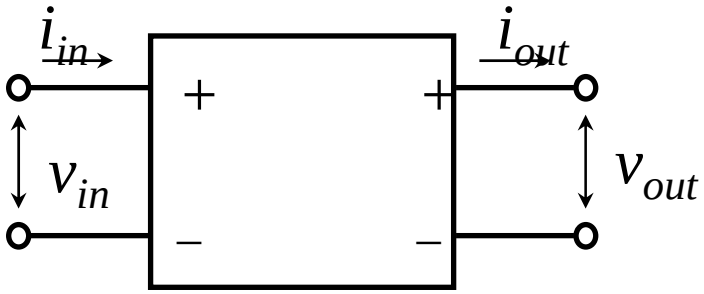
Structured Electronic Design

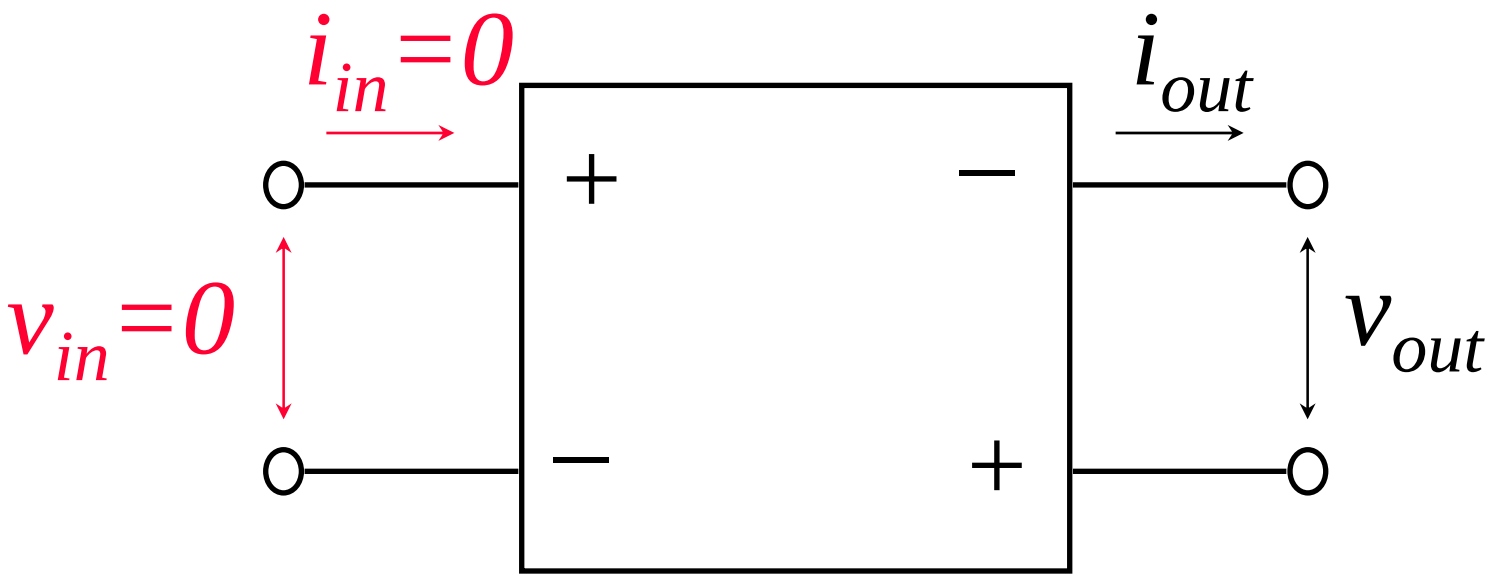
The two-port and its chain matrix



$$\begin{pmatrix} v_{in} \\ i_{in} \end{pmatrix} = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} v_{out} \\ i_{out} \end{pmatrix}$$

$$A = \left.\frac{v_{in}}{v_{out}}\right|_{i_{out}=0} \qquad B = \left.\frac{v_{in}}{i_{out}}\right|_{v_{out}=0} \qquad C = \left.\frac{i_{in}}{v_{out}}\right|_{i_{out}=0} \qquad D = \left.\frac{i_{in}}{i_{out}}\right|_{v_{out}=0}$$

