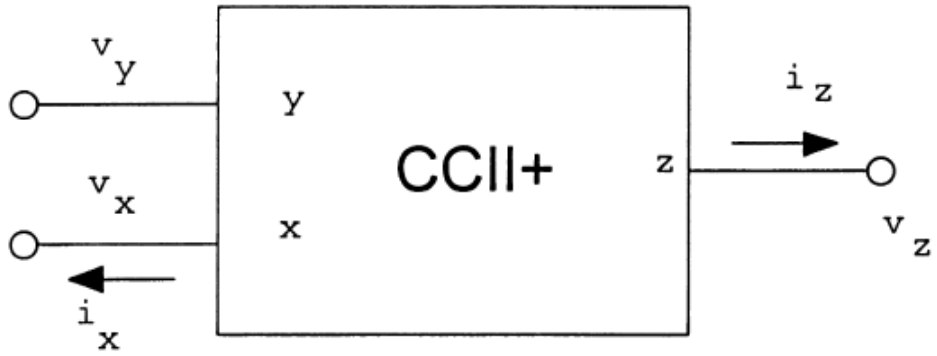
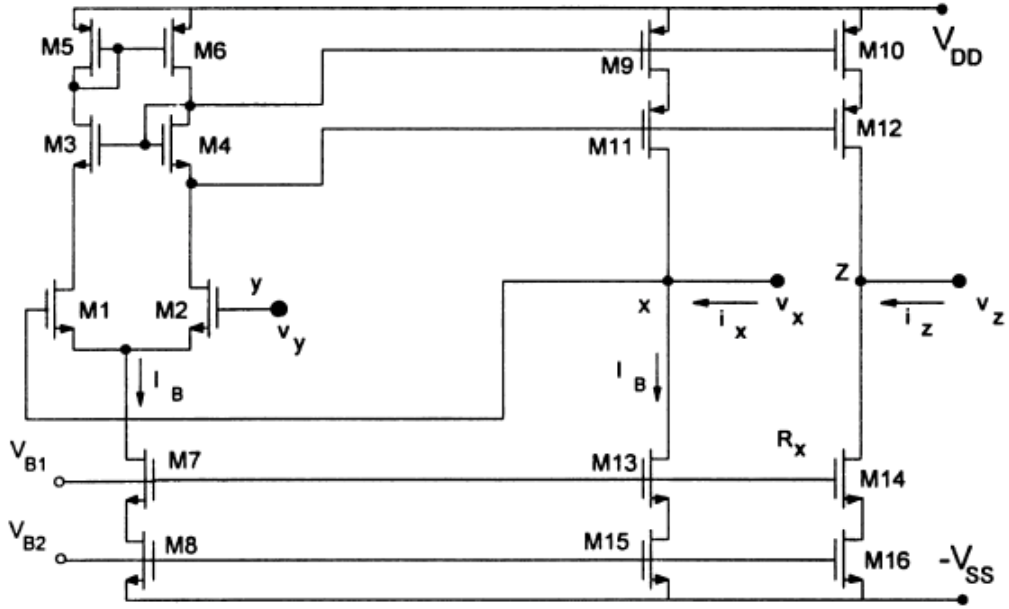
Akım Taşıyıcı Tabanlı Gerilim Modlu Aktif Süzgeçlerde Giriş Gerilimi Kısıtlaması

