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A Novel VDIBAs Based Inverse Band Reject Filter

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Abstract: This paper presents a novel inverse band reject filter configuration based on voltage differencing inverting buffered amplifiers (VDIBAs) and grounded capacitors (GCs). All the capacitors in the proposed scheme are grounded to benefit easier electronic tenability.The feasibility of the proposed scheme is demonstrated by PSPICE simulations using TSMC CMOS 0.18µm technology.

Keywords: Voltage Differencing Inverting Buffered Amplifier, Inverse Analog Filters, Analog Signal Processing.

1. Introduction

Inverse filters are widely used in communication [1], speech processing, audio and acoustic systems [2, 3], and instrumentation [4] to reverse the distortion of the signal incurred due to signal processing and transmission. An inverse filter can correct these distortions because it has frequency response, which is the reciprocal of the frequency response of the system that caused the distortion.The critical issue with continuous time filter approach typically is the RC time constant variation problem where the RC time constant of the circuit varies due to processing tolerance, environmental effects of temperature drift, humidity and aging of components[5].This drawback can be compensated by the use of tunable filters. Thus, there is a growing interest in designing of tunable electronic filters which could compensate for the variation of RC time constant. The progress of analog technology has bred several electronically tunable filters using different active elements such as operational transconductance amplifier (OTA), current conveyors such as second generation current conveyor (CCII), second generation current controlled conveyor CCCII and current differencing transconductance amplifier (CDTA), current controlled conveyor differencing transconductance amplifier (CCCDTA), voltage differencing transconductance amplifier (VDTA), voltage differencing differential input buffered amplifier (VD-DIBA), voltage differencing inverting buffered amplifier (VDIBA) etc. They are versatile and powerful building blocks for many signal processing applications due to their higher frequency operation, wide dynamic range, and current mode.The main aim of this paper is to propose VDIBAs based inverse analog band reject filter.

The paper is organized as follows. Starting from the introduction, section II briefly describes the active element VDIBA. Section III discusses the realization of proposed design. Section IV shows the simulation result of proposed inverse filter. Finally, the conclusion is drawn in section V.

2. Proposed Configuration

The VDIBA, analog active building block with electronic tuning, is characterized by the following matrix [6]

$$\begin{pmatrix} I_+ \\ I_- \\ I_z \\ V_w \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ g_m & -g_m & 0 & 0 \\ 0 & 0 & -\beta & 0 \end{pmatrix} \begin{pmatrix} V_+ \\ V_- \\ V_z \\ I_{w-} \end{pmatrix} \qquad (1)$$

Table 1 describes the characteristics of VDIBA where β is a non-ideal voltage gain of VDIBA. The value of β in an ideal VDIBA is unity and g_m is the transconductance of the VDIBA. The symbolic notation and equivalent model of VDIBA are shown in Fig.1 [6].

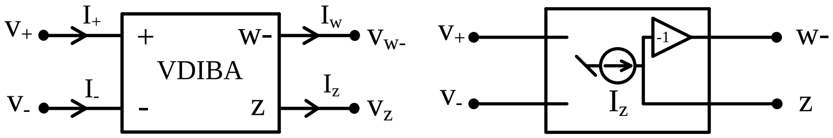


Fig.1. (a) Symbolic notation (b) equivalent model of VDIBA

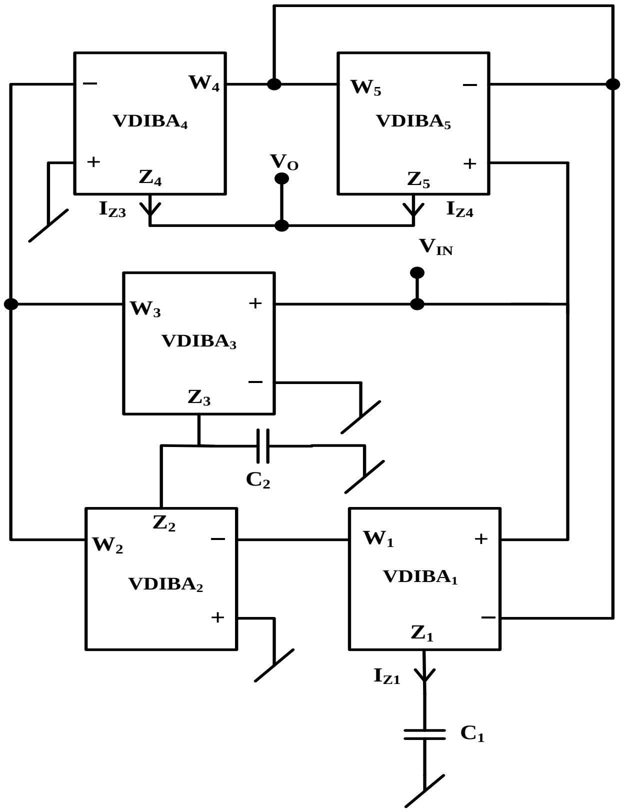


Fig.2 Proposed analog inverse band-reject filter.

