Lifetime Estimation and Health Monitoring

Support for System Qualification Testing

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Introduction

- Impact of FTL and payload on endurance
- Life-time estimation
- Data retention
- Health monitoring
Some Endurance basics...

- \( \text{WAF(workload, FTL, Flash)} = \frac{\text{Bytes written to NAND}}{\text{Bytes written from Host}} \)

- \( \text{TBW} = \frac{\text{Capacity [GB]}}{1000} \times \frac{\text{PE cycles}}{\text{WAF}} = \frac{\text{Capacity [GB]}}{1000} \times \frac{\text{PE cycles}}{\text{WAF}} \)

- \( \text{Lifetime [Years]} = \frac{\text{TBW} \times 1000}{\text{Write Budget per Day [GB]}} \times 365 \)

- \( \text{DWPD} = \frac{\text{TBW} \times 1000}{\text{Warranty [Years]}} \times \frac{\text{Capacity [GB]}}{365} = \frac{\text{PE cycles}}{\text{WAF(workload, FTL, Flash)}} \times \frac{\text{Warranty [Years]}}{365} \)
Write Amplification Factor

- hyMap® sub-page-based FTL
- Block-based FTL

取决于
- 载荷
- FTL
- Flash (Block, Page…)

Payload
Impact of Workloads

Write Amplification Factor

- Block-based FTL
- hyMap® sub-page-based FTL

Payload

- Content & Read-Only

512 Byte | 1 KB | 1.5 KB | 2 KB | 2.5 KB | 3 KB | 3.5 KB | 4 KB | 8 KB | 16 KB | 32 KB | 64 KB | 128 KB | 256 KB | 512 KB | 1 MB | 2 MB | 4 MB | 8 MB
Impact of Workloads

Do you know your workload?

Payload
Lifetime Estimation

Selected configuration

Selected FTL

Life-Time

<table>
<thead>
<tr>
<th>Payload (k)</th>
<th>WAF (Avg.)</th>
<th>TBW</th>
<th>Estimated Life (Years)</th>
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JEDEC enterprise 6.4 38.0 1.6
Aside endurance, consideration should be given to data retention.
Health monitoring

Measuring actual status of your drives’ health

- Erase counts
  - Minimum
  - Maximum
  - Average
  - Per stripe and logical channel
- Spare block count
- Read Disturb Management status
- Global Wear Leveling status
- Total correctable ECC errors
- Total number of LBAs read/written
- Power-on count
- Firmware status
- User defined thresholds to generate yellow & red warnings

Supports qualification and preventive maintenance
Health Monitoring

1. Remaining spare blocks
2. Block erase count
3. Corrected errors
### Health Monitoring

1. **Remaining spare blocks**
2. **Block erase count**
3. **Corrected errors**

![Graph showing remaining spare blocks, block erase count, and corrected errors]
Health Monitoring

1. Remaining spare blocks
2. Block erase count
3. Corrected errors
Health Monitoring

1. Total LBAs read/written
2. Wear-level spread
3. Read disturb refresh
4. Read retry count

Enabling remote monitoring of field data health
Summary

- Use cases with random writes benefit from sub-page based FTL
- Web based Lifetime Estimation helps to reduce cost
- Health Monitoring to verify payload assumptions and schedule preventive maintenance and replacement
- Visit our booth to see a life demo of our tools
Questions?
Lifetime Estimation and Health Monitoring

Thank You!

Axel Mehnert, VP Marketing
Hyperstone Products

USB

SD/eMMC

CF/PATA

SATA