SDA 2021 GLOBAL WORKSHOP EVENT
USA Webinar

October 27, 2021  |  2:00pm Pacific Time
Global Workshop USA

Welcome and Introduction

Sharlene Chin
Senior Product Manager (SanDisk LLC)
## Global Workshop Webinar Presenters

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<th>Company/Position</th>
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<td>Amp Inc SDA Member Company, AMP Inc.</td>
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<td>Delkin Devices SD Express Cards</td>
<td>Jenn Sherry, WW Retail Sales Director</td>
<td>Delkin Devices SDA Member Company, Delkin Devices</td>
</tr>
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</table>
What is the SD Association?

- Established in 2000
- A global ecosystem of companies
- Develops and promotes memory card storage standards
- 800 member companies strong
Global Workshop USA

SD Association Overview and New SD Standard Ver. 8.00

Kazunori Nakano
SDA Board of Directors/Marketing Committee Chair (KIOXIA)
Table of Contents

- SD Association Overview
  - Organization
  - License Scheme & Compliance
  - Benefit of SDA Membership

- SD Standard Specification Overview and New Standard Ver.8.00
  - SD Specification Structure
  - Card Types
  - SD Logos & SDA Pictographs
  - SD Ver.8.00 (SD EXPRESS PCIe Gen.4)

- Summary of SD Standards
SD Association Overview
Mission: SD Card Standardization with Promotion and Adoption of SD Standards Worldwide

- Organization Established in 2000
- Member Company: About 800 Companies Worldwide
- 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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>License</th>
<th>Contract with SDA</th>
<th>Contract with SD-3C LLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card</td>
<td>SDA Membership Agreement (SDAMA)</td>
<td>Card License Agreement (CLA)</td>
</tr>
<tr>
<td>Host</td>
<td>SDA License Agreement (SDALA)</td>
<td>Host Ancillary Product License Agreement (HALA)</td>
</tr>
</tbody>
</table>

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

- Access to all detailed, updated specifications (Card, Host, Test & Logo Guidelines)
- Exposed to all on-going standardization activity and upcoming standards well in advance
- Ability to influence new evolving standards and propose new features for standards
- Two Types of Membership are available
  - Executive and General Membership ➔ https://www.sdcard.org/join/membership-benefits-comparison/

<table>
<thead>
<tr>
<th>Member Benefits</th>
<th>Executive</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be a candidate to serve on the Board of Directors</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Voting Rights in SDA, including Committees and Workgroups</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Ability to chair Committees and Workgroups</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participate in Committee and Workgroup all email reflectors, except closed</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Obtain pre-release access to documents and deliverables</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Ability to make proposals for additions and/or modifications for SD Specifications</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Ability to execute the SD Association License Agreement</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Access to the SD specification matrix</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participate in and contribute to Committee and Workgroup activities</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Attend General and Interim Meetings</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Access to the “Members Only” website</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participate in Interoperability Test Events</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participate in marketing events and workshops</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Annual Dues</td>
<td>$4500</td>
<td>$2500</td>
</tr>
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</table>
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

* 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 – 12 Companies

(in alphabetical order)

ATP
- 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
- Takuji Maeda

Phison
- T.H. Kuang

Hisoi
- Andre Chen

Samsung
- HeeChang Cho
- JiCheol Hong

SanDisk
- Yosi Pinto
- Jeff Tsujimoto

Silicon Motion
- Janice Chiu
- Josh Chen

Sony
- Kenichi Satorii
- Shingo Aso

Tuxera
- Joel Catala
- Thom Denholm

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Compliance Committee Organization

Interoperability WG Co-Chair
Minoru Ohara, Allion
Hiroshi Noda, Canon

Test Tool Evaluation Ad-hoc
Managed by Compliance Committee Chair
*This group is set up based on requests from test tool vendor

SVP Ad-hoc
Managed by Compliance Committee Chair

Compliance WG Co-Chair
Hiroshi Noda, Canon
Shinji Inoue, Panasonic

Designated Labs
Allion Test Labs. (SDHC/SDXC/UHS-I/UHS-II/UHS-III)
Panasonic (SDHC/SDXC/UHS-I)
Granite River Labs, (UHS-II/UHS-III/SD Express)
SD Standard Specification Overview
And
New Standard Ver.8.00 SD Express
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)**
    - PCIe Gen.3 x 1 Lane : (985MB/sec Max.) & NVMe protocol with legacy UHS-I interface
    - PCIe Gen.3 x 2 Lane / Gen.4 x 1 Lane : (1,970MB/sec Max.) & NVMe protocol with legacy UHS-I interface
    - PCIe Gen.4 x 2 Lane : (3,940MB/sec Max.) & NVMe protocol with legacy UHS-I interface
### 1. SD Logo: Capacity (4 Types)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity Range</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**

