3B-08

Accurate and Fast Testing of Operational Amplifier with NULL Method

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1. Research Objective

Accurate and **Fast** measurement of Operational Amplifier

For reliable and low-cost IoT systems

➢ Approach

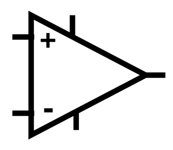
NULL Method

Minus input voltage of amplifier

→ Zero potential with servo loop

2. Background

Operational Amplifier



Extremely high gain

Key device in IoT systems

NULL Method

Measurement time : Long

Mass production testing : Difficult

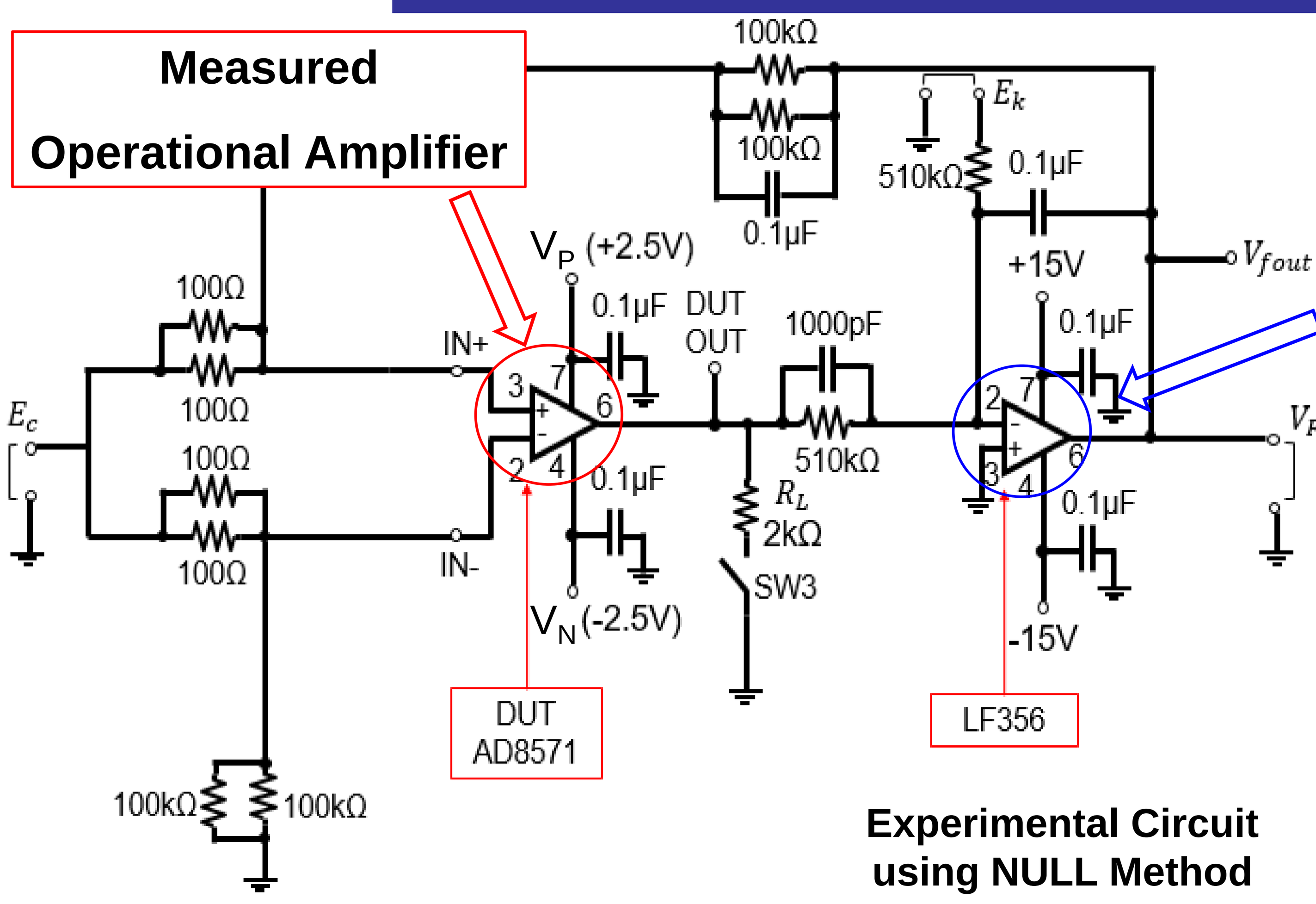
Good capacitor value selection

➡ Fast, stable operation

Goal

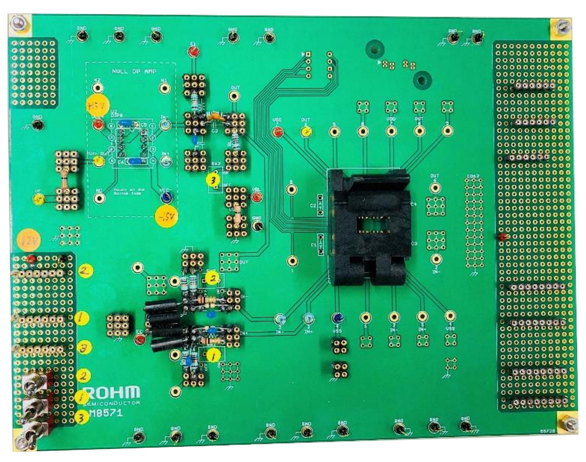
Apply NULL method to mass production testing

