IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Microelectronics: Devices to Circuits

Design of Feedback Amplifier for all configuration

SUDEB DASGUPTA

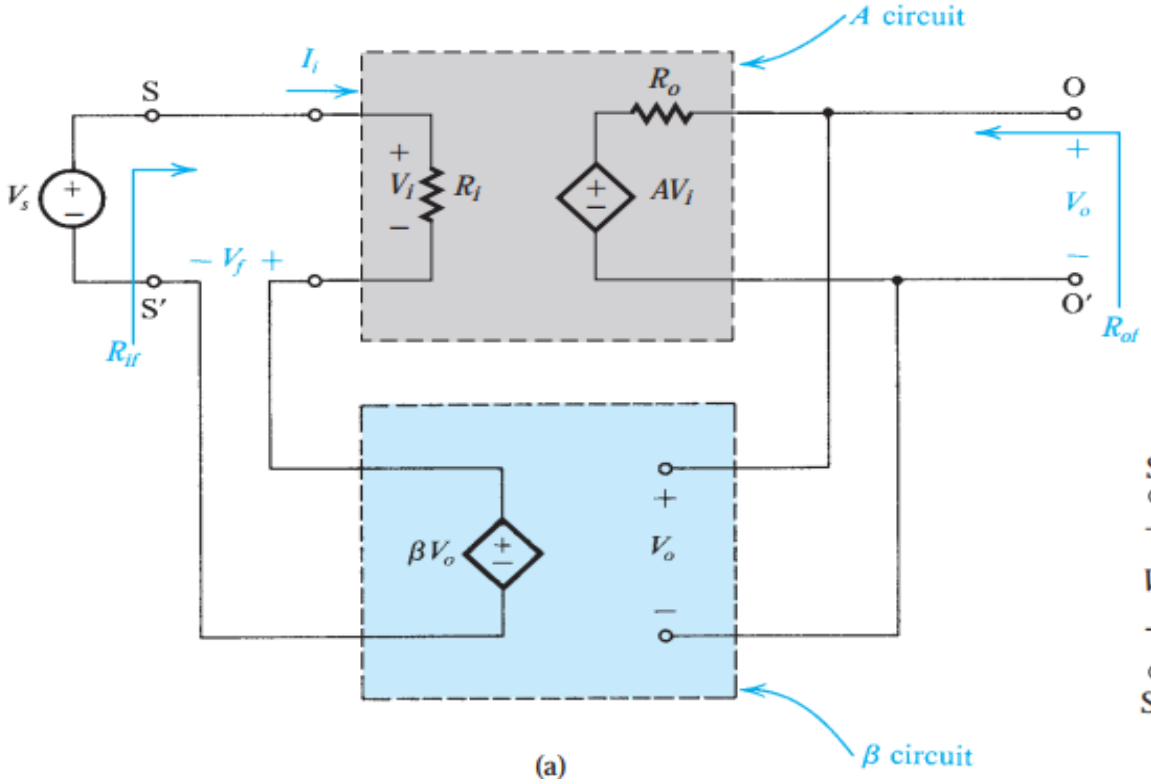
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



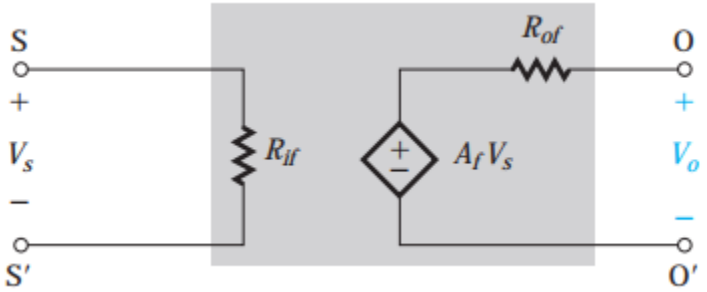
Outline

- Feedback Voltage amplifier (series-shunt) Ideal case
- Feedback Voltage amplifier (series-shunt) Practical case
- Feedback Transconductance amplifier (series-series) Ideal case
- Feedback Transconductance amplifier (series-series) practical case
- Feedback Transresistance amplifier (Shunt-Shunt) Ideal case
- Feedback Transresistance amplifier (Shunt-Shunt) Practical case
- Feedback Current amplifier (Shunt-Series) ideal case
- Feedback Current amplifier (Shunt-Series) Practical case
- Recapitulation

Feedback Voltage amplifier (series-shunt) Ideal case



(a)



