Structured Electronic Design

Asymptotic-gain feedback model

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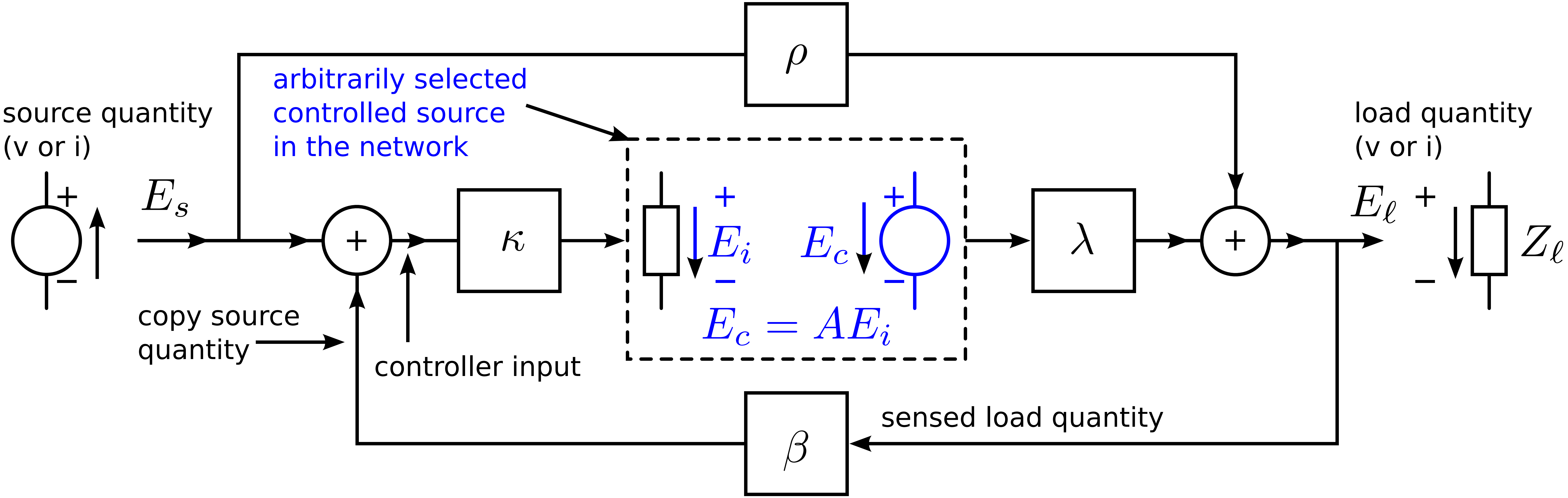
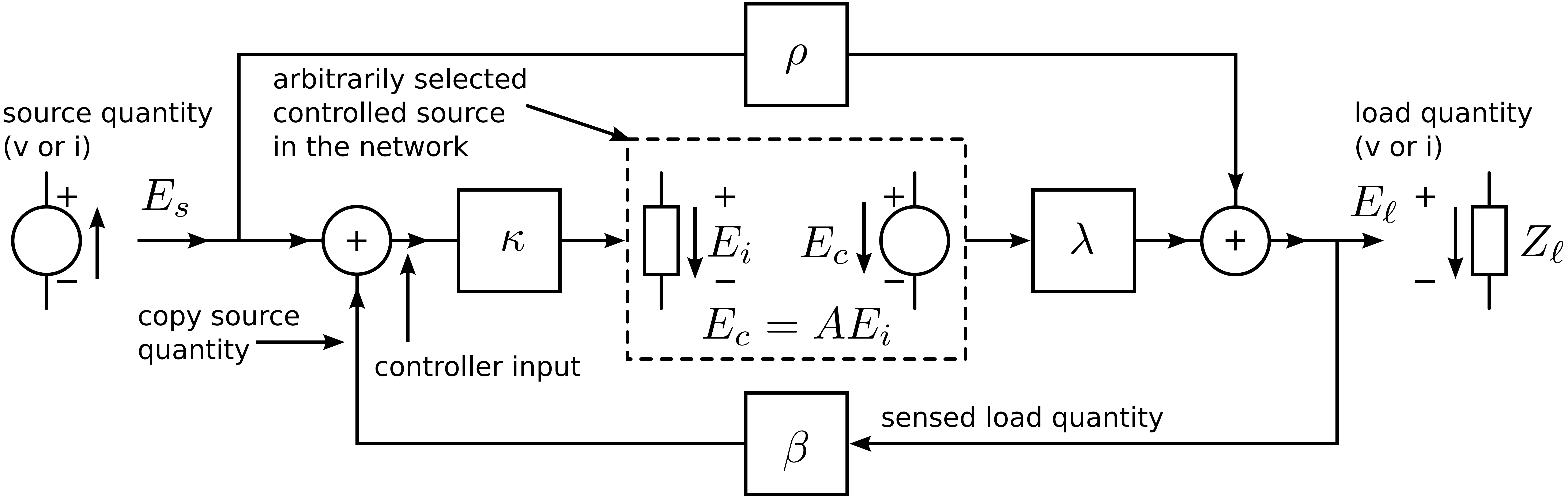
Superposition model



