16 CORES FULL REVIEW OF AMD'S RYZEN 9 5950X

CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 209

RISE OF THE RADEONS

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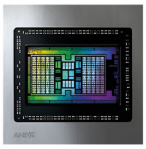
CAN AMD FINALLY BEAT NVIDIA?

- RADEON RX 6800 AND 6800 XT REVIEWED
- HOW TO WATER-COOL THE NEW CARDS



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Welcome

Custom PC Issue 209

/ FROM THE EDITOR

Stock response

The past three months have been enormously exciting and deeply frustrating for PC hardware enthusiasts. On one hand, the covers of our last three issues have all been devoted to awesome new CPUs and GPUs. AMD has soundly beaten Intel on the desktop CPU front, and now Nvidia and AMD's absurdly fast GPUs are duking it out (see p16). All the new chips represent big leaps over their predecessors.

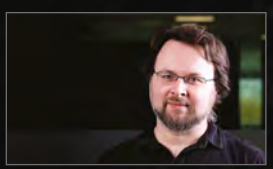
On the downside, all of this is practically meaningless when you can't actually buy any of it. Well, you can, but only if you're lucky enough to make your purchase at the split second that stock goes live, or hand over double the price to a scalper on eBay. Bots are undoubtedly part of the problem here, but it's also very clear that supply can't in any way meet demand at the moment.

As James Gorbold details on p114, this isn't vapourware – the hardware is definitely arriving, sometimes in large quantities, but the stock is mostly being allocated to pre-orders. Any stock that does go up for standard retail sale quickly disappears.

There are several factors at play here. Firstly, there's clearly a huge hunger for new PC gaming hardware. Secondly, TSMC, Samsung, board partners and all the companies that make other individual components on graphics cards, are trying to mass-manufacture new, cutting-edge tech in the middle of a pandemic. Not only that, but the products then have to be shipped internationally, which represents another logistical challenge at the moment.

With so much pent-up demand, and supply only trickling in a bit at a time, it doesn't look like this situation is going to be sorted out for a while. The situation looks particularly dire for the new Radeon cards featured in this issue, with stock looking much sparser than for Nvidia's new GPUs or AMD's Zen 3 CPUs.

If you haven't managed to get hold of a new CPU or graphics card yet , my advice is to hold off until this all blows over. It will, one day. Don't buy a last-gen RTX 2070 or 2080-series card at this year's prices. Don't encourage the hardware speculators on eBay. In the meantime, enjoy reading about all the new chips and tech progress, and start planning your upgrade or new build for when the situation returns to normal. CPC



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CUSTOM PC

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ISSUE 209

ISSUE 209
SUBSCRIBERS EDITION

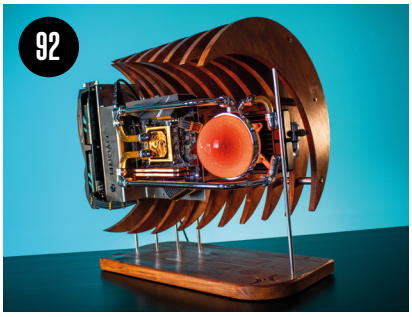
This magazine is printed on paper sourced from sustainable forests. The printer operates an environmental management system which has been assessed as conforming to ISO 14001.

Custom PC magazine is published by Raspberry Pi (Trading) Ltd., Maurice Wilkes Building, St. John's Innovation Park, Cowley Road, Cambridge, CB4 0DS. The publisher, editor, and contributors accept no responsibility in respect of any omissions or errors relating to goods, products or services referred to or advertised. ISSN: 1740-7443.

Contents

Welcome to Issue 209

Highlights



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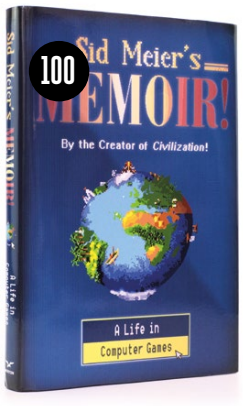

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Intel Standard CPU Cooler

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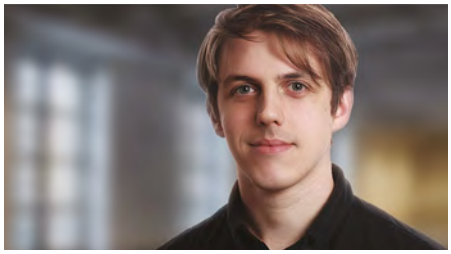

RICHARD SWINBURNE / VIEW FROM TAIWAN

HEDT WILL ROLL

Richard Swinburne can't see Threadripper 5000-series CPUs reaching your local computer shop

There's been a lot of fanfare about AMD's Zen 3 CPUs, which top out at the Ryzen 9 5950X (see p31) with 16 cores and 32 threads – the same number of cores and threads as its predecessor. At this time, there's no mention of a Threadripper 5000-series line-up, and I think it's deliberate – AMD is focused on releasing new laptop and server platforms instead. This year AMD has made big gains in both these markets, and it needs to continue that momentum.

Threadripper was always a halo product, and AMD now no longer needs that edge. I expect AMD either won't release a 5000-series Threadripper range, or it will opt to work exclusively with systems builders rather than releasing them into retail. In fact, there are several trends indicating that the entire high-end desktop (HEDT) market is reaching retirement.

Retrospectively, AMD's first generation of Threadripper chips offered a – now modest – eight, 12 or 16 cores, and sold on their huge number of PCI-E lanes and quad-channel memory support. The second generation superseded this with a doubling to 32 cores. I remember this reveal on stage being an epic mic-drop moment for AMD CEO, Lisa Su, with people in the audience literally gasping. AMD had *doubled* the core count year on year when Intel was only just ticking upwards every now and then. It continued to make the Threadripper platform feel special.

Intel fought back a few months later with its Xeon W-3175X, which was exclusive to system builders and offered fewer cores (28 vs 32), lacking the same spark. Then in late 2019, AMD really nailed the Intel HEDT coffin shut with its Threadripper 3000-series chips, which started at 24 cores and scaled all the way to a whopping 64. Intel didn't even bother to fight back with a refreshed W-series. However, the lustre of the HEDT market had dulled by the time the 64-core Threadripper 3990X launched in early 2020.

Compared with the awe surrounding the Threadripper 2990X reveal, the reception of the 3990X more along the lines of 'but why do we need it?' No games benefited from it, so the whole enthusiast market just shrugged its shoulders. Since SLI and CrossFire are now largely retired, ludicrous numbers of PCI-E lanes are no longer required for most people either. A bog-standard Ryzen 9 3950X is really more than enough for anyone except high-performance computing (HPC) centres.

> No games benefited from it, so the whole enthusiast market just shrugged its shoulders

The story at Intel is also a dead end. Going back to Nehalem in 2008, its HEDT platform used to showcase cutting-edge tech, but its now antiquated X299 platform hasn't been updated since 2017, while its two LGA2066 CPU refreshes were met with lacklustre reception.

Outside of the largest retailers, Threadripper CPU availability in many countries is limited or non-existent. While Amazon US and UK both stock a wider range than average, the number of customer product reviews for Ryzen vs Threadripper is telling of the respective popularity – there are over 100x more for the former. It's not surprising, because HEDT is now so unaffordable that even an entry-level CPU and motherboard runs into several thousand pounds even before you add four channels of memory, plus sufficient power and cooling for these 280W beasts.

With the accelerating cost, the very niche appeal and uncertain roadmaps all considered, I don't think most of us enthusiasts would mind if the HEDT market went into retirement. Instead, pooling resources into a single, focused platform should benefit us all. CPC

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

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TRACY KING / SCEPTICAL ANALYSIS

MATCH MADE IN AMAZON

Amazon has patented a system that reportedly matches 'toxic' gamers, to separate them from 'nice' gamers, but Tracy King has questions

Algorithms are often blunt instruments. I have fairly niche shopping interests that can be well served by smart algorithms, but I often laugh at the results. It doesn't bother me because it's based on my shopping history and I'm daft enough to allow tracking. What's more sinister are 'targeted' ads that know I'm a child-free woman of a certain age, and therefore I must want adverts for fertility treatments. This is intrusive profiling, not based on my actions but on other aspects of my online behaviour or personal life, and the stereotypes associated with them.

I shouldn't have to use ad blockers to preserve some privacy around my 'real' life, as opposed to my online shopping behaviour. It feels like crossing the ethical line. But hey, it's just advertising. I can and probably should live without it. But what if that sort of profiling were used to affect my online gaming experience?

That's a question raised by the discovery of a patent filed by Amazon, positioned by media coverage as an algorithm that matches 'toxic' gamers with other toxic gamers, leaving all the nice gamers to play among ourselves without being bothered by trolls or rage quitters. Protocol, the tech website that discovered the patent filing, called it 'a godsend for gamers'. I read the patent myself and, well, no.

> The site Protocol called it 'a godsend for gamers'. I read the patent myself and, well, no

What's considered 'toxic' behaviour? The patent acknowledges that one gamer's swearing might offend one person, but not another one. This is where it gets complicated. In order to match players who exhibit one type of behaviour with players who behave the same way, you also have to be sure those players are okay with it. In other words, just because someone swears a lot while playing, that doesn't mean they're okay with other players who swear a lot.

To deal with this situation, the patent describes two sets of attributes: a negative preference for a behaviour (maybe 'doesn't like swearing'), and a positive preference (okay with swearing). But what's the source of that data?

There are obvious avenues, such as actual gameplay behaviour. If you get reported a lot, or rage-quit mid-game a lot, you'd expect the algorithm to know that, and take it into account. It's basic stuff, but it's also an extremely blunt instrument, and there's almost certainly not enough data to create well-matched gaming sessions. The algorithm will want more behaviour data, so where will it get it?

The patent has a depressingly 2020 answer – social media. From the patent: 'In certain embodiments, preferences and behaviours are further determined based on player association with one or more external systems, including non-game systems. For example, participation in a specific social networking site (or group on the social networking site) can be considered a behaviour. In some embodiments, players associated with an external system are also assumed to have a preference for participation in the external system by other players.'

In other words, you could be matched with other players based on your politics, interests or other attributes that have nothing to do with the game or your play-style. And of course, if this sort of data collection is opt-out then the matching won't work, because the trolls will simply deny access to their behaviour data.

Perhaps this is why (as far as I know), no developers have implemented this system. However, it's a creepy warning that the lines between online gaming and our 'real' lives are becoming blurred, which I find truly toxic. 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

FRACTAL UNVEILS MESHIFY 2

Fractal Design has updated the design of its Meshify case range, which now includes some of the design tweaks from the company's acclaimed new Define chassis. The cases' new features include a fully removable top panel to make PC building easier, as well as a front nylon filter that can be removed if you want to increase airflow. In addition, Fractal is introducing a new line-up of Meshify 2 XL cases, which scale up the design to give you a roomier interior.

Meanwhile, the new front panel design has a hinged removable mesh filter, and you get a USB 3.1 Gen 2 Type-C port on the front panel as standard. The cases offer plenty of room for water-cooling gear as well. According to Fractal, the standard Meshify 2 chassis can hold up to a 280/360mm radiator in the front, and even a 420mm one in the top. With its more spacious interior, the CL model can also hold a 480/420mm radiator in the front.

There's huge scope for air-cooling options as well, with nine 120/140mm fan mounts in the standard model and up to 11 120mm (or nine 140mm) mounts in the XL version. You get more clearance for a massive graphics card in the CL model as well, with room for up to a 549mm card if you clear out everything else at the front of the case, compared with 491mm in the standard Meshify 2.

The Meshify 2 is available to buy in the UK now, with prices starting at £129 inc VAT from **scan.co.uk**, with the XL model starting at £166 inc VAT.

AOC AND PORSCHE DESIGN UNVEIL 240Hz GAMING MONITOR

AOC and Porsche Design have teamed up to create a new gaming monitor that combines the latter's eye for flashy design with the former's gaming monitor pedigree. The standout features of the display are its 240Hz, 27in LCD panel and tubular roll cage-inspired, polished stainless steel stand.

As well as a fingerprint magnet of a stand, the PD27 includes RGB lighting on the rear, as well as mini AOC and Porsche logos that project onto your desk.

The display itself has a 2,560 x 1,440 resolution, making it one of a relatively low number of monitors to have a 240Hz refresh rate and a resolution higher than 1080p. It also boasts a 1ms GTG response time and 0.5ms motion picture response time (MPRT). A VA-type LCD panel has been chosen for this display, which allows it to offer an impressive 2,500:1 contrast ratio. It also has a slightly extended colour gamut of 119 per cent sRGB, but is only rated for DisplayHDR 400 HDR, which is the most basic level.

AOC is known for including wired remotes in its high-end AGON monitors, for controlling the on-screen display. With the PD27, it has stepped up a notch, though, adding a snazzy-looking wireless remote. Despite the modest screen size, the PD27 also has a curved screen, with a very tight 1000R radius. The AOC AGON PD27 is available now for a rather eye-watering MSRP of £720 inc VAT.

COOLER MASTER UNLEASHES 'SUB-ZERO' COOLER

Cooler Master's latest CPU cooler might look like your everyday all-in-one liquid cooler at first glance, but the MasterLiquid ML360 Sub-Zero offers a new twist on the formula. Inside its waterblock sits a 52 x 52mm thermoelectric cooler (TEC), which works using the Peltier effect.

In simple terms, a TEC contains two different metals and a thermally conducting plate on each side. When you put a current through it, you get a massive shift of energy from side to the other, resulting in a sub-ambient temperature on one side, while the other side gets very hot. You'll need a decent cooling system to shift the heat away from the hot side, while the cool side can be used to chill a CPU.

TECs were previously used quite a lot by PC water-cooling hobbyists in the early days, but their use has declined more recently. However, Intel is reviving the idea with its new Cryo Cooling Technology scheme, which combines a TEC with specific software and firmware to control it. It's this system that Cooler Master is adopting in the MasterLiquid ML360 Sub-Zero.

In the case of this cooler, the TEC sits underneath a waterblock unit equipped with a PCB and sensors for temperature and dew point (to help minimise condensation), and on top of a thermal sensor plate on the cool side, which also reports temperature and humidity information. Unusually for an all-in-one liquid cooler design, the ML360 Sub-Zero also has a separate pump rather than integrating it into the waterblock.

The Cooler Master MasterLiquid ML360 Sub-Zero is available to pre-order from **overclockers.co.uk** now for £310 inc VAT.

RADEON RX 6900 XT INCOMING

AMD has another GPU in its RDNA2 arsenal that's due to be released on 8 December. With a claimed price of $999 US (around £890 inc VAT), the Radeon RX 6900 XT looks set to occupy a unique price league in the current GPU market, sitting between Nvidia's GeForce RTX 3080 and top-end 3090.

The Radeon RX 6900 XT is based on the same Navi 21 GPU as the Radeon RX 6800 and 6800 XT (see p16), but has 80 compute units enabled, giving it 5,120 stream processors and 80 Ray Accelerators. AMD quotes a game frequency of 2015MHz for the GPU, with a maximum boost clock of 2250MHz. However, it still has the same memory system as the cheaper RDNA2 cards, with 16GB of GDDR6 memory running at 16GHz (effective), connected to a 256-bit wide memory interface.

We hope to have a review of the new GPU in our next issue, but in the meantime, you can read our deep dive into AMD's new RDNA2 GPU architecture on p78.

RAZER PUNKS UP VIPER

In anticipation of the release of CD Projekt Red' game Cyberpunk 2077, Razer has released a new version of its ambidextrous wireless Viper gaming mouse that's based on the game's design elements. The bright yellow rodent features Razer's 2nd-gen optical mouse switches, and is equipped with the company's HyperSpeed wireless tech. The mouse weighs 74g , and sports Razer's Chroma RGB lighting, as well as a Chroma charging dock.

The Razer Viper Ultimate with Charging Dock – Cyberpunk 2077 Edition is available to buy now from **razer.com** for £160 inc VAT.

Letters

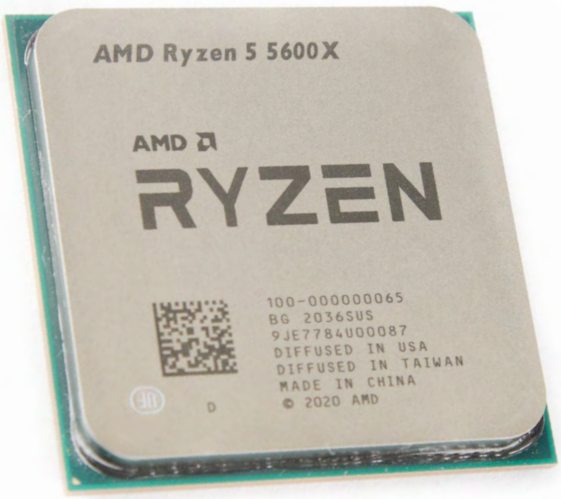
Please send us your feedback and correspondence to
custompc@raspberrypi.com

Where's the Ryzen 5 5600X?

I was reading Issue 208 of **Custom PC** and I couldn't help but notice that there was no in-depth article about the new Ryzen 5 5600X CPU. Is there a reason for this, or did I just not read that you were only testing some of the new Zen 3 CPUs? Either way, I also want to mention how much I love reading your magazine, so just keep up the good work!
LANE WILKINSON

Ben: Thanks for your kind comments, Lane. We worked together with AMD to make sure **Custom PC** was on sale on the same day as the Zen 3 launch, which was a great achievement for us, but also meant we had to compromise. There were four CPUs at launch, but only two of them were available for AMD to send to us for testing before our print deadline – samples of the other two wouldn't be in the country until after we'd gone to press. You'll be pleased to know that there's a full review of the Ryzen 5 5600X in this issue, though, on p30.

See p30 for a full review of the AMD Ryzen 5 5600X



When's the next issue out?

CUSTOM PC

JAN 07

Issue 210
On sale on Thursday, 7 January

Typotastic

I just read your reply to Dave Gwyther which states that 'sometimes mistakes still slip through the net.' Sometimes?! I regularly loose count of the number of typos, and have resigned myself to it just being a regular annoyance of the mag. Most of them do seem to be technical though. The RTX 3090 has a massively larger memory interface than the 32-bit one on the 3080, for example, and I don't think anyone can get much out of a 55W Corsair PSU.
DAVID PRICE

Ben: I apologise on behalf of team **Custom PC**, David. One aspect of working on print magazines is that you often have to work silly hours in order to get the latest kit tested and reviewed, while still meeting the deadline at the printer, and that means we miss this sort of thing sometimes. Sadly, you also can't go back and correct a mistake once it's been printed, and these sorts of technical typos are the ones that won't get picked up by a spell-check or a non-technical proofreader. However, we're going to leave the misspelling of 'lose' in your letter to make us feel better!

Legacy hardware

Your article on building DOS gaming rig with original hardware caught my interest! I want to build a legacy computer, but for my old software as well as gaming, and with at least one PCI slot for my beloved Yamaha SW1000XG sound card.

I also have other hardware that Windows 10 can't handle, such as an excellent high-resolution Epson scanner. I do have access to an old Pentium 4 CPU with an Intel D850GB motherboard.

I'm not sure whether it's worth reviving, or to just jump a little closer to the present for a better spec. I hate waste, even if the end product might not be a brand-new computer.
DANNY HATHAWAY

Ben: Ah, the SW1000XG, that was a killer synthesiser card! Motherboards still came with PCI slots until relatively recently – there was one at the bottom of the ASRock Z370 Pro4, which came out in 2017. The bigger problem will be driver support, either for an old operating system with the new motherboard, or for your SW1000XG with Windows 10.

For your setup, that old Pentium 4 system and 850 motherboard sounds ideal if you put Windows XP on it, as long as you also have some RDRAM spare, and you don't connect it to the Internet. One other idea is to ditch the SW1000XG, and pick up an external Yamaha tone generator on eBay – the MU100R has the same internal hardware as the SW1000XG, and you can connect it to a modern PC with a standard MIDI to USB adaptor and treat it like a normal MIDI synthesiser. The only downsides are that you can't run XGWorks on Windows 10, or use the serial interface controller.

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Reviews

GRAPHICS CARD

AMD RADEON RX 6800 / £530 inc VAT

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AMD is playing to the crowd and PC gamers are loving it. Shortly after delivering a devastating blow to Intel with the Zen 3 launch, AMD CEO Lisa Su lifted the lid on its RDNA2 GPUs in an online presentation, showing faster frame rates than the Nvidia competition. Is AMD's GPU wing, formerly ATi, back? The truth is that it's complicated.

The launch kicks off with two GPUs, the Radeon RX 6800 and the 6800 XT (see p18). The Radeon RX 6800 has 60 enabled compute units, each of which contain 64 stream processors and one Ray Accelerator, AMD's equivalent of Nvidia's RT core. There isn't an equivalent of Nvidia's Tensor cores, but AMD tells us that it's working on a new anti-aliasing mode for its Fidelity FX suite, which may work similarly to DLSS.

However, the Radeon RX 6800 does have some other benefits over Nvidia's equivalently priced GeForce RTX 3070. In particular, the Radeon has twice as much GDDR6 memory (16GB compared to 8GB), and it's clocked at an effective speed of 16GHz, compared to 14GHz on the RTX 3070. It still has a 256-bit-wide memory interface, but the faster memory means you get a total respectable memory bandwidth of 512GB/sec, compared to 448GB/sec for the Nvidia card.

SPEC

Graphics processor
AMD Radeon RX 6800, 1815MHz game clock, 2105MHz max boost clock

Pipeline
3,840 stream processors, 96 ROPS

Ray Accelerators
60

Memory
16GB GDDR6, 16GHz effective

Memory interface
256-bit

Card interface
16x PCI-E 4

Bandwidth
512GB/sec

Outputs/inputs
3 x DisplayPort 1.4a, 1 x HDMI 2.1

Power connections
2 x 8-pin

Number of slots
2

Card length
267mm

The card

The RDNA2 launch also sees AMD moving to a new reference cooler design and, unlike Nvidia's Founders Edition cards, this cooler is also being used by AMD's board partners. It's a massive improvement over AMD's previous reference blower coolers, and bears a passing resemblance to the classy metal brick-like designs of Nvidia's RTX 20-series Founders Edition cards.

There's a red Radeon light on the top edge, and three fans drawing air through the bottom of the card and expelling it out of a vent at the top. You get a chunky backplate as well. It's a decent cooler, and while it's audible when the fans spin up, it's a low-frequency, consistent breeze, rather than an annoying trebly whine that oscillates up and down. There are two 8-pin power connectors on the edge, and no vents on the rear I/O plate.

Performance

So can AMD's new GPUs compete with the equivalent Nvidia GPUs on performance? Let's start with the good news, which is that in standard, non-ray-traced games, the Radeon RX 6800 is a good deal quicker than the GeForce RTX 3070. It's not far off being twice the speed of the Radeon RX 5700 here either.

At 2,560 x 1,440, the Radeon RX 6800 rarely drops below 100fps in these tests – that's some awesome raw shader power for the money. It can comfortably play Doom Eternal

at 4K with Ultra Nightmare settings as well. If you're one of those people who loudly proclaims that you don't care about ray tracing on Twitter, then yes, this is the card to buy in this price league.

Where it starts to get complicated is when you add ray tracing to the mix, and that's important if you want to run Cyberpunk 2077 with all the bells and whistles when it comes out, for example. There's a reason why AMD hasn't discussed ray-tracing performance in much depth, and it's because it can't compete with Nvidia on this front.

The most striking example is Battlefield V, which drops down to a 99th percentile frame rate of 43fps and average of 58fps on the RX 6800, but this jumps to 56fps and 69fps respectively on the GeForce RTX 3070. The gap is even wider at 1080p in this game, and you see a similar performance gap in Shadow of the Tomb Raider with ray-traced shadows enabled. In some other tests, the performance gap isn't quite as pronounced, with the 99th percentile results drawing even in some cases in Metro Exodus, although the RTX 3070's average is still noticeably quicker in this game.

These performance numbers aren't terrible – they're arguably a reasonable counterpoint to the fact that the Radeon RX 6800 has more raw shader power than the RTX 3070. The bigger problem for AMD is that it doesn't have an equivalent of DLSS in its graphics arsenal. If you enable DLSS, you can improve the RTX 3070's (already good) ray-tracing frame rates even further, making 60fps ray-traced gaming at 2,560 x 1,440 a solid proposition.

Also, while both the new Radeon cards ran our ray-tracing benchmarks fine, we couldn't get them working in games that specifically used Nvidia's ray trace extensions, such as Quake II RTX. Nvidia has the advantage of being a couple of years ahead of the game here. On more than one occasion, AMD's Radeon Software app locked up on us soon after opening it as well.

The software now also includes an automatic overclocking tool, which quickly stresses your GPU and memory to find high stable frequencies. On our test sample, that equated to 2324MHz and 2150MHz memory (17.2GHz effective). Annoyingly, though, you can only apply one of these tweaks on its own – if you want to overclock both the memory and the GPU together, you have to head to the manual section.

There's some decent overclocking headroom here though – we kept the automatic memory overclock frequency, and then clocked the GPU to 2355MHz, which added another couple of frames per second to the average on Shadow of the Tomb Raider.

Conclusion

It's already clear that the Radeon RX 6800 stock situation is dire, with no cards available at any of the usual UK etailers. With that in mind, we're basing our conclusion on making a purchase once the stock problems have died down. Based on their standard retail prices, rather than eBay, the Radeon RX 6800 is a little pricier than Nvidia's RTX 3070 Founders Edition, but has a similar price to third-party RTX 3070 cards.

If you're not bothered about ray tracing, and your top priority is maximising frame rates, then that's a reasonable price, although it's arguably bumped up by an extra 8GB of memory that will rarely get used at this card's target resolution. Also, while the Radeon RX 6800 isn't as quick at ray tracing as the RTX 3070, it isn't far off in some tests.

The bigger problem for AMD at the moment is that Nvidia's DLSS tech really reduces the burden of ray tracing, resulting in decent frame rates with amazing visuals. If you want a card that does it all at 2,560 x 1,440 then you want the RTX 3070 rather than the Radeon RX 6800. It's great to have some decent competition in the GPU market again, and the Radeon RX 6800 is good, but it isn't quite the all-out winner that AMD needed.

BEN HARDWIDGE

RADEON

- \+ More raw shader power than RTX 3070
- \+ Decent cooler design
- \+ AMD finally has ray tracing
- \+ Reasonable price

RADION

- – No stock available
- – No DLSS equivalent
- – Ampere faster at ray tracing

PERFORMANCE 32/40

FEATURES 17/20

VALUE 34/40

OVERALL SCORE 83%

VERDICT

A top buy if you want to maximise frame rates, but the RTX 3070's superior ray-tracing performance and DLSS tech make it a better all-rounder in this price league.

GRAPHICS CARD

AMD RADEON RX 6800 XT / £680 inc VAT

SUPPLIER overclockers.co.uk

It's been a long time since we've reviewed a high-end AMD GPU, but AMD clearly thinks its new Radeon RX 6800 XT is in with a chance of competing with Nvidia's mighty GeForce RTX 3080, arming it with a premium price of £680 inc VAT from **overclockers.co.uk**. This was the cheapest UK retail price we could find at the time of launch, although this is largely academic, as all the shelves were cleared of stock a couple of minutes later.

Accordingly, we're reviewing the Radeon RX 6800 XT in the same way we're reviewing all the other graphics cards in this issue, which is on the basis that at some point the stock problems will die down and you'll be able to buy it at the standard retail price, rather than at eBay scalper prices.

AMD hasn't chosen an easy fight here, as the RTX 3080 is a formidable opponent. Unlike the RTX 3070 (see p22), it's based on Nvidia's top-end GA102 GPU and comes with super-fast GDDR6X memory attached to a 320-bit interface. AMD's Radeon RX 6800 XT, meanwhile, is based on the same Navi 21 GPU as the cheaper Radeon RX 6800 (see p16), and has GDDR6 memory connected to a 256-bit memory interface.

The end result is that the AMD's total memory bandwidth of 512GB/sec is up against the RTX 3080's figure of 760GB/sec, as well as Nvidia's superb Ampere GPU architecture. On the plus side, the Radeon does at least have 16GB of memory, compared to just 10GB on the RTX 3080, although it's debatable how much of an advantage this will give it in current games.

The RX 6800 XT does have significantly beefier specs than AMD's cheaper RDNA2 card though. It has 72 of the Navi 21 GPU's compute units enabled, giving it 4,608 stream processors, compared to 3,840 in the Radeon RX 6800. That also means you get 12 more of AMD's Ray Accelerators for real-time ray tracing in games that support it.

SPEC

Graphics processor
AMD Radeon RX 6800 XT, 2015MHz game clock, 2250MHz max boost clock

Pipeline
4,608 stream processors, 128 ROPS

Ray Accelerators
72

Memory
16GB GDDR6, 16GHz effective

Memory interface
256-bit

Card interface
16x PCI-E 4

Bandwidth
512GB/sec

Outputs/inputs
3 x DisplayPort 1.4a, 1 x HDMI 2.1, 1 x USB Type-C

Power connections
2 x 8-pin

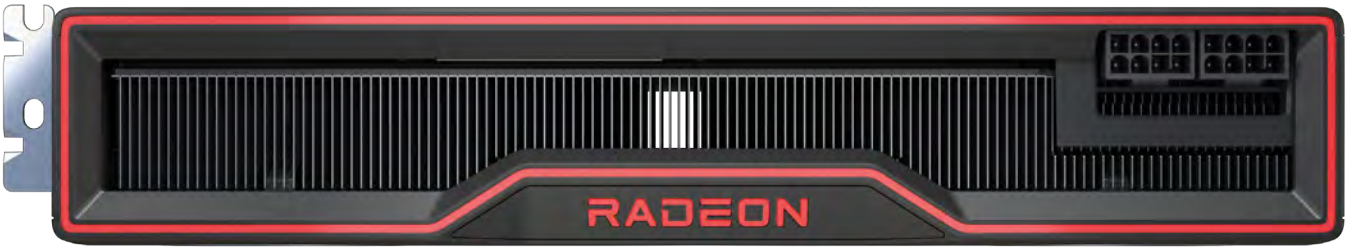
Number of slots
2.5

Card length
267mm

The card

Thanks to a larger cooling system, the Radeon RX 6800 XT has much higher clock speeds than the vanilla model, with AMD quoting a game clock (the realistic frequency you're likely to actually see in games) of 2015MHz, compared to just 1815MHz on the standard RX 6800. We're hoping this might give us some decent overclocking headroom too.

The cooler itself has a very similar layout to that of the Radeon RX 6800, but with a taller heatsink plate. This pushes the card into third expansion slot territory, even if the I/O plate only occupies two slots. It works remarkably well though. We found it to be exceptionally quiet for a reference cooler, even when running demanding game tests – it's a huge upgrade over AMD's previous blower coolers, and it's quieter than the standard RX 6800 cooler too. It makes a bit more noise if you overclock it or enable Rage mode, but it's never irritating.



As we discuss in the RDNA2 deep dive on p78, AMD has focused hard on performance per watt with this generation of GPUs, and this card requires the same pair of 8-pin power connectors as its cheaper sibling. This is also a benefit of this card over the RTX 3080 – at stock speed, our system drew 29W less from the mains with the Radeon RX 6800 XT installed.

Performance

AMD has clearly worked hard on RDNA2, and it represents a huge step up from the first Navi cards we reviewed last year, massively improving performance and bringing hardware support for the DirectX 12 Ultimate feature set. But is this enough to take on the RTX 3080?

Sadly, the answer is no. While the Radeon RX 6800 clearly has lots more raw shader power than the RTX 3070, the same isn't true for the Radeon RX 6800 XT against the RTX 3080. Performance in Doom Eternal is similar for the two GPUs at 1080p, but the GeForce pulls away at 2,560 x 1,440 and 4K.

The Radeon's stock speed performance was slightly behind the GeForce in Shadow of the Tomb Raider as well. On the plus side, the AMD GPU took the lead in Battlefield V, but not by a huge margin.

The situation sadly becomes more vivid when you introduce ray tracing. The Radeon RX 6800 XT is competitive with the RTX 3080 in Shadow of the Tomb Raider at 1080p with High ray-traced shadows, but the Nvidia GPU is well in front in our other game tests. The gap was massive in Battlefield V with High DXR and Ultra settings, where the RTX 3080 managed a 99th percentile result of 75fps at 2,560 x 1,440, compared to just 51fps for the Radeon RX 6800 XT.

Exacerbating the problem further is the fact that AMD currently doesn't have an answer to DLSS, which gives the RTX 3080 a substantial helping hand in ray tracing at higher resolutions.

On the plus side, there is some headroom to push the Radeon RX 6800 XT further, as its hefty cooler provides plenty of overclocking headroom. This card also supports AMD's new Rage mode, which carefully tweaks thermals, GPU voltage and clock frequency to give you an automatic speed boost on the fly without crossing into the danger zone. Sadly, it didn't improve performance in our tests, although you'll be rewarded if you go for a manual overclock.

We were able to take the GPU clock right up to 2500MHz, while also adding another 150MHz to the memory clock. This makes a large difference, with the Radeon RX 6800 XT even beating the stock speed RTX 3080 in some tests. If you're prepared to water-cool your card (see p24), and overclock it, you'll be rewarded.

Conclusion

We don't want to beat up the Radeon RX 6800 XT, because it *is* a decent card. It might not beat the RTX 3080, but it does still churn out over 400fps in Doom Eternal at 1080p, and it also has a good stab at ray tracing, beating Nvidia's last-gen Turing GPUs. The problem is that it's priced at a similar level to the GeForce RTX 3080, and it doesn't have the shading power, ray-tracing performance or memory bandwidth to justify that price. Yes, it has 16GB of memory, but that doesn't translate into winning performance. The Radeon RX 6800 isn't far off the RTX 3070, but the Radeon RX 6800 XT is further away from the RTX 3080.

It's good to see AMD back in the high-end GPU game, though, and we're looking forward to seeing how the top-end Radeon RX 6900 XT performs. If the 6800 XT had a cheaper price, it would be much more competitive. Of course, there's no stock of any of these cards at the moment anyway, but if the pricing stays the same when the dust settles, the RTX 3080 will remain the GPU to buy.

BEN HARDWIDGE

RAGING

- \+ Quiet cooler
- \+ Highly overclockable
- \+ Low power draw
- \+ Decent frame rates

AGING

- – No stock available
- – Disappointing ray tracing
- – Can't beat GeForce RTX 3080
- – Slightly too expensive

VERDICT

AMD's most competitive high-end GPU for a long time, but it's not powerful enough to properly take on the GeForce RTX 3080.

PERFORMANCE **34/40**

FEATURES **17/20**

VALUE **30/40**

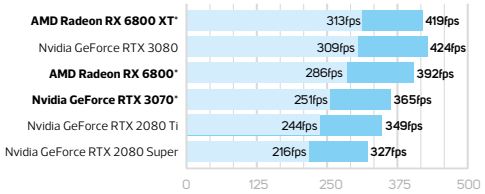
OVERALL SCORE **81%**

GRAPHICS CARDS BENCHMARK RESULTS

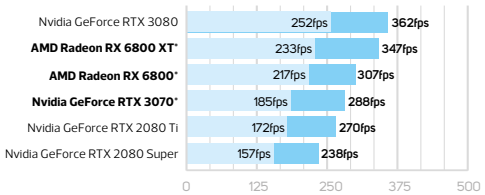
Standard game tests

DOOM ETERNAL

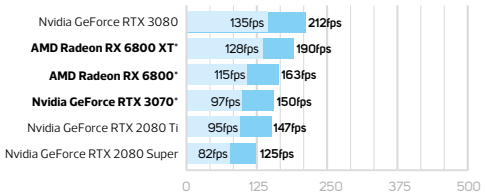
1,920 x 1,080, Vulkan, Ultra Nightmare settings



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

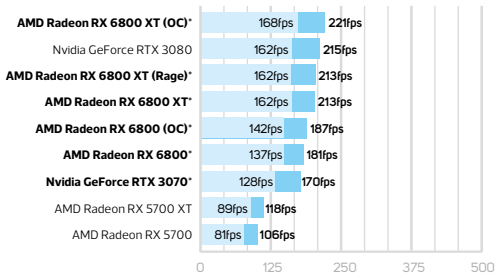


3,840 x 2,160, Vulkan, Ultra Nightmare settings

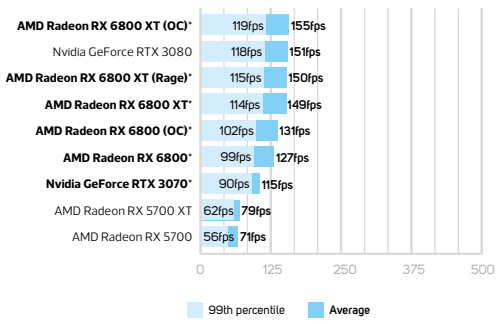


SHADOW OF THE TOMB RAIDER

1,920 x 1,080, Highest settings, no ray tracing, TAA

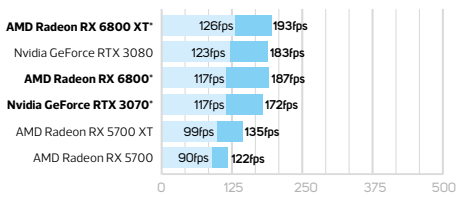


2,560 x 1,440, Highest settings, no ray tracing, TAA

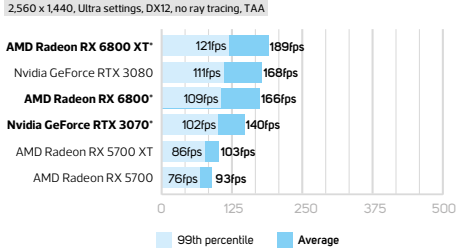


BATTLEFIELD V

1,920 x 1,080, Ultra settings, DX12, no ray tracing, TAA

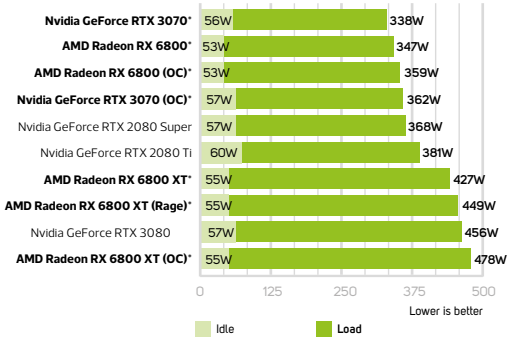


2,560 x 1,440, Ultra settings, DX12, no ray tracing, TAA



Power draw

TOTAL SYSTEM POWER CONSUMPTION



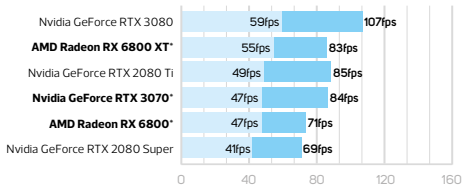
*** Reviewed in this issue**

GRAPHICS CARDS BENCHMARK RESULTS

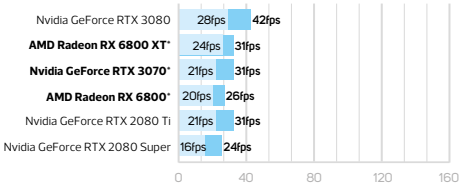
Ray tracing game tests

METRO EXODUS

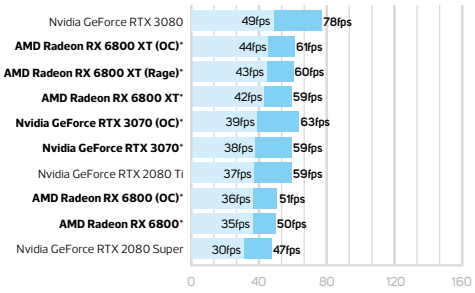
1,920 x 1,080, Ultra settings, HairWorks off, Advanced PhysX off, Ultra RT



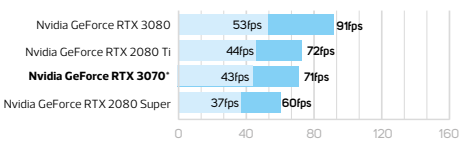
3,840 x 2,160, Ultra settings, HairWorks off, Advanced PhysX off, Ultra RT



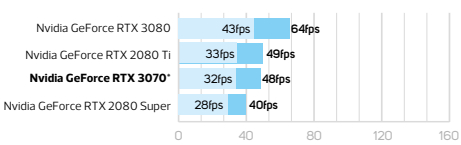
2,560 x 1,440, Ultra settings, HairWorks off, Advanced PhysX off, Ultra RT



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

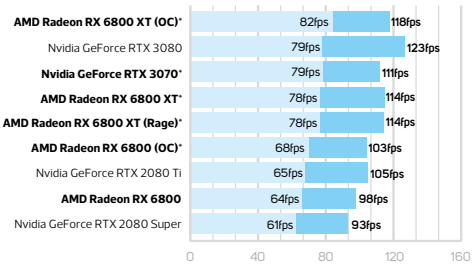


3,840 x 2,160, Ultra settings, HairWorks off, Advanced PhysX off, Ultra RT, DLSS

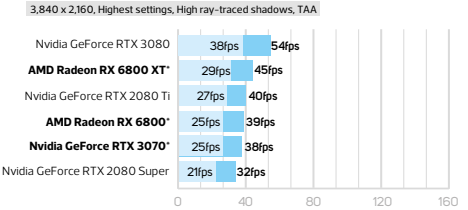


SHADOW OF THE TOMB RAIDER

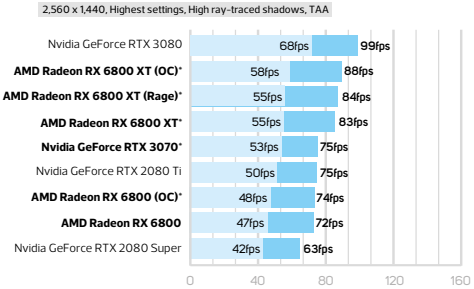
1,920 x 1,080, Highest settings, High ray-traced shadows, TAA



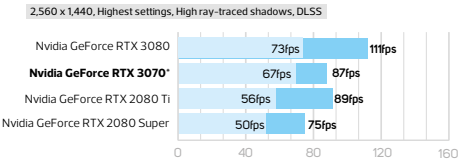
3,840 x 2,160, Highest settings, High ray-traced shadows, TAA



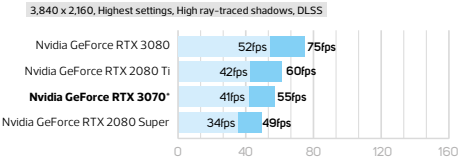
2,560 x 1,440, Highest settings, High ray-traced shadows, TAA



2,560 x 1,440, Highest settings, High ray-traced shadows, DLSS

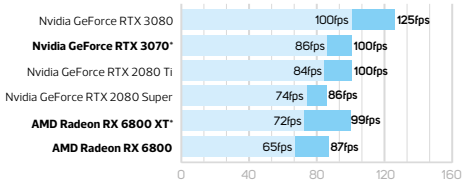


3,840 x 2,160, Highest settings, High ray-traced shadows, DLSS

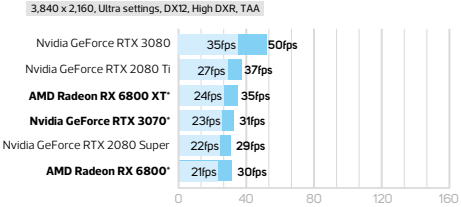


BATTLEFIELD V

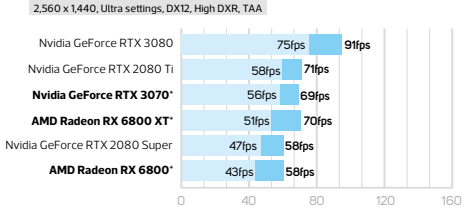
1,920 x 1,080, Ultra settings, DX12, High DXR, TAA



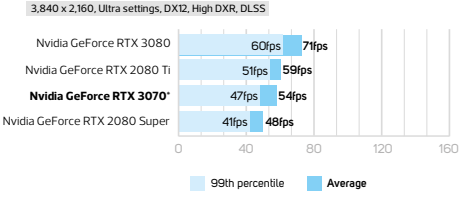
3,840 x 2,160, Ultra settings, DX12, High DXR, TAA



2,560 x 1,440, Ultra settings, DX12, High DXR, TAA



3,840 x 2,160, Ultra settings, DX12, High DXR, DLSS



GRAPHICS CARD

NVIDIA GEFORCE RTX 3070 FOUNDERS EDITION / £469 inc VAT

SUPPLIER nvidia.com

I'll admit that it feels rather silly reviewing this card when we already know the stock levels are so miniscule. As such, we're going to review this card on the basis that you'll be able to buy it at this price at some point in the future when all the stock silliness dies down, but we're well aware that it's impossible to buy at the moment.

