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Voltage Amplifier Based On High Bandwidth Current Conveyor II

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***Abstract*— This paper describes the designing of a Voltage Amplifier using second generation Current Conveyor implemented using a translinear loop. The designed voltage amplifier through CCII+ can be used in different analog computation circuits. All simulations are done through PSPICE using 0.18µm CMOS process parameters.**

***Index Terms*— Current Conveyor, translinear loop, CCII+**

I. INTRODUCTION

Current- mode circuits have evolved as an important class of circuits having properties like versatility, accuracy, better linearity, low power consumption, dynamic range performances and high frequency in a wide range of applications. An emerging class of high performance current mode based analog circuit designs is Current Conveyors. These were first introduced by Sedra and Smith in the year 1968 [1] . Current Conveyors have simple structure, wide frequency range and capability to operate at low voltages. Low voltage operation and high bandwidth make them suitable for use in portable and mobile communication equipment.

Current Conveyor is a three terminal named X,Y,Z and a three-port network device. Its block diagram is shown in fig.1

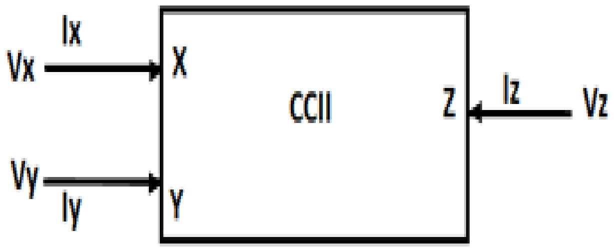

Fig. 1

Current conveyor has following properties :

$I_Y = 0$ (1)
$V_X = V_Y$ (2)
$I_Z = \pm I_X$ (3)

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Where I_X , I_Y , I_Z are currents through terminal X, Y and Z respectively and V_X, V_Y ,V_Z are voltages at terminal X, Y and Z respectively.

The polarity of I_z determines the type of CCII used i.e CCII+ or CCII- . The above equations can be realized using the matrix as shown in fig.2.

$$\begin{pmatrix} I_y \\ V_x \\ I_z \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & \pm 1 & 0 \end{pmatrix} \begin{pmatrix} V_y \\ I_x \\ V_z \end{pmatrix}$$

Fig.2

Thus, Y is a very high input impedance terminal , draws zero current , fed by a voltage signal and transfers the same signal to the terminal X. If a load is connected at X terminal, current will flow through X terminal and will be conveyed to Z terminal according to property (3) given above. The output terminal Z has comparatively high output impedance [2].

In this paper, we have designed a CCII based voltage amplifier. CCII is implemented using CMOS translinear loop [3]. This circuit has the advantage of low power dissipation, low supply voltage requirement, low biasing voltage and high bandwidth as compared to [3].

II. CIRCUIT DESCRIPTION

A. TRANSLINEAR LOOP BASED CURRENT CONVEYOR

A translinear loop based positive current conveyor is shown in the fig.3

CCII+ shown below has translinear loop formed by transistors M1, M2. M3 and M4 which allows the voltage follower function between X and Y terminal (V_X= V_Y) . Transistors M5 and M6 provides appropriate biasing to the translinear loop. M7, M8, M9, M10 forms current mirrors at the output stage and thus, replicates the current from X to Z (I_Z = I_X).

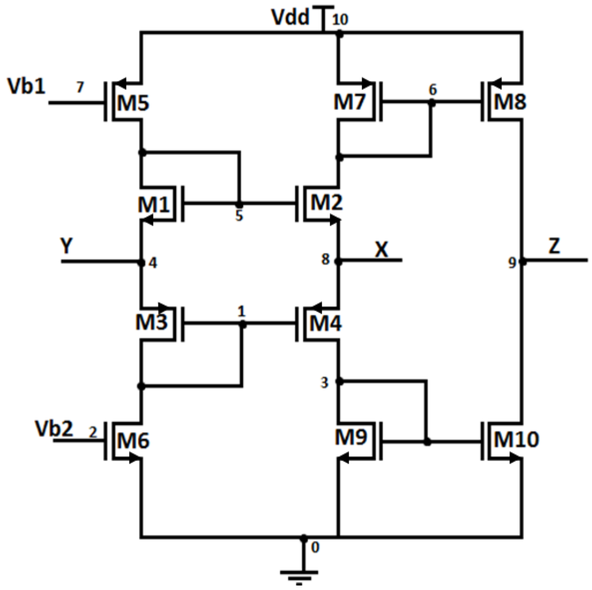

Fig. 3

B. *VOLTAGE AMPLIFIER USING CCII+*

Voltage amplifier amplifies input voltage to a higher output voltage value. Its input impedance is high whereas output impedance is low. A CCII+ based voltage amplifier is shown below in fig.4

