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Welcome

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Custom PC Issue 215

/ FROM THE EDITOR

Hardware spotting

Pack away your binoculars and shut your CPU spotter's guide – AMD's Zen 3 CPUs are no longer rarer than penguins in the Sahara. You can even spot one here in the UK at the retailer of your choice without the need for an overactive imagination. It's as if someone has poured a bottle of bleach down the CPU supply pipe, and whatever gunk was lodged in there has finally been flushed out.

Not only are AMD Ryzen 9 CPUs readily available in the shops, but they're also back to normal pricing. Right now, [scan.co.uk](https://www.scan.co.uk) is selling the 12-core Ryzen 9 5900X for £499 inc VAT – its original retail price. There's plenty of stock of the 16-core Ryzen 9 5950X as well. Meanwhile, the prices of the Ryzen 7 5800X and Ryzen 5 5600X have started to come down.

The competition from Intel's Rocket Lake-S CPUs has undoubtedly helped here, but the healthy supply is the real story. When stock is readily available, you no longer have to look to eBay scalpers for your components. When eBayers can't sell at inflated prices, retailers have to compete with each other on pricing again. It's good for the industry, and it's really good for us. Bang. That's CPUs back to normal.

The next step, of course, is graphics cards. Nvidia GPUs still might as well be fictional for all that they're available in the shops, but stock of AMD's RDNA2 GPUs has regularly started to show up at retailers such as Scan and Overclockers. The only problem is that stock is still selling out quickly, and the prices are still massively overinflated.

They're not nearly as expensive as the equivalent Nvidia cards on eBay though. In this stock shortage, the free market has decided that while AMD GPUs can sell for high prices, they can't sell for the ludicrous prices of Nvidia GPUs, presumably because Nvidia GPUs are better at cryptocurrency mining.

If Nvidia's forthcoming 'lite hash rate' cards (see p12) really deliver on their promise, could we finally see GPUs joining CPUs at healthy stock and supply levels? It's going to take a long time, but the new strong supply of CPUs has given me hope. **CPC**



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CUSTOM PC

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When you have finished with this magazine please recycle it.



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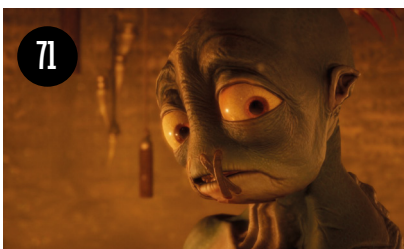
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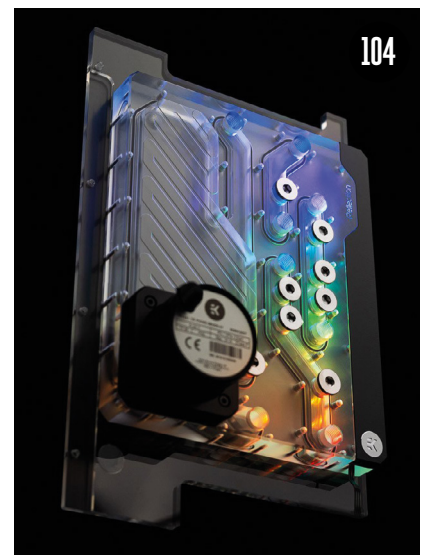
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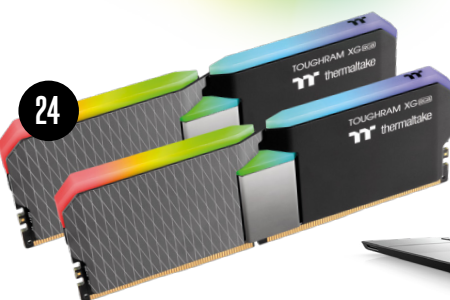
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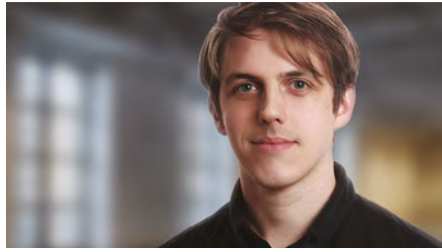
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RICHARD SWINBURNE / VIEW FROM TAIWAN

MODDING KIT LOST TO TIME

Richard Swinburne wants to see the return of cold cathode lights and custom fan grilles

The fan that cools the X570 chip on my Asus motherboard is failing. It's only two years old but even after cleaning, reapplying thermal grease and remounting it, the chipset temperature is still blipping into the 70s. I've looked around for alternatives, but there's nothing out there. Years ago, we used to be able to buy a chunk of anodised metal fins with little wings that jutted out from underneath, so you could align it to the non-standardised heatsink-mounting holes in your motherboard.

I'm surprised at the lack of options – virtually every X570 motherboard needs a chip fan, so there should be a small army of people in the same boat as me, all looking for alternatives. This got me thinking about all the other little bits of kit we used to get but you can't easily find any more.

Back in the early 2000s, you could nip down to Maplin and pick up all manner of modding kit, such as 15cm and 30cm cold cathode lights, for around a fiver each. For me, cold cathodes were the pinnacle of in-case lighting, but they've been difficult to find in the UK since the invention of RGB LED strips.

Amazon US has a single stockist of these *superior* lights, but there's nothing available on the other side of the Atlantic. Cold cathodes can't produce fancy-pants 16.8 million colours, but the few colours they do have emit a beautifully radiant soft glow. They don't illuminate every nook and crevasse; instead, they cast light onto your various bits of hardware, creating interesting hues and shadows, and leaving as much to the imagination.

Now, your average RGB-filled build is so packed with bling that it's like you're housing your own fusion generator. The

Your average RGB-filled build is so packed with bling that it's like you're housing your own fusion generator

whole interior is shadowed in light because every component sports some sort of RGB-fuelled feature. Yes, cold cathodes weren't perfect: they couldn't be bent, required an inverter and they ran warm, adding slightly to case temperatures. However, you didn't need to faff around with a piece of software for every item – you just plugged it in and enjoyed it.

Custom fan grilles are another old modding feature that seems to have fallen by the wayside. You can 3D-print your own ones now, but I used to have a set of laser-cut spirals that were awesome (although they could also slice your fingers). I'll chalk them up on the growing board of 'things

I regret selling'.

They did nothing for my PC's performance – in fact, they got in the way of the airflow – but they added that personal touch, whereas now fans are just another RGB lighting source unless you're a Noctua fan (ahem) and prefer that particular shade of brown.

At least we no longer have to crack out the jigsaw to cut our own case windows – the chunky plastic 'bus window' style never looked that great anyway. Almost all cases have some sort of tempered glass panel option now, although we are missing side panel-mounted fans to give our increasingly hot graphics cards some air.

Bottom-mounted fans work well when graphics cards are placed right near the bottom, but most non-ITX systems have them sat in the middle with no intake fan next to them. I say we should bring back side-panel fans – enough of the front panel trilogy that every case manufacturer seems to offer now. Progress is good, but we also seem to have lost some good ideas along the way. **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

ONE-STOP SHOP

Tracy King analyses the latest rumours about Netflix branching out into video game streaming

I love a one-stop-shop. Those of us old enough to remember bricks-and-mortar Blockbuster stores think as fondly of the bags of Revels and weekly rentable console games as we do the films (Nintendo actually sued Blockbuster to try to stop this, but lost). Likewise, when HMV started selling video games, those £10 vouchers from my nan suddenly got more exciting. Games belong with other multimedia. I watch films and TV on my computers, and play games on my TV.

Blockbuster died off in part because it was bricks-and-mortar, to be replaced by internet services, including Netflix, which started with physical media but has always excelled at seeing what's coming. That's why Netflix's expansion into video games is the surest move I can bet on right now.

We know this in part because the streaming giant is hiring a video games executive, as reported by technology site The Information, but also because it's the obvious next step for a company that has already dabbled in a market that's only going to grow.

Lockdown has driven new gamers to the market like no other factor, with British gaming body Ukie claiming a 70 per cent increase in sales of PC games hardware, in part because people working from home are investing in machines that can also handle games. Likewise, mobile gaming has attracted newbies like never before. If this is true for the UK, it will be true for the USA too.

Netflix usage is also on the up, as you would expect. It has 204 million subscribers. Nielsen statistics show a 61 per cent 'increase in streaming via TV in the US during the coronavirus pandemic, taking daily Netflix usage to an estimated 3.2 hours per day.'

Diversification into new revenue streams is inevitable

A study by Marketing Charts shows that 59 per cent of US 16-34-year-olds say Netflix is indispensable. It's also notable that the movie and TV giant has doubled its user base in Asia. Diversification into new revenue streams is inevitable, and video games are one of them.

Interactive television in the form of meta-show Black Mirror: Bandersnatch showed that Netflix shares cultural values with gamers, also evidenced by the licensing of Stranger Things 3 for good effort at a game that wasn't well received. The current rumour is that Netflix will offer a subscription akin to Apple Arcade, although my betting money is on a tie-in with an existing gaming platform rather than Netflix providing its own platform (and avoiding a repeat of Stadia).

While Bandersnatch worked as interactive television, it's hard to argue that it's more of a video game than a playable show, and despite major investment it still couldn't be 'played' on Chromecast, Apple TV or some older devices. The rumours about Netflix Games (or whatever it will be called) make more sense as a publisher rather than a platform. Otherwise it would be Netflix Interactive Shows and, well, those already exist.

As of writing, no details are known, but I'm hoping Netflix doesn't go mobile-only for its games (while suspecting it probably will). As of 2018, according to the platform's own data, 40 per cent of new subscriptions were on PC, more than on mobile devices. Both types of subscriber eventually migrate to watching on a TV, but more PC users stick with watching Netflix on computers than mobile subscribers with their phones.

It would be great if PC gamers were the first target market. However, given the unstoppable trajectory of mobile and casual gaming, I won't be putting too much money on it. **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



GIGABYTE ADDS HUGE HEATSINK TO PCI-E 4 SSD

Gigabyte has declared war on thermal throttling by launching a PCI-4 SSD with a behemoth of a heatsink attached to it. The new Aorus Gen4 7000s Prem. measures 44.7mm tall, with the SSD PCB sandwiched between an aluminium base plate and a dual heatsink arrangement on top of it, with the two sections linked by a pair of heatpipes.

The SSD itself is based on the same Phison PS5018-E18 as the standard Aorus Gen4 7000s (see p46), which has a small, low-profile heatsink. This SSD became warmer than the Corsair MP600 Pro with its larger heatsink in our tests, but it still didn't throttle under stress testing. As such, it's unlikely the Prem. version of the SSD will be any quicker in most cases, but it will almost certainly be cooler.

NVIDIA CONFIRMS 'LITE HASH RATE' GPUS

Nvidia has confirmed that it's releasing new versions of its GeForce RTX 3080, 3070 and 3060 Ti cards that will deliberately restrict cryptocurrency mining performance. The new 'lite hash rate' cards will have an 'LHR' identifier on the box, and will reduce the hash rate when mining Ethereum cryptocurrency.

'GeForce products are made for gamers,' says the company's VP of Global GeForce Marketing, Matt Wuebbeling, on Nvidia's blog site ([customerc.co.uk/LHR](https://www.nvidia.com/en-us/geforce/news/customerc.co.uk/LHR)). 'We believe this additional step will get more GeForce cards at better prices into the hands of gamers everywhere.'

This isn't the first time Nvidia has dabbled with this strategy to deter people from using its gaming cards for cryptocurrency mining.

The GeForce RTX 3060 also launched with a driver that reduced its hash rate, but a later driver removed it, which Nvidia says was accidental.

Despite the low hash rate at launch, the GeForce RTX 3060 also sold out within a few minutes at UK retailers, so it's unlikely that this move will solve the stock and pricing problems of Nvidia GPUs entirely, but it at least potentially eliminates one of the problems.

CORSAIR PROMISES DDR5 MEMORY 'SOON'

Corsair says that its DDR5 memory modules will be coming 'soon', and has unveiled some of its thoughts in an online primer ([customerc.co.uk/CorsairDDR5](https://www.corsair.com/blog/customerc.co.uk/CorsairDDR5)). The company also says it's 'excited to share more about DDR5 in the coming months', inviting customers to 'keep an eye out for more details from our social channels'.

The new technology offers a number of improvements over DDR4, including a much higher maximum die density of 64Gb per chip, compared to 16Gb on DDR4 modules. This means we could see 128GB on a single DDR5 module (DDR4 modules max out at 32GB). In

its primer, Corsair points out that this could mean standard four-module desktop systems could be kitted out with a massive 512GB of memory.

DDR5 will also offer much more bandwidth than DDR4, with the JEDEC spec maxing out at 6400MHz (51GB/sec), compared to 3200MHz (26GB/sec) on DDR4, and of course, overclocked modules will push this frequency further. DDR5 is also slightly more power-efficient, requiring a Vdd of 1.1V, compared to 1.2V for DDR4.

Both AMD and Intel are expected to introduce desktop platforms that support DDR5 memory over the next year.

Rumour control

WE PRESENT SOME OF THE LATEST UNCONFIRMED TECH GOSSIP. TAKE THESE STORIES WITH THE APPROPRIATE PINCH OF SALT

AMD MOVING TO LGA SOCKET AND DDR5

Bent pins on AMD CPUs could be a problem of the past, as the company is rumoured to be moving to a new land grid array (LGA) socket when it moves to Socket AM5 for its forthcoming 5nm Zen 4 mainstream desktop CPUs. AMD has already used LGA sockets for its high-end EPYC and Threadripper CPUs, where the CPUs have contact plates instead of pins, and the pins are instead arrayed in the motherboard socket.

Twitter user @ExecuFix, who is a regular leaker on upcoming tech, says the new AM5 platform will feature an LGA1718 socket with the same 40 x 40mm footprint as AMD's existing CPUs, meaning the existing coolers should theoretically be able to cover them. The new platform is also rumoured to be based on a new 600-series chipset, which will support DDR5 memory, but will stick with PCI-E 4.

INTEL ALDER LAKE COMING IN NOVEMBER

Tech site [wccftech.com](https://www.wccftech.com) reports that Intel's forthcoming 10nm Alder Lake-S platform is currently scheduled to land in November this year, citing an update from its anonymous sources in the industry. The platform is rumoured to not only support DDR 5 memory, but also beat AMD in the race to get PCI-E 5 out the door.

Alder Lake will be Intel's first CPU microarchitecture to combine both 'big' and 'little' cores, where large brute force cores are assisted by simpler coprocessors. It's a strategy that's paid off in Arm designs such as the acclaimed Apple M1, as well as many mobile SoC designs. According to the rumours, Alder Lake will require a new rectangular LGA1700 socket, requiring new cooler mounting designs and larger contact plates.

AMD GEARING UP FOR RADEON RX 6600 LAUNCH

AMD is reportedly gearing up to launch a budget line of GPUs based on its RDNA2 architecture. Some GPU-Z screenshots were recently shared by user Enthusiastic Citizen on Chinese tech forum [chiphell.com](https://www.chiphell.com), showing some details of the forthcoming Radeon RX 6600 and 6600 XT.

The new cards look set to be based on a new Navi 23 GPU measuring 236mm², with the top-end Radeon RX 6600 XT featuring 2,048 stream processors spread across 32 Compute units, along with 32 Ray Accelerators. The GPU also reportedly has a 128-bits wide memory interface, which will be attached to 8GB of GDDR6 memory running at 2GHz (16GHz effective). According to the GPU-Z screenshot, the GPU boosts to up to 2679MHz.

Meanwhile, the Radeon RX 6600 has four compute units disabled, giving you 1,792 stream processors and 28 Ray Accelerators. This lower-powered GPU also has the same 8GB of GDDR6 memory connected to a 128-bits wide memory interface.

NOBLECHAIRS UNVEILS THE ELDER SCROLLS ONLINE CHAIR

Premium gaming chair maker noblechairs has revealed a new version of its Hero chair that's clad with artwork based on The Elder Scrolls Online. Produced in conjunction with Bethesda, the new design follows in the footsteps of the company's previous chairs based on the Fallout and Doom franchises.

The Ouroboros design from The Elder Scrolls Online is embroidered into the front of the headrest, and you also get patterned side bolsters with gold-coloured sides sporting Daedric sigils. Meanwhile, the back has a gold-coloured embossed The Elder Scrolls Online logo on the headrest, with a large dragon design covering the rest of the back.

The noblechairs HERO Black Edition won a Premium Grade award in our last gaming chairs Labs test (see Issue 211, p54), thanks to its superb build quality and built-in lumbar support. The Elder Scrolls Online Special Edition of the HERO is available to pre-order from [overclockers.co.uk](https://www.overclockers.co.uk) for £390 inc VAT, with stock expected on 21 June.



Letters

Please send us your feedback and correspondence to
custompc@raspberrypi.com

Silly retail prices

I see on your Twitter account that you've recently pointed to stock of graphics cards in stock at Overclockers (Radeon RX 6800 XT) and Scan (Radeon RX 6700 XT). Obviously I'm glad to see graphics cards back in stock, but the prices are still way above the RRP's – they're not really any better than eBay scalper prices. What's going on here, and are the prices ever going to come down to normal levels?

ANDREW PINE

Ben: Indeed, the prices are very high, starting from £780 inc VAT for a Radeon RX 6700 XT, and £1,159 inc VAT for a Radeon RX 6800 XT. It's still preferable to buy a card from a retailer than a scalper, as you'll at least be able to easily return it if it's faulty, but it's a real shame the prices are so silly.

I don't doubt that a chunk of this is extra markup that goes to the retailers, but as we covered in our feature in Issue 213, there will also be other factors driving up the price in the supply chain before it gets to them, including inflated shipping costs,

Radeon RX 6700 XT cards go for at least £780 now, even if you buy direct from retailers



When's the next issue out?

CUSTOM PC

Issue 216

On sale on Thursday, 8 July



silicon shortages, demand outstripping supply and various knock-on effects from the pandemic. I really hope prices come down to normal levels again, but I think it's going to take a while.

DIY projects

After reading Ben's reply to Steven Campbell's letter in Issue 214, I thought I'd throw in some of my thoughts as I've tinkered with a few fun projects. A lot of these could be viewed from the standpoint of using older/spare hardware when upgrading.

1: I've used an old office small form factor Dell PC (Core i3) as a CCTV server (running Zone Minder), using a PoE switch to power IP cameras and connected with outdoor Cat5 to mount on my garage and in the garden. Zone Minder allows you to set up trigger zones and recording/deletion schedules to suit your needs.

2: I've used a spare Pine64 small-board computer (SBC) to make a low-powered web/Nextcloud and home media server. It's currently just using a large USB drive for storage, but I plan to move to a dedicated NAS at some point.

3: I'm hoping to create a DIY NAS, as there seem to be too many security issues with off-the-shelf systems. A feature that not only showed you how to do this, but also dive into the available options, such as suitable mini-ITX boards with enough SATA

connectors, and compact cases with enough 3.5in bays, would help readers to make informed decisions. The requirements for SATA ports and drive bays are also dependent on the type of RAID array that I decide to use for it.

4: I've found that Wi-Fi and powerline networking simply aren't cut out for multi-storey houses, but I've solved this by simply drilling holes in the exterior walls near my router, and in my upstairs office. I then used outdoor Cat 5 cable and a couple of cheap sockets from Screwfix to create a hard link between the two floors.

It's more than capable of Gigabit networking, and it drastically improved my Steam Link performance. For me, this was an easy way to upgrade my network on a Saturday morning, and it didn't require redecorating from attempting to run cables internally, or just tacking a long cable around skirting boards, doorframes and under carpets, which I've done in the past. Keep up the good work.

BEN LANCASTER

Ben: These are all brilliant ideas, Ben – I love them, as well as the idea of properly using old hardware after you upgrade. I'm also an advocate of wired Ethernet in a multi-storey house. In my case, I went to the hassle of routing my cables under the floorboards and ceilings (or rather I paid someone else to do it for me!), but I'm so glad I did. We do have a feature on home networking options planned for the near future, and we've also covered building your own NAS box (see Issue 192, p86), but it could be time to revisit that idea again.

PHILIPS

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Reviews

LGA1200 CPU

INTEL CORE i5-11400F / £149 inc VAT

SUPPLIER scan.co.uk

While AMD's Zen 3 CPUs are killing it in the £300+ market, the company is relying on its older Zen 2 CPUs to offer alternatives to Intel at the cheaper end of the scale, with the likes of the Ryzen 5 3600 and Ryzen 7 3700X going up against Intel's latest Core i5 chips, such as the Core i5-11400F, which costs just £149 inc VAT.

The 'F' after the name indicates that this CPU lacks on-board graphics, but Ryzen desktop CPUs lack on-board graphics too, although the lack of a 'K' in its name means the Intel CPU can't be multiplier-overclocked either. Compared to the Core i5-11600K, the Core i5-11400F has the same count of six cores with 12 threads. The two chips also have the same L3 cache at 12MB, and each natively supports up to 3200MHz memory speeds.

There are some sizeable differences, though, such as frequencies. Although both CPUs support Turbo Boost 2, the Core i5-11600K can hit a peak of 4.9GHz while the Core i5-11400F only boosts to 4.4GHz. The Core i5-11600K also has a TDP of 125W; however, the Core i5-11400F will likely be quite easy to cool with a TDP of just 65W. This limits its all-core boost frequency to 4.2GHz, while the more expensive CPU can reach 4.6GHz across all cores.

Current pricing is key too, of course, and the Core i5-11400F's price of £149 is £20 lower than the Ryzen 5 3600, £60 lower than the Core i5-11600KF and £100 cheaper than the Ryzen 5 5600X. You can still buy the Comet Lake-based Core i5-10400F too,

although it will only save you £25. If the Core i5-11400F can at least vaguely keep up with the rest of its Rocket Lake siblings, it could prove very good value.

Performance

In our RealBench image editing test, which stresses single-threaded performance, the Core i5-11400F blew the Core i5-10400F out of the water with a score of 61,454 vs 38,420 and also bettered the Ryzen 5 3600, even when the latter was overclocked. The Core i5-11600K was a fair way ahead, though, with a score of 68,355.

Meanwhile, our heavily multi-threaded Handbrake video encoding test showed a reasonably close run between the new Rocket Lake Core i5 chips, with the Core i5-11400F scoring 467,568 compared to 507,729 for the Core i5-11600K. The Ryzen 5 3600 also beat the Core i5-11400F here, although not by much – its score of 473,815 is about what you would expect for the extra money.

The Core i5-11400F's overall system score of 193,474 was again just a little behind the Ryzen 5 3600, and a little further behind the 210,741 scored by the Core i5-11600K, but it was miles ahead of the 128,319 managed by the lowly Core i5-10400F.

Moving to Cinebench, the Core i5-11400F's multi-threaded score of 10,294 was 9 per cent higher than the Ryzen 5 3600, where the Core i5-10400F was barely able



SPEC

Base frequency
2.6GHz

Max boost frequency
4.4GHz

Core
Rocket Lake-S

Manufacturing process
14nm

Number of cores
6 x physical (12 threads)

Hyper-Threading
Yes

Cache
12MB L3, 6 x 215KB L2

Memory controller
Dual-channel DDR4, up to 3200MHz

Packaging
LGA1200

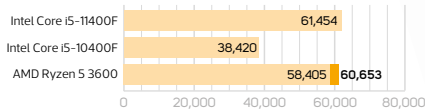
Thermal design power (TDP)
65W

Features

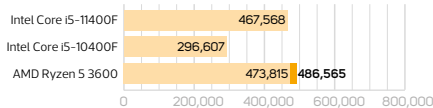
Turbo Boost 2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

BENCHMARK RESULTS

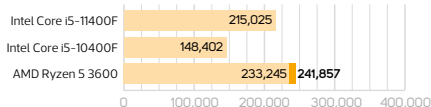
GIMP IMAGE EDITING



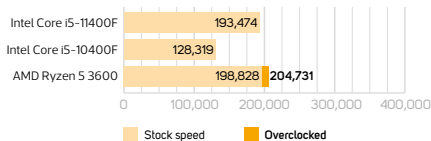
HANDBRAKE H.264 VIDEO ENCODING



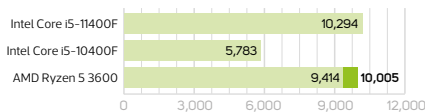
HEAVY MULTI-TASKING



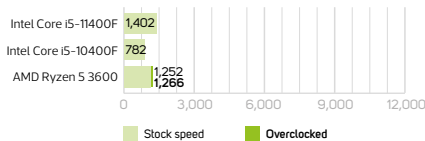
SYSTEM SCORE



CINEBENCH R20 MULTI-THREADED

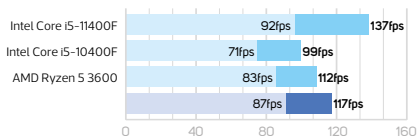


CINEBENCH R20 SINGLE-THREADED



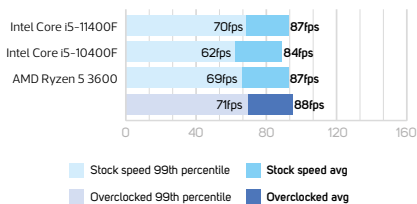
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings



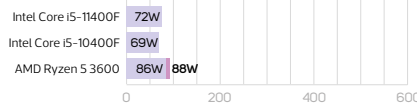
WATCH DOGS: LEGION

1,920 x 1,080, Ultra settings, DX12

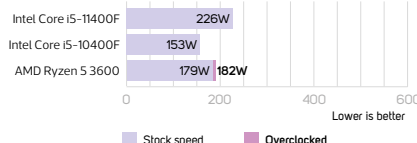


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



to manage half that at 5,783. The single-threaded result of 1,402 was again nearly double the Core i5-10400F's score of just 782, and again the new CPU beat the Ryzen 5 3600, which could only manage 1,252.

Where the Core i5-11400F really excels is in games. In Far Cry New Dawn, its 99th percentile minimum frame rate of 92fps was significantly quicker than the 71fps achieved by the Core i5-10400F and also well in front of the pricier Ryzen 5 3600's result of 83fps. However, the Core i5-11600K showed the benefit of its higher boost clock here, managing 109fps.

Watch Dogs: Legion didn't show a great deal of variation, but the Core i5-11400F still outgunned its predecessor at a minimum 99th percentile of 70fps vs 62fps, and matching the Ryzen 5 3600 with the Core i5-11600K only adding 4fps to the result.

The Core i5-11400F does draw more power than its predecessor, though, with our test system drawing 226W from the mains under load with this CPU installed, compared to just 153W for the Core i5-10400F.

Conclusion

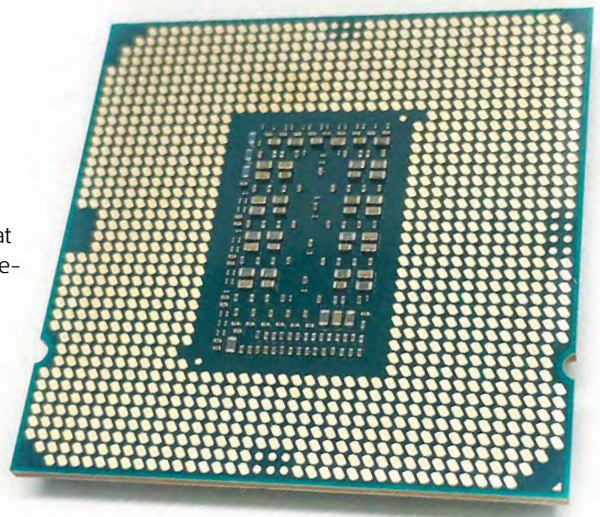
As the Core i5-11400F can't be overclocked anyway, you may as well couple it with an affordable motherboard such as the MSI MAG Z590 Tomahawk WiFi (see p18), or even a cheaper LGA1200 board, making the Core i5-11400F a steal at £149. It's able to better the more expensive Ryzen 5 3600 in most tests, including both our game tests.

The higher score in Cinebench was particularly damning, as that's usually a stronghold for AMD, but the Core i5-11400F is ultimately routing AMD's Zen 2 6-core CPUs and offering much better value. Intel might not have the high-end mainstream CPUs with loads of cores needed to counter AMD at the top end, but it's mightily strong at the cheaper end of its product stack.

ANTONY LEATHER

VERDICT

A huge amount faster than the Core i5-10400F and quicker than the pricier Ryzen 5 3600 in most tests. A great budget gaming chip.



ROCKET LOLLY

- + Much faster than its predecessor
- + Beats Ryzen 5 3600 in most tests
- + Not much slower than Core i5-11600K

ICE POP

- High power consumption
- Locked multiplier

PERFORMANCE

37/50

FEATURES

12/15

VALUE

35/35

OVERALL SCORE

84%

ATX B560 MOTHERBOARD

MSI MAG B560 TOMAHAWK WIFI / £170 incVAT

SUPPLIER scan.co.uk

One of the best bits of news about Intel's recent 500-series chipset launch was that chipsets other than the Z-series models would support memory overclocking. This means that B560-based boards such as this MSI MAG B560 Tomahawk WiFi can run your memory at frequencies above your CPU's natively supported speed, which is usually below 3000MHz.

For example, using a Core i5-10600K on a B460 motherboard would see your memory speed limited to 2666MHz, and no manual tweaks or XMP profiles will allow you to go higher. That's all changed this time, though, as the likes of the B560 chipset, while still not able to tweak your CPU's multiplier, can at least hit much higher memory speeds.

The MSI MAG B560 Tomahawk WiFi can reach up to 5066MHz with standard dual-channel memory, and while you likely won't see much of a real-world performance

boost above 3400MHz, that's way better than 2666MHz.

Another reason to be excited is that this board's Z590 counterpart costs £60 more, but has a similar specification, albeit with slightly beefier M.2 heatsinks and higher-specification audio. This is important, because many of Intel's 11th-gen CPUs, such as the Core i9-11900K, have limited overclocking headroom, so the benefits of spending another £60 are limited in terms of extra performance. This board also supports Intel's Adaptive Boost Technology, which can boost the Core i9-11900K's clock speeds higher if cooling and power delivery allow it.

The board itself has all the features you would expect from a mid-range enthusiast motherboard, including 802.11ax Wi-Fi, six SATA 6Gbps ports and a handy three M.2 ports, although only the top slot offers PCI-E 4 support for the latest SSDs. The other two ports



are limited to PCI-E 3 bandwidth, with one of them also supporting SATA should you have an older drive you want to use. You also get heatsinks for two of those M.2 ports, and our PCI-E 4 SSD was kept below 65°C during our stress test, keeping well away from thermal throttling.

The PCB also offers a USB 3.1 Type-C header, an impressive count of seven 4-pin fan headers, plus both 3-pin and 4-pin RGB lighting headers. It even has a funky cut-out of the PCB next to the PCH heatsink, with the latter being illuminated by RGB lighting.

Power delivery brings 12 phases to the CPU, while two huge heatsinks deal with the heat produced by the VRMs, although they're not linked by a heatpipe. Even so, they did a good job of keeping the VRMs cool, with our loaded Core i9-11900K only seeing them hit 59°C, which is miles away from throttling levels.

Meanwhile, the rear I/O panel offers a total of eight USB ports, four of which are USB 3, in addition to a USB 3.1 Type-C port. There are also antennae connectors for the 802.11ax Wi-Fi, plus the usual audio jacks, including an optical output, although the audio codec itself is only ALC892, which doesn't sound as good as the Realtek ALC1220 codec found on more expensive boards.

SPEC

Chipset

Intel Z590

CPU socket

Intel LGA1200

Memory support

4 slots; max 128GB DDR4 (up to 5066MHz)

Expansion slots

One 16x PCI-E 4, one 16x PCI-E 3, one 1x PCI-E 3

Sound

8-channel Realtek ALC897

Networking

1x Realtek 2.5 Gigabit LAN, 802.11ax Wi-Fi

Cooling

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

Ports

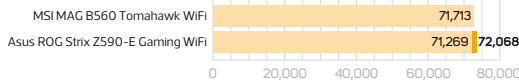
6x SATA 6Gbps 1x M.2 PCI-E 4, 1x M.2 PCI-E 3/SATA 6Gbps, 1x M.2 PCI-E 3, 2x USB 3.1 Type-A, 1x USB 3.1 Type-C, 1x USB 3.1 Type-C header, 2x USB 3, 1x LAN, 3x surround audio out

Dimensions (mm)

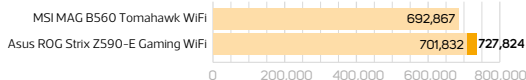
300 x 244

BENCHMARK RESULTS

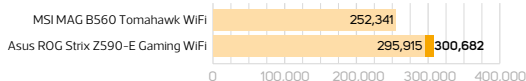
GIMP IMAGE EDITING



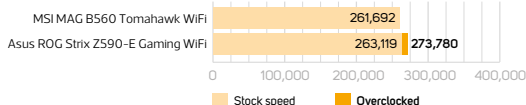
HANDBRAKE H.264 VIDEO ENCODING



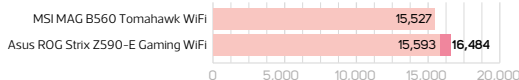
HEAVY MULTI-TASKING



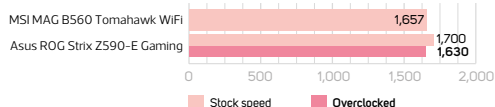
SYSTEM SCORE



CINEBENCH R23 MULTI-THREADED

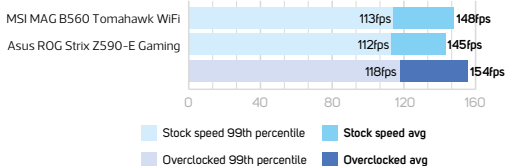


CINEBENCH R23 SINGLE-THREADED



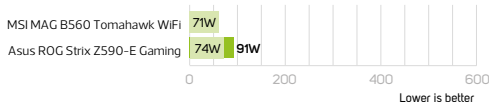
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings

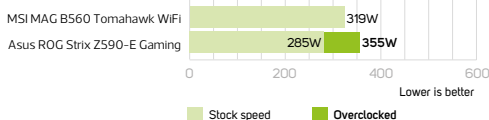


TOTAL SYSTEM POWER CONSUMPTION (WATTS)

Idle



Load



There are precious few other features, though, with no overclocking and testing tools, such as power and reset buttons, clear-CMOS switches or an LED POST code displays. Instead, MSI has clearly ploughed most of the budget into making sure the board can handle Intel's most powerful 10th and 11th-gen CPUs.

Performance

The MSI MAG B560 Tomahawk WiFi showed no evidence of being slower than the Z570 boards we've tested at



stock speed with our Core i9-11900K, matching them in most tests. The stock speed system score is just a little behind the likes of the Asus TUF Gaming Z590-Plus WiFi at 252,341 compared to 263,119, with the Asus board increasing that score to 273,780 once overclocked.

Gaming performance was on par too, and we were also able to enable Intel's Adaptive Boost Technology on our Core i9-9900K, which saw higher boost frequencies, increasing the Cinebench R23 score from 15,527 to 15,980.

At default settings, the total system power draw of 319W was fairly high under load, though, with the Asus TUF Gaming Z590-Plus WiFi drawing under 300W. The M.2 speeds were identical to other boards too, with a read speed of 4,985MB/sec and write speed of 4,267MB/sec. Meanwhile, the audio performance was fairly typical of the ALC897 codec with a dynamic range of 96.1dBA and noise level of -95.9dBA.

Conclusion

We're quite impressed with the MSI MAG B560 Tomahawk WiFi. Not only can it provide a good home to cheaper multiplier-locked CPUs such as the Core i5-11400F (see p16), but it can also handle more powerful K-series CPUs, it can access Adaptive Boost Technology and it can hit the same memory frequencies as Z-series boards.

This means it's definitely worth asking if you need a Z-series board, and whether you can save cash by going for B560 instead. Given what we've seen here, we'd argue that the B560 chipset's appeal is definitely a lot stronger than previous non-Z-series chipsets.

Given its price, there's a lack of overclocking-focused features on this board, but it does have decent VRMs and cooling, three M.2 ports and two heatsinks, so you won't be left wanting for much. If you're happy to stick to stock CPU speed, but want to use fast memory and save some cash, the MSI MAG B560 Tomahawk WiFi will provide a good home to any Rocket Lake CPU.

ANTONY LEATHER

BURY THE HATCHET

- + Good VRM cooling
- + Adaptive Boost works on Core i9-11900K
- + Reasonable value

HATCHET JOB

- Few additional features
- Average audio performance
- There are cheaper B560 options

PERFORMANCE
31/35

FEATURES
26/35

VALUE
27/30

OVERALL SCORE

84%

VERDICT

Successfully showcases Intel's B560 chipset. It might not overclock your CPU, but it gives you PCI-E 4 support and overclockable memory with change from £180.

ATX CASE

FRACTAL DESIGN MESHIFY 2 COMPACT / £90 inc VAT

SUPPLIER scan.co.uk

Hot on the heels of the Define 7 Compact is another rejigged and miniaturised version of a Fractal ATX case – the Meshify 2 Compact. It retains various design aspects of its bigger sibling, the Meshify 2, but in a chassis that measures just 21cm wide and 42cm deep. It's not going to threaten many mini-ITX cases, but it's certainly going to save desk space compared with most ATX cases.

At £90 inc VAT, it's a bit cheaper than the Define 7 Compact, presumably due to the mesh front panel using less material than the plastic panel of the latter. That's the key difference between the two cases, with the Meshify 2 Compact sporting a large angular mesh on the front panel, but also lacking the ability to use a closed roof section. There's no optional panel in the box as there is with the Define 7 Compact, so you're stuck with a vented roof.

Airflow is the focus of the Meshify 2 Compact, and it doesn't just have more vents than the Define 7 Compact either. It also sports an additional front 140mm fan, with a pair of fans pushing air into the case compared to just one with the Define 7 Compact.

With a vented front panel, the case lends itself well to water cooling, and the PSU cover has removable plates that offer extended clearance for radiators. There's more than enough space for a 60mm-thick 280mm or 360mm radiator at the front with a single row of fans, as well as a 240mm radiator in the roof as long as the components on your motherboard sit more than 40mm below the roof.

The mounts in the roof are offset, with Fractal Design giving you as much clearance away from the motherboard as possible. The Define 7 Compact's party trick is on display here too, with the Meshify 2 Compact able to ditch its entire roof section, including the usual support beam that joins the top two corners of the case. This completely opens up the case and makes a whole bunch of building jobs a lot easier, such as fitting the 8-pin CPU power connector, installing a motherboard or mounting radiators.



The front panel offers a pair of USB 3 ports as well as a USB 3.1 Type-C port, which requires a Type-C header on your motherboard. There's also power and reset buttons, and a pair of audio jacks for a microphone and headphones.

