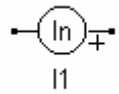
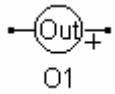
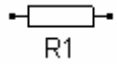
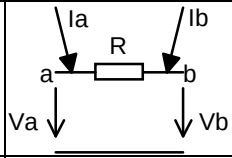
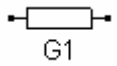
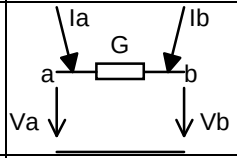
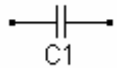
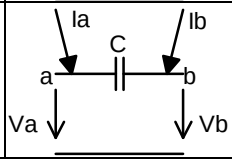
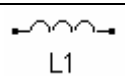
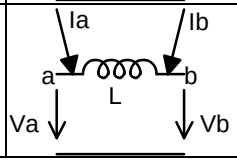
# Prvky z knihovny programu SNAP 2.6, aktualizace z 1.7.2004

Schématické značky jsou definovány v souboru **SNAP.LIB**.
Matematické modely jsou definovány v souboru **SNAP.CDL**.
Maticový popis je vyjádřen zkráceným schématem dle vzoru:

$$\begin{bmatrix} I_a \\ I_b \\ I_c \\ I_d \\ 0 \end{bmatrix} = \begin{bmatrix} a & b & c & d & e \\ f & g & h & i & j \\ k & l & m & n & o \\ p & q & r & s & t \\ u & v & w & x & y \end{bmatrix} . \begin{bmatrix} V_a \\ V_b \\ V_c \\ V_d \\ I_2 \end{bmatrix} \Rightarrow \left[\begin{array}{c|ccccc} & V_a & V_b & V_c & V_d & I_2 \\ \hline I_a & a & b & c & d & e \\ I_b & f & g & h & i & j \\ I_c & k & l & m & n & o \\ I_d & p & q & r & s & t \\ & u & v & w & x & y \end{array}\right] .$$

| *prvek* | *označení* | *značka* | *parametry* | *model* | *maticový popis* |
|---|---|---|---|---|---|
| vstup | *input* |  | - | | |
| výstup | *output* |  | - | | |
| rezistor | $R$ |  | R - odpor |  | $\left[\begin{array}{c\|cc} & V_a & V_b \\ \hline I_a & 1/R & -1/R \\ I_b & -1/R & 1/R \end{array}\right]$ |
| konduktor | $G$ |  | G - vodivost |  | $\left[\begin{array}{c\|cc} & V_a & V_b \\ \hline I_a & G & -G \\ I_b & -G & G \end{array}\right]$ |
| kapacitor | $C$ |  | C - kapacita |  | $\left[\begin{array}{c\|cc} & V_a & V_b \\ \hline I_a & sC & -sC \\ I_b & -sC & sC \end{array}\right]$ |
| induktor | $L$ |  | L - indukčnost |  | $\left[\begin{array}{c\|cc} & V_a & V_b \\ \hline I_a & 1/sL & -1/sL \\ I_b & -1/sL & 1/sL \end{array}\right]$ |

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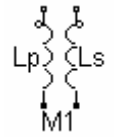
<td>obvod<br>s vzájemnou<br>indukčností</td>
<td>M</td>
<td> 
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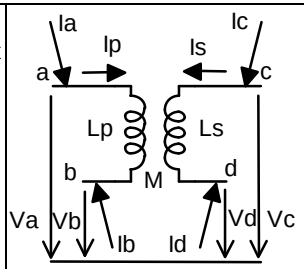
<td>Lp – primární indukčnost<br>Ls – sekundární indukčnost<br>M – vzájemná indukčnost</td>
<td> 
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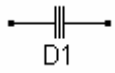
<td> 
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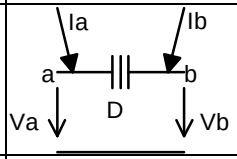
<td> 