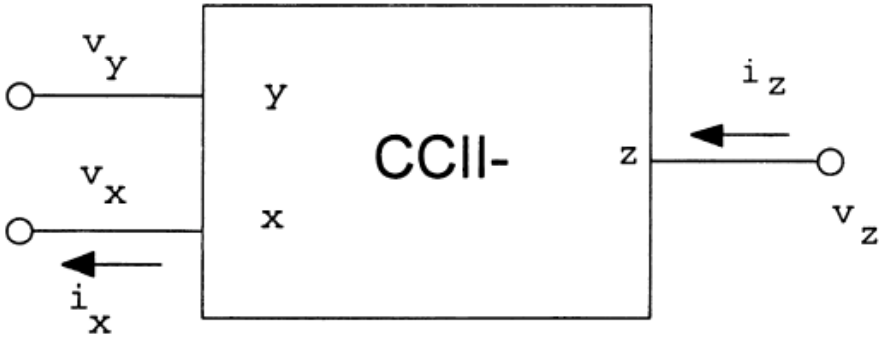
Akım Taşıyıcı
CCII+



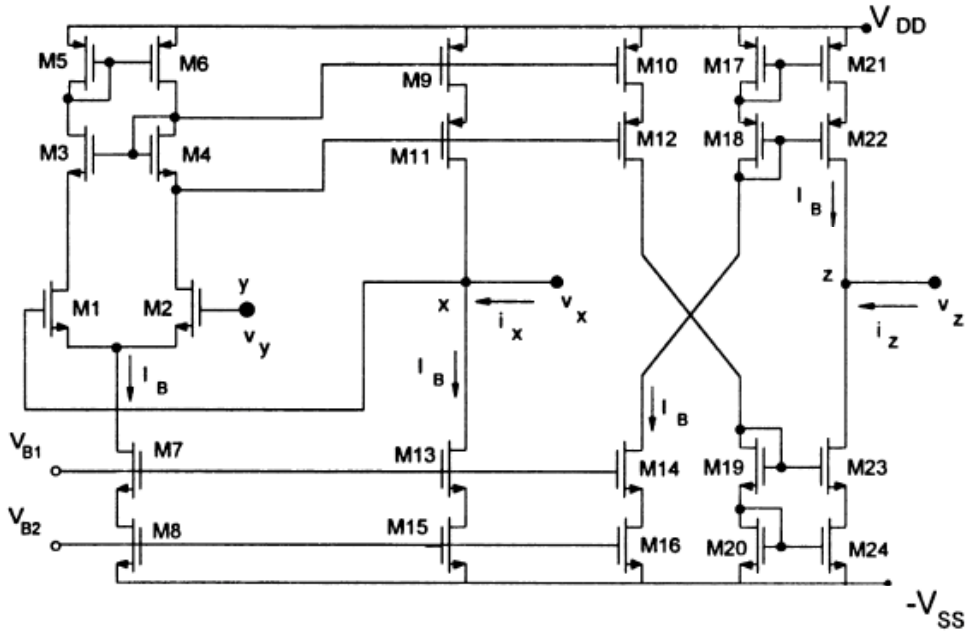
(a)



Akım Taşıyıcı CCII-



(b)



İkinci Kuşak Akım Taşıyıcı Bağıntılar

$$i_y(\mathrm{t}) = 0$$

$$v_x(\mathrm{t}) = v_y(\mathrm{t})$$

$$i_z(\mathrm{t}) = \pm\, i_x(\mathrm{t})$$

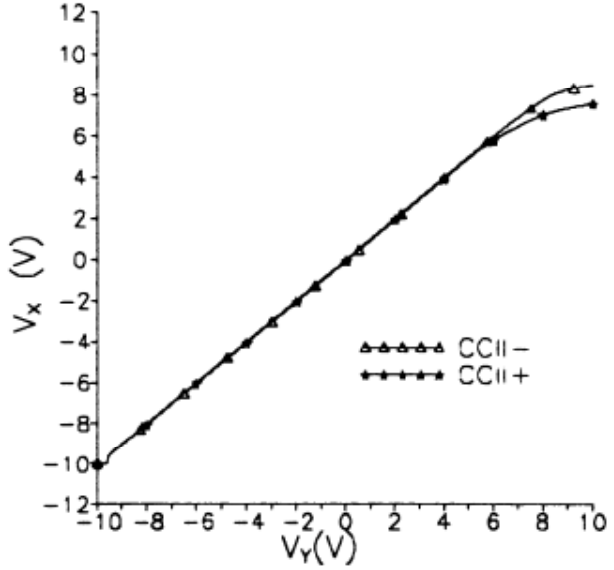
İkinci Kuşak Akım Taşıyıcı,
Uç Büyüklüklerin Sınır Değerleri

