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THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 217

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Custom PC Issue 217

/ FROM THE EDITOR Beating the scalpers

he first promising glimpses of normality appear to be occasionally glitching back into the GPU matrix this month. I even briefly spotted GeForce RTX 3060 Ti and 3080 Ti Founders Editions going for normal prices at Scan, although they sold out shortly afterwards.

That's still rubbish if you didn't happen to be online at that particular time, though, and we're clearly still a long way from being able to regularly buy many PC components at normal pricing. This got me thinking. How could we possibly enable our readers to build a reasonably priced gaming PC in these bizarre times?

I'd spotted that several etailers, including Scan, were offering some of these rare components in bundles that were more keenly priced than buying the components separately. I asked Scan if we could work together and guarantee that the components would be available for **Custom PC** readers for a whole build by buying bulk stock for a fixed spec. Scan said it wouldn't be easy.

With spiralling shipping costs, product shortages and various knock-on effects of the pandemic, we had to carefully pick our components, aiming for a good balance of gear that's not only good quality, but also affordable and available in reliable quantities. James Gorbold has also provided some insight into the process at Scan on p114.

We thrashed out several specs before we came to the one on p74, but we're really chuffed with the end result. Not only does it have an EVGA GeForce RTX 3060 graphics card, but it also has an overclocked AMD Zen 3 CPU, 16GB of RAM, a 240mm Corsair liquid cooler, a 1TB NVMe SSD, a lovely white Fractal case and a Corsair 80 Plus Bronze PSU.

Thanks to **Custom PC** and Scan working together, you can build this PC for just £1,099 inc VAT, with guaranteed stock at Scan's warehouses for 100 **Custom PC** readers. Before they all sell out, turn to p74, get your order in, follow our guide and take this opportunity to build yourself a great gaming PC without having to hand over silly sums of money to eBay scalpers. **BPE**



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CUSTOM PC / ISSUE 217

Contents

Welcome to Issue 217

Highlights

08 RAMifications

With DDR5 arriving later this year, Richard Swinburne looks at what's coming for the longer-term future of desktop RAM.

10 Will China eat our lunch?

The ever-increasing impact of China on the global gaming market raises some human rights concerns, argues Tracy King.

18 Corsair 7000D Airflow Corsair's latest colossal case packs in

plenty of cooling potential but lacks a little flair.

22 Gigabyte Z590 Aorus Xtreme Gigabyte's new Z590 motherboard

has an astronomical price but has the features to show for it.

26 Elgato Facecam

A webcam dedicated purely to streamers, the Facecam is highly adjustable but lacks some features.





37 Razer Opus X

Razer's active noise-cancelling Bluetooth headphones are impressive for their relatively modest price.

40 Temperature tamers

Antony Leather puts six of the latest premium air CPU coolers to the test.

48 Wireless gaming mice

With wireless mice getting ever better, Edward Chester puts eight of the latest through their paces.

66 Arrested development

Rick Lane ponders whether the graphics card shortage will cause developers to hold back on implementing the latest technologies such as ray tracing.

67 Subnautica: Below Zero

The follow-up to the excellent survival game, Subnautica, the latest instalment sees you tackle surviving in the icy depths of the Arctic.

74 Beat the scalpers

Learn how to build a modern RTX 3060-based gaming PC with a Ryzen 55600X CPU, and ensure you can buy all the parts for it, thanks to our exclusive deal with **scan.co.uk**

84 DLSS vs FSR

AMD has finally released its rival resolution scaling technology to DLSS, but does FidelityFX Super Resolution deliver the goods?

90 Oratek Tofu

Make the most of the Raspberry Pi Compute Module 4 with this compact but highly capable carrier board.

98 How to guides

Antony Leather shows you how to add fill and drain ports, and flush and clean your whole water-cooling loop.

104 40 years of the PC

It's 40 years since the first IBM PC 5150 arrived on the scene. We take one apart and chat to IBM about its development.

Cover guide









Regulars

- 3 From the editor
- 8 Richard Swinburne
- 10 Tracy King
- 12 Incoming
- 36 Custom kit
- 58 How we test
- 60 Elite products
- 66 Inverselook
- 72 Reality check
- 90 Hobby tech
- 95 For the win
- 96 Customised PC
- 98 How to guides
- 103 Folding@home
- 104 Retrotech
- 110 Readers' drives
- 114 James Gorbold





Reviewed

CPU COOLERS

16 MSI MPG CoreLiquid K360

CASES

- 18 Corsair 7000D Airflow
- MONITORS20 Acer Predator XB323UGP

MOTHERBOARDS

22 Gigabyte Z590 Aorus Xtreme

WEBCAMS

26 Elgato Facecam

GAMING LAPTOPS

- 28 Asus ROG Strix Scar G733
- 30 MSI Katana

PC SYSTEMS

- 32 CyberPower Infinity X115 GT
- 34 Chillblast Fusion Kraken

Custom kit

- 36 G-Lab K-Stand
- 36 Razer Wrist Rest
- 36 ZEXMTE Long Rane Bluetooth Dongle
- 37 MiiKARE Cooling Egg Stand
- 37 Razer Opus X

Air cooler Labs

- **41** ARCTIC Freezer 50
- 42 be quiet! Shadow Rock 3
- 43 Deep Cool AS500
- 44 Gelid Phantom Black
- 45 Noctua NH-U12S Redux46 SilverStone Hydrogon D120 ARGB

Wireless gaming mouse Labs

- 49 Asus ROG Keris Wireless
- 50 Glorious Model O Wireless
- 51 Logitech G703 Lightspeed with Hero Sensor
- 52 Logitech G Pro X Superlight
- **53** Razer DeathAdder V2 Pro
- **54** Razer Viper Ultimate
- 55 Roccat Kone Pro Air
- **56** SteelSeries Prime Wireless

Games

- 67 Subnautica: Below Zero
- 68 Days Gone
- 70 Hood Outlaws and Legends
- 71 Solasta
- 73 Puzzle Bobble VR: Vacation Odyssey

Hobby tech

- 90 Oratek Tofu
- 92 Zymbit HSM6
- 94 Computers that Made Britain











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RICHARD SWINBURNE / VIEW FROM TAIWAN

DDR6 IS ALREADY ON THE ROAD MAP

DDR5 is getting its first outing later this year, but JEDEC is readying DDR6 and beyond, reveals Richard Swinburne

was recently sent an image that's only available privately for JEDEC members. It shows that the memory standards body has already set out its road map up to 2030, with the memory data rate increasing steadily over the next ten years, where it tops out at an effective frequency of 24GHz, up from DDR4's 3200MHz today.

The graph shows the 'socket bandwidth' target increasing by 20 per cent every year, which in this case alludes to server platforms with ultra-wide, 8-channel memory systems. However, while the big bandwidth numbers won't make it into desktop PCs, we'll benefit from the same tech as it trickles down into smartphones, laptops and PCs.

As we roll into DDR5 this year at 4600MHz, JEDEC expects this tech to scale up to 8000MHz by 2024, and that's the 'official' plug-andplay spec, not just overclocked modules. This is followed by DDR6 launching in 2025 at 9600MHz and scaling beyond 16GHz by 2028.

Considering that DDR4 launched six years ago, and in that time scaled from 2133GHz to 3200MHz, comparatively, JEDEC wants to grow memory bandwidth at 10x per year this decade vs past decade. This is an extremely aggressive road map, and it's surprising – until recently, JEDEC members were talking about DDR5 being the 'last generation' of DRAM while actively looking for alternative technologies.

It seems that, thankfully, the 'next gen problem' has been solved, as DDR6 will introduce more advanced PAM4 signalling between CPUs and memory modules. Very simply, this packs in more data per clock, but it makes the data signal much more complicated, and requires encoding and decoding hardware at each end, which in turn requires more power to process. PAM4 signalling is already being used in PCI-E 5 and GDDR6X tech, among other data centre-grade hardware, so while it's not a new technology, it's currently very expensive to implement.

Can the cost come down fast enough for it to be accessible to PC builders, or will DDR6 remain solely in the realm of servers? It's hard to say – we could look at PCI-E 4, which has been around for a couple of years already in the AMD X570 platform, and sadly those motherboards have yet to drop in price at all.

When Intel finally caught up with its Z590 chipset this year, it followed AMD's premium-pricing strategy, even if the chipset

itself has no PCI-E 4 lanes. This trend doesn't bode well for future performance PC builds.

Another factor is power use and heat. The explosive growth in data rate has to be offset by similarly reducing the energy-per-bit transferred, otherwise every DIMM is going

to need some serious cooling. The bad news is that memory manufacturing has effectively hit a wall at 10nm. This is similar to Intel's long-time 14nm situation, where CPU clock speeds have scaled north of 5GHz, with power use also being pumped up all the time.

We're already faced with CPUs that peak at nearly 300W, and GPUs that draw twice that, so how much power is a premium gaming PC going to require in the DDR6 era?

Of course, there will be some overlap between memory generations – it's not as if DDR4 will disappear as soon as Intel launches the first DDR5 platform later this year. The same will happen when DDR6 arrives, so a DDR5 kit should last through multiple upgrades. **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

JEDEC expects DDR5 to scale up to 8000MHz by 2024

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TRACY KING / SCEPTICAL ANALYSIS

WILL CHINA **EAT OUR LUNCH?**

As publishers look to the Chinese video game market, Tracy King examines the implications for human rights, surveillance and censorship

I care about human

rights and censorship

any years ago when I worked in marketing, business leaders liked to use the phrase 'China will eat your lunch'. By this they meant that British businesses would inevitably lose market share to China, because of aggressive competitive tactics. In February 2021, US president Joe Biden used the phrase to warn America that China wants

profit, and in a call to the Chinese President Xi Jinping set out his concerns about 'coercive and unfair' trade practices to get it. By this, he means the Chinese government doesn't care that eating your lunch means you will go hungry. China has a poor human rights record and an oppressive, censorious government, but it's also a massive market into which companies can sell. It matters because

This has caused problems for all industries, but particularly video games. Developers want access to the 740 million gamers in China, but are learning that they can't eat their lunch and have it. If they want to launch games in China, they have to accept a lower standard of human rights.

One reason why games particularly is an issue is because of the Chinese government's insistence that they're a bad or corrupting influence. Consoles were banned in 2000, but PCs weren't because they're for studying and homework (hee hee), so a gaming market emerged regardless.

China's Tencent is the biggest video game vendor in the world, and one of the most valuable technology companies. What Tencent does matters to me, because it buys shares in Western gaming companies, from the small Cambridge-based Frontier Developments, which makes Rollercoaster Tycoon and Elite: Dangerous, to the giant of League of Legends, Riot Games.

It also matters because I care about human rights and censorship. In a recent Guardian long-read by Oliver Holmes that is well worth reading, we hear from Daniel Camilo, 'a Shenzhen-based specialist in publishing games in China, [who] has said the government's mindset is that "if something isn't fit for one person, it isn't fit for anyone".

In July this year, Tencent added facial recognition to its restrictions on gamers. Since 2019, China has had a 'cyber curfew' in which anyone under 18 is banned from gaming between 10pm and 8am. Tencent has leaned into that by implementing ID and age checks via face ID, reducing the basic

privacy of minors and creating a lot of data for the company and the government.

Britain is currently less hysterical about the non-issue of 'gaming addiction' than China, although from this column you'll know that's an ongoing battle. But we do have a lot of surveillance, and before it started asking for facial

recognition, Beijing asked for - and got - mandatory 'real name' proof of identity for gamers, which some British lobbyists are also pushing for to tackle online abuse.

Surveillance and censorship go hand in hand, as the former is needed to enforce the latter, and Tencent's slow creep into Western gaming is of concern. It's also becoming cheaper and easier to avoid putting anything in a game that will need to be removed for China. Holmes warns, 'as China becomes more dominant in the market, developers will probably start censoring themselves from the outset, altogether avoiding themes that might offend Beijing'. China will find it a lot easier to eat our lunch if we simply hand it over. 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 / NEWS

Incoming

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Letters

Tell us what you think of the mag, ask us questions and suggest your own tips and tricks for other readers! Send all your correspondence to **custompc@raspberrypi.com**

RESIDENT EVIL VILLAGE GETS FSR SUPPORT

The latest patch for Capcom's Resident Evil Village brings support for AMD's FidelityFX Super Resolution to the game. 'FidelityFX Super Resolution (FSR), the most advanced upscaling technology offered by AMD, is now supported in Resident Evil Village,' says the patch notes. 'Players who use FSR will now be able to experience higher frame rates on PC for an improved gaming experience.'

FidelityFX Super Resolution is a resolution scaling system designed to improve frame rates in demanding games. Nvidia's DLSS tech has given the green team's RTX GPUs an advantage over AMD's RDNA2 cards in games with ray tracing enabled, but FSR can potentially make AMD's raytracing performance more competitive, plus it works on both AMD and Nvidia GPUs, including older models.

The handful of supporting games when AMD launched FSR wasn't particularly inspiring, but it may start to take off now that AMD has a AAA title on the roster. We've taken a look at how FSR works compared with DLSS, and tested out its performance, on p84.

NVIDIA DEMOS RTX ON ARM



Nvidia is threatening to shake up the x86's PC stronghold after demonstrating games running with its RTX technologies using an Arm CPU. As part of the Game Developers Conference (GDC), Nvidia teamed up with MediaTek to make a gaming system based on a GeForce RTX 3060 GPU and a MediaTek Kompanio 1200 Arm CPU.

The demonstration showed off ray tracing working on Wolfenstein: Young Blood and The Bistro, with DLSS also enabled on the former. The two firms aren't shy about their ambitions either. 'MediaTek and Nvidia are laying the foundation for a new category of Arm-based high-performance PCs,' claimed PC Tseng, general manager of MediaTek's Intelligent Multimedia Business Unit. Meanwhile, Nvidia stated that the 'energy efficiency of Arm CPUs with Nvidia technologies can open an entirely new class of PCs'.

At the time of going to press, Nvidia is currently in the process of trying to buy Arm, although it's facing scrutiny from the UK government, with digital secretary Oliver Dowden issuing an intervention notice in April this year, and a report from the Competition and Markets Authority due by 30 July. Nvidia has also developed its own Arm-based Tegra silicon-on-chip designs, which power a number of mobile devices, including the Nintendo Switch.

VALVE ANNOUNCES HANDHELD STEAM CONSOLE

Valve has shaken up the PC gaming industry with the announcement of a new handheld games console that plays Steam games. While the Steam Deck looks a bit like a Nintendo Switch on the surface, it's quite a different beast inside.

Rather than being based on an Nvidia Tegra chip with an Arm CPU like the Switch, the Steam Deck uses a custom x86 AMD APU that not only features four SMT-enabled Zen 2 CPU cores, but also has an integrated GPU with eight RDNA 2 Compute Units.

Assuming that it follows the design of previous RDNA 2 GPUs, this would give the Steam Deck's APU 512 stream processors with eight Ray Accelerators. According to Valve, the CPU runs at 2.4-3.5GHz, while the GPU runs at 1-1.66GHz.

That might not seem like much compared with the desktop equivalents, but the hardware only needs to run games on the Steam Deck's 7in screen, which has a 1,280 x 800 resolution and



60Hz refresh rate – it's a remarkable amount of gaming power for a handheld device that weighs approximately 669g.

The device is equipped with 16GB of LDDR5 on-board memory, two full-sized analogue sticks and a battery that Valve claims is good for two to eight hours of gameplay. Three options are available, starting at £349 for a Steam Deck with just a 64GB eMMC card for storage. This goes up to £459 for a version with a 256GB 4x PCI-E 3 SSD, and £569 for a deck with a 512GB high-speed 4x PCI-E 3 drive. The device runs SteamOS 3.0, based on Arch Linux, but it's expected to run a lot more games than the failed Steam Machines from a few years ago.

Not only has Steam's Linux catalogue expanded since then, but Valve is also working on getting a lot of Windows games to run on Linux with its ProtonDB (**protondb.com**) system.

The Steam Deck is available to preorder) at **steamdeck.com/en**, although current orders aren't expected to ship until the second quarter of 2022 now.

CORSAIR DISTRO PLATE MIMICS RGB FANS

Corsair has added a distribution plate to its expanding line-up of custom watercooling gear. The Hydro X Series XD7 RGB is designed to slot into a case's 360mm radiator mount, and imitates the look of a trio of 120mm RGB fans, complete with 36 individually addressable RGB LEDs.

The plate effectively acts as a 140ml reservoir, and features a Xylem D5 pump and three pairs of nylonreinforced inlet/outlet ports for connecting waterblocks, radiators and other water-cooling components.

There are also additional fill and drain ports, and the plate contains a temperature sensor, so you can easily set your pump and fans to respond to the coolant temperature. The Corsair Hydro X Series XD7 RGB is available to buy now for £250 inc VAT from **corsair.com**



THERMALTAKE GEAR GOES TURQUOISE AND RACING GREEN

Taiwanese PC tech firm Thermaltake is bucking the usual trend for PC parts with monochromatic colour schemes. The firm has just added turquoise and racing green to the colour options for both its Tower 100 Mini case and its ToughRAM RGB DDR4 3600MHz memory. Thermaltake's Tower 100 Mini has an unusual design, with a wide view of the interior thanks to three large tempered glass panels around the edge, and the motherboard mount on the back panel. It's proved popular in the modding community, and is featured in The Claw Machine in Readers' drives on p110.





BE QUIET! SLIM COOLER INBOUND

The low-noise cooling experts at be quiet! have designed a new slimline air cooler that it says can cope with a CPUTDP of up to 160W. The Shadow Rock Slim2 achieves this by building upwards rather than outwards, using a large 135mm fan with nine blades and a rifle bearing. According to be quiet!, even at full speed, the overall noise from the fan is 23.7dBA.

The fan attaches to a slimline heatsink that's fed by four 6mm copper heatpipes, which make direct contact with your CPU's heatspreader in the contact plate.

The cooler's slim profile is designed to minimise interference with other components in your motherboard's CPU area, so it shouldn't clash with large memory modules.

The be quiet! Shadow Rock Slim 2 is compatible with AMD Socket AM4 and AM3/+ CPUs, and Intel LGA1200, LGA2066, LGA115x and LGA2011 CPUs. It's available to pre-order now from **scan**. **co.uk** for a price of \pounds 44 inc VAT.





GIGABYTE ANNOUNCES 28GB/SEC PCI-E SSD

Gigabyte has launched a new PCI-E SSD card that it claims can hit enormous speeds of up to 28GB/sec. The Aorus Xtreme Gen4 AIC SSD can contain a maximum of eight 4TB PCI-E 4 M.2 SSDs, along with a Phison PS5018-E18 controller, making for a colossal total capacity of 32TB.

By taking advantage of 16 PCI-E 4 lanes, rather than the usual four of a single M.2 drive, and setting up the drives in a RAID configuration, the card hits astonishing speeds. Gigabyte has supported its claims with a CrystalDiskMark screenshot, showing a sequential read speed of 28,024MB/sec, and a write speed of 26,641MB/sec.

With eight high-speed SSDs in a confined space, the card also needs some hefty cooling power, and the card sports two fans, a large aluminium finned heatsink and ten temperature sensors.

There's no word on UK pricing and availability for the card yet, but with the firm's 8TB Aorus PCI-E 4 card currently going for £1,550 inc VAT at **scan.co.uk**, it's certainly not going to be cheap.

CORRECTIONS AND CLARIFICATIONS THERMALTAKE TOUGHRAM XG RGB

We recently tested Thermaltake's ToughRAM XG RGB memory, but since we wrote the original review we've found that our test system hasn't been pushing memory modules to their limits when we were overclocking them.

Rather than not having any overclocking headroom, when using different a test motherboard, we found the modules could reach 4133MHz and 3933MHz on our Intel and alternative AMD systems respectively. The modules now retrospectively get an overall score of 86% and an Approved award.

If you held back buying the modules based on our overclocking results, rest assured that they actually overclock very well indeed. We've posted an updated review on our website at **custompc.co.uk/toughram**





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SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+, TR4/X Radiator size with fans (mm) 394 x 120 x 52 (W x D x H) Fans 3 x 120mm Stated noise 40dBA

f you're planning a custom water-cooling loop, you'll generally need to set aside a few hundred pounds to cater for all the components you need. If you're pushing the boat out and going for a 360mm radiator just to cool the CPU, you're likely looking at £200-300 for all the gear, including fittings, fans, coolant, tubing and a waterblock. Alternatively, you could opt for an extreme highend all-in-one liquid cooler, such as MSI's MPG CoreLiquid K360, which will set you back £240 inc VAT.

That might seem a tad steep given last month's group test of 240mm liquid coolers saw some great performers costing less than half that amount. However, the MPG CoreLiquid K360 has a number of very interesting features. Firstly, it has a built-in VRM cooling fan, which shaved 10°C off the load temperature of the VRMs on our motherboard, which is a very handy feature indeed.

Secondly, the pump housing includes a 2.4in display, which can show a hardware monitor that displays various metrics, such as the CPU temperature, fan or pump speeds, but can also be customised with your own image. Finally, there's the software control for the pump, fans and RGB lighting – a feature you normally only get on the likes of

> Corsair or NZXT's coolers. Compared with Corsair's latest 360mm RGB and software-equipped coolers, such as the H150i Elite Capellix RGB, the MPG CoreLiquid K360 costs around £60 more, but Corsair's coolers lack the display and VRM cooling.

Meanwhile, the display and pump housing are attractively finished and look smart, with the display offering full colour, and a fairly bright and vivid image. The housing simply pops in place and is held on using magnets, making mounting the pump section to your motherboard less fiddly than usual. It also cleared all the memory slots on our motherboard, despite its size and the tubing sitting on that side too.

Underneath the display sits a 7th-generation Asetek pump, with what MSI claims is evaporation-proof tubing. All-in-one liquid coolers are known for some of their coolant evaporating out over several years, potentially leading to higher noise as air enters the pump. If MSI's claims are true, the MPG CoreLiquid K360 should live a long and happy life.

The downside to all these features is that the pump housing has a mass of cables emanating from it, which connect to the three 120mm digital RGB fans with separate 4-pin PWM cables and 3-pin RGB cables, before they're hooked up via the pump over a USB 2 header.

The whole contraption is powered by a single SATA connector, but there's no escaping the spaghetti. We'd love to have seen MSI use daisy chaining here, which we've seen used on other coolers to good effect, as it would have cut the number of cables dangling around your CPU socket from eight to four. As it stands, you'll be keeping cable tie manufacturers in business, but at least the only cable you'll need to connect to your motherboard is the USB cable. All the other cables connect to the pump.

MSI's software is also excellent, and far easier to use and navigate than the software that MSI provides with its

TEMPERATURE RESULTS



INTEL LGA1200 DELTA T



motherboards. You can upload images to display on the pump screen, pick from various lighting effects and static colours for the fans, and of course control the fan and pump speeds too. You can control each fan individually or together, and MSI's default profile actually tends to spin up one fan before the other two in order to lower noise levels.

You get similar control over the pump speed and VRM fan, but both were very quiet at their standard settings anyway. The fan speed can range from 0-2,500rpm, with the latter dishing out equally huge amounts of air and decibels. However, it's likely you'll hit bottlenecks elsewhere before pushing the radiator to its limits, especially with small mainstream CPUs.

Installation is also simple, with the pump supporting all current CPU sockets, and the Asetek mount using the bracket included in the box of Threadripper CPUs.

Performance

The MSI's CPU delta T of 49°C in our AMD Zen 3 system was the best result we've seen yet with our new test gear, including an overclocked Ryzen 75800X. It bettered the lceGiant ProSiphon Elite with four fans by one degree and the Lian Li Galahad 240mm liquid cooler by two degrees. The MSI also shaved two degrees off the temperature from the Lian Li Galahad 240mm after a 15-minute stress test with our toasty Core i9-11900K.

Fine-tuning the fans to rein in the peak fan speeds didn't have a significant impact on cooling, but did mean





the MPG CoreLiquid K360 was able to offer better cooling at similar or lower noise levels than cheaper liquid coolers. This was also simple to do within Windows, thanks to the excellent software.

Conclusion

At first glance, the MSI MPG CoreLiquid K360 seems to be just another overpriced large RGB liquid cooler, but it's surprisingly capable, thanks to its slick software interface, extensive fan, pump and lighting control, active VRM cooling and snazzy colour LCD. Cooling will only be bettered by a high-end custom water-cooling loop, and even then not by much, plus the large cooling capacity enables you to reduce the fan speed without significantly impacting cooling. It looks fantastic, it's easy to install and, apart from the need for cable tidying, there's little to dislike.

Of course, there are other large liquid coolers to consider at this price, such as Corsair's H170i, which costs less and includes similar features – we'll be reviewing it soon. Even smaller 240mm coolers were rarely far behind the MSI, and significantly cheaper. However, if you have the money, and you want that extra cooling headroom to tweak the fans to your liking, plus VRM cooling and a customisable display, the MSI MPG CoreLiquid K360 is a top-notch CPU cooler.

VERDICT

Excellent software and customisation with top-notch cooling, but it has a price to match.





E-ATX CASE CORSAIR 7000D AIRFLOW / **£239** incvat

SUPPLIER scan.co.uk

orsair's 7000D is the latest cathedral of a case to be added to the company's arsenal, and it offers some benefits over the already excellent 5000D Airflow we reviewed recently (see Issue 212, p44). For starters, you get an extra fan, with three 140mm models included out of the box, two of which are mounted in the front to create positive air pressure.

The water-cooling radiator support of this 60cm-tall and 55cm-deep case is substantial too, as you'd expect. As with the 5000D, there are side fan mounts that sit next to the motherboard tray, but here you get an extra fan mount, with room for a 480mm radiator. You can even squeeze a 420mm or 480mm radiator in the front too, where there's space for a quartet of 120mm fans or a trio of 140mm fans.

SPEC

Dimensions (mm) 248 x 550 x 600 (W x D x H)

Material Steel, plastic, glass

Available colours

Black, white

Weight 18.7kg

Front panel

Power, reset, 4 x USB 3, 1 x USB 3.1 x USB 3.1 x USB 3.1 x USB

Drive bays 6 x 2.5/3.5in, 4 x 2.5in

Form factor(s)

E-ATX, ATX, Micro-ATX

Cooling

4 x 120mm/3 x 140mm front fan mounts (2 x 140mm fan included), 4 x 120mm side fan mounts (fans not included), 1 x 120/140mm rear fan mount (140mm fan included), 3 x 120mm/140mm roof fan mounts (fans not included)

CPU cooler clearance 190mm

Maximum graphics card length 450mm Meanwhile, the roof offers a home to three 120/140mm fans, as well as a 360/420mm radiator. Like the Airflow 5000, all three of the large radiator mounts are removable, allowing you to fit fans, radiators or a combination of the two from the comfort of your desk, instead of reaching inside the chassis.

All four locations use dust filters and are quick to access as well, making it a painfree experience to build a water-cooled PC. However, you'll want to do some stretches before you try to lug this 18.7kg chassis around with you.

Needless to say, there's the potential here for a cooling arrangement that can deal with almost any hardware you can throw at it. Plus, with so many radiator options, any system you build will benefit from that flexibility.

In terms of storage, you get six 3.5in hard disk mounts and four 2.5in SSD mounts, which is plenty, even for a high-end content creator. All the storage mounts are removable too, so you can ditch them



to boost airflow, reduce clutter below the PSU cover or make way for front-mounted radiators, where you'll need to adjust the PSU cover to open up the front of the case. This cover hides the bowels of the case in front of the PSU and the interior does look much smarter as a result.

There are plenty of ways to install your graphics card in the 7000D Airflow too. The case can configure its PCI-E slots in a vertical or horizontal orientation, keeping the graphics card cooler well away from the side panel. Alternatively, there's a triple-slot mount located closer to the side panel, although we recommend only using that for water-cooled GPUs. Sadly, there's no PCI-E riser cable in the box, which we'd expect, given the case won't leave you with much change from £250.



AIRFLOW TEST

Fantastic watercooling support

- + Easy hardware installation
- + Flexible interior

LATERAL FLOW TEST

- Expensive
- No PCI-E riser cable included
- Extremely niche

The front panel doesn't offer any standout features either, except for four USB 3 ports instead of the usual two, plus a Type-C port. The 7000D Airflow lacks the built-in RGB lighting and software control options you'll see in the iCUE-versions of both it and the 5000-series cases as well, so there's no iCUE commander Core XT hub included. However, you do get a 6-port PWM fan hub, with all three included 140mm fans already hooked up, allowing you to power them from a single fan header.

The side panels hinge outwards, so getting at the interior is simple, and another classy touch is a clear cover for a window in the PSU shroud. This gives you a view of the PSU, revealing its logo, but Corsair suggests this can be customised with stickers, vinyl or engraving. Cable routing is excellent as well, with three large Velcro ties, plenty of anchor points and cable-routing holes, although again, nothing here particularly stands out as unique or innovative.

Performance

The 7000D Airflow's CPU delta T of 47°C is excellent, and slightly better than the result from the 5000D, which is to be expected since it has slightly better airflow. If you decide to kit the case out with an air-cooled system, it's good to know it has what it takes out of the box to do a decent job of cooling your hardware. This result was a match for the be quiet! Silent Base 802 and Fractal Design Meshify 2 as well.

The GPU delta T was again a tad better than its smaller sibling and just ahead of the be quiet! Silent Base 802 and Fractal Design Meshify 2. While the fans were



BENCHMARK RESULTS





reasonably quiet, the be quiet! case was quieter still, but the 7000D Airflow isn't going to annoy you with the fans at full speed. With so many fan mounts and room to install radiators, there are plenty of options beyond the stock configuration anyway.

Conclusion

The Corsair 7000D Airflow is one of the easiest cases to water-cool we've ever seen. However, at £250, it's not quite an unequivocal recommendation despite its excellent out-of-the-box cooling, cavernous interior, useful features and flexible design. It's missing the unique features and pizzazz we'd expect at this price. It's far from a bland box, and it has plenty of extra features, but even the basic version costs nearly £250 and the iCUE RGB fan-equipped version retails for £300. That's a lot of money for a case in anyone's books.

You certainly get your money's worth in terms of size, water-cooling support and volume, but it's otherwise unremarkable. The main issue is that you'd need to fill at least two of the massive radiator mounts to make it worthwhile, which means you need a hardware specification to match, and not even high-end gamers will need that much cooling headroom. It's otherwise an excellent case that would look great fully kitted out with water-cooling hardware, but for most people, the 5000D or 5000X will do the job perfectly well for half the price.

VERDICT

Perfect for extreme water cooling, but it's expensive and lacks pizzazz.



32IN GAMING MONITOR ACER PREDATOR XB323UGP / **£750** incvat

SUPPLIER box.co.uk

PREDATOR

- Great gaming performance
- Premium design
- Dazzling highgamut colours

COMMANDO

- Pointless HDR features
- Poor default colour balance
- Poor speaker and headphone sound
- Far too expensive

SPEC

32in

IPS

170Hz

0 5ms

1.000:1

Audio

Extras

Screen size

Resolution 2,560 x 1,440

Panel technology

Response time

Adaptive sync

Display inputs

Stand adjustment

4-port USB 3 hub

Height, pivot, rotation, tilt

100 x 100mm VESA mount,

Stated contrast ratio

FreeSync and G-Sync compatible

2 x 2W speakers, headphone out

1x DisplayPort 1.2, 2 x HDMI

Maximum refresh rate

he Acer Predator XB323UGP is a 32in IPS screen that packs an intriguing feature set, including a 170Hz refresh rate, 2,560 x 1,440 resolution, DisplayHDR 600 rating, and FreeSync and G-Sync compatibility. Taken individually, these aren't groundbreaking features and they don't seem like they would ever justify a £750 asking price, but the full combination is still quite rare. Is the sum greater than its parts?

Well, the XB323UGP certainly makes a big initial impact with its huge box that houses the screen already assembled. The design is premium too, with its largely solid metal stand that's topped by a carry handle, and provides height, pivot, rotation and tilt adjustment (although its long legs hog your desk). It's not particularly slim and there's no extra RGB lighting, but the overall impression is of quality.

This extends to the on-screen display controls clustered on the back right edge of the screen. They're responsive and work intuitively in conjunction with the comprehensive menus. Connection options are good too, with one DisplayPort and

two HDMI inputs, along with a 4-port USB 3 hub that has two

ports on the back and two on the left edge. There's also a headphone jack but, along with the stereo speakers, it offers disappointing, weedy-sounding audio.