$$\frac{V_o(s)}{V_{in}(s)} = -\frac{1}{\dfrac{s^2+\dfrac{g_{m1}g_{m2}g_{m4}}{C_1C_2g_{m5}}}{s^2+s\dfrac{g_{m3}g_{m4}}{C_2g_{m5}}+\dfrac{g_{m1}g_{m2}g_{m4}}{C_1C_2g_{m5}}}} \qquad (2)$$

From equation (2), an inverse analog band reject filter can be realized.

3. Simulation Results

The new proposed inverse high-pass filter was tested through PSPICE simulations using the CMOS implementation of VDIBA [7] as shown in Fig. 3. The CMOS VDIBA is implemented using 0.18µm TSMC real transistor models [8]. The passive elements were selected as C1 = C2 = pF. The transconductances of VDIBAs were controlled by the bias currents Ib1=Ib2= Ib3=Ib4=µA. The results confirm the validity of the proposed configuration. Fig. 4 shows the frequency response of the proposed inverse band-reject filter configuration.

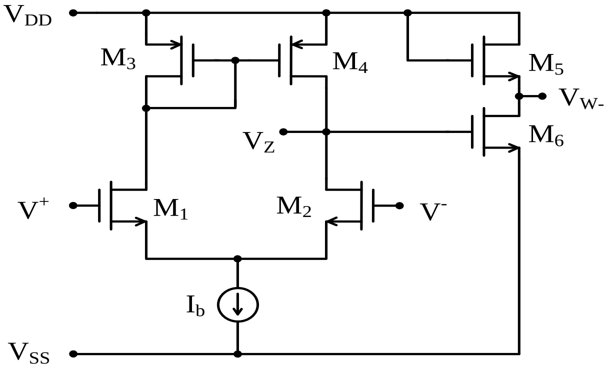
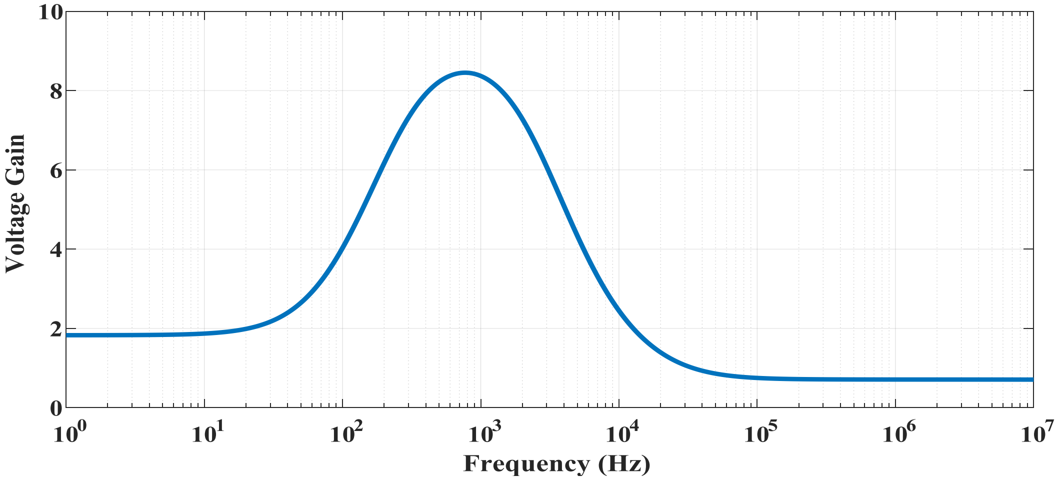


Fig.3 An exemplary CMOS implementation of VDIBA [7], VDD = VSS = 1.9V



4. Conclusions

Among various modern active building blocks, VDIBA is emerging as quite flexible and versatile building block for analog circuit design. However, the use of VDIBAin the realization of inverse analog filter had not been known earlier. This paper has filled this void by introducing new VDIBA- based inverse filter configuration. The workability of new configuration has been confirmed by SPICE simulations.

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