LumenX™ Programming System

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Data I/O Corporation
Agenda

- Introduction to Data I/O
- Flash Technology Trends and Programming Requirements
- LumenX™ Programming Platform Introduction
“Data I/O helps enable the digital world by designing, manufacturing, and selling programming systems to global electronic device manufacturers.”
Data I/O’s programming systems are used by the world’s leading manufacturers, programming centers, and contract manufacturers, to program integrated circuits and bring their devices to life.
Global Customers in Growth Markets

- Data I/O delivers cutting edge products and technology to hundreds of customers around the globe
- Global footprint with headquarters in Redmond, Washington and offices located in Shanghai, China and Munich, Germany
- The only true global programming solutions provider offering local service and engineering support 24/7
- Eight of the top nine automotive electronics companies are customers

<table>
<thead>
<tr>
<th>2014 Sales by End Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive 30%</td>
</tr>
<tr>
<td>Wireless 19%</td>
</tr>
<tr>
<td>Consumer 13%</td>
</tr>
<tr>
<td>Industrial/IoT 21%</td>
</tr>
<tr>
<td>Programing Centers 17%</td>
</tr>
</tbody>
</table>

Sample Customers

<table>
<thead>
<tr>
<th>Automotive</th>
<th>Consumer &amp; Wireless</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENSO</td>
<td>Microsoft</td>
<td>Honeywell</td>
</tr>
<tr>
<td>Panasonic</td>
<td>amazon.com</td>
<td>Schneider</td>
</tr>
<tr>
<td>Continental</td>
<td>LG</td>
<td>Watlow</td>
</tr>
<tr>
<td>BOSCH</td>
<td>Google</td>
<td>Schindler</td>
</tr>
<tr>
<td>Continental</td>
<td>Huawei</td>
<td></td>
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<tr>
<td>Visteon</td>
<td></td>
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<tr>
<td>KOSTAL</td>
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<tr>
<td>PLEXUS</td>
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<tr>
<td>FOXCONN</td>
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<td>JABIL</td>
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<tr>
<td>WISTRON</td>
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<tr>
<td>FLEXTRONICS</td>
<td>SYLVAN</td>
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</tr>
<tr>
<td>AVNET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVNET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>msc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bTV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Programming Centers and EMS
Trends in Managed Flash

• For 2010 - 2014
  – Programming technology has not kept up with device interface and device R/W speeds

  ▪ For 2009 - 2014
    • eMMC devices commonly ship with memory densities of 16GB, 32GB, 64GB and even 128 GB
    • Product image sizes typically range from 2 GB to 32 GB and higher
    • Programming data size continues to increase at a rapid rate
    • Current programming technology limited to <~32 GB of programming data

<table>
<thead>
<tr>
<th>eMMC Standard, Yr. ratified</th>
<th>Device Interface</th>
<th>Seq. Read Speed</th>
<th>Seq. Write Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.41, 2010</td>
<td>52 MHz DDR</td>
<td>~75 MB/s</td>
<td>~30MB/s</td>
</tr>
<tr>
<td>4.5, 2012</td>
<td>200 MHz SDR</td>
<td>~165 MB/s</td>
<td>~60MB/s</td>
</tr>
<tr>
<td>5.0, 2013</td>
<td>200 MHz DDR</td>
<td>~275 MB/s</td>
<td>~85MB/s</td>
</tr>
<tr>
<td>5.1, 2014</td>
<td>200 MHz DDR</td>
<td>~315 MB/s</td>
<td>~130MB/s</td>
</tr>
<tr>
<td>Programming Technology</td>
<td>25 MHz SDR</td>
<td>~10- 20 MB/s</td>
<td>~10- 20MB/s</td>
</tr>
</tbody>
</table>

Source: Micron Marketing
Global Manufacturing and Programming

- Manufacturing is Global
- Programming data is often created on one continent and programmed in another
- Frequently OEM’s create programming images but CM’s or Programming Centers program the data into parts
- Security and Traceability of (Programming)data is very important to OEM’s
Programming Requirements Summary

- **Technology**
  - Increase Programming Performance;
  - Increase Scalability;
    - Technology should scale to 128GB of Programming Data
    - Improve programmer throughput
    - Improve programming system throughput
  - Improve Programming data Security and Traceability;
  - Maintain Reliability (>99.5% programming yields);
  - Faster Custom device support;
  - Leverage Automation;

- **Business Result**
  - Reduce Total Cost Of Programming (TCOP) of each device;
A revolutionary programming platform delivering **Managed and Secure programming** with **unrivaled Performance** at an **extraordinary Value**.

**The LumenX programmer** is optimized for leading high density eMMC devices **maximizing production throughput** for the lowest **Total Cost Of Programming**.
LumenX™ Programming System
Key Functionality and Metrics

- **Performance:**
  - Data Download Performance
    - 25MB/sec Gigabit Ethernet Data Download to Programmer (4X current technology)
  - Data Programming Performance
    - 52 MHz DDR interface (4X current technology), 80 – 100 MB/sec Program and Verify Speeds (4X current technology)

- **Programmer Capacity and Scalability:**
  - 64GB local cache on Programmer. Field upgradeable to 128GB
  - 8 Programming sites per programmer (2X current technology), one socket per adapter
  - 1-14 LumenX programmers per system

- **Managed and Secure Programming:**
  - Job Creation SW is distinct from Job Running SW to eliminate operator error
  - Eliminates security risks of master devices in duplicators
  - Programming metrics reporting (parts consumed, programmed, pass, fail etc.)
  - Remote Monitoring API