Moving down from that panel is the front mesh section. On other meshed cases, the mesh is usually fixed in place, so you have to yank off the whole panel to access filters beneath it, or to mount extra fans or radiators. However, the Meshify 2 Compact allows you to remove the mesh section separately, leaving the plastic frame behind. It's easier to pull off than your typical front panel, and gives full access to the fan mounts beneath. There's even a pull-out dust filter as an added layer of protection behind the front mesh, and an additional dust filter in the base of the case.

The narrow width of the case means there's not a particularly deep space for stowing cables behind the motherboard tray, but it's at least easy to tidy, with six Velcro ties ready to secure cables and plenty of other anchor points for cable ties. Thankfully, the rubber grommets that surround the numerous cable-routing holes proved particularly resilient to popping out too.

There aren't too many stand-out features in terms of storage, with a pair of dedicated 2.5in SSD mounts

SPEC

Dimensions (mm)

210 x 424 x 475 (W x D x H)

Material

Steel, plastic, glass

Available colours

Black, black/white

Weight

7.7kg

Front panel

Power, reset, 2 x USB 3, 1 x USB 3.1 Type-C, stereo, mic

Drive bays

2 x 2.5/3.5in, 2 x 2.5in

Form factor(s)

ATX, micro-ATX

Cooling

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

CPU cooler clearance

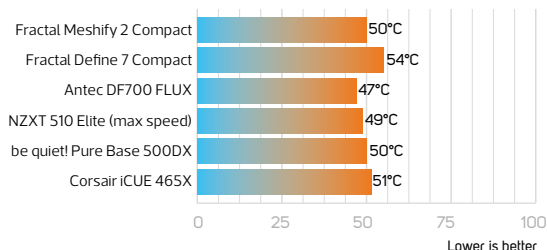
169mm

Maximum graphics card length

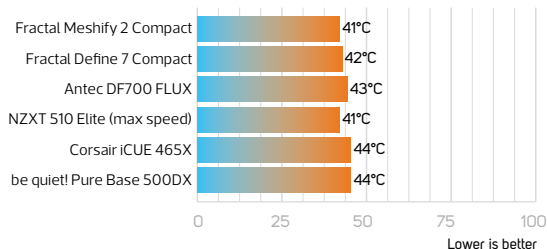
341mm

TEMPERATURE RESULTS

CPU DELTA T



GPU DELTA T



along with two 2.5in/3.5in bays in the base, which are fairly typical of cases this size. Meanwhile the CPU cooler clearance is decent at 169mm, as is the graphics card cooler clearance of 341mm. As you might expect, though, there's no E-ATX motherboard support and you'll need to use a PSU that measures 165mm long or shorter if you intend to use the hard disk mounts and front fan. However, removing the drive trays opens up this area to 200mm of clearance.

Performance

We expected better temperatures compared with the Define 7 Compact, given the addition of a front mesh and extra front fan, and sure enough, the Meshify 2 dropped the CPU delta T by 4°C from 54°C to 50°C. That result is right up there with the best-performing cases we've seen, such as the be quiet! Pure Base 500DX and NZXT 510 Elite with its highest fan speed, but warmer than the Antec DF700 FLUX's excellent result of 47°C.

Meanwhile, the GPU delta T of 41°C was one degree cooler than the Define 7 Compact, though, which makes sense seeing as it also has a fan pointed at its GPU, albeit with slightly restricted airflow. Overall, the Meshify 2 Compact is certainly a very capable case out of the box and the fan noise was extremely quiet at full speed, despite the Meshify 2 Compact's meshed front potentially allowing more sound to escape than the Define 7 Compact's solid panel.

FRACTAL

- + Excellent cooling
- + Very convenient build process
- + Good water-cooling support

FRACTIONOUS

- Only two hard disk mounts
- CPU cooling not chart-topping
- Reasonable rather than excellent value



Conclusion

The Fractal Design Meshify 2 Compact is very similar to the Define 7 Compact in terms of features and layout. The latter may look a little smarter with its closed front panel, but the Meshify 2 Compact is still extremely quiet, and the benefit in airflow is clear, with a much lower CPU delta T than the Define 7 Compact, and the GPU cooling was a little better too. If you're not fussed by the Define 7 Compact's closed front, the Meshify 2 Compact is definitely the better of the two cases, especially as it's otherwise identical and costs less money.

The other cases to bear in mind in this price range are the likes of the be quiet! Pure Base 500DX and Antec DF700 FLUX. Both are cheaper than the Meshify 2 Compact, and also offer RGB lighting, but only the Antec managed to offer better cooling, and that was just a few degrees knocked off the CPU delta T.

The Meshify 2 Compact beats them both in terms of easy building and size though. If you have around £100 to spend on a PC case, these cases should occupy the top three slots on your shortlist – it's then a matter for your priorities.

ANTONY LEATHER

COOLING
26/30

FEATURES
17/20

DESIGN
28/30

VALUE
17/20

OVERALL SCORE

88%

VERDICT

An excellent compact case that's great out of the box and has scope for a decent water-cooling system.



CUSTOM GAMING

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SYSTEMS



VORTEX XT GAMING DESKTOP

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- Gigabyte Z590 UD AC <
- 16GB Corsair VENGEANCE 3000MHz <
- 12GB NVIDIA GEFORCE RTX 3060 <
- 512GB Intel® H10 NVMe SSD + 32GB Optane™ <
- Genuine Windows 10 Home <



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This spec from
£1,299.99



FUSION PRO GAMING DESKTOP

- > AMD Ryzen 7 5800X
- > ASUS® TUF X570-PLUS GAMING
- > 16GB Corsair VENGEANCE 3000MHz
- > 16GB AMD RADEON™ RX 6800
- > 512GB PCS PCIe M.2 SSD
- > Genuine Windows 10 Home



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DDR4 MEMORY KIT

THERMALTAKE TOUGHRAM XG RGB / £132 inc VAT (16GB, 3600MHz, dual-channel)

SUPPLIER ebuyer.com

While you can't buy graphics cards for reasonable money at the moment, memory upgrades are thankfully a little more affordable. However, if you want a cutting-edge kit using the latest features such as RGB lighting, you'll still pay a small premium, as is the case with Thermaltake ToughRAM.

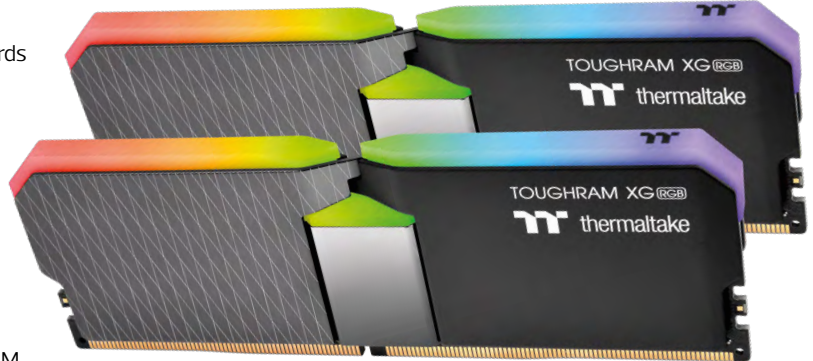
With a price of £132 inc VAT for a dual-channel 16GB kit of 3600MHz RAM, The ToughRAM costs a tad more than the Gigabyte Aorus RGB memory kit we also looked at this month (see opposite), and a good chunk more than Corsair's 3600MHz Vengeance RGB Pro kits. The Thermaltake modules are quite tall too, measuring 48mm high compared to the super-low profile 41mm height of the Aorus modules.

On the plus side, this extra money does at least buy you another couple of hundred megahertz of rated effective frequency at 3600MHz compared to the Thermaltake's 3333MHz. These Thermaltake modules also offer quite a lot more in the way of light customisation than the Aorus sticks, which we'll get to in a minute.

The memory chips use Hynix C dies and have timings of 18-19-19-39 at this speed, while dual-channel 4000MHz, 4400MHz and 4600MHz kits are also available. Sadly, in our AMD X570 system, we couldn't push the frequency any higher than the default 3600MHz, even if we bumped up the DDR voltage to 1.4V, but this frequency is still fast enough to make the most of synchronising with Infinity Fabric on Zen 2 and Zen 3 CPUs anyway.

The modules themselves are beautiful and have three diffusing RGB LED covers each. The top strip comprises two arrow shapes, with the points meeting in the middle, and a third triangular section sits underneath the meeting point. The diffusing covers all sit on top of a glossy grey metal midsection. Eight RGB LEDs sit underneath them, and although you can control the colour of each of them, you can't adjust the colour of each of the three sections independently, as there's some shared lighting that spills over from the centre section into the top strips.

Meanwhile, the heatsinks are black with a crosshatch design on one side. The most impressive part of these modules' attire, though, is of course the RGB lighting. It's



punchy, vivid and all but the white colour setting is accurate – the latter lacks the vibrant pure white we've seen from other modules, with Corsair's latest sticks offering slightly more vibrant lighting too. However, the greens and yellows here were more convincing than they were on the Aorus RGB memory.

Thermaltake's software also allows you to choose from numerous lighting effects, including a static mode. You can set most of the effects to make use of the full RGB spectrum, dishing out fancy rainbow lights or applying effects to single or customised colours, so it's fairly flexible.

Conclusion

Thermaltake's ToughRAM XG RGB modules look unique, and offer vivid and highly customisable RGB lighting. The only colour that wasn't as accurate as the competition was white. However, the ToughRAM XG RGB modules are much shorter than Corsair's standard Vengeance modules and have an interesting trio of illuminated areas, which makes them stand out in terms of looks.

The only issue is price, as Corsair's Vengeance Pro RGB kits currently cost under £110 inc VAT for the same 3600MHz speed. As such, unless you're sold on the ToughRAM XG RGB unique exterior and multiple lighting zones, Corsair's Vengeance Pro RGB memory remains a slightly better buy.

ANTONY LEATHER

VERDICT

Good-looking and vibrantly lit RGB memory, although the competition is a bit cheaper.

THERMOS

- + Separated lighting zones
- + Individual LED control
- + Unique exterior design

PLASTIC CUP

- Zero overclocking headroom
- Whites aren't pure or vibrant
- Competition is cheaper

SPEC

Frequency
3600MHz (tested) / 4000MHz / 4400MHz / 4600MHz

Timings
18-19-19-39 / 18-19-19-39 / 19-25-25-45 / 19-26-26-45

Voltage
1.35V

Height (from base)
48mm

Lighting
Yes (RGB)

PERFORMANCE
24/30

DESIGN
22/25

VALUE
35/45

OVERALL SCORE

81%

DDR4 MEMORY KIT

AORUS RGB MEMORY

/ **£115** inc VAT (16GB, 3333MHz, dual-channel)

SUPPLIER scan.co.uk

It may have taken a while for PC memory manufacturers to work out how to send enough power, as well as the lighting signals, for RGB memory over the bus, but there's now no shortage of RGB memory kits available from all the big players. What's more, we're regularly seeing the designs getting refreshed with attractive module designs and improved lighting.

Gigabyte's last foray into this competitive arena proved quite successful, with the company offering dummy kits that enabled you to fill all your memory slots for a lot less cash than buying a full quad-channel kit. The new Aorus RGB Memory does the same, with kits limited to dual-channel setups and available in a range of speeds, with or without so-called Demo Kits, which essentially give you a pair of dummy lighting modules in addition to the memory modules.

Our sample kit included a pair of 3333MHz modules, which use Hynix D-die memory chips rated to run at 18-20-20-40 timings. From top to bottom, they measure just 41mm tall, which means they shouldn't interfere as much with large coolers as other taller modules, such as Corsair's Vengeance Pro or Dominator modules.

The new Aorus sticks are much darker than the previous generation too, with the PCBs sandwiched between two dark grey aluminium heatsinks. Each memory module has a row of LEDs along the top of each side of the PCB, and these LEDs sit underneath opaque plastic covers that diffuse the light. However, there were clear dark spots between the LEDs in the covers – we thought they looked quite classy, but these aren't the modules for you if you're after seamless joins of colour.

You'll need to use Gigabyte's RGB Fusion 2 software to control the lighting, and we couldn't get it to link up with other

software such as Corsair's iCUE either, but you'll have more luck if you have a Gigabyte motherboard, of course.

The software is also rather limited in that you can't control each LED, like you can with Corsair's kits. Yellows and white weren't particularly convincing either, with white lights especially having a pink-grey hue. However, the



rest of the colours and the rainbow mode looked great, and the colours were particularly vivid.

Being rated at 3333MHz, we hoped we might be able to coax the Hynix D-die memory chips up to 3600MHz, but in the end, we could only hit 3400MHz in our AMD X570 motherboard, which is a boost of just 67MHz.

Conclusion

The Aorus RGB Memory's lighting actually looks rather distinctive, despite there being clear gaps between the LEDs, which are still visible through the diffusing covers. It's a shame, then, that you can't tweak the LEDs individually. The lighting effects are fairly limited too, but as with most RGB memory, you'll either be won over by the aesthetics or the price.

Regarding the former, the Aorus modules are certainly very attractive, although they're not quite as flexible when it comes to dishing out photons as Corsair's Vengeance Pro or Dominator RGB modules. The low-profile status is definitely a big boon, though, and one that even Corsair can't currently match – its Vengeance RGP Pro SL modules measure 3mm taller at 44mm.

The price of £115 inc VAT for a 3333MHz 16GB dual-channel kit isn't terrible, but it's hard to justify when a 3600MHz Corsair Vengeance RGB Pro kit can be bought for just under £100 from scan.co.uk. The Aorus RGB Memory struggles to compete here with the lighting quality on offer, but these are still attractive modules if you want some RGB lighting in a compact form factor.

ANTONY LEATHER

VERDICT

Super-low-profile modules for RGB memory, although it's a bit overpriced and not as flexible as the competition.

RAINBOW

- + Attractive segmented lighting
- + Very low profile
- + Option of dummy modules to fill slots

RAIN STORM

- Limited overclocking headroom
- Lighting effects not that flexible
- Some colours lack purity

PERFORMANCE
24/30

DESIGN
20/25

VALUE
36/45

OVERALL SCORE

80%

SPEC

Effective frequency
3333MHz (tested) /
3733MHz / 4400MHz

Timings
18-20-20-40 / 20-19-
19-43 / 19-26-26-46

Voltage
1.35V

Height (from base)
41mm

Lighting
Yes (RGB)

27IN GAMING MONITOR

DELL S2721HGF

/ £199 inc VAT

SUPPLIER dell.co.uk



Dell's S2721HGF is one of the cheapest 27in displays we've seen for some time, and that makes it a tempting option for anyone who wants a sizeable gaming display without spending silly amounts of cash.

It's kitted out with a 1080p VA panel that's compatible with AMD FreeSync Premium and Nvidia G-Sync at 144Hz, and it has a 4ms response time. On paper, that means it's good enough for tackling mainstream single-player games and esports titles without putting a huge amount of stress on your GPU to hit a sky-high refresh rate.

The Dell has a 1500R curve, too, which improves immersion. That said, twitchy esports players will benefit from a non-VA 240Hz display with a 1ms response time, and a 2,560 x 1,440 resolution would make games look crisper – the 1080p resolution across this 27in display results in a low pixel density and it doesn't look particularly sharp.

On the outside, the Dell looks decent, and it has slim bezels, so affordable multi-monitor gaming is possible. It's easy to assemble, the stand has a cable-routing hole and the on-screen display menu system is well organised, fast and managed by a snappy joystick control.

At this price, though, compromise is inevitable. Build quality is mediocre: the rear moves too much and the screen wobbles. The Dell has 100mm of height adjustment alongside tilt movement and 100mm VESA support, but there's no swivelling, and the movement is stiff. This display has no USB ports or speakers either.

Dell's display squares up against the AOC 27G2U, which is our favourite affordable 1080p 27in panel. That screen has more adjustment, and it includes speakers and USB ports. The AOC isn't curved, but it does have a 1ms response time.

The Dell delivered a stunning contrast ratio of 3,138:1, which is far higher than the AOC's IPS panel. The black point of 0.08cd/m² is stellar, and those results create a bold, punchy display with impressive depth in darker areas. The active sync features provided tear and stutter-free gameplay, although there's still a little blurring in the fastest situations at 144Hz. There's barely any inverse ghosting unless

you use the toughest overdrive mode, but those options don't create a significant improvement either.

Meanwhile, the Dell's delta E of 2.16 is reasonable rather than outstanding, and its colour temperature of 6,359K is good. Its gamma average of 2.37 is wayward, though, and this display rendered 90.8 per cent of the sRGB gamut at 98.4 per cent volume, so it can't display every shade properly. Everyday gaming won't be significantly hindered by these middling figures, but the IPS-based AOC is better.

Conclusion

The Dell S2721HGF has huge contrast and a deep black point, and those attributes mean you get a punchy and vibrant experience. The colours are good enough to handle mainstream gameplay, and it has decent syncing options too. The rival AOC display doesn't match the Dell in contrast, but it still hits 1,447:1 there, and the AOC has superior colours and a more responsive IPS panel. The Dell also has mediocre adjustability and few extra features, and the AOC remains better in those areas too.

The Dell can handle mainstream gaming, and its contrast means it has loads of punch and depth, but there are also disappointing compromises in several other areas. With superior colours and more features, the AOC 27G2U remains our budget 27in display of choice.

MIKE JENNINGS

VERDICT

Impressive contrast results in a punchy image, but the Dell is too middling in too many other areas.

DELL-ICIOUS

- + Great contrast and deep blacks
- + Low price
- + Slim bezels and decent looks

DELL-ETED

- Mediocre colour performance
- Few extra features
- Middling adjustability

SPEC

Screen size
27in

Resolution
1,920 x 1,080

Panel technology
VA

Maximum refresh rate
144Hz

Response time
4ms

Stated contrast ratio
3,000:1

Active sync
AMD FreeSync Premium and
Nvidia G-Sync compatible

Display inputs
1x DisplayPort 1.2, 2x HDMI 2

Audio
Headphone jack

Stand adjustment
Height, tilt

Extras
100 x 100mm VESA mount

IMAGE QUALITY

24/30

GAMING

22/30

FEATURES

14/20

VALUE

17/20

OVERALL SCORE

77%



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24IN GAMING MONITOR

PHILIPS 242E1GAJ

/ £150 inc VAT

SUPPLIER laptopsdirect.co.uk

The Blur Busters UFO ghosting test shows up the slow response time of the 242E1GAJ (left) compared to the AOC 24G2U (right)



SPEC

Screen size
23.6in

Resolution
1,920 x 1,080

Panel technology
VA

Maximum refresh rate
144Hz (165Hz overclocked)

Response time
4ms (1ms MPRT)

Stated contrast ratio
3,500:1

Active sync
FreeSync and G-Sync compatible

Display inputs
1x DisplayPort 1.2, 1x HDMI

Audio
2 x 3W speakers, headphone out

Stand adjustment
Height, tilt

Extras
100 x 100mm VESA mount

Philips' 242E1GAJ is a classy-looking budget gaming monitor that eschews the gamer stylings of many other brands, and instead opts for a simple slim frame and silver stand. The stand offers height and tilt adjustment, but not rotation or pivot, but that's to be expected at this budget end of the market.

Holes to attach a monitor mount are also included above the ports, which all stick straight out the back of the display. From left to right, the ports consist of the input from the mains power brick, a headphone jack, and inputs for HDMI and DisplayPort. It's a modest but adequate selection, and the headphone port sounds clear too, unlike some cheap displays. Likewise, the pair of 3W speakers sound okay, with a little more depth and clarity than the most basic options.

This 24in monitor sports a 1,920 x 1,080 resolution, and its specs suggest a reasonably capable display. It can hit a 144Hz refresh rate, has a 1ms motion picture response time (MPRT) rating, it can deliver a wide colour gamut (130 per cent sRGB), and includes FreeSync Premium support, along with compatibility with G-Sync, so you can eliminate tearing and stutter in games on both AMD and Nvidia GPUs.

However, there are some glaring issues. For a start, maximum brightness is a piddling 209 nits in its default high colour gamut modes, while colour balance is poor (the 6,500K colour temperature mode measured 7,383K) resulting in a cold, blue/green tinge to the image, making this display a poor choice for colour-accurate work such as image editing. We had to select the User colour mode and change the RGB colour values all the way from 100 x 100 x 100 to 100 x 87 x 89 to get the colour balance about right.

An sRGB mode is on hand to reduce the colour gamut (down to 115 per cent) if needed, and you can often rely on such modes to provide good colour balance. However, in



this mode, it was even worse (7,817K), and bizarrely, the brightness was also fixed but at a higher level than the normal modes, hitting 254 nits.

Being a VA panel, contrast is good (as high as 4,191:1 in some modes), and otherwise, image quality is perfectly adequate for movie watching and general desktop use, thanks to good viewing angles, an accurate gamma curve and an ability to produce fine differences in colour.

The biggest problem with this display, though, is its gaming performance. The native response time of the VA panel is terrible, resulting in such long trails behind moving objects that we genuinely struggled to aim in fast-paced games such as first-person shooters. No amount of upping the overdrive (SmartResponse) or backlight-strobing blur reduction (MPRT) really fixed this problem, with the former even adding more problems by introducing inverse ghosting.

Conclusion

The Philips 242E1GAJ gets a lot right with its very low price, ample feature set and stylish design. Its image quality is okay too, especially if you covet the high contrast of VA-type LCD panels. However, its gaming performance is frankly terrible. There are many better gaming displays for a similar price.

EDWARD CHESTER

VERDICT

A gaming display simply can't get away with a response time this bad.

RESPONSIVE

- + High contrast panel
- + Decent features for the price
- + Very low price

ASLEEP

- Very slow response time
- Poor default colour balance
- Low max brightness

IMAGE QUALITY
20/30

GAMING
10/30

FEATURES
15/20

VALUE
15/20

OVERALL SCORE

60%

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SPEC

- **Sensor** PixArt PAW3327DB
- **DPI levels** 800, 1,600, 2,400, 3,200, 4,800 and 6,200
- **Switches** Huano (10-million click lifetime)
- **RGB lighting** 11 modes switchable
- **Software programmable** Supports macro for all buttons
- **Polling rate** 125, 250, 500 and 1000Hz switchable
- **Tracking speed** 220 inches per second
- **Acceleration** 30G
- **Weight** 72g
- **Ascended cord** Light and flexible
- **Dimensions (mm)** 67 x 128 x 38 (W x D x H)

Our generous pals at Chillblast are kindly offering an award-winning Aero RGB gaming mouse (see Issue 208, p33) to anyone who takes out a 12-month UK subscription to Custom PC magazine.

Designed in Poole, Dorset, by Chillblast's team of gaming experts, the Aero RGB is designed for competitive gaming. Its honeycomb mesh design retains incredible strength, while allowing ventilation to keep your palm cool and fresh. Meanwhile, its carefully optimised 72g weight is ideal for gamers who want the fastest possible reaction times.

The PixArt PAW3327DB sensor allows for high DPI levels, while the all-Huano switches provide longevity and a tactile click response. Chillblast's braided, ascended cord also means you're never impeded by the cable, while support for horizontal acceleration of up to 30G means even professional esports players will never overwhelm its tracking hardware.

A plethora of customisation also awaits in the software, where you can program sensitivity, polling rate, recordable macros and RGB lighting effects. The Aero RGB is an awesome weapon for your favourite MOBA, FPS or strategy title.



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34IN GAMING MONITOR

COOLER MASTER GM34-CW / £549 inc VAT

SUPPLIER ebuyer.com

Cooler Master is best known for making cases and coolers, but the GM34-CW is its first gaming monitor, which makes a big impression with a curved, widescreen design. The 34in panel has a resolution of 3,440 x 1,440 and an aspect ratio of 21:9, which means racing and shooting titles benefit from the broad field of view, and the 1500R curve proves immersive rather than overwhelming. The size and resolution match those of the LG UltraGear 34GN850, which is our current favourite 34in widescreen gaming panel.

MASTERY

- + Vibrant colours and great contrast
- + Large curved screen
- + Decent resolution

MYSTERY

- Middling refresh rate ability
- Missing features
- Irritating OSD

SPEC

Screen size
34in

Resolution
3,440 x 1,440

Panel technology
VA

Maximum refresh rate
144Hz

Response time
1ms

Contrast
3,000:1

Active sync
AMD FreeSync 2 and Nvidia G-Sync compatible

Display inputs
2 x DisplayPort 1.4, 1 x HDMI 2, 1 x HDMI 1.4

Audio
Headphone jack

Stand adjustment
Height, pivot, tilt

Extras
75 x 75mm VESA mount

HDR standard
DisplayHDR 400

There are few surprises on the inside – the GM34-CW uses a 10-bit VA panel with a 144Hz refresh rate and 1ms response time. It also supports AMD FreeSync and offers compatibility with Nvidia G-Sync, eliminating tearing artefacts by synchronising the refresh rate with the frame rate from your graphics card.

On the outside, the slim bezels and sleek base impress, and build quality is decent. However, the rear lighting is only available in purple and the stand's extra screws mean it's tricky to assemble. It offers height, tilt and swivel adjustment, but movement feels stiff, and the GM34-CW supports 75mm

VESA mounts rather than 100mm mounting.

Meanwhile, there are pairs of DisplayPort and HDMI connections, but neither HDMI port can run at the display's peak refresh rate. There are no USB ports either, and the on-screen display is disappointing – the menu is slow and the buttons are stiff. That said, the more expensive LG isn't much better in these respects – while it has USB ports, it has weaker ergonomics and no lighting.

On the plus side, the Cooler Master's panel delivers big, bold colours. It rendered 99.4 per cent of the sRGB gamut at 144.6 per cent volume, with 91.2 per cent coverage and 102.4 per cent volume in the DCI-P3 gamut. Combine these results with the acceptable delta E of 3.01 and the colour temperature of 6,223K and you've got a screen that renders almost every shade needed for gaming with huge punch – colours leap from the screen and almost look oversaturated.

The brightness and black point results of 390cd/m² and 0.12cd/m² deliver contrast of 3,250:1, which creates tremendous depth. Those figures improve a little in HDR mode,

so there's a noticeable boost to colour and contrast, although the lack of sophisticated dimming means there's not much nuance.

Meanwhile, the 144Hz refresh rate delivered smooth gaming in fast titles, and the solid response time means you can play mainstream esports games here. The LG is a little quicker, but you'll need to step up to a 240Hz refresh rate for meaningful improvement.

There are some areas where the Cooler Master is less impressive. Its motion blur reduction is poor, with excessive ghosting. The off-centre viewing angles aren't great and there's a little backlight bleed. However, these issues aren't ruinous for most gamers. The more expensive LG is faster and has similar colour coverage alongside better delta E and temperature figures. That product uses an IPS display, so it loses vibrancy but has more natural colour reproduction.

Conclusion

The Cooler Master doesn't have much in the way of extra features, and you can get better options for super-fast esports, but it does offer a vibrant image and a large, immersive widescreen display for mainstream gaming at a low price. At £549 inc VAT, it's easy to forgive some of its shortcomings, making this a solid option if you're looking for a big, bold and immersive display.

MIKE JENNINGS

VERDICT

Bold colours, huge contrast and a sweeping design make this an affordable and effective option for immersive gaming.



IMAGE QUALITY

26/30

GAMING

27/30

FEATURES

14/20

VALUE

18/20

OVERALL SCORE

85%

HackSpace

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GAMING LAPTOP

ALIENWARE M17 R4 / £3,499 inc VAT

SUPPLIER [dell.co.uk](https://www.dell.co.uk)



Alienware's laptops have had some of the boldest designs around, and the fourth iteration of the m17 continues that tradition. This white model pairs its bright finish with black accents, hexagonal air vents and loads of RGB LEDs. The m17 looks superb, and it's available in an all-black shade if the white is too bright.

As usual, Alienware also deploys high-end internals. This

machine contains Nvidia's GeForce RTX 3080 laptop GPU, which uses a mighty 16GB of memory. It runs with a 165W TDP in this laptop, which is as high as this core can go and higher than most laptops with this GPU. It's no surprise that the RTX 3080 is unfettered here – it has to output to a 360Hz display.

Meanwhile, the 8-core Intel Core i9-10980HK has base and boost speeds of 2.4GHz and 5.3GHz, and the rest of the spec includes 32GB of memory and a 1TB (2 x 512GB) Micron NVMe SSD RAID 0 array. Network connections are also solid, with support for dual-band Wi-Fi 6 and 2.5Gbps Ethernet.

The Alienware's swaggering attitude continues elsewhere. It measures 400mm wide, 22mm thick and weighs 2.97kg, and it has great build quality. Around the edges you'll find three USB 3.2 Gen 1 ports and a Thunderbolt 3/USB Type-C port. There's also a micro-SD slot and mini-DisplayPort output, and its upgraded HDMI 2.1 output supports 8K displays.

In some areas, though, this year's m17 remains unchanged from last year's machine. The keyboard retains 1.7mm of travel, n-key rollover, a numberpad and quartet of macro keys, and its buttons are fast and solid – it's the best chiclet option for gaming. Just over the horizon, though, is a better alternative: if you're willing to pay £100 more, you'll get a mechanical keyboard that uses Cherry's new MX Ultra Low switches. The trackpad is fine for casual gaming thanks to its crisp buttons, but a USB mouse is always better.

The spec we've reviewed is one of the priciest models available, but cheaper models are available with Core i7 CPUs, RTX 3070 GPUs and 144Hz displays. At the time of writing, though, these machines still cost at least £2,599 inc VAT, with supply issues putting cheaper RTX 3060 specifications out of reach.

Performance

The high-end RTX 3080 delivers amazing mobile gaming pace. In Doom Eternal, its 99th percentile minimum of 199fps was bolstered by a 306fps average, which bodes well for making the most of the 360Hz display in esports titles. In Cyberpunk 2077, its 99th percentile hit 63fps, and it proved playable in Metro Exodus with ray tracing. This is a very capable mobile GPU, and you can even get a couple of extra frames per second if you deploy the Alienware Command Center's overclocked mode.

Games look fantastic on the display too, with G-Sync at 360Hz running smoothly in fast-paced titles. The contrast ratio of 1,391:1 is great for an IPS display and ensures punchy colours, and the black level of 0.23cd/m² is solid and helps to create nuance and depth in darker areas. A delta E of 1.28 and a colour temperature of 6,445K deliver accurate colours, and a 97.8 per cent sRGB colour gamut ratio

SPEC

CPU

2.4GHz Intel Core i9-10980HK

Memory

32GB 2933MHz DDR4

Graphics

Nvidia GeForce RTX 3080 Laptop 16GB

Screen

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

Storage

2 x 512GB Micron 2300 M.2 SSD

Networking

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

Weight

2.97kg

Ports

3 x USB 3.2 Gen 1, 1 x Thunderbolt 3/USB Type-C, 1 x audio, 1 x HDMI, 1 x mini-DisplayPort, 1 x micro-SD slot

Dimensions (mm)

400 x 294 x 22 (W x D x H)

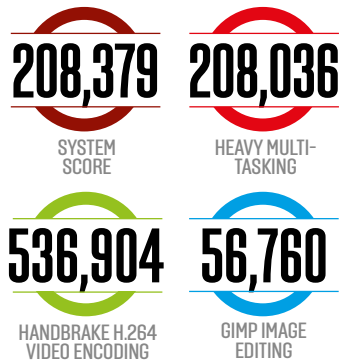
Operating system

Windows 10 Home 64-bit

Warranty

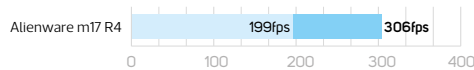
One year parts and labour return to base

BENCHMARK RESULTS



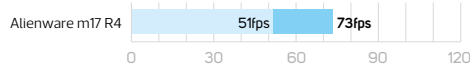
DOOM ETERNAL

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



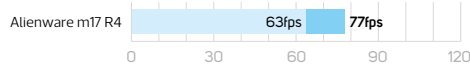
ASSASSIN'S CREED VALHALLA

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



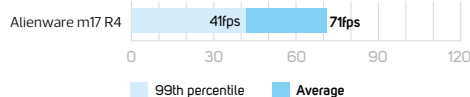
CYBERPUNK 2077

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

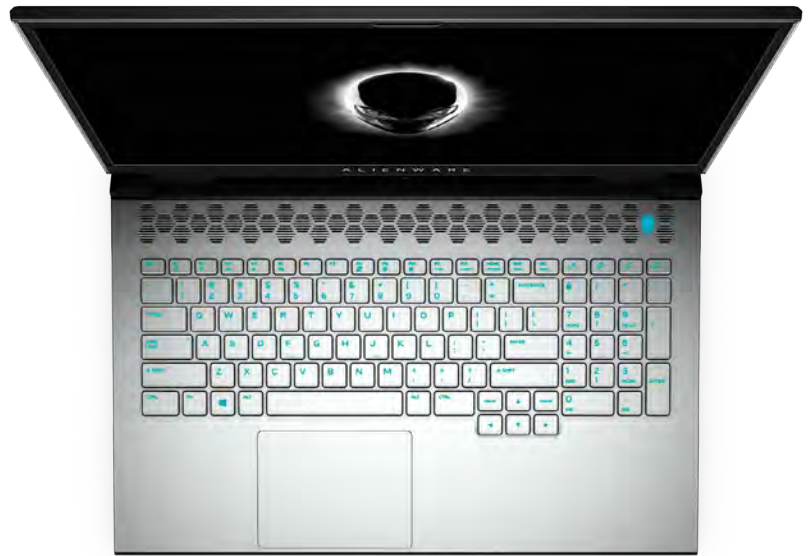


means this panel can produce virtually every shade that mainstream games need. It's a brilliant screen for gaming and movie watching.

The processor is rapid too. Its overall RealBench score of 208,379 rose to 217,997 with the overclocked mode engaged, and that's enough power to handle photo and video editing, content creation and multi-tasking. It's significantly quicker than the Core i7-10875H used in plenty of rivals.

These high-end internals contribute to inconsistent thermal performance though. When gaming, the m17 is no louder than other high-end laptops, so it's easy to tune out the noise with a headset. It was quieter during our usual benchmarks too. The CPU hit a toasty delta T of 77°C in a tough stress test, but it did also achieve its all-core Turbo speed of 4.3GHz, so the cooling system clearly works well.

Unfortunately, though, hot air ejects from the machine's side vents, and the base and area around the keyboard both became uncomfortably hot. You're unlikely to touch these areas when you're at a desk, and these issues aren't unique to the m17, but you won't want it running at full pelt on your lap.



Also, while the CPU is fast and capable, AMD's Ryzen 9 5900HX is faster, especially in heavily multi-threaded software such as Handbrake. It's readily sold in laptops alongside the RTX 3080, usually at a cheaper price than this. Intel's new H-series 11th-gen chips have also just been announced, and it will be worth waiting to see if Alienware plans to upgrade the m17 to the new Core i9-11980HK.

There are a couple of other areas where the Alienware doesn't quite deliver as well. The dual-SSD RAID array only delivered read and write speeds of 3,272MB/sec and 2,348MB/sec. These are satisfactory results that won't slow the laptop, but the RAID configuration used here has no data redundancy and it's no faster than a middling, solo drive. Don't expect much from the speakers either, which are surprisingly tinny.

Not surprisingly, there's not much battery life here either. The m17 lasted for just over an hour while gaming, 90 minutes in a challenging work test and two hours when playing video. As ever, this big beast is best when it's connected to the mains.

Conclusion

Alienware's m17 R4 has big advantages. At its core, it delivers sensational gaming speed, a brilliant 360Hz display, and a bold, robust chassis and keyboard. Those factors make it a superb option for high-end, high-quality gaming with a great design. It's expensive and hot-running, though, and it's not slim or light either. We'd also question the choice of CPU and SSD hardware at this price, but there's no question that the spec still adds up to a great gaming machine if you don't mind it getting hot.

MIKE JENNINGS

VERDICT

A bold, fast gaming option, although it's pricey and gets hot.

OTHERWORLDLY

- + Great gaming power
- + Fantastic 360Hz screen
- + Eye-catching design
- + Solid connection options and ergonomics

NORMALITY

- AMD CPUs are faster
- Poor battery life
- Mixed thermal performance
- Expensive

PERFORMANCE
23/25

DESIGN
22/25

HARDWARE
22/25

VALUE
17/25

OVERALL SCORE

84%

MINI-ITX GAMING PC

CHILLBLAST FUSION
DIABLO / £1,949 inc VATSUPPLIER chillblast.com

hillblast's Fusion Diablo packs an impressive amount of hardware inside a compact and good-looking enclosure.

Indeed, the NZXT H210 is one of the star components in this all-AMD rig. The H210 measures just 349mm tall and 273mm deep, so it's far smaller than any mid-tower ATX case, including the Lian Li used by this month's CyberPower (see p36).

The tiny dimensions make it ideal for compact spaces and frequent travel, and its matt black metal finish and red accents look superb. The tempered glass side panel reveals that the graphics card and cable cover maintain the attractive colour scheme, and the waterblock unit on the NZXT Kraken X53 cooler combines an RGB LED ring with a mirror for an extra eye-catching light effect.

The H210 combines good looks with robust build quality, and it also comes with a USB Type-C connector, three 2.5in drive mounts and neat cabling throughout Chillblast's build.

The compact size does mean limitations though. The installation of the Kraken cooler in the front makes it impossible to use the single 3.5in drive mount, for example, and around the front the case is neat, but cramped – many areas of the motherboard are impossible

to reach without removing other components, and there's no room for a larger graphics card.

Happily, this small system already deploys solid hardware. The Sapphire Radeon RX 6700 XT card runs at stock speed, but it's still equipped with 2,560 stream processors and 40 AMD Ray Accelerators, using AMD's latest RDNA2 architecture. Meanwhile, the AMD Ryzen 5 5600X CPU has six cores and boosts up to 4.6GHz. It's a step back from the 8-core 5800X in the CyberPower, but six cores are fine for gaming.

Chillblast complements those components with great hardware elsewhere. This rig has 32GB of DDR4 memory, a 1TB PCI-E 4 Samsung 980 Pro SSD and an NZXT C750 power supply with a fully modular design and 80 Plus Gold certification. The only missing feature is a secondary hard disk, but that's not a worry if you already use a NAS box.

The Gigabyte B550I Aorus Pro AX motherboard has plenty to admire too. It has 2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi and ALC1220 audio. The rear I/O panel also has USB 3.2 Gen 2 Type-A and Type-C ports, and the board looks good thanks to brushed metal heatsinks and RGB LEDs. However, bear in mind that the mini-ITX design means there are no extra memory slots or PCI-E slots.

Finally, Chillblast protects this PC with a five year labour warranty alongside two years of collect and return service and parts coverage. It's an excellent deal.

