

User Operator MANUAL

VNA6000P

MPTINST INC.

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Revision Sheet

Table 1

Release No.	Date	Revision Description
Rev. 0	07/16/2019	User's Manual Created

USER'S MANUAL

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1.0 GENERAL INFORMATION

A. GENERAL INFORMATION

1.0 Information

VNA6000P is a Portable, full 2-port 6 GHz VNA!

The VNA6000P was originally designed by YL3AKB. Interested users can refer to his website http://www.yl3akb.lv/content/vna_v2/vna_v2.php

Special thanks to YL3AKB for opening his code to me and allowing me to develop products based on his code!

VNA6000P is a fan project, you can study on it! The initial circuit diagram is provided in the manual! However, since this project is also used for commercial purposes, the project code is not available!

Note: the product has a bootloader installed for the firmware upgrade. If the user erases the bootloader, the product will no longer be available for upgrade.

Although YL3AKB has opened up his technology, fans can make a VNA by themselves, but because VNA works to 6G, if there is no skilled knowledge, it is difficult for fans to make it! In addition, due to the large number of devices, the cost of making BOM is very high!

But this design is very clever, especially with a MIXER to solve the directional bridge from 1M to 6G band! This determines that it is very practical and cheap! So I made this product and sold it at a reasonable price!

1.2 Main Features

- ✓ Frequency range: 1 MHz to 6 GHz
- ✓ Full two-port VNA: both ports can function as transmitter and receiver which allows to measure all four S-parameters without physically switching the DUT
- ✓ Above capability allows the implementation of standard VNA calibration procedures. Currently implemented procedures are 1-port OSL, 2-Port OSLT, 2-Port LMR16 and Transmission normalization for S21/S12. Industry standard models of calibration standards (separately for male and female connectors) are supported
- ✓ Due to architecture of this VNA, only one S-parameter can be measured at the time. Separate 1-Port and 2-Port modes are implemented. In 1-Port mode only S11 or S22 is measured which allows for faster trace update. In 2-port mode trace is updated after all 4 parameters are measured successively
- ✓ Currently two traces can be displayed simultaneously which can be set to combination any of four S-parameters and different data representations which includes: Log magnitude, Linear reflection coefficient, Impedance, VSWR, Phase, Group Delay. Trace display range and Ref. level can be changed for all formats
- ✓ Time Domain(TD) function is available in 1-Port mode. Implemented TD modes: Band-Pass impulse, Low-Pass impulse and Low-Pass step. It is possible to zoom and interpolate data in time axis for increased resolution
- ✓ Smith chart display is available which can be displayed simultaneously with Cartesian traces
- ✓ Two scrollable trace markers are available which includes 'Delta' function as well
- ✓ User can save data to Micro-SD card. Available data formats are BMP screen-shots, S-parameters (S1P or S2P files) and OSLT calibration coefficients. SD card also contains description of calibration standard model coefficients.
- ✓ Internal ('factory') calibration allows to do quick 1-Port/2-Port measurements without mechanical calibration
- ✓ Zero span option allows to use VNA as simple signal generator (unfiltered and level uncalibrated). On-board step attenuator allows to change signal power in range of 31.75 dB with steps of 0.25 dB
- ✓ All main settings, when changed, are automatically saved in on-board EEPROM

- ✓ VNA is powered from single 3200 mA Li-Po cell or +5 to +12Vdc wall adapter and includes circuit for automatic battery charging. Approximate battery life ranges from 3 to 4 hours depending on measurement mode (on 1-Port mode one channel can be powered off). Current consumption in operational mode ranges from 600 to 700 mA, but in sleep/power off mode is less than 100 μ A

1.3 Specifications

Technical characteristics of the device are shown in Table 2.

Table 2

Parameter name		Value
Operating frequency range		1-6000 MHz
Frequency resolution		3 Hz
Maximum number of scan points ¹		320
Scanning rate		320 points/s
The direction of the bridge, uncorrected throughout the range		>12 dB
Directivity effective ² (after full single-port calibration)		>50 dB
Standing wave ratio at the input		< 2
Phase measurement precision ²		> 1.5°
Magnitude measurement precision ²		>0.25 dB
Screen diagonal		3.2"
Screen resolution		320x240
Maximum current consumption, not more than	when charging the battery	500 mA
	when working on battery power	600 mA
	when working from Ext power with battery charging	1100 mA
Minimum DC input voltage		4.5 V
Maximum DC input voltage		12 V
Operating temperature range		0 ... + 40°C
Battery capacity		3200mAH
Continuous battery life ³		4H
Battery charge time		~6H
Overall dimensions (L×W×H)		155x81x27 mm
Weight		0.4 kg

In connection with the constant improvement of the design and software, the manufacturer reserves the right to make changes to the scheme, technical characteristics and completeness of this device.

- 1 The number of scanning points is the same as the width of the LCD, and is fixed at 320 points.
But if you use the PC software, the number of scanning points is determined by the setting of the PC software.
- 2 The measurement is performed after warming up the device for at least five minutes with a full (short, open, load) single-port calibration. The change in ambient temperature from the time of calibration to the time of measurement shall not exceed $\pm 3^{\circ}\text{C}$.
- 3 At ambient temperature plus $20\pm 5^{\circ}\text{C}$ after full charge.

1.4 SAFETY

1.4.1. General safety requirements

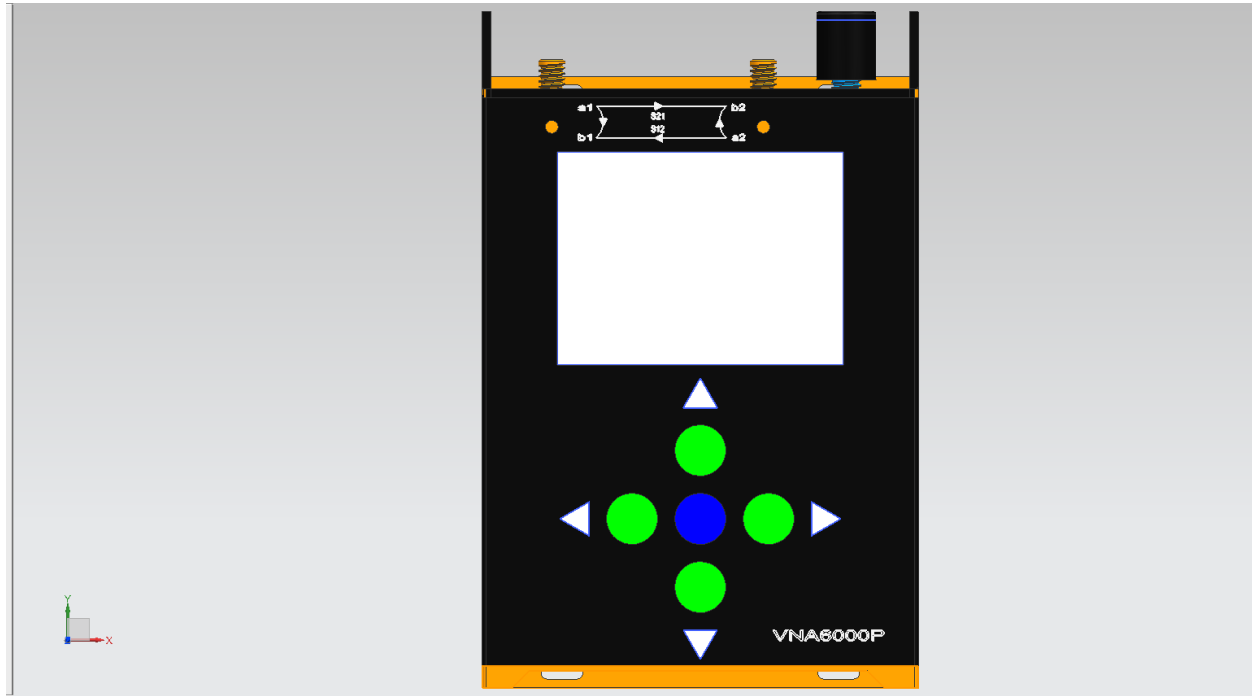
- ➔ To work with the device allowed persons familiar with the present "Manual" and been briefed on rules for safe work with electrical devices.
- ➔ The possibility of injury is possible when you connect or disconnect the charger into the electrical network. Use serviceable outlets and chargers.
- ➔ To avoid damage to the wires and connectors of the device, do not hang anything on the wires, paint and seal the wires and connectors, disconnect the wires pulling the cord.
- ➔ Persons using the device are strictly prohibited: to transfer the device to outsiders, to disassemble and make any repair of the device not agreed with the manufacturer, to use the device with a damaged body.
- ➔ If a fault is detected, stop operation immediately and turn off the device.
- ➔ If you need to leave the workplace, disconnect the device and other devices. Do not leave the device running unattended!
- ➔ Do not use the device in hospitals. Use of the device near medical equipment is allowed only with the consent of the medical staff.