Back to the screen, its combination of a 32in diagonal, IPS panel, high refresh rate and 2,560 x 1,440 resolution is quite rare. The result is a big, fun display that balances the extra resolution of 2,560 x 1,440 (compared to 1,920 x 1,080) with the large screen size – it's the equivalent pixel density of a 24in 1080p screen.

Jump up to 4K resolution and you get a much sharper image, but you won't get this refresh rate and you put a huge amount of extra strain on your graphics card. Meanwhile, dropping to a 27in screen will again get you a sharper image, but you'll lose the visual impact of the bigger screen.

Being an IPS panel, viewing angles are excellent and colour reproduction is generally very good too. However, the sheer size of the screen means that IPS

glow – the greying effect produced from viewing IPS screens at an angle – can be quite noticeable in the corners of the noncurved screen.

Talking of colours, this display has an extended colour gamut to match its DisplayHDR 600 credentials, but you can also tone this down using an sRGB mode. Sadly, both the sRGB and the default extended gamut modes have poor colour temperature readings of 7,819K and 7,319K respectively, which is much cooler than the 6500K we'd expect, resulting in a slightly blue/green-tinged image.

What's more, the HDR capabilities are rather pointless. You get the vivid colours of HDR but the 16 columnar backlight zones don't do anything to boost real-world contrast. HDR is supposed to be about dazzling colours and inky blacks on-screen together, but in practical terms this screen doesn't surpass its panel's native 1,034:1 contrast ratio.

Gaming performance is more accomplished, though, with the quick response time and 170Hz refresh rate producing a sharp image in fast motion, while FreeSync and G-Sync take care of any tearing and stuttering.

Conclusion

The Acer Predator XB323UGP has a lot going for it, with its large screen size, mid-range resolution and high refresh rate combining to make a big, bold and fun gaming experience. However, its HDR credentials don't add up to much, the colour temperature is too cool and it just doesn't do nearly enough to justify its very high price.

EDWARD CHESTER

VERDICT

Big and bold but miles away from justifying its huge price tag.





get in the moment

innovation + you



Momentum 32" 4K UHD, LCD display with Ambiglow 326M6VJRMB















Z590 ATX MOTHERBOARD

GIGABYTE Z590 AORUS XTREME / **£820** incvat

SUPPLIER scan.co.uk

ecommending any motherboard that costs more than twice the price of your typical premium model is always tricky, but the Gigabyte Z590 Aorus Xtreme also has to justify this when the very latest mainstream flagship CPU from Intel only has eight cores.

That's not to say the Core i9–11900K is an easy beast to tame. Enabling Adaptive Boost Technology or overclocking it to its limit still requires high-quality power circuitry, and the Z590 Aorus Xtreme has

SPEC

Chipset Intel Z590

CPU socket Intel LGA1200

Memory support 4 slots: max 128GB DDR4 (up to 5400MHz)

Expansion slots Two 16x PCI-E 4, one 16x PCI-E 3

Sound 8-channel Realtek ALC1220, ESSential USB Type-C external DAC

Networking

1 x Aquantia 10 Gigabit LAN, 1 x Intel 2.5 Gigabit LAN, 802.11ax Wi-Fi

Cooling

10 x 4-pin fan headers, VRM heatsinks, M.2 heatsinks

Ports

6 x SATA 6Gbps, 3 x M.2 PCI-E 4 (two via PCI-E expansion card), 2 x M.2 PCI-E 3/SATA 6Gbps, 8 x USB 3.1 Type-A, 2 x USB 3.1 Type-C (Thunderbolt 4 compatible), 1 x USB 3.1 Type-C header, 2 x LAN, 3 x surround audio out

Dimensions (mm) 305 x 270 eight PCB layers compared to six in many other Gigabyte Z590 boards. It also has 20 power phases rated at 100A. Comparatively, that's eight more than Gigabyte's Z590 Vision G.

The VRMs are cooled by two massive finned arrays of heatsinks, linked by a heatpipe and further aided by a backplate covering the entire rear of the PCB. There's no active cooling, but few Z590 boards have this. Despite the enormous cooling arrangement, there's also plenty of space around the CPU socket, thanks to the board extending out to E-ATX dimensions.

The board also looks fantastic, with most of the PCB covered in shrouds or massive heatsinks, while reflective plates offer two RGB lighting zones. It's one of the best-looking boards we've seen.

Meanwhile, a full-length shroud runs top to bottom on the right, housing six right-angled SATA 6Gps ports, seven 4-pin fan headers, the 24-pin ATX connector, USB headers and even right-angled RGB connectors. The latter two use proprietary cables to connect to your case to save space.

BBBBBBB

As a result, the rest of the board can be covered up, with just a small cap covering the audio header and dual BIOS switches below the third PCI-E slot. With such huge heatsinks covering the three M.2 slots, and all potentially being covered by PCI-E devices, accessing the M.2 slots once your devices are installed might be tricky.

Thankfully, Gigabyte has also included a dual M.2 slot expansion card that not only adds two more PCI-E 4-capable M.2 ports, but is also equipped with a large heatsink – it makes for easy SSD access once your system is up and running. You also get an ESSential USB Type-C external DAC in the box, which costs nearly £90 to buy separately. You get all the usual overclocking and testing tools as well, with the power and reset buttons integrated into the shroud next to the DIMM slots.

Move around to the rear I/O panel and you'll find a healthy tally of eight USB Type-A ports, all of which are USB 3.1, plus two Thunderbolt 4-enabled Type-C ports.

You also get a pair of LAN ports offering 10 Gigabit and 2.5 Gigabit maximum speeds respectively, courtesy of Aquantia

BENCHMARK RESULTS



and Intel networking controllers, while 802.11ax Wi-Fi is also included. Finally, the EFI and software make it easy to apply overclocks and fine-tune your fans and pumps, with thermal probe inputs enabling you to control fans on radiators if you hook them up to coolant probes.

Performance

The PCI-E expansion card kept our PCI-E 4 SSD below 63°C in our stress test, but this only rose to 68°C in the board's own PCI-E 4 M.2 slot, so either option will keep you well clear of any throttling. Even after back-to-back stress tests, our SSD still hit its peak read and write speeds of 4,997MB/sec



and 4,275MB/sec respectively. The audio put in an excellent performance too, with a dynamic range of 110dBA and noise level of -111dBA.

With Adaptive Boost Technology enabled, the VRMs peaked at just 53°C, so the heatsinks and power circuitry do a great job of coping with the power-hungry Core i9-11900K; however, you'll need to turn off Thermal Velocity Boost frequency clipping in the EFI to get the most out of an overclock. Not doing so saw our usual 5.1GHz settings fall back to 4.7GHz. With that setting switched off, the board ran happily at 5.1GHz across all eight cores with a vcore of 1.38V.

The multi-threaded Cinebench R23 score rose from 15,540 at stock speed with Adaptive Boost Technology enabled, to 16,458 with the manual overclock. With a lower voltage being pumped through the CPU, it was much cooler too. The biggest gain was in our heavily multi-threaded video encoding test, with the score from 674,354 to 725,051 with all eight cores fixed at 5.1GHz. This is all good, but you can get similar performance from a board that costs half the price.

There's not much to dislike – you'll only want to look elsewhere if you need a 4K display or a screen that can handle the Adobe RGB or DCI-P3 gamuts. The speakers are excellent too, with bold bass, plenty of mid-range clarity and a crisp high end. They're easily good enough for games, and miles better than the Alienware's speaker.

Finally, the battery lasted for 90 minutes while gaming, three hours when tackling tough work tasks and seven hours when running everyday applications with moderate screen brightness. That's decent for a gaming laptop, and again better than the Alienware.

Conclusion

Apart from some cool-running SSDs and VRMs, you won't get more performance benefit from the Gigabyte Z590 Aorus Xtreme compared with other good-performing and cheaper Z590 boards. Instead, your cash goes towards Thunderbolt 4, an M.2 expansion card, an external USB DAC, right-angled connectors and lashings of aesthetic prowess. It's a beautiful motherboard, and if were money no object, we'd jump at the chance to own it. For those with more sense than money, though, it remains the stuff of dreams.

VERDICT

One of the best-looking, feature-packed motherboards we've ever reviewed. Just don't look at the price tag.

RIGHT ANGLING

- + Beautiful design
- + Feature-packed
- + Excellent VRM and M.2 cooling

RIGHT MANGLING

- Hugely expensive
- Potentially tricky access to main M.2 ports
 - Core i9-11900K isn't exactly high-end







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PCSpecialist



STREAMING CAMERA ELGATO FACECAM / **£190** incvat

SUPPLIER scan.co.uk

imed squarely at gamers and streamers, the Elgato Facecam isn't just any webcam. The company has made a few interesting decisions about what it can and can't do. Specifically, it doesn't include a microphone, so it can't be used as a conventional webcam. The logic is that streamers will either already have a dedicated microphone, or at the very least use a gaming headset for audio.

It's a sound logic that will likely hold true the majority of the time, but this approach does also limit the Facecam's uses. If you do want a webcam that you can also use for Zoom meetings, but you don't always want to be restricted to a headset and haven't yet invested in a desktop microphone, then the Facecam can't do it.

FACING FUTURE

- Great image quality
- + Hugely customisable
- + Fantastic software

HEAD DOWN

- No microphone
- Fixed focus range
- Expensive

SPEC

Dimensions (mm) 79 x 58 x 48 (W x D x H)

Weight 96g

Supported resolutions (uncompressed) 1080p, 720p and 540p (30Hz and 60Hz)

Sensor Sony Starvis CMOS

Lens

f/2.4, 24mm full-frame equivalent, 82-degree FOV (diagonal), 30-120cm focus range

Connections

USB Type-C Extras Removable lens cover

Another interesting choice is that the Facecam has a fixed focus range. The lens is arranged so that anything between 30cm (actually as low as around 25cm in our tests) and 120cm away will remain in focus. Again, this is largely a sensible decision in the context of streaming, as it means your face and most of your on-camera shenanigans will remain in focus, with no distracting focus searching or focusing on your background rather than you.

However, for any occasions where you may want to hold an object up close to the camera, any finer details will be lost. In comparison, the Logitech C920 will allow you to focus right in on the fine writing on a box or other such details.

These considerations aside, the Facecam is a good-quality if large unit. It's over twice as tall as the Logitech C920,

and it packs in a huge lens and sensor. While Elgato hasn't revealed the exact size of the sensor, it claims it's twice the size of typical 1080p models, and judging by the size of the lens and the whole camera, we don't doubt it. The front lens element of the Logitech C920 is approximately 7mm wide whereas the Facecam's is 18mm wide.

Bigger sensors and lenses generally mean more light and better dynamic range, and that's indeed where the Facecam shows its abilities. It trounces the Logitech C920 here, coping better with extreme differences in lighting conditions, producing more accurate colours and suffering far less from image noise.

Elgato's excellent Camera Hub software also lets you customise all manner of settings and save them to the camera, preventing the annoyance of any software from messing with your favourite setup.



The 82-degree field-of-view camera can be digitally zoomed up to 4x, and the picture contrast, saturation and sharpness can all be tweaked.

Meanwhile, the exposure can be set to manual or automatic, with centre-weighted or average modes, and fixed shutter speed can be applied too. White balance can also be manually set, along with noise reduction – 50Hz or 60Hz anti-flicker modes are available as well.

The Facecam can be secured using its standard 1/4in camera stand thread, or via its foldable, rubberised mount for sitting on top of a screen. It isn't as secure as the Logitech's mount but it does the job, while connection to your PC comes courtesy of a USB Type-C cable.

Conclusion

The Elgato Facecam isn't the ultimate do-it-all webcam for all users, thanks to its high price, lack of a microphone and use of a fixed focus, but it's well worth considering if you're prepared to pay out for a dedicated streaming camera. It delivers class-leading image quality and has just the sort of customisation options you need to reliably dial in the exact streaming image you want.

EDWARD CHESTER

VERDICT

Pricey and with niche appeal, but the image quality is fantastic for streaming.



FREE CHILLBLAST AERO RGB GAMING MOUSE WITH A 12-MONTH SUBSCRIPTION TO CUSTOM PC

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 awardwinning 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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WORTH

GAMING LAPTOP

ASUS ROG STRIX SCAR G733QSA / **£3,499** incvat

the lid has a dotted

SUPPLIER overclockers.co.uk

sus' ROG Strix Scar G733QSA isn't shy about showing off. This machine has RGB LEDs everywhere, from the band of lighting on the base to the strip of lights beneath the display. Meanwhile,

pattern that spells 'ROG', the body has translucent plastic that allows a view of the components and there are removable plastic panels for customising the hinge.

It's all contained in a chassis that weighs a hefty 2.7kg and has a thickness of 28mm, and the Scar serves up good build quality, with only minimal flex in the panels. This swaggering machine lines up against the likes of the Alienware m17 R4. Both systems look eye-catching, and the Alienware has marginally better build quality alongside a slimmer, narrower chassis, but it's heavier than the Asus too.

This year's Scar model now has a new opto-mechanical keyboard. It has a decent 1.9mm of travel and the buttons are

SPEC

CPU 3.3GHz AMD Ryzen 9 5900HX Memory 32GB 3200MHz DDR4 Graphics Nvidia GeForce RTX 3080 Laptop 16GB Screen 17.3in 1,920 x 1,080 IPS 360Hz Storage 2 x 1TB Samsung PM981 M.2 SSD Networking Dual-band 802.11ax Wi-Fi, Gigabit Ethernet, Bluetooth 5 Weight 2.7kg Ports 3 x USB 3.2 Gen 1, 1 x USB-C/ DisplayPort, 1x audio, 1x HDMI **Dimensions (mm)** 395 x 282 x 28 (W x D x H) **Operating system** Windows 10 Home 64-bit Warranty One year parts and labour return to base superb – the action is very fast, with a crisp, bouncy and sturdy feel. It's one of the best keyboards you'll find on any gaming laptop, and easily the equal of the Alienware's CherryMX unit. The layout is good too, with extra buttons and a numberpad. As usual, the trackpad is fine, but a gaming mouse will be miles better.

The Scar serves up three USB 3.2 Gen 1 ports, a USB Type-C port with 100W of power delivery and DisplayPort. There's an HDMI 2b output as well, and the Asus Keystone II slot. This notch holds small RFID devices that can activate personalised settings, launch customised groups of applications or trigger encrypted storage, but it's gimmicky and not really useful for most people.

Some features are missing too. Unlike the Alienware, the G733QSA has no webcam, card reader or HDMI 2.1port, and the Asus could also do with faster USB ports. On the inside, the Asus serves up an RTX 3080 Laptop GPU with 16GB of memory and 48 RT cores – it runs at TDPs between 115W and 130W with a maximum boost speed of 1645MHz. That's lower than the Alienware, which peaks at 165W. The GPU sits alongside an AMD Ryzen 9 5900HX CPU, which has eight SMT-enabled cores, the brilliant Zen 3 architecture, and turbo speeds of up to 4.6GHz.

Not surprisingly, the rest of the hardware is beefy. There's 32GB of 3200MHz memory and two 1TB Samsung PM981 SSDs in RAID 0 configuration. That array delivers 1.84TB of formatted space, and brilliant read and write speeds of 6,964MB/sec and 5,650MB/sec, but RAID 0 means no data protection if one drive goes down. You also get dual-band Wi-Fi 6 and Gigabit Ethernet, which is good enough, but the Alienware has the benefit of 2.5Gbps Ethernet.

Performance

The RTX 3080's reduced TDP means it can't quite compete with the Alienware. Its 99th percentile minimum of 50fps in Assassin's Creed Valhalla is solid, but its Cyberpunk 2077 99th percentile result of 52fps is 11fps behind the Alienware. Meanwhile, Doom Eternal scales really well with extra GPU power, pushing the G733QSA's 99th percentile result of 110fps a long way behind the Alienware.

The Asus can't keep up with the Alienware, but it will still play any current game at 1080p, complete with ray tracing, and there's enough GPU power to run esports title titles at the frame rates required by the 360Hz display. It's also worth playing with Asus' Silent Mode, which is a clever and wellbalanced option – it drops the GPU clock to 1100MHz, which is enough to run mainstream games at decent frame rates while producing hardly any noise.

MUFASA

- + Plenty of gaming speed
- + Brilliant AMD CPU
- High-guality display
- + Excellent optomechanical keyboard

The processor is great as well. Its single-threaded image editing score of 69,313 is miles ahead of the Alienware's Intel Core i9-10980HK, and the AMD chip has a comfortable lead over the Intel CPU in our heavily multi-threaded Handbrake test. Some minor throttling in tricky tests means the AMD CPU never quite achieves its theoretical 4.6GHz turbo speed, but it's far faster than the competition.

The Asus is an admirable thermal performer too. The CPU and GPU's peak delta T figures of 72°C and 62°C are fine, and the exterior remained cooler than most gaming laptops. Fan noise was present during games, but it was never irritating or invasive, and it was a tad guieter when tackling tricky work software. The noise only became uncomfortable with the machine's Turbo Mode deployed, and that option only gave us a tiny performance boost, so it's not worth it. Alienware's machine is worse here, with hot air ejected from its sides and panels that become too hot.

The screen is also fantastic. This 17.3 in IPS panel has a 360Hz refresh rate with adaptive sync alongside a 3ms response time, so you get smooth performance in the fastest games. It performed brilliantly in benchmarks too. The brightness level of 319cd/m² means it can handle indoor and outdoor scenarios, the contrast level of 1,329:1is punchy and vibrant, and the delta E of 1.25 is accurate. Likewise, the colour temperature of 6,476K is near perfect, and the panel rendered 97.6 per cent of the sRGB gamut.

There's not much to dislike - you'll only want to look elsewhere if you need a 4K display or a screen that can handle the Adobe RGB or DCI-P3 gamuts. The speakers are excellent too, with bold bass, plenty of mid-range clarity and a crisp high end. They're easily good enough for games, and miles better than the Alienware's speaker.

Finally, the battery lasted for 90 minutes while gaming, three hours when tackling tough work tasks and seven



SCAR

- Other laptops are faster in games
- Some missing features Thicker than rivals







hours when running everyday applications with moderate screen brightness. That's decent for a gaming laptop, and again better than the Alienware.

Conclusion

The Asus ROG Strix Scar G733 may not have the gaming pace of its rival, but there's still enough power here to handle games at the screen's native resolution. This machine fights back with more CPU ability, better thermal operation, superior battery life, a top-notch keyboard and great speakers. The bold looks won't suit everyone, and the Asus is undeniably expensive too. However, if you're looking to buy a high-end laptop, this machine combines eye-catching design with well-balanced performance.

MIKE JENNINGS

VERDICT

Superb speed, quality and design, albeit for a high price and with some missing features.



GAMING LAPTOP MSI KATANA GF66 11UE / **£1,199** incvat

SUPPLIER cclonline.com

SI's Katana GF66 11UE is one of the most affordable gaming laptops you can buy, and on paper it still delivers a solid specification – including an RTX 3060 with a competitive peak power output of 85W. The 85W version of the RTX 3060 has a boost clock of 1425MHz alongside 3,840 CUDA cores and 6GB of memory.

SPEC

CPU 2.3GHz Intel Core i7-11800H Memory

16GB 3200MHz DDR4 Graphics Nvidia GeForce RTX 3060 Laptop 6GB

Screen 15.6in 1,920 x 1,080 IPS 144Hz

Storage 512GB Kingston OM8PCP3512F-AI1 M.2 SSD

Networking Dual-band 802.11ax Wi-Fi, Gigabit Ethernet, Bluetooth 5

Weight 2.25kg

Ports

2 x USB 3.2 Gen 1, 1 x USB 3.2 Gen 1Type-C/DisplayPort, 1 x USB 2, 1 x audio, 1 x HDMI

Dimensions (mm) 395 x 259 x 25 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base That compares surprisingly well with the RTX 3070 inside the £1,299 Asus TUF Dash F15 (see Issue 216, p32). That GPU has more stream processors and 8GB of memory, but it has an 85W TDP with a lower clock speed.

Meanwhile, the MSI's 11th-gen Core i7-11800H CPU has eight Hyper-Threaded cores, a turbo speed of 4.6GHz and a TDP range of 35W to 45W. It's another component that compares well with the Asus, which uses a Core i7-11370H with a lower TDP range and half the cores. Elsewhere, the MSI has no surprises. There's 16GB of dual-channel DDR4 memory, a 512GB Kingston NVMe SSD, dual-band Wi-Fi 6, Gigabit Ethernet and Bluetooth 5. They're fine specs for mainstream gaming.

This laptop doesn't push the design envelope though. The Katana is largely made from plastic and the exterior has no RGB LEDs – the only illumination comes from the keyboard's single-zone red backlight. Build quality is solid enough, but its 2.25kg weight and 25mm-thick body are both entirely average measurements. The rival Asus looks similarly plain, but it's slimmer and lighter while sacrificing no strength. The MSI serves up two USB 3.2 Gen 1 ports that peak at 5Gbps, a USB Type-C connection at the same speed and a USB 2 port, along with an HDMI output and an audio jack. The Asus is better here, with three USB 3.2 Gen 1 ports and a USB Type-C connector that supports Thunderbolt and power delivery.

As usual with affordable gaming laptops, the MSI has no card or fingerprint readers, but it does have a webcam. It has surprisingly good speakers too; there's hardly any bass, but mid-range and high-end sounds are crisper and clearer than the audio on the Asus. A headset is always better, but for casual media and gaming, the MSI is fine.

Meanwhile, the keyboard has a reasonable amount of travel, the base is robust, and the keys are fast and comfortable to use. The layout includes a numberpad, albeit with small keys, which is a step up from the Asus. The touchpad's buttons are a little soft, but a USB mouse will solve that problem and make gaming more enjoyable.

Performance

In Assassin's Creed Valhalla and Cyberpunk 2077, the MSI returned 99th percentile minimums of 39fps and 35fps, and the latter improved by 2fps with Medium ray tracing and DLSS enabled. The Katana will play today's top games, but you'll need to dial back the settings to hit a 60fps average in the trickiest titles.

The MSI's Doom Eternal 99th percentile result of 104fps is good, though, and its 163fps average means this laptop has the pace to play esports titles on the 144Hz display. The MSI only faltered in Metro: Exodus, delivering a barely playable 99th percentile minimum of 25fps with ray tracing, although that figure improved to 31fps with DLSS enabled.



BENCHMARK RESULTS

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In comparison with the Asus machine with its RTX 3070, the MSI was quicker in Doom, it matched the 99th percentile result in Assassin's Creed and it was only a couple of frames per second behind in Cyberpunk and Metro. The Katana's averages were further behind, but the Asus' RTX 3070 didn't deliver a transformative improvement. If you want a significant gaming performance boost, you'll need to splash out on an RTX 3070 with beefier TDP.

Impressively, the Katana remained quiet during gameplay. It's one of the most subdued gaming laptops we've tested for ages, and it's quieter than the Asus. The exterior remained cool, and internal temperatures were fine.

MSI's beefier Core i7 processor also maintained a comfortable lead over the Asus in our tests. Its RealBench result of 166,861 outpaced its rival by 45,000 points, and it was consistently quicker than the 10th-gen Core i7 CPUs that remain popular in laptops. The CPU ran at speeds of 4.5GHz

SHARPENED

- + Good 1080p gaming pace
- + New Intel CPU is fast
- Versatile, fast keyboard
- + Consistently cool and quiet

BLUNTED

- Poor screen qualityUnderwhelming battery life
- Dull design
- Few extra features

and 2.8GHz in single and multi-core benchmarks, showing the cooling system works well too. Meanwhile, the SSD's read and write speeds of 1,984MB/sec and 977MB/sec are average, but quicker than a SATA drive and fine for general use and gaming.

Moving to the screen, the MSI's 144Hz 1080p display has no active sync, but it's still smooth enough for mainstream gaming and esports. The contrast measurement of 1,274:1is good and combines with the 0.19cd/m² black point to deliver decent depth and vibrancy. The brightness level of $242cd/m^2$ is only good enough for indoor use, though, and the delta E of 4.9 is mediocre.

Combine this with an sRGB coverage level of 57.7 per cent and you've got a panel that looks lifeless and pallid. It's not ruinous, and you can still game on this unit, but bold graphics lose vibrancy on this display. The Asus is significantly better, with bolder colours and a 240Hz refresh rate.

Don't expect much from the modestly sized 53.5Wh battery either. It lasted for just under two hours when gaming, two hours when working and three hours when viewing media. The Asus was far better, with an eight-hour lifespan when working.

Conclusion

The MSI's low price means it can only excel in a few areas. The RTX 3060 is an excellent 1080p and esports GPU, and the new Intel processor offers solid power. The Katana has a good keyboard, and its cooling system is quiet too. It falters elsewhere though. Its battery life isn't great, its design and display are disappointing and there are missing features.

If you're on a budget, the Katana is a reasonable 1080p gaming laptop, and it's also worthwhile if you want that new Intel CPU or a quiet machine. But if you can afford to spend a bit more, the Asus TUF Dash F15 has more features and finesse. **MIKE JENNINGS**

VERDICT

Good core performance for the money, but cost cutting results in the display and battery suffering.



INTEL B560 GAMING PC CYBERPOWER INFINITY X115 GT / **£1,299** incvat

SUPPLIER cyberpowersystem.co.uk

he Infinity X115 GT isn't expensive or flashy, but it's a good mainstream gaming option at a great price. It's built around the affordable GeForce RTX 3060, and this rig's card comes from MSI. The Gaming X 12G card improves the reference boost clock from 1777MHz to 1837MHz. It's also equipped with a whopping 12GB of GDDR6 memory and 3,584 stream processors, which is ideal for gaming at 1,920 x 1,080.

The processor is an entry-level part too, but while the Intel Core i5-11400 can't be overclocked, its six cores are Hyper-Threaded and the base clock of 2.6GHz rises to a boost peak of 4.4GHz. The rest of the specification follows suit, with 16GB

SPEC

CPU

2.6GHz Intel Core i5-11400 Motherboard

MSI B560M PRO-VDH WIFI

Memory 16GB Corsair Vengeance LPX 3200MHz DDR4

Graphics MSI GeForce RTX 3060 12GB

Storage 1TB Intel 670p M.2 SSD

Networking 2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5.1

Case Cooler Master MasterBox MB311L

CPU: Intel low-profile cooler with 1 x 80mm fan; GPU: 2 x 90mm fans; front: 2 x 120mm fans; rear: 1 x 120mm fan

PSU

Cooler Master MWE 650W

Ports

Front: 2 x USB 3.2 Gen 1, 2 x audio; rear: 2 x USB 3.2 Gen 2, 2 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 Warranty

Five years labour, two years parts, six months collect and return then return to base of dual-channel 3200MHz memory and a 1TB Intel 670P NVMe SSD with decent read and write speeds of 3,351MB/sec and 2,525MB/sec. It's all powered by a Cooler Master MWE PSU that's impressive at this price, with a fully modular design and 80 Plus Gold certification.

MSI provides the motherboard alongside the GPU, but the B560M PRO-VDH WIFI is an underwhelming micro-ATX offering. On the positive side, it has two spare memory slots, two M.2 connectors and two 1x PCI-E slots, and networking is impressive: it has 2.5Gbps Ethernet, dual-band Wi-Fi 6 and Bluetooth.

Understandably, though, there are plenty of missing features: only the first M.2 connector and neither of the 1x PCI-E slots support PCI-E 4, and audio comes from the entry-level Realtek AL897 chipset. The board has no fancy heatsinks and no RGB LEDs, and the rear I/O serves up two 10Gbps USB 3.2 Gen 2 ports and a pair of slower USB 3.2 Gen 1 connectors, but no USB Type-C and only three audio jacks. This isn't a board for overclocking or upgrading, but it has solid connection options and room for extra memory and storage.

CyberPower's micro-ATX motherboard means CyberPower can use a smaller case than usual too. Cooler Master's MasterBox



MB311L is affordable, but there's still plenty to like – the 120mm intake fans have loads of RGB LEDs, so they look superb through the mesh fascia. The MasterBox has a tempered glass side panel and a PSU shroud, and its 410mm height makes it smaller than most mid-tower enclosures.

At the front the cabling is neat, and the chassis is spacious – but that's also because the graphics card isn't big and the processor is chilled by an Intel low-profile cooler rather than a more substantial cooler. At the rear, the Cooler Master has a fan hub and a cage with room for two hard disks, but no hard disk bays.

Meanwhile, the top of the chassis has two USB 3.2 Gen 1 ports, but no USB Type-C connector and no button to alter the lighting. The only other issue with the chassis is the build quality – while most of the metal used is sturdy, the mesh front panel and the roof are noticeably weaker.

The CyberPower isn't the only affordable system we've seen recently. The Scan 3XS Gamer RTX also used an RTX 3060. That rig had a poorer motherboard, but it did deploy a Core i5-11600K processor with a water-cooling unit alongside more capacious storage, and it now costs £1,349. Also, our lead feature this month shows you how to build an RTX 3060 machine with a Ryzen 5 5600X for a cheaper price.

What you don't get with our build, of course, is a Windows installation, a ready-built system and a warranty. The CyberPower warranty is generous as well, with five years of labour coverage and two years of parts protection alongside six months of collect and return service.

BENCHMARK RESULTS



Performance

The RTX 3060 remains a solid option for 1080p gaming. It played Assassin's Creed Valhalla and Cyberpunk 2077 with 99th percentile minimums of 46fps and 49fps, and it was a little faster in the latter with Medium ray tracing and Balanced DLSS enabled, so you can play big games with ray tracing, although DLSS looks a bit blurry at this resolution.

This machine's Doom Eternal 99th percentile result of 150fps shows this PC can cope with high frame rates in less demanding titles too. Scan's PC was consistently a little quicker, with its bigger GPU overclock.



Indeed, the Core i5–11400 is pretty unremarkable. Its image editing score of 59,586 is around 5,000 points behind Intel and AMD's best mid-range chips, including the Scan's i5–11600K, and the CyberPower fell behind in the rest of our application benchmarks.

The Core i5-11400 returned a mediocre overall score of 165,888, which is good enough to handle everyday office apps and browser-based tasks, but it can't compete with the Core i5-11600K and AMD's Ryzen 5 chips. That's to be expected at its price, but it's important to be aware of its limitations.

The CyberPower is a good thermal performer, though. When gaming, its noise output is modest and the GPU delta T of 40°C is great too. In stress testing, the processor peaked with a high delta T of 73°C before throttling, but in conventional work tests, it didn't have issues, hitting its single and all-core Turbo speeds of 4.4GHz and 4.2GHz without any problems.

Conclusion

The CyberPower's overclocked RTX 3060 is ideal for 1080p gaming and esports, the case is compact and tidy, and this rig has decent memory, a reasonably fast SSD and a versatile PSU. It's consistently quiet too. Of course, though, there are compromises at this price, and here, that means a mediocre motherboard and processor.

For mainstream gaming, though, the unremarkable motherboard and processor aren't big issues. CyberPower's rig delivers solid 1080p frame rates inside a compact, quiet and affordable build, making it a solid buy in the current climate. MIKE JENNINGS

VERDICT

Solid gaming pace inside an affordable, quiet build make the CyberPower a decent 1080p gaming option.

BUZZ LIGHTYEAR

- Solid 1080p
 gaming pace
- Consistently quiet operation
- + Low price
- Decent RAM, SSD and PSU

EMPEROR ZURG

- Mediocre CPU
- Basic motherboard
- Rivals are quicker in games



WATER-COOLED AMD X570 GAMING PC CHILLBLAST FUSION KRAKEN / **£6,599** incvat

SUPPLIER chillblast.com

hillblast's Fusion Kraken is a beast of a machine with a sensational design. The major components are linked by expertly curved hard-line water-cooling tubing with white coolant, and the processor and graphics card are topped by Corsair XC7 and XG7 waterblocks. A Corsair XD5 reservoir and pump unit sits in the front of the

SPEC

CPU 3.4GHz AMD Ryzen 9 5950X

Motherboard Asus ROG Strix X570-E Gaming

Memory 128GB Corsair Vengeance RGB Pro 3200MHz DDR4

Graphics Asus GeForce RTX 3090

Storage 2TB Samsung 980 Pro M.2 SSD

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

Case Lian Li PC-011 Dynamic Razer Edition

Cooling

CPU: Corsair Hydro X XC7 waterblock with Corsair XD5 pump, Corsair XR5 radiator with 3 x 120mm fans; GPU: Corsair XG7 waterblock with Corsair XR5 radiator with 3 x 120mm fans

PSU

Corsair RM850x 850W

Ports

Front: 2 x USB 3.2 Gen 1,1 x USB 3.2 Gen 1 Type-C, 2 x audio; rear: 7 x USB 3.2 Gen 2,1 x USB 3.2 Gen 2 Type-C, 1 x optical S/PDIF, 5 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 chassis, and an XR5 radiator lurks in the roof. Strips of RGB LEDs line the case, and the custom-spray white exterior looks fantastic against the black exterior.

