



Home / Memory and Storage

Memory and Storage

# MLC vs TLC vs QLC NAND SSDs: What's the Difference?



Areej • March 27, 2021 • 0 comments • 3 minutes read



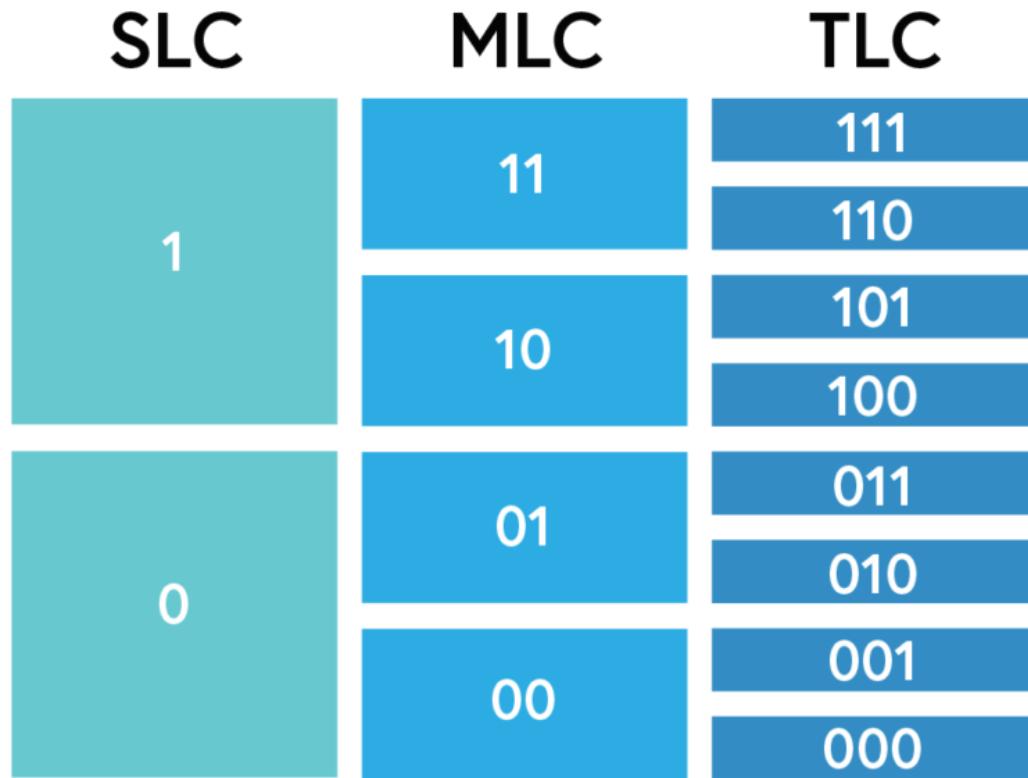
&lt;



If you want a top-of-the-line system, especially for gaming or content creation, then an SSD is absolutely necessary. However, before you go hunting for one, you should know what to look for. There are multiple different types of SSDs. As far as the basic SSD storage cells are concerned, you've got SLC, MLC, TLC, and QLC. Out of these, TLC is the most popular, though, QLC is going to eventually replace them. In terms of I/O, there's SATA and NVMe.

Lastly, the latest SSDs are also based on 3D NAND/VNAND technology. This can make it really confusing to decide on one particular SSD. Let's break down all these terms.

