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# kt/c cancellation




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# Main content

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- Procedure of cancellation 
- Comparison between ktc cancellation and os 
- Noise analysis 

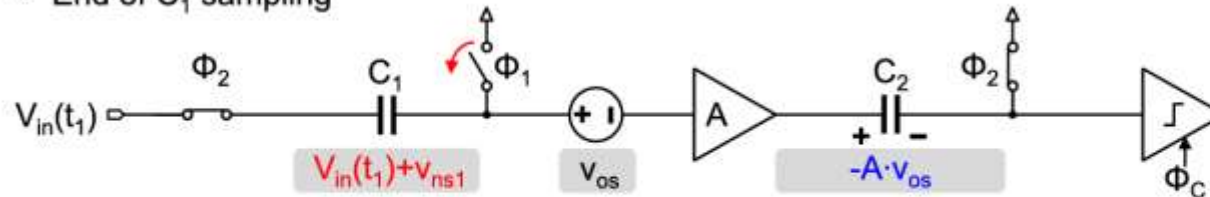
# Cancellation

- Procedure of cancellation



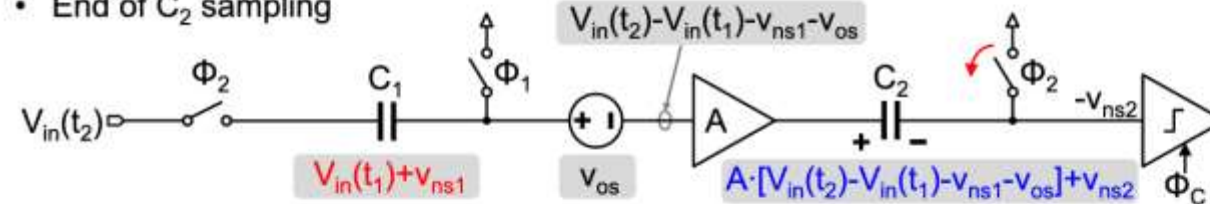
- Phase 1

- End of  $C_1$  sampling



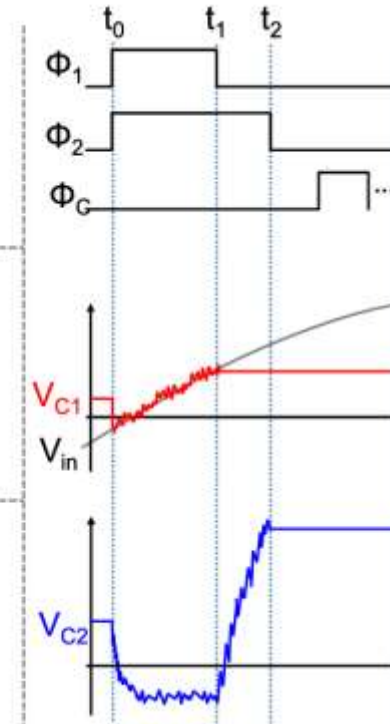
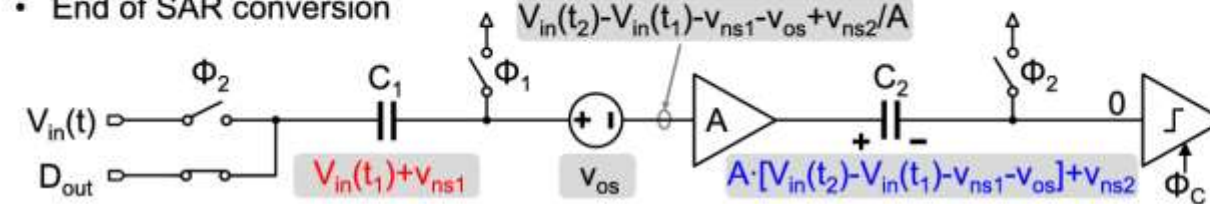
- Phase 2

- End of  $C_2$  sampling



- Phase 3

- End of SAR conversion



# Analysis of phases

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## Phase 1 c1 sample

to begin with, all switches close, c1 (cdac) has finished sampling the input signal, when os is stored in c2 (is it necessary to force preamp to work? ) and then open switch 1, ktc1 is stored in c1

## Phase 2 c2 sample

to begin with, preamp is settling and drives c2, leading to the suitable amount of interval between t1 to t2. switch 2 opens, and then ktc2 is stored in c2. meanwhile, the preamp thermal noise is introduced. Also it is the form of ktc

## Phase 3 adc conversion

in the end, there is residue in the comp. Actually, the  $v_{in} = v_{in}(t_2) + v_{ns2}/A + v_{res}/A$ .