SPEC

CPU

3.7GHz AMD Ryzen 5 5600X

Motherboard

Gigabyte B550I Aorus Pro AX

Memory

32GB G.Skill TridentZ RGB
3200MHz DDR4

Graphics

Sapphire Radeon RX 6700 XT 12GB

Storage

1TB Samsung 980 Pro M.2 SSD

Networking

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

Case

NZXT H210

Cooling

CPU: NZXT Kraken X53 with 2 x
120mm fans; GPU: 2 x 90mm fans;
roof: 1 x 120mm; rear: 1 x 120mm fan

PSU

NZXT C750 750W

Ports

Front: 1x USB 3.2 Gen 1, 1x USB
3.2 Gen 1 Type-C, 1x audio; rear: 1
x USB 3.2 Gen 2, 1x USB 3.2 Gen 2
Type-C, 4x USB 3.2 Gen 1, 3 x audio

Operating system

Microsoft Windows 10 Home 64-bit

Warranty

Two years parts and labour collect
and return, followed by three
years labour only return to base

DEVILISH

- + Great mainstream gaming speed
- + Impressive components and connection options
- + Good-looking, small case
- + Generous warranty

SAINTLY

- GPU falls behind overclocked models
- More multi-threaded CPU ability available elsewhere
- Limited upgrade options
- More expensive than ATX rivals



Performance

The Chillblast's 6-core AMD processor is a solid mainstream option. Its single-threaded image editing score of 70,362 isn't far behind the 8-core chip in the CyberPower and beats the Core i5-11600K, and its Handbrake result of 542,885 snuck ahead of the Intel chip while falling behind the 5800X.

The 5600X's overall result of 231,160 follows the same pattern: just ahead of Intel and further behind the 5800X. This CPU has the power to handle mainstream content creation, and it's capable of tackling everyday multi-tasking and gaming without bottlenecks. The Samsung SSD bolsters the Chillblast with stunning read and write speeds of 7,121MB/sec and 5,185MB/sec in CrystalDiskMark.

Meanwhile, the Radeon RX 6700 XT delivers solid gaming performance. At 1,920 x 1,080, it returned 99th percentile minimums of above 60fps in all our single-player titles without ray tracing. It didn't struggle at 2,560 x 1,440 either, with playable scores in most benchmarks.

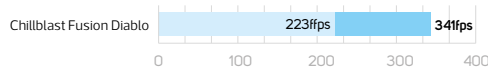
It only faltered in challenging ray-traced scenarios, and that's because AMD's GPUs lack ray-tracing power compared with Nvidia's equivalent Ampere GPUs, and AMD also doesn't have an equivalent of DLSS to help. It's solid mainstream gaming performance, although the CyberPower's GPU overclock made that machine slightly quicker.

Amazingly for such a small machine, its internal temperatures are fine and its noise levels are superbly quiet. When idle and gaming, the noise output is extremely quiet, and if it's underneath a desk, it just won't be noticeable. It was just as quiet during work tests too, and only produced a little extra noise during a full-system stress test.

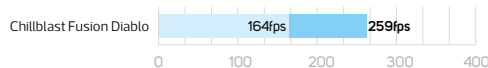
BENCHMARK RESULTS

DOOM ETERNAL

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

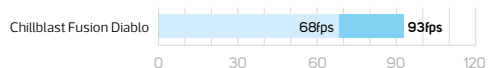


2,560 x 1,440, Vulkan, Ultra Nightmare settings

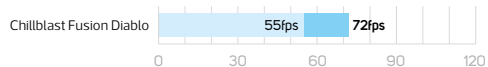


ASSASSIN'S CREED VALHALLA

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

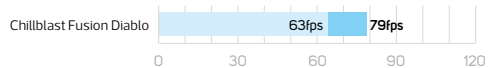


2,560 x 1,440, Ultra High settings, High AA

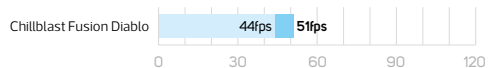


CYBERPUNK 2077

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

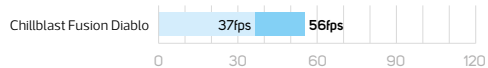


2,560 x 1,440, Ultra preset, no ray tracing

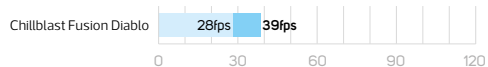


METRO EXODUS

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



2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, High RT



99th Percentile Average

70,362
GIMP IMAGE EDITING

542,885
HANDBRAKE H.264 VIDEO ENCODING

286,795
HEAVY MULTI-TASKING

231,160
SYSTEM SCORE

Conclusion

This Chillblast Fusion Diablo might share its Radeon RX 6700 XT GPU with the CyberPower, but these systems are otherwise quite different. Positively, the Chillblast has a sleeker, compact design, twice as much memory, a larger, faster SSD, a superior PSU and quieter performance.

Negatively, the CyberPower's 8-core chip makes it faster in heavily multi-threaded software, and it's also £200 cheaper, but if gaming is your top priority then those two extra cores don't gain you much benefit anyway. If you want a potent, well-built mini gaming rig amid the current GPU shortage, the Chillblast Fusion Diablo is a small, quiet and well-balanced machine, if a bit overpriced.

MIKE JENNINGS

VERDICT

Compact, quiet and fitted with good components, although it's not necessarily the fastest hardware available for the price.

PERFORMANCE
21/25

DESIGN
22/25

HARDWARE
22/25

VALUE
19/25

OVERALL SCORE
84%

AMD B550 GAMING PC

CYBERPOWER ULTRA
R57 ELITE / £1,799 inc VAT

SUPPLIER cyberpowersystem.co.uk

Both of this month's review systems rely on AMD components amid ongoing component shortages, and this CyberPower machine undercuts Chillblast's mini machine. That's quite impressive when you consider the components on show. The R57 Elite deploys a Ryzen 7 5800X processor, with eight multi-threaded Zen 3 cores clocked at base and peak boost speeds of 3.8GHz and 4.7GHz respectively.

Meanwhile, the MSI Radeon RX 6700 XT graphics card has a slight overclock – its original boost speed of 2581MHz now sits at 2622MHz. It can handle ray tracing thanks to 40 AMD Ray Accelerators, but there's no equivalent of DLSS, and this GPU's ray-tracing performance can't match the equivalent competition from Nvidia. It's still a decent gaming GPU,

however, especially amid the current stock shortage.

The rest of the specification is less noteworthy. There's 16GB of memory and a 500GB WD Blue SN550 PCI-E 3 SSD alongside a 2TB hard disk. The Corsair CX750m PSU also only offers 80 Plus Bronze certification and a semi-modular design. Comparatively, the Chillblast serves up double the memory, a 1TB PCI-E 4 Samsung SSD and a fully modular PSU.

All the CyberPower's components plug into an MSI B550M PRO-VDH motherboard, which is generally underwhelming. It has a couple of extra DIMM slots, but expansion is limited elsewhere – the micro-ATX design means you only get two additional 1x PCI-E slots, one of which is used for a meagre single-band 802.11n Wi-Fi card, while the other is covered by the massive graphics card.

This board has entry-level audio and networking as well, and at the rear it only has USB 3.2 Gen 1 ports rather than faster standards, and there's no Type-C port. This is all adequate for most people's needs, but the board does limit this PC's potential.

It's all housed in a conventional Lian Li LanCool 215 mid-tower chassis, so it's far



larger than the Chillblast. It looks bolder too – at the front, its two 200mm intake fans glow with RGB LEDs through the mesh panel. The top has a button for altering the lights, but again there's no USB Type-C connection.

The interior looks plainer than the neat Chillblast, and its build quality isn't quite as impressive, but this larger case has several practical advantages. It's far more spacious, for starters. You can reach more of the motherboard, and the roof-mounted Cooler Master MasterLiquid Lite 240 cooler doesn't impede any other area of the build. Around the rear there are two 2.5in bays and an accessible 3.5in mount as well as a fan hub.

Finally, CyberPower's standard five year labour warranty includes six months of collect and return service and two years of the all-important parts coverage. That's a good deal, although the Chillblast offers the same labour and parts coverage alongside two years of collect and return service.

Performance

The Radeon RX 6700 XT's overclock helped this system to deliver a small advantage over the Chillblast in games. This card can comfortably play games at 1080p, including triple-A titles at frame rates beyond 60fps and esports games at the speeds needed for high refresh-rate displays – at 1080p, it delivered 99th percentile minimums of 66fps in Cyberpunk 2077 and 228fps in Doom Eternal.

It played most games smoothly at 2,560 x 1,440 too – it only faltered when tasked with running Metro Exodus with ray tracing. We solved that problem by deactivating that setting and watching its 99th percentile result improve

SPEC**CPU**

3.8GHz AMD Ryzen 9 5800X

Motherboard

MSI B550M PRO-VDH

Memory16GB Corsair Vengeance
LPX 3200MHz DDR4**Graphics**

MSI Radeon RX 6700 XT 12GB

Storage500GB WD Blue SN550 M.2 SSD;
2TB Seagate Barracuda hard drive**Networking**Gigabit Ethernet, single-
band 802.11n Wi-Fi**Case**

Lian Li LanCool 215

CoolingCPU: Cooler Master MasterLiquid
Lite 240 with 2 x 120mm fans;
GPU: 2 x 90mm fans; front: 2 x
200mm fans; rear: 1 x 120mm fan**PSU**

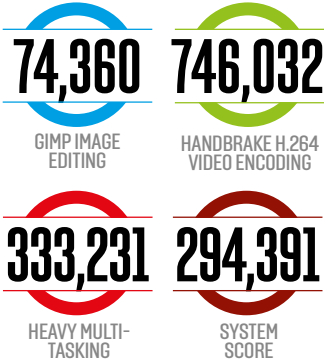
Corsair CX750m 750W

PortsFront: 2 x USB 3.2 Gen 1, 1x
audio; rear: 4 x USB 3.2 Gen 1, 2
x USB 2, 1 x PS/2, 3 x audio**Operating system**

Microsoft Windows 10 Home 64-bit

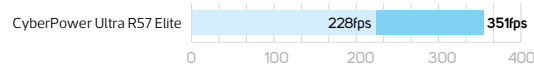
WarrantyFive years labour with two years parts
and six months collect and return

BENCHMARK RESULTS

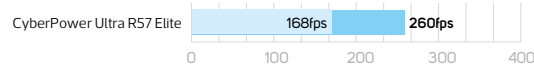


DOOM ETERNAL

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

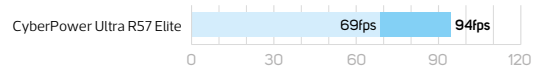


2,560 x 1,440, Vulkan, Ultra Nightmare settings

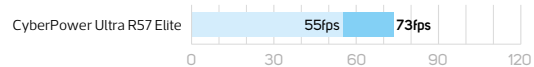


ASSASSIN'S CREED VALHALLA

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

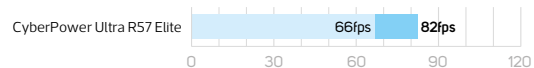


2,560 x 1,440, Ultra High settings, High AA

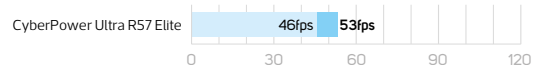


CYBERPUNK 2077

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

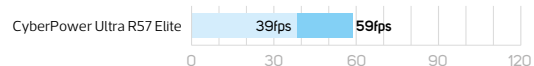


2,560 x 1,440, Ultra preset, no ray tracing

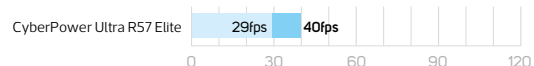


METRO EXODUS

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



2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, High RT



99th Percentile Average

from 29fps to 46fps. The comparatively poor ray-tracing performance and lack of a DLSS equivalent is this GPU's only real weakness – it's generally faster than the GeForce RTX 3060 Ti.

Meanwhile, the 8-core Ryzen chip is comfortably quicker than the 6-core CPU inside the Chillblast. Its Handbrake result of 746,032 is around 200,000 points ahead, which shows the advantage of two extra cores in heavily multi-threaded software, and its overall result of 294,391 is more



than 60,000 points beyond the 6-core chip. The Ryzen 7 5800X is a productivity and content-creation powerhouse.

The PCI-E 3 SSD's read and write results of 3,401MB/sec and 2,703MB/sec are reasonable too, and help the CyberPower in file transfers. This is an area where the Chillblast wins, though, with a far faster Samsung drive.

CyberPower's machine is a little underwhelming in thermal tests too. Its internal temperatures are fine, and its all-core boost speed sat between 4.5GHz and 4.6GHz during tough work benchmarks – an excellent result. The fan noise is consistently audible during idle workloads and gaming, though, and it's a little noisier when it's working hard too. Speakers or a headset will easily deal with this issue in games, but this PC isn't quiet.

Conclusion

This CyberPower system is noticeably noisy and it falters in other areas: its motherboard and connection options are merely adequate, and while the case offers reasonable upgrade room, it's not particularly flashy. In benchmarks, though, this rig shines. Its processor offers fantastic multi-threaded performance, and the GPU is great for 1080p and 2,560 x 1,440 gaming without ray tracing.

If getting the best performance for your money is your top priority over sleek design and next-gen connection options, this machine offers an affordable and effective way to get your hands on a solid chunk of computing power. It's a little rough around the edges though.

MIKE JENNINGS

VERDICT

Great performance for a decent price in the current climate, but the motherboard is underwhelming and this PC is also a bit noisy.

ELITE

- + Solid gaming performance
- + Superb 8-core CPU
- + Reasonable price

DEFEAT

- Underwhelming motherboard
- Semi-modular PSU
- Relatively noisy

PERFORMANCE

23/25

DESIGN

20/25

HARDWARE

18/25

VALUE

22/25

OVERALL SCORE

83%

Custom kit

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

COOLENATOR DRINK COOLER / £14.95 inc VAT

SUPPLIER [amazon.co.uk](https://www.amazon.co.uk)

The Coolenator is a device for keeping drinks cold, providing an alternative on hot days to chugging drinks before they start to warm up, or watering them down with ice. The Coolenator looks simple enough – it's a plastic-covered Styrofoam cup around a central aluminium core, but the clever bit is the gel pack underneath the aluminium. To prepare the Coolenator, you leave it in a freezer for a few hours and the gel pack in the bottom retains that coldness for around four hours once you take it out.



In practice, the Coolenator isn't potent enough to chill a drink from room temperature in a reasonable time frame, but if you drop a cold 330ml can in there, or even a 500ml beer can, it can definitely maintain that chill for long enough that the bigger problem becomes the drink going flat.

One very noticeable effect of using the Coolenator is that your drink might well be colder by the time you get to the bottom of the can. This can take some getting used to but it certainly isn't unpleasant.

Cold feet ●●●●○ Cold drink

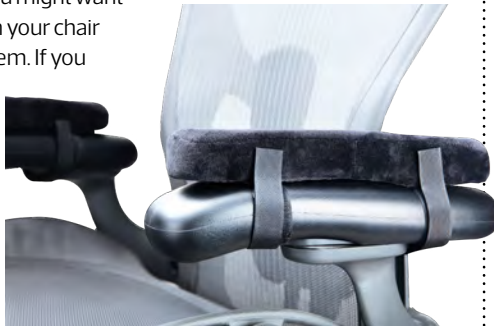
TSUNNEE ARMRESTS

/ £14.29 inc VAT

SUPPLIER [amazon.co.uk](https://www.amazon.co.uk)

The TsunNee Armrests are a pair of soft memory foam pads designed to attach onto the armrests of chairs, either because the original rests aren't comfortable or because they've worn out, been picked at by children, pets or anxious players, or disintegrated by experimental lasers – the fates that typically befall a gaming chair.

Each armrest has two Velcro straps and there's no particular puzzle about their installation. Depending on the shape of the existing armrest, you place the TsunNee on top and attach it as best as possible with the straps. The pads are very comfortable, and thick enough that you might want to lower the arms on your chair to accommodate them. If you want to make a lumpy chair a comfy chair or extend the life of a fading favourite, the TsunNee Armrests do the job.



Cushion ●●●●○ Armrest

ENDGAME GEAR MB1

MOUSE BUNGEE / £13.99 inc VAT

SUPPLIER [overclockers.co.uk](https://www.overclockers.co.uk)

The Endgame Gear MB1 is a mouse bungee that shows an appreciable dedication to the role. It's not a USB hub with an arm on top, and it's not the centre of a light show with a convenient groove along the back for a cable. It simply takes your mouse cable and lifts it out of the way, so you can play games unimpeded.

The MB1 is a weighty lump on your desktop, which is exactly as it should be, with a springy metal arm on top. This arm can be retracted in order to provide what's ostensibly an adjustable length, but it doesn't hold the selected length well, and really works best simply to allow the MB1 to retract into a more mobile shape for transport.

Despite this, the MB1 handles the role of a basic mouse bungee really well.



Grungy ●●●●○ Bungee

ENDGAME GEAR MPC1200 / £49.99 inc VAT

SUPPLIER overclockers.co.uk

With formidable dimensions of 60 x 120cm, the Endgame Gear MPC1200 operates as a sort of universal desktop gaming surface – you run your mouse on it, your keyboard on it and you can have a little nap on it if you want. It's everywhere you want to be – it's vast. Although it's designed to sit more towards the middle of the desk than a regular mousepad that goes off to the side, the MPC1200 still affords acres of space for a mouse on a low sensitivity setting to roam at leisure.

The surface of the pad is made of an optical sensor-friendly fabric called Cordura, which feels comfortable and responsive, and the underside of the pad is rubberised for grip. The MPC1200 is also relatively thin at 3mm, which helps it to avoid feeling squashy or intrusive. It's very light, but the sheer amount of area on the desk gives it enough traction to stay put. A very good acreage of desktop upholstery.



Bath mat ●●●●● Magic carpet

SAMSUNG GALAXY SMARTTAG / £19.99 inc VAT

SUPPLIER amazon.co.uk

The Samsung Galaxy SmartTag is a chunky little tag with a big button – it fits neatly on a key ring, pet collar or really any object that can attach to the loop on its corner. What makes the SmartTag different from many similar devices is that the software is in-depth at the phone-end, while the device itself is relatively simple.

The SmartTag uses Bluetooth Low Energy 5 to connect to your phone for setup, but after that it can use the Galaxy Find network to let you know its location, so it won't go dark as soon as it's out of range of your phone. The Bluetooth range on the SmartTag is ideally up to 120m, although obstacles and conditions will affect this range.

Meanwhile, the SmartThings app is very easy to use – even if you have multiple SmartTags, each one can be labelled and the last known location of each one will be displayed on a map. Once you're close to a SmartTag, the app helps you to search for it by either using the signal strength from the tag, which lets you know if you're getting closer, or by using an alarm. Having an alternative to an audible alarm for searching for the tag is a particularly useful feature.

You can also use the SmartThings app to make use of the button on the tag, either to press and let go or press and hold, so it can act



as a Bluetooth remote in its own right for other connected devices. The 3V lithium battery is expected to last for around 300 days depending on use, and it can be replaced with a little tinkering but it's not rechargeable. The practical usefulness of the SmartTag is subjective, particularly with its range limited to Bluetooth, but if you often find yourself needing to ransack the house to find your keys, the SmartTag is a great addition for under £20.

Seeking ●●●●○ Finding

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

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We're offering an award-winning Chillblast Aero RGB mouse with a 12-month UK subscription for £45 at custompc.co.uk/chillblast, using code **CPCMOUSE**. See p29 for more information.

LABS TEST

Speedy sticks

Antony Leather takes a look at a range of PCI-E 3 and PCI-E 4 SSDs to see which models are worth your cash

How we test

While PCI-E 4 support is now present on both AMD and Intel's latest chipsets, is it worth spending more on the latest SSDs that offer speeds up to 7,000MB/sec, or do cheaper ones represent better value and ultimately better buys? This month we're looking to answer that question. In addition to our SSD feature on p90, we've tested eight SSDs from popular PCI-E 3 models to the latest PCI-E 4 drives, to find the benefits and identify any sweet spots.

We've used an MSI MEG Z590 Ace and Intel Core i5-11600K in our test system to allow PCI-E 4 SSDs to stretch their legs, although many Z490 motherboards also support PCI-E 4 as long as they're

paired with Intel 11th-gen CPUs. We've conducted some real-world tests in our feature, but for this Labs test we're concentrating on raw benchmark speed. We've run a battery of tests using CrystalDiskMark and AS-SSD, as well as carrying out thermal tests to check for throttling.

We test a variety of read and write scenarios, including sequential and random tests, and we also measure the IOPS in AS-SSD. Whether you're looking to upgrade from a SATA SSD to a simple speedier drive, or if you want to shunt around files at 7,000MB/sec, you'll find the drive for you over the next few pages.

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ADATA XPG GAMMIX S50 LITE / **£119** (1TB) inc VAT; **£241** (2TB) inc VAT

SUPPLIER cclonline.com

Offering 2TB of speedy storage for under £250 inc VAT, and 1TB for under £120, the ADATA XPG GAMMIX S50 Lite is certainly an SSD that should be on your radar if you're looking to jump on the PCI-E 4 bandwagon for as little money as possible. However, it doesn't offer much of a performance benefit over the fastest PCI-E 3 SSDs, such as WD's SN750, which cost around the same amount of money.

It's significantly cheaper than the latest PCI-E 4 SSDs, though, most of which retail for around £180 inc VAT for a 1TB module, compared to just £119 here. That said, you'll save even more cash if you're happy to stick with a slower PCI-E 3 drive, as the WD Blue SN550 we've also tested this month only costs £86 for a whole 1TB of storage.

The XPG GAMMIX S50 Lite has an impressive endurance rating of 740 terabytes written (TBW) and a five-year warranty, while it uses TLC memory and a Silicon Motion SM2267EN controller. It uses a cache to speed up write speeds, which sits at around 300GB in size on our 2TB sample. This drive has a formatted capacity of 1,860GB, and transferring more than that in one go will see the maximum write speed fall to below 1000MB/sec, although this is only going to be an issue for extremely large file transfers.

The S50 Lite also includes a thin heatsink, but it wasn't heavy-duty enough to cope



with our five-minute stress test, which saw the temperature top 75°C and the SSD throttling as a result, with the write speed falling to just 600MB/sec.

It's clearly designed to sit under your motherboard's own M.2 heatsink, though, and here, the sequential write speed sat at 3,183MB/sec, even after repeated benchmarks. Likewise, the sequential read speed in CrystalDiskMark sat at 3,858MB/sec, with temperatures staying below 60°C.

Interestingly, the XPG GAMMIX S50 Lite also produced a decent 4K random 32 queue depth read speed of 1,842MB/sec, which was faster than many of the more expensive SSDs in CrystalDiskMark. That said, the write test here saw it fall short of the pricier drives by over 300MB/sec. The S50 Lite was also much slower than the fast-paced competition in AS-SSD's default 4K random read test.

Finally, software for this drive is freely downloadable and easy to use in terms of firmware updates, but it's rather basic.

Conclusion

As long as you use it with your motherboard's M.2 heatsink, the ADATA XPG GAMMIX S50 Lite offers decent performance for its low asking price. It's cheaper than many other PCI-E 4 SSDs, and while the faster drives outpace it in many synthetic tests, that difference isn't always tangible in real-world use. Its write cache is large enough for it to shift a couple of hundred gigabytes around at full speed too, and it also had

SILICON MOTION

- + Good overall performance
- + Better value than fastest PCI-E 4 SSDs
- + Five-year warranty

LOOSE MOTION

- Latest SSDs have quicker sequential speeds
- Needs a third-party heatsink
- Not much faster than best PCI-E 3 SSDs

slightly better performance overall than Samsung's similarly priced PCI-E 3 980 SSD.

The only issues are that original PCI-E 4 SSDs based on Phison E16 controllers are still readily available and slightly faster, with many including large heatsinks for just £10-20 more. You can also get PCI-E 3 SSDs for a lot less money, although WD's £85 SN550 does have significantly lower speeds overall.

Ultimately, the ADATA XPG GAMMIX S50 Lite strikes a good balance of performance and value. It's cheaper than drives that offer higher speeds, but ultimately little real-world benefit, and it still offers a substantial boost over the likes of the WD SN550.

VERDICT

A good balance of price and performance, although it's not much faster than PCI-E 3 drives.

PERFORMANCE
42/50

FEATURES
18/20

VALUE
25/30

OVERALL SCORE
85%

SPEC

Interface PCI-E 4

Full capacity 2TB

Formatted capacity 1,860GB

Heatsink Yes, slimline

NAND TLC

Controller Silicon Motion SM2267EN

Endurance 740TBW

Warranty Five years

ADATA GAMMIX XPG S70 BLADE / £340 (2TB) inc VAT; £157 (1TB) inc VAT

SUPPLIER box.co.uk

There's a mix of super-fast PCI-E 4 SSDs in this month's Labs test, and unlike the last time we looked at a bunch of them, we now have numerous different controllers being used, rather than the reliance on Phison controllers. ADATA's GAMMIX XPG S70 Blade uses an InnoGrit IG5236 controller, along with TLC memory.

As with most TLC-based SSDs, it also has a write cache. This is made up of 1GB of DRAM and around 333GB of pseudo-SLC cache, where the SSD repurposes TLC memory, but only writes one bit of data per memory cell (instead of the usual three with TLC), speeding up the writing process.

If you fill up the SSD completely, there won't be any memory left for the caching, so speeds can drop, and write speeds can fall again if you fill the cache before that data has been offloaded. You're unlikely to encounter this scenario unless you regularly shift enormous amounts of files, however.

The GAMMIX XPG S70 Blade is available in versions with either a large heatsink or a thin slimline one, but we recommend either opting for the former or making use of your motherboard's M.2 heatsink, as the slim heatsink failed to prevent the SSD from throttling after just a minute or two under load in our tests. This saw the write speed fall to just 2,200MB/sec as the SSD passed 70°C, but fitting the drive with our



BLADE RUNNER

- + Fast sequential performance
- + Above-average endurance rating
- + Cheaper than other high-speed SSDs

BLADE II

- Not the fastest in all tests
- Slim heatsink couldn't prevent throttling
- WD SN850 is slightly cheaper

motherboard's heatsink stopped this throttling and kept the temperature below 60°C.

The 1TB sample we tested retails for £157 inc VAT, which is a good deal more than the company's cheaper GAMMIX XPG X50 Lite, but the S70 Blade did post some very impressive figures in our synthetic benchmarks.

It managed a sequential read speed in CrystalDiskMark of 7,011MB/sec and write speed of 5,764, with the latter being the fastest result on test this month. Bizarrely, though, its 4K 32 queue depth performance of 1,577MB/sec was slower than the GAMMIX XPG X50 Lite. However, the 4K random write test saw it better the cheaper SSD, but fail to match the likes of the WD Black SN850, Corsair MP600 Pro and Gigabyte Aorus Gen4 7000s, which managed more than 100MB/sec more.

Meanwhile, AS-SSD saw the S70 Blade match those SSDs in the sequential tests, as well as the 4K random write test, but it was fairly slow in the 4K read test with a speed of just 53MB/sec compared to 78MB/sec for the Gigabyte Aorus Gen4 7000s. Again, the IOPS rating showed a slow performance

in the 4K read test too, at 354,577 versus 504,200 for the Gigabyte SSD – even the XPG GAMMIX S50 Lite was faster in this test. The S70 Blade redeemed itself in the write test with a more on-par result.

Conclusion

The GAMMIX XPG S70 Blade had one or two wobbles in our benchmarks, but the fact remains that overall this is a very fast SSD, with mind-bending sequential speeds that will annihilate big data transfers, as long as you stay within the write cache limits. It offers a higher TBW endurance rating that's higher than that of other SSDs too.

Its biggest trump card, though, is that it costs around £20 less than the competition from Corsair and Gigabyte – they do include more effective heatsinks, but that point is moot if your motherboard already comes with decent heatsinks. The only problem for the S70 Blade is that the faster WD Black SN850 is similarly equipped and costs a bit less, making it ultimately a better buy.

VERDICT

Ridiculously fast in most tests, although the WD SN850 is a slightly better buy.

PERFORMANCE
48/50

FEATURES
18/20

VALUE
18/30

OVERALL SCORE
84%

SPEC

Interface PCI-E 4

Full capacity 1TB

Formatted capacity 953GB

Heatsink Yes, slimline

NAND TLC

Controller InnoGrit IG5236

Endurance 740TBW

Warranty Five years

CORSAIR MP600 PRO

/ **£369** (2TB) inc VAT; **£185** (1TB) inc VAT

SUPPLIER ebuyer.com

Both the Corsair MP600 Pro and Gigabyte Aorus Gen4 7000s use the latest version of Phison's SSD controller – the E18. This is uprated over the original E16 controller used in the first PCI-E 4 SSDs, which were launched in conjunction with AMD's X570 chipset a few years ago.

Now, though, these Phison-based drives have some controller competition, from Samsung's Elpis, WD's Black G2 and ADATA with its InnoGrit IG5236. Under the hood, of course, the SSD is near identical to other SSDs based on the Phison E18, although Corsair has added some extra swagger with a large heatsink, as well as the option of a waterblock-equipped version, complete with its own inlet and outlet using G1/4in ports.

The heatsink alone proved to be very effective on our 1TB sample, though, solving the throttling issue that plagued a few other SSDs this month and allowing you to show off your SSD. We recorded a peak temperature of just 51°C, and the base of the SSD is also thermally attached to the heatsink. You can, of course, remove the heatsink and use one that came with your motherboard, but what's here is more than up to the task of keeping the MP600 Pro cool enough to prevent it from getting too toasty.

The 2TB version costs £369, while our 1TB sample will set you back £185. This is similar to the near-identical Gigabyte Aorus Gen4

7000s, which sports a slightly smaller, less effective heatsink. However, both the WD Black SN850 and ADATA XPG S70 Blade offer similar speeds for cheaper prices, although these drives also rely on you using a third-party heatsink to deal with the heat.

Depending on conditions and its remaining storage space, the MP600 Pro offers around 100GB of SLC write cache in addition to a much smaller DDR4 cache. The SLC cache total isn't as big as on the likes of the ADATA XPG S70, so if you'll be shunting more than 100GB around regularly, this isn't the SSD for you. Thankfully, the need to do so is likely to be rare – for most of us, it will simply never happen. However, the ADATA also trumps the Corsair with its endurance rating, which stands at 740TBW as opposed to 600TBW.

As it's part of the latest PCI-E 4 generation, not surprisingly, we saw some epic sequential speeds from the Corsair drive, recording 7,009MB/sec read and 5,439MB/sec write speeds in CrystalDiskMark's sequential tests. That said, both the Phison E18 SSDs suffered from surprisingly low 4K random read speeds, as did the ADATA XPG S70 Blade.

Only the WD SN850 was able to push through here, managing a speed of 2,172MB/sec compared to just 1,428MB/sec for the MP600 Pro. The 4K random write speed of 1,829MB/sec was back on par, though, and also noticeably faster than the ADATA XPG S70 Blade. The Corsair traded blows with the Gigabyte Aorus Gen4 7000s in AS-SSD, which was slightly ahead in most tests, while the ADATA XPG S70



E18

- + Excellent sequential performance
- + Good 4K random write speeds
- + Effective heatsink

EAST 17

- Smaller than average SLC cache
- Not much of an improvement over previous generation
- Heatsink-less WD SN850 is cheaper

Blade was either similar or slower, being significantly so in the 4K random read test.

Conclusion

We'd pick the Corsair MP600 Pro over the Gigabyte Aorus Gen4 7000s, thanks to its slightly lower temperatures, but there's not much between them. For an SSD that can keep itself cool, the Corsair MP600 Pro is a good buy, as long as you're aware of its average-sized write cache. However, if your motherboard has a heatsink, then the better PCI-E 4 SSD to buy is the WD SN850 – it's a little quicker in some tests and it's cheaper too.

VERDICT

A speedy SSD that doesn't require a third-party heatsink to get the most out of it.

PERFORMANCE
48/50

FEATURES
19/20

VALUE
17/30

OVERALL SCORE
84%

SPEC

Interface PCI-E 4

Full capacity 1TB

Formatted capacity 931GB

Heatsink Yes

NAND TLC

Controller Phison PS5018-E18

Endurance 600TBW

Warranty Five years

GIGABYTE AORUS GEN4 7000S

/ **£360** (2TB) inc VAT; **£184** (1TB) inc VAT

SUPPLIER scan.co.uk

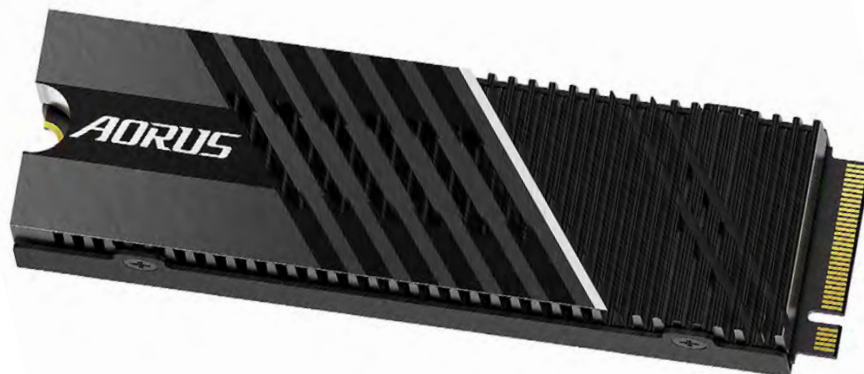
Gigabyte's Aorus Gen4 7000s is the second of two PCI-E 4 SSDs based on Phison's E18 controller on test this month. It's the successor to the original Aorus NVMe Gen4 SSD, and Gigabyte has ditched the large copper heatsink of the original with an aluminium one.

The heatsink also cools the base of the drive, although the whole contraption is a little smaller than Corsair's MP600 Pro. While both SSDs handled our stress test without throttling, the Gigabyte Aorus Gen4 7000s got quite a bit warmer.

The two SSDs are mostly identical otherwise, using TLC flash memory and a 1GB portion of DDR4 for caching. That's in addition to repurposing spare TLC memory in faster SLC mode for an extended speedy cache, which is only a few hundred gigabytes in size when the drive is empty.

Once that's full, you'll see a sizeable drop in performance, but you'd need to be shifting around a heck of a lot of data for that to happen, and even if it does, performance is still going to be far higher than on SATA SSDs and even some PCI-E 3 SSDs.

Our 1TB review sample offers similar performance to the 2TB model, with both drives priced at £184 and £360 inc VAT respectively. The only notable exception is the quoted random read IOPS speed, where Gigabyte states 350,000 IOPS for the former, but 650,000 for the latter. The

**GIG RESCHEDULED**

- + Super-fast sequential speeds
- + Effective heatsink
- + Decent endurance rating

GIG CANCELLED

- 2TB model has some higher claimed speeds
- 4K random read slower than competition
- WD SN850 is cheaper

.....

sequential write speed is lower at 5,500MB/sec compared to 6,850MB/sec too.

The Gigabyte drive does gain a small advantage over the Corsair MP600 Pro in write endurance too, with Gigabyte quoting 700TBW compared to Corsair's 600TBW. Meanwhile, freely downloadable software provides basic information about the SSD, including health, temperature and a means to update the firmware, but there's not much else on offer.

As we expected, the Gigabyte Aorus Gen4 7000s was right up there with the best of them in terms of sequential speeds, hitting 7,021MB/sec read and 5,385MB/sec write speeds in CrystalDiskMark. The 4K random read speed was lower than we expected, though, sitting next to the similar Corsair MP600 Pro at 1,425MB/sec in CrystalDiskMark. That's much slower than the 2,172MB/sec achieved by the WD Black SN850, with the WD SSD confirming this result in the 4K 64-thread test in AS-SSD too.

The Gigabyte's 4K random write speed was on par at 1,833MB/sec, however, and the 4K 64-thread write performance was higher than the WD SSD's result at 854,124 IOPS compared to 707,595 IOPS.

Conclusion

The Gigabyte Aorus Gen4 7000s is good-looking and able to cool itself effectively without the need for a third-party or motherboard heatsink.

This not only prevents it from throttling out of the box, but also allows you to show it off behind a window without hiding it under your motherboard's heatsinks.

If you have a motherboard that supports PCI-E 4 SSDs, the Gigabyte definitely worth considering, although the fact that it's nearly identical to the Corsair MP600 Pro means you have a choice between the two – and the Corsair has a superior heatsink.

The only real issue for the Gigabyte Aorus Gen4 7000s is the price, especially compared with the WD Black SN850, which is slightly faster in some tests and around £30 cheaper, albeit without a heatsink. If your motherboard already comes with M.2 heatsinks, the WD SN850 is a slightly better buy.

VERDICT

A well-rounded fast SSD with an effective heatsink, although the Corsair MP600 Pro runs a bit cooler.

SPEC

Interface PCI-E 4

Full capacity 1TB

Formatted capacity 953GB

Heatsink Yes

NAND TLC

Controller Phison PS5018-E18

Endurance 700TBW

Warranty Five years

PERFORMANCE

48/50

FEATURES

18/20

VALUE

17/30

OVERALL SCORE

83%

SAMSUNG 980 1TB / £117 inc VAT

SUPPLIER ebuyer.com

Some of Samsung's older PCI-E 3 SSDs have been among our favourites over the years and, rather unexpectedly, the company's new vanilla 980 drive doesn't offer PCI-E 4 performance on a budget. Instead, it sticks with the same PCI-E 3 interface as Samsung's 970-series drives. Only its more expensive sibling, the Samsung 980 Pro, has made the move up to the speedier PCI-E 4 interface.

Thankfully, with a cost of £117 inc VAT for 1TB of storage space, the 980 is certainly more wallet-friendly than the £183 inc VAT demanded by the 980 Pro, with its nearest competitor being the ADATA XPG GAMMIX S50 Lite. However, that ADATA drive has made the move to PCI-E 4, and it has a 2TB option as well. Comparatively, the Samsung 980 range stops at 1TB at the moment.

Firstly, in an effort to make the 980 as affordable as possible, Samsung has ditched a DRAM cache and instead relied on its TurboWrite 2 technology to write to the SLC cache. This cache is also a little smaller than the allocation on some other SSDs on test this month at 160GB, although this is still a lot larger than the likes of Samsung's 970 Evo Plus.

The ADATA XPG GAMMIX S50 Lite has a bigger SLC cache, for example, at least when the drive is empty, and it also sports DRAM caching, so it could have a little more grunt in some areas.