With that out of the way, let's take a look at what Nvidia's practically non-existent mid-range GPU has to offer. Unlike the RTX 3080 and 3090, which are based on Nvidia's top-end GA102 Ampere desktop GPU, the RTX 3070 uses the much smaller GA104 chip. It has a 392mm^2 die containing 17.4 billion transistors, compared with the GA102's 628mm^2 die with 28.3 billion transistors.

The RTX 3070 doesn't have a fully enabled GA104 GPU either, as it has one texture processing cluster (TPC) turned off. That means you lose two streaming multiprocessors (SMs) compared with a fully enabled chip. Accordingly, the RTX 3070 has 5,888 CUDA cores, but a fully enabled GA104 GPU would have 6,144 of them, potentially paving the way for a fully enabled GA104 GPU in the future. You also get 46 2nd-gen RT cores for ray tracing, and 184 3rd-gen Tensor cores.

The RTX 3070's memory system steps down from the GA102 cards as well, with 8GB of GDDR6 memory, rather than GDDR6X, and it's attached to a 256-bit wide memory interface. The memory is clocked at 1750MHz (14GHz effective), making for a total bandwidth of 448GB/sec – that's substantially narrower than the RTX 3080 and 3090, but it should be fine for the RTX 3070's target resolution of 2,560 x 1,440.

Meanwhile, the GPU has a base clock of 1500MHz, and boosts to 1725MHz, although some third-party cards push the latter much higher. For example, Asus has a ROG Strix card that boosts all the way to 1905MHz, so there could be some good overclocking potential here.

SPEC

Graphics processor
Nvidia GeForce RTX 3070, 1500MHz base clock, 1725MHz boost clock

Pipeline
5,888 CUDA cores, 96 ROPS

RT cores
46 (2nd-gen)

Tensor cores
184 (3rd-gen)

Memory
8GB GDDR6, 14GHz effective

Memory interface
256-bit

Card interface
16x PCI-E 4

Bandwidth
448GB/sec

Outputs/inputs
3 x DisplayPort 1.4a, 1 x HDMI 2.1

Power connections
1 x 12-pin (1 x 8-pin adaptor included)

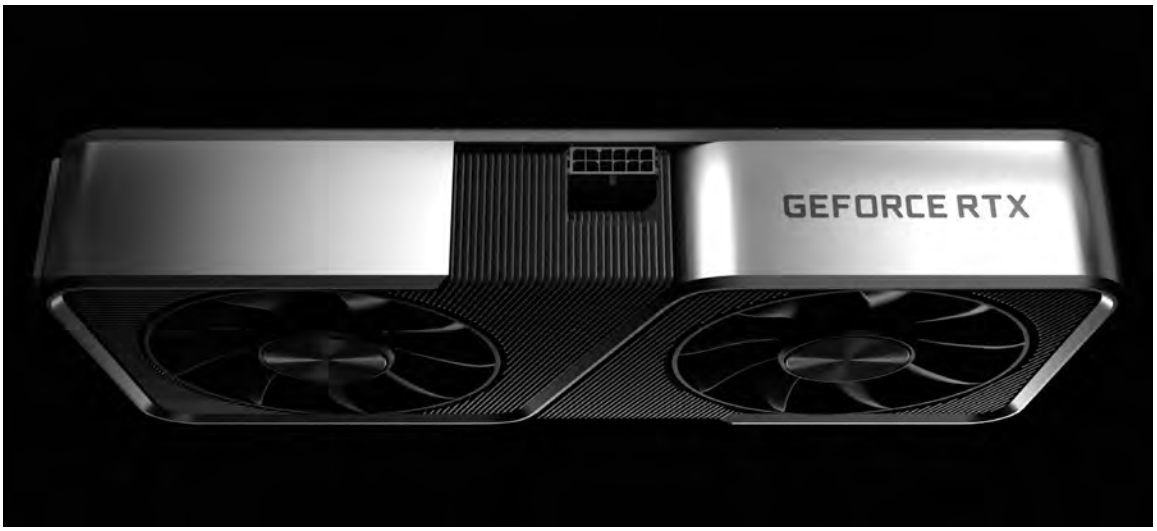
Number of slots
2

Card length
242mm

The card

As with the RTX 3080 Founders Edition, Nvidia's new RTX 3070 card has a revised cooler design, but it's a little different from the RTX 3080's flow-through system. The RTX 3070's cooler looks more conventional, with two fans on the front, rather than one on the front and one on the back. The airflow system has a two-pronged approach here, with air being pushed out of both the I/O plate, as well as a vented section on the back of the card.

It's not quite as reliant on bottom-to-top case airflow as the RTX 3080, but it's still clearly optimised for such a setup. If your case has a different airflow design, such as a mini-ITX case that uses PCI-E risers, you'll likely be better off with a third-party card with a conventional cooler, where you're not in danger of blocking a key airflow outlet.



Otherwise, the card has a neat design. There's no lighting, but it looks classy and minimalist. Like the RTX 3080 Founders Edition, power also comes from a 12-pin socket, but Nvidia provides an 8-pin-to-12-pin adaptor in the box – and you only need one 8-pin plug. However, the 12-pin connector is right in the middle of the top edge, which makes for awkward cable tidying – unless your PSU has a 12-pin connector, you're going to have an adaptor trailing across the middle of your case.

Performance

In its original announcement, Nvidia claimed the RTX 3070 is faster than the RTX 2080 Ti, and it clearly has a similar level of performance (see the full results on p20-21). However, the RTX 3070's narrower memory interface means it falls away from the 2080 Ti in some tests. Last month, that would have made the RTX 3070 a clear winner in this price league, but the situation is now complicated by the release of AMD's Radeon RX 6800.

If your top priority is getting the fastest frame rates possible, and you don't care about ray tracing, then the Radeon is the card you want. It was consistently well in front of the RTX 3070 in Doom Eternal, and in Shadow of the Tomb Raider with ray-traced shadows disabled. It was closer in Battlefield V, but the Radeon was again the winner here.

If you want to max out the eye candy, though, the RTX 3070 is the better card. The situation is complicated, however. In Battlefield V, for example, the RTX 3070 is much quicker than the Radeon with ray tracing enabled – it's particularly noticeable at 2,560 x 1,440, where the RTX 3070's 99th percentile frame rate of 56fps is well in front of the Radeon RX 6800's 43fps. The picture isn't quite as stark in our other tests though.

What the RTX 3070 really has going for it, however, is support for Nvidia's DLSS anti-aliasing mode, which massively improves the frame rate with ray tracing, and with little visual impact at 2,560 x 1,440 and 4K. With DLSS enabled, the RTX 3070 maintained a 67fps 99th percentile frame rate in Shadow of the Tomb Raider, averaging 87fps – that's smoothly playable.

Likewise, its 43fps 99th percentile and 71fps average in Metro Exodus at 2,560 x 1,440 is a decent result in this highly demanding test – dropping from Ultra to High ray tracing will make the game smoothly playable. Without DLSS, the Radeon RX 6800 could only manage a 35fps 99th percentile result in this game at this resolution, which is only borderline playable.

There's also scope to squeeze even more performance out of the RTX 3070, as it's really overclockable. We were easily able to add an extra 250MHz to the memory clock, and another 170MHz to the GPU boost frequency. This brought the Shadow of the Tomb Raider 99th percentile frame rate up 3fps to 56fps at 2,560 x 1,440 with ray tracing enabled.

Conclusion

Nvidia's dire stock situation and the new competition from AMD complicates the RTX 3070's standing, but if you can wait until the stock problems are sorted, this is the card to buy if you want to play the latest games with ray tracing at 2,560 x 1,440. There's certainly no point in buying a Turing card at current prices now.

That said, with the exception of Battlefield V, AMD's ray-tracing performance isn't too far behind, and the Radeon RX 6800 is faster in terms of raw shading power. If the latter is your priority, then the Radeon is clearly a better buy. However, the RTX 3070's DLSS support and superior ray-tracing performance means it just about clinches our choice for the best all-round sub-£500 card, if you can find one.

BEN HARDWIDGE

VERDICT

The RTX 3070 is the new sub-£500 all-round graphics king, if you can find one.

RAY TRACING

+ RTX 2080 Ti performance
+ Quiet cooler
+ Ray tracing at 2,560 x 1,440
+ Great price

RAY WINSTONE

– No stock anywhere
– Radeon RX 6800 has more raw shading power
– Awkwardly positioned power connector
– Flow-through cooler not ideal for all cases

PERFORMANCE **33/40**

FEATURES **19/20**

VALUE **35/40**

OVERALL SCORE **87%**

Water-cooling the Radeon RX 6800 XT

Graphics cards have often been attractive targets for water-cooling systems, as their coolers can be noisy when gaming, and modern boosting algorithms actively take temperature into consideration too, meaning you can boost performance. Tie your graphics card to a water-cooling loop with a decent cooling capacity, and you can cut noise and temperatures by huge margins, allowing you to game in peace and quiet, while also having an awesome-looking PC.

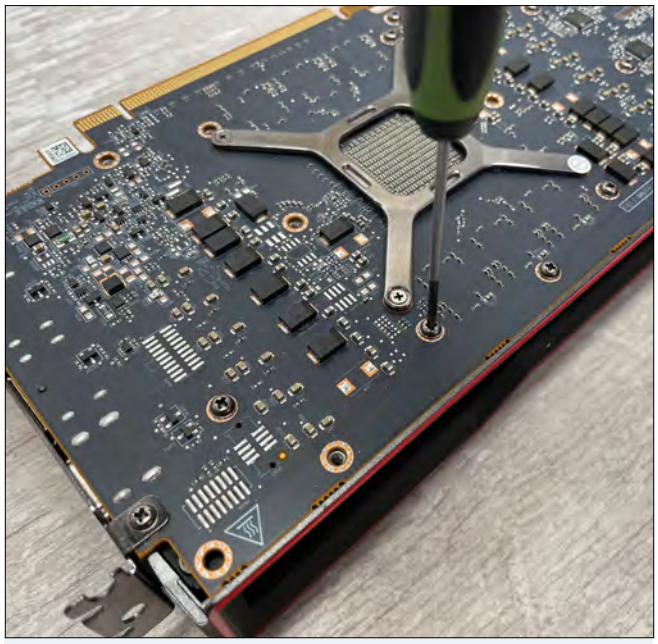
We're happy to have one of EKWB's first samples of its Radeon RX 6800 XT full-cover waterblock, so we can see if replacing the card's triple-fan cooler is worth it in terms of boosting cooling and cutting noise. We'll also show you how to install a waterblock on the RX 6800 XT in the process.

INSTALLING THE RX 6800 XT WATERBLOCK

Installing GPU waterblocks can be tricky due to the number of screws and cables used on modern graphics cards, but we're pleased to report that the RX 6800 XT is a relatively easy card to dismantle and water-cool. In this guide we'll show you how to do it step-by-step, and the only the only extra gear you'll need is a micro screwdriver, some thermal paste cleaner and a lint-free cloth.

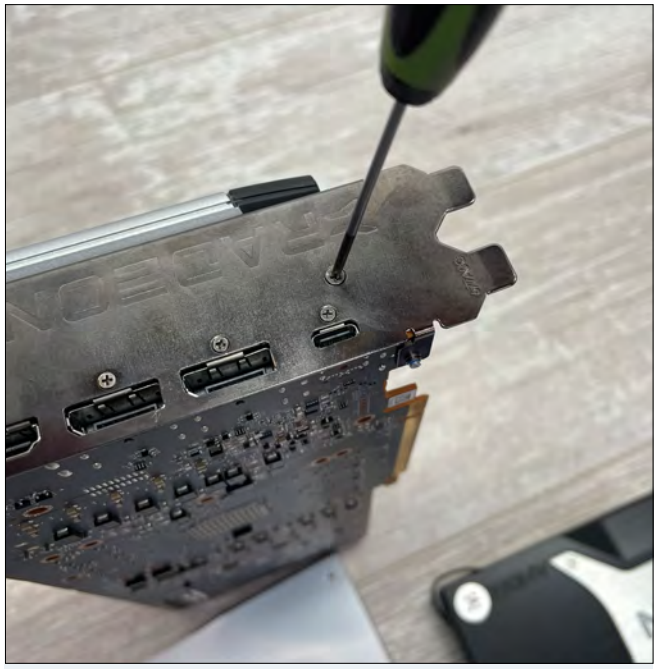
1 / REMOVE BACKPLATE

The Radeon RX 6800 XT has a large backplate on the top side of the PCB, which you'll need to remove in order to access the heatsink-securing screws underneath it. Lay the card fan-down on a flat, sturdy surface and locate the backplate's mounting screws, removing all of them.



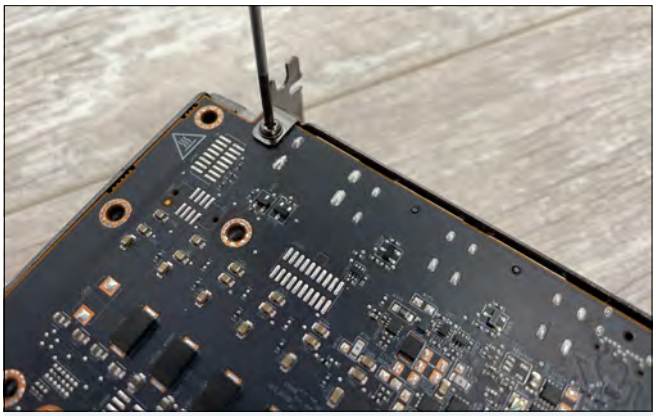
2 / REMOVE SCREWS

There are four screws in a cross-shape bracket, which secure the cooler to the core of the GPU, and these screws need to be left until last to prevent the heatsink from falling away at one end. Remove all the other screws around the PCB, and use a container to store them so none of them rolls away.



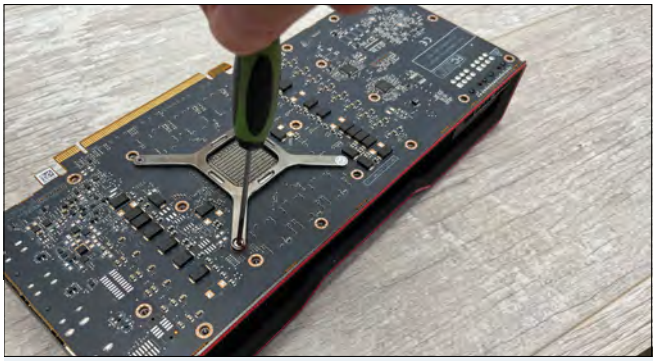
3 / REMOVE BRACKET SCREWS

The waterblock comes with a single-slot bracket that can replace the card's two-slot bracket. This might be useful if you have a vertical graphics card mount, as you can then place the card close to your side panel. There are several screws at the end of the bracket, which need to be removed in order to dislodge the stock bracket.



4 / REMOVE EXTRA PCB SCREWS

There are some other screws around the bracket, which attach to the PCB, securing both the cooler and the bracket. You'll need to remove these screws next.



5 / REMOVE CORE SCREWS

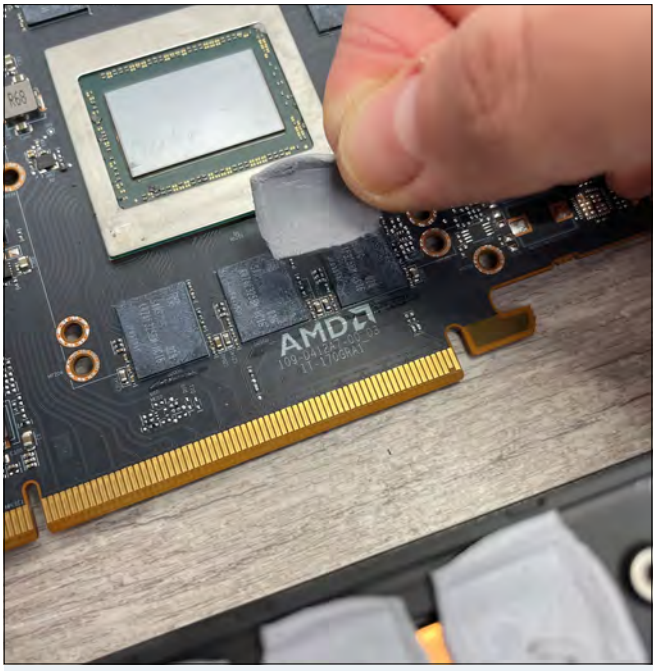
Making sure the card is placed on a flat surface, remove the four screws and bracket surrounding the GPU core. When lifting the card, the cooler will now be loose, so take care to support the cooler from underneath. Not doing so could see it fall off the card, potentially damaging the cables still attached to it.

6 / DETACH CABLES

Gently lift the cooler from the bracket end, to reveal where the cables attach to the PCB. Use a plastic pick or thin-nose pliers to gently dislodge the cables. Apply any force to the connector, not the cables, or you risk damaging them.

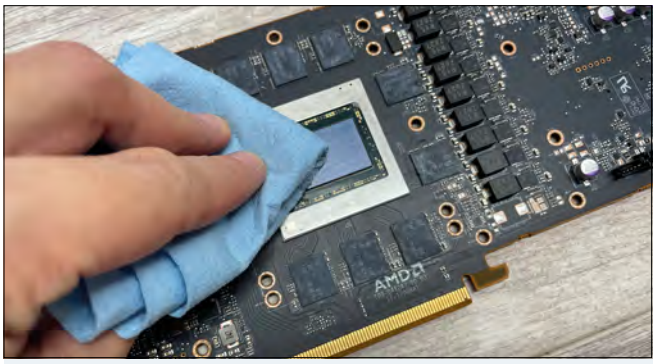
7 / LIFT OFF THE COOLER

The cooler should come away easily. If not, check for screws you may have missed. The thermal paste on the core can also set and make it tricky to dislodge. A hairdryer can warm the paste, making removing the cooler easier – use a high heat setting for 20 seconds, blowing 6in away from the rear of the card, aiming at the core area.



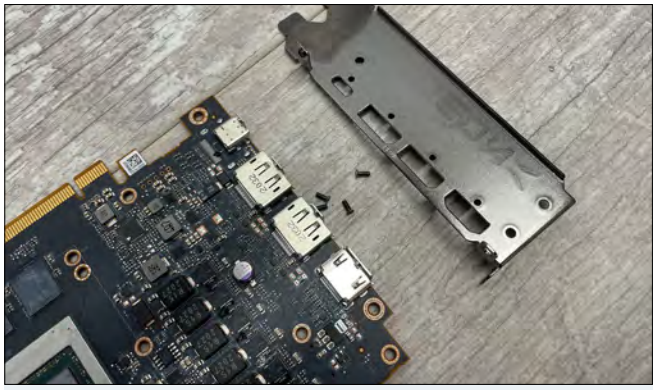
8 / REPLACE THERMAL PADS

You'll want to keep any thermal pads that are dislodged on the cooler, so you can replace it if you decide to sell your card in the future, or if you otherwise need to replace the cooler. Use a flat plastic tool, such as a credit card, to lift them off the PCB in one piece, and then place them back onto the cooler.



9 / CLEAN THE GPU

The stock thermal paste needs to be removed before you apply fresh paste, which is included with the waterblock. Use thermal paste cleaner and a lint-free cloth or high-density workshop towel to remove the bulk of the paste first, then use the cleaner to deal with any residue.

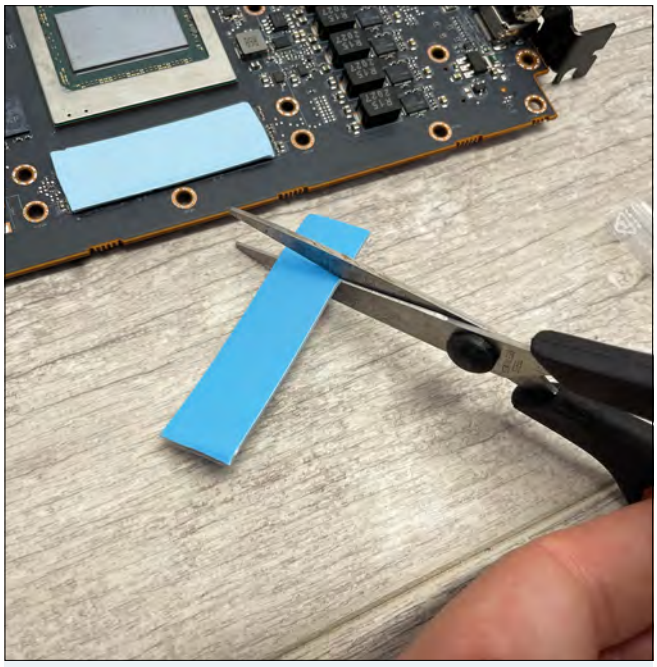


10 / REMOVE STOCK BRACKET

If you plan on using the included single-slot bracket for the card, go ahead and remove any remaining screws needed to detach the stock dual-slot bracket. Keep the screws and bracket safe in the graphics card's original box.

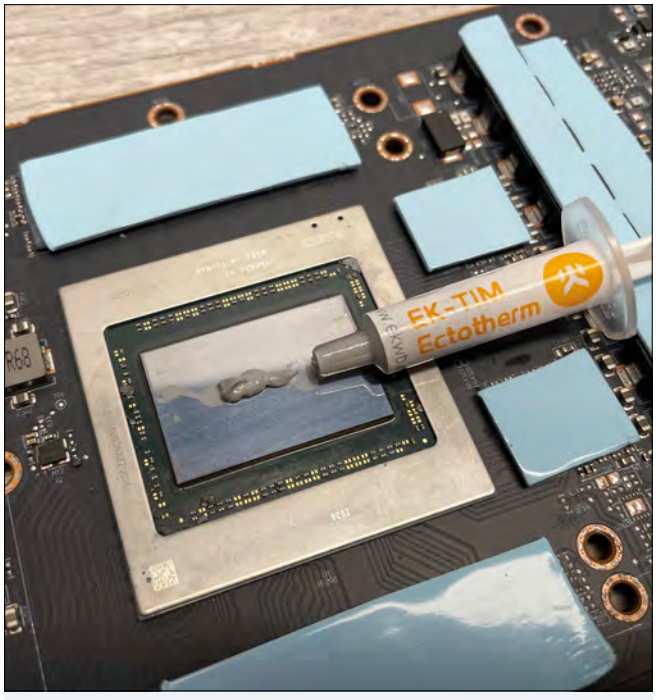
11 / ATTACH THE BRACKET

With your card clean and ready for its new components, attach the new single-slot bracket if you want to use it. This is secured using the screws at the end of the card. Be sure to align the ports first, then use a micro screwdriver to secure the screws.



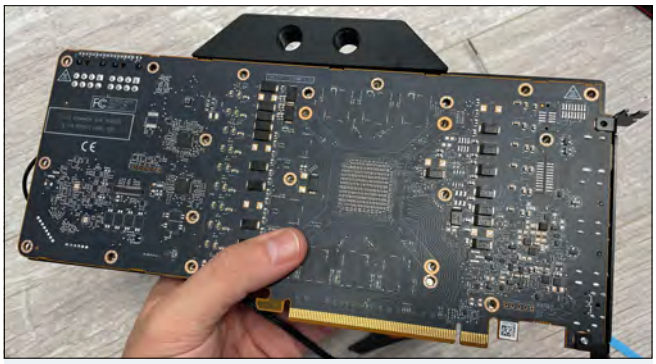
12 / CUT THERMAL PADS

Two sizes of thermal pads are included with the waterblock, and the thinner pads are to be used on the main PCB. Cut the pads into strips according to the instructions, remove both sides of protective film and then place the pads on the memory and power circuitry.



13 / APPLY THERMAL PASTE

The waterblock includes thermal paste, but you can, of course, use your own. Apply a strip of paste the size of a grain of rice in the middle of the GPU core. The pressure from the block should spread out the paste on its own, which we'll double-check in the next step.

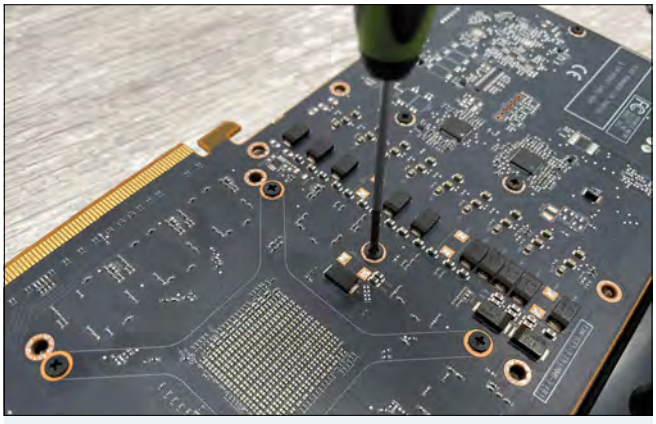


14 / TEST-FIT THE WATERBLOCK

Place the waterblock onto the PCB and press them together. It should fit snugly, with the block making contact with the memory if you look at it from the side. Now remove the waterblock gently and check the paste on the core has spread evenly. This will ensure that adequate pressure has been applied and the block is seating properly.

15 / APPLY BACKPLATE PADS

The thicker pads are used on the backplate to cool the rear of the card, behind various hot spots on the PCB such as the GPU core. Apply these pads according to the instructions, making sure to remove the protective film from both sides before doing so.

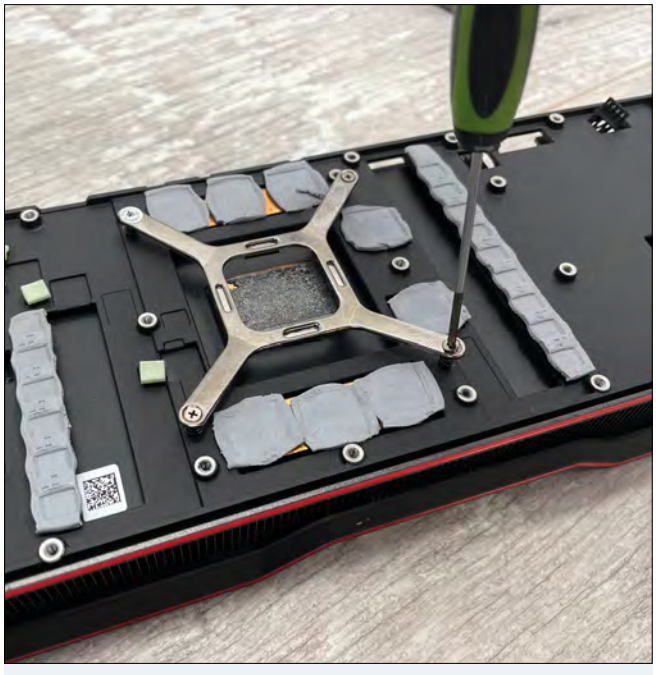


16 / INSTALL NEW SCREWS

The waterblock uses its own screws to secure to the PCB, so follow the instructions on how and where to use these screws. The backplate will use some of the visible mounting holes, so be sure to avoid these holes when you're installing the first set of screws.

17 / FIT BACKPLATE AND PORT BUNGS

Lay the backplate onto the rear of the card, then insert the screws into its mounting holes. Secure it from the centre screws first, and work your way outwards, tightening each screw firmly. Finally, install the port bungs in any unused ports. You're now free to install your fittings and connect your water-cooled graphics card to your PC.



18 / REINSTALL ORIGINAL SCREWS

Just misplacing one or two of the small screws used to mount the stock cooler can prevent you from refitting it in future. Keep them in a bag until your water-cooled graphics card is ready to use, then reattach them to the cooler where possible and place it in the box. This way you'll know where each screw goes and keep them all safe.

COOLING PERFORMANCE

You'd expect to see a drop in temperatures when moving from air to water cooling and we weren't disappointed. We first ran a looped stress test using Metro Exodus' built-in benchmark at 2,560 x 1,440 with Ultra settings. This was with the card at stock speed, and we recorded the GPU boost and memory frequencies, as well as the GPU core and hot-spot temperatures recorded in GPU-Z. This way, we could gauge the impact of both overclocking and water-cooling the card.

There are several ways to overclock the RX 6800 series, from simply increasing the power limit to using the Rage Mode setting that lifts power and thermal limits to boost frequencies. You can also use a full manual overclock. We opted for the latter to be able to turn as many dials up as possible.

Our overclock entailed raising the power limit in Radeon Settings to 115 per cent, the peak boost frequency up to 110 per cent (due to the maximum setting of 115 per cent crashing our stress test), and the memory overclock up to 107 per cent. This saw the peak boost frequency rise from 2383MHz to 2577MHz, and the memory frequency from 1992MHz to 2140MHz.

At stock speed, the peak GPU temperature hit 77°C and the hot-spot temperature reported in GPU-Z hit a toasty 93°C with the stock air cooler installed. The overclock resulted in the core temperature rising just one degree, but the hot-spot temperature hitting 98°C. In our Metro Exodus benchmark at 2,560 x 1,440 with Ultra settings, the overclock saw the minimum 99th percentile rise from 63fps to 70fps, which is a healthy gain of 11 per cent, and the average going from 107fps to 112fps. Even with the stock cooler, overclocking is definitely worthwhile.

Once we'd fitted the waterblock, we started by looking at the temperatures. The peak temperature with the card at stock speed fell from 77°C to 56°C, while the hot-spot temperature fell from 93°C to just 72°C. Our air-cooled boost frequency peaked at 2383MHz, but water-cooling the card added nearly 100MHz of boost headroom, rising to 2470MHz. However, it did nothing for the memory, which sat at 1990MHz.

Compared with the stock speed performance in Metro Exodus, the minimum frame rate rose 2fps from 63fps to 65fps, with 2fps being added to the average frame rate too.

We applied the same overclock settings as we did to the air-cooled card and managed to bump up the average frame rate to 116fps from an air-cooled overclocked result of 112fps.

However, it was the temperatures that were really interesting here. They fell from 78°C for the core to 63°C, and the hot-spot temperature fell from a massive 98°C to just 84°C, although the latter measurement did increase significantly from the 72°C result at stock speed.

Overall, then, you'll see gains in performance and noise reduction at both stock speed and when overclocked with the RX 6800 XT. Temperatures fell by up to 22°C and boosting increased by nearly 100MHz just by dropping the temperatures. A combination of overclocking and water cooling resulted in the minimum and average frame rates rising from 63fps and 107fps to 70fps and 116fps.

The higher temperature headroom clearly allowed for higher boosting at stock speed, resulting in performance gains without touching any overclocking controls. However, it's the temperature reductions that are the biggest hits, with massive falls in the core and hot-spot temperatures, both when overclocked and at stock speed. Thankfully, the RX 6800 XT is also quite easy to water-cool compared with many RTX-series cards, and there are waterblocks available at launch too. **CPC**

NEW

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SOCKET AM4 CPU

AMD RYZEN 5 5600X / £280 inc VAT

SUPPLIER scan.co.uk

VACCINE

+ Excellent overclocker
+ Great gaming performance
+ Comes with cooler

VIRUS

– Ryzen 7 3700X better for multi-threaded work
– Best when overclocked
– Pricey for a 6-core CPU

AMD's 6-core CPUs have been some of our favourites over the past few years, and the Ryzen 5 5600X looks set to continue that trend. However, at £280, it's not cheap and has plenty of stiff competition. The Ryzen 7 3700X has two more cores and four more threads, albeit based on older Zen 2 technology, and costs the same price, while the Core i5-10600K now retails for around £40 less and is a stellar gaming CPU.

The Ryzen 5 5600X might only have a 65W thermal design power (TDP), but it's still extremely potent, thanks to AMD's new Zen 3 microarchitecture. It's able to boost to a peak frequency of 4.6GHz, which is good, but also a fair bit slower than the 4.9-5GHz we saw with the Ryzen 9 5950X (see opposite). The 5600X's all-core boost was decent at 4.4GHz, though, so it should be able to hold its own in lightly threaded applications.

Unlike other Zen 3 CPUs, AMD has also included its Wraith Stealth cooler in the 5600X's box, enabling you to save a little bit of cash if you don't plan to overclock your chip. In terms of specs, the Ryzen 5 5600X has just a single CCX enabled, so you get half the L3 cash of the two most expensive Zen 3 CPUs at 32MB, but the same amount as the Ryzen 7 5800X. There's a little less L2 cache, though, at 3MB, compared to 4MB. Also, the 5800X has a higher TDP of 105W, potentially allowing it to hit higher frequencies depending on your cooling.

SPEC

Base frequency
3.7GHz

Max boost frequency
4.6GHz

Core
Zen 3

Manufacturing process
7nm

Number of cores
6 x physical (12 threads)

IGP
None

Simultaneous Multithreading
Yes

Cache
32MB L3, 3MB L2

Memory controller
Dual-channel DDR4, up to 3200MHz

Packaging
AMD Socket AM4

Thermal design power (TDP)
65W

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

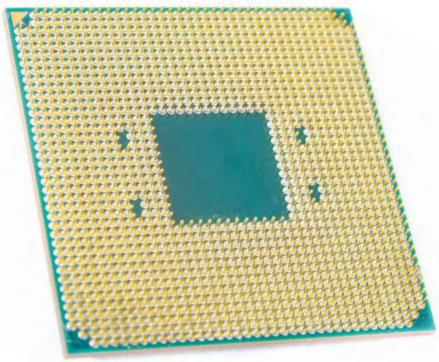
Performance

Overclocking the Ryzen 5 5600X proved very fruitful, and we managed to hit 4.7GHz across all cores with a vcore of 1.25V, bettering the peak stock speed boost frequency by 100MHz. This means there's very little reason not to apply a manual overclock to this CPU, since you're increasing both the peak single-core boost and all-core boost. Even if you prefer to use less voltage, you'll still likely match that single-core boost of 4.6GHz across all cores.

Our predominantly single-threaded image editing test certainly benefited from the high boost clock, with a score of just under 71,000, which is significantly higher than the Core i9-10900K and Ryzen 5 3600XT. It even bettered both 16-core Ryzen CPUs here, likely because they boosted to lower frequencies.

The 5600X's score of 542,000 in our video encoding test was also high enough to see off the Core i5-10600K and was again much higher than the Ryzen 5 3600XT, but significantly slower than the Ryzen 7 5800X. However, the Ryzen 7 3700X only scored 577,540, so it isn't too far ahead in this multi-threaded test, despite having two more cores.

The 5600X's system score of 236,431 was a little way behind the Ryzen 7 3700X, but bettered the Ryzen 5 3600XT and was a little quicker than the Core i5-10600K too. Overclocking saw it edge closer towards the Ryzen 7 3700X overall and increase its lead over the Core i5-10600K further.



Meanwhile, the 5600X's Cinebench single-threaded score of 600 was a fair climb down from other Zen 3 CPUs, but it's still much higher than any other chips. The multi-threaded Cinebench test also saw its score of 4,296 better the Ryzen 5 3600XT by a few hundred points, and it held an 800-point lead over the Core i5-10600K. The Ryzen 7 3700X was a few hundred points ahead, though, and even overclocking didn't see the Ryzen 5 5600X catch it.

In terms of gaming, Far Cry New Dawn offered a great result for the Ryzen 5 5600X with a minimum frame rate of 100fps and average of 134fps, climbing to 106fps and 140fps once overclocked – the fastest of any CPU on test. The Ryzen 7 3700X could only muster a minimum and average of 82fps and 122fps, while the Core i5-10600K was well down with a 90fps minimum and 129fps average. Metro Exodus saw the Core i5-10600K offer a slightly higher average frame rate, and overclocking the AMD CPU didn't offer any benefit, but it was still a little quicker than the Ryzen 5 3600XT.

The power draw was also low at just 223W for our whole system, shaving over 20W off the Core i5-10600K, although the Ryzen 9 3600XT was better still at 208W.

Conclusion

The Ryzen 5 5600X rarely shows any deficit compared with pricier Zen 3 options in games, while comfortably outpacing the Core i5-10600K and Ryzen 5 3600XT. The latter CPUs are cheaper and still worth considering, but the Ryzen 5 5600X is a potent all-rounder, although the Ryzen 7 3700X is a slightly better buy if multi-threaded performance is your top priority. AMD's new 6-core CPU isn't as affordable as its predecessors, but it's still a fantastic buy and very overclockable too.

ANTONY LEATHER

VERDICT

Not the bargain 6-core chip we're used to seeing but a stunning CPU nonetheless.

PERFORMANCE **44/50**

FEATURES **13/15**

VALUE **31/35**

OVERALL SCORE **88%**

SOCKET AM4 CPU

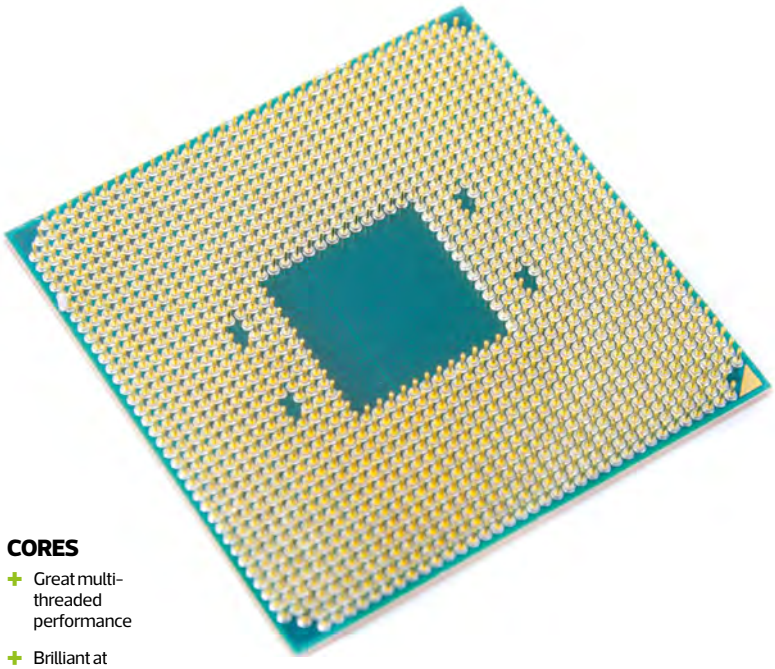
AMD RYZEN 9 5950X / £750 inc VAT

SUPPLIER scan.co.uk

While AMD's Ryzen 9 3950X was generally a killer CPU, it lagged behind Intel's CPUs in plenty of games, meaning it wasn't quite the king of mainstream desktop performance. With the Ryzen 9 5950X, though, we're hoping the gaming prowess of the other Zen 3 CPUs we saw last month will be present here too.

It's quite a different beast to the likes of the Ryzen 5 5600X and Ryzen 7 5800X, though, as it has both its 8-core core complexes fully enabled. This means AMD has to rein in the frequency when lots of cores are loaded. As a result, while other Zen 3 CPUs can boost to higher than 4.4GHz across all cores in multi-threaded workloads, the Ryzen 9 5950X only hit 3.85GHz in our water-cooled system.

However, the single core boost was spectacular, zipping past the rated specification of 4.9GHz and peaking at 5.05GHz. With two of the new 8-core complexes enabled, the CPU has the full 64MB L3 cache and the 16 cores give you the full 8MB of L2 cache.



CORES

- \+ Great multi-threaded performance
- \+ Brilliant at nearly everything
- \+ Fast gaming pace

BORES

- – Boost clocks fall as you load more cores
- – Ryzen 7 5900X just as fast in games
- – Expensive

Performance

Overclocking can be hit-and-miss with Ryzen CPUs, and some of them are best left at stock speeds to enable them to hit those high boost frequencies. However, with the Ryzen 9 5950X, if you need the best multi-threaded performance, it's worth trying manual overclocking, as we managed to hit 4.6GHz with a 1.25V vcore. That's a massive 800MHz higher than the stock speed all-core boost, and is also a lot higher than the typical 200MHz or so you'll see by enabling Automatic Overclocking. The downside is that it's still 400MHz lower than the single-core boost we observed, so lightly threaded applications will take a performance hit.

Our image editing test revealed slightly slower results than the other Zen 3 CPUs, at 66,182 compared to 71,875, with the Ryzen 9 5900X and there was no advantage over the Ryzen 9 3950X either. It's likely that the 6-core and 8-core CPUs were able to boost to higher frequencies in this particular test, offering slightly more grunt. Overclocking also saw a slightly lower result, which was largely expected in this predominantly single-threaded test.

Our multi-threaded video encoding test told a very different story though. Once all the cores were loaded, the Ryzen 9 5950X was a monster, topping one million points for the first time in our benchmarks, and adding over 100,000 points to the score of the Ryzen 9 3950X. Overclocking added another 60,000 points to the score too. Handbrake isn't as heavily multi-threaded as some software, though, and scales poorly once you go above 12 cores, so it wasn't surprising to see the Ryzen 9 5900X coming within 100,000 points of the 5950X.

The Ryzen 9 5950X also managed the highest multi-tasking score, leaving it with the highest system score we've seen at 379,264, compared to the Ryzen 9 3950X's 326,395. Comparatively, the Core i9-10900K managed 319,958 overall, but again, the Ryzen 9 5900X wasn't far behind AMD's new flagship with a score of 352,999. Once it was overclocked, the Ryzen 9 5950X's system score sat just shy of 400,000 points, which is amazing.

Likewise, the single-threaded score in Cinebench of 647 is stunning, being over 100 points faster than the Core i9-10900K and Ryzen 9 3950X. The Cinebench multi-threaded test also brought us a result over 10,000, and overclocking yielded a massive 11,826, which is only a couple of thousand points short of the Threadripper 3960X.

Meanwhile, Far Cry New Dawn loved the new flagship AMD CPU, with a minimum frame rate of 104fps and an average of 135fps, comfortably beating the Core i9-10900K and Ryzen 9 3950X, but not really offering much more performance than the other Zen 3 CPUs. Metro Exodus was less impressive, with this test clearly still leaning on our GPU to a degree, but the Core i9-10900K was a little faster on the average frame rate at 82fps compared to 72fps, with the AMD CPU climbing to 78fps once overclocked.

Finally, the 5950X's power consumption at stock speed was superb for such a powerful CPU, with our system only drawing 293W from the mains – that's 100W lower than with the Core i9-10900K.

