

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

- (a) Determine R_g .
- (b) Explain why the drop in level of $V(0, t)$ at $t = 6\text{ }\mu\text{s}$ 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:

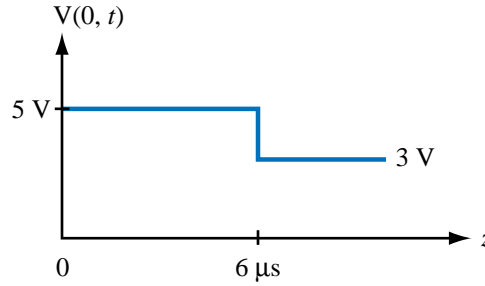


Figure P2.79: Observed voltage at sending end.

(a)

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

From Fig. P2.79, $V_1^+ = 5\text{ V}$. Hence,

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

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

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

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

which is much longer than $6\text{ }\mu\text{s}$, 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^+ ,

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

which yields $\Gamma_f = -0.3$. But

$$\Gamma_f = \frac{Z_{Lf} - Z_0}{Z_{Lf} + Z_0} = -0.3,$$

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