



Candlewood Amateur Radio Association (CARA)

Test Equipment for Amateur Radio

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VOM/DVM

- A VOM (Volt-Ohm-Milliammeter) is a versatile tool used to measure voltage, current, and resistance in electrical circuits.



VOM/DVM

- A digital multimeter can be used for voltage, resistance, current, continuity, resistance, capacitance to test transistors, even the internal resistance of capacitor in /out the circuits.
- Digital multimeters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters are now far more common due to their cost and precision, but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value.

How to Measure Voltage Safely with a VOM/DVM

- **Basic Steps to Use a VOM**
 - Knowledge of task
 - Proper PPE
 - Know what to expect
 - Know if you are measuring AC or DC Current
 - **Select the Measurement Type:**
 - Turn the dial to the desired measurement type (voltage, current, or resistance). Ensure you select AC or DC as needed.
 - Probes in the proper inputs
 - Proper polarity (if Known)
 - Touch probes to point to be measured

Clamp on Ammeter



How to Measure Current Safely with a Clamp-On Ammeter

- Safely measuring current is a fundamental skill for any electrician, crucial for troubleshooting, load balancing, and ensuring system safety. To measure current with a clamp meter, you must first select the appropriate AC or DC current function on the meter. With proper Personal Protective Equipment (PPE) donned, open the spring-loaded jaw and clamp it around a single, individual conductor—never a bundled cable. Clamping both hot and neutral wires will yield a zero reading as their magnetic fields cancel each other out. Once clamped, the meter provides an immediate reading in amperes (Amps). For professional applications, a journeyman electrician must understand advanced features like **True RMS** for accurate readings on non-linear loads and the **inrush current** function for diagnosing motor startups. Adhering to strict **electrical safety standards** and understanding the meter's **CAT ratings** are non-negotiable for preventing accidents during **AC/DC current measurement**.
- Knowledge of task
- Proper PPE
- Know what to expect
- Know if you are measuring AC or DC Current

RF Dummy Loads

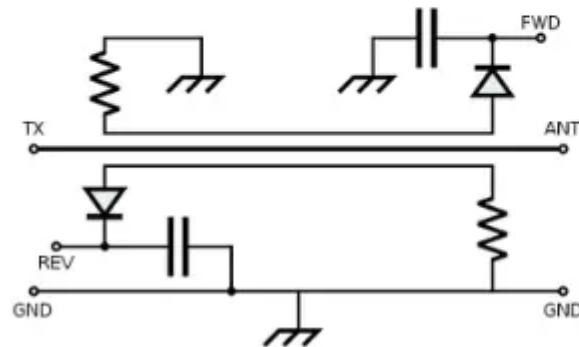


RF Dummy Load

- Used to simulate transmitter antenna
- Provide a Low VSWR
- Protect the output stage of a transmitter