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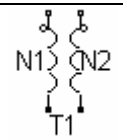
<td> 
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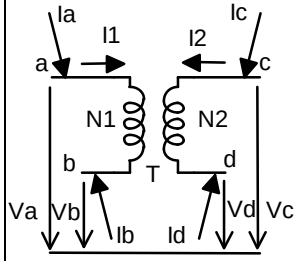
<td> 
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<td>tranzistor s H-<br>parametry</td>
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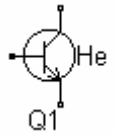
<td> 
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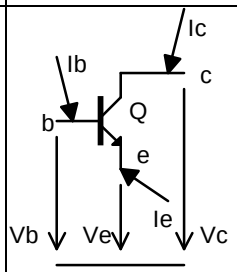
<td>h11e, h12e, h21e, h22e –<br>H-parametry tranzistoru<br>v zapojení se společným<br>emitorem<br>$y_{11} = 1/h_{11}$<br>$y_{12} = -h_{12}/h_{11}$<br>$y_{21} = h_{21}/h_{11}$<br>$y_{22} = h_{22} - h_{12}h_{21}/h_{11}$</td>
<td> 
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<tr><td>$I_c$</td><td>$y_{21}$</td><td>$y_{22}$</td><td>$-y_{21}-y_{22}$</td></tr>
<tr><td>$I_e$</td><td>$-y_{11}-y_{21}$</td><td>$-y_{12}-y_{22}$</td><td>$y_{11}+y_{12}+y_{21}+y_{22}$</td></tr>
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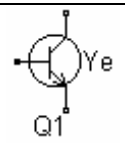
<td> 
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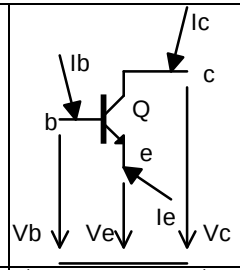
<td>y11e, y12e, y21e, y22e – Y-parametry tranzistoru v zapojení se společným emitorem</td>
<td> 
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<tr><td>$I_c$</td><td>$y_{21}$</td><td>$y_{22}$</td><td>$-y_{21}-y_{22}$</td></tr>
<tr><td>$I_e$</td><td>$-y_{11}-y_{21}$</td><td>$-y_{12}-y_{22}$</td><td>$y_{11}+y_{12}+y_{21}+y_{22}$</td></tr>
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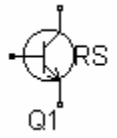
<td>tranzistor – zjednodušený model pro výpočty v nf pásmu</td>
<td>Transistor_RS</td>
<td> 
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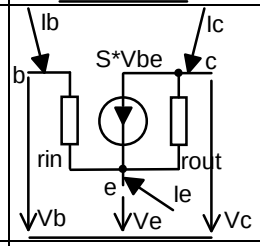
<td>rin – vstupní odpor B-E<br>S – strmost Ic/Uce<br>rout - výstupní odpor C-E</td>
<td> 
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<tr><td>$I_e$</td><td>$S-1/r_{in}$</td><td>$-1/r_{out}$</td><td>$1/r_{in}+1/r_{out}-S$</td></tr>
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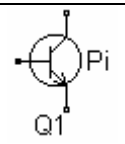
<td>Π - model bipolárního tranzistoru</td>
<td>Transistor_Pi</td>
<td> 
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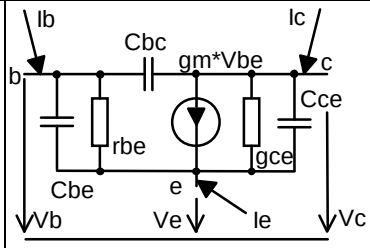
<td>rbe - vstupní odpor B-E<br>gm - strmost Ic/Uce<br>gce – výstupní vodivost C-E<br>Cbe – kapacita B-E<br>Cbc – kapacita B-C<br>Cce – kapacita C-E</td>
<td> 