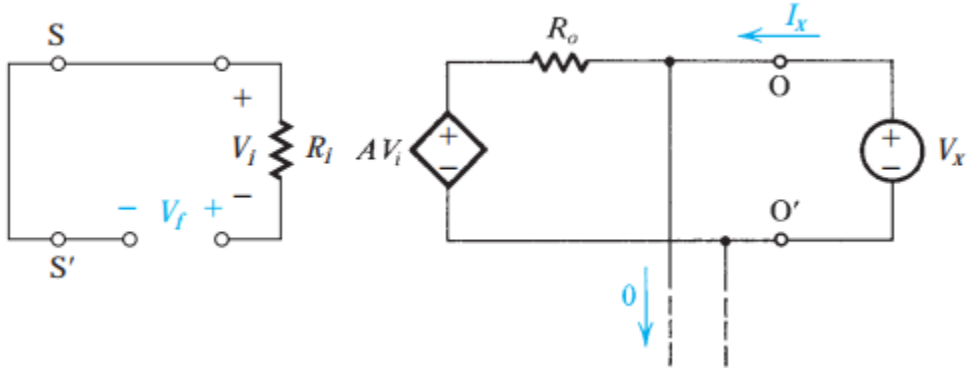
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

$$A_f = \frac{V_0}{V_s} = \frac{A}{1+A\beta}$$ A_f open circuit voltage gain

$$V_i = \frac{V_s}{1+A\beta} \qquad I_i = \frac{V_s}{(1+A\beta)R_i} \qquad R_{if} = (1+A\beta)R_i$$

$$R_{of} = \frac{V_x}{I_x} \qquad I_X = \frac{V_x - AV_i}{R_o} \qquad V_i = -V_f$$

$$V_i = -\beta V_X \qquad I_X = \frac{V_X(1+A\beta)}{R_0} \qquad R_{0f} = \frac{R_0}{1+A\beta}$$

