Karadeniz Technical University
Faculty of Engineering
Department of Electrical and Electronics Engineering
<u>Microwave Laboratory</u>

MICROSTRIP ELEMENTS

Preliminary Information:

<u>Microstrip Line:</u> A microstrip line is a type of transmission line consisting of a conducting strip, a dielectric substrate, and a conductive ground plane (Figure 1).

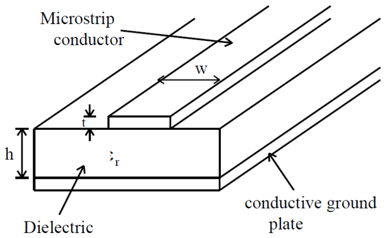


Figure 1: Microstrip line structure

The characteristic impedance of microstrip lines and the wavelength of the signal propagating on the line are calculated based on the width of the strip (w) and the height of the substrate (h).
The insertion loss characteristic of a passive element is the variation of the ratio of its input and output powers with frequency. From this variation, the behavior of the element over a specific frequency band can be determined.

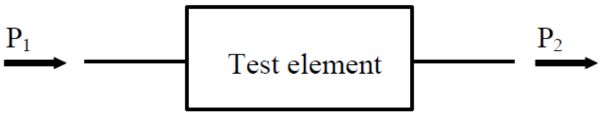
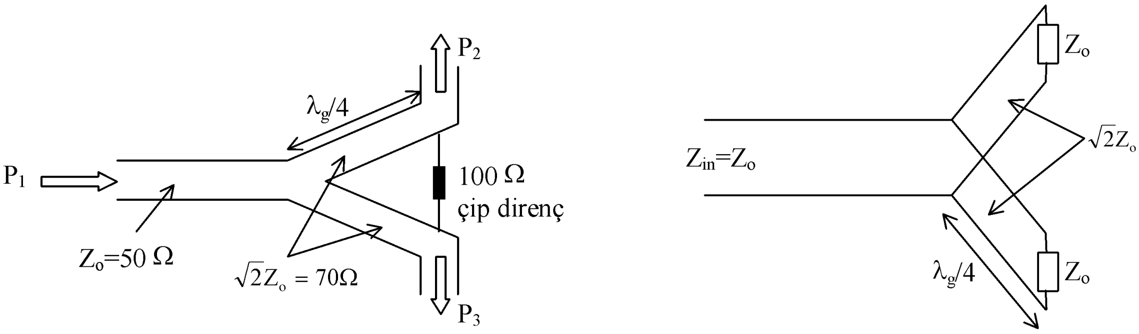


Figure 2: A two-port test element with input power P1 and output power P2.

From Figure 2,

$$\text{Insertion Loss (IL)} = 10\log\frac{P_1}{P_2} \quad \text{(dB)}$$

<u>Wilkinson Power Divider:</u> Power dividers are components that split the input signal power and deliver it to their outputs. A 3-dB Wilkinson power divider splits the input power into two equal halves and delivers them to the outputs. Figure 3 shows a 3-dB Wilkinson power divider and its equivalent input circuit.



(a) (b)

Figure 3: (a) 3-dB Wilkinson power divider schematic, (b) its equivalent input circuit.

The chip resistor in Figure 3a is used for isolation between the output lines. It acts as a dissipative load against reflections that may occur due to impedance mismatches on these lines. Examples of applications for the Wilkinson power divider include feeding a twoelement array and measuring insertion loss.

Experimental Procedure:

1. Power Divider Measurements

1.1 Set up the experimental apparatus as shown in Figure 4.

1.2 For the frequencies given in Table 1, set the Voltage Controlled Oscillator Voltage (VCOV) to the corresponding values in the same table. Read the voltages V1 from the Digital Voltmeter (DVM) and find the corresponding powers P1 from the detector voltage-power calibration curves, then record them in the table.

1.3 Set up the experimental apparatus as shown in Figure 5.

1.4 For the frequencies given in Table 1, measure the voltages at output port 2. From the relevant calibration curve, find the corresponding powers P2 and record them.

1.5 Swap the connections at the output ports of the power divider and repeat the procedures in step 1.4 for P3.

1.6 Plot the variation of the output powers with frequency. Interpret the results.

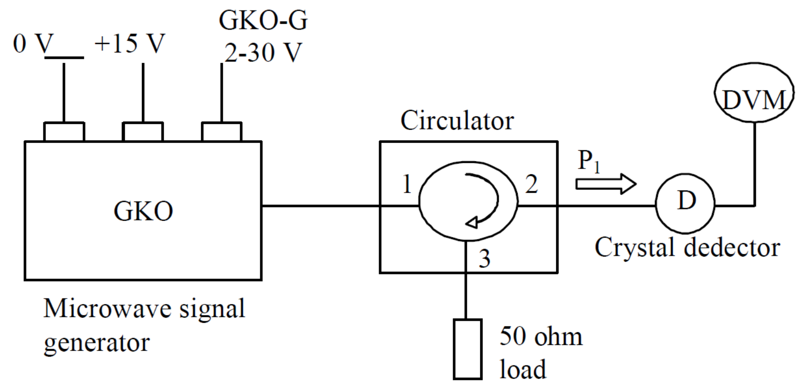


Figure 4: Measurement of the microwave source's output power (P1).

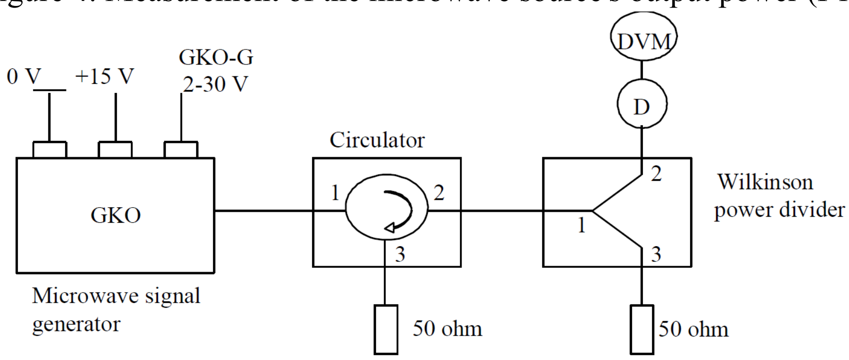


Figure 5: Power divider experimental setup.

Table 1

GKO-G (V)	3.56	4.54	5.71	7.12	8.81	10.83	13.07	15.18	17.52	20.55	23.92
f (GHz)	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5
P_1(mW)											
P_2(mW)											
P_3(mW)											

Pre-Laboratory Preparation Questions:

1. What is a microstrip line? Define the layers that constitute its structure and explain which geometric and material parameters the characteristic impedance depends on.
2. What is insertion loss (IL)? How is it defined in terms of input and output powers? What does the frequency-dependent insertion loss of a passive component indicate?
3. Explain the operating principle of a 3-dB Wilkinson power divider. How is the input power distributed to the output ports?
4. What is the purpose of the resistor connected between the output ports in a Wilkinson power divider? Explain its effect on isolation.

Requirements for the Laboratory Report:

1. What is the purpose of using a circulator in the experimental setup? Introduce this component and explain its function.
2. In the power divider experiment, the powers P1, P2, and P3 are measured. For an ideal 3-dB Wilkinson power divider, how should P2 and P3 relate to P1? Compare the measured results with the ideal case and interpret them.
3. Ideally, how is the power at the output ports expected to vary with frequency? Explain the possible reasons for deviations observed as frequency increases.