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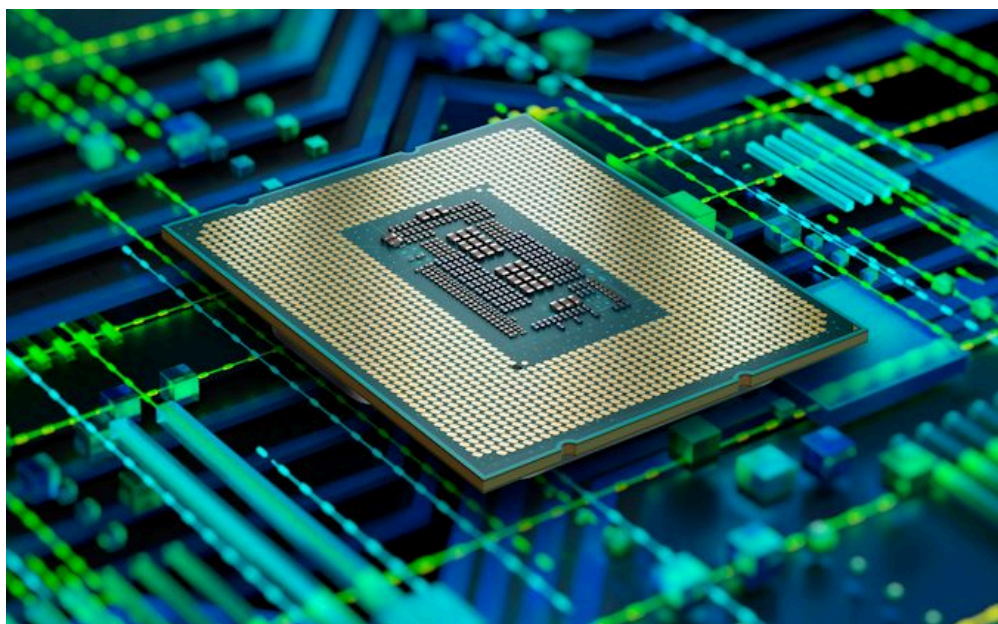
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Intel 12th Gen Core Alder Lake for Desktops: Top SKUs Only, Coming November 4th

by [Dr. Ian Cutress](#) on October 27, 2021 12:00 PM ESTPosted in [CPUs](#) [Intel](#) [DDR4](#) [DDR5](#) [PCIe 5.0](#) [Alder Lake](#) [Intel 7](#) [12th Gen Core](#) [Z690](#)

INTEL ANNOUNCES 12TH GEN CORE ALDER LAKE ▾



Over the past few months, Intel has been drip-feeding information about its next-generation processor family. Alder Lake, commercially known as Intel's 12th Generation Core architecture, is officially being announced today for a November 4th launch. Alder Lake contains Intel's latest generation high-performance cores combined with new high-efficiency cores for a new hybrid design, along with updates to Windows 11 to improve performance with the new heterogeneous layout. Only the six high-performance K and KF processor variants are coming this side of the New Year, with the rest due for Q1. We have specifications, details, and insights ahead of the product reviews on November 4th.

Today's announcement also coincides with [Intel's InnovatiON virtual event](#) happening today and tomorrow. This event is, as described in a number of press releases, a mini-Intel Developer Forum (IDF) event designed to emulate a small part of the [highly prized annual conference](#) that the company culled in 2017. As part of the event, there are 60+ sessions designed to cover new technology such as AI, networking, custom silicon, programming technologies/challenges, and introduce developers to more of Intel's ecosystem. It includes a day one keynote from CEO Pat Gelsinger and other executives to share the new hardware announcements, and a day two keynote from CTO Greg Lavender on the software side. The goal was for this event to be in-person, which is usually where the most value came from the old IDF event, however this is the first attempt to revive the format.

Six Alder Lake CPUs, \$589 For Core i9

The first things we'll go into are the new CPUs that Intel is announcing today: the overclockable models of Intel 12th Gen Core. As with previous launches, we have Core i9, Core i7, and Core i5, with the key highlights

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including new support for DDR5, PCIe Gen 5, new overclocking features, and a change in how Intel is promoting its Thermal Design Power (TDP).

