SDA Overview and SD Standard
Ver.8.00 SD Express / Ver.9.00 for semi embedded

Kazunori Nakano,
Board of Directors & Marketing Committee Chair
@ Computex & Global Workshop Taipei 2023, Taiwan
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Introduction

- Kazunori (Kaz) Nakano
  - Senior Expert, Memory Application & Marketing Engineering Dept. KIOXIA Corporation
  - Board of Directors & Marketing Committee Chair SD Association

Starting his global electronic components marketing jobs from 1986 at Toshiba Corporation after graduation of Sophia University in Tokyo, he has been engaging in flash memory business @KIOXIA (former Toshiba Memory) from 2002 focused on SD Memory Card market & application development. Kaz has been dedicating his life with SD Card Association as Marketing Committee Chair from 2009 and Board of Directors from 2015. His global activity is endless, challenging and borderless to try to create new SD Card specifications and market for better IT interactions on a removable memory devices.

Forward-Looking Statements
During our session today we may provide forward-looking statements. Any statement that refers to expectations, projections or other characterizations of future events or circumstances is a forward-looking statement, including those relating to industry trends, standardization plans and any SD Association’s related plans. Actual results may differ materially from those expressed in these forward-looking statements due to various factors. We undertake no obligation to realize these forward-looking statements, which speak only as of the date hereof.
SD Association Overview
SD Association Organization

SD Association: SDA (www.sdcard.org)
Mission: SD Card Standardization with Promotion and Adoption of SD Standard Worldwide

- Board of Directors
- President
- Financial Committee
- Legal & License Committee
- Technical Committee
  - Physical Specification
  - File System
  - Security
  - Application
  - SDIO
  - Host Controller
  - Test Guideline
- Compliance Committee
  - Test Tools
  - Interoperability
  - Market Inspection
  - Compliance News
  - Designated Labs
- Marketing Committee
  - SD/SDA Logo Guideline
  - SDA Public Web Site
  - SDA Brochure
  - Press Release
  - Promotional Exhibition
  - Promotional Seminar
  - Global Workshop
- Designated Labs
  - Allion Test Labs. (SDHC/SDXC/UHS-I/UHS-II/SD Express)
  - Panasonic (SDHC/SDXC/UHS-I)
  - Granite River Labs, (UHS-II/SD Express)

- Organization Established in 2000
- Member Company: About 785 Companies Worldwide as of May 2023.
- Member Fee: Executive Member $4,500/year   General Member $2,500/year
## License Scheme & Compliance

<table>
<thead>
<tr>
<th>Specification</th>
<th>SD Association</th>
<th>SD-3C LLC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SDA Specification</td>
<td>SD Group Specification</td>
</tr>
<tr>
<td></td>
<td>SDA Pictographs</td>
<td>SD Logos</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Patents</td>
</tr>
<tr>
<td>License</td>
<td>Contract with SDA</td>
<td>Contract with SD-3C LLC</td>
</tr>
</tbody>
</table>

**Card**

- **SDA Membership Agreement (SDAMA)**
- **Card License Agreement (CLA)**

**Host**

- **SDA License Agreement (SDALA)**
- **Host Ancillary Product License Agreement (HALA)**

Licensee should comply with SD/SDA Specifications and SD/SDA Logo Guideline (As Normative Document)
SDA Officers

President: Hiroyuki Sakamoto  
Hiroyuki.sakamoto@t-net.ne.jp

Chairman: Yosi Pinto  
Yosi.pinto@sandisk.com

Treasurer: Bo Li  
Bo.Li@sandisk.com

Executive Director*: Stan Moyer  
sdcard_ed@inventures.com

Secretary: Thom Denholm  
Thom Denholm thom@tuxera.com

* Stan is not an official SDA officer per the bylaws definition. Though he is considered as a team member in the Officers Team as being the Executive Director of the association. A service provided by our SDA Office contractor – Global Inventures
SDA Board of Directors – 11 Companies

(in alphabetical order)

