

CALIBRATION REPORT

F.1 Data Acquisition Electronics (DAE4 - SN:1710)



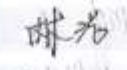
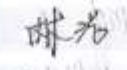
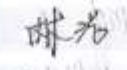
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CALIBRATION LABORATORY

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CALIBRATION
CNAS L0570

Client : **baluntek**
Certificate No: **Z23-60062**

CALIBRATION CERTIFICATE																			
Object	DAE4 - SN: 1710																		
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)																		
Calibration date:	January 30, 2023																		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature$22\pm 3^{\circ}\text{C}$ and humidity$<70\%$. Calibration Equipment used (M&TE critical for calibration)																			
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																
Process Calibrator 753	1971018	14-Jun-22 (CTTL, No.J22X04180)	Jun-23																
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;"></th> <th style="width: 20%;">Name</th> <th style="width: 20%;">Function</th> <th style="width: 40%;">Signature</th> </tr> </thead> <tbody> <tr> <td>Calibrated by:</td> <td>Yu Zongying</td> <td>SAR Test Engineer</td> <td></td> </tr> <tr> <td>Reviewed by:</td> <td>Lin Hao</td> <td>SAR Test Engineer</td> <td></td> </tr> <tr> <td>Approved by:</td> <td>Qi Dianyuan</td> <td>SAR Project Leader</td> <td></td> </tr> </tbody> </table> Issued: January 31, 2023 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.					Name	Function	Signature	Calibrated by:	Yu Zongying	SAR Test Engineer		Reviewed by:	Lin Hao	SAR Test Engineer		Approved by:	Qi Dianyuan	SAR Project Leader	
	Name	Function	Signature																
Calibrated by:	Yu Zongying	SAR Test Engineer																	
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Glossary:

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

Methods Applied and Interpretation of Parameters:

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



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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu\text{V}$, full range = $-100\ldots+300\text{ mV}$

Low Range: 1LSB = 61nV , full range = $-1\ldots+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$404.284 \pm 0.15\% (k=2)$	$404.533 \pm 0.15\% (k=2)$	$404.207 \pm 0.15\% (k=2)$
Low Range	$3.96582 \pm 0.7\% (k=2)$	$3.99682 \pm 0.7\% (k=2)$	$3.995 \pm 0.7\% (k=2)$

Connector Angle

Connector Angle to be used in DASY system	$245^\circ \pm 1^\circ$
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F.2 Data Acquisition Electronics (DAE4 - SN:1454)

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



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S Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **Balun-SZ**
Shenzhen, China

Certificate No: **DAE4-1454_Mar23**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1454**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **March 20, 2023**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-22 (No:34389)	Aug-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	27-Jan-23 (in house check)	In house check: Jan-24
Calibrator Box V2.1	SE UMS 006 AA 1002	27-Jan-23 (in house check)	In house check: Jan-24

Calibrated by: **Name**
Dominique Steffen **Function**
Laboratory Technician

Signature

Approved by: **Sven Kühn** **Technical Manager**

Issued: March 20, 2023

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**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary

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

Methods Applied and Interpretation of Parameters

- **DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- **Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
 - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
 - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
 - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
 - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - **Input resistance:** Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
 - **Power consumption:** Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	404.187 $\pm$ 0.02% (k=2)	403.680 $\pm$ 0.02% (k=2)	403.750 $\pm$ 0.02% (k=2)
Low Range	4.01310 $\pm$ 1.50% (k=2)	3.99119 $\pm$ 1.50% (k=2)	4.00106 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	23.0 $^{\circ}$ $\pm$ 1 $^{\circ}$
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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	199993.53	-0.16	-0.00
Channel X + Input	20000.37	-1.52	-0.01
Channel X - Input	-19999.85	2.00	-0.01
Channel Y + Input	199992.61	-1.01	-0.00
Channel Y + Input	19996.38	-5.29	-0.03
Channel Y - Input	-20002.70	-0.67	0.00
Channel Z + Input	199993.15	-0.43	-0.00
Channel Z + Input	19998.47	-3.23	-0.02
Channel Z - Input	-20002.38	-0.20	0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2001.24	0.12	0.01
Channel X + Input	201.71	0.37	0.18
Channel X - Input	-197.46	1.13	-0.57
Channel Y + Input	2000.95	-0.02	-0.00
Channel Y + Input	200.51	-0.63	-0.31
Channel Y - Input	-199.24	-0.64	0.32
Channel Z + Input	2001.05	0.27	0.01
Channel Z + Input	200.02	-1.14	-0.56
Channel Z - Input	-199.76	-1.03	0.52