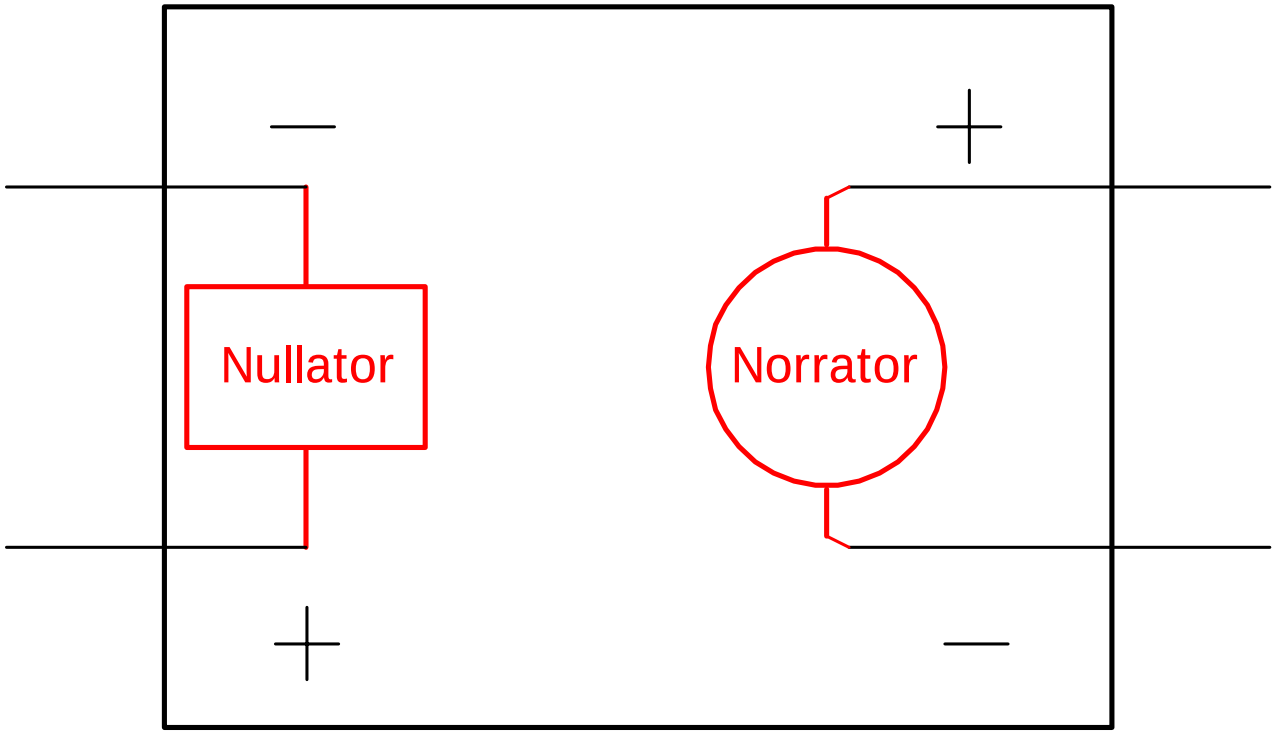
Nullor



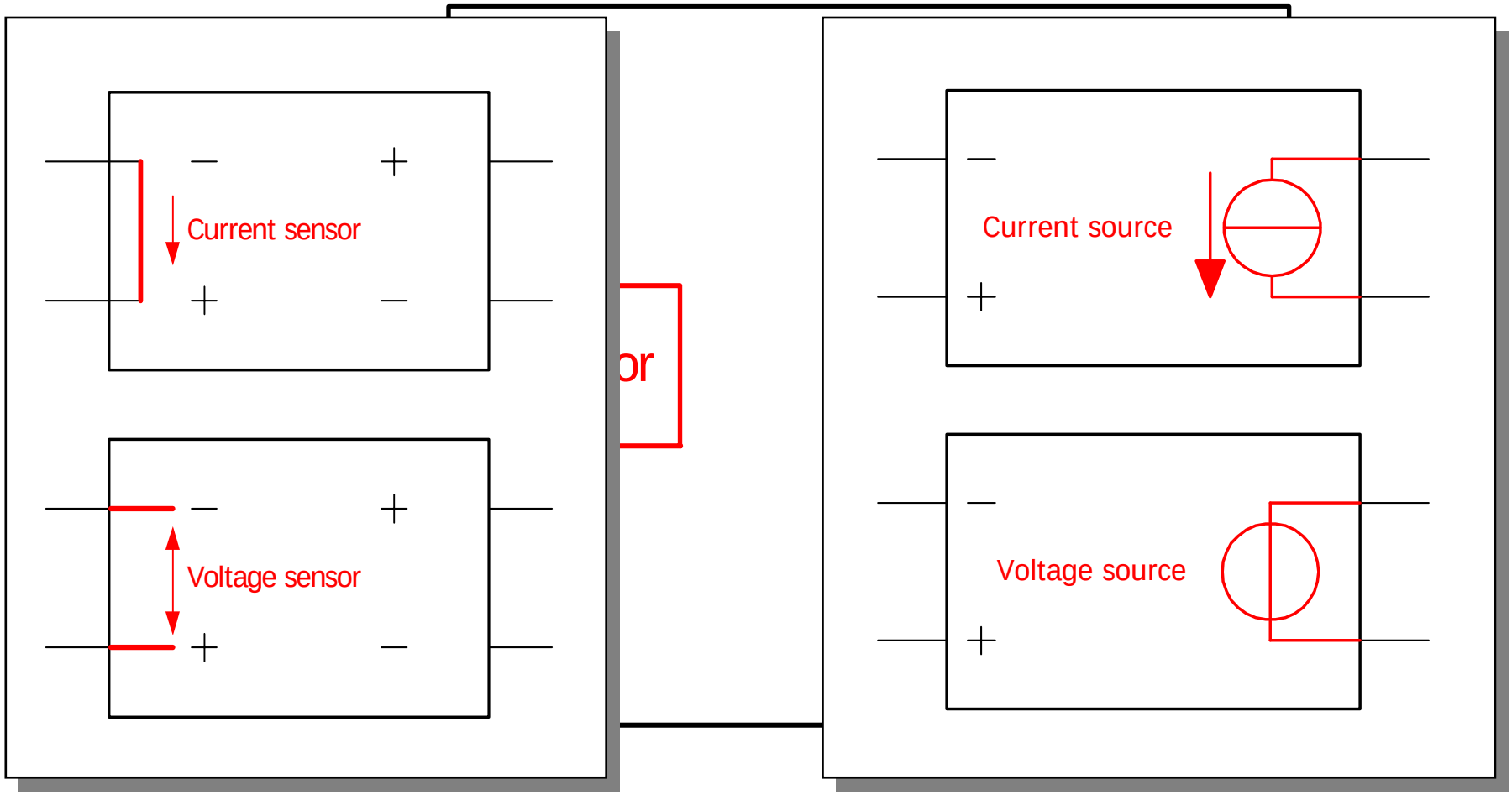
Input current and input voltage of the nullor are made zero via the output signals of the nullor

$$\begin{pmatrix} v_{in} \\ i_{in} \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} v_{out} \\ i_{out} \end{pmatrix}$$

