CABLE MEASUREMENTS USING A VNA

VNA Model Used: CMT 804/1 VNA

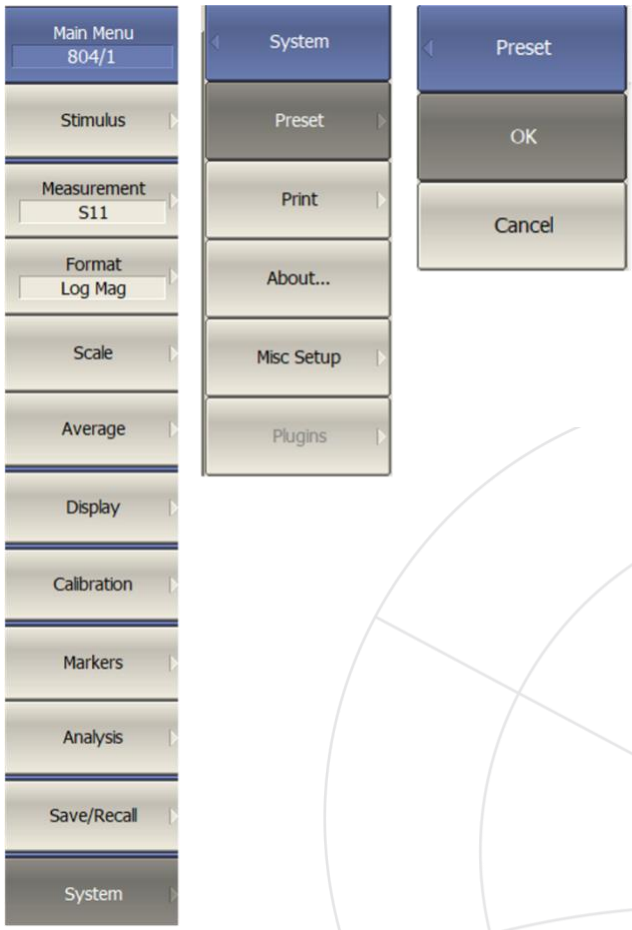
Frequency Range: 100 kHz to 8 GHz

Device Under Test: 50 Ohm Cable (2 ft long)

1. Frequency Domain Measurements

The goal of this measurement is to configure the VNA to make *return loss and insertion loss measurements* of a 2 ft long cable (connected between two ports of the VNA).

Before we begin making any sort of measurement, let us preset the VNA to make sure we have a fresh start. To preset the VNA, click on System > Preset – Ok.



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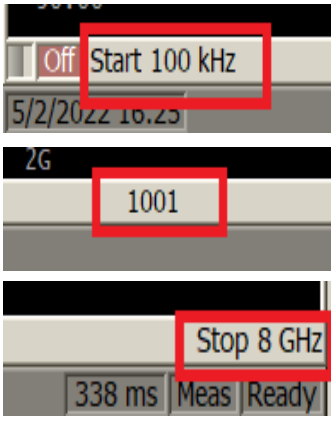
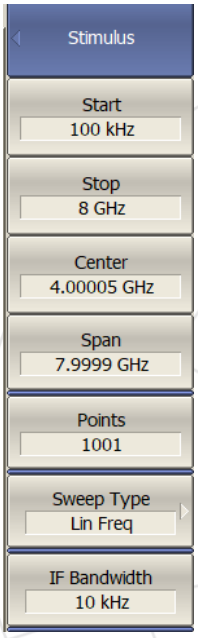
Since the cable is already connected to the ports of the VNA, let us go ahead and display the S parameters that help us look at the return loss and insertion loss of the cable.

We are eliminating the process of calibration since the cable is directly connected to the ports of the VNA. A full 2-port factory calibration has already been performed at the VNA ports at the time of manufacturing.

Let us make sure we have the right stimulus settings before we jump into making measurements. The cable that is connected to the VNA is a N-type to N-type cable and works from DC to all the way up to 18 GHz.

For this reason, we will use the entire range of this VNA (100 kHz to 8GHz). By default, the VNA displays this frequency. We will leave the start and stop frequency of the VNA unchanged (you can adjust this at the bottom of the screen directly or use the "Stimulus" menu on the right-hand side). Now add a lot of measurement points. The higher the number of points, higher the accuracy of measurement. Let us set it to 1001 points.





