

# Digital Pulse Generator for Neuromorphic Devices

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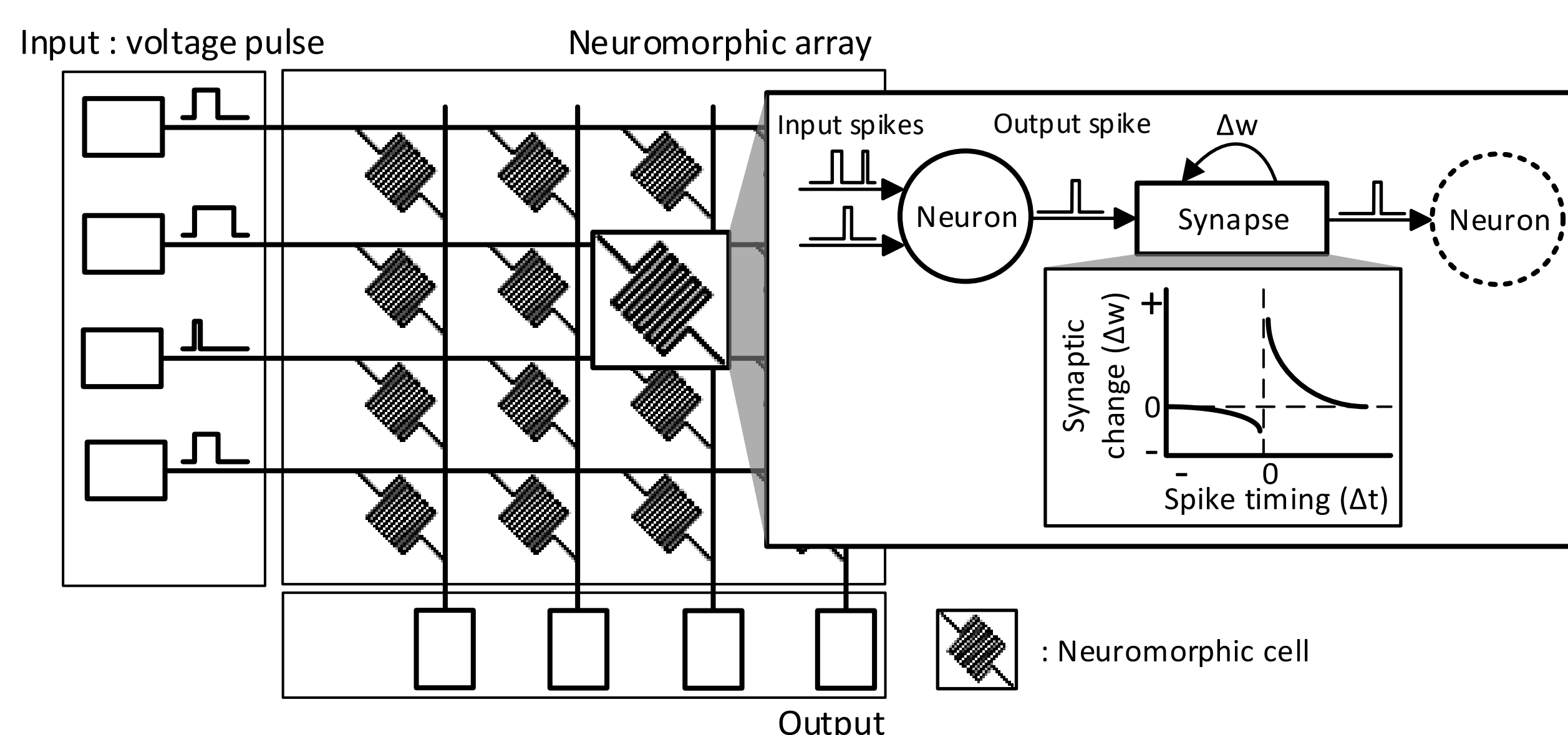
## Abstract

We propose a digital pulse count controller for neuromorphic devices to verify the resistance change characteristics of neuromorphic devices. In general, the resistance change characteristics of neuromorphic devices are verified based on pulse. The proposed digital pulse generator consists of two components: Counter to count the number of pulses and MUX that specifies the number of output pulses. Due to the neuromorphic element and the structure that can be integrated, the proposed pulse generator is low-cost and easy to use. As an experiment, The digital pulse generator was designed using a CMOS 180nm process, and it was shown that it can be used to verify the resistance change characteristics of neuromorphic devices through operation verification.

