1D-13:
Implementation of a Standby-Power-Free CAM Based on Complementary Ferroelectric-Capacitor Logic

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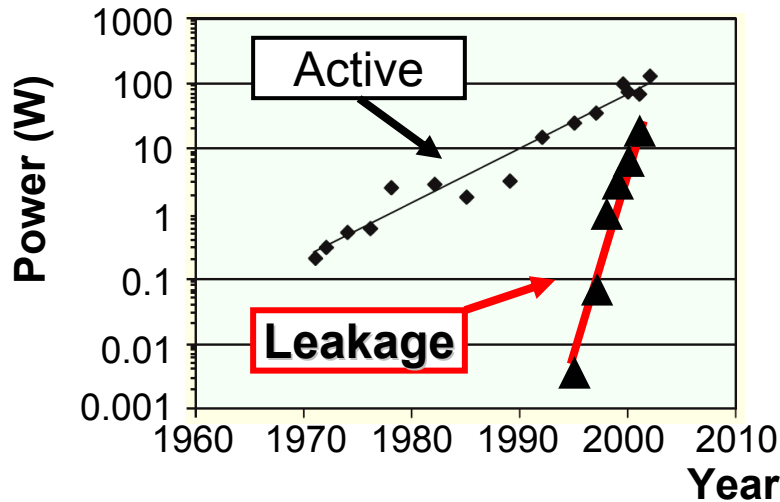[*1] : Research Institute of Electrical Communication
Tohoku University, JAPAN
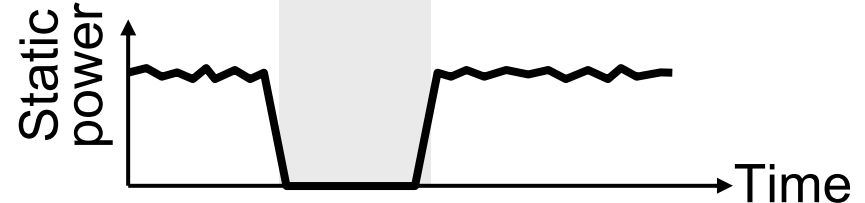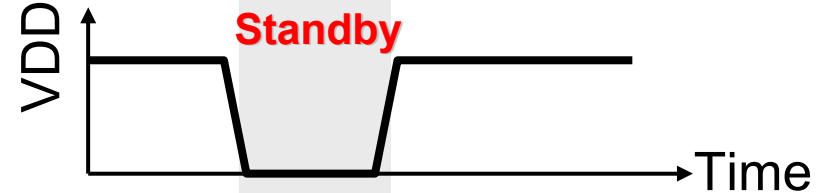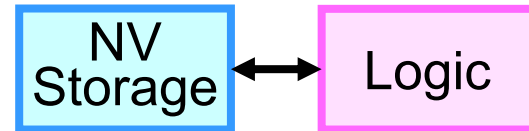[*2] : ROHM Corporation, JAPAN

January 24, 2007

Background

CAM (Content-Addressable Memory)

- •Search engine
- •Data compression
- •Network router

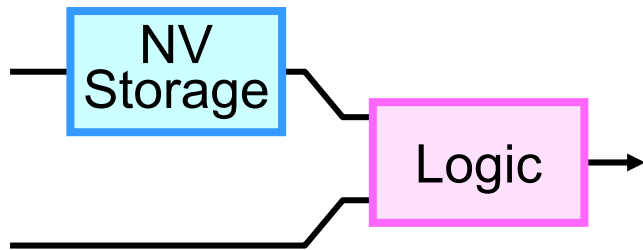W. M. Elgharbawy et. al., IEEE CAS Magazine, 2005.

Problem

Static power

Non-volatile storage

Normally-off system solves static power problem.

