R. Ludwig and G. Bogdanov
"RF Circuit Design: Theory and Applications"
2nd edition

Figures for Chapter 2

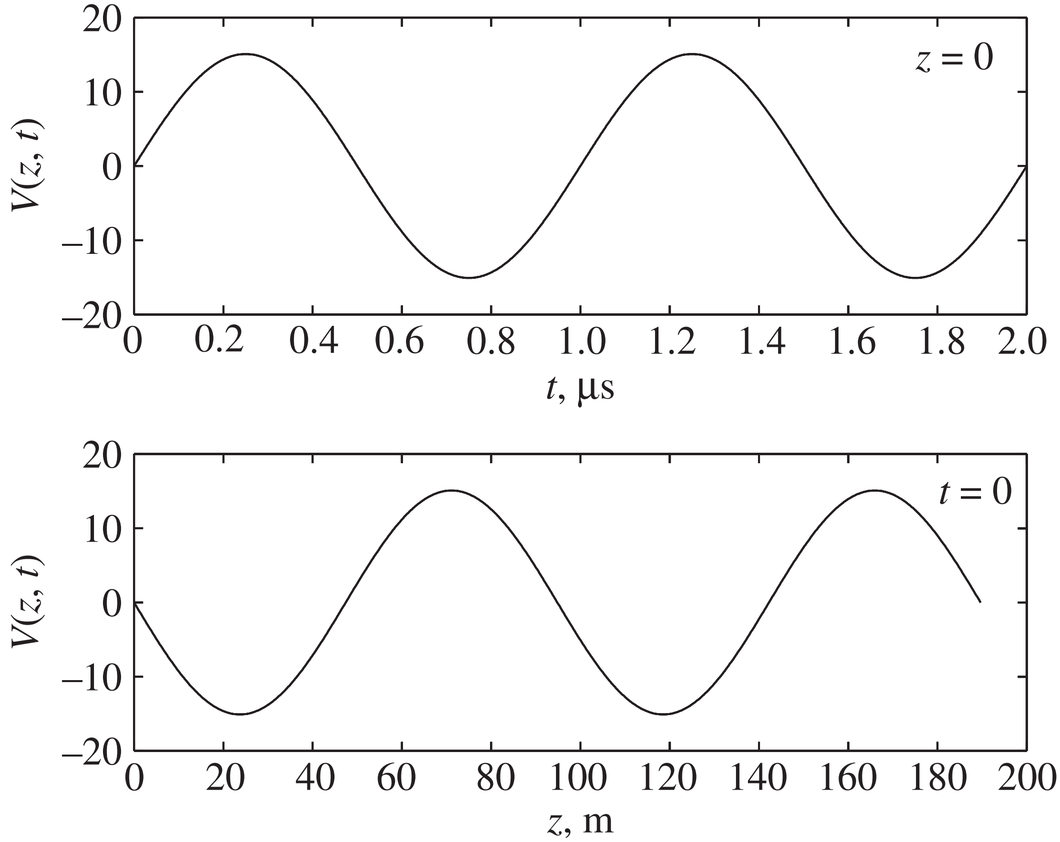


Figure 2-1 Voltage distribution as a function of time (z = 0) and as a function of space (t = 0).

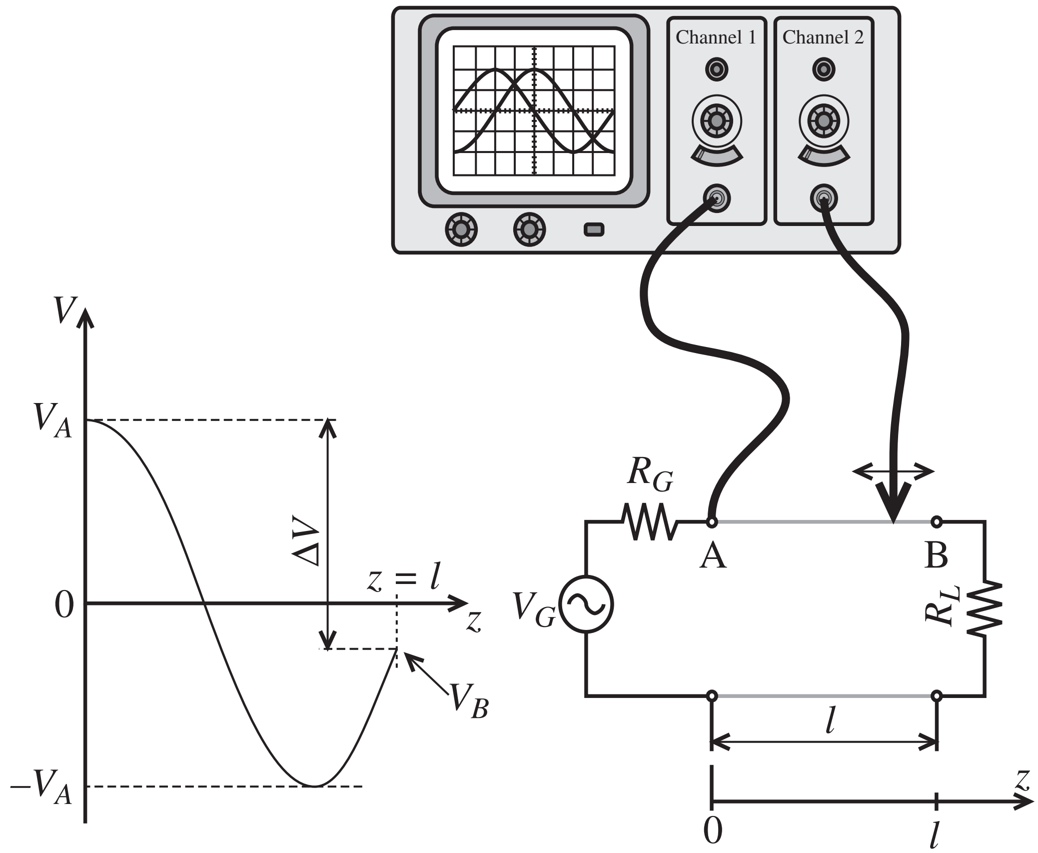


Figure 2-2 Amplitude measurements of 10 GHz voltage signal at the beginning (location A) and somewhere along a wire connecting load to source.

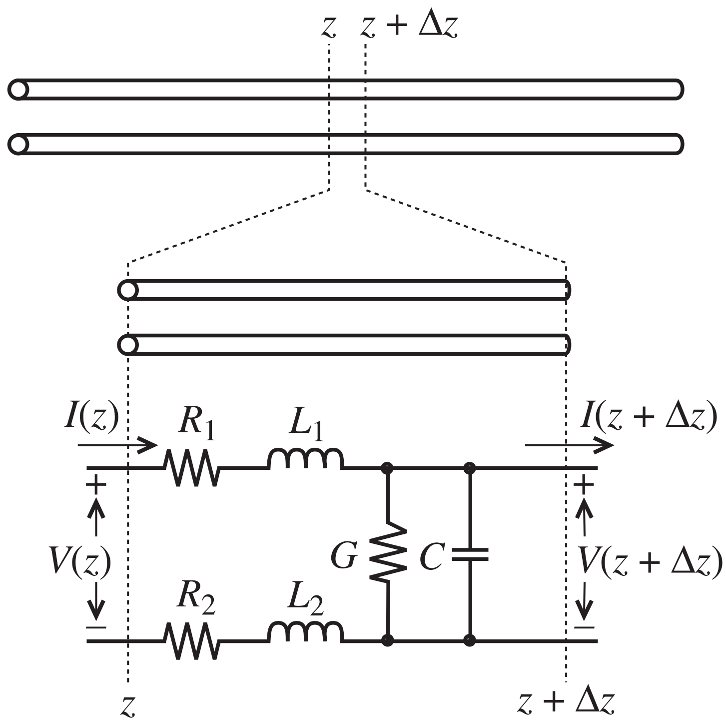


Figure 2-3 Partitioning an electric line into small elements Δz over which Kirchhoff's laws of constant voltage and current can be applied.

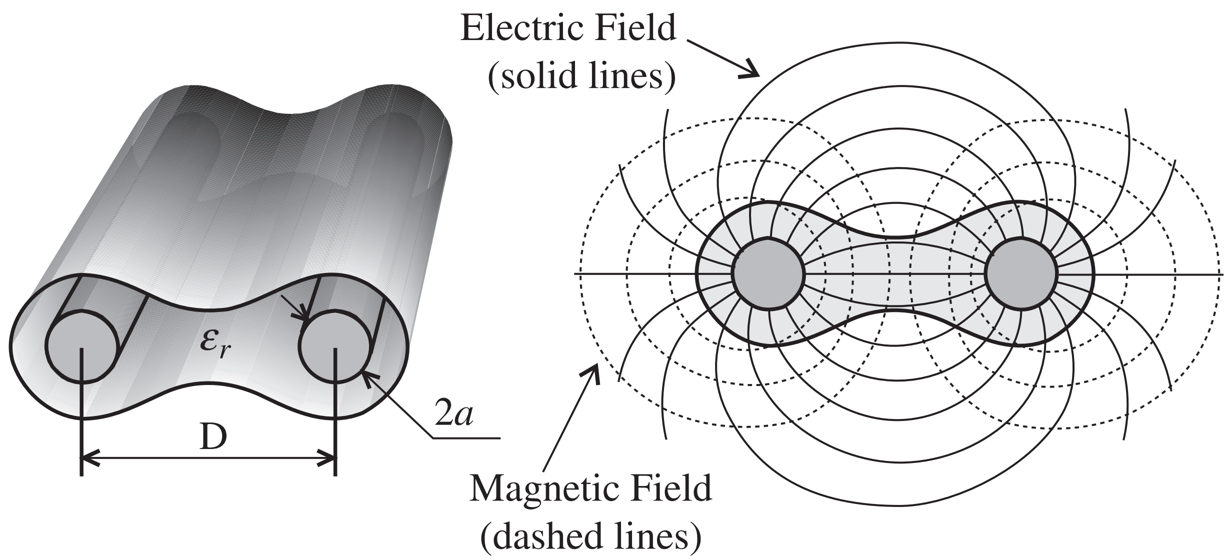


Figure 2-4 Geometry and field distribution in two-wire parallel conductor transmission line.