1.4.2. Additional safety requirements

- ➔ Use the device only for its intended purpose. Familiarize yourself with the purpose, device and technical characteristics of the device.
- ➔ Keep the balance and steady posture while working with the device. Move slowly, do not run.
- ➔ Avoid working in open spaces during snow or rain. Increased humidity and all types of liquid, once inside the device, can damage it.
- ➔ Do not expose the device to very low or very high temperatures; exposure to extreme temperatures may damage the internal battery.
- ➔ Do not use the device in areas with corrosive and explosive environments. Pairs of aggressive substances can destroy the insulation, which can lead to the failure of the device.
- ➔ Do not carry the device by the cables and wires connected to it, do not unplug the connectors by pulling the cable or cord.
- ➔ Do not apply excessive force to the control buttons and the device screen.

- ➔ Avoid bumps and drops. If dropped, the device may be damaged.
- ➔ Do not disassemble or modify the device without the approval of the manufacturer or outside the steps described in this manual. Incorrect self-intervention in the device will lead to loss of warranty.
- ➔ Do not allow children to play with the device, as they could hurt or injure others, or disable the device.
- ➔ Use chargers, cords, adapters and other accessories recommended by the manufacturer.
- ➔ When connecting to the device other devices, carefully read their purpose, technical characteristics and safety rules in their manuals. Do not connect incompatible devices.
- ➔ Maintenance and repair of the device should be performed only by the manufacturer or an authorized service center.

1.5 Composition Overview



performance results (see next section), but currently I will rely on calibration and leave more optimum solution for future revisions. Solution with separate front-end mixers also has potentially lower leakage in comparison if receive channel switching were carried out at RF. It also reduces port match modulation when switching between port 1 and port 2 measurements.

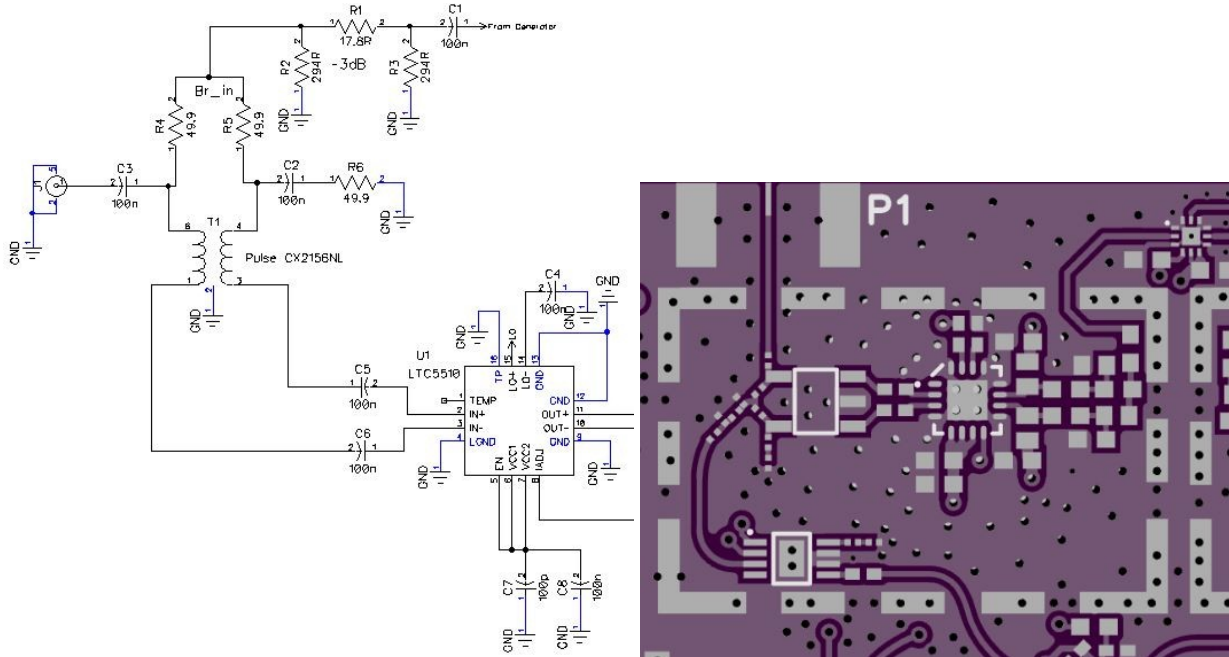


Fig. 2. Front-end schematic and layout (only single channel is shown).

1.7 Project References

References that were used in preparation of this document in order of importance to the end user.

<http://www.mptinst.com/>

http://www.yl3akb.lv/content/vna_v2/vna_v2.php

2.0 User interface

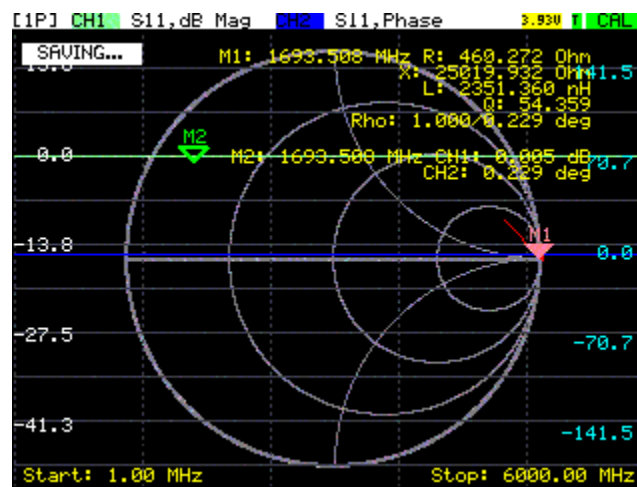
B. USER INTERFACE

2.1 User Interface Overview

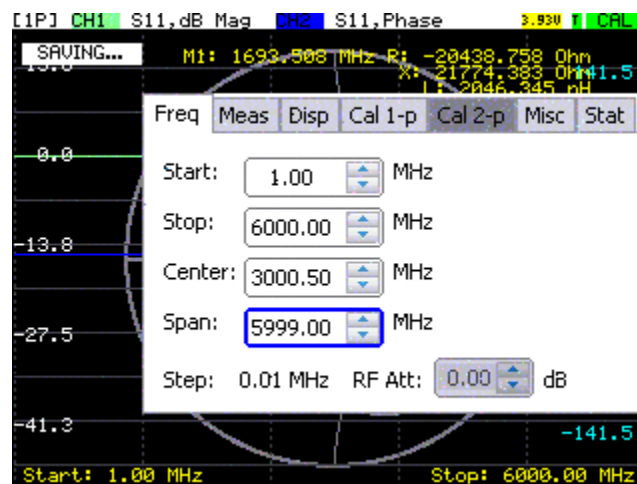
Graphical user interface is based on [STemWin library](#) which is provided free for STM32 microcontrollers. Although had option to use touch screen, with such small screen (3.2 inch, 320x240px) and cheap resistive touch panel, it would be pain to operate so instead dedicated rotary encoder with push-switch and five push-buttons were used. Controls change function based on current menu - although it sounds complicated to operate the device with such small amount of buttons, after a getting a little accustomed, everything can be done very quick and easy.