- **2004**
- **2006**
- **2009**
- **2010**
- **2011**
- **2013**
- **2016**
- **2018-2020**
### SD Ver.8.00 SD Express PCIe Gen.4 x 2 Lane

<table>
<thead>
<tr>
<th>Pin Layout</th>
<th>SD Memory Card</th>
<th>SD Express Memory Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIe Bus Interface</td>
<td><img src="image1" alt="PCIe bus interface" /></td>
<td><img src="image2" alt="PCIe bus interface" /></td>
</tr>
<tr>
<td>SD Bus Interface</td>
<td><img src="image3" alt="SD bus interface" /></td>
<td><img src="image4" alt="SD bus interface" /></td>
</tr>
<tr>
<td>Capacity (file system)</td>
<td><img src="image5" alt="Capacity" /></td>
<td><img src="image6" alt="Capacity" /></td>
</tr>
</tbody>
</table>

#### PCIe Bus Interface
- **PCIe Gen.4x2**
- **PCIe Gen.4x1 / Gen.3x2**
- **PCIe Gen.3x1**
- **New**

#### SD Bus Interface
- **UHS-I**
- **UHS-II**
- **UHS-III**

#### Capacity (file system)
- **Ultra Capacity**: Up to 128TB (SD UC)
- **Extended Capacity**: Up to 2TB (SD XC)
- **High Capacity**: Up to 32GB (SD HC)

![Image links to actual diagrams and specifications](image7)
## Bus Speed Mode

<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>UHS-I</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>UHS-II</td>
<td></td>
<td></td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td>FD156</td>
<td>52MHz x 30 (PLL)</td>
<td>UHS-II PHY</td>
<td>156 MB/sec</td>
<td>4.00</td>
</tr>
<tr>
<td>HD312</td>
<td>52MHz x 30 (PLL)</td>
<td>UHS-II PHY</td>
<td>312 MB/sec</td>
<td>4.20</td>
</tr>
<tr>
<td>UHS-III</td>
<td></td>
<td></td>
<td></td>
<td>6.00</td>
</tr>
<tr>
<td>FD312</td>
<td>52MHz x 60 (PLL)</td>
<td>UHS-III PHY</td>
<td>312 MB/sec</td>
<td></td>
</tr>
<tr>
<td>FD624</td>
<td>52MHz x 120 (PLL)</td>
<td>UHS-III PHY</td>
<td>624 MB/sec</td>
<td></td>
</tr>
<tr>
<td>PCIe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen.3</td>
<td>100MHz x 40 (PLL)*</td>
<td>PCIe Gen3 PHY</td>
<td>1-Lane 1GB/sec</td>
<td>7.00</td>
</tr>
<tr>
<td>Gen.4</td>
<td>100MHz x 80 (PLL)*</td>
<td>PCIe Gen4 PHY</td>
<td>1-Lane 2GB/sec</td>
<td>8.00</td>
</tr>
</tbody>
</table>

* Theoretical Value
SD Express Card: Background

Client Computing, Imaging, Automotive – Transition to Higher Speed Interfaces

New Markets Demand More Memory with Higher Speed

- Autonomous vehicles and connected cars with multi-sensor data collection & processing
- Multi-channel video capture
- Gaming with 3D high resolution graphics
- New evolving imaging market (360o, VR, AR etc...)
- Imaging market is already heading to PCIe
- Edge Computing Gateway: High Speed, Small and Robust
Advantages of PCIe Interface

- **PCIe® standard developed by PCI-SIG**
  - PCIe Gen 3 (up to 8Gb/s) and Gen 4 (up to 16Gb/s) are proven…
  - PCIe released already Gen 5 and Gen6 is underway…

- **NVMe™ standard developed by NVM Express**
  - The command layer protocol for Non Volatile Memories that teamed up with PCIe…
  - A scalable and sophisticated protocol – ready to handle future system needs
  - Become more and more popular as the de-facto standard for SSDs and others…
  - Supported by all major OS’s
  - Proven test environments were defined

Both are recognized worldwide as the preferable protocols for future needs ➔ Easy to adopt!

**PCle and NVMe Interfaces – Test Advantages**

*Many Bus Analyzers, Protocol Analyzers, Test Suites are in the market…*
Summary of New SD Standards

- SDA defined performance standards for sequential writes serving the imaging market with focus on growing demands of video capturing.
  - SDA defined **UHS-III (624MB/s)** to further enhance these market needs.

- But it's not just storing content …it’s App Running demanding enhanced random access…
  - SDA defined **Application Perf Class A1 (Nov. 2016)** and **A2 (Feb. 2017)** along with enhanced features: **Command Queuing, Cache and Maintenance**.

- Evolving technology trends of mobile SoCs raised a request to operate only with 1.8v Signaling (w/o need for 3.3v initialization).
  - SDA defined the **Low Voltage Signaling** card with full backward compatibility.