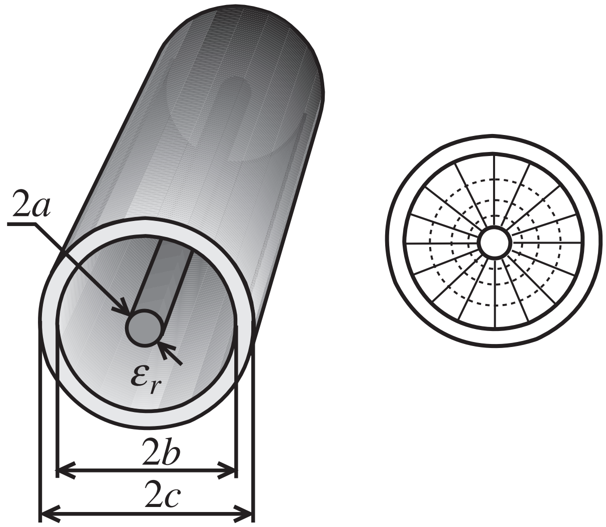


Figure 2-5 Coaxial cable transmission line.

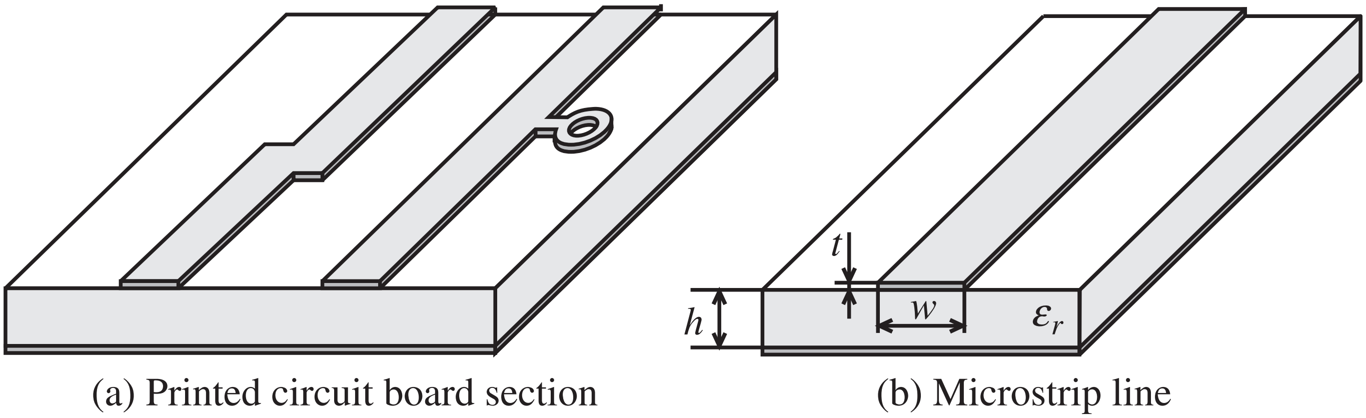
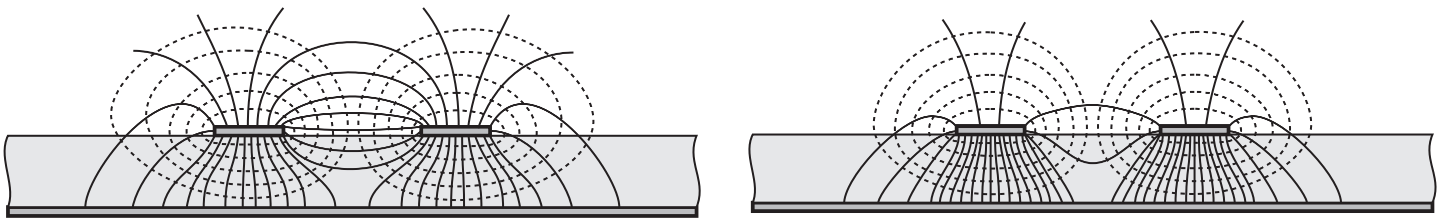
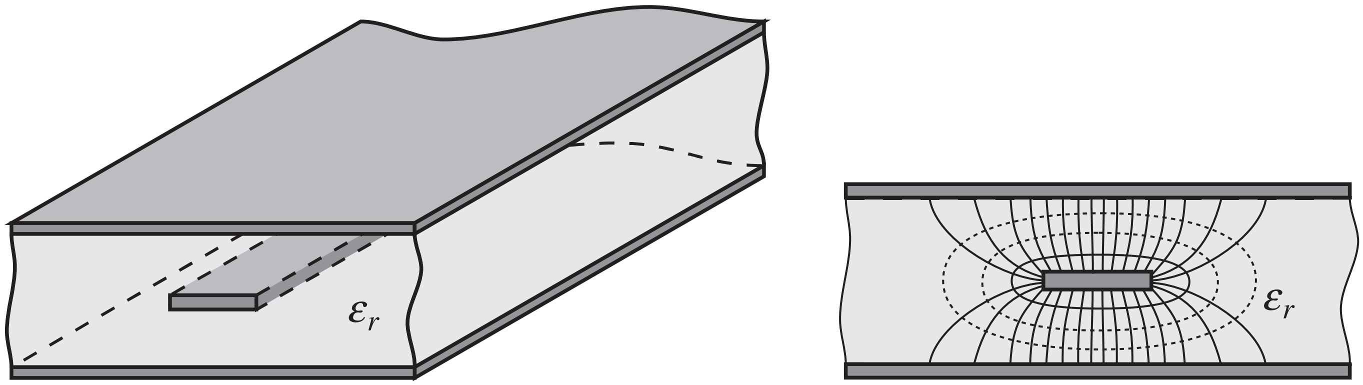


Figure 2-6 Microstrip transmission line representation.



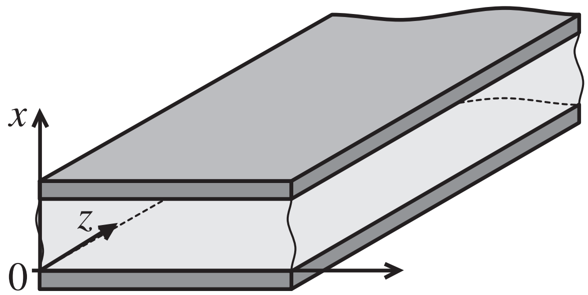
(a) Teflon epoxy ($\varepsilon_r = 2.55$) (b) Alumina ($\varepsilon_r = 10.0$)

Figure 2-7 Electric flux density field leakage as a function of dielectric constants.

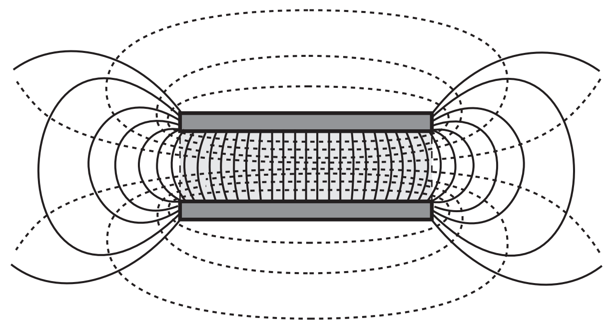


(a) Sandwich structure (b) Cross-sectional field distribution

Figure 2-8 Triple-layer transmission line configuration.



(a) Geometric representation



(b) Field distribution

Figure 2-9 Parallel-plate transmission line.

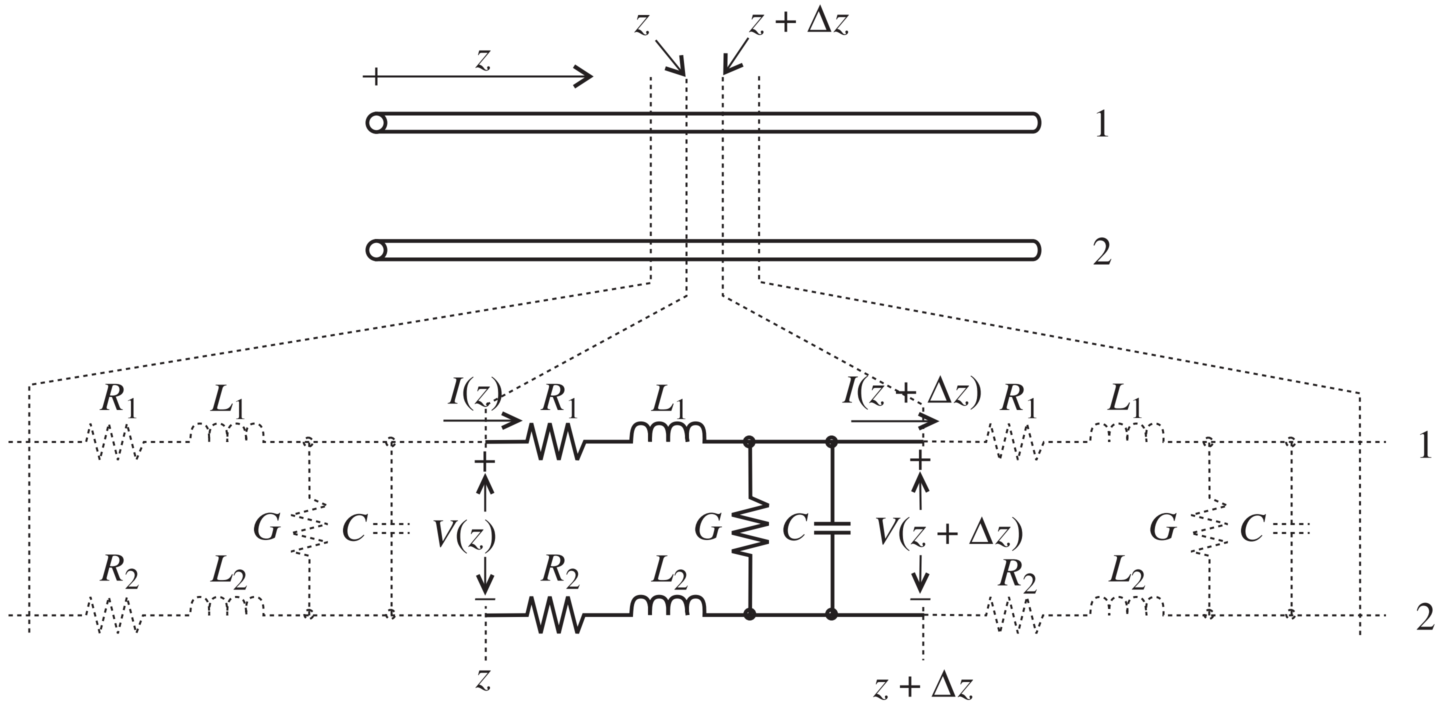


Figure 2-10 Segmentation of two-wire transmission line into Δz-long sections suitable for lumped parameter analysis.

