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Current Conveyor Based Sinusoidal Oscillator with its Application

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Abstract: ***Current Conveyors have been used as a basic building block in a variety of electronic circuit in instrumentation and communication systems. Today they replace the conventional OPAMP in so many applications such as active filters, oscillators, analog signal processing and A/D, D/Convertors. Current conveyor is a high performance analog circuit design block based on current mode and voltage mode approach. It is basically a unity gain element that exhibits high linearity, wide dynamic range, high bandwidth and better high frequency performance. The current conveyor is a combination of voltage as well as current follower. Current conveyor has the advantages of a wide current and voltage bandwidths. We use a translinear configuration for first, second and third generation current conveyor. Here, Sinusoidal oscillator by using CCI CCII and CCIII perform good accuracy and frequency response at 1.5V supply voltage. The current conveyor is simulated in terms of voltage offset, current offset, current bandwidth and voltage bandwidth in 180nm CMOS technology using Mentor Graphics tools.***

Keywords: Voltage Mode Circuits (VMC), CMOS *Current Conveyor, CCII, and Miscellaneous symbolic representation of CCII.*

1. Introduction

A current conveyor is a four (possibly five) terminal device which arranged with other electronics elements in a specific circuit configuration can perform several analog processing functions like traditional op – amp. This stems from the fact that the CC offers an alternative way of abstracting complex circuit function, thus aiding in the creation of new and useful implementations. Moreover likewise op – amp the terminal behavior of op – amp approaches its ideal behavior quite closely. Hence the circuit designed with CC matched the predicted theoretical values. The concept of current conveyor was first presented in 1968[1] and further developed to a second generation current conveyor in 1970[2].The current conveyor is intended as a general building block as with the operational amplifier. Because of the operational amplifier concept has been current since the late 1940's, it is difficult to get any other similar concept widely accepted. However, operational amplifiers do not perform well in application field for current conveyor circuits. Since current conveyors operate without any global feedback, different high frequency behavior compared to operational amplifier circuits results. Specifically a CC can provide a higher voltage gain over a large signal bandwidth under small or large signal conditioning than a corresponding op – amp circuit in effect a higher GBW product. In addition, CCs have been extremely successful in the development of an instrumentation amplifier which doesn't depend critically on the matching of external components, instead depends only on the absolute value of signal component.

2. Voltage Mode Circuits (VMC)

The current mode design technique is a good alternative for the high performance analog circuit design as it offers voltage independent high bandwidth. In current-mode design, the stress is more on the current levels for the operation of the circuits and the voltage levels at various nodes are immaterial. In voltage-mode circuits (VMCs), such as operational amplifiers (op amp), the performance of the circuit is determined in terms of voltage levels at various nodes including the input and the output nodes. Therefore, VMCs are not suitable for high frequency applications. When signals are widely distributed as voltages, the parasitic capacitances are charged and discharged with the full voltage swing, which limits the speed and increases the power consumption of voltage-mode circuits. Current-mode circuits cannot avoid nodes with high voltage swing either but these are usually local nodes with less parasitic capacitances [5]. Therefore, it is possible to achieve higher speed and lower dynamic power consumption with current-mode circuit techniques. When the signal is conveyed as a current, the voltages in MOS transistor circuits are proportional to the square root of the signal, if the devices are assumed to be operating in saturation region. Therefore, a compression of voltage signal swing and a reduction of supply voltage are possible. This feature is utilized in log domain filters, switched current filters and in non-linear current-mode circuits [6]. However, as a result of the device mismatches, this non-linear operation may generate an excessive amount of distortion and cannot be used for the applications where high linearity is required. Thus, linearization techniques are utilized in current-mode circuits to reduce the nonlinearity of the transistor transconductance and in this case the voltage signal swing is also not reduced.

3. Basic Principle of Sinusoidal Oscillator

The basic structure of a sinusoidal oscillator consists of an amplifier and a frequency selective network connected in positive-feedback loop. Although in an actual oscillator circuit, no input signal will be present, we include an input signal here to explain the principle of operation. With exception such as relaxation oscillator, the operation of oscillator is based on principle of positive feedback where portion of the output signal is feedback into input without phase change. Thus, it reinforces the input and sustains the continuous sinusoidal output. Beside this, the phase shift of feedback signal must be either 0^o or 360^o. The last requirement is the loop gain T of amplifier must be equal to one, which is also named as *Barkhausen criterion*. Thus mathematically, the loop gain T is

$$T = A_V\beta = 1$$

Where A_V is the voltage gain of the amplifier and beta is the feedback at output voltage. 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. As we Compared the sinusoidal oscillator by using first, Second and third generation of current conveyor then second generation current conveyor iis the best among these.

