SUSTech Southern University of Science and Technology

Microwave Engineering (Lab)

Project: LibreVNA Test

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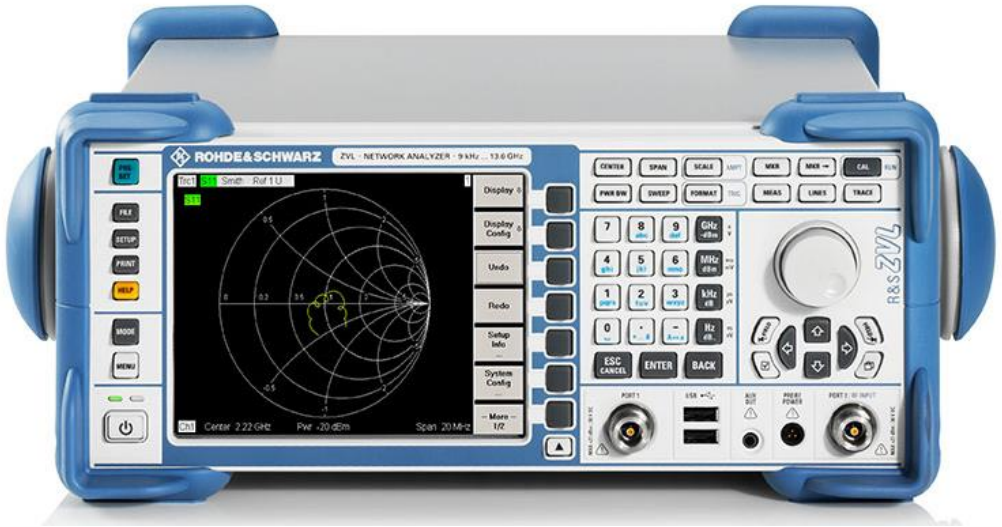
矢量网络分析仪(Vector Network Analyzer, VNA)

网络分析仪是一种用于测量微波器件网络参数的仪器。网络分析仪通常用于测量 S参数，以及其他网络参数集，例如Y参数、Z参数和 ABCD参数。

- 标量网络分析仪（scalar network analyzer）：仅测量幅度属性
- 矢量网络分析仪（vector network analyzer）：测量幅度和相位特性



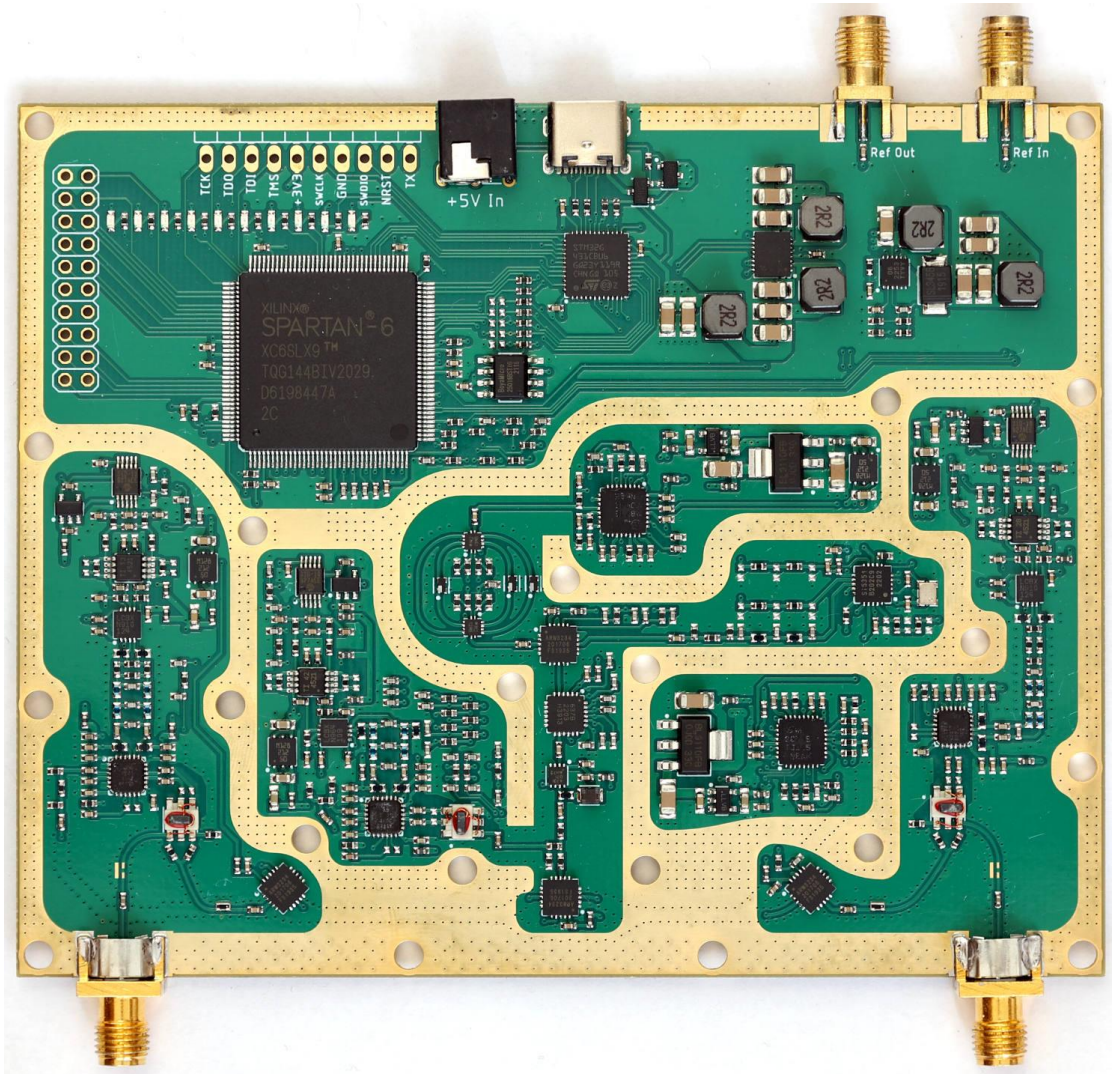
USB接口矢量网络分析仪

100kHz-6GHz全双端口快速扫描　　s21优于100dB高动态

最快扫描速度超过每秒10000点　　双端口完整S参数一次完成

信号发生器功能，功率可调　　受限的频谱分析仪功能

频率精度优于2ppm　频率稳定性优于0.5ppm　支持外部参考频率



https://github.com/jankae/LibreVNA

USB接口矢量网络分析仪

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信号发生器功能，功率可调　受限的频谱分析仪功能

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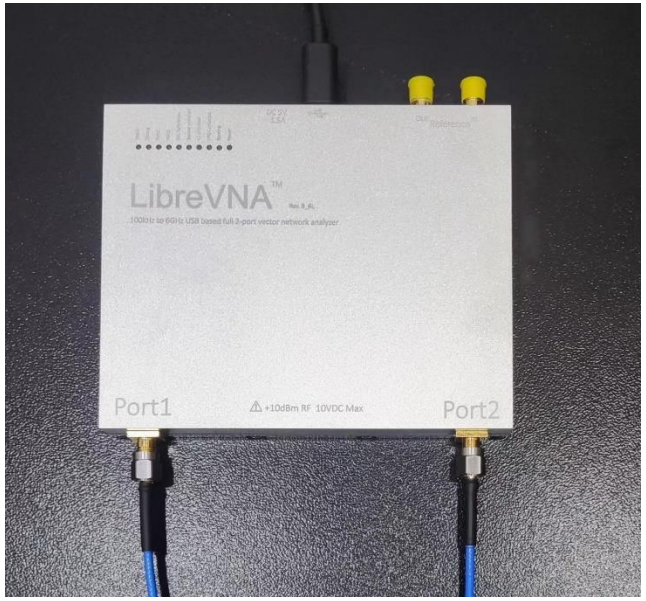
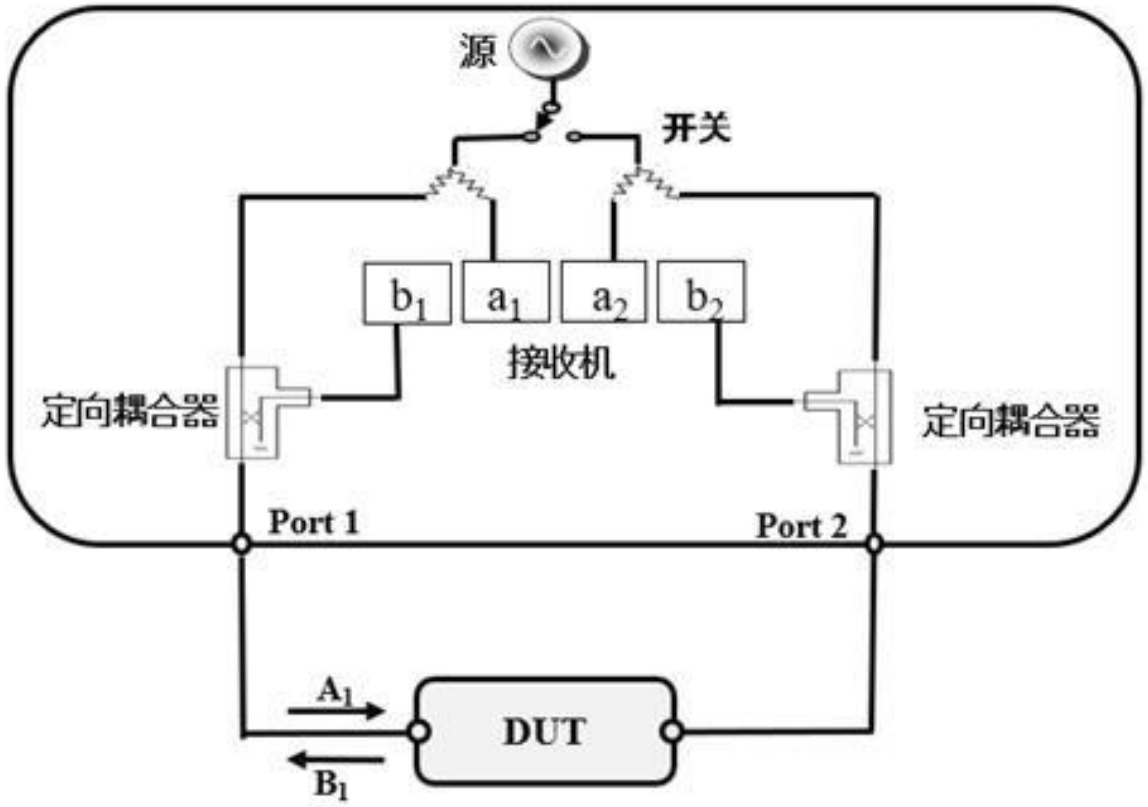


Impedance	50Ω
Test Port Connector	SMA, female
Number of Test Port	2
Frequency Range	100kHz to 6GHz
Frequency Accuracy	<2ppm
Number of Measurement Points	2 to 4501
Speed 2-port - 4000 pts	<500ms (IFBW=50 kHz)
Measurement Bandwidths	10Hz to 50kHz
Dynamic range (IFBW 10Hz)	> 100 dB to 3GHz > 50 dB to 6 GHz (Note 1)
Measurement parameters	S11, S21, S12, S22
Reflection directivity	> 40 dB (after calibration) (Note 2)
Output power	-40 dBm to 0 dBm (Note 3)
Power Supply	DC 5V, 1.5A(USB powered, or 3.5mm connector)
Power consumption	approx. 7W.
Interface	USB type-C
Supported Operating System	Windows, Linux, MacOS. (Only 64-bit software is available for now)
External Reference Input	SMA female; 10 MHz;
External Reference Output	SMA female; 10 MHz or 100MHz;
Further measurement options	Simple spectrum analyzer (Lack of mirror suppression and slower speed) Signal generator (Not precisely calibrated)

VNA测量原理



$$S_{11} = \frac{b_1}{a_1} \qquad S_{21} = \frac{b_2}{a_1} \qquad S_{12} = \frac{b_1}{a_2} \qquad S_{22} = \frac{b_2}{a_2}$$