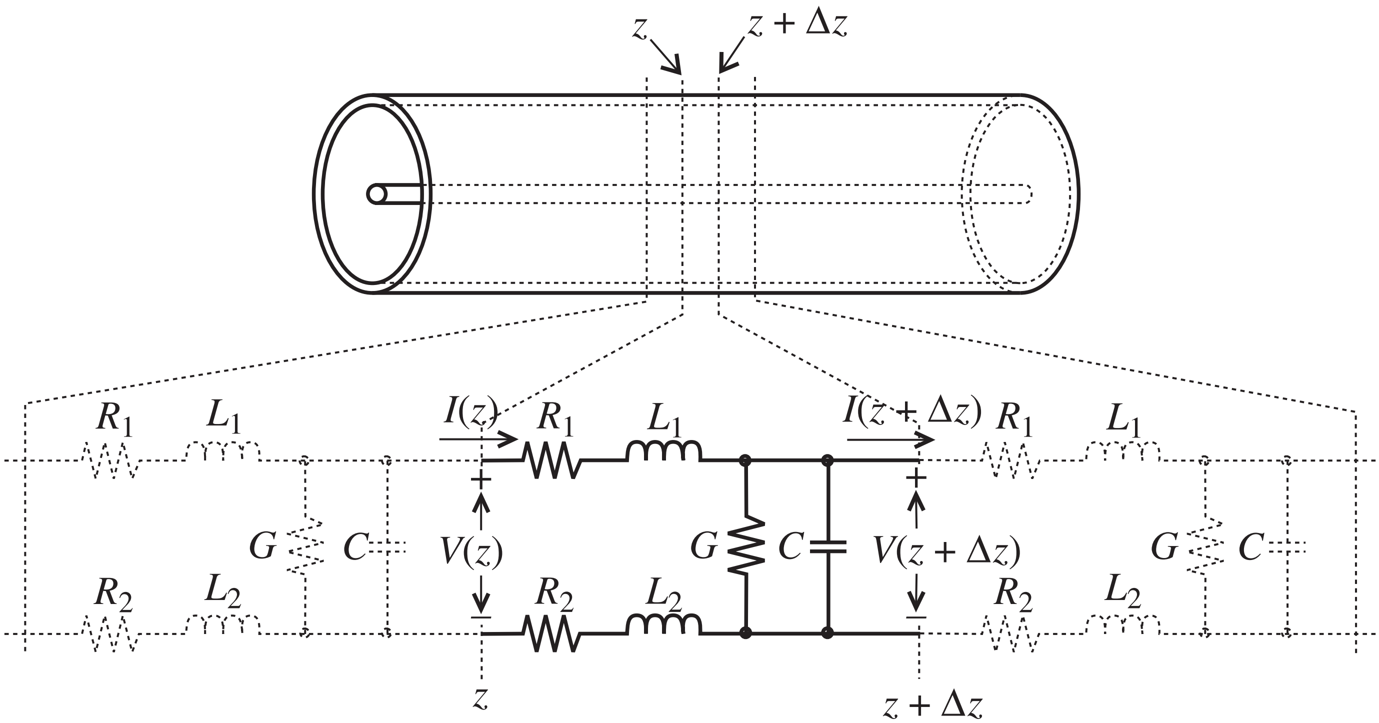


Figure 2-11 Segmentation of a coaxial cable into Δz length elements suitable for lumped parameter analysis.

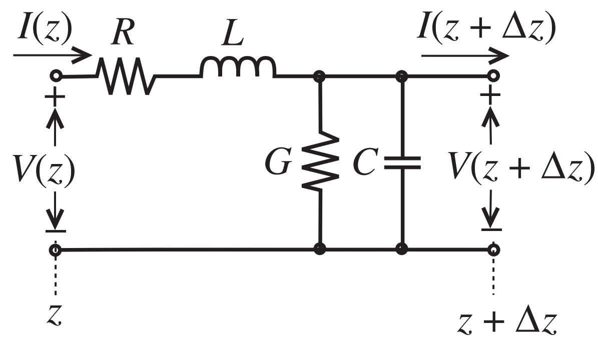


Figure 2-12 Generic electric equivalent circuit representation.

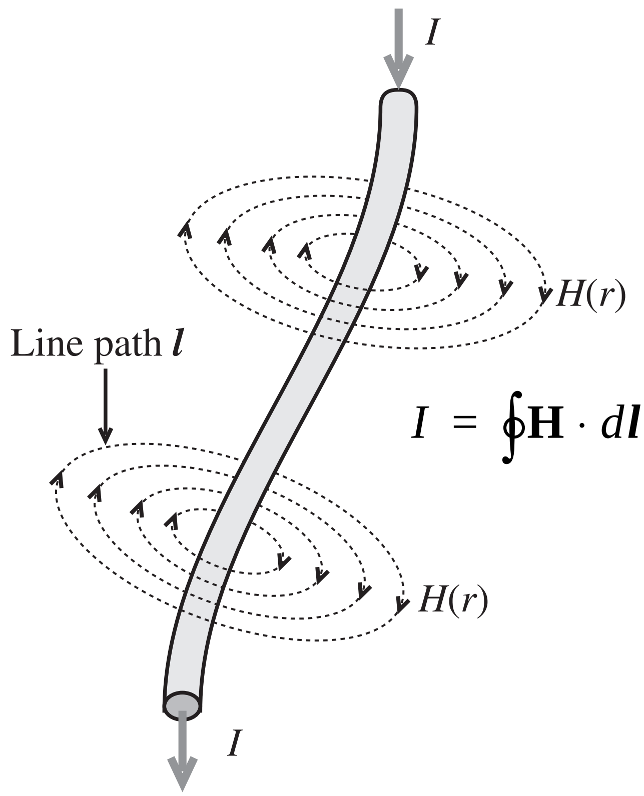


Figure 1-1 Ampère's law linking the current flow to the magnetic field.

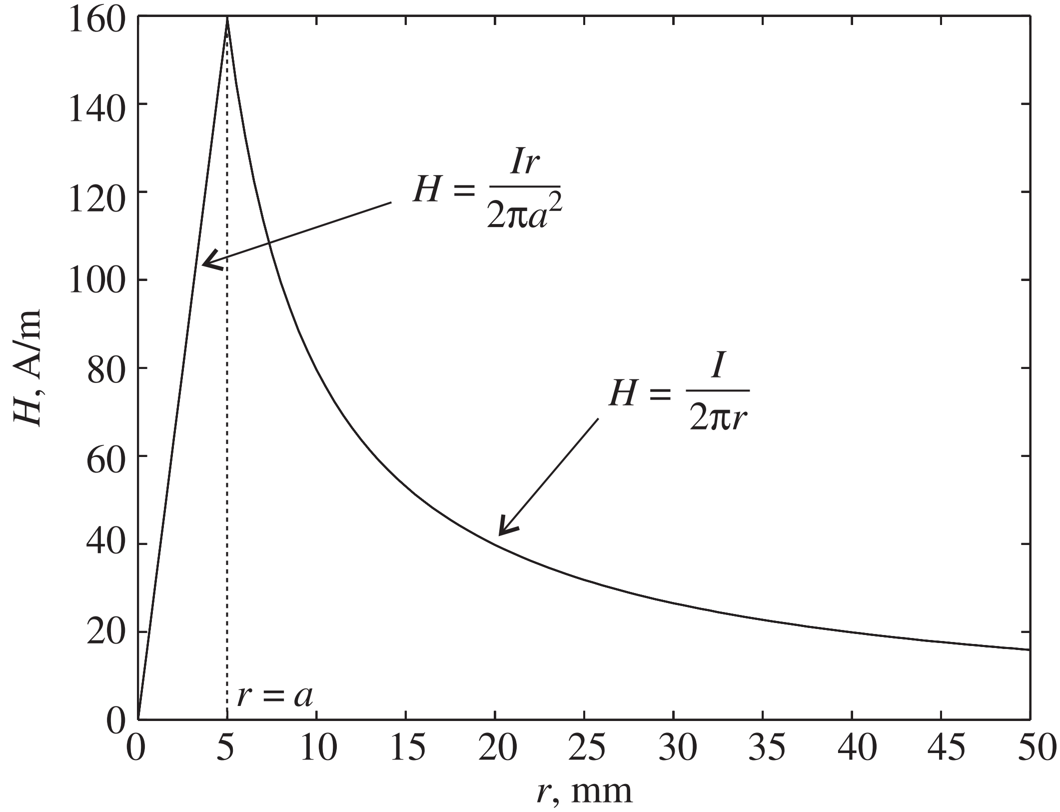


Figure 2-13 Magnetic field distribution inside and outside of an infinitely long wire of radius a = 5 mm carrying a current of 5 A.