SPEC

Interface PCI-E 3

Full capacity 1TB

Formatted capacity 931GB

Heatsink Thin copper strip

NAND TLC

Controller Samsung Pablo

Endurance 600TBW

Warranty Five years



There's no large heatsink included with the 980, but Samsung has included the usual sliver of copper on the underside. Of course, one area that PCI-E 3 SSDs usually have going for them is that throttling generally isn't an issue, and we're pleased to report that, despite hitting some fairly lofty temperatures with the peak hitting over 70°C, this didn't seem to impact on the drive's performance. This is in contrast to the ADATA XPG GAMMIX S50 Lite, which saw its speeds fall away quickly if we didn't use our motherboard's heatsink to keep its temperature in check.

Sadly for Samsung, the ADATA XPG GAMMIX S50 Lite was faster in practically every test, adding over 400MB/sec to the sequential read speed in CrystalDiskMark and nearly 200MB/sec to the write speed.

The difference between the drives was even when it came to 4K random read and write tests, but switching to AS-SSD again saw the Samsung 980 perform noticeably worse in its 4K random read and write tests, with leads for the ADATA SSD in the 64-thread random 4K IOPS read and write tests as well – the latter produced 527,058 IOPS compared to just 399,375 for the Samsung drive.

On the plus side, the Samsung 980 was much faster almost across the board than the WD SN550, adding over 1,000MB/sec to the CrystalDiskMark sequential right speed and nearly doubling its 4K 64-thread read speed, but that WD drive is also £34 cheaper.

PABLO PICASSO

- + No need for heatsink in most cases
- + Good warranty and endurance
- + As fast as pricier SSDs in some tests

PABLO ESCOBAR

- Similarly priced PCI-E 4 SSDs are faster
- Average 4K random read and write performance
- No 2TB option

Conclusion

The Samsung 980's lack of a heatsink didn't result in throttling, but the omission of a DRAM cache seems to hurt it in a few tests, and the similarly priced ADATA XPG GAMMIX S50 Lite is quicker almost across the board.

The Samsung is certainly a lot quicker than the WD SN550, but it demands a £34 premium for the privilege, and you're unlikely to notice much difference in real-world use. Ultimately, there are no stand-out numbers here for Samsung and the ADATA XPG GAMMIX S50 Lite is definitely a better buy if you have a heatsink for it.

VERDICT

Not a bad SSD, but its performance is disappointing given Samsung's previously excellent PCI-E 3 drives.

PERFORMANCE
41/50

FEATURES
17/20

VALUE
21/30

OVERALL SCORE
79%

SAMSUNG 980 PRO

/ **£389** (2TB) inc VAT; **£183** (1TB) inc VAT

SUPPLIER box.co.uk

Samsung's highly anticipated first PCI-E 4 SSD, the 980 Pro, uses Samsung's own Elpis controller along with 3D TLC NAND memory. However, it failed to convincingly win us over in our last SSD Labs test thanks to a comparatively high price of £216 inc VAT for a 1TB drive. This has now fallen to £183, putting it in a similar price range to the latest Phison PCI-E 4 SSDs.

Samsung has paired its V-NAND TLC memory with DRAM and SLC caches, with around 114GB available in total for stashing data at faster speeds than TLC NAND. That's a smaller cache setup than the competition, but Samsung claims the drive can maintain up to a 2,000MB/sec write speed outside of TLC caching.

The 2TB model also boasts an impressive 1,200 TBW rating, although this falls to 600TBW with the 1TB model we reviewed, which is less than Samsung's MLC-based predecessors.

No heatsink is included other than Samsung's usual thin copper strip on the underside, and not surprisingly, the peak temperature hit a toasty 79°C during testing. However, the 980 Pro didn't exhibit any throttling here, sticking to the same speeds when using our motherboard's heatsink. That said, the heatsink dropped the temperature by over 20°C, so it's worth fitting a heatsink if you have one.

SPEC

Interface PCI-E 4

Full capacity 1TB

Formatted capacity 931GB

Heatsink Thin copper strip

NAND TLC

Controller Samsung Elpis

Endurance 600TBW

Warranty Five years



The 980 Pro also supports Samsung's Magician software, enabling you to see drive information, run performance tests and adjust overprovisioning, as well as view the drive's health and how much data has been written to it. Samsung offers free separate data migration software as well, which is more than some of the competition offers.

In terms of raw performance, the Samsung 980 Pro's peak sequential read and write speeds in CrystalDiskMark of 6,662MB/sec and 4,926MB/sec are still significantly quicker than PCI-E 3 drives, although three of the other high-speed PCI-E 4 drives managed to get over the 7,000MB/sec read barrier here, and four of them managed write speeds above 5,300MB/sec as well. It's fair to say that the competition has largely caught up now.

Also, while the 980 Pro's 4K random read test in the same software was on par with the likes of the Corsair MP600 Pro and WD Black SN850, the 4K random write speed of 1,636MB/sec was around 200MB/sec slower. AS-SSD also showed the 980 Pro's sequential write speed, 4K random read and 4K random write speeds being lower.

It was only in the 4K 64-thread peak IOPS results that the Samsung 980 Pro was a little more competitive, coming second behind the WD SN850, massively outpacing the two Phison-based SSDs and coming a clear first place in the write test.

PRO

- + Excellent sequential speeds
- + Superb 4K 64-thread performance
- + Good software

CON

- Slower than competition in some tests
- Low TBW compared with other SSDs
- No heatsink

Conclusion

Despite a price cut, the Samsung 980 Pro is still a tad lacklustre, as its performance now lags behind the competition. We didn't need a heatsink to get the most out of it, but it was still quite a long way behind the latest high-speed competing drives in a few tests.

In particular, the WD Black SN850 offered more consistent performance, and while it needs a heatsink to remain cool, it also costs less money.

Meanwhile, the ADATA XPG GAMMIX S50 Lite won't be noticeably slower in real-world use and costs a lot less money.

VERDICT

Some decent performance results, but the competition has now caught up.

PERFORMANCE
47/50

FEATURES
17/20

VALUE
15/30

OVERALL SCORE
79%

WD BLACK SN850

/ **£339** (2TB) inc VAT; **£158** (1TB) inc VAT

SUPPLIER scan.co.uk

WD hasn't been around as long as some manufacturers in the SSD world, but it's catching up quickly with a host of good models already. The SN850 is the pinnacle of its mainstream SSD achievements so far, and certainly boasts some impressive specifications. This high-end drive clearly aims to topple the Samsung 980 Pro and any Phison-based SSDs from their perches, thanks to the company's in-house WD Black G2 controller.

The SN850, like other SSDs this month, uses TLC memory, a portion of which is siphoned off to create an SLC-like cache that's fast at writing data. In this case, there's around 300GB on offer, which betters the 114GB of the Samsung 980 Pro, but is similar to other PCI-E 4 SSDs. Once you get beyond that point, the write speed will tail off.

There's also a DDR4 cache and a dedicated 12GB SLC chunk of cache too, which is available even when the SSD is full, although that's rarely going to be an issue unless you're regularly shoving around enormous amounts of data.

The drive comes either with or without a heatsink, but it definitely needs a heatsink of some sort. Without one, the SSD rocketed up to 80°C after just a few moments and topped 90°C before our five-minute stress test finished. This saw the CrystalDiskMark sequential read and

write speeds fall to 4,000MB/sec and 3,230MB/sec respectively, compared to 6,931MB/sec and 5,330MB/sec when we installed our motherboard's heatsink.

It's a shame, then, that WD charges an extortionate amount for the heatsink-clad SN850, which won't leave you with much change from £220. If your motherboard lacks a heatsink, you'd be better off buying a third-party one from the likes of EK or SilverStone, which will cost you under £20.

With the CrystalDiskMark sequential tests out of the way, the 32 queue depth 4K random speeds were fantastic, with the SN850's read speed of 2,172MB/sec being the fastest result on test by a big margin. AS-SSD's sequential tests showed a similar story, albeit with the SN850 being a few hundred megabytes per second off the Gigabyte Aorus Gen4 7000s' top spot.

In AS-SSD, the 4K random read speed was also slower than the competition, with a result of 60MB/sec compared to over 70MB/sec for both the Phison-based SSDs on test this month, and the ADATA XPG GAMMIX S50 Lite wasn't far behind. The WD Black SN850 redeemed itself in the write test, though, again claiming the top spot here and in the 64-thread 4K IOPS read test too. That said, the write test put it below the competition again, albeit with big leads over cheaper models.

Conclusion

With a substantial price saving if you opt for the heatsink-less model and use your



BLACK SABBATH

- + Excellent performance in most tests
- + Good combination of cache systems
- + Cheaper than competition

BLACK SACK

- Needs a third-party heatsink to prevent throttling
- Heatsink-equipped model is expensive
- Not the fastest in all tests

own, the WD SN850 currently offers a great buy if you want maximum performance and value – it's cheaper than the Phison-based SSDs on test, as well as the Samsung 980 Pro and ADATA XPG S70 Blade.

If you don't need quite as much grunt, the ADATA XPG GAMMIX S50 Lite offers even better value, and for maximum value, WD's own SN550 is half the price. It's slower on paper, but you won't notice much difference in everyday operation. If you want the fastest performance possible for the best price, though, then the SN850 is for you.

VERDICT

Faster and cheaper than the high-speed PCI-E 4 competition, but don't forget a heatsink.

PERFORMANCE
49/50

FEATURES
17/20

VALUE
21/30

OVERALL SCORE
87%

SPEC

Interface PCI-E 4

Full capacity 1TB

Formatted capacity 930GB

Heatsink Optional

NAND TLC

Controller WD Black G2

Endurance 600TBW

Warranty Five years

WD BLUE SN550

/ **£180** (2TB) inc VAT; **£83** (1TB) inc VAT

SUPPLIER cclonline.com

The WD Blue SN550's prices of just £83 for 1TB and £180 for a whole 2TB of storage show that owning an NVMe PCI-E 3 SSD is now cheaper than ever. Plus, as this month's investigation into the real-world benefits of fast SSDs (see p90) has showed, there are diminishing returns as you approach the top and spend more money anyway.

The SN550 isn't a new drive, though, and this Labs test's selection of SSDs include some other excellent alternatives that sport newer tech and faster speeds for not much more money. The question is, just how much slower is the SN550?

The main issue, if you dig deeper into the specifications, isn't only a lack of a DRAM cache, but also a miniscule SLC cache that's typically just a few gigabytes in size, even for the 2TB model we tested. This is clearly a lot less than all the other SSDs we've tested this month – even Samsung's budget-focused 980 has over 150GB of SLC cache to boost write speeds when dealing with large workloads.

In perfect conditions, dipping only into its small SLC cache, the SN550 can write data at 1,800MB/sec, but that will quickly drop to SATA-level performance if you're writing just a few tens of gigabytes. That's not likely to be an issue for storage workloads that are largely

**BLUE SKY**

- + Less than £85 for 1TB
- + Good read speed for the cash
- + No heatsink required

BLUE MOULD

- Much faster SSDs cost just £30 more
- No DRAM cache
- Tiny SLC cache

read-focused, but it could waste a lot of time if you intend to shift around large files regularly.

You certainly won't need to worry about cooling though – the Blue SN550 only hit 64°C in our stress test, which is well away from throttling, although the SSD itself isn't particularly attractive if you want to show off your PC's interior. That's a far cry from the monstrous SN850, which rocketed up to 90°C in the same test. The ADATA XPG GAMMIX S50 Lite, which is closest in price at under £120, also required a heatsink.

For an extra £35, though, the ADATA XPG GAMMIX S50 Lite does offer quite a bit more if you can keep it cool using your motherboard's heatsinks. It has a DRAM cache, as well as a sizeable SLC cache of several hundred gigabytes, meaning it's far more flexible when it comes to dealing with large files, and won't leave you waiting as it writes them either.

The ADATA drive offered significantly quicker read speeds than the WD Blue SN550 too, with CrystalDiskMark's sequential test seeing a read speed of 3,858MB/sec compared to 2,603MB/sec for the SN550, while its write speed was nearly twice as fast, even when the SN550 was able to make use

of its small SLC cache. The 4K random tests saw the drives perform more evenly, but once again in AS-SSD's 4K 64 thread test, the ADATA drive was significantly faster at both reading and writing than the SN550.

Conclusion

As a read-focused, affordable SSD, the SN550 still makes sense for people building a budget system. It offers incredibly good value and can wipe the floor with a SATA SSD in many situations – it may be slower than the other NVMe competition this month, but it can still hit speeds well over the 550MB/sec SATA limit.

The main issue for the SN550 is that you only need to spend £30 more to get the ADATA XPG GAMMIX S50 Lite, which is a far better buy. It has better speeds across the board than the WD Blue SN550, and a vast SLC cache by comparison, allowing it to deal effectively with all manner of workloads. **GPE**

VERDICT

Still worth considering for those on a tight budget, but you can get a much faster drive for just a little more money.

PERFORMANCE
40/50FEATURES
16/20VALUE
24/30OVERALL SCORE
80%**SPEC**

Interface PCI-E 3

Full capacity 2TB

Formatted capacity 1,810GB

Heatsink No

NAND TLC

Controller WD in-house

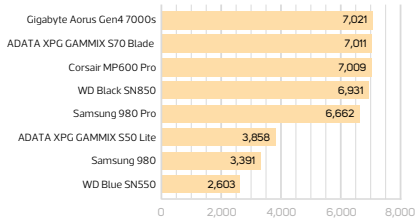
Endurance 600TBW

Warranty Five years

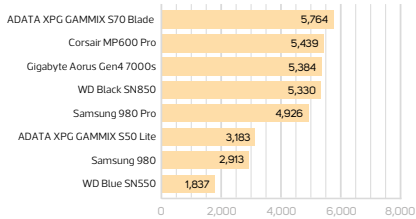
M.2 SSD BENCHMARK RESULTS

CRYSTALDISKMARK

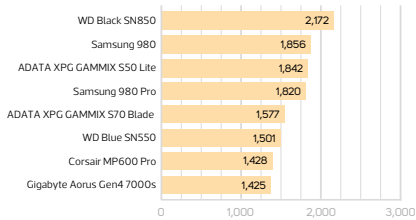
SEQUENTIAL 1M Q8 READ (MB/SEC)



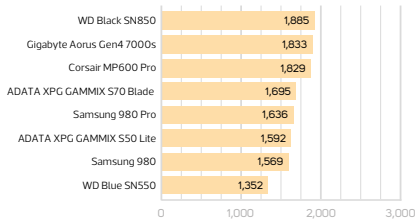
SEQUENTIAL 1M Q8 WRITE (MB/SEC)



RANDOM 4K Q32 T4 READ (MB/SEC)

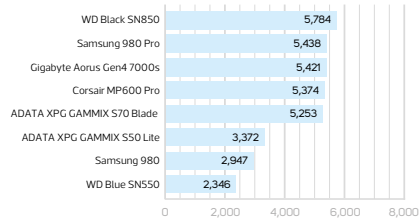


RANDOM 4K Q32 T4 WRITE (MB/SEC)

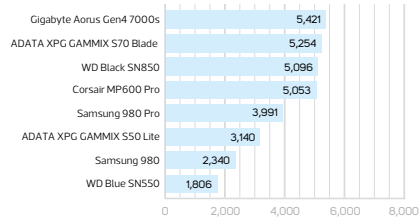


AS-SSD

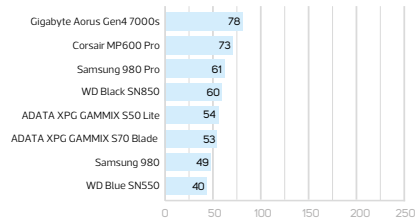
SEQUENTIAL READ (MB/SEC)



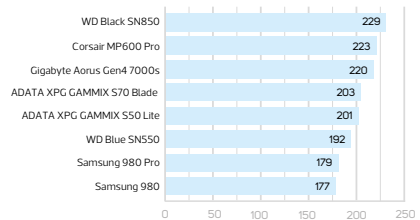
SEQUENTIAL WRITE (MB/SEC)



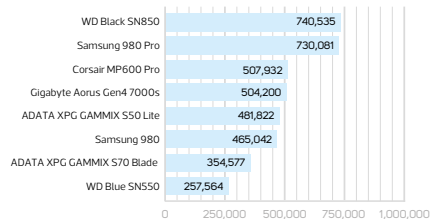
RANDOM 4K READ (MB/SEC)



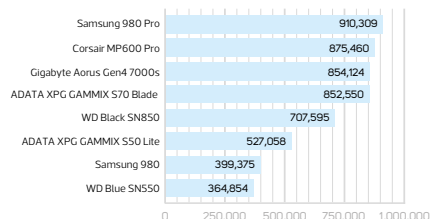
RANDOM 4K WRITE (MB/SEC)



4K 64-THREAD READ IOPS



4K 64-THREAD WRITE IOPS



LABS TEST

Mighty mice

.....

Edward Chester puts eight of the latest symmetrical-style gaming mice to the test

How we test

You'd be forgiven for thinking the gaming mouse market is fairly stable these days, with great optical sensors and some fantastic shapes having been around for many years. However, with the arrival of ultra-lightweight designs, as-good-as-wired wireless mice and a general trend towards simple feature sets, there's still plenty to pick apart.

Given the dozens of genuinely capable mice available, we need some means of compartmentalising them into manageable and meaningful categories for Labs tests. As such, for this test we've concentrated on mice that have a symmetrical or ambidextrous shape (symmetrical with thumb buttons on both sides) and that are wired, rather than wireless. The former means you can zero in on the general style of mouse you like, while the latter means all these mice cost well below £100, with most costing under £50.

To test them, we're concentrating on their performance in fast-paced games. Other mice with more buttons and extra features

can be better suited to complex games such as MMOs, but for first-person shooters, a simple feature set, solid tracking performance and a comfortable, lightweight shape are the priorities.

As well as the comfort and performance of the mice, we're looking at their features, build quality and practicality. We're also assessing each mouse for its suitability for different hand sizes and grip styles. We consider small hands to be any with a length under 17cm (from the tip of your middle finger to the wrist/base of your thumb), medium to be 17-20cm and large to be over 20cm.

Fingertip grip is where the mouse is held between your thumb and little or ring fingers with little to no palm contact. Palm grip is with your full palm resting on the mouse and claw grip is a bit like a hybrid between the two, where the base of the palm nestles against the back of the mouse and the fingers are held in a bent (claw-like) position. Some mouse sizes and shapes suit different combinations of grip and hand sizes better than others.

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- › SteelSeries AeroX 3 / p60

BENQ ZOWIE S1 / £63 inc VAT

SUPPLIER amazon.co.uk

BenQ has carved out quite a reputation for creating excellent bare bones gaming mice in a wide range of shapes and sizes. However, its line-up has remained largely unchanged for several years now, and the firm hasn't embraced the latest trend for shedding weight and adding RGB lighting. Does this dash the Zowie S1's chances?

Well, weighing in at 87g, the S1 is indeed one of the weightier mice on test. That figure was relatively light just a few years ago, but with the likes of the Cooler Master MM711 and SteelSeries Aerox 3 weighing 60g and 57g respectively, you really do notice the extra heft of this mouse. It still glides very smoothly thanks to its large, high-quality glide pads, but you can feel the extra inertia when changing direction. BenQ also offers a smaller, lighter variant that's 2mm narrower, 1mm shallower and 4mm shorter but it still weighs 82g.

Both the S1 and its little sibling, the S2, offer a symmetrical shape but with buttons on only one side. Up until recently, BenQ provided the FK series with a similar (although lower-profile) shape to the S range, but with buttons on both sides. However, for its latest update to that



SPEC

Weight 87g

Dimensions (mm) 61x126x39 (WxDxH)

Sensor PixArt PMW3360, 3,200 DPI, 50g acceleration, 250 IPS

Buttons 5 (left, right, scroll wheel, back, forwards)

Cable 1.8m, non-braided

Extras DPI and polling rate buttons on underside

range it dropped the extra buttons, so now it doesn't offer an ambidextrous mouse.

Back to the S1, its shape is typical for this type of mouse and for good reason. From the top, the front flares outwards slightly, while the back also widens before coming together in a smooth, round shape. This gentle out-in-out curve means your fingers nestle naturally in the dip on the sides of the mouse. The buttons also have slightly flared edges, again creating a natural divot for your fingers to rest.

The sides of the mouse then just slightly tuck in towards the bottom, creating a natural wedge shape that means very little squeezing/friction force is required to pick up the mouse. In short, it's a fantastic shape that's well suited to most grip styles and ideal for medium-to-large hand sizes. Meanwhile, the S2 is great for smaller hands.

Under the hood, the S1 uses the PixArt PMW3360 sensor, which maxes out at a DPI of just 3,200. However, this still proved ample in our tests – once again proving that optical sensors have been good enough for years. You can also change the DPI to 400, 800 or 1,600 via a button on the bottom of the mouse, but you can't tweak these settings further, so you'll have to fine-tune your aim with in-game sensitivity settings.

Similarly, you can change the polling rate of the mouse via another button on the base, but BenQ doesn't provide any software for you to make other changes. This lack of software also ties into the lack of RGB lighting – after all, why have software when there's so little to program on the mouse? However, the button system does mean you can change your mouse settings anywhere on any machine without having to install software.

The buttons and scroll wheel on this mouse are also excellent. They're crisp (and quite loud) in response, with a fairly strong spring action, so you really know when you've pressed them, but they're not tiringly stiff to use.



WOWIE

- + Fantastic shape
- + Great tracking
- + Snappy button response

OWIE

- Heavy by today's standards
- Lacks RGB or other extras
- Expensive for basic features

Conclusion

The BenQ Zowie S1 is a revered mouse for a good reason. It has a great shape, precise buttons and generally excellent performance. However, it's quite heavy by today's standards and its price is now quite high when you consider that you miss out on extras such as RGB lighting.

VERDICT

An excellent mouse, but there are equally good, lighter and cheaper alternatives.

DESIGN 14/20	FEATURES 12/20	OVERALL SCORE 72%
PERFORMANCE 26/30	VALUE 20/30	

COOLER MASTER MM711 / £50 inc VAT

SUPPLIER overclockers.co.uk

Cooler Master offers two variants of its ultra-light MM7xx mouse. There's the 53g MM710, which doesn't include lighting, and the 60g MM711 that's equipped with RGB illumination. We've reviewed the MM710 previously and been impressed with its very light design, but how does its illuminated sibling hold up?

Well, given that we were sent the white version of the MM711 to evaluate, it's this aspect that makes the biggest first impression. Not only does the white stand out from the crowd but it really sets off the RGB lighting.

Conversely, as with any white product, there's a concern about how much it's going to show up any dirt on it, especially given that the braided cable is white too and the chassis is full of holes. That said, the Glorious PC Gaming Race Model O we tested is white too, and despite a year or so of on-and-off use, it's still surprisingly clean and tidy. Your own self-discipline with cleaning your hands and desk may be the bigger factor here.



SPEC

Weight 60g

Dimensions (mm) 63 x 117 x 38 (W x D x H)

Sensor PixArt PMW3389 sensor, 16,000 DPI, 50g acceleration, 400 IPS

Buttons 6 (left, right, scroll wheel, back, forwards, DPI)

Cable 1.8m, lightweight braided

Extras RGB lighting

Those aforementioned holes are larger than on many competing ultra-light mice, with the squashed hexagonal shapes neatly matching the company's logo. The holes cover the whole back of the mouse, the rear third of the left and right buttons and sides, plus the rear two thirds of the base.

Depending on your grip, the side holes may or may not be under where your thumb and fingers grip the mouse. I found my little finger nestled on the holes, and the rear third or so of my thumb also rested there. We found this greatly aided the overall secure feeling of gripping this mouse – once positioned on a hole, your finger won't be sliding anywhere.

The overall shape of the mouse is similar to that of the BenQ, Glorious and Razer models on test, with a slightly flared front end and relatively straight sides, making it a good universal shape for a variety of hand sizes. However, where those other mice have gently sloped back ends that allow for a more relaxed palm grip when required, the MM711 has a much more abrupt, steeper slope. This clears space under the palm for really agile fingertip grip movement, but means this mouse isn't ideal for palm or claw grip unless you have small hands.

One other factor to note is that the left and right buttons fold over the sides of the mouse – an arrangement that made it feel like it could lead to accidental pressing of the button. I found my ring finger would rest on the button rather than the side of the mouse, although this didn't actually seem to affect my gaming.

BRIGHT AS A BUTTON

- + Very light
- + Fantastic performance
- + Superb fingertip grip shape

DULL AS DISHWATER

- Less suited to claw and palm grip
- RGB lighting adds weight and cost
- Buttons fold over edges



In terms of features, this mouse is very much the same as the others on test, with its six buttons, all of which feel fine, and fixed lightweight braided cable. The scroll wheel is also firmly notched and accurate. The rear glide pads are a little small but this mouse still slides effortlessly due to its very low weight. Meanwhile, the excellent PixArt PMW3389 sensor provides the top-notch performance we expected.

Conclusion

The Cooler Master MM711 is a fantastic lightweight gaming mouse. For many, its RGB lighting, and resultant extra weight, may not make it a worthwhile upgrade over the cheaper MM710, but if you like a bit of illumination, this mouse certainly looks the part and it's still very light. The performance is flawless and it has a good shape too.

VERDICT

A fantastic lightweight gaming mouse, although the MM710 offers better value if you don't need RGB lighting.

DESIGN 17/20	FEATURES 15/20	OVERALL SCORE 80%
PERFORMANCE 27/30	VALUE 21/30	

CORSAIR KATAR PRO XT / £35 inc VAT

SUPPLIER amazon.co.uk

It has taken a long time for Corsair to embrace the current trend for compact, lightweight gaming mice, with its beefy long-time flagship, the M65 Pro RGB, tipping the scales at a whopping 136g. However, with the newest addition to its mouse line-up, Corsair has finally joined in the lightweight fun.

The Katar Pro XT is a compact, simple and light mouse that weighs just 75g. That's actually on the heavier side compared with truly ultra-light models, but any weight under 80g puts it in the right ballpark for these FPS-focused gaming tools.

Corsair has also embraced the fact that a simple, lightweight mouse means fewer components and less material, making for lower manufacturing costs and, as a result, a low price – we're looking at you, Logitech



KATAR

- + Great value
- + Solid performance
- + Smart design

CATARRH

- Not the best shape
- Could be lighter
- Slippery plastic finish

SPEC

Weight 75g

Dimensions (mm) 64 x 116 x 38 (W x D x H)

Sensor PixArt PMW3391, 18,000 DPI, 50g acceleration, 400 IPS

Buttons 6 (left, right, scroll wheel, back, forwards, DPI)

Cable 1.8m, lightweight braided

Extras RGB lighting

G Pro X Superlight. That said, while the Katar Pro XT does represent good value, you do get a step up in build quality from the likes of the Razer Viper 8K, and it's understandable that perforated designs such as the Cooler Master MM711 and SteelSeries Aerox 3 can be trickier and thus costlier to manufacture.

For features, you get the standard six buttons, with this mouse using a top-mounted DPI button, rather than the underside-mounted ones on some rivals. The cable is tethered, rather than removable, and it's of the more flexible, low-resistance cables that are common these days, so it doesn't push back against your movements. Corsair has even added RGB lighting to the scroll wheel; together with the all-black symmetrical design, this makes for a smart-looking mouse.

The mouse's shape is intriguing, as it narrows towards the front, rather than flaring out slightly, and has quite a narrow, pointy back end, rather than the more rounded shapes of the BenQ, Razer and SteelSeries mice on test this month.

The narrow front means your fingers have a tendency to slide forwards, while the narrow back means it doesn't really suit palm grip styles, at least for medium-to-large hands. What's more, we found the sides to be too sloped to gain a particularly easy fingertip grip. They narrow down considerably to the base, to the point where your fingers tend to slide down and under the mouse. The overall effect is that it feels like you have to grip the mouse quite firmly for your fingers to stay in position.

Meanwhile, the sides are finished in hard plastic that has a triangle pattern embossed in it to aid grip. It sort of works, but nowhere near as well as finer matt finishes or indeed soft-touch or rubberised finishes. On the plus side, the buttons all fall to hand nicely, without being easily accidentally knocked, and the scroll wheel has well-defined notches, making for a precise feel when gaming. The buttons' Omron switches are on the light side but respond crisply.



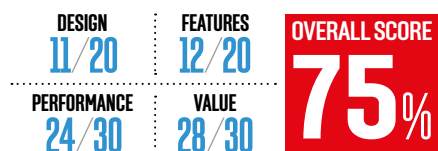
Corsair has used the very capable PixArt PMW3391 sensor for this mouse and it tracks as well as we'd expect, keeping up with our most extreme movements during gaming and tracking precisely for slower movements, such as tracing objects in Photoshop. Corsair's iCUE software is also on hand to control the RGB lighting, DPI settings and button assignments.

Conclusion

The Corsair Katar Pro XT is a good-value addition to the lightweight, FPS-focused gaming mouse stable. It has a low cost, a great sensor and good buttons. However, its shape isn't the most universally appealing, and there's nothing outstanding about its styling, features or performance. If your hands can get on with its shape, though, it's very competitively priced and delivers the tracking performance needed for fast-paced gaming.

VERDICT

The shape could be improved, but the Katar is still a solid option for a great price.



ENDGAME GEAR XM1R / £50 inc VAT

SUPPLIER overclockers.co.uk

The original Endgame Gear XM1 (see Issue 195, p57) impressed us with its lightweight design and low price.

With the updated XM1r, Endgame Gear has added an uprated sensor and custom Kailh GM 8 switches, and it's also available in a couple of new finishes.

Instead of the plain matt black or glossy white of the original, you can now get glossy and matt translucent black versions. We tested the matt translucent (Dark Frost) version for this review and it does look rather good. The slight transparency gives a glimpse of what's inside, while the smoky look gives the rest of the mouse a cool moody vibe.

What lets the look down, rather, is the lack of any internal lighting, RGB or otherwise. This means you really do only get a hint of the interior and miss out on the potentially cool dispersed lighting look that the matt finish could provide.

In terms of features, there's not a lot going on with this mouse. You get the basic selection of five main buttons, with just one set of side

thumb buttons and the standard trio of left, right and scroll wheel buttons. A DPI button on the underside is the only addition.

However, the DPI button can also change the polling rate, and settings for both are indicated via two RGB LEDs that sit alongside the button. It's a useful system, although some gamers will prefer to have a DPI button on the top for making quick on-the-fly changes.

All the main buttons feel tight and responsive in action, with none of the mushiness of some mice buttons. However, the scroll wheel button could be easier to press, and the notching on the scroll wheel is on the finer side, making it easy to scroll when you press it instead of activating the button, which can throw you off if you use the wheel in-game.

Meanwhile, the cable is a lightweight and highly flexible braided affair that's tethered to the mouse. It offers a minimum of resistance to your movements, which is ideal for first-person shooters. Four relatively small gliding pads are attached to the underside of the mouse and they offer excellent gliding and stability. If you prefer larger pads, though, Endgame Gear includes a set of two large pads in the box, which is a useful extra.

Where this mouse notably differs from the competition is with its shape. The back is wider than the front, so it fills the area under your palm. Meanwhile, the sides slope aggressively inwards from the top to the bottom. As such, it lends itself to using a palm grip more than a fingertip grip, as the wide back limits the range of motion under your hand and the sloping sides don't allow a great deal of purchase.

Performance of the PixArt PAW3370 sensor is flawless though. It's smooth,



accurate and able to cope with the fastest of movements. This is a top-end, modern sensor and its performance reflects that. The lack of currently available configuration software restricts you to only using the preset DPI settings, though, so your in-game settings can take a bit of tweaking before you get the feel you want.

Conclusion

The Endgame Gear XM1r offers excellent gaming performance and a fetching smoky black design. It's not packed with features, and the wide-backed shape is of less universal appeal than some straighter shapes, but it's a solid option if you can get on with the shape, and it's also competitively priced.

VERDICT

An intriguing shape that isn't ideal for fingertip grip, but the performance of this mouse can't be faulted.



SPEC

Weight 68g

Dimensions (mm) 66 x 122 x 38 (W x D x H)

Sensor PixArt PAW3370 - 19,000 DPI, 50g acceleration, 400 IPS

Buttons 5 (left, right, scroll wheel, back, forwards)

Cable 1.8m, lightweight braided

Extras DPI and polling rate control button on underside

ENDGAME

- + Excellent tracking performance
- + Cool smoky look
- + Decent value

INFINITY WAR

- Shape isn't universal
- Very basic feature set
- No software yet

DESIGN
12/20
PERFORMANCE
28/30

FEATURES
12/20
VALUE
24/30

OVERALL SCORE
76%

GLORIOUS PC GAMING RACE MODEL O / £50 inc VAT

SUPPLIER box.co.uk

The Glorious Model O made quite a splash when it first arrived a few years ago, thanks to its combination of fantastic shape, low weight and excellent performance, all for a relatively low price. With so many more companies joining in the lightweight mouse trend, though, does it still have what it takes to compete?

Well, one factor we still can't forgive is the company name and the logo on the side of the mouse. The joke had worn thin before the company even existed and it sits ever less well as time goes on. Back to the mouse, and although the competition has indeed ramped up, the Model O's basic formula is still very much on point.

It has a relatively large, symmetrical design with a very gently sloped rear and slightly flared out front end. It's a similar shape to the BenQ Zowie S1 and essentially the same as the Razer Viper's shape, but here of course you get holes. Lots of holes.



SPEC

Weight 67g

Dimensions (mm) 66 x 128 x 38 (W x D x H)

Sensor PixArt PMW3389 sensor, 16,000 DPI, 50g acceleration, 400 IPS

Buttons 6 (left, right, scroll wheel, back, forwards, DPI)

Cable 1.8m, lightweight braided

Extras RGB lighting, DPI indicator on underside

The whole back and base of the mouse are perforated with small hexagonal holes, along with the rear quarter of the left and right buttons. Thanks to all that lost material, this relatively large mouse weighs just 67g, which puts it right among the lightest mice available. The insides here aren't protected by any water resistance, but the circuitboard isn't as exposed as on the SteelSeries Aerox 3.

This combination of shape and lightness makes for a mouse that's really easy to sling around your mouse mat. Your fingers just naturally nestle in the concave sides and curves in the left and right buttons, and the mouse is perfectly balanced under its back and forward buttons. It also works with just about any grip style for medium-sized hands, and it's sufficiently mid-sized to work with small and large hands to a lesser extent as well.

Available in black and white versions, with both glossy and matt finishes, it's reasonably attractive too, with its RGB-illuminated slashes on the sides and around the scroll wheel.

The buttons are on the lighter side in terms of click response, but they still feel precise and we had no problems using the mouse in the heat of battle. Likewise, the scroll wheel has deep notches in its rubber cover for excellent grip, and very pronounced internal notches for precise up and down control.

In terms of performance, the Model O employs the PixArt PMW3389 sensor, which is a very capable unit that proved as flawless in our gaming as we'd expect. However, a very small gripe is that we'd like to see slightly larger glide pads on this mouse. Despite its low weight, it doesn't feel as smooth in action as the Razer or Cooler Master mice on test.

Meanwhile, the cable is a very flexible braided type. In fact, the braiding is very wide and loose on the thin cabling beneath. It looks a bit strange but it hits the mark for offering minimum resistance. Glorious' software also lets you fully configure the mouse, including



MASTERFUL

- + Fantastic, versatile shape
- + Very light
- + Excellent performance

RACE TO THE BOTTOM

- Silly company name
- Only one RGB zone

assigning up to six DPI levels for the DPI button, and editing and assigning macros. One slight disappointment is that the RGB lighting zones aren't individually controllable – it's all or nothing across the lot.

Conclusion

The Glorious PC Gaming Race Model O remains one of the top symmetrical choices for first-person shooters. It's light, has a great shape, looks good and is competitively priced. There are lighter or smaller options (including the Model O-) but this is a great option for average-sized hands and most grip types.

VERDICT

Light, comfortable and with excellent performance. There's nothing not to like, other than the name.

DESIGN 17/20	FEATURES 16/20
PERFORMANCE 27/30	VALUE 26/30

OVERALL SCORE
86%

LOGITECH G203

LIGHTSYNC / £22 inc VAT

SUPPLIER currys.co.uk

Logitech's gaming mouse line-up is a bit odd at the moment, as the company's superb but pricey G Pro Wireless and G Pro X Superlight models aren't available in wired versions. Instead, if you want a compact, symmetrical, lightweight wired mouse, the company offers two essentially identical options, the £70 G Pro or the £22 G203.

Technically, the G Pro has the superior sensor – the company's 25,000 DPI Hero model. However, with modern sensors already being so good, the G203's modest 8,000 DPI rating doesn't really hold it back. It coped just fine in all our tests, providing

accurate tracking with no unwanted acceleration or drops in accuracy due to fast motion. As such, the choice of which of these two mice offers better value is clear. What's less clear is whether the G203 Lightsync is a top choice in its class.

In terms of overall shape and proportions, the design of this mouse is very similar to that of the Corsair Katar Pro XT. It has a similar tapered back end and sides that cut in quite severely, resulting in a small base to the mouse and generally compact feel. So much so, in fact, that I didn't particularly get on with its shape, finding it too small for my hands, but of course mileage will vary here.

As with the Corsair mouse, the ergonomics are helped by the sides having slight convex curves, providing slightly more surface to grip than the SteelSeries Aerox 3. However, this mouse is also relatively heavy for its size. Its weight of 85g isn't historically heavyweight but it's at the top end of the scale these days, making this compact mouse feel quite dense. The small glide pads on the base don't help either, making it a relatively high-resistance mouse to move.

For features, this mouse is as basic as its price suggests, but Logitech has still managed to pack some RGB lighting into the design, which explains the Lightsync in the name. This lighting swoops round the back of the mouse and illuminates the Logitech G logo. It makes for a fetching appearance at this price, although it lacks the aggressive lines of many competitors, which has the effect of making it look a little cheaper and toylike.

When it comes to the basics, you get six buttons, with the sixth button being a top-mounted DPI switcher. We found this worked well in terms of being out of the way enough to avoid hitting accidentally, but being easy to press when needed.

The lighting and DPI settings can all be changed via Logitech's software, and you can

reprogram the other buttons, and record and assign macros. On the downside, the scroll wheel has quite light notches, making it too easy to nudge the wheel when pressing it to trigger a middle click. Otherwise, the buttons all feel snappy enough.

Meanwhile, the cable isn't as flexible as the braided ultra-flexible types favoured by most of the other mice on test this month, but it's still reasonably thin and bendable – we didn't find that it pushed back against our movements too much.

Conclusion

The Logitech G203 Lightsync is a great-value, perfectly capable gaming mouse. It has all the performance you should need and a simple feature set that contains all the essentials. The shape isn't for everyone, and it's a little compact for our tastes, especially given that it's not all that light, but smaller hands may find it more accommodating. There's nothing too remarkable here, but this is a decent budget option for its price.

