

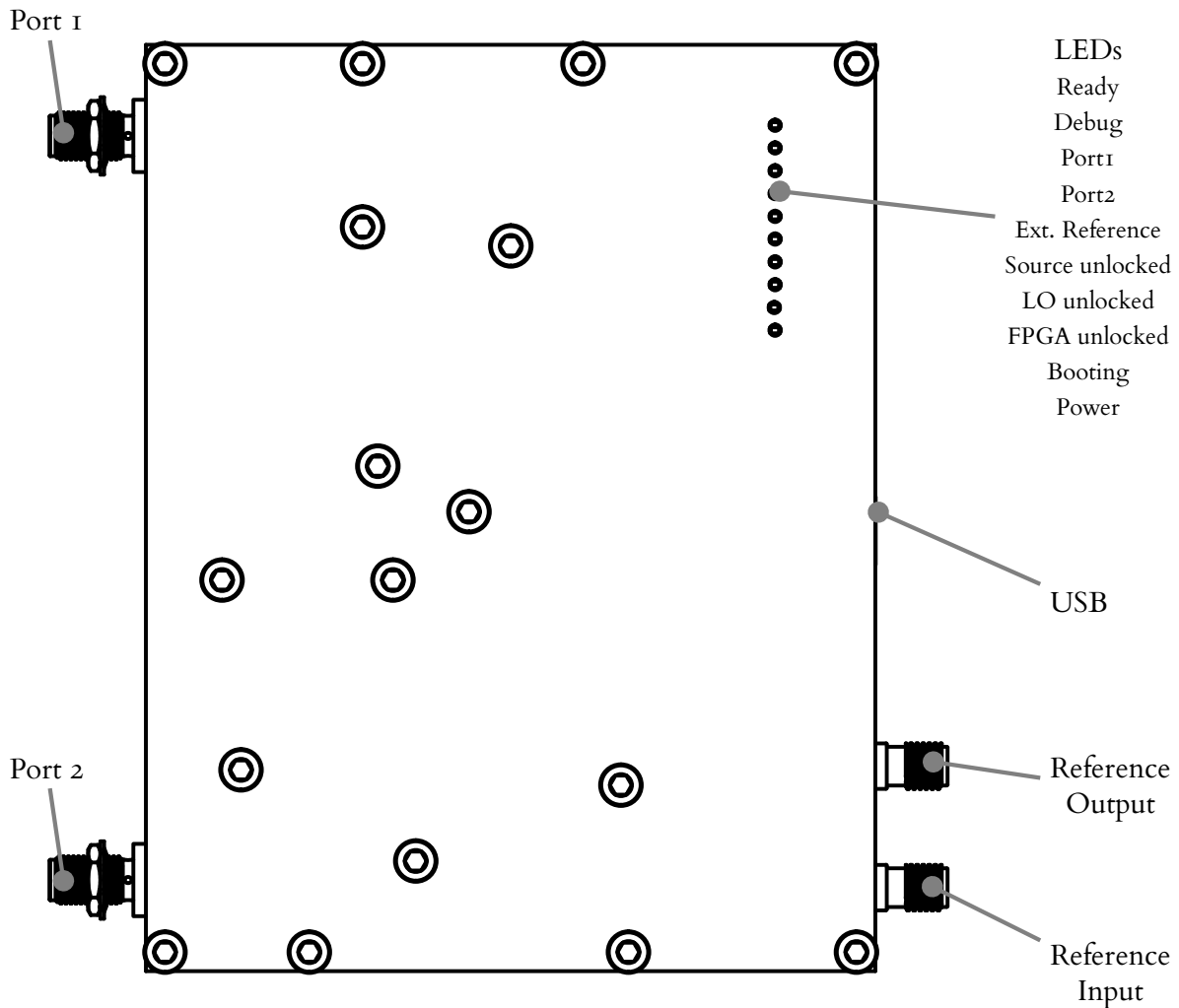
VNA User Manual

September 20, 2020

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I Overview



I.1 USB

The VNA uses a USB-C connector as the power supply and for data transmission. The hardware supports the USB power delivery standard¹, requires 5 V and draws up to 1.2 A of current.

