



DEFINITION

M.2 SSD

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What is an M.2 SSD?

An M.2 SSD is a small form factor solid-state drive ([SSD](#)) that is used in internally mounted storage expansion cards. M.2 SSDs conform to a computer industry specification and are designed to enable high-performance storage in thin, power-constrained devices, such as ultrabook laptops and tablet computers. They are generally smaller than other comparable SSDs, such as the mini Serial Advanced Technology Attachment (mSATA).

SSDs are a form of storage media that saves persistent data on solid-state flash memory. Unlike a hard disk drive ([HDD](#)), an SSD has no moving parts to break or spin up or down. The M.2 SSD interface specification was originally known as the Next-Generation Form Factor, but the name was changed to M.2 (pronounced *M-dot-2*). M.2 SSDs are useful for someone who is building or upgrading a personal computer (PC) or laptop for use cases such as gaming, 3D animation, video editing or large file transfers.

M.2 supports multiple protocols and applications such as Peripheral Component Interconnect Express ([PCIe](#)) and SATA. M.2-compatible products are not limited to solid-state drives either. The specification also supports protocols such as Universal Serial Buses (USBs) and Wi-Fi and can be used in graphics cards and [artificial intelligence accelerator](#) cards that use the M.2 specification.

The M.2 form-factor specification was defined by the SATA International Organization, as well as the PCI Special Interest Group -- a consortium of technology industry vendors.

How does an M.2 SSD work?

M.2 modules can integrate with device classes such as Wi-Fi, Bluetooth, [near-field communication](#) and wireless wide area networks. But M.2 form factors are most commonly associated with SSDs for data storage.

M.2 drives do not need a cable to connect to a motherboard. Instead, they are plugged directly into the motherboard with a dedicated M.2 connector slot.

An M.2 SSD can be used with both SATA and PCIe protocols. SATA is a standard for connecting and transferring data from HDDs to computer systems. PCIe, which is a serial expansion bus standard, is used to connect a computer to one or more peripheral devices.

M.2 SSDs also support PCIe-based non-volatile memory express (NVMe) drives. NVMe can accelerate the transfer speed of data between client systems and SSDs over a PCIe bus. NVMe support was developed to reduce bottlenecks and improve performance. It also enables increased [parallel processing](#) for read and write requests. Because of its design, NVMe support can add up to five times more bandwidth than SATA M.2 models and may enable a computer to provide better performance for tasks like file transfers.

M.2 SSDs can also be either single- or double-sided. Single-sided M.2 boards are used where space is limited, such as with ultra-thin laptops. Double-sided chips, however, take up more physical space but have greater storage capacities.

The M.2 device has notches in one end, which act as connectors, called module keys. M.2 modules are rectangular. An edge connector is located on one side with a mounting hole at the opposite edge. The edge connector has 75 positions with up to 67 pins. Each pin is rated up to 50 volts and 0.5 amps.

M.2 SSD form factor

Generally, M.2 SSDs are 22 millimeters wide and 60 mm or 80 mm long; although, card lengths can vary. The card size is identified by a four- or five-digit number. The first two digits are the width and the remaining numbers are the length. For example, a 2260 card is 22 mm wide and 60 mm long. Longer M.2 drives usually hold more [NAND](#) chips for extra capacity. Other sizes include:

- 2280 -- 22 mm x 80 mm
- 2230 -- 22 mm x 30 mm
- 2242 -- 22 mm x 42 mm
- 2260 -- 22 mm x 60 mm
- 22110 -- 22 mm x 110 mm

The 22 mm width is the standard for desktops and laptops. An 80 mm or 110 mm length card can hold eight NAND chips for 2 terabytes (TB) of capacity.

M.2 module keys

Keys -- the notches in the edge connectors of M.2 modules -- can distinguish the type of M.2 product.

M.2 SSD module keys		
KEY ID	PIN LOCATION	INTERFACE
A	8-15	2x PCIe x1 / USB 2.0 / I2C / DP x4
B	12-19	PCIe x2 / SATA / USB 2.0 / USB 3.0 / HSIC / SSIC / Audio / UIM / I2C
C	16-23	Reserved for future use
D	20-27	Reserved for future use
E	24-31	2x PCIe x1 / USB 2.0 / I2C / SDIO / UART / PCM
F	28-35	Future Memory Interface (FMI)
G	39-46	Not used in M.2 / Custom use / Non-standard apps
H	43-50	Reserved for future use
J	47-54	Reserved for future use
K	51-58	Reserved for future use
L	55-62	Reserved for future use
M	59-66	PCIe x4 / SATA

 A list of M.2 SSD module keys, including key IDs, PIN locations and interfaces.

M.2 SSD modules plug into circuit boards through connectors on either side. Unlike mSATA, M.2 SSD cards have two types of connectors, also known as sockets: B key sockets and M key sockets. A single card can also have both key types. The type of key determines the number of PCIe lanes the socket supports. A B key holds one or two PCI express lanes, while an M key holds up to four PCIe lanes. The B key edge connector is six pins wide, and the M key edge connector is five pins wide.

For Wi-Fi and Bluetooth wireless adapters, M.2 cards are keyed for A and E slots in a motherboard. Most M.2 wireless cards support both A and E key slots.

