NanoVNA

Very tiny handheld Vector Network Analyzer

User Guide
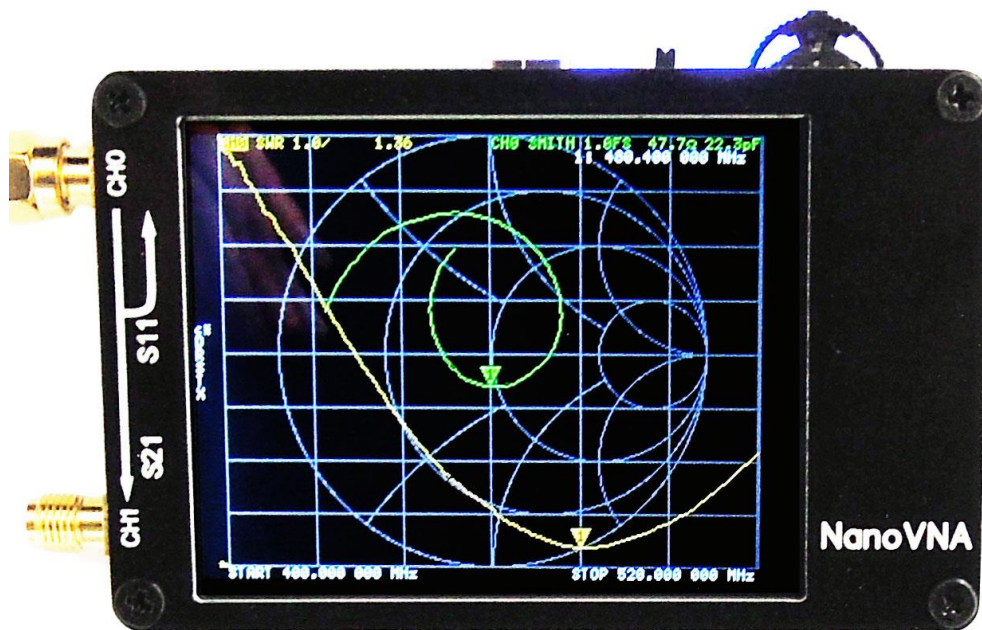
Overview:

We designed NanoVNA based on edy555 (https://twitter.com/edy555), but modified some circuits, added battery management circuits, and redesigned the PCB. The PC control software can export Touchstone (snp) files which can be used for various radio design and simulation software. The improved frequency algorithm can use the odd harmonic extension of si5351 to support the measurement frequency up to 900MHz. The metal shield is designed to reduce the external interference and improve the measurement accuracy. The 50k-300MHz frequency range of the si5351 direct output provides better than 70dB dynamic. The extended 300M-600MHz band provides better than 50dB of dynamics, and the 600M-900M band is better than 40dB of dynamics.   is very tiny handheld Vector Network Analyzer (VNA). It is standalone with lcd display, portable device with battery. This project aim to provide an RF gadget but useful instrument for enthusiast.

DIY's vector network analyzer, with reference to the related design of. Designed with simple and practical PC control software, you can export Touchstone (snp) files for various radio design and simulation software through PC software. NanoVNA is an open source hardware project, everyone can be free to clone and DIY, but we hope you can do more understanding before you do it, there are some customers reflected that they have bought the low quality nanoVNA from other sources. We have found some low quality clones on the Internet which claimed have completed the project. Buying such hardware may be harm on NanoVNA performance, or leading to measurement error.

We will continue to provide updates and technical support services for NanoVNA within 3 years after purchase. You can get the latest detail of products and software updates from the Web Store: gen111.taobao.com.

We provide 5 firmware on the network hard drive, you can choose the appropriate brush in accordance with the relevant tutorials, 5 firmware differences are as follows:

nanoVNA_300_ch：50K-300MHz，5*7 Bitmap font，4 tracks
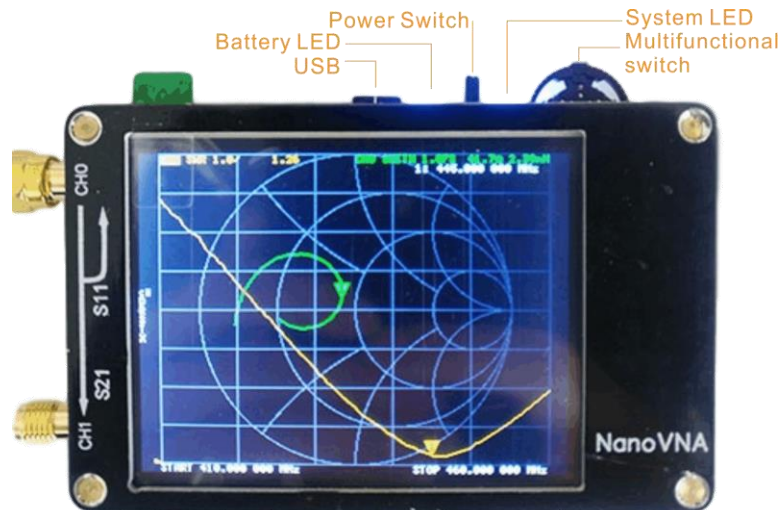nanoVNA_900_ch：50K-900MHz，5*7 Bitmap font，4 tracks(Default)
nanoVNA_900_aa：50K-900MHz，7*13 Bitmap font，2 tracks (Antenna Analyzer)

The 800MHz firmware works better at higher temperatures.
nanoVNA_800_ch：50K-900MHz，5*7 Bitmap font，4 tracks(Recommended)
nanoVNA_800_aa：50K-900MHz，7*13 Bitmap font，2 tracks (Antenna Analyzer)

Front panel

You can use the USB interface to connect to computer communications or connect standard 5V charger charging.

When charging the battery indicates that the battery LED flashes in charge, the constant light indicates full. When discharging the battery LED constant light indicates normal discharge, LED flicker indicates low power, please connect the charger in time to charge.

Toggle the power switch can switch the machine, the battery indicates that the Led needs to be turned off after 40 seconds of shutdown.

The system LED light and dark changes when the system is properly scanned. You can move the mark Point or perform a menu operation via the multifunctional switch, use the touchscreen operation directly also.

Main interface
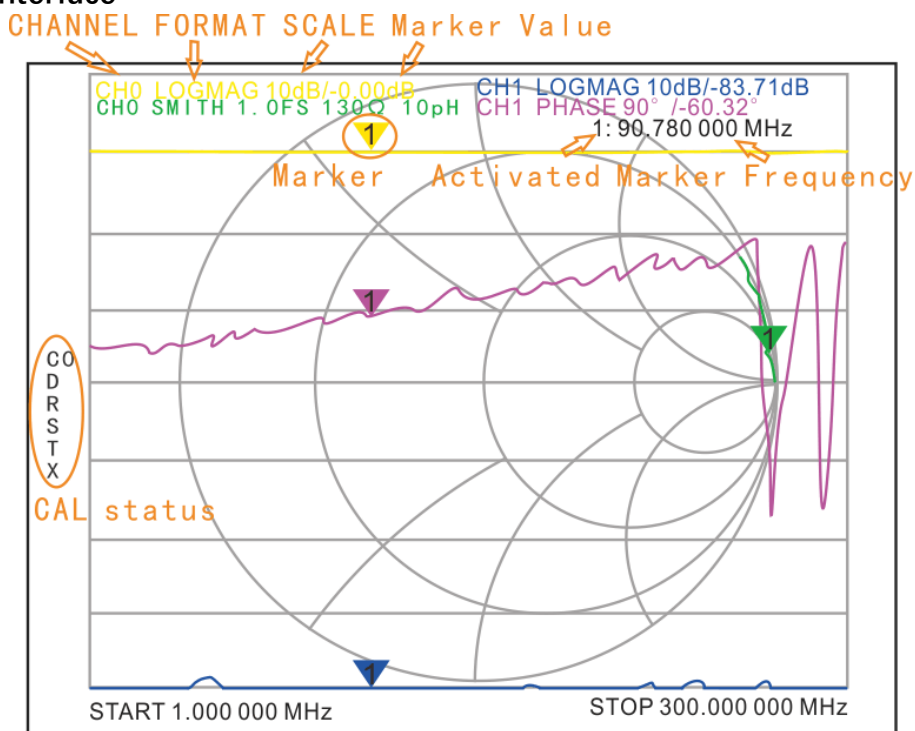
Basic operations：

1. Set the frequency range (STIMULUS>START/STOP or CENTER/SPAN)
2. Calibration (CAL)
3. Select display format and channel (DISPLAY)
4. Save(SAVE)

You can change the display format and channel selection at any time. In the normal test mode, tap the right area of the screen or press the multifunctional switch to call up the menu. Tap the screen or turn the multifunctional switch to select a menu item.