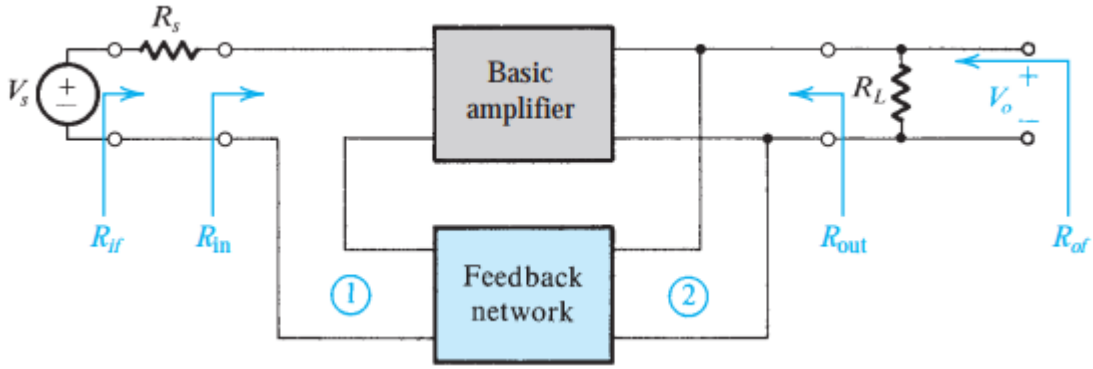


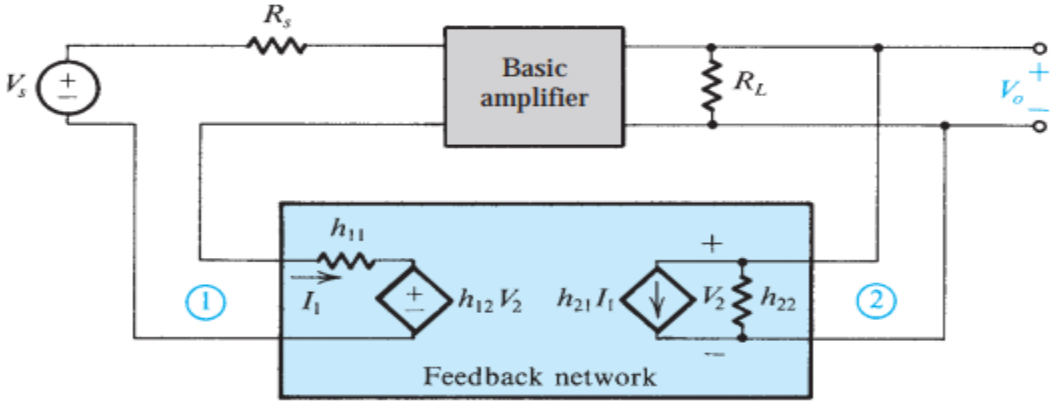
$$V_f = \beta V_0 = \beta V_X$$

R_{if} input resistance
R_{of} output resistance
I_i input current

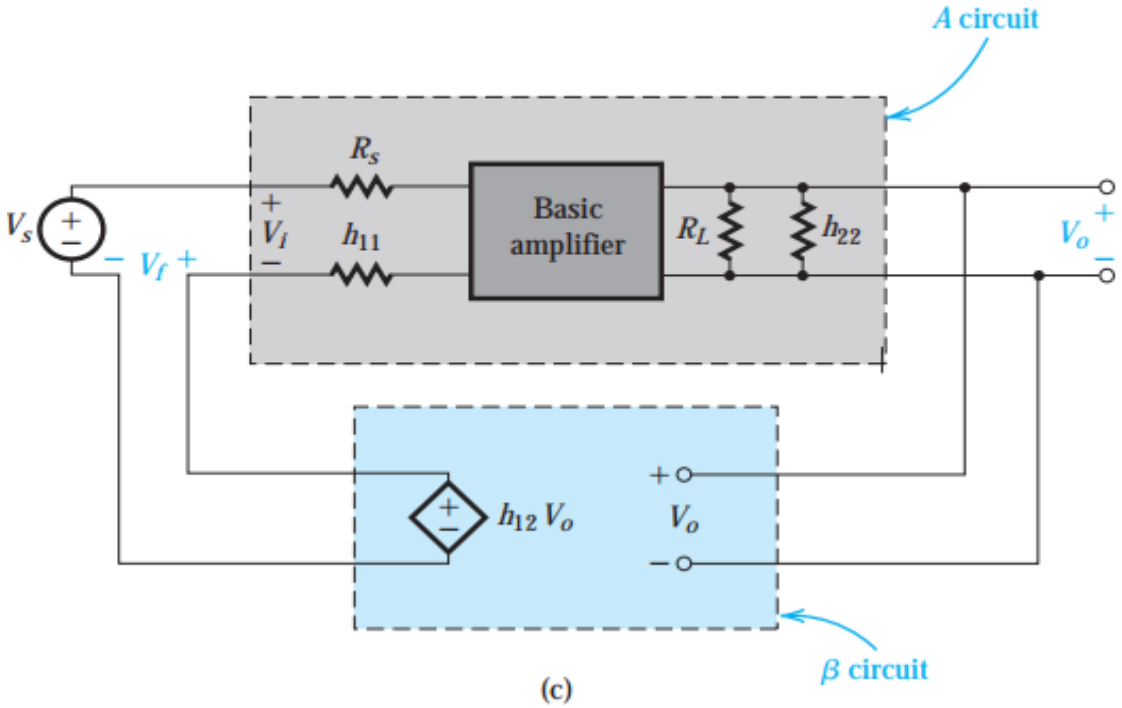
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Feedback Voltage amplifier (series-shunt) Practical case





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

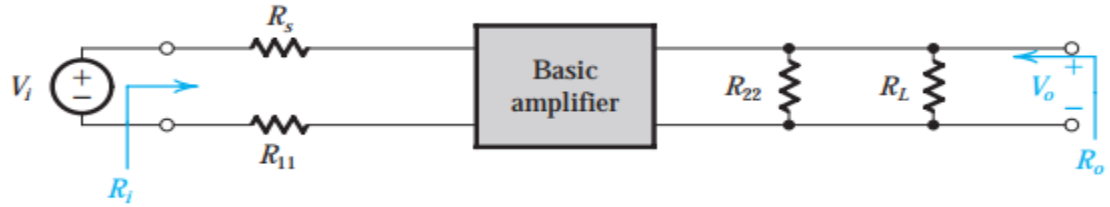


(c)

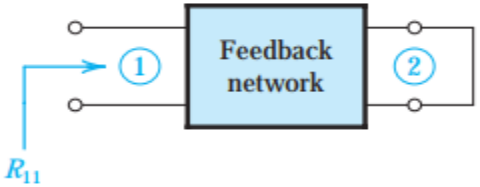
$$\beta = h_{12} \equiv \left.\frac{V_1}{V_2}\right|_{I_1=0}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