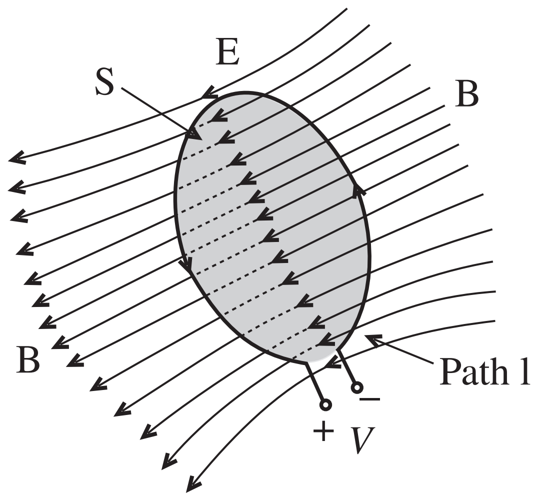


Figure 2-14 The time rate of change of the magnetic flux density induces a voltage.

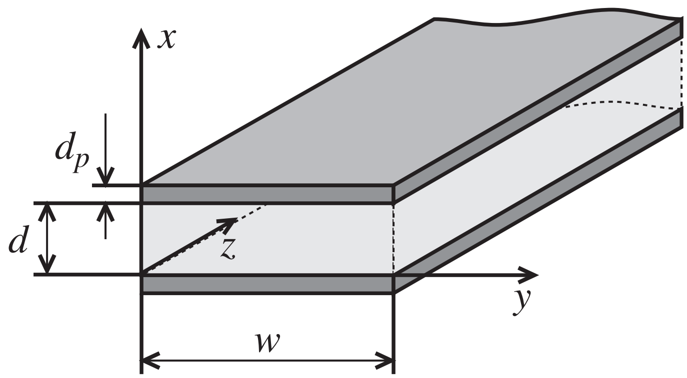


Figure 2-15   Parallel-plate transmission line geometry. The plate width *w* is large compared with the separation *d*.

Table 2-1 Transmission line parameters for three line types

Parameter	Two-Wire Line	Coaxial Line	Parallel-Plate Line
R Ω/m	$\dfrac{1}{\pi a \sigma_{\mathrm{cond}} \delta}$	$\dfrac{1}{2\pi \sigma_{\mathrm{cond}} \delta}\left(\dfrac{1}{a} + \dfrac{1}{b}\right)$	$\dfrac{2}{w \sigma_{\mathrm{cond}} \delta}$
L $\mathrm{H/m}$	$\dfrac{\mu}{\pi} \cosh^{-1}\left(\dfrac{D}{2a}\right)$	$\dfrac{\mu}{2\pi} \ln\left(\dfrac{b}{a}\right)$	$\mu \dfrac{d}{w}$
G $\mathrm{S/m}$	$\dfrac{\pi \sigma_{\mathrm{diel}}}{\cosh^{-1}(D/(2a))}$	$\dfrac{2\pi \sigma_{\mathrm{diel}}}{\ln(b/a)}$	$\sigma_{\mathrm{diel}} \dfrac{w}{d}$
C $\mathrm{F/m}$	$\dfrac{\pi \varepsilon}{\cosh^{-1}(D/(2a))}$	$\dfrac{2\pi \varepsilon}{\ln(b/a)}$	$\varepsilon \dfrac{w}{d}$

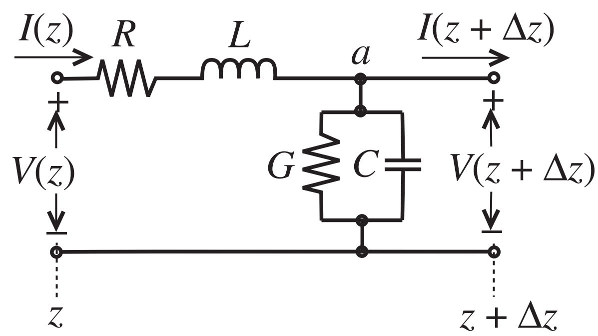


Figure 2-16 Segment of a transmission line with voltage loop and current node.

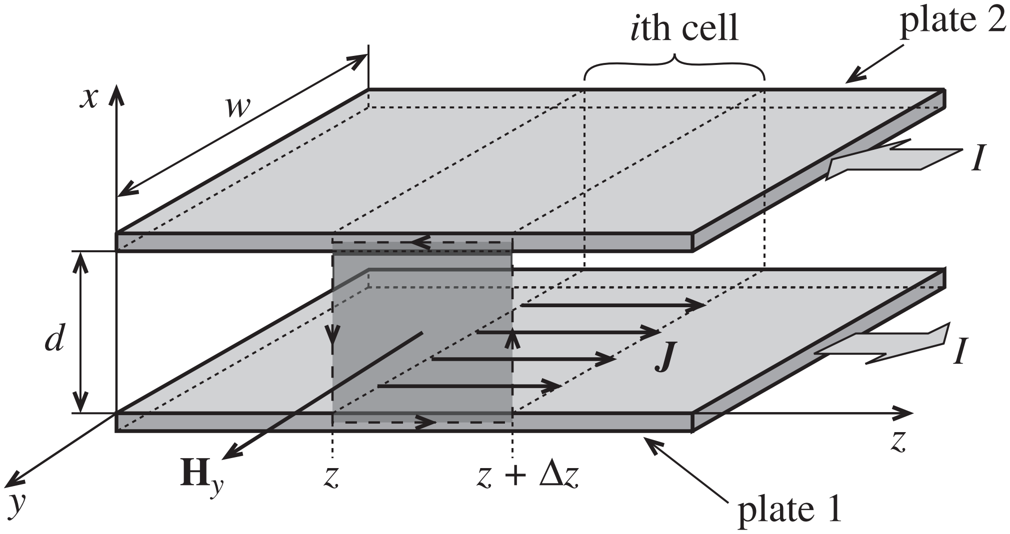


Figure 2-17 Integration surface element for Faraday’s law application.

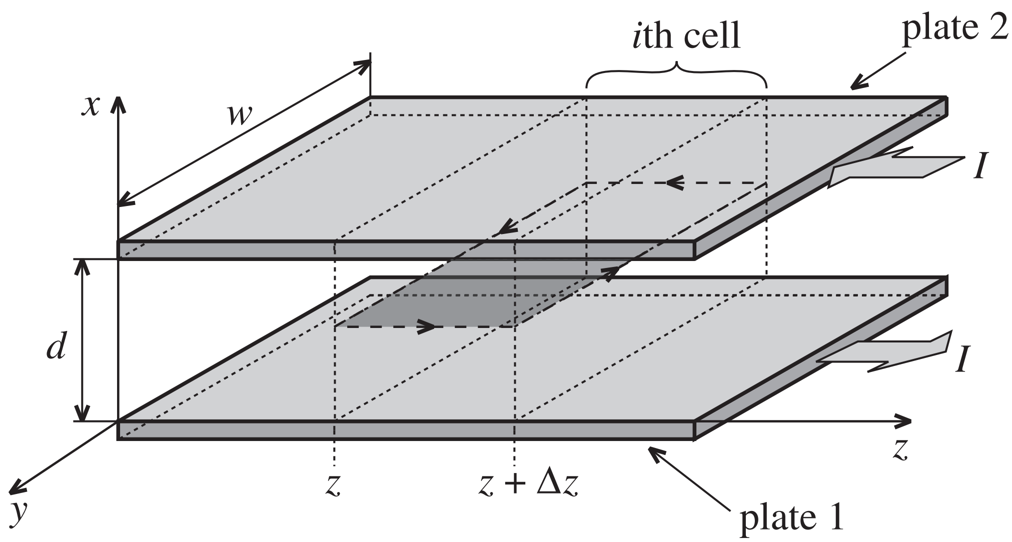


Figure 2-18 Surface element used to apply Ampère’s law.

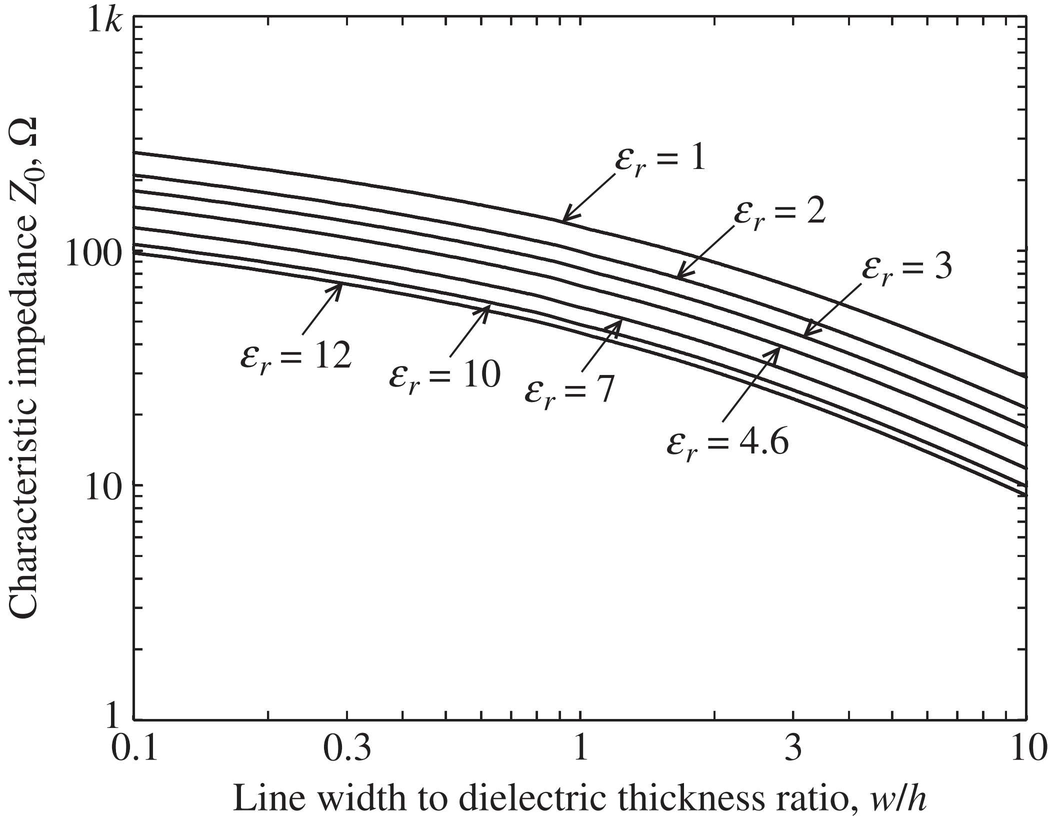


Figure 2-19 Microstrip characteristic impedance as a function of *w/h*.