This is *the table*:

Intel 12th Gen Core, Alder Lake

AnandTech	Cores P+E/T	E-Core Base	E-Core Turbo	P-Core Base	P-Core Turbo	IGP	Base W	Turbo W	Price \$1ku
i9-12900K	8+8/24	2400	3900	3200	5200	770	125	241	\$589
i9-12900KF	8+8/24	2400	3900	3200	5200	-	125	241	\$564
i7-12700K	8+4/20	2700	3800	3600	5000	770	125	190	\$409
i7-12700KF	8+4/20	2700	3800	3600	5000	-	125	190	\$384
i5-12600K	6+4/16	2800	3600	3700	4900	770	125	150	\$289
i5-12600KF	6+4/16	2800	3600	3700	4900	-	125	150	\$264

Each processor has a number of performance cores (P-cores) and efficiency cores (E-cores). The P-cores have SMT, whereas the E-cores do not, so we're dealing with non-standard numbers of total threads. Inside the system, the P-core threads, E-core threads, and SMT threads are categorized for performance and efficiency, which we'll get to later in the article. But with a new hybrid design also comes with new ways to showcase frequencies, and each set of cores will have its own base frequency and turbo frequency. The way power is marketed and used has also changed, designed to be clearer.

All processors will come with 16 lanes of PCIe 5.0 from the processor, and an additional 4 lanes of PCIe 4.0 for storage. Memory support is listed as both DDR5-4800 and DDR4-3200, although systems will only support one or the other, for a maximum of 128 GB. The K processors also feature 32 EUs of Intel's Xe-LP graphics, designated as UHD Graphics 770. Prices will start at \$264 for the base Core i5 model, up to \$589 for the top Core i9 model.

Core i9-12900K/KF

For the Core i9-12900K, if we work from the ground up, the E-cores have a base frequency of 2.4 GHz but will turbo up to 3.9 GHz; the P-cores have a base frequency of 3.2 GHz, and an all-core turbo of 5.1 GHz. The P-cores that are considered the best (aka favored cores) will turbo up to 5.2 GHz.

With all the cores active, the system has all 30 MiB of L3 cache available. Intel lists the base power as 125 W, with a turbo power of 241 W. The 1000-unit price for the K model is \$589, and the KF model without integrated graphics as \$564. As these are 1000-unit prices, retail is expected to be \$10-\$50 higher, depending on how Intel bundles the chip.

Compare at \$550-\$600

AnandTech	Cores P+E/T	P-Core Base	P-Core Turbo	IGP	Base W	Turbo W	Price \$1ku
i9-12900K	8+8/24	3200	5200	770	125	241	\$589
R9 5900X	12/24	3700	4800	-	105	142	\$549

On price, the Core i9 parts are up against the Ryzen 9 5900X (12C/24T, 3.7-4.8 GHz) at \$549. Intel has more actual cores, but AMD has more high-performance cores. At 105W/142W, AMD has the power advantage, but Intel has PCIe 5.0 and DDR5 support, with the K also having integrated graphics.

Core i7-12700K/KF

For the Core i7, Intel has removed one set of four E-cores, and also reduced the L3 cache to 25 MiB. This leads to an 8P+4E design, with 20 total threads. Over the Core i9, the E-cores in the Core i7 have a higher base frequency at 2.7 GHz, but a lower turbo frequency of 3.8 GHz. The P-cores are also higher at 3.6 GHz, but the turbo is 4.9 GHz, with the favored core at 5.0 GHz.

Intel lists the base power here as the same 125 W, but the turbo power is only 190 W. Pricing is at \$409 for the K model in 1000-unit quantities, with the KF at \$384. This puts it favorably against the Ryzen 7 5800X.

Compare at \$400-\$450

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AnandTech	Cores P+E/T	P-Core Base	P-Core Turbo	IGP	Base W	Turbo W	Price \$1ku
i7-12700K	8+4/20	3600	5000	770	125	190	\$409
R7 5800X	8/16	3800	4700	-	105	142	\$449

On price, the Core i7 \$40 is cheaper. While both have eight performance cores, the addition of four efficiency cores on the i7 is an interesting twist that might come down to how threads are managed and how Intel's single-core performance changes when threads are loaded. At 125 W, AMD still has the on-paper power advantage, but real-world testing will see if Intel is drawing level.

Core i5-12600K/KF

The Core i5-12600K loses two P-cores compared to the Core i7, for a 6P+4E design totaling 16 threads. What we have here is a design that effectively replaces 2P cores for a 4-core E complex, and so up against the traditional 8C/16T chips will be an interesting scenario – even against Intel's previous flagship, the 8C/16T Core i9-11900K.

The frequencies here change a bit as before, with an increased E-core base but lower E-core turbo. The P-core base is up too, but the P-core turbo is the same 4.9 GHz – the difference to the i7 is that there is no preferred core turbo mode.

