Current-Mode Multifunction Filters Using Current-Feedback Amplifiers and Grounded Capacitors

Anisur Rehman Nasir$^1$ and S. Naseem Ahmad$^2$

$^1$Electronics Engg. Section, University Polytechnic, F/O Engineering and Technology, Jamia Millia Islamia, New Delhi-25
$^2$Dept. of Electronics and Communication Engg., Jamia Millia Islamia, New Delhi-25

1arnasir@hotmail.com

ABSTRACT

A current-mode multifunction filters using two current feedback amplifiers (CFAs) is presented. The proposed current mode filter exhibits low-pass, band-pass and high-pass filter functions simultaneously for a single input analog current source. The proposed filters offer no requirements for component matching, using grounded capacitors. The second order current- mode all-pass and notch filters can also be obtained from the same circuit without any extra hardware. The simulation results are included.

KEYWORDS

Active filters, Current feedback amplifiers

1. INTRODUCTION

The current mode circuits are receiving considerable attention in analog signal processing circuits [1]. Current feedback amplifiers have been used to realize active filters because they offer several advantages like constant gain over fairly large bandwidth, higher slew rate and better linearity compared to contemporary IC amplifiers [2].

Many multifunction filters have been developed using analog devices such as current-feedback amplifiers (CFAs) [3-7], operational transconductance amplifiers (OTAs)[3], current conveyors[4,5], four terminal floating nullors (FTFNs)[6], current followers(CFs) and current differencing buffered amplifiers(CDBAs)[7]. The multifunction filters realized using two current feedback amplifiers [8-12] are generally voltage-mode and multi input single output type.

In this paper, a new multifunction filter which uses two current feedback amplifiers (CFAs) and five passive components is presented. The proposed circuit uses three resistors and two grounded capacitors and realizes low-pass, high-pass, and band-pass filter functions. All pass and notch filters can also be realized using same circuit configuration. The filter circuit has negligible component spread at low quality factors and has low sensitivity values. If the ratio of two resistors is kept constant the cutoff frequency of the filter can be varied independently of quality factor Q of the filter. The simulation results are included.

2. CIRCUIT DESCRIPTION

The port relationships of current feedback amplifier are given in equation (1) as

\[ v_x = v_y, \quad i_x = 0, \quad i_z = i_x \quad \text{and} \quad v_0 = v_z \quad (1) \]

Fig 1

The proposed circuit is shown in Fig.1. In the proposed circuit, two grounded capacitors, three resistors and only two CFAs are employed. The use of grounded capacitor is particularly attractive for integrated circuit implementation.

Fig. 2: Magnitude response of proposed current-mode universal filter

A simple circuit analysis using port relations of current feedback amplifier yields the following current transfer functions.
The component spread is also very low around Q=1.

Thus, the circuit realizes a low-pass, a band-pass and a high-pass response which can be simultaneously obtained from this filter. The pole-frequency \( \omega_o \) and pole Q of the proposed minimum component current-mode filter are given as

\[
\omega_o = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}} \tag{5}
\]

\[
Q = \frac{R_1 C_2}{\sqrt{R_2 C_1}} \tag{6}
\]

From Eq.(5) and (6), it is evident that the cutoff frequency and the quality factor Q of the current-mode filter are dependent on each other, that is when ever \( \omega_o \) is changed, the value of quality factor is disturbed. But if ratio of either \( C_1 \) and \( C_2 \) or \( R_1 \) and \( R_2 \) is kept constant. \( \omega_o \) can be varied without disturbing the quality factor. The component spread is also very low around Q=1.

3. EXPERIMENTAL RESULTS

Experiments were carried out to demonstrate applicability of the proposed circuit. The circuit of proposed current mode multifunction filter is implemented using P-spice model of CFA AD 844A for current feedback amplifier on P-spice based software TINA pro for \( f_c=15.23kHz \) and Q=1 with component value \( C_1=C_2=10nF \) and \( R_1=R_2=1Kohm \). Figure 2 represent the magnitude responses for the lowpass, bandpass and highpass filters of figure 1. The experimental results validate the theoretical analysis.

4. CONCLUSION

A novel current-mode multifunction filters using two CFA is presented. This filter provides following advantages: low-pass, band-pass and high-pass filter function can be realized simultaneously without changing circuit configuration, use of only grounded capacitors makes the circuit suitable for integrated circuit implementation, it has low active and passive sensitivities, there are no requirements for critical component matching condition. The experimental results agree well with the theoretical analysis. The results will be useful in analog signal processing applications.

REFERENCES


