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# Simple sinusoidal active RC oscillators

AHMED M. SOLIMAN†

Two novel active RC oscillator circuits suitable for integration are given. The active building block used is the current conveyor. Both networks have the advantage of using earthed capacitors. One circuit is of a second order and uses two opposite polarity current conveyors and the other is a third-order oscillator with the advantage of using only one current conveyor.

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## 1. Introduction

Active RC oscillators are commonly used for audio frequencies. The active building block used is usually a single input–single output amplifier, a buffer stage or a two output differential amplifier (Sidorowics 1972). In other cases the negative impedance converter is used as the active element (Patranabis and Sen 1971).

The use of the current conveyor as the active element in the realization of transfer functions was introduced by Soliman (1972, 1973).

The present paper utilizes the current conveyor in realizing simple sinusoidal RC oscillators having earthed capacitors.

## 2. The current conveyor CC

The CC is a grounded three port network with the following instantaneous port relations :

$$\begin{bmatrix} i_b \\ v_a \\ i_c \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & \pm 1 & 0 \end{bmatrix} \begin{bmatrix} v_b \\ i_a \\ v_c \end{bmatrix} \tag{1}$$

The conveyor will include a positive sign if $i_c = i_a$ and a negative sign if $i_c = -i_a$ as shown in Fig. 1 (*a*) and (*b*), respectively (Sedra and Smith 1970).

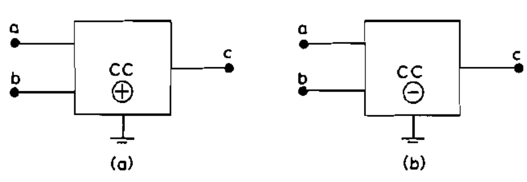


Figure 1. Symbolic representation of the current conveyor.

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† Electronics and Communications Engineering Department, Faculty of Engineering, Cairo University, Cairo, Egypt.

### 3. A second order RC oscillator

Figure 2 represents a second order sinusoidal RC oscillator which uses two opposite polarity current conveyors. The state equation for circuit is given by :

$$\begin{bmatrix} \dot{v}_1 \\ \dot{v}_2 \end{bmatrix} = \begin{bmatrix} 0 & -\frac{1}{R_2C_1} \\ \frac{1}{R_1C_2} & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \tag{2}$$

Hence the characteristic equation is :

$$s^2 + \frac{1}{R_1R_2C_1C_2} = 0 \tag{3}$$

which represents sustained constant amplitude sinusoidal oscillations having an angular frequency,

$$\omega_0 = \frac{1}{\sqrt{(R_1R_2C_1C_2)}} \tag{4}$$

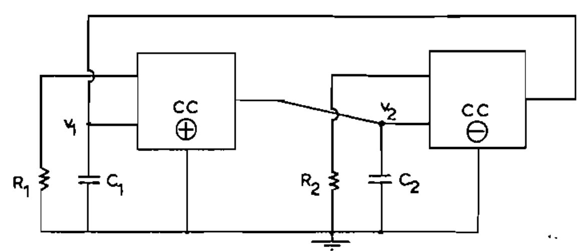


Figure 2. A second-order RC oscillator.

It is seen that the oscillator can be tuned by varying $R_i$ or $C_i$ $(i = 1, 2)$. The $\omega_0$ sensitivities to the passive circuit components are given by :

$$S_{R_1}^{\omega_0} = S_{R_2}^{\omega_0} = S_{C_1}^{\omega_0} = S_{C_2}^{\omega_0} = -\tfrac{1}{2} \tag{5}$$

where $S_x^{\omega_0}$ is defined as

$$S_x^{\omega_0} = \frac{\partial \omega_0}{\partial x} \cdot \frac{x}{\omega_0} \tag{6}$$

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## 4. A third-order RC oscillator

Figure 3 represents a phase shift oscillator which uses a single current conveyor as the active element. The state equation for the circuit is given by :

$$\begin{bmatrix} \dot{v}_1 \\ \dot{v}_2 \\ \dot{v}_3 \end{bmatrix} = \begin{bmatrix} -\frac{1}{CR} & \frac{1}{CR} & 0 \\ \frac{1}{CR} & \frac{-2}{CR} & \frac{1}{CR} \\ -\frac{1}{CR_1} & \frac{1}{CR} & -\frac{1}{CR} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \tag{7}$$

Hence the characteristic equation is :

$$s^3 + \frac{4}{CR} s^2 + \frac{3}{C^2R^2} s + \frac{1}{C^3R^2R_1} = 0 \tag{8}$$

which represents an oscillator if

$$R = 12R_1 \tag{9}$$

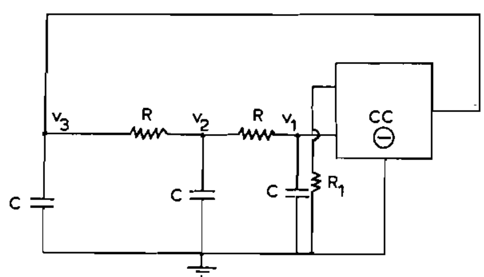


Figure 3. A third-order RC oscillator.

The angular oscillation frequency is :

$$\omega_0 = \frac{\sqrt{3}}{CR} \tag{10}$$

It is seen that the oscillator can be tuned by varying the three earthed tuning capacitors without affecting the oscillation condition.

## 5. Conclusions

The use of the current conveyor as the active element in the realization of simple sinusoidal oscillators is illustrated by two networks. Both networks have the advantage of using earthed capacitors. Other possible RC oscillators can be generated using the current conveyor as the active element.

## References

Patranabis, D., and Sen, P. C., 1971, *Int. J. Electron.*, **31,** 441.
Sedra, A., and Smith, K. C., 1970, *I.E.E.E. Trans. Circuit Theory*, **17,** 132.
Sidorowics, R. S., 1972, *Proc. Inst. elect. Engrs*, **119,** 283.
Soliman, A. M., 1972, *Int. J. Electron.*, **33,** 273 ; 1973 a, *I.E.E.E. Trans. Circuit Theory*, **20,** 80 ; 1973 b, *Int. J. Electron.*, **35,** 135.

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