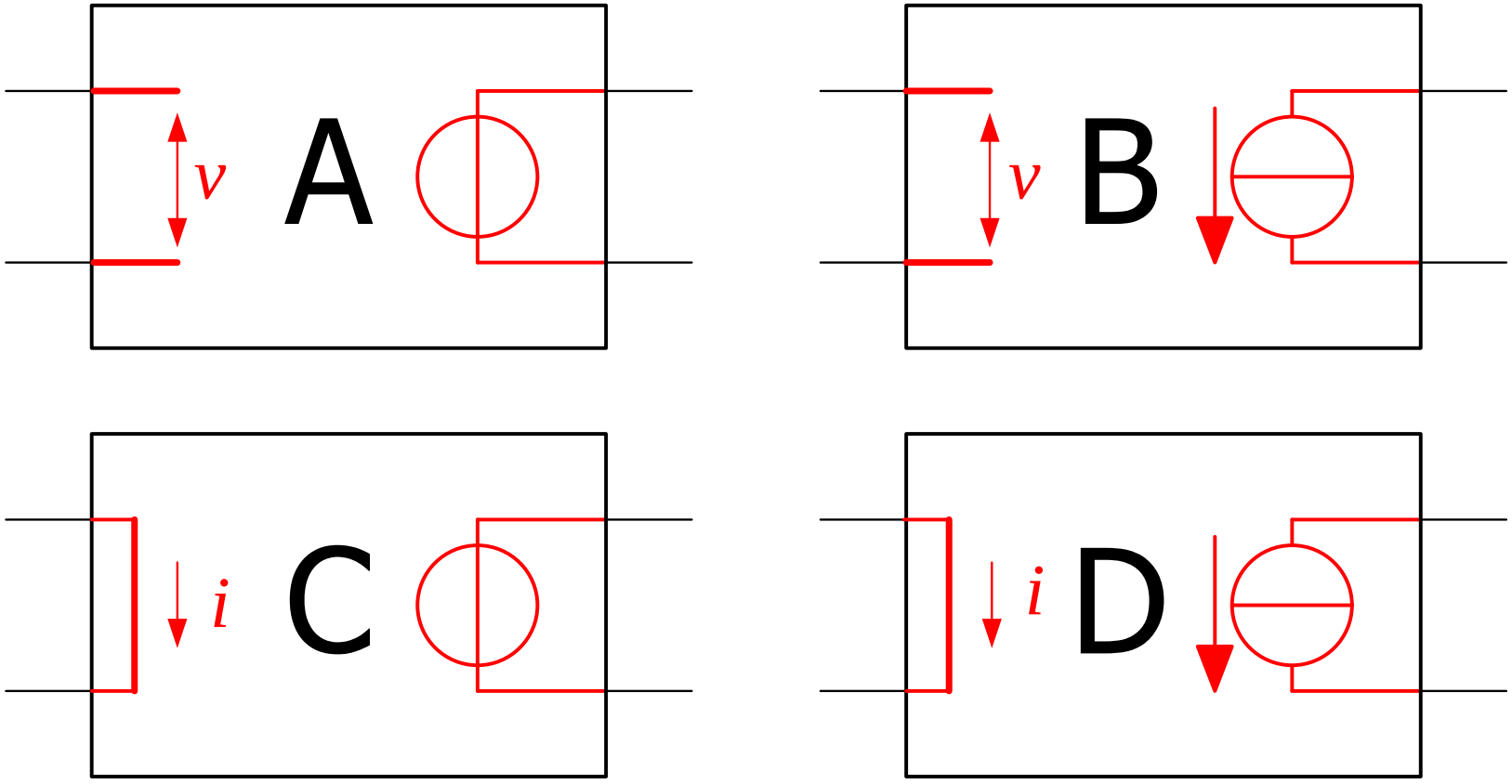
Inside the Nullor



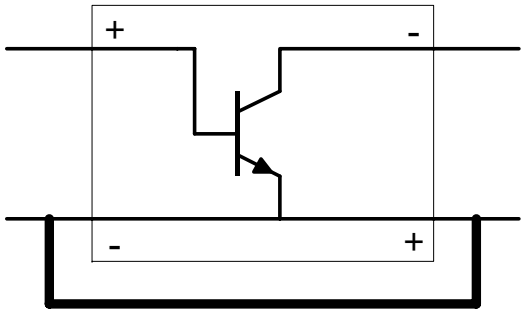
Nullator? Norrator?



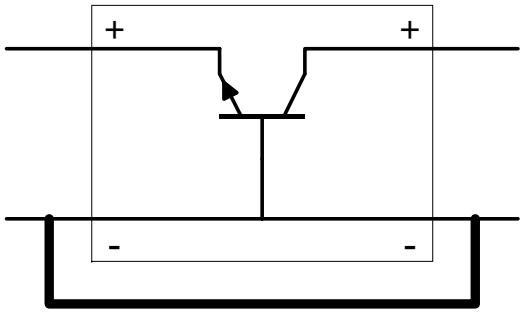
practical nullor implementations



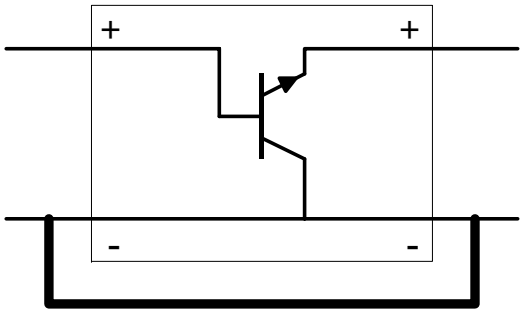
Transistor implementations ?



