

# INTRODUCTION TO THE NANO VNA

Neil Goldstein

W2NDG

A series of several parallel white lines of varying thicknesses, slanted diagonally from the bottom-left towards the top-right, located on the right side of the slide.

- ▶ 20 years as an IT professional
- ▶ SWL since childhood
- ▶ Licensed in 2008
- ▶ Raised in Ulster County
- ▶ Recently returned to the Hudson Valley
- ▶ Ham Radio University forums on Linux, SDR, Digital Modes, and Raspberry Pi
- ▶ Currently living in Poughkeepsie. Spouse (Jill) also a Ham
- ▶ Working at Sloan Kettering Cancer Center as a Research Computing Specialist
- ▶ HF, VHF/UHF, Kit Building, SDR, Digital Modes, Transmitter Hunting, More
- ▶ Fun Fact: I used to lecture about edible wild plants
  
- ▶ Shameless Plugs: [radiokitguide.com](http://radiokitguide.com), and the Long Island CW Club (W2LCW) [longislandcwclub.org](http://longislandcwclub.org)

## WHO IS W2NDG?

# NANO WHAT?

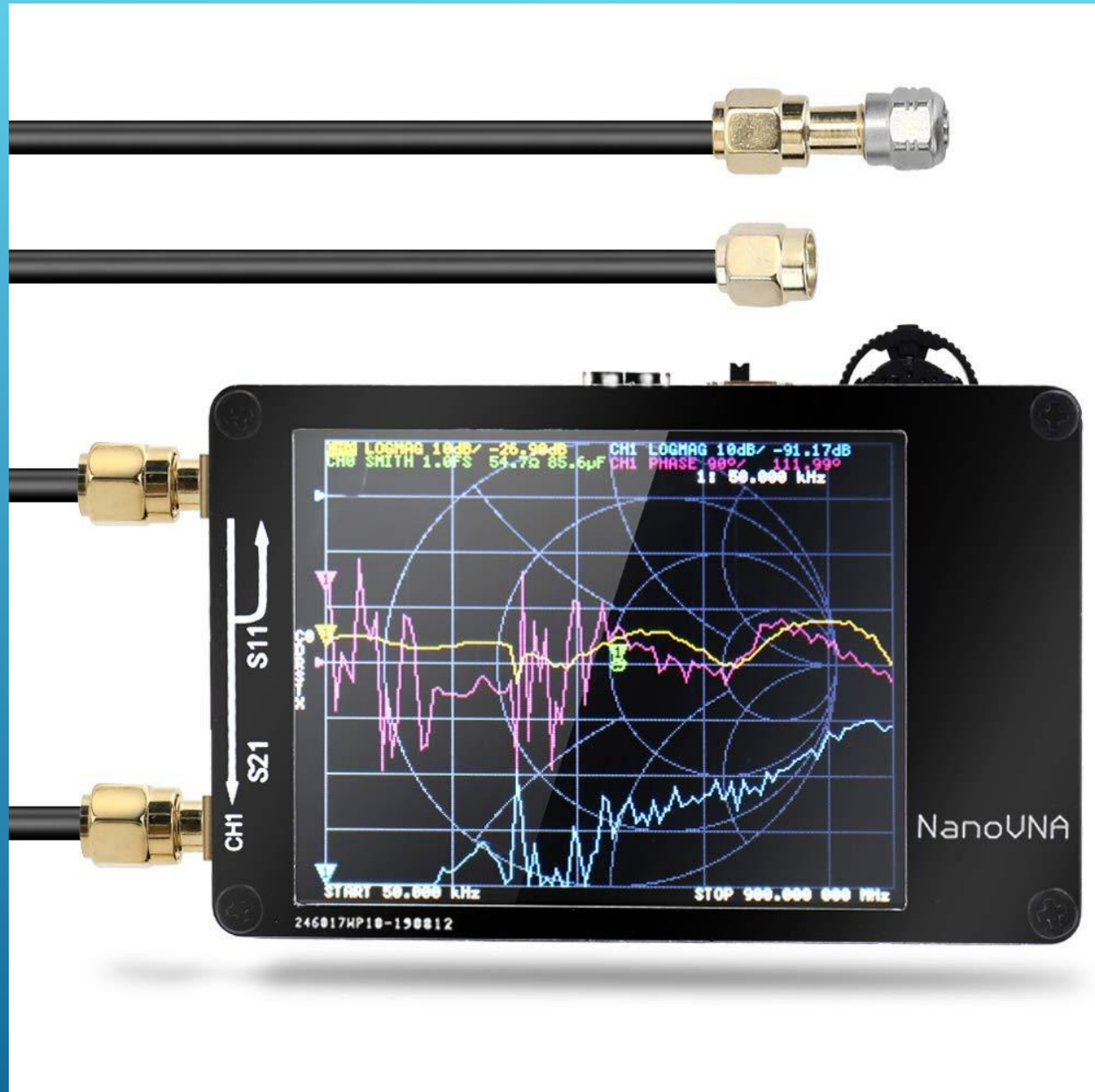
ORIGINAL OPEN SOURCE NANOVNA  
PROJECT BY @EDY555 AND TTRFTECH

## VNA

### Vector Network Analyzer

A VNA is a form of RF network analyzer widely used for RF design applications (Wikipedia)

Like an antenna analyzer, but with input and output connectors for testing loop antennas, filters, cables, and other pass-thru devices as well as single connector uses (like an AA)





Keysight Field VNA

Forget the NANO for a moment. What does a VNA look like?

Where can you find one?

How much do (did) they cost?

How do they work?

