Numerical Demonstration of Single-Electron Inverter with Input Discretizer
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1. Introduction
Single-electron (SE) four-junction inverter (FJI) [1] is very attractive to low power dissipation and high density integration applications. In this paper, we propose to employ an SE input discretizer (ID) [2] for improvement in reliable operation.

2. Characteristics of a SE ID-FJI
Fig.1. shows the diagram of an ID-FJI. The idea to make the switch of a FJI sharper is the utilization of discrete charge shift in the ID. Monte-Carlo simulation was executed with following conditions.
ID: $J_0$ (1 aF, 100 kΩ), $C = 72$ aF; FJI: $J_1$ & $J_4$ (1 aF, 100 kΩ) $J_2$ & $J_3$ (2 aF, 50 kΩ) , $C_{g1} = C_{g2} = 8$ aF, $C_{b1} = C_{b2} = 7$ aF; $V_s = 6.7$ mV, $C_{out} = 1$ fF, $T = 0$K, no co-tunneling.

The simulated input-output ($V_{in}$-$V_{out}$) characteristics of the ID-FJI are shown in Fig. 2. Sharper (negatively infinite) switching is demonstrated in comparison with an FJI whose voltage gain is -3.7. This result can be explained by characteristics of charge $Q_0$ at the center island of ID (Fig. 2), $N = Q_0/e$ . In the middle of the input signal $V_{in} \approx 3.35$ mV, there is a tunnel from $N = 1$ to $N = 2$, resulting in a sharp switching of the output voltage at this point.

The device can work well if we connect them with each other (Fig. 3). Furthermore, from the 2nd output voltage, its amplitude is absolutely constant.

3. Conclusion
The ID-FJI operates absolutely reliably in the switch region when it works alone, and in series.

References

Fig. 1. Diagram of a SE ID-FJI

Fig. 2. Characteristics of a solo FJI, and an ID-FJI.

Fig. 3. Output signals of 3 ID-FJIs in series.