## SLC, MLC, TLC, and QLC: These are Memory Cells



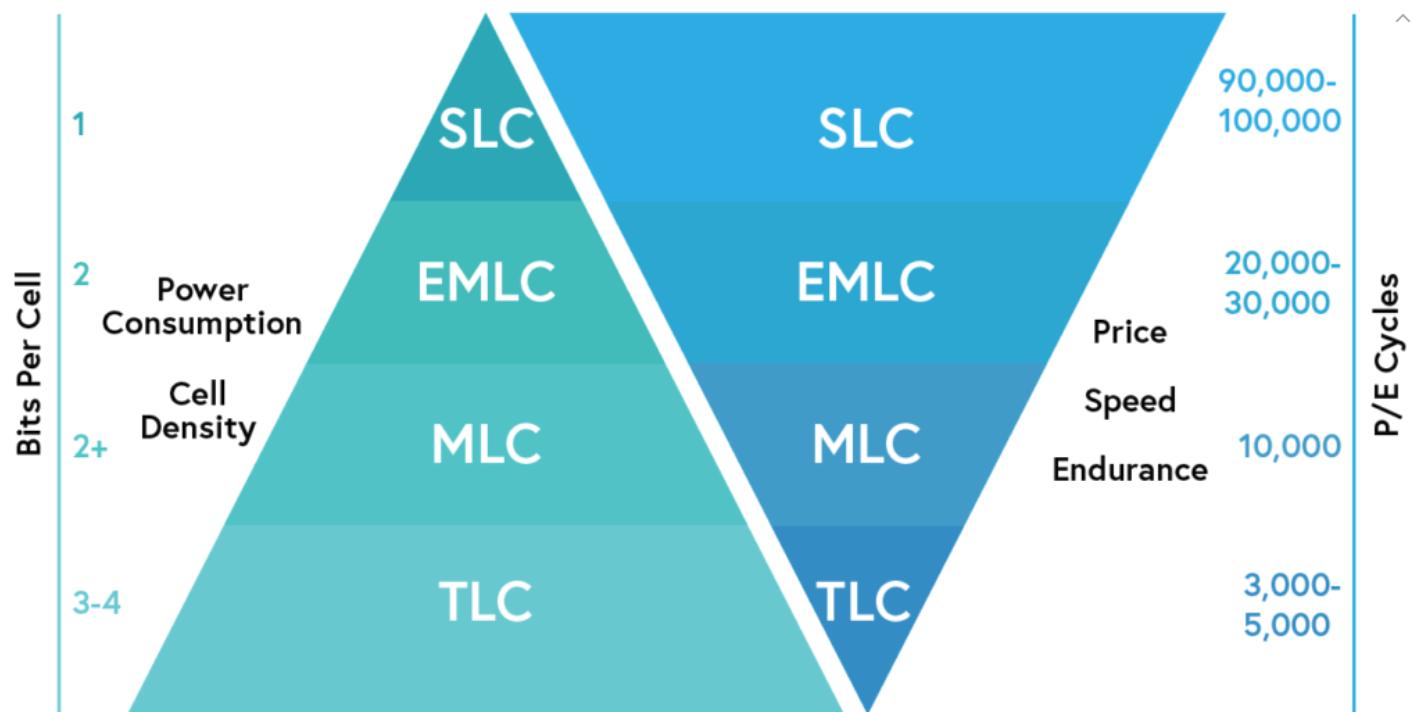
In HDDs, tracks are the building blocks of the storage memory. In SSDs, that same functionality is provided by cells. A cell is essentially a Gate Circuit. How much memory each cell can store depends on the type of cells an SSD uses. The most popular ones are: SLC, MLC, TLC, and QLC. These stand for Single-Layer Cell, Multi-Layer Cell, Triple-Layer Cell, and Quad-Layer Cell.

- [HDDs and SSDs: Which is Better for Gaming: Speed, Reliability, Lifespan, and Prices](#)

As the names suggest, cells in SLC SSDs can store only one bit per cell. MLC stores two, TLC stores three, and QLC stores four. While this might seem like a “bigger is better,” situation, that’s not quite the case here. It’s easiest to increase capacity (at the same price point) with QLC drives since they require 1/4 as many cells as an SLC drive for the same amount of storage.

**Bigger isn't always better**

# NAND Flash Specs



However, it takes more time to write multiple bits to a single cell. This affects SSD durability, too. What this means is that SLC SSDs are actually the fastest and most reliable. But they're substantially more expensive. Most commercial SSDs out there are TLC, which offers a reasonable compromise between performance, reliability, and cost.