SPEC

Base frequency
3.7GHz

Max boost frequency
4.9GHz

Core
Zen 3

Manufacturing process
7nm

Number of cores
16 x physical (32 threads)

IGP
None

Simultaneous Multithreading
Yes

Cache
64MB L3, 8MB L2

Memory controller
Dual-channel DDR4, up to 3200MHz

Packaging
AMD Socket AM4

Thermal design power (TDP)
105W

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

Conclusion

There are some important points to take away with the Ryzen 9 5950X. Firstly, it rarely offers higher performance in games than cheaper Zen 3 models, and even then the difference is small. When all those cores and threads are put to use, it's a monster, comfortably outstripping the competition and its predecessor, but slipping slightly in some tests compared with CPUs with higher all-core boost clocks. It's not quite a clean sweep of massive numbers, but if you need a CPU that's great for every possible task, the Ryzen 9 5950X is by far the best CPU for the job.

ANTONY LEATHER

VERDICT

The most powerful all-round CPU the PC has ever seen, but not everyone can make full use of its 16 cores.

PERFORMANCE **48/50**

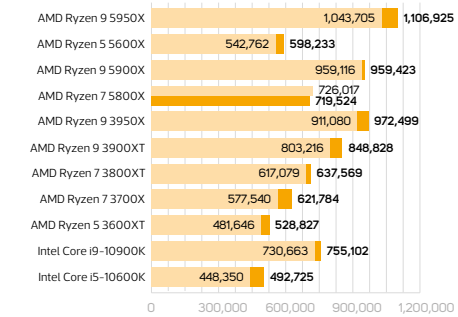
FEATURES **13/15**

VALUE **28/35**

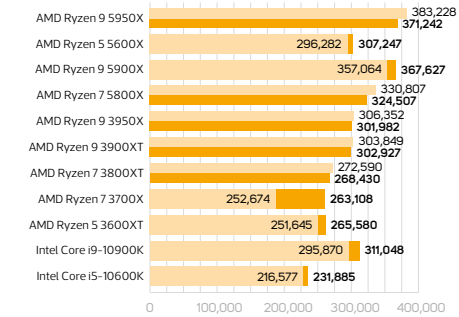
OVERALL SCORE **89%**

BENCHMARK RESULTS

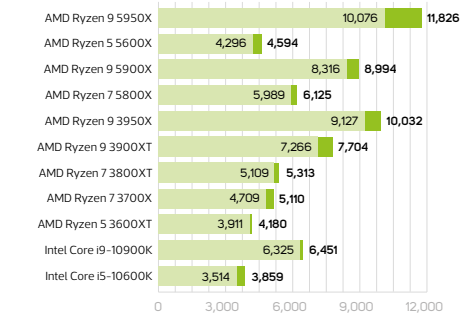
HANDBRAKE H.264 VIDEO ENCODING



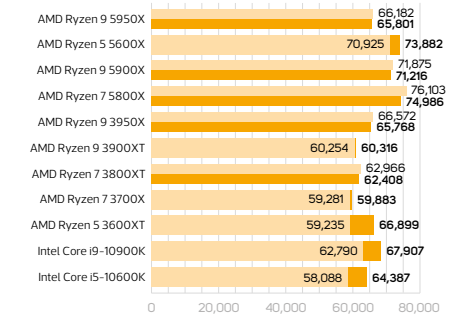
HEAVY MULTI-TASKING



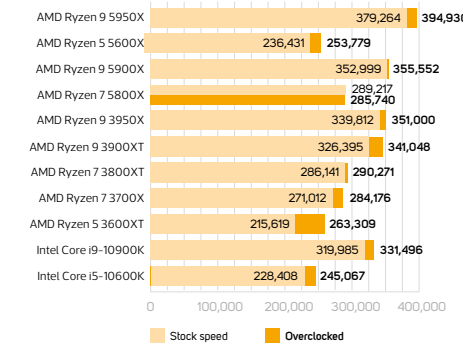
CINEBENCH R20 MULTI-THREADED



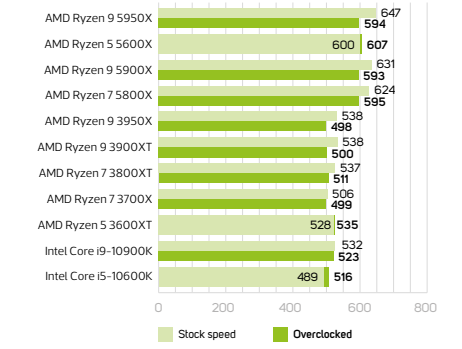
GIMP IMAGE EDITING



SYSTEM SCORE

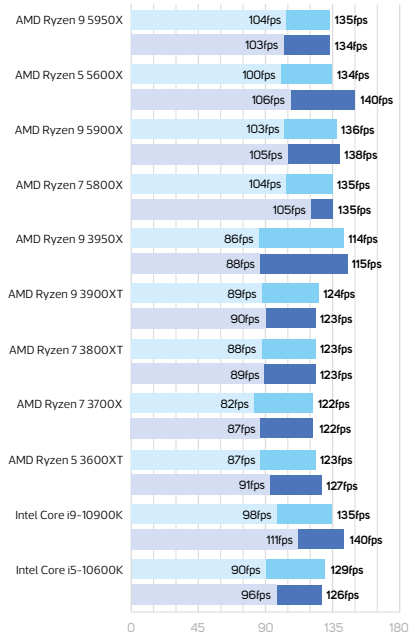


CINEBENCH R20 SINGLE-THREADED



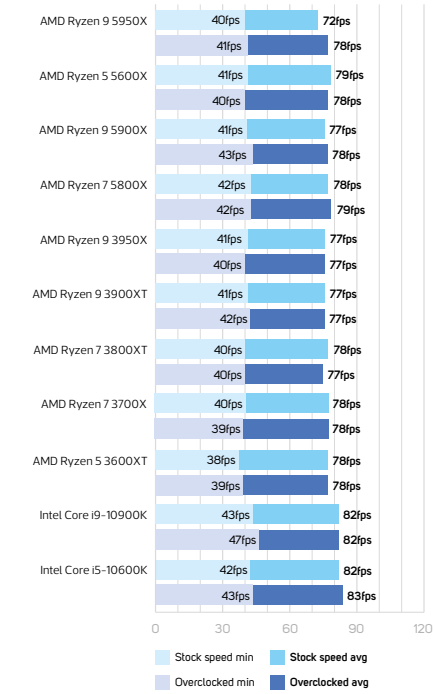
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings



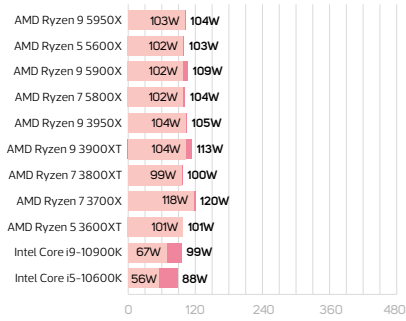
METRO EXODUS

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

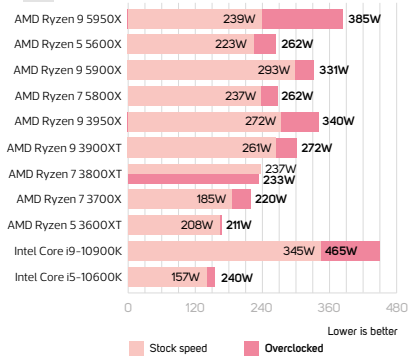


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



ATX CASE

PHANTEKS ECLIPSE P400A DRGB / £85 inc VAT

SUPPLIER overclockers.co.uk

HOLE IN ONE

- + Excellent CPU and GPU cooling
- + Reasonably priced
- + Snazzy RGB lighting

HOLE IN THE HEAD

- – No USB Type-C
- – No roof radiator support
- – Limited CPU cooler clearance
- – Lacks new ideas

If we could make one complaint to Phanteks about its cases over the years, it would be that the airflow and cooling haven't always been top-notch. Thankfully, these cases' cooling results have rarely been poor enough to be dealbreakers, especially when Phanteks usually includes excellent features and forward-thinking, unique designs.

However, the company is now changing tack and offering cases with mesh panels and improved cooling, with the Eclipse P400A DRGB adding a top-to-bottom front mesh with RGB fans, plus some useful features.

It's an attractive case, and it comes equipped with a single glass side panel and three digital RGB 120mm fans (included and installed) in the front, pointing at a generous dose of positive air pressure – we would advise adding a rear fan to this setup. The fans' lights are still vibrantly visible through the mesh here, although they would likely look crisper behind a glass front. If the black stylising isn't to your tastes, this case is also available in white.

The side panel is held on by four thumbscrews, so it's not as easy to remove and reinstall as the toolless one on the Fractal Design Define 7 Compact, for example. When we started removing the side panels, we spotted that, as with the Fractal Design Define 7, you can remove the roof entirely, revealing a large void that makes building your PC much easier. However, you'll need to deal with half a dozen or so screws first.

Meanwhile, the roof sports a large magnetic dust filter, with a smaller pull-out filter in the base for the PSU. The front mesh panel also pops off easily, enabling you to clean out the dust, and we were pleased to see no gaps in the bottom here either, which could let dust into the case.

SPEC

Dimensions (mm)
210 x 465 x 470 (W x D x H)

Material
Steel, plastic, glass

Available colours
Black, white

Weight
7kg

Front panel
Power, reset, 2 x USB 3, stereo, mic

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

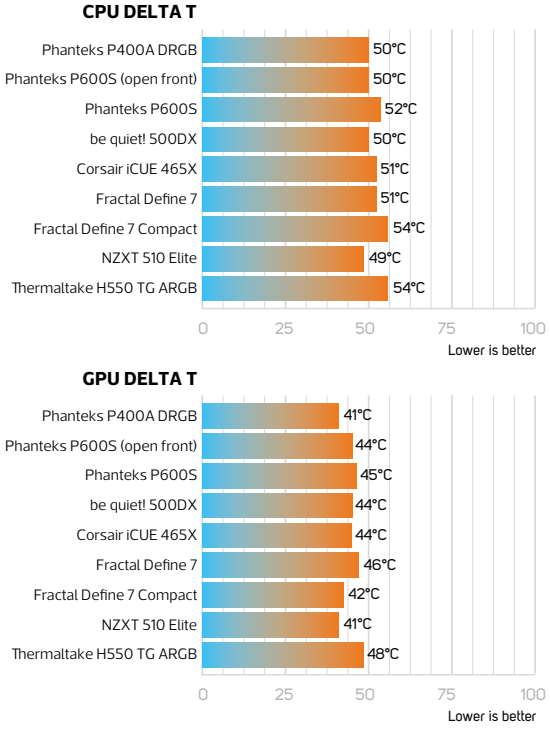
Form factor(s)
E-ATX, ATX, micro-ATX

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

CPU cooler clearance
160mm

Maximum graphics card length
420mm

TEMPERATURE RESULTS (DELTA T)



The front panel lacks a USB Type-C, but there are two USB 3 Type-A ports, audio jacks and an illuminated power button, so the basics are covered. There are also three buttons underneath the front roof's overhanging section, which control the lighting mode and colour, as well as providing a reset switch, with the P400S version of the case also sporting a fan controller in the same place. The RGB lighting can alternatively be controlled from 3-pin RGB headers on your motherboard, and Phanteks includes daisy-chain cables for the lighting, enabling you to add other Phanteks RGB components to the lighting system.

Measuring 47cm tall and deep, the P400A is reasonably compact, but there's still plenty of scope for housing a water-cooling system inside it. The front fan mounts comprise a trio of 120mm or pair of 140mm fan mounts, with the option of installing 360mm or 280mm radiators respectively. However, if you choose to take the 360mm route, you'll need to remove the storage cage in the bottom of the case, which is home to a pair of slide-out 2.5in/3.5in trays.

The roof can also house an additional pair of 120mm or 140mm fans, with a single 120mm fan mount in the rear, but there's not enough space in the roof to house radiators due to clearance with the motherboard. That's a shame, since the ability to remove the roof would make installing a radiator in this location easier than with a fixed roof.

For air cooling, the CPU 160mm of cooler clearance is reasonable, but it does rule out the largest coolers available.

The 420mm of graphics card clearance is much better, but there's no included PCI-E riser cable or mounting bracket to situate your graphics card vertically – you'll need to buy those parts separately.

Storage options are basic overall, with just another two 2.5in mounts behind the motherboard tray in addition to the aforementioned cage. However, there's space for a further four hard disks at the front if you purchase optional brackets.

Cable tidying is decent, which we expect given Phanteks' usual high standards, with meaty pre-installed Velcro ties. However, we'd like to see a few more of these Velcro ties included, rather than a bunch of standard cable ties. The case also feels rather dated in terms of features compared with recent efforts both by Phanteks itself and the likes of Fractal Design – there's a real lack of cutting-edge ideas here.

Performance

While there's no rear fan, the meshed front panel and trio of fans helped the case to achieve an excellent CPU delta T of 50°C, matching the be quiet! Pure Base 500DX and Fractal Design Define 7, while bettering the Define 7 Compact by a few degrees. Only the NZXT 510 Elite was cooler, albeit with far more noise, so despite our concerns, the P400A is a great case for CPU cooling.

Switching to the GPU delta T, the Eclipse P400A DRGB managed a result of 41°C, which is the joint best result we've seen recently. Undoubtedly, those front fans pointing at the graphics card helped here, but mesh-fronted cases usually do well overall. The fans were quiet too, despite the mesh leaking some noise – this case is a good choice for noise-sensitive enthusiasts.

Conclusion

The Eclipse P400A DRGB is up against some very stiff competition in the sub-£100 price category. The Fractal Design Define 7 Compact offers a few more features and expansion potential for the same cash, but the Eclipse P400A DRGB does offer better cooling. Meanwhile, the superb be quiet! Pure Base 500DX has more scope for bigger air coolers and roof-mounted radiators, while offering similar cooling and USB 3.1 Type-C support.

Ultimately, we'd choose the be quiet! or the Fractal options over the Eclipse P400A DRGB, as you get more for your money. However, that's not to completely dismiss Phanteks' offering. It looks great, it has excellent cooling, it makes for easy PC building and it has reasonable expansion options. It doesn't quite blow our socks off though.

ANTONY LEATHER

VERDICT

Superb cooling for the price, but there are more feature-rich options in this price league.

COOLING
28/30

FEATURES
15/20

DESIGN
25/30

VALUE
17/20

OVERALL SCORE
85%

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PCI-E 4 NVME SSD

1TB TEAMGROUP T-FORCE CARDEA ZERO Z440 / £180 inc VAT

SUPPLIER overclockers.co.uk

THE MANDALORIAN

+ Excellent read and write speeds
+ Faster than PCI-E 3 SSDs
+ Good warranty

THE KARDASHIANS

− Gets hot under sustained loads
− Slightly pricier than the competition
− Basic software bundle

While we're finally seeing companies such as Samsung offer controllers for PCI-E 4 SSDs, the Phison E16 controller was the only option until recently, and there are still manufacturers pushing M.2 SSDs with this popular controller into a crowded marketplace. As we saw in our recent PCI-E 4 NVMe M.2 group test, only Samsung's 980 Pro begged to differ with its own in-house controller.

One such Phison-based drive is Teamgroup's T-Force Cardea Zero Z440, which is left with price, aesthetics, software and cooling to win us over. While stock shortages have reduced it to pre-order status for now, its price of £180 makes it £10 more expensive than the likes of the Sabrent Rocket, which came top in our group test thanks to its low price and inclusion of Acronis True Image in the package.

The trouble with the Teamgroup T-Force Cardea Zero Z440 is that it doesn't make up for the lack of extras and price with a snazzy heatsink, unlike the Gigabyte Aorus NVMe Gen4 SSD and Corsair MP600. There's a thin sliver of what Teamgroup claims is a copper-graphene composite with a snazzy logo on it.

Unlike Samsung's drive, the T-Force Cardea Zero Z440 has a blue SSD, so it isn't quite as colour-neutral if you're intending to show it off. The thin, thermally conductive material also didn't do a particularly good job of cooling the SSD either, which hit 80°C in our test, although strapping our motherboard's heatsink to it saw that fall to around 50°C.

Being based on the Phison E16 controller and using 3D TLC memory, the SSD has similar specs to most of the drives we saw last month, with claimed read speeds up to 5,000MB/sec and write speeds up to 4,400MB/sec, which are apparently the same for both the 1TB model we're reviewing and the 2TB model that's also available. Both come with a five year warranty, but the endurance rating differs at 1,800TBW (terabytes written) for the 1TB model and 3,600TBW for the 2TB SSD.

Performance sat at 767,031 IOPS for 4K random reads, and 697,125 IOPS for 4K random writes in CrystalDiskMark, with sequential readings of 4,995MB/sec read and 4,293MB/sec write. The sequential speeds are right on the money compared with other Phison E16 controller SSDs, and only the Samsung 980 Pro offers more throughput here. The 4K random speeds in AS SSD were on par too, at 73MB/sec read and 189MB/sec write. The software included is rather basic, though, with a data migration option being the only particularly useful feature. Unlike other SSD software packages we've tested, we couldn't find a way to update the firmware either.

SPEC

Form factor
M.2

Interface
PCI-E 4

Protocol
NVMe

Capacities
1TB, 2TB

Controller
Phison E16

NAND
3D TLC

Warranty
Five years

Write endurance
1,800TBW (1TB), 3,600TBW (2TB)

Conclusion

If you're keen on using your motherboard's M.2 heatsink, and just want to drop in your SSD and go, your only real concern is price when it comes to PCI-E 4 SSDs. Here, the Teamgroup T-Force Cardea Zero Z440 is £10 more expensive than the otherwise identical Sabrent Rocket. What's more, the latter also comes with Acronis True Image, while other SSDs have more capable in-house software and heatsinks compared with the Z440.

As a result, while there's just a £10 price difference and it performs admirably, we can't really recommend this Teamgroup drive, since you can essentially get the same SSD for less money. Of course, it's always worth keeping track of prices, and were it cheaper than the Sabrent Rocket, it would be worth a punt. Until then, it doesn't offer any benefit over other Phison E16 SSDs, while costing a little more money.

ANTONY LEATHER

VERDICT

Plenty fast enough, but a little too expensive for a basic Phison-based PCI-E 4 SSD.

PERFORMANCE 47/50
FEATURES 14/20
VALUE 23/30
OVERALL SCORE 84%

GAMING HEADSET

CORSAIR HS60 HAPTIC / £120 inc VAT

SUPPLIER ebuyer.com

Haptic feedback is all the rage at the moment, with the PlayStation 5's DualSense controller being a particularly well-received recent example. With its HS60 Haptic, though, Corsair isn't aiming to enhance the sensory experience of your fingers, but of your head, by adding haptic bass rumbles to your listening experience.

The headset builds on the company's existing HS60 headset line-up, with the new haptic feedback provided by the addition of a device called a Taction Transporter. Developed by a new company called Taction Technology, this device is a small transducer module that converts an audio signal into a bass rumble that you feel rather than hear.

It covers a range of frequencies, from 180Hz all the way down to 12Hz, and is billed as providing the feel of a 200lbs subwoofer in a 1oz module. The HS60 Haptic is the first headset to use the Taction Transporter, but other products from other companies are apparently incoming.

So does the technology work? In a word, yes. Crank up a really bass-heavy track and your head is treated to the same sort of pummelling that your whole body experiences in a nightclub. The same effect accompanies deep rumbles and explosions in games or videos, and it genuinely adds to the atmosphere and goes far beyond what any normal headphones can deliver. It also does this while feeling surprisingly natural and well integrated into the overall sound.

There are some fairly major downsides though. In particular, when listening to music – especially the sort of music that such headphones are designed to enhance – the constant vibration is relentless. Some of us also found the vibrations tickled inside our ears, eliciting the occasional shudder, although this didn't affect all who tried it.

When gaming, the extra rumbles will also likely prove a distraction for any competitive gaming, where you're more concerned about hearing opponents' footsteps than sinking deep into the aural experience. For more atmospheric games, though, it can add a little extra immersion.

Meanwhile, the headset itself is a wired, USB affair, which we'd normally expect to mean it also offers virtual surround sound. However, that isn't the case, as this is a stereo headset only, although it does support Windows Spatial Sound.

As well as the haptic intensity control on the right earcup, on the left earcup you get a digital volume wheel that's annoyingly slow to adjust, along with a socket for the basic bendy microphone and a microphone mute button.

The basic HS60 is a relatively budget headset, and the drawbacks of that basic core design are clear. The earcup padding isn't all that thick, soft or well contoured, so it doesn't tuck under and around your ears very well, and the headband padding isn't particularly comfortable either.

The earcups also don't twist or offer up much flexibility to conform to the varied shapes of different people's heads. Overall sound quality is also only on par with the £60 HS60, rather than other £100+ headsets.

Conclusion

The addition of bass rumbles makes the HS60 Haptic stand out from most basic gaming headsets, and in the right scenario it can really enhance your gaming immersion or music listening fun. However, it's certainly not a feature you'll want to enable all the time, and it doesn't positively change overall sound quality. Meanwhile, the rest of the HS60 Haptic feels very much like the budget headset on which it's based, which makes it hard to recommend at this price.

EDWARD CHESTER

SPEC

Audio config
Stereo

Frequency range
20-20,000Hz

Mic frequency range
100Hz-10,000Hz

Connection
USB

Weight
390g

Extras
Haptic feedback, volume and haptic dials, mic mute button

VERDICT

The haptic tech works well, and can enhance some gaming situations, but it's built into a slightly disappointing budget headset package.

FORCE FEEDBACK

+ Haptic feedback impressively powerful
+ Good overall build quality

FORCE FEEDING

– Haptic feedback can be tiring and distracting
– Fairly basic overall sound quality
– Not very comfortable
– Expensive

DESIGN 15/20

FEATURES 17/20

SOUND QUALITY 18/30

VALUE 18/30

OVERALL SCORE 68%

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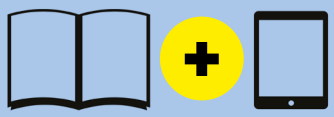

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MECHANICAL GAMING KEYBOARD

CORSAIR K60 RGB PRO / £110 inc VAT

SUPPLIER overclockers.co.uk

VIOLA

+ Smart design
+ Viola switches feel good
+ Cherry MX keycap compatibility
+ Great RGB lighting

VIOLENCE

– Pricey for budget mechanical switches
– Lack of extra features

The K60 RGB Pro is Corsair's first keyboard (and one of the first in the world) to feature Cherry's new lower-cost mechanical switch, the Viola. With a much simpler internal design that only uses four parts, compared with the eight parts used in Cherry MX switches, these true mechanical switches are designed to take on other budget switch designs, such as membrane or 'membranichal' switches.

One of the obvious presumed benefits of a mechanical switch that uses metal springs and contacts over any rubber dome-based switch is a longer, more reliable lifespan, but Cherry hasn't stated the lifespan of these switches, which is a bit disappointing. Nonetheless, we would expect these to last considerably longer. For now, the Violas are only available in a linear switch style, without the tactile or clicky feedback of some mechanical switches. However, such variants will be arriving at a later date.

The switches feel good, featuring a 2mm pretravel that requires a 45cN force – then, after actuation, you get a 75cN stronger feedback before the switch bottoms out. This makes for a fast initial key response, and a quick key return, which reduces the harsh bottoming-out feel of some keys.

The keys are also compatible with standard Cherry MX cross keycaps, so you can easily swap out the caps for a style of your choice. What's more, the switches themselves are hot-swappable. Just squeeze the tabs on the side of the switch and they pop right out. In fact, the contact points of the switches stay on the base of the keyboard – the switch isn't complete without the baseplate.

Back to the K60 RGB Pro, this keyboard also sports a fetching minimalist design. You still get the aluminium top plate that's a signature of Corsair boards, but it's a smaller plate than the one on the company's older K70-style boards, with a smoother brushed finish, and it sits flush to the sides. Even the Corsair logo is reduced to a tiny silver spec in the top right, alongside the four white Lock key indicator lights – it's a very classy-looking keyboard.

Aside from the RGB lighting, though, you get absolutely no extra features. There's no USB pass-through, no extra media keys and no volume wheel. There's not even a basic wrist rest in the box. The cable is a simple, fixed and unbraided affair as well. However, Corsair's iCUE software does provide macro recording and assignment, as well as comprehensive per-key lighting effect support. The lighting looks great as well.

Despite the lack of frills, though, the K60 RGB Pro does look great and the typing experience is very good. The way you can remove the switches would seem to make them a bit more vulnerable to spills and other crud affecting their operation, but it's also easy enough to remove and clean them.

Conclusion

The Corsair K60 RGB Pro is an attractive, simple RGB mechanical keyboard, and its new Cherry Viola switches are an intriguing addition. If Cherry really can make them cheap enough to compete with budget membrane keyboards then they'll make for a good, affordable upgrade for many users. However, £110 isn't really cheap enough compared with the roughly £140 required for an equivalent Cherry MX keyboard. The Corsair K60 RGB Pro is a decent keyboard, but it's too expensive for what's on offer.

EDWARD CHESTER

SPEC

Dimensions (mm)
478 x 216 x 33 (W x D x H)

Weight
880g

Format
Full size (105+6 gaming keys)

Connections
Fixed USB 2

Switch type
Cherry Viola linear

Backlighting
RGB

VERDICT

Cherry's Viola switches show promise, but £110 is a lot to ask for an apparent budget keyboard option with so few extra features.

DESIGN 37/40

FEATURES 23/35

VALUE 17/25

OVERALL SCORE 77%

GAMING KEYBOARD

ASUS ROG STRIX SCOPE RX / £125 inc VAT

SUPPLIER overclockers.co.uk

Asus' ROG Strix Scope RX is designed for FPS gamers who demand lightning-fast key actuation, and it features Asus' first opto-mechanical switch. These RX switches use infrared beams rather than metal contact plates, and the buttons have a linear design with a 1.5mm actuation point and a 40g actuation force.

As a point of comparison, the last Asus Scope device we reviewed was the TKL Deluxe, which used Cherry MX Red switches with a 2mm actuation point and a 45g actuation force. Other common Cherry MX switches tend to be taller and need more force, and even Cherry MX Speed switches require more weight, despite their shorter actuation distance. Meanwhile, the latest optical keyboard we reviewed was the Corsair K100, which balanced a 45g actuation force with a tiny 1mm actuation point.

The RX switch has a moderate specification, then, and it's combined with a new key design that's intended to make the buttons more rigid and less wobbly. Accordingly, the keycaps are mounted on a wider base than the narrow, cross-style mounts used by many mechanical keyboards, and they sit on top of a scissor-style framework.

The results are impressive. The buttons respond with fantastic speed, they actuate quickly and they bottom out with a satisfying snap. The soft-touch coating and redesigned construction makes them feel comfortable, consistent and solid under your fingers too. These keys have more speed than any mechanical keyboard we've tested, and their revised design means they feel heavier than those on most optical units, which pair their improved speed with ultra-lightweight keys.

You should only look elsewhere if you crave optical speed with keys that feel notably lighter. As ever, though, the difference between mechanical and optical hardware is relatively small, but keen players of fast-paced games may appreciate the difference.

The buttons float above an aluminium alloy plate that does a great job of showing off the scissor-style switches and the per-key RGB LED lighting. The build quality is tremendous too, and it's bolstered with IP56 protection against dust and water, as well as a 100-million keystroke endurance rating. The buttons serve up n-key rollover and anti-ghosting as well.

Meanwhile, the lighting is bright, crisp and even, plus it can be managed and synchronised using Asus' Armoury Crate app. Asus has extended the size of the Ctrl key to aid FPS gameplay, and five profiles can be stored to the device. There's also a Stealth key to instantly minimise apps and mute audio, and a USB 2 pass-through port at the rear, although USB 3 would arguably be more useful these days.

As this isn't a TKL device, this particular Scope model is more versatile than many other keyboards with an eye on FPS and esports gamers. The 1.07kg weight is still light enough for frequent transport, and the dimensions are decent for a full-sized keyboard because the design barely extends beyond the keys.

There are some significant omissions though. Media controls are handled by Function key shortcuts, because the Scope doesn't have any extra buttons. Also, the 1.8m cable isn't detachable, there's no wrist rest, no travel sleeve and no alternate keycaps.

SPEC

Connection
Wired, USB

Cable
1.8m braided

Material
Plastic, aluminium

Switch type
Asus ROG RX Optical

Backlighting
RGB

Extras
USB 2 pass-through

TELESCOPIC

- \+ Superb, well-balanced opto-mechanical switches
- \+ Excellent build quality
- \+ Bright, crisp RGB LEDs
- \+ Cheaper than other opto-mechanical keyboards

CATASTROPHIC

- – Not many additional features
- – No wrist rest
- – No extra buttons

Conclusion

The absence of extra features means the Scope won't suit everyone, and the move to optical is impressive but not transformative. The Scope RX is cheaper than the vast majority of other optical units, though, and you'll notice the difference if you're a committed FPS or esports player. The Scope serves up a fast, comfortable experience that sits between lighter optical alternatives and slower, heftier mechanical hardware. If you want optical speed with plenty of substance, it's a great option.

MIKE JENNINGS

VERDICT

Great speed from robust, comfortable keys, as well as a decent design, but the feature set is lacking for the price.

DESIGN **36/40**

FEATURES **27/35**

VALUE **20/25**

OVERALL SCORE **83%**

GAMING LAPTOP

ACER PREDATOR TRITON 300 / £1,499 inc VAT

SUPPLIER currys.co.uk

Acer's Predator Triton 300 is one of the most affordable RTX laptops we've used, and this machine uses the Max-Q edition of the RTX 2070. It has 2,304 stream processors and 8GB of memory alongside base and boost speeds of 885MHz and 1185MHz. However, the full-fat RTX 2070 is quicker in our tests.

Still, it should handle mainstream gaming without problems, and it's paired with decent mid-range components elsewhere. The popular Core i7-10750H CPU has six Hyper-Threaded cores alongside base and boost speeds of 2.5GHz and 5GHz, and it's paired with 16GB of dual-channel DDR4 memory and a 1TB WD SN730 SSD. You also get dual-band Wi-Fi 6 and Gigabit Ethernet.

Aesthetically, the Predator Triton 300 doesn't really push the envelope – there are big blue logos, outlandish air vents and thick bezels. The weight of 2.3kg and the 23mm thickness are reasonable, and build quality is middling – the base is sturdy but the screen flexes too much. It's not particularly slim or stylish, but the Acer will cope with frequent transport.

On the left, the Acer has two full-sized USB 3.2 Gen 2 ports, and on the right there's another full-sized USB port alongside a Type-C connection. You also get both HDMI and mini-DisplayPort outputs. On the inside, you can get access to both memory slots, the NVMe SSD and a spare 2.5in drive bay. It's a decent feature set – the Acer is missing Windows Hello support in its webcam, as well as card and fingerprint readers, plus Thunderbolt support, but it covers the essentials.

The keyboard has a good layout too, with a numberpad, loads of function row options and full-sized cursor keys. In terms of layout, negatives are minor: there's no Caps Lock light, the RGB LEDs are only installed in four zones, and the power button is installed on the keyboard. The keyboard quality is decent – there's lots of travel in the keys, a robust base and consistent movement. The buttons could be a little faster and crisper, but only the keenest esports players will want extra speed. Meanwhile, the decent trackpad is smoothly responsive and equipped with two fast buttons.

SPEC

CPU
2.6GHz Intel Core i7-10750H

Memory
16GB 3200MHz DDR4

Graphics
Nvidia GeForce RTX 2070 Max-Q 8GB

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

Storage
1TB WD SN730 M.2 SSD

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

Weight
2.3kg

Ports
3 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 1 x audio, 1 x HDMI, 1 x mini-DisplayPort

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

Operating system
Windows 10 Home 64-bit

Warranty
One year parts and labour return to base

Performance

The GeForce RTX 2070 Max-Q graphics core is a solid gaming GPU at this price, but it doesn't quite have the power for ray tracing on high settings at the screen's 1,920 x 1,080 native resolution. In Shadow of the Tomb Raider and Metro Exodus, its 99th percentile minimums of 22fps and 23fps are poor, although the averages were fine – it clearly has trouble

maintaining a playable frame rate in demanding gaming scenarios. Activating DLSS only saw those minimums rise to 25fps. You'll need to tone down the ray-tracing settings if you want to achieve playable frame rates.

The Acer was faster in Doom Eternal, though, where it returned a 99th percentile minimum of 98fps, so it clearly has more than enough power to play games without ray tracing, and you'll be able to enable ray tracing at lower settings too.

Meanwhile, the Core i7 processor returned a middling overall score of 151,146, which isn't as quick as AMD's latest mobile chips, but it's plenty fast enough to handle gaming and most work tasks, and the SSD's read and write speeds of 3,083MB/sec and 2,954MB/sec are fine.

This laptop is only a mediocre thermal performer though. The GPU's peak delta T of 58°C is fine, and this laptop was never loud when gaming, but that's where the good news ends. During a gaming test, the CPU reached a toasty delta T of 70°C before throttling to below 4GHz – it ran at around 2.8GHz with just the CPU stressed and it throttled again to 2.5GHz in a full-system test – this also goes some way to explaining the disappointing 99th percentile frame rates in some of our game tests.

It was loud in a full system test too, and during all stress tests, the area above the keyboard and base panel both became too hot to touch, which precludes long-term usage on your lap.

Meanwhile, the 15.6in display is a 1080p, IPS panel with a 144Hz refresh rate and no active sync – it's a fine specification for delivering smooth mainstream gameplay. Its peak brightness of 299cd/m^2 is good enough for indoor use and contributes to a punchy contrast ratio of 1,246:1. The delta E of 2.53 is good as well, but the colour temperature of 7,505K is too chilly, which means the display looks washed out. This display is fine for everyday gaming and work, but it's not going to make games look their best, and it's not accurate enough for colour-sensitive workloads.

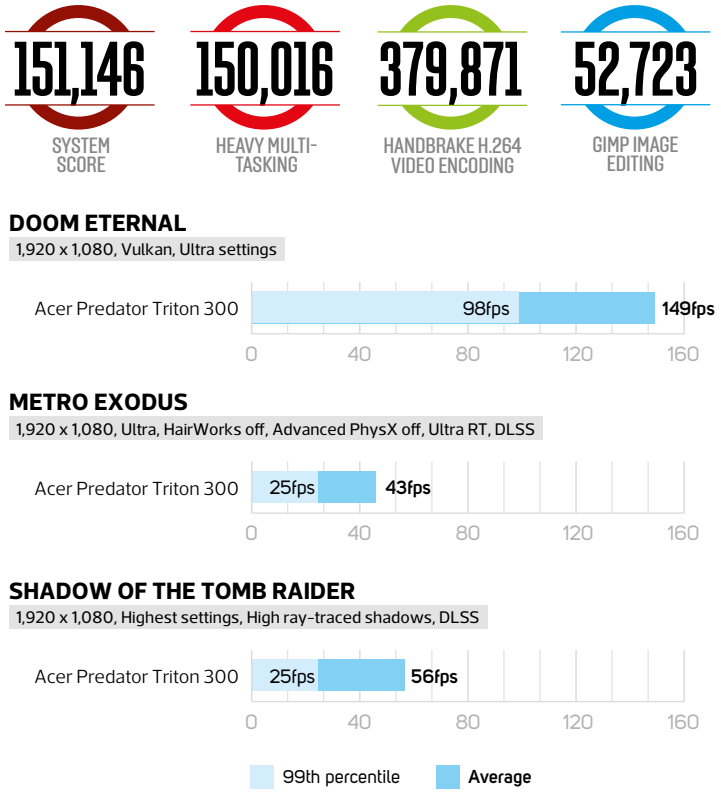
FLOATING

- \+ Good mainstream gaming speed
- \+ Solid keyboard and trackpad
- \+ Fast SSD

DROWNING

- – Struggles with ray tracing
- – Washed-out display
- – CPU throttles in games
- – AMD CPUs are faster

BENCHMARK RESULTS



You'll want to invest in a headset too – the speakers are good enough for casual gaming, but the bass is weak and the high end is tinny. Don't expect much from the Triton's battery either. In a gaming test it lasted for one hour and 15 minutes, and that lifespan doubled in a work test.

Conclusion

The Triton 300 is one of the more affordable RTX 2070-based laptops around, and it's decent in several areas beyond its price: it has enough graphics ability for mainstream games and esports titles, the Core i7 CPU is reasonable, and it has a sturdy base, a good keyboard and trackpad, as well as solid memory, storage and network options. It does fall short in several areas though.

The Max-Q graphics chip and throttling CPU result in disappointing frame rates, and the CPU performance falls behind equivalent AMD chips. If you need an affordable, mid-range laptop for mainstream gaming, the Triton will do the job, but more refinement is never far away.

MIKE JENNINGS

PERFORMANCE 17/25

DESIGN 18/25

HARDWARE 17/25

VALUE 18/25

OVERALL SCORE 70%

VERDICT

A respectable mid-range gaming laptop, but the lower price means serious compromises.

AMD X570 GAMING PC

SCAN 3XS ABSORBERE / £5,199 inc VAT

SUPPLIER scan.co.uk

The Absorbere is the first system we've seen with an Nvidia GeForce RTX 3090 and an AMD Ryzen 9 5950X in it. It's fearsome, futureproofed hardware, and the numbers are sensational. The CPU is a 16-core chip that supports 32 threads, with base and boost speeds of 3.4GHz and 4.9GHz respectively. Meanwhile, the GPU has 10,496 CUDA cores and 24GB of GDDR6X memory.

Beneath those numbers are new microarchitectures too. AMD's Zen 3 chips are fabricated on a 7nm process, and feature a load of improvements designed to reduce latency in core-to-core communication, while massively increasing the number of instructions per clock, as well as the boost frequencies, compared with Zen 2 CPUs.

Likewise, Nvidia's 8nm Ampere cards make huge gains in the number of CUDA cores compared with top-end Turing GPUs, alongside 2nd-generation RT cores, 3rd-generation Tensor cores and GDDR6X memory. In this Scan PC, the CPU and GPU run at their stock speeds, with the card coming from the Asus TUF range.

The specification is rounded out by 32GB of dual-channel DDR4 memory clocked to 3600MHz, a 2TB Samsung 980 Pro PCI-E 4 SSD and a Corsair RM850x PSU with 80 Plus Gold certification and a fully modular design.

It all plugs into a muscular Asus ROG Crosshair VIII Hero motherboard, with dual heatsink-equipped PCI-E 4 M.2 slots, 2.5Gbps Ethernet, a POST display, and both power and reset buttons. You also get SupremeFX audio with a high-quality ESS ES9023P DAC, and a multitude of spare SATA ports.

At the rear, it has seven full-sized USB 3.2 Gen 2 ports, alongside a Type-C connection and both clear-CMOS and BIOS Flashback buttons. The board's only significant omissions are USB 3.2 Gen 2x2 ports and Wi-Fi. There's no secondary hard disk in the Scan either, although that hardly matters when you have 2TB of high-speed PCI-E 4 NVMe storage.

Most importantly, the Absorbere chills the core components with a high-end custom water-cooling system. The front and roof of the chassis are occupied by two EK CoolStream SE 360 radiators, each with three fans, and the space between the front radiator and the motherboard is dominated by an attractive EK Quantum Kinetic 200mm reservoir and pump.

The CPU is topped with an EK Quantum Magnitude waterblock, but the GPU's EK Quantum Vector block is more eye-catching, thanks to the card's vertical installation. Scan's work here is superb: the matt black hard tubing looks fantastic, the braided cabling is meticulous, and the white lighting adds drama and contrast to this classy, monochromatic interior. A custom-built PSU shroud allows room for the front radiator, and a custom-made motherboard backplate allows more cabling to be concealed than normal too.

It's all fitted inside a robust NZXT H710 chassis, which looks slick with its minimal front panel. There's a tempered glass side panel, and there's more superb cable tidying around the rear. Behind the custom backplate, you'll also find pairs of 2.5in and 3.5in drive bays. The top of the

SPEC

CPU
3.4GHz AMD Ryzen 9 5950X

Motherboard
Asus ROG Crosshair VIII Hero

Memory
32GB Corsair Vengeance RGB Pro 3600MHz DDR4

Graphics
Asus GeForce RTX 3090 24GB

Storage
2TB Samsung 980 Pro M.2 SSD

Networking
2.5Gbps Ethernet, Gigabit Ethernet

Case
NZXT H710

Cooling
CPU: EK Quantum Magnitude waterblock, EK Quantum Kinetic TBE 200 D5 pump and reservoir, EK CoolStream SE 360 radiator with 3 x 120mm fans; GPU: EK Quantum Vector RTX RE Ti D-RGB waterblock, EK Vector backplate, EK Coolstream SE 360 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 2 Type-C, 1 x audio; rear: 7 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 4 x USB 3.2 Gen 1, 1 x optical S/PDIF, 5 x audio

Operating system
Microsoft Windows 10 Home 64-bit

Warranty
Three years parts and labour. First year on site, then return to base

CUSTOMISATION OPTIONS

Scan's 3XS Absorbere makes use of two custom parts that modify its NZXT H710 case – the PSU shroud and the motherboard backplate. Both of these sections have been designed, manufactured and finished with automotive-grade paint by Scan to provide better cable management for complex systems, and the PSU shroud also has laser-cut logos.

This sort of customisation is part of a new service that Scan is offering with its broad range of 3XS PCs. It's now possible to have your name, gamertag or logo etched on any panel on your system.

Plus, if you have a high-end water-cooling loop then Scan can also design a custom distribution plate that's specific to your requirements, including different measurements, inputs, outputs and logos. Elsewhere, any 3XS machine can be enhanced with custom braided cables, professional airbrushing to exterior panels and case spraying.

Scan also has another new service that goes beyond its 3XS machines – the Custom Shop (**scan.co.uk/3xs/custom-shop**). This product category goes far further than the customisations on offer on Scan's more conventional 3XS systems. It's a boutique option that allows customers to order unique machines that are designed and customised to their requirements. It's even possible to order a scratch-built case, if that's what you'd prefer.

The sky – and the budget – is the limit here. The Custom Shop will offer custom-built panels, shrouds, cables and etchings, and you can opt for bespoke waterblocks, distribution plates and reservoirs. Scan has its own CNC machine at its Bolton-based factory in order to produce unique parts, and the firm has already gone to extreme lengths for Custom Shop builds. For example, Scan tells us that one customer wanted a front panel with a rusted effect, so Scan used a chemical reaction to produce real rust quickly, and then applied another chemical to stop any further rusting from ruining the look.

It's virtually impossible to find this level of customisation elsewhere in the UK market, and this two-pronged approach is attractive. Scan's 3XS options allow for conventional alterations, and the Custom Shop delivers a bespoke service for those who want a truly unique rig.

chassis has two USB 3.2 Gen 1 connectors and a USB 3.2 Gen 2 Type-C port.

There aren't many downsides, although the water-cooling loop and vertically mounted GPU means accessing the motherboard is difficult – you'll have to be careful even if you're just adding memory or fitting a SATA cable.

As usual, Scan's three year warranty is generous, with three years of return to base, parts and labour coverage, and a year of on site service.

Performance

The 16-core AMD Ryzen 9 5950X processor is a beast. Its Handbrake video encoding score of 1,050,657 is one of the best we've seen – it's almost 100,000 points beyond the 12-core Ryzen 9 5900X, more than 1,000 points ahead of AMD's previous 16-core chip, the Ryzen 9 3950X, and around 320,000 points ahead of Intel's Core i9-10900K.

The Scan's overall system score of 380,149 is brilliant, and easily faster than any Intel setup we've tested. For content creation, the 5950X is virtually unmatched – although only those with extremely high-end workloads will make the most of this chip, and those with more conventional demands could save cash by dropping down to the 5900X or 5800X. The Scan's single-threaded image editing score of 64,395 is also fine, and on a level we normally see from Intel systems.