VERDICT

Cheap and cheerful, the Logitech G203 Lightsync is also perfectly capable.

DESIGN 10/20	FEATURES 12/20	OVERALL SCORE 72%
PERFORMANCE 20/30	VALUE 30/30	



LIGHT FANTASTIC

- + Fantastic value
- + Solid gaming performance
- + Really low price

LIGHT ENTERTAINMENT

- Shape isn't for everyone
- A little heavy for its size
- Scroll wheel moves too easily

SPEC

Weight 85g

Dimensions (mm) 62 x 117 x 38 (W x D x H)

Sensor PixArt PMW3366, 8,000 DPI, 40g acceleration, 400 IPS

Buttons 6 (left, right, scroll wheel, back, forwards, DPI)

Cable 1.8m, non-braided

Extras RGB lighting

RAZER VIPER 8K

£80 inc VAT

SUPPLIER currys.co.uk

We looked at the Razer Viper 8K in a standalone review just a few months ago (see Issue 213, p23) and found it to be an excellent offering. Has our impression changed in the intervening few months? Nope, not at all. This is still a fantastic mouse.

The reasons to be cheerful start with it having a truly ambidextrous design, so lefties and righties can take advantage of its stellar design and features. Back and forward buttons can be found on both sides of the symmetrical design, and they perfectly balance being easy to hit with your thumb while remaining out of the way of your ring and little fingers. Of course, your mileage can vary here, depending on hand size and shape, as well as grip style, but this has been our finding.

Meanwhile, the overall shape balances its proportions in a way that makes it useful for all grip styles (although it's mainly aimed at fingertip grip), making it hugely versatile. A particular highlight is the addition of large, thick,



SPEC

Weight 71g

Dimensions (mm) 58 x 127 x 38 (W x D x H)

Sensor Razer optical - 20,000 DPI, 50g acceleration, 650 IPS

Buttons 7 (left, right, scroll wheel, 2 x back and forwards)

Cable 1.8m, lightweight braided

Extras Ambidextrous, 8kHz polling rate, RGB lighting, DPI button on underside

textured rubber side pads, which ensure that gripping this mouse is effortless. Whether your fingers are dry, or your palms are sweaty, the side grips provide excellent purchase.

Although this is a very light mouse by historical standards, and it's also nearly 20g lighter than the heaviest mouse on test this month, by today's ultra-light standards it's only mid-range in terms of weight. Weighing in at 71g, it's a good 20 per cent heavier than the very lightest mice available – those rubber sides probably add a few grams.

The Viper 8K looks great too. The symmetry of the mouse, along with the angular lines that edge the buttons and rubber side pads, balance a simple classy feel with just a little bit of aggression. The RGB-backlit, ouroboros-esque Razer logo also looks good.

In terms of other features, the mouse is fairly modest, with its tethered braided cable and simple button selection. Along with the thumb buttons, you get just left, right and scroll wheel buttons, plus a DPI switching button on the underside of the mouse. This is the common trend with modern mice, but it's notable here given the relatively high price of this mouse – other than being ambidextrous, it doesn't offer a lot in terms of meaningful extras over cheaper mice. Meanwhile, the cable is of the modern ultra-flexible, braided type and it feels great, offering minimal resistance to your movements.

For gaming performance, the Viper 8K can't be faulted. Its buttons feel crisp and responsive, while its scroll wheel is grippy, with defined notches and a middle button that's easy to press without knocking the wheel. Tracking is also flawless, but that's to be expected of even much less capable sensors these days. The 20K DPI and 600 IPS figures might be impressive, but sensors with half those figures are still excellent. The titular 8KHz polling rate is also largely overkill, with many games not supporting it and those that do seeing microscopic real-world gains.



POLLING RATE

- + Superb shape
- + Ambidextrous
- + Flawless tracking performance

POLLING STATION

- 8K polling fairly pointless
- Expensive
- Not the lightest

Conclusion

The Razer Viper 8K is a fantastic gaming mouse for a host of reasons. Its shape is a good match for all sorts of hand sizes and shapes, and the rubber on the sides means it stays secure no matter what. The truly ambidextrous button layout further broadens its universal appeal, and the tracking performance is flawless. It's right up there with the best mice around. It's quite expensive, but it delivers just about enough to justify the extra outlay.

VERDICT

An expensive but truly world-class mouse that's suited to left and right-handed users.

DESIGN 18/20	FEATURES 15/20	OVERALL SCORE 84%
PERFORMANCE 30/30	VALUE 21/30	

STEELSERIES AEROX 3 / £50 inc VAT

SUPPLIER amazon.co.uk

SteelSeries' Rival 600 has been at the top of our charts for the best FPS gaming mouse for a while now, and it remains a great option.

However, the company's latest addition to its gaming mouse line-up is a symmetrical, lightweight design.

The Aerox 3 weighs just 57g, putting it firmly in ultra-light territory and making it the lightest on test. It achieves this thanks to the now common method of filling the outer case with holes.

In this case, they're square holes that cover the entire top and base of the mouse, as well as the rear of the left and right buttons.

Inevitably, the holes do allow dust and grime to collect inside the mouse – and the circuitboard within the shell is particularly exposed – but all the innards are dust and water-resistant, so while the mouse might end up looking grotty, it should still function.

It's a shame SteelSeries hasn't also perforated the sides of the mouse, as we

found them rather slippery. The whole mouse is constructed from ABS plastic that hasn't been given any extra soft-touch or rubber coating, but instead has a slightly rough finish that doesn't provide much purchase.

The shape of the mouse doesn't help here either. The sides angle inwards towards the bottom and have a slightly concave feel, so your fingers don't naturally sit in the middle of the sides but rather hang on the very top edge, where the side buttons are located.

Combine this with the fact that the back widens out quite sharply, and there's no flared-out front, and I found my fingers would slide down and forwards, requiring a constant resetting of my grip. As ever, your mileage may vary depending on your hand size and grip style, but I struggled to get along with this mouse's shape.

Otherwise, the Aerox 3 is an impressive little mouse. Its RGB lighting looks great, shining around the base and out through the perforated structure, and the addition of a detachable Type-C USB cable is a massive boon. We feared that the cable might come loose, but we didn't have any issues.

All the buttons feel crisp and fall to hand in the right places, although we did occasionally accidentally hit the thumb buttons – another symptom of those sloped, slippery sides. The scroll wheel also has a good grippy surface, light action and well-defined notches, making it easy to use accurately in the heat of battle.

Meanwhile, the sensor has modest headline figures of 8,500 DPI and 35G acceleration, but that's fine – the tracking didn't hold us back. It's still a top-notch



optical sensor that will keep up with the most extreme gaming movements.

The mouse is also fully programmable via SteelSeries' software, allowing you to configure the lighting and button configuration. Here you can also change other settings, such as the number and level of DPI settings through which you can cycle with the top-mounted DPI button.

A wireless version of the Aerox 3 is available for £80 inc VAT as well, and it offers essentially the same experience (we tested both), but with wireless convenience – it only weighs a modest extra 11g as well.

Conclusion

The SteelSeries Aerox 3 is a very capable, very light mouse for a great price, and its detachable USB cable is a particularly useful feature that should guard against a damaged cable ruining the mouse. However, the shape of the mouse and the finish of its plastic makes gripping it a little tricky. Your mileage may vary, though, and those with smaller hands could fare better with it. **GPE**

VERDICT

Light and very capable but it's not the most comfortable mouse to hold.



SPEC

Weight 57g

Dimensions (mm) 67 x 121 x 38 (W x D x H)

Sensor SteelSeries TrueMove Core – 8,500 DPI, 35g acceleration, 300 IPS

Buttons 6 (left, right, scroll wheel, back, forwards, DPI)

Cable 1.8m, lightweight braided Type-C

Extras RGB lighting, removable cable

AERATED

- + Exceptionally light
- + Neat RGB lighting
- + Removable cable

FULL OF HOLES

- Plastic finish is slippery
- Not our favourite shape
- Plastic feels slightly cheap

DESIGN
12/20
PERFORMANCE
24/30

FEATURES
19/20
VALUE
22/30

OVERALL SCORE
77%

Wireframe

Join us as we lift the lid
on video games



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How we test

MOTHERBOARDS

TEST PROCESSORS

- **Intel LGA1200** Intel Core i9-11900K
- **AMD AM4** AMD Ryzen 9 5900X, and AMD Ryzen 9 3900X for standalone reviews that require comparisons with older results.

Common test hardware between our CPU test rigs includes 16GB (2x8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 memory, a 2TB Samsung 970 Evo SSD, a 1TB PCI-E 4 Corsair MP600 SSD and an Nvidia GeForce RTX 3070 Founders Edition graphics card.

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 New Dawn on Windows 10 Home 64-bit. We also test the board's M.2 ports, and record the noise level and dynamic range of integrated audio using RightMark Audio Analyzer.



PROCESSORS

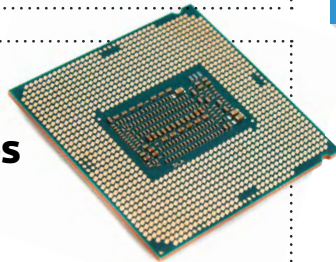
TEST MOTHERBOARDS

- **Intel LGA1200 Rocket Lake**
MSI MEG Z490 Ace
- **Intel LGA1200 Comet Lake**
Asus ROG Strix Z590-E Gaming WiFi
- **AMD AM4** MSI MPG Gaming B550 Carbon WiFi

Common gear between our CPU test rigs includes 16GB (2x8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, a 2TB Samsung 970 Evo SSD and an Nvidia GeForce RTX 3070 GPU. Cooling comes from 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 10 with security updates, as well as the latest BIOS versions and drivers. We record results at stock speed and overclocked, and our tests include the CPC RealBench suite for image editing, video encoding and multi-tasking, Cinebench's single and multi-threaded tests, Far Cry New Dawn and Watch Dogs: Legion.

For our game tests, we record the 99th percentile minimum and average frame rates either using the game's built-in benchmark or Nvidia FrameView. Finally, we measure the idle and load power consumption of the whole system, using Prime95's smallfft test with AVX disabled to stress the CPU.



MONITORS

We test image quality with an X-Rite iDisplay Pro colorimeter and DisplayCal software to check for 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 responsiveness subjectively and then also use Blur Buster's excellent ghosting UFO test to check the sharpness of the display in high-speed motion.



CPU COOLERS

We measure the CPU temperature with CoreTemp, and subtract the ambient air temperature to give a delta T result, enabling us to test in a lab that isn't temperature controlled. We load the CPU with Prime95's smallfft test and take the reading after ten minutes.

TEST KIT

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

INTEL LGA1200

Intel Core i9-11900K overclocked to 5.1GHz with 1.38V vcore.

INTEL LGA1151

Intel Core i5-9600K overclocked to 4.8GHz with 1.2V vcore.

INTEL LGA2066

Intel Core i9-9980XE overclocked to 4.2GHz with 1.08V vcore.

AMD AM4

AMD Ryzen 9 5900X overclocked to 4.5GHz with 1.25V vcore, or AMD Ryzen 7 1700 overclocked to 3.9GHz with 1.425V vcore for standalone reviews that require comparisons with older results.

AMD TRX4

AMD Threadripper 3960X overclocked to 4.2GHz with 1.265V vcore, 32GB of 3466MHz Corsair Vengeance RGB memory, Samsung 960 Pro SSD, Corsair RM850i PSU.



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.



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 HX750 PSU, Cooler Master MasterCase H500M case, 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.

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.

Budget system with integrated graphics

Quad-core CPU, basic gaming

Needs a micro-ATX or ATX case.

We recommend a 350W 80 Plus power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 3400G	amazon.co.uk	#194 p20	£250
CPU COOLER	AMD Wraith air cooler included with CPU	N/A	#194 p20	£0
GRAPHICS CARD	AMD Radeon RX Vega 11 integrated into CPU	N/A	#194 p20	£0
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2 Z3200C16)	scan.co.uk	#204 p74	£91
MOTHERBOARD	Asus TUF B450M-Plus Gaming (micro-ATX)	scan.co.uk	#204 p74	£83
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	#204 p24	£53

Total £477

Entry-level RTX gaming

6-core CPU, 1080p gaming

Needs a micro-ATX or ATX case.

We recommend a 500W 80 Plus power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-11400F	scan.co.uk	#215 p16	£150
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	#202 p20	£18
GRAPHICS CARD	Nvidia GeForce RTX 3060	overclockers.co.uk	#213 p16	£699
MEMORY	16GB (2 x 8GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	#204 p74	£91
MOTHERBOARD	MSI MAG B560 Tomahawk WiFi (ATX)	scan.co.uk	#215 p18	£170
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	#204 p24	£53

Total £1,181

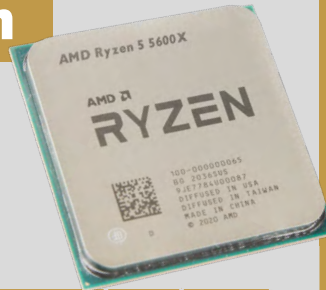
UPGRADES

SWAP GRAPHICS CARD	AMD Radeon RX 6700 XT (2,560 x 1,440 gaming)	scan.co.uk	#213 p19	£780
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£119

2,560 x 1,440 gaming system

6-core CPU, 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 i5-11600K	scan.co.uk	#213 p49	£246
CPU COOLER	Antec Neptune 240	scan.co.uk	#204 p16	£80
GRAPHICS CARD	AMD Radeon RX 6700 XT	scan.co.uk	#213 p19	£780
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£105
MOTHERBOARD	ASRock Z590 PG Velocita	scan.co.uk	#213 p58	£276
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£119

Total £1,606

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£80
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Mid-range gaming system



8-core CPU, 2,560 x 1,440 and some 4K gaming

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	AMD Ryzen 7 5800X	scan.co.uk	#213 p44	£389
CPU COOLER	Antec Neptune 240	scan.co.uk	#204 p16	£80
GRAPHICS CARD	AMD Radeon RX 6800 XT	overclockers.co.uk	#211 p42	£1,290
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£105
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	#193 p44	£290
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£119

Total £2,273

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£80
SWAP CPU COOLER	Corsair H100i RGB Platinum (240mm AIO liquid cooler)	amazon.co.uk	#185 p82	£125

*This motherboard may require a BIOS update in order to recognise the new CPU.

Core component bundles cont ...

4K gaming system

8-core CPU, 4K gaming

Needs an ATX case with room for a 240mm all-in-one liquid cooler. We recommend an 850W 80 Plus Gold power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	#213 p44	£389
CPU COOLER	Corsair H100i RGB Platinum (240mm AIO liquid cooler)	amazon.co.uk	#175 p20	£125
GRAPHICS CARD	AMD Radeon RX 6900 XT	scan.co.uk	#212 p44	£1,500
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£105
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	#193 p44	£290
STORAGE	1TB WD Black SN850	scan.co.uk	#215 p49	£185
Total £2,567				

UPGRADES

ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	#166 p54	£80
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* This motherboard may require a BIOS update in order to recognise the new CPU

Content creation system

12-core CPU, 2,560 x 1,440 gaming

Needs an E-ATX case with room for a 280mm all-in-one liquid cooler. We recommend a 750W 80 Plus Gold power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 9 5900X	scan.co.uk	#213 p45	£530
CPU COOLER	NZXT Kraken X63 (280mm AIO liquid cooler)	scan.co.uk	#207 p47	£130
GRAPHICS CARD	AMD Radeon RX 6700 XT	scan.co.uk	#213 p19	£780
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 3600MHz (CMW32GX4 M2D3600C18)	scan.co.uk	#210 p74	£175
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	#193 p48	£440
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£339
Total £2,394				

UPGRADES

SWAP GRAPHICS CARD	AMD Radeon RX 6900 XT (4K gaming)	scan.co.uk	#212 p44	£1,500
SWAP CPU	AMD Ryzen 9 5950X (16 cores - more multi-threaded power)	scan.co.uk	#213 p46	£740
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	#166 p54	£80

* This motherboard may require a BIOS update in order to recognise the new CPU

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 Z590 (LGA1200)	Gigabyte Z590I Vision D	scan.co.uk	#214 p18	£270
Intel Z490 (LGA1200)	Asus ROG Strix Z490-I Gaming	scan.co.uk	#206 p40	£275
AMD B550 (AM4 budget)	Asus ROG Strix B550-I Gaming	scan.co.uk	#206 p44	£197
AMD X570 (AM4 mid-range)	Asus ROG Strix X570-I Gaming	scan.co.uk	#198 p20	£270

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	#206 p18	£100
TOWER	SilverStone LD03-AF	quietpc.com	#214 p58	£95
PREMIUM	Streacom DA2 V2	quietpc.com	#214 p51	£190

Micro-ATX



Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Budget AMD B450 (AM4)	Asus TUF B450M-Plus Gaming	scan.co.uk	#204 p74	£83
AMD B550 (AM4)	MSI MAG B550M Mortar	ebuyer.com	#204 p42	£120

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Fractal Design Focus G Mini	scan.co.uk	#180 p46	£46
MID-RANGE	Fractal Design Define Mini C	scan.co.uk	#161 p26	£75

ATX cases



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Phanteks Eclipse P300 Glass	overclockers.co.uk	#176 p28	£48
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	#214 p26	£70
SUB-£100	be quiet! Pure Base 500DX	scan.co.uk	#202 p39	£99
COMPACT	Fractal Design Meshify 2 Compact	scan.co.uk	#215 p20	£90
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	#212 p45	£125
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	#202 p44	£139
SUB-£150	Fractal Design Define 7	overclockers.co.uk	#204 p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	#187 p24	£215

Networking



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ROUTER (WI-FI 6)	TP-Link Archer AX6000	overclockers.co.uk	#196 p57	£280
MESH ROUTER (WI-FI 6)	Asus AiMesh AX6100	amazon.co.uk	#196 p54	£349
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	#196 p58	£60
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	#200 p22	£148
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	#174 p34	£207
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	#212 p25	£275

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

Monitors



Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
24IN, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 24G2U	box.co.uk	#214 p28	£176
25IN, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	#209 p57	£299
25IN, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	#212 p20	£699

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	£210
27IN, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	scan.co.uk	#209 p60	£349
27IN, 144Hz, IPS, 2,560 X 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	#201 p54	£429
27IN, 240Hz, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£480
27IN, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£685

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, 165Hz, VA, 2,560 X 1,440, F, G	Dell S3220DGF	amazon.co.uk	#214 p28	£399
34IN, 144Hz, VA, 3,440 X 1,440, W, F, G	Cooler Master GM34-CW	ebuyer.com	#215 p30	£549
34IN, 144Hz, IPS, 3,440 X 1,440, W, F	iiyama G-Master GB3461WQSU	cclonline.com	#206 p53	£430
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	currys.co.uk	#206 p55	£799
38IN, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,499
35IN, 200Hz, VA, 3,440 X 1,440, W, G, HDR	Asus ROG Swift PG35VQ	scan.co.uk	#198 p58	£2,389

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 75Hz, IPS, 2,560 X 1,440, F	LG 27QN880	ebuyer.com	#210 p26	£395

Peripherals and audio

Gaming keyboards



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
MEMBRANE	Corsair K55 RGB	amazon.co.uk	#201 p45	£45
BUDGET TKL MECHANICAL	HyperX Alloy FPS Pro	amazon.co.uk	#201 p46	£90
MECHANICAL	Corsair K68 RGB	amazon.co.uk	#181 p53	£120
OPTICAL ESPORTS	Asus ROG Strix Scope RX	overclockers.co.uk	#209 p43	£125
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£185
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	#193 p56	£150
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£140
LUXURY MECHANICAL	Ducky Shine 7 RGB	overclockers.co.uk	#212 p53	£175
LUXURY WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	scan.co.uk	#208 p60	£180

Gaming mice



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Corsair M55 RGB Pro	amazon.co.uk	#200 p24	£35
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	box.co.uk	#215 p57	£50
MMO	Razer Naga Trinity	amazon.co.uk	#186 p52	£80
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£80
WIRELESS	Corsair Dark Core RGB Pro	amazon.co.uk	#202 p25	£95
PREMIUM WIRELESS	Razer Deathadder V2 Pro	scan.co.uk	#210 p28	£126
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	#211 p28	£48
PREMIUM LIGHTWEIGHT	Logitech G Pro X Supertight	currys.co.uk	#213 p22	£159

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
GAMEPAD	Microsoft Xbox One Wireless Controller	currys.co.uk	#191 p56	£50
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	#207 p52	£40
FLIGHT STICK	Thrustmaster T.16000M FCS HOTAS	scan.co.uk	#207 p56	£150

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	£68
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	#204 p50	£160
PREMIUM WIRELESS	Razer BlackShark V2 Pro	overclockers.co.uk	#211 p26	£180

Speakers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
STEREO	Edifier R1280DB	amazon.co.uk	#192 p57	£120

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS MULTI-DEVICE	Logitech K780	currys.co.uk	#203 p58	£70
WIRELESS TKL MECHANICAL	Keychron K2 Version 2	keyboardco.com	#208 p57	£84
TKL MECHANICAL	Filco Majestouch Convertible 2 Tenkeyless	keyboardco.com	#203 p55	£140

PCs and laptops



Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
6-CORE GAMING	PC Specialist Torva Elite R	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	pcspecialist.co.uk	#214 p36	£1,349
MINI-ITX GAMING	Chillblast Fusion Diablo	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	chillblast.com	#215 p34	£1,949
8-CORE RTX 3080 GAMING	PC Specialist Obsidian I	Intel Core i7-10700KF	Nvidia GeForce RTX 3080	pcspecialist.co.uk	#209 p40	£2,164
WATER-COOLED 12-CORE GAMING	Scan 3XS Absorbere	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3090	scan.co.uk	#209 p46	£5,818
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	#145 p58	£14,868

Laptops



CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
RTX GAMING	Gigabyte Aorus 15G XC	Intel Core i7-10870H stock speed	Nvidia GeForce RTX 3070	15.6in 1,920 x 1,080 IPS 240Hz	overclockers.co.uk	#213 p30	£1,799
PREMIUM RTX GAMING	Alienware m17 R4	Intel Core i9-10980HK stock speed	Nvidia GeForce RTX 3080	17.3in 1,920 x 1,080 IPS 360Hz	dell.co.uk	#215 p32	£3,499

Games



RICK LANE / INVERSE LOOK

SKILL CHECK

Skill trees have become omnipresent in video games, but Rick Lane argues that they aren't always what they seem

Skill trees and upgrade systems used to be limited to RPGs, but they've become staples of nearly all modern games, from massive open-world games such as Assassin's Creed Valhalla, to shooters such as Doom Eternal. Even Crusader Kings III has a skill tree that lets you manually upgrade your dynasty.

Skill trees and upgrade systems are a useful way to mediate player-progression, especially as games have grown larger and more interactively diverse. They demonstrate the extent of what a game's systems have to offer, while also providing regular progression breadcrumbs to keep players engaged. At least, that's the idea, but it isn't always the case. Some games include skill trees out of a sense of obligation, while others use them to mislead the player about a game's actual depth.

In general, a good upgrade system dedicates itself towards not only improving your character's stats, but also increasing the tools at your disposal and altering the way you play the game. Every new ability you unlock in Dishonored, for example, adds dramatically to your character's tool-set. Here, your abilities let you slow down time, possess enemies and even link enemies together so that what happens to one happens to them all. Upgrading those abilities also changes how they work. For example, upgrading Possession lets you possess different beings, from rats to humans.

In short, a good upgrade system clearly demonstrates how its upgrades affect the way you play. A bad upgrade system will invest heavily in abstract numbers and percentages. Its

unlocks will increase health by ten points, decrease cooldowns by five seconds and make your attacks 2 per cent faster. It will focus on incremental stat increases that are entirely passive, thereby requiring no additional animations or new mechanical features to function. There's a sense of improving your character, without actually altering how the game plays.

Recent examples include Outriders and Cyberpunk 2077, with the latter being a particularly egregious example. Cyberpunk's 2077's upgrade system is enormous, with 12 different skill trees, each with around 20 different upgrades. Yet nearly all

of the available upgrades are passive, incremental stat increases, with some adjusting those stats by as little as 3 per cent. It's almost impossible for a player to interpret what difference 7 per cent damage to limbs will make to their experience.

Cyberpunk was released in a clearly unfinished state, so it's not unreasonable to wonder whether this massive yet shallow skill tree was designed to deliberately conceal the game's lacks of mechanical and interactive depth. This is where skill trees become problematic, because they can easily be designed to suggest a wealth of opportunities, when those 'unlocks' really exist primarily for the sake of unlocking them.

Essentially, they're skill-based slot machines, cynically designed to keep you playing by giving you a token reward for pushing a button. This kind of design is increasingly rife in gaming, and if we get better at identifying it, we'll get better games in the long run. **CPC**

Essentially, they're skill-based slot machines, cynically designed to keep you playing by giving you a token reward

Rick Lane is Custom PC's games editor [@Rick_Lane](#)



Oddworld: Soulstorm / £39.99 inc VAT

DEVELOPER Oddworld Inhabitants, Fat Kraken Studio, Sabotage Studio, Just Add Water and Frima Studio / **PUBLISHER** Oddworld Inhabitants

Oddworld Soulstorm isn't bad, but it is a bad remake. This 'reimagining' of Oddworld: Abe's Exoddus removes much of what made the original game unique and interesting, replacing it with flashy visuals and needless gimmickry.

Soulstorm rebuilds Exoddus from the ground up, completely changing the levels, mechanics and story. Starting with the latter, the tale still revolves around the Soulstorm brew and how it poisons Abe's fellow Mudokons. However, the story's structure has been reshuffled, with Hollywood-budget cutscenes and action-driven set-pieces added. Indeed, the game commences with a frantic evacuation of the Mudokon homeland as it's assaulted by Glukkon forces, with Abe's tribe running for the hills as their camp is bombarded from above.

Visually, Soulstorm is undeniably impressive. The elaborate level design is excellent, playing with perspective and distance in clever ways and featuring breathtaking looping and twisting pathways. The levels are also much longer than previously, although it takes four or five of Soulstorm's 15 levels for it to get going, which translates

to roughly the same number of hours of play. The opening levels are also the least visually pleasing, placing a heavy emphasis on brown and grey.

The real issue, however, is that this glitzy spectacle comes at the cost of Oddworld's distinctive personality. For starters, there's no fart button, a staple of the series since its inception. But the real loss is Exoddus' emotionally driven Mudokons. In the original game, Abe's companions could be angry, sad or energised, all of which affected their behaviours and the resulting puzzles. This, along with much of Exoddus' more nuanced gamespeak, has been discarded completely.

Meanwhile, Soulstorm adds crafting into the game's precision-focused puzzle-platforming. Alongside jumping, sneaking, possessing enemies and rescuing Mudokons, Abe can combine ingredients found in the world to create various items, ranging from smoke grenades to exploding soda cans.

Sadly, the crafting fails to add much to the Oddworld formula, while actively detracting from the experience. The crafting is so simplistic it might as well not be included – it amounts to gathering resources from the immediate area, then pressing a button to make the relevant object.

What's more, because Soulstorm uses a checkpoint save system, whenever you die you have to collect all those ingredients again. Anyone who has played an Oddworld game before will know that you die frequently, so this system adds an extra level of frustration.

Abe's Exoddus was developed in just nine months. Soulstorm, by comparison, took six years. The result is far prettier and considerably longer, but ultimately a worse game. Bigger isn't necessarily better.

RICK LANE

EXODDUS

- + Looks (mostly) good
- + Impressive level design

SOULSTORM

- Extremely slow start
- Missing Exoddus' best features
- Insipid crafting system

/ VERDICT

A disappointing remake of Abe's Exoddus, Soulstorm trades personality for bombast and comes off worse for it.

OVERALL SCORE

60%





Don't tell me you still had people in Cryo.

Outriders / £49.99 inc VAT

DEVELOPER People Can Fly / PUBLISHER Square Enix



Outriders is a game at war with itself, a looter-shooter where neither the looting nor the shooting are what make it worth playing. Developed by People Can Fly, creator of Bulletstorm, Outriders' structure seems focus-tested to be as generically appealing as possible. However, it also has a rebellious streak, and a cover system that it doesn't want you to use. It's a weird, expensive mess that somehow comes together and just about works.

It doesn't look like it will swing that way at first though. Taking place after the destruction of Earth, Outriders begins with the arrival of the generation ship Flores at a nameless, biologically verdant planet selected as humanity's new home. You play as one of the titular Outriders, the Flores' special scout force tasked with paving the way for the colony's establishment.

However, a combination of bureaucratic foolishness and a hostile, anomalous weather system destroys all the colonists' electrical systems and obliterates their efforts at settlement, while your character is placed into cryostasis after being wounded by the anomaly.

Defrosted 30 years later, your character awakens to discover the surviving colonists have split into two warring factions, battling over meagre supplies in a tiny valley where they're safe from the anomaly. Fortunately, the anomaly has given you superpowers, and you're promptly tasked with finding a way to reconnect with the orbiting Flores, retrieving supplies that will hopefully end the conflict.

All this is communicated to you in the space of half an hour, mostly through cutscenes. This makes for an introduction that feels simultaneously rushed and overlong.

It relentlessly throws story points in which you have no investment at you, with seemingly major characters killed off before they have time to state their names. At the same time, it's reluctant to let you play, only allowing intermittent control that's regularly snatched away for more plot exposition.

Mercifully, once the intro is over, Outriders settles into a much steadier flow. The broad goal is to meld the cover shooting of Gears of War with the incremental loot harvesting of games such as Destiny and The Division. Your adventures across Outriders' planet are split between 20 large, semi-open levels, each of which has a primary objective and several optional secondary missions. All these involve shooting large numbers of enemies before stealing their trousers, which are usually slightly better than your current pair of trousers.

In both areas, Outriders is fine, but totally unremarkable. While loot becomes rather more exotic later in the game, for

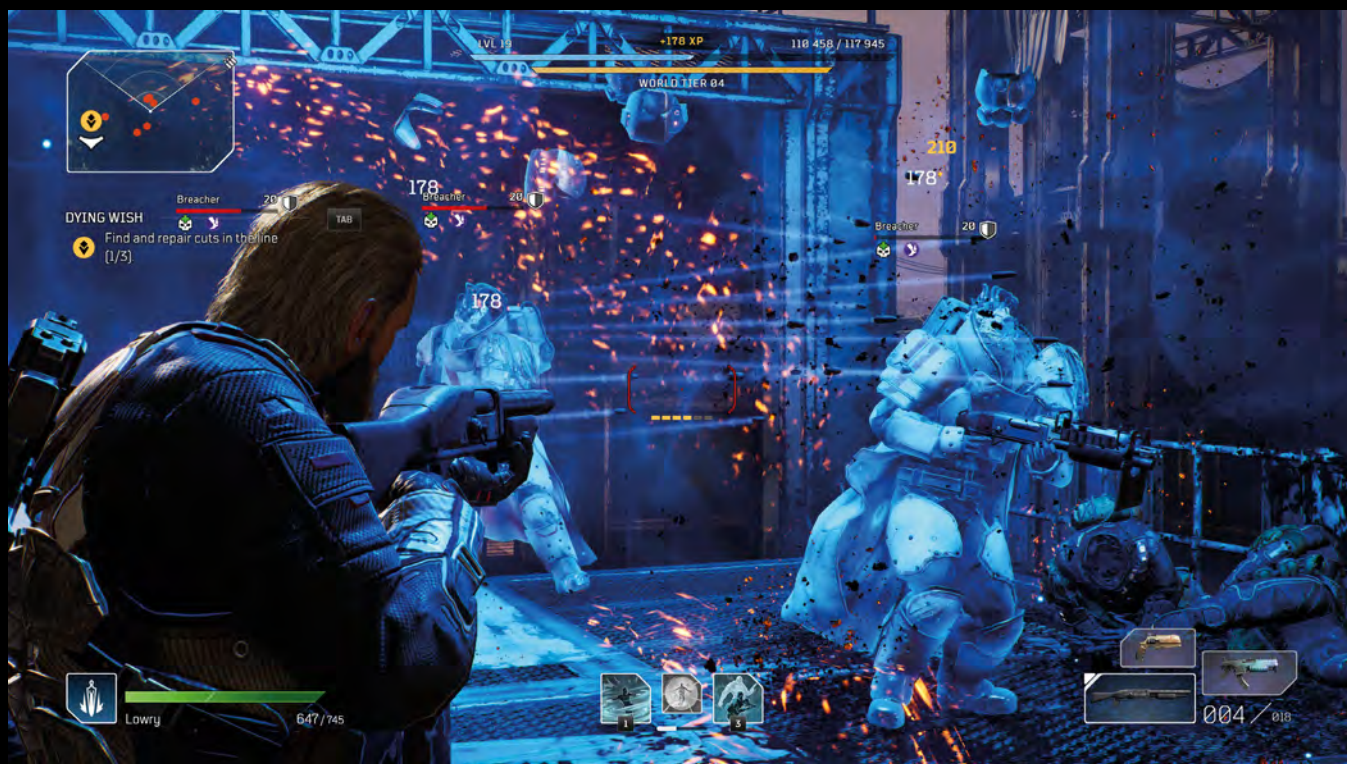
OUTRIDERS

- + Excellent character classes
- + Spectacular, bloody combat
- + More interesting than it initially seems

OUTSIDERS

- Confused and tedious opening
- Loot takes a long time to get interesting
- Nothing massively new





at least the first ten hours, you'll be fighting with drab pieces of military equipment that you'll often struggle to distinguish from each other. The combat system, meanwhile, is ripped straight from Gears of War (People Can Fly previously worked on Gears of War Judgment).

The most notable aspect of the gunplay is that it's a lot gorier than other looter-shooters, with heads bursting and intestines falling out of enemies like a string of sausages out of an overloaded plastic bag. This makes combat more viscerally satisfying than relying solely on numbers falling out of enemies for damage feedback, but it doesn't exactly make Outriders an essential purchase.

What does elevate Outriders above mediocrity is its character classes. Your anomalous superpowers can be channelled into four different fighting styles. You could become a Technomancer – a magical sniper who can conjure gun turrets and other equipment onto the battlefield. Alternatively, you could be a Pyromancer (mid-range fire starter) or a Devastator (close-range tank built to absorb huge amounts of damage and reflect it back at enemies).

Our favourite class, however, is the Trickster. The Trickster is a hit and run character with the ability to manipulate time. Their powers include the ability to teleport instantly behind an enemy, to create a slow-time field through which both enemies and bullets move as if passing through treacle, and to hit them with a 'temporal blade' that rapidly ages them like the baddie in Indiana Jones and the Last Crusade. These are combined with a passive ability, where the Trickster can heal themselves by killing enemies at close range.

The Trickster transforms Outriders' combat from crouching behind walls to a Doom Eternal-like rampage of zipping around the battlefield using enemies as meaty health dispensers. You gamble your survival on your

ability to kill enemies as quickly as possible and not be pinned down, making every encounter tactical, thrilling and spectacular. Trapping an enemy in a time bubble before stepping around their bullets to slice them with the temporal blade makes for a stunning display of cobalt-blue effects.

Also, while the story is initially a confused mess, it eventually untangles those knots into a capable sci-fi yarn, balancing a pulpy, knockabout tone with a ruthless tendency to kill off characters when you least expect it. Similarly, after a rather bizarre initial obsession with World War I-style landscapes, Outriders' locations become more interesting. You'll traverse icy mountains, forests of giant trees and a sprawling shanty town built in the shadow of a wrecked spaceship engine.

Yet while Outriders is better than you might expect, it still isn't a great game. Although environments may be varied, the level design is largely uniform. Combat arenas feel samey, and it's only the character abilities that prevent fights from becoming achingly repetitive. Indeed, the game often struggles to imbue variation into the combat.

There are too few enemy types for the game's size as well, and although your character gains a new ability every few levels, you can only ever use three of them at once. Meanwhile, the skill tree is geared mostly towards incremental stat boosts rather than altering the functions of abilities or general combat.

Outriders isn't going to revolutionise gaming, but while it's less radical than some of People Can Fly's previous efforts, it still holds some surprises. Its character classes are excellent, its story is better than it initially seems, and both the shooting and looting are robust enough that they don't detract from the game's more exciting systems.

RIK LANE

/ VERDICT

A solid slice of cooperative gunfighting with just enough surprises to make it worth playing.

OVERALL SCORE

70%

SPACEBASE STARTOPIA / £45.99 inc VAT

DEVELOPER Realmforge Studios / PUBLISHER Kalypso Media

STARTOPIA

- + Base building basics are enjoyable
- + Looks good

DYSTOPIA

- Nonew ideas
- Underwhelming simulation
- Annoying micromanagement
- Disastrous humour

/ VERDICT

If you need the loo and see Spacebase Startopia looming in the headlights, cross your legs and hold it in for the next few light years.

OVERALL SCORE

40%

A reboot of the 2004 management sim named simply 'Startopia', Spacebase Startopia dedicates itself to recreating the look, feel and mechanics of the original game. Unfortunately, this means it fails to evolve the concept of managing your own space station meaningfully, while also retaining and exacerbating the problems that prevented Startopia from becoming a classic.

While managing your own space station is Startopia's premise, in practice you only ever manage part of it. The giant metal doughnut that forms the game map is split into multiple segments, and you start inside only one of them. From here, you must design the perfect intergalactic motorway services, constructing an array of practical and recreational establishments catering for an array of alien species.

What separates Startopia from other management sims is the structure of the station. Alongside the multiple segments, the station has three different decks, each geared towards a different function. In the station's bowels is the utility deck, providing basic habitation for vacationing aliens, alongside

medical services, security operations and rubbish recycling. Above this is the fun deck, where you build space discos, amusement arcades and an alien cat café. At the top of the station resides the biosphere, which grows various resources your station needs.

Constructing and expanding your base is fun, and although the visual design lacks the consistency and precision of Evil Genius 2, there are some loving details baked into the simulation. Your alien guests will physically climb into sleeping pods, and recoil when examining the medicine provided at the space doctor. The way your mobile bins vomit up rubbish at the recycling facility is a particularly neat touch.

Sadly, new features are few and far between, and although the simulation looks good, it lacks depth. There's little meaningful interaction between you and the aliens, or between different species of alien. Moreover, the reboot fails to address Startopia's existing issues, particularly when it comes to tedious micromanagement. Manually collecting rubbish, squashing vermin and dealing with space pirate incursions are all rudimentary busywork – they only distract you from the fact that there isn't much going on beneath Startopia's hull.

Startopia's biggest problem, however, is its risible attempt at humour. This takes the form of an AI companion who directly and constantly insults the player, deriding their capability as a manager and generally being unpleasant. There's no wit or variation to the jokes, just an incessant barrage of putdowns that isn't funny and ultimately makes you want to stop playing.