2.2 User Interface Flows

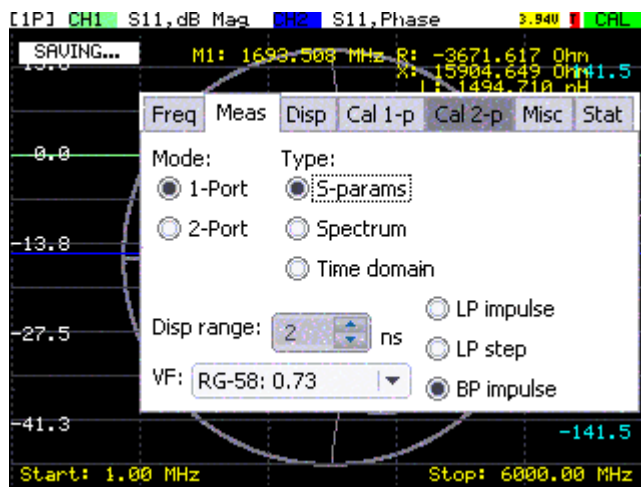
Main Screen



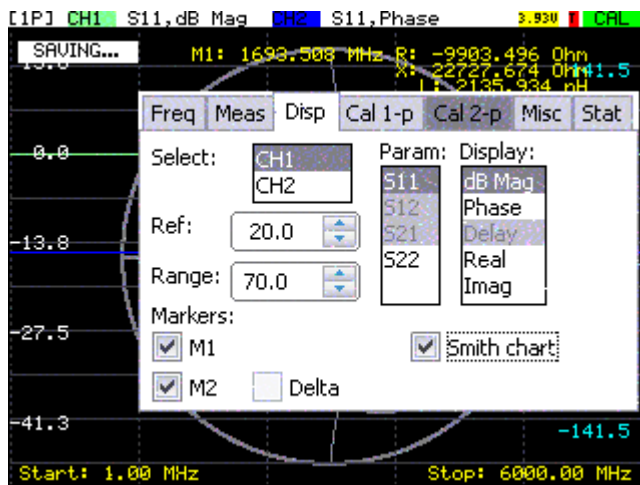
Frequency Setting Menu



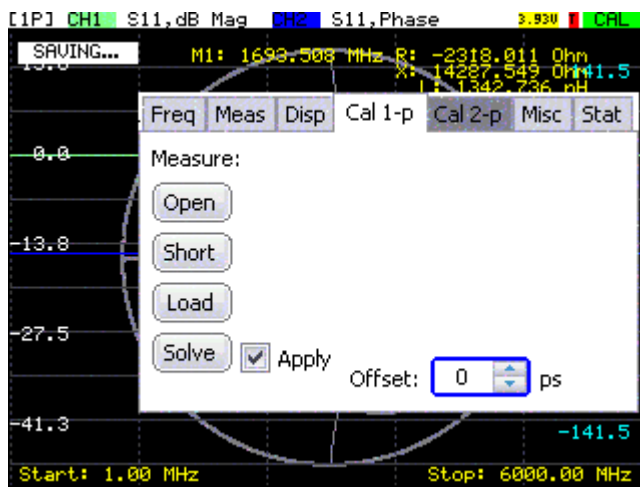
Meas Setting Menu



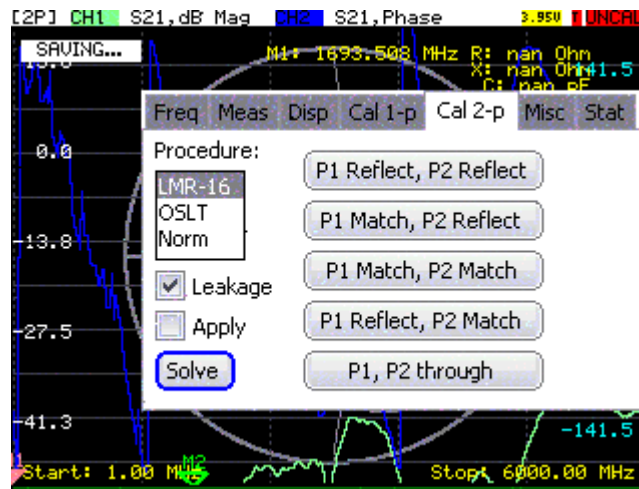
Disp Setting Menu



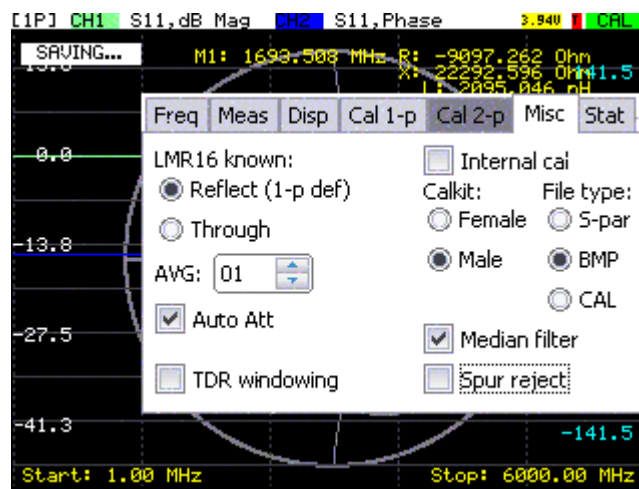
Cal 1 Port Menu



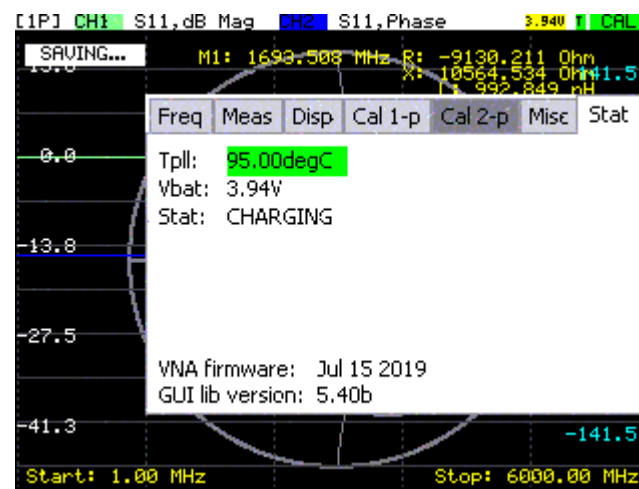
Cal 2 Port Menu



Misc Menu

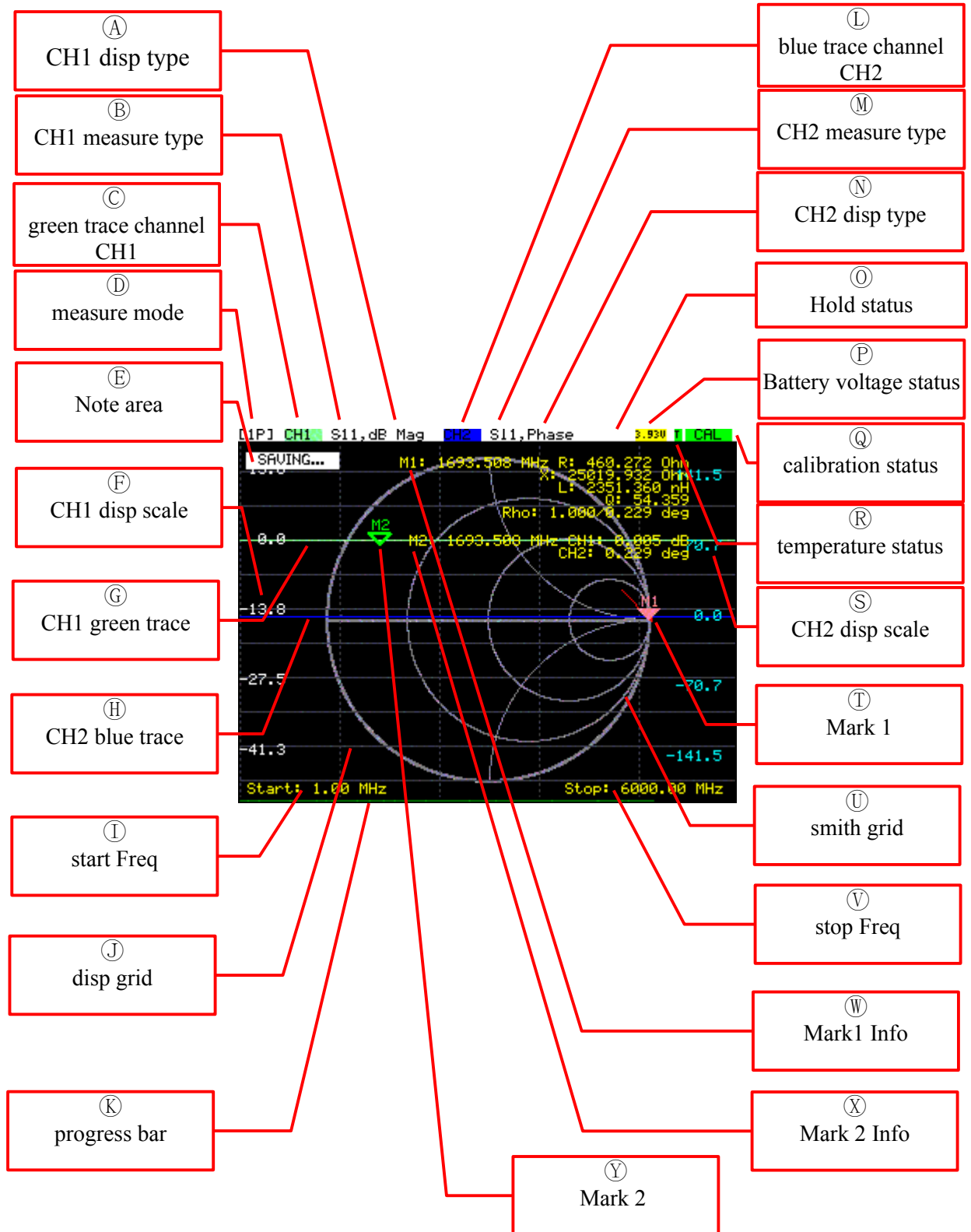


Stat Menu



2.3 User Interface Description

Main Screen



Ⓐ CH1 disp type

CH1 data representations type, is one of the following types:

dB Mag,Phase,Delay Real,Imag, VSWR,Abs,T-check,off

For the corresponding type description, please refer to the display settings.

Ⓑ CH1 measure type

CH1 measure type, is one of the following types:

S11,S12,S21,S22

For the corresponding type description, please refer to the display settings.

Ⓒ green trace channel

green trace channel number, Fixed to CH1

Ⓓ measure mode

device measure type, is one of the following types:

1P or 2P

For the corresponding type description, please refer to the measure settings.

Ⓔ note area

Note area display some system note

For the corresponding type description, please refer to the note info.

Ⓕ CH1 disp scale

CH1 display scale for current representations type

Ⓖ CH1 green trace

green trace is fixed to representations CH1 measure data

trace can turn off on display settings

H CH2 blue trace

blue trace is fixed to representations CH2 measure data

trace can turn off on display settings

I start Freq

start frequency for scan parameters

For the detailed description, please refer to the frequency settings.

J disp grid

display cartesian grid

K progress bar

progress bar

L blue trace channel

blue trace channel number, Fixed to CH2

M CH2 measure type

CH2 measure type, is one of the following types:

S11,S12,S21,S22

For the corresponding type description, please refer to the display settings.

N CH2 disp type