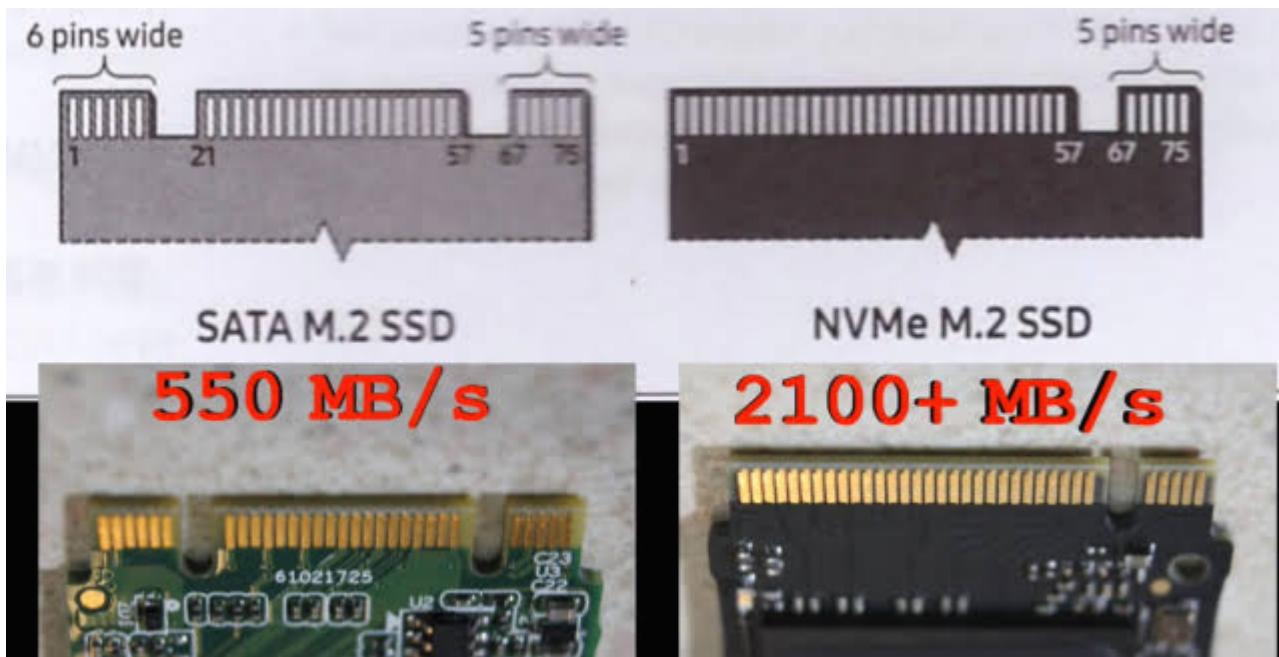
	SLC	3D TLC	SLC mode	INDUSTRIAL MLC	TLC
<b>Reliability</b>	Highest	High	High	Medium	Low
<b>Speed</b>	Fastest	Fast	Fast	Medium	Slow
<b>Price</b>	£ £ £ £	£	£ £ £	£ £	£
<b>P/E Cycles/Endurance</b>	*****	**	****	***	**
<b>Warranty</b>	5 years	2-5 years	2-5 years	2 years	2 years
<b>Operating Temp -40°C to 85°C</b>	✓	✓	✓	✓	✗
<b>Operating Temp 0°C to 70°C</b>	✓	✓	✓	✓	✓
<b>Controlled BOM</b>	✓	✓	✓	✓	✗
<b>Typical NAND Production cycle</b>	5 years	1-2 years	3 years	3 years	6-12 Months

There's a finite number of times that a cell can be read to and written from before it stops working. This is usually on the scale of several hundred thousand reads and writes. However, it does mean that SSDs have a finite limit to their usability, even if it can take several years to get there.

## Connectivity: SATA vs NVMe: What's M.2?

You might've noticed these terms in descriptions of SSDs and HDDs. They look scary, but they're really not. Two of these simply refer to the type of input connector used. SATA is both a connector as well as an interface. It's an old, legacy standard and all conventional HDDs leverage it.

The main limiting factor is that SATA's maximum transfer rate is 600 MB/s. This isn't a problem with HDDs since they top out below 200 MB/s. But SATA SSDs will be substantially slower than their theoretical max speed. Furthermore, SATA based drives can perform only one kind of function at a time, read or write, not both. NVMe based M.2 SSDs can.



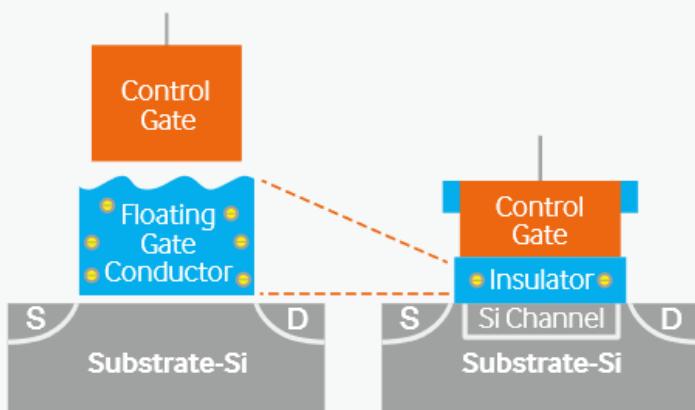
M.2 is simply a newer connection type. It slots right into your motherboard on an M.2 socket and can be connected to either a SATA or PCIe bus. M.2 SATA SSDs are smaller and thinner but still deliver SATA speeds. Meanwhile, M.2 NVMe SSDs connect through PCIe lanes on your motherboard and are smaller, thinner, and a whole lot faster. If you want the fastest storage, an NVMe SSD, connecting over M.2 is the way to go.