At its best, Spacebase Startopia is an uninspired but innocuous throwback. At its worst, it's a tedious and actively unpleasant experience. In other words, not that much different from using an actual motorway service station.

RICK LANE





TRIALS OF FIRE / £15.49 inc VAT

DEVELOPER Whatboy Games / PUBLISHER Whatboy Games

Presented as a virtual storybook, cracking the spine of Trials of Fire will see you select three brave adventurers and one of several quests on which to send them. Travelling across a procedurally generated map, your heroic trio must complete a sequence of objectives scattered across the game's blighted landscape. As you travel, you'll need to regularly search secondary locations for food and equipment to upgrade your abilities.

Arriving at any location will trigger an encounter (a story vignette picked randomly and presented through text). Each encounter must be resolved with a series of choices. Some will require a skill check, while others will result in a battle. If the latter occurs, the game switches to a hex-based battlefield map with both heroes and enemies represented as board game-style counters. On your turn, each character draws three cards from their deck, all of which will be used during the turn.

Used, but not necessarily played. Trials of Fire's most important mechanic is that cards act both as powers and resources. Playing cards and moving counters across the

battlefield costs 'willpower', and the main way to accrue willpower is to sacrifice cards. Consequently, every turn requires you to make tough decisions about which cards to use or burn.

More powerful cards cost more willpower to use, while there are other cards that provide free actions or even add willpower to the pool when played. The board-state can affect your decisions as well. If your warrior is out of melee range, for example, you might be better spending your willpower on your hunter's ranged attacks.

Then again, if you have multiple characters adjacent to an enemy, attacking that enemy will trigger a combo strike, dealing additional damage. Alternatively, then, you could spend those cards moving both your warrior and hunter into melee range, then using your remaining willpower on one big melee strike.

The broader design is built to fuel this combat system. Despite being both turn-based and card-based, the combat feels excellent. Your hunter's arrows thud into enemy counters, which explode when defeated. Levelling up and finding new equipment unlocks more powerful cards and new party characters, both of which enable greater flexibility with your deck. You'll unlock cards that boost your armour when you move, plus cards that steal cards from enemies and cards that add more cards into your hand. The deck's diversity is remarkable.

The only real negative is that the quests are a little staid. Individual encounters are interesting, but the broader arcs aren't that engaging, while your characters lack personality outside of battle. Otherwise, however, Trials of Fire is a finely stitched mesh of different ideas, presented in a way that even card game sceptics will find hard to resist.

RICK LANE

TRIAL OF FIRE

- + Smartly presented
- + Clever card-sacrificing mechanic
- + Impressive tactical range and depth

TRIAL BY ORDEAL

- Quests and characters lack personality

/ VERDICT

Trials of Fire ticks all the boxes of its broad conceptual checklist.

OVERALL SCORE

85%



REALITY CHECK

Rick Lane clammers up some virtual landscapes and checks out the latest Oculus Quest 2 software in his latest VR roundup



NEWS

RESIDENT EVIL 4 COMING TO OCULUS QUEST 2

Like Doom and Skyrim, Resident Evil 4 seems destined to exist on every platform. Even so, the announcement that this classic survival horror is coming to Oculus Quest 2 still came as a surprise.

Developed by Armature Games with Capcom's input, it's by no means a straightforward port. The Quest 2 version of Resident Evil 4 is being significantly retooled into a proper VR game. Unlike all other versions of the game, the Quest 2 version will be played in first person with fully optimised touch controls.

Weapons and ammo are being redesigned to function like other VR

shooters, with manual aiming and reloading. Weapons will be holstered on the player's virtual body, meaning you won't have to rummage through your inventory to equip your shotgun. It even adds dual-wielded weapons, which aren't featured in any previous versions of the game.

Positional audio is also being added to Resident Evil 5, in order to help you keep track of off-screen enemies, while Capcom has stated that over 4,500 textures have been repainted, presumably to make the 16-year-old game look sharper in VR. You can expect Resident Evil 4 to launch for VR later this year.



REVIEW

THE CLIMB 2 / £22.99 inc VAT

DEVELOPER Crytek/ PUBLISHER Crytek

Released in 2016, The Climb was a unique VR experience that acted as a fantastic showcase for the technology. Inevitably, The Climb 2 can't replicate the same 'wow' moments of the original, but it's nonetheless a smart and substantial iteration over its predecessor.

The Climb 2 doesn't add any radical new features – the core experience is still largely the same as the first game. Its globetrotting adventure comprises 15 different levels, each of which tasks you with ascending a complex vertical route. Using your Touch controllers, you climb by moving your hands to different handholds, using the controllers' bespoke 'grip' buttons to grab hold, before 'pulling' yourself up.

In this way, you must carefully navigate sheer faces, shimmy across ledges and scramble up precipitous overhangs, all while picking the correct handholds and monitoring your grip to prevent you from falling.

The Climb 2's most notable addition is two new environment types – North and City. The former transports you to an Arctic-like region where you clamber frigid waterfalls and icicle-lined crevasses, while confused polar bears and puffins watch from the sidelines. However, it's City that represents the biggest



change to the game. Mantling around City's glittering skyscrapers introduces several new environmental features, such as ziplines, scaffolding and revolving 'trivision' billboards.

These new locations are mixed with the three existing environments – Canyon, Bay and Alps, all of which have had significant redesigns to make their climbing more diverse. Each climbing challenge has multiple routes you can explore, some of which are more dangerous than others. At times you'll need to leap across perilous gaps, or deal with loose handholds and rickety ladders that can break away if you linger too long. There are even handholds that you have to clean with a sweep of your hand first.

The Climb 2 also strives to improve general immersion. Handholds are more subtly baked into the environment, lending a more natural feel to your climbing. Levels are also filled with little details designed to capitalise on the stereoscopic 3D effect, such as curious animals watching you from nearby ledges, or jets flying past you at eye level while you climb.

For the most part, The Climb 2 is a visual treat, eking an impressive amount of detail out of the Oculus Quest and Quest

2's limited hardware. That said, it can still struggle to render far-off vistas. This may be a consequence of overzealous foveated rendering, which maximises rendering detail at the focus of your eye, while lowering detail at the periphery. This works great when you're facing the walls themselves, but results in the fringes of the game's panoramic views looking fuzzy.

This is our only substantial complaint about The Climb 2. It isn't a significant leap forward for Crytek's virtual climbing series, but it does more than enough to justify itself as a sequel to one of the most unusual and rewarding VR games around.

CLIMB

- + More diverse locations
- + Multiple pathways per level
- + More nuanced climbing environments

FALL

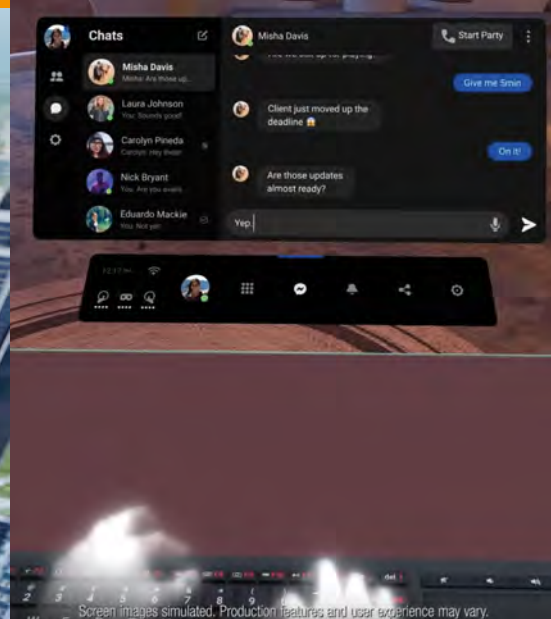
- Some issues rendering distant objects

VERDICT

The Climb 2 is a fine sequel to one of VR's best games.

OVERALL SCORE

80%



NEWS

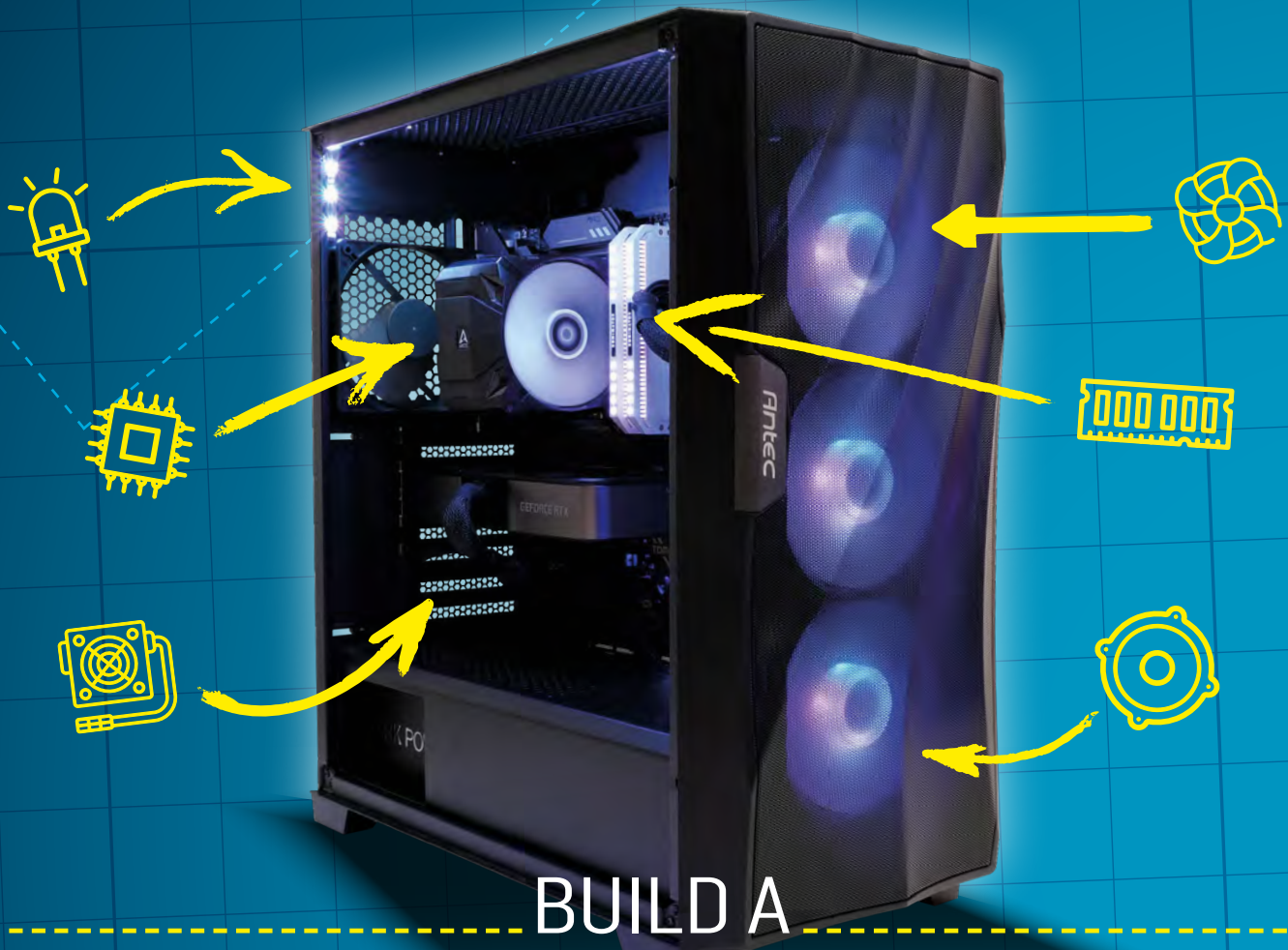
QUEST 2 V28

Normally we wouldn't cover a software update in Reality Check, but the v28 update for Oculus Quest 2 is a biggie. It adds a whole bunch of new and experimental features for Oculus' latest headset, some of which have potentially radical implications for your VR experience.

The most notable addition is Oculus Air Link, an experimental feature that lets you pair your headset with your PC via Wi-Fi, then stream VR games directly from your PC to the headset. While there are third-party programs that already let you do that, this is Oculus' official system for wireless PC-to-VR gaming.

In addition, v28 adds several new features bundled under the title Infinite Office, which are designed to let you perform more everyday tasks in VR. One of them lets you scan your desk and bring it into VR, while another lets you track your keyboard in VR, combining a 3D representation of your keyboard with the Quest's built-in hand-tracking, so you can type accurately without having to remove the headset. Initially, this latter feature will only be compatible with the Logitech K380, but Oculus plans to expand compatibility to other keyboards over time.

Finally, v28 adds support for 120Hz refresh rates, although currently there are no apps that officially support it, so this is very much a feature for the future. Nonetheless, v28 represents a significant expansion of the Quest 2's capabilities, putting it even further out front as the best all-round headset. **GPC**



BUILD A

BETTER PC

GIVE YOUR PC A PROFESSIONAL TOUCH WITH OUR TOP TIPS

ANTONY LEATHER SHARES HIS TOP TIPS AND TRICKS FOR PERFECTING YOUR PC BUILDING SKILLS

With PCs consisting of just a handful of components, you'd be forgiven for thinking that putting them all together in the right order and installing Windows is all you need to do to build a great PC. However, you'd also be very wrong. A huge part of being a proper PC enthusiast is about taking pride in your creation and understanding the basics of crucial factors such as cooling and airflow direction.

Not doing so can make for an unpleasant PC building experience and future problems. Each step of the PC building process has been honed over decades by enthusiasts, from picking the right components and limiting cable clutter, to applying thermal paste and ensuring cooling is up to scratch without making too much noise. There's a wealth of tips and tricks to get the very best out of your PC and ensure it's running as smoothly as possible.

We've got plenty of experience in PC building here at Custom PC, and in this guide we'll give you the tools to make your PC run as cool and quiet as possible, look great and even run faster. We've split this guide into several individual tips covering various aspects of PC building, so you can pick and choose the ones that apply to your PC, tweak your existing build or use the information when you're building a whole system from scratch.

BEFORE YOU START

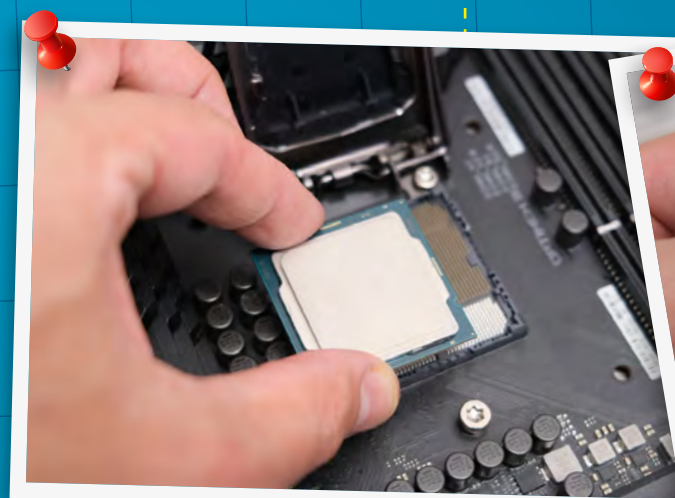
There are two steps when it comes to building your PC that have the potential to seriously ruin your day before you've even played a game, so we'll start by highlighting them and what steps you can take to avoid making these mistakes.

Firstly, be careful when installing your CPU. Both AMD and Intel systems suffer from a singular problem in slightly different ways, and they both revolve around pins. Intel sockets have highly delicate pins that make contact

with pads on the CPU, while AMD CPUs have delicate, bendable pins on the underside of the processors – both sets of pins are incredibly easy to damage.

When installing an Intel CPU, leave the socket cap in place, open the latch and move the CPU over the socket from a low height. This way, if you drop it you stand a chance of not damaging the motherboard pins. Close the latch and allow the cap to pop off itself, so the socket is protected for as long as possible.

Secondly, make sure you remove your CPU cooler's protective cover. CPU coolers often come equipped with a plastic film on their underside to prevent the metal tarnishing or being scratched. This will kill its cooling capability if you leave it on, and it's easy to forget, so remove it when you unbox the cooler. It's all too easy to leave it on – even the best of us have done it at some point.



Leave the plastic cap on the lid at first, so the socket pins are exposed for the shortest amount of time



Make sure you remove your CPU cooler's protective cover before fitting it

HOW TO APPLY THERMAL PASTE

The key factor to remember with thermal paste is that only applying too little will have any significant effect on cooling. Pastes that spread easily, and are quite liquid-like, can spread evenly using just the pressure of the cooler – you just need to put a blob of paste in the middle of your CPU that's about the size of a grain of rice, and the pressure from the clamping mechanism will do the rest.

Thicker, dryer pastes don't spread as readily, and while these are rare, the grain-of-rice method can see these pastes fail to spread evenly in the gap between your CPU and cooler. There are better ways to spread the

paste, though, and it's best to use slightly different techniques for different sizes of CPU heatspreader.

For Intel's mainstream desktop CPUs, a single thin line of paste from top to bottom in the middle of the heatspreader will consistently allow the paste to spread evenly. For AMD Ryzen and Intel high-end desktop CPUs, which both have larger heatspreaders, a cross shape with thin lines of paste is best, allowing for an equal spread of paste under pressure.

Finally, the largest CPUs you'll come across as a PC enthusiast are AMD's Threadripper

CPUs, which have enormous heatspreaders. Here, a large cross method of applying paste, followed by dots or lines in the gaps to fill them works best, a bit like drawing a Union Jack flag.

There's very little performance difference between pastes these days, but we've regularly used ARCTIC MX-4, Corsair XTM, Noctua NT-H1, Gelid GC-Extreme and Thermal Grizzly Conductonaut, and can vouch for their performance. Many coolers come with paste pre-applied, but it's always handy to have spare paste in case you want to swap coolers or CPUs in the future.



For the best results, apply thermal paste in different shapes depending on the size of your CPU's heatspreader

CHOOSE THE RIGHT CPU COOLER



The cooler supplied with some CPUs will handle your CPU at stock speed, but not overclocked

Some CPUs come with coolers in the retail box, which are designed to handle that CPU at stock speed. If you plan on overclocking your CPU, which makes it run hotter, that stock cooler can quickly become overwhelmed. This is where third-party coolers come in, offering more cooling power while often making less noise. Even a relatively affordable cooler, such as the ARCTIC Freezer 7X or 13X, offers far more cooling power than a stock cooler, and at lower noise levels.

Picking the right cooler for your CPU can be tricky though. One of the metrics to see how much heat your CPU produces is its thermal design power (TDP), which is quoted by CPU manufacturers, specifying the thermal energy in watts that a CPU will produce.

With AMD CPUs, this figure doesn't refer to electrical power, although we're still dealing with watts and a joule per second is a joule per second, whatever energy you're measuring. Intel, though, specifically defines TDP as related to power consumption. The difference here is that its CPUs can and do exceed the TDP in boosting conditions, even if they adhere to it in other conditions. As you can see, TDP isn't always an accurate measurement for assessing cooling requirements.

Cooler manufacturers do still use TDP as a measurement of what's required to offer an



An ARCTIC Freezer 7X offers more cooling power than a stock cooler, and at lower noise levels

acceptable amount of cooling for any given CPU, and many offer advice on which of their coolers cope with specific CPUs, so that's a great place to start.

ARCTIC's Freezer 7X and Freezer 13X, for example, are great for cooling 4-core or 6-core CPUs, but fitting them to CPUs with eight or more cores (from either Intel or AMD) can result in the fans needing to really spin up under heavy loads, which defeats the point of spending more money on a cooler. This limit is only due to its size and small number of heatpipes.

Stepping up to a Deepcool Gammaxx GTE V2 gets you a larger fan and heatsink for greater heat dissipation, resulting in a cooler that will easily handle AMD and Intel CPUs with eight, ten or 12 cores, albeit with limited overclocking potential.

More expensive coolers justify their price tags in a couple of ways. Adding a second fan will ensure that the heatsink is performing at its best and dissipating as much heat as possible. They can also allow for better airflow at lower noise levels, since noise doesn't double if you add another fan, but the static pressure will increase, boosting airflow through the heatsink.

Of course, a bigger heatsink will help too by dissipating more heat. This can firstly mean

your fans don't need to spin up as regularly, as the heatsink will absorb the heat from your CPU first – the bigger the heatsink, the longer this takes to happen. Secondly, with bigger heat dissipation potential, cooling heavily overclocked CPUs with more than eight cores becomes easier and quieter.

This level of cooling should be the starting point for the likes of AMD's Ryzen 9 5950X, Threadripper CPUs and Intel's high-end desktop CPUs. The downside is that these massive air coolers with large heatsinks and dual fans can cost as much as some all-in-one liquid coolers.

All-in-one liquid coolers have several benefits over CPU air coolers. They're able to offer more efficient cooling by dealing with thinner heatsinks in the form of radiators, and these radiators can be positioned so they expel the warm air directly out of your case instead of into it, which is what otherwise happens with an air cooler.

They're also able to deal with the heat more effectively at the source as well, with water having a higher heat capacity than air. The downsides are that some liquid coolers can be noisy, especially where pumps are concerned, there are more points of failure and they're comparatively expensive.



An air cooler with a second fan will increase static pressure without making much more noise



Liquid coolers have radiators that can be positioned to expel warm air directly out of your case instead of into it

THE ART OF CABLE TIDYING

Cable tidying is a polarising task among PC builders, with some people relishing spending a weekend ensuring their PC is as tidy as possible. Some even go as far as creating custom cables for their power supplies that fit perfectly in their case.

It's easy to just plug in all your components and leave the cables trailing anywhere, but poorly tidied cables can kill airflow by getting in the way, and a mass of spaghetti can also hinder upgrade access and troubleshooting, plus they look terrible.

Thankfully, modern PC cases make it relatively easy to do a decent job of cable tidying, but it's still easy to mess it up if you don't know what you're doing.

Routing some cables before others, knowing where to stow them and also how to use any included cable management systems are all vital when it comes to making sure you nail your build the first time. Even spending an hour tidying up your cables will mean your PC looks better, is easier to maintain and may even run cooler too.



Deal with the other cables

This part is very case-specific and one rule definitely does not fit all. Some cases have limited stowage space for cable slack under the PSU cover, and some cases don't have a PSU cover at all.

In the latter case, try to anchor the rest of the cables behind the motherboard tray, adding them next to the main strand of cables to the left of the motherboard tray, then along the bottom of it. With every case, avoid stuffing the cables near any vents and keep them well away from case fans. Group them together and check that the bundle won't prevent the side panel from closing easily.

Only use necessary PSU cables

If you have a modular PSU, only use the cables you need. However, if you think future additions to your PC warrant using extra cables, such as SATA and Molex cables, or an extra graphics PCI-E cable, it's worth attaching those cables now rather than doing it once you've installed your PSU, especially if you can easily tuck them away out of sight.



Start with main cables

Each case is different when it comes to cable tidying, but they often require you to tie up all your cables between the motherboard tray and side panel. Doing so can often mean the side panel becomes impossible to fit, so the first step is to anchor the main cables in place. Start by routing the 24-pin ATX and 8-pin CPU cables from your PSU.

Thread the former through the cable-routing hole that will be nearest to the position of the ATX connector on your motherboard, and thread the 8-pin CPU cable through the hole above where your motherboard will be installed. Ideally, you want to do this before you install your motherboard to make installation as easy as possible. Once these cables are in place, install your motherboard and graphics card.

Thread the latter's power cables through the hole nearest to the graphics card. Some cases have PSU covers with cable-routing holes in them, and these can be a better place to thread your graphics card's power

cables than the side holes, especially if its connectors are on the side rather than the far edge. Route these cables up the left side of your motherboard tray, which is where case manufacturers usually place the main cable-routing features, such as anchor points or Velcro ties.



Tie up the cables

If your bundles don't interfere with the side panel, use the included cable ties or Velcro straps to anchor the cables in place. Our two top tips here are to invest in extra cables ties, as cases rarely include enough in the box. It can be handy to have ties of different lengths too, for dealing with various thicknesses of bundles.

Even better, albeit a little more expensive, is to use Velcro ties. Velcro can do a much better job of gathering cables together to look neater, and will be much easier to remove – it's also reusable, unlike standard plastic ties. However, you may still need to use plastic cable ties to secure your cables to your case's anchor points.

Find other cable-stowing spaces

If there's not enough space to bunch the cables behind the side panel, then you'll need to find other locations for some of them. This usually involves tucking them under the PSU cover, and Velcro is again a great tool here, as it enables you to tie up the cables in tight bunches to stow in front of your PSU.



Create your own anchor points

Quite often, cases simply won't have enough anchor points to tie all your cables in the best places, but it's easy to make your own ones. Adhesive cable anchors can be fixed anywhere in your case, and they can help to tidy cables behind your motherboard tray, as well as helping to deal with RGB cables, front panel cables, SATA cables and liquid cooler cables.



Use fan and lighting hubs

A fantastic way to deal with the reams of spaghetti that are often accompanied with RGB lighting and multiple fans is to use a hub. These can simply split a fan or RGB header on your motherboard into numerous outputs, allowing you to route all your fan and lighting cables to one point and control them all from a single motherboard header, or to control all the parts attached to a single hub using software. Some cases and coolers include these hubs as standard, and some also sport manual lighting and fan speed controllers too, avoiding the need for software.



OTHER CABLE-TIDYING CONSIDERATIONS

Plenty of cases can often pose further challenges when it comes to cable tidying. Some mini-ITX cases, and larger cases at the cheaper end of the spectrum, lack PSU covers, leaving you with a tricky situation when it comes to hiding and tidying your cables. Again, custom anchors can be a huge help here, and don't be afraid to secure cables in every available space.

You have two options and you'll likely need to use both of them. Firstly, gather your cables in bunches and anchor them as out of sight as possible, again avoiding vents and fans and avoid hampering your case's airflow. The next option is to find alternative routes inside your case's chassis, such as beams and internal fittings. Anchoring your cables to these parts will allow the cables to blend in with the interior.

Making your cables look attractive and work as an aesthetic feature in your case is a great way to beat the cable-tidying gremlins and is especially useful in cases with little space for stowage. The easiest way to do this is to buy a custom cable set for your PSU.

Many manufacturers, such as Corsair, offer their own kits, while companies such as cablemod.com can create custom kits for your own PSU, allowing you to specify the colour of every cable strand, as well as the length of the cables, meaning your cables can be made to the perfect length for your build.



Find alternative routes inside your case's chassis, such as beams and internal fittings

A custom cable set for your PSU will help to smarten up your case's interior

AIRFLOW AND COOLING

Airflow is the most critical consideration when building your PC – if your components get too hot, they can often throttle performance and even live shorter lives. Thankfully, ensuring your case has good airflow is relatively simple. As long as you have good airflow, you can generally deal with the heat dumped into your case by graphics cards and CPU air coolers.

Most cases are designed with a front-to-back airflow design, which will be evident in the locations of their fans and dust filters. This is logical too, since many PCs have their rear ends sat against walls or other stuffy locations under desks – it's much better to dump hot air into these locations than draw air from them.

A front-to-back setup also means that every component benefits from airflow – generally speaking, your PSU, graphics card and motherboard are stacked vertically, with your graphics card in the middle of the case and usually hindering any attempt at bottom-to-top or chimney airflow arrangements. If you're fairly new to the PC building scene, here are a few key airflow factors to make sure you get right at the start.

HOW MANY FANS?

In any case, a rear exhaust fan is essential for a number of reasons. Drawing air into your case with front fans is critical, but a rear fan can significantly aid the removal of warm air from your case, irrespective of whether your case has negative or positive airflow.

The former means that you have more air-pushing power getting air out of your case than getting air into it, meaning that air will be drawn in through any open sections in your case, which can potentially mean dust ingress too. Positive air pressure, on the other hand, means more air is being drawn into your case using fans, which is generally preferable, as those nooks and crannies will now be expelling air.

To achieve a positive airflow setup, you just need to have one or two more intake fans than exhaust fans – as a bare minimum, we recommend having two front fans and



We recommend having one front fan in line with your CPU and another one in line with your graphics card



Pointing a fan directly at your graphics card from below can help if it has a flow-through cooler design

one rear exhaust fan. After that you see diminishing returns, although placing extra fans in key locations can boost cooling for not much money. If your case only has one front fan, consider shifting this up, so it sits in line with your CPU cooler, then add a second fan below it that's in line with your graphics card.

This will ensure that both components are aided as much as possible by direct airflow, and it can also help to move warm air that's been exhausted out the sides of the graphics card to the rear of the case. Adding a bottom fan pointing at your graphics card can help cool it too, especially if you have an Nvidia Founders Edition RTX 3000-series card with flow-through fans – if you're using one of these cards, adding a roof fan can help to expel the hot air too.



Always point your CPU air cooler in the same direction as the rear fan

ORIENTATE YOUR CPU AIR COOLER CORRECTLY

The rear fan installed in a typical case can actively aid CPU cooling by getting shot of the warm air from your CPU cooler and promoting the front-to-back airflow arrangement. In short, it can act as a second CPU cooler fan, helping to draw air through the cooler and prevent it pooling at its rear. For this reason, you should always have your CPU cooler pointing in the same direction as the rear fan.

WHERE SHOULD YOU LOCATE LIQUID COOLERS?

All-in-one liquid coolers are designed to have the pump sitting lower than the radiator, and for the radiator to act as a reservoir, trapping air inside it instead, so it doesn't find its way to your pump and cause it to be noisy. A few of these coolers are refillable, in which case you can top up the coolant occasionally, and place the pump and radiator wherever you like. If you can't refill yours, though, the coolant can slowly evaporate, which can lead to some radiator orientations seeing your pump receive air rather than water. After this point, it will get noisy and eventually stop working.



The roof of your case is the best location for a liquid cooler's radiator



A fan will push more air through a radiator than it will pull through it from the other side

For this reason, it's best to have the radiator in the roof of your case, which will mean any air in the loop will sit in the radiator and not find its way to the pump. It also means that mounting the radiator in the front of your case is unwise, at least in the long term, since the air could transfer to your pump, as the latter won't be lower than the radiator if the tubes are at the top.

If you have the tubes at the bottom of the radiator when it's mounted in the front, then any air that does find its way to your pump will likely stay there. Mounting the radiator in the roof has another benefit too, which is that the warm air it exhausts will be expelled straight out of the case and not be dumped back into it.

WHERE SHOULD YOU MOUNT RADIATOR FANS?

Plenty of tests have been performed over the years to work out whether fans are best placed so they push or pull air through a radiator. In general, there isn't much difference, but the highest static pressure is behind the fan blades, not in front of it, which means a fan will push more air through a radiator than it will pull through it from the other side.

This is important with radiators, as some designs can be far more restrictive in terms of airflow than a CPU air cooler, so static pressure is important. However, there are some instances where case or motherboard components require fans to be placed in the roof of your case and the radiator below them – doing so won't result in significantly worse cooling performance.

VERTICAL GRAPHICS CARD MOUNTS

Many graphics card coolers have sexy designs, which makes it a shame that in most cases they end up face down and obscured from view. This is one reason why vertical graphics card mounts are popular, as they allow your graphics card's cooler and fans to be visible through a glass side panel.



Placing your graphics card right next to an unvented side panel seriously impacts airflow



PCI-E 3 riser cables supplied by case manufacturers can cause serious stability issues with a PCI-E 4 graphics card and motherboard

However, there are hidden dangers from mounting your graphics card in this way. For starters, many vertical mounts place the graphics card right next to the side panel, and even those that are sensibly offset away from it still have less clearance than if the graphics card were simply sat in your motherboard's PCI-E slot.

This lack of clearance, and the fact that glass side panels aren't vented, means your graphics card will have to fight harder for air, making its fans spin up more regularly to higher speeds and it will run warmer too, potentially affecting boosting speeds. We've run our own tests with this on numerous occasions and it's always the same – vertical graphics card mounts are usually a bad idea for air-cooled cards.

There are some exceptions, though, such as cases with vented side panels. Admittedly, you won't be able to see your graphics card here, but you shouldn't be wary of a case's cooling just because it has a vertical graphics card mount. Many mini-ITX cases have this type of setup and they still offer excellent cooling thanks to vented side panels that allow the card to breathe.

The other exception is if your graphics card is water-cooled. Here, there will be little if any difference compared with it being mounted

directly on your motherboard, since its hot spots are being cooled using the waterblock.

Another issue with vertical graphics card mounts is that they require the use of a PCI-E riser cable. At the moment, all case manufacturers include PCI-E 3 riser cables, which not only lack support for PCI-E 4, but can also cause serious stability issues if you use them with a PCI-E 4 enabled GPU and motherboard combination. A way around this, though, is to drop back to PCI-E 3 mode in your motherboard's BIOS on your PCI-E slot.

COOLING MINI-ITX CASES

A common misconception with mini-ITX cases is that they're small and therefore must be stuffy, hot and generally undesirable for high-end PCs. The fact is, there are so many varieties in terms of internal design, that any blanket statement is inaccurate in the first place. As we've already mentioned, some mini-ITX cases sport vented side panels for graphics card cooling and for this reason they can actually outperform larger cases when it comes to cooling.

Modern mini-ITX cases can also support radiators, so it's generally easy to cool your CPU and even add custom liquid cooling. In fact, with many mini-ITX cases lacking decent CPU cooler height support, liquid cooling is often the best way to cool your CPU in a mini-ITX case. However, just like a CPU cooler heatsink, the volume of air in a mini-ITX case is smaller and as a result, can warm faster than in larger cases.

For this reason, it's advisable to fill all available fan mounts to shift the air quickly. This doesn't mean having your fans on full speed all the time, just that you'll want plenty of fans to keep the air moving through the case. Similarly, it's a bad idea to put any extra heat into the case, so it's best to install radiators so that they exhaust warm air out of the case, rather than into it.



A mini-ITX case with a large vented side panel can outperform the cooling of some ATX cases

ILLUMINATION

RGB lighting isn't for everyone, but some degree of illumination can make your PC look decidedly cool. However, with LED strips being quite expensive and coming with various connector types, you'll need to know which ones work with your own hardware and where to place them to avoid wasting money.

Best strip locations

For good illumination of your whole PC, the roof of your case close to a windowed side panel is the best place for LED strips. This setup will also mean you won't be blinded by the LEDs if your PC is on your desk either. Another great place is at the rear of the case facing forwards. This can look great, with pinpoints of light pointing forwards in the case, but it can be a bit much if you look at it from this angle for long periods.

Connectors

There are two types of standard RGB connectors. The first have four pins, and they generally only allow you to change the colour of the entire strip or RGB component at the same time. If you want lighting effects that move along strips, or you want to control individual LEDs, you'll need to opt for a 3-pin digital connector. Modern motherboards usually support both, although you'll need to use your motherboard's software to control them.

Cutting strips to length

Some LED strips can be cut to length at specific points, which is useful for splitting one long strip into numerous lengths, or simply trimming them to a manageable size. The cutting points are clearly marked on the strips, and the circuitry inside is wired so that cutting the strip doesn't break the circuit, allowing for all LEDs to receive power and lighting-related signals.

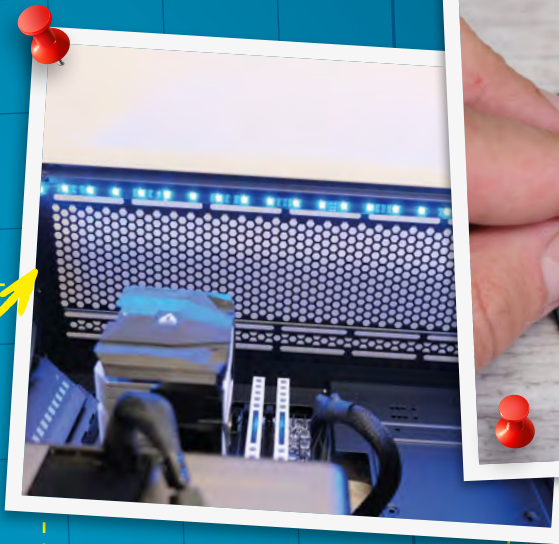
Using extension cables

Getting LEDs into the right location in your case will invariably require the use of extension cables, which are usually included with your motherboard and RGB lighting hardware. However, additional lengths of both 3-pin, 4-pin and proprietary extensions are available separately if you need more.

Proprietary connectors

Some RGB lighting components connect to their manufacturers' hubs and controllers using proprietary connectors, and these aren't compatible with standard 3-pin and 4-pin LED components. However, companies such as Corsair and Phanteks, which often restricted users to their own ecosystems, are now opening up some of their hardware to standard connectors as well.

It's worth checking before you buy, but there are ways around it. Adaptors converting proprietary connectors to standard connectors are available on eBay and Amazon, so if you've fallen in love with some proprietary RGB gear, head to Google and type the manufacturer name plus 'RGB adaptor'. You might get lucky.



Software vs physical control

RGB lighting can be controlled by software or physical means, with buttons on cases and separate controllers being common features. Software will give you more detailed control, especially when it comes to controlling individual LEDs with 3-pin addressable LED strips or picking exact colour shades.

However, if you're happy with a pre-set lighting effect or standard colour, then a manual controller can mean you don't need to install software, which isn't always particularly easy to use. There are third-party manual controllers available too, and even wireless remote controls.

Recommended hardware

The easiest way to add RGB lighting to your PC is to use standard 4-pin or 3-pin LED strips and connect them to your motherboard. These are readily available from most PC retailers. Coolers such as the Antec Neptune series include their own hubs that can control these LED strips, so if you're building a new PC, opting for a cooler that can do this can save money.

RGB fans can also be purchased separately, but beware of them tying you into certain ecosystems. We'd recommend using the same RGB fan make and model throughout your PC, though, as the colour accuracy and vibrancy can vary a lot between different models.



HARDWARE INSTALLATION

Install your memory correctly

If you're not intending to fill all the memory slots on your motherboard, make sure you fill the right slots to enable specific memory channel modes. This will be detailed in your motherboard manual, but with motherboards equipped with four slots offering dual-channel memory support, which is most mainstream Intel and AMD boards, the second and fourth slots are the ones you'll need to fill.

Meanwhile, for quad-channel boards with eight slots, you usually need to use slots one, three, six and eight.

Use the right M.2 slot

We've looked at several PCI-E 4 SSDs in this month's Labs test (see p42), but sadly not all M.2 ports support this standard. Check your motherboard specifications to identify the right port to get the most out of your chosen PCI-E SSD. You'll need to do this for SATA M.2 SSDs as well, as these are powered using the SATA controller and aren't PCI-E or NVMe-

enabled – not all M.2 slots support them, but at least one M.2 port on your motherboard will usually accommodate one.



