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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

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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

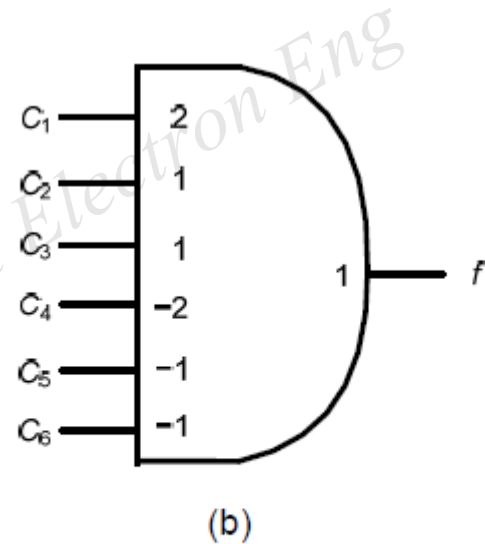
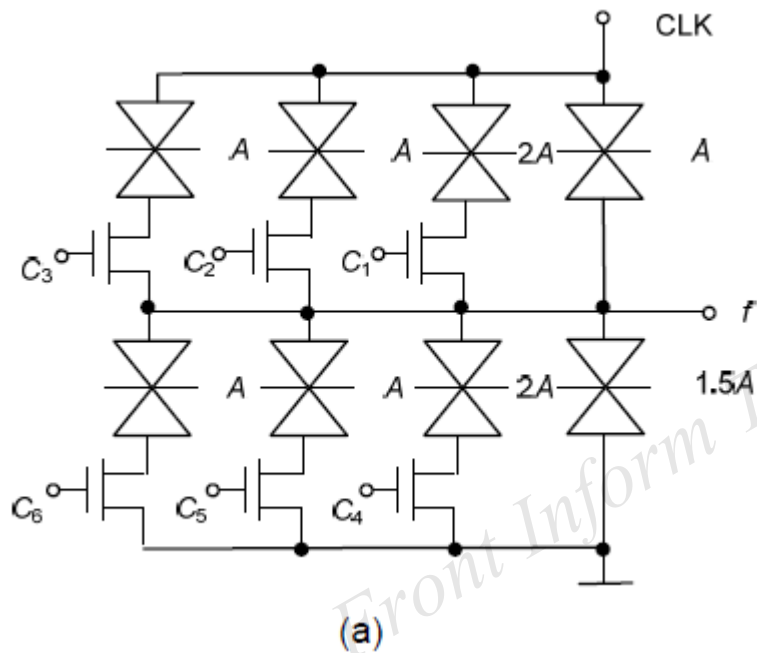


Fig. 1 The universal threshold logic gate (UTLG)
(a) Schematic; (b) Symbol

XOR3

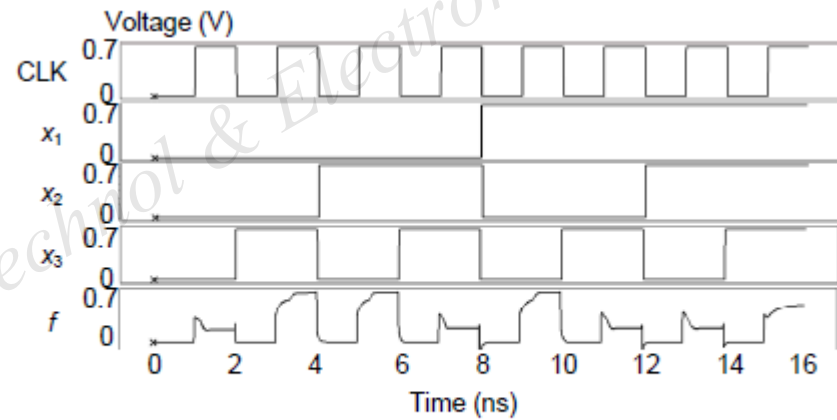
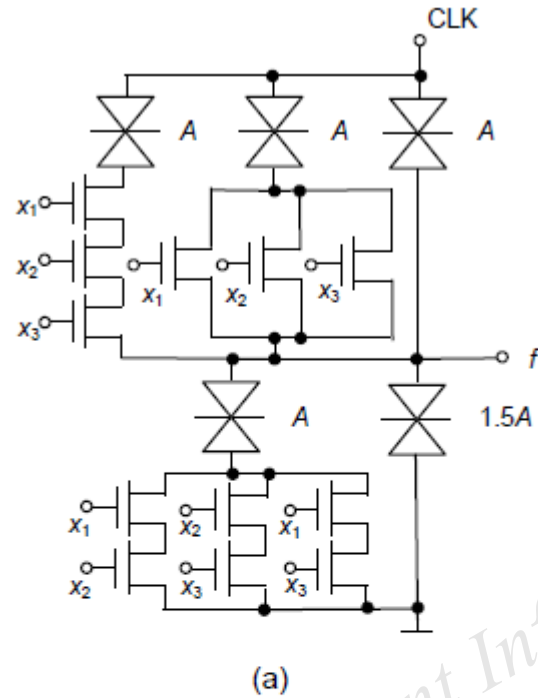


Fig. 3 Transient waveforms of the proposed XOR3

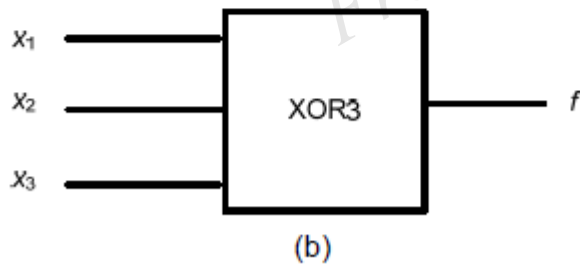


Fig. 2 Three-variable XOR gate (XOR3)

(a) Schematic; (b) Symbol

ULG3

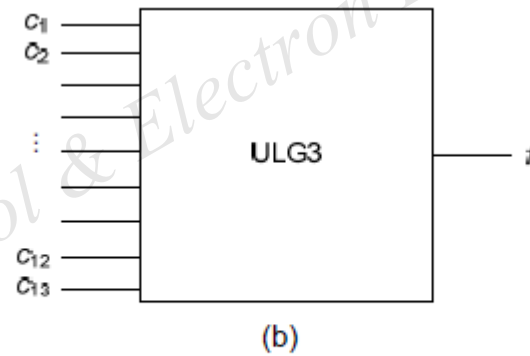
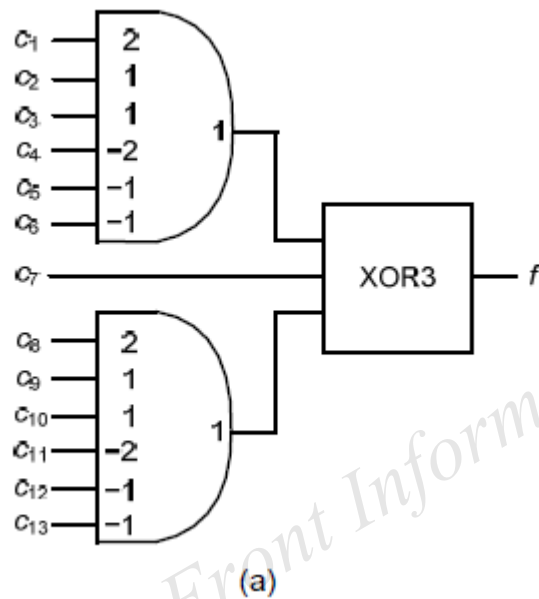


Fig. 4 Three-variable universal logic gate (ULG3)
(a) Schematic; (b) Symbol

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.