Concept

Simple solution

NV Storage

Logic

- **Standby power ： 0**
- Area ： Large
- Critical path ： Long

Non-volatile Logic

NV storage
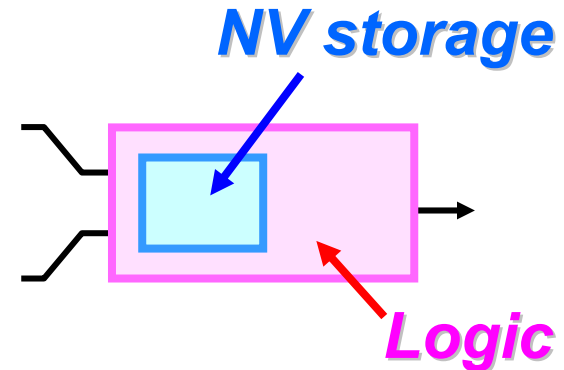
Logic

- **Standby power ： 0**
- **Area ： Small**
  - ⟹ **Low-power**
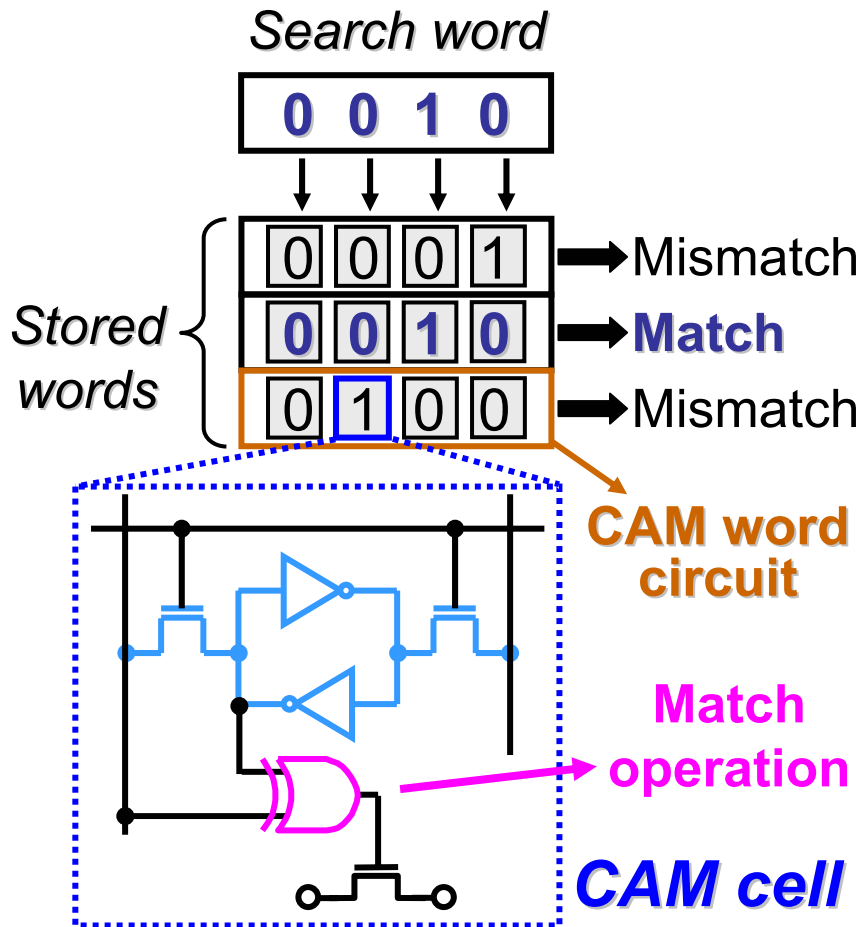- **Critical path ： Short**
  - ⟹ **High-speed**

Non-volatile logic

⟱
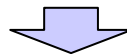
**Standby-power-free
with compact and high performance**