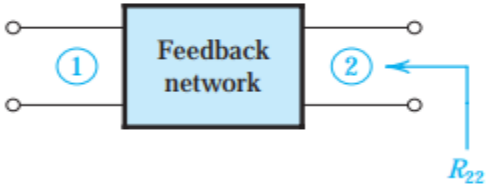
(a) The A circuit is



where R_{11} is obtained from

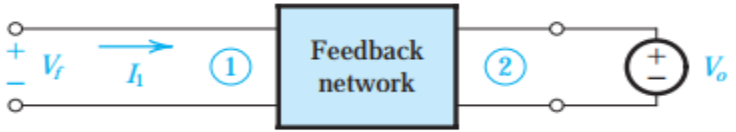


and R_{22} is obtained from



and the gain A is defined $A \equiv \frac{V_o}{V_i}$

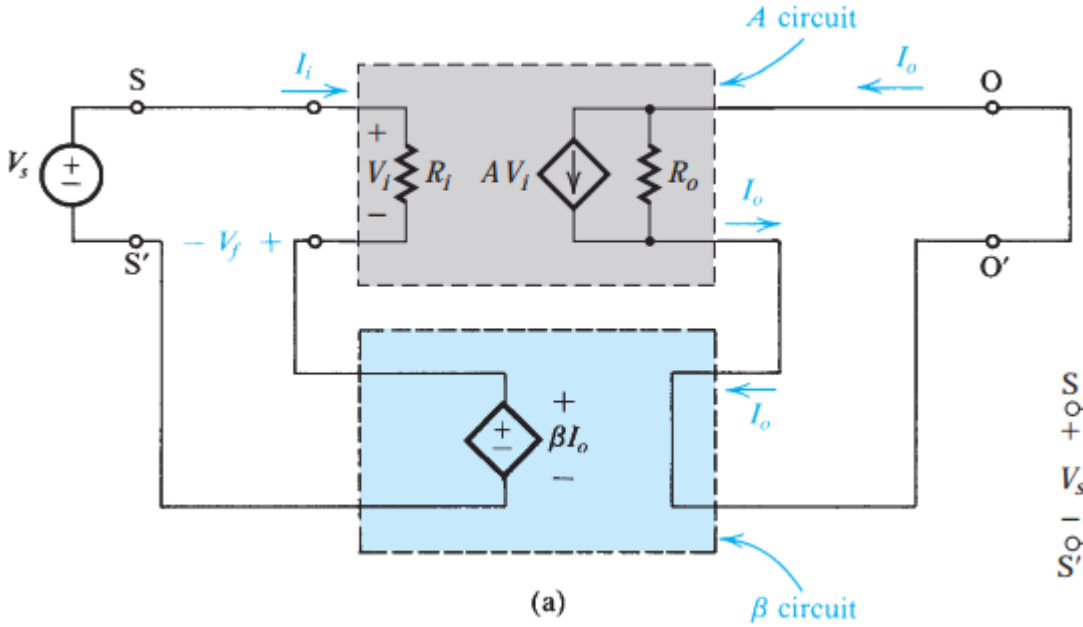
(b) β is obtained from

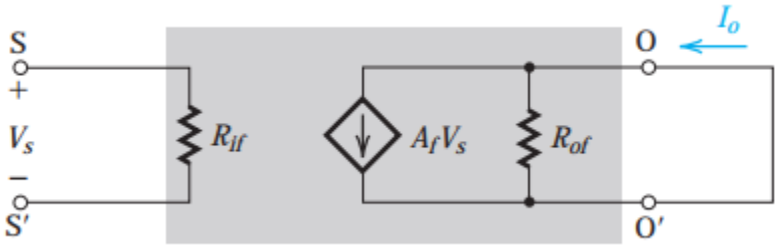


$$\beta \equiv \left.\frac{V_f}{V_o}\right|_{I_1 = 0}$$

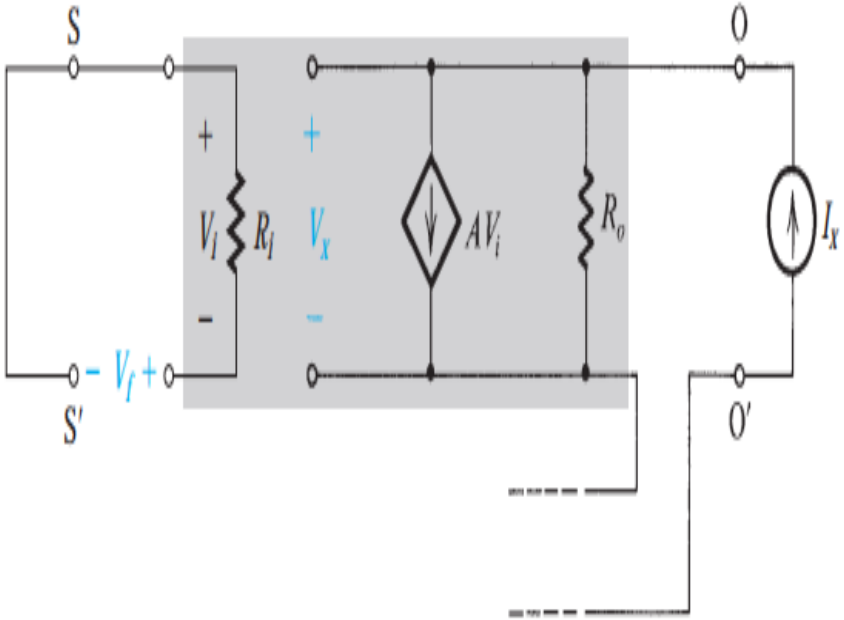
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Feedback Transconductance amplifier (series-series) Ideal case





