Research Paper Engineering

Design of sinusoidal Oscillator using Second generation current conveyor

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ABSTRACT

A novel second-generation current conveyor (CCII) - based resistance–capacitance (RC) sinusoidal oscillator operating over a wide dynamic range is presented. The oscillation condition and the oscillation frequency can be adjusted independently by two control resistors. The leakage power consumed by CMOS based positive current conveyor is 6.6mW. Sustained oscillation obtained at 200MHz. The output waveforms presented and the results discussed in the paper are the simulated outcomes of the proposed circuit, carried out using CADENCE 0.18um technology.

Keywords:

I. Introduction

An oscillator enjoys the same status in the domain of electrical and electronics engineering as do wheels in the mechanical engineering. Sinusoidal Oscillators of variable frequency find wide range of applications in instrumentation & measuring systems, communication, control systems and signal processing. For the implementation of RC (resistance–capacitance) sinusoidal oscillator the voltage-mode operational amplifier circuits have been shown to be very commonly used due to its simplicity in design only, but at the same time it suffers a number of disadvantages. The first is that in voltage mode the circuit's parasitic capacitances create dominant poles at relative low frequencies, which limits the bandwidth. The second is the dynamic range of operation dictated by the frequency-dependent gain of op-amp. The third is the difficulty to change the frequency of oscillation independent of the necessary and sufficient condition required to sustain the oscillations. On the other hand the current-mode op amp circuits like CCII+, has shown to offer improved performance over the conventional op-amp-based oscillators.

It has low node impedances and the small voltage swings. Thus the time constant effect is minimal. Hence the slew rate is sufficiently high. They are well suited to work at higher frequencies. It has larger dynamic range and wider bandwidth. Furthermore they are also suitable for integration with CMOS technology and thus become more and more attractive in electronic circuit design.

Hence in recent years the current-mode circuits are most widely used instead of their voltage-mode counter parts and it has shown that the CCII+ is very useful as an analogue building block and receiving much attention in oscillator design [1,2,3]. The implementation of Integrated Circuit (IC), technology has gone extremely advanced and the plus-type CCIIs are now available from commercial monolithic IC's, like PA 630, PA630A (Phototronics), AD 844 (Analog Devices) and CCII01 (LPT Electronics Ltd)

II. Design of Second generation CMOS based Positive current conveyor

In positive current conveyor the design of op-amp is similarly as shown above and the design of two current mirror units is given below. In current conveyor the current mirror is formed by transistor MN_1, MN_2 and MP_1, MP2. The current flow through MP_1 corresponding to V_{GSP1}. Since $V_{GSP1}=V_{GSP2}$, Ideally the same current or a multiple of the current in MP_1 flow through MP_2 If the MOSFET are the same size the same drain current flow in each . MOSFET provided MP_2 stay in the saturation region. The current I_{MP} is given by

$$I_{MP1}= \beta_1/2*(V_{GS1} - V_{thp})^2 \quad 1$$

$$I_{MP2}= \beta_2/2*(V_{GS2} - V_{thp})^2 \quad 2$$

$$I_{MP1}/ I_{MP2} = (W/L)_2/(W/L)_1 = \beta_2/ \beta_1 \quad 3$$

The equation show how to adjust the W/L ratio of the two devices to achieve the desired output current I_{MP2}. The design of second current mirror is similarly as explained

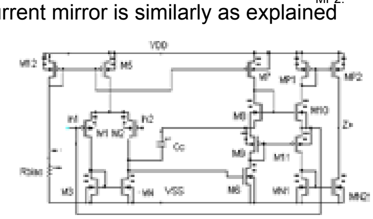


Fig: 2.1 Schematic of Second generation CMOS based Positive current conveyor.

Transistor	W/L	Transistor	W/L
M1,M2	25.7/0.6	M8,M10	40/0.755
M3,M4	7.5/1.5	M9	86.25/0.75
M5,M7,M12	22.5/1.5	M11	120.75/.75
M6	14.25/1.5	MP1,MP2	54.75/1.5
MN1,MN2	30/1.5		

