Electromagnetism Practical, Session 1
Transmission Lines

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Assignment 1: Transmission Lines in Frequency Domain

Part 1: Standing Waves in Waveguide

The measured wavelength of the standing wave is 4.4 cm. The phase velocity is determined by equation 1. The wavelength in the waveguide is determined by equation 2 with an a of 22.86 mm at a frequency of 9.475 GHz. The result is that the phase velocity is $v = 1.39c$. This is the case because the wavelength is modified inside the waveguide.

$$v_p = \frac{\lambda}{T} \tag{1}$$

$$\lambda_w = \frac{\lambda_0}{\sqrt{1 - (\frac{\lambda_0}{2a})^2}} \tag{2}$$

2.

The voltage-standing-wave ratio (VSWR) of different loads is measured.

a.

The open waveguide

b.

Both the short circuits give a minimum of 0.02 mV and a maximum of 80 mV. This gives a VSWR of about $4.0 \cdot 10^3$.

c.

The matched load gives a minimum of 45.4 mV and a maximum of 50.3 mV giving a VSWR of 1.11.

d.

The horn antenna gives a minimum of 45.2 mV and a maximum of 51.1 mV. This gives a VSWR of 1.13.

3.

There is no shift in antinodes in our measurement regarding the two short-circuits. This is not surprising as the difference between the 33mm and the 55mm short-circuit is exactly 22mm which is half of the wavelength.

Assignment 2: Transmission Lines in Time Domain

Part 1: Time Domain Reflectometry: estimate the loads impedance

Z_l can be determined with equation 3. The voltage standing wave ration is measured as $VSWR = \rho = 0.2$ and our $Z_0 = 50\Omega$

$$\rho = \frac{Z_l - Z_0}{Z_l + Z_0} \tag{3}$$

$$Z_l = -\frac{\rho + 1}{\rho - 1} \cdot Z_0 = 75\Omega \tag{4}$$

Part 2: Dielectric in Coaxial Cable: the Estimation of the Propagation Speed and Relative Permittivity

From the reflections the propagation velocity turned out to be $0.77c$, which is exactly what the datasheet of the cable states[**?**]. Using equation 5 the relative permittivity ϵ_r can be calculated.

$$v = \frac{c}{\sqrt{\epsilon_r}} = 0.77c \tag{5}$$

$$\epsilon_r = (\frac{c}{v})^2 = 1.69 \tag{6}$$