Hindawi Publishing Corporation
Active and Passive Electronic Components
Volume 2009, Article ID 595324, 4 pages
doi:10.1155/2009/595324

Letter to the Editor

Comment on "Voltage-Mode All-Pass Filters Including Minimum Component Count Circuits"

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Received 17 January 2009; Accepted 8 February 2009

This comment is related to the recently published article "Active and Passive Electronic Components" by S. Maheshwari (2007), which presents single current differencing buffered amplifier (CDBA) and current-controlled current differencing buffered amplifier- (CC-CDBA-) based first-order voltage-mode (VM) all-pass filtering (APF) sections. The paper is reviewed, and additional first-order APF realizations have been proposed.

1. Introduction

First-order all-pass filters (APFs) are very important circuits for many analog signal processing applications and are generally used in phase equalization and for introducing a frequency-dependent delay while keeping the amplitude of the input signal constant over the desired frequency range. The design of both voltage-mode (VM) and current-mode (CM) APFs using active building blocks (ABBs) has been researched extensively and numerous circuits have been reported in the literature [1–15].

One such recently proposed work in creating voltage-mode (VM) APFs has been reviewed here. The work [16] presents APFs based on a recently proposed ABB, namely, the current differencing buffered amplifier (CDBA). The author had argued that the paper then was a first attempt at creating VM APFs using CDBA or variant. Although a total of four circuits had been exemplified in the paper [16], these examples do not exhaust the other possible realizations of VM APFs using a single CDBA and reduced number of passive components. This letter presents additional possibilities of such realizations.

2. Discussion

A total of four VM APFs had been proposed in [16], but all of them made use of floating capacitors. Grounded capacitor realizations are fit for monolithic integration, since grounded capacitor circuits can compensate for the stray capacitances at their nodes [17, 18]. Hence, a possible drawback for all the circuits in [16] is that they may not be suitable for monolithic integration. Another drawback of the single CDBA-based APFs (in general) is the critical requirement of resistor matching, for an example, the requirement of $R' = R/2$ for the first circuit [16, Figure 2(a)] and $R' = R$ for the second circuit [16, Figure 2(b)]. Any mismatch would deteriorate the circuit operation as APF. Even for the equivalent CC-CDBA-based circuits in [16], the parasitic resistances at terminals p and n have to be tuned by means of the bias current to meet the matching condition. Any desired change in the pole frequency of CC-CDBA-based APFs by means of the bias current could not be achieved independently, since the matching condition was needed to be satisfied simultaneously for the APF operation. In this case, the CC-CDBA circuits reduced the number of passive components, but the feature of current tunability was not noninteractive. An advantage worth mentioning is the low output impedance exhibited by the circuits, which made the circuits suitable to be cascaded to produce higher-order filters. In the subsequent section, additional realizations of single CDBA-based APFs have been proposed.

3. Additional Realizations

Without going into the construction/schematic details of CDBA (which could be found in [16, 19]), the circuits are directly reported.

3.1. CDBA-Based VM-APF—Figure 1(a). The CDBA-based VM-APF is shown in Figure 1(a) and it requires the use of matched resistors. Since $V_n = 0$, the capacitor is grounded (in the ideal case), a feature which is absent in all the circuits in [16]. In the ideal case, CDBA is characterized by

$$V_p = V_n = 0, \qquad I_z = I_p - I_n, \qquad V_w = V_z. \tag{1}$$

Using (1) and doing routine circuit analysis, the voltage transfer function of circuit in Figure 1(a) is given as

$$\frac{V_o}{V_{\text{in}}} = \frac{R'(1 - sCR)}{2R(1 + sCR)}. \tag{2}$$

This circuit was initially proposed in [20] and it serves to counter the statement by Maheshwari in [16] that "*The CDBA has so far not been attempted for realizing voltage mode first-order all-pass filters in open literature*". But in [20],the authors chose $R' = 2R$ for a unity gain, which is not required in cases where a suitable signal amplitude gain is desired.

