Industrial Embedded Flash Storage Applications

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EmBestor Technology Inc.
http://www.embestor.com
Outline

- Internet of Things and Industry 4.0
- The trend of Intelligent Machinery
- Illustration of uSD/SD card for Industrial Embedded Applications
- Customization Examples
- Industrial eMMC and eUSB for Industrial Embedded Applications.
**Internet of Things (IoT) and Industry 4.0**

**From Industry 1.0 to Industry 4.0**

**First Industrial Revolution**
- Based on the introduction of mechanical production equipment driven by water and steam power.
- First mechanical loom, 1784

**Second Industrial Revolution**
- Based on mass production achieved by division of labor concept and the use of electrical energy.
- First conveyor belt, Cincinnati slaughterhouse, 1870

**Third Industrial Revolution**
- Based on the use of electronics and IT to further automate production.
- First programmable logic controller (PLC), Modicon 084, 1969

**Fourth Industrial Revolution**
- Based on the use of cyber-physical systems.

Source: DFKI (2011)
Intelligent Machinery

Motion

Sensing

Thinking

The Brain of Intelligent Machine => the Computer Systems

Connect
EFS in Computer Systems

Interface Controller
- SD, UFD
- uSD, eSD
- eMMC, UFS
- SATA, PCIe

NAND Controller
- VLSI
- ECC
- DMA & Buffer
- Flash Sequencer
- Algorithms
- MCU & F/W

The Flash Storage System

Flash Memory Summit 2015
Santa Clara, CA
## What is “For Industrial”?

<table>
<thead>
<tr>
<th></th>
<th>Industrial</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>Enterprise/Group</td>
<td>Personal</td>
</tr>
<tr>
<td>Customize</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Life Cycle</td>
<td>&gt; 5~20 years</td>
<td>[1~5] years</td>
</tr>
<tr>
<td>Quality</td>
<td>High</td>
<td>Just Enough</td>
</tr>
<tr>
<td>Design-In</td>
<td>Long-term</td>
<td>Timing, Cost</td>
</tr>
<tr>
<td>Environment</td>
<td>Versatile, Severe</td>
<td>With People</td>
</tr>
</tbody>
</table>

... ... ... ...
Industrial SD/uSD Features

Features:

• Industrial Grade microSD / SD Card
• Density: 1GB ~ 32GB (SLC)
  8GB ~ 64GB (MLC)
• Support SD3.0 UHS-1 (SDR-104) Class10
• High IOPS performance as eMMC
• High Endurance (WAF = 1.5)
• Fixed BOM 3 years
• -40°C ~ + 85°C wide temp. support
• Complete SMART function
• Read Disturbance management
• Adaptive Wear Leveling
• Management of sudden power-fails
High Performance SD SLC

- SLC Flash Random Read/Write performance
  (Read IOPS >1500, Write IOPS >1000)
MLC Flash Random Read/Write performance
(Read IOPS >1500, Write IOPS >400)
High Endurance SD Card

- High Endurance: TBW (Tera-Bytes Written) and WAF (Write Amplification Factor) value

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

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

<table>
<thead>
<tr>
<th>Item</th>
<th>EmBestor</th>
<th>Others</th>
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<tbody>
<tr>
<td>WAF</td>
<td>1.5</td>
<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>Capacity</th>
<th>16GB</th>
<th>32GB</th>
<th>64GB</th>
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<tbody>
<tr>
<td>TBW</td>
<td>32TB</td>
<td>64TB</td>
<td>128TB</td>
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S.M.A.R.T. for SD card

- Support Customized Windows AP, the normal reader could get the SMART Info.
- Support different Linux OS version SDK

<table>
<thead>
<tr>
<th>Item</th>
<th>EmBestor</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Monitor</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Total Erase Count</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Average Erase Count</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>MP Version</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Flash Type</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Abnormal Shutdown Count</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Power Cycle Count</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Spare Block Count</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>ECC Uncorrectable Count</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Initial Bad Block Count</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Later Bad Block Count</td>
<td>O</td>
<td>X</td>
</tr>
</tbody>
</table>
Real-time Remote S.M.A.R.T.

- Host can get easily more of device’s SD SMART Info.
- Support Customized Windows AP, the normal reader could get the SMART Info.
- Support different Linux OS version SDK
The EmBestor i-TF & i-SD card provide Hidden Card mechanism. Customer Host device need follow the Hidden Card spec. rule.

