How to use the Smith Chart to make a ¼ wave notching stub or calculate Velocity Factor.

If you have attended one of my Basic RF Technology courses, you will have learnt a bit about Smith Charts and notching stubs.

So to recap, let's take a quick look at the Smith Chart which all of the Anritsu SiteMaster series can display in the measurements option.

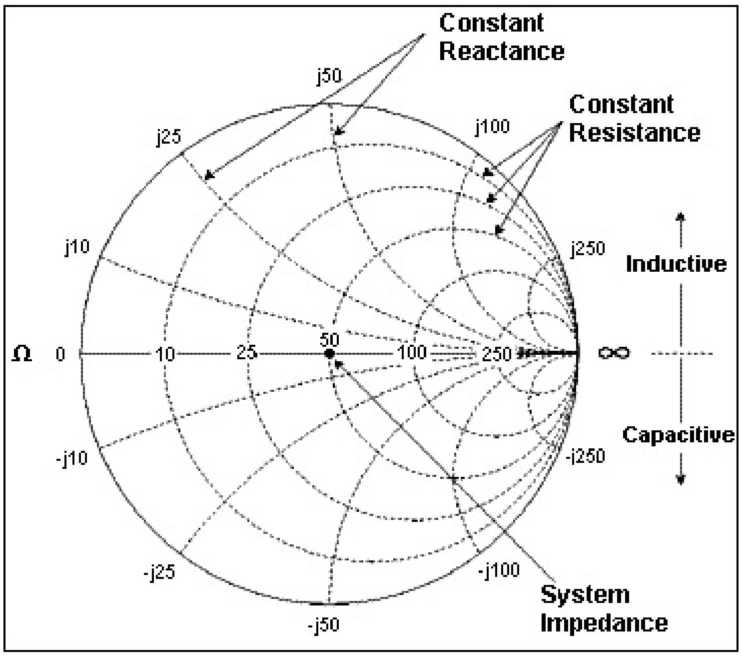

Figure 1: Smith Chart

If we look at the Figure 1, we will notice that on the horizontal axis, which displays the Real Component, indicates a Short Circuit (SC) on the left and an Open Circuit (OC) at the right. Above and below are the Imaginary Component.

So when the SiteMaster is in the Smith Chart mode, take a random piece of RF cable with a known velocity factor, and connect it to the RF port of the SiteMaster. Estimate the frequency range by measuring the length of the RF cable and calculating what is expected to be the working frequency short it be used as a ¼ wavelength open ended stub. (See course for purposes)

With reference to the following displays:

- Figure 2 - M1 is at 100.217 MHz as that is the SC frequency point for an open ended stub which will be infinity impedance.
- The cable measured 54.5 cm in length allowing for the connector and that equates to a wavelength of:
  4 x 0.545 meters = 2.18 meters and the cable had a velocity factor of 0.74
  There the frequency would be 300/(2.18 m/0.74) = 101.83 MHz
- With reference to Figure 2, that is pretty much what we expected as the physical measurement will produce some errors.

