18 W/kg; SAR(10 g) = 4.94 W/kg
Smallest distance from peaks to all points 3 dB below = 10 mm
Ratio of SAR at M2 to SAR at M1 = 56.3%
Maximum value of SAR (measured) = 14.0 W/kg
```



0 dB = 14.0 W/kg = 11.46 dBW/kg

Certificate No: Z22-60335

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Impedance Measurement Plot for Head TSL







# 1900MHz Dipole

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CALIBRATION C	ERTIFICAT	ſE	
Object	D1900	V2 - SN: 5d088	Grand Land
Calibration Procedure(s)	FE-711	-003-01	
	Calibra	tion Procedures for dipole validation kits	
Calibration date:	Octobe	er 18, 2021	
measurements (SI). The me bages and are part of the ce	easurements and ertificate.	I the uncertainties with confidence probability	are given on the following
measurements (SI). The me bages and are part of the ce All calibrations have been numidity<70%. Calibration Equipment used	easurements and ertificate. conducted in t (M&TE critical fo	I the uncertainties with confidence probability in the closed laboratory facility: environment to or calibration)	are given on the following emperature (22±3)°C and
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#### lossary:

TSL tissue ConvF sensi N/A not ap

tissue simulating liquid sensitivity in TSL / NORMx,y,z 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	V52.10.4
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

	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	39.9±6%	1.39 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	atoma (	

#### SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.5 W/kg ± 18.7 % (k=2)

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

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.7Ω+ 6.80jΩ	
Return Loss	- 22.6dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.110 ns
----------------------------------	----------

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

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

#### Additional EUT Data

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Manufactured by	SPEAG

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# DASY5 Validation Report for Head TSL

Test Laboratory: CTTL, Beijing, China

Date: 10.18.2021

# **DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN; 5d088** Communication System: UID 0, CW; Frequency: 1900 MHz: Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz; $\sigma = 1.387$ S/m; $\varepsilon_r = 39.88$ ; $\rho = 1000$ kg/m<sup>3</sup> Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 SN7517: ConvF(7.81, 7.81, 7.81) (a) 1900 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 (7501)

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

Reference Value = 103.6 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 19.2 W/kg SAR(1 g) = 10 W/kg; SAR(10 g) = 5.1 W/kg Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 52.1% Maximum value of SAR (measured) = 15.8 W/kg



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

Certificate No: Z21-60357

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# Impedance Measurement Plot for Head TSL



Certificate No: Z21-60357

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# 2450MHz Dipole

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CALIBRATION CI	ERTIFICAT	Έ	and the second second
Object	D2450	√2 - SN: 873	
Calibration Procedure(s)	FE-711	-003-01	
	Calibra	tion Procedures for dipole validation kits	
Calibration date:	Octobe	r 21, 2021	
This calibration Certificate	documents the	traceability to national standards, which rea	alize the physical units (
measurements (SI). The me	asurements and	the uncertainties with confidence probability	are given on the followin
pages and are part of the ce	ertificate.		
All calibrations have been	conducted in t	he closed laboratory facility: environment	temperature (22±3)°C an
humidity<70%			
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Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S	(M&TE critical fo ID # 106277 104291	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326)	Scheduled Calibration Sep-22 Sep-22
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Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	(M&TE critical fr ID # 106277 104291 SN 7517 SN 1556 ID # MY49071430 MY46110673	Cal Date (Calibrated by. Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by. Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Scheduled Calibration Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
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#### Glossary:

TSL

N/A

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- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

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- 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%.