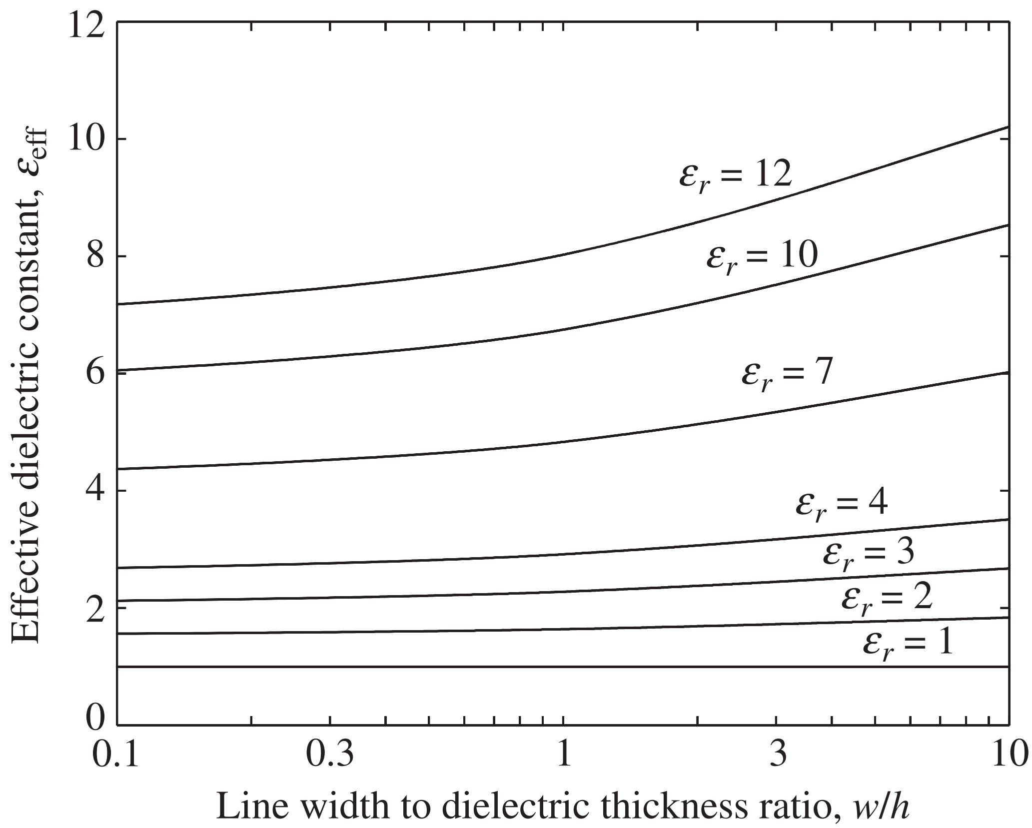


Figure 2-20 Effective dielectric constant of the microstrip line as a function of *w/h* for different dielectric constants.

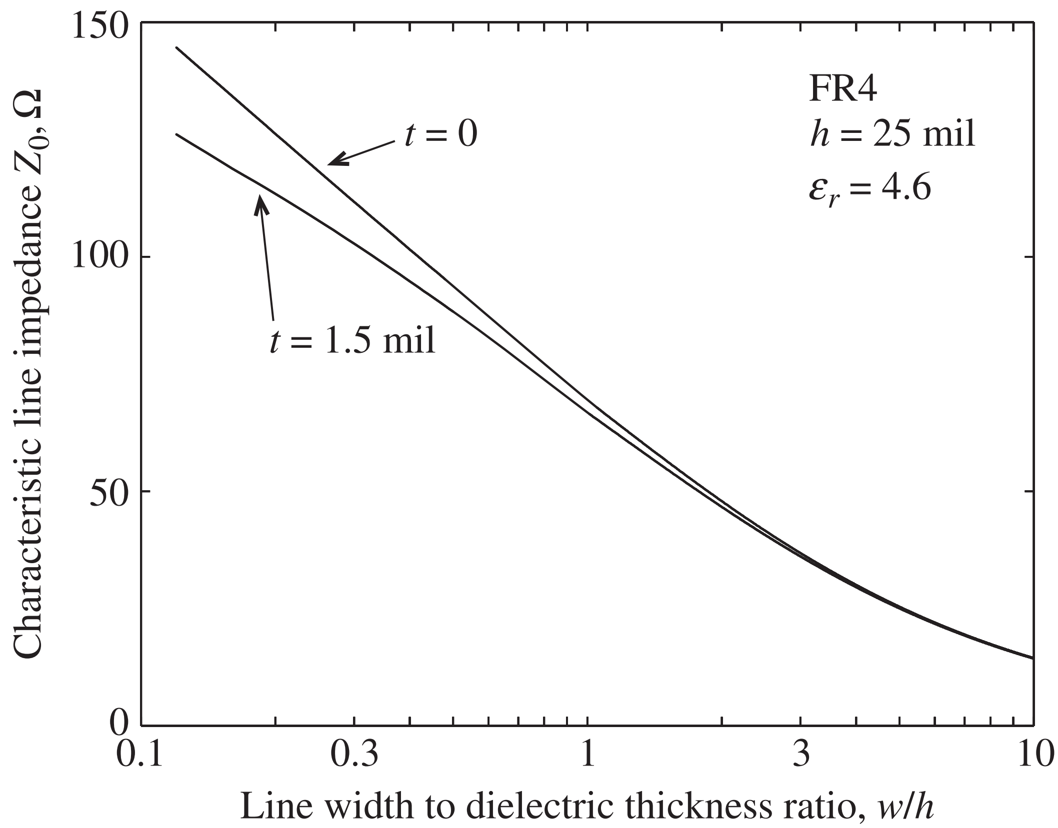


Figure 2-21 Effect of conductor thickness on the characteristic impedance of a microstrip line placed on a 25 mil thick FR4 printed circuit board.

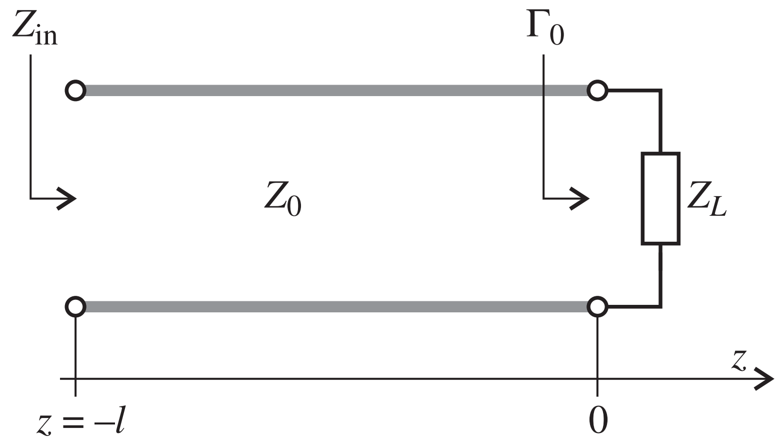


Figure 2-22 Terminated transmission line at location z = 0.