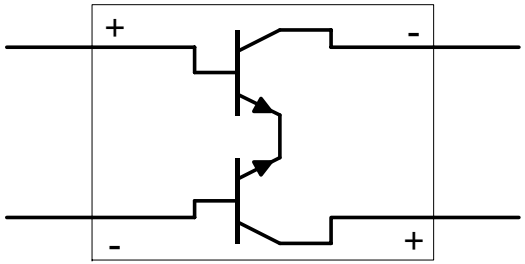
CE-stage



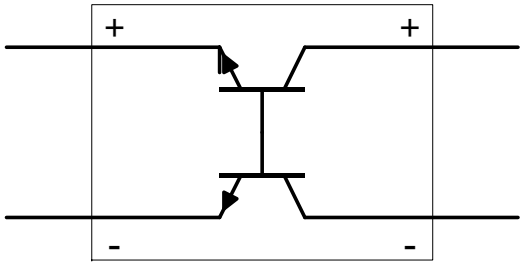
CB-stage



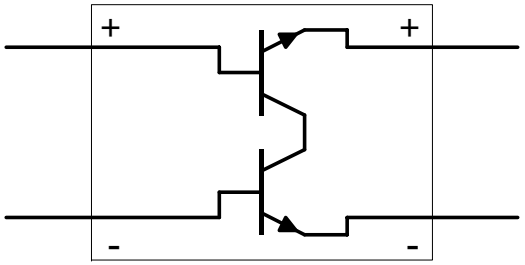
CC-stage



Differential CE-stage