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<tr><td>$I_c$</td><td>$-sC_{bc}+g_m$</td><td>$s(C_{ce}+C_{bc})+g_{ce}$</td><td>$-g_m-g_{ce}-sC_{ce}$</td></tr>
<tr><td>$I_e$</td><td>$-g_{be}-g_m-sC_{be}$</td><td>$-g_{ce}-sC_{ce}$</td><td>$g_m+g_{ce}+g_{be}+s(C_{ce}+C_{be})$</td></tr>
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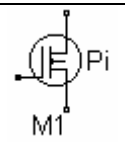
<td> 
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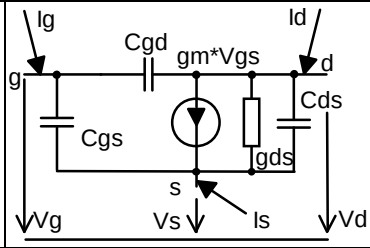
<td>gm - strmost Id/Uds<br>gds – vstupní vodivost D-S<br>Cgs – kapacita G-S<br>Cgd – kapacita G-D<br>Cds – kapacita D-S</td>
<td> 
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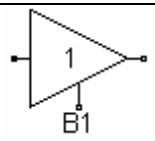
<td> 
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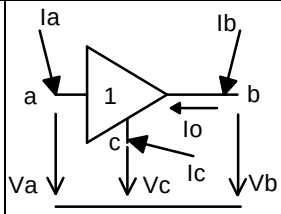
<td> 
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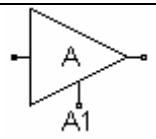
<td> 
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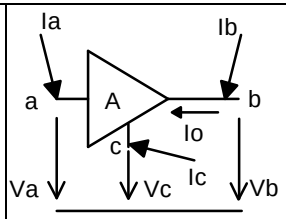
<td> 
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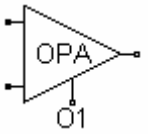
<td> 
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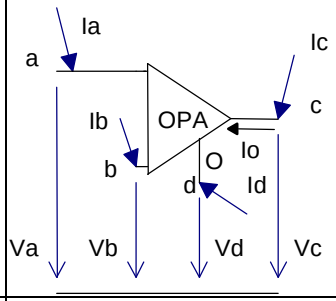
<td> 
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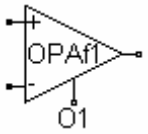
<td> 
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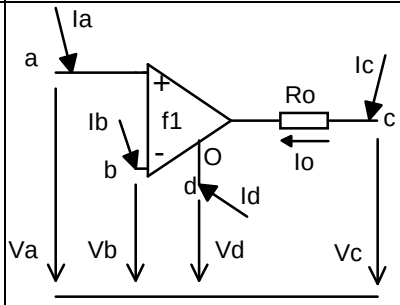
<td> 
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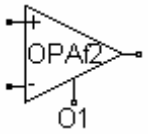
<td> 
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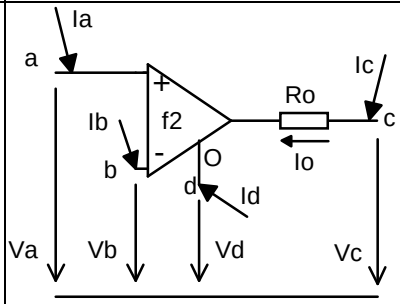
<td> 
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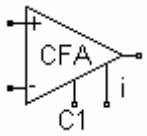
<td> 
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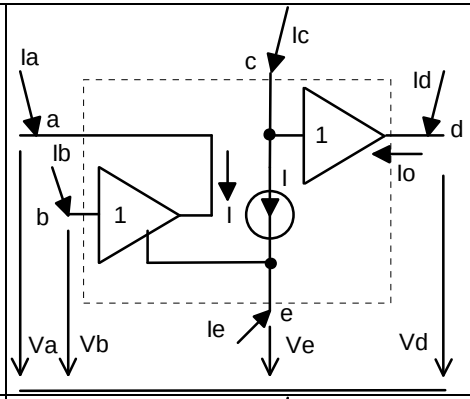
<td> 
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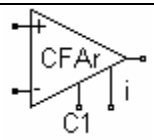
<td> 
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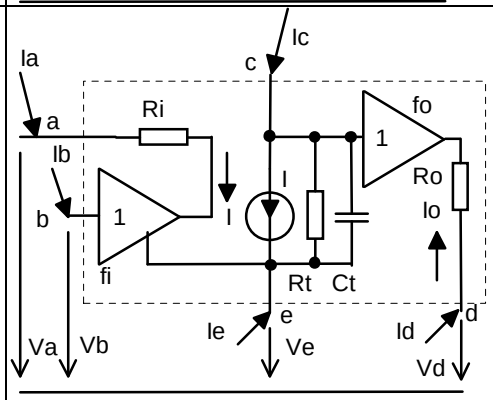
<td> 
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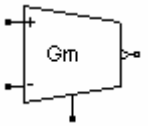
<td> 
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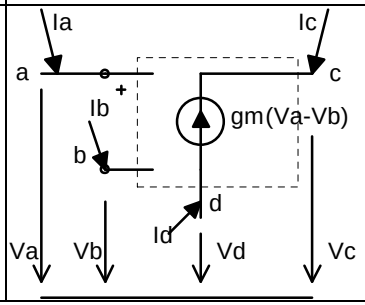
<td> 
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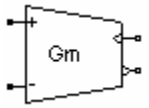
<td> 
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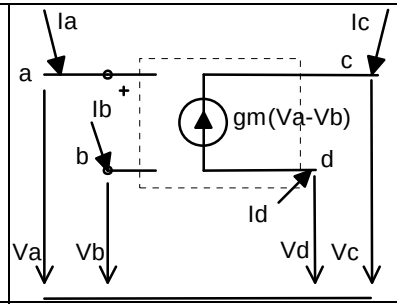
<td> 