VNA校准

校准原理是对已知参数的校准器件进行测量，将这些测量结果贮存起来，利用这些数据来计算误差模型。然后，利用误差模型从后续测量中去除系统误差的影响。

单端口矢量校准

单端口校准(1-Port Cal)需要用到 3 个校准件（Short、Open、Load），进行 3 次校准测试操作。

当网络分析仪用于被测器件的单端口性能测试时，只需要进行单端口校准。

双端口矢量校准

双端口校准(2-Port Cal)需要用到 4 个校准件（ Short、Open、Load、Through），进行 7 次校准测试操作。

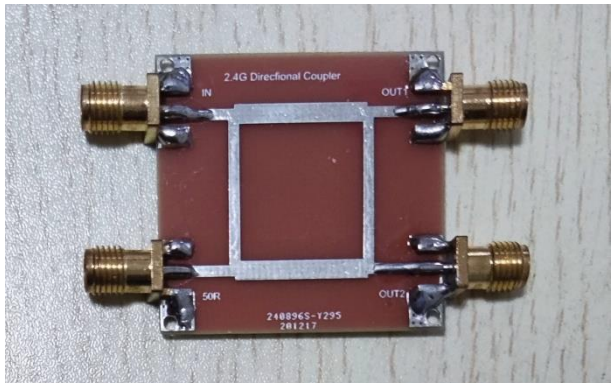
当网络分析仪用于被测器件的传输性能测试时， 就需要对网络分析仪的测试端口和传输连接线进行双端口校准。

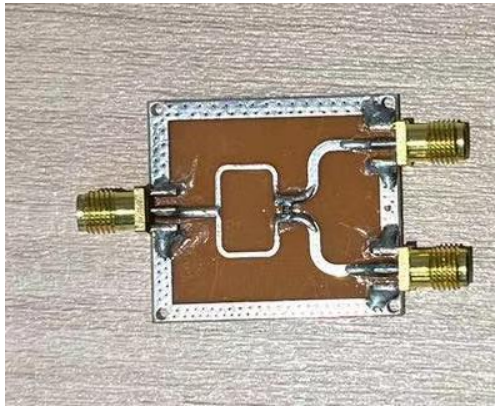
LibreVNA盒内器件清单

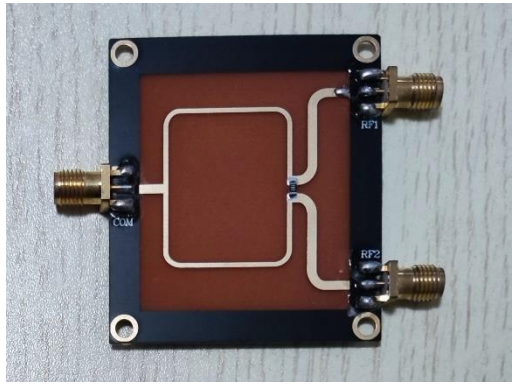
1. LibreVNA 主机 **x 1**
2. USB type-C 数据线 **x1**
3. USB转3.5mm电源线 **x1**
4. 30cm SMA SS405 测试电缆 **x2**
5. SMA 公头校准件 - OPEN **x1**
6. SMA 公头校准件 - SHORT **x1**
7. SMA 公头校准件 - LOAD **x2**
8. SMA 公对公连接器 **x2**
9. SMA 母对母连接器 **x2**
10. 英文用户手册 **x1**
11. 垫脚 **x4**

