19a-A7-5

Numerical Demonstration of Single-Electron Inverter with Input Discretizer

Dept. Engineering Science, The Univ. of Electro-Communications (UEC Tokyo)

Tran Thi Thu Huong, Hiroshi Shimada, Yoshinao Mizugaki

E-mail: huongtran@uec.ac.jp

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 = 0K, 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} ≈ 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

[1] J. R. Tucker, J. Apple. Phys., **72** (1992) 4399.

[2] Y. Mizugaki, et al., IEEE Trans. Nanotech., **7** (2008) 601.

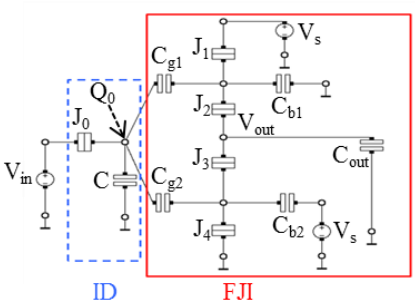

Fig. 1. Diagram of a SE ID-FJI

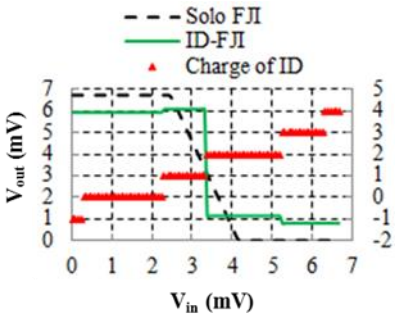

Fig. 2. Characteristics of a solo FJI, and an ID-FJI.

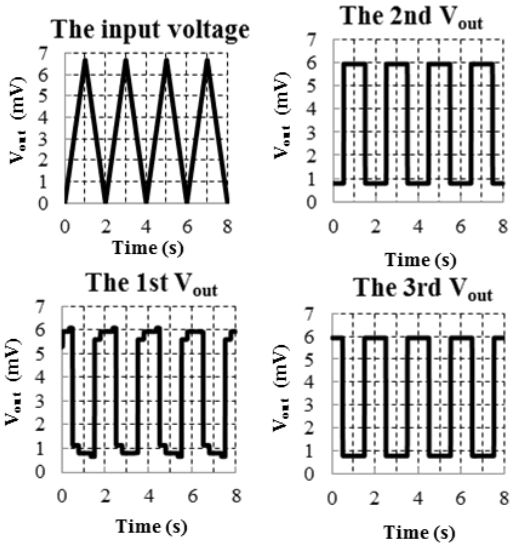

Fig. 3. Output signals of 3 ID-FJIs in series.