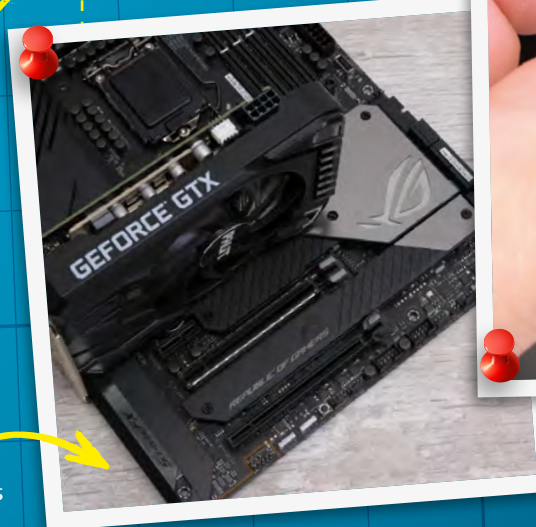
Use an M.2 heatsink

Keeping a high-speed SSD in check under extended loads is important, as it can get toasty in some situations, causing it to throttle. Most boards include a heatsink for the primary M.2 slot, but some cheaper or older boards don't. Third-party heatsinks are available from the likes of EK – they're easy to install and often better-looking than bare SSDs too.



Where to place hard disks

Some cases allow you to mount hard disks in all manner of locations, but this isn't always a good idea. Hard disks can get toasty under sustained loads and it's best to locate them in well-ventilated places near case fans, especially if you're using several of them. If your case offers anti-vibration mounts, they're definitely worth using, as the vibrations from a hard disk can make a lot of noise in an otherwise quiet PC.



Which PCI-E slots to use

Your motherboard's top 16x PCI-E slot is usually the one you want to use for your graphics card, as it's the one slot that's guaranteed to offer the full 16 PCI-E lanes it needs. Occasionally, you may want to use a lower slot, for example if your graphics card's backplate fouls another component. If there's no other option, you can use another slot

and on some motherboards, these slots are configurable to similar speeds. However, some are limited to just four PCI-E lanes, which can impact on gaming performance, so check your motherboard's manual first.



Check your motherboard accessories

Premium motherboards often include handy tools that can make your life easier when building a PC. Specifically, block adaptors allow you to connect your case's front panel connectors together and install them all in one go on the front panel pins on your motherboard, which is otherwise a very fiddly job.



Many motherboard EFI systems offer elaborate fan control curves

COOL, BUT IS IT QUIET?

If you have sensitive ears, or you don't want fan noise to interrupt important audio work, there's plenty you can do to make sure noise levels are kept to a minimum without making cooling suffer.

USE YOUR MOTHERBOARD'S EFI

Modern motherboard EFI systems can control both 3-pin and 4-pin fans, and most offer elaborate fan control suites that allow detailed control over your fan speeds. Fan control curves allow you to set the speed at specific temperatures and can even shut down fans completely under low loads, which is ideal if you just want to kick back and watch Netflix in peace and quiet.

OTHER WAYS TO CONTROL YOUR FANS

There's a few other ways to control your fans, such as fan controllers and resistor cables. The former allows you to hook up several fans to a single hub, which either offers its own control

system using buttons, dials or software. A simpler method is to use fan speed-limiting cables. These work with 3-pin or 4-pin fans and sit between them and the motherboard, simply reducing the resulting speed without needing to delve into the EFI.

BE CAREFUL WHEN LIMITING FAN SPEED

Limiting fan speeds can reduce noise significantly, but isn't without risk. You'll need to check your hardware's temperatures when playing games or when your PC is performing other high-load tasks. You don't want your CPU or graphics card temperature to rise too much, or their coolers will simply spin up and become noisier to compensate.



A physical fan controller enables you to reduce fan speeds without needing to delve into the EFI

All GPUs are different in terms of their typical operating temperatures, but you should aim to keep GPU temperatures below 80°C and CPU temperatures below 90°C for safety, and likely much lower than this to avoid their cooler becoming unpleasantly loud.

KEEP IT CLEAN

If dust clogs your case, you'll be undoing all of the great work you've done following our guide so far – dust can impact on cooling, causing your fans to spin faster and creating more noise.

Clean the filters

Use a household vacuum cleaner to remove dust from your case's filters every three to six months. These filters are designed to trap dust and they usually work well. Remember to check them all, as some can be hidden out of sight. Using a brush attachment can help to dislodge any clumps and allow the Hoover to pick it up.



Install additional filters

If some fan vents or other areas lack dust filters, extra filters can be purchased quite cheaply, allowing you to add them yourself to specific locations. It doesn't matter whether this is inside or outside the case, as long as they seal the openings.



Use an air duster

An air duster is a fantastic tool for blasting dust and detritus out of your PC. They can deal with dust filters too; however, this is best done outdoors, as particularly dirty PCs can shed clouds of dust. Cheap mini cordless vacuum cleaners are, sadly, usually terrible in terms of their suction power, so unless you've spotted one with good reviews, we recommend leaving them alone and sticking to household vacuums and air dusters instead. **SPC**





DO YOU NEED A FAST SSD?

SSDs CONTINUE TO GET FASTER AND FASTER, BUT CAN YOU GENUINELY USE THAT EXTRA SPEED? EDWARD CHESTER AND BEN HARDWIDGE FIND OUT JUST WHAT DIFFERENCE THE LATEST SUPER-FAST PCI-E 4 SSDs MAKE TO REAL-WORLD USE

The revolution brought about by affordable solid-state storage has been a slow and steady one. When first introduced, solid state drives (SSDs) weren't all that fast in practical terms, didn't last long and were very expensive, making them the reserve of enthusiasts only. However, as the years have gone by, we've finally got to the stage where SSDs have almost completely taken over from hard drives, offering blisteringly fast performance, low cost and reliability. It's now not uncommon for desktop PCs with several terabytes of storage to use only SSDs.

Not all SSDs are created equal, though, and nor has progress on making SSDs ever faster and more capacious halted. So, while multi-terabyte SSDs are now relatively affordable, you'll still be looking at opting for slower SSDs to get such capacities without breaking the bank. Meanwhile, the very latest PCI-E 4 drives offer astonishingly fast performance but don't come cheap.

All of which begs the question of just how fast an SSD your typical PC user needs. Are you better off spending your money on extra capacity, faster performance or a balance of the two? After all, many tasks that we

perform day to day don't put much strain on our storage. Other than booting up your PC, loading games and moving around the odd file, what else do you need fast storage for?

To answer those questions and more, we've put a range of different drives to the test in various real-world scenarios, from hard drives all the way up to the latest NVMe SSDs, to find out just where the extra performance can be felt and when it might be worth spending the extra.

But first, with so many SSD variants, let's recap the current options available to you and the technology that powers them.



SSDs have evolved from using the old SATA standards of hard drives to new compact form factors such as M.2

Storage evolution

Peruse the menus of your favourite online tech retailer and you'll find half a dozen main types of storage. At the cheapest end of the market (in terms of cost per gigabyte) are hard drives, while at the top sit the latest PCI-E 4 SSDs, with plenty of options in between, but what differentiates them all? Let's get back to basics.

Most obviously, hard drives and SSDs are completely different technologies. Hard drives rely on spinning platters of magnetic material, which are then manipulated by read/write heads that move back and forth across the surface of the disk. Traditionally available in 3.5in or 2.5in form factors for use in desktop PCs and laptops respectively, they used to be available with a number of interface options. However, they now nearly all use the SATA standard, which defines both the physical cable connection and the protocol used to transmit data.

It's this same cabling and protocol system that the first SSDs used, with the new purely electronic form of data storage simply replacing the internals of the drive. We never

really got to enjoy the prospect of 3.5in SSDs, but 2.5in SATA SSDs are still commonplace and they tend to offer good value – it's relatively easy for manufacturers to stuff lots of storage into (in SSD terms) quite a large form factor.

The next big change in SSDs was the embracing of new form factors, with some drives being mounted directly on PCI-E cards, while we also saw the development of tiny mSATA and M.2 cards. Crucially, some of these form factors can still use the SATA interface standard, which is limited to 550MB/sec read/write speeds, regardless of the speed of the underlying silicon.

However, as native operating system support for non-SATA drives has improved, we now see SSDs tap directly into the PCI-E system interface using the new SSD-dedicated storage protocol called non-volatile memory express (NVMe). This new protocol is limitless in terms of theoretical performance, while the speed limits of PCI-E far exceed that of SATA, with a typical four-lane (4x) PCI-E 3 connection offering up to 3,500MB/sec of throughput and the latest

PCI-E 4 standard doubling the bandwidth up to 7000MB/sec.

Realistically, the current situation is that your PC storage options break down into four main categories. You can either buy a 3.5in hard drive, a 2.5in or M.2 SATA SSD, a PCI-E 3 M.2 SSD or a PCI-E 4 M.2 SSD, with performance and price increasing as you move from one to the next. But just what is the performance difference?

Crunching the numbers

There's a massive difference between the performance of a hard drive and the latest SSDs, but not all the steps in performance are equal, so let's break it down. With a hard drive, the biggest encumbrance to performance is access time. Because the read/write heads have to physically move to the right spot and the magnetic platters also have to spin



It's easier for manufacturers to stuff lots of storage into the relatively large 2.5in form factor

The latest SSDs possess some truly astonishing performance figures

Typical claimed drive specs

Drive type	Form factor	Interface	Protocol	Access time (lower is better)	Max sequential read	Max sequential write	Max random read	Max random write
Hard drive	2.5in/3.5in SATA	SATA	SATA	10ms	550MB/sec	550MB/sec	125 IOPS	225 IOPS
SSD	M.2/2.5in SATA	SATA	SATA	0.03ms	550MB/sec	550MB/sec	100,000 IOPS	80,000 IOPS
SSD	M.2	PCI-E 3	NVMe	0.03ms	3,500MB/sec	3,000MB/sec	500,000 IOPS	450,000 IOPS
SSD	M.2	PCI-E 4	NVMe	0.03ms	7,000MB/sec	5,000MB/sec	1,000,000 IOPS	700,000 IOPS

round, it can take a relatively long time to start reading or writing data. So, a hard drive's average access time is typically in the region of 10–15ms, regardless of its later read or write speed.

Meanwhile, the purely electronic nature of SSDs means they're much quicker to get going, with access times in the region of 0.03ms, over 300 times faster. Notably, the latest, fastest SSDs don't improve much on this figure – it's throughput where big leaps have been made.

This access time advantage is reflected in the number of random read or write operations a drive can perform. That is, where the disk is having to hop about from one area to another to read or write small chunks of data, rather than reading or writing one continuous (sequential) stream of data.

That slow access time means a hard drive can perform roughly 125 random read operations per second or 225 write operations. In comparison, even today's most basic SSDs can perform nearly 100,000 input/output operations per second (IOPS) for both reads and writes. It's for this reason that SSDs feel so much snappier than hard drives in use.

However, the most basic SSDs are limited to the relatively slow SATA standard of communication. You can generally buy SATA SSDs in either 2.5in or M.2 form factors and

they'll top out at sequential read and write speeds of just 550MB/sec. As such, these drives aren't much faster than hard drives for reading and writing large sequential chunks of data (although their access times are still hugely better).

The next option is to move from a SATA drive to a PCI-E 3, NVMe drive, with most such drives available in an M.2 form factor (PCI-E expansion card SSDs used to be commonplace but less so these days, and for most home use, they're not worth considering). The faster NVMe standard and PCI-E interface allow these drives to hit up to 3,500MB/sec sequential read and write speeds, with random read and write speeds of up to 500,000 IOPS.

Finally, we come to the very latest PCI-E 4 NVMe drives, which basically double up those performance numbers. Accordingly, sequential speeds hit up to 7,000MB/sec and random speeds can hit 1,000,000 IOPS.

Breaking down those numbers, it's easy to see why the general consensus of SSD performance is one of diminishing returns. Moving from a hard drive to an SSD nets a 300x improvement in access time (that's maintained with faster SSDs) for a 800x increase in random read IOPS (444x random write IOPS), but with only a small improvement in the maximum sequential read/write speed. As we then move from



Mechanical hard drives have much slower access times than solid state drives

SATA SSDs to PCI-E 3 SSDs, we see up to a 7x uptick in sequential speeds and a 5x increase in random speeds.

Then, with the move from PCI-E 3 to PCI-E 4, both sequential and random speeds receive just a 2x improvement. The PCI-E 4 figures might look astonishing, but they represent a much smaller proportional leap than the move from SATA to PCI-E 3.

AS WE THEN MOVE FROM SATA SSDs TO PCI-E 3 SSDs, WE SEE UP TO A 7x UPTICK IN SEQUENTIAL SPEEDS AND A 5x INCREASE IN RANDOM SPEEDS



Opening Photoshop with a 277MB PSD file was barely quicker on a PCI-E 4 drive compared with a PCI-E 3 one

The real-world consequences

It's one thing to discuss the theoretical advantages of ever faster SSDs, but the proof of the pudding is in real-world usage, which is what we set out to test. We took a typical example each of a modern 3.5in hard drive (WD Blue 4TB), a SATA SSD (Samsung 850 Evo), a PCI-E 3 SSD (Samsung 980) and a PCI-E 4 SSD (Samsung 980 Pro), and put them through a host of tests.

To start off, we simply installed PCMark 10 on the drive, which is a hefty multi-gigabyte installation. The program was installed from a compressed installation file already copied to the drive. Now, because much of the installation process for software for which the installer is already on the hard drive is taken up with the CPU unpacking the software, we saw very little difference between the four drives. Just three seconds, or just over 3 per cent, separated all four results.

This test also confirms one of the strong points of hard drives, which is that they're generally quite good at writing (and reading) sequential chunks of data, which is largely what an installation is doing once the CPU has unpacked the data. Meanwhile, at the other end of the scale, the whole process is clearly completely limited by CPU speed, so there's no advantage to faster SSDs.



SATA SSDs are now noticeably slower than the latest NVMe drives, but they still offer a major upgrade over hard drives

Next up, we recorded how long it takes to launch Photoshop from scratch while opening a 277MB PSD file, and here we start to see those SSDs stretch their legs. While the hard drive took 30 seconds, the SATA SSD took just 19 seconds and the PCI-E 3 drive just 14. The PCI-E 4 drive showed no

improvement over the PCI-E 3 drive, though, again suggesting the CPU is the limit when we get to drives of this speed.

For our next test, we loaded each drive with a Windows installation and tested how long each took to boot from a cold start to the desktop. We omitted the hard drive

M.2 is now the de facto standard SSD form factor, but not all M.2 drives are created equal



IF YOU'RE LOOKING FOR A FAST BOOT DRIVE THAT WILL HOLD YOUR GAMES AND SOFTWARE, IT'S WORTH BUYING A DECENT PCI-E 3 NVME SSD

for this test, instead leaving the SSDs to battle it out, and the story was again one of modest gains. The PCI-E 4 drive eked out a one-second advantage over the other two drives – a hardly worthwhile gain, we're sure you'll agree.

However, that test was with a clean installation of Windows. Adding several more startup apps – Adobe Creative Cloud, Ubisoft Connect, Origin, Bethesda Launcher, Steam and GOG Galaxy – to the mix created a different picture. Here we see the two PCI-E drives again split by just one second



There aren't many real-world performance benefits to PCI-E 4 SSDs over PCI-E 3 drives

but the SATA drive falls back by ten seconds. In theory, you're only booting your PC once a day, so what's ten seconds of difference going to make, but there are certainly situations where you want your PC to boot up as quickly as possible, so a ten-second saving is worth having.

You could argue our next test isn't really a real-world one – as duplicating data is inherently a pointless task – but nonetheless it certainly shows what these different drives can do when shunting around real files. We ran three tests, taking a cluster of several files totalling 3.13GB (six large files), 18.8GB (36 large files) and 55.6GB (4,703 small media files), and copied and pasted each from and to the same drive. This essentially asks the drive to read and write in a sequential manner as quickly as possible at the same time.

Sure enough, we saw massive differences across all the drives, with the PCI-E 4 drive finally able to stretch its legs. For instance, in the 18.8GB test, the PCI-E 4 drive was 54 per cent faster than the PCI-E 3 drive,

although this actually reduced significantly for the largest 55.6GB test (down to just 17 per cent), suggesting the on-board RAM or SLC cache of the drives was affecting the tests. Regardless, this test really showed just where SATA SSDs and hard drives are lacking.

For our final test, we made use of that PCMark 10 installation and ran the program's secondary storage tests that mimic a host of real-life software storage access patterns, such as booting Windows, starting up Battlefield V and Call of Duty Black Ops 4 and doing some heavy processing in Adobe Photoshop.

In the Windows boot test, we again see how this isn't affected massively by the different types of SSD, but that hard drives are miles off the pace. Indeed, the latter is a trend we see right across the board.

When it comes to the other tests, we consistently see a barely perceptible advantage moving from PCI-E 3 to PCI-E 4, but a decent improvement from SATA to PCI-E 3, showing that the upgrade is worth it

for any data storage that will sometimes be called upon to provide fast storage access. Meanwhile, as if we didn't know already, you really shouldn't be using hard drives for any other purpose than bulk backup storage these days.

Why don't faster drives make a big difference?

With our testing done, it's clear to see that while ever-faster SSDs can make a difference in a few isolated cases, by and large any decent modern SSD is adequate in most instances. At the very least, most buyers don't need to be shopping for the fastest PCI-E 4 drives unless they feel they really need the very fastest storage and are prepared to pay the price. But why is that? Why is all that latent performance advantage going to waste?

Well, the simple fact of the matter is that storage speed is no longer the performance bottleneck for most tasks, even ones that seem like they're putting a strain on performance. When Windows is booting up or a game is loading, a lot of time is spent with the CPU unpacking and manipulating data and processing all manner of tasks.

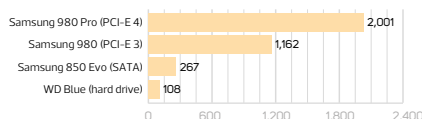
Meanwhile, unless you're moving big bulk loads of data or performing very specific specialist workloads that constantly read and write data back and forth, storage access tends to come in short bursts. So, once the massive gains were made in access time by moving from hard drives to SSDs, that ability to quickly start and stop delivering or writing data was met. Clearly, there was a little bit of residual performance left untapped by being restricted to SATA connection speeds, but even then most such drives are fast enough for most people's needs.

Certainly, if you're looking to just swap over your bulk storage and backup drives to solid state, SATA models will be more than sufficient. Meanwhile, if you're looking for a fast boot drive that will hold your games and software, it's worth buying a decent PCI-E 3 NVMe SSD. However, spending big on PCI-E 4 drives is only really worth it for specialist tasks and, dare we say it, showing off. One day, prices will fall further, and PCI-E 4 will simply become the new standard, but until we get to that point, it's fair to say that most people don't need to spend big money on PCI-E 4 SSDs yet. **CPC**

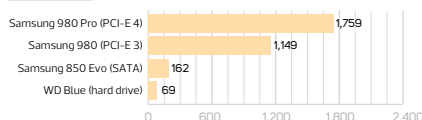
BENCHMARK RESULTS

FILE TRANSFER (MB/SEC)

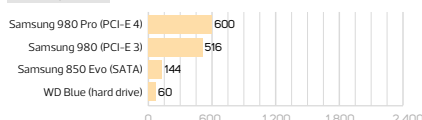
3.13GB (6 files)



18.8GB (36 files)

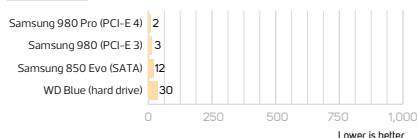


55.6GB (4,703 files)

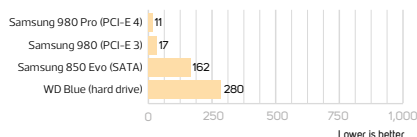


FILE TRANSFER (SECONDS)

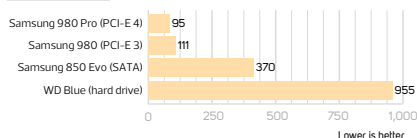
3.13GB (6 files)



18.8GB (36 files)

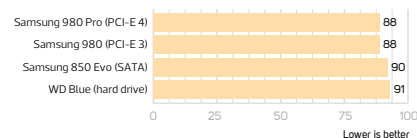


55.6GB (4,703 files)



SOFTWARE INSTALLATION (SECONDS)

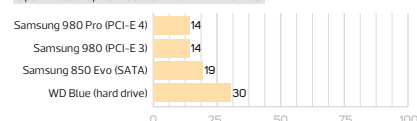
Time to install PCMark 10



Lower is better

SOFTWARE OPENING (SECONDS)

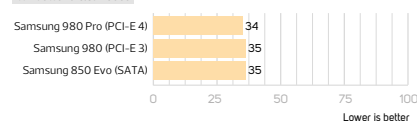
Open Photoshop from scratch with 277MB PSD file



Lower is better

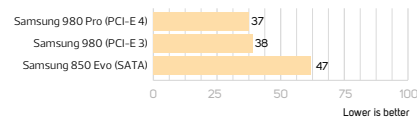
BOOTRACER (SECONDS)

Windows 10 clean boot



Lower is better

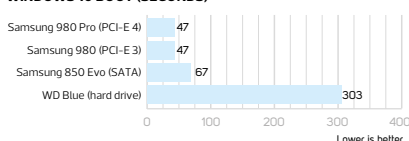
Windows 10 boot with startup software



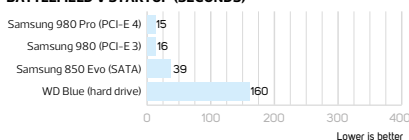
Lower is better

PCMARK 10

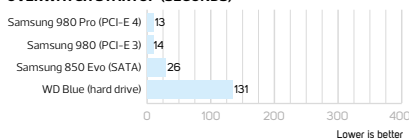
WINDOWS 10 BOOT (SECONDS)



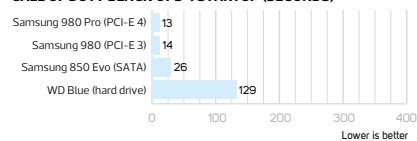
BATTLEFIELD V STARTUP (SECONDS)



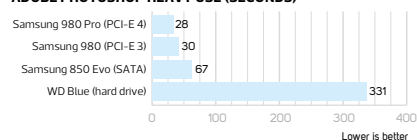
OVERWATCH STARTUP (SECONDS)



CALL OF DUTY BLACK OPS 4 STARTUP (SECONDS)



ADOBE PHOTOSHOP HEAVY USE (SECONDS)



Lower is better



GARETH HALFACREE'S

Hobby tech

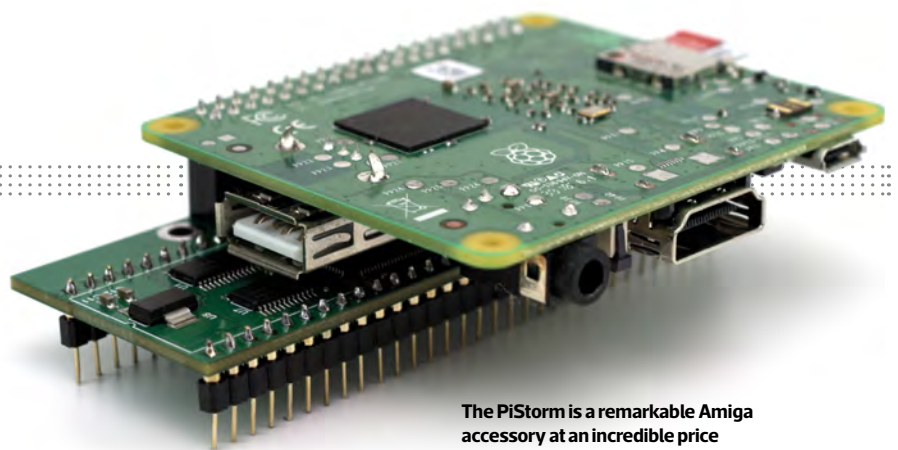
The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino, and Android to retro computing

REVIEW PiStorm

Officially, the Commodore Amiga died in 1996, 11 years after Commodore brought the innovative machines to market with the Amiga 1000. In reality, there are people out there from whom you will never take their Amigas – even if the legal rights surrounding the trademarks, technology, hardware, software and so on are increasingly muddled in the face of competing legal claims.

It's this band of enthusiasts that's keeping the Amiga alive with new hardware, typically designed to bridge the gap between classic and modern computing. The most popular of these are accelerators, designed to increase a stock Amiga 1000 or 500 from its aging 7MHz Motorola 68000 to a system that's a little faster.

The PiStorm, designed by Amiga fan Claude Schwarz, is just one of them, but one that stands out from the crowd for a variety of reasons. The first is its open hardware; Schwarz doesn't sell the PiStorm, but instead publishes the source code and design files for anyone to submit to a PCB fabricator. If you don't fancy fighting with minimum



The PiStorm is a remarkable Amiga accessory at an incredible price

order quantities, the community around the PiStorm organises semi-regular group buys, in which an assembled board, requiring only the headers to be soldered in place, can cost as little as \$13 US (around £9 ex VAT).

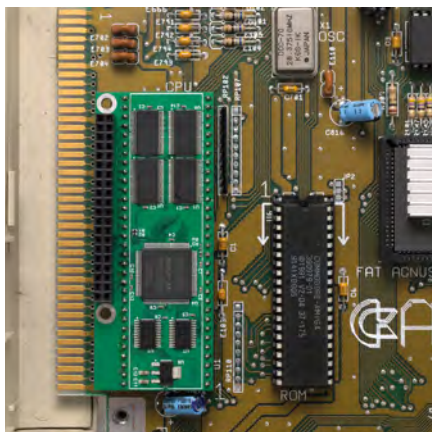
In a market where your average Amiga accelerator costs 5–15 times as much money, an accelerator for that little would be remarkable, but the PiStorm is far from a simple accelerator. The board itself is simple, driven by an Intel Altera MAX II complex programmable logic device (CPLD) – akin to a field-programmable gate array (FPGA), but simpler and cheaper.

The CPLD acts as 'glue logic' between the host Amiga and a Raspberry Pi single-board computer in an unusual fashion. Connected via the Raspberry Pi's 40-pin general-purpose

input/output (GPIO) header, the PiStorm allows the Amiga to treat the Raspberry Pi as a replacement processor and more.

Installation is simple – remove the processor from your Amiga 1000, 500 or 500 Plus, and push the PiStorm into its place. Add the Raspberry Pi on top, with a micro-SD card loaded with the lightweight Linux distribution of your choice, and you're done.

The software side is a little trickier. PiStorm is a constantly evolving project, and there's no ready-to-run software image. The documentation walks you through downloading and compiling the software, updating the CPLD and finally loading the Muhashi emulator. It's here that the PiStorm cuts its costs – rather than having a real processor or an FPGA loaded with a soft



The PiStorm nestles in an Amiga's CPU socket, with the stock processor removed

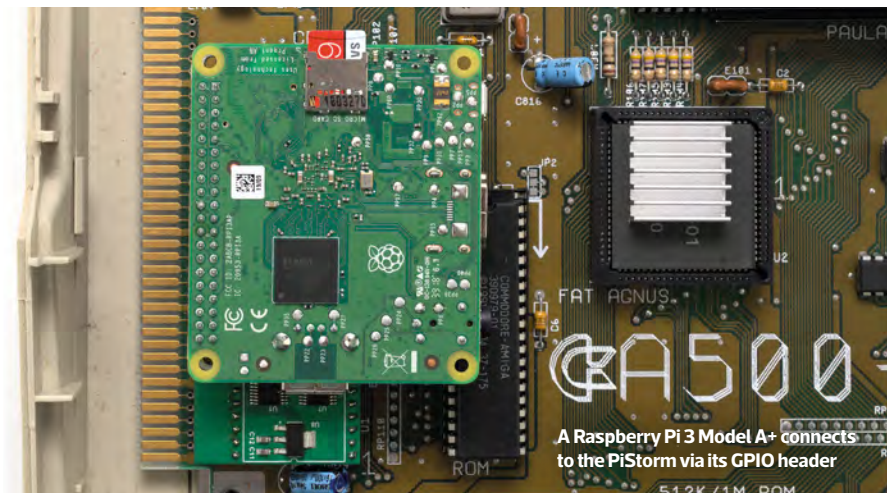
core, the PiStorm connects the Amiga to a software emulator.

This unusual blend of real and emulated hardware unlocks additional features too. By default, the PiStorm is configured to act as a

NEWS IN BRIEF

Olimex jumps on Pico wagon

Bulgarian open hardware specialist Olimex has announced a carrier board for the Raspberry Pi Pico microcontroller (see Issue 212), along with its own Pico-style RP2040 development board dubbed the RP2040-Py. The RP2040-PICO-PC turns a Raspberry Pi Pico into a personal computer, with DVI-over-HDMI video output, analogue audio, micro-SD storage and more. The RP2040-Py, meanwhile, is a pin-compatible drop-in Pico replacement, boasting a UEXT connector, reset button, 2A 3V3 DC-DC converter, an optional second micro-USB power input and JTAG debug support. See custompc.co.uk/OlimexPico for more information.



A Raspberry Pi 3 Model A+ connects to the PiStorm via its GPIO header

Motorola 68020 and a 128MB chip memory expansion. Tweak the configuration and you can increase that to a Motorola 68040 – albeit with a few compatibility issues that are still being worked on – with 8MB of additional Zorro II memory – just about the most you could ever fit in a classic Amiga.

Handling the CPU and RAM is just the beginning though. The PiStorm's keyboard and mouse pass-through also allow you to connect USB peripherals to the Raspberry Pi and have them control the Amiga. Meanwhile, a network pass-through, which will allow the Amiga to use the Raspberry Pi's Wi-Fi connection, is on the road map.

The PiStorm can also turn hard drive images, or physical block devices, into SCSI Amiga drives, making it easy to expand your Amiga's storage. The board acts as a real-time clock as well, setting the Amiga's clock to the Raspberry Pi's clock – which is, in turn, set automatically over the network via NTP.

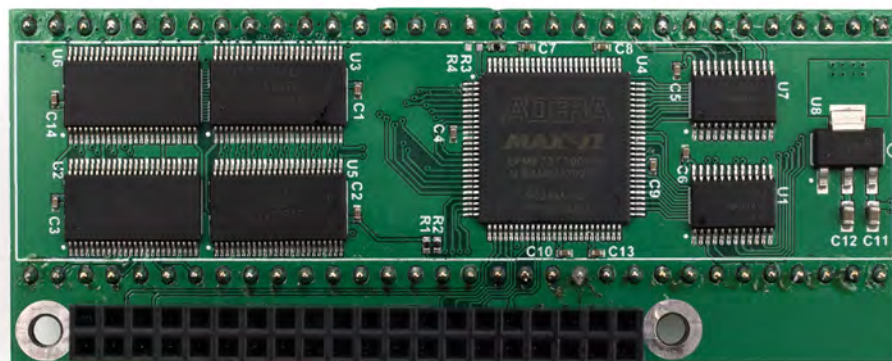
The board isn't finished there either. The PiStorm can also emulate a retargetable

graphics (RTG) card, a common form of add-in card that gives an Amiga high-resolution and high-colour-depth capabilities. Better still, when configured as an RTG – a task that requires adjusting the configuration on both the Raspberry Pi and the Amiga itself – the video is output from the Raspberry Pi's HDMI port, making it easy to connect your Amiga to modern monitors and TVs.

In short, the PiStorm is remarkable. It's not perfect – the ability to boot from physical Kickstart ROMs didn't work during testing, for example, with the PiStorm failing unless a ROM dump file was provided, and when the Amiga is powered off, the Raspberry Pi loses power without shutting down safely. Also, among other compatibility issues, it's currently limited to the Raspberry Pi 3 Model A+, with Raspberry Pi 4 and Compute Module 4 support in progress, but for the money there's still nothing else like it.

More information on the PiStorm is available from custompc.co.uk/PiStorm, where you'll also find a readme file containing a link to the Discord channel where group buys are organised.

The board is surprisingly simple, with a CPLD at its heart to act as 'glue logic'



REVIEW

Remodo X

Remotec's Remodo X is billed as 'a designer remote for Raspberry Pi,' which is only partially true – but, perhaps, true enough to cut the company a little slack. The low cost of the Raspberry Pi family of single-board computers, combined with their origins as devices based on a system-on-chip developed by Broadcom for multimedia set-top boxes, make them a popular presence in home theatre setups.

Their easy extensibility and, in modern variants, built-in wireless and wired network capabilities mean they're equally popular for smart home and automation tasks. Both these usages have one factor in common: it would be handy if you could control them without hooking up a keyboard and mouse. That's where the Remodo X comes in – a compact, sleek and programmable Bluetooth Low Energy (BLE) remote.

The fact that Remotec is rather bending the truth here is obvious from the moment you insert two AAA batteries into the device and set about configuring the remote – there's no Raspberry Pi software to be found. Instead, the controller is configured using an Android or iOS application running on your smartphone or tablet.

Hitching the device to the Raspberry Pi wagon was clearly an idea that came late in development, as the first question the software asks

is whether you're using Windows or macOS. For those looking to control a Raspberry Pi, the answer is most likely 'neither', but that's not an option.

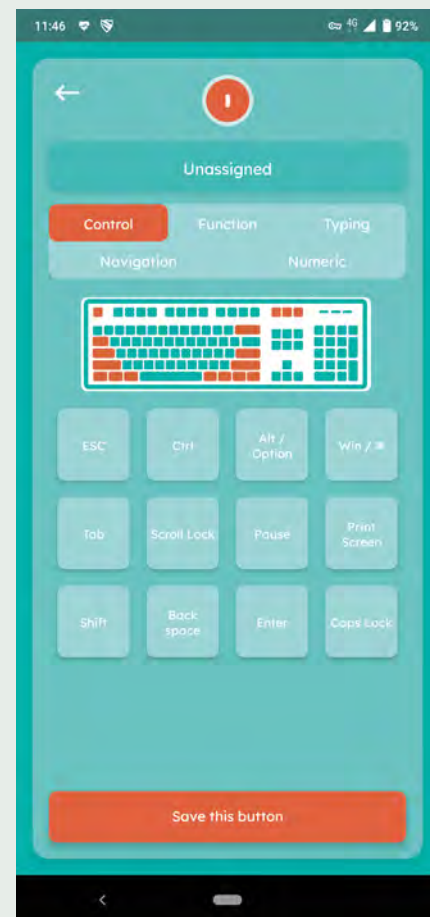
The Remodo X has only four buttons on its face, marked with symbols and with the primary button highlighted in an eye-catching orange. However, the device can be configured for eight total control tasks, through a differentiation between short-press and long-press actions. The configuration can be stored in profiles, for easy switching. Disappointingly, though, choosing a particular type of profile from selections, including Kodi, OpenHAB, Spotify, Instagram and more, doesn't load a configuration preset but simply changes the profile's icon.

There are three 'key types' for each of the eight possible key presses. There are 'third



Billed as 'a designer remote for Raspberry Pi', the Remodo X is surprisingly versatile

The remote is plastic and lightweight, but feels reassuringly well built in the hand



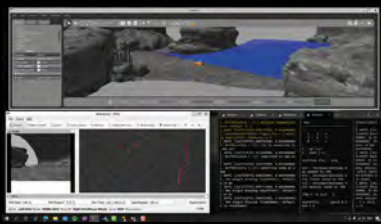
The remote can't be programmed on the Raspberry Pi, instead requiring a mobile app

NEWS IN BRIEF

Microsoft brings Linux graphical apps to Windows subsystem

Microsoft has launched a preview of what it calls WSLg, adding support for running graphical applications in the Windows Subsystem for Linux (WSL) on Windows 10.

'WSL lets you run a Linux environment, and up until this point has focused on enabling command line tools, utilities, and applications,' explains Microsoft's Craig Loewen. 'GUI app support now lets you use your favourite Linux GUI applications as well.' WSLg includes support for 3D acceleration, meaning Linux-exclusive games are compatible, and is available in Windows 10 Insiders preview build 21364 or higher.



The Remodo X uses two AAA batteries, which last well thanks to a sleep mode



There are only four programmable buttons, but eight possible actions through short and long presses

party apps/services shortcuts', which at the time of writing only includes controls for Zoom, WebEx, Google Meet, Microsoft Teams and Skype. There are also HID keys, which can be configured for any key combination, multimedia keys or mouse scroll actions. Finally, there are 'infrared device keys' to control non-Bluetooth devices, such as amplifiers, TVs and air conditioning systems.

There's a lot of flexibility here, but integrating it with the Raspberry Pi is another matter. The official instructions, hidden away on GitHub, aren't the easiest to follow – at one point, they walk the reader through installing the TED Talks plug-in Kodi, for no discernible reason. Once you've paired the remote with the Raspberry Pi's Bluetooth radio, though, the world is your oyster. When configured for keyboard inputs, the Remodo X is ready to control absolutely any software you could imagine – providing, that is, the software accepts keyboard inputs.

At first, it looks as though the Remodo X can't quite seem to settle on its purpose. As a dedicated Raspberry Pi device, you'd expect dedicated Raspberry Pi software for configuration; as a smart remote, four buttons – even though they map to eight keys – feels a little restrictive. With a little work, though, the flexibility of the Remodo X becomes clear.

By not being tied to any particular software, it's easily integrated into any workflow – one preset offers the ability to use the gadget as a presentation clicker with a laptop, for

example. The addition of an infrared emitter on top of the Bluetooth Low Energy connection further also extends its capabilities, allowing one key to fire up your hi-fi while another press gets your Raspberry Pi playing your favourite music.

The handset is also well designed. While it's made wholly from plastic and surprisingly lightweight, it feels well made and the keys depress crisply with no discernible mush. A single status LED can be found at the top, while the shiny lower half slides down to reveal the battery compartment.

The only part that feels like a missed opportunity is the bundled dock. Its flip-out kickstand, and the inclusion of screw holes for wall mounting, are both welcome, but the dock itself is too light for desktop use. Rather than pulling smoothly out of the stand when you try to remove it, the Remodo X has a tendency to bring the stand along for the ride, folding the kickstand back into the body of the dock for good measure.

As the Raspberry Pi supports Consumer Electronics Control (CEC), meaning playback can be controlled using a TV's remote control and communicated to the Raspberry Pi over HDMI, the Remodo X isn't strictly speaking a must-have accessory. However, its flexibility, particularly for non-multimedia tasks such as smart home control, make it a handy add-on.

The Remodo X is available to buy from custompc.co.uk/RemodoX for a price of £20 (ex VAT), plus shipping.

REVIEW

Using Open-Source Projects

Create, Share, and Save Money Using Open-Source Projects, which we're calling Using Open-Source Projects, so it doesn't take over this page, by Dr Joshua M Pearce, aims to look at a range of open-source hardware and software projects. However, it's as wide as an ocean and as deep as a puddle.

