instruments in conjunction with a computer or calculator are used. For numerical reasons, however, the selected frequencies should be located sufficiently far away from each other, e.g., one near the maximum of the magnitude function, one below and one above it.

EVALUATION OF EQUATIONS

A program for the evaluation of equations (7) and (9) to (11) on a Texas Instruments pocket calculator SR52 is available. The algorithm covers 220 programming steps and uses approximately 5 s for the calculation of the three parameters d_∞, H_0 and f_∞. During the implementation, special keys of this pocket calculator are utilized: with the help of six so-called user-defined keys, the three frequencies f_1 to f_3 and the corresponding magnitude values H_1 to H_3 are fed into the calculator at random. With the help of a further user-defined key the parameter d_∞ is evaluated. With another two user-defined keys the temporary results for H_0 and f_∞ could be obtained. In addition to the data input procedure, there are only nine keys to be pressed during a tuning cycle. The available tuning program is on a handy magnetic card. In addition to the lowpass tuning program, there exist two programs for both the high- and the bandpass type second-order active filters.

REFERENCES

1. K. Mossberg and D. Akerberg, 'Accurate trimming of active RC filters by means of phase measurements', *Electron Lett.*, **5**, 520–521 (1969).
2. B. Huber, 'Ein neues Verfahren für den Abgleich elektrischer Netzwerke', *NTG-Fachberichte*, **51**: Vorträge der NTG-Fachtagung 'Rechnergestüzter Schaltungsentwurf' am 13. und 14. März 1975 in Stuttgart, 31–38 (1975).
3. K. Antreich, E. Gleissner and G. Müller, 'Computer aided tuning of electrical circuits', *Nachrichtentechn. Z.*, **28**, 200–206 (1975).
4. E. Lüder and B. Kaiser, 'Precision tuning of miniaturized circuits', *Proc. 1976 IEEE Int. Symp. on Circuits and Systems, Munich*, 722–725 (1976).

A NEW ACTIVE C DIFFERENTIAL INPUT INTEGRATOR USING THE DVCCS/DVCVS

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Since the introduction of the DVCCS/DVCVS, which is a linear versatile active building block,[1] several configurations for realizing different types of voltage transfer functions have appeared in the technical literature.[1–3] In this letter a novel active C realization of the generalized differential input integrator is given. This integrator requires only a single DVCCS/DVCVS and an earthed capacitor. Positive and negative integrators may be obtained by shorting to ground one of the two input terminals of the active device. This integrator has the following advantages over the well-known integrators using the operational amplifier (OA) as the active element: (a) The input impedance is infinite, (b) only a single grounded capacitor is required per integrator.

The new active C differential input integrator is shown in Figure 1(a), with the DVCCS/DVCVS defined by the relations[1]

$$I_o = G(V_2 - V_1) \tag{1}$$

$$V_o = \alpha V_g \tag{2}$$

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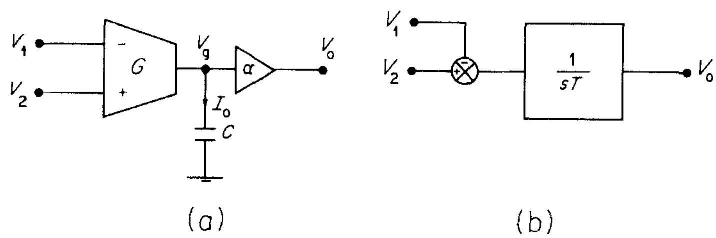

Figure 1. (a) A new active C differential input integrator using the DVCCS/DVCVS, (b) The block diagram representation of the differential input integrator

By direct analysis it is seen that

$$V_o = \frac{1}{sT}(V_2 - V_1) \tag{3}$$

where

$$T = \frac{C}{\alpha G} \tag{4}$$

The block diagram representation of this differential input integrator is shown in Figure 1(b).

A noninverting integrator may be obtained from the generalized differential input integrator by shorting to ground the inverting input terminal of the DVCCS/DVCVS. On the other hand, the inverting integrator is obtained by shorting the noninverting input to ground.