$$V_{xm-} \le v_x(t) \le V_{xm+}$$

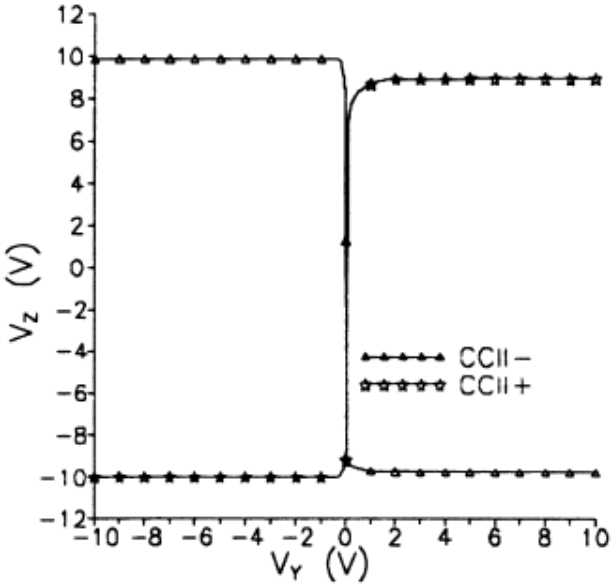
$$V_{zm-} \le v_z(t) \le V_{zm+}$$

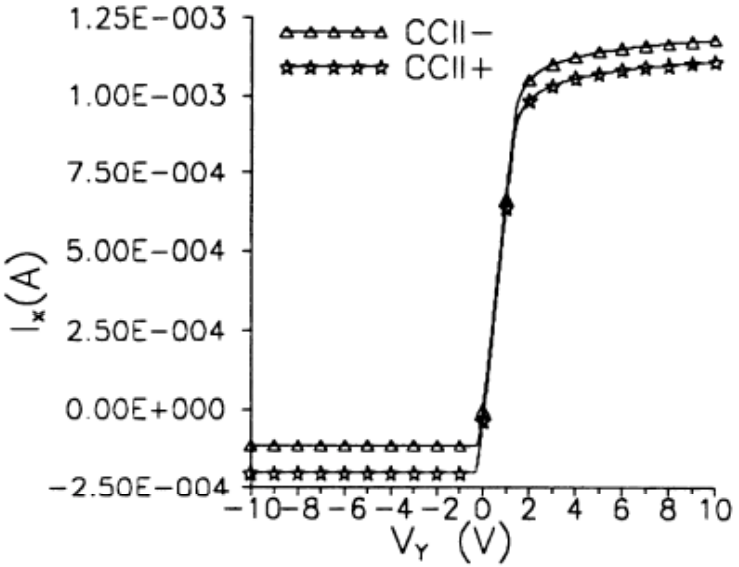
$$I_{xm-} \le i_x(t) \le I_{xm+}$$

İkinci Kuşak Akım Taşıyıcı, Karakteristikler



(a)





n akım taşıyıcı ile kurulan süzgeç

$$|V_{\mathrm{i}}|.|T_{xk}| \leq V_{\mathrm{s}xk}$$

$$|V_{\mathrm{i}}|.|T_{zk}| \leq V_{\mathrm{s}zk}, \quad k = 1, 2, \ldots, n$$

$$|V_{\mathrm{i}}|.|Y_{xk}| \leq I_{\mathrm{s}xk}$$

$$T_{xk} = \frac{V_{xk}(j\omega)}{V_{\mathrm{i}}}, \quad k = 1, 2, \ldots, n$$

Bağıntıdaki Büyüklükler

- Vi giriş gerilimi
- Txk: k. Akım taşıyıcının x çıkışına kadar gerilim kazancı
- Vsxk: k. Akım taşıyıcının x ucundaki sınır gerilim
- Tzk: k. Akım taşıyıcının z ucuna kadar gerilim kazancı
- Vszk: k. Akım taşıyıcının z ucundaki sınır gerilim
- Yxk: k. Akım taşıyıcının x ucuna kadar geçiş admittansı
- Isxk: k. Akım taşıyıcının x ucundaki akım sınırı

