ECE 342
Electronic Circuits

Lecture 28
Feedback Topologies

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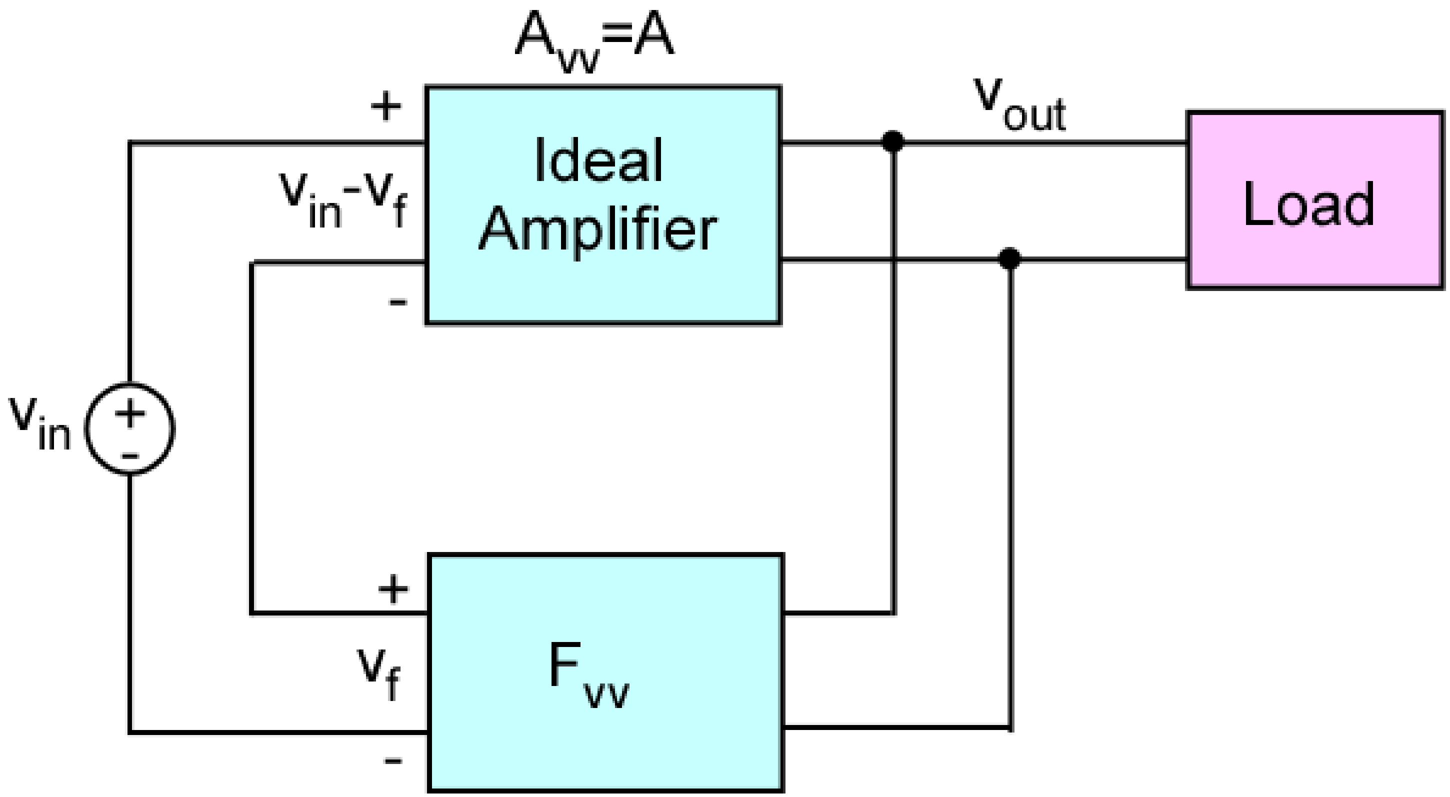
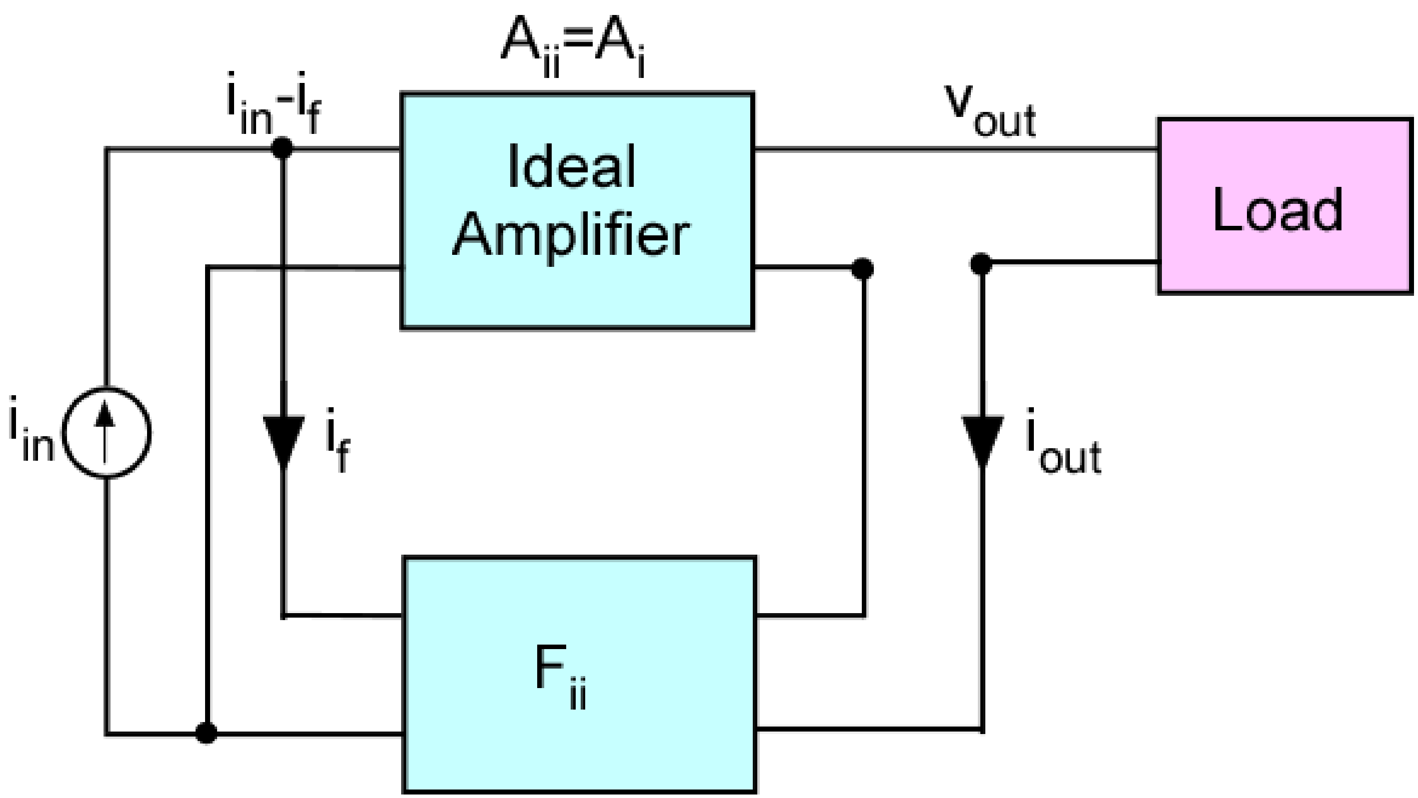
Series-Shunt Feedback



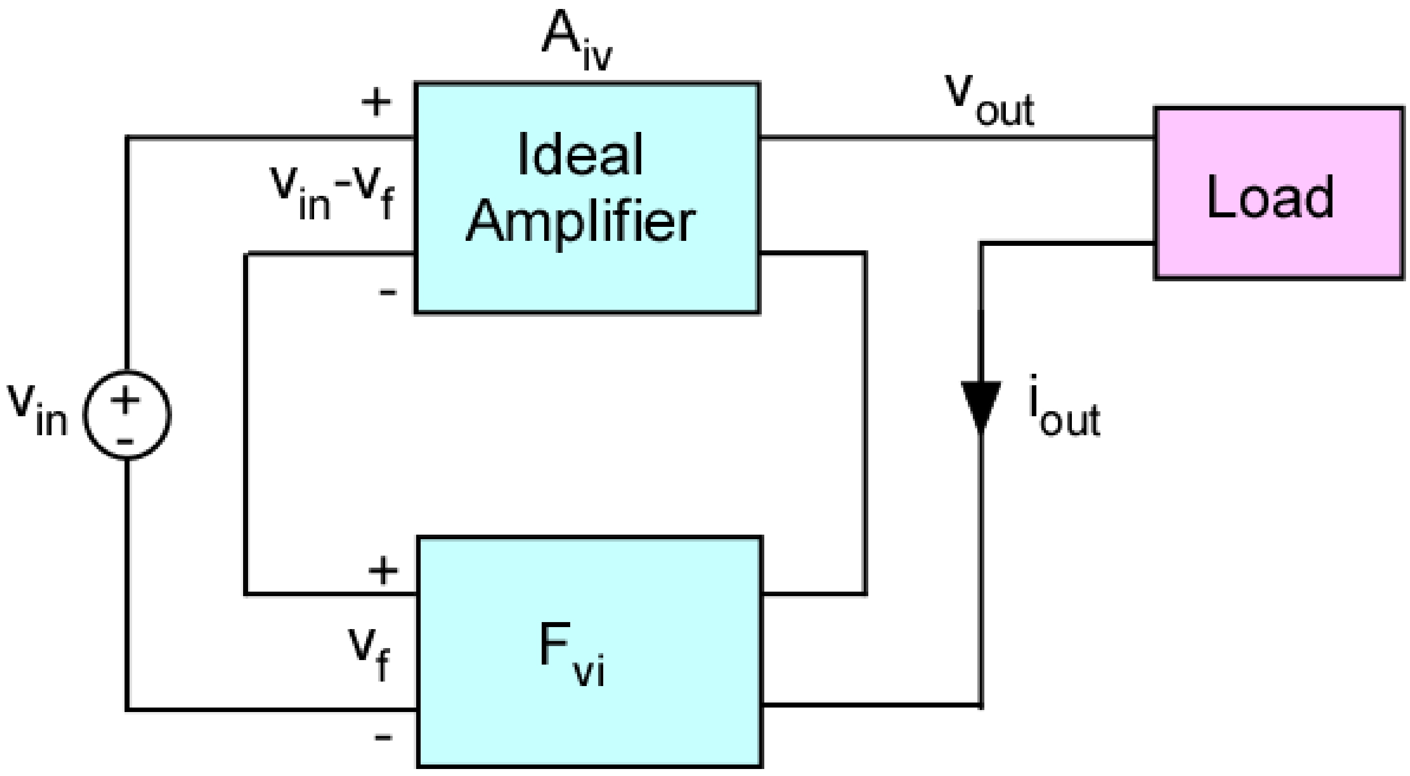
Voltage mixing-voltage sampling feedback