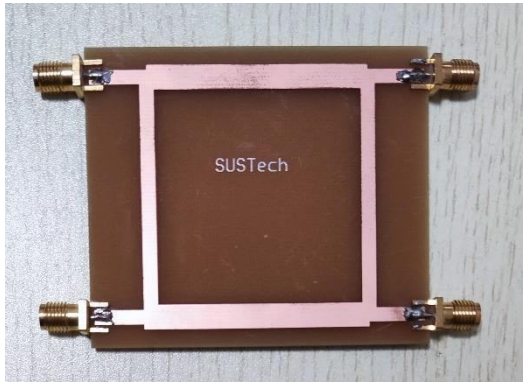
校准件

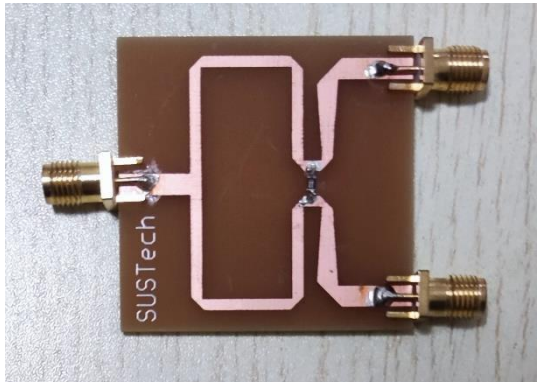
DUT： Device Under Test，被测器件

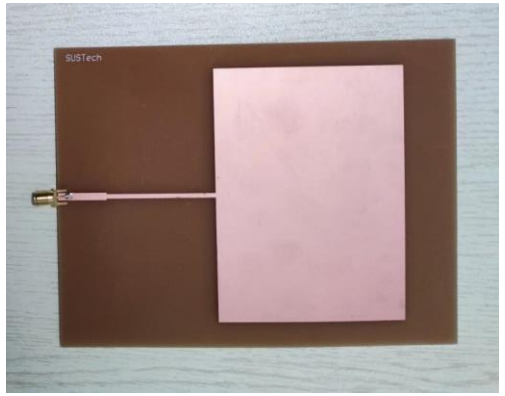


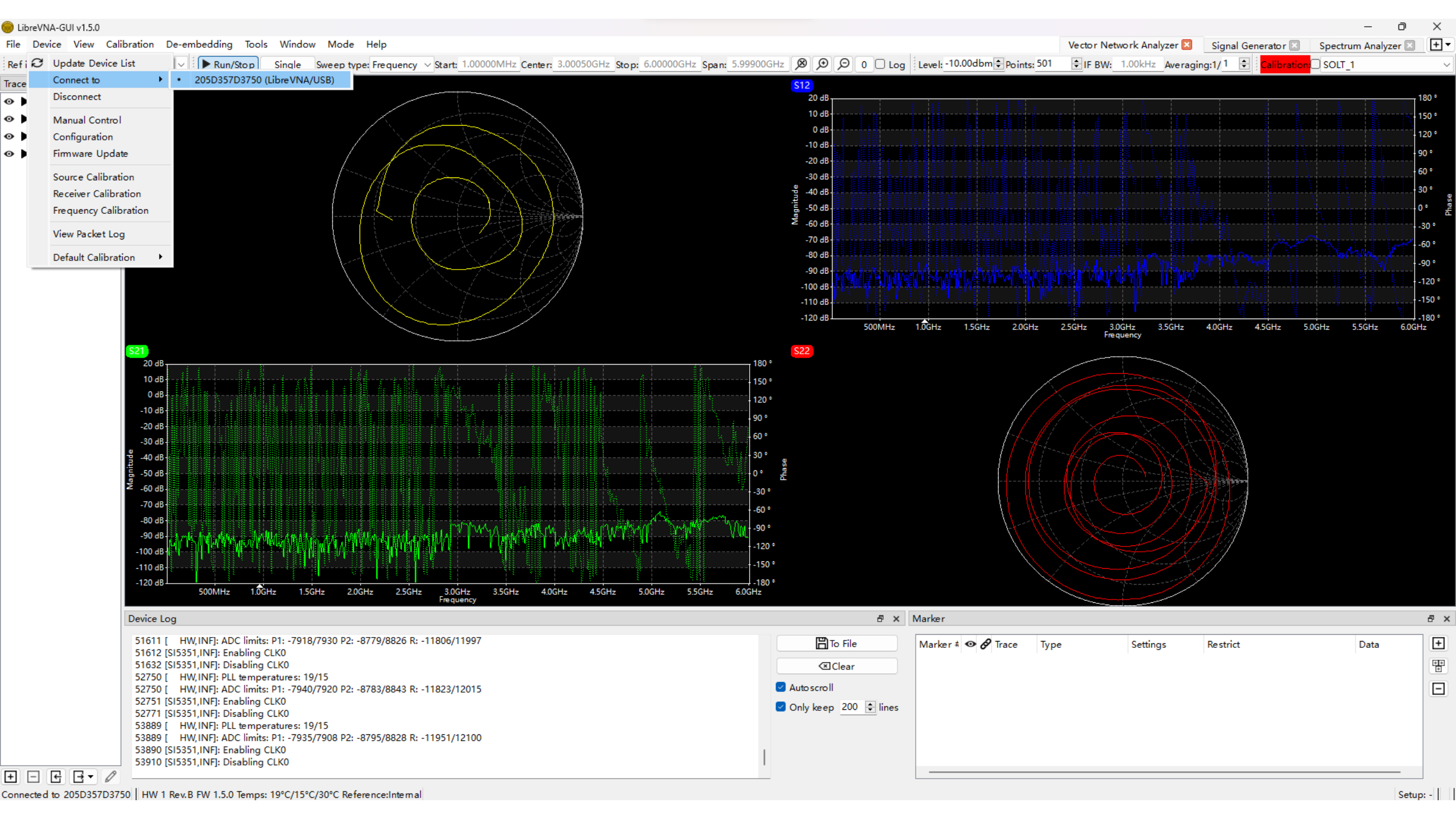




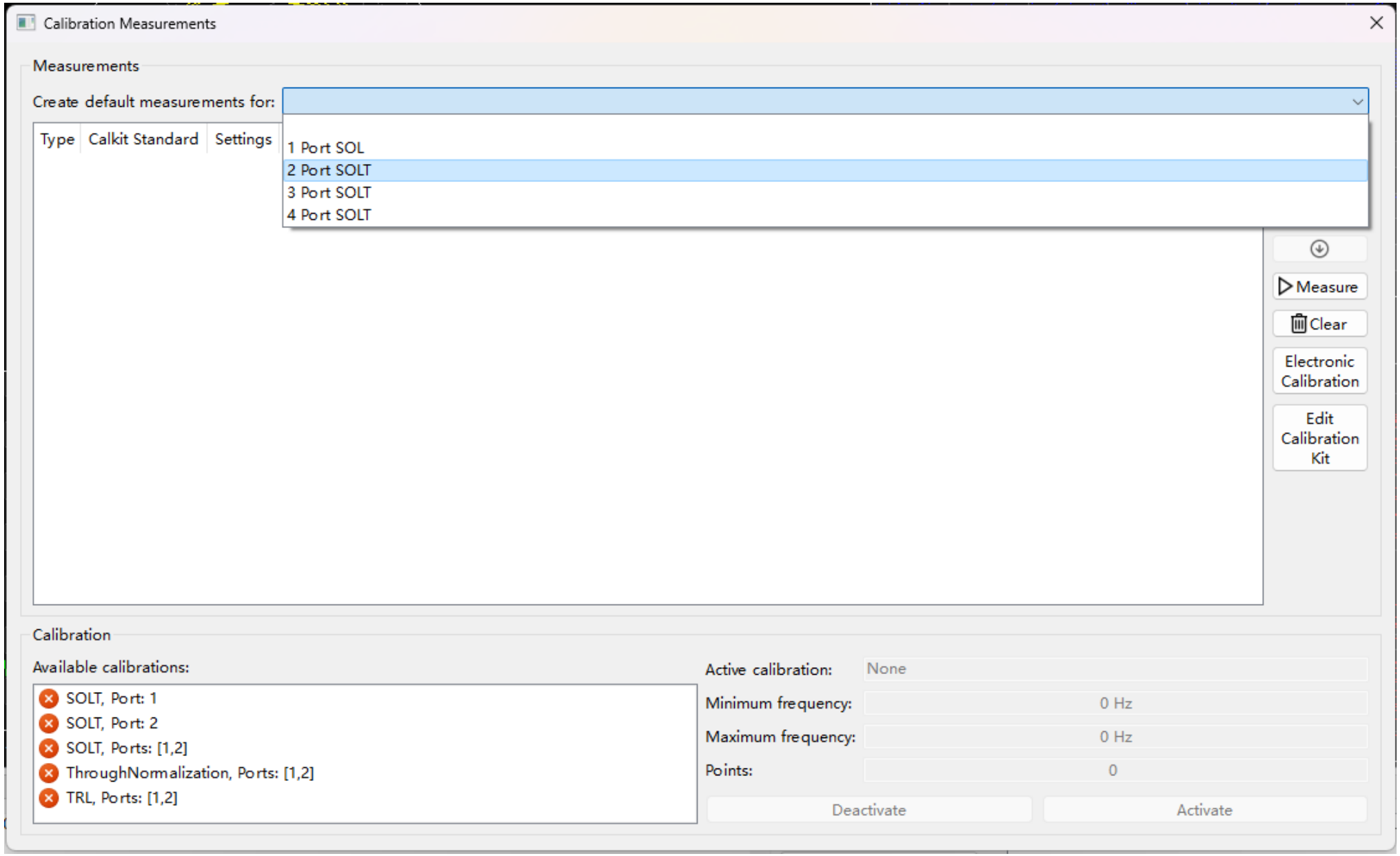




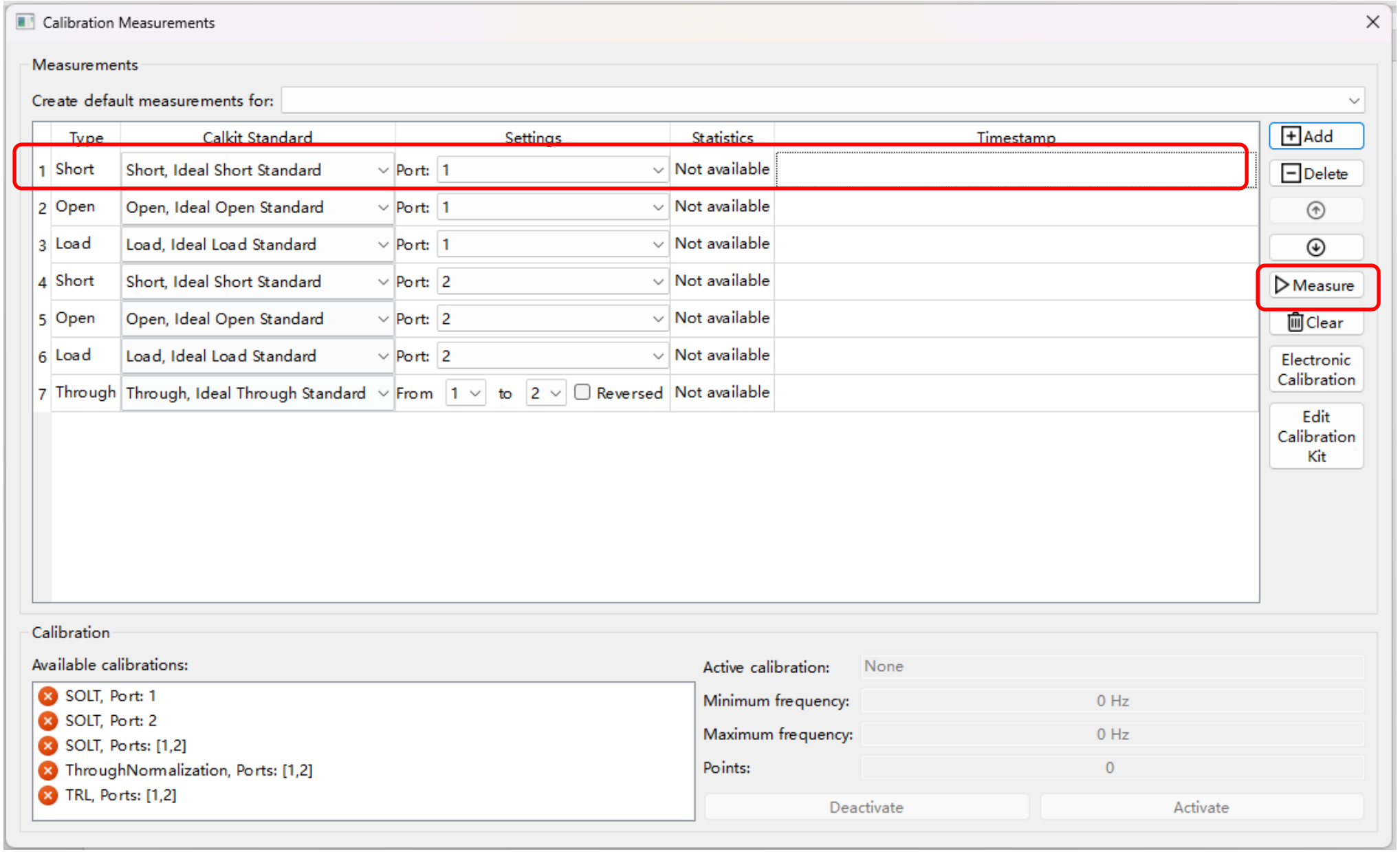


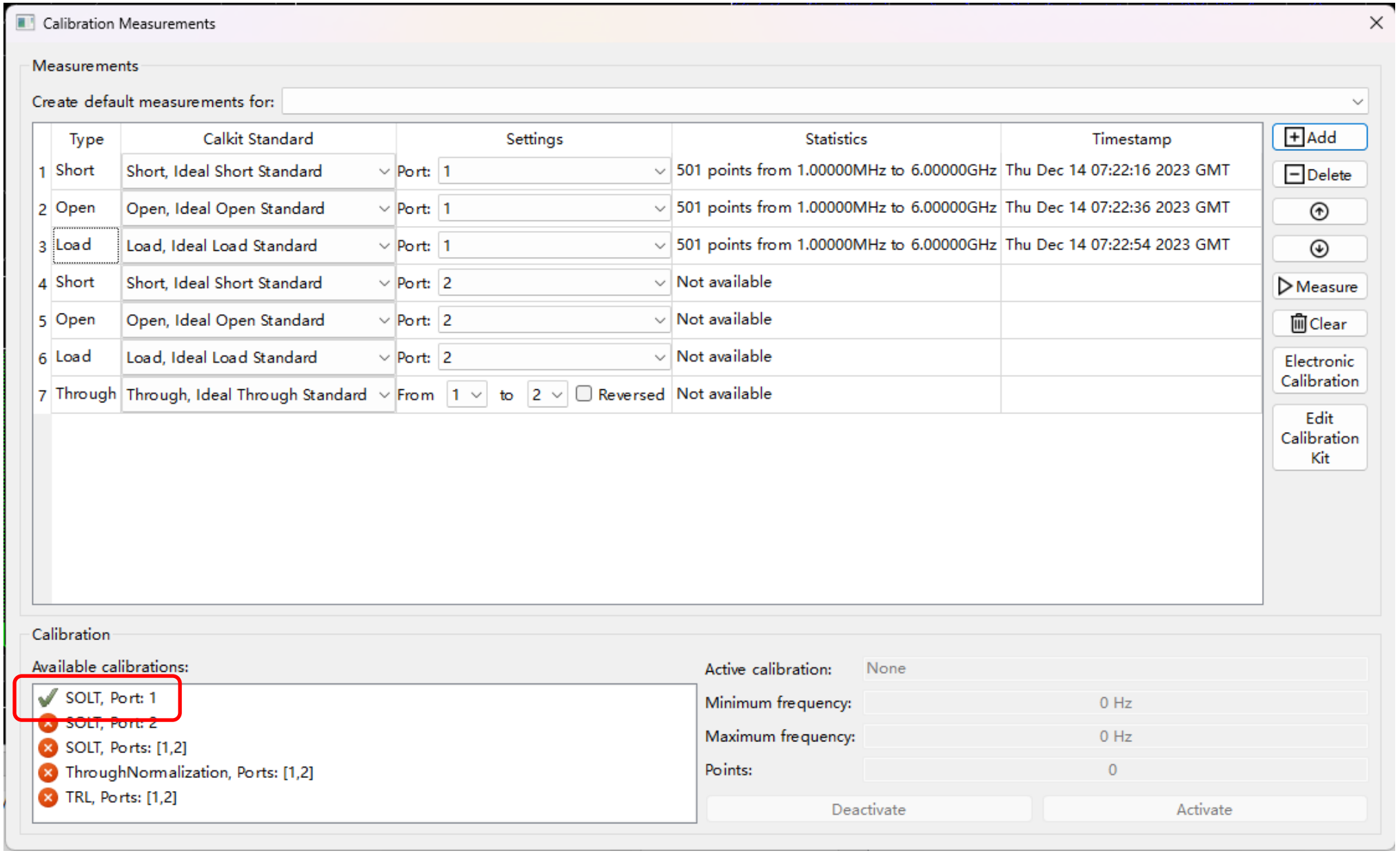

LibreVNA-GUI v1.5.0
File
Device
View
Calibration
De-embedding
Tools
Window
Mode
Help
Vector Network Analyzer
Signal Generator
Spectrum Analyzer
Update Device List
Connect to
205D357D3750 (LibreVNA/USB)
Disconnect
Manual Control
Configuration
Firmware Update
Source Calibration
Receiver Calibration
Frequency Calibration
View Packet Log
Default Calibration
Run/Stop
Single
Sweep type: Frequency
Start: 1.00000MHz
Center: 3.00050GHz
Stop: 6.00000GHz
Span: 5.99900GHz
Log
Level: -10.00dbm
Points: 501
IF BW: 1.00kHz
Averaging:1/1
Calibration
SOLT_1
S12
S21
S22
Magnitude
Phase
Frequency
500MHz
1.0GHz
1.5GHz
2.0GHz
2.5GHz
3.0GHz
3.5GHz
4.0GHz
4.5GHz
5.0GHz
5.5GHz
6.0GHz
Device Log
51611 [HW,INF]: ADC limits: P1: -7918/7930 P2: -8779/8826 R: -11806/11997
51612 [SI5351,INF]: Enabling CLK0
51632 [SI5351,INF]: Disabling CLK0
52750 [HW,INF]: PLL temperatures: 19/15
52750 [HW,INF]: ADC limits: P1: -7940/7920 P2: -8783/8843 R: -11823/12015
52751 [SI5351,INF]: Enabling CLK0
52771 [SI5351,INF]: Disabling CLK0
53889 [HW,INF]: PLL temperatures: 19/15
53889 [HW,INF]: ADC limits: P1: -7935/7908 P2: -8795/8828 R: -11951/12100
53890 [SI5351,INF]: Enabling CLK0
53910 [SI5351,INF]: Disabling CLK0
To File
Clear
Autoscroll
Only keep 200 lines
Marker
Marker #
Trace
Type
Settings
Restrict
Data
Connected to 205D357D3750
HW 1 Rev.B FW 1.5.0 Temps: 19°C/15°C/30°C Reference:Internal
Setup: -