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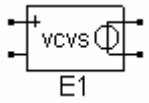
<td> 
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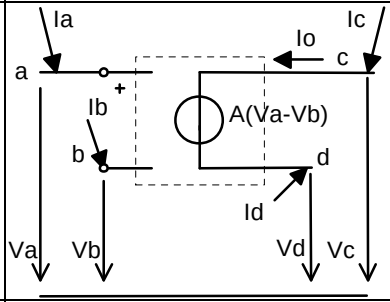
<td> 
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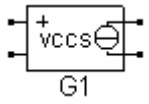
<td> 
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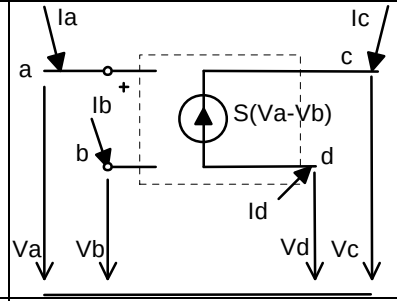
<td> 
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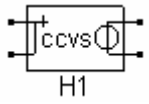
<td> 
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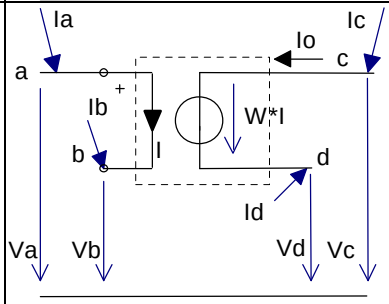
<td> 
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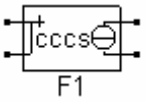
<td> 
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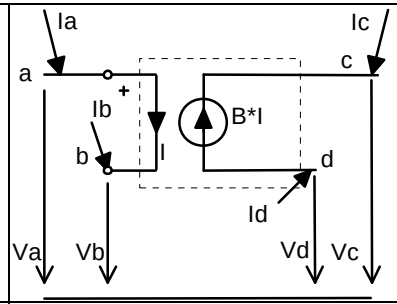
<td> 
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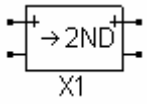
<td> 
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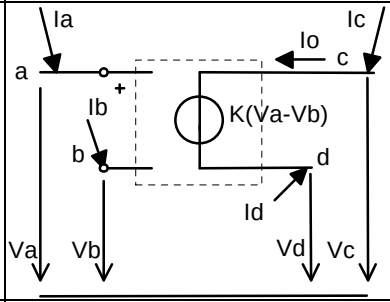
<td>a2, a1, a0 – koeficienty čitatele přenosové funkce<br>b2, b1, b0 – koeficienty jmenovatele přenosové funkce<br>$K = \frac{a_2 s^2 + a_1 s + a_0}{b_2 s^2 + b_1 s + b_0}$</td>
<td> 
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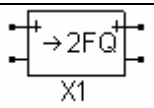
<td> 
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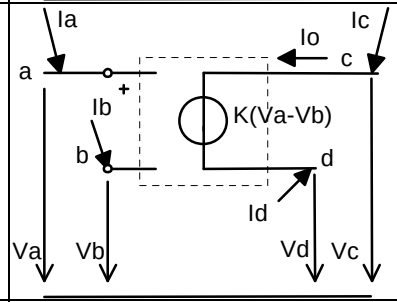
<td> 
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<tr><td></td><td>$K$</td><td>$-K$</td><td>$-1$</td><td>1</td><td></td></tr>
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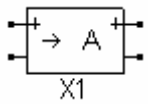
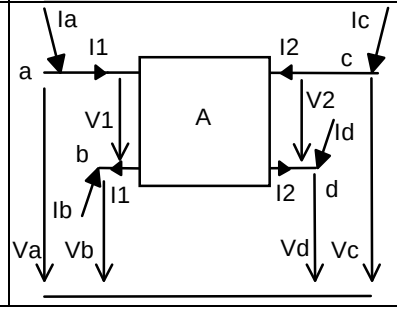
<td>dvojbran popsaný parametry A</td>
<td>2-port_A</td>
<td> 
</td>
<td>a11, a12, a21, a22 – přímé kaskádní parametry<br>$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & V_2 \\ a_{21} & a_{22} & -I_2 \end{bmatrix}$<br>$y_{11} = a_{22} / a_{12}$<br>$y_{12} = a_{21} - a_{11}a_{22} / a_{12}$<br>$y_{21} = -1 / a_{12}$<br>$y_{22} = a_{11} / a_{12}$</td>
<td> 
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<tr><td></td><td>$V_a$</td><td>$V_b$</td><td>$V_c$</td><td>$V_d$</td></tr>
<tr><td>$I_a$</td><td>$y_{11}$</td><td>$-y_{11}$</td><td>$y_{12}$</td><td>$-y_{12}$</td></tr>
<tr><td>$I_b$</td><td>$-y_{11}$</td><td>$y_{11}$</td><td>$-y_{12}$</td><td>$y_{12}$</td></tr>
<tr><td>$I_c$</td><td>$y_{21}$</td><td>$-y_{21}$</td><td>$y_{22}$</td><td>$-y_{22}$</td></tr>
<tr><td>$I_d$</td><td>$-y_{21}$</td><td>$y_{21}$</td><td>$-y_{22}$</td><td>$y_{22}$</td></tr>