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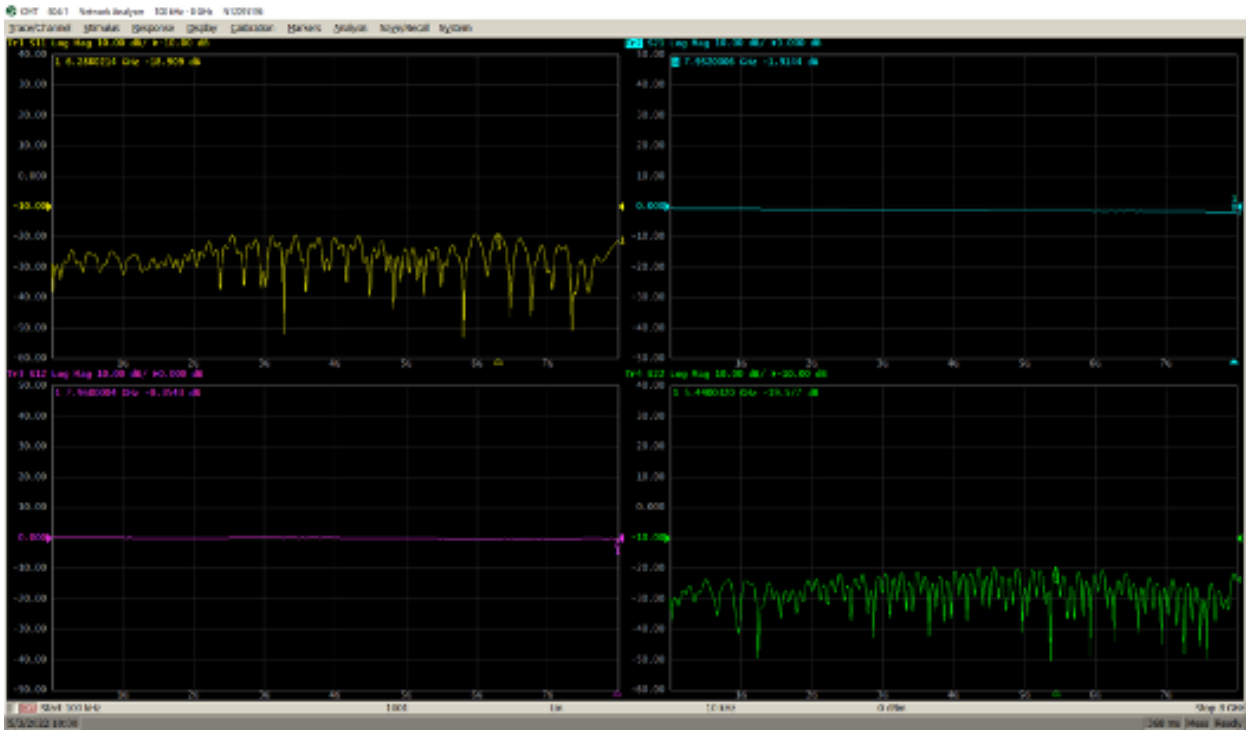
We want to display four traces. To do this, click on 'Display' > 'Num of Traces' and change it to 4. Then go back to the display menu and click on 'Allocate Traces' and then click on the 'x4' option to display these traces in different windows for better visualization.

Now what you can see on screen is S_{11}, S_{21}, S_{12} and S_{22}. S_{11} and S_{22} are forward and reverse return loss of the cable and S_{21} and S_{12} are the forward and reverse insertion loss of the cable.



Return loss and Insertion loss measurement of cable under test

The lower the return loss, the better the performance of the cable since reflections are undesired.

For insertion loss, the higher the value, the better. The closer the value is to zero, the better. We want most of the signal to go through the network from port 1 to port 2.

You should see a return loss of the cable around 20dB and an insertion loss of around 1.14 dB. The word loss and a negative value cannot be associated together. This is the reason you simply write 20 dB even though the actual value is -20 dB.

2. Group Delay Measurements

The goal of this measurement is to be able to *measure the group delay of the cable*.

