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CUSTOM PC

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- 2 | PICK THE RIGHT COMPONENTS
- 3 | FIT A GAMING GPU
- 4 | BUILD YOUR TINY PC



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Welcome

.....
Custom PC Issue 219

/ FROM THE EDITOR

All PCs great and small

The last time I stayed in a hotel, I asked the staff if they had any toothpaste and I was presented with a charmingly tiny tube about one third the size of my finger. I felt myself gawping like a dog being shown a biscuit as I prodded it around my palm. There was something almost cute about this miracle of miniaturisation.

Similarly, a friend once cooked me a miniature breakfast, with fried quail's eggs, cocktail sausages and so on – again it almost looked endearing when it arrived on a saucer. There's just something really appealing about big things being made tiny.

Of course, miniaturising a PC is massively more complicated than making a tiny tube of toothpaste, but the PC industry is having a good go at it, resulting in a lot of really interesting ideas. There are so many challenges involved, from thermal demands to making space for standard components.

The result is a host of innovative products that make standard ATX monoliths look stale by comparison. As you'll see in our feature on p72, mini-ITX cases now come in all sorts of shapes and sizes, with case designers putting serious work into new ideas. Likewise, there are some really interesting designs in our low-profile cooler Labs on p50, with cooling manufacturers having to really think about how to shift as much air as possible from a CPU without building too far upwards.

While it's really exciting to see so much innovation going on in this part of the PC industry, though, one downside of there being so many ideas is that it also makes building a mini PC for yourself a challenge. There are various incompatibilities between different designs, and you have to work in a tight space.

That's why we've dedicated 12 pages of this issue to taking you through the various ways in which you can build a mini PC, covering case designs, hardware options and building tips, along with an example build. Most importantly, your small PC doesn't have to use feeble components – our one even has a GeForce RTX 3080 Ti installed in it. A powerful PC doesn't have to be a big box any more – you can now have a top-end gaming PC that's tiny and, dare I say it, cute. **CPC**



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this magazine please recycle it.



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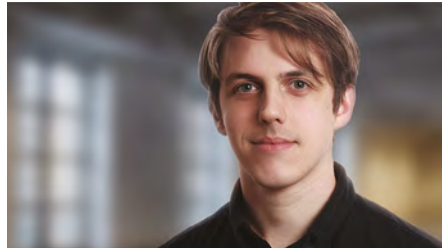
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RICHARD SWINBURNE / VIEW FROM TAIWAN

WILL HYBRID CPUs WIN?

Richard Swinburne asks if Intel's 'big and little' approach to CPU design will ultimately work, and if AMD is now falling behind

At its recent architecture day, Intel disclosed more details about its 12th-gen Core 'Alder Lake' CPUs. Firstly, it confirmed there are two types of processors inside – Performance Cores and Efficiency Cores, with different types of devices (mobile and desktop, for example) varying the number of Performance Cores inside.

The idea is that the Performance Cores are focused on single-threaded performance and do the most immediate tasks as fast as possible, while the Efficiency Cores work on the jobs the OS and programs conduct in the background to keep your PC ticking over.

This is very similar to how Arm's Cortex-based CPUs are made for smartphones and tablets, so this 'heterogeneous design' isn't new, but it is a first on PC. At the time Arm launched its groundbreaking 2-core-type CPU design in October 2011, there were claims it would be too complicated to get right.

To be fair, it did take years between Google, Arm and chipmakers to engineer firmware, and for Android to get the most out of it, but in the end, smartphones are better for it – it would have been unviable to build them with only powerful cores.

Finally, the PC world has admitted that increasingly bigger, more powerful cores can't handle all the little jobs efficiently. But unlike Arm, Intel doesn't have years to get it right. Intel must prove it will work in your PC or laptop from the get-go against AMD's tried and tested all-big-core CPUs.

To that end, Intel also announced its Thread Director, and it has worked with Microsoft to ensure that Windows 11 caters to heterogeneous CPU designs. Windows 11 is aware that two types of CPU cores exist, and it should know which

system event needs which type of core. Interestingly, every 12th-gen chip announced has the full set of eight Efficiency Cores, with product differentiation largely dependent on the number of Performance Cores included.

It appears the Efficiency Cores don't take up much die space, but I have to wonder if we really do need eight of them, since it's also a happy coincidence that they boost the core count for people who don't know the difference.

Buying a '16-core CPU' in this case would bag you only eight Performance Cores, vs 16 full-power cores in an AMD Ryzen 9 5950X. The good news is that Alder Lake isn't just an attempt to shovel crappy Atom cores into the package, as the Efficiency Cores are supposedly even better than Skylake cores.

If Intel does manage to create another 'Conroe' moment with its 12th-gen CPU design, can AMD counter it? AMD used to have two core designs – big and little Cat cores, but those were discontinued in 2015. To get Skylake-level performance, it would likely have to go back to the original Zen core and attempt to tweak the design for more efficiency.

However, Efficiency cores aren't the only differentiation for Alder Lake. In a shock announcement, Intel has dumped AVX-512 in its consumer Performance Cores, yet AMD still appears to be committed to introducing it in Zen 4. Building your whole product line on one iteration of Zen architecture now seems like a risk, rather than a benefit. What's more, Intel's 12th-gen platform also introduces DDR5 and PCI-E 5 for the first time. AMD has had plenty of time to prepare an equal platform, but Zen 3 is only getting Z-Cache, rather than a platform update this year. Concerningly, AMD appears to be falling behind. **GPC**

Unlike Arm, Intel
doesn't have years
to get it right

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

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TRACY KING / SCEPTICAL ANALYSIS

MAN ENOUGH TO PLAY GAMES?

Tracy King looks at the still-persistent myth that men who play video games aren't 'manly'

Years ago, I debunked the then-common myth that girls are naturally inferior at games. That belief is still around in a few dank corners, but I've definitely observed a shift away from it, perhaps because female gamers are so visible now that it's an accusation easily dismissed.

Most adults under 40 grew up with some gaming experience, and many of them will have kids of their own with whom gaming is important family time. I know mums who play Minecraft and dads who spend hours in Animal Crossing, and one family of four who play Battlefield together. But while progress has been made in the perception of female gamers, there's still a slew of people who think male gamers are somehow ... not real men.

It's an accusation as old as games, historically made by grandparents or parents with old-school values who thought kids should be outside kicking a football (a 'man's' game), throwing a rugby ball (a 'real man's' game) or hitting a ball with a bat (a 'gentleman's' game).

Mucking about with Tetris would rot your brain or your muscles, and then you wouldn't be a real man, whatever that is. Overall, there's less of that attitude now the Tetris kids are the parents, but in 2015, the psychologist Philip Zimbardo, most famous for his (now debunked) Stanford Prison experiment, tried to claim that it's literally true, that video games are somehow making men less ... manly.

In a 2011 TED talk and the inevitable following book, he claimed that men aren't as awesome (by his standards) as before, and by 2015 he'd concocted a theory that this was partly because video games are for softy losers. Or something. I'm unclear about exactly what went on there because my

brain is obviously addled from decades of gaming and, more importantly, he didn't actually provide any proof.

Zimbardo wants us to believe that men in society have specific roles and attributes that passive hobbies such as gaming are destroying. Men should play sports and be in charge of everyone, perhaps like it was in his youth when men were men and women were in the kitchen.

Never mind the evidence, society should go backwards. Aside from the sexism, it's hard not to detect a hint of homophobia here as well. In September 2021, the Chinese government outlawed 'effeminate' male characters in games

for much the same logic as Zimbardo – young men are apparently so easily influenced, they'll abandon their potential futures as real manly men and instead become gay or weak.

At the same time on this side of the world, a Telegraph journalist wrote that 'grown men shouldn't be wasting their lives playing video games'. This genuinely bothered me, not just because it's kind of nasty but also because it shows a major newspaper propagating myths that gaming reduces something in men that's essential for their progress.

She was specifically ranting about a Nintendo advert on the London Underground that features adults using a Switch, which she claims is and should only be for children (terrible news for my commute and the forthcoming Steam Deck).

It's all transparently stupid, not least because what's considered 'masculine' has changed multiple times throughout history. If playing video games isn't masculine enough then masculinity will adapt, because games aren't going anywhere and real men aren't afraid to play them. **GPG**

More importantly, he didn't actually provide any proof

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdot](#)

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Letters

Please send us your feedback and correspondence to
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Thank you for beating the scalpers

I'm not on Twitter so I hope you'll be happy with this email response to Issue 217. As a subscriber I usually can't wait to rip off the wrapper and dive straight into every new issue of **Custom PC**, mentally bookmarking the items that most interest me and the order in which I'll read through the mag.

Thanks to some unexpected 'Big Life Stuff', Issue 217 only got a cursory glance from me and I put it aside. I'll be honest, I saw the 'Beat the scalpers' cover splash and thought it would be another one of those articles about being careful buying from eBay, watching out for ex-cryptocurrency mining boards, not feeding the scalpers and so on. I was fortunate enough to time my new build just before the ridiculous supply situation hit, so I thought 'there's nothing for me here'. Hmm.

When's the next issue out?

Custom PC

Issue 220

On sale on Thursday, 4 November



Fortunately, I was able to finally sit down with the mag around the time it was due to appear on general sale. I was barely into the fourth paragraph of the article when the implications and enormity of what I was reading and what you were actually doing hit me.

So what could be the importance of your work to me if I already had a shiny new PC? Barely a month previously I'd been asked by a friend's daughter for PC advice – she'd graduated from university and (quite justifiably) wanted to replace her on-its-last-legs laptop and treat herself by getting her first gaming PC. It was without a doubt one of the saddest conversations I've ever had about PCs, as it was just impossible for her to buy anything worthwhile.

Fast forward to Issue 217 – when I'd finished coughing up my tea-dunked Bourbon biscuit I immediately sent out the alerts by Signal and email to father and daughter: 'DROP EVERYTHING AND BUY THIS NOW!' I didn't even bother reading the remainder of the article in any detail at that time – **Custom PC** + Scan? Sold!

Keith's friend's daughter is happy with her new affordable PC build



I've bought from Scan for decades and have never been let down; the components were from familiar and trusted brands, and you lot seem to know what you're talking about.

The result has been happy people all round – my friend's daughter now has the rig featured in the attached photo, her dad's happy that she's happy and I'm happy that they're both happy.

I also got to build another new PC from scratch – an activity that I don't get to enjoy that often these days, as this has never been a cheap hobby and the market is obviously ridiculous right now.

Oh, and a modest build fee means that next year's **Custom PC** subs are already covered when I renew again. So thank you, thank you, thank you from all of us for putting your money where your mouth is and doing such a wonderful thing for your readers – you've made a real difference.

KEITH SULLIVAN

Ben: Thank you so much for your lovely letter, Keith – knowing that we're genuinely helping our readers is what makes our jobs worthwhile on **Custom PC**. I'm so pleased that your friend's daughter now has an awesome PC, courtesy of our feature.

We're still really pleased that we managed to create an affordable DIY PC bundle by cooperating with Scan – these times are ridiculous for anyone who wants to build an affordable gaming PC right now, and it was great to be able to offer a genuine solution.

If anyone else wants to build the £1,099 PC from Issue 217, Scan has also rounded up some more stock of the



hardware after the initial batch sold out. There aren't many left, but there's still time to head to custompc.co.uk/bundle and pick up the parts to build a GeForce RTX 3060 PC with a Ryzen 5 5600X and more for just £1,099.

Sound advice

I wondered if there was any chance of you doing a small article on dedicated sound cards and on-board sound? Do quality motherboards now offer a genuine system for 5.1 gaming on speakers or headphones? There appears to be little information online, and the situation may have changed for those upgrading their gaming PCs for the first time in a few years.

JON GREETHAM

Ben: The PC audio market has changed massively over the past ten years or so, and unless you're a strict audiophile (get a USB DAC) or a musician (get a USB I/O box) there's little need for a dedicated sound card any more. I say this as someone who has been an advocate of discrete sound cards for decades, but is now a convert to integrated audio. For most people's needs, Realtek's ALC1220 audio codec is more than up to the job.