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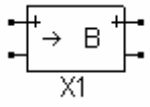
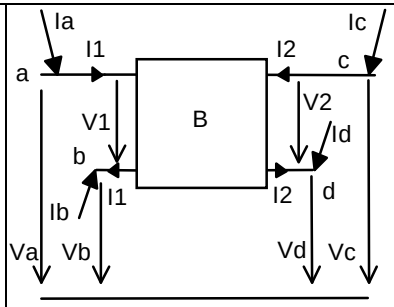
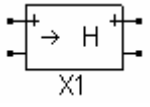
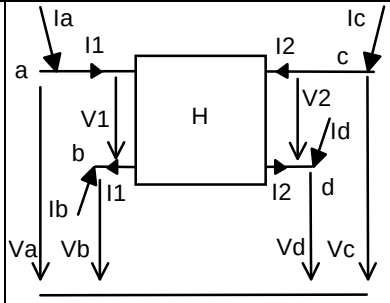
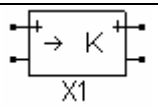
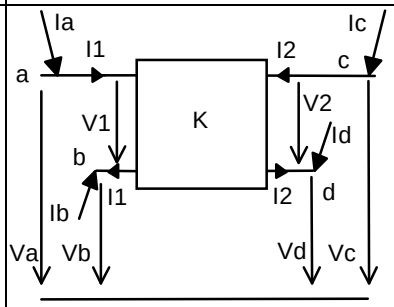
|---|---|---|---|---|---|
| dvojbran popsaný parametry B | *2-port_B* |  | b11, b12, b21, b22 – zpětné kaskádní parametry<br>$\begin{bmatrix} V_2 \\ -I_2 \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ I_1 \end{bmatrix}$<br>$y_{11} = -b_{11} / b_{12}$<br>$y_{12} = -1 / b_{12}$<br>$y_{21} = b_{11}b_{22} / b_{12} - b_{21}$<br>$y_{22} = -b_{22} / b_{12}$ |  | $\begin{array\|cccc} & V_a & V_b & V_c & V_d \\ \hline I_a & y_{11} & -y_{11} & y_{12} & -y_{12} \\ I_b & -y_{11} & y_{11} & -y_{12} & y_{12} \\ I_c & y_{21} & -y_{21} & y_{22} & -y_{22} \\ I_d & -y_{21} & y_{21} & -y_{22} & y_{22} \end{array}$ |
| dvojbran popsaný parametry H | *2-port_H* |  | h11, h12, h21, h22 – paralelně-sériové hybridní parametry<br>$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$<br>$y_{11} = 1 / h_{11}$<br>$y_{12} = -h_{12} / h_{11}$<br>$y_{21} = h_{21} / h_{11}$<br>$y_{22} = h_{22} - h_{12}h_{21} / h_{11}$ |  | $\begin{array\|cccc} & V_a & V_b & V_c & V_d \\ \hline I_a & y_{11} & -y_{11} & y_{12} & -y_{12} \\ I_b & -y_{11} & y_{11} & -y_{12} & y_{12} \\ I_c & y_{21} & -y_{21} & y_{22} & -y_{22} \\ I_d & -y_{21} & y_{21} & -y_{22} & y_{22} \end{array}$ |
| dvojbran popsaný parametry K | *2-port_K* |  | k11, k12, k21, k22 – sériově-paralelní hybridní parametry<br>$\begin{bmatrix} I_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ I_2 \end{bmatrix}$<br>$y_{11} = k_{11} - k_{12}k_{21} / k_{22}$<br>$y_{12} = k_{12} / k_{22}$<br>$y_{21} = -k_{21} / k_{22}$<br>$y_{22} = 1 / k_{22}$ |  | $\begin{array\|cccc} & V_a & V_b & V_c & V_d \\ \hline I_a & y_{11} & -y_{11} & y_{12} & -y_{12} \\ I_b & -y_{11} & y_{11} & -y_{12} & y_{12} \\ I_c & y_{21} & -y_{21} & y_{22} & -y_{22} \\ I_d & -y_{21} & y_{21} & -y_{22} & y_{22} \end{array}$ |

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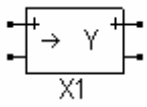
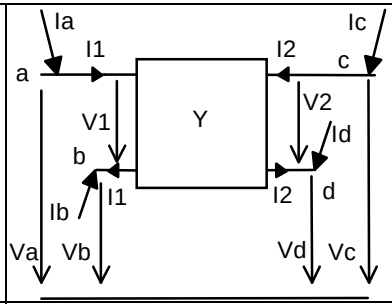
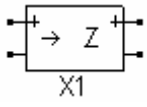
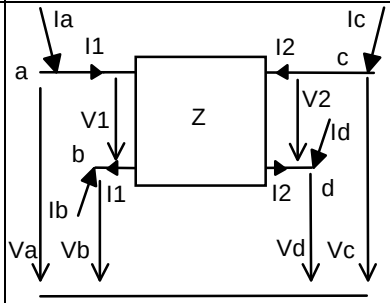
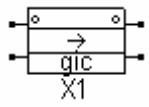
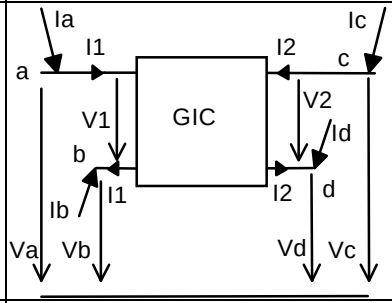
<td>dvojbran popsaný parametry Y</td>
<td>2-port_Y</td>
<td> 
</td>