$$T_{xk} = \frac{V_{xk}(j\omega)}{V_{\mathrm{i}}}, \quad k = 1, 2, \ldots, n$$

$$T_{zk} = \frac{V_{zk}(j\omega)}{V_{\mathrm{i}}}, \quad k = 1, 2, \ldots, n$$

$$Y_{xk} = \frac{I_{xk}(j\omega)}{V_{\mathrm{i}}}, \quad k = 1, 2, \ldots, n$$

Aşağıdaki 3 eşitsizlik sağlanmalı

$$|V_{\mathrm{i}}| \leq \frac{V_{\mathrm{s}xk}}{|T_{xk}|}$$

$$|V_{\mathrm{i}}| \leq \frac{V_{\mathrm{s}zk}}{|T_{zk}|}$$

$$|V_{\mathrm{i}}| \leq \frac{I_{\mathrm{s}xk}}{|Y_{xk}|}$$

Maksimum Giriş Gerilimi

$$\left|V_{\mathrm{i}}\right|_{\max}$$

$$= \min\left\{ \frac{V_{\mathrm{s}xk}}{\left|T_{xk}\right|_{\max}}, \frac{V_{\mathrm{s}zk}}{\left|T_{zk}\right|_{\max}}, \frac{I_{\mathrm{s}xk}}{\left|Y_{xk}\right|_{\max}}, k = 1, 2, \ldots, n \right\}$$

$$\omega \in \left(\omega_1, \omega_2\right)$$

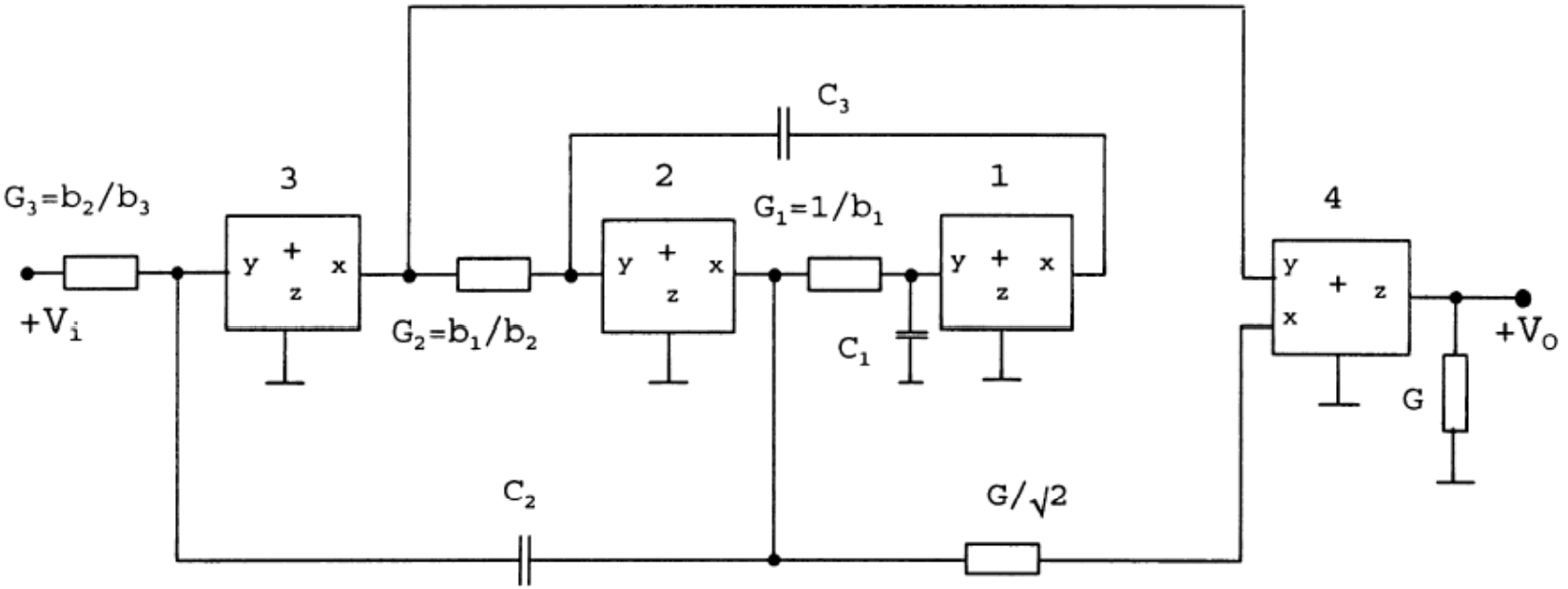
Akım taşıyıcıların birbirinin eşi olmaları halinde