Certificate No: Z21-60358

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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504 E-mail: cttl@chinattl.com http://www.chinattl.cn

# **Measurement Conditions**

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

DASY52	V52.10.4
Advanced Extrapolation	
Triple Flat Phantom 5.1C	
10 mm	with Spacer
dx, dy, dz = 5 mm	
2450 MHz ± 1 MHz	
	DASY52 Advanced Extrapolation Triple Flat Phantom 5.1C 10 mm dx, dy, dz = 5 mm 2450 MHz ± 1 MHz

# Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.5±6%	1.81 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.2 W/kg ± 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 W/kg ± 18.7 % (k=2)

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6Ω+ 1.26jΩ
Return Loss	- 28.8dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.066 ns	1000
		and the second

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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Certificate No: Z21-60358

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E-mail: ettl a chinattl.com

**DASY5 Validation Report for Head TSL** 

Date: 10.21.2021

Test Laboratory: CTTL, Beijing, China DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 873 Communication System; UID 0, CW: Frequency: 2450 MHz: Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz;  $\sigma = 1.809 \text{ S/m}$ ;  $\epsilon_r = 39.51$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Right Section DASY5 Configuration:

http://www.chinattl.en

- Probe: EX3DV4 SN7517; ConvF(7.34, 7.34, 7.34) @ 2450 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 (7501)

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

```
Reference Value = 108.0 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 28.0 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.05 W/kg
Smallest distance from peaks to all points 3 dB below = 9.2 mm
Ratio of SAR at M2 to SAR at M1 = 46.9%
Maximum value of SAR (measured) = 22.6 W/kg
```



0 dB = 22.6 W/kg = 13.54 dBW/kg

Certificate No: Z21-60358

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Impedance Measurement Plot for Head TSL



Certificate No: Z21-60358

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# 2550MHz Dipole

alibration Laboratory o chmid & Partner Engineering AG ughausstrasse 43, 8004 Zurich, S	of iwitzerland	Nac MRA O s	Schweizerischer Kalibrierdienst Service sulsse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
credited by the Swiss Accreditation s Swiss Accreditation Service is Itiliateral Agreement for the reco	Service (SAS) one of the signatories gnition of calibration of	to the EA pertificates	coreditation No.: SCS 0108
ent TMC-SZ (Auden)		Certificate N	o: D2550V2-1010_May21
ALIBRATION CE	RTIFICATE		
bject	D2550V2 - SN:10	10	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Source	s between 0.7-3 GHz
Calibration date:	May 21, 2021		
Calibration Equipment used (M&TE	critical for calibration)	Par Plate (Partilization No.)	Behadulari Colibertion
Primary Standards	10 #	Cal Date (Certificate No.)	Ann.32
'ower meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Anr. 90
Power sensor NRP-291	SN: 103244	09-Apr-21 (No. 217-05291) 09-Apr-21 (No. 217-05291)	Apr-22
Ner sepen nine-cen	SN- RH0394 (20k)	09-Apr-21 (No. 217-033-63)	Apr-22
SuperMinimitation	SN-310982 / 06327	09-Apr-21 (No. 217-03544)	Apr-22
Beterence Probe EX30V4	SN: 7349	28-Dec-20 (No. EX3-7349 Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601 Nov20)	Nov-21
Secondary Standards	10 #	Check Date (in house)	Scheduled Check
Power meter E44198	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RE cenerator B&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Bernard and a second second second	C211 110 4 10 0 0 477	31-Mar-14 (in house check Oct-20)	In These serves in The standard of the standard standar
Network Analyzar Agilant E8358A	134.0847080477		ITT HOLENE CRECK, CARACT
Network Analyzar Agilant E8358A	Name	Function	Signature
Network Analyzar Agilent E8358A Celibrated by:	Name Jeffrey Katzman	Function Laboratory Technician	Signature
Network Analyzar Agilant E8358A Calibrated by: Approved by:	Name Jeffrey Katzman Katja Pokovic	Function Laboratory Technician Technical Manager	Signature J. H.J.
Network Analyzar Agilant E8358A Calibrated by: Approved by:	Name Jeffrey Katzman Katja Pokovic	Function Laboratory Technician Technical Manager	Signature

Certificate No: D2550V2-1010\_May21

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



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

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Accreditation No.: SCS 0108

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

#### Glossary:

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

# Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D2550V2-1010\_May21

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# Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2550 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.1	1.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	$37.4\pm6~\%$	1.99 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	74420	19222

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.9 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.42 W/kg

Body TSL parameters The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.6	2.09 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) "C	50.8 ± 6 %	2.16 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		1.000

# SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	52.4 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	6.04 W/kg

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# Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.8 Ω - 3.8 jΩ	