The latest USB and wireless headsets have their own DACs and surround-sound features, negating the need for a separate sound card

You can input 1.25V manually in Ryzen Master, or add a positive offset of +0.15V in the EFI

Regarding surround sound, many motherboards can still be set up to output 5.1 audio over three analogue jacks (just check the spec list for the motherboard online to see if it will do it), and companies such as Logitech still make speakers that will connect to them, but I think these analogue surround systems are largely redundant now.

If you're looking for surround sound over headphones, that's largely down to the headset rather than the PC's sound system now, as the USB and wireless models have their own on-board DACs. Your choice is then whether you get a true surround headset with individual surround speakers in the earcups, or a virtual surround system with a stereo set – the latter works surprisingly well on headsets such as the Corsair Virtuoso RGB Wireless XT.

If you want to output surround sound to speakers, your best bet now is to plug the HDMI output on your graphics card (or an optical/coaxial digital output on your motherboard if it has one) into a dedicated surround sound decoder. Again, the sound system in your PC is irrelevant at this point, as the sound is digitally transferred to the decoder, which then outputs the analogue audio over a set of surround speakers.

Overclocking help

I have a question on one of your articles in Issue 217. I've bought your

Scan bundle and put together the computer – it seems great! However, while reading your section on overclocking, I'm having trouble finding what you said to do – this is my first time overclocking so I wanted to get it right.

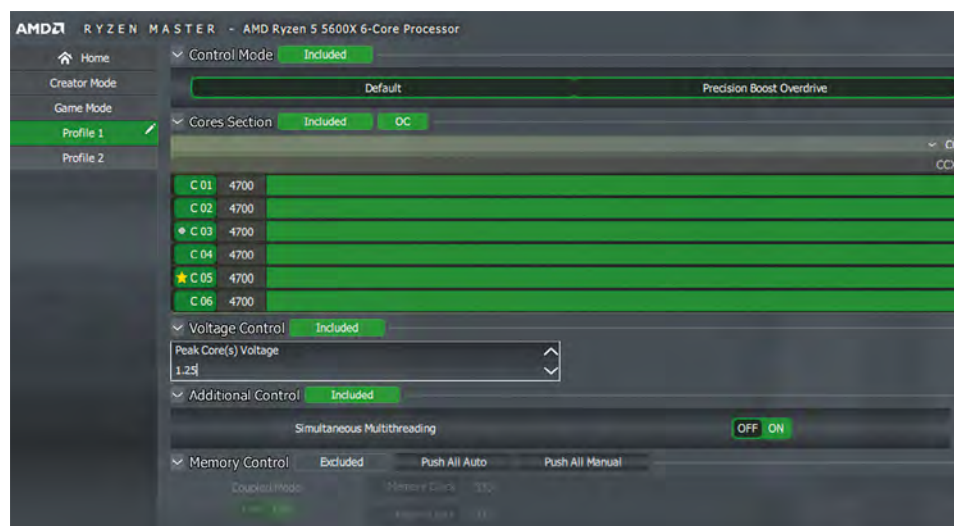
I have found the AITweaker section and changed the CPU core ratio, so that bit is okay. However, you say 'then head down the page and find the CPU vcore setting – set this to manual/fixed and then input 1.25V'. However, I can't find CPU vcore setting in the section on the screen. There is a section for CPU voltage but this has no manual/fixed option, only 'offset' and you can't input 1.25 only + or – the offset. Please can you help me locate the correct setting to use?

DUNCAN ERSKINE

Ben: This was a mistake on Antony's part when he was writing the feature, as he mainly used Ryzen Master for the overclocking part, but you can still set up the motherboard correctly.

You need to set a positive offset of +0.15V in the BIOS, but you'll also need to check in CPU-Z that the vcore is hitting 1.25V under load, and then adjust it up or down a little until CPU-Z reports that it's sticking on 1.25V when it's running at full load.

The Offset adds or subtracts voltage to the stock CPU voltage, which can vary between CPUs. **GP6**



Incoming

NEW INTEL SOCKET PICTURED

The new LGA1700 socket for Intel's Alder Lake CPUs has been pictured on Chinese site [bilibili.com](https://www.bilibili.com), and reported by [videocardz.net](https://www.videocardz.net). The socket's array of pins is clearly longer than that of Intel's current LGA1200 socket, but Intel appears to have shrunk the latch system surrounding it, so it takes up a similar amount of space.

The socket latch sports the codename '15R1' on the top, along with 'LGA17xx / LGA18xx', suggesting that CPUs with 100 more pins could arrive in the future. LGA1700 is expected to be used for Intel's Meteor Lake CPUs after Alder Lake, but Intel usually moves to a new CPU socket after two generations.



RADEON RX 5000 CARDS GET SAM

Owners of 1st-gen RDNA AMD GPUs can now enjoy the benefits of Resizable BAR, as the company has just rolled out support for its Smart Access Memory (SAM) feature to the Radeon RX 5000 series.

Smart Access Memory is AMD's brand for Resizable BAR, which it introduced on its RDNA2 GPUs. It circumvents the previously standard 256MB limit that CPUs have for accessing GPU memory, allowing a CPU to tap directly into a graphic card's full bank of GDDR6 memory, which can boost performance in some games.

This performance-improvement technique has since been adopted by Nvidia on its most recent RTX 3000-series GPU launches, and it's also supported by many Intel-based motherboards now.

While Smart Access Memory doesn't improve performance in all games, we've found that it makes a significant difference to Assassin's Creed Valhalla, taking the Radeon RX 6600 XT's average frame rate from 79fps to 88fps at 1,920 x 1,080, for example. You can download the latest AMD GPU drivers from amd.com/en/support

Rumour control

OUR ROUNDUP OF THE LATEST UNCONFIRMED TECH GOSSIP. TAKE THESE STORIES WITH THE APPROPRIATE PINCH OF SALT

GEFORCE RTX 3090 SUPER INBOUND

GPU tech leaker 'Greymon55' has tweeted that Nvidia has another high-end graphics card in the works called the 3090 Super, which will feature 10,752 CUDA cores and have a TDP over 400W. The configuration implies that the new cards will feature a fully enabled GA102 GPU, which would mean it has two more Streaming Multiprocessors enabled than the RTX 3090 and two more RT processors, for a total of 84.

INTEL ALCHEMIST AS FAST AS RTX 3070

An apparently leaked presentation slide showing the performance of Intel's GPUs has been published by [videocardz.net](https://www.videocardz.net). The slide shows two Intel designs – SOC1 and SOC2. The latter is listed with a TDP of 65W and is shown to be as fast as a GeForce GTX 1650 Super at the top end.

Meanwhile, SOC1 is listed with a TDP of 175W-225W, with the lower end apparently offering outpacing the GeForce RTX 3060, and the top end being on par with the GeForce RTX 3070 and Radeon RX 6700 XT.

CORSAIR LAUNCHES WIRELESS ESPORTS MOUSE

Corsair has launched a lightweight wireless mouse for esports that weighs just 79g and comes with RGB lighting.

The Sabre RGB Pro Wireless features Corsair's Marksman sensor, which the company claims has a native resolution of 26,000 DPI. Corsair also claims that the

mouse's battery is good for up to 90 hours and that its Slipstream Wireless technology 'transmits inputs at sub-1ms speeds, delivering mouse movements and clicks up to 2x faster than conventional gaming mice'.

The Corsair Sabre RGB Pro Wireless is available from scan.co.uk for £90 inc VAT.



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Reviews

Z590 MINI-ITX MOTHERBOARD

ASUS ROG STRIX Z590-I GAMING WIFI / £310 inc VAT

SUPPLIER scan.co.uk

With a price of £310, the Asus ROG Strix Z590-I Gaming WiFi is far from cheap, costing around £40 more than the excellent Gigabyte Z590I Vision D. Both boards sport Thunderbolt 4, but the ROG Strix Z590-I Gaming WiFi is definitely geared towards gamers and lovers of RGB lighting.



SPEC

Chipset

Intel Z590

CPU socket

Intel LGA1200

Memory support

2 slots: max 64GB DDR4 (up to 5133MHz)

Expansion slots

One 16x PCI-E 4

Sound

8-channel SupremeFX ALC4080

Networking

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

Cooling

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

Ports

4x SATA 6Gbps 1x M.2 PCI-E 4, 1x M.2 PCI-E 3, 8x USB 3.1 Type-A, 1x USB 3.1 Type-C (Thunderbolt 4 compatible), 1x USB 3.1 Type-C, 1x USB 3.1, 1x USB 3, 4x USB 2, 1x USB 3.1 Type-C header, 12x LAN, 3x surround audio out

Dimensions (mm)

170x170

You get the usual 3-pin and 4-pin RGB connectors, but the M.2 heatsink also sports a snazzy RGB ROG logo. It's quite restrained, but it does look very attractive. While it's lacking the clean white theme of the Gigabyte board, the ROG Strix Z590-I Gaming WiFi is still extremely good-looking.

It has large heatsinks for the teamed 8+2 phase VRMs, which are linked by a heatpipe and actively cooled by a small fan. This can be fully controlled in the EFI, even to the point of switching it off. Otherwise, it will gradually spin up when the VRMs hit 60°C. Thankfully, the heatsinks kept the VRMs below this temperature even after a couple of minutes of running at full load in Prime95 – they peaked at 68°C after ten minutes, and the fan was still inaudible.

There are three 4-pin fan headers, although one of them is very tricky to access once you've installed your graphics card. The reason for this limited accessibility is a funky bit of engineering in the form of a double-stacked, removable pair of M.2 ports. These ports sit beneath the illuminated RGB

logo, with the upper layer attached using a ribbon cable to the one below, and the latter connecting directly to the motherboard. You need to remove both layers to install the lower M.2 SSD, but just the top heatsink if you need access to the top port.

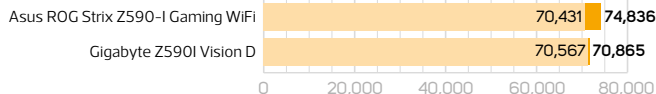
This proved to be quite tricky, as it's an extremely cramped area – installing two SSDs took us nearly 20 minutes of fiddling, not helped by mediocre instructions. Also, the upper SSD didn't seem to make contact with the lower portion of the thermal pad – only the top part, although it could just be designed to cool SSDs with most components on the lower portion.

It feels a little overengineered – it would be preferable for the second port to be on the underside of the main PCB as usual. Thankfully, our M.2 SSD was kept below 65°C in our stress test and the heatsink got very warm, so it's clearly doing its job.

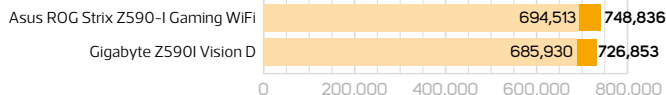
We also found the board's heatsinks left very little space for air coolers in the CPU socket area. In fact, many failed to fit, including the be quiet! Dark Rock TF 2 and Noctua NH-L12S we reviewed in this month's Labs test, as well as ARCTIC's Freezer i13X, with the latter's mounting plates

BENCHMARK RESULTS

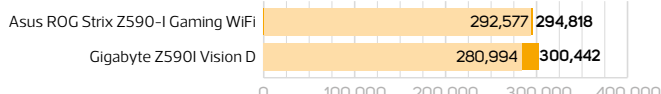
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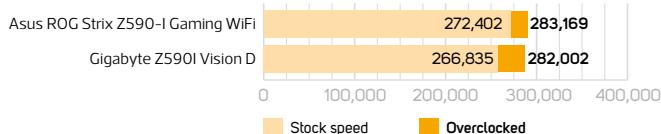
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

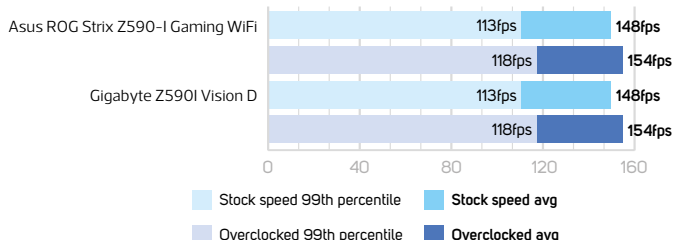


SYSTEM SCORE



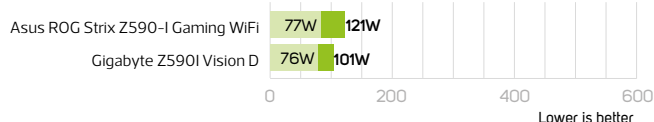
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings

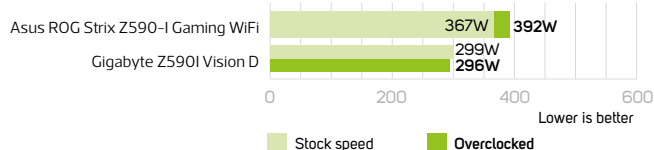


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



fouling the board's heatsinks. As such, if your case only gives you room for a low-profile cooler or AIO liquid cooler, we strongly suggest opting for the latter to avoid issues.

