



Flash Technology Characterization for Enterprise Systems

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Flash Technology Characterization for Enterprise Systems

Agenda

- Background / Capabilities
- Characterization Platform
- Characterization Approach
- Enterprise Usage Model
- Flash Endurance Example
- Increased Focus on Read Disturbs
- Additional Areas of Analysis
- Requests for Suppliers
- Summary



Flash Technology Characterization for Enterprise Systems

Background

- In-depth knowledge of Flash technology characteristics is needed to maximize performance and manage reliability for Enterprise Systems designs
- Driving to establish center of competence for Flash characterization supporting enterprise usage
- Support development and verification of Flash management schemes through characterization

Capabilities

- Perform supplier / technology comparisons and competitive analyses on common platform
- Provide in-depth understanding of Flash technology features and functions
- Identify strengths and weaknesses of leading-edge Flash technologies based on enterprise usage cases
- Assess new technologies and investigate approaches to improve performance / extend Flash reliability



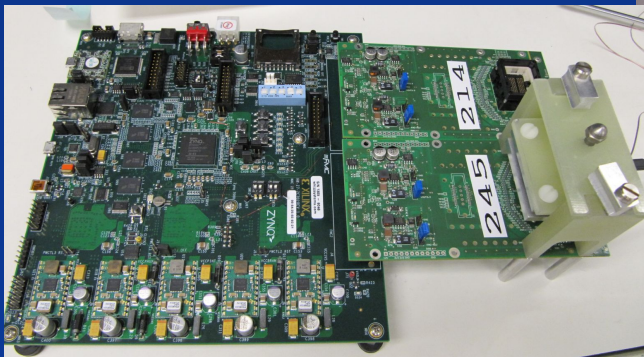
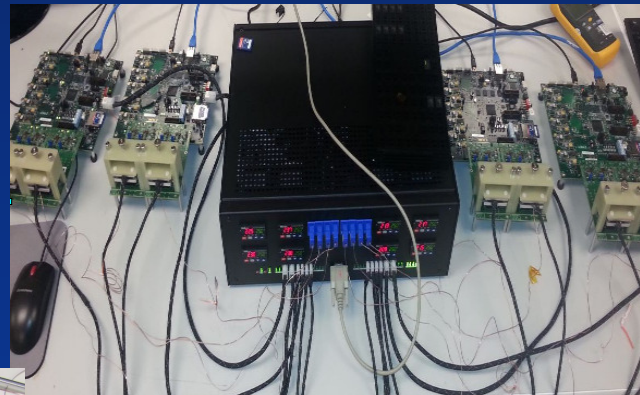
Flash Technology Characterization for Enterprise Systems

■ Characterization Platform

- Flash test node (2 shown)
- Node includes 4 Flash test stations
- Up to 256 dice available for test



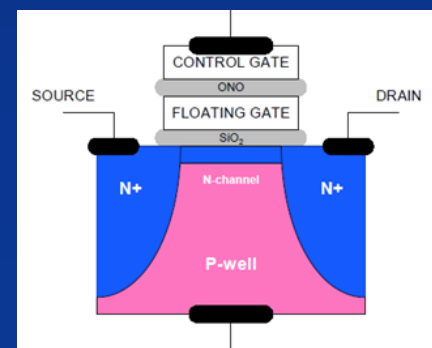
- Node controller manages power & thermal for 4 Flash test stations
- Thermal controllers drive external heaters
- Power control provided for ZC702



- Flash test station
- Xilinx ZC702 FPGA evaluation board
- 2 Flash daughter cards (one 16DP per card)
- Resistive thermal heater

Flash Technology Characterization for Enterprise Systems

- Characterization Approach
 - Perform extended testing across technology process
 - Endurance
 - Data retention
 - Read disturb
 - Evaluate key parametrics
 - Array timings
 - Power consumption
 - AC timings
 - Additional experiments based on enterprise usage cases





Flash Technology Characterization for Enterprise Systems

■ Enterprise Usage Model

- Initially SLC, next Enterprise MLC, now enhanced Commercial MLC raw NAND
 - Cost management and industry Flash management capabilities driving transitions
- High endurance and optimized data retention
- Largest available die density
- Widely distributed designs maximize Flash subsystem performance and not device I/O speed
- Power management now increasingly important with high capacity systems
- Advanced packaging requiring enterprise quality

