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Welcome

Custom PC Issue 227

/ FROM THE EDITOR

Socket to me

AMD hasn't been left cowering by Intel's Alder Lake assault, and it's continuing to return competitive fire. As you can see from this month's Labs test (see p50), the CPU market is really complex at the moment. Intel is going all out on performance and pricing, while AMD is bolstering its aging Zen 3 microarchitecture with new tech, such as 3D V-Cache.

AMD has also added another interesting weapon to its arsenal, and it's one where Intel simply doesn't have an answer – backwards compatibility. For a lot of people, it doesn't matter if your latest CPU is awesomely fast in isolation, if it then also needs a new motherboard then it's a bigger investment. AMD knows this, and the longevity of its AM4 socket gives it an advantage.

Socket AM4 was first launched way back in 2017, a good five years ago, but AMD's recent move to open up 300-series chipsets to the latest CPUs means you could put a brand-new Ryzen 7 5800X3D CPU in a motherboard that you bought back then. It will involve removing support for a whole load of older CPUs, of course, as the old BIOS chips simply don't have room for that much information, but it's an olive branch for people using older systems. You might not get access to new tech such as PCI-E 4, but you'll get a fast CPU, and many aging motherboards also already support new features such as Resizable BAR.

Compare this with Intel, which introduced its 8th-gen Coffee Lake CPUs with the LGA1151 socket in the same year. Since then, LGA1151 has been dropped in favour of LGA1200, which has now been replaced by LGA1700. Forget opening up room in the BIOS – the new CPUs simply won't even go in the old sockets.

This isn't just about cynically building obsolescence into your products – there are benefits to Intel's new sockets from the extra pins, even if it's sometimes just grounding. However, Intel really needs to look at the longevity of its sockets, and think about adding those extra pins for future CPUs before they're needed.

If AMD can make one socket last through three different microarchitectures, and five years of CPU launches, then so can Intel. If you make your platform as flexible as possible, then more people are going to sign up to it and continue to buy into it as time goes on. CPC

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CUSTOM PC

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Contents

Welcome to Issue 227

Highlights

Cover guide

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Reviewed

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CPU Labs

Games

Hobby tech

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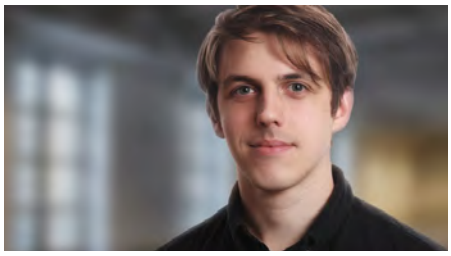

RICHARD SWINBURNE / VIEW FROM TAIWAN

DO WE NEED A 240W LAPTOP?

Richard Swinburne takes a sceptical look at Asus' latest top-end gaming laptop, which packs a 16-core CPU and RTX 3080 Ti GPU

Intel recently launched its new Core-i9 12900HX and 12950HX mobile CPUs – 16-core, 24-thread beasts with peak clock speeds of 5GHz and 5.2GHz respectively. It's not the first time we've seen 16-core chips shoehorned into laptops, as both the AMD Ryzen 9 3950X and 5950X found their way into a couple of desktop-replacement designs, but these Intel models are official mobile CPUs for laptops.

I say laptops, but we're talking occasionally portable machines at best here. There's no way one of these machines is going to sit on your thighs without you repurposing several pairs of oven gloves into shorts first.

The Asus ROG Strix Scar 17 Special Edition crams both a Core i9-12950HX and an Nvidia GeForce RTX 3080 Ti GPU into a reasonably slim slab for your desk. Asus claims its design can handle up to a sustained 240W of power – 65W from the CPU and 175W from the GPU. That's 25W more legroom for the RTX 3080 Ti over the previous Scar 17 launched just a few months ago.

The fact that all this top-end gear is packed into a machine measuring 2.83cm thick is impressive. Asus has managed this by using a gigantic vapour chamber that covers half the motherboard, plus a special Conductonaut Extreme thermal compound co-developed with Thermal Grizzly.

However, that heat still needs to get out of the machine, and Asus uses just two fans to push out the heat via four vents. It claims the fans produce under 40dB in its Performance Mode, but doesn't reveal how hot the surface temperature becomes during extended use. This sounds like a marketing opportunity for desk-sized, water-cooled mouse mats.

> A gigantic vapour chamber covers half the motherboard

Rounding off the uncompromising excess, the Scar 17 SE also packs up to 4TB of M.2 storage in RAID 0 configuration, up to 64GB of DDR5 memory and an extremely fast 360Hz display if you only need a 1,920 x 1,080 resolution, or 'just' 240Hz if you want a roomier 2,560 x 1,440 resolution.

But how many people are going to be really interested in such a machine and, what's more, who is the competitor here? It seems Intel is pushing this new chip because, finally, AMD Ryzen 6000 laptops are starting to appear on the market. Launched at CES in January six months ago, we had only seen a smattering of laptops from just two brands – Asus and Lenovo. Since late May, suddenly several more laptops, and even a handled Steam Deck clone, suddenly started appearing with them.

Asus' new ROG Flow X16 features a Ryzen 9 6900HS too, and at just over half the price of the Scar 17 SE, it seems a *much* better option. Its 16.1in QHD display may 'only' be 165Hz, but its mini-LED display provides proper HDR with 512 dimming zones and 1,100 nits of maximum brightness. The 16:10 aspect ratio also gives a touch more useful vertical height, and its 360-degree hinge design folds back on itself like a tablet, or it can sit tented, keeping the keyboard out the way, so you can use your own mechanical keyboard and mouse.

The Flow X16 can come with up to an Nvidia RTX 3070 Ti GPU and 2TB of M.2 storage, which is plenty. Importantly, it's thinner, lighter and cooler-running, although Asus does use three fans to cool the (and I'm not making this up) 'Frost Force Technology with Pulsar Heatsink'. You'll probably get a few hours of use away from a plug socket from this machine too, unlike the Scar 17 SE. More power isn't always better. CPC

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan @ricswi

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TRACY KING / SCEPTICAL ANALYSIS

FIFA FO FUM

Tracy King looks at the current row between FIFA and EA for official video game rights to the beautiful game

FIFA and EA are no longer playing on the same team, although it's impossible at this stage to tell which of them has taken the ball and gone home. FIFA wanted a billion pounds over four years, a bigger cut of a franchise worth 20 times that, and now the fans at the intersection of football and video games are torn. Should we remain loyal to EA and the game we've known and loved for 20 years? Or is FIFA's stamp of officialdom – and all the perks that might include – ultimately a dealbreaker?

In an official statement, FIFA said it 'is currently engaging with leading game publishers, media companies and investors in regard to the development of a major new FIFA simulation football game title for 2024', which is laughably ambitious. Starting from scratch would require more than two years, unless FIFA partners with, say, Konami or 2K.

Last year, Pro Evolution Soccer – EA's biggest competitor – rebranded as eSoccer and lost a lot of fans, with its janky gameplay earning it a kicking on Steam. A great way to regain some trust and bring in loads of new players (and investor cash) on the back of a failing reputation would be to partner with FIFA. Alternatively, 2K is riding high in the sports franchise wars with the NBA, and could plausibly rework its resources to turn round a football game in two years.

Without investing in and rebranding an existing game, FIFA risks launching a duff, and then it won't matter what name is on the front. But what does the data say? Football fans might stay loyal in the face of criticism. For example, while the International Olympic Committee and other major sporting bodies widely condemned FIFA's plans for a men's World Cup every two years instead of four, a worldwide fan survey showed that over 60 per cent of fans would support the idea.

Of course, that survey was done by FIFA and had the slightly dodgy caveat 'provided that player workload does not increase'. However, continued fan support for the World Cup in Qatar, despite multiple accusations of human rights abuses, modern slavery and corruption, does also lend some weight to the FIFA side. But there isn't an alternative World Cup to support instead, so that point is moot.

What isn't moot, though, is whether that real-life loyalty has a significant impact on video game loyalty. A 2004 study in the Journal of Interactive Advertising showed that gamers are keen on in-game billboard adverts if they add to realism, which in this case would mean real brands and ideally copies of real in-stadium billboards. Another study by the same researcher suggests that sports gamers in particular feel positively about in-game ads. Authenticity matters in football. Teams, grounds and players are huge brands.

> The biggest selling point of EA's offering is real players

The biggest selling point of EA's offering is real players, real kits and real clubs. EA has a contract with FIFPRO, extended at the same time that the EA SPORTS FC trademark was registered back in October 2021. A sort of a union for footballers, the association negotiates image and media rights for players, and has committed to EA for the foreseeable future, which includes a licence for the major leagues, including the Premier League.

And that's where EA currently has the advantage, but for how long? Big players including Zlatan Ibrahimovic have recently criticised EA and FIFPRO, and a controversy is brewing. If there's a mutiny over image rights then FIFA will sweep in and it will be game over for EA. CPC

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming @tkingdot

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Incoming

AMD UNVEILS ZEN 4 GOODIES

AMD has revealed a few more snippets of information about its forthcoming Zen 4 platform. The company says that the chiplets for its forthcoming Ryzen 7000-series desktop CPUs are still on schedule to be manufactured on a 5nm process node, and will also feature a new I/O die manufactured on a 6nm process.

AMD says the latter will feature integrated RDNA2 graphics, as well as a PCI-E 5 controller and DDR5 memory controller. The latter will bring AMD's CPUs in line with the I/O standards of Intel's 12th-gen CPUs, while the former will potentially give AMD CPUs an advantage over Intel equivalents for people using integrated graphics. The platform will offer 24 PCI-E 5 lanes and up to 14 high-speed 20Gbps USB ports.

AMD states that the CPUs can have maximum boost speeds in excess of 5GHz, 1MB of L2 cache per core (double the 512KB in Zen 3 CPUs) and a 15 per cent uplift in single-threaded performance. AMD has also lifted the lid on its motherboard chipset line-up, which will feature the new AM5 socket with 1,718 LGA pins. At the top of the line is the X670 Extreme chipset, which AMD says offers PCI-E 5 everywhere, as well as 'extreme overclocking' capabilities. Meanwhile, the standard X670 chipset offers 'enthusiast overclocking' capabilities, and has support for PCI-E 5 storage and graphics. At the bottom of the pile is the B650 chipset, which supports PCI-E 5 storage.

Regarding the latter, AMD says that several manufacturers are already lining up to make PCI-E 5 SSDs based on Phison's new controller, including Seagate, Micron, Crucial, Corsair and Sabrent.

According to AMD, these SSDs are projected to improve the sequential read speed by up to 60 per cent compared with PCI-E 4 drives. The new CPUs and chipsets are due to be officially launched in autumn this year.

ASUS ANNOUNCES ZEN 5 BOARD

Following on from AMD's Zen 5 reveal, Asus has announced a top-end motherboard based on the forthcoming X670 Extreme chipset. The ROG Crosshair X670E Extreme will offer two 16x PCI-E 5 slots, along with five M.2 slots, four of which support 4x PCI-E 5 mode. Other top-end features include both 2.5Gbps and 10Gbps networking, an ESS ES9218PQ Quad DAC for the audio system and a very fancy 'AniMe Matrix' display, made up of an array of LEDs that Asus says can 'show off custom retro-style animations'.

CORSAIR SHOWS OFF ITS FIRST GAMING LAPTOP

Corsair has revealed that it's branching out into the laptop market, with a new portable machine that's aimed at streamers. The Voyager a1600 is based on all-AMD core silicon, including a Radeon RX6800M GPU and a choice of two 8-core CPUs – the Ryzen 7 6800HS and Ryzen 9 6900HS.

The laptop also comes with either 1TB or 2TB of PCI-E 4 storage, 32GB or 64GB of DDR5 memory, Cherry MX Ultra-Low Profile mechanical key switches and a row of ten Elgato Stream Deck keys at the edge below the screen. Meanwhile, that screen has a resolution of 2,560 x 1,600, giving it a 16:10 aspect ratio, and a super-fast 240Hz refresh rate.

Corsair has also kitted out the keyboard with Capellix LEDs on a per-key basis, and there are plenty of other streaming features too, including a directional array of four microphones with ambient noise cancellation, and a 1080p webcam. Prices start at $2,700 (around £2,579 inc VAT) for the Ryzen 7 6800HS model with 32MB of RAM and 1TB of storage.

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Letters

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Water really works

The Issue 225 editorial, called Water works, says that the thermal benefits of water cooling have no importance. An editor trying to be ... what? I'm hoping that you get a few letters commenting on this. My own system, which I use for home computing plus a DVD jukebox, is a Ryzen 9 3900X in an Asus X470 Crosshair motherboard with two 280mm radiators, without overclocking.

My typical CPU temperatures are between 30-65°C – usually on the low side, but with occasional peaks to 71°C. I would prefer the temperatures to be lower, but it's still better than when I used a good air cooler, from the Titan Fenrir to the Corsair A500. I'm hoping that a 65W CPU will soon perform almost as well as a 3900X, as that will be easier to get running really cool.

ANNEVE JANE BARKER

Ben: Don't get me wrong – I *love* water cooling and, to be pernickety, I said the thermal benefits aren't *that* important now, not that they have no importance – I'm not deliberately trying to be one of those columnists who pushes people's buttons for a reaction, and I'm sorry if that's how I came across. To be clear, water-cooling your system can be a great way to not only reduce temperatures, but also fan noise (the latter is one reason why I water-cool my hardware).

However, it can also be a struggle to justify these benefits to the average PC gamer when the cost of buying all the gear for a custom loop is so enormously higher than the cost of a decent air cooler or AIO cooler, and the benefits in terms of tangible performance and throttling are minimal. Your 12-core CPU is obviously going to challenge an air cooler, but a decent AIO cooler would do the job without your CPU throttling, even if the temperatures weren't as low.

My point was that there's a lot more to water cooling than thermals, such as the fun of building and planning a loop, the challenge of cutting and bending hard tubing, and the reward of having a system that looks amazing at the end of it.

Our water-cooled PC keeps our CPU super-cool, while also presenting a fun building challenge and rewarding you with an awesome-looking PC

When's the next issue out?

CUSTOM PC

JULY 07

Issue 228
On sale on Thursday, 7 July

Mini coolers

I'm a long-term subscriber now living in the USA and reading digitally, and I still routinely read the magazine cover to cover, so keep up the excellent work!

Quick question – I love the Lian Li W58 and will hopefully pick one up for a new system using a Core i5-12600K (I'll run it at stock speed – I agree with recent comments by James Gorbold on overclocking not being worth it these days, sadly).

I just wondered what CPU air cooler you used in the mini-ITX case Labs – the case has a 67mm CPU cooler height limit, and the Noctua NH-L12S unfortunately is 70mm high.

JOSHUA PRIEST

We use a Noctua LH-L9i to cool our CPU for mini-ITX case tests

Antony: We used the Noctua LH-L9i. This is a very low-profile cooler, and the Core i5-10600K we used in the Labs pushed it to its limit in the poorer-performing cases. However, using this cooler means we can use the same motherboard, CPU and cooler in any mini-ITX case. The trouble with mini-ITX is that many cases, the Q58 included, are more geared towards AIO liquid coolers, as they use a sandwich-style setup with space in the roof and sacrifice CPU heatsink clearance.

I recommend you also look at the Noctua NH-L9x65; as its name suggests, this is only 65mm tall but has a thicker heatsink than our LH-L9i, so it should be able to cope with a stock speed Core i5-12600K. In addition, Lian Li sells full vented side panels for the case, which replace the top glass section for improved airflow.

Wireframe

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Reviews

SAPPHIRE NITRO+ RADEON RX 6750 XT / £650 inc VAT

SUPPLIER scan.co.uk

Determined to squeeze every last drop of performance from its RDNA2 GPU architecture before it disappears over the horizon, AMD has introduced some 'new' GPUs that add a 50 to their predecessors' model names. At the top of the line is the Radeon RX 6950 XT (see over), while in the mid-range sits the Radeon RX 6750 XT.

Don't get too excited here – these aren't new GPUs by any stretch of the imagination. They're not even old GPUs with a couple more Compute Units enabled. The Radeon RX 6750 XT is basically exactly the same as the Radeon RX 6700 XT that came before it. There are 2,560 stream processors, 40 Ray Accelerators and 12GB of GDDR6 memory attached to a 192-bit wide interface.

The only differences are the clock speeds. For starters, the memory speed has been increased from 2GHz (16GHz effective) to 2250MHz (18GHz effective), which is faster than the reference memory clock on any of AMD's previous RDNA2 GPUs. The core clock has also been improved, with AMD's reference spec having a 2495MHz game clock and 2600MHz maximum boost clock, compared to 2424MHz and 2581MHz respectively for the Radeon RX 6700 XT.

The Sapphire Nitro+ card we're reviewing here also increases those clock speeds a little further to 2554MHz and 2623MHz effectively. However, monitoring the clock speed during testing showed the real-world figures were much higher, with the GPU peaking at 2789MHz and averaging around 2697MHz.

SPEC

Graphics processor
AMD Radeon RX 6750 XT, 2554MHz game clock, 2623MHz boost clock

Pipeline
2,560 stream processors, 64 ROPS

Ray Accelerators
40

Memory
12GB GDDR6, 2248MHz (18GHz effective)

Infinity Cache
96MB

Memory interface
192-bit

Card interface
16x PCI-E 4

Bandwidth
432GB/sec

Power connectors
1 x 6-pin, 1 x 8-pin

Card length
310mm

Expansion slots
3

Lighting
3 x ARGB fans, 2 x ARGB lighting zones on cooler

Extras
Expansion slot support bracket, BIOS switch

The card

Unlike Sapphire's Nitro+ Pure card over the page, the Nitro+ Radeon RX 6750 XT looks more like the Nitro+ cards we've seen before. It's a bit wider, taking up three expansion slots, rather than the two and a half of the Nitro+ 6700 XT, and there are some changes to the design of the backplate, but the two cards look very similar from the front.

You also get an expansion slot support bracket to prevent the card from drooping in your case, and there's RGB lighting on the side edge and backplate of the card. There's no RGB lighting on the fans, but that doesn't really matter much when you won't be able to see the fans in most cases anyway.

It's a great-looking card, and as with the Nitro+ Pure card, you can switch between BIOSes by flicking a switch on top of the card, or using Sapphire's Trixx software, which also enables you to control the lighting. The lighting options are a bit limited, with no option to cycle through different custom colours, for example, but the addition of a 3-pin ARGB header on the back of the PCB enables you to connect the lighting system to your own controller and sync it with the rest of your system.

SAPPHIRE

- \+ Attractive design
- \+ Cool and quiet card
- \+ Faster than Radeon RX 6700 XT

LEAD GLASS

- – Struggles with ray tracing
- – Can't compete with RTX 3070
- – Too expensive

Performance

Let's start with the good news, which is that the Sapphire Nitro+ 6750 XT's extra clock speed really helps it in AMD-optimised games. At 1,920 x 1,080 and 2,560 x 1,440 with Resizable BAR enabled, it was even faster than the GeForce RTX 3080 Ti in Assassin's Creed Valhalla, for example, with frame rates staying well above 60fps at the latter resolution, and averaging a mighty 118fps at the former.

Sadly, the picture isn't so rosy in our other test games. The Sapphire Radeon 6750 XT was consistently behind the GeForce RTX 3070 in Cyberpunk 2077 and Metro Exodus, for example, even without ray tracing and it's priced in a similar league to RTX 3070 cards.

Once you add some ray tracing, the situation gets worse, with the Sapphire 6750 XT even lagging behind the cheaper GeForce RTX 3060 Ti across the board. You can get a playable frame rate in Cyberpunk 2077 at 1,920 x 1,080 with Medium ray tracing if you enable FSR, but that's a low bar for a £650 card.

It could handle Doom Eternal with ray tracing at 2,560 x 1,440 with ray tracing, though, at a decent average of 130fps. It also held up surprisingly well in this game at 4K without ray tracing, averaging 137fps, compared to 120fps for the RTX 3070. In comparison, the Radeon RX 6700 XT is only a little slower than this card. That extra clock speed gives it a solid 20fps advantage in Assassin's Creed Valhalla at 1,920 x 1,080, but in other games, the difference is more muted, especially once you start playing at 2,560 x 1,440 – it's not an enormous upgrade.

On the plus side, we love Sapphire's work on the cooler. The fans hit a peak of 1,620rpm under load in our tests, and you could barely hear them even then. The peak GPU temperature of 60°C, and peak junction temperature of 86°C, are also fine, and there was no evidence of throttling, with the GPU able to go well beyond the stated maximum clock speeds. You'll need to make sure your case has room for it, but this is a good-looking, quiet and cool-running card.

Conclusion

We've been fans of Sapphire's Nitro+ cards for a while, with their low-noise operation, decent build quality and great looks, and the Nitro+ Radeon RX 6750 XT is another fine example. It's cool, quiet, great-looking and really well designed. However, that's not a lot of help when the GPU under all that cooling gear struggles to keep up with the competition, and that's the case here.

The Radeon RX 6700 XT enjoyed a brief moment as our mid-range GPU of choice for a while, when it was significantly cheaper than the GeForce RTX 3070, but the price of Nvidia's GPUs has now come right down, and not even a healthy injection of clock speeds can help this GPU compete with the RTX 3070 now that it's in the same price range.

This is a top-end example of a Radeon RX 6750 XT card, of course, and there are cards going for around £570, but the same is also true for the RTX 3070. That's a shame, as Sapphire has done a great job with the build. If you have £650 to spend on a graphics card, though, you'll get better all-round performance from a GeForce RTX 3070 card.

BEN HARDWIDGE

VERDICT

A solid bump in clock speed and a cool, quiet and good-looking card, but at this price, you'll be better served by a GeForce RTX 3070.

PERFORMANCE **38/50**

FEATURES **17/20**

VALUE **16/30**

OVERALL SCORE **71%**

SAPPHIRE NITRO+ PURE RADEON RX 6950 XT / £1,200 inc VAT

SUPPLIER overclockers.co.uk

Ah, remember those halcyon days when a £1,200 graphics card price tag seemed extortionately expensive, rather than comparatively good value after two years of chaos? While Nvidia's all-out Ampere swansong, the GeForce RTX 3090 Ti (see Issue 226, p19) will set you back at least £1,879 inc VAT, AMD is hoping to tempt 4K gamers its way with the much cheaper Radeon RX 6950 XT.

Of course, the GeForce RTX 3090 Ti isn't just a speed-binned RTX 3090 with higher clock speeds – it also has two extra Streaming Multiprocessors enabled, giving it a (very slight) advantage in parallel shading power. Comparatively, the Radeon RX 6950 XT's Navi 21 GPU is the same as that of the Radeon RX 6900 XT – it just has faster clock speeds.

In this case, though, Sapphire has paired these new speed-binned GPUs with a super-powerful PCB and cooler setup that frees the GPU to boost far beyond the stated spec. AMD quotes a typical board power of 'at least' 330W for Radeon RX 6950 XT cards, with a 2100MHz game clock and 2310MHz boost clock.

Comparatively, Sapphire quotes a 2162MHz game clock and 2368MHz maximum boost clock for the Nitro+ Pure Radeon RX 6950 XT, thanks to a 370W total board power. What's more, there's the ability to push it up to 390W with a 2425MHz boost clock in its OC mode, enabled by swapping the card to a different set of BIOS settings. It comes with a handy BIOS switch on the top of the card, which enables you to switch between modes.

However, we found that the OC mode made little difference to performance, as the Sapphire card's extra power and immense cooling system already frees up the GPU to boost much further than the stated specs. We observed a 2660MHz peak in our game tests, with the clock speed generally running at around 2555MHz, so we happily left the card running at its default settings.

AMD has also taken this opportunity to increase the memory clock speed from the Radeon RX 6900 XT's 2GHz (16GHz effective) to the 6950 XT's 2250MHz (18GHz effective), and Sapphire has left this setting alone. As with the Radeon RX 6900 XT, you still get 16GB of GDDR6 memory attached to a 256-bit wide interface, but the 6950 XT's extra clock speed boosts the total bandwidth from 512GB/sec to 575.5GB/sec. That's still a long way off the 1TB/sec+ speeds Nvidia now command, but the Radeon RX 6950 XT can also fall back on a 128MB pool of Infinity Cache to help here.

Pure white

Sapphire has really gone to town on the Radeon RX 6950 XT Nitro+ Pure, building on the existing Nitro+ cooler design to create an enormous brick of a card that still manages to look attractive. It's wrapped in a well-engineered, two-part chunky white metal frame (the Pure in the name refers to this colour) made from die-cast aluminium-magnesium alloy.

It's peppered with large vent holes to allow the heatsinks beneath it to breathe, and the backplate part is thermally

SPEC

Graphics processor
AMD Radeon RX 6950 XT, 2162MHz game clock, 2368MHz boost clock, 2435MHz OC boost clock

Pipeline
5,120 stream processors, 128 ROPS

Ray Accelerators
80

Memory
16GB GDDR6, 2250MHz (18GHz effective)

Infinity Cache
128MB

Memory interface
256-bit

Card interface
16x PCI-E 4

Bandwidth
575.5GB/sec

Power connectors
1 x 6-pin, 2 x 8-pin

Card length
320mm

Expansion slots
3.5

Lighting
3 x ARGB fans, 3 x ARGB lighting zones on cooler

Extras
Expansion slot support bracket, BIOS switch

PURE BLISS
+ Fantastic design
+ Amazing boost speeds
+ Very fast at rasterisation

PURE EVIL
– Struggles with ray tracing
– High price

attached to the PCB with a pad. The card also has three areas of ARGB lighting – two on the back and one on the edge. The trio of fans also sport ARGB lighting, but it's hard to see them through a case window on a card that's this thick and, let's face it, you're not going to put this 3.5-slot monster in a vertical GPU mount.

The lighting can be controlled through Sapphire's Trixx software, which also offers options for creating custom resolutions to improve performance, along with temperature and clock speed monitoring features, and the ability to switch between BIOSes.

There's a number of lighting effects available, although custom colours are disappointingly left static, with no way to cycle between two custom colours, for example. Thankfully, Sapphire has also provided another option, with a standard 3-pin RGB cable on the edge of the PCB, which you can access under a backplate vent to tie the card to your own lighting control system.

You also get a support bracket in the box, although we found that the card's thick metal frame already prevented the card from drooping in our test rig. It's a well-built hunk of metal with a solid structure.

Performance

While the Radeon RX 6950 XT doesn't offer any extra stream processors or Ray Accelerators over its predecessor, the extra clock speed does make a difference. In particular, this is the fastest card we've ever tested in Assassin's Creed Valhalla – here, the Sapphire Nitro+ Pure 6950 XT even beats the GeForce RTX 3090 Ti by 3fps at 4K with Resizable BAR enabled, and by larger margins at lower resolutions, which is where extra clock speed usually makes a bigger difference.

For this game, we also forced the Sapphire card down to AMD's reference spec to see how much more power you get from the Nitro+ Pure and there's a stark difference. While the reference spec Radeon RX 6950 XT's average frame rates are 3-6fps quicker than those of the Radeon RX 6900 XT, the immense boosting power of the Sapphire card pushes it much further – it gets you an extra 6fps than the reference spec at 4K, and 14fps more at 1,920 x 1,080.

In non-ray-traced tests at 1,920 x 1,080, this card is also the king of the benchmark graphs, happily beating the pricier GeForce RTX 3090 Ti. In standard game tests without ray tracing, this clocked-up RDNA2 GPU is generally competitive with the RTX 3080 Ti at 4K as well, either beating it or only being a small margin behind.

However, once you add ray tracing, the Radeon starts to struggle. The RTX 3080 Ti was 12fps faster in Metro Exodus

with High ray tracing at 4K, for example. Likewise, in Doom Eternal, the Sapphire card did manage a decent average of 103fps with a 68fps 99th percentile result with ray tracing at 4K, but the RTX 3080 Ti gets better results of 140fps and 113fps respectively, and the RTX 3090 Ti is even quicker.

The Sapphire couldn't achieve a playable frame rate in Cyberpunk 2077 with Medium ray tracing at 4K either, even with FSR enabled, although to be fair, even the GeForce RTX 3090 Ti struggles in this test.

One definite advantage of this Sapphire card, however, is its awesome cooler. It remained barely audible throughout testing, with its noise always eclipsed by the 240mm AIO liquid cooler on our CPU. That's amazing for a card that's regularly achieving such high clock speeds.

The latter shows that there aren't any throttling problems too, and we measured a GPU peak temperature of 71°C during testing, with a junction temperature of 88°C (Sapphire claims 74°C and 89°C for these results respectively).

What's more, despite the sky-high clock speeds, and the need for three power connectors (2 x 8-pin and 1 x 6-pin), the peak total system power consumption of 558W with this Sapphire card was 133W lower than with the new GeForce RTX 3090 Ti.

Conclusion

The Nitro+ Pure Radeon RX 6950 XT is a triumph in terms of card design, allowing great boost clocks without making a racket, and all packaged in a satisfyingly well-built and good-looking chunk of expansion card. Its only problem is that the GPU on which it's based can't handle ray tracing as well as the competition from Nvidia, and if you're spending this much money on a new graphics card, you're going to want to enable the top eye candy. If ray tracing isn't important to you, though, this is an awesomely powerful, well-built graphics card.

BEN HARDWIDGE

PERFORMANCE 44/50

FEATURES 18/20

VALUE 12/30

OVERALL SCORE 74%

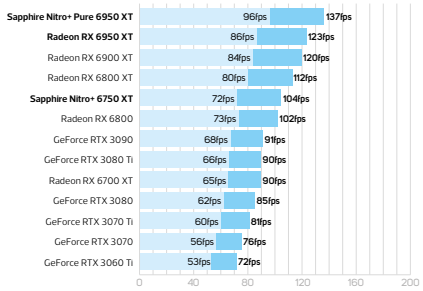
VERDICT

A really well-designed and well-built high-end graphics card. This is as good as RDNA2 gets with air cooling, although it still struggles with ray tracing.

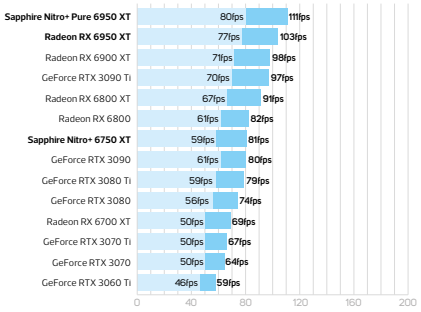
GPU BENCHMARK RESULTS

ASSASSIN'S CREED VALHALLA

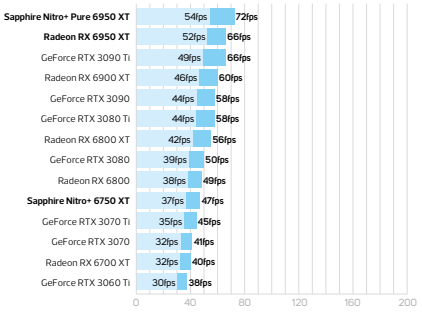
1,920 x 1,080
Ultra high settings, High AA



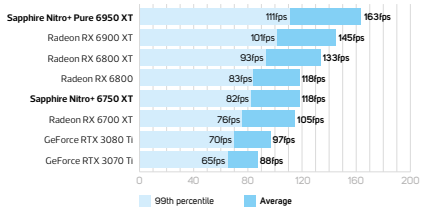
2,560 x 1,440
Ultra high settings, High AA



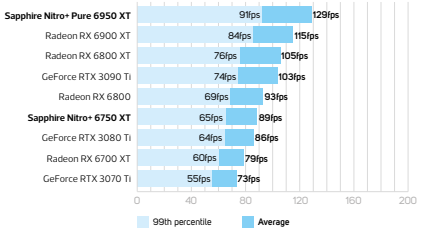
3,840 x 2,160
Ultra high settings, High AA



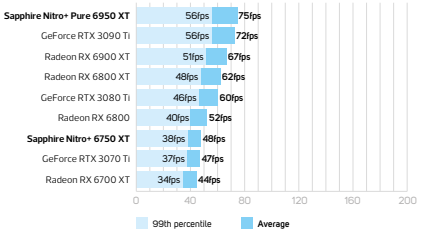
1,920 x 1,080 - RESIZABLE BAR
Ultra high settings, High AA



2,560 x 1,440 - RESIZABLE BAR
Ultra high settings, High AA

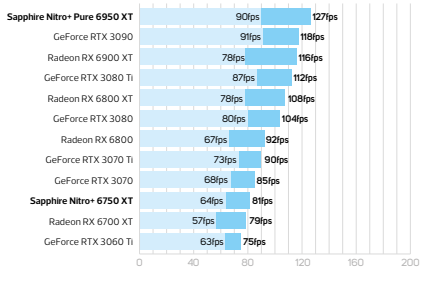


3,840 x 2,160 - RESIZABLE BAR
Ultra high settings, High AA

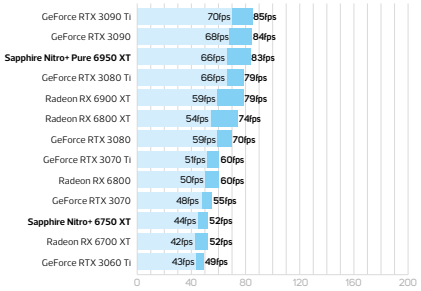


CYBERPUNK 2077

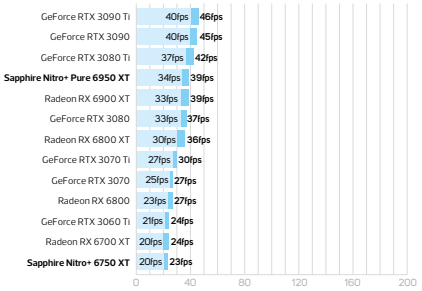
1,920 x 1,080
Ultra preset, no ray tracing



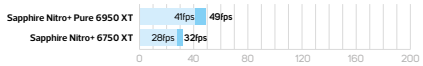
2,560 x 1,440
Ultra preset, no ray tracing



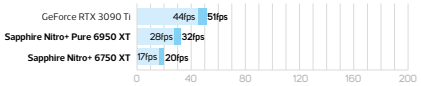
3,840 x 2,160
Ultra preset, no ray tracing



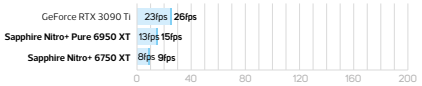
1,920 x 1,080 - RAY TRACING*
Medium ray tracing preset



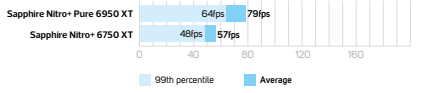
2,560 x 1,440 - RAY TRACING*
Medium ray tracing preset



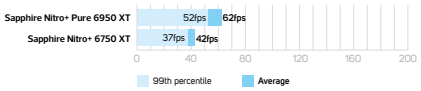
3,840 x 2,160 - RAY TRACING*
Medium ray tracing preset



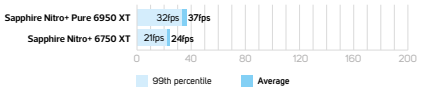
1,920 x 1,080 - RAY TRACING + FSR*
Medium ray tracing preset, FSR Balanced



2,560 x 1,440 - RAY TRACING + FSR*
Medium ray tracing preset, FSR Balanced



3,840 x 2,160 - RAY TRACING + FSR*
Medium ray tracing preset, FSR Balanced

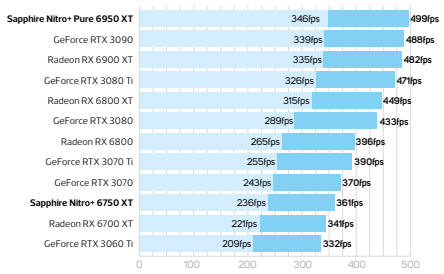


Note: The latest Cyberpunk 2077 patch causes a substantial drop in performance at this preset, meaning previous results from our graphics cards Labs aren't comparable.

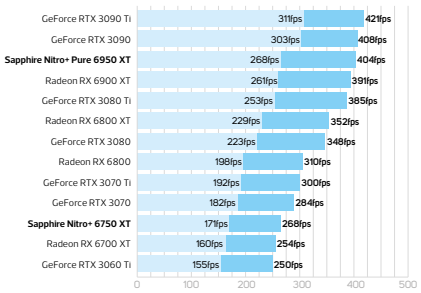
GPU BENCHMARK RESULTS

DOOM ETERNAL

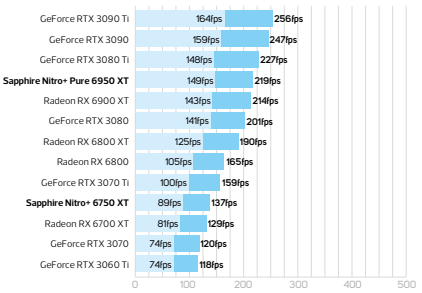
1,920 x 1,080
Ultra Nightmare settings



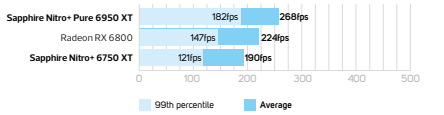
2,560 x 1,440
Ultra Nightmare settings



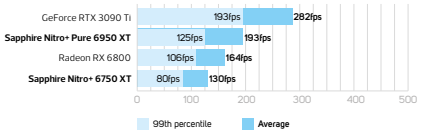
3,840 x 2,160
Ultra Nightmare settings



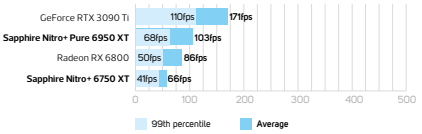
2,560 x 1,440 – RAY TRACING*
Ultra Nightmare settings, ray tracing enabled



2,560 x 1,440 – RAY TRACING
Ultra Nightmare settings, ray tracing enabled

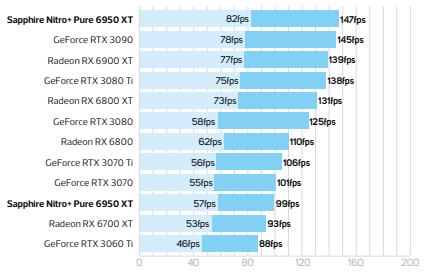


3,840 x 2,160 – RAY TRACING
Ultra Nightmare settings, ray tracing enabled

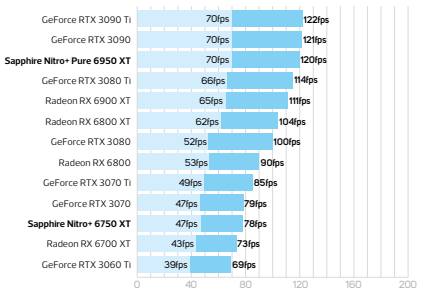


METRO EXODUS

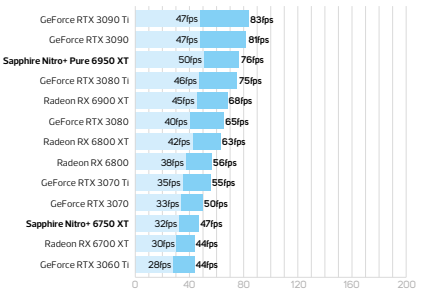
1,920 x 1,080
Ultra settings, HairWorks off, PhysX off



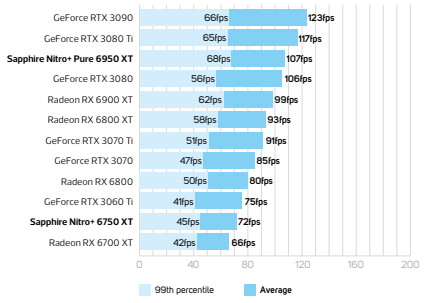
2,560 x 1,440
Ultra settings, HairWorks off, PhysX off



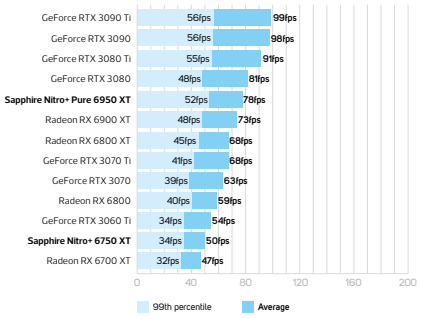
3,840 x 2,160
Ultra settings, HairWorks off, PhysX off



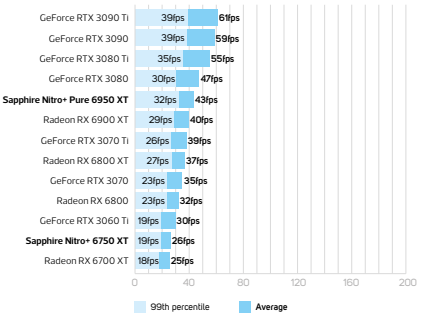
1,920 x 1,080 – RAY TRACING
Ultra settings, HairWorks off, PhysX off, High ray tracing



2,560 x 1,440 – RAY TRACING
Ultra settings, HairWorks off, PhysX off, High ray tracing

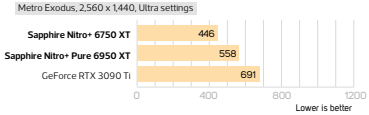


3,840 x 2,160 – RAY TRACING
Ultra settings, HairWorks off, PhysX off, High ray tracing



POWER DRAW

PEAK TOTAL SYSTEM POWER CONSUMPTION (WATTS)*
Metro Exodus, 2,560 x 1,440, Ultra settings



Note: We had to change our PSU to test the GeForce RTX 3090 Ti last month, so previous power draw results from our last graphics card Labs aren't comparable.

