System Benefits of EZ-NAND/Enhanced ClearNAND™ Flash

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Agenda

- NAND challenges
  - Scaling
  - ECC complexity
- The EZ-NAND solution
- Additional controller benefits
- Enhanced ClearNAND™ Flash
- Summary
The Drawbacks of NAND Scaling

- Endurance
- ECC Requirements

Graph showing the trend of Endurance and ECC Requirements as the size decreases from 72nm to 20nm.
ECC Complexity vs. Logic

Increasing RBERs requires more ECC to achieve equivalent UBERs.
The EZ-NAND Solution

- Minimizes impact of NAND technology transitions
- Current technology can be used sooner
- Allows host processor to focus on system-level optimization
- Internal controller offers performance and scaling benefits
- Provides buffer to reduce channel loading, improving signal integrity
Raw NAND vs. EZ-NAND

System Using Raw NAND

- Host Processor
  - Block Management
  - ECC
  - Driver

NAND

System Using EZ-NAND

- Host Processor
  - Block Management
  - Driver

EZ-NAND Controller
  - ECC

NAND

Vs.

EZ-NAND

- Relieves host’s ECC burden
- Host maintains control
  - Block management
  - Driver optimization
- Allows higher NAND densities
  - Serves as NAND buffer
  - Reduces loading
EZ-NAND: Loading Improvements

System Using Raw NAND

- Raw NAND 8-Die Package
- Flash LUN
- Control & DQ[7:0]1
- CE 1
- Control & DQ[7:0]2
- CE 2
- Host NAND Controller

Raw NAND
- Loading increases with additional NAND die
- May limit I/O speed; reduces system performance

System Using EZ-NAND

- EZ-NAND 8-Die Package
- Flash LUN
- Control & DQ[7:0]1
- CE 1
- EZ-NAND Controller
- Control & DQ[7:0]2
- CE 2
- Host NAND Controller

EZ-NAND
- EZ-NAND controller serves as buffer to NAND die
- Allows for faster I/O speed with more NAND die
Additional Controller Benefits

• Internal controller allows for additional features
  • Command queuing; multi-core/multi-threaded architecture support
  • LUN optimization
    • Commands optimized to utilize LUNs efficiently
    • Reduces host command complexity
  • Power management limits number of active LUNs
Command Queuing

- Available on enhanced ClearNAND Flash via enhanced command set
- Allows commands to be queued if LUNs are busy
  - READ/ERASE queue dependent on command queue depth
  - PROGRAM queue dependent on buffer availability
• Internal controller able to optimize LUN usage by combining commands where possible
  • Multi-LUN commands
  • Additional NAND optimization
• Allows each NAND vendor to utilize expertise without requiring host to customize commands
Power Management

- Internal controller can assist with power management
  - Limit number of active LUNs
  - Additional power management techniques
- Allows each EZ-NAND device to be tailored for power/performance based on application requirements
Enhanced ClearNAND Flash

- Host Processor
- X8 NAND Interface
- Enhanced ClearNAND Controller
  - Command Queue
  - Channel 01
  - Channel 02
- Channel 01 Read/Write Buffer
- Channel 02 Read/Write Buffer
- DIE 0
  - Plane 0
  - Plane 1
- DIE 1
  - Plane 0
  - Plane 1
- DIE 2
  - Plane 0
  - Plane 1
- DIE 3
  - Plane 0
  - Plane 1
- Up to 4 LUN per channel
Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Command Queue

Read/Write Buffer

Channel 01

Channel 02

DIE 0

DIE 1

DIE 2

DIE 3

Plane 0

Plane 1

Plane 0

Plane 1

Plane 0

Plane 1

Plane 0

Plane 1

Up to 4 LUN per channel

Up to 4 LUN per channel
Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Command Queue

Channel 01
Read/Write Buffer

Channel 02
Read/Write Buffer

Channel 01

Channel 02

DIE 0

DIE 1

DIE 2

DIE 3

Plane 0

Plane 1

Plane 0

Plane 1

Plane 0

Plane 1

Plane 0

Plane 1

Plane 0

Plane 1

Up to 4 LUN per channel
Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Channel 01
Read/Write Buffer
A
B

Channel 01 Command Queue

Channel 02
Read/Write Buffer
C

DIE 0

Plane 0
A
Plane 1
B

DIE 1

Plane 0

Plane 1

DIE 2

Plane 0

Plane 1

DIE 3

Plane 0

Plane 1

Up to 4 LUN per channel
Enhanced ClearNAND Flash

- Host Processor
- X8 NAND Interface
- Enhanced ClearNAND Controller
- Command Queue
- Channel 01
  - Read/Write Buffer
  - A
  - B
- Channel 02
  - Read/Write Buffer
  - C
  - D
- Channel 01
- Channel 02
- Up to 4 LUN per channel

DIE 0
- Plane 0
- Plane 1
- A
- B

DIE 1
- Plane 0
- Plane 1
- C

DIE 2
- Plane 0
- Plane 1

DIE 3
- Plane 0
- Plane 1

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Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Command Queue

Channel 01
Read/Write Buffer

A
B
E

Channel 02
Read/Write Buffer

C
D

DIE 0

Plane 0
Plane 1

A
B

DIE 1

Plane 0
Plane 1

C
D

DIE 2

Plane 0
Plane 1

A
B

DIE 3

Plane 0
Plane 1

C
D

Up to 4 LUN per channel
Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Channel 01
Read/Write Buffer
F
B
E

Channel 02
Read/Write Buffer
C
D
G

Command Queue

Channel 01

Channel 02

DIE 0
Plane 0
A
Plane 1
B

DIE 1
Plane 0
C
Plane 1
D

DIE 2
Plane 0
E
Plane 1
F

DIE 3
Plane 0

Plane 1

Up to 4 LUN per channel

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Enhanced ClearNAND Flash

Host Processor

X8 NAND Interface

Enhanced ClearNAND Controller

Channel 01
Read/Write Buffer

I
B
E

Channel 02
Read/Write Buffer

H
D
G

Command Queue

Channel 01

Channel 02

DIE 0
A
B
Plane 0
Plane 1

DIE 1
C
D
Plane 0
Plane 1

DIE 2
E
F
Plane 0
Plane 1

DIE 3
G
H
Plane 0
Plane 1

Up to 4 LUN per channel
Summary

- EZ-NAND allows host to optimize NAND usage for each application
- Additional features are available based on internal controller capabilities
- Enhanced ClearNAND provides flexible NAND solution to suit many applications

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