VSWR / RF Power Meter

**What is an
SWR Meter?**



Electrical 4 U

VSWR / RF Power meter

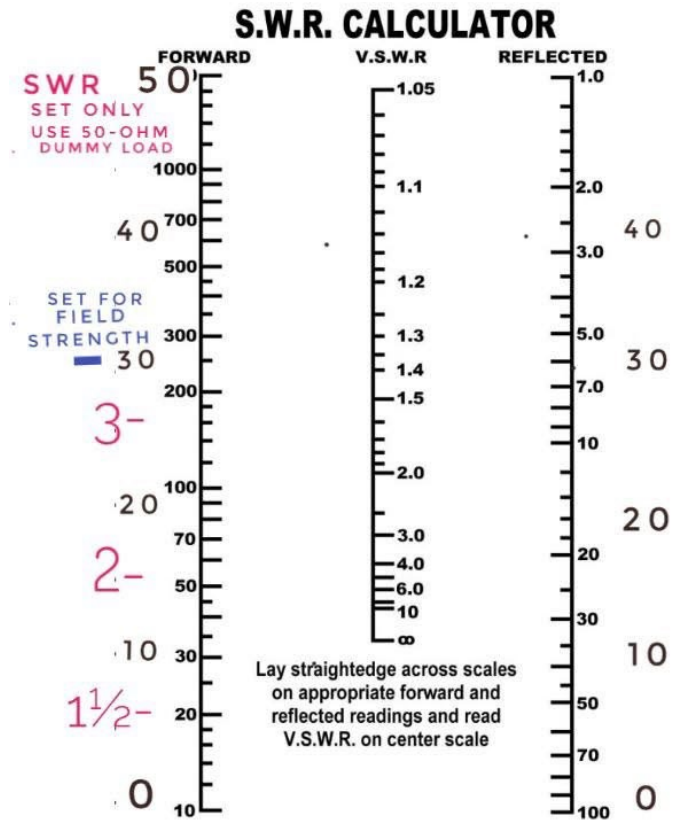
- **VSWR**

- A standing wave ratio meter – also known as an SWR meter, ISWR meter (current “I” SWR), or VSWR meter (voltage SWR) – is defined as a device that measures the standing wave ratio (SWR) in a transmission line. The SWR meter indirectly measures the degree of mismatch between a transmission line and its load (usually an antenna). This is helpful to know the effectiveness of the impedance matching performed by technicians.
- An SWR meter helps determine how much radiofrequency energy is reflected back to the transmitter compared to the amount sent out. The ideal ratio is 1:1, meaning all the power reaches its destination with no reflection.
- Used to help set a tuner or matching network to simulate a 50 ohm match to the transmitter.

- **RF POWER**

- Used to indicate the RF power in watts the transmitter is providing to the load

VSWR / RF Power meter



SWR Formulas and Calculations

- VSWR can be calculated from various parameters. By definition, VSWR is given as ratio of maximum voltage on the line to the minimum voltage.

$$VSWR = \frac{V_{max}}{V_{min}}$$

- The same can be expressed in terms of forward and reflected wave voltages.

$$VSWR = \frac{V_{fwd} + V_{ref}}{V_{fwd} - V_{ref}}$$

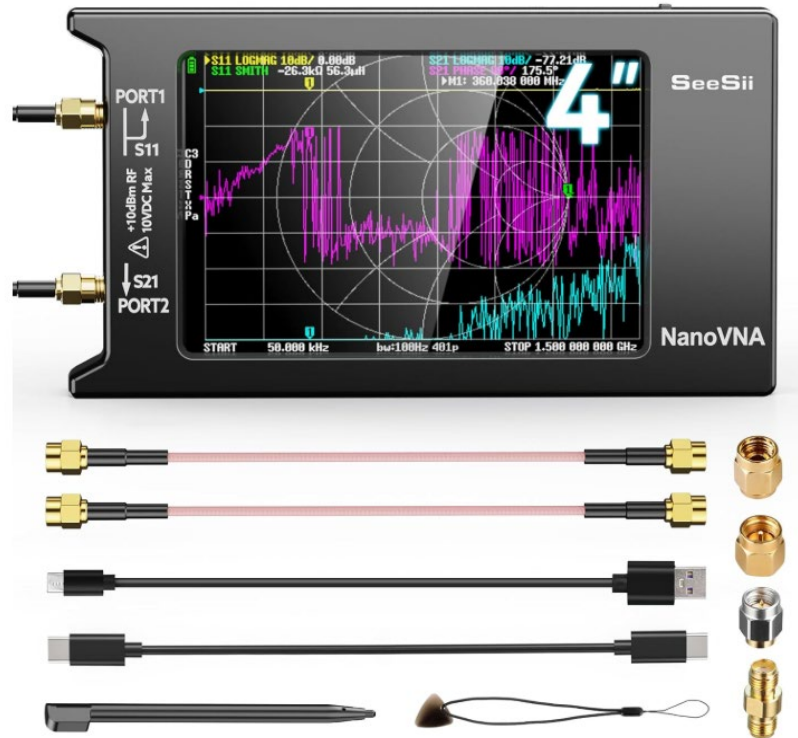
Antenna Analyzer (MFJ / Rig style)



Antenna Analyzer (MFJ / Rig style)