Shunt- Series Feedback



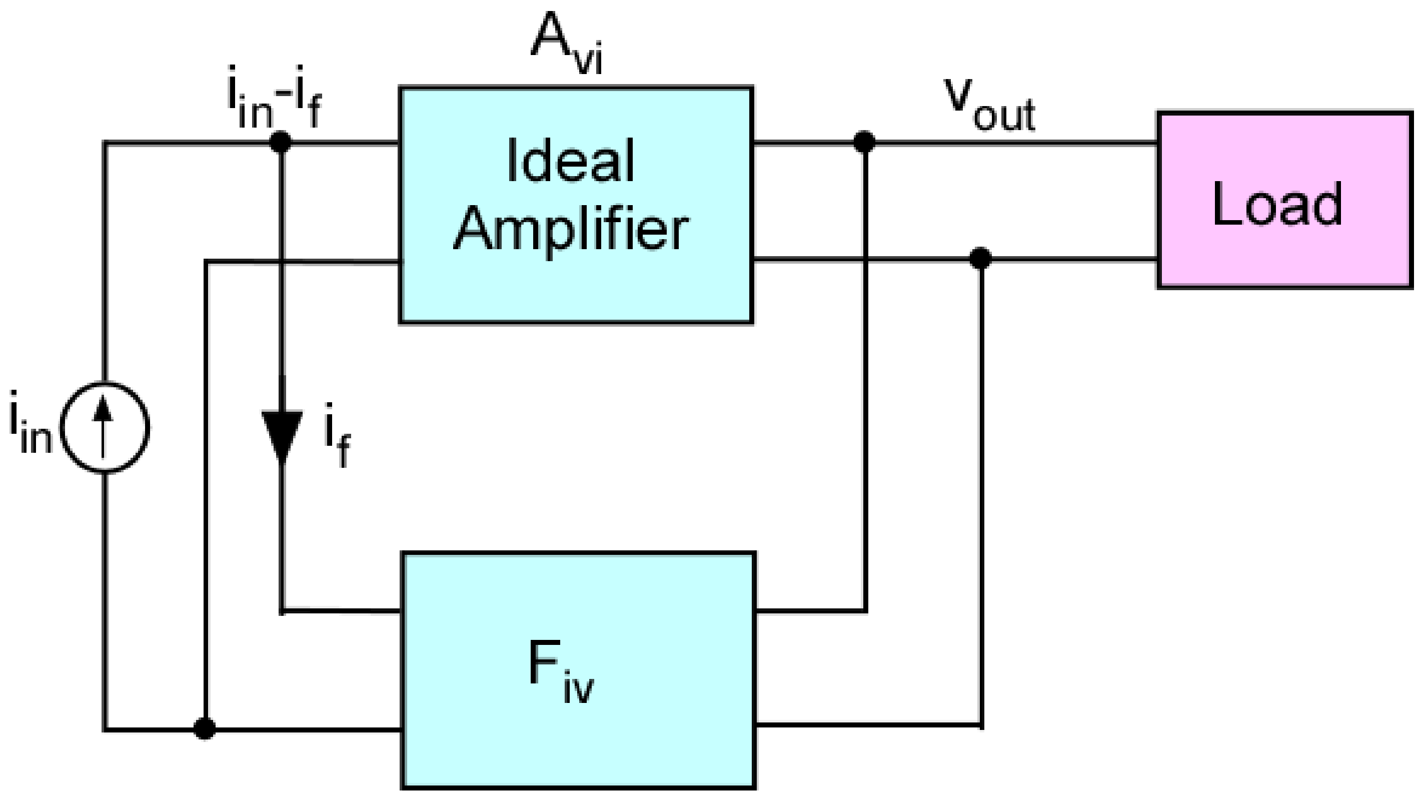
Current mixing-current sampling feedback

Series-Series Feedback



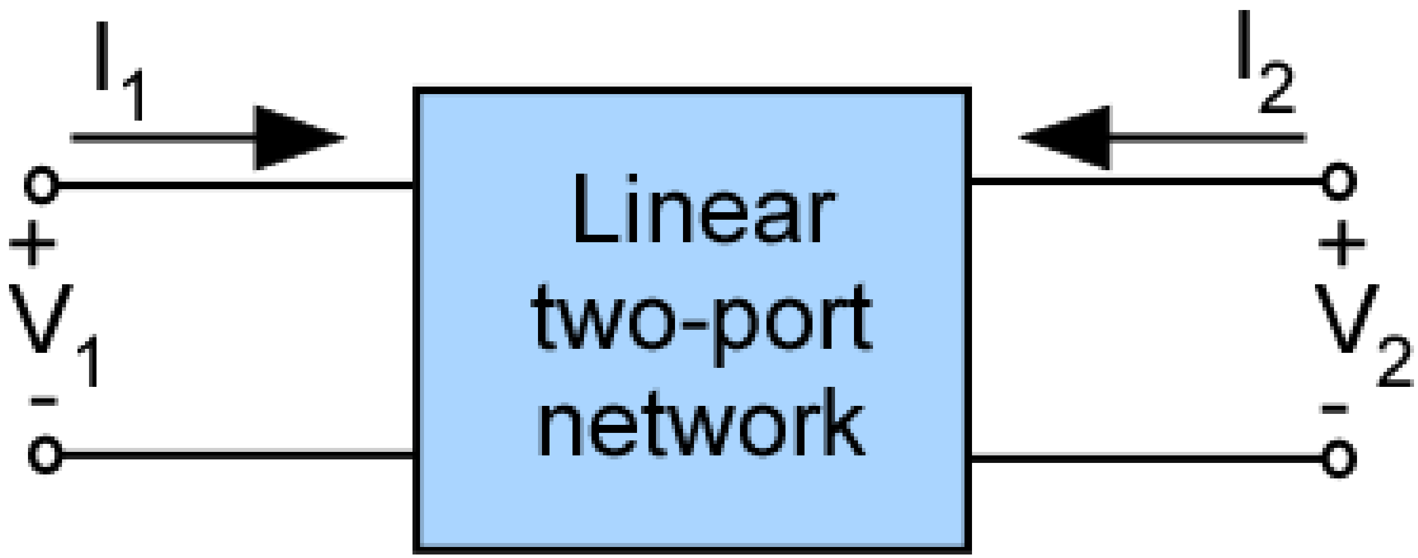
Voltage mixing-current sampling feedback

Shunt-Shunt Feedback



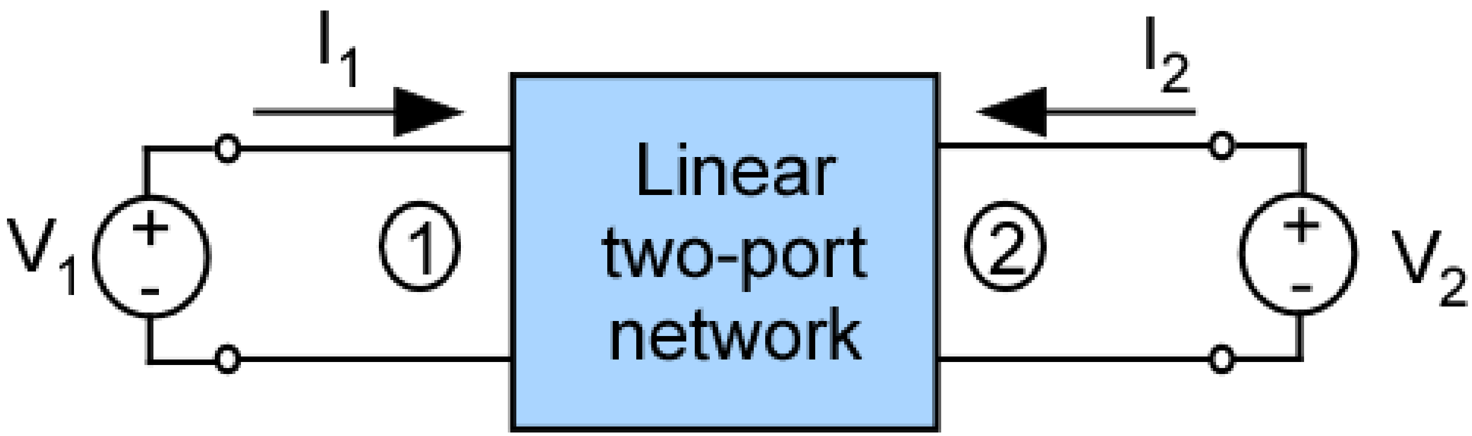
Current mixing-voltage sampling feedback

