RC Filter Circuits, Waveforms

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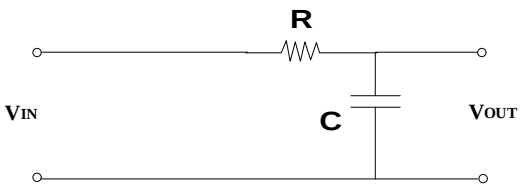
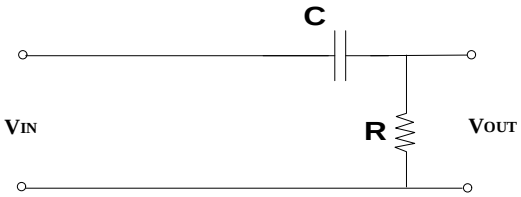
Low Pass Filter



High Pass Filter



Constants and Definitions:

$k \equiv 1000 \cdot ohm$ $kHz := 1000 \cdot Hz$ $MHz := 10^{6} \cdot Hz$ $\mu F := 10^{-6} \cdot farad$ $dB(x) := 20 \cdot \log(x)$

Variables

$V_{in} := 1 \cdot volt$ $R \equiv 5 \cdot k$ $C \equiv 1 \cdot \mu F$ $frequency \equiv 100 \cdot Hz$

Calculated Paramters

$R \cdot C = 0.005 \cdot sec$ $\frac{1}{2 \cdot \pi \cdot R \cdot C} = 31.831 \cdot Hz$

Equations for RC Filters:

$$A_{HP}(f) := \frac{(2 \cdot \pi \cdot f) \cdot R \cdot C}{\sqrt{(2 \cdot \pi \cdot f)^2 \cdot R^2 \cdot C^2 + 1}}$$ Amplitude of high pass filter

$$A_{LP}(f) := \frac{1}{\sqrt{(2 \cdot \pi \cdot f)^2 \cdot R^2 \cdot C^2 + 1}}$$ Amplitude of low pass filter

$$\phi_{HP}(f) := \operatorname{atan}\left[\frac{1}{(2 \cdot \pi \cdot f) \cdot R \cdot C}\right]$$ Phase of high pass filter

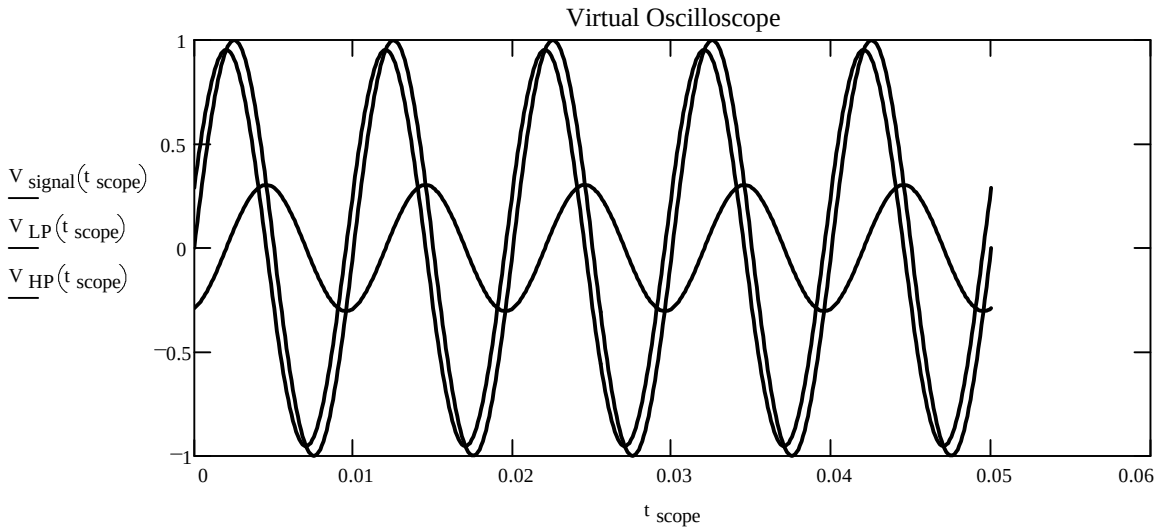
$$\phi_{LP}(f) := \left[-\operatorname{atan}\left[\frac{-1}{(2 \cdot \pi \cdot f) \cdot R \cdot C}\right] - \frac{\pi}{2}\right]$$ Phase of low pass filter

$$t_{scope} := 0 \cdot sec, \frac{5}{frequency \cdot 500} .. \frac{5}{frequency}$$

$V_{signal}(t) := \sin((2 \cdot \pi \cdot frequency) \cdot t)$

$V_{LP}(t) := A_{LP}(frequency) \cdot \sin\left[(2 \cdot \pi \cdot frequency) \cdot t + \phi_{LP}(frequency)\right]$

$V_{HP}(t) := A_{HP}(frequency) \cdot \sin\left[(2 \cdot \pi \cdot frequency) \cdot t + \phi_{HP}(frequency)\right]$



Circuit Gain:

Low Pass $A_{LP}(\text{frequency}) = 0.303$

High Pass $A_{HP}(\text{frequency}) = 0.953$

Circuit Gain (in decibals):

Low Pass $dB\left(A_{LP}(\text{frequency})\right) = -10.362$

High Pass $dB\left(A_{HP}(\text{frequency})\right) = -0.419$

Circuit Phase Shift:

Low Pass $\phi_{LP}(\text{frequency}) = -0.402 \cdot \pi \cdot \text{rad}$ $\phi_{LP}(\text{frequency}) = -72.343 \cdot \text{deg}$

High Pass $\phi_{HP}(\text{frequency}) = 0.098 \cdot \pi \cdot \text{rad}$ $\phi_{HP}(\text{frequency}) = 17.657 \cdot \text{deg}$