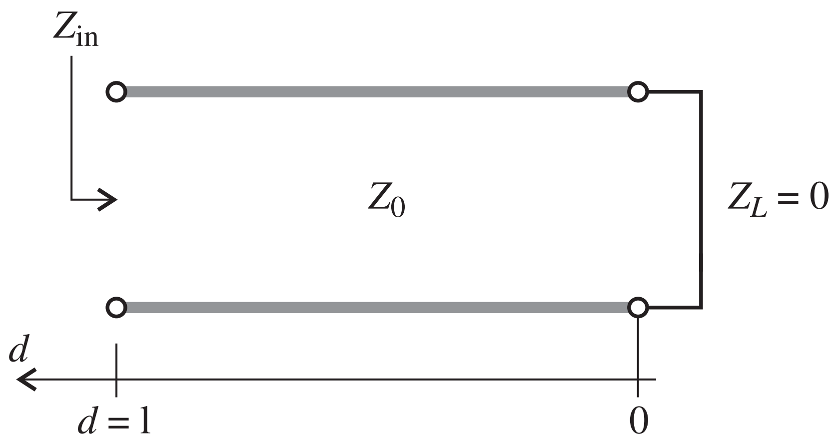


Figure 2-23 Short-circuited transmission line and new coordinate system *d.*

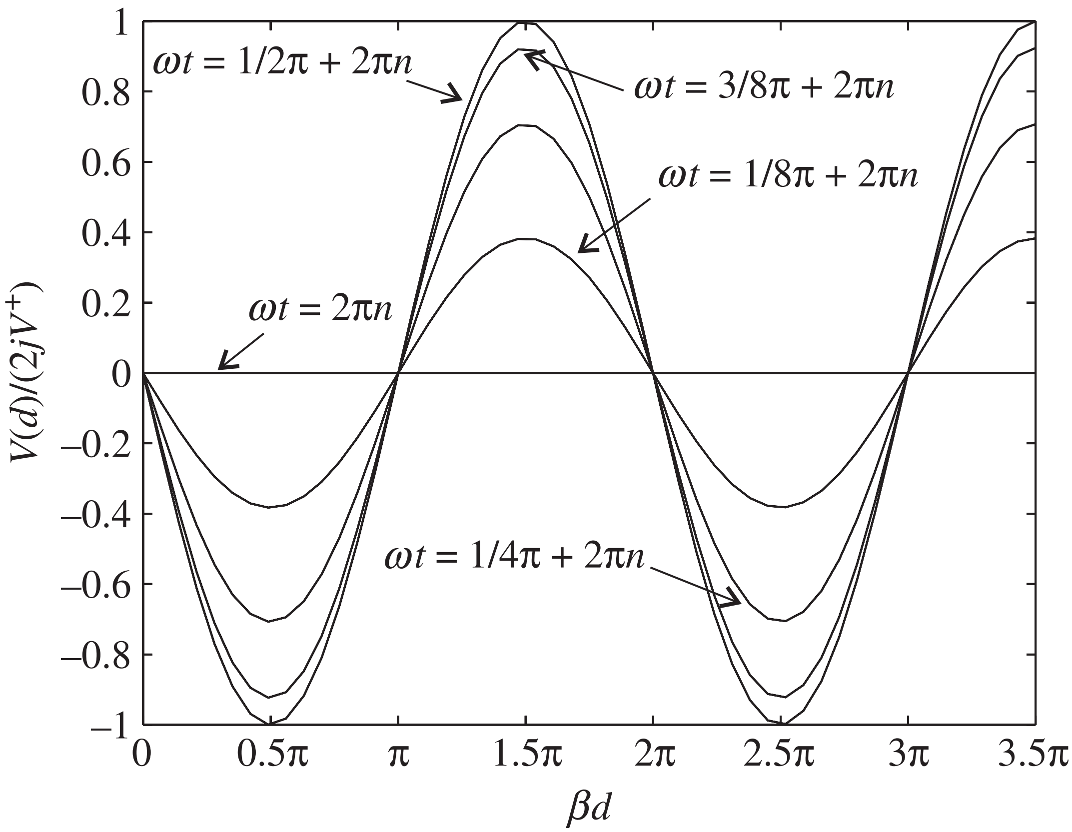


Figure 2-24 Standing wave pattern for various instances of time.

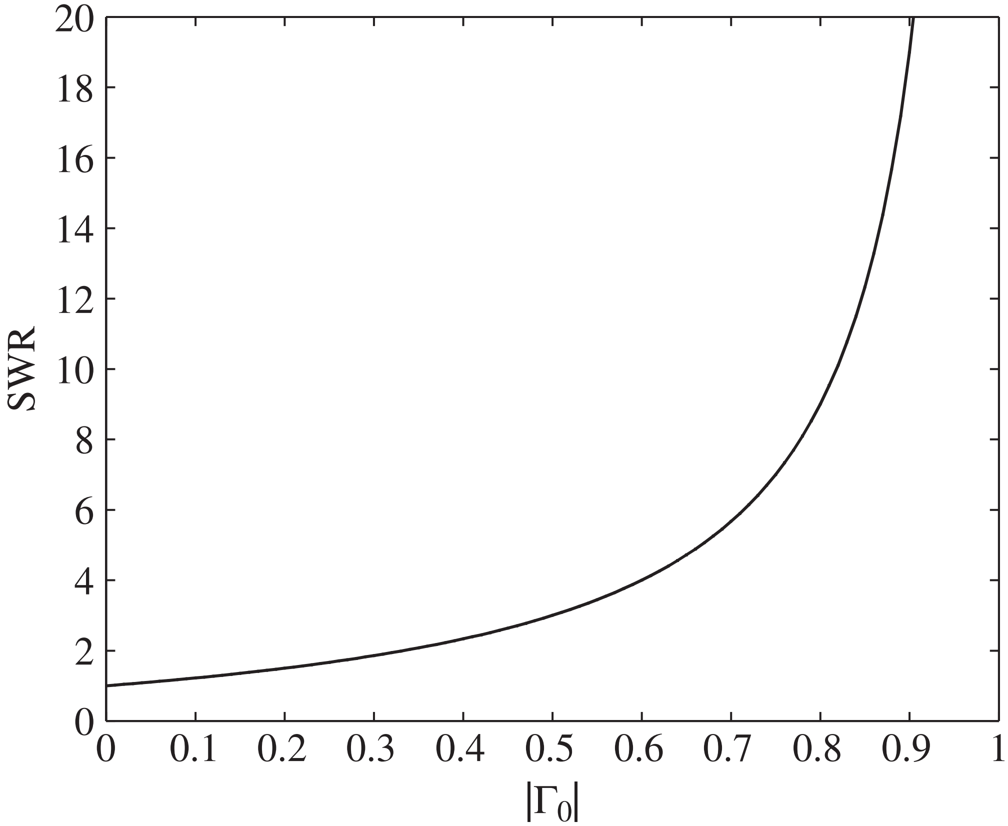


Figure 2-25 SWR as a function of load reflection coefficient $|\Gamma_0|$.

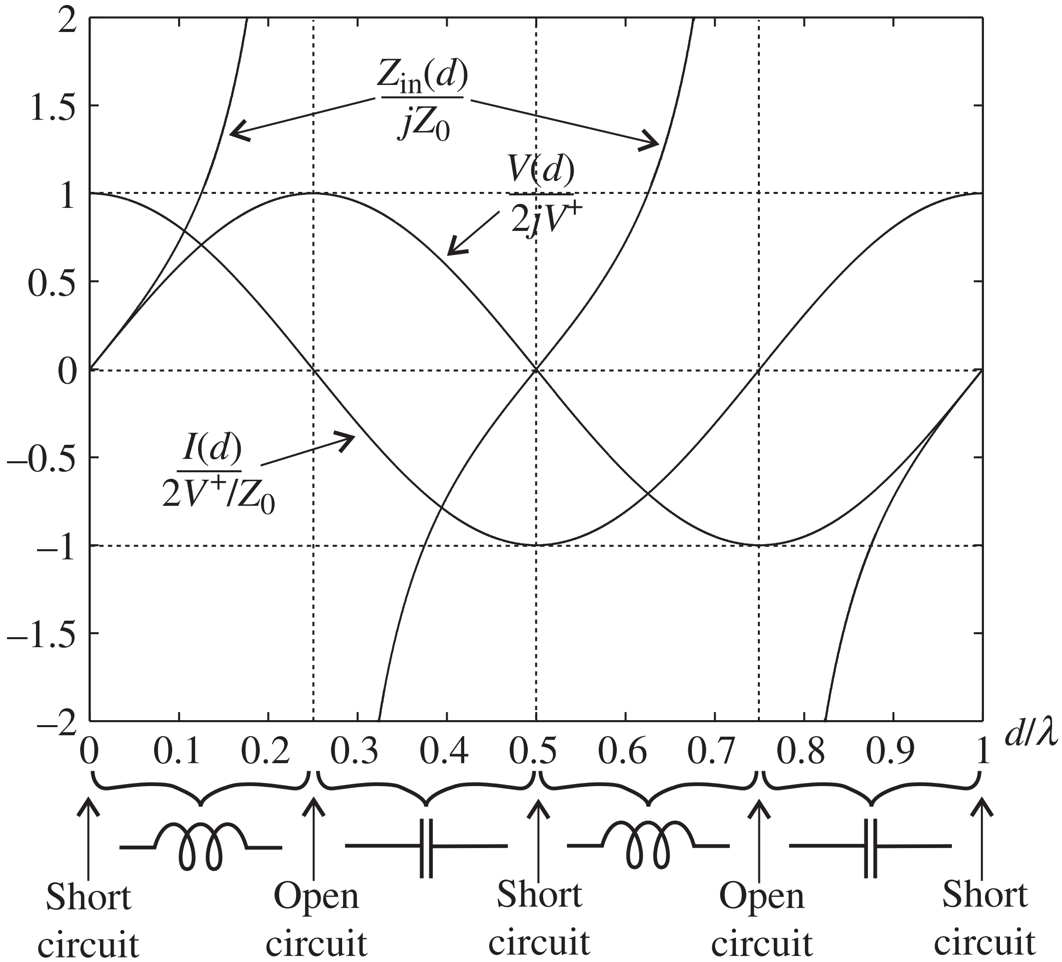


Figure 2-26 Voltage, current, and impedance as a function of line length for a short-circuit termination.

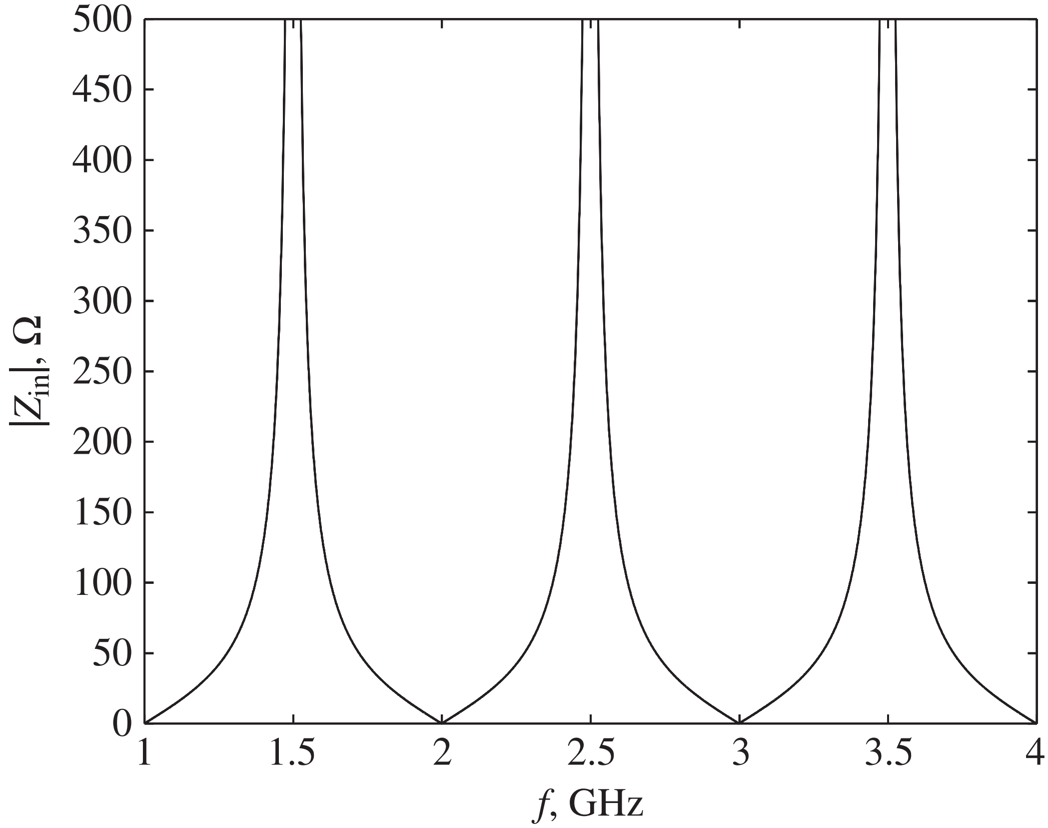


Figure 2-27 Magnitude of the input impedance for a 10 cm long, short-circuited transmission line as a function of frequency.

