Design and Implementation of Read-Compare-Write Circuits for Low Power Multi-Gigabit DRAM

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Outline

- Introduction
- Read-Compare-Write (RCW)
- Adaptive Column Control (ACC)
- Simulation Results
- Conclusions
Introduction

- Low Power Memory for Mobile Multimedia Application

Limited Battery Lifetime

3D Graphics

Frequent Memory Write Operations

Portable Video
Conventional Write Operation

Case 1
Write operation is necessary

Case 2
Write operation is redundant
DB Line Swing in Memory R/W

Small DB Swing

Read
3mW

Full DB Swing

Write
12mW

4 \times P_{\text{READ}} = P_{\text{WRITE}}

Eliminate Unnecessary Write Operation!!!
Read-Compare-Write (1/2)

Compare before DB Swing
Read-Compare-Write (2/2)

Update Write

Non-update Write
Conventional Column Control

Update write

Non-update write

Undesired DB Swing by BLSA and CDi
Adaptive Column Control

Update write

Non-update write

$CD_i^{NEW} = CD_i \cdot (WEN + REN)$
Circuit Schematic

Occupies Small Area
Power Distribution Result

13% Overhead

24% Saving

Data Update Ratio

Frame Buffer Application
Die Micrograph

<table>
<thead>
<tr>
<th>Capacity</th>
<th>6Mb</th>
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<tbody>
<tr>
<td>Technology</td>
<td>0.16um DRAM with 1-W 3-Al Metal Layers</td>
</tr>
<tr>
<td>Power</td>
<td>47mW (Data Update Ratio=0.0)</td>
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<tr>
<td></td>
<td>70mW (Data Update Ratio=1.0)</td>
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Conclusions

- **RCW** and **ACC** scheme are proposed to reduce the power consumption of memory write operations.

- **RCW** and **ACC** reduce the power consumption up to **24%** during the write operation.

- Less than **5%** Area Overhead

- Applicable to the **Mobile Multimedia System**