TUNABLE FLOATING RESISTOR BASED ONCURRENT INVERTING DIFFERENTIAL INPUTTRANSCONDUCTANCE AMPLIFIER

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Abstract

This study uses CIDITA to illustrate a floating resistor (current inverting differential input transconductance amplifier). The proposed floating resistor is built using 0.18 m CMOS technology. No other passive components are needed in the construction of this floating inductor, taking advantage of the smaller chip surface and thus lower losses. The ability to implement both positive and negative resistors is a benefit of the proposed circuit layout. This paper presents a simple circuitry of floating resistor in whichthe value of resistance can be tuned by adjusting the gate voltage of MOSFET. The PSpice simulation result shows constant resistance of 1.6 KΩ for frequencybandwidth of 1 Hz to 1 MHz, with supply voltage of ±1.25 volts.

Keywords

Floating Resistor, CDTA, CIDITA

1. Introduction

The use of passive resistors is generally avoided while implementing precision based analog integrated CMOS circuits. The tolerance value, fabrication process it has undergone or the temperature variations in which the passive resistors are being used can also contribute to 20% change in the accurate value of resistor [1]. These reasons are enough for the requirement of CMOS based active resistors. Several other varieties of applications of the floating resistor include AGC cir- cuits (automatic gain control), automatically tuned oscillators and filters and even in voltage controlled amplifiers [2]. Several other floating resistors have been pro- posed in literature to date using CMOS technology, such as square law floating resistor, positive-negative floating resistor, voltage controlled resistor, etc. [1]-[17].

This paper has proposed a novel approach to realize a floating resistor using modern active building block CIDITA. As it is a current mode based active build- ing block, it has several advantageous features when compared with voltage mode. To characterize the performance of proposed voltage-controlled fully floating resistor the simulation results are provided using PSpice.

Vast numbers of active building blocks are already proposed to date. CDTA (current differencing transconductance amplifier) has been proved to be an im- portant and versatile building block with several advantageous features. Similar to CDTA there is CITA (current

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inverting transconductance amplifier), with the difference that the current differencing unit (CDU) is replaced by current in- verting unit (CIU). If the single input transconductance amplifier in CITA is re-placed by differential input transconductance amplifier, then CIDITA (current inverting differential input transconductance amplifier) is obtained. It was dis- cussed first of all in [18]; however its CMOS implementation and characteristic parameters have been discussed in [19]. CIDITA shows several advantageous features such as wider bandwidth, input current with better linearity range, greater accuracy and low operating voltage. CIDITA shows maximum transconductance better than that of CCCCTA and DDCCTA. For CMOS implementation, CIDITA uses lesser number of transistors and consumes less power than above mentionedtwo active building blocks [20] [21].

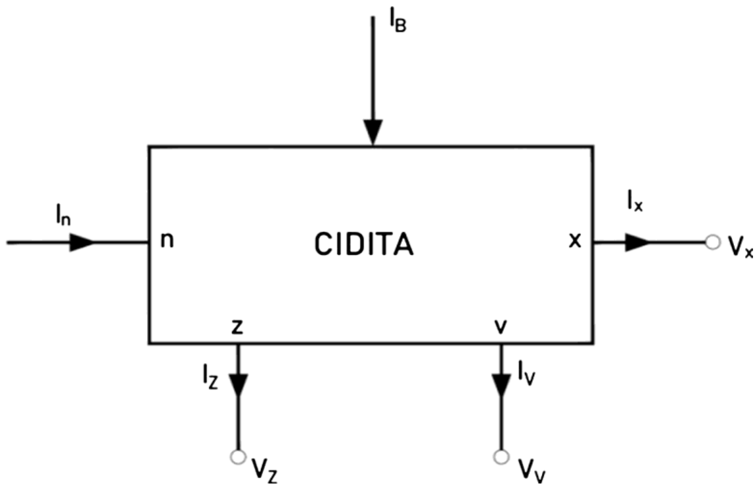
2. Block Description

The CIDITA has been used to propose a floating resistor. The symbol of CIDITAis shown in **Figure 1**.

Here I_B represents the bias current. CIDITA has four terminals *n*, *x*, *v* and *z*,
where,

I_n represents current at the terminal *n*;

I_x and V_x represents current and voltage at terminal *x* respectively; I_v and V_v represents current and voltage at terminal *v* respectively;I_z and V_z represents current and voltage at



terminal *z* respectively.

Figure 1. Symbolic representation of CIDITA [20].

It has transconductance of g_m.

$$\sqrt{\frac{\mu_n C_{ox} W}{I_{B\,L}}}$$

μ_n is the mobility of electron;

$g_m =$

C_{ox} is capacitance of gate oxide/unit area;

W/L is the aspect ratio.

3. Proposed Floating Resistor Using CIDITA

The following figure shows the realization of floating resistor using CIDITA (see **Figure 2**).

