



TRANSMISSION LINE EXPERIMENT

Aims:

- To study transmission lines and determine their parameters.
- To gain important concepts such as standing waves, reflection coefficient and attenuation.

Objectives:

- To calculate wave velocity and compare it against theoretical value.
- To calculate the permittivity of the cable insulation.
- To calculate the cable wavelength, phase constant and attenuation constant.
- To calculate reflection coefficient and voltage standing wave ratio (VSWR).

1. Equipment:

The experiment consists of a signal generator, an oscilloscope and a transmission line box. The overall transmission line length is 32 m and tapping is provided at every 1m length which will be used to observe wave characteristics at different lengths. Several terminations at different values are provided together with two X10 probes and BNC adaptors. The transmission line is RG174AU coaxial cable with 50 Ω characteristic impedance and 101 pF/m per-unit-length capacitance.

2. Experiment:

2.1. Line characteristics

a) Terminal reflections

- i. Set the *output impedance* of the signal generator to 50 Ω and connect it to the transmission line box at "0m" terminal via a BNC TEE adaptor. Connect the other end of the TEE adaptor to Ch.1 of the Scope.
- ii. Output pulse wave of 1 MHz, 10ns width, 10 V p-p and minimum edge time (~ 4 ns) from the signal generator.
- iii. Terminate the transmission line in a matched load of 50 Ω and observe the reflections on Ch.1 of the scope.
- iv. Replace the matched load with open and short circuits respectively and in each case observe the reflections.

b) Travelling wave speed and cable relative permittivity

- v. For the last case observe the propagation delay between the input and reflected pulse and *determine the wave velocity* in the transmission line.
- vi. From the given values for characteristic impedance and capacitance calculate the theoretical value for the wave velocity and compare it against the experimental value. The relevant formulas are given in the Appendix.
- vii. Use these equations to calculate the relative permittivity ϵ_r of the cable insulation, the wavelength and phase coefficient.

2.2. Reflection coefficient:

- i. Keep the same circuit connections set in 2.1, at the line end (32m), change the terminations (27 Ω , 100 Ω , open circuit, short circuit) and measure the input and

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