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NEW SINGLE-RESISTOR CONTROLLED SINUSOIDAL OSCILLATOR CIRCUIT USING UNITY-GAIN CURRENT FOLLOWERS

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A new configuration for realizing current-follower-based sinusoidal oscillator is presented. The circuit uses two unity-gain current followers, three capacitors, and three resistors, and enjoys independent control of its frequency and condition of oscillation. Experimental results are included.

INTRODUCTION

At present there is a growing interest in designing filters and oscillators using unity-gain current and voltage followers (Zele, Allstot and Fiez, 1993, Ramirez Angulo and Sanchez-Sinencio, 1994, Tsividis and Papananos, 1994, Celma, Sabadell and Martinez, 1995, Abuelma'atti, 1995a,b). This is attributed to the fact that unity-gain current and voltage follower circuits are simple compared to the conventional operational amplifier and other complicated active elements, which require large areas on the chip and consume relatively large powers. Of particular interest here is the design of RC-sinusoidal oscillators using unity-gain current followers. While a number of such oscillator circuits have been reported (Abuelma'atti, 1995a,b), unfortunately none of them enjoy the attractive

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feature of independent control of the frequency and the condition of oscillation. The realization of sinusoidal oscillators using unity-gain current-followers and enjoying independent control of the frequency and the condition of oscillation would be attractive as they can provide variable-frequency oscillations using a small area on the chip and consuming relatively low power.

PROPOSED CIRCUIT

Consider the general circuit shown in Fig. 1. Assuming ideal current-followers with $i_x = i_y$ and $v_x = 0$, routine analysis yields the characteristic equation given by

$$Y_3(Y_4(Y_1 + Y_2 + Y_5) + Y_2Y_5) + Y_2Y_5Y_6 = 0 \quad (1)$$

If we choose

$$Y_1 = G_1 = 1/R_1,\ Y_2 = sC_2,\ Y_3 = G_3 = 1/R_3,\ Y_4 = G_4 = 1/R_4,\ Y_5 = sC_5,\ Y_6 = sC_6$$

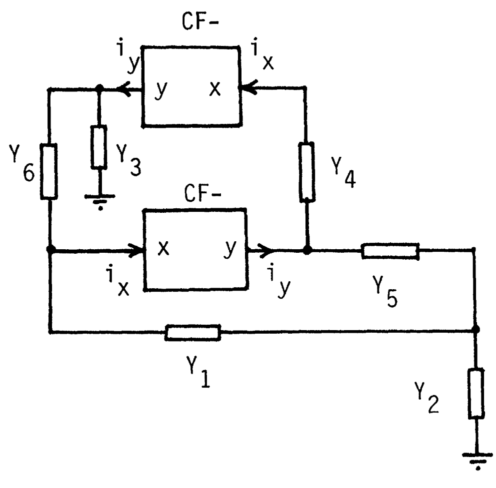

FIGURE 1 Proposed oscillator configuration.

(1) reduces to

$$G_3(G_4(G_1 + s(C_2 + C_5)) + s^2C_2C_5) + s^3C_2C_5C_6 = 0 \tag{2}$$

Therefore, the frequency and the condition of oscillation can be expressed by

$$\omega_o^2 = \frac{G_1G_4}{C_2C_5} \tag{3}$$

and

$$G_1C_6 = G_3(C_2 + C_5) \tag{4}$$

From (3) and (4), one can easily see that the frequency of oscillation can be adjusted by changing the conductance $G_4 = 1/R_4$ without disturbing the condition of oscillation and the condition of oscillation can be adjusted by changing the condutance $G_3 = 1/R_3$ without disturbing the frequency of oscillation. Thus, the circuit enjoys independent control of the frequency and the condition of oscillation.

EXPERIMENTAL RESULTS

Although there are several ways to implement the current-followers required for testing the proposed oscillator circuit, the test was performed using the AD844 positive-type second-generation current-conveyor(CCII+) configured as as unity-gain current-follower with its high impedance input terminal grounded. Two CCII+ can be configured to provide a minus-type current-follower. Obviously, this is not the simplest unity-gain current-follower realization. However, the kernel of the work presented in this paper is independent of the current-follower realization selected. Figure 2 shows the results obtained with $R_1 = 11k\Omega$, $R_3 = 20k\Omega$, $C_2 = C_5 = 1.2\ nF$, and $C_6 = 2.2\ nF$. From Fig. 2, one can see that the experimental results are in excellent agreement with the theory presented.

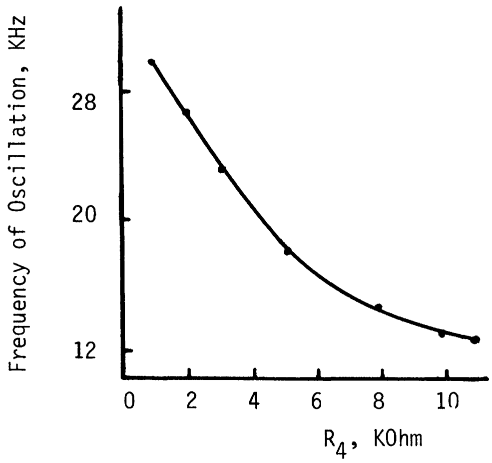

FIGURE 2 Measured (·) and calculated (-) frequency of oscillation of the circuit obtained from Fig. 1 with: $C_2 = C_5 = 1.2\ nF$, $C_6 = 2.2\ nF$ $R_1 = 11\ k\Omega$, $R_3 = 20\ k\Omega$.

However, as the frequency increases the discrepancies between measured and calculated frequencies of oscillation increase. This is attributed to the current-follower parasitics.

CONCLUSION

In this paper, a new current-follower-based sinusoidal oscillator circuit has been presented. The circuit uses two unity-gain current followers, three capacitors, and three resistors. In contrast with available current-follwer-based sinusoidal oscillators, the proposed ciruit enjoys the attractive feature of independent control of the frequency and the condition of oscillation. It is worth mentioning that another oscillator circuit, enjoying the same atrractive features, can be obtained by interchanging the capacitors and resistors.

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