CAM cell based on CFC logic

Block diagram of CAM

Search word

| 0 | 0 | 1 | 0 |

Stored words

0	0	0	1	→ Mismatch
0	0	1	0	→ **Match**
0	1	0	0	→ Mismatch

CAM word circuit

Match operation

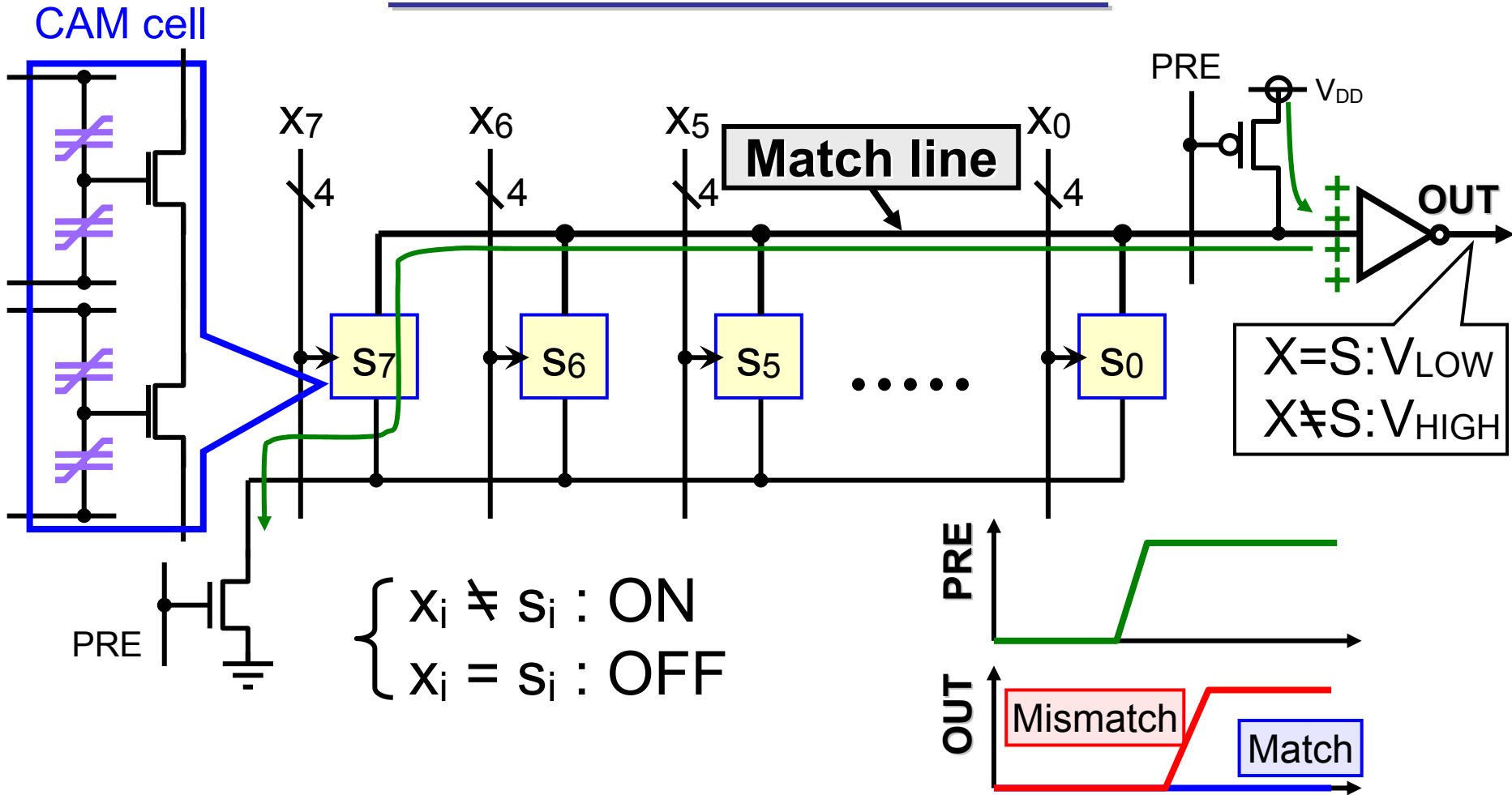*CAM cell*

Complementary Ferroelectric-Capacitor (CFC) Logic

- Large driving capability
- Small number of device counts

CFC logic gate

$\overline{S}$ S S $\overline{S}$