Compare at ~\$300

AnandTech	Cores P+E/T	P-Core Base	P-Core Turbo	IGP	Base W	Turbo W	Price \$1ku
i5-12600K	6+4/16	3700	4900	770	125	150	\$289
R5 5600X	6/12	3700	4600	-	65	88	\$299

The price competition for the Core i5-12600K is going to be one of AMD's best sellers. The Ryzen 5 5600X is effectively the same price, and uses a 6C/12T design, rather than Intel's 6P4E/16T. If that looks confusing, we've got a fun few years ahead. It should be noted though that AMD's hardware has a TDP of 65W, almost half of the base 125 W power listed for the Core i5. The comparison of performance against efficiency is going to be an important one.

Chipset and Motherboards

Inside each processor, alongside the 16x PCIe 5.0 lanes for add-in cards and 4x PCIe 4.0 lanes for storage, is an additional link to the chipset. Intel lists this as a DMI 4.0 x8 link, as they use a custom protocol over an effective PCIe physical connection – we asked Intel, and they said the link is rated for 15.76 GB/s, which means the chipset can take two PCIe 4.0 x4 drives at peak before getting near to that limit. This is doubled compared to Z590, which was only 7.88 GB/s.

Today Intel is only announcing its Z690 chipset, built on Intel's 14nm, and the motherboard manufacturers have about 60+ models to launch in the upcoming week. The processors use a new LGA1700 socket, which means everyone buying the new CPUs also need a new motherboard. Most of the big motherboard companies are holding their own product announcement events, so keep a lookout for those. Each motherboard will support either DDR5 or DDR4, not both, along with enhanced overclocking - more detail on that below.

Introducing the Intel® 600 Series Chipset

New Platform Capabilities

NEW Chipset PCIe 4.0 lanes

NEW x8 DMI Gen 4.0 for double and faster bandwidth between chipset and processor

NEW Integrated Intel® Wi-Fi 6E (Gig+)

NEW Intel® Volume Management Device (Intel® VMD) for user friendly PCIe device management

Additional USB 3.2 Gen 2x2 20Gbps for double the USB connectivity speed[†]

Integrated Intel® Wi-Fi 6E (Gig+)	DMI Gen 4.0 – 8x Lanes	Intel® High-Definition Audio
Intel® 2.5G Base-T MAC/PHY Ethernet	Intel® Extreme Tuning Utility Support	Intel® Smart Sound Technology
Intel® Integrated 10/100/1000 MAC	Intel® Platform Trust Technology	Intel® Management Engine Firmware
USB I/O		Intel® Rapid Storage Technology for SATA & PCIe Storage
Up to 4 x USB 3.2 Gen 2x2 Ports		Intel® Rapid Storage Technology with RAID
Up to 10 x USB 3.2 Gen 2x1 Ports		Intel® Optane Memory with Solid State Storage Support
Up to 10 x USB 3.2 Gen 1x1 Ports		
14 x USB 2.0 Ports		
PCIe Gen 4.0 – up to 12x Lanes + PCIe Gen 3.0 – up to 16x Lanes		SATA 6Gb/s – 8x Lanes