The implemented USB device is limited to USB 2.0 Fullspeed and data transmission will work with any USB 2.0 or 3.0 port (no USB-C required). However, the current consumption exceeds the specifications for USB 2.0 and 3.0 ports and the VNA may be unable to fully boot when the USB host limits the current.

I.2 RF ports

RF connector to connect the DUT. Both ports are identical and the device architecture support full S-Parameter measurements (S_{11} , S_{21} , S_{12} and S_{22}).



The RF ports have no input protection, do not apply a signal with more than +10 dBm of power.

I.3 LEDs

Ten LEDs indicate the status:

¹Work in progress, the device will not negotiate USB-PD yet

Ready (green) Indicates fully booted VNA, ready to take measurements

Debug (green) Not used at the moment

Port 1 (green) Active output signal on port 1

Port 2 (green) Active output signal on port 2

Ext. Reference (green) External reference in use

Source unlocked (red) The source PLL failed to lock (it may turn on briefly during a sweep, this is not a problem)

LO unlocked (red) The 1. LO PLL failed to lock (it may turn on briefly during a sweep, this is not a problem)

FPGA unlocked (red) The FPGA clock PLL failed to lock

Booting (red) Indicates boot process, also used for error codes

Power (green) USB power valid

1.4 Reference Output

Optional reference output port (user selectable 10 MHz or 100 MHz). The output power is approximately +3 dBm.

1.5 Reference Input

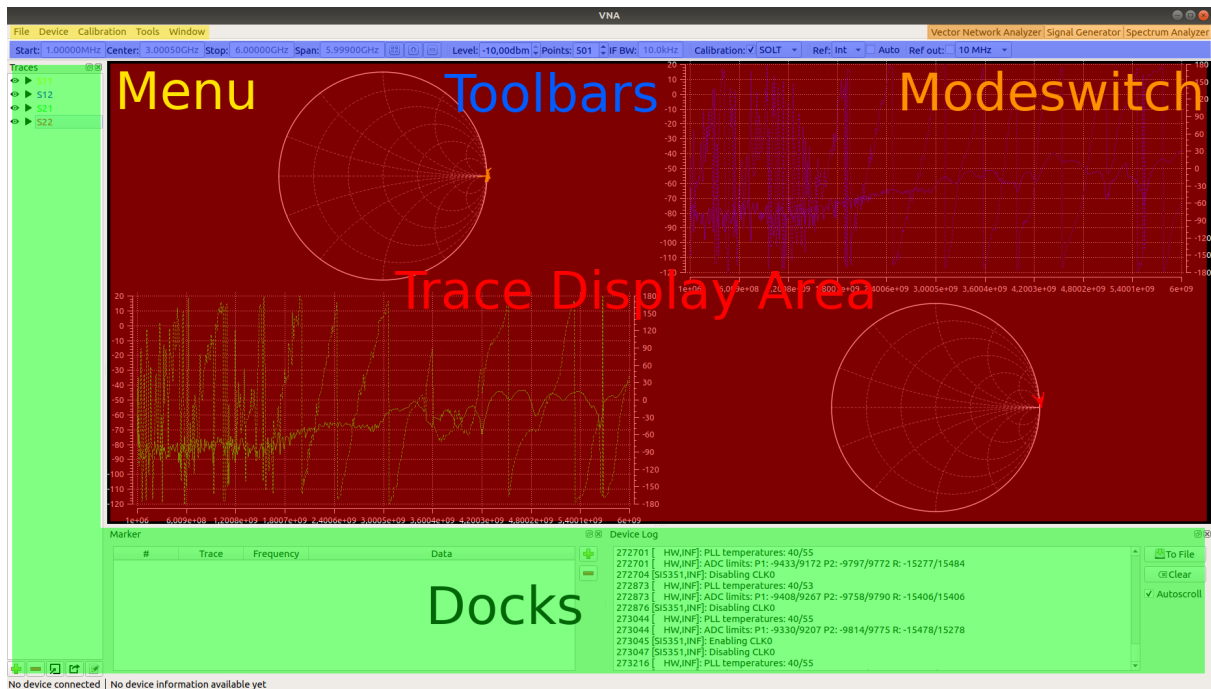
High impedance reference input port. When applying a 10 MHz input signal, it can be used to overwrite the internal TCXO.