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$$R_{if} = R_i(1+A\beta)$$

$$R_{of} = \frac{V_X}{I_X}$$

$$V_i = -V_f = -\beta I_0 = -\beta I_X$$

$$V_X = (I_X - AV_i)R_0 = (I_X + A\beta I_X)R_0$$

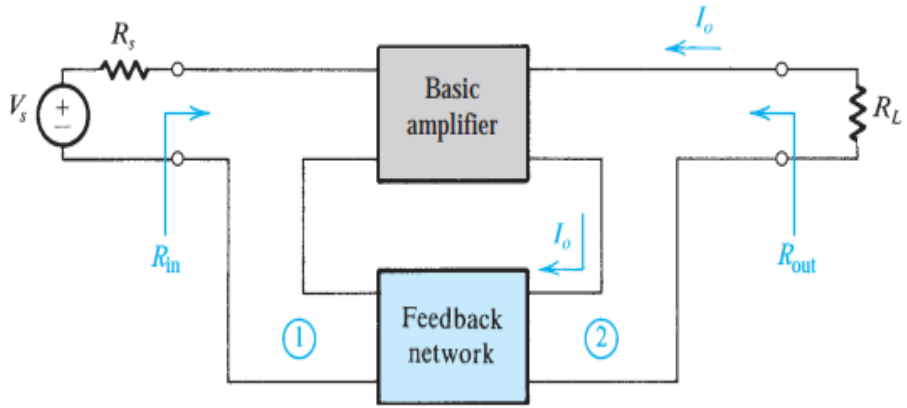
$$R_{of} = (1+A\beta)R_0$$

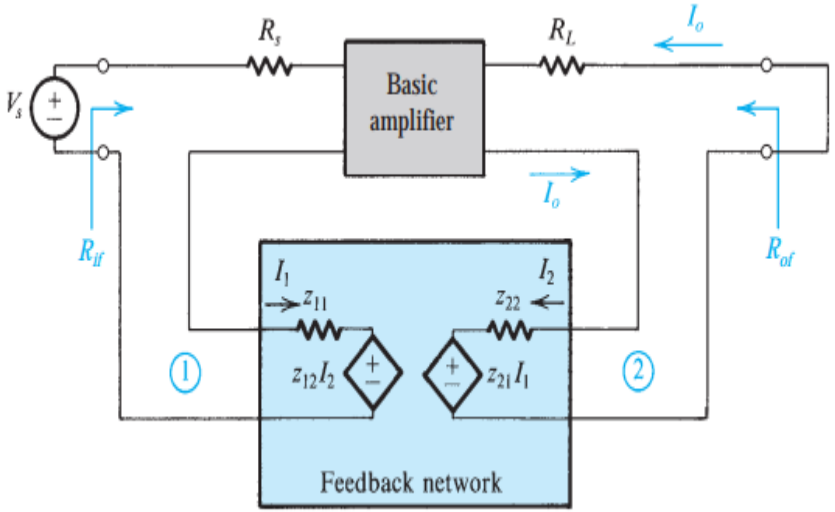
$$\beta = Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$A_f = \frac{I_0}{V_s} = \frac{A}{1+A\beta}$$

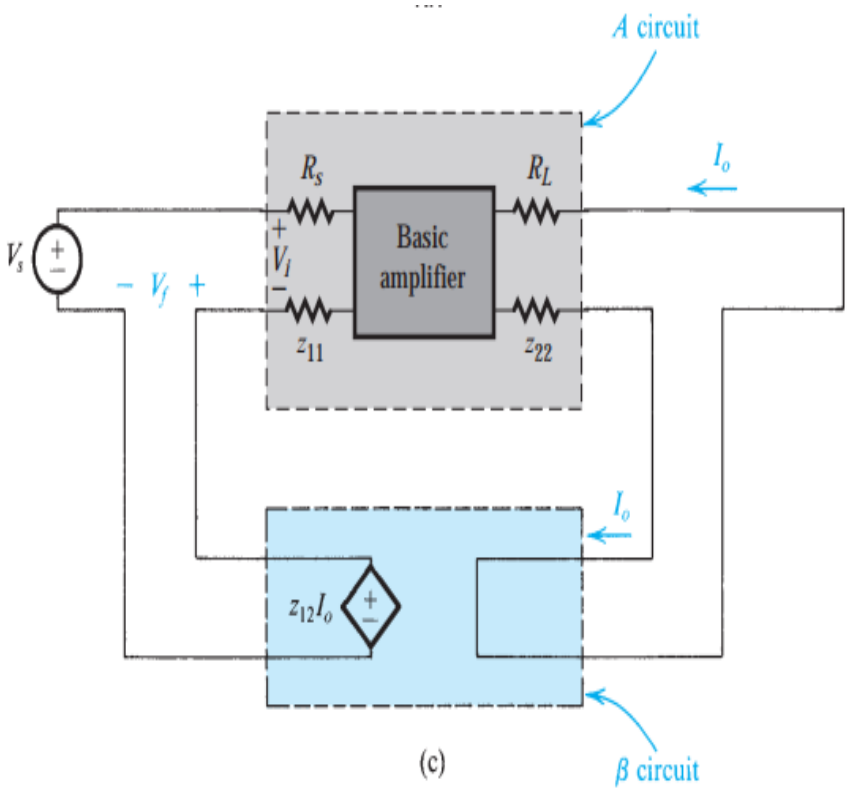
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Feedback Transconductance amplifier (series-series) practical case

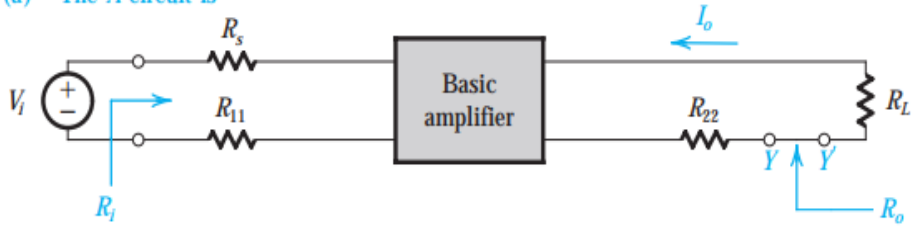




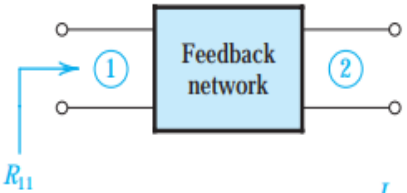
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