- ATD
  - Danny Lin
  - Jeff Hsieh

- Kingston Technology
  - David Chen
  - Joel Tang

- KIOXIA
  - Kazunori Nakano
  - Open

- Lexar
  - Joseph Yuan
  - Jordan Zhong

- Micron
  - Jyh Chau
  - Open

- Panasonic
  - Shuichi Ohki
  - Takui Maeda

- Phison Electronics Corp.
  - T.H. Kuan
  - Andre Chen

- Samsung
  - HeeChang Cho
  - JiCheol Hong

- SanDisk
  - Yosi Pinto
  - Jeff Tsujimoto

- Silicon Motion
  - Janice Chiu
  - Open

- TUXERA
  - Joel Catala
  - Thom Denholm

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SD Standard Specification
and
Ver.8.00 SD Express
Ver.9.00 Boot / TCG / RPMB Options
**SD Card Specifications Evolution**

- **Bus Interface**
- **Form Factor / File System / Boot & Security Option**

>6 Billion SD & microSD cards sold by 2022*

SD is the de-facto worldwide removable memory card standard

### 1. SD Logo: Capacity (4 Types)

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>≤ 2GB Standard Capacity</td>
</tr>
<tr>
<td>2006</td>
<td>2GB &lt; - ≤ 32GB High Capacity</td>
</tr>
<tr>
<td>2009</td>
<td>32GB &lt; - ≤ 2TB eXtended Capacity</td>
</tr>
<tr>
<td>2018</td>
<td>2TB &lt; - ≤ 128TB Ultra Capacity</td>
</tr>
</tbody>
</table>

### 2. Bus Mark: Data Transfer Performance

- **No Mark**
- **UHS-I**
- **UHS-II**
- **UHS-III**
- **SD Express**

### 3. Speed Class Mark: Video Recording

- **Speed Class**
- **UHS Speed Class**
- **Video Speed Class**
SD Card Types

- **Form Factors**
  - Standard SD Card
  - microSD Card

- **Functions**
  - SD Memory Card
  - SDIO Card
  - SD Combo Card (SD Memory + SDIO Functions)
    - iSDIO Wireless LAN SD Card
    - iSDIO TransferJet SD Card
  - smart microSD
    - microSD with Secure Element or with/without NFC interface

- **Memory Capacities**
  - SDSC: Standard Capacity (≤ 2GB) / SDHC: High Capacity (2GB < - ≤ 32GB)
  - SDXC: eXtended Capacity (32GB < - ≤ 2TB)
  - **SDUC: Ultra Capacity (2TB < - ≤ 128TB)**

- **Bus Interfaces**
  - Non UHS (Non Ultra High Speed) Card
    - Default Speed : 12.5 MB/sec
    - High Speed : 25 MB/sec
  - UHS-I Card
    - UHS 50: SDR50 is mandatory (50MB/sec Max.)
    - UHS104: SDR50 and SDR104 is mandatory (104MB/sec Max.)
  - UHS-II Card
    - UHS156: FD156 is mandatory (Full Duplex 156MB/sec Max.)
    - HD312 is optional (Half Duplex 312MB/sec Max.)
  - UHS-III Card
    - UHS312: FD312 is mandatory (Full Duplex 312MB/sec Max.)
    - UHS624: FD624 is mandatory (Full Duplex 624MB/sec Max.)
  - **SD Express Card (New from SD Ver.7.00/8.00)**
    - PCIe Gen.3 x 1 Lane : (985MB/sec Max.) & NVMe protocol with legacy UHS-I interface (SD Ver.7.00)
    - PCIe Gen.3 x 2 Lane / Gen.4 x 1 Lane : (1,970MB/sec Max.) & NVMe protocol with legacy UHS-I interface (SD Ver.8.00)
    - PCIe Gen.4 x 2 Lane : (3,940MB/sec Max.) & NVMe protocol with legacy UHS-I interface (SD Ver. 8.00)
## Bus Mode & Speed

