2.81 A generator circuit with $V_g = 200$ V and $R_g = 25\ \Omega$ was used to excite a 75 Ω lossless line with a rectangular pulse of duration $\tau = 0.4\ \mu$s. The line is 200 m long, its $u_p = 2 \times 10^8$ m/s, and it is terminated in a load $R_L = 125\ \Omega$.

(a) Synthesize the voltage pulse exciting the line as the sum of two step functions, $V_{g_1}(t)$ and $V_{g_2}(t)$.

(b) For each voltage step function, generate a bounce diagram for the voltage on the line.

(c) Use the bounce diagrams to plot the total voltage at the sending end of the line.

Solution:

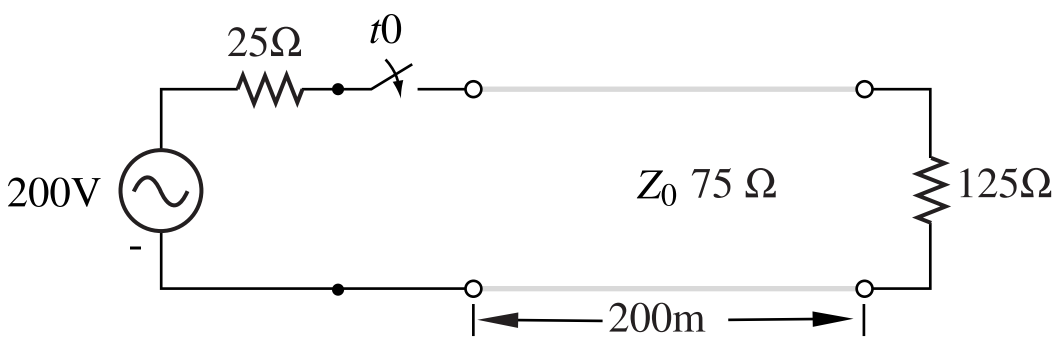

Figure P2.81 (a) Circuit for Problem 2.81.

(a) pulse length $= 0.4\ \mu$s.

$$V_g(t) = V_{g_1}(t) + V_{g_2}(t),$$

with

$$V_{g_1}(t) = 200\,U(t) \qquad \text{(V)},$$
$$V_{g_2}(t) = -200\,U(t - 0.4\ \mu\text{s}) \qquad \text{(V)}.$$

(b)

$$T = \frac{l}{u_p} = \frac{200}{2 \times 10^8} = 1\ \mu\text{s}.$$

We will divide the problem into two parts, one for $V_{g_1}(t)$ and another for $V_{g_2}(t)$ and then we will use superposition to determine the solution for the sum. The solution for

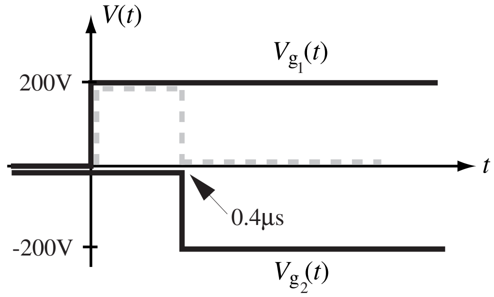

Figure P2.81 (b) Solution of part (a).

$V_{g_2}(t)$ will mimic the solution for $V_{g_1}(t)$, except for a reversal in sign and a delay by 0.4 μs.

<u>For $V_{g_1}(t) = 200U(t)$:</u>

$$\Gamma_g = \frac{R_g - Z_0}{R_g + Z_0} = \frac{25-75}{25+75} = -0.5,$$

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{125-75}{125+75} = 0.25,$$

$$V_1^+ = \frac{V_1 Z_0}{R_g + Z_0} = \frac{200 \times 75}{25+75} = 150 \text{ V},$$

$$V_\infty = \frac{V_g Z_L}{R_g + Z_L} = \frac{200 \times 125}{25+125} = 166.67 \text{ V}.$$

(i) $V_1(0,t)$ at sending end due to $V_{g_1}(t)$:

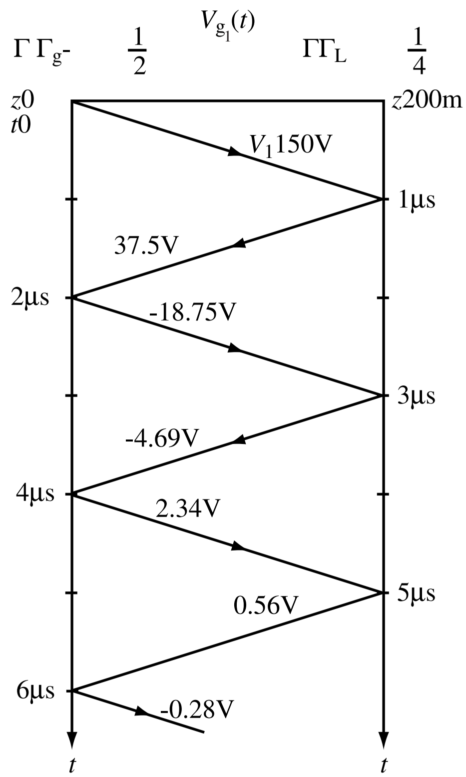

Figure P2.81 (c) Bounce diagram for voltage in reaction to $V_{g_1}(t)$.

