ICA_BPF -- Overview

Vaegae Naveen kumar
Assistant Professor(Senior)
School of Electronics Engineering
VIT University

Design of Band Pass Filter using IC 741 Operational Amplifier

Objectives:

- To identity the function of each pin of IC 741
- To construct a band pass active low pass filter using discrete and active components
- To design the filter parameters for the given cut-off frequency
- To plot the frequency response of the band pass filter
- To verify and analyze the practical characteristic of the band pass filter

Components:

- IC 741
- Bread board
- Regulated power supply
- Function generator
- Oscilloscope
- Resistors
- Capacitors
- Connecting wires

Theory:

Active filters consist of active elements like op-amps in conjunction with resistor and capacitor networks.As they use active elements they provide excellent gain and so signal will not be attenuated.They provide excellent isolation properties. So they can be designed and tuned independently, easily with minimal interaction.As they provide high input impedance and low output impedance, there is no problem of loading the preceding and succeeding stage. A frequency selective electric circuit that transmits signals within a band and attenuates the signals outside the band is referred as band pass filter.A band pass filter is constructed using a low pass and high pass filters.The cut-off frequency of the low pass filter should be greater than the cut-off frequency of high pass filter. The gain of the active element is governed by the resistors R1 and RF.

The pass band gain of the band pass filter is given by

$$A_f = \left(1 + \frac{R_{f1}}{R_1}\right)\left(1 + \frac{R_{f2}}{R_2}\right)$$

The laplace tarnsfer function of the band pass filter is given by

$$\frac{V_o(s)}{V_{in}(s)} = \left(\frac{1}{1 + sR_lC_l}\right)\left(\frac{sR_hC_h}{1 + sR_hC_h}\right)$$

The frequency tarnsfer function of the band pass filter is given by

$$\frac{V_o(j\omega)}{V_{in}(j\omega)} = \left(\frac{1}{1 + j\omega R_lC_l}\right)\left(\frac{j\omega R_hC_h}{1 + j\omega R_hC_h}\right)$$

$$\frac{V_o(jf)}{V_{in}(jf)} = \left(\frac{1}{1 + j2\Pi fR_lC_l}\right)\left(\frac{j2\Pi fR_hC_h}{1 + j2\Pi fR_hC_h}\right)$$

$$\frac{V_o(jf)}{V_{in}(jf)} = \left(\frac{1}{1 + j\frac{f}{f_{c1}}}\right)\left(\frac{j\frac{f}{f_{c2}}}{1 + j\frac{f}{f_{c2}}}\right)$$

The cut-off frequency of the filter is given by

$$f_{c1} = \frac{1}{2\Pi R_lC_l}\quad f_{c2} = \frac{1}{2\Pi R_hC_h}$$

The frequency response of the filter is given by

Magnitude response,

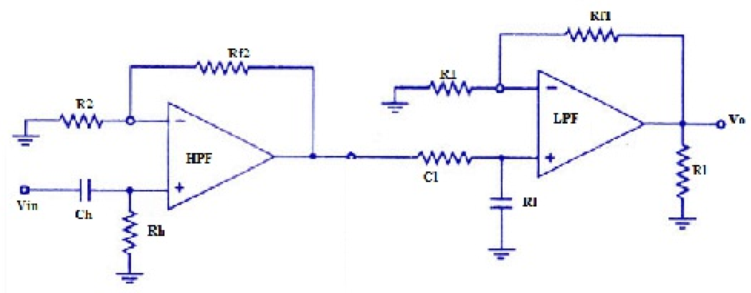
$$M = \left(\frac{1}{\sqrt{1 + \left(\frac{f}{f_{c1}}\right)^2}}\right)\left(\frac{\frac{f}{f_{c2}}}{\sqrt{1 + \left(\frac{f}{f_{c2}}\right)^2}}\right)$$

Phase response ,

$$\Phi = \frac{\Pi}{2} - tan^{-1}\left(\frac{f}{f_{c1}}\right) - tan^{-1}\left(\frac{f}{f_{c2}}\right)$$

ICA_BPF -- Procedures

Step 1



Step 2

Select a sine wave of 2 volts peak to peak from the function generator as the input voltage to the circuit and vary its frequency over a range including the cut-off frequencies range to note down the output voltage .

Step 3

S.No	Operating frequency f(Hz)	Output voltage (volts) V_o	Gain= $M = 20log_{10}\left(\frac{V_o}{V_{in}}\right)dB$

Step 4

Plot the magnitude response on a semilog graph sheet.
Calculate the roll-off rate from the graph

Step 5

Obtain the phase angle at each operating frequency from the CRO X-Y mode

Step 6

S.No	Operating frequency f(Hz)	Phase angle from CRO

Step 7

Plot the phase response .

Step 8

Identify the pass band,stop band and transmission band of the filter from the graph.

Calculate the 3-dB frequency from the graph

Step 9

Result:
Cut-off frequency values : Derived values =
Practical values =
Roll-off rate value :Derived value =
Practical value =
Passband range :
Stopband range :