Transfer Function Representation



Use a two-terminal representation of system for input and output

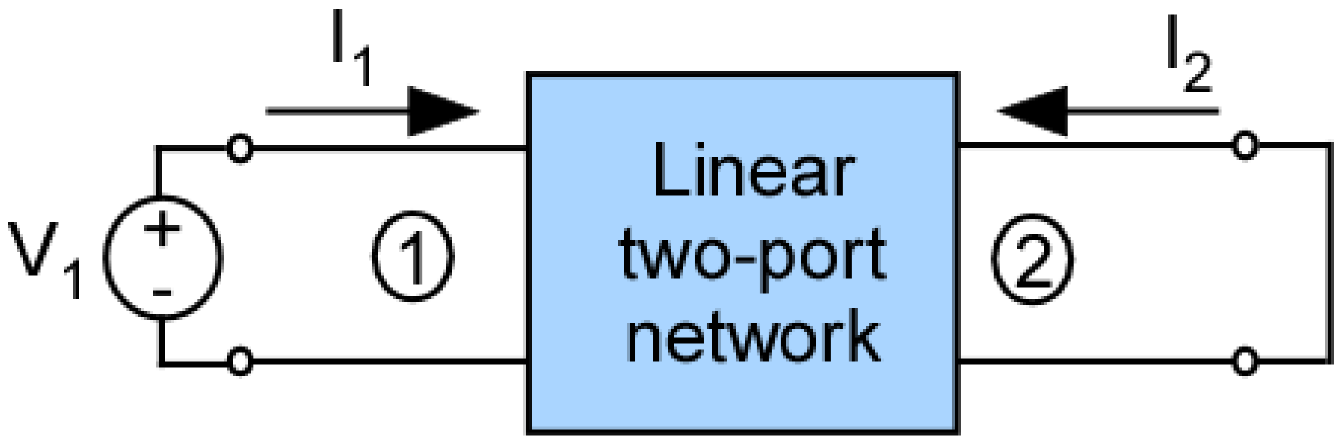
Y-parameter Representation



$$I_1 = y_{11}V_1 + y_{12}V_2$$

$$I_2 = y_{21}V_1 + y_{22}V_2$$

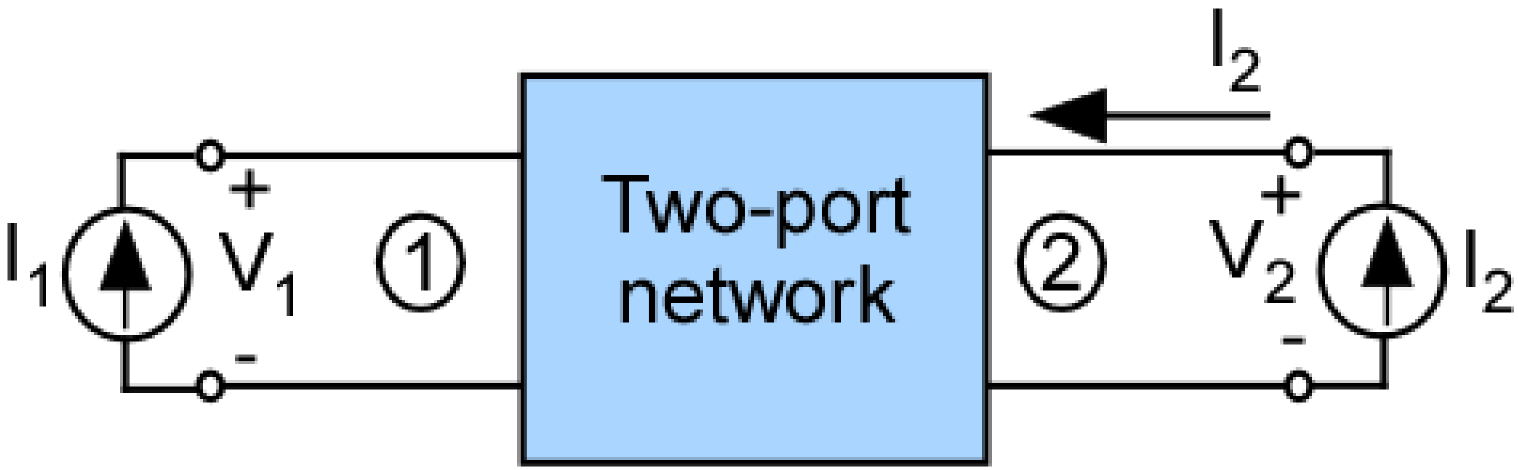
Y Parameter Calculations



$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

To make $V_2 = 0$, place a short at port 2

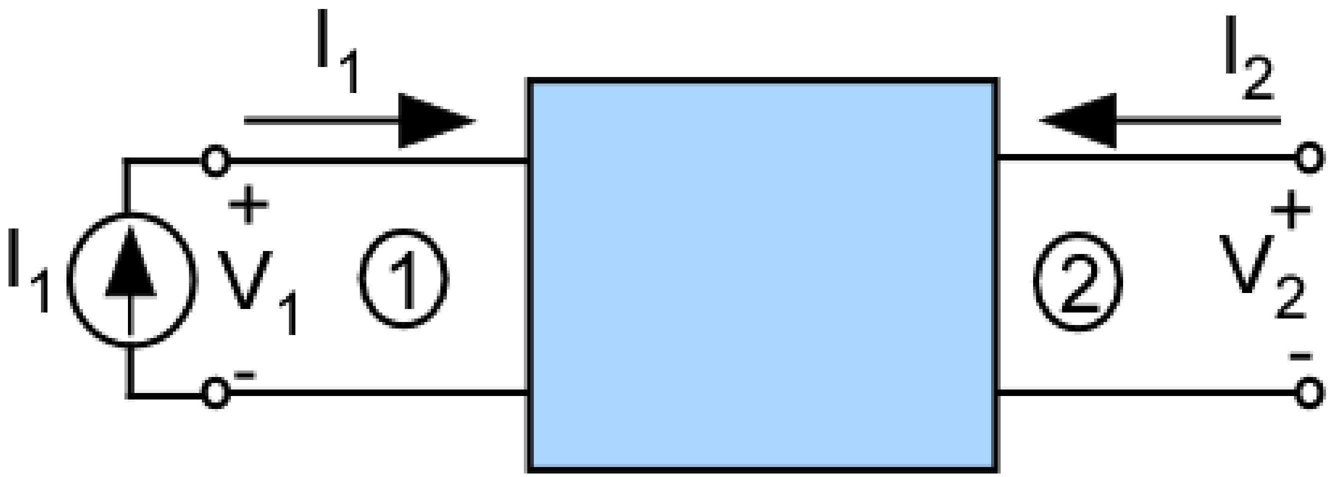
Z Parameters



$$V_1 = z_{11} I_1 + z_{12} I_2$$

$$V_2 = z_{21} I_1 + z_{22} I_2$$

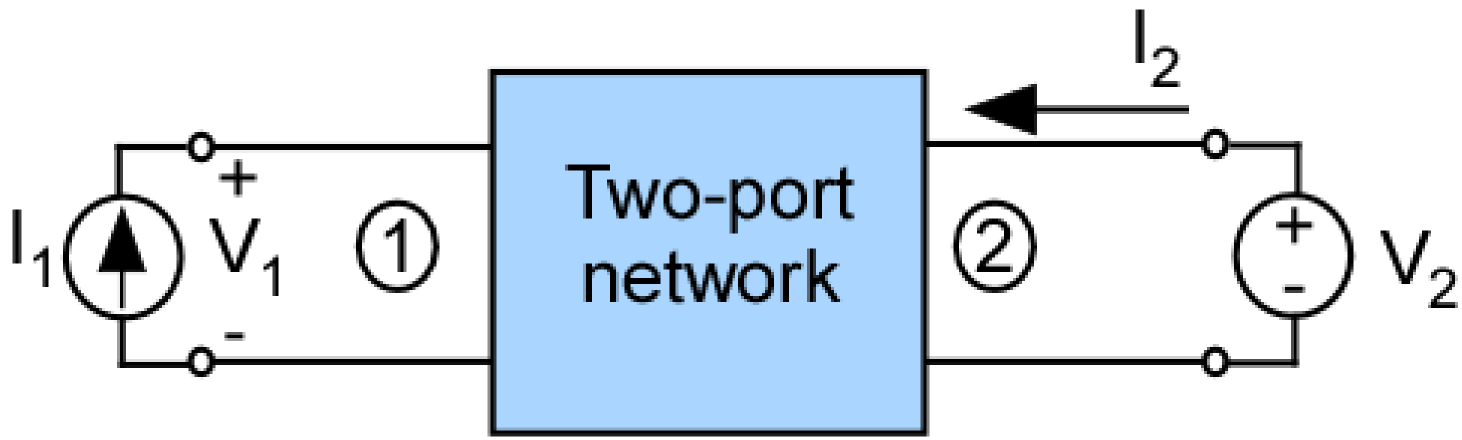
Z-parameter Calculations



$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

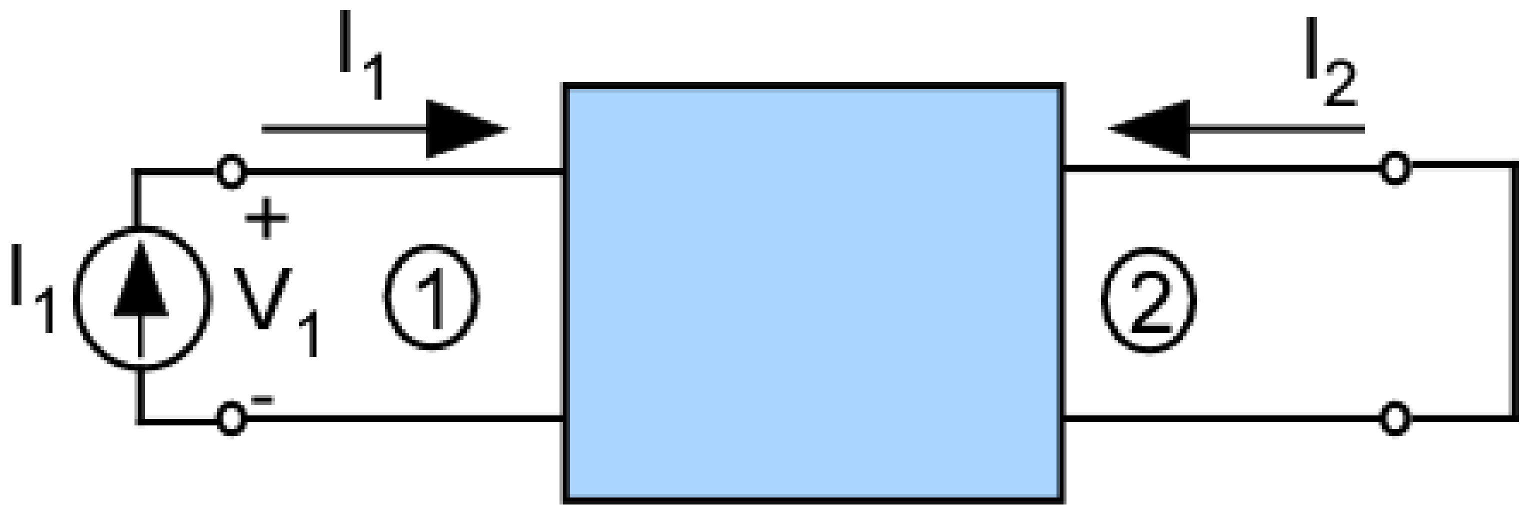
To make $I_2 = 0$, place an open at port 2

H Parameters



$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

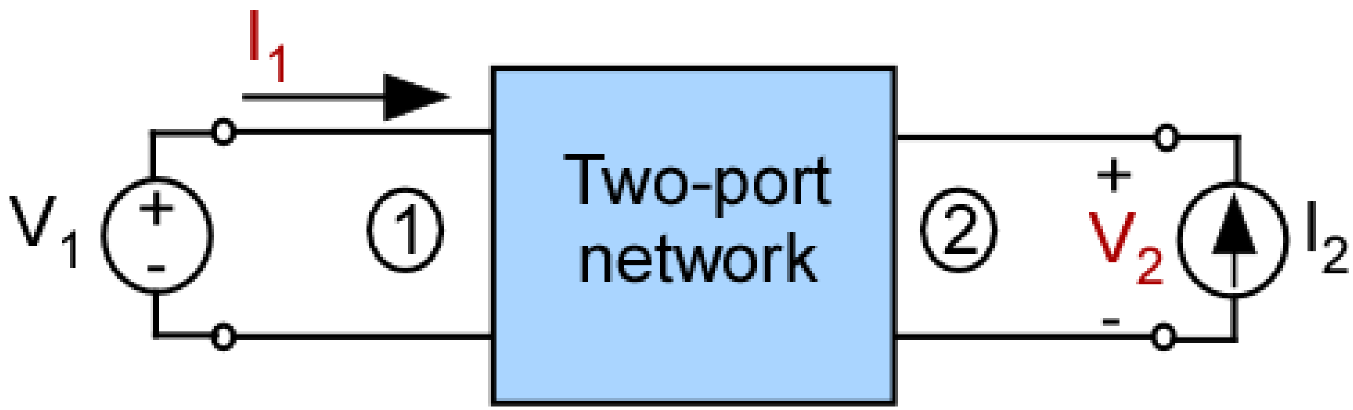
H Parameter Calculations



$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} \qquad h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$

To make $V_2 = 0$, place a short at port 2

G Parameters



$$I_1 = g_{11}V_1 + g_{12}I_2$$

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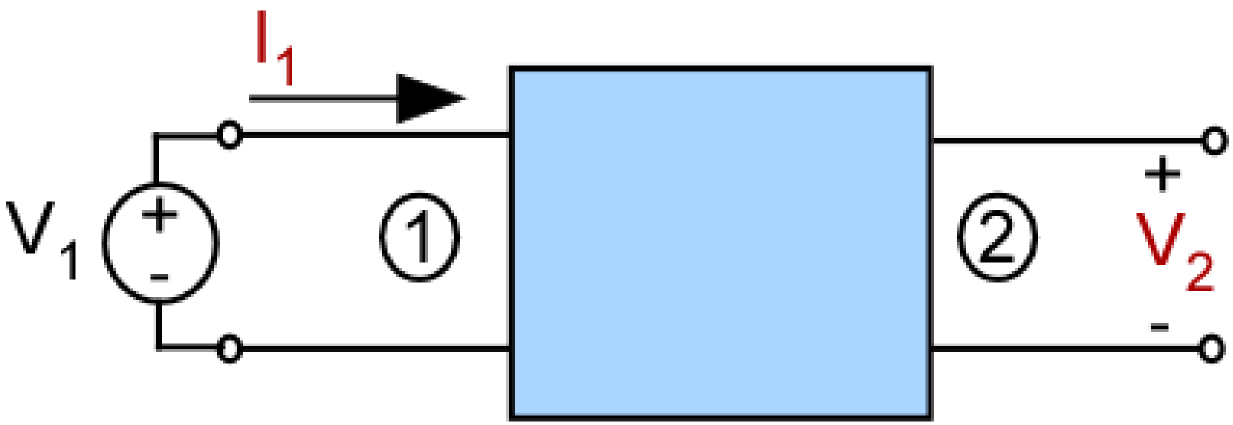
G-Parameter Calculations



$$g_{11} = \left.\frac{I_1}{V_1}\right|_{I_2=0} \qquad g_{21} = \left.\frac{V_2}{V_1}\right|_{I_2=0}$$