The front and side panels are also made of tempered glass to really show off the interior, and the materials used are robust. What's more, the Lian Li PC-011 Dynamic Razer Edition case a features RGB LEDs that can be configured and synchronised using Razer software.

Chillblast's building is neat and sensible. The only cables visible at the front are the power leads, and they're braided in white. Around the rear, there's another XR5 radiator, two fan hubs and a Corsair RM850x PSU. The power supply is excellent, with a fully modular design and 80 Plus Gold rating.

There are no big problems, although there's not much room to upgrade. You have to remove the roof to take off the sides, and the huge amount of cooling hardware means upgrade room is scarce beyond space for a couple of hard disks. This water-cooled rig isn't designed for frequent user upgrades, though, especially when you consider the components installed.

The GeForce RTX 3090 GPU, for example, is a monster, with 10,496 stream processors, 24GB of GDDR6X memory and 82 RT cores – the Asus ROG Strix card in the Chillblast also overclocks the GPU boost clock from 1695MHz to 1860MHz. The AMD Ryzen 9 5950X processor is another range-topping part, with 16cores alongside base and boost speeds of 3.4GHz and 4.9GHz.

The situation gets even more full-on when you see the DIMM slots, where Chillbast has deployed 128GB (4 x 32GB) of 3200MHz DDR4 memory. Storage is great too, with the 2TB Samsung 980 Pro SSD clocking up a fantastic sequential read speed of 7,076MB/sec.

All the gear is accommodated by an excellent Asus ROG Strix X570-E Gaming motherboard. It has 2.5Gbps Ethernet and dual-band 802.11ax Wi-Fi, as well as highend SupremeFX S1220A audio, and the rear I/O panel deploys seven USB 3.2 Gen 2 ports and a Type-C connector. Elsewhere, the board's 16x PCI-E slot and M.2 connectors support PCI-E 4, and the PCB has loads of connectors and headers, but these features are hard to reach behind the cooling hardware.

It's a specification that's designed as much for content creation as gaming. It's also protected by Chillblast's superb warranty, which has five years of labour coverage alongside two years of parts protection.

Performance

The 16-core Ryzen 9 5950X is a peerless mainstream processor. Its Handbrake result of 1,063,048 is better than the scores delivered by the more common 12-core 5900X, and it's miles ahead of any of Intel's Rocket Late chips. The only place where other CPUs have an upper hand is in our image editing benchmark, which stresses single-threaded

KRAKEN

+ Sensational CPU performance

- + Top-tier gaming ability
- Fantastic water-cooled design
- Great memory, storage and PSU
- CUTTLEFISH
- Incredibly expensiveOverkill for many tasks
- Tricky to upgrade



performance, but the 5950X is hardly a slouch here either.

It's one of the best CPUs on the market and, when combined with the huge memory allocation, it will slice through workstation-level tasks, from 3D rendering to video editing and running multiple virtual machines. The sheer power on offer means huge futureproofing too. These components are overkill for the majority of users though – you won't see any benefit from the 16 CPU cores and huge memory allocation if you only want a gaming PC.

Meanwhile, the graphics card tackled Cyberpunk 2077 at 4K with a 99th percentile minimum of 40fps, with that score improving to 48fps with Medium ray tracing and DLSS enabled. It was similarly smooth in Metro Exodus and Assassin's Creed Valhalla. The RTX 3090 will play today's top titles at 4K at high settings without breaking a sweat, and its performance at 2,560 x 1,440 is superb too.

Not surprisingly, the Chillblast's Doom Eternal scores are sky-high, showing that this PC will happily run welloptimised, undemanding games that scale with extra GPU power – ideal for 360Hz displays. The GPU compares well with other high-end options. It's a little quicker than the RTX 3080 Ti, and it has a comfortable advantage over AMD's Radeon RX 6900 XT.

Corsair's water-cooling hardware does a great job too. In a gaming test, the GPU's clock ran at speeds between 1900MHz and 2000MHz with a great delta T of 32°C. In a single-core work benchmark, the CPU ramped up to just over 4.8GHz, which is barely short of its theoretical turbo peak, and in a multi-core test it topped out at a solid 3.75GHz. The processor's peak delta T of 38°C is another

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DOOM ETERNAL					
2,560 x 1,440, Vulkan, Ultra Nightmar	e settings				04 400
Chillblast Fusion Kraken		255fps	4	400fps	64.429
0	100	200	300	400	
3,840 x 2,160, Vulkan, Ultra Nightmar	e settings				GIMP IMAGE
Chillblast Fusion Kraken	146fps		242fps		EDITING
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ASSASSIN'S CREED VALHA 2,560 x 1,440, Ultra High settings, Higi	ALLA h AA			1	
Chillblast Fusion Kraken		62fps	82fps		.,UDJ,U4
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Chillblast Fusion Kraken		72fps	86fps		001,710
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3,840 x 2,160, Ultra preset, no ray trac	ing				TASKING
Chillblast Fusion Kraken	40fps 4	15fps			
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Chillblast Fusion Kraken	55	fps	96f	ps	000,02
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3,840 x 2,160, Ultra, HairWorks off, Ad	lvanced PhysX off	, High RT			SCORE
Chillblast Fusion Kraken	37fps	57fps			
0	30	60	90	120	
g	9th Percentile	Average	e		

great figure. Fan noise was present during testing, but the Chillblast is no louder than PCs with half as much power, so it's easily manageable.

Conclusion

There's a huge amount to like about this rig. The processor and graphics card are market-leading options, and they're combined with loads of memory and fast storage. The water-cooling system and lighting are superb too.

The only issue is the enormous price. This Chillblast PC will be at the top of its game for years, but you can make big savings if you compromise on some components or cooling. For lots of people, though, the price will be worth paying to get this top-notch spec and design. It's overkill for many people, but it's a superb high-end system for both gaming and content creation if you can afford it.

MIKE JENNINGS

VERDICT

Incredible speed, design and spec choices, but with an incredible price too.



Custom kit

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

G-LABK-STAND / £19.99 inc VAT

SUPPLIER amazon.co.uk

The G-Lab K-Stand fills the roles of a headphone stand, a 2-port USB hub and a provider of random-coloured lighting ambience. It does a perfectly serviceable job in its first role as a headphone stand – it's stable and weighty, with the centre of gravity in the right place, and it doesn't take up a whole expanse of precious desktop.

It also works nearly as a USB hub – you can power and run the K-Stand from any of the three ports, one of which is located on either side with a third at the back. This makes it a convenient base for your

RAZER WRIST REST / **£19.99** inc VAT

SUPPLIER razer.com

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The Razer Wrist Rest is a big chunky beast of a pad that keeps your wrists off the table when you're typing, gaming or doing anything else with your keyboard.

The cushion is made from memory foam, and it's very thick and comfy, with a pleather covering. While the cushion is a formidable squodgy block, the body of the wrist rest is surprisingly lightweight, with a degree of twist and flex to it. It's a wrist rest, of course, so it doesn't have to be rigid or reinforced, but the flimsiness was unexpected when we set it up.

On the underside, the Razer Wrist Rest has six rubbery feet that anchor it fairly well to your desk, although it relies on contact with the keyboard for it to stay fixed in place.

Its biggest problem, though, is that it's slightly too thick for its purpose, which can make keys on the bottom levels of a keyboard slightly less accessible – not hugely so, but it can be awkward for the fine margins of game control. It might be thick and comfy, but we found it a bit much in actual use.



desktop peripherals, and the port placement mitigates any risk of cable spaghetti.

Meanwhile, the lighting serves a vaguely practical purpose, so you can find the K-Stand if you enjoy sitting in the dark, but past that, the repeating colour pattern is merely there – it's not showy enough to distract, but it doesn't do enough to be interesting. As a light-up headphone stand and USB hub, it does its job, but it's also nothing out of the ordinary.

.....

Flare **•••** Flair

ZEXMTE LONG RANGE BLUETOOTH DONGLE / **£22.99** inc vat

SUPPLIER amazon.co.uk

This ZEXMTE Bluetooth 5 dongle aims to deliver a connection between a Windows PC and any given Bluetooth device at a range

of 100m. It achieves this feat by effectively being more antenna than dongle – the front 4cm of the gadget plugs into a USB port (USB 2 or better), and then the 10cm of antenna can be directed to stick out in whichever direction gets you the best signal, or whichever way is practical, given that it's quite a sizeable device for a USB port.

ZEXMTE claims it has a 100m range, but unless you live in the perfect conditions of a giant indoor space with no interior walls and a PC 100m away at the far end, you're not going to get that. However, the ZEXMTE easily covers a good-sized house and even a few houses down the road. It's ideal as an overkill approach to domestic

> Bluetooth needs, but don't forget to mute your headset microphone when you go to the bathroom.

Tinkling


MIIKARE COOLING EGG STAND / **£9.99** inc vat

SUPPLIER amazon.co.uk

The MiiKARE Cooling Egg Stand is an odd yet surprisingly clever duck. Despite sounding like something you might use to ensure you don't get burned by your breakfast, this egg-like device operates as a stand for a laptop and a smartphone. To use it, you simply open up the egg and the two halves of the outer shell act as risers for a laptop.

The shells are lightly grippy on the outside, while the bottoms of the halves have little rubbery feet – between them they can lift up a laptop, providing reasonable stability and a gap underneath to help with airflow. Inside the egg is a little fold-out stand that holds a smartphone at two different angles; despite its size, this is easily stable enough for watching a movie.

Darkwing

RAZER OPUS X / £99.99 inc VAT

SUPPLIER razer.com

The Opus X is a set of surprisingly low-key headphones from Razer. It's comfy and light to wear, using a Bluetooth 5 connection for audio and USB Type-C for charging. In spite of the lack of heft, the headphones are well put together and the batteries are good for up to 30 hours with noise cancelling engaged, or 40 hours without it.

The Opus X employs active noise cancellation, which does an unsettlingly good job of squashing any unwanted sounds before they can make it to your eardrums. This noise cancelling can be controlled by the power button, enabling you to quickly disengage it at will, so if you need your sense of hearing back you can quickly disengage the system and get unfettered use of your ears again.

Sound quality from the Opus X is very good – the bass isn't going to rattle your brain, but it's beefy enough, while the higher ranges and overall definition are crisp. At the front of the Opus X, there's also an internal microphone for phone calls and other voice comms – it's nothing fancy but it works.

.....

The standout feature here is definitely the noise cancelling, which is superb. This makes the Razer Opus X ideal if you have to contend with a lot of competing noises and you don't want to overcome them with tinnitus-inducing brute force.

Magnum PI •••• Magnum Opus

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LABS TEST / PREMIUM AIR COOLERS

LABS TEST

e

Antony Leather puts the latest premium air coolers to the test

heatsinks

How we test

e're testing a bunch of air coolers this month that retail for around $\pounds 40-\pounds 50$, putting them at the premium end of the air cooler market. Several feature large heatsinks, two fans or as many as six heatpipes, making for significantly greater overall cooling power than cheaper options.

However, extra fans and higher price tags count for nought if the cooler doesn't make good contact with the CPU you're trying to cool, and this is a key aspect of our testing. All these coolers are compatible with multiple CPU sockets but mounting mechanisms vary between them, which can lead to significant differences in cooling performance. So, to ensure we get the best picture of the overall capability of these coolers, we test them with both AMD and Intel CPUs.

This month we're using the latest 8-core CPUs from AMD and Intel – the Core i9-11900K and Ryzen 75800X – to see how each of our chosen coolers performs on Socket AM4 and LGA1200. With the Intel CPU, we've left it at stock speed, but enabled Adaptive Boost technology, which can hit 5.1GHz across all cores and also dish out a lot of heat – a great test for any cooler. Our Ryzen 75800X was overclocked to 4.6GHz using a vcore of 1.25V. We used an MSI MEG Z590 Ace motherboard for Intel testing and MSI's MEG X570 Unify for AMD testing along with 16GB of Corsair Vengeance RGB Pro memory.

1111

Alongside these components, we also use a 256GB Samsung 960 Evo SSD and Corsair CM550 PSU. Both systems are housed in a Fractal Design Meshify C case and use the latest versions of Windows, plus the latest BIOS and driver versions.

We use CoreTemp to measure the CPU temperature before subtracting the ambient air temperature to give a delta T result to allow us to test in a lab that is not temperature controlled. We use Prime95's smallest FFT test with AVX instructions disabled to load the CPU and take the reading after ten minutes. For the Intel system, we take an average reading across all eight cores to iron out any hot spots that might be misleading. AMD only lists a single temperature reading rather than per-core, so we list what's reported in CoreTemp.

We calculate scores based on cooling performance, noise, features, ease of installation and value, with a weighted calculation giving an overall score.

Contents

- ARCTIC Freezer 50 / p41
- be quiet! Shadow Rock 3 / p42
- Deep Cool AS500 / p43

- Gelid Phantom Black / p44
- Noctua NH-U12S redux / p45
- SilverStone Hydrogon D120 ARGB / p46



ARCTIC FREEZER () / **£50** incVAT

SUPPLIER scan.co.uk

e've already tested the Freezer 50's Threadripper-compatible sibling, the Freezer 50 TR, but the standard Freezer 50 is meant for modest CPUs, namely mainstream AMD and Intel models. It's the biggest cooler here, standing 166mm tall and its large dual heatsink design is 150mm deep too. Its width of 148mm adds further to the volume and also means the cooler overhangs most memory slots, cutting module clearance to just 37.5mm.

Thankfully, the huge size does mean it's rather potent in the cooling department. As well as its twin heatsink stacks and six direct contact 6mm heatpipes, you get one 120mm and one 140mm fan, with the latter sitting in a removable shroud that you'll need to extract to get at the installation screws. Because of this, and the cooler's weight, installation was guite fiddly and is definitely best done with your motherboard out of the case.

It's one of three coolers to offer RGB lighting this month too, with the ARCTIC logo and strips down the top shroud illuminating when using the included RGB controller or plugged into a 3-pin RGB header on your motherboard.

SPEC

Intel compatibility LGA115x, LGA1200. LGA2066. LGA2011

AMD compatibility Socket AM4

Heatsink size with fans (mm) 148 x 150 x 166 (W x D x H)

Fans 1x 120mm. 1x 140mm

Stated noise 0.4 sones

However, the fans themselves don't glow like they do on the SilverStone Hydrogon D120 ARGB. You get a small sachet of thermal paste, but this is likely only good for one application and was quite tricky to use as well compared with the syringes included with other coolers.

With a peak speed of 1.800rpm, the fans were some of the louder models on test at full speed, although the shroud likely helps to contain some noise as well as direct the airflow through the heatsink.

A CPU delta T of 52°C in our Ryzen 75800X system was the best on test, matching the Gelid Phantom Black and bettering the Deep Cool AS500, Noctua NH-U12S redux and SilverStone Hydrogon D120 ARGB too, albeit not by much. Pitted against our Core i9-11900K with Adaptive Boost Technology enabled, the CPU delta T of 68°C was again the best on test, albeit with a generous helping of decibels too. However, at lower speeds it was far quieter.

Conclusion

The fact it has RGB lighting and excellent cooling means the ARCTIC Freezer 50 is definitely worth considering if you need the best cooling from an air cooler with a £50 budget. It outperformed every other cooler we tested in this price range, although you'd hope

80MM FAN

clearance

Noisy at full speed

Limited memory

Fiddly installation

140MM FAN

- Excellent cooling on AMD and Intel systems
- + RGB lighting
- Looks good

memory height and some cases may struggle with its 166mm height too, and ultimately there are cheaper or similarly priced coolers that are slightly better options. SilverStone's Hydrogon D120 ARGB, for

so given its huge size. This size also restricts

example. also has RGB lighting and good cooling performance, but its smaller offset design means it doesn't interfere with dualchannel memory slots and it's much shorter than the ARCTIC cooler too.

VERDICT

Excellent cooling and RGB lighting, but it's loud and its size means it has some restrictions too.



BEQUIET! SHADOW ROCK 3/**£48** incvat

SUPPLIER overclockers.co.uk

he latest air and liquid coolers to come our way from be quiet! have been highly competitive with a mix of great cooling, build quality and reasonable pricing. However, with a similar price tag to other coolers on test, the fact that the Shadow Rock 3 only has a single 120mm fan and five heatpipes means it's at a bit of a disadvantage.

Most of the competition has an extra fan and heatpipe, and even with the most efficient heatsink and fan in the world, higher airflow and static pressure will usually win, although the Shadow Rock 3 does aim to make the most of its single Shadow Wings 2 fan. Its heatsink fins are widely spaced to provide less resistance to airflow, but is still 10cm deep to provide decent surface area. This is just as well as the fan can only hit 1,600rpm at full speed.

We also believe be quiet!'s sound rating too. At 24dBA, it has the quietest rating on test and that proved to be the case in the real world too, as it was practically inaudible. Installation was fiddly, though, thanks to one of the mounting screws requiring a super-long screwdriver to reach into the depths of the heatsink, although, this was thankfully included in the box.

SHADY Airflow is limited

Restricted cooling

Fiddly installation

headroom

 Wide heatsink fin spacing

+ Super low noise levels

SHADOWY

- + Well made
 -

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011, LGA775, LGA1366

AMD compatibility Socket AM4, AM3/+

```
Heatsink size with fans (mm)
121 x 130 x 163 (W x D x H)
Fans 1 x 120mm
```

Stated noise 24dBA

Our Intel system also required constructing a backplate and top side mounts; while straightforward, this meant a lot more work than other coolers and means it's probably best to remove your motherboard to install it if you're performing an upgrade. Build quality was excellent, though, with a brushed aluminium top and the best fan clips on test, which were particularly easy to install. You also get a tube of thermal paste, so you'll be good for another application in future.

While the Shadow Rock 3 was exceptionally quiet, its modest airflow and widely spaced heatsink fins meant it struggled to keep up with more powerful coolers on test. It's CPU delta T of 57°C in our AMD system pitched against an overclocked Ryzen 7 5800X meant it was 5°C warmer than the Gelid Phantom Black and the smaller Noctua NH-U12S redux, which was nearly as quiet, also managed to knock a degree off too.

In our Intel system, the toasty Core i9-11900K with Adaptive Boost Technology enabled eventually proved too much for the Shadow Rock 3 and it was unable to keep the CPU sat at 5GHz like the other coolers, instead falling to 4.85GHz.

Conclusion

We commend be quiet! for offering a welldesigned, supremely quiet cooler and for the noise-obsessed out there running their CPUs at stock speed, it's definitely worth considering if low decibel levels are a priority. It also kept our overclocked Ryzen 7 5800X in check too with lower noise than any other cooler on test, but ultimately it was also the warmest, while the Core i9-11900K proved a bridge too far, with its high heat load seeing the Shadow Rock 3 causing it to throttle.

Without Adaptive Boost Technology enabled, though, we have no doubt it would

fare much better, but as all the other coolers didn't stumble here, we have to point this out. Plus, there's the fiddly installation and limited cooling headroom compared with other coolers on test due to its low fans speed and widely spaced heatsink fins.

be quiet

VERDICT

Supremely quiet and able to handle most CPUs even with overclocks, but it can get toasty, especially dealing with Intel's Core i9-11900K with all its boosting bells and whistles turned on.



DEEP COOL AS500/**£50** incvat

SUPPLIER scan.co.uk

ather than go massive like ARCTIC's Freezer 50 or deep like be quiet!'s Shadow Rock 3, Deep Cool is the only cooler on test to opt for a lone 140mm fan design, with the AS500. The heatsink, as a result, stands 164mm tall and 142mm wide, but only 74mm deep, so unlike the ARCTIC cooler, you won't run into any issues with tall memory modules. You'll need to keep an eye on your case's CPU cooler height limit, as some smaller, slimmer cases may struggle.

Despite a fairly low peak speed of 1,200rpm, the fan produced a noticeable airflow noise and sat in the middle of the pack above the super-quiet be quiet! Shadow Rock 3 and Noctua NH-U12S redux. This is a shame, as we'd hoped the larger fan would have amounted to lower noise levels, although it was still far quieter than the Gelid Phantom Black, a SilverStone Hydrogon D120 ARGB and ARCTIC Freezer 50.

The fan clips were simple to install on the AS500, although the mounting mechanism was reasonably involved on our LGA1200 and Socket AM4 test systems, with a total of ten components including nuts, pins and mounting plates needing to be dealt with.

Despite this, it should be possible to install it without removing your motherboard, since the cooler isn't too heavy or particularly fiddly, which can't be said for the likes of the be quiet! Shadow Rock 3 and ARCTIC Freezer 50.

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Heatsink size with fans (mm) 142 x 74 x 164 (W x D x H)

Fans 1x140mm

Stated noise 29dBA

The AS500 also includes RGB lighting with the option of using an included SATA-powered controller or plugging the 3-pin connector to a port on your motherboard. Being 3-pin addressable lighting, you can have the full rainbow effect, although your retinas can relax as the lighting, while bright and vivid, only runs around the edges of the top shroud.

In our Socket AM4 system, the AS500 was only a degree off the best result achieved by both the Gelid Phantom Black and ARCTIC Freezer 50 while matching the SilverStone Hvdrogon D120 ARGB, and shaving several degrees off the CPU temperatures of the be quiet! Shadow Rock 3 and Noctua NH-U12S redux. albeit with much more noise.

A CPU delta T of 70°C put it in joint second place dealing with the Core i9-11900K in our Intel system, second only to the ARCTIC Freezer 50 by one degree and again outperforming the Noctua and be quiet! coolers, but by slimmer margins than when dealing with our AMD Ryzen 75800X.

Conclusion

Despite offering decent RGB lighting in addition to great cooling on both Intel and AMD mainstream sockets, the Deep Cool AS500 still costs the same as similarly performing coolers with no lighting. The only real issue is higher than average noise at full speed, but you'd only see these speeds reached with your CPU under full load, so assuming you use PWM control the rest of the time, the AS500's large 140mm fan will remain guiet.

DEEPLY UNCOOL

A little loud at

The competition is

slightly cheaper

full speed

Quite tall

DEEP COOL

.

- Good cooling
- **RGB** lighting ÷
- No memory compatibility issues

With a straightforward installation and memory-friendly dimensions in the mix too, the AS500 is a great choice for a premium air cooler. It's more flexible than the ARCTIC Freezer 50 and has more headroom than the be quiet! Shadow Rock 3. It's just pipped to the top spot by the slightly cheaper SilverStone Hydrogon D120 ARGB, which offers similar cooling and lighting, but for a few pounds less and with a much shorter heatsink too.

VERDICT

Decent cooling, straightforward installation, RGB lighting and it will leave your memory unmolested too.



LABS TEST / PREMIUM AIR COOLERS



e were amazed to find a premiumlooking cooler with a dual heatsink and fan design for around £15 less than other coolers on test, but the Gelid Phantom Black does indeed cost £34, and very little here appears to be any less worthy than the five other coolers on test.

You get a pair of 120mm fans that can spin up to 1,600rpm and a dual heatsink stack, but thanks to these being relatively slim and one side offset, there's no issue with memory clearance.

That said, the fans were some of the noisiest on test at full speed and the fan clips were also far trickier to mount than those on the likes of the be quiet! Shadow Rock 3 or Deep Cool AS500.

It's not a simple installation kit either, with no fewer than 12 components needed excluding backplates. If you enjoy a bit of construction, that's fine, but it feels a little overcomplicated even if it's fairly simple and hassle-free. Ultimately, we can't complain too much about this, though, since it's still possible to install the cooler without removing the motherboard from your case.

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011, LGA775, LGA1366

AMD compatibility Socket AM4, AM3/+

Heatsink size with fans (mm) 126 x 118 x 160 (W x D x H) Fans 2 x 120mm

Stated noise 27 dBA

GELID PHANTOM BLACK / **£34** incvat

SUPPLIER quietpc.com

While there are no noteworthy extras or RGB lighting, you do at least get a tube of thermal paste, allowing you to mount the cooler again should you move it to a new system or upgrade your CPU or motherboard. The heatsink is packed with

relatively dense fins and feeding these with heat is a total of seven heatpipes – three 8mm and four 6mm – which is more than any cooler we've seen for a while.

This might help to explain the cooling results too, as it matched the best result in our AMD test system, cooling our overclocked Ryzen 7 5800X to a delta T of 58°C and matching the ARCTIC Freezer 50's performance. This was lower than every other cooler, all of which cost a lot more.

It even tamed our toasty Core i9–11900K, matching the Deep Cool AS500 and SilverStone Hydrogon D120 ARGB, although it wasn't quite able to match the ARCTIC cooler. It was also a degree lower than the Noctua NH–U12S redux, but most other coolers were significantly quieter, especially the Noctua.

Conclusion

Three things impressed us with the Gelid Phantom Black. Firstly, that it had no shortcomings in its design other than fiddly fan clips and a longer than average list of mounting components. It's well made and has more heatpipes than any other cooler on test too. Secondly, it offers chart-topping cooling thanks to its large heatsink and dual fans. Finally, it barely costs more than many budget-focused and feature-poor coolers.

The main issue, though, is noise. It's not quiet at full speed and while this does result in some of the best cooling in both our Intel and AMD test systems, there are quieter options that perform similarly, but for

THE PHANTOM OF THE OPERA

- + Excellent cooling
- 🕂 Costs just £34
- + Good build quality

THE PHANTOM MENACE

- Excessive installation components
- Noisy at full speed
- Much quieter coolers available

significantly fewer decibels. The Deep Cool AS500 is one such cooler and it also includes RGB lighting while the SilverStone Hydrogon D120 ARGB is only \pounds 12 more, includes lighting and provides near-identical cooling with a little less noise.

Still, if you'd rather spend the extra cash elsewhere and don't regularly push your CPU to its limits, the Gelid Phantom Black is a good choice for those on a tighter budget.

VERDICT

Fantastic cooling for just £34, but it's not the quietest cooler out there.

cooling 36/40 design 8/20		lga1200 Features 15/20 Value 20/20	overall score
		fitting Easy	
cooling 36/40 design 8/20		am4 features 15/20 value 20/20	overall score
	-	FITTING Easy	

NOCTUA NH-U12S REDUX / **£48** incvat

SUPPLIER cclonline.com

hile Noctua is well known for expensive coolers, it has recently been trying to tempt in those with more modest budgets as well as those opposed to its familiar colour scheme of beige and brown. To address the latter, the NH-U12S opts for a black fan and grey surround, which is a combo that we think looks fantastic. The whole cooler is also supremely well-made, giving you a strong sense you're looking at something that's worthy of its £50 price tag, even before you even install it in your PC.

However, the heatsink is relatively small compared with the competition and the single 120mm fan is also one fewer than half the others on test this month too. Noctua did kindly send us an optional NA-FK1fan kit, though, which will set you back an extra £15 but includes the second fan, anti-vibration mounts, a splitter cable and fan speed reduction cables as well as extra clips to mount it. We've tested both the stock fan and its dual-fan configuration to see if it makes a difference.

There are other signs the NH-U12S redux is a cut-down version of what we usually expect from Noctua. There's no thermal paste tube in the box, as the company has opted to pre-apply

BLACK AND GREY

- + Quiet
- + Excellent build quality
- Pre-applied
- thermal paste

BEIGE AND BROWN

- Performance isn't exceptional
 No extra thermal paste
 - No extras in the box

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4

Heatsink size with fans (mm) $125 \times 71 \times 158$ (W x D x H)

Fans 1x 120mm (optional second fan kit available)

Stated noise 25 dBA

it to the base of the heatsink. This is easier than applying it yourself, but you need to be super-careful not to touch it before you install the cooler and you'll also need to buy more if you ever want to upgrade or transplant the cooler to another PC.

There are also no fan speed reduction cables, which are instead found in the optional fan kit. Surprisingly, you'll also be better off removing your motherboard to install it.

The installation kit requires plastic spacers on both AMD and Intel mainstream motherboards, and these need to be held in place along with mounting plates while you screw these to the backplate. In short, you'd need three or four hands to do this if your motherboard wasn't sat outside of your PC case.

We can't complain about anything else, though, as you get change from £50, epic build quality and a compact cooler that's just 158mm tall and 71mm deep along with a powerful 1,700rpm NF-P12 redux fan. Noise was second only to the be quiet! Shadow Rock 3, but did increase further when we added the second fan. Even with one fan, though, the NH-U12S redux tamed our overclocked Ryzen 7 5800X with a CPU delta T of 56°C, although this was 4°C warmer than the ARCTIC Freezer 50 and Gelid Phantom Black and only the Be Quiet! Shadow Rock 3 produced a warmer result.

Our Core i9–11900K nearly proved too much for this cooler, but the delta T of 71°C was enough to prevent the CPU from throttling, making it the quietest cooler on test to achieve this. The extra fan only shaved one degree off that temperature and two degrees off its result in our AMD system, so in our experience, the extra kit probably isn't worth it in terms of boosting maximum speed performance.

Conclusion

Despite only wielding one fan, the Noctua NH-U12S redux proved to be capable of handling both our CPUs and it managed to



do this with lower noise levels than most of the rest of the field, and with a smaller heatsink than most too. Only the be quiet! Shadow Rock 3 was quieter than the Noctua in our tests, but that cooler also failed to deal with our Intel Core i9–11900K CPU.

Otherwise, the Noctua is quiet, capable and very well made. However, it wasn't the best performer on test and it's quite a basic design for a cooler that costs nearly \pounds 50.

VERDICT

Quiet, compact and well made, but you can get better cooling for less money.



SILVERSTONE HYDROGON D120 ARGB/**£46** incvat

SUPPLIER watercoolinguk.co.uk

f you were to pick a cooler you thought had it all this month, you'd probably pick the SilverStone Hydrogon D120 ARGB. It has RGB lighting and a dual heatsink design with a pair of 120mm fans, so it looks like it means business but can add some pizzazz to your PC's aesthetics too.

The RGB fans look great with their semiopaque construction diffusing punchy and colour-accurate lighting across the blades. You'll need a 3-pin RGB header to power them, though, and there's no RGB controller in the box either, which you get with the ARCTIC Freezer 50 and Deep Cool AS500, so you'll either need to make do with the standard rainbow effect or use your motherboards software if you don't have a separate controller.

Despite wielding two large heatsinks, both are highly offset to move them away from the memory modules on Intel and AMD mainstream motherboards, so you'll have no issues with memory compatibility, unlike the ARCTIC Freezer 50. However, the fan clips left a lot to be desired. They're fiddly compared with the be quiet! Shadow Rock 3 and Deep Cool AS500, and significantly upped the chances of ending up with minced fingers. This is a shame, as SilverStone has previously used fantastic rubber clips in that were the best we've used.

Rather than mixing heatpipe sizes or going for larger ones, SilverStone has opted for six modest 6mm heatpipes that sit within a contact plate, while the heatsinks are quite

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Heatsink size with fans (mm) $125 \times 112 \times 153 (W \times D \times H)$

•••••••

Fans 2 x 120mm

Stated noise 30dBA

slim too. Something we like about the Hydrogon D120 ARGB, though, is its height. At just 153mm, it's going to fit in nearly all cases that aren't restricted to low-profile coolers and is more than 10mm shorter than some other coolers on test.

Installation is once again an exercise in patience with no fewer than 14 components needed to attach it to our AMD motherboard. With the need to get in between the heatsinks to secure the mounting bracket, SilverStone has had to include an extra-long screwdriver as well. Add this to the need for spacers and more than a dozen components, and it's definitely not a cooler you'll find easy to install without removing your motherboard.

Thankfully, its powerful if rather noisy fans were able to power it to some of the best cooling on test, coming a close second to the Gelid Phantom Black and ARCTIC Freezer 50 in our AMD system while it again hit second spot behind the ARCTIC Freezer 50 cooling the Core i9–11900K.

