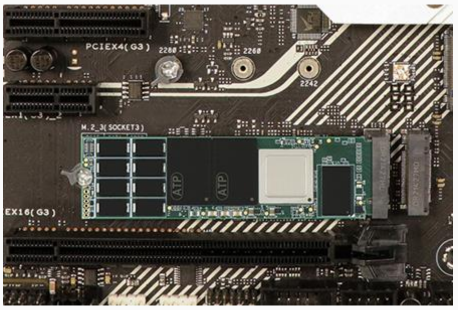
PCIe vs. NVMe: Are They the Same?



A Basic Guide to PCIe: Types and Generations

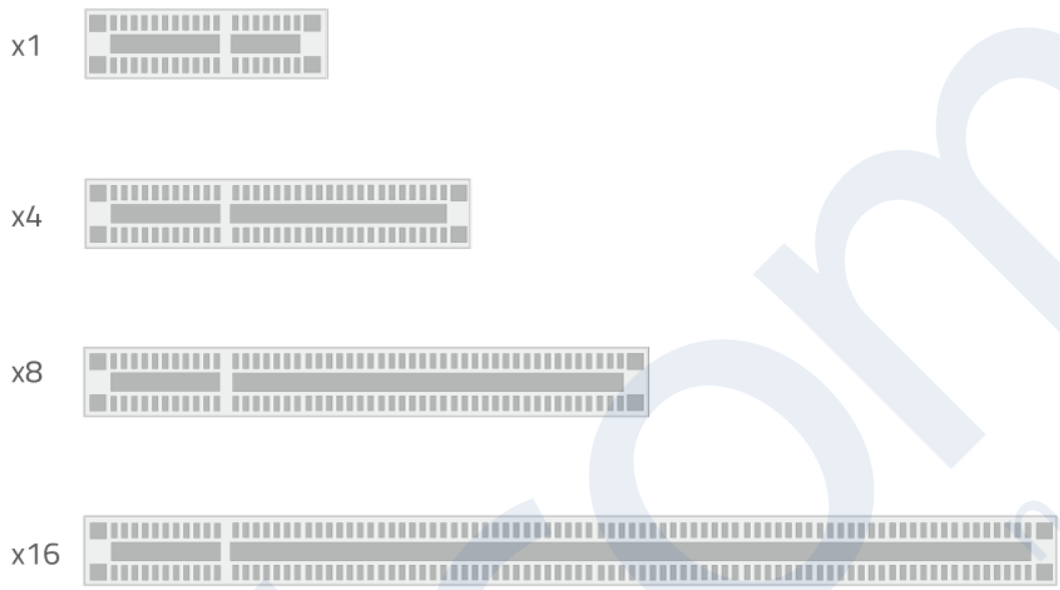
Peripheral component interconnect express, more commonly known as PCIe, is a standard interface used for connecting high-speed motherboard components such as graphics cards, network cards, and storage devices. It succeeds the PCI bus standard, with “express” added to its name to distinguish it as the new standard that offers significant performance improvements.

Types and Nomenclature

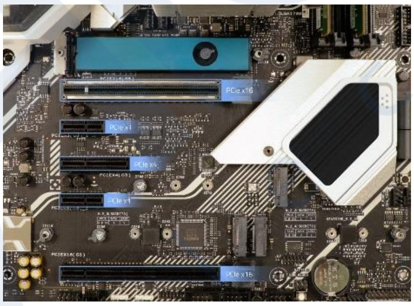
PCIe comes in different physical configurations: PCIe x1, x4, x8, and x16. The number following the “x” represents how many lanes are on that slot. PCIe lanes serve as the physical link between the device and the processor or chipset. Just as vehicles travel simultaneously in two directions on an expressway, data “travels” (sent/received) on a PCIe lane. A PCIe x1 slot for example, has one lane. PCIe x2 has two lanes, x4 has four, and so forth.

Unlike the older PCI standard, which can send data and receive data only one at a time (unidirectional), PCIe sends data at full duplex (bidirectional), meaning it can send and receive at the same time.

You may insert a card into a slot of a different size; however, the bandwidth will depend on the card's and slot's capabilities. For example, if you insert a PCIe x8 card into a x4 slot, it will only perform at half the bandwidth.



Different Types of PCIe Slots



Different PCIe and PCI slots on a Motherboard

PCIe Generations

Each PCIe generation brings notable improvements over the previous one, practically doubling the bandwidth and data transfer rate of each PCIe lane.

PCIe generations are backward compatible but will run at the lowest generation of either the card or the slot. For example, inserting a PCIe 3.0 card on a PCIe

4.0 slot will give you PCIe 3.0 performance.

The table below provides a comparison of maximum bidirectional bandwidth and data transfer rate of each generation.

- Bandwidth: measured in gigabytes per second (GB/s). It measures the transmission capacity or the rate at which each lane sends or receives bits of data.
- Data transfer rate: measured in gigatransfers per second (GT/s). It measures how fast data is transferred from one point to another. It also refers to the actual amount of data transferred.

	Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6
Bandwidth	8 GB/s	16 GB/s	32 GB/s	64 GB/s	128 GB/s	256 GB/s
Data Transfer Rate	2.5 GT/s	5 GT/s	8 GT/s	16 GT/s	32 GT/s	64 GT/s

Maximum Bandwidth and Data Rate of PCIe Generations

PCIe Gen 3 vs PCIe Gen 4

PCIe 4.0 offers twice the data rate and maximum bandwidth of PCIe 3.0, allowing faster data transfers. The standard was released in 2017 initially for enterprise-grade servers and was used in solid state drives (SSDs) in 2019.

The following table compares the maximum bandwidth of PCIe 4.0 with PCIe 3.0 according to the number of PCIe lanes supported.

	x1	x2	x4	x8	x16
PCIe Gen 3	1 GB/s	2 GB/s	4 GB/s	8 GB/s	16 GB/s
PCIe Gen 4	2 GB/s	4 GB/s	8 GB/s	16 GB/s	32 GB/s

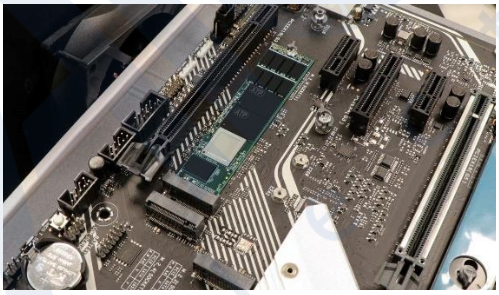
PCIe 4.0 vs. PCIe 3.0: Maximum Bandwidth per Lane

PCIe vs. NVMe: Are They the Same?

You’re probably wondering why “PCIe” is typically written with “NVMe” when you look at SSDs. Are they the same?

As mentioned in the beginning of this article, PCIe, is a standard interface used for connecting high-speed motherboard components. This means that it is a *physical* connection, an input/output (I/O) interface used to attach or insert components like graphic cards, network cards, and storage devices like SSDs to the motherboard. PCIe’s point-to-point architecture allows attached devices to connect directly to the host. This eliminates the need to share a bus, thereby reducing latency and speeding up data transfers.

NVMe, which stands for Non-Volatile Memory Express, is the *communication protocol* or *interface specification* optimized for NAND flash and solid state technologies. It leverages the PCIe architecture to deliver performance enhancements over Advanced Host Controller Interface (AHCI), the standard that defines the operation of Serial ATA (SATA).



ATP’s M.2 NVMe SSDs connect to the motherboard using the PCIe 4.0 x4 interface

PCIe NVMe SSD Form Factors

ATP offers PCIe NVMe NAND flash storage devices in the following form factors:

PCIe® Gen 4 NVMe™ M.2 2280 SSD

- Superior Read/Write performance
- MCU-based Power Loss Protection Design with Level 4 (data-in-flight) protection*
- Self-Encrypting Drive (SED) with AES 256-bit Encryption, TCG Opal 2.0*
- Thermal Heatsink Solutions**
- End-to-End Data Path Protection
- Anti-sulfuric resistor support*

* May vary by product and project support

** Customization available on a project basis

PCIe® Gen 4 NVMe™ U.2 SSD

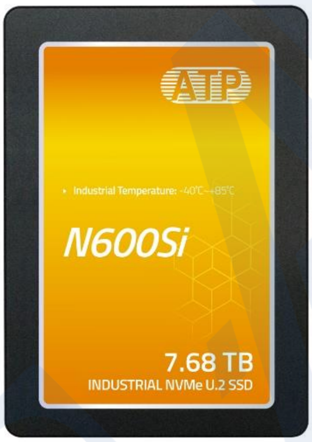
- 15 mm Fin-Type Heatsink Design
- MCU-based Power Loss Protection Design with Level 4 (data-in-flight) protection*
- Self-Encrypting Drive (SED) with AES 256-bit Encryption, TCG Opal 2.0*
- End-to-End Data Path Protection
- Hot-swappable
- pSLC mode support*
- Anti-sulfuric resistor support*

* May vary by product and project support

PCIe® Gen 3 NVMe™ M.2 2280/2242/2230 SSD

- MCU-based Power Loss Protection Design with Level 4 (data-in-flight) protection*
- Self-Encrypting Drive (SED) with AES 256-bit encryption, TCG Opal 2.0*
- Thermal Heatsink Solutions**
- End-to-End Data Path Protection
- TRIM function support

* May vary by product and project support
** Customization available on a project basis



PCIe® Gen 3 NVMe™ U.2 SSD

- Thermal Management Solutions*
- High-Capacity NVMe Drive
- LDPC & RAID Data Recovery
- End-to-End Data Path Protection
- S.M.A.R.T / TRIM / Global Wear Leveling
- Hot-swappable

* Customization available on a project basis