The loop is 'opened' by replacing this controlled source with an independent source, while denoting:

$$E_c = AE_i$$

Superposition model

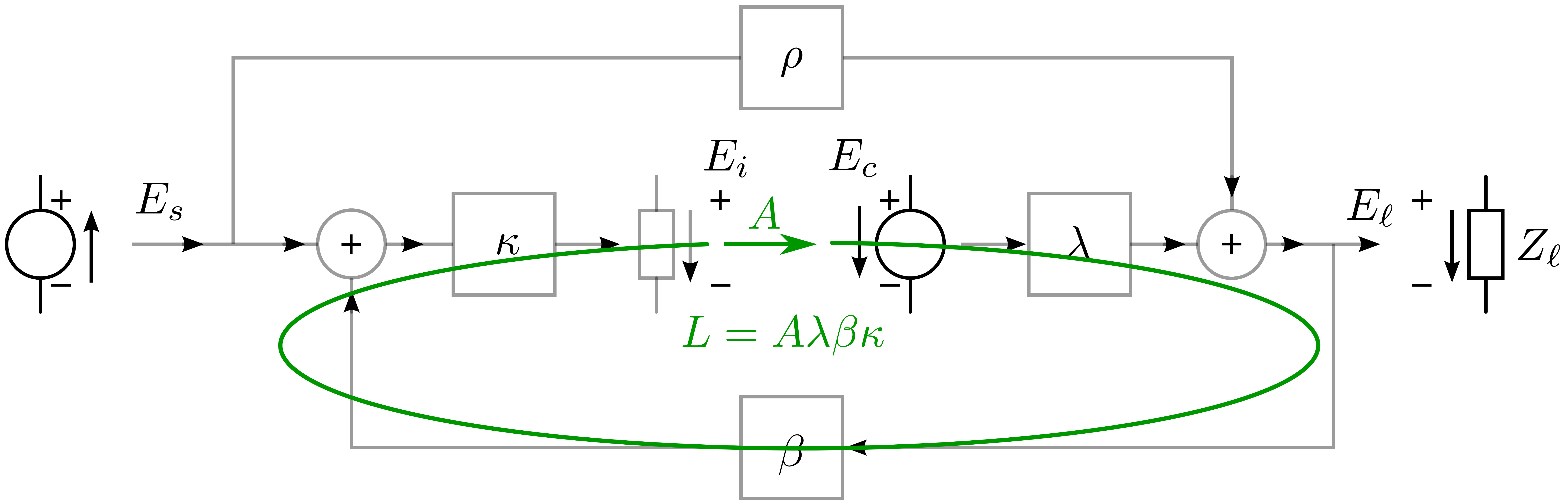


We now have the following equations:

$$\begin{pmatrix} E_\ell \\ E_i \end{pmatrix} = \begin{pmatrix} \rho & \lambda \\ \kappa(1+\rho\beta) & \lambda\beta\kappa \end{pmatrix} \begin{pmatrix} E_s \\ E_c \end{pmatrix}$$