The reliance on AMD hardware also means Scan can install a fast PCI-E 4 SSD. The Scan's Samsung drive returned read and write speeds of 6,709MB/sec and 5,167MB/sec, which are excellent and better than any speeds we've seen from current Intel-based builds.

The RTX 3090 is fantastic, too. It played Shadow of the Tomb Raider at 4K with a 99th percentile minimum of 60fps, which improved by 8fps with DLSS, and its 32fps minimum in Metro Exodus improved to a playable 43fps with DLSS – you can seriously play demanding games at 4K with all the eye candy enabled on this machine.

This GPU is realistically the only feasible option right now if you want to play 4K games with every graphics setting ramped up. While the RTX 3090 is tremendous, though, it's also massively expensive. It costs around double the price of the RTX 3080, but it's nowhere near twice as fast.

However, this £5,199 system isn't about getting the best value for money, but about maximising performance with amazing water-cooling gear. The Scan delivers benchmark-breaking power, and it's a decent thermal performer too. Its CPU and GPU delta Ts of 56°C and 34°C are fine, and noise levels aren't uncomfortable. This level

ABSORBENT

+ Amazing performance in every category
+ Mature, good-looking water cooling
+ Classy-looking case
+ Great SSD and motherboard

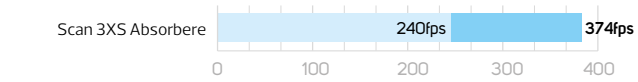
LEAKY

– Incredibly expensive
– No Wi-Fi
– Internal access can be tricky

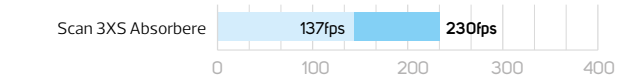
BENCHMARK RESULTS

DOOM ETERNAL

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

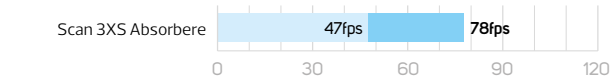


3,840 x 2,160, Vulkan, Ultra Nightmare settings

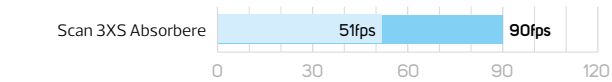


METRO EXODUS

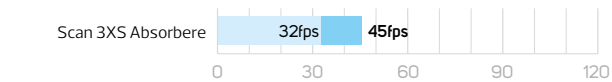
2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, Ultra RT



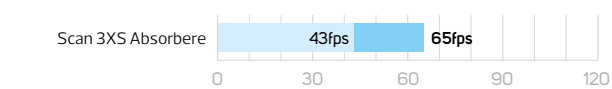
2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, Ultra RT, DLSS



3,840 x 2,160, Ultra, HairWorks off, Advanced PhysX off, Ultra RT

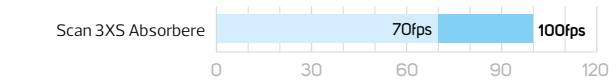


3,840 x 2,160, Ultra, HairWorks off, Advanced PhysX off, Ultra RT, DLSS

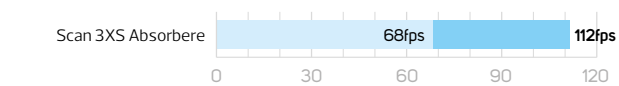


SHADOW OF THE TOMB RAIDER

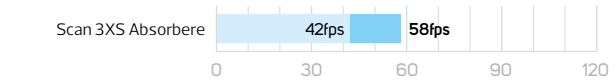
2,560 x 1,440, Highest settings, High ray-traced shadows, TAA



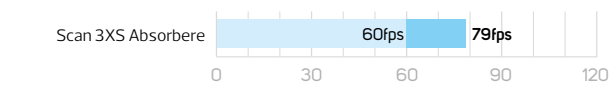
2,560 x 1,440, Highest settings, High ray-traced shadows, DLSS



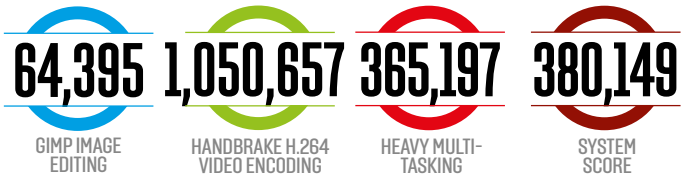
3,840 x 2,160, Highest settings, High ray-traced shadows, TAA



3,840 x 2,160, Highest settings, High ray-traced shadows, DLSS



99th Percentile Average



of cooling hardware with so many fans will always produce noise, of course, and an audible rumble is always present, but it's consistent and never annoying.

Conclusion

The Scan 3XS Absorbere is marvellous. Its monochrome water cooling and monolithic case look bold and eye-catching while remaining classy, the build is superb and the components are top-notch. AMD's Ryzen 9 5950X offers unmatched power for content creation, and Nvidia's GeForce RTX 3090 will play any game at virtually any combination of resolution and graphics settings. The other components are impressive, and this system isn't even that loud in operation.

It's a serious build with a serious price, though, which means some important factors need to be considered. It's simply not worth paying this much money if you won't make use of the hardware, and you can save cash with lesser parts and conventional cooling. Also bear in mind that the water-cooling loop hardware restricts motherboard access. Nevertheless, if you want top-tier performance in a great build, and if you have lashings of cash to spare – this combination of AMD and Nvidia hardware with Scan's build quality is unmatched.

MIKE JENNINGS

PERFORMANCE 24/25

DESIGN 24/25

HARDWARE 23/25

VALUE 19/25

OVERALL SCORE 90%

VERDICT

An incredible build with top-tier speed, but also a stratospheric price.

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)

WORTH £40

Custom PC APPROVED

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

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

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

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

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INTEL Z490 GAMING PC

PC SPECIALIST OBSIDIAN I / £1,899 inc VAT

SUPPLIER pcspecialist.co.uk

VOLCANIC

+ Great gaming pace
+ Sturdy, good-looking case
+ Solid mainstream motherboard

UNEVENTFUL

– AMD's CPUs are faster
– No PCI-E 4
– Underwhelming Wi-Fi

PC Specialist's Obsidian I isn't the first system we've seen with Nvidia's RTX 3080, but it's the cheapest. Pleasingly, PC Specialist hasn't deployed an entry-level card in this rig either – its Gigabyte-made card takes the GPU boost speed from 1710MHz to 1800MHz.

The rest of the components are fine, but not out of the ordinary. The Intel Core i7-10700KF CPU has eight Hyper-Threaded cores, a base speed of 3.8GHz and a boost peak of 5.1GHz, but it looks ordinary alongside AMD's existing Zen 2 silicon and its new Zen 3 parts. The 16GB of 3200MHz memory is fine, the 1TB Samsung 970 Evo Plus NVMe SSD is reliably fast, and there's a 1TB hard disk, which hardly seems worth the effort. The Corsair RM750x PSU is good though – it's a modular unit with 80 Plus Gold certification.

Meanwhile, the Asus ROG Strix Z490-F Gaming is a good mainstream motherboard, which has a free M.2 slot with a heatsink, 2.5Gbps Ethernet and an on-board Thunderbolt header. It looks the part, with large heatsinks and plentiful RGB LEDs. It has a decent ALC1220 audio codec, a hefty count of eight USB ports at the rear, including a Type-C connector, and on-board diagnostic LEDs.

There are areas where the motherboard falls behind though. Intel's Z490 chipset means no PCI-E 4 support, there's no super-fast USB 3.2 Gen 2x2, and no on-board power and reset buttons either. The board doesn't have Wi-Fi either. PC Specialist has added its own single-band 802.11n card, but it's pretty basic when dual-band 802.11ax support is quickly becoming the norm.

The Obsidian I's components slot inside a Lian Li Lancool II chassis. It's immediately impressive, with fantastic build quality and great looks. The bold strips of mesh on the front panel are illuminated with bright, even RGB LEDs. Meanwhile, two buttons on the top of the case alter the lighting, and both sides have magnetic, hinged tempered glass panels.

Beneath the panels are metal shrouds that flip down to reveal more features. At the rear, the shroud holds a pair of 2.5in drive mounts, and at the front, it obscures the PSU and three hard disk bays. The cabling at the front is neat and the rear is kept neat, thanks to tidy cabling and Lian Li's cable covers. There are smaller, welcome features too, such as magnetic dust covers, and you can buy accessories for it, including a vertical GPU mount and a hot-swappable hard disk kit.

There are only minor issues. The radiator for the 240mm all-in-one cooler in the roof blocks the top of the motherboard, the trio of hard disk caddies aren't tool-free and the chassis doesn't have USB-C – the separate accessory kit isn't included. There's also no control board for extra fan connections and synchronisation.

The PC comes with PC Specialist's standard three year warranty, although this only covers parts for the first year, and there's just a month of collect and return cover. We prefer to see at least two years of parts cover on a PC.

SPEC

CPU
3.8GHz Intel Core i7-10700KF

Motherboard
Asus ROG Strix Z490-F Gaming

Memory
16GB Corsair Vengeance RGB Pro 3200MHz DDR4

Graphics
Gigabyte GeForce RTX 3080 10GB

Storage
1TB Samsung 970 Evo Plus M.2 SSD, 1TB Seagate Barracuda hard drive

Networking
2.5Gbps Ethernet, single-band 802.11n Wi-Fi

Case
Lian Li Lancool II

Cooling
CPU: PC Specialist FrostFlow 240 RGB with 2 x 120mm; GPU: 3 x 90mm fans; front: 1 x 120mm fan; rear: 1 x 120mm fan

PSU
Corsair RM750x 750W

Ports
Front: 2 x USB 3.2 Gen 1, 1 x audio; rear: 3 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 2 x USB 3.2 Gen 1, 2 x USB 2, 1 x optical S/PDIF, 5 x audio

Operating system
Microsoft Windows 10 Home 64-bit

Warranty
One year parts and labour, plus two years labour only. First month collect and return, then return to base

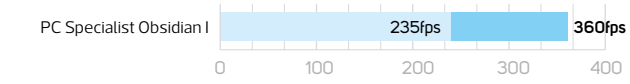
Performance

Nvidia's GeForce RTX 3080 is superb. In Doom Eternal at 4K, this PC's 99th percentile minimum was a super-smooth 132fps, and it can cope with ray tracing at 4K too, especially if you enable DLSS. With Nvidia's super-sampling anti-aliasing method employed, the PC managed to sustain a 99th percentile frame rate of 51fps, and an average of 64fps in Shadow of the Tomb Raider with ray-traced shadows. Even

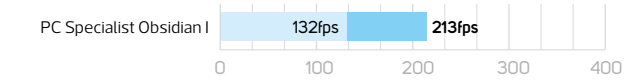
BENCHMARK RESULTS

DOOM ETERNAL

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

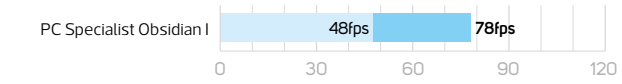


3,840 x 2,160, Vulkan, Ultra Nightmare settings

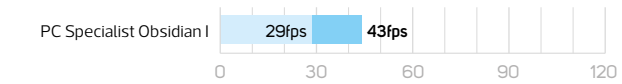


METRO EXODUS

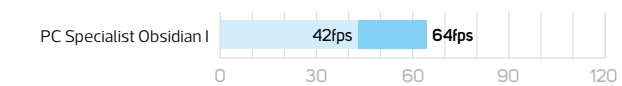
2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, Ultra RT



3,840 x 2,160, Ultra, HairWorks off, Advanced PhysX off, Ultra RT

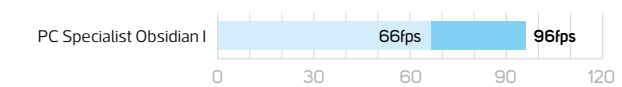


3,840 x 2,160, Ultra, HairWorks off, Advanced PhysX off, Ultra RT, DLSS

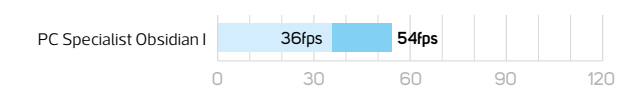


SHADOW OF THE TOMB RAIDER

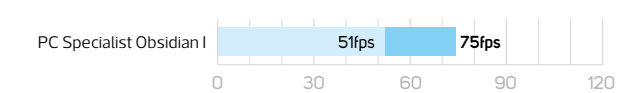
2,560 x 1,440, Highest settings, High ray-traced shadows, TAA



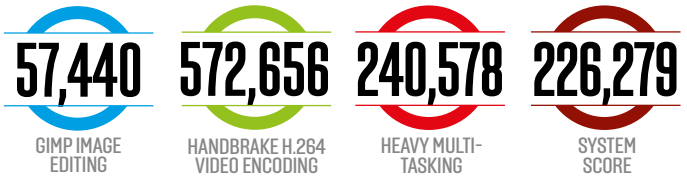
3,840 x 2,160, Highest settings, High ray-traced shadows, TAA



3,840 x 2,160, Highest settings, High ray-traced shadows, DLSS



99th percentile | Average



our highly demanding Metro Exodus ran at a respectable 99th percentile figure of 42fps at 4K with DLSS enabled, with an average of 64fps.

Impressively, this PC also outpaced the RTX 3080-equipped PCs we've recently seen from CyberPower and Scan PCs. Thanks to its overclocked graphics card, it edged out modest leads in Doom Eternal and Metro Exodus, and a wider gap in Shadow of the Tomb Raider.

Meanwhile, the Core i7-10700KF CPU has the grunt to handle gaming, everyday work and mainstream content creation, but there's no denying the power available elsewhere – AMD's Ryzen 7 3800X and 3800XT are quicker, and the Ryzen 7 5800X is miles ahead.

The PC Specialist's overall score of 226,279 is around 50,000 points behind systems with older AMD chips and further behind the Ryzen 7 5800X. If you need a system for work alongside gaming – or just want more futureproofing – you'd be better off buying into AMD's ecosystem. The SSD suffers too. The Samsung's read and write speeds of 3,536MB/sec and 3,292MB/sec are fast, but PCI-E 4 drives will be quicker.

PC Specialist's machine is a reasonable thermal performer though. The CPU and GPU delta Ts of 48°C and 45°C are fine, and the Obsidian I only produces a modest rumble when idle and running games.

Conclusion

The Obsidian I system serves up gaming power to better rivals alongside a sturdy, versatile chassis. The lower price does mean compromise, though, with a CPU beaten by the latest AMD silicon, and some mediocre components elsewhere. If you want a relatively affordable RTX 3080 system, the Obsidian is a great build, but it's worth spending a bit more to get the latest AMD CPUs too.

MIKE JENNINGS

PERFORMANCE 23/25

DESIGN 23/25

HARDWARE 19/25

VALUE 22/25

OVERALL SCORE 87%

VERDICT

Great gaming pace, a robust build and a keen price, but it makes some compromises in the process.

CUSTOM PC

MINCE PIE MEGATEST

We apply our demanding testing principles to the latest festive pastry treats to find this year's top mince pie

MR KIPLING
/£1.50 for six

Mr Kipling's 2020 festive effort is a sweet, crumbly pie with a partially open-top star design. It has the sort of agreeable flavour you would expect from a pie setting out its stall in the comfortable area between pies that are trying to be avant-garde, and pies that are phoning it in.

We've encountered plenty of pies over the years that don't clear the hurdle of being pie-shaped and tasty, but this Mr Kipling mince pie makes it over the line. It's not amazing, but it's not awful either.

6/10

CO-OP MINCE PIES
/£1 for six

A boldly zesty effort with a good texture to the pastry and the filling, despite the very basic design with just a star on top. The case has a tasty, but not overwhelming, sprinkling of sugar crystals on top, and this combines well with hints of citrus in the filling. If there's one criticism, it's that the pastry is a little too crumbly.

It's not exactly what you'd expect in terms of taste from a mince pie, but it's the better for it. This pie is surprising in a few ways, and most of them are good. Perhaps most surprisingly of all, these pies only cost £1 for six.

7/10

Lockdown threatened to derail the annual mince pie megatest this year, but some things are just too important to let slip, so we all rallied to make sure it happened. All the pies were sent to a designated employee known as the 'pie hub', who then numbered them and distributed them among the tasting panel in plain packaging. We then did all the taste testing over Zoom. It's all a bit different from our usual get together, but we can still deliver our authoritative verdict on this year's festive snacks.

Taste testers: Antony Leather, Ben Hardwidge, Charlotte Milligan, Edward Chester, Mike Jennings and Phil Hartup

Reviews: Phil Hartup

SAINSBURY'S TASTE THE DIFFERENCE ALL BUTTER / £1.50 for six

Underneath this pie's faintly overdesigned snowflake and star case design lurks the heart of a boozy champion. You get a deep filling with a sweet, rich flavour and a sense that whoever concocted the recipe likes a heavy pour. It's balanced out by some cracking buttery pastry that has a firm crunch to it and holds the pie together well. While this is a tasty pie, though, you perhaps shouldn't drive after eating it.

8/10

MORRISONS THE BEST DEEP FILL / £1 for six

Sticky and chewy, with a flavour reminiscent of walking into a cloud of body spray, and not a nice one. There's a weird hint of an artificial root beer flavour to the filling, and the pastry lingers on and on while you're chewing it, well after you'd normally expect to be done with it. Meanwhile, there's a strong hint of butter in the pastry that's about as subtle as the bass drop in a movie trailer – it's more like butter flavour than real butter, but it means the sum of this pie's parts isn't a total write-off.

4/10

ASDA EXTRA SPECIAL LUXURY / £1.75 for six

Asda's premium effort is top-heavy, with a pattern of concentric snowflakes on its top. It manages to cram plenty of superlatives into its name, but not a whole lot of splendour into the pie. The filling is decent but rather encumbered by the three layers of lid, leaving the overall impression that this is more about style than substance. That's great for an Arctic expedition, but less so for a festive after-dinner treat.

6/10

WAITROSE ESSENTIAL SHORT CRUST / £1 for six

The Waitrose Essential Short Crust effort might be cheap, but it doesn't even look like it wants to be a mince pie. Without so much as a bell to jingle, these plain pies don't look the part or even taste it. We could forgive an ordinary-looking pie if it tasted amazing, but that's not the case here. The flavour is almost bitter and the texture is bland, with the pastry being so forgettable, it may as well not even exist. It's like the pastry version of a split Jiffy bag delivering the filling into your face.

3/10

FORTNUM AND MASON TRADITIONAL / £12.95 for six

This giant pie manages to be both light and almost cake-like, while equally being a massive cognac-laden unit. There are hints of fruit and flowers to this behemoth, with enough of a kick from the booziness to keep it from wandering too far from the expected mince pie flavour. Meanwhile, the crumbly pastry melts away as you bite into it. These huge lads cost around six times the cost of most other pies, and they're not *that* much better, but they taste extremely nice if you're not expecting traditional pastry.

8/10

M&S COLLECTION / £2.50 for six

The pastry for this M&S Collection pie and its filling seem to be on separate wavelengths. The pastry is floury and crumbly, almost to the point of being dusty. Meanwhile, the filling is conversely vibrant and fruity, with a citrus twang. It doesn't sound like a combination that would work, but the end result isn't bad. This is a pleasant pie that melts in your mouth, although £2.50 per pack is also quite expensive compared with other mainstream supermarkets.

7/10

WAITROSE BUTTER ENRICHED / £1.66 for six

Waitrose's Butter Enriched pies come in a perfunctory case with two stars on the lid, although the cutouts weren't all that great on all of them, with some of the stars looking more like toddlers' drawings of birds. To make matters worse, the pastry tastes bland, and it conceals a filling that doesn't just taste bad, but is just plain wrong – there's an almost meaty flavour to it. There's the sense of an experiment gone awry here, with a bold flavour ending up as a misjudged one.

1/10

FAVORINA / £1.59 for 12

This Favorina pie is available from Lidl. It's a dry, crumbling pie with plain, uninteresting pastry and two cheap-looking holly leaves on the lid. It's rescued to a degree by a respectable filling that just about lifts the whole effort to mediocrity rather than awfulness. While there's a bold attempt to overcome quality with quantity here (you get 12 pies in this box, rather than the usual six), this doesn't feel like a smart pie-shopping strategy if you actually want to enjoy Christmas this year.

3/10

ALDI SPECIALLY SELECTED / £1.49 for six

This Aldi Specially Selected pie has quite a heavy pastry case surrounding a blob of tasty filling. The sheer heft of pastry is substantial, but not in a bad way, because the pastry itself is pretty good. The filling is also tasty – it's nothing fancy or out of the ordinary, but equally, it's not untoward either. This is another example of the no-frills 'be a Christmassy-looking pie full of mincemeat' approach, and it works. Textbook.

6/10

TESCO FINEST ALL BUTTER / £1.75 for six

Tesco's Finest All Butter mince pie goes big on a citrus-flavoured filling under a fancy casing design made out of ordinary, inoffensive pastry. The filling comes on strong with its lemon/orange flavours, but it also has quite a strong and unpleasant aftertaste to match.

For folks on the panel who found the flavour agreeable, this was a middling effort; for folks who don't like it at all, it's a bad idea full stop. Either way, you can do better this Christmas.

4/10

HARRODS CLASSIC / £10 for six

The is the pie version of the Chelsea Tractor. It goes big on size with a robust construction, and with a luxurious interior. Everything about this pie was good, with no weakness or compromise. Our editor even thought this pie was the best of the lot. By the same token, though, no risks were taken, there was no attempt at anything exciting and, let's face it, £10 is ridiculous for six pies. If you don't mind spending, though, the Harrods Classic is an awesome traditional mince pie.

7/10

M&S ALL BUTTER / £2 for six

As always, the brown star-shaped hole in the top of M&S' All Butter mince pie defies mockery at this point. It knows what it is, but it didn't prevent this range of pies from winning our taste test last year

This year, the pie itself is again rich and tasty, with pastry that melts away in your mouth. The filling is rather underwhelming compared with some efforts this year, but that's perfectly fine for an unassuming pie. These remain a good choice.

CPC

7/10

Custom kit

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

REDSTORM PC GAME PAD / **£32.99** inc VAT

SUPPLIER amazon.co.uk

The Redstorm is that rarest of birds, a game controller designed purely for the PC, although it does share most of its layout with Xbox-pattern pads. The Redstorm uses a 2m long cable, so there are no concerns about batteries, connection, latency or other issues that might arise from using a wireless pad, with the obvious trade-off that you need to be sitting within reach of a USB port.

Without the need for batteries, wireless hardware or extra sensors, the Redstorm is much lighter than your average a wireless pad, which is fine, but it takes a while to get used to such a lightweight pad when you're used to today's hefty controllers. This difference is particularly noticeable when the vibrations kick in.

The vibration levels are adjustable, which is a considerate but unnecessary feature unless you ever find the pad reacting to a game while it isn't in use, and growling at you from across your desk. An on/off switch would have been a better option here – it's not as if the default setting kicks off like a jack hammer. The lighting controls, which enable you to choose whether the buttons and right stick are illuminated, also seem superfluous unless you have transparent fingers and don't want to look at the screen.

Meanwhile, the turbo function is easy to use, and binds to a single button of your choosing rather than all of them, which is clever. The buttons and sticks are comfortable to use and they're also precise. The trigger controls are longer than usual and initially feel odd, but they provide great control for racing game features such as accelerators and brakes. The Redstorm feels a shade overdesigned in some respects, but under the frills, it's a robust, precise and reliable game controller for a reasonable price.

Red Dawn ●●●●○ **Red October**

MOBILE GAME FINGER SLEEVES / **£5.58** inc VAT

SUPPLIER amazon.co.uk

These Mobile Game Finger Sleeves are tiny little sleeves for your thumbs, so you can play games on your phone with the skill and precision of a person with tiny little sleeves on their thumbs. In theory this idea seems absurd, but in practice, well, it also seems absurd, but they do work.

There's no loss of precision when you play games with these sleeves on your thumbs, and if the surface of your phone or the skin on your thumbs is sweaty, slippery or slimy, then the sleeves offer a big improvement.

The sleeves are made of a breathable blend of fibres, which makes them grippy and stretchy, so they stay in place while also being comfy. You get three pairs of sleeves in a pack, and a little metal box in which to keep them. That's helpful, because without a box they'd be getting lost probably five seconds after you take them off, like incredibly tiny socks.

Theory ●●●○○ **Practice**

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

LABS TEST

Rapid fire

Need a gaming monitor that can keep up with triple-digit frame rates? **Edward Chester** puts some of the latest super-fast 240Hz options to the test

How we test

Just a couple of years ago, buying a 240Hz monitor meant having to compromise on image quality, as the only options available used TN LCD panels. Widely known for having the fastest response times, but poor viewing angles and often middling image quality, TN panels aren't ideal if you want a monitor that's good for more than just ultra fast-paced gaming. You also paid a hefty premium for that headline 240Hz speed.

You can now get 240Hz screens with IPS and VA panels, though, making for improved image quality. For this test, we've grabbed four of the latest 240Hz options and put them to the test. All available for well under £350, they're affordable, and three out of the four screens use IPS and VA panels as well.

All of the displays on test this month fully support AMD's FreeSync technology, but are also compatible with G-Sync, even if they don't have official Nvidia hardware. This means they can deal with image tearing and stuttering in games, whether you're using an AMD or an Nvidia GPU.

To test the screens, we prioritised assessing their performance in fast-paced FPS gaming, as this is the main target use of such screens. We test subjectively while playing games on the screens, and use BlurBusters' ghosting test to assess the response time of the screens.

We then test for image quality using an X-Rite iDisplay Pro colorimeter and DisplayCal software, assessing the contrast, colour range, colour balance and more. We also test for subjective image quality criteria, such as viewing angles.

We also gauge the design and extra features of each display. We check the adjustability of the stand, see what connections are on offer and find out whether the on-screen display controls are easy to use.

Contents

ACER PREDATOR XB253Q / £330 inc VAT

SUPPLIER currys.co.uk

Acer's Predator XB253Q display is easily the most stylish model on test. From the slender metal feet of its stand, to the ultra-slim bezels that sit partially below the top surface of the screen, it's daintier and classier-looking than its competitors. This first impression is backed up by excellent build quality and a premium feel throughout, including a fully adjustable stand.

Elsewhere, in terms of basic features, there's not too much to set this display apart from the others on test. Unlike the Asus TUF Gaming VG279QM and AOC 32G2Z, it includes a USB hub, with two ports on the side and two around the back, but that's about it for extra features.

The panel itself has a 24.5in diagonal and is based on IPS technology, with a top refresh rate of 240Hz. There's also support for AMD's FreeSync technology, and compatibility with Nvidia's G-Sync tech, eliminating tearing effects. You get a claimed 1ms response time too, making for an impressive list of overall gaming features.

SPEC

Screen size 24.5in

Resolution 1,920 x 1,080

Panel technology IPS

Maximum refresh rate 240Hz

Response time 1ms

Contrast 1,000:1

Adaptive sync FreeSync and G-Sync compatible

Display inputs 1 x DisplayPort 1.2, 2 x HDMI 2

Audio 2 x 2W speakers, headphone out

Stand adjustment Height, pivot, rotation, tilt

HDR certification HDR 400

Extras 100 x 100mm VESA mount, 4-port USB 3 hub

One feature that isn't present is any sort backlight strobing blur reduction technology. In this regard, the Asus display has a clear advantage for sheer gaming performance. It's only a feature we'd feel the need to enable during fast-paced FPS gaming anyway, but of course, that's the main domain of these 240Hz screens.

Otherwise, overall gaming performance from this screen is excellent. The AOC AG251FZ2E's TN panel feels just a bit snappier, thanks to its even faster response time, but this display didn't hold us back in our gaming sessions.

What's more, while this display lags behind the Asus a little in terms of gaming performance, it has an advantage in image quality. The moment you turn on this display, you're immediately struck by the depth of the dark parts of its image, and the brightness of strong colours. This is down to the Acer's panel having a much higher native contrast ratio than the Asus, at 1,279:1 compared to 937:1.

The smaller size of this screen also feels like a more natural fit for the 1080p resolution than a 27in panel.

While its pixel pitch of 0.28mm isn't quite as sharp as the pitch of a typical 27in screen with a 2,560 x 1,440 resolution (0.23mm), it's well ahead of the 0.31mm of the 27in 1080p Asus monitor. As such, this screen looks much sharper.

Overall image quality is great too. Although the colour balance is a little off the mark right out of the box, it's not enough to cause major concern and this display's image quality delivers in every other regard.

The use of an IPS panel ensures viewing angles are excellent too. Meanwhile, the on-screen menus are easy to navigate and the controls are easy to use too – this display is easy to set up exactly how you want it.

DUTCH

- \+ High contrast for IPS
- \+ Great overall image quality
- \+ Premium design and extra features
- \+ G-Sync compatibility

BILLY

- – TN panels can feel snappier
- – No ELMB support
- – No blur reduction

Conclusion

The prices of 240Hz monitors are astonishing compared with just a year or so ago. This Acer display delivers fantastic 240Hz gaming performance and has excellent image quality. You get a few premium touches, such as a quality stand and USB ports, all for £330. It's only the absence of Asus' proprietary ELMB blur reduction technology that holds it back.

VERDICT

Top-notch all-round performance, great image quality and a premium feel make this Acer display an easy recommendation.

IMAGE QUALITY	GAMING	OVERALL SCORE
28/30	26/30	89%
FEATURES	VALUE	
17/20	18/20	

AOC AGON AG251FZ2E / £310 inc VAT

SUPPLIER box.co.uk

This entry from AOC may be a second edition, denoted by the '2E' in its model name, but it eschews one feature sported by many new 240Hz monitors, which is an IPS or VA LCD panel. Instead it uses a TN panel, which is unlikely to offer the same level of image quality as those two alternatives, but it still has a faster response time and therefore better gaming performance.

Sure enough, this display easily tops the charts in terms of its sheer responsive feel compared with the other displays on test. The Asus gives it a serious run for its money, thanks to its ELMB blur reduction technology, but the AG251FZ2E still feels a smidge faster and pulls well ahead when its own MBR blur reduction tech is engaged. Considering that 240Hz displays are primarily bought to provide the ultimate gaming performance, there's a lot to be said for not compromising on this front. However, MBR doesn't work with FreeSync or G-Sync, unlike ELMB.

The flip side, of course, is image quality. TN panels inherently have poor viewing angles and tend not to have particularly impressive contrast. Sure enough, this panel looks a little dull compared with the others on test. It has the narrowest colour gamut (although it still comfortably hits 100 per cent sRGB) and the lowest contrast. The narrow ideal viewing angle makes the image appear less stable too, as colours shift slightly as your head moves.

One reason why this display initially looks dull is its gamma setting, which is just 1.97 – well away from the ideal of 2.2. However, simply changing to the Gamma3 setting sorts this problem (it's still comparatively dull, but nowhere near as bad as before), so we used this setting for the rest of our testing. Otherwise, image quality is impressive. Out-of-the-box colour balance is the best on test, and colour accuracy is solid – this display may not have eye-popping colours and contrast but it's accurate.

Elsewhere, the AOC is packed with extra features. The stand offers a full range of ergonomic adjustments, and even has a height indicator that makes it easy to dial in your preferred setting. There's also a flip-down headphone stand that sits above two USB ports on the side, plus a carry handle atop the stand.

For video connections, you get one each of DisplayPort 1.2, HDMI 2, HDMI 1.4, DVI and even VGA inputs. There are two further USB ports alongside the video connections around the back, and a pair of basic speakers. AOC also claims this display has an e-sports flat base, which may sound like nonsense, but we agree with the practicality of simple compact bases, compared with fancy long-legged designs. They take up less space, and the space they do occupy becomes more usable.

You also get a wired remote control for the on-screen menus, which is surprisingly useful, not least because – as with AOC's other display on test – the buttons on the screen aren't very easy to use. The menus are also slower and more cumbersome than the ones on the Acer and Asus displays.

Conclusion

The TN LCD panel's gaming performance immediately puts this display ahead of the others on test for gaming prowess, and you get a host of practical extra features. However, image quality is held back by the usual TN problems. There are better all-round options available, but this is a fantastic option for fast-paced competitive gaming.

SECOND EDITION

- \+ Excellent gaming performance
- \+ Blur reduction
- \+ Loads of features

PROTOTYPE

- – Image looks a little dull
- – Poor viewing angles
- – Blur reduction can't be used with Freesync

SPEC

Screen size 24.5in

Resolution 1,920 x 1,080

Panel technology TN

Maximum refresh rate 240Hz

Response time 0.5ms

Contrast 1,000:1

Adaptive sync FreeSync and G-Sync compatible

Display inputs 1 x DisplayPort 1.2, DVI, VGA, 2 x HDMI 2

Audio 2 x 2W speakers, headphone out

Stand adjustment Height, pivot, rotation, tilt

HDR certification HDR 400

Extras MBR blur reduction, 100 x 100mm VESA mount

VERDICT

A performance king but the TN panel results in some inherent image quality compromises.

IMAGE QUALITY	GAMING	OVERALL SCORE
20/30	30/30	86%
FEATURES	VALUE	
18/20	18/20	

AOC C32G2ZE / £304 inc VAT

SUPPLIER laptopsdirect.co.uk

AOC C32G2ZE's is an outlier in this test in a number of ways. Most obviously, it uses a VA panel, which isn't common for 240Hz screens, as they tend not to have the same responsive feel of IPS or TN screens. It also measures a whopping 32in from corner to corner, despite sporting the same 1,920 x 1,080 resolution as the other panels on test.

The upshot of that relatively low resolution on such a large panel is a very noticeably blocky image. This doesn't make much difference in terms of usability, but the picture is far from sharp. AOC hasn't equipped the C32G2ZE with a height-adjustable stand either. You can tip the panel forwards and back a little but that's it for ergonomic adjustment. You'll have to remove the stand and use an alternative monitor mount if you want more movement.

Along with this omission, there's little other in the way of extra features. There are no USB ports or speakers, nor the flip-down headphone stand of its sibling. The power supply is also external. It's a bare bones unit through and through.

Another difference compared with the other monitors is that this display is curved. This is common for displays of this panel type (and that are this large), as the curve helps to disguise the drop-off in image quality of VA panels when viewed from an angle. It's not entirely necessary, but along with the size of the screen, the curve helps to create a noticeably more immersive view.

Of course, this monitor is mainly built for gaming, and it offers a 240Hz maximum refresh rate with a 1ms Motion Picture Response Time (MPRT) and it supports FreeSync Premium, as well as G-Sync compatibility. MPRT is a version of response measurement that, instead of simply taking the minimum response time of the panel, tries to account for the visual impact too – it can be useful when measuring displays with backlight strobing blur reduction, as this technology reduces perceived motion blur. However, that technology isn't employed here. Instead, MPRT is often a figure quoted for VA LCD panels, as they tend to have a comparatively slow raw response time.

Sure enough, in our testing, while the C32G2ZE appeared initially to be just as snappy as its counterparts, in gaming, the slower response of the panel became noticeable. During very fast motion, the trailing ghost image of the pixels that hadn't yet fully changed colour was much more noticeable.

Otherwise, though, this display is still impressively fast, and its standout image quality helps make up for its slight gaming shortcomings. We measured its contrast ratio – traditionally the main benefit of VA panels – at a whopping 4,139:1, way ahead of the other displays on test. This really makes films and games pop, helped in no small part by the extended 125.6 per cent sRGB colour space coverage. The downside is that the high contrast and extended colour gamut aren't so good for work – this isn't a great all-rounder.

SPEC

Screen size 32in

Resolution 1,920 x 1,080

Panel technology VA

Maximum refresh rate 240Hz

Response time 1ms MPRT

Contrast 4,000:1

Adaptive sync FreeSync and G-Sync compatible

Display inputs 1 x DisplayPort 1.2, 2 x HDMI 2

Audio Headphone out

Stand adjustment Height, pivot, rotation, tilt

HDR certification Tilt

Extras 100 x 100mm VESA mount

HIGH CONTRAST

+ Very high native contrast
+ Very large screen for the price
+ Surprisingly good gaming performance

HIGH CHAIR

– Can't compete with IPS and TN for gaming
– Very basic feature set
– Stand isn't height-adjustable
– Blocky image

Conclusion

AOC's choice of a VA panel comes with inherent compromises. Gaming performance is a little behind the other panels on test, but you get incredible contrast that makes games and video appear very vibrant, plus a large immersive screen. The downside is a blocky image, a lack of features and a display that isn't a great all-rounder. If you want a large, high-contrast screen for 1080p gaming, then this is a great monitor, but you can get a better balance elsewhere.

VERDICT

Great contrast and a huge screen for the price, but you make some compromises to get there.

IMAGE QUALITY	GAMING	OVERALL SCORE
26/30	24/30	76%
FEATURES	VALUE	
10/20	16/20	

ASUS TUF GAMING VG279QM / £370 inc VAT

SUPPLIER argos.co.uk

While it can't claim the same headline-grabbing 360Hz refresh rate of its flagship sibling, the Asus PG259QN, the Asus VG279QM still packs an astonishing amount of gear into its package, while still costing well under £400.

Perhaps the least meaningful of this display's many high-end gaming features is its 280Hz maximum overclocked refresh rate. The monitor certainly had no problem achieving that overclock in our tests, and neither did the overclock detrimentally affect image quality.

However, the extra 40Hz didn't noticeably affect our gaming experience either. There's a reason the next big leap is seen as being 360Hz, as you simply need that large an increase over 240Hz for it to be perceptible.

Otherwise, the gaming experience is excellent. Boasting a 1ms response time, this display feels very snappy, although it's notable that 240Hz TN displays still feel faster despite often having the same 1ms response time on paper.

The real crown jewel of this monitor, however, is Asus' proprietary ELMB-Sync technology. This is a variation on quite common blur reduction techniques that flash the backlight on and off to reduce eye-tracking motion blur. However, unlike all the others, it works with both FreeSync and G-Sync, so you get the benefits of both a sharper image in fast motion, plus no tearing and stuttering. The combination really does feel like the next big step in gaming screen performance. It's utterly smooth, sharp and highly responsive.

The only downside is that at 120Hz, the image quality drops dramatically as a large amount of inverse ghosting noise is introduced, and at 60Hz, the technology isn't available at all. So, essentially, ELMB-Sync isn't much use for console gaming at lower frame rates.

Image quality is also excellent. Right out of the box, the colour balance is near perfect, gamma is all but perfect, and you get decent contrast and good colour accuracy. With the Asus being based on an IPS panel, viewing angles are great too, and while some IPS glow is inevitable, it's no worse than usual. The one major caveat is the ratio of screen size to resolution.

It's not as obvious as the 32in AOC C32G2ZE, but a 27in screen is still large for a 1,920 x 1,080 resolution, resulting in a very obviously coarse-looking image and large 0.31mm pixel pitch. Combined with the simple fact that 1080p doesn't give you a huge desktop area, it's clear this display isn't ideal for general work.

In terms of physical design and features, this is one of Asus' more basic displays. The bezels are slim but not integrated into the surface of the display, so it doesn't look as sleek as some models. The stand is also a bit dull and there's no RGB lighting. However, it's practical; the stand offers full ergonomic adjustment and its base is neat and compact. Video connection options are typical too, although you don't get any USB ports. The on-screen menus are easy to navigate and its controls are easy to use.

SPEC

Screen size 27in

Resolution 1,920 x 1,080

Panel technology IPS

Maximum refresh rate 240Hz (280Hz overclocked)

Response time 1ms

Contrast 1,000:1

Adaptive sync FreeSync and G-Sync compatible

Display inputs 1 x DisplayPort 1.2, 2 x HDMI 2

Audio 2 x 2W speakers, headphone out

Stand adjustment Height, pivot, rotation, tilt

HDR certification HDR 400

Extras ELMB Sync blur reduction, 100 x 100mm VESA mount

Conclusion

The Asus TUF VG279QM is a superb gaming display for its price. You get near best-in-class high-speed IPS gaming, thanks to the combination of that 280Hz overclocked refresh rate, ELMB-Sync, and both FreeSync and G-Sync compatibility.

What's more, the image quality is exceptional. The slightly staid design, chunky resolution and lack of extra physical features (except for some very weedy speakers) are a tiny price to pay for the superb gaming performance and decent overall image quality. CPC

TOUGH

+ Top gaming performance
+ Great overall image quality
+ Simple practical design
+ Fantastic value
+ ELMB-Sync blur reduction is brilliant

FLUFF

− 1080p looks blocky on 27in screen
− ELMB-Sync doesn't work below 60Hz
− Weedy speakers

VERDICT

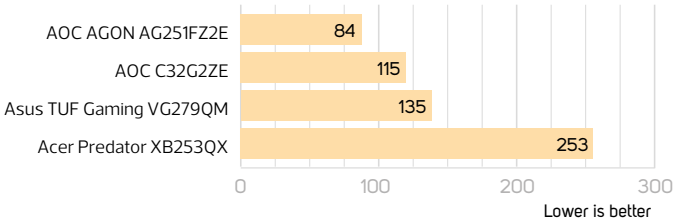
A fantastic all-rounder, as long as you don't mind the low resolution on a large display.

IMAGE QUALITY	GAMING	OVERALL SCORE
26/30	28/30	87%
FEATURES	VALUE	
15/20	18/20	

IMAGE QUALITY RESULTS

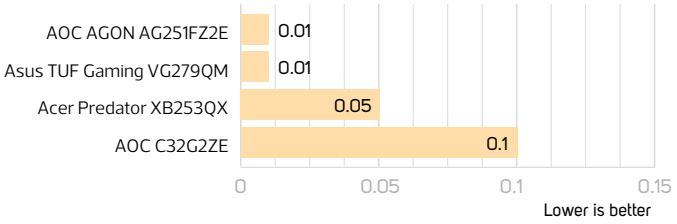
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



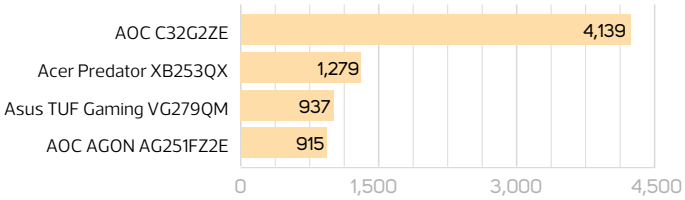
AVERAGE GAMMA

Deviation from ideal result (2.2)



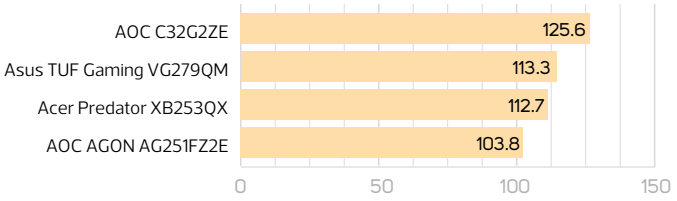
CONTRAST RATIO

Ratio of white-to-black luminance



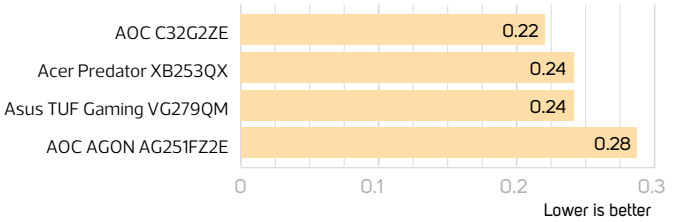
SRGB COLOUR SPACE

Percentage of sRGB colour space covered



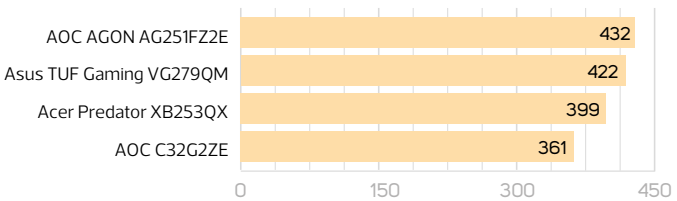
COLOUR ACCURACY

Average delta-E 2000



MAXIMUM BRIGHTNESS

Brightness in cd/m^2 (nits)



How we test

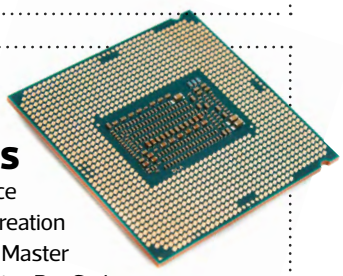
MOTHERBOARDS

TEST PROCESSORS

- **Intel LGA1200** Intel Core i9-10900K
- **Intel LGA2066** Intel Core i9-7900X
- **AMD AM4** AMD Ryzen 9 3900X
- **AMD TRX4** AMD Threadripper 3970X

Our test gear comprises a GeForce RTX 2070 Super Founders Edition and a 2TB Samsung 970 Pro SSD (or a PCI-E 4 1TB Corsair MP600 SSD on X570 and TRX40 boards). We also use Corsair Vengeance RGB 3466MHz DDR4 RAM – a 16GB dual-channel kit for mainstream systems, and a 32GB quad-channel kit for HEDT systems. 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. Where possible, CPUs are overclocked and benchmarked again.



