# The second order LP filtering structures using the CCC

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***Abstract*** **Frequency filtration of electric analogue signals is a question that bothered engineers for many years. The filtered signal is mostly a voltage signal, however, it is of-ten necessary to design the structure for which parameters of transmission of other electric signals such as current are important. Very fast developing techniques of digital systems did not eliminate, as was thought, the need of the use of analogue systems, but only imposes on them very high requirements. Authors have proposed in this paper a new biquad low pass filtering structures with Controlled Current Conveyors.**

***Keywords*** **Controlled Current Conveyors, Operational Amplifiers, Analogue Filters.**

## I. Controlled Current Conveyors

A controlled current conveyor CCC is a universal wide-band analogue amplifier allowing for an alternative approach towards signal filtration on the basis of a classic operational amplifier OA taking filtration of current signals into consideration. Ideal equivalent circuit diagram on the basis of controlled source is shown in Fig. 1.

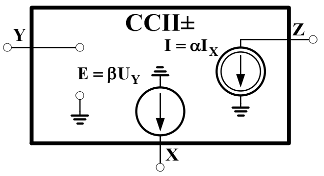


Fig. 1. Controlled Current Conveyor CCC

## II. Biquad LP Filtering Structures with One CCC

For the active realisation of LP filtering structures with one CCC depicted in Fig. 2 is sufficient.

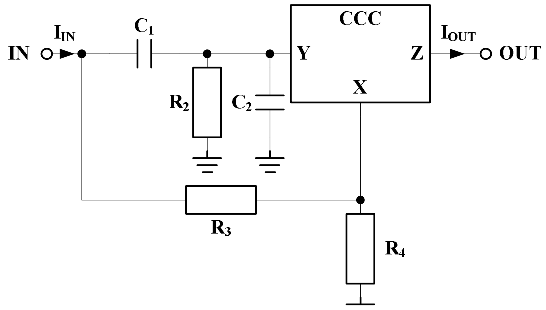


Fig. 2. Biquad LP filtering structures with one CCC

Transmittance of such a filter is given by formula:

$$K_i(s) = K_0 \cdot \frac{\omega_0^2}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}, \tag{1}$$

$$\omega_0^2 = \frac{G_2 G_3}{C_1 C_2}, \tag{2}$$

$$\frac{\omega_0}{Q} = \frac{C_1 G_2 + C_2 G_3 + C_1 G_3 (1-\beta)}{C_1 C_2}, \tag{3}$$

$$K_0 = -\alpha \tag{4}$$

and also assuming

$$G_4 = \frac{C_2 G_3 + C_1 G_3 (1-\beta)}{C_1 \beta} \tag{5}$$

## III. Biquad LP Filtering Structures with Two CCC

For the active realisation of LP filtering structures with two CCC depicted in Fig. 3 is sufficient.

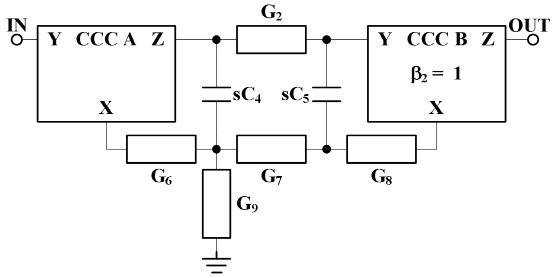


Fig. 3. Biquad LP filtering structures with two CCC

Transmittance of such a filter is given by formula (1) and:

$$\omega_0^2 = \frac{G_2 G_6 G_7 G_8 \alpha_1}{C_4 C_5 (G_2 + G_7)(G_6(\alpha_1 + 1) + G_9)}, \tag{6}$$

$$\frac{\omega_0}{Q} = \frac{G_2 (C_5 G_7 + C_4 (G_7 + G_8))}{C_4 C_5 (G_2 + G_7)}, \tag{7}$$

$$K_0 = G_9 \alpha_2 \beta_1 . \tag{8}$$

## IV. Conclusion

The application of such electronic analogue amplifiers in transmittance others than OA ones is necessity, associated mainly with the bandwidth [1]. One should not leave design work and searches of suitable systems consisting electronic amplifiers of various types such as a CCC proposed in the paper [2], [3]. One cannot forget that the world surrounding us is dominated by analogue signals and analogue electronics cannot be disregarded and only analogue systems allowing for unconstrained cooperation with new and commonly used systems of digital electronics should be searched.

## V. References

[1] Fliege, N.: A new class of second order RC-active filters with two operational amplifiers. Patent P 23 17 644.5, Germany 1973.

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[3] Holajn, P., Sztymelski, K.: Hybrid six-input operational transconductance amplifier. Conference AMTEE '11, Klatovy. Plzen 2011.