

REVIEWED **AMD'S RADEON RX 6600 XT**



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Welcome

Custom PC Issue 218

/ FROM THE EDITOR

Intel's new GPU should worry AMD

Intel dropped a silicon bomb on the PC gaming community in August when it announced its new Arc GPU architecture (see p14). We knew Intel had been working on improving its lacklustre graphics tech, but we'd also seen its x86-based graphics project, Larrabee, crash and burn, and the first demonstrations of its Xe DG1 GPU were hardly awe-inspiring. We just weren't expecting Intel to suddenly announce Alchemist, a proper GPU complete with hardware ray tracing and AI-based super sampling.

It's a situation that should seriously worry AMD. Back in 2006, AMD bought ATI, and focused hard on integrating decent GPUs into its CPUs. The first consumer desktop product, Llano, might have had a poor CPU architecture, but its integrated GPU was way better than what Intel could offer at the time.

It didn't take off massively on the PC at the time, but AMD's ability to build a CPU and GPU into the same die worked a treat with the new consoles. It took a long time to develop though – designing a combined CPU and GPU clearly wasn't easy. Since then, the firm's development of CPUs with integrated graphics has also dropped down the priority list.

Now that AMD has both its Zen 3 CPU and RDNA2 GPU architectures, you would think it's a good time to launch an incredible product that combined both, but instead we have a great 8-core CPU backed by a comparatively feeble Radeon RX Vega 8 GPU. AMD has just about got away with this launch, as the move to eight CPU cores, coupled with short supply of affordable graphics cards, means there's still a market for the Ryzen 7 5700G (see p20). It's still a worthy component in our £625 PC build this month (see p76) for people who don't prioritise gaming, but it could have been so much better.

If Intel really does have decent GPU tech in the works, then it potentially also has the ability to make CPUs with potent gaming graphics abilities in the future. There are rumours that AMD's forthcoming Zen 4 CPUs will have integrated GPUs as standard – let's hope they're good, as AMD now has to watch its back. **GPC**



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ISSUE 218



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.

ISSUE 218 SUBSCRIBERS EDITION



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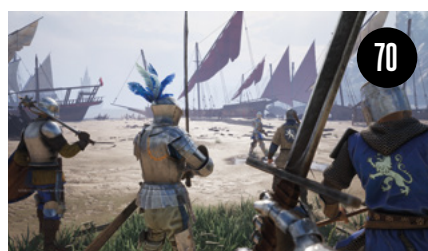
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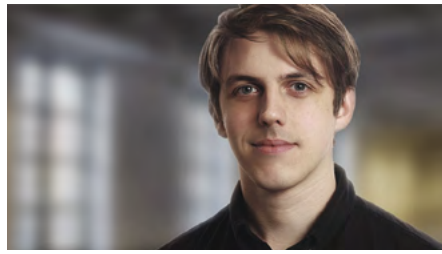
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RICHARD SWINBURNE / VIEW FROM TAIWAN

VALVE AND EPIC SHOULD SELL GRAPHICS CARDS

Subsidising affordable upgrades is in the interest of online game retailers, argues Richard Swinburne

Here's an idea. Instead of Valve and Epic spending hundreds of millions of dollars on vanity projects, such as handheld game systems or giving away free games every week, they should build and sell graphics cards direct through their stores.

The recent AMD Radeon RX 6600 XT release raised the price of mainstream 1080p graphics to around £330 inc VAT in the UK at launch, and that's already gone up to well over £400 at most retailers. The genuinely affordable GPU market is pretty much dead.

This situation leaves a huge number of gamers without any upgrade path. We're over a year into these ridiculous graphics card prices, and recent comments by a few semi-conductor CEOs state that we won't see the other side of the chip shortage until 2023.

How long can mainstream 1080p gamers wait before giving up and changing platform?

Another 18 months of this will see the market shrink and prompt developers to refocus on platforms other than PC. We've been lucky so far, with patrons such as Microsoft, Valve and Epic continuing to push PC gaming as a first-tier platform.

If gamers change where they spend their cash, it will hurt the bottom line of Valve and Epic. Subsidising affordable graphics cards and getting them in the hands of gamers in need would help desperate folks and build some community love.

Valve recently went to AMD to build a semi-custom chip for its Steam Deck, so AMD is clearly willing to entertain even moderately low-volume custom design. Poking AMD to license the design for a Radeon RX 570 and RX 590 shouldn't be out of the question either.

How long can 1080p gamers wait before changing platform?

Why older Polaris GPUs and not the latest RDNA2 ones? Well, it's unlikely AMD will hurt its long-term partnerships with Sapphire, Asus, MSI and so on by letting a new customer undercut them. Plus, of course, AMD is currently enjoying great margins for its chips, publicly stating in its last investor relations announcement that it will focus on maintaining that situation, which means no discounts.

Even then, TSMC has no spare capacity anyway. Picking up an older Polaris GPU means going to GlobalFoundries and using its 12nm process, which should only take around half the time it takes TSMC to produce a 7nm chip.

None of the most popular games on Steam require extreme GPU performance. The likes of DOTA 2, Counter-Strike, Destiny 2, PUBG Battlegrounds, Fall Guys, Rainbow 6, GTA V, Civ VI or even Apex Legends can be played on older-generation cards fine. Also, while, the likes of triple-A games, such as Doom Eternal and Assassin's Creed Valhalla, look spectacular on the latest gear, they can still be enjoyed on older hardware without taking away from the experience too much.

Rereleasing Radeon RX 570 and 590 cards would still be viable and affordable if they could retail for, say, £129 and £199 inc VAT respectively. These GPUs would make a world of difference over integrated graphics, while still being much cheaper than the latest graphics cards on the market today.

These cards don't have to be built with flamboyant materials that manufacturers typically love to splash on their designs. They just need a simple, cost-effective design that's quiet and reliable. That will surely benefit far more gamers than a stream of mediocre free games or a handheld console. **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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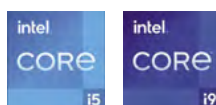
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TRACY KING / SCEPTICAL ANALYSIS

CONTENT WARNINGS

Following the online backlash against Boyfriend Dungeon, Tracy King asks whether some content warnings are genuinely useful

One of the hardest aspects of critical thinking is reconciling 'but that doesn't work, here is the evidence' with the emotional impact of taking away hope from people who might be vulnerable. When I debunk untrue health claims, I'm taking something away from people who are ill. This rarely comes up in my tech and video game writing, as the stuff I'm critical about generally isn't being sold to vulnerable groups, but this month I find myself face to face with the dilemma of Boyfriend Dungeon.

The game is a PEGI 12 novelty dungeon crawler in which the weapons are also sexy people (and one cat) that you can date. The relationships progress along with the plot, and one of the characters becomes a stalker and therefore the baddie. It's this content that prompted the developer to add a content warning at the beginning of the game, saying: 'This game may include references to unwanted advances, stalking, and other forms of emotional manipulation. Play with care.'

This note was added after playtesters felt uncomfortable with how the plot unfolded, and has sparked controversy and debate that a few years ago would have been about games pandering by including any warnings at all, but instead is about accusations that the note doesn't go far enough. The developers have received abuse as a result, from the very people they were trying to help.

In response, developer Kitfox Games has said it will update the warning with 'a more accurate' one. I have enormous sympathy for anyone who has experienced trauma and then found themselves invested in a plot that then revives that trauma. It's happened to me. I'm a huge fan of horror films, but sometimes I check the website doesthedogdie.com to quickly

check if certain types of scenes may be in a film, because I'm not always in the mood for revisiting my own demons.

However, I'm also aware there's an individualistic element to emotional needs that would make any attempt to add a content warning to a horror film or game absurd. We're all upset by different things, at different times, in different ways. Horrible themes go with the horror genre, it's in the name.

But Boyfriend Dungeon isn't a horror game, or rated 18. It's rated 12, which means its content isn't mature enough to bother a pre-teen, but it's somehow also mature enough to distress those who have experienced abusive relationships, an inconsistency I find odd.

Horrible themes go
with the horror genre,
it's in the name

It's not surprising that those with relationship trauma were upset. It's because the game is billed as a cute rom-com that the stalking plot is so jarring. I played it to confirm my suspicion that the problem here is mixed messages. If it was called Bad Boyfriend Dungeon, or had an older age rating, that

would do the content warning's job without having to spoil the plot or pin down specific wording to individual traumas. I like that the developers are being thoughtful about impact, but I don't think a content warning after purchase is better than other types of signposting, such as marketing.

It's difficult to say this about something designed to help vulnerable people, but it needs saying because this issue isn't going away. A major 2020 study in Clinical Psychological Science even found that, contrary to helping trauma survivors process difficult content, content warnings actually made it harder for them to do so and might even reinforce the trauma. The most important criticism of content warnings is this: based on available evidence, they don't work. **GPC**

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@ikingdot](https://twitter.com/ikingdot)

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Letters

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Days Gone divides opinion

I just read Rick Lane's review of Days Gone and I think the 60 per cent score is a little wrong. For me it's more of a 75 per cent, and it's probably one of my best games of the year so far. Gamers on one of the forums I frequent also agree it's a pretty entertaining game.

The review in your magazine basically covers what I call Act 1, which is a slow burner. However, there are three parts to Days Gone and once you get to what I call Act 2 – with the biker cult – it steps up another level. The final act involves infiltrating the Mad Colonel's military organisation to find and rescue the main character's wife. This culminates in a massive battle, which I haven't seen in a single-player game for a while and is an excellent finish if you let the story pull you into it.

I also think the actual story is better than the review says. You get to learn a lot about the NPCs and the character development is good. You also get to see some pre-apocalypse scenes mainly from the perspective of your character. There's no mention of the Nero 'story within a story' that culminates in the hidden ending, which you discover after

When's the next issue out?

Custom PC

Issue 219

On sale on Thursday, 7 October



the main battle that leads the story into a possible sequel. Plus there is a petition online with something like 200,000+ signatures asking for a sequel.

Also, there are different types of Freakers you meet – the Screecher, the Juggernaut and the fast one (I can't remember the name) – each have their own introductory mini-mission. If you get three of four Juggernauts in a location, they sometimes attack each other, and sometimes they attack other Freakers – they are really hard to defeat.

Later in the game, you get perks and access to Napalm, which makes taking out hordes even easier, and you get better stamina too. You get access to better traps, which you can lay in the path of a horde then lure them onto it. Plus the review didn't mention the massive 600+ horde mission in the Saw Mill (after I did that one, my final tally of kills was 662!) you have to defeat. There was no mention of the Criers either – the zombie-type birds that attack you and you have to take out their nests.

I know space is at a premium with reviews, but it just seemed to concentrate on the beginning, which is the poorest part of the game, with no mention of any of the above, which really should be included as the second and third parts do affect how you approach the game.

I'm not saying it's perfect, and parts can be repetitive, but after all, it is a game from 2018 and this is just a copy of the console version. Even the NPCs that you rescue get on your nerves, as they use the same miserable character model, but rescuing them adds to the various camps' respect of your character, and helps to open up extra services at the camps you frequent in order to improve your character. Basically, I just think the review doesn't reflect the whole of the game.

JULIAN VICARI

Rick: It's true that Days Gone improves in its second half, but you're looking at around 20 hours of play before it gets to that point. I'm not sure a game can justify calling itself 'slow burn' for that long, certainly not when I can boot up The Witcher 3 and be playing an incredible game from the first instant, particularly when it comes to elements such as pacing and character development.

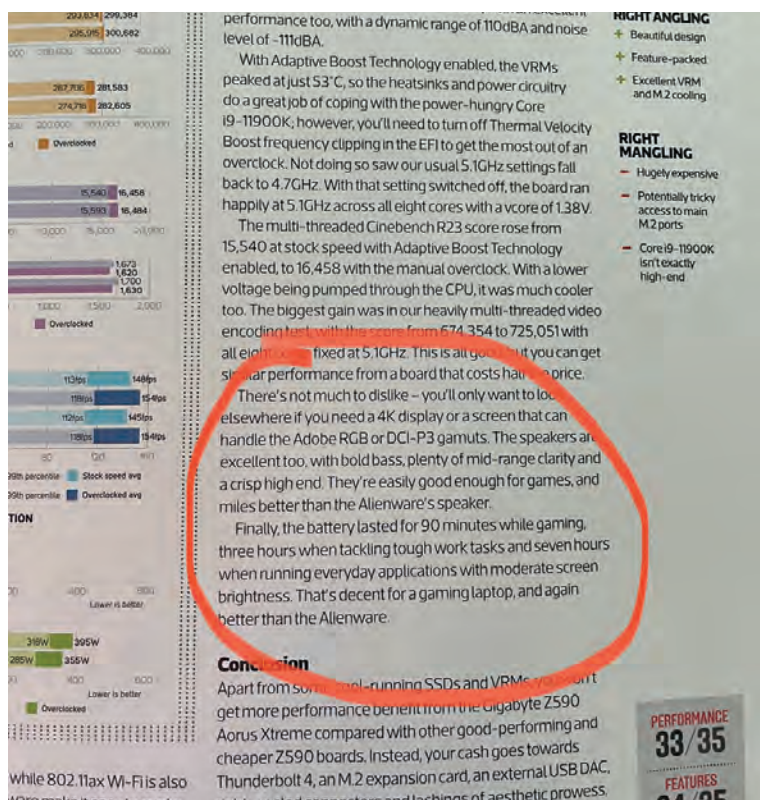
Ultimately, though, we're talking about a 15 per cent difference of opinion, which isn't exactly massive. We both agree that it's an above-average experience, and I'm glad you found more to enjoy in it than I did. I merely thought the destination wasn't worth quite such a long journey.

Impressive speakers for a laptop

Do you remember when **Custom PC** ran competitions to identify distorted photos from the magazine? Well I think I've spotted a couple of paragraphs that have accidentally been squeezed into a different review. In Issue 217, on p23, imagine my confusion when reading about

Days Gone is above average, but by how much is down to personal taste





the quality of speakers and battery life of the new amazing Gigabyte Z590 Aorus Xtreme motherboard.

Wow, I thought, this motherboard really does have everything! And then imagine my disappointment when I saw the same text appear on p29 in an Asus gaming laptop review. I'm not being critical, just wanted you to know. Is there a prize?

JOHN MULCAHY



The Gigabyte Z590 Aorus Xtreme might be feature-packed, but it doesn't come equipped with its own laptop battery and speakers

On p23 of the 'October' issue (the Z590 Aorus Xtreme review), it seems like a few paragraphs of the article are missing/have been muddled up with a review of something else. Needless to say, I was a little surprised to read that this motherboard would not work with 4K displays and has a battery that lasts 90 minutes while gaming although, given the price of the board, perhaps those features would be welcome! Any idea what's going on?

WILLS BITHREY

Ben: Thanks to the many, many people who emailed and tweeted us about this clanger in our last issue. It looks as though our design team laid out the Gigabyte motherboard review using the Asus laptop review as a template, and whoever proofed the page didn't spot that two paragraphs from the latter were still lurking in the review.

Thankfully, they didn't actually replace any of the words from the Gigabyte review, but just added a bit of confusion in the performance section. Appropriately, they're also close to the

words 'right mangling' in the right-hand column. The Gigabyte Z590 Aorus Xtreme might be feature-packed, but not quite that much!

Keeping a low profile

I find your magazines somewhat interesting, although you have a strong emphasis on full-sized chunky desktop cases. Perhaps you could dedicate an issue to all things low-profile, such as desktop cases, graphics cards and CPU coolers? Where can I go for more info about these kinds of hardware? What about a particularly good low-profile PC build?

COLIN OMARA

Ben: We do indeed tend to focus on ATX desktop hardware, as that's still (by far) the most popular format for cases and motherboards in terms of both sales and interest.

Not all of us love ATX hardware though. Our modding editor Antony Leather is a big advocate of mini-ITX gear, and he'll be writing a big feature about mini PC gear in our next issue.

It's been a while since we looked at building a low-profile system, though, as their popularity really dropped when media PCs started to decline and Microsoft abandoned Windows Media Center. For the record, I still have a media PC in my hi-fi rack, but I know I'm in the minority!

I'd be interested in other readers' opinions here – are you interested in building a low-profile desktop PC, or have you already built one? If so, what do you use it for? We're game for taking a look at low-profile hardware in the magazine if enough people are interested in it.

Low-profile graphics cards, such as this MSI GeForce GTX 1650 model, are ideal for squeezing into slimline desktop cases



Incoming

FRACTAL UNLEASHES TORRENT

Fractal Design has released a new case designed to maximise airflow. The Torrent has an open-grille design at the front, backed by two large 180mm fans. The case is also equipped with three more 140mm fans mounted in the base by default, and Fractal says you could even replace these with a second pair of 180mm fans.

Other features include a GPU support bracket, an open interior and a pre-installed Nexus 9P Slim PWM fan hub. Six versions are available, starting from £147 inc VAT from [scan.co.uk](https://www.scan.co.uk) for a black version with no window or lighting, going up to £156 for various colour options with tempered glass panels and topping out at £190 if you want RGB lighting.



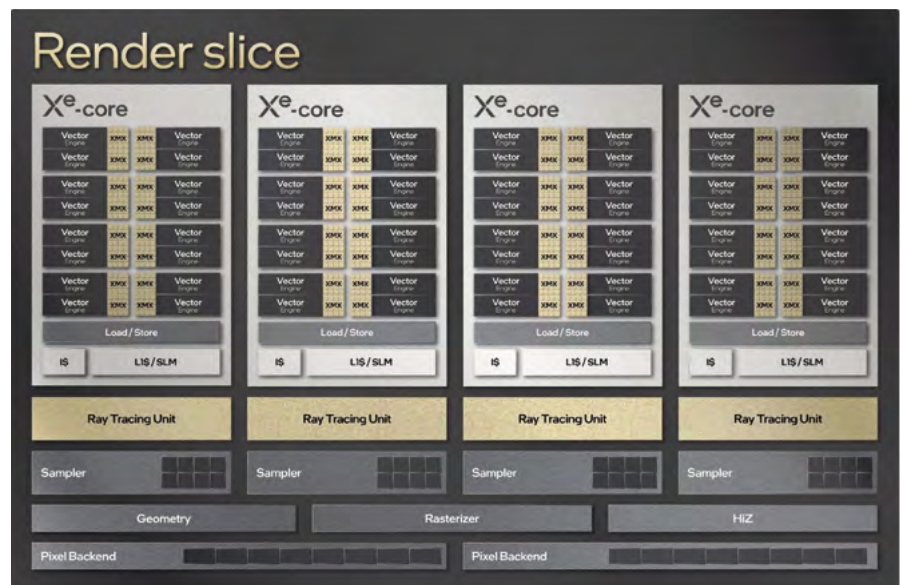
INTEL ANNOUNCES SURPRISE GAMING GPU

Intel has just astounded the PC hardware market by announcing plans to produce a proper gaming GPU in the first quarter of 2022. Codenamed Alchemist (formerly known as Xe DG2), the new GPU not only has full hardware ray tracing, but also supports Intel's own AI-based super-sampling technique to improve performance.

The Xe cores on which Alchemist is based each contain 16 Vector Engines and 16 Matrix Engines (which Intel calls XMU units). The full workings of these parts haven't been revealed yet, but Intel has unveiled how they will be incorporated into the GPU design. Alchemist will be divided up into what Intel calls Render Slices, each of which contains four Xe cores, along with four ray-tracing units that support both Vulkan and DirectX.

'Render slices also add samplers, pixel backends, and geometry and rasterisation pipelines that are all designed for DirectX 12 Ultimate,' explained Roger Chandler, Intel's vice president and general manager of Client Graphics Products and Solutions. Up to eight Render Slices can be chained together in a single Alchemist chip, giving you 32 Xe cores (512 Matrix Engines and 512 Vector Engines) and 32 ray-tracing units.

In addition to ray-tracing support, Intel says Alchemist will also support Variable Rate Shading (VRS) 2, as well as mesh shading.



The company also revealed that it has its own AI-based super-sampling tech in the works called XeSS, which aims to increase frame rates in demanding titles.

'XeSS touches the sweet spot by using deep learning to synthesise frames that are very close to the quality of native high-resolution rendering,' explained Chandler. 'It reconstructs subpixel details based on information from not only neighbouring pixels, but also motion-compensated previous frames that add temporal awareness.'

'This process runs on a neural network trained to deliver high performance and

fidelity, and it's accelerated by our XMU hardware.' Not only that, but a version of XeSS will also be able to run on competitors' GPUs. 'We want the benefits of XeSS to be available to a broad audience,' says Chandler, 'so we developed an additional version based on the DP4a instruction, which is supported by competing GPUs and Intel Xe LP-based integrated and discrete graphics.'

Intel has demonstrated Alchemist running on several games in an online video, including The Riftbreaker, Metro Exodus and Psychonauts 2, among others. For more information, see [intel.com/arc](https://www.intel.com/arc)



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Reviews

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Hats off to AMD for achieving the seemingly

impossible task of actually making enough GPUs to sate demand in 2021. Weeks after the launch of the Radeon RX 6600 XT, the cards are still for sale at retailers for under £500. It's a low bar, but it's one that's rarely passed these days.

Part of the reason is undoubtedly that the GPU is already overpriced by previous standards. It was only last year that the Radeon RX 5600 XT provided award-winning 1080p gaming performance for £255 inc VAT, with a 192-bit-wide memory interface and 2,304 stream processors.

Fast forward to 2021 and AMD's latest 1080p-focused GPU, the Radeon RX 6600 XT, has 2,048 stream processors and a 128-bit wide memory interface with a recommended retail price of \$379 (around £334 inc VAT). There were even some cards priced at that level on launch day, but we're now looking at around £400 inc VAT for a card.

We can keep complaining about the pricing of today's cards for at least another year by the looks of it, though, and no amount of griping is going to magic up more GPUs from the mining stations of Kessel. The Radeon RX 6600 XT may well be overpriced for what it is, but that's what we have to pay when there's no cheaper competition and demand is greater than supply.

At this price, it goes up against Nvidia's GeForce RTX 3060 (with the RTX 3060 Ti being practically non-existent). If you want a new 1080p gaming GPU, and you have £400 to spend, the question is whether you should buy the Radeon RX 6600 XT or the RTX 3060, and that's the question we'll be answering here.

Inside Navi 23

Rather than using a cut-down version of an existing GPU, the Radeon RX 6600 XT is based on AMD's brand-new Navi 23 chip. It has a comparatively small die area of just 237mm² and contains 11.06 billion transistors. As a point of comparison, the Navi 22 chip on which the Radeon RX 6700 XT is based measures 336mm² and contains 17.2 billion transistors.

Inside that die you'll find 32 compute units based on AMD's latest RDNA2 architecture, with 32 corresponding Ray Accelerator processors for ray tracing. The spec gives you a total of 2,048 stream processors, along with 8GB of GDDR6 memory attached to a 128-bit wide interface. With a memory clock of 2GHz (16GHz effective), that gives you a memory bandwidth of 256GB/sec.

Comparatively, the RTX 3060 has 12GB of memory attached to a wider 192-bit interface, giving you a total memory bandwidth of 360GB/sec with its 15GHz (effective) memory. On paper, the Nvidia GPU has the upper hand here, but AMD hopes to bolster the Radeon RX 6600 XT's performance with 32MB of Infinity Cache. Again, though, that's only a third of the 96MB Infinity Cache on the Radeon RX 6700 XT.

There's also a potential performance issue from the PCI-E interface. It's PCI-E 4, but it only uses eight lanes. That's not an issue if you have a PCI-E 4 motherboard and CPU combination, as eight PCI-E lanes offer more than enough bandwidth for this level of GPU power.

However, that's not true if you're still using a PCI-E 3 motherboard and/or CPU, such as an Intel Comet Lake CPU or an AMD X470 motherboard. With these setups, you only get eight PCI-E 3 lanes, which starts to eat into this card's

SPEC

Graphics processor

AMD Radeon RX 6600 XT, 1968MHz base clock, 2359MHz game clock, 2589MHz max boost clock

Pipeline

2,048 stream processors, 64 ROPS

Ray Accelerators

32

Memory

8GB GDDR6, 2GHz (16GHz effective)

Infinity Cache

32MB

Memory interface

128-bit

Card interface

8x PCI-E 4

Memory bandwidth

256GB/sec

Power connectors

1x 8-pin

Number of slots

2

bandwidth requirements when it gets going, compared with having the full 16 PCI-E 3 lanes.

The final key part of the spec equation is the clock speed. At stock frequencies, the Radeon RX 6600 XT has a 2359MHz game clock and a 2589MHz boost clock, but there are plenty of third-party cards that push the frequency higher.

Our MSI review card

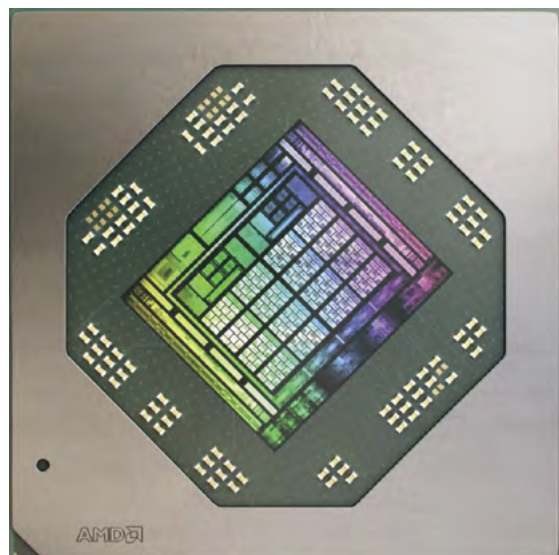
One such card is the MSI Gaming X model that we were sent for review. It bumps up the game clock to 2428MHz, resulting in a 1-2fps increase over the scores from the stock spec that we've reviewed. This pushed the average frame rate in Metro Exodus from 78fps to 80fps at 1,920 x 1,080 and from 59fps to 60fps at 2,560 x 1,440.

There's a decent metal backplate on the rear of the PCB, and a rigid metal anti-bending strap built into the cooler that prevents the card from drooping. There's even RGB lighting under the MSI logo on the top edge, but it's a bit feeble compared with the bright lighting displays we see these days.

Meanwhile, the card's Twin Frozr 8 cooler features a pair of MSI's Torx Fan 4 fans, which binds pairs of blades together with an outer ring to more efficiently exhaust air. The shroud for the cooler looks a bit dated with its 'gamer' style of angles, but the card was exceptionally quiet during testing, even during demanding game tests. It doesn't have the class and panache of Sapphire's Nitro X cards, for example, but it's still a reasonable-looking card with an effective, quiet cooler.

Performance

The good news for the Radeon RX 6600 XT is that it's generally quicker than the GeForce RTX 3060 at its target resolution of 1,920 x 1,080. In Metro Exodus at Ultra settings, its 99th percentile result of 44fps is well in front of the 35fps of the RTX 3060, and its average of 78fps is 14fps faster too. Even adding ray tracing on the High setting didn't give the RTX 3060 an advantage, with the Radeon achieving the same average result, and adding 3fps to the 99th percentile result.



The news is even better in Assassin's Creed Valhalla, which is always a strong title for AMD's latest GPUs. It averaged a massive 79fps here, with a 58fps 99th percentile result. What's more, if your motherboard and CPU support Resizable BAR, you can take advantage of AMD's Smart Access Memory tech, which boosted these figures to 64fps and 88fps respectively. Comparatively, the RTX 3060 could only average 58fps, which increased to 62fps with Resizable BAR enabled.

The gap was much smaller in Doom Eternal, where the Radeon RX 6600 XT was again ahead of the RTX 3060. Even Cyberpunk 2077, which is usually where Nvidia gains the upper hand, was handled fine by the Radeon, with its 59fps average being just in front of the RTX 3060's 58fps, although the latter's 99th percentile result was 2fps higher than that of the Radeon.

Where the GeForce fights back is when you add ray tracing to the mix in this game. With Medium ray tracing enabled, the GeForce averaged 35fps while the Radeon averaged just 18fps. Neither result is great, to be fair, but the GeForce is substantially quicker. It also has the benefit of DLSS support to improve performance even further, although DLSS tends to look quite blurry at 1,920 x 1,080.

Stepping down to PCI-E 3 does indeed make a slight difference to performance on the Radeon RX 6600 XT as well, as we tested it with PCI-E 3 mode forced for the top slot of our motherboard. In Metro Exodus, the average dropped by 3fps to 75fps, and in Valhalla it dropped by 2fps to 77fps. Neither result is disastrous, but running this card on a PCI-E 3 setup is the equivalent of underclocking it a little bit.

The restrictive memory setup also means the Radeon's performance starts to drop off once you get beyond 1,920 x 1,080. Move up to 2,560 x 1,440, and the GeForce RTX 3060 moves in front of it in Cyberpunk 2077 and Doom Eternal. Go up to 4K, and the difference is starker, but to be fair, neither of these GPUs is designed for 4K gaming. At the target resolution of 1,920 x 1,080, the Radeon is generally the better choice.

Conclusion

If you have some money in the bank for a new 1080p gaming GPU, the Radeon RX 6600 XT is a pretty good contender in these silly times. It's generally quicker than the GeForce RTX 3060 at 1080p and it's easier to find in stock as well. The Nvidia GPU is better at ray tracing in Cyberpunk 2077, but it's still not smoothly playable. The problem is that, even though the Radeon RX 6600 XT is readily available, it was still too expensive at launch and it's even pricier now.

Just 18 months ago, £400 would buy you a solid 2,560 x 1,440 gaming card – a 1080p card such as the Radeon RX 6600 XT shouldn't cost more than £250. These are the prices we have to pay at the moment, though, and if you do have £400 to spend on a 1080p gaming GPU, this is the one to get.

BEN HARDWIDGE

.....

VERDICT

It's fast at 1,920 x 1,080, it's in stock and it generally beats the RTX 3060, but it's still too expensive for what it is.

2019 PRICES

- + Actual real stock available
- + Generally beats RTX 3060
- + Decent 1080p frame rates

2021 PRICES

- Only eight PCI-E lanes
- Expensive for a 1080p card
- Poor ray tracing in Cyberpunk 2077

PERFORMANCE
31/40

FEATURES
17/20

VALUE
22/20

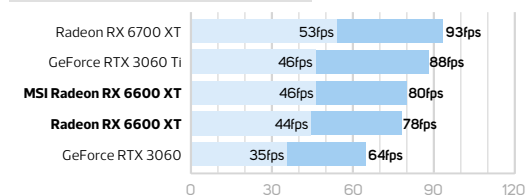
OVERALL SCORE

70%

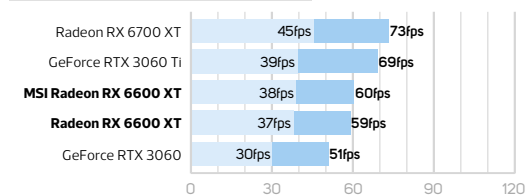
BENCHMARK RESULTS

METRO EXODUS

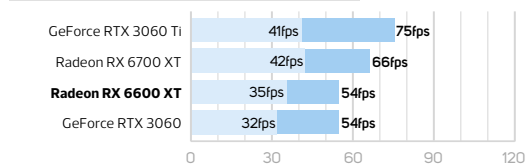
1,920 x 1,080, Ultra settings, HairWorks off, PhysX off



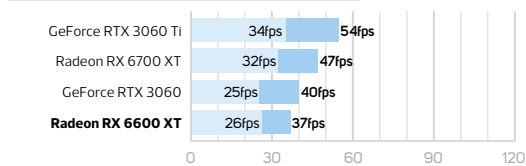
2,560 x 1,440, Ultra settings, HairWorks off, PhysX off



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

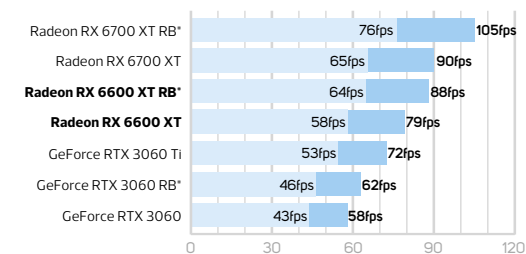


2,560 x 1,440, Ultra settings, High RT, HairWorks off, PhysX off

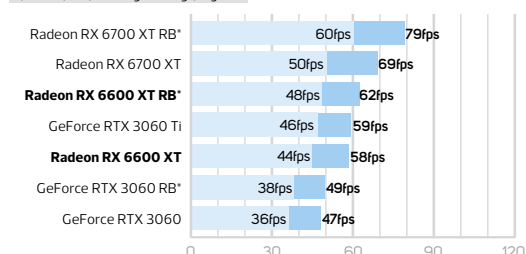


ASSASSIN'S CREED VALHALLA

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



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

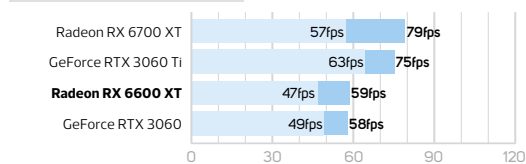


99th percentile Average

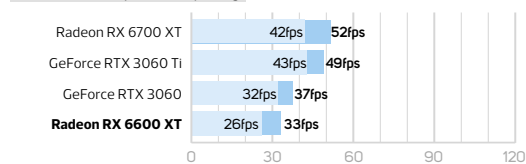
*RB = Resizable BAR

CYBERPUNK 2077

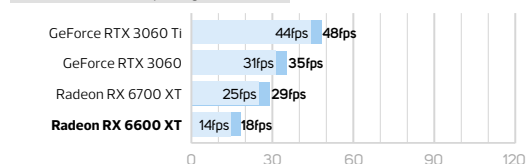
1,920 x 1,080, Ultra preset, no ray tracing



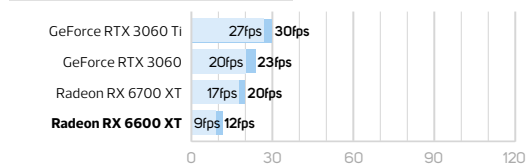
2,560 x 1,440, Ultra preset, no ray tracing



1,920 x 1,080, Medium ray tracing, DLSS disabled

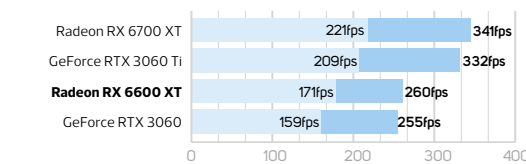


2,560 x 1,440, Medium ray tracing, DLSS disabled

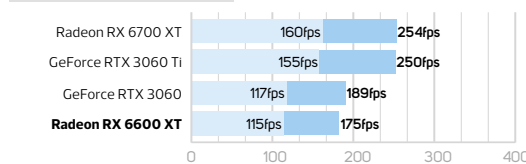


DOOM ETERNAL

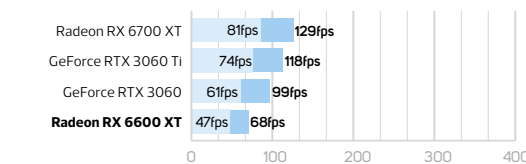
1,920 x 1,080, Ultra Nightmare settings



2,560 x 1,440, Ultra Nightmare settings



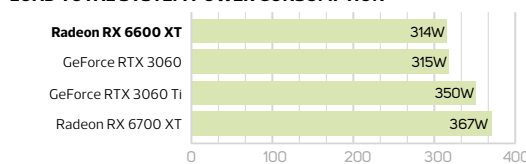
3,840 x 2,160, Ultra Nightmare settings



99th percentile Average

*RB = Resizable BAR

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Lower is better



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RDNA2

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- + Excellent multi-threaded performance
- + Reasonable integrated GPU

VEGA

- No PCI-E 4 support
- Aging Vega GPU holds back gaming
- Cheaper CPUs faster in some tests

SPEC

Base frequency
3.8GHz

Max boost frequency
4.6GHz

Core
Zen 3

GPU core
Radeon RX Vega 8

Manufacturing process
7nm

Number of cores
8 x physical (16 threads)

Cache
16MB L3 cache, 4MB L2 cache

Memory controller
Dual-channel DDR4, up to 3200MHz

Packaging
Socket AM4

Thermal design power (TDP)
65W

Features

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

Ever since AMD introduced its first APUs, we've keenly awaited each release as their integrated GPUs usually offer acceptable frame rates at 1080p and below, saving a lot of cash compared with buying a separate graphics card. They've also previously left you with plenty of change from £200, but at £329, the new Ryzen 7 5700G is significantly more expensive.

One reason is that it has eight cores (16 threads) instead of four, although it's not quite a performance match for the Ryzen 7 5800X. While both chips have eight cores, the latter has double the L3 cache at 32MB, and adds 100MHz to the peak boost speed. We observed an all-core boost clock between 4.2GHz and 4.35GHz on the 5700G, which is also behind the 4.5GHz on the Ryzen 7 5800X at stock speed.

This is mainly because the Ryzen 7 5700G has a TDP of 65W compared to 105W for the 5800X, so it has a

lower power limit even before you consider the integrated GPU. It has the same 4MB L2 cache and the same 7nm Zen 3 architecture, but AMD has reined in the spec to reduce its cooling requirements. One benefit, though, is that you comfortably cool it using the included Wraith Stealth cooler. At stock speed, the temperature of the CPU portion of the Ryzen 7 5700G didn't top 70°C with this cooler, so it's more than up to the task.

The less welcome news is that AMD hasn't really upgraded the Radeon RX Vega GPU over the Ryzen 5 3400G. The 5700G has a beefier version of the GPU core, which is now fabricated on a 7nm process, rather than 12nm, but it doesn't use AMD's latest RDNA architecture. The Ryzen 7 5700G doesn't support PCI-E 4 either, so you may as well use it with an older PCI-E 3 motherboard chipset.

Performance

Our image editing test revealed a distinct lack of lightly threaded grunt, with the Ryzen 7 5700G lagging behind both the

5600X and 5800X. However, its eight cores helped in our heavily multi-threaded Handbrake test, where it easily sees off all the 6-core chips, even if it can't keep up with the Core i7-11700K and Ryzen 7 5800X.

Overall, though, the RealBench tests revealed a CPU that isn't much faster than the Ryzen 5 5600X and is a fair way off the Ryzen 7 5800X. Cinebench was similar. The Ryzen 7 5700G easily outpaced the 6-core CPUs in the multi-threaded test, but fell behind in the single-threaded test.

The comparatively lacking single-threaded performance has an impact in games too. In Far Cry New Dawn, the 5700G proved to be noticeably slower than most other CPUs at 1080p when using a discrete RTX 3070. In fact, it was only a little quicker than the Ryzen 5 3600.

Switching to the integrated graphics resulted in an impressive 99th percentile frame rate of 40fps at stock speed in Doom Eternal at 1080p with High settings. That's great for an integrated GPU, although we had to drop Dirt 5 to Low settings for the frame rate to stay above 25fps. This is still a comparatively strong integrated GPU, but it's a real shame it doesn't use AMD's latest RDNA architecture.

Meanwhile, overclocking saw us hit a maximum of 4.5GHz across all cores with a 1.275 vcore, which is lower than the peak boost frequency. Instead, we decided to use Precision Boost Overdrive on the CPU and GPU, which increased the system score from 244,400 to 251,418, and also saw the minimum 99th percentile frame rate rise from 40fps to 45fps in Doom Eternal, although the load power consumption rose from 112W to 187W.

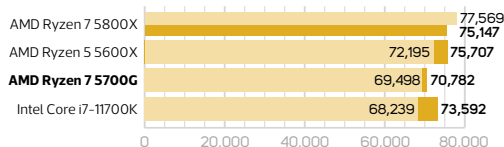
Conclusion

It's a shame AMD hasn't moved to its latest GPU architecture with the Ryzen 7 5700G, as it might have allowed for higher settings to be used at 1080p in more demanding titles.