<td>y11, y12, y21, y22 – admitanční parametry<br>$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$</td>
<td> 
</td>
<td>$\begin{array}{c|cccc} & V_a & V_b & V_c & V_d \\ \hline I_a & y_{11} & -y_{11} & y_{12} & -y_{12} \\ I_b & -y_{11} & y_{11} & -y_{12} & y_{12} \\ I_c & y_{21} & -y_{21} & y_{22} & -y_{22} \\ I_d & -y_{21} & y_{21} & -y_{22} & y_{22} \end{array}$</td>
</tr>
<tr>
<td>dvojbran popsaný parametry Z</td>
<td>2-port_Z</td>
<td> 
</td>
<td>z11, z12, z21, z22 – impedanční parametry<br>$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$</td>
<td> 
</td>
<td>$\begin{array}{c|ccccc} & V_a & V_b & V_c & V_d & I_2 \\ \hline I_a & 1/z_{11} & -1/z_{11} & & & -z_{12}/z_{11} \\ I_b & -1/z_{11} & 1/z_{11} & & & z_{12}/z_{11} \\ I_c & & & & & 1 \\ I_d & & & & & -1 \\ & z_{21}/z_{11} & -z_{21}/z_{11} & -1 & 1 & z_{22}-z_{12}z_{21}/z_{11} \end{array}$</td>
</tr>
<tr>
<td>obecný impedanční konvertor</td>
<td>GIC</td>
<td> 
</td>
<td>a11, a22 – kaskádní parametry<br>$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} a_{11} & 0 \\ 0 & a_{22} \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$</td>
<td> 
</td>
<td>$\begin{array}{c|cccccc} & V_a & V_b & V_c & V_d & I_2 \\ \hline I_a & & & & & -a_{22} \\ I_b & & & & & a_{22} \\ I_c & & & & & 1 \\ I_d & & & & & -1 \\ & -1 & 1 & a_{11} & -a_{11} & \end{array}$</td>
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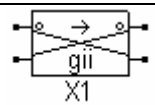
<tr>
<td>obecný impedanční invertor</td>
<td>GII</td>
<td> 
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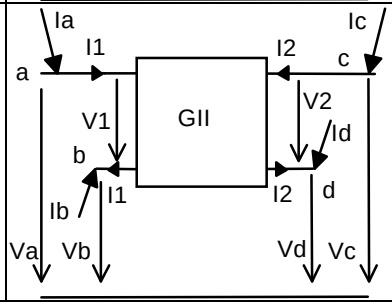
<td>a12, a21 – kaskádní parametry<br>$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} 0 & a_{12} \\ a_{21} & 0 \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$</td>
<td> 
</td>
<td>$\begin{array}{c|cccc} & V_a & V_b & V_c & V_d \\ \hline I_a & & & a_{21} & -a_{21} \\ I_b & & & -a_{21} & a_{21} \\ I_c & -1/a_{12} & 1/a_{12} & & \\ I_d & 1/a_{12} & -1/a_{12} & & \end{array}$</td>
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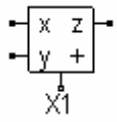
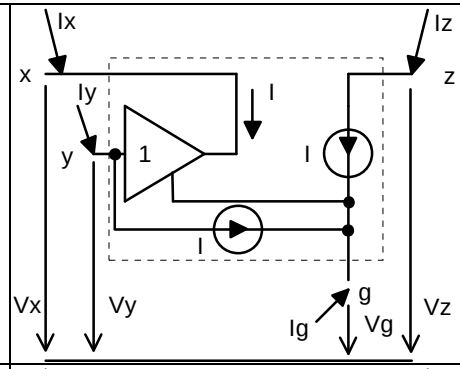
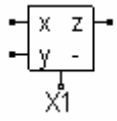
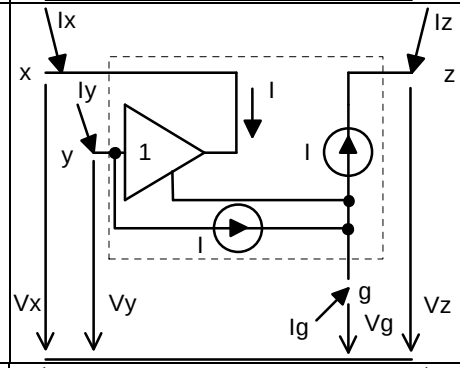
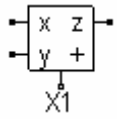
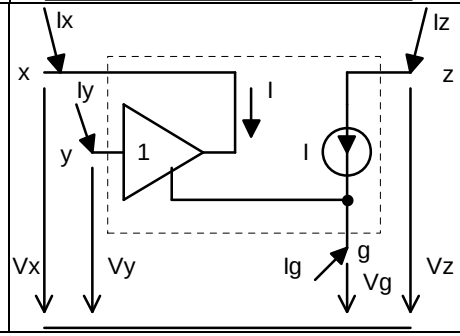
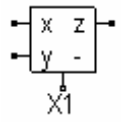
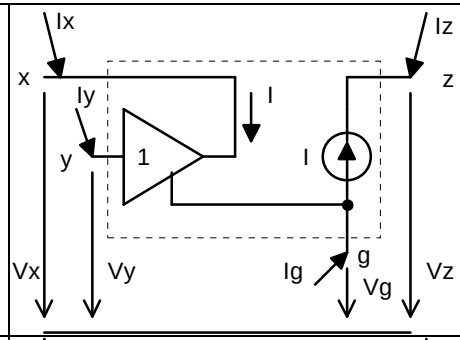
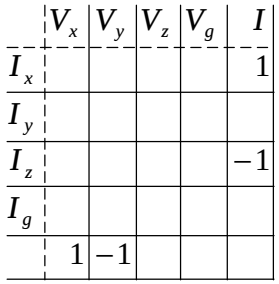
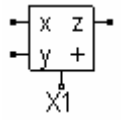
