Tailor-made-SSD to Excel in Specified Storage Fields

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Background History: Silicon Motion Inc.

10+ years of contribution to NAND flash storage
Overcome embedded storage challenges

- Tailor-made-SSD
- All available host Interface
- Designed for embedded market
- Customizing for your needs!
Can one SSD fit all application?

• A big density SLC SSD can probably satisfy some of the application requirements..
  • SLC offers the best Performance, Reliability, Endurance, Data retention, …

  Can SLC be the answer for every application??

The high price premium makes SLC unacceptable to most application..

Yet, there are still many other problems..
Tailor-make-SSD for each application

Requirements

• Avoid downtime for Embedded System
  - Simulation Model for Design Improvement
  - Eliminate Potential Defects (lower dPPM)
  - Remote Monitoring/Recovery System

• Firmware Data Protection: Retention/Disturbance
  - Read Intensive: 95/5% Read/Write ratio
  - Mixed Usage: 66/34% Read/Write ratio
  - Write Intensive: 15/85% Read/Write ratio

• System Level Protection Consideration
  - System Level (Electrical) Protection
  - Sudden Power off Handling
  - Misc Package Level Protections
Actual Case Study – Design Review

**Improve Quality for Embedded System**
Goal: Lower than 50dPPM for SSD overall
Challenge: NAND Flash > 100dPPM

**Firmware Data Protection on DR/RD**
Goal: No Data Lost in > ~17 years
Challenge: Intensive Read vs Rarely access

**Sudden Power off Handling**
Goal: No Data Damage in the event of sudden power lost
Challenge: NAND Flash tend to have pair-page concern
Lowering dPPM – In Vehicle Infotainment

High/Low Temperature Burn-in Chamber

- Enable MP Level Screening to eliminate early weak blocks
- 100% Screen on every cell blocks at customer’s specified operation temperature

Production Chambers to simulate user operating temperature

Massive & effective setup for 100% burn in for each SSD before shipping

Effective screen out all early failure parts in order to lower dPPM
Firmware protection – Retention/Disturbance

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<tr>
<th>Illustration</th>
<th>Description</th>
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<tr>
<td>X X X X X</td>
<td>= access extremely frequently</td>
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<td>= access hourly/daily</td>
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<td>= access yearly or less.</td>
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Solution:
- Idle (FW) activate
- Intelligent Scan
- DataRefresh
**System Level Protection - Sudden power lost**

Standard SSD SPOR recovery method

DRAM cache - same as HDD & some pair-page data lost

FerriSSD Data Flush SPOR recovery method

Data Flush pin or Module w/ capacitor (no data lost from SPOR)
Simulation Model – Continuous Improvement

**Improve Quality for Embedded System**
Goal: Lower than 50dPPM for SSD overall
Challenge: NAND Flash > 100dPPM
Solution: Hi/low Temp. Chamber to screen defect

**Firmware Data Protection on DR/RD**
Goal: No Data Lost in > ~17 years
Challenge: Intensive Read vs Rarely access
Solution: Firmware to Perform Scan & DataRfresh

**Sudden Power off Handling**
Goal: No Data Damage in the event of sudden power lost
Challenge: NAND Flash tend to have pair-page concern
Solution: Cost Effective Capacitance for Write to complete
Tailor-made-SSD to overcome challenges

- **Data Integrity**
  - SSDLifeGuard
  - Intelligent Scan/DataRefresh

- **Performance**
  - Intelligent Clean
  - Energy Saving Mode

- **Security:**
  - FDE w/ Password
  - Secured Erase
  - Quick Erase
BCH vs LDPC
- Codeword level protection
  - Improves PE/DR from 50% to 2x..

NANDXtend = LDPC + Page Raid
  - increase SSD life up to 3x

Page Raid
- Page level Protection
  - Enables Raid-5 or Raid-6 protection

Current vs Future
- Continuous improving – Ready for the future
- SLC -> MLC -> TLC -> 3D NAND -> QLC

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Summary

• Not one SSD type can satisfy all embedded application

• Case study:
  • Improve Quality for Embedded System
  • Firmware Protection on Retention & Disturbance
  • System Level Design Consideration

• Simulation for design confirmation & continuous improvement

• Tailor make SSD to excel in specified storage application!
Q & A ...

THANK YOU!

Visit us at the booth – 313

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