

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



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

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:

- 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-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:** This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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%.

Measurement Conditions

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

DASY Version	DASY52	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	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	38.0 $\pm$ 6 %	1.81 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	$53.5 \Omega + 5.4 j\Omega$
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.151 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
-----------------	-------

DASY5 Validation Report for Head TSL

Date: 27.03.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1103

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ S/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 114.9 V/m; Power Drift = -0.00 dB

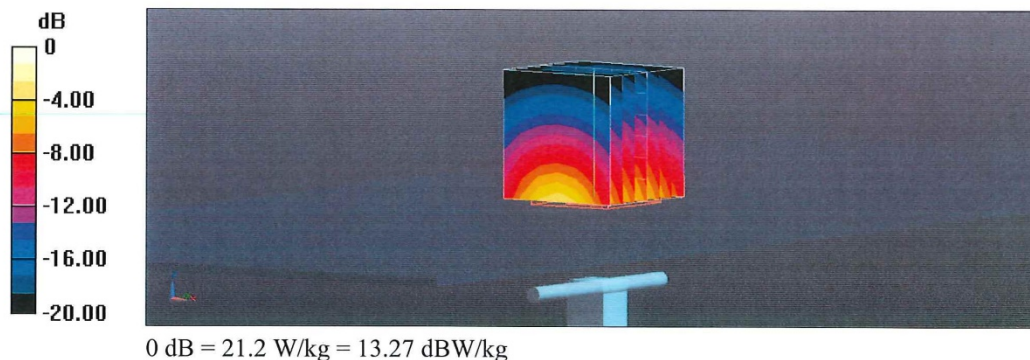
Peak SAR (extrapolated) = 25.3 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.10 W/kg

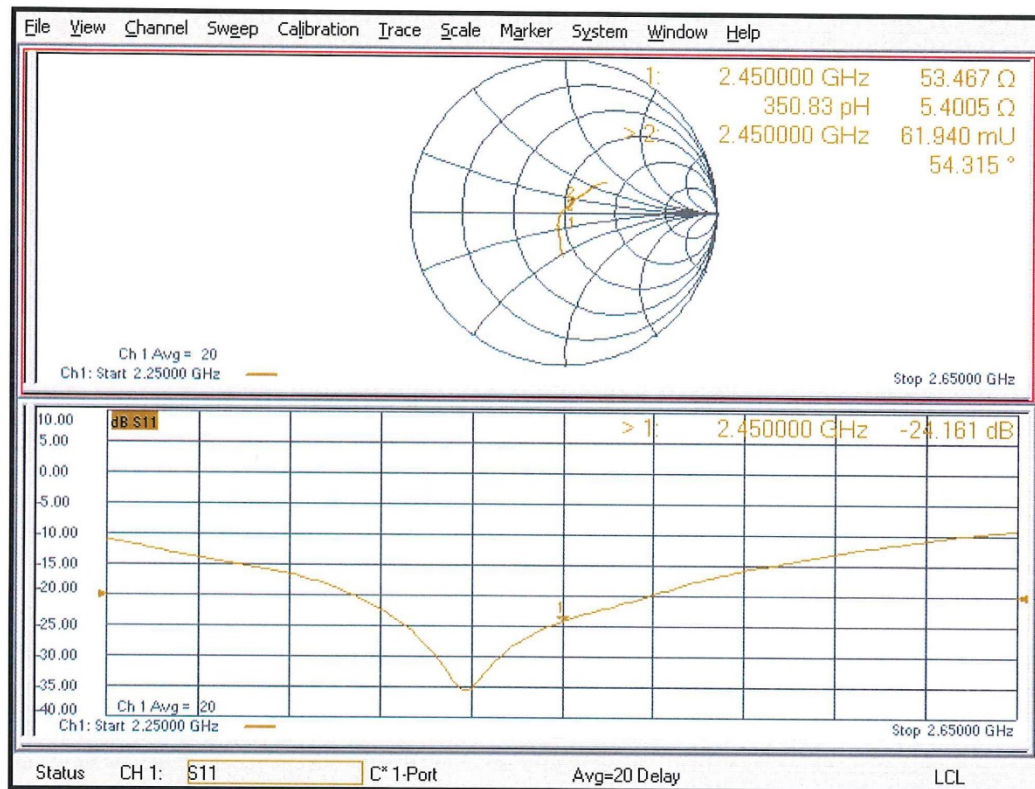
Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 51.3%