Conclusion

The SilverStone Hydrogon D120 ARGB isn't without its faults, such as awkward fan clips and above-average noise levels, but we feel it strikes the best balance here between cooling, noise, value and aesthetics. There's plenty of scope for cooling overclocked CPUs, its fans are quiet at medium and low speeds, and also sport great-looking RGB lighting. The result is a cooler that does well just about everywhere and is our pick of the bunch this month.

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HYDROGEN FUEL CELL

- + Cheaper than the competition
- + RGB fans
- + Good cooling

COAL

 A tad noisy at full speed

.

- Tricky fan clips
- Eyebrow-raising number of installation components

The Gelid Phantom Black is cheaper than the SilverStone and performs similarly, but it lacks lighting and also makes more noise. Meanwhile, the Deep Cool AS500 also has lighting and was a tad quieter, but the Hydrogon D120 ARGB is cheaper and has more effective RGB lighting. It just pips the AS500 to the post, thanks to a lower price, better aesthetics and a shorter heatsink. **EPC**

GEDM

VERDICT

A compact, powerful cooler with great RGB lighting and reasonable price tag.

	cooling 36/40 design	 IGA1200 FEATURES 19/20 VALUE	OVERALL SCORE
	9/20	16/20 FITTING Easy	
•	cooling 37/40 design 9/20	 ama features 19/20 Value 16/20 Fitting	overall score
		Easy	



LABS TEST

Wireless wonders

Edward Chester puts eight of the latest wireless gaming mice to the test

How we test

ireless gaming mice have come of age in recent years, with the latest wireless technology finally delivering latencies no worse than with wired mice. We're also starting to see convenient Type-C charging and switchable Bluetooth connections as widespread options. We grabbed eight of the latest wireless gaming mice to see how they compare.

We start our testing by assessing the features and build quality of the mice, looking for whether the mouse hits the modern trends for keeping overall weight low and including convenient Type-C charging cables. Some mice also include handy adaptors that allow you to plug the wireless transceiver into the end of the charging cable.

Next, we assess the comfort of the mouse, using it in a variety of both gaming and desktop situations, and with different grip styles. When assessing grip and comfort, we consider the mouse's suitability for different hand sizes too. We consider small hands to be below 17cm in length (from the tip of your middle finger to the wrist/base of your thumb), medium to be between 17 and 20cm, and large to be over 20cm, with most hands falling within the medium size range.

Fingertip grip is where the mouse is held between the thumb and little fingers or ring fingers, with little to no palm contact. Palm grip is with the full palm resting on the mouse and claw grip is 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 size better than others.

Next we assess the sensor performance of the mouse, checking that it keeps up with extreme movements and fine, slow tracking, and doesn't apply any unwanted acceleration or smoothing. We also check for any wireless lag and issues with range (within normal use – we're not testing for whether it works 10m down your garden) and check that the battery life tallies reasonably well with the companies' claimed figures.

Contents

- Asus ROG Keris Wireless / p 49
- Glorious Model O Wireless / p50
- Logitech G703 Lightspeed with Hero Sensor / p51
- Logitech G Pro X Superlight / p52

- Razer DeathAdder V2 Pro / p53
- Razer Viper Ultimate / p54
- Roccat Kone Pro Air / p55
- SteelSeries Prime Wireless / p56

ASUS ROG KERIS WIRELESS / **£90** incvat

SUPPLIER overclockers.co.uk

Ithough Asus has been producing gaming mice for some time, its rodents haven't made the biggest impact on the best gaming mice lists of the world. The ROG Keris Wireless, though, certainly makes a darn good go of breaking into the top tier.

This tri-mode mouse supports Bluetooth, alongside wired and conventional 2.4GHz wireless modes, the latter via an included USB dongle. It also boasts a high-end PixArt PAW3335 16K DPI sensor, hot-swappable main button switches and conforms to the latest trend for keeping the design compact and light.

With a footprint of just 118 x 62mm, it's the shortest and one of the narrowest mice on test, and it's not overly tall either. Its weight of 79g isn't among the very lightest on test, but it just sneaks below the 80g mark that qualifies a mouse as lightweight in our book.

The shape of this mouse is resolutely righthanded, with none of the symmetry of some designs. This style tends to lend itself well to a relaxed, palm-filling type of grip. However, you'd have to have quite small hands to use this mouse in this way. Instead, its size made it only usable in a fingertip grip with our mediumsize hands.

Meanwhile, the sides of the mouse both tilt to the left and don't have any rubber or textured

SPEC

Weight 79g

Dimensions (mm) $62 \times 118 \times 39 (W \times D \times H)$

Sensor PixArt PAW3335 sensor, 16,000 DPI, 40g acceleration, 400 IPS

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

Cable 1.8m Type-C, lightweight braided

Stated battery life 52/78 hours (lit/unlit)

Extras RGB lighting, Bluetooth and 2.4GHz wireless, dongle stowage plus DPI and pairing buttons on underside, spare side buttons

finish, other than the matt plastic used throughout the mouse. In the summer heat we didn't find this a problem for grip, but in winter with cold, dry hands, we suspect your ring and little fingers might struggle for purchase on the right edge.

Atop the mouse there are just the standard five buttons, with no top-mounted DPI buttons. However, on the underside there's a DPI button along with a pairing button for the Bluetooth connection, a sliding switch for moving between wireless, Bluetooth and wired modes, plus a hole into which you can slot the USB transceiver.

The two main left and right buttons use a PBT plastic for better wear/shine resistance than the ABS of the rest of the mouse, and you can also hot swap the switches for these buttons. Undo the two screws on the underside of the mouse, and you can access the innards to just pull off the switches and replace them with the included Omron 1M switches.

This doesn't just mean you can try the Omron switches – as opposed to the default ROG switches, but it also means you can easily swap out broken switches. Asus provides hot-swappable side buttons as well, with bright pink, black and grey options included. Up front there's also the USB Type-C port for the lightweight, braided, low-pushback cable, which is typical of modern mice. There's no adaptor for you to plug the transceiver into the end of the cable though.

In our testing, the Keris Wireless performed superbly, with precise tracking, no unwanted acceleration and an excellent lack of wireless



LETHAL WEAPON

- Versatile Bluetooth and wireless modes
- + USB Type-C cable

+ Very versatile

BLUNT INSTRUMENT

- Iffy grip on sloped right edge
- Not the lightest

lag, although like other mice with Bluetooth modes, we don't recommend Bluetooth for high-speed gaming. It looks fetching too, with its simple all-black finish, and RGB lighting glowing from the fully translucent scroll wheel and ROG logo on the rear.

Conclusion

All told, the Keris Wireless has a decent feature list and adds up to being a very capable mouse. It's reasonably comfortable, has excellent overall performance and its customisability is very welcome. However, the market is highly competitive and there are slightly better options in this price range.

VERDICT

Compact and very capable, there's a lot to like about Asus' latest gaming mouse, but there's stiff competition.



GLORIOUS MODEL O WIRELESS / **£82** incvat

SUPPLIER overclockers.co.uk

he Glorious Model O has been at or near the top of our gaming mouse charts ever since we first reviewed it a couple of years ago. Lightweight, comfortable and affordable, it impressed across the board. Now, finally, we're getting round to reviewing the Wireless version and it doesn't disappoint.

Its shape and most of its spec list is identical to that of the wired version, which makes the Model O among the larger of the mice on test. Its shape is quite long, but with a low, gently sloped back. Meanwhile, its symmetrical form has sides that gently tuck in under the mouse and provide a bump on which your thumb, ring finger and little fingers can rest and grip, just under the back and forward buttons.

It's a shape we find to be very comfortable for a variety of grip styles, with the long and sloping back allowing for a relaxed palm grip, as well as providing support for claw grip, while the mouse's easy-grip sides and low



SPEC

Weight 79g

Dimensions (mm) $66 \times 128 \times 38$ (W x D x H)

Sensor Glorious BAMF, 19,000 DPI, 50g acceleration, 400 IPS

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

Cable 1.8m, lightweight braided

Stated battery life 71 hours unlit

Extras RGB lighting, USB dongle extension

overall height work well for fingertip grip.

The balance is also excellent, with the mouse sitting perfectly straight when gripped just below the back and forward buttons. Add the fact that it weighs just 69g – plus there are no cables to hold you back – and you have a mouse that's effortless to fling around your mat. It's definitely suited more to medium to large–sized hands though. The smaller Model O- will suit smaller hands.

It looks good too, with its RGB illuminated sides stripes and scroll wheel. Our only complaints about the design are the lack of water and dust resistance of the internal components, which are exposed by the many hexagonal holes that cover the mouse and the Glorious company's logo on the side.

In terms of features, it's among the most basic mice on test. You do get a top-mounted DPI button, which we found to perfectly balance accessibility with accidental knock avoidance, but otherwise there's not a lot else. On the underside you'll find the power button and DPI indicating light, but no stowage for the USB transceiver and no Bluetooth mode option. You do, though, get an adaptor for connecting the transceiver to the cable, so you can have it closer to the mouse.

The cable itself is a 1.8m braided affair with the modern-style braiding that's loose and highly flexible. It also terminates in a Type-C plug rather than micro-USB, which is a bit more useful these days.

.....

- MASTERCLASS
 + Very light
- + Fantastic shape
- + USB Type-C cable
- No Bluetooth
 No protection for exposed innards

dongle stowage

DETENTION

NoUSB

The sensor used here is Glorious' own BAMF (no prizes for guessing what it stands for), which appears to be a reworked PixArt 3370, given its 19K DPI, 400 IPS and 50G movement specs. Regardless, it works very well, offering up precise tracking and no lag or unwanted acceleration.

Glorious' simple configuration software also lets you assign up to six DPI levels, and set the lift off distance (although only with options of 2mm or 3mm). You can also choose between 125Hz, 250Hz, 500Hz and 1000Hz polling rates, and tweak debounce time from between 4ms and 16ms. Plus you can reassign all the buttons as you please.

Conclusion

The Glorious Model O Wireless is a very simple option. It offers nothing over and above its wired sibling other than being able to disconnect that wire. However, if that's all you need then there's very little else to dislike. Its shape is fantastic, it's very light and its performance is superb. It's also very reasonably priced.

VERDICT

..........

A simple but highly effective lightweight wireless gaming mouse.





LOGITECH G703 LIGHTSPEED WITH HERO SENSOR / **£75** incvat

SUPPLIER currys.co.uk

ogitech's G703 Lightspeed with Hero Sensor certainly tells you what to expect from it the moment you hear its name. It's the latest revision of the company's G703 wireless mouse that includes its Lightspeed wireless tech – we first tried this on the Logitech G Pro Wireless and were very impressed by – and its 25K DPI Hero sensor.

The G703 name, meanwhile, signifies the wireless version of the company's excellent G403 mouse, which is a simple but very comfortable gaming mouse. It uses a right-handed-only shape, which slopes downwards to the right and has a tall midsection, and average-sized length and width. This makes it very comfortable for draping your whole palm onto the mouse, providing good palm support and a relaxed wrist angle.

However, it can still be used for claw and fingertip grip styles, with the thick rubber sides providing superb grip in all temperature conditions. It really is surprising just how few gaming mice include rubber sides at the moment, as they make a huge difference to your grip when compared with harder plastics.

FASTER THAN LIGHT

SNAIL PACE

Relatively stiff cable

Micro-USB rather

than Type-C

Not very light

- Comfortable righthanded design
- Secure grip from rubber sides
- + Superb performance



Sensor Logitech Hero, 25,000 DPl, 40g acceleration, 400 IPS

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

Cable 1.8m, un-braided

Stated battery life 35/60 hours (lit/unlit)

Extras RGB lighting, 10g optional weight

If it had come out a couple of years ago, the G703 Lightspeed's 95g weight would be considered reasonably light, but it's a little on the heavy side by today's ultra-light standards. The balance of the mouse is just a touch backheavy too, although this can be tweaked by removing the cover plate on the underside of the mouse.

Speaking of which, there's a magnetically attached cover on the underside that's used to hold an optional 10g weight, but this seems like a strange throwback now. Not only that, but it's also an active impediment to adding genuinely useful features. A tiny tweak to the design and there could have been room here to stow the USB dongle but sadly it doesn't fit.

There's precious little else to this mouse in terms of features, with a power switch being the only other aspect of note on the underside. Move to the top and you get a single, quite large, DPI button alongside the five standard buttons but that's your lot. Although it's large, we didn't find we ended up hitting the DPI button accidentally in games, yet it still fell within easy reach when needed.

Another slightly old-school feature here is the use of a micro-USB cable, rather than USB Type-C. It's also a non-braided cable. On the plus side, this cable is tough and reasonably flexible – it's far better than the terrible thick cable Logitech used to use on the G502, for instance. However, it's not a patch on the latest lightweight flexible braided cables in terms of manoeuvrability.





proves again why we like the G403 so much. Logitech's sensor hardware is top-notch and the buttons feel great in action too. Combine all this with the comfortable shape and excellent grip, and it's very easy to get along with the G703 Lightspeed.

Conclusion

The Logitech G703 Lightspeed with Hero Sensor – don't you just love how that name trips off the tongue? – is a great little wireless gaming mouse. Its shape is super-comfy and its rubber sides put the slippery plastic of many competitors to shame. Its sensor and wireless performance are also flawless and it's competitively priced. However, it's a touch on the heavy side and lacks modern touches like Type-C USB, a lightweight braided cable and USB dongle storage. If you prefer a heavier mouse, this is a good-value wireless option.

VERDICT

Not one for ultra-lightweight mouse lovers, but it's otherwise a solid, comfortable and good-value option.



_OGITECH G PRO X SUPERLIGHT / **£120** incvat

..... **SUPPLIER** currvs.co.uk

e were verv impressed, if a little miffed, at the G Pro X Superlight when we first reviewed it a few months back. Here was Logitech refining its already superb G Pro Wireless mouse, making it even lighter and fixing the double-click problem of that first mouse. In doing so, however, it dropped its ambidextrous design and even ditched the bottom-mounted DPI button, all while not dropping the already high price. It still performed well enough to keep us happy at the time, but does it still impress?

One fact that's immediately highlighted when you're reviewing over half a dozen other wireless mice at the same time is that the original G Pro Wireless' original performance advantage, with its very lowlatency wireless technology at the time, has now all but vanished. The G Pro Wireless and G Pro X Superlight offer fantastic, low-latency wireless performance but so do all the other mice on test.

The other obvious feature you notice is just how many wireless mice now offer USB Type-C charging/wired-mode ports. It's not



SPEC

Weight 63g

Dimensions (mm) $64 \times 125 \times 40$ (W x D x H)

Sensor Logitech Hero, 25,000 DPI,

40g acceleration, 400 IPS

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

Cable 1.8m, un-braided

Stated battery life 70 hours

Extras Dongle stowage on underside

a dealbreaker but being able to use a single cable from your PC to charge your phone and many other devices, as well as occasionally plug in your mouse for a charging top up (and to carry on gaming while it's connected) is definitely a boon. The Superlight's micro-USB connection is starting to feel a little dated.

The unbraided cable isn't overly flexible either, and wouldn't be our first choice for using the mouse in wired mode. Its pushback isn't too bad, but the likes of the Glorious Model O Wireless offer far less resistance.

What hasn't diminished is our love for the overall shape of this mouse. Its symmetrical design, with its quite straight sides, is perfectly suited to fingertip grip for all but the smallest or largest hands, and it does a decent job for palm and claw grip too.

The Glorious Model O's gentler sloping back is better for palm grip if you have medium-tolarge hands, but the G Pro X Superlight's more compact design is better for fingertip grip. On the plus side, the Superlight's tiny 63g weight is astonishingly light for a wireless mouse and does indeed make it effortless to use.

This comes at the price of a lack of features though. The G Pro X Superlight has just the standard five main buttons on top - the hot-swappable right and left side buttons that made the G Pro Wireless ambidextrous have been removed - and a power switch underneath. A similar cover to the one on the G703 does indeed hide the USB dongle stowage hole, but there are no extra buttons, RGB lighting or much else of note.

You also get a dongle adaptor for the cable and some grip tape that you can stick to the

Nolonger

ambidextrous

Stiff, unbraided cable

Very expensive

No RGB lighting

FLOATATION DEVICE

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



surface of the mouse. Although this mouse does just have a very finely textured matt black plastic surface, its excellent shape and low weight meant we didn't feel any need to use the grip tape.

Conclusion

If a mouse shape suits you, it can make up for a lot of other sins, and for us, that's the case with the G Pro X Superlight. Its shape is fantastic and it's very lightweight - it's just so effortless to use, at least in intense gaming sessions - larger, palm-grip mice can be more comfortable for desktop use. Its performance is also excellent in all aspects. However, you get precious little for your money here, with a stripped-back feature set and high price.

VERDICT

A fantastic wireless mouse, but only if you can afford it.

CONCRETE BOOTS DESIGN FEATURES **OVERALL SCORE** 19/**2**0 12/20 PERFORMANCE VALUE 29/30

RAZER DEATHADDER V2PRO / £94 inc VAT

he two mice that flank this one in these pages could hardly be more different. While the G Pro X Superlight and Viper Ultimate have compact, symmetrical and lightweight designs that are laser-focused on high-performance gaming, the DeathAdder V2 Pro is a far more versatile beast, with a focus on a more relaxed palmgrip design.

A stalwart of the gaming mouse world, the DeathAdder has been around in some form for over 15 years, and in all that time its core shape hasn't changed a great deal. It's one of the original ergonomic designs, with a large footprint, raised left side and low-profile back that just cossets your whole hand when you use it in a palm grip. That said, it does have a particularly high left edge – the higher middle section of the Logitech G703 nestles in the palm a little better.

However, despite being primarily focused on that palm-grip style, it does also work for fingertip and claw grip, although the large back end limits the amount of room under



SPEC

Weight 88g

Dimensions (mm) 62x127x43 (WxDxH)

Sensor Razer Focus+ Optical, 20,000 DPI, 50g acceleration, 650 IPS

Buttons 7 (left, right, scroll wheel, back, forward, 2 x DPI)

Cable 1.8m, lightweight braided

Stated battery life Up to 120 hours unlit

Extras RGB lighting, dongle stowage, Bluetooth mode, charging dock compatibility your hand when you use it in a fingertip grip. The rubber-coated sides help greatly with grip, although they're not quite as grippy as the sides of the G703.

Crucially, as compared with some previous iterations of the DeathAdder, the V2 Pro has lost a considerable amount of weight, weighing in at just 88g. That's impressive for a mouse of this size, especially when it has quite a few extra features.

Speaking of which, this mouse is among the most feature-rich on test. Along with a double DPI button arrangement on the top of the mouse, there are all sorts of features on the underside as well.

Here, you'll find a button for switching profiles, a sliding switch for changing between wireless, Bluetooth and wired/off modes, a stowage compartment for the USB transceiver and contact points for nestling the V2 Pro in its optional charging dock. However, the little clip-on cover for the USB storage feels like it will get easily broken and/or lost and the dongle isn't secure without it.

This mouse does also show its age with its inclusion of a micro-USB port, which is also annoyingly nestled in such a deep, narrow hole that only the included cable will fit in it.

In terms of performance, this latest iteration of the DeathAdder is equipped with Razer's latest 20K DPI optical sensor and HyperSpeed wireless tech, and both work flawlessly to maintain accurate tracking and low latency.

Meanwhile, Razer's software provides ample customisation options and does a good job of syncing up all your Razer devices' lighting – the V2 Pro has an illuminated logo on the rear of the mouse. However, the software can be a little obtrusive, popping up with a software install prompt when the mouse is plugged into your PC, and with its regular updates once it's installed.

VENOMOUS CONCEPT

Excellent all-round performance Comfortable, easy-

- grip design

 Impressively light
-

+ Ideal for palm grip

Conclusion

The DeathAdder is an oldie but goodie, with its latest iteration undergoing the performance upgrades and weight reduction required to keep it competitive with the latest gaming mice. Its large shape is reasonably versatile, but particularly great for palm grip, although it's not built for small hands.

POISON IDEA

Quite pricey

Not suited to

smaller hands

Micro-USB not Type-C

The charging dock compatibility is a good addition too, although it feels less needed these days with wired/charging modes on hand to quickly charge and carry on gaming. Along with the micro-USB port, this points to there being further room for modernisation, but this remains a great (if pricey) mouse.

VERDICT

A big, versatile and comfortable gaming mouse, although it could do with some modernising.



RAZER VIPER ULTIMATE / **£85** incvat

SUPPLIER box.co.uk

e've looked at the wired version of the Viper before and been impressed by its compact, easy-grip design and effortless performance, so how does its wireless sibling hold up? Not surprisingly, it doesn't disappoint.

This is Razer's most compact high-end mouse, with a small footprint and low 74g weight. That's not the absolute lightest you can get but it's impressively featherweight for a wireless rodent. Also, unlike some very light mice, Razer hasn't opted to fill the Viper with lots of holes – instead, all the weight saving is



FANG YOU

Type-C

Pricey at MSRP

Micro-USB not

- THANK YOU
- True ambidextrous design
- Very light
- + Fantastic performance
- Excellent shape for many grip styles

SPEC

Weight 74g

Dimensions (mm) $58 \times 127 \times 38 (W \times D \times H)$

Sensor Razer Focus+ Optical, 20,000 DPI, 50g acceleration, 650 IPS

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

Cable 1.8m, lightweight braided

Stated battery life 70 hours unlit

Extras RGB lighting, DPI button on underside, dongle stowage, charging dock compatibility

internalised, reducing the potential for dust and grime working its way into the interior.

One aspect of both the Viper and Viper Ultimate that stands out is that they're not just symmetrical in design but are also truly ambidextrous. There are thumb buttons on both sides of the mouse, so it's an easy recommendation for both left and

right-handed users. The positioning of

these buttons is also well balanced – they're easy to hit with your thumb without getting in the way of your ring and little fingers.

Another great addition is the rubber on the sides. It's not as thick or grippy (despite having a textured pattern), as with the sides on the Logitech G703, but it still makes wielding this mouse effortless whether your hands are dry or sweaty, which can't always be said for plastic finishes. The design is stylish as well, with its generally sleek vibe helped by its symmetrical shape and simple RGB-backlit logo. The white version looks great too.

Joining the four side buttons are just the standard left, right and scroll-wheel buttons, with DPI changes made via a button on the underside. In this location, you'll also find the same slightly clunky clip-on door system for stowing the transceiver as on the DeathAdder, along with the power switch and charging dock connections. You don't get a Bluetooth mode with this mouse, however.

The mouse is available with and without a dock, with the docked version costing a little more. The dock has a slot for plugging in the transceiver, to ensure a close signal, and the cable can be unplugged from the back and plugged into the front of the mouse. The non-docked version just keeps the cable and dongle separate, with no adapter to attach them. The mouse and dock also use micro–USB, rather than the newer USB Type–C connection.

Sporting Razer's latest HyperSpeed wireless and 20K optical sensor, the Viper Ultimate provides superb tracking performance and showed no signs of any wireless latency in our tests.

Pricing of the Ultimate is a bit all over the place at the moment, though, with the docked version available for \pounds 97 inc VAT on **amazon.co.uk** and the dockless version costing just \pounds 85 from **box.co.uk**

However, pricing on Razer's site is far higher, at \pounds 150 and \pounds 130 respectively. At the lower prices, these are fantastic quality mice but at full price, they're a much tougher sell.

Conclusion

The Viper Ultimate is a fantastic versatile, lightweight, ambidextrous wireless gaming mouse with performance that's up there with the best. Its shape is comfortable for a wide variety of hand sizes and grip styles, with its rubber sides greatly aiding grip too. The MSRP puts this mouse right at the top of the stack, making it an expensive and middling value proposition, but it's a bargain at current etailer pricing.

VERDICT

A truly top-end, lightweight ambidextrous wireless gaming mouse, even if it doesn't use USB Type-C.



54

ROCCAT KONE PRO AIR / **£110** incvat

SUPPLIER scan.co.uk

he Kone Pro Air and its wired sibling represent Roccat's attempt to create the ultimate ergonomic mouse, with a design that's full of lopsided curves and sculpted sections. It's a design that's in stark contrast to the company's two other most popular mouse designs, the Burst and Kain, which have symmetrical shapes that feature quite a few straight lines.

While it's curvy, though, we found that the Kone Pro Air didn't offer the kind of relaxed palm-grip comfort of the Razer DeathAdder V2 Pro, Logitech G703 Lightspeed or even the Glorious Model O Wireless.

The overall modest dimensions of this mouse probably didn't help with our testing here, so if you have smaller hands, it probably fills the hand a little better. However, with Roccat not offering any size variants of the Kone, there are better options for those with medium and large hands.



SPEC

Weight 75g

Dimensions (mm) 72 x 126 x 40 (W x D x H) Sensor Roccat Owl-Eye 19K (PAW 3370)

sensor, 19,000 DPI, 50g acceleration, 400 IPS

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

Cable 1.8m, lightweight braided

Stated battery life 100+ hours unlit

Extras RGB lighting, dongle stowage, profile button on underside

The same is true when it comes to other grip styles. The Kone Pro Air is certainly usable for fingertip and claw grip, but other shapes worked better in our testing – the particularly deep scallop in the left edge for your thumb didn't really suit any grip style all that well. As ever, though, mouse shape will always have a degree of personal preference. The very light 75g weight of this mouse certainly helps to smooth out any issues with ergonomics.

It's a similar story when it comes to design, where beauty is in the eye of the beholder. The rather mundane painted-on Roccat logo looks a little staid, but the firefly-like illumination right at the front of the mouse looks a little different from usual – whether you like it or not is largely down to personal taste.

Thankfully, when it comes to features, the Kone Pro Air has much more universal appeal. You get tri-mode support, with a switch on the underside for selecting wireless, Bluetooth or wired/off modes, and in this location, you'll also find a profile button, along with stowage for the USB dongle.

Up front there's a Type-C USB port, although it's deeply recessed, so most cables won't fit in it – you'll need to use the lightweight, braided one that's included. There's no dongle adaptor included, though, so you'll have to plug both the transceiver and cable into your PC directly (or via a USB passthrough on a keyboard) to keep both on hand.

In terms of buttons, you miss out on a topmounted DPI button, leaving just the standard five buttons that you expect these days. The scroll wheel is an intriguing one, as it's milled from aluminium and has a very hard, rough surface. It feels a bit strange at first, but it provides superb grip levels when you're used to it, and its very light build and defined notches means it feels precise and easy to control.

Performance is also rock-solid, with the PixArt 3370-based, Roccat Owl-Eye sensor providing precise tracking at high speed and no unwanted acceleration or smoothing. Likewise,



ROCKET SHIP

 Excellent all-round performance

+ Very light

SOAPBOX CART

- Shape is peculiar
- On the expensive side
- + Bluetooth support

the company's wireless tech performed without noticeable fault, providing lightningquick, lag-free gaming.

Conclusion

The Roccat Kone Pro Air is an accomplished mouse, with a top-end sensor and low-latency wireless tech. The inclusion of Bluetooth makes it versatile too. Add in its very low weight and there's a lot to like. We didn't find its shape particularly comfortable, but gamers with smaller hands may like it. With a £110 asking price, it's among the priciest options, but it just about justifies it with the features on offer.

VERDICT

Not the best shape for medium or large hands, and it's quite expensive, but you get plenty of features and great performance.



STEELSERIES PRIME WIRELESS / £105 incvat

SUPPLIER ebuyer.com

nce at the forefront of gaming mouse design, SteelSeries has been slow to react to the latest trends, with its Rival 600 being overly complex and still including a weights system, while its recent Aerox 3 offers a lightweight design but doesn't quite nail its shape. The Prime, then, is every bit the cut-down, simplified and focused gaming mouse that could put the company back on top.

The simplicity starts with the design, which is reminiscent of the Logitech G Pro X Superlight in terms of offering just the basics. It's just a whole lot of black plastic with an RGB-illuminated scroll wheel and a paintedon SteelSeries logo at the rear of the mouse.

While it looks similar at first glance, the Prime Wireless doesn't share the Superlight's symmetrical design though. Instead, it has the raised left side and lowered right-hand side of other ergonomic mice, and we found it does a good job of providing a relaxed surface for palm grip while still providing enough grip on



SPEC

Weight 80g

Dimensions (mm) 68 x 125 x 42 (W x D x H)

Sensor TrueMove Air, 18,000 DPI, 40g acceleration, 400 IPS

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

Cable 1.8m, lightweight braided

Stated battery life 35/100 hours (lit/unlit)

Extras RGB lighting, profile button on underside

its sides for fingertip and claw grip.

The left side has a pleasingly large flat surface similar to the Superlight, which we found works well for providing ample space and flexibility for different grip styles, as opposed to the more sculpted shapes that only work optimally for certain hand sizes and grip styles.

Meanwhile, the scroll wheel is notably close to the front of the mouse, which makes sense in theory - it puts it closer to your fingertips - but we didn't find it any more convenient than rolling the wheel with the lower portion of our fingers rather than the tip.

You get a simple selection of features, with just the five standard buttons on top and a DPI button on the underside, alongside the power button. There's no transceiver stowage, though, which isn't surprising when you see the size of the transceiver (oddly, it also uses a Type-C plug).

The cable is flexible, lightweight and braided, and it uses a modern Type-C connector at its end. SteelSeries also includes a Type-C to Type-C dongle for connecting the transceiver to the end of the cable.

Underneath the left and right buttons, the Prime uses a relatively new type of switch, with a combined magnetic and optical activation system and a large, robust spring. SteelSeries claims this improves the longevity and responsiveness of the switches and provides a sharp click.

In our tests, they certainly proved quite clicky and responsive, although they didn't feel like they made any meaningful

USB Type-C

transceiver

OPTIMUS

- Cut-back. lightweight design
- Good overall shape
- Solid tracking and wireless performance

improvement to our gaming. Moreover, there have been reports that the mouse can click by itself when hit against the desk, such as when rapidly picking up and moving the mouse when you use a low mouse sensitivity. We didn't find this to be a problem in our testing, but it's worth noting.

As for the sensor and wireless systems, they both held up well in our tests, providing accurate tracking and a snappy response. However, lift-off distance is quite high, which some users can find problematic, and there's no option to adjust this in SteelSeries' software.

Conclusion

The SteelSeries Prime Wireless sees the company return to producing simple, performance-focused mice, and it's a move we're very happy to see. However, some of the feature decisions on this mouse are a bit odd. The USB Type-C transceiver sort of makes sense, except Type-A ones are generally smaller and can be stowed in the mouse. Also, the fancy new switches didn't wow us and the overall price is high. It's not a bad mouse, but you can get better value for money elsewhere. CPC

VERDICT

A step in the right direction but you can get better value elsewhere.



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 (2 x 8GB) 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 (2 x 8GB) 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 multithreaded 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 use CoreTemp to measure the CPU temperature, before subtracting the ambient air temperature from this figure to give us a delta T result, which enables us to test in a lab that isn't temperature controlled. We use Prime95's smallest FFT test with AVX instructions disabled to load the CPU and take the temperature reading after ten minutes.

For the Intel LGA1200 system, we take an average reading across all eight cores in order to compensate for any hot spots that might be misleading. AMD's CPUs only report a single temperature reading, rather than per-core readings, so we list what's reported in CoreTemp.

TEST KIT

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

INTEL LGA1200

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

AMD AM4

Ryzen 75800X overclocked to 4.6GHz with 1.25V vcore, MSI MEG X570 Unify motherboard, or AMD Ryzen 71700 overclocked to 3.9GHz with 1.425V vcore for standalone reviews that require comparisons with older results.

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.

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 Frame View. 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.



CUSTOMPC AWARDS

Some products are gloriously over the top. They

.....

.....

don't always offer amazing value, but they're

Premium Grade products are utterly desirable,

offering a superb balance of performance and

features without an over-the-top price.

outstanding if you have money to spend.

EXTREME ULTRA

PREMIUM GRADE





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.