(ii) $V_2(0,t)$ at sending end due to $V_{g_2}(t)$:

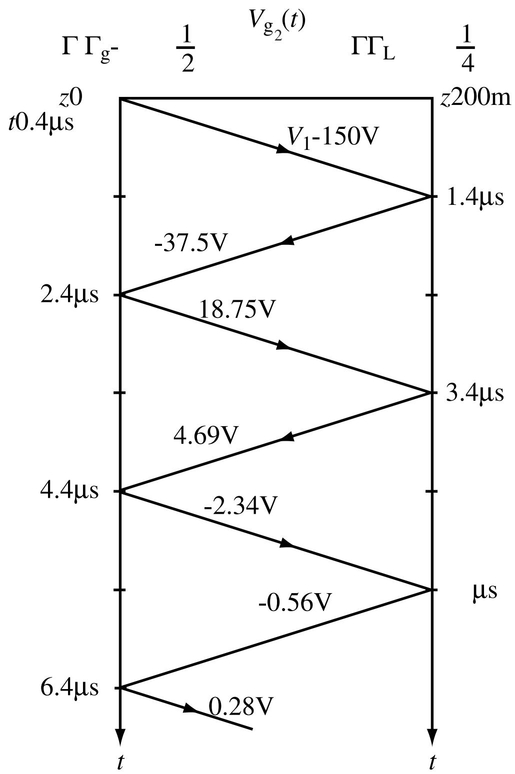

Figure P2.81 (d) Bounce diagram for voltage in reaction to $V_{g_2}(t)$.

(b)

(i) $V_1(0,t)$ at sending end due to $V_{g_1}(t)$: see Fig. P2.81(e).

(ii) $V_2(0,t)$ at sending end: see Fig. P2.81(f).

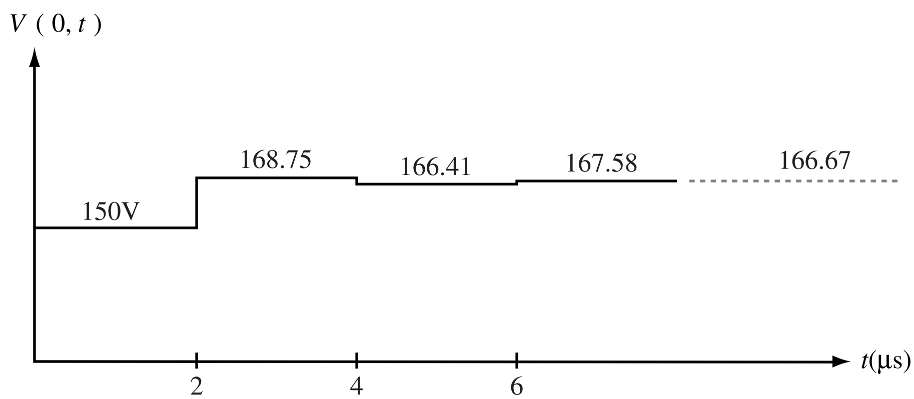

Figure P2.81 (e) $V_1(0,t)$.

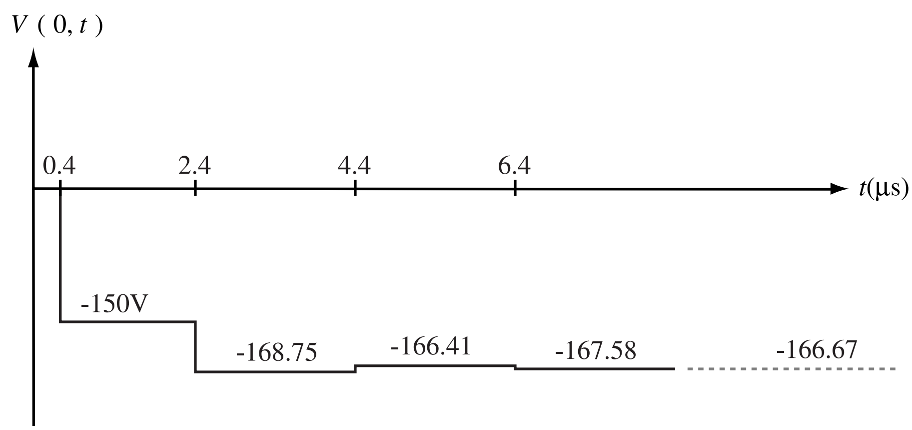

Figure P2.81 (f) $V_2(0,t)$.

(iii) Net voltage $V(0,t) = V_1(0,t) + V_2(0,t)$: see Fig. P2.81(g).

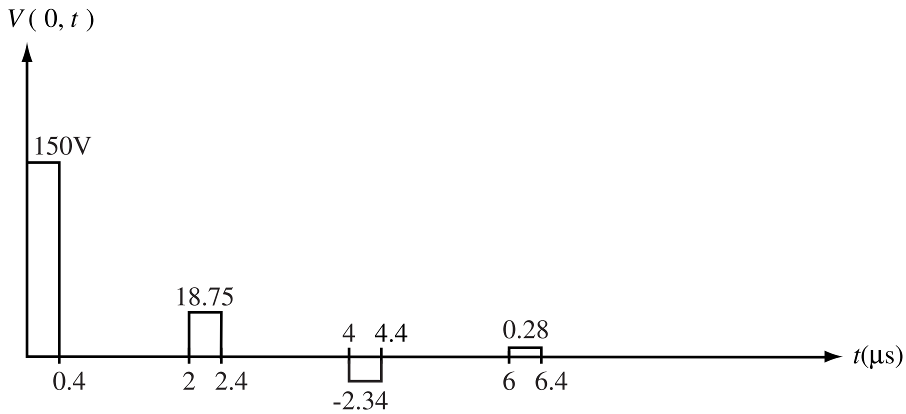

Figure P2.81: (g) Net voltage $V(0,t)$.