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	-14.84	-16.14
	- 200	17.57	16.14
Channel Y	200	-22.27	-23.07
	- 200	22.28	21.89
Channel Z	200	-12.61	-12.43
	- 200	10.08	10.17

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	-	-2.54	-1.12
Channel Y	200	3.48	-	-1.60
Channel Z	200	10.43	2.06	-

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	16118	16673
Channel Y	16296	16437
Channel Z	16044	14637

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.42	-0.45	1.19	0.37
Channel Y	-0.56	-1.57	0.44	0.44
Channel Z	-0.66	-1.58	0.32	0.35

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <251A

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)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

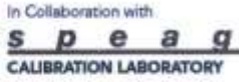
Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

F.3 2450 MHz Dipole



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 CNAS L0570

Client: **baluntek** Certificate No: **Z21-60171**

CALIBRATION CERTIFICATE			
Object	D2450V2 - SN: 952		
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits		
Calibration date:	May 19, 2021		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22±3)°C and humidity<70%. Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Power sensor NRP8S	104291	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
ReferenceProbe EX3DV4	SN 3846	26-Apr-21(CTTL-SPEAG,No.Z21-60084)	Apr-22
DAE4	SN 777	08-Jan-21(CTTL-SPEAG,No.Z21-60003)	Jan-22
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21
NetworkAnalyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00516)	Feb-21
Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature 
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	
Issued: May 24, 2021			
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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.4 $\pm$ 6 %	1.79 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.0 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.1 W/kg $\pm$ 18.7 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.2 $\pm$ 6 %	1.96 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	52.5 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	6.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.2 W/kg $\pm$ 18.7 % (k=2)



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.1Ω+ 2.20 jΩ
Return Loss	- 27.0dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.0Ω+ 3.93 jΩ
Return Loss	- 27.8dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.068 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

Additional EUT Data

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DASY5 Validation Report for Head TSL

Date: 05.19.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.788$ S/m; $\epsilon_r = 39.43$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.45, 7.45, 7.45) @ 2450 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 107.4 V/m; Power Drift = -0.04 dB

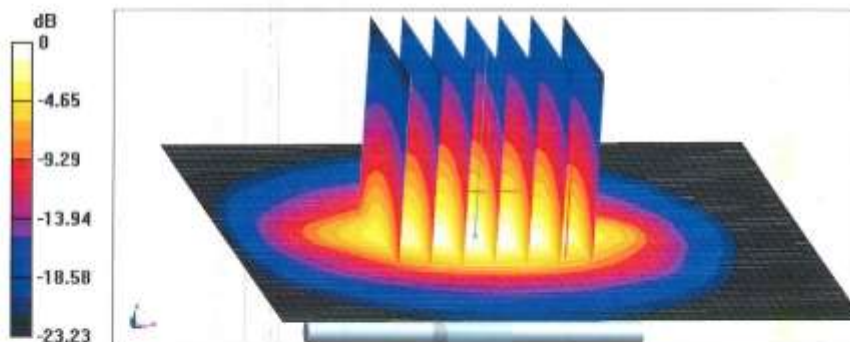
Peak SAR (extrapolated) = 28.2 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 46.4%

