ECE 451
Automated Microwave Measurements Laboratory

Experiment No. 9

MICROSTRIP MEASUREMENTS ON PNA

PART I

2-PORT MEASUREMENTS ON E8357A

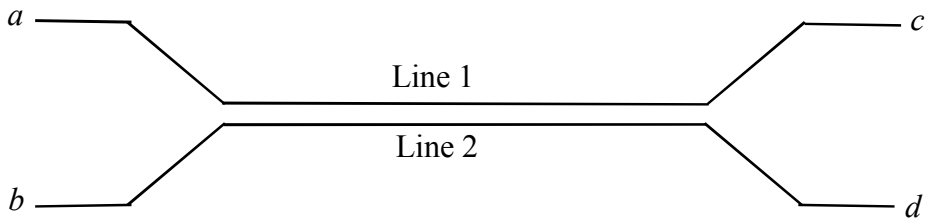
In this experiment, we will characterize a microstrip line with discontinuities from 300 KHz to 6 GHz using the PNA series E8357A network analyzer.

a. Perform a twelve-term calibration (Full SOLT 2-Port)
b. Connect and measure the transmission line
c. Plot all 4 s parameters in Smith chart or polar formats
d. Record and save your data

PART II

4-PORT MEASUREMENTS ON E8357A

In this experiment, we will characterize a 4-port system consisting of two coupled microstrip lines. The 4-port will be characterized by making several 2-port measurements. The measurements will be done from 300 KHz to 6 GHz using the PNA series E8357A network analyzer.



b. Perform a twelve-term calibration (Full SOLT 2-Port)
e. Perform 3 measurements by connecting the 4-port as indicated in the table below
f. Using reciprocity and symmetry, explain how the other scattering parameters can be obtained
g. Record and save your data

	Port 1	Port 2
Meas 1	a	b
Meas 2	a	c
Meas 3	a	d

PART III

E8363B LOW PASS MODE, TIME DOMAIN MEASUREMENTS

CAUTION: The PNAs are very delicate instruments and must be handled accordingly. It can be severely damaged by electrostatic discharge (ESD). Therefore, before making any connections to the measurement ports, be sure to discharge (ground) your body by grasping the outer conductor of the measurement port or the metal part of the coaxial cable attached to the port. Also, any device being attached to either port must be discharged; that includes both the outer and inner conductors. Never touch the center conductor of the measurement ports.

This experiment consists of using the E8363B Network Analyzer to make time domain measurements in Low Pass mode.

The Time Low Pass mode is used to simulate the traditional TDR measurement. This mode gives the user information to determine the types of discontinuities that are present. Time Low Pass provides the best resolution (fastest rise time), and it may be used to give either the step or impulse response of a device.

The Time Low Pass requires that the frequency domain data points be harmonically related from DC to the Stop frequency (Stop = n x Start, where n is the number of points). The DC frequency response is extrapolated from the low frequency data. The requirement to pass DC is the same limitation that exists for traditional TDR measurements. When the Start frequency data is noisy, the trace will "bounce" and be difficult to interpret. If the minimum Stop frequency range is beyond the upper bandwidth of the device and the frequency domain is noisy, the time domain response will also be noisy.

Interpreting the Time Low Pass Reflection Response Horizontal Axis:- The horizontal axis for the Low pass measurement is the 2-way travel time to the discontinuity, the same as for the Time Band pass mode. Also, the Marker function display both the time (x2) and electrical length (x2), obtained by multiplying the time by the velocity of light in vacuum. To get the actual physical length, multiply by the relative velocity of light in the propagation medium.

Interpreting the Time Low Pass Reflection Response Vertical Axis: - The vertical axis depends on the format chosen. In Time Low Pass, the most useful format is REAL, which display the TDR response in reflection coefficient units. In the Time Low Pass mode, because the frequency domain data is taken at harmonically related frequencies

down to DC, the inverse Fourier Transform has only a real part (the imaginary part is zero). Therefore the most useful format for the Low Pass mode is the REAL format.

1) To make measurements in the Low Pass mode, use the following procedure:
   - **a.** Under **System**, click **Preset**. The PNA will reset to default values.
   - **b.** Click **Sweep** and Change **Number of Points** to 801.
   - **c.** Set the **maximum frequency** to 10 GHZ.
   - **d.** Under **Trace,** Click on **Transform.** A new menu bar will pop up. Click on **More** and **Set Freq. Low pass.** This will set the Start frequency to a lower value.
   - **e.** Under **Calibration**, choose **Calibration Wizard** which will walk you through the calibration steps. Create a new Cal Set under **UNGUIDED** Calibration. Choose **1-PORT reflection** and **View or Select Cal Kit**. Choose **ID 7**, 3.5mm Calibration kit. Perform the open, short and load measurements by following the instructions. Once the cal is completed, save it and verify it. NOTE: It is always good practice to check your cal by measuring open, short and load.
   - **f.** Check on Transform. Adjust the Transform Start and Stop times to make it visible for your readings. Change the display format to **S11 real.**
   - **g.** Click on **More** in the Transform menu bar. And also set the Transform mode to **Low Pass Impulse** response**.**
   - **h.** Connect open and short, Put markers on the trace and plot impulse response results.
   - **i.** Also get plots of open and short low pass step response.

2) Connect your test board. Terminate the other side of the board with short. Put markers on the traces. Get the plot of an impulse and step response of your board.