Maximum value of SAR (measured) = 21.2 W/kg



Impedance Measurement Plot for Head TSL



APPENDIX E RETURN LOSS&IMPEDANCE MEASUREMENT**Equipment Details:**

Description: Dipole
Manufacturer: Speag
Model Number: D1900V2
Serial Number: 5d231
Calibration Date: 2025/02/01
Calibrated By: Bob Lu
Signature: Bob Lu

All Calibration have been conducted in the closed laboratory facility: Lab Temperature 18°C-25°C and humidity < 70%

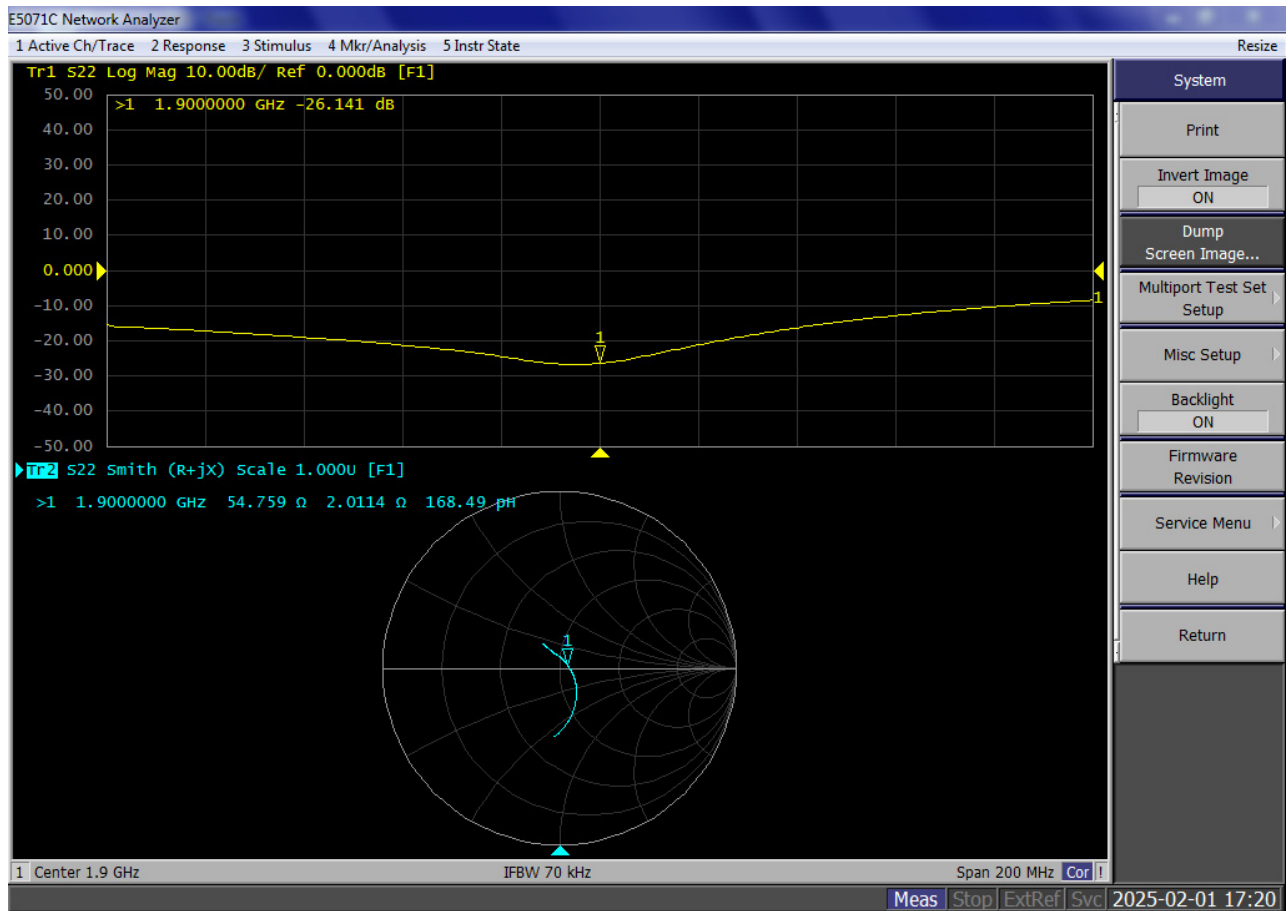
Calibrated Equipment:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2024/05/21	2025/05/20
Network Analyzer Calibration Kit	50 Ω	51026	NCR	NCR