PROCESSORS

TEST MOTHERBOARDS

- **Intel LGA1200** MSI MEG Z490 Ace
- **Intel LGA2066** MSI MEG X299 Creation
- **AMD AM4** Gigabyte X570 Aorus Master
- **AMD AM4 (APU)** MSI X470 Gaming Pro Carbon
- **AMD TRX4** Asus ROG Zenith II Extreme

Our CPU test setup comprises a GeForce RTX 2070 Super Founders Edition (or an APU's integrated GPU), a 2TB Samsung 970 Pro SSD, and Corsair Vengeance RGB 3466MHz DDR4 memory – a 16GB dual-channel kit for mainstream systems, and a 32GB quad-channel kit for HEDT systems. A Corsair Hydro-X water-cooling loop, with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock is also used.

We use Windows 10 Home 64-bit, and test with our RealBench suite, as well as Cinebench for 3D rendering and Adobe Premiere Pro for video export times. Far Cry New Dawn and Metro Exodus test gaming performance. Finally, we record the total power draw of the test PC. We run all tests at stock speed and at the highest stable overclocked frequency.

MONITORS

We test image quality with an X-Rite iDisplay Pro colorimeter and DisplayCal software to check for colour accuracy, contrast and gamma, while assessing more subjective details such as pixel density and viewing angles by eye. For gaming, we test a monitor's responsiveness subjectively and then also use Blur Buster's excellent ghosting UFO test to check the sharpness of the display in high-speed motion.

CPU COOLERS

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

TEST KIT
Fractal Design Meshify C case, 3000MHz Corsair Vengeance LPX memory, 256GB Crucial MX100 SSD, be quiet! System Power 9 500W PSU, Windows 10 64-bit.

INTEL LGA1151
Intel Core i5-9600K CPU overclocked to 4.8GHz with 1.2V vcore, Asus ROG Strix Z370-E Gaming motherboard.

INTEL LGA2066
Intel Core i9-7900X overclocked to 4.2GHz with 1.15V vcore, MSI X299M Gaming Pro Carbon AC motherboard.

AMD AM4
AMD Ryzen 7 1700 overclocked to 3.9GHz with 1.425V vcore, MSI X470 Gaming Pro Carbon AC motherboard.

AMD TRX4
AMD Threadripper 3960X overclocked to 4.2GHz with 1.265V vcore, 32GB of 3466MHz Corsair Vengeance RGB memory, Samsung 960 Pro SSD, Corsair RM850i PSU, ASRock TRX40 Taichi motherboard.

GRAPHICS CARDS

We mainly evaluate graphics cards on the performance they offer for the price. However, we also consider the efficacy and noise of the cooler, as well as the GPU's support for new gaming features, such as ray tracing.

Every graphics card is tested in the same PC, so the results are directly comparable. Each test is run three times, and we report the average of those results.

We test graphics cards at 1,920 x 1,080, 2,560 x 1,440 and 3,840 x 2,160, although we omit the latter resolution on cheaper cards that can't produce playable frame rates at this setting.

TEST KIT

Intel Core i7-8700K overclocked to 4.7GHz on all cores, 16GB Corsair Vengeance LED 3000MHz DDR4 memory, Gigabyte Z370 Aorus motherboard, Cooler Master MasterLiquid 240 CPU cooler, Corsair HX750 PSU, Cooler Master MasterCase H500M case, Windows 10 Home 64-bit.

GAME TESTS

Metro Exodus Tested at Ultra settings with Ultra ray tracing, but with Advanced PhysX and HairWorks disabled. We run the game's built-in benchmark, and report the 99th percentile and average frame rates.

Battlefield V Tested in DirectX 12 at Ultra settings on every card. If a GPU also supports real-time ray tracing, we then test it with DXR enabled on High settings with TAA, and also with DLSS if it's supported. We run through a one-minute custom benchmark in the 'Under No Flag' War Story, recording the 99th percentile and average frame rates with FrameView.

Shadow of the Tomb Raider Tested at the Highest settings preset with High ray-traced shadows enabled. We test with TAA, and also with DLSS if it's supported. We run the built-in benchmark and record the 99th percentile and average frame rates with OCAT.

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 FrameView.

POWER CONSUMPTION

We run Metro Exodus at Ultra settings with Ultra ray tracing at 2,560 x 1,440. We measure the power consumption of our whole graphics test rig at the mains during the test, and record the peak power draw. This result is for the whole system, not the graphics card alone.

CUSTOM PC AWARDS

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

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

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

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

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

CUSTOM PC REALBENCH

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

GIMP IMAGE EDITING

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

HANDBRAKE H.264 VIDEO ENCODING

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

LUXMARK OPENCL

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

HEAVY MULTI-TASKING

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

Elite

Our choice of the best hardware available

Core component bundles

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

Budget system with integrated graphics

Quad-core CPU, basic gaming

Needs a micro-ATX or ATX case.
We recommend a 350W 80 Plus power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 3400G	scan.co.uk	**#194** p20	£140
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	£70
MOTHERBOARD	Asus TUF B450M-Plus Gaming (micro-ATX)	awd-it.co.uk	**#204** p74	£79
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£62
		Total £351		

Budget gaming system

Quad-core CPU, 1080p gaming

Needs a micro-ATX or ATX case. We recommend a 450W 80 Plus power supply. See Issue 204, p74 for an example build guide.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 3 3300X	ebuyer.com	**#203** p28	£120
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	**#202** p20	£18
GRAPHICS CARD	PowerColor Radeon RX 5600 XT	ebuyer.com	**#204** p74	£252
MEMORY	16GB (2 x8GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	**#204** p74	£70
MOTHERBOARD	Asus TUF B450M-Plus Gaming (micro-ATX)	awd-it.co.uk	**#204** p74	£79
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£62
		Total £599		

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 2060 (1080p gaming with ray tracing and some 2,560 x 1,440 gaming)	scan.co.uk	**#199** p50	£288
SWAP STORAGE	1TB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£108

Entry-level RTX gaming system

6-core CPU, 2,560 x 1,440 gaming with real-time ray tracing

Needs a micro-ATX or ATX case. We recommend a 600W 80 Plus Bronze power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 5600X	scan.co.uk	**#209** p30	£280
CPU COOLER	Antec Neptune 240	scan.co.uk	**#204** p16	£75
GRAPHICS CARD	Nvidia GeForce RTX 3070 Founders Edition	nvidia.com	**#209** p22	£469
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3466MHz (CMW16GX4 M2C3466C16)	scan.co.uk	**#201** p76	£120
MOTHERBOARD	MSI MAG B550M Mortar (micro-ATX)*	ebuyer.com	**#204** p42	£140
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£62
	Total £1,146			
UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£95
SWAP STORAGE	1TB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£108

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

Mid-range gaming system

8-core CPU, 2,560 x 1,440 and some 4K gaming with real-time ray tracing

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	**#208** p16	£410
CPU COOLER	Antec Neptune 240	scan.co.uk	**#204** p16	£75
GRAPHICS CARD	Nvidia GeForce RTX 3080 Founders Edition	nvidia.com	**#207** p16	£649
MEMORY	16GB (2 x 8GB) ADATA XPG Spectrix D60G 3600MHz (AX4U3600 38G17-DT60)	amazon.co.uk	**#199** p57	£129
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	**#193** p44	£290
STORAGE	1TB Sabrent Rocket NVMe 4.0	amazon.co.uk	**#208** p51	£170
	Total £1,723			
UPGRADES				
SWAP CPU	AMD Ryzen 9 5900X (12 cores)	scan.co.uk	**#208** p18	£500
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£95
SWAP CPU COOLER	Corsair H100i RGB Platinum (240mm AIO liquid cooler)	scan.co.uk	**#185** p82	£125

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

Core component bundles cont ...

4K gaming system

12-core CPU, 4K gaming with real-time ray-tracing abilities

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 9 5900X	scan.co.uk	#208 p18	£500
CPU COOLER	Corsair H100i RGB Platinum (240mm AIO liquid cooler)	scan.co.uk	#175 p20	£125
GRAPHICS CARD	Nvidia GeForce RTX 3090	nvidia.com	#208 p24	£1,399
MEMORY	16GB (2 x 8GB) ADATA XPG Spectrix D60G 3600MHz (AX4U3600 38G17-DT60)	amazon.co.uk	#199 p57	£129
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	#193 p48	£440
STORAGE	1TB Samsung 980 Pro	scan.co.uk	#208 p52	£222
	Total £2,815			
UPGRADES				
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	#166 p54	£95
SWAP CPU	AMD Ryzen 9 5950X (16 cores)	scan.co.uk	#209 p31	£750

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

Heavy multi-threading workstation

Serious multi-threaded power, 1080p gaming

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Threadripper 3960X	scan.co.uk	#197 p18	£1,240
CPU COOLER	NZXT Kraken X63 (280mm AIO liquid cooler)	overclockers.co.uk	#207 p47	£135
GRAPHICS CARD	Nvidia GeForce GTX 1660 Super	ebuyer.com	#199 p46	£210
MEMORY	32GB (4 x 8GB) Corsair Dominator Platinum RGB 3600MHz	scan.co.uk	#197 p20	£271
MOTHERBOARD	ASRock TRX40 Taichi (E-ATX)	overclockers.co.uk	#198 p44	£470
STORAGE	1TB Samsung 980 Pro	scan.co.uk	#208 p52	£222
	Total £2,548			
UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3070 Founders Edition (2,560 x 1,440 gaming with real-time ray tracing)	nvidia.com	#209 p22	£469
SWAP CPU	AMD Threadripper 3970X (32 cores - massive multi-threaded power)	scan.co.uk	#197 p19	£1,800
ADD SECONDARY STORAGE	4TB Western Digital Blue	cclonline.com	#166 p50	£95

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. We've also recommended a small PSU and a low-profile CPU cooler, if your chosen case requires them.

Mini-ITX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Intel Z490 (LGA1200)	Asus ROG Strix Z490-I Gaming	scan.co.uk	**#206** p40	£280
AMD B550 (AM4 budget)	Asus ROG Strix B550-I Gaming	overclockers.co.uk	**#206** p44	£210
AMD X570 (AM4 mid-range)	Asus ROG Strix X570-I Gaming	overclockers.co.uk	**#198** p20	£290

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	overclockers.co.uk	**#206** p18	£90
PREMIUM	NZXT H1	scan.co.uk	**#201** p24	£299

CPU coolers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
LOW-PROFILE	Noctua NH-D9L	amazon.co.uk	**#143** p17	£45

ATX cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Phanteks Eclipse P300 Glass	overclockers.co.uk	**#176** p28	£55
BUDGET QUIET	be quiet! Pure Base 500	scan.co.uk	**#196** p24	£70
SUB-£100	be quiet! Pure Base 500DX	overclockers.co.uk	**#202** p39	£95
COMPACT	Fractal Design Define 7 Compact	scan.co.uk	**#203** p32	£92
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	**#202** p44	£128
SUB-£150	Fractal Design Define 7	overclockers.co.uk	**#204** p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	**#187** p24	£200

Micro-ATX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD X399 (TR4)	ASRock X399M Taichi	scan.co.uk	**#179** p28	£320
AMD B550 (AM4)	MSI MAG B550M Mortar	ebuyer.com	**#204** p42	£140

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Fractal Design Focus G Mini	scan.co.uk	**#180** p46	£47
MID-RANGE	Fractal Design Define Mini C	scan.co.uk	**#161** p26	£70

Networking

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ROUTER (WI-FI 6)	TP-Link Archer AX6000	overclockers.co.uk	**#196** p57	£280
MESH ROUTER (WI-FI 6)	Asus AiMesh AX6100	amazon.co.uk	**#196** p54	£350
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	**#196** p58	£60
SINGLE-BAY NAS BOX	Synology DS118	box.co.uk	**#174** p34	£155
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	**#200** p22	£152
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	**#174** p34	£209

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

Monitors

Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
24in, 144Hz, TN, 1,920 x 1,080, F, G	AOC G2590FX	scan.co.uk	#190 p53	£178
24in, 144Hz, VA, 1,920 x 1,080, F	AOC C24G1	cclonline.com	#191 p28	£185
25in, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	currys.co.uk	#209 p57	£330

Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5in, 60Hz, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£350
34in, 144Hz, IPS, 3,440 x 1,440, W, F	iiyama G-Master GB3461WQSU	cclonline.com	#206 p53	£349
34in, 144Hz, IPS, 3,440 x 1,440, W, F, G	LG UltraGear 34GN850	overclockers.co.uk	#206 p55	£970
38in, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,500
35in, 200Hz, VA, 3,440 x 1,440, W, G, HDR	Asus ROG Swift PG35VQ	scan.co.uk	#198 p58	£2,499
43in, 120Hz, VA, 4K, F, G	Asus ROG Strix XG438Q	amazon.co.uk	#205 p39	£1,065

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27in, 144Hz, IPS, 1,920 x 1,080, F, G	AOC 27G2U	scan.co.uk	#201 p53	£220
27in, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	argos.co.uk	#209 p60	£370
27in, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Nitro XV273	alza.co.uk	#204 p25	£378
27in, 144Hz, IPS, 2,560 x 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	#201 p54	£409
27in, 165Hz, IPS, 2,560 x 1,440, F, G	Gigabyte Aorus FI27Q	overclockers.co.uk	#201 p55	£475
27in, 240Hz, TN, 2,560 x 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£580

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27in, 60Hz, IPS, 4K	AOC U2790PQU	amazon.co.uk	#194 p30	£365

Peripherals and audio

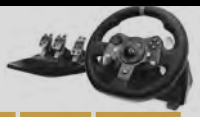
Gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
MEMBRANE	Corsair K55 RGB	amazon.co.uk	#201 p45	£50
BUDGET TKL MECHANICAL	HyperX Alloy FPS Pro	amazon.co.uk	#201 p46	£80
MECHANICAL	Corsair K68 RGB	overclockers.co.uk	#181 p53	£100
OPTICAL ESPORTS	Asus ROG Strix Scope RX	overclockers.co.uk	#209 p43	£125
MECHANICAL MMO	Corsair K95 RGB Platinum	overclockers.co.uk	#164 p26	£150
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	#193 p56	£150
PREMIUM TKL MECHANICAL	Asus ROG Strix Scope TKL Deluxe	scan.co.uk	#202 p24	£140
LUXURY MECHANICAL	Razer Hunstman Elite	box.co.uk	#193 p59	£185
LUXURY WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	scan.co.uk	#208 p60	£230

Gaming mice

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Corsair M55 RGB Pro	amazon.co.uk	#200 p24	£38
FIRST-PERSON SHOOTER	SteelSeries Rival 600	box.co.uk	#184 p59	£74
MMO	Razer Naga Trinity	scan.co.uk	#186 p52	£90
WIRELESS	Corsair Dark Core RGB Pro	amazon.co.uk	#202 p25	£97
AMBIDEXTROUS	Razer Lancehead Tournament Edition	amazon.co.uk	#177 p53	£75
ULTRA LIGHTWEIGHT	Glorious PC Gaming Race Model O	overclockers.co.uk	#195 p58	£53

Peripherals and audio cont ...



Game controllers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	**#202** p50	£215
PREMIUM RACING WHEEL	Fanatec CSL Elite PS4 Starter Kit	fanatec.com	**#202** p49	~£506
GAMEPAD	Microsoft Xbox One Wireless Controller	argos.co.uk	**#191** p56	£50
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	**#207** p52	£34
FLIGHT STICK	Thrustmaster T.1600M FCS HOTAS	thrustmaster.com	**#207** p56	£140

Gaming headsets

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
STEREO	Sennheiser GSP 300	amazon.co.uk	**#194** p56	£89
SURROUND	Asus ROG Centurion	amazon.co.uk	**#163** p49	£215
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	**#204** p50	£160

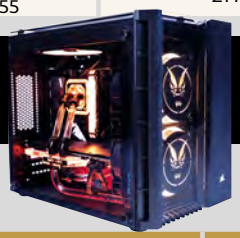
Speakers

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

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS MULTI-DEVICE	Logitech K780	currys.co.uk	**#203** p58	£74
WIRELESS TKL MECHANICAL	Keychron K2 Version 2	keyboardco.com	**#208** p57	£84
TKL MECHANICAL	Majestouch Convertible 2 Tenkeyless	keyboardco.com	**#203** p55	£140

PCs and laptops



Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
8-CORE GAMING	Wired2Fire Predator	AMD Ryzen 7 3700X	Nvidia GeForce RTX 2060 Super	wired2fire.co.uk	**#196** p40	£1,361
8-CORE RTX 3080 GAMING	PC Specialist Obsidian I	Intel Core i7-10700KF	Nvidia GeForce RTX 3080	pcspecialist.co.uk	**#209** p40	£1,899
10-CORE RTX 3080 GAMING	CyberPower Infinity 910 RTX	Intel Core i9-10850K	Nvidia GeForce RTX 3080	cyberpowersystem.co.uk	**#208** p42	£2,285
PREMIUM MINI-ITX	Corsair One i160	Intel Core i9-9900K	Nvidia GeForce RTX 2080 Ti	corsair.com	**#190** p32	£3,250
WATER-COOLED 16-CORE GAMING	Scan 3XS Absorbere	AMD Ryzen 9 5950X	Nvidia GeForce RTX 3090	scan.co.uk	**#209** p46	£5,199
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	**#145** p58	£13,785

Laptops

CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
THIN AND LIGHT GAMING	Asus ROG Zephyrus G14 GA401IV	AMD Ryzen 9 4900HS stock speed	Nvidia GeForce RTX 2060 Max-Q	14in 2,450 x 1,440 IPS 60Hz	overclockers.co.uk	**#202** p28	£1,800
GAMING	Chillblast Phantom 17	Intel Core i7-10875H stock speed	Nvidia GeForce RTX 2070	17.3in 1,920 x 1,080 IPS 144Hz	chillblast.com	**#197** p53	£1,660
HIGH-PERFORMANCE GAMING	Lenovo Legion 7i	Intel Core i7-10875H stock speed	Nvidia GeForce RTX 2080 Super Max-Q	15.6in 1,920 x 1,080 IPS 144Hz G-Sync	laptopsdirect.co.uk	**#208** p40	£2,100

RICK LANE / INVERSE LOOK

WHEN CINEMA STUMBLES

Films are still considered artistically superior to games, but games frequently make better use of some of cinema's best franchises, argues Rick Lane

For decades, gaming has looked up to cinema as a bigger, smarter sibling. Even today, when the game industry has outgrown the medium of celluloid by some margin, film often remains the industry's main inspiration when it comes to storytelling and structure. Whenever a rousing or dramatic event occurs in a game, that moment is generally described as being 'cinematic', a consequence of how games from Call of Duty to Red Dead Redemption ape the conventions of Hollywood.

Ironically, though, games are often better at telling stories with some of cinema's biggest franchises than cinema itself. If you want an example, look no further than Star Wars. There are considerably more great Star Wars games than great Star Wars films. From the classic space-combat sims, such as X-Wing and TIE Fighter, through shooters such as Dark Forces and Jedi Knight, right up to brand-new releases such as Star Wars: Squadrons. All of these Star Wars spinoffs are superior experiences to at least four of the nine films.

> There are more great Star Wars games than great Star Wars films

Games have also repeatedly proven that they can provide better direct follow-ups to classic films. One of the best examples is Alien: Isolation, a game far more in the spirit of the Ridley Scott classic than any of the subsequent films (including the excellent but highly different Aliens). Isolation makes use of technology and systems to revitalise the terror of the culturally omnipresent Xenomorph, reminding players of what made this creature so terrifying when the original film released in 1979.

Other examples include Escape from Butcher Bay, a tie-in to the Chronicles of Riddick series that was considerably better than the actual film. Even Ghostbusters: The Video Game (which is a decent game but by no means a classic) is in many ways the Ghostbusters 3 that fans wanted but was never released. Certainly, it's better than the risible 2016 reboot that, despite an excellent cast, completely missed the tone and spirit of the original.

When you consider the reputation of gaming movie tie-ins, it's surprising there are so many examples that are not just good, but also better than the equivalent films. What's the secret? As I said about Alien, portraying these experiences through a different lens helps – exploring the ideas of these films through different mechanics and systems.

However, it also comes down to passion. In the case of Ghostbusters, Dan Ackroyd and Harold Ramis were actively engaged and directly involved with the project, even managing to get Bill Murray (who was partly responsible for preventing a third Ghostbusters film being made) to lend his voice to the game.

That's not to say that games are better storytelling devices than films. For one, there's at least a half-dozen terrible movie tie-ins for every hit. The point is that many of these genuinely great games deserve recognition as canon entries in the series upon which they're based.

Does it matter more that Alien gets a great film sequel, or just a great sequel? Is it important that Ghostbusters 3 is a film, or an authentic and enjoyable Ghostbusters production? Should sequels to great stories be constrained to a particular medium, or is it the experience that ultimately matters, regardless of the form in which it's delivered? CPC

Rick Lane is Custom PC's games editor @Rick_Lane

Doom Eternal: The Ancient Gods Part 1 / £15.99 inc VAT

DEVELOPER id Software / **PUBLISHER** Bethesda

The Ancient Gods is an expansion pack to Doom Eternal in the same way that heavy metal is an expansion pack to rock music. It eschews the typical expansion territory of adding a bunch of new mechanics to the base game. There are no new weapons and only a couple of new enemies. Instead, it continues the story directly from the end of Eternal, adding three new levels that test your ripping and tearing skills to the limit.

Within a minute of starting the first level – a sprawling UAC oceanic research platform – it's clear The Ancient Gods isn't messing about. Where it would normally warm you up with a bit of imp and soldier bashing, the opening battle throws multiple Revenants and Mancubuses at you. Within an hour you're battling devious combinations of the base game's most challenging enemies with a fully unlocked arsenal, trying to remember what all the buttons do while dodging the homing rockets of multiple Titan demons.

Essentially, The Ancient Gods is a modern attempt at a classic Doom expansion – 'you've mastered the base game, now master this'. Even on the standard difficulty (Hurt Me Plenty), it's seriously challenging. The few new additions it brings are all intended to push you out of your comfort zone. There are stationary turrets that require you to precisely pop their hovering ball of energy to destroy them, while wandering spirits can possess other enemies, making them twice as hard to defeat.

At first the ferocity of The Ancient Gods can be shocking, but soon the old neural pathways start to reconnect, as you remember the little details of Eternal's combat – how to instantly stun a Cacodemon by firing a grenade into its mouth, or shatter an Aranchotron's cannon with a pinpoint shot from the Assault Rifle's scope. Some of the later battles in The Ancient Gods are so thrilling that your hands will be shaking by the end of them.

The Ancient Gods also smooths out many of the original game's creases. There are fewer delineations between the big arena fights and the platforming sequences, with smaller but still challenging fights breaking up the pattern. Indeed, The Ancient Gods has a knack for delightfully unpleasant surprises, such as dropping a Baron of Hell in a narrow corridor, or locking you in a room with two Marauders at once.

It isn't a perfect expansion. The story is still hot nonsense, and the environment designs could be more interesting. However, The Ancient Gods is a huge improvement over the base game, and offers some of the most exhilarating FPS action we've had all year.

RICK LANE

OLD GODS

+ Three massive new levels
+ Superbly designed combat encounters
+ Harder than a granite worktop

NEW DEMONS

– Still too much silly story
– Levels could be prettier

/ VERDICT

The Ancient Gods Part 1 is so good, we're almost afraid to see what Part 2 looks like.

OVERALL SCORE

90%

Noita / **£15.49** inc VAT

DEVELOPER Nolla Games / **PUBLISHER** Nolla Games

Today it's rare for a game to genuinely blow you away with its tech, given how good the majority of modern games look. It's even rarer when that game looks more like one you'd play in 1990 than 2020. But don't be fooled by Noita's retro-styled pixel art. Wizardry lies beneath it, and we're not referring to the magic wands that form your primary weapons in the game.

Noita is a roguelike that, at first glance, looks cast firmly in the Spelunky mould. You play as a witch, who, for unknown reasons, must descend through a series of mines, caverns and other subterranean locations, picking up gold and attempting to survive the game's enormously hostile environments. If you die, and you will, you're transported back to the start of the game, while the level layouts reshuffle themselves, so no two runs are exactly the same.

What's more, Noita goes one step further than using random generation to make its world unpredictable. The environments are built from many different substances, and the game's bespoke Falling Everything engine simulates their properties.

As a simple example, fire will propagate realistically across any flammable substance; in Noita, this includes wood, coal, petroleum and alcoholic spirits such as whisky. Water, meanwhile, will douse any fire, as will mud and blood.

There are around 100 such substances within Noita's world, ranging from solid objects such as stone and metal, liquids such as acid and lava, gases such as smoke and steam, and even grainy materials such as gunpowder. Noita doesn't limit itself to real-world substances either. More exotic examples include Ambrosia, a fluid that temporarily makes you immortal, and Polymorphine, another liquid that transforms anything that steps in it into something else, such as a flying sheep.

All of this forms the foundation of a game that, like Spelunky, plays according to logical rules. If you set fire to gunpowder, it will start to explode. If an enemy casts a fire spell on gunpowder, it will also explode. As you can imagine, there are lots of explosions in Noita. On some levels, you'll spawn to find the screen shaking slightly, which is evidence of a huge cascade of concussions popping off somewhere below you.

It isn't just the environments that follow these rules, however. Most of the game's enemies use the substance system in some way. Early on, you'll encounter miners who try to blow you up with sticks of dynamite, while Fire Elementals can set half the level ablaze with their fireballs. One of our favourite enemies is a giant green eyeball that, when killed, explodes in a deadly shower of acid that will often eat right through to the bottom of the level.

Between its aggressive enemies and the highly volatile environment, Noita is highly challenging. Unlike Spelunky,

however, where most of the game's features are directed towards killing you, Noita lets you wield the powers of its world in your own hands through flasks and wands.

Flasks let you carry many of the game's substances around with you, and they can either be thrown like a one-off grenade, or sprayed in a gradual stream. Flasks can be used in many different ways. A flask filled with acid or lava can be a powerful weapon, whereas a flask filled with water can be used to douse fires, or turn impassable lava into traversable rock.

While flasks are useful in specific situations, your real power comes from wands. Most wands work like guns, firing a projectile with a click of the mouse button.

However, thanks to Noita's elaborate spell system, that projectile could be almost anything. It could be a magic missile. It could be a fireball. It could be a Looney Tunes-style bomb. It could even be a level-destroying nuclear warhead. Noita's spell-crafting system is made more elaborate by an abundance of modifiers. You can have spells that bounce, spells that scatter like a shotgun, spells that cast other spells – the list goes on.

All of this combined makes Noita as unbalanced as it is hilarious. Often your most dangerous adversary will be yourself, as you casually test a new wand and end up scattering your body parts across a five-mile radius. Noita's difficulty can sometimes be frustrating, but the game's highly dynamic nature means it's fun even when you're terrible at it. It's also more generous than similar games in some ways, completely refilling your health at the end of each level, and giving you unlimited time to explore each area.

A bigger problem is that Noita doesn't like to explain itself. The spell-crafting system is arcane, and you have to study the nuances of how wands work to make effective spells. Noita could also do a better job of explicating how its world works. Noita doesn't have to be a downwards-leading adventure – you can also explore sideways and even upwards, leading you to whole new areas.

Similarly, Noita has an abundance of secrets and surprises. It's fantastic that Noita has so much to discover, but given that much of your time will simply be focused on staying alive, it's a shame the game is so wilfully reticent about much of its content. Even if you play Noita as a straightforward runner, it remains an immense amount of fun.

The throwback pixel art also belies a distinctly modern heft to the combat. The most basic wand has a satisfying kick to it, and you feel the force of nearby explosions as they crack like a thunderstorm, leaving gaping holes in the environment.

Noita will probably be remembered for its remarkable technology, offering a truly simulated environment where almost anything can happen. However, it isn't just a game that relies on a gimmick – it looks and feels great to play too.

RICK LANE

NOITA

+ Spectacular technology
+ Fun, often amusing game design
+ Feels great to play

NO, TA

– Very difficult
– Poorly explained world rules

/ VERDICT

A frenetic roguelike underpinned by marvellous technology, Noita is a dynamic delight.

OVERALL SCORE

90%

SPELUNKY 2 / £15.49 inc VAT

DEVELOPER Mossmouth / **PUBLISHER** Mossmouth

SPELUNKY

+ Impressive dynamic systems
+ Chaotically entertaining

KERPLUNKY

– Conceptually safe
– Difficult to the point of being unfair
– Too much emphasis on killing the player

The original Spelunky was a key influence on modern roguelike games, ushering in a new era of titles that rely on random generation, logic-driven systems and being harder than Tyson Fury's dietician. The sequel transports the first game's randomly generated platforming to the moon, where the daughter of the original game's protagonist (Spelunky Guy), must descend through another endlessly shifting maze of hazards and horrors, being killed more frequently than Kenny from South Park.

Spelunky gives you simple controls in a world that can produce complex interactions. Your basic abilities include running, jumping, a basic whip attack, and the ability to pick up and throw objects. Meanwhile, the game world is built according to a logical set of rules, where every part can interact with every other part. If you throw a rock at an enemy, for example, that enemy could fly off a ledge and hit another enemy, which flies off another ledge and sets off an arrow-trap, which rebounds off the wall and kills you.

The sequel makes these interactions more complex, adding dozens of new enemies, arenas, secrets and so on. Examples include the Lizard, an early enemy that curls into a ball and continues to roll at you until it hits a wall. Meanwhile, the Mole can burrow into the ground and pop up at random locations, ambushing the unwary spelunker from below.

The result is an extremely challenging game. You can only take four hits before dying, and only regain health by carrying your pet dog (which spawns randomly in the environment) to the end of the level. The difficulty is rather mitigated by the quickfire design (Spelunky 2 can be completed in around an hour if you're good enough) and the fact you can unlock shortcuts by completing a stage several times.

However, there are times when the game simply feels unfair, such as laying down bear traps in a jungle level with foliage obscuring the floor.

Also, while it's possible to turn Spelunky 2's clockwork world to your advantage, it's often simply too chaotic to predict how a decision might work against you. Moreover, you're not given many tools to manipulate the game world. While there are some new gadgets to pick up, your starting equipment is exactly the same as in the first game, and there are no new mechanics or abilities to compensate for the additional enemies and hazards.

In the end, that extra content tips the scales too far in favour of your enemies. It's still a fascinating contraption to watch in motion, but there are only so many times you can be kicked in the crotch before you start to think you should move on somewhere else.

RICK LANE

/ VERDICT

A decent follow-up to the original, but one that's overly punishing and lacking in ambition.

OVERALL SCORE

64%

AMNESIA: REBIRTH / £23.79 inc VAT

DEVELOPER Frictional Games / **PUBLISHER** Frictional Games

Amnesia: The Dark Descent was an influential horror game, eschewing survival horror's penchant for guns and combat in favour of storytelling, puzzles and being trapped in dark rooms with monsters. Set 100 years after The Dark Descent, Amnesia: Rebirth tells the story of Tasi Trianon, a French archaeologist whose plane crashes in the Algerian desert while en route to a dig site.

Scrambling out of the wreckage, Tasi finds herself alone with no memory of what happened, and sets out into the sands to find her companions missing from the plane. Rebirth's narrative is basically two stories rolled into one. The first largely concerns itself with Tasi, her past and what happened to the rest of her team. The second harks back to The Dark Descent, with Tasi stumbling on a portal to an alien world rendered inhospitable by some apocalyptic event.

These two strands have the potential to be compelling, but they work against each other more than they complement the broader narrative. The story of Tasi's past and her relationship with her children (one deceased, another yet to be born) is moving, but also overly sentimental, with thinly sketched secondary characters undermining the emotive drama. The alien world, meanwhile, doesn't get enough spotlight to seem believable, lacking the detail and worldbuilding seen in Frictional's previous games, particularly SOMA.

Beyond the story, Rebirth relies on familiar mechanics to build its horror, deftly blending physics-based puzzling with stealth and the odd chase sequence – the level set in a crumbling Foreign Legion fortress seamlessly combines all three mechanics. It's also undeniably scary, carefully building up the tension to several terrifying peaks. A heart-stopping sequence set in some Roman catacombs is another highlight, smartly subverting your expectations of how the sequence is going to play out.

Sadly, Rebirth fails to add any new ideas to the formula. Much of it still involves relying on a perilously small number of matches to illuminate environments, amid dozens of perfectly portable light sources. A new gadget is introduced in the form of an amulet that opens the portals between worlds, but there's only a handful of scripted interactions using this amulet, and most of them happen in the first third of the game. Meanwhile, Tasi's crumbling sanity can be partly restored by looking at her baby bump and talking to her unborn child. This is a touching if rather bizarre feature, but it doesn't dramatically affect how the game plays.

In the end, Rebirth suffers from both too much ambition and not enough of it. There are too many ideas that aren't sufficiently explored, and the game cries out for a system that binds its disparate elements together. Rebirth may give you a good fright, but it won't be one that recurs in your nightmares.

RICK LANE

AMNESIA

+ Story has potential
+ Good puzzles
+ Intermittently scary

FORGETTABLE

– Few new ideas
– Not enough world or character building

/ VERDICT

A decent enough horror, but it fails to build on Frictional's previous work.

OVERALL SCORE

60%

REALITY CHECK

Gnomes, goblins and personal data worries. It's **Rick Lane's** roundup of the latest happenings in the VR world

NEWS

I SPY

A research team at Stanford University has devised a system that can identify individuals after just a five-minute session in a VR setup. According to the published research paper, the study (which involved 511 participants) saw the system identify 95 per cent of users correctly under 'typical VR viewing circumstances, with no specially designed identifying task'.

The experiment involved users wearing an HTC Vive headset with touch controllers as they watched 360-degree VR videos and answered questionnaires in VR, although the latter task was designed for a different research project. The researchers then took the tracking data from the head and hands of the participants and fed them into machine learning algorithms, creating a profile of the participants based on information that included height, posture, head rotation speed and how the individual moved.

The point of the experiment was to demonstrate that individuals can be specifically identified with no other information beyond the biometric data taken from the headset. On its own, this may not sound particularly worrying.

However, both Oculus and HTC are permitted to share VR data with whomever they like, provided the identities of the users are removed. Yet, according to the study, such data could potentially be used to identify a person regardless of whether their name or other personal information had been removed from the dataset.

NEWS

OCULUS QUEST 2

The Oculus Quest was, for our money, the best all-round VR headset available, and it was inevitable that Oculus would follow it up with a newer version. Sure enough, in October, Oculus released the Quest 2. In many ways, the new headset offers substantial improvements over the original at a considerably cheaper price.

The technical specs of the Quest 2 are impressive too. Most notably, it increases the screen resolution over the original Quest, with its LCDs offering 1,832 x 1,920 pixels per eye compared to the Quest's 1,440 x 1,600 resolution. The Quest 2 also has superior internal hardware, with 6GB of RAM and a Qualcomm Snapdragon XR2 chip providing higher-fidelity experiences when using it as a mobile headset.

There's also been a general redesign that includes controllers with double the battery life, for a price of £299. That's £100 less than the RRP of the original Quest. It's fantastic value for money, but there's a catch.

Using the Quest 2 requires users to link it to their Facebook account. In other words, unless you're happy for Facebook to suck up all your personal information like a thirsty data elephant, you'll have to pass on the Quest 2 entirely. Owners of the original Quest can still use their headsets just with an Oculus account until 2023. Forcing players to use a Facebook account has resulted in other issues too, such as headsets being rendered unusable after player's accounts were wrongly identified as fake accounts, and then being banned.

REVIEW

GNOMES & GOBLINS / £30.99 inc VAT

DEVELOPER Pixel Reef / **PUBLISHER** Pixel Reef / Plug in Digital

Gnomes & Goblins is a work of remarkable technological achievement in search of a game in which to use it. This is arguably the best-looking VR game ever made, and it offers a fantastically simulated fantasy environment. However, it also seems unable to decide what kind of game it wants to be and how much it wants to involve the player. The result is an experience that's enchanting and frustrating in equal measure.

The core game revolves around a picturesque fairy-tale village situated inside a giant forest, which is probably the most impressive environment ever rendered in VR. With lush vegetation and miniature tree houses illuminated by candlelight from within, Gnomes & Goblins resembles a set designed for a film such as Willow or The Dark Crystal. Given that the project was created by Hollywood director Jon Favreau, perhaps this shouldn't be surprising. Indeed, the boggle-eyed goblins that are the subject of the game were apparently the inspiration for Baby Yoda in Disney's Star Wars show The Mandalorian.

Gnomes & Goblins is strongest in its opening hour, offering a narrative-driven experience that sees you befriending the goblins and familiarising yourself with the village. It's a wonderful place to explore in VR, thanks mainly to the way it plays with scale. The titular creatures are superbly animated and interacting with them is a delight. Meanwhile, peering into the tiny windows and hollowed-out tree stumps that form their homes offers some quietly thrilling exploration.

After that first hour, however, Gnomes & Goblins' small amount of story comes to an end. At this point, the game switches to an Animal Crossing-style farming simulation. Exploring the forest freely, you'll stumble across recipes that unlock different types of seeds that can be planted and grown into crops. These crops can then be harvested and given to your goblin pals.

From a systems perspective, the VR farming is fun enough. Scattering seeds and plucking ears of corn from giant green stalks hasn't been done in VR before, and the game communicates the physicality of farming in a way that can't be achieved in games such as Stardew Valley.

The problem is that Gnomes & Goblins seems reluctant to offer any direction on what exactly you're supposed to do, and there doesn't seem to be much point in the experience beyond enjoying the moment. In short, there isn't much to this game for £30, especially given that there are large areas of the game marked 'coming soon', implying that Gnomes & Goblins isn't actually a finished product.

Like Paper Beast, Gnomes & Goblins feels like two different games stitched together. Both games have the potential to be brilliant, but this one would be better if it committed to one of these ideas, rather than offering a half-hearted version of both. If you're happy to spend £30 to see how good VR can look, Gnomes & Goblins accomplishes that much. Otherwise, we'd advise you wait and see how the developer fleshes out the game in the months to come. CPC

GNOMES

- \+ Looks incredible
- \+ Some clever community simulation
- \+ Enjoyably tactile

GOBLINS

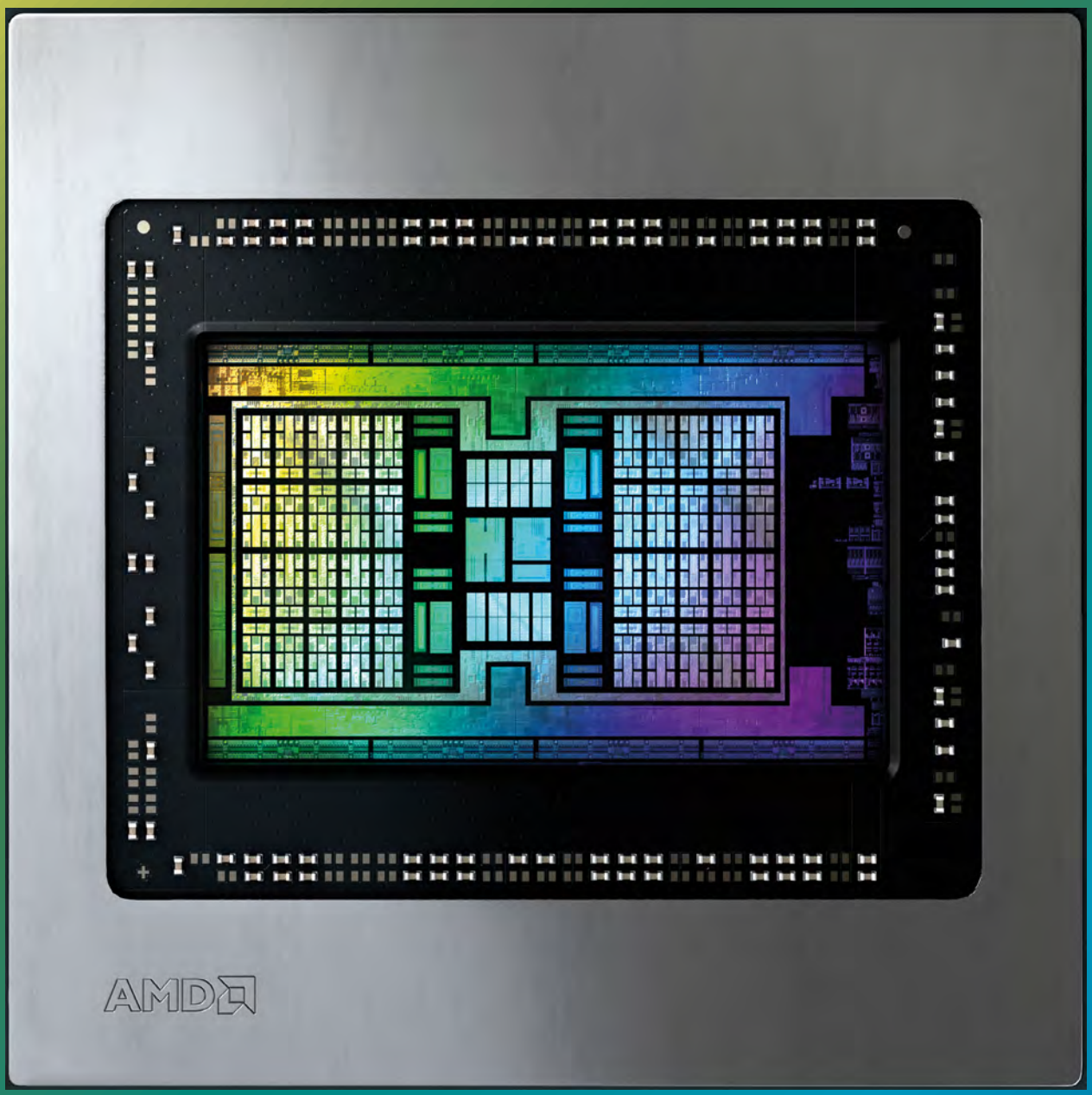
- – Very light story
- – Poor player instruction
- – One good idea beats two mediocre ones

VERDICT

Gnomes & Goblins has great potential, but it doesn't seem to know what to do with it.