- New evolving technologies of multi-core, high-speed IOs with **SD Express PCIe Gen.3 & Gen.4 NVMe** will raise even higher demands for SD card performance in high end applications.
  - 1.8W Max. Power Consumption vs (Normal SSD ~ 3W)
  - Bus Mastering for inter chip communication between devices to help efficient latency path and longer battery life
  - Dedicated CMD Queue in DRAM for every CPU core
  - Host Memory Buffer (HMB) to save cost (No SRAM Model)
  - Backward Compatibility with SD Interface

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The team that directly supports the SDA with their titles related to SDA:

- Stan Moyer – Executive Director
- Kevin Schader – Director of Communication
- Belinda Lucero - Marketing & Events Manager
- Jessica Esparza – Finance Manager
- Jamie Reyes – Program Manager & Membership Services
New SDA Virtual Booth on SDA Public Home Page

sdcard.org
Thank You

Kazunori Nakano, Marketing Chair
Email: kazunori.nakano@kioxia.com
Global Workshop USA

SD Express Host Implementation

Yosi Pinto
SDA Chairman of the Board/Technical Committee Chair
(SanDisk LLC)
Agenda

- SD Standard Evolution
- SD Express cards – SD7.0, SD7.1 and SD8.0 in brief
- SD Express Host Implementation
  - How to implement hosts with SD Express interface using SDA’s Host Controller Spec
  - Other implementation methods
~800 members as of March 2021

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2000 SD Card Introduced

2004 High Speed mode of 25MB/s (SD Ver.1.10)

microSD Introduced (SD Ver.1.20)

2006 SDHC Introduced (SD Ver.2.00)

2009/10 UHS-I mode 104MB/s, SDXC (SD Ver.3.00/3.01)

2011 Command Queue Low Voltage (SD Ver.6.00)

2017 UHS-II mode 312MB/s (SD Ver.4.00)

2018/19 SD Express & microSD Express (PCIe®/NVMe™) 985MB/s, SDUC (SD Ver.7.00/7.10)

2020 SD Express (PCIe®/NVMe™) up to 4GB/s (SD Ver.8.0)

>5 Billion SD & microSD cards sold by 2019*. SD is the de-facto worldwide removable memory card standard

SD Express Cards – SD7.0, SD7.1 and SD8.0 in brief
SD Express Cards

- SD Express cards are SD cards that supports both: PCIe/NVMe interface and the standard legacy SD (UHS-I) interface, allowing backward compatibility
- SD7.0 and SD7.1 (2019) introduced the full size SD Express and microSD Express, respectively, supporting the PCIe 3.1 x1 interface (up to 985MB/s)
- SD8.0 (2020) introduced the full size SD Express with PCIe 3.1 x2, PCIe 4.0 x1, PCIe 4.0 x2 (up to 4GB/s)
SD Memory Card Bit Rates

SD Memory Cards
Sequential Performance

- SD Express - PCIe G4 x2 (SD8 Mar 2020)
- SD Express - PCIe G3 x2, G4 x1 (SD8 Mar 2020)
- SD Express & microSD Express - PCIe G3 x1 (SD7 2018-19)

Bandwidth (MB/s)

- SD UHS-III ~ x10
- SD UHS-II "x20
- SD UHS-I ~ x40

PCIe G3x2
PCIe G4x2
PCIe G3x1
PCIe G4x1
SD Express Benefits and Implementation Method
Material published by SDA that you may use

- **SD Express Host Implementation Guideline** (for SD7.x cards)

  ![Diagram of SD Express Host Implementation Guideline]

  Update to existing SD Driver – As explained in Implementation Guideline

- **SD Express Test Fixtures** – As explained in the **SD7 Test Guideline**

  Enables Host and Card vendors to test their PCIe interface using standard test equipment
  The set is available for borrow by our members
  at our approved labs (GRL and Allion)

- **SDA Brochure** – updated for SD8.0

- **Two SD Express whitepaper (updated with new material about SD8.0):**
  - **SD Express Memory Cards with PCIe® and NVMe™ Interfaces**
  - **SD Express and microSD Express Cards: The Best Choice for Your Future Product Designs**
SD Express Host Implementation
Pinout Functionality in SD Express Cards – General Description

1. 1st row: conventional SD in SD mode or PCIe side band (PERST#, CLKREQ#, REFCLK+/-) in PCIe mode
2. 2nd row: PCIe 1st lane differential IO’s in PCIe mode
3. 3rd row: PCIe 2nd lane differential IO’s in PCIe mode
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

Card Detection
SDCLK
CMD
DAT[3:0]

Interrupts
Card Insertion
Card Removal

VDD1_ON
Supply control
3.3v

SD Express Host Controller – Building blocks:
⇒ SD Host Controller (at least v3.0)
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