If you use custom water cooling, you can also benefit from a thermal sensor input on the PCB to control your radiator fans using the coolant temperature. Only Asus offers this feature on its premium mini-ITX motherboards and we're pleased to see that continuing with this Z590 Strix model.

The board also gives you four SATA 6Gbps ports and a USB 3.1 Type-C header. However, for the cash we'd like to have seen more overclocking and testing tools. There's no LED POST code display or on-board power and reset buttons – you don't even get a clear-CMOS button on the rear I/O panel. There's only a USB BIOS FlashBack button, but as we're not expecting any more LGA1200 CPUs now that Alder Lake is around the corner, this is a redundant feature.

Performance

Audio performance was excellent, with a noise level of -110dBA and dynamic range of 110dBA, but there's only a trio of ports on the rear panel rather than the usual six and no optical port. Overclocking also proved a little tricky due to some vdroop, but a 1.38V vcore, a standard loadline calibration setting and boosting the power limits to their peaks saw us get our Core i9-11900K stable at 5.1GHz across all cores. This did see the load power

draw rise from 367W to 392W, but the result was some blistering results in our benchmarks, with the system score rising from 272,402 to 283,169.

Conclusion

With excellent VRM cooling, reasonable M.2 cooling and useful features such as a thermal sensor input, Thunderbolt 4 and a pair of USB Type-C ports, along with 2.5 Gigabit LAN and 802.11ax Wi-Fi, the Asus ROG Strix Z590-I Gaming WiFi is certainly a high-end, feature-packed mini-ITX motherboard. We also think it looks fantastic and has everything you need to push your 10th or 11th-gen Intel CPU to its limits.

However, the heatsinks round the CPU socket severely limit cooler compatibility, especially when it comes to low-profile coolers – you'll want to stick to liquid cooling if you can't house a standard tower heatsink in your case. It's also tricky to deal with the M.2 arrangement, thanks to a complicated stacked set of ports, but you'll only have to contend with it a couple of times. If you can plan around these issues, though, this board packs a huge amount of power into a very small space.

ANTONY LEATHER

VERDICT

A stunning enthusiast-focused mini-ITX motherboard with good overclocking potential, but it does have a couple of niggles.

MINI CHEDDAR

- + Attractive design
- + Good overclocking
- + Excellent VRM and M.2 cooling

MINI ROUNDABOUT

- Expensive
- Tricky M.2 installation
- Heatsinks restrict cooler compatibility

PERFORMANCE
33/35

FEATURES
31/35

VALUE
23/30

OVERALL SCORE

87%



ATX Z590 MOTHERBOARD

NZXT N7 Z590 / £240 inc VAT

SUPPLIER scan.co.uk



Intel might have new CPUs around the corner, but with a potentially hefty upgrade coming thanks to DDR5 support, it's still worth considering Comet Lake or Rocket Lake CPUs, especially if they come down in price. NZXT is rather late to the Z590 party, but it's good to see a fresh face in the motherboard arena, with NZXT making this board in conjunction with ASRock,

much like the N7 B550 we reviewed a few months ago.

At £240, it's reasonably priced for a premium Z590 motherboard, although it does lack Thunderbolt 4 support despite offering a Type-C port on the rear I/O panel. It's quite similar to its B550 counterpart, with a very familiar aesthetic design. It's available in an all-black or a black and white design, with the white coming predominantly from the large shrouds that cover the PCB. In fact, apart from the CPU socket area, there's very little of the PCB is visible at all.

We certainly can't argue with the aesthetics – it's a stunning motherboard that looks exceptionally clean in either the black or white versions. It's also bristling with ports and features. You get on-board power and reset buttons, 4-pin and 3-pin RGB LED headers, plus several more that cater for NZXT's proprietary lighting hardware, and a total of seven fan headers too. Add the clear-CMOS

clear button on the rear I/O panel, and the NZXT has more overclocking and testing features than many other boards at this price.

Parts of the shroud are also removable, popping off to reveal two M.2 ports, one of which supports PCI-E 4, while the other is limited to PCI-E 3 and SATA.

However, these ports suffer from the same issue as those of the B550 model, which is that the top plates don't act as heatsinks. If your SSD is thin enough to sit underneath them, there's no airflow to cool it and our stress test saw our PCI-E 4 SSD throttle after five minutes under load.

Leaving off the caps solved this issue, though, and you'll have to do this anyway if your SSD has a large heatsink, as it won't fit underneath the caps.

As well as a USB Type-C header on the PCB, there's also a Type-C port on the I/O panel and a generous total of nine Type-A USB ports, most of which are USB 3 or faster. There's the full complement of audio ports as well, along with both a 2.5 Gigabit LAN port and 802.11ax Wi-Fi. You also get an HDMI output, should you wish to build a system without a discrete GPU, or to use your CPU's integrated graphics for troubleshooting.

SPEC

Chipset

Intel Z590

CPU socket

Intel LGA1200

Memory support

4 slots: max 128GB DDR4 (up to 4600MHz)

Expansion slots

One 16x PCI-E 4, one 16x PCI-E 3 (4x speed), three 1x PCI-E 3

Sound

8-channel Realtek ALC1220

Networking

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

Cooling

Seven 4-pin fan headers, VRM heatsinks

Ports

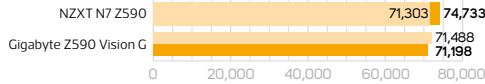
4 x SATA 6Gbps 1x M.2 PCI-E 4, 1 x M.2 PCI-E 3, 3 x USB 3.1 Type-A, 1x USB 3.1 Type-C, 4 x USB 3, 2 x USB 2. 1x USB 3.1 Type-C header, 1x LAN, 3 x surround audio out

Dimensions (mm)

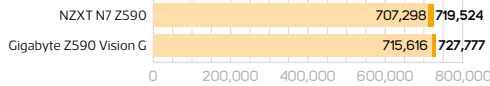
305 x 244

BENCHMARK RESULTS

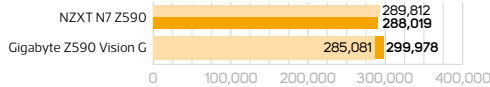
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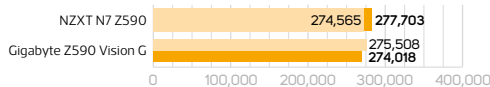
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

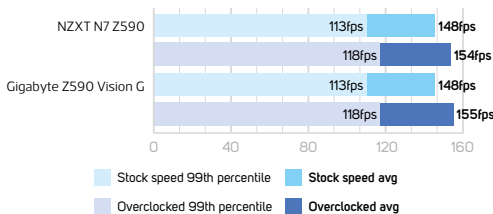


SYSTEM SCORE



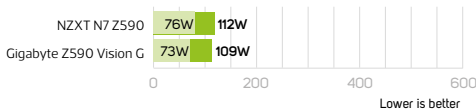
FAR CRY NEW DAWN

1,920 x 1,080, Ultra settings

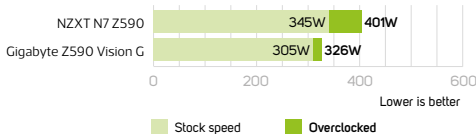


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



One of this board's main features is its integration into NZXT's CAM control software. This allows you to easily control each fan header from within Windows and assign it to respond to either the CPU or GPU temperature. You can completely customise each fan curve and even switch off fans below certain temperatures. It's a shame, then, that there's no thermal sensor input to control radiator fans based on coolant temperatures.

Like the B550 board, the BIOS is also devoid of the usual fan control user interface, so you'll either need to sift through some antiquated fan control options or use NZXT's CAM software. Thankfully, the latter is easy to use, well laid out and offers plenty of other control over lighting

Meanwhile, the VRMs are organised into a 12+2 power phase design that's kept cool by two large heatsinks. We



didn't see temperatures above 60°C in our testing, but when it actually came to pushing our Core i9-11900K in the BIOS, we had to apply a 1.41V vcore in order to hit a stable 5.1GHz across all cores. This is higher than most other boards we've tested, and you'll need some seriously beefy CPU cooling to cope with this amount of voltage.

Performance

At stock speed, the power draw of 345W for the system was rather high and this didn't get any better once our Core i9-11900K was overclocked to 5.1GHz across all cores, peaking at 401W – the highest we've seen from a Z590 board. However, the CPU remained well below 95°C even during our Prime95 stress test.

Stock speed performance with Intel Adaptive Boost Technology enabled was also excellent, with some of the highest results we've seen in our RealBench tests. Even though Adaptive Boost Technology can hit high frequencies across all cores, our manual overclock still offered real-world gains, with the Cinebench R23 score rising from 15,536 to 16,450. However, the overclocked system score of 277,703 wasn't quite as impressive as that of the Asus ROG Strix Z590-I Gaming WiFi and Gigabyte Z590 Aorus Xtreme, with both managing over 280,000 points.

The NZXT's audio performance was excellent, with a dynamic range of 111dBA and noise level of 110dBA. Storage performance was also fine, with our PCI-E 4 SSD hitting the usual 4,996MB/sec read and 4,276MB/sec write speeds we've come to expect, at least with the top cap left off.

Conclusion

Although it has a couple of niggles, the NZXT N7 Z590 is extremely attractive if you like clean-looking motherboards and want to build a white-themed PC. The M.2 port covers are the main fly in the ointment, with our SSD getting toasty in a lengthy stress test, but leaving off the covers doesn't impact the aesthetics too much, plus you can always buy a white heatsink for your SSD.

NZXT's CAM software is excellent too, although it may alienate people who prefer to set and forget these settings in the BIOS. As long as you remember to remove the M.2 port covers, especially if you'll be hammering your SSD a lot, this is an otherwise excellent Z590 board that also has a reasonable price for its expansive feature set.

ANTONY LEATHER

VERDICT

Not without niggles, but this is a feature-rich Z590 motherboard for a good price, and it's ideal if you want to build a white-themed PC.

BLACK AND WHITE PC

- + Attractive design
- + Good Windows-based fan control
- + Generous feature set

BLACK AND WHITE TV

- M.2 slot covers can cause throttling
- No Thunderbolt 4
- No BIOS-based modern fan control suite

PERFORMANCE

31/35

FEATURES

28/35

VALUE

25/30

OVERALL SCORE

84%

MINI-ITX CASE

SSUPD MESHLICIOUS /

£102 inc VAT (side window), **£111** inc VAT (full mesh)SUPPLIER overclockers.co.uk

Every now and then a case appears that takes either the ATX, micro-ATX or mini-ITX world by storm, and we've seen a fair few of them in the latter category recently too. We had the Phanteks Shift, the NZXT H1 and the Cooler Master NR200P, but 2021 is now looking set to belong to the Ssupd Meshlicious.

If you haven't heard of the company, you're not alone. It's actually a Lian Li spinoff, and the clean lines, good build quality and general finesse do betray that fact when you see the case in the flesh. What's immediately obvious when you open the box, though, is the truly small size of the Meshlicious. It's far shorter than the NZXT H1 and Phanteks Shift, measuring just 36cm high. It's also extremely narrow at 166mm wide and is 25cm deep. This case has a decidedly small footprint.

The exterior comes in several guises, including black or white, along with either full mesh or a single glass side panel. However, even the most expensive version won't set you back much more than £100 inc VAT with an included PCI-E 3 riser cable, although you'll have to lay out a few extra tenners to swap out that cable for a PCI-E 4-compatible version. The riser cable is also neatly tucked away in place and ready to use out of the box.

There are no fans included as standard, but there's space for either two 120mm or 140mm fans or corresponding radiators. If you opt for the tempered glass version, you'd want to use those mounts to house an AIO liquid cooler, allowing the graphics card to breathe through the lone mesh panel. There's scope for custom water-cooling too, with enough space for a 30mm radiator behind the fans and a few places to stow a combined small pump and reservoir, and places to route tubing.