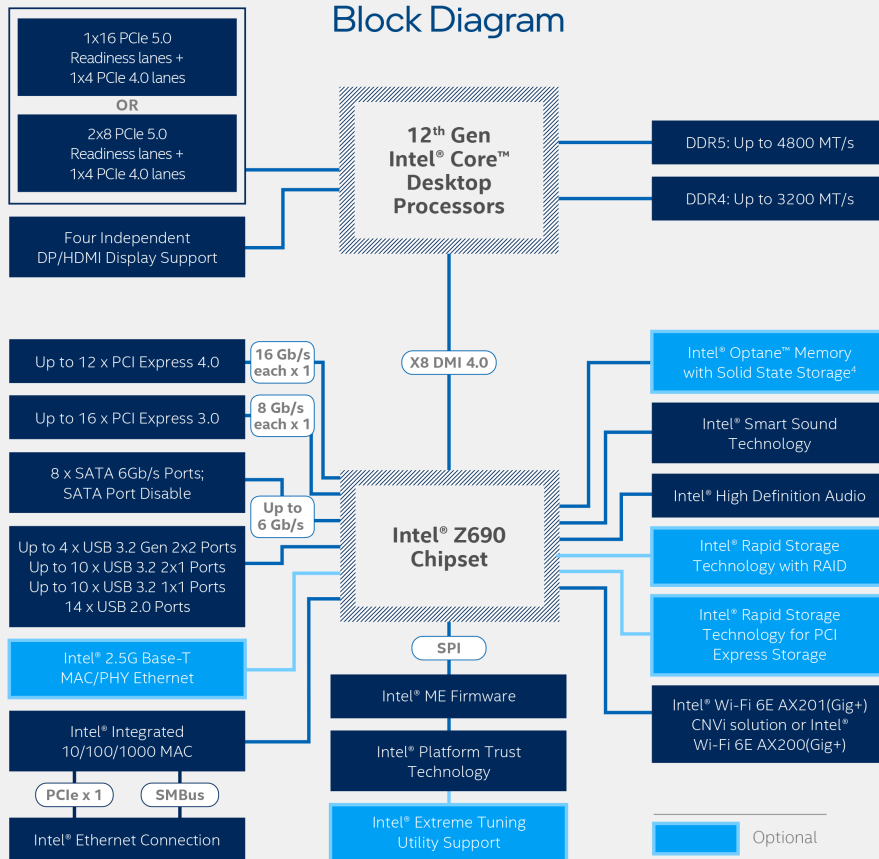
INTEL® Z690 CHIPSET

[†]USB 3.2 Gen 2x2 compared to USB 3.2 Gen 2x1 10Gbps.
[‡]CPU/PCIe lanes are only validated for discrete graphics (dGPU) and PCIe storage.
[§]Intel Hybrid Storage devices such as Pervasive Storage (P-SSD) can't attach to CPU/PCIe due to PCIe 3x2 requirement.
 See 12th Gen Intel Core Desktop Processor Blueprint Appendix for additional details. Results may vary.

Embargoed until October 27, 2021 at 9:00 AM PT

The Z690 chipset will have 12x PCIe 4.0 lanes and 16x PCIe 3.0 lanes, some of which will be earmarked for general IO use. This includes up to four 20 Gb/s USB ports, up to ten 10 Gb/s USB ports, up to ten 5 Gb/s USB ports, and up to fourteen USB 2.0 ports (although not all at the same time). There are eight SATA ports, along with support for Intel's onboard RAID. The PCIe storage also now uses Intel's Volume Management Device (VMD) to assist with PCIe management.

Intel® Z690 Chipset Block Diagram



Intel lists an integrated Wi-Fi 6E MAC in the chipset as well, requiring the respective PHY and RF connected over CNVi, which is a proprietary Intel interface – any motherboard manufacturers wanting to use other Wi-Fi 6 solutions will have to directly connect via PCIe as they can't use the closed standard.

Intel also lists 2.5G Base-T support for wired Ethernet, although that's a bit of a misnomer here – it's simply an attached PCIe device using the above-mentioned lanes, and the MAC/PHY still needs to be purchased. This is a similar tactic to previous announcements – users could also add a RAID card in a similar fashion or an FPGA accelerator, however Intel doesn't highlight those.

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Intel's chipsets employ a great deal of port flexibility – it is essentially a big PCIe switch with a few added extras. It means almost everything that can be attached to a PCIe bus can be used. But with previous generations, there are going to be some limitations with the high-speed IO lanes (such only certain lanes can be used for SATA or Ethernet, limiting perhaps the number of PCIe x4 slots), but some combinations will be better supported than others. Users looking for Thunderbolt 4 support will have to find motherboards with an added controller, as the Alder Lake desktop processors do not have it built-in like the mobile versions.

Intel has not specified the TDP of the Z690 chipset, however we're yet to see a motherboard with active cooling, so it's likely to be in that 7-12W range as with previous generations. We expect to see Z690 motherboards range in price from \$200 up to \$700+, similar to Z590 pricing.

No More TDP: Base Power and Turbo Power

In the past, Intel promoted its processor power as a single number: TDP (Thermal Design Power*). The issue wasn't so much that this number was wrong, it was because it lacked massive context that wasn't communicated to anyone. Arguably [it took us several years](#) to find out what it really meant, especially in relation to its turbo.

**Technically TDP is defined differently to power consumption, however they are effectively interchangeable at this point, both in common parlance and Intel documentation.*

What Intel was promoting wasn't the power consumption in regular operation, but the guaranteed power consumption for the base processor specifications. That means if a user purchased a six-core processor, base frequency at 3.0 GHz, and a TDP of 65 W, then those are the only specifications that were covered under warranty. Even if the box showcased that the processor was capable of enabling a turbo up to 4.0 GHz, that wasn't guaranteed. Beyond that, the power consumption of the turbo mode wasn't specified either, so if the same processor went up to 30-50% higher than 65 W, there was no explicit number from Intel, aside from digging through specification sheets that sometimes weren't even public, to get a number to help build cooling into the system. It also meant that reviews of hardware that were labeled as 125 W, but consumed 250W+ in turbo mode, weren't able to accurately demonstrate the scope of the product without additional power monitoring. It got to a point where Intel's power consumption under turbo became a bit of a meme, and enthusiasts got annoyed that Intel buried this information away.