Return Loss	- 26,8 dB	

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	49,3 Ω - 1,8 jΩ	
Return Loss	- 34,3 dB	

# General Antenna Parameters and Design

	1 150 m	
Electrical Delay (one direction)	1,153 hs	

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

Gertificate No: D2550V2-1010\_May21

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## DASY5 Validation Report for Head TSL

Date: 21.05.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2550 MHz; Type: D2550V2; Serial: D2550V2 - SN:1010

Communication System: UID 0 - CW: Frequency: 2550 MHz Medium parameters used: f = 2550 MHz;  $\sigma$  = 1.99 S/m;  $\varepsilon_r$  = 37.4;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.85, 7.85, 7.85) @ 2550 MHz; Calibrated: 28.12.2020
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 119.0 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 29.6 W/kg SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.42 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 48,2% Maximum value of SAR (measured) = 24.3 W/kg



0 dB = 24.3 W/kg = 13.86 dBW/kg

Certificate No: D2550V2-1010\_May21

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# Impedance Measurement Plot for Head TSL



Certificate No: D2550V2-1010\_May21

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# DASY5 Validation Report for Body TSL

Date: 21.05.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2550 MHz; Type: D2550V2; Serial: D2550V2 - SN:1010

Communication System: UID 0 - CW; Frequency: 2550 MHz Medium parameters used: f = 2550 MHz;  $\sigma$  = 2.16 S/m;  $\epsilon_r$  = 50.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.98, 7.98, 7.98) @ 2550 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 110.2 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 26.1 W/kg SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.04 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 51.9% Maximum value of SAR (measured) = 22.1 W/kg



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# Impedance Measurement Plot for Body TSL



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# **5GHz Dipole**

E-mail: emf@caict.ac.on Client SAI	http://www.caid	.ac.cn Certificate No: Z2	22-60336
Client SAI	СТ	Certificate No: Z2	2-60336
CALIBRATION C			
	ERTIFICAT	E	
Object	D5GH2	V2 - SN: 1238	
Calibration Procedure(s)	CE 744	-000.04	
12-51	FF-Z11 Calibra	-003-01 tion Procedures for dipole validation kits	
Colibration data:	ar ann an 1947 a	and the second s	
-allbration date:	August	17, 2022	
	N 10470 A 10470	ne closed laboratory lacility. environment	temperature (22±3)°C and
numidity<70%. Calibration Equipment used	d (M&TE critical fr	pr calibration)	temperature (22±3)℃ and
uumidity<70%. Calibration Equipment used Primary Standards	d (M&TE critical f	or calibration) Cal Date (Calibrated by, Certificate No.)	temperature (22±3)℃ and Scheduled Calibration
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2	d (M&TE critical fr ID # 106277	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326)	temperature (22±3)℃ and Scheduled Calibration Sep-22
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S	d (M&TE critical fr ID # 106277 104291	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22
Calibration Equipment user Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	d (M&TE critical fr ID # 106277 104291 4 SN 7464 SN 1555	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4	d (M&TE critical fr ID # 106277 104291 \$ SN 7464 SN 1556	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards	d (M&TE critical fe ID # 106277 104291 4 SN 7464 SN 1556 ID #	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	d (M&TE critical fr ID # 106277 104291 4 SN 7464 SN 1556 ID # MY49071430	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No. J22X00409)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	d (M&TE critical fe ID # 106277 104291 4 SN 7464 SN 1556 ID # MY49071430 2 MY46110673	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No. J22X00409) 14-Jan-22 (CTTL, No.J22X00406)	temperature (22±3)℃ and Scheduled Calibration Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C	d (M&TE critical fr ID # 106277 104291 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23 Jan-23
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E50710	d (M&TE critical fe ID # 106277 104291 4 SN 7464 SN 1556 ID # MY49071430 5 MY46110673 Name Zhao Jing	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23 Signature
aumidity<70%. Calibration Equipment used Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C Network Analyzer E5071C Calibrated by: Reviewed by:	d (M&TE critical fe ID # 106277 104291 4 SN 7464 SN 1556 ID # MY49071430 MY46110673 Name Zhao Jing Lin Hao	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 26-Jan-22(SPEAG,No.EX3-7464_Jan22) 12-Jan-22(CTTL-SPEAG,No.Z22-60007) Cal Date (Calibrated by, Certificate No.) 13-Jan-22 (CTTL, No.J22X00409) 14-Jan-22 (CTTL, No.J22X00406) Function SAR Test Engineer SAR Test Engineer	temperature (22±3)℃ and Scheduled Calibration Sep-22 Sep-22 Jan-23 Jan-23 Scheduled Calibration Jan-23 Jan-23 Signature

Certificate No: Z22-60336

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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2117 E-mail: emt@caict.ac.en http://www.caic.ac.en

# Glossary:

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) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

c) 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%.