4. Sinusoidal Oscillator by using CCII

Sinusoidal oscillator by using Second generation current conveyor is the best one as compared with first and third generation of current conveyors. A second generation current conveyor (CCII) based resistance-capacitance (RC) sinusoidal oscillator operating over wide range. The oscillation condition and oscillation frequency can be adjusted independently by two control resistors. The leakage power consumed by CMOS based Second generation current conveyor (CCII) is 9.5mW.Sustained oscillation obtained at 250MHz. The circuit proposed makes use of grounded capacitors the circuit enjoys low sensitivities and suitable for integration. Sinusoidal oscillator of variable frequency find extensive applications in communication systems, instrumentation and measurement. The simplicity of 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. Here, the sinusoidal oscillator by using CCII is design by the miscellaneous symbol of CCII, which is generated by the schematic of CCII as shown in fig.1 and fig.2 below:

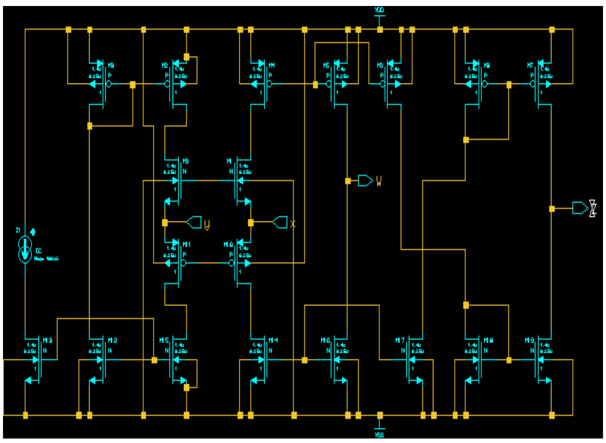

Figure 1: Schematic designing of CCII

After the designing of Second-generation current conveyor (CCII) its symbol is designed by selecting the whole circuit by using the Mentor Graphics tools and coping it in the new schematic by a new name and in miscellaneous press the option of generate symbol then first generation current conveyor miscellaneous symbol will be generated as shown in fig.2

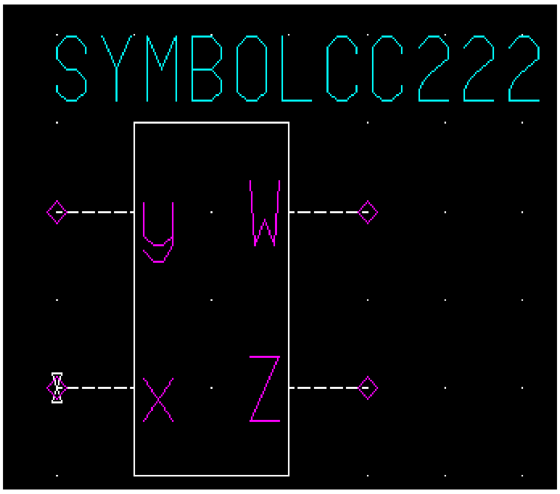

Figure 2: Miscellaneous symbolic representation of CCII

Symbol of Second generation current conveyor is the dual output (DO-CCII). After the miscellaneous symbolic representation of CCII, that symbol is also called as the black block representation. Here, by this symbol we will design sinusoidal oscillator as shown in fig.3. The second generation current conveyor (CCII) is sometimes claimed as the standard building block of current mode operation which stems largely from the fact that the CCII offers a useful way of realizing complex circuit functions. In the recent years, their applications and advantages in the RC sinusoidal oscillators with the salient features of controlling the frequency of oscillation without affecting the condition for oscillation have received considerable attention [3]. The proposed RC sinusoidal oscillator using second generation current conveyor (CCII) with grounded capacitor is as shown below