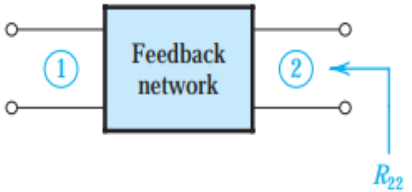
(a) The A circuit is



where R_{11} is obtained from

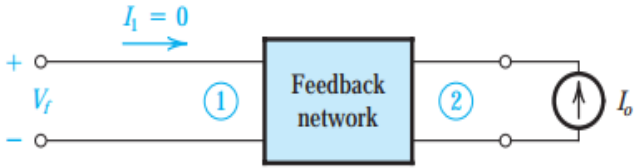


and R_{22} is obtained from



and the gain A is defined $A \equiv \frac{I_o}{V_i}$

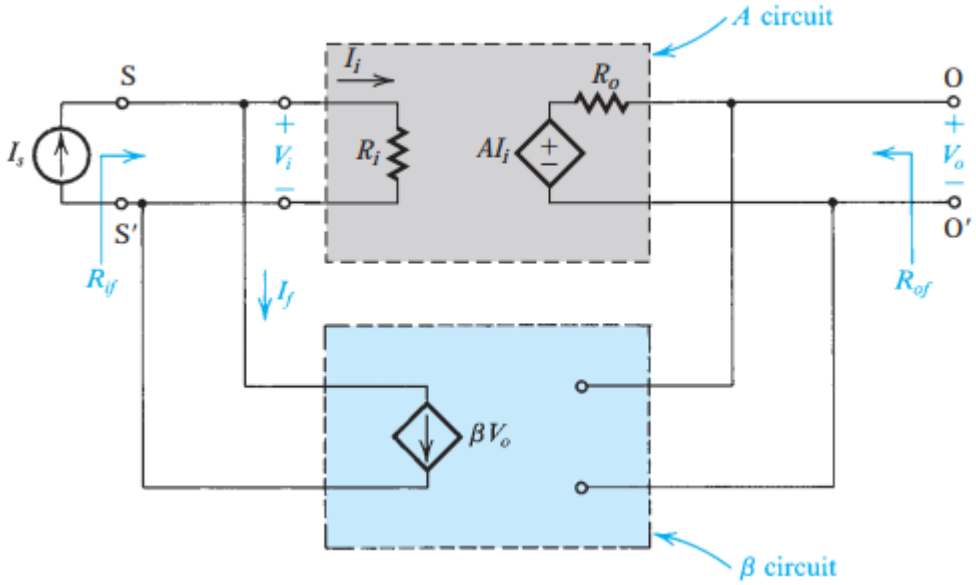
(b) β is obtained from

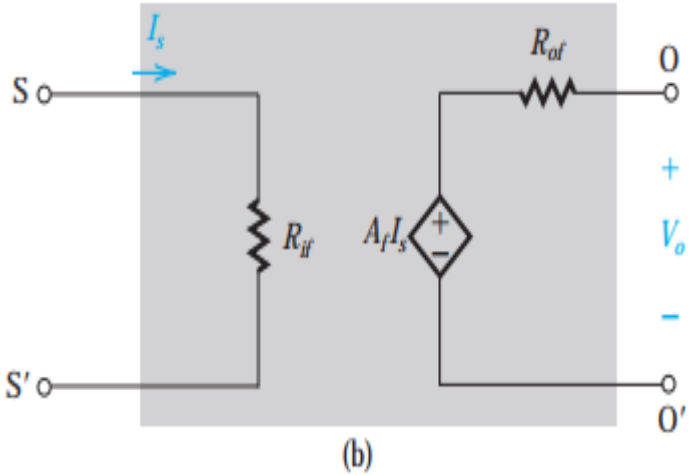


$$\beta \equiv \left.\frac{V_f}{I_o}\right|_{I_1 = 0}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Feedback Transresistance amplifier (Shunt-Shunt) Ideal case





$$A_f = \frac{V_0}{I_S} = \frac{A}{1 + A\beta}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