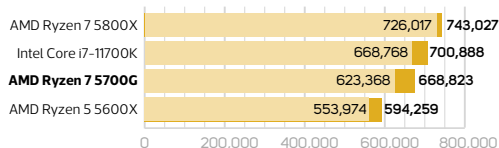


BENCHMARK RESULTS

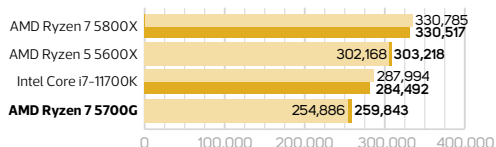
GIMP IMAGE EDITING



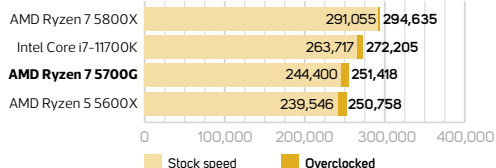
HANDBRAKE H.264 VIDEO ENCODING



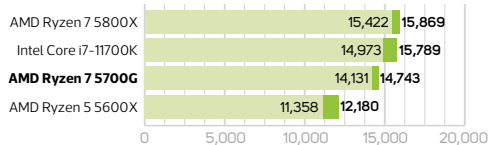
HEAVY MULTI-TASKING



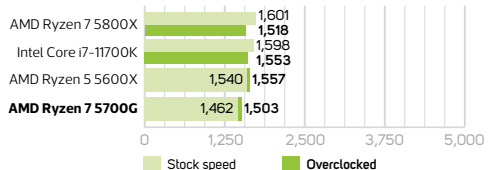
SYSTEM SCORE



CINEBENCH R23 MULTI-THREADED

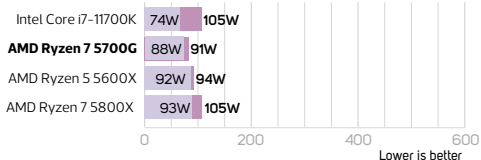


CINEBENCH R23 SINGLE-THREADED

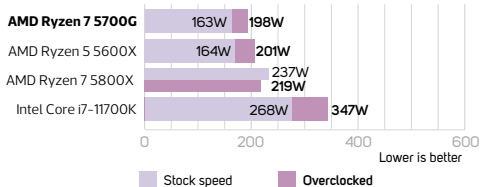


TOTAL SYSTEM POWER CONSUMPTION

Idle

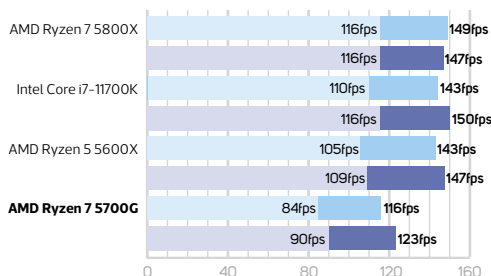


Load



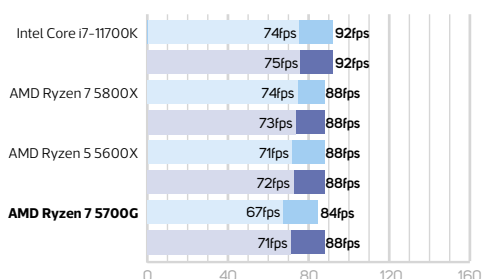
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings



WATCH DOGS: LEGION

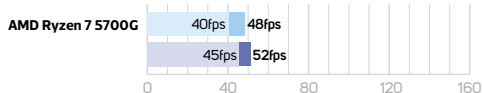
1,920 x 1,080, Ultra settings, DX12



INTEGRATED GRAPHICS

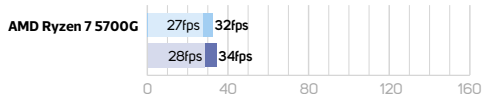
DOOM ETERNAL

1,920 x 1,080, high settings



DIRT 5

1,920 x 1,080, Low settings, DX12



Stock speed 99th percentile Stock speed avg
Overclocked 99th percentile Stock speed avg

Playing DIRT 5 at 1080p with playable frame rates is no mean feat, but we had to turn off most of the eye candy in this relatively easy-to-run game.

We have few complaints with the Zen 3 part of the CPU, which solves the old issue of mediocre CPU performance in AMD's APUs. However, it's swung so far in this direction that the GPU is now noticeably lacking. That said, AMD has no real competition here, and if you want an affordable 8-core CPU for content creation, along with a bit of gaming power, but you can't afford a discrete GPU, the AMD Ryzen 7 5700G offers unbeatable performance as a whole.

ANTONY LEATHER

VERDICT

It's not going to beat a GTX 1050 Ti in games, but this is still AMD's most powerful APU ever.

PERFORMANCE

34/50

FEATURES

15/15

VALUE

32/35

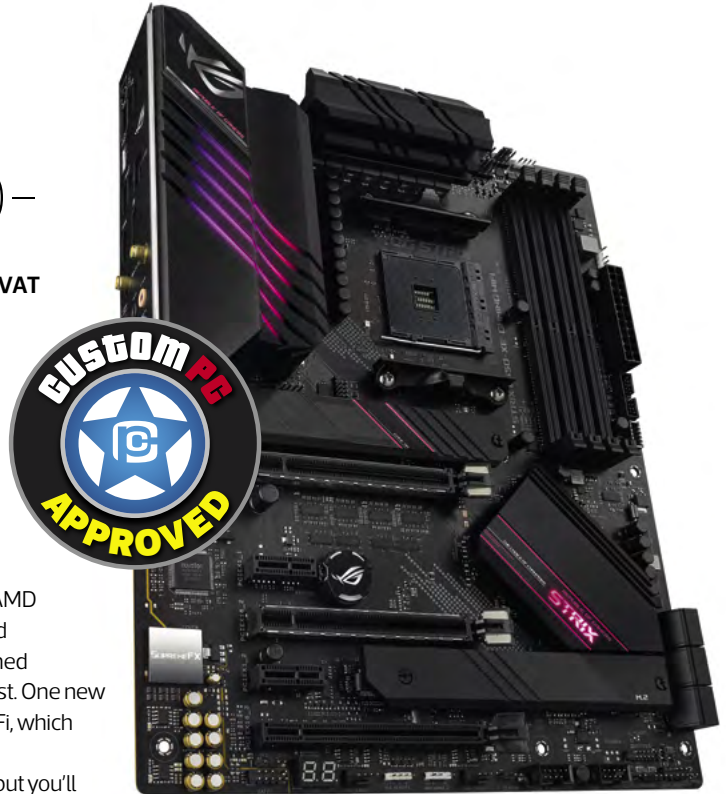
OVERALL SCORE

81%

ATX B550 MOTHERBOARD

ASUS ROG STRIX B550-XE GAMING WIFI / £210 inc VAT

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We haven't seen any new chipsets from AMD for some time, but that hasn't prevented manufacturers from offering up refreshed motherboards to generate a bit of upgrade interest. One new example is Asus' ROG Strix B550-XE Gaming WiFi, which comes in at £210 inc VAT.

You might think that's pricey for a B550 board, but you'll be lucky to get change from £200 for premium models

based on this chipset. You still get most of the benefits of the X570 chipset too, with PCI-E 4 support, but also features such as USB Type-C ports and headers, plus 2.5 Gigabit Ethernet. The ROG Strix B550-XE Gaming WiFi also comes with quite a few features we're only used to seeing on more expensive boards.

For instance, there's a 4-slot PCI-E 4 expansion card, bringing the total number of M.2 slots to six, five of which are PCI-E 4-compatible. The card sports a massive fan-assisted heatsink that kept our PCI-E 4 SSD below 50°C under extended loads.

You can put multiple SSDs on the board, which could increase the temperature if the fan is switched off, but it doesn't have an impact with just one SSD on it. The SSD's speed hit respective read and write speeds of 5,000MB/sec and 4,269MB/sec, which are right on the money.

The two M.2 ports on the board itself are both equipped with heatsinks, but only the top one is PCI-E 4-compatible, while

you get six SATA 6Gbps ports as well, allowing an extensive storage setup.

The board also has potent cooling for the 14+2 phase VRMs, with large, heatpipe-equipped heatsinks and a small cooling fan. This can be fully controlled in the EFI, when you can switch it off entirely or run it at a low speed. We found any speed above 60 per cent was audible, but it's also linked to the VRM temperature rather than CPU temperature, so this fan should only spin up when needed. By default, it started spinning at 60°C, but with it set to a constant low speed our VRMs didn't top 52°C under load, which is remarkably low.

The B550-XE doesn't quite have the full complement of overclocking and testing tools, but there is an LED POST CODE display and USB BIOS FlashBack, although the latter isn't much use now, use seeing as there probably won't be any more AMD Socket AM4 CPUs.

There are six 4-pin fan headers, which is the bare minimum we'd consider for a board costing over £200, but there is a thermal probe header, which you can use to control your radiator fans based on coolant temperature if you're using water cooling. There are also just four Type-A USB ports on the I/O panel too, and only two of them are faster than USB 2. That's a little below par for some people, although USB hubs are relatively cheap if you need more.

SPEC

Chipset

AMD B550

CPU socket

AMD Socket AM4 (Zen 2, Zen 3)

Memory support

4 slots: max 128GB DDR4 (up to 4866MHz)

Expansion slots

Two 16x PCI-E 4, one 16x PCI-E 3, two 1x PCI-E 3

Sound

8-channel Realtek ALC1220

Networking

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

Cooling

Six 4-pin fan headers, VRM heatsink, VRM fan

Ports

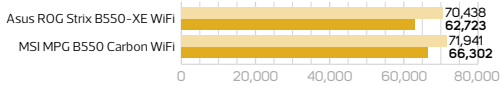
6x SATA 6Gbps 5x M.2 PCI-E 4, 1x M.2 PCI-E 3, 2x USB 3.1, 1x USB 3.1 Type-C, 4x USB 2, 3x surround audio out jacks, 1x USB Type-C audio

Dimensions (mm)

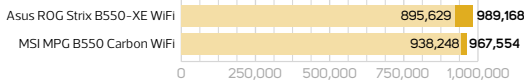
305 x 244

BENCHMARK RESULTS

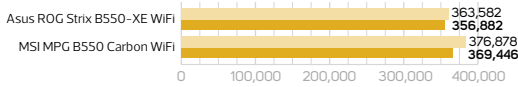
GIMP IMAGE EDITING



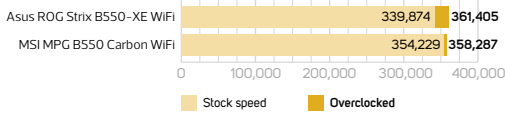
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

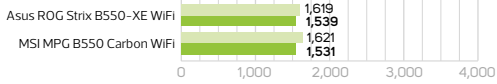


SYSTEM SCORE

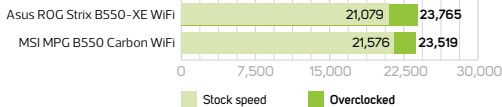


CINEBENCH R23

Single-threaded

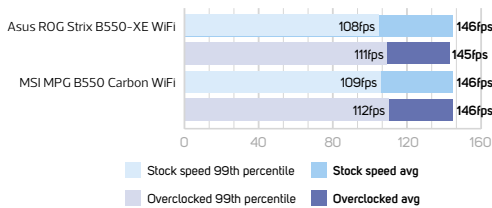


Multi-threaded



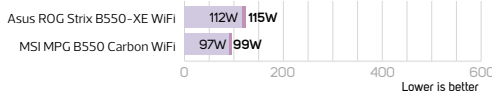
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings

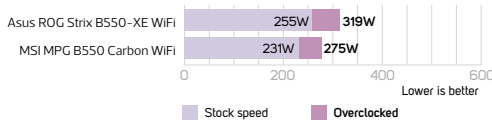


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



As usual with B550 motherboards, you get 802.11ax Wi-Fi and 2.5 Gigabit Ethernet, while the board offers the Realtek-based S1220A on-board audio, complete with a Type-C audio port for use with Type-C audio devices.

The board isn't bad-looking either, but we're glad Asus has focused on features and cooling rather than RGB lighting. You still get plenty of 3-pin and 4-pin RGB headers, though, and there are RGB LEDs that shine through vents in the heatsink above the I/O shroud – it's not overly snazzy, but there's some lighting there.



Performance

The Asus RealBench system score at stock speed closely matched that of MSI's MPG B550 Carbon WiFi, edging into a slight lead once overclocked. We had to apply a little more voltage to our Ryzen 9 5900X than usual for overclocking, needing 1.2625V instead of 1.25V to hit a 4.6GHz all-core overclock, but this proved to be stable and temperatures were well within limits. The extra vcore did result in relatively high power consumption, though, rising from 255W to 319W, compared to 275W with the MSI board.

As the overclocked frequency was lower than the CPU's peak single-core boost speed, the overclocked CPU was slower than stock speed in our image editing test and Cinebench 23's single-threaded test. The benefits, though, were nearly 100,000 points added to the video encoding score and over 2,600 points added to the Cinebench multi-threaded score.

Meanwhile, the audio results were typical of a premium implementation of the Realtek ALC1220 audio codec, with a noise level of -114dBA and dynamic range of 114dBA along with a THD of 0.005 – all among the best results we've seen.

Conclusion

The Asus ROG Strix B550-XE Gaming WiFi boasts an enviable specification of high-end features that make it a solid base for those wanting to go all-out with overclocking, or massive M.2-based storage arrays thanks to its bundled expansion card, and without costing much more than £200. The VRMs sport excellent active cooling, while there's a thermal probe input for expanding the board's cooling potential with liquid cooling.

There are a couple of flies in the ointment, such as the sub-par USB ports and on the I/O panel, plus a lack of fan headers and RGB fans visual prowess as well. It's a bit of a mixed bag, but it's an overall solid choice for the money, especially if you're using a high-end Zen 3 CPUs such as the Ryzen 9 5900X.

ANTONY LEATHER

ROG

- + Excellent VRM cooling
- + M.2 expansion card
- + Latest networking and USB standards

RAG

- Sub-par USB ports on I/O panel
- Average number of fan headers
- Few overclocking and testing tools

PERFORMANCE
32/35

FEATURES
31/35

VALUE
24/30

OVERALL SCORE

87%

VERDICT

A generally very well-featured motherboard that punches above its price tag in several areas.



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0333 011 7000

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PCSpecialist



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MICRO-ATX CASE

KOLINK CITADEL
MESH RGB / £60 inc VATSUPPLIER overclockers.co.uk

There appears to have been some hardware snobbery surrounding micro-ATX cases and motherboards lately, with very few new designs appearing compared to ATX. However, this hasn't prevented Kolink from having a stab at a decidedly compact box called the Citadel Mesh RGB. It looks rather funky too, giving you three RGB fans in a small PC case for just £60 inc VAT.

Size-wise, it still cuts swathes off the smaller ATX cases out there. For example, the Fractal Design Meshify 2 Compact is nearly 8cm taller and 3cm deeper, upping the ante in volume and desk space requirements. Despite its price, the Citadel Mesh RGB actually looks very smart too, with chunky chrome feet, clean lines and a top-to-bottom tempered glass side panel.

We're reviewing the Mesh version here, and there is indeed plenty of mesh, with a large front section sandwiched between side vents. There are glass-clad versions as well,

with extra RGB lighting if you're happy to prioritise aesthetics over airflow and spend a little more cash, but we suspect they'll have significantly reduced airflow as a result.

It's well made and sturdy too, despite it only weighing 5.3kg, and the side panel, which is held in place with magnets, is extremely easy to open, since it sits on hinges and swings open. However, while the little fabric tab stuck to the panel that allows you to do this makes your job a lot easier, it's quite unsightly. We'd much rather be able to pull the panel open from the top or bottom, perhaps using recesses in the case to get your finger behind it. Alternatively, Kolink might have considered a way to secure it when not in use, so it's less obvious.

Another little gripe is the average cable-tidying features. There are simple holes around the motherboard tray, but they lack rubber grommets and the case needs a few more anchor points for tying down cables too. While the front panel offers audio jacks and three USB ports, there's also no USB Type-C support, but that's to be expected at this price. Apart from this, though, there really aren't any other complaints.



In addition to the excellent build quality, the case includes three fans as standard, which are arranged in a positive airflow arrangement and sport vibrant RGB lighting. There's even a remote control for them, as well as a button on the case, which you can use to switch colours and lighting modes. There's a 3-pin connector too, so you can also use your motherboard or a third-party controller to change the lighting.

The fans and their lighting connectors are all hooked up to a hub, which allows you to use a single 4-pin PWM connector and lighting connector to control all three fans. It's fantastic to see this feature in such a cheap case, and we're



SPEC

Dimensions (mm)

285 x 400 x 430 (W x D x H)

Material

Steel, plastic, glass

Available colours

Black, white

Weight

5.3kg

Front panel

Power, reset, 2 x USB 3, 1 x USB 2, stereo, mic

Drive bays

2 x 2.5/3.5in, 2 x 2.5in

Form factor(s)

Micro-ATX, mini-ITX

Cooling

2 x 120/140mm or 1 x 180mm front fan mounts (2 x 120mm fans included), 1 x 120/140mm rear fan mount (1 x 120mm fan included), 2 x 120/140mm roof fan mounts (fans not included)

CPU cooler clearance

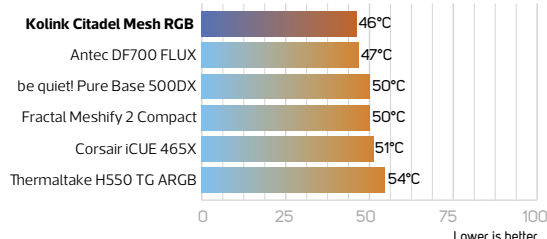
190mm

Maximum graphics card length

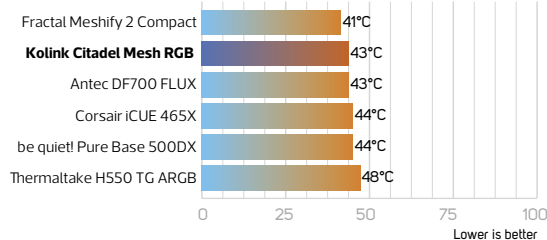
345mm

TEMPERATURE RESULTS

CPU DELTA T



GPU DELTA T



glad to see Kolink departing from its previous ways of using fixed-speed fans.

There's plenty of customisation on offer in terms of layout and cooling too, with a vertical GPU mount, albeit with no riser cable included, and space for up to a 280mm radiator in the front and a 240mm model in the roof. There are essentially no limits when it comes to CPU air coolers too, with 190mm clearance available, while graphics cards up to 345mm long will fit, limited to 2.5-slot models if you use the vertical mount.

Meanwhile, the roof and PSU mounts are kitted with removable dust filters, but the front section relies on the mesh alone to keep your PC's innards from getting clogged. Storage options are reasonable as well, with a pair of 2.5/3.5in bays and three 2.5in bays available, and there's support for an ATX PSU too, hidden beneath a full-length cover.

Performance

The noise from the Citadel's fans proved to be quite noticeable at full speed, so you'll definitely want to tune them down unless you place the Citadel Mesh RGB under your desk. Thankfully, the decibels did translate into cooling performance that benefited our 6-core AMD Ryzen CPU and GeForce GTX 1660 graphics card.

The CPU delta T of 46°C was excellent, being the best we've seen for a while and beating the likes of the Fractal Design Meshify 2 Compact, Antec DF700 FLUX and be quiet! Pure Base 500DX. The GPU delta T of 43°C was also very good, again outstripping the be quiet! Pure Base 500DX, but just by a single degree, while the Fractal Design Meshify 2 Compact



was 2°C cooler and the Antec DF700 FLUX's result matched that of the Kolink case.

Part of the reason for the GPU delta T being a tad less competitive is that Kolink has placed the lower fan in a position that means half of it is dishing out airflow into the lower chamber to cool hard disks that might be placed there. This means the GPU gets a little less airflow than normal, but we think this is a good idea and there's still a little gap to shift it up if you don't have any hardware to cool down below.

Conclusion

We're suitably impressed with the £60 Kolink Citadel Mesh RGB for a number of reasons. Firstly, it's reasonably priced for a solid, good-performing micro-ATX case, but when you consider that it includes three fantastic-looking RGB fans, a PWM, and lighting hub and remote lighting control as standard, that price looks like even better value.

It's well made, it has excellent CPU and GPU cooling and while it's not as small as a mini-ITX case, it shaves plenty off the dimensions of most small ATX cases. It also offers space for large air coolers and graphics cards, and there's reasonable liquid-cooling support, albeit only for 240mm and 280mm radiators. Throw in a hinged tempered glass side panel and it's a fantastic compact case for the cash.

ANTONY LEATHER

CITADEL MINIATURES

- + Excellent cooling
- + Three RGB fans as standard
- + Fan and lighting hub

GREEN ARMY MEN

- Quite wide
- Not as small as some mini-ITX cases
- Limited cable-routing features

VERDICT

Great cooling, snazzy RGB fans and a reasonable price make for a cracking micro-ATX chassis.

COOLING
26/30

FEATURES
17/20

DESIGN
27/30

VALUE
18/20

OVERALL SCORE

88%

360MM AIO LIQUID CPU COOLER

ASUS RYUJIN II 360

/ **£417** incVATSUPPLIER [amazon.co.uk](https://www.amazon.co.uk)

The last 360mm all-in-one liquid cooler from Asus that we reviewed was the original Ryujin 360, which offered interesting features and excellent cooling, but for a slightly eye-watering price tag. Unfortunately, Asus clearly thought that was a positive selling point, as the new Ryujin II 360's only listing when we went to press was for over £400 at [amazon.co.uk](https://www.amazon.co.uk). So, let's see what you get for the price of a high-end custom water-cooling system.

The cooler uses a 7th-gen Asetek pump, which proved to be extremely quiet in our testing with no noticeable whine even at full speed. This sits below a VRM fan and the cooler's centrepiece – a large 3.5in customisable LCD. This display can dish out a custom logo, show temperature and fan speeds, or play a funky Asus ROG animation. We have to admit this really does look good inside a system, and we were impressed by some of the circuitry design in the display housing as well.

This unit houses all the cables and circuitboards and is held in place using magnets, lifting off to allow you to get at the screws that secure the pump section to your motherboard. The contacts on the pump section mean this can all be done without disconnecting any cables, although it does feel a tad overengineered. For instance, similar contraptions from MSI and Phanteks leave the display in place on the pump – you simply remove the plastic housing in order to access the mounting screws.

Asus also includes a fan and lighting hub in the box, which connects to the display housing

using a USB cable, with the pump also hooking up to your PC using a USB 2 header. The hub has four fan headers and five 3-pin RGB headers, and again this feels overengineered, being clad in elegant solid metal rather than plastic housing. It looks and feels great, but it's overkill for its purpose.

Asus has aimed high with the trio of 120mm fans as well, opting for no less than three Noctua NF-F12 Industrial 2,000rpm fans, which would normally cost £75 inc VAT alone if you bought all three of them separately. Asus is definitely attempting to build the most premium liquid cooler on the market with the Ryujin II 360, but despite the price, Asus has fallen short in several areas too.

The cooler doesn't include another set of screws to mount extra fans, for example. The rest of the cooler is also very similar to other Asetek liquid coolers, with a typical 27mm-thick aluminium radiator and braided tubes. We've

**SPEC**

Intel compatibility
LGA115x, LGA1200,
LGA2066, LGA2011

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

Radiator size with fans (mm)
121 x 394 x 27 (W x D x H)

Fans
3 x 120mm

Stated noise
30dBA

LIQUID CRYSTAL DISPLAY

- + Great cooling
- + VRM fan
- + Funky display

LUDICROUS DISPLAY

- Core components don't justify price
- Cheaper coolers perform similarly on AMD CPUs
- Software feels bloated

seen beefier radiators supplied with much cheaper liquid coolers, while others have offered refillable cooling systems or even expandability, and the lack of these features definitely isn't reflected in the price tag.

Installation is your typical Asetek affair, with a backplate for Intel mainstream motherboards, while it makes use of the stock backplates and mounting points on Socket AM4, Threadripper and Intel LGA2066 motherboards. You'll need to install the correct mounting pins, and then it's just a case of securing the pump section with thumbscrews.

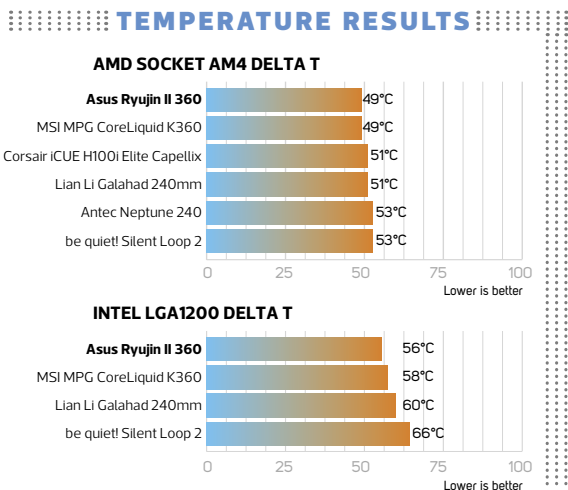
Meanwhile, the software Asus uses is great in some areas, giving you easy control over the fans and pump speed, as well as making it easy to update the software and firmware of the Ryujin II 360 itself. There are also lighting controls for the fan and lighting hub, which can control your motherboard if it's an Asus model as well.

However, the software is bloated with other tabs and controls that make it feel cluttered, and it took us a few moments each time to work out where the fan control section was located.

The likes of NZXT's CAM and Corsair's iCUE software are more polished and customisable, and Asus' software isn't on par for the price this cooler demands. It should be better than this, and also more focused on cooling.

Performance

Our Core i9-11900K certainly pushes out a fair amount of heat, so efficient, high-airflow coolers usually do well in our Intel cooling tests. The Ryujin II 360 topped the chart with a CPU delta T of 56°C, managing to better the MSI MPG CoreLiquid K360 by 2°C and shaving 10°C off the be quiet! Silent Loop 2's temperature.



Meanwhile, our Ryzen 7 5800X was kept at a delta T of 49°C, which was equal to the MSI cooler, but not much cooler than the other AIO CPU coolers we've tested recently. The noise wasn't quite ear-splitting at full speed, but the fans were certainly noisy. Thankfully, there's enough cooling headroom here to rein in the fan speeds a bit.

One other feature you get with this cooler is a VRM fan, which definitely made a difference, shaving 5°C off the peak load temperature of the VRMs. However, it can be noisy at full speed, so it's definitely worth avoiding higher speeds. Thankfully, the software does at least make it easy to fine-tune individual fan curves, but it's fixed to respond to CPU temperature. We'd prefer it to link to the VRM temperature, otherwise the fan can potentially be spinning up for no reason, or not spinning up enough. We'd set it at a fixed speed that's comfortable to your ears and leave it there.

Conclusion

Asus has got a lot right with the Ryujin II 360. The display looks fantastic, the pump housing is immaculately engineered, you get some of the best premium fans available, plus you get software control and excellent cooling. There's also the software-controlled fan and lighting hub, as well as the VRM fan, which made a real difference in our testing.

However, we'd expect a lot more at this price, such as a thicker radiator, the option to mount another row of fans, a refill port or an expandable loop. As it stands, this setup costs far more than a basic custom water-cooling loop, even if you include a GPU waterblock. For £150 less, our judgement would be far more favourable, but you need more than fancy fans, software control and a display to justify this kind of price.

ANTONY LEATHER

VERDICT

Excellent cooling and features, but the price is silly.

LGA1200

COOLING
39/40

FEATURES
17/20

DESIGN
15/20

VALUE
08/20

FITTING
EASY

OVERALL SCORE
79%

Socket AM4

COOLING
39/40

FEATURES
17/20

DESIGN
15/20

VALUE
06/20

FITTING
EASY

OVERALL SCORE
77%

CPU AIR COOLER

NOCTUA NH-U12A

/ £90 inc VAT

SUPPLIER cclonline.com



REASSURINGLY EXPENSIVE

- + Excellent Intel cooling
- + Superb build quality
- + Reasonable noise levels

OVERPRICED

- Very expensive
- Not great value for AMD CPUs
- Liquid coolers can perform better

SPEC

Intel compatibility
LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility
Socket AM4, AM3/+

Heatsink size with fans (mm)
125 x 112 x 158 (W x D x H)

Fans
2 x 120mm

Stated noise
22dBA

While Noctua products often demand a premium, the firm has an enviable reputation for great cooling and premium quality. As a case in point, the NH-U12A costs £90, which seems like a huge sum for a dual 120mm-fan air cooler, especially when some of the dual-fan air coolers we reviewed in last month's Labs test cost half the price.

The quality is obvious as soon as you open the box though. The instructions are clear and separate leaflets deal with AMD and Intel sockets. You get fan resistor cables, a screwdriver and all the parts are neatly packaged. The heatsink sports seven heatpipes and increased fin surface area to boost heat dissipation. Two of Noctua's much-revered NF-A12x25 fans are included, which retail for £25 apiece. These fans sport the most pleasant fan clips we've used too, for which our fingers were grateful.

Meanwhile, the mounting mechanism is simple to use and should enable you to keep your motherboard in your case to upgrade your cooler, although you need to attach the fans after you mount the heatsink. Noctua is also pledging free upgrade kits for Intel's incoming LGA1700 motherboards for this cooler, which will require slightly tweaked mounting components.

In our Intel Core i9-11900K system with Adaptive Boost enabled, the NH-U12A set a super-low delta T of just 66°C, beating the SilverStone Hydrogen D120 ARGB by 4°C, while making less noise. It even managed to

outperform the be quiet! Silent Loop 2 liquid cooler and IceGiant ProSiphon Elite on this system.

It wasn't quite as competitive on our overclocked AMD Ryzen 7 5800X rig, with the delta T of 55°C being 2°C warmer than the SilverStone Hydrogen D120 ARGB's result, but still within a few degrees of some liquid coolers. The noise from the Noctua's fans also proved to be far more pleasant when sat next to them at full speed than with the SilverStone Hydrogen D120 ARGB, and they were quieter at medium speeds too.

Conclusion

While its performance on our AMD system wasn't outstanding, its performance on our Intel system was fantastic. While there are far better-value air coolers available, especially for AMD sockets, if you want to avoid liquid cooling, or want a compact air cooler that doesn't interfere with memory slots or require ridiculous height clearance in your case, the Noctua NH-U12A is one of the most potent air coolers we've ever tested.

ANTONY LEATHER

VERDICT

Excellent cooling on Intel systems, but not great value for AMD owners.



LGA1200

COOLING

38/40

FEATURES

15/20

DESIGN

18/20

VALUE

14/20

FITTING

EASY

OVERALL SCORE

85%

Socket AM4

COOLING

33/40

FEATURES

15/20

DESIGN

18/20

VALUE

12/20

FITTING

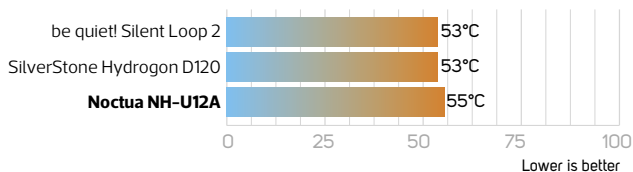
EASY

OVERALL SCORE

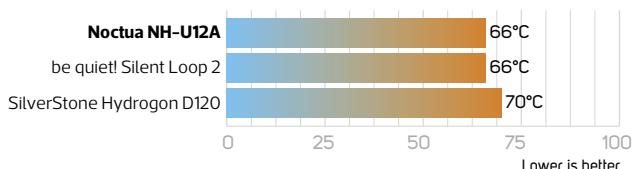
78%

TEMPERATURE RESULTS

AMD SOCKET AM4



INTEL LGA1200



Wireframe

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SUPPLIER corsair.com

FRIGATE

- + Great sound quality
- + Useful core features
- + Wireless convenience

DINGHY

- Fixed microphone
- Fiddly power button
- Expensive

The HS80 RGB Wireless is the latest addition to Corsair's gaming headset line-up, and it continues the company's recent trend of having a completely different physical design for each of its headset ranges. There's a little bit of the aggressive angles of the Void range here, along with the more muted aesthetic of the Virtuoso series, all finished off with a headband that's unique to this headset.

Instead of simply adding some padding to the underside of a stiff headband, here, the headset rests on an elasticated band that's slung between a fixed outer headband. This arrangement does away with adjustable arms on the outer band – instead you can loosen or tighten the elastic to adjust the band's height. It's a system that works well, although the adjustment takes a bit of trial and error, and can't easily be adjusted once it's on your head.

The earcups have an angled, straight-edged shape that does a decent job of emulating the overall shape of most ears, and in doing so, provides a comfortable, cossetting fit. The earcup pads are comfortable and deep so as not to squash your ears, and they have a very soft fabric cover. They make for a fit that balances being secure on your head without applying too much pressure.

The non-removable microphone and large, angled earcup shape mean this is a resolutely 'gamer'-looking device, but the muted all-black colour scheme looks smart enough.

There is some RGB lighting but it's relatively subtle, being confined to the Corsair logos on the sides of each earcup, and it can be turned off to conserve power. The microphone also has a small ring of light around its tip, which will switch from red to white automatically when the microphone is deployed.

Hosted by the left earcup, the microphone rotates up and down, and can be bent slightly to bring it closer to your mouth. Also on the left earcup is the USB Type-C charging port, power switch and digital volume wheel. The latter works well – although like many digital volume wheels, it can be a little slow to adjust, but the power switch is a little small.

As well as charging, the USB port can be used for audio, which upgrades the headset from the 24-bit/48kHz sample rate it uses in wireless mode to a 24-bit/96kHz sample rate when tethered.



In terms of sound quality, the microphone is nothing special. It's fine for getting the point across with in-game voice comms but it lacks the depth and clarity of the likes of the Sennheiser GSP 300, for instance. Headphone sound quality is very good though. There's plenty of bass but it doesn't feel forced, instead just providing warmth and power to the sound. Clarity is excellent too, allowing you to clearly pick out subtle game sounds and the intricacies of your favourite music.

The headset also supports Dolby Atmos for Headphone and it works as well as we've come to expect, providing greater positional feel in games and other audio sources with multi-channel audio support. Meanwhile, the rated battery life of 20 hours is on the low side for a wireless gaming headset, although the ability to charge and provide USB audio at the same time slightly makes up for it.

Conclusion

The Corsair HS80 RGB Wireless is an accomplished gaming headset that looks and sounds great, is comfortable to wear and has just enough core features to do the job. The inclusion of USB charging (and USB audio) makes it convenient for modern systems and its virtual surround works well. It's not packed with extra features and it's priced fairly high but it's a quality unit.

EDWARD CHESTER

VERDICT

A well balanced if slightly pricey high-end wireless gaming headset.

SPEC

Connections

USB Type-C (charging and audio)

Audio config

Stereo and Dolby Atmos virtual surround

Frequency range

20-40,000Hz

Sensitivity/sound pressure level

109db

Mic frequency response

100-10,000Hz

Mic sensitivity

-40db

Battery life

20 hours

Weight

367g

Extras

USB Type-C cable, wireless dongle

DESIGN

16/20

FEATURES

16/20

SOUND QUALITY

34/40

VALUE

14/20

OVERALL SCORE

80%

WIRELESS GAMING HEADSET

RAZER BARRACUDA X

/ **£115** inc VAT

SUPPLIER [razer.com](https://www.razer.com)

By Razer's standards, the Barracuda X is an affordable wireless headset with its £100 asking price, but it's still a good-looking set of cans. Much like Razer's BlackShark V2 Pro, it offers a minimalistic design, ditching Razer's traditional green in favour of a matt all-black affair. It looks both stylish and functional, looking more like a pair of premium headphones than a gaming headset.

Every segment of the Barracuda X feels relatively well made, but also pretty standard. There's no wire-driven headband adjustment, but the metal innards and light padding put the headset in good stead in terms of easy adjustment and overall comfort.

With a weight of only 250g, we found the Barracuda X felt remarkably light on the head in comparison with a lot of gaming headsets at this price, with the soft, squishy earcups providing a relatively tight, yet comfortable, seal. The clamping force is middling enough to suit most people too – you know you're wearing a headset, but it won't strangle your cranium.

Meanwhile, the relatively sizeable selection of on-board controls can all be found on the left-hand can's side. Here

you'll find a microphone mute button, a small volume dial, a power button, a 3.5mm analogue jack input and a Type-C port for charging. All the controls are convenient to use, although the volume wheel can be a little sticky at times.

In the Barracuda X's box, you'll also find a detachable microphone, a USB Type-C 1.5m charging cable and a 1.3m USB Type-A to Type-C extender. We had no issues connecting the Barracuda X to either a PC or phone through the Type-C dongle, although it's a shame there's no Bluetooth support.

For sound quality, these headphones produce a

relatively clear and balanced sound, although they lose some power at the lower end, lacking the usual thumping bass of other Razer headsets. This can make for a flat sound profile for other forms of media, such as music, but the sound lacks a bit of impact in games. Comparatively, the likes of Corsair's HS70 offer a little more bass and energy in games.

There's no virtual surround sound as standard either, and the lack of Synapse 3 support is a sore miss. Usually, there's the ability to fiddle with the 7.1 surround sound on Razer headphones, but the option for surround is only an optional paid extra on the Barracuda X. In contrast, the Corsair HS70 supports both Bluetooth and virtual 7.1 surround as standard.

On the plus side, the HyperClear microphone sounds clear enough for chatting to mates on Discord. It's also super-easy to move around and bend into position when needed. It's a fine inclusion for the price.

Battery life is pretty good too, with the Barracuda X exceeding the quoted 20 hours of battery life by a couple of hours in real-world testing, even with intensive usage. There's no backlighting to act as an extra drain, of course, which is a plus point here.

Conclusion

The Razer Barracuda X is a decent headset for those seeking a convenient audio option that works with not only a PC, but also a phone, PlayStation or Nintendo Switch. It's easy to connect with the included Type-C dongle and it provides balanced audio. However, while it's keenly priced, it lacks surround sound and software support, and the bass could be stronger. Comparatively, Corsair's HS70 gets you Bluetooth and surround sound, but the Barracuda X is still worth considering if comfort and light weight are top priorities.

REECE BITHREY

VERDICT

A good overall choice for consoles and PCs that's affordable, comfortable and easy to use, but it's missing some features.



KICKING BASS

- + Comfortable fit
- + Easy to connect
- + Balanced and clear audio
- + Good battery life

SOMETHING FISHY

- Lack of Synapse support
- No free surround sound
- Lacks a bit of bass

SPEC

Connections

USB Type-C (adaptor and charging), 3.5mm stereo, USB Type-A (with extender)

Audio config

Stereo

Frequency range

20-20,000Hz

Sensitivity/sound pressure

96dB

Mic frequency response

100-10,000Hz

Mic sensitivity

42dBV/Pa

Weight

250g

Stated battery life

20 hours

Extras

Removable mic, USB Type-C and 3.5mm analogue cables

COMFORT

17/20

FEATURES

14/20

SOUND QUALITY

31/40

VALUE

17/20

OVERALL SCORE

79%

AMD X570 GAMING PC

PC SPECIALIST INFINITY LC / £3,299 inc VAT

SUPPLIER pcspecialist.co.uk

PC Specialist's Infinity LC has an all-AMD specification that looks great on paper, with a monster 16-core Ryzen 9 5950X CPU sitting alongside a liquid-cooled Radeon RX 6900 XT GPU. The addition of liquid cooling gives room to overclock the GPU, with the original game clock of 2015MHz rising to 2250MHz and the boost clock now sitting at 2435MHz. Meanwhile, the 16GB of memory runs at an effective

frequency of 18GHz, rather than 16GHz. The dual-slot card is chilled by a 120mm radiator that's installed on the system's rear fan mount.

The Ryzen 9 5950X is another high-end AMD addition. It has 16 cores (and 32 threads via SMT) alongside base and boost speeds of 3.4GHz and 4.9GHz – it's overkill for gaming, but tremendous for content creation and tough, heavily multi-threaded work tasks.

The rest of the system is well suited to creative tasks too. PC Specialist has deployed 32GB of 3200MHz DDR4 memory, and there's a 1TB Samsung 980 Pro PCI-E 4 SSD alongside a 4TB Seagate IronWolf Pro hard disk. It's all powered by a mighty Corsair RM1000x PSU, which has a fully modular design and an 80 Plus Gold efficiency rating.

Meanwhile, the Asus TUF Gaming X570-Plus motherboard is good, but it's not great. It gets the basics right, with two PCI-E 4 M.2 connectors, a trio of 1x PCI-E slots and loads of on-board connectors. You get decent Realtek S1200A audio, good-looking heatsinks and a pre-installed rear I/O cover. Go beyond the fundamentals, though, and it's lacking.

You only get Gigabit Ethernet, rather than 2.5Gbps networking, and you don't get on-board buttons or displays. At the

rear, the Asus has two full-sized USB 3.2 Gen 2 ports and a Type-C connector, alongside four USB 3.2 Gen 1 ports, but there are no USB 3.2 Gen 2x2 ports. The board doesn't have Wi-Fi, but PC Specialist has added a dual-band Wi-Fi 6 card in one of the 1x PCI-E slots.

