1S-4

A Scalable Time-Domain Biosensor Array Using Logarithmic Cyclic Time-Attenuation-Based TDC for High-Resolution and Large-Scale Bio-Imaging

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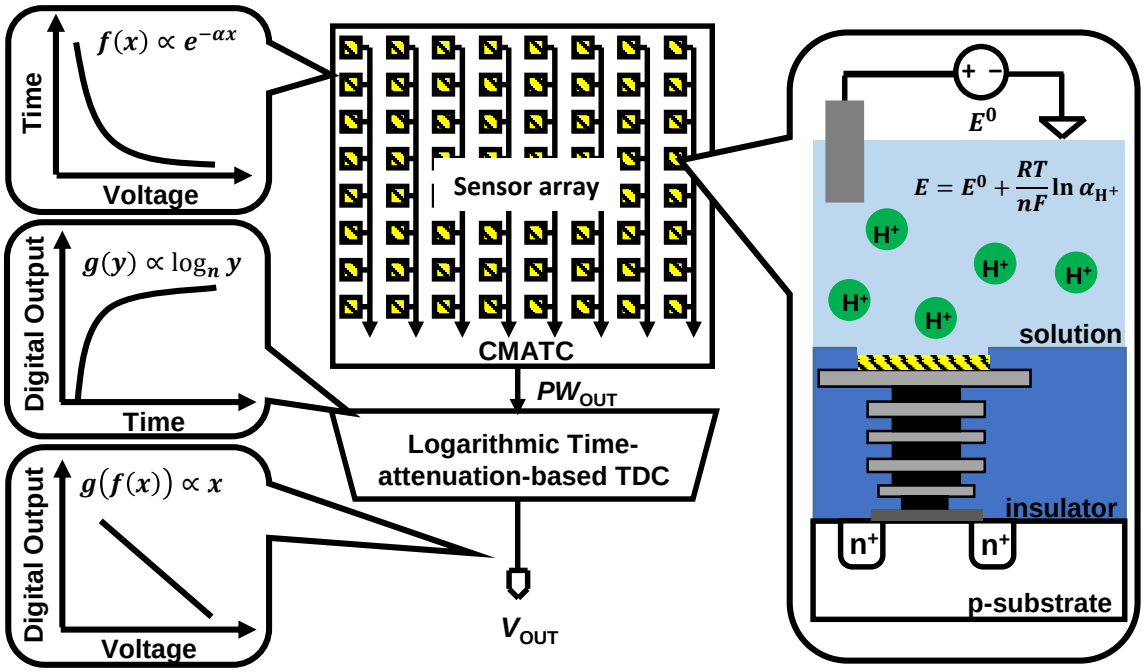
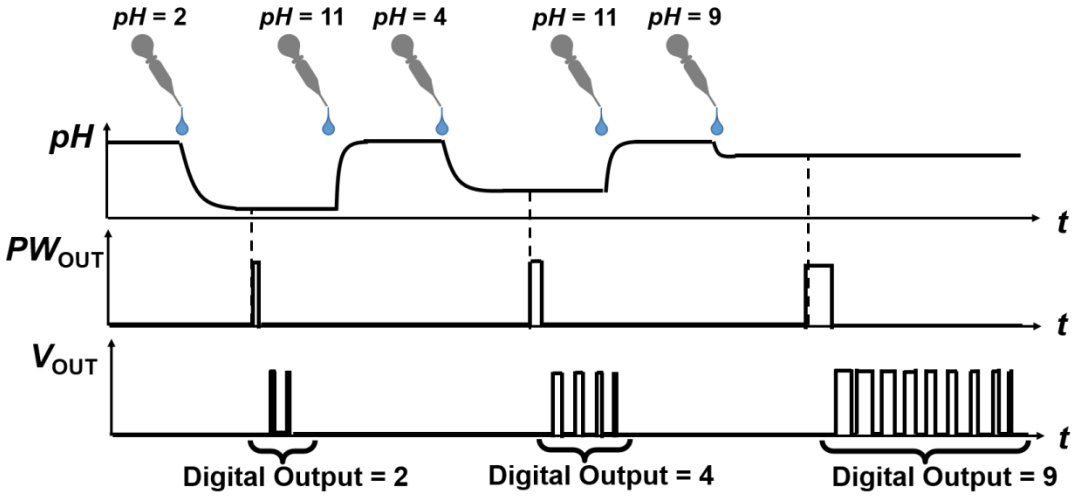
Architecture of the proposed biosensor system