All four exterior panels are tool-free and removable, popping into place with push-to-close fittings, which is far quicker and easier than having to use thumbscrews. The panels are

held in place tight enough so that even a little pressure from cables and so on won't pop them open. Removing them gives you fantastic access to the interior, and there are quite a few options with regards to layouts here too.

Sadly, the CPU cooler height limit is paltry, although there's just enough space to house this month's low-profile cooler Labs winner – Noctua's NH-L12S, although you'll need to have a mesh panel sitting over it for it not to be starved of air. You can shift the motherboard tray over a bit too, which cuts the CPU cooler clearance further from 73mm to 53mm, but gains you an extra slot – four in total – for a large graphics card cooler. Full-length cards sit vertically, and an angled DisplayPort cable is included, so the output can be run out the bottom of the case.

Graphics cards that don't stretch beyond 211mm long can sit horizontally across the top of the case with their fans still facing outwards, although you'll need to invest in an 18cm riser cable in order to do that. Doing so gives you space for a hard disk rack that can house up to two 3.5in hard disks. You'll have to make do with a pair of 2.5in mounts or M.2 SSDs if your graphics card is longer than 211mm.

Meanwhile, both SFX and ATX PSUs are supported, although using the latter will result in you losing free space and having a much trickier job tidying cables. The latter is

**SPEC****Dimensions (mm)**

166 x 245 x 360 (W x D x H)

Material

Steel, plastic, glass

Available colours

Black, white

Weight

3.7kg

Front panel

Power, 1x USB 3, 1x USB Type-C

Drive bays

2 x 2.5in (ATX PSU and full-length GPU), 7 x 2.5in (mini graphics card and SFX PSU), 2 x 3.5in (mini graphics card)

Form factor(s)

Mini-ITX

Cooling

2 x 120/140mm front fan mounts (fans not included)

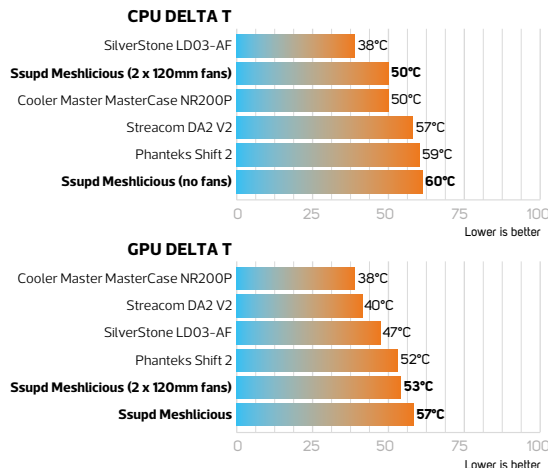
CPU cooler clearance

73mm (53mm using four-slot graphics mode)

Maximum graphics card length

336mm (211mm in small form factor mode)

TEMPERATURE RESULTS



already a difficult job as there are few places to hide them, so we definitely recommend opting for an SFX PSU if possible.

There's also a USB Type-C port on the front panel, which requires a Type-C header on your motherboard, and you also get a USB 3 port here as well. However, apart from a power button, there are no other ports here. It's quite spartan, but ultimately the case looks smart and clean, if a little uninteresting compared with the NZXT H1 and Phanteks Shift 2. There are downloadable objects available for 3D printing too, including case feet, radiator mounts and additional fan mounts, which is great to see.

Performance

With no fans and the glass panel sat on the graphics card side, the Meshlicious was poor in the cooling department, producing a high CPU delta T of 60°C and 57°C for the GPU delta T – again a high result. Clearly, you'll need to add a couple of fans to the mix, and we did this to see how it would impact on performance.

Adding two 120mm fans as intakes lowered the CPU delta T by 10°C, matching the Cooler Master MasterCase NR200P. The GPU delta T also fell by 4°C to 53°C, which was similar to the result from the Phanteks Shift 2, but a long way off matching the better cases we've tested.

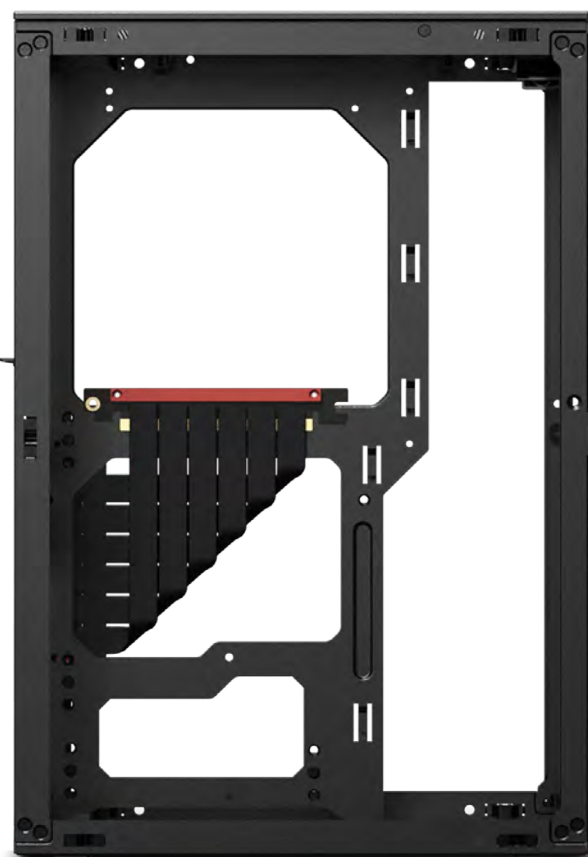
Finally, we switched the panels, so the mesh side was over the GPU and the glass was covering the CPU chamber. With the front fans installed, this had no impact on the CPU temperature, but the better airflow for the GPU saw its peak temperature fall from a delta T of 53°C to 47°C, which was a much better result, if not quite chart-topping.

MESH

- + Great cooling potential
- + Excellent layout
- + Tool-free panels
- + Great value

MUSH

- No fans included
- Bland appearance
- No room for hard drives with full-length graphics cards
- Limited CPU cooler height



Conclusion

The Meshlicious isn't perfect, but taking the mini-ITX route always involves compromises, and this case gets the balance right. The exterior is a tad bland compared with some of the competition, though, and despite having a tweakable interior, the layout doesn't quite move around enough to really open the case up to its full potential regarding custom water-cooling hardware. The paltry CPU cooler height doesn't help here either. If you want to install a high-end PC in this case with a 12 or 16-core CPU, or a Core i9-11900K, you're going to need to liquid-cool it with either an AIO cooler or a basic custom loop based on a 240mm radiator.

Even so, being able to do this in such a small case is remarkable and especially so, given Ssupd has managed to shoehorn an ATX PSU mount and space for enormous graphics cards into the case. It's easy to work with the Meshlicious, plus it's tweakable, available with a mix of mesh or glass and doesn't have a premium price tag. We can think of no better way to begin your mini-ITX journey than using the Ssupd Meshlicious, especially if you'll be dabbling in liquid cooling.

ANTONY LEATHER

VERDICT

A fantastic piece of engineering. The Meshlicious makes for an easy and versatile route into the world of mini-ITX PCs.

COOLING
25/30

FEATURES
16/20

DESIGN
28/30

VALUE
19/20

OVERALL SCORE

88%

WIRELESS GAMING HEADSET

ROCCAT SYN PRO AIR / £130 inc VAT

SUPPLIER game.com

What first strikes you about Roccat's latest wireless gaming headset is its appearance. The Syn Pro Air follows the company's recent trend of including RGB lighting with its peripherals but only in one section. On its Kone Pro mouse, the lighting is only under the buttons, while here it's found in the bottom rear quarter of each earcup.

The lighting is diffused through a semi-translucent grey outer plastic, with a honeycomb structure visible beneath the surface. The default colouring is an ever-changing, pulsing rainbow of colours that's reminiscent of the iridescence you'll find on the surface of many insects. Indeed, the overall feeling is of an organic light source such as a firefly. Whether you like it or not is largely down to personal taste.

When it comes to build quality, this is a resolutely plastic headset, which at first can make it feel less premium than some options. However, it's actually a very practical choice that keeps this headset light yet robust, weighing in at just 310g with its mic (295g without).

Combined with the reasonably deep headband and earcup padding, this makes for a comfortable headset to use for long periods. The fit is adjusted via free-sliding (rather than indented) arms, which don't offer much width adjustment but do have plenty of height adjustment. As a result, the fit can be a touch loose, but we didn't find it bad enough to slide off. The earcups interfered with my glasses more than some designs, though, catching on the ends and pushing the glasses forwards, but your mileage may vary.

The microphone is removable, but unlike most removable models, it doesn't just use a jack socket input but instead has a rotating mounting system that means the microphone can rotate up and away and auto mute, beeping at you to denote when the mic is active or stowed. More beeps then sound to signify the headset is on, and they're rather obnoxiously loud and shrill.

There's a digital volume wheel on the back of each earcup, with the left one used to control system volume and the right to control microphone monitoring/side tone volume. Also on the left earcup is the power button and USB Type-C charging port. In the box there's a Type-A to Type-C charging cable, a Type-A transceiver and a Type-C to Type-A adaptor, so you should be set for all connection options.



The Syn Pro Air doesn't offer on-headset sound profile control, but Roccat's software lets you switch between impressive virtual surround and stereo, as well as adjust the lighting. The software also includes controls for EQ, various other game-specific audio effects, a mic noise gate and battery status.

When it comes to sound quality, the mic is basic but adequate, while the headphones sound generally rather good. There's boosted bass and slightly boosted treble but not enough to suck the life out of music, and general detail and clarity is excellent. However, we did find the amped bass and treble a touch tiring, and ended up using Roccat's software EQ to tone it down a bit. Meanwhile, battery life is excellent. Quoted as 24 hours of playtime, we comfortably used the headset for a week without the need to charge it.

Conclusion

The Syn Pro Air is an accomplished, good-sounding headset that's comfortable, light and long-lasting. The Corsair Virtuoso Wireless RGB SE outclasses it in terms of looks and sound quality, but the Syn Pro Air is lighter and more comfortable to wear, making it worth considering if that's a bigger priority for you.

EDWARD CHESTER

VERDICT

A capable wireless gaming headset for a decent price, especially if you prioritise lightness and comfort.

SYNCHRONISED

- + Lightweight, practical design
- + Decent feature set
- + Solid sound quality

SYNFUL

- Strange lighting choice
- Annoying status beeps

SPEC

Audio config

Stereo and virtual surround

Headphone frequency range

20-20,000Hz

Sensitivity/sound pressure

Not stated

Mic frequency response

Not stated

Mic sensitivity

Not stated

Weight

295g without mic, 310g with mic

Battery life

24 hours gaming

Extras

USB Type-C cable, wireless dongle, USB Type-A to Type-C adaptor, removable mic

DESIGN
16/20

FEATURES
16/20

SOUND QUALITY
32/40

VALUE
16/20

OVERALL SCORE

80%

PHILIPS

Monitors

get in the **moment**

innovation  you



Momentum 32" 4K UHD, LCD display with Ambiglow
326M6VJRGB

4K
Ultra HD



VESA CERTIFIED
DisplayHDR™ 400



UltraWideColor



Adaptive Sync

Available at:

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SYSTEMS

SWIFT ELITE GAMING DESKTOP

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PCSpecialist



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BUCKLING SPRING KEYBOARD

UNICOMP NEW MODEL M / £129 inc VAT

SUPPLIER keyboardco.com



For the best part of 30 years, IBM's Model M keyboard that was bundled with the company's PCs from 1985 to 1997 has been revered among computing veterans for its incredible typing experience and build quality. Now, 25 years on, Unicom has released a new version of the famed Model M, bringing vaguely modern creature comforts such as illuminated lock lights and Windows keys.

Of course, this isn't a keyboard for the gamers in the audience; it's chiefly designed for typists and those wanting to relive the days of typing with that distinctive, firm click. Its design is remarkably classic looking, opting for a black outer casing that offers plenty of heft.

Inside, you'll find a rather heavy piece of curved steel, which was also found in the original Model Ms in order to offer unrivalled structural rigidity, although it does mean the keyboard weighs a hefty 1.6kg.