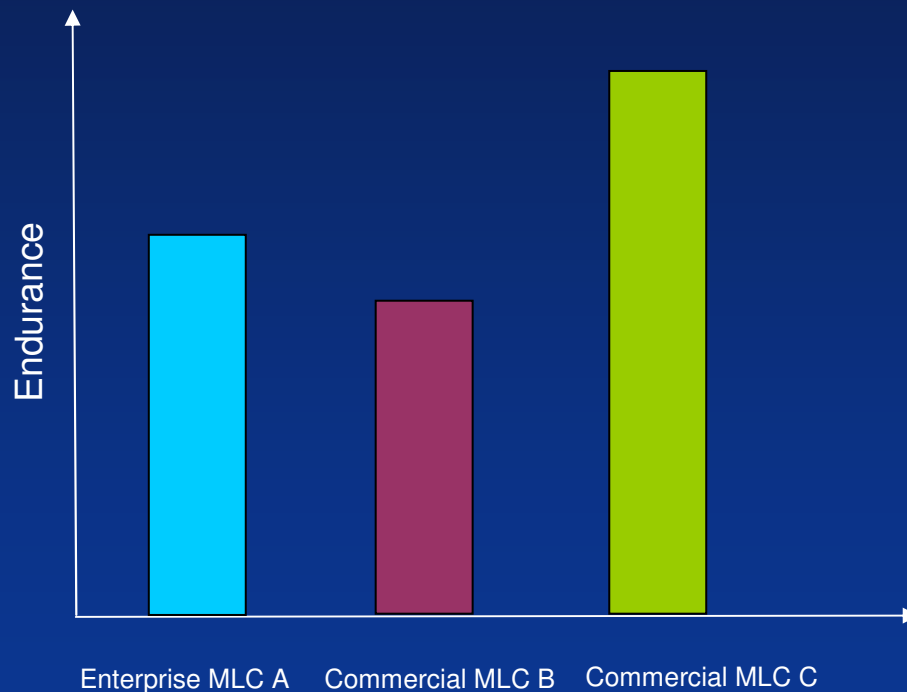


IBM FlashSystem 840



Flash Technology Characterization for Enterprise Systems

- Flash Endurance Example (Similar Technology Node)

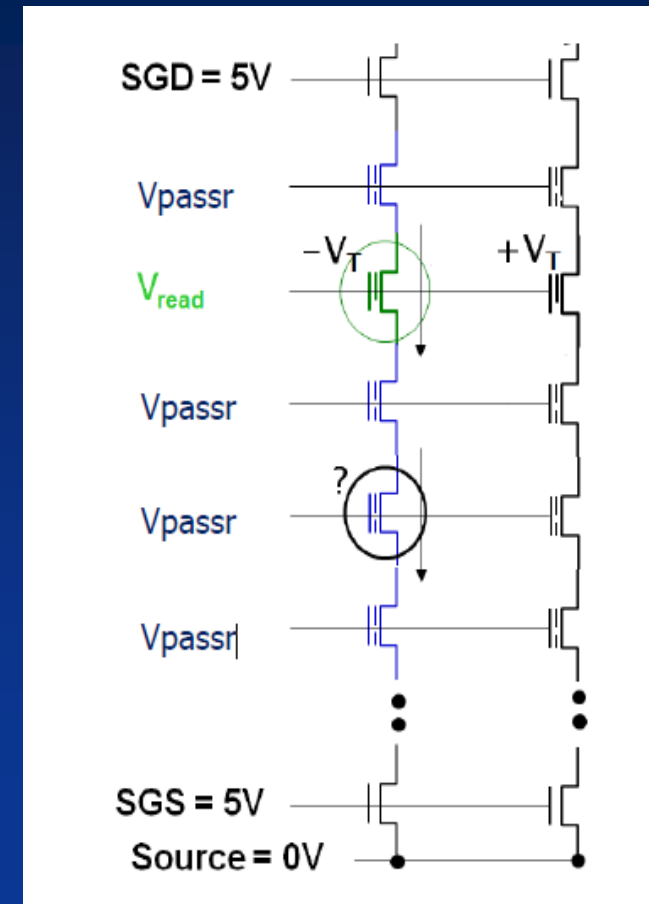


- Seek improved raw endurance for commercial MLC devices
- Apply additional capabilities to extend endurance further

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■ Increased Focus on Read Disturbs

- Read disturb characteristics:
 - When cell is read, other cells on same bit line weakly programmed
 - Repeated reads without erase may cause cells to shift enough to change state
 - More pronounced in smaller technology nodes
 - Block erase resets read disturb exposure
- Read disturb characterization approach:
 - Pre-cycling followed by read disturb testing
 - Record errors at end of read cycling as well as at intermediate points
 - Apply appropriate temperature to evaluate usage case for pre-cycling and read disturb testing



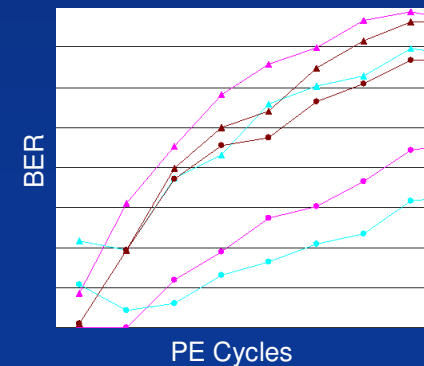
Source: Micron



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- Additional Areas of Analysis
 - Exhaustive testing to point-of-failure
 - Process window / lot variation investigations
 - System duty cycle / dwell time-related experiments
 - Workload / command sequence robustness checks
 - Typical power evaluation based on design attributes

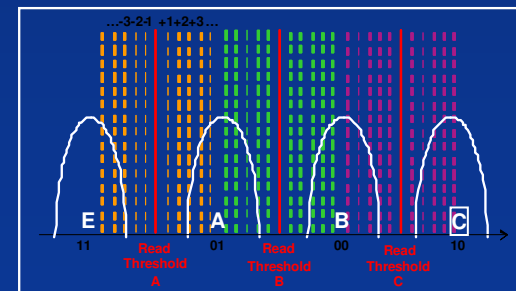
Sample Endurance vs. BER Curves



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■ Requests to Suppliers

- Improve specifications including all supporting documentation
- Open test mode access to further extend Flash viability
- Continue to pursue reliability improvements in support of enterprise
- Seek power consumption improvements with new designs
- Enable 3D NAND with advanced capabilities if technology warrants



Typical MLC Voltage Distributions



Flash Technology Characterization for Enterprise Systems

■ Summary

- In-depth knowledge of Flash technology characteristics is needed to maximize performance and manage reliability for Enterprise Systems designs
- Driving to establish center of competence for Flash characterization supporting enterprise usage
- Increased focus on commercial MLC endurance and read disturb capabilities is required for enterprise
- Suppliers are requested to improve specifications, open test modes, continue to pursue reliability improvements, reduce power consumption and aggressively enable 3D technologies going forward