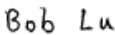
Test Data:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
1900	Head	Return Loss	26.141 dB	26.067 dB	0.284 %	±20%; ≥20dB	Pass
		Real Impedance	54.759 Ω	50.307 Ω	4.452 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	2.011 Ω	4.985 Ω	-2.974 Ω	≤ 5 Ω	Pass

Note: Return Loss Deviation = (Measured-Target)/Target×100%

Dipole, 1900MHz, 5d231

Equipment Details:

Description: Dipole
 Manufacturer: Speag
 Model Number: D1900V2
 Serial Number: 5d231
 Calibration Date: 2025/02/01
 Calibrated By: Bob Lu
 Signature: 

All Calibration have been conducted in the closed laboratory facility: Lab Temperature 18°C-25°C and humidity < 70%

Calibrated Equipment:

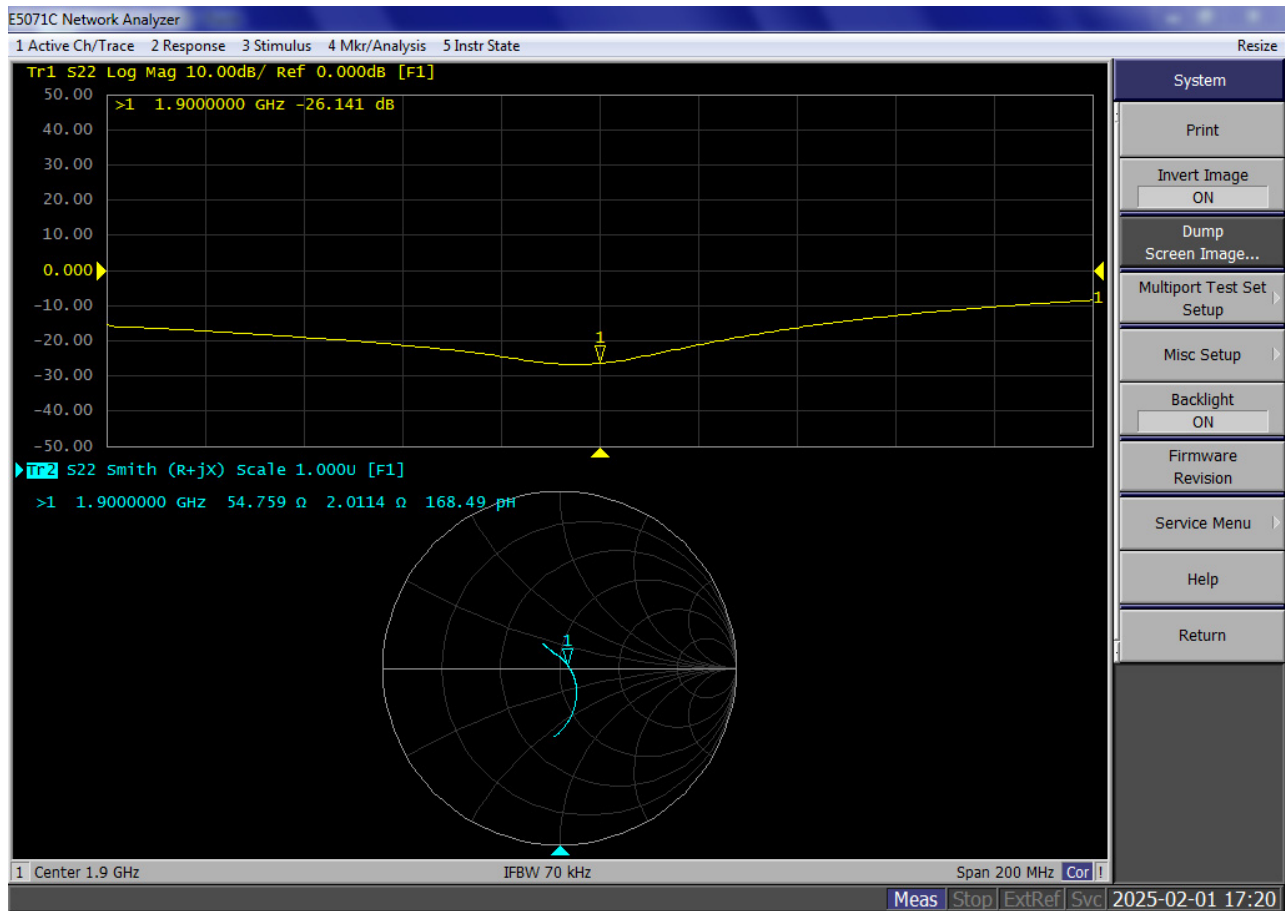
Equipment	Model	S/N	Calibration Date	Calibration Due Date
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2024/05/21	2025/05/20
Network Analyzer Calibration Kit	50Ω	51026	NCR	NCR

