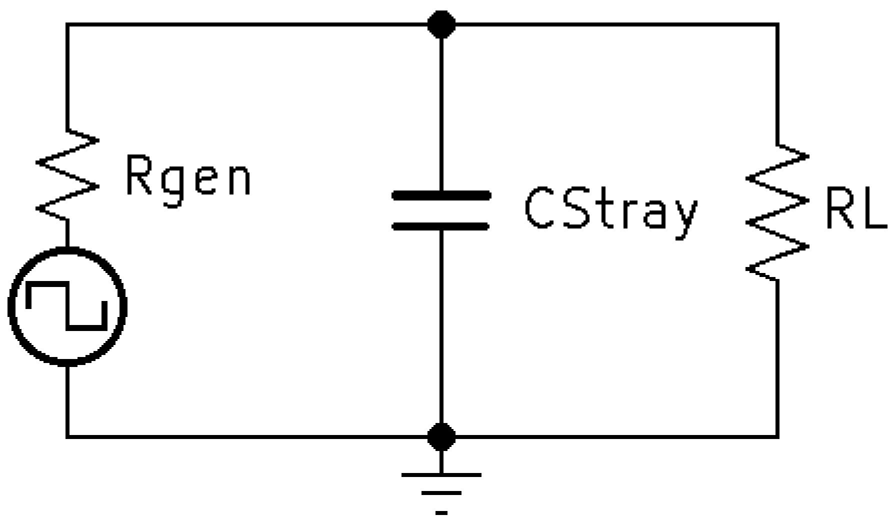
High Frequency Distortion is caused by **parallel capacitance** and results in an increase in the **Rise & Fall Times** of a square wave.

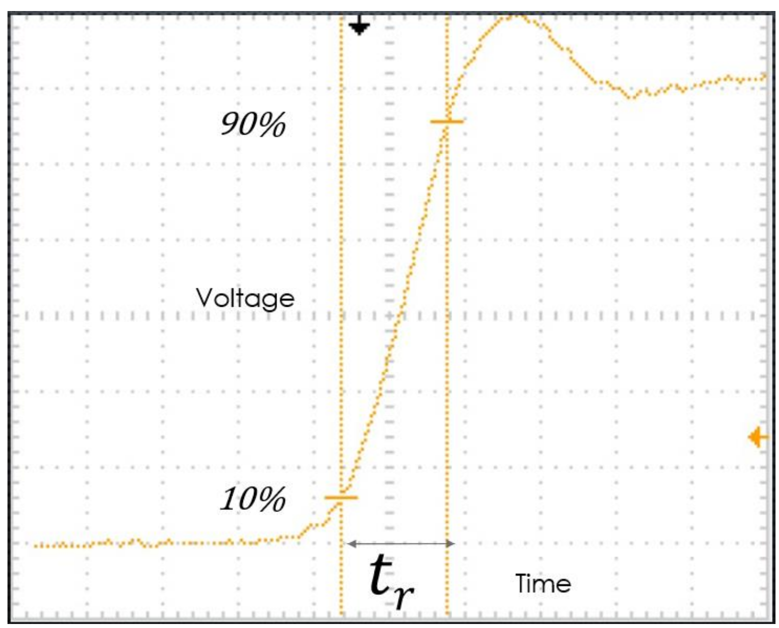
- Consider the following circuit



- Using Square-Wave analysis and a known rise time, we can calculate the circuits high critical frequency by dividing .35/(rise time).

    - $f_{CH} = \frac{0.35}{tr}$

    - $tr = \frac{0.35}{f_{CH}}$



Deriving the High Critical Frequency Formula:

Givens:

- *Rise Time is measured from 10% to 90%*
- $Rise\ Time = tr$
- $Frequency\ Cutoff\ High = fch$
- $fch = \frac{0.35}{tr}$

Known Formulas from Second Semester:

- $X_c = \frac{1}{2\pi FC}$
- $Vc = vfin - (vfin - vin)e^{\frac{-t}{RC}}$

Knowing that at Critical Frequency Xc is equal to R, we can derive the following

- $Xc = \frac{1}{2\pi FC}$
- @ F_{CH}, R = XC
- $R = \frac{1}{2\pi FC}$
- $F_{CH} = \frac{1}{2\pi RC}$

Rise time is the time measured from 10% to 90% of the waveform amplitude. Therefore, If you set the equation in terms of rise time we get the following

- $Vc = vfin - (vfin - vin)e^{\frac{-t}{RC}}$
- $Vc = .9vfin$
- $vin = .1\ vfin$
- $t = tr$

And Therefore,

- $.9vfin = vfin - (vfin - .1\ vfin)e^{\frac{-tr}{RC}}$

- $.9vfin = vfin\ - (vfin\ - .1\ vfin\ )e^{\frac{-tr}{RC}}$
- $.9vfin - vfin =\ (-vfin + .1\ vfin)e^{\frac{-tr}{RC}}$
- $-.1vfin = (-.9\ vfin)e^{\frac{-tr}{RC}}$
- $\frac{-.1vfin}{-.9vfin} = e^{\frac{-tr}{RC}}$
- $\frac{1}{9} = e^{\frac{-tr}{RC}}$
- $\ln\frac{1}{9} = \frac{-tr}{RC}$
- $-2.19722 = \frac{-tr}{RC}$
- $RC = \frac{tr}{2.19722}$

We have solved for two formulas, now we can solve the final equation.

- $RC = \frac{tr}{2.19722}$ & $F_{CH} = \frac{1}{2\pi RC}$
- $F_{CH} = \frac{1}{2\pi\ \frac{tr}{2.19772}}$
- $F_{CH} = \frac{2.19772}{2\pi tr}$
- $\boldsymbol{F_{CH} = \frac{.349778}{tr}}$ OR $\boldsymbol{F_{CH} = \frac{.35}{tr}}$

References:

Bell, D. A. (1997). *Solid state pulse circuits*. Sarnia, ON: David A. Bell.