The motherboard is the only area where the PC Specialist falls behind a similarly specified (and pricier) rival. The £3,799 Chillblast Fusion Testarossa (see Issue 216, p36) included an air-cooled Radeon RX 6900 XT alongside the 12-core Ryzen 9 5900X, but its Asus Strix X570-E Gaming board included 2.5Gbps Ethernet, better USB options and more connectors.

The PC Specialist rig is housed in a heavy-duty Corsair iCUE 5000X chassis, with flawless build quality and four tempered glass panels. It's packed – there are six intake fans, and the rear-mounted GPU cooler is joined by the radiator for the roof-mounted Corsair Hydro H100i CPU cooler.

PC Specialist has done a great job with cable routing too, but the sheer amount of hardware means it's a little cramped. You can get to the key areas, but it's delicate work. Around the rear you'll find a maze of neat cables and expansion hubs – the case includes a PWM splitter and Corsair iCUE synchronisation boards, and PC Specialist has added three more control boxes. It's an impressive array of hardware, but it's tricky to add more storage.

Finally, PC Specialist's three year labour warranty includes one years of parts coverage and a month of collect and return service. That's decent enough, but we expect more than a year of parts coverage at this price.



SPEC

CPU

3.4GHz AMD Ryzen 9 5950X

Motherboard

Asus TUF Gaming X570-Plus

Memory

32GB Corsair Vengeance RGB Pro 3200MHz DDR4

Graphics

AMD Radeon RX 6900 XT 16GB

Storage

1TB Samsung 980 Pro M.2 SSD, 4TB Seagate IronWolf Pro hard disk

Networking

Gigabit Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5

Case

Corsair iCUE 5000X RGB

Cooling

CPU: Corsair Hydro H100i RGB Pro XT with 4 x 120mm fans; GPU: AMD Liquid Cooling with 1x 120mm fan; front: 3 x 120mm fans; side: 3 x 120mm fans

PSU

Corsair RM1000x 1000W

Ports

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

Operating system

Microsoft Windows 10 Home 64-bit

Warranty

Three years labour with one year parts and one month collect and return

LIMITLESS

- + Top-tier CPU speed
- + Impressive gaming pace
- + Cool and quiet
- + Neat, sturdy chassis

LIMITED

- CPU is overkill for gamers
- RTX 3080 Ti quicker at ray tracing
- Tricky to upgrade
- Missing motherboard features

Performance

The Ryzen 9 5950X is a brilliant CPU for heavily multi-threaded work. Its Handbrake video encoding score of 1,044,068 is around 100,000 points better than the Chillblast's 12-core 5900X and further ahead of any Intel alternative, and the 5950X exhibits similarly commanding speed in our heavy multi-tasking benchmark.

The PC's single-threaded score of 67,463 is great as well, and not far behind more affordable CPUs with fewer cores. Cinebench R23 illustrates just how good this CPU is; in our last CPU Labs, the 5950X scored 25,635 points, with the 5900X around 4,000 points back and Intel's chips further behind. The SSD doesn't disappoint either – its read and write speeds of 6,542MB/sec and 5,162MB/sec are excellent.

Not surprisingly, the liquid-cooled Radeon RC 6900 XT is quicker than the air-cooled version as well. At 2,560 x 1,440, the beefier 6900 XT returned 99th percentile minimums of 79fps, 60fps and 59fps in Assassin's Creed Valhalla, Cyberpunk 2077 and Metro Exodus, with those results opening a solid lead over the conventional card. The 6900 XT easily plays games at 4K – it hit a 51fps minimum in Assassin's Creed at top settings.

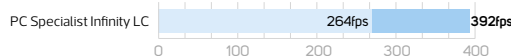
This card will handle almost anything, but Nvidia's RTX 3080 Ti remains a more compelling high-end option, thanks to its speed and its improved ray-tracing and DLSS abilities – it's significantly quicker in demanding games such as Cyberpunk 2077. AMD's GPU only really wins the day in Assassin's Creed Valhalla.



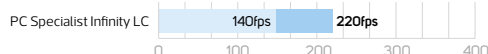
BENCHMARK RESULTS

DOOM ETERNAL

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



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



ASSASSIN'S CREED VALHALLA

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



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

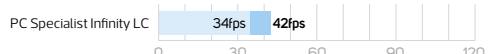


CYBERPUNK 2077

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



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



METRO EXODUS

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



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



99th Percentile Average

67,463
GIMP IMAGE EDITING

1,044,068
HANDBRAKE H.264 VIDEO ENCODING

384,918
HEAVY MULTI-TASKING

384,363
SYSTEM SCORE

PC Specialist's reliance on liquid cooling and loads of case fans translates to excellent thermal performance though. The CPU and GPU's delta Ts of 45°C and 48°C are superb, and the CPU maintained great single and multi-core speeds of 4.85GHz and 3.7GHz in work tests, with the GPU attaining its boost speed with no complaints. The Infinity is quiet, with a low rumble during tough tasks but no loud, irritating noise.

Conclusion

PC Specialist's Infinity is impressively powerful, cool, quiet and well priced – this kind of specification costs hundreds of pounds more elsewhere. The motherboard could be better, there's not much room for upgrades and the RTX 3080 Ti is still superior for ray tracing. However, this remains one of the best all-AMD PCs we've seen, and it's a top-notch option for both demanding productivity tasks and high-end gaming.

MIKE JENNINGS

VERDICT

PC Specialist's system delivers heavyweight speed and design at a decent price.

PERFORMANCE
23/25

DESIGN
23/25

HARDWARE
23/25

VALUE
21/25

OVERALL SCORE

90%

INTEL H470 MINI BAREBONE SYSTEM

ZOTAC MAGNUS ONE ECM73070C / £1,449 inc VAT

SUPPLIER scan.co.uk

Zotac has always been at the forefront of the mini PC market, and that's still true with its Magnus One ECM73070C – a tiny rig that crams an Nvidia GeForce RTX 3070 inside an 8.3-litre chassis. It's an unassuming chassis. On the outside it has modest brushed metal patterns and panels covered in air vents, and it's sturdy enough to move around the house without issue.

There are no RGB LEDs, and it's visually discreet. It's only 249mm tall and 266mm deep, so it will fit into a huge array of spots – below your TV, in a cramped bedroom or unobtrusively on your desk. Removing a couple of thumbscrews from the back allows the lid and side panels to lift free, revealing some clever design. One side of the system holds the Zotac-made mini-ITX motherboard, while an expansion board allows the graphics card to occupy the other half of the chassis.

This keeps the graphics card out of the way while allowing users to fit their own hardware into the two PCI-E 3 M.2 connectors, the pair of SODIMM memory slots and the single 2.5in storage caddy. It only takes a couple of minutes to install the core components, although there are some limitations – there's no room for any more storage, the memory can't go beyond 2933MHz and there are no extra PCI-E slots.

The front of the case has a USB 3.2 Gen1 type-A and a type-C connector, and an SD card reader, while the rear has six more full-sized USB ports. There's plenty of room for peripherals and external drives, but none of the USB ports goes beyond 5Gbps, which is a shame.

There are also no extra audio connectors at the rear, so you'll have to rely on the front panel's audio connector or your display cable. The network and wireless options are far better – there are dual Ethernet ports with one at 2.5Gbps, and Zotac includes dual-band 802.11ax Wi-Fi and Bluetooth 5. A decent three year warranty completes the specification.

The RTX 3070 card deployed in this desktop is smaller than usual, so it's not overclocked, but there are no cutbacks – it still has 5,888 stream



processors, a 1725MHz boost clock and 8GB of memory. The CPU doesn't use the latest tech though. The Core i7-10700 may have eight cores and a boost speed of 4.8GHz, but it's still a last-gen Comet Lake chip with no PCI-E 4 support.

Because this is a barebone machine, that's it for components. Unless you're lucky enough to have memory and storage lying around then you'll have to buy those parts yourself alongside an OS. That's going to add at least £200 to the build. Add it all up and the Zotac's small stature results in a relatively high price; you can find full-sized machines with RTX 3070 cards and similar CPUs for around £1,499, for example.

Performance

The RTX 3070 might be old for an Ampere GPU, but it's still quick enough to handle mainstream games. It played Cyberpunk 2077 at 1080p with a 99th percentile minimum



SPEC

CPU

2.9GHz Intel Core i7-10700

Motherboard

Zotac ECM73070C

Memory

2 x DDR4 SODIMM
slots up to 2933MHz

Graphics

Zotac GeForce RTX 3070 8GB

Storage

Two M.2 4x PCI-E 3 slots,
1 x 2.5in SATA bay

Networking

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

Case

Zotac Magnus One

Cooling

CPU: Low-profile cooler with 1
x 80mm fan; GPU: 2 x 90mm
fans; roof: 2 x 90mm fans

PSU

Zotac 500W

Ports

Front: 1x USB 3.2 Gen1, 1x
USB 3.2 Gen1 Type-C, 1x SD, 1
x audio; rear: 6 x USB 3.2 Gen1

Operating system

Not supplied

Warranty

Three years parts and
labour return to base

BENCHMARK RESULTS

58,399 **450,287**

GIMP IMAGE
EDITING

HANDBRAKE H.264
VIDEO ENCODING

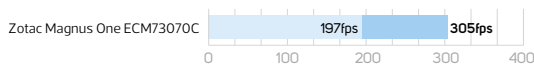
204,239 **186,021**

HEAVY MULTI-
TASKING

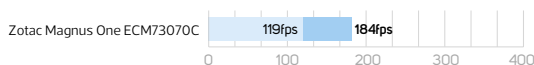
SYSTEM
SCORE

DOOM ETERNAL

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

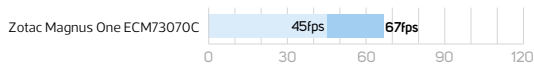


2,560 x 1,440, Vulkan, Ultra Nightmare settings

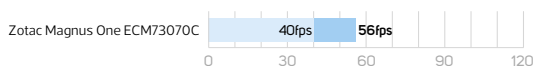


ASSASSIN'S CREED VALHALLA

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

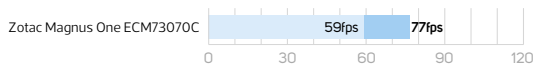


2,560 x 1,440, Ultra High settings, High AA

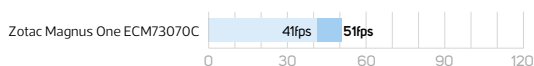


CYBERPUNK 2077

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

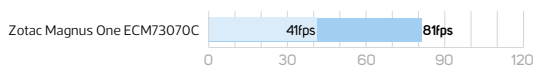


2,560 x 1,440, Ultra preset, no ray tracing



METRO EXODUS

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



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



99th Percentile Average

of 59fps and ran through Assassin's Creed Valhalla at 45fps, hitting 41fps in Metro Exodus with ray tracing enabled. Most games will average beyond 60fps at 1080p, and this machine easily handles less demanding titles at high frame rates, averaging 305fps in Doom Eternal. The RTX 3070 also returned playable results at 2,560 x 1,440 as well. However, if you're only going to be playing games at 1080p and want to save some money, bear in mind that Zotac also produces a £1,129 version of this PC with an RTX 3060 and Core i5 CPU.

Meanwhile, the Zotac's aging processor avoids game bottlenecks and can handle everyday computing tasks fine,



but it's no speed demon. Its single-threaded image editing score of 58,399 is more than 10,000 points short of today's best Core i7 and Ryzen 7 chips, with the gulf widening in multi-threaded benchmarks. It's a decent enough CPU, but it's not outstanding.

So far so good – the Magnus One has its limitations, but it handles gaming surprisingly well for such a small system. However, during demanding games, the Zotac produced an irritating, high-pitched fan noise, and it was only a little quieter in less intensive games, such as esports titles. The GPU temperature was fine, and speakers or a headset will drown out the noise, but this isn't the PC to buy if you want a quiet, compact gaming system.

On the plus side, the Zotac was always quiet during CPU-based tasks – the low-profile processor cooler does a respectable job, with hardly any noise and a top-notch delta T of 40°C. The CPU also reached its stated turbo speed in single-threaded tests. However, the chip only boosted to 3.2GHz in heavily multi-threaded tests.

Conclusion

Those noise issues mean the Zotac isn't ideal if you want a quiet gaming PC, and it does falter elsewhere: its connection options could be better, the processor is underwhelming, there's no PCI-E 4 support and your money will go further if you aren't dead set on a smaller PC. If you really want a tiny gaming PC, though, the Magnus One's clever design manages to produce surprisingly strong gaming performance from a very small unit.

MIKE JENNINGS

VERDICT

Decent gaming performance from a tiny, cleverly designed case, but it's not quiet and the last-gen Intel hardware has some limitations.

ZBOX

- + Solid gaming speeds
- + Tiny, sturdy case
- + Easy to build

Z-LIST

- Last-gen Intel hardware
- Restrictive connection options
- Relatively expensive
- Loud during gameplay

PERFORMANCE

19/25

DESIGN

19/25

HARDWARE

17/25

VALUE

18/25

OVERALL SCORE

73%

Custom kit

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

IGOKOTI MINI VACUUM / £10.98 inc VAT

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

Approaches to desktop cleaning vary. There's the classic lazy 'brush stuff onto the floor so it comes under the jurisdiction of the proper grown-up sized vacuum cleaner' approach, or there's just 'wipe the surface, brushing stuff into the bin by hand, or a cloth if you're feeling fancy' method.

However, now there's new option, a tiny desktop vacuum cleaner. The Igokoti Mini Vacuum is a palm-sized, battery-operated cleaner that scoops up whatever it sits on, like a tiny Roomba without the clever automation. It works surprisingly well at picking up small crumbs and debris, despite not being massively



powerful, while the brushes on the bottom of the cleaner prevent it from scuffing the surface and help to dig up stubborn grubbiness.

Emptying it out is very easy too – just pop off the bottom and shake it over a bin. The main problem the Igokoti has to face is more existential than technical – namely, it isn't better than brushing stuff into the bin by hand in a practical sense. It's not a labour-saving device; it's just a device. It is cool though.

Want ●●●●○ Need

SANDISK IXPAND WIRELESS CHARGER / £29.99 inc VAT

SUPPLIER [westerndigital.com](https://www.westerndigital.com)

The SanDisk Ixpond Wireless Charger takes a no-frills approach so far that you might be forgiven for thinking it's a coaster. Physically, it's basically a simple disc with a USB Type-C port that you can run to a computer or mains adaptor. Placing a compatible smartphone on the charger initiates the charging, which works at a rapid 15W using Qualcomm Quick Charge 3.0.

The charging process works reliably through plastic or rubber cases up to 5mm thick, although you might have to move the phone around a little to find a sweet spot if there's an armoured shell in the way. The Ixpond can be a little unsettling at first, because it makes your phone warm, but this is to be expected given the rate of charge.

A device pared down to this extent is remarkable for sheer simplicity – you plug it in and it works when you put your phone on it – there's almost no way it could be further simplified.



Easy to get right ●●●●○ Impossible to get wrong

RETRO-BIT LEGACY CONTROLLER / £17.57 inc VAT

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

When you absolutely, positively, want as close to the authentic Super Nintendo experience on a PC, you need an appropriate controller. The Retro-Bit Legacy seeks to be that controller by delivering a design and feel as authentic to the original SNES pad as possible, while also being compatible with modern hardware.

The end result is extremely close to the original, but in a good way, with a chunky, comfy D-pad and buttons of the right sizes in the right places. While its shape isn't identical to the original SNES controller, it matches the way the original is gripped, which is what's important.

The modern necessity of a Home button is minimalist but present and correct, and there are also two more shoulder buttons than on the SNES pad, in case a game should require them. However, the main shoulder buttons have priority in keeping with the original layout and the extra ones are a little hard to access. You only need to couple this pad something as basic as a browser-based emulator and it hits the nostalgia spot with aplomb.



Browser ●●●●○ Bowser

RAZER HAMMERHEAD TRUE WIRELESS X / £69.99 inc VAT

SUPPLIER [razer.com](https://www.razer.com)

The Hammerhead True Wireless X is much what you would expect if you engineered a gaming headset down into a pair of wireless earbuds. They're not visually subtle – they've got lights for a start – and they're also quite big by earphone standards in order to accommodate the hardware.

This comprises a Bluetooth 5.2 connection, 13mm headphone drivers and batteries that can provide six hours of playback, with 18 hours of standby off a single charge, plus slightly more if you use the audio control app to turn off the lights.

The payoff for the size is found mostly in the sound quality, which is sharp, well defined and potent. Expect to turn the volume down to maybe half what you'd use with regular earphones, because the Hammerheads can go much louder than you might expect.

Outward voice communication is fine, and the control interface is rudimentary but effective once you learn the system of taps on the earpieces to pause, play, adjust volume or take calls. Interestingly, there's no on-board off switch – instead, you put the Hammerheads back in



their charging box and that switches them off, although they can be also configured with the Razer Audio app to turn themselves off after a period of inactivity.

A low-latency gaming mode is also included to decrease any audio connection latency for when you're playing games on your phone. The Hammerhead True Wireless X is a surprisingly comfortable marriage of gaming headset style and mobile earbud priorities.

Dogfish ●●●●● Hammerhead

XINXUAN SQ11 MINI SPY CAMERA / £14.99 inc VAT

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

The Xinxuan Mini Spy Camera is a surprisingly endearing device considering its ostensibly nefarious purpose. What makes it so endearing is how the designers have wrestled with cramming a 1080p night-vision-capable video camera, microphone, motion sensor, battery, tiny USB port and SD card slot into a very small cube.

What's more, the control interface has also been boiled right down, being based on two buttons and one light that can be red, blue or off. There's no computer interface here – once the necessary (but not supplied) SD card is installed, a PC just sees the data folders for the footage and images when the SQ11 is plugged into it.

The controls have a curious system of pressing one or the other button for different amounts of time. It requires you to keep the manual handy, and some trial and error, but it works. It's not an obstinate design so much as a limited one.



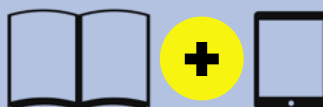
These limitations extend to the camera itself, however. Even under ideal circumstances, and using the supplied clip for stability, the SQ11 doesn't offer great image or sound quality. It also doesn't know the date for its timestamps and lacks any real means to adjust it. It's an amusing gadget that gamely struggles to be fit for any substantive purpose.

Mini Spy ●●○○○ Macro Spy

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

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LABS TEST

Sub-£1,500 gaming laptops

Mike Jennings lines up eight Nvidia-powered gaming laptops to find the best affordable options

How we test

A gaming laptop is an expensive investment, even if you want a model that doesn't cost the earth, and it makes sense to evaluate these machines from every angle before you decide which one to buy.

It's important to have a robust set of test procedures to find out which laptops are the fastest, strongest and quietest, and which ones have the best screens, so we've locked and loaded our full range of benchmarks to discover which laptops are worth your money.

Our gaming tests see which laptops can handle a range of titles at playable frame rates, and we've run our application benchmarks so we can see which laptops are suitable for tougher content-creation

tasks too. We've run SSD benchmarks to fine the fastest storage systems, and used our X-Rite i1 Display Pro colorimeter to test displays for contrast, colour accuracy and gamut coverage levels.

Our benchmarks finish with thermal stress tests in both Unigine Valley and Cinebench. We run these tough apps alongside CoreTemp, Prime95 and GPU-Z in order to determine which laptops are the coolest and quietest options when pushed to their limits – and to see which ones can't handle the heat.

To obtain our final scores, we carefully judge each machine's performance, design, hardware and value, then add these scores together to get an overall score.

Contents

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ACER NITRO 5 / £1,099 inc VAT

SUPPLIER laptopsdirect.co.uk

Acer's Nitro 5 looks like a traditional gaming laptop. The rear has bold red air vents, and a slash design adorns the metal lid. Ease back the lid, and you'll find more angles and a sunken keyboard. Some people will love it; others will find it dated. Build quality is decent, though, and it competes well here with its key budget rivals: it offers similar strength to the Gigabyte and Dell machines and it's more robust than the MSI.

It's not all good news though. The Acer weighs 2.3kg, which makes it heavier than some rivals, and its 25mm body is thicker than most too. Connection options are also a little frustrating – the Acer does have a fast USB 3.2 Gen 2 port, but its USB Type-C socket doesn't support DisplayPort.

Meanwhile, the keyboard has a numberpad with narrow keys, and quality is decent – the

buttons are comfortable and fast with plenty of travel and reasonable crispness. That trackpad isn't so good – it's small, soft and sits on the left of the machine, so it's easy to trigger accidentally.

While the Acer looks like a typical gaming laptop, though, it's surprising on the inside because it prioritises the processor. This machine deploys AMD's superb Ryzen 7 5800H CPU, but its RTX 3060 GPU is restricted to a modest peak power level of 85W.

That subdued power envelope means the Nitro's gaming performance didn't blow us away. It achieved a 99th percentile frame rate of 34fps in Assassin's Creed Valhalla, so it's playable, but that's behind most other RTX 3060 machines. It fell behind in Cyberpunk and only held its own in the easier Doom Eternal benchmark. There's enough power here to tackle mainstream games, but the Dell is faster and the cheaper Gigabyte offers similar pace.

The Acer was better in application benchmarks. Its Handbrake score of 587,445 is the best in the Labs, even creeping ahead of the PC Specialist's Ryzen 9 chip, and its overall result of 223,332 is the best here too. There's huge CPU power on offer, and the Acer is great if you want a laptop that can handle

multi-tasking and content creation. It's a decent thermal performer too; the noise levels were consistently modest and none of the external panels became too hot.

Battery life, though, isn't the Nitro's strong suit. It lasted for one hour and 16 minutes in a gaming test, and its Windows work lifespan of 3.5 hours is the poorest in the group.

This machine doesn't have the best display either. The 165Hz refresh rate is good for esports and its contrast ratio of 1,347:1 means you get good depth, but the Nitro's delta E of 5.82 is poor and the display only rendered 60.2 per cent of the sRGB gamut. Those core colours pop, but the Gigabyte's screen will produce more shades.

Conclusion

The Acer isn't the fastest or most modern gaming laptop, but it's still a budget contender and worth examining if you need a machine with loads of CPU power. For different scenarios, though, other machines remain stronger. The Gigabyte is cheaper and faster in games, and the pricier Dell offers more gaming pace and better battery life.

VERDICT

Superb CPU ability at a decent price, but the Nitro is only average elsewhere.

SPEC

CPU 3.2GHz AMD Ryzen 7 5800H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB

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

Storage 1TB Samsung PM991M.2 SSD

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

Weight 2.3kg

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

Dimensions (mm) 363 x 255 x 25 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base

NITROUS

- + Impressive processor
- + Reasonable gaming pace
- + Good keyboard
- + Cool and quiet

NOXIOUS

- Other laptops are faster in games
- Poor battery life
- Dated design
- No USB Type-C DisplayPort

PERFORMANCE

21/25

HARDWARE
18/25

DESIGN

19/25

VALUE
19/25

OVERALL SCORE

77%



ALIENWARE M15 RYZEN EDITION R5 / £1,499 inc VAT

SUPPLIER [dell.com](https://www.dell.com)

With its hexagonal grilles, rear-mounted RGB LEDs and single-hinged design, the Alienware is arguably the best-looking laptop on test. What's more, the m15 has super-fast 2.5Gbps Ethernet and it's one of the only laptops on test with a Windows Hello webcam.

The keyboard has a generous 1.8mm of travel and the keys are bouncy, consistent and satisfying – this is the best keyboard in the Labs. It's also possible to spend an extra £100 and upgrade to a low-profile Cherry MX mechanical keyboard that's faster and crisper.

The display impresses too. The 1080p resolution and 165Hz refresh rate are ideal at this size, and the contrast level of 1,454:1 is tremendous – the best in the Labs and high enough to deliver huge depth and vibrancy. It's the brightest display on test as well. The

RIISING

- + Solid speed
- + Good-looking exterior
- + Comfortable, snappy keyboard
- + High-quality 165Hz screen

FALLING

- Expensive for the GPU
- Heavier than most rivals
- Not particularly cool or quiet
- Average battery life

SPEC

CPU 3.2GHz AMD Ryzen 7 5800H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB

Screen 15.6in 1,920 x 1,080 IPS 165Hz

Storage 512GB Kioxia BG4 M.2 SSD

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

Weight 2.47kg

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

Dimensions (mm) 356 x 273 x 23 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base

delta E of 2.09 is good, and the panel rendered a superb 97.5 per cent of the sRGB gamut. Games look bold and bright on this screen.

On the inside, Alienware's machine relies on a 125W RTX 3060 GPU and a Ryzen 7 5800H CPU, bolstered by 16GB of memory. You only get a 512GB SSD though – a 1TB drive would be welcome at this price.

In terms of performance, the m15 returned playable 99th percentile minimums in our games, including Metro Exodus with DLSS and ray tracing, and it zipped through Doom Eternal with the pace required to save the 165Hz display in esports titles. This isn't the fastest RTX 3060 machine though – the Dell was consistently a little quicker. Plus, for £1,499, you could also buy the Lenovo or PC Specialist systems with their RTX 3070 GPUs.

Meanwhile, the Ryzen 7 5800H is quicker than any of the Intel chips on test in our single-threaded image editing benchmark, and it's miles ahead in multi-threaded tests. It's not just good for gaming – it's also capable of tackling tough content-creation and work scenarios. Even more power is available though – the other 5800H-based laptops in the Labs were faster, and the PC Specialist has a Ryzen 9 CPU.



There are other areas with the Alienware doesn't match its luxurious billing. It's only a little quieter during games than the PC Specialist, and the underside and area above the keyboard both become too hot to touch. Its 22.8mm thickness isn't bad, but its weight of 2.47kg is heavy and the power brick is large, so you'll notice this laptop in a bag. Also, while build quality is good, there's too much movement around the keyboard. Faster USB ports would be welcome too, although you at least get DisplayPort over USB Type-C here.

Don't rely on the trackpad or the speakers either – the former is soft, and the latter have a muffled mid-range, with too much bass and a tinny top end. The battery is mediocre as well – the Alienware lasts for around 90 minutes in gaming, but the Dell and PC Specialist laptops are better.

Conclusion

The Alienware has good looks, solid performance and an excellent keyboard and display, but it's expensive, heavy and frequently outpaced in benchmarks. While this machine is good-looking and high quality, the Lenovo provides more pace for less cash, and Dell's cheaper G15 offers similar speed with fewer frills.

VERDICT

Alienware's bold machine is a high-quality choice, but it's pricey and not the fastest option.

PERFORMANCE

21/25

HARDWARE
21/25

DESIGN

22/25

VALUE
18/25

OVERALL SCORE

82%

ASUS TUF DASH F15 / £1,299 inc VAT

SUPPLIER scan.co.uk

Asus' TUF Dash F15 has one of the most interesting specifications on test. It uses one of Intel's new Core i7-11370H processors, which is a quad-core chip with base and turbo speeds of 3.3GHz and 4.8GHz. It's designed for slim and light laptops, so it has a low TDP of 35W, but Asus has created performance modes that overclock the chip back up to 45W.

Asus has fiddled with the power levels on the graphics side too. The F15 features an RTX 3070, but it has a peak power draw of 85W – the lowest of this group's trio of RTX 3070 machines. The rest of the spec is fine, if unremarkable. There's 16GB of memory, a 512GB SSD with mediocre read and write speeds of 1,413MB/sec and 834MB/sec, and both dual-band Wi-Fi 6 and Gigabit Ethernet.

The F15's modest power envelopes mean it's a mediocre performer. It played Assassin's Creed Valhalla and Cyberpunk 2077 with 99th percentile minimums of 39fps and 36fps, but those scores were level with most of the Labs' RTX 3060 laptops and miles behind the RTX 3070 laptops from Lenovo and PC Specialist. There's enough power here to handle



mainstream titles and esports games at 1080p, but the RTX 3070 is better elsewhere, and you can get similar performance from the RTX 3060-based Dell and Gigabyte machines.

The low-power Core i7 processor also disappointed. Its single-threaded result is slower than the AMD chips on test here, and its multi-core Handbrake result was miles behind the Ryzen 7 silicon. You won't encounter gaming bottlenecks here, and the Asus can handle everyday computing, but it's not the best option for content creation and multi-tasking. It does have reasonable battery life at least, lasting for eight hours when working – only the Dell is better here.

Annoyingly, the modest power levels don't translate to improved thermal performance though. The F15 was quiet when playing less demanding games, but tougher situations saw the underside become too hot to touch and the fan noise become noticeable and high-pitched.

On the plus side, the F15's unambitious power targets mean it weighs 2kg and measures just 19.9mm thick, so it's one of the smallest machines on test – ideal for frequent travel. It's robust too, with solid build quality despite the small size. It has Thunderbolt 4 support as well, but there's no webcam or card reader.

There's no numberpad either, and the keyboard has no RGB LED backlighting. The buttons are fast and comfortable, so they're fine for everyday gaming, but they're among the softest in the Labs. The trackpad buttons are soft too, and the speakers have overwhelming bass and underwhelming sound elsewhere – you'll want to use a headset for gaming.

The laptop's final element, the screen, is mediocre. The contrast ratio of 1,136:1 provides decent depth, and the delta E of 2.58 is good – but the panel only renders 57.1 per cent of the sRGB colour gamut, so games don't look vibrant.

Conclusion

The Asus has the pace to handle mainstream games, along with a slim, light chassis and decent battery life, but its processor is sluggish, the keyboard is soft and it's not particularly quick. Comparatively, the Dell has a quicker CPU and superior battery life, while the Gigabyte has a better screen.

VERDICT

The Asus is slim, light and has reasonable speed, but it's beaten by stronger rivals.

SPEC

CPU 3.3GHz Intel Core i7-11370H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3070 Laptop 8GB

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

Storage 1TB SK Hynix HFM512GD3JX013N M.2 SSD

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

Weight 2kg

Ports 3 x USB 3.2 Gen 1, 1 x Thunderbolt 4 / USB Type-C, 1 x audio, 1 x HDMI

Dimensions (mm) 360 x 252 x 20 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base

SONIC

- + Reasonable gaming pace
- + Slim, light chassis
- + Impressive battery life

SLOWDOWN

- Rivals are faster
- Disappointing processor
- Narrow colour gamut
- Soft keyboard

PERFORMANCE

18/25

HARDWARE
17/25

DESIGN

18/25

VALUE
16/25

OVERALL SCORE

69%



DELL G15 5515 RYZEN EDITION / £1,199 inc VAT

SUPPLIER dell.com

Gaming laptops are often black or littered with RGB LEDs, but Dell's G15 Ryzen Edition uses a matt finish called Phantom Grey, which is covered with a speckled pattern, and it really stands out. Dell has paired the bold looks with impressive build quality. This sturdy laptop will easily cope with frequent travel. The downside is size: at 2.44kg in weight and with a body that's 26.9mm thick and 273mm deep, it's also one of the largest laptops on test.

The Dell pairs a 125W RTX 3060 with an AMD Ryzen 7 5800H and performance is impressive. It achieved playable 99th percentile frame rates in every game and proved marginally quicker than the Alienware in most tests. It outpaced the low-power RTX 3070 inside the Asus too. The processor is virtually level with the Alienware, better than any of the Intel chips on test, and performance

is only beaten by the Lenovo, Acer and PC Specialist.

Those solid results mean you can play games and run content-creation tasks fine on this machine. You even get brilliant battery life – the Dell's gaming lifespan of one hour and 48 minutes is the best on test, and it lasted for nearly ten hours when running basic work tasks.

Thermal performance is also solid. When gaming, the Dell isn't particularly loud and the exterior panels are hot, but not uncomfortable. During a work test, the CPU's delta T of 70°C is a tad high, and saw the CPU's all-core speed drop to 3.5GHz, which would explain the 5800H falling behind other machines with the same CPU. That's not perfect, but it's not disastrous either, and the throttling helped the G15 to stay extremely quiet during work scenarios.

The keyboard impresses too, with a slimmed-down numberpad and a crisp, clean action – it's one of the best typing units on test. The trackpad is small and soft, but it's easy enough to attach a USB mouse instead.

Meanwhile, the screen's 120Hz refresh rate is fine for mainstream gaming, but it's the lowest in the Labs – keen esports fans should seek out 144Hz or 165Hz panels. The delta E of 4.88 and sRGB coverage level of 59.6 are also poor, and mean this panel produces a narrow range of underwhelming colours.

The contrast ratio of 1,300:1 is better, giving the display reasonable depth, but the lack of colour quality means games look bland. That's not a big issue for mainstream play, especially in gritty titles set in urban environments, but colourful games don't pop from this panel.

SPECKLED

- + Solid performance
- + Fantastic battery life
- + Crisp, comfortable keyboard
- + Cheaper than rivals

HECKLED

- Mediocre display
- Pretty heavy and thick
- Some missing connectivity
- Some CPU throttling

The speakers don't have much bass either, and they sound tinny – they're usable but not impactful. It's also disappointing to see USB 2 ports included around the G15's edges.

Conclusion

That poor screen is the Dell G15 5515 Ryzen Edition's biggest issue, but it's not so bad that you can't use it for everyday gaming. Thankfully, the G15 has plenty going for it elsewhere – it delivers solid game and application performance, superb battery life, a great keyboard and bold, robust design.

The Alienware is better if you prize display quality, and the Lenovo is superior if you want more power, but both are more expensive. The Dell's otherwise solid quality and lower price make it a worthy award winner.

VERDICT

Impressive performance, design and battery life combined with a very reasonable price, although the screen could be better.

SPEC

CPU 3.2GHz AMD Ryzen 7 5800H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB

Screen 15.6in 1,920 x 1,080 IPS 120Hz

Storage 512GB Samsung PM991a M.2 SSD

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

Weight 2.44kg

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

Dimensions (mm) 357 x 273 x 27 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base

PERFORMANCE

22/25

HARDWARE
19/25

DESIGN

21/25

VALUE
21/25

OVERALL SCORE

83%

GIGABYTE G5-KC

/ **£999** inc VAT

SUPPLIER scan.co.uk

Gigabyte's G5 is the cheapest laptop in the Labs. It's natural to be sceptical of a gaming machine with such a low price, but it gets off to a good start with an RTX 3060 that runs at 105W. That mid-range power envelope translates into decent performance.

The Gigabyte's finest result came in Valhalla, where its 99th percentile minimum of 39fps matched the group's best RTX 3060 machines. It was a couple of frames per second behind the 125W competition in other games, but the gaps weren't huge and there's still ample power for mainstream gaming. The Gigabyte's nearest rival at the checkout is the Acer, and the G5 was almost always quicker.

The G5 is also the only laptop in the Labs with a Core i5 processor. Intel's i5-10500H is outdated on paper, but it still has six Hyper-



Threaded cores alongside base and turbo speeds of 2.5GHz and 4.5GHz. It's not the fastest CPU in the group, of course – its image editing score of 54,504 is around 10,000 points behind the all-conquering AMD Ryzen 7 5800H, and it's further behind in multi-threaded scenarios.

There's enough power here for everyday computing, though, and it's quicker than the low-power Core i7 CPUs used elsewhere. This machine doesn't get too loud or warm either.

Meanwhile, the display's contrast level of 1,200:1 delivers good depth and vibrancy, and the brightness level of 324cd/m² is ample. The display rendered an impressive 93.8 per cent of the sRGB gamut with a delta E of 1.88, so colours are accurate. The colour temperature of 7,395K is a little too cool, but it's not a big deal at this price, and games still look excellent.

The keyboard is decent too – it included a narrow numberpad, and the buttons are crisp and quick – well suited for fast-paced games. The Dell and Alienware keyboards are firmer, but the G5 isn't far behind. The trackpad has soft, flimsy buttons, but you can always use a USB mouse on a desk.

On the downside, the G5 looks bland, and build quality is middling – we'd recommend

a sleeve to protect the screen. The 2.2kg weight isn't bad, but the 27.9mm thickness means the G5 is larger than most rivals. There's more to shout about in practical areas – this is the only system in the Labs with an SD card slot, and there are two NVMe connectors and a 2.5in SATA slot on the inside, so there's scope for adding storage. The two year warranty is generous as well too.

Don't expect much from the 49Wh battery though. The G5 lasted for just over an hour when gaming and it only just limped beyond four hours in a work test.

Conclusion

The G5 is the most affordable laptop in the Labs, so it won't excel in every department, but it has a good screen, solid gaming speed and a high-quality keyboard. For single-player gaming and esports on a budget, it's a great choice. The battery, exterior design and processor are average, but none of that's a surprise. However, the Acer and Dell are viable contenders if you can spend a little more – the former has more processing power and the latter is faster in games and has better battery life.

VERDICT

It's not perfect, but the G5 offers solid gaming pace and a great screen for a surprisingly low price.

TIGER LAKE

- + Great price
- + Solid gaming speed
- + High-quality 144Hz display
- + Crisp, snappy keyboard

TIGER KING

- Thick, underwhelming exterior
- Poor battery life
- Mediocre Core i5 CPU

SPEC

CPU 2.5GHz Intel Core i5-10500H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB

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

Storage 512GB Phison ESR512GTLCC-EACM.2 SSD

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

Weight 2.2kg

Ports 2x USB 3.2 Gen1, 1x USB 3.2 Gen1 Type-C / DisplayPort, 1x USB 2, 1x audio, 1x HDMI, 1x mini-DisplayPort, 1x SDXC

Dimensions (mm) 361x258x28 (WxDxH)

Operating system Windows 10 Home 64-bit

Warranty Two years parts and labour return to base



PERFORMANCE

19/25

HARDWARE
18/25

DESIGN

17/25

VALUE
24/25

OVERALL SCORE

78%



LENOVO LEGION 5

/ **£1,299** inc VAT

SUPPLIER laptopsdirect.co.uk

Lenovo's Legion 5 is one of the most intriguing machines in the Labs, because it serves up an Nvidia GeForce RTX 3070 and AMD Ryzen 7 5800H for a relatively low price of just £1,299 inc VAT. That figure undercuts the Alienware, which uses an RTX 3060, and it also ducks below the PC Specialist, which pairs the RTX 3070 with a beefier AMD processor.

The RTX 3070 in this laptop has a solid peak power limit of 130W, and the 8-core CPU runs at base and turbo speeds of 3.2GHz and 4.4GHz. There's 16GB of memory and a 512GB SSD with impressive read and write speeds of 3,594MB/sec and 1,681MB/sec.

In Assassin's Creed Valhalla, the Lenovo returned a 99th percentile minimum of 52fps, which is the best in the Labs, and its scores in our other games competed well with the PC Specialist. The Lenovo is comfortably quicker than the Alienware, and there's enough speed here to play single-player games and esports titles without issue.

Four laptops in this group use the Ryzen 7 5800H, and the Lenovo is the fastest one.

SPEC

CPU 3.2GHz AMD Ryzen 7 5800H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3070 Laptop 8GB

Screen 15.6in 1,920 x 1,080 IPS 165Hz

Storage 512GB SK Hynix PC711 M.2 SSD

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

Weight 2.4kg

Ports 4x USB 3.2 Gen1, 2x USB 3.2 Gen2 Type-C/DisplayPort, 1x audio, 1x HDMI

Dimensions (mm) 363 x 261 x 26 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base



It's comfortably quicker than the Intel-based machines, and isn't far behind the Ryzen 9-based PC Specialist. Content creation and multi-tasking are well within the Legion's remit. Plus, impressively, the Legion is consistently quieter than the PC Specialist and Alienware machines, and the exterior is never too hot.

The Legion's keyboard has a numberpad, separated cursor keys and large, well-spaced buttons. The latter are comfortable and fast to use, although they're a little softer than those on the Alienware, PC Specialist and Dell machines. They're easily good enough for gaming and typing.

The Legion's biggest issue is its screen. Its black point of 0.46cd/m² is high, which means a low contrast ratio of 713:1. It's a bright panel but, in real-world use, that means dark areas lack depth. The colour temperature of 7,809K is cool too. The panel renders almost all of the sRGB gamut, and it does have a 165Hz refresh rate, so games are fast, smooth and perfectly playable, but colourful games look washed out.

Battery life is middling too. The Lenovo lasted for longer than rivals while working and

playing media, but it only managed little more than an hour when gaming – the Alienware and PC Specialist were both better here.

As with most mid-range laptops, the exterior has some omissions. There are loads of USB ports, but no card reader, and the speakers sound tinny and muffled. Build quality is fine, but the Alienware is stronger, and the Lenovo weighs 2.4kg, so it's hardly light either. It doesn't look eye-catching, but many people will also prefer its subtle design.