$$V_{sx}, V_{sz}, I_{sx}$$

$$|V_i|_{max} = \min\left\{ \frac{V_{sx}}{|T_{xk}|_{max}}, \frac{V_{sz}}{|T_{zx}|_{max}}, \frac{I_{sx}}{|Y_{xk}|_{max}}, k = 1, 2, \ldots, n \right\},$$

$$\omega \in (\omega_1, \omega_2)$$

Örnek: 3. derece aktif süzgeç, Butterworth



$R_1 = 40\ \text{k}\Omega \quad R_2 = 20\ \text{k}\Omega \quad R_3 = 10\ \text{k}\Omega \quad R = 20\ \text{k}\Omega$

$C_1 = 50\ \text{pF}, \quad C_2 = 50\ \text{pF} \quad C_3 = 50\ \text{pF}$

$\omega_p = 10^6\ \text{rad sec}^{-1}$

$$V_{sx} = 7.94\ \text{V}$$

$$V_{sz} = 9.1\ \text{V}$$

$$I_{sx} = 116\ \mu\text{A}$$

$$T_{zi} = \frac{V_{zi}}{V_i} = 0,\ \ i = 1, 2, 3$$

$$T_{z4} = \frac{V_{z4}}{V_i} = \frac{\sqrt{2}(j\omega)^2}{D(j\omega)}$$

$$T_{x1} = \frac{V_{x1}}{V_i} = \frac{1}{D(j\omega)}$$

$$Y_{x1} = \frac{I_{x1}}{V_i} = j\omega C_3 \left(T_{x1} - T_{x2}\right)$$

$$T_{x2} = \frac{V_{x2}}{V_i} = (1 + j\omega C_1 b_1) \cdot T_{x1}$$

$$T_{x3} = \frac{V_{x3}}{V_i} = \left(1 + j\omega C_3 \frac{b_2}{b_1}\right) \cdot T_{x2} - j\omega C_3 \frac{b_2}{b_1} T_{x1}$$

$$T_{x4} = \frac{V_{x4}}{V_i} = T_{x3}$$

$$Y_{x2} = \frac{I_{x2}}{V_{\mathrm{i}}} = j\omega C_2 \left(T_{x2} - T_{x3}\right) + \frac{1}{b_1}\left(T_{x2} - T_{x1}\right) + \frac{G}{\sqrt{2}}\left(T_{x2} - T_{x4}\right)$$

$$Y_{x3} = \frac{I_{x3}}{V_{\mathrm{i}}} = \frac{b_1}{b_2}\left(T_{x3} - T_{x2}\right)$$

$$Y_{x4} = \frac{I_{x4}}{V_{\mathrm{i}}} = G.T_{z4}$$

$$D(j\omega) = b_3(j\omega)^3 + b_2(j\omega)^2 + b_1(j\omega) + 1$$

$$\left| T_{x1}(j\omega) \right|_{\max} = 1 \qquad \left| Y_{x1}(j\omega) \right|_{\max} = 72.516\ \mu\text{A V}^{-1}$$