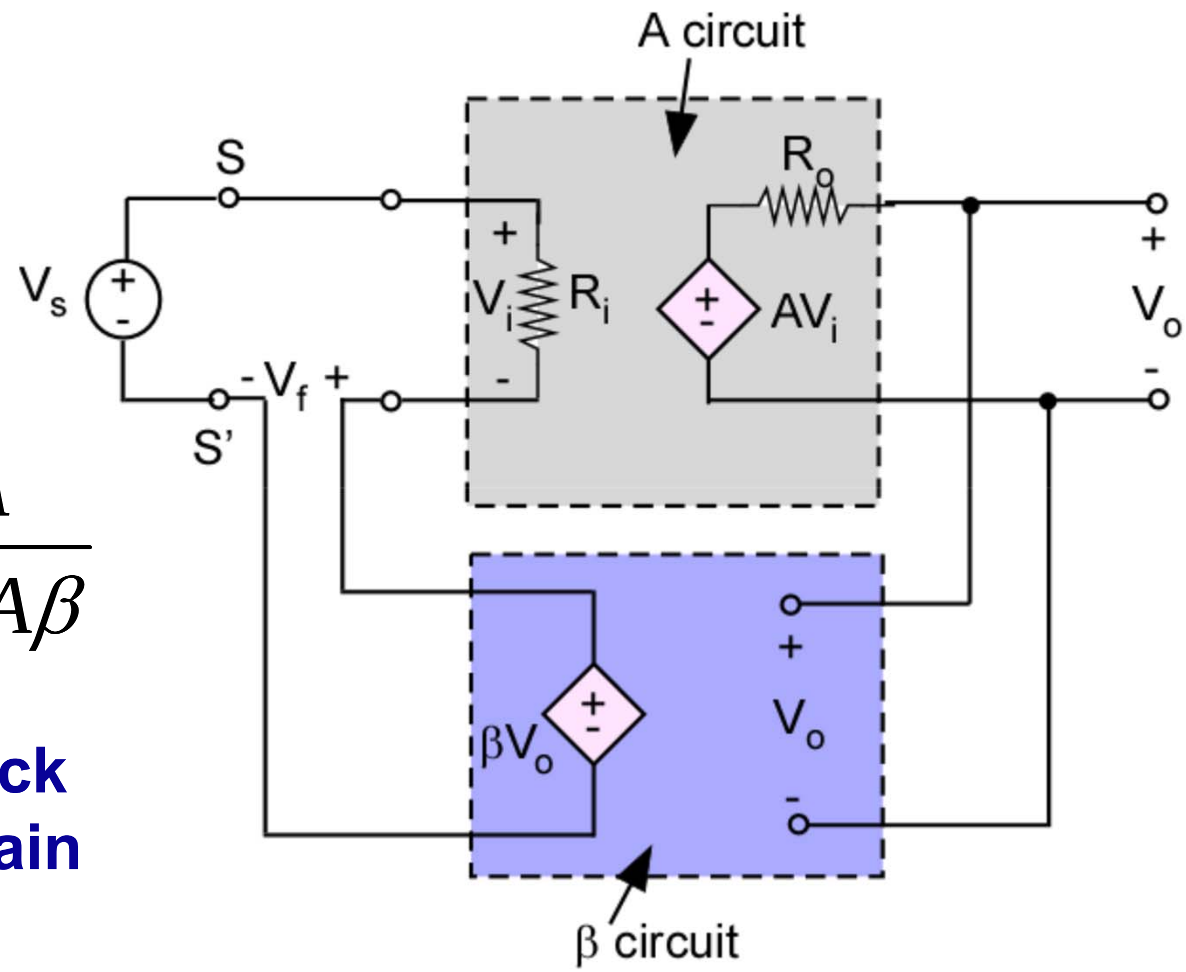
To make $I_2 = 0$, place an open at port 2

Series-Shunt Feedback - Ideal

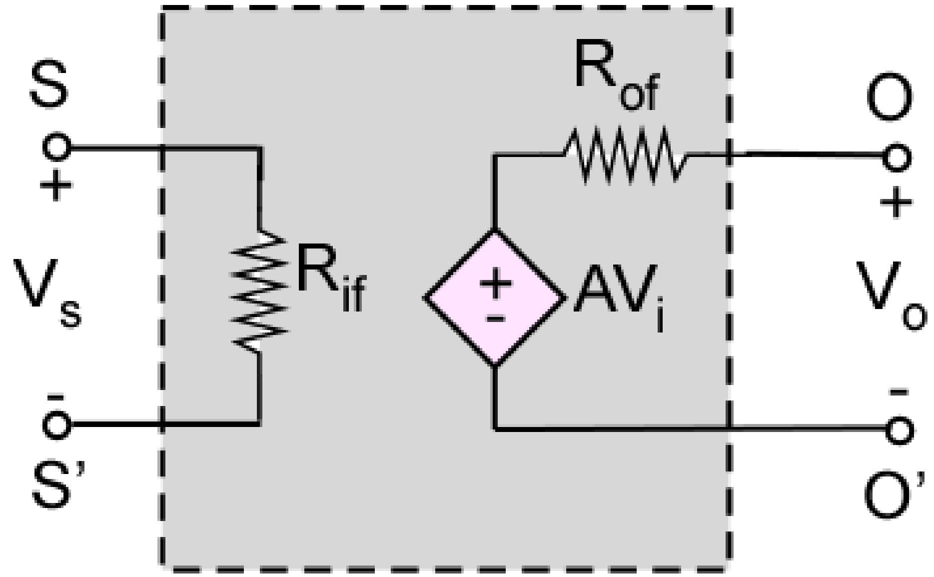
$$A \equiv \frac{V_o}{V_i}$$

$$A_f \equiv \frac{V_o}{V_s} = \frac{A}{1+A\beta}$$

Negative feedback decreases the gain



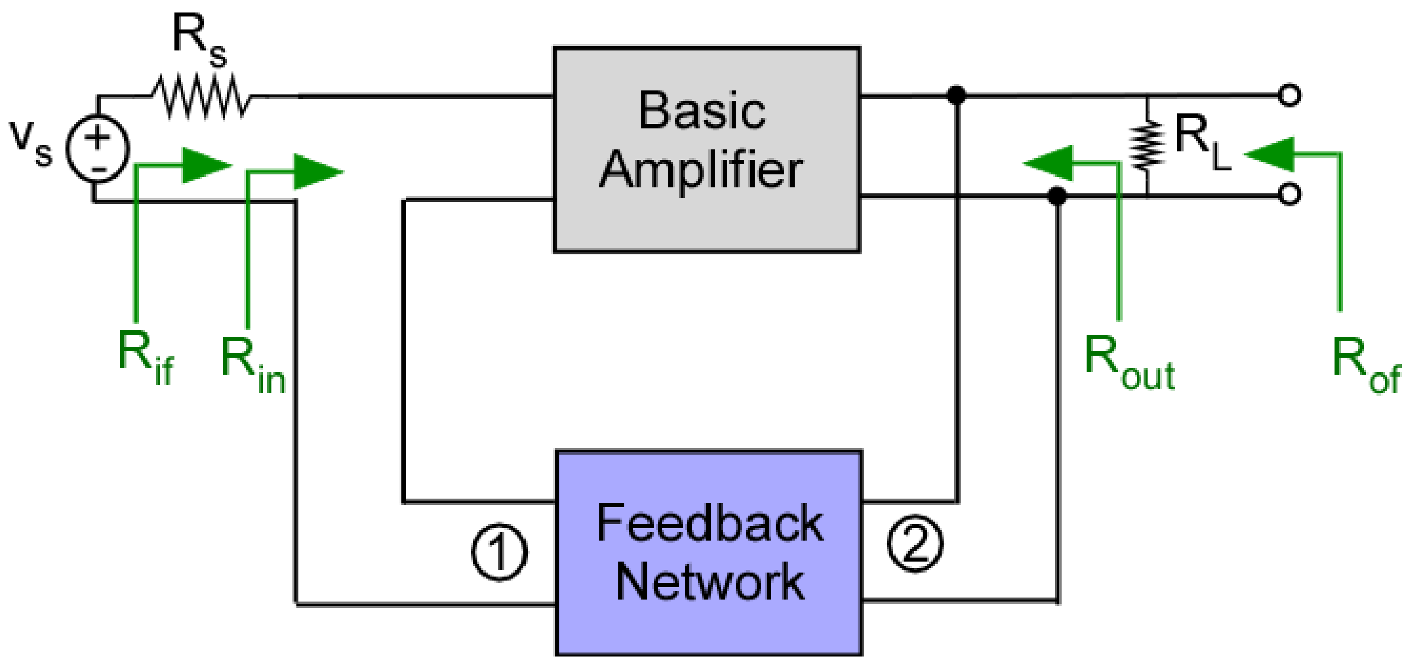
Series-Shunt Feedback – Equivalent Circuit



