

Op-Amp Golden Rules

Electrical Engineering

The two assumptions that solve almost every op-amp circuit, and their exact conditions.

Under negative feedback the op-amp drives its inputs to the same voltage and draws no input current.

$$V_+ = V_- \cdot I_+ = I_- = 0$$

Inverting stage

Virtual ground.

Gain = $-R_f/R_1$

Non-inverting stage

Never below one.

Gain = $1 + R_f/R_1$

Voltage follower

Buffering only.

Gain = 1

THE COMMON MISTAKE

- ✗ Applying the rules with positive feedback
- ✓ Using them only when feedback is negative

With positive feedback the output sits at a rail and the inputs are not equal. That circuit is a comparator or an oscillator.

The rules are an ideal limit. They hold while loop gain is large, which means at low frequency and within the supply rails.