The initial state of NanoVNA (no data is stored in 0)
Scan range: 50KHz ~ 900MHz
Track 1: LOGMAG CH0 (reflection)
Track 2: SMITH CH0 (reflection)
Track 3: LOGMAG CH1 (through)
Track 4: CH1 stage (through)
Mark 1: Activated
Uncalibrated.

We will test before shipment and connect directly to the SMA port for calibration, the calibration data is stored in state 0, and the boot will load the status 0 data directly.

Calibration and Normalization:

The VNA Master is a field portable unit operating in the rigors of the test environment. In order to ensure measurement accuracy, RF calibration (OSLT) must be performed prior to making a measurement in the field. Calibrating with the specified mechanical calibration requires three loads, open, short, and match(load). Calibration data is saved as user calibration data. It can be saved to status 0 and can be automatically loaded at the next boot, It can be also saved to status 1-4 and can be loaded via the RECALL menu.

Click the CAL→CALIBRATE menu to open the calibration interface, then connect open, short and load three loads in turn, wait for the screen to stabilize and click on the menu corresponding to calibrate CH 0. The machine is accompanied by a calibration piece, for the public head calibration parts inside the needle copper is short-circuited, the interior with a needle white plastic and stainless steel shell connected to the (LOAD) 50 ohm load, the internal empty for the open. For the head calibrator, the back uses solder short circuit for short, welding two 100 ohms resistor for 50 ohm load, open circuit for open.

Isolation calibration of CH 1 requires two load loads to connect CH0 and CH1, respectively, to obtain the best isolation, usually with only one set of calibration loads for port 0, and to connect the load Calibrator to CH1, CH0 to remain open, and then press the ISOLN menu to calibrate.

Connect the CH0 and CH1 of the analyzer with an optional Through Adapter(SMA to SMA kit or cable), and then press the THRU menu to calibrate. The normalization operation moves the measurement reference plane to both ends of the Through Adapter. This function is only available when the measurement item is S21.

After the calibration is complete, press the Done button, eject the Save screen to select the required status to save. Once the calibration is complete, the three calibrators can be connected to port 0 again, and the correct calibration should be based on the SMITH chart, which should be: when connected to OPEN, the curves should be concentrated on the far right of the SMITH chart, and when connecting SHORT, the curves should be concentrated on the leftmost side of the

SMITH chart, When connecting LOAD, the curves should all be concentrated in the middle of the SMITH chart. Using RF cables to connect Port 0 and port 1, view S21 curve errors should not exceed 0.1dB. If calibration data abnormalities are found, they should be re-calibrated.

Note: If there is already saved calibration data, first press "Reset" to clear the calibration data and then calibrate!

If the calibration has been applied, CAL status is displayed.
It is hidden in a state that has not been applied. C * is the state in which the unsaved calibration value is applied (it disappears when the power is turned off).
C0 ~ C4 0 to 4 indicates that a saved calibration value has been applied to one of the save locations.
SAVE Unsaved
It changes to this state when saving by an operation. Each of the characters shown below C indicates that the following error terms are applied:
D: Directivity, R: Reflection Tracking, S: Source Match, T: Transmission Tracking, X: Isolation

Select the display trace and display format:

The DISPLAY→TRACE item of the menu can choose to turn the corresponding display curve on or off, showing that the curve color is consistent with the color of the interface curve, and the display curve of the final operation is the active tracking curve, when the menu FORMAT, the SCALE,CHANNEL operation is valid for the display curve.

The display type can be modified by the DISPLAY→FORMAT of the menu, DISPLAY→SCALE can adjust the scale, DISPLAY→CHANNEL can select the measured port.

Setting the frequency range：

The frequency range of a channel can be expressed by three groups of parameters: Start Frequency, Center Frequency and Stop Frequency. If any of the parameters change, the others will be adjusted automatically in order to ensure the coupling relationship among them

$$f_{center} =(f_{start} +f_{stop})/2$$

$$f_{span}= f_{stop} - f_{start}$$

Where f_{span} is the span.

Set the center frequency point of the current screen through the STIMULUS→CENTER of the menu, and display the values of the center frequency and sweep span, respectively, to the left and right of the bottom of the grid. **In the lower-right corner of the pop-up Settings value screen, click to eject the soft keyboard and enter the frequency value via the soft keyboard.**

Please pay attention to the following points:
The start and stop frequencies will vary with changes to the center frequency when the span is constant.
In Zero Span, the start frequency, stop frequency and center frequency are always set to the same value. Now, you can use port 0 as a signal source for a fixed output amplitude, but it is important to note that this machine uses the clock signal generator S5351 as the signal source, the output signal is square wave, contains a larger odd harmonic.