- Antenna Analyzers are powerful antenna analyzers designed for testing, checking, tuning, or repairing antennas and antenna feed-lines.
- Gives you a complete picture of your antenna. Read antenna SWR and Complex Impedance Built-in frequency counter.
- **Read** Complex Impedance as series equivalent resistance and reactance
- **Determine** velocity factor, coax loss in dB, length of coax and distance to short/open in feet, read SWR, return loss and reflection coefficient at any frequency simultaneously at a single glance. Also reads match efficiency. Also read inductance in uH and capacitance in pF at RF frequencies. Measure SWR and loss of coax with any characteristic impedance, * Tuning an antenna to resonance
 - * Antenna SWR and impedance measurement and comparison before and after a specific event (rain, hurricane, winter, etc.)
 - ** Cable testing and fault location
 - * Measuring capacitance or inductance of reactive loads

Antenna Analyzer (VNA)



Antenna Analyzer (VNA)

- VNA - Vector Network Analyzer
- NanoVNA is a handheld Vector Network Analyzer (VNA) with small outline, with LCD display, and can be powered from a 3.7V Li-ion battery.
- As known by most hobbyists, NanoVNA has become the most popular VNA and antenna analyzer project in the community since its release in 2019.

NanoVNA basics

- VNA (Vector Network Analyzer) measures the frequency characteristics of reflected power and passing power of a high frequency network (RF Network).
- NanoVNA measures the following elements:
- Input voltage I / Q signal
- Reflected voltage I / Q signal
- Pass voltage I / Q signal
- From here we calculate:
- Reflection coefficients S11
- Transmission coefficient S21
- The following items that can be calculated from these can be displayed.
- Reflection loss
- Passing loss
- Complex impedance
 - resistance
 - reactance
- SWR