# VNA BASICS



Keysight Field VNA

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Industrial & Scientific > Test, Measure & Inspect > Electrical Testing > Spectrum Analyzers

by Rigol  
**Rigol DSA815-TG Tracking Generator Spectrum Analyzer**  
 ★★★★★ 26 ratings | 20 answered questions

Price: **\$1,299.00** ✓prime  
 New (3) from **\$1,299.00** ✓prime FREE Shipping

Specifications for this item


Part Number	DSA815-TG
UPC	696738160279
Brand Name	Rigol
EAN	0696738160279
Model Number	DSA815-TG
Specification Met	certified frustration-free
UNSPSC Code	41110000

[See more product details](#)

WHERE CAN YOU FIND ONE?



Keysight Field VNA



All Products ▾

Q

All Products ▾
Manufacturers
Quick Order ▾
Orders & Quotes ▾

## Keysight Technologies N9913A

Test & Measurement / Analyzers / N9913A





Image may be a representation.  
See specs for product details.


SHARE

**4 GHz FieldFox RF Analyzer**

Manufacturer #: N9913A

Allied Stock #: 70244135

-
1
+

ADD TO CART

Resources

[Datasheet](#)

[View More from Keysight Technologies >>](#)

- Due to the unusual shape or weight of this item, additional shipping charges may apply.

Pricing (USD) & Availability

Standard Pricing

\$11164.00 (Each)

1     \$11164.00

Availability

0 can ship immediately.

[Request Lead Time](#)

Minimum Quantity: 1

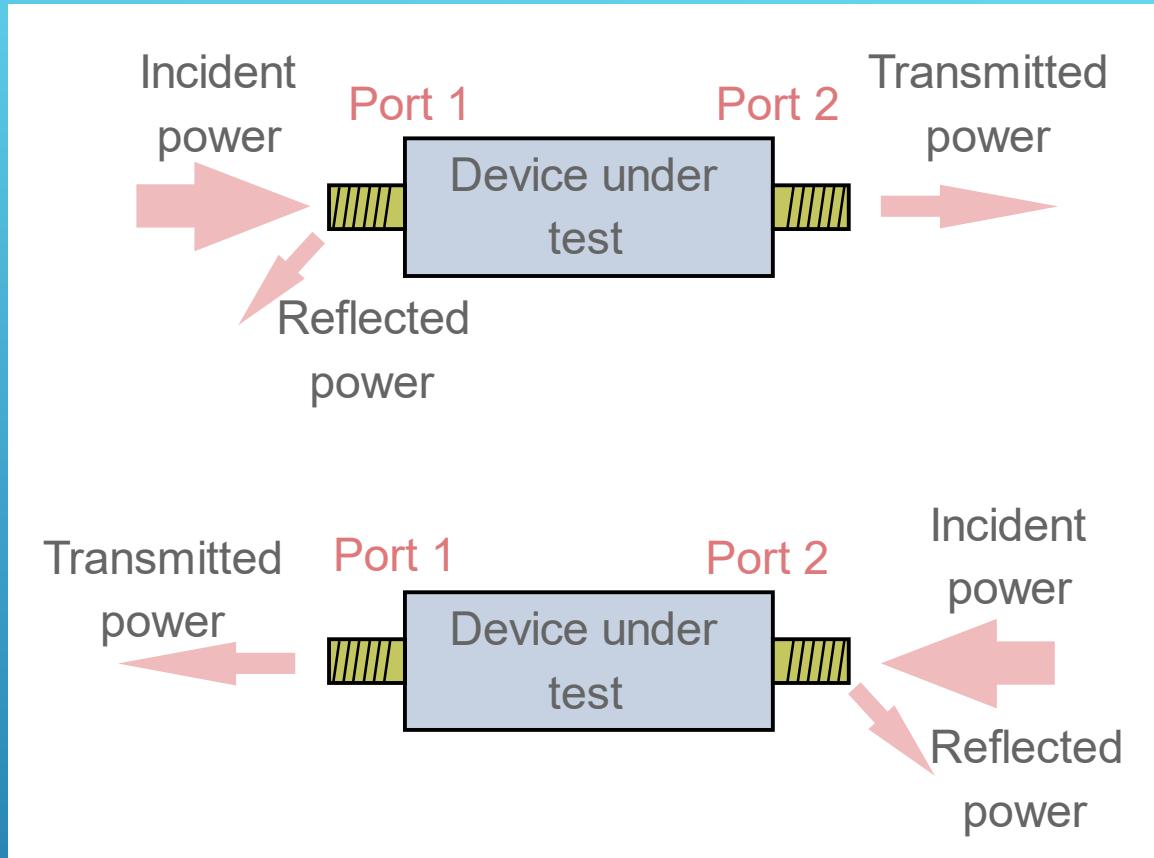
Multiples Of: 1

HOW MUCH DO (DID) THEY COST?