Set the frequency range through the STIMULUS→SPAN of the menu, display the center frequency and sweep span values on the left and right sides of the grid, and click on the lower right corner of the pop-up settings value screen to eject the soft keyboard and enter the frequency values through the soft keyboard.
Please pay attention to the following points:
The start and stop frequency vary with the span when the center frequency is constant.
When the span is set to the maximum, the analyzer enters full span mode.
In Zero Span, the start frequency, stop frequency and center frequency are always set to the same value.

Set the start frequency through the STIMULUS→START of the menu and display the start frequency and stop frequency values on the left and right sides of the grid, respectively. Click on the bottom right corner of the pop-up settings screen to eject the soft keyboard and enter the frequency value through the soft keyboard.
Please pay attention to the following points:
The span and center frequency vary with the start frequency when the Span does not reach the minimum (The parameters vary with the span, please refer to "Span");
In Zero Span, the start frequency, stop frequency and center frequency are always the same value.

Set the stop frequency through the STIMULUS→STOP of the menu, and display the start frequency and stop frequency values on the left and right sides of the grid, respectively, in the lower right corner of the pop-up Settings screen, click to eject the soft keyboard and enter the frequency value through the soft keyboard. Please pay attention to the following points:
The span and center frequency vary with the stop frequency. The change of the span will affect other system parameters. For more details, please refer to "Span".
In Zero Span, the start frequency, stop frequency and center frequency are always the same value.

Menu items:

DISPLAY
- ○ TRACE
  - ▪ 0
  - ▪ 1
  - ▪ 2
  - ▪ 3
- ○ FORMAT
  - ▪ LOGMAG
  - ▪ PHASE
  - ▪ DELAY (Not implemented, computer software provides Group delay functionality)
  - ▪ SMITH
  - ▪ SWR
  - ▪ MORE
    - ▪ POLAR
    - ▪ LINEAR
- ○ SCALE
  - ▪ SCALE/DIV
  - ▪ REFERENCE POSITION
  - ▪ ELECTRICAL DELAY
- ○ CHANNEL
  - ▪ CH0 REFLECT
  - ▪ CH1 THROUGH

● MARKER
- ○ SELECT
  - ▪ 1
  - ▪ 2
  - ▪ 3
  - ▪ 4
- ○ MARKER→START
- ○ MARKER→STOP
- ○ MARKER→CENTER
- ○ MARKER→SPAN (Not implemented,)

● STIMULUS
- ○ STAR
- ○ STOP
- ○ CENTER

- ○ SPAN
- ○ CW FREQ
- ● CAL
  - ○ CALIBRATE
    - OPEN
    - SHORT
    - LOAD
    - ISOLN
    - THRU
    - DONE
      - SAVE
  - ○ RESET
  - ○ CORRECTION
- ● RECALL/SAVE
  - ○ 0 (Default)
  - ○ 1
 - ○ 2
  - ○ 3
  - ○ 4
- ● CLOSE

Basic performance:

● PCB: 54mm x 85.5mm x 11mm (without connectors, switches)

● Measurement frequency: 50KHz -900MHz

● RF output: -13dbm (maximum -9dbm)

● Measurement range: 70dB (50kHz-300MHz), 50dB (300M-600MHz), 40dB (600M-900MHz));

● Port SWR: < 1.1

● Display: 2.8 inch TFT (320 x240)

● USB interface: USB type-C communication mode: CDC (serial)

● Power: USB 5V 120mA, built-in 400mAh battery, maximum charging current 0.8A

● Number of scanning points: 101 (fixed)

