TDT6: Initially Charged Transmission Lines

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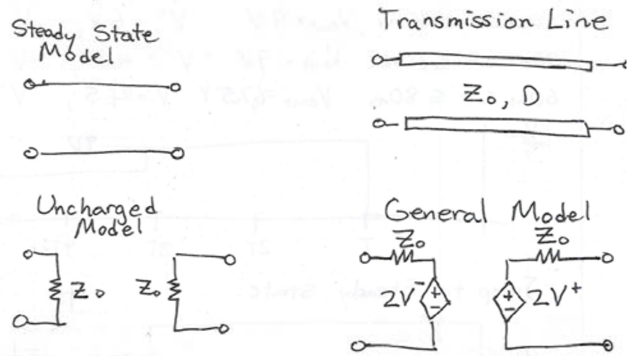
Equivalent Circuits for Transmission Lines

Initially Charged Lines



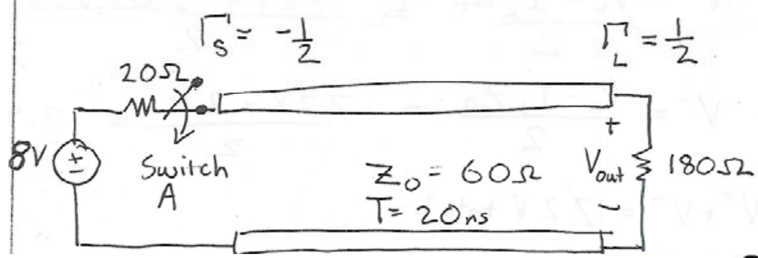
Caveat: – V^- as measured at the source-side of the line
– V^+ as measured at the load-side of the line

Example of a Discharged Line

Charged Lines: DC-switched to a second state or "off" state.

Represents a reversal of logic pulse.

Example: On the line below, switch A is closed



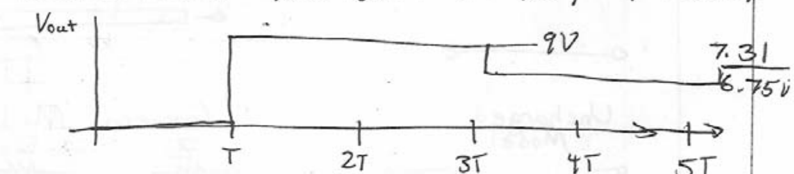
Transient vs. Steady State Solution

$0 \le t \le 20\,ns$: $V_{out} = 0\,V$, $V^+ = 6\,V$, $V^- = 0\,V$

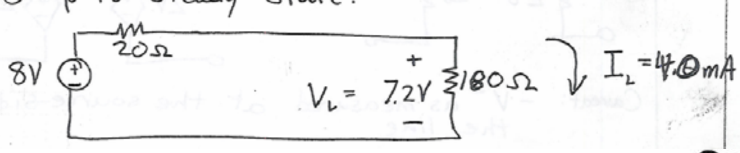
$20\,ns \le t \le 40\,ns$ $V_{out} = 9\,V$ $V^+ = 6\,V$, $V^- = 3$

$40\,ns \le t \le 60\,ns$ $V_{out} = 9\,V$ $V^+ = 4.5\,V$, $V^- = 3\,V$

$60\,ns \le t \le 80\,ns$ $V_{out} = 6.75\,V$ $V^+ = 4.5$, $V^- = 2.25\,V$

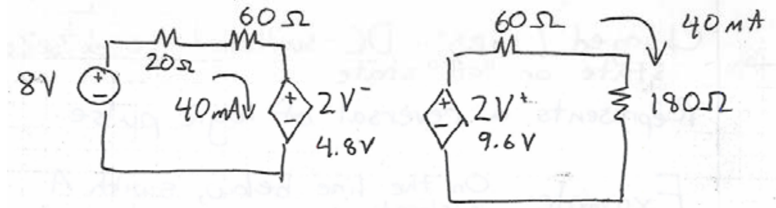


Jump to Steady State:



Calculating Traveling Voltages

Alternately



$$V^+ = \frac{V_L + I_L Z_o}{2} = \frac{7.2V + 0.04(60)}{2} = 4.8V$$

(2.4)

$$V^- = \frac{V_L - I_L Z_o}{2} = \frac{7.2V - 2.4}{2} = 2.4V$$

$V^+ + V^- = 7.2V$ total

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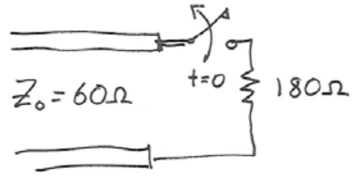
Transient on a Pre-charged Line

Now open the switch ...



before

$V^+ = 4.8V$ $V^- = 2.4V$

$\Gamma_L = +\frac{1}{2}$

after

$\Gamma_L = +1$

for a brief moment: $V^- = +4.8V$ $V_L = +9.6V$

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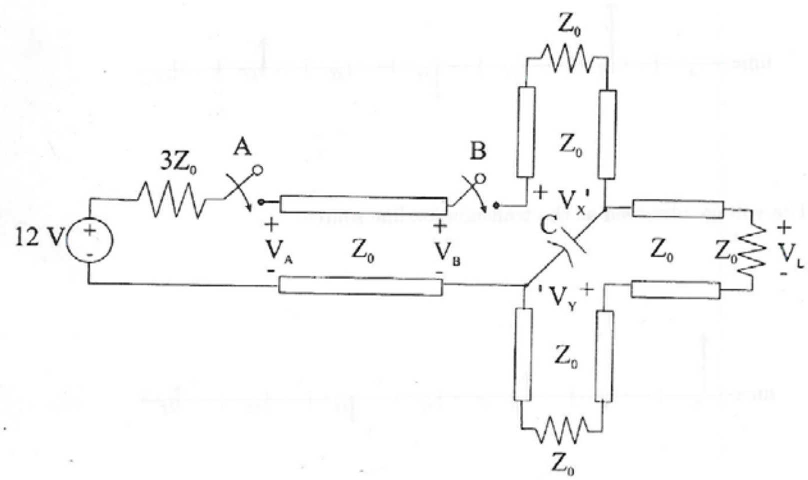
Example Circuit



Switching Network

Switching Network: The circuit below is switched according to the following states:

- State 0: Both switches are open and both lines are uncharged.
- State 1: Immediately after switch A is closed.
- State 2: Switch A has been closed for a while.
- State 3: Immediately after switch B is closed.
- State 4: Switch B has been closed for a while.

Fill out the following table according to these switching states (**40 points**):

	V_A	V_B	V_L	V_X	$V_{Y'}$
State 0	0	0	0	0	0
State 1					
State 2					
State 3					
State 4					

Answers

Switching Network (40 points)

	V_A	V_B	V_L	V_X	V_Y
State 0	0	0	0	0	0
State 1	3	0	0	0	0
State 2	12	12	0	0	0
State 3	12	6	0	6	0
State 4	6	6	2	2	2

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