59



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)	
СРИ	AMD Ryzen 5 3400G	awd-it.co.uk	# 194 p20	£147	
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 x8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2 Z3200C16)	scan.co.uk	# 204 p74	£88	
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	£49	
Total £367					

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

Needs a micro-ATX or ATX case. We recommend a 500W 80 Plus power supply.



and the second				
COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
СРИ	Intel Core i5-11400F	scan.co.uk	# 215 p16	£150
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	# 202 p20	£16
GRAPHICS CARD	Nvidia GeForce RTX 3060	overclockers.co.uk	# 213 p16	£600
MEMORY	16GB (2 x8GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	#204 p74	£88
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	£49

Total £1,073

UPGRADES				
SWAP GRAPHICS CARD	AMD Radeon RX 6700 XT (2,560 x 1,440 gaming)	overclockers.co.uk	# 213 p19	£690
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	# 215 p43	£119
SWAP CPU COOLER	SilverStone Hydrogon D120 ARGB	watercoolinguk.co.uk	# 217 p43	£46

2,560 x 1,440 gaming system

AMD Ryzen 5 5600X

6-core CPU, some 2,560 x 1,440 gaming

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

Mid-range gaming system

8-core CPU, smooth 2,560 x 1,440 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	£380
CPU COOLER	Lian Li Galahad 240mm	overclockers.co.uk	#216 p47	£110
GRAPHICS CARD	Nvidia GeForce RTX 3080	scan.co.uk	#211 p43	£1,070
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	scan.co.uk	#210 p74	£106
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 £2,075

UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£80
SWAP CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	#216 p46	£150
*This motherheard may require a BIOS undate in				

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
СРИ	AMD Ryzen 5 5600X	scan.co.uk	#213 p43	£260
CPU COOLER	SilverStone Hydrogon D120 ARGB	watercoolinguk.co.uk	#217 p43	£46
GRAPHICS CARD	AMD Radeon RX 6700 XT	overclockers.co.uk	#213 p19	£690
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	scan.co.uk	#210 p74	£106
MOTHERBOARD	MSI MPG B550 Gaming Carbon WiFi	cclonline.com	#210 p74	£178
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£119

Total £1,399

UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	# 166 p54	£80
SWAP CPU COOLER	Antec Neptune 240	overclockers.co.uk	# 216 p44	£80
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	scan.co.uk	# 216 p16	£815

4K gaming system

8-core CPU 4K gaming

Core component bundles cont ...

AMD Ryzon 7 5800X

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		
СРИ	AMD Ryzen 7 5800X	scan.co.uk	#213 p44	£380		
CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	#216 p46	£150		
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	scan.co.uk	#216 p18	£1,630		
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	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	box.co.uk	#215 p49	£159		
	Total £2,714					
UPGRADES						
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

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.

AMD Ryzen 9 5900 X

RYZEN

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
СРИ	AMD Ryzen 9 5900X	overclockers.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	overclockers.co.uk	# 213 p19	£690
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 3600MHz (CMW32GX4 M2D3600C18)	scan.co.uk	#210 p74	£169
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	# 193 p48	£389
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£370

Total £2,348

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	scan.co.uk	# 216 p18	£1,630
SWAP CPU	AMD Ryzen 9 5950X (16 cores - more multi- threaded power)	scan.co.uk	#213 p46	£720
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-IT	K



Motherboards					
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)	
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	scan.co.uk	# 214 p18	£276	
Intel Z490 (LGA1200)	Asus ROG Strix Z490-I Gaming	scan.co.uk	# 206 p40	£250	
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	£195



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	£65
SUB-£100	be quiet! Pure Base 500DX	scan.co.uk	# 202 p39	£90
COMPACT	Fractal Design Meshify 2 Compact	cclonline.com	# 215 p20	£91
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	£200

Motherboards				
SUPPLIER	ISSUE	PRICE (inc VAT)		
scan.co.uk	# 204 p74	£83		
)M ebuyer.com	# 204 p42	£130		
SUPPLIER	ISSUE	PRICE (inc VAT)		
scan.co.uk	#180 p46	£46		
scan co uk	#161	£69		
	SUPPLIER scan.co.uk	SUPPLIER ISSUE scan.co.uk #180 p46		

Networking

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	#216 p52	£80
ROUTER	Asus RT-AX68U	scan.co.uk	# 216 p51	£174
MESH ROUTER	Asus AiMesh AX6100	amazon.co.uk	# 196 p54	£331
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	# 196 p58	£60
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	# 200 p22	£151
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	£281

Monitors



p58

F-FREESYNC. G-G-SYNC. W-ULTRAWIDE

Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
241N, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 24G2U	box.co.uk	# 214 p28	£178
251N, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	# 209 p57	£287
251N, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	# 212 p20	£649

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
271N, 144Hz, IPS, 1,920 x 1,080, F, G	AOC 27G2U	overclockers.co.uk	#201 p53	£214
271N, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	scan.co.uk	# 209 p60	£349
271N, 144Hz, IPS, 2,560 x 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	# 201 p54	£519
271N, 240Hz, TN, 2,560 x 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£480
271N, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£700

NAME SUPPLIER ISSUE 31.5IN, 60Hz, VA, iiyama ProLite #205 £370 scan.co.uk 4K, F XB3288UHSU p43 32IN, 165Hz, VA, #214 Dell S3220DGF £399 amazon.co.uk 2,560 X 1,440, F, G p28 34IN, 144Hz, VA, Cooler Master #215 3,440 X 1,440, W, ebuyer.com £549 GM34-CW p30 EG iiyama 34IN, 144Hz, IPS, #206 G-Master cclonline.com £423 3.440 x 1.440. W. F p53 GB3461WQSU 34IN, 144Hz, IPS, LG UltraGear #206 3,440 x 1,440, W, currys.co.uk £934 34GN850 p55 F.G 38IN, 144Hz, IPS LG UltraGear #208 3.840 X 1,600, W, £1,299 currys.co.uk 38GN950 p30 F, G, HDR 35IN, 200Hz, VA, Asus ROG Swift #198 3,440 x 1,440, £2,751 cclonline.com

Non-gaming

W, G, HDR

PG35VQ

Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
271N, 75Hz, IPS, 2,560 X 1,440, F	LG 27QN880	ebuyer.com	# 210 p26	£330

Peripherals and audio

Gamin	<mark>ig keyl</mark>	poards		
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	£90
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	# 164 p26	£180
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	overclockers.co.uk	#208 p60	£190

Gaming mice PRICE SUPPLIER NAME ISSUE Corsair M55 RGB #200 BUDGET GAMING amazon.co.uk £30 Pro p24 Glorious PC FIRST-PERSON #215 Gaming Race £50 box.co.uk SHOOTER p57 Model O Razer Naga #186 ммо amazon.co.uk £70 Trinity p52 #215 AMBIDEXTROUS Razer Viper 8K currvs.co.uk £80 p59 Razer Viper #217 WIRELESS box.co.uk £85 Ultimate p54 Razer PREMIUM #210 Deathadder scan.co.uk £126 WIRELESS p28 V2 Pro ULTRA #211 £48 Roccat Burst Pro scan.co.uk LIGHTWEIGHT p28 PREMIUM Logitech G Pro X #217 LIGHTWEIGHT currys.co.uk £120 Superlight p52 WIRELESS

Peripherals and audio cont ...

Game	control	lers	19.4	
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	# 202 p50	£249
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.16000MFCS 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	£69
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	# 204 p50	£150
PREMIUM WIRELESS	Razer BlackShark V2 Pro	overclockers.co.uk	# 211 p26	£170

Speakers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)	
STEREO	Edifier R1280DB	amazon.co.uk	# 192 p57	£130	

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	СРИ	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
6-CORE GAMING	CyberPower Infinity X115 GT	Intel Core i5-11400	Nvidia GeForce RTX 3060	cyberpowersystem.co.uk	# 217 p32	£1,299
MINI-ITX GAMING	Chillblast Fusion Diablo	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	chillblast.com	# 215 p34	£1,949
4K GAMING	Wired2Fire Ultimate – Powered by MSI	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3080 Ti	wired2fire.co.uk	# 216 p34	£3,294
WATER-COOLED 4K GAMING	Scan 3XS Absorbere	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3080 Ti	scan.co.uk	# 209 p46	£5,289
PREMIUM WATER-COOLED 4K GAMING	Chillblast Fusion Kraken	AMD Ryzen 9 5950X	Nvidia GeForce RTX 3090	chillblast.com	# 217 p94	£6,599
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	# 145 p58	£14,854

Laptops

CATEGORY	NAME	СРИ	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
RTX GAMING	Gigabyte Aorus 15G XC	Intel Core i7-10870H	Nvidia GeForce RTX 3070	15.6in 1,920 x 1,080 IPS 240Hz	overclockers.co.uk	# 213 p30	£1,799
PREMIUM RTX GAMING	Asus ROG Strix Scar G733QSA	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3080	17.3in 1,920 x 1,080 IPS 360Hz	overclockers.co.uk	# 217 p28	£3,499





RICK LANE / INVERSE LOOK

SYSTEM SHOCK

Rick Lane asks what effect the GPU shortage will have on PC gaming

s you probably know, getting hold of a graphics card is currently like trying to grab the proverbial pot of gold at the end of a rainbow. Head to the website of any hardware retailer and almost every card will be either out of stock or ridiculously priced.

There are various causes. Some are short-term, such as the pandemic. Some are long-term, such as the growing popularity in cryptocurrency mining and a general world shortage of semiconductors. We've investigated the causes of this shortage previously (see Issue 213, p88), but what are the potential consequences for PC gaming?

This industry is always trying to push ahead in graphics development, as one of the best ways to sell your game is to ensure it looks nicer than anybody's else's, but what happens when you make a game that few people have the hardware to run?

For PC gaming, the hardware shortage has happened at a bad time. Firstly, there's the advent of ray tracing. It's the biggest new gaming graphics technology in years, and running it necessitates owning the most in-demand cards on the market.

Due to its technical demands, the general implementation of ray tracing in games might have remained limited for years were it not for the launch of the new consoles. The PlayStation 5 and both new Xboxes feature AMD RDNA2 GPUs with ray-tracing support, meaning that many major multiplatform titles will be looking to support ray tracing not as an additional feature, but as a core part of the experience.

The new consoles will also bump up system requirements in general

in general, as developers building multiplatform titles are working towards a markedly higher baseline than they were a year ago. Consequently, players with mid-tier PCs will likely find their rigs struggling to run the biggest new titles, while players with higher-end rigs will find a premium experience (4K, ray tracing enabled) harder to maintain.

The new consoles will also bump up system requirements

Under normal circumstances, the solution would be to upgrade. Currently, though, acquiring a new GPU is either extremely hard or extremely expensive, and it doesn't look like the situation will improve any time soon.

Are we likely to see gaming graphics stagnate over the next year or two? Possibly. But Nvidia's DLSS and AMD's new FidelityFX Super Resolution (see p84) could also help. Their methods of upscaling games to higher resolutions with minimal effect on image

quality can help in both ray-traced and rasterised graphics. DLSS and FSR could be major factors when ensuring that contemporary graphics cards can keep up with increasing system requirements.

Of course, DLSS requires a 20 or 30-series Nvidia GPU, which isn't a lot of help if you still have a Pascal GPU, but FSR is already supported on the new Xboxes, and on old and new GPUs from both Nvidia and AMD, going back to GeForce 10-series and Radeon RX 400-series GPUs.

If enough game developers get on board (and that's a big 'if'), it could help to mitigate some of the problems with the hardware shortage. **GPD**



Subnautica: Below Zero / £24.99 incvat

DEVELOPER Unknown Worlds Entertainment / PUBLISHER Unknown Worlds Entertainment

ubnautica: Below Zero is a superb follow-up to the best survival game ever made. Returning you to the aquatic planet 4546B, it sees you exploring the world's Arctic region, gathering resources, building bases and delving into dazzling underwater environments rich with colourful and bizarre wildlife.

You play as Robin Ayou, who has ventured to 4546B on a personal mission to discover the fate of her sister Sam, allegedly killed in an accident while on a research expedition to the planet. Sam's own messages to Robin suggest there's more to this story, however.

It's a more fleshed-out story than that of Subnautica, with a fully voiced protagonist and side characters who appear properly in the game. Unfortunately, it doesn't have the same payoff as Subnautica, with plot threads that fizzle out, and a tendency to explain facts to you rather than letting you discover them yourself.

Otherwise, however, Below Zero is Subnautica's equal. Its biggest success is its new biomes, which range from towering lily-pad forests to purple crystalline caverns. Below Zero also adds proper land exploration, with



several terrestrial biomes that include glittering icebergs, glacial bays and the formidable Arctic Spires, a tundra-like landscape peppered with giant spikes of icy rock.

This frigid world is populated by an almost entirely new array of wildlife, ranging from cute penguin-like creatures to terrifying Leviathan-class sea monsters. Specific highlights include the Titan Hole-Fish, whose doughnut-shaped body traps bubbles of air that can prove a lifeline while exploring underwater. The Sea Monkey, meanwhile, is a cheeky aquatic mammal that will try to steal your equipment one moment, and help you find resources the next.

Mechanically, Below Zero is similar to Subnautica, with a mixture of exploration, resource gathering, base-building and a tiny bit of terrified running from aquatic monstrosities looming from the darkness.

That said, it adds a few new tools to help you explore, such as a mineral detector for finding resources, as well as a 'quantum-locker' that lets you deposit resources in one such locker, then instantly access them from another, regardless of its location.

The biggest change to play, however, can be found in the vehicles. Below Zero introduces two new modes of transport – a terrestrial hoverbike called the Snowfox, and a Submarine called the Seatruck. The latter is particularly interesting, being a small submersible that can have individual modules attached to it for crafting, resting or storage purposes. This makes it extremely versatile, although it isn't quite as cool as Subnautica's Cyclops.

Minor quibbles aside, Subnautica: Below Zero is a fine follow-up to the first game – it's a strange and enchanting adventure that hides surprises around every coral outcrop.

BELOW ZERO

- Wonderful new biomes and animals
- Greatnew vehicles
- A generally great adventure

BELOW THE BELT

 Story isn't quite as good as Subnautica

/ VERDICT

Below Zero's Arctic adventure is only slightly less brilliant than that of Subnautica.



Days Gone / £39.99 inc VAT

DEVELOPER Bend Studio / **PUBLISHER** Sony

ays Gone is the latest Sony exclusive to make the transition to PC, after Death Stranding and Horizon: Zero Dawn. Like those games, it's a bigbudget open-world experience with a strong emphasis on storytelling and characterisation. Unlike those games, Days Gone doesn't have an original bone in its body, while suffering from several baffling creative decisions.

You play as Deacon St John, a biker and former gang member who is surviving a zombie apocalypse in rural Oregon with his friend Boozer (yes, that really is his name). Deacon is still grieving for his wife, whom he believes died two years ago, after the rescue helicopter that airlifted her crashed. But when the research organisation for which Deacon's wife worked begins sniffing around the area, he discovers that all may not be as it seems.

This is a very loose sketch of a very loose plot, which meanders around for a good 20 hours before it starts sauntering toward the point. Deacon spends much of this time running odd jobs for various survivor enclaves, with more significant events sporadically interspersed between them. This is intentional – Days Gone is supposed to be a slow-burn mood piece. However, there's a difference between 'slow' and 'boring', and Days Gone definitely falls into the latter. The main problem is that Deacon isn't particularly likeable. Bend Studio wants to present him as flawed but well-meaning, but he comes across as a petulant misanthrope, constantly grumbling under his breath, always escalating arguments or tense situations, and responding to bad news like a teenager who has just been told they can't go out for the evening.

In one example, when a female doctor has to amputate the gangrenous arm of one of Deacon's friends, he acts as if she chopped off his limb for no good reason, rather than saving his life. This is the man with whom you're going to spend the next 40 hours travelling across zombified Oregon.

On that subject, Days Gone employs a depressingly standard example of an open-world template, featuring exactly what you'd expect and nothing else. There are main quests, side quests, bandit camps to clear, an upgrade system, a crafting system, a stealth system, and a blend of ranged and melee combat. It all works well enough -2 combat feels weighty and stealth is slick enough to be functional. However, there's little in the core template that sparks the imagination.

Days Gone bets all its chips on two features. The first is your bike. Wherever you go in Days Gone, you'll probably

DAYS GONE

- Looks pretty
- + Bike is fun
- Freakers hordes an impressive spectacle

TIME WASTED

- Deeply unoriginal
 Unlikeable protagonist
- Wastes its most interesting feature



get there on your grunting, Harley–Davidson–like American chopper. While primarily your mode of transport, the bike also acts as a lynchpin in the game's survival systems. Rather than needing to seek out food or water, you must frequently stop off at abandoned towns or survivor enclaves to find fuel and scrap to repair your bike.

An extremely loud bike that requires regular refuelling might not make much logical sense in a zombie apocalypse, but it's hard to deny that it's a fun way to scoot about the world. It helps that the game world also makes scooting about in it fun. Bend's representation of rural Oregon is impressively luscious, featuring the best forests this side of Red Dead Redemption 2. Beyond the central woodland are open plains, distant mountains and swampy marshlands, all interspersed with believably laid-out dilapidated settlements. It's not particularly interesting, but it's pretty.

Days Gone's other gambit is its zombies, or Freakers as they're known for some bizarre reason. On their own, Freakers are pretty much identical to any 28 Days Laterstyle zombie. They're fast and vicious, but you can easily deal with them when they're isolated, and even when they're in small groups.

Freakers become more interesting when they cluster together in hordes. These massive, broiling tidal waves of bodies are Days Gone's most original and most visually impressive feature. Getting caught by a horde will kill you quickly, so taking them down requires tactics and planning.

At least, that's the idea. In practice, fighting a horde mostly involves running around in circles, occasionally spinning around to take a few pot shots at the Freakers, or blasting some nearby explosives. It's a war of attrition that quickly becomes tedious. Part of the problem is that all that biking has left Deacon with the constitution of an asthmatic snail. He can barely run for 30 seconds without slowing to an exhausted stagger.





It soon becomes clear that Bend doesn't know how to capitalise upon Days Gone's star feature. Rather than wandering around the game world, Freaker hordes are mostly limited to set locations, used as events. It's a shame, because their potential for surprise horror and dynamic play is enormous. One way you can get a horde off your tail is to lead the Freakers to a nearby bandit camp. The bandits will be alerted and begin to shoot at the Freakers, which both takes the Freakers off your tail, and deals with the bandits in the process.

Days Gone needs more of this greater interaction between the Freakers and other AI agents, such as the game's various factions and animals like wolves. Instead, the game world feels static and shallow. This even applies to the world-building. The various towns and settlements you explore look great, but there's no sense that humans ever lived there, no environmental storytelling or notes that you can read to provide an insight into the world before the apocalypse.

Days Gone isn't terrible – even at its worst, it's a pretty and serviceable open-world experience, but it rarely rises above that definition. It's almost completely devoid of innovation, both in its zombie apocalypse theme and its broader mechanics, and its one decent idea is wasted as a side attraction rather than being placed front and centre as the game's main event. **RICK LANE**

/VERDICT

Days Gone has its heart in the right place, but its brains have been eaten by one of its Freakers.



Hood: Outlaws and Legends / £26.99 incvat

DEVELOPER Sumo Digital / PUBLISHER Focus Home Interactive

n Hood: Outlaws and Legends, Robin Hood is the victim of his own success. His exploits robbing the rich and giving to the poor has resulted in a bunch of copycat hoods trying to carve out their own slice of the Sheriff of Nottingham's pie, and they'll happily slice the throats of Robin and his not-so-Merry men to get it. This is the premise of Sumo Digital's asymmetrical multiplayer game.

Here's how the game works. Two gangs of thieves vie for a chest locked in a vault hidden somewhere in a large and elaborate multiplayer map. To acquire the chest, players must first steal a key off the belt of the Sheriff, who stomps around the map like a Terminator clad in plate armour.

Players must then locate the vault, open it and retrieve the chest. They must then carry it to a winch at one end of the map, before defending that location long enough to keep the chest away from the sheriff and his guards.

As a team-based stealth game, Hood is well designed. Players can assume the roles of one of four characters, each of whom specialises in a different area of larceny. Robin is an



archer, best used supporting other characters from afar with his bow. Marianne is your primary stealth character, skilled in the art of evasion and silent kills. Friar Tooke acts as the party's main healer, while John is the brawler of the group, able to deal the most damage and withstand the most punishment.

Unpicking Hood's shifting environmental puzzles with these four characters is usually fun. Overseeing a carefully planned heist as Robin, rescuing an embattled comrade as John – everything about the core game clicks together well. It also looks stunning, and its dark and exaggerated Gothic maps of crumbling fortresses and towering citadels are fantastic to explore.

Hood's problems arise when the competitive multiplayer element takes effect. Your rival doppelgangers are after the same objective as you, and they'll do anything to get it. The intent is clearly to make the game more dynamic, and it works to an extent, adding back-and-forth action to a game that otherwise wouldn't have it, while enabling some devious strategies, such as deliberately leading the sheriff

toward your rival players.

Unfortunately, it also means stealth usually falls out the window towards the end of a match, with contests often devolving into bloody slugfests. That's a problem, because Hood's combat is the game's weakest element, being a rather clumsy and tedious exercise in swinging wildly at your foe until one of you falls over.

Slicker combat would help here, but Hood would work better as a straight coop stealth game with bigger, more elaborate missions that encourage teamwork.

RICK LANE

OUTLAW

- + Clever concept
- Good stealth play
 Great-looking maps

OUTCAST

- Competitive element doesn't click
- Rough combat

/ VERDICT

Hood: Outlaws and Legends is a slick operator, but its competitive multiplayer element is flawed.



Solasta: Crown of the Magister / **£29.99** Incvat

DEVELOPER Tactical Adventures / PUBLISHER Tactical Adventures

olasta: Crown of the Magister is an RPG throwback, but not in the usual way. Whereas games such as Pillars of Eternity and Torment: Tides of Numenera aim to recreate the art or writing style of games such as Baldur's Gate or Planescape, Solasta instead dedicates itself to bringing back classic D&D style combat.

It's based on the fifth edition of Dungeon and Dragons, the most streamlined version. THACO is a distant memory, but armour classes and spell-preparation are still a part of combat. This edition also adds some new combat rules, such as advantage and disadvantage rolls, where fighting in the dark, for example, requires players to roll two d2Os and take the lower number as their result.

If this sounds complicated, don't worry, Solasta is both an efficient teacher and a generally streamlined package. Its combat scenarios are structured like X-COM, with characters taking turns to move, attack and perform special abilities such as spells.

Hits and misses are based on dice rolls, but you can increase your chances of hitting by taking advantage of positioning and enemy weaknesses. The first ten hours







of Solasta's campaign is also designed as a gradual tutorial, instructing you on all you need to know about how D&D works and how Solasta represents those rules.

Solasta bakes all this into a 40-hour campaign, the scope and flexibility of which makes up for its lack of refinement. You create your own party from scratch, right down to individual personality traits that affect how characters respond in dialogue and the choices they're likely to make.

Meanwhile, the story involves tracking down several magical jewels that form part of the Crown of the Magister, an ancient and powerful artefact that can open rifts in the fabric of reality. The story mainly serves as an excuse to string together a series of massive, elaborate dungeons.

One example, Dark Castle, is a vast, crumbling fortress that plays home to a Necromancer who has fallen under the influence of a powerful vampire. You can approach Dark Castle in several ways, attacking the skeletal guards on the main guard, or sneaking through the crypt and trying to bluff your way past the Necromancer's weary Apprentice.

On the downside, however, Solasta's voice acting is like listening to an amateur dramatics group read through a play for the first time, and its fantasy story is also unoriginal.

None of this prevents Solasta from being fun though. Its world is fun to explore, the dungeons are well designed, and the combat has a clever blend of tactical manoeuvring and randomised surprises. If you're stuck for an RPG to play, you could do worse than Tactical Adventures' fantasy debut.

CROWN OF THE MAGISTER

- Authentic D&D representation
- + Great turn-based combat
- Grand, complex dungeons

CLOWN OF THE MAGISTER

- Rote story
- Mediocre writing
- Terrible voice acting

/ VERDICT

Some great dungeons and satisfying combat, but Solasta's story isn't much to write home about.



REALTY CHECK

In his latest VR roundup, **Rick Lane** plays Puzzle Bobble from a firstperson perspective and awaits in-game VR ads with trepidation

NEWS AMID EVIL VR

Indefatigable's excellent shooter AMID EVIL is getting a VR version, although it's being handled by a third-party developer known as Immersive. Details on what the VR version will





contain are still fairly light, but it will include fully implemented VR controls, letting you swing your weapons around as you would in real life. Well, if swinging weapons around in real life was a regular occurrence, but fortunately we don't live in such times any longer.

Released in 2019, AMID EVIL is one of my favourite shooters to come out in recent years. It has a fascinating blend of retro-styled graphics rendering and level design, but with modern visual effects laid on top. It sees players exploring seven otherworldly realms and battling hordes of chunky polygonal enemies with magical melee weapons, including a trident that shoots electricity and a crystal Morningstar that pins enemies to walls.

Whether the VR version is a separate release or a free update is uncertain, although given publisher New Blood Interactive's community-centric nature, there's a chance it will be the latter. Either way, the opportunity to experience one of the best and most unusual shooters in recent memory in VR is an extremely tantalising prospect.

OPINION FACEBOOK VR ADS

In a depressingly predictable move, Facebook is beginning to place targeted ads inside certain VR games. In an Oculus Blogspot, the company said the move is currently 'a test with a few apps'. Depending on the outcome, Facebook will 'provide more details on when ads may become more broadly available across the Oculus Platform and in the Oculus Mobile app'.

Facebook claims these targeted ads will be driven by web usage rather than locally stored Quest data, such as images from the Quest's cameras or physical characteristics such as height and weight. Images released by Facebook show examples such as advertising billboards being embedded into game worlds. The announcement has already sparked controversy. One of the games intended to be part of the test, the 1v1VR shooter Blaston (a paid game priced at £4.99) has ducked out after a backlash from its community.

'After listening to player feedback, we realise that Blaston isn't the best fit for this type of advertising test,' developer Resolution Studio said. However, it's not withdrawing from placed ads in games entirely, saying that 'as an alternative, we are looking to see if it is feasible to move this small, temporary test to our free game, Bait! sometime in the future'.

Placed ads in games has always been a subject of contention among gamers, but the

issue here isn't so much the ads themselves as the company behind them.

Facebook has previously been less than candid about what it does with all the data it harvests from its users, so count me as sceptical about the limits of its VR data collection in VR games.




REVIEW PUZZLE BOBBLE VR: VACATION ODYSSEY / £14.99 incvat

DEVELOPER Survios / PUBLISHER Survios, Taito Corporation

Puzzle Bobble VR slickly executes a fundamentally flawed concept. It successfully transposes the light-hearted puzzling of Puzzle Bobble into a VR space. However, it doesn't improve the experience in any meaningful way, and it's much easier and more convenient to just fire up a non-VR equivalent of Puzzle Bobble's instead.

For those unfamiliar with Puzzle Bobble, it's a simple colour-matching game that has become the staple of many mobile games. To play, you need to shoot coloured 'bobbles' into matching groups of other coloured bobbles to burst them. Keep going until all the bobbles are burst, and you win.

In the transition to VR, a couple of twists are added to the formula. For starters, you play from a first-person perspective, firing your bobbles from a 'bobble cannon' that functions like a slingshot. You have to load individual bobbles, pull back the elastic and then release it to fire.



In addition, the bobbles are clustered together to form 3D shapes that spin on an axis when struck by your bobbles. This means that every shot alters the visible plane of the puzzle. Learning to turn these spinning bobble clusters to your advantage, and avoid snookering yourself with a badly aimed shot, is one of the key elements of the game's puzzling element.

There are 100 levels, amounting to roughly six hours of play. These levels also gradually evolve the puzzling as they progress, introducing new challenges such as bobbles that shift and rotate, and new items such as exploding bombs. It's relatively enjoyable and pleasantly presented, with the colourful vacation theme probably being the closest we'll get to having a holiday abroad for the rest of this year.

The problem with Puzzle Bobble VR is that the game simply isn't a great fit for virtual reality. Puzzle Bobble is a simple, compulsive puzzler designed to be easy to pick up, play and put down. Puzzle Bobble VR unnecessarily complicates it. Because of the highly analogue nature of VR controls, the first-person bobble-launching system is far less reliable than the simpler, traditional controls of the series.

More broadly, the experience simply isn't rewarding enough to merit the faff of

setting up and playing in VR. If you're going to stand around with a sweaty box strapped to your face, it needs to be for an experience you can't get anywhere else, such as Half-Life: Alyx or The Walking Dead: Saints and Sinners. Putting a casual game into a fundamentally non-casual gaming medium doesn't work.

There is one circumstance where Puzzle Bobble VR might be an ideal Virtual Reality experience, and that's for first-time VR users. It sets up a gentle, comfortable VR space, with a game that's simple and familiar enough for players to be able to grasp the core concepts without worrying about the challenge of the game itself.

Ultimately, Puzzle Bobble VR: Vacation Odyssey is a pleasant and innocuous little game, but not one that has much to offer experienced VR players. **and**

BOBBLE

kes for a decent

gateway to into VR gaming, but

not much else.

+ Colourful + Gentle

+ Pleasant

VERDICT

 Flawed at a conceptual level

BOBBINS

overall score

311

Show us using: #ThanksCustomPC



FI

GEFORCE R

EVGA

WANT TO BUILD A NEW GAMING PC WITHOUT TRAWLING EBAY FOR OVERPRICED PARTS? WE'VE GOT AN EXCLUSIVE BUNDLE DEAL WITH SCAN FOR A **£1,099** PC, AND ANTONY LEATHER WILL SHOW YOU HOW TO BUILD IT

hether it's down to the pandemic, cryptocurrency mining, silicon shortages, shipping costs from China, lorry driver shortages or all of the above, the cost of PC components has rocketed up like competitive billionaires trying to beat each other into space over the past year.

Can you imagine being able to buy an RTX 3080 for £649 or an RTX 3060 for £300? Currently, you're looking at more than double those prices or more, which has made the prospect of building a new gaming PC highly depressing for lots of us. It's been a while since we've done a build guide in **Custom PC** and for good reason – we simply wouldn't have recommended buying a lot of components over the past year because you would have to pay vastly over the odds for them.

Pricing might finally be showing some early signs of dropping, but we're still a long way from normality, so we've teamed up with the brilliant folks at Scan (**scan.co.uk**) to offer our readers an exclusive scalper-busting bundle deal. For just £1,099.99 inc VAT, you'll be able to build yourself a liquid-cooled RTX 3060 system with an AMD Ryzen 5 5600X at the helm, along with a 1TB NVMe SSD and 16GB of memory.

SCANG

fractal.

Scan has kindly set aside 100 of these bundles just for **Custom PC** readers, which you can grab from **custompc.co.uk/bundle**. This was only made possible by bulk-buying specific components, which were chosen by us from parts that were readily available in large quantities, in order to guarantee stock. As such, there's no flexibility on these hardware choices, but this does give you a chance to build a decent gaming PC for a normal price.

OUR CHOSEN HARDWARE

Your first step is to grab all the hardware from **custompc.co.uk/bundle**. You'll need to keep to the exact specification here, but you can add other components into the mix, which we've mentioned below. These might be useful if you want to add fans or RGB lighting to build upon on the PC further.



Case Fractal Design Meshify C TG

As sub-£100 cases go, Fractal Design's Meshify C is hard to beat, and it's also available in decent quantities at the moment.

The case comes with two 120mm fans as standard, which are organised sensibly as an intake and exhaust, and you also get a decent amount of air pulled into the chassis, thanks to the perforated front panel.

There's plenty of space for an all-in-one liquid cooler, plus you get decent cable-routing options and you even get a tempered glass side panel, giving you a view of your handiwork inside. It's a case we'd happily use for a highend system, let alone a mid-range one, and it's great to have it in this bundle.



PSU **550W Corsair CV Series CV550**

Mid-range PC hardware is pretty powerefficient these days, and our system draws under 300W from the mains when playing games. This means our chosen Corsair 550W power supply has plenty of headroom, so its fan doesn't have to spin up to high speeds when it's powering this PC's components, and it will also operate more efficiently than if it was pushed to full load.

We've chosen a PSU with captive cables to save some money here, but there's plenty of room for cable routing in our chosen case and this unit also has 80 Plus Bronze certification for efficiency, meaning it has an 85 per cent efficiency rating at 50 per cent load.