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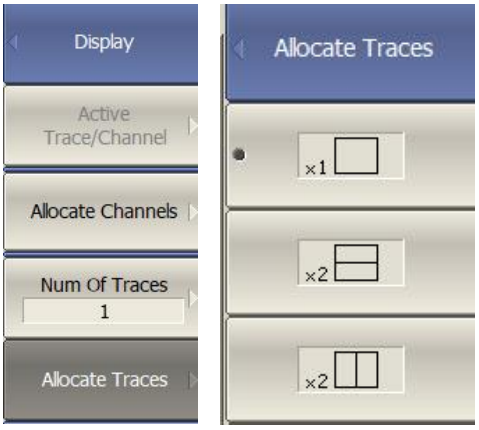
We need only one trace to make these measurements. To do this, click on 'Display' > 'Num of Traces' and change it to 1 and then allocate it to one window.



Next, we will change the trace to display S21 Delay. You can change this directly on the software screen as shown below:

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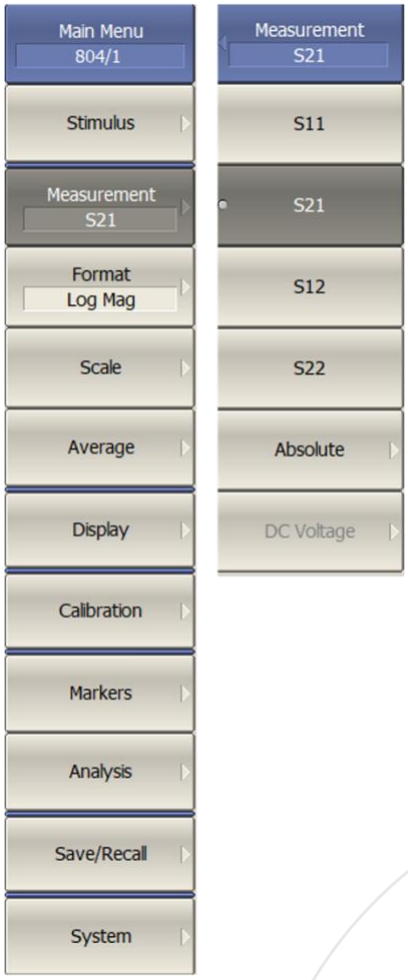
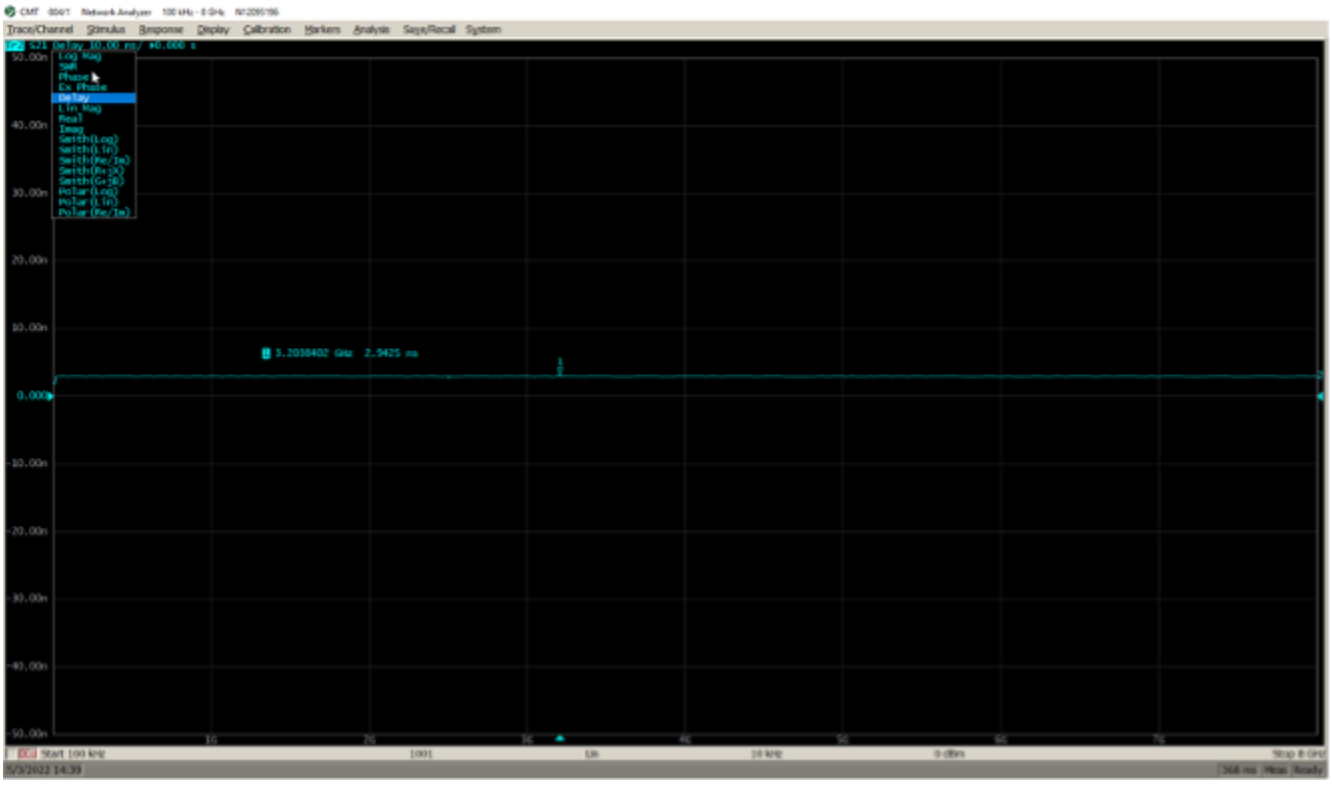
You could also change the trace to display S21 by using the menu on the right-hand side. First, click on the trace to that you want to change and then click on the following options on the right-hand side of the software:



You must now see a response that looks like what is displayed below:



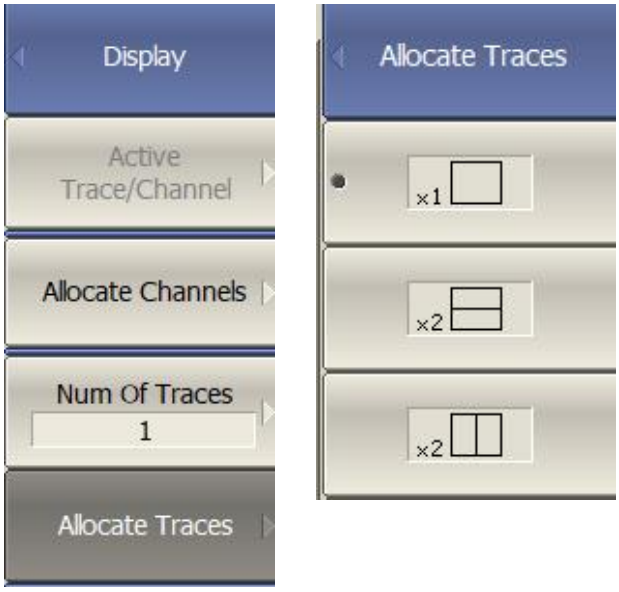
You can add a marker by clicking on 'Marker' > 'Add Marker' to read the value of group delay. You should read around 2.9 ns for this cable under test.

3. Time Domain - Impedance measurements

The goal of this measurement is to be able to measure impedance of the cable under test. We know that this 2ft long cable is a 50 Ohm cable. Let us see how this can be measured using a VNA.

To measure and display the impedance of the cable under test, let's go ahead and add only one trace. If you have only one trace displayed on the software window, ignore this step.

To do this, click on 'Display' > 'Num of Traces' and change it to 1 and then allocate it to one window.



Now that we have one trace, let us go ahead and change the trace to S_{11} Log Mag. Make sure that the start and stop frequencies are set to the default values (100 kHz and 8 GHz) and ensure that you have around 1001 points for better resolution.