$$I_i = I_s - I_f \qquad I_f = \beta V_0 = \beta A I_i$$

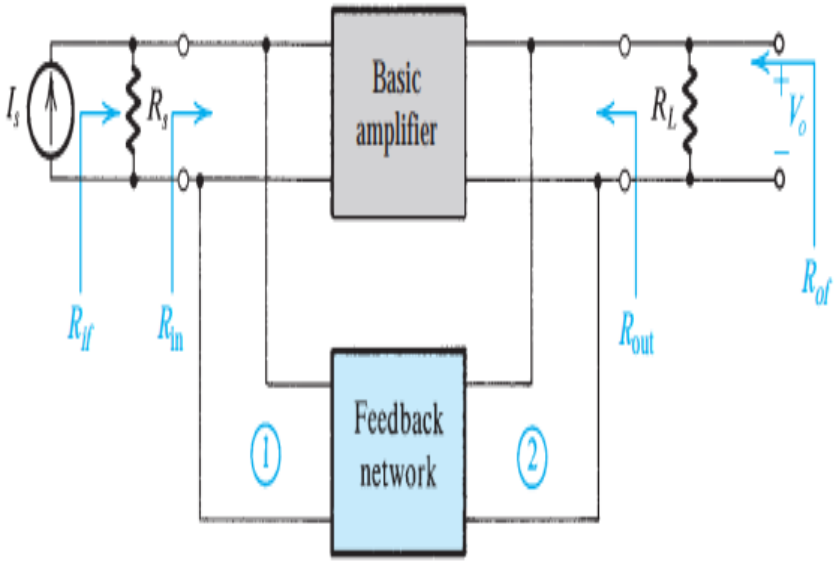
$$R_{if} = \frac{V_i}{I_s} = \frac{V_i}{(1+A\beta)I_i}$$

$$I_i = \frac{I_S}{1+A\beta} \qquad X_s = I_S \qquad X_i = I_i$$

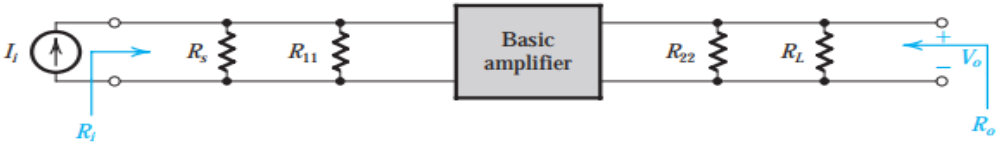
$$R_{if} = \frac{R_i}{(1+A\beta)} \qquad R_{0f} = \frac{R_0}{(1+A\beta)}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

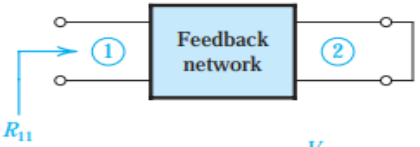
Feedback Transresistance amplifier (Shunt-Shunt) Practical case



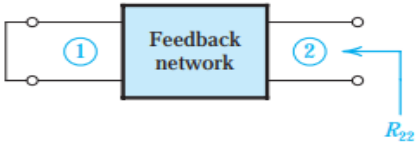
(a) The A circuit is



where R_{11} is obtained from

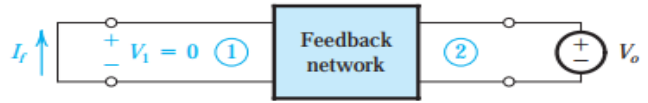


and R_{22} is obtained from



and the gain A is defined $A \equiv \frac{V_o}{I_i}$

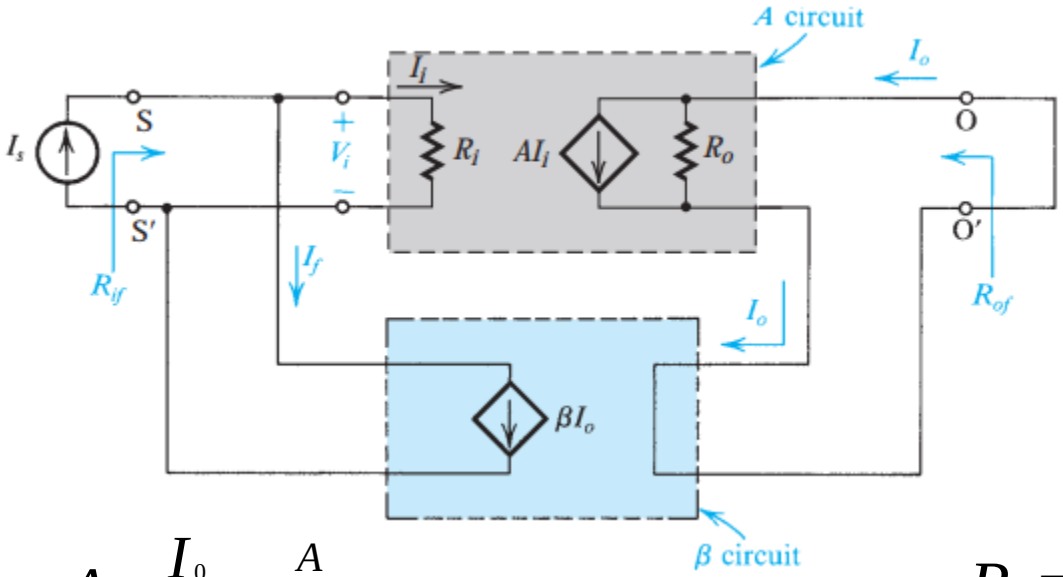
(b) β is obtained from



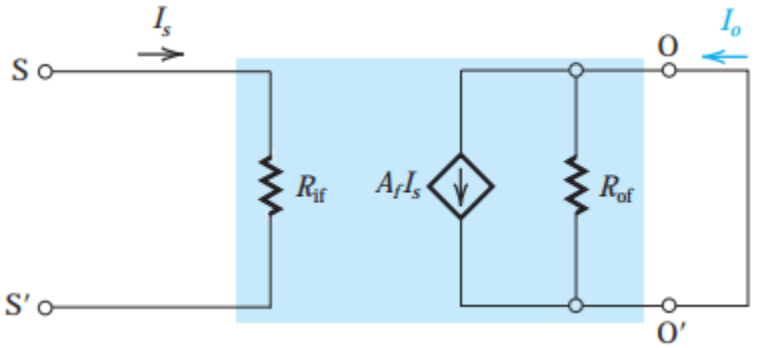
$$\beta \equiv \left.\frac{I_f}{V_o}\right|_{V_1 = 0}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Feedback Current amplifier (Shunt-Series) ideal case