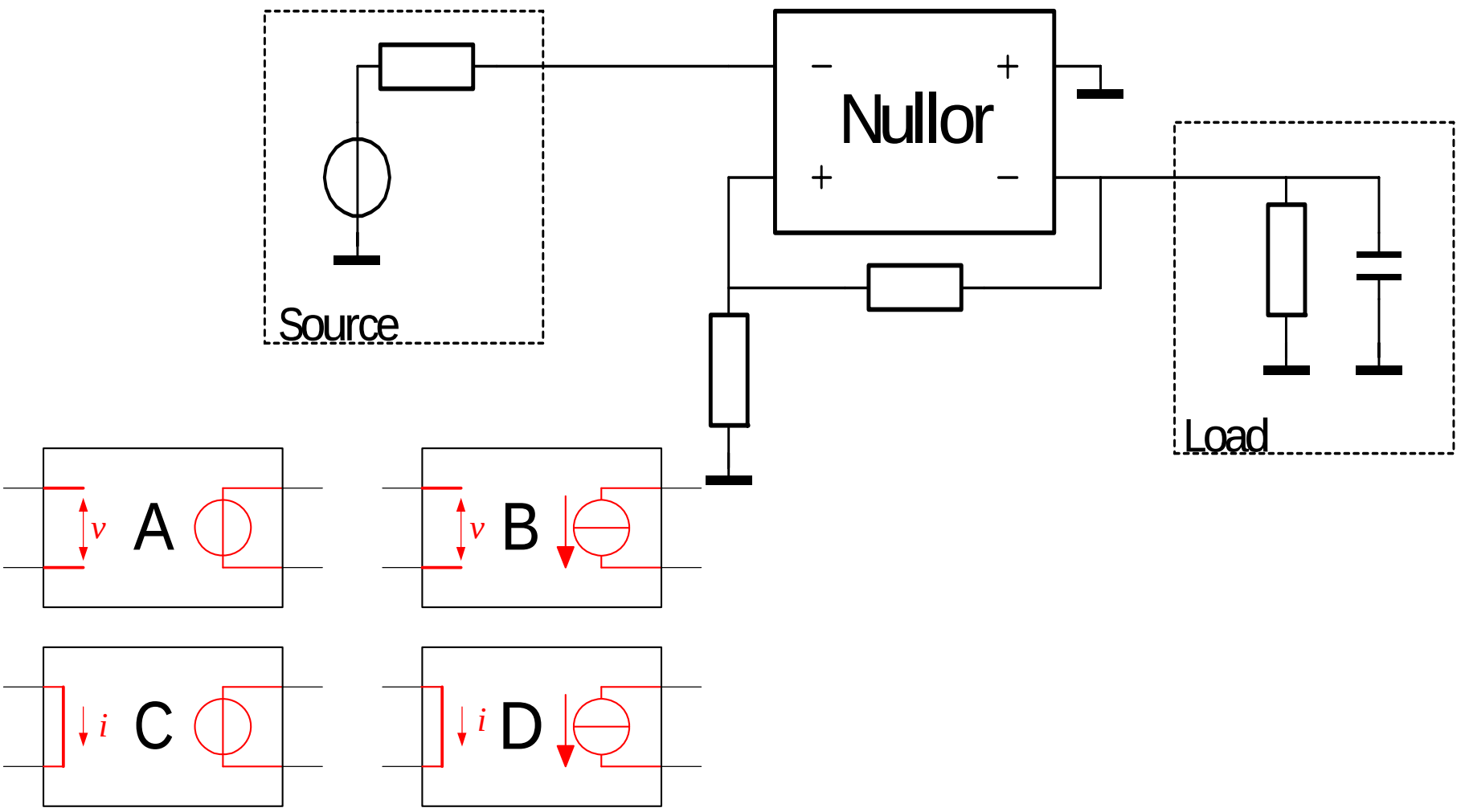


Differential CB-stage

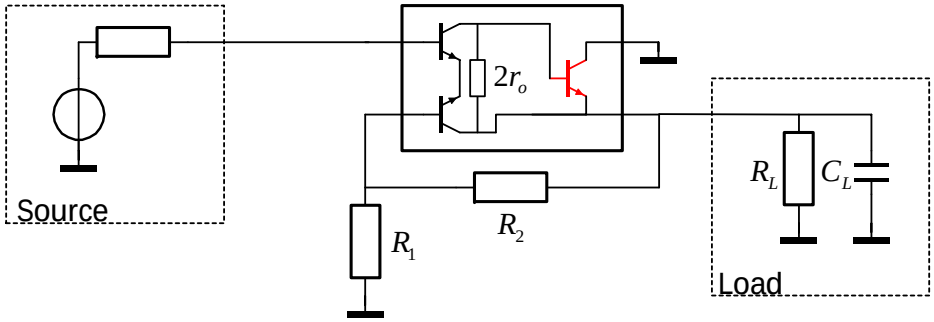


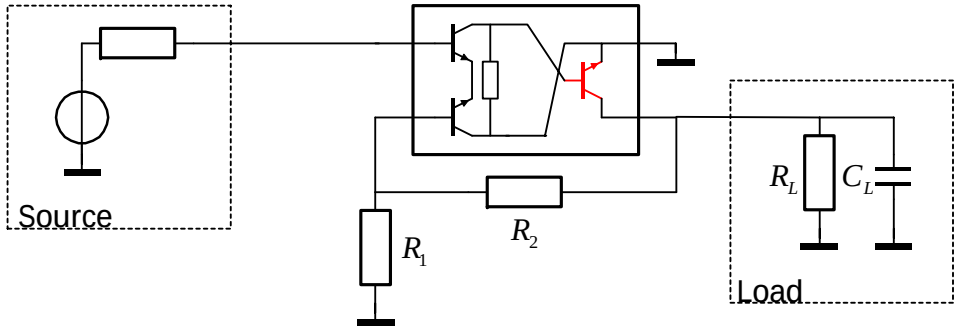
Differential CC-stage

Choose



“Expert” versus “logic”