Certificate No: Z22-60336

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## **Measurement Conditions**

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

DASY Version	DASY52	52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ±1 MHz 5600 MHz ±1 MHz 5750 MHz ±1 MHz	

Head TSL parameters at 5250MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ±0.2) °C	36.3 ±6 %	4.64 mho/m ±6 %
Head TSL temperature change during test	<1.0 °C		9 <u>1112</u>

# SAR result with Head TSL at 5250MHz

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.7 W/kg ±24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 W/kg ±24.2 % (k=2)

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## Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ±0.2) °C	35.2 ±6 %	5.01 mho/m ±6 %
Head TSL temperature change during test	<1.0 °C		

# SAR result with Head TSL at 5600MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.6 W/kg ±24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg ±24.2 % (k=2)

# Head TSL parameters at 5750MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5,22 mho/m
Measured Head TSL parameters	(22.0 ±0.2) 'C	35.0 ±6 %	5.18 mho/m ±6 %
Head TSL temperature change during test	<1.0 °C	-	

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

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.5 W/kg ±24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg ±24.2 % (k=2)

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

#### Antenna Parameters with Head TSL at 5250MHz

Impedance, transformed to feed point	48.4Ω- 3.36jΩ
Return Loss	- 28.5dB

# Antenna Parameters with Head TSL at 5600MHz

Impedance, transformed to feed point	50.8Ω+ 2.69jΩ	
Return Loss	- 31.1dB	

# Antenna Parameters with Head TSL at 5750MHz

Impedance, transformed to feed point	53.5Ω+ 2.34jΩ		
Return Loss	- 27.9dB		

## General Antenna Parameters and Design

cleaning four anotably	1.098 ns	
------------------------	----------	--

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

# Additional EUT Data

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## DASY5 Validation Report for Head TSL Test Laboratory: CTTL, Beijing, China

Date: 2022-08-17

Test Laboratory: CTTL, Beijing, China **DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1238** Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz Duty Cycle: 1:1 Medium parameters used: f = 5250 MHz;  $\sigma$  = 4.643 S/m;  $\epsilon_r$  = 36.34;  $\rho$  = 1000 kg/m<sup>3</sup> Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.006 S/m;  $\epsilon_r$  = 35.17;  $\rho$  = 1000 kg/m<sup>3</sup> Medium parameters used: f = 5750 MHz;  $\sigma$  = 5.18 S/m;  $\epsilon_r$  = 34.96;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Right Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration: Probe: EX3DV4 - SN7464; ConvF(5.43, 5.43, 5.43) @ 5250 MHz; ConvF(4.91, 4.91, 4.91) @ 5600 MHz; ConvF(4.85, 4.85, 4.85) @ 5750 MHz; Calibrated: 2022-01-26 Sensor-Surface: 1.4mm (Mechanical Surface Detection) Electronics: DAE4 Sn1556; Calibrated: 2022-01-12 Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial:

- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Ser 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 67.66 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 31.9 W/kg SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.1% Maximum value of SAR (measured) = 18.8 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 68.44 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 35.2 W/kg SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.37 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 63.5% Maximum value of SAR (measured) = 20.1 W/kg

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Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.17 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 35.8 W/kg SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.22 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 61.3% Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.88 dBW/kg

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# ANNEX J: Extended Calibration SAR Dipole

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dBm, 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.

# Justification of Extended Calibration SAR Dipole D835V2 - serial no. 4d057

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2021-10-18	-27.5	/	49.8	/	-4.19	/
2022-10-18	-26.8	2.5	51.4	1.6	-3.97	0.22

Justification of Extended Calibration SAR Dipole D1900V2 - serial no. 5d088

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2021-10-18	-22.6	1	53.7	/	6.80	/
2022-10-18	-22.2	1.8	54.6	0.9	6.93	0.13

Justification of Extended Calibration SAR Dipole D2450V2 - serial no. 873

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2021-10-21	-28.8	/	53.6	/	1.26	/
2022-10-20	-28.1	2.4	54.9	1.3	1.43	0.17

Justification of Extended Calibration SAR Dipole D2550V2– serial no.1010

Head							
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)	
2021-05-21	-26.8	/	52.8	/	-3.80	/	
2022-05-20	-26.3	1.9	53.6	0.8	-3.64	0.16	

The Return-Loss is <-20dB, and within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the value result should support extended cabration.





# ANNEX K: UL duty cycle detection mechanism specification

# K.1. General Description of UL duty cycle detection mechanism

We have a mobile phone device supporting the UL duty cycle detection mechanism for LTE TDD & NR5G (including FR1 SA and FR1 ENDC), the rest RAT will not apply. The main purpose is to distinguish duty cycle of UL symbol and apply the relevant power levels accordingly. The main purpose is to provide enhanced user experience while meeting the SAR compliance for transmission scheduling.

UL duty cycle	P <sub>cmax</sub>
k1%	P <sub>max</sub> – Max(P <sub>SAR</sub> - P <sub>offset</sub> @k1, 0)
k2%	P <sub>max</sub> – Max(P <sub>SAR</sub> - P <sub>offset</sub> @k2, 0)
kn% (max UL duty cycle)	P <sub>max</sub> – Max(P <sub>SAR</sub> - P <sub>offset</sub> @kn, 0)

# Table K.1: Summary of UL duty cycle detection mechanism (Note 1)

Note 1 (See note 4 for more information):

UL duty cycle: Uplink duty cycle.

 $\mathsf{P}_{\mathsf{cmax}}\!:$  Power level for each UL duty cycle.

P<sub>max</sub>: Max power level.

P<sub>SAR</sub>: A pre-defined value which is used to derive the P<sub>cmax</sub> to ensure time-average power level to associates with SAR compliance

P<sub>offset</sub>: The theoretical value of power offset calculated according to the duty cycle K parameter, equals to -[10\*log(TX duty cycle)]

The Radio Communication Tester measures peak and average output power for active the symbols. For SAR the timebased average power(Pcmax frame-average) is relevant. The difference in between depends on the duty cycle of the symbols.





