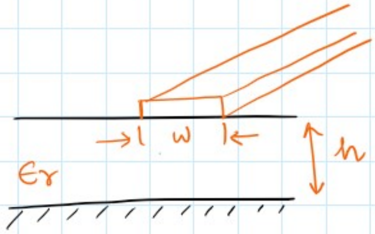
Lec-12

Wednesday, April 22, 2020 5:57 PM

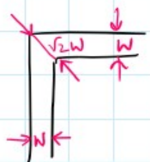
Characteristic Impedance cont...

3) Microstrip Line.



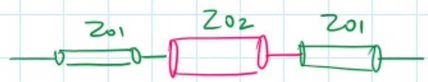
$$Z_0 = \frac{377}{\sqrt{\epsilon_r}\,\left((W/h)+2\right)}$$

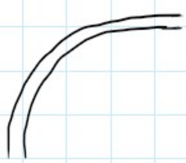
Discontinuity / Reflections in a PCB trace.



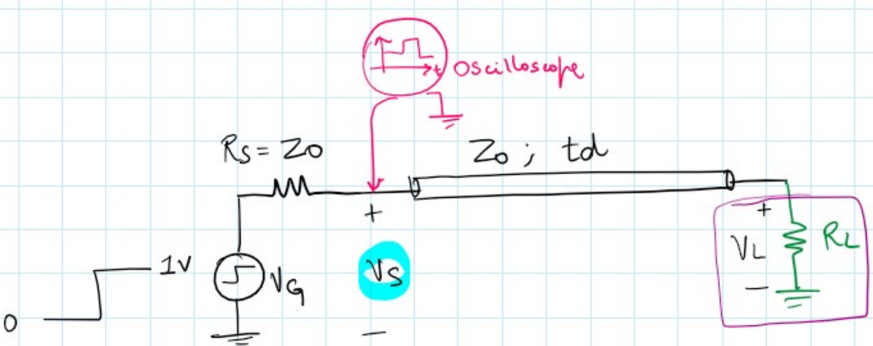
90° bend

equivalent $\equiv$





Observations on a Transmission Line with different resistive termination

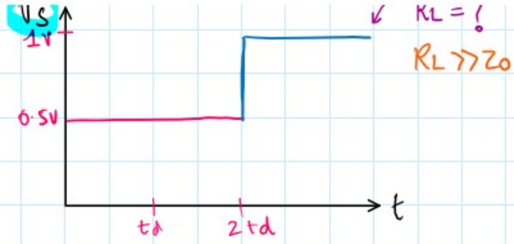


How to know the load by observing the voltage V_S.

$\Gamma = \frac{R_L - Z_0}{R_L + Z_0}$

a) $R_L < Z_0 \rightarrow \Gamma_L < 0$

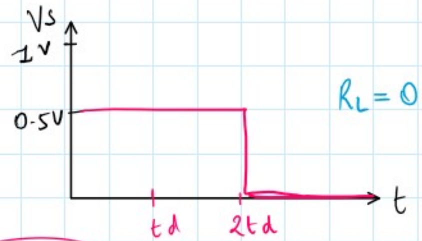
b) $R_L > Z_0 \quad \Gamma_L > 0$

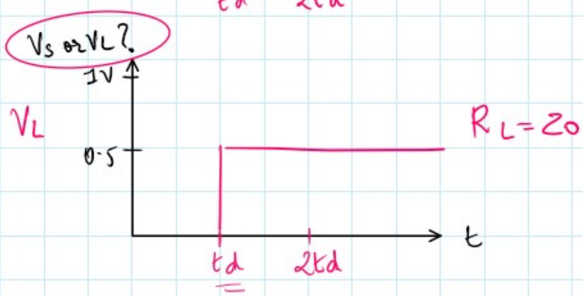


a) $R_L < Z_0 \rightarrow \Gamma_L < 0$
b) $R_L > Z_0 \quad \Gamma_L > 0$
c) $\boxed{R_L \gg Z_0} \rightarrow \underbrace{\Gamma_L \approx 1}$
d) $R_L \approx 0 \rightarrow \Gamma_L = -1$