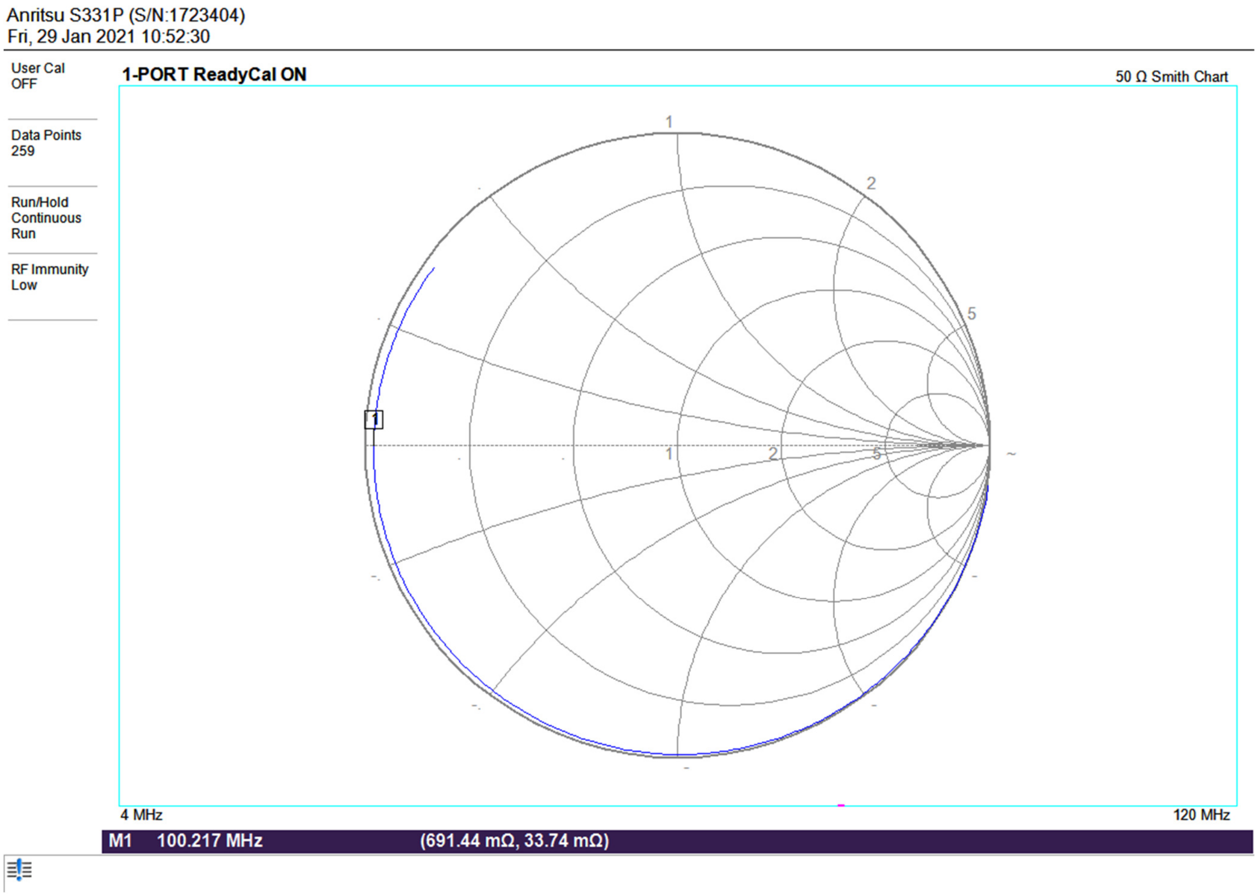

Figure 2: Anritsu S331P Smith Chart Sweep

What should be pointed out is that the voltage distribution over a wavelength (Figure 3) is as displayed below. At 0° the voltage is at zero and at 90° it is at a maximum which indicates an OC. However the net effect of an open ended ¼ wave stub is that at a certain frequency it produces a short circuit as that is displayed at Marker 1 in Figure 2.

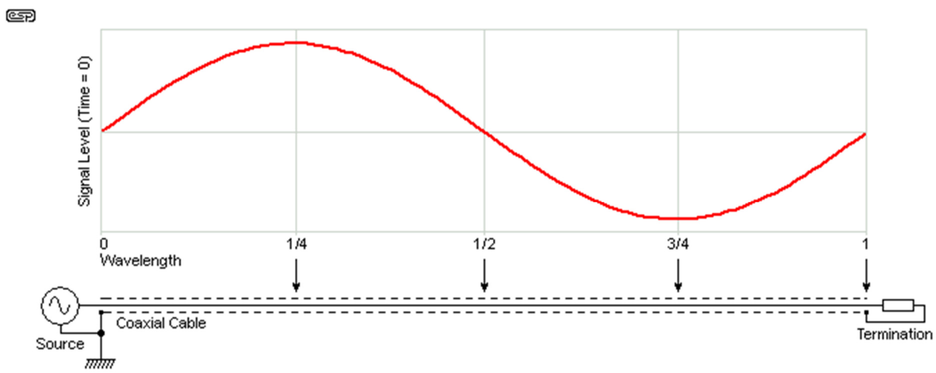

Figure 3: Voltage distribution with respect to phase.

The SiteMaster also has a 1 Port Phase measurement option. As can be seen in the display below Figure 4, the point of 180° is where the signal travels to the end of the stub and is reflected back so that produces a cancellation of the signal and that occurs where the marker is. This concurs with what is seen on the Smith Chart display for a ¼ wave of 90° phase shift.

