2C-01

Parallel Low-Gain Amplifiers Equivalent to High-Gain Amplifier

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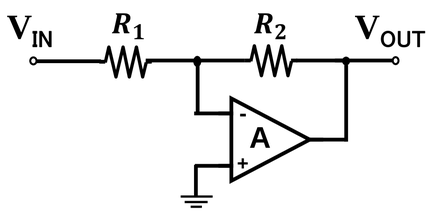
1. Research Background

Conventional Amplifier Problem

Amplifier with accurate amplification factor

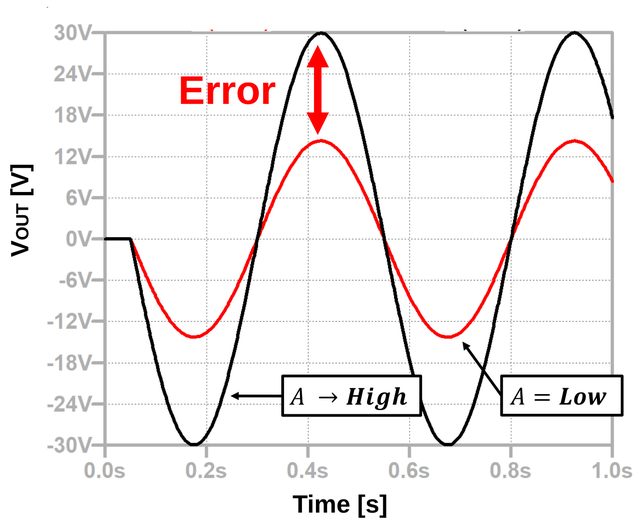
Operational amplifier with extremely high gain is required.

Open Loop Gain = A



$$V_{OUT} = -\frac{AR_2}{(1+A)R_1+R_2}V_{IN}$$

$$A \to \infty \quad V_{OUT} \cong -\frac{R_2}{R_1}V_{IN}$$



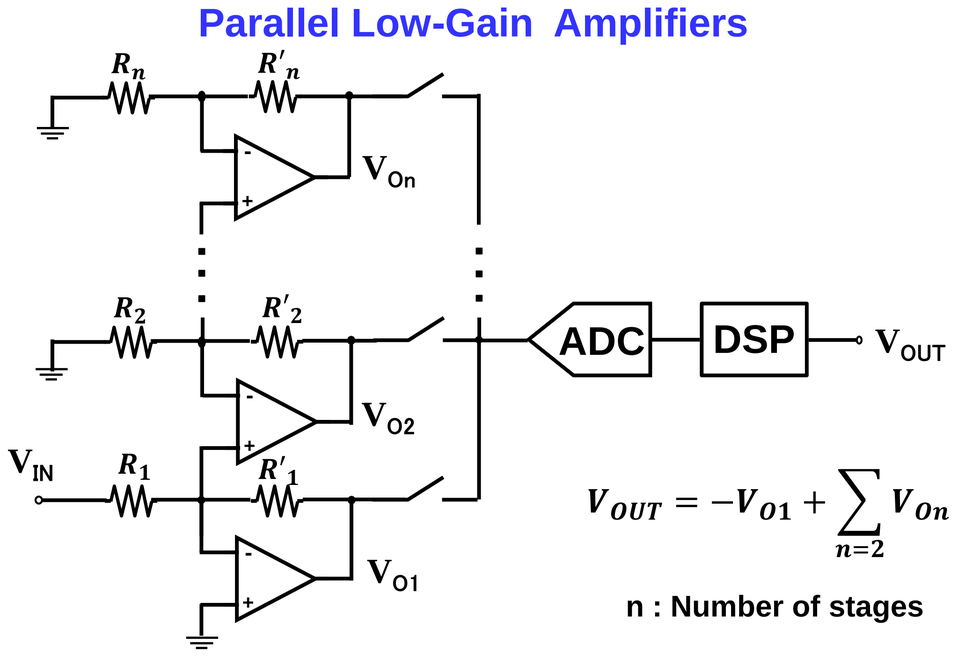
Purpose of This Work

If open loop gain is low, sufficient accuracy cannot be obtained.

Several low-gain operational amplifiers with accuracy comparable to a high-gain operational amplifier

2. Investigated Circuit

Parallel Low-Gain Amplifiers



$$V_{OUT} = -V_{O1} + \sum_{n=2} V_{On}$$

n : Number of stages

Circuit Assumption

- Resistance values of R1 .. Rn are fixed.
- Resistance values of R'1 .. R'n are adjusted according to the desired amplification factor.
- All operational amplifiers have almost the same gain without offsets.