CPU AMD Ryzen 5 5600X

When it comes to CPU prices, AMD hasn't had an easy time with many of its models. The Ryzen 95900X and 5950X were near-impossible to buy at retail for much of the past year and the 6-core Ryzen 55600X has spent a lot of time with a price well north of £300, meaning it was out of reach for many looking to build an affordable gaming system.

Thankfully, as part of the bundle this month, you can pick up AMD's fastest-ever 6-core CPU, which is seriously powerful in a system at this price. It's much faster than Intel's Core i5-11600K in multi-threaded tests, and a match or faster in games too – plus it's also far more power-efficient.



Motherboard Asus TUF Gaming B450M-Plus II

While the latest chipsets offer PCI-E 4 support, the benefits of spending more for this new standard are very limited. You'll see next to no boost in graphics performance, and while PCI-E 4 M.2 SSDs offer higher sequential speeds than their PCI-E 3 counterparts, you'll see few benefits in real-world use unless you're regularly shifting around massive files around regularly.

This means that, unless you have specific reasons for opting for a newer chipset motherboard, a B450-chipset model will do all you need while saving you a load of money. In fact, the Asus TUF Gaming B450M-Plus II costs under £85 inc VAT at retail, yet it supports the latest Zen 3 Ryzen 5000-series processors and has all the essentials.

There's an M.2 port for NVMe SSDs and a generous count of six SATA 6Gbps ports too. Out of the box, most B450chipset motherboards will support Ryzen 5000-series CPUs now, and that was the case with the sample we used here. In rare cases, the BIOS is slightly too old, but this board also includes a USB FlashBack button, so you can update the BIOS easily without a compatible CPU. We'll show you how to do that later on.

FEATURE / CUSTOMISATION



CPU cooler Corsair Hydro Series H100X

All-in-one liquid coolers with closed loops offer an efficient way of getting the heat from your CPU out of the case, and they usually make less noise and shift more heat than a mid-range air cooler too. They also look great through a glass side panel. They can be a tad pricey, but you can still bag a powerful 240mm liquid cooler for less than £100.

The Corsair H100X is a fine example. It sports similar hardware to the company's other coolers, but there's no lighting and it's all controlled using your motherboard, rather than a USB interface and Corsair software. The benefit is that the cooler is cheaper and easier to setup than pricier models, but it still boasts two powerful 120mm fans and a 240mm radiator with loads of cooling headroom.



Memory 16GB (2 x 8GB) Corsair 3200MHz DDR4 Vengeance LPX

Memory prices fluctuate quite a bit, but the basic specification you need hasn't changed for quite a while. A capacity of 16GB is still what we'd recommend for most home PCs, particularly for gaming, as today's games won't require anywhere near 32GB of RAM.

It's worth getting a fast frequency, though, especially when it comes to AMD systems, as the memory speed is linked to AMD's Infinity Fabric interconnect, so memory frequency has a much bigger impact on performance here than in an Intel system. Our exclusive bundle is equipped with 16GB of 3200MHz Corsair Vengeance LPX memory, and we'll show you how to coax it to higher frequencies to boost performance for free.



Graphics card EVGA Nvidia GeForce RTX 3060 XC Gaming

The price of graphics cards has been the bane of our lives over the last year or so. AMD and Nvidia looked set to have a good old battle and there were great choices at numerous prices points.

However, for various reasons we've already mentioned, the supply of graphics cards have been far from normal, and the hugely inflated prices have put us off recommending a purchase.

This month, though, we're finally able to build an awesome 1080p-focused gaming PC without paying silly money and with an RTX 3060 at the helm – a GPU that has retailed for upwards of £700 on occasions. Based on Nvidia's potent Ampere architecture, the RTX 3060 has 3,584 CUDA cores, as well as 28 RT cores for ray tracing and a 12GB stack of GDDR6 memory.

The GeForce RTX 3060 has proved itself to be a decent gaming GPU at 1,920 x 1,080 in our tests, and the EVGA card we're using ups the GPU boost clock from 1777MHz to 1882MHz. Needless to say, our fantastic bundle means you're not paying silly money for this card either.



Storage 1TB WD Blue SN550

Don't let anyone tell you that a 250GB SSD is enough for a gaming PC, as you'll forever be deleting games to save space. With the latest games topping hundreds of gigabytes in some cases, even a 500GB SSD will be swallowed up quickly, meaning that any cost savings over a 1TB model could turn out to be a false economy.

For this reason, our bundle is equipped with a 1TB SSD, but we haven't skimped on performance. It's a WD's Blue SN550, which can read your data at up to 2,400MB/sec while writing at 2,000MB/sec. It also doesn't get nearly as hot at other SSDs we've tested, and is generally happy to run without a heatsink under sustained heavy loads. Its 1TB capacity means you have plenty of space for Windows and a very healthy game library.



Additional hardware

A great addition to the build, if you can afford it, is an extra 120mm fan. This means you can exhaust more air out the rear of the case and easily add some RGB lighting too.

We've opted for a Corsair ML120 LED fan to sit in the rear mount of our case, which will set you back an extra £17 on top of our bundle build price. This isn't essential, but adding an extra fan can only serve to boost airflow. Our motherboard doesn't have enough fan headers to power the case fans and radiator fans in addition to an extra fan, so we've also grabbed a two-way splitter so we can power both front fans from a single header, leaving one free for the optional rear fan should you wish to buy one.

BUILDING THE PC

Install the CPU

The pins are very delicate on the bottom of AMD CPUs, so be extremely careful when unboxing it and moving it over to the motherboard. To install it, lift up the latch on the CPU socket and align the small gold triangle in the green coating on the top of the CPU with the small triangle on the CPU socket.

This can be tricky to see, as both are small, so another way to align the CPU correctly is to ensure the model name sits vertically and next to the socket hinge as shown here 1. This will work for Ryzen 5000-series CPUs. Once the CPU is firmly sat in the socket, push down the latch to lock it into place.

Install the memory

Normally we'd install the CPU cooler next, but since the pump section of our liquid cooler is so easy to install, we've decided to install it once the motherboard is installed into the case instead. This means we'll be installing other components first, starting with the memory modules.

It's impossible to install them the wrong way around, as they have a notch that lines up with a pin in the memory socket, preventing any mistakes. You can check the correct way by offering the memory modules up to the socket a first before opening the socket latches and clicking both modules into place in the second and fourth slots – push the modules down and the latches will flip up to grip them in place. To ensure that dual-channel mode is enabled for best performance, install the memory in the second and fourth slots furthest away from the CPU socket a.

Install the M.2 SSD

The M.2 slot is located next to the small heatsink at the bottom of the motherboard. To install your M.2 SSD, grab the mounting nut and screw from the motherboard box. The nut needs to go into the third socket away from the M.2 port, towards the left side of the motherboard **1**. This supports the SSD.

To install the M.2 SSD, line up the notch in the SSD's gold connector with the notch in the M.2 $\,$











socket. Thankfully, this is another component that's impossible to fit the wrong way around and here, a quick reference point is to have the model label facing upwards. Insert the SSD in the socket raised at a shallow angle, and push it down, so it's firmly in place in the socket

You can now use the included screw to secure the SSD by pressing it flat against the supporting nut **6**. A magnetic screwdriver is extremely useful here, as the screw is tiny and very easy to lose. If the screw doesn't line up with the socket, try pushing the SSD into the slot a little firmer so you can see the socket for the screw.

Install the I/O shield

The motherboard has a separate I/O shield that needs to be installed in your case before securing the motherboard. Check the orientation by looking at the rear of the motherboard and notice the three audio ports on the left.

You'll want the I/O shield to line up the same way, with the black side facing out of the back of the case . It can be a tricky fit, but you'll need to slot it all the way into the hole at the back of the case, so the motherboard can slot in place behind it.

Install the motherboard

The motherboard has various screw mounting points that line up with standoffs, which you'll need to install on the motherboard tray to prevent the solder points on the PCB from shorting out on the metal in your case. Install the standoffs in the holes in your case that correspond with the mounting holes on your



FEATURE / CUSTOMISATION

motherboard, using the small socket tool provided with your case 8.

Your case includes screws that are indicated in its manual, so dig them out and then sit the motherboard in the case, being careful not to scrape the bottom on the standoffs. Check that the rear I/O ports slot into the I/O shield you just installed, and the motherboard will then line up with the standoffs in its mounting holes on the motherboard tray

Before you screw the motherboard into the case, though, you'll want to perform a couple of additional tasks that are easier to do before the motherboard is secured in place. Firstly, locate the front panel connectors for your case. These include the tiny power and reset button cables, USB headers and so on. Thread these cables through any holes near the motherboard and connect them to the corresponding connectors on your motherboard (these are detailed in the manual)¹⁰.

The front panel header on the motherboard is next to the row of four SATA 6Gbps ports and the pins you need to hook up are labelled. However, you may find it easier to refer to the larger diagram in the motherboard's manual. The headers for the case's USB 3 and audio connectors are to the left of this cluster on the bottom of the motherboard.

Fit the PSU and motherboard

Next, unpack your PSU. Before securing your motherboard you need to deal with one last cable – the 8-pin CPU power connector. This is labelled, so make sure you get the right one, as there are similar-looking connectors for your graphics card too. Thankfully, you can't plug the

Quick Windows installation

To easily install Windows 10 from a thumb drive, head to **custompc.co.uk/W10** and find the 'Create Windows 10 installation media' section. Here you can create an installer for Windows 10 using a USB flash drive that will install super-quickly, allowing you to input your key code from your licence and crack on with installing your games.

To boot from the thumb drive, insert your thumb drive into a USB port, switch on your PC and enter the EFI by pressing Del. Then go to the Boot section and select your thumb drive as the first boot device.

⁶A MAGNETIC SCREWDRIVER CAN BE VERY USEFUL HERE["]







wrong connectors into the wrong hardware, but checking first will save time.

This plug can be a real pain to connect when the motherboard is installed, so it's always best to hook it up beforehand. Thread the cable from the PSU, around the back of the motherboard tray and then through the cable-routing hole at the top **11**.

Next, locate the 8-pin connector on the motherboard. It's positioned to the left above the CPU socket and heatsink. Pull the cable through the hole so you have some slack then, with the plug the right way around, insert it into the connector 12.

You can now go ahead and install the motherboard using the screws included with your case 1. Again, a magnetic screwdriver can be very useful here to prevent the screws from falling into the depths of your case. It's important to make use of all of the









motherboard's mounting holes, as you don't want it moving around, which can happen if you move your case and the motherboard isn't secured property.

Install the CPU cooler

The thermal paste is pre-applied on this CPU cooler, so there's no need to mess around with tubes of it. However, this does mean you need to be especially careful with the pre-applied paste, as accidentally knocking the base of the cooler's waterblock/pump unit can remove the paste and potentially impact on cooling.

Leave the protective cap on the base until you're ready to install it **14**, but first let's install the radiator. The best orientation is in the roof of the case, with the tube end of the radiator at the front, and the fans on the inside blowing air through the radiator and out of the case at the top.

The cooler is equipped with various screws, and you'll need both the long ones and short ones here. Start by securing the fans to the radiator using the long screws, with the fan cables lined up on the edge facing the motherboard. That way, you won't have fan cables staring at you through the side panel, which will look neater. Position the fans with their top sides facing away from the radiator and the rear sides with the plastic support arms facing towards the radiator, which is their exhaust side

Now place the radiator into the roof with the tubing end at the front of the case 10, and use the short screws to secure it from the outside of the roof. You only need to use four screws here – one in each corner. Leave them slightly loose for now, as you may need to adjust the radiator's position in the top fan mounts when you're mounting the pump section, or to take up some slack.

Meanwhile, the waterblock/pump section makes use of the standard AMD motherboard mounting brackets, so unlike some other coolers, there's no need to remove them here.











Install the AMD mounting bracket and pins to the pump section and then remove the protective cap on the bottom of the pump to reveal the thermal paste. Again, be careful not to touch the paste on the bottom of the contact plate with anything, as it will rub off and potentially cause your CPU to overheat.

Lower the pump into the CPU socket and you'll feel it sit flat on the CPU. Now manoeuvre the mounting clips onto the bracket pins and tighten the thumbscrews a few turns each to hold the pump in place. After that, apply five turns to each screw in turn to ensure an even mount, then continue tightening the thumbscrews until they won't turn any more ¹¹⁰.

Connect cooler cables

There's a bunch of cables you now need to connect to power the pump and fans. The fans need to be connected to the motherboard's CPU fan connector, and you'll find a splitter cable in the cooler's accessories, which you can use to connect both fans to this single connector

The CPU fan connector is located to the top left of the memory modules. It has a little flange on one side to ensure you connect the fan cable the right way around 20. Once you've done this, tuck the excess cable length through one of the nearby routing holes.

The pump also has two cables of its own. The SATA connector provides its power, while the smaller 3-pin connector can be connected to your motherboard to read the pump speed. The latter is of limited use, and our motherboard also doesn't have enough fan headers to connect it anyway, so just tuck this cable out of sight. The SATA power cable needs to be threaded through to the back to meet up with a corresponding SATA power connector on your power supply 21.



FEATURE / CUSTOMISATION







Install the graphics card

The last component we need to install is the graphics card. You'll need to remove two expansion slot brackets from the rear of the case to allow the graphics card's own rear bracket to sit in their place 22.

Once you've done that, remove all packaging and socket plugs on the graphics card and install it in the top 16x PCI-E slot on the motherboard . It should click into place and rest neatly on the mounting plate at the back of the case. Use the mounting screws you just removed with the expansion slot brackets to secure the graphics card in place.

Final cables

Now it's time to deal with all the remaining cables. First, locate the 24-pin ATX connector on the PSU, thread it around the back and









ROUTE THE REAR FAN UNDER THE MOTHERBOARD'S I/O SHROUD AND PLUG IT INTO THE HEADER"

through a cable-routing hole near the 24-pin socket on your motherboard, then plug it into the socket 24.

Do the same for your graphics card, except in this case you'll need an 8-pin PCI-E GPU connector. These are often split into one 6-pin and one 2-pin connectors allowing you to power a range of models – we'll need all eight pins here for our graphics card. Again, thread it around the back and through a cablerouting hole in the case by the bottom of the motherboard, then plug it into the graphics card's power socket

You now just have to hook up the fans. If you're just using the included fans, go ahead

and connect them to the two spare fan headers on the motherboard – route the rear fan cable under the motherboard's I/O shroud and plug it into the header above the graphics card 23; route the front fan cable across the back, and through a cable-routing hole next to the 24-pin ATX cable, where you'll find a header for it. 22.

Optional cooling tweaks

If you're using an extra fan for a little more cooling and illumination, it's now time to tweak the case's cooling arrangement. Our radiator will be exhausting hot air through two fans out of the case, so ideally we want to have a few









fans acting as intakes too. We've removed the rear fan, as we want to put an LED fan in its place (again this part is optional and you don't have to do it), and transplanted the original rear fan into one of the front fan mounts to boost intake airflow.

Pop off the case's front panel and locate the fan mounts at the front and install the rear fan in the same orientation below the existing one ²⁰, moving the latter up if necessary.

Now go ahead and install the rear fan. It will come with screws allowing you to do this. Place the fan in the mount, with the cable pointing at the motherboard, so it's hidden as much as possible 29.

Hook up the new rear fan to the header above the graphics card, then connect the power cables for the two front fans to a splitter cable around the back of the case ⁵⁰.

You can then thread the plug from this splitter cable through one of your case's cablerouting holes, and over to the fan header next to the 24-pin ATX connector on the right of the motherboard.

Flashing the BIOS

If your PC fails to show anything on the screen, it could be due to the BIOS that's installed being too old to support the latest 5000-series processors. In this situation you'll be met with a black screen.

Power down the PC, grab the latest BIOS for this specific motherboard from Asus' website (**custompc.co.uk/TUFBIOS**) on another system – borrow a friend's laptop if you need to, then grab a blank USB stick.

You'll need to right click on the flash drive in File explorer, hit format and select FAT32 under the file system option. Click Start to format the drive and then drop both the files you just got from Asus onto the flash drive. Run the BIOS renamer program to configure the BIOS file name correctly so your motherboard can use it.

Power down your PC but keep the power connected and your PSU switched on. Insert the USB stick in the USB port that's labelled 'BIOS' then press the BIOS FlashBack button on the I/O panel. This will flash the BIOS with the new version, allowing it to work properly with your new CPU. Wait for it to finish, and your PC should then be able to start up with your new CPU.

Tidy those cables

The case comes with Velcro and plastic cable ties that you can use to tidy the cables, gathering them into groups behind the motherboard tray out of sight.

Doing this is good practice anyway, but it can also improve airflow compared with having the cables bunched around your fans, and it gives you easy access to your motherboard's hardware slots.

There are anchor points, through which you can hook cable ties, but it can also help to do a practice run first, gathering the cables together around the anchors to see where it's best to tie them.

At this stage, you'll also want to check that you can close the side panel properly.

Bunching too many cables together can mean they stick out too far and prevent you closing the case, so don't gather them in huge bunches and avoid having spare connectors sat between the motherboard tray and side panel .

81

SETUP AND OVERCLOCKING

Target CPU Speed : 3700MHz Target DRAM Frequency : 3200MHz Target FCLK Frequency : 1600MHz Ai Overclock Tuner D.O.C.P. D.O.C.P. D.O.C.P DDR4-3200 16-18-18-3(+ SB Clock Spread Spectrum Auto Memory Frequency DDR4-3200MHz FCLK Frequency Auto FCLK Frequency Auto CPU Core Ratio Auto	My Favorites	Main	Ai Tweaker	Advanced	Monitor	Boot	Tool	Exit			
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Configure the EFI

Power on your PC, plug in a keyboard, mouse and monitor and then press the Del key when it starts up, so you can enter the BIOS and configure the memory. We'll set it up at default settings first, but we'll suggest some overclocking settings in the next section if you want to get a little more performance.

Start by heading to the Ai Tweaker section and find the AI Overclock Tuner option – select D.O.C.P. and in the box below it select the option that corresponds to the memory speed, in this case 3200MHz. Check that this is reflected in the memory frequency box below **1**.

Now head down the page and locate the DDR or memory voltage. Just to be sure, it's worth manually changing this to the default setting for our memory, which is 1.35V

This will ensure that the memory is getting enough voltage to run at its rated frequency, as not doing so can occasionally cause stability issues with your system.

Overclock the CPU

AMD's Ryzen 5 5600X is one CPU that can benefit from a manual overclock, and our CPU cooler is more than up to the task of dealing with a little extra heat too.

We recommend using AMD's Ryzen Master (custompc.co.uk/RyzenMaster) Windows software to test your overclock first within Windows, before then heading to the EFI to apply the settings in the long term, as Ryzen Master won't allow the settings to stick when you reboot.

Click on the Profile 1 tab, then at the top of the window select Manual and then click on the CCD tabs to open them up. Now click the small green cross-shaped icon at the far right. This will allow you to apply your settings to all of your CPU's cores at once.

Type in 4700 for the frequency on the first core and tabbing to the second core will apply the same setting across all cores. This is a 300MHz boost over what the CPU can do itself across all cores at stock speed, and 100MHz higher than what it can reach on a single core as well. Below this is the voltage, which you'll need to set to 1.25V. Now click on Apply & Test at the bottom. This will give you a good idea of whether the overclock is stable, but as an extra test, the multi-threaded test in Cinebench R23 (maxon.net) is a good stress test too. If this completes without issue, your overclock settings will be fine. If not, try reducing the CPU frequency by 100MHz and trying again.

Now restart your PC, press Del to enter the EFI again and find the CPU core ratio setting under the Ai Tweaker section. Set this to 47 (for 4700), or whatever setting you found to be stable in the steps above . Then head down the page and find the CPU vcore setting – set this to manual/fixed and then input 1.25V.

If your overclock is stable, it's also worth reducing the voltage as much as possible, so when you find a stable frequency, try lowering it in 0.01V steps in Ryzen Master and retesting it in Cinebench until you hit stability issues.

Overclock the memory

Our memory's speed of 3200MHz is fast enough, but pushing it a little further can offer benefits in lots of software, so here we'll show you how to overclock it. Head to the EFI again, find the memory frequency option and use the dropdown menu to select 3466MHz We've found this to be stable at the stock DDR voltage.

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OC Tuner Keep Current Settings	
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DRAM Timing Control	
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VDDCR SOC Voltage 0.45v Auto	
DRAM Voltage 1.200V 1.35000	
VDDG CCD Voltage Control Auto	
VDDG IOD Voltage Control Auto	2

BENCHMARK RESULTS







Overclock the GPU

The EVGA Nvidia GeForce RTX 3060 XC Gaming already offers a GPU core overclock compared with the standard RTX 3060, but we managed to add an additional 150MHz to the core speed with ease, and also increased the memory speed by 900MHz to hit an effective 16.8Hz speed, up from 15Gbps. To do this we used MSI Afterburner (**msi.com/Landing/afterburner**) and moved the core clock slider to +150 and the memory to +900.

Performance and overclocking

At stock speed, our PC managed a system score of 230,544, but this rose to 247,839 once we'd overclocked the PC with a 9 per cent boost to the video encoding score. Metro Exodus saw smooth frame rates at 1080p and enabling DLSS meant that we got similar results even when ray tracing was enabled.

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Overclocking saw the minimum 99th percentile frame rate rise by 11 per cent while we saw a 47fps minimum 99th percentile frame rate in Assassins Creed Valhalla, rising by 9 per cent to 51fps once overclocked. Cyberpunk 2077 saw less of a boost from overclocking with or without ray tracing and DLSS enabled, but our PC already managed minimum 99th percentiles of 50fps and 49fps with DLSS and Medium ray tracing enabled. **GPG** FEATURE / DEEP DIVE

AMD'S NEW FIDELITYFX SUPER RESOLUTION TECHNOLOGY IS BEING BILLED AS A COMPETITOR TO NVIDIA'S DLSS BUT DOES IT HOLD UP? EDWARD CHESTER INVESTIGATES

vidia's Deep Learning Super Sampling (DLSS) technology has proved to be the company's ace up its sleeve for the past year or two, providing impressive performance gains in games by reducing the resolution at which the game is being rendered, but without significantly impacting visual quality at high resolutions. If you want to turn on ray tracing, enabling DLSS has often been the only viable way of getting playable frame rates. The problem with DLSS is that it's exclusive to Nvidia RTX card owners, putting it out of reach for many.

AMD's answer is its newly released FidelityFX Super Resolution (FSR) technology that looks to ape the same upscaling wizardry as DLSS and provide great-looking games at playable frame rates for gamers on just about any platform. There are some limitations on supported hardware – it doesn't work on AMD cards prior to the RX 480 series or Nvidia cards prior to the GTX 10 series – but any modern graphics card should support it.

However, like DLSS, FSR is a gamedependent feature that has to be baked into the game, rather than a feature that can be enabled via a driver. As such, its uptake will depend on developers implementing it, and while there's talk of it being an easy feature to implement and many developers say they're on board, right now there are just a handful of games available that support it.

Moreover, currently there are no games that support both DLSS and FSR, so we can't make a direct comparison. However, what we can do is explain what both technologies are trying to achieve, how both technologies work and how they compare in terms of performance and image quality in different games. Left: 50 per cent resolution scaling. Middle: Native resolution. Right: 200 per cent resolution scaling



IT'S ALL ABOUT SCALE

DLSS and FSR both target an idea that's been around for decades. If your graphics hardware is struggling to deliver the required frame rate to make a game playable, you run it at a lower resolution to get more performance and stretch the resultant image out across the pixels of your screen.

Monitors have been able to do this themselves for years. There are several problems with letting monitors do the work though. The first is that the simple bilinear scaling algorithms they use result in blurry images that fail to maintain the sharpness of the edges of objects.

Both DLSS and FSR, as well as other software resolution scaling systems, look to resolve this problem by using a more sophisticated algorithm for upscaling. This is the same reason why you get tech such as ClearType in Windows to make text look smooth and clear at any size. It's also why integer scaling is good for upscaling low-res old games (see Issue 208, p86).

Another issue with simply changing the resolution of a whole game is that it can also affect the size of the heads up display (HUD) and other interface elements of a game. Stretching a game running at 1080p over the expanse of a 32in 4K screen, for instance, can result in comically large interface elements.

The final annoyance with simply changing a game's overall resolution is that it can mess with all the windows on your desktop. Switch back from playing a game at a lower resolution on a high-resolution screen and you'll often find all your windows all over the place.

All of which brings us to the general concept of software resolution scaling. Here, instead of letting a dumb monitor do the work, the game will take over. Dive into the graphics



settings of many modern games and you'll find a variation on resolution scaling. This will let you render the 3D portion of the game at a different resolution to the rest of the game, essentially eliminating several of the problems outlined above.

Because the game is still running at your desktop's native resolution, it won't mess around with your desktop resolution and move your windows. The HUD can also remain at a sensible native-resolution size, as the lowerresolution 3D portion of the game is rendered before these HUD elements are added.

Finally, and most importantly when it comes to comparing DLSS and FSR, handing this work to software allows a game to use any number of algorithms to get the best image quality.

As an aside, many games also offer the ability to not just reduce the resolution of the 3D rendered parts of a game to improve performance, but also allow for the render resolution to be increased to improve image quality at the expense of performance. This is



essentially the same brute force image qualityimprovement technique as super-sampling anti-aliasing. However, super sampling simply doesn't work in many modern games, due to the nature of how modern graphics pipelines work, so resolution scaling is your only option (and it does indeed look fantastic).

TEMPORAL VS SPATIAL SCALING

Several key techniques can be employed to create a better upscaling algorithm, which can broadly be confined to two categories: spatial and temporal. The former refers to any technique that only involves a single image in a single moment in time. The upscaler will receive the lower-resolution image from the game's 3D engine and then do its best to make it look good at a higher resolution.

Temporal scaling, however, uses information from previous frames (and/or other aspects of the game) for comparison, which it uses to inform how the next image should look. The same sort of technique is used for the most

FSR ESSENTIALLY DOESN'T STAND A CHANCE OF REPLICATING THE IMAGE QUALITY OF DLSS



DLSS (right) can actually extract even more detail than native resolution (left) in some instances



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Temporal effects such as DLSS (below) and TAA (right) can greatly reduce image quality in fast movement when compared with using neither mode (bottom)





common anti-aliasing (AA) used in modern games known as temporal AA (TAA or TXAA) – traditional AA methods, such as multisampling AA and super-sampling AA don't work with the deferred rendering used in many modern games.

Temporal AA compares previous frames with subsequent ones in order to reduce the jagged lines at the edges of objects, and the shimmering effect on high-frequency elements such as foliage. There's just no upscaling involved.

This fundamental dichotomy defines the difference between DLSS and FSR. DLSS uses a combination of previous image data and movement vectors (how far the view moved from the last frame) from the game to predict how the next image should look, with the company's AI-optimised Tensor cores rapidly running those predictions. FSR, on the other hand, is a purely spatial algorithm that works on one frame at a time. It's for this reason that FSR is, despite the hype, not really a direct competitor to DLSS. It essentially doesn't stand a chance of replicating the image quality of DLSS, as it's working with much less data.

Instead, FSR runs two different passes on the rendered image, first using an edgerecognising and reconstructing upscaling algorithm to try to maintain smooth but defined edges, then it applies a sharpening algorithm to crisp up the look of the final image. The key advantages with FSR are that it's supposed to be a very simple plug-and-play system that requires very little extra effort from developers to implement. It also works across different platforms, and it's supposed to offer better image quality than some previous equivalent techniques.

There are some other notable differences between DLSS and FSR. Because of the way DLSS is tightly integrated into the graphics pipeline, and looks to compare images and data from previous frames, it actually benefits from working with non-anti-aliased images, so it replaces traditional TAA. Moreover, it can do an even better job than TAA in some instances, leading to a situation where some games that can only offer TAA anti-aliasing actually look better with DLSS.

In contrast, FSR simply inherits whatever other anti-aliasing mode has already been applied and so benefits from it.

TAA OR NOT TAA

Diving a little deeper into the subject of temporal AA, and its role in DLSS and FSR, it throws up some interesting questions when trying to compare the two techniques, as TAA and DLSS both suffer from image quality problems when it comes to fast movement. They both compare previous frames with the current one, so if there's a large difference between the two – for example, if you quickly move a mouse in a first-person shooter, they can both struggle to interpret the change.

DLSS tends to cope better than TAA here, but both can still suffer from a general softness and loss of detail in the image and a ghosting effect around some objects. To highlight this problem, we captured some screenshots in Cyberpunk 2077 while moving the mouse around reasonably quickly. We tested it with the game's default TAA setting turned on, with DLSS set to Quality mode and with both features turned off (you have to change the game's ini file to force TAA off). It's clear that both DLSS and TAA can both suffer huge losses in detail and some ghosting.

However, most users will still prefer the smoother look created by TAA and particularly DLSS to the massive amount of shimmering

and the second stranger of the

FSR (middle) doesn't introduce its own temporal blur but enabling TAA (right) will do it. The left image has no AA or FSR





and jagged edges without AA – especially for slower-paced, more cinematic games and in scenarios with lots of fine foliage. For faster-paced or competitive games where ensuring a crisp image at all times is important, though, turning on DLSS to gain some extra performance may inhibit clarity and playability.

Conversely, running the same tests with FSR (Ultra quality) in The Riftbreaker and, while forcing off the game's default TAA setting, we can see that there's no extra loss in detail or ghosting, over and above the generally softer look from the upscaling.

Turn TAA on, though, and there's clear ghosting evident above the moving robot. If a game were to offer a conventional, nontemporal AA setting, though, it would scale well with FSR, which wouldn't be the case with DLSS. If you're looking to get the sharpest scaling techniques benefit from being able to work with as many pixels as possible, so the higher-resolution your screen, the better the end result.

It's for this reason that DLSS has largely been seen as most significant a feature for gamers running screens with resolutions above 1,920 x 1,080, and wanting to engage all the visual bells and whistles in game, such as ray tracing. If you want to wander the cinematic world of Cyberpunk 2077, but your graphics card can only deliver an unplayable 20–30 fps, engaging DLSS can get you a still great–looking image at a playable 40–60 fps.

The same is true for FSR. In fact, you only have to look at the scale factors available for each technology to see that FSR is even more dependent on having that higher resolution. With FSR, there are four modes

YOU'RE STILL BETTER OFF TURNING DOWN OTHER SETTINGS TO INCREASE PERFORMANCE

image for performance gaming, you're still probably better off turning down other in-game settings to increase performance before turning on FidelityFX Super Resolution.

However, there may be some games where this isn't an option, and at least you can be reassured that FSR at least doesn't degrade image quality with temporal artefacts.

THE ROLE OF RESOLUTION

If there's one single factor that affects how well both DLSS and FSR work, as well as how much satisfaction you might get from using these features, it's the resolution of your screen. Both on offer, called Ultra Quality, Quality, Balanced and Performance. Each of these modes progressively renders the game at a lower and lower resolution, equating to scale factors of 1.3x, 1.5x, 1.7x and 2x. So, for a 2,560 × 1,440 monitor, Ultra Quality mode will render at 1,970 x 1,108 while Performance mode drops all the way to 1,280 × 720. Meanwhile, on a 4K screen, Ultra Quality mode runs at 2,954 × 1,662 and Performance mode runs at 1,920 × 1,080.

With DLSS, though, its Quality mode immediately jumps to a scale factor of 1.5x and its Ultra Performance mode stretches to a 3x scale factor. The extra information Nvidia



is able to extract from the previous frames means DLSS is less reliant on data from any single frame.

DLSS VS FSR IMAGE QUALITY

For our image quality comparisons, we chose to include screenshot examples from a 2,560 x 1,440 screen. This resolution sits between the 4K resolution where these scaling modes work best, but picking out differences can be tricky, and 1,920 x 1,080, where these scaling modes are largely so starved of pixels that we don't recommend using either DLSS or FSR. This resolution is also far more common than 4K, making the results a little more meaningful for most folks.

To start with a baseline, we first grabbed a screenshot with TAA turned off in both The Riftbreaker and Cyberpunk 2077, then with TAA turned on and with DLSS replacing TAA in Cyberpunk, and then with TAA and FSR engaged in The Riftbreaker.