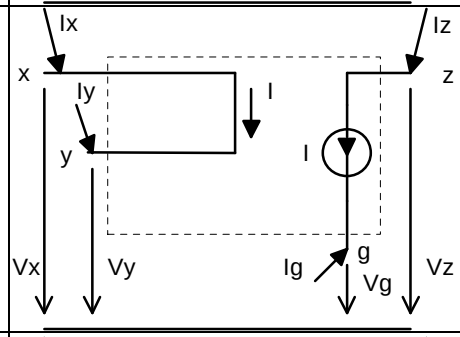
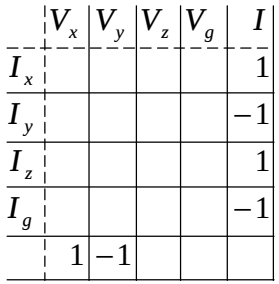
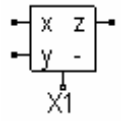
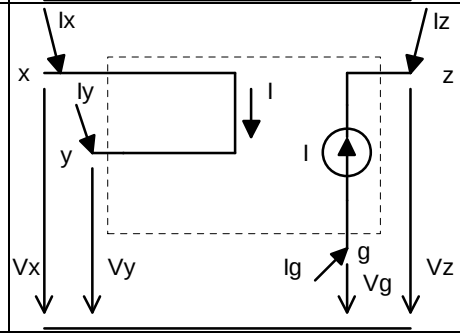
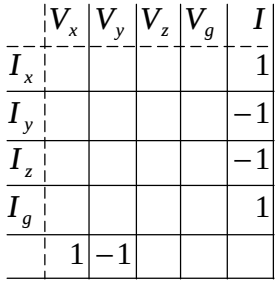
| | | | | | |
|---|---|---|---|---|---|
| pozitivní proudový konvejor I. generace | *CC*I+ |  | - |  | $\begin{array}{\|c\|c\|c\|c\|c\|c\|}\hline & V_x & V_y & V_z & V_g & I \\ \hline I_x & & & & & 1 \\ \hline I_y & & & & & 1 \\ \hline I_z & & & & & 1 \\ \hline I_g & & & & & -3 \\ \hline & 1 & -1 & & & \\ \hline \end{array}$ |
| negativní proudový konvejor I. generace | *CC*I- |  | - |  | $\begin{array}{\|c\|c\|c\|c\|c\|c\|}\hline & V_x & V_y & V_z & V_g & I \\ \hline I_x & & & & & 1 \\ \hline I_y & & & & & 1 \\ \hline I_z & & & & & -1 \\ \hline I_g & & & & & -1 \\ \hline & 1 & -1 & & & \\ \hline \end{array}$ |
| pozitivní proudový konvejor II. generace | *CC*II+ |  | - |  | $\begin{array}{\|c\|c\|c\|c\|c\|c\|}\hline & V_x & V_y & V_z & V_g & I \\ \hline I_x & & & & & 1 \\ \hline I_y & & & & & \\ \hline I_z & & & & & 1 \\ \hline I_g & & & & & -2 \\ \hline & 1 & -1 & & & \\ \hline \end{array}$ |

| | | | | | |
|---|---|---|---|---|---|
| negativní proudový konvejor II. generace | *CC*II- |  | - |  |  |
| pozitivní proudový konvejor III. generace | *CC*III+ |  | - |  |  |
| negativní proudový konvejor III. generace | *CC*III- |  | - |  |  |

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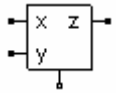
<td> 
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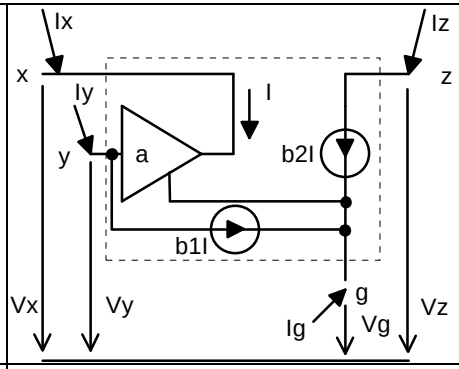
<td>a=Vx/Vy<br>b1=Iy/Ix<br>b2=Iz/Ix<br><br>[a b1 b2]<br>CCI+ [1 1 1]<br>CCI- [1 1 –1]<br>CCII+ [1 0 1]<br>CCII- [1 0 –1]<br>CCIII+ [1 –1 1]<br>CCIII- [1 –1 –1]</td>
<td> 
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<tr><td>$I_y$</td><td></td><td></td><td></td><td></td><td>$b_1$</td></tr>
<tr><td>$I_z$</td><td></td><td></td><td></td><td></td><td>$b_2$</td></tr>
<tr><td>$I_g$</td><td></td><td></td><td></td><td></td><td>$-1-b_1-b_2$</td></tr>
<tr><td></td><td>1</td><td>$-a$</td><td></td><td></td><td></td></tr>
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<td>Prvek CDBA (Current Differencing Buffered Amplifier)</td>
<td>CDBA</td>
<td> 
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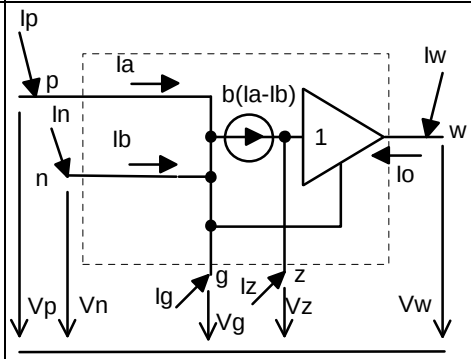
<td>b – zisk interního zdroje proudu;<br>implicitní nastavení<br>b = 1</td>
<td> 
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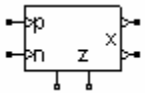