In contrast to the older IBM Model Ms, there are a few key differences. Chief among them is the connector on the end of the fixed cable – these new ones can connect via USB as well as PS/2. Those older keyboards also usually only came in beige, whereas these new ones can also come in black. You could get a black Model M back then if you wanted the optional Trackpoint mouse feature (known as a Model M13), but they were otherwise beige or industrial grey. Of course, you also get a blue Unicom logo as opposed to the older IBM labels.

The fundamental motivation for buying a Model M hasn't changed since 1985 though – the buckling spring switches. On a basic level, the press of a key causes a spring underneath the keycap to buckle, with the sideways movement tilting the metal contacts together. This offers an arguably truer mechanical typing experience (compared with a typewriter, say) than the typical switches found in usual mechanical keyboards.

In action, they're some of the most satisfying and tactile key switches to use, offering a defined and marvellous click with every input. In contrast to Cherry MX Blues, for example, the click here feels more purposeful and analogue. Fans of more linear switches will miss out here, and also those who

want quiet actuation – the New Model M's buckling springs are rather loud, especially if you're touch-typing quickly.

The keycaps here are a two-tone grey and white PBT dye-sublimated set, which mirrors the original Model Ms for quality, with practically permanent legends on the keycaps. The only difference between the ones on the Unicom New Model M and some original IBM variants is that the older ones came in two pieces as opposed to one.

While there aren't any of the usual flashy extras you see with gaming keyboards, such as RGB lighting and media keys, Unicom does offer some customisation options. You can buy some custom keycaps directly from the website that were commissioned exclusively for the Geekhack forum, as well as some that feature a custom print of the Linux mascot, Tux the penguin.

Conclusion

The Unicom New Model M is a truly marvellous keyboard. It retains the now-vintage charm of the original IBM Model M designs, as well as the unrivalled feeling of buckling spring switches that, while heavy, feel amazing under your fingers. They can be rather noisy, and you won't find too much customisation here, but if you're looking for a superb typing keyboard that will last until doomsday, and you're happy to splash out £129 for it, this is the keyboard for you.

REECE BITHREY

VERDICT

An incredible combination of marvellous build quality, vintage flourishes and the best switches around today, this is a proper typist's keyboard.

BELT BUCKLES

- + Brilliant build quality
- + Super-clicky buckling springs
- + High-quality keycaps
- + Incredible typing experience

IAN BUCKELLS

- Rather heavy
- No extra features
- Noisy keys aren't for everyone

SPEC

Dimensions (mm)

455 x 180 x 50 (W x D x H)

Weight

1.6kg

Format

Full size – 103/104 keys

Connections

USB Type-A / PS/2

Switch type

Buckling spring

Switch life

25 million+ key stroke

Backlighting

None

Extras

None

DESIGN

20/25

FEATURES

18/25

PERFORMANCE

24/25

VALUE

20/25

OVERALL SCORE

82%

HackSpace

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GAMING LAPTOP

ASUS ROG FLOW X13 GV301

Laptop **£1,499** incVAT / Laptop and eGPU **£2,699** incVAT

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

The Asus ROG Flow X13 is one of the most exciting gaming laptops on the market right now, as it's not just a laptop. This machine is at its best when you buy it alongside the ROG XG Mobile graphics dock,

which turbo-charges its gaming ability.

The dock contains an Nvidia GeForce RTX 3080 Laptop GPU with a hefty peak power level of 150W, alongside its conventional 6,144 stream processors and 8GB of memory. The reliance on laptop graphics is a smart move – it means the dock weighs just 1kg and is only 208mm long and 30mm thick. Companies such as Razer have experimented with graphics docks, but those products are larger, weigh more than 5kg and take a desktop graphics card.

Asus' dock doesn't just provide extra graphics power – it improves connection options too. It has four USB 3.2 Gen 1 ports, plus DisplayPort and HDMI outputs, as well as an SD card reader and a Gigabit Ethernet connection. There are two downsides – the cable should be longer, and the laptop GPU can't match the desktop RTX 3080 for performance and can't be upgraded.

The dock makes sense when you consider the Flow X13 itself. This laptop weighs just 1.3kg and measures 16mm thick, so there's no room for a top-tier GPU. Instead, it uses a modest GeForce

GTX 1650 Max-Q. Meanwhile, processing power comes from an AMD Ryzen 9 5980HS, which has eight SMT-enabled cores (16 threads) alongside base and boost speeds of 3GHz and 4.8GHz – a serious processor for such a slim machine.

Elsewhere, the tiny Asus has 32GB of dual-channel LPDDR4 memory and a 1TB WD SN530 M.2 SSD. The laptop has dual-band Wi-Fi 6 and Bluetooth 5.1. Exterior connections on the laptop itself are only middling though – there are two USB 3.2 Gen 2 Type-C ports, with one needed to power the machine, alongside single audio, HDMI and USB 3.2 Gen 2 Type-A ports.

The X13 is also equipped with a 1,920 x 1,200 IPS display, which has a 16:10 aspect ratio and 120Hz refresh rate. The taller-than-usual display provides more on-screen real estate, while that refresh rate is ideal for mainstream gaming and esports, although it's not quite high enough for super-competitive gaming. It's a touch-screen model too, and it has 360-degree hinges, so it can swing around into tablet or tent modes.

The screen itself has great image quality. The 297cd/m² backlight and black point of 0.17cd/m² are excellent – the former is bright enough for most situations and the latter offers superb depth. The contrast ratio of 1747:1 is fantastic, and means you get loads of punch and vibrancy. The delta E of 0.82 is great, and the panel rendered 97.3 per cent of the sRGB colour gamut. It's a brilliant display and makes games look bold, accurate and colourful.

The Asus even has good speakers – there's punchy bass, a pleasing mid-range and a clear, detailed top end. These speakers are easily good enough for mainstream gaming, and better than those included on most larger laptops.

SPEC

CPU

3GHz AMD Ryzen 9 5980HS

Memory

32GB 2133MHz LPDDR4

Graphics

Nvidia GeForce GTX 1650 Max-Q
4GB / GeForce RTX 3080
Laptop 8GB in eGPU dock

Screen

13.4in 1,920 x 1,200 IPS 120Hz

Storage

1TB WD SN530 M.2 SSD

Networking

Dual-band 802.11ax Wi-Fi,
Gigabit Ethernet, Bluetooth 5.1

Weight

Laptop: 1.3kg; dock: 1kg

Ports

Laptop: 2 x USB 3.2 Gen 2 Type-C/
DisplayPort, 1 x USB 3.2 Gen 2, 1 x
HDMI, 1 x audio; dock: 4 x USB 3.2
Gen 1, 1 x HDMI, 1 x DisplayPort, 1 x SD

Dimensions (mm)

Laptop: 299 x 222 x 16; dock:
208 x 155 x 30 (W x D x H)

Operating system

Windows 10 Home 64-bit

Warranty

One year parts and labour
return to base



The X13's small size means the keyboard has no numberpad, and the backlighting is white rather than RGB. The buttons are crisp, fast and consistent, though, and their solid base means you can hammer the keys in games without issue. Many people will prefer larger keys, but this hardware is excellent for gaming on a small machine. The trackpad is fine too, although you'll want a USB mouse for gaming.

On the outside, the X13 is built from aluminium, magnesium and plastic, and it looks subtle with some industrial touches. It's robust, with a rigid base and hardly any screen movement. The laptop and dock are easily sturdy enough to put into a bag and take to gaming events.

The X13 and XG create a two-tier environment that Asus reckons will prove easier to manage than using a thicker, heavier conventional laptop. If you want a small, light laptop for work and esports, you can use the X13, and if you want extra gaming power, you can bring the dock too – or attach it when you're at home.

Performance

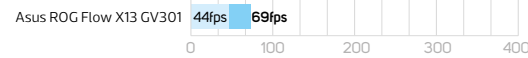
The 150W RTX 3080 zipped through Assassin's Creed Valhalla with a 99th percentile minimum of 48fps and 68fps average, and it handled Cyberpunk 2077 with a 99th percentile result of 48fps. Its 40fps 99th percentile and



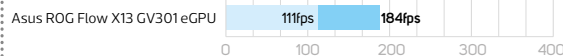
BENCHMARK RESULTS

DOOM ETERNAL

1,920 x 1,080, Vulkan, High settings

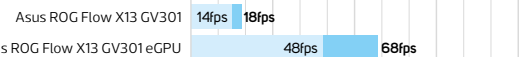


1,920 x 1,080, Vulkan, Ultra Nightmare settings



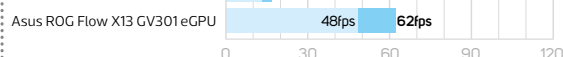
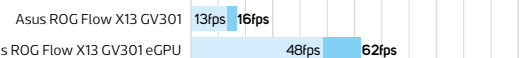
ASSASSIN'S CREED VALHALLA

1,920 x 1,200, Ultra High settings, High anti-aliasing



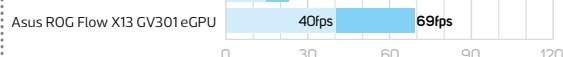
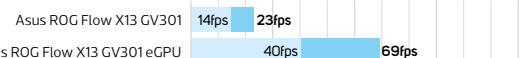
CYBERPUNK 2077

1,920 x 1,200, Ultra preset, no ray tracing



METRO EXODUS

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



99th percentile Average

64,648

GIMP IMAGE EDITING

521,898

HANDBRAKE H.264 VIDEO ENCODING

179,156

HEAVY MULTI-TASKING

194,786

SYSTEM SCORE

69fps average in Metro Exodus with ray tracing enabled is also a great result – all three of those games benefited from average frame rates beyond 60fps.

In Doom Eternal, the Asus' dock delivered a 99th percentile result of 111fps and an average of 184fps. Those scores bode well for high-end gaming. You'll be able to play today's top games smoothly without any graphical compromise, and the dock is quick enough to handle esports games on the laptop's 120Hz screen.

Those results were all recorded at 1,920 x 1,080. Upgrading to the Asus' 1,920 x 1,200 native resolution only saw results decline by a couple of frames. Conversely, you can get a few more frames by deploying the laptop's Turbo mode, albeit with extra noise.

They're good scores, but this isn't the best performance you can find from the laptop RTX 3080. We reviewed the Asus ROG Strix Scar G733 with its 130W RTX 3080, and the machines were virtually identical in terms of performance. Also, the Alienware m17 R4 ran the chip at 165W and was a few frames per second faster.

Without the dock, the modest GTX 1650 delivered a playable result in Assassin's Creed Valhalla with the game running at its Low settings, but the laptop GPU couldn't get



beyond a 25fps minimum in Cyberpunk 2077 and Metro Exodus with the graphics settings dialled right down. The X13's Doom Eternal 99th percentile result of 44fps was playable, albeit not at the speeds required by the 120Hz display. Without the dock, the X13 is only suitable for esports – and it did, at least, play Rainbow Six Siege with a minimum of 110fps at Medium settings.

Meanwhile, the Ryzen 9 5900HS is a low-power version of AMD's beefiest laptop chips, and it performs well. In our single-threaded image editing test it scored 64,648, and it dashed through our heavily multi-threaded Handbrake benchmark to deliver a result of 521,898. Both are better than Intel's current Core i7 laptop chips, and the latter is barely slower than Intel's Core i9-10980HK.

AMD's own Ryzen 7 5800H, Ryzen 9 5900HS and Ryzen 9 5900HX are faster, but they're used in larger laptops. Those are the CPUs to buy for proper multi-core mobile power, but the 5900HS is still excellent. It's easily capable of tackling mainstream content-creation work, and it never struggles with any number of browser tabs and Office applications.

Deploying the laptop's Turbo mode also saw the X13's Handbrake score improve to 546,523, giving you a modest boost to heavily multi-threaded content creation software.

While it's admirable that Asus has crammed such a powerful CPU into this slim, light laptop, the Ryzen chip pushes the machine's thermal limits. In single and multi-threaded benchmarks the processor hit a delta T of 67°C, which is as high as this processor can handle. In the single-

core test, the CPU ran at 4.5GHz, and in the multi-threaded test it ran at 3.2GHz. Both speeds fall short of the chip's theoretical pace. On the plus side, the laptop GPU hit a delta T of 52°C, and the dock's RTX 3080 peaked at 54°C – both acceptably low temperatures.