$$\left| T_{x2}(j\omega) \right|_{\max} = 1.677 \qquad \left| Y_{x2}(j\omega) \right|_{\max} = 127.636\ \mu\text{A V}^{-1}$$

$$\left| T_{x3}(j\omega) \right|_{\max} = 1.58 \qquad \left| Y_{x3}(j\omega) \right|_{\max} = 72.658\ \mu\text{A V}^{-1}$$

$$\left| T_{x4}(j\omega) \right|_{\max} = 1.58 \qquad \left| Y_{x4}(j\omega) \right|_{\max} = 51.334\ \mu\text{A } V^{-1}$$

$$\left| T_{zi}(j\omega) \right|_{\max} = 0 \quad i = 1, 2, 3$$

$$\left| T_{z4}(j\omega) \right|_{\max} = 1.027$$

$$\left| V_{\text{i}} \right|_{\max} = \min\{6.7\text{ V}, 4\text{ V}, 4.24\text{ V}, 4.24\text{ V}, 6.98\text{ V}, 2.81\text{ V},$$
$$1.6\text{ V}, 2.8\text{ V}, 3.97\text{ V}\}$$

$$\left| V_{\text{i}} \right|_{\max} = 1.6\text{ V}$$

Akım Taşıyıcı Tabanlı Akım Modlu Aktif Süzgeçlerde Giriş Akımı Kısıtlaması

n akım taşıyıcı ile kurulan süzgeç

$$|V_{xk}| \leq V_{sxk}$$

$$|V_{zk}| \leq V_{szk} \quad k = 1, 2, ..., n$$

$$|I_{xk}| \leq I_{sxk}$$

$$\omega \in (\omega_1, \omega_2)$$

$$|I_{in}| \leq \frac{V_{sxk}}{|Z_{xk}|} \quad |I_{in}| \leq \frac{V_{szk}}{|Z_{in}|} \quad |I_{in}| \leq \frac{I_{sxk}}{|A_{in}|}$$
$$k = 1, 2, ..., n$$

$$Z_{xk} = \frac{V_{xk}(j\omega)}{I_{in}} \quad Z_{zk} = \frac{V_{zk}(j\omega)}{I_{in}} \quad A_{xk} = \frac{I_{xk}(j\omega)}{I_{in}}$$
$$k = 1, 2, ..., n$$

$$|I_{in}|_{max} =$$

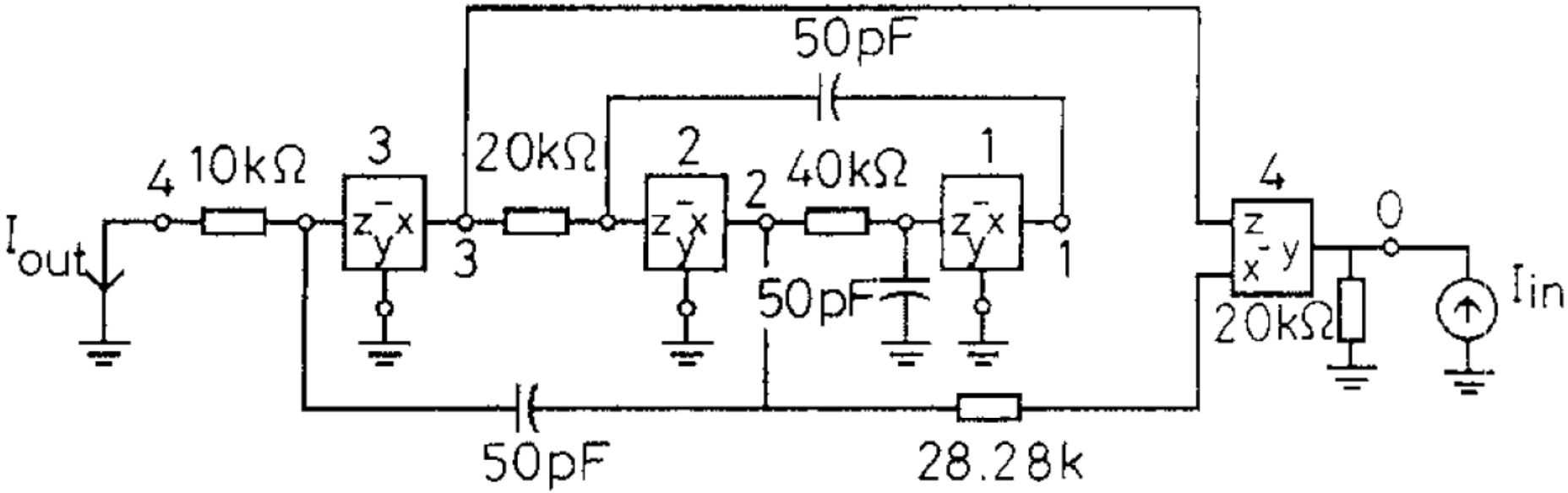
$$\min\left\{ \frac{V_{sxk}}{|Z_{xk}|_{max}}, \frac{V_{szk}}{|Z_{zx}|_{max}}, \frac{I_{sxk}}{|A_{xk}|_{max}}, k = 1, 2, ..., n \right\}$$