Z690 ATX MOTHERBOARD

NZXT N7 Z690 / £269 inc VAT

SUPPLIER ebuyer.com

While it might be late to the Z690 party, NZXT's N7 Z690 was an interesting item to land in our lab. It features a PCB cover in black or white, with our white sample just begging to be placed in a clean, white PC case, preferably with other white hardware.

At £270, it's also reasonably priced for a Z690 motherboard. This is in part thanks to it using DDR4 memory rather than DDR5, as well its lack of fancy features such as Thunderbolt 4 or 10 Gigabit Ethernet. However, as you'd expect at this price, nearly every other feature you could want is here.

You get 802.11ax Wi-Fi, 2.5 Gigabit Ethernet, Realtek ALC1220 audio and we're pleased to see that NZXT's board partner with the N7 Z690, ASRock, has added on-board overclocking and testing tools as well. There are power and reset buttons, and the I/O panel offers clear-CMOS and USB BIOS flash buttons, with the latter potentially being useful if you pick up the board later to use with Intel's forthcoming 13th-gen CPUs.

We had one major gripe about previous NZXT motherboards, which was that the M.2 covers, which didn't make thermal contact with the SSDs, could end up cooking your SSDs, or at the very least making them run far hotter than with a heatsink or even with the covers removed. The N7 Z670 has solved this problem, at least with the top PCI-E 4 M.2 connector.

This sits above the primary 16x PCI-E slot, and now includes a separate plate below the cover that's equipped with a thermal pad and acts like a heatsink. We saw a peak M.2 SSD temperature of 45°C using this system, which is a vast improvement than without the heatsink on previous versions of the board, so if you'll be hammering a PCI-E 4 SSD, be sure to install it in this slot.

There are three slots in total, all of which offer PCI-E 4 support and are hidden by magnetic covers. These can be tricky to remove, especially if there's a graphics card in the way, but thankfully, the top cover cleared our graphics card's backplate, so you should be able to remove the cover without needing to remove your graphics card too.

Meanwhile, the power delivery stands at 13 CPU power phases and is cooled by two slabs of black aluminium, although they're not linked using a heatpipe. There's plenty of space around the CPU socket too and, to keep the PCB cover as clean as possible, the four SATA 6Gbps ports and USB 3 header are both at right angles to the PCB, with just a small cut-out for the 24-pin ATX connector and USB Type-C header.

The rear panel also offers a reasonable amount of USB ports, with seven Type-A ports in total from a mix of USB 2, USB 3 and USB 3.2 Gen 2, plus a Type-C port that supports high-speed USB 3.2 Gen 2x2 too. There are also aerial connectors for the on-board Wi-Fi, as well as the full complement of audio jacks, plus an HDMI output should you want to use the board without a discrete GPU.

As with previous versions of the N7, there are both NZXT proprietary and standard 3-pin and 4-pin RGB headers, plus seven 4-pin fan headers, although there's no fan control graphical interface in the EFI. The idea is

SPEC

Chipset
Intel Z690

CPU socket
Intel LGA1700

Memory support
4 slots: max 128GB DDR4 (up to 4800MHz)

Expansion slots
One 16x PCI-E 5, one 16x PCI-E 4, one 16x PCI-E 3

Sound
8-channel Realtek ALC1220

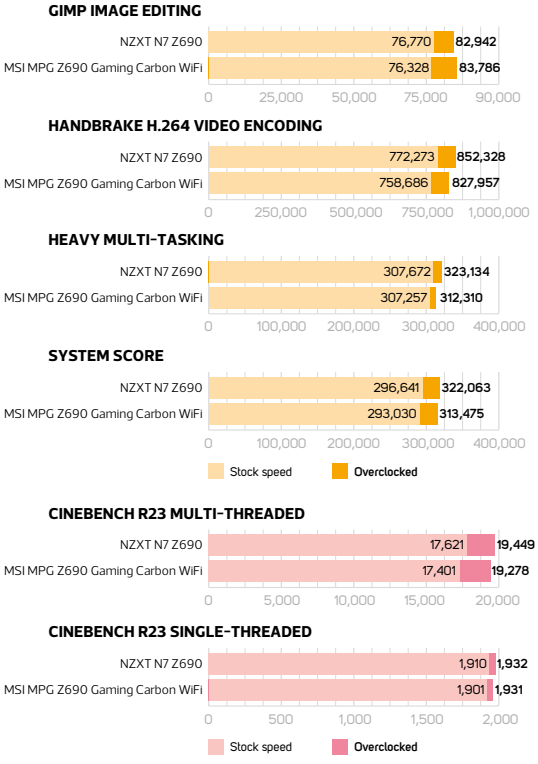
Networking
1 x Realtek 2.5 Gigabit LAN

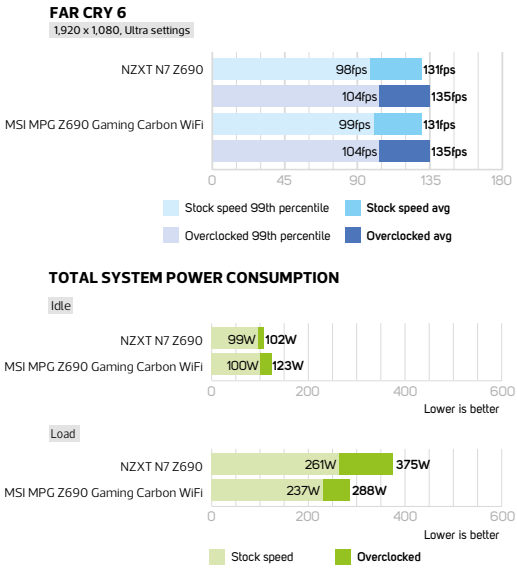
Cooling
Seven 4-pin fan headers, VRM heatsinks, M.2 heatsink

Ports
4 x SATA 6Gbps, 3 x M.2 PCI-E 4, 2 x USB 3.2 Gen 2, 3 x USB 3, 2 x USB 2, 1 x USB 3.2 Gen 2x2 Type-C, 3 x surround audio out

Dimensions (mm)
305 x 244

BENCHMARK RESULTS





FASHIONABLY LATE

- + Looks great
- + Decent feature set
- + Effective M.2 heatsink

TOO LATE

- – Comparatively poor value
- – Fan GUI relies on software
- – Basic EFI

that you instead use NZXT's CAM software to control the fans and RGB lighting.

Unlike NZXT's coolers, the software is hardwired to control the fan and RGB headers without the need for separate USB cables. It works well, giving good control over the fan headers, while giving you real-time readouts of speeds and even the ability to switch between the CPU and GPU for temperature input. However, the lighting wasn't that flexible, with no way to manually change the colour except to white or to one of several preset lighting effects.

PERFORMANCE

Audio performance from the Realtek ALC1220 codec was decent, with a dynamic range of 110dBA, noise level of -110dBA and THD of 0.0021 – these are much better results than many of the less capable codecs doing the rounds on B660 motherboards. Overclocking was simple too, with the EFI proving to be basic compared with the likes of Asus and MSI, but offering simple and easy-to-navigate menus.

We hit the usual 5GHz on our Core i5-12600K's P-Cores and 4GHz across its E-Cores, using a vcore of 1.36V. This saw the image editing score rise from 76,770 to 82,942, the video encoding score increase from 772,273 to 852,328 and the Cinebench multi-threaded score go from 17,621 to 19,449, with the latter two being the highest results we've seen from this CPU at stock speed and when overclocked. The downside is that overclocked power consumption was quite high at 375W for the whole system, which was much higher than the other Z690 boards we've tested recently.

CONCLUSION

Looking at alternative Z690 boards for £300 and below, the NZXT N7 Z690 does have some stiff competition. For example, the Gigabyte Z690 Gaming X DDR4 costs around £200, and it also has 2.5 Gigabit Ethernet, Realtek ALC1220 audio, PCI-E 4 M.2 ports with heatsinks, plus it overclocked just as well and has more USB ports on the I/O panel. It also has a good fan control section in its EFI that means you don't need to use software.

However, it lacks Wi-Fi and the extensive aesthetic shroud, plus it has fewer fan headers and audio ports, and it lacks all the overclocking and testing tools too. Whether all that is worth an extra £70 is largely down to personal preference, but if you're building a white or black-themed PC, need Wi-Fi and the other extra gubbins we just mentioned, the NZXT N7 Z690 does the job well.

ANTONY LEATHER

VERDICT

Great-looking with plenty of features, although the need to use software for fan and lighting control isn't for everyone, and it's a bit pricey too.

PERFORMANCE **32/35**

FEATURES **28/35**

VALUE **22/30**

OVERALL SCORE **82%**

MAGNUS ULTRA GAMING DESKTOP

- Intel® Core™ i9-12900KS
- Asus® ROG STRIX Z690-F Gaming WIFI
- 32GB Corsair DOMINATOR PLATINUM 5600MHz DDR5
- 12GB NVIDIA® GeForce® RTX 3080
- 1TB Samsung 980 Pro M.2 PCIe NVMe
- 4TB Seagate Ironwolf Pro HDD
- Windows 11 Home

This spec from
£3,350.00*

TOPAZ PRO GAMING DESKTOP

- AMD Ryzen 7 5800X
- Asus® ROG STRIX B450-F Gaming
- 16GB Corsair VENGEANCE 3200MHz
- 12GB AMD RADEON™ RX 6700 XT
- 1TB Seagate FIRECUDA 520 NVMe
- 1TB Seagate BARRACUDA HDD
- Windows 11 Home

This spec from
£1,730.00*

ELIMINA NOVA GAMING LAPTOP

- 15.6" 144Hz FHD Matte Screen
- Intel® Core™ i7-12700H
- 16GB Corsair 3200MHz
- NVIDIA® GeForce® RTX 3050 Ti
- 1TB Intel® 670p M.2 PCIe NVMe
- Multi-Colour Backlit Keyboard
- Windows 11 Home

This spec from
£1,190.00*

WWW.PCSPECIALIST.CO.UK 0333 011 7000

*Prices are including VAT and are correct at time of printing, but subject to change.
Images are for illustration purposes only, components may differ in aesthetics and brand.

PCSpecialist

ATX CASE

COOLER MASTER MASTERBOX 500 / £97 inc VAT

SUPPLIER dodax.co.uk

If you're in the market for a PC case that costs under £100, there are some excellent options available, whether you want RGB lighting, or handy building features such as removable top sections and tool-free side panels. Getting most of these features in one box at this price is a tall order, but Cooler Master might just have pulled it off with the MasterBox 500.

It will only leave you with enough change from £100 to buy couple of chocolate bars, but we were impressed by how much it provides, both externally and internally, for the price. Let's start with the RGB lighting, which stems from a digital RGB fan located in the base of the front section – the only area to have mesh. However, additional fan mounts do sit behind the (two thirds-height) removable front panel, which has RGB lighting channels embedded into it.

While the front panel conforms neither to the cleanly sealed or fully meshed ethos, it strikes a good aesthetic balance between the two approaches to front panel design. There's a vibrant retro feel to the lighting, which can be controlled using a button on top of the case, which cycles between modes and colours, or using a 3-pin RGB cable connected to your motherboard.

There's also a SATA-powered fan and lighting hub, but it only offers a handful of channels, so you'll need to use fan and RGB splitter cables to control any extensive cooling or lighting systems.

The front panel is sadly devoid of a USB Type-C port, however, and only has two USB 3 ports and a single 3.5mm audio jack that supports tri-pole connectors for headphones and microphones. We don't have too many other criticisms though. The tempered glass side panel is tool-free, albeit with optional thumbscrews being pre-applied out of the box to lock it in place, but otherwise pulling on a tab at the rear of the case hinges the panel open from the top.

Cooler Master has taken a leaf out of Fractal Design's book too, by providing a removable top section. Remove a few screws and the entire top panel lifts out of the case, making it far easier to install your hardware in the case, as well as making light work of adding a radiator or fans to the roof.

Both the roof and front fan mounts can handle some serious cooling hardware too. Despite the case only stretching to around 50cm in terms of depth and height, 360mm radiators can be installed in both locations, with space for 280mm radiators too.

A 120mm SickleFlow ARGB fan is pre-installed into the front of the case, with a non-LED 120mm fan also included in the rear. The latter can also slide up and down on rails, so you can align it with your CPU cooler in order to boost airflow.

Cable-routing options are decent too, with plenty of grommet-covered holes, although the situation is very basic behind the motherboard tray, with just a bunch of cable ties included, and an average amount of clearance between the motherboard tray and the side panel.

Thankfully, there's a PSU cover underneath which you can stow cables, and there's plenty of space here despite there also being a cage for two hard disks in this location. Each tray mount in this cage can handle a 2.5in SSD and 3.5in hard disk at the same time, and you get a further count of two dedicated 2.5in SSD mounts as well.

If you're hoping to use an E-ATX motherboard then you're also in luck, although the MasterBox 500 will only accommodate a PCB with a width of up to 272mm and hitting this limit will result in you slightly obscuring some of

SPEC

Dimensions (mm)
209 x 505 x 499 (W x D x H)

Material
Steel, plastic, glass

Available colours
Black

Weight
7.7kg

Front panel
Power, reset, 2 x USB 3, 3.5mm headphone /mic jack, LED control

Drive bays
2 x 2.5in/3.5in, 2 x 2.5in

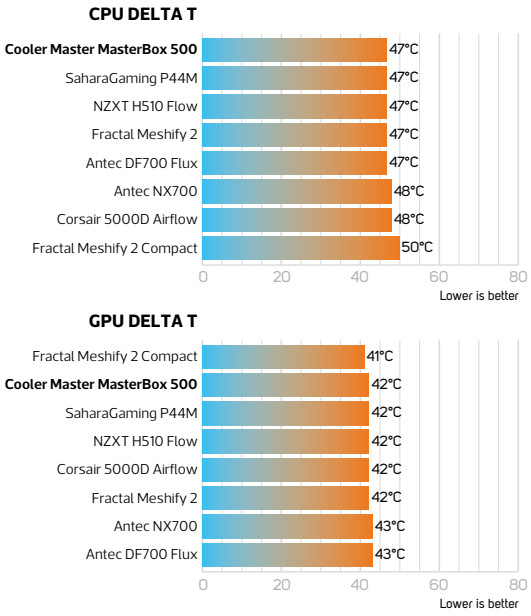
Form factor(s)
E-ATX, ATX, micro-ATX

Cooling
3 x 120mm/2 x 140mm front fan mounts (1 x 120mm fans included), 1 x 120mm rear fan mount (120mm fan included), 3 x 120/2 x 140mm roof fan mounts (fans not included)

CPU cooler clearance
165mm

Maximum graphics card length
410mm

TEMPERATURE RESULTS



the cable-routing holes. There's plenty of clearance for CPU cooler heatsinks and graphics cards as well, with 165mm of CPU cooler clearance and room for graphics cards measuring up to 410mm wide, do you're highly unlikely to run into issues with squeezing large hardware into the case.

As you'd expect from a case at this price, there are dust filters too. The top features a large magnetic filter, while the front section relies on the area of mesh at the bottom of the panel to prevent dust ingress.

Thankfully, there are no open vents in the base of the panel that we've seen in other cases. Combine all of this with (an admittedly fiddly to remove) PSU dust filter, and the MasterBox 500 is well protected.

Build quality is decent too, thanks to the case's mostly steel construction. Our only real complaint is that, aside from the removable roof section, the interior is a little bland and by-the-books, with no standout features.

Performance

The MasterBox 500's fans weren't particularly powerful, but this resulted in pleasantly low noise levels, with the sound from the case fans outgunned by the noise from our CPU cooler and graphics card. Thankfully, despite this, the case was still able to dish out some decent thermal performance.

Its CPU delta T of 47°C is a match for any other case we've tested recently, such as the Antec NX700, and it was a few degrees cooler than the Fractal Design Meshify 2 Compact. The GPU delta T of 42°C was certainly aided by the front fan pointing at our graphics card, and it matched the rest of the field, bettering the Antec NX700 by one degree, although the Fractal Design Meshify 2 Compact was slightly cooler.

Conclusion

If you just want a case that gives you loads of RGB lighting for the best price possible, then the Antec NX700 is a better option than the Cooler Master MasterBox 500, but if you want a smooth and enjoyable PC building experience, the ample cooling options and removable top section in the MasterBox 500 shouldn't be overlooked.

It's fun to work with this case, it stands out from the usual mesh and RGB-laden cases, and it can house a seriously powerful PC with more space for fans and radiators than the Antec case. Our main complaint is that it's otherwise a slightly plain package, but it comes recommended whether you're building a budget-focused rig or going all-out with custom liquid cooling, particularly with its price of just £97.

ANTONY LEATHER

BOX OF DELIGHTS

- \+ Good CPU and GPU cooling
- \+ Unique RGB lighting
- \+ Removable roof section

BOX OF SHAME

- − Not many stand-out features
- − Fan hub has low number of ports
- − Bland interior

VERDICT

Some great features and good cooling for the money, making for a smooth PC building experience, although it looks a bit bland.

COOLING 26/30

FEATURES 16/20

DESIGN 25/30

VALUE 16/20

OVERALL SCORE 83%

240MM AIO LIQUID COOLER

COOLER MASTER MASTERLIQUID PL240 FLUX / £133 inc VAT

SUPPLIER cclonline.com

Cooler Master's MasterLiquid PL240 Flux costs a good £60 more than the Antec Symphony 240 we've also reviewed in this issue (see over), and it also doesn't come with a fancy LCD, so what exactly do you get for that extra cash?

At first glance, it looks good for justifying the extra premium. The fans included with the Cooler Master are much more powerful than the 1,600rpm fans on the Antec cooler, peaking instead at 2,300rpm, meaning they're likely to provide enough airflow for the 240mm radiator to cope with any desktop CPU. The RGB lighting on the fans is also far more evenly spread and vivid than the lighting on the Antec Symphony 240's fans too, spanning out over the entire fan blades, and looking as vibrant as it appears in the press photos.

You don't need to use your motherboard's software to control the lighting either. Cooler Master instead gives you the option of using its MasterPlus+ software by using a USB-powered RGB controller, from where you can control the fans and lighting independently. In fact, you can even control each individual LED, which gives you the ability to create some interesting patterns on the fan blades.

Cooler Master's new PL-Flux fans don't just look good either, according to Cooler Master. They also offer an additional 10CFM (cubic feet per minute) of airflow and nearly 20 per cent higher static pressure than the company's older SickleFlow fans. Its 240mm radiator only measures 27mm thick too, which means it might be able to squeeze into tighter spaces than other models.

The included hub only has a trio of 3-pin RGB ports, but this should be enough for most setups, especially if you add a couple of splitter cables. Sadly, the software lacks control for the fan or pump speeds, so you'll still need to configure these speeds in your BIOS or motherboard software.

Meanwhile, splitter cables are included for both the RGB and fan PWM cables, but the Cooler Master doesn't offer any innovations to make cable routing easier, such as running some of the cables inside the cooler's tubes from the pump to the fans, or daisy chaining the fans in some way. Other CPU cooler manufacturers have achieved both these feats, so it's a shame Cooler Master seems to be

SPEC

Intel compatibility
LGA1700, LGA1200, LGA115x, LGA2066, LGA2011

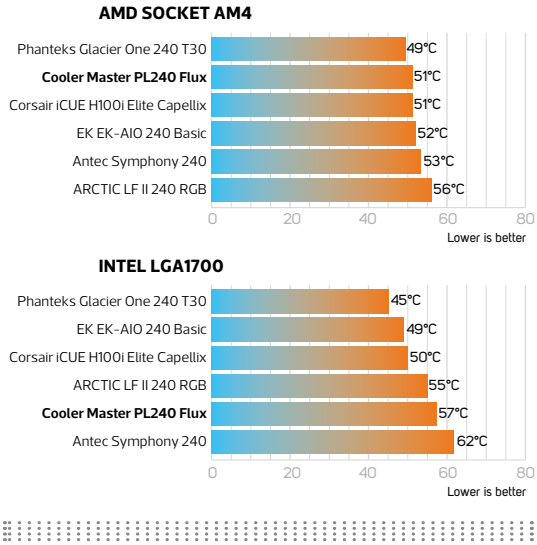
AMD compatibility
Socket AM4, AM3/+, TR4/X

Radiator size with fans (mm)
120 x 272 x 52 (W x D x H)

Fans
2 x 120mm

Stated noise
32dBA

TEMPERATURE RESULTS



FLUX CAPACITOR

- \+ Top-notch RGB lighting
- \+ Easy installation
- \+ LGA1700-compatible out of the box

BLOWN CAPACITOR

- – Struggles with Core i9-12900K
- – Not many standout features
- – Competition offers better cooling

behind the curve here, as it will mean you have to spend extra time tidying cables in order to avoid making a mess.

On the plus side, the Cooler Master has an interesting pump design with dual chambers. This allows for a compact design that's unlikely to foul any heatsinks or memory modules, even on space-starved mini-ITX motherboards. The ultra-thin contact plate fins sit in a thinned section of copper, reducing the distance between them and your CPU's heatspreader, in theory boosting heat transfer.

The pump section feels extremely well made too, although you still need to manually attach the mounting brackets using screws, which is a fiddlier process than on many other coolers. There's a tube of thermal paste too, so if you switch CPUs or motherboards in future, there will be enough thermal paste for another application or two.

It's good to see Intel's LGA1700 socket supported out of the box as well, with the new socket just requiring a different backplate from other sockets, in order to lower the mounting pin height to cater for the lower heatspreader height on Intel's 12th-gen CPUs.

Installation is otherwise fairly simple, and the short threads on the fan screws, combined with large screw heads, meant we didn't need to reach for a screwdriver to fit them either, with our thumbs sufficing. The same was nearly true for the nuts that lock the pump section in place, but these needed a small tweak with a screwdriver.

Performance

Once the cooler was up and running, the pump was inaudible above the noise made by the rest of our system, exhibiting a low-level whirring sound, but not an annoying whine. The fans proved to be much quieter than we were expecting at full speed too, making a significantly less noticeable noise than those on the Corsair iCUE H100i Elite Capellix, for example, while also seeming to shift less air.

However, the latter was also much better at dealing with our Core i9-12900K, with the Cooler Master's CPU delta T of 57°C being 7°C warmer than the result from the Corsair cooler. It did at least better the Antec Symphony 240 by a substantial 5°C, but it's clear that if you have Intel's Core i9-12900K, or the more recent 12900KS, then you'd do better to get a cooler with a wider or thicker radiator. For example, the Phanteks Glacier One 240 T30 is a good 12°C cooler than the Cooler Master, thanks to its 45mm-thick radiator and powerful fans.

In our less toasty AMD Ryzen 7 5800X system, however, the MasterLiquid PL240 Flux managed a CPU delta T of 51°C – a great result that's second only to the and Phanteks Glacier One 240 T30 in our tests.

Conclusion

We were expecting more from the Cooler Master MasterLiquid PL240 Flux in our Intel system given Cooler Master's claims, but it seemed to struggle a little against our Core i9-12900K. However, you need a powerful pump and monstrous airflow to hit the top spots in the cooling graphs with this CPU. We'd feel comfortable pitching it against a Core i7-12700K or below, but the fact remains that there are better options if you want the best cooling for Intel's most powerful CPUs.

In our AMD system, though, the Cooler Master fared much better thanks to lower heat loads, and here the pump seemed to perform well, with the cooler able to match or better all except one other cooler we've recently tested.

Even then, though, the trouble for Cooler Master is that Corsair has cut the price of the iCUE H100i Elite Capellix, so it retails for just £100 inc VAT on **ebuyer.com** at the moment. With software fan control and similar or better cooling, the Corsair cooler is still the best buy, but for more restrained noise levels and universally compatible RGB lighting, the Cooler Master MasterLiquid PL240 Flux is still worth considering, especially if you have an AMD system.

ANTONY LEATHER

VERDICT

Not quite as potent on LGA1700 as we were hoping, but its quiet operation and universally compatible RGB lighting makes it still worth considering.

LGA1700

COOLING **33/40**

FEATURES **16/20**

DESIGN **17/20**

VALUE **14/20**

FITTING **EASY**

OVERALL SCORE **80%**

CUSTOM PC APPROVED

Socket AM4

COOLING **37/40**

FEATURES **16/20**

DESIGN **17/20**

VALUE **14/20**

FITTING **EASY**

OVERALL SCORE **84%**

240MM AIO LIQUID COOLER

ANTEC SYMPHONY 240 / £70 inc VAT

SUPPLIER scan.co.uk

If you've scoffed at the prices of some AIO liquid coolers recently, then you're not alone, as fancy features such as software control, RGB lighting and LCDs all bump up the price. In some situations, a custom water-cooling kit would be cheaper, but thankfully, there are still ways to own a 240mm AIO liquid cooler and get plenty of change from £100. One example is Antec's new £70 Symphony 240, which has to live up to some expectations, being the successor to the excellent Neptune 240.

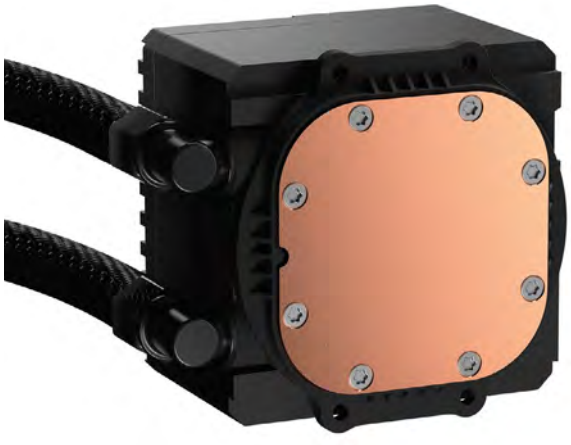
At £70, the price is very reasonable indeed, especially as the Symphony 240 sports digital RGB lighting not only on its fans, but on the pump as well. The colours on the fans' lights don't quite pop as vividly as the photos suggest, with the lighting sitting at the centre of the fan hub and diffusing outwards across translucent fan blades. The pump looks very snazzy, though, with a large square top that sports an attractive RGB lighting design.

The downside is that you have to deal with quite a few cables when you're installing the Symphony, especially as there's no fan and lighting hub included, unlike the Neptune 240. At least the fans are equipped with a splitter cable, so you just need to connect them to a single fan header.

The pump has a single 3-pin connector, so you'll need to ensure it's connected to the AIO pump header on your motherboard if you have one. Meanwhile, the RGB lighting requires just one 3-pin header, as both the fans and the pump are daisy-chained, so at least this setup shouldn't result in too much cable spaghetti. There's also an adaptor to convert the standard 3-pin cables to Gigabyte's 3-pin RGB headers, which are slightly different from the usual ones.

We also love the fact that the fans are pre-installed onto the cooler. The out-of-the-box setup will cater for PCs with the cooler located in the roof or front of the case, where you want to push air through the radiator, but pull setups will require the fans to be flipped around. The fans are also rotated, so their cables sit on the side of your motherboard tray for easy cable routing.

You get a tube of thermal paste rather than it being pre-applied, which we prefer, as it means you won't have to buy more paste if you upgrade your CPU in future, or if you accidentally touch the pre-applied paste. Out of the box, the cooler is compatible with all current CPU sockets too, including Intel's new LGA1700 socket for its 12th-gen Alder Lake CPUs, which uses a specific backplate and mounting pins.



SPEC

Intel compatibility
LGA1700, LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility
Socket AM4

Radiator size with fans (mm)
120 x 277 x 52 (W x D x H)

Fans
2 x 120mm

Stated noise
30dBA

The installation process is largely the same across other sockets, with sprung thumbscrews securing the pump section to the motherboard. It's a little overcomplicated, though, with the need to manually screw different mounting plates to the pump depending on whether your CPU is made by AMD or Intel, and the backplates don't hold themselves to the CPU socket with double-sided tape or some sort of securing system on the CPU side either. This means you'll need to hold the backplate in place while you install the cooler, which can be tricky.

Performance

The two 120mm fans supplied with the Symphony are a tad underpowered, with their peak of 1,600rpm meaning they're up to 1,000rpm slower than some of the more powerful coolers we've tested. This did mean the Symphony 240 was quieter at full speed than the likes of the Corsair iCUE H100i Elite Capellix, but the downside is that it lacks the flexibility to ramp up its fans to similar cooling levels, perhaps dealing with extended high loads on hot summer days with a high-end CPU.

The pump proved to be very quiet, with just a low droning noise evident with our ear against it, but otherwise, it was inaudible above the noise from the rest of our components. The slower than average fans predictably struggled, though, with the CPU delta T hitting 62°C when battling against a Core i9-12900K in our LGA1700 system – our ten-minute stock speed stress test clearly pushed the cooler to its limits.

As a point of comparison, the Phanteks Glacier One 240 T30 was a whole 17°C cooler, with its radiator noticeably being less warm, which is a clear sign that the lowly fan speeds were the main culprit behind the Symphony 240 struggling to cope. It was also 7°C warmer than the ARCTIC Liquid Freezer II 240 RGB, which also has fans that can spin up to 200rpm faster at peak speed.

In our AMD system, pitched against our Ryzen 7 5800X, the Symphony 240 held up a little better, with the CPU delta T of 53°C actually being slightly cooler than the ARCTIC cooler, perhaps thanks to a better mounting mechanism or its more powerful pump. However, it was still a long way from bettering the best-performing 240mm AIO liquid coolers we've tested recently.

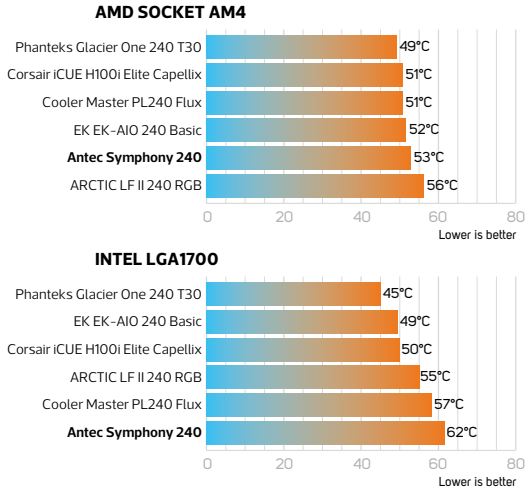
SYMPHONY

- \+ Pre-installed fans and cables
- \+ Low noise
- \+ Excellent price

CACOPHONY

- – Fans aren't very powerful
- – Limited RGB lighting
- – Uncompetitive cooling

TEMPERATURE RESULTS



Conclusion

It's pretty clear that, when it comes to dealing with toasty high-end CPUs, the Antec Symphony 240 doesn't have the fans and airflow to deal with the added heat those components produce. It's quiet for sure, but the fact its radiator got very warm after dealing with our Core i9-12900K for ten minutes under full load is a clear sign that the radiator was overloaded, and the fans weren't shifting enough air to deal with the heat.

Our LGA1700 test rig represents exceptional circumstances, though, with one of Intel's top-end CPUs that's known for being a toasty customer, with its 16 cores and 24 threads under full load for ten minutes, which few people will be doing on a regular basis. Its performance in our AMD system with the cooler-running Ryzen 7 5800X is evidence that, when its fans do shift enough air to deal with the heat load, the Symphony 240 is actually pretty good.

What's more, its price is £10 cheaper than that of the ARCTIC Liquid Freezer II 240 RGB, making the Antec Symphony 240 a better-value option for mid-range AM4 CPUs, as you get similar cooling, as well as more extensive RGB lighting, for less money. However, if you'll regularly be putting you CPU under full load and it has more than 12 cores, especially where Intel is concerned, we'd look elsewhere.

ANTONY LEATHER

Intel LGA1700

COOLING 28/40

FEATURES 15/20

DESIGN 16/20

VALUE 14/20

FITTING MEDIUM

OVERALL SCORE 73%

AMD Socket AM4

COOLING 33/40

FEATURES 15/20

DESIGN 16/20

VALUE 18/20

FITTING MEDIUM

OVERALL SCORE 82%

VERDICT

A great price for the lighting, and decent cooling on mid-range CPUs, but it struggles to cool high-end LGA1700 CPUs.

27IN GAMING MONITOR

ASUS ROG SWIFT PG279QM / £799 inc VAT

SUPPLIER overclockers.co.uk

THE REFLEX

+ Solid image quality
+ Superb gaming performance
+ Very high colour gamut

THE REFLUX

– Reflex Analyzer of limited use
– No contrast boost for HDR
– Very expensive

For several years, 144Hz and 165Hz displays with a resolution of 2,560 x 1,440 (1440p) have been commonplace. However, it's only recently that displays of this resolution have stepped up to 240Hz, and the Asus PG279QM is one of those select few.

This 27in, IPS panel also includes support for G-Sync Ultimate (complete with dedicated hardware) across its full 1-240Hz range and includes Nvidia's Reflex Analyzer. This tech lets you connect your mice via the monitor's USB hub, and then uses a built-in detection tool to work out the latency between clicking a mouse button and the effect being shown on screen.

It's an interesting addition but requires specific game support and has limited use. Your old wireless mouse may cause significant input lag, rather than your monitor. You can also use the feature to optimise in-game settings, but most such gains would also be flagged by an increase in frame rate.

The most obvious use case is for highlighting the benefits of another Nvidia feature, which is the Reflex option found in a handful of games. When enabled, this optimises the game for reduced latency, and sure enough, we saw our latency in Apex Legends drop from 22ms to 18ms with this feature turned on. However, you don't need this monitor to enable that feature.

Elsewhere, the PG279QM generally impresses. Its image quality is decent out of the box, with contrast that exactly matched its rated 1,000:1 ratio in our tests, and it has the option of either an sRGB mode for reducing the colour gamut when needed and a high gamut mode that will dole out 100 per cent of the rec.2020 colour space, for truly dazzling colours in HDR.

However, colour balance was a little off, hitting a colour temperature over 7,000K even in its sRGB mode, so a little tweaking will be required if you're using this display for colour-critical work. HDR is also a little underwhelming, as the mere 32 edge-lit backlight zones can't produce a measurable boost in contrast in most content.

Meanwhile, the physical design is a little fussy, with a metallic grey finish, copper highlights and RGB lighting on the rear. The connections around the back are also awkward to reach, thanks to a lip on the bottom edge of the screen sitting directly in line with the ports and pushing against the cables.

Gaming performance is excellent though. The 240Hz refresh rate combines with an impressive average initial response time of 3.7ms at maximum overdrive and 4.4ms at medium overdrive, making for a very snappy, responsive feel. Overshoot can creep up at high overdrive settings, but is manageable at medium overdrive, so we'd stick with that setting. It's a shame Asus hasn't included a backlight strobing blur reduction mode though.

The step up to a 1440p resolution over 1080p – as is more common for 240Hz displays – is significant for some games but less so for others. In Counter-Strike: Global Offensive, Valorant and even Apex Legends, the extra resolution isn't so critical, but in Call of Duty: Warzone, the extra detail is essential for picking out enemies among the distant trees.

SPEC

Screen size
27in

Resolution
2,560 x 1,440

Panel technology
IPS

Maximum refresh rate
240Hz

Response time
1ms

Max brightness
350cd/m² SDR, 400cd/m² HDR

Backlight zones
1

Stated contrast ratio
1,000:1

Adaptive sync
FreeSync and G-Sync Ultimate

Display inputs
1 x DisplayPort 1.4, 3 x HDMI 2

Audio
2 x 2W speakers, headphone out

Stand adjustment
Height, pivot, rotation, tilt

Extras
100 x 100mm VESA mount, 2-port USB 3 hub, rear RGB lighting

HDR standard
VESA DisplayHDR 400

Conclusion

The Asus ROG Swift PG279QM's combination of a 2,560 x 1,440 resolution and a 240Hz refresh rate works to great effect, but it comes at a very high price. Several direct competitors are similarly pricey, but there are many 165Hz options for under half this display's price that will serve many gamers fine.

EDWARD CHESTER

VERDICT

Cutting-edge gaming performance and fantastic image quality, but boy, does it come at a price.

IMAGE QUALITY 26/30
GAMING 26/30
FEATURES 14/20
VALUE 8/20

OVERALL SCORE 74%

32IN GAMING MONITOR

MSI OPTIX MPG321UR-QD

/ **£900** inc VAT

SUPPLIER ao.com

KVM

+ Excellent image quality
+ Solid gaming performance
+ Decent value

KLF

– Only edge-lit backlight zones
– High price if you don't need the KVM
– **Ed:** Oi, I like The KLF!

While the Asus PG279QM (opposite) feels a little lacking in meaningful features for its high price, the same can't be said of the MSI MPG321UR-QD. As well as an extra 5in of screen real estate, this 32in bruiser packs in a 4K resolution with a 144Hz refresh rate, quantum dot filter technology for boosted brightness and colour range, plus it has a built-in KVM and even a mouse bungee.

This versatility is directly aimed at people who want to connect their PC and games consoles through a single big screen, with the KVM feature enabling you to easily switch between devices. The USB Type-C connection can also be used for video, making it easy to connect a laptop via a single cable.

It's fantastic if you use so many devices, but if you only intend to use the screen for one desktop PC, there are cheaper ways to get a 4K 144Hz monitor. Also, considering the multi-device focus, it's surprising there are no speakers.

The physical design is mostly black with a small strip of RGB lighting on the back – it's simple, but not too garish. Meanwhile, the stand offers height, swivel and tilt adjustment, and there's a 100 x 100mm VESA mount for monitor arms. The connections are arranged around the back, facing down, and include three USB uplink ports for distributing the KVM switch to your devices, along with four USB downlink ports for peripherals, two HDMI 2.1 ports (for 4K at 120Hz compatibility), one DisplayPort input and one USB Type-C port.

Also on the underside are holes to the left and right edges of the display, where you can attach the included mouse bungee for either left or right-handed use. It's a useful addition for wired mouse users. The extensive menus are controlled via a mini joystick on the back that works well, or you can download the GamingOSD app to control them. The menus are so comprehensive that we found the display quite confusing to set up, so expect to spend a while searching through every option to work out what the display is doing.

You get an sRGB mode (with adjustable brightness) and a high gamut mode, along with an HDR option but, as HDR content is held back by just having 16 edge-lit backlight zones, you get no real-world contrast boost.

Overall image quality from the IPS panel is very good, with solid viewing angles, dazzling colours in high gamut mode and a decent colour balance. The sRGB mode dips to only 92 per cent sRGB coverage, though, so looks a tad desaturated.

Gaming performance is also good, but not at the level of the Asus PG279QM. Its initial response time averaged 12.7ms at normal overdrive and 8ms at maximum overdrive. Combine these figures with the 144Hz refresh rate, and this monitor isn't a top choice for esports, but it's great for a 4K monitor. What's more, that maximum overdrive came with almost no overshoot, so image quality remains excellent.

SPEC

Screen size
32in

Resolution
3,840 x 2,160

Panel technology
IPS

Maximum refresh rate
144Hz

Response time
1ms (MPRT)

Max brightness
400cd/m² SDR, 600cd/m² HDR

Backlight zones
16 (edge-lit)

Stated contrast ratio
1,000:1

Adaptive sync
FreeSync and G-Sync

Display inputs
1 x DisplayPort, 2 x HDMI, 1 x USB Type-C

Audio
Headphone out

Stand adjustment
Height, pivot, rotation, tilt

Extras
100 x 100mm VESA mount, KVM with six USB 2 inputs and two USB 2 outputs, rear RGB lighting

HDR standard
VESA DisplayHDR 600

Conclusion

MSI's MPG321UR-QD is an impressive display, and worth its price for those that want to plug many devices into one big, 4K display. MSI really has left very few stones unturned to add all the features you might need, other than speakers and proper multi-zone backlighting for true HDR. For single-PC users, though, there are cheaper ways to get the same core 4K at 144Hz performance.

EDWARD CHESTER

VERDICT

An impressively feature-packed panel for those wanting one display for many devices.

IMAGE QUALITY **24/30**

GAMING **22/30**

FEATURES **20/20**

VALUE **14/20**

OVERALL SCORE **80%**

ERGONOMIC MOUSE

LOGITECH LIFT / £70 inc VAT

SUPPLIER amazon.co.uk

LIFT ME UP

+ Smart appearance
+ Useful Logitech Flow features
+ Long battery life

LET ME GO

– Vertical design impairs movement
– Only modest comfort improvement
– No wired connection option

The Logitech Lift is a new, more compact variant of the company's MX Vertical mouse, designed for users with smaller hands or smaller wallets – the MX Vertical costs £25 more than the Lift. The idea behind both these ergonomic mice is that they tilt your hand into a much more upright angle than typical mice, in order to reduce wrist and forearm pain.

Conventional mice typically set your wrist at an angle of around ten degrees from your desk, while some slightly more ergonomic mice, such as the Logitech MX Master, might open this angle up to around 25 degrees. However, the Lift goes all the way to 57 degrees.

The effectiveness of this change is immediately apparent but not all positive. Your wrist angle does indeed open up, reducing any inherent forearm aggravation. However, the way your hand grips the mouse can feel a little odd. Your fingers stretch out flat over the side with the buttons, rather than curling round, as they would when holding a joystick, for instance.

We found this meant we had to grip the mouse with the meat of the palm to pull it back and lift it – as you need to do on occasion when you run out of mouse mat area with a normal mouse – incurring more hand strain and decreasing dexterity and accuracy.

The switch to a different forearm angle also means you no longer rest your arm on the meatier muscular part of your forearm between the ulna and radius, but instead expose the side of the ulna to the surface of your desk. You can get around this by using a wrist rest, but these can limit your movements, as your arm snags on the wrist rest. Raising your arm slightly so that it doesn't rest on the desk can work too, but we didn't find this comfortable, as you have to bend your wrist back further.