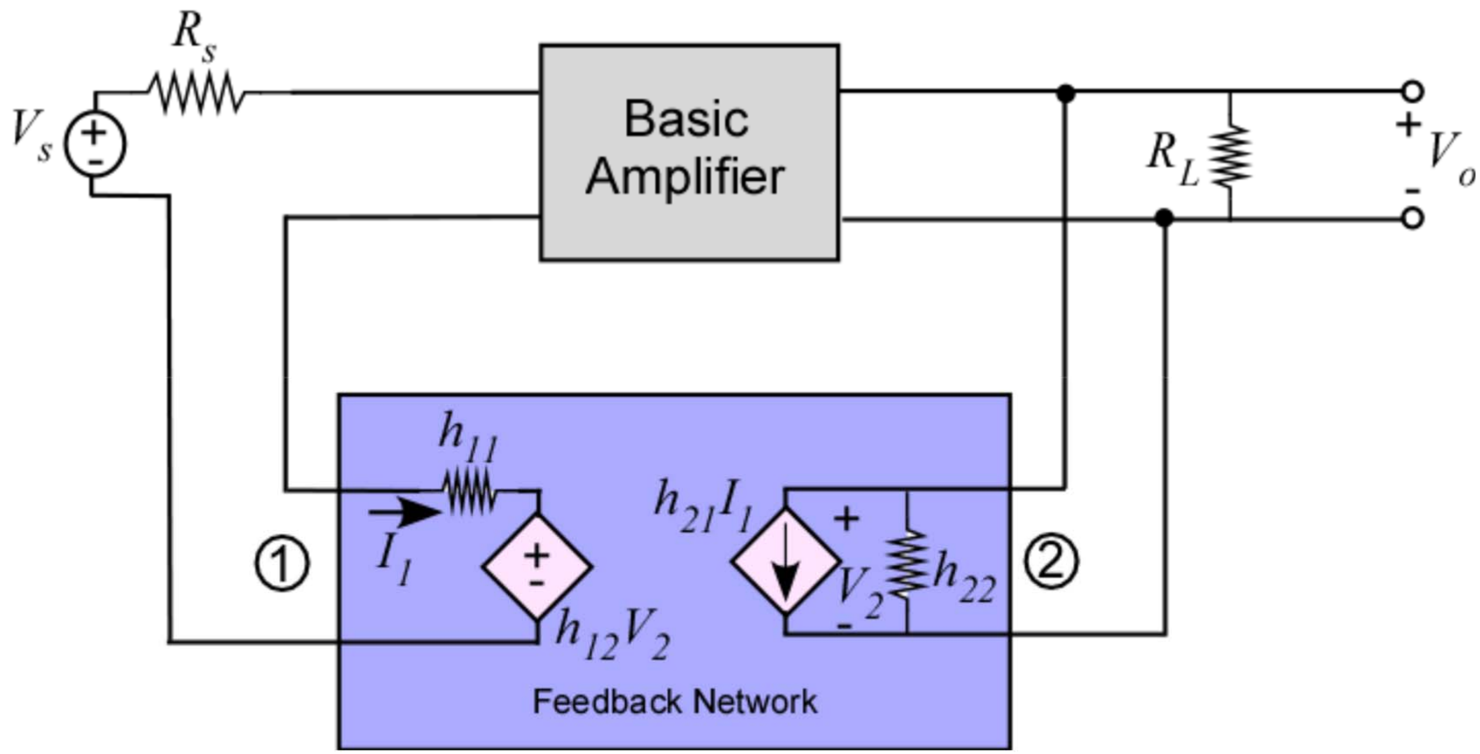
$$R_{if} = R_i\left(1 + A\beta\right) \qquad R_{of} = R_o / \left(1 + A\beta\right)$$

Negative feedback increases the input resistance and decreases the output resistance by a factor equal to the feedback

Series-Shunt Feedback - Actual

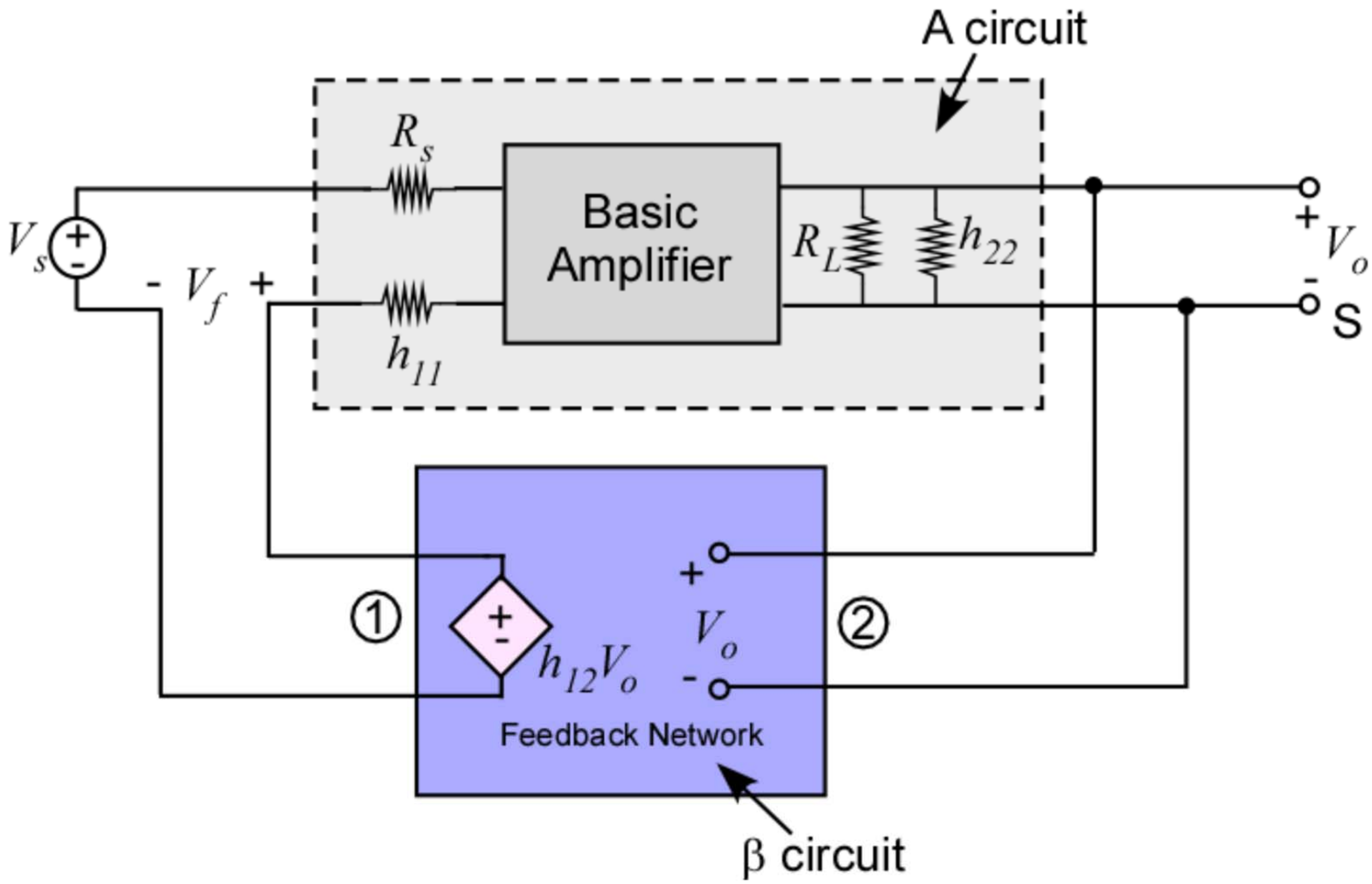


Series-Shunt Feedback : h-Parameters



Account for all 4 h parameters

Series-Shunt Feedback : h-Parameters



$$\left|h_{12}\right|_{\substack{basic\\amplifier}} \ll \left|h_{12}\right|_{\substack{feedback\\network}} \qquad \left|h_{21}\right|_{\substack{feedback\\network}} \ll \left|h_{21}\right|_{\substack{basic\\amplifier}}$$

Series-Series Feedback - Ideal

$$A \equiv \frac{I_o}{V_i}$$

$$A_f \equiv \frac{I_o}{V_s} = \frac{A}{1 + A\beta}$$

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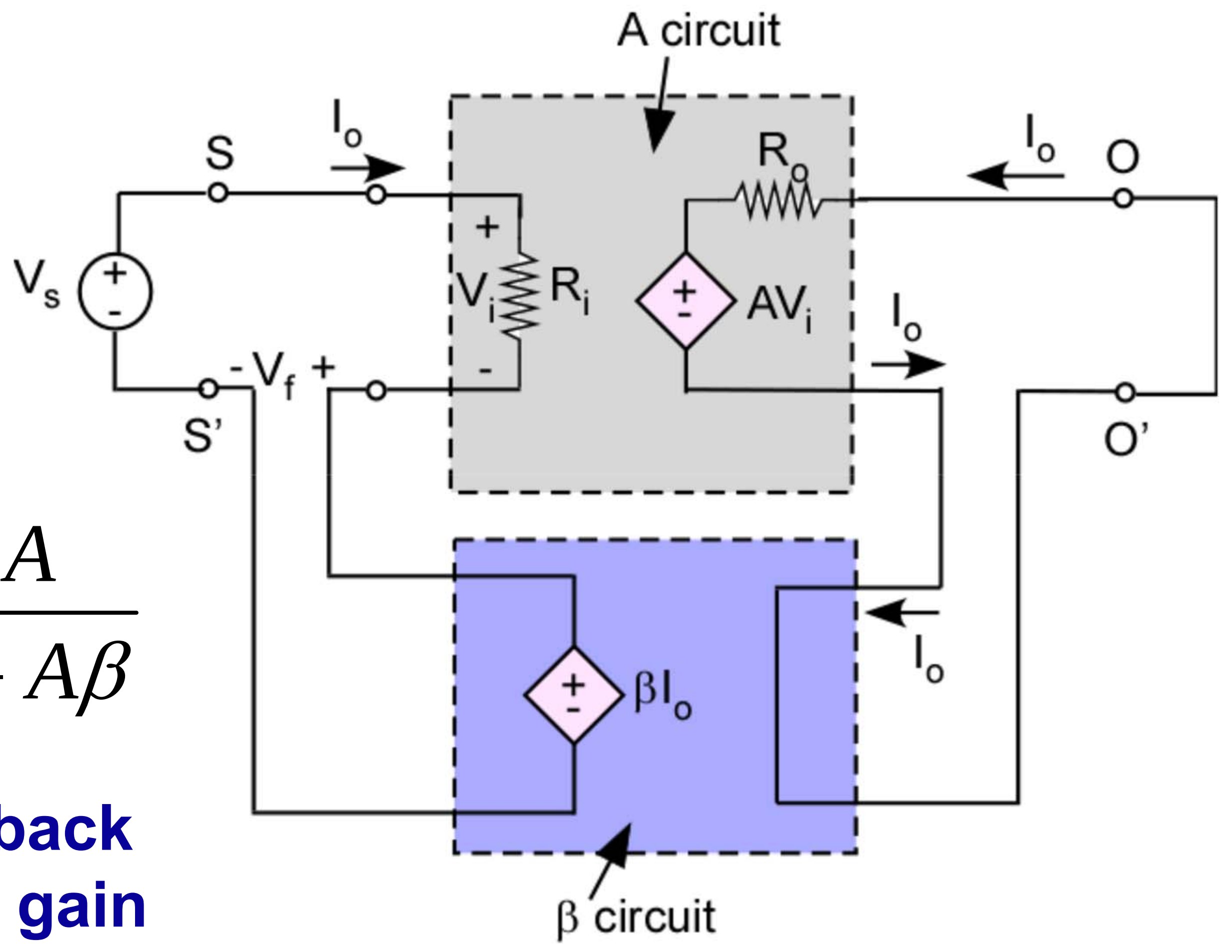
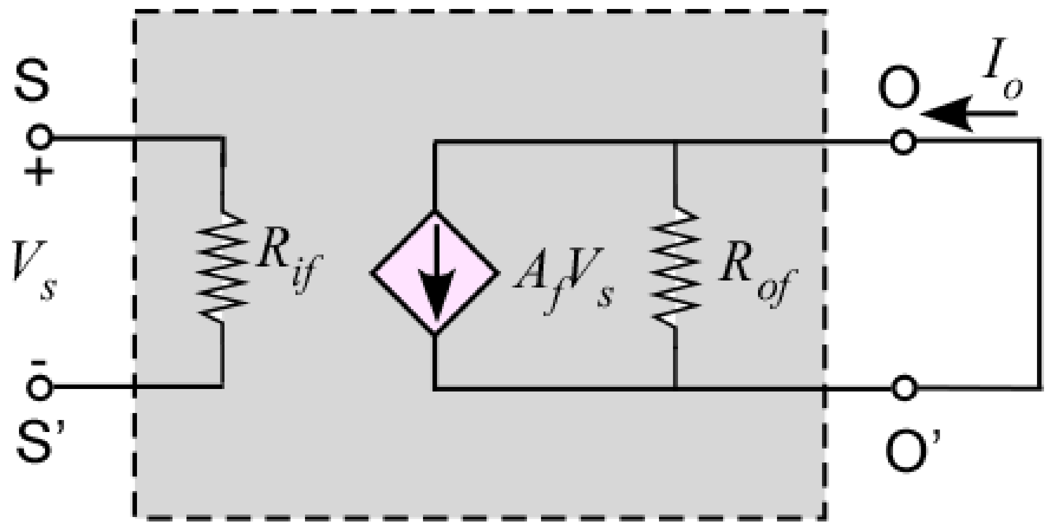