PCle Port (Hot Plug Supported)

Card Detection
SDCLK
CMD
DAT[3:0]
PRSNT#
REFCLK+/-, PERST#, CLKREQ#
PCle Tx +/-, Rx +/-

Interrupts
Card Insertion
Card Removal

VDD1_ON
Supply control
3.3v

SD Express Host Controller – Building blocks:

- SD Host Controller (at least v3.0)
- PCIe Port with hot plug in support
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

PCIe Port (Hot Plug Supported)

Card Detection
SDCLK
CMD
DAT[3:0]
PRSNT#
REFCLK+/-, PERST#, CLKREQ#
PCIe Tx +/-, Rx +/-

Interrupts
Card Insertion
Card Removal

VDD2_ON

Supply control
3.3v
1.8v

New

PCIe/NVMe_Interface_Enable

Card Detection

Supply control

1.8v

3.3v

SD Express Host Controller – Building blocks:

- SD Host Controller (at least v3.0) + VDD2_ON & PCIe/NVMe_Interface_Enable (New)
- PCIe Port with hot plugin support
SD Express Host Controller – Building blocks:
- SD Host Controller (at least v3.0) + VDD2_ON & PCIe/NVMe_Interface_Enable (New)
- PCIe Port with hot plugin support
- 4 bit Signal Switch (New)
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

PCle Port (Hot Plug Supported)

Card Insertion
Card Removal

Interrupts

VDD2_ON
PCle/NVMe Interface_Enable

New

VDD2_ON

Card Detection

SDCLK
CMD

DAT[3:0]

PRSNT#

REFCLK+/-, PERST#, CLKREQ#

DAT[3:0]

PCIe Tx +/-, Rx +/-

4-bit Signal Switch for 1st row Signals
New

SD/PCIe Sel

VDD1_ON

Supply control

3.3v
1.8v

VDD1
VDD2

Card Detect SW

First Row

Second Row

SD Express Card Socket

PCIe/NVMe Interface_Enable

VDD2_ON

New

New

Card Detection

Interrupts

Supply control

VDD1_On

VDD2

VDD1
VDD2

PCle Port (Hot Plug Supported)

SD Express Host Controller – Full Circuit
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

PCIe Port (Hot Plug Supported)

Card Detection

SDCLK

CMD

DAT[3:0]

PCIe Tx +/-, Rx +/-

REFCLK+/, PERST#, CLKREQ#

SD/PCIe Sel

4-bit Signal Switch for 1st row Signals

New

Card Insertion

Card Removal

Interrupts

PRSNT#

VDD2_ON

PCle/NVMe_ Interface_Enable

VDD1_ON

Supply control

3.3v

1.8v

VDD1

VDD2

New

New

Card Detect SW

First Row

Second Row

SD Express Card Socket

VDD1

VDD2

SD Express Host Controller – Operation:
SD Express Host Controller – Operation: Card Insertion-detection
SD Express Host Controller – Operation:
Card Insertion-detection, PCIe support check
SD Express Host Implementation

SD Express Capable Host

SD Host Controller (at least 3.0)

PCIe Port (Hot Plug Supported)

SD Express Card Socket

Card Detect SW

First Row

Second Row

SD driver asserts:
- VDD2_ON
- PCIe/NVMe_int_Enable

PCi & NVMe drivers starts operation

SD Express Host Controller – Operation:
Transfer control to the PCIe host and start operation through PCIe channel
SD Express Host Implementation – other possible methods

The shown example recommends to initiate first through SD interface
SD Express Capable Host

The shown example recommends to initiate first through SD interface and than switch to PCIe, if supported.
Host may be also implemented with initiation first through PCIe interface (the specification allows it)
Host may be also implemented with initiation first through PCIe interface (the specification allows it)
Off the shelf components that may serve PCIe/USB3 to SD Interface
Thank You

Email: yosi.pinto@wdc.com
SVP Introduction

Miki Takahashi
Executive Vice President of Engineering (Granite River Labs)
SVP Overview

☐ SVP - SD Express/UHS-II Verification Program

☐ SDA runs the program allowing SDA members to check UHS-II electrical conformance and SD Express Electrical /PCI Express protocol conformance. The product which passes the test will be listed as Verified Product. The list will be open to public.

☐ SVP provides better interoperability and cost effective option for partial conformance test for SDA members.

☐ Two options in Test Schedule

  1) Test Shuttle: Fixed Test Schedule and Share test cost with multiple members (1st Round (closed): Sep 13, 2nd Round: Planned in Jan 2022)

  2) On Demand: Test immediately
How SVP helps SDA members and End Users

☐ Data Rate gets higher and protocol gets complicated. At the same time, the risk of interoperability gets higher. However large investment is involved to create test environment. SVP provide cost effective option to assess the risk of signal integrity and protocol conformance.