Test Data:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
1900	Head	Return Loss	26.141 dB	26.067dB	0.284 %	±20%;≥20dB	Pass
		Real Impedance	54.759 Ω	50.307 Ω	4.452 Ω	≤5Ω	Pass
		Imaginary Impedance	2.011 Ω	4.985 Ω	-2.974 Ω	≤5Ω	Pass

Note: Return Loss Deviation = (Measured-Target)/Target×100%

Dipole, 1900MHz, 5d231



Equipment Details:

Description: Dipole
 Manufacturer: Speag
 Model Number: D2450V2
 Serial Number: 1103
 Calibration Date: 2024/03/26
 Calibrated By: Bob Lu
 Signature: Bob Lu

All Calibration have been conducted in the closed laboratory facility: Lab Temperature 18°C-25°C and humidity < 70%

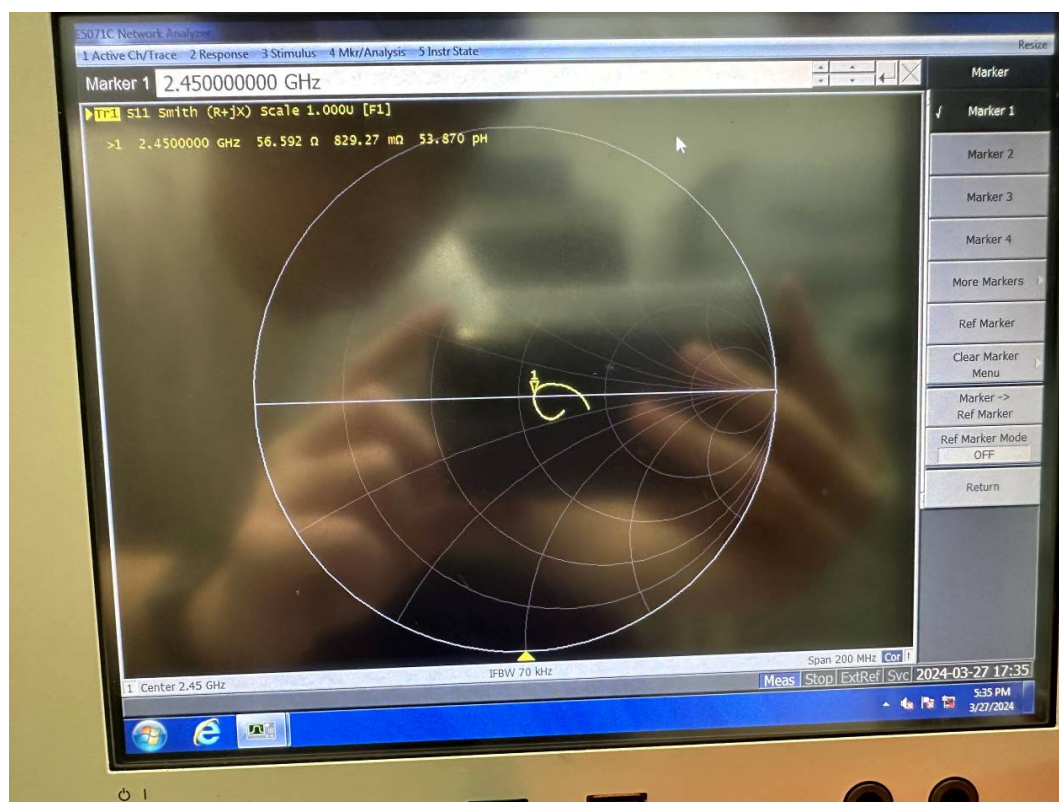