$$\left(X + S \right) \bullet \left(\overline{X} + \overline{S} \right)$$

$$= X \oplus S$$
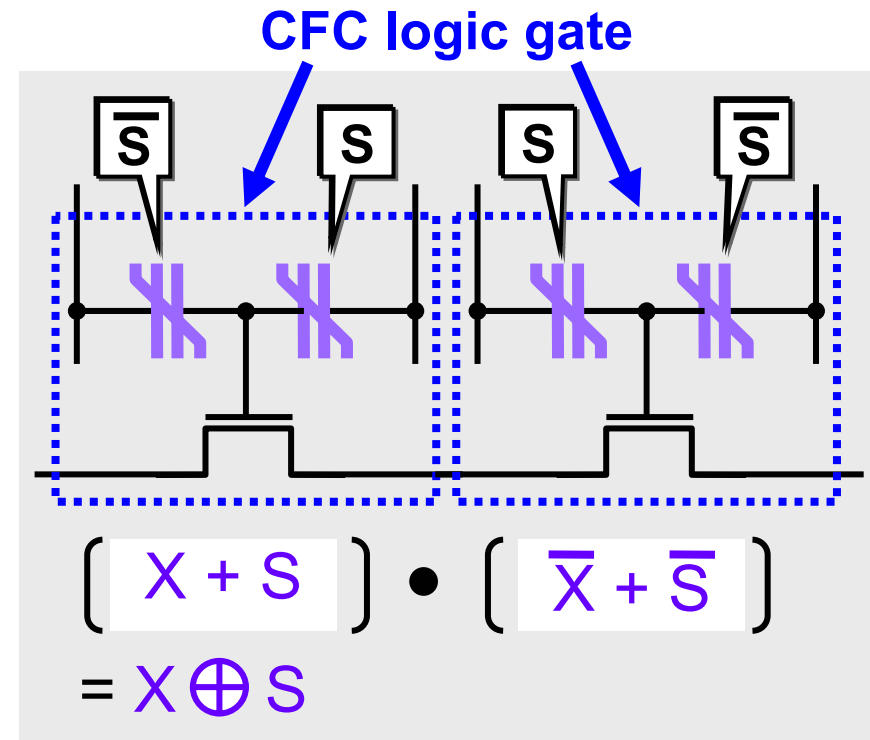
CFC logic gates ⇒ Compact CAM cell

CAM word circuit

CAM cell

X_7 X_6 X_5 **Match line** X_0

PRE V_{DD}

4 4 4 4

OUT

S_7 S_6 S_5 ..... S_0

$X = S : V_{LOW}$
$X \neq S : V_{HIGH}$

PRE

$\begin{cases} x_i \neq s_i : ON \\ x_i = s_i : OFF \end{cases}$
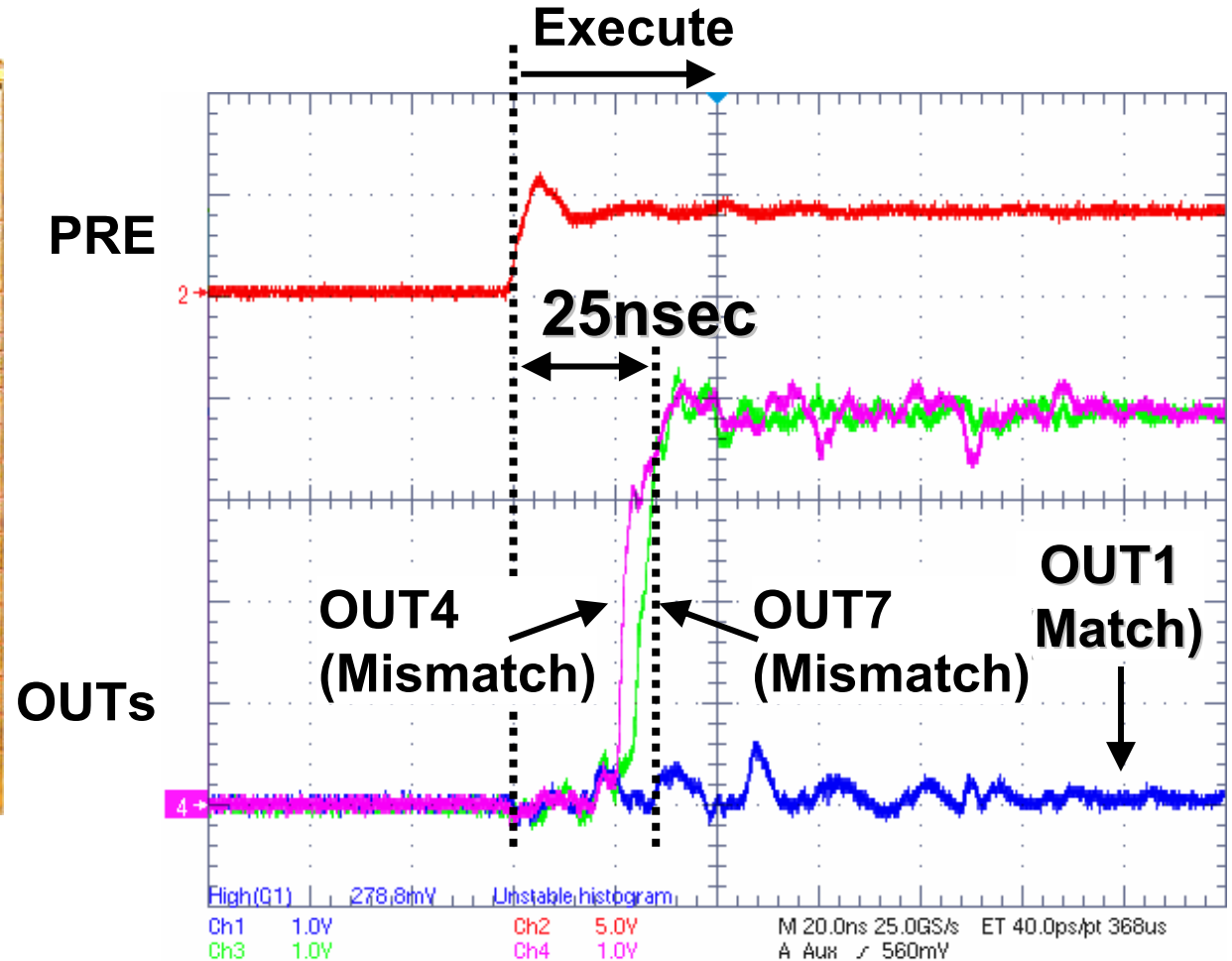
PRE