No matter what you do with this laptop, you'll have to contend with heat and noise. If you play games or run work tasks, there's noticeable fan noise – it's level with most larger gaming machines – when you're gaming, you'll want to use a headset or speakers to drown it out.

The dock outputs at a similar volume. If you push the laptop components hard, the underside becomes very warm, the area above the keyboard becomes too hot to touch and plenty of hot air is ejected from the right-hand side of the base. The dock outputs loads of hot air too, but at least you can move that out of the way, and using the dock does reduce the laptop's temperature.

Don't expect outstanding battery life either.

Without the dock, the X13 lasted for one hour and 16 minutes during gaming, and it ran out of juice after four hours of video playback and three hours of everyday work. In that respect, it's a conventional gaming laptop.

Conclusion

The Asus ROG Flow X13 and its accompanying XG Mobile dock offer the best combination of a laptop and external GPU that we've yet seen.

The external GeForce RTX 3080 dock offers genuine high-end gaming pace in a box that you can easily sling into a bag, and only desktop GPUs and the beefiest laptops provide more speed. Meanwhile, the laptop packs plenty of CPU power into a slim and sturdy body, along with a good keyboard, its own esports-capable GPU and a dazzling display.

There are downsides though. The laptop and dock are hot and loud when they're working, battery life remains mediocre and the keyboard is small. Many people will prefer traditional gaming laptops, which provide bigger screens and keyboards in heavier, thicker bodies.

Impressively, though, the Asus ROG Flow X13 and XG Mobile bundle doesn't cost any more than a gaming laptop with equivalent components, so there's no real premium to pay if you want to go down this modular route.

This setup won't suit everyone, but this hardware is worth consideration if you want the portability that only comes from an ultra-portable laptop, along with the gaming performance of a high-end GPU. The laptop is worth buying in isolation too, if you want a slim and light laptop that's also capable at handling esports.

MIKE JENNINGS

VERDICT

An innovative package that combines ultra-portable computing with genuine high-end gaming power.

FLOWING

- + Genuine high-end gaming power
- + Innovative form factor
- + Great screen quality
- + Powerful processor

SLOWING

- Often hot and loud
- Mediocre battery life
- Small display
- Few ports on laptop

PERFORMANCE

22/25

DESIGN

23/25

HARDWARE

21/25

VALUE

21/25

OVERALL SCORE

87%

Wireframe

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AMD APU PC

PC SPECIALIST LOTUS ELITE R / £699 inc VAT

SUPPLIER pcspecialist.co.uk

PC Specialist's Lotus Elite R arrives with a wallet-friendly price of just £699, which makes it the cheapest gaming desktop we've seen for ages. That's because this PC doesn't include a discrete GPU. Instead, PC Specialist has deployed one of AMD's new Cezanne APUs, which crams Zen 3 CPU cores alongside Radeon graphics hardware inside one chip.

SPEC

CPU

3.9GHz AMD Ryzen 5 5600G

Motherboard

Asus TUF Gaming B550-Plus Wi-Fi

Memory

16GB Corsair Vengeance LPX 3000MHz DDR4

Graphics

AMD Radeon RX Vega 7

Storage

512GB Intel 670p M.2 SSD

Networking

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

Case

PC Specialist P209

Cooling

CPU: PC Specialist FrostFlow 100 V3 with 1x 120mm fan; rear: 1x 120mm fan

PSU

Corsair CV650 650W

Ports

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

Operating system

Windows 10 Home 64-bit

Warranty

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

The Ryzen 5 5600G used here has six SMT-enabled processing cores alongside a Radeon RX Vega 7 GPU with 448 stream processors. The CPU core has base and boost speeds of 3.9GHz and 4.4GHz – the former is better than the conventional Ryzen 5 5600X desktop chip, but the latter is 200MHz slower.

Meanwhile, the integrated GPU runs at 1900MHz, but it needs to share system RAM. Disappointingly, the GPU also uses AMD's older Vega architecture, rather than RDNA. Another disappointment is that while the APU has 24 PCI-E lanes, they're PCI-E 3 rather than PCI-E 4.

This budget CPU slots into an Asus TUF Gaming B550-Plus motherboard. It's a better board than you'll find in many affordable PCs and there's plenty to like. Networking is covered by 2.5Gbps Ethernet and dual-band 802.11ax Wi-Fi, and the board has a Thunderbolt 3 header alongside loads of other connectors.

The rear I/O panel is well stocked with USB 3.2 Gen 2 Type-A and Type-C ports that run at a rapid 10Gbps alongside four USB 3.2 Gen 1 connectors. There's Realtek ALC S1200A audio, three 1x PCI-E slots and two M.2 connectors. The board looks

decent, but it doesn't have huge heatsinks or any on-board buttons and displays.

The rest of the spec is fine. There's 16GB of dual-channel 3000MHz DDR4 memory, and the Intel 670p SSD delivered decent read and write speeds of 3,315MB/sec and 2,412MB/sec – although it's a shame there's only 512GB of space. The Corsair CV650 PSU is acceptable for a budget PC and it has 80 Plus Bronze certification, but it's not modular. Meanwhile, the warranty includes a year of parts protection and three years of labour coverage, which is decent at this price.

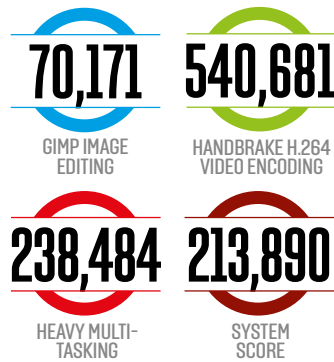
PC Specialist uses its own P209 chassis here. This mid-tower case offers every feature you'd expect from a mid-range design, including a tempered glass side panel, a metal front panel, a magnetic dust filter in the roof and a vertical stripe of RGB LED lighting. There are no surprises on the inside either, with a PSU shroud and neat cabling. The PC Specialist FrostFlow cooler doesn't impede the spare memory slots, and at the rear there's room to add single 2.5in and 3.5in drives. It's a basic case, but entirely serviceable for an everyday rig.

Performance

The Ryzen 5 5600G offers solid application performance in single-threaded tasks. In the image editing benchmark, the 5600G scored 70,171, which is hardly different from the

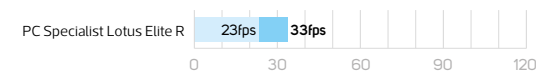


BENCHMARK RESULTS

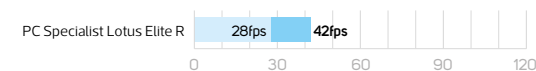


DOOM ETERNAL

1,920 x 1,080, Vulkan, High settings

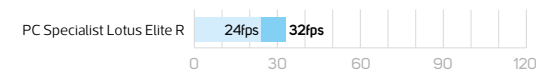


1,920 x 1,080, Vulkan, Medium settings



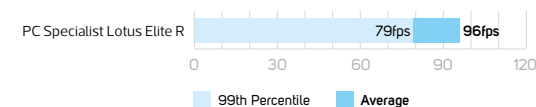
DIRT 5

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



RAINBOW SIX SIEGE

1,920 x 1,080, Low settings



pricier Ryzen 7 5700G APU and Ryzen 5 5600X. The score of 540,681 in our heavily multi-threaded Handbrake test is also only around 13,000 points behind the normal desktop chip.

These results bode well for everyday computing – you'll have no issue with web browsers, office tools or light creative work. That Handbrake result was more than 80,000 points behind the 8-core 5700G, though, and the 5600G's multi-tasking result of 238,484 is a huge 63,000 points behind the Ryzen 5 5600X. Those underwhelming Handbrake and multi-tasking results indicate that the 5600G struggles with tougher tasks and complex workloads. If you want to handle those challenging situations, you'll be better off with a fully fledged non-APU chip.

The 5600G's integrated graphics core wasn't particularly impressive either. In Doom Eternal at High settings, the GPU returned an unplayable 99th percentile minimum of 23fps, and it only improved to 28fps and 32fps when we dropped the settings to Medium and Low respectively. As a point of comparison, the Ryzen 7 5700G GPU's extra compute unit (giving it 512 stream processors), achieved a 99th percentile result of 40fps in this game at High settings last month. The 5600G's averages always sat beyond 30fps, but that's cold comfort when confronted with poor minimums.



ELISE

- + Reasonable esports and CPU pace
- + Affordable price
- + Decent future graphics potential
- + Capable motherboard

EUROPA

- Underwhelming graphics core
- Fully fledged CPUs are faster

The APU's 32fps average in Dirt 5 matched the 5700G, but its 24fps minimum was unplayable and 3fps slower. This chip only proved its worth in the undemanding Rainbow Six Siege, where it delivered a 1080p minimum of 79fps at Low settings. That's the limit for this chip – it will play popular esports such as Fortnite and League of Legends, but it won't run many of them at the speeds required by 144Hz screens. Don't expect it to tackle big single-player titles unless you're happy to drastically drop the graphics quality settings.

There were no thermal issues at least. The PC Specialist was virtually silent in all situations, the chip never got too hot and it achieved its stated boost speeds.

Conclusion

The Lotus Elite R has a great price, and it's also neat, tidy and quiet. Meanwhile, the motherboard, storage and memory are decent, and you get a good warranty. It's a solid base if you want an affordable system for later expansion. The mid-range APU tackles everyday computing tasks and 1080p esports games at reasonable speeds.

You'll find limitations though. Nvidia's most modest GPUs are significantly quicker, and the 8-core 5700G also delivers a significant performance boost. You'll have to pay a fair bit more for a PC with a discrete GPU though. As a base for esports gaming right now and future expansion, the Lotus is affordable and worth considering. However, spending a little more on a better APU or a discrete GPU will deliver more immediate performance gains.

MIKE JENNINGS

VERDICT

Decent entry-level speeds, a low price and some solid upgrade potential, but the integrated GPU's performance is disappointing.

PERFORMANCE

16/25

DESIGN

17/25

HARDWARE

18/25

VALUE

20/25

OVERALL SCORE

71%

AMD X570 GAMING PC

WIRED2FIRE PREDATOR
EXTREME / £2,300 inc VAT

SUPPLIER wired2fire.co.uk

Wired2Fire's Predator Extreme uses the popular combination of an Nvidia GeForce RTX 3080 and AMD Ryzen 7 5800X, with an impressive price of £2,300 – that's towards the bottom of the price bracket for systems with these components.

MSI provides much of the hardware inside this build, including the Gaming Z Trio graphics card. This card improves the GPU boost clock from 1710MHz to 1830MHz, and sports three fans and a multitude of RGB LEDs. The other core components are good, but offer no surprises. The Ryzen 7 5800X has eight SMT-enabled Zen 3 cores alongside base and boost speeds of 3.8GHz and 4.7GHz, and Wired2Fire

has installed 32GB of dual-channel DDR4 memory clocked to a modest 3000MHz.

There's also a 1TB WD SN550 SSD with middling read and write speeds of 2,487MB/sec and 1,984MB/sec, but no secondary hard disk. It's all powered by a 700W Kolink Enclave PSU, which has a modular design and 80 Plus Gold certification.

Meanwhile, the MSI MPG X570 Gaming Pro Carbon WIFI motherboard is solid. It looks the part, with big heatsinks, RGB lighting and two PCI-E 4 M.2 connectors. Elsewhere, the board has dual-band 802.11ax Wi-Fi, plenty of PCI-E slots, Realtek ALC1220 audio and spare memory slots. At the rear, you'll find USB 3.2 Gen 2 Type-A and Type-C connectors alongside plenty of USB 3.2 Gen 1 ports and a PS/2 plug. This is a capable and well-built mainstream board, with the only notable omission being 2.5Gbps Ethernet.

It's housed in an MSI Gungnir 110M chassis, which looks good, with slats and angles on the front panel and three glowing RGB LED intake



fans. It has a tempered glass side panel, and every part is robust. It's not particularly big, and the top has a USB 3.2 Gen 2 Type-C port as well. The modest dimensions mean that it's easy to slot the Wired2Fire into compact spaces, but it does leave the interior feeling cramped.

The graphics card stretches across most of the case, and the MSI CPU cooler's 240mm radiator has two chunky fans that inhibit the top of the motherboard, although they do thankfully leave the memory slots accessible. The rig is messy around the rear, though, and you'll have to move cables to use the 3.5in drive bays. If you don't plan to upgrade your PC, these issues won't be a problem, but larger enclosures are easier to use.