- **Reliability:**
  - Partnering with flash memory vendors to enable devices per spec. Programming Yields > 99.5%
  - Partner prior to market launch

- **Faster Device Support:**

- **Total Cost of Programming cut by 2/3:**
LumenX™ Programmer **minimizes** setup times for (large files) for **maximum productivity**

- **LumenX™ Large File Download**
  - Faster setup time
  - Optimized machine utilization
  - Data I/O TCOP advantage

- **LumenX™ Download Speeds**
  - 25MB/bytes per second
  - Fast set-up time for large files
  - Data I/O TCOP advantage
<table>
<thead>
<tr>
<th>Vendor</th>
<th>eMMC Std. Ver.</th>
<th>Capacity</th>
<th>Interface</th>
<th>Seq. Write</th>
<th>Seq. Read</th>
<th>Program</th>
<th>Verify</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>5.1</td>
<td>32 GB</td>
<td>52 MHz DDR</td>
<td>85 MB/s</td>
<td>90 MB/s</td>
<td>75 MB/s</td>
<td>80 MB/s</td>
</tr>
<tr>
<td># 2</td>
<td>5.0</td>
<td>32GB</td>
<td>52 MHz DDR</td>
<td>70 MB/s</td>
<td>300 MB/s</td>
<td>75 MB/s</td>
<td>85 MB/s</td>
</tr>
<tr>
<td># 3</td>
<td>4.51</td>
<td>64GB</td>
<td>52 MHz DDR</td>
<td>50 MB/s</td>
<td>125 MB/s</td>
<td>51 MB/s</td>
<td>82 MB/s</td>
</tr>
<tr>
<td># 4</td>
<td>4.50</td>
<td>16GB</td>
<td>52 MHz DDR</td>
<td>29-36 MB/s</td>
<td>71 MB/s</td>
<td>41 MB/s</td>
<td>82 MB/s</td>
</tr>
<tr>
<td># 5</td>
<td>5.0</td>
<td>32GB</td>
<td>52 MHz DDR</td>
<td>70 MB/s</td>
<td>280 MB/s</td>
<td>67 MB/s</td>
<td>81 MB/s</td>
</tr>
</tbody>
</table>

- LumenX™ Programmers deliver data close to Interface speed
- Maximum Program/Verify speeds are gated by Sequential Read/Write speeds
LumenX™ Advantage – Program/Verify Speed

LumenX™ programs at the speed of today’s fastest eMMC devices

- Program / Verify up to 100 Mbytes/sec.
  - limited only by device speeds
- DDR 50Mhz Interface (today)
- As eMMC device speeds increase
  - LumenX will keep up while our competitors are speed limited

Duplicator 1: 8 devices in (49 minutes)
Programmer 1: 4 devices in (42 minutes)
Duplicator 2: 8 devices in (33 minutes)
Programmer 2: 4 devices in (26 minutes)
LumenX™: 8 devices in (19 minutes)
PSV7000 w/LumenX™ Socket Capacity

- LumenX™ programmer supports up to 112 sockets in a PSV7000 system

- PSV7000 with LumenX™ technology
  - has more than 3x programming capacity than the competition
  - Total Cost Advantage
Flash memory vendors endorse the LumenX™ Programmer

- **Toshiba**
  - “Toshiba Semiconductor & Storage Products Company and Data I/O Corporation, have a long standing history of collaboration and teamwork to ensure the highest quality programming for our mutual customers. Data I/O’s new LumenX™ programming system delivers the highest programming speed performance (at-the-speed-of-the-device) with programming algorithms developed according to our specification for Toshiba’s latest eMMC™ 4.5, 5.0 and 5.1 devices.”

- **Cypress**
  - “Cypress Semiconductor Corporation has onsite device support engineers trained and ready to support Data I/O’s new LumenX™ programming platform” said Adam Fogle, Sr. Manager of Failure Analysis with Cypress Semiconductor Corporation. “The LumenX™ programmer delivers superior programming performance for our latest eMMC devices with algorithms written to our product specifications. Our mutual customers have expressed their appreciation for the superior support that Cypress Semiconductor Corporation and Data I/O deliver as a team”

- **Micron**
  - “Micron Technology, a world leader in the semiconductor industry is pleased to support Data I/O’s new LumenX™ programming platform” said Bob Baltar, Applications Engineering Director with Micron Technology, Inc. “The LumenX™ programmer delivers superior programming performance for our latest eMMC 4.5, 4.51 and 5.0 devices. Micron Technology and Data I/O have a long standing history of working together to ensure that programming algorithms for all Micron products are developed and tested according to the specifications.”
LumenX™ Programmer Summary

- **Performance and Scalability**
  - Streamlined Algorithm Development for faster device support delivery
  - Support for eMMC and SD first, followed by other device types

- **Data Management and Security**
  - Data Management Software - Job Creator, Job Runner
  - Security
  - Reliability
  - Traceability

- **Time to Market**

- **Cost**
  - Lower $ / socket
  - Individually replaceable sockets
  - Lowers Total Cost of Programming by 2/3

- **Key Features**
  - Lowest $ / socket
  - Individually replaceable sockets
  - Lowers Total Cost of Programming by 2/3
  - Streamlined Algorithm Development for faster device support delivery
  - Support for eMMC and SD first, followed by other device types
  - Highest performance Program/Verify speeds ~ 100MB/s
  - Faster changeover with high download speeds (25MB/sec)
  - Data size < 128GB
  - Up to 14 programmers/system
  - Up to 8 sockets/programmer

- **Data Management Software**
  - Job Creator, Job Runner

- **Performance and Scalability**
  - Streamlined Algorithm Development for faster device support delivery
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