$$R_{of} = R_o(1 + A\beta)$$

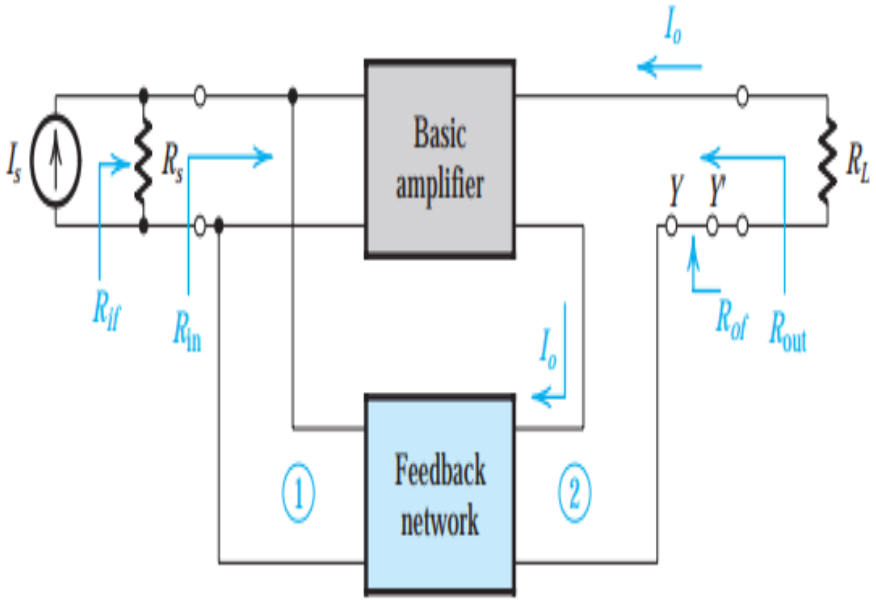


$$A_f = \frac{I_0}{I_s} = \frac{A}{1 + A\beta}$$

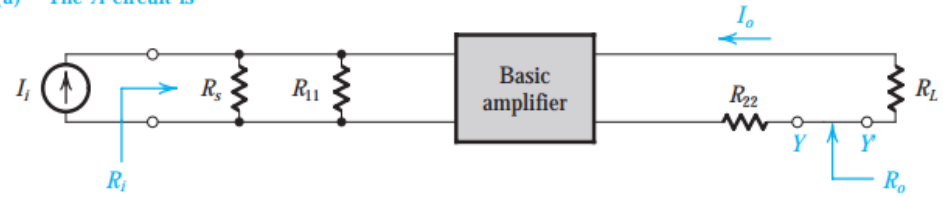
$$R_{if} = \frac{R_i}{1 + A\beta}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

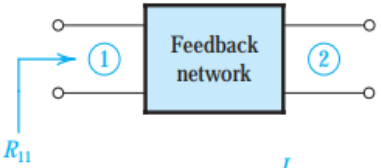
Feedback Current amplifier (Shunt-Series) Practical case



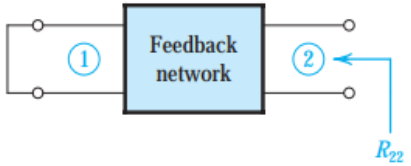
(a) The A circuit is



where R_{11} is obtained from

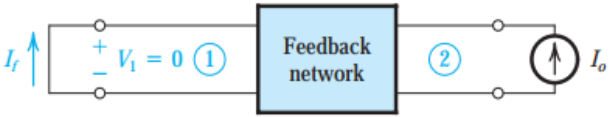


and R_{22} is obtained from



and the gain A is defined as $A \equiv \frac{I_o}{I_i}$

(b) β is obtained from



$$\beta \equiv \left.\frac{I_f}{I_o}\right|_{V_1 = 0}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

Feedback Amplifier	Feedback Topology	R_{if}	R_{of}
Voltage	Series–shunt	$R_i(1 + A\beta)$	$\frac{R_o}{1 + A\beta}$
Current	Shunt–series	$\frac{R_i}{1 + A\beta}$	$R_o(1 + A\beta)$
Transconduc-tance	Series–series	$R_i(1 + A\beta)$	$R_o(1 + A\beta)$
Transresistance	Shunt–shunt	$\frac{R_i}{1 + A\beta}$	$\frac{R_o}{1 + A\beta}$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Thank You