CH2 data representations type, is one of the following types:

dB Mag,Phase,Delay Real,Imag,VSWR,Abs,T-check,off

For the corresponding type description, please refer to the display settings.

O Hold status

Hold status ,in hold mode,here will display H

Ⓟ Battery voltage status

Battery voltage status. Different colors represent different states

red : low voltage or unknown voltage

yellow : charging

orange : end of charging

green : normal voltage, battery standby

Ⓠ calibration status

calibration status.

INTER (yellow) : use Internal factory calibration

CAL (green) : use user calibration

UNCAL (red) : user calibration no available

Ⓡ temperature status

Internal VCO temperature status

T(red) : vco temperature not good

T(green) : vco temperature is good

Ⓢ CH2 disp scale

CH2 display scale for current representations type

Ⓣ Mark 1

Mark 1

if smith grid is on, mark 1 is on smith trace, otherwise is on trace 1 and 2

Ⓤ smith grid

Smith grid ,can turn off

Ⓥ stop Freq

stop frequency for scan parameters

For the detailed description, please refer to the frequency settings.

Ⓦ Mark1 Info

Mark 1 information

mark1 information for smith chart:

FREQ [R:]

[X:]

[L:]

[Q:]

[RHO:]

FREQ is mark frequency

mark1 information for other chart same as mark2

ⓧ Mark 2 Info

Mark 2 information

FREQ [CH1] [VAL]

[CH2] [VAL]

FREQ is mark frequency

CHx is corresponding channel name

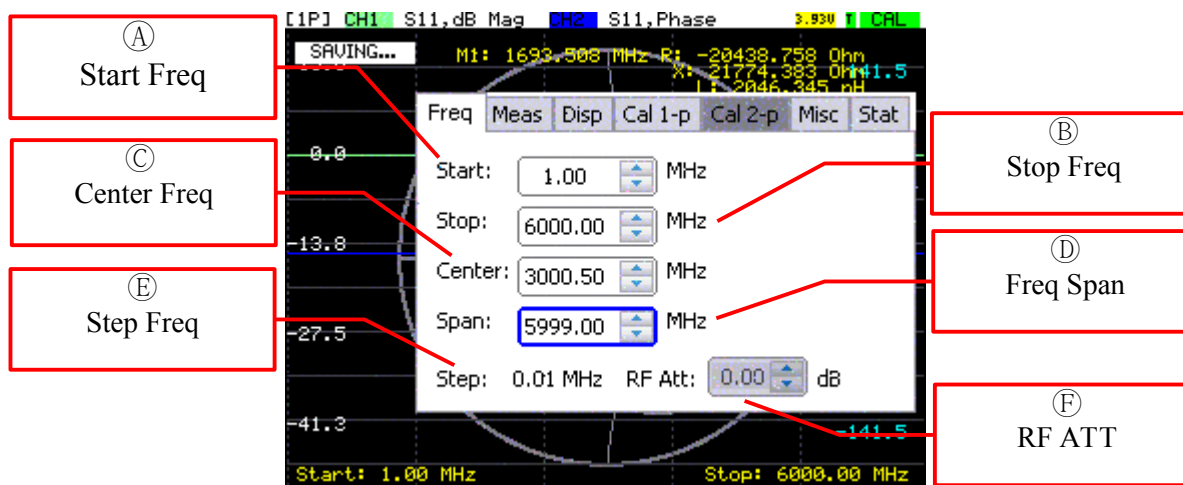
VAL is mark value,unit Corresponding to the display type setting

Ⓨ Mark 2

Mark 2

mark 2 can only on trace 1 and 2

Frequency Setting Menu



The value of Start, Stop, Center, Span, Att can be modified with rotary encoder. The value of step is modified with the button of the rotary encoder.

Note: The value of start can be equal to the value of stop. When start is equal to stop, the frequency can be fixed at the set value. This way the device can behave like a signal generator. This mode can be modified to SPAN to 0, quickly set by changing the value of CENTER.

