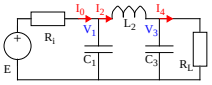
Lektion 7 – Extra

Uppgift 1.22



Sambanden:

$$I_0 = \frac{E - V_1}{R_i}$$

$$V_1 = \frac{1}{sC_1}(I_0 - I_2)$$

$$I_2 = \frac{V_1 - V_3}{sL_2}$$

$$V_3 = \frac{1}{sC_3}(I_2 - I_4)$$

$$I_4 = \frac{V_3}{R_L}$$

Normerade med ett R:

$$RI_0 = \frac{R}{R_i}(E - V_1)$$

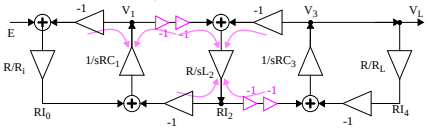
$$V_1 = \frac{1}{sC_1R}(RI_0 - RI_2)$$

$$RI_2 = \frac{R}{sL_2}(V_1 - V_3)$$

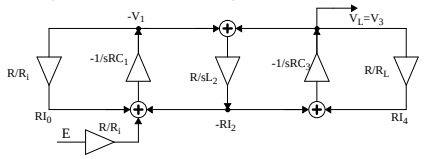
$$V_3 = \frac{1}{sRC_3}(RI_2 - RI_4)$$

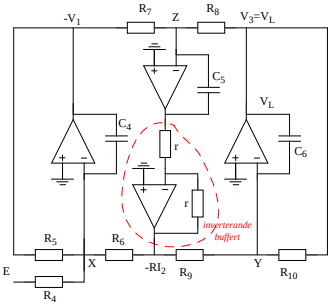
$$RI_4 = \frac{R}{R_L}V_3$$

Ur dessa ekvationer skisseras ett signalflödesschema:



Nätet modifieras genom att dra inverterare (-1) genom nätet:





Leapfrog SignalflödesschemaResultat

$$[-V_1]_E = -\frac{1}{sC_4}\cdot\frac{E}{R_4}\,[-V_1]_E = \frac{R}{R_i}\cdot\frac{-E}{sRC_1} = -\frac{E}{sR_iC_1}\,C_4R_4 = C_1R_i$$

$$[-V_1]_{-V_1} = -\frac{1}{sC_4}\cdot\frac{V_1}{R_5}\,[-V_1]_{-V_1} = \frac{R}{R_i}\cdot\frac{-V_1}{sRC_1} = -\frac{-V_1}{sR_iC_1}\,C_4R_5 = C_1R_i$$

$$[-V_1]_{-RI_2} = -\frac{1}{sC_4}\frac{-RI_2}{R_6}\,[-V_1]_{-RI_2} = -\frac{1}{sRC_1}(-RI_2)\,C_4R_6 = C_1R$$

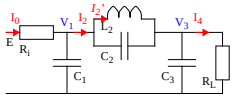
$$[-RI_2]_{-V_1} = -\frac{(-1)}{sC_5}\cdot\frac{-V_1}{R_7}\,[-RI_2]_{-V_1} = \frac{R}{sL_2}(-V_1)\,C_5R_7 = L_2/R$$

$$[-RI_2]_{V_3} = -\frac{(-1)}{sC_5}\cdot\frac{V_3}{R_8}\,[-RI_2]_{V_3} = \frac{R}{sL_2}V_3\,C_5R_8 = L_2/R$$

$$[V_3]_{-RI_2} = -\frac{1}{sC_6}\frac{-RI_2}{R_9}\,[V_3]_{-RI_2} = -\frac{1}{sRC_3}(-RI_2)\,C_6R_9 = C_3R$$

$$[V_3]_{V_3} = -\frac{1}{sC_6}\frac{V_3}{R_{10}}\,[V_3]_{V_3} = -\frac{1}{sRC_3}\frac{R}{R_L}V_3 = -\frac{V_3}{sC_3R_L}\,C_6R_{10} = C_3R_L$$

Uppgift 1.26



Samband:

$$I_0 = \frac{E - V_1}{R_i}$$

$$V_1 = \frac{1}{sC_1}(I_0 - I_2)$$

$$I_2 = \frac{1}{L_2 \| C_2}(V_1 - V_3)$$

$$V_3 = \frac{1}{sC_3}(I_2 - I_4)$$

$$I_4 = \frac{V_3}{R_L}$$

Normerade med R:

$$RI_0 = \frac{R}{R_i}(E - V_1)$$

$$V_1 = \frac{1}{sRC_1}(RI_0 - RI_2)$$

$$RI_2 = \frac{R}{sL_2/(1 + s^2L_2C_2)}(V_1 - V_3)$$

$$V_3 = \frac{1}{sRC_3}(RI_2 - RI_4)$$

$$RI_4 = \frac{R}{R_L}V_3$$

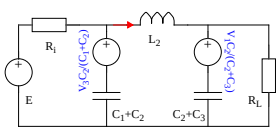
Formlerna för I_2 modifieras till:

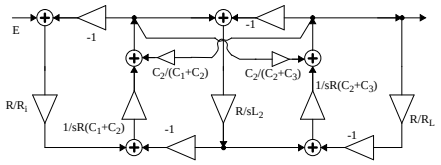
$$RI_2 = RI_2' + sRC_2(V_1 - V_3) \text{ och } RI_2' = \frac{R}{sL_2}(V_1 - V_3)$$

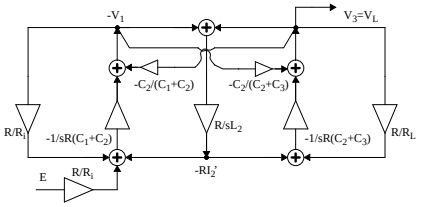
På detta sätt kan uttrycket för RI_2 elimineras i ekvationerna för V_1 och V_3:

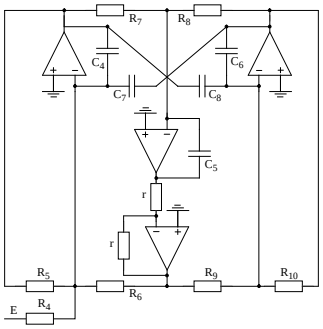
$$V_1 = \frac{1}{sR(C_1 + C_2)}(RI_0 - RI_2') + \frac{C_2}{C_1 + C_2}V_3$$

$$V_3 = \frac{1}{sR(C_2 + C_3)}(RI_2' - RI_4) + \frac{C_2}{C_2 + C_3}V_1$$









Aktivt leapfrogfilter	Signalflödesschema	Resultat
$[-V_1]_E = -\frac{1}{sC_4}\cdot\frac{E}{R_4}$	$[-V_1]_E = \frac{R}{R_i}\cdot-\frac{E}{sR\alpha_1} = -\frac{E}{sR_i\alpha_1}$	$C_4R_4 = \alpha_1R_i$
$[-V_1]_{-V_1} = -\frac{1}{sC_4}\cdot\frac{V_1}{R_5}$	$[-V_1]_{-V_1} = \frac{R}{R_i}\cdot-\frac{-V_1}{sR\alpha_1} = -\frac{-V_1}{sR_i\alpha_1}$	$C_4R_5 = \alpha_1R_i$
$[-V_1]_{-RI_2} = -\frac{1}{sC_4}\frac{-RI_2}{R_6}$	$[-V_1]_{-RI_2} = -\frac{1}{sR\alpha_1}(-RI_2)$	$C_4R_6 = \alpha_1R$
$[-V_1]_{-V_3} = -\frac{C_7}{C_4}V_3$	$[-V_1]_{-V_3} = -\frac{C_2}{\alpha_1}V_3$	$C_4C_2 = C_7\alpha_1$
$[-RI_2]_{-V_1} = -\frac{(-1)}{sC_5}\cdot\frac{-V_1}{R_7}$	$[-RI_2]_{-V_1} = \frac{R}{sL_2}(-V_1)$	$C_5R_7 = L_2/R$
$[-RI_2]_{V_3} = -\frac{(-1)}{sC_5}\cdot\frac{V_3}{R_8}$	$[-RI_2]_{V_3} = \frac{R}{sL_2}V_3$	$C_5R_8 = L_2/R$
$[V_3]_{-RI_2} = -\frac{1}{sC_6}\frac{-RI_2}{R_9}$	$[V_3]_{-RI_2} = -\frac{1}{sR\alpha_2}(-RI_2)$	$C_6R_9 = \alpha_2R$
$[V_3]_{V_3} = -\frac{1}{sC_6}\frac{V_3}{R_{10}}$	$[V_3]_{V_3} = -\frac{1}{sR\alpha_2}\frac{R}{R_L}V_3 = -\frac{V_3}{s\alpha_2R_L}$	$C_6R_{10} = \alpha_2R_L$
$[V_3]_{-V_1} = -\frac{C_8}{C_6}(-V_1)$	$[V_3]_{-V_1} = -\frac{C_2}{\alpha_2}(-V_1)$	$C_2C_6 = C_8\alpha_2$

Där $\alpha_1 = C_1 + C_2$ och $\alpha_2 = C_2 + C_3$.