loop gain reference $E_c = AE_i$

Superposition model: loop gain

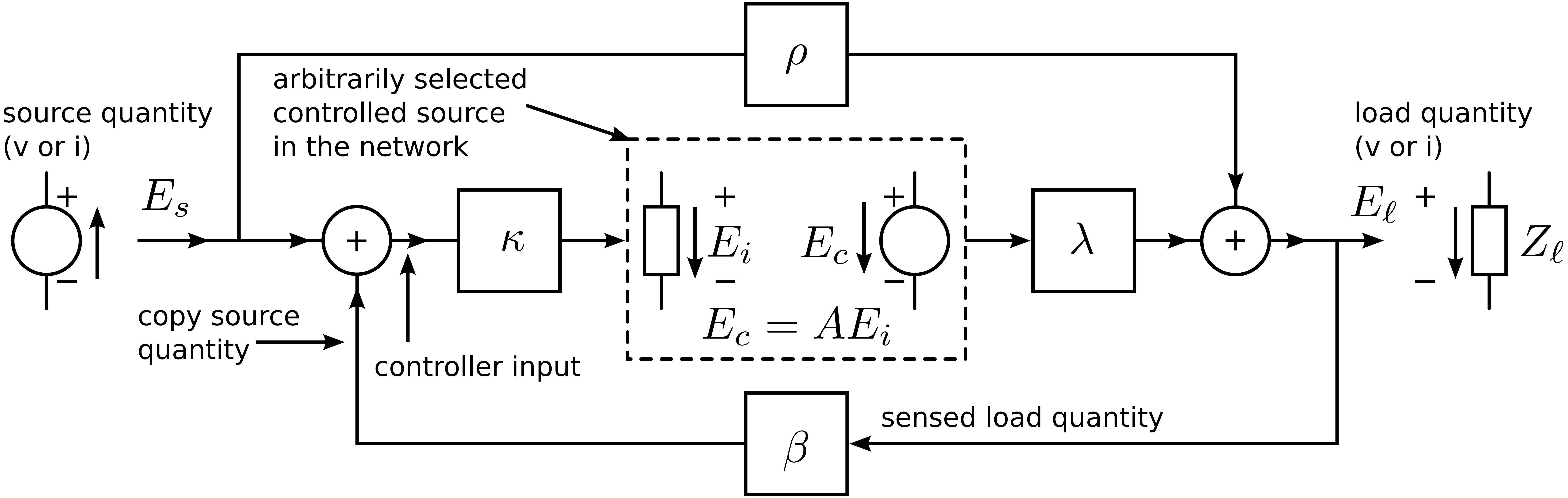


$L =$ Loop gain = gain enclosed in the loop $= A\lambda\beta\kappa$

Calculate from product of: A and $\left.\frac{E_i}{E_c}\right|_{E_s=0}$

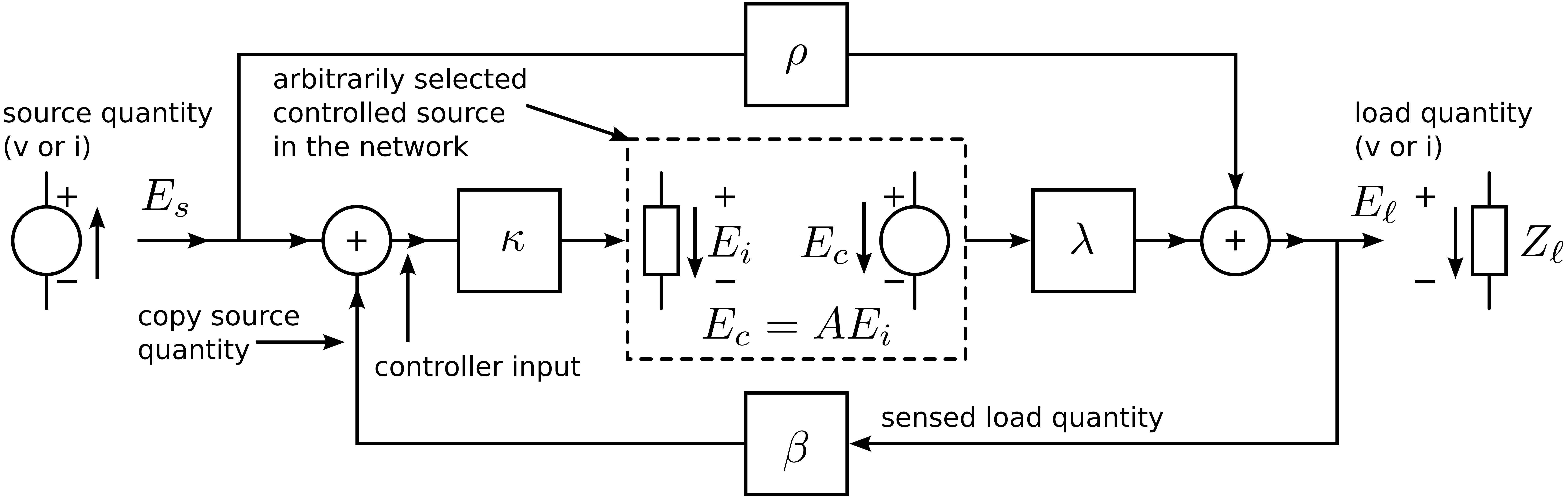
Negative feedback: $L < 0$

Superposition model



Source-to-load transfer: $A_f = \frac{E_\ell}{E_s} = \rho\frac{1+L}{1-L} - \frac{1}{\beta}\frac{-L}{1-L}$

Asymptotic-gain model



Asymptotic-gain:

$$A_{f\infty} \triangleq \lim_{A\to\infty} A_f$$

$$A_{f\infty} = -\rho - \frac{1}{\beta}$$

Source-to-load transfer:

$$A_f = A_{f\infty}\frac{-L}{1-L} + \frac{\rho}{1-L}$$

Asymptotic-gain model

$$A_f = A_{f\infty}\frac{-L}{1-L} + \frac{\rho}{1-L}$$

$$A_{f\infty} = \text{Asymptotic-gain}$$

$$L = \text{Loop gain}$$

$$\rho = \text{Direct transfer}$$

$$\text{If } \frac{\rho}{A_{f\infty}(1-L)} \ll 1 \text{ then: } A_f = A_{f\infty}\frac{-L}{1-L}$$

Looks like Black's model, but no premisses

Two-step design if ideal gain (designed in first step) equals asymptotic gain

$$A_f \approx A_i \frac{-L}{1-L}$$

- A_f: Gain
- A_i: Ideal gain
- $-L$: Loop gain
- $\frac{-L}{1-L}$: Servo function

This requires proper selection of the loop gain reference

Equal to Black's model if:

$$\rho = 0$$

$$\kappa = 1$$

$$\lambda = 1$$

$$\beta = \frac{1}{k}$$