<table>
<thead>
<tr>
<th>Bus Mode</th>
<th>Clock Frequency</th>
<th>Interface Method</th>
<th>Bus Maximum Performance</th>
<th>Spec. Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default Speed (DS)</td>
<td>25MHz</td>
<td>3.3V single-ended</td>
<td>12.5MB/sec</td>
<td>1.01</td>
</tr>
<tr>
<td>High Speed (HS)</td>
<td>50MHz</td>
<td>3.3V single-ended</td>
<td>25 MB/sec</td>
<td>1.10</td>
</tr>
<tr>
<td><strong>UHS-I</strong></td>
<td></td>
<td></td>
<td></td>
<td>3.01</td>
</tr>
<tr>
<td>SDR12</td>
<td>25MHz</td>
<td>1.8V single-ended</td>
<td>12.5MB/sec</td>
<td></td>
</tr>
<tr>
<td>SDR25</td>
<td>50MHz</td>
<td>1.8V single-ended</td>
<td>25 MB/sec</td>
<td></td>
</tr>
<tr>
<td>SDR50</td>
<td>100MHz</td>
<td>1.8V single-ended</td>
<td>50 MB/sec</td>
<td></td>
</tr>
<tr>
<td>SDR104</td>
<td>208MHz</td>
<td>1.8V single-ended</td>
<td>104 MB/sec</td>
<td></td>
</tr>
<tr>
<td>DDR50</td>
<td>50MHz</td>
<td>1.8V single-ended</td>
<td>50 MB/sec</td>
<td></td>
</tr>
<tr>
<td><strong>UHS-II</strong></td>
<td></td>
<td></td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td><strong>UHS-III</strong></td>
<td></td>
<td></td>
<td></td>
<td>6.00</td>
</tr>
<tr>
<td><strong>PCIe</strong></td>
<td></td>
<td></td>
<td></td>
<td>7.00</td>
</tr>
<tr>
<td>Gen.3</td>
<td>100MHz x 40 (PLL)*</td>
<td>PCIe Gen3 PHY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen.4</td>
<td>100MHz x 80 (PLL)*</td>
<td>PCIe Gen4 PHY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Bus Mode and Backward Compatibility

<table>
<thead>
<tr>
<th>Pin Layout</th>
<th>SD Memory Card</th>
<th>SD Express Memory Card</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PCIe Bus Interface</strong></td>
<td>25 MB/sec</td>
<td>25 MB/sec</td>
</tr>
<tr>
<td></td>
<td>104 MB/sec</td>
<td>104 MB/sec</td>
</tr>
<tr>
<td></td>
<td>312 MB/sec</td>
<td>312 MB/sec</td>
</tr>
<tr>
<td></td>
<td>628 MB/sec</td>
<td>628 MB/sec</td>
</tr>
<tr>
<td></td>
<td>PCIe Gen.4x2</td>
<td>PCIe Gen.4x1 / Gen.3x2</td>
</tr>
<tr>
<td></td>
<td>PCIe Gen.3x1</td>
<td>PCIe Gen.3x1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SD Bus Interface</th>
<th>UHS-I</th>
<th>UHS-I</th>
<th>UHS-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (file system)</td>
<td>UHS</td>
<td>UHS</td>
<td>UHS</td>
</tr>
<tr>
<td>Ultra Capacity</td>
<td>Up to 128TB</td>
<td>Up to 128TB</td>
<td>Up to 128TB</td>
</tr>
<tr>
<td>Extended Capacity</td>
<td>Up to 2TB</td>
<td>Up to 2TB</td>
<td>Up to 2TB</td>
</tr>
<tr>
<td>High Capacity</td>
<td>Up to 32GB</td>
<td>Up to 32GB</td>
<td>Up to 32GB</td>
</tr>
</tbody>
</table>
NVMe™/PCIe is gaining popularity as the de-facto highly capable memory interface standard for the next generation computing, mobile computing, gaming and more.

The flash memory technology continues to evolve allowing higher performance access and higher capacities in small devices.
PCle and NVMe Interfaces – Test Advantages

Many Bus Analyzers, Protocol Analyzers, Test Suites are in the market*...

- SD Express Test Fixtures – for SD7.x & SD8.0
- Enables Host and Card vendors to test their SD Express’s PCle interface using standard test equipment
- The set is available for borrow by our members at our approved labs (GRL and Allion)

In parallel, there are new lower-cost SD Express card dedicated testers available or under development

* May not be a complete list of available solutions
SD Express Card – What is it?