## 3D NAND and VNAND: These are Layers

What happens when you got no space remaining around you? You go up. That's basically what 3D NAND does. Traditionally, NAND cells were arranged in 2D. The more the number of cells, the larger the drive capacity (increased memory per chip). But as the demise of Moore's Law has taught us, there's a limit to how much you can shrink silicon.

So since there's no place for the cells in 2D, we start stacking them one upon another. This is called 3D NAND. It is not only cheaper but faster as well as more power-efficient. [This video explains it quite well.](#) Manufacturers often pair TLC and QLC based SSDs with 3D stacking or VNAND to further improve the price-performance ratio, making the drives more affordable.

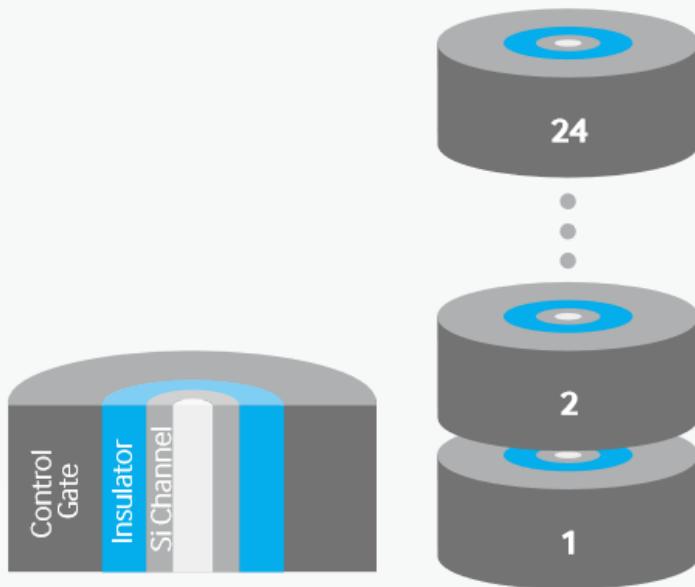
### 1 Innovation Material (2003)



