



In Collaboration with
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CALIBRATION LABORATORY



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CALIBRATION
CNAS L0570

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

Client

Cerpass

Certificate No: Z21-60267

CALIBRATION CERTIFICATE

Object

D2450V2 - SN: 914

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

August 26, 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 $(22\pm3)^{\circ}\text{C}$ and humidity $<70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Power sensor NRP8S	104291	23-Sep-20 (CTTL, No.J20X08336)	Sep-21
Reference Probe EX3DV4	SN 7517	03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Feb-22
DAE3	SN 536	06-Nov-20(CTTL-SPEAG,No.Z20-60452)	Nov-21
Secondary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-21 (CTTL, No.J21X00593)	Jan-22
NetworkAnalyzer E5071C	MY46110673	14-Jan-21 (CTTL, No.J21X00232)	Jan-22

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

Issued: August 31, 2021

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



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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	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	40.0 $\pm$ 6 %	1.77 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	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.6 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	5.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 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	54.3Ω+ 2.55jΩ
Return Loss	- 26.4dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.056 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

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 08.26.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 914

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.772$ S/m; $\epsilon_r = 40.04$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7517; ConvF(7.34, 7.34, 7.34) @ 2450 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2020-11-06
- 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 = 108.2 V/m; Power Drift = -0.03 dB

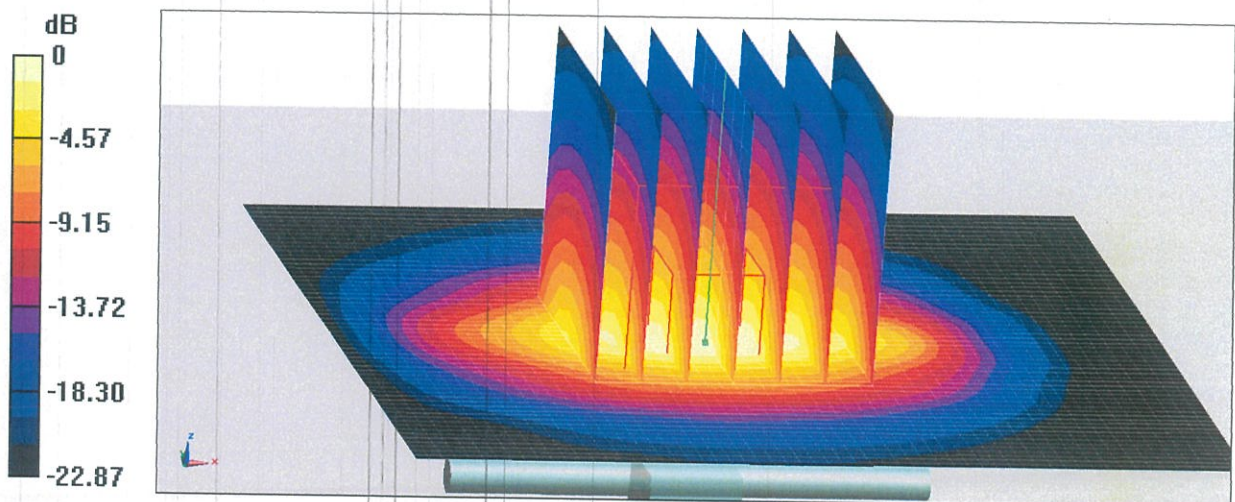
Peak SAR (extrapolated) = 27.7 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 5.92 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 46.8%