3. NULL Method Prototype



Operational Amplifier : Vendor provided SPICE model

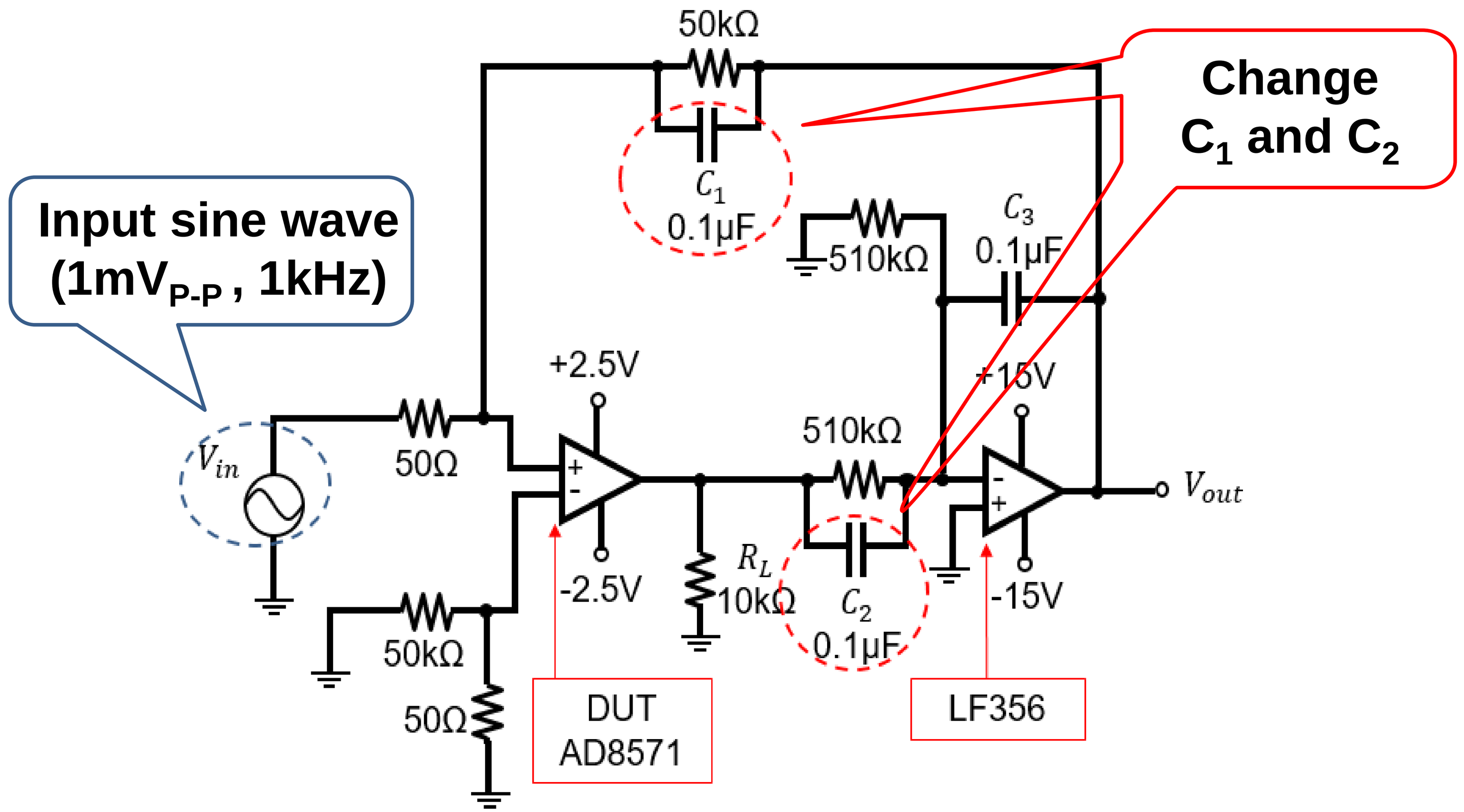
Auxiliary Operational Amplifier

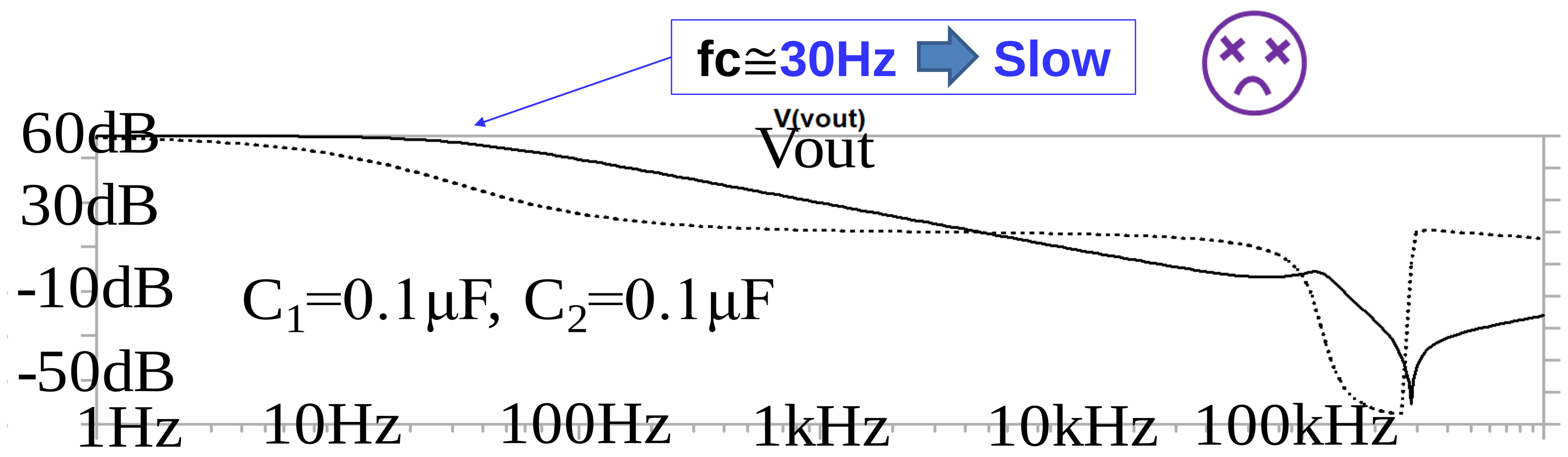


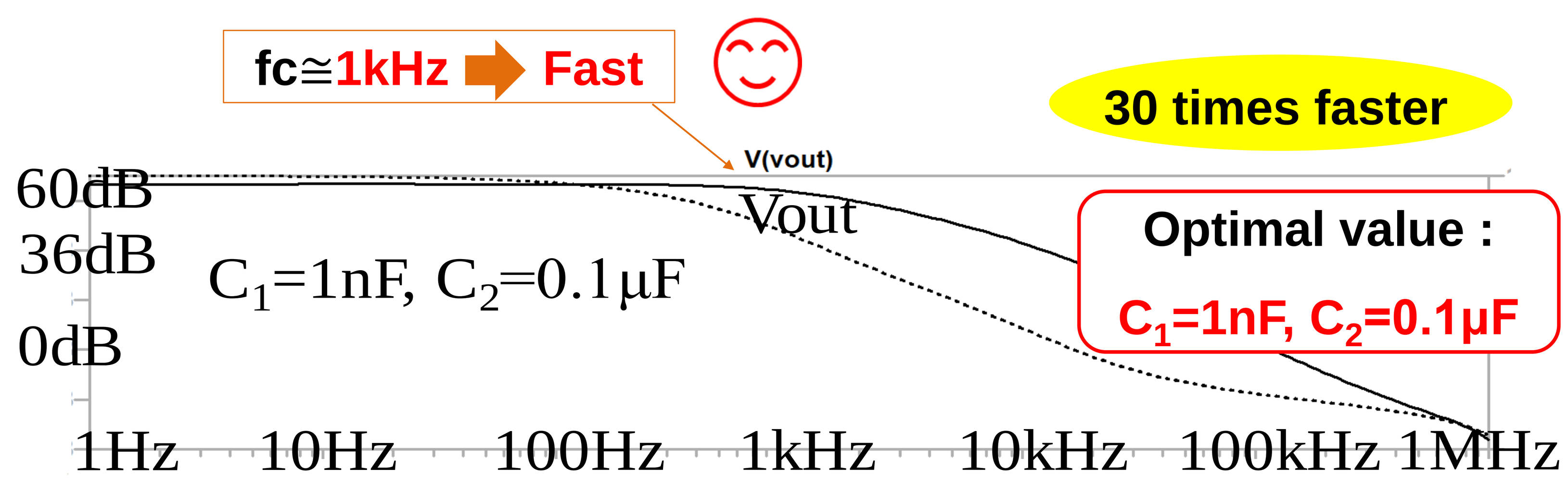