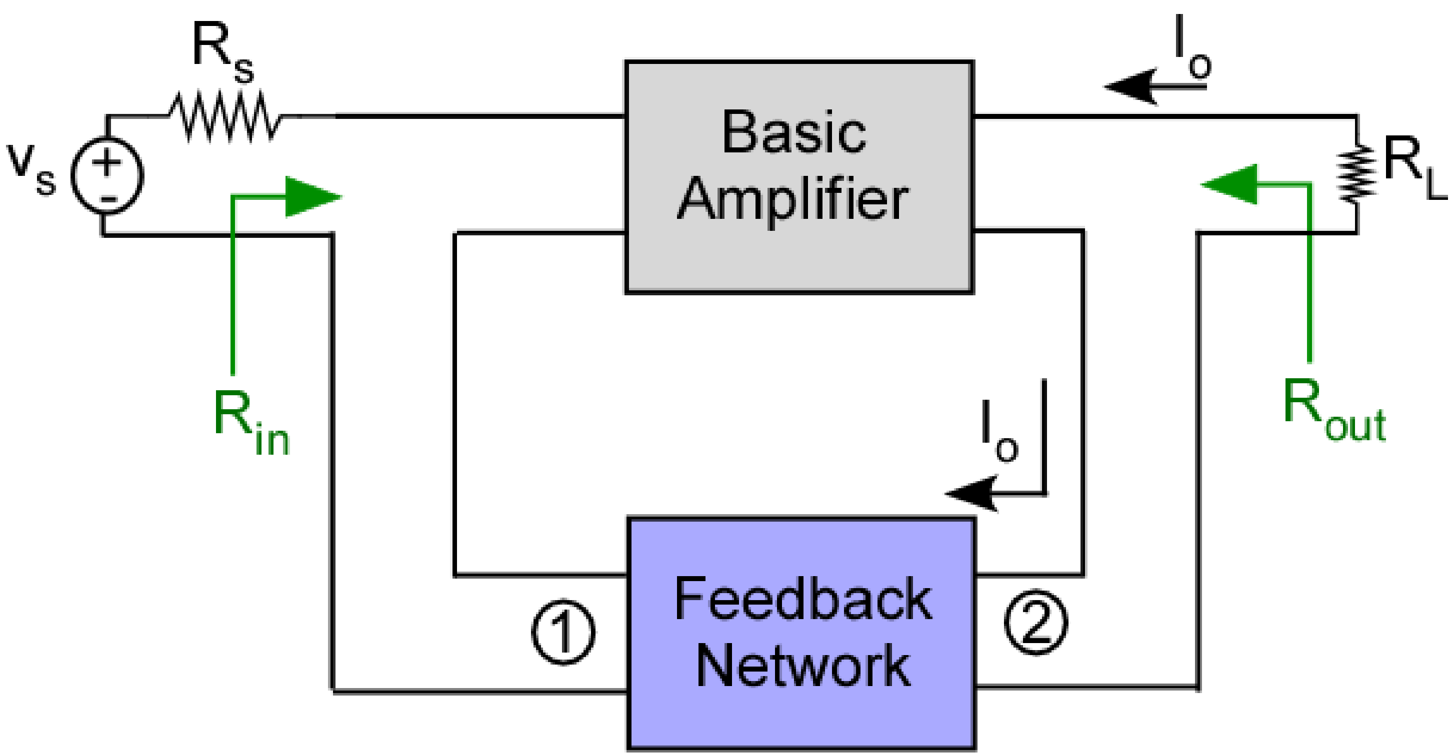
Series-Series Feedback – Equivalent Circuit



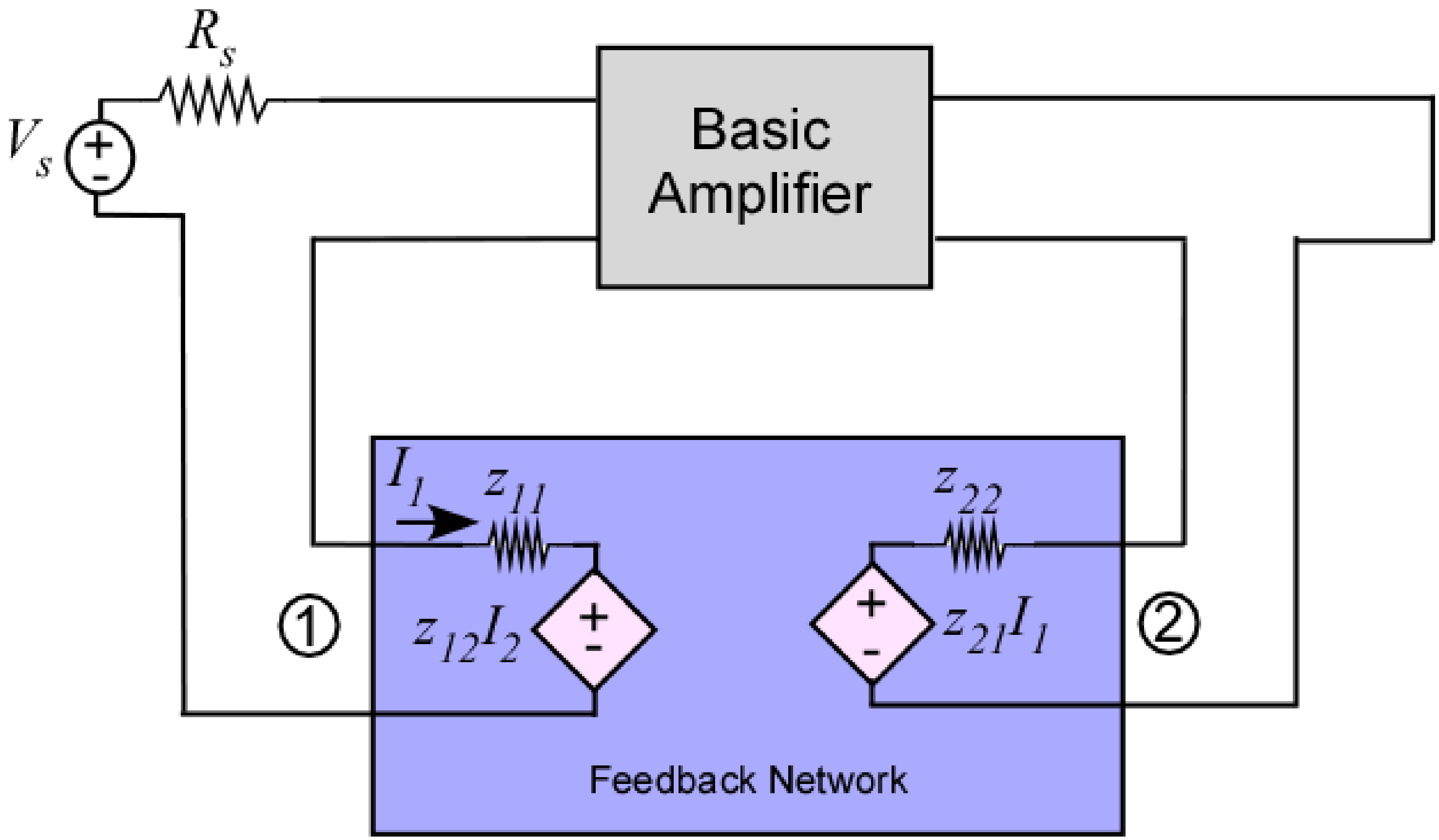
$$R_{if} = R_i\left(1 + A\beta\right) \qquad R_{of} = R_o\left(1 + A\beta\right)$$

Negative feedback increases the input resistance and increases the output resistance by a factor equal to the feedback