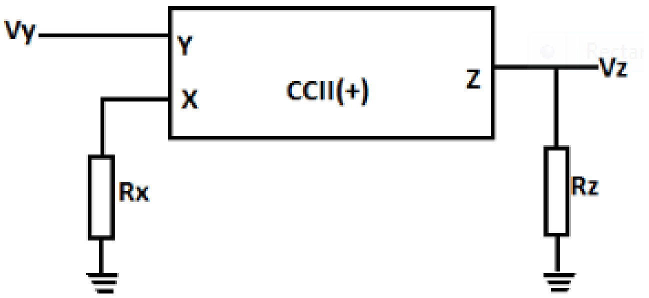

Fig. 4

The ratio of resistances R_Z and R_X determines the gain of the voltage follower as :

$$Gain\ (A_v) = \frac{Vz}{Vy} = \frac{Rz}{Rx}$$

III. SIMULATION RESULTS

The voltage amplifier is simulated using PSPICE on .18µm CMOS process parameters and power supply of 1.91volt is used for implementing CCII, however its applications may require higher supply voltages. The aspect ratios of the CCII+ transistors are given in Table I. Table II represents the comparison between this paper and [3] on different parameters. Fig. 5 shows output amplified waveform. Current transfer frequency response is shown in fig.7 respectively. Bandwidth from the frequency response is found to in the order of GHz.

TABLE I. ASPECT RATIOS

TRANSISTOR	W(µm) / L(µm)
M1, M2	3/.18
M3, M4	9/.18
M5, M7, M8	9/2
M6, M9, M10	3/2

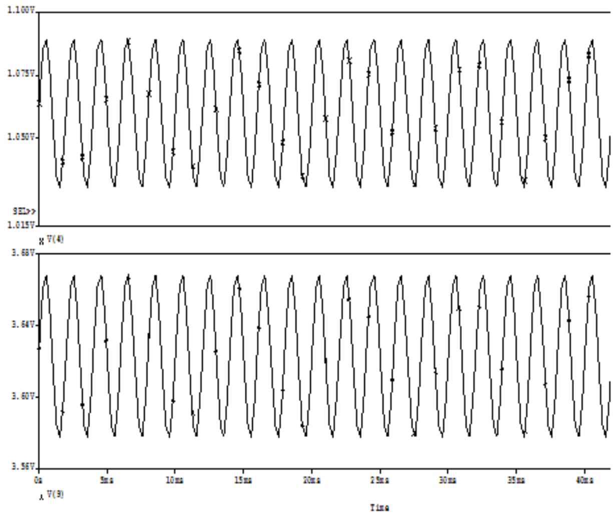

Fig. 5 Output voltage waveform

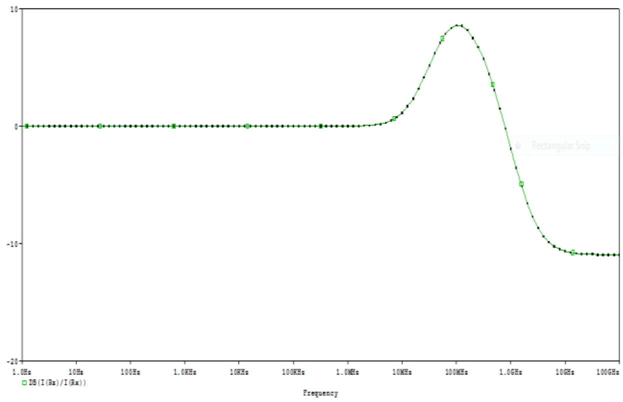

Fig. 6 Frequency response of current transfer of CCII

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