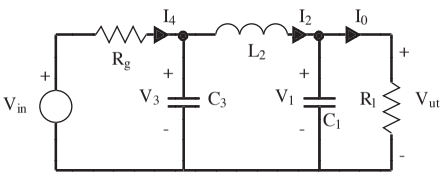
10. TOPOLOGIC SIMULATION

10.1

10.2

10.3 Define the currents in series arms and voltages over shunt arms from let to right and multiply the corresponding equations with an arbitrary positive constant R.

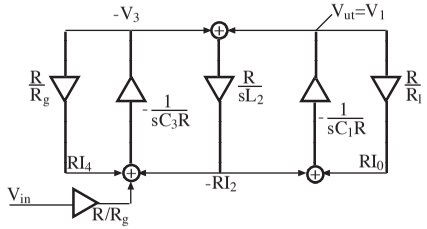


$$R \cdot I_0 = R \cdot \frac{V_{ut}}{R_l} \qquad V_1 = \frac{1}{sC_1R} \cdot (RI_2 - RI_0)$$

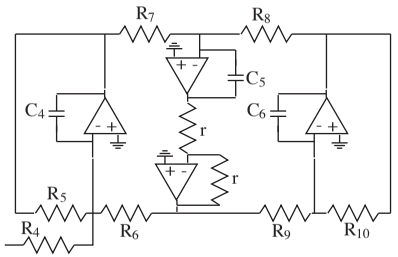
$$R \cdot I_2 = R \cdot \frac{V_3 - V_1}{sL_2} \qquad V_1 = \frac{1}{sC_3R} \cdot (RI_4 - RI_2)$$

$$R \cdot I_4 = R \cdot \frac{V_{in} - V_3}{R_g}$$

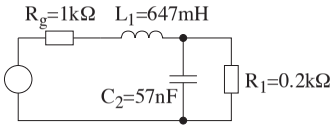
The corresponding signal-flow graph, shown below, is obtained after "moving" the – signs and the input node V_{in}.

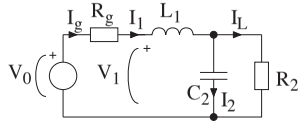


Finally we get



10.4 Use the filter shown below as reference filter for design of a leapfrog filter. Determine the element values and select free capacitors to 10 nF and resistances to 10 kΩ.





$I_1 = I_g$; $V_2 = V_L$

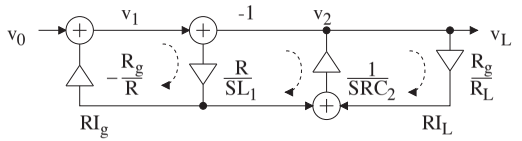
$$V_1 = V_0 - I_gR_g \Rightarrow V_1 = \frac{R}{R}(V_0 - I_gR_g)$$

$$I_g = (V_1 - V_2)\frac{1}{sL_1} \Rightarrow RI_g = \frac{R}{sL_1}(V_1 - V_2)$$

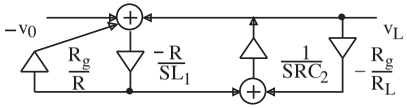
$$V_2 = (I_g - I_L)\frac{1}{sC_2} \Rightarrow V_2 = \frac{R}{R}\frac{1}{sC_2}(I_g - I_L)$$

$$I_L = \frac{V_2}{R_L} \Rightarrow RI_L = \frac{RV_2}{R_L}$$

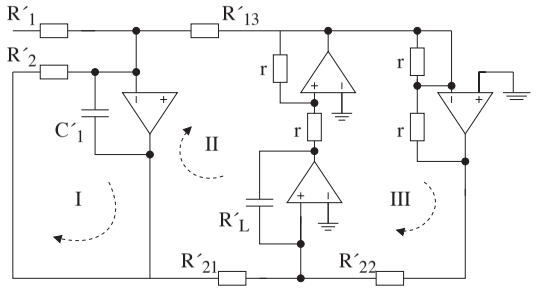
The corresponding signal-flow graph is



After modifying the SFG to obtain negative integrators we get



and the corresponding realization is



By equalizing the loop gain in the two last figures we can identify the element values.

$$I: \frac{R_g}{R}\frac{R}{sL_1} = \frac{1}{R'_2C'_1s} \Rightarrow R'_2C'_1 = \frac{L_1}{R_g}$$

$$II: \frac{-R}{sL_1}\frac{1}{sRC_2} = -\frac{1}{R'_2 sC'_1}\frac{1}{R'_{13}sC'_2} \Rightarrow R'_{13}C'_1 \cdot R'_{21}C'_2 = L_1C_1$$

$$III: \frac{-R}{R_2}\frac{1}{sRC_2} = \frac{-1}{sR'_{22}C'_2} \Rightarrow R'_{22}C'_2 = R_LC_L$$