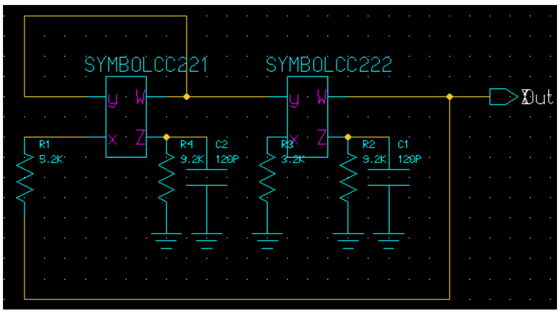

Figure 3: Sinusoidal oscillator by using CCII

The output waveforms presented and the results discussed in this are simulated outcomes of the proposed circuit carried out by use of mentor graphic 0.18um technology. Delay in the start of oscillation=137.64ns, Frequency achieved=250MHz and Amplitude achieved-664.13mV. Simulation result of sinusoidal oscillator by using CCII is as in fig.4

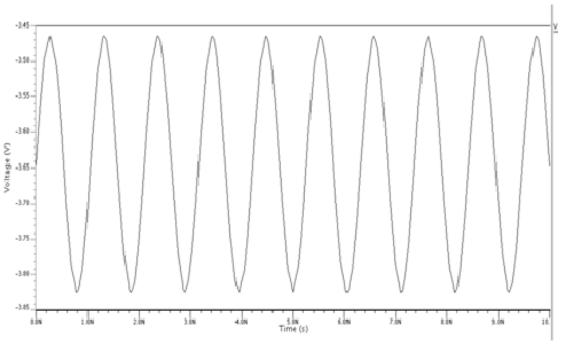

Figure 4: Waveform of Sinusoidal oscillator by using CCII

Result: A proposed CMOS second generation based sinusoidal oscillator has been described and simulate up to a maximum frequency of 250MHz.The circuit follow the input-output characteristics of second generation current conveyor(CCII).R1=R2=R=9.2KΩ,C1=C2=C=120PF and Rf=3.2 KΩ under the condition Rc=5.2 KΩ.

5. Implementation of Application

Here, second generation current conveyor (CCII) based sinusoidal oscillator application like implementation of voltage mode chaos generator is presented. As all Current conveyors are compared in which the second generation current conveyor is the best one so by choosing an application of sinusoidal oscillator like voltage mode chaos generator and designed this application by using second generation Current conveyor (CCII).Here, firstly the voltage mode four phase sinusoidal quadrature oscillator (VMFPSQO) is implemented and then Voltage Mode Chaos Generator (VMCG) is implemented.

6. Voltage Mode Four Phase Sinusoidal Quadrature Oscillator(VMFPSQO)

Chaos generator circuit using dual output second generation current conveyor (DO-CCII) as active device with grounded passive components are realized. The starting circuit is a voltage mode four phase sinusoidal quadrature oscillator (VMFPSQO) circuit for realizing with chaos generator. The chaos generator is derived by modifying the voltage mode four phase sinusoidal quadrature oscillator (VMFPSQO), by inserting an additional frequency dependent negative resistor (FDNR).This is to introduce the non linearity into the sinusoidal oscillator. In the second chaos generator, non linearity in the sinusoidal oscillator is introduced by using an additional block consists of an FDNR follower by differentiator. The VMFPSQO is as shown in fig. 5 below:

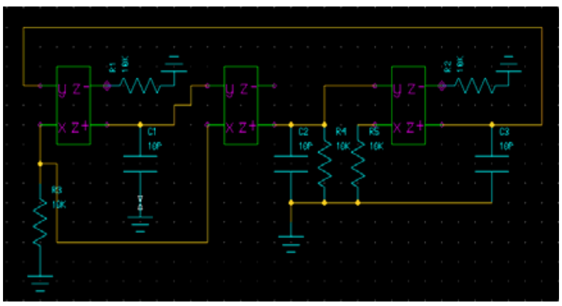

Figure 5: Voltage Mode four phase sinusoidal quadrature oscillator (VMFPSQO)