Maximum value of SAR (measured) = 22.5 W/kg



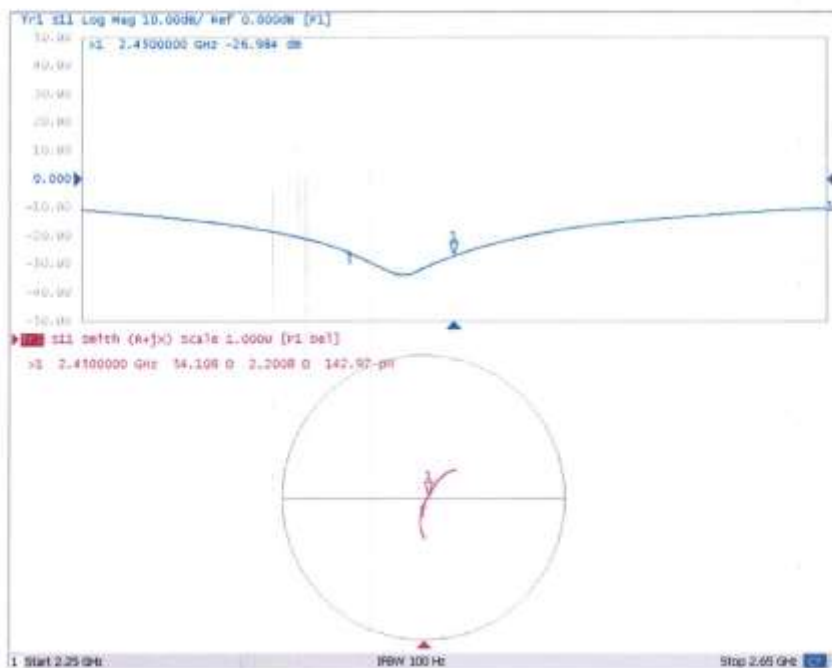
0 dB = 22.5 W/kg = 13.52 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 05.19.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.96$ S/m; $\epsilon_r = 52.15$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.37, 7.37, 7.37) @ 2450 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 101.3 V/m; Power Drift = 0.04 dB

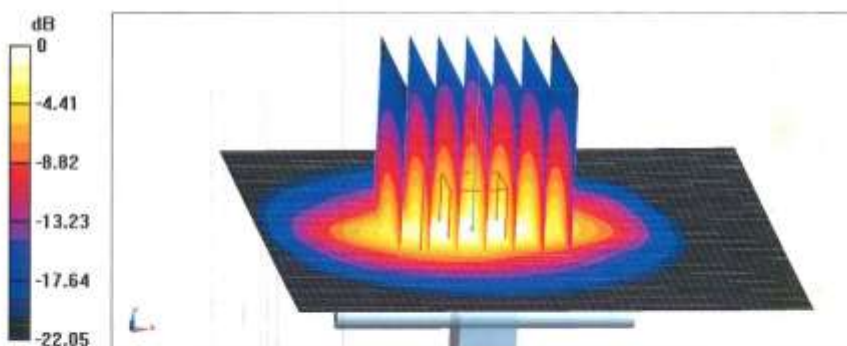
Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.06 W/kg