● Display Tracking: 4, Marking: 4, Setting Save: 5

●Frequency Tolerance:<2.5ppm

●Frequency Stability:<0.5ppm

Packing list

NanoVNA host (with 400mAh battery) x 1
USB Type-C data cable   x1
30cm SMA male to male RG174 RF cable x2
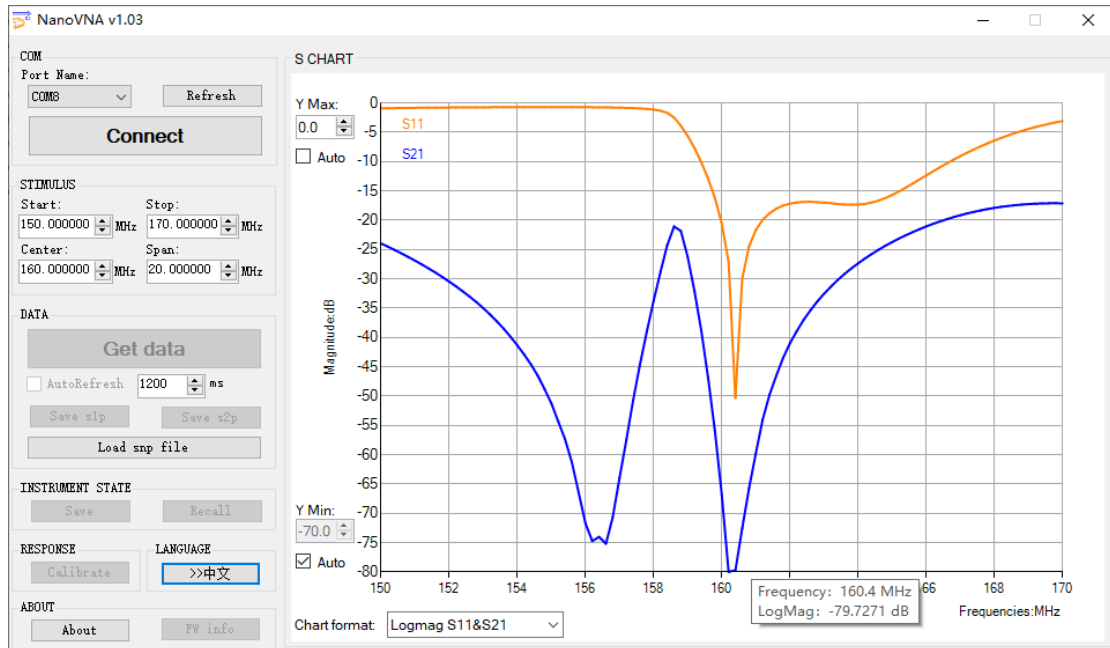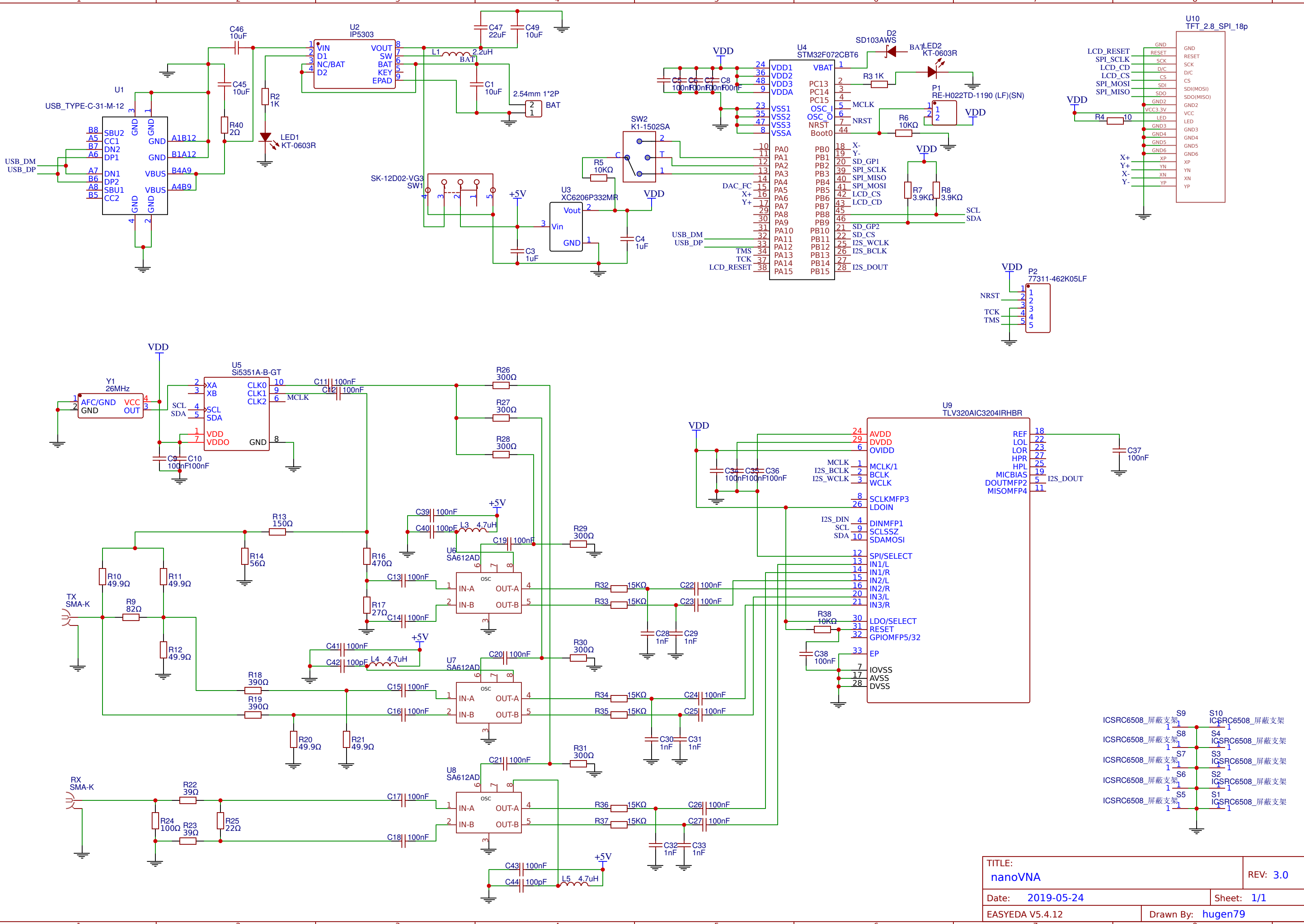SMA male calibration kit (OPEN / SHORT /LOAD) x1
SMA female to female connector x1