Conclusion

The Legion isn't flawless, but its issues aren't unique and they aren't dealbreakers at this price – if you want a better screen, then the Dell, Gigabyte and Alienware machines all have better displays, albeit with negatives elsewhere. Indeed, the Legion's positives significantly outweigh the negatives.

It has tremendous gaming and application speed, loads of ports, a good keyboard and decent thermal performance. Combine all this with the moderate price and you have a worthy award winner.

VERDICT

Huge speed, a good keyboard and a surprisingly low price make for a formidable portable gaming machine.

ROMAN CHARGES

- + Consistently fast gaming speed
- + Superb AMD processor
- + Cheaper than key competitors
- + Consistently cool and quiet

ROAMING CHARGES

- Mediocre display
- Average battery life
- Tinny speakers
- Heavy chassis

PERFORMANCE

22/25

HARDWARE
20/25

DESIGN

20/25

VALUE
23/25

OVERALL SCORE

85%

MSI STEALTH 15M

/ **£1,149** inc VAT

SUPPLIER currys.co.uk

As its name suggests, MSI's Stealth 15M is designed for discretion. Its sleek black chassis measures just 16.15mm thick and weighs 1.7kg, making the MSI the slimmest and lightest laptop in the Labs. Build quality is reasonable – there's some movement in the chassis' base and around the display, but a sleeve will protect the laptop.

The added bounce doesn't prevent the keyboard from being pleasingly crisp in action either, but bear in mind that there's no numberpad and the trackpad has too much movement. The slimline design makes the MSI more portable than most gaming laptops, but it does mean there are restrictions under the hood. This machine may have an RTX 3060, but it's restricted to 65W – the lowest



power envelope in the Labs. Meanwhile, processing power comes from an Intel Core i7-11370H, a quad-core chip with a modest TDP of 35W.

As with every other machine on test, there's 16GB of memory, and the 1TB SSD has reasonable read and write speeds of 2,227MB/sec and 1,938MB/sec, with a decent capacity for the price. You also get dual-band Wi-Fi 6 and Bluetooth, but the there's no Ethernet port. Connection options are better elsewhere, with two full-sized USB ports and two USB Type-C connections, one of which supports Thunderbolt 4. There's a microSD card reader too.

Not surprisingly, though, the low-power RTX 3060 contributed to underwhelming gaming performance. This was the slowest laptop in the Labs, with sub-25fps 99th percentile results in Assassin's Creed, Cyberpunk 2077 and Metro Exodus, and unplayable averages in the latter two titles. The MSI was half as quick as the other RTX 3060 laptops in Doom as well. However, most games will be playable at reduced graphics settings, and you'll still get decent performance in undemanding esports titles.

It's a similar story in application benchmarks – the same CPU was quicker in the Asus, the Gigabyte's Core i5 CPU was faster again, and AMD's CPUs opened a huge lead in other machines. The MSI can handle mainstream office tasks, but you won't want to use it for demanding video editing work.

The MSI isn't the best in thermal tests either. The fan noise is irritatingly high-pitched, and the base was almost too hot to

touch during intense gaming. On the plus side, the battery lasted for nearly two hours when gaming, but it didn't last particularly long in our work test compared with other machines on test.

Meanwhile, the screen's colour temperature of 7,930K is too cool, and the delta E of 5.75 is mediocre, so colours aren't particularly accurate. The sRGB coverage level of 51.8 per cent is low, which means the MSI can't render many of the shades that games require. Games look underwhelming, and the decent contrast ratio of 1,150:1 can't save this panel.

Conclusion

MSI's machine doesn't have the pace to compete with the best laptops in the Labs, and rivals have better keyboards and screens too. The Stealth's best feature is its slim, light body, giving you a modicum of gaming ability inside a laptop that's easy to carry. However, the modest performance means this laptop is more suited to casual gamers than anyone who wants a portable laptop with serious application or gaming ability.

VERDICT

Slim, light and portable, but the screen isn't great and it lacks gaming power.

PERFORMANCE

15/25

HARDWARE
17/25

DESIGN

19/25

VALUE
19/25

OVERALL SCORE

70%

BOMBER

- + Slim, light chassis
- + Can handle everyday gaming
- + Includes Thunderbolt 4

BOMBED

- Relatively sluggish internals
- Restrictive, inaccurate screen colours
- Gets hot and makes irritating noise

SPEC

CPU 3GHz Intel Core i7-11370H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB

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

Storage 1TB Micron 2210 M.2 SSD

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

Weight 1.7kg

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

Dimensions (mm) 395 x 248 x 16 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base



PC SPECIALIST IONICO / £1,499 inc VAT

SUPPLIER pcspecialist.co.uk

The PC Specialist is the only laptop in this Labs from a British system builder, and it stands out with high-end hardware. It's the only machine on test with an AMD Ryzen 9 5900HX processor, with eight cores alongside base and turbo speeds of 3.3GHz and 4.6GHz. The rest of the specification is similarly muscular. The 140W RTX 3070 is the most powerful GPU in the Labs on paper, and you get 2.5Gbps Ethernet alongside dual-band Wi-Fi 6.

That CPU made the Ionico the fastest laptop on test in our image editing benchmark, and it was the second fastest chip in the Handbrake test, so it clearly has the pace to scythe through creative workloads. The SSD helps too – its read and write speeds of 3,108MB/sec and 2,477MB/sec are excellent.

However, the 2933MHz memory held back performance a little in our heavy multi-tasking

test, with a result of 167,165. During this test the CPU also throttled to around 3.5GHz, compared to a slightly quicker 3.6GHz on the Ryzen 7 5800H-based Lenovo and Acer machines. The PC Specialist's overall system score of 212,414 is still solid though.

Not surprisingly, the GPU is quick too. At 1080p, the Ionico produced the fastest 99th percentile results in Doom, Cyberpunk 2077 and Metro Exodus. Games remained playable at the machine's native resolution of 2,560 x 1,440 too: the Ionico played Assassin's Creed and Cyberpunk with 99th percentile minimums beyond 30fps. In practice, though, the Lenovo was just as fast for the most part, and sometimes faster.

Meanwhile, the screen's 2,560 x 1,440 resolution makes games look crisper than on 1080p panels, and the 165Hz refresh rate is good for esports. The screen's brightness level of 361cd/m² delivers solid punch, and the delta E of 1.85 means colours are accurate. The contrast level of 976:1 is middling, so imagery lacks a little depth on this display, but it's not a terminal issue.

You even get reasonable battery life. The PC Specialist lasted for more than 90 minutes when gaming and more than seven hours in a video playback benchmark, with both figures beating most rivals on test this month. Despite the spec, the fan noise isn't awful either. The PC Specialist is a little louder than most gaming laptops, but the racket isn't ruinous.

While the Ionico has solid core performance, though, it's inconsistent elsewhere. It's sturdy and no larger than the Alienware, but it looks comparatively bland. The trackpad also feels flimsy and while the speakers have ample bass, they sound tinny at the high end.

ICONIC

- + Impressive gaming speed
- + 2,560 x 1,440 display
- + Fast 8-core CPU
- + Three year warranty

IRONIC

- Not always the fastest in games
- Underwhelming design
- Cramped keyboard
- Disappointing speakers

Plus, while its RGB-backlit keyboard has a numberpad and its buttons are crisp, the layout is cramped. However, the Ionico's three year warranty is the best in the Labs, although there's only a year of parts cover.

Conclusion

The PC Specialist Ionico combines impressive performance with a 2,560 x 1,440 display, a generous warranty and a reasonable price. If these are your priorities, then it's well worth considering, but this is also a competitive market.

The award-winning Lenovo Legion 5 is cheaper and just as fast in practice, and the Alienware has better looks and a superior display. The Ionico offers a great spec for the money, but it also lacks the panache of some of its competitors. **GPC**

VERDICT

Loads of power and a good warranty, but it lacks the panache of some of its competitors.

SPEC

CPU 3.3GHz AMD Ryzen 9 5900HX

Memory 16GB 2933MHz DDR4

Graphics Nvidia GeForce RTX 3070 Laptop 8GB

Screen 15.6in 2,540 x 1,440 IPS 165Hz

Storage 1TB Intel 670p M.2 SSD

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

Weight 2.25kg

Ports 3 x USB 3.2 Gen1, 1 x USB 3.2 Gen1 Type-C / DisplayPort, 1 x audio, 1 x HDMI, 1 x microSD

Dimensions (mm) 357 x 236 x 23 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty Three years labour with one year parts and one month collect and return

PERFORMANCE

23/25

HARDWARE
20/25

DESIGN

18/25

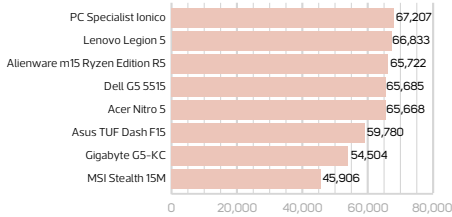
VALUE
20/25

OVERALL SCORE

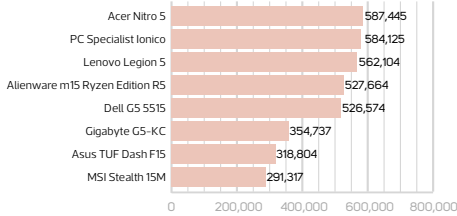
81%

GAMING LAPTOPS BENCHMARK RESULTS

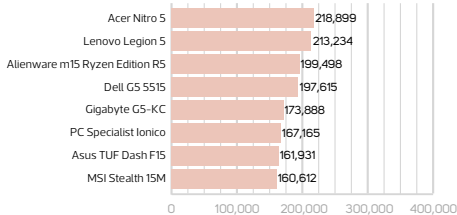
GIMP IMAGE EDITING



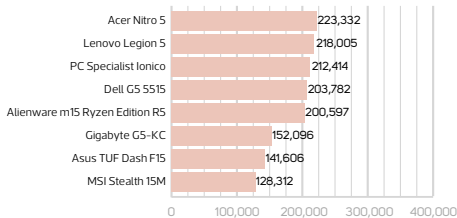
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

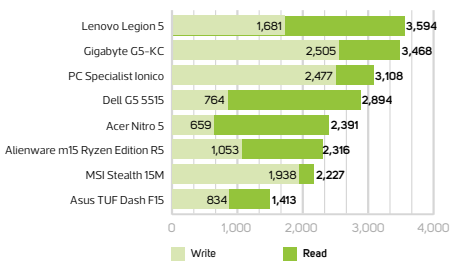


SYSTEM SCORE



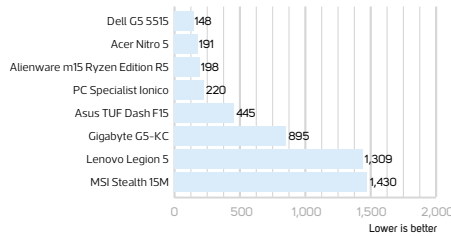
SSD PERFORMANCE (MB/SEC)

CrystalDiskMark, sequential 32-queue depth

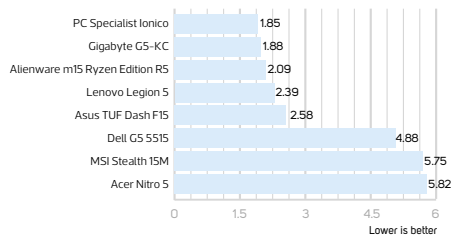


SCREEN COLOUR TEMPERATURE (KELVIN)

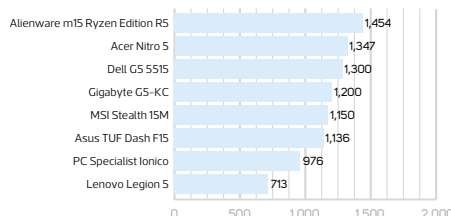
Deviation from ideal result of 6,500K



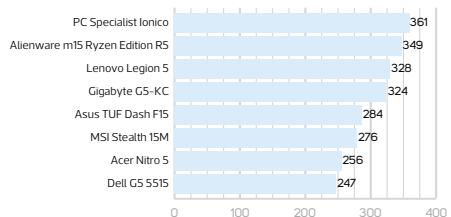
SCREEN COLOUR ACCURACY (DELTA E)



SCREEN CONTRAST RATIO

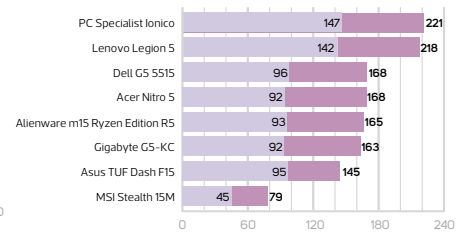


SCREEN BRIGHTNESS (CD/M²)



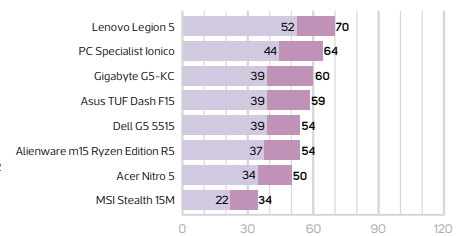
DOOM ETERNAL (FPS)

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



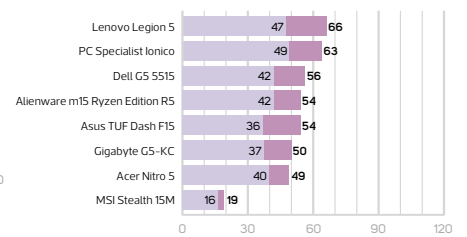
ASSASSIN'S CREED VALHALLA (FPS)

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



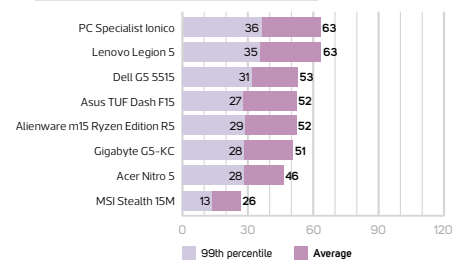
CYBERPUNK 2077 (FPS)

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



METRO EXODUS (FPS)

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



99th percentile Average

LABS TEST

Pixel packers

Still the ultimate in pixel-peeping resolution for most people, **Edward Chester** puts four of the latest 4K monitors to the test.

How we test

If you're looking for pin-sharp image quality, opting for a 4K monitor is still the ultimate upgrade for most people, whether you go for an enormous 30in+ panel or a display size that's a little more modest. In recent years we've also seen 4K gaming screens finally offer higher refresh rates than 60Hz, greatly enhancing their gaming potential.

We've grabbed four of the latest 4K screens over a range of prices and feature sets, to demonstrate what 4K options are available. Whether you're looking for the ultimate do-it-all screen, or just a high-res panel for productivity, one of these displays will likely fit the bill.

We start our testing by assessing the fit, finish and features of the monitors, looking at the quality of materials, the adjustability of the stand, the connections on offer and any other extra features. Height adjustability, USB hubs, easy-to-use OSD controls and more can all greatly affect the usability of a monitor.

Next, we look at image quality, subjectively assessing the viewing angles and colour reproduction of the panel, before moving on

to testing colour accuracy, contrast, panel uniformity and more with a colorimeter. In general, monitors should ideally hit a colour temperature of 6,500K, a contrast of around 1,000:1, an sRGB colour space coverage of up to 100 per cent (not over), a gamma number of 2.2 and an average delta E colour accuracy of under three.

For displays that offer HDR modes, contrast should be as high as possible (generally achieved by breaking up the backlight into zones to allow for deep blacks and bright colours on-screen at the same time), while colour space coverage should be well over 100 per cent.

Next, we assess the gaming performance of the screen subjectively by playing games on them. We look at the responsiveness of the screen (generally determined by its refresh rate and response time) and whether it offers any clarity-improving modes for fast motion, such as backlight strobing blur reduction, adaptive sync (FreeSync and G-Sync) or overdrive options in the OSD. We also assess the response time of the display using the BlurBusters UFO ghosting test, where we take pictures of the screen to determine the level of ghosting or smearing in the image.

Contents

- AOC U28G2AE / p53
- BenQ EW2780U / p57
- Asus ROG Swift PG32UQX / p54
- Results graphs / p58
- Asus TUF Gaming VG28UQL1A / p56

AOC U28G2AE / £205 inc VAT

SUPPLIER laptopsdirect.co.uk



The AOC U28G2AE is a super-low-budget 4K gaming screen that lacks many of the high-end features that adorn pricier models. However, it still boasts some key features that make it well worth considering if image quality is your main priority.

The key upgrade it offers over some cheap 4K monitors of the past is the use of an IPS LCD panel. This ensures you get good viewing angles and better colour reproduction than TN LCD panels. Another key addition is adaptive sync support, gaining you tear and stutter-free gaming with both AMD and Nvidia GPUs.

The big downside when it comes to gaming performance is the 60Hz refresh rate. While adaptive sync will keep your games looking relatively smooth, the slow rate of update means this monitor isn't ideal for fast-paced competitive gaming. Instead, it's cinematic games where this screen shines. Thanks to excellent overall image quality right out of the

box, and of course that 4K resolution, the likes of Cyberpunk 2077 look fantastic.

Putting that image quality into numbers, we start with a decent contrast ratio of 941:1, making for an engaging-looking image, with none of the washed-out feel of lower-contrast displays.

Meanwhile, the out-of-the-box colour temperature of 6,744K is close enough for all but the very most critical of colour-accurate work. The gamma rating of 2.29 is a touch high, leading to a slight tendency to crush dark detail, but there's a small enough difference between this figure and the ideal 2.2 figure to only worry image editing professionals. There are further gamma options in the OSD, but these measured 2.09 and 2.51, so none quite hits that 2.2 mark.

The display also offers a slightly extended colour gamut of 110 per cent sRGB, but that's the extent of any HDR pretensions – HDR can't be enabled in Windows. There's also an sRGB mode that clamps the colour gamut, but it actually goes too far, dropping to 89 per cent coverage in our measurements. This mode also fixed brightness at too high a level, so we'd leave the screen in its slightly extended gamut default.

Adjusting the settings isn't all that easy either, as the OSD is the worst aspect of this screen. It has all the settings you should need, and they're generally arranged in an

intuitive enough manner, but the controls for navigating them are terrible. They consist of four buttons on the underside of the screen that also sit alongside the identical power button. The buttons are fiddly to find, the way they interact with the menus isn't that intuitive, and it's also very easy to just hit the power button and accidentally turn off the screen.

Other more basic features include the stand, which only offers tilt adjustment, and there's no USB hub or any other extras. Video connection options are similar to those on most more expensive displays, though, with one DisplayPort input and two HDMI ports. The display still has a fetching modern design too, with slim, low-profile bezels and a pointy-footed stand, plus the stereo 3W speakers and headphone jack sound okay.

Conclusion

The addition of adaptive sync just about qualifies this display as a gaming monitor, but its 60Hz refresh rate means it's only good for slower-paced games. For such games – and every other task – it excels though. Image quality is solid across the board and it looks smart too. For its price, that's really all you can ask.

VERDICT

A low price and great image quality make this a decent entry-level 4K monitor, as long as you don't want to play fast-paced games.

SPEC

Screen size 28in

Resolution 3,840 x 2,160

Panel technology IPS

Maximum refresh rate 60Hz

Response time 4ms

Max brightness 350cd/m² (SDR)

Stated contrast ratio 1,000:1 (SDR)

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.4, 2x HDMI 2

Audio Headphone out, 2 x 3W speakers

Stand adjustment Tilt

Extras 100 x 100mm VESA mount

LOW COST

- + Solid 4K image quality
- + Elegant design
- + Adaptive sync support
- + Amazingly low price

BARGAIN BIN

- 60Hz limits gaming performance
- Basic stand
- Poor OSD controls

IMAGE QUALITY

26/30

FEATURES
11/20

GAMING

17/30

VALUE
20/20

OVERALL SCORE

74%

ASUS ROG SWIFT PG32UQX / £3,299 inc VAT

SUPPLIER scan.co.uk

Cast your mind back a couple of years to the time when we got our first glimpse of true HDR gaming monitors with the Asus PG27UQ. This 27in 4K display came equipped with 512 individual backlighting zones, which properly allowed for the dazzling contrast that's the defining feature of HDR content. The problem was, with a diagonal of just 27in, it lacked the big-screen impact that you'd hope to get from such a colossally expensive display.

The ROG Swift PG32UQX, then, ups the ante on all fronts, more than doubling the number of backlight zones to 1,152 and increasing the screen size to 32in. Now you get a vision-filling image and a screen size



that's large enough to allow you to take advantage of all those pixels in Windows desktop tasks. Instead of having to run Windows scaling at 150 per cent to make text readable, this monitor can be used at 125 per cent, resulting in a larger usable desktop area.

You get plenty more than just a bigger screen too. Asus has equipped the PG32UQX with an OLED display on the front lower bezel, which can show images or display information such as your current frame rate in a game. The latter is particularly useful for quickly keeping tabs on performance in games. Other monitors and software offer on-screen overlays, but these take up screen space and are generally far harder to see at a glance.

RGB lighting abounds too, with an illuminated ROG logo on the back of the display and a downlight on the underside of the stand, which projects onto your desk.

A red ROG logo also projects out the top of the stand. It's all utterly frivolous stuff – to the point where many of us would rather have the price reduced by a few hundred pounds than have it all included, but it certainly looks impressive.

The generally premium feel also extends to the overall build quality and stand design, with the tiptoe feet of the stand being made from solid metal. It's actually not a particularly practical foot design but it looks good. The stand also offers all the usual adjustments, other than pivot, plus there's a 100 x 100mm VESA mount for using other stands and mounting systems.

Meanwhile, the connection options on offer are decent if not outstanding, with three HDMI 2 inputs and a 4-port USB hub. However, having only one DisplayPort input (1.4) is a bit of a letdown at this price, and while two of the USB ports are 3.1, two of them only support the much slower USB 2 standard.

SPEC

Screen size 32in

Resolution 3,840 x 2,160

Panel technology IPS

Maximum refresh rate 144Hz

Response time 1ms

Max brightness 500cd/m² (SDR), 1,400cd/m² (HDR)

Backlight zones 1,152

Stated contrast ratio 1,000:1 (SDR), 400,000:1 (HDR)

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.4, 2x HDMI 2

Audio Headphone out

Stand adjustment Height, tilt, rotation

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

BACKLIGHT ZONES

- + Stunning HDR
- + Packed with features
- + Fantastic overall image quality
- + Solid gaming performance
- + Almost big enough to justify its price

ZONED OUT

- Its price!
- Some superfluous flashy extras
- No backlight strobing mode





Another premium feature is the OSD control system, which consists of a rotating dial on the underside of the screen, along with a pair of flanking buttons. We actually found it slightly unintuitive to use, as the scroll direction when twisting the dial seemed the wrong way around, but you get used to it eventually. Otherwise, the OSD menu system itself is speedy and easy to use with a plethora of options.

Performance

When it comes to image quality, we were pleased to see that this display defaults to using an sRGB colour space, rather than the extended colour gamut it can offer for HDR (or that can be manually activated). This is how all monitors should be set up by default.

You can also engage the 1,152 backlight zones in sRGB mode, giving a boost to contrast (up to 4,665:1 in our tests) for non-HDR content, or turn off this feature to get a flat uniform response, which will be the best option for desktop work and image/video editing.

Turn on HDR (or the extended colour gamut) and this display offers 121 per cent of the DCI-P3 colour space (a whopping 170

per cent sRGB), providing dazzling, vibrant colours. Combined with its 1,152 backlight zones, this results in jaw-dropping HDR reproduction, with a contrast ratio rated to 400,000:1, although our equipment could only measure up to 13,375:1. We recorded an incredible 1,605 nits maximum brightness, alongside inky blacks of just 0.08 nits. Typical IPS screens can deliver around 400 nits maximum and 0.4 nits minimum.

We tend to go on about the limitations of pseudo or lower-tier HDR modes in displays with single backlights, or with only slightly extended colour gamuts, and it's when you see a display such as this one that you can fully appreciate the point. This is true HDR and the rest is a poor imitation.

Gaming performance is solid too. You get support for FreeSync (only supported on DisplayPort) and G-Sync (DisplayPort and HDMI), along with a 144Hz maximum refresh rate and a decent response time for an IPS panel. As such, you don't only get a visually stunning gaming display, but also one that can hold its own in faster-paced games. It can't really compete with 240Hz+ esports displays but it's good enough for most people's needs.



The one key feature you miss out on is ELMB-Sync, as on Asus' VG28UQL1A (see p56). This backlight strobing blur reduction mode sharpens up the image considerably in fast motion, and sadly there simply isn't any sort of backlight strobing mode available here.

Conclusion

After a few false starts with full-array, local-dimming HDR gaming monitors, the Asus ROG Swift PG32UQX finally hits the mark in all the right ways. Its HDR performance is fantastic, the screen is big enough to make it feel at least a little closer to being worth its huge asking price and its gaming performance is solid. You technically do still miss out on a few features here and there, such as any backlight strobing mode, but otherwise this display is a stunner, as you'd hope given its astronomic price tag.

VERDICT

Just about everything you could ever want from a 4K gaming monitor, except an affordable price.

IMAGE QUALITY 30/30	GAMING 25/30	OVERALL SCORE 80%
FEATURES 20/20	VALUE 5/20	

ASUS TUF GAMING VG28UQL1A / £749 inc VAT

SUPPLIER scan.co.uk

Monitors with both a 4K resolution and a fast refresh rate aren't entirely new, but choices have largely been limited so far and there have been restrictions such as the maximum refresh rate you can achieve while maintaining full colour depth. With the TUF Gaming VG28UQL1A, though, there are very few such compromises.

This 28in, 4K IPS screen boasts a 144Hz maximum refresh rate, which it can maintain even when driven with a high colour depth HDR signal. It also includes a degree of backlight zoning for better HDR reproduction. Add in a fully adjustable stand and a USB hub and you have quite the feature list.

However, the TUF branding is one that Asus applies to its more budget-focused monitors, and sure enough, there isn't the level of finish or features of the PG32UQX, although that's forgivable given the colossal price difference. In this case, for example, the stand is finished in plain black plastic and lacks all the RGB lighting of its more expensive sibling, although it's at least fully adjustable.

SPEC

Screen size 28in

Resolution 3,840 x 2,160

Panel technology IPS

Maximum refresh rate 144Hz

Response time 1ms

Max brightness 350cd/m² (SDR), 450cd/m² (HDR)

Backlight zones 8

Stated contrast ratio 1,000:1 (SDR and HDR)

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.4, 2x HDMI 2

Audio Headphone out, 2x 2W speakers

Stand adjustment Height, pivot, rotation, tilt

Extras 100 x 100mm VESA mount, 2-port USB hub



The USB hub has also dropped to just two ports, but they're both USB 3.1 and you get four HDMI inputs (2 x 2.1, 2 x 2.0), along with one DisplayPort 1.4 input and a headphone jack. The latter sounds decent too, as do the stereo 2W speakers – there's none of the loss of clarity as on some cheaper monitors.

The OSD controls ranged down the rear right of the display don't match that of the PG32UQX, but they still have a crisp feel and snappy response while the menus are intuitively laid out.

Being an IPS panel, viewing angles are excellent and colour reproduction is very accurate. This display also has a slightly extended colour gamut of around 120 per cent sRGB (depending on the exact mode). However, this isn't sufficient for the most demanding HDR standards and, moreover, the gamut can't be clamped to 100 per cent sRGB, so it sits in a slightly awkward middle ground. That's not ideal for sRGB-based image/video editing, and not really capable for HDR, although it's fine for most gaming tasks.

Speaking of HDR, the eight full-height backlighting zones/columns here may allow Asus to claim a 1,000,000:1 contrast ratio, but in practice, they don't produce any meaningful boost to contrast with real-world HDR content.

When it comes to gaming, though, the 4K resolution produces just the sort of stunningly sharp image you'd anticipate, with vivid and accurate colours. It may not do HDR very well, but it's still a great-looking screen right out the box.

Gaming performance is excellent too, with adaptive sync (FreeSync and G-Sync support), a decently rapid 1ms response time rating and that 144Hz refresh rate combining to produce an

PIN SHARP

- + Solid 4K image quality
- + Great gaming performance
- + ELMB-Sync is superb

PIN PRICK

- Can't really do HDR
- No sRGB mode
- A bit pricey

impressively smooth image – assuming your graphics card can keep up. What's more, Asus has included its ELMB-Sync technology, which allows the display to offer backlight strobing blur reduction in conjunction with adaptive sync for even greater clarity in fast motion.

This display also includes variable overdrive to ensure it maintains the best balance of response time and image quality, no matter what the frame rate of your game.

Conclusion

This is a fantastic, high-performance 4K gaming monitor. Its image quality is rock solid and gaming performance is class-leading for a 4K panel. Its HDR pretensions don't amount to much, and its lack of an sRGB mode is a shame, but it delivers the goods for gaming performance with 4K crispness.

VERDICT

A near-perfect balance of image quality and performance.

IMAGE QUALITY

25/30

FEATURES
15/20

GAMING

27/30

VALUE
15/20

OVERALL SCORE

82%

BENQ EW2780U

/ **£380** inc VAT

SUPPLIER ebuyer.com

BenQ markets the EW2780U as an entertainment monitor, rather than a gaming model, and for good reason. Along with its comparatively limited 60Hz refresh rate, you don't even get support for adaptive sync, so there are no meaningful gaming features.

Instead, the focus here is on HDR and overall image quality, along with a few extras such as an ambient light sensor, uprated speakers and USB Type-C support. The latter lets you deliver 60W of power to connected devices, as well provide a data connection and video connection using DisplayPort Alt mode. Essentially, you can plug in a laptop and this one port provides everything you need through one

AMBIENT LIGHT

- + Solid 4K image quality
- + Useful ambient light sensor
- + Half-decent speakers
- + USB Type-C connection

SPOTLIGHT

- No gaming extras
- Pointless HDR modes
- Pricier than more basic 4K screens

SPEC

Screen size 27in

Resolution 3,840 x 2,160

Panel technology IPS

Maximum refresh rate 60Hz

Response time 5ms

Max brightness 320cd/m² (SDR), 320cd/m² (HDR)

Backlight zones 1

Stated contrast ratio 1,300:1 (SDR and HDR)

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.4, 2x HDMI 2, USB Type-C with DisplayPort

Audio Headphone out, 2x 5W speakers

Stand adjustment Tilt

Extras 100 x 100mm VESA mount, 2-port USB hub

cable, although the lack of a USB hub means you can't connect a keyboard and mouse through the screen.

The rest of the connection options are more typical, consisting of one DisplayPort 1.4 input and two HDMI 2 ports. All the connections are ranged around the back, facing down, where it's relatively easy (depending on how many cables you're using) to cram the cables into a covered channel that runs down the back of the stand, making for a neat setup.

The stand isn't much to write home about though. It only offers tilt movement, and the screen sits quite low, topping out at 461mm. You can alternatively use a 100 x 100mm VESA mount, though, and the mounting section is neatly covered by a pop-off plastic cover when not in use.

Meanwhile, that ambient light sensor is incorporated into the bottom bezel and, once enabled, does a great job of slowly adjusting the screen's brightness in response to lighting conditions. Unfortunately, it also messes with the colour response of the screen, greatly reducing contrast, and the colour balance gets noticeably bluer as the screen brightens. Both of these factors can be good for work and reading, but not great for multimedia or gaming.

Another feature on the front bezel is a button for the HDR modes. These are HDR-emulating modes that adjust the colour response and backlight brightness in accordance with what appears on the screen.

However, with no backlight zoning available and only a 110 per cent sRGB colour space coverage, the HDR abilities here don't amount to much. It's a shame BenQ sullied the otherwise clean bezel with a dedicated button for such a disappointing feature.

Otherwise, BenQ has done a good job with the controls and menus, with a set of buttons and a mini joystick running down the



back right edge of the panel providing a very intuitive control system. You get all the image quality controls you need, plus a few handy extras, such as the brightness logo that pops up when the ambient sensor detects a change in brightness.

Overall image quality is solid too, with good colour balance and native contrast joining the crisp, stable image provided by the IPS panel. There's no sRGB mode for reining in the colour gamut though. Further adding to this screen's multimedia credentials, its pair of 5W speakers are noticeably better than most. There's better clarity and more depth than typical 2W speakers.

Conclusion

The USB Type-C support, ambient light sensor and uprated speakers of the BenQ make it a practical office screen when combined with its solid 4K image quality. However, you pay quite a premium for those features, while missing out on some basics such as height adjustability. **GPE**

VERDICT

A practical one-stop monitor for an office screen, but there are cheaper 4K screens with equally good image quality.

IMAGE QUALITY

25/30

GAMING

11/30

FEATURES

16/20

VALUE

15/20

OVERALL SCORE

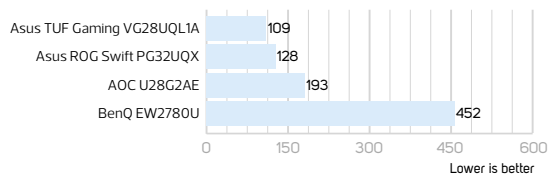
67%

4K GAMING MONITOR LABS RESULTS

DEFAULT / HDR MODE

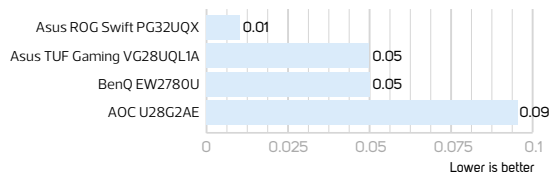
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



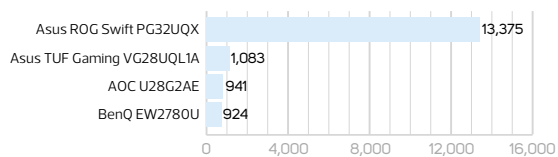
AVERAGE GAMMA

Deviation from ideal result (2.2)



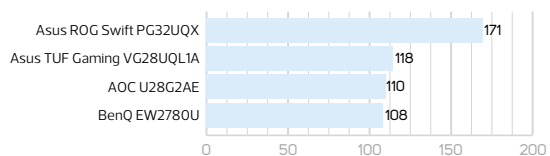
CONTRAST RATIO

Ratio of white-to-black luminance



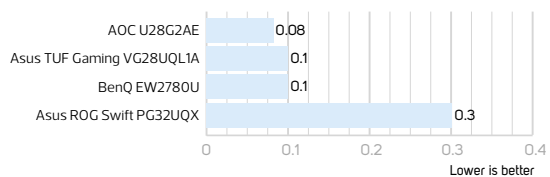
SRGB COLOUR SPACE*

Percentage of sRGB colour space covered



COLOUR ACCURACY

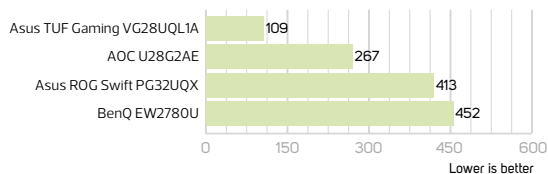
Average delta E 2000



CALIBRATED / SRGB MODE

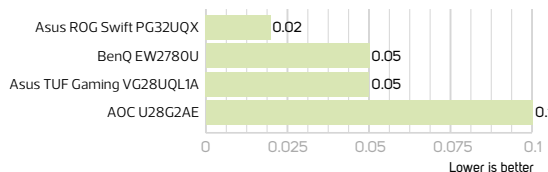
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



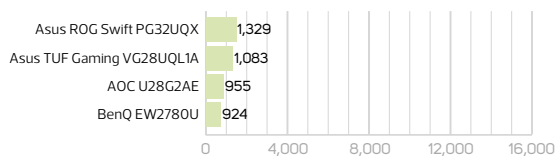
AVERAGE GAMMA

Deviation from ideal result (2.2)



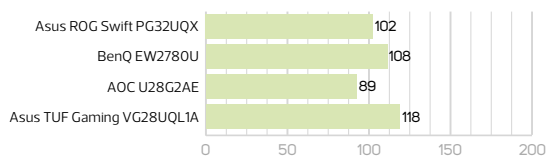
CONTRAST RATIO

Ratio of white-to-black luminance



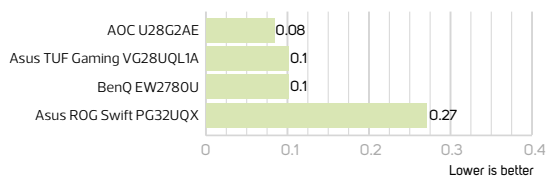
SRGB COLOUR SPACE*

Percentage of sRGB colour space covered



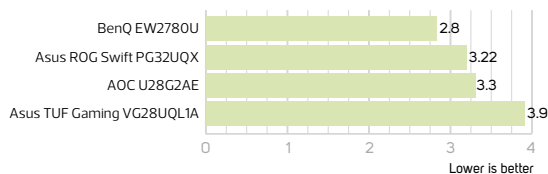
COLOUR ACCURACY

Average delta E 2000



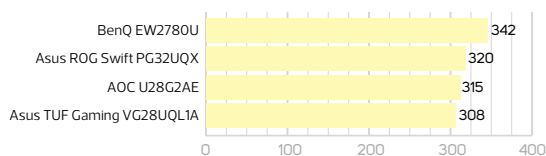
PANEL UNIFORMITY

Deviation from ideal 150cd/m² (nits)



MAXIMUM BRIGHTNESS

Brightness in cd/m² (nits)



* A HIGHER COLOUR SPACE PERCENTAGE IS BETTER FOR HDR, BUT AS CLOSE TO 100 PER CENT AS POSSIBLE IS BETTER FOR SRGB MODE

FREE CHILLBLAST AERO RGB GAMING MOUSE

WITH A 12-MONTH SUBSCRIPTION TO CUSTOM PC

SPEC

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

Our generous pals at Chillblast are kindly offering an 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.



SUBSCRIBE TODAY!

£45 for 12 months – UK ONLY use code **CPCMOUSE**

 **01293 312182**

 **custompc.co.uk/chillblast**

Mouse will be delivered within 28 days of signing up for subscription. Limited quantities available. This subscription gift will be awarded on a first come first served basis.

How we test

MOTHERBOARDS

TEST PROCESSORS

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

Common test hardware between our CPU test rigs includes 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, a 2TB Samsung 970 Evo SSD, a 1TB PCI-E 4 Corsair MP600 SSD and an Nvidia GeForce RTX 3070 FE graphics card.

All CPUs are cooled by a Corsair Hydro-X water-cooling loop, with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock. We test with our RealBench suite and Far Cry New Dawn on Windows 10 Home 64-bit. We also test the board's M.2 ports, and record the noise level and dynamic range of integrated audio using RightMark Audio Analyzer.



PROCESSORS

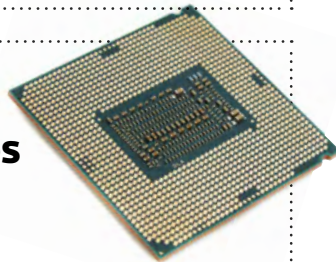
TEST MOTHERBOARDS

- **Intel LGA1200 Rocket Lake**
MSI MEG Z490 Ace
- **Intel LGA1200 Comet Lake**
Asus ROG Strix Z590-E Gaming WiFi
- **AMD AM4** MSI MPG Gaming B550 Carbon WiFi
- **AMD AM4 APU** MSI MEG X570 Unify

Common gear between our CPU test rigs includes 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, a 2TB Samsung 970 Evo SSD and an Nvidia GeForce RTX 3070 GPU. Cooling comes from a Corsair Hydro-X water-cooling loop with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock.

We use the latest version of Windows 10 with security updates, plus the latest BIOS versions and drivers. We record results at stock speed and overclocked, and tests include the CPC RealBench suite for image editing, video encoding and multi-tasking, Cinebench's single and multi-threaded tests, Far Cry New Dawn and Watch Dogs: Legion. We also run Doom Eternal and Dirt 5 on integrated GPUs.

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



MONITORS

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



CPU COOLERS

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

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



TEST KIT

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

INTEL LGA1200

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

AMD AM4

Ryzen 7 5800X overclocked to 4.6GHz with 1.25V vcore, MSI MEG X570 Unify motherboard, or AMD Ryzen 7 1700 overclocked to 3.9GHz with 1.425V vcore for standalone reviews that require comparisons with older results.