Table: 2.1 CMOS Transistor sizing for Positive current conveyor**.**

III. Design of sinusoidal oscillator using second generation CMOS based Positive current conveyor

A novel second-generation current conveyor (CCII) - based resistance–capacitance (*RC*) sinusoidal oscillator operating over a wide dynamic range is described. The oscillation condition and the oscillation frequency can be adjusted independently by two control resistors. The circuit proposed makes use of grounded capacitors the circuit enjoys low sensitivities and is suitable for integration. Sinusoidal oscillators of variable frequency find extensive applications in communication systems, instrumentation, and measurement. Voltage-mode operational amplifier (op-amp)-based circuits have been shown to be very well suited for the generation of sinusoidal waveforms incorporating resistance–capacitance (*RC*) networks. The simplicity in the design approach turns into a disadvantage when it is desired to change the frequency of oscillation independent of the necessary and sufficient condition required to sustain the oscillations. Moreover, the dynamic range of operation is dictated by the frequency-dependent gain of op-amp. The composite op-amp configurations are then used to overcome the shortcomings of one op-amp-based oscillator. The OTA-C-based circuits, and the current feedback amplifier (CFB op-amp)-based circuits, have been shown to offer improved performance over the conventional op-amp-based oscillators. In recent years the current-mode approach of signal processing has provided elegant solutions for analogue circuit problems. The main advantages that this mode of operation exhibits are wide bandwidth, high slew rate and the fact that the gain can be realized independent of a constant gain-bandwidth product constraint.

IV. Proposed sinusoidal oscillator circuit using positive. Current conveyor

The second-generation current conveyor (CCII) is sometimes claimed as the standard building block of the current mode operation which stems largely from the fact that the CCII offers a useful way of realizing complex circuit functions.

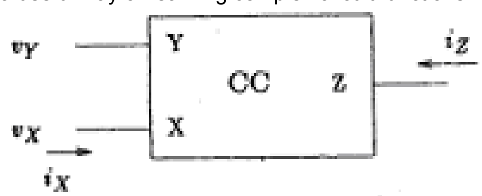


Fig.4.1 Symbol of CCII

Fig.4.1 shows the symbol of a CCII. Whose terminal characteristics can be defined by a hybrid matrix giving the output of the three ports in terms of their corresponding inputs. The output current , thus, depends only on the input current at terminal X (Fig.4.1) which may be injected directly at X, or it may be produced by the copy of the input voltage , from terminal Y, acting across the impedance connected at X. The sign in (1) indicates whether the conveyor is formulated as an inverting or non inverting circuit, termed CCII+ or CCII- . By convention, positive is taken to mean and both flowing simultaneously toward or away from the conveyor (Fig.6.2.1). The use of second-generation current conveyors, CCII+ or CCII- , for the design of *RC* sinusoidal oscillator circuits has been demonstrated to be potentially advantageous in regard to dynamic range of operation and the overall operational stability. In recent years, their applications and advantages in the synthesis of *RC* sinusoidal oscillators with the salient features of controlling the frequency

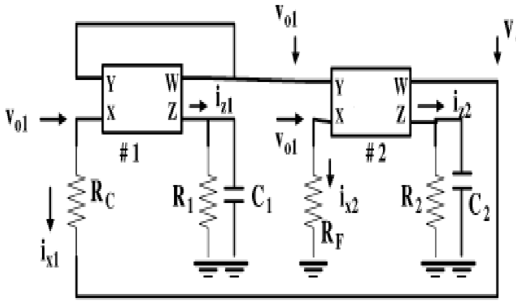


Fig.4.2. Proposed sinusoidal oscillator circuit using positive. Current conveyor.

of oscillation without affecting the condition for oscillation have received considerable attention. In the absence of a commercially available integrated circuit current conveyor *RC* sinusoidal oscillator configurations reported earlier were tested in the laboratory, employing current conveyor features implemented using op-amps with current mirrors. The use of second-generation current conveyors, CCII +or CCII -, for the design of *RC* sinusoidal oscillator circuits has been demonstrated to be potentially advantageous in regard to dynamic range of operation and the overall operational stability .In recent years, their applications and advantages in the synthesis of *RC* sinusoidal oscillators with the salient features of controlling the frequency of oscillation without affecting the condition for oscillation have received considerable attention. The proposed *RC* sinusoidal oscillator using CCII+ with grounded capacitors is depicted in Fig.6.2.2

V. Simulation result

As the idea of working research was to optimize the circuit for stability and to achieve the highest frequency possible by varying the value of components like coupling capacitors, load capacitors, terminal impedances, feedback register etc. The same has been carried out in the following steps.

S.No.	Current at Input Terminal (μA)	Current at Output Terminal (μA)
1	10	10.63
2	50	50.00
3	100	99.73
4	150	149.94
5	200	200
6	300	297.4
7	350	345.67

Table: 5.1 Current at current in-put terminal (X) and current out-put terminal (Z+)

The above table shown the relationship at current input terminal (X) and current out -put terminal (Z+). When an input current I being forced into terminal X will result in an equal amount of current flowing into terminal Z+ with same polarity up to current range o to 300 μA.