Smallest distance from peaks to all points 3 dB below = 8.5 mm

Ratio of SAR at M2 to SAR at M1 = 49.7%

Maximum value of SAR (measured) = 22.1 W/kg



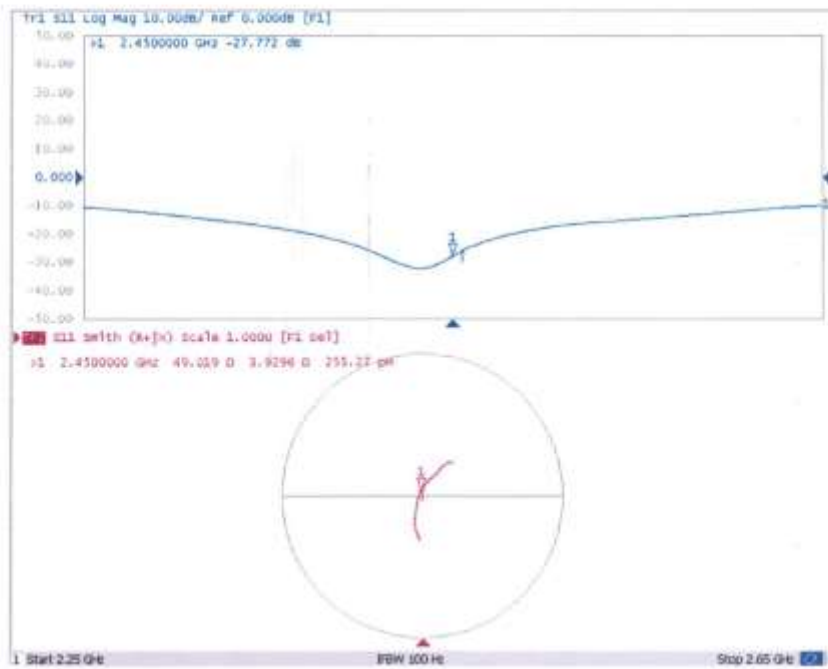
0 dB = 22.1 W/kg = 13.44 dBW/kg



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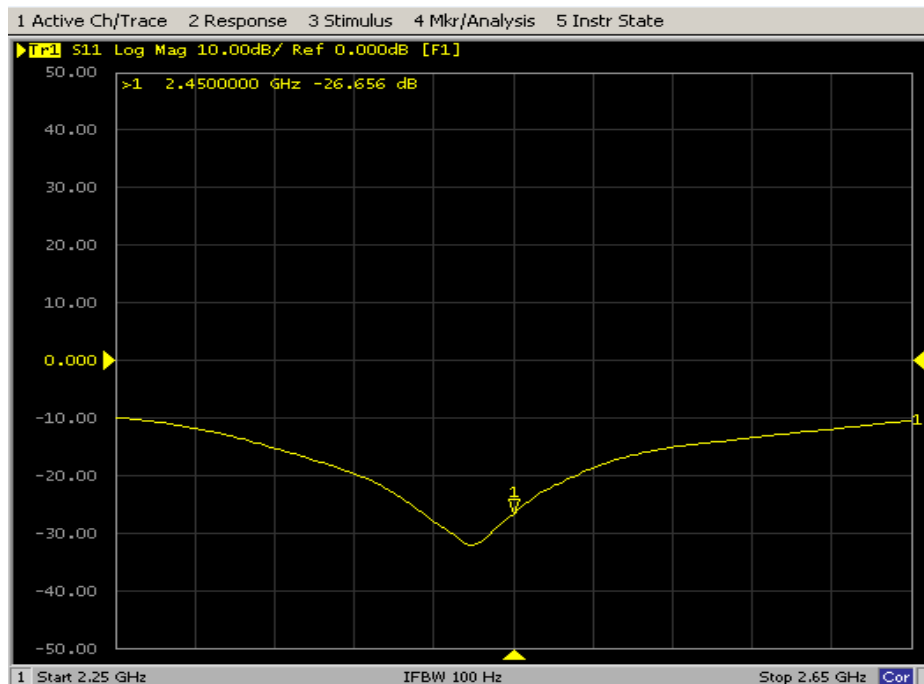
Impedance Measurement Plot for Body TSL



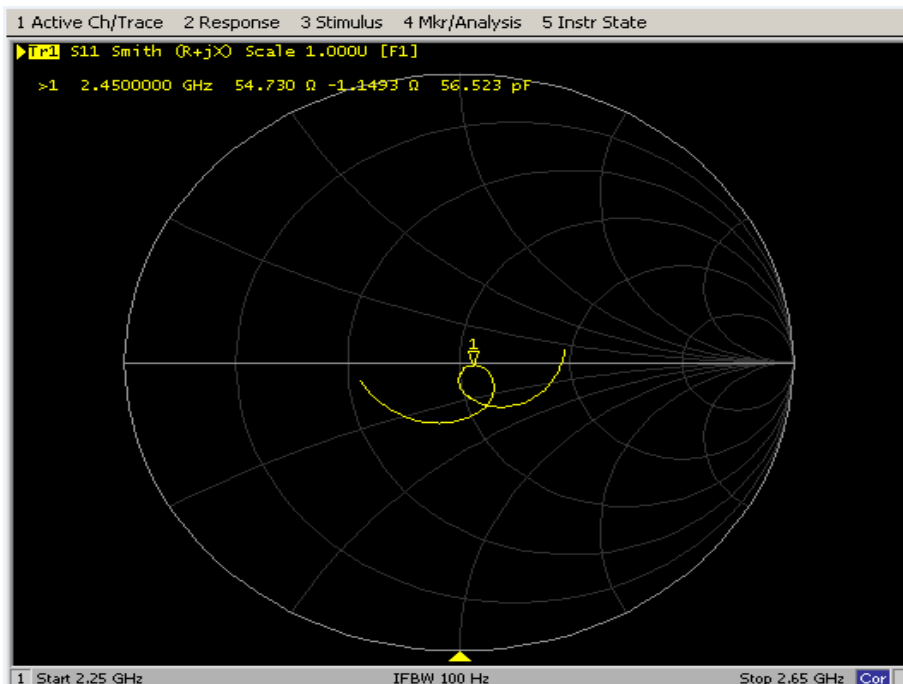
D2450V2 Dipole impedance and return loss Validation

Meas. Results	Current Meas.	Previous Meas.	Max. Deviation
Meas. Data	2023.05.17	2022.05.18	/
Return Loss(dB)	-26.656	-26.401	0.97%
Impedance	54.73 Ω -1.149 j Ω	54.102 Ω +2.830 j Ω	-3.979 Ω (Imaginary part)