## Introduction

### ■ Neuromorphic devices

- Neuromorphic devices consist of neuron/synapse device
- Both devices use pulses to verify the resistance change characteristics
- The device parameter analyzer is **high cost** and **hard to control** pulses to verify the characteristics

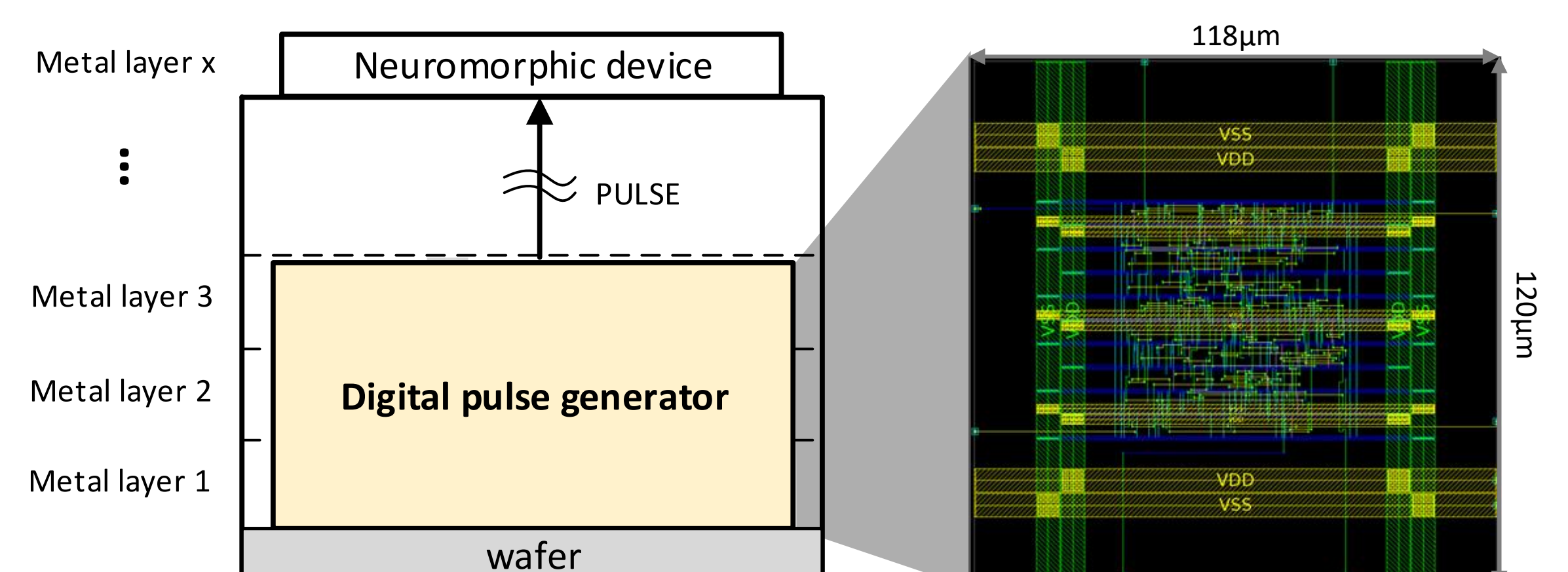