☐ SDA is subsidizing SVP in initial phase to enable the program quickly.

☐ SDA will publish the list of products which pass SVP. User will see the products qualified in a certain quality requirement.
“Be a member of SDA and go to SVP webpage”
SDA SVP Product List

**UHS-II**

<table>
<thead>
<tr>
<th>No.</th>
<th>Listed Date</th>
<th>Product Type</th>
<th>Company</th>
<th>Brand</th>
<th>Model</th>
<th>Revision</th>
<th>SD Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Listed Date1</td>
<td>Product Type1</td>
<td>Company1</td>
<td>Brand1</td>
<td>Model1</td>
<td>Revision1</td>
<td>SD Spec Version1</td>
</tr>
<tr>
<td>2</td>
<td>Listed Date1</td>
<td>Product Type1</td>
<td>Company1</td>
<td>Brand1</td>
<td>Model1</td>
<td>Revision1</td>
<td>SD Spec Version1</td>
</tr>
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</table>

Showing 1 to 2 of 2 entries

**SD Express**

<table>
<thead>
<tr>
<th>No.</th>
<th>Listed Date</th>
<th>Product Type</th>
<th>Company</th>
<th>Brand</th>
<th>Model</th>
<th>Revision</th>
<th>SD Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Listed Date</td>
<td>Product Type</td>
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<td>Brand</td>
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<td>Revision</td>
<td>SD Spec Version</td>
</tr>
<tr>
<td>2</td>
<td>Listed Date</td>
<td>Product Type</td>
<td>Company</td>
<td>Brand</td>
<td>Model</td>
<td>Revision</td>
<td>SD Spec Version</td>
</tr>
</tbody>
</table>

Showing 1 to 2 of 2 entries

- Downloadable List
- Sortable
- Separate List for UHS-II and SD Express
Who is GRL?

☐ SDA Executive Member since 2013
☐ SD Association Designated Lab
☐ Support SD Card Eco-System for Testing and Test Solution
  - GRL Headquarters in the Heart of Silicon Valley
  - 8 Labs World Wide (Europe, Asia and India) to support global supply chain
  - SD Card/Host Test Services and Troubleshooting
  - SD Card/Host Test Solutions (Protocol and Electrical Test Solutions)
  - Runs SVP as Exclusive Designated Lab

https://graniteriverlabs.com/
Thank You

Miki Takahashi
Email: mtakahashi@graniteriverlabs.com
SD Express Applications

Anson Phan
Senior Product Marketing Manager (Phison Electronics Corp.)
SD Express Card An Overview

First Released in June 2018 as part of SD7.0

PCIe Gen3, Gen4 and NVMe v1.3 v1.4 interface added

Legacy UHS-I interface supported allowing backward compatibility with billions of host devices

Existing SD form factor
A small SSD-Like card in reliable small SD form factor including backward compatibility with existing SD products

**Good Things from PCIe NVMe SSD**
- SSD grade performances and features
- PCIe/NVMe – a continuously innovated market-wide platform
- Scalable SW stack widely supported
- Bus mastering and reduction ram and cost
- Leveraging existing investments for card and products manufacturers

**Good Things from SD Card**
- Most popular removable card in consumer market
- Enhanced features: Command Queue, Cache
- SD UHS-I operation mode supported
Theoretical sequential read and write transfer performance ranging from 985 MB/s to a maximum of nearly 4 GB/s
Higher Performance Requirement

1. Larger Content Size
2. Burst mode photo shooting
3. More VR & AR Content
4. Record RAW Content
5. More 8K+ Resolution (10K, 16K in the future)
High Resolution Video & Photo Device

Video Capacity is increasing with higher resolution technology showing. Those devices will increase dependence on memory cards with SSD-like performance.

- Drone
- 360 Degree Camera
- 8K UHD Video device
Portable SSD Level Storage

SD Express Card is the smallest portable storage with SSD level transfer performance.

- UHS-I: 104MB/s
- UHS-II: 312MB/s
- SD Express (SD7.0 Gen3 x1): 985MB/s
- SD Express (SD8.0 Gen4x2): 3940MB/s
Data/information capacity is increasing in the future and People will always look for the storage with faster performance to handle these data
Phison SD Express Card solution PS5017


FEBRUARY 24, 2021

PHISON

PHISON IS THE FIRST TO SHIP THE NEW PCIe SD EXPRESS CARD (SD 7.0)

San Jose, Calif., February 24th, 2021 – Phison Electronics Corp., a global leader in NVMe flash controllers, integrated circuits, and storage solutions, announced today that it will be the first to ship the new PCIe interface SD card, SD Express 7.0. The card will start shipping in March, 2021, and will come in a PS5017 and a PS5006 solution.