Instead, it feels like the Lift (and MX Vertical) could do with an extension on the back of the mouse to rest and slightly raise your hand away from the desk, such as on the Posturite Penguin. This would take the strain off your hands and fingers to grip the mouse, and protect your arm from rubbing on your desk.

Elsewhere, the Lift is available in both left and right-handed versions, and comes in fetching pink and white shades, as well as grey. It has a basic feature set with five main buttons – left, right, middle/scroll, back and forward – along with a button for switching the DPI.

This mouse also supports Logitech's Flow technology, which uses the company's Options software to allow you to transfer files between different devices that are connected to the mouse, which can be very handy. A button on the underside lets you cycle through the three connected devices. Here, there's also a hatch that houses the AA battery (that will last for up to two years) and a hole for the USB dongle. The Lift doesn't support wired connection, unlike the MX Vertical.

SPEC

Weight
125g

Dimensions (mm)
70 x 108 x 71 (W x D x H)

Sensor
Logitech optical (4,000 DPI)

Buttons
6 (left, right, scroll wheel, 2 x side buttons, DPI)

Cable
None

Extras
Connects to up to three devices, supports Logitech Flow

Conclusion

The Logitech Lift is a laudable attempt to create a relatively affordable vertical mouse design that's better suited to smaller hands than the company's MX Vertical. However, we're not entirely convinced about the benefits of the overall ergonomic improvements, and find it more difficult to move accurately than conventional mice. It's a capable productivity mouse otherwise though.

EDWARD CHESTER

DESIGN 12/20
FEATURES 12/20
PERFORMANCE 18/30
VALUE 26/30

OVERALL SCORE 68%

VERDICT

Despite admirable ergonomic aims, this otherwise solid productivity mouse needs a bit of a redesign in places.

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GAMING MICE

ASUS TUF GAMING M4 AIR AND M4 WIRELESS / £42 inc VAT (M4 Air); £54 inc VAT (M4 Wireless)

SUPPLIER overclockers.co.uk

Despite sharing the same name, shape and overarching feature set, Asus' new M4 Air and M4 Wireless are quite different mice. One is an ultralight, wired-only option that's covered in weight-saving holes, while the other is a wireless-only model that runs on conventional AA or AAA batteries.

Their shared M4 shape is reminiscent of the likes of the Glorious Model O, with a symmetrical form but with thumb buttons only on the left sides of the mice, so they're not ambidextrous. With dimensions of 64 x 126 x 40mm (W x D x H), it's a mid-sized mouse design that's ideally suited to fingertip grip for medium to large hands, but also works well for palm and claw grips for medium to smaller hand sizes. There's a reason this shape and size of mouse has become so prevalent – it's so versatile.

Both M4s have just five main buttons – left, right, middle, back, forward and a top-mounted DPI button, and use a lightweight scroll wheel with very defined notches. These make the scroll wheel ideal for precise control in games, although they're less useful for quickly scrolling through documents on the Windows desktop.

The slightly confusingly named M4 Air (where 'air' means 'light', rather than 'wireless') is covered in holes that help bring down its weight to an impressive 47g, making it among the lightest mice you can buy. Despite this, its build doesn't feel compromised, with a generally sturdy feel and no creaks from the panels. The holes are filled in where the triangular hole pattern continues onto the sides of the mouse, but there's just enough of a dip to each triangle to make for a useful grippy surface.

It's an effective weight saving implementation but it's not particularly elegant. There are visible mould seams to the inside edges of the holes, and the intentional variation in the size of the holes and how much they're filled in makes it look a bit uneven. The size and number of the holes also leaves the insides very exposed. A water-repellent coating should keep the electronics safe from spills but it's not a particularly interesting or good-looking interior.

Meanwhile, the M4 Wireless weighs in at 77g with the included AAA battery (86g with an AA battery). It's still technically quite a light mouse, but you certainly notice the weight difference compared with the M4 Air. The battery

M4 AIR SPEC

Weight
47g

Dimensions (mm)
64 x 126 x 40 (W x D x H)

Sensor
PixArt PAW3335 optical (16,000 DPI, 40G acceleration, 400 IPS)

Buttons
5 (left, right, scroll wheel, 2 x side buttons)

Cable
1.8m, lightweight braided

Extras
None

M4 WIRELESS SPEC

Weight
77g (AAA battery) / 86g (AA battery)

Dimensions (mm)
64 x 126 x 40 (W x D x H)

Sensor
PixArt PMW3311 optical (12,000 DPI, 35G acceleration, 300 IPS)

Buttons
5 (left, right, scroll wheel, 2 x side buttons)

Cable
None

Extras
Wireless and Bluetooth connections, AAA battery

M4 CARBINE

- \+ Great overall shape
- \+ M4 Air is incredibly light
- \+ Excellent overall performance

M4 MOTORWAY

- – M4 Wireless is unbalanced
- – M4 Wireless lacks wired option
- – M4 Air looks a bit basic

also makes the mouse a little back-heavy, while the lack of the triangular texture on the sides makes this mouse less easy to grip than its wired counterpart.

On the plus side, the versatility and months-long battery life are handy, but there's no doubt a smaller rechargeable battery would have saved weight and provided better balance. The lack of a means to use the mouse in a wired mode also means that you're out of luck if you're caught short without a replacement battery.

There are no weight-saving holes on the M4 Wireless. Instead, the smooth back slides off to reveal the battery compartment and a stowage hole for the USB dongle. On its underside is a sliding switch for turning off the mouse or sliding between its USB dongle's wireless or Bluetooth modes.

Tracking performance for both mice is excellent, despite them using slightly different sensors. Combined with its incredibly low weight, this makes the M4 Air a top-class affordable gaming mouse for sheer performance, but the M4 Wireless is let down slightly by its higher and uneven weight.

Conclusion

The Asus TUF Gaming M4 Air's incredibly low weight, excellent performance and low price make it a top-choice ultralight gaming mouse for its price, as long as you don't mind its slightly utilitarian design and budget build quality. The M4 Wireless also offers decent value for its spec, but its slightly back-heavy design and lack of an optional wired connection let it down.

EDWARD CHESTER

VERDICT

Asus' latest gaming mice are decent value options, though the lightweight wired M4 is a bigger hit than the wireless model.

	M4 Air	M4 Wireless
DESIGN	16/20	12/20
FEATURES	12/20	14/20
PERFORMANCE	28/30	23/30
VALUE	27/30	25/30
OVERALL SCORE	83%	74%

GAMING LAPTOP

ALIENWARE x17 R2 / £3,184 inc VAT

SUPPLIER custompc.co.uk/AlienwareX17

The x17 is the biggest expression of Alienware's Legend 2 design language we've seen, and it's an imposing beast. The white body shines, the distinctive x17 logo dominates the lid and the familiar ring of RGB LEDs glows at the rear. Build quality is impeccable, and the Alienware is only 21mm thick – a slim figure for a high-end gaming laptop. Bear in mind, though, that this laptop weighs 3.2kg and measures 399mm wide, so it will weigh down your bag and occupy a large area of your desk.

Happily, Alienware has filled the sizeable body with good features. There's a Thunderbolt 4 connection and a USB 3.2 Gen 2 Type-C port, both of which offer power delivery, alongside two full-sized USB ports. The laptop has a microSD slot, HDMI output and 2.5Gbps Ethernet too, and on the inside, there's Killer 802.11ax Wi-Fi and Bluetooth 5.2. Almost all the ports sit at the machine's rear as well, which is handy for cable tidying, although Alienware's bright ring of RGB LEDs makes them difficult to see.

Meanwhile, the keyboard sits in the middle of the large base, and the switches are fast, crisp and pretty quiet. They keyboard has per-key RGB LED lighting and extra media keys, and it's a robust chiclet keyboard. That said, it's not without flaws – there's no numberpad, despite the sheer size of this laptop, and other machines have macro keys and extra buttons.

The 1.5mm of travel is also mediocre; Alienware's low-profile CherryMX option is miles better, with a snappier action and 2mm of travel. This is a £100 upgrade, and it's one we'd seriously consider. In front of the keyboard sits a small and unassuming trackpad that's fine for daily use, but you'll want a proper mouse for gaming.

Not surprisingly, this brute of a laptop has muscular internals. The Nvidia GeForce RTX 3080 Ti Laptop GPU has 7,424 CUDA cores and 16GB of memory alongside an unfettered 150W TDP. You also get an Intel 12th-gen CPU, with the Core i7-12700H deploying six P-Cores with a turbo speed of 4.7GHz, alongside eight E-Cores. In addition, the spec includes 32GB of DDR5 memory and a 1TB SSD with rock-solid read and write speeds of 6,413MB/sec and 4,131MB/sec.

The x17 isn't cheap. This configuration, which includes a 360Hz display, costs a whopping £3,184, and it still costs north of £3,000 if you settle for one with an RTX 3070 Ti GPU. The entry-level model, with 16GB of memory, a 165Hz display and an RTX 3060, still costs £2,149, and if you max out every customisation option, you'll pay beyond £4,000.

Remarkably, the x17 represents relatively good value though. Only a couple of laptops from Gigabyte and Razer mimic the x17's specification, including the RTX 3080 Ti and 360Hz screen, and they're all more expensive.

SPEC

CPU
2.3GHz Intel Core i7-12700H

Memory
32GB 4800MHz DDR5

Graphics
Nvidia GeForce RTX 3080 Ti Laptop 16GB

Screen
17.3in 1,920 x 1,080 IPS 360Hz

Storage
1TB Kioxia XG5 M.2 SSD

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5

Weight
3.2kg

Ports
1 x Thunderbolt 4/USB Type-C/DisplayPort, 1 x USB 3.2 Gen 2 Type-C, 2 x USB 3.2 Gen 1, 1 x audio, 1 x HDMI 2.1, 1 x microSD

Dimensions (mm)
399 x 300 x 21 (W x D x H)

Operating system
Windows 10 Home 64-bit

Warranty
One year parts and labour return to base

PERFORMANCE

The RTX 3080 Ti mobile GPU is a beast. Its smooth 99th percentile of 56fps in Assassin's Creed Valhalla is a great result with the 87fps average, and the 64fps 99th percentile result in Cyberpunk 2077 in superb. Not only that, but it stayed above 60fps with Medium ray tracing and Balanced DLSS enabled.

There's no high-end game this rig won't run smoothly at the screen's native 1,920 x 1,080 resolution. Meanwhile, its 322fps average in Doom Eternal shows it can handle undemanding games at high frame rates – it might not quite hit 360fps, but it's close, and the screen's G-Sync support means the screen will still sync with your graphics card's frame rates when they slow down too. It even hit a 42fps 99th percentile in Metro Exodus with High ray tracing enabled, and that will improve further with DLSS enabled.

LEGENDARY

- + Fantastic gaming speed
- + Immersive display
- + Decent thermal abilities
- + Good-looking, robust exterior

FORGETTABLE

- – Tinny-sounding speakers
- – Underwhelming keyboard
- – Large and heavy

That said, you might not hit these figures out of the box. By default, the x17 uses Nvidia Optimus, but with that option selected, the rig's Metro Exodus 99th percentile result dipped to 36fps and its Doom Eternal 99th percentile dropped to 127fps. With Optimus deployed, the GPU rarely drew 150W, and instead hovered between 130W and 140W.

You'll want to disable this feature if you're plugged into the mains and use the x17's Balanced thermal mode, which we used to get the results above. The x17 produced moderate, manageable fan noise under these settings, the GPU's delta T of 60°C was fine and only the area above the keyboard became uncomfortably warm.

If you want even more performance, the Full Speed thermal option saw the rig's Doom average jump to 342fps and the GPU's power draw rise beyond 150W. While fan noise is louder here, we've heard worse from conventional laptops, and a headset will easily drown out the racket – it's certainly not prohibitive. Elsewhere, the Quiet mode reduces fan noise at the expense of performance, while the two overclocked options had little impact on pace.

The Core i7-12700H is more predictable. Its overall system score of 280,778 is fast enough to manage any mainstream creative task, and its Handbrake H.264 video encoding result of 756,770 is superb. Noise levels are never bad during processing benchmarks, and the CPU achieves decent speeds – in single-threaded tests, the chip hit its turbo speed of 4.7GHz, and in heavily multi-threaded benchmarks, it peaked at 3.7GHz.

Meanwhile, the 17.3in display pairs its super-fast 360Hz refresh rate with G-Sync support, a 1ms response time and ample quality. The 385cd/m^2 brightness and 0.32cd/m^2 black point create a contrast ratio of 1,203:1, so colours are vibrant and nuanced. The delta E of 1.78 means colours are accurate, and the panel rendered 98.8 per cent of the sRGB gamut with a moderate 115.7 per cent volume. This display is bold and realistic rather than oversaturated, and it's great for gaming.

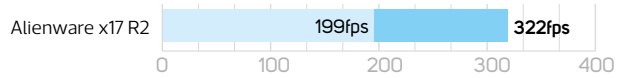
Not surprisingly, battery life is dismal – expect an hour of gameplay and three hours of work or media playback time. You'll want to stick to the mains with this machine where possible. Finally, the speakers have loads of volume and bass, but the top end is tinny – you'll want to use a headset or external speakers.

BENCHMARK RESULTS

66,381	756,770	265,522	280,778
GIMP IMAGE EDITING	HANDBRAKE H.264 VIDEO ENCODING	HEAVY MULTI-TASKING	SYSTEM SCORE

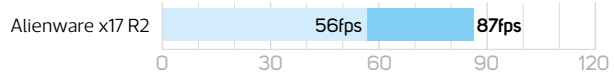
DOOM ETERNAL

1,920 x 1,080, Vulkan, Ultra Nightmare settings



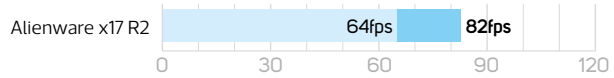
ASSASSIN'S CREED VALHALLA

1,920 x 1,080, Ultra High settings, High anti-aliasing



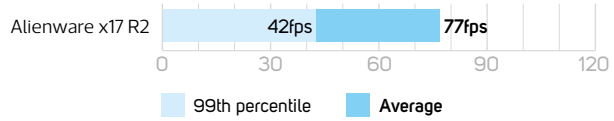
CYBERPUNK 2077

1,920 x 1,080, Ultra preset, no ray tracing



METRO EXODUS

1,920 x 1,080, Ultra settings, High RT, PhysX off, HairWorks off



CONCLUSION

The Alienware x17 R2 has fantastic design, superb gaming performance and an excellent display. Plus, given the components inside, it even offers reasonable value. Negatively, the speakers and keyboard should both be better, but you do at least have the option of upgrading the latter. If you've got the cash, the x17 is a fast, immersive gaming investment.

MIKE JENNINGS

VERDICT

Alienware's high-speed gaming rig offers sensational speed and design alongside a top screen, although it's a chunky beast and the keyboard could be better.

PERFORMANCE	24/25
DESIGN	22/25
HARDWARE	22/25
VALUE	20/25
OVERALL SCORE	88%

GAMING LAPTOP

ASUS ROG STRIX SCAR 15 G533ZW / £2,399 inc VAT

SUPPLIER custompc.co.uk/AsusScar15

Asus' ROG Strix laptops are some of the most gregarious machines around, and that's not changed for 2022 – this rig is still littered with RGB LEDs and big logos, with translucent plastic on the wrist rest and a trio of interchangeable panels that add some customisation to the area behind the display.

It shouts about its gaming ambitions, but this machine also offers substance alongside style. Build quality is good, with only a little movement in its panels, and its 2.3kg weight is comparatively light for a powerful 15.6in machine. The only minor physical issue is the 27mm-thick body, which makes the Asus feel chunky.

On the left-hand edge, you'll find two USB 3.2 Gen 1 ports and a headphone jack, while the rest of the connections lurk around the back – there's a Thunderbolt 4 connector, a USB 3.2 Gen 1 Type-C port with power delivery, and an HDMI 2.1 output. You also get 2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, and Bluetooth 5.2.

Faster full-sized USB ports would have been welcome though – there's one fewer here than on last year's model. The Scar also has no webcam, card reader or biometrics either, and the right-hand side still retains the notch for the gimmicky Asus Keystone – a slot that holds RFID devices that can be customised with settings or encrypted storage.

On the plus side, there's lots to like about the Scar's keyboard. The keys have 2mm of travel, which is more than most laptop keyboards, and their action is crisp and responsive – they're not a million miles away from opto-mechanical hardware and they're excellent for gameplay. Beyond the satisfying typing, the keyboard has per-key RGB lighting and extra media buttons, but no numberpad. The Scar 15's large and snappy trackpad can function as a numperpad too, although in practice, it doesn't work anywhere near as well as physical buttons.

On the inside, Asus deploys an RTX 3070 Ti mobile GPU with 5,888 CUDA cores, 8GB of memory and a peak TDP of 125W that can hit 150W with Dynamic Boost – figures that are right at the chip's upper limit. Meanwhile, its Core i9-12900H CPU is similarly muscular, containing six Hyper-Threaded P-Cores with a 5GHz turbo speed, underpinned by eight 3.8GHz E-Cores. The 1TB Samsung SSD is fast too, delivering quick read and write scores of 6,961MB/sec and 5,074MB/sec, and you get 16GB of 4800MHz DDR5 memory as well.

That's a lot of fast hardware for £2,399 inc VAT, but when it comes to value, the Scar's biggest threat actually comes from within the Asus stable. The 17.3in version of this machine costs £2,599 for the same core components, but with 32GB of memory, a 2TB SSD and a larger display. If you won't move the laptop much, that's an affordable upgrade for added performance and immersion.

SPEC

CPU
2.5GHz Intel Core i9-12900H

Memory
16GB 4800MHz DDR5

Graphics
Nvidia GeForce RTX 3070 Ti Laptop 8GB

Screen
15.6in 2,560 x 1,440 IPS 240Hz

Storage
1TB Samsung PM9A1 M.2 SSD

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5

Weight
2.3kg

Ports
1 x Thunderbolt 4 / USB Type-C / DisplayPort, 1 x USB 3.2 Gen 2 Type-C, 2 x USB 3.2 Gen 2, 1 x audio, 1 x HDMI 2.1

Dimensions (mm)
354 x 259 x 23 (W x D x H)

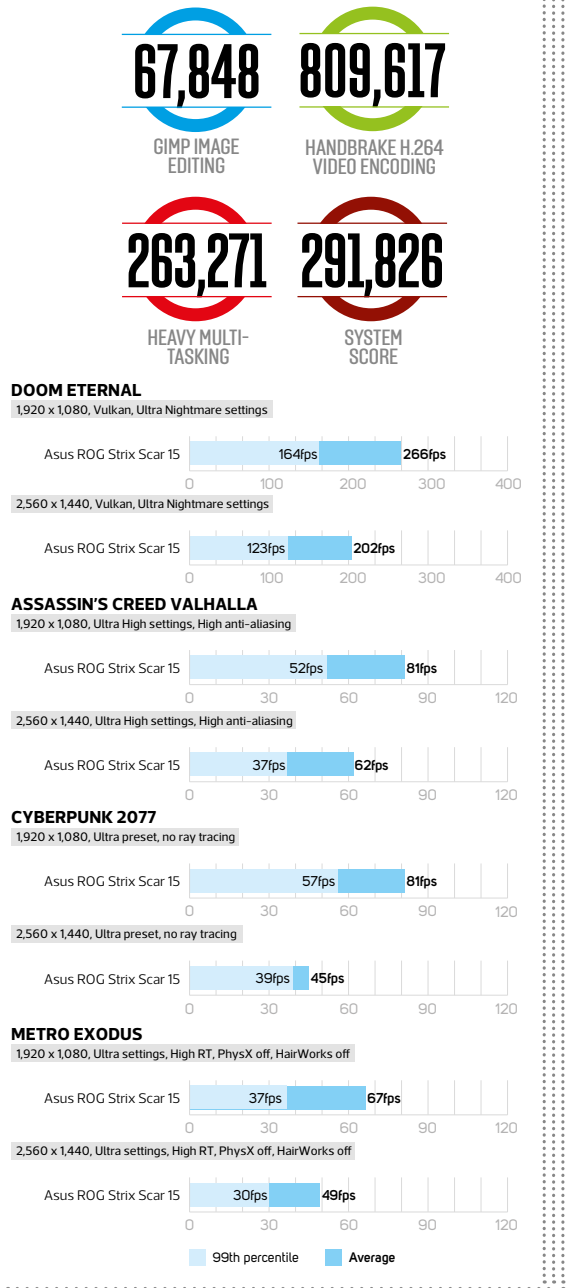
Operating system
Windows 10 Home 64-bit

Warranty
One year parts and labour return to base

PERFORMANCE

In Assassin's Creed Valhalla at 1,920 x 1,080, the Scar 15 delivered a great average of 81fps, and only dropped to a 99th percentile of 52fps, with a similarly smooth result in Cyberpunk 2077. It fared less well in these tests at the screen's native 2,560 x 1,440 resolution, but our tests are run at demanding settings – a little tweaking in the settings will make these games playable at this resolution. This machine is also well suited to running less demanding games at high frame rates on the 240Hz screen too – the Scar 15 averaged 202fps in Doom Eternal at 2,560 x 1,440, which improved to 266fps at 1080p.

BENCHMARK RESULTS



Meanwhile, the Core i9-12900H produced a system score of 291,826 in our RealBench application benchmarks, which is a great result for a portable machine. Its Handbrake H.264 video encoding score of 809,617 is particularly potent, thanks to all those cores, making the Scar 15 a formidable machine for heavily multi-threaded content creation tasks.

The Asus is a good thermal performer too. During gameplay, the noise levels are noticeable but quieter than most 15.6in gaming machines, and there are no internal or external heat issues, with that extra thickness providing

a bit of thermal headroom. The noise was quieter during processing tests, and CPU speeds were reasonable – the P-Cores hit 3.6GHz in a heavily multi-threaded test and 4.9GHz in single-threaded workloads.

The Scar has a Turbo mode as well, but we don't recommend using it – the huge noise increase isn't worth the extra 3fps in games and a 5 per cent application benchmark improvement. Conversely, the Silent mode is worthwhile – it runs mainstream games at still playable frame rates, while keeping down the noise, and the machine still has enough power for everyday computing.

There are no surprises in battery tests. The Scar lasted for one hour, 47 minutes in a gaming benchmark, which is a decent result, albeit with reduced graphical power, and five hours during work and media runs. As with all gaming laptops, you'll get the most out of the Scar if you keep it plugged into the mains.

The Scar's display is excellent too. Along with its 240Hz refresh rate, its 1,157:1 contrast ratio supplies ample vibrancy, the delta E of 2.4 ensures solid colour accuracy and the display rendered 99.6 per cent of the sRGB gamut and 97.2 per cent of the DCI-P3 colour space – this screen produces every shade needed by games with accuracy and punch. Finally, the speakers are bassy and loud, so they provide a booming (if a bit unbalanced) experience.

CONCLUSION

The Asus ROG Strix Scar 15 is a great gaming laptop. It's fast, the keyboard is satisfying, the display is rock-solid and the exterior isn't hot or loud. Not everyone will be keen on the chunky body or gaming style, and connection options could be better, but the Scar is sturdy, well built and easy to use.

MIKE JENNINGS

VERDICT

A fast, bold and sturdy gaming notebook with few significant issues.

SIMBA

+ Consistently superb performance
+ Accurate and fast 240Hz screen
+ Satisfying keyboard
+ Robust, eye-catching exterior

SCAR

− Thicker than rivals
− Connection options could be better
− Mediocre battery life

PERFORMANCE 23/25

DESIGN 21/25

HARDWARE 22/25

VALUE 21/25

OVERALL SCORE 87%

AMD B550 GAMING PC

OCUK SPECTRA GAMING CELESTE

/ £1,399 inc VAT

SUPPLIER overclockers.co.uk

The Celeste, made by Overclockers UK, is an impressively cheap gaming system that aims to deliver mainstream gaming pace without an absurd cost, and it gets off to a good start by using a GeForce RTX 3060 Ti GPU. This mid-range Nvidia GPU has 4,864 stream processors, 8GB of memory and 38 RT cores, and the Asus-made card in this rig overclocks the boost frequency from 1665MHz to 1710MHz.

Sitting above the graphics card is an AMD Ryzen 5 5600G APU, which has six SMT-enabled Zen 3 cores and a peak pace of 4.4GHz. It's a little unusual that Overclockers has chosen an APU for this PC, given its discrete graphics card and its relative lack of performance alongside conventional CPUs, but we can only assume it was a budgetary decision, as the 5600G is a little cheaper than the Ryzen 5 5600X.

Elsewhere, the Celeste has 16GB of dual-channel DDR4 memory running at 3200MHz and a Kolink PSU with 80 Plus Bronze certification but no modular design. The Celeste also offers a 500GB WD Blue SSD and a 1TB hard disk. While that's decent storage capacity for an affordable gaming PC, the SSD uses the SATA rather than NVMe protocol, so it can only read and write at modest speeds of 422MB/sec and 455MB/sec.

The Celeste is responsive in everyday use and the SSD won't hinder gaming, but you'll notice its lack of pace if you use this machine for large file transfers, and the absence of NVMe hardware is disappointing in a PC at this price.

The Asus TUF Gaming B550-Plus WiFi II motherboard is more befitting the budget. It has two M.2 sockets, and two spare memory sockets. Beneath the GPU, you'll find three 1x PCI-E slots and plenty of fan and lighting headers. The military-inspired design is attractive, and at the rear, there are seven USB ports of varying speeds. It even offers 2.5Gbps Ethernet alongside dual-band 802.11ax Wi-Fi and Bluetooth 5.2.

It's still not a high-end board, though, so there are limitations – the Realtek ALC897 audio codec is entry-level, for example, and you don't get any fast USB 3.2 Gen 2x2 USB ports. Also, while one of the M.2 connectors supports the latest fast PCI-E 4 SSDs, the AMD APU doesn't, so you'll need to upgrade the CPU to get the most out of a future storage upgrades.

It's all housed in a Phanteks P360A chassis, which is sturdy, clean and attractive – two RGB LED intake fans glow through a meshed front panel and the cabling is neat. The PSU shroud has RGB LEDs, Overclockers has added more lighting and the entire motherboard is accessible and unobstructed, with the radiator for the Corsair H100x AIO CPU cooler occupying the roof.

Two buttons on top of the chassis allow for lighting changes, and there are two USB 3.2 Gen 1 ports here but no USB Type-C port. Elsewhere, the cables are untidy around the rear, with one large cable dragging right across the two

SPEC

CPU
3.9GHz AMD Ryzen 5 5600G

Motherboard
Asus TUF Gaming B550-Plus WiFi II

Memory
16GB Team Group Vulcan T-Force 3200MHz DDR4

Graphics
Asus GeForce RTX 3060 Ti 8GB

Storage
500GB WD Blue M.2 SATA SSD, 1TB Seagate Barracuda hard disk

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5.2

Case
Phanteks Eclipse P360 Air

Cooling
CPU: Corsair Hydro Series H100x with 2 x 120mm fans; GPU: 3 x 90mm fans; front: 3 x 120mm fans; rear: 1 x 120mm fan

Ports
Front: 2 x USB 3.2 Gen 1, 2 x audio; rear: 1 x USB 3.2 Gen 2 Type-C, 1 x USB 3.2 Gen 2, 4 x USB 3.2 Gen 1, 2 x USB 2, 1 x optical S/PDIF, 5 x audio

Operating system
Windows 11 Home 64-bit

Warranty
Three years parts and labour collect and return

2.5in drive mounts, and the tool-free 3.5in bays are only accessible if you remove the system's front panel.

On the plus side, it's really good to see a decent warranty with a PC at this price, with Overclockers offering a three-year collect and return deal that covers both parts and labour.

PERFORMANCE

The GeForce RTX 3060 Ti remains an effective mid-range GPU. At 1080p, it delivered 99th percentile minimums beyond 60fps in Assassin's Creed Valhalla and Cyberpunk 2077 with Medium ray tracing and DLSS, so it can play demanding big-name games without issues. Its 287fps average in Doom Eternal also shows it can churn out super-fast frame rates in undemanding games on 240Hz displays.

Upping the resolution to 2,560 x 1,440 saw the RTX 3060 Ti remain playable in Doom Eternal and Assassin's Creed Valhalla, but this GPU doesn't quite have the clout to run games with ray tracing at this resolution.

The Ryzen 5 5600G proved underwhelming though. Its overall system score of 205,827 is a little slower than the score from the Core i5-12400F in the £1,099 Wired2Fire Phoenix Intel (see Issue 224, p38), and it's miles behind the 294,013 scored by the £1,499 PC Specialist Magnus Supreme's Core i5-12600KF (see Issue 223, p26).

Comparatively, the Ryzen 5 5600X scores around 230,000. While the Celeste's chip won't hinder everyday gaming and multi-tasking, it doesn't have the chops for content creation or other tricky workloads. Thankfully, the Celeste's pairing of a large cooler with this APU means there are no thermal issues. It's extremely quiet during all gaming and work situations, and the CPU and GPU delta Ts of 34°C and 42°C are great. The processor also attained its stated boost speed of 4.4GHz.

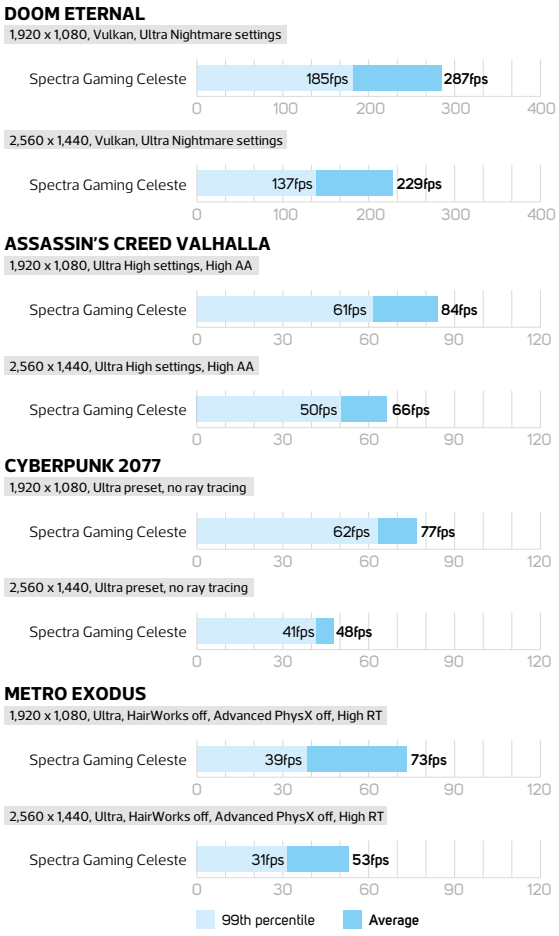
MOUNT CELESTE

+ Decent gaming performance
+ Sturdy, smart case
+ Consistently cool and quiet

DAPHNE & CELESTE

– Sluggish processor
– Overpriced
– Slow SATA SSD

BENCHMARK RESULTS



66,408
GIMP IMAGE EDITING

511,848
HANDBRAKE H.264 VIDEO ENCODING

229,642
HEAVY MULTI-TASKING

205,827
SYSTEM SCORE

CONCLUSION

The first PC we've seen from Overclockers' Spectra brand has a great GPU, a robust and attractive chassis, a decent motherboard and a powerful CPU cooler – plus it's very quiet. However, those solid attributes are undermined by poor storage and an underpowered processor.

It's expensive too – you can easily find GeForce RTX 3060 Ti PCs elsewhere with better CPUs and storage for similar prices. The Celeste supplies capable gaming speed inside a sturdy, quiet chassis, but it needs to offer a better-balanced spec at this price.

MIKE JENNINGS

VERDICT

Solid gaming pace inside a robust and quiet machine, but the processor and storage disappoint.

PERFORMANCE 18/25
DESIGN 19/25
HARDWARE 18/25
VALUE 17/25
OVERALL SCORE 72%

Custom kit

Phil Hartup checks out the latest gadgets, gizmos and geek toys

JBL REFLECT FLOW PRO / £129.99 inc VAT

SUPPLIER uk.jbl.com

The JBL Reflect Flow Pro is a set of surprisingly comfy earbuds. Beneath their sleek exterior, they pack extremely effective noise cancelling, and enough clarity and power to deliver all the good noises and none of the bad ones with substantial force. A comfortable fit is provided by not only being able to swap the ear tips, but also with JBL's 'Powerfins' – squashy rubber fins that helps the buds to fit to your outer ears.

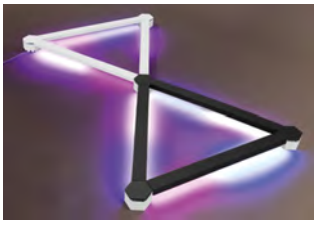
The noise-cancelling system has two modes, one that does what you'd expect (actively cancels noise), while the second is adaptive, allowing you to hear some background noise and making it safer for situations where you might need more of your wits about you. Being designed with exercise in mind, the buds are rated to IP68, so they're fine to use in the rain as well.

Meanwhile, the charging case is compatible with wireless charging and provides an extra 20 hours of battery life. The sound quality is very good as well – it's clear and sharp where necessary but beefy at the lower range too. This high quality also extends to the microphones, however, so be sure to get your breath back before calling anybody.

Sweaty ●●●●● **Comfy**

NANOLEAF LINES SKIN / £14.99 inc VAT

SUPPLIER nanoleaf.me



The Skins are fairly simple plastic covers for Nanoleaf Lines lighting systems. Two colours are available, matt black and matt pink, making them ideal for both traditional goths and pastel goths, although others might find the change in colour from the default stark white used by the Nanoleaf Lines an improvement too.

The covers slot onto the panels easily enough, although removing and replacing the covers on the connection points can be a little fraught. The Skins themselves don't change the lighting or anything to do with it, since that emanates from the uncovered underside of the Lines and is more dependent on the surface onto which the light is shining. However, they do have an overall softening effect on the whole installation. It's hard to say if a series of lighting panels can ever be understated, but the Skins can make them fit in more comfortably with background décor.

Skin ●●●●○ **Reskin**

RUGD RHINO POWER / £19.99 inc VAT

SUPPLIER rugdlife.com

It is difficult to quantify the power of a rhino, but at least thanks to RUGD, the capacity to transfer that power between USB Type-C ports apparently exists. The RUGD Rhino Power cable is, as the name suggests, a heavily reinforced USB Type-C to USB Type-C charging cable. The cable is rated to be able to pull 100kg, which is probably more than most people need to pull with a USB Type-C cable, unless you've got a power bank the size and weight of a tombstone, but it's the sort of reassuring level of overkill that's expected from toughened hardware.

The cable is braided and resistant to tangles and bends, and it even has a little Velcro tab, so you can loop it tidily for storage, which is a smart addition for any hardware designed for travel. Outdoorsy and tough, the RUGD Rhino Power is a good upgrade on a standard plastic cable if you're worried about kinks, breaks and general instability letting you down.

Undercooked ●●●●○ **Overkilled**

SANDISK EXTREME PRO SSD /

£189.99 inc VAT (1TB); **£305.99** inc VAT (2TB); **£612.99** inc VAT (4TB);

SUPPLIER westerndigital.com

The long-named SanDisk Extreme Pro Portable SSD V2 is a USB 3.2 Gen 2x2 SSD that's available in a range of capacities. Like most SSDs using the latest USB technology, it's extremely fast, boasting a read speed of 1,089MB/sec and a write speed of 1,070MB/sec when tested with CrystalDiskMark. This isn't nearly as fast the peak speeds you can get from a PCI-E M.2 motherboard-mounted SSD, but for an external drive, it's fast enough to juggle huge amounts of data relatively quickly.

As well as being fast, the SanDisk is also small and surprisingly tough. Measuring 11cm long, 6cm wide and 1cm deep, it's relatively small compared with a smartphone. It's rated for a 2m drop height, which should be enough for most use situations outside of using it as a projectile, and it has an IP55 rating for water and dust resistance. This is a formidable example of the quality of external drives now.

Big names ●●●●● **Big numbers**

BRAINWAVZ TREO / **£15.99** inc VAT

SUPPLIER amazon.co.uk

The Treo is a bold attempt to stack as many different devices as possible onto a single hanger mounted underneath a shelf or desk. On one side it has two shelves, which accommodate ordinary-sized wireless gamepads. Any pad that fits within the same general size and shape parameters as a standard Xbox or PlayStation controller should be fine here, unless it has a cable, in which case there's no chance.

On the other side of the Treo, there's another shelf from which to hang headphones, and this is fine for any headphones or headset regardless of whether it's wireless or not. The Treo attaches with a big slice of double-sided tape, giving it plenty of stability, and its plain black look isn't garish or distracting.

However, due to its size in accommodating all these items, you'll need a fair bit of underdesk room for it not to interfere with your legs. It's probably a better fit for a shelf above a desk rather than underneath it. That size, coupled with the lack of accommodation for wired controllers, undermines the intended versatility.

Underneath ●●●○○ **Overboard**

Seen something worthy of appearing in Custom Kit? Send your suggestions to phil.hartup@gmail.com

How we test

MOTHERBOARDS

TEST PROCESSORS

- **Intel LGA1700** Intel Core i5-12600K
- **Intel LGA1200** Intel Core i9-11900K
- **AMD AM4** AMD Ryzen 9 5900X

Common test hardware between our CPU test rigs includes a WD Red SN750 SSD, along with a WD Black SN850 SSD to test the speed of M.2 ports, and an Nvidia GeForce RTX 3070. We use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, or 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM.

All CPUs are cooled by a Corsair Hydro-X water-cooling loop with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock. We test with our RealBench suite and Far Cry 6 on Windows 11. We also test each board's M.2 ports, and record the noise level and dynamic range of integrated audio using RightMark Audio Analyzer.

PROCESSORS

TEST MOTHERBOARDS

- **Intel LGA1700**
  Asus ROG Maximus Z690 Apex
- **Intel LGA1200** MSI MEG Z490 Ace
- **AMD AM4 APU** MSI MPG Gaming B550 Carbon WiFi
- **AMD AM4** MSI MEG X570 Unify

Common gear includes a 2TB Samsung 970 Evo SSD and Nvidia GeForce RTX 3070 FE graphics card. For LGA1700 CPUs, we use 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM and a Thermaltake Toughliquid Ultra 360 CPU cooler. For other systems, we use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz RAM and a Corsair Hydro-X water-cooling loop, with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock.

We use the latest version of Windows 11 with security updates, plus the latest BIOS versions and drivers. We record results at stock and overclocked speeds, and tests include our RealBench suite, Cinebench, Far Cry 6 and Dirt 5.

For games, we record the 99th percentile and average frame rates either using the game's built-in benchmark or Nvidia FrameView. Finally, we note the idle and load power draw of the whole system, using Prime95's smallfft test with AVX disabled.

MONITORS

We test image quality with an X-Rite iDisplay Pro colorimeter and DisplayCal software to check colour accuracy, contrast and gamma, while assessing more subjective details such as pixel density and viewing angles by eye. For gaming, we test a monitor's response time with an Open Source Response Time Tester, and use Blur Busters' ghosting UFO test to check the sharpness of a display in high-speed motion.

CPU COOLERS

We use CoreTemp to measure the CPU temperature, before subtracting the ambient air temperature from this figure to give us a delta T result, which enables us to test in a lab that isn't temperature controlled. We use Prime95's smallest FFT test with AVX instructions disabled to load the CPU and take the temperature reading after ten minutes.

For the Intel LGA1200 system, we take an average reading across all eight cores, and for the LGA1700 system, we take an average reading across both the P-Cores and E-Cores. AMD's CPUs only report a single temperature reading, rather than per-core readings, so we list what's reported in CoreTemp.

TEST KIT
Fractal Design Meshify C case, 16GB of Corsair Vengeance RGB Pro memory, 256GB Samsung 960 Evo SSD, Corsair CM550 PSU.

INTEL LGA1700
Intel Core i9-12900K at stock speed, Asus ROG Maximus Z690 Apex motherboard.

INTEL LGA1200
Intel Core i9-11900K at stock speed with Adaptive Boost enabled, MSI MEG Z590 Ace motherboard.

AMD AM4
Ryzen 7 5800X overclocked to 4.6GHz with 1.25V vcore, or Ryzen 5 5600X overclocked to 4.6GHz with 1.25V vcore on low-profile coolers, MSI MEG X570 Unify motherboard.

GRAPHICS CARDS

We mainly evaluate graphics cards on the performance they offer for the price. However, we also consider the efficacy and noise of the cooler, as well as the GPU's support for new gaming features, such as ray tracing. Every graphics card is tested in the same PC, so the results are directly comparable. Each test is run three times, and we report the average of those results. We test at 1,920 x 1,080, 2,560 x 1,440 and 3,840 x 2,160, using an AOC U28G2XU monitor.

TEST KIT

AMD Ryzen 9 5900X, 16GB (2 x 8GB) of Corsair Vengeance RGB Pro SL 3600MHz DDR4 memory, Asus ROG Strix B550-E Gaming motherboard, Thermaltake Floe Riing 240 CPU cooler, Corsair RM850 PSU, Cooler Master MasterCase H500M case, AOC U28G2XU monitor, Windows 10 Professional 64-bit.

GAME TESTS

Cyberpunk 2077 Tested at the Ultra quality preset and Medium ray tracing preset if the GPU supports it. We run a custom benchmark involving a 60-minute repeatable drive around Night City, and record the 99th percentile and average frame rates from Nvidia FrameView.

Assassin's Creed Valhalla Tested at Ultra High settings with resolution scaling set to 100 per cent. We run the game's built-in benchmark, and record the 99th percentile and average frame rates with Nvidia FrameView.