# Comparison

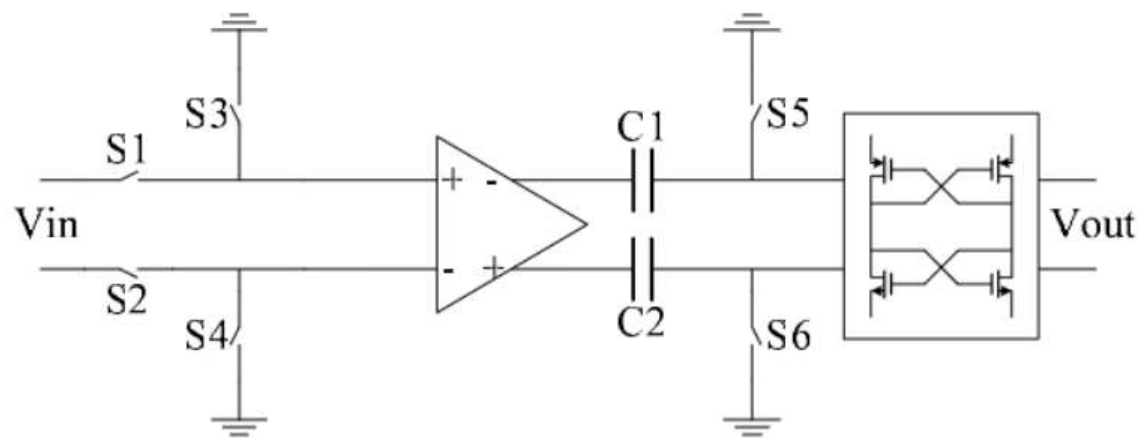


图 4.7 失调校准方法之 OOS

引入 $2kT/C$ 噪声

$$\Delta V_{os} = \frac{\Delta Q}{A_0 C} + \frac{V_{OSL}}{A_0}$$

# Comparison

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Os cancellation when s5, s6 open, os is stored, however, s1, s2 open preceding by s5, s6.

Ktc cancel when switch s1 open, ktc1+os are stored in c2, and then s2 open.

**The difference is the stored charge. Os is os charge, ktc is os+ktc.**

# Noise analysis

- **sources**
  - **Switch 1**

Phase1, switch 1 ktc1 can not be canceled completely, due to limited preamp bandwidth and gain non ideality

$$v_{ns1,C2} = -A \cdot v_{ns1} \cdot (1 - e^{-\Delta t/\tau})$$

Settle time increase, vns1 cancel more completely
  - **Switch 2**

Phase 2, ktc2 goes down by the square of gain. C2 increase, ktc2 decrease, settle time increase or more performance preamp.
  - **Preamp thermal noise**

Phase 2, preamp constantly work, introducing the thermal noise in the form of ktc\*alpha. Moreover, the thermal noise is dominated in the total noise

$$R_{ON} \ll 1/G_m \ll R_{out} \cdot \frac{\overline{v_{nin,amp}^2}}{\Delta f} = \frac{4kT\gamma}{G_m}$$

# Noise analysis

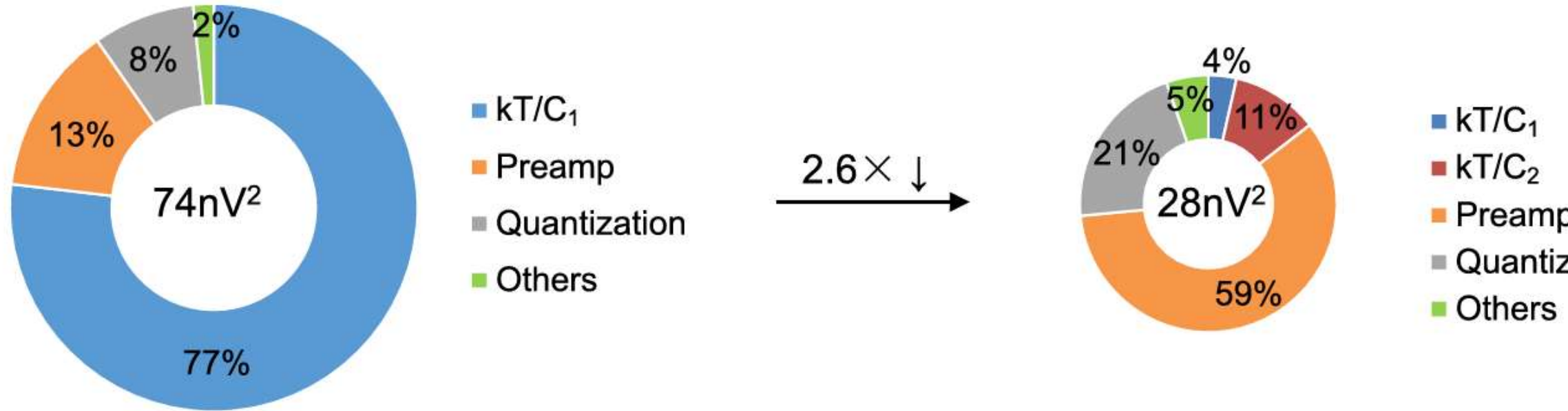


Fig. 7. Noise summary and comparison between SAR ADCs with and without kT/C noise cancellation.



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# Thanks for attention