Control Systems

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1 Op-amps

The common-mode signal v_{icm} is the average of the input voltages and given by:

$$v_{icm} = \frac{v_1 + v_2}{2}$$

The differential signal is the difference between the input voltages and given by:

$$v_{id} = v_1 - v_2$$

An opertional amplifier (op-amp) is an idealized amplifier with the following properties:

- Infinite input impedance
- Infinite open-loop gain A_OL for the differential signal
- Zero gain for the common-mode signal
- Zero output impedance
- Infinite bandwidth

Slewrate

The slewrate is the maximum rate of change of the output voltage and is given by:

$$|\frac{dv_{out}}{dt}| <= SR$$

Full power bandwidth

The full power bandwidth of an op amp is the range of frequencies for which the op amp can produce an undistorted sinusoidal output with peak amplitude equall to the guaranteed maximum output voltage.

The full power bandwidth is given by:

$$f_{FP} = \frac{SR}{2\pi V_{omax}}$$

2 Feedback

2.1 Negative feedback

In negative feedback, a portion of the output voltage is fed back to the inverting input.

Closed loop gain can be calculated using the formula:

$$A_f = \frac{A_{OL}}{1 + \beta A_{OL}}$$

Where A_f is the closed loop gain, A_{OL} is the open loop gain and β is the feedback factor.

The product $A * \beta$ is called the loop gain and is a measure of the feedback strength. The loop gain must be much larger than 1 for the feedback to be effective.

2.2 Positive feedback

In positive feedback, a portion of the output voltage is fed back to the non-inverting input

Positive feedback leads to poor gain stability.

Because of the probelms with gain instability and oscillation, positive feedback is almost never used intentionally in amplifiers.

2.3 Types of feedback

- Voltage feedback: If the feedback network samples the output voltage
- Current feedback: If the feedback network samples the output current
- Series feedback
- Parallel feedback

2.4 Effects of feedback

Feedback type	x_s	x_0	Gain stabilized	Input impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_0	$A_{vf} = \frac{A_v}{1+A_v\beta}$	$R_i(1 + A_v\beta)$	$\frac{R_0}{1+\beta A_{voc}}$	Voltage
Series current	v_s	i_0	$G_{mf} = \frac{G_m}{1+G_m\beta}$	$R_i(1 + G_m\beta)$	$R_0(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_0	$R_{mf} = \frac{R_m}{1+R_m\beta}$	$\frac{R_i}{1+R_m\beta}$	$\frac{R_0}{1+\beta R_{moc}}$	Transresistance
Parallel current	i_s	i_0	$A_{if} = \frac{A_i}{1+A_i\beta}$	$\frac{R_i}{1+A_i\beta}$	$R_0(1 + \beta A_{isc})$	Current

Definition of dB gain: Rewriting voltage gain to dB:

$$20 \log_{10}(\frac{v_0}{v_s})$$

Rewriting current gain to dB:

$$20 \log_{10}(\frac{i_0}{i_s})$$

Rewriting power gain to dB:

$$10 \log_{10}(\frac{p_0}{p_s})$$

3 Frekvensbegrænsninger

4 Offset- og biasfejl

5 Komparatorer og multivibratorer

An ideal comparator compares two input voltages and produces a logic output signal whose value (high or low) depends on which of the two inputs is largest. For a comparator it has an inverting and a non-inverting input, and the output is a digital signal. If the voltage v_1 applied on t the noninverting input is larger than the voltage v_2 applied to the inverting input, the output will be high, and vice versa.

Comparators are designed to minimize the time delay between the input signal and the output signal.

Schmitt trigger is a comparator with hysteresis, which means that it has two different threshold levels for rising and falling edge. A schmitt trigger uses positive feedback to prevent oscillation and to increase the speed of the switching.

Astable multivibrator is a switching oscillator, that can be formed by adding an RC feedback network to a Schmitt trigger. These circuits are useful for generating relatively low frequency square waves. The output of the multivibrator is a square wave.

When designing an astable multivibrator you should think of asmall capacitance calls for a large resistance. However, using a large resistance leads the charging current to be small and can be significantly affected by the bias current of the comparator, which is unpredictable.

555 Timer

The 555 timer IC is economical and convenient for use in multivibrator circuits because few external components are required.

A 555 monostable multivibrator is a circuit that produces an output pulse of fixed duration in response to a trigger signal. Monostables are useful in producing timing signals. For example, automatic garage-door openers often have a light that is turned on when the door is opened. The light stays on for a few minutes and then automatically turns off.

For a 555 monostable multivibrator circuit only two external components are needed: a resistor and a capacitor.

6 Differensforstærkerne

7 Applikationer