OVERALL SCORE

50%



RDNA 2 UNRAVELLED

Matt Lambert and Edward Chester sequence the genome of AMD's RDNA 2, the ray tracing-enabled architecture powering the new Radeon RX 6000 series

The original RDNA architecture debuted in the mid-range RX 5700 XT card, based on the 'small' Navi 10 GPU

THIS 26.8 BILLION-TRANSISTOR GPU MEASURES 519.8MM² AND HOUSES 80 COMPUTE UNITS, ESSENTIALLY DOUBLING IN SIZE OVER NAVI 10

AMD's new RDNA 2 graphics architecture has been a long time coming, the driving force behind the long-awaited and much anticipated 'Big Navi' discrete GPUs. Already deemed worthy by Sony and Microsoft for use in both the PlayStation 5 and Xbox Series X, the launch of the RX 6000-series graphics cards now presents RDNA 2 to the most discerning client of all: the PC gamer.

RDNA originally launched last year, following a full eight years of iterative updates to Graphics Core Next (GCN) – the AMD architecture launched for PC in 2011 via the Radeon HD 7970. As a truly new architecture, then, RDNA was a welcome change in 2019, making its PC debut in the 251mm² Navi 10 GPU. In its full implementation comprising 40 Compute Units (CUs), this GPU powers the RX 5700 XT; at launch, it easily outperformed the GCN-based Vega 64 while consuming less power and using 24 fewer CUs.

With a redesigned CU, a new multi-level cache hierarchy, and a streamlined pipeline, Navi was a healthy step forwards in performance. It also injected AMD graphics cards with a desperately needed boost to efficiency, or performance per watt (PPW). In fact, the PPW increase was around 50 per cent, largely assisted by the move from 14nm to 7nm manufacturing.

However, Navi's launch was underwhelming for those hoping for a takedown of Nvidia akin to Ryzen's impact on Intel CPUs. The £380 launch price certainly humbled Nvidia into some price cuts for mid-range RTX 20 Series cards, but it also told consumers that AMD still had no stake at the top of the GPU market, while the RTX 2080, RTX 2080 Super and RTX 2080 Ti were left unphased despite having launched almost a year before.

Worse still, Nvidia maintained a small edge in efficiency, even though Turing was manufactured on 12nm, and RDNA 1 noticeably had no answer to Nvidia's support for real-time ray tracing, which was (finally) gaining some traction and appearing in games.

With the first Navi launch, AMD had stronger products but still had significant ground to reclaim in three key areas: performance, efficiency and features. For those hoping for better competition across the entire GPU market, hope quickly shifted to Big Navi. To say there's been an appetite for RDNA 2 and Big Navi among PC gamers would be an understatement.

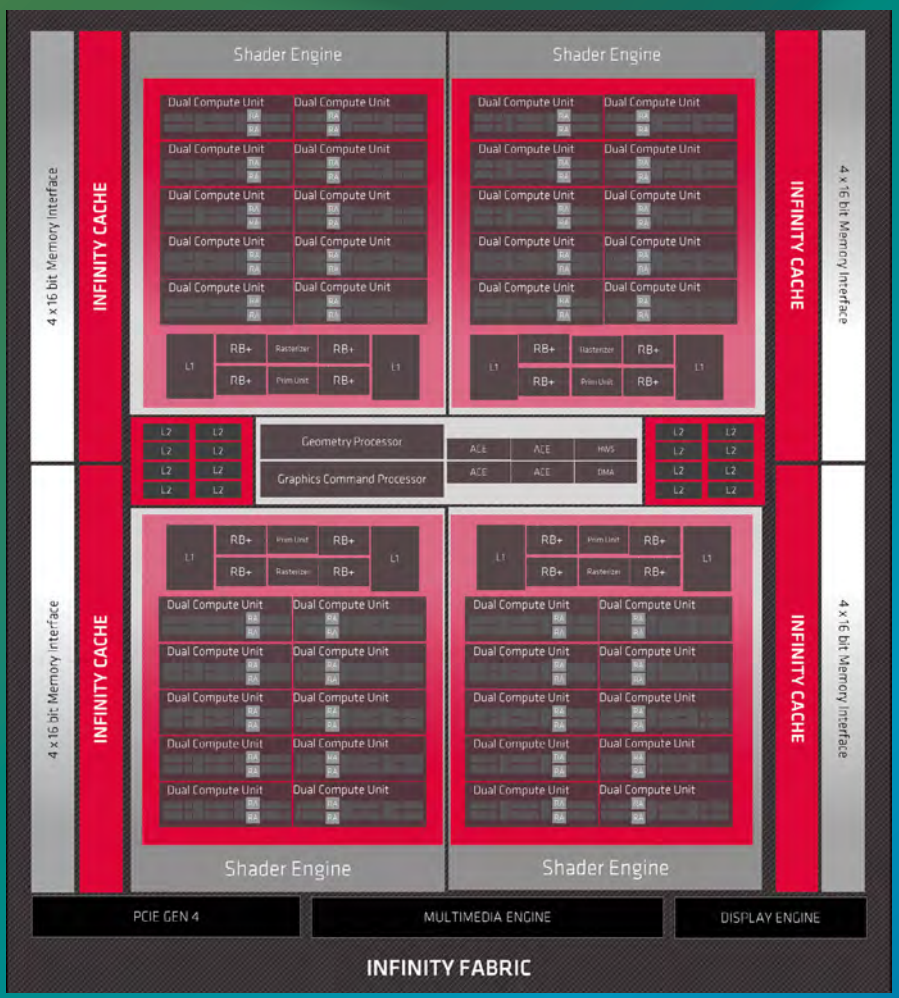
The overview

All of which brings us to today. By now, Nvidia has extended its lead over AMD even further with Ampere and the RTX 30 Series. Nevertheless, AMD has finally brought the fight to Nvidia where it was needed most – at the top. The RX 6000 series currently comprises three cards, with the RX 6800 and RX 6800 XT priced at £530 and £680 respectively, and the forthcoming Radeon RX 6900 XT waiting in the wings to take on the RTX 3090.

Remember those three key areas? With the RX 6000 series, AMD claims it can deliver up to double the frame rate of the RX 5700 XT and up to 54 per cent more PPW, ticking off the performance and efficiency criteria. As you can see in the results on p20, it's not far off. As for features, the RX 6000 series graphics cards come with full, hardware-level support for DirectX 12 Ultimate, including dedicated logic for real-time ray tracing.

Making all this possible is the Navi 21 GPU, which powers the RX 6900 XT, RX 6800 XT and RX 6800. This 26.8 billion-transistor GPU measures 519.8mm² and houses 80 Compute Units, essentially doubling in size over Navi 10 – Big Navi definitely lives up to its name. Indeed, it's worth reiterating just what Big Navi represents. AMD simply didn't release a 'big' GPU based on its first RDNA architecture. Big Navi not only brings all the

All three RX 6000 cards, from the 6800 (pictured) to the 6900 XT, are based on the Navi 21 GPU



The overall block diagram of Navi 21 looks surprisingly unchanged from Navi 10, other than the doubling of compute units

improvements of RDNA 2 with it, but it's also is simply the first 'big' GPU AMD has released in some time.

The inherent parallelism of GPU computing means that adding more Compute Units in this way (going wider) is a guaranteed way to boost performance. The other way to ensure more frames per second is to go faster with a clock speed increase. With boost clocks well north of 2GHz on all three cards, Big Navi has achieved this as well.

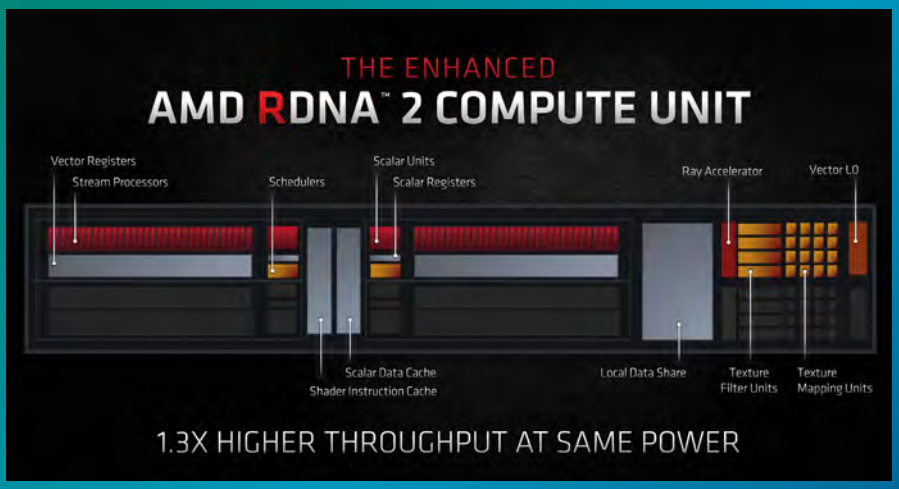
The cost of going wider and faster is, of course, power draw. One 'easy' way to save power is to transition to a more efficient node (just as we saw with the move from GCN to RDNA), but AMD is sticking to the same TSMC 7nm process with these GPUs. Nevertheless, where the RX 5700 XT had 40 CUs and a boost clock of 1905MHz, resulting in a total board power of 225W, the RX 6900 XT has fully double the CU count and an 18 per cent higher boost clock, yet the total board power has only increased to 300W.

This figure also compares favourably with the competition, with the RTX 3080 and RTX 3090 hitting 320W and 350W respectively. As you'll see in our results on p20–21, our system did indeed draw 29W less at peak load with the Radeon RX 6800 XT than with the GeForce RTX 3080.

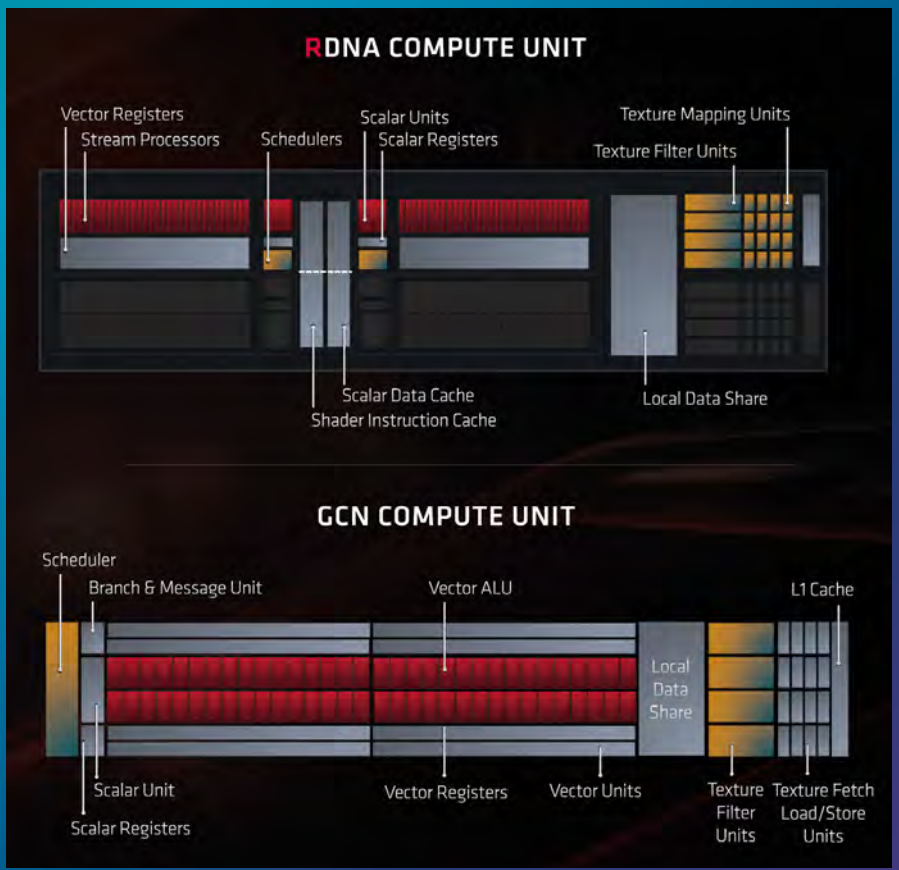
The specifics of AMD's efforts in crafting RDNA 2 for Big Navi are what we'll be exploring in this feature. The inimitable **CPC** reviews team will of course delve into quite how well the GPU performs in its different configurations. In this feature, we're looking more closely at how it performs. Let's start by familiarising ourselves with how the GPU is configured.

Navi 21

With one key exception, the high-level structure of Big Navi hasn't changed all that much. The Graphics Command Processor receives the CPU's API commands via the PCI-E 4 bus, and in turn it has one command stream for each type of shader program (one for vertex shaders, one for pixel shaders and so on). We also again have four Asynchronous Compute Engines, each with its own independent command stream, which manage compute shaders. The scheduling logic means graphics commands



RDNA 2's CU is almost identical to the first RDNA CU, other than the addition of a ray-tracing accelerator unit



The CU of RDNA was a significant change from the one used in AMD's GCN architecture

THE SINGLE BIGGEST DIFFERENCE IS THE INTRODUCTION OF A VERY LARGE CACHE BLOCK, DUBBED INFINITY CACHE

can be entirely suspended when a latency-sensitive, high-priority compute task needs to be carried out.

The majority of work is again distributed between the Shader Engines, which house all of the programmable compute resources. Meanwhile, the Geometry Processor lives up to its name, managing the fixed-function pipeline and assisting with tasks such as tessellation and vertex assembly.

Each of the four Shader Engines of this GPU contains ten Dual Compute Units, which AMD describes as 'the essence of the RDNA architecture'. Each of these has four of the 32-wide SIMDs (128 stream processors) introduced with RDNA last year, as well as eight texture units and two scalar units. In its full implementation, as used in the RX 6900 XT, Navi 21 is rocking 5,120 stream processors, 320 texture units and 160 scalar units. These counts are reduced in line with the Compute Units, with the RX 6800 XT having 72 active CUs and the RX 6800 having 60.

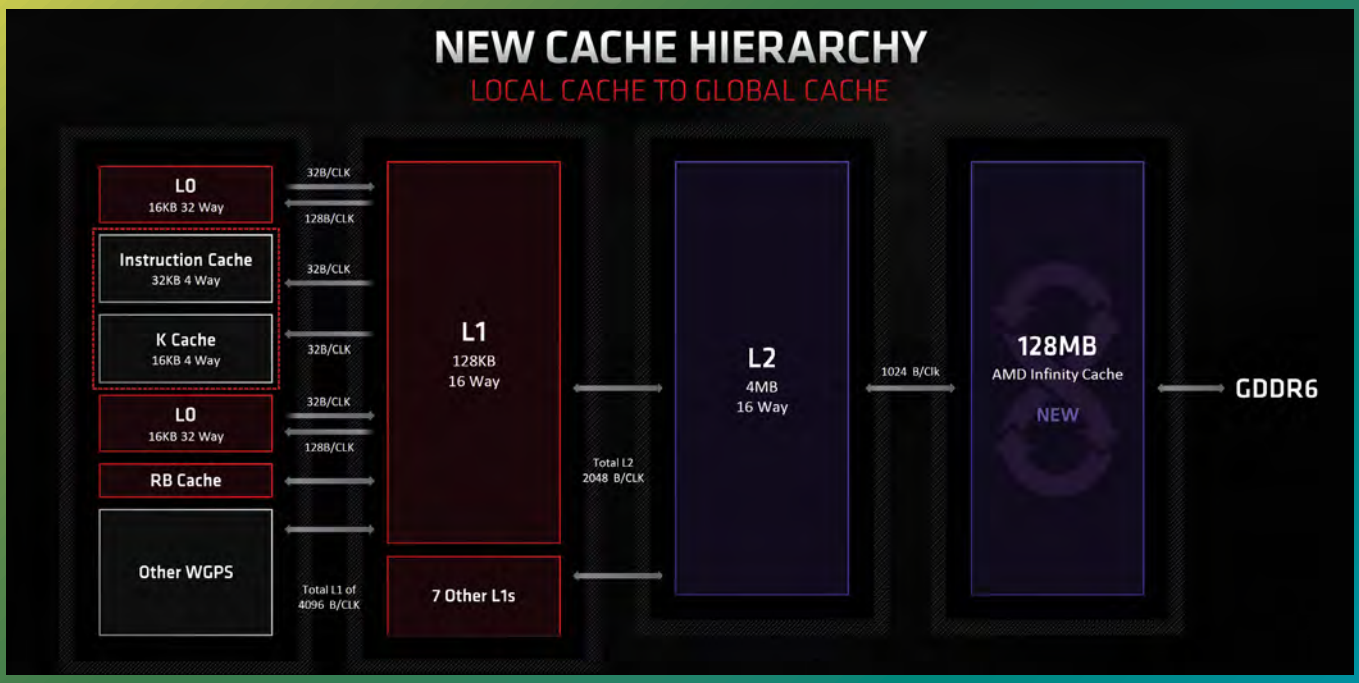
Infinity Cache

Aside from the overarching increase in CU count per Shader Engine in RDNA 2 vs RDNA, from a block diagram perspective, the single biggest difference is the introduction of a very large cache block, dubbed Infinity Cache. This 128MB cache is shared across the entire GPU, and it provides a massive pool of relatively fast-to-access data, which saves the GPU from having to resort to querying the much slower pool of GDDR6 memory.

To put Infinity Cache into perspective, the rest of the GPU's cache structure consists of a selection of 16KB and 32Kb L0 caches that are available to each CU, then there's a 128KB L1 cache shared across each Shader Engine. A larger 4MB block of L2 cache is then shared across the whole GPU. For RDNA that was it – 4MB of L2 cache then straight on to GDDR6. As you can see, the introduction of a massive new block of 128MB of L3 cache is quite something.

The advantages of an extra level of cache are fairly obvious, as any data store that's kept on the GPU die is (generally) inherently much faster than one kept on a separate chip. In an ideal world, the full whack of up to 16GB of memory that comes attached to modern graphics cards would be built right into the GPU.

However, this is neither cost-effective nor practical, as the chips would be enormous and thus expensive and difficult to manufacturer.



RDNA 2's massive Infinity Cache is a final buffer before full GDDR6 memory access is required

Indeed, even the addition of a 128MB cache would, according to AMD, be impractical using conventional GPU L2 cache technology that's optimised for the very high bandwidth demands of a GPU.

To get around the problem of wanting to introduce a very large extra layer of cache without the associated problems, AMD turned to the cache designs it developed for its EPYC CPUs. This type of cache is four times denser than AMD's existing L2 GPU cache while remaining power-efficient.

The downside is relatively slow performance for a cache. Infinity Cache is accessed via the 16 x 64-byte channels of Infinity Fabric running at 1.94GHz, giving you a total bandwidth of 1.99TB/sec. That's 'only' around four times the 512GB/sec of GDDR6 memory bandwidth you get via the Radeon RX 6800's 256-bit memory interface with 16GHz (effective) memory.

For an on-die cache to be only four times faster than an off-chip memory is relatively slow in the computing world – normally, the difference is measured in orders of magnitude. Nonetheless, it's fast enough to ensure that the rest of the cache structure (and in turn the GPU) is kept fed with data at a sufficient speed to accommodate the doubled CU count and higher clock speeds of RDNA 2 relative to the initial RDNA chips.

Putting some further numbers to that claim, the addition of Infinity Cache results in a 34 per cent reduction in effective average memory latency, providing a massive potential uptick in performance.

Along with performance gains, the greater utilisation of on-board cache instead of GDDR6 memory has power consumption benefits too. Where Infinity Cache access uses 1.3pJ of energy, GDDR6 access uses 7-8pJ. With the average number of cache hits rising by up to 58 per cent, thanks to the addition of Infinity Cache, that's a huge reduction in GDDDR6 accesses and a significant reduction in total board power consumption.

This reduction in the number of overall GDDR6 memory accesses also enables AMD to operate Navi 21 with a relatively narrow 256-bit memory interface, which has its own power-saving benefits. In comparison, while Nvidia's Ampere-based RTX 3070 also uses a 256-bit interface, the RTX 3090 uses a 384-bit wide memory interface.

Previous AMD GPU designs pushed the boundaries of memory interfaces – most notably with the High Bandwidth Memory (HBM) of the Radeon R9 Fury, which had the memory stacked on the GPU and used a massive 4096-bit wide interface. To see AMD change this strategy so dramatically highlights magnitude of this new cache system.

Further power saving comes from the ability to change the frequency of the Infinity Cache. While dynamic clock speed adjustment isn't a new concept in processor design, it wasn't necessarily a given for the Infinity Cache. By allowing the cache to boost up to its 1.94GHz peak speed (for up to 550GB/sec of bandwidth) then drop back down, AMD can further enhance the overall power efficiency of RDNA 2.

Further performance per clock improvements

Infinity Cache may be the most obvious change to the core number-crunching design of RDNA 2, but it's by no means the only change. AMD set itself the task of enhancing the clock speed, performance per clock and overall power efficiency of its design, and all three of these factors required a multitude of sometimes large, but often small, incremental changes to achieve a significant overall improvement.

AMD claims that RNDA 2 provides an overall performance per watt (PPW) gain over RDNA of 54 per cent. On top of the 50 per cent increase RDNA already brought with it over the company's previous GCN architecture, this is a huge change from the disastrously power-hungry designs AMD was churning out just a couple of years ago.

Looking more closely at each of those three factors, then, we can start with further improvements in the performance-per-clock enhancements RDNA 2 brings, alongside Infinity Cache.

First up is an improved Translation Lookaside Buffer (TLB), which is a component that translates virtual memory addresses to physical ones, and is a crucial part of any processor's memory and cache management system. The new TLB design now performs physical address translations on L0 misses rather than checks, reducing the overall load on the TLB and its resultant latency. This change benefits all CU vector data requests, resulting in improved overall performance.

Another improvement concerns the render back end (RB) of the GPU's pipeline. This section is responsible for performing depth, stencil and alpha tests, as well as blending pixels for anti-aliasing. On RDNA, each RB unit (four per Shader Engine) could process four 32-bit pixels per clock. RDNA 2's RB+ units have upped that to eight 32-bit pixels per clock. The new RB+ section required a complete rework to enable this change, along with adding features to enhance support for DirectX 12's variable rate shading (VRS) and support for HDR formats.

As well as improving sections of the GPU design in this way, AMD has also improved clock speed and power efficiency across the board through a host of tweaks. A lot of this enhancement is simply down to the company being able to dig deep into the workings of the 7nm process on which the GPU is built.

With AMD's RDNA and RDNA 2 GPUs, as well as its Zen 2 and 3 CPUs, being built (at least in part) using TSMC's 7nm process, AMD is already several generations and several architectures into using the process, so it's gleaned plenty of knowledge about how to get the best from the process. This is undoubtedly similar to the way in which Intel has been able to squeeze ever greater performance from its own 14nm process.

For example, chip design works on multiple levels, in what's known as cell-based design. For much of the process, a chip designer will be working with higher-level logic structures, such as NAND gates, without any specific knowledge of the underlying process for manufacturing that logic. In this way, AMD's engineers can largely concentrate on designing the higher-level logic, while its cell partners and manufactures, such as TSMC, can work on optimising the performance and manufacture of cells.

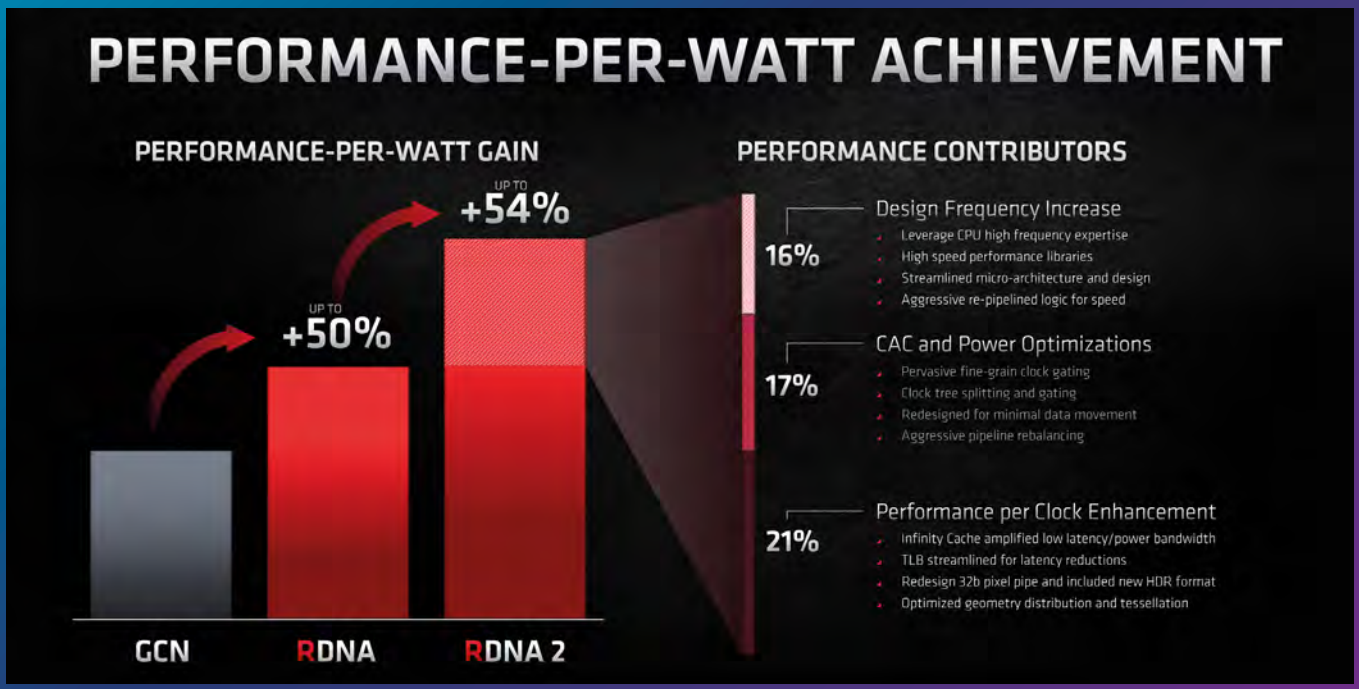
That's a very simplified description but it gets the point across. By working more closely with TSMC and its other cell partners, AMD can work on actually improving the performance of the underlying cells, specifying new cell types or at least optimising its logic for those cells.

For instance, AMD can identify common logic patterns that can be replaced by a combined and optimised single logic cell.

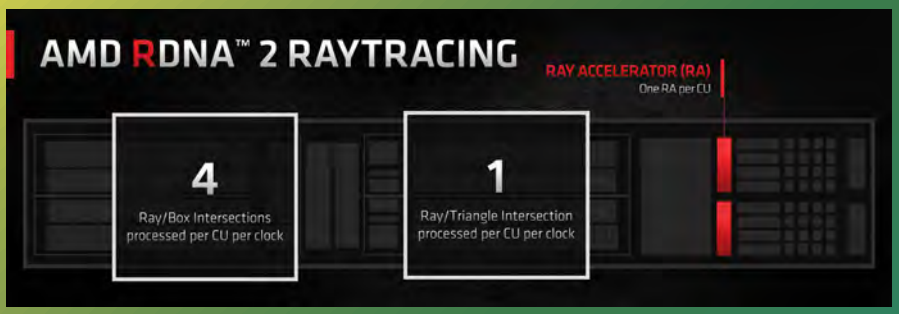
AMD has also reduced unnecessary movement of data throughout the GPU with RDNA 2. By minimising data movement between the functional blocks of the GPU, you can save power and then use that power budget to improve performance instead. Similarly, the company has rebalanced the overall graphical pipeline to minimise the amount of extra computation needed between each stage of the pipeline.

Overall dynamic switching power (CAC) consumed by each CU has also been reduced between generations, and ever greater and finer control of clock gating has been implemented. Clock gating is where the

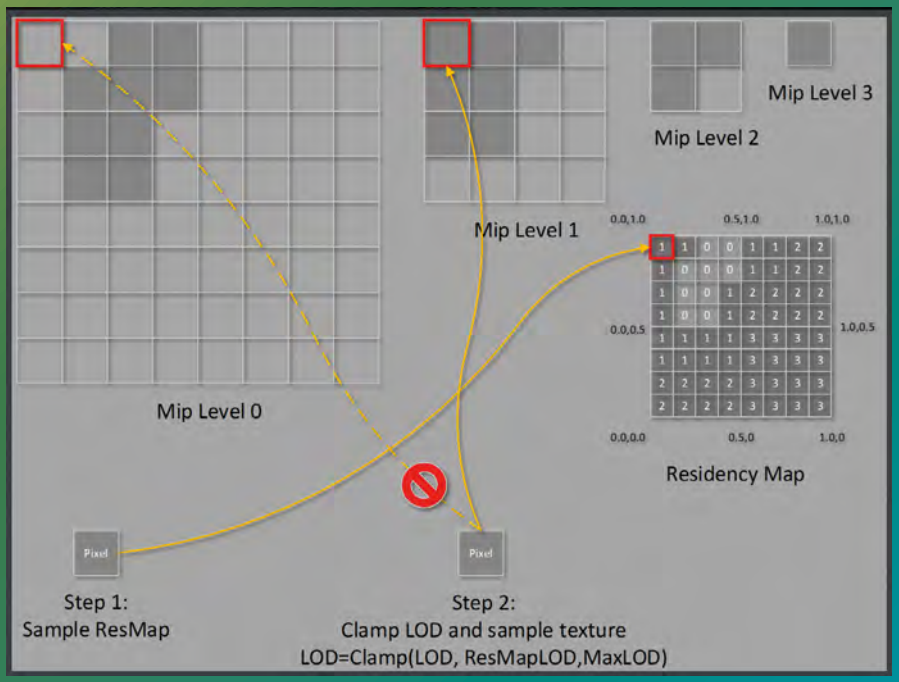
AMD HAS ALSO IMPROVED CLOCK SPEED AND POWER EFFICIENCY ACROSS THE BOARD THROUGH A HOST OF TWEAKS



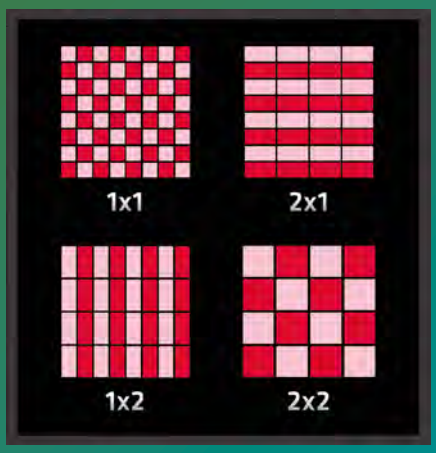
A higher frequency, improved power efficiency and more performance per clock results in a massive 54 per cent improvement in performance per watt from RDNA to RDNA 2



RDNA 2 has dedicated ray-tracing hardware, but its Ray Accelerators aren't as powerful as the RT cores in Nvidia's Ampere architecture



Sampler Feedback can greatly reduce memory usage by more efficiently controlling what sections of a mipmapped texture are loaded into memory



Variable rate shading (VRS) allows a developer to reduce the pixel shading workload for a scene by decreasing the pixel shading detail on the fly

clock signal to a part of a processor is disabled, essentially switching off that part of the circuit. By turning off as much of a circuit as possible when it's not in use, you not only reduce power consumption but open up the possibility of eking out higher clock speeds elsewhere due to the reduction in overall power usage and thermal output.

DirectX 12 Ultimate support

On top of simply enhancing the core performance capability of RDNA 2, AMD also faced the challenge of implementing support for several new features that arrived with Microsoft's DirectX 12 Ultimate, the most obvious example being ray tracing. While Nvidia is already several years and a second generation of hardware into creating GPUs with hardware-accelerated ray tracing, Big Navi is AMD's first go.

Put plain and simply, the stream processors that are normally used in GPUs aren't much use for ray-tracing calculations, so dedicated hardware is required. Nvidia introduced its RT cores for this process back with its RTX 20 series and AMD's version is called the Ray Accelerator (RA).

Each CU in RDNA 2 contains one RA (two per dual CU configuration), so the number of RAs will scale in line with the reduction in CUs you'll see in the RX 6800 XT and RX 6800. This is much like Nvidia's configuration, with RT cores scaling with its Streaming Multiprocessor clusters. Also, like Nvidia's approach, the Ray Accelerators only perform ray-box and ray-triangle intersection testing and not Bounding Volume Hierarchy (BVH) traversal, with that task taken on by the CUs.

As a quick refresher, ray tracing works by calculating if a ray of light intersects with a triangle. However, to improve performance, before triangle intersection is tested, first a bounding volume check is performed – a bounding box is a simple cuboid that encompasses a complex model that can be made up of many triangles. It's these two core tasks that are accelerated by the RA cores.

Another crucial step in ray-tracing calculations is traversing bounding volume hierarchies (a tree-like structure defining which bounding volumes fit within which other larger bounding volumes – a Russian doll of bounding volumes, as it were). However, neither AMD nor Nvidia's ray-tracing cores yet perform this function, with this instead performed on the usual stream processors.

AMD has specified that each RA unit can process four ray/box intersections per clock and one ray/triangle intersection per clock, which doesn't mean a great deal when compared with Nvidia's RT cores, as Nvidia hasn't specified these numbers. Nvidia has only said that the new RT cores in Ampere can perform twice as many of these operations as its 1st-generation cores. Sure enough, despite Navi 21 having 80 RA cores compared to Ampere's 84 RT cores, Nvidia still has a significant advantage in ray-tracing speed, as evidenced by our testing (see p16).

Ray tracing is actually another area where RDNA 2's Infinity Cache comes into play, as this large data pool can hold a 'very high percentage' of the BVH working set, which minimises the potential latency of intersection

calculations on that set. Plus, of course, having any sort of dedicated hardware provides a big leap over software-based ray tracing, with AMD citing a 10x performance improvement for the tasks its RA cores do accelerate.

While it's certainly the most prominent one, ray tracing isn't the only feature to arrive with DirectX 12 Ultimate. Another crucial tool for developers will be variable rate shading (VRS). This is where instead of a pixel shader shading just one pixel it can be assigned to cover up to 16 (4x4) pixels. In practice, 16 pixels is an extreme example, and more common will be to have a single pixel shader value shared across two (2x1 or 1x2) or four (2x2) pixels.

It's this smaller subset of coarse pixel configurations that RDNA 2 supports. The advantage here isn't so much that this software feature is accelerated in hardware, but simply that the hardware supports the feature at all, allowing developers to implement VRS in games, where it provides an inherent performance advantage.

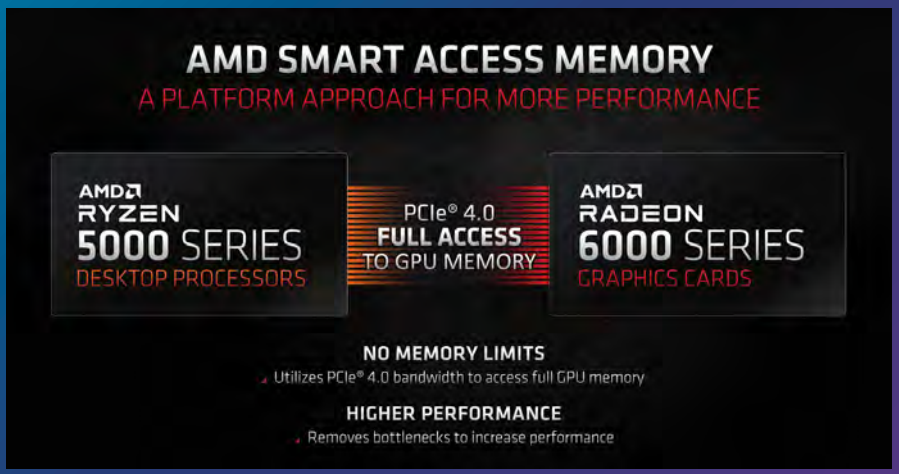
It's a similar situation with Mesh Shading, another new addition with DirectX 12 Ultimate. This is a significant feature that sees a complete reworking of the front end of the graphics pipeline. Whereas previously the meshes of triangles that describe the surface of a 3D object had to be processed in one lump for any given mesh, with mesh shading the whole mesh can be broken down and processed in parallel.

This ability to break down and apply extra processing to a mesh also makes it easy to incorporate geometry modifications such as tessellation. Again, though, we're not talking about a specific task that's sped up by the GPU in such a way that would allow for an apples-to-apples performance comparison, but simply that the new GPU is able to provide these new software features.

DESPITE NAVI 21 HAVING 80 RA CORES COMPARED TO AMPERE'S 84 RT CORES, NVIDIA STILL HAS A SIGNIFICANT ADVANTAGE IN RAY-TRACING SPEED

The penultimate piece of this new feature puzzle is Sampler Feedback. This is a framework that allows the graphics pipeline to keep track of the method and details of a texture sampling call. This is useful for when a scene might rapidly require a texture to be sampled at different rates (using texture mipmap streaming). By keeping track of what's being sampled, the system is able to keep more granular control over what sections of a mipmapped texture (textures in modern games can be very large!) are loaded into memory, reducing the memory footprint.

DirectStorage is the final major notable DirectX 12 Ultimate feature that's newly supported with RDNA 2. This in essence allows a GPU to directly access the latest ultra-fast NVMe SSDs, bypassing the overheads that were inherent with previous storage APIs. The most obvious benefit of this will be reduced game load times, as data is able to stream straight into the GPU much more rapidly. However, there will also be potential improvements in performance in situations such as where massive amounts of texture data is being streamed into and out of a graphics card's memory.



Smart Access memory, which circumvents the current 256MB limit that CPUs have for accessing GPU memory

Best of the rest

Outside of DirectX 12 Ultimate features, there's a handful of other miscellaneous improvements and features in or coming to RDNA 2. The first is Smart Access memory, which circumvents the current 256MB limit that CPUs have for accessing GPU memory. Currently, only available with AMD Ryzen 5000-series CPUs and RDNA 2 GPUs, this BIOS-enabled feature will allow a CPU to tap directly into a graphic card's full bank of GDDR6 memory, providing a small (up to 11 per cent) performance uplift.

AMD has also announced its FidelityFX suite of software features, which will be available to developers. Consisting of seven image quality enhancing tools – including VRS support – it's basically an all-in-one, branded suite of tools to highlight to developers the extra effects that can be implemented with RDNA and RDNA 2. One key forthcoming feature is called Super Resolution, which looks as though it may work similarly to Nvidia's DLSS technology.

What lies ahead

We've seen from our performance testing that RDNA 2 does deliver on everything AMD has promised. The massive gains in performance, power efficiency and features have put the company's graphics cards right back into contention, but there are clearly still some areas that need improvement.

Ray-tracing performance is notably behind Nvidia, so we'd hope to see a straight beefing up of its RA cores in subsequent iterations of RDNA. How easy that might be and how Nvidia will respond is anyone's guess, but given the adequate performance RTX 30-series cards provide already, simply reaching parity with Nvidia's current cards would be a significant step up for AMD.

It will also be interesting to see how Infinity Cache scales both for smaller configurations of RDNA 2 and for future 'RDNA 3' designs. Is a massive cache the way forward from now on, or just a workaround for this generation? We certainly look forward to finding out.

CUSTOM PC

CHRISTMAS GIFT GUIDE

Stuck for stocking fillers? Fishing for festive favours? If you're out of ideas for what to add to your Christmas list, or struggling to think of affordable gifts for family and friends, our Christmas gift guide is here to help. From pocket-money stocking fillers to the most outlandish techy treats, these are our current picks for the best way to share in some Christmas cheer.

STOCKING FILLERS

These presents will put smiles on faces without devastating your bank balance

SCREWDRIVER

It may not be glamorous, but one of the most eternally useful additions to any PC tinkerer's toolkit is a good screwdriver. Forget your multi-bit, ratchet fanciness. Just a solid No.2 Philips-head screwdriver with a long shaft will cover 90 per cent of your screwing needs when building a PC. The Stanley FatMax 65-224 (£7 from **toolstop.co.uk**) is a great option, as its 250mm shaft allows you to reach even the deepest recessed screws and its comfortable rubber handle provides good purchase.

THERMAL PASTE

Next on the essentials list is thermal interface material (TIM), or thermal paste to you and us. A tiny tube of quality TIM will not only last you many CPU and CPU cooler upgrades, but a quality product will reduce CPU temperatures too. Plus, of course, you can use the same TIM to upgrade the cooling interface of other components in your system or even your laptop's cooling. The ultimate low-cost go-to paste remains Arctic Silver 5, which you can find in a 3.5g tube for just £6.50 (**overclockers.co.uk**). Don't forget to grab a bottle of TIM cleaner (£4.99 from **scan.co.uk**) as well, for cleaning off the old stuff.

Meanwhile, if you're looking for more exotic cooling, you can experiment with liquid metal TIM. A mere 1g tube of Thermal Grizzly Conductonaut (£7.99 from **overclockers.co.uk**) will last you many applications, and can help you can shave double digits off your chip temperatures. This isn't one to try with your younger family members or friends though – liquid metal requires delicate application in order not to fry your system.

CPU COOLER

If you still have the cooler that came with your CPU, a better way to improve CPU cooling is by upgrading the cooler itself. The ARCTIC Cooling Freezer 7X (£19 from **overclockers.co.uk**) is a teeny (by modern standards) cooler with a 92mm fan, but it still packs a punch while remaining impressively quiet. It's also compatible with all the latest mainstream CPU sockets.

NEW FANS

Adding or upgrading your system fans is a simple one-stop shop for better overall system temperatures (and resultant stability and longevity), as well as lower noise levels. A top dog for cooling efficiency and low noise is Noctua's NF-A12x25 (£26.99 per fan from **scan.co.uk**) – these fans aren't cheap, but are whisper-quiet and highly effective when it comes to cooling.

Alternatively, you can add some extra bling to your PC with RGB fans. Corsair's LL120 fans (£24 each from **scan.co.uk**) pack a total of 16 LEDs into both the fan itself and the mount surrounding it. It's also a top-spec fan that provides whisper-quiet operation with plenty of air-pushing power.

RGB LED STRIP

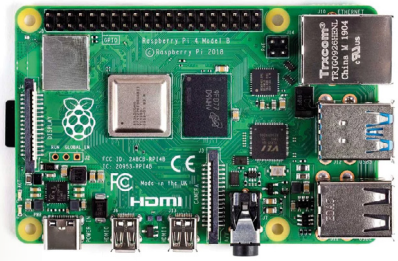
If you're seeking to add some more pizzazz to your PC, a simple single strip of RGB LEDs offers a quick and easy way to light up its interior. The Phanteks Neon Digital (550mm, £14 from **overclockers.co.uk**) is easy to install with its double-sided adhesive tape, and it's compatible with the majority of motherboard RGB lighting headers, plus it looks great with its smooth, translucent lighting.

MASSIVE MOUSE MAT

For simple gaming upgrades, you can't beat investing in a quality soft mouse mat, which will cushion your arm against your desk, reduce noise and improve tracking performance over most alternative surfaces with modern optical mice. Grab an extra-large mat, such as the Corsair MM200 (£28 from **scan.co.uk**), and you won't have to worry about squeezing in your mat next to your keyboard – it can stretch all the way under your keyboard too.

MOUSE BUNGEE

A mouse bungee is an indispensable addition to your desktop, unless you're using a wireless mouse. By lifting up your mouse's cord and providing a secure yet flexible hold, a bungee will eliminate cable snags and cable push-back, reducing the likelihood of your mouse's tail being the reason for your gaming failures. The aptly named Mouse Bungee by Glorious PC Gaming Race will set you back just £13.99 from **overclockers.co.uk** and is a great example.