Doom Eternal Tested at Ultra Nightmare settings, with resolution scaling disabled. We run a custom benchmark in the opening level of the campaign, and record the 99th percentile and average frame rates with Nvidia FrameView. This test requires a minimum of 8GB of graphics card memory to run, so it can't be run on 6GB cards.

Metro Exodus Tested at Ultra settings with no ray tracing and both Advanced PhysX and HairWorks disabled. We then test it again with High ray tracing if the GPU supports it. We run the game's built-in benchmark, and report the 99th percentile and average frame rates.

POWER CONSUMPTION

We run Metro Exodus at Ultra settings with High ray tracing at 2,560 x 1,440, and measure the power consumption of our whole graphics test rig at the mains, recording the peak power draw.

CUSTOM PC AWARDS

EXTREME ULTRA

Some products are gloriously over the top. They don't always offer amazing value, but they're outstanding if you have money to spend.

PREMIUM GRADE

Premium Grade products are utterly desirable, offering a superb balance of performance and features without an over-the-top price.

PROFESSIONAL

These products might not be appropriate for a gaming rig, but they'll do an ace job at workstation tasks.

APPROVED

Approved products do a great job for the money; they're the canny purchase for a great PC setup.

CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.

CUSTOM PC REALBENCH

Our own benchmark suite, co-developed with Asus, is designed to gauge a PC's performance in several key areas, using open source software.

GIMP IMAGE EDITING

We use GIMP to open and edit large images, heavily stressing one CPU core to gauge single-threaded performance. This test responds well to increases in CPU clock speed.

HANDBRAKE H.264 VIDEO ENCODING

Our heavily multi-threaded Handbrake H.264 video encoding test takes full advantage of many CPU cores, pushing them to 100 per cent load.

LUXMARK OPENCL

This LuxRender-based test shows a GPU's compute performance. As this is a niche area, the result from this test has just a quarter of the weighting of the other tests in the final system score.

HEAVY MULTI-TASKING

This test plays a full-screen 1080p video, while running a Handbrake H.264 video encode in the background.

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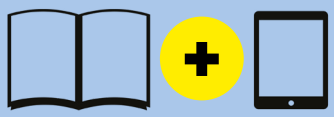

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LABS TEST

CPU megatest

Antony Leather straps 12 of the latest mainstream desktop CPUs from Intel and AMD to the test bench, to find the best options for a variety of budgets

How we test

With AMD's Socket AM5 and Zen 4 CPUs still some way off, and its current Zen 3 CPUs having received substantial price cuts, the CPU market has changed significantly in the past six months. Intel's 12th-gen CPUs have also been well received for the most part, offering compelling performance, especially below the £400 mark.

However, there are some newcomers from AMD as well; when combined with some price cuts, these could put Intel on the back foot. We've picked 12 of the latest CPUs to put them through our usual mix of game and application benchmarks, to see where you should put your cash, whether you have £170 to spend or £500.

Our CPU test systems include an Asus Maximus Z690 Apex for Intel 12th-gen CPUs, and an MSI MEG X570i Unify for AM4 CPUs. We use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 memory for our AMD system, and 32GB (2 x 16GB) of Corsair Dominator Platinum RGB 5200MHz DDR5 memory for our Intel system (none of our benchmarks uses more than 16GB of memory). The other test components comprise a 2TB Samsung 970 Evo and an Nvidia GeForce RTX 3070 graphics card, along with dual 240mm radiators and a custom water-cooling system.

All systems use the latest version of Windows 11, along with the latest security updates, BIOS versions and drivers. We record results at both stock speed and overclocked, and our benchmarks include the CPC RealBench suite, which covers image editing (lightly threaded), video encoding (heavily multi-threaded) and multi-tasking tests. We also run Cinebench's single and multi-threaded tests.

For our game tests, we run Far Cry 6 and Watch Dogs: Legion, recording the 99th percentile and average frame rates, either using the game's built-in benchmark or Nvidia Frame View. Finally, we also measure the idle and load power consumption of the whole test rig using Prime95's smallfft test with AVX disabled.

Contents

INTEL CORE i5-12400F / £165 inc VAT

SUPPLIER cclonline.com

In previous CPU generations, Intel's Core i5 CPUs have usually had the same underpinnings, just with different frequencies and cache amounts, but the Core i5-12400F is a very different CPU to the Core i5-12600K. The 12400F sticks to the familiar 6-core design, while the more expensive Core i5-12600K adds four E-Cores into the mix for a total of ten cores and 16 threads, compared to six cores and 12 threads for the CPU on review here.

Thankfully, the Core i5-12400F is also significantly cheaper, retailing for just £165, which is £100 less than its Core i5 sibling. The F in its name denotes the fact it has no on-board GPU, and it costs a little less than the standard model as a result. This price also makes it around £20 cheaper than AMD's Ryzen 5 5600, which is its main competitor.

Its peak boost frequency is significantly lower than its sibling this month, at just 4.4GHz, while the Core i5-12600K can hit 4.9GHz. The latter can also hit 4.5GHz on its P-Cores under full load too, while the Core i5-12400F falls back to just 4GHz. Still, with plenty of change from £200 and some affordable LGA1700 motherboards available now, the 12400F is still a potential winner if you're on a budget.

Its image editing score of 69,757 was a match for that of the AMD Ryzen 5 5600 but a long way off the 76,451 scored by the Core i5-12600K. It was a little slower than the AMD CPU in our heavily multi-threaded video encoding test, but a huge amount off the pace of the more expensive Core i5. It also posted the lowest system score on test, although its result wasn't far behind the Ryzen 5 5600.

However, Cinebench saw the Intel CPU beat the Ryzen 5 5600 convincingly, and not even a massive overclock could help the AMD chip here, although it did cement the Ryzen 5 5600's lead in our image editing, video encoding and multi-tasking tests. This is a benefit of the AMD chip, as the Core i5-12400F's locked multiplier prevents overclocking.

Likewise, the Core i5-12400F was much faster than the Ryzen 5 5600 in Far Cry 6, but the AMD CPU matched it once overclocked. The Intel CPU took the lead in Watch Dogs: Legion, though, even when the AMD chip was overclocked. It fared well against the Core i5-12600K in games too, but the latter did manage a noticeably higher average frame rate in Far Cry 6.

Finally, with a 180W peak power draw for our system as a whole, our Core i5-12400F test system was barely any more power hungry than our Ryzen 5 5600 setup at stock speed, while the AMD rig drew a further 31W from the mains when it was overclocked.

SPEC

Base frequency 2.9GHz

Max boost frequency 4.4GHz

Core Alder Lake

Manufacturing process 10nm

Number of cores 6 x P-Cores (12 threads)

IGP None

Hyper-Threading Yes

Cache 18MB L3, 7.5MB L2

Memory controller Dual-channel DDR4 up to 3200MHz, dual-channel DDR5 up to 4800MHz

Packaging LGA1700

Thermal design power (TDP) 65W

Features Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

LOCKED FRONT DOOR

+ Great value
+ Faster than equivalent AMD CPUs in games
+ Reasonable content creation performance

LOCKED MULTIPLIER

– No overclocking
– Lowly boost frequencies
– No E-Cores

Conclusion

With its ability to keep pace with AMD's Ryzen 5 5600 at stock speed, and with better performance in our game tests, the Core i5-12400F makes a strong case as a budget CPU. The AMD CPU claws back ground once it's overclocked in a number of tests, though, so it's far from an outright win for Intel.

If you can afford a bit of extra slack in your budget, the Core i5-12600K is also much more powerful, thanks to its extra cores, threads and higher boosting frequencies. However, if you won't be overclocking, and you want the best gaming CPU possible on a tight budget, the Core i5-12400F is the chip to buy.

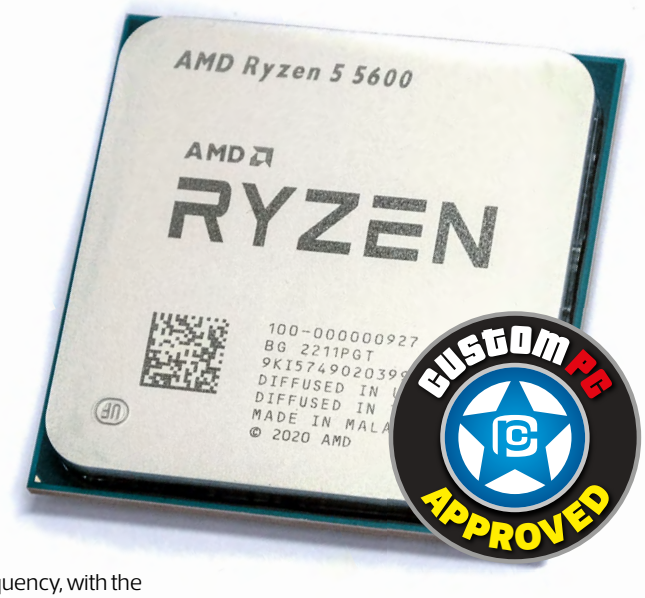
VERDICT

Solid gaming performance and reasonable all-round speed for a generous price, although it can't be overclocked.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
36/50	11/15	35/35	82%

AMD RYZEN 5 5600 / £179 inc VAT

SUPPLIER scan.co.uk



The Ryzen 5 5600 is designed for one purpose – to make AMD more competitive at the low end. The company has struggled to appeal to budget gamers with the Ryzen 5 5600X which, while brilliant, still set you back £300 until very recently, yet has been the cheapest Zen 3 Ryzen CPU.

AMD has instead relied on its aging Zen 2 CPUs to cater for those on lower budgets. This means that Intel has enjoyed some success here, given that Zen 2's now mediocre performance in games means even low-end Intel CPUs were comparatively decent budget gaming chips. It's another reason why the Core i5-12600K was such a great choice too, costing significantly less than the Ryzen 5 5600X, but matching it in most tasks, with no AMD offering below it able to get close.

Clearly, if you have around £200 to spend on an AMD CPU, you'll need to consider either this CPU or its slightly dearer sibling. Thankfully, it's a fairly simple comparison.

SPEC

Base frequency 3.5GHz

Max boost frequency 4.4GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 6 x physical (12 threads)

IGP None

Simultaneous Multithreading Yes

Cache 32MB L3, 3MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 65W

Features Precision Boost 2, Precision Boost Overdrive, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

Like the 5600X, the 5600 has six cores and 12 threads, the same 32MB L3 cache, a 65W TDP and it still uses the 7nm Zen 3 architecture.

The only difference is frequency, with the more expensive Ryzen 5 5600X stretching to a 4.6GHz maximum boost, with us observing an all-core boost of 4.4GHz in multi-threaded applications. The Ryzen 5 5600, meanwhile, can only peak at 4.4GHz and we saw an all-core boost frequency of 4.1GHz at stock speed.

Overclocking proved very fruitful, though, and while other Zen 3 CPUs topped out at 4.6GHz here, we managed to clock the Ryzen 5 5600 to 4.7GHz with a vcore of 1.25V. This means we gain 300MHz over the peak boost frequency, and a massive 600MHz over the highest all-core boost we saw – its clock speed also eclipses the more expensive Ryzen 5 5600X.

Its stock speed results were average, with the lowest image editing and Cinebench multi-threaded scores on test, as well as the lowest frame rates in both our game tests. However, the overclock saw it rise from last to mid-table in the image editing test, even beating the Ryzen 9 5900X, and having the measure of the Core i5-12400F in every RealBench test.

The Intel CPU was faster in Cinebench though – even when overclocked, the Ryzen 5 5600 couldn't better the Intel chip's multi-threaded or single-threaded scores. The Intel CPU was also quicker in Far Cry 6, with the Ryzen 5 5600 only managing to match it once overclocked, while it failed to get that far in Watch Dogs: Legion, even when overclocked. For once, AMD didn't hold much benefit in power consumption either, with our test system only drawing 10W more under load with the Intel CPU installed.

SIX FEET TALL

+ Generous price
+ Good multi-threaded performance
+ Decent overclocking headroom

SIX FEET UNDER

– Intel CPUs quicker in games
– Meagre stock speed performance
– Cheaper Core i5-12400F is faster in many tests

Conclusion

Thanks to decent overclocking potential and a price that's significantly south of the Core i5-12600K's price, the Ryzen 5 5600 is a great choice, and a manual overclock will see it match or better the Ryzen 5 5600X too. It offers decent content creation performance and, as a sweetener, AMD's older B350 and X370 motherboards now support Ryzen 5000-series CPUs too, potentially saving cash compared to buying an Intel LGA1700 board if you already own a Ryzen system. The Intel Core i5-12400F is a slightly better choice in raw performance terms, though, especially in games.

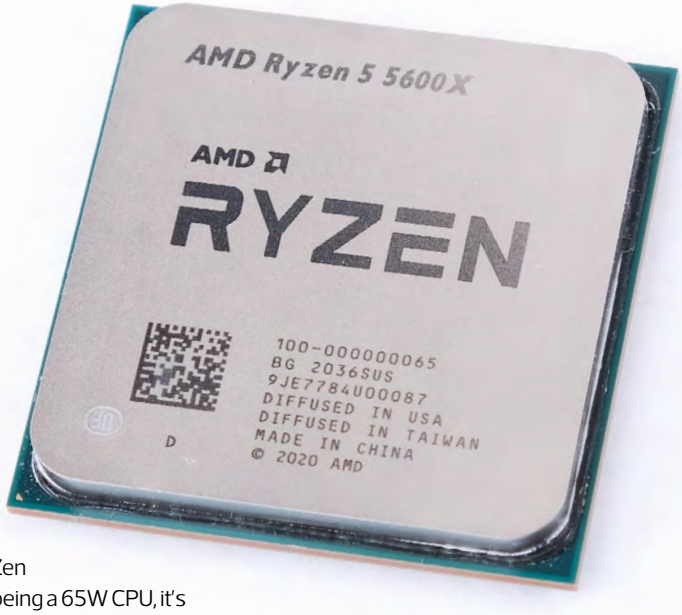
VERDICT

A brilliant, overclockable low-end CPU that's a great upgrade for 1st-gen or 2nd-gen Ryzen owners.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
34/50	12/15	34/35	80%

AMD RYZEN 5 5600X / £210 inc VAT

SUPPLIER scan.co.uk



Like most original Ryzen 5000-series CPUs, the Ryzen 5 5600X has recently enjoyed a significant price cut, thanks to Intel's 12th-gen CPUs being rather good. Significantly, the Core i5-12600K substantially undercut the AMD chip, but was just as fast. As we went to the printers this month, though, the Ryzen 5 5600X had become cheaper still, retailing for just £210 inc VAT, which is £100 less than when we first reviewed it.

This means it now undercuts Intel's Core i5-12600K by quite a margin, but with the latest drivers, Windows updates and BIOS versions installed in our test systems, performance can swing either way. Still, you get a lot of CPU for money. It has the latest 7nm Zen 3 architecture and, being a 65W CPU, it's particularly easy to cool, especially at stock speed. Its peak boost of 4.6GHz is paired with an all-core boost of 4.4GHz, so it's noticeably quicker than the slightly cheaper Ryzen 5 5600, making it a better option if you don't want to overclock.

This was very evident in our benchmarks, with the 5600X having a 9 per cent advantage in the image editing test over the 5600, and scoring a few hundred extra points in Cinebench's multi-threaded and single-threaded results too. Both our game tests revealed the Ryzen 5 5600X adding a few frames per second to the 99th percentile results as well, so ultimately it's worth the extra cash at stock speed. It now makes for a compelling upgrade from older Ryzen 4-core and 6-core CPUs, especially as AMD has opened up Zen 3 compatibility to B350 and X370 chipsets.

The Core i5-12400F is a fair bit cheaper, but noticeably slower in the image editing test and video encoding test, and it has an overall slightly lower system score. However, it was much faster in Cinebench, with a huge gulf in the single-threaded scores of 1,531 compared to the Intel CPU's score of 1,668 – the Intel chip was quicker in our game tests too.

You can squeeze out a bit more performance with overclocking too. Our manual overclock hit 4.6GHz across all cores, matching what we saw on the peak boost of one core at stock speed, and adding 200MHz to the stock all-core boost speed. The Ryzen 5 5600 managed 4.7GHz, though, so it was slightly faster once overclocked.

The overclock still didn't provide enough power for the 5600X to eclipse the Core i5-12400F in Cinebench, though, despite adding nearly 1,000 points to the score, and while its gaming performance improved a little, it was still slower than the Intel chip. Thankfully, the overclocked CPU manage to cement its lead in the RealBench tests, edging out a system score of 249,776 compared to 221,139 for the Intel chip.

Conclusion

The Ryzen 5 5600X's price cut is timely, but also necessary, as the Core i5-12600K is significantly faster in nearly every test. The latter now costs £60 more than the 5600X, but the Intel CPU is still worth the extra cash, as it's much faster in most tests. The Ryzen 5 5600 is also a better bet if you're up for some overclocking, while the Core i5-12400F is cheaper and faster in games. As a good all-rounder for around £200, though, the Ryzen 5 5600X is still a solid choice, especially if you don't want to overclock your CPU.

X MARKS THE SPOT

- \+ Good value
- \+ Decent multi-threaded performance
- \+ Power-frugal

X MARKS ON YOUR HOMEWORK

- – Core i5-12600K is significantly faster
- – Overclocked Ryzen 5 5600 is as fast
- – Cheaper Core i5-12400F is faster in games

SPEC

Base frequency 3.7GHz

Max boost frequency 4.6GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 6 x physical (12 threads)

IGP None

Simultaneous Multithreading Yes

Cache 32MB L3, 3MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 65W

Features Precision Boost 2, Precision Boost Overdrive 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

VERDICT

A hefty price cut means the Ryzen 5 5600X now offers decent value, despite its aging architecture.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
35/50	12/15	31/35	78%

AMD RYZEN 7 5700X / £270 inc VAT

SUPPLIER overclockers.co.uk

Unlike the Ryzen 5 5600, the second new AMD CPU to land in this Labs test isn't aiming to battle Intel at the budget end of the market, but instead trade blows with the similarly priced Core i5-12600K, while offering a cheaper 8-core AM4 option than the Ryzen 7 5800X.

That said, there's barely £20 between the two Ryzen 7 chips. Plus, as we saw with the Ryzen 5 5600 and 5600X, there are slim pickings when identifying the spec differences between the two chips. Both the Ryzen 7 5700X and 5800X have eight cores and 16 threads via SMT. They also both use AMD's 7nm Zen 3 architecture and have 32MB of L3 cache. Despite being a new model, the Ryzen 7 5700X lacks the 3D V-Cache of the Ryzen 7 5800X3D.

The only differences are the clock speed and TDP. The latter sits at 105W for the pricier chip, but at just 65W for the Ryzen 7 5700X, making it a little easier to cool at stock speed.

SPEC

Base frequency 3.4GHz

Max boost frequency 4.6GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 8 x physical (16 threads)

IGP None

Simultaneous Multithreading Yes

Cache 32MB L3, 4MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 65W

Features Precision Boost 2, Precision Boost Overdrive, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

The peak boost frequency you'll see with the new CPU is 4.6GHz, while the Ryzen 7 5800X can hit 4.7GHz, which isn't a significant difference. However, the 5800X can also hit upwards of 4.4GHz across all cores in multi-threaded tasks, while the Ryzen 7 5700X could only hit 3.9GHz in the same test, so it's likely to be noticeably slower than the 5800X as you load more cores.

Sure enough, there were a few thousand points between the 5700X and the Ryzen 7 5800X in our image editing test, but a sizeable gulf of over 11 per cent in our heavily multi-threaded Handbrake video encoding test and 16 per cent in Cinebench's multi-threaded test too, thanks to that much lower all-core boost clock.

It also didn't manage to topple Intel's Core i5-12600K, which beat it in nearly every test – the only exception was our RealBench multi-tasking test. It's when it comes to games that Zen 3 is really showing its age against Intel now – even the far cheaper Core i5-12400F was either faster or kept pace with the Ryzen 7 5700X in these tests, while the Core i5-12600K was noticeably quicker. In quite a few cases, the Ryzen 5 5600X is almost as quick as the 5700X.

Meanwhile, overclocking the 5700X saw us hit an all-core frequency of 4.6GHz with a 1.25V vcore, which closed the gap a little compared with the Core i5-12600K, which only offered small advantages in games and content creation. One area where the 5700X excels, though, is power efficiency. Our system drew nearly 60W less from the mains with the 5700X at load compared with the 5800X, and our Intel system drew 30W more than the 5700X system with the Core i5-12600K installed too.

ZENOMORPH

- + Good multi-threaded performance
- + Power-frugal
- + Compatible with 1st-gen AM4 boards

ZENOPHOBE

- – Slower than Core i5-12600K in most tasks
- – Ryzen 7 5800X only £20 more
- – Cheaper Ryzen 5 5600X is often as fast

Conclusion

With just £20 separating the Ryzen 7 5700X and 5800X at the time of writing, there doesn't seem much point opting for the former when the latter offers tangible benefits in a number of tests for such a small amount extra. However, it does draw a lot less power, requiring less lavish cooling and it can be overclocked to similar levels. Even so, the Core i5-12600K is still a better overall buy, retailing for the same price – the Ryzen 7 5700X is really only worth considering if you're upgrading from an older Ryzen CPU.

VERDICT

Very power-frugal, and overclocking unlocks its multi-threaded potential, but it needs a more competitive price.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
38/50	12/15	26/35	76%

INTEL CORE i5-12600K / £270 inc VAT

SUPPLIER scan.co.uk

Historically, Intel's Core i5 CPUs were usually the best bang-per-buck options for building an affordable, but still powerful PC, but the situation has been quite different since AMD's Ryzen 5 chips came on the scene. Thankfully, the Core i5-12600K brought that status back to Intel, and with some considerable style too. It cost far less than AMD's Ryzen 5 5600X at launch, while also being faster in most areas.

A lot has already changed since then, though, as AMD has drastically cut its Zen 3 CPU prices, with the Ryzen 5 5600X now undercutting the Core i5-12600K by around £60. The question now is whether Intel's best Core i5 CPU in years is still worth buying for £270.

In terms of spec, you get a total of ten cores and 16 threads, with six performance-focused P-Cores and four energy-efficient E-Cores. The former can hit a lofty 4.9GHz peak boost, falling back to around 4.5GHz across all cores in multi-threaded workloads. These figures are significantly higher than those of the Core i5-12400F, so the Core i5-12600K is also worth considering even if you don't intend to overclock it.

The 12600K has a sizeable 20MB L3 cache too, as well as 9.5MB L2 cache, making it a potent mid-range Alder Lake CPU. Its price tag matches that of the new Ryzen 7 5700X now, so that's the CPU it needs to beat, but we'll also be keeping an eye on the Core i7-12700K, which adds more cores and higher frequencies into the mix, but costs around £100 more. One other benefit of the Core i5-12600K is that it has on-board graphics, which might not cut it in games, but will still be fine for most desktop work, and can be handy for troubleshooting.

The Core i5-12600K was noticeably slower than the Core i7-12700K in our lightly threaded image editing test, but it certainly has the measure of the Ryzen 7 5700X and Ryzen 7 5800X here, as it did in our heavily multi-threaded video encoding test. However, both of those AMD CPUs weren't far behind in the RealBench system score, thanks to some solid results in our multi-tasking benchmark.

The AMD chips couldn't get close to the Core i5-12600K in Cinebench, though, and once we'd overclocked the P-Cores to 5GHz and the E-Cores to 4GHz (with a vcore of 1.36V), it extended its lead, with its score rising from 17,383 to 19,349.

The Core i5-12600K was quicker than the AMD chips in both our game tests as well, with a notably higher average frame rate in Far Cry 6 than both the Ryzen 7 5800X and the Core i5-12400F, and it extended this lead a little once overclocked too, closely following the Core i7-12700K in both our game tests.

Conclusion

The Core i5-12600K offers significantly more performance across the board than the Ryzen 5 5600X, justifying the added premium it now demands. Critically, though, it's also a better choice overall than the Ryzen 7 5700X. It's not a clean sweep – performance is often similar, and you'll need a new motherboard for this CPU, but if you're building a new system, this CPU is the obvious mid-range choice now. It might not have the original swagger over the Ryzen 5 5600X that it had at launch, but the Core i5-12600K is still a fantastic CPU.

P-CORES

- + Great gaming pace
- + Decent content creation performance
- + Overclockable
- + Faster than competition

PEA CORES

- – Requires new motherboard
- – Cheaper Core i5-12400F isn't far off gaming pace
- – Price isn't as competitive now

SPEC

Base frequency P-Core 3.7GHz, E-Core 2.8GHz

Max boost frequency P-Core 4.9GHz, E-Core 3.6GHz

Core Alder Lake

Manufacturing process 10nm

Number of cores 6 x P-Cores, 4 x E-Cores (16 threads)

IGP Intel UHD Graphics 770

Hyper-Threading Yes

Cache 20MB L3, 9.5MB L2

Memory controller Dual-channel DDR4 and DDR5

Packaging LGA1700

Thermal design power (TDP) 125W

Features Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

VERDICT

Still a superb mid-range CPU, although AMD's new CPUs and hefty price cuts mean it's not as cut and dried any more.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
40/50	14/15	28/35	82%

AMD RYZEN 7 5800X / £290 inc VAT

SUPPLIER currys.co.uk

When we last reviewed the Ryzen 7 5800X a year ago, it cost over £400, but like the rest of AMD's first line of Zen 3 CPUs, it's recently received a price cut, shaving over £100 off this price. If you're in the market for an upgrade and aren't fussed about holding out for Zen 4, there are some good deals to be found now, but is AMD's fastest 8-core CPU still your best bet for around £300?

Its competition comes from within, as well as from Intel, with the new Ryzen 7 5700X snapping at its heels for just £20 less, while Intel's Core i5-12600K goes for a similar price, but has a newer, more powerful architecture. Like all of AMD's Zen 3 CPUs, the Ryzen 7 5800X is now also backwards compatible with B350 and X370 motherboards, so the Ryzen 7 5800X isn't only worth considering if you're building a new system, but also as an upgrade from an old Ryzen system.

The 5800X gives you eight cores and 16 threads, but its higher TDP than the cheaper Ryzen 7 5700X enables it to hit higher frequencies out of the box. For instance, its peak boost frequency is 4.7GHz compared to 4.6GHz for its cheaper sibling, and it can run all its cores up to 500MHz faster than the 5700X in heavily multi-threaded scenarios too. The downside is that our test system drew 60W more power under full load with the 5800X compared with the Ryzen 7 5700X, and the 5800X ran noticeably warmer too, so it will need a pricier cooling arrangement.

The extra frequency certainly helped the 5800X's performance, with it producing noticeably higher scores than the 5700X in our RealBench image editing, video encoding and multi-tasking tests, as well as Cinebench's multi-threaded test. It's quicker in games too. The Ryzen 7 5700X posted a 99th percentile frame rate of 88fps in Far Cry 6, which rose to 91fps with the Ryzen 7 5800X, while 3fps were added to the frame rate of the cheaper CPU in Watch Dogs: Legion too.

The bigger problem for the 5800X, of course, is the Core i5-12600K, which it matched on the RealBench system score, thanks to a decent multi-tasking result, but the 5800X was slower in our image editing and video encoding tests, and it was a long way behind in Cinebench. It wasn't far off the pace in games, but it was a little slower than the Intel CPU in Watch Dogs: Legion, and the Core i5-12600K also managed a higher average frame rate in Far Cry 6.

Overclocking saw us hit an all-core speed of 4.6GHz on the 5800X, but this meant we lost 100MHz of stock speed boost frequency, gaining only 200MHz of all-core frequency, so you may wish to play with Precision Boost Overdrive 2 to edge out more multi-threaded performance, but keep that peak 4.7GHz boost. Overclocking saw it fail to close the gap to the Core i5-12600K though.

Conclusion

While the Ryzen 7 5800X represents a decent upgrade if you're tied to AMD's ecosystem, the Core i5-12600K is better overall, with higher frame rates in games and in the majority of content creation tasks, while costing a little less money. Motherboard pricing may ultimately influence your decision too, especially with the Ryzen 7 5800X's excellent backwards compatibility, but Intel still has a performance advantage, despite AMD's price cuts.

AGE LIKE A FINE WINE

- \+ Decent multi-threaded performance
- \+ Fast out of the box
- \+ Backwards compatible

AGE LIKE A USED TYRE

- – Core i5-12600K faster
- – Cheaper Ryzen 7 5700X is cooler and more power frugal
- – Limited benefits to manual overclocking

SPEC

Base frequency 3.8GHz

Max boost frequency 4.7GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 8 x physical (16 threads)

IGP None

Simultaneous Multithreading Yes

Cache 32MB L3, 4MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 105W

Features Precision Boost 2, Precision Boost Overdrive 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

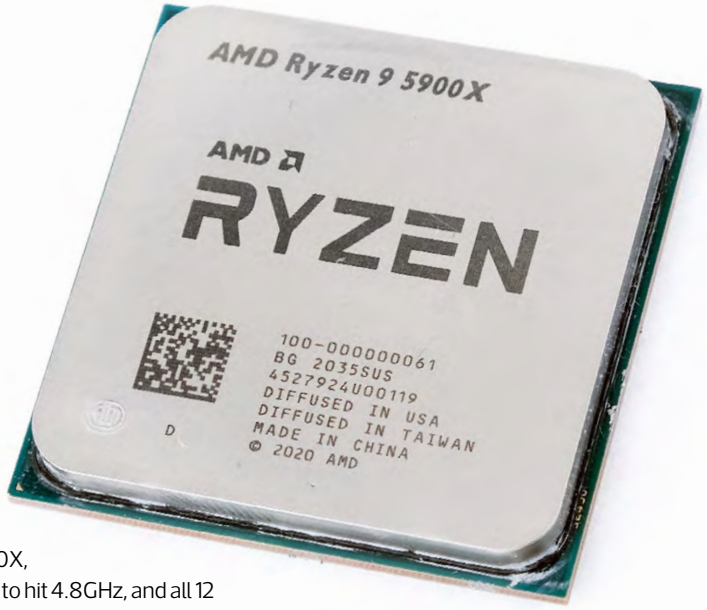
VERDICT

A welcome price cut makes the 5800X a great AM4 upgrade, although Zen 3 is now showing its age.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
39/50	12/15	25/35	76%

AMD RYZEN 9 5900X / £360 inc VAT

SUPPLIER scan.co.uk



It wasn't that long ago that the price 5900X would read £600, but this 12-core Zen 3 CPU has seen a monumental price cut recently. That's all thanks to the likes of Intel's Core i7-12700K and Core i9-12900K retailing for well south of the AMD CPU's launch price, and offering compelling performance for the cash.

With 12 cores and 24 threads, this is still a mighty CPU, of course, even if it's based on the now aging Zen 3 architecture. However, while it was once one of the most powerful gaming CPUs and multi-threaded monsters in one potent chip, there are plenty of new kids on the block looking to usurp the Ryzen 9 5900X as both gaming CPUs and perfect premium all-rounders.

With two core complex dies (CCDs), the CPU has much the same setup as the 16-core Ryzen 9 5950X, and it still has access to the full 64MB L3 cache these dies offer, despite having four of its cores disabled. That figure still pales compared to the 96MB on offer with the Ryzen 7 5800X3D courtesy of its 3D V-Cache, but there are also some seriously high frequencies on offer with the 5900X, with single cores able to hit 4.8GHz, and all 12 cores can sit at 4.1GHz when they're churning through multi-threaded workloads.

We managed to overclock it to 4.6GHz across all 12 of its cores too, with a vcore of 1.25V, bringing a 500MHz benefit to all-core multi-threaded loads, but you'll lose 200MHz of peak boost speed for lightly threaded software if you do this.

As a result, depending on your priorities, it might be better to spend some time playing with AMD's Precision Boost Overdrive 2 instead of going for an all-core overclock, unless you're gunning for maximum multi-threaded performance.

In terms of performance, the Ryzen 9 5900X was the second fastest AMD CPU on test in our RealBench image editing test, which stresses single-threaded performance, although it was pipped to the post by the Core i5-12600K.

The Core i7-12700K was faster still, bettering the AMD CPU in our heavily multi-threaded Handbrake video encoding test and in Cinebench, although not by huge margins, and the 5900X clawed back some ground when it was overclocked too.

Our gaming tests saw the 5900X offer a much slower average frame rate than the Intel CPU in Far Cry 6, but a slightly higher 99th percentile result., Meanwhile, in Watch Dogs: Legion, the 5900X was soundly beaten and didn't offer a significant improvement in power consumption either, with our 5900X test system only drawing 20W less under load than our Core i7-12700K test setup.

Conclusion

Despite a massive price cut, the Ryzen 9 5900X isn't able to topple the cheaper Core i7-12700K, which is faster in most tests and sometimes noticeably so. Of course, buying a new Intel CPU will involve buying a new motherboard too, so the 5900X is still worth considering if you own an older Ryzen CPU and fancy an upgrade. Ultimately, however, the Intel CPU is a better buy, and if you're only interested in gaming performance and don't mind sticking with Socket AM4 for a while, the Ryzen 7 5800X can offer higher frame rates.

SPEC

Base frequency 3.7GHz

Max boost frequency 4.8GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 12 x physical (24 threads)

IGP None

Simultaneous Multithreading Yes

Cache 64MB L3, 6MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 105W

Features Precision Boost 2, Precision Boost Overdrive, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

CUTTHROAT PRICE

+ Decent multi-threaded performance
+ Compatible with 1st-gen AM4 motherboards
+ Manual overclock benefits multi-threaded speed

CUTTHROAT BARBER

− Cheaper CPUs are faster
− Ryzen 7 5800X3D is much faster in games
− Manual overclock cuts lightly threaded performance

VERDICT

Despite a massive price cut, Intel's cutthroat approach with its Core i7-12700K ultimately has this once proud 12-core CPU beaten.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
41/50	12/15	21/35	74%

INTEL CORE i7-12700K / £380 inc VAT

SUPPLIER overclockers.co.uk

With the advent of Intel's Core i9 brand, Intel's Core i7 CPUs have often struggled to find their place, and we initially thought the Core i7-12700K would find this tricky, given the awesome performance of the cheaper Core i5-12600K. With its various mixes of performance-focused P-Cores and energy-efficient E-Cores, though, Intel has more ways to differentiate its product stack, and here there are eight of the former in this CPU, plus four of the latter.

This gives it more raw clout than the Core i5-12600K, which only has six P-Cores, but curtails its performance enough compared with the Core i9-12900K, which has an extra four E-Cores. The result is a 12-core Alder Lake CPU with 20 threads and a peak boost frequency of 5GHz, so it's certainly no slouch.

At a price of £380 inc VAT, though, it has a few competitors from AMD, plus it also has to justify the extra outlay over the Core i5-12600K. The Ryzen 7 5800X3D costs noticeably more money at £430, with its 3D V-Cache offering stunning gaming performance in quite a few games, while the Ryzen 9 5900X costs around the same price, and also has 12 cores plus an extra four threads.

The Core i7-12700K's P-Cores are quite sprightly too, hitting 5GHz regularly in not just lightly threaded workloads, but in multi-threaded workloads too. This explains the CPU's stunning performance in our heavily multi-threaded video encoding test, where the 12700K's result sits between those of the Ryzen 9 5900X and 5950X. It does the same in Cinebench too, while massively outstripping the Core i5-12600K as well. Our lightly threaded image editing test also saw it crack 80,000 points, which was again much faster than those three CPUs.

Conversely, it was noticeably slower than the Core i9-12900K in multi-threaded workloads. For example, in Cinebench, its multi-threaded score of 22,802 compared to 27,579 for the Core i9-12900K. However, in our image editing and game tests, it was practically on par with the Core i9 chip.

There's some overclocking headroom as well. We hit a 5GHz overclock on the P-Cores, and forcing them to stick at this frequency did result in benefits, with the image editing score rising from 80,885 to 84,450, the video encoding score increasing from 927,289 to 986,910 and the Cinebench multi-threaded score going from 22,802 to 24,19.

This did add nearly 40W to the peak power consumption, though, and didn't do much for gaming performance.

Conclusion

Despite AMD's price jostling over the past few months, the Core i7-12700K remains a force to be reckoned with at its £380 price. It's significantly faster than the Core i5-12600K, and it outperforms the Ryzen 9 5900X in most tests – you'd have to opt for the Ryzen 7 5800X3D or Ryzen 9 5950X to see more performance.

Even then, the former isn't great in content creation, while the AMD flagship is much slower in games, making the Core i7-12700K a potent all-rounder. It also slots neatly between the Core i5-12600K and the Core i9-12900K, with the latter offering more performance in multi-threaded work, but not much benefit in games and lightly threaded tasks. If your budget is substantial, but not unlimited, this is the sensible but still lustworthy CPU to get for a high-end system.

SPEC

Base frequency P-Core 3.6GHz, E-Core 2.7GHz

Max boost frequency P-Core 5GHz, E-Core 3.6GHz

Core Alder Lake

Manufacturing process 10nm

Number of cores 8 x P-Cores, 4 x E-Cores (20 threads)

IGP Intel UHD Graphics 770

Hyper-Threading Yes

Cache 25MB L3, 12MB L2

Memory controller Dual-channel DDR4 and DDR5

Packaging LGA1700

Thermal design power (TDP) 125W

Features Turbo Boost Max Technology 3, Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

JCB

+ Excellent gaming performance
+ Faster than Ryzen 9 5900X in content creation
+ Well priced

GARDEN SPADE

– Ryzen 7 5800X3D faster in some games
– Core i9 chips significantly quicker at multi-threaded work
– Core i5-12600K is nearly as fast in games

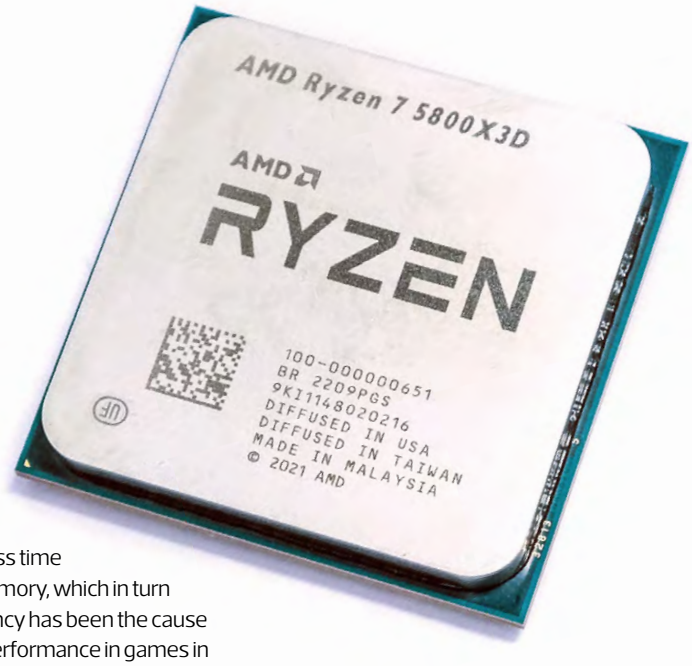
VERDICT

Excellent performance across the board makes the Core i7-12700K a fabulous all-rounder.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
45/50	14/15	25/35	84%

AMD RYZEN 7 5800X3D / £430 inc VAT

SUPPLIER overclockers.co.uk



When we initially reviewed the AMD Ryzen 7 5800X3D, we were hoping for a price closer to £400 or maybe a little below, but when it's currently retailing for £430, which is nearly £150 more than the Ryzen 7 5800X. That's a serious amount of cash and it not only pushes the price of the 5800X3D close to the cost of the mighty 16-core Ryzen 9 5950X, but it's much more expensive than the Ryzen 9 5900X and Core i7-12700K too.

That's a lot of money for an 8-core, 16-thread CPU based on an aging architecture, but the Ryzen 7 5800X3D isn't any old Zen 3 CPU. It sports a massive 96MB L3 cache, two thirds of which is made up of 3D V-Cache. This is stacked directly on top of a core chiplet die, specifically above the existing L3 cache.

The benefit of more cache means less time accessing system memory, which in turn cuts latency. This latency has been the cause of AMD's lacklustre performance in games in the past, which improved with Zen 3 and, as we saw last issue, was bettered further by 3D V-Cache.

It comes at a cost, though, as AMD has had to rein in the boosting frequencies to deal with the extra heat created by stacking the cache on top of the chiplet, and our sample certainly proved to be a toasty customer. The result is a 4.5GHz peak boost frequency, which is 200MHz slower than that of the Ryzen 7 5800X, and it could only reach 4.2GHz across all cores in multi-threaded applications. That's a deficit of up to 300MHz compared to the Ryzen 7 5800X.

The reduced latency certainly benefits some applications, but not all, so with reduced clock speeds, it's likely to be noticeably slower in some tasks than the significantly cheaper Ryzen 7 5800X.

Delving into the numbers, the 5800X3D was 3 per cent slower than the 5800X in our image editing and video encoding tests, but the multi-tasking test benefited from the extra cache – it was a long way behind the Core i7-12700K here though.

Cinebench was less forgiving, with an 8 per cent deficit to the Ryzen 7 5800X in the multi-threaded test, and the 5800X3D had the lowest single-threaded score of any CPU this month too. It was also a huge amount slower than the Core i7-12700K in Cinebench.

We're currently unable to overclock the Ryzen 7 5800X3D, so both the Ryzen 7 5700X and Ryzen 7 5800X leapfrogged it in the system score when overclocked, while both these CPUs and the Core i7-12700K extended their leads in Cinebench.