3.2. CDBA-Based Transimpedance (TI) APF—Figure 1(b). A mixed-mode filter having current-input and voltage output is useful as an interface circuit connecting a CM circuit to the VM circuit. Since, the outputs of the many digital/analog converters (DACs) are available as current signals, the transimpedance (TI) mode filters could be used for both filtering and conversion operations [21, 22]. One such TI APF using a single ABB is proposed here and is shown in Figure 1(b). The transfer function of the circuit is given as

$$\frac{V_o}{I_{\text{in}}} = \frac{R'(1 - sCR)}{1 + sCR}. \tag{3}$$

The circuit not only uses a grounded capacitor, but also does not require any component matching condition.

3.3. Nonideal Case. In the nonideal case, considering α_p and $\alpha_n$as the current transfer gains from p and n terminals to z terminal, respectively, and β is the voltage transfer gain from z to w terminal, the characterizing equation of the CDBA is given as:

$$V_p = V_n = 0, \qquad I_z = \alpha_p I_p - \alpha_n I_n, \qquad V_w = \beta V_z. \tag{4}$$

Using (4), the transfer function of Figures 1(a) and 1(b) gets modified to

$$\frac{V_o}{V_{\text{in}}} = \frac{\beta R'(\alpha_p + (\alpha_p - 2\alpha_n)sCR)}{2R(1 + sCR)}, \tag{5}$$

$$\frac{V_o}{I_{\text{in}}} = \frac{\beta R'(\alpha_p - \alpha_n sCR)}{1 + sCR}, \tag{6}$$

respectively. These effects could be alleviated with a better design of CDBA, such that the values of voltage/current transfer gains are close to unity.

A nonideal effect, previously not considered in [16], is the parasitic resistance R_z and parasitic capacitance C_z appearing at high-impedance z terminal. Considering the effect of these nonidealities, (5) and (6) get modified to

$$\frac{V_o}{V_{\text{in}}} = \frac{\beta(R' \| R_z)[\alpha_p + (\alpha_p - 2\alpha_n)sCR]}{2R(1 + sCR)[1 + sC_z(R' \| R_z)]}, \tag{7}$$

$$\frac{V_o}{I_{\text{in}}} = \frac{\beta(R' \| R_z)(\alpha_p - \alpha_n sCR)}{(1 + sCR)[1 + sC_z(R' \| R_z)]}, \tag{8}$$

respectively.

It is evident from (7) and (8), that there is a first-order low-pass roll-off with a cut-off frequency of $1/(R' \| R_z)C_z$ and the pole limits the high-frequency performance/potential of the circuit. Since R_z value is in the order of $M\Omega$ and hence when a resistor of value $R' \ll Rz$ is connected at this terminal, $R_z \| R' \approx R'$. Therefore, the working frequency range for the APF operation is restricted to $\omega < 1/R'C_z$.

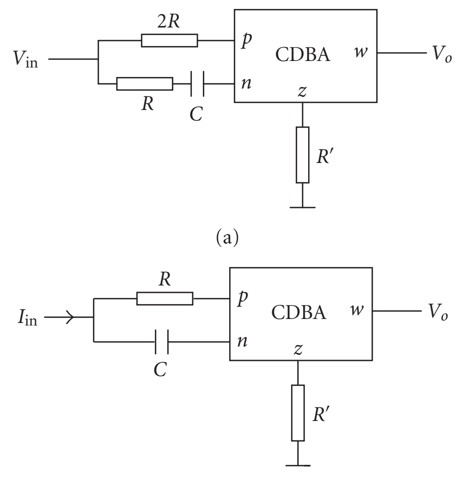


Figure 1: The proposed CDBA-based APFs: (a) VM APF (b) TI APF.

3.4. Equivalent APFs with Canonic Component Count. An evident drawback is that unlike the circuits of [16], the proposed circuits here are not directly compatible with CC-CDBA, that is, equivalent CC-CDBA circuits cannot be directly realized from the CDBA counterparts. However, it could be accomplished by using a modified CC-CDBA with dual bias currents, namely, the dual-current-controlled CDBA (DCC-CDBA). A simple construction of this novel ABB using two second-generation current-controlled conveyors (CCCII) [23] and one unity gain voltage follower (buffer) is shown in Figure 2. The parasitic resistances at the terminals p and n could be expressed as $R_p = V_T/2I_{B1}$ and $R_n = V_T/2I_{B2}$, respectively.

