Port Extension

Port Extension corrects the phase measurement of the DUT and can also compensate for loss of the connecting lines.

For example, calibration was performed on the end of a test cable and then attached to a PCB with two connectors with a 2.75”, 50Ω microstrip trace between them. When measured from 100 kHz to 8.5 GHz and displayed in Polar mode, one would see the measurement of **Error! Reference source not found.**

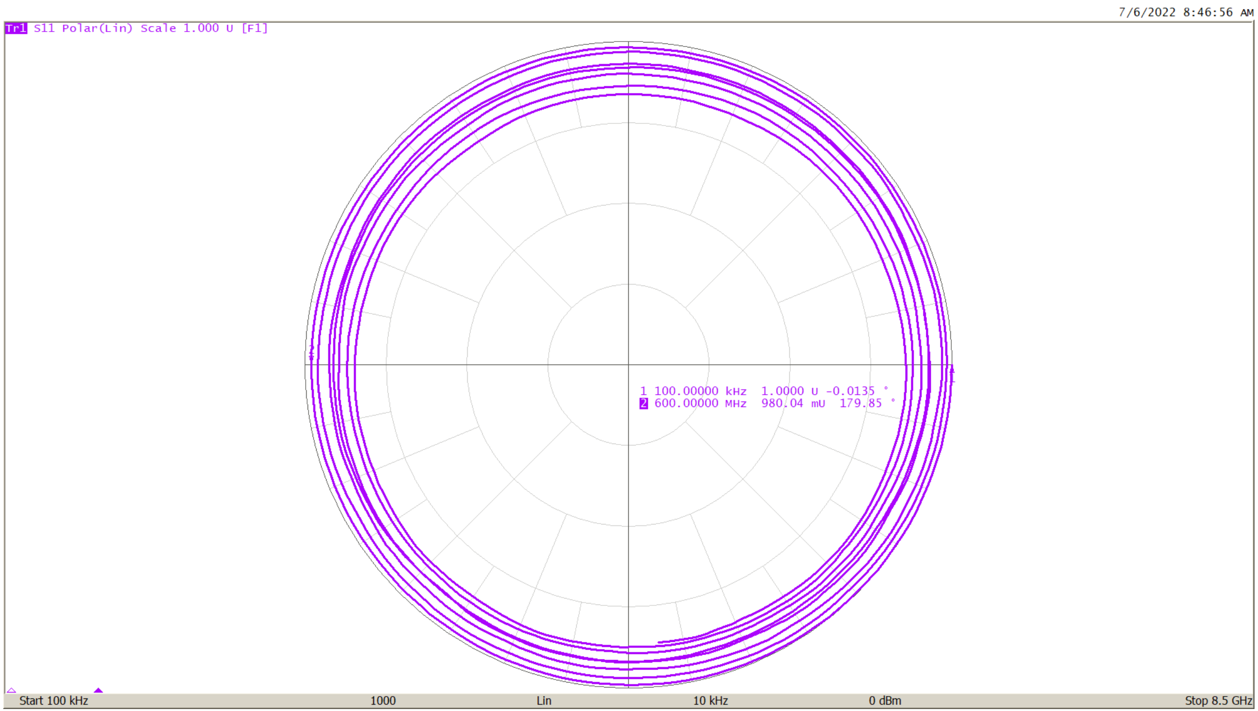

Figure 1 - 2.75" Open Trace on PCB

The measurement is smooth with no discontinuities or visible resonances. At 100 kHz, the phase is very near zero as one would expect for an open circuit. But as the frequency increases, there is an additional phase difference as the stimulus signal from the VNA traverses the open trace twice, once to the open circuit and then back again to be detected by the VNA. The reflection sees a total distance of 5.5”. Marker 2 at 600 MHz is at nearly 180°, or a half period, which is 833 pS round trip. Note how the reflection measurement spirals in as the frequency increases. This is due to the increasing Insertion Loss in the circuit board trace. If a 416 pS port extension is dialed into Port 1, the result is the measurement of Figure *2*.

