

## Introduction

The vector voltmeter plugin can accompany Copper Mountain Tech's VNAs in measuring phase difference, which has many useful applications, such as antenna characterization, creating phase match cables, and analyzing MIMO antenna structures.

## Setup

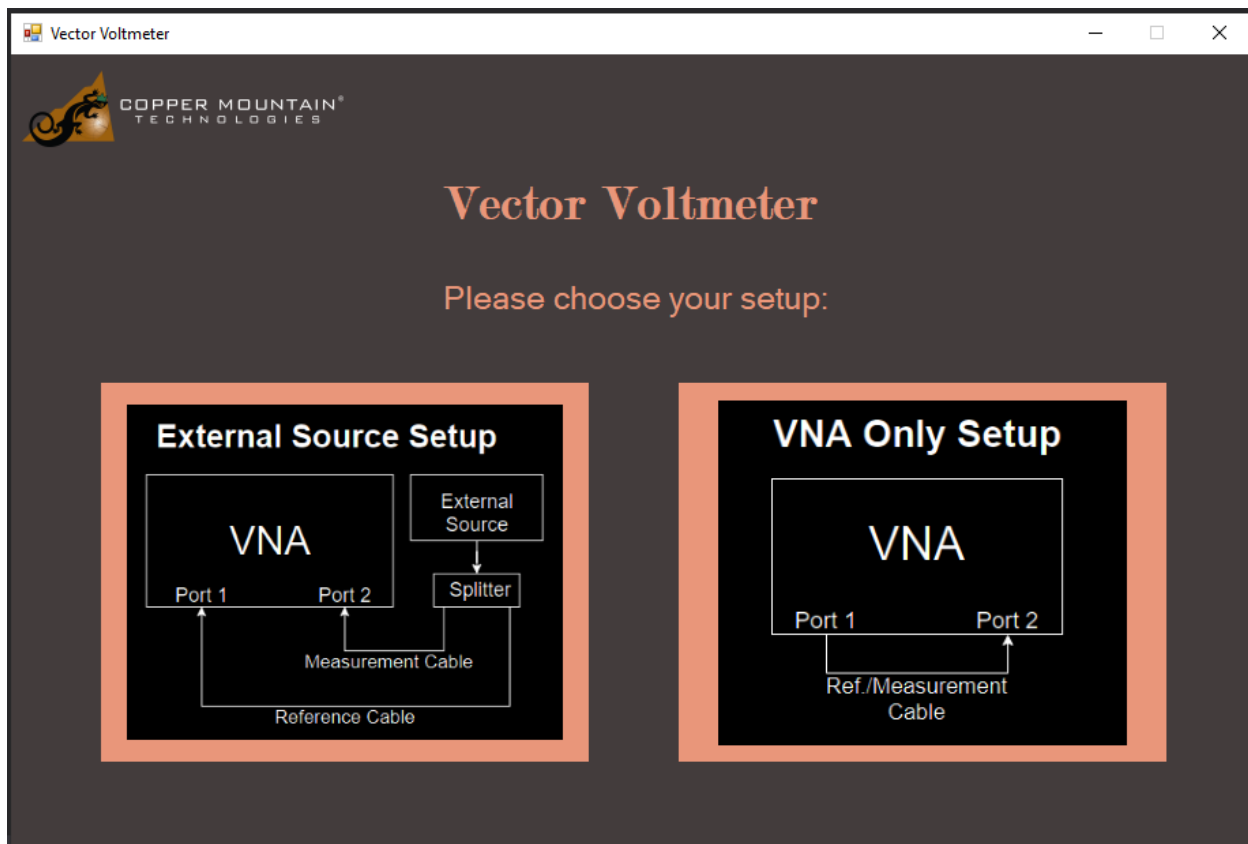
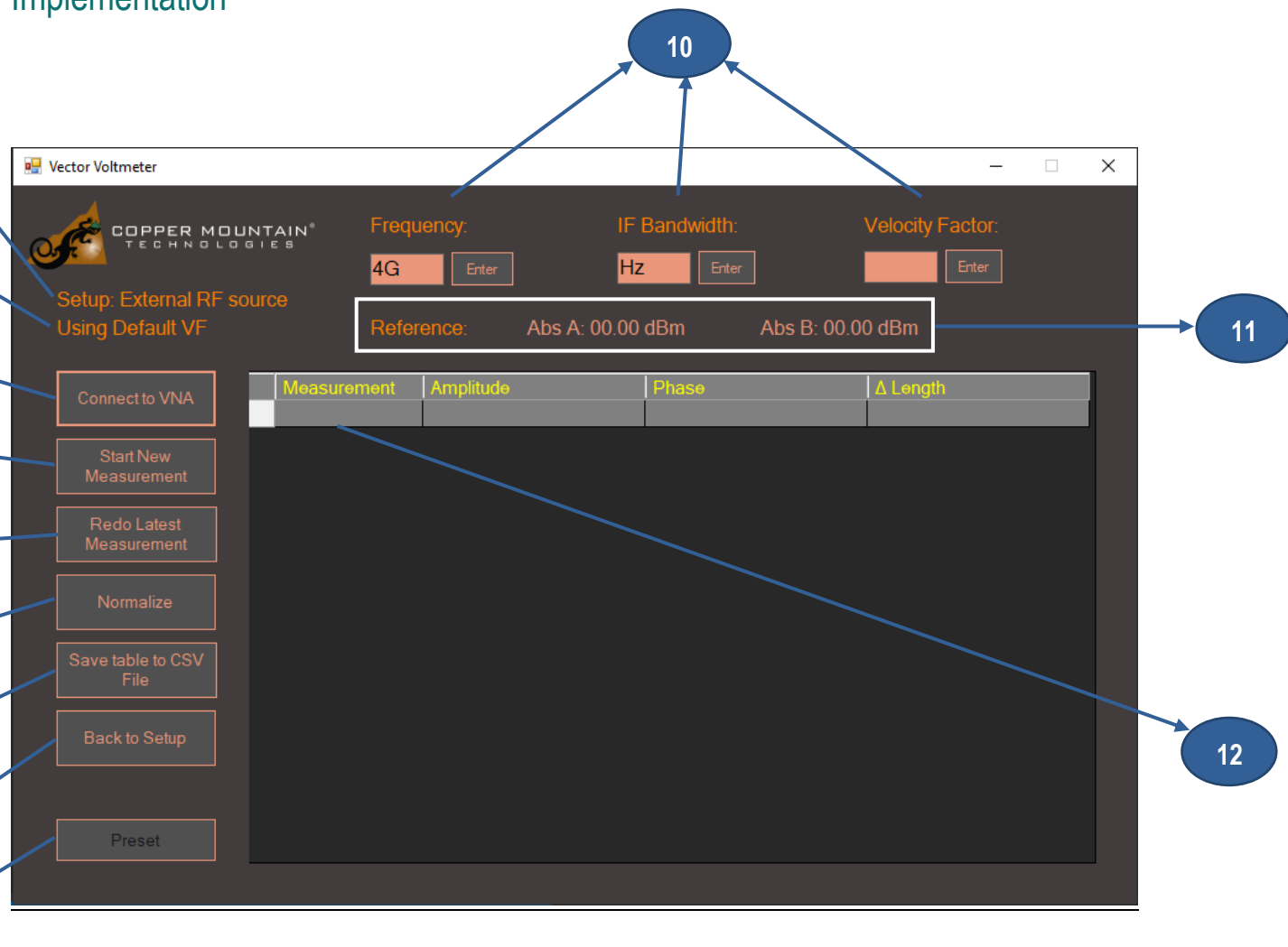