Starting with those baseline shots with no AA, Cyberpunk 2077 looks horribly jagged, with stepped lines all along the edges of the car. The Riftbreaker, though, doesn't look too bad as a static screenshot. It's only in real time where you see the massive amount of shimmering/ pixel-flipping from all the moving foliage that you really see the effects of having no AA at all. However, with both games, there's a sharpness and clarity that's notable.

Engaging TAA at native resolution sees both games lose their jagged edges and the worst of the shimmering effect from the moving foliage, although there's a general softness introduced that you don't tend to get from older non-temporal AA methods.

Again, this is less noticeable in The Riftbreaker in a static screenshot, but there's a huge reduction in the foliage flicker. Meanwhile,

From left to right: No AA, TAA, DLSS



in Cyberpunk 2077, there's much more of an obvious painterly, softened effect to the background, but the reduction in foliage flicker makes up for this.

When you engage DLSS at Quality mode and FSR at Ultra Quality mode, you really see just what DLSS can and can't do. Pick out details such as the grille on the rear window of the car, and they're far more detailed and accurate than at native resolution.

However, there's also an overall softening, with a slight haziness being introduced to distant objects (which actually looked quite good to our eyes), and the foliage to the side of the road lost detail and looked more painterly.

With FSR, the effect is much subtler thanks in part to the lack of perspective and stark contrast in this game - with just a slight softness throughout. It's in the tips of the large palm trees that you really see a drop in detail, with the fringes losing their sharpness. Clearly, though, there's no example here of FSR in any way improving some details of the image.

Moving onto DLSS Balanced mode and FSR Quality mode, DLSS holds up well. The grille isn't as clear as before, but it's still better than the two native resolution options. Meanwhile. the rest of the image is remarkably unchanged. It's just a little soft compared with native resolution image. With FSR, though, we see a

more obvious loss of detail, with those palm trees starting to look almost out of focus.

Even as we move down to DLSS Performance mode, it still holds up remarkably well. Again, the grille is reasonably clear and there are impressive spots of detail throughout. Again, the static images here slightly oversell the situation, as the quality drops dramatically with fast movement, especially as you drop to these lower quality modes, but it's still impressive and the same problems occur with TAA when used with FSR.

With FSR in Balanced mode, we see a continuation of the linear drop off in overall detail. The whole image is just softer, with those fringes of the palm tree leaves now almost completely lost. As we drop to FSR Performance mode, the general softening continues to the point where the whole image looks slightly out of focus. It's still playable but there's not a strong sense that it's doing much better than a monitor stretching the image.

It's a similar story for DLSS Ultra Performance, but it manages to do a better job of maintaining a sense of some sharpness in key areas, so the whole image doesn't look out of focus. Nvidia has also said that it only really recommends Ultra Performance mode with 8K screens (where it would actually render at 1440p).

PERFORMANCE

Looking at how performance scales with FSR in The Riftbreaker, we've included results for 1080p, 2,560 x 1,440 and 4K resolutions, tested on a Radeon RX 6700 XT. It's notable that the performance gains do tend to increase the higher your target resolution.

At 1080p, we're a long way from doubling of performance. At 2,560 x 1,440, we just about hit a doubling of performance in Performance mode, while Ultra Quality nets us a 28 per cent gain. At 4K, though, performance triples in Performance mode while Ultra Quality nets us a 65 per cent gain and Quality mode more than doubles performance.

Given the perfectly reasonable image guality provided by the Ultra Quality mode (which looks even better at 4K), it will likely prove a popular option for those seeking to get a playable frame rate in visually demanding games. Even Quality mode will be worth a punt for some users, given its huge frame rate gains at 4K.

At 2,560 x 1,440, the performance gains are certainly good, but arguably not enough to justify the more obvious drop in sharpness, so you may want to drop other in-game detail settings first.

This is in stark contrast to DLSS, where in Cyberpunk 2077 at 2,560 x 1,440, we see a near doubling of the frame rate from 25fps to 42fps using Quality mode with the game set to max detail levels. Considering we're actually gaining some fine detail over native resolution here, you can see why DLSS has been talked about in such glowing terms. Drop to Performance mode and you'll hit 59fps on a modest RTX 2060.

Bear in mind that our testing and discussions of DLSS here use and refer to the latest DLSS 2.0 implementation. This was introduced in March 2020 and brought huge improvements over the company's initial DLSS attempts.

Where the original DLSS implementation needed the AI to be pre-trained for each game – using Nvidia's servers to compare 16K renders of the game to low-resolution renders – before being implemented in a game, DLSS 2.0 has been trained already across a broad range of games. This means any new game doesn't need to retrain the AI, making it easier to implement.

Perhaps more importantly for gamers, resolution/scaling options were also originally limited in DLSS, so there was less opportunity to fine-tune performance and image quality.

CONCLUSIONS

Overall, FSR isn't strong enough to directly compete with DLSS. The latter offers superior image quality with better performance gains across different resolutions and scaling ratios.

However, FSR does close the gap a little in terms of feature support when it comes to deciding whether to go for team red or team green, and it helps to boost ray-tracing performance on AMD cards. There's also a good chance that its easy implementation and wide hardware support means it will see widespread support very quickly, whereas DLSS remains a not overly common option. **CPC**

FIDELITYFX SUPER RESOLUTION BENCHMARK RESULTS

THE RIFT BREAKER

Radeon RX 6700 XT, 1,920 x 1,080, High RT shadows, RT ambient occlusion



Radeon RX 6700 XT, 2,560 x 1,440, High RT shadows, RT ambient occlusion



Radeon RX 6700 XT, 2,560 x 1,440, High RT shadows, RT ambient occlusion





CUSTOMISATION / HOBBY TECH



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 Oratek Tofu

he launch of the Raspberry Pi Compute Module 4 family (reviewed in Issue 209) last year sparked an entirely unsurprising explosion of interest in designing carrier boards. This was aided in no small part by the Raspberry Pi Foundation's decision to release its own in-house carrier board design under a



An optional adaptor converts the M.2 B-Key slot into an M-Key for NVMe storage

permissive licence from which others could springboard with their own creations.

Oratek doesn't hide its inspiration. 'Inspired by the official CM4IO board,' chief executive Aurélien Essig openly admits, 'it is intended for industrial applications. With user-friendly additions, it may also be used by enthusiasts looking for a compact yet complete solution to interface the many inputs and outputs of the single-board computer.'

The board is undeniably compact, although it bulks out when paired with the optional 3D-printed Switchblade Enclosure designed by Studio Raphaël Lutz. The reason for the name is that there are hinged lids on the top and bottom, which swing out for easy access, locking into place with small magnets when closed.

At least, that's the theory. In practice, the magnets are a little weak; there's also no way to fasten the lid shut beyond overtightening the screw in the corner. Otherwise, it's a welldesigned enclosure with top and bottom ventilation. Sadly, that's not enough to prevent a Compute Module 4 from hitting its thermal



Smartly designed with some clever features, the Tofu is a great carrier for a Raspberry Pi CM4 or compatible boards

throttle point under sustained heavy load, so you'll need to budget for a third-party heatsink or fan accessory.

The Tofu board itself is well thought out, and finished in an attractive black. Two highdensity connectors accept a Raspberry Pi Compute Module 4 board – or one of the increasing number of pin-compatible alternatives on the market, although you'll need to provide your own mounting bolts.

The 90 x 90mm board then breaks out as many features of the computer-on-module as possible. The right side houses a Gigabit Ethernet port with Power-over-Ethernet



The 3D-printed case comes in an attractive 'galaxy' finish, but it isn't cheap

(PoE) support if you add a Raspberry Pi PoE HAT or PoE+ HAT, two USB 2 Type-A ports, along with barrel-jack and 3.5mm terminalblock power inputs. These accept any input from 7.5V to 28V, which is brought out to an internal header for accessories that need more power than is available on the 40-pin general-purpose input/output (GPIO) port.

Meanwhile, the bottom has 22-pin connectors for Camera Serial Interface (CSI)

NEWS IN BRIEF

Commodore PET clone kit launched

Tynemouth Software and The Future Was 8-bit (TFW8b) have announced the MiniPET 40/80, a kit-form 8-bit Commodore PET clone. Designed for maximum compatibility with the original PET family, the new model adds an 80-column text mode alongside improved RGBi, CGA, MDA and Hercules video output options, plus composite video.

Supplied as a soldering kit, the MiniPET 40/80 is priced at £300 inc VAT with a power supply and spiral-bound manual. A board-only variant is planned, for installing in an original PET chassis, at £250 inc VAT. The MiniPET 40/80 is available from **thefuturewas8bit.com** now.



and Display Serial Interface (DSI) peripherals, a full-sized HDMI port and an additional USB 2 port. These ports aren't available outside the Switchblade Case by default, although a quick snap of the already-measured capped-off holes fixes that.

The left side includes a micro-SD slot for Compute Module 4 variants without on-board eMMC storage, plus a micro-SIM slot – hinting at another feature that becomes visible once the board is flipped. There's also a USB Type-C port, which can be used for programming or as an On-The-Go (OTG) port. Oddly, there's no cut-out at all for this in the Switchblade Case; if you want one, you'll need to take a drill and file to it.

Turning over the board reveals the micro-SIM slot's purpose. The Compute Module 4's PCI-E lane is brought out to an M.2 B-Key slot, providing a connection for additional hardware including 3G/4G modems. For storage, you can use an optional adaptor board to convert it to M-Key for Non-Volatile Memory Express (NVMe) devices, with a spacer fitted for 2230, 2242, 2260, or 2280 form factor drives.

That's not as flexible as it sounds, unfortunately. The spacer is soldered in place and needs to be chosen at the time of

The Tofu has plenty of ports, but no USB 3

Both the top and bottom rotate out of the way for easy access to the hardware inside

ordering. If you want to switch to a differentsized drive, you'll need another adaptor.

There's one other design point that makes the Tofu stand out: the inclusion of a user-replaceable fuse, a Littelfuse Nano 2 3.5A unit that was originally designed for automotive projects.

While it's primarily there for protection, it also enables you to cut off the on-board power supply when the board is driven through PoE. With the fuse in place, there's clearly audible coil whine, which can be silenced by carefully popping the fuse out of its holder. Just remember to put it back in if you stop using PoE.

The biggest problem is price. At 99 CHF (around £78 ex VAT) you'll be into triple figures by the time you've picked up a suitable power supply and Compute Module 4 board. The M.2 M-Key adaptor adds a further 19 CHF (around £15 ex VAT), and the Switchblade Case is another 35 CHF (around £28 ex VAT). If you have access to a 3D printer, you can opt to print the latter yourself, but you'll still pay 8 CHF (around £6 ex VAT) for access to the files.

The Tofu is available to order now from oratek.com. Compatible Raspberry Pi Compute Module 4 boards can be found at the usual stockists, including **pimoroni.com**



REVIEW Zymbit HSM6

our average computer hobbyist usually wouldn't care much about hardware security modules, unless the presence of one prevented them from doing something. Zymbit, though, has been trying to convince hobbyists that hardware security modules are of interest for some time – and its latest attempt piggybacks onto the growing popularity of cryptocurrencies.

The Zymbit HSM6 is a direct successor to the earlier HSM4, which in turn is a designedfor-manufacture module based on the same technology as its Zymkey4.

All three devices have one feature in common: an Arm Cortex-MO microcontroller coupled with a Microchip ATECC608 secure element, which is accessible through application programming interfaces (APIs) for C, C++ and Python.

The Zymkey4 is a stick-like board that attaches to the general-purpose input/ output (GPIO) header of a Raspberry Pi 3 or 4, or an Nvidia Jetson Xavier NX or Jetson Nano single-board computer. The HSM4

The actual HSM6 is tiny, and entirely encased in resin bar a single connector



and HSM6, by contrast, are tiny modules whose electronics are entirely encased in resin to protect them from physical attack. The only exposed part is a high-density connector on the underside.

If you're designing a product, a tiny module such as this one is easy to integrate into it. If you're a hobbyist, or someone experimenting at the very start of a product design cycle, it's not so easy.

Thankfully, Zymbit sells a kit that bundles a single module with a compact carrier board. You pop the module and a battery – CR2032, not CR2023 as labelled – onto the board, then the board onto the GPIO header of your Raspberry Pi or Nvidia Jetson.

Getting the software is quick and easy, although it falls into the same trap as many other products for Linux-based devices, encouraging the user to pipe a script, sightunseen, through the shell as the root user. Thankfully, the script doesn't do anything nasty. It checks your system, installs various prerequisites and adds Zymbit's repository to the apt package manager for future updates.

Once installed, the HSM6, like the HSM4 before it, fires up in 'developer mode'. There's a reason why this mode is the default – 'production mode' irrevocably binds the module to the current host.

If you switch from developer to production mode, there's no way to go backwards. If you

The developer's kit comes with a carrier board, compatible with the Raspberry Pi 3 and 4, as well as the Nvidia Jetson family

want to switch to a different host device, you'll need to pick up a new HSM6 module.

That's not a criticism, but a key aspect of the HSM6. It aims to provide as close to complete security as possible. Keys are generated, stored and used directly on the HSM6 without being exposed to the host system. Follow the guide for encrypting data, or even your entire storage device, using the HSM6 and you've got data that will work on that single Raspberry Pi or Nvidia Jetson board and no other.

Encryption, decryption, signing and verification are only some of the tricks up the HSM6's compact sleeve. Another key feature is a true random number generator (TRNG), which can provide high-quality entropy to your applications – or, with a little ingenuity, the host operating system



The high-density connector is surprisingly robust for its small size

#!/usr/bin/python3

Code samples are provided alongside C, C++ and Python APIs, but no end-user software

#Create a master seed and return the bip39 mnemonic master_key = bytearray("3xampleMgsterK3Y", 'utf-8') wallet_name = "MyExampleMallet" master_slot, bip39_mnemonic = zymkey.client.gen_wallet_master_seed("nistp256", master_key, wallet_name, True) print("Master Slot:%s\nBip39 mnemonic (write this down!):\n%s" % (master_slot, bip39_mnemonic)) #Generate a child key from the master seed child_slot = zymkey.client.gen_wallet_child_key(master_slot, 3, True) child_pub_key = zymkey.client.get_public_key(child_slot) print("Child Slot:%s\nChild Public Key:%s" % (child_slot, child_pub_key)) #Get node address of the child key slot node_addr = zymkey.client.get_wallet_node_addr(child_slot) print("Node address: '%s' Wallet Name: '%s' Master Slot: '%s'" % (node_addr[0], node_addr[1], node_addr[2])) #Get the key slot of the child key usion our previous master key slot and wallet name

#Get the key slot of the child key using our previous master key slot and wallet name key_slot = zymkey.client.get_wallet_key_slot(node_addr[0],"MyExampleWallet", master_slot) print("Key Slot:%s" % (key_slot,))

#Remove the master seed
zymkey.client.remove_key(master_slot)

#Restore the master seed with our previous written down bip39 mnemonic! restored_seed_slot = zymkey.client.restore_wallet_master_seed_from_bip39_mnemonic("nistp256", bytearray("3xampleMasterK3Y", 'utf-8'), "MyExampleWallet", bip39_mnemonic) print("Restored slot:%s" % (restored_seed_slot.))

#Clean up the example slots
zymkey.client.remove_key(master_slot)
zymkey.client.remove_key(child_slot)

The HSM6 also includes three elements designed to protect against physical attack, on top of the binding to a single host. A power quality monitor flags attempts to mess with the power supply, an accelerometer can be triggered on shocks or changes in orientation, and a two-ring perimeter monitoring circuit can be wired to trigger on a device's case being opened or damaged.

It's easy to play with the latter as well. It's brought out to a simple pin header on the carrier board, and wires bundled with the kit let you simulate the monitoring circuits being broken. Be careful though – one of the possible responses to physical attack is a self-destruct mode, which leaves the module permanently out of action.

So far, the features of the HSM4 and HSM6 have been identical. What the HSM6 adds is support for handling the keys for a cryptocurrency wallet, allowing for BIP32/39/44 wallet generation while keeping the keys hidden from the host operating system.



NEWS IN BRIEF

Custom chips for under \$10K

Efabless is now offering custom chip production to everyone for \$9,750 US (around £7,000 ex VAT) per project. The firm earlier partnered with Google and SkyWater to offer open-source hardware projects the opportunity to build their designs as actual silicon chips.

For the cash, customers – who can be anyone from well-heeled hobbyists to commercial ventures – receive either 100 QFN or 300 WCSP-packaged chips of their design on a 130nm process node. Additional chips are available at an extra cost, the company has confirmed. More information on the scheme, dubbed chiplgnite, is available at **efabless.com**



Python source code is provided, showing how to take advantage of the HSM6's new digital wallet API, but that's as far as Zymbit goes. There's no user-facing software supplied, and no integration with common wallet software. Unless the HSM6 enjoys considerable success in the market, that's unlikely to change. This means the cryptocurrency support could be of interest to developers, but it's not much use to end users simply looking to keep their crypto coins out of the hands of ne'er-do-wells.

The biggest issue with using the HSM6 as a hobbyist, though, is the price. The developer kit is priced at \$155 US, with additional modules costing \$125 each (around £112 and £90 respectively, ex VAT). For security wonks, the feature list makes the asking price worth it; for the merely curious, though, it's too much. For cryptocurrency enthusiasts, a dedicated hardware wallet is similarly priced and far more usable. The HSM6 is available from **zymbit.com** now.

REVIEW The Computers That Made Britain

he Computers That Made Britain isn't an exhaustive history. With only 19 systems between its covers – mostly given a chapter each, although the Sinclair ZX80 and ZX81 share a chapter – that wouldn't be possible. What Tim Danton, editor of PC Pro, has created is more of an overview.

While it traverses well-trodden ground, it does so without feeling stale – and, in Danton's own words, attempts to be 'as close to 'truth' as I can get', and doesn't shy away from 'slaying myths that have no root in reality'. The book, which is printed in black and white with barely more illustration than a single picture of each computer at a chapter's opening, can be read in two ways.

The first is to find your favourite system and skip straight there; it's written so that you don't necessarily need to have read earlier chapters. The other is to read it cover to cover, and it's undeniably enjoyable to do so. Danton's writing is approachable and friendly, and the prose flows fluidly from chapter to chapter with only enough repetition to allow each one to stand alone as much as possible.

There's not much in the way of imagery, with the stories taking centre stage instead

The book uses a mixture of original source material, such as magazines and company reports, modern works including Brian Bagnall's exhaustive Commodore series, and fresh interviews with all sorts of people, from the engineers who put the machines together to journalists such as Dick Pountain.

The exact mix varies considerably from chapter to chapter, though, and it's hard not to interpret it as favouritism. The BBC Micro chapter, for example, enjoys never-beforepublished content from interviews with Chris Curry, Hermann Hauser, Steve Furber, Andy Hopper, Sophie Wilson, Chris Turner and Dick Pountain. Conversely, a chapter on the Apple Macintosh only cites an email interview with Andy Hertzfeld, with the remainder being researched from contemporaneous reports or previously published works.

The very presence of the Macintosh in the 19 machines covered clarifies any misreading of the title This is The Computers That Made Britain, not The Computers That *Were* Made In Britain. It's hard to argue that American machines such as the Commodore 64 didn't have a profound impact in this country; it's harder to argue for the inclusion of the Apple





With 19 machines, readers of a certain age are sure to find something familiar in Tim Danton's new book

II and Apple Mac, which Pountain himself called out as 'rather expensive as business computers, let alone for home use' in a column for BYTE published in 1985.

Danton, though, makes the entirely fair point that even if Apple's machines weren't best-sellers in Britain, their impact on the global computer market means they're worthy of inclusion. Given that, for many, the first experience of a graphical user interface driven by a mouse was on an Apple machine, that's a point well made.

There's definitely something here for anyone who had a computer in the UK from the late 1970s through to the 1990s. The book covers the Research Machines 380Z, as well as loads of machines from Commodore, Sinclair, Acorn, Apple, Amstrad, IBM and Atari.

An epilogue that praises the Raspberry Pi for continuing the trend of the 'British computer' closes the book, ahead of an impressively detailed index that turns the tome into a great reference book. The Computers That Made Britain is on sale now for £12 (VAT exempt) at all good bookstores under ISBN 978-1-912047-90-1; a digital version is available from wfmag.cc/ctmb for free download. EPC

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at freelance.halfacree.co.uk 🔽 @ghalfacree

WIN A 1TB ADATA PCI-E 4 SSD

TO BE WON!

ADATA's XPG GAMMIX S50 Lite SSD deservedly picked up an Approved award in our latest NVMe SSD Labs test, and the fine folks at ADATA are now offering two of them up to **Custom PC** readers in this month's competition.

If you already own a PCI-E 4-capable PC, or you're thinking of building one, this is a great chance to snag yourself a speedy storage system with a mighty 1TB capacity for Windows and your games library.

Delivering read speeds of up to 3,900MB/sec and write speeds of up to 3,200MB/sec, the ADATA XPG GAMMIX S50 Lite is up to eight times faster than a SATA SSD, and will bring your system to the next level. It's ideal for gamers, overclockers and PC enthusiasts, and it's also backwards compatible with PCI-3.

Whether you're doing video editing, animation or gaming, this SSD has you covered.



SPEC

- Read speed up to 3,900MB/sec
- Write speed up to 3,200MB/sec
- Silicon Motion SM2267EN controller
- Slimline aluminium heatsink
- Ultra-fast 4x PCI-E 4 interface
- Five-year warranty
- SLC caching and DRAM cache buffer
- AES 256-bit encryption support

SUBMIT YOUR ENTRY AT CUSTOMPC.CO.UK/WIN

Competition closes on Friday, 10 September 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.

MODDING / OPINION



ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Preparing and maintaining water-cooling loops

f last month's Dream PC feature whetted your appetite for water cooling then we're glad. This exotic form of cooling has a fan base and ecosystem all of its own, and it makes for a hobby that's fun as well as rewarding.

However, filling, draining, colourmatching and flushing are terms you probably won't have come across in any other areas of PC hardware.

The water-cooling world tends to attract those with a passion for PCs and a sense of perfectionism, focusing on optimum performance and meticulous aesthetics, at least in our own eyes. There are plenty of factors to consider, from coolant colour to prepping your loop and making it easy to maintain.

Sure, you can just connect all the bits into a loop, fill it with coolant and have a great-looking, cool PC, but there are some often unspoken rules about what else you should do. It doesn't help that there aren't really any manuals for water cooling, especially as most of us mix and match our components. You want to be able to fill your loop easily, with minimum mess



Your first job before you start is to flush your components, especially the radiators, with deionised or distilled water. There can be residue from the soldering process lurking inside them, which can interfere with the chemical balances in the loop, as and it can also interfere with the fine channels in your waterblocks.

Filling your loop can also be a challenge, especially if you have a small PC or an unconventional loop, as some

components might not fill properly, leaving some sections with air bubbles.

Using the right tools to fill your loop are important too, and the worst part of any water-cooling experience – draining – can also be made much easier by considering a few simple steps and adding components such as drain valves.

Having a setup that enables you to fill your loop easily, and with minimum mess, means you can quickly add coolant, preventing your pump from running dry and creating excessive air bubbles. Of course, you also need to avoid spilling any coolant, especially if your fill port is near any components.

Draining can be a pain, but it's essential for maintenance reasons, or if you fancy a change of coolant or a component upgrade. Getting all or enough of the coolant out of the loop in order to do these tasks is deceptively tricky, so well-placed drain valves can make the difference between this task taking hours or just a few minutes.

In this month's How to guide (see p98) you can see my top tips for flushing, filling and draining your loop. Armed with this knowledge that I've gained from building water-cooled PCs of all shapes and sizes over the years, I hope you'll find these tasks accessible, and that they enable you to build a perfect water-cooling loop that you can keep running smoothly.



the difference between draining taking hours or a few minutes

Are PCI-E4 riser cables worth it?

've written a lot about PCI-E 4 riser cables recently, as you'll need one if you want to get the full benefits of a PCI-E 4 graphics card with a compatible motherboard, such as those based on AMD's X570 and B550 chipsets, as well as Intel Z590 boards. If you use a PCI-E 3 riser cable with PCI-E 4 hardware, you'll run into stability issues that are quite horrific, although they won't damage your hardware. Alternatively, you can disable PCI-E 4 in your motherboard's EFI and select PCI-E 3 instead.

In last month's Dream PC feature, we decided to use a PCI-E 4 riser kit for the Lian Li O11D Mini case. We were using compatible hardware, and you'd want to maximise the top theoretical performance of your graphics card, right? Having thought about this for the last few weeks since I built that PC, though, I'm not so sure.

Firstly, PCI-E 4 riser cables have been tricky to obtain until recently. Thankfully, there are a few available now, and Thermaltake has recently announced availability of its own model, but they're still not available for every case. Secondly, they're expensive. Even the bare cable will likely set you back at least £60, and the O11D Mini's custom kit with a bracket costs even more.

The vertically mounted graphics card looks fantastic though – with the full

block on show, it just looks better than a standard horizontally mounted card, especially in a large case such as those in Lian Li's O11 series.

That was especially true given that I was using a tiny motherboard – in that case, the Asus Crosshair VIII Impact. However, you need to be careful if you're air-cooling your GPU, as vertical mounts can often hamper airflow if they put the card's fans right next to a solid case panel.

The choice to use this riser did present problems though. Mounting the graphics card vertically meant I couldn't take the usual route of fitting two 360mm radiators in the case. You're already limited to slim radiators from EK when you use this case's distro plate and the PCI-E 4 riser kit compounds the compatibility issues with radiators. This is especially true with mini-ITX motherboards, as the CPU socket ends up sitting much higher than on an ATX board, meaning you can't fit a waterblock to it without it fouling the radiator.

In short, I had to completely rework the tube layouts and ditch one of the radiators, although there's still space for a 240mm one in the side. I think it was worth it in the end for the visuals, but it wasn't easy. What is questionable, though, is the benefit of bothering with PCI-E 4 compatibility.



Fitting a vertical riser to our Dream PC looked great, but it limited our options elsewhere PCI-E 4 makes a difference to high-speed SSD performance, but very few games and settings show any real benefit in terms of graphics performance from PCI-E 4 compared with PCI-E 3, and even Smart Access Memory and BAR support work on PCI-E 3 too, albeit with only specific motherboards and CPUs.

This means that a PCI-E 3 riser cable is enough for the vast majority of situations – you just need to disable PCI-E 4 on your 16x graphics slot in your motherboard's EFI. If your case already comes with a riser cable and it's PCI-E 3, I'd seriously consider not bothering to upgrade it to PCI-E 4, and I wouldn't spend extra money on a PCI-E 4 riser if I were starting from scratch either. EPE

Antony Leather is Custom PC's modding editor 🗾 @antonyleather

How to Flush, fill and drain a loop

Antony Leather shows you how to incorporate fill and drain ports into your water-cooling system, plus how to flush your radiators

TOTAL PROJECT TIME / 2 HOURS

C water-cooling systems work a lot like a car's cooling system, with coolant travelling from hot spots through tubing to a fan-cooled radiator. However, water-cooling loops don't come pre-built if you're buying off-the-shelf components. You have to build the whole system and fill it with coolant, which needs to be drained if you want to replace it. There aren't any strict guides on how best to fill and drain your loop, though, at least not that are included with manufacturers' components.

Meanwhile, radiators can often have residue and particulates left over from the manufacturing process, which can come loose once you fire up your pump and potentially clog the fine channels in your waterblocks. In this guide, we'll take you through radiators, as well as adding fill ports and drain ports, so you can ensure your loop runs properly and is easy to maintain.

TOOLS YOU'LL NEED



Fill bottle liquidgaming.co.uk



Distilled, deionised or battery top-up water Halfords or hardware stores



Drill and step drill Most hardware stores



1 / USE DEIONISED OR DISTILLED WATER

Avoid using tap water to flush your radiator, as this can leave limescale and other residues when it dries. Deionised, distilled or battery top-up water should be used instead, all of which are relatively cheap and easily available.



2 / FILL THE RADIATOR

Fill the radiator with water using a fill bottle, then drain a little of the water to create an air gap so the water can slosh around. For 120mm radiators, drain three egg cups or so; for larger radiators, remove about half a cup. You don't need to be precise here, as you're just looking to create a reasonable air pocket.



3 / SEAL WITH PLUGS

So you don't make a mess, use two G1/4in plugs to seal the radiator. You can then shake it without fear of the water coming out. Shake the radiator vigorously for 60 seconds, side to side and end to end.



4 / DRAIN THE RADIATOR

Open up one of the port plugs and drain the radiator into a cup to see if any particles have been dislodged. There may not be anything visible, but it's still worth going through this process just to make sure nothing is lurking in there.



5 / USE A FILL BOTTLE

If you have an easily accessible port for filling, your best option to add the coolant is to use a fill bottle. This can be squeezed to slowly add coolant to the loop and is great for preventing spills.



6 / ADD A FILL PORT

If your reservoir isn't easily accessible, consider installing a fill port. Some cases come with a pre-cut hole allowing you to fit them, but you can also use a drill and appropriately sized step drill to make your own. Remove your hardware first, apply masking tape to protect the paintwork, check for clearance and then drill the hole.



7 / INSTALL THE FILL PORT

The fill port slots in place and has a locking ring to secure it inside your case. There's a G1/4in thread on the inside, allowing you to connect it to an inlet on your reservoir. Externally, there's a screw cap, allowing you to add coolant without delving inside your case.



8/ ADD DRAIN PORTS

A drain port should be located low down and ideally close to the reservoir and radiators, allowing them to drain out through the port. It's unlikely you'll drain the whole system through one port, so feel free to add more than one for when you want to change the coolant.



9 / USE EXTENSION AND DRAIN BOWL It's best to drain the coolant outside of your PC, so before you open the drain port, add an extension tube using a fitting and a length of tubing. This will allow you to drain the coolant into a bowl, so you don't get it anywhere near your components.

99

How to Clean your water-cooling loop

Antony Leather shows you how to use Mayhems' Blitz kit to clean your water-cooling system

🖰 TOTAL PROJECT TIME / 48 HOURS

ver time, the components in your water-cooling loop can seep chemicals into your coolant, which can tarnish other parts and discolour tubing. The coolant can separate or stain tubing and components too. One option here is to rebuild your loop with fresh coolant and tubing and manually clean your components. However, there is an easier way to spring-clean your loop without dismantling everything and that's using Mayhems' Blitz cleaning kit.

The latest version comes with two bottles, with one being used to clean a whole loop while the other comprises a highly acidic solution to clean radiators separately. This is different to flushing (see p98), which is only needed with new radiators. In this guide we'll show you how to clean a whole loop and freshen up your radiators to keep your watercooling system performing optimally.

TOOLS YOU'LL NEED



Fill bottle liquidgaming.co.uk



Distilled, deionised or battery top up water Halfords or hardware stores





Measuring beaker Most hardware stores



1 / DRAIN THE LOOP

Start by draining the loop from your drain port or reservoir. It's important to clear out as much coolant as possible, so the Blitz solutions can make contact with the insides of your components, and not be diluted by existing coolant.



2 / **REMOVE REMAINING COOLANT** If the initial drain fails to remove all the coolant, try tilting the PC to force the coolant around to the opening, or blowing from one end. If necessary, you can disconnect some sections of tubing to allow the coolant to get out.



3 / **REMOVE RADIATORS IF NECESSARY** If you want to use part 1 of the Blitz kit to give your radiators a deep clean, you'll need to remove them from your loop, drain them and then refit them afterwards, as this solution can't be used with other components.



4 / MIX BLITZ SOLUTION PART 1

Follow the instructions to mix the correct quantities of part 1 Blitz solution and deionised water. It's a good idea to do this part in a measuring beaker, adding the Blitz solution first and allowing the water to mix as you add it.



5 / FILL RADIATOR

Lay your radiator on a flat waterproof surface, or on a surface where spills won't matter. You're aiming to completely fill the radiator, so the solution comes into contact with all of the insides.



6 / SEAL RADIATOR AND SHAKE SOLUTION INSIDE Use seals or plugs to prevent the solution from coming out. You can try the seals that came with the radiator, but these often aren't watertight so, if necessary, buy some proper plugs with O-rings to seal the ports.



7 / RINSE AND REFIT RADIATOR

Follow the instructions to leave your radiator for the specified amount of time for your setup. This is usually 12 hours. Next, drain the radiator, fill it with deionised water, drain again and repeat this four more times to flush the part 1 Blitz from the loop.