Happily, the Predator Extreme has an excellent warranty, comprising a five year labour deal alongside two years of parts cover.

Performance

The overclocked RTX 3080 served up smooth, fast results in our standard game tests at 2,560 x 1,440, and its scores in Cyberpunk 2077 and Metro Exodus improved by a couple of frames per second with ray tracing and DLSS activated. At this resolution, it tackled Doom Eternal with a 224fps 99th percentile minimum – a huge result. The Wired2Fire beat the 30fps barrier in Cyberpunk and Metro Exodus at 4K as well, and was even quicker in Assassin's Creed Valhalla.

SPEC**CPU**

3.8GHz AMD Ryzen 7 5800X

Motherboard

MSI MPG X570 Gaming Pro Carbon WIFI

Memory

32GB Corsair Vengeance LPX 3000MHz DDR4

Graphics

MSI GeForce RTX 3080 10GB

Storage

1TB WD Blue SN550 M.2 SSD

Networking

Gigabit Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5.1

Case

MSI MPG Gungnir 110M

Cooling

CPU: MSI MAG CoreLiquid 240R with 2 x 120mm fans; GPU: 3 x 90mm fans; front: 3 x 120mm fans; rear: 1 x 120mm fan

PSU

Kolink Enclave 700W

Ports

Front: 2 x USB 3.2 Gen 1, 2 x USB 3.2 Gen 2x2 Type-C, 2 x audio; rear: 3 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 2 x USB 3.2 Gen 1, 2 x USB 2, 1 x PS/2, 1 x optical S/PDIF, 5 x audio

Operating system

Windows 10 Home

Warranty

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

BENCHMARK RESULTS

73,205

GIMP IMAGE
EDITING

742,889

HANDBRAKE H.264
VIDEO ENCODING

317,945

HEAVY MULTI-
TASKING

292,284

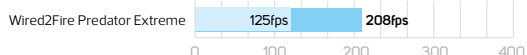
SYSTEM
SCORE

DOOM ETERNAL

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

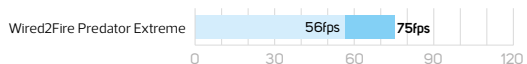


3,840 x 2,160, Vulkan, Ultra Nightmare settings



ASSASSIN'S CREED VALHALLA

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



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

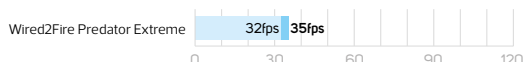


CYBERPUNK 2077

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

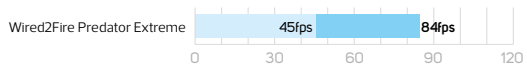


3,840 x 2,160, Ultra preset, no ray tracing

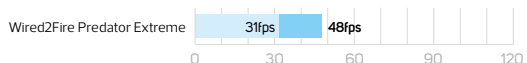


METRO EXODUS

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

Ultimately, there's little this GPU won't handle. It will play top games at 4K, and it can run undemanding games at the speeds necessary for 360Hz displays. You'll get more performance from the RTX 3080 Ti, but the overclock on this GPU keeps the gap small – you'll spend hundreds more for a PC with that card, but you won't get a huge performance boost – the only benefit will be in 4K at high settings.

Meanwhile, the Ryzen 7 5800X can handle any mainstream application task. Its Handbrake result of 742,889 is almost 100,000 points beyond the Intel Core i7-11700K and it's quicker than the Core i9-11900K. The Wired2Fire



delivered a result of 317,945 in our multi-tasking benchmark – another score that handily beat Intel chips. AMD's CPU even led the way in the single-threaded image editing benchmark. This CPU is adept at multi-tasking and ideal for streaming and content creation. You'll only need the power of a Ryzen 9 CPU for challenging, heavily multi-threaded tasks.

Wired2Fire's machine delivers good performance, but it's also louder than most other PCs at this level when playing games, and the noise increased marginally during demanding work tests. Decent speakers or a headset will drown out the noise in games, and the GPU never got hot, but it's easy to find quieter rigs.

When running a multi-threaded task, the CPU hit an all-core Turbo peak of 4.4GHz, and it ran at 4.5GHz in a single-core benchmark. Both figures are a little lower than the chip's theoretical speeds, and the processor's peak delta T of 67°C is also right at the CPU's thermal limit. You won't get the best performance from the 5800X in this PC, and you'll want to upgrade the cooler if you want to install a faster CPU.

Conclusion

On the plus side, the Predator Extreme offers excellent performance, solid components and a generous warranty, and it's a bit cheaper than many other PCs with the same hardware. Negatively, though, it's loud, the processor doesn't achieve its full potential and the chassis is a bit cramped. This is a fast and capable gaming rig that you can buy today at a good price, but it's a shame it's noisy.

MIKE JENNINGS

VERDICT

Wired2Fire's machine has a fair price and plenty of pace, but it makes a fair bit of noise when it gets going.

EXTREME

- + Fast in games and applications
- + Versatile, well-featured motherboard
- + Reasonable price
- + Extensive warranty

EXHUME

- Processor gets hot
- Louder than most rivals
- Cramped and untidy chassis

PERFORMANCE
22/25

DESIGN
18/25

HARDWARE
20/25

VALUE
21/25

OVERALL SCORE

81%

Custom kit

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

ZEROWATER 10 CUP JUG / £34.99 inc VAT

SUPPLIER zerowater.co.uk

ZeroWater claims that its water filter will remove 99 per cent of dissolved impurities from water, which is a lot (usual water filters remove about half of them). In this variant, it's attached to a 2.3-litre jug with a neat little slot on top for an included TDS (total dissolved solids) water quality meter.

In testing, the ZeroWater does very much what you'd expect given the name. When filled with tap water with a TDS level of 267, which is for all intents and purposes fine, it filtered out everything, down to a TDS level of zero. This is accomplished by a five-stage filter,



which manages to be extremely thorough while not taking all day about it.

The website also features a video with Philip Schofield pouring a glass of red wine into it, which is then turned into pure water. It tastes different from tap water as well, although

whether it tastes better is down to your own

tastes. While this is all technically impressive,

though, purifying tap water to this extent

is only really useful if your tap water is

particularly bad. If that's the case with

your water, though, the ZeroWater does

a remarkably good job of cleaning it up.



Parity ●●●●○ Purity

BOOMPODS POWERBOOM X10

/ £19.99 inc VAT

SUPPLIER amazon.co.uk

The Boompods Powerboom X10 is a 10,000mAh power bank that feels like it was named to tempt fate. The design is much more sensible than the name, with ports and buttons kept to a minimum, and it also has IPX7-rated water resistance, with a tight cover over the USB Type-C charging port and the USB output.

Meanwhile, a button on the side activates the torch on the top after a second of holding it down, or you can just tap it to activate the power level indicator lights. This button is also a part of the case, so there are no gaps for water to get into the device. The Powerboom X10 is roughly the same size as a smartphone, but a little weightier, as it's almost entirely made of battery. The recharge rate isn't very fast, but it's good enough for a power backup. It's nothing out of the ordinary, but the Powerboom X10 is tough, minimalist and effective.



Boom ●●●●○ Shake the room

SINJIMORU CABLE CLIP

/ £12.99 inc VAT

SUPPLIER amazon.co.uk

The Sinjimoru cable clip is a neat and tidy system that keeps USB charging cables and other similar wires under control in such a way that, if necessary, you can detach them and take them away. The clip has two parts – a square magnetic dock that you attach with double-sided tape to your chosen surface, and then a small square block that grips onto the cable and snaps neatly into the magnetic dock.

You can pull the magnets apart if the cable is needed elsewhere and you can then snap them back together later. If you're absolutely certain that you don't want

even the most

unobtrusive

piece of

cabling to start

wandering free,

the Sinjimoru will

handle it, and look

pretty smart while

it's doing it.



A place for everything ●●●●○ Everything in its place

NURATRUE EARBUDS

/£199.99 inc VAT

SUPPLIER nuraphone.com

The sound-profile-creating tech seen in the NuraPhones and the NuraLoop is back, miniaturised to a further degree in the NuraTrue earbuds. When setting up these earbuds for the first time, they create a personalised profile by scanning your ears and then use it to attempt to adapt what your listening to specifically for your ears.

This manifests itself in extremely high sound quality from the buds at quiet and loud volumes. Enjoying all this good noise is made easier by the inclusion of active noise cancelling, which does an amazing job of cutting out pretty much any noise going on around you. Another interesting feature is the Social Mode, which you enable by simply tapping the left earbud. This mode activates external microphones that allow the earbuds to play exterior sounds to you, so you don't have to remove an earbud to talk to people.



The NuraTrue earbuds are good for around six hours of battery life before needing to go back in their charging case, and the charging case is good to charge them up three times before needing to be topped up itself from a USB Type-C cable. The sound quality is tremendous, the user experience is great and the battery life is substantial – wins all round.

Small packages ●●●●● Good things

G-DRIVE MOBILE SSD /£315.95 inc VAT for 2TB

SUPPLIER westerndigital.com

The G-Drive is a USB SSD that boasts a mighty 2TB capacity. The external design is visually low-key, made from lightweight plastic and metal, but it's rated to IP67, which covers protection against dust and immersion in up to 1m of water for up to half an hour. It's also rated for up to 3m drop protection and has a crushproof rating of 454kg. This means you should be good if you drop it from horseback, but not if the horse steps on it.

This level of protection, coupled with the lack of moving parts in the drive itself, makes the G-Drive an extremely tough cookie. Within the case an aluminium heatsink surrounds the drive's PCB, and it's clearly needed, as it gets warm. That's because it offers some pretty fast speeds when it gets going – when connected to a USB 3.2 Gen 2x2 cable, it reads at up to 1,088MB/sec and writes at up to 1,055MB/sec.

The G-Drive is formatted for macOS 10.10+ by default, and needs to be reformatted for Windows or Android systems, which is easy enough. The G-Drive is fine to sit at home next to a PC as a backup

drive, but with its rugged construction, it's better suited to going out and about. If you want lots of speedy storage in a tough package, then the G-Drive does the job brilliantly, even if it's a bit pricey.

Homebody ●●●●● Pioneer



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LABS TEST

Clear call

Make muddled messages a problem of the past with a dedicated USB streaming microphone. **Edward Chester** puts eight of the latest models to the test

How we test

USB microphones aimed squarely at the burgeoning game streaming market are the latest must-have accessories for gamers and gaming peripheral makers alike. In just the past year or two we've seen all the big players in gaming peripherals introduce quality desktop microphones, while several stalwarts of the microphone industry have embraced the home-recording and streaming trend too.

To test these microphones we first assessed the build quality, design and physical features. Given their premium price tags, most are solidly built units but some are better than others, while ease of use of the included stands and pivot mounts varies wildly. All the models on test provide a USB interface, but some use older USB connections while some have embraced the latest USB Type-C standard.

Several microphones also include headphone amps, which provide audio output from your PC as well as real-time monitoring of the microphone, which makes managing your audio setup much easier.

The biggest physical differentiator between the microphones, though, is their choice of pickup patterns. This is the 2D pattern of the directions from which the microphone can detect sound. The

most common pattern for microphones is known as cardioid, which provides a relatively uniform response for the whole front of the microphone, which then tails off towards the sides and back.

However, by using multiple condenser capsules (the physical parts that detect the sound), several of these microphones offer other patterns that are useful for different recording scenarios. For instance, a bidirectional pattern biases listening to the front and back but blocks side noise, which can be ideal for recording interviews, and a stereo pattern is great for picking up the ambience of a room.

For our sound quality tests, we set up each microphone a fixed distance from a hi-fi speaker and recorded the same section of audio through each microphone, ensuring the gain (volume) of each microphone was as close to the same level as possible. Throughout the recording, we made noise behind the microphone and moved the microphone around the room to test the pickup pattern response.

We also performed a spoken word recording, checking for how clear the microphone sounded when recording a voice and how well it coped with plosives, wind and other noises that can disturb the presentation of your voice.

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BLUE YETI / £110 inc VAT

SUPPLIER amazon.co.uk

The Blue Yeti is a hugely popular USB microphone that's been around for years and has become something of a standard option for podcasters and streamers alike, thanks to its audio quality, versatility and reasonable price. Is it really worthy of its popularity though?