THIS ONE IS OVER \$11K  
OUR KEYSIGHT AGAIN  
REMEMBER THAT



Keysight Field VNA

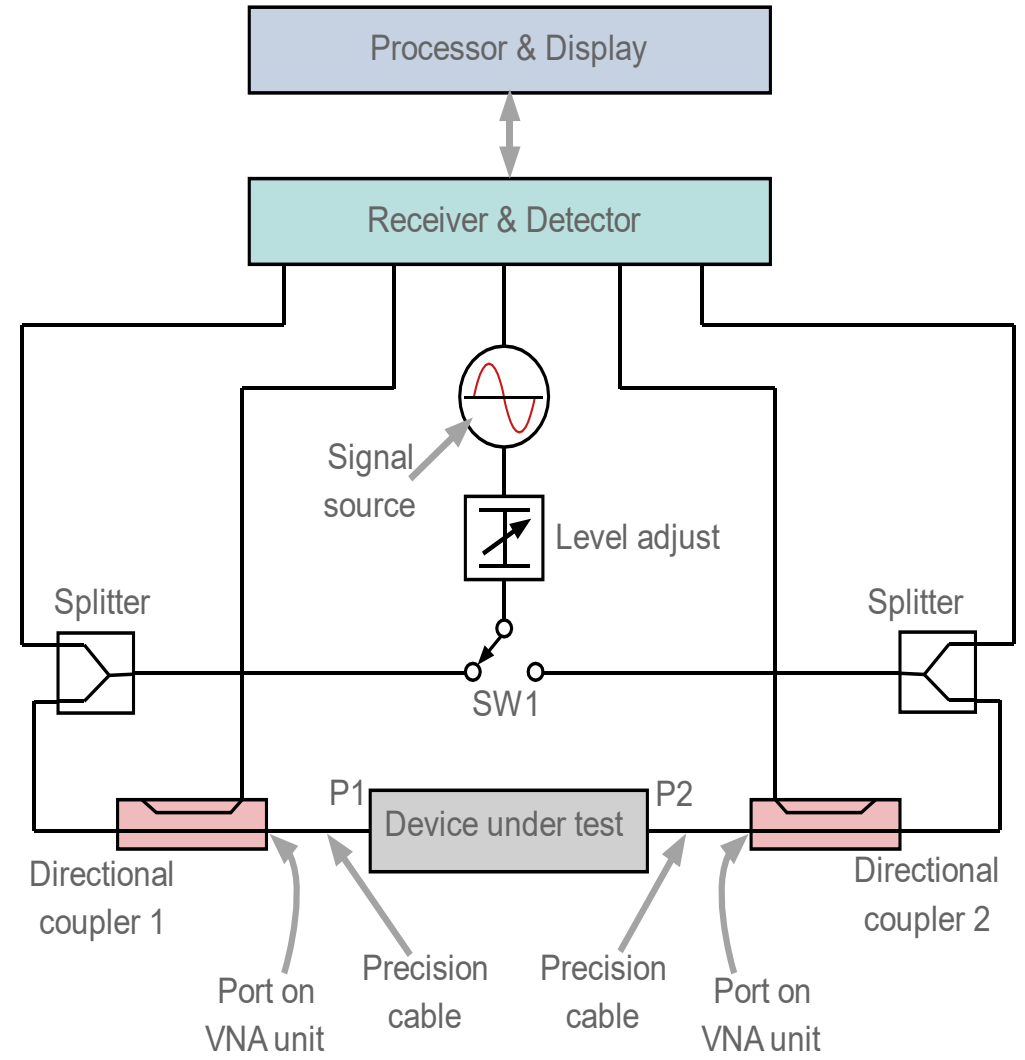


# HOW DO THEY WORK?

The block diagram of a basic two port vector network analyzer is shown above. This shows the high level blocks needed for a typical VNA.

The VNA has precision connectors on the front panel of the unit itself and then precision cables are used to connect these to the device under test. Precision cables are required because the phase and loss of a standard cable would vary too much with even slight movement, etc.

To test the device, a variable frequency signal is generated within the vector network analyzer and the output is switched to test the DUT in either one direction or the other. In this case the left hand side on the diagram is selected. The signal passes to the splitter where one output is used as the reference signal for the receiver and the other side is passed to a direction coupler and then into the DUT via the external connection on the VNA and the precision cables.