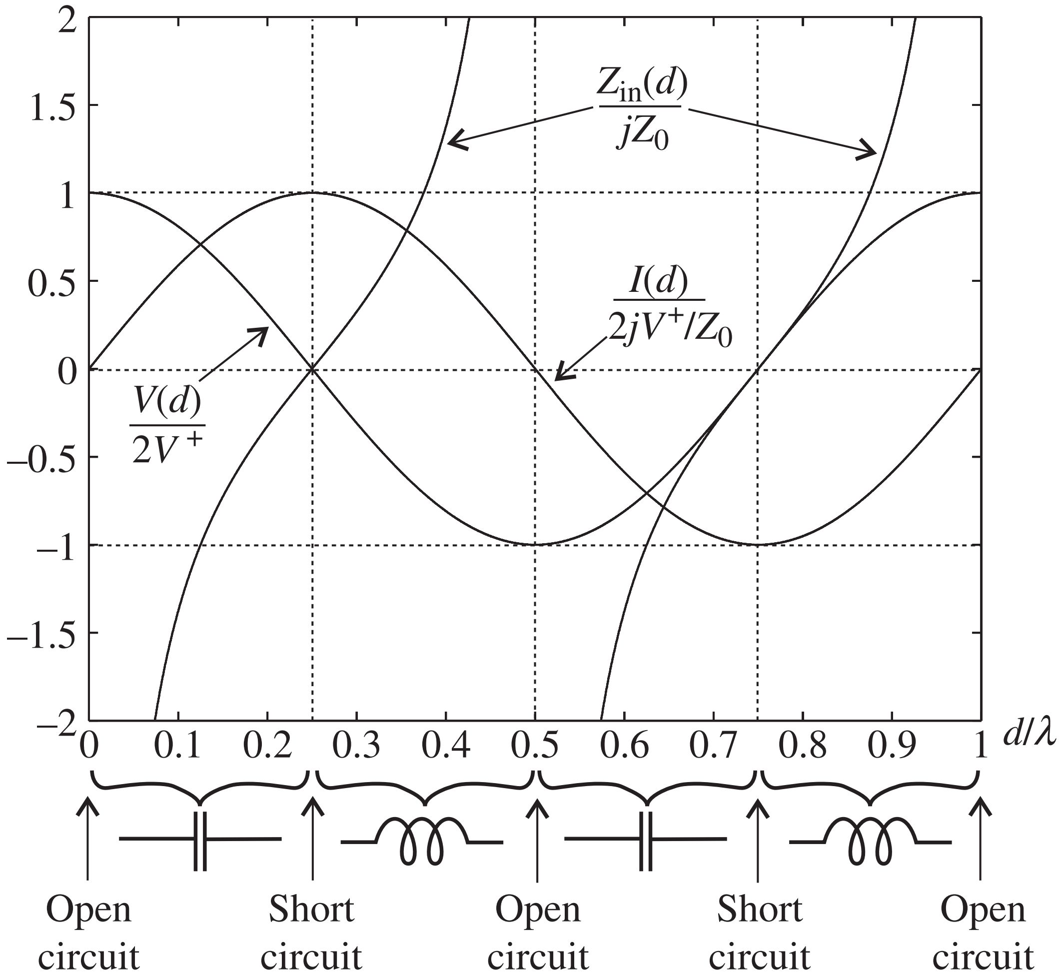


Figure 2-28 Voltage, current, and impedance as a function of line length for an open-circuit termination.

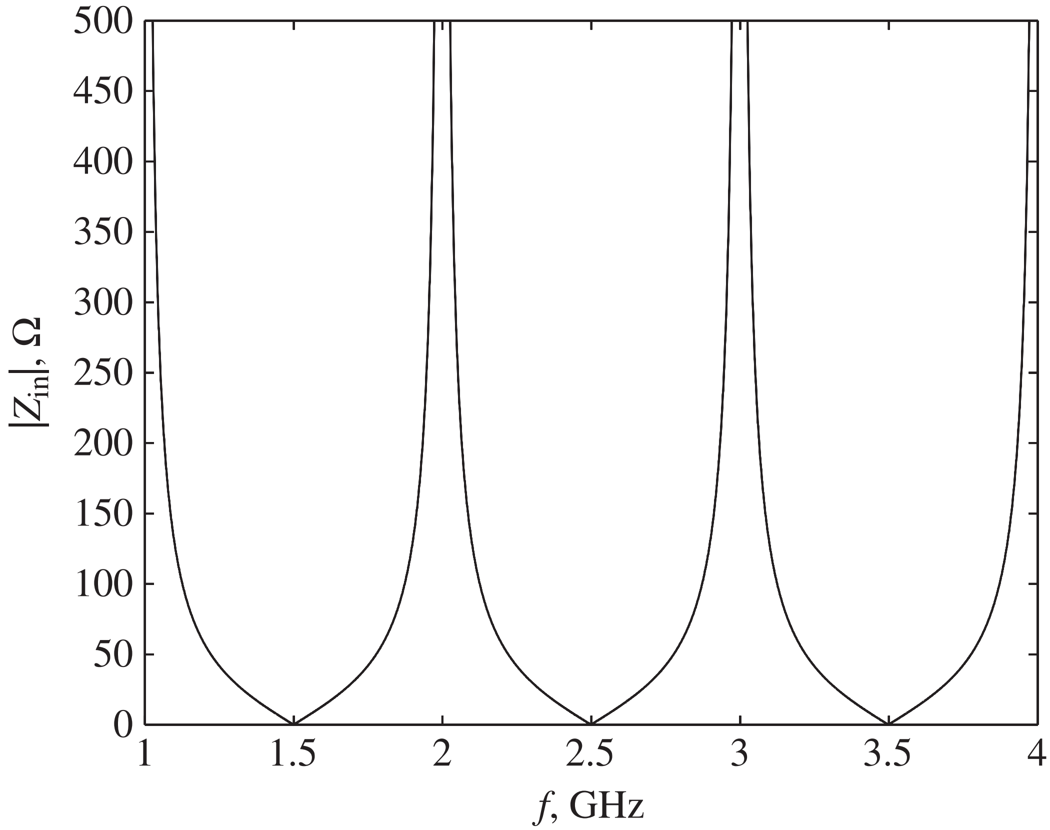


Figure 2-29 Impedance magnitude for a 10 cm long, open-circuited transmission line as a function of frequency.

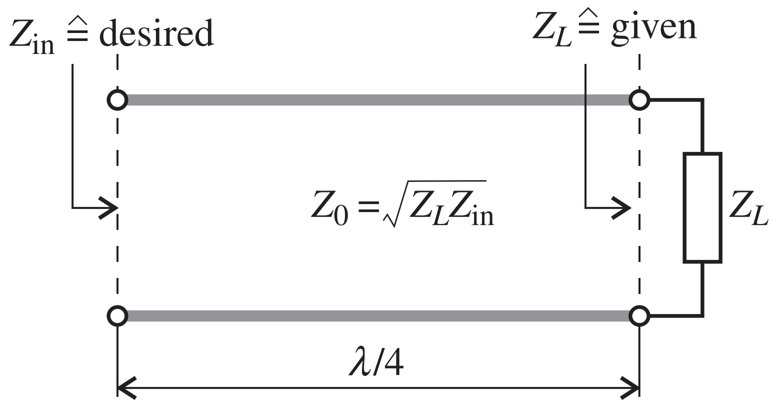


Figure 2-30 Input impedance matched to a load impedance through a $\lambda/4$ line segment.

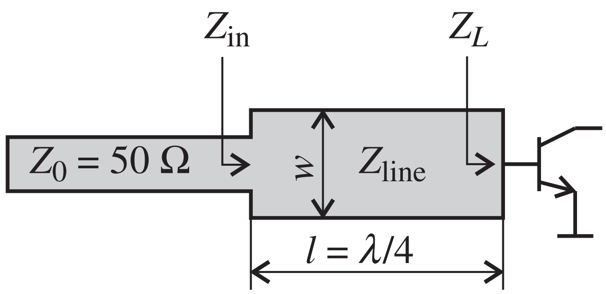


Figure 2-31   Input impedance of quarter-wave transformer.

