A 0.6 V Supply CMOS Amplifier Using Noise Reduction Technique of Autozeroing and Chopper Stabilization

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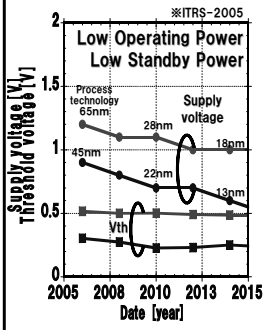
1 Motivation



■ Present situation

Improvement of integration technology
Miniaturization of process

⟨Digital-circuit⟩	⟨Analog-circuit⟩
High performance High speed	Appear many problem

⇒Miniaturization is not effective for analog circuit

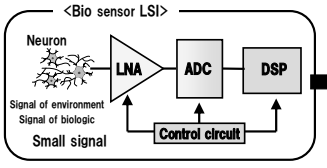
■ Problem of analog-circuit

Device deviation
Decrease of signal swing
Impossible to use analog-switch

Many problem of analog circuit
⇒ Propose a solution by circuit designs

2 Objectives

Application example of low voltage operation and highly accurate analog circuit
Mobile phone ・Mobile audio ・Pace maker ・Battery operation device etc



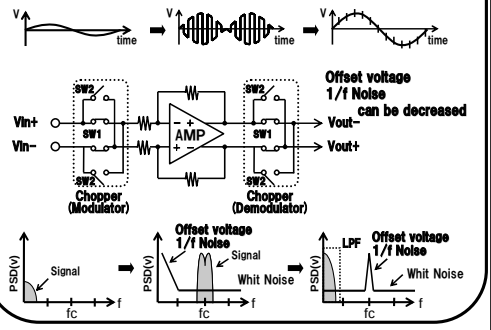
Mixed-signal
Require a Low noise AMP

Operated by New type battery
Require a Low voltage AMP

Achievement of low noise Amplifier for sensor LSI

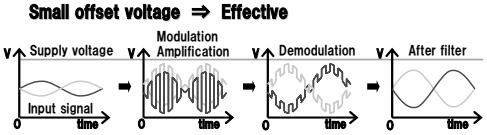
3 Design techniques

⟨Principle of Chopper stabilization technique⟩

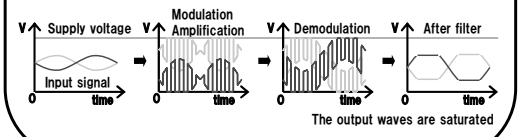


⟨Effect of Chopper stabilization technique⟩

Small offset voltage ⇒ Effective



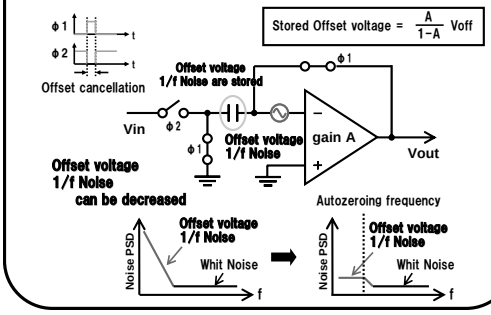
Large offset voltage ⇒ Ineffective



The output waves are saturated

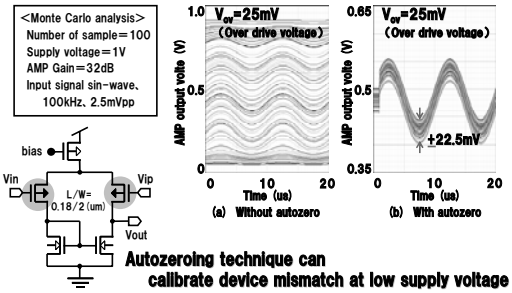
⟨Principle of Autozeroing technique⟩

Autozeroing technique can calibrate device Mismatch



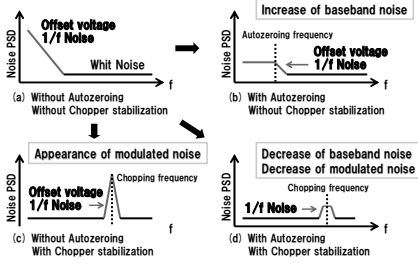
⟨Effect of Autozeroing technique⟩

<Monte Carlo analysis>
Number of sample=100
Supply voltage=1V
AMP Gain=32dB
Input signal sin-wave, 100kHz, 2.5mVpp



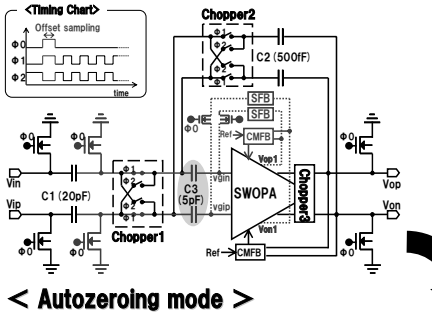
Autozeroing technique can calibrate device mismatch at low supply voltage

⟨ Autozeoing + Chopper stabilization ⟩



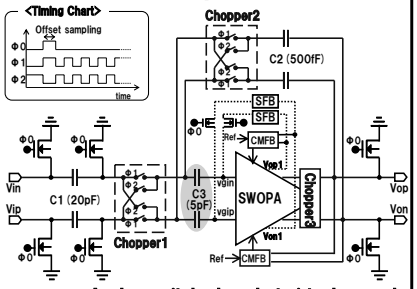
Combination of autozeroing and chopper stabilaization is required at low supply voltage

4 Ultra low supply voltage Amplifier



< Autozeroing mode >

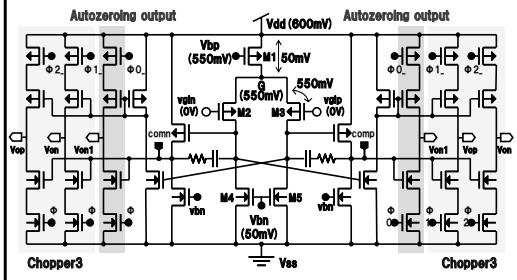
<Amplification mode>



Analog switch placed at virtual ground

< SWOPA >

0.6V is the limit supply voltage in 0.18um CMOS process (Vthn=0.42V,Vthp=0.5V).



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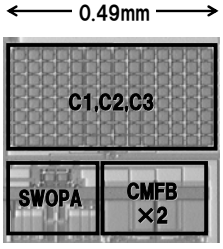
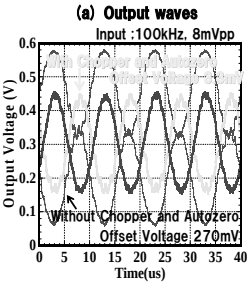
5 Measurement results



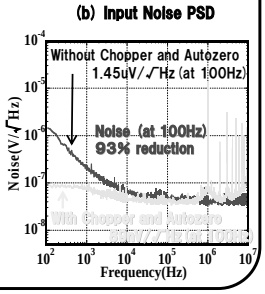
⟨Performance Summary⟩

Technology	0.18um
Supply voltage (V)	0.6V
Power consumption	0.13mW
Chip area (mm²)	0.186mm²
Loop gain	32dB
Noise@100Hz	89nV/√Hz

(a) Output waves



(b) Input Noise PSD



6 Conclusions

- Influence that device deviation exerts on an amplifier is cleared up, and noise reduction techniques are presented
- Low-noise amplifier based on autozeroing and chopper stabilization is presented
- Low-noise amplifier achieved 89nV/√Hz noise PSD, 32dB Loop gain and 1.6MHz cut-off at 0.6V supply voltage