The DCC-CDBA equivalents derived from the CDBA-based circuits of Figure 1 have been shown in Figure 3. The circuits use minimum number of active and passive components and hence present a low-cost solution. For the DCC-CDBA-based VM-APF shown in Figure 3(a), the matching condition required for the APF operation could

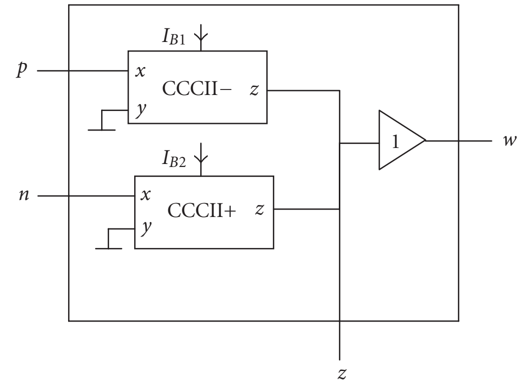


Figure 2: Implementation of DCC-CDBA using CCCII.

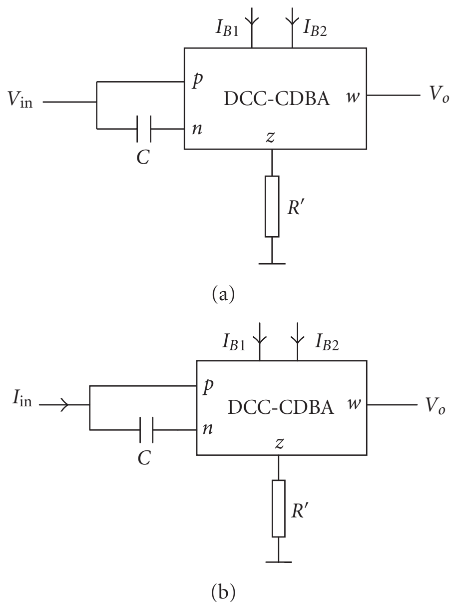


Figure 3: The proposed DCC-CDBA APFs: (a) VM APF (b) TI APF.

be achieved by making $R_p = 2R_n$, that is, adjusting the bias currents such that $I_{B2} = 2I_{B1}$. For DCC-CDBA-based TI APF shown in Figure 3(b), the required adjustment of the bias currents for the APF operation should be such that $I_{B2} \gg I_{B1}$. The angular pole frequency for the VM APF shown in Figure 3(a) is $\omega_0 = 1/R_nC$ and is tunable by means of the bias current I_{B2}, but I_{B1} has to be simultaneously adjusted to meet the required matching condition for the APF operation—a drawback which is also present in the CC-CDBA APFs of [16]. Similarly, the pole frequency of TI APF shown in Figure 3(b) could be tuned by bias current I_{B1}.

4. Concluding Remarks

The recently proposed CDBA-based first-order voltage-mode all-pass filters (APFs) have been reviewed, and additional realizations of APFs with the same component count have been reported. Novel transimpedance APFs have also been proposed. It is expected that this paper, in conjunction with the previous work [16], will prove to be beneficial for analog circuit designers, and the researchers in this field and that CDBA circuits with more advantageous features would be reported in the near future.

Acknowledgments

The author would like to thank Professor Raj Senani, the Director of Netaji Subhas Institute of Technology (NSIT), who has always been a source of immense motivation and academic help. The author would also like to thank the reviewer for his valuable suggestions, which have helped in improving the manuscript.

References

[1] O. Cicekoglu, H. Kuntman, and S. Berk, “All-pass filters using a single current conveyor,” *International Journal of Electronics*, vol. 86, no. 8, pp. 947–955, 1999.

[2] I. A. Khan and S. Maheshwari, “Simple first order all-pass section using a single CCII,” *International Journal of Electronics*, vol. 87, no. 3, pp. 303–306, 2000.

[3] S. Maheshwari, “New voltage and current-mode APS using current controlled conveyor,” *International Journal of Electronics*, vol. 91, no. 12, pp. 735–743, 2004.

[4] S. Maheshwari, I. A. Khan, and J. Mohan, “Grounded capacitor first-order filters including canonical forms,” *Journal of Circuits, Systems and Computers*, vol. 15, no. 2, pp. 289–300, 2006.