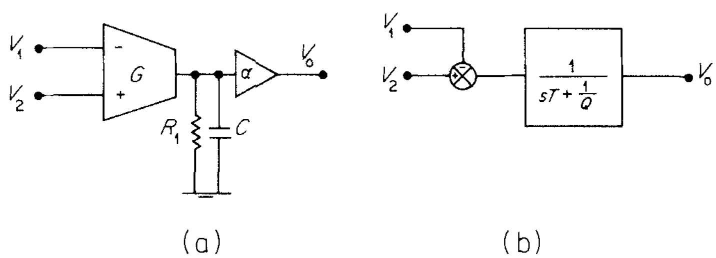

Figure 2. A lossy integrator, (a) Circuit realization, (b) Block diagram representation

Figure 2(a) represents a new realization of the differential input lossy integrator using the DVCCS/DVCVS. In this case

$$V_o = \frac{1}{(sT + 1/Q)}(V_2 - V_1) \tag{5}$$

where

$$Q = \alpha G R_1 \tag{6}$$

The block diagram representation of this lossy integrator is shown in Figure 2(b). It is seen that the grounded capacitor C controls the magnitude of T without affecting Q. The grounded resistor R_1 controls Q without affecting T of the integrator.

As an application to the active C differential input integrator a new noninverting active C lowpass filter is described in Figure 3.

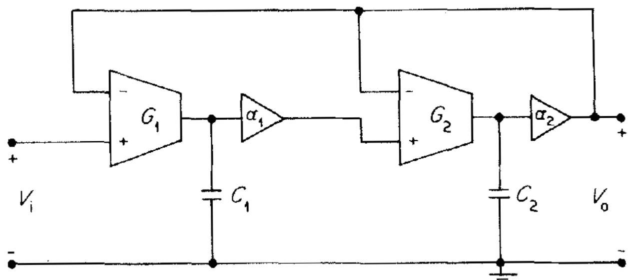

Figure 3. A novel canonic active C lowpass filter

Analysis of the circuit yields

$$\frac{V_o}{V_i}=\frac{\alpha_1\alpha_2G_1G_2}{s^2C_1C_2+s\alpha_2C_1G_2+\alpha_1\alpha_2G_1G_2} \tag{7}$$

The DC gain is unity: ω_0 and Q are given by

$$\omega_0=\sqrt{\frac{\alpha_1\alpha_2G_1G_2}{C_1C_2}} \tag{8}$$

$$Q=\sqrt{\frac{\alpha_1G_1C_2}{\alpha_2G_2C_1}} \tag{9}$$

From the above equations, it is seen that the ω_0 and the Q sensitivities to all circuit components are equal in magnitude to $\frac{1}{2}$. The disadvantage of this lowpass filter is that its Q cannot be tuned independently without affecting the ω_0.

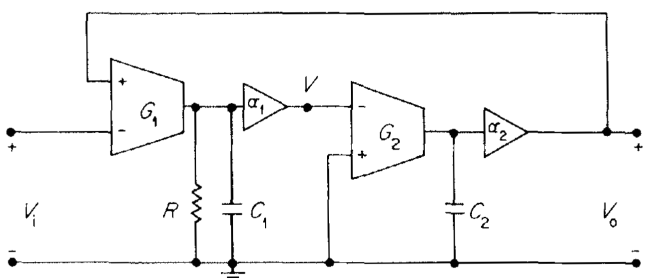

Figure 4. An inverting bandpass, noninverting lowpass active filter

In order to have independent control on the filter selectivity, the following new circuit, shown in Figure 4, is introduced. Analysis of the circuit yields

$$\frac{V_o}{V_i}=\frac{1}{s^2T_1T_2+(sT_2/Q_1)+1} \tag{10}$$

$$\frac{V}{V_i}=\frac{-sT_2}{s^2T_1T_2+(sT_2/Q_1)+1} \tag{11}$$

$$T_i=\frac{C_i}{\alpha_iG_i} \qquad (i=1,2) \tag{12}$$

$$Q_1=\alpha_1G_1R \tag{13}$$

From (12), (13), in (10) and (11) the ω_0 and Q of the filter are given by

$$\omega_0 = \sqrt{\frac{\alpha_1\alpha_2 G_1 G_2}{C_1 C_2}} \tag{14}$$

$$Q = R\sqrt{\frac{\alpha_1\alpha_2 G_1 G_2 C_1}{C_2}} \tag{15}$$

It is seen that the grounded resistor R controls the selectivity of the filter without affecting ω_0.

REFERENCES

1. M. Bialko, W. Sienko and R. W. Newcomb, 'Active synthesis using the DVCCS/DVCVS', *Int. J. Cir. Theor. Appl.* **2**, 23–38 (1974).
2. F. S. Atiya, A. M. Soliman and T. N. Saadawi, 'Active RC bandpass and lowpass filters using the DVCCS/DVCVS', *Electron Lett.* **12**, 360–361 (1976).
3. F. S. Atiya, A. M. Soliman and T. N. Saadawi, 'Active RC nonminimum phase network using the DVCCS/DVCVS, *Proc. IEEE*, **65**, 1606–1607 (1977).