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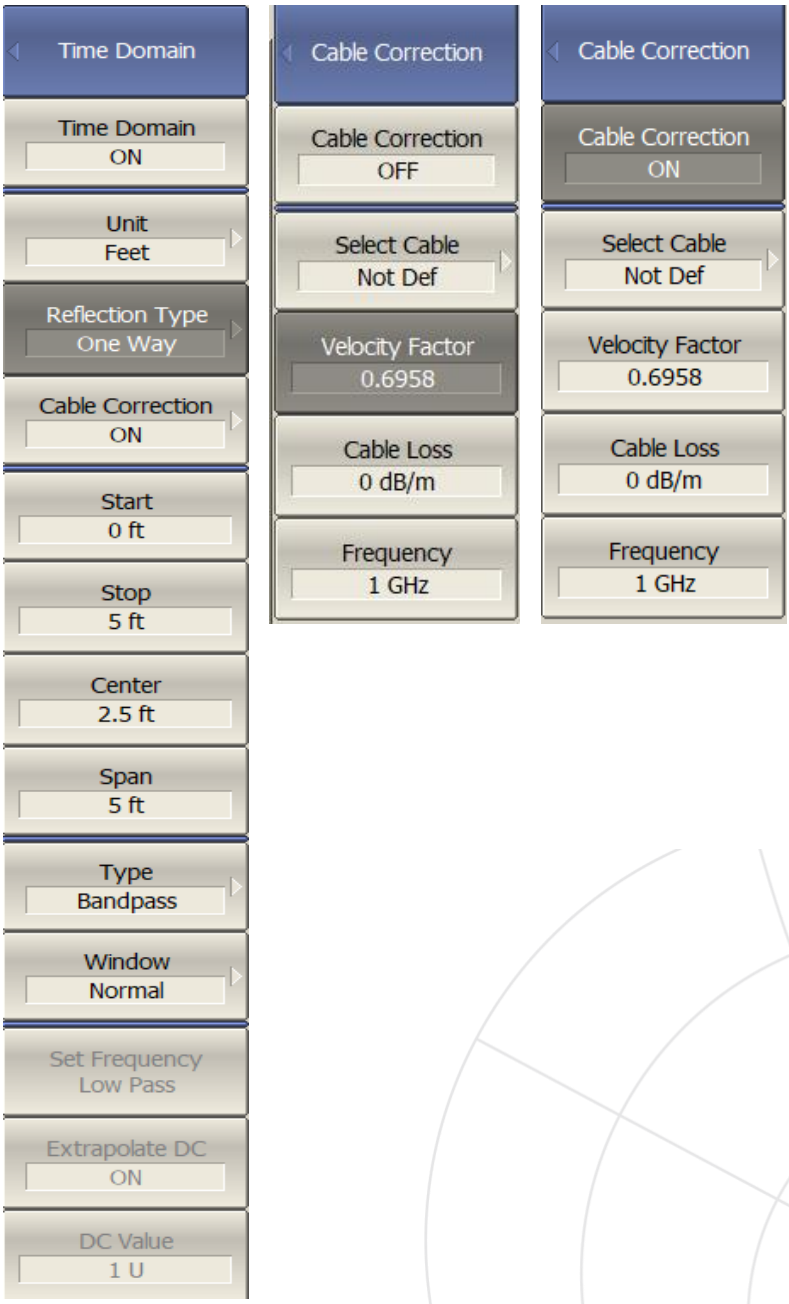
Now, turn the time domain on with the following settings-



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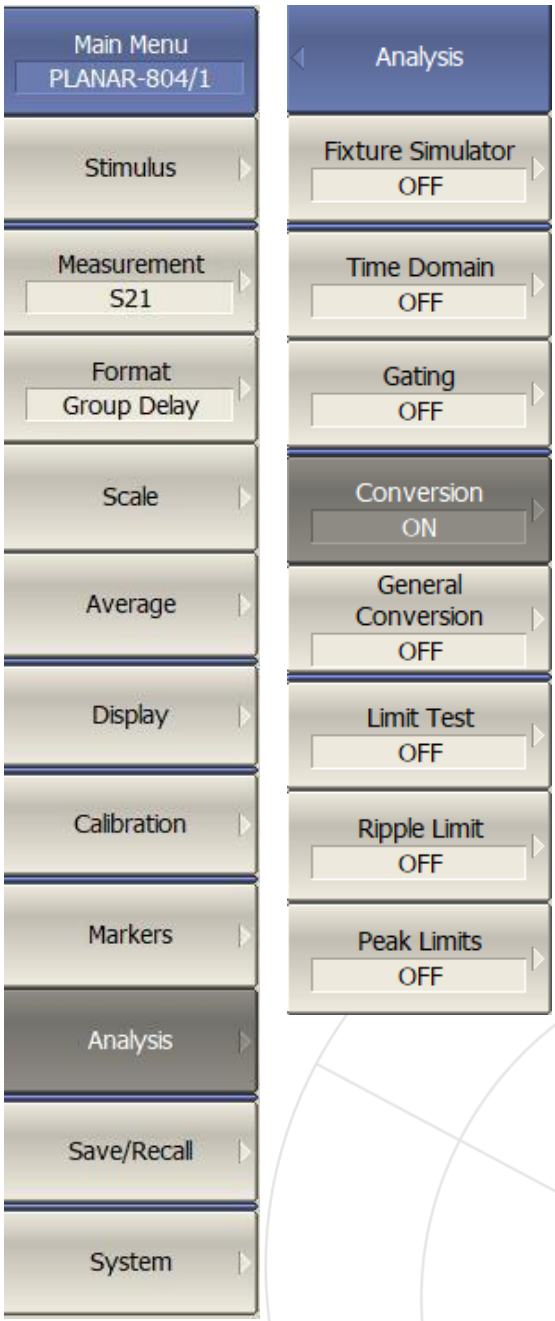
Now, to make impedance measurements turn the conversion on.