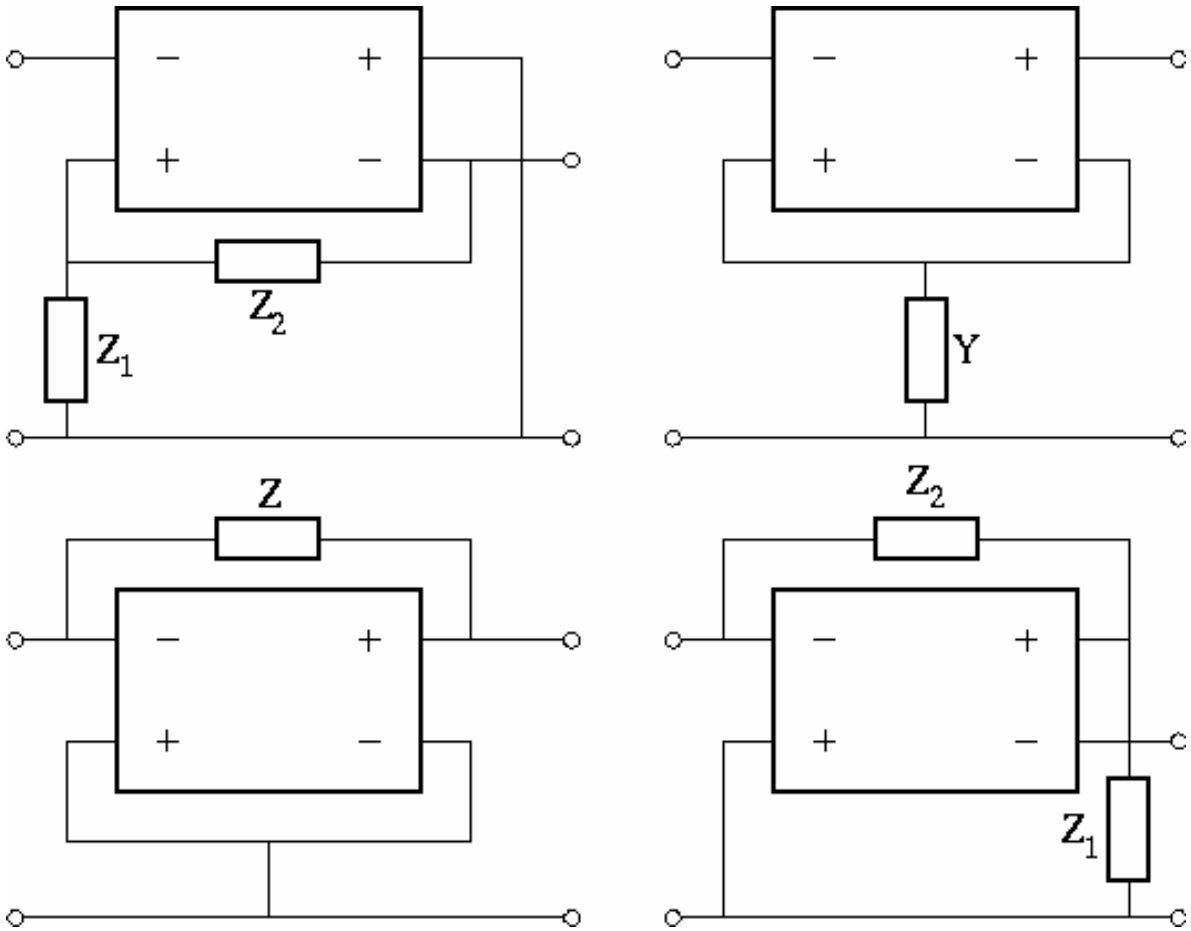
$$L = \frac{1}{A_{CE}A_{CC}}\left(\frac{R_1}{R_1+R_2}\right)\frac{\left(\dfrac{\dfrac{R_L}{1+j\omega R_L C_L}(R_1+R_2)}{\dfrac{R_L}{1+j\omega R_L C_L}+R_1+R_2}\right)}{2r_o D_{CC}+\left(\dfrac{\dfrac{R_L}{1+j\omega R_L C_L}(R_1+R_2)}{\dfrac{R_L}{1+j\omega R_L C_L}+R_1+R_2}\right)}$$

$$L = \frac{1}{2B_{CE}}\frac{1}{D_{CC}}R_1\left(\frac{\dfrac{R_L}{1+j\omega R_L C_L}}{\dfrac{R_L}{1+j\omega R_L C_L}+R_1+R_2}\right)$$