# K.2. UL duty cycle detection mechanism clarifications

UL duty cycle detection mechanism, based on MTK platform. There is sliding windows moving by one slot and real-time caculate the percentage of the symbols with transmit, then apply the relevant power levels accordingly.



The software of the device has standalone module (Note 2) to monitor the UL scheduling with sliding windows and caculate the current transmission percentage k, and apply the relevant power levels accordingly on next UL slot.

Note 2: This standalone module only monitor LTE TDD & NR5G (including FR1 SA and FR1 ENDC), the rest RAT will not apply.

The device offers max to 9 sets power offset NVs for each NR5G band, and 6 sets power offset NVs for each LTE TDD band. These NVs offer addition power offset for all LTE TDD/NR bands. When certain set NVs works,  $P_{cmax}$  will caculate with below function:

# P<sub>cmax</sub> = P<sub>max</sub> - Max(P<sub>SAR</sub> - P<sub>offset</sub>@kn, 0) (Note 3)

Note 3 (See note 4 for more information):

P<sub>cmax</sub>: Power level for each UL duty cycle.

P<sub>max</sub>: Max power level.

 $P_{SAR}$ : A pre-defined value which is used to derive the  $P_{cmax}$  to ensure time-average power level to

associates with SAR compliance

Poffset: The theoretical value of power offset calculated according to the duty cycle K parameter, equals to -[10\*log(TX duty cycle)]





Table K.2: NR 5G bands (Note 4)									
(1#) UL duty cycle	(2#) Max UL duty cycle	(3#) Max UL duty cycle factor	(4#) P <sub>offset</sub>	(7#) P <sub>cmax</sub> (dBm)	(8#) P <sub>cmax</sub> frame-average(dBm)				
0%≤ K1 ≤10%	10%	-10.00	10.00	24.50	14.50				
10%< K2 ≤20%	20%	-6.99	6.50	24.50	17.51				
20%< K3≤ 30%	30%	-5.23	5.00	23.50	18.27				
30%< K4 ≤40%	40%	-3.98	3.50	22.00	18.02				
40%< K5 ≤50%	50%	-3.01	3.00	21.50	18.49				
50%< K6 ≤60%	60%	-2.22	2.00	20.50	18.28				
60%< K7 ≤70%	70%	-1.55	1.50	20.00	18.45				
70%< K8 ≤80%	80%	-0.97	0.50	19.00	18.03				
80% <k9 td="" ≤100%<=""><td>100%</td><td>0.00</td><td>0.00</td><td>18.50</td><td>18.50</td></k9>	100%	0.00	0.00	18.50	18.50				
(5#)P <sub>max</sub> = 24.50 (	$(5\#)P_{max} = 24.50 \text{ (dBm)}, (6\#)P_{SAB} = 6.00 \text{ (dB)}$								

More details information followings:

#### Note 4:

(1#)UL duty cycle: The device offers 9 sets UL duty cycle for each NR5G band. determined by UL symbol numbers percentage during dedicated period, 5G NR UL duty cycle range from 0% to 100%, is an invariant parameter.

(2#)Max UL duty cycle: Maximum duty cycle for each UL duty cycle interval sets, is an invariant parameter. This is a conservative approach

(3#)Max UL duty cycle factor= 10\*log(Max UL duty cycle).

(4#)P<sub>offset</sub> = The theoretical value of power offset calculated according to the maximum duty cycle K parameter, is an invariant parameter. The 5G NR values are shown in Table G.2, and the 4G LTE TDD values are shown in Table G.3.

(5#)P<sub>max</sub> : Max power level, the maximum power value of each band is different, defined by factory. (6#)P<sub>SAR</sub>: Actual max power offset, the max power offset of each band is different, defined by factory. The value of P<sub>SAR</sub> is affected by the SAR value of the maximum UL duty cycle configuration(5G NR is 100%, LTE TDD is 63.3%). For example, the SAR of the UE meets the standard requirements under the maximum UL duty cycle and the highest power (P<sub>max</sub>- 0) configuration, and P<sub>SAR</sub> = 0dB; the SAR of the UE meets the standard requirements under the maximum UL duty cycle and the highest power (P<sub>max</sub>- 4) configuration, and P<sub>SAR</sub> = 4dB.

 $(7\#)P_{cmax}$ : Power level for each UL duty cycle, the power level of each band is different,  $P_{cmax} = P_{max} - Max(P_{SAR} - P_{offset}@kn, 0)$ , the larger UL duty cycle, the lower power level; the smaller UL duty cycle, the higher power level, but will not greater than the full power of UE.