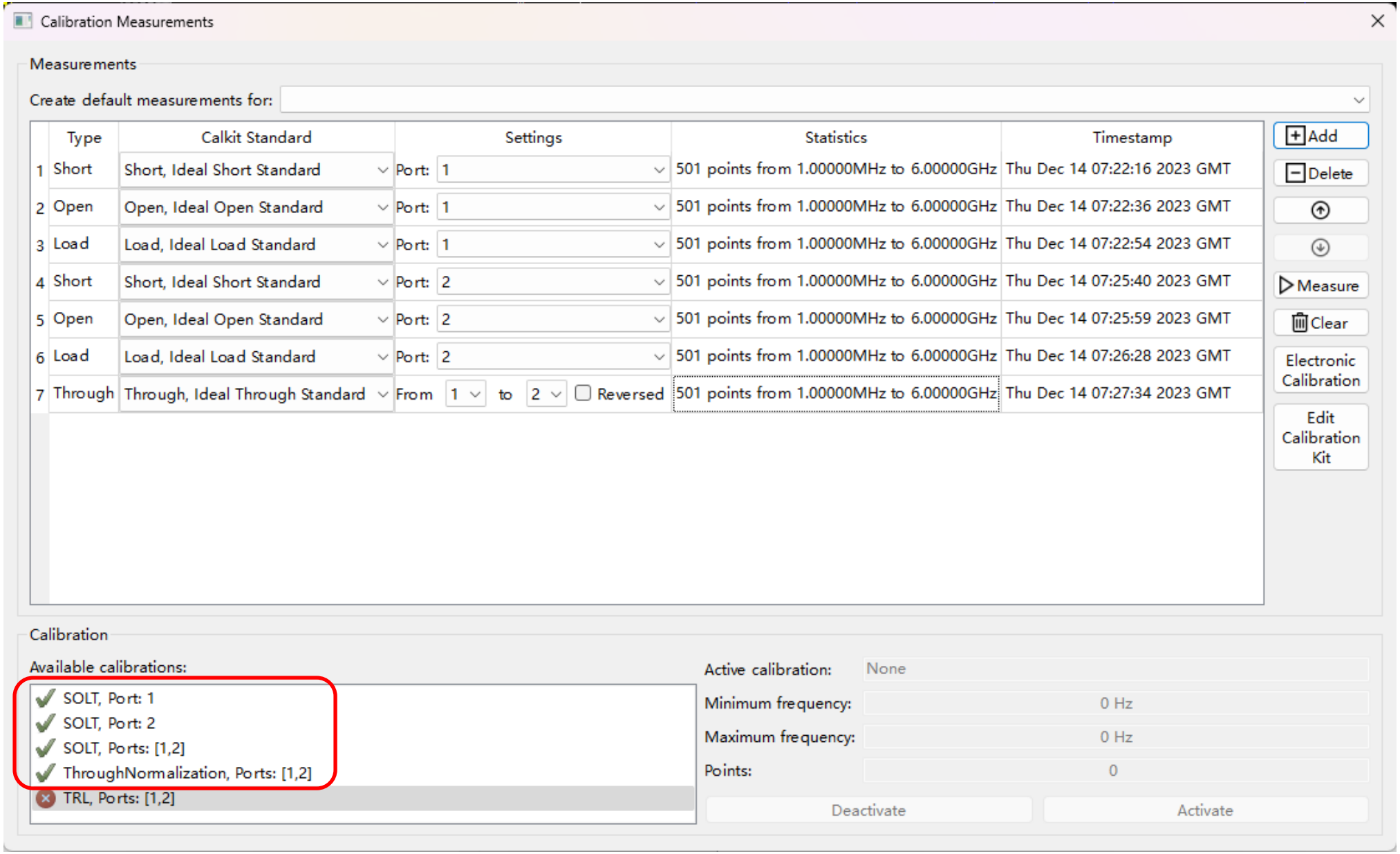
Calibration-> Calibration Measurements



逐一进行校准测量


Calibration Measurements
Measurements
Create default measurements for:
Type
Calkit Standard
Settings
Statistics
Timestamp
1 Short
Short, Ideal Short Standard
Port: 1
Not available
2 Open
Open, Ideal Open Standard
Port: 1
Not available
3 Load
Load, Ideal Load Standard
Port: 1
Not available
4 Short
Short, Ideal Short Standard
Port: 2
Not available
5 Open
Open, Ideal Open Standard
Port: 2
Not available
6 Load
Load, Ideal Load Standard
Port: 2
Not available
7 Through
Through, Ideal Through Standard
From 1 to 2 Reversed
Not available
Add
Delete
Measure
Clear
Electronic Calibration
Edit Calibration Kit
Calibration
Available calibrations:
SOLT, Port: 1
SOLT, Port: 2
SOLT, Ports: [1,2]
ThroughNormalization, Ports: [1,2]
TRL, Ports: [1,2]
Active calibration:
None
Minimum frequency:
0 Hz
Maximum frequency:
0 Hz
Points:
0
Deactivate
Activate


Calibration Measurements
Measurements
Create default measurements for:
Type
Calkit Standard
Settings
Statistics
Timestamp
1 Short Short, Ideal Short Standard Port: 1 501 points from 1.00000MHz to 6.00000GHz Thu Dec 14 07:22:16 2023 GMT
2 Open Open, Ideal Open Standard Port: 1 501 points from 1.00000MHz to 6.00000GHz Thu Dec 14 07:22:36 2023 GMT
3 Load Load, Ideal Load Standard Port: 1 501 points from 1.00000MHz to 6.00000GHz Thu Dec 14 07:22:54 2023 GMT
4 Short Short, Ideal Short Standard Port: 2 Not available
5 Open Open, Ideal Open Standard Port: 2 Not available
6 Load Load, Ideal Load Standard Port: 2 Not available
7 Through Through, Ideal Through Standard From 1 to 2 Reversed Not available
Add
Delete
Measure
Clear
Electronic Calibration
Edit Calibration Kit
Calibration
Available calibrations:
SOLT, Port: 1
SOLT, Port: 2
SOLT, Ports: [1,2]
ThroughNormalization, Ports: [1,2]
TRL, Ports: [1,2]
Active calibration: None
Minimum frequency: 0 Hz
Maximum frequency: 0 Hz
Points: 0
Deactivate
Activate


Calibration Measurements
Measurements
Create default measurements for:
Type
Calkit Standard
Settings
Statistics
Timestamp
1 Short
Short, Ideal Short Standard
Port: 1
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:22:16 2023 GMT
2 Open
Open, Ideal Open Standard
Port: 1
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:22:36 2023 GMT
3 Load
Load, Ideal Load Standard
Port: 1
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:22:54 2023 GMT
4 Short
Short, Ideal Short Standard
Port: 2
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:25:40 2023 GMT
5 Open
Open, Ideal Open Standard
Port: 2
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:25:59 2023 GMT
6 Load
Load, Ideal Load Standard
Port: 2
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:26:28 2023 GMT
7 Through
Through, Ideal Through Standard
From 1 to 2 Reversed
501 points from 1.00000MHz to 6.00000GHz
Thu Dec 14 07:27:34 2023 GMT
Add
Delete
Measure
Clear
Electronic Calibration
Edit Calibration Kit
Calibration
Available calibrations:
SOLT, Port: 1
SOLT, Port: 2
SOLT, Ports: [1,2]
ThroughNormalization, Ports: [1,2]
TRL, Ports: [1,2]
Active calibration:
None
Minimum frequency:
0 Hz
Maximum frequency:
0 Hz
Points:
0
Deactivate
Activate

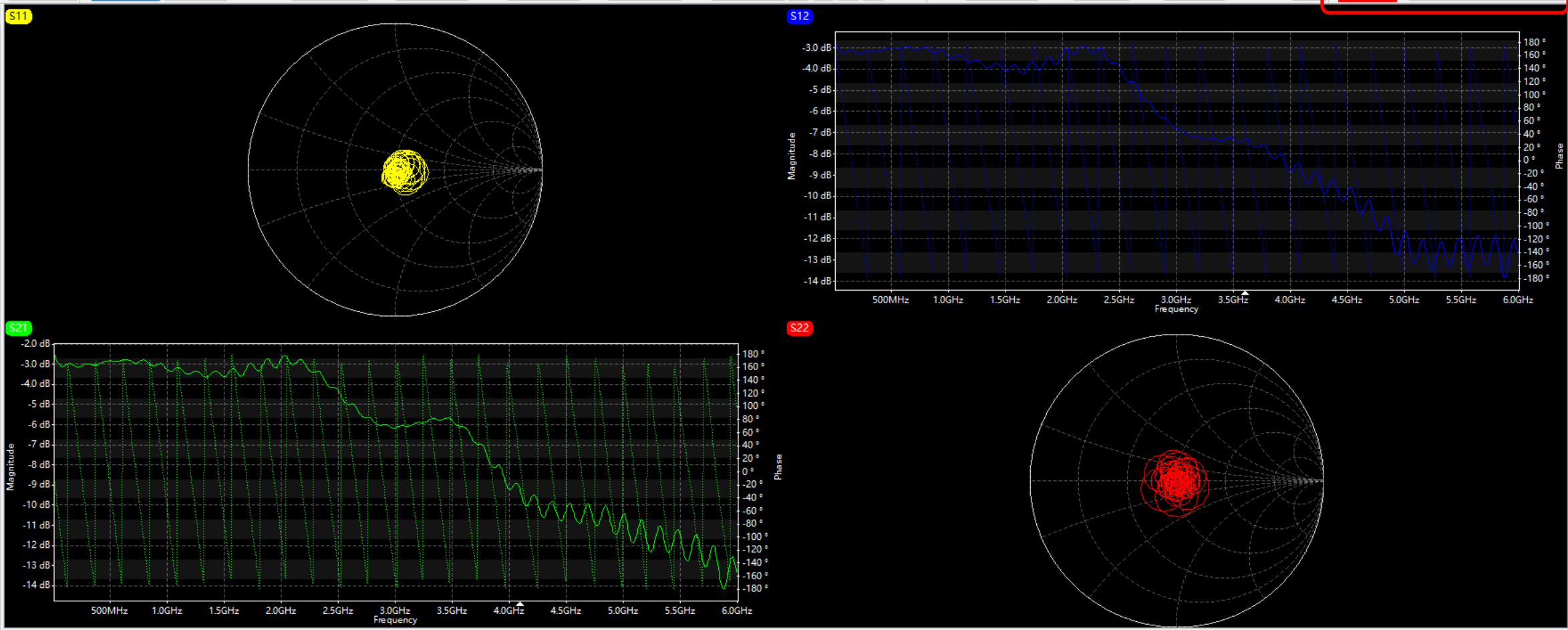
LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 1.00000MHz | Center: 3.00050GHz | Stop: 6.00000GHz | Span: 5.99900GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_1