Experimental Circuit using NULL Method

4. SPICE Simulation Verification

< Frequency Characteristics >





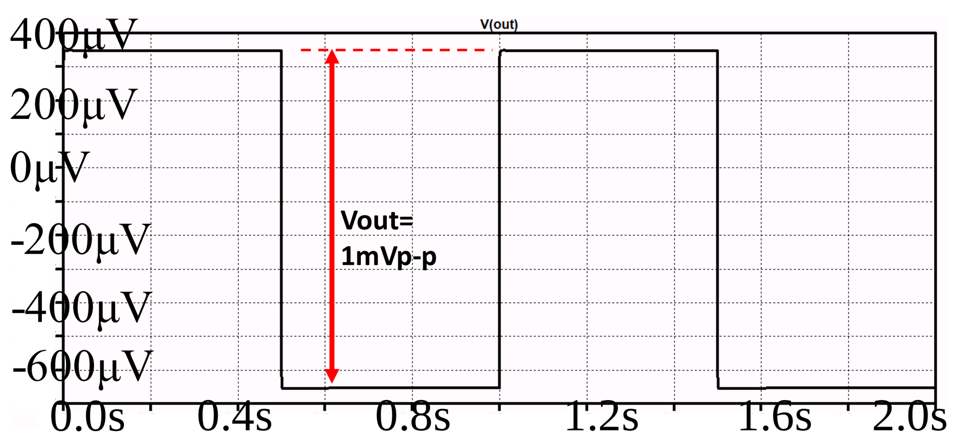


< Offset Voltage >

Ideal $V_{in+} = V_{in-}$

In practice $V_{in+} \neq V_{in-}$

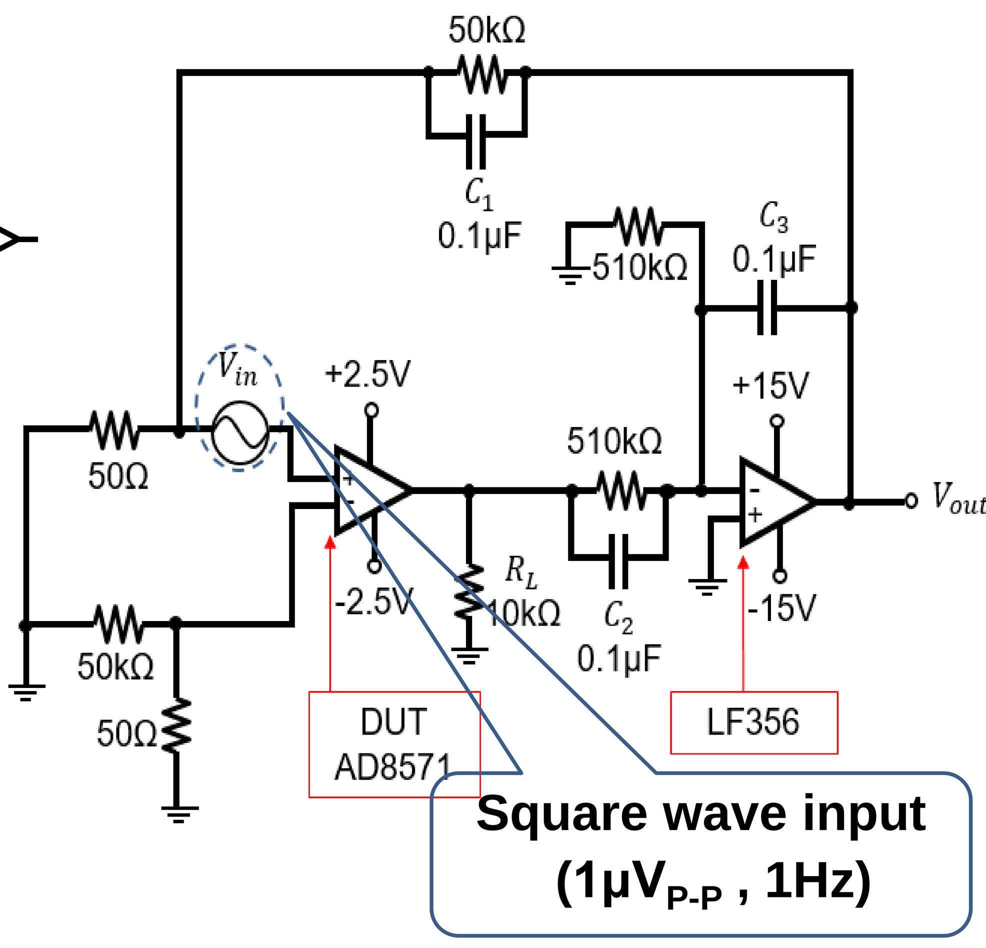