## Implementation Results

### ■ Synthesis & Layout results

- CMOS 180 nm CMOS process @ 250 MHz

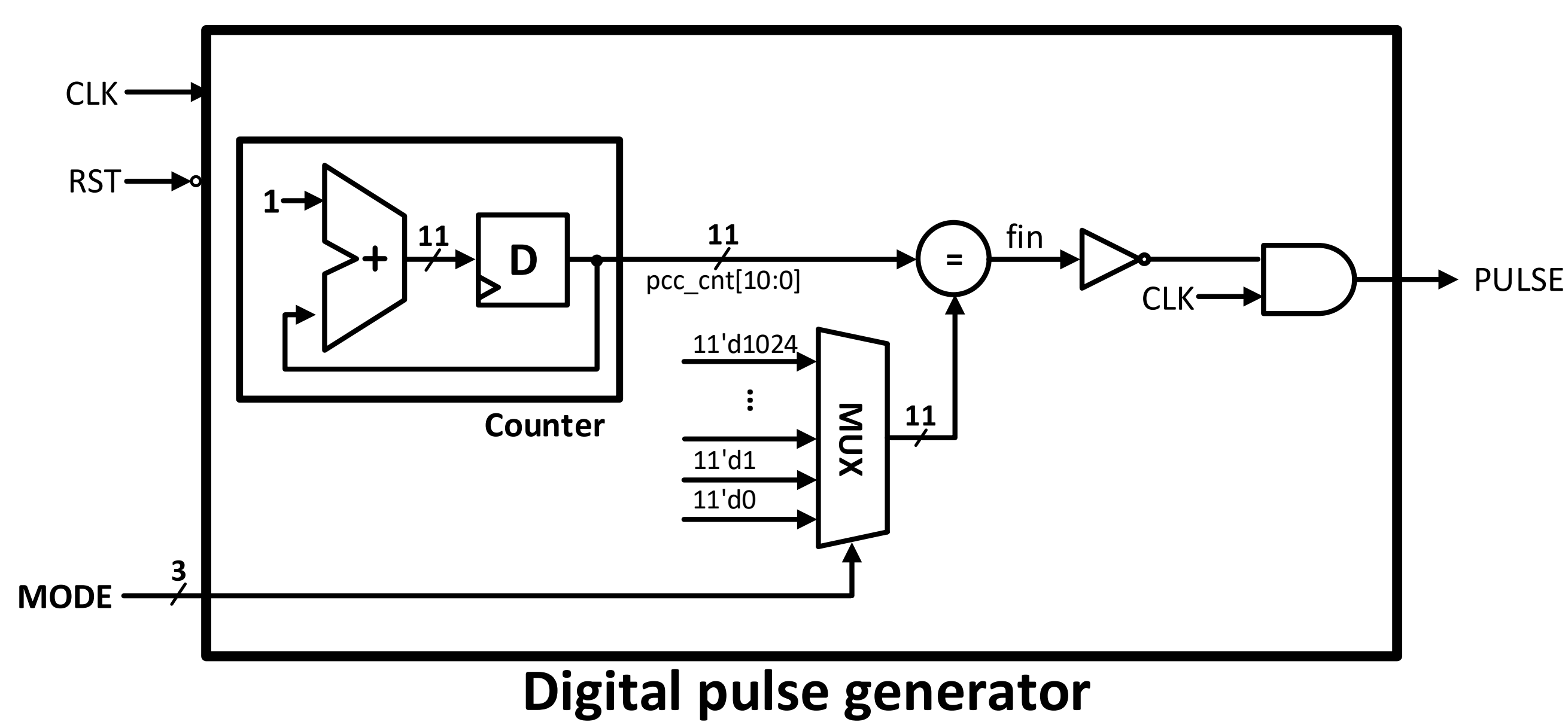
Physical metrics	Digital pulse generator
Area	0.01357mm <sup>2</sup>
Equivalent gate count	188
Critical-path delay	3.36ns
Throughput	297.619 Mbps
Max metal layer	3