(8#)  $P_{cmax}$  frame-average:  $P_{cmax}$  frame-average = (7#) $P_{cmax}$  + (3#)Max UL duty cycle factor, SAR test reduction for 9 sets (1#)UL duty cycle is determined by the source-based time-averaged output power





specified for production units, including tune-up tolerance. The highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions.

For 5G NR test, using factory test mode to perform SAR with the highest Pcmax frame-average configuration, and UL duty cycle =100%.

UL duty cycle	Max UL duty cycle	Max UL duty cycle factor	Poffset	Pcmax (dBm)	P <sub>cmax</sub> frame-average (dBm)		
0%< K1 ≤20%	11.7%	-9.32	5.00	23.00	13.68		
20%< K2≤ 30%	23.3%	-6.33	3.50	23.00	16.67		
30%< K3 ≤40%	31.7%	-4.99	2.00	22.50	17.51		
40%< K4 ≤50%	43.3%	-3.64	1.50	22.00	18.36		
50%< K5 ≤60%	53.3%	-2.73	0.50	21.00	18.27		
60%< K6 ≤63.3%	63.3%	-1.99	0.00	20.50	18.51		
P <sub>max</sub> = 23.00 (dBm), P <sub>SAR</sub> = 2.50 (dB)							

Table K.3: LTE TDD bands (Note 5)

Note 5:

UL duty cycle: The maximum uplink duty cycle of LTE TDD is 63.3%.

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

# Figure K.2-1: Frame structure type 2







Created	No	ormal cyclic prefix in	downlink	Exte	ended cyclic prefix ir	n downlink
Special	DwPTS	UpF	PTS	DwPTS	UpF	νTS
subirante		Normal cyclic	Extended cyclic		Normal cyclic	Extended cyclic
configuration		prefix in uplink	prefix in uplink		prefix in uplink	prefix in uplink
0	$6592 \cdot T_{\rm s}$			$7680 \cdot T_{\rm s}$		
1	19760 $\cdot T_{\rm s}$			$20480 \cdot T_{\rm s}$		
2	$21952 \cdot T_{\rm s}$	$(1+X)\cdot 2192\cdot T_{c}$	$(1+X) \cdot 2560 \cdot T_s$	$23040 \cdot T_{\rm s}$	$(1+X)\cdot 2192\cdot T_{s}$	$(1+X)\cdot 2560\cdot T_s$
3	$24144 \cdot T_{\rm s}$			$25600 \cdot T_{\rm s}$		
4	$26336 \cdot T_{\rm s}$			$7680 \cdot T_{\rm s}$		
5	$6592 \cdot T_{\rm s}$			$20480 \cdot T_{\rm s}$	$(2+X)\cdot 2192\cdot T_{s}$	$(2+X)\cdot 2560\cdot T_{s}$
6	$19760 \cdot T_{\rm s}$	$(2 + \mathbf{V}) 2102 T$	$(2 + \mathbf{X})$ 2560 T	$23040 \cdot T_{\rm s}$		
7	$21952 \cdot T_{\rm s}$	$(2+\Lambda)\cdot 2192\cdot I_s$	$(2+\Lambda)\cdot 2300\cdot I_s$	$12800 \cdot T_{\rm s}$		
8	$24144 \cdot T_{\rm s}$			-	-	-
9	$13168 \cdot T_s$			-	-	-
10	$13168 \cdot T_s$	$13152 \cdot T_{\rm s}$	$12800 \cdot T_{\rm s}$	-	-	-

Table K.2-1: Configuration of special subframe (lengths of DwPTS/GP/UpPTS)





Configuration	Doriodicity	Subframe number											
Conliguration	Periodicity	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		

# Table K.2-2: Uplink-downlink configurations

According to Figure G.2-1, one radio frame is configured by 10 subframes, which consist of

Uplink-subframe, Downlink-subframe and Special subframe. For TDD-LTE, the Duty Cycle should be calculated on Uplink-subframes and Special subframes, due to Special subframe containing both Uplink transmissions. So for one radio frame, Duty Cycle can be calculated with formula as below. The count of Uplink subframes are according to Table G.2-2:

Duty cycle = (30720Ts\*Ups+Uplink Component\*Specials)/ (307200Ts)

About the uplink component of Special subframes, we can figure out by Table G.2-1:

Uplink Component=UpPTS

In conclusion, for the TDD LTE Band, Duty Cycle can be calculated with formula as below all these sets are ok when we test, or we can set as below.