Measure



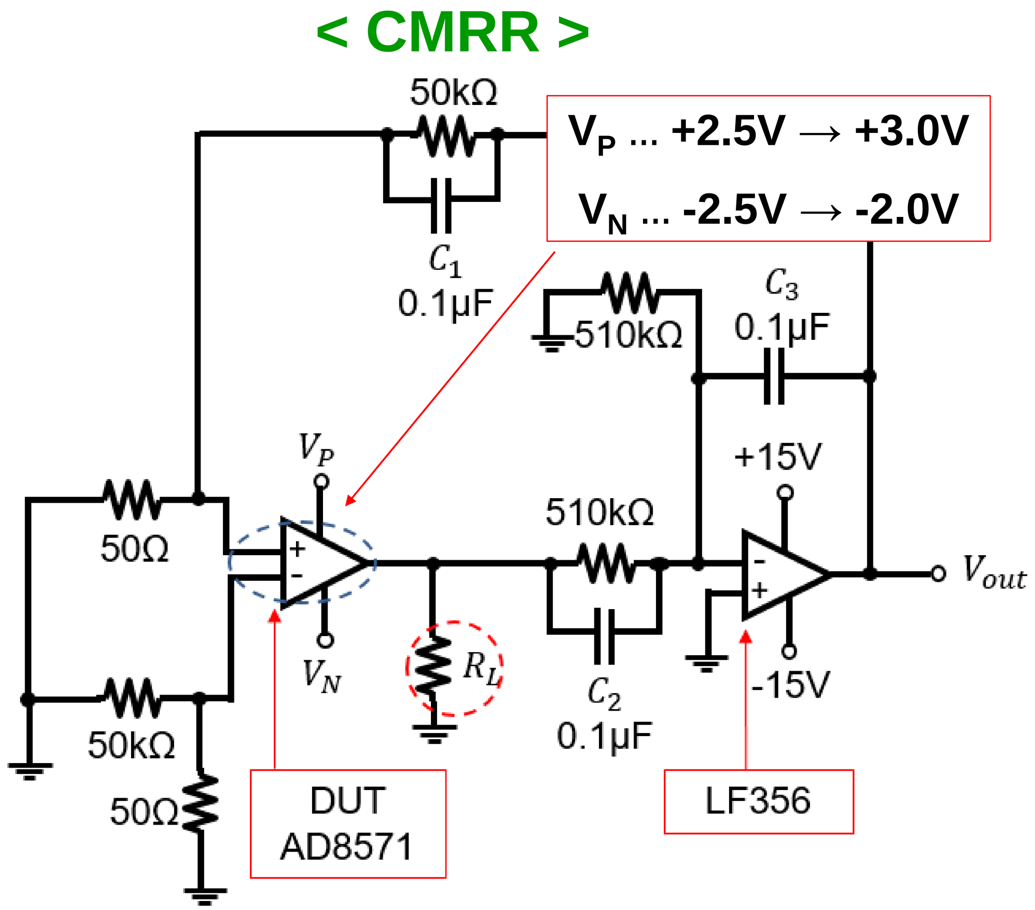
$1\mu V_{P-P}$ ➡ $1mV_{P-P}$

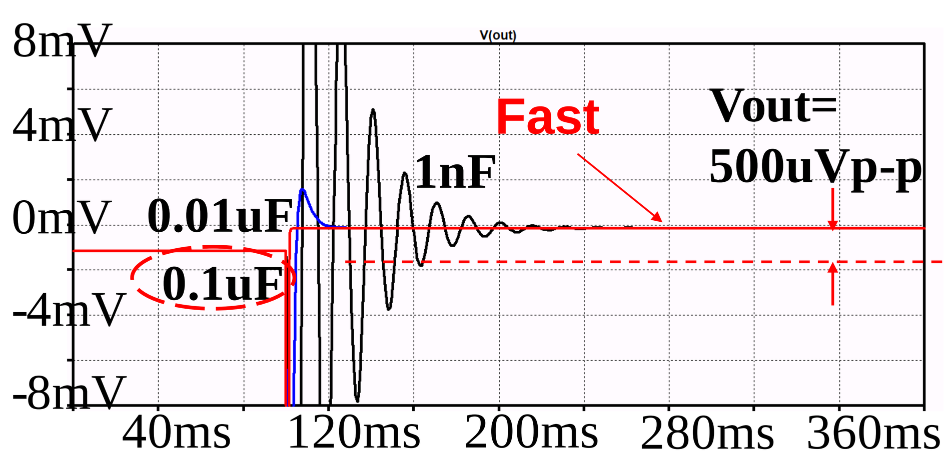
Minute error → ×1,000

Easy Measurement



< CMRR >





When R_L=10kΩ, C_1=1nF, C_2 is varied

R_L → 10kΩ, C_1 → 1nF, C_2 → Large

CMRR → **Fast** response

Experimental results (dB) for R_L=10kΩ

No.1	No.2	No.3	No.4	No.5
131	131	134	115	125

Almost the same

Simulation results

R_L [kΩ]	CMRR [dB]
2	126
10	126
100	126

5. Conclusion

- Optimization of phase compensation constants
  C_1=1nF, C_2=0.1μF
  ➡ NULL Circuit → Fast and Stable
- Switching C_1 and C_2 depending on the measurement item
  ➡ Settling time reduction → ≒ 1/10

References

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