Figure 1: Setup

- External Source Setup:** An external RF source is applied to 2 different cables, reference and measurement. This option simply compares the phase difference between the 2 cables.
- VNA Only Setup:** Use the VNA's internal RF source to measure a single cable's phase. This option is usually only for phase matching cables. Replace the original reference cable with different measurement cables to compare their phase measurements to the reference cable.

## Implementation



- 1) This tells you which setup you currently have. If you mis-click the wrong setup, you can always go back to the start screen with (8).
- 2) If you did not enter a velocity factor when you connect to the VNA, the velocity factor is set to default, and this message shows. The default velocity factor (VF) is 0.69.
- 3) **Important:** Before you start using the vector voltmeter, you must connect to the VNA by clicking on this button. It will prompt you to enter the center frequency, IF Bandwidth, and velocity factor.  
If nothing is entered in as the material's velocity factor, it will be set to default. This will set up the initial reference frame and later measurements will be normalized based on this (although you can normalize again if needed).

Center freq. & IF bandwidth

Please give center frequency and IF bandwidth below.

Frequency:

IF Bandwidth:

(Optional) Velocity Factor:

OK

- If you do not connect to the VNA, you cannot perform any other operations.
  - If you want to reset everything, preset the VNA, and delete the measurement table, you can press this button again (It will say 'Disconnect from VNA' when you are connected).
  - VNA software must be running and TCP connection must be on to use this plugin. To make sure TCP connection is on, in the VNA software, go to **System > Misc Setup > Network Remote Control Settings > Socket Server > On** (if it is already on, you are good to go).
- 4) Start a new measurement that compare phase and amplitude of the measurement cable to the reference cable. In the VNA only setup, the reference cable is the initial cable. In other words, if you do not switch out for a different cable, the table should have zero-valued entries for all measurement columns.
  - 5) Delete the latest (or lowest) column on the table.
  - 6) This button lets you reset the reference frame to be the currently connected measurement cable. In other words, it is similar to a 'Tare' button on a scale.
  - 7) Save data from the current table to a .csv file.
  - 8) Reset the plugin and return to setup.
  - 9) Restore factory default settings of the VNA.
  - 10) These show the current center frequency (0 span is always applied), IFBW, and VF. You can change these numbers and hit 'Enter' to apply it to the VNA. Here is a list of what you can enter and what the VNA will read:



- a. 3 → 3Hz
  - b. 3G → 3GHz
  - c. 10k → 10kHz
  - d. 5M → 5MHz
  - e. 3.2MHz → 3.2MHz
  - f. Bunny → Invalid input
- 11) This is the reference frame. It shows the reference cable's absolute A and absolute B in dBm. You will see the numbers reset when you connect to the VNA or press 'Normalize'.
- 12) Each measurement is by default named 'Measurement [Entry's index]'. However, you can edit their names by clicking on the name you want to change and type in your preferred name, as illustrated here:

Reference:		Abs A: 0.005 dBm	Abs B: -112. dBm
Measurement	Amplitude	Phase	Δ Length
Measurement 1	0	0	0 mm
Measurement 2	0.52	8.36	-150114.83 m
Honeydew	4.27	1.62	-29089.24 m

### Limitation:

- Phase measurement is calculated with an arctan, so its value is  $-180^\circ < x < 180^\circ$ . Since Δ Length is calculated from phase, it can be affected too in cases like when  $330^\circ$  gets switched to  $-30^\circ$  by the VNA software.