Due to the high impedance input, the external input may detect a valid signal when picking up external radiation. If this is a problem, either terminate the reference input connector or disable automatic reference switching.

2 Getting started

1. Connect the VNA to a computer using the USB port. After a couple of seconds, only the "Power" and "Ready" LEDs should stay on. If the "Ready" LED does not turn on or the "Booting" LED indicates an error code, there is a problem and the device will not function properly. See section 4 for possible solutions.
2. Start the PC application to connect to the VNA. The window should look similar to this:



2.1 GUI elements types

The VNA application is made up of six areas containing different types of control:

- The **Trace Display Area** shows the measured data in various diagrams.
- The **Toolbars** provide access to commonly used device settings.
- The **Menu** at the top left handles less common settings or more complex actions (often with additional popup windows).
- The **Docks** mostly provide access to display related settings such as traces and markers.
- The **Statusbar** at the bottom show some basic informations about the connected device.
- The **Modeswitch** at the top right allows changing the VNA operating mode. Although it is primarily designed as a vector network analyzer, the hardware architecture allow some other operating modes with certain limitations.

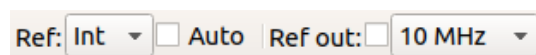
Depending on the current operating mode, the available toolbars, docks and menu entries change. It is also possible to rearrange the docks and toolbars.

2.2 Common GUI elements

Certain control elements are always available, regardless of the selected mode. They control settings of the VNA that are not specific to any of the operating modes.

2.2.1 Reference Toolbar

The reference toolbar controls the external reference output as well as the input.



The reference can be set to "Int" (internal TCXO), "Ext" (external 10 MHz signal) or to automatic mode. In automatic mode, the reference will switch to the external input when a signal is detected, otherwise it will use the internal TCXO.

The external reference output may either be disabled or set to 10 MHz or 100 MHz.

2.2.2 Device Log Dock

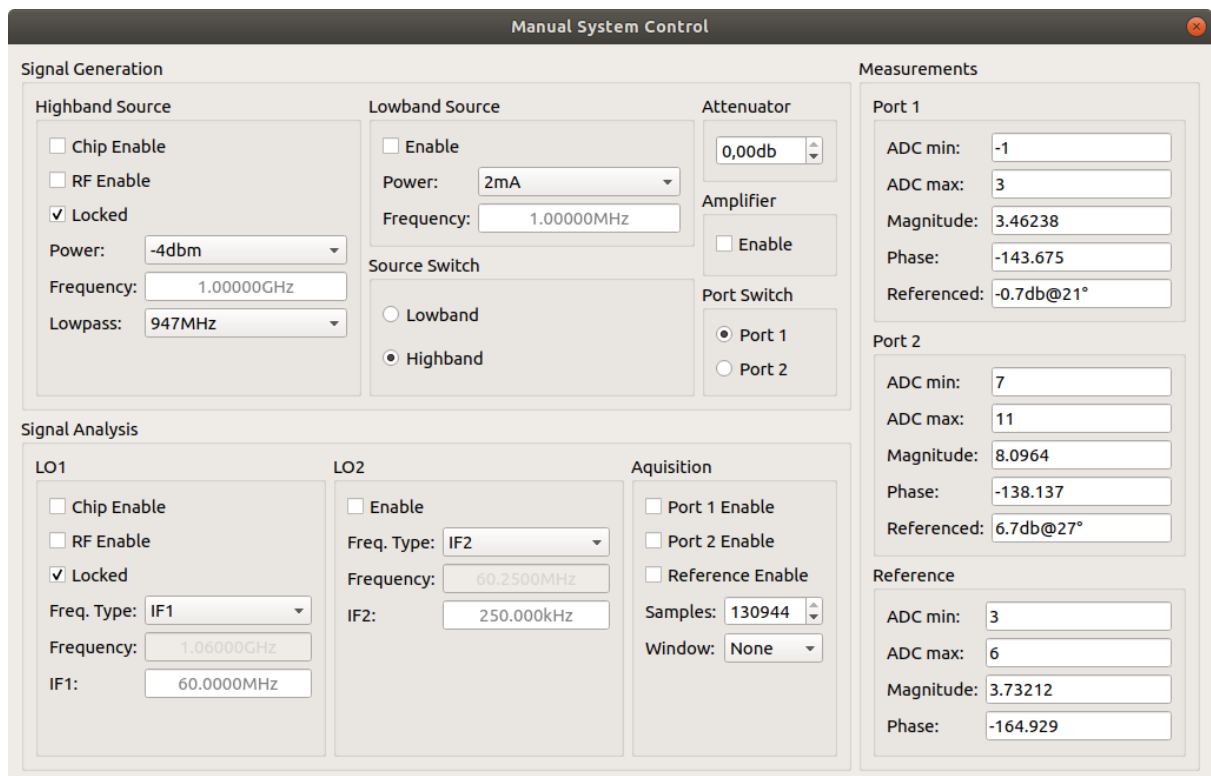
This dock shows the debug output of the VNA (the same messages as on the internal UART port). It may help to identify problems, otherwise it is not required for operation.