M.2 SSD pros and cons

Benefits of using an M.2 SSD include:

- **Size and capacity.** In a laptop, an M.2 SSD takes up far less space and uses much less power than a standard SATA or Serial-Attached SCSI (SAS) interface solid-state drive. However, if massive storage capacity is required in a mobile device, other form factors will likely be a better fit.
- **Performance.** An M.2 SSD based on the NVMe specifications, for example, can read and write at much faster rates than SATA or SAS SSDs.
- **Flexible interface.** An M.2 SSD supports PCIe, SATA, [USB 3.0](#), Bluetooth and Wi-Fi. If a user purchases a laptop with an M.2 interface, they will have many configuration options for peripheral gear.

However, some of the drawbacks that come with M.2 SSDs include:

- **Price.** An M.2 SSD costs more than a SATA SSD. Prices for 2.5-inch SATA SSDs have plummeted, as they are produced in greater numbers.
- **Limited capacity.** While 1 TB or 2 TB is probably adequate for most mobile applications, enterprise storage systems require higher capacities.

What is an M.2 SSD? M.2 vs. mSATA SSDs



What are the buying options for M.2 SSD?

M.2 cards are typically used in newer mobile computing devices. Because the form factor is different from mSATA cards, M.2 SSDs are not compatible with older systems and may not fit large enterprise storage devices. However, enterprise storage vendors are beginning to incorporate M.2 SSDs in their hybrid and [all-flash storage](#) arrays. Even with limited capacities, the size and density of M.2 SSDs still enable storage vendors to pack a lot of high-performance capacity into a small area.

Some examples of different M.2 SSDs to choose from include the Adata XPG SX8200 Pro or Samsung 970 EVO Plus. [Storage performance specifications](#) for the Adata M.2 SSD include 256 gigabyte (GB) to 2 TB storage capacity, with read and sequential write speeds up to 3,500 MB and 3,000 MB per second, respectively. Its mean time between failures ([MTBF](#)) is rated at 2 million hours. Random access speeds fall short compared to other choices, however -- meaning the storage speed may be slower, comparatively.

M.2 vendors

The price for a 2 TB M.2 SSD typically ranges from \$150 to \$200; lower capacities are considerably less expensive, with 256 GB M.2 SSDs available for around \$50. As noted above, Adata and Samsung, for example, sell a variety of M.2 SSDs in different capacities. Other M.2 SSD vendors include:

- Crucial, which is owned by Micron Technology
- Kingston Technology
- Plextor
- Team Group
- Toshiba

In addition, Intel is the largest vendor of M.2 wireless adapters.

How do you choose an M.2 SSD?

M.2 SATA drives and M.2 NVMe drives are becoming the standard recommendation for new PC builds and upgrades, as they are becoming less expensive and more popular.

The first consideration when planning to purchase an M.2 device for a computer is whether it has one or two M.2 plugs. If a laptop is compatible with M.2 specifications, it will have the physical interface, and the device's operating system should already include the required [Advanced Host Controller Interface](#) drivers need to enable installation of the M.2 storage card. It may also be necessary to make an adjustment in the device's [basic input/output system](#) so that it can recognize the M.2 storage.

If the computer will be used mainly for daily tasks or gaming, then an M.2 SATA drive should suffice. However, if the user needs the best computing speed or requires fast sequential read and write speeds for use cases such as editing 4K video or large file transfers, then an M.2 NVMe drive should be selected.

If the motherboard does not have an M.2 slot, then the user can get a M.2 drive on a card, which vendors like Asus or MSI provide. These put the M.2 drive on a PCIe expansion card, enabling the use of an M.2 through the PCIe slots.

What are the differences between M.2, mSATA and NVMe SSDs?

M.2 is commonly referred to as an mSATA replacement, but mSATA SSDs still exist and may continue to for some time -- especially, in laptop platforms that support that form factor. Because M.2 and mSATA cards are different and have different connectors, they cannot be plugged into the same devices -- meaning they both still have their use cases.

M.2 is a form factor that can take the form of a SATA SSD or a PCIe NVMe SSD.



 Micron Technology M600 SSD form factors (left to right): mSATA SSD, M.2 SSD (22 mm x 60 mm double-sided), M.2 SSD (22 mm x 80 mm single-sided) and a 2.5-inch SATA SSD.

M.2 SSDs are faster and store more data than most mSATA cards. M.2 SSDs support a variety of interface standards such as PCIe 3.0, SATA 3.0 and USB 3.0 interfaces, compared to mSATA, which only supports SATA interface standards. M.2 SATA SSDs have a similar level of performance to mSATA cards, but M.2 PCIe cards are notably faster. In addition, SATA SSDs have a maximum speed of 600 MB per second, while M.2 PCIe cards can hit 4 GB per second.

PCIe support also allows M.2 cards to take advantage of the NVMe protocol. An NVMe drive provides a large performance advantage over drives based on other types of interfaces due to reduced latency, increased [input/output operations per second](#) and lower power consumption.

The main benefit of an NVMe-based PCIe SSD over SATA and mSATA is speed. While SATA drives clock in at 750 MB per second, NVMe clocks in at 1 GB per second on the low end.

Given the speed benefits of the NVMe drives, M.2 NVMe SSDs are a good choice for hard drive-intensive workloads or workloads that require many hard drive reads and writes.

Learn how [NVMe stacks up against](#) serial-attached SCSI. Specifically, how they compare when it comes to flexibility, performance, scalability and manageability.

This was last updated in July 2021

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A graphic showing a stylized head profile composed of circuitry and binary code (0s and 1s) on a dark blue background.

SSD form factor

By: Paul Kirvan

A graphic showing a perspective view of a server aisle with blue lighting and server racks.

Kioxia releases PCIe 5.0 EDSFF SSDs

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A graphic showing binary code (0s and 1s) in various colors (blue, green, yellow, orange) on a dark background.

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