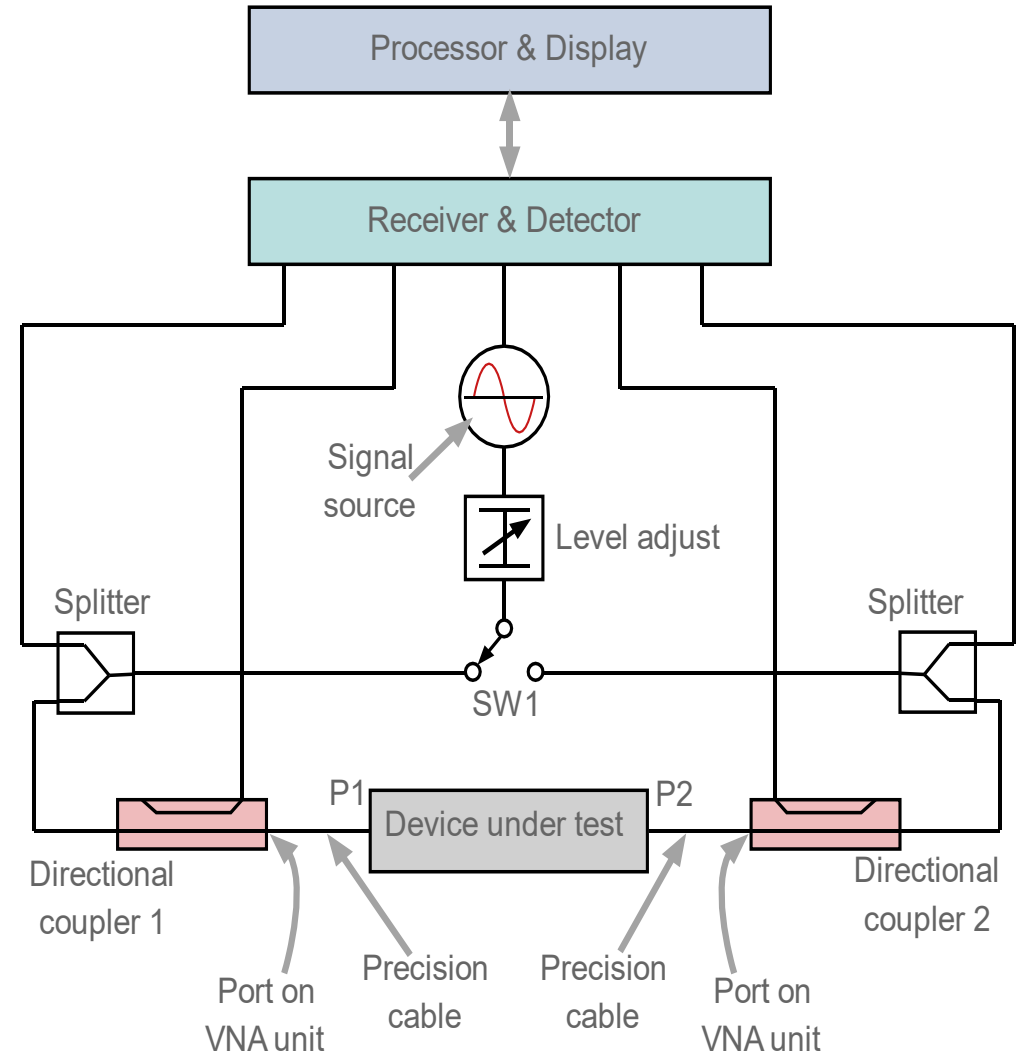


Power passes through the directional coupler (directional coupler 1) to the DUT, but the third port detects the reflected power and this is connected to the receiver again.

Power that passes through the device under test is sampled by directional coupler 2 and this signal is connected to the receiver.

The signals are processed by the receiver and are then fed to the processor and display. This section will again make heavy use of microprocessor technology to provide the control, functionality and user-friendly displays that are needed for modern test instrumentation.

Although this very simplified example of an RF network analyzer shows two ports, some vector network analyzers may use more ports for systems where many different signal paths exist.  
FROM ELECTRONICS-NOTES.COM