S.NO.	Voltage at Y terminal (V_y) (Volt)	Voltage at X terminal (V_x) (Volt)	Current at out put terminal (Z+) (μA)
1	1.50	1.35	50.98
2	1.35	1.34	51.11
3	1.25	1.25	50.00
4	1.00	1.00	50.90
5	0.50	0.50	49.9
6	-0.50	-0.50	49.9
7	-1.00	-1.00	49.9
8	-1.50	-1.57	49.9
9	-2.00	-1.57	49.9
10	-2.50	-1.57	49.9

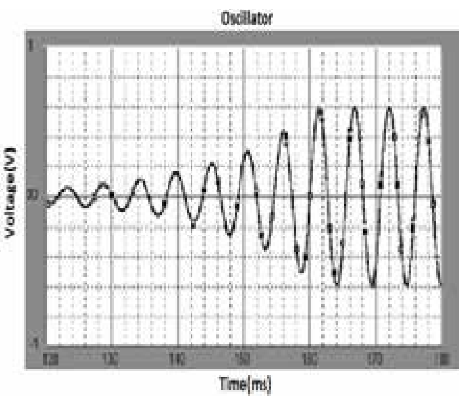
Table 5.2 Voltage at terminal Y, X and current at terminal Z+ when 50 μA is applied at terminal X.

The above table shown that whatever the voltage applied at Y terminal it will convey to X terminal and independence the value of current applied at X terminal up to voltage range 1.35 to -1.35.

S.No.	Voltage at X terminal (V_x) (Volt)	Current at Output Terminal (μA)	Load at Out put terminal
1	-1	49.98	10 Ω
2	-1	49.98	100 Ω
3	-1	49.98	10000 Ω
4	-1	49.98	10k Ω
5	-1	49.98	15k Ω
6	-1	47.89	20k Ω
7	-1	47.45	25k Ω
8	-1	47.30	30k Ω
9	-1	46.41	35k Ω

Table: 5.3 showed the variation of resistive load with out-put current.

The above table show that what the current applied at input terminal X will be conveyed to current out- put terminal Z+ up to resistive load 15k Ω .



Fig; 5.1 Sustained oscillations for sinusoidal oscillator circuit using positive Current conveyor The simulation results showing growth and sustained oscillation at 200Hz for $R_1=R_2=R=$ 9.12kΩ, $C_1=C_2=C=$120pF, R_f=9.2 under the condition R_c=4.8k Ω

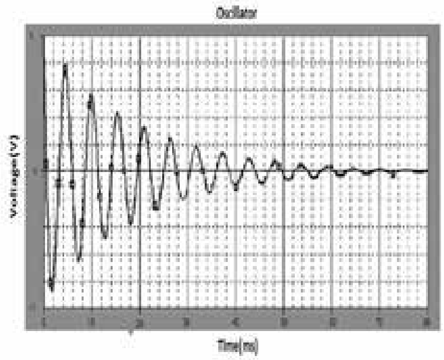


Fig 5.2 Decay of oscillations for sinusoidal oscillator circuit using positive Current conveyor.

The Simulation results showing decay of oscillation at 200MHz for $R_1=R_2=R=$ 9.2k Ω, $C_1=C_2=C=$120pF, R_f=3.2, under the condition R_c=5.2k Ω

Results:
Delay in start of oscillation=117.64 ns
Frequency achieved = 200.000 MHz
Amplitude achieved = 669.13 mV

VI. Conclusion

A proposed CMOS CCII+ based Sinusoidal Oscillator has been described and simulated up to a maximum frequency of 200 MHz. The circuit follow input-output characteristics of CCII. The output currents *(Iz+* and *Iz-.)* follow the input current through terminal X. *Iz+* has the same polarity as ***Ix for CCII+*** **,**and ***Iz-*** is in the opposite polarity as ***Ix for CCII-*** .. The voltage at X follows that applied to Y, thus X exhibits zero input impedance.

The proposed circuit of Oscillator allows independent control of the oscillation condition and oscillation frequency. The oscillation frequency is controlled with a single grounded resistance which in turn allows digital control Of the frequency if weighted resistors are used.The oscillation condition and the oscillation frequency can be adjusted independently by two control resistors.

The proposed DDCC circuit is quite useful as a powerful building block of current-mode circuits because of its high performances. The DDCC is useful for processing differential voltages signals.

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