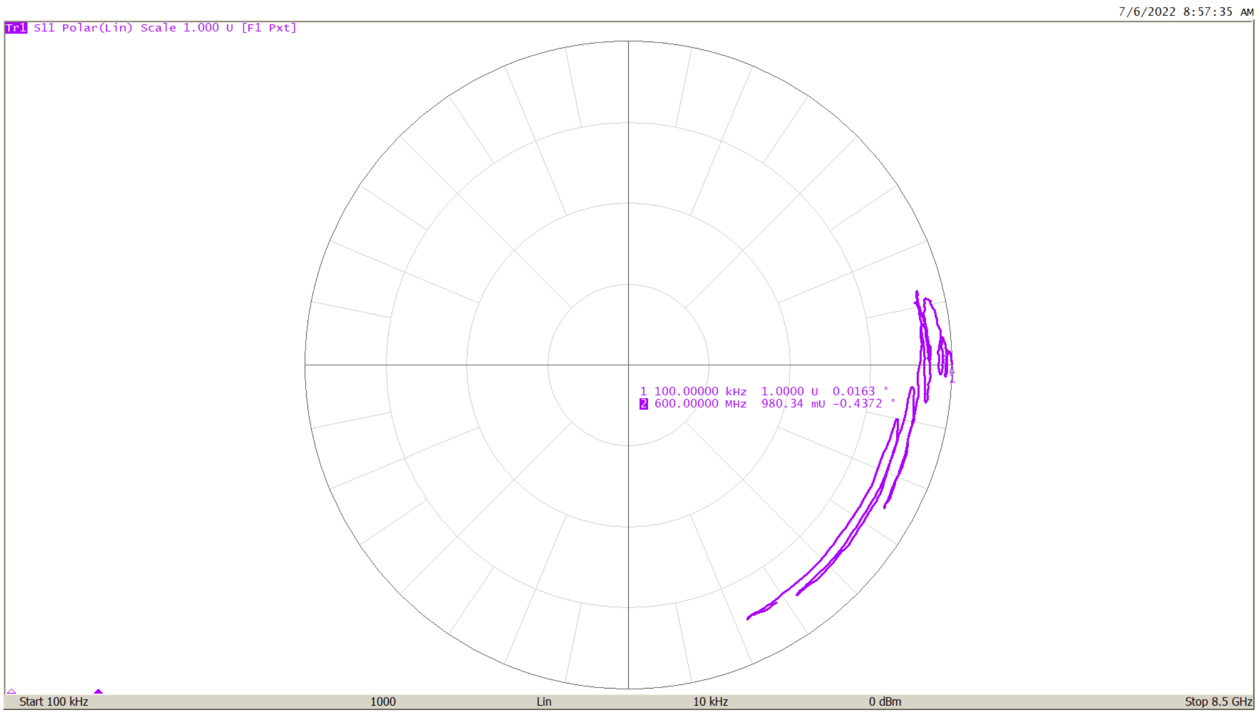

Figure 2 - 416 pS Port Extension enabled

The measurement is now *somewhat* compensated up to about 5 GHz, but from 5 to 8.5 GHz, there is an additional delay, or dispersion, due to the properties of the circuit board material, and the phase moves clockwise once again. There are also retraces in the response above 5 GHz, which are likely due to higher order modes in the signal propagation. The Loss function may be used to set a linear loss compensation between any two frequency points. With the Loss settings shown in Figure *3*, the new measurement in Figure *4* is closer to the circumference of the Smith Chart.

These results are not very good over such a broad range, and there would be a great deal of phase error at higher frequencies if a broadband measurement were required. But if it were only necessary to measure over a narrow bandwidth, the extension could be successfully optimized. For instance, for Wi-Fi frequencies from 2.412 to 2.472 GHz, the phase error would only be a few degrees from one end of the band to the other.

Port Extension amounts to a simple, linearly frequency dependent rotation of the measured S-Parameters about the center of the Smith Chart with some Insertion Loss correction. It is a useful software feature in many circumstances, but the method has its limitations.

While Port Extension corrects the delay and phase to the DUT and may also correct for a certain amount of loss, de-embedding provides a full correction, point-by-point over the entire frequency range.

