Efficiency and Fitness of Embedded Flash Storage

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Outline

- Introductions: Embedded Systems and Applications
- Embedded Flash Storage (EFS) in Versatile Applications
- Versatile Embedded Flash Storage
- Customization Design Procedure
- Examples
Embedded Systems & Applications

Application Environment

- Embedded System
  - Hardware
  - RTOS
  - Software
  - User Interface
  - Input Devices
  - Output Devices
  - Storage
  - Communication

- Temperature
- Moisture
- Dust
- Data Security
- Shock & Vibration
- Performance
- EMI & ESD
- Workload
- Power

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Versatile Embedded Applications

- **Computer networking & peripherals**: image processing, networking systems, printers, network devices, monitors and displays.

- **Digital consumer electronics**: set-top boxes, DVDs, high definition TVs, digital signage and digital cameras.
Versatile Embedded Applications

- **Industrial**: Equipment, Instrument, Factory Automation, etc.

- **Satellites and missiles**: defense, communication, and aerospace.
Versatile Embedded Applications

- **Automobiles**: motor control, cruise control, body safety, engine safety, car infotainment, Autonomous Driving, etc.

- **Telecoms**: telephone, mobile phone, walkie-talkie, etc.

- **Smart cards**: banking, security systems.
EFS in Industrial Applications

- Smart Meter
- Measurement
- Ticket machine
- Factory automation
- POS system
- Health Care
- Industrial PC/NB
- Security Camera
- Automotive
- Server
**Embedded Flash Storage:**

- For the "Things": Sensors, Actuators, IP Cams, I/O Controllers. *(Low density)*
- For the Gateway: Controller Hub, Network Gateway. *(Mid Density)*
- For the Server: the Cloud, Data Center. *(Large/ Super Density)*
- Data Logger for All: *(Low Density)*
Versatile Embedded Flash Storage

**Interface Types:**
- SD:
- USB:
- PATA:
- SATA:
- eMMC:
- UFS:
- DOM:
- PCIe/NVMe:
- CFast:

**SATA Form-factor:**
- 2.5” SSD:
- Half-slim:
- mSATA:
- M.2:
- U.2:
- DOM:
- CFast:

**Capacity:**
- 8GB
- 16GB
- ... 512GB
- 1TB
- ...

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Typical Customization Procedure

Project Start

Application Case Discussion Phase
Custom RFI Form:
Application Scenario & Platform:
System Goal & Target Performance:

Specification Discussion Phase
RFI => System Specification Form:
Application Scenario => Features:
Goal & Target => Performance Spec.:
Design Spec.: H/W, F/W, S/W, Test Plan, …
Project Schedule Plan:

Design & Verification Phase
Design & Verification Iterations:
Schedule Control:

Qualification & Preparing for MP Phase
Engineering Samples:
Engineering Verification Test:
Design Verification Test:
Pilot Production:

Mass Production
# EFS Design-In Check List

## Basic Functions:
- Interface:
- Form-factor:
- Memory Type:
- Capacity:
- Performance:
- Data Read/Write behavior:
- Power Consumption:

## Additional Functions:
- Workload & product lifecycle.
- Data Integrity: Data Retention, Power-fails, Data Robustness.
- Data Security.

## Environmental:
- Operation Temperature Range.
- Dusty, Humid, Chemical.
- Electro-Magnetic: EMI, EMC.
- Mechanical: Vibration, Shock.
Select the Best Fit EFS

- **Must be Satisfied**: Items by Check-list Table.

<table>
<thead>
<tr>
<th>Item Specification</th>
<th>CHK</th>
<th>Item Specification</th>
<th>CHK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form-factor, MO297</td>
<td>✓</td>
<td>S.M.A.R.T. items</td>
<td>✓</td>
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<tr>
<td>Interface, SATA 3</td>
<td>✓</td>
<td>Customized items</td>
<td>✓</td>
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<td>Temperature, -40~85</td>
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<td>✓</td>
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</tbody>
</table>

- **Selectable Items**: by optimizing the Performance Index.

Performance Index = \( f(Capacity, Data Rate, Power, ...) \)

- **Configurable**: Flexible, Extensible, Adaptive, ...
EX: Edge Storage with Security

- **Application Scenario:**
  - Edge Storage for Security Camera, 24/7 video recording.
  - With Remote Monitoring & Control function.
  - With Video & Image Data Privacy function.
  - High endurance & Sustainable Write for Full HD Video buffer.

- **Main Specifications:**
  - uSD Card Form-factor; SLC 2GB/4GB (PE cycle: 60K);
  - WAF < 1.5; TBW > 80; Non-stop write;
  - Support Privacy Data security.
WAF: Write Amplification Factor. The low WAF value means high endurance

\[
WAF = \frac{\text{Bytes written to NAND}}{\text{Bytes written from Host}}
\]

<table>
<thead>
<tr>
<th>Item</th>
<th>EmBestor</th>
<th>Others</th>
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</thead>
<tbody>
<tr>
<td>WAF1*</td>
<td>30</td>
<td>1000</td>
</tr>
<tr>
<td>WAF2*</td>
<td>1.1</td>
<td>1.6</td>
</tr>
</tbody>
</table>

*Testing condition:
- WAF1: JEDEC 218 & 219 standard
- WAF2: Surveillance video recording
Real-time Remote S.M.A.R.T.

- Host can get more of device’s SMART Information easily.
- Support Customized Windows AP, the normal reader could get the SMART Info.
- Support SDK for several Linux OS versions
Data Privacy: Proprietary Use

- The EmBestor EFS Devices provide Hidden Data mechanism. Customer Host device need follow the Hidden Data specifications.
- This mechanism can provide the data privacy and enhance the data security level.
Thank You !!

Enjoy Best Service !!