Return Loss for Head TSL



Impedance for Head TSL



F.4 5GHz Dipole

Client **baluntek**Certificate No: **Z21-60173****CALIBRATION CERTIFICATE**Object **D5GHzV2 - SN: 1200**Calibration Procedure(s) **FF-Z11-003-01**
Calibration Procedures for dipole validation kitsCalibration date: **May 18, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Power sensor NRP8S	104291	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
ReferenceProbe EX3DV4	SN 3846	26-Apr-21(CTTL-SPEAG, No.Z21-60084)	Apr-22
DAE4	SN 777	08-Jan-21(CTTL-SPEAG, No.Z21-60003)	Jan-22
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21
NetworkAnalyzerE5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21

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

Issued: May 24, 2021

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

Certificate No: Z21-60173

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.5 $\pm$ 6 %	4.67 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	---

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.8 W/kg $\pm$ 24.4 % ($k=2$)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg $\pm$ 24.2 % ($k=2$)



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Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	5.21 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.75 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.7 W/kg ± 24.2 % (k=2)



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Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.1 ± 6 %	5.34 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	---	---

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.33 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.4 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.5 W/kg ± 24.2 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.4 ± 6 %	5.82 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	---	---

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.72 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.6 W/kg ± 24.2 % (k=2)



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Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.1 ± 6 %	6.05 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.34 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.4 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.3 W/kg ± 24.2 % (k=2)



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Appendix (Additional assessments outside the scope of CNAS L0570)
Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	$45.1\Omega + 1.25j\Omega$
Return Loss	- 25.5dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$49.7\Omega + 7.81j\Omega$
Return Loss	- 22.1dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	$45.9\Omega + 4.85j\Omega$
Return Loss	- 23.5dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	$43.9\Omega + 2.08j\Omega$
Return Loss	- 23.3dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	$50.3\Omega + 8.89j\Omega$
Return Loss	- 21.1dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	$46.8\Omega + 5.63j\Omega$
Return Loss	- 23.3dB



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General Antenna Parameters and Design

Electrical Delay (one direction)	1.096 ns
----------------------------------	----------

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

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

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 05.18.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1200

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

Medium parameters used: $f = 5250 \text{ MHz}$; $\sigma = 4.668 \text{ S/m}$; $\epsilon_r = 35.48$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: $f = 5600 \text{ MHz}$; $\sigma = 5.045 \text{ S/m}$; $\epsilon_r = 34.88$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: $f = 5750 \text{ MHz}$; $\sigma = 5.208 \text{ S/m}$; $\epsilon_r = 34.67$; $\rho = 1000 \text{ kg/m}^3$,

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(5.43, 5.43, 5.43) @ 5250 MHz; ConvF(4.69, 4.69, 4.69) @ 5600 MHz; ConvF(4.9, 4.9, 4.9) @ 5750 MHz; Calibrated: 2021-04-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

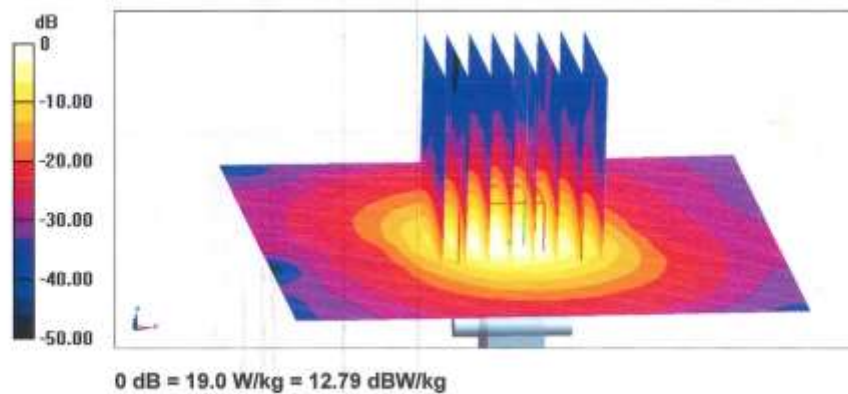
Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
 Reference Value = 69.22 V/m; Power Drift = -0.08 dB
 Peak SAR (extrapolated) = 32.9 W/kg
SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.22 W/kg
 Smallest distance from peaks to all points 3 dB below = 7.2 mm
 Ratio of SAR at M2 to SAR at M1 = 63.3%
 Maximum value of SAR (measured) = 18.9 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 = 70.18 V/m; Power Drift = -0.07 dB
 Peak SAR (extrapolated) = 35.5 W/kg
SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.32 W/kg
 Smallest distance from peaks to all points 3 dB below = 7.4 mm
 Ratio of SAR at M2 to SAR at M1 = 62.9%
 Maximum value of SAR (measured) = 19.8 W/kg



