

Circuit Simulation Project

<https://esim.fossee.in/circuit-simulation-project>

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Title of the circuit : CONSTANT K HIGH PASS FILTER

Theory/Description : A constant K- filter is a T or π -network in which series or shunt impedance, Z1 & Z2 are connected by the relationship,

$$Z_1 Z_2 = R_k^2$$

Where, R_k – real constant and is termed as nominal impedance or design impedance of the constant K- filter.

It can be shown by-

$$Z_1 = j\omega L \text{ and } Z_2 = -j/\omega C$$

Hence the product of Z1 & Z2,

$$Z_1 \cdot Z_2 = j\omega L \times -j/\omega C = L/C .$$

Since the product is independent of frequency, the filter is constant – K type.

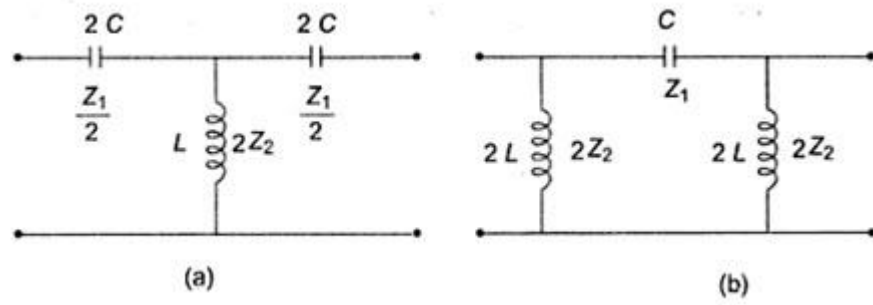
$$\text{Thus, } Z_1 Z_2 = R_k^2 = L/C$$

$$R_k = \sqrt{L/C}.$$

There is a variety of different filter variants that can be used dependent upon the requirements in terms of in band ripple, rate at which final roll off is achieved, etc.

The π section can be calculated from the equations below and using the multipliers, i.e. 2L and C.

The T section high pass filter can be designed using the equations below to calculate L and C, but note that this must be scaled as 2C and L are required for this design configuration.



The values for C and L using in the two LC high pass filter design configurations can be calculated from the equations below.

$$L = \frac{Z_0}{4 \pi f_c} \text{ Henries}$$

$$C = \frac{1}{4 Z_0 \pi f_c} \text{ Farads}$$

$$f_c = \frac{1}{4 \pi \sqrt{LC}} \text{ Hertz}$$

Where

- Z_0 = characteristic impedance in ohms
- C = Capacitance in Farads
- L = Inductance in Henries
- f_c = Cut off frequency in Hertz

EXPLANATION FOR T TYPE

Consider the T-section filter. The first capacitor presents high impedance at low frequency, while the inductor presents low impedance. This results in considerable attenuation of the signal at the inductor node. The filter is usually terminated at a load resistance. The high impedance of the second capacitor (high compared to load resistance) further chokes even the little voltage developed at that point at low frequencies. Thus, the signal appearing across the output is a doubly attenuated version and is quite small at low frequencies.

The capacitors go short and the inductor goes open at high frequencies. Thus, working as High Pass Filter.

Circuit Diagram(s) :