Thankfully, AMD's claims about improved gaming performance were justified, as the 5800X3D was the fastest CPU in Far Cry 6, even bettering the Core i9-12900KS and adding over 10fps to the result of the Ryzen 7 5800X. It was by far the fastest AMD CPU in Watch Dogs: Legion too, but it wasn't quite as quick as the Core i7-12700K.

Conclusion

The addition of 3D V-Cache makes the Ryzen 7 5800X3D by far the fastest AMD CPU in games yet, but its reduced overall performance elsewhere means it isn't a great all-rounder.

The Core i7-12700K is significantly quicker in most tests, and in some games, making it the better option for a new system.

However, if you're upgrading a Socket AM4 system, and you're primarily concerned with games, the Ryzen 7 5800X3D is a potent if overpriced upgrade.

VERTICAL CACHE

- \+ Faster than Intel in games
- \+ Compatible with old Socket AM4 boards
- \+ Cheaper than Core i9-12900K

VERTICAL DROP

- – Poor content creation performance
- – High internal temperatures
- – No overclocking

SPEC

Base frequency 3.4GHz

Max boost frequency 4.5GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 8 x physical (16 threads)

IGP None

Simultaneous Multithreading Yes

Cache 96MB L3, 4MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 105W

Features Precision Boost 2, Precision Boost Overdrive 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

VERDICT

Fantastic gaming performance for a Zen 3 CPU, but it's mediocre elsewhere.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
44/50	12/15	19/35	75%

AMD RYZEN 9 5950X / £500 inc VAT

SUPPLIER overclockers.co.uk

We doubt many CPUs have changed the desktop market more than AMD's 16-core mainstream monsters, forcing Intel to drastically cut the prices of its high-end desktop CPUs and ushering previously unheard-of numbers of cores into the home computing market. The Ryzen 9 5950X built on the success of the Ryzen 9 3950X, made large swathes of the high-end desktop CPU market obsolete in the process, and is now available for just £500.

A year ago it was still the most powerful mainstream desktop CPU by far, but Intel has now finally responded, both in terms of single-threaded and multi-threaded performance. The Core i9-12900K also cost less than the 5900X at launch, so AMD's mainstream desktop flagship now sits at £500, which is just below the price of the Intel chip.

It has a massive peak boost frequency of 4.9GHz, even if its all-core boost has to remain below 4GHz in order for the chip to stay within its 105W power envelope. It also comes with 64MB of L3 cache and 8MB of L2 cache, so when it was launched, it was fast at pretty much any task you threw at it. It still gives Intel a run for its money too, with its score of 74,586 in our lightly threaded image editing test, beating the score of the Core i5-12600K, although falling short of the 80,155 scored by the Core i9-12900K.

THREAD READER

- \+ Excellent multi-threaded performance
- \+ Manual overclock really helps multi-threaded work
- \+ Power-frugal at stock speed

THREADWORM

- – Low all-core boost clock
- – Zen 3 no longer top dog in games
- – Core i9-12900K is faster for not much more cash

The fact it has more threads than the Core i9-12900K, with the latter only offering Hyper Threading on its P-Cores, means the 5900X is also a potent force in heavily multi-threaded applications, with its Handbrake video encoding result being just 3 per cent behind the Core i9-12900K, while the system score sat at 373,168 vs 387,778 for the Intel chip. While the Ryzen 9 5950X wasn't too far behind the Core i9-12900K in Cinebench's multi-threaded test, however, it was night and day in the single-threaded test, with the Core i9 enjoying a 21 per cent lead.

We managed to hit 4.6GHz across all cores with a manual overclock, using a 1.25V vcore, although this was a big climb down from the peak single-core boost frequency we saw at just over 5GHz, even if it adds 600MHz to the all-core boost frequency. Not surprisingly, this overclock provided mixed results in our tests, seeing lightly threaded tasks – such as our image editing test – slow down, but it resulted in big gains in multi-threaded results, such as Cinebench, where it leapfrogged both the Core i9 chips to claim the top spot.

The overclock didn't change much in our game tests, where the 5950X produced a similar 99th percentile frame rate to the Core i9-12900K in Far Cry 6, but a much slower average frame rate, while it was noticeably slower than the Intel chip in Watch Dogs: Legion. It's biggest advantage, though, was in power efficiency, with our 5950X test rig drawing nearly 90W less from the mains at stock speed than the Core i9-12900K system.

Conclusion

The Ryzen 9 5950X no longer dominates the desktop CPU market. Intel's 12th-gen CPUs are more than a match, offering better performance across the board. It's definitely worth considering as an upgrade for an old AM4 system, but if you're building a new PC and need monstrous gaming and content creation performance, the Core i9-12900K is a better buy.

SPEC

Base frequency 3.4GHz

Max boost frequency 4.9GHz

Core Zen 3

Manufacturing process 7nm

Number of cores 16 x physical (32 threads)

IGP None

Simultaneous Multithreading Yes

Cache 64MB L3, 8MB L2

Memory controller Dual-channel DDR4, up to 3200MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 105W

Features Precision Boost 2, Precision Boost Overdrive 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE

VERDICT

No longer the king of the hill, but it's still a monstrously powerful CPU for an AM4 upgrade.

PERFORMANCE 42/50 | FEATURES 12/15 | VALUE 18/35

OVERALL SCORE 72%

INTEL CORE i9-12900K / £539 inc VAT

SUPPLIER overclockers.co.uk

It's no secret that Intel struggled to match AMD's 16-core mainstream desktop CPUs with its previous mainstream offerings, and had to completely rethink its approach to CPU design to beat the likes of the Ryzen 9 5950X. The answer was to mix different types of cores to boost lightly threaded and multi-threaded performance. By combining this approach with a move from 14nm to a smaller 10nm manufacturing process, plus a new architecture, Intel finally regained its performance lead with the Core i9-12900K.

It has eight performance-orientated P-Cores and eight power-efficient E-Cores, with the latter being four more than the Core i7-12700K. These four extra cores also give it four more threads than the Core i7, at 24 versus 20, plus it has an extra 5MB of L3 cache and 2MB more L2 cache. This monster CPU is capable of matching or bettering the most powerful high-end desktop CPUs Intel has made for its aging LGA2066 socket too.

This comes at a price, though, and at £539, the 12900K is pricier than any AMD CPU on test this month. This means it needs to match or better the Ryzen 7 5800X3D in games, which costs £100 less, and do the same with the mighty Ryzen 9 5950X, but in content creation, with that CPU costing a little under £500.

You'll need some potent cooling for this CPU, plus a decent power supply. We saw our system draw over 300W when the CPU was under load, which is nearly 100W more than our AMD system with the Ryzen 9 5950X and nearly 50W more than with the Ryzen 7 5800X3D, and the 12900K runs hot as well.

It didn't disappoint, though, beating the Ryzen 9 5950X in every test except when the latter was overclocked, where it was slightly better in Cinebench's multi-threaded test. Meanwhile, its RealBench system score was second only to the Core i9-12900KS. In games it was a mixed bag, though, with Far Cry 6 seeing the Ryzen 9 5950X offer an extra one or two frames per second on the 99th percentile frame rate, but the Intel chip was nearly 10fps faster on the average frame rate.

The Ryzen 7 5800X3D was much faster in this game, however, adding 12fps to the 99th percentile frame rate. Even overclocking the P-Cores to 5GHz and the E-Cores to 4GHz didn't see it beat the AMD CPU. Watch Dogs: Legion favoured the Intel chip, though, and here the Core i9-12900K was a little faster than the Ryzen 7 5800X3D.

Conclusion

As we mentioned in the Core i7-12700K review, the Core i9-12900K is geared towards those who have plenty of cash to burn and want both top-notch gaming and content creation performance. However, the Core i9-12900K doesn't bag you any noticeable improvements in most games; it's only in content creation that its additional E-Cores help it edge out a lead.

The Ryzen 7 5800X3D is certainly a worthy alternative for gaming, being faster in Far Cry 6, and it can slot into old AM4 boards too, but it was much slower in heavily multi-threaded content creation work. The Core i9-12900K isn't a CPU that many of us need, or can even afford, but it's never far from the top of the performance graphs. If you have the money for a super-fast CPU, it delivers the goods.

SPEC

Base frequency P-Core 3.2GHz, E-Core 2.4GHz

Max boost frequency P-Core 5.2GHz, E-Core 3.9GHz

Core Alder Lake

Manufacturing process 10nm

Number of cores 8 x P-Cores, 8 x E-Cores (24 threads)

IGP Intel UHD Graphics 770

Hyper-Threading Yes

Cache 30MB L3, 14MB L2

Memory controller Dual-channel DDR4 and DDR5

Packaging LGA1700

Thermal design power (TDP) 125W

Features Turbo Boost Max Technology 3, Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

FAST

+ Good gaming performance
+ Much faster than Ryzen 7 5800X3D in content creation
+ Better than Ryzen 9 5950X overall

FURIOUS

− Power-hungry
− Needs substantial cooling
− Expensive

VERDICT

Blisteringly fast in just about everything, but with a price to match.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
47/50	14/15	18/35	79%

INTEL CORE i9-12900KS / £720 inc VAT

SUPPLIER scan.co.uk

Last month we reviewed Intel's latest extreme flagship CPU, the Core i9-12900KS. In some ways, it's Intel's answer to the Ryzen 7 5800X3D's gaming performance – it's essentially a cherry-picked Core i9-12900K with a massive peak boost frequency of 5.5GHz. Cherry picking never comes cheap, though. Speed binning only results in a small number of chips that are capable of having all their parts enabled and running at high clock speeds, so buying this CPU involves forking out an extra £200 over the already pricey Core i9-12900K.

SUMMER BREEZE

- \+ Chart-topping gaming performance
- \+ Incredible in lightly threaded and multi-threaded tasks
- \+ Keeps up with the best AMD has to offer

TORNADO

- – Massively power-hungry
- – Runs extremely hot
- – Enormous price tag

SPEC

Base frequency P-Core 3.4GHz, E-Core 2.5GHz

Max boost frequency P-Core 5.5GHz, E-Core 4GHz

Core Alder Lake

Manufacturing process 10nm

Number of cores 8 x P-Cores, 8 x E-Cores (24 threads)

IGP Intel UHD Graphics 770

Hyper-Threading Yes

Cache 30MB L3, 14MB L2

Memory controller Dual-channel DDR4 and DDR5

Packaging LGA1700

Thermal design power (TDP) 150W

Features Thermal Velocity Boost, Turbo Boost Max Technology 3, Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

Last month we were doing some very early testing on the CPU, though, and this time we're using the latest BIOS from Asus, which has been specifically designed to offer the best performance with the Core i9-12900KS. In short, this means giving it more power, and sure enough, our test system peaked at a massive 489W at load, which was over 160W than it drew with the Core i9-12900K installed. This power draw is borderline obscene, as were the CPU temperatures, which regularly topped 90°C, despite the fact we were using a custom water-cooling loop with the latest LGA1700 waterblock from EK.

You'd hope, then, that performance was unmatched, and thankfully we weren't disappointed. The Core i9-12900K accelerated its way to offering a massive 86,284 points in our lightly threaded image editing test, and no other CPU came close to this result, even when overclocked.

The story in our heavily multi-threaded Handbrake video encoding test was similar, with the Core i9-12900KS scoring 1,137,489 compared to 1,061,918 for the Core i9-12900K and 1,029,189 for the Ryzen 9 5950X. Both those CPUs needed to be overclocked up to the hilt to beat the Core i9-12900KS in Cinebench too, where its stock speed score of 28,645 was over 3,000 points higher than that of the Ryzen CPU, and over 1,000 points clear of the Core i9-12900K.

The Core i9-12900KS was also the only Intel CPU on test this month that was able to keep up with the Ryzen 7 5800X3D in games, mostly matching it in Far Cry 6 and offering a 99th percentile frame rate that was around 10fps higher than that of other Intel CPUs on test.

It also grabbed the top spot in Watch Dogs: Legion, and even held on to that spot when other CPUs on test were overclocked too. With the temperatures we saw from this CPU at stock speed, we didn't dare attempt a manual overclock on it, but it's worth playing with power limits, as they can rein in power consumption (and heat) at the expense of some performance.

Conclusion

If you must have the fastest mainstream desktop CPU, and don't care how much it costs, the Core i9-12900KS won't disappoint. Using a honed BIOS that was freely available from Asus, it was a monster, even outstripping the Core i9-12900K by significant margins in some tests. It needs a big wallet and an even bigger cooling system, but given its thermals and power consumption, as well as it's exorbitant price tag, we can't recommend it outright as a chip that's worth buying. However, that still doesn't prevent us from hoping Intel forgets to ask for our sample back. It's a ridiculous CPU, but if you have the money, PSU and cooling system for it, you won't be disappointed.

VERDICT

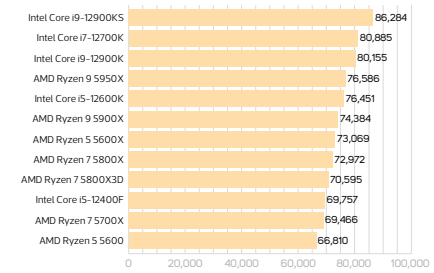
Outrageous and obscene in so many ways that we can't help but love it.

PERFORMANCE	FEATURES	VALUE	OVERALL SCORE
49/50	14/15	11/35	74%

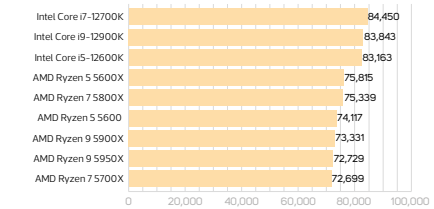
CPU LABS BENCHMARK RESULTS

GIMP IMAGE EDITING

Stock speed

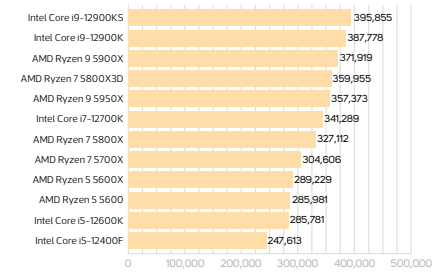


Overclocked

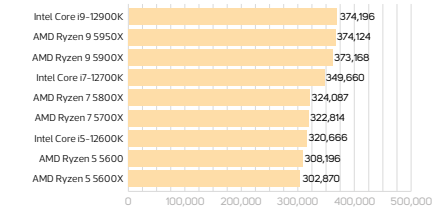


HEAVY MULTI-TASKING

Stock speed

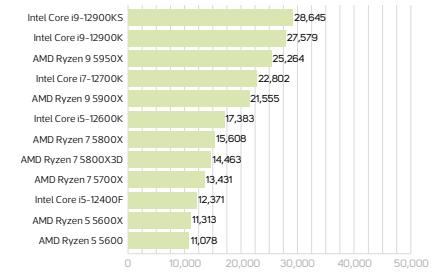


Overclocked

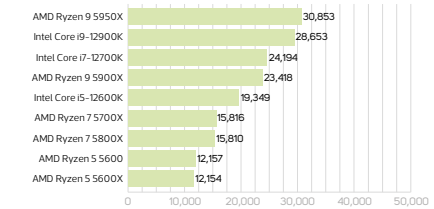


CINEBENCH R23 MULTI-THREADED

Stock speed

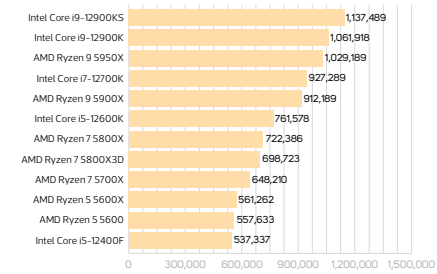


Overclocked

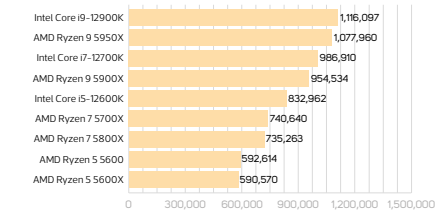


HANDBRAKE H.264 VIDEO ENCODING

Stock speed

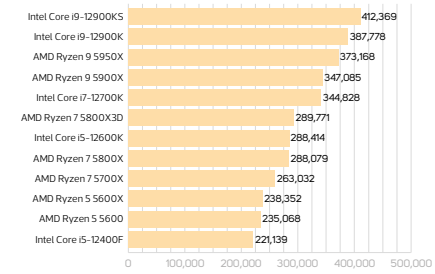


Overclocked

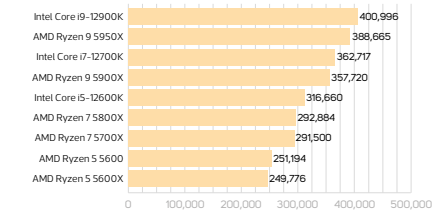


SYSTEM SCORE

Stock speed

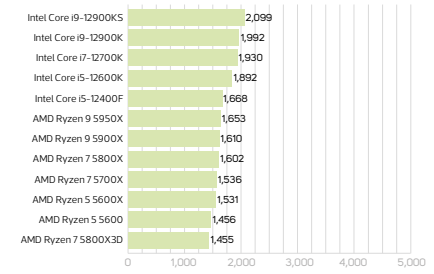


Overclocked

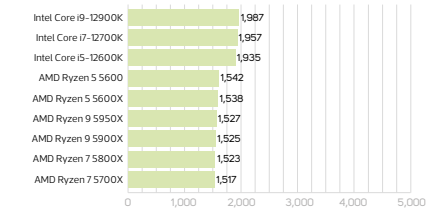


CINEBENCH R23 SINGLE-THREADED

Stock speed



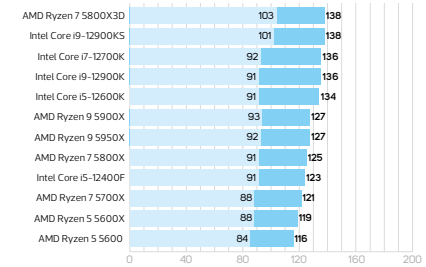
Overclocked



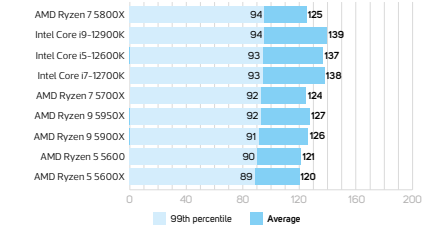
CPU LABS BENCHMARK RESULTS

FAR CRY 6 (FPS)

Stock speed, 1,920 x 1080, Ultra settings

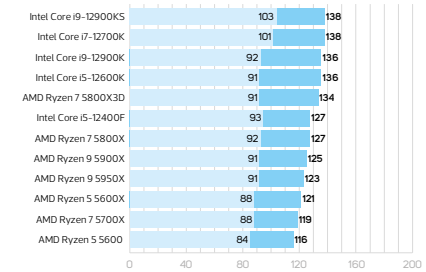


Overclocked, 1,920 x 1080, Ultra settings

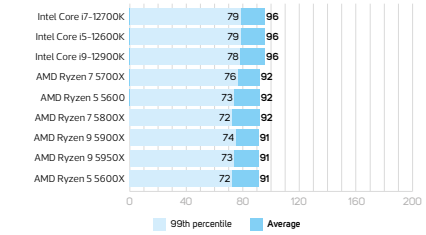


WATCH DOGS: LEGION (FPS)

Stock speed, 1,920 x 1080, Ultra settings

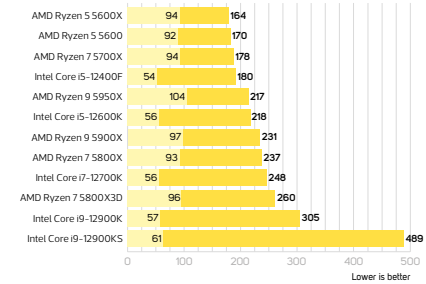


Overclocked, 1,920 x 1080, Ultra settings

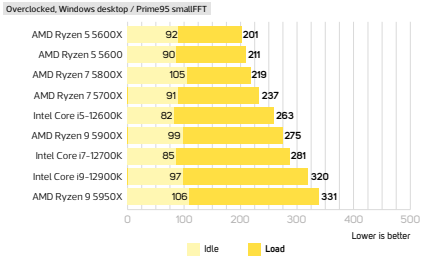


TOTAL SYSTEM POWER CONSUMPTION (W)

Stock speed, Windows desktop / Prime95 smallFFT



Overclocked, Windows desktop / Prime95 smallFFT



Elite

Our choice of the best hardware available

Core component bundles

The fundamental specifications we recommend for various types of PC. Just add your preferred case and power supply, and double-check there's room in your case for your chosen components, especially the GPU cooler and graphics card. We've largely stopped reviewing power supplies, as the 80 Plus certification scheme has now effectively eliminated unstable PSUs. Instead, we've recommended the wattage and minimum 80 Plus certification you should consider for each component bundle. You can then choose whether you want a PSU with modular or captive cables.

8-core system with integrated graphics

8-core CPU, basic gaming

Needs a micro-ATX or ATX case. We recommend a 450W 80 Plus Bronze power supply. See Issue 218, p76 for an example build guide.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5700G	scan.co.uk	**#218** p20	£280
CPU COOLER	AMD Wraith air cooler included with CPU	N/A	**#218** p20	£0
GRAPHICS CARD	AMD Radeon RX Vega 8 integrated into CPU	N/A	**#218** p20	£0
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M 2B3200C16)	scan.co.uk	**#218** p78	£60
MOTHERBOARD	Asus TUF B450M-PLUS II (micro-ATX) with BIOS flash	awd-it.co.uk	**#218** p78	£90
STORAGE	500GB WD Blue SN570 (M.2 NVMe)	scan.co.uk	**#222** p20	£43
		Total £473		

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

Needs an ATX case. We recommend a 500W 80 Plus power supply. See Issue 224, p76 for an example build guide.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-12400F	cclonline.com	**#227** p51	£165
CPU COOLER	ARCTIC Freezer i13X	scan.co.uk	**#224** p76	£20
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	**#220** p53	£360
MEMORY	16GB (2 x8 GB) Corsair Vengeance LPX DDR4 3200MHz (CMK16GX4 M2B3200C16)	scan.co.uk	**#224** p76	£60
MOTHERBOARD	Gigabyte B660 Gaming X DDR4 (ATX)	scan.co.uk	**#224** p50	£141
STORAGE	1TB WD Blue SN570 (M.2 NVMe)	scan.co.uk	**#222** p20	£73
		Total £819		

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	scan.co.uk	**#220** p55	£490
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£105

2,560 x 1,440 gaming system

10-core CPU, 1080p and some 2,560 x 1,440 gaming

Needs an ATX case. We recommend a 550-600W 80 Plus Bronze power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-12600K	scan.co.uk	**#227** p56	£270
CPU COOLER	ARCTIC Liquid Freezer II 240 RGB (240mm AIO liquid cooler)	scan.co.uk	**#226** p49	£80
GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	scan.co.uk	**#220** p55	£490
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX 4M2C3200C16)	scan.co.uk	**#221** p76	£73
MOTHERBOARD	Gigabyte Z690 Gaming X DDR4	scan.co.uk	**#222** p46	£200
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£105
		Total £1,218		

UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	ebuyer.com	**#166** p54	£81

Mid-range gaming system

10-core CPU, smooth 2,560 x 1,440 gaming and ray tracing

Needs an ATX case with room for a 240mm all-in-one liquid cooler. We recommend a 750W 80 Plus Bronze power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-12600K	scan.co.uk	**#227** p56	£270
CPU COOLER	ARCTIC Liquid Freezer II 240 RGB (240mm AIO liquid cooler)	scan.co.uk	**#226** p49	£80
GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	overclockers.co.uk	**#220** p43	£660
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX 4M2C3200C16)	scan.co.uk	**#221** p76	£73
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	ebuyer.com	**#222** p48	£260
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£105
		Total £1,448		

UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	ebuyer.com	**#166** p54	£81

Core component bundles cont ...

4K gaming system

12-core CPU, 4K gaming

Needs an ATX case with room for a 360mm all-in-one liquid cooler. We recommend an 850W 80 Plus Gold power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i7-12700K	overclockers.co.uk	#227 p59	£380
CPU COOLER	Corsair iCUE H150i Elite LCD (360mm AIO liquid cooler)	scan.co.uk	#226 p78	£250
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	nvidia.com	#226 p78	£1,050
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2 C3200C16)	scan.co.uk	#226 p78	£73
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	ebuyer.com	#226 p78	£260
STORAGE	2TB WD Black SN770	box.co.uk	#226 p78	£220
	Total £2,233			
UPGRADES				
ADD SECONDARY STORAGE	4TB Western Digital Blue	ebuyer.com	#166 p54	£81

Content creation system

16-core CPU, 1,920 x 1,080 gaming

Needs an E-ATX case with room for a 360mm all-in-one liquid cooler. We recommend a 750W 80 Plus Gold power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i9-12900K	overclockers.co.uk	#227 p62	£539
CPU COOLER	Corsair iCUE H150i Elite LCD (360mm AIO liquid cooler)	scan.co.uk	#226 p78	£250
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	#220 p53	£360
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 5200MHz DDR5 (CMT32GX5M2 B5200C40)	scan.co.uk	#221 p76	£287
MOTHERBOARD	MSI MEG Z690 Unify	scan.co.uk	#222 p50	£550
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£250
	Total £2,236			
UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	nvidia.com	#221 p48	£1,050
ADD SECONDARY STORAGE	4TB Western Digital Blue	ebuyer.com	#166 p54	£81

Mini PCs

Our favourite components for building a micro-ATX or mini-ITX PC. Always double-check how much room is available in your chosen case before buying your components. Some mini-ITX cases don't have room for large all-in-one liquid coolers, for example, or tall heatsinks. You'll also need to check that there's room for your chosen graphics card.

Mini-ITX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Intel Z690 (LGA1700)	Asus ROG Strix Z690-I Gaming WiFi	scan.co.uk	**#220** p22	£375
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	awd-it.co.uk	**#214** p18	£180
AMD B550 (AM4)	Asus ROG Strix B550-I Gaming	scan.co.uk	**#206** p44	£225

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	**#206** p18	£100
TOWER	Ssupd Meshlicious	overclockers.co.uk	**#225** p51	£100
HIGH AIRFLOW	Fractal Design Torrent Nano	scan.co.uk	**#225** p45	£120
PREMIUM	Streacom DA2 V2	quietpc.com	**#214** p51	£203

Other components

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
LOW-PROFILE CPU COOLER	Noctua NH-L12S	scan.co.uk	**#219** p54	£55
SFX POWER SUPPLY	SilverStone SX750	scan.co.uk	**#219** p72	£130

ATX cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	**#214** p26	£75
SUB-£100 AIRFLOW	Corsair 4000D Airflow	scan.co.uk	**#222** p56	£90
COMPACT	Fractal Design Meshify 2 Compact	scan.co.uk	**#215** p20	£100
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	**#212** p45	£140
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	**#202** p44	£140
SUB-£150	Fractal Design Define 7	scan.co.uk	**#204** p18	£147
PREMIUM HIGH AIRFLOW	Fractal Design Torrent RGB TG	scan.co.uk	**#225** p20	£220
LUXURY	Corsair iCUE 5000T RGB	scan.co.uk	**#224** p22	£350

Micro-ATX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD B450 (AM4)	Asus TUF B450M-PLUS II	awd-it.co.uk	**#218** p76	£80
AMD B550 (AM4)	MSI MAG B550M Mortar	scan.co.uk	**#204** p42	£130

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Kolink Citadel Mesh RGB	overclockers.co.uk	**#218** p26	£63

Networking

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	**#216** p52	£130
ROUTER	Asus RT-AX68U	scan.co.uk	**#216** p51	£170
MESH ROUTER	Asus ZenWiFi AX Hybrid XP4	amazon.co.uk	**#226** p59	£270
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	**#196** p58	£60
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	**#200** p22	£154
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	**#174** p34	£202
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	**#212** p25	£280

Monitors

F – FREESYNC, G – G-SYNC, W – ULTRAWIDE

Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
24IN, 144HZ, IPS, 1,920 X 1,080, F, G	AOC 24G2U	cclonline.com	#214 p28	£160
25IN, 240HZ, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	box.co.uk	#209 p57	£230
25IN, 360HZ, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	scan.co.uk	#212 p20	£519

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 144HZ, IPS, 1,920 X 1,080, F, G	AOC 27G2U	overclockers.co.uk	#201 p53	£180
27IN, 240HZ, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	ebuyer.com	#209 p60	£279
27IN, 165HZ, VA, 2,560 X 1,440, F, G	AOC CQ27G3SU	box.co.uk	#223 p45	£279
27IN, 240HZ, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£570
27IN, 240HZ, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£699
28IN, 144HZ, IPS, 3,840 X 2,160, F, G	AOC U28G2XU	amazon.co.uk	#221 p29	£579

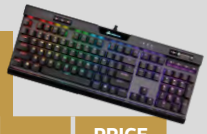
Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5IN, 60HZ, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£370
32IN, 144HZ, VA, 2,560 X 1,440, F, G	iiyama G-Master GB3266QSU	ebuyer.com	#224 p30	£362
32IN, 165HZ, IPS, 2,560 X 1,440, F, G	LG UltraGear 32GP850	overclockers.co.uk	#220 p38	£350
34IN, 144HZ, IPS, 3,440 X 1,440, W, F	iiyama G-Master GB3461WQSU	overclockers.co.uk	#206 p53	£450
34IN, 144HZ, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	overclockers.co.uk	#206 p55	£750
38IN, 144HZ, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	overclockers.co.uk	#208 p30	£1,200
32IN, 144HZ, IPS, 3,840 X 2,160, F, G, HDR	Asus ROG Swift PG32UQX	scan.co.uk	#218 p54	£3,299

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 75HZ, IPS, 2,560 X 1,440, F	LG 27QN880	amazon.co.uk	#210 p26	£350

Peripherals and audio



Gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET TKL	SteelSeries Apex 3 TKL	currys.co.uk	#221 p59	£40
OPTICAL ESPORTS	Asus ROG Strix Scope RX	amazon.co.uk	#209 p43	£70
MECHANICAL TKL	NZXT Function MiniTKL	cclonline.com	#226 p32	£100
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£180
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£150
PREMIUM MECHANICAL	Corsair K70 RGB Pro	overclockers.co.uk	#225 p30	£170
PREMIUM WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	overclockers.co.uk	#208 p60	£160

Gaming mice

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	NZXT Lift	scan.co.uk	#226 p32	£40
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	overclockers.co.uk	#215 p57	£50
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£50
MULTI-BUTTON	Roccat Kone XP	roccat.com	#225 p60	£80
WIRELESS	Razer Viper Ultimate	amazon.co.uk	#217 p54	£65
PREMIUM WIRELESS	Razer DeathAdder V2 Pro	ebuyer.com	#210 p28	£100
ULTRA LIGHTWEIGHT	Asus TUF Gaming M4 Air	overclockers.co.uk	#227 p36	£42
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	#217 p52	£109

Peripherals and audio cont ...

Game controllers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	**#202** p50	£269
PREMIUM GAMEPAD	Razer Wolverine V2 Chroma	currys.co.uk	**#221** p30	£129
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	**#207** p52	£36
FLIGHT STICK	Thrustmaster T.16000M FCS HOTAS	scan.co.uk	**#207** p56	£100

Gaming headsets

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET STEREO	Roccat Elo X Stereo	scan.co.uk	**#210** p56	£40
STEREO	Epos | Sennheiser GSP 300	amazon.co.uk	**#210** p54	£62
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	**#204** p50	£146
PREMIUM WIRELESS	Razer BlackShark V2 Pro	scan.co.uk	**#211** p26	£162

Speakers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
STEREO	Edifier R1280DB	overclockers.co.uk	**#224** p59	£110

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS 84-KEY ELECTRO-CAPACATIVE	Niz Mini 84 Pro	keyboardco.com	**#220** p29	£165
WIRELESS TKL MECHANICAL	Keychron K2 Version 2	keyboardco.com	**#208** p57	£84
TKL MECHANICAL	Filco Majestouch Convertible 2 Tenkeyless	keyboardco.com	**#203** p55	£140
BUCKLING SPRING MECHANICAL	Unicomp New Model M	keyboardco.com	**#219** p26	£129

PCs and laptops

Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD APU PC	Wired2Fire Ultima Ryzen Gamestation	AMD Ryzen 5 5600G	Integrated AMD Radeon RX Vega 7	custompc.co.uk/W2F	**#222** p36	£692
BUDGET GAMING	Wired2Fire Phoenix Intel – Powered by MSI	Intel Core i5-12400F	Nvidia GeForce RTX 3060	custompc.co.uk/Phoenix	**#224** p38	£1,119
QUIET GAMING	Gladiator Nocturnal	Intel Core i5-12600K	Nvidia GeForce RTX 3070	custompc.co.uk/Nocturnal	**#225** p36	£1,799
4K GAMING	PC Specialist Magnus Pro K500	Intel Core i7-12700K	Nvidia GeForce RTX 3080 Ti	custompc.co.uk/MagnusPro	**#225** p34	£2,499
WATER-COOLED ALDER LAKE	CyberPower Hyper Liquid Infinity X129	Intel Core i9-12900K	Nvidia GeForce RTX 3080	custompc.co.uk/CPHL	**#222** p34	£3,820
ULTIMATE PERFORMANCE	Scan 3XS Torrent Ti	Intel Core i9-12900K	Nvidia GeForce RTX 3090 Ti	custompc.co.uk/TorrentTi	**#226** p36	£4,899

Laptops

CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Lenovo Legion 5 Pro	AMD Ryzen 7 5800H	Nvidia GeForce RTX 3070 Laptop	16in, 2,560 x 1,600 IPS 165Hz G-Sync	custompc.co.uk/Legion5Pro	**#222** p32	£1,399
ULTRA PORTABLE GAMING	Razer Blade 14	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3070 Laptop	14in 1,920 x 1,080 IPS 144Hz	custompc.co.uk/Blade14	**#220** p40	£2,120
MID-RANGE GAMING	Asus ROG Strix Scar 15 G533ZW	Intel Core i9-12900H	Nvidia GeForce RTX 3070 Ti Laptop	15.6in 2,560 x 1,440 IPS 240Hz	custompc.co.uk/AsusScar15	**#227** p40	£2,399
HIGH-SPEED GAMING	Alienware x17 R2	Intel Core i7-12700H	Nvidia GeForce RTX 3080 Ti Laptop	17.3in 1,920 x 1,080 IPS 360Hz G-Sync	custompc.co.uk/AlienwareX17	**#227** p38	£3,184

RICK LANE / INVERSE LOOK

A SENSE OF PLACE

Ghostwire Tokyo and Weird West demonstrate the importance of understanding your setting for different reasons, says Rick Lane

This month I reviewed Ghostwire Tokyo and Weird West, two games where my reaction to playing them surprised me. Ghostwire is an open-world action game where you're chased around Japan's capital city by a bunch of weird spectres known as yokai. Weird West, meanwhile, is a hybrid of immersive sim and CRPG that puts heavy emphasis on simulation and player choice.

As someone who prefers immersive sims to open-world games, I expected Weird West to appeal more to me. However, I ended up being more intrigued by Ghostwire – despite several notable flaws – while finding it harder to get into Weird West.

There are various reasons why I find Ghostwire enjoyable and Weird West merely admirable. For one, Ghostwire has superior combat and is undoubtedly the more accessible game overall. But what most sets the two games apart is how they represent their respective settings.

> Taking Ghostwire out of Tokyo would kill the experience

Ghostwire strives to immerse you in its depiction of abandoned central Tokyo. Its presentation of the city, from major landmarks to shopping districts, suburbs and subways, is authentic and steeped in atmosphere. Simply standing in a back alley, amid the shopping crates and awkwardly parked scooters, listening to the patter of the rain and the hum of air conditioners, is as fundamental to the experience as blasting ghosts with your supernatural powers.

Weird West, by comparison, never feels especially convincing in its setting. Despite the title, its 'West' is a derivative pastiche – all bandits, broncos and bounty hunters. The townships, farms, mines and so on are all capably designed, but they lack the authenticity and atmosphere Ghostwire does so well.

This divide is also evident in the games' shared fondness for the supernatural. Many of Ghostwire's yokai are based on Japanese folklore, such as the Nurikabe, which manifests as an invisible wall to misdirect travellers. It's a truly bizarre mythical creature that has no comparison anywhere else in the world. Weird West's supernatural elements, by comparison, feel like a spooky blanket laid on top of the setting.

There are some important caveats. Ghostwire is a first-person game, while Weird West is isometric, which automatically gives the former an immersive advantage. However, isometric games can be deeply atmospheric, with examples including Obsidian's Tyranny and Divinity: Original Sin 2. Beyond this, Ghostwire had a much larger budget than Weird West, although a large sack of cash doesn't guarantee an atmospheric experience – just look at the deeply uninspired Ghost Recon: Breakpoint for an example of that.

Nonetheless, you could take Weird West's ideas, systems, mechanics and characters, and put them in a bunch of different settings (fantasy, cyberpunk, take your pick) without significantly impacting the game's baseline quality. Taking Ghostwire out of Tokyo, however, would kill the experience.

Compared side by side, the two games demonstrate how a game's setting is an active participant in its quality. How a game feels when the player is doing nothing is often as important as how it feels when they're moving and fighting. This is one of the reasons why Elden Ring is such a phenomenon – simply existing inside that world is breathtaking. And it's why the rain-slicked streets of Ghostwire will linger in my mind longer than the dusty plains of Weird West. CPC

Rick Lane is Custom PC's games editor @Rick_Lane

Tiny Tina's Wonderlands

/ **£54.99** inc VAT

DEVELOPER Gearbox Software / **PUBLISHER** Finji

Tiny Tina's Wonderlands is a sequel to the Borderlands 2 DLC, Assault on Dragon Keep. Arguably the best bit of the entire Borderlands series, Dragon Keep was a playful send-up of tabletop RPGs that explored themes of loneliness and friendship. Tiny Tina's Wonderlands takes this core concept and massively expands upon it.

Players assume the role of a custom hero inside Tiny Tina's homebrew D&D campaign 'Bunkers and Badasses' – a parody fantasy world given a Borderlands spin (it has guns in it). Here, you embark on a quest to defeat the evil Dragon Lord, in a story heavily subject to the whims of your Dungeon Master, Tiny Tina herself.

The premise is as tantalising as it was ten years ago, and Wonderlands quickly reveals itself to be funnier and less annoying than its parent game. Not only does the setting give the writers a clear focal point for their jokes, but Borderlands' whole shtick simply works better in a D&D spoof.

For example, it makes sense that the characters are constantly talking in the background, as the atmosphere of tabletop roleplaying is usually filled with player debating ideas, making suggestions, and dipping in and out of character. It helps that the voice acting is incredible, with the cast including Bojack Horseman's Will Arnett as the Dragon Lord, and Brooklyn 99's Andy Samberg as Valentine, your heartthrob co-player who tries to solve every problem with seduction.

Although the transition to fantasy works well for Wonderlands narratively, it's less effective in play. It's essentially a mechanical reskin of Borderlands, replacing grenades with spells, energy shields with magic armour, and adding melee weapons you'll rarely use because the guns are more fun and effective.

It's still a dependable co-op FPS, and the random weapon generation is as wild and entertaining as ever. However, Wonderlands throws way too much loot at you; combined with Borderlands' increasingly archaic inventory managements, this means you spend too much time fiddling around in menus rather than enjoying the adventure.

That's a shame, because Wonderland's adventure is genuinely entertaining. Writing aside, the game features some spectacular locations to explore, while its playful approach to storytelling enables a dynamic approach to level design. Levels will reshuffle themselves as Tina adjusts the story on the fly, with objects such as bridges and catapults suddenly appearing to fit with the narrative.

Meanwhile, key locations are connected by a tabletop 'overworld', explored by a bobbleheaded version of your character. Constructed by Tina herself, it has rivers of orange soda and passages blocked by giant cheese puffs.

In its unbridled sense of fun, Wonderlands is probably the best Borderlands game. The jokes are amusing, and the shapeshifting world is fun to explore. However, it doesn't do enough to modernise Borderlands' central systems, which means the activity you spend most of your time doing – shooting enemies – is also where the game is weakest.

RICK LANE

WONDERLANDS

+ Entertaining fantasy spoof
+ Good writing and excellent voice acting
+ Environments fun to explore

BLUNDERLANDS

– Mechanical reskin doesn't go far enough
– Overdoes the loot
– Tedious inventory management

/ VERDICT

Enjoyable spin-off from the main series that deserves more bespoke combat mechanics.

OVERALL SCORE

73%

Ghostwire Tokyo / **£49.99** inc VAT

DEVELOPER Tango Gameworks / **PUBLISHER** Bethesda

WIRED

+ Stunning recreation of inner-city Tokyo
+ Fun world design with lots of interesting touches
+ Decent combat

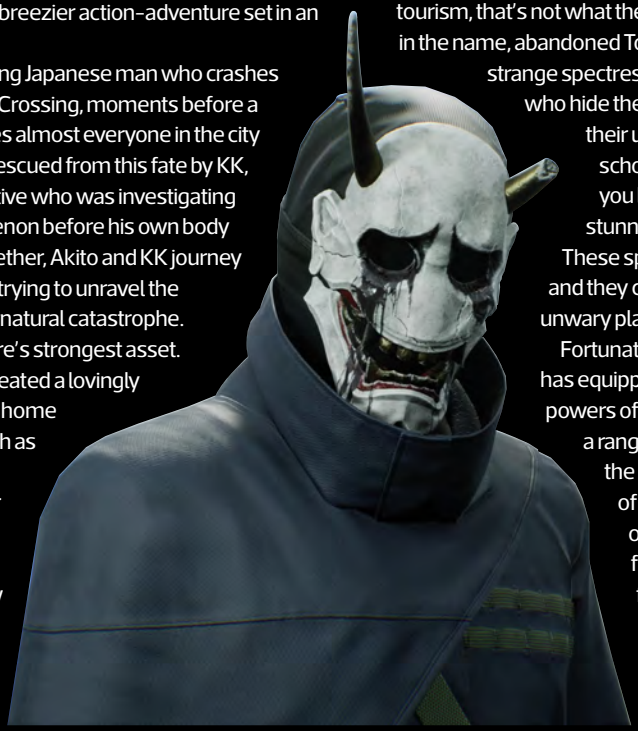
GHOSTED

– Underwhelming story
– Combat too static
– Open world lacks depth

Ghostwire Tokyo isn't the game it initially seems. Developed by Tango Gameworks, whose heritage includes Resident Evil 4 and The Evil Within, Ghostwire Tokyo at first resembles a survival horror experience similar to the studio's previous work. But it slowly reveals itself to be lighter, breezier action-adventure set in an open world.