The device has a 0-31.75dB digital step attenuator. Attenuator value is automatically set to optimize measurement performance. This feature can be turned off in the misc setup menu.

Ⓐ Start Freq

Start frequency for scan parameters

When the cursor is in this position, you can modify the value with rotary encoder. The modified value is stepped with the value of STEP

Ⓑ Stop Freq

Stop frequency for scan parameters

When the cursor is in this position, you can modify the value with rotary encoder. The modified value is stepped with the value of STEP

Ⓒ Center Freq

Center frequency for scan parameters

When the cursor is in this position, you can modify the value with rotary encoder. The modified value is stepped with the value of STEP

Ⓓ Freq Span

Frequency span for scan parameters

When the cursor is in this position, you can modify the value with rotary encoder. The modified value is stepped with the value of STEP.

Note: Zero span option allows to use VNA as simple signal generator (unfiltered and level uncalibrated). On-board step attenuator allows to change signal power in range of 31.75dB with steps of 0.25 dB

Ⓔ Step Freq

Frequency step size for frequency modify

You can modify the value with the button of the rotary encoder. The step values that can be selected are as follows:

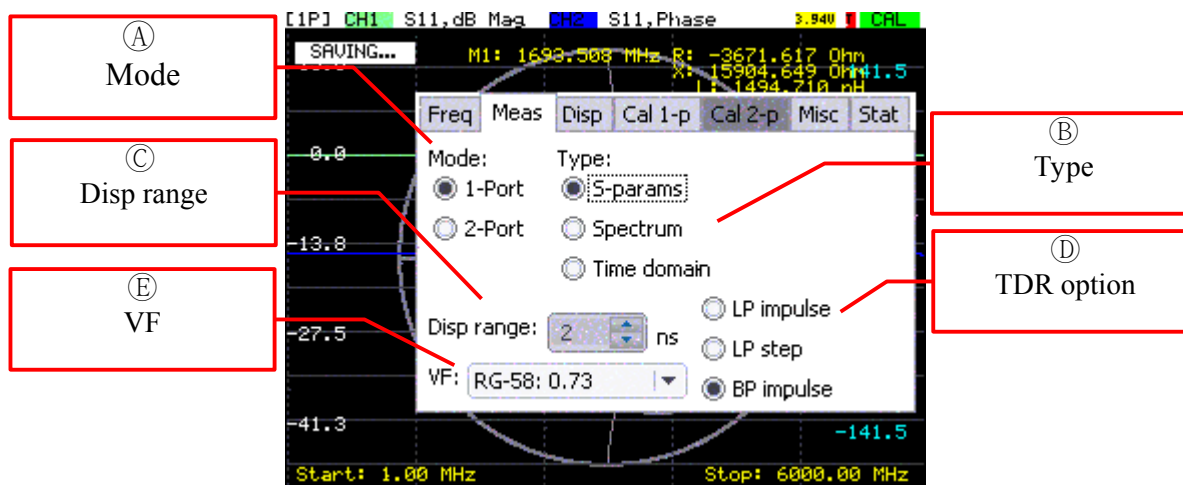
0.01MHz, 0.1MHz, 1MHz, 10MHz, 100MHz

Ⓕ RF ATT

Digital step attenuator value

When the cursor is in this position, you can modify the value with rotary encoder. The modified value is stepped with 0.25.

Meas Setting Menu



Ⓐ Mode

Measure mode

1-Port: one port mode, use Port1 or Port2 to measure parameters.

In this mode, user can select measure type. On Disp menu select S11 or S22 to select port. S11 use Port1, S22 use Port2

2-Port: two port mode, on this mode can only use S-Params type. Therefore, in this mode, the cursor is fixed at mode. 2-Port mode can measure all four S-Params S11, S21, S12, S22. But since there are only 2 traces, only two of these 4 parameters can be displayed.

Ⓑ Type

Measure type

S-params: measure s-parameters S11, S21, S12, S22. On 1-Port mode can measure S11 or S22. On 2-Port mode can measure all.

Spectrum: measure Port1 or Port2 input signal amplitude

In this type, only SYNTHB works for local mixer, the device can behave like a Spectrum Analyzer.

Since the internal IF detection uses only one narrow band, this feature is experimental.

Time domain: Use the mathematical conversion method to convert the frequency domain to the time domain. In this type, the device behaves like a TDR.

Ⓒ **Disp range**

Time domain analyzer time range

When Time domain type is selected, you can modify the value with the rotary encoder. The modified value is stepped with 1ns.

Ⓓ **TDR option**

Time domain analyzer option

LP impulse: Low-Pass impulse

LP step: Low-Pass step

BP impulse: Band-Pass impulse

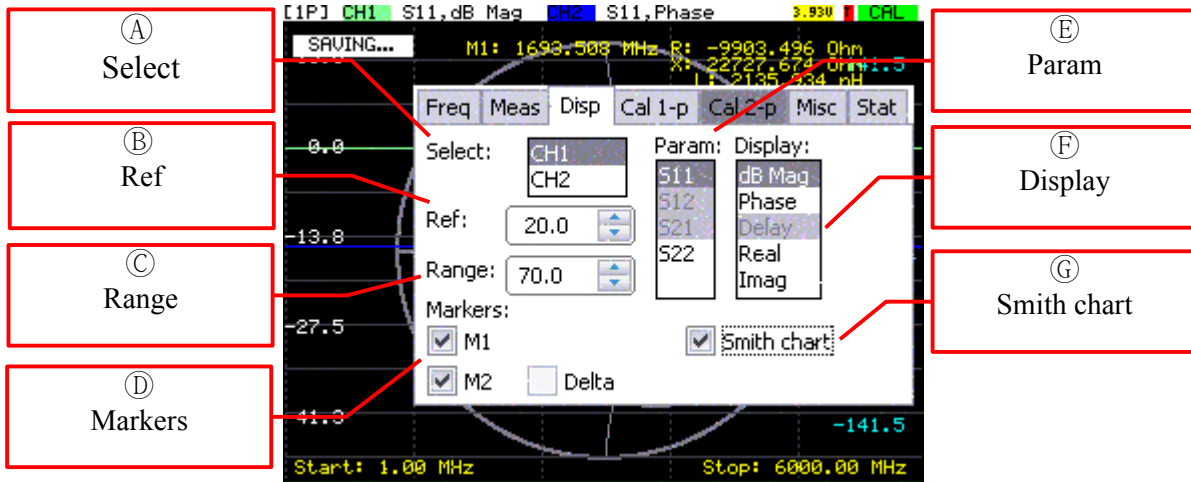
Ⓔ **VF**

Time domain analyzer Speed factor

You can modify the value with the button of the rotary encoder. The values that can be selected are as follows:

Vacuum 1.0, RG-58 0.73, RG-174 0.66, Ecoflex-15 0.86

Disp Setting Menu

**A Select**

Select the display channel you want to set, and the other settings on this page are based on this!

Note: main screen markers are also corresponding to this.

B Ref

Reference line value.

The reference line is a white dotted line on the main screen.

The unit of the reference line is related to the display type

C Range

Measured data range.

The value is related to the display type

D Markers

Marker display option.

M1: turn on/off Marker 1

M2: turn on/off Marker 2

Delta: turn on/off Delta Marker

Note: turn on the delta marker, M1 and M2 marker must on

Ⓔ Param

Select the parameters to be measured.

On 1-port mode, Only S11 and S22 can be selected. S11 select Port1, S22 select Port2. CH1 and CH2 share this setting.

On 2-port mode, all type (S11, S21, S12, S22) can be selected. CH1 and CH2 can select different types respectively.

Ⓕ Display

Select the display type.