We select $C = 10$ nF.

$$I \Rightarrow R'_{12} = \frac{L_1}{R_3}\frac{1}{C'_1} = \frac{0.647}{1000}10^8 = 64.7 \text{ k}\Omega$$

$$III \Rightarrow R'_{22} = \frac{R_LC_2}{C'_2} = \frac{200 \cdot 57 \cdot 10^{-9}}{10^{-8}} = 1140\ \Omega$$

$$II \Rightarrow R'_{13}R'_{21} = \frac{L_1C_2}{C'_1C'_2} = \frac{0.647 \cdot 57 \cdot 10^{-9}}{10^{-16}}$$

Select $r = 10$ kΩ.

Select $R'_{13} = 10\text{k}\Omega \Rightarrow R'_{21} = 36550\ \Omega$

10.5 samma som ovan?

10.6

10.5

St 266Ex

10.6

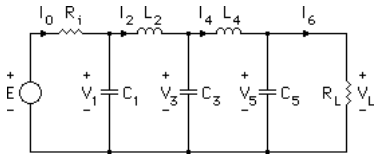
ST EX10.6

10.7

St EX 10.7

Allpolfilter

Det visar sig fruktbart att följa den diskuterade idén även i praktiken. För t ex ett lågpassfilter av allpoltyp får vi ett filter bestående av summerande integratorer, vilka enkelt realiseras med operationsförstärkare, resistorer and kondensatorer. Betrakta ett allpolnät enligt figuren nedan.



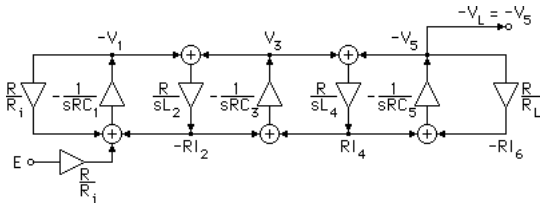
På samma sätt som tidigare får vi nätets ström-spänningsrelationer:

$$RI_0 = \frac{R}{R_i}(E - V_1);\ V_1 = \frac{1}{sRC_1}(RI_0 - RI_2);\ RI_2 = \frac{R}{sL_2}(V_1 - V_3);$$

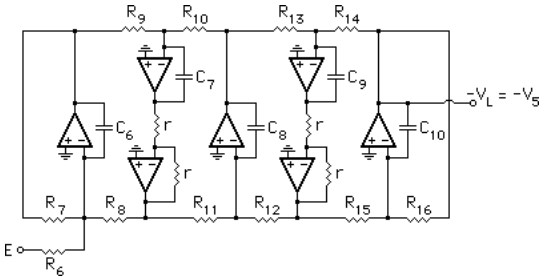
$$V_3 = \frac{1}{sRC_3}(RI_2 - RI_4);\ RI_4 = \frac{R}{sL_4}(V_3 - V_5);\ V_5 = \frac{1}{sRC_5}(RI_4 - RI_6);$$

$$RI_6 = \frac{R}{R_L}V_5$$

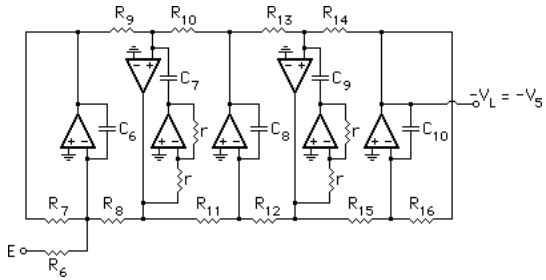
Ekvationerna kan åskådliggöras med hjälp av signalflödesschemat:



Signalflödesschemat leder till följande aktiva filterrealisering:



De icke-inverterande integratorgrenarna kan realiseras på alternativt sätt enligt figuren nedan, vilket ger en realisering med bättre högfrekvensegenskaper än den första (jämför den tidigare presenterade realiseringen av en DIG-länk).



Regler för beräkning av elementvärden erhålls relativt enkelt, om man jämför kretsschemat and flödesschemat med avseende på koefficienter and överföringsfunktioner. Vi inser att följande samband skall vara uppfyllda:

$$-\frac{1}{sR_6C_6} = -\frac{1}{sR_iC_1} \Rightarrow R_6C_6 = R_iC_1;\ \frac{1}{sR_9C_7} \cdot \frac{r}{r} = \frac{R}{sL_2} \Rightarrow R_9C_7 = \frac{L_2}{R};\ \text{etc}$$

På motsvarande vis för övriga elementvärden.