SD Express (SD 7.0) is the first memory card to apply a PCIe interface to an SD interface compatible with all the existing button SD slots. This innovation takes the

https://www.youtube.com/watch?v=RjrbhKD8O48&ab_channel=PhisonElectronicsCorp.
Phison SD Express Card solution PS5017
Thank You

Anson Phan
Email: anson_phan@phison.com
Global Workshop USA

SD Express Interconnect Solution

Zhineng Fan
Technologist, Amphenol

Amphenol
Amphenol

SD EXPRESS INTERCONNECT SOLUTION PROVIDER

SD Connector supports multi standards.
- **SD 7.0** (PCIe Gen 3)
- **SD 3.01** (UHS-I)
- **SD 4.0** (UHS-II)

microSD Connector supports multi standards.
- **SD 7.1** (PCIe Gen 3)
- **SD 3.01** (UHS-I)
- **SD 4.0** (UHS-II)

Connector SI performance is future proof;
- up to PCIe Gen 4

**Contact Amphenol for more details**
Connector Evolution with micro SD Express

Amphenol

SD 3.0
UHS I

SD 3.0
UHS I

SD 4.0
Micro UHS II

LVDS
TIA/EIA-644

1st Row Contacts
Card Detect Pin

2nd Row Contacts

Optional Pins for Other Standards

High Speed Pads are OFFSET

SD 3.0
UHS I

Micro SD Express

SD 3.0
SD 7.0

Standards
Off the Shelf

Connector is rated up to Gen 4
Connector Evolution with **micro** SD Express

**Standard**
Off the Shelf

P/N: 101019966912A

Dimension spec
L*W*H=14.65*13.50*1.55mm
Connector Evolution with microSD Express

**Standard Off the Shelf**

**1st Row Contacts**

**2nd Row Contacts**

**BACKWARD COMPATIBLE OPTION**

**NEW DEVELOPMENT**

**VERY CHALLENGING**
Dual contact apex to handle offset 2nd row high speed signal transmission

**PCI EXPRESS**

**LVDS TIA/EIA-644**

©SD Association. All Rights Reserved.
Connector Evolution with micro SD Express

Backward Compatible Option

New Development

LVDS TIA/EIA-644

PCI Express

PRELIMINARY RESULTS

Insertion Loss

Return Loss

NEXT

TDD11

Pass

Pass

Pass
Micro SD Express SD7.1 Connector
With UHS II Compatibility

INDUSTRY’S 1ST
Amphenol

Backward UHS II compatibility powered by Bayhub controller enabled by Amphenol connector

1st Row Contacts

NEW DEVELOPMENT

2nd Row Contacts

Dimension spec (TBC)
L\*W\*H=14.65*13.50*2.10mm

Mechanical Spec
Durability: 5000 cycles (TBD)
Mating force: 40N max (TBD)
Un-mating force: 0.5N-40N (TBD)

Electronic Spec
Working current: 0.5A
Voltage: 100V AC
Full Size SD Express SD7.0 Connector
With UHS II Compatibility

Solder leads arranged in a single row for ease of AOI deployment

Host has the option of deploying these contacts for customisation.

Dimension spec
L*W*H = 29.40 * 28.35 * 3.15mm

Mechanical Spec
Durability: 5000 cycles (min)
Mating force: 40N max
Un-mating force: 0.5N - 40N

Electronic spec
Working current: 0.5A
Voltage: 100V AC

P/N: GSD21001X7BHR

Backward UHS II compatibility powered by Bayhub controller enabled by Amphenol connector

Contact finish:
0: Gold Flash
1: 5 µ" Gold
2: 10 µ" Gold
3: 15 µ" Gold
WE ARE “THE BRIDGE” FOR SD EXPRESS

Do drop us a mail if you have any enquiries
louis.feng@amphenol.com.tw

Thank You!
Thank You

Zhineng Fan
Email: zhineng.fan@amphenol-tcs.com
Introduction of Lexar SD Express

Julia Huang
Senior Marketing Manager (Lexar)
Product Overview

Specification

- SD7.1, PCIe Gen 3x1
- Capacity: 128G/256G/512GB (SD)
  128G/256G (microSD)
- Form factor: SD and microSD
- Controller: SMI SM2708
- Flash: WD BiCS4 3D TLC
- Power/performance throttling

Status

- UHS-I compatibility test
  Passed over 200pcs UHS-I devices
- Passed SD7.1 card reader test
  Realtek (PCIe Gen3x1 to SD7.x)
  Genesys (PCIe Gen3x1 to SD7.x)
  BayHub (PCIe Gen3x1 to SD7.x)
  JMicron (USB3.2 Gen2 to SD7.x)
- Device list
  Notebook/Laptop--ongoing