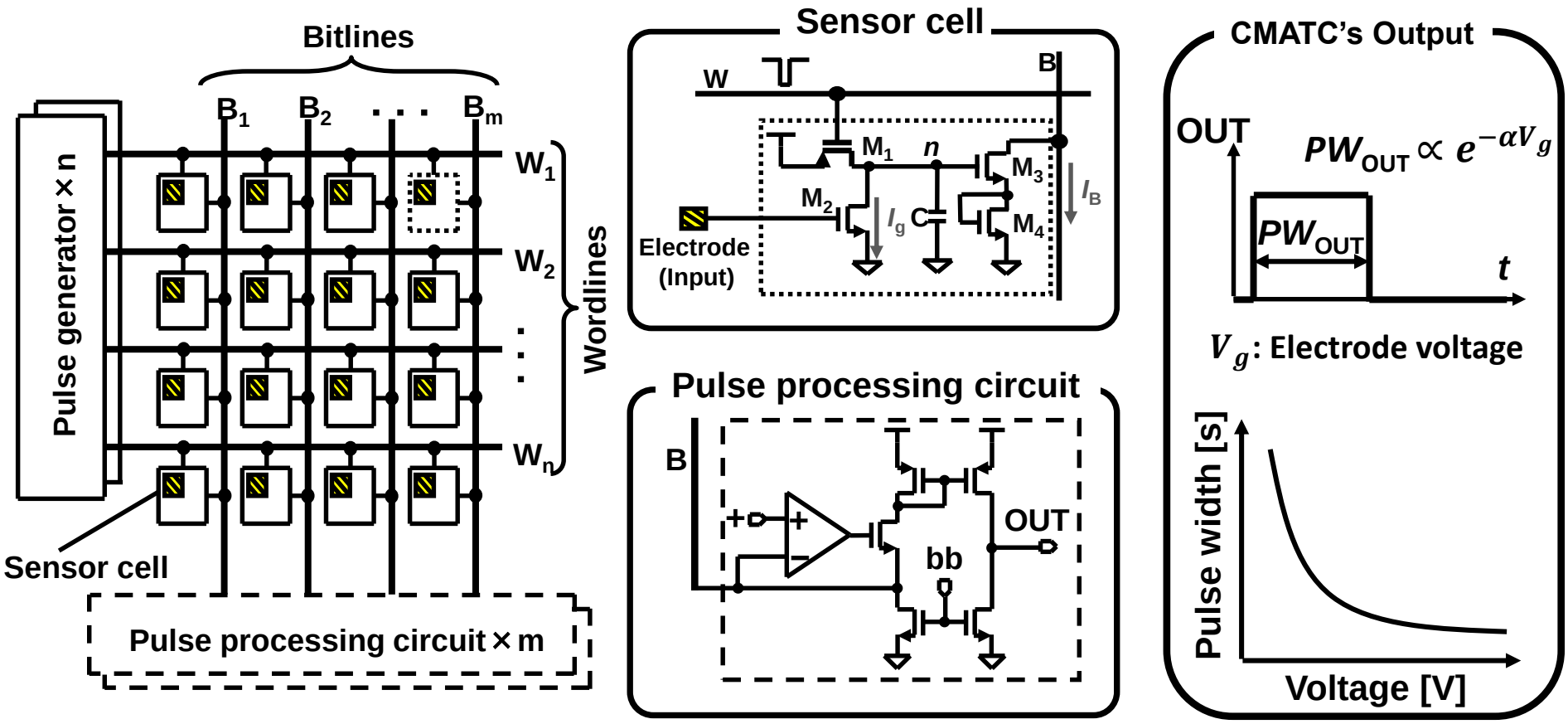


This work is the first to present a biosensor array that uses a newly-proposed bio-oriented logarithmic TDC.



Combining the exponential function of the CMATC and logarithmic function of the proposed TDC offers linear input–output characteristics.

Current-mode analog-to-time converter.