### 2 Innovation Structure (2008)

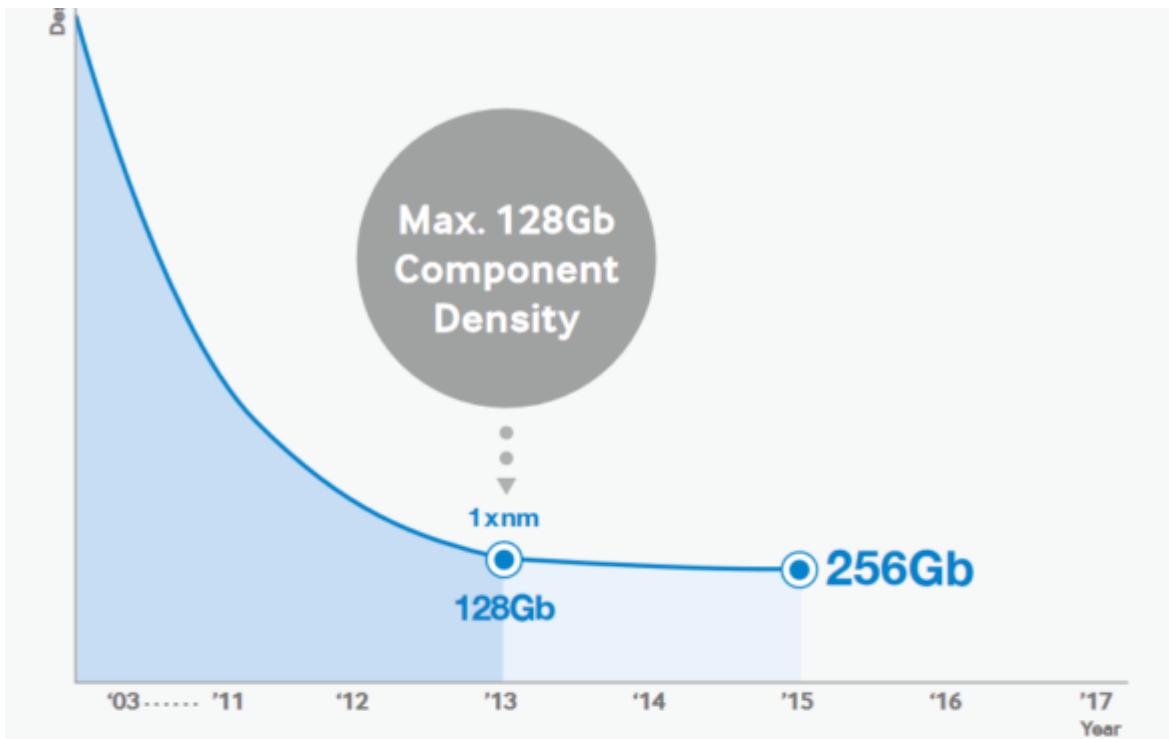


### 3 Innovation Integration (2008)

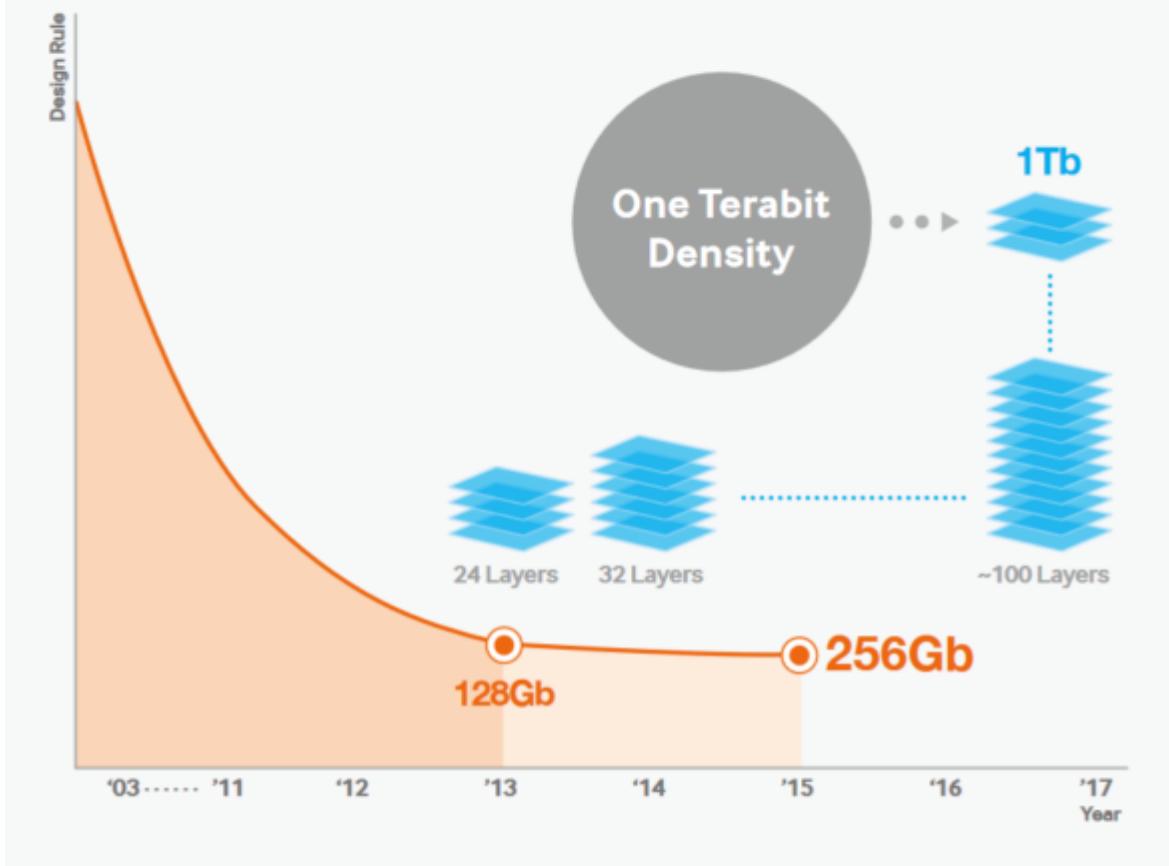


Samsung's VNAND technology is their version of 3D NAND, with some proprietary modifications in between.