## Proposed Architecture

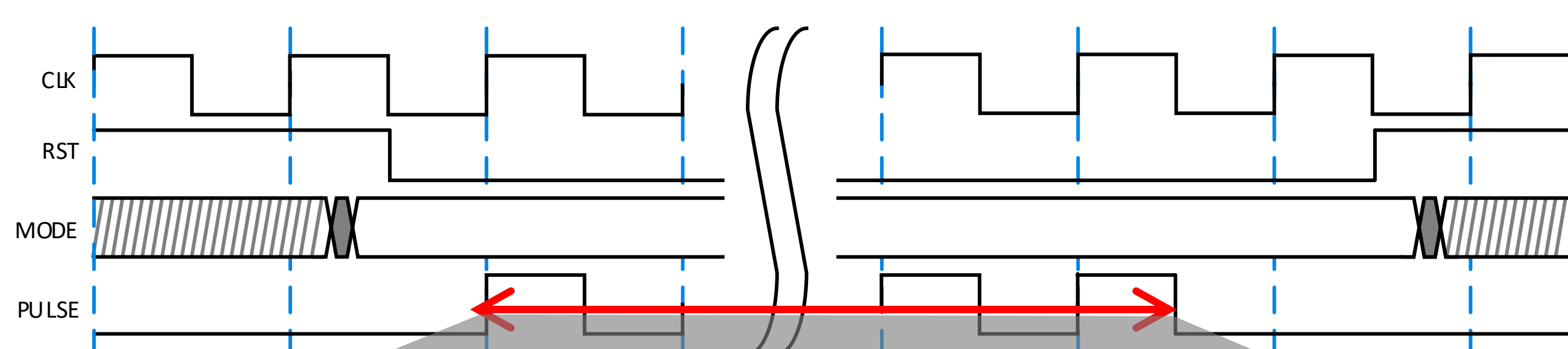
### ■ Digital pulse generator

- Digital pulse generator consisted of 2 modules
  - Counter : counting the number of pulses
  - Multiplexor : specifying the number of output pulses