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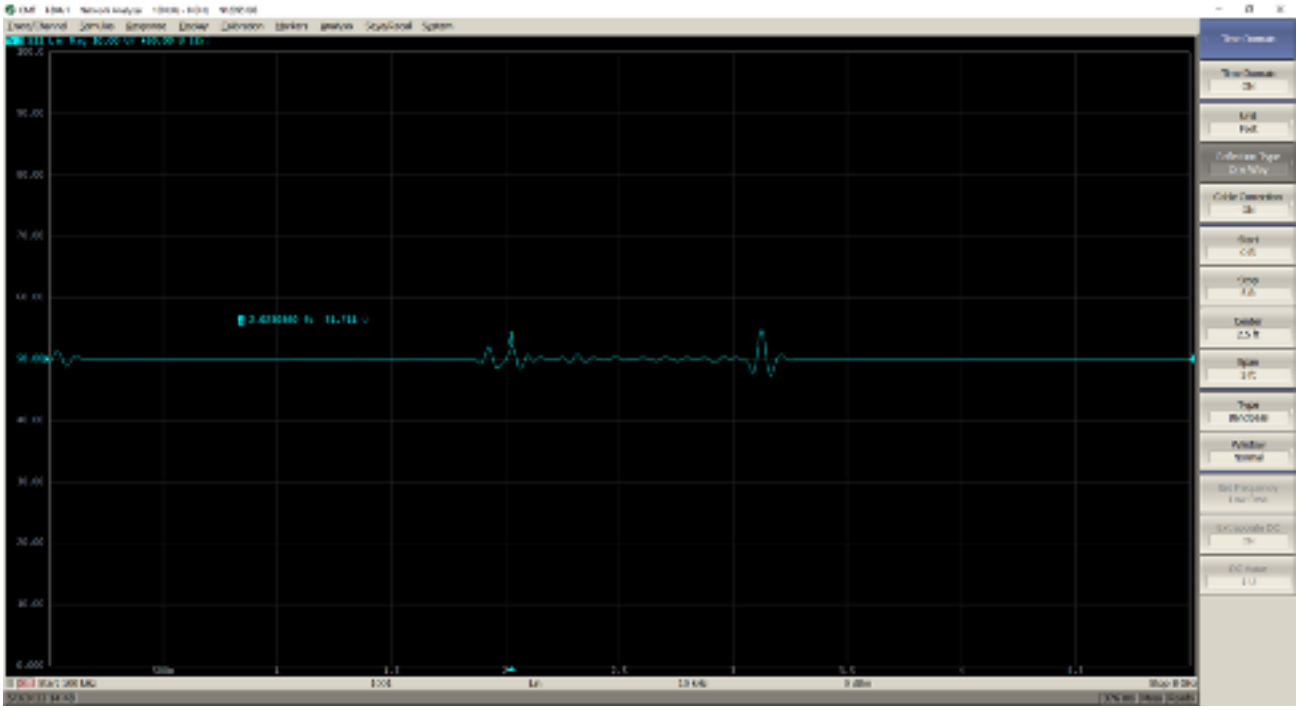
To read the impedance value we need to change the S11 trace format from Log Mag to Lin Mag. You can change this directly where you see Log Mag next to the trace or under the “Format” menu on the right-hand side of the software screen.

Once you make this change, your trace should look like this:



Impedance measurement of cable under test

You can add a marker to read the distance on the bump as shown in the picture above. This indicates the end of the cable in the software. The average value of impedance along the length of the cable is around 50 Ohms, as expected.

Please feel free to reach out to us at support@coppermountaintech.com if you have any questions.