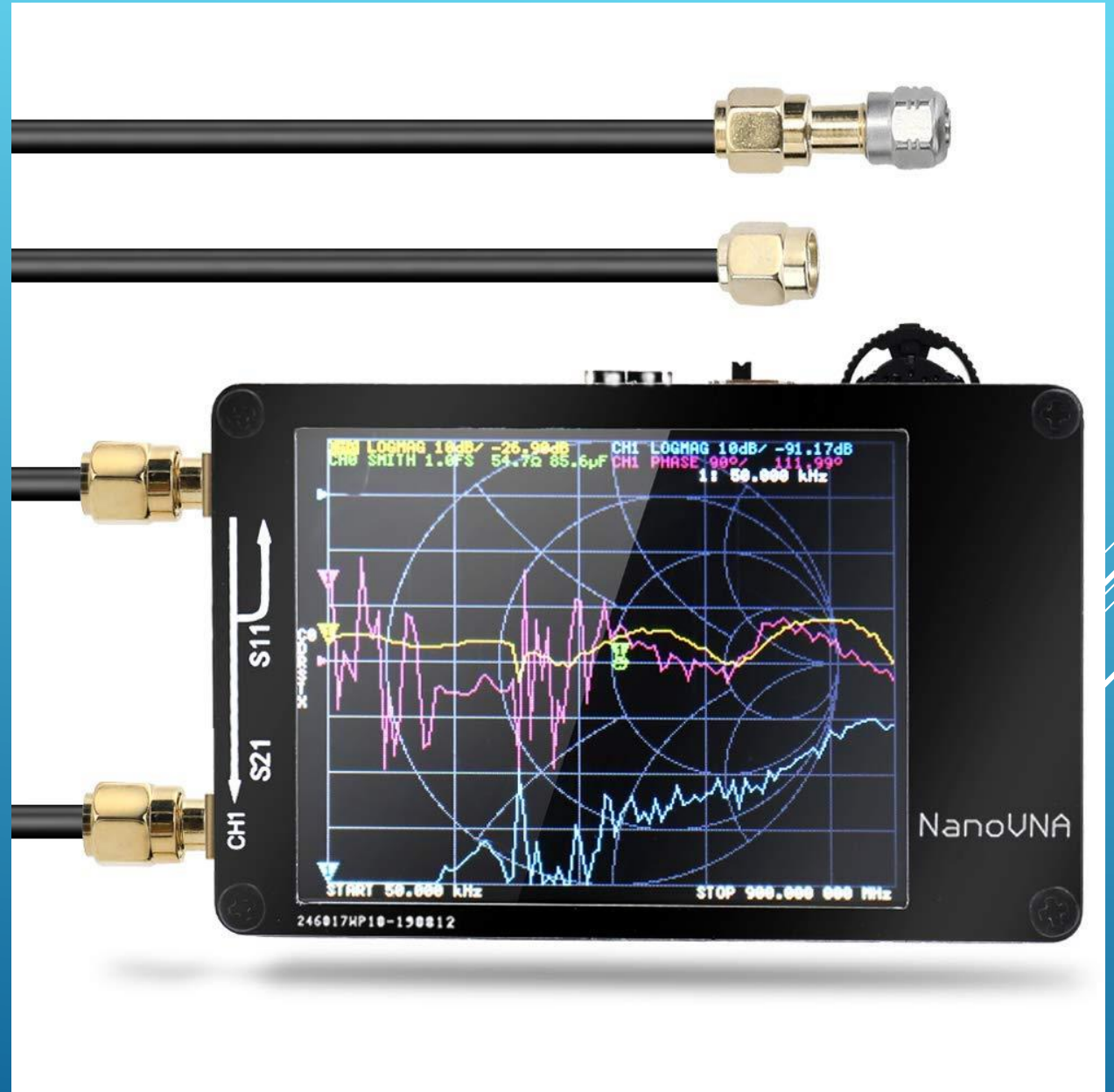


# ENTER THE NANO VNA

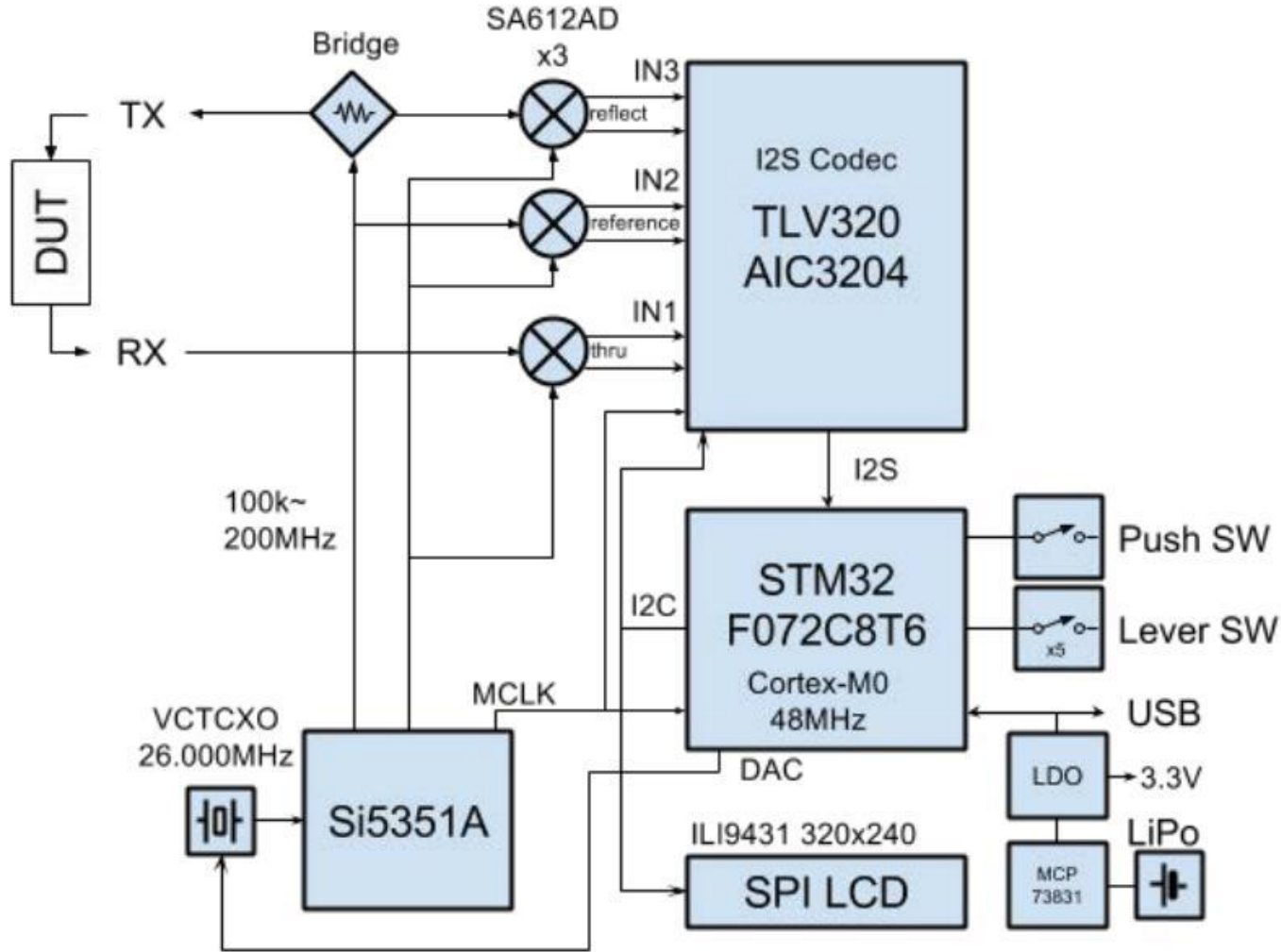
An inexpensive basic VNA for experimenters. Typical cost between \$40 and \$60

Comes with most of what you need to start testing

Some come with Li-ion battery



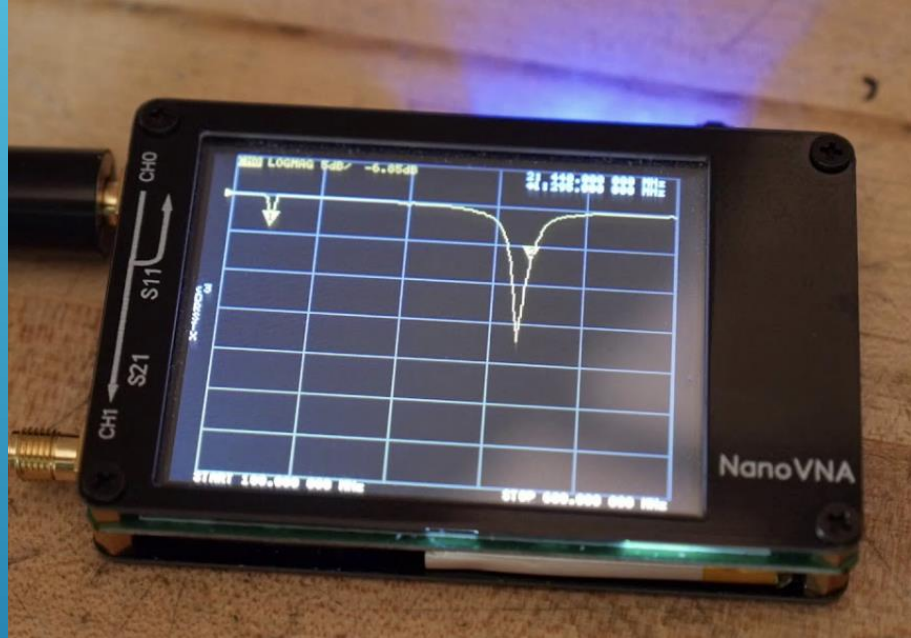
System Block Diagram:



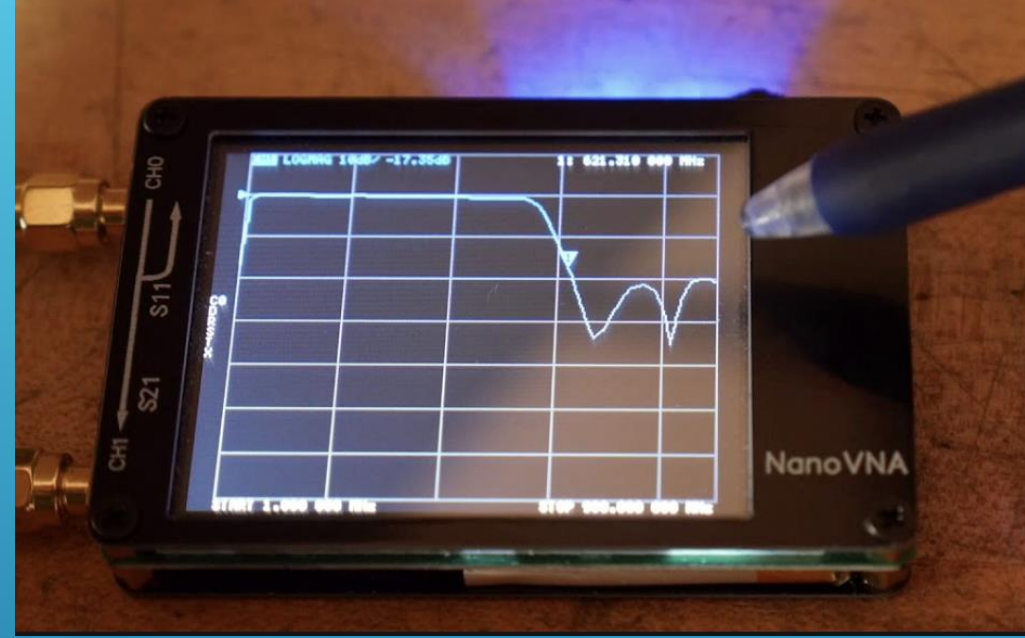
## WHAT'S INSIDE?

- Si5351A Clock Generator
- TLV320 AIC3204 I2S/PCM interface audio codec
- STM32 Microcontroller
- LCD
- SA612AD Mixer-Oscillator

# Antenna Analyzer



# Filter Analyzer

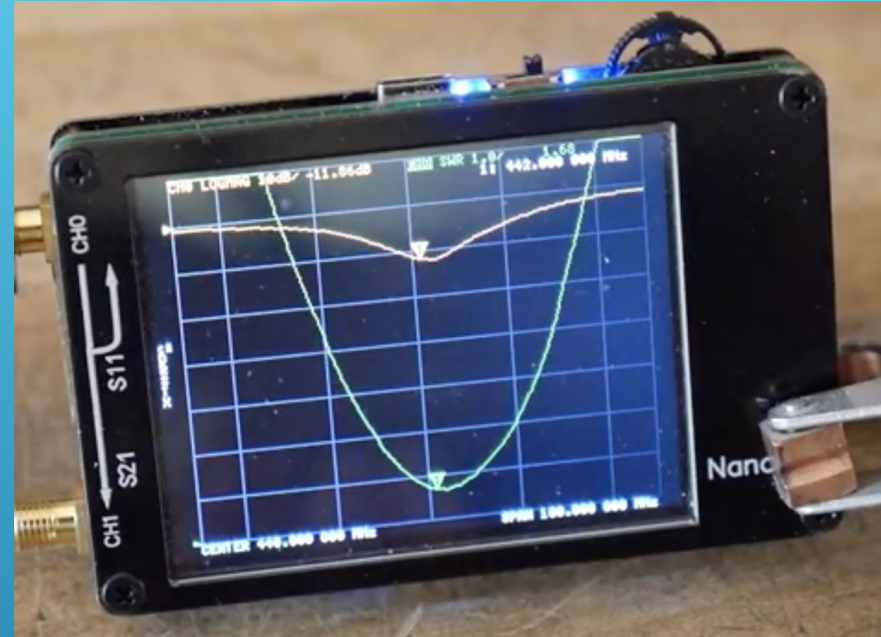


USES FOR THE NANO VNA

## Multiple Ways to Display

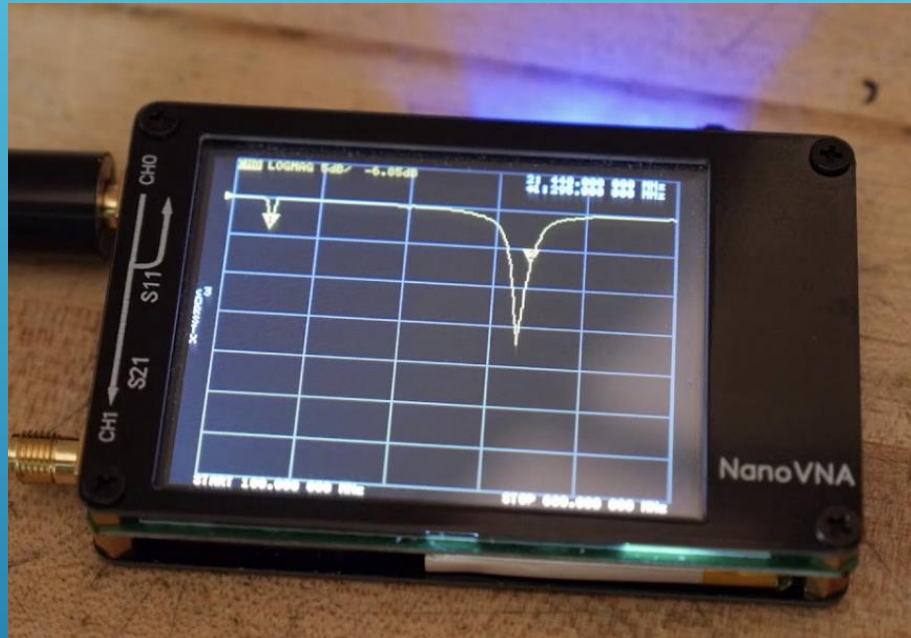
- ▶ SWR ratios are something that are common to Amateur Radio and some other radio hobbyists. Usually in commercial radio, antenna performance is measured as return loss in Db. The NanoVNA defaults to this mode out of the box, but can be set to display either or both, as well as Smith charts, and others