That changes with Alder Lake. Intel is now acknowledging that its turbo mode does indeed have a power increase, and is providing that number alongside the regular set of numbers. To that end, the base 'TDP' number of previous generations is gone, and we get two numbers to talk about:

- *Processor Base Power (Base): Guaranteed Peak Power at Base Frequency*
- *Maximum Turbo Power (Turbo): The Maximum Power at full turbo mode that is in spec*

So for example, the Processor Base Power (Base) for the Core i9-12900K is set at 125 W. The Maximum Turbo Power is 241 W. This means that systems using this processor will be able to boost up to 241 W if the system is set up to do so, and that is within specification.



For the six processors being announced today, there's also an added bonus. Under the previous regime, how long a processor could spend in that higher power mode was limited. Intel had a specification for this, which to be honest most motherboard manufacturers ignored anyway, because that length of time was only a

guideline, not a rigid specification, and it didn't break the warranty. Intel is now so confident in its turbo performance, that the new K processors have a default guideline of an unlimited turbo. It should be noted that when Intel launches the rest of the Alder Lake processors, this won't always be the case.

For users who understand the former PL1/PL2 methodology, it still technically exists under the hood here, where Base is PL1 and Turbo is PL2, but Tau is effectively infinite for K processors.

More in this overview:

- *Cache and Hybrid Designs*
- *Thread Director*
- *DDR5: Support, XMP, New Features*
- *Packaging and Overclocking*
- *Performance and Conclusions*

CACHE AND HYBRID DESIGNS

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[shabby](#) - Wednesday, October 27, 2021 - link

Typo in the 12600 charts... 20 threads or 16?

[nandnandnand](#) - Wednesday, October 27, 2021 - link

16 threads.

$2p + e = 2*6 + 4$

Thread count typos are going to happen a lot with Alder Lake, Raptor Lake...

[at_clucks](#) - Friday, October 29, 2021 - link

20-30 years ago it was really easy to know everything important about a CPU (frequency more or less, maybe multiplier/FSB) just by looking at the model name. Intel made it really confusing for the past few generations even for the relatively mundane setup with multi-identical-cores at a certain frequency. Now with the different types of cores, different base and turbo frequencies, different thread count, etc. you'll have to search for the table every time.

And we're in the easy part now, just high end, all models ending in "00". Can't wait for the "12672KSF" which has random tweaks here and there depending on what they could get out of the wafer.

[yeeeman](#) - Friday, October 29, 2021 - link

Neah, if you went to school at least you can count.

[Hifihedgehog](#) - Wednesday, October 27, 2021 - link

AMDead... until Zen 4. Zen 3+ is dead to me, because Zen 3+ is a band-aid solution to hobble along until they can get Zen 4 is out the door. Packing on a cache block is not going to beat this. Only a fresh and fast microarchitectural update can regain performance for AMD. And that update is Zen 4.

[Hifihedgehog](#) - Wednesday, October 27, 2021 - link

Also, timing is crucial and hitting the moving target. Zen 4 may beat Alder Lake but can it beat Raptor Lake which will likely come out late next year? If not, AMDead will be dead even with Zen 4, even if Zen 4 is a huge improvement over Zen 3. AMD has to compete against Intel's best at time of release, not against itself.

[schujj07](#) - Wednesday, October 27, 2021 - link

Yes because we have independent benchmarks out already from real world usage and not Geekbench. Don't forget to look at the power usage on the new Intel CPUs. They very well could be faster than AMD, however, if they need double the power to be 15% faster that really isn't a win.

[shabby](#) - Wednesday, October 27, 2021 - link

Don't think intel cares about losing the efficiency crown on the desktop, they just want to be at the top of the charts at all costs. Now in the server department with dozens of cores then it starts to bite them in the ass.

[Hifihedgehog](#) - Wednesday, October 27, 2021 - link

Most desktop users could care less about power efficiency. If this were a laptop or notebook question, that would be a totally different story. That is an interesting point you bring up, though! It's likely why Intel released desktop BEFORE mobile. Historically, they release first to mobile and then desktop. Power efficiency may be very well why they opted to avoid pushing it to mobile first. Or not at all. They may just be trying to counter AMD where it hurts most, in their current Ryzen stronghold.

[schujj07](#) - Wednesday, October 27, 2021 - link

Power efficiency does make a slight difference on the desktop. If you need use a huge AIO or air cooler compared to a mid range air cooler that hurts your pocket book. That can also make your system louder than the comparable other system. Not to mention it will affect your summertime electric bill if it keeps heating up the room so your AC is kicking on.

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