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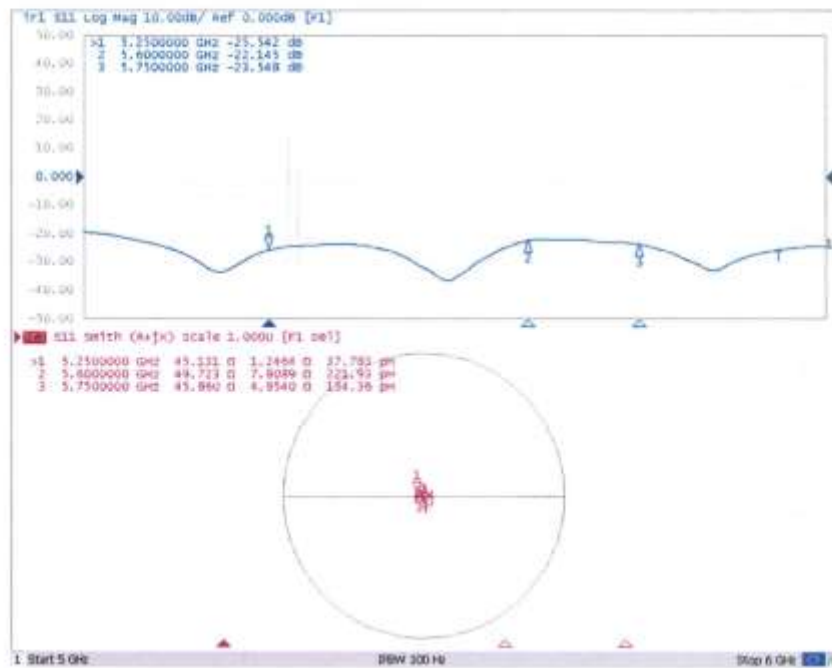
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 68.06 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 34.6 W/kg
SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.18 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 62.1%
Maximum value of SAR (measured) = 19.0 W/kg





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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 05.18.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1200

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

Medium parameters used: $f = 5250$ MHz; $\sigma = 5.34$ S/m; $\epsilon_r = 49.12$; $\rho = 1000$ kg/m³,
 Medium parameters used: $f = 5600$ MHz; $\sigma = 5.815$ S/m; $\epsilon_r = 48.44$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 6.045$ S/m; $\epsilon_r = 48.11$; $\rho = 1000$ kg/m³,

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(4.95, 4.95, 4.95) @ 5250 MHz; ConvF(4.32, 4.32, 4.32) @ 5600 MHz; ConvF(4.38, 4.38, 4.38) @ 5750 MHz; Calibrated: 2021-04-26,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 2021-01-08
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Dipole Calibration /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 = 65.86 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 29.6 W/kg

SAR(1 g) = 7.33 W/kg; SAR(10 g) = 2.05 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 65.3%

Maximum value of SAR (measured) = 17.2 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 = 66.06 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 33.1 W/kg

SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.16 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

