



PRACTICE 07 – TIME DOMAIN MEASUREMENTS

DEVICE: HP8753E (30 kHz – 6 GHz) (**VNA1**)

1. RISE TIMES AND WINDOWS EFFECT ON MEASUREMENTS

Choose 3 different calibration ranges ($f_{\max} = 60\text{MHz}$, $f_{\max} = 500\text{MHz}$, $f_{\max} = 6\text{GHz}$, 1600 points, $IF = 3\text{ kHz}$). Use the 1-port calibration and report the calibration check. **Follow the operation list attached to the text.**

In Low Pass Step mode:

1.1 Measure in Time Domain the open circuit used in the calibration. **(REPORT)**

1.2 Overlap the responses achieved with the three calibrations in one plot so that the different rise times are evident. **(REPORT)**

1.3. Measure manually the rise time ΔT in the 3 cases ($\Delta T = T_{0.9} - T_{0.1}$). **(REPORT)**

By choosing the calibration with $f_{\max} = 6\text{GHz}$, study the effect of the 3 available windows.

1.4 Visualize the Low Pass Step for the 3 available windows, measuring the rise time. Overlap in one plot (with MATLAB) the 3 curves, by choosing a proper range time and normalizing the results so that all the plots have time $t=0$ in the centre; report the rise times in a table (for the used windows). **(REPORT)**

In Low Pass Pulse mode:

1.5. Visualize the Low Pass Pulse response by varying the windows between the 3 available (magnitude, both in linear and logarithmic scale). Overlap in one plot (with MATLAB) the 3 curves, choosing a proper time interval for the plots. Report also the FWHM width (Full Width Half Maximum) in a table for the 3 different windows and the step (in dB) between the central peak and the first side-lobe. **(REPORT)**



2. FAULT LOCATION IN COAXIAL STRUCTURES

Use the fissured coaxial line that was designed to have a characteristic impedance of 50Ω . Use the VNA settings (maximum frequency and number of points) that guarantee the best spatial resolution and report it. In order to recognize the end of the line, is useful to end it in different ways (50Ω , open or short) and see to which part of the measured signal it corresponds.

2.1 In **Los Pass Pulse** mode, analyse the signal by identifying, for example, the beginning and/or the end of the coaxial line and the multiple reflections by varying the termination of the line itself.

To simulate the break of the cable, it was inserted a Teflon ring whose location can be varied.

2.2 Through TDR, measure the position of this obstacle (for example the centre) using Pulse Response. Compare it with the measure of the position with the meter. Is it an inductive or a capacitive obstacle? **(REPORT)**

2.3. Using the Low Pass Step, plot S_{11} as a function of the time; put 3 markers: before, in the centre and after the obstacle and use the Smith Chart to evaluate the impedance in those points; estimate the ϵ_r of the section. Save $S_{11}(t)$ data. Plot also $Z(t)$ with MATLAB, by ending the line with 50Ω and applying the transformation formula that link Z to S_{11} . **(REPORT)**

2.4 Plot Z as a function of the position on the line, by using the theoretical propagation speed. Pay attention because the length of the line is $\sim 1\text{m}$. **(REPORT)**



3 CHARACTERISTIC IMPEDANCE MEASUREMENT OF A STRIP

A quick measure of the impedance of a point in the line can be obtained putting a marker and by visualizing the value of the marker on the Smith Chart.

For nominal impedance lines 25Ω e 100Ω , in a condition of maximum resolution:

3.1 (**Low Pass Pulse**) Measure the electrical length (time) and from the geometrical length, measure the propagation speed of the signal. It could vary from strip to strip. **(REPORT)**

3.2 Report $S_{11}(z)$ starting from one of the connectors and closing the other with 50Ω (**Step response**). **(REPORT)**

3.3 Take a measure (overlap it to the previous one) by inverting the two connectors (**Step response**). **(REPORT)**

3.4 In the two cases of 25Ω and 100Ω , estimate the effective dielectric constant of the substrate, motivating the answer. **(REPORT)**



4. CHARACTERIZATION OF THE VBFZ-3590 FILTER USING THE GATING

On channel 1, leave the settings used for point 2. Calibrate the transmission measurement on channel 2 (calibration Response THRU).

4.1 In frequency domain, measure S11 on **channel 1**. On **channel 2**, measure the S21 of the filter. **(REPORT)**

4.2 Leaving the filter connected on port 1 of the VNA, connect the cable on the table to the other port of the filter and measure S11 in this condition (**channel 1**). Overlap the plot of |S11| in dB to that of the filter measured at point 4.1. What do the oscillations depend on? Visualize both the measurements using the memory function of the VNA. **(REPORT)**

4.3 In time domain (impulse), leave the free end of the cable open. With the gating, select the range times referred to the signal coming from the end of the cable (move the markers and enable GATE ON).

4.4 Move back to frequency domain (leaving gating on) and visualize |S11| both with the gating on and without gating. **(REPORT)**

4.5 Try to interpret the measurements by comparing the |S11| plot achieved with gating on and the |S21| plot of the filter. In measuring the |S21| of the filter, starting from TDR measurements, consider that the EM field passes two times in the filter. In the report, overlap the plot of |S21| achieved with TDR measurements with the |S21| of the filter (see point 4.1). Which is the difference between the two curves? Why? If it is possible, add a third curve to the plot, adding a proper offset to the |S21| measured with TDR to make it overlap with the one measured in a direct way (see point 4.1). **(REPORT)**



5 CHARACTERISTIC IMPEDANCE MEASUREMENTS OF A MICROSTRIP

OPTIONAL

The last two microstrips are made of a main line and two “identical” line in parallel.

Characterize, with the measurements you consider significant, those two lines and explain the reasons of the difference between the measurements. In the report, explain the settings of the instrument and explain why you chose them.

(REPORT)