OUT

Mismatch

Match

Match operation can be performed by switching of pass transistors in the CAM cells.

8-bit CAM
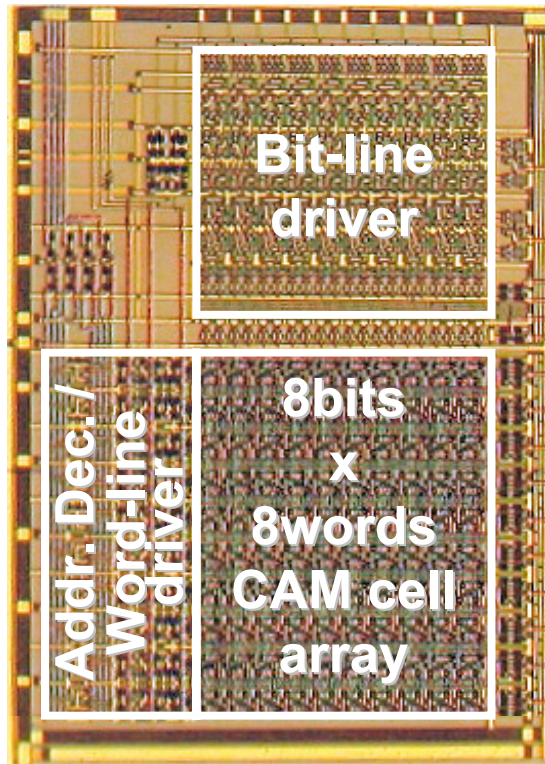
0.35μm CMOS / 0.6μm ferroelectric technology

Bit-line driver

Addr. Dec. / Word-line driver

8bits x 8words CAM cell array

Execute

PRE

25nsec

OUTs

OUT4 (Mismatch)

OUT7 (Mismatch)

OUT1 Match)

High(G1) | 278.8mV | Unstable histogram
Ch1 1.0V   Ch2 5.0V   M 20.0ns 25.0GS/s ET 40.0ps/pt 368us
Ch3 1.0V   Ch4 1.0V   A Aux ∫ 560mV

Basic behavior of the 8-bit CAM was confirmed.

I will explain details in the poster session.