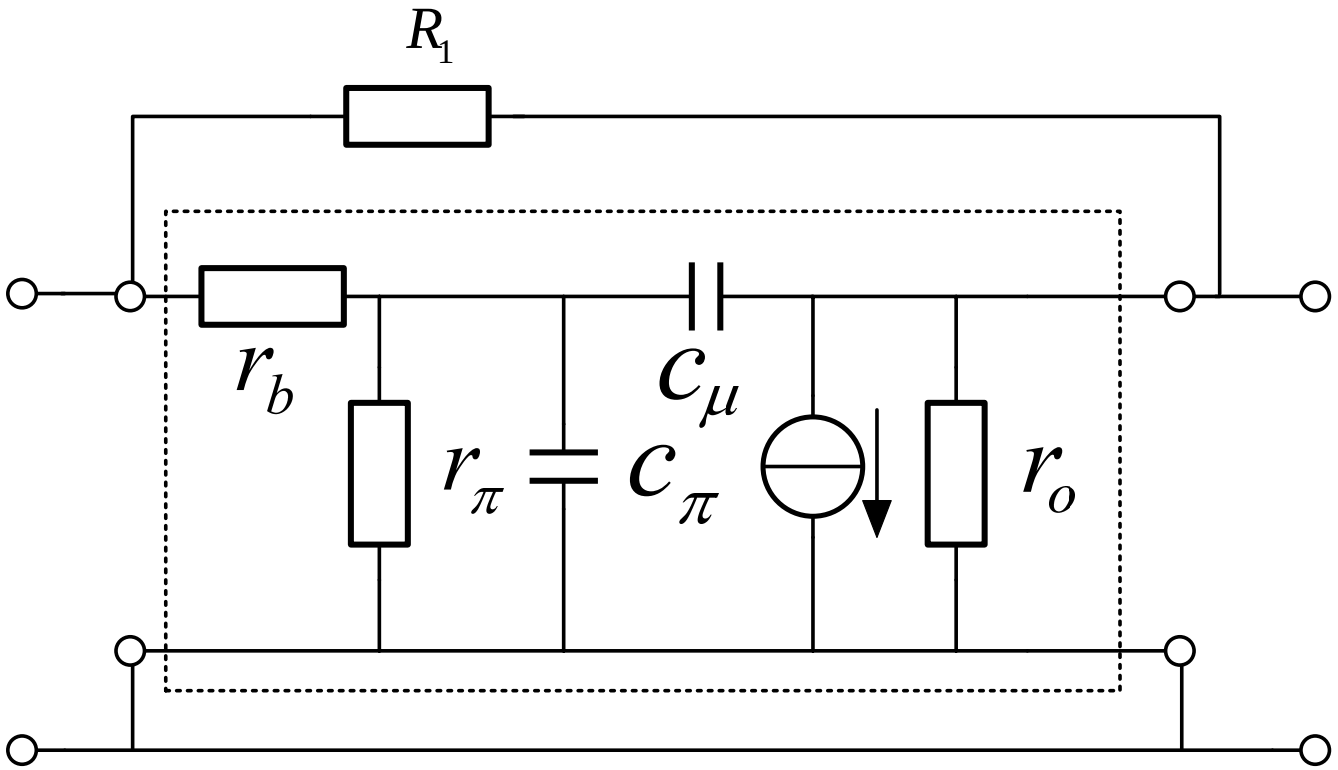
☹ miller effect first stage
☹ distortion and clipping first stage
☺ Loopgain not(less) load dependent

☺ no miller effect
☺ less distortion
☹ Load dependent loopgain

Direct transfer A_{t0}



Direct transfer A_{t0}



Exercises

Today:

- **You work**
- We walk around and help you when you are desperate

- Work on the exercises in the book, chapter 1
- Handouts exercises 1

- Take your time, there are still more exercise sessions to come

- When you have a result, **check/discuss it with others**, then you will find out if your answer is correct.
- The discussion will help the to understand the **"WHY"** part of the design.
- There will some solutions available at the end of this course
  (but probably you do not need them anymore at that time ☺)