INTEL LGA1151

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

INTEL LGA2066

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

GRAPHICS CARDS

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



TEST KIT

AMD Ryzen 9 5900X, 16GB (2 x 8GB) of Corsair Vengeance RGB Pro SL 3600MHz DDR4 memory, Asus ROG Strix B550-E Gaming motherboard, Thermaltake Floe Riing 240 CPU cooler, Corsair HX750 PSU, Cooler Master MasterCase H500M case, Windows 10 Professional 64-bit.

GAME TESTS

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

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

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

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

POWER CONSUMPTION

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



CUSTOM PC AWARDS



EXTREME ULTRA

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



PREMIUM GRADE

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



PROFESSIONAL

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



APPROVED

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



CUSTOM KIT

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

CUSTOM PC REALBENCH

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

GIMP IMAGE EDITING

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

HANDBRAKE H.264 VIDEO ENCODING

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

LUXMARK OPENCL

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

HEAVY MULTI-TASKING

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

Core component bundles

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

8-core system with integrated graphics

8-core CPU, basic gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5700G	scan.co.uk	#218 p20	£329
CPU COOLER	AMD Wraith air cooler included with CPU	N/A	#218 p20	£0
GRAPHICS CARD	AMD Radeon RX Vega 8 integrated into CPU	N/A	#218 p20	£0
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4 M2D3000C16)	scan.co.uk	#218 p78	£63
MOTHERBOARD	Asus TUF B450M-PLUS II (micro-ATX)*	scan.co.uk	#218 p78	£88
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	#204 p24	£50

Total £530

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

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

Needs an ATX case. We recommend a 500W 80 Plus Bronze power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-11400F	scan.co.uk	#215 p16	£150
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	#202 p20	£15
GRAPHICS CARD	AMD Radeon RX 6600 XT	novatech.co.uk	#218 p16	£400
MEMORY	16GB (2 x 8GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	#204 p74	£79
MOTHERBOARD	MSI MAG B560 Tomahawk WiFi (ATX)	scan.co.uk	#215 p18	£170
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	#204 p24	£50

Total £864

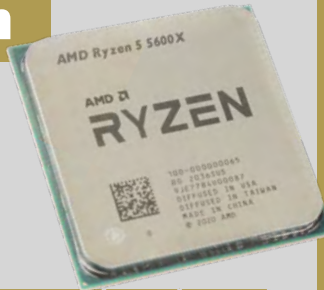
UPGRADES

SWAP GRAPHICS CARD	AMD Radeon RX 6700 XT (2,560 x 1,440 gaming)	overclockers.co.uk	#213 p19	£650
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£124
SWAP CPU COOLER	SilverStone Hydrogon D120 ARGB	watercoolinguk.co.uk	#217 p43	£46

2,560 x 1,440 gaming system

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

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 5600X	scan.co.uk	#213 p43	£260
CPU COOLER	SilverStone Hydrogen D120 ARGB	watercoolinguk.co.uk	#217 p43	£46
GRAPHICS CARD	AMD Radeon RX 6700 XT	overclockers.co.uk	#213 p19	£650
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£102
MOTHERBOARD	MSI MPG B550 Gaming Carbon WiFi	cclonline.com	#210 p74	£160
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£124

Total £1,342

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£80
SWAP CPU COOLER	Antec Neptune 240	scan.co.uk	#216 p44	£80
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	overclockers.co.uk	#216 p16	£860

Mid-range gaming system

8-core CPU, smooth 2,560 x 1,440 gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	#213 p44	£380
CPU COOLER	Lian Li Galahad 240mm	overclockers.co.uk	#216 p47	£110
GRAPHICS CARD	AMD Radeon RX 6800 XT	scan.co.uk	#211 p42	£950
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£102
MOTHERBOARD	Asus ROG Strix B550-XE Gaming WiFi	scan.co.uk	#218 p22	£210
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£124

Total £1,876

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£80
SWAP CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	#216 p46	£150

Core component bundles cont ...

4K gaming system

8-core CPU, 4K gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	#213 p44	£380
CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	#216 p46	£150
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	overclockers.co.uk	#216 p18	£1,320
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£102
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	#193 p44	£290
STORAGE	1TB WD Black SN850	box.co.uk	#215 p49	£165
Total £2,407				

UPGRADES

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

Content creation system

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

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 9 5900X	overclockers.co.uk	#213 p45	£530
CPU COOLER	NZXT Kraken X63 (280mm AIO liquid cooler)	scan.co.uk	#207 p47	£130
GRAPHICS CARD	AMD Radeon RX 6600 XT	novatech.co.uk	#218 p16	£400
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 3600MHz (CMW32GX4M2D3600C18)	scan.co.uk	#210 p74	£150
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	#193 p48	£389
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£389
Total £2,039				

UPGRADES

SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	scan.co.uk	#216 p18	£1,430
SWAP CPU	AMD Ryzen 9 5950X (16 cores - more multi-threaded power)	scan.co.uk	#213 p46	£700
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	#166 p54	£80

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

Mini PCs

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

Mini-ITX



Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	scan.co.uk	#214 p18	£270
Intel Z490 (LGA1200)	Asus ROG Strix Z490-I Gaming	scan.co.uk	#206 p40	£250
AMD B550 (AM4 budget)	Asus ROG Strix B550-I Gaming	scan.co.uk	#206 p44	£197
AMD X570 (AM4 mid-range)	Asus ROG Strix X570-I Gaming	scan.co.uk	#198 p20	£268

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	#206 p18	£100
TOWER	SilverStone LD03-AF	quietpc.com	#214 p58	£95
PREMIUM	Streacom DA2 V2	quietpc.com	#214 p51	£195

Micro-ATX



Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Budget AMD B450 (AM4)	Asus TUF B450M-PLUS II (micro-ATX)	scan.co.uk	#218 p76	£88
AMD B550 (AM4)	MSI MAG B550M Mortar	ebuyer.com	#204 p42	£120

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Kolink Citadel Mesh RGB	overclockers.co.uk	#218 p26	£60

ATX cases



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Phanteks Eclipse P300 Glass	overclockers.co.uk	#176 p28	£44
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	#214 p26	£75
SUB-£100	be quiet! Pure Base 500DX	scan.co.uk	#202 p39	£90
COMPACT	Fractal Design Meshify 2 Compact	cclonline.com	#215 p20	£101
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	#212 p45	£130
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	#202 p44	£139
SUB-£150	Fractal Design Define 7	overclockers.co.uk	#204 p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	#187 p24	£200

Networking



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	#216 p52	£130
ROUTER	Asus RT-AX68U	scan.co.uk	#216 p51	£174
MESH ROUTER	Asus AiMesh AX6100	amazon.co.uk	#196 p54	£338
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	#196 p58	£60
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	#200 p22	£151
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	#174 p34	£208
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	#212 p25	£281

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

Monitors



Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
24IN, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 24G2U	box.co.uk	#214 p28	£195
25IN, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	#209 p57	£291
25IN, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	#212 p20	£699

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 27G2U	overclockers.co.uk	#201 p53	£220
27IN, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	scan.co.uk	#209 p60	£349
27IN, 144Hz, IPS, 2,560 X 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	#201 p54	£460
27IN, 240Hz, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£480
27IN, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£700
28IN, 144Hz, IPS, 3,840 X 2,160, F, G	Asus TUF Gaming VG28UQL1A	scan.co.uk	#218 p56	£749

Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5IN, 60Hz, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£370
32IN, 165Hz, VA, 2,560 X 1,440, F, G	Dell S3220DGF	amazon.co.uk	#214 p28	£399
34IN, 144Hz, VA, 3,440 X 1,440, W, F, G	Cooler Master GM34-CW	ebuyer.com	#215 p30	£550
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	iiyama G-Master GB3461WQSU	scan.co.uk	#206 p53	£415
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	currys.co.uk	#206 p55	£779
38IN, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,199
32IN, 144Hz, IPS, 3,840 X 2,160, F, G, HDR	Asus ROG Swift PG32UQX	scan.co.uk	#218 p54	£3,299

Non-gaming

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

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	£66
MECHANICAL	Corsair K68 RGB	amazon.co.uk	#181 p53	£104
OPTICAL ESPORTS	Asus ROG Strix Scope RX	overclockers.co.uk	#209 p43	£90
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£180
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	#193 p56	£150
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£140
LUXURY MECHANICAL	Ducky Shine 7 RGB	overclockers.co.uk	#212 p53	£175
LUXURY WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	overclockers.co.uk	#208 p60	£160

Gaming mice



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Corsair M55 RGB Pro	ebuyer.com	#200 p24	£22
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	overclockers.co.uk	#215 p57	£52
MMO	Razer Naga Trinity	amazon.co.uk	#186 p52	£70
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£80
WIRELESS	Razer Viper Ultimate	box.co.uk	#217 p54	£70
PREMIUM WIRELESS	Razer Deathadder V2 Pro	scan.co.uk	#210 p28	£126
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	#211 p28	£48
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	#217 p52	£120

Peripherals and audio cont ...



Game controllers



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	#202 p50	£249
GAMEPAD	Microsoft Xbox One Wireless Controller	currys.co.uk	#191 p56	£55
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	#207 p52	£40
FLIGHT STICK	Thrustmaster T.16000M FCS HOTAS	scan.co.uk	#207 p56	£140

Gaming headsets

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET STEREO	Roccat Elo X Stereo	scan.co.uk	#210 p56	£40
STEREO	Epos Sennheiser GSP 300	amazon.co.uk	#210 p54	£58
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	#204 p50	£150
PREMIUM WIRELESS	Razer BlackShark V2 Pro	overclockers.co.uk	#211 p26	£180

Speakers

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

Non-gaming keyboards

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

PCs and laptops



Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
6-CORE GAMING	CyberPower Infinity X115 GT	Intel Core i5-11400	Nvidia GeForce RTX 3060	cyberpowersystem.co.uk	#217 p32	£1,270
MINI-ITX GAMING	Chillblast Fusion Diablo	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	chillblast.com	#215 p34	£2,050
4K GAMING	PC Specialist Infinity LC	AMD Ryzen 9 5950X	AMD Radeon RX 6900 XT	pcspecialist.co.uk	#218 p34	£3,299
WATER-COOLED 4K GAMING	Scan 3XS Absorbere	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3080 Ti	scan.co.uk	#209 p46	£4,705
PREMIUM WATER-COOLED 4K GAMING	Chillblast Fusion Kraken	AMD Ryzen 9 5950X	Nvidia GeForce RTX 3090	chillblast.com	#217 p34	£6,599
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	#145 p58	£14,842

Laptops



CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Lenovo Legion 5	AMD Ryzen 7 5800H	Nvidia GeForce RTX 3070 Laptop	15.6in, 1,920 x 1,080 IPS 165Hz	laptopsdirect.co.uk	#218 p48	£1,299
RTX GAMING	Gigabyte Aorus 15G XC	Intel Core i7-10870H	Nvidia GeForce RTX 3070 Laptop	15.6in, 1,920 x 1,080 IPS 240Hz	overclockers.co.uk	#213 p30	£1,799
PREMIUM RTX GAMING	Asus ROG Strix Scar G733QSA	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3080 Laptop	17.3in, 1,920 x 1,080 IPS 360Hz	overclockers.co.uk	#217 p28	£2,999

Games



RICK LANE / INVERSE LOOK

FAILURE SPECTRUMS

The ability to carry on playing if you fail is crucial for creating exhilarating gaming experiences, argues Rick Lane

This month, I've spent most of my free gaming time chopping off people's heads in the excellent *Chivalry 2* (see p70). Or to be more precise, having my own head chopped off by better players in *Chivalry 2*. Death is frequent in *Chivalry 2*, but it's also rarely frustrating, and in many cases it's downright fun.

There are several reasons for this. One is that dying in *Chivalry 2* is often an absurd experience. It's hard to begrudge another player's victory when they defeat you by throwing a severed head at you. But there are also lots of ways you can mitigate the chance of death in the game. *Chivalry 2* sports a generous blocking system and an elaborate parrying system with multiple ways to respond to attacks.

It also provides all players with a single-use bandage with which to heal. Hold your own for long enough in a fight, and other players may well arrive to help you out. Of course, there's also a chance your opponent's allies will arrive to help out *them* too, but even then, the game sports a system whereby a successful parry blocks *all* incoming damage, giving you the opportunity to hold off multiple opponents.

In short, *Chivalry 2* furnishes players with a wide array of tools to put distance between themselves and the virtual Grim Reaper. When the scythe finally comes down, it feels fair and reasonable. This type of design actually has a name – a failure spectrum. Coined by indie game developer Tom Francis (creator of *Gunpoint* and *Heat Signature*), a failure spectrum is, to quote Francis 'where you can fail at something but still carry on playing'.

Failure spectrums can take many different forms, but ultimately they involve putting multiple stages of failure between the player and the 'Game Over' screen. Many failure spectrums also provide opportunities for players to recover from those various stages.

A classic example of a failure spectrum is the one forming the backbone of all stealth games. If a guard hears a player make a noise, they become suspicious and begin to search for them. If they find the player, they become alerted and chase them. If they catch the player, a fight ensues. If the guard wins the fight then, and only then, is it Game Over.

Generally speaking, a broader failure spectrum results in a more interesting and fun player experience. There's a reason why players often complain about 'insta-fail' stealth sections in games. Getting caught in a stealth game isn't fun, whereas *almost* getting caught, but then escaping through evasion or by use of a clever gadget is thrilling.

It's important to stress that failure spectrums aren't about making games easier. A game can still be challenging without constantly bouncing the player back to the Game Over screen. Instead, they're about keeping the player immersed in their experience for longer, making failure interesting and fun, rather than frustrating and dispiriting.

A great boxing match isn't won by knockout in the first round. It goes the distance, putting both boxers on the ropes and on the mat multiple times. This is the experience a good failure spectrum is intended to create – one that turns your boring Game Over screen into a Thrilla in Manila. **EPG**

They put multiple stages of failure between the player and the 'Game Over' screen

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

Griftlands / £12.39 inc VAT

DEVELOPER Klei Entertainment / PUBLISHER Klei Entertainment

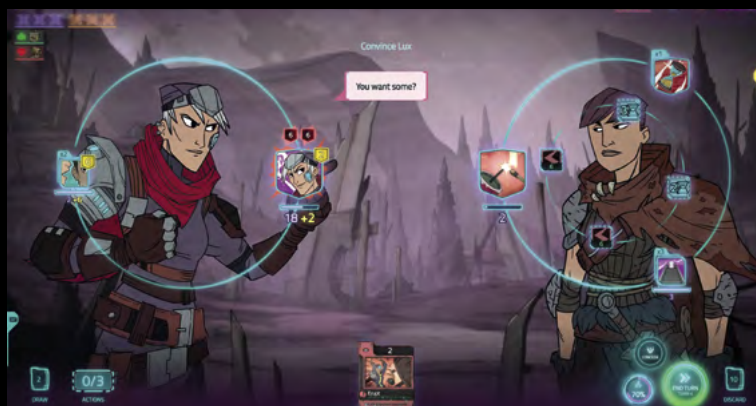
Griftlands is the latest creation from Klei Entertainment, developer of several excellent games, such as Don't Starve and Invisible, Inc. The studio has an uncanny knack for turning its hand to any genre and producing something interesting. Griftlands is no different, although the result isn't as successful as the studio's earlier titles.

The game is essentially a deck-building RPG where conversations are treated with the same level of mechanical depth as physical battles. You play as a Grifter, and by that, we don't mean a professional YouTube contrarian trying to sell you brain enhancement pills.

No, a Grifter is a mercenary gifted both in martial arts and debating techniques. You start off the game playing as Sal, a freed slave who returns to the Griftlands seeking vengeance on the woman who initially enslaved her.

Griftlands' basic structure is familiar RPG stuff. You spend much of your time running odd jobs for people, either fighting or arguing your way to victory. As an RPG, Griftlands is well written and impresses with its many branching choices. You can form relationships with most of the major characters in the game; depending on the nature of those relationships, these can have varying consequences for you further down the line. That said, the game world itself isn't particularly cohesive, being a mishmash of various sci-fi and fantasy elements with anthropomorphic animals sprinkled into it for some baffling reason.

When an encounter with another character occurs, it can be resolved in one of two ways – peaceful debate or violent battle. Both take the form of a card game where combatants play various abilities out of their hand. Some cards deal damage, while others will increase your defences. As you win more fights/arguments, you'll gain access to new, more powerful cards that let you perform more actions, draw additional cards and so on.



This is normally where we'd discuss the difference between the debating and fighting systems, but therein lies Griftlands' biggest problem. Mechanically, there really isn't much difference between having a verbal argument and a physical battle. The argument cards essentially do the same jobs as the battle cards, they just have different names. You play a card such as 'Fast-Talking' to damage an opponent's resolve, just as you would play a regular attack card to damage an opponent's health.

There's another issue with this, namely that your 'debates' don't really resemble an actual verbal exchange. Your characters simply throw abstracted debating techniques at one another like weapons, while talking in a Sims-like nonsense language. This, combined with the similarity between debating and regular combat, makes the addition of a second card game rather redundant. The problem is further compounded by a handful of mandatory physical battles that are really tough if you don't prepare for them, meaning you're better off focusing on honing your fighting skills over your debating ones.

This isn't to say Griftlands is terrible. It's still a well-made and typically stylish game from Klei. However, unlike the studio's previous genre-hopping efforts, Griftlands' central concept simply doesn't work very well. What's left is a slick but otherwise fairly unremarkable card battler.

RICK LANE

GRIFT

- + Competently made RPG
- + Good writing
- + Lots of ways the story can shake out

SWINDLE

- Card debating concept doesn't really work
- Fairly mundane CCG elsewhere



/ VERDICT

Griftlands is an imaginative spin on an established genre from Klei, but it doesn't quite pay off.

OVERALL SCORE

65%



Chivalry 2 / £35.99 inc VAT

DEVELOPER Torn Banner Studios / PUBLISHER Tripwire Interactive, Deep Silver



On the bloody battlefields of Chivalry 2, the rival armies of skill and stupidity crash into each other like metal waves. The results are simultaneously spectacular and hilarious.

This is a game where you can successfully fight off two knights at the same time in an epic duel, only to be slain by a man wielding his own severed arm, where a mighty charge into the fray can be abruptly ended by someone throwing a barrel at you. This blend of deeply nuanced melee combat and taking foolish chances makes Chivalry 2 one of the finest multiplayer games we've played in years.

A sequel to 2012's Chivalry: Medieval Warfare, Chivalry 2 is broadly similar to its predecessor. It sees two teams of armour-clad warriors – the noble Knights of Agatha and the ruthless Mason Order – battling for glory across a series of large, objective-based maps. One side plays the role of attacker, pushing forwards to break down barricades, burn villages or push siege engines into positions, while the opposing side must hold those objectives for a set amount of time, falling back to a new position if overwhelmed.

Likewise, combat follows the same core principles of that first game. Unless you're playing as an archer, your fighting skills revolve around three basic attacks. Pressing the left mouse button performs a wide horizontal swipe that will cut through anything 180 degrees in front of you.

Rolling the scroll wheel backward performs a powerful vertical slash, useful if you're fighting in a crowd and don't want to hit your teammates. Rolling the scroll wheel

forwards performs a forwards thrust, which has the greatest reach of the three attacks.

Chivalry combines this with the ability to alter the timing of your swings by 'turning' into them. When you move the mouse left to right, your character essentially turns at the hips, meaning you can make attacks faster or slower by turning with or against your strike. This can be used to fool enemies into blocking at the wrong time – an essential component of Chivalry's combat.

The sequel expands the combat system's potential enormously. For example, there are several ways to respond to being attacked. Enemy blows can be deflected by simply holding the block button, but this burns your stamina and will eventually leave you vulnerable. It's far better to tap the block button at the right moment, then immediately follow it up with a riposte, which you can actually start performing before your opponent's blow has hit, making it much faster.

Alternatively, you can 'counter' an attack by watching your opponent carefully, then performing the same type of strike as them just before their attack connects. If successful, the result will be that your opponent receives damage. You can also dodge attacks, and even duck underneath them, although the latter is extremely risky.

Other skills involve feinting, which is achieved by starting one attack and then quickly switching to another, useful for bamboozling an opponent with a robust parry. Alternatively, you can open up a turtling enemy with a kick, essentially

KNIGHT

- + Incredible 64 player battles
- + Brilliant combat system
- + Extremely funny

KNAVE

- Small number of maps



giving you a free attack. Finally, pressing G will let you throw whatever item is in your hands, be it a throwing axe, a sword, your shield or even an object littering the environment, from sacks of wheat to severed heads.

Even at the level of a one-on-one duel, the number of ways a fight can go is enormous, with vast potential for extended back-and-forths, counters to the other player's counters, dastardly tricks and good old-fashioned luck. But Chivalry 2's matches aren't one-on-one duels, they're 64-player weaponised mosh pits with archers and siege engines thrown into the mix.

When a match of Chivalry 2 is in full swing, the experience is unlike anything else. Whereas in most other multiplayer games players are spread out across the map, Chivalry 2's players are often clustered together, hacking and stabbing at one another as each side attempts to push forwards without getting killed or accidentally killing someone else on their team. Being stuck in the muddle of one of these crushes is exhilarating and terrifying.

If this makes Chivalry 2 sound forbidding to newcomers, then we should stress that it is anything but. Although the combat system is complex, you only need to know your basic attacks and how to block to stand up in a fight. With those techniques under your belt, there's plenty of room to find your place among the chaos of Chivalry's battles, whether that's chasing objectives, sniping from the rear as an archer or crossbowman (which is a great way to ease yourself into Chivalry's battles), or as a blood-crazed lunatic who throws his sword at enemies before trying to pummel them with his fists.

This is another crucial point – Chivalry 2 is extremely silly. Visually it appears very serious, offering a grim and bloody representation of Medieval combat. But hearing your own character yell 'I needed that arm!' before being tossed 20 feet into the air by a boulder from a catapult is just too ridiculous to be anything other than funny.

Chivalry plays up to this in exactly the right ways too, letting players shriek exaggerated war cries and make snide insinuations about their enemy's mothers through a variety of colourful barks. But it never gets too deliberately goofy, letting the players and the systems provide most of the humorous moments.

There are dozens of smart design touches too. For example, when you die, you always respawn at a run, letting you get back into the fray that much faster than usual. In addition, when you successfully parry an attack, it momentarily blocks all incoming damage, making it possible to defend yourself against multiple opponents at once. It's still entirely possible to be overwhelmed, but successfully fending off three enemy knights for even a few seconds always feels amazing.

Such attention to detail in the system design is what makes Chivalry 2 special, raising it up above its predecessor and many other melee fighters. It's also a fairly seamless package, with excellent visual and sound design complementing the combat. The only notable flaw is a slight dearth of maps. There are eight in total – five team-objective maps, and three for the less popular team deathmatch and free-for-all modes.

The Team Objective maps are all well designed, rangy and multifaceted levels, each comprising several locations, such as battlefields, villages, fortresses and so on. However, it's possible to see them all within a few hours of play. There are new maps on the horizon, though, as well as other planned features such as the introduction of horses.

There's not much else to say. Chivalry 2 is a multiplayer masterpiece, equal parts spectacular and silly, but always captivating and simply a joy to experience. Getting your head chopped off by a halberd has never been so much fun.

RICK LANE

/ VERDICT

Bold, bloody and brilliant, Chivalry II is the new bannerman of multiplayer slashers.

OVERALL SCORE

92%





Necromunda: Hired Gun / £14.99 inc VAT

DEVELOPER Stream On Studio / PUBLISHER Focus Home Interactive

Necromunda: Hired Gun is about six months away from being a decent first-person shooter. Set in the largest Hive City in the Warhammer 40,000 Universe, Hired Gun puts you in the role of a mercenary who becomes embroiled in a turf war after being hired to assassinate a group of thugs, who in turn murdered a local guildler. It's a likeable game with considerable potential, but it's undone by being, well, unfinished.

Necromunda's standout achievement is its stunning recreation of 40K's infamous Hive City, simultaneously a gigantic armaments factory, a sprawling slum, a spaceship graveyard and Space Hell. Each of the story's loosely connected missions takes you to a new location in Necromunda, each brilliantly conceived and designed.

Mission highlights include the Koloss-44, where you battle your way along a massive freight train pulled by a locomotive the size of a cathedral. Later levels see you partaking in trench warfare in a massive junkyard, leaping between the skyscrapers of a cyberpunk-like cityscape, and delving into the inky darkness of the Cold Black, an ancient spaceship where an encounter with one of 40K's most formidable foes awaits.



The environment design is remarkable, and if Hired Gun's gunplay matched it, we'd have a pretty great FPS on our hands. Unfortunately, it doesn't. Problems begin with the weapons. In themselves, the guns are decently designed, with your arsenal ranging from iconic 40K weapons such as the bolter, to more exotic firearms, such as a gun that shoots exploding gravity vortices. Yet instead of being issued in standard FPS fashion, they're instead bundled into a pointless loot system where you randomly pick up endless variants of near-identical guns, obliterating the game's sense of progression and completely flattening the combat loop.

In addition, Hired Gun heaps a pile of gimmicky mechanics onto the game that add little to the experience. These include a canine companion whose 'quick' attacks are actually slower than simply shooting enemies, procedurally generated side-missions that involve replaying chunks of existing levels simply to gain extra cash, and Doom-Eternal style 'melee kills' that can instantly kill any regular enemy, meaning you barely have to use your weapons at all.

These superfluous mechanics would be less of an issue if the combat actually felt good. But again, Hired Gun falls short. While weapons are weighty and satisfying to wield, enemies are basically rag dolls, flying around like helium-filled balloons when killed. The AI is thicker than asbestos soup, either running mindlessly at you, or standing around waiting to be shot. Worse, some features are clearly unfinished. For example, there are missing animations on gadgets such as the grappling hook – one of the few additional mechanics that's actually useful on a regular basis.

Hired Gun has the components to make a great FPS. However, instead of nailing the fundamentals, it focuses too much on secondary features while failing to get the basics right. The result is pretty, but also clunky and unsatisfying.

RICK LANE

HIRED

- + Excellent environments

FIRED

- Buggy
- Core combat lacks refinement
- Pointless loot system
- Overemphasis on unnecessary secondary mechanics.

/ VERDICT

Necromunda: Hired gun scuppers its potential with a plainly unfinished design.

OVERALL SCORE

45%

Overboard! / £11.39 inc VAT

DEVELOPER Inkle / PUBLISHER Inkle

Overboard! is a fascinating experiment in interactive fiction and detective gaming, where you play not as the sleuth trying to solve the crime, but the criminal trying to evade capture. What results is a fantastic little game that packs wit, charm and ingenuity into every pixel.

Set in the 1930s, Overboard! sees you play as Veronica Villensey, a former starlet on a transatlantic voyage between London and New York. The night before the SS Hook arrives at its destination, Veronica pushes her husband Malcolm over the port-side railing into the ocean. After taking sleeping tablets, Veronica awakes the following morning with eight hours until they reach port. In that time, she must avoid being accused of the crime by the ship's crew and passengers, which includes nosy aristocrats, distraught witnesses and a retired army Major who fancies himself a detective.

As with Inkle's previous games, such as the magnificent 80 Days, Overboard! is primarily a narrative adventure, where you interact by making dialogue choices that affect the direction of the story. Like 80 Days, however, the game isn't a static set of decisions. As the day progresses, the different characters move around the ship, on a routine independent of Veronica. In addition, it takes time for Veronica herself to navigate the vessel, meaning you only have a limited time to explore, talk to characters about what they know, and attempt to build yourself an alibi.

The result is a scintillating blend of puzzle solving and subterfuge, where you must weigh every choice you make against how it might make you look farther down the line, where capitalising on one opportunity may mean sacrificing another one. Do you attempt to actively cover for Malcolm's disappearance, or feign ignorance about his whereabouts? If a character raises a point that contradicts your story, do you hasten to change it, or stick to your guns? Every word from Veronica's mouth could potentially place her in the spotlight, making each conversation in Overboard! thrilling.

A single run of Overboard! doesn't take long, perhaps 20 minutes, but it's unlikely you'll escape on your first try. Moreover, successfully evading arrest isn't the end of the game. In fact, it's only the beginning of Veronica's scheme, the first of several increasingly challenging objectives that



require you to learn every facet of the ship's routine within those eight hours. Adding to Overboard!'s replayability is the sheer range of approaches you can take. For example, one way you can attempt to get away with murder is by committing further murders. There's even an achievement for killing everyone else on the ship.

Inkle delivers its changeable tale with breezy, humorous writing and excellent characterisation. Veronica is delightfully despicable, while the secondary characters all have their own quirks and foibles that make you feel justified in lying to them and even tossing them over the side. What's more, it's all shoehorned into a marvellously compact package that costs a smidge over a tenner. In short, Overboard! is a killer.

RICK LANE

OVERBOARD!

- + Great concept
- + Excellent writing
- + Wide range of approaches

OVERBORED

- Fairly short

/ VERDICT

Mixing narrative adventure with an ingenious reverse-detective concept, Overboard! is truly a game to die for.

OVERALL SCORE

90%



REALITY CHECK

Rick Lane eyes Nazis in his sniper scope and checks out some Half-Life: Alyx mods in his monthly VR roundup

REVIEW

SNIPER ELITE VR / £22.99 inc VAT

DEVELOPER Rebellion/Just Add Water / PUBLISHER Rebellion

Sniper Elite VR isn't a great VR game, but it's the first one to get virtual sniping right. Rebellion's VR entry in the long-running sharpshooting series not only makes VR sniping functional, but fun enough to carry an entire game. That's just as well, because Sniper Elite VR isn't short of rough edges.

You play as a crackshot Italian partisan fighting against Nazi forces along the peninsula. The story is relatively thin, mainly serving as an excuse to string together a bunch of World War II-themed sniping challenges. Yet unlike Medal of Honor: Above and Beyond, it has the sense not to interrupt play every five minutes. It also features an interesting framing device, with your character reminiscing about his experiences of the war long after it has ended, using an interactive diary that doubles as a mission selection screen.

The game sports a wide array of missions, but they mostly come in two forms. Infiltration-style missions involve sneaking and shooting your way through Nazi-occupied facilities, while defence missions see you ensconced in

an elevated position where you must use your sniping skills to fend off enemies.

You'll do a lot of sniping in both cases, as that's where the game is most effective and enjoyable. When you raise the rifle to your eye, your vision automatically narrows to looking down the scope. Squeezing the left trigger of your touch controllers increases your 'Focus', zooming in and slowing down time. Squeezing the right trigger lets off the shot.

It's an elegant control system bolstered by Sniper Elite's satisfying weapon feedback. The series' famous 'X-Ray' system provides a thorough (and grisly) account of the bones shattered and organs punctured by your bullets. Your shots are also given a numerical score based on distance, which part of the body you hit and the amount of damage.

All this makes for a satisfying core feedback loop. Lining up your shot, watching it punch through a Nazi's braincase, sliding the rifle bolt back and forwards to chamber another round and then lining up your next shot, all while being peppered by enemy gunfire, is a thoroughly enjoyable VR interaction.

It isn't without frustrating elements though. For example, it's very easy to accidentally drop your rifle, while picking it up again can be difficult thanks to the game's overly particular weapon handholds.

While the sharpshooting is excellent, every other aspect of the game is merely acceptable.

It offers a range of other weapons, including pistols, submachine guns and grenades, all of which are functional, but nowhere near as interesting as the sniper rifle. There are silenced weapons too, making stealth theoretically possible.

But again, it's much easier to simply hang back and snipe every Nazi in sight. Your inventory, which is situated on your body, is overcrowded, making it easy to equip the wrong weapon or item. Finally, while the game looks reasonably good, it's clearly pushing the limits of the Quest's hardware, with flat lighting and some raw-looking textures.

It's no masterpiece, but Sniper Elite VR deserves credit for making a VR sniping game that's both fun and functional. It's also a more enjoyable WWII VR experience than Respawn's Medal of Honor, which is a notable feat in its own right.

CRACKSHOT

- + Great VR sniping
- + Decent WWII VR experience

CRAPSHOOT

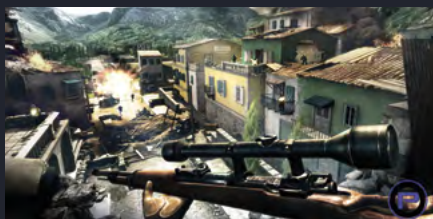
- Middling shooter otherwise
- Controls can be fiddly
- Visually a bit rough

VERDICT

A competent WWII shooter elevated by fun VR sniping, though it looks a bit rough.

OVERALL SCORE

70%





NEWS

FRUIT NINJA VR 2

How many ways can you slice an apple? Clearly the answer is more than one, as 2016's juicy hack 'n' slash Fruit Ninja VR is getting a sequel later this year. Shockingly titled Fruit Ninja VR2, the sequel will bring 'gorgeous areas to explore, never before seen fruit-slicing techniques, and juicy new ways to interact with the environment and other ninjas around the globe', according to its developer Halfbrick Games.

But how exactly do you expand on such an extremely simple premise? Well, Fruit Ninja VR 2 introduces a semi-open

world that you can explore on foot, moving between 25 levels, each containing various challenges. More significant is the addition of a bow and arrow, opening up a new suite of archery challenges where you'll be able to shoot satsumas, pierce pineapples and loose at lemons.

Fruit Ninja VR 2 is currently pipped solely for Steam VR, although it may eventually land on Oculus platforms too. No firm released date has been announced yet, but expect to be honing your fruit-slicing skills towards the end of this year.



MODDING

HALF-LIFE: ALYX MODS

We haven't covered VR modding much in Reality check before, largely because most VR Games offer little scope for modders to get creative. That isn't the case with Half-Life: Alyx, however. Like most Valve Games, Alyx has extensive support for both creating mods using the Source 2 engine, and hosting them via Alyx's Steam Workshop page.

A fair number of mods sprung up in the 18 months since Alyx's release. They range from new weapons and enemies to whole new adventures, both within and without the Half-Life universe.

Highlights include Overcharge, which sees you play as a Half-Life resistance fighter trying to prevent the Combine from building a sub-station in a residential block. Belomorskaya Station, meanwhile, is a short, survival horror-inspired map where you must creep through a zombie-infested subway station.

More ambitious Alyx mods include Return to Rapture, a huge eight-map crossover mod that sees the Combine discover Bioshock's infamous underwater city, while Alyx must fight to prevent them from getting their clutches on Andrew Ryan's gene-splicing tech.

Aperture VR, meanwhile, brings a bunch of custom-designed Portal 2 test chambers into Half-Life: Alyx. They don't feature portals, sadly, as Alyx doesn't support that mechanic, but the puzzles are still complex enough to be engaging without Portal's primary gimmick.

If you own Half-Life: Alyx, all these mods (and more) can be freely downloaded by heading to Alyx' Steam Workshop page and clicking Subscribe on the relevant mod. Once downloaded, you'll be able to access them from Alyx's main menu. **GPC**



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BUILD A POWERFUL PC
FOR A BUDGET PRICE

AMD's APUs (CPUs with integrated Radeon graphics) are back, and this time they're sporting Zen 3 CPU cores. This means that one of the issues with previous APUs – CPU performance – has been remedied, boosting performance across the board in games and content creation.

Buying an APU means you don't necessarily need a discrete GPU, giving you a sizeable cost saving, especially at the moment, when the cost of graphics cards is massively inflated, thanks to the silicon shortage, huge demand for GPUs and the popularity of cryptocurrency mining. This means our system only needs a paltry PSU as well, further saving money.

However, what other gear do you need for your APU system? Do you need a third-party cooler, and what sort of motherboard should you choose? We'll be looking at all these options to see what kind of PC you can build if you need plenty of change from £700.



SHOPPING LIST



Case **Kolink Citadel Mesh RGB**

£60 inc VAT

► overclockers.co.uk

If you're dead set on avoiding the purchase of a discrete GPU, and don't plan on upgrading, then a lot will come down to your choice of motherboard and you have a few options. Micro-ATX and ATX boards are usually the cheapest, while smaller mini-ITX motherboards and their associated cases – especially those that don't support GPUs – will allow you to build a supremely small PC with a tiny footprint.

The downside is that tiny cases and mini-ITX motherboards can be more expensive than their larger counterparts, so you'll need to prioritise if you really want to go super-small. We've decided to strike a balance by using a micro-ATX motherboard and case. This enabled us to still build a relatively compact PC, but with none of the price premiums involved with a mini-ITX system.

We've opted for Kolink's Citadel Mesh RGB micro-ATX case, which comes with three RGB fans, a hub for PWM and RGB control, a handy hinged tempered glass side panel and a height of just 38cm. It costs only £60, but provides expansion room, a vertical GPU mount and space for radiators – if you fancy an upgrade later on, you just need to drop in new hardware.

Alternatives

There's nothing wrong with scaling up and going for an ATX case, especially if you know you'll want to add more storage or expansion cards later. The other option,

of course, is to go smaller and there are many mini-ITX cases available.

The vast majority of them still support full-sized graphics cards and ATX PSUs, such as the Cooler Master NR200P, so there's still good upgrade potential, but you save a huge amount of space compared with micro-ATX and ATX cases. Even smaller models are available, such as the GEEK A30 V2.0, but going even smaller means ditching traditional PSU sizes too. The A30 V2.0 is tiny at just 25cm tall, but you'll need to buy a Flex-ATX PSU as well. We'll be covering mini-ITX hardware in next month's issue.

Motherboard

Asus TUF Gaming B450M-PLUS II

£88 inc VAT

► scan.co.uk

Even mini-ITX motherboards have a PCI-E slot for a discrete graphics card so, unlike cases, there's no way to cut costs further if you're not using a discrete GPU. However, opting for a micro-ATX board does give you a cheaper price, shaving up to £50 off the cost of a B450 or B550-based mini-ITX motherboard, and often coming with better cooling, more DIMM slots and additional PCI-E slots too.

One of our tried and tested boards is the Asus TUF Gaming B450M-PLUS II. It costs under £90, but you still get an M.2 port and rear USB Type-C port. It also has video outputs for AMD APUs and, crucially, a USB BIOS FlashBack button that allows you to update the BIOS to support AMD's new APUs. As a result, it doesn't matter which BIOS version is loaded when you buy it, as you're guaranteed to be able to get it to work. We've included a short guide to doing this on p81.



Alternatives

There are plenty of other options when it comes to motherboards, but you'll need to make sure their BIOS versions are up to date enough to include AGESA version 1.2.0.3B or higher, in order to guarantee compatibility with AMD's Ryzen 5000-series APUs. As long as it's available from the list on the motherboard manufacturer's website, you can perform the upgrade yourself using USB BIOS FlashBack, which is available on most AMD motherboards.

With this in mind, other options are Gigabyte's Aorus B450 I Aorus Pro WiFi, which is mini-ITX, but a little pricier than our chosen micro-ATX board. Still, it includes Wi-Fi, an M.2 heatsink and additional video outputs. If you want to stick with micro-ATX, but want extra features such as built-in Wi-Fi and a front panel USB Type-C header, you can step up to the MSI MAG B550M Mortar. However, it will set you back another £45, as it sports AMD's more modern B550 chipset.

Finally, you also have the option of going large with an ATX case and motherboard. Features such as Wi-Fi were relatively rare on B450 motherboards, but the MSI B450 Gaming Pro Carbon Max WiFi includes it for a little over £100. If you want a USB Type-C header too, then you'll want to opt for MSI's MPG B550 Gaming Edge WiFi for around £140.

Power supply

Corsair CV450

£40 inc VAT

► scan.co.uk

Even with the Ryzen 7 5700G's eight Zen 3 cores overclocked at full load, our testing shows you're unlikely to see a system power draw over 200W. This means you can rein in your PSU budget if you're unlikely



to upgrade, as opting for any capacity over 400W is pointless. It's worth adding in some headroom, though, so you can drop in a discrete graphics card at some point.

Our chosen Corsair CV450 PSU only costs £40 anyway, and picking a less powerful unit won't save much cash either. If you do upgrade to a discrete GPU, there are two 8-pin PCI-E connectors, so there's headroom for a mid-range graphics card.



CPU
AMD Ryzen 7 5700G
£324 inc VAT
► scan.co.uk

The Ryzen 7 5700G is the most powerful APU AMD has made yet, with eight Zen 3 cores and integrated Radeon Vega-based graphics. It's a shame not to see AMD's RDNA 2 architecture GPU here, which it has used since the Radeon RX 5000-series GPUs, but the extra CPU horsepower is very welcome for content-creation clout.