Traces
- S11
- S12
- S21
- S22



Device Log

```
2577533 [    HW,INF]: ADC limits: P1: -7897/7864 P2: -8183/8088 R: -11538/11670
2577533 [SI5351,INF]: Enabling CLK0
2577553 [SI5351,INF]: Disabling CLK0
2578672 [    HW,INF]: PLL temperatures: 36/32
2578672 [    HW,INF]: ADC limits: P1: -7946/7951 P2: -8121/8118 R: -11534/11628
2578673 [SI5351,INF]: Enabling CLK0
2578693 [SI5351,INF]: Disabling CLK0
2579812 [    HW,INF]: PLL temperatures: 36/32
2579812 [    HW,INF]: ADC limits: P1: -7936/7906 P2: -8119/8112 R: -11502/11653
2579812 [SI5351,INF]: Enabling CLK0
2579833 [SI5351,INF]: Disabling CLK0
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #		Trace	Type	Settings	Restrict	Data

Connected to 205D357D3750 | HW 1 Rev.B FW 1.5.0 Temps: 36°C/32°C/44°C Reference:Internal | Setup: -

非常重要!

LibreVNA-GUI v1.5.0

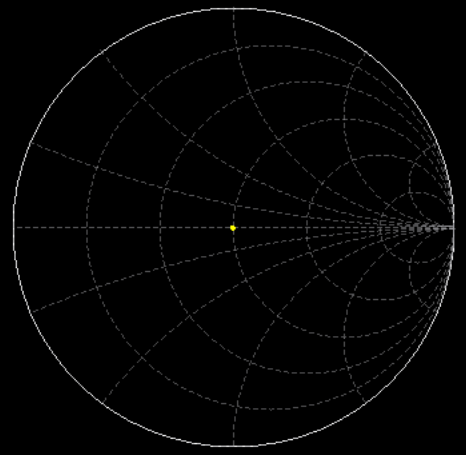
File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

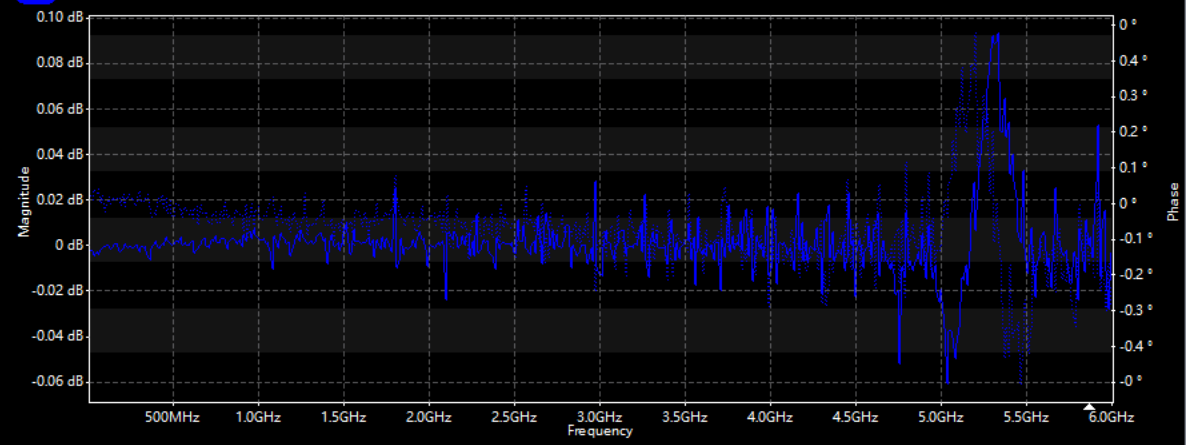
Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 1.00000MHz | Center: 3.00050GHz | Stop: 6.00000GHz | Span: 5.99900GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22

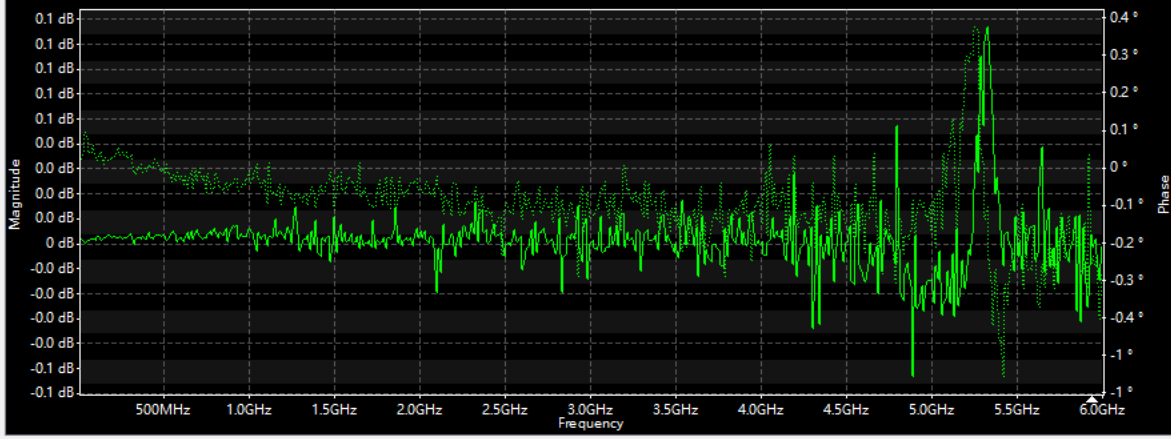
S11



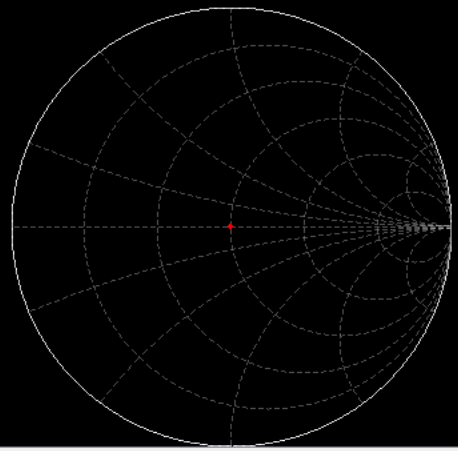
S12



S21



S22



Device Log

```
2801370 [    HW,INF]: ADC limits: P1: -7957/7922 P2: -8120/8122 R: -11511/11732
2801371 [SI5351,INF]: Enabling CLK0
2801391 [SI5351,INF]: Disabling CLK0
2802510 [    HW,INF]: PLL temperatures: 36/32
2802510 [    HW,INF]: ADC limits: P1: -7924/7956 P2: -8016/8030 R: -11494/11660
2802511 [SI5351,INF]: Enabling CLK0
2802530 [SI5351,INF]: Disabling CLK0
2803649 [    HW,INF]: PLL temperatures: 36/32
2803649 [    HW,INF]: ADC limits: P1: -7995/7984 P2: -8095/8156 R: -11564/11716
2803650 [SI5351,INF]: Enabling CLK0
2803670 [SI5351,INF]: Disabling CLK0
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #	Trace	Type	Settings	Restrict	Data

Connected to 205D357D3750 | HW 1 Rev.B FW 1.5.0 Temps: 36°C/32°C/44°C Reference:Internal | Setup: - | Calibration: Unsaved

一般在工作频率附近进行校准

LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 1.00000MHz | Center: 3.00050GHz | Stop: 6.00000GHz | Span: 5.99900GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/1 | Calibration: SOLT_12

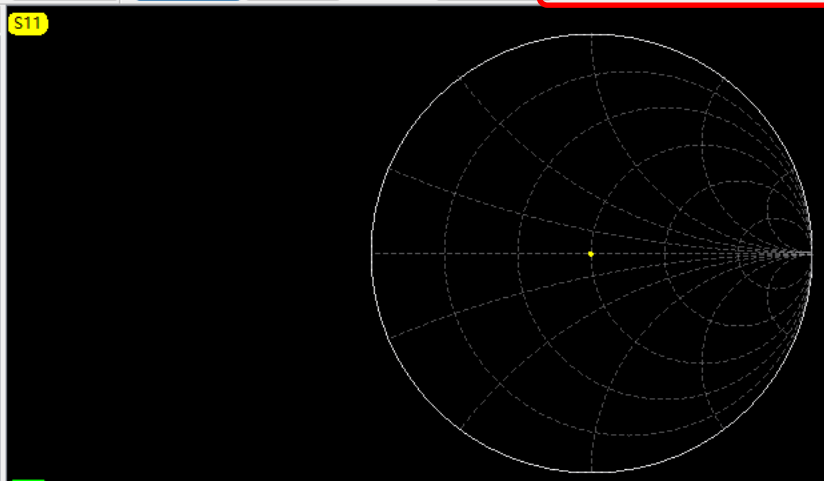
Traces

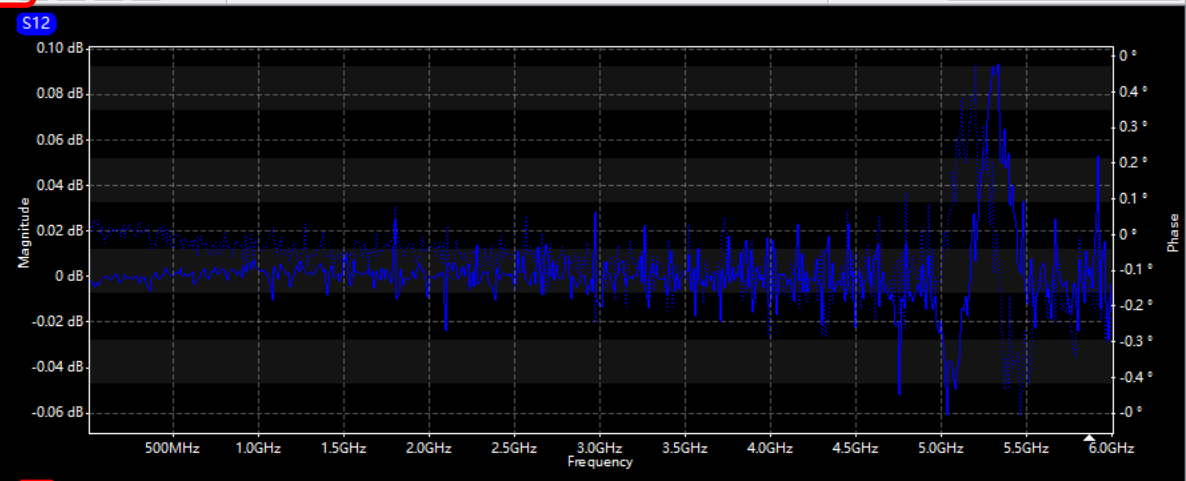
S11

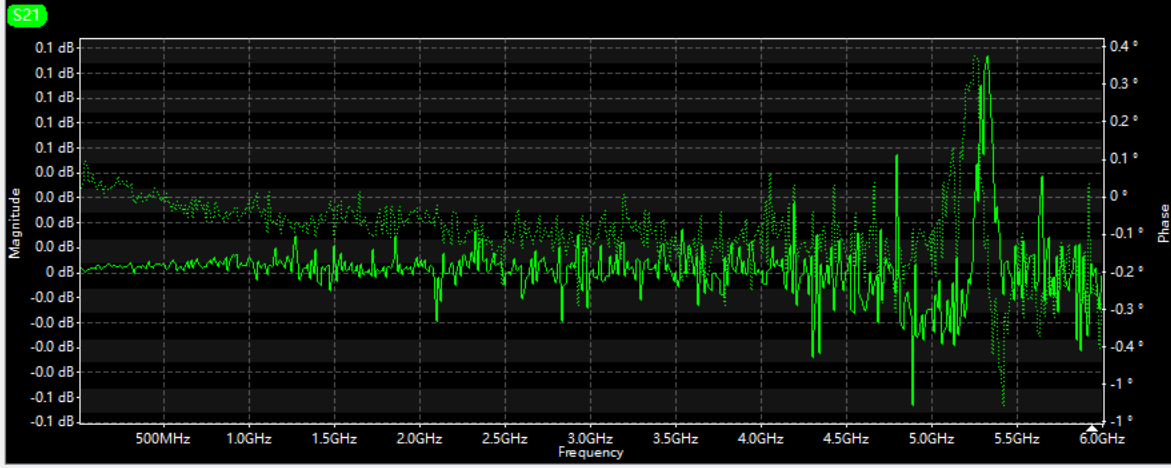
S12

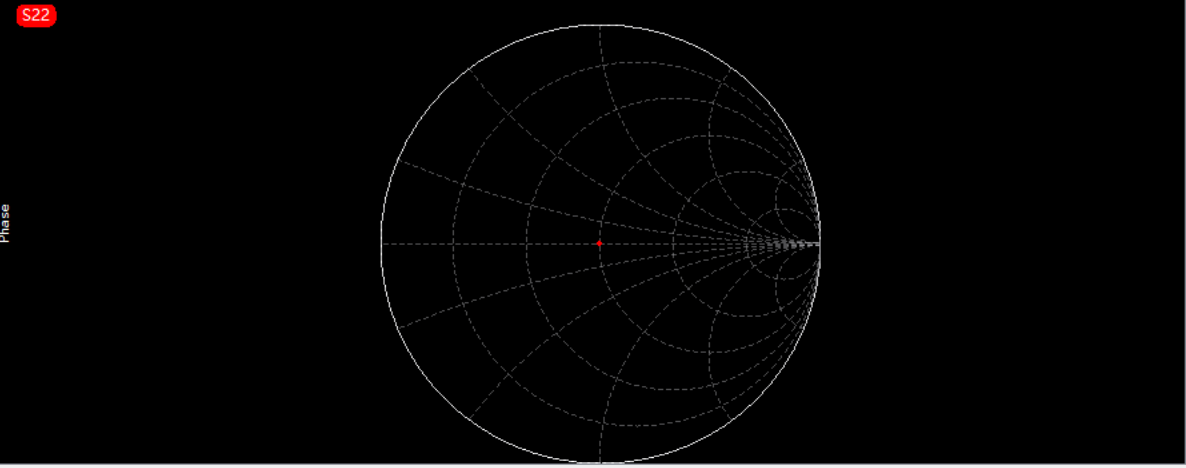
S21

S22









Device Log

```
2801370 [    HW,INF]: ADC limits: P1: -7957/7922 P2: -8120/8122 R: -11511/11732
2801371 [SI5351,INF]: Enabling CLK0
2801391 [SI5351,INF]: Disabling CLK0
2802510 [    HW,INF]: PLL temperatures: 36/32
2802510 [    HW,INF]: ADC limits: P1: -7924/7956 P2: -8016/8030 R: -11494/11660
2802511 [SI5351,INF]: Enabling CLK0
2802530 [SI5351,INF]: Disabling CLK0
2803649 [    HW,INF]: PLL temperatures: 36/32
2803649 [    HW,INF]: ADC limits: P1: -7995/7984 P2: -8095/8156 R: -11564/11716
2803650 [SI5351,INF]: Enabling CLK0
2803670 [SI5351,INF]: Disabling CLK0
```