<table>
<thead>
<tr>
<th>PCIe Gen3x1 Performance</th>
<th>128G&amp;256GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential Read</td>
<td>824 MB/s</td>
</tr>
<tr>
<td>Sequential Write Burst</td>
<td>410 MB/s</td>
</tr>
<tr>
<td>Random Read</td>
<td>404 MB/s</td>
</tr>
<tr>
<td>Random Write</td>
<td>349MB/s</td>
</tr>
</tbody>
</table>
Thermal Comparison vs UHS-I

Test Method

1. Write and read 20GB data through H2testw
2. Measure power consumption
3. Based on the same Flash type
4. 256GB capacity
**Advanced Packaging**

**Flip Chip advantage vs Wire Bonding**

1. Excellent electrical and thermal properties.
2. With arrayed pad design, can have higher pin count within same die size.
3. Can greatly reduce the size and weight.
Plan and Challenge

Next Plan
- SD 8.0 Gen3x2 2Gb/s evaluation
- High-capacity evaluation

Challenge
- Thermal control for both small form factor size (especially microSD) with high PCIe performance
- Packaging process capability of high capacity of 512GB/1TB/2TB
- New protocol interface requires more host manufacturers to participate. Laptop is the first to support SD Express

<table>
<thead>
<tr>
<th>Brand</th>
<th>Application</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACER</td>
<td>Concept Laptop</td>
<td>MP</td>
</tr>
<tr>
<td>ASUS</td>
<td>ProArt Studio Book</td>
<td>MP</td>
</tr>
<tr>
<td>MSI</td>
<td>GE76 Raider</td>
<td>MP</td>
</tr>
</tbody>
</table>
Market Application

Host Adoption Status

- SD7.x Bridge Chip
  - Realtek (PCIe to SD7.x / USB3.2 Gen 2 to SD7.x)
  - Genesys (PCIe to SD7.x)
  - BayHub (PCIe to SD7.x)
  - JMicron (USB3.2 Gen 2 to SD7.x)

- Workstation/PC/Laptop
  - ACER/ASUS/MSI Laptop MP
    The laptop comes packed with every port that may need such as HDMI, SD 7.0 and many more.

Market Visibility

2022

Future Application for Retail/OEM Market

The speed of SD Express is essential for high-resolution content applications

- 8K Video Recording
- Professional DV/DSR
- High Resolution 3D Gaming
- Computing
- Drone Shooting
Thank You

Julia Huang
Email: julia.huang@lexar.com
AMP Inc.’s Current & Future SD Express Products & Solutions Roadmap

Rick Neil
Sr. Principal Memory Module Applications Engineer & Digital Hardware SME (AMP Inc.)
Presentation Agenda:

- 01 -- Introduction to AMP Inc.
- 02 -- AMP Inc. Memory Solutions In General
- 03 -- AMP Inc. SD Express Solutions: Current
- 04 -- AMP Inc. SD Express Solutions: Datasheet Overview
- 05 -- AMP Inc. Roadmap to SD Express Solutions
  - Data Encryption
  - Security Tool Chain
  - Hidden Card
  - TRNG and Authentication
  - Hardware Security Module
  - Key Generation
  - Symmetric Cryptography Support Ecosystem
Introduction to AMP Inc.

* AMP Inc is Based in Southern California, in Santa Ana.
* AMP Inc products are available worldwide to a wide array of businesses and industries: Commercial, Industrial, Medical, Military, Space, Automotive, Surveillance, Data Center.
* AMP Inc specializes in standard and advanced, and custom Memory and Storage Solutions.
* From concept to completion, AMP delivers fully integrated R&D support.
* Every AMP Inc product is backed by a commitment to the highest quality and the fastest turnaround times possible.
* AMP Inc is proud of the Alliances & Affiliations developed in the memory and storage industry throughout the years. We are a proud member of SD Association and JEDEC.
* AMP Inc is committed to customer satisfaction and compliance with AS9100D and DFARS standards.
AMP Inc. Memory Solutions In General.

- DRAM Modules
  - DDR1, DDR2, DDR3, DDR4, Coming Soon DDR5
  - Every available mechanical form-factor

- Solid State Drives (SSD): SATA, PATA, mSATA, mPATA, PCIe-Express
  - M.2, 1.8”, 2.5”, NVMe, EDSFF

- SD Cards
  - SD, microSD, SD Express

- USB, USB Embedded & Compact Flash Solutions
  - eMMC, BGA, UFS
AMP Inc. SD Express Value Proposition