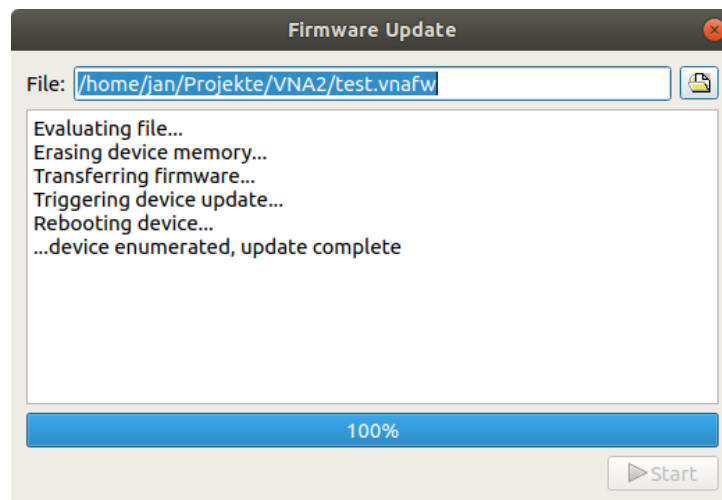
2.2.3 Device Menu

The device menu controls the connection state, allows low level hardware access and to perform firmware updates:

- **Update Device List:** Scans the USB port for connected devices. Clicking this action simply updates the list of devices, no connection is established.
- **Connect to:** Select which VNA to connect to. Different devices are identified by their serial number.
- **Disconnect:** Disconnect from the VNA.
- **Manual Control:** Starts the manual control dialog in which all hardware settings are accessible (mostly used for testing purposes):



- **Firmware Update:** Load a new microcontroller firmware and FPGA configuration into the VNA. Do not disconnect power while updating the firmware!



2.2.4 Window Menu

The window menu allows hiding not needed toolbars and docks. It also contains some application preferences.

3 Operating Modes

3.1 Vector Network Analyzer

In this operating mode, the VNA takes S-parameter measurements. A source signal is generated and alternately applied to the RF ports. The incoming signal at both RF ports is measured, resulting in the four S-parameters S_{11} and S_{21} (when the source signal is routed to port 1) as well as S_{12} and S_{22} (when it is routed to port 2).

3.2 Signal Generator

3.3 Spectrum Analyzer

4 Troubleshooting

If there was an error in the boot process, the "Booting" LED will blink an error code repeatedly:

Error Code	Meaning	Possible solution
1	Failed to detect FLASH memory	
2	Invalid FLASH content	Perform firmware update
3	Failed to configure FPGA	Check FPGA bitstream generator settings
4	Hardware initialization failed	Verify that FPGA bitstream and uC firmware are created from the same release