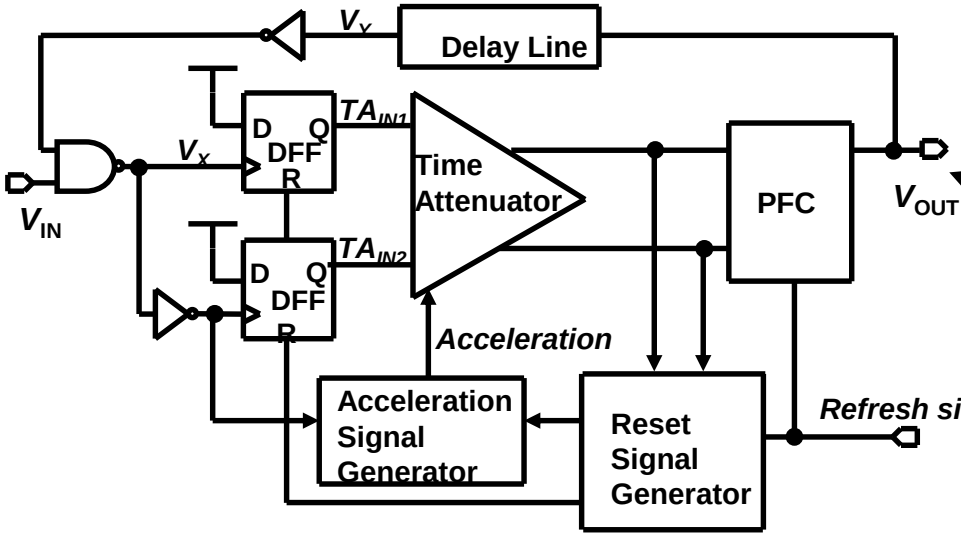


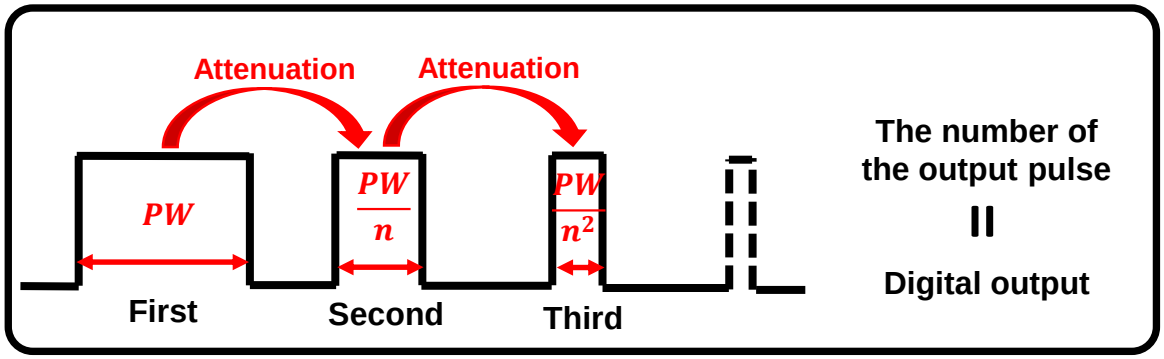
The CMATC consists of the pulse generator, sensor cell, and pulse processing circuit (PPC). The sensor cell outputs the current pulse, and the PPC converts the current pulse to the voltage pulse. The CMATC's output is as follows

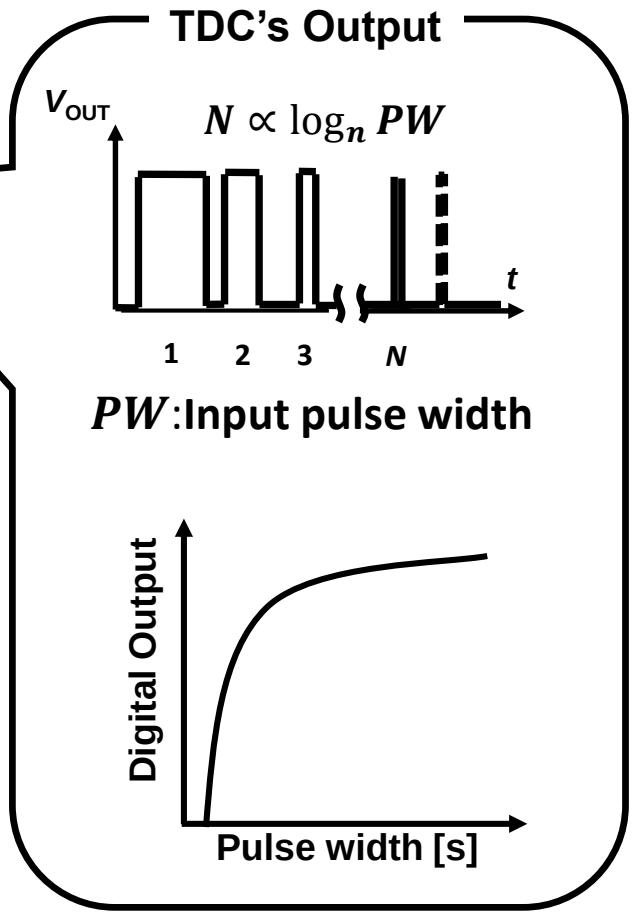
$$PW_{OUT} = \frac{C\,(V_{DD} - V_{th})}{I_g}$$

The CMATC generates a exponential output because I_g is subthreshold current.