This mechanism can enhance the data security level.
Customization: e-Commerce

- Support data encryption function, according to communicate with AES chip
- EmBestor support security customization based on customer requirement.
Industrial eEMMC Device

- Complete Solution, Full Integration.
- World-Class Solutions with System Expertise

- Industrial Temperature Range: -40°C to 85°C
- High Endurance

- Extended Life Cycles with BOM Control
- Product Change Notification (PCN)

- FAE and Customer Quality Support
- Qualification and Failure Analysis Reports
Industrial eMMC Device

Features:
• Compliant with v4.51 + HS200
• High Endurance
• High Random IOPS
• Design for Industrial application
• Management of sudden power-fails
• High Reliability

Operating System:
• Windows family
• Linux family
• DOS or embedded system

Flash support:
• MLC: 4GB ~ 64GB

Temperature:
• Industrial Grade: -40°C ~ 85 °C
• Extended Grade: -25°C ~ 85 °C

Performance:
• Max. Sequential Read: 120 MB/s
• Max. Sequential Write: 35 MB/s
• Max. Random 4KB Read IOPS: 4500
• Max. Random 4KB Write IOPS: 1200
Features:
- Compliant with USB 2.0 Mass Storage
- Operating as Boot Disk
- Adaptive Wear Leveling
- Management of sudden power-fails
- Complete S.M.A.R.T. function
- High Random 4KB IOPS
- Fixed BOM: SLC(5), MLC(3) years

Operating System:
- Windows family
- Linux family
- DOS or embedded system

Flash support:
- SLC: 256MB ~ 32GB
- MLC: 8GB ~ 64GB

Temperature:
- Industrial Grade: -40 °C ~ 85 °C
- Standard Grade: 0 °C ~ 70 °C

Performance:
- Max. Sequential Read: 33 MB/s
- Max. Sequential Write: 20 MB/s
- Max. Random 4KB Read IOPS: 1500
- Max. Random 4KB Write IOPS: 800
Thank You!
# EmBestor Overview

<table>
<thead>
<tr>
<th>Company</th>
<th><strong>EmBestor</strong> =&gt; <strong>Embedded Storage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish</td>
<td>July 4, 2013</td>
</tr>
<tr>
<td>President</td>
<td>Chanson Lin</td>
</tr>
<tr>
<td>Capital</td>
<td>USD $4.8 million</td>
</tr>
<tr>
<td>Employee</td>
<td>45 staffs</td>
</tr>
<tr>
<td>Business</td>
<td>Embedded Flash Storage: SIP &amp; Modules;</td>
</tr>
<tr>
<td></td>
<td>Removable Commodity: SD, UFD Controllers.</td>
</tr>
<tr>
<td>Philosophy</td>
<td>Empower <strong>Teamwork</strong>;</td>
</tr>
<tr>
<td></td>
<td>Enable <strong>Passion</strong>;</td>
</tr>
<tr>
<td></td>
<td>Create <strong>Value</strong>.</td>
</tr>
<tr>
<td>Operation</td>
<td>Hsinchu – Headquarters, R&amp;D, back-end &amp;</td>
</tr>
<tr>
<td></td>
<td>manufacturing support</td>
</tr>
<tr>
<td></td>
<td>Shenzhen – Field application support</td>
</tr>
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</table>
2002: Founded

2004: Launched UFD Controllers

2007: Renamed as Afatech

2007: Launched Card Reader Controllers

2008: Launched SD Card Controllers

2009: Integrated to ITE Tech. Inc.

2013: EmBestor Founded. (Spun-off from ITE Tech. Inc.)

2014: Launched EFS Modules
EmBestor Product Overview

Removable Commodity (Controllers)
- USB Flash Disk: USB2.0 & USB3.0
- Memory Cards: SD2.0 & SD3.0
- eMMC Application: eMMC to UFD

Industrial Applications (Industrial Modules)
- Industrial SD Cards: i-TF & i-SD
- CF/C-Fast Cards: CF, CFast, i-CF
- SATA/PATA Modules: mSATA, SATA/PATA DOM
- Industrial UFD Modules: USB DOM & i-UFD

NAND Flash
EmBestor Merits

Technical
- More than 10 Years Flash controller design experience
- Support Customized and Platform Design
- In-house Testing Capability

Manufacturing
- EOL/Revision Management
- Fixed BOM
- Lead time advantage

Product
- Complete solution provider
- Focus on Industrial markets