You play as Akito, a young Japanese man who crashes his car in Tokyo's Shibuya Crossing, moments before a rapture-style event causes almost everyone in the city centre to vanish. Akito is rescued from this fate by KK, the spirit of a police detective who was investigating this paranormal phenomenon before his own body was stolen from him. Together, Akito and KK journey across abandoned Tokyo trying to unravel the mystery behind the supernatural catastrophe.

Tokyo is by far Ghostwire's strongest asset. Tango Gameworks has created a lovingly authentic replication of its home city. Major landmarks, such as the famous Crossing and the glittering Tokyo Tower are stunningly recreated, while the absence of the crowds that normally flow through these places is strikingly eerie. But it's the suburban areas, with their cramped pathways, jumbled houses and liberally scattered street furniture that are the true joys to explore. Ghostwire's world design justifies the game in and of itself, which is a strong starting point.



Yet while Ghostwire is a great facilitator of digital tourism, that's not what the game is about. As implied in the name, abandoned Tokyo is prowled by a host of strange spectres, from besuited businessmen who hide their faceless guises behind their umbrellas, to headless schoolgirls who skip towards you before lashing you with a stunning reverse-roundhouse. These spirits tend to cluster in groups, and they can quickly overwhelm unwary players.

Fortunately, KK's possession of Akito has equipped him with supernatural powers of his own. Akito can unleash a range of elemental attacks on the ghosts, from quickfire blasts of green wind (not that kind of wind) to a supercharged fireball attack that sends those fiends flying. Hitting a ghost enough times will reveal their 'core', which Akito can rip out to instantly destroy the spirit. Removing

cores also replenishes his spirit energy and charges devastating special attacks, making it the foundation of the combat's central loop.

For the most part, the combat is well designed. Blasting ghosts full of holes is entertaining, while the core-ripping mechanic lends a pleasing crowd control element to encounters. The nearer you are to a ghost, the less time it takes to remove the core, encouraging you to risk charging into the fray for quicker kills.

However, the thrill of combat is undermined by its surprising lack of dynamism. Both Akito and his opponents move oddly slowly, while smaller encounters can often be resolved without moving at all. The game would benefit from an injection of momentum, encouraging you to dodge and weave between enemies rather than relying on a static block and parry system.

Combat isn't the only area where Ghostwire feels underbaked. Alongside the main story, the open world is liberally scattered with side missions.

They're bizarre affairs that involve helping lost spirits solve specific problems so they can move on from the earthly realm. They range from exorcising the spirit of a hoarder from his filthy house to, er, helping a ghost stuck on the toilet by passing him some loo roll.

The framing of these missions is generally amusing or interesting, but they always end the same way. You either talk to the ghosts until the problem is resolved, or end up in an arena fight against waves of standard enemies. There isn't enough variety in enemy types or the general mechanics to make encounters feel as if you've influenced them, which makes exploration less rewarding than it should be.

This would be less of an issue if the central story excelled, but at best, it's okay. Ghostwire is framed as a detective story, which fits well with the moody urban environments.

However, the main characters are all tedious stock archetypes. The grizzled detective, the wide-eyed newbie, the sassy female sidekick, the megalomaniacal villain. Meanwhile, the game struggles to shape its 'ghost rapture' premise into an interesting plot, an issue that partly derives from the fact that the ghosts never feel especially scary. They're weird and fun, but rarely threatening.

For all its flaws, though, Ghostwire is consistently entertaining, and there are sparks of brilliance along the way. The game's world is enormous fun to explore, not only for its atmosphere, but also for its surprising verticality. You frequently find yourself climbing up tower blocks, leaping across rooftops and descending into the shop-lined mazes that form Tokyo's subway tunnels.

The game plays with 3D geometry in some wild ways, with some sequences reshaping the entire environment around you in real time. There are also wonderful smaller touches, such as the floating cat spirits that serve you in shops, or the yokai that conceal hidden passages by pretending to be walls.

Like The Gunk (see Issue 224, p69), Ghostwire is a game by a studio in transition. It's Tango's first proper open-world game, its first game to use a first-person perspective and its first game that isn't explicitly survival horror. It's a major departure in many ways, which explains why some of its systems feel slightly archaic or slightly underbaked.

However, Ghostwire Tokyo is also a deeply earnest experience that intimately understands both the place and culture it represents, and it wholly commits to that representation. It's revealing that the game's default language for the Western release is Japanese, as is how appropriate it feels to play the game with subtitles.

Ghostwire may not be Tango's best game, but it's the studio's most interesting title. By liberating itself from the shadow of Resident Evil, Tango delivers a characterful and entertaining adventure. With more depth to its open world, and more dynamism to its combat, it could have been truly brilliant. But even in its slightly compromised state, Ghostwire's supernatural vision of Tokyo is always compelling.

RICK LANE

/ VERDICT

Ghostwire Tokyo's systems are too lightweight for its remarkable open world, but it's an entertaining supernatural adventure regardless.

OVERALL SCORE

80%

NIGHTMARE REAPER / £19.49 inc VAT

DEVELOPER Blazing Bit Games / **PUBLISHER** Blazing Bit Games

NIGHTMARE REAPER

+ Huge variety of weapons
+ Great core shooter
+ Strong retro style

SLEEP PARALYSIS

− Annoying minigames
− Gauche representation of mental health

/ VERDICT

A spectacular retro shooter, although we wouldn't recommend coming to its psych ward for treatment.

OVERALL SCORE

74%

Nightmare Reaper is a volatile blend of FPS and procedural rogue-like elements. Its slightly unsavoury premise sees you play a woman in a psychiatric ward who, when she goes to sleep, descends into a terrifying world of demonic creatures. Here, she must blast her way through monstrous hordes with a wide array of weapons, in a gleefully violent throwback to the shooters of yore.

Nightmare Reaper's key feature is its emphasis on randomness. Not only are its Doom-like levels procedurally generated every time you play, but weapons are also randomly distributed throughout its pixelated labyrinths. Whereas most shooters give you ten to 15 weapons, Nightmare Reaper has 80, ranging from trusty pistols and shotguns through to nailguns, spellbooks, cluster-rocket launchers and Hellraiser-style tesseracts that trap enemies within their pocket hellholes.

It's a truly dizzying arsenal. More impressive still is how satisfying these weapons feel to wield. While Nightmare Reaper may look like it fell straight out of 1993's bumbag, with simply blocked-out levels and papercraft enemies, it feels thoroughly modern. Weapons have enormous heft, while blasted enemies fly apart like tomatoes thrown into a fan. As if 80 weapons weren't enough, each one also has an alt-fire mode. The chainsaw, for example, has a grappling-hook attachment that lets you zip across rooms to carve up enemies in double-time.

It's an incredibly satisfying combat engine, and picking up new weapons is always a thrilling moment of discovery. More broadly, Nightmare Reaper is filled with clever touches. At the end of a level, you can only pick one weapon to take with you, encouraging you to experiment and preventing you from over-relying on specific combinations.

The upgrade system is also tied to a bunch of quickfire minigames, such as a 1980s-style platformer and a Pokémon-like RPG. These further establish Nightmare Reaper's retro credentials, although neither is anywhere near as compelling as the core shooting. The platforming minigame, for example, is simplistic and not especially well produced. It's a fun novelty the first few times you play it, but that novelty quickly wears thin.

This isn't the only unwelcome demon in Nightmare Reaper's braincase either. It's also easy to become lost in Nightmare Reaper's procedural mazes, and the levels aren't much fun to explore when they aren't filled with enemies. Also, the framing of your character as a psychiatric patient isn't exactly the most empathetic portrayal of mental health, and given how little this framing contributes to the core experience, it could easily have been omitted.

Then again, perhaps it's unreasonable to expect tact from a game that's about blowing demons inside out with more weapons than you can shake a broomstick at. Nightmare Reaper may not be as sophisticated as other retro shooters such as Dusk or Amid Evil, but it makes up for this with its sheer relentlessness and variety. For better or worse, it's thoroughly committed to its distinctive brand of chaos, and the result are, for the most part, a riot.

RICK LANE

WEIRD WEST

/ £30.99 inc VAT

DEVELOPER WolfEye Studios / **PUBLISHER** Devolver Digital

Weird West is a fascinating yet flawed attempt to merge the dynamic systems of an immersive sim with the CRPG structure of a game such as Baldur's Gate. Its most distinctive feature is its unique approach to storytelling. Rather than playing as one character, you assume the roles of five difference characters in a predetermined sequence. Starting as a vengeful bounty hunter named Jane, your adventure will see you assume the roles of a native American warrior, an occult wizard and, er, a mutant pigman.

Each of these stories plays out as its own mini-RPG, with you exploring a wide variety of locations connected by an overworld map, complete with side quests and randomly occurring events. While each character's story is separate, they interlink via the player's choices. The links include major story decisions in each character's arc, but also in player-directed actions, such as killing in-game characters. This includes major characters crucial to the plot's story, with the game cleverly working around your reckless disregard for virtual life.

Weird West couples this narrative flexibility with an impressive layer of simulation. Players can approach challenges through combat or stealth, while also using the environment to their advantage. Groups of enemies can be eliminated by shooting an oil lantern around which they're clustered, or by throwing a barrel of poisonous chemicals at them. Rain will make guards more susceptible to electrical attacks, while also refilling water barrels from which you can drink to restore health. Fire can be used as a distraction, drawing enemies away from an objective, so you can complete it.

Manipulating the game world in this way is fun, but pulling off shenanigans successfully is difficult. Most encounters ultimately descend into a gunfight, and combat is by far the game's weakest element. The top-down perspective makes the fighting over-reliant on precision, which is difficult when enemies tend to blindly rush you and your character can be killed by a handful of shots. The ability to perform a bullet-time dodge feels less like a satisfying power, and more like necessary compensation for the combat's lack of refinement.

The character abilities are also largely devoid of the creative potential seen in games such as Dishonored. Jane's most functional ability is a powerful kick – useful for booting around barrels and other objects, but not particularly exciting. The multi-protagonist structure also leaves little room for characters to grow, making each one's progression path feel narrow and underwhelming.

You can get a rewarding experience from Weird West, but the rewards require far more patience to earn than in games such as Dishonored or Divinity: Original Sin. Those games build their fun toys and tricks into the moment-to-moment experience, working from the characters outwards. In Weird West, the coolest ideas are scattered around the fringes, while the characters and combat – the game's two most central features – are also its least interesting.

RICK LANE

COWBOY

+ Interesting narrative structure
+ Highly reactive world
+ Impressive dynamic systems

COW PAT

– Tedious core combat
– Underwhelming character abilities

/ VERDICT

Weird West's experiment of melding an immersive sim with a CRPG is intriguing, but only partly successful.

OVERALL SCORE

73%

REALITY CHECK

Rick Lane checks out the Meta Quest Gaming Showcase and flings around his virtual tentacles in his latest VR roundup

REVIEW

TENTACULAR / £19.49 inc VAT

DEVELOPER Firepunchd Games / **PUBLISHER** Devolver Digital

Tentacular is a light-hearted throwback to the early days of VR, when throwing and catching stuff in a virtual-reality environment was the coolest thing you'd ever done. Yet while the base mechanics may be simple, it ekes an impressive amount of fun and humour out of its silly controls and daft Kaiju theme.

You play as a gigantic octopus creature that's been adopted by the island paradise of La Kalma. Having reached your 16th birthday and therefore come of age, you're expected to give back to the community by getting a job. After a short stint of manual labour, you're eventually selected to test experimental technology for the island's cutting-edge scientific research team.

The game is controlled entirely with the two floppy tentacles that replace your arms in VR. Pressing the triggers on your controllers while touching an object will cause it to stick to your tentacle's suckers. Using this highly inefficient control scheme, you must solve a wide range of physics-based puzzles. These start out simply, such as throwing objects into a set area, or building a Jenga tower out of shipping crates. However, later puzzles introduce elements such as rockets that propel objects in the direction you point them, or magnets that stick in-game items together.

Much like cult hit Octodad: Dadliest Catch, the fun of Tentacular stems from the dynamic slapstick humour of trying to perform manual tasks without any digits or, indeed, bones. En route to completing most puzzles, you'll invariably wreck half the neighbourhood, sending civilians flying into the sea with a rogue swipe of a tentacle, or squashing them flat when a van slips from your suckery grasp.

It's all presented in a cartoon style where there are no long-term consequences for the havoc you cause. Citizens chucked into the sea will magically pull a life-ring from their beach shorts, while those you accidentally flatten will quickly buff out their squashed bodies.

Tentacular doesn't do anything radically new, but its presentation and puzzle structure help to refresh these fundamental VR interactions. There's one notable problem, though, which is that the game loves the sounds of its own voice, or to be more specific, the sight of its own text.

Almost every puzzle in Tentacular is prefaced with lengthy conversations delivered via speech bubbles, which you must stand and endure all over again if you fail a puzzle and need to reset.

You can tap the game's bobbleheaded citizens on the head to skip dialogue, which is funny the first few times you do it, but an option to skip dialogue entirely would be very welcome after the first hour or so.

Tentacular won't be knocking on the doors of Half-Life: Alyx (not least because it doesn't have knuckles), but it's a fine alternative to Job Simulator as an entry-level VR game, while its slapstick humour and creative puzzles will appeal to veteran VR players too. Tentacular may not quite be kraken, but it's worth a few squid regardless.

DOCTOR OCTOPUS

- \+ Good puzzles
- \+ Funny
- \+ Accessible

SQUIDWARD TENTACLES

- – Nothing dramatically new
- – A little verbose

VERDICT

Tentacular deftly balances slapstick silliness with deftly crafted puzzling, although the script sometimes gets in the way of the fun.

OVERALL SCORE

70%

NEWS

QUEST GAMING SHOWCASE

Meta recently unveiled its 2022 Quest Gaming Showcase, revealing a bunch of exciting VR games that are coming to the platform. This includes sequels to some of the very best VR games, and at least one huge surprise. Most of these games will release in the next year, some as soon as the summer. So here's a quick rundown of the highlights coming to the Quest 2 in the coming months.


Ghostbusters VR

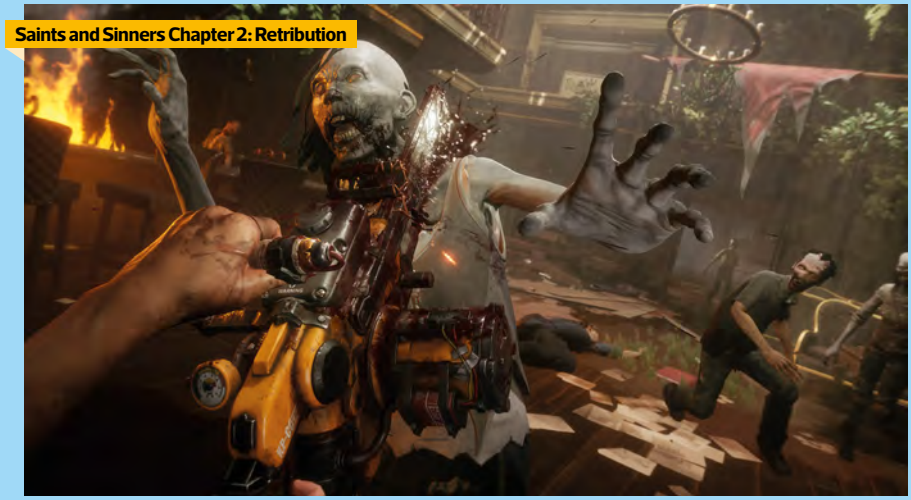
Ghostbusters VR

By far the most surprising announcement of the showcase, Ghostbusters VR is a whole new adventure that will see players solving a 'deep mystery' in the Ghostbusters universe. Developed by N-Dreams, it's designed to be played both solo and with up to three other players in cooperative multiplayer. More specific details on how the game will play are thin, but footage shows players working together with proton packs to take down a bunch of colourful spirits.

We also don't know whether any of the original Ghostbusters cast will make an appearance, as they did in the underrated third-person shooter from 2009.

The Walking Dead: Saints and Sinners Chapter 2: Retribution

The Walking Dead: Saints and Sinners was one of VR's biggest surprise hits when it launched early in 2020. Its incredible use of VR's interactive capabilities (including some spectacularly grisly melee combat) combined with a deep survival simulation and intriguing story to make it one of the most fleshed-out experiences available in VR. The sequel is a direct continuation of the first game's storyline, seeing you play as 'The Tourist' in a new, zombie-infested location. Expect jazzed-up visuals and a wider array of weapons, including a very messy-looking chainsaw.


Saints and Sinners Chapter 2: Retribution

Bonelab

Bonelab is the sequel to 2019's Boneworks, the chaotic VR shooter inspired by Half-Life 2. Most notable for its advanced physics simulation and metaphysical storytelling, Boneworks was a fantastic game slightly overshadowed by the release of Half-Life: Alyx a few months later.

The sequel sees players returning to the series' bizarre online platform MythOS, and will feature a more advanced physics simulation, full mod support and new places to explore, including Ultima Underworld-style fantasy dungeons. It even has a gravity gun.


Bonelab

Moss: Book II

Moss: Book II is the sequel to one of VR's most unusual games. A blend of first-person puzzling and side-scrolling action, players in the first game assumed control of a little mouse named Quill and a narrator helped to guide Quill through the game's storybook world. It was a beautiful and inventive game, but it was also held back from greatness by being too short and lightweight.

Both problems appear to have been solved in Moss: Book II, which is already available on PSVR. The sequel offers a longer campaign, more enemy types, new weapons and more advanced platforming. It also expands the abilities of the narrator, letting players spawn objects in the game world, such as vines for Quill to climb. The Quest 2 version is coming this summer. CPC


Moss: Book II

Home comforts

Make your home office or gaming setup more comfortable, relaxing and functional with Edward Chester's top tips for creating the ultimate desk setup

Whether you're one of the many office workers that has now found themselves working from home permanently (or at least semi regularly), or even if you just spend many hours every evening in front of a computer of your own volition, ensuring your home computer desk space is comfortable and functional is crucial to optimising your performance and minimising your discomfort.

To this end, we've spoken to ergonomics experts, tapped into the expertise of colleagues and other home workers, and tested a whole slew of potential desk area upgrades to find the best ways to upgrade and optimise your working or gaming space.

Get a proper office chair

It's such an obvious place to start that it almost feels silly to have to say it, but getting a good office chair really should be your first port of call for making the most of your office space. A good chair will support and cushion your body, raise you to the correct height for optimal comfort and allow for adjustment to suit your body type. Not only is it worth spending as much as possible to get these features and improve your comfort, but often, cheap chairs just don't last very long – we've used chairs that lose their padding and structural integrity within a year.

Our tried and tested top choice is the Herman Miller Aeron. The taut mesh seat and back provide excellent support and breathability, keeping you cool and dry. What we also love about this chair is the excellent and easy-to-adjust lumbar support, superb build quality and the excellent recline system, which tilts both the seat and the back in unison, and does so with effortless ease. Comparatively, some chairs won't stay tipped back unless you rest your feet on an object to hold them up.

The only problem with this chair is that it costs £1,000 inc VAT new. You can get them for as little £250 (and they regularly go for well under £500) second-hand, but they're still pricey options. For a slightly more affordable option, the inSync 24 (£434 inc VAT) offers many of the same core design features that we like in the Aeron, such as the fully mesh seat and back and full tilt mechanism. The lumbar support isn't as good though.

It's a similar story with the likes of the Ergo-Task Fully Loaded Mesh office chair (£271 inc VAT). The mesh is much looser than that of the Aeron, the back is more wobbly and only the back tilts, not the seat. However, the padded seat is wonderfully deep and remains comfortable for hours on end, while the lumbar support is decent too.

Either a good mesh option or one that offers lots of padding is the way to go – skimp on this area and you'll only end up resorting to cushions later

If none of these options suits your style or budget, there are some general tips we can suggest. Firstly, we really do like mesh chairs. The breathability is a huge help in keeping comfortable for hours on end. Second, make sure the lumbar support is good. While sitting on stools or exercise balls is great for your core muscles, the reality of sitting at a desk for hours on end for most people is that your core muscles

The Herman Miller Aeron is a proven top-class office chair, but it comes with a high price

The Ergo-Task Fully Loaded Mesh chair is more affordable, but still offers good seat comfort and back support

want to take a break and get a bit of support. A chair that can nestle into the small of your back and support your spine is essential.

When it comes to the seat, either a good mesh option or one that offers lots of padding is the way to go – skimp on this area and you'll only end up resorting to cushions later. Also, make sure the front edge of the chair drops off and doesn't stay flat or, worse still, raises up slightly – this is the case with many gaming chairs that emulate the bucket seats of cars. The gentle downwards slope helps to reduce pressure on the underside of your legs, improving comfort and circulation.

Meanwhile, headrests can be comfy, but for most people they're a luxury that's only useful when it comes to reclining, not while sat up working. Likewise, armrests can be useful, but often just as much comfort can be obtained from using wrist rests and otherwise improving the comfort of your peripherals.

Make the most of your old chair

If your budget really can't stretch to buying a new chair or, you're stuck with having to use a hard folding chair thanks to your work space being temporary, there are a few options available to you. For a start, invest in one or several dedicated seat cushions/pads. Don't rely on scatter cushions salvaged from your sofa, as these seldom offer consistent padding – they slide around and you end up with little control over the height they provide.

Instead, the likes of Ikea's Hillared cushions (£8 inc VAT) offer a consistent thickness that means they offer padding right to the edge of the seat. Plus, the flatness and rubber grip on the underside of each cushion means they stack really well, making it easy to layer them up to get to the height you need for optimal comfort. What's more, these same attributes make it relatively easy to tuck one behind your back once you've sat down. Normal cushions just slide off.

If you are rocking an office chair, but it's rather basic, there are a few upgrades you can make. Firstly, if the seat cushion is on the blink, grab some of those very same seat pads for an easy cushion upgrade. Meanwhile, if lumbar support is lacking, you can get lumbar supports such as the Kensington Lumbar Back Rest (£50 inc VAT), which strap to the back of your chair and provide the extra lower back bump needed to support your back. The support isn't as firm or smoothly integrated as in quality office chairs, but it's better than nothing.

Turn tables

If your current desk consists of little more than a budget table, such as the Ikea Linnmon (100 x 60cm – £29 inc VAT), then it's well worth upgrading to a proper desk, even if you keep the same cheap table legs. Such basic tables tend to be built internally from cardboard (made into a hexagonal, lattice-like honeycomb), so they wobble around, struggle to support heavy objects and can't have devices such as monitor arms clamped to them.

Proper seat cushions can be piled up to get more cushioning and the right height for your needs

Their thickness also increases the likelihood that chair arms or your knees will knock into the edge, which is made all the worse by the surprisingly sharp edges on these cheap tables. At the same time, the area of these tables often isn't deep enough to accommodate a large monitor with a hefty stand that takes up half your desk depth.

Handily, you can pick up proper desktop surfaces for around £100 inc VAT for a 120 x 70cm desk – 70cm depth is the minimum we'd recommend. These proper desk surfaces are slimmer in profile than a table, with slightly more rounded corners (it doesn't take much to make a difference), and they're generally deeper, giving you more desk space for all your finest desk clutter. The solid, dense build material can also support greater weight, and be used with desk-clamping monitor arms and other such accessories.

What about a standing desk?

All the rage at the moment, standing desks have been hailed as the ultimate way to improve your posture, help burn a few extra calories and generally improve your health,

Even old or basic offices chairs can be enhanced with additions such as ergonomic back supports

Cheap Ikea tables can suffice as desks, but they have several shortcomings

all while still stuck at your desk. Some of these claims are certainly exaggerated – a recent study by the Physical Activity department at the University of Pittsburgh showed that standing only burns eight calories more per hour than the 80 consumed when sitting, compared to 130 more when walking. However, a change of position is generally considered a positive move compared with prolonged periods of sitting, with it helping to improve circulation and core stability, as well as helping to relieve tension in the neck and shoulders.

Just bear in mind that, as Senior Faculty Editor of Harvard Publishing, Robert H. Shmerling, points out, suddenly standing for prolonged periods can introduce just as many problems as it solves, such as lower back, leg and foot pain. As such, switching to a fixed standing desk isn't recommended – instead, one of the many adjustable sit-stand desks is the way to go.

We've tested several options, from simple foldout laptop stands that sit on your existing desk, to electrically motorised desks – the whole of which raise and lower at the touch of a button. In general, the electric, full-desk option is the best option, as it makes switching between sitting and standing quick and easy, plus you don't have to worry about rearranging any objects on your desk.

The Flexispot EG1 can be raised and lowered at the touch of a button, and the frame costs under £200

These desks also have a secondary benefit, which is that they allow you to easily set the desk at a comfortable sitting height and not be forced to work around the fixed height of a normal desk – great for taller or shorter-than-average users. What's more, particularly since the pandemic, the market for these desks has exploded and there are now hundreds of affordable options. The likes of the Flexispot EG1 can be had for just £180 inc VAT for the frame, and just £280 inc VAT with an included 120 x 80cm white desktop.

Spend more on the likes of the Yo-Yo Desk Pro 2 (£645 inc VAT with a 120 x 80cm top) and you get a sturdier build, but for most people, the Flexispot is a great option. Just a couple of 20-minute standing sessions a day is a great way to keep yourself moving just a little, while not taking you away from work. Just remember to take a break from your screen and go for a walk regularly too.

Get a monitor arm

One of the unexpected consequences of using a standing desk is that, when you stand up, the relationship between your head height and a comfortable arm-resting position changes. In other words, when you stand up, you'll generally want your monitor to sit higher in relation to your desk than when sat down. Some monitors will have stands with sufficient height adjustment to accommodate a standing desk setup, but many won't have enough or any at all.

That's where a monitor arm becomes a useful addition.

Fixed to the back of your display in place of its existing stand, and then either clamped to the desk or screwed into a wall, a monitor arm uses the standard VESA screw holes you'll find on the back of almost all monitors. Some monitors require you to remove some extra parts to access these screws, and there are two versions of the standard – a 75 x 75mm and a 100 x 100mm version – so be sure to check which one your monitor needs.

As well as allowing for extra height adjustment, a good monitor arm will enable you to easily pull the monitor back and forth, and twist round the display

As well as allowing for extra height adjustment, a good monitor arm will enable you to easily pull the monitor back and forth, and twist round the display – great for plugging in cables and using the display in a portrait mode. The likes of the Invision

A monitor arm provides loads of positioning adjustment and frees up desk space

MX200 that can be had for just £35 inc VAT from **amazon.co.uk**, offers 19-32in screen holding capacity, effortless gas piston-assisted height adjustment, and an easy-to-install and secure desk clamp. However, you might want to slide a slim piece of wood between the clamp and the desk to ensure the clamp doesn't mark your desktop.

We've also been impressed by the company's MX900, which offers two arms and has a 2-port USB 3 hub in its base – ideal for connecting the cables for your keyboard and mouse. It's again available from **amazon.co.uk** for £60 inc VAT.

Playing footsie

The final key piece of the puzzle when it comes to sitting or standing comfortably at your desk is ensuring your feet are correctly positioned in relation to your body. Or, in the case of standing desks, that you're standing on a comfortable surface.

When it comes to sitting down, many shorter users will find their legs dangle off the front of their chair, even if they've lowered their desk as far as they'll go. This isn't ideal, as it puts extra pressure on the underside of your legs. Even for taller users that don't have a problem with their feet finding the floor, raising your feet further can make for a more comfortable sitting position, with less desire to cross your legs or fidget. For both these situations, it's best to invest in a footrest.

Your two main options are hard plastic rests with adjustable height/angle tops, or you can go for softer solid foam options. We preferred the initial feel of the softer foam Huahuo foot rest we tried (£21 inc VAT from **amazon.co.uk**), but liked the way the Kensington SoleMassage Footrest (£40 inc VAT) tipped forwards and back, allowing you to slightly exercise/stretch your feet.

When you're standing, we can recommend the use of cushioned mats such as the Yo-Yo mat (£60 inc VAT from **sit-stand.com**). They're nothing more than 1.5in-thick dense foam mats for slightly cushioning your feet, but they do genuinely work, taking the pressure off your feet and promoting a little extra imbalance that engages your core muscles. However, the big downside with these mats is that once you sit back down, they're in the way, so you'll need somewhere on hand to store them.

A foot rest can make a surprising difference to your desk comfort, even if your feet comfortably reach the floor

The wrist rests included with keyboards are nearly all rubbish, so buy a proper soft one

Rest those wrists

Whichever type of keyboard you own, whether it's a super high-end custom mechanical keyboard that weighs 3kg, or a lightweight, low-profile Bluetooth option, nearly all conventional keyboards come with rubbish wrist rests. They're usually insufficiently tall, made from hard plastic and have sharply angled corners – they're seldom even worth taking out the box. Instead, we recommend buying a proper soft wrist rest.

There are umpteen options available, with custom graphics and novelty shapes aplenty. However, for sheer longevity and reliability, you can't beat the Kensington ErgoSoft (£25 inc VAT from **box.co.uk**). Available in slim, standard and mechanical keyboard variants, which each differ in

Ergonomic keyboards can reduce wrist pain, but there can be a learning curve to using them

More curvaceous mice provide a better angle for your wrist, which can reduce wrist and forearm pain

height to match your choice of keyboard, they offer a wonderfully soft gel top and sturdy rubber base. They also have a smooth uninterrupted surface, so they're easy to keep clean.

Go ergo

If upgrading your wrist rest doesn't prove enough of a comfort upgrade for your typing duties, consider swapping to an ergonomic keyboard. These keyboards use a split design where your hands sit on either side of a blank, raised middle section, then incorporate a soft wrist rest that's raised up above the rest of the keyboard.

The reason for all these changes is that the end product allows your hands to sit at a much more natural angle, and not be forced upwards and into a straight line.

These keyboard designs have been around for a long time now, and we can attest to their effectiveness.

Even though it's Microsoft's Natural (now known as Sculpt) line that is most associated with the style, we recommend the latest Logitech option, the Ergo K860 (£80 inc VAT). It has a great, lightweight, low-profile key action, USB dongle-based wireless and Bluetooth connections, key legends for both Mac and PC and it has buttons for quickly switching between the devices with which it's paired (up to three at once). It's also really comfortable to use.

There are two main downsides to these types of keyboards. The first is that there can be a steep learning curve for those not used to disciplined touch-typing. The other factor is that, if you're a heavy user, these keyboards do wear out quicker than keyboards with mechanical switches.

There are ergonomic mechanical options available, such as the Truly Ergonomic Cleave and Dygma Raise, but they're very expensive and neither of these options includes a numpad, which rather limits their appeal. In this instance, you basically have to choose between mechanical actuation or typing comfort.

Mouse movements

We're strong advocates for the latest lightweight, compact mice for gaming, because of the performance and accuracy they provide. However, when it comes to longer sessions at your desk, they generally aren't the most comfortable rodents to use.

It's well established that excessive or prolonged pronation of the forearm (twisting your hand inwards, as you do when using a normal mouse) leads to a host of painful conditions - ideally our hands should be perpendicular to the desk, not rotated flat onto them. Regular breaks and stretches are all essential tools to alleviate these issues, but what can also help is a more forearm-friendly mouse.

We're advocates of the extended mats that go under your keyboard too, as they eliminate the chance of your keyboard and mat getting in the way of each other

The first stage of slightly improving your wrist position is to opt for a more ergonomic but still conventional mouse. For gaming, the likes of the Logitech G703 and Razer DeathAdder offer a bit more hand support and sloped sides to open up your wrist angle more than flatter gaming mice designs – moving from around ten to 15 degrees. However, for gaming mice, that's about as much difference as you can get.

Instead, a great non-gaming option is the Logitech MX Master 3 (£85 inc VAT), which sets your wrist at a 25-degree angle. It also features several other ergonomic improvements, including a fully rubberised top that helps to prevent your hand from sliding off the mouse and back into a flatter position. Meanwhile, the clever auto-freewheeling, weighted scroll wheel

Vertical mice, such as the Posturite Penguin, provide a natural angle, but it can take a seriously long time to get used to them

also makes it effortless to scroll through large documents, while the addition of a sideways scroll wheel for your thumb further reduces the strain on your middle finger having to use the main scroll wheel.

If that's not enough for you, the next stage is to move up to a proper vertical mouse. The likes of the Logitech Lift (see p34) and larger Logitech MX Vertical (£95 inc VAT) offer a claimed 57-degree wrist angle (around 53 degrees in our measurements), while the Posturite Penguin (£95 inc VAT) has a fully vertical, 90-degree design.

The problem we've tended to find with these sorts of mice is that they significantly impact your mousing precision, as you have to rely on large wrist movements rather than precise finger movements. We found that the two Logitech ones also require gripping the mouse a bit more firmly than a normal mouse, which introduces its own strains – the Posturite is better in this regard.

The final issue we've found with these mice is that the more you twist your forearm back to a neutral/vertical position, the more it exposes the bone of your arm to the edge of your desk. When laid flat, the meat of your forearm muscles act as a cushion, but there isn't much muscle between the outside edge of your ulna and your skin. The upshot is that using these mice comfortably also means getting a soft wrist rest for your mouse.

Large-format mouse mats provide a soft landing for your hands and grip for your keyboard, as well as a smooth surface for your mouse

Get a decent mouse mat

Whatever sort of mouse you buy, getting a quality mouse mat is an essential addition to any desk. For a start, while some mice such as the MX Master 3 can work on tricky reflective surfaces, most mice struggle on them, so a proper mouse mat will improve tracking performance and reliability on some surfaces.

What's more, opting for a soft mouse mat will give you a secondary benefit, which is a slightly cushioned desk surface. This goes a surprisingly long way to helping ease any pain from where your wrist rests against the desk, plus it reduces noise and wear on the glidepads/feet of your mouse.

There are countless options available, most of which perform very similarly, but we can attest to the quality and reasonable pricing of Corsair, Glorious, Logitech and SteelSeries' mats, which start at well under a tenner for a 320 x 270mm mat. When it comes to size, it's generally the case that the larger the better, so your mouse movements don't feel cramped and your mouse doesn't fall off the edge.

In particular, we're advocates of the extended mats that go under your keyboard too, as they eliminate the chance of your keyboard and mat getting in the way of each other (a problem on smaller desks if your mat is too large to sit alongside your keyboard). They also provide a secure grip of your keyboard, and the softness can even help your wrists if you don't have a keyboard wrist rest.

The super-sized mats that cover most of a desk are good too, but in practice they don't actually provide much meaningful benefit – it's just handy to have a soft landing zone for your various bits of desk clutter.

Try a trackball

If neither a more ergonomic nor a vertical mouse work for you, then a trackball is a great alternative. The smaller amount of wrist movement, relaxed wrist angle and use of the more powerful thumb for a lot of movement, means they naturally put far less strain on your body than using a normal mouse. The fact that the unit doesn't actually move around like a mouse also means they're well suited to small desk spaces – you can comfortably use one in a gap of only 5in.

Trackballs are a great alternative if your hands suffer after too long spent using a normal mouse

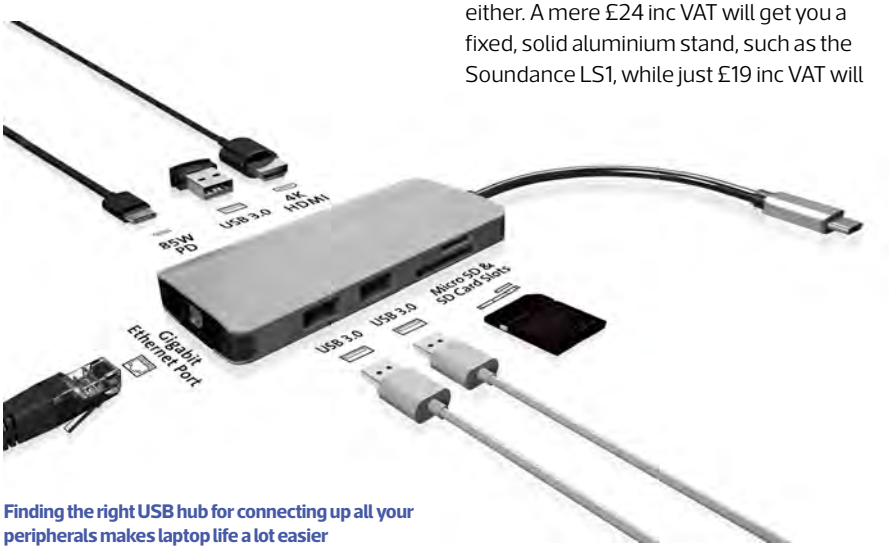
What's more, it's surprisingly easy to get used to them. Having never used a trackball before, I tried the wireless Kensington Orbit (£45 inc VAT) for this feature and took to it like a duck to water. There are some movements that don't quite feel as natural as when using a normal mouse – and any first-person gaming is a non-starter – but it was great for standard PC use. The only issue that regularly caught us out was the lack of back/forward buttons, but the Logitech MX Ergo (£77 inc VAT) offers those features too.

Fold-flat laptop risers are ideal for people who regularly move between home and the office, or work on the move

Laptop loadouts

For those of us who either primarily use a laptop or must use one for work, there are a couple of obvious upgrades that we consider essential. The first is a good USB Type-C hub. Many modern laptops now only include USB Type-C outputs, which are no good for plugging in most peripherals, so a hub is essential for providing extra inputs and outputs. Moreover, even for those laptops that do have more varied outputs, having a single device that you can leave in place plugged into all your peripherals makes life a lot easier.

There are countless options from which to choose, from small portable units with just a couple of full-sized USB ports and an HDMI output, to hefty desk-bound units with masses of connections, mains power input for charging and even KVM switching support – for switching between your laptop and your PC, for instance, at the touch of a button.



Finding the right USB hub for connecting up all your peripherals makes laptop life a lot easier

There are many examples of the smaller style of hubs on **amazon.co.uk**, which we've found to be fine, from brands such as Qgeem and Zmuipng. However, availability of specific options and specific brands can be quite unreliable so often it's difficult to recommend one.

One of the best known-brand examples we've used is the Kensington UH1400P. In its impressively small 105 x 52 x 14mm form factor, it fits three Type-A USB 3 ports, a USB Type-C port (with pass-through power up to 85W), micro and full-sized SD card slots, HDMI 2 and Gigabit Ethernet. The latter port is a particularly rare find on these smaller portable units but still super-useful if you've networked up your home. However, at £80 inc VAT, the UHP1400P is more than twice the price of many equivalent Amazon specials.

The other big laptop upgrade worth buying is a laptop stand. As well as raising up the screen of your laptop so that it sits at a more comfortable height to view on your desk, a good laptop stand will help your laptop to keep cool by opening up access to the bottom ventilation system, and generally improving airflow around the whole chassis.

You don't have to spend megabucks either. A mere £24 inc VAT will get you a fixed, solid aluminium stand, such as the Soundance LS1, while just £19 inc VAT will get you a convenient fold-flat option, such as the Kensington SmartFit Easy Riser Go that's ideal for travel.

Keep your cool

Whether you tend to reach for a hot or cold drink, a universal truth is that it's all too easy to forget about the drink you just fetched, and by the time you remember it has turned tepid. That's where the likes of the Yeti Rambler come in handy (£35 inc VAT from **amazon.co.uk**).

These double-walled stainless steel mugs are amazingly good at keeping drinks at their starting temperature, far more so than many other insulated mugs we've tried. So much so, in fact, that you'll need to leave off the lid for a few minutes to let the drink cool down to a vaguely drinkable temperature, before locking in that heat loss with the lid. They'll work for keeping your chosen cooling beverage cold too.

If you simply can't do without your favourite mug, another option for hot drinks is a mug warmer. Available in all sorts of

The Evapolar Evachill is surprisingly effective at keeping you cool in peak summer months

Far from the most stylish accessory but highly effective, Yeti mugs are excellent at keeping drinks hot or cold

random brands on **amazon.co.uk** for around £20 inc VAT, the couple of options we've tried make fantastic additions to any desk. They're certainly not the most energy-efficient options, and won't keep your drink piping hot (at least not without a lid for your mug to minimise evaporated heat loss), but they can make all the difference when you've been distracted for half an hour and forgotten to finish your brew. No longer will you have to down a stone-cold half mug of tea.

As for keeping yourself cool in these summer months, an obvious room upgrade is an air conditioning unit, but they're expensive, noisy and not very efficient. Instead, we can recommend the Evapolar EvaChill (£85 inc VAT) evaporative cooler. This compact, USB-powered unit blows air over a membrane that you dampen with water, and the evaporation of the water helps to cool the air as it's blown past it. They're nothing new as a concept, but the EvaChill is remarkably compact and relatively quiet. It can sit on your desk pretty much unnoticed, and just takes off the edge when temperatures really start to rise.