Maximum value of SAR (measured) = 22.2 W/kg



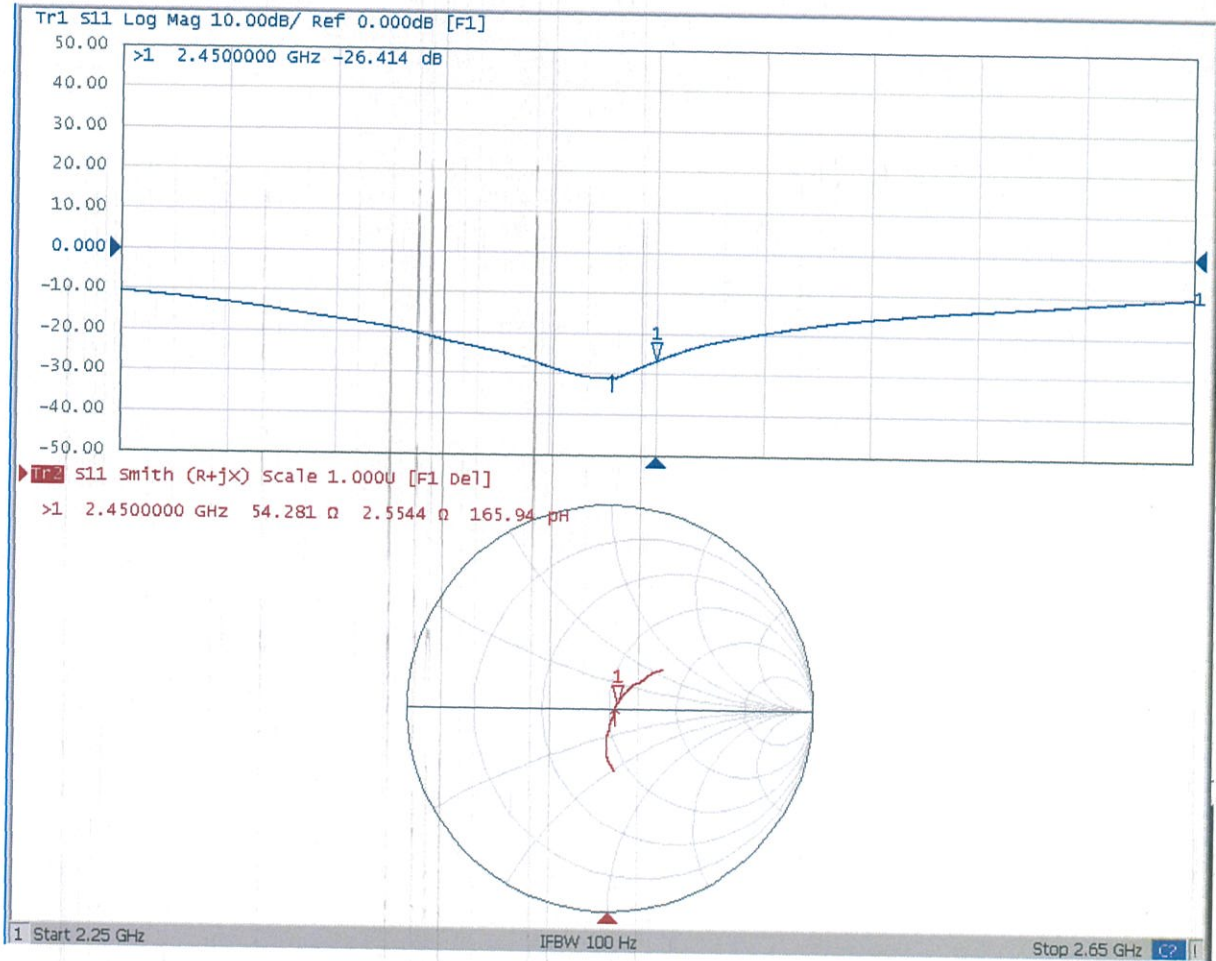
0 dB = 22.2 W/kg = 13.46 dBW/kg



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Impedance Measurement Plot for Head TSL





Appendix B. System Performance Check

Tissue Calibration Result :

6.1.3

Frequency (MHz)	Liquid Temp	Measured Values (W/kg)		Target Values (W/kg)		Deviation[%]		Limit	Measured. Date
		σ	ϵ_r (e')	σ	ϵ_r (e')	1g	10g	%	
2450	22.2	1.88	40.5	1.8	39.2	4.44%	3.32%	±5%	2023/9/4

Result of System Performance Check :

6.1.7

Frequency (MHz)	Dipole S/N	Measured SAR Values (W/kg)		Target SAR Values (W/kg)		Deviation[%]		Limit	Measured. Date
		1g	10g	1g	10g	1g	10g	%	
2450	914	13.5	6.45	13	5.92	3.85%	8.95%	±10%	2023/9/4



System Performance Check Report

Summary

Dipole	Frequency [MHz]
D2450V2 - SN914	2450.0

Exposure Conditions

Phantom Section, TSL	Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat, HSL	10		, 0--	2450.0, 0	7.97	1.88	40.5

