ECE 342
Electronic Circuits

Lecture 27
Introduction to Feedback

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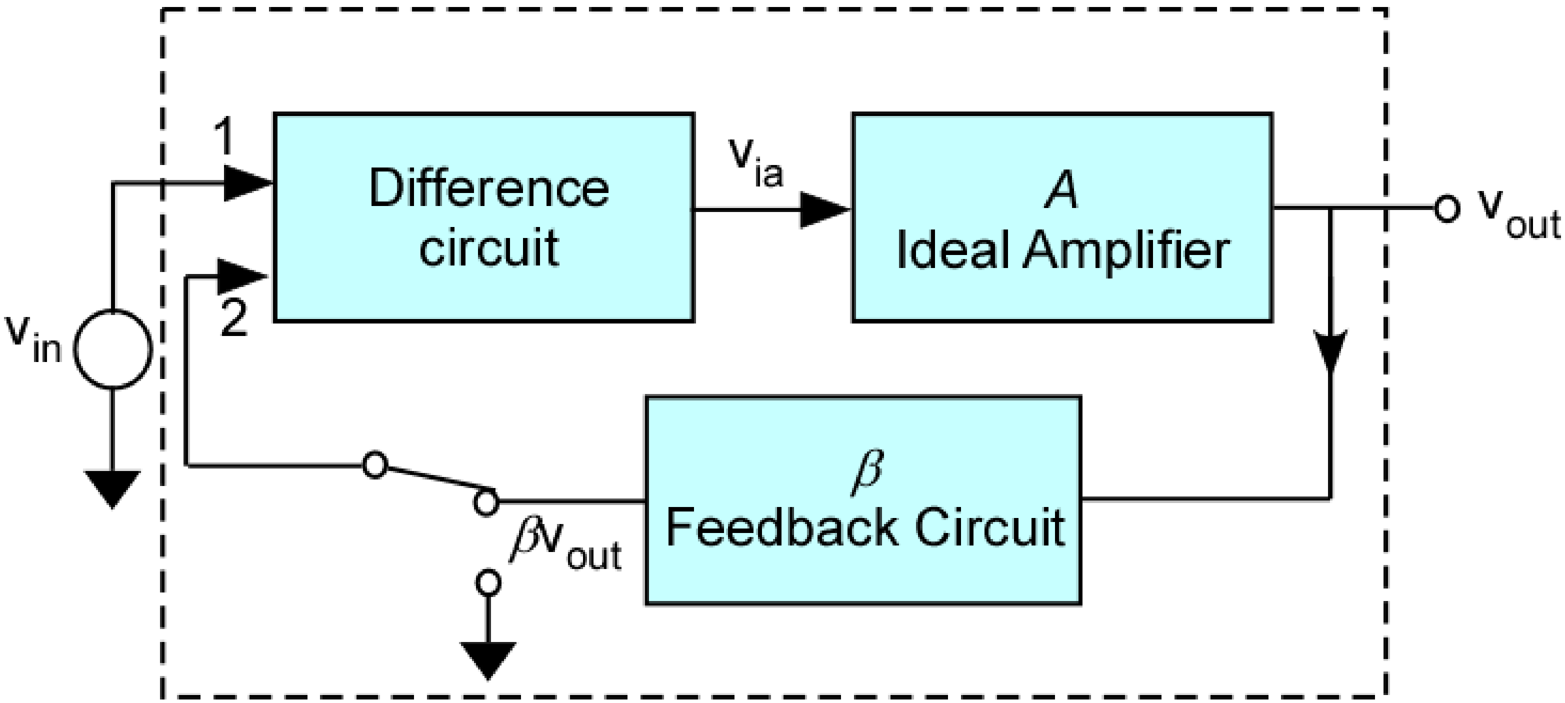
Feedback

- ## Why Use Feedback?

1. To desensitize the gain
2. To reduce nonlinear distortion
3. To reduce the effect of noise
4. To control terminal impedances
5. To increase the bandwidth

Feedback – Basic Concepts



Feedback – Analysis

The ideal amplifier gain is defined by

$$A = \frac{v_{out}}{v_{ia}}$$

The overall gain of the feedback circuit is defined by

$$G = \frac{v_{out}}{v_{in}}$$

If input 2 is grounded

$$v_{ia} = v_{in} - 0 = v_{in}$$

We then get

$$G = \frac{v_{out}}{v_{in}} = \frac{v_{out}}{v_{ia}} = A$$ **This is the open-loop gain**

Feedback – Analysis

When the switch is closed, then

$$v_{ia} = v_{in} - \beta v_{out}$$

so that

$$v_{out} = A\left(v_{in} - \beta v_{out}\right) = G v_{in}$$

from which we get

$$G = \frac{v_{out}}{v_{in}} = \frac{A}{1 + A\beta}$$ which is the closed-loop gain

The closed-loop gain is always less than the open-loop gain for negative feedback

Feedback – Bandwidth Extension

The high-frequency response of an amplifier (single-pole) is given by:

$$A(s) = \frac{A_M}{1 + s/\omega_H}$$

A_M is the midband gain and ω_H is the upper 3-dB frequency. With negative feedback, we get

$$A_f(s) = \frac{A(s)}{1 + \beta A(s)}$$

After substitution,

$$A_f(s) = \frac{A_M/(1 + A_M\beta)}{1 + s/\omega_H(1 + A_M\beta)}$$

Feedback – Bandwidth Extension

The feedback amplifier will have a midband gain of

$$\frac{A_M}{(1+A_M\beta)}$$

and an upper 3-dB frequency of $\omega_H(1+A_M\beta)$

Bandwidth is increased by factor equal to amount of feedback. It can also be shown that the lower 3dB frequency is

$$\frac{\omega_L}{(1+A_M\beta)}$$

The gain-bandwidth product is constant