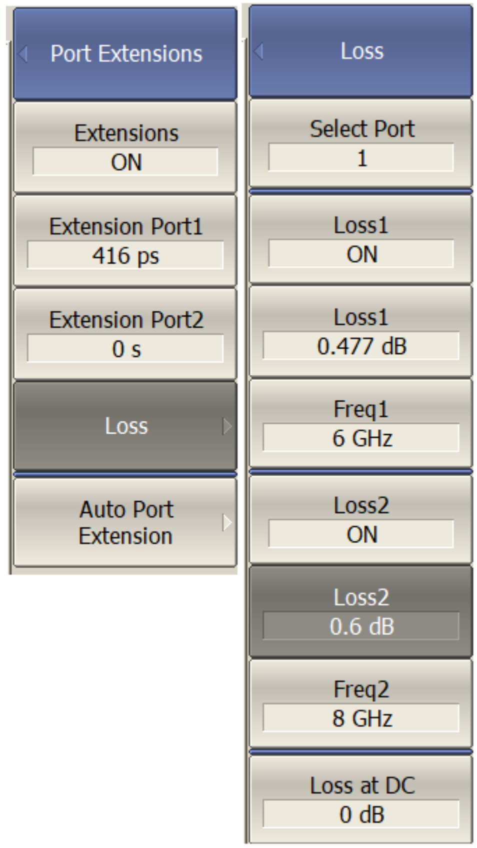

Figure 3 - Port Extension Settings with Loss

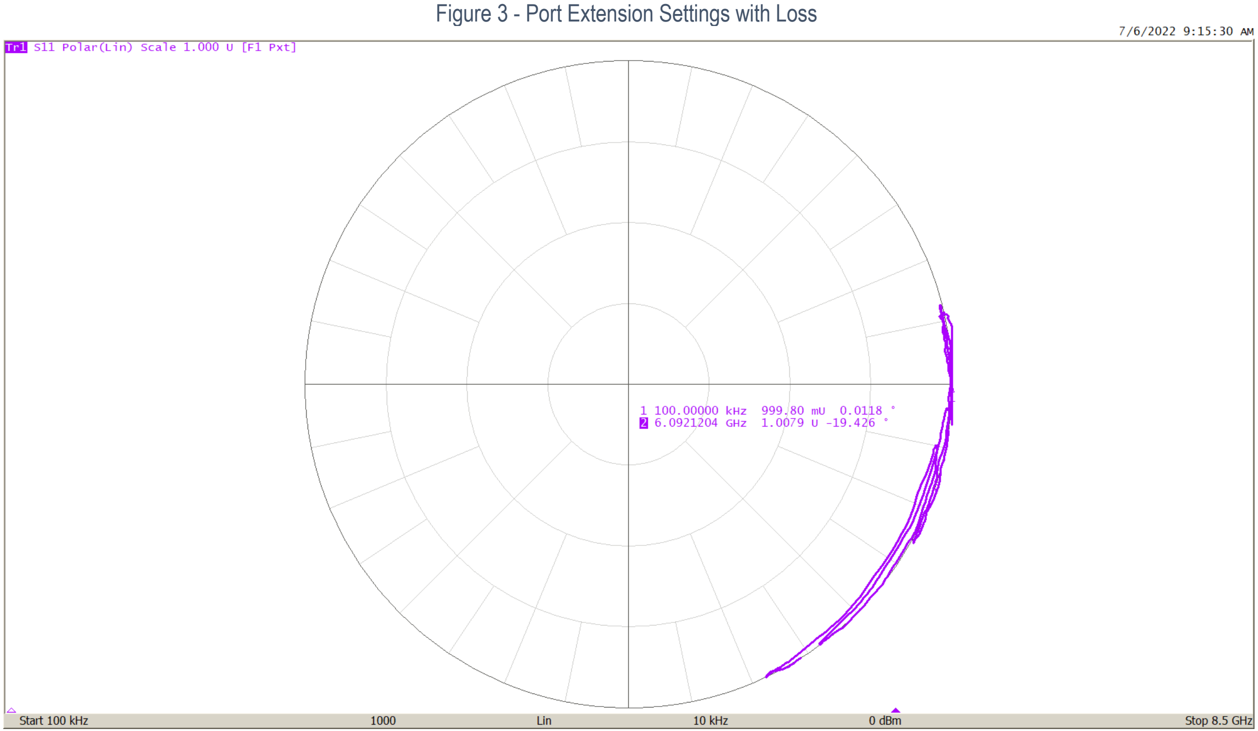

Figure 4 - Port Extension with Loss Compensation