Hardware Setup

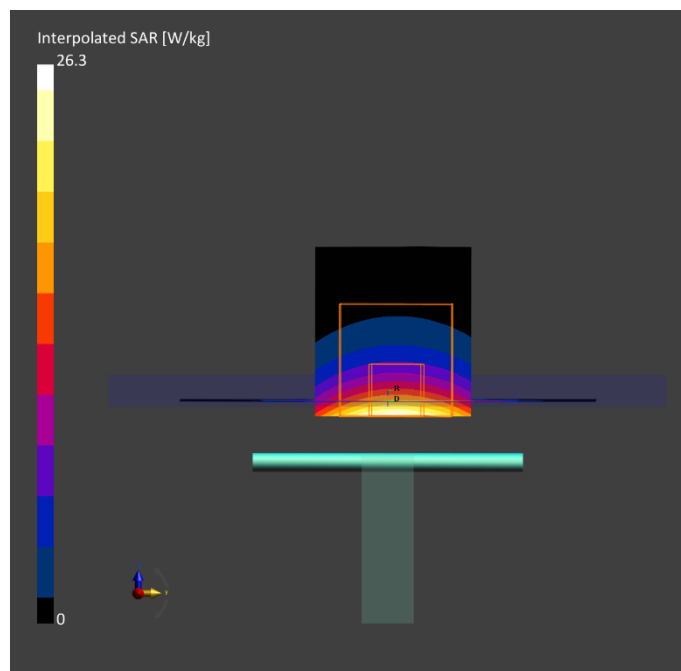
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
ELI V5.0 (20deg probe tilt) 1211	HSL2450	EX3DV4 - SN3927, 2023-06-26	DAE4 Sn1379, 2023-06-16

Scan Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	40.0 x 80.0	30.0 x 30.0 x 30.0
Grid Steps [mm]	10.0 x 10.0	5.0 x 5.0 x 1.5
Sensor Surface [mm]	3.0	1.4

Measurement Results

	Area Scan	Zoom Scan
Date	2023-09-04	2023-09-04
psSAR1g [W/Kg]	14.4	13.5
psSAR10g [W/Kg]	6.75	6.45
Power Drift [dB]	-0.22	-0.17
TSL Correction	No correction	No correction





Appendix C. Measured Conducted Power

FHSS:

Frequency	Modulation	Channel	Data Rate	Conducted Power	Target power
2402	GFSK	0	1M	8.18	8.50
2441	GFSK	39	1M	8.69	9.00
2480	GFSK	78	1M	8.73	9.00
2402	$\pi/4$ -DQPSK	0	2M	6.08	6.50
2441	$\pi/4$ -DQPSK	39	2M	6.23	6.50
2480	$\pi/4$ -DQPSK	78	2M	6.02	6.50

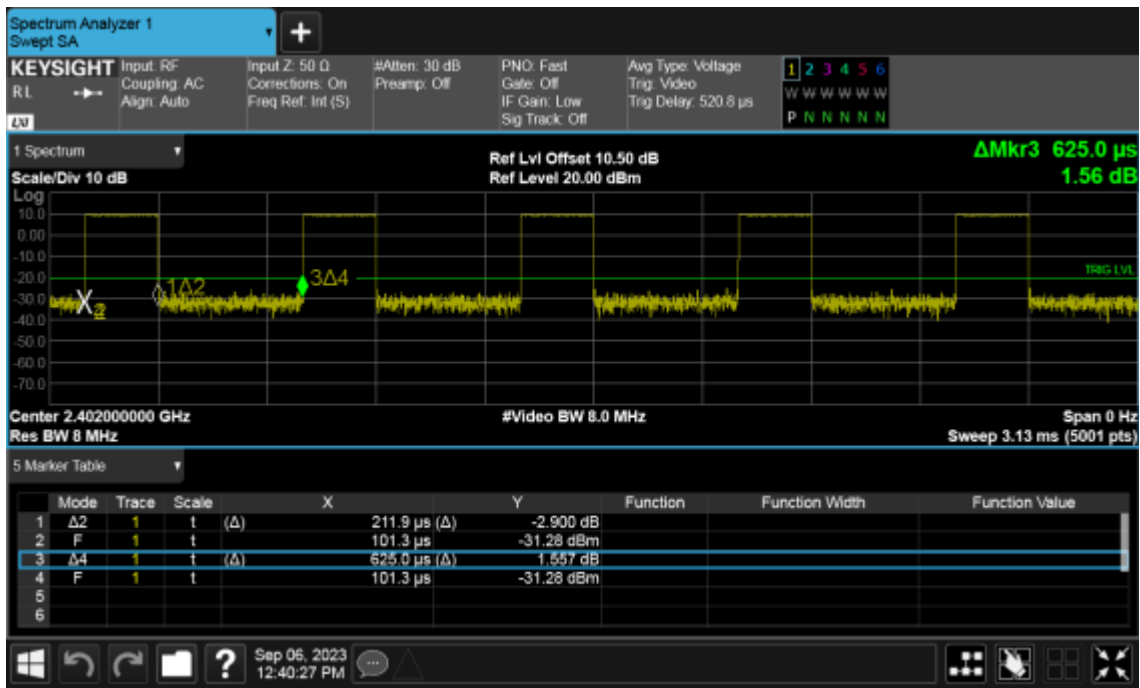
DTS:

Frequency	Modulation	Channel	Data Rate	Conducted Power	Target power
2402	GFSK	0	1M	5.54	6.00
2440	GFSK	19	1M	5.51	6.00
2480	GFSK	39	1M	5.52	6.00
2402	GFSK	0	2M	6.79	7.00
2440	GFSK	19	2M	6.76	7.00
2480	GFSK	39	2M	6.72	7.00



Result for duty cycle test

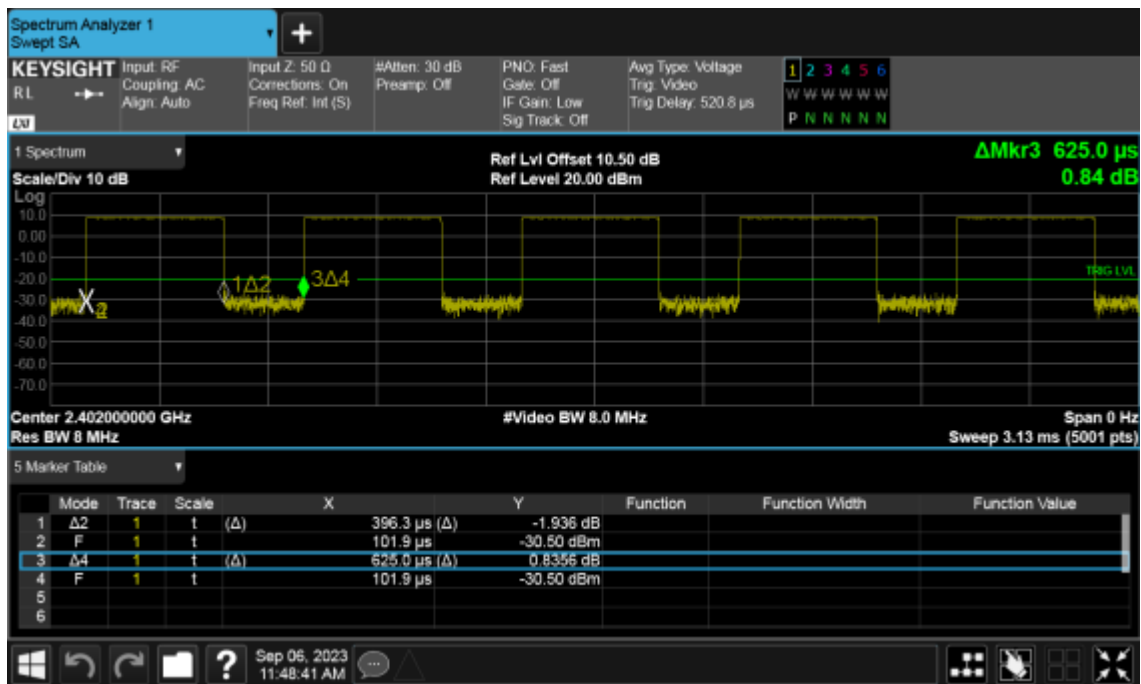
DTS



Modulation Type	On Time (ms)	Period Time (ms)	Duty Cycle (%)
GFSK(2MBps)	0.21	0.63	33.83%



FHSS



Modulation Type	On Time (ms)	Period Time (ms)	Duty Cycle (%)
GFSK(1MBps)	0.40	0.63	63.41%



Appendix D. SAR Measurement Data

**<SAR>**

Plot.No	Band	Mode	Channel	Frequency (MHz)	Data Rate	Test Position	Gap (mm)	Avg Power (dBm)	Tune-up (dBm)	Duty Cycle (%)	SAR 1g (W/Kg)	Reported SAR 1g(W/Kg)
	FHSS	GFSK	78	2480	1M	Ear Front	0	8.73	9.0	63.41	0.031	0.05
	FHSS	GFSK	0	2402	1M	TOP Elge	0	8.18	8.5	63.41	0.053	0.09
	FHSS	GFSK	39	2441	1M	TOP Elge	0	8.69	9.0	63.41	0.065	0.11
1	FHSS	GFSK	78	2480	1M	TOP Elge	0	8.73	9.0	63.41	0.066	0.11
	DTS	GFSK	0	2402	2M	Ear Front	0	6.79	7.00	33.83	0.007	0.02
	DTS	GFSK	0	2402	2M	TOP Elge	0	6.79	7.00	33.83	0.022	0.07
	DTS	GFSK	19	2440	2M	TOP Elge	0	6.76	7.00	33.83	0.027	0.08
2	DTS	GFSK	39	2480	2M	TOP Elge	0	6.72	7.00	33.83	0.029	0.09