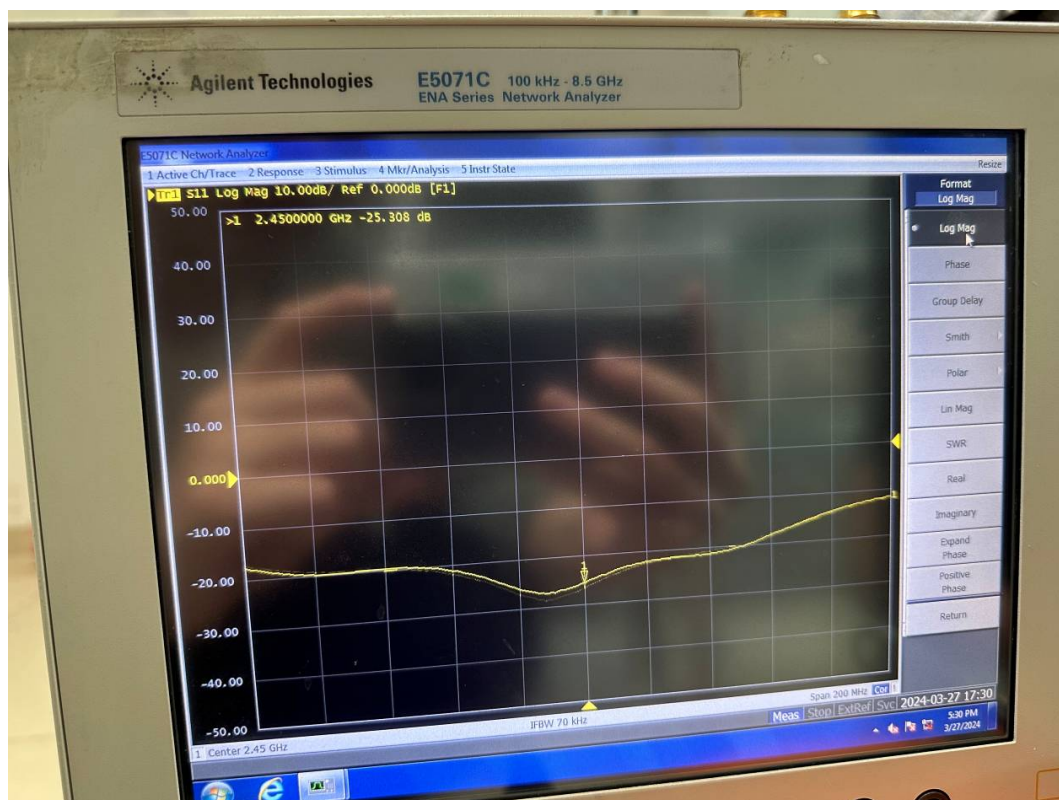
Calibrated Equipment:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2023/06/08	2024/06/07
Network Analyzer Calibration Kit	50Ω	51026	NCR	NCR

Test Data:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
2450	Head	Return Loss	25.308 dB	24.161 dB	4.747 %	±20%;≥20dB	Pass
		Real Impedance	56.592 Ω	53.467 Ω	3.125 Ω	≤5Ω	Pass
		Imaginary Impedance	0.829 Ω	5.400 Ω	-4.571 Ω	≤5Ω	Pass

Note: Return Loss Deviation = (Measured-Target)/Target×100%

Dipole, 2450MHz, 1103

Equipment Details:

Description: Dipole
Manufacturer: Speag
Model Number: D2450V2
Serial Number: 1103
Calibration Date: 2025/03/26
Calibrated By: Bob Lu
Signature: Bob Lu