Duty cycle = [(30720Ts\*Ups) + UpPTS \*Specials]/ (307200Ts)

						Con	figuration of	special subfr	ame					
Linlink-	S	ubfrar	ne	Nor	mal cyclice p	orefix in dowr	nlink	Extended cyclice prefix in downlink						
Downlink configura tion	r	numbe	ər	Normal cy in u	clice prefix plink	Extende prefix i	d cyclice n uplink	Normal cy in u	clice prefix plink	Extended cyclice prefix in uplink				
	D	s	U	configura tion 0~4	configura tion 5~9	configura tion 0~4	configura tion 5~9	configura tion 0~3	configura tion 4~7	configura tion 0~3	configura tion 4~7			
0	2	2	6	61.43%	62.85%	61.67%	63.33%	61.43%	62.85%	61.67%	63.33%			
1	4	2	4	41.43%	42.85%	41.67%	43.33%	41.43%	42.85%	41.67%	43.33%			
2	6	2	2	21.43%	22.85%	21.67%	23.33%	21.43%	22.85%	21.67%	23.33%			
3	6	1	3	30.71%	31.43%	30.83%	31.67%	30.71%	31.43%	30.83%	31.67%			
4	7	1	2	20.71%	21.43%	20.83%	21.67%	20.71%	21.43%	20.83%	21.67%			
5	8	1	1	10.71%	11.43%	10.83%	11.67%	10.71%	11.43%	10.83%	11.67%			
6	3	2	5	51.43%	52.85%	51.67%	53.33%	51.43%	52.85%	51.67%	53.33%			

# And we can get different Duty cycles under different configurations:

For LTE TDD test, power class using uplink-downlink configuration 0 and special subframe configuration 7 for frome structure type to perform SAR with the highest Pcmax frame-average configuration, and UL duty cycle =63.3%.





# K.3. SAR test Plan

For each band, the SAR evaluation uses the highest P<sub>cmax</sub> frame-average configuration.

(1) For 5G NR test, using factory test mode to perform SAR with the highest  $P_{cmax}$  frame-average configuration, and UL duty cycle =100%.

(2) For LTE TDD test, power class using uplink-downlink configuration 0 and special subframe configuration 7 for frame structure type to perform SAR with the highest  $P_{cmax}$  frame-average configuration, and UL duty cycle =63.3%.

# K.4. SAR Comparative measurements for all configurations

(1) SAR Comparative measurements for 9 sets UL duty cycle configuration of n41:

Test No.	Ant	Band	Test Position	Mode	Bandwidth	scs (KHz)	Channel	RB	offset	UL duty cycle	Duty cycle division factor	P <sub>omax</sub> (Tune- up) (dBm)	P <sub>cmax</sub> (Meas.) (dBm)	P <sub>cmax</sub> frame- average (dBm)	Scaling Factor	SAR 1g (W/kg)	Reported 1g SAR (W/kg)	Drift (dB)	Date
T51	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	10%	-10.00	24.50	24.48	14.50	1.00	0.467	0.469	-0.047	2/15
T52	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	20%	-6.99	24.50	24.49	17.51	1.00	0.522	0.523	0.000	2/15
T53	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	30%	-5.23	23.50	23.10	18.27	1.10	0.553	0.606	0.094	2/15
T54	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	40%	-3.98	22.00	21.70	18.02	1.07	0.586	0.628	-0.069	2/15
T55	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	50%	-3.01	21.50	21.40	18.49	1.02	0.621	0.635	-0.090	2/15
T56	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	60%	-2.22	20.50	20.04	18.28	1.11	0.604	0.671	0.002	2/15
T57	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	70%	-1.55	20.00	19.61	18.45	1.09	0.613	0.671	0.013	2/15
T58	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	80%	-0.97	19.00	18.62	18.03	1.09	0.590	0.644	0.101	2/15
T59	1	n41	Right Cheek	DFT-s-OFDM QPSK	100M	30	518598	135	67	100%	0.00	18.50	17.59	18.50	1.23	0.626	0.772	0.086	2/15

When the UL duty cycle is 10%, 20%, 30%, 40%, 50%, 60%, and 70%, we use the radio communication tester to establish the connection;

When the UL duty cycle is 80% and 100%, we use the factory test mode.

The results show that the highest  $P_{cmax}$  frame-average configuration (UL duty cycle = 100%) has the highest SAR value.

