High-Temperature Discrete and Managed NAND Solutions

Chris Bueb
Embedded Memory System Architect
Micron Technology, Inc.

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Agenda

- Embedded Temperature Ranges
- Why Temperatures Above 85°C?
- Comparison of NAND-Based Solutions
- NVM Trends
- High-Temperature Data Integrity Challenges
- Summary
Embedded Temperature Ranges

- **Commercial**: 0°C to 70°C
  - Cost-optimized

- **Industrial (IT)**: –40°C to 85°C
  - Uncontrolled temperature environments

- **Beyond industrial**: –40°C up to 105°C
  - Demonstrated to exceed 85°C

Focus is on “beyond industrial”
Fanless and quiet
Small and cute
Thermal suffocation
Increased electronics in automotive with higher temperatures
  • Automakers are jointly defining temperature ranges that exceed 85°C
# Comparison of NAND-Based Solutions

<table>
<thead>
<tr>
<th></th>
<th>Discrete NAND</th>
<th>e.MMC</th>
<th>SSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density range</td>
<td>16MB to 64GB</td>
<td>2GB to 128GB</td>
<td>2GB to 512GB</td>
</tr>
<tr>
<td>Temperature range</td>
<td>–40°C to 105°C</td>
<td>–40°C to 105°C</td>
<td>–40°C to 85°C</td>
</tr>
<tr>
<td>Media management effort</td>
<td>Low to High</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
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- All solutions are essential across the entire range of high-temperature embedded applications
- Choice depends heavily on density and willingness to manage NAND media

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Santa Clara, CA
NVM Trends

- Improved NAND performance
- Improved discrete NAND usability
- Low-density NAND still needed
- More aggressive product qualifications
High-Temperature Data Integrity Challenges

- High temperatures make data retention worse

- Higher temp $\Rightarrow$ wider X-temp $\Rightarrow$ rel challenges
  - SLC to improve P/E cycling and data retention
  - Relaxation of cold temperature extreme

- Data refresh is an important consideration
  - Longer product life (in excess of 15 years)
  - Sustained high temperatures
Summary

- Maximum embedded temperatures are rising
- Embedded product life is increasing
  - Discrete and managed NAND are fulfilling these requirements
- High-temperature data integrity issues must be solved at all levels of integration