Operation Explanation

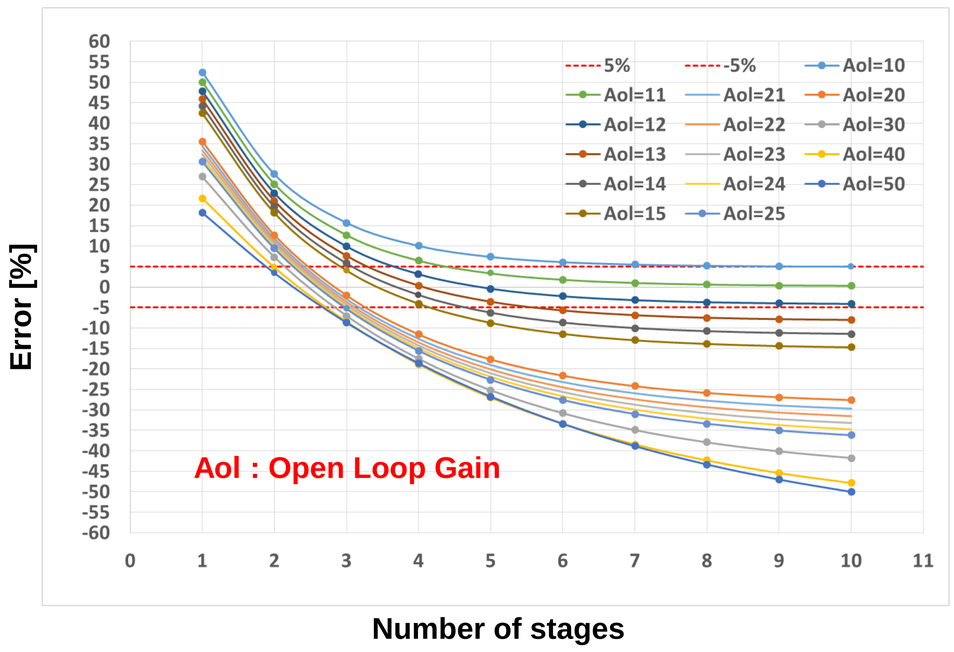
① Amplifies the inverting input potential of the previous-stage operational amplifier.

② All outputs are multiplexed, converted to digital and added by DSP.

3. Simulation Results

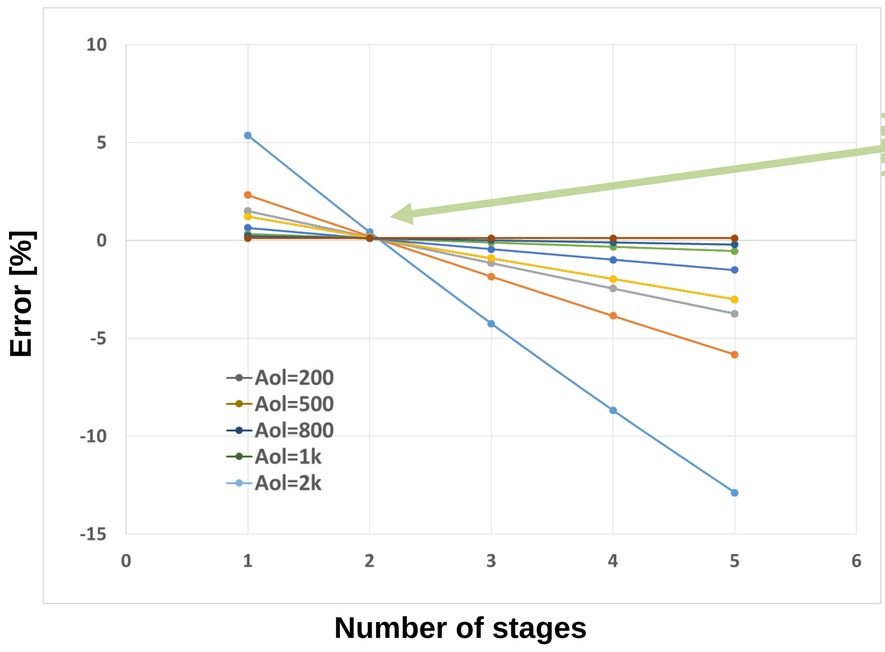
Simulation Result 1

Errors for Low Open Loop Gain



Simulation Result 2

Errors for High Open Loop Gain



$$V_{OUT} = -V_{O1} + V_{O2}$$

The higher the Aol, the smaller the error.

$$Error = \frac{V_{IDEAL} - V_{OUT}}{V_{IDEAL}} \times 100\ [\%]$$

V_{IDEAL} : **Output for very high open loop gain**

4. Conclusions

Conventional Amplifier

- Low gain operational amplifier → Inaccurate output
- High gain operational amplifier → Sufficient accuracy

Parallel Low-Gain Amplifiers

- Low gain operational amplifier → Approximate to ideal value
  → Appropriate number of stages depending on open loop gain
- Middle gain operational amplifier → Higher precision gain
  → Two stages are enough

5. Future Works

- Experiments using actual circuits
- Investigation of load resistance change effect
- Theoretical analysis for parallel low-gain amplifiers

6.Reference

[1] Texas Instruments, Handbook of Operational Amplifier Applications (Rev. B), SBOA092B, Bruce Carter, Thomas R. Brown, October 2001.