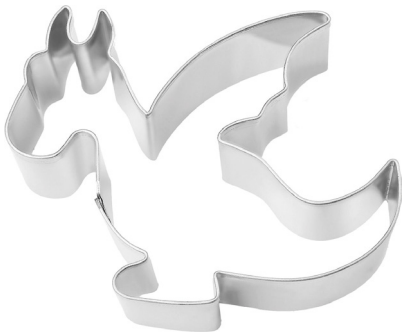


SMALL BOARD COMPUTER

Unlock a multitude of tinkering and learning possibilities with an easy-to-program minicomputer board, such as the Raspberry Pi 4 (£34 from **thepihut.com**) or Arduino Due (£34 from **store.arduino.cc**). And, of course, if dealing with a bare board doesn't appeal, you can always pick up the Raspberry Pi 400 that has a Raspberry Pi 4 built right into a keyboard, a bit like the 8-bit home computers of the 1980s (£67 from the **thepihut.com**).

COOKIE CUTTER

Moving away from tech, you can turn out some tantalising treats with a range of novelty Birkmann cookie cutters (£2–£6 from **interismo.co.uk**). From diggers to dinosaurs and campervans to Christmas trees, there's a great range of fun shapes to try. Cookie quality not guaranteed.



DOOM SLAYER BOTTLE OPENER

This fantastic Doom Slayer bottle opener (£5 from **geekstore.com**) will prove a welcome addition to gamers of any age over 18. Made from solid metal, and with magnets on the rear for easy fridge attachment, it makes prising the heads from your enemies (bottles) as easy as popping a cap in a demon's rear end.

BABY YODA

If you're looking for something cuddly, you can't go wrong with a Baby Yoda soft toy (£21 from **shopdisney.co.uk**). The character might be a cheesy, cynical and corporate cash grab, but it's also spectacularly cute, and this little guy measures just 25 x 25 x 8cm.

MAIN PRESENTS

If you're buying for someone a little extra special, or if your budget can simply stretch further, there are loads of affordable PC and tech upgrades available

KEYBOARDS AND MICE

Perhaps the most obvious affordable upgrades for your PC are a new mouse and keyboard. Readily available for between £50 and £150, they're great options for gamers of all persuasions. At the more affordable end, a quality wired mouse, such as the Glorious PC Gaming Race Model O (£52.99 on **overclockers.co.uk**) is a great lightweight gaming mouse. Meanwhile, the Razer Viper (£79.99 from **overclockers.co.uk**) provides excellent tracking performance and comfort. You can also pick up a great mechanical gaming keyboard, such as the HyperX Alloy FPS Pro, for £80 from **amazon.co.uk**

It's also well worth upgrading to the latest wireless mice and keyboards. When it comes to mice, the Logitech G Pro Wireless (£120 from **currys.co.uk**) has been a favourite of ours since it arrived over two years ago, and it remains a fantastic option that suits both left and right-handed users. The new Razer DeathAdder V2 Pro (£130 from **amazon.co.uk**) is another fantastic option for those that prefer a large, contoured mouse.

When it comes to wireless keyboards, the Keychron K2V2 (£79 from **keyboardco.com**) is a great compact wireless keyboard option that's not too pricey. If your budget can stretch further, the Razer BlackWidow V3 Pro (£230 from **razer.com)** is a full-sized chunk of quality wireless keyboard.

AUDIO UPGRADES

If your PC is more in need of a sonic upgrade, a gaming headset or quality headphone amp are great Christmas gift options. A good example is the Sennheiser GSP 300 (£89 from **overclockers.co.uk**), which is comfortable and sounds great. Alternatively, if you can't be doing with wires trailing over your desktop, a wireless headset such as the Corsair Virtuoso RGB Wireless (£154 from **ebuyer.com**) is the way to go.

If you already have a headset or headphones you like to use, you can still improve your audio setup, particularly if your on-board audio isn't great, with a dedicated headphone amp or sound card. The Epos | Sennheiser GSX 300 (£69 from **eposaudio.com**) is an affordable desktop USB amp that offers an easy one-touch control to switch between stereo and virtual surround modes. It also has a physical volume control, microphone input and headphone output, as well as decent sound quality.

REACH FOR THE SKY

For any flying enthusiasts, a quality flight controller and a copy of Microsoft Flight Simulator 2020 (£60 on Steam) and/or Star Wars Squadrons (£35 on EA Origin) will make for a mighty combination. The Logitech Extreme 3D Pro flight stick costs a mere £56 from **novatech.co.uk**, and provides all the essentials for both terrestrial and space flight.

GAMEPADS

Another form of game controller that can benefit many PC games is a simple gamepad. Both Microsoft and Sony have new gamepads arriving with their consoles, but we've yet to see just how well they'll play with PCs. Instead, the standard Xbox One Wireless controller (£50 from **argos.co.uk**) is a great option that's reasonably affordable, comfortable and compatible with a vast range of games.

If mobile gaming is more your giftees' thing then the Razer Kishi (£80 from **razer.com**) is a great addition. It's a gamepad accessory for Android phones and iPhones that wraps around the phone and provides convenient thumb and finger controls for playing your favourite mobile games. When you're done with gaming, it slides closed to make for a compact device that's easy to carry.

TOOLKIT

If you're into fixing and tinkering with your tech gear, you can't beat a good-quality toolkit, and there are few better, more complete kits for messing around with your gadgets than those by iFixit. The Pro Tech toolkit (£64 from **ifixit.co.uk**) features a small screwdriver with a comprehensive set of bits that will gain you entry into just about any gadget out there. The set also includes scratch-safe pry tools, tweezers, a suction gripper (for pulling off the glued-down backs of phones), and plenty more bits and pieces.

DREMEL

A favourite of case modders for decades, the quintessential compact rotary tool is an incredibly versatile addition to anyone's toolkit. You can pick up a basic model for £45 from **amazon.co.uk**, and its vast range of tiny attachments make it easy to cut, grind, sand, drill, engrave, clean and polish all manner of materials, allowing you to make short work of tweaking your case layout and much more besides.

A NEW HOME FOR YOUR PC

A new chassis may be just the upgrade your giftee (or indeed you) needs. There's a surprising amount of benefit to a case upgrade over and above just a nice-looking exterior, including better airflow, room for liquid cooling and modern features. The be quiet! Pure Base 500DX (£99 from **overclockers.co.uk**) is just such an example. It has a full-fat Type-C port on the front panel, a tidy internal layout, attractive lighting and excellent cooling. Add in its quiet operation and you're onto a winner.

NVME SOLID STATE DRIVE

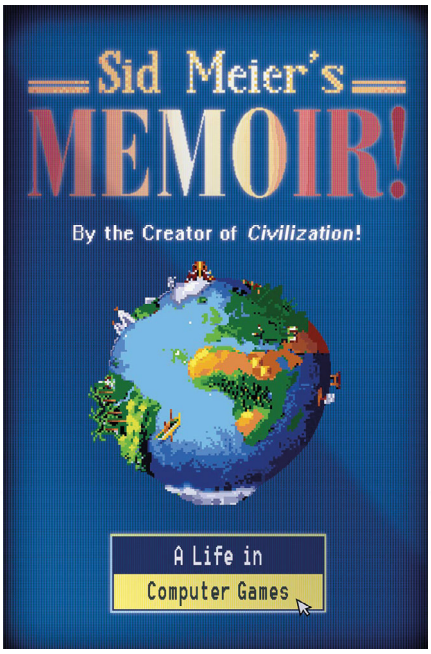
There are few better ways of unlocking the performance of a modern PC than putting ever more of your data on a fast SSD. If your motherboard has an NVMe-capable M.2 slot, it's well worth populating it with a fast drive.

You can now readily get fast 1TB drives, such as WD's SN550, for just £90 from **ebuyer.com**, making them well worth the upgrade over an old SATA SSD, or a hard drive for that matter. If you or your giftee are lucky enough to own a PCI-E 4-equipped motherboard, then a super-fast SSD such as the 1TB Sabrent Rocket NVMe 4.0 (£165 from **amazon.co.uk**) is an even better upgrade.

READING MATTER

If your giftee has all the tech they need right now, but you still want to get them something tech-related, you can't beat a good book. Famed creator of the Civilization games, Sid Meier, has just released his memoir A Life in Computer Games (£22 from **waterstones.com**), which chronicles his four-decade career in game creation, including the development of title such as Pirates!, Railroad Tycoon and, yes, Civilization.

Alternatively, head over to **bitmapbooks.co.uk** and you'll find a vast selection of fantastic-quality hardback, coffee table books celebrating all things retro gaming. You can find books about the box art of Game Boy games, the art of point-and-click adventures, and an array of visual compendiums of retro computers and consoles.



SPECIAL PRESENTS

If you've got a generous family, you've won the lottery, or you have cash to burn on a special person, check out these elite present ideas

It's been a bit of a bumper year for pricey, new tech upgrades. There are the new Xbox Series X and PlayStation 5 games consoles, Apple's new iPhones and ARM-powered Macs (if you're into that sort of thing), AMD's new Ryzen 5000-series CPUs and of course, the double whammy of AMD and Nvidia's new graphics cards. If you're into jumping on pre-order queues or lining the pockets of eBay scalpers, there's plenty of choice. But, for the rest of us, here are a few more obtainable options.

NEW MOTHERBOARD

While AMD's Ryzen-5000 series CPUs may be difficult to pick up at the moment, you can still buy new motherboards that can accommodate one. If you have a Ryzen 2000-series CPU, you can grab a new B550 or X570 motherboard now and it will work with both your existing CPU and a future Zen 3 upgrade. The MSI MPG B550 Gaming Plus (£160 from **scan.co.uk**) is a great all-rounder, while the Asus ROG Strix X570-E (£290 from **scan.co.uk**) packs in all the latest features.

WATER-COOLING KIT

A full water-cooling kit is a great way to enter the realm of custom water cooling, giving you all the gear you need in one package. The Corsair Hydro X Series XH303i (£450 from **overclockers.co.uk**) brings together an RGB

waterblock, a trio of RGB fans, a 360mm radiator, coolant, hardline tubing (plus all the necessary tools) and an iCUE Commander Pro fan and lighting controller. If you're happy with flexible tubing, there's also EKWB's EK-Kit S240 (£250 from **scan.co.uk**), which includes a waterblock, reservoir/pump combo, 240mm radiator and all the tubing and fittings you'll need to complete the loop.

ENTER VIRTUAL WORLDS

Along with loo roll and hand sanitiser, VR headsets have also proved incredibly difficult to find at times throughout this year. However, the stock situation has improved, at least at the time of writing. If you're new to the world of VR, the affordable and portable Oculus Quest 2 (£299 from **oculus.com**) is the place to start. Its portability and standalone nature means you can enjoy the VR experience without being tethered to your computer, but with the addition of an Oculus Link cable, you can also play your PC's VR games on the headset.

FANCY MINI CASE

While many of us would love to have the space to indulge in an enormous powerhouse of a PC, the reality is that space is often at a premium, and actually small PCs do look really cool. If we had £300 burning a hole in our pockets for a gift idea, we'd opt to build a system in the wonderfully tiny and tidy NZXT H1. This mini-ITX chassis has a teeny 187 x 187mm footprint, and it comes with its own all-in-one CPU cooler and PCI-E riser cable for mounting the graphics card vertically. It simply looks fantastic. CPC

PROJECT ONDA

ALESSANDRO ZAITI

Project ONDA began as my first attempt at 3D modelling and CNC machining, as I had just upgraded my workshop with a CNC machine and I could finally stop doing every single thing by hand. The design came from a brainstorming session, where I was just drawing lines and seeing what would happen.

'Onda' is the Italian word for wave. I've always been inspired by space and sci-fi when coming up with new designs, and ONDA was no exception, as the crescent moons are the central point of this concept. The way they wrap around the hardware gives off that wavy look I was looking for.

Other than the moon, I was inspired by a range of different other elements while designing ONDA: Japanese art; The Great Wave Off Kanagawa; and the skeleton of a dinosaur displayed in a museum. There were a lot of very diverse inspirations and I think that's why it looks so interesting and appealing to the eye.

Moreover, I've always been a big fan of floating things, and I really wanted to incorporate that feature into this concept, especially because of its open-air nature. I achieved this by making the mounting for the Hydra Mini as stealthy as possible, so that all the hardware seemed to actually float inside the wave. Also, the wave itself is suspended on a pedestal using aluminium rods, with inspiration again coming from dinosaur displays in museums.

Choosing the hardware

While this is clearly meant to be a mind-blowing build for its unique aesthetics, it's still technically 'just a computer', so specs are important, right? Well, not for me really, as I mainly work with sponsors for these kinds

SYSTEM SPECS

Sponsors HWLegend Modding, PC Hunter, Seasonic, Alphacool, OCPC Gaming, CableMod, Hydra

Case Hydra Mini

CPU Intel Core i5-9400F

Motherboard Asus ROG Strix B360-I Gaming

RAM OCPC Gaming X3treme 16Gb 3000MHz

Graphics card Asus ROG Strix Radeon RX 5500XT

PSU Seasonic Focus SGX-650

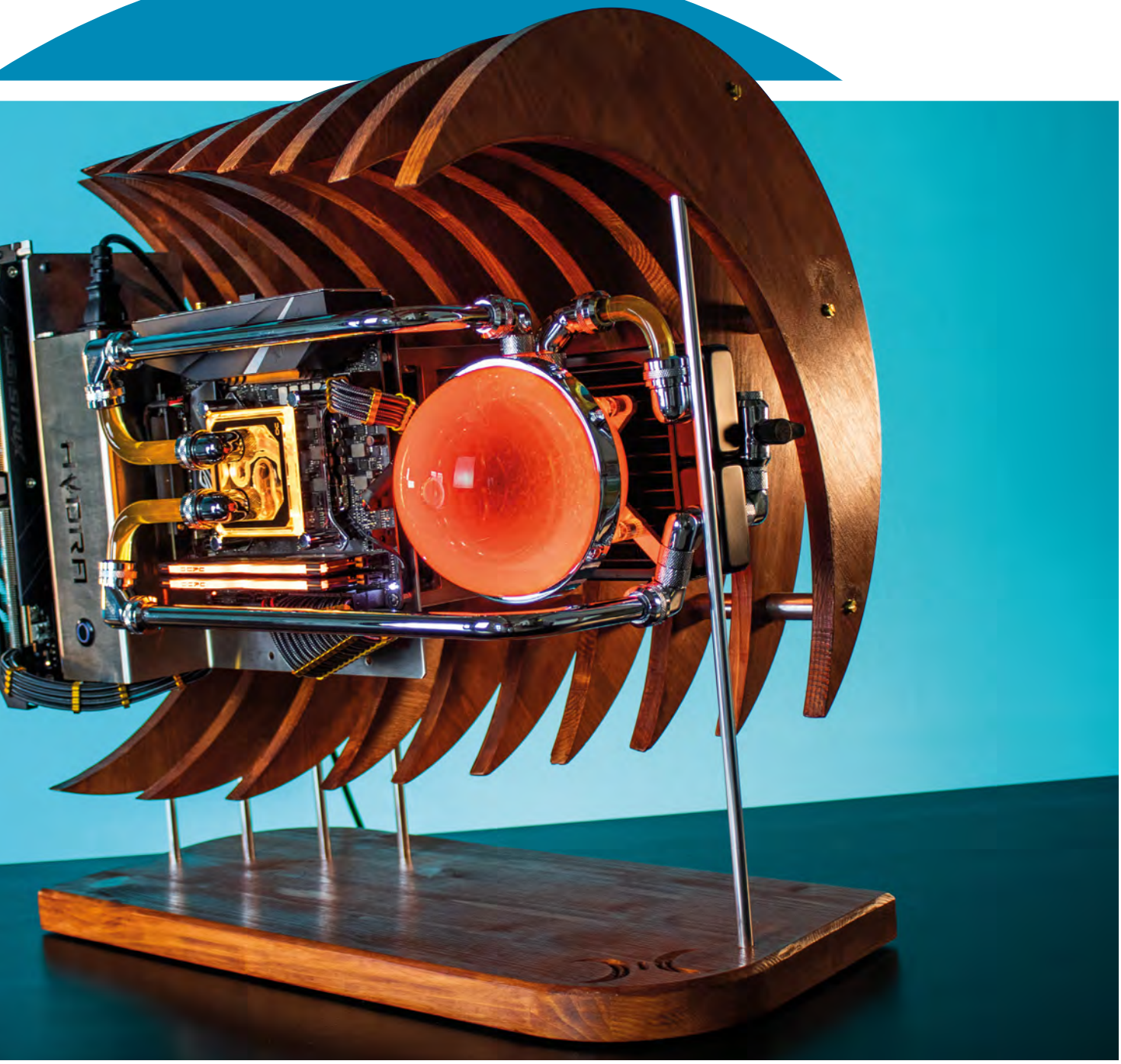
Storage OCPC Gaming M.2 XT 256GB SSD

CPU waterblock Alphacool XPX Aurora Edge

Pump/reservoir Alphacool Eisball

Using a CNC router was crucial for cutting out the crescent shapes

The PC is built around the tiny Hydra Mini mini-ITX chassis



of projects and they usually don't have much high-end hardware to provide. This build features a humble AMD Radeon RX 5500XT graphics card provided by my network HWLegend Modding, an Intel Core i5-9400F sent by an Italian store called PC Hunter, and 16GB of RAM from OCPC Gaming. So it's a decent build for gaming at 1080p and for getting some work done.

Everything is powered by an SGX-650 by Seasonic, which is a super-cute SFX power supply paired with custom cables from CableMod, and cooled by custom water-cooling hardware from Alphacool.

One piece worth mentioning is the Alphacool Eisball, which is the glowing eye at the centre of the PC. ONDA received a lot of praise for this addition because it was actually making good use of the peculiar spherical pump/reservoir combo.

THE WAVE ITSELF IS SUSPENDED ON A PEDESTAL USING ALUMINIUM RODS, WITH INSPIRATION AGAIN COMING FROM DINOSAUR DISPLAYS IN MUSEUMS

Although some people might be puzzled by the use of such relatively low-end components on a PC that has had such care and attention placed on its design, I'm happy to say that ONDA has standard mountings for graphics cards (up to 29.5cm in length) and mini-ITX motherboards, so the main hardware can be easily upgraded later.

This ability to swap hardware isn't as obvious as it sounds, as a lot of extremely customised builds often have non-standard mountings for the hardware – sometimes

The crescent shapes were identical but each required holes in different positions

Fir and pine woods are rather dull-looking, so stain was used to darken the look of the wooden parts

Aluminium rods and tubes were used to hold all the wooden parts together

it's just easier to design and make a part rather than work around standard mounts. The downside is it makes them very hard to upgrade without making new custom plates and brackets. This is a problem I've encountered before with almost all of my projects, but with ONDA and future projects, I decided to put in the extra effort to make everything as upgradable as possible, so that the projects are easier to sell and I'm not bound to the poor specs I originally use for their design.

Wooden waves

Stepping away from boring specs talk, we can get started on how ONDA was actually made. Although technically it's a case mod, since there's a Hydra Mini case integrated into it, this is essentially a scratch-built PC, as the Mini is really just a mounting plate for the core hardware, with the entire rest of the PC needing to be built around it.

The first thing to do was finalise the 3D design files of each wooden crescent, as they all have different hole positions, so they can be mounted in an offset pattern to create the wave effect. I used fir wood for making the crescents and instantly regretted it, as it's a very dry and fragile wood. If I could go back and choose another type of wood, I would at least go for a higher grade of pine, given that

FOR MOUNTING THE CRESCENTS TOGETHER, I USED THREE ALUMINIUM RODS WITH THREADED HOLES AT THE ENDS

I was on a budget. If money were no object, it would have been ideal to use a type of hard wood such as cherry, maple or walnut.

At least it was a cheap way to practise CNC machining and I didn't have much of a hard time getting these parts done. The same wood was used for the pedestal, only in a 27mm thickness instead of the 14mm thickness I used for the crescents.

The two most tedious aspects of making ONDA were the way the crescents were fixed together and evenly spaced, as well as how the structure was attached to the pedestal using the rods. For mounting the crescents together, I used three aluminium rods with threaded holes at the ends. Evenly spaced between each crescent is a 36mm section of aluminium tubing, and this was the first real hassle of the build, as I needed 27 sections and I didn't have a tool that I could use to cut those precisely enough. Neither could I find someone who could do it for me. So I just bought a cheap mitre saw that let me achieve a pretty decent result, even though it could be better as far as precision goes.

For suspending the structure in the air, the most difficult aspect was that I had to manually drill 8mm holes on the edges of the first four crescents, so that I could slide in the aluminium rods, and it was pretty difficult to do that precisely enough without damaging the very fragile fir wood. Once I had done that successfully, I realised it wasn't nearly as stable as I hoped, so I had to figure out a way to address that issue. The idea of putting an additional long rod below the last crescents was a winning one for improving stability and

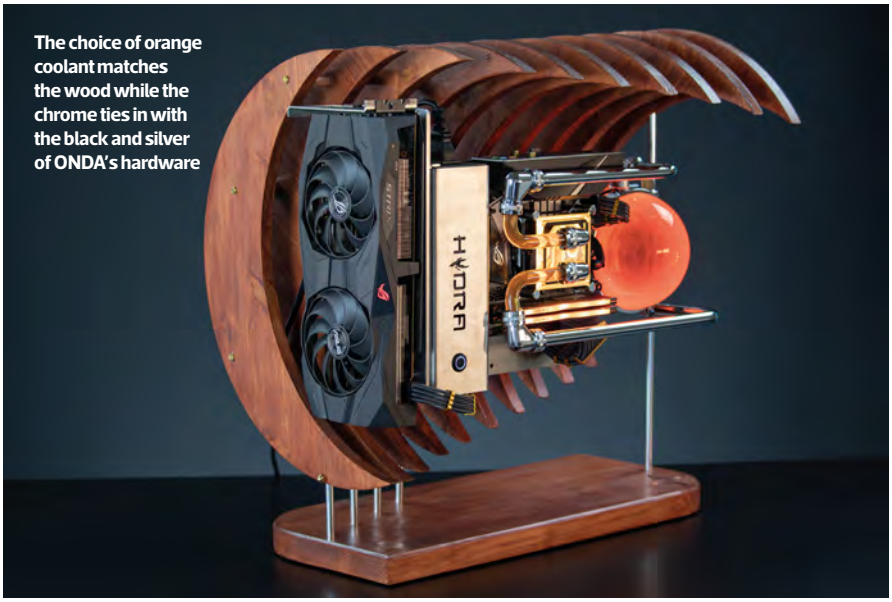
The Alphacool Eisball is a pump and reservoir combo with built-in RGB LEDs

I think it also added to the aesthetics of the finished product.

To stay on the fir wood dissing train, it also looks very dull, and I wanted a dark and reddish shade to the wood parts, so I gave all the wooden parts two coats of mahogany stain. I was pretty satisfied with the finish, even though a nice dark wood without stain would have clearly been a better option. I'm all about making the best out of cheap stuff when I can, though, so it's all good.

Hardware headaches

Another difficult phase for ONDA was fixing the radiator and Hydra Mini to the crescents. The problem stemmed largely from my newbie nature at 3D modelling, as I simply couldn't come up with optimal brackets for both. I made two aluminium brackets that had to be mounted to the crescents, but I'd cut these in advance, so I had to drill mounting holes manually later on, and let's just say the shape wasn't very easy to work with for tracing those measurements. Plus, the poor structural capability of the wood wasn't helping stability for the Hydra Mini, so I had to adapt the radiator brackets to also be fixed to the case, so that it stayed in place properly.



The choice of orange coolant matches the wood while the chrome ties in with the black and silver of ONDA's hardware

Another custom aluminium piece was used to mount the graphics card on what is normally the base of the Hydra Mini

Custom-made brackets were used to hold the Hydra Mini to the wooden crescents

Once I managed to fit all of the main parts together, I had to find a new way to mount the graphics card, as the original mount of the Hydra Mini was no longer serviceable. So I made a custom plate that could be mounted on the bottom of the Mini, then attached to the original graphics card bracket from the case. This moved the graphics card from 'inside' the case to the end, where it stands, vertically mounted.

The final key component was the Alphacool Eisball, which sits right in the centre of the PC, mounted on the radiator. The original bracket to mount on the radiator just wasn't cutting it design-wise, so I made a new one from aluminium to fix it to the portion of radiator that was sticking out from behind the Hydra Mini. This way, I was able to fill in the empty space on that side of the case and make for a really neat layout for the hard water-cooling tubing, since every major cooling component was right next to one another.

I've always been a fan of parallel hard tubing, but this time I had very little to work with, since there wasn't much plumbing to do at all, and the graphics card didn't have a suitable waterblock, so I had to play around with the CPU block piping. The way I proceeded was by mixing chrome and clear tubing, to provide a nice contrast and fill in the space at the left of the CPU block. This layout also allowed me to satisfy my addiction to parallel tubes, and it made it a very easy process to add the graphics card to the loop in a future upgrade. The chrome tubing was easy to work with, as I used the pre-bent ones from Alphacool.

Once the build was complete, it was time to wrestle with one of my least favourite parts of modding: RGB settings. It's tedious and never works how it's supposed to, but it can't be avoided these days, and I do like that we have the option to set all the lights to the colours we want. In this case, having the full range of RGB colours allowed me to set the lights to that nice warm orange tone that goes well with the shade of the wood and provides a good contrast to the metal parts.

Riding high

Overall, I'm very happy with this project, it was probably my most innovative design to date, and I've been modding for around four years now. It was a great success among the community as well, and I was so pleased to see that my work was finally being seen first and foremost as art rather than just a PC mod. ONDA won first place in **bit-tech.net**'s Mod of the Month and **builds.gg**'s Build of the Month contests, which makes me very proud.

I'm also now working on an acrylic and stainless steel version for a client and also on a version meant for sale, in limited numbers. All new versions will be stand-alone cases without the Hydra Mini, and will also be built using better materials.

Right now I'm competing in the Case Mod World Series (CMWS) 2020 with a project called A.R.E.S., which takes even more advantage of my enhancing skills in 3D modelling and CNC machining. I got third place at last year's CMWS 2019 with my Realgar Project, so I hope I'll have success in the competition this year too. CPC

GARETH HALFACREE'S

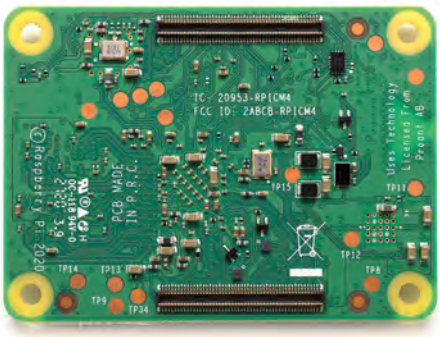
Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino, and Android to retro computing

REVIEW
Raspberry Pi Compute Module 4

It's been a wait, but the Raspberry Pi Compute Module 4 is finally here

After the success of the original Raspberry Pi, launched back in 2012, the Raspberry Pi Foundation made a surprise discovery – while many of the low-cost single-board computers were going to their intended homes in education, others were popping up in industrial uses. The result was the launch of the Raspberry Pi Compute Module, a system-on-module (SOM) designed to be integrated into all sorts of devices, from consumer products to industrial robots.



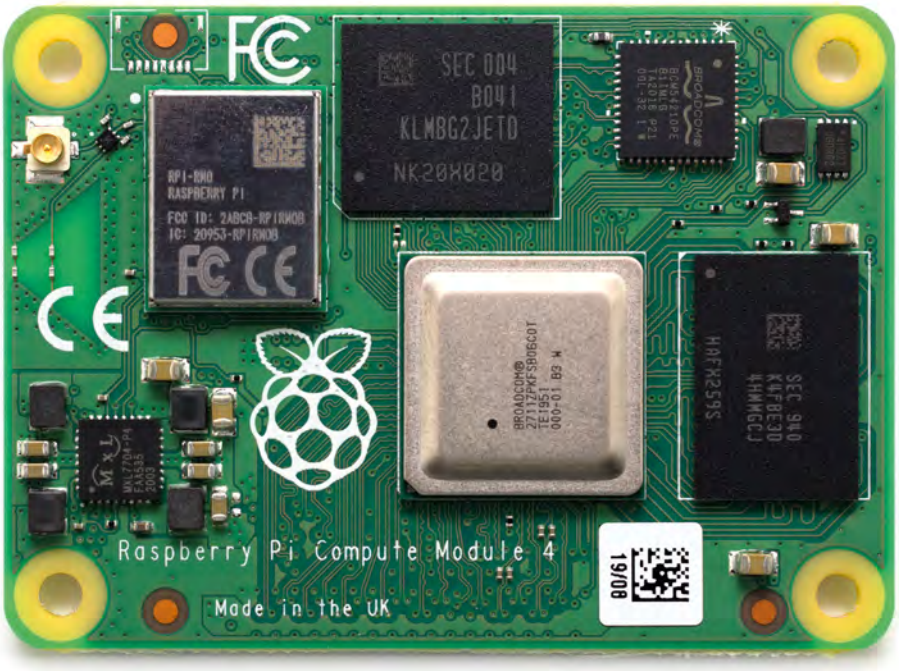
The compute module uses a new form factor, which does away with backwards compatibility

The Compute Module appeared to have been forgotten when the Raspberry Pi 2 launched, but the Raspberry Pi 3 brought a matching Compute Module 3, and the Raspberry Pi 3+ was followed by the Compute Module 3+.

Now, the same technology at the heart of the Raspberry Pi 4 is available in the Compute Module 4. However, it does come at the loss of backwards compatibility, moving away from the Compute Module's traditional SODIMM-based design to a new form factor with two high-density connectors on its underside.

There's a workaround, though, for those looking to upgrade an existing carrier board from a Compute Module 3+ or older. Gumstix (**gumstix.com**) has launched an interposer board that converts the Compute Module 4 into the old-style SODIMM form factor, although the resulting device is larger than the original and may not fit in all cases.

The Compute Module 4 itself is a major upgrade. Based on the same Broadcom BCM2711C0 system-on-chip as the Raspberry Pi 4, the Compute Module 4 is available across a range of models. For the builder on a budget, the entry-level Compute Module 4 Lite has no on-board storage, 1GB of RAM and lacks a radio

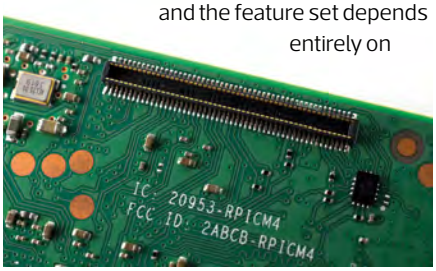


The module is compact and, thanks to four mounting points, mechanically robust

module. Meanwhile, the top-end Compute Module 4 boasts a 32GB eMMC, 8GB of RAM and a Wi-Fi and Bluetooth radio. There are also various combinations available between these models, including versions with 1-8GB of RAM and 8-32GB of eMMC storage.

All the modules boast the same mechanical characteristics, and the same core specifications. It's no surprise, then, to find that the Compute Module 4 performs identically to the Raspberry Pi 4 in most benchmarks. The exceptions are storage benchmarks, where it offers nearly double the throughput when using the eMMC storage over a microSD card.

The module itself only has two 100-pin connectors and a U.FL connector for an optional external radio antenna – there are no user-accessible ports. Instead, those are instead found on a carrier board – and the feature set depends entirely on the features your carrier board manufacturer chooses to expose.



The new high-density connectors have 200 pins in total, the same as the old SODIMM edge connector

The Raspberry Pi Compute Module 4 IO Board is the flagship design. Released under an open-source licence, it offers as many features as possible. These include Gigabit Ethernet via the module's on-board PHY, two USB 2 ports, two micro-HDMI ports, two camera ports, a real-time clock, a 40-pin general-purpose input/output header and even a PWM header for an optional fan.

Its crowning feature, though, is a full-sized 1x PCI-E 2 port. The launch of the Raspberry Pi 4 saw hackers desoldering the PCI-E USB 3 controller in order to connect other PCI-E peripherals, and the Compute Module 4 in the IO Board lets you achieve the same result without any awkward soldering.

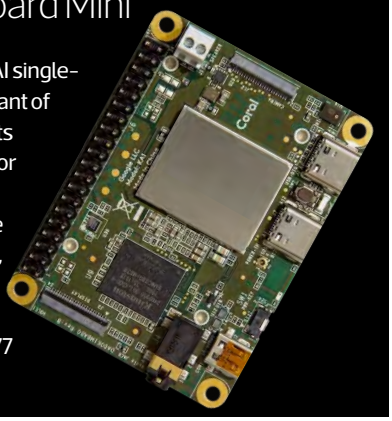
To demonstrate the port's potential, we connected an NVMe SSD via a PCI-E host bus adaptor, and saw storage performance break 400MB/sec for the first time on a Raspberry Pi, beating the previous best effort via a USB 3 SSD, and at lower CPU usage. The same port could be used to connect to high-speed network interfaces, USB 3 cards, SATA cards, deep-learning accelerators or even graphics cards – if someone wanted to write a driver, at least.

There's one area where the Compute Module 4 fails to match its full-sized equivalent, though, and that's thermals. Owing to its considerably smaller footprint and the insulating air trapped between it and the IO Board, the module gets hot very quickly. The fan header isn't for show – without it, a heavily loaded Compute Module 4 throttles faster and for longer than a Raspberry Pi 4. A heatsink is a necessity in enclosed designs as a minimum.

The best feature of the new Compute Module 4 range, though, is the pricing. The entry-level model, with no radio and 1GB of RAM, costs just £23.26; the top-end model with wireless features, 8GB of RAM and 32GB of eMMC storage costs £83.71, and the carrier board costs just £32.56 – a third of the price of the carrier board for the Compute Module 3 range (all prices inc VAT). An optional antenna kit is also available, for those who can't use the on-board ground-plane antenna, for £4.66 inc VAT. The Compute Module 4 and IO Board are available from **okdo.com** now.

NEWS IN BRIEF

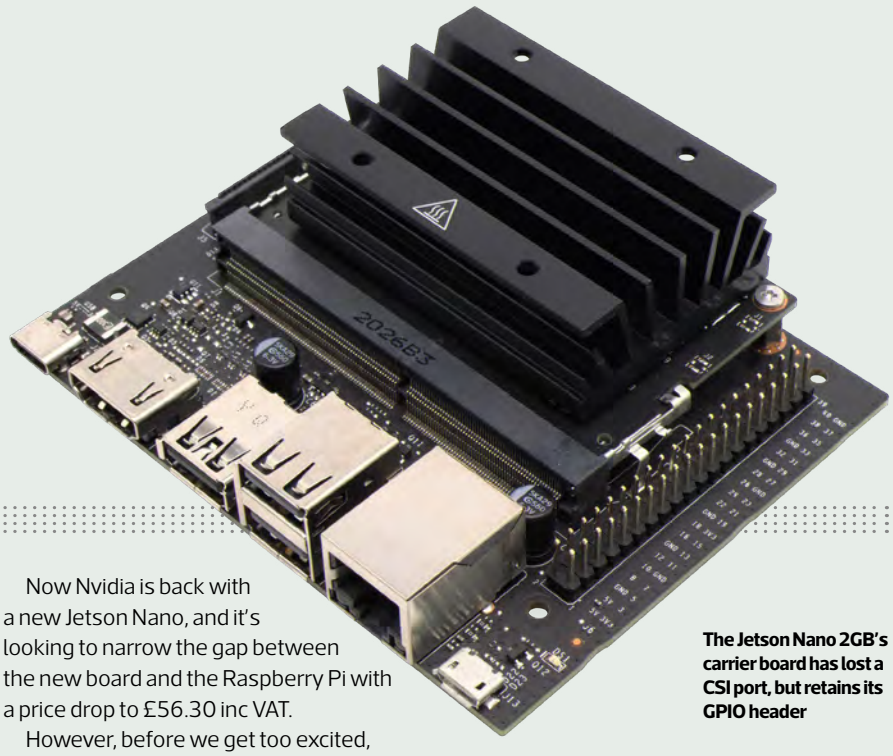
Google launches Coral Dev Board Mini



Google is continuing to push its way into the edge-AI single-board computer market, announcing a cheaper variant of its Coral Dev Board: The Coral Dev Board Mini. Like its predecessor, the Coral Dev Board Mini is designed for deep-learning workloads. It pairs a quad-core Arm processor with 2GB of RAM and Google's own Edge Tensor Processing Unit (TPU) accelerator – offering, the company claims, four trillion operations per second (4 TOPS). UK pricing has not yet been confirmed, with US pricing set at $99.99 (around £77 ex VAT). See **coral.ai** for more information.

REVIEW

Nvidia Jetson Nano 2GB



The Jetson Nano 2GB's carrier board has lost a CSI port, but retains its GPIO header

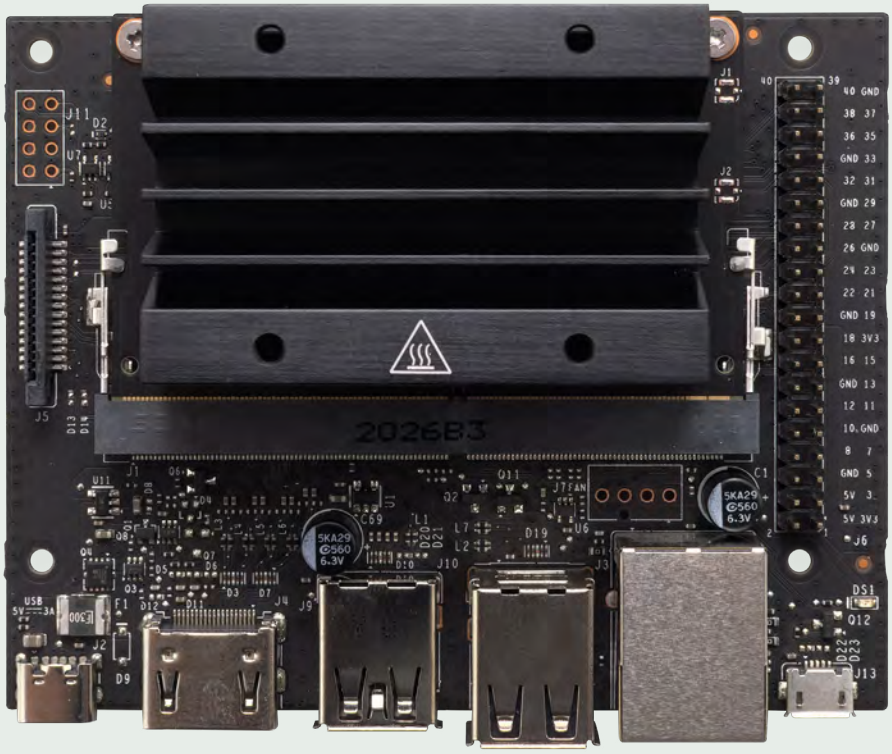
It's been around a year and a half since Nvidia announced its plan to attack the educational and maker markets with the Jetson Nano, its most affordable artificial intelligence platform since the original £200 (inc VAT) Jetson TK1 single-board computer. At £95 inc VAT, the Jetson Nano (reviewed in Issue 191) offered a considerable performance advantage over the rival Raspberry Pi 4 Model B range, but at an equally considerable price hike.

Now Nvidia is back with a new Jetson Nano, and it's looking to narrow the gap between the new board and the Raspberry Pi with a price drop to £56.30 inc VAT.

However, before we get too excited, it's important to understand exactly what drives those cost savings. The headline change is the memory setup.

The original Jetson Nano had 4GB of RAM, matching what was at the time the highest RAM capacity variant of the Raspberry Pi 4. However, the new model has 2GB of memory.

The cost reduction hasn't, thankfully, hit the impressively chunky heatsink



For a device aimed at GPU-accelerated edge-AI tasks while simultaneously running a graphical user interface – the lightweight LXDE – that's not much memory.

Even running a web browser is enough to trigger low memory warnings. However, if you use the microSD card for swap memory, and ZRAM to compress memory contents, you can push the device further than you might expect.

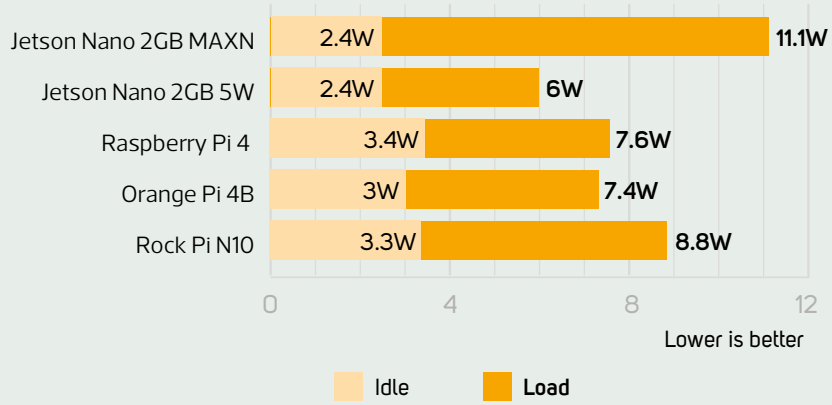
The other changes are harder to spot. The two Camera Serial Interface (CSI) ports of the Jetson Nano's mid-stream refresh earlier this year have reverted back to a single port. There's also only a single USB 3 port and two USB 2 ports, compared with the original device's four USB 3 ports.

Meanwhile, the DisplayPort 1.2 connector – and its ability to offer dual-display capabilities alongside the HDMI port – is entirely gone, and there's no sign of the PCI E M.2 slot under the heatsink-equipped Jetson Nano module itself either.

The lack of an M.2 slot means there's no way to add Wi-Fi to the Jetson Nano 2GB, either alongside or instead of the Gigabit Ethernet port.

That's a shortcoming that Nvidia has addressed in surprisingly generous fashion: for most countries, including the UK, the Jetson Nano 2GB comes bundled with a USB Wi-Fi dongle. The downside is that, once

POWER CONSUMPTION



you've added the dongle, a keyboard and a mouse, you've filled all three USB ports. Even switching to a combined keyboard/mouse receiver leaves you with just one spare port.

NEWS IN BRIEF

New Micro:bit adds audio capabilities

The Micro:bit Educational Foundation has launched an updated version of its eponymous learner-focused microcontroller development board, the BBC micro:bit, four years after the original board was reviewed back in Issue 154. The updated model is priced the same, but includes a microcontroller with twice as much flash storage and eight times the amount of RAM, plus a built-in microphone and speaker for voice and audio projects. The radio is also recertified to Bluetooth 5, and the logo above the LED matrix display doubles as a touch-sensitive input. See **microbit.org** for the full details on the new board.

Little has changed on the software side. The JetPack Software Development Kit (SDK) is still based on Ubuntu 18.04 LTS, though the GNOME Shell desktop has been replaced with LXDE to free up some memory.

As before, compatibility is key – the Jetson Nano 2GB is capable of running any software that can be run by its more expensive stablemates, providing you can squeeze them into the 2GB of RAM.

To prove the point, we ran our review sample through a series of performance benchmarks, including Nvidia's own artificial intelligence workloads.

Originally designed to showcase the Jetson Nano against other models in the Jetson family, the deep-learning benchmarks ran fine on the new 2GB variant – after, that is, we halved the workspace sizes to prevent the processes from being immediately killed as they exceeded the amount of available memory.

Nvidia positions the Jetson Nano as ideal for education, and it has a lot resting on its adoption. Its AI examples all use Nvidia's CUDA system to accelerate the networks through the on-board GPU, and once someone has begun learning the CUDA ecosystem, the chance of them abandoning it in favour of a different system, such as Google's Coral Edge TPU platform – which is outpaced by the Jetson Nano in the majority of benchmarks, is minimal.