- The fastest SD™ and microSD™ memory cards with backward compatibility
- Supporting the following interfaces:
  - NVMe™ + PCIe® interface – up to PCIe 4.0 x2
  - SD interface (UHS-I up to 105MB/s)
SD Express Memory Card (SD 8.00 w/PCIe Gen4) Applications

- **Multi Channel Video Capturing**: requires multi-stream high speed recording and captures large amount of data.

- **Gaming with 3D high-resolution graphics**: requires more memory and high-speed capability for real-time usage.

- **VR & AR video increasing in quality**: requires a high-speed real-time view of 360°.

- **4K cameras are everywhere**
  - Plus growing 8K, 12K and 8k 360° VR cameras
  - Huge data/speed requirements
  - (8K/24fps uncompressed requires 6GB per minute or 360GB per hour!)

- **Multi-sensor Data Collection And/or Multimedia Apps running from cards**

- **Right To Repair**

- **Semi-embedded applications (IoT, Mobile-Compute etc)**
SVP Verified Product
SD Express / UHS-II Verification Program (SVP)

SVP Verified Product List — SD Express

<table>
<thead>
<tr>
<th>Model</th>
<th>Company</th>
<th>Product Type</th>
<th>Listed Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT170G7</td>
<td>BayHub Technology</td>
<td>Card &amp; Host Interface Controller</td>
<td>2023/1/10</td>
</tr>
<tr>
<td>FD5326</td>
<td>Adisumon Semiconductor Corp.</td>
<td>Card &amp; Host Interface Controller</td>
<td>2022/4/30</td>
</tr>
<tr>
<td>GLY9767</td>
<td>Ganeys Logic Inc.</td>
<td>Card &amp; Host Interface Controller</td>
<td>2021/12/5</td>
</tr>
<tr>
<td>FSF617</td>
<td>Phison Electronics Corp.</td>
<td>SD Card</td>
<td>2021/12/1</td>
</tr>
<tr>
<td>4SD350E0911-C</td>
<td>ADEA Technology Co.,Ltd.</td>
<td>SD Card</td>
<td>2021/12/27</td>
</tr>
<tr>
<td>6SD350E0911-C</td>
<td>ADEA Technology Co.,Ltd.</td>
<td>SD Card</td>
<td>2020/12/7</td>
</tr>
<tr>
<td>SD50FS16256G</td>
<td>SanDisk, a Western Digital Brand</td>
<td>SD Card</td>
<td>2022/12/13</td>
</tr>
<tr>
<td>SD502P4N256G</td>
<td>SanDisk, a Western Digital Brand</td>
<td>microSD Card</td>
<td>2021/1/13</td>
</tr>
</tbody>
</table>

SD Express Card & Host Interface Controller

SD Express Memory Card

The SD Association has developed the SD Express/UHS-II Verification Program (SVP). This new verification program checks the electronic interface of UHS-II and SD Express cards/products, giving consumers and businesses greater confidence that devices passing SVP meets the interface standards, while ensuring compatibility based on the Physical Test Guidelines.
What's New

February 08, 2023

Solutions for Implementing SD Express into Your Products

On-Demand Video  Presentation
SD Ver.9.00

- New Optional Functions for semi-embedded Higher Security Applications


- SD9.0 features provide enhanced features that may open new opportunities for SD cards usually tightly bound to a specific host product as:
  - Semi-embedded devices replacing the soldered embedded memory (IoT, Chromebooks etc)
  - As a secured memory for OEM applications (ie Gaming, Automotive, VR etc)

1. **Boot**
   - Fast Boot and Secure Boot features give cards the ability to serve as a device’s boot code memory by using a simple and easy fast boot code uploading process, along with secured methods of providing boot code updates

2. **TCG Storage**
   - A secured storage method defined by the Trusted Computing Group adding a self-encrypted drive capability

3. **Replay Protected Memory Block (RPMB)**
   - Offers a secured hidden memory accessible only through a secured authentication process and provides a secured write-protect mechanism, secured boot code update and replay protection security mechanism
Thank You
www.sdcard.org