Currently, can choose the following types:

dB Mag	:	Magnitude	(dB)
Phase	:	Phase	(deg)
Delay	:	Delay	(ns)
Real	:	Z Real	(Ohm)
Imag	:	Z Imag	(Ohm)
VSWR	:	VSWR	
Abs	:	ABS value	
T-check	:	2-Port Accuracy	⁴
Off	:	turn off trace	

Ⓖ Smith chart

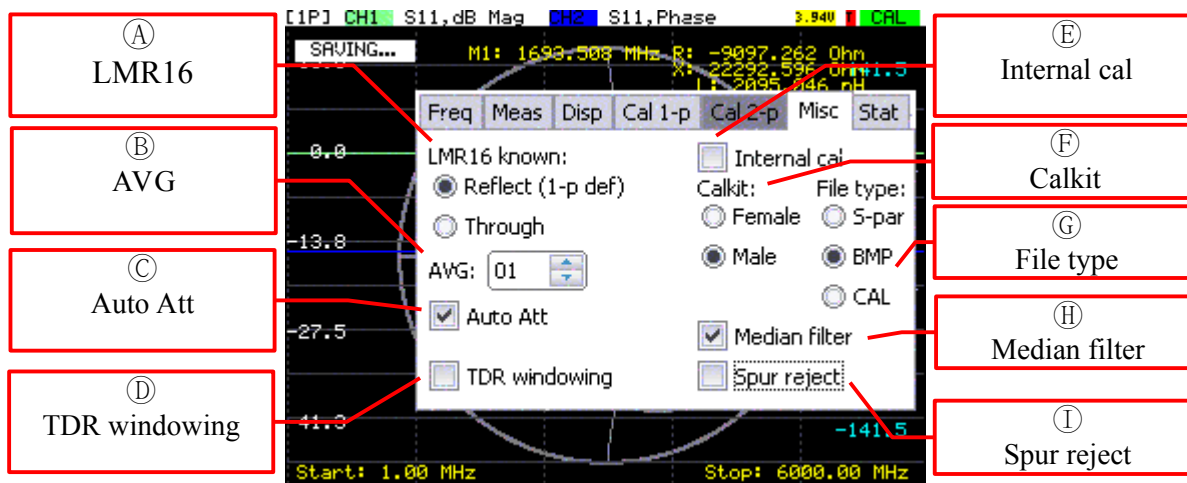
Smith chart option, turn on/off smith chart

Smith chart makes sense in S-params mode, other modes are meaningless.

Smith chart will slow down the software, so you can turn it off when you don't need a smith chart.

⁴ R&S, Application Note 1EZ43_0E: T-Check Accuracy Test for Vector Network Analyzers utilizing a Tee-junction

Misc Setting Menu

**(A) LMR16**

2-Port LMR16 calibration option

Reflect: use known reflect

Through: use known through

(B) AVG

Average number of measurements.

Set to 1 to turn off this feature.

The maximum average that can be set is 32

(C) Auto Att

Automatically set the value of the attenuator.

Turn off this option to manually set the attenuation value.

Manual attenuation values can be set in the FREQ menu.

(D) TDR windowing

TDR windowing on/off

Ⓔ Internal cal

Internal factory calibration allows to do quick 1-Port/2-Port measurements without mechanical calibration .

Ⓕ Calkit

Calkit Polarity selection.

Ⓖ File type

Save file type selection.

When the SAVE button is pressed for 3 seconds, the selected type is saved to the SD card. The file will be automatically numbered.

S-par: save current S-parameters data to file (S1P or S2P)

BMP: save the current screen-shots as a BMP file

CAL: save the current calibration coefficients to file

Ⓗ Median filter

Median filter for trace display

Recommend to open this option

Ⓘ Spur reject

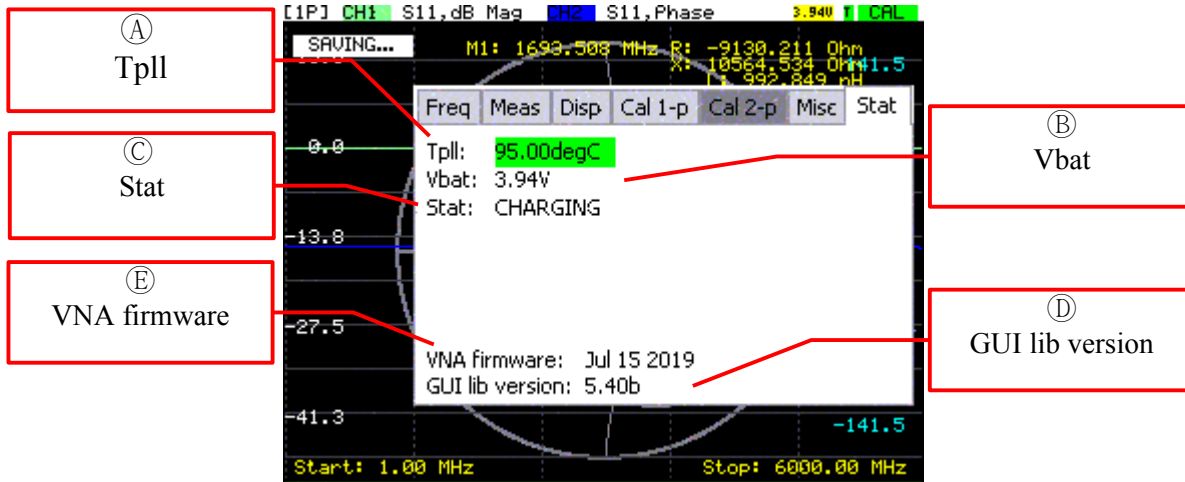
IF image rejection.

This option can suppress IF image.

If the measurement frequency is close to the intermediate frequency (45MHz), you can turn this option on to improve measurement accuracy.

This option will reduce the measurement speed. If the measurement frequency is not in the intermediate frequency range, turning this option off can increase the measurement speed.

Stat Menu

**Ⓐ Tpll**

PLL temperature. Value is for reference only

Ⓑ Vbat

Li-Ion battery voltage or system power voltage

Ⓒ Stat

Li-Ion battery charging status Measure mode

UNKNOWN :unknown status

CHARGING :charging status

EOC :end of charging status

STANDBY :use battery power

BAT LOW :battery low voltage

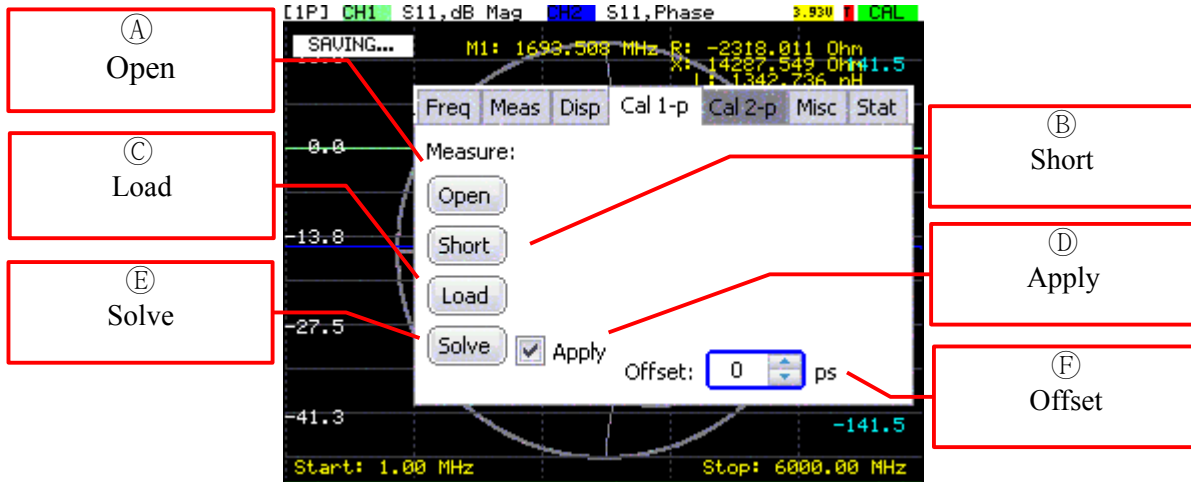
Ⓓ GUI lib version

STemWin gui lib version

Ⓔ VNA firmware

VNA firmware version

Cal 1-p Menu

**A Open**

Press this button to measure open standard.