[5] J.-W. Horng, C.-L. Hou, C.-M. Chang, W.-Y. Chung, H.-L. Liu, and C.-T. Lin, “High output impedance current-mode first-order allpass networks with four grounded components and two CCIIs,” *International Journal of Electronics*, vol. 93, no. 9, pp. 613–621, 2006.

[6] U. Çam, O. Cicekoglu, M. Gülsoy, and H. Kuntman, “New voltage and current mode first-order all-pass filters using single FTFN,” *Frequenz*, vol. 54, no. 7-8, pp. 177–179, 2000.

[7] M. A. Ibrahim, H. Kuntman, and O. Cicekoglu, “First-order all-pass filter canonical in the number of resistors and capacitors employing a single DDCC,” *Circuits, Systems, and Signal Processing*, vol. 22, no. 5, pp. 525–536, 2003.

[8] J.-W. Horng, C.-L. Hou, C.-M. Chang, Y.-T. Lin, I.-C. Shiu, and W.-Y. Chiu, “First-order allpass filter and sinusoidal oscillators using DDCCs,” *International Journal of Electronics*, vol. 93, no. 7, pp. 457–466, 2006.

[9] B. Metin, O. Cicekoglu, and K. Pal, “DDCC based all-pass filters using minimum number of passive elements,” in *Proceedings of the 50th Midwest Symposium on Circuits and Systems (MWSCAS ’07)*, pp. 518–521, Montreal, Canada, August 2007.

[10] S. Maheshwari, “A canonical voltage-controlled VM-APS with grounded capacitor,” *Circuits, Systems, and Signal Processing*, vol. 27, no. 1, pp. 123–132, 2008.

[11] A. Uygur and H. Kuntman, “Low-voltage current differencing transconductance amplifier in a novel allpass configuration,” in *Proceedings of the 13th IEEE Mediterranean Electrotechnical Conference (MELECON ’06)*, pp. 23–26, Malaga, Spain, May 2006.

[12] A. U. Keskin and D. Biolek, “Current mode quadrature oscillator using current differencing transconductance amplifiers (CDTA),” *IEE Proceedings: Circuits, Devices and Systems*, vol. 153, no. 3, pp. 214–218, 2006.

[13] A. Lahiri, "Novel first-order all-pass filter realization and its application in oscillator design," to appear in *Journal of Active and Passive Electronic Devices*.

[14] S. Maheshwari and I. A. Khan, "Novel first order allpass section using single CCIII," *International Journal of Electronics*, vol. 88, no. 7, pp. 773–778, 2001.

[15] M. Ün and F. Kaçar, "Third generation current conveyor based current-mode first order all-pass filter and quadrature oscillator," *Journal of Electrical and Electronics Engineering*, vol. 8, no. 1, pp. 529–535, 2008.

[16] S. Maheshwari, "Voltage-mode all-pass filters including minimum component count circuits," *Active and Passive Electronic Components*, vol. 2007, Article ID 79159, 5 pages, 2007.

[17] M. Bhushan and R. W. Newcomb, "Grounding of capacitors in integrated circuits," *Electronics Letters*, vol. 3, no. 4, pp. 148–149, 1967.

[18] A. M. Soliman, "New grounded capacitor current mode band-pass low-pass filters using two balanced output ICCII," *Journal of Active and Passive Electronic Devices*, vol. 3, pp. 175–184, 2008.