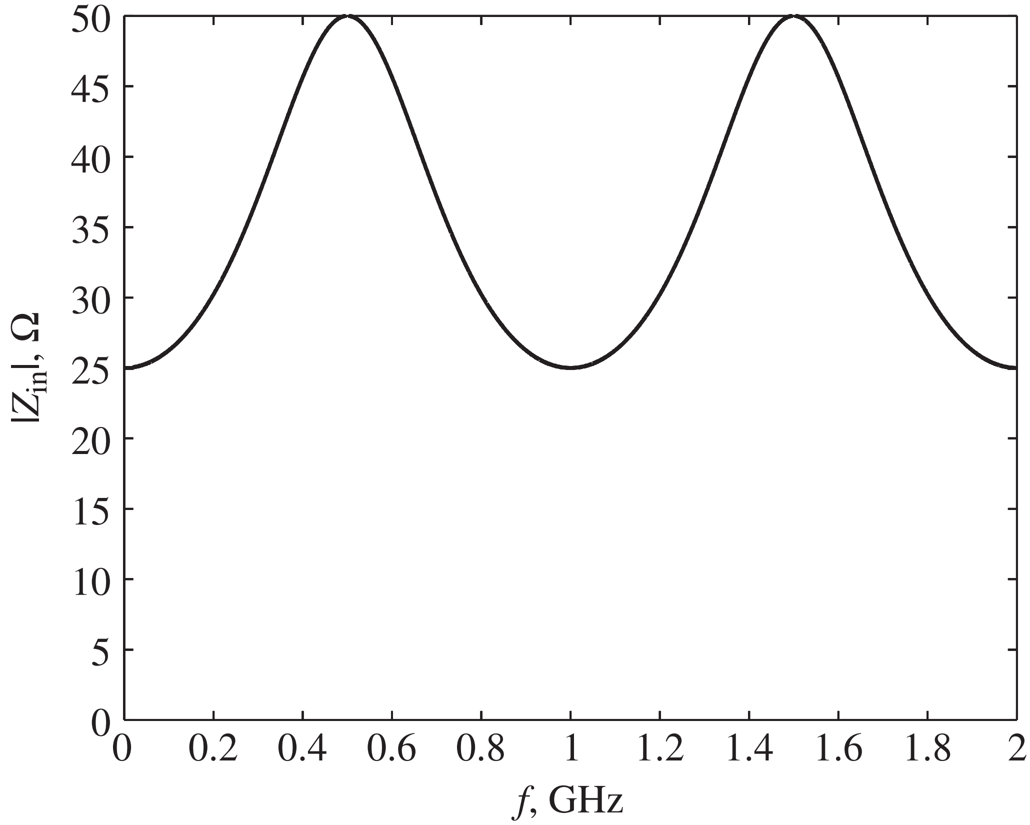


Figure 2-32 Magnitude of Z_{in} for frequency range of 0 to 2 GHz and fixed length d.

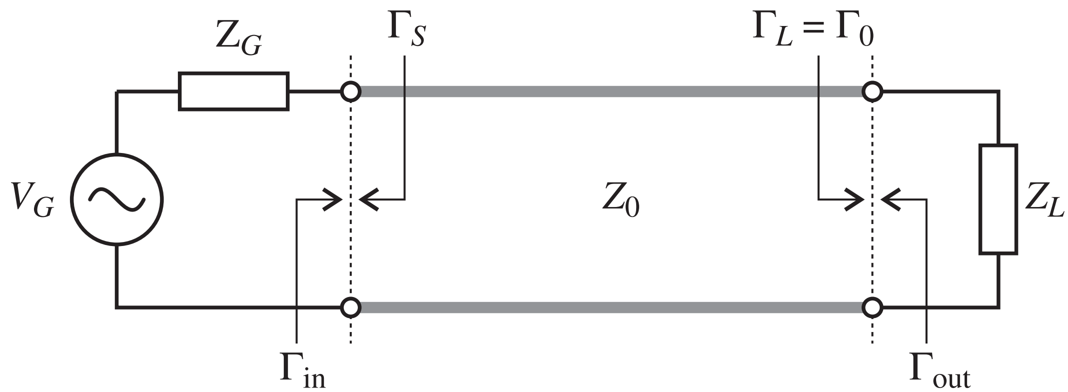


Figure 2-33 Generic transmission line circuit involving source and load terminations.

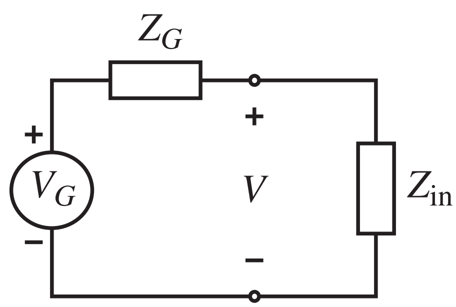
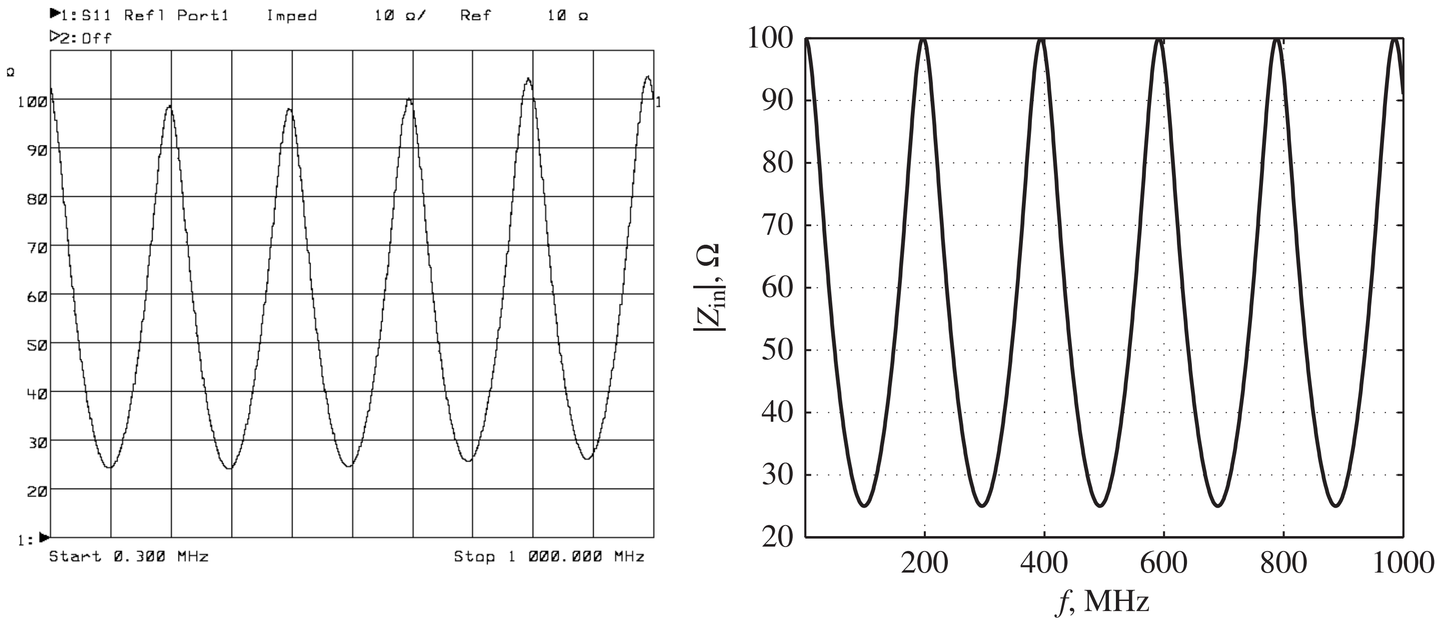


Figure 2-34 Equivalent lumped input network for a transmission line configuration.



(a) (b)

Figure 2-35 Impedance of a coaxial cable terminated by a 100 Ω resistor: (a) network analyzer measurement, (b) theoretical prediction.

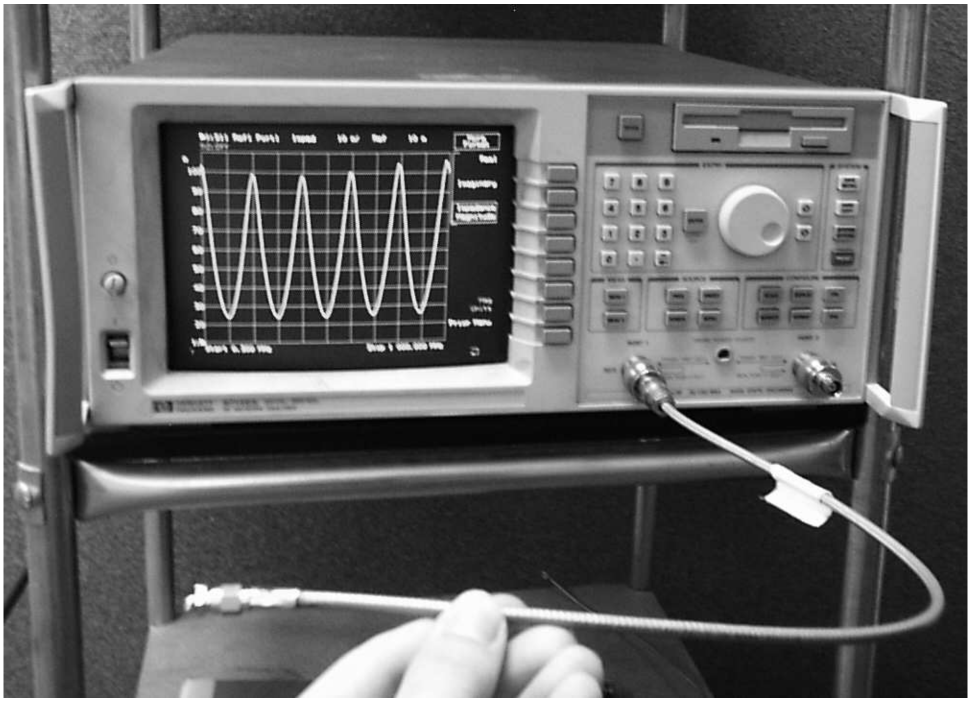


Figure 2-36 Network analyzer with the resistive 100 Ω test load attached.