To File | Clear | Autoscroll | Only keep 200 lines

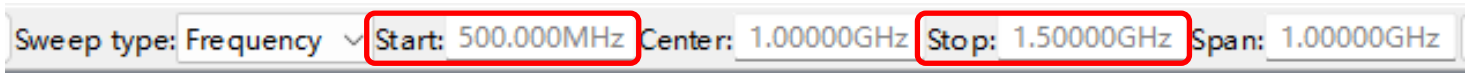
Marker

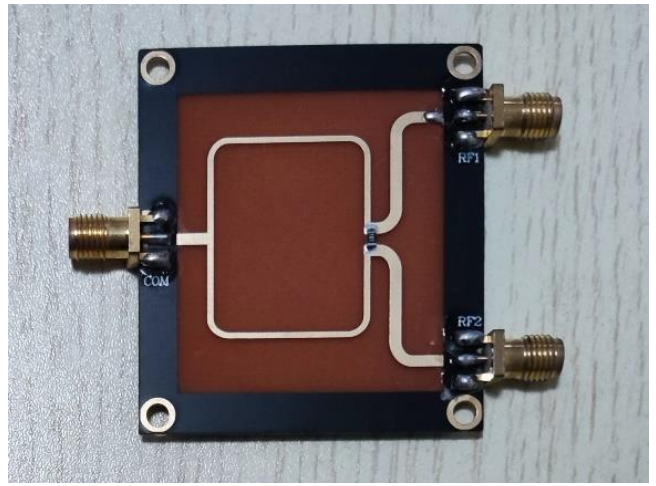
Marker #	Trace	Type	Settings	Restrict	Data

Connected to 205D357D3750 | HW 1 Rev.B FW 1.5.0 Temps: 36°C/32°C/44°C Reference:Internal | Setup: - | Calibration: Unsaved

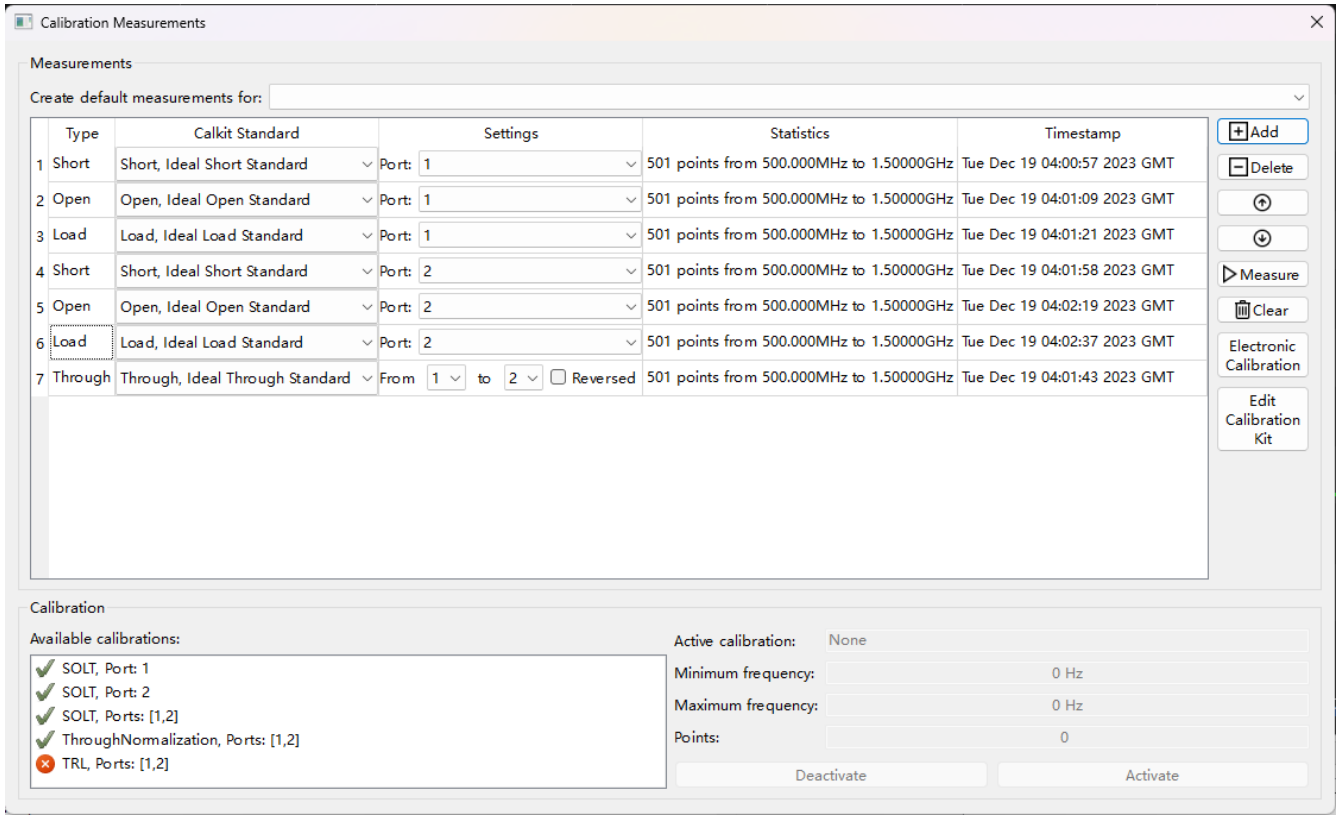
威尔金森功分器测试

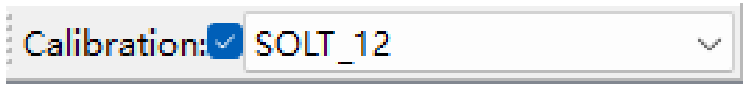
设置频率：500M-1.5G





带内校准





LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 500.000MHz | Center: 1.00000GHz | Stop: 1.50000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22

S21 S11

S11 & S21

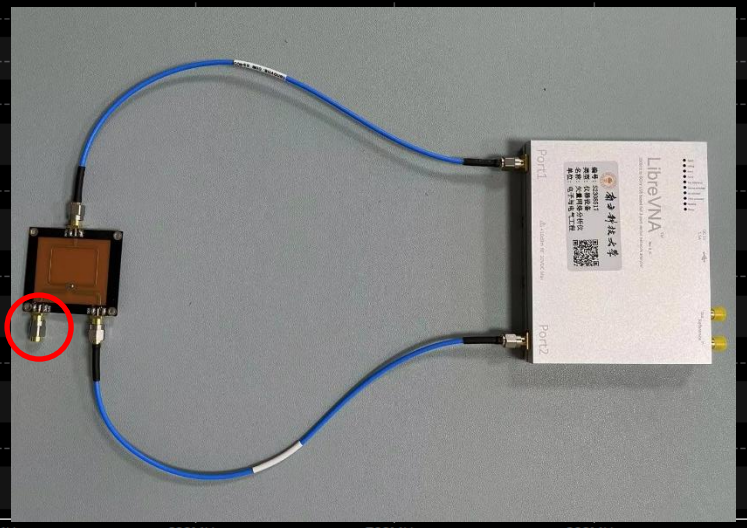
2 1.00000GHz
-3.455 dB
-3.455 dB/-177.9 °
-0.6714 +-0.02489 j

1 1.00000GHz
-26.68 dB
-26.68 dB/78.7 °
0.00908 +0.04546 j
50.704 Ω+4.6204 Ωj
VSWR: 1.0972 :1
50.70 Ω
-34.45pF
0.7354nH
Q:0.091

Magnitude: -2.0 dB, -4.0 dB, -6 dB, -8 dB, -10 dB, -12 dB, -14 dB, -16 dB, -18 dB, -20 dB, -22 dB, -24 dB, -26 dB, -28 dB, -30 dB, -32 dB, -34 dB, -36 dB, -38 dB, -40 dB

Phase: 180 °, 150 °, 120 °, 90 °, 60 °, 30 °, 0 °, -30 °, -60 °, -90 °, -120 °, -150 °, -180 °

Frequency: 500MHz, 600MHz, 700MHz, 800MHz, 900MHz, 1.0GHz, 1.1GHz, 1.2GHz, 1.3GHz, 1.4GHz, 1.5GHz



Device Log

```
946159 [    HW,INF]: ADC limits: P1: -4699/4734 P2: -4696/4707 R: -10539/10682
947332 [    HW,INF]: PLL temperatures: 26/33
947332 [    HW,INF]: ADC limits: P1: -4691/4728 P2: -4682/4709 R: -10507/10738
948505 [    HW,INF]: PLL temperatures: 26/33
948505 [    HW,INF]: ADC limits: P1: -4691/4731 P2: -4691/4713 R: -10508/10700
949678 [    HW,INF]: PLL temperatures: 26/33
949678 [    HW,INF]: ADC limits: P1: -4688/4734 P2: -4736/4710 R: -10504/10712
950851 [    HW,INF]: PLL temperatures: 26/33
950851 [    HW,INF]: ADC limits: P1: -4683/4729 P2: -4733/4700 R: -10507/10704
952023 [    HW,INF]: PLL temperatures: 26/33
952024 [    HW,INF]: ADC limits: P1: -4706/4731 P2: -4700/4714 R: -10537/10714
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #		Trace	Type	Settings	Restrict	Data
1		S11	Manual	1.00000GHz	from 0 Hz to 0 Hz	-26.68 dB/78.7
2		S21	Manual	1.00000GHz	from 0 Hz to 0 Hz	-3.455 dB/-17..

Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 26°C/33°C/31°C Reference:Internal | Setup: - | Calibration: SOLT_12_1_00M-6_00G_501pt.cal

LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 500.000MHz | Center: 1.00000GHz | Stop: 1.50000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22

S21 S11

S11 & S31

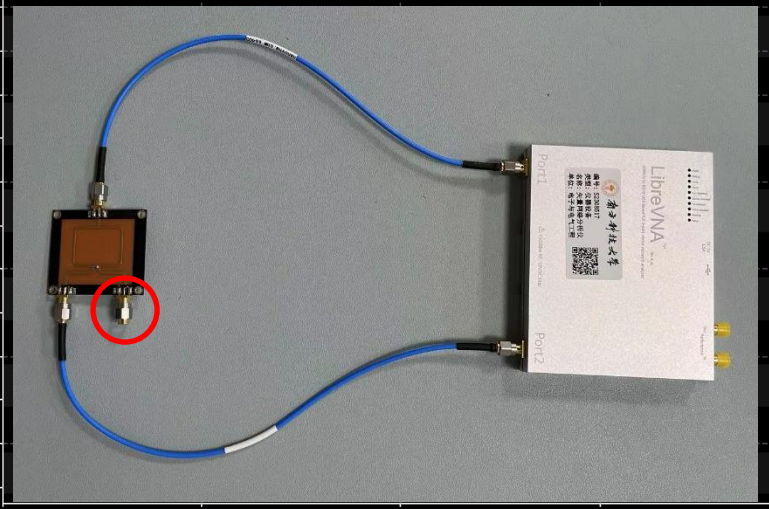
2 1.00000GHz
-3.490 dB
-3.490 dB/-177.8 °
-0.6686 +-0.02598 j

1 1.00000GHz
-27.75 dB
-27.75 dB/74.3 °
0.01110 +0.03944 j
50.962 Ω+4.0264 Ωj
VSWR: 1.0854 :1
50.96 Ω
-39.53pF
0.6408nH
Q:0.079

Magnitude: -2.0 dB, -4.0 dB, -6 dB, -8 dB, -10 dB, -12 dB, -14 dB, -16 dB, -18 dB, -20 dB, -22 dB, -24 dB, -26 dB, -28 dB, -30 dB, -32 dB, -34 dB, -36 dB, -38 dB, -40 dB

Phase: 180 °, 150 °, 120 °, 90 °, 60 °, 30 °, 0 °, -30 °, -60 °, -90 °, -120 °, -150 °, -180 °

500MHz 600MHz 700MHz 800MHz 900MHz 1.0GHz 1.1GHz 1.2GHz 1.3GHz 1.4GHz 1.5GHz
Frequency



Device Log

```
1124455 [  HW,INF]: PLL temperatures: 27/34
1124455 [  HW,INF]: ADC limits: P1: -4704/4703 P2: -4668/4678 R: -10465/10685
1125627 [  HW,INF]: PLL temperatures: 27/34
1126801 [  HW,INF]: PLL temperatures: 27/34
1126801 [  HW,INF]: ADC limits: P1: -4670/4715 P2: -4665/4695 R: -10446/10661
1127973 [  HW,INF]: PLL temperatures: 27/34
1127974 [  HW,INF]: ADC limits: P1: -4687/4717 P2: -4700/4693 R: -10432/10635
1129147 [  HW,INF]: PLL temperatures: 27/34
1129147 [  HW,INF]: ADC limits: P1: -4695/4720 P2: -4718/4693 R: -10475/10667
1130320 [  HW,INF]: PLL temperatures: 27/34
1130320 [  HW,INF]: ADC limits: P1: -4695/4719 P2: -4678/4698 R: -10475/10669
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #	Trace	Type	Settings	Restrict	Data
1	S11	Manual	1.00000GHz	from 0 Hz to 0 Hz	-27.75 dB/74.3
2	S21	Manual	1.00000GHz	from 0 Hz to 0 Hz	-3.490 dB/-17..

Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 27°C/34°C/32°C Reference:Internal | Setup: - | Calibration: SOLT_12_1_00M-6_00G_501pt.cal

LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 500.000MHz | Center: 1.00000GHz | Stop: 1.50000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22

S21 S11

S22 & S32

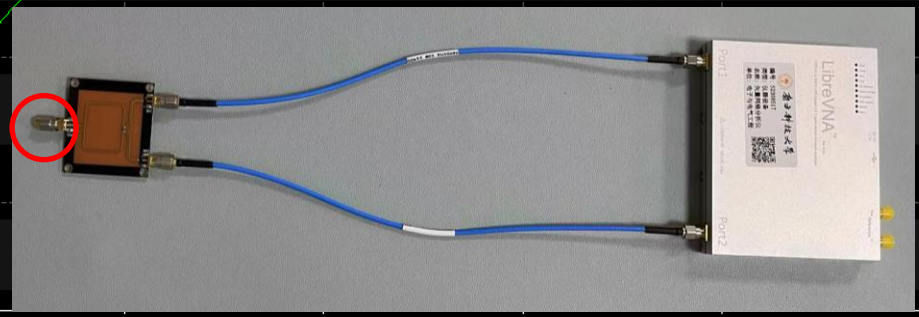
2 1.00000GHz
-27.30 dB
-27.30 dB/17.18 °
0.04125 +0.01275 j

1 1.00000GHz
-20.74 dB
-20.74 dB/-156.5 °
-0.08419 +-0.03661 j
42.130 Ω+-3.1112 Ωj
VSWR: 1.2022 :1
42.13 Ω
51.2pF
-495.2pH
Q:0.074

Magnitude: -10 dB, -12 dB, -14 dB, -16 dB, -18 dB, -20 dB, -22 dB, -24 dB, -26 dB, -28 dB, -30 dB, -32 dB

Phase: 180 °, 150 °, 120 °, 90 °, 60 °, 30 °, 0 °, -30 °, -60 °, -90 °, -120 °, -150 °, -180 °

500MHz 600MHz 700MHz 800MHz 900MHz 1.0GHz 1.1GHz 1.2GHz 1.3GHz 1.4GHz 1.5GHz
Frequency



Device Log

```
1448203 [  HW,INF]: ADC limits: P1: -2177/2173 P2: -2069/2065 R: -10406/10589
1449376 [  HW,INF]: PLL temperatures: 30/36
1449376 [  HW,INF]: ADC limits: P1: -2178/2172 P2: -2065/2058 R: -10388/10607
1450549 [  HW,INF]: PLL temperatures: 30/36
1450549 [  HW,INF]: ADC limits: P1: -2179/2169 P2: -2054/2073 R: -10386/10584
1451722 [  HW,INF]: PLL temperatures: 30/36
1451722 [  HW,INF]: ADC limits: P1: -2156/2183 P2: -2054/2066 R: -10390/10617
1452895 [  HW,INF]: PLL temperatures: 30/36
1452895 [  HW,INF]: ADC limits: P1: -2173/2175 P2: -2053/2072 R: -10427/10618
1454068 [  HW,INF]: PLL temperatures: 30/36
1454068 [  HW,INF]: ADC limits: P1: -2176/2183 P2: -2078/2061 R: -10408/10625
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

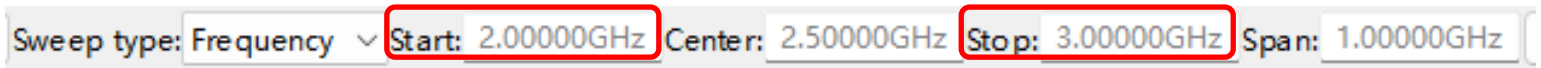
Marker #	Trace	Type	Settings	Restrict	Data
1	S11	Manual	1.00000GHz	from 0 Hz to 0 Hz	-20.74 dB/-15..
2	S21	Manual	1.00000GHz	from 0 Hz to 0 Hz	-27.30 dB/17...

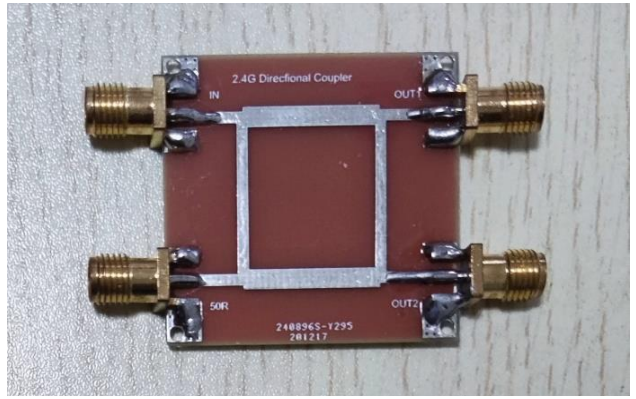
Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 30°C/36°C/35°C Reference:Internal

Setup: - | Calibration: SOLT_12_1_00M-6_00G_501pt.cal

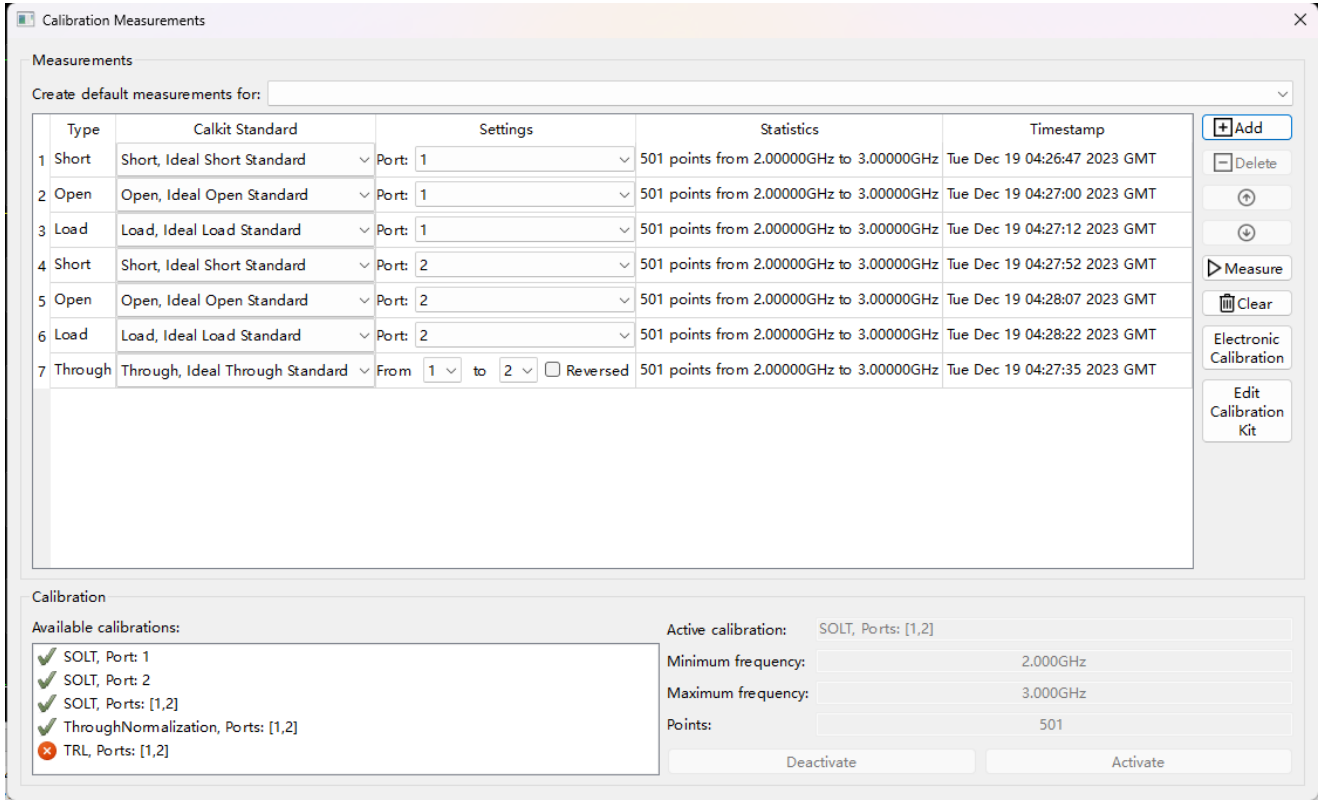
分支线定向耦合器测试

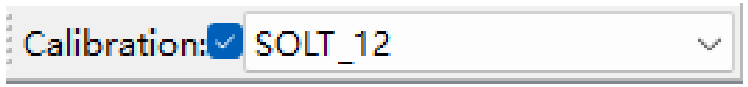
设置频率：2G-3G





带内校准





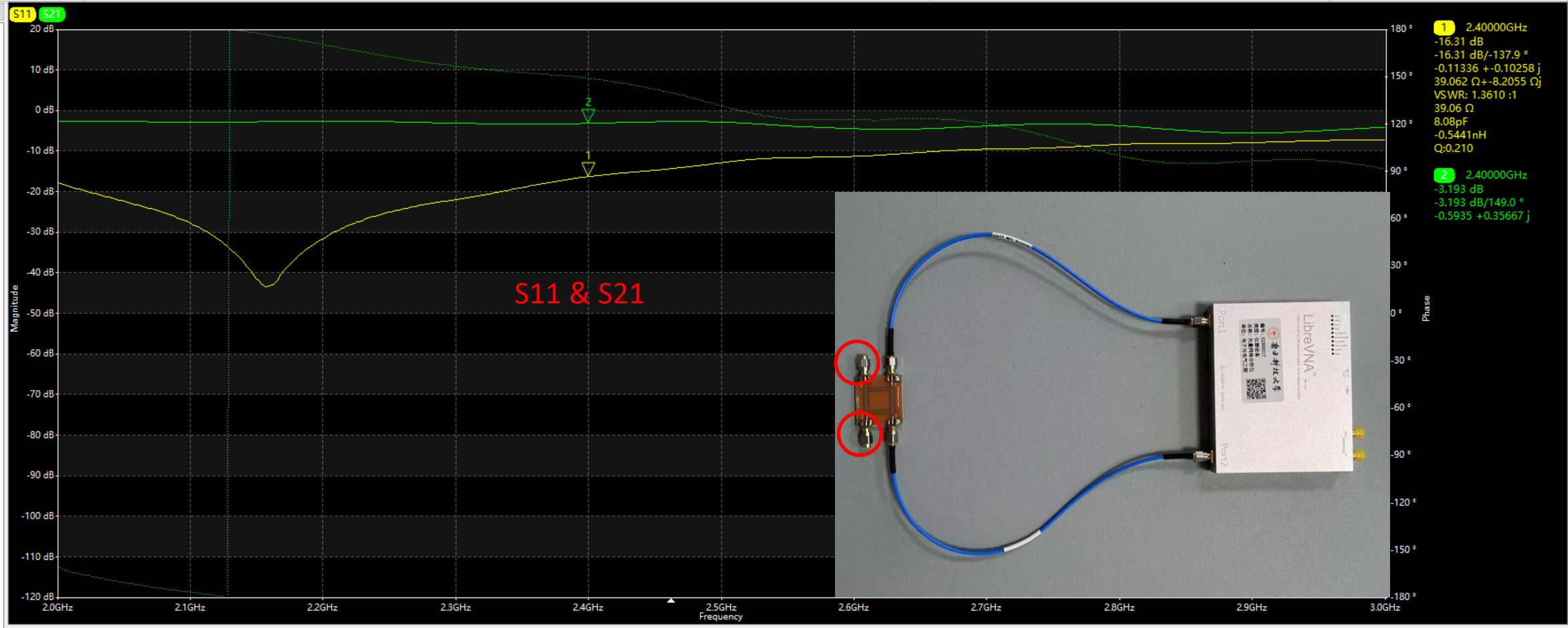
LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 2.00000GHz | Center: 2.50000GHz | Stop: 3.00000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22



Device Log