All Calibration have been conducted in the closed laboratory facility: Lab Temperature 18°C-25°C and humidity < 70%

Calibrated Equipment:

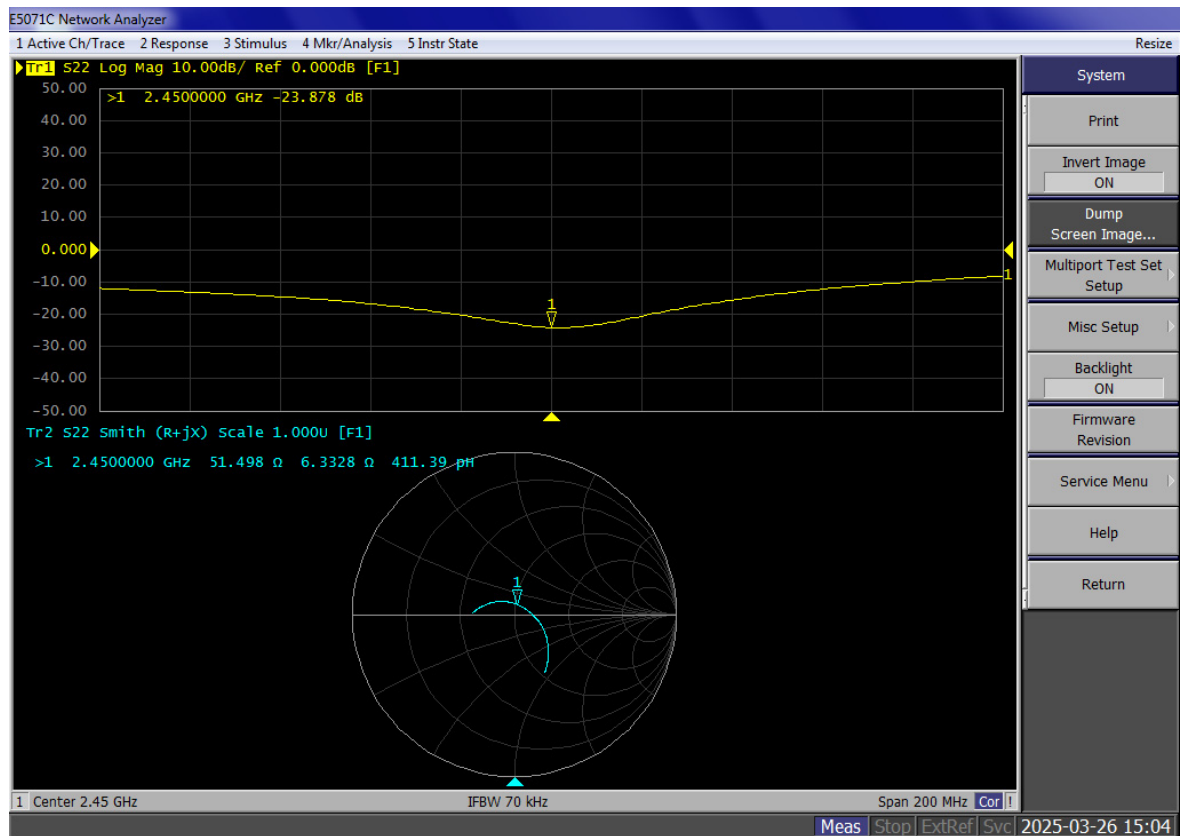
Equipment	Model	S/N	Calibration Date	Calibration Due Date
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2024/05/21	2025/05/20
Network Analyzer Calibration Kit	50Ω	51026	NCR	NCR

Test Data:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
2450	Head	Return Loss	23.878 dB	24.161 dB	-1.171 %	±20%;≥20dB	Pass
		Real Impedance	51.498 Ω	53.467 Ω	1.969 Ω	≤5Ω	Pass
		Imaginary Impedance	6.333 Ω	5.400 Ω	0.933 Ω	≤5Ω	Pass

Note: Return Loss Deviation = (Measured-Target)/Target×100%

Dipole, 2450MHz, 1103



***** END OF REPORT *****