<td> 
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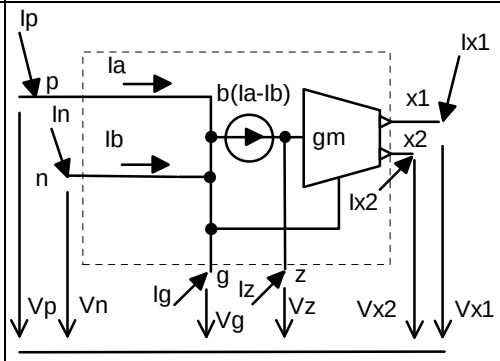
<td> 
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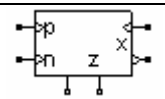
<td> 
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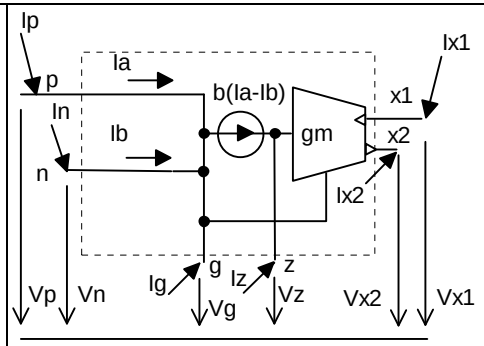
<td> 
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| $I_n$ | | | | | | | | 1 |
| $I_z$ | | | | | | | $-b$ | $b$ |
| $I_{x1}$ | | | $g_m$ | | | $-g_m$ | | |
| $I_{x2}$ | | | $-g_m$ | | | $g_m$ | | |
| $I_g$ | | | | | | | $b-1$ | $-b-1$ |
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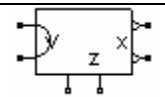
<td> 
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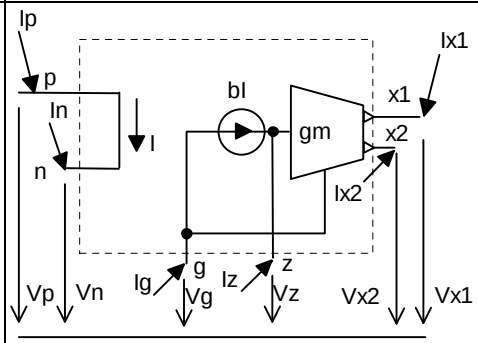
<td> 
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| $I_n$ | | | | | | | $-1$ |
| $I_z$ | | | | | | | $-b$ |
| $I_{x1}$ | | | $-g_m$ | | | $g_m$ | |
| $I_{x2}$ | | | $-g_m$ | | | $g_m$ | |
| $I_g$ | | | $2g_m$ | | | $-2g_m$ | $b$ |
| | 1 | $-1$ | | | | | |

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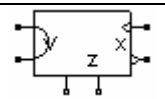
<td> 
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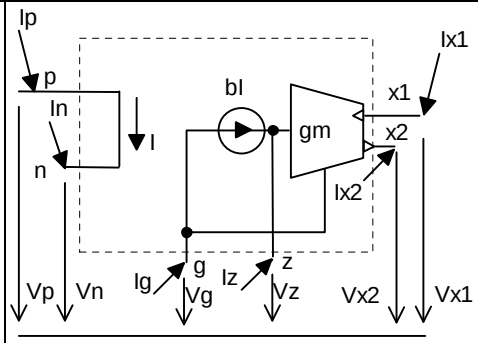
<td> 
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| $I_n$ | | | | | | | $-1$ |
| $I_z$ | | | | | | | $-b$ |
| $I_{x1}$ | | | $g_m$ | | | $-g_m$ | |
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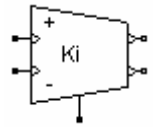
<td> 
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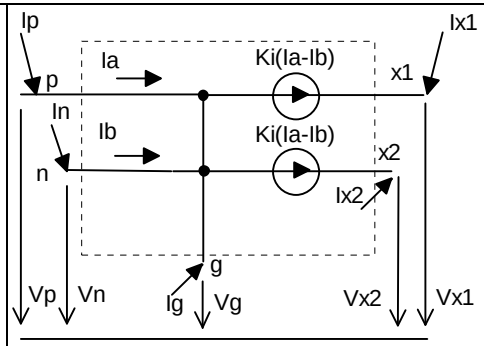
<td> 
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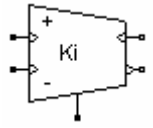
<td> 
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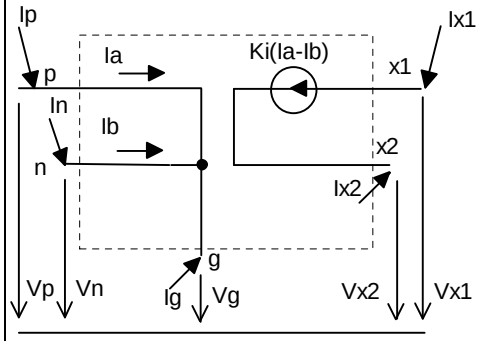
<td> 
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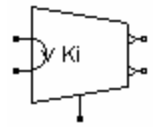
<td> 
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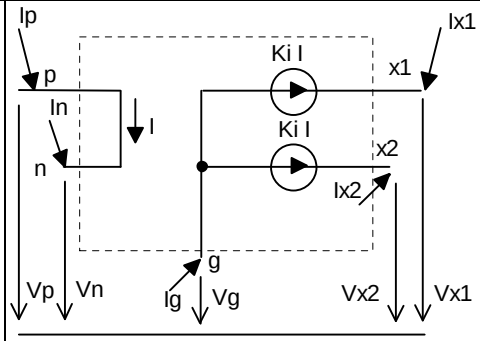
<td> 
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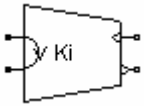
<td> 
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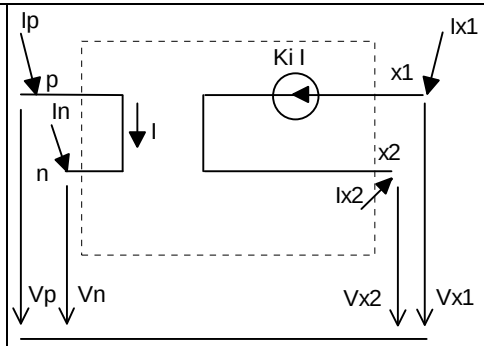
<td> 
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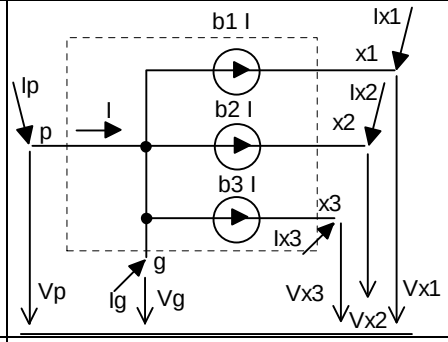
<td> 
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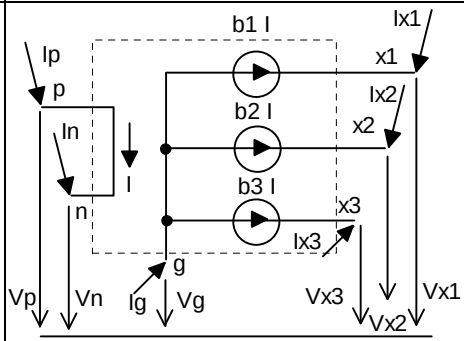
<td> 
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