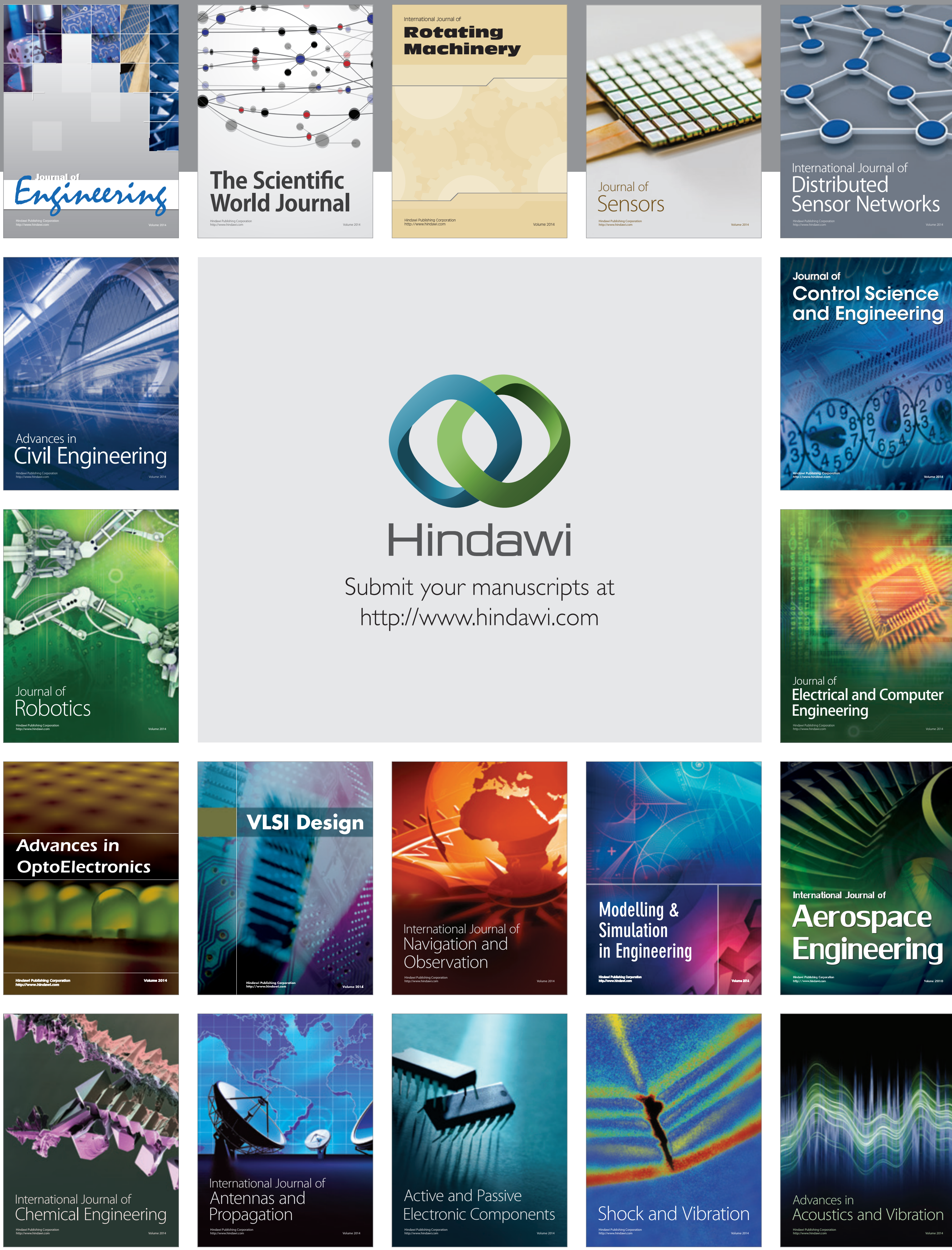
[19] A. U. Keskin and E. Hancioglu, "CDBA-based synthetic floating inductance circuits with electronic tuning properties," *ETRI Journal*, vol. 27, no. 2, pp. 239–242, 2005.

[20] N. Tarim and H. Kuntman, "A high performance current differencing buffered amplifier," in *Proceedings of the 13th International Conference on Microelectronics (ICM '01)*, pp. 153–156, Rabat, Morocco, October 2001.

[21] S. Minaei, G. Topcu, and O. Cicekoglu, "Low input impedance trans-impedance type multifunction filter using only active elements," *International Journal of Electronics*, vol. 92, no. 7, pp. 385–392, 2005.

[22] N. A. Shah, M. Quadri, and S. Z. Iqbal, "CDTA based transimpedance type first-order all-pass filter," *WSEAS Transactions on Electronics*, vol. 5, no. 6, pp. 280–284, 2008.

[23] A. Fahre, O. Saaid, F. Wiest, and C. Boucheron, "High frequency applications based on a new current controlled conveyor," *IEEE Transactions on Circuits and Systems I*, vol. 43, no. 2, pp. 82–91, 1996.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