• For SD Express Cards:
  • Life Time Support [7 to 10 year Life Cycle Support]
  • Locked BOM [upon customer request]
  • Full Spectrum SD Express Compliance Testing
<table>
<thead>
<tr>
<th>Form Factor</th>
<th>SDXC Express SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>PCIe/NVMe Gen 3x1</td>
</tr>
<tr>
<td>Flash</td>
<td>QLC</td>
</tr>
<tr>
<td>SDA Specification</td>
<td>• Part 1 Physical Layer Specification Ver. 7.10</td>
</tr>
<tr>
<td></td>
<td>• Part 2 File System Specification Ver. 7.00</td>
</tr>
<tr>
<td></td>
<td>• Part 3 Security Specification Ver. 7.00</td>
</tr>
<tr>
<td></td>
<td>• Standard Size SD Card Mechanical Addendum Ver. 8.00</td>
</tr>
<tr>
<td>Capacity</td>
<td>256GB, 512GB</td>
</tr>
<tr>
<td>Speed Class</td>
<td>U3</td>
</tr>
<tr>
<td>Application Performance Class</td>
<td>A1</td>
</tr>
<tr>
<td>Video Speed Class</td>
<td>V30</td>
</tr>
<tr>
<td>Performance</td>
<td>Reads: Up to 894 MB/s  Writes: Up to 774 MB/s</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>Operating: -25 °C to 85 °C  Storage: -40 °C to 85 °C</td>
</tr>
<tr>
<td>Compliance</td>
<td>RoHS, EMI, ESD</td>
</tr>
</tbody>
</table>
Product Features:

- Optional CPRM (Content Protection for Recordable Media)
- Static and Dynamic Wear Leveling
- ECC
- Bad Block Management
- Write Protect
- Hot Plug
- SD SPI mode
- Optional Password Protection
- S.M.A.R.T
- Design for intensive R/W applications
- Shock/Vibration Proof
- Waterproof
3. ELECTRICAL INTERFACE OUTLINES

3.1. Pad Assignment and Descriptions
AMP Inc. Roadmap to SD Express Solutions

- Data Encryption
- Security Tool Chain
- Hidden Card
- TRNG and Authentication
- Hardware Security Module
- Key Generation
- Symmetric Cryptography Support Ecosystem

Technology Feature Set:

- Wear leveling, Longevity, Wide temperature support, Data care management
- Power Fail Protection & Recovery, Power fail protection, Shock & Vibration, ESD and EMI safe
- Optional: Ruggedization.

Markets

Applications
Contact Us:

Accelerated Memory Production, Inc. [Amp Inc.]
1317 E Edinger Ave,
Santa Ana, CA 92705

Phone: 714-460-9800

https://www.ampinc.com

sales@ampinc.com
Thank You

Rick Neil
Email: rick.neil@ampinc.com
Delkin Devices SD Express Memory Cards

Jenn Sherry
Worldwide Retail Sales Director (Delkin Devices)
US Headquarters / UK Office / Japanese Agent / Government Programs Officer
Retail & Industrial Support
Can We Launch Without SD Express Hosts?

YES:

It is Slightly Faster in Existing Hosts

Future Proofs Users with the Purchase

Improves Workflow (Time is Money)
Backwards Compatibility – to UHS-I/II

How Important is Backwards Compatibility?
• It is critical to the launch success of SD Express
• The opposing standard is not backwards compatible, thus giving SD Express a HUGE selling advantage
• Must include Hosts, OS and Readers

SDA has carved out a unique position in allowing this.
Test #1 - 512GB ADVANTAGE UHS-I (V30) SDXC Memory Card:
• 58 Photos (RAW + JPEG at Highest Resolution and Quality) Captured in 6 Seconds [Maximum Buffer Capacity]
• Wait Time to Take Next Photo: 7 Seconds
• Wait Time to Completely Clear Camera Buffer: 41 Seconds (After Taking 58 Continuous Photos)

Test #2 - 512GB SD Express Memory Card:
• 58 Photos (RAW + JPEG at Highest Resolution and Quality) Captured in 6 Seconds [Maximum Buffer Capacity]
• Wait Time to Take Next Photo: 0.5 Second
• Wait Time to Completely Clear Camera Buffer: 34 Seconds (After Taking 58 Continuous Photos)
Delkin SD Express Specifications

Initial Testing Performance Speeds:
256GB: Up to 820 MB/s Read, 500 MB/s Write
512GB: Up to 894 MB/s Read, 774 MB/s Write

Initial Specifications:
• SDXC Express Memory Card
• UHS Speed Class 3 / Video Speed Class 30
• SD Express will be available in SDXC
• Capacities: 256GB & 512GB (Intention to Add Larger Capacities)
  o Operating Temperature: -25°C to 85°C
  o Storage Temperature: -40°C to 85°C
What’s Next?

Final Testing

Production

Market Launch
Consumers can “Future Proof” themselves by buying a form factor that works in their current hosts, but is also fast enough for high-resolution video capture and high-speed data transfers that are likely to be available in future hosts.

Even today, the advantage of the improved workflow speeds makes it a viable product.
Thank You

Jenn Sherry
Email: jsherry@delkin.com