One-Chip Flash Storage Solution for Industrial Applications

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Outline

- Background: Industrial Applications
- Overview of One-Chip Flash Storage
- Industrial Embedded Systems & Applications
- One-Chip Flash Storage for Industrial Applications
- Application Examples
- Conclusions
Market Segments for Flash Storage

Density

Low

High

Quality

3D QLC

3D TLC

MLC

sMLC

SLC

Consumer

Performance Consumer

Professional Consumer

Soft Industrial

Industrial
## Industrial vs. Consumer

<table>
<thead>
<tr>
<th></th>
<th>Industrial</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Users</strong></td>
<td>Enterprise/Group</td>
<td>Personal</td>
</tr>
<tr>
<td><strong>Customize</strong></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Life Cycle</strong></td>
<td>&gt; 5~20 years</td>
<td>[1~5] years</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>High</td>
<td>Satisfactory</td>
</tr>
<tr>
<td><strong>Longevity Supply</strong></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Design-In</strong></td>
<td>Long-term</td>
<td>Timing, Cost</td>
</tr>
<tr>
<td><strong>Applications</strong></td>
<td>Specific</td>
<td>Common</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Versatile, Severe</td>
<td>General</td>
</tr>
</tbody>
</table>
Versatile Industrial Applications

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

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

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

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

**Flash Memory Summit 2018**
Santa Clara, CA

<table>
<thead>
<tr>
<th>NAND Flash</th>
<th>SLC</th>
<th>sMLC</th>
<th>MLC</th>
<th>TLC</th>
<th>3D</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT (-40~85°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET (-25~85°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT (0~70°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Concept of One-Chip Flash Storage

**Interface Controller**
- SD, UFD
- uSD, eMMC, UFS
- SATA, PCIe/NVMe

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

The Flash Storage System

- **Aux. Memory**
- **Flash Controller**
- **Flash Memory Array**
- **Passive Components**
- **Peripheral Components / ICs**
### One-Chip Storage vs. Module

<table>
<thead>
<tr>
<th></th>
<th>One-Chip Storage</th>
<th>Module Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size &amp; Shape</strong></td>
<td>Small, One Package.</td>
<td>Middle to Large, PCBA.</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>Small</td>
<td>Small to Large</td>
</tr>
<tr>
<td><strong>Water/Dust Proof</strong></td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Anti-Vibration</strong></td>
<td>Strong</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Heat Dissipation</strong></td>
<td>Difficult</td>
<td>Simple</td>
</tr>
<tr>
<td><strong>Repair &amp; Maintenance</strong></td>
<td>Need Special Care</td>
<td>By replacement</td>
</tr>
<tr>
<td><strong>Role in whole system</strong></td>
<td>Components</td>
<td>Sub-systems</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>IC Packaging (SIP)</td>
<td>SMT</td>
</tr>
</tbody>
</table>
Developing Technology Trend

- **Innovative Technology to:**
  - Refine and improve the performance.
  - Integrate the functions.
  - Reduce the physical size.
  - Simplify and shrink the components.
  - Form the solid and compact package.

- **Standardized Manufacturing to:**
  - Increase operation efficiency.
  - Provide high quality and reliability.
  - Reduce the cost.
  - Shorten delivery cycle.
## Industrial One-Chip vs. Standard

<table>
<thead>
<tr>
<th></th>
<th>Industrial One-Chip</th>
<th>Standard One-Chip</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications</strong></td>
<td>Industrial, Niche, Specific.</td>
<td>Commodity, High Volume.</td>
</tr>
<tr>
<td><strong>Flash Memory</strong></td>
<td>High Quality, Versatile. EX: SLC, sMLC, MLC,...</td>
<td>Standard, Main stream. EX: MLC, 3D NAND, ....</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>Quality, Reliability.</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Design Flexibility</strong></td>
<td>SDK for Developers</td>
<td>Standard and no option</td>
</tr>
<tr>
<td><strong>Wide Temperature</strong></td>
<td>Support</td>
<td>No</td>
</tr>
<tr>
<td><strong>Security Features</strong></td>
<td>Support</td>
<td>No</td>
</tr>
<tr>
<td><strong>Longevity</strong></td>
<td>Support</td>
<td>No</td>
</tr>
<tr>
<td><strong>Customization</strong></td>
<td>Support</td>
<td>No</td>
</tr>
</tbody>
</table>
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
Power
Workload
EMI & ESD
Industrial Embedded Applications

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

- **Aerospace**: Aircraft, Defense, Communication, etc.
Industrial Embedded Applications

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

- **Server and Networking**: IIoT, Edge computing, etc.

- **Security**: Surveillance, Healthcare, Medical, Banking.
**EFS in Industrial IoT Applications**

**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)*
Industrial One-Chip Flash Storage

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

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

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

- FAE and Customer Quality Support
- Qualification and Failure Analysis Reports
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
**EX: Camera/Sensor Module in IIoT**

- **Smart Security Camera Module:**
  - Smart Security Camera with 365 24/7 video recording.
  - With Remote Monitoring & Control function.
  - With Video & Image Data Privacy function.
  - With Edge Storage and Data Analysis.

- **Smart Integrated Sensor Module:**
  - Smart Integrated Sensor for the environment sensing signals/data.
  - With Remote Monitoring & Control function.
  - With Privacy Data security.
Smart Security Camera Module

SoC Main Chip

DRAM Memory

Industrial embedded SD for OS Data

eSD

WiFi or Ethernet for the Communications

WiFi Ethernet

Industrial uSD or SD card for Edge Storage

Peripherals & Control

Drum for System Memory

Digital Video Signal Input

Camera
Smart Integrated Sensor Module

- **Main Chip**
  - Multiple Sensing Data/Signal Input
  - SRAM or DRAM for Auxiliary Memory

- **Aux. Memory**
  - eSD

- **Communication Unit**
  - Industrial embedded SD for System and Environment sensing Data
  - Communication unit to connect to the systems or other extensions

Flash Memory Summit 2018
Santa Clara, CA
Conclusions

- One-Chip Flash Storage provides the small-size, neat, simple, compact, reliable solution for embedded systems.
- One-Chip Flash Storage will become more popular according to the developing trend of technology improving and innovations.
- Modularized hardware with relative standardized features is suitable for One-Chip Flash Storage.
- For industrial applications, One-chip Flash Storage needs to meet each application requirements in the versatile industrial embedded systems.
Thank You!!

Enjoy Best Service!!