Mao-qun Yao, Kai Yang, Cong-yuan Xu, Ji-zhong Shen, 2015. Design of a novel RTD-based three-variable universal logic gate. *Frontiers of Information Technology & Electronic Engineering*, **16**(8):694-699. [doi:10.1631/FITEE.1500102]

Design of a novel RTD-based three-variable universal logic gate

Key words: Resonant tunneling diode (RTD), Threshold logic gate, Reed-Muller expansion, Universal logic gate

Contact: Mao-qun Yao
E-mail: yaomaoqun@163.com
ORCID: Mao-qun YAO, http://orcid.org/0000-0001-6484-4972

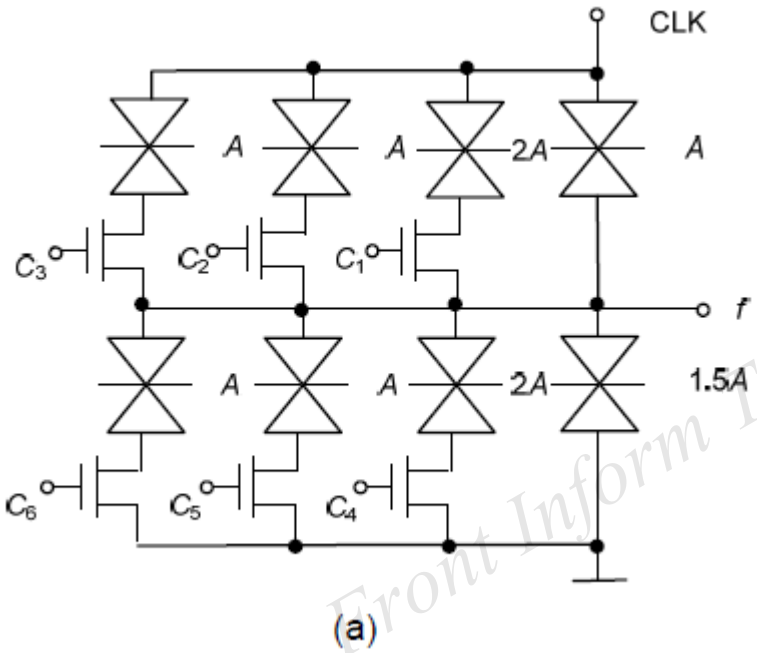
Introduction

- Compared to CMOS, a resonant tunneling diode (RTD) has better performance and features.

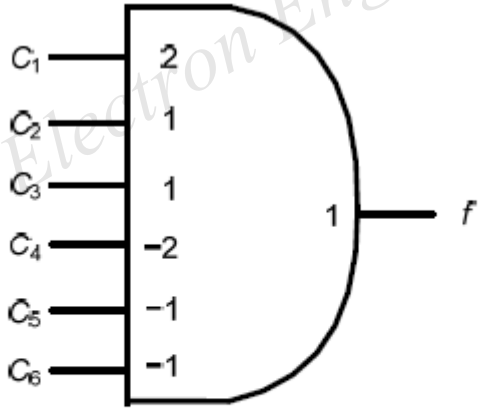
- An RTD is more suitable for implementing the threshold logic gate because of its negative differential resistance characteristics.

- A three-variable universal logic gate (ULG3) based on UTLG is proposed, which can implement an arbitrary three-variable function with a single ULG3.

UTLG



(a)



(b)