To help the Jetson Nano 2GB along, it also launches alongside the Jetson AI Certification Programme. Aimed at 'educators and learners', this programme looks to walk users through training and inference, data collection, real-time computer vision, classification, segmentation and even robotics, all on the Jetson platform.

The Nvidia Jetson family has always been specialised, but as the prices drop, it becomes increasingly tempting to look at these boards as general-purpose computing devices.

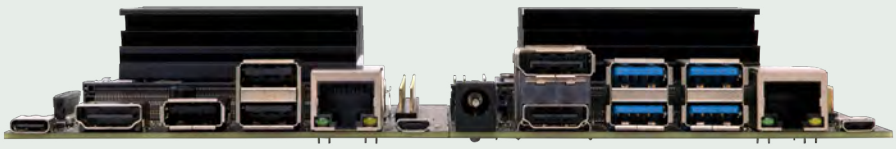
Sadly, they're not quite in that position yet though. Performance for non-GPU-accelerated workloads sits somewhere slightly south of the cheaper Raspberry Pi 4 (see Issues 193 and 204), and considerably below more powerful devices, such as the Orange Pi 4B (see Issue 200) and Rock Pi N10 (see Issue 203). Also, while there's a lot of performance in the Jetson Nano, you only need to look at the above graphs to see that it gets power-hungry at full tilt.

Support for general GPU operations, such as 3D acceleration and video encoding, is also weaker than you'd expect – as is support for installing operating systems other than the JetPack SDK.

For readers with an Nvidia graphics card already installed in their PC, there's little reason to pick up a Jetson Nano, even at the newly reduced price for the 2GB version. You can just install a development environment on your existing system instead.

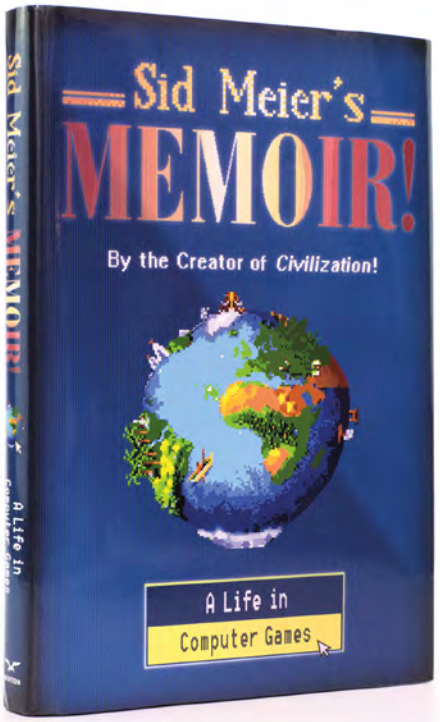
For educators, or anyone looking for a board for use in embedded projects up to and including robotics, however, the story is different. You'd be hard-pushed to find any such device better than the Jetson Nano at the same price point. The Nvidia Jetson Nano 2GB is available to purchase now from **okdo.com** at a price of £56.30 inc VAT.

There's a definite loss in connection options between the 2GB (left) and 4GB (right) variants



REVIEW

Sid Meier's Memoir!



Could you imagine a better title for Sid Meier's book?

Anyone with even a passing interest in strategy gaming will be familiar with the name Sid Meier, co-founder of MicroProse, father of Civilization and one of the first industry people to have his name proudly emblazoned on game boxes. Sid Meier's Memoir! is, first and foremost, a first-person romp through the man's career in gaming, with the occasional diversion through childhood.

It's also more properly termed 'Sid Meier's Sid Meier's Memoir!' – both the exclamation mark and the name form part of the proper title, in a nod to the games described within the book. It's written by Jennifer Lee Noonan, and based on exhaustive interviews – although, like Sid Meier's Colonization, which was written by MicroProse staffer Brian Reynolds, it's Meier's name that graces the cover. The book adopts a friendly, conversational fireside tone that matches well with Meier's personality.

Meier himself also makes a distinction between Meier the person and Sid Meier! with an exclamation mark. Meier the person is only human, he explains, but Sid Meier! is whoever he needs to be for any given fan of his games. Meier doesn't gloss over his past though – even when it comes to events he might like to forget, such as the ill-fated dinosaur game that never made it past the prototyping stage.

Within the pages of the hardbound book, interrupted only briefly by greyscale box art shots and the occasional photograph, you'll find Meier confessing a plan to 'never write design documents', considering three-dimensional graphics a 'flash in the pan' that simply wouldn't stand the test of time, dismissing the Commodore Amiga as having 'failed to live up to its promise in sales numbers' and admitting to casual game piracy in his youth.

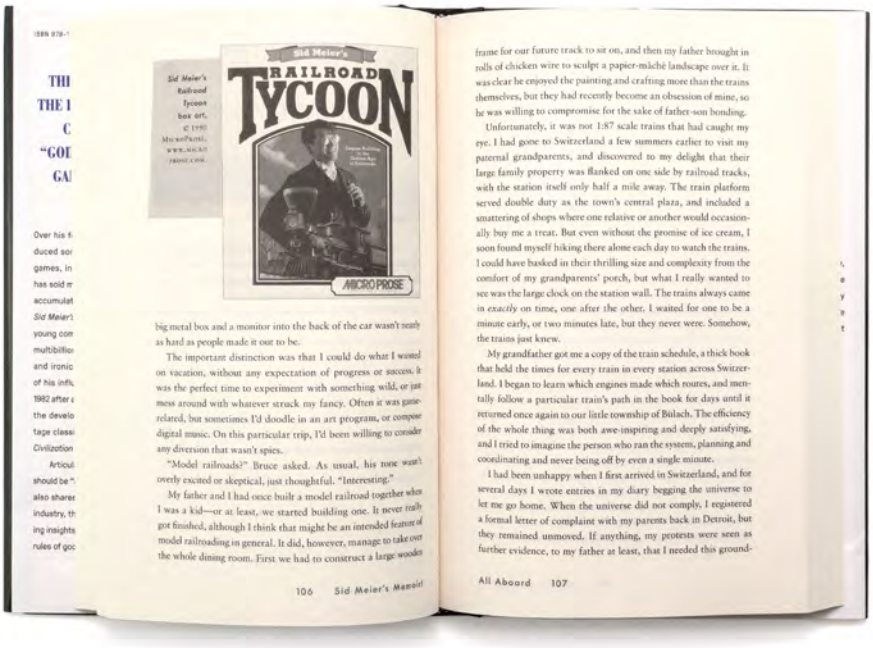
He was even completely against the concept of allowing players to modify a game. 'I was completely wrong,' Meier admits here. He says the modding community drove sales of later games, and that some of what came out of the community was little short of incredible.

Elsewhere, Meier pulls no punches in describing 'the slow, public strangling of our once-beloved title [Civilization]', following the takeover of MicroProse by Spectrum HoloByte, and his hopes when he formed current franchise operator Firaxis.

Meier also burns five pages debunking a common myth: that a programming error resulting in an underflow causes Gandhi, the most peaceful world leader in Civilization, to become the most aggressive once diplomacy has been researched. There's no truth to it, Meier claims, given that the game didn't use unsigned integers that could underflow in that way. He places the blame firmly at the door of a pseudonymous TV Tropes user for the origin of this fun-but-untrue factoid.

One aspect of the book that will either delight or grate, depending on your personality, is the 'achievements'. Presented as footnotes, these mark monumental milestones, including having read the word 'the' 1,000 times, or having reached the middle of the book.

Sid Meier's Memoir! is a delight that should be on the shelf of any gamer who ever had 'one more turn' at a silly time in the morning. It costs £22 (VAT exempt) from **blackwells.co.uk**, or can be ordered from your bookshop under ISBN 978-1-324-00587-2. CPC



Imagery is sparse, and presented entirely in shades of grey; the words are the focus

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at **freelance.halfacree.co.uk** @ghalfacree

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- Extra-thick insulation mats for improved noise reduction
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- Decoupled motherboard tray can be relocated for inverted layout
- Detachable top bracket ensures easy installation of radiators and fans
- Ready for radiators up to 420mm
- Tinted and tempered glass side window provides a superb view

Here's an awesome opportunity to grab yourself a brand-new case, thanks to the lovely folks at be quiet! What's more, there are two of them to be won. The be quiet! Silent Base 802 is the perfect case for sophisticated users who strive for whisper-quiet operation and maximum performance alike.

A choice of two interchangeable top covers and front panels are provided, so you can optimise your case for quiet operation or extra airflow.

Meanwhile, the front and sides are equipped with dampening mats measuring up to 10mm thick, resulting in maximum stability and superb noise-dampening capabilities. The decoupled PSU bracket, motherboard tray and hard drive cages also minimise vibrations, while the full metal body provides stability for the case.

In addition, the motherboard tray is decoupled and can be installed alongside the left panel in an inverted layout, or removed for use as a test bench. You also get a USB 3.2 Gen 2 Type-C connector on the front I/O panel, along with an integrated 4-step fan controller.

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ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

I'm switching to AMD

My new Event HoRyzen rig sees me switching from Intel to AMD for this first time in years

While my column is usually about modding and water cooling, I couldn't help add my personal opinion about the launch of AMD's Ryzen 5000-series CPUs. I'm honestly staggered at what AMD has achieved with the Zen 3 architecture, and find it incredible that the company is probably in a stronger position against Intel than it was with its Athlon CPUs back in the early 2000s. AMD is now on par with Intel in games (faster in some of them), and its CPUs sport incredible performance in content creation too.

I'm not a massive fan of Cinebench's single-threaded test as an indicator of general performance, as it only takes a mundane background task niggling at your CPU to cut lightly threaded boost frequencies, but AMD's scores in excess of 630 here are phenomenal. It just goes to show Intel's stagnant nature over the past few years, occasionally adding cores or cutting prices, but ultimately failing to add much else to its offerings.

Of course, not all of us will need (or can afford) one of AMD's new CPUs, but the mere fact that the competition has heated up this far means that Intel will be forced to step up or bow out on the desktop. For us old-timers who saw a similar situation 20 years ago, the path back to dominance may take a while for Intel, if that's even the path it chooses to take. I remember switching to AMD around 2001 and it wasn't until 2006 with the Core architecture that I switched back to Intel.

Anyway, I'm putting my money where my mouth is, and using AMD hardware in my new PC. This month I made the switch. I now have an AMD system as my main rig for the first time in nearly 15 years. I'm temporarily using a Ryzen 9 3950X test sample, which I dropped into my new mini-ITX build called Event HoRyzen, which you can check out on my CrazyTechLab YouTube channel, but I'll soon be splashing out on a Ryzen 5000-series CPU for this rig.

Aside from raw performance, I also like the fact that the 5000-series CPUs are more overclockable than their predecessors. I managed to achieve a 4.6GHz all-core frequency with the Ryzen 9 5900X with a vcore under 1.25V, which offers better performance pretty much across the board compared with stock speed. What's more, as AMD's CPUs are less power-hungry than Intel's equivalents, you don't need monstrous cooling either.

As an added sweetener for Socket AM4 motherboard owners, 400-series chipsets will get BIOS updates in a couple of months that enable them to support the new CPUs too, and you don't even need to change CPU coolers or waterblocks either.

It's almost a shame that we won't be seeing swathes of new motherboards, or a new chipset for that matter.

After all, the launch of AMD's X570 chipset saw manufacturers step up and release high-end models for AMD CPUs for the first time in years. Asus' Crosshair VIII range, for example, finally enabled AMD to compete with Intel at the high end.

As a result, you'd think that the Ryzen 5000-series CPUs deserve their own refreshed range of high-spec motherboards dripping with features, but we probably won't see a big release this time.

That said, with the new processors sporting similar TDP ratings to their predecessors, and with no new features such as PCI-E 4 being added, there isn't really a good reason for motherboard manufacturers to completely refresh their ranges, and that's good for consumers, especially those who already have compatible motherboards.

However, with motherboard stocks being tight at the moment, and owners of B450 and X470 boards likely outnumbering their B550 and X570 counterparts, thanks to longer availability and cheaper prices, it's possible the delay in BIOS releases for older boards could impact on AMD's Ryzen 5000-series sales. In any event, the Ryzen 5000 series is super-exciting, offering the best reason to upgrade your CPU for a long time.

A mini case for Nvidia's latest RTX cards

Last month I was horrified by how poorly NZXT's H1 mini-ITX case handled Nvidia's GeForce RTX 3080 Founders Edition when it came to cooling. The card's flow-through fan design might aid cooling in a standard case, and make the most of the smaller PCBs in the Founders Edition cards, but there are plenty of cases available that are most definitely not suited to it.

That includes many mini-ITX cases, especially when it comes to designs where the graphics card is flipped using a PCI-E riser cable. Personally, I love the design of Nvidia's Founders Edition cards and would seriously consider using one in my own PC just for the aesthetics. However, as I'm a massive mini-ITX fan, I'd be forced to consider a third-party card and, even then, many of their coolers still have a degree of flow-through airflow.

Thankfully, I've found at least one mini-ITX case that can handle the RTX 3080 Founders Edition and even has space for some monstrous RTX 3090 cards too. Cooler Master's MasterCase NR200P isn't the smallest case available, but it's still very compact. However, its cooling-focused design means that it's not just adept at cooling flow-through cards effectively, but can do so in several layouts too.

Despite its modest dimensions, Cooler Master's NR200P proved adept at cooling the GeForce RTX 3080 Founders Edition

The case can be arranged to have the graphics card sat vertically, either drawing in air through a vented side panel or face down in the base of the case. It's even able to house monstrous RTX 3090 cards, such as the Palit Game Rock we reviewed last month, in either location with acceptable thermals. The only situation that warranted concern was using an RTX 3080 or 3090 in the vertical mount when using the glass side panel. However, the RTX 3070 was cooled reasonably well in this location, thanks to its thinner dimensions moving it away from the side panel.

Add in the case's reasonable water-cooling support, and the NR200P remains a great small case and definitely the one I'd recommend if you want to throw an RTX 3000-series card into the mix too. CPC

Antony Leather is Custom PC's modding editor @antonyleather

How to Install a motherboard monoblock

Antony Leather shows you how to water-cool your motherboard's components, as well as your CPU, by fitting a monoblock

TOTAL PROJECT TIME / 2 HOURS

Water-cooling enthusiasts used to covet chipset and VRM waterblocks that enabled you to cool these motherboard hot spots and open up extra overclocking potential. However, plumbing several waterblocks into your loop in close proximity was tricky, unsightly and expensive.

Enter the monoblock, a single-piece waterblock that spans large areas of your motherboard and cools several hot spots, including the CPU. Their main attraction is that just a single inlet and outlet is needed to cool all these areas, making the job easier and better looking. Modern monoblocks even have RGB lighting and thermal sensor displays built into them. In this guide, we'll look at how to prepare your motherboard for monoblock installation, and how to fit the block itself.

TOOLS YOU'LL NEED

Thermal paste
overclockers.co.uk

Micro screwdriver set
Most hardware stores

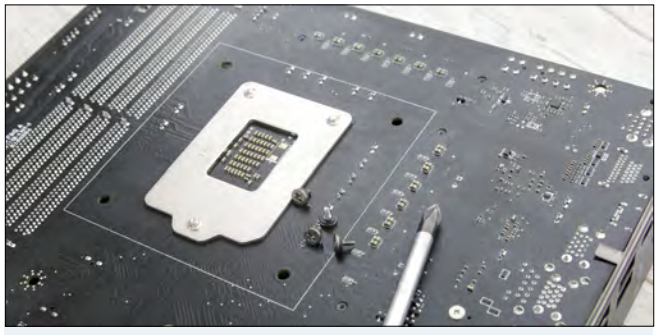
Motherboard monoblock
overclockers.co.uk

TIM cleaner
overclockers.co.uk

Hairdryer
amazon.co.uk

1 / LOCATE STOCK HEATSINK SCREWS

Your motherboard will have its own heatsinks, which will be secured using screws on the underside of the PCB. These screws are usually easy to spot, but some of them may be buried among other parts, or hidden within rear-mounted heatsinks. Find all of them.



2 / REMOVE SCREWS

Come prepared with a micro screwdriver set that includes both crosshead and hex bits, as either of these heads can be used in different screws across the board and waterblock. Remove the screws across the motherboard, one heatsink at a time.

3 / REMOVE STOCK HEATSINKS

Once you've removed the screws, gently pry the heatsinks off the motherboard. Occasionally this can prove tricky if the thermal paste or pads have set. If they won't budge, direct a hairdryer on a high setting at them for ten seconds to warm up the paste, which will loosen them up.

4 / REATTACH THERMAL PADS AND SCREWS

Once the heatsinks are removed, reattach any screws and thermal pads to the heatsinks. This is important if you want to sell your motherboard at a later date, or if you decide to switch back to air cooling later.

5 / CLEAN VRMS AND CPU

The VRMs will likely have residue from whatever pads or paste were applied at the factory, and this can perform poorly compared with decent thermal paste. Use isopropyl alcohol or thermal paste cleaner to clean and prepare the surfaces, so you get the best thermal performance.

6 / TEST-FIT MONOBLOCK

With numerous mounting points, monoblocks can be tricky to fit first time, so do a test run before you apply thermal paste, so you know how it sits. Make sure the mounting holes line up on the rear of the PCB too.

7 / APPLY CPU THERMAL PASTE AND PADS

You can use liquid metal paste on the CPU, but you can only use non-conductive ceramic paste on the VRMs if you need to apply it there, as liquid metal paste can run and cause a short circuit. Most blocks use thermal pads on the VRMs though.

8 / INSTALL MONOBLOCK

With the thermal paste and pads applied, place the motherboard on a flat surface and install the waterblock, taking care not to twist the board too much. Hold the block in place and install its mounting screws from the rear.

9 / INSTALL FITTINGS

Tighten all the screws a little in turn before they're all secured, then flip the motherboard back over. It's best to install the fittings and connect any RGB cables before you place the motherboard in your case, as this job might be tricky later. Finally, check the temperatures are up to scratch once your new system is up and running.

How to Leak-test water-cooling loops

Antony Leather shows you how to leak-test, fill and bleed your water-cooling loop like a pro

TOTAL PROJECT TIME / 1 HOURS

Once your water-cooling loop is set up, it needs very little maintenance apart from cleaning dust from the fans and radiators once or twice a year. However, the filling and leak-testing stage is undoubtedly the most tedious and hazardous part of the setup process, and getting it wrong can result in your loop taking much longer to build. Plus, we all know what can happen if it leaks all over your live circuitboards.

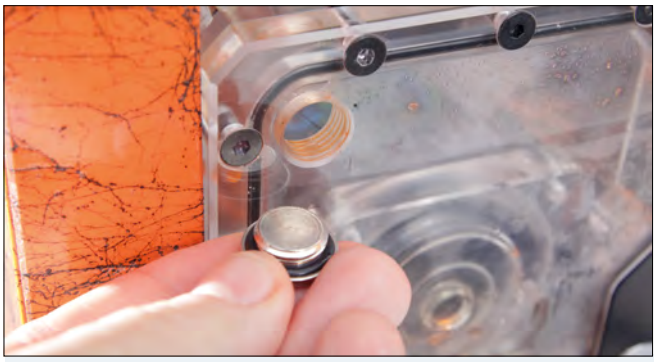
What's more, if air remains in your loop after you fill it, the noise created by this air will make your PC noisier than a typical air-cooled PC, rendering all your hard work pointless. There are some tried and tested methods of dealing with leak testing, filling and bleeding your loop of air, though, and they're quick and easy to perform. In this guide, we'll take you through these essential parts of any water-cooled build process.

TOOLS YOU'LL NEED

Funnel
Most hardware stores

Leak pressure tester
ekwb.com

Fill bottle
overclockers.co.uk



1 / IDENTIFY A SPARE PORT

The leak tester needs to be attached to a port in order to pressurise the loop and identify leaks. Ideally, you want to attach it to a spare port on a reservoir, rather than dismantling part of your loop, to ensure that you're testing the whole loop.

2 / ASSEMBLE LEAK TESTER

EKWB's leak pressure tester uses a G1/4in port to connect to your water-cooling loop. Connect the fitting to it so that you can plumb it into your water-cooling loop.

3 / FIT TO VACANT PORT

Make sure the spare port has enough clearance for you to connect the pressure tester, and then screw it into the port. You may need to use a wrench to lightly tighten it, as it can be difficult to access the rotary fitting at the end.

4 / ATTACH PUMP SECTION

Once the tester is connected, attach the pump section. The pump works like a bicycle pump, and you can test it by holding a finger on one end first to make sure it works properly.

5 / ENSURE 2-WAY VALVE IS OPEN

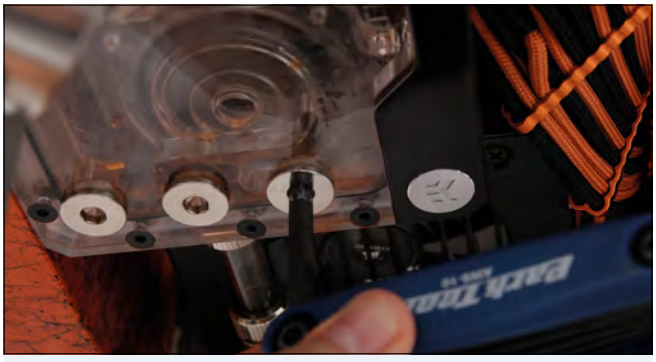
The pressure tester has a valve at the end, so once you've added enough pressure, you can lock it off to prevent air from escaping, which can give a false leak reading. Make sure this valve is open when you're pumping.

6 / PUMP UP TO 0.5-0.75BAR

Aim to increase the pressure in your loop to 0.5-0.75bar. This will be more than enough pressure to find any leaks, putting your loop under similar pressure to a high-power water-cooling pump.

7 / CLOSE VALVE

Once you're up to pressure, lock the valve to the closed position and, if necessary, disconnect the pump section to prevent it from dangling down. Leave it set up like this for ten minutes. Any loose fittings and so on will then be obvious, as the air will quickly leak out and the gauge will drop.



8 / FIND THE LEAK

Your first job in the event of finding a leak is to tighten all your fittings and connectors, but you can also get someone to pump up to the redline on the gauge with you listening inside the case. You can usually identify a loose section by the sound of a faint hiss.

9 / USE A FUNNEL

Once your loop is leak-tested, it's time to fill it. You can usually pour coolant straight into the reservoir, but if it only has a small fill hole, and not a cap, you can use a funnel to add coolant quickly.

10 / USE A FILL BOTTLE

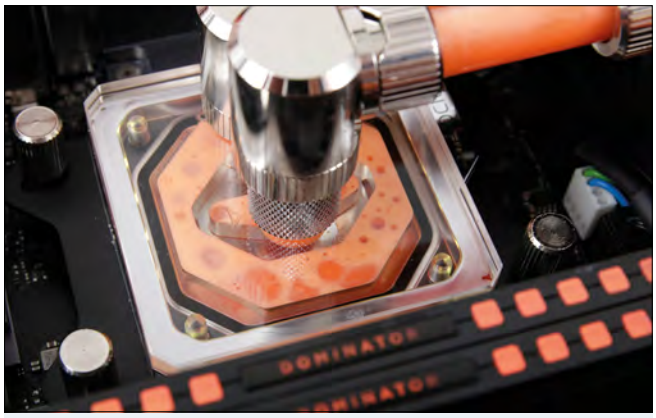
For adding smaller amounts of coolant, a fill bottle is a great tool for topping up your system. This can be particularly useful in the latter stages, when your loop is shedding air bubbles and the reservoir coolant level drops.

11 / ADJUST D5 PUMP SPEED

Depending on your loop's layout and pump power, it may be necessary to take some extra steps to bleed the loop of air, especially if it's still gurgling several hours after you've filled it. You can try speeding up your pump to shift air bubbles, or slow it down to help trap air in the reservoir.

12 / ADJUST PUMP SPEED VIA SOFTWARE

If your pump doesn't have a speed adjuster, many have PWM connectors that enable you to change their speed in your motherboard's EFI or software. If your pump speed is too fast, it can sometimes hinder bleeding, especially if you have a small reservoir.



13 / WATCH FOR BUBBLES

An easy way to tell when your loop still requires bleeding is to check for air bubbles. These bubbles will be present in the reservoir, and larger ones may form in waterblocks, potentially impacting on performance.

14 / TILT THE SYSTEM

If adjusting your pump doesn't shift the air, you may need to tilt your system to dislodge bubbles. This is common with smaller systems or low-power pumps. Laying the PC on its side can also work here.

15 / TOP UP RESERVOIR

As the air is gradually bled from your system, it should become trapped in the reservoir, which will cause the coolant level to drop. That's good, but you need to top it up with coolant, so inspect the level every hour and add more coolant when necessary. CPC

Folding@home

Join our folding team and help medical research

ACTIVE USER MILESTONES

USERNAME	POINTS MILESTONE
Dave_Goodchild	2,000,000,000
tarka_dahl	1,000,000,000
sonic_vortex	600,000,000
BurnedFastfood	300,000,000
rjcman	300,000,000
gKitchen	90,000,000
chubarker	90,000,000
TechnoStuck	90,000,000
phys1csb0y	80,000,000
meandmymouth	80,000,000
40138	80,000,000
Bedders	60,000,000
Dutchchemist	40,000,000
Will_Walton	40,000,000
Dainye	20,000,000
marcostheblack	10,000,000
Mikloid	10,000,000
GJBriggs	9,000,000
crazystuntman	8,000,000
markdiss	7,000,000
sparrowm7	7,000,000
4zm4n	6,000,000
TheLimey	6,000,000
G4zm4n	6,000,000
PendragonOrion	5,000,000
Pausanias828	5,000,000
Pedro8888	5,000,000
leeoliver24	5,000,000
NotFred	4,000,000
Peanut.Rec.	3,000,000

USERNAME	POINTS MILESTONE
Ratski	2,000,000
Cole	1,000,000
Matt_Livermore	1,000,000
LatinSpirit247	1,000,000
Curtis.Perdue	1,000,000
yonedafolding	1,000,000
Bazil	700,000
raptor4216	700,000
Wenna	600,000
Braeden	600,000
GingerFox	600,000
mjgray87	500,000
Bloo_Town	500,000
Boohoo	400,000
Jared18639	400,000
mhfz48	300,000
iamannie	200,000
neo-internalforce	200,000
Shiny-Robot	200,000
topshed	70,000
Almark	70,000
battletux	70,000
Goonzquad-Fanboy	60,000

WHAT IS FOLDING?

Folding@home uses the spare CPU and GPU cycles for medical research, with a current focus on COVID-19. You can get the client from **foldingathome.org/start-folding** and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag – we'll print all the milestones we can fit on the page. You can discuss folding with us and other readers online at the bit-tech forums (**custompc.co.uk/FoldingForum**).

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	Dave_Goodchild	22,058,464	2,112,140,229
2	DocJonz	15,575,252	13,283,861,018
3	Desertbaker	7,837,431	2,990,402,888
4	Slavcho	6,548,419	3,334,109,490
5	Lordsoth	6,135,495	4,770,876,662
6	tarka_dahl	5,591,381	1,097,147,462
7	BurnedFastfood	3,302,990	367,098,636
8	kcanti	2,028,535	853,644,589
9	Little_Willie	1,411,808	346,522,184
10	sonic_vortex	1,312,579	601,314,494
11	gKitchen	1,120,483	98,765,235
12	PC_Rich	1,102,660	6,323,568,350
13	Dickie	737,984	1,155,125,163
14	Will_Walton	663,700	46,862,994
15	meandmymouth	652,817	82,062,990
16	BeezaBob	641,712	897,992,049
17	KevinWright	595,190	1,263,118,956
18	phys1csb0y	589,851	87,739,687
19	GWallace	579,774	264,592,813
20	Bloo_Toon	554,847	311,500,240

TOP 15 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	DocJonz	13,283,861,018	330,545
2	PC_Rich	6,323,568,350	163,692
3	Shirty	5,123,598,623	38,984
4	Lordsoth	4,770,876,662	176,535
5	Nelio	4,638,586,520	523,610
6	HHComputers	3,544,050,839	85,007
7	Slavcho	3,334,109,490	69,829
8	Desertbaker	2,990,402,888	63,017
9	piers_newbold	2,703,256,197	107,638
10	Scorpuk	2,544,545,152	57,727
11	clanseven	2,223,720,446	33,156
12	Dave_Goodchild	2,112,140,229	150,454
13	Unicorn	1,753,462,654	57,079
14	daxchaos	1,637,104,710	41,302
15	Laguna2012	1,527,029,380	51,930

Readers' drives

Project ISAC

After sinking over 1,000 hours into The Division, Andy Makin built this system of two halves, inspired by the game's Intelligent System Analytic Computer concept

SEE THE FULL PROJECT LOG AT custompc.co.uk/ISAC

/MEET THY MAKER

Name Andy Makin

Age 38

Occupation Cripple

Location Birmingham

Main uses for PC Gaming

Likes Coffee, full fat pop and food – the filthier the better. For the perfect bacon sandwich, butter the bread and then fry the buttered side a little in the pan after you've cooked the bacon

Dislikes Salad, gyms and TV series doing musical episodes

CPC: What was the inspiration behind Project ISAC?

Andy: I had applied to participate in the Thermaltake UK 2020 Case Mod Challenge, and after getting through the initial vetting, I was asked to submit a case mod design. After watching The Division's 'State of the Game' weekly update stream, I was writing the recap notes for my clan's Discord when it dawned on me that the Riing Quad fans we'd been given for the competition could be made to look like the ISAC ring in The Division and it just snowballed from there. Having spent over 1,000 hours playing The Division, it seemed a fitting tribute to a game that had helped me to get through a really difficult year, after suffering complications following hernia surgery.

In The Division, ISAC (Intelligent System Analytic Computer) is a highly advanced artificial intelligence entity available to all active Division agents equipped with an SHD Tech transceiver. The transceiver , which is worn by agents on their shoulder, has an orange LED ring on it when activated, and it's a prominent design feature throughout the game.

CPC: What were your design cues?

Andy: The general idea was that it would be a mobile lab, since a lot of the second Division game is based around finding a cure for the Green Poison virus. Being well into a global catastrophe that has brought down law and order, the exterior would be beaten up, damaged, dirty and rusted up, which would carry through into the rear chamber of the case for a boiler room feel.

Then the front chamber of the case would be much cleaner, like a lab, with bare metal finishes and the water-cooling tubes running around like caricature chemistry experiments.

CPC: How did you mod the GPU waterblock?

Andy: It's a Thermaltake Pacific V-RX 5700 block that we were all given for the competition, which has a normal nickel-plated coldplate with an acrylic top block. To get it to fit in with the theme of the main chamber, I made a shroud out of 2mm

I've always tried to have really tidy cabling in my systems. After all, it's the hardware you want to show off, right?

aluminium, from which I cut out the Division 2 logo over the jetplate and fins of the block. This was done by hand, using a drill to make lots of holes and then filing out the rest. I also made a cover for the CPU block and motherboard, complete with a brass mesh-covered chipset vent, again made by hand from 2mm aluminium.

CPC: What's the story behind the custom silver radiator vent?
Andy: I've long liked the aesthetics of louvred panels, and I knew one would look perfect in this environment with the industrial lab theme. I bought some vent covers and two sets of louvres, with the idea that I could cut them out, sit them on top of each other and cover the full length of the radiator. They were brushed stainless steel, so they would look perfect. In reality, though, the stainless steel was really tough to cut and file, and the louvres made clamping and getting the cutting tools into the right places really difficult. A scroll saw or angle grinder would have made mincemeat of them, but it wasn't so easy with just a jigsaw and a Dremel.

CPC: How did you achieve the brass pipe effect on the fittings?
Andy: Thermaltake sent me some black fittings, but I knew that fittings were usually made of brass and, sure enough, a little scrape with a knife showed just that. I used some abrasive wheels on the Dremel to remove the paint, and then went back over them with a finer grit to smooth and even out the finish. They came out way better than I'd anticipated.

CPC: How did you plan the water-cooling loop?
Andy: I planned out how I wanted the piping to work in MS Paint (high tech or what?), but once I'd made the new steel motherboard tray/dividing wall and put all the gear where it would finally sit, it didn't all line up quite like expected. I set all the pass-throughs for water cooling and wiring around the motherboard, and moved them around like chess pieces until I found an arrangement that worked practically and looked good.

I used 16mm OD PETG, which was supplied by Thermaltake. This was my first time using hardline tubing, and I thought it would be easy, but it's a lot trickier than you imagine, especially when you're putting a few bends in a single run. Even with a simple 90-degree bend, there's definitely an art to it. My first few

were okay, but you could see a kind of pinch line where the bend started and ended because I wasn't heating enough of the tube. Through a bit of trial and error I found I needed to heat 3-4in of the tube to create a smooth, seamless bend.

I used a bending mandrel and another piece of tube to help measure where I would need to start a bend to get the correct spacing, and then I marked it with masking tape. I could then take it away, to heat, bend and cool. It took a while to nail the technique, and I ended up redoing most of the runs after getting a good system going.

CPC: What's the story behind the metal connectors for the power cables?

Andy: The original design had the cables bunched and sleeved in steel braiding. However, when lockdown set in, my source of steel braiding dried up and I couldn't find it anywhere. In my hunt for alternatives I found the aviator (or GX) connectors and I knew instantly that they were the answer. They would look awesome, and allow me to separate the front and rear cables as I wanted. There would be clean colour-coded sleeving around the front with the female connector, then cables that looked like dirty drain pipes going from the PSU to the Male bulkhead connector.

Working with them was quite tricky – both sides needed soldering and I was a soldering novice. It took me quite a long time to do all the soldering and sleeving, particularly because the nerve damage I have makes it impossible to sit at a desk or table for more than half an hour, so most of it was done on the sofa. I watched half a dozen or so tutorials on YouTube about how best to tackle these particular connectors; first putting solder into the connector cups, then tinning the wires, before heating them together to make a connection.

CPC: How did you plan the cable routing?

Andy: I've always tried to have really tidy cabling in my systems. After all, it's the hardware you want to show off, right? All the non-power cables come through two holes behind the motherboard, then around the edge of the board and back into the main chamber, so there's as little cabling on show as possible. The cables for the two LED strips and three fans in the bottom of the case go through their own pass-through holes along the bottom of the new motherboard tray, which have brass plumbing fittings for a little extra bling.

However, in this mod it didn't feel right to have pristine cabling in the dank dirty boiler room section, so I muddied and frayed it in places – there's loose heatshrink and electrical tape – it looks nasty. However, at the same time, all the cables flow to the right places in a reasonably ordered, natural-looking fashion, all without a cable tie in sight and that's not by accident. All the wires were twisted and soldered in just the right way, so they hold

SYSTEM SPECS

CPU AMD Ryzen 7 3700X

Case Thermaltake View 51 Snow

GPU Asus Radeon RX 5700 8GB

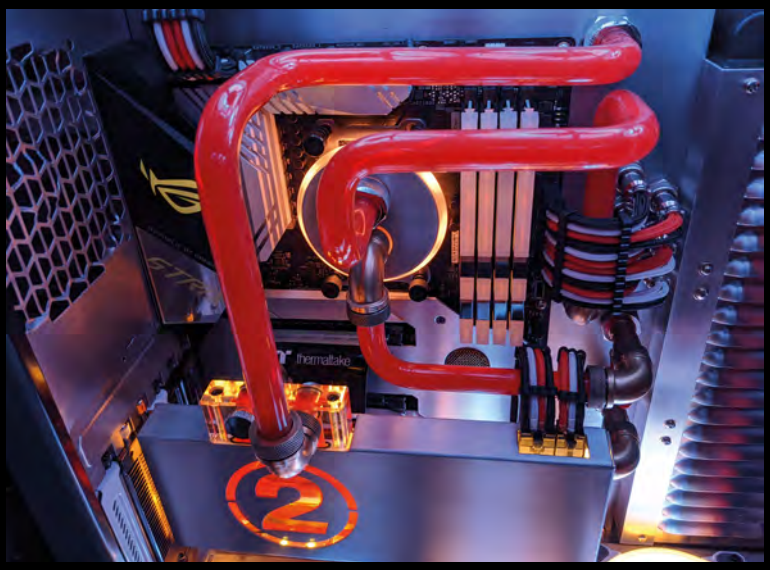
Storage 500GB Seagate FireCuda 520 PCI-E 4 SSD, 14TB Seagate IronWolf Pro hard drive

Memory 32GB (4 x 8GB) Thermaltake Toughram RGB 3000MHz

Motherboard Asus ROG Strix X570-F Gaming

PSU Thermaltake Toughpower GF1 850W

Cooling Custom water-cooling loop, featuring the following Thermaltake parts: Pacific W4 ARGB CPU waterblock, Pacific V-RX 5700 Series Plus GPU waterblock, Pacific PR15-DDC pump/res combo, Pacific C360 radiator, Pacific CL360 radiator, Riing Quad 120mm fans (six white, three black), C-PRO 16mm OD fittings in chrome and black, Pacific Black 90 and 45 degree adaptors, Black 90-degree 16mm compression fitting, V-Tubler PETG Tube 16mm OD



their own once the bulkhead connector has been fastened into place.

CPC: How did you make the etchings on the panels?
Andy: They were made using Armour Etch cream, which turned out to be surprisingly easy. The designs were simple enough – the text on the top and side panels required a little research into the font used in the game (Borda), and I just calculated the font size I needed, then I needed the SHD Emblem from the game for the front. I contacted Hamish Bode, the content lead on the game, and he couldn't have been more helpful about getting a copy of it for me. Once I had the designs, I looked around a few places that do custom vinyl stencils and found 4D Model Shop, which cut the vinyls and delivered them in just a couple of days.

To do the etching, I first measured and marked where the stencil would go by placing some masking tape as a guide, with a couple of lines drawn on both the tape and stencil to get it in exactly the right spot. Once the stencil was stuck to the glass, I used a rubber caulk tool to push out any bubbles along the edges. Then I just blobbed on a thick layer of the etching cream with a spatula, making sure it got into all the crevices. After a couple of minutes, I gave it a bit of a dab with a paint brush for good measure, then removed the cream with a wet cloth after five minutes. I then rinsed it in warm water, and it came up really well when it was fully dried. I couldn't believe how quick and easy it was.

CPC: Are you happy with the end result?
Andy: Yes. I'm really happy with how it came out. In all honesty, I never thought I was capable of building anything like this, and the reaction online has been amazing – it was even featured on The Division's 'State of the Game' stream. There are a few little things that got left on the cutting room floor because I ran out of time.

I'd like to make an additional rear I/O cover, because I shifted it 1cm forward there's a gap behind the motherboard, and the black plastic stock one looks a little out of place. The fan cables are also currently bare and rather long. I got some tinned metal braided sleeve to put on them, but when I came to do it, I hadn't slept for three days, and my hands were crippled at that time, so I just had to abandon it and get the build completed. CPC

WIN CORSAIR HYDRO X 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

WORTH £151

The Corsair Hydro X Series XD3 RGB Pump/Reservoir Combo features a high-performance 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

WORTH £70

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose the AM4/LGA1151 or LGA2066 version.

Corsair Hydro X Series XR5 240mm Radiator

WORTH £55

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

SOLD OUT IN MINUTES

James Gorbold gives a sneak peek behind the curtain of the AMD Ryzen 5000-series launch

Product launches from major brands such as AMD, Intel and Nvidia are always intense, with a huge amount of work behind the scenes in logistics, production, marketing and PR. The usual pattern is to see a spike in demand over the course of several weeks following the launch, as customers learn about the new products and build up confidence to buy. There have always been a few early adopters who buy on day one, but even these typically will read a few reviews before buying.

The last few months saw that launch rulebook torn up and thrown out the window. The PC gaming market has seen a surge in demand since the start of the first lockdown earlier this year, with sales of gaming PCs, components and games up by as much as 200 per cent, depending on your source of statistics.

Now, highly desirable products from AMD and Nvidia, with far larger generation-on-generation performance increases than other recent launches, are fuelling demand even further. The launch of the first Nvidia GeForce RTX 30-series cards saw extraordinary interest, with many websites struggling to keep up with demand, and unparalleled sales.

AMD's recent launch of its Ryzen 5000-series processors, based on the new Zen 3 architecture, has once again set new records for sales. Just as we saw with the Nvidia 30-series, the web traffic built up massively in the run-up to the non-disclosure agreement (NDA) lifting, and within minutes, our launch was all sold out and we transitioned to taking pre-orders. While the Zen 3-related web traffic and sales were significantly lower than that of the Nvidia 30-series, launch day sales were still unprecedented for a CPU.

Within the overall huge amount of demand, there are some interesting patterns in the launch that are worth exploring. For instance, despite the increasing competitiveness of Ryzen over the past few generations, the mid-range Ryzen 5 3600X was the best-seller of the 3000-series. However, while its successor, the Ryzen 5 5600X, still sold well, it was the Ryzen 9 5900X that really stole the show and is AMD's new best-seller. There are two possible causes for this change.

Firstly, the Ryzen 9 5900X is a damn good chip. At just over £500, its price sits between the Intel Core i9-10850K and 10900K, but it outperforms both of them, delivering 34 per cent superior performance in multithreaded applications such as video encoding and 3D rendering, and it's equally fast in games, which was traditionally a weak point for Ryzen.

> The Ryzen 9 5900X really stole the show, and is AMD's new best-seller

AMD has now been able to catch the attention of high-end gamers, taking away sales from Intel.

Secondly, while the Ryzen 5 5600X is a highly desirable CPU, it's held back by a lack of affordable motherboards. AMD's strategy of providing backwards compatibility is laudable, but the BIOS revisions that enable support for Ryzen 5000-series CPUs on older X470 and B450 motherboards won't appear until next year.

This means that, for now, the most affordable gaming motherboard you can use with a 5600X is based on the B550 chipset. Unfortunately, due to the higher cost of implementing PCI-E 4, these boards cost around double the price of B450 PCI-E 3 motherboards. As such, when B450 boards do start to support Ryzen 5000-series CPUs, I expect sales of the 5600X to take off like a rocket.

In the meantime, if you pre-ordered a Ryzen 5000-series CPU, or you're just curious about the state of play when it comes to stock, I recommend following our pre-order status page at **custompc.co.uk/ScanStock** CPC

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

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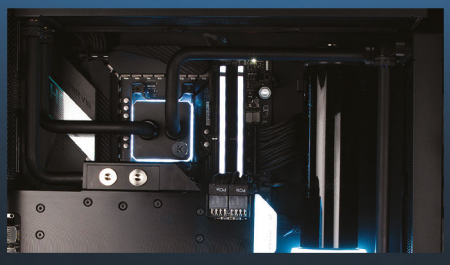

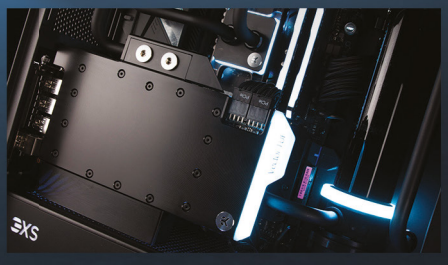

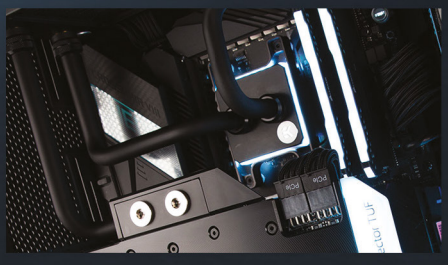

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