V^-

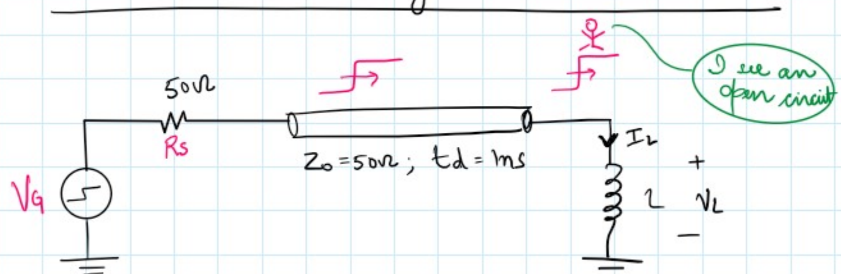
- Reverse travelling wave will have a +ve amplitude.
- It will add on to the forward travelling wave



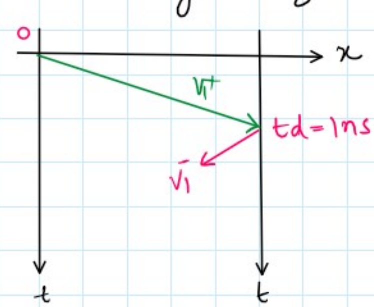


$\Gamma_L = \frac{R_L - Z_0}{R_L + Z_0}$ $\qquad R_L = Z_0 \rightarrow \Gamma_L = 0$

Reactive Termination of Transmission Line



- Inductor acts like an open circuit to the incident voltage.
- $\Gamma_L = 1 \rightarrow$ Voltage is double at load (instantaneously).
- Current in the inductor goes to zero.



$V_1^+ = 0.5V$
$V_1^- = 0.5V$ (@ $t = td$

$$V_L(t) = L\frac{d}{dt} I_L(t)$$

$$\left.\begin{aligned} V_L(t) &= V_1^+(t) + V_1^-(t) \\ I_L(t) &= I_1^+(t) + I_1^-(t) \end{aligned}\right\}$$

$I_1^+ = \frac{V_1^+}{Z_0}$; $I_1^- = -\frac{V_1^-}{Z_0}$

$$I_L(t) = \frac{V_1^+(t)}{Z_0} - \frac{V_1^-(t)}{Z_0}$$

$\longrightarrow$ Because $V_1^+(t) = V_1^-(t)$ @ $t = td$

$\Rightarrow I_L(t) = 0$ @ $t = td$

$$V_1^+(t) + V_1^-(t) = L\left[\frac{d}{dt}\left(\frac{V_1^+(t)}{Z_0} - \frac{V_1^-(t)}{Z_0}\right)\right]$$

$$V_1^+(t) + V_1^-(t) = \frac{L}{Z_0}\frac{d}{dt}V_1^+(t) - \frac{L}{Z_0}\frac{d}{dt}V_1^-(t)$$

$$\left.V_1^+(t) = \text{Constant} = \left(\frac{Z_0}{Z_0+R_S}\right) \cdot V_G\right\} \to V_0$$

$$\frac{dV_1^+(t)}{dt} = 0$$

$$\frac{dV_1^-(t)}{dt} + \frac{Z_0}{L}V_1^-(t) + \frac{Z_0}{L}V_0 = 0$$

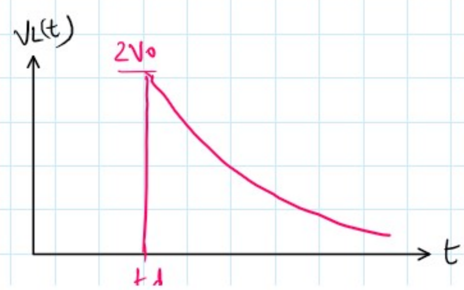
$$V_1^-(t) = -V_0 + \underbrace{K}_{\text{Integration constant}} e^{-(Z_0/L)(t-td)}$$

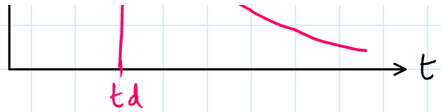
Boundary condition $\rightarrow$ @ $t = td$

$V_1^-(t) = V_0 = V_1^+(t)$,

$K = 2V_0$

$$\boxed{\begin{aligned} V_1^-(t) &= -V_0 + 2V_0\, e^{-(Z_0/L)(t-td)} \\ V_L(t) &= 2V_0\, e^{-(Z_0/L)(t-td)} \end{aligned}}$$





td
t