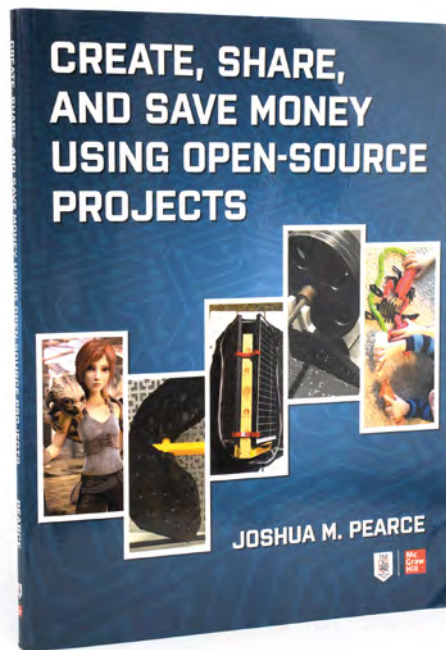
Aimed at 'beginning hobbyists and makers', the book highlights projects across as many fields as possible. In order, the book covers: recipes, 'life hacks' and household tips; digital photography and open-source cameras; art; music, music software and instruments; book digitisation, book sharing, and paper and audio book creation; videos; maps and geographic information system (GIS) data; clothing; woodworking 'and other old-school skills'; electronics; 3D printing and milling; scientific equipment; citizen journalism; recycling; 'big free stuff' such as cars, buildings and 'free electricity', plus 'how to make a million dollars of value'.

You get all this in 165 pages – including the introduction, a chapter on the philosophy of open source, an essay about the future of open source and an index. If that doesn't sound like enough pages, that's because it isn't.

You never actually learn to create or use anything in the book without visiting a URL. The section on 'open-source cameras', for instance, is a mere 308 words long and looks at just one project – Elphel (elphel.com), which concentrates on specialist hardware and software for 3D photogrammetry.

In the same chapter you'll find a look at 'free software for photo lovers', which spends just 54 words talking about the existence of 'DigiCamControl' (digidigamcontrol.com), then 304 words talking about the GNU Image Manipulation Program (gimp.org) – using an example of a black and white image from the Great Depression being colourised to highlight its capabilities. However, the book is printed in faded black and white, making both the original and colourised versions look identical.

The chapter on video is particularly egregious. It's just four and a third pages long, with imagery taking up the equivalent of one full page. The majority of chapters clock in at between five to ten pages, with the longest – Chapter 12, on 'Making and Sharing Digital At-Home Manufacturing' – being a mere 16 pages, several of which are either wholly or



This book could have been a fantastic resource, but it's just too shallow

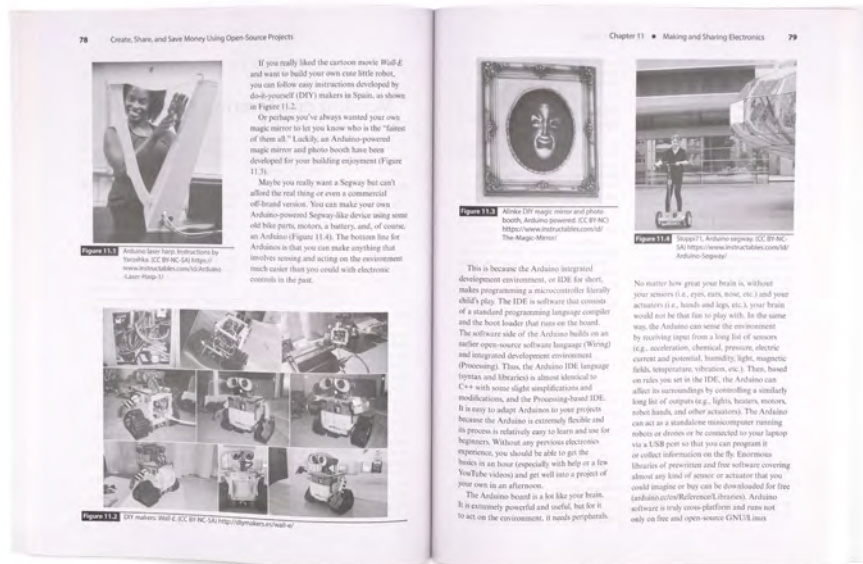
primarily taken up with pictures and the last of which is given over to references.

There are other problems too. The URL given for Local Motors' Rally Fighter car, which isn't actually open source, is localmotors.com, but there's nothing there bar a single picture, with only a few more details to be found at the actual project site at rally-fighter.com

For those wholly unfamiliar, this book could provide a useful road map of selected projects in particular fields – guiding the reader to websites in order to learn more. There's nothing more though.

The closing chapter, 'Making the Future of Sharing', is interesting but contains a figure showing the growth in scholarly papers referencing open-source software or hardware that stops at 2017, four years before the book's publication. The introduction, meanwhile, conflates open-source, free software and the Creative Commons organisation and its licences as all being equivalent, which is definitely not the case.

Using Open-Source Projects is published by McGraw Hill's TAB DIY impression under ISBN 978-1-260-46176-3, and can be purchased from blackwells.co.uk for £14.67 (VAT exempt). **GPC**



The print quality is poor, and wholly black and white, including a figure highlighting a colourised photograph

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at freelance.halfacree.co.uk @ghalfacree

WIN

ENDGAME GEAR MICE AND MOUSEPADS

Endgame Gear is kindly offering some fantastic gaming mouse bundles to three lucky **Custom PC** readers. Each bundle not only contains one of the company's £50 XM1r gaming mice in a classy translucent Dark Frost colour scheme, but also includes one of Endgame's top-line MPX390 mousepads worth £50.

ENDGAME GEAR XM1R

The XM1r is a refresh of the acclaimed Endgame Gear XM1 gaming mouse. With the inclusion of the new PixArt PAW3370 optical sensor and Kailh GM 8 switches, topped with two new transparent shell editions, the XM1r has been designed with precision and style in mind.

The XM1r's responsiveness is significantly improved by the sensor's resolution of up to 19000 CPI, 1mm of lift-off-distance and its ability to track at up to 400 IPS. Every effort has been made to squeeze the last ounce of performance from this sensor. Meanwhile, the Custom Kailh GM 8 switches have been pre-sorted to an operating force of 55–60gf, which results in an extremely pleasant and fast click.

ENDGAME GEAR MPX390

With the MPX390 Endgame Gear offers demanding gamers the mousepad they've always wanted. With its unique combination of silicone and CORDURA, it offers a unique feel and combines the advantages of soft



and hard pads. Its black surface made of CORDURA is particularly tough, as well as being dirt and water-repellent, and it offers excellent sliding properties. The base of the mousepad is made of yellow silicone. The Endgame Gear MPX390 isn't just a non-slip pad, but it also has a smooth surface.



SUBMIT YOUR ENTRY AT **CUSTOMPC.CO.UK/WIN**

Competition closes on Friday, 9 July 2021. Prize is offered to participants in the UK aged 13 or over, except employees of the Raspberry Pi Foundation and Trading, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from Custom PC magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. Winners will be contacted by email to arrange delivery. Any winners who have not responded 60 days after the initial email is sent will have their prize revoked.



ANTHONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Should there be more water-cooling bundles?

This month I've been playing with a hardware bundle that MSI and EK sent me, which includes MSI's MPG Z590 Carbon WiFi board plus a waterblock that cools the CPU as well as the VRMs. You also get EK's leak tester thrown into the package, plus a voucher worth €50 to spend in EK's online store.

The two companies partnered up for the Z490 version of the board as well, but that board was decidedly mid-range and water-cooling it seemed a little pointless in the first place. The new board, though, is much beefier, both in terms of its 16-phase power delivery and its price. At £300 inc VAT, it's firmly in premium territory even if the MPG range sits below the MEG range in MSI's motherboard arsenal.

Meanwhile, the bundled waterblock has a fairly standard-looking design that cools the CPU and both banks of VRMs – I definitely prefer these types of blocks to ones that just cool your CPU, as it usually pays to cool as many hot spots on your motherboard as possible.



EK and MSI's bundle includes an MPG Z590 Carbon WiFi motherboard, a CPU and VRM waterblock, a leak tester and an EK store voucher

The inclusion of all the gear in one box is definitely a boon, saving you having to fish around for a compatible waterblock on EK's website. The inclusion of EK's leak tester is a great idea as well – I suspect that many newcomers to water

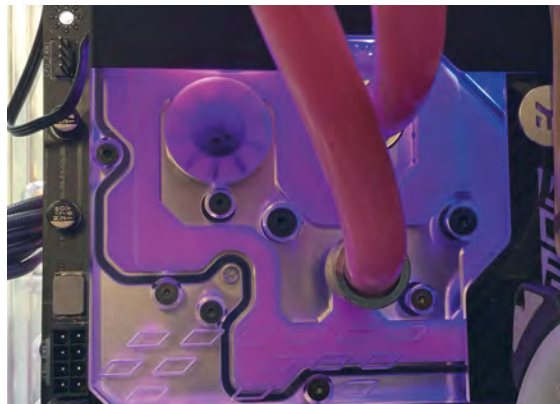
cooling, and maybe even quite a few seasoned veterans, don't own one yet.

The results were good too, with a 5–10°C drop in VRM temperatures, and our water-cooling system was able to keep Intel's Adaptive Boost Technology

active for our entire 15-minute stress test on our Core i9-11900K. This means that all of its eight cores sat at 5.1GHz and didn't move a megahertz.

However, it wasn't the performance that impressed me most with the MPG Z590 Carbon EK X, but the price. The kit currently costs £450 inc VAT, which includes the motherboard, leak tester and waterblock. When you price up these components individually, and consider the included voucher too, you're looking at over £530.

That's an £80 saving, and the voucher could pay for your tubing and fittings, or go towards paying for a pump, reservoir or GPU waterblock. Being able to sell extra gear is probably why EK included the voucher too, but the point is that this bundle saves you money and includes all the gear (or money) needed to get the product working.



Water-cooling kits very often don't meet both these criteria, and they also remove customisation from the equation. I think most people will want to choose their own fittings, tubing and coolant, and this bundle enables you to do that. If you want this board with a compatible CPU and VRM

The waterblock covers the motherboard's VRMs as well as your CPU, both of which were cooler than with high-end AIO liquid coolers

waterblock, as well as a leak tester, it's essentially a no-brainer.

This got me thinking about whether other manufacturers should follow suit. We already have pre-water-cooled motherboards, but they're invariably hugely expensive due to their unique integrated design.

Comparatively, the waterblock included here has only been tweaked slightly between models, so it isn't expensive to design, plus it's easy to fit, especially as the motherboard has also had its heatsinks removed.

Bundles such as this one offer a great way for manufacturers to make their products more accessible, and to encourage enthusiasts to head to their websites to buy the rest of their gear, especially if a voucher is included. If we save money in the process then that's a win-win situation.

In praise of slim fans

In our last fan Labs test, we included Noctua's NF-A12x15, which was the first slim 120mm fan we'd tested at Custom PC. Despite measuring only 15mm thick vs the usual 25mm for a standard fan, it performed very closely to its fatter counterparts. If you want to squeeze a fan into a tight spot that's too small to otherwise use a normal fan, you have a very good option in the NF-A12x15.

What's more, using these fans with a super-slim radiator, such as those in the XSPC TX series, means you have

a radiator with fans that measures just 35mm thick. This makes water cooling now possible in cases where it wasn't before. That's pretty exciting, especially if, like me, you love water-cooling small form factor systems.

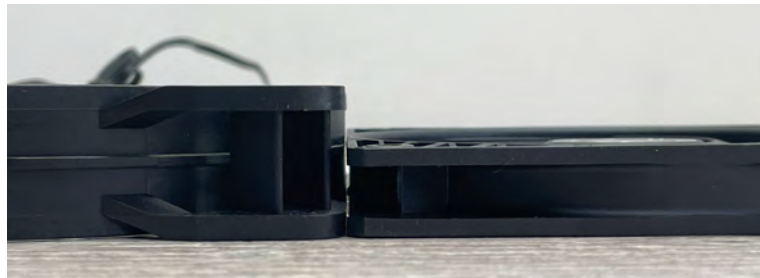
I'm seeing increasing numbers of people using them, and not just for space-saving purposes. They actually look neater if they're on show, and they're popular with cases that have lower fan mounts, where you can point air at graphics cards for better cooling. Some people have even modded their



There are now numerous models of slim 120mm fans from which to choose

graphics cards to use these fans to blow air through the heatsink for better performance – I've covered this in the How To section on p102.

Amazingly, just a few years ago, there were just one or two slim fans available, including Noctua's model, but during a recent Internet search I uncovered a total of nine models from different manufacturers. There's a whole bunch of price points too, with some fans being much more affordable than the pricey Noctua one. That's good news, as while the Noctua slim fans might be great, it's still going to cost a fortune to kit out your case and several radiators with them. **GPC**



Slim fans are around 10mm thinner than standard fans

How to Install a distro plate

Antony Leather shows you how to transform your water-cooling tubing routes by fitting a distribution plate into your case

TOTAL PROJECT TIME / 2 HOURS

The amount of custom high-end water-cooling hardware available these days is staggering, with many components that traditionally had to be custom-made now available as off-the-shelf products. Cases are a good example. A decade ago, if you wanted a distribution (distro) plate – a large acrylic block that has numerous ports and often a reservoir built into it – for your case, you'd have to make it yourself.

However, there are now plenty of off-the-shelf models that are made for specific cases or are even universal, fitting into fan mounts in nearly any case. We'll be taking a look at how to choose one for your case, the different types available and how you can use them to make it easier to route tubing through your case.

TOOLS YOU'LL NEED



Distro plate
overclockers.co.uk



3M picture hanging strips
Most hardware stores



3M mounting tape
Most hardware stores



1 / CHECK FOR CUSTOM PLATES

Sadly, not all cases have custom distro plates available, even premium cases, so start by checking Google to see if there are any models available for your case. Several manufacturers make them, so you might be in luck, and some models even include pump mounts.



2 / USE A UNIVERSAL DISTRO

Custom distro plates can be tricky to obtain, and are also expensive, but universal ones are more readily available and will fit in practically any PC case – even small ones. They usually fit into 120mm or 140mm fan mounts, although you can't have one installed at the same time as a fan.



3 / REMOVE CASE PARTS

Universal distro plates often require the sole use of a fan mount, and the rear mount is usually the best place to install them, both for tube routing and aesthetic reasons. Remove any components, such as fans or GPU brackets, to make room for you to test-fit the plate.



4 / CHECK FOR BEST LOCATION

You might want to put the distribution plate on show, which is usually a simple job with custom-made plates that sit in the front of the case or next to the motherboard. With universal fan mount plates, the rear fan mount gives the best visibility, but you also need to consider your tubing routes.



5 / MAKE TUBE ROUTING EASIER

There are situations where using a distro plate can actually make it easier to route tubing through your case. For example, in this case the motherboard and graphics card are in separate chambers, but the distro plate can offer an easy way to direct coolant from one chamber to another.



6 / WORK OUT TUBING ROUTES

Work out your final tubing routes – you don't need to use all the ports, just enough to route the coolant through the plate and then to your components. Check for components fouling the ports on the plate, especially with universal plates that might not account for unique case or motherboard features.



7 / MOUNT DISTRO WITH SCREWS

Universal distro plates can be mounted in two ways. Those that use fan mounts are simple to install, as they use standard fan screws and screw locations. You may even get lucky in areas with vents if they line up with the screw holes on the plate.



8 / MOUNT DISTRO WITHOUT SCREWS

If you want to mount the distro plate in an alternative location, such as against a section of the case without fan screw holes, you can use 3M mounting strips or 3M mounting tape to secure it. The strips are thicker, but act like Velcro. The tape is thinner and stronger, but harder to remove.



9 / INSTALL YOUR FITTINGS

Once your distro plate is installed, check it's secure by giving it a wiggle and then install your fittings. Be sure to check that your fittings have O-rings attached first. You don't want to find that one is missing and have to detach all the tubes from your distro plate once your system is at the leak-test stage.

How to Mod your GPU cooler

Antony Leather shows you how to replace your graphics card cooler's fans

TOTAL PROJECT TIME / 2 HOURS

Graphics card coolers are far better today than they were ten years ago, and modern cards are generally pretty quiet now, even in games. However, their fans are often very slim, and lack sufficient airflow and static pressure to make the most of your GPU's heatsink, even at full speed. If you're looking to cut noise, increase cooling and even lift boost frequencies, there's a simple modification you can perform.

Replacing your graphics card's fans with high-performance case fans can not only cut noise levels, but increase cooling too. Best of all, it's relatively easy to do, requiring just a couple of fans and cable ties. However, you need to know a few tricks to getting everything working, so if you want to get your graphics card cooler tweaked in time for summer, this guide is for you.

TOOLS YOU'LL NEED



Fan splitter cable
overclockers.co.uk



Micro screwdriver set
amazon.co.uk



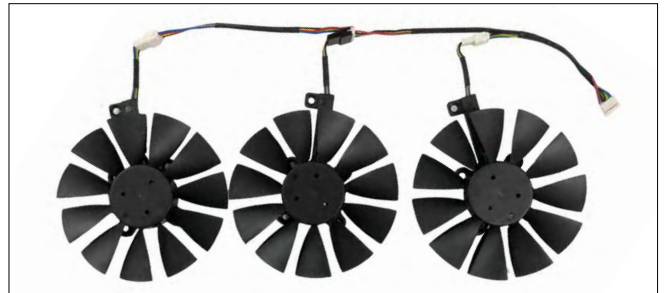
Fans
overclockers.co.uk



Cable ties
Most hardware stores



Thermal probe
overclockers.co.uk



1 / CHECK FOR REPLACEMENT FANS

If you've broken a blade on one of your graphics card's fans, there's a good chance there's a replacement set available. EBay is a great place to find them, so if you're here because your graphics card is currently out of action and would prefer to keep the stock cooler, you may be able to just replace the existing fans.



2 / MEASURE GRAPHICS CARD

If you want to boost cooling, then adding custom fans is the way to go. To do this, first measure the width of your graphics card's heatsink in order to assess the size of fans you'll need. Large heatsinks can accommodate 120mm fans while smaller ones may need 92mm models.



3 / CHOOSE CUSTOM FANS

Once you've chosen your fan size, you have a couple of further options. If there's limited space, you can use slim fans to allow your graphics card to adhere to tight height limits. Otherwise, standard-height fans with at least 2,000rpm speeds should do the trick and a fan splitter cable will enable you to use just one power header.



4 / CHECK FOR SOFTWARE CONTROL

You can't use your graphics card's fan connector to power the new fans, so you'll need to use a motherboard fan header. Check if your graphics card's temperature can be used to control the fan speed in your motherboard's software. Alternatively, Argus Monitor can do this (argusmonitor.com), but it costs around £20.



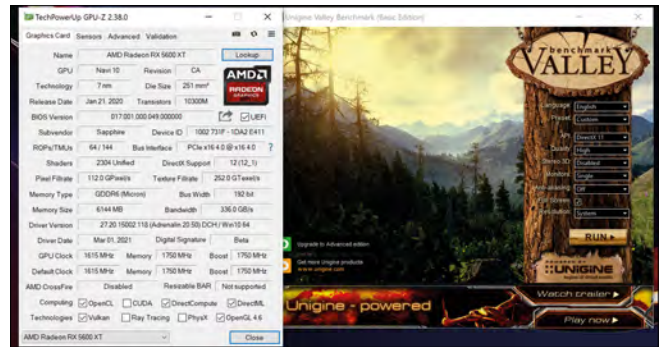
5 / CHECK EFI FAN CONTROL

The EFI can often have options that are missing in the software, so be sure to check there for both GPU and thermal probe temperature inputs – both of them are useful for controlling the new GPU fans.



6 / USE A THERMAL PROBE

If there's no GPU temperature input, you can fix the fan speed to a suitable level manually, or use a thermal probe if your motherboard supports them. This connects to your motherboard with the other end sitting inside the GPU heatsink – you then adjust the fan speed in the software or EFI to keep GPU temperatures in check.



7 / TEST GPU COOLING

Before you get going, check the GPU temperature, so you can see if your modding has actually improved temperatures. Download GPU-Z (techpowerup.com) and Unigine's Valley benchmark (benchmark.unigine.com), run the Valley benchmark for ten minutes and take a GPU core temperature reading using GPU-Z.



8 / IDENTIFY CABLE TIE ANCHORS

You can secure the cable ties to the GPU backplate, spare mounting holes or slip the ties through and under the heatsink. If you have no other option, heatpipes can also work as anchors, but they're not ideal, as they can get hot. You only need to hold the fan using two diagonal mounting holes to secure it, but ideally use all four.



9 / IDENTIFY FAN SHROUD SCREWS

If possible, only remove the fan shroud and fans on your graphics card – you probably won't need to remove the entire cooler and heatsink. Doing so will also likely void your warranty, but with our card, at least we could remove the fans and shroud without breaking the warranty seals.



10 / REMOVE SCREWS

The screws can have a mix of head types, so make sure you have the correct tool to hand before you start. Once you remove the shroud, place the screws back into it for safe keeping, and keep any additional ones in a sealed bag or container in your graphics card's box.



11 / UNPLUG POWER AND LIGHTING CABLES

Carefully lift the shroud, but beware of any cables that are still connected to the card's PCB. You'll need to detach these cables before fully removing it. If there are lighting elements that can remain attached to the heatsink or PCB, and don't foul the fans, feel free to keep them and leave their cables attached.



12 / REMOVE SHROUD AND FANS

Go ahead and lift the shroud and fans off the heatsink. There may be hidden screws or connectors you haven't yet spotted, so if there's resistance, check they've all been removed. The fans may well stay behind; lifting the shroud will give you access to the remaining screws.



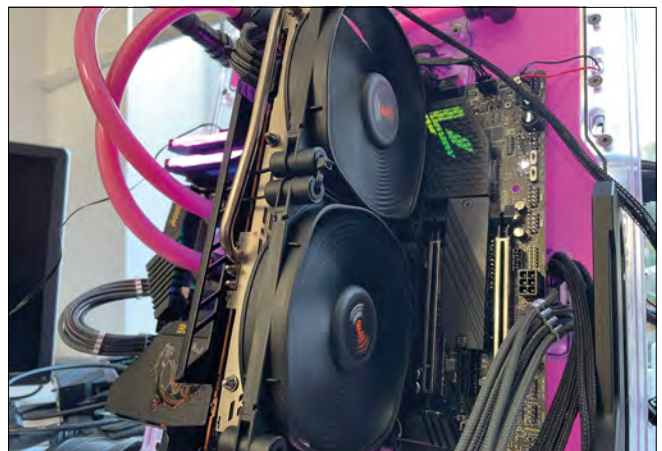
13 / LINE UP NEW FANS WITH HEATSINK

You want the new fans to exhaust air into the heatsink, so align them with their base sections sitting on it. You also want the fans to cover all or most of the heatsink, even if the final contraption looks a bit lopsided as a result.



14 / SECURE USING CABLE TIES

You'll need the right length of cable ties to mount the fans. Use a piece of string to mimic the ties so you know the lengths of ties you'll need to buy.



15 / TEST NEW FANS

Finally, reinstall your graphics card and run the same test you did earlier for the same amount of time. Our GPU core temperature fell from 67°C to just 47°C and only hit 53°C with the fans reduced to inaudible speeds. The memory temperature dropped from 72°C to 50°C at full speed, and 58°C with the fan speed reduced. **CPC**

Folding@home

Join our folding team and help medical research

ACTIVE USER MILESTONES

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
Gwallace	400,000,000	Team_DS-WHS2011	3,000,000
C2TBD	300,000,000	MDT	3,000,000
gKitchen	300,000,000	McSpoon	3,000,000
peete	200,000,000	Trotsky	3,000,000
mort6dav3	200,000,000	Andy__k	2,000,000
YDCN22	100,000,000	ttexk	2,000,000
GreenPig	80,000,000	stevec83	2,000,000
paul_warden	50,000,000	Wenna	2,000,000
Manda_Chuva	50,000,000	Ayeska	1,000,000
G4zm4n	30,000,000	Rabaks	800,000
ArtMovesTheSoul	30,000,000	dhhowells	800,000
knobtasticus	30,000,000	PatWI	700,000
sparrowm7	30,000,000	neo-internalforce	500,000
Daniel_Selley	30,000,000	Mister_M	400,000
Mr_Blue_Jam	30,000,000	capt_carl	100,000
Pausanias828	9,000,000	fiddler	100,000
Bluehubble	9,000,000		
JasperofBelper	8,000,000		
StoneColdJay	6,000,000		
geofftswin	5,000,000		
Parmesan	4,000,000		
Wickermoney	4,000,000		
Ratski	4,000,000		

WHAT IS FOLDING?

Folding@home uses the spare CPU and GPU cycles for medical research, with a current focus on COVID-19. You can get the client from foldingathome.org/start-folding and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag – we'll print all the milestones we can fit on the page. You can discuss folding with us and other readers online at the bit-tech forums (custompc.co.uk/FoldingForum).

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	DocJonz	15,439,475	16,158,943,502
2	Desertbaker	8,166,402	4,538,064,730
3	Slavcho	6,506,860	4,436,079,515
4	Lordsoth	6,009,684	5,897,841,093
5	madmatt1980	4,009,109	1,184,348,258
6	C2TBD	3,574,552	383,002,416
7	PC_Rich	3,358,397	6,905,484,031
8	sonic_vortex	1,835,730	749,626,327
9	peete	1,445,888	236,978,161
10	1car1_Garforth	1,364,930	257,161,814
11	gKitchen	1,228,128	324,801,349
12	mort6dav3	820,627	208,235,103
13	filreed	797,059	137,814,461
14	Simlec	777,947	432,775,177
15	KevinWright	621,731	1,528,285,330
16	BeezaBob	592,186	997,631,976
17	Little_Willie	558,859	574,395,240
18	40138	508,466	178,564,689
19	YDCN22	417,828	101,414,229
20	coolamasta	366,655	1,113,579,243

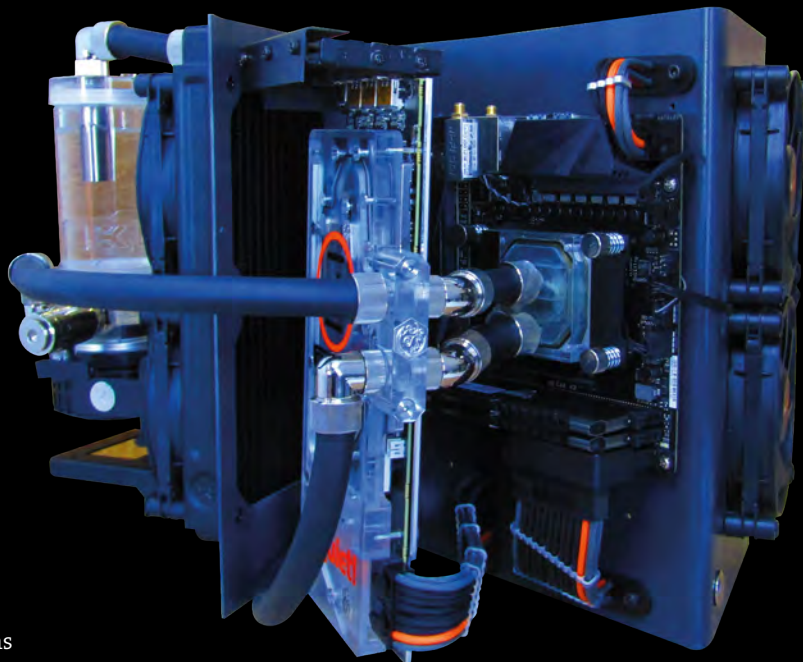
TOP 15 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	DocJonz	16,158,943,502	351,694
2	PC_Rich	6,905,484,031	166,921
3	Lordsoth	5,897,841,093	184,196
4	Shirty	5,266,143,058	39,848
5	Nelio	4,638,586,520	523,610
6	Desertbaker	4,538,064,730	74,792
7	Slavcho	4,436,079,515	76,331
8	HHComputers	3,544,050,839	85,007
9	Dave_Goodchild	3,111,786,591	161,164
10	piers_newbold	2,703,256,197	107,638
11	Scorpuk	2,565,487,007	57,788
12	clanseven	2,223,720,446	33,156
13	tarka_dahl	1,846,090,140	26,361
14	Unicorn	1,753,462,654	57,079
15	daxchaos	1,637,104,710	41,302

Readers' Drives

Project Mini Z

Michael Sheppard cut and bent several steel panels to make the open-air chassis for this water-cooled mini-ITX PC



GPC: What inspired you to build this mini open-air PC, and what were your design goals?



/MEET THY MAKER

Name Michael Sheppard

Age 31

Occupation Chef

Location Sunderland

Main uses for PC

Gaming, video editing and CNC design

Likes Food, PC, gaming and YouTube

Dislikes Sitting still and relaxing (time is money and life's too short)

Michael: The idea was to create an iteration of my previous project, Project Z. My main goal was to downsize the footprint using a mini-ITX motherboard and a full-sized ATX power supply, as well as making a few design improvements to make it more user-friendly.

GPC: Where did the design process start, and how did you go about planning this build?

Michael: Pen and paper is always my first choice when starting any project – it makes it so easy to quickly design and brainstorm new

ideas. However, I would like to try digital drawing and 3D designing a little more, as I now have access to a small CNC machine. As I had the original micro-ATX Project Z case at hand, I went straight to marking out locations for various components and marking holes for cables straight onto the case using a marker pen – this made it easier for me to visualise the end result.

GPC: That's some lovely neat cabling! How did you go about planning the routes for the cables and tubing?

Michael: Cables are always an important aspect for me – they can make or break any system. I design and custom-make all my cables, as well as ones for local modders in the industry and UK YouTubers such as eTeknix – this gives me a little experience with what does and

doesn't work within a system. The cable routes were dictated by the location of the motherboard and wherever was convenient – I just went with what made sense.

I also CNC-cut some panel-mounted combs – I wanted this upgrade, as in the last build, I fed the cables through each hole in the chassis. This new way was much tidier and gave me the ability to remove the cables in one go for easy maintenance or upgrades.

The runs of water-cooling tubing required a lot of visualising, planning and sketching. I knew I had to take the tubing through the case rather than around it or over the top, and it made sense to put the radiator on the inside, reducing the footprint by 30mm. In the end, it made more sense to use a parallel loop, which gave the system a much cleaner and tidier look.



GPC: How did you get the custom logo design onto the GPU waterblock?

Michael: I purchased a vinyl cutter last year, which has opened up a whole world when it comes to making modifications. I'd spent a lot of money on stencils and stickers for previous builds, so it made sense to buy a vinyl cutter, as it would give me so much freedom with personalising builds in the future.

I went about making a backplate and waterblock decals by firstly taking a picture of my graphics card, in this case an AMD Radeon RX Vega 64. I then transferred the pictures to the software and cropped it to the exact measurements in physical form.

I then pretty much based my design around the backplate, trying to incorporate a similar look to the Star Wars light-speed stripe. I wanted to keep a factory-made look, as painting this lovely aluminium felt like a crime. I also put the Z and be quiet! logos on the top, and carried on the line and dash effect throughout the design.

GPC: Why did you use soft black tubing and clear coolant?

Michael: The tubing is 16/10mm ZMT by EK Water Blocks, and this is the first soft-tubing build I've ever done. I chose soft tubing, as it's a lot easier to manipulate around bends, which is definitely needed on a system this shape. The coolant was a toss-up between using clear or pastel orange. I went with clear in the end, as I thought it would look better with the RGB waterblocks.

GPC: Tell us about the build process.

Michael: I went with 2mm-thick steel sheet that I'd recycled from the last (Project Z) build. Basically, it involved me cutting 30 per cent off the top, cutting off the pre-bent radiator side and rebending it to make it shorter. The end result made the case 6 x 10 x 12in (W x D x H).

I wanted to improve the location of the I/O panel by putting it on the top – in the original Project Z, the panel was too close to my desk, resulting in me having to use





SYSTEM SPECS

CPU AMD Ryzen 5 3600

GPU AMD Radeon RX Vega 64

Storage Crucial P1 NVMe 512GB SSD

Memory Patriot Viper Steel 3600MHz

Motherboard Asus Strix B450i AM4

PSU be quiet! SFX-L 600W

Cooling EKWB Velocity RGB CPU Block, EKWB Quantum Kinetic D5 Pump and Reservoir, 2 x EKWB 240 SE Classic Radiators, EKWB ZMT 16/10mm tubing, 14 x 16/10mm EKWB silver nickel fittings, 2 x 45-degree rotary silver nickel fittings, 4 x 90-degree rotary silver nickel fittings, Bitspower full-cover nickel/acrylic waterblock for Vega 56/64, 4 x be quiet! Silent Wings 3 fans

angled adaptors to plug in a mouse and keyboard.

The second major design improvement was adding holes for fan airflow – in the last build, the radiators were mounted on standoffs but they still didn't get enough air. This whole process was done using an angle grinder, a small cutting disc on a Dremel, hacksaw blades, files and 240-grit sandpaper just to smooth out those lines.

CPC: Did you come across any difficulties?

Michael: The main issue was that I didn't quite have room to mount the graphics card in the way I originally planned, which was with no riser cable and going straight into the PCI-E slot. I went through several new designs in my head and resorted to cutting down a PCI-E riser bracket several times to reach its final form.

I knew the fit was going to be super-tight, so I ordered the smallest riser I could find, which was a Phanteks 150mm model,

and then thought about how I was going to mount the bracket above the radiator. The idea was to show off the backplate and have it parallel with the front 240mm radiator, but this location was too tight for the riser cable, so I moved to plan B.

This involved using 23 x 43mm angled steel – I cut into the wider side at a 45-degree angle and bent in the shorter side to square up against it. I then took it to my local garage and put some welds in the join to add some extra strength. After that, it was a case of adding the PCI-E riser bracket to that.

I think if the case had been in longer then the original plan would have worked fine. However, if I had made the case longer, I don't think I could have made a parallel loop, which I think is one of the cleanest-looking aspects of the final build.

CPC: How many radiators and fans did you use?

Michael: There are two 240mm EK Classic SE radiators – one on the

The maximum temperature of the CPU is 45°C, and the GPU temperature is generally in the high 30s





inside rear and the other on the front outside, loaded with four be quiet! Silent Wings 3 fans. Both radiators are placed at the end of the loop, pulling air away, although airflow isn't really an issue with the open-case design anyway.

GPG: How are the PSU and reservoir mounted on the main chassis?

Michael: The power supply is mounted using an ATX-to-SFX bracket, again attached to a piece of 23 x 43mm angled steel. The intention was to house a standard ATX power supply measuring up to 150mm, but with the ability to possibly go up to 165mm. The reservoir uses the standard EKWB UNI pump bracket for 120mm fan mounts. That's then mounted to the radiator through the fans, with the vertical D5 pump clamp housing the reservoir.

GPG: What are the CPU and GPU temperatures like?

Michael: I've only been doing some 2,560 x 1,440 gaming since I completed this project, but they're much better since the rebuild from my last mod, thanks to better airflow and better paste application. The maximum

temperature of the CPU is 45°C, and the GPU temperature is lower – it's generally in the high 30s. This is quite a surprise when you consider that the Radeon Vega 64 GPU can pull around 300W – the Bitspower waterblock does a fantastic job here.

GPG: How long did the build process take?

Michael: I started in mid-March and it was completed in early April. I did aim to for it to be started and finished in March, but lockdown and family life caused a few delays.

GPG: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect?

Michael: I'm really over the moon with the end result. There are some revisions I'd like to make, such as extending the footprint to house the radiator on the inside and have the graphics card not plugged into a riser cable. The idea is to be able to make these systems and fulfil custom orders from a single piece of aluminium and include custom cables. A VRM waterblock would also be a good addition, or a fan over that area for cooling – it does get warm after long sessions. **GPG**

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WORTH
£151

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WORTH
£55



JAMES GORBOLD / HARDWARE ACCELERATED

PLAY YOUR CARS RIGHT

James Gorbald discovers the similarities between buying a new PC and a car

Over the past few months, my trusty steed has begun to show its age, developing all sorts of quirks and ultimately no longer living up to its name. This has meant the start of the same exhaustive process of selecting and buying a new car that I went through earlier this year when my old PC started to fail me.

The process of buying a new car has many similarities to buying a new PC. After all, both purchases represent significant outlay for most of us, so it pays to do your research. While I don't have the same passion for cars as PCs, the process of research is interesting.

For instance, whether you're buying a car or a PC, you should always start with considering how you're going to use it. In PC terms, that means which games and/or applications you'll be running alongside what room you'll need for add-in cards and drives; in other words, which shape and style of case you need.

Cars start off similarly too, with myriad body shapes, all of which have an equally important role in determining suitability for different tasks and types of journey.

Despite the choices, it shouldn't be surprising then that the PC and car markets are dominated by a jack-of-all trades choice – the ATX case and hatchback chassis respectively.

Once you've settled on a case for your PC, or a chassis for your car, you need to think about the most important component. For prospective PC gamers, and a lot of computing professionals, that means choosing the right GPU. The analogy in cars is the powerpack, not just the power rating of the engine but the power source, be it petrol, diesel, electric or some sort of hybrid.

Just like your GPU choice, choosing the right powerpack not only determines responsiveness and performance but also efficiency, with some options being far more efficient

under specific conditions. For example, the 24GB of a RAM on a GeForce RTX 3090 is utterly useless for gaming, but absolutely essential for 3D rendering, and is arguably even more important than the 3090's tonne of compute cores here. Similarly, as I discovered through my research, a plug-in-hybrid car is barely any more efficient than a mild hybrid for the sort of journeys I undertake each month.

The analogy continues the further you research too, with close similarities between the decisions PC buyers make over monitors and car buyers make over gearboxes, both of which are down to personal preference. After all, while IPS monitors are clearly more superior for graphics work than TN monitors, that's not necessarily true for fast-paced competitive games. Similarly, an automatic gearbox is great

for everyday driving, especially in urban locations, but a manual gearbox provides more control over performance.

You can also draw parallels between technologies such as CPU and GPU boosting automatically, and new car tech, such as lane assist and auto parking – features that

were inconceivable not many years ago.

PC and car buyers also benefit from being able to choose models from two very vibrant markets, new and second-hand. Even the payment system is similar, with both purchases typically costing well above the disposable income of most buyers, necessitating either saving up or buying on a credit scheme.

There is one notable difference here, however, and that's while it's possible to buy or hire a car on credit and then return it according to the conditions of the contract, no PC manufacturer has managed to successfully replicate a similar deal yet. **GPC**

The 24GB on a GeForce RTX 3090 is useless for gaming, but essential for 3D rendering

James Gorbald has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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