Here, the Voltage Mode Four Phase Sinusoidal Quadrature Oscillator (VMFPSQO). The component values for frequency dependent negative resistance (FDNR) were C_4=C_5= 0.0358 nF, R_6 = 1.5 K, R_7 = 10 K and the value of R_5 was 84K.The simulation result of VMFPSQO is as shown in figure 5. A proposed modified CMOS CCII+ based Sinusoidal Oscillator has been described and simulated up to a maximum frequency of 125 MHz The circuit allows independent control of the oscillation conditions and oscillation frequencies which are controllable with the help of resistors RF and a few capacitors. 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 proposed circuit allows independent control of the oscillation condition and oscillation frequency. The transient frequency of oscillation of VMFPSQO is shown as in fig. 6 below:

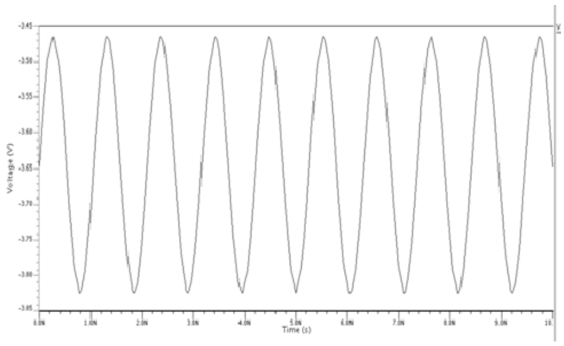

Figure 6: Transient analysis of VMFPSQO

7. Voltage Mode Chaos Generator

During recent years, a large number of chaos generators have been proposed [4, 7] In particular, the interest of many researchers has focused on analog circuits, became their structural simplicity which make their realization easy. Design of simple chaotic circuits is important not only to explicate, on linear phenomena, but also for engineering application. In this section voltage mode chaos generator (VMCG) is presented based on the sinusoidal oscillator.

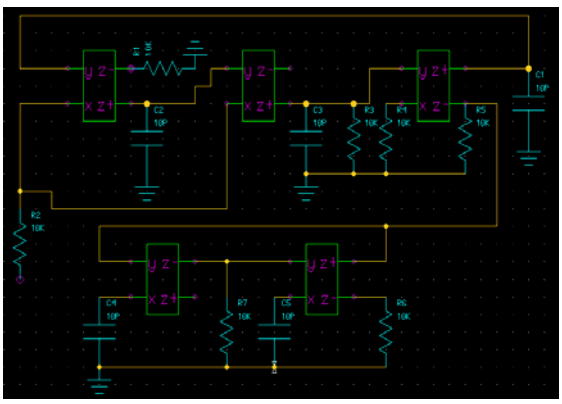

Figure 7: Voltage Mode chaos generator (VMCG) using CCII

Starting with a sinusoidal oscillator, that is later modified for chaos allows for attractive features obtained via linear design techniques to be transformed into the non linear domain. The proposed circuit allows independent control of the oscillation condition and oscillation frequency [8]. Phase space trajectory waveform of Voltage mode chaos generator is occurring as shown in the waveform below:

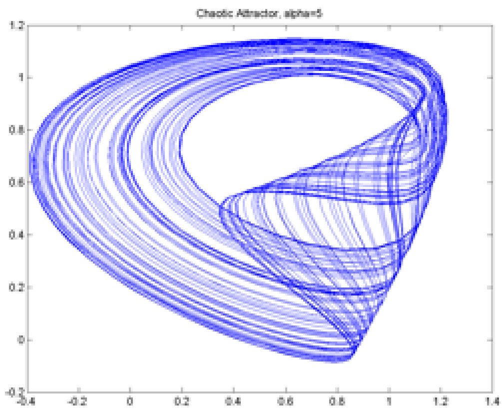

Figure 8: Transient analysis of VMCG

8. Conclusion

The nonlinearity is introduced by an FDNR to obtain the VMCG, is derived by introducing the nonlinearity from a nonlinear composite which consists of a FDNR followed by a differentiator. The proposed chaos generator has the following attractive features:

1. Sinusoidal oscillator exhibits the chaos by introducing and adjusting the non linearity via a non linear composite.
2. Circuit is tuned through single grounded resistor.
3. No inductor is used in their realizations.
4. Use of grounded passive components, which make the circuit suitable for modern IC technologies.

So, due to these features, the use of all grounded passive components makes both the generator circuits most suitable for monolithic implementation in contemporary IC technologies. So, that application is widespread in IC's Technology due to these features.

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