```
2515840 [ HW,INF]: ADC limits: P1: -4531/4595 P2: -4570/4606 R: -9980/10189
2516976 [ HW,INF]: PLL temperatures: 32/39
2516976 [ HW,INF]: ADC limits: P1: -4564/4606 P2: -4552/4598 R: -10009/10175
2518111 [ HW,INF]: PLL temperatures: 32/39
2518111 [ HW,INF]: ADC limits: P1: -4552/4603 P2: -4587/4588 R: -10107/10222
2519246 [ HW,INF]: PLL temperatures: 32/39
2519246 [ HW,INF]: ADC limits: P1: -4588/4609 P2: -4563/4599 R: -9977/10179
2520381 [ HW,INF]: PLL temperatures: 32/39
2520381 [ HW,INF]: ADC limits: P1: -4552/4593 P2: -4558/4598 R: -10027/10191
2521517 [ HW,INF]: PLL temperatures: 32/39
2521517 [ HW,INF]: ADC limits: P1: -4571/4617 P2: -4586/4597 R: -10032/10160
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker		Trace	Type	Settings	Restrict		Data
1		S11	Manual	2.40000GHz	from 0 Hz	to 0 Hz	-16.31 dB/-137.9 °
2		S21	Manual	2.40000GHz	from 0 Hz	to 0 Hz	-3.193 dB/149.0 °

Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 32°C/39°C/37°C Reference:Internal | Setup: - | Calibration: Unsaved

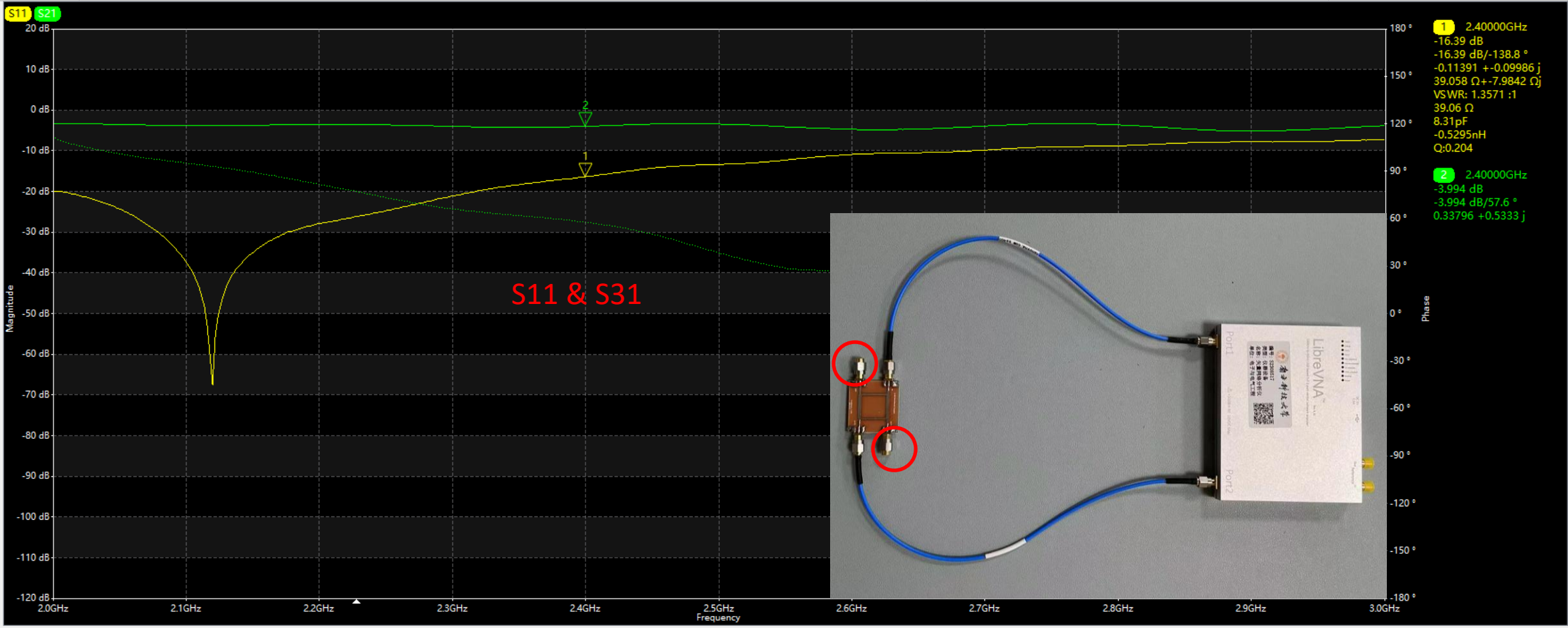
LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 2.00000GHz | Center: 2.50000GHz | Stop: 3.00000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging: 1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22



Device Log

```
2756501 [  HW,INF]: ADC limits: P1: -4103/4136 P2: -4136/4197 R: -9953/10142
2757636 [  HW,INF]: PLL temperatures: 33/40
2757636 [  HW,INF]: ADC limits: P1: -4131/4132 P2: -4141/4179 R: -9986/10206
2758771 [  HW,INF]: PLL temperatures: 33/40
2758771 [  HW,INF]: ADC limits: P1: -4098/4127 P2: -4171/4153 R: -10028/10151
2759906 [  HW,INF]: PLL temperatures: 33/40
2759906 [  HW,INF]: ADC limits: P1: -4135/4169 P2: -4221/4166 R: -9987/10151
2761041 [  HW,INF]: PLL temperatures: 33/40
2761041 [  HW,INF]: ADC limits: P1: -4129/4154 P2: -4156/4186 R: -9987/10152
2762176 [  HW,INF]: PLL temperatures: 33/40
2762176 [  HW,INF]: ADC limits: P1: -4119/4137 P2: -4177/4234 R: -9994/10153
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #	Trace	Type	Settings	Restrict	Data
1	S11	Manual	2.40000GHz	from 0 Hz to 0 Hz	-16.39 dB/-138.8 °
2	S21	Manual	2.40000GHz	from 0 Hz to 0 Hz	-3.994 dB/57.6 °

Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 33°C/40°C/38°C Reference:Internal | Setup: - | Calibration: Unsaved

LibreVNA-GUI v1.5.0

File Device View Calibration De-embedding Tools Window Mode Help

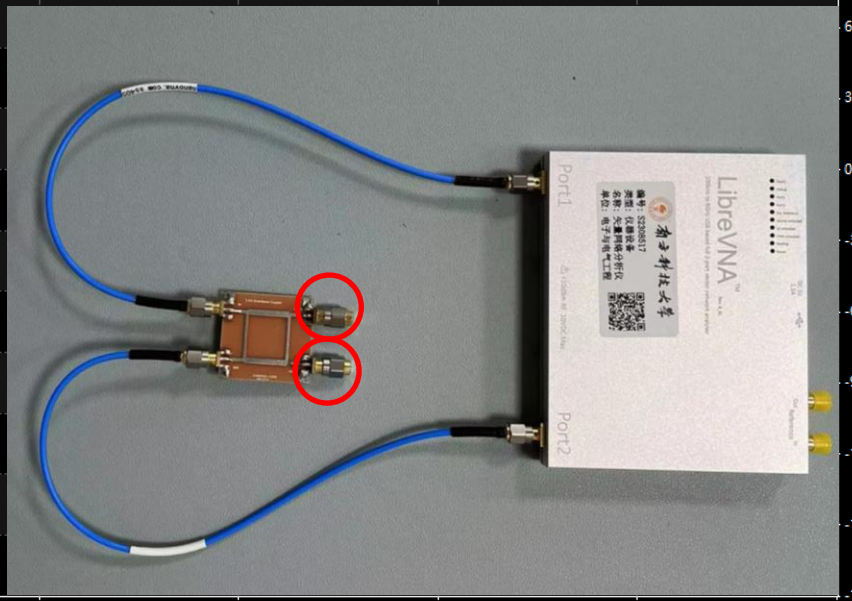
Vector Network Analyzer | Signal Generator | Spectrum Analyzer

Ref in: Internal | Ref out: Off | Run/Stop | Single | Sweep type: Frequency | Start: 2.00000GHz | Center: 2.50000GHz | Stop: 3.00000GHz | Span: 1.00000GHz | 0 | Log | Level: -10.00dbm | Points: 501 | IF BW: 1.00kHz | Averaging:1/ 1 | Calibration: SOLT_12

Traces
- S11
- S12
- S21
- S22

S11 S21

S11 & S41



1 2.40000GHz
-17.30 dB
-17.30 dB/-137.6 °
-0.10073 +-0.09212 j
40.217 Ω+-7.5507 Ωj
VSWR: 1.3162 :1
40.22 Ω
8.78pF
-0.5007nH
Q:0.188

2 2.40000GHz
-15.59 dB
-15.59 dB/-160.9 °
-0.15708 +-0.05427 j

Magnitude: 20 dB, 10 dB, 0 dB, -10 dB, -20 dB, -30 dB, -40 dB, -50 dB, -60 dB, -70 dB, -80 dB, -90 dB, -100 dB, -110 dB, -120 dB

Phase: 180 °, 150 °, 120 °, 90 °, 60 °, 30 °, 0 °, -30 °, -60 °, -90 °, -120 °, -150 °, -180 °

Frequency: 2.0GHz, 2.1GHz, 2.2GHz, 2.3GHz, 2.4GHz, 2.5GHz, 2.6GHz, 2.7GHz, 2.8GHz, 2.9GHz, 3.0GHz

Device Log

```
2850718 [  HW,INF]: ADC limits: P1: -2324/2341 P2: -2560/2556 R: -9978/10131
2851853 [  HW,INF]: PLL temperatures: 33/40
2851853 [  HW,INF]: ADC limits: P1: -2282/2298 P2: -2548/2541 R: -10006/10161
2852988 [  HW,INF]: PLL temperatures: 34/40
2852988 [  HW,INF]: ADC limits: P1: -2319/2339 P2: -2530/2545 R: -9941/10134
2854123 [  HW,INF]: PLL temperatures: 33/40
2854123 [  HW,INF]: ADC limits: P1: -2307/2329 P2: -2518/2531 R: -9927/10184
2855258 [  HW,INF]: PLL temperatures: 33/40
2855258 [  HW,INF]: ADC limits: P1: -2345/2363 P2: -2533/2542 R: -9936/10145
2856393 [  HW,INF]: PLL temperatures: 34/40
2856393 [  HW,INF]: ADC limits: P1: -2388/2393 P2: -2525/2568 R: -10005/10108
```

To File | Clear | Autoscroll | Only keep 200 lines

Marker

Marker #	Trace	Type	Settings	Restrict	Data
1	S11	Manual	2.40000GHz	from 0 Hz to 0 Hz	-17.30 dB/-137.6 °
2	S21	Manual	2.40000GHz	from 0 Hz to 0 Hz	-15.59 dB/-160.9 °

Connected to 206735AC3750 | HW 1 Rev.B FW 1.5.0 Temps: 34°C/40°C/38°C Reference:Internal | Setup: - | Calibration: Unsaved

小组课堂提交：

1、LibreVNA校准结果（Short、Open、Load、Through）

2、LibreVNA功分器和耦合器测试结果