The fact that this APU sports eight Zen 3 cores has resulted in a hefty price hike over previous APUs, though, costing double the amount the Ryzen 5 3400G's price at launch a few years ago. However, given that GPU prices remain stubbornly high, the fact you're getting eight Zen 3 cores and a reasonable GPU for a little over £300 still represents good value.

Alternatives

There is the cheaper Ryzen 5 5600G to consider, which drops the price to £240. Its six Zen 3 cores will still be capable for a lot of people's needs, but its GPU also only has seven compute units, compared to eight on the Ryzen 7 5700G, so it's likely to struggle more in games.



CPU cooler
AMD Wraith Stealth
► Included with CPU

Unlike some of its Ryzen 5000-series siblings, the Ryzen 7 5700G includes AMD's Wraith Stealth cooler in the box, so you don't actually need to invest in a third-party cooler to get up and running. It's not the quietest cooler around, but it's more than up to the task of dealing with our APU, which has a TDP of just 65W.

Alternatives

If you want your PC to be as quiet as possible, or if you plan on overclocking your Ryzen 7 5700G, then it will be wise to invest in a third-party cooler. Our pick is the be quiet! Pure Rock 2, which costs under £30, but it offers more cooling headroom than the Wraith and also cuts fan noise.



Memory
16GB (2 x 8GB) Corsair
3200MHz DDR4 Vengeance LPX
(CMK16GX4M2D3000C16)
£63 inc VAT
► scan.co.uk

It's important to use fast RAM with an APU, and AMD's Zen 3 architecture benefits from



it too. You definitely don't want to drop below 3000MHz, as this can severely impact performance, but opting for 3200MHz can save money over pricier sets and you can usually push the memory speed a little higher too through overclocking. We've picked Corsair's 16GB 3200MHz DDR4 Vengeance LPX dual-channel kit, as we were impressed with its value for money in last month's feature PC. It retails for £63 inc VAT and manages



to overclock to 3466MHz easily.
Storage
500GB WD Blue SN550
£50 inc VAT
► scan.co.uk

There's no need to dip to paltry SATA SSD speeds in order to keep the price below £700, and we've managed to squeeze a 500GB WD Blue SN550 M.2 NVMe SSD into the budget, which offers read and write speeds of 2,400MB/sec and 1,750MB/sec respectively. In fact, 500GB SATA 6Gbps SSDs will only save around £5, so they're practically redundant these days unless you don't have an M.2 port.

Alternatives

Our motherboard only has one M.2 slot, so if you need more capacity, your best bet is to get a bigger SSD and the SN550 comes in 1TB and 2TB flavours for £84 and £192 inc VAT respectively. The case has space for two hard disks as well, so if you need terabytes of space for mass storage of photos and videos, a hard disk such as WD's 4TB Blue will set you back £80 inc VAT from overclockers.co.uk

TOTAL
£625 inc VAT

BUILD THE PC



1 INSTALL CPU

Be extra careful with the pins on the underside of the CPU, as dropping it can see them bend and prevent it from being inserted into the CPU socket. Leave the CPU in its protective case until you're ready to install it and only unbox it next to the motherboard. Pull up the lever next to the socket, line up the triangle in the corner of the CPU with the one on the socket, fit the CPU into the socket and then push down the lever to secure it in place.

2 INSTALL MEMORY

Our motherboard has four memory slots and we have two modules. You'll want to use the second and fourth slots away from the CPU to enable dual-channel memory mode. Not doing so can see a hefty performance drop on an APU. Push back the clips at the top of the DIMM slots, and push down the memory modules until they click into place.

3 REMOVE COOLER MOUNTING BRACKETS

The CPU cooler requires the removal of the mounting brackets on the top of the motherboard. This is easy to do with a medium-sized screwdriver. Leave the mounting backplate on the rear of the motherboard in place.



4 INSTALL CPU COOLER

The AMD cooler comes with thermal paste pre-applied so you don't need to worry about applying it. However, be careful not to touch the paste, as dislodging it could mean your CPU will overheat. Keep the protective base on until you're ready to install it. The cooler itself screws into the motherboard's existing backplate – just screw it into the holes a bit at a time, going between opposite corners, until it's secured in place.

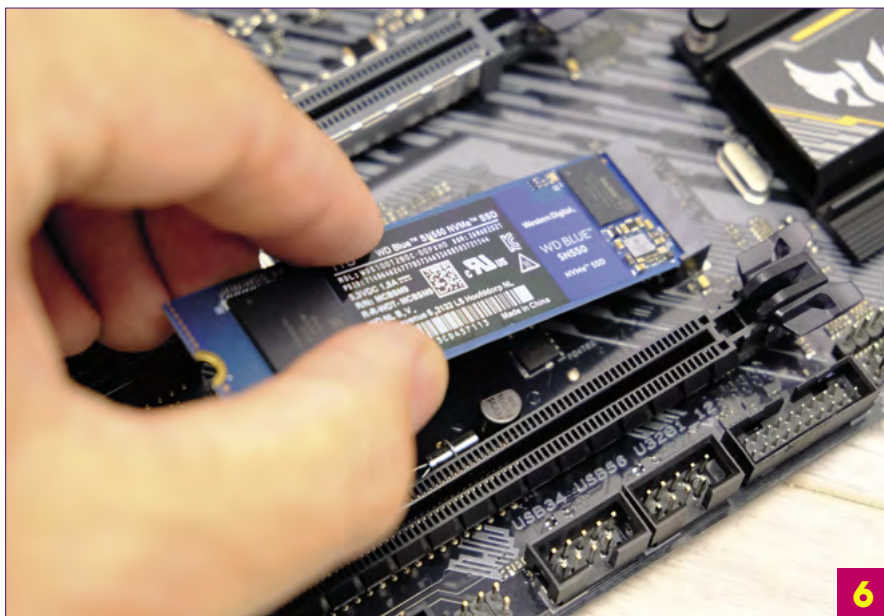
5 CONNECT CPU COOLER CABLE

The cooler's fan needs to be powered by the CPU fan header on your motherboard. Use the header labelled CPU and not one of the system fan headers, as the latter can operate differently and could cause your CPU to overheat.



6 FIT M.2 SSD

Fit the M.2 SSD before installing the motherboard, as this job can be fiddly. There's no M.2 heatsink included with the motherboard, but the SN550 doesn't need one. Locate the screw pack in your motherboard box, insert the SSD, so the end connector aligns with the M.2 slot and insert it at a 45-degree angle until it clicks into place. Then use the screw to secure it.



6

7 FIT I/O SHIELD

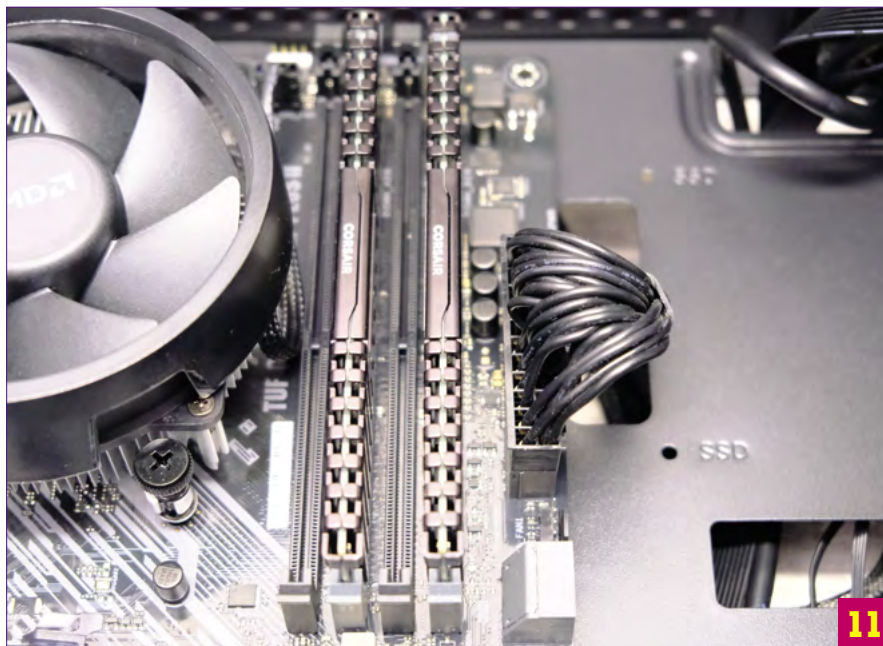
Fit your motherboard's I/O shield into the hole at the back of the case – it can be fiddly, but you only need to do it once. Line up the shield with the ports on the back of the motherboard to orientate it correctly, then press it firmly into the I/O opening in the case.

8 INSTALL MOTHERBOARD

With the CPU, cooler, memory and M.2 SSD fitted to the motherboard, you can now install the latter into your case. The motherboard tray has standoffs pre-applied to line up with our motherboard, so use the screws included with the case to secure the motherboard in place. Be careful not to scrape the PCB traces on the bottom of the motherboard on the standoffs as you fit it in place.

9 INSTALL PSU

The PSU needs to be slid into the case from the side and fixed to the rear using the provided screws. You can then unravel the cables and begin to thread them through the cable-routing holes in the case.



10 CONNECT CPU POWER

Start by locating the 8-pin CPU power connector on your power supply and passing it through the hole above the motherboard, before plugging it into the socket on the top left corner of your motherboard.

11 CONNECT MOTHERBOARD POWER

Next, do the same for the 24-pin ATX connector, but pass this cable through the nearest hole to the 24-pin socket on the right side of the case's motherboard tray.

12 CONNECT FRONT PANEL CABLES

The case's buttons and ports now need to be connected to the motherboard, so locate the case's thin front panel cables, USB and audio cables and connect them to the appropriate headers on the motherboard, as shown here. The locations of all the headers are documented in your motherboard's manual, so use it for reference if you're not sure.

13 CONNECT FAN HUB POWER CABLE

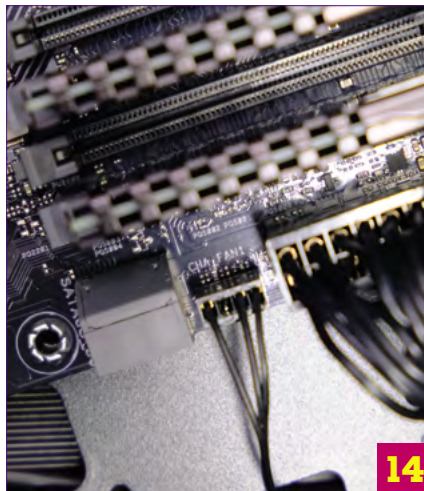
The PWM and lighting fan hub is powered by a single SATA connector, which means all the fans and RGB lighting will run off one power connector instead of a bunch of individual cables. Run a SATA power connector from your power supply to the connector coming from the hub.

14 CONNECT PWM CABLE

The fan hub has all fans pre-installed and ready to be controlled using a single 4-pin PWM cable, which we need to attach to our motherboard. You can use any of the 4-pin system case fan headers on the motherboard for this function, but don't connect it to the CPU header, or the case fans will spin up every time the CPU is under load, even for short periods.

15 CONTROL THE LIGHTING

To control the three fans' lighting, you can use the LED button on the case. There's also a 3-pin RGB cable that you can hook up to a third-party controller, but unfortunately our motherboard only has a 4-pin RGB connector, which isn't compatible.



16 TIDY CABLES

Start by using the included cable ties to gather bunches of cables together, and then use your case's anchor points to tie them down. There aren't many to spare with this case, so you'll need to think strategically as to where they can be used to best effect.

17 SWITCH IT ON

You now have a neat and tidy PC that's ready to try out. Plug in the power cable, as well as a monitor, keyboard and mouse, and try powering it on. If you're met with a black screen, you may need to update the BIOS (see below). If it fires up fine, you're ready to start setting it up (see over).



UPDATE THE BIOS

If your motherboard's BIOS is too old to recognise the CPU, you'll be met with a black screen when you power on the PC. Thankfully, it's simple to update it using the motherboard's USB BIOS FlashBack feature.

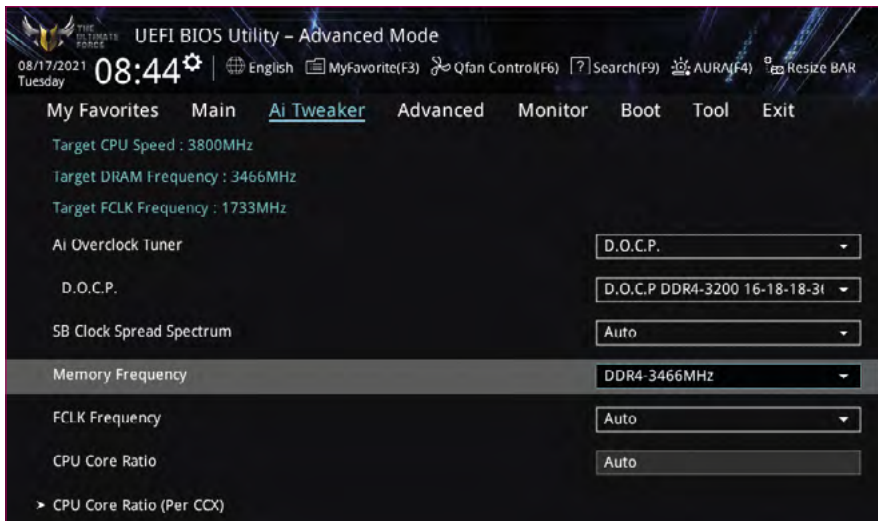
You'll need access to another PC for this, so if you don't have one, enlist the help of a friend who might have a desktop or laptop you can use. You can then grab the latest BIOS from the motherboard's product page (custompc.co.uk/TUFBIOS). You'll see two files. Copy these to the main directory of a blank USB flash drive, then double-click on

the one that's called BIOS renamer. This will change the file name of the BIOS file, so it can be read by the FlashBack program.

Now locate the FlashBack USB port on the motherboard's I/O panel. This is the only port that will work with the FlashBack process. Make sure the PSU is switched on, but leave the PC off, then press and hold the FlashBack button for five seconds until the light starts flashing. This will indicate the BIOS is updating and it will take around five minutes for the process to complete. Once the light stops flashing, turn on the PC and you should be met with the POST screen.



SETUP AND OVERCLOCKING



We've found that this 3200MHz memory kit usually overclocks to 3466MHz without any problems

Your first job is to configure the EFI, so hit the Del key when your PC starts up. You need to locate the Ai Tweaker section and, under Ai Overclock Tuner, select D.O.C.P and select your memory profile from the box below. Moving down, find the memory frequency option. This is set to 3200MHz by default, but we've found this memory easily hits 3466MHz, so select that instead from the drop-down list to overclock it.

Heading down the page, find the DRAM voltage option and make sure it's set to 1.35V to ensure the memory is getting its rated amount. We'll be tweaking the APU frequencies in a minute.

Next we'll configure the motherboard properly for using the integrated Radeon graphics. Head to the Advanced section and then the NB Configuration tab. Go to the menu for the UMA frame buffer size section. This is the amount of system RAM allocated to the integrated graphics.

Leaving it at Auto is usually fine, but you can occasionally run into issues in games when loading textures. Setting it manually can help, and we have plenty of RAM to set aside. Set this option to the maximum, which is 2GB.

Next we want to tell the motherboard to treat the integrated graphics as the primary video output. Our PC booted fine when this was set to PCI-E anyway, which refers to discrete graphics cards, but forcing it to use integrated graphics and the motherboard's own HDMI port first can make accessing the EFI easier at startup.

Next, we can set the system fan speeds. We found the RGB case fans were fairly punchy and loud at their default speeds – to tune them down a bit, head to the Q-Fan Control section in the EFI.

Here we switched from Standard to Silent mode, but if you like, you can also

switch to Manual and slow them down further. However, be sure to check your CPU temperatures after doing this.

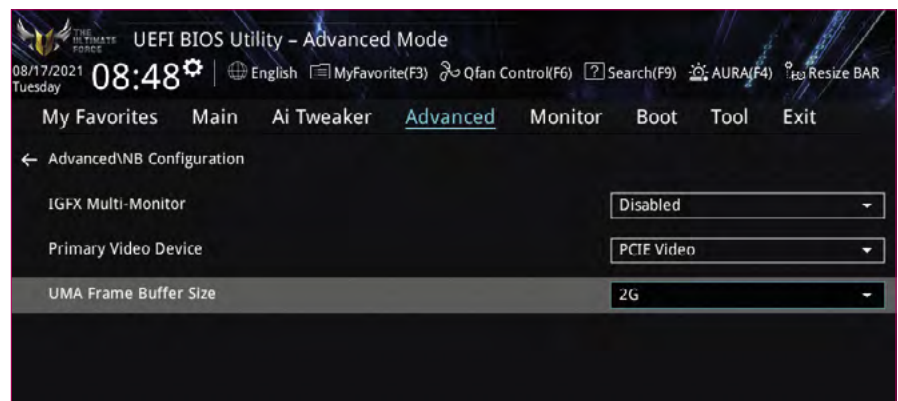
OVERCLOCK THE APU

We'll be increasing the frequencies of our APU a little within the limits of our modest stock cooler, so we can squeeze out a little extra performance. Out of the box, the APU temperature failed to rise much above 70°C so there's scope for small overlocks. A manual overclock resulted in 4.5GHz being unstable across all cores, which means dropping back further, as we were already at our maximum safe voltage of 1.275V. Given the CPU can hit 4.6GHz on a single core on its own at stock speed, we tried a different approach.

From here, we headed to the EFI and used AMD's Precision Boost Overdrive to add some frequency headroom to both the Zen CPU cores and the integrated Radeon graphics. This means the APU will stick to its peak boost frequencies, but where possible, it will increase frequencies across the board automatically beyond what you'd normally see at stock speed. This is usually most beneficial with all-core boosting – the frequency that most or all of the CPU cores will be able to hit at the same time.

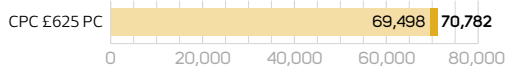
In the Advanced section in the EFI, find the AMD overclocking option, head through

Set the frame buffer to the maximum, which is 2GB

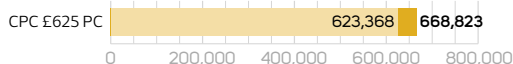


BENCHMARK RESULTS

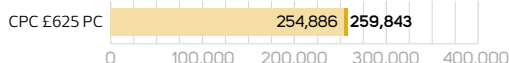
GIMP IMAGE EDITING



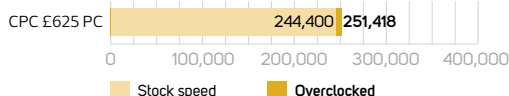
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING



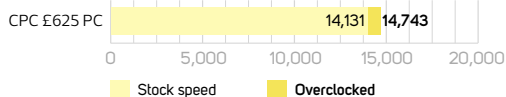
SYSTEM SCORE



CINEBENCH R23 SINGLE-THREADED

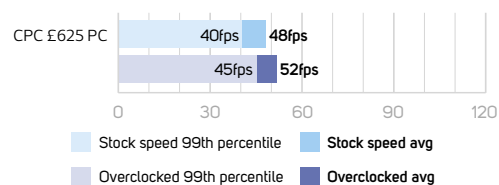


CINEBENCH R23 MULTI-THREADED



DOOM ETERNAL

1,920 x 1,080, High settings

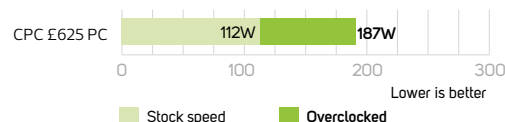


TOTAL SYSTEM POWER CONSUMPTION

Idle



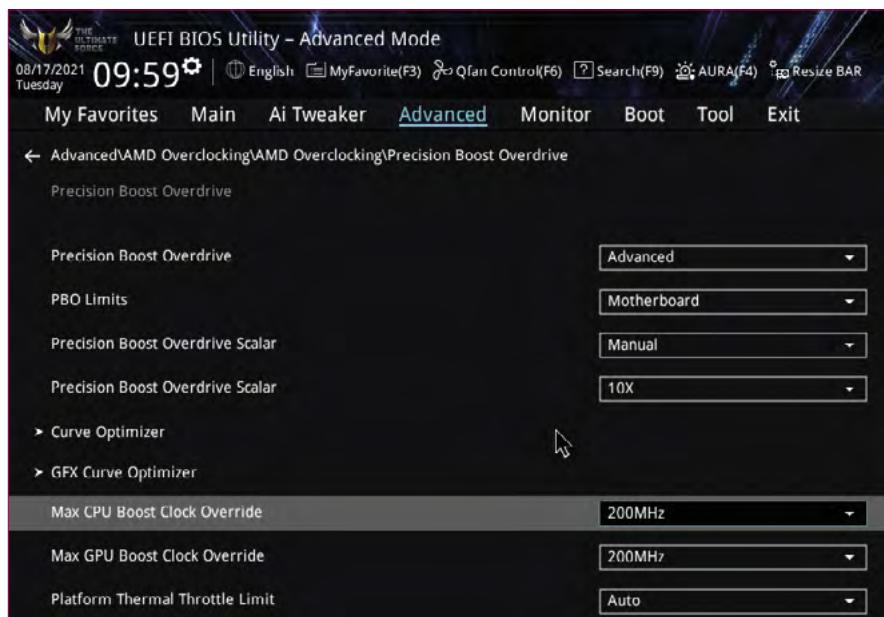
Load



any disclaimers that pop up and then set Precision Boost Overdrive to Advanced. Set the motherboard to control the PBO limits and then set a manual scalar of 10x. Down the bottom, add 200MHz in the boxes for both the CPU and GPU.

With the CPU at stock speed, we saw a system score of 244,400, but this rose to 251,418 once we'd overclocked the CPU, largely thanks to the video encoding score rising from 623,368 to 668,823. Cinebench saw the multi-threaded score rise from 14,131 to 14,743 and the single-threaded score from 1,462 to 1,503.

While you won't be able to hit playable frame rates in the latest highly demanding 3D games, you can still have a surprising amount of fun with the integrated graphics. For example, we were able to run Doom Eternal at 1,920 x 1,080 with High settings, with a 99th percentile of 40fps at and a 48fps average at stock speed, so you won't even need to drop down to 720p for this game. With the CPU and GPU allowed to stretch their legs thanks to our EFI tweaking, the average frame rate rose from 48fps to 52fps.



The CPU temperature rose to 82°C when we stress-tested our system under load in Prime95, but this is well within limits and is also a worst-case scenario. The power consumption rose significantly, though, to

We've used Precision Boost Overdrive to add some frequency headroom to the CPU and GPU cores

187W under load from 112W. However, this still leaves some headroom for adding a separate graphics card later down the line. **GPC**

First look Windows 11

Windows 11 is just around the corner and brings some key new features with it. *Edward Chester* fires up an early version to see what's in store

Back in 2015 when Microsoft launched Windows 10, the company claimed it would be the last ever version of Windows, with subsequent updates coming in dribs and drabs to that OS in perpetuity. Well, let's be generous and say that Microsoft has clearly changed its mind. Windows 11 is expected to launch at the tail end of this year, bringing a host of feature updates with it, including a new central Start menu, integrated Android app support and a new rounded-corner look.

It's set to be a free upgrade for Windows 10 users, although not all Windows 10 machines will be compatible, at least officially. Otherwise, licences for fresh copies of Windows 11 are likely to cost similar amounts of money to current Windows 10 licences, at least from what we've been led to believe.

Right now, you can upgrade to Windows 11 by signing up to the Microsoft Insider Programme, which will apply the new software through Windows Update if your system is compatible. That's what we did for this feature, and here are our first impressions.

Installation and compatibility

Ostensibly, the installation process for Windows 11 is dead easy; however, there are some caveats to getting the update. For a start, you need to sign into your PC with a Microsoft account rather than a local account, then you'll need to make sure you've opted into the optional Diagnostics and Feedback. With that done, you should be able to opt into the Windows Insider Programme, and you'll have to choose the

most aggressive Dev update stream in order to get hold of Windows 11 right away.

Once you've jumped through these hoops, the update should just fire up if your system is compatible. The main stumbling block is that Windows 11 requires your system to support Trusted Platform Module 2 (TPM 2), which is a cryptoprocessor built into new CPUs. All CPUs since 2018 should support it, but older ones – most notably 1st-gen Ryzen chips – don't have it built in. Any Intel CPUs prior to Coffee Lake (8000 series) won't work either.

TPM support can also come via dedicated hardware or even firmware (fTPM) support on motherboards. You'll have to check with your motherboard maker as to whether this feature is available, sometimes as an optional module you can plug into a header.

There are, however, ways around these limitations. A bit of Googling will provide plenty of hits on how to install Windows 11 on unsupported hardware as well, although these methods are officially unsupported.

The desktop and dock

The single most obvious aspect of Windows 11 that you notice once it's installed is that the Start Menu is no more, at least technically. What Microsoft is now calling the Dock sits centrally on the taskbar, in a move that brings the OS more in line with mobile operating systems and, of course, macOS.

The central positioning doesn't bring any benefit to desktop users that we could observe but, sure enough, it does work better for tablet devices and convertible, fold-flat laptops.

Considering that such devices are still quite rare, it seems a little optimistic to optimise an operating system's layout for them.

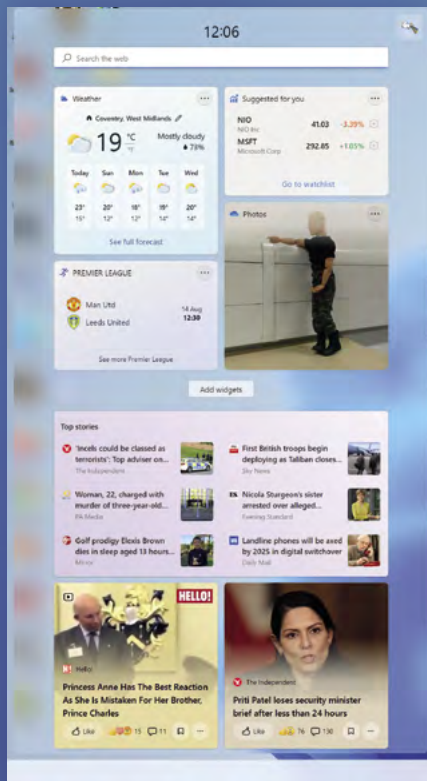
This aside, there are some other aspects that make the move an eyebrow raiser. Confusingly to us at least, the actual Dock icon sits to the left of any other icons that you can still place on the taskbar, so the more programs you have open, the further left the Dock icon will move.

It's bad enough that a central icon requires careful mouse positioning, compared with an icon in the corner that means you can just sling your mouse in that general direction and hit it, but having the icon change position as you open and close programs is a major no-no in our book.

Thankfully, you can opt to have the Dock back in the left corner, although only the left



In general, Intel chipsets back to the 100 series (Z170 and so on), plus AMD's chipsets since the 300 series, are supported. However, we tried installing Windows 11 on an old Asus Z170-A motherboard with a Core i7-7700K and, sure enough, it wasn't having any of it. However, a Core i7-8700K system with an Asus Z370-P motherboard worked just fine.



The new widgets app brings news, weather, calendar and search features together

corner. You can't move the taskbar to different edges of the screen now either.

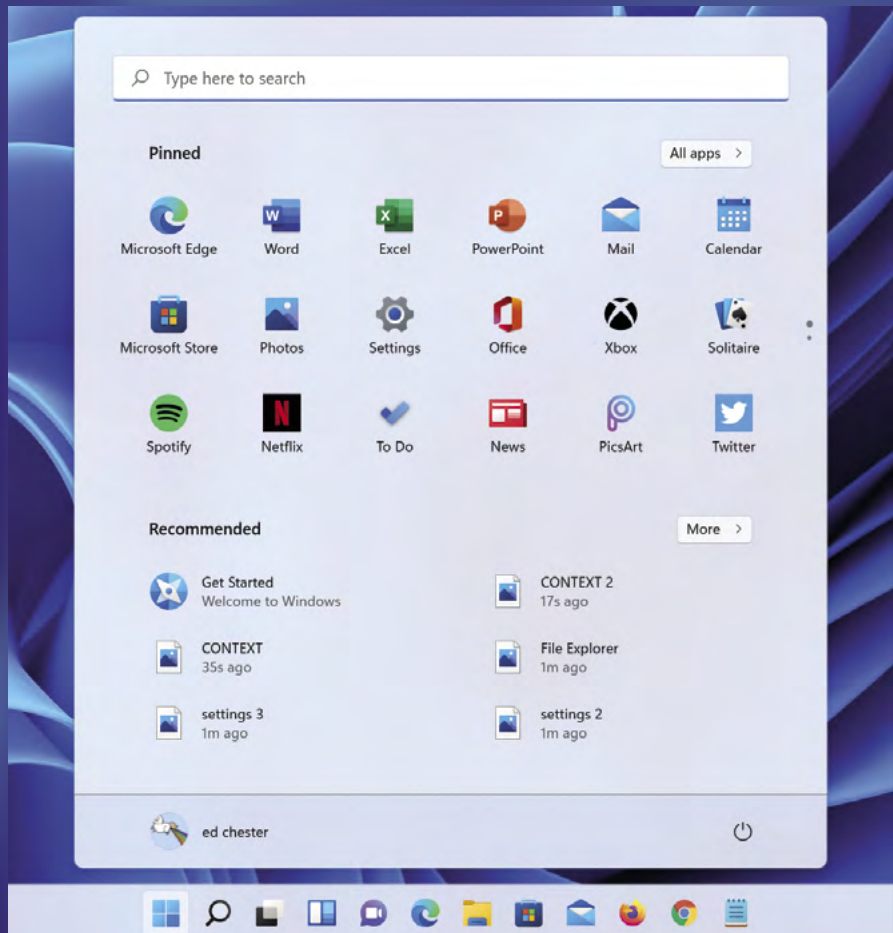
Tap the Dock and you'll find other major changes. The icons for Settings, Pictures and Documents have gone, along with the extended pinned apps/Live Tiles and any immediately accessible list of apps. Instead, there are small, pinned app icons, recent docs and apps, an account icon and the power options icon, all topped by a search bar.

Tap the All Apps button and you get a conventional list of your installed apps but, as with much of the rest of the interface, the spacing is optimised for poking icons with fingers on touch-screens, not clicking with a mouse – it takes an age to scroll through it. Further restrictions include not allowing groups and folders of apps on the Dock, and the Dock can't be resized either.

The taskbar has also been fundamentally changed. Along with being fixed on the bottom (although it can still be set to autohide), clicking on it no longer brings up a list of links to useful apps such as Task Manager. Instead, it just shows a taskbar settings link. Tap this link and it opens the main Settings interface, where you can change settings such as autohide and which items are shown on the taskbar.

Processor:	1 gigahertz (GHz) or faster with 2 or more cores on a compatible 64-bit processor or System on a Chip (SoC)
RAM:	4 gigabyte (GB)
Storage:	64 GB or larger storage device Note: See below under "More information on storage space to keep Windows 11 up-to-date" for more details.
System firmware:	UEFI, Secure Boot capable
TPM:	Trusted Platform Module (TPM) version 2.0
Graphics card:	Compatible with DirectX 12 or later with WDDM 2.0 driver
Display:	High definition (720p) display that is greater than 9" diagonally, 8 bits per color channel
Internet connection and Microsoft accounts:	Windows 11 Home edition requires internet connectivity and a Microsoft account to complete device setup on first use. Switching a device out of Windows 11 Home in S mode also requires internet connectivity. Learn more about S mode here. For all Windows 11 editions, internet access is required to perform updates and to download and take advantage of some features. A Microsoft account is required for some features.

The Windows 11 system requirements are relatively modest, but TPM 2 support and a Microsoft account are required

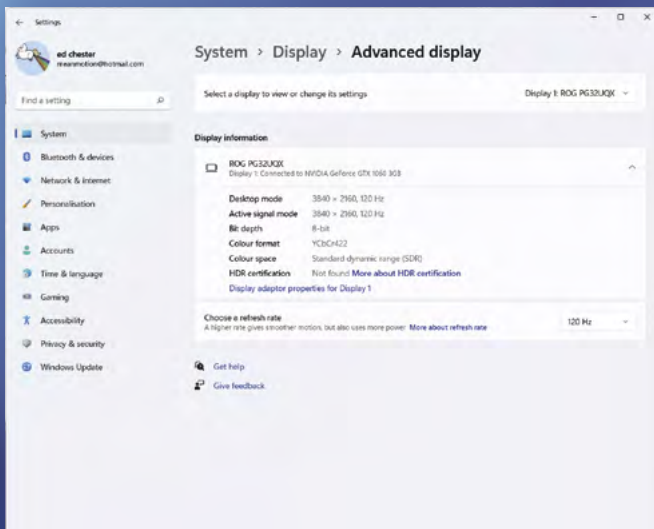
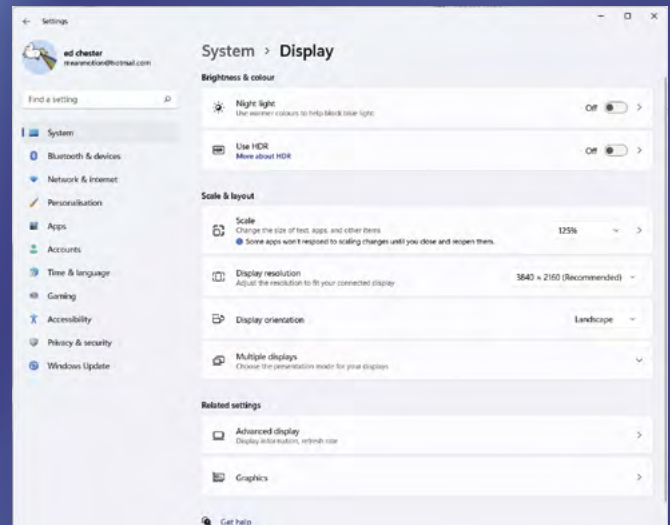
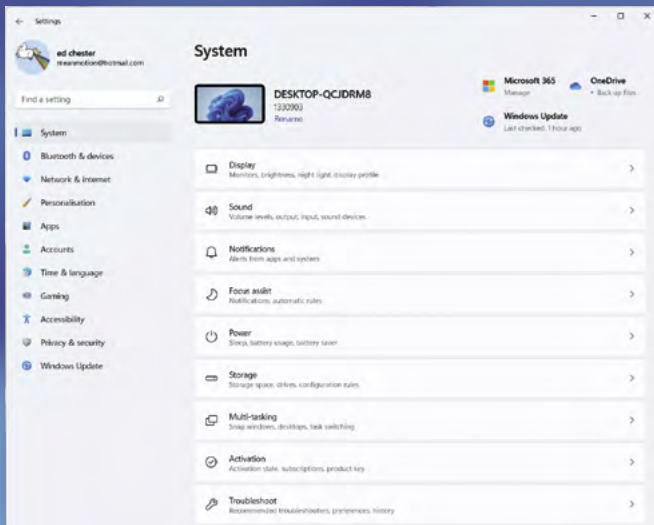


For power users accustomed to hitting the Windows key to bring up the search feature, or tapping Ctrl-Shift-Esc to bring up Task Manager, the mouse navigation downgrade of Windows 11 may not be a major problem. However, for those people who are more used to clicking their way around Windows, this new OS feels like a step backwards in some ways.

The Windows 11 Dock has been simplified

Live tiles and widgets

While the Live Tiles of Windows 10 may have been ditched, they're still around in spirit thanks to a new Widgets section, with a dedicated icon on the taskbar. Tap this icon and the widgets will slide into place from the left



The Settings menu in Windows 11 stays consistent as you move through it

of the screen in a full-height (not adjustable) column. Ostensibly, this feature offers the same weather and news update fluff, along with calendars and to-do lists that previous widget iterations have provided, although you now get integrated web search as well.

These sorts of widgets have always been a 'love it or hate it' addition, and there's little to suggest the Windows 11 version will convert many people one way or the other. If you tailor the feed to your preferences, making use of the calendar and to-do lists (all of which are linked into your Microsoft account), it could prove a useful one-stop shop for information. However, if you get all these updates from more direct sources, you're unlikely to find the whole widgets interface useful.

A new look

The second most obvious change with Windows 11 is what can basically be described as a return to the rounded look of Windows 7. Microsoft had steadily been moving away from the stark colours, sharp lines and flattened look of Windows 8 and early versions of Windows 10, with Windows 11 completely ditching that aesthetic.

Smooth animations, drop shadows, rounded corners, 3D button effects and an emphasis on light grey and pastel colours define the new look, and we have to admit to much preferring it, even if some of the animations make the OS feel a little sluggish.

Moving to the whole Windows 8 aesthetic was a mistake in our eyes (an all too big one when it came to Windows Phone), both aesthetically and practically. The reintroduction of a generally more tactile look to the OS

A similar widgets app was installed with the latest version of Windows 10, although it's smaller and lacks web search. One potentially handy feature about that version is that, instead of a static icon on the taskbar, it has a live weather update (18°C, Mostly Cloudy today, in case you were wondering), but sadly this isn't in the Windows 11 version.

makes it look cleaner and improves ease of use, thanks to better distinction between buttons, borders and backgrounds.

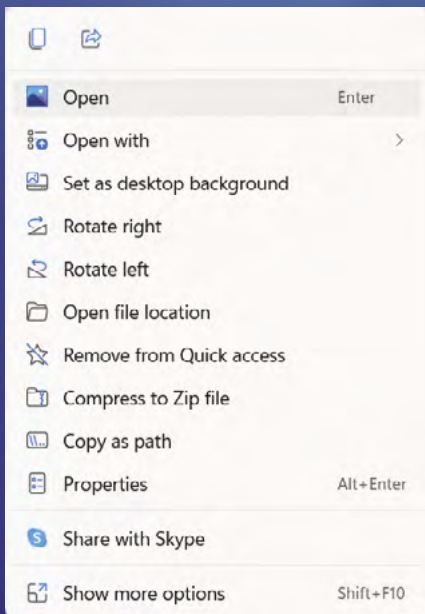
While this change is welcome, though, it's sure to irk a few app developers who have finally gotten round to updating their icon designs to fit the flat look that was favoured by both Microsoft and Apple for a few years. If there's one area that you'd hope wouldn't be so influenced by changing tastes and fashions, it's something as fundamental as a user interface for the billions of computers on this planet, but apparently that's too much to ask.

Beyond the animations and smooth edges, the other major motivator for the new design is better touch-screen accessibility. Icons are larger, the taskbar's taller and there's generally less of a fiddly feel throughout the interface. However, it's by no means comprehensive. In File Explorer, for instance, the left-hand panel that lists the folders is still surprisingly compact and fiddly for touch-screen use.

Regardless, all these touch optimisations are especially critical as Windows 11 no longer has a tablet mode. Time will tell if the one-size-fits-all approach is best, or if we once again see Microsoft reintroduce more of a dedicated interface for, in particular, small touch-screen use.

Settings

The central Settings menu has undergone a significant visual overhaul in Windows 11, embracing the new visual language of the OS and rearranging key elements. This greatly improves the overall navigability of the whole menu, making some key settings more visible and the whole system more intuitive. However,

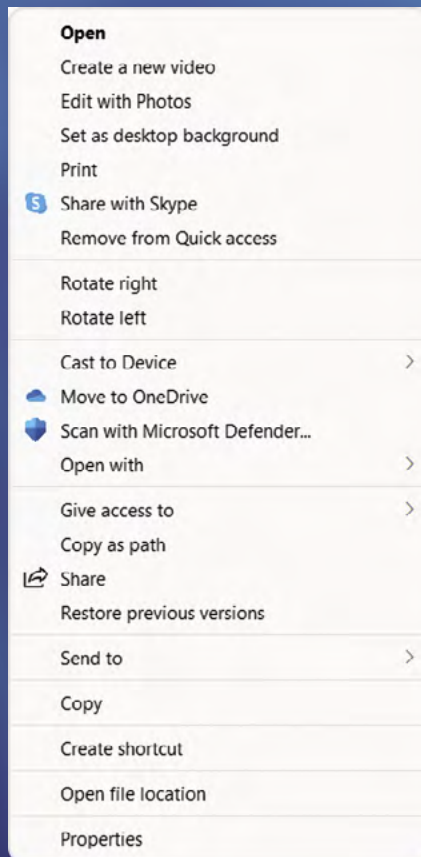


The initial Windows 11 context menu (left) has been simplified compared with Windows 10 (right), although it can be expanded (middle)

not as much has changed under the surface as it first appears.