Series-Series Feedback - Actual

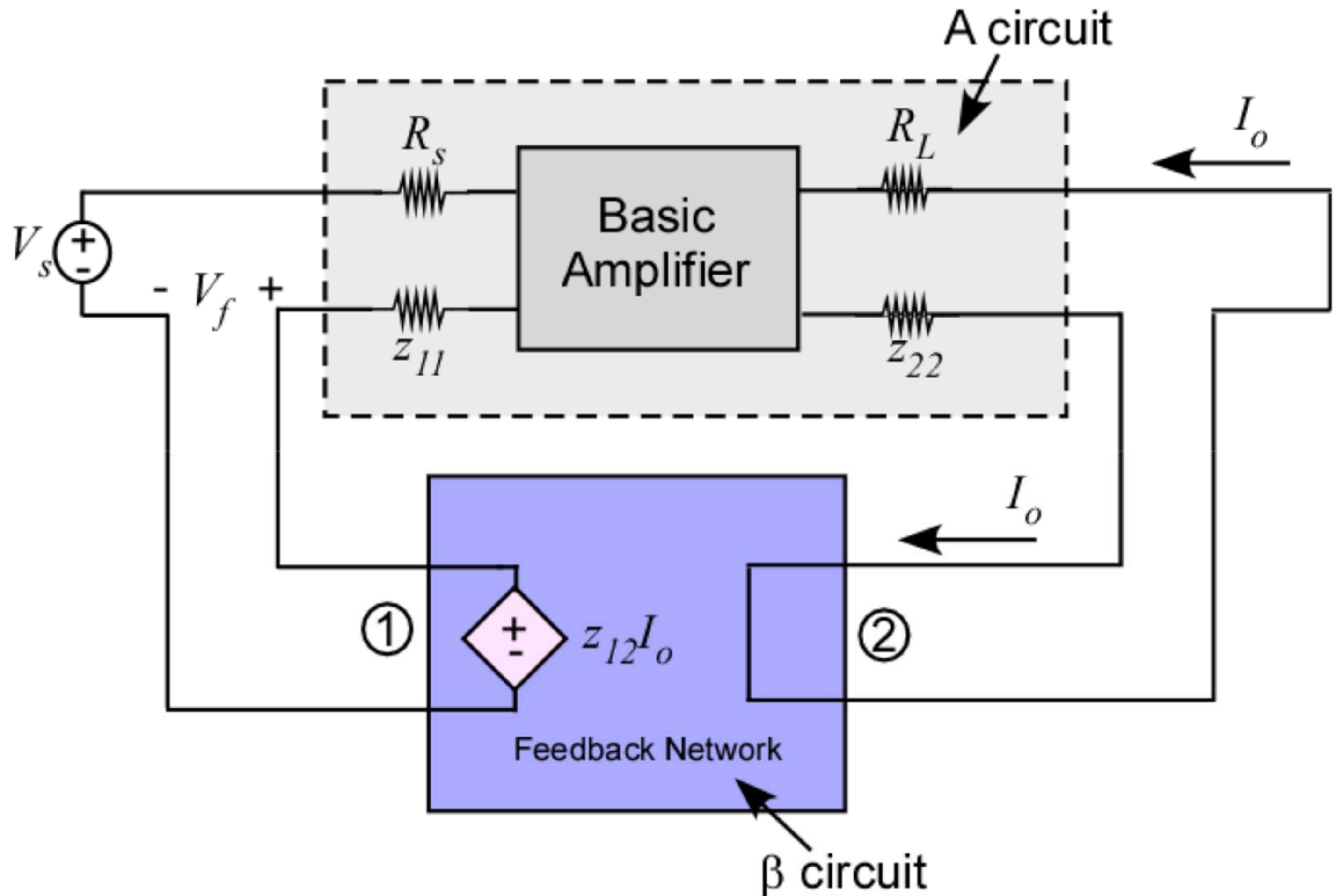


Series-Series Feedback: Z Parameters



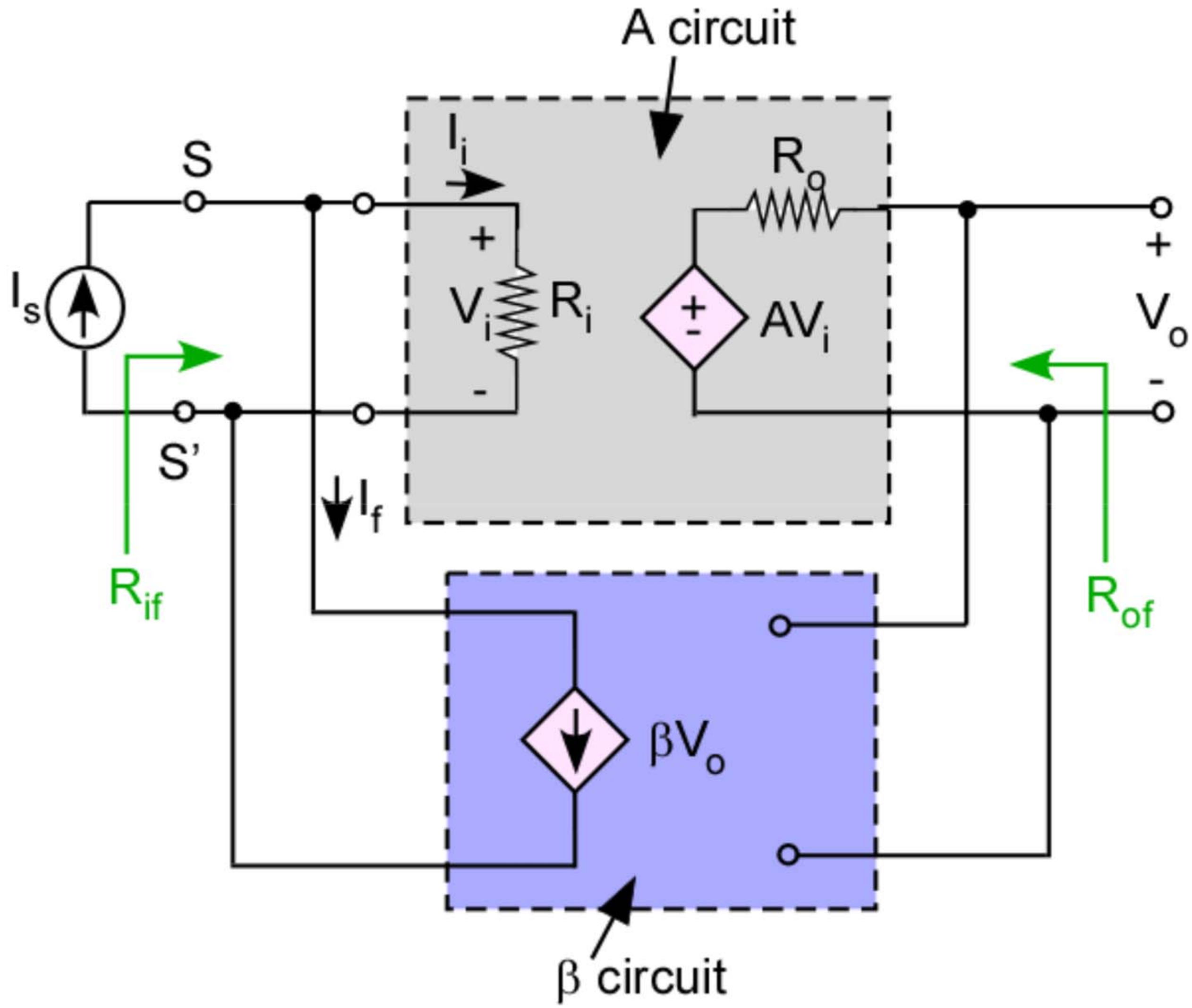
Account for all 4 z parameters

Series-Series Feedback: Z Parameters



$$\left|Z_{12}\right|_{\substack{basic \\ amplifier}} \ll \left|Z_{12}\right|_{\substack{feedback \\ network}} \qquad \left|Z_{21}\right|_{\substack{feedback \\ network}} \ll \left|Z_{21}\right|_{\substack{basic \\ amplifier}}$$

Shunt-Shunt Feedback - Ideal



$$A \equiv \frac{V_o}{I_i}$$

Shunt-Shunt Feedback

$$A_f \equiv \frac{V_o}{I_s} = \frac{A}{1+A\beta}$$

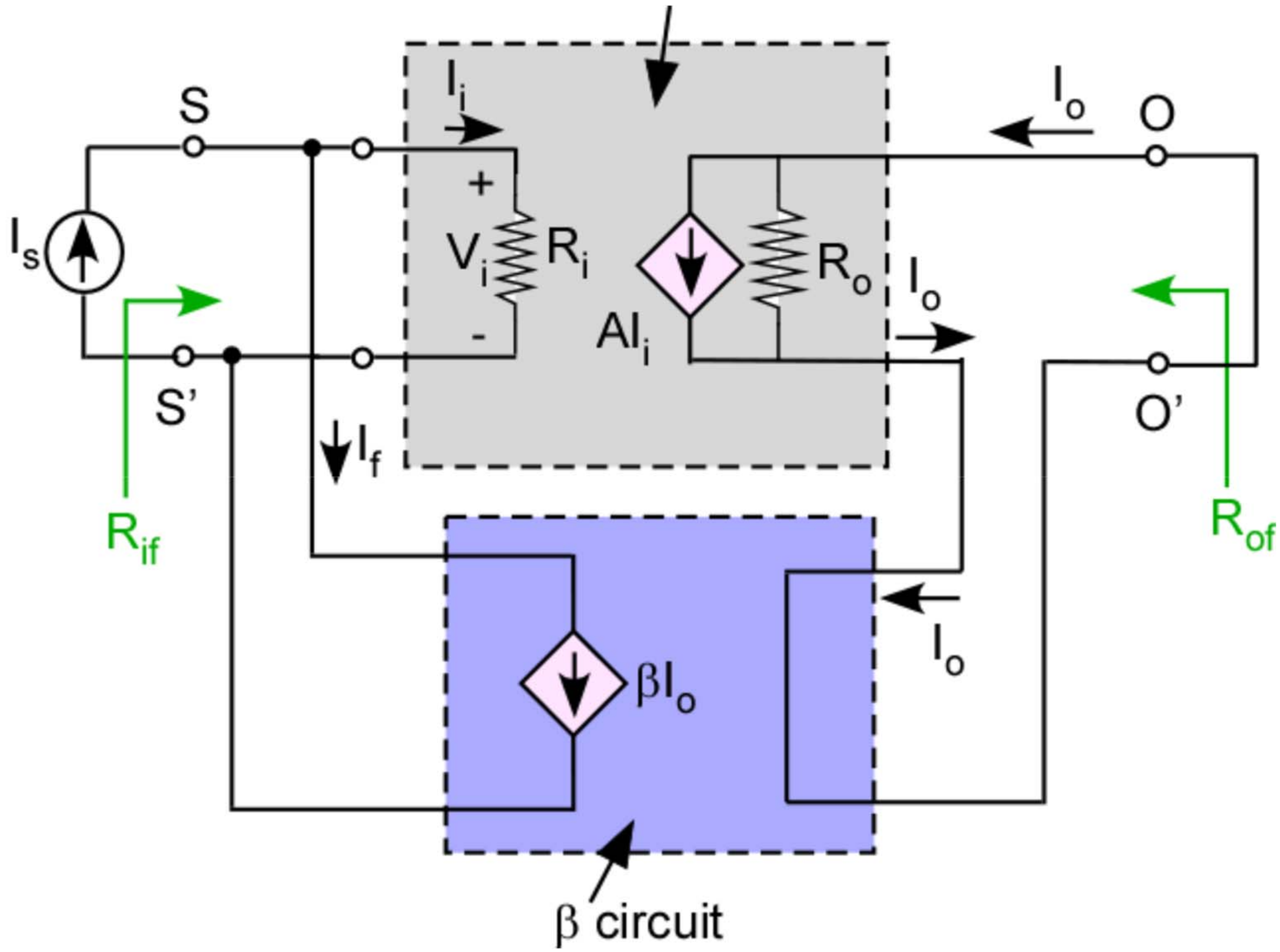
Negative feedback decreases the gain

$$R_{if} = R_i / \left(1 + A\beta\right) \qquad R_{of} = R_o / \left(1 + A\beta\right)$$

Negative feedback decreases the input resistance and decreases the output resistance by a factor equal to the feedback

$$\left|y_{12}\right|_{\substack{basic\\ amplifier}} \ll \left|y_{12}\right|_{\substack{feedback\\ network}} \qquad \left|y_{21}\right|_{\substack{feedback\\ network}} \ll \left|y_{21}\right|_{\substack{basic\\ amplifier}}$$

Shunt-Series Feedback - Ideal



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Shunt-Series Feedback

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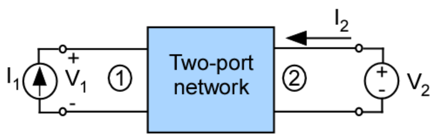
$$\left|g_{12}\right|_{\substack{basic\\amplifier}} \ll \left|g_{12}\right|_{\substack{feedback\\network}} \qquad \left|g_{21}\right|_{\substack{feedback\\network}} \ll \left|g_{21}\right|_{\substack{basic\\amplifier}}$$