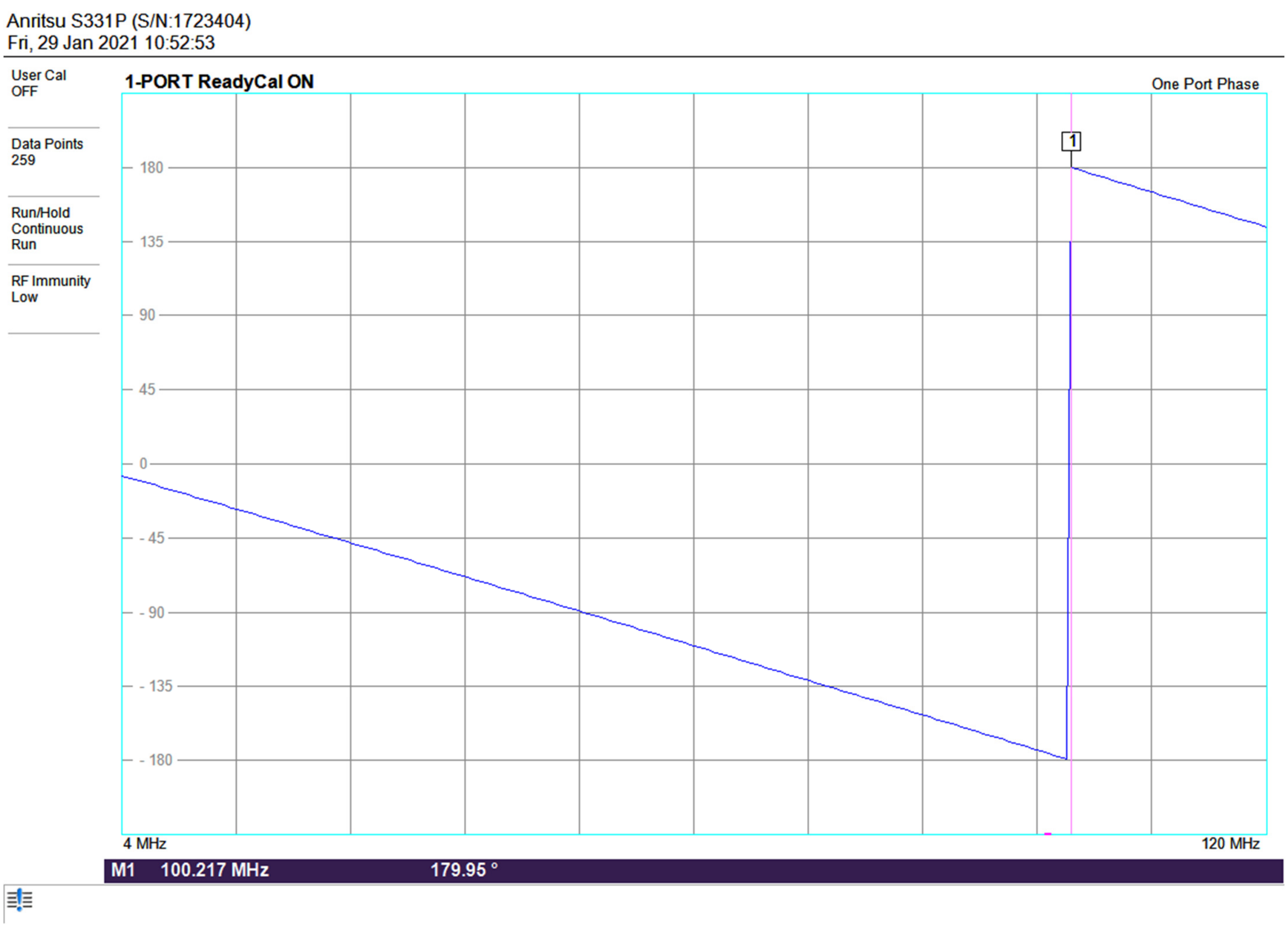

Figure 4: Anritsu S331Pp 1 Port Phase Sweep.

This knowledge and method can be used for the following and maybe even more applications:

- Manufacturing a ¼ Wave open ended stub to null out an unwanted carrier.
- Manufacturing a ¼ wave shorted stub to act as a static or lightening arrestor.
- Manufacturing equal lengths of cable for phasing harnesses, etc.
- Determining the Velocity Factor of a RF cable.

I trust this bit of knowledge will be of use to you in the field.

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