(2) SAR Comparative measurements for 6 sets UL duty cycle configuration of LTE B38:

Test No.	Ant	Band	Test Position	Mode	Bandwidth	Channel	RB	Offset	UL duty cycle	Duty cycle division factor	P <sub>omax</sub> (Tune-up) (dBm)	P <sub>cmax</sub> (Meas.) (dBm)	P <sub>omax</sub> frame- average (dBm)	SAR 1g (W/kg)	Scaling Factor	Reported 1g SAR (W/kg)	Drift (dB)	Date
T41	1	LTE B38	Right Cheek	QPSK	20M	38000	1	0	11.7%	-9.32	23.00	22.70	13.68	0.364	1.07	0.390	0.005	2/15
T42	1	LTE B38	Right Cheek	QPSK	20M	38000	1	0	23.3%	-6.33	23.00	22.60	16.67	0.505	1.10	0.554	-0.007	2/15
T43	1	LTE B38	Right Cheek	QPSK	20M	38000	1	0	31.7%	-4.99	22.50	22.20	17.51	0.493	1.07	0.528	0.078	2/15
T44	1	LTE B38	Right Cheek	QPSK	20M	38000	1	0	43.3%	-3.64	22.00	21.70	18.36	0.554	1.07	0.594	-0.005	2/15
T45	1	LTE B38	Right Cheek	<b>QPSK</b>	20M	38000	1	0	53.3%	-2.73	21.00	20.70	18.27	0.527	1.07	0.565	0.072	2/15
T46	1	LTE B38	Right Cheek	QPSK	20M	38000	1	0	63.3%	-1.99	20.50	20.20	18.51	0.580	1.07	0.621	0.083	2/15

Uplink-downlink configuration 0,1,2,3,4,5,6 respectively and special subframe configuration 7.

The results show that the highest  $P_{cmax}$  frame-average configuration (uplink-downlink configuration 0 and special subframe configuration 7, and UL duty cycle =63.3%) has the highest SAR value.





# K.5. Power measurements for SAR test mode

# (1) Power Measurement Overview

Table K.5-1: n41													
UL duty cycle	Max UL Max UL duty duty cycle cycle factor		Poffset	Pcmax (dBm)	Pcmax frame-average (dBm)	Power measurement (dBm)	SAR test?	Highest SAR?					
0%≤ K1 ≤10%	10%	-10.00	10.00	24.50	14.50	24.48	/	/					
10%< K2 ≤20%	20%	-6.99	6.50	24.50	17.51	24.49	/	/					
20%< K3≤ 30%	30%	-5.23	5.00	23.50	18.27	23.10	/	/					
30%< K4 ≤40%	40%	-3.98	3.50	22.00	18.02	21.70	/	/					
40%< K5 ≤50%	50%	-3.01	3.00	21.50	18.49	21.40	/	/					
50%< K6 ≤60%	60%	-2.22	2.00	20.50	18.28	20.04	/	/					
60%< K7 ≤70%	70%	-1.55	1.50	20.00	18.45	19.61	/	/					
70%< K8 ≤80%	80%	-0.97	0.50	19.00	18.03	18.62	/	/					
80% <k9 td="" ≤100%<=""><td>100%</td><td>0.00</td><td>0.00</td><td>18.50</td><td>18.50</td><td>17.59</td><td>yes</td><td>yes</td></k9>	100%	0.00	0.00	18.50	18.50	17.59	yes	yes					

Note : We set the  $P_{max}$  and  $P_{SAR}$  parameters of n41 as  $P_{max}$  = 24.50 (dBm) and  $P_{SAR}$  = 6.00 (dB) respectively,

according to  $P_{cmax} = P_{max} - Max(P_{SAR} - P_{offset}@kn, 0)$ 

and  $P_{cmax}$  frame-average =  $P_{cmax}$  + Max UL duty cycle factor,

The calculation results of  $P_{cmax}$  and  $P_{cmax}$  frame-average for each UL duty cycle are shown in the table K.2.

UL duty cycle	Max UL duty cycle	Max UL duty cycle factor	P <sub>offset</sub>	P <sub>cmax</sub> (dBm)	P <sub>cmax</sub> frame-average (dBm)	Power measurement (dBm)	SAR test?	Highest SAR?					
0%< K1 ≤20%	11.7%	-9.32	5.00	23.00	13.68	22.70	/	/					
20%< K2≤ 30%	23.3%	-6.33	3.50	23.00	16.67	22.60	/	/					
30%< K3 ≤40%	31.7%	-4.99	2.00	22.50	17.51	22.20	/	/					
40%< K4 ≤50%	43.3%	-3.64	1.50	22.00	18.36	21.70	/	/					
50%< K5 ≤60%	53.3%	-2.73	0.50	21.00	18.27	20.70	/	/					
60%< K6 ≤63.3%	63.3%	-1.99	0.00	20.50	18.51	20.20	yes	yes					
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# Table G.5-2: LTE TDD B38

Note : We set the  $P_{max}$  and  $P_{SAR}$  parameters of B38 as  $P_{max}$  = 23.00 (dBm) and  $P_{SAR}$  = 2.50 (dB) respectively,

according to  $P_{cmax} = P_{max} - Max(P_{SAR} - P_{offset} @kn, 0)$ 

and  $P_{cmax}$  frame-average =  $P_{cmax}$  + Max UL duty cycle factor,

The calculation results of  $P_{cmax}$  and  $P_{cmax}$  frame-average for each UL duty cycle are shown in the table K.3.