Problem 2.79 Suppose the voltage waveform shown in Fig. P2.77 was observed at the sending end of a 50-Ω transmission line in response to a step voltage introduced by a generator with $V_g = 15$ V and an unknown series resistance R_g. The line is 1 km in length, its velocity of propagation is 1×10^8 m/s, and it is terminated in a load $R_L = 100\ \Omega$.

(a) Determine R_g.

(b) Explain why the drop in level of $V(0,t)$ at $t = 6\ \mu$s cannot be due to reflection from the load.

(c) Determine the shunt resistance R_f and location of the fault responsible for the observed waveform.

Solution:

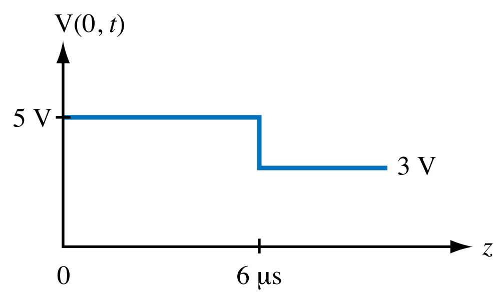

Figure P2.79: Observed voltage at sending end.

(a)

$$V_1^+ = \frac{V_g Z_0}{R_g + Z_0}.$$

From Fig. P2.79, $V_1^+ = 5$ V. Hence,

$$5 = \frac{15 \times 50}{R_g + 50},$$

which gives $R_g = 100\ \Omega$ and $\Gamma_g = 1/3$.

(b) Roundtrip time delay of pulse return from the load is

$$2T = \frac{2l}{u_p} = \frac{2 \times 10^3}{1 \times 10^8} = 20\ \mu\text{s},$$

which is much longer than 6 μs, the instance at which $V(0,t)$ drops in level.

(c) The new level of 3 V is equal to V_1^+ plus V_1^- plus V_2^+,

$$V_1^+ + V_1^- + V_2^+ = 5 + 5\Gamma_f + 5\Gamma_f\Gamma_g = 3 \quad \text{(V)},$$

which yields $\Gamma_{\mathrm{f}} = -0.3$. But

$$\Gamma_{\mathrm{f}} = \frac{Z_{\mathrm{Lf}} - Z_0}{Z_{\mathrm{Lf}} + Z_0} = -0.3,$$

which gives $Z_{\mathrm{Lf}} = 26.92\ \Omega$. Since Z_{Lf} is equal to R_{f} and Z_0 in parallel, $R_{\mathrm{f}} = 58.33\ \Omega$.