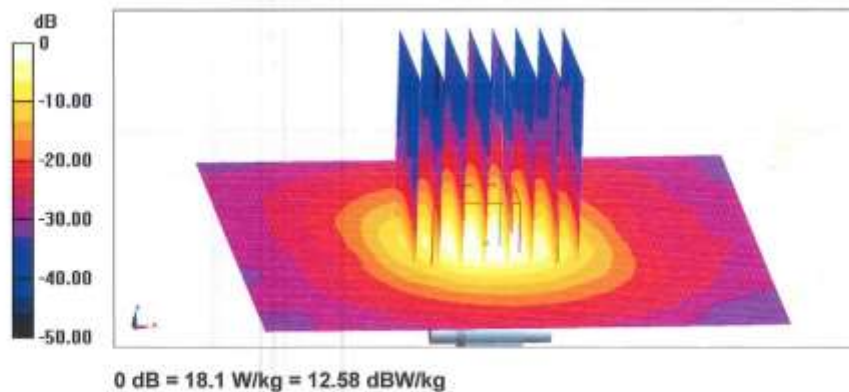
Ratio of SAR at M2 to SAR at M1 = 63.1%

Maximum value of SAR (measured) = 18.8 W/kg



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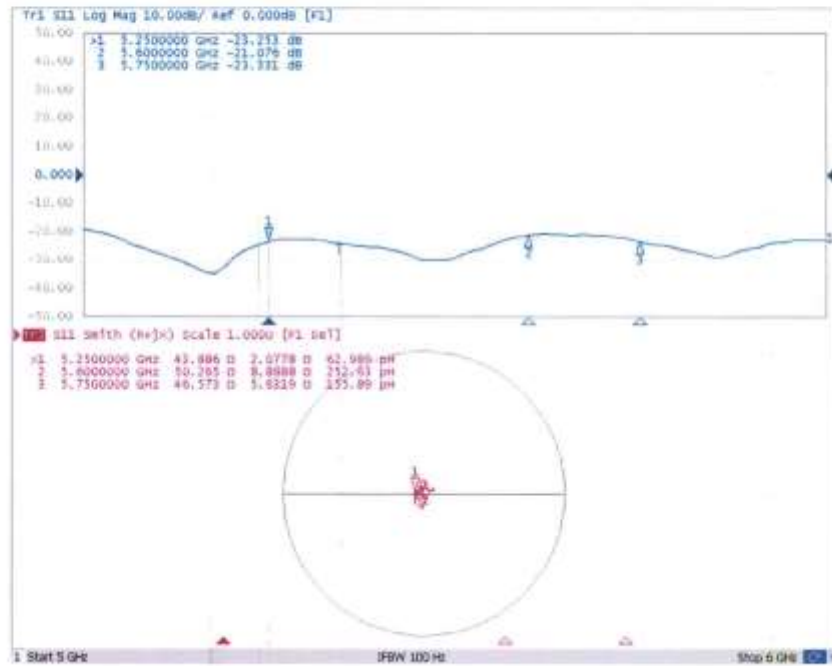
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dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.58 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 32.8 W/kg
SAR(1 g) = 7.34 W/kg; SAR(10 g) = 2.03 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 62%
Maximum value of SAR (measured) = 18.1 W/kg