$$\omega \in (\omega_1, \omega_2)$$

$|Z_{xk}|_{max}$, $|Z_{zk}|_{max}$, $|A_{xk}|_{max}$ büyüklükleri

$|Z_{xk}|$, $|Z_{zk}|$, $|A_{xk}|$ için maksimum değerler

Örnek: 3. derece aktif süzgeç, Butterworth



$$\omega_p = 10^6 \text{ rad sec}^{-1}$$

$$\frac{I_{out}}{I_{in}} = \left. \frac{\sqrt{2}S^2}{S^3 + 2S^2 + 2S + 1} \right|_{S=s/\omega_p}$$

CCII+

$$-9.5\ \text{V} \leq v_x(t) \leq 6.7\ \text{V} \quad -9.31\ \text{V} \leq v_z(t) \leq 7.17\ \text{V}$$
$$-204\ \mu\text{A} \leq i_x(t) \leq 1.1\ \text{mA}$$

CCII–

$$-9.5\ \text{V} \leq v_x(t) \leq 7.94\ \text{V} \quad -9.3\ \text{V} \leq v_z(t) \leq 9.1\ \text{V}$$
$$-116\ \mu\text{A} \leq i_x(t) \leq 1.12\ \text{mA}$$

$$|Z_{xi}(j\omega)|_{max} = 0, i = 1, 2, 3 \quad |Z_{x4}(j\omega)|_{max} = 20 \text{ k}\Omega$$
$$|Z_{z1}(j\omega)|_{max} = 20.19 \text{ k}\Omega$$
$$|Z_{z2}(j\omega)|_{max} = 23.4 \text{ k}\Omega \quad |Z_{z3}(j\omega)|_{max} = 10 \text{ k}\Omega$$
$$|Z_{z4}(j\omega)|_{max} = 0 \text{ k}\Omega$$
$$|A_{x1}(j\omega)|_{max} = 1.11 \quad |A_{x2}(j\omega)|_{max} = 1.56$$
$$|A_{x3}(j\omega)|_{max} = 1.17 \quad |A_{x4}(j\omega)|_{max} = 0.69$$

$$|I_i|_{max} = \min\{\infty, \infty, \infty, 397\ \mu\text{A}, 450\ \mu\text{A}, 388\ \mu\text{A}, \infty,$$
$$104.6\ \mu\text{A}, 74.4\ \mu\text{A}, 99.3\ \mu\text{A}, 167\ \mu\text{A}\} = 74.4\ \mu\text{A}$$

KAYNAKLAR

C. Acar and H. Kuntman: Limitations on input signal level in voltage-mode active-RC filters using current conveyors, Microelectronics Journal, Vol.30, No. 1, pp.69-76, 1999.

C. Acar, H. Kuntman, Limitations on input signal level in current-mode active-RC filters using CCIIs, Electronics Letters, Vol.32, 16, pp.1461-1462, 1996.