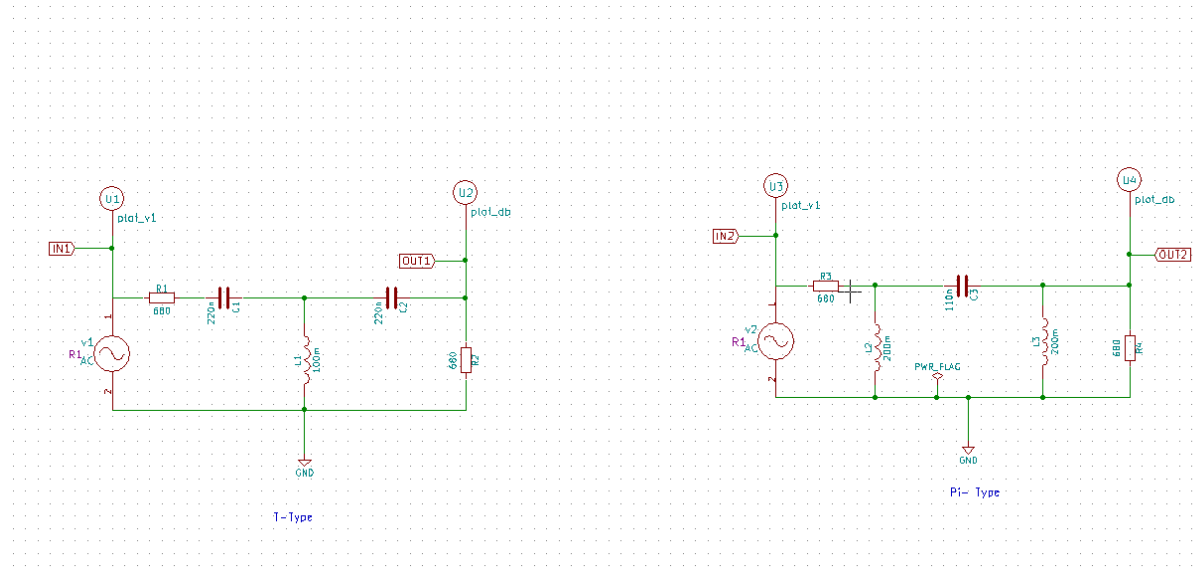


Figure 1: schematic diagram of T-type and Pi-Type constant k high pass filter

Results (Input, Output waveforms and/or Multimeter readings) :

NgSpice Plots:

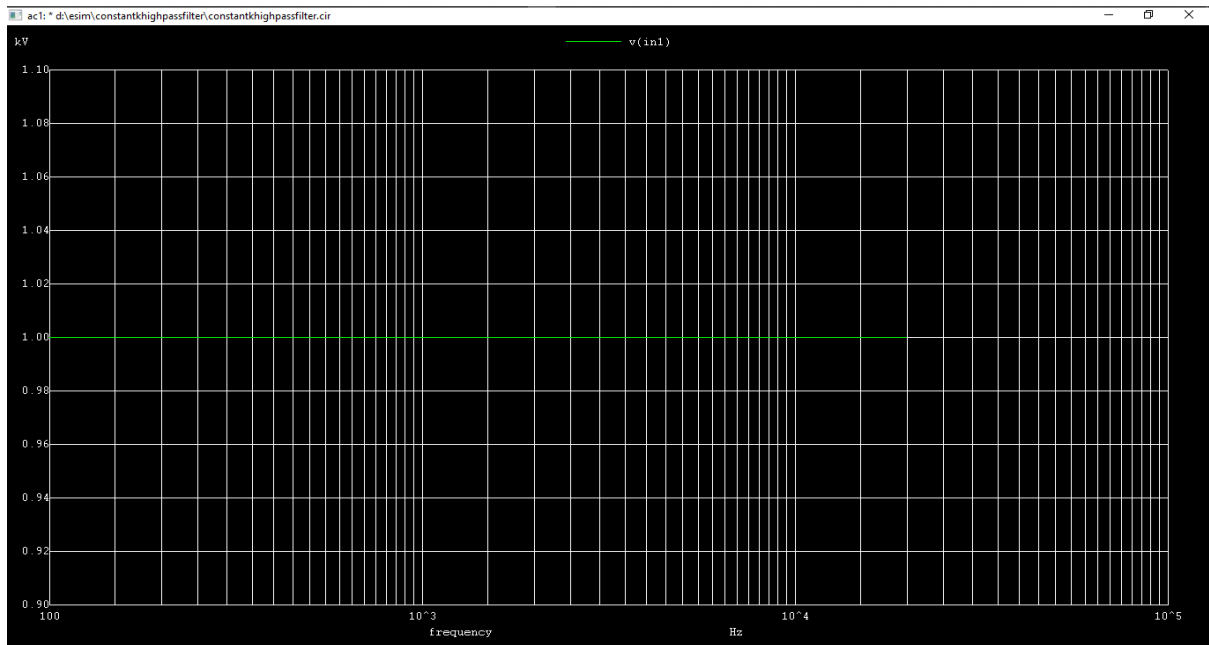


Figure 2 : Input Plot

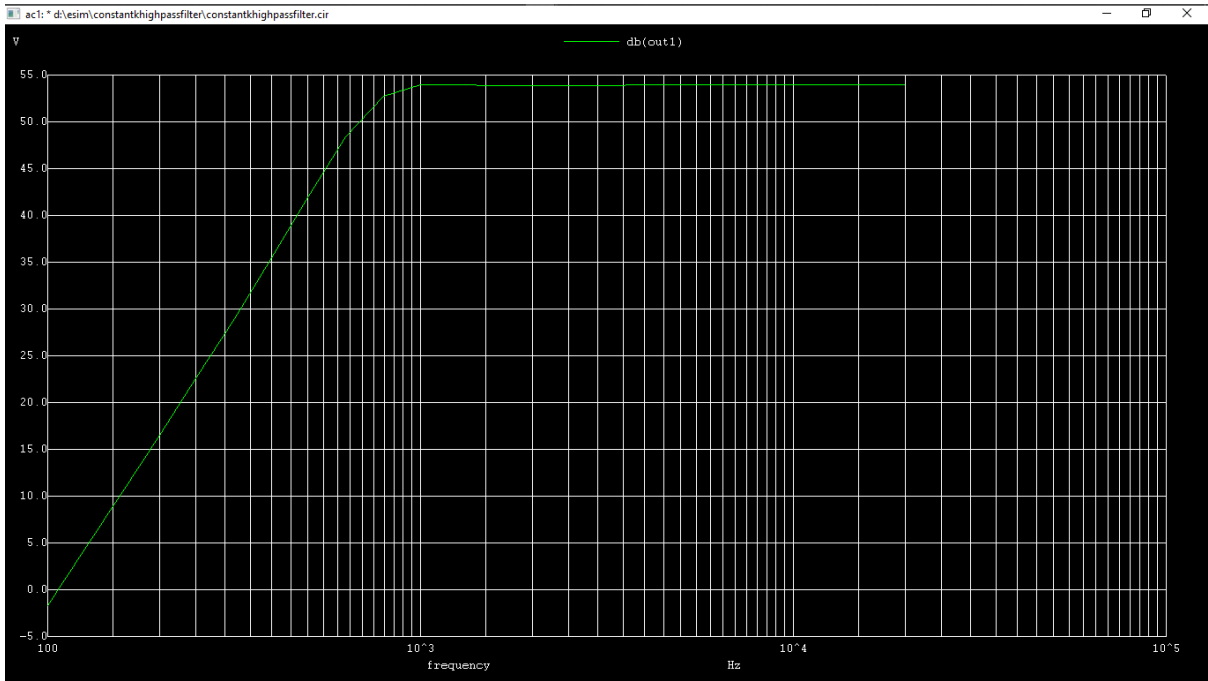


Figure 3: output 1 plot (t-type)