8/ DO A LEAK TEST

Reinstall your radiators in your loop, connect up all the gear and then perform a leak test. The part 2 Blitz solution works in a running loop, so you'll need to make sure it's leakproof and ready to go.



9 / MIX BLITZ SOLUTION PART 2

Part 2 of the Blitz solution should be mixed with deionised, distilled or battery top-up water to the ratio specified in the instructions. Again, do this in a measuring beaker on a waterproof surface.



10 / ADD SOLUTION TO LOOP

Use a fill bottle to add the solution to your loop. Fill the reservoir as much solution as possible at the start, then top up the bottle, so you can continue to fill the loop once the pump is activated.



11 / REDUCE PUMP SPEED

Initially, you want to run the pump at one third of its maximum speed or below, as the solution can otherwise foam up too much. You can use the pump's PWM connector to control the speed using your motherboard EFI or software, or run it at ten-second intervals until the loop is full.



12 / ALLOW SOLUTION TO CIRCULATE

The solution will likely foam up, but don't worry about this. Leave it running for 24 hours to allow the loop to be fully cleaned. It's best to use an ATX jumper on your PSU for this part, so you're only powering your pump and your components aren't live.



13 / DRAIN SOLUTION

Once you're done, drain the solution out of the PC and tilt it if necessary to remove as much of it as possible. It may have absorbed some old coolant, but don't worry about this.



14 / REFILL LOOP

You'll need to flush the solution out of the loop with distilled, deionised or battery top-up water – fill up the loop, run it for an hour and then drain it again, repeating that process two more times to remove the acid from the loop.



15 / CHECK PH LEVEL

Test the pH level of the liquid from the final flush using the included litmus paper. You're aiming for a pH level of between six and eight. The included card shows the pH colours – ours is pH 7, which is perfect. If it's still too acidic, flush it again. Once your pH level is right, you can fill the loop with your own coolant. **EPE**

Folding@home

Join our folding team and help medical research

ACTIVE USER MILESTONES

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	
PC_Rich	7,000,000,000	Life_is_Strange	20,000,000	MDT	4,000,000	
Lordsoth	6,000,000,000	Arboreal	20,000,000	ttexk	3,000,000	
BeezaBob	1,000,000,000	JasperofBelper	10,000,000	Gary_Seymour	2,000,000	
sonic_vortex	800,000,000	Bluehubble	10,000,000			
Little_Willie	600,000,000	Pausanias828	10,000,000	WHAT IS FOLDIN	G?	
C2TBD	C2TBD 400,000,000		9,000,000	Folding@home uses the	spare CPU and GPU	
1car1_Garforth	300,000,000	StoneColdJay	8,000,000	on COVID-19. You can ge	t the client from	
GreenPig	90,000,000	geofftswin	6,000,000	foldingathome.org/star	-folding and our team's	
SgtDunk	60,000,000	Team_DS-WHS2011	5,000,000	dropped off sharply now,	this is the last time we're	
Daniel_Selley	40,000,000	Ratski	5,000,000	going to print this stats pa folding with us and other	age. You can discuss readers online at the bit	
Pedro 8888	30,000,000	Bazil	4 000 000	tech forums (custompc.c	o.uk/FoldingForum)	

TOP 20 PRODUCERS

TOP 20 OVERALL

RANK	USERNAME	DAILY POINTS	OVERALL SCORE	RANK	USERNAME	POINTS	WORK UNITS	
	-	AVERAGE		1	DocJonz	16,941,401,815	355,788	
1	DocJonz	13,323,811	16,941,401,815	2	PC_Rich	7,103,673,538	167,863	
2	Desertbaker	8,725,343	4,995,195,140	3	Lordsoth	6.206.270.571	185.433	
3	Lordsoth	5,274,651	6,206,270,571	4	Shirty	5 266 142 059	20.949	
4	PC_Rich	3,400,114	7,103,673,538	4	Shirty	3,200,143,038	33,848	
5	Slavcho	2,840,507	4,590,820,788	5	Desertbaker	4,995,195,140	//,153	
6	madmatt1980	2,745,057	1,326,343,726	6	Nelio	4,638,586,520	523,610	
7	1car1_Garforth	1,378,723	328,884,562	7	Slavcho	4,590,820,788	77,007	
8	C2TBD	1,252,041	487,931,852	8	HHComputers	3,544,050,839	85,007	
9	gKitchen	1,235,015	396,950,304	9	Dave_Goodchild	3,115,545,746	161,211	
10	Simlec	1,111,647	497,666,541	10	piers_newbold	2,703,256,197	107,638	
11	Little_Willie	703,436	637,165,518	11	Scorpuk	2,565,487,007	57,788	
12	filreed	671,751	180,493,578	12	clanseven	2,223,720,446	33,156	
13	sonic_vortex	671,500	810,766,397	13	tarka_dahl	1,846,294,310	26,376	
14	mort6dav3	644,467	249,902,366	14	Unicorn	1,753,462,654	57,079	
15	BeezaBob	451,212	1,020,682,870	15	daxchaos	1,637,104,710	41,302	
16	kcanti	389,323	1,212,514,487	16	KevinWright	1,544,266,028	54,565	
17	SP1	355,759	447,460,292	17	Laguna2012	1,527,029,380	51,930	
18	fatchef	233,814	153,124,288	18	apeman556	1,477,299,139	52,024	
19	GWallace	209,826	411,381,361	19	madmatt1980	1,326,343,726	64,573	
20	Daniel_Selley	202,238	40,832,149	20	Dickie	1,271,873,313	50,902	

Retro tech

40 YEARS OF THE PC

Ben Hardwidge travels back to August 1981, when IBM released its Personal Computer 5150 and the PC was born

big ape had only just started lobbing barrels at a pixelated Mario in Donkey Kong arcade machines, Duran Duran's very first album had just rolled off the vinyl presses and Roger Federer was just four days old. In this time, the UK was even capable of winning Eurovision with Bucks Fizz. It's August 1981, and IBM has just released the foundation for the PCs we know and love today, the PC 5150.

'By the late 1970s the personal computer market was maturing rapidly from the many build-it-yourself hobbyist kits to more serious players like Apple, Commodore and Tandy,' retired IBM veteran Peter Short tells us. 'As people realised the greater potential for personal computers in business as well as at home, pressure grew on IBM to enter the market with their own PC.'

Short is now a volunteer at IBM's computer museum in Hursley (**slx-online.biz/hursley**), which holds a huge archive of the company's computing machines and documentation, from Victorian punch card machines to the company's personal computers. We ask him if it felt like the beginning of a new era when the PC was first launched 40 years ago. 'Yes,' he says, 'but probably not the beginning of something so huge that its legacy lives on today.'

At this time, the home computer market was really starting to take off, with primitive 8-bit computers, such as the Sinclair ZX80 and Commodore VIC-20, enabling people at home to get a basic computer that plugged into their TV. At the other end of the scale, large businesses had huge mainframe machines that took up entire rooms, connected to dumb terminals.

There was clearly room for a middle ground. IBM was going to continue producing mainframes and terminals for many years yet, but it also wanted to create a powerful, independent machine that didn't need a mainframe behind it, and that didn't cost an exorbitant amount of money.

The PC 5150's launch price of \$1,565 US (around £885 ex VAT) for the base spec in 1981 equates to around £3,469 ex VAT in today's money. That's still very far from what we'd



IBM's System 23 Datamaster, pictured here at the IBM Hursley Museum, cost \$9,000 US

An AMD 4.77MHz 8088 DIP CPU sits in the bottom socket, with an optional IBM 8087 coprocessor sitting above it for floating point operations

call cheap, but it was a colossal price drop compared with IBM's System/23 Datamaster, an all-in-one computer (including screen) that had launched earlier the same year for \$9,000 US – six times the price. And even that was massively cheaper than some of IBM's previous microcomputer designs, such as the 5100, which cost up to \$20,000 US in 1975.

The ticking heart of the box is a 4.77MHz 8088 processor made by AMD

IBM needed to act quickly. Commodore had already got a foothold in this market several years earlier with the PET, for example, and IBM realised that it couldn't spend its usual long development time on the project. The race was on, with the project given a one-year time frame for completion.

'At the time, IBM was more geared up to its traditional, longer-term development processes,' explains Short. 'But it eventually realised that, with a solid reputation in the marketplace, it was time to look for a way to do fast-track development that would not produce a machine three, four or five years behind its competitors.'

PROCESSORS AND COPROCESSORS

We opened up a PC 5150 for this feature, so we could have a good look at the insides and see how it compares with PCs today. It's hugely different from the gaming rigs we see now, but there are still some similarities. For starters, the floppy drive connects to the PSU with a 4-pin Molex connector, still seen on PC PSU cables today. The PC was also clearly geared towards expansion from the start.

The ticking heart of the box is a 4.77MHz 8088 CPU made by AMD – Intel had given the company a licence to produce clones of its chips so that supply could keep up with demand. It's for this reason that AMD still has its x86 licence and can produce CPUs for PCs today, but at this point, the two companies weren't really competitors in the way they are now. To all intents and purposes, an AMD 8088 was exactly the same as an Intel one, and PCs generally came with whichever one was in best supply at the time of the machine's manufacture.

The CPU itself is an interesting choice. It's a cut-down version of Intel's 8086 CPU that it had launched in 1978. The 8088 has the same execution unit design as the 8086, but has an 8-bit external data bus, compared with the 8086's 16-bit one. As with today's PCs, the CPU is also removable and replaceable, but in the case of the PC 5150, it's in a long dual in-line package (DIP) with silver pins, rather than a square socket.

Immediately above the CPU sits another DIP socket for an optional coprocessor. At this point in time, the CPU was only an integer unit with no floating point processor. This

RETRO TECH / ANALYSIS



The floppy drive connects to a 4-pin Molex connector on the PSU – a plug that's still sometimes used in today's PCs

was generally fine in an era when most software didn't overly deal with decimal points, but you had the option to add an 8087 coprocessor underneath it. This worked as an extension of the 8088 CPU. 'Adding the 8087 allowed numeric calculations to run faster for those users who needed this feature,' explains Short.

The decision to use a CPU based on Intel's x86 instruction set laid the machine code foundation for future PCs, and hasn't changed since. Comparatively, Apple's Mac line-up has had a variety of instruction sets, including PowerPC, x86 and now Arm. Nvidia might be making big noises about the future of Arm in the PC, but the x86 instruction set has stood its ground on the PC for 40 years now.

IBM itself has also dabbled with different instruction sets, including its own 801 RISC processor. Why did it go with Intel's CISC 8088 CPU for the first PC? The answer, according to Short, is mainly down to time and a need to maintain compatibility with industry standards at the time.

'The first prototype IBM computer using RISC architecture only arrived in 1980 and required a compatible processor,'

It's typical of the Wacky Races vibe, with multiple features shoehorned into one slot

he explains. 'In order to complete the 5150 development in the assigned one-year time frame, IBM had already decided to go with industry-standard components, and there was existing experience with the 8088 from development by GSD (General Systems Division) of the System/23. RISC required the IBM 801 processor, but the decision was made to go with industry standard components.'

EXPANSION SLOTS

In addition to the ability to add a coprocessor, the IBM PC 5150's motherboard also contains five expansion slots, with backplate mounts at the back of the case, just like today's PCs. Three of the slots in our sample were also filled.

One card is actually two PCBs sandwiched together – it's a dual-monitor video card with the ability to output to both an MDA screen and a CGA screen simultaneously (more on



these standards later) – each standard required a separate PCB on this card – there's a composite TV output in addition to the pair of 9-pin monitor outputs as well. Bizarrely, this card also doubles as a parallel port controller, with a ribbon cable providing a 25-pin port. It's typical of the Wacky Races vibe seen on cards at the time, with multiple features shoehorned into one expansion slot.

Similarly, there's also a 384KB memory expansion card, which also doubles as a serial I/O card, with a 25-pin port on the backplate. The final card is an MFM storage controller for the 5.25in floppy drive at the front of the machine.

Although the PC was clearly built with expansion in mind, Short points out that 'IBM was not the first to introduce

expansion slots. As far back as 1976, Altair produced the 8800b with an 18-slot backplane, the Apple II also featured slots from 1977 and there was also an expansion bus on the BBC Micro from 1981. No doubt market research and competitive analysis showed that this approach would provide additional flexibility and options without having to redesign the motherboard'.

Interestingly, though, Short also says IBM was keeping an 'eye on the hobby market. A standard bus with expansion slots would allow users to create their own peripherals. IBM even announced a Prototyping Card, with an area for standard bus The IBM PC 5150 had five 8-bit ISA slots for expansion cards

A raw ISA card at the Hursley museum, designed for hobbyists to make their own expansion cards





A 5.25in floppy drive was the standard storage system for the 5150, with no hard drive ontion at launch

interface components and a larger area for building your own design'. It's a far cry from the heavily populated PCI-E cards with complex machine soldering that we see today.

MEMORY

That 384KB memory card shows a very different approach to memory expansion than the tidy modules we have today. Believe it or not, at launch, the PC 5150 base spec came with just 16KB of memory (a millionth of the amount of memory in today's 16GB machines), which was supplied in the form of DRAM chips on the bottom right corner of the motherboard.

The top spec at launch increased that amount to 64KB, although you could theoretically also install the DRAM chips yourself if you could get hold of exactly the right spec of chips and set it up properly. The chips on the motherboard are split into four banks, each with nine chips (eight bits and one parity bit). In the original spec, the 16KB configuration filled one

IBM's colour 5153 monitor didn't come out until 1983, shown here with an IBM PC XT at Hursley, with Alley Cat in full CGA glory





The memory is organised in four banks in the bottom right corner of the motherboard – in this case there are four 64KB banks, adding up to a total of 256KB

bank, while the 64KB configuration filled all four banks with 16KB of memory each.

A later revision of the motherboard expanded this to 64KB as the base spec with one bank filled, and 256KB with all four banks filled (this is the spec in our sample). If you then added a 384KB memory card, such as the one in our sample, vou ended up with 640KB of memory – the maximum base memory addressable by PCs at this time.

GRAPHICS AND DISPLAYS

As we previously mentioned, our PC 5150 sample has a dual-monitor card, which supports both the display standards available to the IBM PC at launch. A Mono Display Adaptor (MDA) card could only output text with no graphics, while a Color Graphics Adaptor (CGA) card could output up to four colours (from a palette of 16) at 320 x 200, or output monochrome graphics at 640 x 200.

However, as Short notes, 'the PC was announced with the mono 5151 display in 1981. The CGA 5153 was not released until 1983'. Even if you had a CGA card in your PC 5150, if you used the original monitor, you wouldn't be able to see your graphics in colour. Seeing colour graphics either required you to use the composite output or a third-party monitor.

'Once the colour monitor became available,' says Short, 'it could either be attached as the sole display with its own adaptor card, or equipped with both a mono and colour adaptor card, and could be attached together with a mono screen. Now you could run your spreadsheet on the mono monitor and display output graphics in colour."

There's an interesting connection with the first PC monitors and the legacy of IBM's computing history too. When we interviewed the Hursley Museum's curator Terry Muldoon (who has now sadly passed away) in 2011, he told us the reason why the first PC monitors had 80 columns. 'It's because it's the same as punch cards,' he said. 'All greenscreen terminals had 80 columns, because they were basically emulating a punch card.'



DOS running on an IBM PC 5150 with a monochrome green screen at Hursley

STORAGE

Storage is another area where the PC is at a crossroads between new tech. As standard, the PC 5150 came with a single 5.25in double-density floppy drive, with 360KB of storage space on each disk. There was the option to add a second floppy drive in the empty drive bay, but there was no hard drive at launch.

'The first hard drive for microcomputers did not arrive until 1980 – the Seagate ST506 with a capacity of 5MB,' explains Short. 'By that time, the PC specifications had already been agreed and the hardware development team in Boca Raton was in full swing. The requirement was for a single machine developed within a one-year time frame.

'A small company called Microsoft was also developing the first version of DOS under sub-contract. The 5150 BIOS therefore had no hard disk support – DOS 1.0 and 1.1 are the same. The power supply selected for the 5150 wasn't beefy enough at 63W to power the 5150 and a hard drive.'

Later versions of the 5150, such as our sample, came with a 165W PSU, and future DOS versions enabled you to run a hard drive, but it wasn't until the IBM PC 5160 XT in 1983 that there was a hard drive option with an IBM PC as standard.

The PSU also connects to a massive red switch power switch on the side, which is very different from the delicate touch-buttons we have today. You had to literally flip a switch to power on the first PCs. This was another legacy of IBM's past – a time when, if a machine needed to be shut down drastically, you would 'BRS it' – BRS stands for big red switch.

The back of the PC 5150 also alludes to another form of storage. There are two DIN sockets on the back, one of which

is labelled for the keyboard – the other is labelled 'cassette'. 'It was common at the time to provide software on cassette tapes, which could also be used to store user written programmes,' says Short. 'My own Radio Shack TRS80 in 1979 used this method. A standard cassette tape machine such as the Philips could be connected through this socket.'

SOFTWARE SUPPORT

This brings us neatly to the subject of software support. We're now used to graphical user interfaces such as Windows as standard, but in 1981 Microsoft was a small company, which had developed a popular version of the BASIC programming language.

'Microsoft Basic was already very much an industry standard by 1980,' says Short. 'It was Microsoft's first product. This fitted with the concept of using industry standard components. IBM chose to sub-contract its

operating system development to Microsoft, perhaps for this reason. Again, the compressed development schedule influenced these decisions.'

Terry Muldoon gave us some more insight into the development of the PC's first operating system, IBM PC DOS 1.0, when we spoke to him in 2011. 'The story I heard is that basically IBM needed an operating system,' he said, 'and IBM didn't have time to write one – that's the story. So they went out to various people, including Digital You flip the big red switch (BRS) on the side to power the PC 5150 up or down



and the second se
Research for CPM, but Digital Research didn't return the call. Bill Gates did, but he didn't have an operating system, so he went down the street and bought QDOS.

'The original DOS was a tarted-up QDOS, supplied to IBM as IBM Personal Computer DOS, and Gates was allowed to sell Microsoft DOS (MS-DOS). And they carried on for many years with exactly the same numbers, so 1.1 was DOS 1 but with support for us foreigners, then we went to DOS 2 with support for hard disks. DOS 2.1 for the Junior. DOS 3 for the PC80 and so on."

You can have a play with DOS 1.0 on an emulated PC 5150 at custompc.co.uk/5150, and it's a very basic affair. Even if you've used later versions of DOS, there are some notable absences, such as the inability to add '/w' to 'dir' to spread out the directory of your A drive across the screen, rather than list all the files in a single column.

What's also striking is the number of BASIC files supplied as standard, which can be run on the supplied Microsoft BASIC. One example is DONKEY.BAS, a primitive top-down game programmed by Bill Gates and Neil Konzen, where you move a car from left to right to avoid donkeys in the road (really). What's more, this game specifically requires your PC to have a CGA card and to run BASIC in advanced mode you couldn't run it on the base spec.

A FUTURE STANDARD

With its keen pricing compared with previous business computers, the IBM PC 5150 was well received in the USA, paving the way for a launch in the UK in 1983, along with DOS 1.1 and the option for a colour CGA monitor. Clone machines

The power supply wasn't beefy enough to power the 5150 and a hard drive

from companies such as Compag soon followed, claiming (usually, but not always, rightly) to be 'IBM PC compatible', and the PC started to become the widespread open standard that it is today. Was this intentional on IBM's part?

'Industry standard components, an expansion bus and a prototyping card would naturally lead to an open standard,' says Short. 'Not publishing the hardware circuitry would make it difficult to capture the imagination of "home" developers. Open architecture was part of the original plan.'

Muldoon wasn't so sure when we asked him back in 2011. 'Now where did IBM make the mistake with DOS?' He asked. 'This is personal opinion, but IBM allowed Bill Gates to retain the intellectual property. So we've now got an Intel processor - the bus was tied to Intel - and another guy owns the operating system, so you've already lost control of all of your machine in about 1981. The rest is history.

'The only bit that IBM owned in the IBM PC was the BIOS, which was copyright. So, to make a computer 100 per cent IBM compatible, you had to have a BIOS. There were loads



PCs we know and love today

of software interrupts in that BIOS that people used, such as the timer tick, which were really useful. You get that timer tick and you can get things to happen, so you have to be able to produce something that hits the timer tick, because the software needs it.'

Rival computer makers could circumvent the copyright of the BIOS by examining what it did and attempting to reverseengineer it. Muldoon explained the process to us.

'The way people did it is: with one group of people, say: "this is what it does", and another group of people take that specification, don't talk to them, and then write some code to make it do that - that's called "clean room". So one person documents what it does, and another person now writes code to do it – in other words, nobody has copied IBM code. and there's a Chinese wall between these two people.

'What some of the clone manufacturers did is, because we published the BIOS, they just copied it. Now, the BIOS had bugs in it, and we knew they'd copied our BIOS because they'd copied the bugs as well. This was only the small companies that came and went. Phoenix produced a clean room BIOS, so if you used a Phoenix chip in your clones, you were clean.'

Of course, any self-contained personal computer can technically be called a PC. Peter Short describes a PC as a machine that 'can be operated directly by an end user, from beginning to end, and is general enough in its capabilities'. It doesn't require an x86 CPU or a Microsoft OS. In fact, there was and still is a variety of operating systems available to x86 PCs, from Gem and OS/2 in the early days, through to the many Linux distributions available now.

However, the PC as we generally know it, with its x86 instruction set and Microsoft OS, started with the PC 5150 in 1981. Storage and memory capacities have hugely increased, as have CPU clock frequencies, but the basic idea of a self-

contained box with a proper CPU, enough memory for software to run, its own storage and a display output. as well as room to expand with extra cards, started here. Thank you, IBM. CPC

THANKS

Custom PC would like to thank Tim Beattie for the loan of his PC 5150 for this feature, and the team at IBM's Hurlsey Museum. RIP Terry Muldoon - you're very much missed.

Readers' drives The Claw Machine

Michael Dexter turned his mini-ITX PC into an arcade-style claw machine, with a hand-built cabinet, loads of neon paint and a large mechanical claw

SEE THE FULL PROJECT LOG AT custompc.co.uk ClawMachine

GPD: We've never seen a PC with a mechanical claw in it before – what



/ MEET THY MAKER Name Michael Dexter

Age 36 Occupation Cleaner,

dog walker, washer and stay-at-home parent Location Nottinghamshire

Main uses for PC Gaming, which is even better now the kids get to take part too! Likes RGB, RGB and more RGB! Seriously, it can look great when set up correctly Dislikes Noisy neighbours – I should probably move somewhere more remote was the inspiration behind this project? Mike: Some gaming sessions with my friends led to some banter, and we discussed various themes and ideas about would fit in such a small case.

The claw machine idea sounded bonkers enough for me to attempt it – Ilike to be different when it comes to my builds.

FPE: How did you go about designing it? Mike: I don't follow a direct plan, but regularly evaluate the next step towards achieving my final design. Honestly, this could be said to be my Achilles heel. However, I find I have

the ability to see how

the completed build will look in my head, and this method hasn't failed me so far.

BPE: What wood did you use for the cabinet?

Mike: I used 6mm and 16mm plywood. The 6mm plywood was used for the panels on the roof, as it was easier to work with than the 16mm wood. I used it to help smooth out the lines for the quadrant moulding around the top of the cabinet – it didn't look right without this. The cabinet underneath the system is made from 16mm wood.

Working with limited tools, I made my design reasonably simple, hoping that the final result would speak for itself in terms of uniqueness. I used the cheapest jigsaw money could buy, which was a big mistake, but it worked well enough for me to get a result with which I was happy, following some minor sanding work. My other tools included a drill, a holesaw kit, an electric sander, some wood filler and the most important tool in my opinion for a build such as this one – a framing square!

11:11

CPC: How did you paint the panels?

Mike: I used plenty of painter's tape, as the glass panels are glued in place, so I had to mask them off. However, this did help me add a nice little touch of colour around the glass frames – it's very subtle but it works well. I also used some glitter on the white parts of the case, but I went with a 'less is more' approach to avoid it looking like a glitter bomb. You can't really see it in the photos, but it's an attractive subtle touch when you see it with your own eyes.

GPG: Where did the claw come from? Mike: It was a long wait for the claw, as they're not that easy to come





across, especially in the UK–I had to order one from a direct supplier from China. I had problems with the original order not being shipped after four weeks of waiting, so I had to reorder it again, but thankfully it turned up the second time round.

GPP: What's the arcade stick for, and can it control the claw?

Mike: This is a question just about everyone asks. I'm sorry to disappoint you, but there is no way to control the claw – it's for aesthetics only, as are the coin slot and keyhole. I did toy with the idea of making it work, but the parts for these claw machines aren't easy to find and I just couldn't see how the parts would physically fit inside the top of the case in a working manner.

The arcade stick and button both light up independently from the PC, and are powered by a 12V adaptor that I discreetly wired through the underside of the cabinet. There are also air vents on the rear of the cabinet and roof to help with airflow.

GPD: How did you work with the acrylic on the cabinet?

Mike: This was just a case of simply lining up where I needed to drill the holes in the acrylic for the controller box, and hoping it didn't break again – it took multiple attempts. The acrylic on the side for the prize hole was a simple fit – it's secured with plaited rope and screws, so this part at least functions.

EFG: What's the deal with NeonBurst energy drinks?

Mike: The colours were always going to be bright and bold from the start, and I'd already decided on them early on. After seeing some promotional content from NeonBurst, I instantly felt that the brand would work with the build, as it had the same



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SYSTEM SPECS

CPU AMD Ryzen 5 1600

Case Thermaltake Tower 100 **GPU** XFX Radeon RX 480 DD RS Edition

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Storage Kingston A2000 250GB NVMe boot drive, 2TB external drive for games

Memory 16GB (2 x 8GB) HyperX Fury DDR4 2666MHz

Motherboard Gigabyte B450 I Aorus Pro Wi-Fi

PSU Thermaltake Toughpower Grand RGB 850W

Cooling Thermaltake TH120 ARGB and 3 x Thermaltake Riing 12 Duo fans

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kind of energy I was aiming for, so I went ahead and got talking with the people there about doing a themed build for them. They have spoken about using it in some of their marketing, but I can't really tell you anything more at this moment. Watch this space!

EPE: What specs did you choose and why?

Mike: The case itself was actually a surprise gift from my partner, who had seen me looking at this particular case. The Thermaltake Tower 100 particularly appealed to me, as I've worked strictly on ATX or E-ATX cases over the years, and I wanted a change.

Thermaltake has also supported and encouraged this project by supplying me with a Lumi Plus LED kit and a TH120 ARGB Sync AIO CPU cooler. I bought the Aorus mini-ITX motherboard myself, and most of the other parts in this PC were reused from previous systems.

GPG: What's this PC going to be used for?

Mike: Ultimately this build was always designed to be used by my two daughters – they may be young, but they've seen many great mods over the years, and not just my ones. Despite them having a modded PC that I built a few years ago, my eldest daughter was using my own build to play more demanding games, as their one was far past being ready for an upgrade. I'm hoping this that build will keep them happy long enough for me to enjoy my own one.

GPG: Did you come across any difficulties?

Mike: There were some issues along the way, the biggest of which was a leak in the shed. This caused parts of the wood on the cabinet to warp and the case wouldn't actually fit whatsoever – I managed to get it to fit again with some sanding, phew!

Also, while these were the original basic colours, I started painting it



with colours that weren't quite so 'neon'. Sadly, I was unable to finish the build with the original paint, as it just wasn't possible to find the same brand and colour anywhere any more. This did allow me to go with some even bolder tone choices though.

The paint change proved to be an issue when it came to repainting, though, as the old paint was causing many issues underneath it, even after sanding. It wouldn't have been so much of a problem for the metal parts, but I had already sprayed the plastic on the GPU and case, which meant I couldn't just put them in a bucket of paint stripper.

GPD: How long did it take you to complete this build?

Mike: Time and weather haven't been my friends on this build. On

some days, I got a little work done; on other days I didn't. I wouldn't want to give a time frame for this one, as it did stretch over a few months, but ultimately, it could have been done a lot quicker if I had more free time and parts on hand.

CPC: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect?

Mike: Yes, I'm 100 per cent happy with the end result, but this was my first time working with wood and I learned a few things in the process of the build, which would certainly help me if I ever was to do another wooden build.

For starters, I'd use a solid wood next time, but the type of wood doesn't affect the look of this build so I'm happy with it. **GPD**

WIN CORSAIR HYDRO X JAN WATER-COOLING GEAR CORSAIR

To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (@ **CustomPCMag**) or Facebook (**CPCMagazine**), or email low-res ones to **ben.hardwidge@raspberrypi.com**. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

The Corsair Hydro X Series XD3 RGB Pump/ Reservoir Combo features a highperformance DDC PWM pump, integrated RGB lighting and in-loop temperature sensor to drive even the most compact custom cooling systems. It has a high-performance Xylem DDC PWM pump controlled via PWM to



deliver the perfect flow balance for your loop. There are also 16 individually addressable RGB LEDs, which light up the pump head to produce stunning, customisable lighting effects to match your build.

Corsair Hydro X Series XC7 RGB CPU Water Block

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 highefficiency micro-cooling fins, which



efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose the AM4/LGA1151 or LGA2066 version.

Corsair Hydro X Series XR5 240mm Radiator

The Corsair Hydro X Series XR5 240mm Water Cooling Radiator delivers extreme custom cooling performance, with a 30mm radiator thickness and premium copper core. Its dual 120mm fan mounts on each side are ready for your most ambitious custom cooling build, and its 25 micron-thick cooling fins offer a high thermal transfer rate.





JAMES GORBOLD / HARDWARE ACCELERATED

BEHIND THE SCENES AT SCAN

James Gorbold reveals some of the challenges involved with creating this month's cover feature

If we listed 100 RTX 3060

cards for sale, they would sell

out in just a few minutes



ustom PC has always worked closely with selected partners in the tech industry to get access to hardware early for reviews, as well as the inside scoops on new developments. It's one of the reasons that so many ex Custom PC contributors, myself included, end up working in the tech industry in one role or another.

This issue's cover feature is a case in point. As it's not a review of a Scan system, but a guide on how to build an affordable gaming PC, it was the perfect opportunity for Custom PC and Scan to work together. We're well aware that customers find it hard to buy many products at the moment, so we didn't want the PC in the cover story to be impossible to purchase.

The first challenge to resolve was the spec. In previous years, Custom PC has put together the spec and just done a quick check to make sure that none of the components is expected to go end-of-life when the issue goes on sale.

This year, that simply wouldn't have

worked. Even as one of the largest computer resellers in Europe, Scan hasn't always been able to offer sufficient stock for sale during the supply shortage over the past nine months, so the challenge was how ensuring that Custom PC readers could buy the featured components.

After lots of discussion and research, Custom PC and Scan were able to collectively come up with a list of components that should be available this summer. To further solidify this plan, the Scan team went away and worked with our partners to secure the necessary stock for 100 builds.

That in isolation may not sound like a huge quantity, but remember that many items, such as the GeForce RTX 3060

graphics card, have only been available to buy on a handful of occasions since its launch, and even then only in tiny quantities.

To make matters more challenging, this all had to be based on a forecast for the situation when Issue 217 would be on sale, by which time prices and supply would have changed. In some instances, this was quite easy, as we already had sufficient stock, but in other cases, we bought fresh stock or used some of the stock normally reserved for 3XS system builds that isn't available to buy standalone on the website.

Once we had all the components in stock in one of our warehouses, the next challenge was making the bundle of components available to Custom PC readers. All the items in the

> PC are standard off-the-shelf components, so if we simply listed them online, there would be no guarantee that normal retail customers wouldn't swoop in and buy them. In fact, I can guarantee that if we listed 100 GeForce RTX 3060 graphics cards for sale, they would sell out in just a few minutes.

We've therefore set up a special bundle, which isn't browsable or searchable on the website, and can only be reached if you know the URL, which is published in the feature starting on p74. I implore you not to share this URL online, as the more Custom PC readers that have a chance to buy this bundle and build the PC, the better.

We were also able to agree to agree a special price for the bundle with our partners. At standard retail pricing, the whole lot comes to £1,203.91, but the first 100 Custom PC readers to put in an order will be able to buy the limited-edition bundle for £1099.99, a saving of over £100. Enjoy building your new PCs. CPC

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James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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