Fig. 1 The universal threshold logic gate (UTLG)
(a) Schematic; (b) Symbol

XOR3

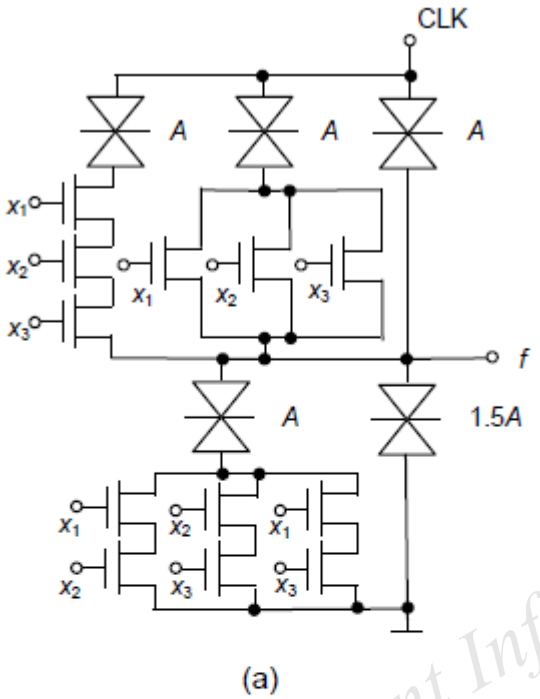


Fig. 2 Three-variable XOR gate (XOR3)
(a) Schematic; (b) Symbol

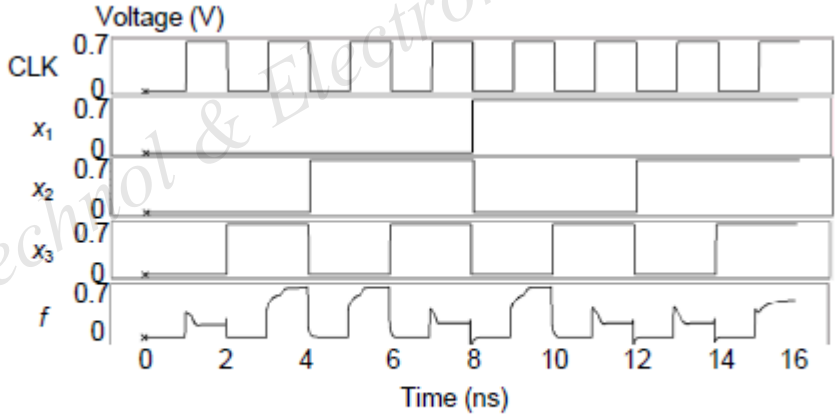
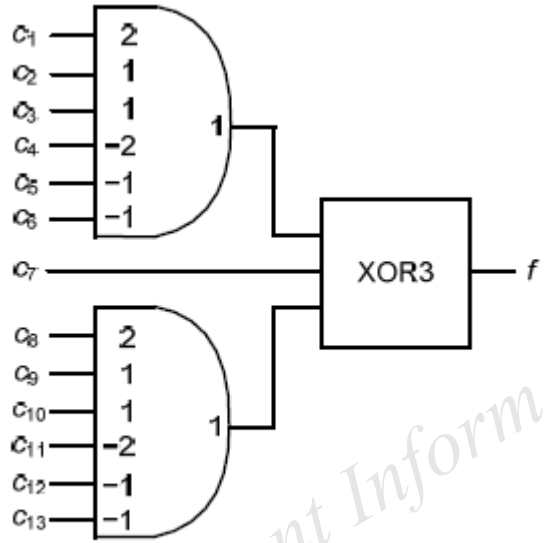
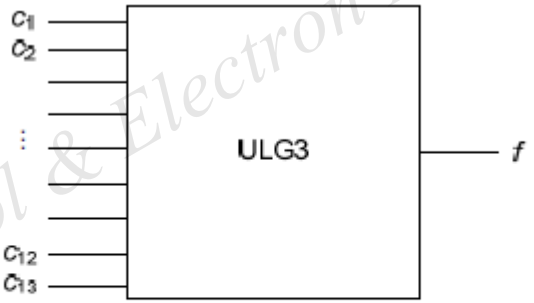


Fig. 3 Transient waveforms of the proposed XOR3

ULG3



(a)



(b)

Fig. 4 Three-variable universal logic gate (ULG3)
(a) Schematic; (b) Symbol

Performance comparison

Table 2 Numbers of ULG3 or UTLG implementing the three-variable non-threshold function

Device name	Number of functions	Device number/ function	Average device number/function	Average number of RTDs/function	Average number of MOSFETs/function	Average number of RTDs+MOSFETs/function
ULG3	152	1	1	21	24	45
UTLG	134	3	3.47	27.76	20.82	48.58
	18	7				

Conclusions

- All the three-variable non-threshold functions can be presented by the XOR of two threshold functions except for two special non-threshold functions.

- A novel three-variable universal logic gate (ULG3) was proposed, which consists of two UTLGs and an XOR3 gate.