Let's look first at what has changed. Instead of the initial horizontal layout of the base Settings app in Windows 10, which then confusingly switches to a vertical list layout, then back to a full white screen again for each individual setting, Windows 11 maintains the same list layout throughout. Click on an item such as System and the left column of options stays static, while the right column shows the submenus of each category, with the nested menus (System > Display > Customised scaling) listed at the top of the window.

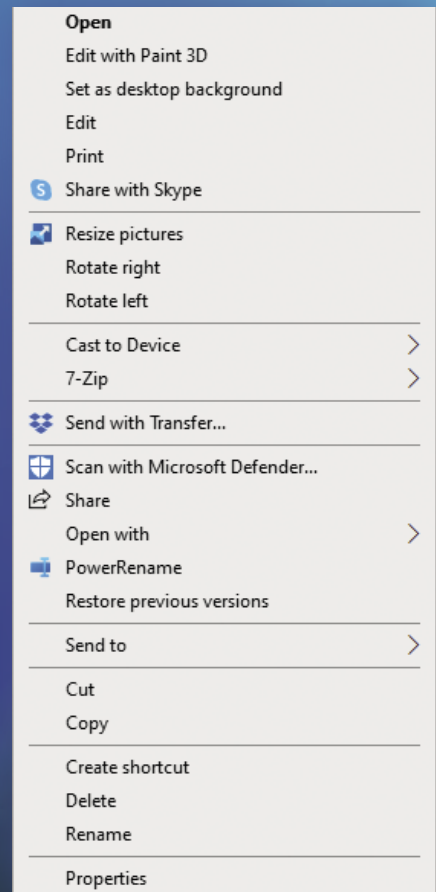
All the settings themselves also use a uniform, full-width vertical list layout, which visually separates each category or option with subtle shading. It's a huge improvement



and if you dive deep into certain settings, such as the Display adaptor properties menu, you'll still get a classic context menu popup. Still, overall it's a big improvement over Windows 10.

Context menus and File Explorer

Speaking of popup menus, one feature that has seen a more significant change with Windows 11 is context menus. Right click on most icons and, instead of the great long list of options that could accompany some files,



and Properties, along with other file-type dependent options such as Rotate for images or 'Open in new window' for folders. If you do need to access all the old context menus you can click on 'Show more options'.

Eliminating some of the more extraneous clutter of the old-style context menus is certainly a welcome move (on our Windows 10 installation, some icons would bring up context menus with 25 or more items), as keeping the menus compact makes it easier to zero in on the most common items quickly. However, if you regularly use certain items on the old context menus, the new ones will just be an added encumbrance.

It feels like there could have been a better compromise between easy readability and accessibility without confining certain options to a secondary menu.

Moreover, given how difficult it can sometimes be to tidy up the old style of context menus (it often requires jumping into the registry), it would have been a welcome addition to have a comprehensive overhaul of the whole system and make it easier for users to edit the menus directly.

For those people who are more used to clicking their way around Windows, this new OS feels like a step backwards

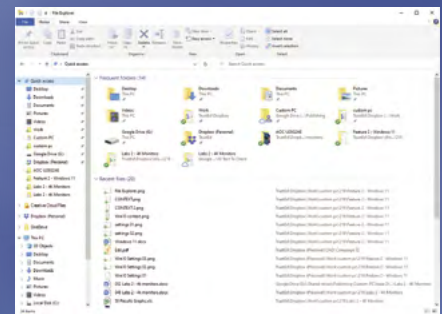
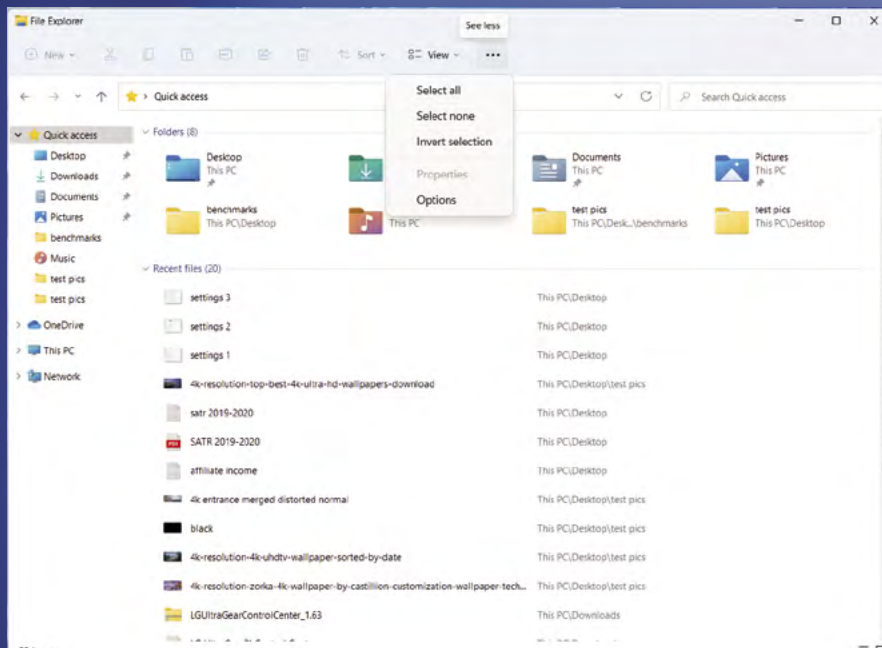
over the vast, undefined white space used in Windows 10.

However, while the two approaches are visually quite different, the actual arrangement of menus hasn't changed much at all and they don't offer too many new settings.

For instance, the refresh rate is still a setting that's confined to advanced display settings,

Windows 11 has a much more condensed set of options.

Along the top of the new menu is a convenient row of touch-friendly icons for the most common tasks of Cut, Copy, Rename, Paste and Delete, while below this are listed other common tasks with both icons and text. These include Open, 'Open with'



Windows 11 (left) has ditched the Ribbon navigation bar at the top of the File Explorer in Windows 10 (right)

Another simplifying tweak along similar lines to the Context Menus is the layout of the File Explorer window. Here, the Ribbon interface at the top of the window has been dropped in favour of a smaller selection of touch-friendly icons for common tasks, such as Cut and Paste. You'll have to click on the ellipsis button to bring up further options, although there isn't quite the number of options you'd find on the old-style Explorer.

While this change does feel like an oversimplification that could hinder some usability, by and large we don't miss the Ribbon interface of the old Explorer. It was a cluttered mess at the best of times (as it is in Office apps too) and was due a rethink. We're just not entirely sure that this very simple version is quite the right compromise either.

Improved display device switching

One exciting addition to Windows 11 could easily be missed if you just use one monitor, but for users of laptops or people that regularly switch monitors or resolutions, it will be a huge boon. Now, the OS will recognise the attached device and remember app layouts accordingly.

If you plug your laptop into a monitor, instead of the windows on your desktop being stretched out and moved around, Windows will remember how each window should be displayed for each display. Plus, if you swap out monitors or use multiple monitors, Windows 11 won't screw up your window layouts.

What's more, this new system also works when switching between resolutions on the desktop. For example, previously if you lowered the resolution (or changed the scaling settings), windows would be squished to fit inside the smaller desktop space. When you then switched back to a higher resolution, the windows would stay in their squished state.

This was perhaps most often seen when running games at lower than native resolution. Just by trying to get some extra performance in your games, you could ruin your carefully curated window layout. Now, though, you can chop and change as much as you like, and your windows layout will stay the same.

This has historically been an advantage of using resolution scaling in games, as rendering

Store and provided via the Amazon Appstore, enabling you to natively run most of the apps you would find on an Android phone.

Although there's huge potential for this feature, it won't necessarily enable the easy transitioning of tasks on Apple devices, where you can seamlessly pick up from where you left off as you switch from an iPad to a laptop.

In these cases, there's a great deal more going on under the hood than simple app compatibility, which enables that sort of device-to-device movement of data.

Regardless, we haven't yet been able to test exactly what will or won't be possible, as the feature isn't currently enabled. Indeed, there's a good chance it won't go live until the OS launches officially, given the integration it requires with existing live services.

Multiple desktops and windows snapping

One of our favourite additions to Windows 11 is its improved multiple desktop management and window snapping. Open a new desktop and you can now rename it, rearrange the

The reintroduction of a generally more tactile look to the operating system makes it look cleaner and improves ease of use

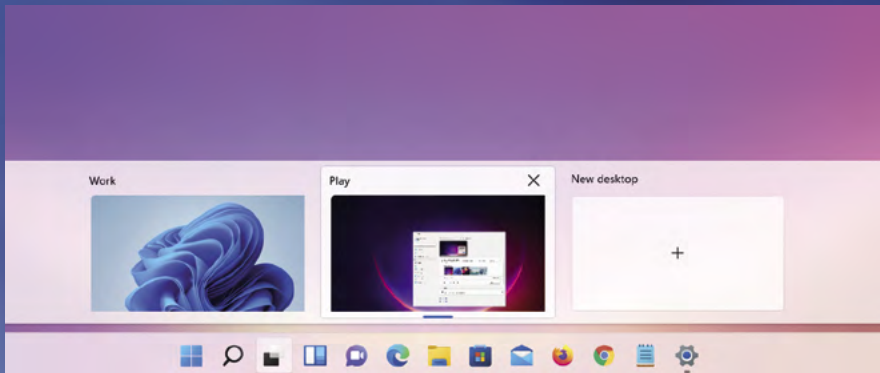
the 3D portion of the game at a lower resolution but keeping the main game at native resolution wouldn't mess with your windows. With Windows 11, though, you no longer have to bother, which is a bonus for games that never supported resolution scaling.

Integrated Android apps

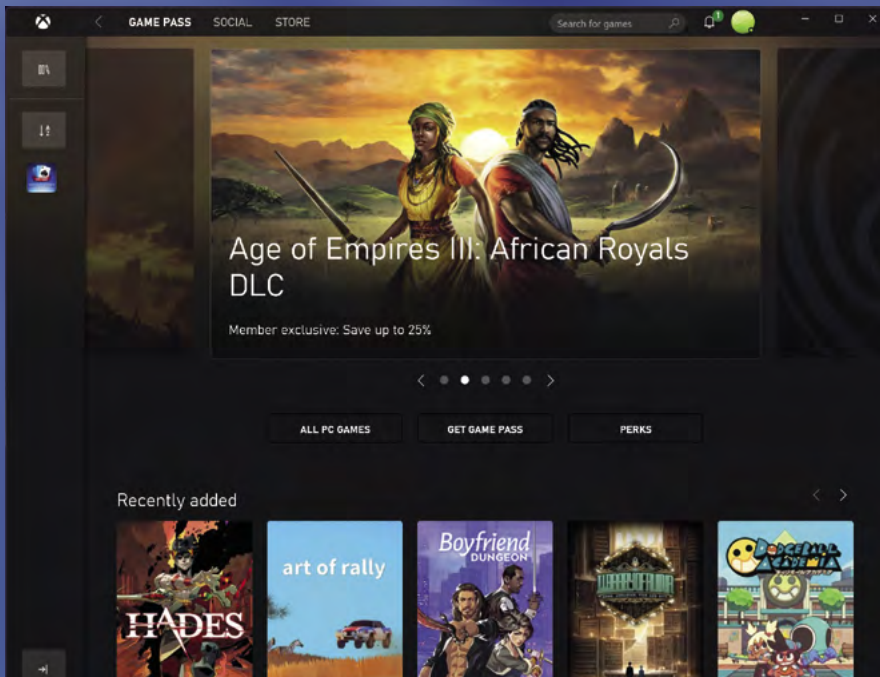
Arguably the biggest new feature of Windows 11 is its native support for Android apps. These will be downloadable from the Microsoft

order of the desktops and even change their desktop backgrounds. It's not real power user stuff – you can't assign different desktops to different displays, for example, or change the taskbar apps for each desktop – but it's a step in the right direction.

Similarly, window snapping has been upgraded so that you can now quickly opt for several suggested window layouts. Drag one window to the side of the screen as usual and you can then hover over the maximise button



The new multiple desktops interface allows you to rename desktops and apply new backgrounds



The new Xbox app brings Xbox Game Pass to Windows 11 and allows direct purchase of games for PC

of another window to bring up options for how to then arrange the remaining space. Again, it's not at the level of even Microsoft's own Fancy Zones app but it's a welcome improvement on Windows 10.

Updated apps and dictation

As we're still in the pre-launch period of Windows 11, many features haven't been updated and others have only just received updates. The Calculator, Calendar and Mail apps have all been updated in the latest release, mainly with only visual overhauls, although the Calculator app has been reimplemented in C#, enabling developers to contribute improvements via GitHub.

A larger update has arrived for the screenshot-capturing Snipping Tool and

Snip and Sketch apps, which have now been combined into one tool.

Hit Win+Shift+S to fire up the capture, then click on the image to edit it. It's a great consolidation of the two features, plus the capture tool now includes a dark mode option, so it will match your Windows 11 theme.

Microsoft Teams is also now integrated into the OS, with a new Chat app appearing on the taskbar, although again this has only just added basic functionality like audio and video calls and screen sharing.

Proving the point that many of the changes and updates that you'll find in Windows 11 are small and subtle – outside of the visual overhaul – one crucial update for some users will be the improved dictation. Now, there's no need to spell out punctuation – instead, the

dictation will recognise that you've ended a sentence or used a questioning inflection to your last statement, adding the appropriate punctuation marks. This allows for a much more natural flow to your dictation and it worked well in our tests.

Xbox and gaming

There are three key changes coming to Windows 11 with regards to gaming, or at least that was apparently the original plan. However, two of these changes have already found their way into Windows 10, in the shape of DirectStorage and AutoHDR. These features respectively enable your GPU's memory to directly access your storage devices to load game data to where it's needed more quickly, and add a pseudo-HDR look to otherwise non-HDR games, both of which are features that have also been added to the latest Xbox.

Speaking of Xbox, the third main gaming feature added to Windows 11 is full integration of the Xbox app. This makes it easy to access your Xbox Game Pass library from your PC, assuming you have a subscription, or you can buy and download games directly. The game selection doesn't rival the likes of Steam yet, but just as with integrating Internet Explorer and Edge, simply having a pre-installed app could go a long way towards driving users to buy games through this platform.

Final thoughts

It's still early days for Windows 11, with more apps being updated and features added in the run up to what's expected to be an October release date. However, given that time frame, what we've experienced has to be pretty close to what will hit shop shelves in a couple of months.

Overall, we're fans of the new look, with it greatly improving the navigability of the OS and simply looking more attractive than Windows 10. There are some welcome tweaks to core features, such as the improved multiple desktops, resolution/monitor handling and Settings menu layout too.

We're less keen on some of the touch-screen-centric features and oversimplification of some features, but they don't feel as egregious as when Microsoft introduced the Windows 8 Start Menu.

Ultimately, you're never going to please everyone, but so far, we feel Microsoft has done a decent job of improving Windows for the majority of users. **HP**



DESK DRAWER 2.0

STARTING AS A PROJECT FOR HIS CARPENTRY COURSE, MADS ALEXANDER BUILT A CUSTOM DESK WITH A WATER-COOLED PC BUILT INTO THE DRAWER. IT WAS SO WELL RECEIVED THAT HE'S BACK WITH A FOLLOW-UP VERSION THAT HE'S HOPING TO START SELLING

SYSTEM SPECS

CPU AMD Ryzen 7 5800X

Motherboard Asus ROG Strix 570X-F Gaming

Memory 32GB (4 x 8GB) G.Skill TridentZ Neo 3200MHz

Graphics card AMD Radeon RX 6800

PSU Cooler Master SFX 650W

Storage 1TB NVMe SSD, 2TB 2.5in SATA SSD

Cooling Custom water-cooling loop, using EKWB waterblocks, a 360mm Alphacool X-Flow radiator (60mm thick) and a Swiftech pump/reservoir combo

This PC-in-a draw desktop carpentry project started in the autumn of 2019 during my training to become a carpenter. I thought it would be awesome to use wood to build a computer case, or in some way combine the woodworking skills I was learning with the art of computer modding.

For my final exam project, I came up with the concept of a computer built into a desk. However, rather than taking the traditional approach with desk PCs, where the PC is just built into the desktop itself and topped by a large sheet of glass – making for a very thick desk – I decided to build the PC into a drawer.

What's more, I decided to do it in such a way that the drawer looks like it's hovering under

the desktop, and when pulled out, a full water-cooled computer just appears. I also wanted the drawer to be openable while the PC was still running, so you could see all the lights flashing, fans blowing and coolant flowing in the tubes.

I got the green light from my teachers, so I began designing. It didn't take more than a couple of hours to make a rough sketch, and from there I made the 3D drawings in Inventor and ordered all the components.

What I particularly liked about this project was that it combined three aspects that generally shouldn't be combined. Water and wood don't belong together, at least when it comes to fine furniture. Water and



Mads was very pleased with the overall design of the first desk PC, but there was room for improvement



The layout of the PC in the drawer was simpler on the original version of the desk

electronics also only mix well in very limited circumstances, and computers and wood aren't often paired due to the poor thermal conductivity of wood, making it harder to keep your PC's thermals under control.

I wanted to combine these elements in an elegant way that's both beautiful but functional. It felt to me that no one had quite achieved this combination before, so it was a unique challenge. I've seen lots of people building computers into boxes, and lots of awesome desktops, but I haven't seen anyone combine all three parts at once, and in a sleek Nordic style.

The first attempt

At this point, I had only a few weeks of experience with woodworking, so my teachers helped me out a lot, but in the end I did almost all the work myself. I came up with the idea, made the drawings from scratch, bought all the hardware with my own money, milled every hole by hand and made sure everything was just right – with such a clean

One of the first changes to version 2.0 was the addition of a diagonal cross brace under the desktop



design, it had to be perfect or imperfections would be obvious.

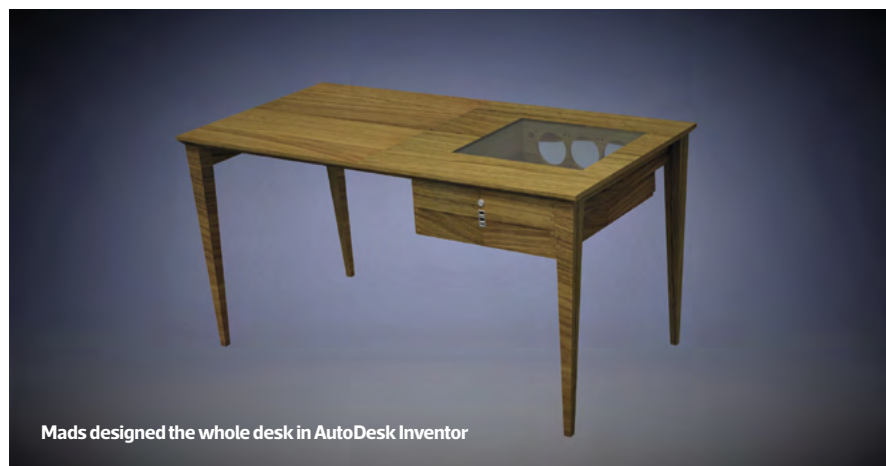
As an example of the precision required, the chamfer around the edge of the table sits at the same three-degree angle as on the legs. In turn, those angles then determine where the drawer needs to sit, which determines if

THE CHAMFER AROUND THE EDGE OF THE TABLE SITS AT THE SAME THREE-DEGREE ANGLE AS ON THE LEGS

the glass is square with the drawer and so on. One wrong move and all those angles and straight lines don't match up properly.

A part of the requirement for my course was that the table was built out of chipboard with a veneered top, which actually proved to be a problem in terms of the strength of

and making sure they were made cleanly without any burn marks. I used solid oak for the drawer, which helped a lot, as its strength meant the drawer panels could still be quite thin and filled with holes, while still maintaining their structural integrity. However, its hardness does make it more difficult to work with.



Mads designed the whole desk in AutoDesk Inventor



The second iteration of the drawer has a split design, with the PSU, pump and SATA SSD housed in the front

Overall, the desk, drawer and PC came out looking stunning, in my humble opinion. I loved every aspect of it. I was also very happy to receive a 12/12 grade in my exam.

As I was building the desk, I filmed the process and, once it was finished, I put together a video and uploaded it to YouTube. The extra work of filming was a major headache but it was worth it, as that video received over two million views!

Because of this success, I immediately started working on a second version of the desk to improve its design, and with the hope that I could actually manufacture and sell the new version. This was the beginning of MA Modified, the modding company and YouTube channel ([youtube.com/MAModified](https://www.youtube.com/MAModified)) I've now started.

The second coming

I spent the next eight months working solely on developing the new version of the desk,

The drawer uses a false bottom with two large holes for ventilation, along with a horizontal GPU bracket



working with skilled people in Denmark who excel at water cooling and high-end computer construction, as well as people who have their own companies and experience of all the small details needed to turn an idea into a business.

We sat down to examine my concept, thinking about how we could optimise it, and one of the first jobs was to reinforce the desk. The simple addition of a single cross brace fixed several problems, adding support for the desktop, as well as stabilising the whole unit.

Next, we removed some fans. There were eight at the start, but we got this number down to just three in the back of the drawer. They were all arranged as exhaust fans, with no intake fans. Instead, air is drawn in through 12 holes in the bottom of the drawer. The holes are covered with dust filters in order to keep the insides of the PC clean.

We were also able to reduce the number of fans because both the CPU and GPU

Mads also created a standalone version of the drawer that could be mounted to any desk



The build process is still very much hands on, which adds to the cost of the final desk

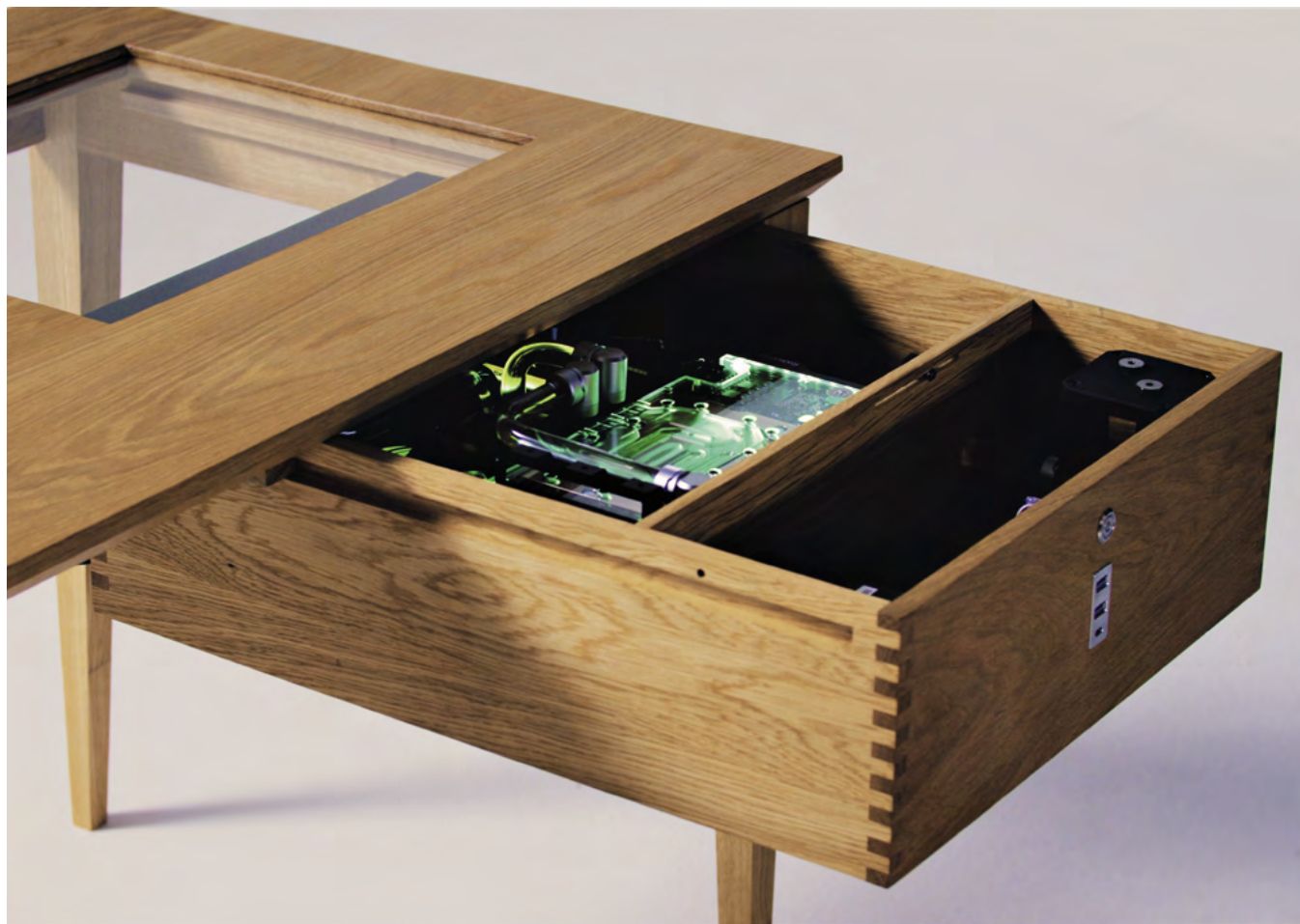


The ventilation grilles on the underside of the drawer are the only air intakes

are water-cooled. As long as the radiator is powerful enough to pull out all the heat, it's the only part that needs to be supplied with regular, strong airflow. That requirement meant the radiator had to be very thick and the fans quite powerful. However, as we hid the 60mm-thick Alphacool X-Flow radiator at the back of the drawer, it will almost never be seen.

The drawer's false bottom was also a crucial aspect of the design. The true bottom is the panel into which all the ventilation holes are drilled, then above this is the panel for mounting all the components. Air passes between the two panels via two big holes under the motherboard, which means the motherboard (with its hot power delivery components and M.2 SSDs) gets a good supply of cool air before it's sucked through the radiator.

Also hidden – at least when the drawer is closed – is the power supply, pump, SSD and the back of the USB ports and power button, which are on the front of the drawer. These are housed in a section at the front of the drawer,



which is hidden under the front edge of the desk when closed.

It took months to find the right pump/reservoir combo unit that would allow us to mount the pump upright and still have it fit in the drawer, and we still ended up having to modify it to make it fit. By ensuring the pump is mounted vertically, and the tubing is

Another example was the bracket used to hold up the GPU, which I found on EKWB's website. It's mounted to the wall separating the compartments, creating the appearance of the graphics card just plugging into the side of the drawer.

To aid with airflow and cable management, the motherboard is mounted on 20mm

of the drawer next to the motherboard is available for custom names or other logos to be added, for example, or a custom reservoir/distribution block could be added.

On this version of the desk, we also drilled individual holes through the false floor for the 24-pin and 8-pin power cables, which looks super-clean, but this will be a custom order option in the final product. I've also made a standalone drawer version with rails on the sides, so you can mount it under any table you like, as long as it's pretty sturdy.

We're still some way from determining a final price for a desk based on this design, but our current estimates put it in the region of \$3,000 US (around £2,185) for the desk without the PC. Meanwhile, the drawer would cost around \$1,000 US (around £728). The quality of materials and amount of manual work means it's hard to make these cheaply. I'm investing heavily into my business – buying power tools and camera gear – and I'm aiming for a part-time launch in Q12022, so stay tuned to find out more. **GPG**

I'VE ALSO MADE A STANDALONE DRAWER VERSION WITH RAILS ON THE SIDES, SO YOU CAN MOUNT IT UNDER ANY TABLE YOU LIKE

carefully arranged, we eliminate air bubbles in the system, reducing noise. The tubing goes through the bottom of the drawer and comes back out again at other locations, adding a unique, stylish and clean look to the system.

The little details

Creating such a clean look for the PC involved making a lot of small tweaks, such as the tubing and hidden radiator described above.

standoffs, rather than the more typical sub-10mm standoffs. This simple change means no further holes or other machining processes are needed in that general area, reducing the amount of work and still resulting in a clean look.

As we're looking to sell these desks, we thought about where we could add customisation options for buyers and we came up with a few ideas. The right side



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

Mooltipass Mini BLE

It's been a long road for the Mooltipass Mini BLE, a Bluetooth-equipped successor to the Mooltipass Mini password safe (reviewed in Issue 168), not helped by a global components shortage that continues to bite the electronics industry. When previewed in Issue 201, it was hoped the gadget would reach backers of its crowdfunding campaign by January 2021, but it would be nearly six months later when backers finally started receiving their devices.

The delay has been put to good use. At its heart, the Mooltipass Mini BLE is unchanged

from when we previewed it a year ago. It's an open-source pocket-sized gadget that stores all your passwords in a secure element, protected by a physical smart card and four-digit hexadecimal PIN.

Stored passwords can be retrieved using a companion application dubbed Moolticute, extensions for the most popular browsers or directly on the device, where they are typed out as though on a keyboard or, optionally, displayed on the screen.

The Mooltipass Mini BLE improves on its predecessor with an integrated battery and Bluetooth Low Energy connection. Since our preview, the latter has been vastly improved – it's now wholly functional, both for use as a Bluetooth keyboard on smartphones and tablets, and for connection to Moolticute on desktops and laptops, bar a few edge cases and compatibility with unusual devices.

The promised FIDO2 feature, which allows the Mooltipass Mini BLE to act as second-



After a slight delay, the Mooltipass Mini BLE has landed, and it lives up to its promise

factor or password-free authentication for websites and apps supporting the WebAuthn standard, has also been completed in time for launch. Integrated into the Moolticute app, it works more or less seamlessly.

However, it only supports WebAuthn and not the older FIDO U2F standard, meaning it's not compatible with Firefox on Linux. If you're not a Linux or Firefox user, though, it's a fantastic string to the Mooltipass bow, and saves needing to buy and carry a second security token with you.

Mobile compatibility is now completely solved too, with one issue of note – there's still no mobile version of Moolticute, so while you can manually retrieve credentials and have the Mooltipass Mini BLE type them over Bluetooth, there's no way to add or update



The device is a little bulky, but feels solid in the hand



Each Mooltipass Mini BLE comes with two custom-designed smart cards – one to use and one as a backup

credentials without moving to a desktop or laptop running Windows, macOS or Linux.

There have been additional improvements too. It's now possible to add time-based one-time password (TOTP) credentials, which typically require a physical dongle or companion app such as Google Authenticator or Authy. The storage for arbitrary files has also been improved, and you can now store notes on the device.

The latter is a particularly smooth feature. Previously, files could only be stored or retrieved, so if you had a file you needed to update, you had to retrieve it, edit it, delete the copy on the Mooltipass and then store it again before deleting the local copy. Now, you can just click 'edit' and change a file's contents directly in Mooltipass.

The hardware is less changed. The casing is now more secure, with the original beta units having been built for fit-testing rather than security, and it's difficult to separate the parts

without leaving obvious signs of tampering. Bugs in battery charging and display brightness have been fixed, and the bundle now includes a neat silicon case to prevent the body from being scratched in your pocket. Sadly, though, the single-colour OLED display is still left unprotected.

Meanwhile, the jog button at the side, which serves to scroll through menus and select or confirm items, is also improved. Those who had an original Mooltipass Mini may have

encountered it skipping over items, but that shouldn't be an issue with the new model, although this problem is relatively easy to resolve on the original unit with the application of a little contact cleaner.

With a number of online password safe services having introduced new ongoing charges, or admitting to security breaches, the Mooltipass Mini BLE is more tempting than ever. However, it still comes with the same caveat as the original, which is cost. At £91 (ex VAT), the Mooltipass Mini BLE will set you back more than the cost of several years' subscription to a cloud-based password management service and, effectively, doesn't do much that you can't do in software with a couple of open-source applications.

The improved security, though, makes it a great buy. Plus, when you consider that you don't need a separate FIDO2 dongle, it could even be considered a bargain. Longevity could be an issue, true, thanks to the non-replaceable NiMH battery, but in over a year's use our beta unit hasn't skipped a beat.

The Mooltipass Mini BLE should, bar any more delays, now be available to buy at mymooltipass.com for £91 (ex VAT), including a USB cable, silicon case and two programmable smart cards.



Each package includes the unit itself, two smart cards, a silicone cover and a USB cable

NEWS IN BRIEF

PineTime hits commercial availability

The low-cost open-source PineTime smartwatch has now launched as a polished device, complete with charging dock and sealed IP67 dust-and-water-resistant housing.

Built around a colour 240 x 240 1.3in IPS capacitive-touch display, the Nordic Semiconductor nRF52832-powered watch includes open-source firmware that hits all the major feature points, from step-tracking to smartphone connection via Bluetooth 5 Low Energy (BLE).

The company has also landed extremely close to its target \$25 US target selling point, launching the device on pine64.com for just \$26.99 (around £20 inc VAT).



REVIEW

SQFMI Watchy Smartwatch Kit

The death of the Pebble smartwatch brand, which had launched to great acclaim via crowdfunding, but fell at the final hurdle when trying to release an updated model with heart-rate tracking, left behind a cadre of enthusiasts.

Many turned to commercial offerings to fill the hole; others tried to eke extra life out of their Pebbles and Pebble Times with third-party firmware. A small group, though, opted to make their own watch.

Enter the Watchy, from SQFMI. At its heart, the Watchy is a smartwatch driven by an

e-paper display, meaning it draws very little power and is fully readable in direct sunlight. It's available commercially, but that's not its focus – it's an open-source project to prove there's a market for devices more flexible than those offered by big companies.

Supplied in kit form, with a moulded plastic housing that can be swapped out for an optional milled aluminium version, the Watchy is surprisingly polished. The instructions form part of the packaging, but were slightly outdated at launch – the first step in assembly, removing protective film from a vibration motor to stick it down, is now carried out at the factory on the buyer's behalf.

The rest of the process is simple. The battery plugs into a small connector to supply power. The ribbon cable for the 1.54in 200 x 200 e-paper display is slotted through the custom PCB and into the matching connector, then stuck down with supplied tape – the display requires power only when it's changing states, and retains the last image displayed even when unplugged. Then it's just a case of popping the four



The e-paper display needs power only when changing states, and is fully readable in sunlight

buttons into place and clicking the two halves of the case together, which is by far the most fiddly part of the process.

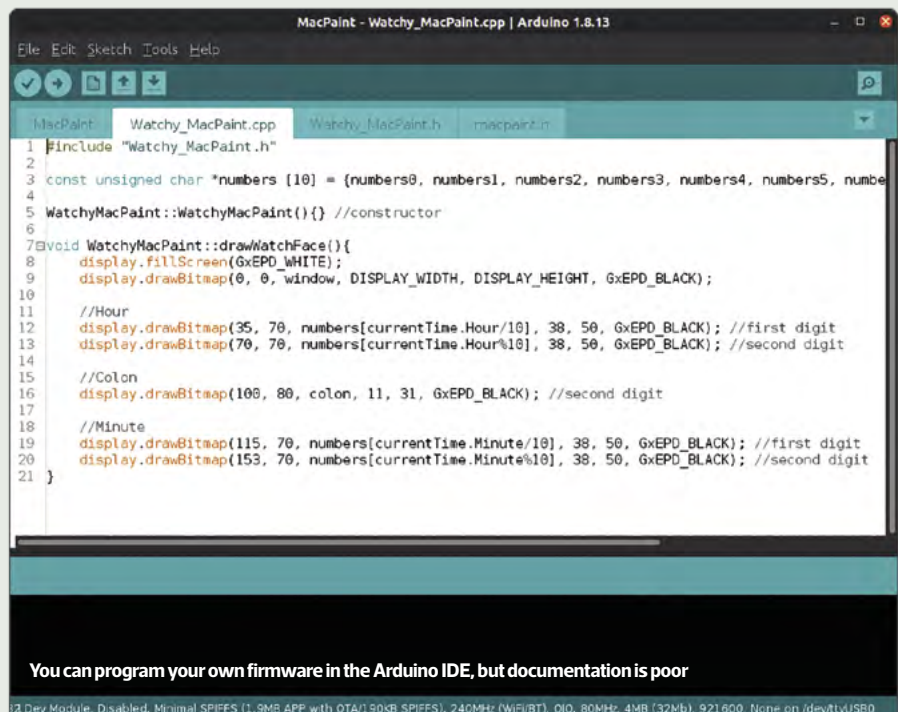
It's possible to use the Watchy with its bare circuitboard, outside the case, if you add a NATO-style watch strap; the rubber strap supplied is only of use if you're using the case – which sad to say, manages to be both bulky

NEWS IN BRIEF

ClockworkPi DevTerm arriving 'soon'

ClockworkPi's TRS-80 Model 100-inspired modular computer has finally begun shipping after component shortages caused it to miss an April 2021 launch target. Designed as a follow-up to the GameShell (see Issue 184), the DevTerm is a surprisingly compact device featuring a custom motherboard or Raspberry Pi Compute Module 3+ carrier, as well as an ultra-wide colour display.

Pseudonymous creator 'Hal' announced shipping by showcasing the gadget running a range of workloads, from games to productivity applications, and even a TRS-80 Model 100 emulator. A full review will appear in a future issue.



You can program your own firmware in the Arduino IDE, but documentation is poor

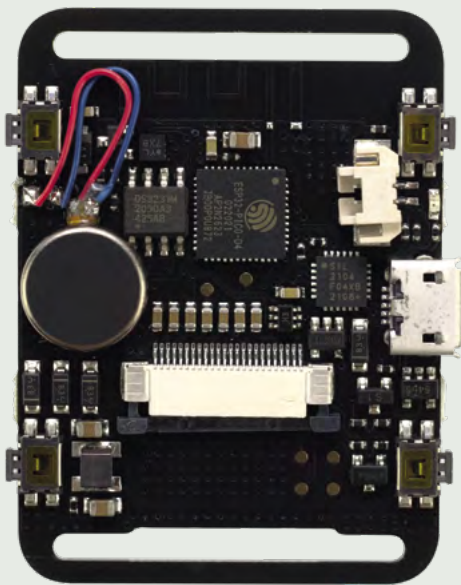
2 Dev Module, Disabled, Minimal SPIFFS (1.9MB APP with OTA/190KB SPIFFS), 240MHz (WiFi/BT), QIO, 80MHz, 4MB (32Mb), 921600, None on /dev/tty/USB0

The Watchy is an ambitious project, but the promise of the hardware is let down by its software



and flimsy while showing obvious stress lines from an incorrectly configured injection moulding machine.

You'll only get one chance at the process too. Once it's glued together, the thin glass display isn't going to move without damage, unless you're willing to spend considerable time carefully freeing it from the adhesive with floss. To make matters worse, it's all too easy to attach it off centre.



The PCB can be used without the supplied case, but you'll need your own NATO-style strap

Once assembled, you can get started with the watch straightaway. The stock firmware, running on the watch's Espressif ESP32-PICO-D4 system-on-chip, shows the current time, date, weather and step count as recorded by an internal accelerometer, as well as the connection status for Bluetooth and Wi-Fi.

Here's where the cracks begin to show. You connect the Watchy to your Wi-Fi network using a simple configuration system – you trigger the link from the watch's menu, connect another device to the 'Watchy' access point and use the captive portal to enter your own network details.

Once connected, the Watchy can pull weather data from the Internet but not, oddly, time data, which you need to enter manually using a laborious three-button process.

Unless you live in New York City, you'll also find the weather information is wrong – and there's no mention of how to fix it in the documentation. The answer, it transpires, lies in editing a hidden configuration file buried in the example source code provided. That's the other edge of the open-source blade. You can write your own software for the Watchy using the Arduino IDE and a supplied library, but the documentation on how to do it, at the time of writing, severely lacking.

As is, sadly, the watch's feature set. The internet connection isn't used for any data

other than weather, and there's nothing there to make use of the Bluetooth connection. With notifications from a connected smartphone being one of the most common reasons to use a smartwatch, that's a big hole in the feature set, although one that the community may come together to address in future firmware updates.

If the Watchy were the only open-source smartwatch on the market, it would be easy to overlook the poor state of the software and documentation, but that's not the case.

For example, PINE64, best known for its as-open-as-possible PineBook and PinePhone laptop and desktop range, recently launched the PineTime smartwatch (see p95). While the Pine Time lacks the Watchy's e-paper display, instead using a lower-power LCD that switches off when you're not looking at it. The Pine Time's feature set is miles ahead of that of the Watchy, and it's considerably cheaper too.

At \$59 US (around £43 ex VAT) from **crowdsupply.com**, plus an extra \$49 (around £36 ex VAT), the Watchy is cheap enough. However, it's hard to recommend the Watchy unless you're happy spending your time figuring out how to implement basic features yourself. Otherwise, consider the PineTime as an alternative.

