Simulation of Highpass and Bandpass Filter Using FTFN

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***Abstract*--A new multifunctional filter circuit based on four terminal floating nullors (FTFN) and simultaneously supporting highpass (HP) and bandpass (BP) filtering signals is presented. The circuit has high impedance which permits to use it in cascade to obtain higher order filters without any need for buffer. The circuit facilitates the tuning of bandwidth and cut off frequency in the orthogonal manner. The sensitivity figures of parameters of interest are small. PSPICE simulation results are included.**

***Index Terms*—High pass, Low pass , FTFN.**

I. Introduction

AT present current mode circuits are receiving significant attention in analog signal processing applications owing to their many potential advantages over their voltage mode counterparts. But the implementation of higher order filters through the employment of these circuits in cascaded mode often necessitate the use of additional buffers. Thus there is overwhelming need to develop high input impedance voltage mode (VM) filters to evade the practical difficulties in realizing higher order filters. The feature of having high input impedance circuits permits their use in cascade mode thereby circumventing the need for impedance matching devices. Towards this end some high input impedance VM filter circuits based on FTFN, second generation current conveyors (CCIIs) and current feedback amplifiers (CFAs) have been reported in the literature [1]-[4]. However not much work has been done towards the development of high input impedance filter using FTFN, which is a more flexible and versatile building block than operational amplifier or a CCII [5]-[8] to fulfill the varying and stringent requirements of the circuit designers. One of the reported circuits [1] based on two FTFNs and five basic components implements only one filtering function (LP or BP or HP) depending on the selection of passive components. In this communication we present a new high input impedance multifunction filter circuit with single input and two outputs. The circuit employs two each of FTFNs, capacitors and resistors which is the absolute minimum requirement for this class of filter and implements simultaneously HP and BP filtering functions. Thus the presented circuit employs lesser number of passive components than the reported one [1] and provides two output simultaneously.

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II. Proposed Circuit

The positive FTFN can be characterized by the port relations with $V_x = V_y$, $I_x = I_y = 0$ and $I_z = I_w$.

The analysis of the circuit in Fig. 1 yields the high pass and band pass transfer function respectively as given by

$$\frac{V_{O1}}{V_{in}} = \frac{s^2 C_2 C_4}{D(s)} \tag{1}$$

$$\frac{V_{O2}}{V_{in}} = \frac{\frac{sC_4}{R_3}}{D(s)} \tag{2}$$

where

$$D(s) = s^2 C_2 C_4 + 2\frac{sC_2}{R_1} + \frac{1}{R_1 R_3} \tag{3}$$

The parameter of the filter natural frequency (ω0), the quality factors (Q) and bandwidth (ω_0//Q) are calculated as follows:

$$\omega_0 = \frac{1}{\sqrt{C_2 C_4 R_1 R_3}} \tag{4}$$

$$Q = \frac{1}{2}\sqrt{\frac{C_4 R_1}{C_2 R_3}} \tag{5}$$

$$\frac{\omega_0}{Q} = \frac{2}{C_4 R_1} \tag{6}$$

From (2) it can be seen that band pass gain of the circuits can be controlled by the ratios $\frac{C_2}{C_4}$ without changing the cut off frequency ω_0. The cut off frequency and the Q factor of the filter are orthogonal to each other. The sensitivity measurements of the passive components with respect to cut off frequency and Q factor are given as follows:

$$S^{\omega_0}_{C_2,C_4,R_1,R_3} = -\frac{1}{2}$$

$$S^{Q}_{C_4,R_1} = -S_{C_2,R_3} = \frac{1}{4}$$

which shows that sensitivities are less than unity.

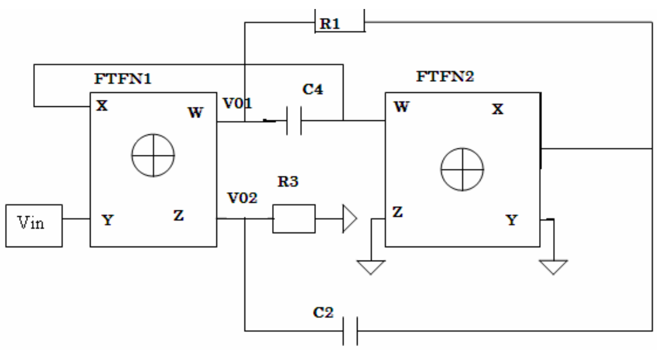

Fig.1 Proposed Voltage Mode FTFN Filter

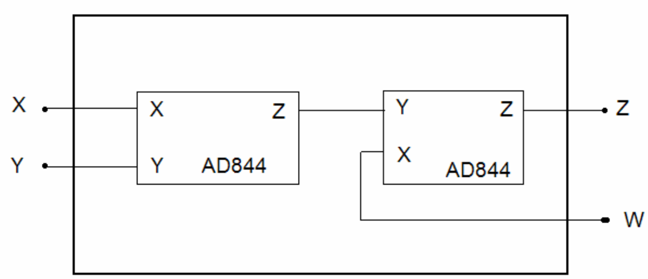

Fig. 2 FTFN realization using AD844

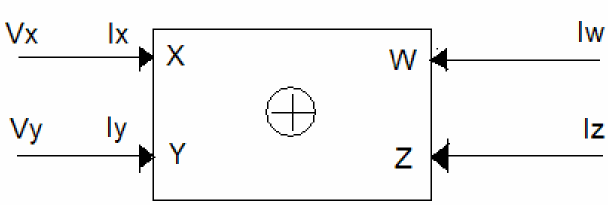

Fig3. Symbolic Representation of FTFN

III. Simulation Result

PSPICE simulation was performed to verify the functionality of the circuit. The positive FTFN is implemented by cascading two AD844s as shown in Fig. 2. To realize HP and BP, the passive components were chosen with R1=10 kΩ, R3=1 kΩ and C2=5nF, C4=10nF. The cut off frequency and Q of the circuit is 7 KHz and 2.24 respectively. The complete circuit is simulated in PSPICE. The results are shown in Fig.3 which agrees with the theoretical calculation.

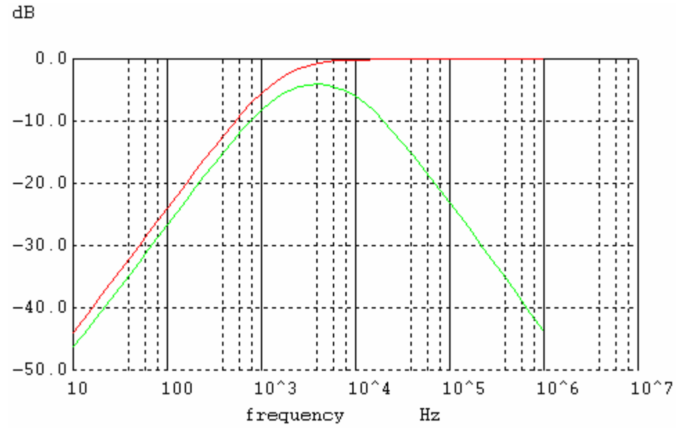

Fig.4 Highpass and Bandpass filter realization simultaneously

IV. Conclusion

The realization of FTFN is done by using AD844. FTFN offers very high input impedance. It is quite useful in the cascading the system. The two FTFNs are used to simulate the second order high pass and band pass filter responses simultaneously at two different nodes. The only capacitor and two resistors are used for the implementation. The cut off frequency and Q are orthogonal to each other. The presented filter is offering a better value of Q. The sensitivity parameters are also very low.

V. References

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VI. Biographies

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