Block diagram :
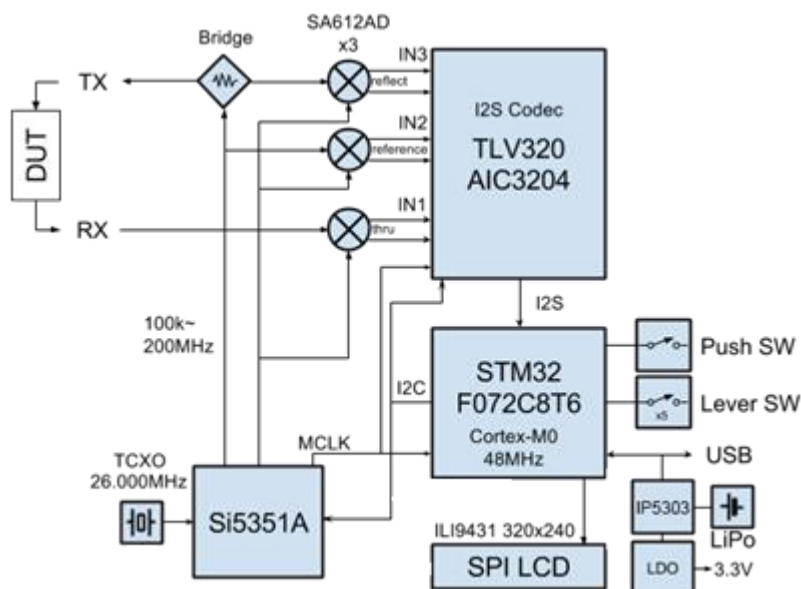
NanoVNA Sharp:

This PC software is designed for control NanoVNA and export Touchstone(snp) files.

nanoVNA schematic (EasyEDA V5.4.12)

Key components and labels:

- U1 USB_TYPE-C-31-M-12
- U2 IP5303
- U3 XC6206P332MR
- U4 STM32F072CBT6
- U5 Si5351A-B-GT
- U6 SA612AD
- U7 SA612AD
- U8 SA612AD
- U9 TLV320AIC3204IRHBR
- U10 TFT_2.8_SPI_18p
- Y1 26MHz
- D2 SD103AWS
- P1 RE-H022TD-1190 (LF)(SN)
- P2 77311-462K05LF
- SW2 K1-1502SA
- SW1 SK-12D02-VG3
- LED1 KT-0603R
- LED2 KT-0603R
- BAT 2.54mm 1*2P
- TX SMA-K
- RX SMA-K

Signals: USB_DM, USB_DP, VDD, VBAT, +5V, MCLK, NRST, SCL, SDA, SPI_SCLK, SPI_MISO, SPI_MOSI, LCD_CS, LCD_CD, LCD_RESET, I2S_WCLK, I2S_BCLK, I2S_DOUT, I2S_DIN, SD_GP1, SD_GP2, SD_CS, TMS, TCK, X+, X-, Y+, Y-