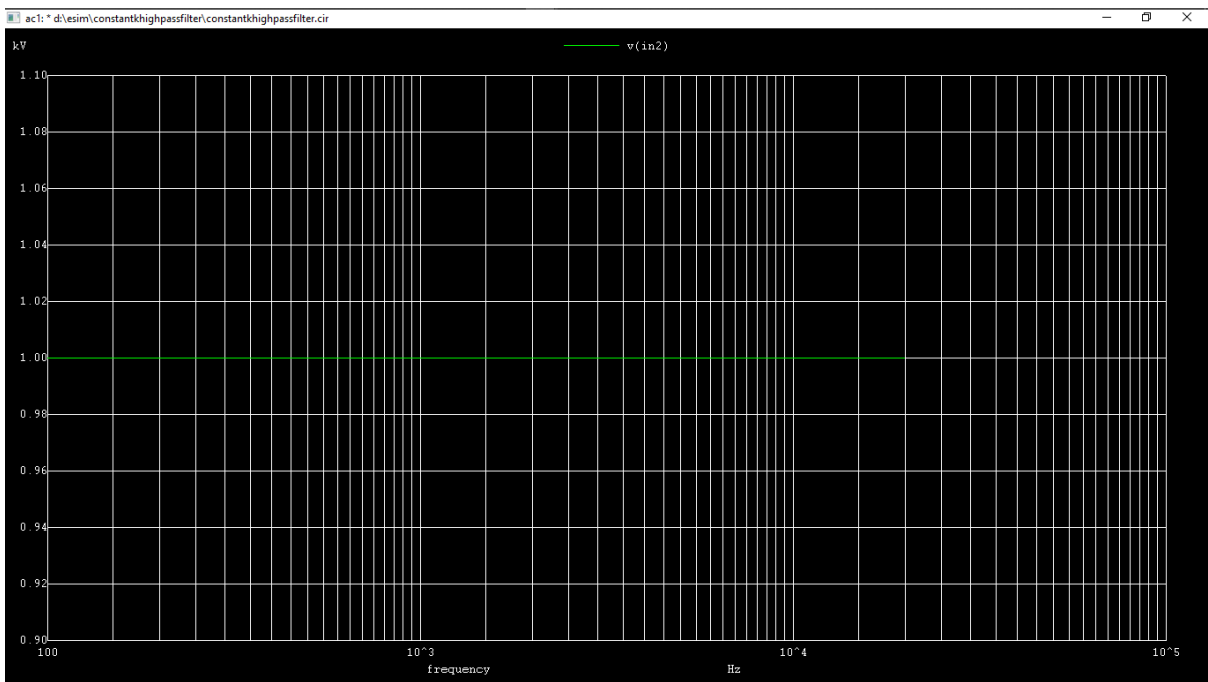


Figure 4 : Input 2 Plot

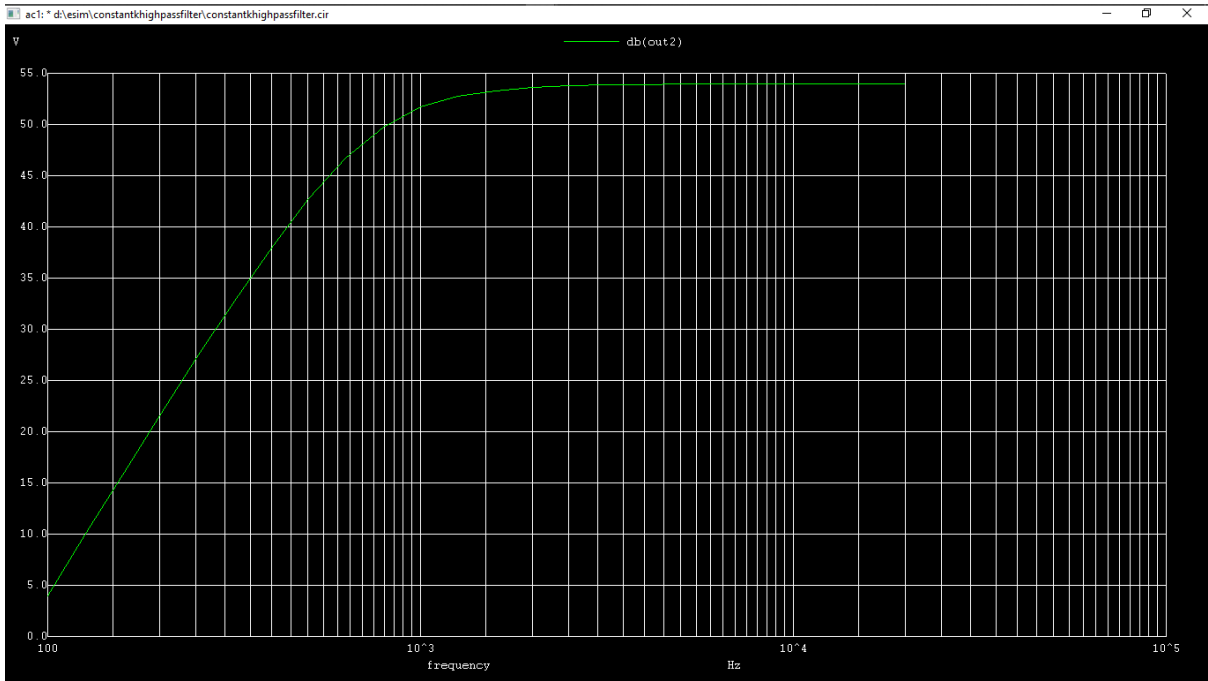


Figure 5: output 2 plot (pi- type)

Python Plot:

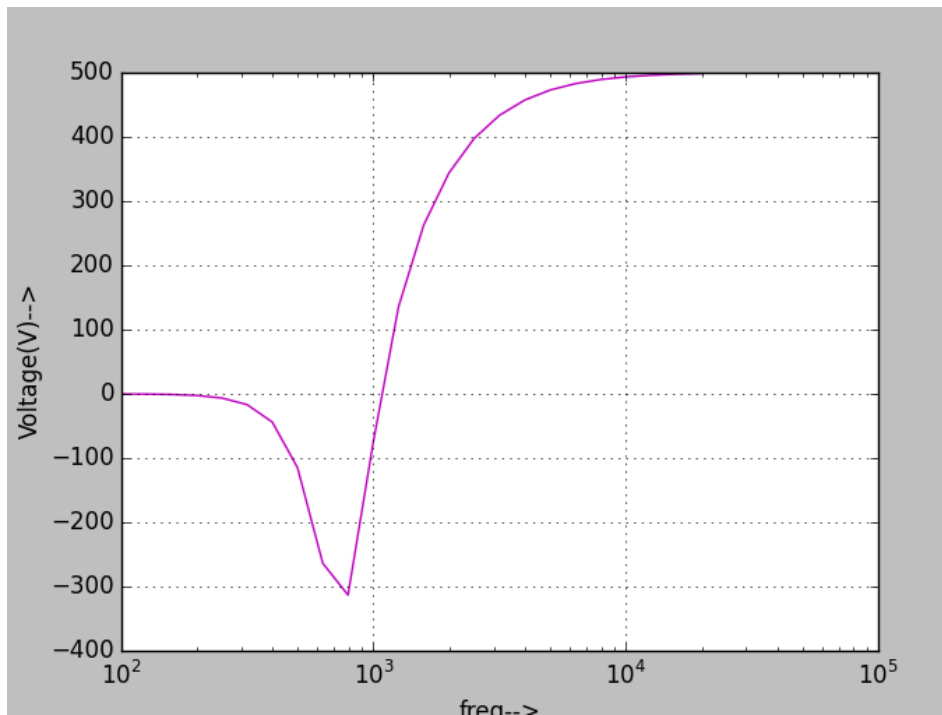


Figure 6 : output 1 plot

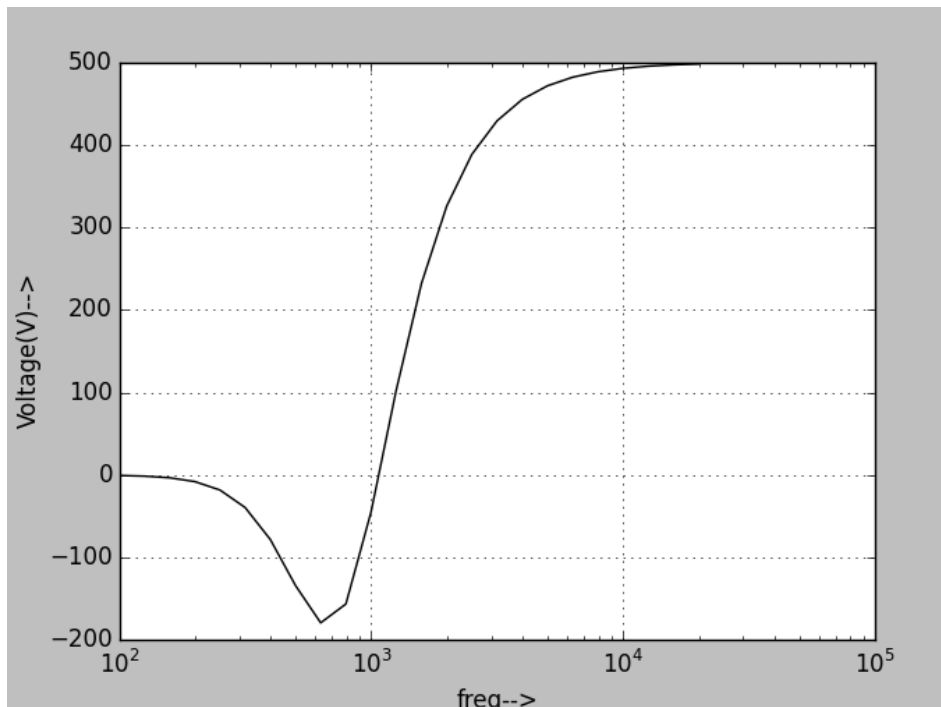


Figure 7 : output 2 plot

Source/Reference(s) :

- www.rgctpdypdy.ac.in/Notes/ECE/III%20YEAR/EC%20T55%20-TLW/Unit%201.pdf
- <https://www.electronics-notes.com/articles/radio/rf-filters/constant-k-simple-high-pass-lc-rf-filter-design-calculations.php>