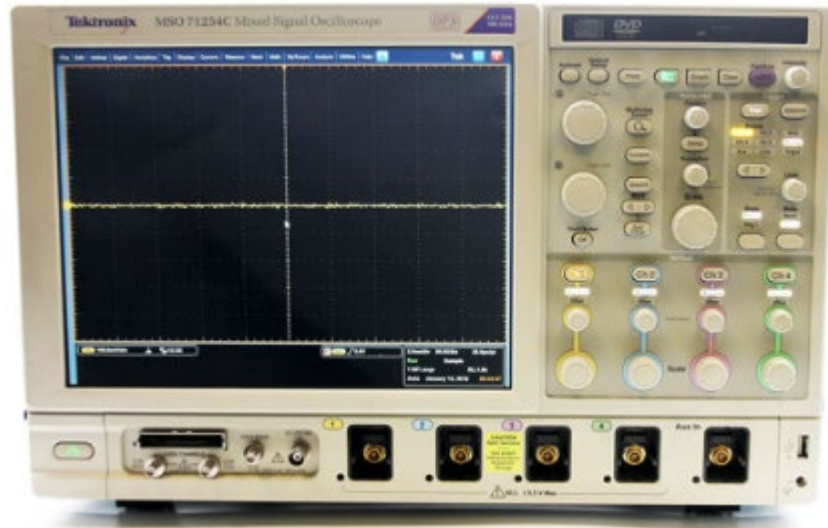
LCR Meter



LCR Meter

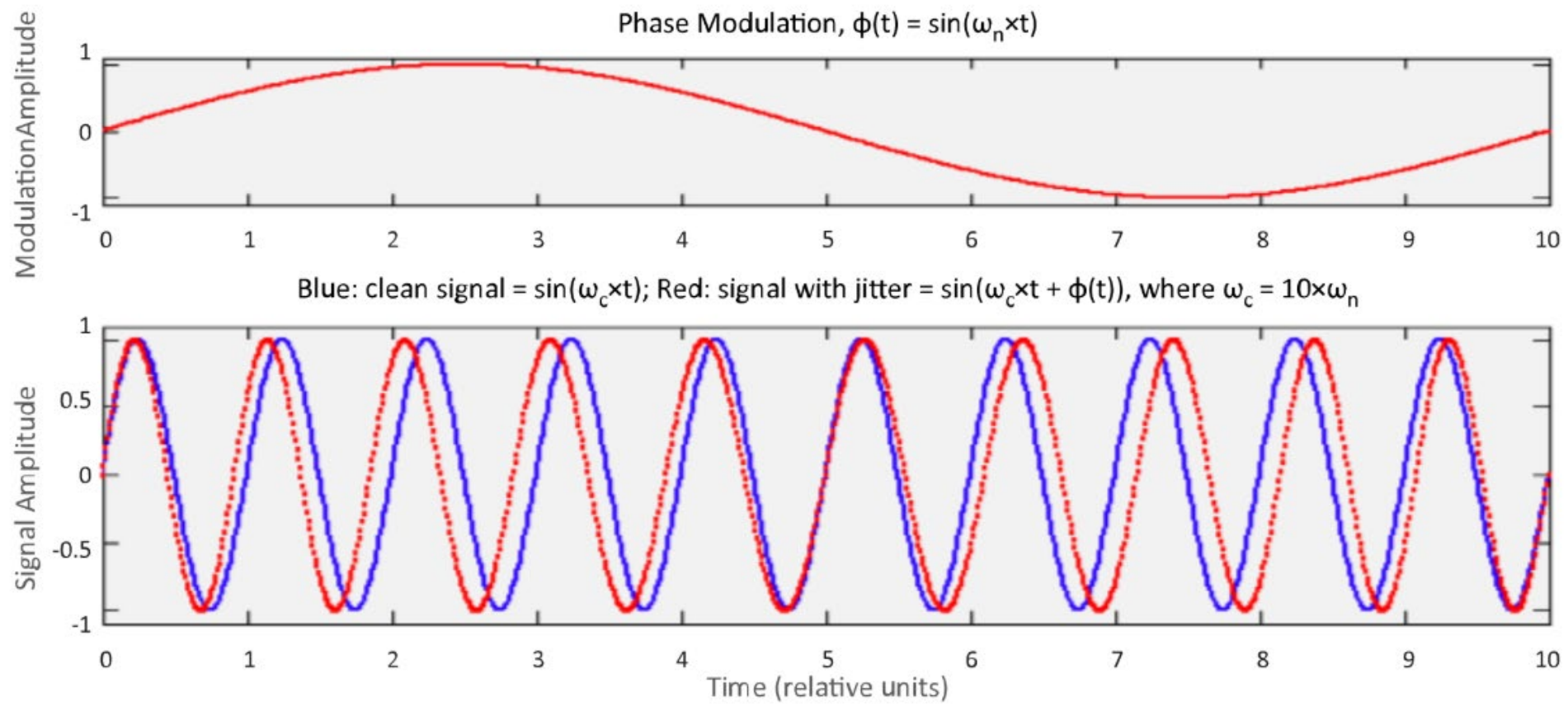
- LCR Meters measure Capacitance, Resistance and Inductance.
- LCR meters are useful when troubleshooting or constructing electronic projects
- Measure the inductance and Q of a coil

Oscilloscopes



Oscilloscopes

- Measures Voltage in the time domain
- An oscilloscope is a vital tool in electronics that allow users to visualize and analyze electrical signals. It displays waveforms, enabling users to measure frequency, amplitude, and signal shape
- Allows you to monitor the RF carrier and modulation
- Allows viewing of waveshapes
- Allows viewing of phase displacement
- Allows viewing of peak and peak-peak voltages
- Oscilloscopes come in desktop and portable, Analog and digital systems



Spectrum Analyzers



Spectrum Analyzers

- A **spectrum analyzer** measures the magnitude of an input signal versus frequency.
- The primary use is to measure the power of the spectrum of known and unknown signals.
- [The input signal that most common spectrum analyzers measure is electrical; however, spectral compositions of other signals, such as acoustic pressure waves and optical light waves, can be considered through the use of an appropriate transducer.
- Spectrum analyzers for other types of signals also exist, such as optical spectrum analyzers which use direct optical techniques such as a monochromator to make measurements.
- Spectrum analyzers are widely used to measure the frequency response, noise and distortion characteristics of all kinds of radio-frequency (RF) circuitry, by comparing the input and output spectra. For example, in RF mixers, spectrum analyzer is used to find the levels of third order inter-modulation products and conversion loss. In RF oscillators, spectrum analyzer is used to find the levels of different harmonics.

Miscellaneous Equipment

- Coax jumpers
- Coax Adapters
- Low Pass filter
- High Pass filters
- Coax Attenuators
- Soldering Iron
- Small tools ie. Cutters, needle nose pliers, small screwdrivers (Philips, Stright)

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•Questions

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•Thank You