#### ■ 2D Planar NAND Capacity Limitation



### ■ V-NAND Capacity Breakthrough



Higher density SSDs basically have a higher layer count. These days up to 96 layers of cells are stacked in consumer and enterprise SSDs. An estimated density of 1Tb is expected for 100-layer NAND chips.

We hope that cleared up everything about SSDs. If not, let us know in the comments section below.

Share this:



Areej

Computer Engineering dropout (3 years), writer, journalist, and amateur poet. I started Techquila while in college to address my hardware passion. Although largely successful, it suffered from many internal weaknesses. Left and now working on Hardware Times, a site purely dedicated to Processor architectures and in-depth benchmarks. That's what we do here at Hardware Times!



## Difference Between Intel and AMD Ryzen Processors: Chiplet vs Monolithic

## What do you think?

0 Responses

 Upvote Funny Love Surprised Angry Sad

0 Comments

Hardware Times

 1 Login Recommend Tweet Share

Sort by Best



Start the discussion...

LOG IN WITH

OR SIGN UP WITH DISQUS ?

Name

Be the first to comment.

Recent

Popular

Comments



MLC vs TLC vs QLC NAND SSDs: What's the Difference?

🕒 March 27, 2021



Difference Between Intel and AMD Ryzen Processors: Chiplet vs Monolithic

🕒 March 27, 2021

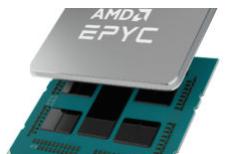


Analysts Upgrade AMD Stock Price, Calling Intel's IDM 2.0 a Blunder

🕒 March 26, 2021

5 Amazing Casino Myths

🕒 March 26, 2021



## Internet of Things: Trends of 2021

⌚ March 26, 2021

## NVIDIA RTX 3070 Ti to Launch with 8 and 16GB Variants of GDDR6X 19Gbps Memory

⌚ March 26, 2021

## Two New Security Vulnerabilities Discovered in Intel CPUs: Attackers Can Take Control of your PC

⌚ March 26, 2021

## NVIDIA and AMD were the Fastest Growing Chipmakers in 2020 with a Growth of 52% and 45%, respectively

⌚ March 26, 2021

## NZXT N7 B550: A Closer Look at the VRM and What We Like the Most

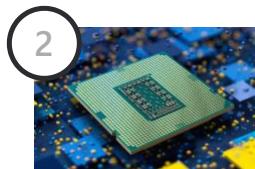
⌚ March 25, 2021

## Most Reviewed



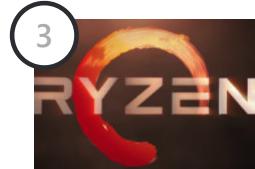
### MLC vs TLC vs QLC NAND SSDs: What's the Difference?

⌚ March 27, 2021



### Difference Between Intel and AMD Ryzen Processors: Chiplet vs Monolithic

⌚ March 27, 2021



### Analysts Upgrade AMD Stock Price, Calling Intel's IDM 2.0 a Blunder

⌚ March 26, 2021



### 5 Amazing Casino Myths

⌚ March 26, 2021



## Internet of Things: Trends of 2021

⌚ March 26, 2021

^

## Additional Content

We spoke with Sai Bhatti, Editor and Chief for Casinoexpressindia.com, and he explained to us which hardware he uses to test [Online Casino India](#). He uses the ASUS TUF Gaming A15 with a Ryzen 7 4800H and a GeForce RTX 2060 GPU, which offers ideal performance in games. It allows him to write the best reviews for his readers, providing them with the best experience.

## Categories

> News	1,423
> CPUs	815
> GPUs	604
> Gaming	461
> Memory and Storage	46
> Best	17
> PC Builds	14
> Uncategorized	13
> Peripherals	12
> Reviews	10
> Sponsored Post	4
> Deals	2

## Related Articles

[Micron May bring 3D XPoint \(Optane Memory\) to AMD Systems in the Next Few Years](#)

⌚ November 28, 2020



^

Apple Charging 700% More for its Memory (Yes RAM) than other Vendors, Despite Performing Exactly the Same

⌚ December 11, 2019



Xbox Series S Features a Repleacable SSD in M.2 2230 Form Factor

⌚ November 10, 2020

BenQ launches Zowie XL2746S eSports monitor with 0.5 ms Response Time and 240 Hz Refresh Rate

⌚ March 28, 2020

© Copyright 2021, All Rights Reserved | ❤️ HardwareTimes