Going green

There are few better shortcuts to creating a calming environment than simply seeing some greenery, and while a quick walk in the garden – if you have one – or stroll around the nearest park can work wonders, often it's not possible to get away from your desk. To this end, one or two plants for your desk, or the shelves next to your desk, are a great way to bring a bit more of a relaxing vibe.

The range of possible indoor plants is vast, but there are a few obvious options that are suited to desk environments. In particular, any sort of succulent such as cacti, aloe, agaves, sansevieria and sempervivum are ideal, as they're slow-growing and only need occasional watering.

There are many other varieties that are suitable too, but any that require higher humidity – such as ferns, spider plants, orchids and peace lilies – will take a bit more care and attention, as they may need spraying regularly to keep up their ambient moisture level.

While house plants can be lovely, don't believe the hype when it comes to them oxygenating or cleaning the air in the room.

While house plants can be lovely, don't believe the hype when it comes to them oxygenating or cleaning the air in the room

While numerous studies have shown plants can reduce levels of some harmful gases, such as volatile organic compounds (VOCs), the likes of Michael Waring, an environmental engineer and indoor air quality expert at Drexel University, point out that the rate at which they do so is far slower than the rate of air exchange via windows, doors and other gaps in rooms. In other words, you'd need wall-to-wall plants and a very well-sealed room to notice any improvement over the ambient air around you. CPC

RAPID RESPONSE

EDWARD CHESTER EXPLORES WHAT'S MEANT BY YOUR MONITOR'S RESPONSE TIME, HOW IT VARIES AND HOW OUR NEW TESTING WILL ASSESS THIS CRUCIAL ASPECT OF EACH MONITOR

The response time of a screen is the average time it takes for a pixel to change from one colour to another. In an ideal world, a pixel would change colour the instant it receives a signal. However, the way display technologies work means there can be vast differences in how quickly this change happens.

Back in the days of CRTs, response time wasn't a consideration, as the phosphor coating on the back of the screen that would glow in response to the electron beam being fired at it responded very quickly – in the order of 0.01ms or faster. Meanwhile, technologies such as plasma and OLED can have similarly rapid sub-0.01ms response times.

However, the liquid crystal displays (LCDs) that dominate the computer display market – and most of the TV market too – respond far more slowly. The very fastest panels can reach as low as 0.5ms for some colour transitions, but they typically average 3-4ms across a range of transitions while the slowest panels can take as long as 30ms or more.

The far slower response of LCDs is down to the fact that they must physically move the liquid crystals in each red, green and blue sub-pixel in order to affect how the light from the screen's backlight passes through them. In contrast, the other technologies above have no moving parts above a molecular level.

Why does response time matter?

When showing a static image on-screen, to all intents and purposes, response time doesn't matter. However, as soon as a screen is showing a changing image, such as a video, game or even just the moving cursor of a mouse, a slow response time can create several problems.

The most obvious issue is that you get a ghostly, trailing image behind moving objects. These ghost images are the pixels that were previously showing the object that just moved, still showing a hint of the previous image. With a slow enough response time, fast enough frame rate and fast enough movement, you can see many ghost images smeared across several inches of your screen.

Not only can these trails be distracting but they also obscure details, making for a fuzzy, low-quality image. This combination can blur fast action in movies, and even basic movements such as getting a cursor to hit the right button can be affected. As for gaming, a slow response time can make faster-paced games such as first-person shooters almost unplayable, while even slower-paced but detailed games, such as real-time strategy games, can suffer from the blurriness.

A slow response time can result in ghostly trails and blurred detail during fast on-screen movement

Also, while the pixels of even displays with slow response times tend to start changing colour quite quickly, they can take a long time to change enough to be noticeable. This slowness can in turn make the display feel less responsive to your inputs. This is less of a problem when passively watching video, but when gaming or interacting with your display, these slight delays can be a matter of virtual life and death.

Response time vs frame rate

The importance of response time is inherently linked to the refresh rate of a display. For a 30fps video, each frame is shown for 33ms, so there should be plenty of time for most monitors to fully transition the colour of each pixel before the next frame appears, essentially eliminating the visibility of ghosting and other problems with a slower response time.

However, even just moving to a 60fps video, or playing a game on a 60Hz monitor, will drop the frame time to just 16ms. Move up to a 144Hz screen and you're looking at a 7ms frame time while 240Hz screens are hitting just 4ms per frame. Putting aside arguments about the visibility of such fast changes to the human eye, it's obvious that running a 240Hz screen with a response time of 10ms results in the display being incapable of updating its image as fast as the signals it's being sent.

How fast is fast enough?

So, a fast response time is important for keeping up with the fast refresh rates of modern gaming monitors, but just how important are both these factors? Well, all the way back in 1968, Robert Miller of IBM established that humans would perceive as instantaneous any visual response from pressing a button that was quicker than 0.1 second (100ms), and multiple studies since have reinforced the notion that 100ms is the limit of our ability to visually perceive the world around us. This seems to indicate that it doesn't matter if a screen has a refresh rate of 60Hz or 240Hz, or a response time of 5ms or 30ms.

However, this figure is misleading when it comes to monitors for two reasons. First, we're not just considering the response of your eyes, but also their interaction with your brain as it perceives pressing a button, sending that signal to your finger then waiting for your eyes to detect a response, then sending that signal back to your brain for it to process.

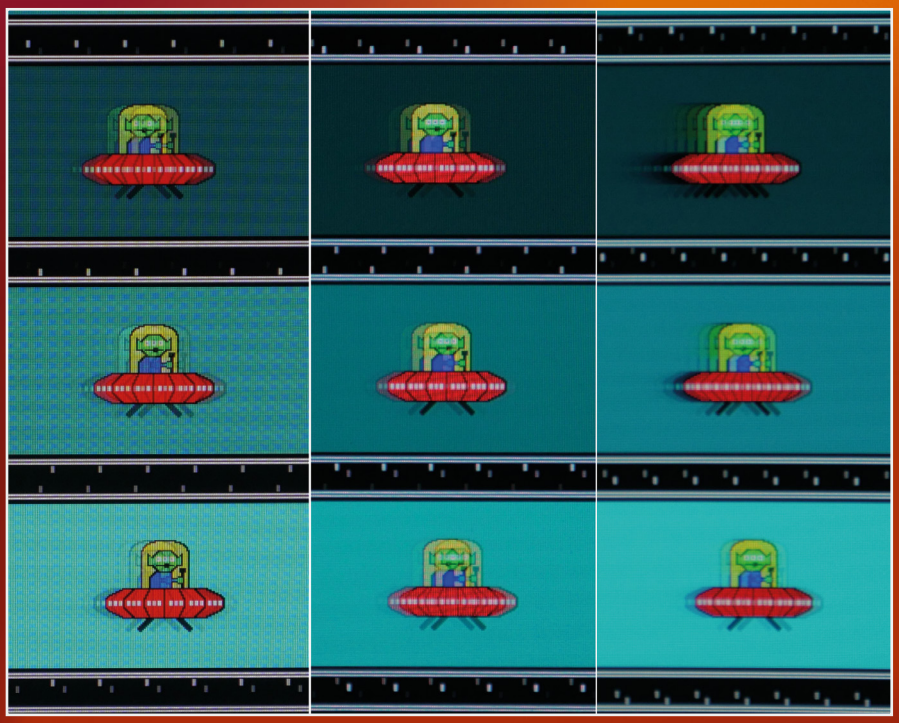
Instead, the best indication yet found of just how fast humans can react to visual stimulus was a study published in 2014 by Mary Potter, professor of brain and cognitive sciences at MIT, which showed that the human visual cortex is able to detect a change in an image when seen for as little as 13ms.

This figure is low enough that it starts to cross over with the lower end of frame times for monitors with fast refresh rates, and the upper end of response time figures for LCD monitors. So, if a display has a frame time or response time slower than this figure, then technically, our eyes can detect that slowness.

The other reason why the first latency test figure is misleading comes back to the issue of ghosting. While you can argue the merits of fast refresh rates, what your eyes see when there's fast motion on a display with a fast refresh rate and slow response time is still an image that's full of ghostly smearing and blurred detail. It's not your eyes creating the blur (which is a whole other topic of conversation) but the screen showing the blur.

Ultimately, the point at which visual ghosting or a delayed feel to the responsiveness of a screen becomes problematic will vary between users and different tasks. Subjectively, for fast-paced gaming in our tests, we've been able to detect

Without overdrive (left) we see the least clear image. With a little overdrive (middle) the image is sharper, but with too much overdrive (right) inverse ghosting ruins in the image



The faster response time of TN (left) makes for a slightly sharper image than IPS (middle), while VA is much blurrier (right)

the difference in responsive feel between 240Hz and 144Hz panels with response time averages of 4ms and 6ms respectively, and we've found any response time above that 13ms figure to be meaningfully detrimental to gaming performance.

However, for slower-paced gaming and movie watching, any response time below 13ms is fine, and often you can get away with a slower response time too. The most significant cut-off for most uses, even with non-gaming monitors, is the 16ms figure that translates to the frame time of a 60Hz display. If your monitor's response time is slower than 16ms, then you may see ghosting and perceive a slight sluggishness in the responsiveness of your cursor, even on 60Hz displays.

Shades of grey

Crucial to understanding the response time of LCDs is the fact that different colour transitions can happen at different rates. This is because the brightness of any given red, green or blue sub-pixel is determined by the amount of twist or movement of its liquid crystals, and that twist is determined by the voltage applied across the crystals. The greater the voltage, the greater the change in liquid crystal position.

Crucially, though, as that voltage increases, so does the rate of change of position of the liquid crystals. In other words, the greater the change in colour of a pixel, the faster the rate of change of colour of that pixel. As a result, it can be quicker for a pixel to change from black to white than from one middling shade of grey to another.

THERE ARE THREE MAIN LCD PANEL TYPES – IPS, TN AND VA – AND AVERAGE RESPONSE TIMES VARY CONSIDERABLY BETWEEN THEM

This is also why monitor manufacturers can report such low response time figures for their displays – these figures pertain to the fastest possible colour transition. However, the real-world experience of using a monitor is that you're seeing a whole range of colour transitions, so an average figure is more meaningful. Some manufacturers report a grey-to-grey response time figure, but even that depends on exactly how many samples the manufacturer has tested.

This difference in rate of change is also why monitors tend to have an overdrive setting. This setting increases the voltage applied to the liquid crystals in order to speed up their transition. However, the downside is that by increasing the initial voltage, the display runs the risk of over or undershooting the colour for which it's aiming, requiring the pixel to pull back and correct the colour. This visual effect of this over or undershoot is known as inverse ghosting or corona.

A little bit of overdrive can tighten up a display's response well, but too much can result in regular over or undershoot, creating a poor-quality image that looks like the result of a worse response time than at lower overdrive settings, due to the extra correction needed.

Response time and LCD types

There are three main LCD panel types – IPS, TN and VA – and average response times vary considerably between them. Famously, TN panels typically offer the fastest response time, with modern gaming displays averaging around 3–4ms. IPS panels can also dip as low as this but tend to average between 4–6ms. VA panels typically average 8–12ms, although some of Samsung's latest panels have been shown to achieve sub-3ms average response times. But we've yet to test these ourselves.

This typical average response time of VA panels is why we don't recommend them for gamers that play faster-paced games. VA panels have the advantage of higher native contrast ratios than either IPS or TN panels, which is why they're favoured for TVs, but for PC gaming screens, we tend to recommend IPS instead.

Meanwhile, TN is still the top choice for fast-paced games, particularly if you're thinking of stepping up to a 240Hz screen. However, the big disadvantage with this display type is their poor viewing angles. As well as making them a poor choice for sitting back and watching a video (the image can become unwatchable even viewed just a little way off-centre), this can make for an image that looks uneven across the span of the screen. So, again, this is why we've tended to view IPS panels as the best all-rounder choice of LCD panel type.

Testing for response time

Testing for response time is in theory quite simple. You just need to record a signal being sent to a display and use a high-

The OSRTT sensor straps to the front of a display and measures the light output as the screen's brightness changes

speed optical sensor to measure how the display's brightness changes (a change in brightness is effectively a colour transition). However, setting up such a test, calibrating it and collating the results is no mean feat. Thankfully, though, there is now an all-in-one response time testing tool available that we'll be incorporating into our testing.

The Open Source Response Time Tester (OSRTT) – created by tech YouTuber TechTeamGB – automatically measures a whole host of brightness transitions and collates the results into a comprehensive picture of a monitor's response time performance.

It measures 30 different brightness transitions, split across 15 transitions that increase the brightness and 15 that decrease the brightness.

The results of these tests are visualised in a number of ways, but the most relevant ones are three heatmaps showing the brightness values (measured in cd/m^2) along their axes, and the response time in milliseconds in the corresponding cells.

These three heatmaps show initial response time – a measure of how quickly a display initially hits its intended value, as well as the complete transition time – how long it takes to fully reach the intended value after over or undershooting and returning to the intended colour. The third heatmap shows the perceived response time – a weighted calculation of the apparent speed of the display when over and undershoot are accounted for). From these results, we can immediately get a good picture of how generally fast a display is both before and after overshoot has been accounted for.

The test also produces a heatmap for overshoot and undershoot, so it's again easy for us to see just how badly or not a display is affected by this effect. Other key figures include how many colour transitions are fast enough to complete within the frame time of the monitor's refresh rate, and input lag is measured too.

All these figures are collated into an overall OSRTT score. However, while this is useful as a single metric, it's ultimately an arbitrary value. What's more useful for us is being able to report the individual figures that have the most bearing on our conclusions about a monitor's capabilities.

Generally, these will include the average initial and perceived grey-to-grey response time for the best overdrive setting for the monitor. We will also report any particularly notable issues with different settings, such as if the highest overdrive setting results in significant overshoot.

A summary of the sort of key comparisons for any given monitor can be seen in the table below. The results represent the three main LCD panel types, and we've compared their initial response time, average perceived response time, peak/worst perceived response time and the level of overshoot. Each monitor was fixed to a 144Hz refresh rate to keep comparisons as fair as possible.

From these tests, it's plain to see the key advantage of TN panels, with the initial response time hitting as low as 2.2ms compared to 4.5ms for the IPS panel and 9.8ms for the VA panel, when using a maximum overdrive setting.

However, at this maximum overdrive setting, the TN panel also has atrocious overshoot, to the point that its perceived response time is worse than the other panels. However, this won't always be the case with very fast TN panels, and if we drop back to a middle/normal overdrive setting the TN panel provides a healthy response time lead over the other panels, while having only a tiny bit of overshoot.

In this particular sample of monitors we've tested, it's interesting just how little overshoot was measured on the VA panel, even at its highest overdrive setting. This means that, despite consistently poor response times with no or mid-level overdrive, you could in this instance crank the overdrive right up to get a markedly better response time without compromising image quality or perceived response time. This means it could well offer the ideal balance of fast enough response time and high contrast image quality for some users. It's just this sort of insight we'll now be able to pass on to you in future reviews. CPC

The key differences between LCD panel types and overdrive settings can be seen in our tests

	Panel type	Initial response time average (ms)			Perceived response time average (ms)			Worst perceived response time (ms)			Average overshoot from intended RGB value		
Overdrive		***Off***	***Normal***	***High***	***Off***	***Normal***	***High***	***Off***	***Normal***	***High***	***Off***	***Normal***	***High***
Acer Predator XB252Q	TN	10.1	4.7	2.2	10.1	5.1	12.3	20.8	14.7	26.7	0	1.4	32.8
Asus ROG Swift PG279QM	IPS	9.7	5.5	4.5	9.7	7	9.5	15.2	12.6	12.7	0	4	14.3
AOC AGON CQ27G3SU	VA	17	14.1	9.8	17.1	14.2	9.9	41.6	35.2	25.9	0	0	0.3

GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino, and Android to retro computing

REVIEW

Nvidia Jetson AGX Orin

This stylish cube packs Nvidia's most powerful system-on-module yet, under a surprisingly quiet fan

Nvidia's embedded Jetson family continues to grow, and its latest entry, the Jetson AGX Orin Developer's Kit, is one for the most well-heeled of machine learning enthusiasts. Designed as the successor to the Jetson AGX Xavier Developer's Kit (reviewed in Issue 190), the AGX Orin is a powerful system-on-module (SOM) wrapped in a reference carrier board design with an attractive, actively cooled chassis.

The SOM has capacity for four 10Gbps Ethernet ports, plus a Gigabit port, but only a single 10Gbps port is broken out

When Nvidia says the machine is powerful, it's not kidding. The AGX Orin is built around the company's Ampere GPU architecture and includes, in Developer's Kit form, 2,048 CUDA cores and 64 Tensor cores with a 1.3GHz GPU clock speed. On top are a pair of Nvidia Deep Learning Accelerator v2 (NVDLA v2) coprocessors, each running at up to 1.6GHz, a single Programmable Vision Accelerator v2 (PVA v2), and no fewer than 12 Arm Cortex-A78AE CPU cores running at up to 2.2GHz.

To round off the spec, the kit includes 32GB of LPDDR5 memory running at 3200MHz, 64GB of on-board eMMC 5.1 storage, with M.2 NVMe and microSD support for expansion, plus an M.2 Key E slot pre-populated with a dual-band Wi-Fi and Bluetooth 5 module. There's also a 40-pin general-purpose input/output (GPIO) header, an RJ45 network port with 10Gbps Ethernet support, and a DisplayPort 1.4a multi-function video output.

All these features are squeezed into a 110 x 110mm footprint once the SOM has been factory-installed in the shiny new chassis. The encased AGX Orin is slightly bigger than its predecessor, but not by much. The new case is a big improvement over its predecessor too, offering a quieter (yet more powerful) fan with better airflow, and a neat cover for the 16x-sized 8x PCI-E slot hidden to the side.

Nvidia makes some bold claims for the new AGX Orin, saying, depending on workload, it can be up to eight times

You'll need to budget for additional storage plus whatever sensors you'll need, such as a camera or microphone

faster than its predecessor. Benchmarking bears that out, although only for highly parallelisable tasks that can take advantage of the accelerators and make use of the new 'sparsity' feature.

A note on the latter – Nvidia claims an impressive 275 trillion operations per second (TOPS) of INT8 compute for the AGX Orin, up from 32 TOPS on the AGX Xavier. This, however, relies on building a sparse network; a traditional dense INT8 network, of the type you'd run on the AGX Xavier, is limited to 138 TOPS – still comfortably faster than the AGX Xavier, but a chunk lower than would initially appear.

Despite these impressive performance gains, though, Nvidia still stubbornly refuses to position its high-end developer's kits as all-in-one systems. While you can run artificial intelligence and deep learning workloads on the AGX Orin, you're not supposed to use all that power for training. Instead, you train on a traditional workstation with a dedicated Nvidia GPU (or six) – or on cloud systems, potentially via the company's admittedly impressive TAO model customisation toolkit.

In testing, almost every aspect of the AGX Orin proved to be an upgrade from the AGX

The plastic cover hides a PCI-E slot, but you'll want to pick up a bigger power supply before using it

There's room for an NVMe SSD, and there's also a populated M.2 slot for a wireless card and a high-density connector for cameras

Xavier. GPU, DLA and CPU performance are all measurably higher, with the latter benefiting from an additional four cores as well as architectural improvements. The cost, of course, is power draw. Where the AGX Xavier was configurable from 10W to 30W, the AGX Orin starts at 15W and draws 60W in its top-end 'MAXN' mode.

At least, that's the claim. Measured at the wall, the draw is considerably higher, peaking at 98W during intensive benchmarking, and idling around an oddly high 20W even when configured in its 15W operating mode. However, Nvidia promises these figures will drop with the impending release of a software update.

All this power, provided by a USB Type-C Power Delivery (PD) adaptor, comes out as heat. When the AGX Orin is idle, the fan spins inaudibly; under heavy load, the fan ramps up with an audible whooshing sound which manages to remain just below the point of annoyance – it measured around 50dBA in an office environment with the Jetson positioned at arm's length.

On the software side, the Jetson AGX Orin serves as the flagship for Nvidia's JetPack software development kit – now built atop Canonical's Ubuntu 20.04, which remains in mainstream support until April next year. The software is preloaded on the eMMC, but 64GB soon fills up – making an M.2 NVMe drive a must-have add-on.

Not every aspect of the AGX Orin is an upgrade either. The hardware video encode and decode capabilities have been cut in half compared with the AGX Xavier, although now with AV1 support, and a maximum of

NEWS IN BRIEF

Google taps Arduino for Little Signals project

Google has unveiled the latest in what it calls its 'Digital Wellbeing Experiments,' in the form of Little Signals – physical devices that provide notifications using 'calm technology', powered by Arduino microcontrollers.

'Each object has its own method of communicating, like through puffs of air or ambient sounds,' Google's team explains. 'Additionally, their small movements or simple controls bring the objects to life and make them responsive to changing surroundings and needs.' You can find more information at **experiments.withgoogle.com/little-signals**, and while there's no plan to commercialise the creations, source code and 3D print files have been made available.

The Jetson AGX Orin's case is smaller even than its own power supply, in length at least

16 cameras are supported compared to the AGX Xavier's 36.

Largely, though, it's a major improvement, albeit one that will set buyers back $1,999 US (around £1,530 ex VAT) from **developer.nvidia.com**. For hobbyists, then, the considerably less powerful Jetson Nano (reviewed in Issue 191, and Issue 209 for the 2GB variant) remains the go-to impulse purchase.

REVIEW

TheA500 Mini

You won't find Commodore's name or logo, but TheA500 Mini is a convincing miniature replica nonetheless

TheA500 Mini is not, as you might expect, a typo, but the follow-up to Retro Games Limited's equally oddly styled TheC64 Mini (reviewed in Issue 180) – a miniature Commodore Amiga 500. Designed as a mostly fully functional scale replica, TheA500 Mini sits comfortably on the very back corner of a real Amiga 500. The keyboard is present, but only for show, and there's a moulded fake floppy drive to the side, but no effort has been made to create a fake expansion trapdoor or expansion port.

The classic Commodore 'chicken-head' logo is also missing, replaced by a boing-ball. You'll find no mention of Commodore anywhere on the box either, nor in the quick-start guide – and only once in the downloadable full manual.

Despite lack of approval from the current Commodore trademark holders, TheA500 Mini is a fully licensed replica. The Kickstart ROMs are provided by Cloanto and 25 licensed games come pre-loaded, with a 26th available for download, taking advantage of the machine's ability to load games from a USB drive.

The total of 25 games is a little low, given TheC64 Mini came with 64, but there are plenty of big-hitters in the mix, including Alien Breed, Another World, Simon the Sorcerer, Pinball Dreams, The Chaos Engine, Worms and Zool. Sadly absent are any games by Sensible Software, including the classics Sensible Soccer and Cannon Fodder. Lemmings is also notably missing.

Cracking open the casing reveals a tiny single-board computer, taking up a fraction of the device's overall footprint, and with a few lumps of metal to provide heft. Under a passive heatsink is an Allwinner H6 system-on-chip, with four Arm Cortex-A56 cores running at up to 1.8GHz, while elsewhere on the board are chips for a total of 512MB of RAM and 256MB of NAND flash.

As well as the games, the flash holds the operating system – an embedded Linux install with a carousel for game selection, using the Amiberry fork of the WinUAE emulator to run the games themselves. Video output is via HDMI and capped at 720p, and while 60Hz is supported, the manufacturer recommends 50Hz due to the use of PAL-region games. Three video filter options are supported – a blurry smoothed option, a CRT-style scanline filter and no filter, with native resolution, mid-zoom and full-zoom options.

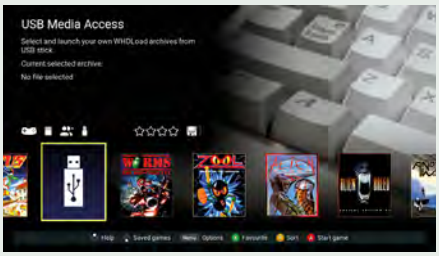
The bundle includes the console itself, a CD32-style gamepad, a tank mouse, HDMI and USB cables, but no power supply

NEWS IN BRIEF

Vega Processor project unveils first dev boards

The Vega Processor project, from India's Centre for Development of Advanced Computing (C-DAC), has shown off its first publicly available development boards, both playing host to its wholly indigenous RISC-V-based Vega chip.

The Aries is designed to roughly mimic the Arduino Uno form factor, although with doubled-up general-purpose input/output (GPIO) pins, while the Aries Micro uses a more compact breadboard-friendly design. Both are powered by the Vega THEAJS32 chip, built in India and based on the RISC-V ISA, with a 100MHz clock speed, 256KB of SRAM and 2MB of flash memory. Visit **vegaprocessors.in** for more details.



The user interface is functional, but a replica Workbench would have been more fun

Sitting TheA500 Mini atop a real Amiga 500 demonstrates the difference in scale

A special mention also goes to the bundled accessories. There's no joystick this time, but you do get a gamepad inspired by the Amiga CD32 and an optical two-button mouse mimicking the Amiga's original 'tank' design. Both connect via USB, leaving one port free for a USB storage device.

Performance is fine for most games, although the demanding Alien Breed 3D struggles a little. A look at the published source code for RGL's version of Amiberry reveals why: a cap on the emulated CPU speed of 28MHz, up from a 25MHz planned limit, to prevent the device from overheating. A look at the SBC itself shows there was another option mooted too – an unpopulated header for a cooling fan, which isn't fitted in the final revision.

There are comments suggesting other issues too, including a comment in the source code warning 68040 emulation 'runs like a dog' and a partial workaround for audio buffer underruns.

The default smoothing setting (left) is blurry, but can be switched for no filter (middle) or CRT-style scanlines (right)

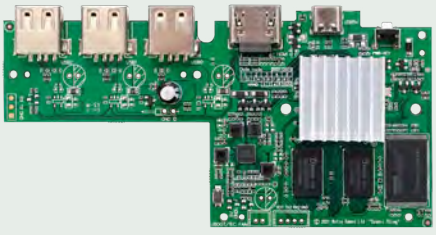
Despite its name, TheA500 Mini appears to default to emulating an Amiga 600 – switching to an Amiga 1200 if required. Software designed for Original Chipset (OCS), Enhanced Chipset (ECS) and Advanced Graphics Architecture (AGA) are all compatible, although some may need the emulator settings to be tweaked.

Elsewhere, there are missed opportunities. Where TheC64 Mini could boot into Commodore BASIC, which was admittedly unusable unless you connected a USB keyboard, there's no AmigaDOS or Workbench on TheA500 Mini.

The ability to load your own games from USB storage is welcome, but limited to WHDLoad archives with no support for (far more common) Amiga Disk Format (ADF) images. Also, while RGL warns you should only load games for which you own a legal copy, there's no easy way to turn a physical floppy disk into a WHDLoad LHA that doesn't involve already owning a genuine Amiga.

That's not to say TheA500 Mini isn't a valiant effort. The controllers are solid, unlike the terrible joystick provided with TheC64 Mini, and you can use them on any other computer too. The design is Amiga-like enough to conjure nostalgia, and performance in pre-loaded games is mostly solid.

Yes, you could make your own equivalent with a Raspberry Pi 4 or Raspberry Pi 400 and a copy of Amiberry, and the performance would be better, but once you factor the licensed games into the £115 (inc VAT) asking price – £4.60 per game, dropping to £4.42 if you download the free copy of Citadel and load it onto a USB drive – it seems a lot more reasonable. TheA500 Mini is available now from resellers, and you can visit **retrogames.biz** for more details.



As with TheC64 Mini, TheA500 Mini's single-board computer is absolutely tiny

REVIEW

Amazon Smart Air Quality Monitor

Fitting comfortably in the palm of your hand, Amazon's first own-brand air quality sensor is neat

Home automation is hardly a new concept, but it's only relatively recently become as simple as plug-and-play. Devices such as the Airxed IRX Smart Home Hub (reviewed in Issue 219) need little more than a USB power cable and a few minutes' setup from a smartphone app, and it's this level of simplicity Amazon hopes to replicate with its Smart Air Quality Monitor.

A surprisingly compact rounded box, easily fitting in the palm of your hand, Amazon's latest smart-home gadget is designed as an accessory to an existing Alexa setup. There's no on-board display or speaker, and no dedicated app – if you want more than the green-amber-red traffic light notification provided by its on-board LED, you'll need Alexa's help.

The gadget integrates into the Alexa app and provides instant reporting and historical graphs for all five sensors

Installation is simple, connecting to power via the included micro-USB adaptor. If you're lucky, and bought the device brand-new direct from Amazon, the monitor arrives already configured and appears in the Alexa app automatically. If not, you'll need to scan the QR Code on its underside, with a higher-contrast version printed on a bundled card.

When powered up from cold, the monitor goes through a calibration phase that takes around seven minutes. If you pull the power at any time, it will do the same calibration again, but a longer 48-hour calibration period is only required the very first time, during which time readings are available but may not be entirely accurate.

Accuracy is a problem. Amazon's margins of error on each of the five sensors – particulate matter (PM2.5), volatile organic compounds, carbon monoxide, humidity and temperature – are wide, and our first unit's humidity reading was a full and steady ten percentage points off the mark. Two subsequent units showed more accurate results, but you may find yourself returning a unit or two for replacement if you're buying enough for whole-house monitoring.

The chosen sensors are a little odd too. PM2.5 and VOCs make sense, while humidity and temperature are environmental monitoring standards, but carbon monoxide is a strange choice. High levels of CO would indicate an air quality problem, true, but the documentation is clear that the monitor isn't to be used in place of a traditional carbon monoxide alarm. Carbon dioxide, which is a great indicator of poor ventilation, would have been better.

An internal pulls air through the front grille towards the sensors, but it's entirely silent during sampling. Meanwhile, dedicated device pages in the Alexa smartphone app graph an overall air quality score, in points out of 100, over 15-minute, one-hour and day intervals, while similar graphs for each individual sensor are also available. However, the VOC sensor only reports relative changes rather than an absolute parts-per-million reading.

At launch, you could only trigger a routine based on changes in temperature, but a post-launch update has unlocked this restriction, and now it's possible to set Alexa to run a routine based on changes on any of the five sensors plus overall air quality. You could have an air purifier run automatically, for instance, or have an Echo tell you to open a window.

At £69.99 inc VAT, the Smart Air Quality Monitor is a pricey bit of kit, and lacks features such as a battery for portable use or an on-board screen, which similarly priced alternatives include. It's undeniably sleek, though, and a subtle addition to an already Alexa-kitted home. The Smart Air Quality Monitor is available from **amazon.co.uk** now. CPC

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at **freelance.halfacree.co.uk** @ghalfacree

WIN

A 260Hz AOC GAMING MONITOR

WORTH **£400!**

Here's a treat for players of competitive first-person shooters – we have one of AOC's super-fast 260Hz AGON AG274FZ 27in gaming monitors up for grabs. The 260Hz refresh rate completely unleashes the power of top-end GPUs, bringing unprecedented fluidity to the picture on your screen.

Not only that, but its active sync support means its refresh rate can sync with the frame rate output of both Nvidia and AMD GPUs, eliminating stuttering and tearing artefacts. With every detail brought sharply into focus, and every movement shown with crystal clarity, you can feel your reactions become one with the action and elevate your game.

Meanwhile, the pixel response time of 1ms (grey-to-grey) results in fast performance without smearing. Fast-moving action and dramatic transitions are rendered smoothly without ghosting effects. What's more, the IPS panel ensures an excellent viewing experience with lifelike yet brilliant and accurate colours. Colours look consistent no matter from which angle you look at the display.

SPEC

- 260Hz refresh rate
- 27in IPS panel
- G-Sync compatible
- FreeSync Premium Pro
- 1,920 x 1,080 resolution
- 1ms response time (GTG)
- Height-adjustable stand
- 2 x 5W speakers

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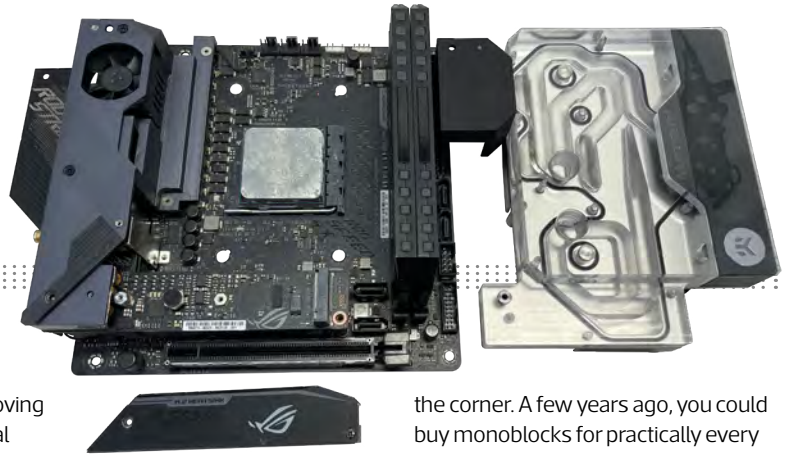
Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

EK's ROG Strix X570-I Gaming monoblock



EK's Quantum Momentum² ROG Strix X570-I Gaming monoblock is finally here

It's been a long time coming, but EK's monoblock for Asus' ROG Strix X570-I Gaming mini-ITX motherboard is finally here. If you're not familiar with monoblocks, imagine a large waterblock that not only cools your CPU, but other hotspots on the motherboard too.

This is especially useful in stuffy mini-ITX systems, as it means VRMs, and in some cases, chipsets and M.2 SSDs, are effectively water-cooled, taking some pressure off the often limited airflow in these cases.

I say it's been a long time because this motherboard is nearly two years old, being released shortly after Asus' other X570 motherboards. However, it's taken a while for a couple of reasons. Firstly, it's a highly complex waterblock. EK has decided to not just water-cool the VRMs, but the chipset too. On this board, this has the added advantage of removing the need for its dual cooling fans.

Having used the Asus ROG Strix X570-I Gaming in my own personal system for the past year or two, I can vouch for the fact these fans can be noisy when your system is under medium to high loads, and there's no way to tune them both down in Asus' software or EFI either. Another reason is that, according to EK, its monoblock releases have been few and far between recently too.

This is due to AMD and Intel releasing new chipsets in quick succession a few years ago, meaning that by the time EK had been through the process of designing and producing monoblocks, a new chipset and range of CPUs were just around the corner. A few years ago, you could buy monoblocks for practically every mini-ITX motherboard, but there has been precious few for the past couple of chipset generations.

The Asus ROG Strix X570-I Gaming has proven itself to be a decent mini-ITX board for AMD's Ryzen CPUs, though, and with the launch of the Ryzen 7 5800X3D, as well as the board proving to be popular with enthusiasts, EK felt it was worth a shot. Clearly, I'd have loved to have seen a block 18 months ago, but at least it's here, even if Socket AM4 now has a limited shelf life.

Thankfully, you lose no motherboard features if you install the monoblock, but on the flip side, you need to completely dismantle the top side of the motherboard, right down

to the PCB, in order to fit the block. It's a complex process, even compared with installing previous monoblocks I've used. If you already own the motherboard then, like me, you'll need to strip down your PC and remove the board, as you'll find it extremely difficult fitting the block if the board is still mounted in your case.

It looks fantastic, though, and I love the fact that EK has employed its Exact Mount backplate, which makes the rest of the installation process a breeze, and access to the top-side M.2 port is exactly the same with or without the block. The only part of the design I'd change is the location of the inlet and outlet. The ports are a long way from where they would be located on a standard CPU waterblock, so if you've already been water-cooling this board, you'll need to create new lengths of tubing.

It's a small price to pay to ditch the chipset fans, though, so if you have the board and fancy water-cooling it or upgrading your current waterblock, I can highly recommend it.

The Asus ROG Strix X570-I Gaming has two on-board fans that can be quite noisy

Be wary of clip-together fans

Last month I got some hands-on time with Lian Li's SL120 fans for the first time and also tested similar models from SaharaGaming. The two companies' fans feature a similar design, in that they lack any sort of cables out of the box, instead using a clip-together design and a detachable cable on one end that controls fan speed and lighting. The idea works extremely well in practice, cutting down on cables significantly and making fan installation much easier too.

As they clip together, there's generally only a need, for example, to secure three fans with four screws – one in each corner – instead of using 12 screws. The Lian Li SL120 fans look fantastic too, with vibrant RGB lighting and great build quality. You may well have seen them on Facebook or Instagram too, as they're very photogenic, especially when paired with the likes of Lian Li's O11D case.

However, there is an issue with these fans that should make anyone think twice about using them. It has nothing to do with the lighting, cable-free design or noise levels, but with the fan blades themselves. The actual fan blade wheel's diameter is much smaller than on a typical 120mm fan – it's not as small as on a 92mm fan, but it's small enough to restrict airflow.

Lian Li's SL120 clip-together fans look great, but they have smaller fan blades than standard 120mm fans

As most of us know, the smaller the fan, the faster it needs to spin in order to shift the same amount of air as a larger one, assuming all other factors are equal.

The smaller fan blades also mean that, when the fans are strapped to a radiator, they struggle to dish out airflow over a large enough area, with the edges relying purely on static pressure and not direct airflow to shift air through the radiator's fins. This is probably one reason why Lian Li's Galahad SL 240mm AIO liquid cooler didn't perform very well compared with the competition in last issue's Labs test.

The comparatively small fan blade area hurts airflow performance when the fans are mounted on a radiator

This is a shame, as they do look good, and an inspection of the fan frame does show what seems to be an excess of plastic framing around the fan, which could easily be made smaller, creating a large enough area accommodate bigger fan blades.

The smaller blades on these fans don't seem to impact performance as much when they work as case fans, rather than radiator fans though – the SaharaGaming P44 case we reviewed in Issue 226 used similar fans and performed quite well in terms of cooling and airflow.

However, I'd avoid these fans for use on radiators and heatsinks, as they're a good example of form over function – they look great, but the small fan blades result in comparatively low airflow. CPC

Antony Leather is Custom PC's modding editor @antonyleather

How to Water-cool new Radeon GPUs

Antony Leather shows you how to fit a waterblock to AMD's latest Radeon RX 6000-series graphics cards

TOTAL PROJECT TIME / 3 HOURS

The process of water-cooling Radeon RX 6000-series GPUs is largely the same across AMD's reference cards, which are identifiable by their triple-fan coolers, black and silver design and 'R' fan logos, and many board-partner cards are based on these designs too. What's more, while some board-partner cards use different PCBs from the reference design, there are usually a lot of similarities among air-cooler cards.

As such, you can use this guide as a reference for water-cooling most RX 6000-series cards from the RX 6600 XT upwards, since this is the lowest card in the range that has waterblocks available. Most cards have a heatsink and backplate, but they generally don't require the complicated deconstruction of Nvidia's RTX 3000-series Founders Edition cards (see over), instead using a standard PCB, cooler and backplate design that's simple to disassemble.

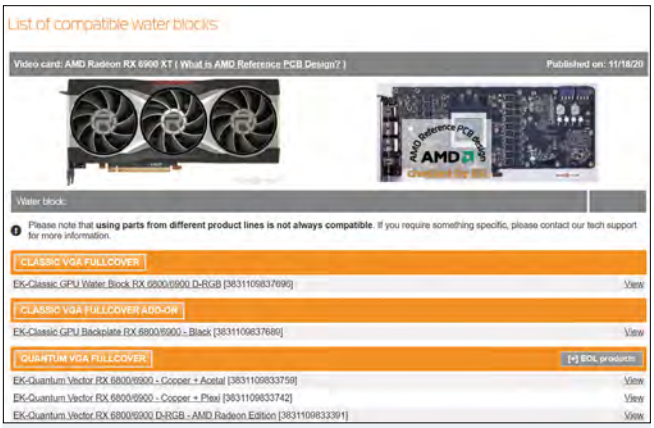
We're using the AMD flagship RX 6900 XT, but the EK Special Edition Quantum Vector RX 6800/6900 block, as its name suggests, is compatible with reference models of the RX 6800 and 6800 XT too.

TOOLS YOU'LL NEED

EK Special Edition Quantum Vector RX 6800/6900 waterblock
overclockers.co.uk

Micro screwdriver
amazon.co.uk

TIM cleaner or isopropyl alcohol
amazon.co.uk

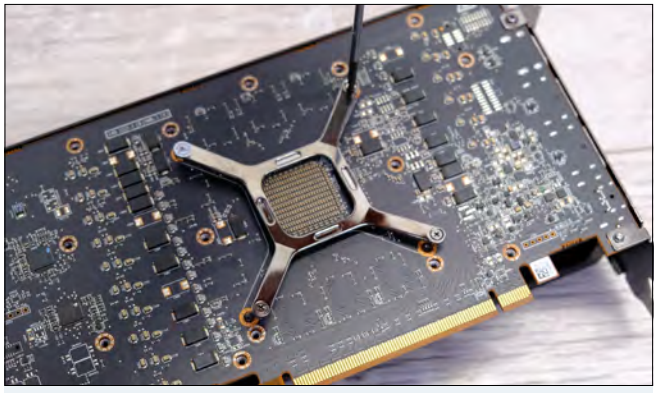


1 / PICK THE RIGHT WATERBLOCK

EK offers waterblocks for the Radeon RX 6700 XT and higher, but we found RX 6600 XT waterblocks from the likes of Byski available online too. EK's online compatibility tool (**ekwb.com/configurator**) allows you to enter your specific card model to see if it has a compatible waterblock, so this is a good place to start.