REVIEW

Crackers I: The Gold Rush

Readers of a certain age may remember social piracy: meeting up in playgrounds, coffee shops and office break rooms to swap cassettes holding the latest 8-bit entertainment. While there are arguments to be made for and against the idea that every pirated copy of a game represents a lost sale, there's no denying it triggered a cat-and-mouse game between those looking to protect software and those looking to break that protection. Crackers are in the latter group.

Microzeit's Crackers I: The Gold Rush – the first in a planned duology of books – looks to document the growth of the cracking scene in Europe. And what a scene. When increasingly sophisticated copy protection systems attracted technically capable crackers with a new puzzle to solve, the groups banded together under brands: The Medway Boys, Pompey Pirates, LSD, Automation, 42-Crew and more, each with their own unique style.

Cracked games weren't simply pirated, but entirely repacked – typically with a demoscene-style introduction, dubbed a 'cracktro', featuring unique artwork and music alongside diary-style

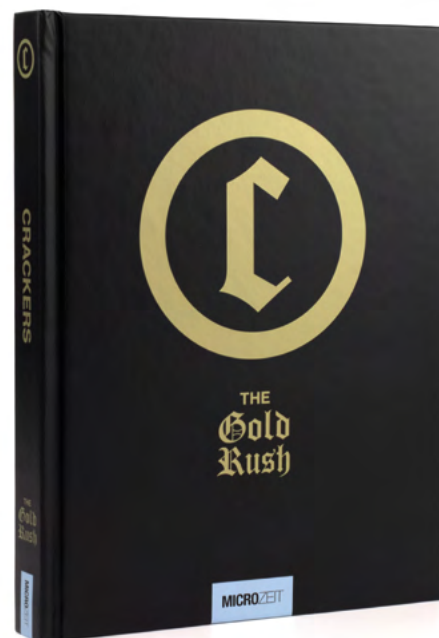
The book is in full colour and well presented, although it's image-heavy

messages and shout-outs to the crackers' friends and foes alike.

While the book's primary focus is on the Atari ST cracking scene, there's coverage in this impressively weighty 336-page tome of groups working on other systems, from the Apple II to the Sinclair ZX Spectrum. Coverage comes from a mixture of contemporary sources and later reportage, with plenty of interviews with those who were there, and the occasional extract cribbed from the documentation supplied with cracked software.

It's also far from wordy. At least half, sometimes more, of each page is taken up with full-colour imagery, ranging from screenshots of cracked games to technical illustrations on how a piece of hardware or copy protection system worked, plus a few screen grabs from news reporting of the era.

The European scene is well covered in the book, but it's by no means a geographic exclusive: the opening chapter, in fact, looks at the rise of the personal computing industry in the USA and Microsoft's part therein. This sets the scene for the rest of the book, with a quote from Bill Gates bemoaning the lack of quality software available on the market at the time.



Microzeit's Crackers covers the glory days of software piracy, without judgement

Most imagery – all credited in an appendix at the rear of the book – is printed in high quality, although some, including a particularly poor example of an anti-piracy advert from the 1980s, shows evidence of having been cribbed from low-quality magazine scans shared on The Internet Archive.

While a little scattershot at times, the prose draws in the reader, particularly when it quotes a group member responsible for a fondly remembered game. It doesn't shy away from considering the other side of the argument either, including the undeniable impact of piracy on the industry.

It ends, arguably, a little abruptly, despite its impressive size. There's a reason, of course: Crackers II: The Data Storm, the follow-up title which at the time of writing had successfully completed crowdfunding on Indiegogo and was awaiting completion and production, will cover the rest of the story through to what crackers are doing now.

Alone, Crackers I is an enjoyable romp through a fascinating time when software piracy and artistic self-expression went hand in hand. When paired with its follow-up, the two books will make for a must-have set. Crackers I: The Gold Rush is available on microzeit.com now, priced at €39.90 (around £34 inc local VAT). **GPG**



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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ANTONY LEATHER'S

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Are giant PC cases redundant?

When I first got into water cooling, the case features I wanted changed dramatically. I was no longer interested in funky-looking cases. Instead, I wanted plenty of fan mounts, ideally 120mm or larger, and clearance for radiators. Back then, this was difficult to find, as case manufacturers were only just beginning to gear their PCs towards good air cooling, and migrating from 80mm fans to 120mm models.

All-in-one liquid coolers didn't exist then as we know them today, so case manufacturers admittedly had little reason to factor radiators into their chassis design choices.

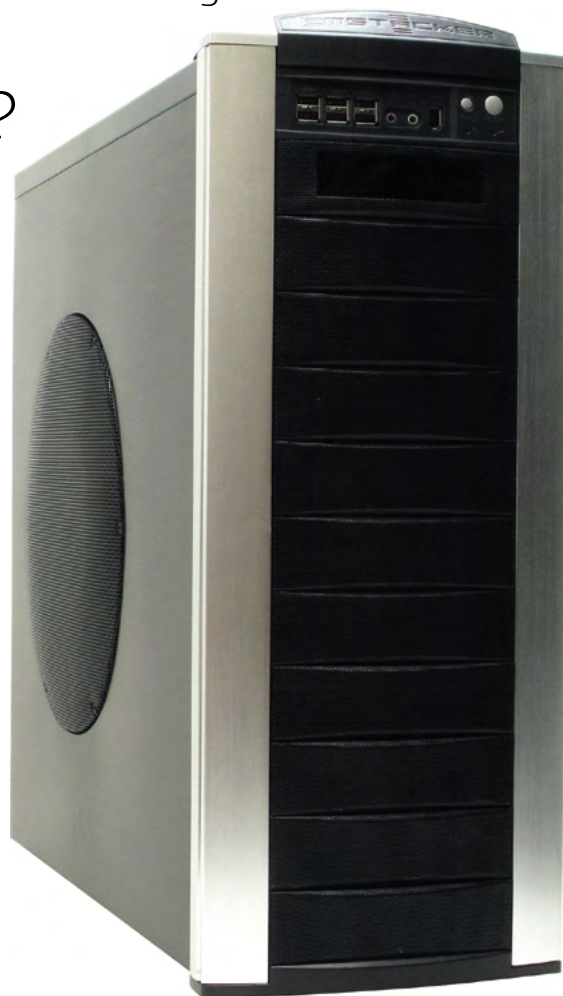
As a result, very few cases made decent homes for water-cooled hardware. Cases that did tick all the water-cooling boxes were either extremely expensive due to their size and niche appeal, or not particularly attractive and required modifying.

For instance, one of the first cases I used that could house large radiators was the original Cooler Master Stacker.

The only reason it was good for water cooling was its massive stack of hard disk bays in the front of the case, hence its name. You could remove these bays, leaving a mesh-fronted chamber that was just wide enough for 120mm radiators, although you had to mount them yourself. There was no space in the roof for a radiator without significant modding, but you could fit a radiator in the base too.

However, even ten years ago, if you bought a mainstream case for around £150, it would probably be limited to housing one radiator, or maybe both a 240mm and 120mm radiator – not enough to handle a high-end, overclocked system without the fans needing to spin up under load. If you wanted to fit a 360mm radiator, your choice was very limited, and if you wanted more radiators than that, so your PC could stay quiet all the time, only a handful of cases could do the job.

Fast forward to 2021 and we have a choice of numerous enormous cases – in Issue 217, I reviewed one of them –



Around 15 to 20 years ago, you needed a massive case, such as the Cooler Master Stacker, to properly house water-cooling gear

the Corsair 7000D Airflow. Corsair now offers several super-sized chassis, and these are the types of cases that used to really excite me when I heard they were inbound. I'd want to know where radiators could be fitted and what size of radiators would fit, as well as whether there were any other water-cooling features. Size was immaterial – you needed to go big if you wanted a high-end water-cooled system.

The situation is very different now though. If you look at any case manufacturer's line-up, you'll find much smaller and cheaper cases that can still house plenty of water-cooling gear. Take Corsair's 5000D Airflow, for example, which can house two 360mm radiators simultaneously.

It costs a little over £100, which is half the price of the larger 7000D Airflow, yet has enough water-cooling capacity to deal with any single-GPU system. We did just this with our recent ultimate water-cooled gaming PC feature, using the RGB-equipped version of the case – the iCUE 5000X RGB, and equipping it with two 360mm radiators to deal with our AMD Ryzen 9 5950X and Nvidia GeForce RTX 3080.

As planned, the system could easily cool our hardware with low fan speeds, with the speeds only rising slightly on warm days in lengthy gaming sessions. It's cases such as the 5000X that I wish we'd had 15 years ago, especially as they're just as good at air-cooling your hardware as water-cooling it.

Even if you drop down to micro-ATX and mini-ITX cases, you'll find far better water-cooling support than most ATX cases had 15 years ago. Most can handle 240mm or 280mm radiators with ease, and some can even handle multiple radiators, especially if you use slim fans and radiators.

For that reason, I switched from monstrous towers that take up half my bedroom or office, to small form factor cases, simply because I don't need anything bigger. I can house multiple radiators and cool a high-end PC with

a single GPU, multiple SSDs and a powerful CPU in a small case now.

I can still appreciate the need for cases such as the 5000D Airflow, though, as there are days when my mini-ITX PC gets toasty and ramps up its fan speeds. It's also a little trickier to maintain and the water-cooling components I've used were specifically picked to fit in this case, so migrating them to another one might not be possible either, unlike with an ATX case.

For me, cases such as the 5000D Airflow offer a perfect balance of air cooling and water cooling, which begs a serious question. Do we need cases to be bigger? The 7000D Airflow is a solid case with support for 420mm and 480mm radiators, but if you have a single GPU, there's simply no reason to buy it over the 5000D other than willy-waving. It costs more than twice as much money, and that money would be far better put towards a larger SSD or faster graphics card. It's also hugely heavy and absolutely enormous.

For me, while I hate to admit it, these ultra-large cases just don't fit into the typical

Corsair's iCUE 5000X RGB is cheaper and smaller than the 7000D, but still has room for plenty of water-cooling gear, as demonstrated in our recent dream PC build



Corsair's massive 7000D Airflow is arguably overkill for gamers' needs now



PC gamer ethos anymore. They're excessively large, have unnecessarily extensive water-cooling potential for single-GPU systems and they cost a fortune too.

I don't doubt some people will buy them, and some of those people may genuinely need that amount of cooling too. After all, if you have two RTX 3090 cards to cool, or a workstation-focused multi-GPU setup, then you'll likely need more than a pair of 360mm radiators. This is especially true if you want to work in peace and quiet with a monstrous PC sitting in the same room. That's a tiny niche in the PC gaming world now though.

This is all good in the end, however, as it means case manufacturers have listened – even sub-£150 cases now have what it takes to deal with high-end hardware, whether it's cooled with air or water. It's partly for this reason that we're seeing so many water-cooled PCs now, as it's cheaper and easier to do than it was ten years ago.

This is all part of what I love about the PC industry – it keeps bettering itself in most areas as a result of enthusiast feedback – long may that continue. **GPC**

How to

Move your motherboard tray

Antony Leather shows you how to move your case's motherboard and graphics card mounts by reconfiguring your case layout

 **TOTAL PROJECT TIME / 6 HOURS**

There are precious few modular cases available that allow you to move key components such as motherboards. However, doing so can make your case more water cooling-friendly, removing components or shifting them around to offer more clearance for radiators, pumps and reservoirs. Some cases are designed to be air cooling-friendly too, which can often mean there's lots of wasted space if you plan to use AIO liquid coolers or custom water cooling.

One way to drastically alter your case's internal layout is to move the motherboard tray. This might sound like a nightmare, but it's actually nothing a Dremel, rivet gun and a couple of hours of modding can't handle. In return, you gain lots of space to house fans and radiators, increased clearance for other components, and you can even invert your motherboard tray to further benefit your specific layout. In this guide we'll show you how to do this with a minimum of fuss, using Cooler Master's NR200P case as the test subject.

TOOLS YOU'LL NEED



3mm steel or aluminium sheet
ebay.co.uk



Dremel and cutting discs
Most hardware stores



Drill and drill bit
Most hardware stores



Metal file
Most hardware stores



Matt black spray paint
Most hardware stores



Safety goggles
Most hardware stores



Rivet gun and 3mm rivets
Most hardware stores



1 / DECIDE ON GOALS

Start by deciding exactly where and why you want to move your motherboard – focusing on one or two aspects can help to get the most out of the result. Here, we want to shift it to the middle of the case, switching to a sandwich-style layout, while also moving it down to make room for a radiator.



2 / REMOVE FIXTURES AND FITTINGS

It's important to remove any components that don't make up the structural part of the case, as these can prevent you from removing sections, or they can simply get in the way. Remove every part you can, but take note of the parts you'll need to replace afterwards.



3 / REMOVE CABLES

As there will be lots of dust and metal shards flying around, you need to remove all cables, such as those for the power and front panel ports. This way you won't have to waste time cleaning (or repairing) them later.



4 / INSTALL FINAL COMPONENTS

If you're tweaking your case to make room for new components such as radiators, place these parts into the case where possible, so you can work out if your endeavours will work. Here, we want to be able to place a radiator in the roof as well as the base of the case.



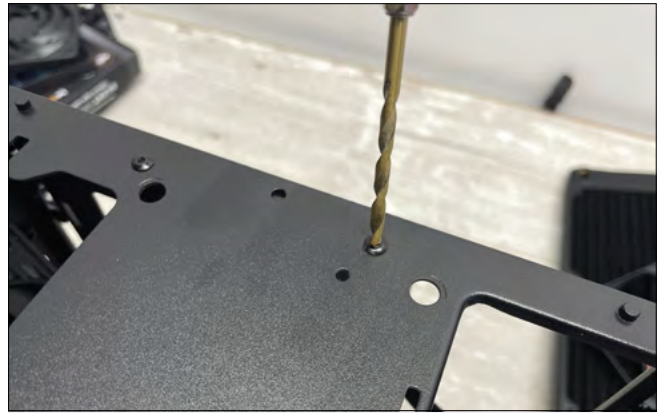
5 / TEST-FIT MOTHERBOARD

The motherboard's location will be key, so you need to work out where it needs to sit. In our example, there's enough space to reside between the radiators, which we've checked by test-fitting the motherboard between them.



6 / MARK UP CUTTING LINES

Use a marker pen to set out where you need the motherboard I/O panel cut-out to be located. This will dictate the position of the motherboard tray.



7 / DRILL OUT RIVETS

Most cases are held together using rivets, which you'll need to drill out in order to remove the motherboard tray. Use a 3mm drill bit, as this is the most common rivet size used in cases.



8 / CHECK COMPONENTS ARE LOOSE

Once the motherboard tray's rivets are removed, dislodge the tray at one end to make sure it's loose. It's easy to miss a rivet or a securing screw, so if it doesn't come free easily, check again.



9 / REMOVE MOTHERBOARD TRAY

The motherboard tray needs to be removed from the case, so you can adjust its position and alter the rest of the case as necessary. At this point you also need to think about where to secure it using rivets later.



10 / USE SAFETY GOGGLES

Before you start cutting, put on a pair of safety goggles. Cutting disks and metal shards can fly off when using power tools, so make sure you wear them, even for short jobs.



13 / VACUUM DUST

The cutting process will generate a lot of dust, so use a vacuum cleaner as you work, in order to keep your work area clean and tidy.



11 / CUT OUT I/O PANEL

Use a rotary tool and cutting disk to carefully cut out the I/O panel area. You'll need to remove a section with at least 8mm of frame surround in order to reattach the panel to the tray. Alternatively, you can leave it in place and cut a new hole, blanking off the old one with aluminium sheet.



14 / USE THE RIGHT RIVETS

To rivet sections back together, you'll need to use the correct-size rivets. The thick head of the rivet passes through the hole, and this section is the actual width of the rivet. Most cases use 3mm rivets, but use a ruler to check the diameter of the holes.



12 / REMOVE I/O PANEL

All cases are different, but we've gone with the cut-out method, removing the old I/O panel area, as we can re-rivet it back onto the motherboard tray.



15 / INSERT RIVETS INTO GUN

The tail of the rivet is inserted into the rivet gun as shown, so the head pokes out. You then insert the head into the case hole, squeeze the gun's handle two or three times and this compresses the head and pulls off the tail.



16 / RIVET SECTIONS BACK TOGETHER

Do this with any sections you need to reattach together. Here we need to reattach the motherboard tray to the I/O area we just cut out, so we can then secure both parts to the case in their new position.



19 / CUT I/O PANEL OPENING

Now go ahead and use your rotary cutting tool to remove the section required, again donning your safety goggles. Focus on cutting straight lines, as this will mean the I/O panel section will line up properly.



17 / TEST-FIT MOTHERBOARD

With that done, check if the motherboard sits correctly on the tray and I/O panel opening. If you're rotating and flipping the tray around, it's easy to make mistakes, but it's easier to remedy them now than when you've used a dozen rivets to reassemble the case.



20 / CUT AWAY FLANGES

If there are any metal ridges or flanges in the way of the motherboard tray, you can use the cutting tool to remove them, or alternatively a metal file. We encountered these on one end of the case, which prevented the far end of the tray from sitting flush with the front panel.



18 / MARK UP FOR CUTTING

We're cutting a new hole for our motherboard's I/O panel, and to do this, we inserted the new motherboard tray and I/O panel area into the case to use as a template to mark up the required opening.



21 / CREATE SUPPORT PLATE

You can use aluminium and steel sheet to close off any gaps created by cutting out sections, providing extra support. Here we're using 3mm-thick, 10mm-wide steel profile to sit over the back panel to support the motherboard tray. Cut it to length using a hacksaw or rotary cutting tool, so it stretches from top to bottom.





22 / DRILL SUPPORT PLATE

Steel is best used here, as it's stiffer than aluminium. Line it up with any existing holes, or drill new ones through the plate and into the rear of the case and motherboard tray. Use a 3mm drill bit here, so you can use 3mm rivets.



23 / SPRAY SUPPORT PLATE

Once the support plate's modifications are done, you can spray it so that it matches the colour of your case. Don't worry about spending too much time preparing the plate. Just place the plate on a spare cardboard sheet and spray each side, allowing each side to dry for an hour before you handle it.



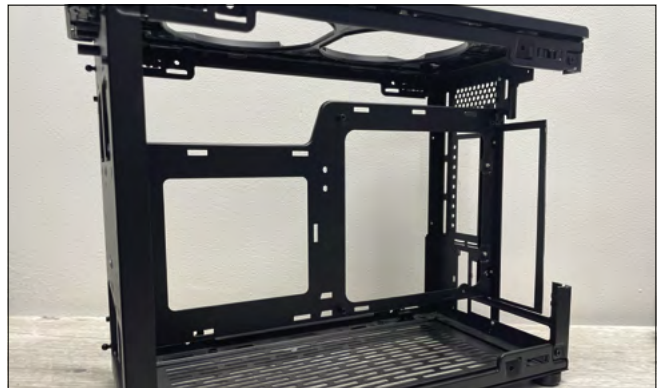
24 / FILE EDGES

Use a metal file to smooth cut areas on the panels, removing shards or sharp edges. If any visible areas stick out, you can spray-paint them, so they don't show. Smaller sections can be hidden using permanent marker, or by spraying paint into a pool on a piece of cardboard and painting it onto the panel with a small brush.



25 / RIVET PLATE IN PLACE

Now fit the support plate to the motherboard tray. If the rivets won't pass through the metal sheets, use a slightly larger drill bit – for example, a 3.2mm for a 3mm rivet – as this can sometimes make all the difference.



26 / RIVET MOTHERBOARD TRAY AND I/O PANEL AREA

Now add rivets to the rest of the motherboard tray. We've added two at the rear and two at the front, securing it to the front and rear panels using the same process as before, drilling 3mm holes in both surfaces and then using rivets.



27 / INSTALL YOUR HARDWARE

All being well, your hardware can now be installed, but not before a final clean and vacuum. We've opened up the case to allow two 240mm radiators to be installed, and also created a sandwich layout to make the graphics card and motherboard both visible through the side panels. **CPG**

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Retro tech

INTEL 740

With Intel attempting to get into 3D gaming graphics again, **Ben Hardwidge** looks at the time it failed to take on 3dfx in the late 1990s

Back in the late 1990s, I worked at a computer shop in Derby, where we sold components over the counter, while pointing to a sign that said 'components are sold on the basis that the customer is competent to fit it themselves'. There were often compatibility issues between components, but there were two cards I'd always try to steer customers away from, as they nearly always came back to the shop, accompanied by a tired, angry face and colourful vocabulary.

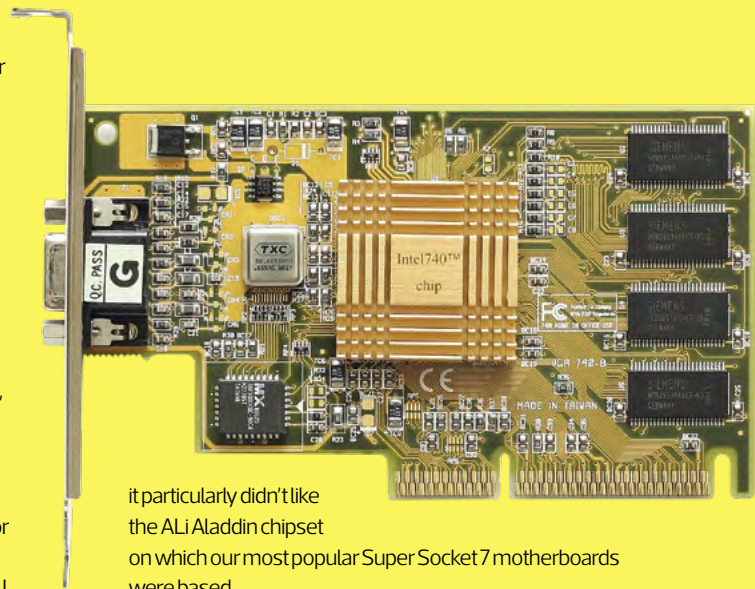
One was a PCI soft modem that required an MMX CPU and refused to cooperate with Freeserve, Dixons' free ISP that was taking the UK by storm. The other was Express 3D graphics card, based on Intel's 740 gaming chip.

This was before Nvidia had coined the term 'GPU' for its first GeForce cards, which could take the burden of transform and lighting calculations away from the CPU. The CPU was still expected to do a fair bit of work in the 3D pipeline, but you bought a 3D card to speed up the process and make games look much smoother than software rendering.

However, unlike the 3dfx Voodoo and VideoLogic PowerVR cards at the time, which required a 2D card to output to a monitor, the i740 wasn't a sole 3D card – it could function as a 2D and a 3D card in one unit, and at £30 it was also cheap. You can see why people were drawn to it.

Another factor in its popularity was being made by Intel; thanks to the company's relentless marketing campaigns, this meant people assumed it would just work without problems. It also used the brand-new Accelerated Graphics Port (AGP) interface, which people often assumed meant it would be faster than the PCI-based 3D accelerator cards.

The problem for us was that people who wanted cheap graphics cards usually also wanted cheap CPUs and motherboards, which meant going for an AMD K6 or Cyrix 6x86 CPU and a non-Intel motherboard chipset. The i740 didn't like the AGP implementation on non-Intel chipsets very much, and



it particularly didn't like the ALi Aladdin chipset on which our most popular Super Socket 7 motherboards were based.

If you wanted the i740 to run properly, you really needed a Pentium II CPU and Intel 440LX or 440BX motherboard, and they were expensive. Then, once you'd paired your cheap graphics card with your expensive foundation gear, the i740 wasn't actually that great, with comparably poor performance and still a load of compatibility issues. However, it had some interesting tech and history behind it that's worth revisiting.

AEROSPACE BEGINNINGS

Intel didn't have much in the way of graphics tech in the 1990s, but it had spotted a big market for 3D acceleration. The ATX motherboards for its latest Pentium II CPUs also came with an AGP slot, and a 3D AGP graphics card could potentially encourage people to upgrade (more on this later).

With little 3D accelerator expertise in house, Intel teamed up with US aerospace company Lockheed Martin to develop a consumer graphics card. That might seem a bit left field, but Lockheed Martin had acquired a variety of assets through various mergers and takeovers. In 1993, GE Aerospace was

sold to Martin Marietta, and in 1995, Martin Marietta merged with Lockheed to form Lockheed Martin.

GE Aerospace was a division of General Electric, and its main business was providing systems and electronic gear to the aerospace and military industries, including simulators. In 1994, it started to branch out, working with Sega to produce the hardware for its Model 2 arcade machines, including 3D graphics tech for texture-mapped polygons and texture filtering. It was used for titles such as Daytona USA and Virtua Fighter 2.

In 1995, Lockheed Martin created a spin-off dedicated to consumer 3D graphics tech called Real3D, mostly using employees from GE Aerospace. Real3D worked with Sega on the 3D graphics hardware in its Model 3 cabinet, which was released in 1996, and then later began working with Intel to produce a consumer 3D graphics card, codenamed 'Auburn', which would become the 740.

It needed to be cheap and it needed to showcase the new AGP interface

AN AGP SHOWCASE?

Intel had clear aims for the i740 when it was released in 1998 – it needed to be cheap and it needed to showcase the new AGP interface featured on the latest Pentium II motherboards. AGP had huge potential.

Although AGP was mainly based on the existing PCI interface, it had a direct connection to the CPU, as opposed to sharing the PCI bus with other cards. This not only freed up bandwidth, but also meant the AGP bus could run at a higher clock speed than the PCI bus.

Another one of its benefits was sideband addressing via a dedicated bus, meaning that all the usual address/data lines could be used solely for data throughput rather than both addressing and data functions, with the sideband bus handling address requests.

The Intel 740 was marketed as being 'optimised for the Intel Pentium II Processor' – it certainly didn't like working on motherboards for other processors



This massively increased the speed at which an AGP card could read from system memory compared with a PCI card, and meant an AGP card could practically use system memory as well as its on-board memory. You may remember the 'AGP aperture' setting in old motherboard BIOS screens – that was the amount of system memory you could allocate to your graphics card.

Most 3D cards didn't rely on this feature, instead being piled with fast on-board memory to maximise performance, but Intel decided to go all out on it with the i740. The result was a card that only used its on-board memory as a frame buffer, with textures being stored in system memory.

This meant Intel could save money on memory (the cheapest i740 cards only came with 2MB compared to 8MB on the cheapest Voodoo2 cards), while also ensuring the cards required the new AGP interface.

The first problem, of course, was that using system memory and its interface wasn't anywhere near as fast as using on-board graphics memory. The other problem was that the need for the graphics card to constantly access system memory ended up starving the CPU of memory bandwidth.

That was a big problem at a time when the CPU was still doing a fair bit of the work in the 3D pipeline. The growing use of larger textures in 3D games to improve detail made the situation even worse. What's more, as I mentioned earlier, the AGP implementations on most Super Socket 7 motherboards just weren't designed with a card such as the i740 in mind.

It also didn't help that some board makers (including Real3D under the Starfighter brand) started making PCI versions of the i740 with a bridge chip and more on-board memory, and these cards were usually faster than the AGP equivalents, as they didn't rely on system memory for texture storage.

CURTAINS FOR THE i740

What seems bizarre now is that, at the time, I remember a lot of discussion before the launch about how Intel's work with Real3D was going to result in Intel having a monopoly on 3D graphics, and putting the likes of ATI, 3dfx and VideoLogic out of business.

Intel had access to huge silicon manufacturing facilities, it had a massive research and development budget, and it had the proven expertise of Real3D at its disposal. In reality, the i740 was soon cancelled and almost completely forgotten by the end of 1999. **GPC**

Real3D's PCI i740 card was often faster than the AGP equivalent, as it didn't rely on system memory. Photo credit: vgamuseum.ru

Readers' drives

Project Taichi

Jason Simm went all out on the cooling system for this open-air build, which sports two 480mm radiators, hand-cut PETG tubing and custom aluminium panels



CGP: How did this project start, and what was your inspiration to build an open-air PC based on ASRock's Taichi design scheme?

Jason: It all started when I won the motherboard back in 2019 at the

Tweaktown party in Taipei. I love the layout and the look of the cogs on the Z390 Taichi board. However, due to a shortage of parts as a result of the pandemic, I decided to redesign my old gaming case and utilise the water-cooling parts.

CGP: We've not seen an open-air chassis like this before, but parts of it look a little like one of Thermaltake's Core P-series case designs. Was this the starting point for the chassis, or is it a full custom scratch build?

Jason: The chassis began as a single Thermaltake Core P5 case, but I wanted to modify it to incorporate a dual liquid-cooling system. Once I had the design in place, I extended the case using an old side panel from a Core P7 case, and reversed the glass panel bars, removing the glass all together.

CGP: Tell us about the design process for the main chassis – what did you build yourself, how did you work out the design, and what materials and tools did you use?

Jason: I'm old-fashioned, and everything I design is done with pen and paper, rather than CAD. To extend the case, I fixed the left-hand P7 side panel with nuts and bolts so I could incorporate a second radiator.

I used ACP (aluminium composite panels) to cover the front and rear of the case – I cut them by hand using

an old sharpened knife for a clean-cut finish. The panels were then measured, drilled and cut, so they could mount the PC components. The panels were sanded and primed before I finished them off with matt black rust-oleum paint to create the flat matt look.

Meanwhile, the aluminium grilles were fitted with a hot glue gun. The cables combs were 3D-printed using SLA/resin, and the panel brackets were 3D-printed with FDM/filament. I also added an extra foot from the Core P7 to give the case more support.

CGP: Where did the cogs come from?

Jason: They were bought from eBay – they were laser-cut and the shapes matched the details on the Taichi motherboard I was using, which is what I wanted.



/MEET THY MAKER

Name Jason Simm

Age 51

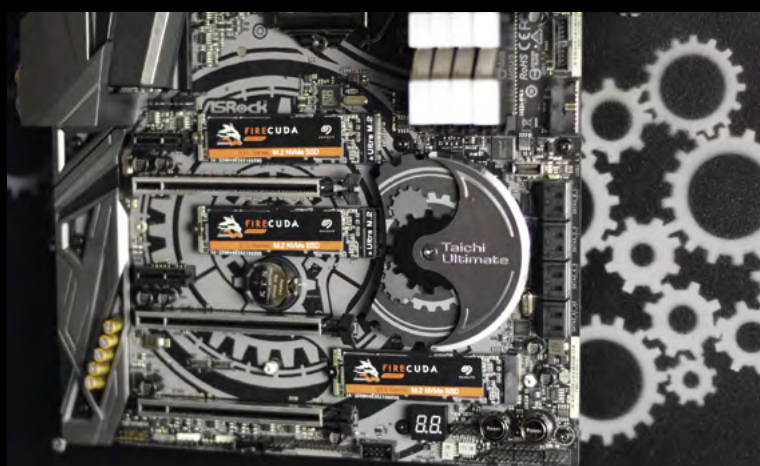
Occupation Transport manager

Location Sunderland

Main uses for PC Gaming

Likes Family time, PC modding and gaming

Dislikes Apple products



GPG: Does this PC light up?

Jason: The PC can light up, believe me, but I wanted to do a non-RGB build this time around. I tend to run it with just a soft white light at night.

GPG: We're intrigued by the minimalist look of the water-cooling loop – we can only see four tubes on the front – what does it all hook up to inside?

Jason: I used pass-through fittings on each loop to create a clean look from the front. Inside, each loop hooks up to a quad-fan radiator, then back into a D5 reservoir/pump combo and back through the front of the case to the waterblocks.

GPG: How did you plan and install the water-cooling loop? Did you cut and bend the tubing yourself?

Jason: I designed the loop so that

I could run a dual water-cooling system, with one radiator for the CPU and one for the GPU. All the tubing was bent and measured freehand – I just use my eyes to gauge where I need to cut, and make my cuts around 5mm longer than necessary to allow for mistakes.

To get the pass-through fittings level and in the right place, I had to build the PC, measure it and strip it down several times to check that the locations were correct and aligned properly, using a small spirit level and tri square ruler.

GPG: That's some immaculate cable-tidying work on the power cables – what's the secret?

Jason: I used 3D-printed cable combs, which are screwed to the case to keep the cables tidy – they're then tucked away behind and under the motherboard.





SYSTEM SPECS

CPU Intel Core i9-9900K

Case Thermaltake Core P5 Black Edition

GPU Zotac GeForce RTX 3080 Trinity

Storage 3 x 1TB Seagate FireCuda 510 NVMe M.2 SSDs

Memory 32GB Thermaltake ToughRAM 3600MHz

Motherboard ASRock Z390 Taichi Ultimate

PSU Thermaltake Toughpower PF1 ARGB 1200W Platinum

Cooling Custom water-cooling loop comprising the following Thermaltake parts: 2 x Pacific CL480 radiator, 2 x Pacific PR15-D5 reservoir/pump combo, Pacific W4 Plus CPU waterblock, Pacific PETG G1/4 C-PRO 16mm fittings, Pacific G1/4 90-degree adaptors, Pacific G1/4 female-to-male extenders, 16mm V-Tubler PETG tubing, P1000 white pastel coolant, Riing Trio 12 RGB radiator fans in push-pull configuration, Corsair Hydro series XG7 RGB GPU waterblock

GPC: Where does the airflow from those eight fans on the front go, and how is it exhausted?

Jason: The fans on the front are mounted on quad radiators, pushing air at 1,000rpm, but there are also eight fans inside the case pulling air at 1,100rpm. I fitted three aluminium grilles at the rear to allow the fans to exhaust the heat from the rear and top of the case.

GPC: What sort of peak CPU and GPU temperatures do you get with two 480mm radiators?

Jason: When I'm gaming, the RTX 3080 GPU (which is overclocked to 2070MHz), runs at 34-36°C, while the Core i9-9900K (which is overclocked to 5GHz) runs at 38-40°C.

GPC: Is there a way to use the ports on the motherboard's rear I/O plate without the interior getting messy with cables?

Jason: Yes, the motherboard actually sits on 15mm standoffs, so I could run two Anker 4-Port USB 3 slim data hubs under it – this means I can connect all the peripherals inside the rear of the case.

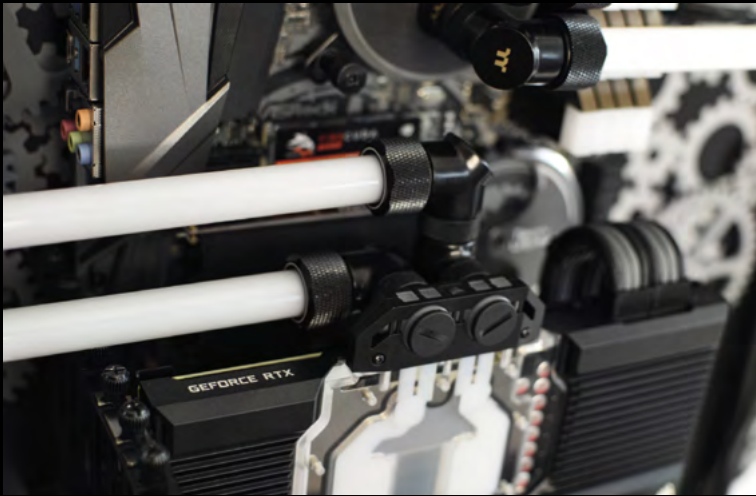


GPC: How often do you need to clean this PC?

Jason: Every 12 weeks – I just remove the front fans and clean any dust on the radiators with a paintbrush or a can of compressed air.

GPC: What specs did you choose and why?

Jason: I used the ASRock Z390 motherboard I had previously won at the Tweaktown party in Taipei. I was going to use my old GeForce RTX 2080 graphics card, but I managed to get a Zotac GeForce RTX 3080 Trinity card just in time before I completed the build, which is cooled with a Corsair waterblock. I won from bit-tech.net. The other parts came from sponsorships, thanks to Thermaltake and Seagate.



GPG: Did you come across any difficulties in the build process?

Jason: Yes, making the front panel was a challenge. I had it all cut perfectly, and I decided to drill the pass-through holes while the ACP panel was fitted to the case.

As the aluminium panel was soft, the step drill bit slipped while I was trying to drill through the steel case, so the holes were out of alignment. I had to make a whole new panel, putting back the completion of this mod by ten days.

GPG: How long did it take you to complete this build, from start to finish?

Jason: It was postponed last year due to the pandemic – I managed to make a start in mid-April 2021 and completed the build by mid-July.

I'm old-fashioned, and everything I design is done with pen and paper, rather than CAD

GPG: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect?

Jason: Yes, I'm very happy the way the build turned out – the only part I would have done differently, especially if the case was going to be showcased at an event, would be to make the cog parts move. **GPG**

WIN CORSAIR HYDRO X WATER-COOLING GEAR



To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (@CustomPCMag) or Facebook (CPCMagazine), or email low-res ones to ben.hardwidge@raspberrypi.com. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

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.



WORTH
£151

Corsair Hydro X Series XC7 RGB CPU Water Block

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overlocks. You can choose the AM4/LGA1151 or LGA2066 version.



WORTH
£70

Corsair Hydro X Series XR5 240mm Radiator

The Corsair Hydro X Series XR5 240mm Water Cooling Radiator delivers extreme custom cooling performance, with a 30mm radiator thickness and premium copper core. Its dual 120mm fan mounts on each side are ready for your most ambitious custom cooling build, and its 25 micron-thick cooling fins offer a high thermal transfer rate.



WORTH
£55



JAMES GORBOLD / HARDWARE ACCELERATED

INTEL'S GPU GAME

James Gorbald takes a look at the potential for Intel's new Alchemist gaming GPU

Intel's PR campaign for its upcoming GPUs kicked off in earnest this month. After years of teasers, rumours and leaks, the company's GPU strategy is starting to firm up, and it's even begun to talk publicly about the release window for some products.

Of most interest to **Custom PC** readers will be Intel's first new discrete gaming GPU in close to 20 years. Until now this first GPU was called DG2, but Intel has given it a new name, Alchemist.

Planned for release in Q1 of 2022, Alchemist GPUs are based on the Xe-HPG gaming variant of the Xe architecture, on which Intel has been working for the past few years. Think of Xe as the overall architecture of all Intel GPUs, from its integrated GPUs inside CPUs to its upcoming datacentre GPU accelerators, and Alchemist as the specific generation of GPU.

Another new brand is Arc for Intel's gaming GPUs. If you're struggling to get your head around these codenames, I think of Alchemist being like Ampere or RDNA2, while Arc is like GeForce or Radeon. Intel has also started to reveal a fair few technical details.

The first and arguably most important fact that is now publicly known is that Alchemist is in many ways a traditional GPU. I mean this as a compliment, as Intel's last attempt at developing a gaming GPU, Larrabee, used heavily modified x86 CPU cores and didn't even make it to market.

Instead, Alchemist is built from a number of Xe cores, in turn made up of a number of vector engines that conduct traditional compute tasks, along with XMX engines that are responsible for matrix maths and dedicated ray-tracing units. Xe cores are bundled together into Render slices, which Intel can then add together to make different GPUs. If this

modular design sounds remarkably like an Nvidia GPC or AMD Compute Unit then that's no accident.

Continuing with the good, Intel has also confirmed support for DirectX 12 Ultimate, Microsoft DXR and Vulkan. Intel has even jumped on the upscaling bandwagon, with XeSS - the last two letters stand for 'super sampling'. This sounds like it uses a similar technique to Nvidia DLSS, using neural networks to upscale games to a higher resolution.

Finally, Intel revealed that Alchemist GPUs will be manufactured by TSMC using the N6 process, rather than in Intel's own fabs. This is probably a sensible decision considering the challenges Intel still faces ramping up production of any

transistors smaller than 14nm, but it does have some potentially serious repercussions.

Most notably, it almost certainly won't positively impact GPU supply in a meaningful way, which is one of the biggest hopes for a third major player entering the discrete GPU market. Supply will be

further subdivided between Nvidia, AMD and Intel, rather than new supply being added.

It's also unclear how Alchemist will be sold. Will there be Intel-branded cards, akin to Nvidia's Founder's Edition cards, or will there be OEM cards as well? This is crucial in terms of availability and will have a big role in determining the form of Alchemist cards. The cooler can be a crucial factor in deciding between one graphics card and another, for example. I also have big concerns about how much game developers will be willing to support yet another graphics ecosystem.

I could write another 1,000 words on what we don't know about Alchemist, but we're still months away from launch and I need to be careful about what's still under NDA. All I'll say is watch this space. **GPC**

If this modular design sounds remarkably like an Nvidia GPC or AMD CU, that's no accident

James Gorbald has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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