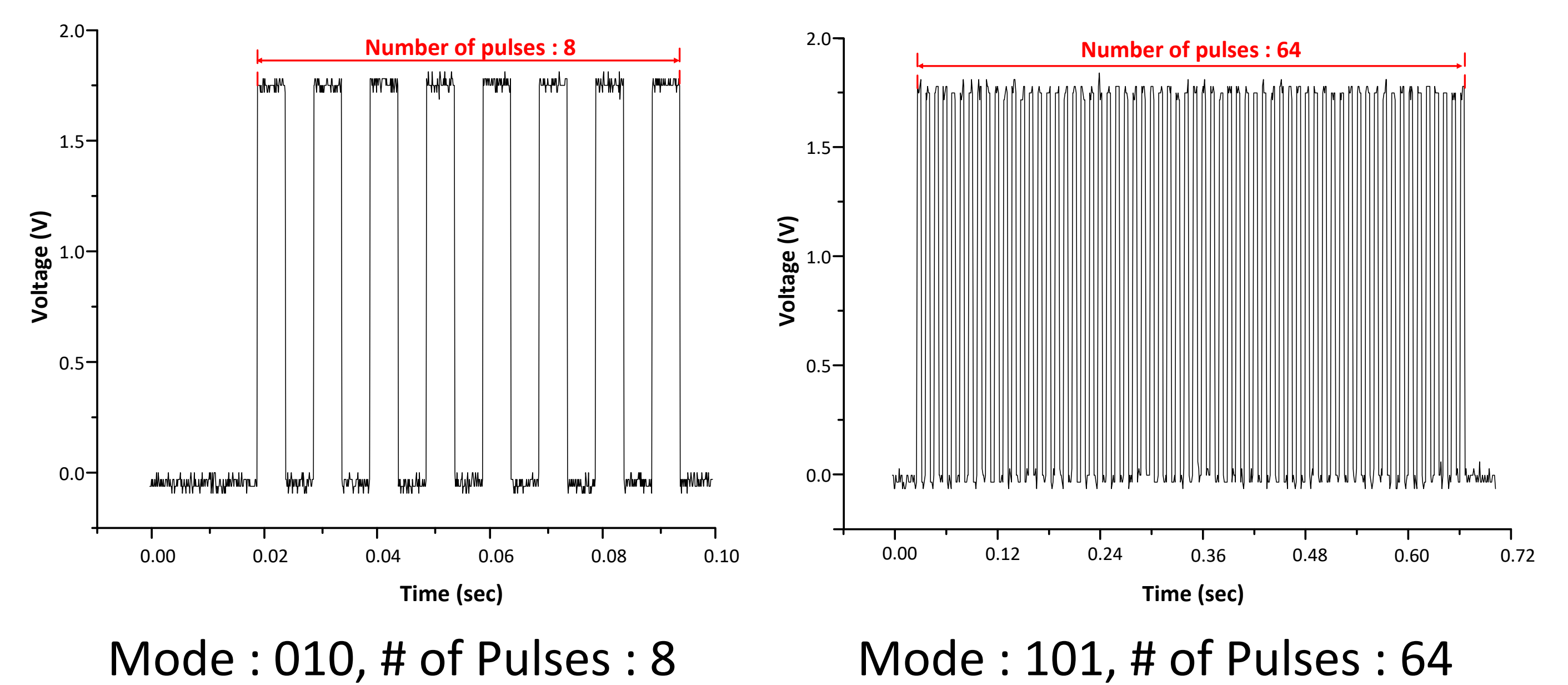
### ■ Timing diagram

- Number of output pulses generated according to the mode



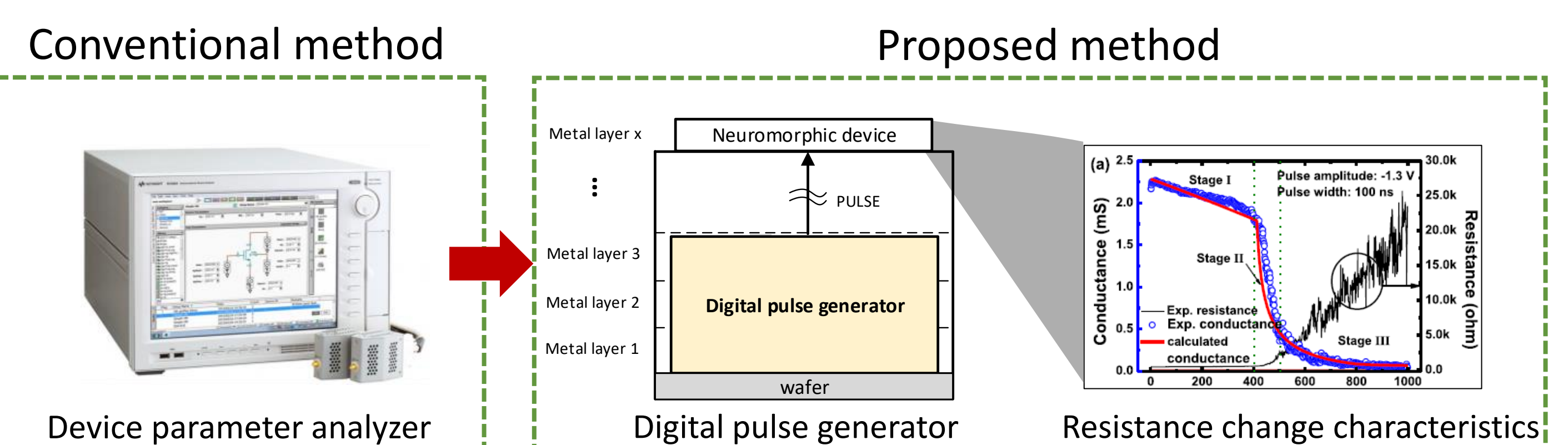
Mode	Number of pulses
000	0
001	1
010	8
011	16
100	32
101	64
110	128
111	1024

### ■ Experimental results



## Conclusion

### ■ Proposed digital pulse generator



- Structure that generates pulse by applying digital signal → Easy to use
- Structure that can be integrated with neuromorphic devices → Low cost

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