01_FHSS_GFSK_CH78_1M_TOP Elge_0mm

Device under Test Properties

Exposure Conditions

Phantom	Position, Test	Band	Group,	Frequency [MHz],	Conversion	TSL Conductivity	TSL
Section, TSL	Distance [mm]		UID	Channel Number	Factor	[S/m]	Permittivity
Flat,	FRONT,	ISM 2.4	Bluetooth,	2480.000,	7.97	1.90	40.5
HSL	0.00	GHz Band	10032-CAA	78			

Hardware Setup

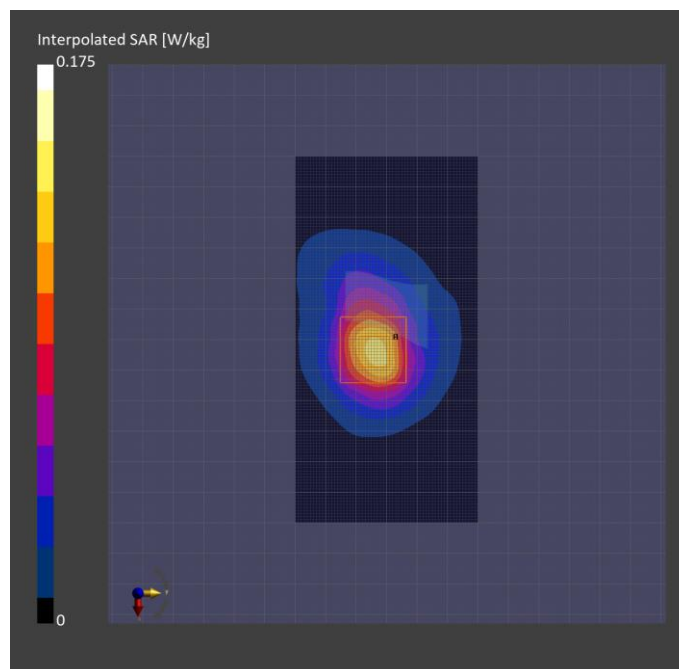
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
ELI V5.0 (20deg probe tilt) 1211	HSL2450	EX3DV4 - SN3927, 2023-06-26	DAE4 Sn1379, 2023-06-16

Scan Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	120.0 x 60.0	30.0 x 30.0 x 30.0
Grid Steps [mm]	10.0 x 10.0	5.0 x 5.0 x 1.5
Sensor Surface [mm]	3.0	1.4

Measurement Results

	Area Scan	Zoom Scan
Date	2023-09-04	2023-09-04
psSAR1g [W/kg]	0.064	0.066
psSAR10g [W/kg]	0.031	0.031
Power Drift [dB]	-0.16	-0.12
M2/M1 [%]		83.5
Dist 3dB Peak [mm]		9.5





02_DTS_GFSK_CH39_2M_TOP Elge_0mm

Device under Test Properties

Exposure Conditions

Phantom	Position, Test	Band	Group,	Frequency [MHz],	Conversion	TSL Conductivity	TSL
Section, TSL	Distance [mm]		UID	Channel Number	Factor	[S/m]	Permittivity
Flat,	FRONT,	ISM 2.4	Bluetooth,	2480.0,	7.97	1.90	40.5
HSL	0.00	GHz Band	10032-CAA	39			

Hardware Setup

Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
ELI V5.0 (20deg probe tilt) 1211	HSL2450	EX3DV4 - SN3927, 2023-06-26	DAE4 Sn1379, 2023-06-16

Scan Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	120.0 x 60.0	30.0 x 30.0 x 30.0
Grid Steps [mm]	10.0 x 10.0	5.0 x 5.0 x 1.5
Sensor Surface [mm]	3.0	1.4

Measurement Results

	Area Scan	Zoom Scan
Date	2023-09-04	2023-09-04
psSAR1g [W/kg]	0.028	0.029
psSAR10g [W/kg]	0.013	0.013
Power Drift [dB]	0.05	0.29
M2/M1 [%]		84.3
Dist 3dB Peak [mm]		> 15.0