B Short

Press this button to measure short standard.

C Load

Press this button to measure load standard.

D Solve

Press this button to solve the calibration coefficients.

Note : You can press this button only after the first three standard information is collected.

E Apply

Calibrate measurement results with calibration coefficients.

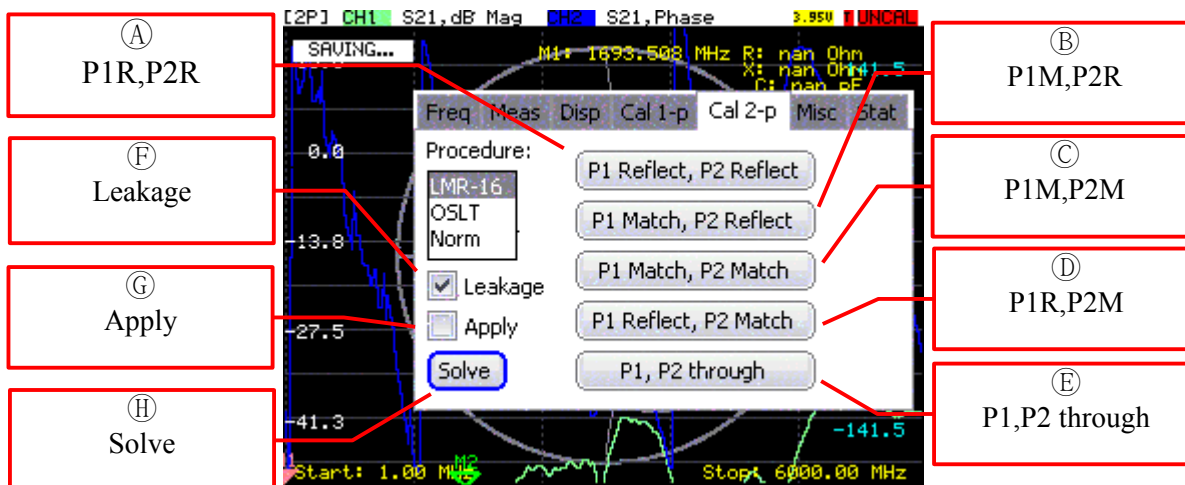
After press solve button, this will auto enable.

Can be manually switched.

F Offset

port extension delay

Cal 2-p LMR-16 Menu

**(A) P1R,P2R**

Press this button to measure P1 reflect and P2 reflect

(B) P1M,P2R

Press this button to measure P1 match and P2 reflect

(C) P1M,P2M

Press this button to measure P1 match and P2 match

(D) P1R,P2M

Press this button to measure P1 reflect and P2 match

(E) P1,P2 through

Press this button to measure P1 through to P2

(F) Leakage

Measure leakage

Ⓒ Apply

Calibrate measurement results with calibration coefficients.

After press solve button, this will auto enable.

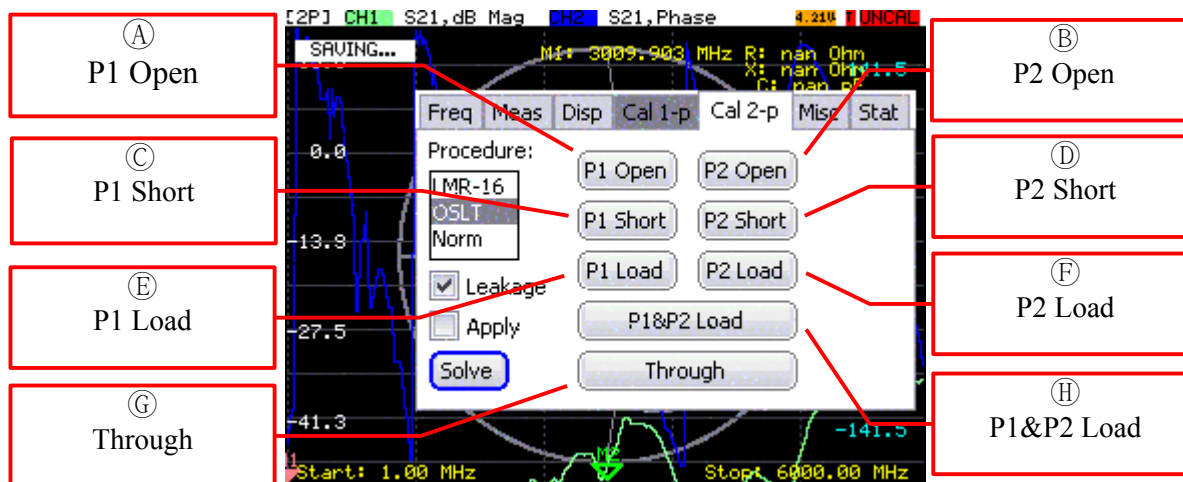
Can be manually switched.

Ⓗ Solve

Press this button to solve the calibration coefficients.

Note : This button can only be pressed after the perfect information has been collected.

Cal 2-p OSLT Menu

**Ⓐ P1 Open**

Press this button to measure open standard on P1.

Ⓑ P2 Open

Press this button to measure open standard on P2.

Ⓒ P1 Short

Press this button to measure short standard on P1.

Ⓓ P2 Short

Press this button to measure short standard on P2.

Ⓔ P1 Load

Press this button to measure load standard on P1.

Ⓕ P2 Load

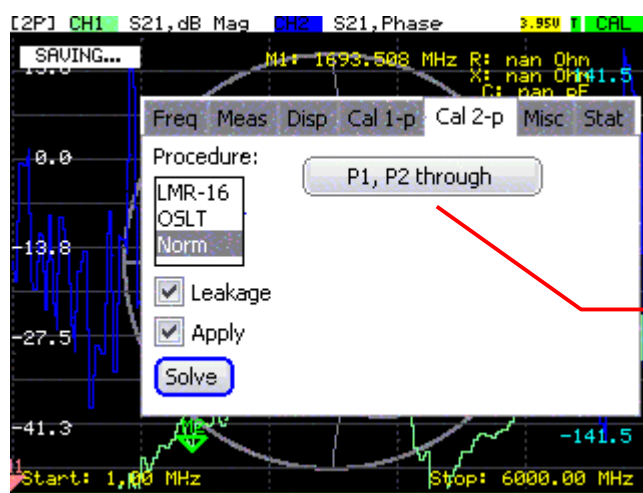
Press this button to measure load standard on P2.

Ⓖ Through

Press this button to measure P1 through to P2.

H P1&P2 Load

Press this button to measure load standard on P1 and P2.

Cal 2-p Norm Menu**A P1,P2 through**

Press this button to measure P1 through to P2.

3.0 GETTING STARTED

C. GETTING STARTED

3.1 Basic Measurement Sequence

There are five basic steps when you are making a measurement.

1. Choose the measurement parameters.
2. Perform and apply the appropriate error-correction.
3. Connect the device under test and any required test equipment.
4. Measure the device under test.
5. Output the measurement results.

3.1.1 Basic Measurement Example

This example procedure shows you how to measure the transmission response of a bandpass filter.

Step 1. Choose the measurement parameters.

Setting the Frequency Range.

To set the center frequency to 500MHz,press:

Enter.

Move cursor to center:

Rotary rotary encoder ,set center value to 500

To set the span to 30 MHz:

Move cursor to span

Rotary rotary encoder ,set span value to 30

Note You could also edit START and STOP field and set the frequency range limits as start frequency and stop frequency values.

Step 2. Perform and apply the appropriate error-correction.

Refer to the Optimizing Measurement Results Chapter for procedures on correcting measurement errors.

Step 3 . Connect the device under test and any required test equipment.

Replace any standard used for error-correction with the device under test.