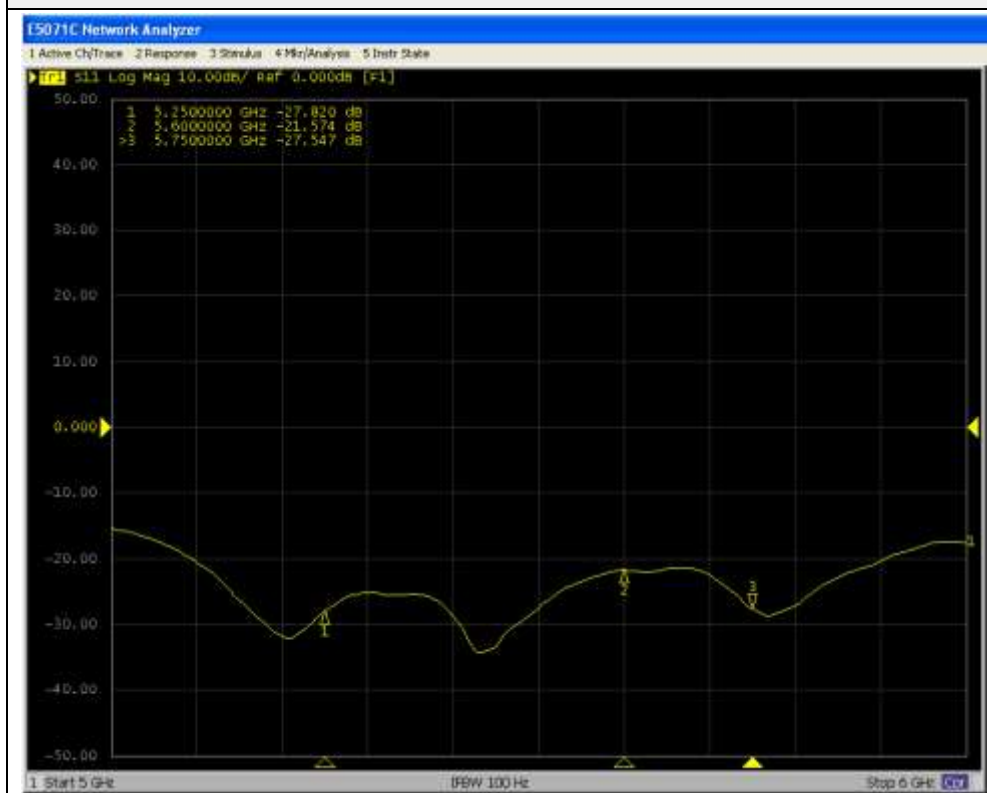
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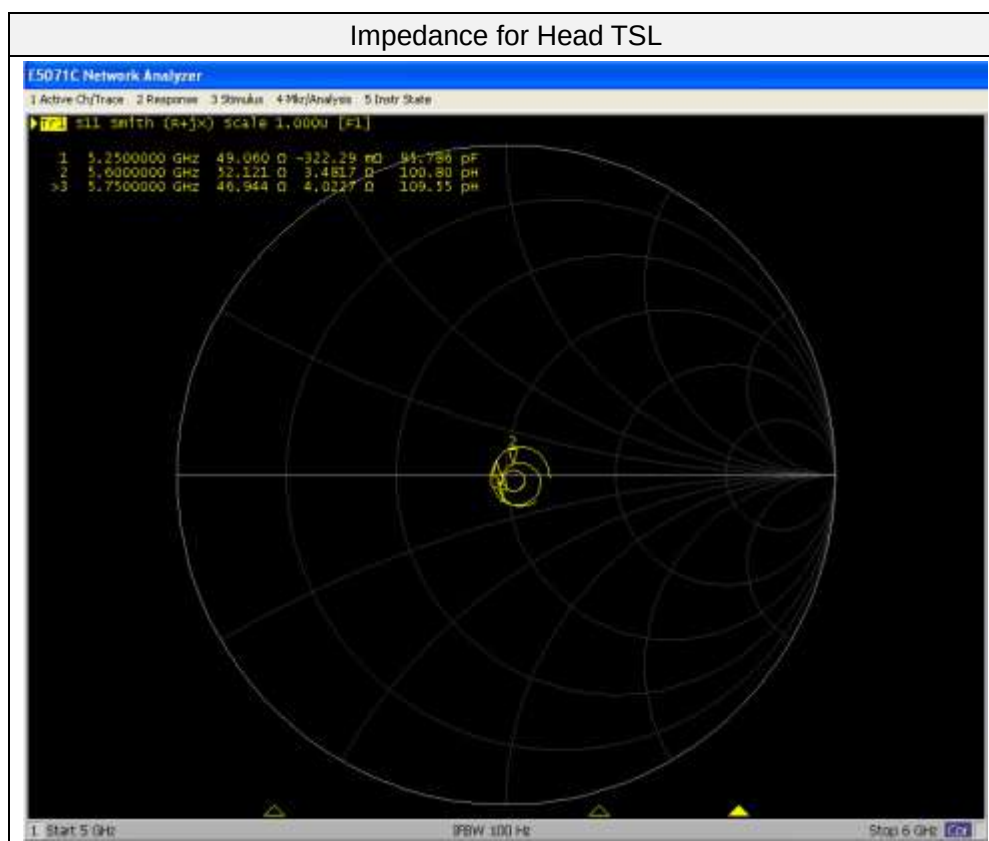
Impedance Measurement Plot for Body TSL



D5GHzV2 Dipole impedance and return loss Validation

Meas. Results	Current Meas.	Previous Meas.	Max. Deviation
Meas. Data	2023.05.16	2022.05.17	/
5.25GHz Return Loss(dB)	-27.820	-29.961	-7.15%
5.25GHz Impedance	49.06 Ω -0.322 j Ω	48.925 Ω +1.802 j Ω	-2.124 Ω (Imaginary part)
5.6GHz Return Loss(dB)	-21.574	-25.244	-14.54%
5.6GHz Impedance	52.121 Ω +3.482 j Ω	47.163 Ω +3.417 j Ω	4.958 Ω (Real part)
5.75GHz Return Loss(dB)	-27.547	-27.284	0.96%
5.75GHz Impedance	46.944 Ω +4.023 j Ω	50.693 Ω +8.724 j Ω	-4.701 Ω (Imaginary part)
Return Loss for Head TSL			





--END OF REPORT--