Logarithmic Cyclic Time-attenuation-based TDC



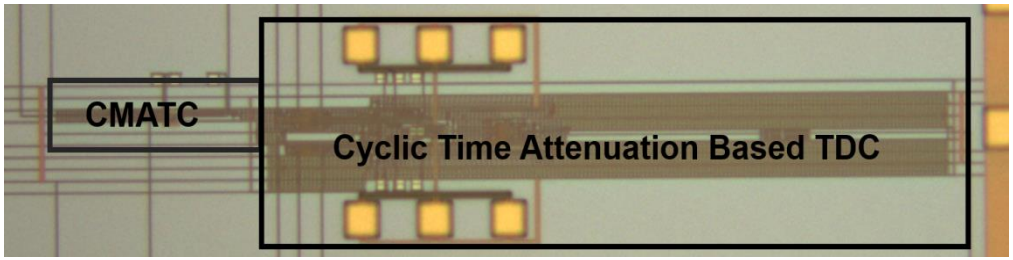




The time-attenuation-based TDC has the logarithmic input output characteristic. This circuit attenuates a input pulse width with a certain gain. This repetitive operation with a constant attenuation ratio (gain of less than unity) enables a logarithmic input–output characteristic.

Chip configuration and measurement result

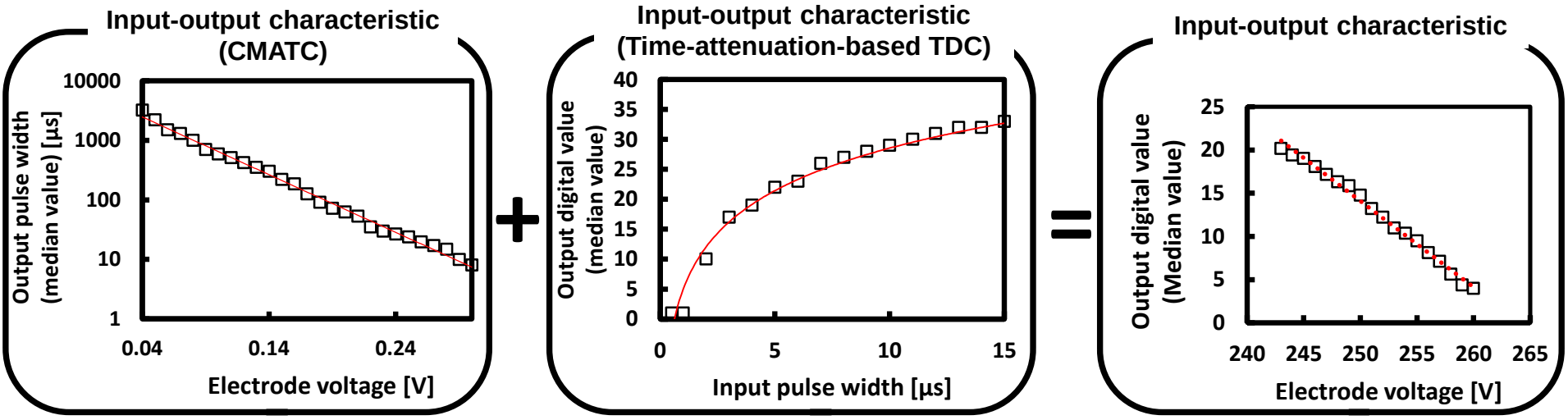
■Chip microphotograph



Process	250nmCMOS
Area	43000μm^2
Supply Voltage	0.96V

A test chip was fabricated with 0.25-μm CMOS technology. The area occupied by the core circuit, including the CMATC and TDC, was 43,000 μm^2. The operating voltage is 0.96V

■Input-output characteristic



By combining the exponential and logarithmic characteristic,
Linear characteristics between the input voltage and output digital value emerge.