Rules for Series-Shunt Feedback



$$V_1 = h_{11} I_1 + h_{12} V_2$$

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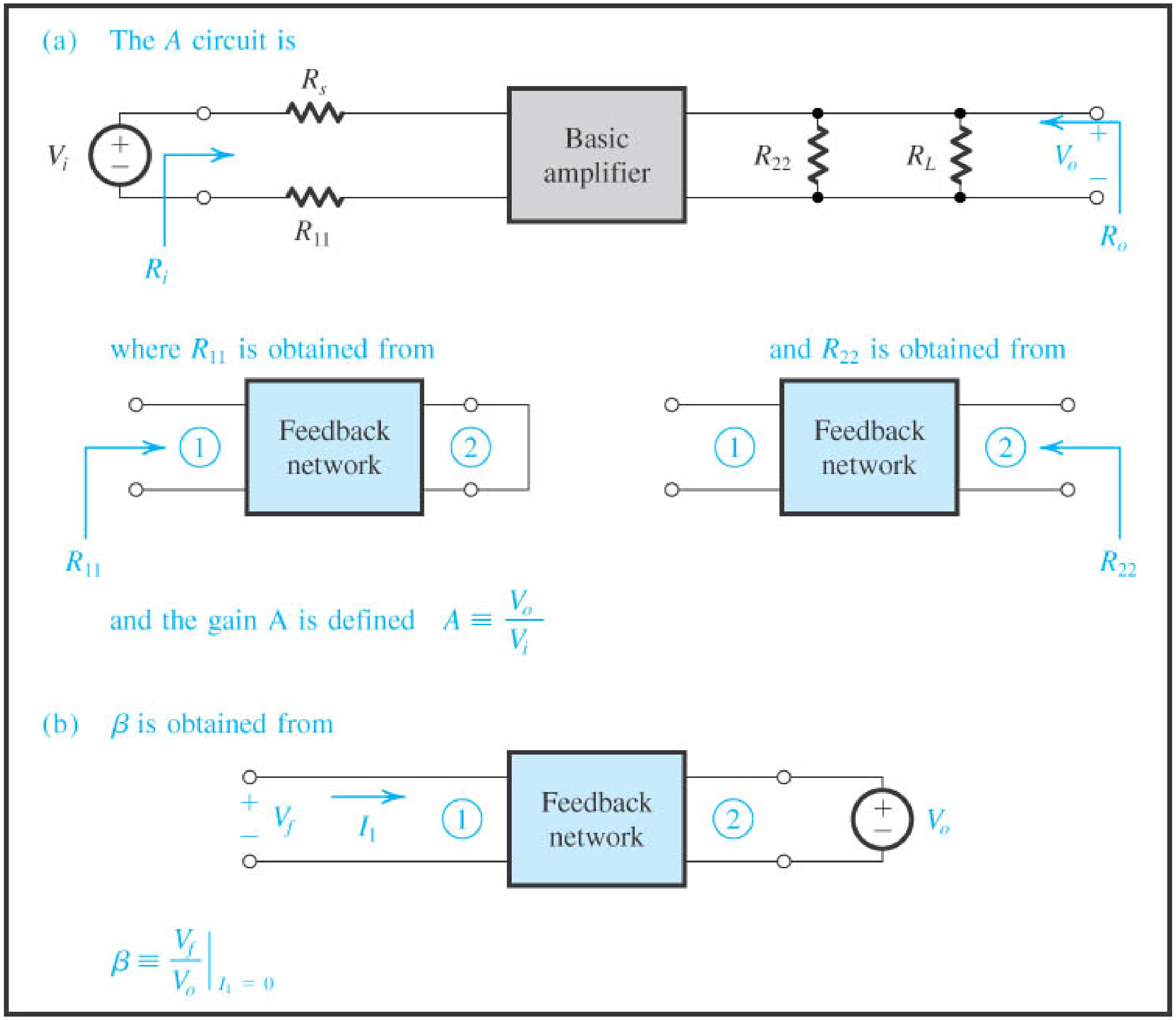
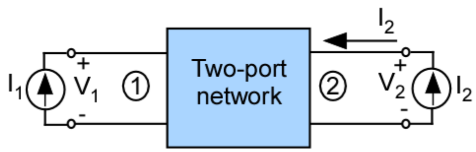


Rules for Series-Series Feedback



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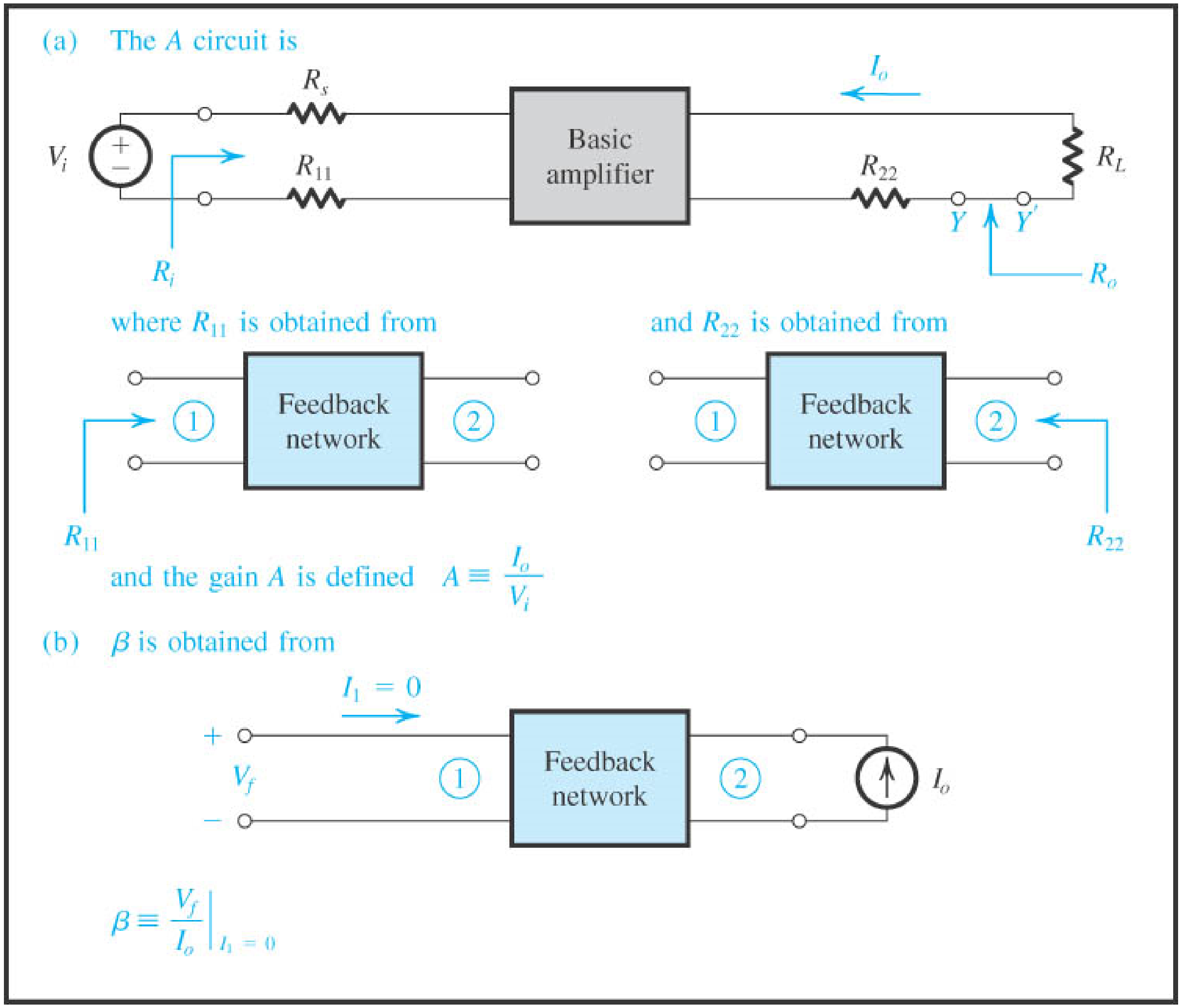
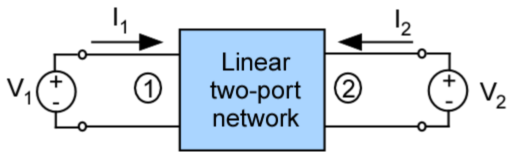


Rules for Shunt-Shunt Feedback



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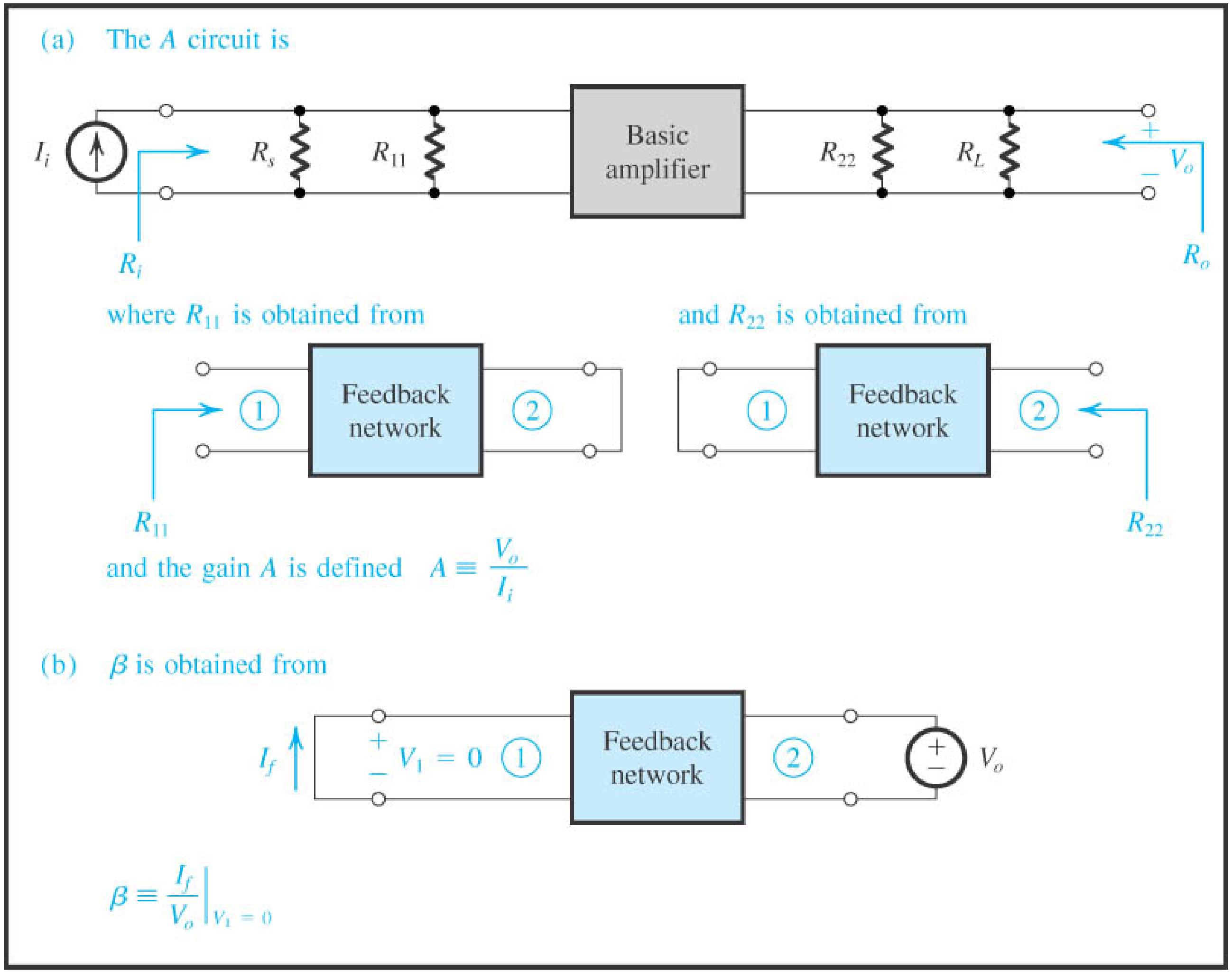
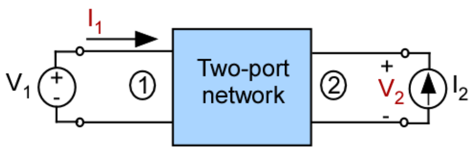


Rules for Shunt-Series Feedback



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