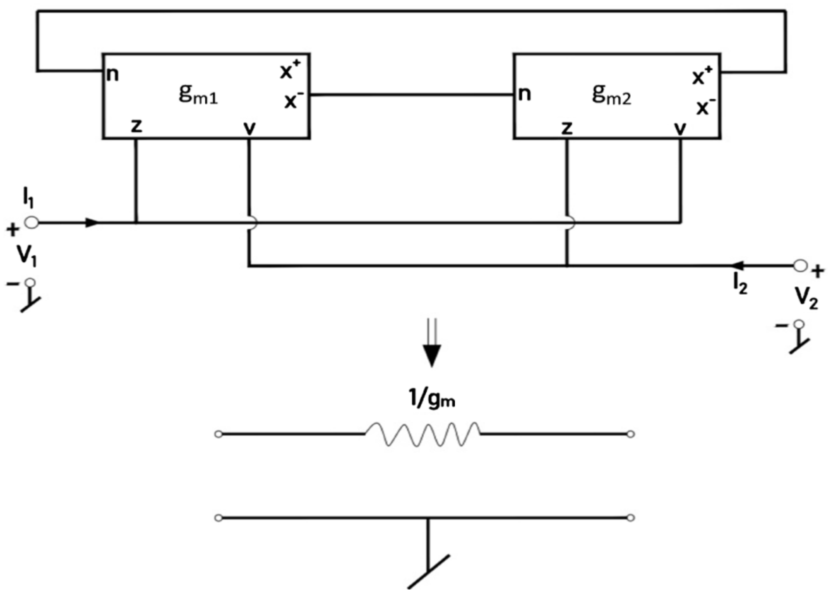


Figure 2. Floating resistor based on CIDITA and its equivalent symbol.

$I_1 \, g_{m2} \, V_1 \, V_2 \, I_2 \, g_{m1} \, V_1 \, V_2$

(2)

(3)

$I_1 \quad g_{m2} \quad g_{m2} \quad V_1 \quad I \quad g \quad g \quad V$

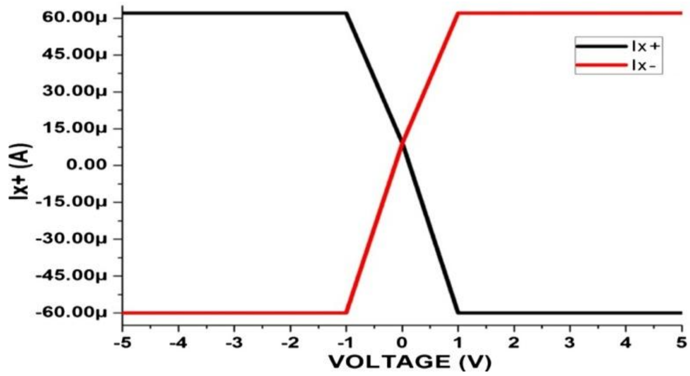
If,

$gm1 \quad gm2$

$2 \quad m1$

$m1 \quad 2$

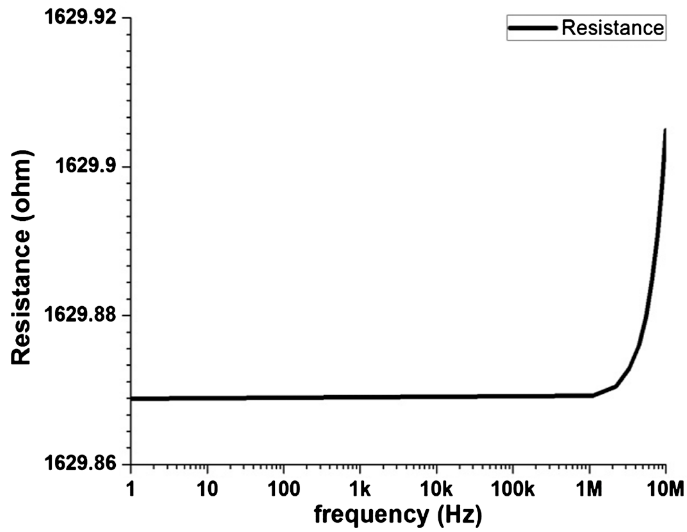
ISSN: 2278-4632
Vol-10 Issue-1 January 2020



The floating resistor can be characterized by the following matrix.

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = g_m \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

4. Simulation Results



To evaluate the performance of recently proposed voltage-controlled floating re- sistor, PSpice simulations have been done. The technology node used is 0.18 µm TSMC and supply voltage of ±1.25 volts.

It is clear from above magnitude response of the proposed floating resistor shown in **Figure 3**, that the resistance remains constant for the frequency range of 1 Hz to 1 MHz, hence providing same value for wider bandwidth, that is re- sistance of 1.629 kΩ. The DC characteristic (Voltage versus I_{x+}/I_{x-}) of the pro- posed floating resistor is shown in **Figure 4**.

Figure 3. Input impedance of proposed floating resistor.

Figure 4. DC characteristics of the proposed floating resistor.

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

5. Conclusion

Using a current inverting differential input transconductance amplifier, a novel configuration of voltage-controlled floating resistor has been presented (CIDITA). The proposed resistor has a number of distinguishing characteristics, including no matching restrictions needed, electrical tunability, improved linearity range, and simplicity of circuit. The circuit benefits from having no passive components, which lowers losses and chip area. A variety of RC circuits and precision-based analogue integrated CMOS circuits can employ the proposed resistor.

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