## Both SWR and Return Loss

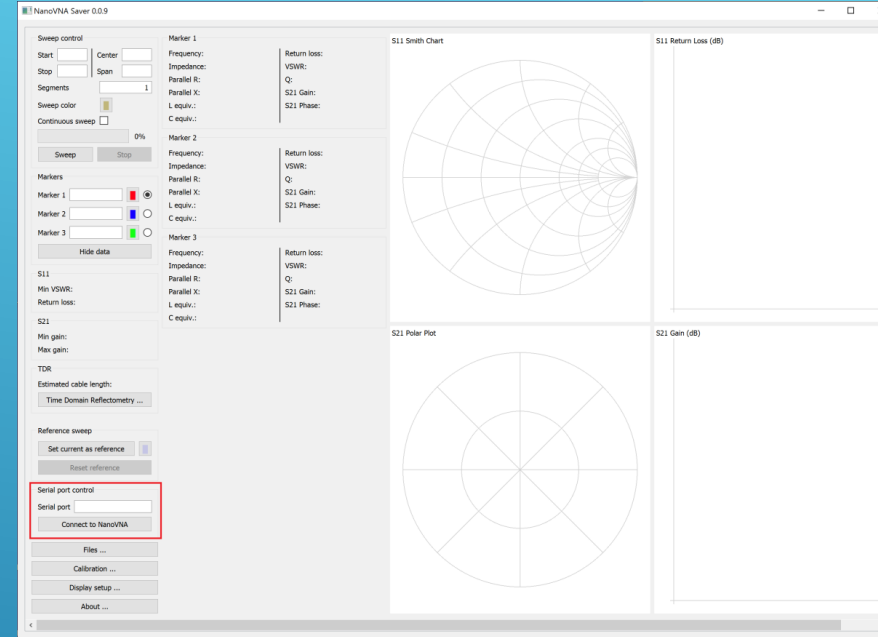


# MULTIPLE DISPLAY MODES

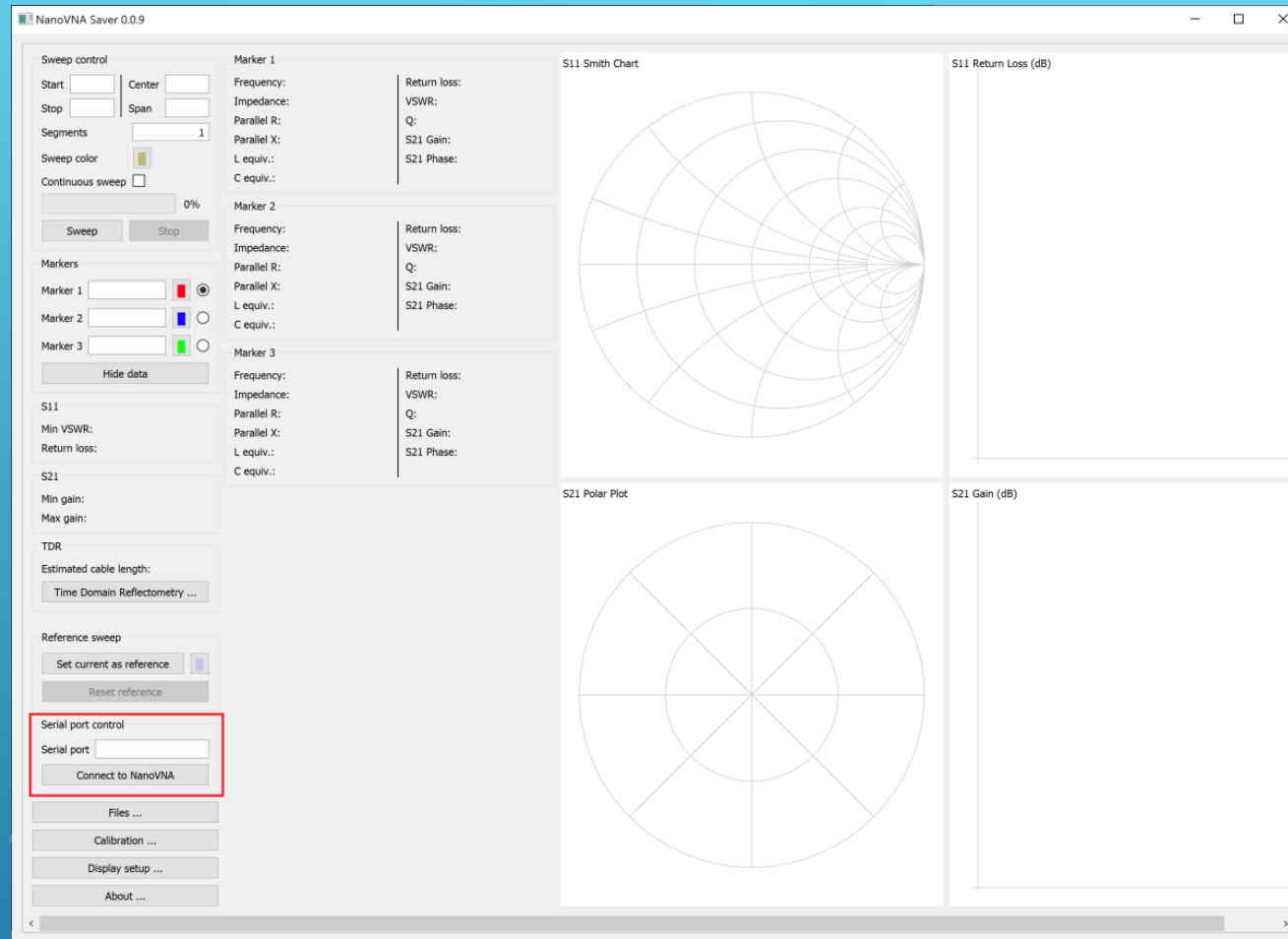
# Cable Analysis



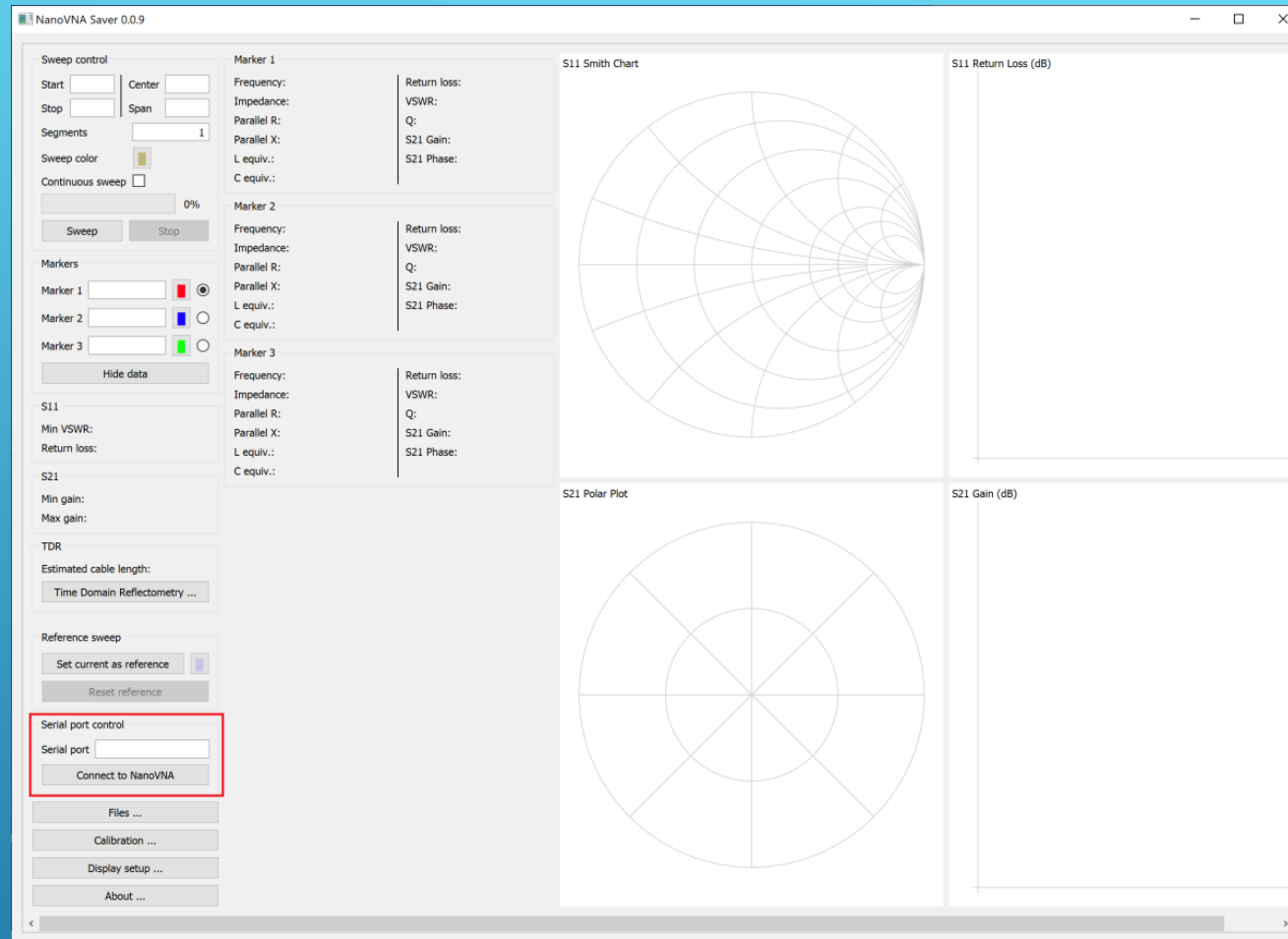
# More Uses With Software



# MORE USES FOR THE NANO VNA



# NANOVNA SAVER



Python software. Easy install on Windows. A little more complicated on a Mac

All functions of the VNA directly plus some more analysis, like Time Domain Reflectometry (TDR)



- ▶ Small and portable
- ▶ Includes two SMA male jumpers
- ▶ Female barrel coupler and male coupler
- ▶ 50 Ohm load, shorted load, and open load
- ▶ Some come with Li ion battery
- ▶ USB C connector for data and charging
- ▶ Some models range 100kHz to 300 MHz
- ▶ Most now to 900 MHz
- ▶ Recent firmware updates to 1.5 GHz
- ▶ Amazon seller KKM00N is where I got mine
- ▶ ALL OVER eBay, but roll the dice

## WHAT, WHERE, HOW MUCH?

Information will be posted on my blog: FOFIO!

Go to [neilgoldstein.com](http://neilgoldstein.com) and click on the link to FOFIO!

## SOME OF THE LINKS AT THE BLOG:

- ▶ Comparison with "real" VNA
  - ▶ Read how well it does in the real world
- ▶ RTL-SDR.com reviews and articles
- ▶ Original open source project
- ▶ Electronics-notes.com primer on VNA's
- ▶ Hex and Flex guides 1, 2, and 3
- ▶ NanoVNA-saver download and source