Step 4. Measure the device under test.

To measure the insertion loss of the bandpass filter:

press UPKEY select mark1

move mark1 to 490MHz

press UPKEY select mark2

move mark2 to 510MHz

Step 5. Output the measurement results.

Press SAVE key to save file to SD card

3.2 Optimizing Measurement Results

Increasing Measurement Accuracy

Connector Repeatability

Connector repeatability is a source of random measurement error. Measurement error-corrections do not compensate for these errors. For all connectors, you should frequently do the following:

- inspect the connectors
- clean the connectors
- gauge the connectors
- use correct connection techniques

Interconnecting Cables

Cables connecting the device under test to the analyzer can contribute random errors to your measurement. You should frequently do the following:

inspect for lossy cables

inspect for damaged cable connectors

practice good connector care techniques

minimize cable position changes between error-correction and measurements

inspect for cables which dramatically change magnitude or phase response when exiting (This may indicate an intermittent problem.)

Temperature Drift

Electrical characteristics will change with temperature due to the thermal expansion

characteristics of devices within the analyzer, calibration devices, test devices, cables, and adapters. Therefore, the operating temperature is a critical factor in their performance. During a measurement calibration, the temperature of the calibration devices must be stable and within 25.65 ± 0.5 °C.

use a temperature-controlled environment

ensure the temperature stability of the calibration devices

avoid handling the calibration devices unnecessarily during calibration

ensure the ambient temperature is 26 ± 0.5 °C of measurement error-correction temperature

Reference Plane and Port Extensions

Use the port extension feature to compensate for the phase shift of an extended measurement

reference plane, due to such additions as cables, adapters, and fixtures, after completing an error-correction procedure (or when there is no active correction).

Using port extensions is similar to using electrical delay. However, using port extensions is the

preferred method of compensating for test fixture phase shift. Table 5-1 explains the difference

between port extensions and electrical delay.

4.0 MAINTENANCE

D. MAINTENANCE

4.1 General care of the device

- When working with the device, use an adapter to protect the high-frequency connector of the device from excessive wear.
- When working, do not allow moisture or dust to enter the device.
- After completing work with the device, turn off the device, disconnect all connected cables and connectors from it. Wipe the unit with a clean rag. Remove heavy dirt with a cloth moistened with soapy water. To clean the device, it is recommended to use household wet wipes. Do not use alcohol-based or petroleum-based solvents to clean the screen and body of the device! These fluids can damage the outer cover of the screen and the case of the product.
- Charge the device battery according to 4.2 Charge the battery

4.2 Charge the battery

After a certain period, the capacity of the Li-Ion battery is reduced, and long-term use of the device without recharging becomes difficult.

Replacing the battery is necessary when the following symptoms occur:

- The battery charges very quickly and discharges very quickly;
- The battery charges for a very long time (more than 8 hours);
- The battery does not accept charge;
- The device does not turn on offline (with the cord disconnected from the charger).

To replace, you must purchase a new Li-Ion battery with an operating voltage of 3.7 V, a capacity of at least 3200 mA and dimensions of not more than: height 4 mm, length 80 mm, width 50 mm

Note – When purchasing and installing a battery with a capacity other than the one installed by the device manufacturer, it is necessary to take into account the fact that the battery charging time will also change up or down.

Attention! When using a battery of another capacity, the correspondence of the displayed charge level of the battery on the device screen to the real value is not guaranteed.

4.3 RETURN THE DEVICE TO THE FACTORY SETTINGS

A hardware reset is a reboot of the device, which restores the factory settings of the system. Hardware reset is used when it is impossible to turn on the device or go to the main menu to change the settings. This removes the parameters of the main application.

Reset to factory settings is used by the user in case of software problems to restore the standard configuration of the device.

The operation method is: power off (OFF) without connecting the external power supply, and then press and hold the "down button" to power on (ON), do not release the button until you hear a beep.

5.0 APPENDIX

A. APPENDIX

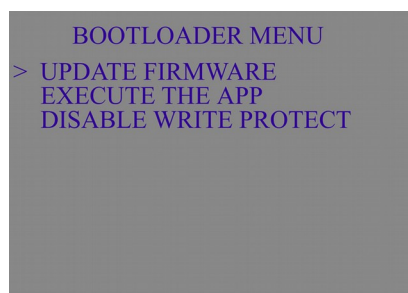
5.0 Firmware upgrade instructions

5.1 Upgrade preparation

copy the latest version of the upgrade file "firmware.bin" into the SD card, and insert the SD card into the corresponding SD card slot of the device when the power is turned off (please do not connect an external power supply and ensure that the power switch is OFF)

5.2 Enter firmware upgrade mode

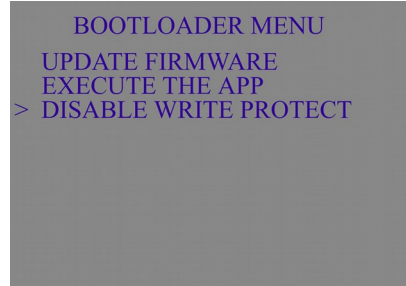
press and hold the "green button" in the middle to turn on (ON) until the firmware upgrade interface appears, as shown below



5.3 Remove firmware protection

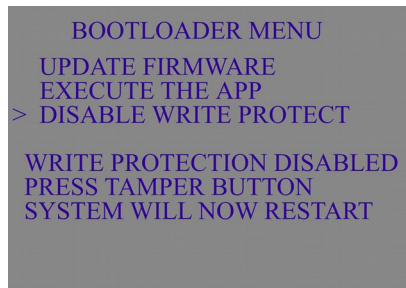
5.3.1

press "up key" or "down key" to move the cursor (">") to DISABLE WRITE PROTECT, as shown below



5.3.2

press the rotary encoder button at the top right of the device once, and the following prompt appears



The above prompt indicates that the firmware protection has been turned off

5.3.3

press and hold the middle "green button" to restart the device, press and hold the green button until the following picture appears



5.4 Update firmware

press the rotary encoder at the top right of the device once to erase the chip program (it takes about 5 seconds), as shown below

```
BOOTLOADER MENU
> UPDATE FIRMWARE
  EXECUTE THE APP
  ENABLE WRITE PROTECTION

LIPDATE ONGOING
ERASE FLASH
```

After the chip is erased, the firmware will be upgraded automatically (it takes about 20 seconds) as shown below

```
BOOTLOADER MENU
> UPDATE FIRMWARE
  EXECUTE THE APP
  ENABLE WRITE PROTECTION

LIPDATE ONGOING
USER FLASH ERASED
FIRMWARE LIPDATE
>>>>>>>>
```

After the upgrade is complete, the following prompt appears

```
BOOTLOADER MENU
> UPDATE FIRMWARE
  EXECUTE THE APP
  ENABLE WRITE PROTECTION

DOWNLOAD DONE
WRITE PROTECTION ENABLE
PRESS TAMPER BUTTON
SYSTEM WILL NOW RESTART
```

5.5 Complete firmware upgrade

Turn off the power (OFF) and turn on the power again (ON) to complete the firmware upgrade operation.

Note 1: Before firmware upgrade, be sure to copy the latest version of the upgrade file "firmware.bin" into the SD card, and insert the SD card into the corresponding SD card slot of the device (the integrity and correctness of the file must be guaranteed. Name the other file "firmware.bin" for the upgrade operation, which will cause the device firmware to be lost and cannot be used normally).

Note 2: When upgrading the firmware, please do not use an external power supply and ensure that the battery voltage is normal.

Note 3: The option "EXECUTE THE APP" in the upgrade menu, select this option when you no longer enter the upgrade or other operations, the device is normally turned on, the operation method is: move the cursor to this option, and press the rotary encoder at the top right of the device once That's it.

Note 4: If the SD card is not inserted, or the inserted SD card does not have the correct upgrade file, the system prompts as shown in the figure below, and the user only needs to perform the upgrade steps again.