2 / REMOVE BACKPLATE SCREWS

You need to deal with a few screws on your card's backplate, which have to be removed first, but they're all standard-sized crosshead screws and you can remove them with a standard crosshead micro screwdriver.

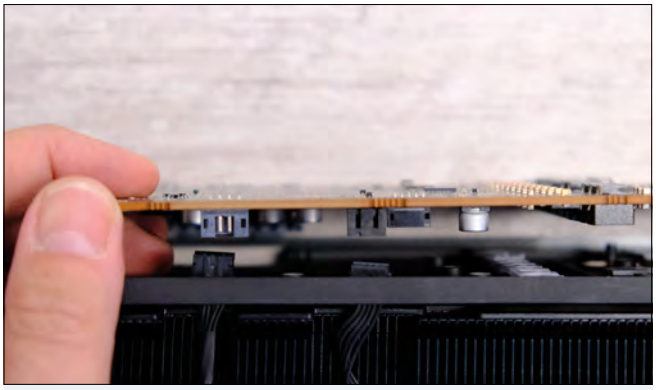


3 / REMOVE PCB SCREWS

With the backplate removed, you can now attack the rest of the screws on the PCB, including the ones around the GPU core securing a square plate. Make sure you take a note of which parts goes where (take some photos if need be) and keep all the screws in a sealable container.

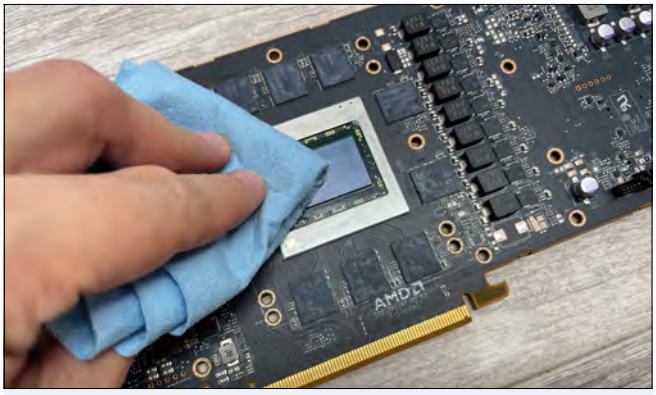
4 / REMOVE SLOT BRACKET

The waterblock comes with a replacement expansion slot bracket, seeing as you won't be needing the card's existing chunky exhaust system. The stock bracket is held in place with a few crosshead screws, which you now need to remove.



5 / LIFT THE HEATSINK

The heatsink should now lift off with a little force, but be wary of any cables connecting it to the PCB and make sure you detach them first. On the reference models, there are two cables that power the fans and lighting.

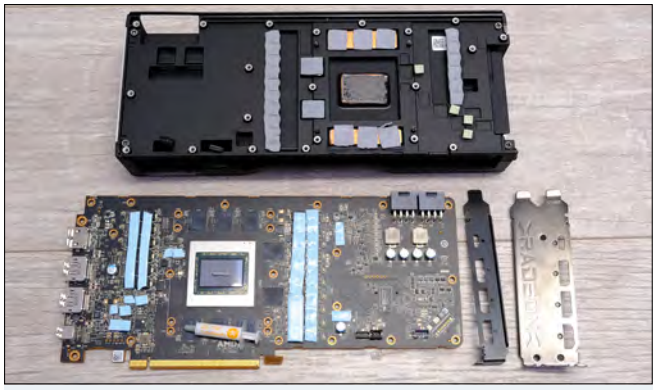


6 / CLEAN GPU AND MEMORY

Remove any thermal pads stuck to the PCB and place them back onto the heatsink. You can then use thermal paste cleaner or isopropyl alcohol, and a lint-free cloth, to clean the GPU and memory modules, so they're prepared for new paste and pads.

7 / FIT NEW BRACKET

A single-slot bracket is included with the waterblock, so install this bit first. Make sure you fit it the right way around and place the original bracket in your graphics card's box, along with the original cooler and screws.



8 / APPLY NEW THERMAL PASTE AND PADS

Follow the waterblock's manual to install new thermal pads, which you'll need to cut to size, and apply thermal paste on the GPU. The GPU core is fairly small, so apply a blob of paste slightly larger than a grain of rice in the centre of the core.

9 / INSTALL WATERBLOCK

Install the waterblock and backplate according to the instructions. You now need to work out how to add it to your loop. It's best to run the card in series with other components, so you'll need to have coolant going in one port and out the other, but an inlet and outlet are accessible from either side of the waterblock.

How to Water-cool an RTX 3080 Ti FE

Antony Leather shows you how to disassemble a GeForce RTX 3080 Ti Founders Edition card, so you can fit a waterblock to it

TOTAL PROJECT TIME / 3 HOURS

Last month we discovered that Nvidia's GeForce RTX 3080 Ti Founders Edition (FE) was readily available at its MSRP of £1,049 for several weeks, making it a great 4K gaming card to pick up. As such, this month decided to look at the process of water-cooling it with EK's fantastic Quantum Vector FE waterblock.

This is a fiddly job, and the RTX 3080 Ti FE has quite a specific dismantling process, a lot of which also applies to the RTX 3080 and RTX 3090 Founders Edition models, but not to most board-partner cards. It's well worth doing if you can put in the time though.

TOOLS YOU'LL NEED

EK Quantum Vector FE waterblock
overclockers.co.uk

Precision micro screwdriver bit set
amazon.co.uk

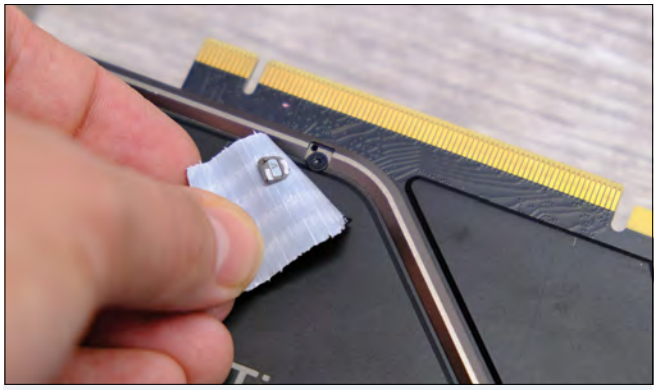
Plastic pry tool
amazon.co.uk

Duct tape
amazon.co.uk

TIM cleaner or isopropyl alcohol
amazon.co.uk

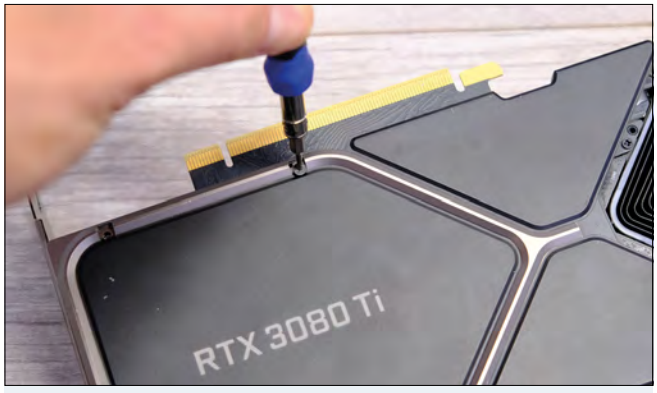
1 / PICK THE RIGHT WATERBLOCK

For the RTX 3080 and RTX 3080 Ti Founders Edition cards, the same EK Quantum Vector FE RTX 3080 D-RGB waterblock fits both cards as their PCBs are a close enough match, and it does include a backplate to help cool the memory.



2 / REMOVE SCREW COVERS

The trickiest part of the installation is removing the magnetic caps that sit on the outer screws. We found that pressing duct tape firmly on them can lift them out of their sockets without scratching the cooler, although you might need several tries.



3 / REMOVE BACKPLATE SCREWS

Nvidia uses various screw types and sizes, so a precision micro screwdriver bit set is essential. Make sure you place all the screws and caps into a container for safekeeping, so you can reinstate the original cooler if you plan to sell the card in future.

4 / LIFT GREY BAR SECTION

Next, lift the magnetic grey V-shape bar in front of the fan at the opposite end to the slot bracket. Again, this part is easy to scratch, but the gaps are bigger here than with the caps, so you can use a plastic pry tool to lift out the section.

5 / REMOVE REMAINING SCREWS

The remaining screws have standard crossheads. Go ahead and remove the rest of the screws around the backplate and put them in a container for safekeeping.

6 / REMOVE BACKPLATE

It will now be possible to remove the backplate. It has thermal pads linking it to the PCB, so make sure that you remove any pads that end up stuck to the components, and place them back on the backplate.

7 / REMOVE GPU SCREWS

There are four screws around the GPU core that fit into a square metal bracket. You'll need to switch back to the star head fitting to remove them.

8 / DETACH RIBBON CABLES

You need to detach three cables from the RTX 3080 Ti FE's PCB. The first you need to detach are two ribbon cables. Lift up the grey latches in the sockets, and you'll be able to remove the cables. Do this carefully, as the cables and sockets are very delicate.

9 / DETACH CONNECTOR

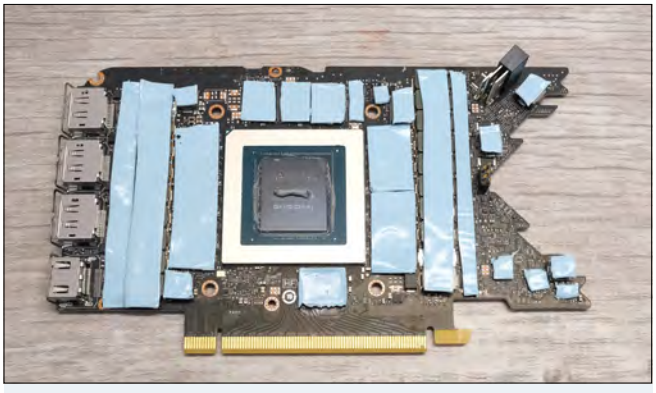
Next there's a two-pin connector. You need to move the metal section forwards away from the cables and gently pull the connector backwards out of the socket. Use a plastic pry tool to do this job, and be very gentle, as it's easy to damage the cables or socket.

10 / REMOVE BRACKET SCREWS

The waterblock comes with a replacement expansion slot bracket, as there's no need for a large exhaust vent if you're water-cooling the card. Detach the bracket by removing the screws. Once you've done this, you'll be able to completely remove the PCB.

11 / CLEAN GPU AND REMOVE PADS

Use thermal paste cleaner or isopropyl alcohol, together with a microfibre cloth, to clean the GPU core and memory. Both will benefit from thermal paste and pad residues being removed in order to ensure the waterblock can perform optimally.



12 / APPLY NEW THERMAL PADS

New thermal paste and thermal pads are included in the waterblock kit. Follow the instructions to apply the correct pads to the VRMs and memory chips, then apply thermal paste to the GPU core in a thin line across the centre.

13 / FIT WATERBLOCK

Place the main waterblock onto the card and have it facing down with the PCB facing up. Follow the supplied instructions to secure it with screws; in this case, it involves just the four screws surrounding the GPU core.

14 / INSTALL BACKPLATE

Now apply thermal pads on the rear of the PCB according to the instructions, then go ahead and install the backplate, followed by the V-shaped end section.

15 / USE THE RIGHT END SECTION

Finally, you need to decide on the end section that best suits your loop. Two are included, with one providing an inlet and outlet coming out the end of the card, while the other one positions the ports at right angles to the PCB. CPC

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the

COMPUTERS THAT MADE BRITAIN

"The Computers that Made Britain is one of the best things I've read this year. It's an incredible story of eccentrics and oddballs, geniuses and madmen, and one that will have you pining for a future that could have been. It's utterly astonishing!"

- **Stuart Turton**, bestselling author and journalist

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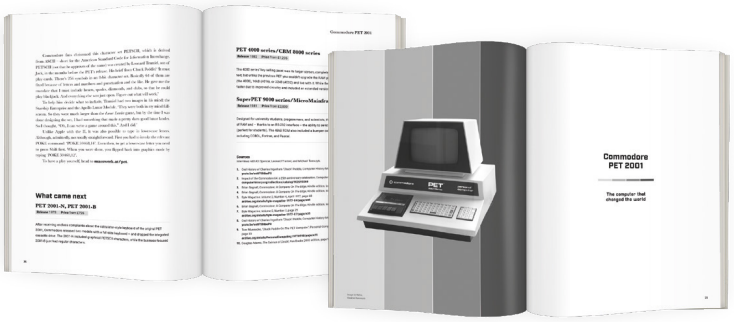

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Retro tech

BIG BOX GAMES

Before we downloaded PC games, they came in boxes. Big ones. **Rick Lane** unboxes the history of PC gaming's iconic packaging

If you walked into a shop that sells video games today, you'd be forgiven for thinking that PC gaming didn't exist. In 2021, less than one per cent of global PC gaming revenue stemmed from sales of physical copies. Nearly all PC games were sold on digital distribution services or funded themselves through free-to-play models. Nowadays, the closest you can get to a physical PC game purchase is to buy a gift card for Steam or the Epic Store.

Go back 25 years, however, and the situation couldn't be more different. Not only would you find PC games in shops, but they would also dominate the shelves, because of the gigantic cardboard boxes in which they were packaged.

These so-called 'big boxes' were the face of the hobby throughout the 1980s, 1990s and early 2000s – the first thing you saw when you bought the latest Quake or Command & Conquer game. And although they had vanished from shelves completely by 2005, big boxes remain an iconic aspect of PC gaming.

'I've spent way too many hours in stores buying big box games,' says Benjamin Wimmer, a PC game enthusiast who has been collecting big boxes since the 1980s. With 691 classic PC games in his collection, Wimmer intimately understands the unique appeal of big boxes. 'Most of the time, the money was well spent even if the game wasn't that good, because you'd get a printed manual with additional lore, and trinkets such as maps or coins,' he says. 'Those boxes were like a physical link to whatever fantastic world you'd decided to visit for the next hour or two.'

PC game big boxes are unique artefacts. Yet despite covering walls of shelves in countless shops for over a decade, much about their history is uncertain. The origins of the big box are unclear, and because the games themselves were always the centre of attention, there's little information about the process behind the design of big boxes. That's why we're going to lift the lid on the history of the big box, and browse the manual to find out how they were designed and how they vanished entirely within only a couple of years.

UNPACKING THE PAST

Before we can dive into the origin of the big box, it's important to understand what we mean by the term. The typical dimensions of a big box were 7in wide, 9in tall and 2in deep.

Wimmer has 691 classic PC games in his collection

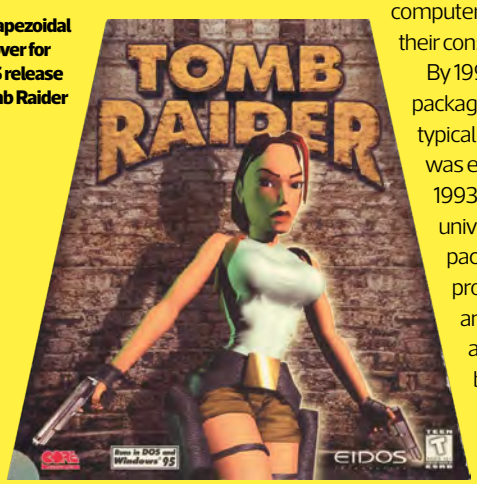
Wimmer with his collection of big boxes

The word 'typical' in the previous sentence hints at why tracing the origins of the big box is difficult. Unlike games for consoles such as the Mega Drive or the PlayStation, where the packaging was regulated by the manufacturer, there was no official standardisation of packaging for PC games.

Instead, PC game publishers gradually converged on what we would recognise as a big box between 1987 and 1991. Before this time, games were packaged in any number of ways. Early games for home computers, such as Zork or Sierra's The Dark Crystal, were sold in cardboard sleeves like vinyl records, and some were even sold in plastic bags.

When games began appearing on shelves in boxes, those boxes could vary wildly in size, often dictated by the form factor of the game itself. Atari's boxes, for example, were based around the size of its VCS cartridges, while early PC games required a box that could house one or more 5.25in floppy disks.

In addition, as games became more elaborate, they required even more disks, as well as extensive documentation, resulting in large boxes to hold the manuals (which often also doubled as copy protection systems). Marketing likely played a role too, with big boxes making computer games stand out over their console-based counterparts.



The trapezoidal box cover for the US release of Tomb Raider

By 1991, most publishers were packaging their PC games in typical big boxes, and the design was entirely dominant by 1993. That's not to say it was universal, however. PC game packaging never became properly standardised, and variations on it would appear throughout the big box's heyday.

One notable example is the 'trapezoidal' big box of Eidos Interactive, which appeared exclusively in America from around 1995. Unlike rectangular big boxes, the trapezoidal boxes had diagonal edges that tapered in toward the top of the box. Games sold in trapezoidal boxes include Tomb Raider, Thief: The Dark Project and Legacy of Kain: Soul Reaver.

Even boxes that were the same size and shape could have significant variation. Some boxes would have two parts – a lid and a base, while others would be a solid box with flaps at either end. Some boxes had a cover flap that opened to reveal more key art or further information about the game.

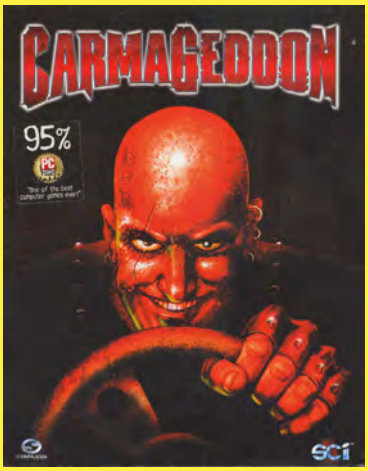
And none of this is to mention what came inside the box, whether the game would be on floppy disks or CD, what the manual would be like, whether the game came with a physical map or other extras. In short, every box was different, which in turn means that every box was differently designed.

BOXING CLEVER

Victoria Hart is a professional graphic designer, artist and gallery director. Today she runs Pink Kitty Creative, her own graphic design firm, but around the turn of the millennium, she worked at Westwood Studios, the developer of Command & Conquer, and its many spin-offs and sequels. Specifically, Hart designed the box and packaging for Tiberian Sun, Red Alert 2, Blade Runner and Dune 2000.

Designing the packaging for a game was essentially its own project, with its own pipeline for conception, production and manufacturing. 'We talk to the designers to understand the strategy of the game, the style and tone in the mood, and who's going to be playing it,' Hart says. 'Once we have that foundation, we're able to develop concepts and present to the marketing director. Usually, the concepts will go through numerous rounds of revisions before we finalise a look.'

The most important part of any big box was its cover art. This was what any potential player would see when they walked into a shop, so it had to immediately grab their attention, while providing some indication of what the game inside was like. For Tiberian Sun, Hart had a strong baseline from which to start.



The incredible UK box cover of Carmageddon (left) and the less incredible US cover (right)

'The original Command & Conquer box was such a success, we wanted to continue to make the Command & Conquer line follow that single visual head image to get as much impact as possible.' Hart says. 'Because the eyes were covered with goggles, it also gave the viewer the impression that it could be them as the main player.'

Most box art around this time would have been drawn by an artist either employed by or associated with the studio, or in the case of games such as Quake, relied on a simple, yet bold logo. The process of creating Tiberian Sun's box art, however, was much more physical.

'For the Tiberian Sun box, we designed and manufactured the helmet, got a model and photographed the headshots, then effects and graphics were applied over the top of the photography,' Hart explains. It wasn't just the front of the box that was important either. 'The back of the box was all about continuing to tell the story and showcasing the key selling features of the game in a visually exciting way,' she adds.

By 1991, most publishers were packaging their PC games in typical big boxes

While the visual elements of the box took precedence, the texture of the box was also crucial to making it appealing as a product. 'While designing, I would always keep in mind the end effect with printing and all the different specialty techniques that can be added, such as custom varnishes, chiselled bevels, debossing and special foiling techniques that really help to take the box to the next level and add to the overall design,' Hart says.

Hart's responsibilities didn't end with the box itself. She also designed the manual, the disk label, the case cover and any other items included in the box, such as pins or collector figurines. She cites one particularly memorable example. 'We did a Hummer giveaway contest that was pretty epic, where we created 3D box mock-ups of the Hummer and missiles for the point of purchase displays in Walmart.'

Westwood may have designed its boxes in-house, but this wasn't necessarily the case for other developers. One example is Stainless Games, developer of the Carmageddon series. Like Command & Conquer's box art, the grinning head of Carmageddon's Max Damage makes for one of the most distinctive big box covers.

Unlike Westwood, however, Stainless had almost no involvement in what the final box looked like. 'SCi were the publishers of the original Carmageddon series, and the decisions regarding the box – its design, content and all the rest – were theirs,' says Neil Barnden, co-founder of Stainless. 'SCi did run the artwork past us for our comments/approval. We loved the artwork for Max Damage for the original Carmageddon packaging.'

Having a publisher handle the box design may have taken pressure off the developers, but it also meant the developer had less creative control, which could lead to some unfortunate situations. In the USA, Carmageddon was published by Interplay, which created its own box design with very different art.

'The US publisher didn't even use Max Damage for their box art – there was an awful photo collage of a pedestrian being hit by a car that we had no idea about until we saw the retail packaging,' Barnden says. This isn't the only case of a box art misfire. Hart cites an example from the original box for Red Alert 2, which released in November 2000. 'The inside flap showed the Soviet airplanes attacking New York,' she says. 'The box was printed and then 9/11 happened, so we had to redesign and reprint thousands of units.'

DUSTING OFF

PC games continued to be sold primarily in big boxes until the early 2000s. At this point, the popularity of console gaming was rapidly on the rise, reaching critical mass with the launch of the Xbox and PlayStation 2. With more games demanding space on the shelf, stocking big box PC games became less

Victoria Hart designed many of Westwood's big boxes. Now she runs her own graphic design firm, Pink Kitty Creative

Westwood combined photography, modelling and graphics effects for the cover of Tiberian Sun

The rear of the Tiberian Sun box, designed by Victoria Hart to showcase the game's key selling features

cost-effective for stores. Consequently, PC game packaging would shrink to DVD size, initially still in cardboard boxes, but eventually switching to plastic cases little different from those of the Xbox and PS2.

But the story of big boxes doesn't end with the introduction of Steam in 2005. While developers and publishers may have stopped putting games in big boxes, the affection for them from the PC gaming community never waned, as demonstrated by collectors such as Wimmer.

'Then 9/11 happened, so we had to redesign and reprint thousands of units'

Yet while Wimmer's own collection spans four decades, it's only in more recent years that collecting has become a more active hobby. 'In 2012, I rediscovered my love for boxed games, and I started browsing eBay, local classifieds and flea markets to track down all the games I couldn't afford as a teen.'

Indeed, the past decade has seen an explosion of interest in big box collecting, as PC gamers seek to reconnect with the physical roots of the hobby. The Big Box PC Game Collectors Facebook group has almost 6,000 members, while some rarer big boxes can sell on eBay for hundreds or even thousands of pounds. For his part, Wimmer isn't interested in either buying or selling boxes for silly amounts of money.

'Prices did go up but I'm not really buying into the current hype of big boxes being investments and so on. I'm still trying to follow my '€10 per game' rule.' Mostly, he's pleased to see new people getting involved in big box collecting. 'I've met a lot of enthusiastic folks from all over the world thanks to those dusty cardboard boxes.'

Wimmer's collection of big box games is also unique. Not in its size or the rarity of the games, but because it's both physical and digital. Shortly after rediscovering his love of big boxes, Wimmer began creating digital 3D models of the boxes and uploading them to his website **bigboxcollection.com**

'At first, I took photos of the box covers and was sharing them on the net and social media. Due to the varying quality of my photos, I invested in a scanner and replaced the photos one by one with high-res scans,' he says. 'I soon realised that recreating the whole box digitally was what I'd been after – experiments with photos and mock-ups eventually led to the 3D models that are now available.'

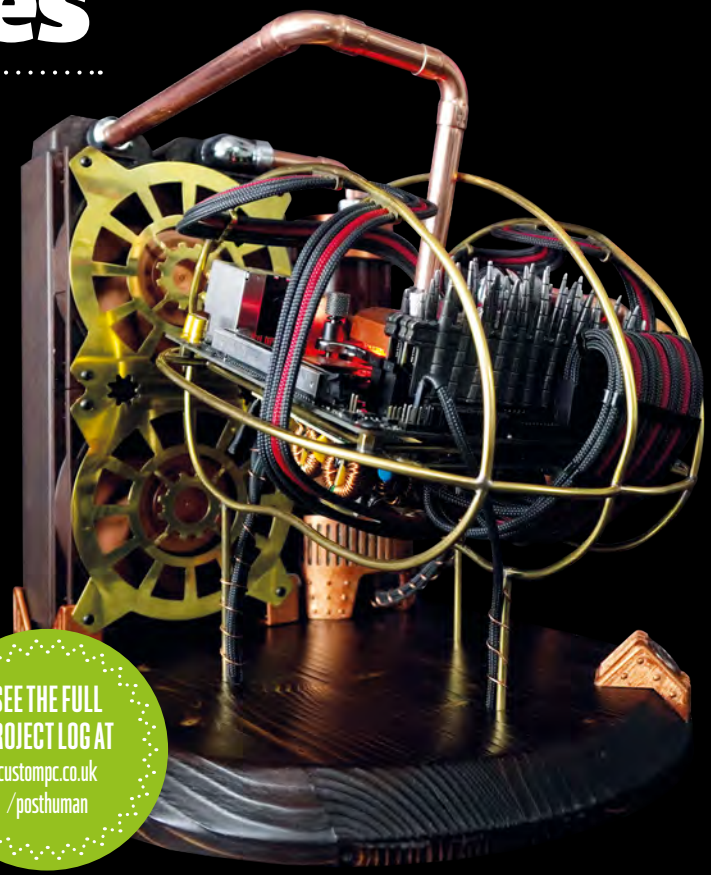
The result is a wonderful potted history of PC gaming big boxes, as well as a great resource for people fond of early PC gaming, but who don't have a collection of their own.

Which is the best PC gaming big box? Wimmer is definitive in his conclusion. 'Ultima Underworld. Fantastic cover art by Denis Loubet and it comes with extra manuals, a map and a bag of runes.' CPC

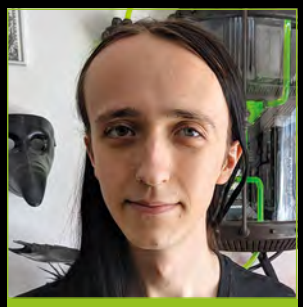
Readers' drives

Posthuman

Inspired by the idea of a brain in a jar connected to a computer, David Wieland created this steampunk-themed build, with copper piping, CNC-machined metal, 3D-printed parts and even a custom matching keyboard



SEE THE FULL PROJECT LOG AT custompc.co.uk/posthuman



/MEET THY MAKER

Name David Wieland

Age 21

Occupation Electrical engineering student

Location Switzerland

Main uses for PC Video editing, CAD, occasional gaming

Likes Heavy metal, machines, fantasy

Dislikes Bananas, software without a dark mode

CPC: Let's start at the beginning. What inspired you to build this PC – what were your design inspirations and what look were you trying to achieve?

David: I'd wanted to build a steampunk-themed PC for a while, so when I needed a computer for my workshop, I spent months building a PC from scratch, instead of just buying a practical and cheap box.

The main concept is having a brain connected to a computer in a vat – it thinks it's a real person but only exists virtually. I then switched that idea around and made the computer the brain. To stay true to the steampunk style, I featured a lot of copper and brass elements. For the base, I wanted an antique-looking piece of wood to make the whole system look like it had been around for a while.

CPC: On your project log, you originally intended this to be a full-immersion mineral oil project. What happened to that idea?

David: In the beginning, I planned to submerge the whole computer in a fish tank to achieve the 'brain in a jar' aesthetic, and abandoning this idea was not a decision I took lightly. The main reason was that, due to my overly high expectations of the quality of workmanship, every part of the process took forever, and no end seemed in sight. After putting the build aside for a few months, I then decided to simplify it drastically, so I could finish it in a reasonable time frame.

As the mineral oil cooling idea complicated the whole build, I was worried it might cause problems and I decided to abandon it. I didn't have to change too much of the build to move to water cooling, as I already needed a radiator and pump to keep the oil cool. It's just a shame that I couldn't use the custom CPU waterblock (pictured right) I'd made any more. Since the whole computer was originally going to be submerged, the block only had an inlet directing the cooled oil onto the fins, and was then open on the sides – that's not ideal if you're using water though.

CPC: How did you plan and design this build throughout its various stages?

David: While I've used Fusion 360 in the past to model every bolt of a build before getting started, this

time I took a different approach. To get the first rough measurements, I used my own 'CAD' process, which I call 'cardboard aided design'. I built a rough model with old boxes and some wire.

From there, I just made it up as I went. This was definitely outside of my comfort zone, but it allowed me to work with much more organic shapes that I would have never considered in CAD. The only parts I 3D-modelled were the ones I needed to 3D-print or cut out with a CNC machine.

CPC: How did you plan the copper plumbing system, and how did you go about cutting, polishing and linking it all together?

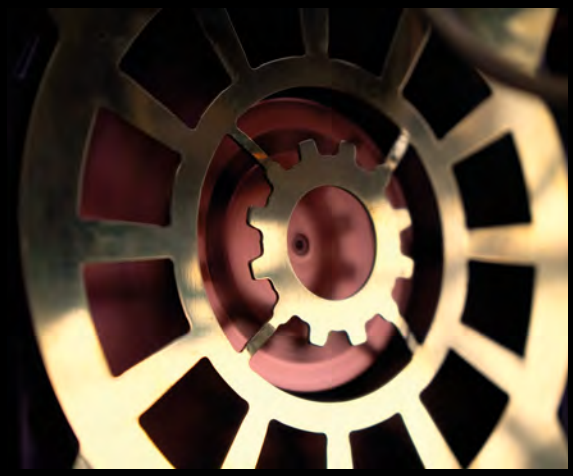
David: Finding the copper tubing was probably the only part of this build that went much easier than I expected. I just went to the local hardware store and picked up some 12mm plumbing parts. While I would have liked to go bigger, 12mm (diameter) is the only size that's both common in plumbing around here and has PC water-cooling fittings available.

To connect them, I used regular plumbing solder, which only left polishing. I started by filing away excess solder and then moved up through the sandpaper grits. Finally, I used a polishing paste and a handheld polishing wheel to get it to shine. I have nightmares about all the polishing involved in this project – it was my least favourite part of the building process.

CPC: How did you dismantle the PSU, and how much work was involved in crimping and sleeving the cables?

David: The power supply is a 400W SFX model from be quiet!, which came with good old ketchup and mustard cables. To fit it underneath the motherboard without being too bulky, the enclosure had to go.

Since it was originally supposed to be submerged in mineral oil, safety wasn't much of a concern originally. The way it's mounted now is not recommended and could be quite dangerous. It's properly grounded and none of the live wires is exposed, but I only kept it this way knowing that I would be the



only person ever using this PC. The hardest part of making the custom cables was soldering them back into the power supply.

The wires I chose are slightly thicker than the stock ones, so it's a tight fit once they have the sleeving on top of them. Getting the lengths exactly right for all the cables was also crucial, as they're completely in view with nowhere to hide any slack. Customising the pump and fan cables was a breeze in comparison.

CPC: You made your own custom frame parts to mount the components, as well as cable combs. Tell us about the metals you used, and how you shaped them and secured them together.

David: The entire brain frame is made from brass, which I mostly cut by hand and soldered together. The 4mm round stock was just soft enough to be easily bent into shape, but also strong enough not to deform. The cable combs were CNC-machined on my RatRig Killerbee CNC machine, and I also CNC-machined the wooden base and the brass fan grille.

As these parts are all fairly simple, they were perfect projects to learn how to use my newly built CNC machine. To give the base an aged look, I used a blowtorch to char it almost completely, leaving only a few light spots. I then used a Scotch Brite pad to remove all the charring. The resulting surface had a great colour as well as some texture as if it had been around for a hundred years. To protect the wood and my fingers, I coated it in a satin varnish.

CPC: We love the custom memory heatsinks. How did you design them and get them made?

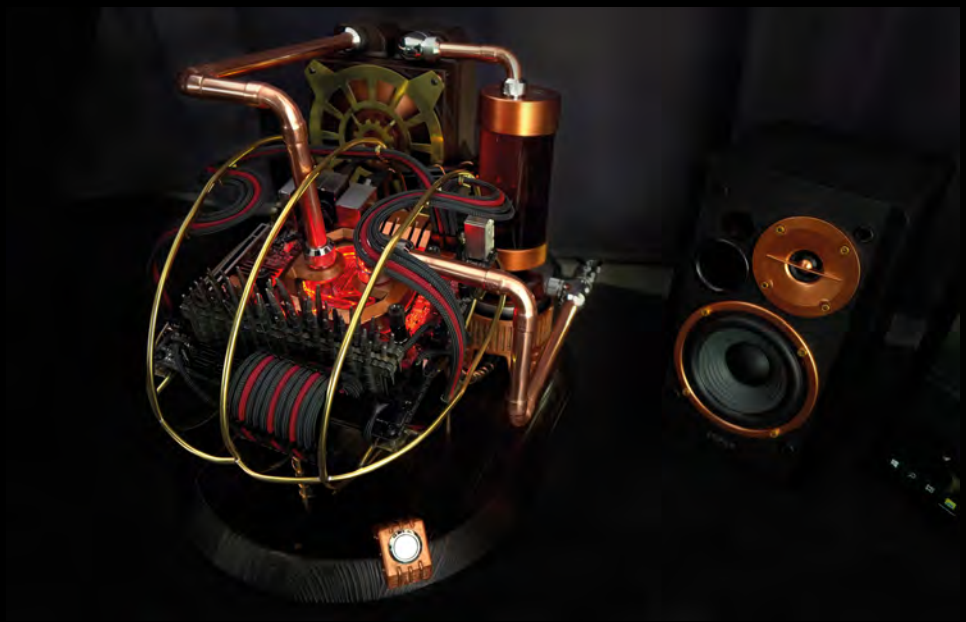
David: The custom heatspreaders and the original CPU waterblock are by far my favourite parts of this build. I modelled them in CAD and then had them 3D-printed from aluminium with a selective laser melting printer. I always wanted to try out that technology but never had a good excuse, so this was the perfect opportunity.

The finished metal 3D prints are quite rough and have a matt finish, so I sanded and polished them. I also attempted to anodise them in a copper colour but something in the alloy used for 3D printing didn't agree with my setup and they turned black, so I went back to just polishing them.

CPC: You effectively made your own keyboard for this build. How did you design and make the brass plate?

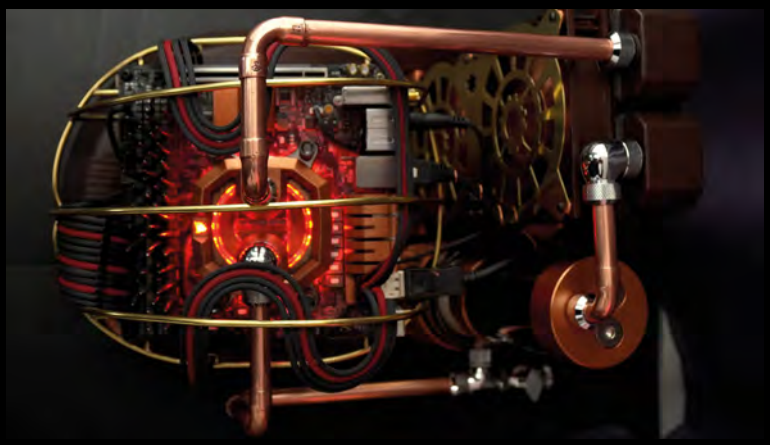
David: The custom keyboard was another project that resulted in me procrastinating on this build. I designed it completely in Fusion 360 and made my own PCB using Eagle. I then 3D-printed the parts for the frame and used the CNC machine to cut the brass plate.

The keycaps for the letter blocks are made from actual metal, so I



SYSTEM SPECS

CPU AMD Ryzen 5 Pro 4650G
GPU Integrated Radeon RX Vega 7
Storage 512GB Samsung M.2
Memory 16GB Crucial Ballistix
Motherboard ASRock B450 Gaming ITX
PSU 400W be quiet! SFX Power 2
Cooling Custom water-cooling loop, featuring D5 pump, Corsair CPU waterblock, EK 240mm radiator, EK Vardar fans



used Gateron Black switches for these keys, as they have a higher activation force compared with the Red switches used for the other keys. This ensures that, even though the metal keycaps are much heavier than the plastic ones, the keys feel almost the same when you're pressing them down. After a paint job and some software configuration, I had a keyboard to match the PC build. I already had a Mad Catz RAT mouse, which was perfect for this setup after a quick paint job too.

CPC: How did you create the copper-effect touches on the heatsinks, radiator, pump/res combo and so on?
David: At first, I tried to use an expensive copper spray paint I found, but it just ended up looking brown. Then I remembered that I still had some metallic acrylic paints lying around, which worked great. It was a challenge to hide the brushstrokes, but almost anything can be hidden if you use enough weathering. Originally, I also painted some inside parts of the reservoir, but it turned out that the paint wasn't as waterproof as I thought, so it came right off. Some remnants of that paint are still stuck in the fins of the CPU waterblock today.

CPC: Did you come across any difficulties?
David: For this build, I experimented with many techniques that were completely new to me, so the challenges I faced could fill a book. Figuring out how to solder the brass pieces cleanly was quite difficult. Even after many attempts, I was only eventually saved by a Dremel and a lot of filing to remove all the excess solder. I also had some connections break during polishing, which meant starting over again.

CPC: How long did it take you to complete this build, from start to finish?
David: From start to finish, it took me around nine months, but there were around four or five months where I didn't do any work on it.

CPC: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect? Do you plan to make any changes to it at a later date?
David: I do wish I had stayed with the mineral oil-cooling idea, but most likely the build would still be in pieces now if I'd done that, so I think I made the right call. Now that GPU prices are coming down again, I've considered adding one.

However, I don't really need a GPU in this PC (it's just a secondary machine) and it would change the aesthetics a lot, plus I would need a new power supply. If I ever feel like I need more GPU power, I might add an external GPU box with its own PSU that just connects through a PCI-E riser cable. CPC

WIN CORSAIR HYDRO X WATER-COOLING GEAR

To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (@**CustomPCMag**) or Facebook (**CPCMagazine**), or email low-res ones to **ben.hardwidge@raspberrypi.com**. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

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Corsair Hydro X Series XC7 RGB CPU Water Block

WORTH £70

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose a version for Intel or AMD CPU sockets.

Corsair Hydro X Series XR5 240mm Radiator

WORTH £55

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JAMES GORBOLD / HARDWARE ACCELERATED

THE DIFFERENCE A NEW CPU MAKES

James Gorbold looks at how using an old CPU can limit the performance of modern GPUs

With this month's CPU Labs test focused on exploring which of the latest CPUs are the best at different price points, I thought it would be interesting to look at the findings of some recent research we carried out in the 3XS lab at Scan.

Rather than benchmarking a boatload of modern CPUs against each other, we wanted to discover the benefits of upgrading from a popular old CPU to one of today's champions. To make the test more interesting, we wanted to see how much, if at all, old CPUs hold back the latest graphics cards, so we conducted all our testing with the best-selling Nvidia GeForce RTX 3080.

We picked the Core i9-9900K as our old CPU, as when it launched in 2018 it was by far and away the most popular high-end CPU on the market. For the modern champion, we chose the new Core i9-12900K. To make the comparison as fair as possible, both CPUs were tested in a very similar configuration, with the same cooler, same amount of RAM and identical SSDs.

We started by looking at gaming, so we set about benchmarking both systems across a collection of seven popular games at two resolutions, 1,920 x 1,080 and 2,560 x 1,440. The games were Counter-Strike: Global Offensive, Cyberpunk 2077, Far Cry 6, GTA 5, Metro Exodus, Rainbow 6 Siege and Shadow of the Tomb Raider.

Intel focused a lot of its resources on improving instructions per clock in its 12th-gen CPUs, so it wasn't a huge surprise to see a significant average speed boost of 13 per cent between the 9900K and 12900K, showing that even a CPU that's only four years old does limit modern GPUs.

The results can be further broken down to an average speed of up of 16 per cent at 1,920 x 1,080 and 10 per cent at 2,560 x 1,440, which is due to the GPU doing more of the heavy lifting than the CPU as you increase the resolution. Even so, 10 per cent is quite a lot of performance to lose when you've spent all that money on a GPU.

The next area we wanted to test was content creation application performance – tasks such as 3D modelling and rendering, which can be very taxing on the CPU. We used the 3D modelling benchmark SPECviewperf to measure the percentage speed up in 3D modelling and found that the 12900K was on average 10 per cent faster than the 9900K, very similar to the speed-up we found in games.

> We measured a ludicrous 134 per cent speed difference

We also used Cinebench and Blender to benchmark the speed-up during 3D rendering, and measured a ludicrous 134 per cent speed difference between the two CPUs, thanks to all those extra cores. This an incredible speed boost and would be a real game-changer for content creators, giving you far more time to keep tinkering with your projects until they're perfect or simply complete them sooner.

However, it would be remiss to point out that the RTX 3080 itself is already much faster at rendering than the 12900K. Still, if you're working with CPU-limited renderers, that 134 per cent speed up is going to be very welcome.

While it's fair to say that the CPU has far less of a role to play in determining overall system performance than it did in previous decades, our testing shows that you do still need to careful when upgrading to keep your system in balance. After all, the Core i9-9900K is by no means an old CPU – it was only discontinued at the end of last summer. CPC

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

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