The single most striking aspect of this microphone is its size. Both the microphone itself and its included stand are huge, with the mic being about the size of a 500ml can of drink and weighing half a kilo, while the solid metal stand weighs in at 1kg.

Yet despite this size, there's no height adjustment for the stand, and while the microphone does stand much taller than the other microphones on test (27cm for address position), you'll still need two or three pre-2000s-style phone books to get it up to mouth height.

You can of course direct the microphone towards your mouth via its sturdy pivot mount, or mount the mic on another stand. However, unlike the likes of the Elgato Wave 1 and 3 and the Shure MV7, the mounting point isn't on the base of the pivot arm but on the microphone

itself, so the base/mounting system is totally redundant if you use another stand.

Meanwhile, on the underside of the microphone are its ports, which consist of a mini-USB – yes, mini-USB in this day and age – and a 3.5mm headphone socket. If you move up to the £210 Blue Yeti Pro, you'll get an XLR output while the newer £155 Yeti X moves up to a new-fangled micro-USB output.

Around the body are four controls, with two on the front and two on the back. Up front you'll find the headphone monitoring volume and microphone mute buttons, while around the back are the mic gain level and pickup pattern selector, the latter of which brings us onto the real selling point of this microphone, especially at this price.

Inside the Yeti are three condenser capsules that can be combined to provide four different pickup patterns. As well as the standard cardioid pattern, you can select a bidirectional output, where the microphone essentially picks up what's directly in front and behind it, which is ideal for interview type situations. The omnidirectional pattern opens up the microphone to picking up every sound around it, while stereo does what it suggests, picking up a stereo image rather than the mono output of the other modes – ideal for picking up the ambience of a room.

Few of these extra pickup patterns are likely to be all that useful for game streaming and home recording, but they greatly increase the versatility of this microphone. Where the Yeti suffers a little is in its sampling and bit rate. Unlike the Yeti Pro that's rated to 24-bit and 192kHz, the vanilla Yeti is limited to 16-bit at

48kHz. That's still above CD-quality audio, and it's ample for most home purposes, but will limit its use in more demanding applications.

In our tests it performed superbly, though, providing very clear, full-sounding recordings with each of the pickup patterns clearly delivering on exactly their promises.

Conclusion

The lack of XLR output and limited bit and sample rates make this mic less impressive on paper, but in practice it well and truly delivers the goods sonically. Considering its price, that makes it a real bargain. It's very large, though, so if you don't need the extra pickup patterns, we'd suggest a more compact option.

VERDICT

A bit of a bruiser, but the versatile Yeti sounds great and has a fair price.



SPEC

Dimensions (mm) 120 x 125 x 295 (W x D x H)

Weight 1.55kg (1kg stand, 550g mic)

Sample rate 48kHz

Bit rate 16-bit

Capsules 3 x Blue 14mm condenser capsules

Pickup patterns Cardioid, bidirectional, omnidirectional, stereo

Frequency response 20Hz–20kHz

Sensitivity Not stated

Max SPL 120dB

Interface Mini-USB

Extras Headphone amp with 3.5mm output, gain and pickup pattern controls

SNOWMAN

- + Great sound quality
- + Multiple pickup patterns
- + Great value

ABOMINABLE

- Very large
- Only 16-bit output
- Mini-USB!

DESIGN
12/20
SOUND QUALITY
34/40

FEATURES
18/20
VALUE
18/20

OVERALL SCORE
82%

ELGATO WAVE 1 / £100 inc VAT

SUPPLIER scan.co.uk

Since its purchase by Corsair a few years ago, Elgato has been cementing its place as one of the most popular game streaming peripheral makers, with a line-up of video capture devices, a just-launched webcam, lights, control decks and – as of last year – USB microphones. The company offers two variants of its Wave microphones, both of which we're reviewing in this group test.

The Wave 1 is the cheaper option and comes with a reduced feature set, but its lower price doesn't mean any drop in build quality. The mic itself has a tough metal mesh cover, with a sturdy and elegant body that's made of a mix of metal and plastic. The included stand is a solid metal affair too, with knurled metal knobs providing tilt tension adjustment.

MICROWAVE

- + Stylish, compact design
- + Versatile with compatible extras
- + Solid audio quality

MICROWAHVEY

- Basic feature set
- Middling value
- Lacks bass in recordings

SPEC

Dimensions (mm) 66 x 40 x 141 (W x D x H)

Weight 555g (310g stand, 245g mic)

Sample rate 48kHz

Bit rate 24-bit

Capsules 1 x condenser capsule

Pickup patterns Cardioid

Frequency response 70Hz–20kHz

Sensitivity -25dBFS

Max SPL 120dB

Interface USB Type-C

Extras Headphone amp with 3.5mm output, headphone volume and mic mute control

It's an elegant-looking and compact device, making for a smart and unobtrusive addition to any desktop. The included stand is relatively short, though, with the address portion of the mic (the middle of the grille with the Elgato logo) reaching to just 16.5cm. There's also no built-in vibration reduction or wind reduction (as with most of the mics on test), other than the metal grille.

However, Elgato offers a compatible boom arm, pop filter and anti-vibration mount, the latter two of which make for a notably very compact setup, compared with the mess of elastic and bendable arms that can result from using third-party pop shields and vibration mounts – an issue that's also demonstrated by the Trust GXT 241 Velica. The base of the stand unscrews, and an adaptor can be attached to fit the mic to standard 1/4in and 3/8in mounting points.

In terms of connections, you get a USB Type-C port and 3.5mm headphone socket, which as about all you'd expect at this price. There's also just a single dial on the front for controlling the headphone volume, and it will also mute the mic when it's pressed, with the ring of white light around the dial turning red when it's muted.

The microphone itself (made by Lewitt audio) offers a relatively basic feature set. It uses a single capsule to deliver a single cardioid pickup pattern, so you don't get the versatility of setup of some of the other mics on test. Its sample rate of 48kHz and maximum bit depth of 24-bit are entirely adequate though.

In our tests, the Wave 1 provided excellent clarity, although it lacked a little bass. That's generally preferable when it comes to streaming voice recording, but it reduces the mic's appeal for broader recording uses.

Meanwhile, one of best aspects of Elgato's extensive streaming peripherals selection is its excellent integrated software, which



makes it very easy to control all its many products. Its Wave Link software, for instance, makes it really easy to manage all the audio inputs on your machine (microphone, game audio, stream audio) and link them up with the buttons on its Stream Deck, for instance. It's not the most open platform for use with other products but it's a slick system if you stick to Elgato.

Conclusion

The Wave 1 appears to offer relatively poor value compared with the far more feature-rich Roccat Torch and Blue Yeti. However, it offers excellent quality audio for voice, and it does so in an impressively stylish and compact package. If you're only after a mic for basic streaming and self-recording purposes, it's more than up to the task.

VERDICT

A simple feature set and middling price, but it does its job well.

DESIGN
18/20
SOUND QUALITY
30/40

FEATURES
12/20
VALUE
16/20

OVERALL SCORE
76%

ELGATO WAVE 3 / £130 inc VAT

SUPPLIER currys.com

Elgato has made the Wave 1 and Wave 3 so similar and priced them so closely that they could potentially confuse buyers (or maybe it's all about the upsell). The two microphones look almost identical and have almost identical hardware, with only a £20 price difference between them too, but thankfully digging a little deeper quickly reveals what sets them apart.

The Wave 3 adds two key features over and above the Wave 1. Firstly, its interface can sample at up to 96kHz rather than the 48kHz limit of the Wave 1, and as upgrades go, that's about as minor as you can get for a mic that's as focused on streaming as these models.

While it's a good-quality microphone, the entire use case of the Wave range is to get decent audio for live streaming or uploading to YouTube. Occasionally, they might be used for recording voice overs or for simple 'guitar and voice' music setups.

Those sorts of use simply don't benefit from the higher sampling rate in the vast majority of cases. All that said, it's a feature that might be useful if you start getting into more sophisticated mixing and recording setups.

SPEC

Dimensions (mm) 66 x 40 153 (W x D x H)

Weight 585g (305g stand, 280g mic)

Sample rate 96kHz

Bit rate 24-bit

Capsules 1x condenser capsule

Pickup patterns Cardioid

Frequency response 70Hz–20kHz

Sensitivity -25dBFS

Max SPL 120dB

Interface USB Type-C

Extras Headphone amp with 3.5mm output, multi-function control dial, capacitive mute button

The other features are more useful and tangible, with the Wave 3 including a capacitive touch-sensitive pad on its top to mute the microphone and a dial on the front that's more versatile than that on the Wave 1. Tap it and the dial cycles through controlling the microphone gain, headphone monitoring level, and a blending feature for panning between mic monitoring and PC output audio levels.

Turn the dial and it will adjust each setting up and down, while a row of eight lights above the dial indicate the level of each option as you go. A ring of light around the dial again glows white when the microphone is on and red when it's muted.

Nearly every other aspect of the Wave 3 is the same as the Wave 1, except it's slightly taller in order to accommodate those extra physical features. You get the same single mic pickup pattern (cardioid), frequency response, sensitivity rating and bit rate. In other words, there's not much here that really makes the Wave 3 feel like a significant upgrade over the Wave 1, such as extra pickup patterns or an XLR output, but that's why the price difference is only £20.

One very slight advantage of the larger Wave 3 is that the address position sits a little higher, although by under 1cm. Like the Wave 1 and most of the other mics on test, in the long term, you may want to invest in a movable boom arm, along with a pop shield and anti-shock mount. The latter would be more beneficial for these desktop mounts than the boom arms with which they're often used, as any knock of your desk will travel straight up through the rigid stands.

RIDE THE WAVE

- + Extra functions are useful
- + Compact design
- + Solid sound quality

RIDE THE TUBE

- 96kHz sample rate unnecessary
- Not amazing overall value



In our testing, the Wave 3 did indeed sound identical to the Wave 1, with the same slightly less prominent bass pickup than some of the other mics but still a generally pleasing, clear sound that lends itself very well to voice recording.

Conclusion

The extra features of the Elgato Wave 3 over the Wave 1 aren't essential for most buyers. The higher sample rate is almost entirely unnecessary, but the extra mix/monitoring controls on the mic are certainly more convenient than using software. For an extra £20, it's an easy upsell, although neither Wave feels like outstanding value.

VERDICT

Slightly more versatile than its cheaper sibling and just as compact and convenient.

DESIGN
18/20
SOUND QUALITY
30/40

FEATURES
14/20
VALUE
14/20

OVERALL SCORE
76%



EPOS B20 / £180 inc VAT

SUPPLIER epos.com

single-sided mounting arm. However, it's rather a case of style over substance, as there are some usability issues with the stand.

For a start, assembling it is just a bit awkward, thanks to the way the metal ring base attaches to the arm with a single large bolt. Unlike the bases on many monitor stands, which slightly lock into place, so you don't have to support the base while you're screwing in the bolts, here the base just falls off unless you hold it in place, making it fiddly to screw the bolt into place.

That same bolt hole is a standard 3/8in one for use with other stands, but EPOS doesn't make its own stand nor a compatible pop shield, so you'll have to search out for third-party ones that work.

It's also odd that there isn't enough clearance for the USB Type-C cable between the microphone and the base, so it gets bent as you swing the B20 into a vertical position. It's the sort of oversight we wouldn't expect from a product that costs £180.

The final oddity with the stand is that the single-arm swing mount point is very stiff. Depending on your setup, and whether you need to easily change the angle of the microphone, this could be a problem.

More successful are the four controls that again mirror those of the Blue Yeti, with headphone volume and mute on the front, and gain and the pickup pattern selection on the back. A light above the mute button glows white in normal use and red when the microphone is muted. Meanwhile, the underside of the microphone is home to the USB Type-C port and headphone jack.

Thankfully, when it comes to sound quality, the B20 impresses. Like the Yeti, it produces a very full, clear sound that has slightly more depth than the two Wave microphones, but with plenty of clarity up top. The different pickup patterns also do just what they suggest, making this a very versatile microphone that

EPOCH

- + Great sound quality
- + Multiple pickup patterns
- + USB Type-C connection

APOCRYPHAL

- Odd stand design
- Expensive

can be used for voice, music, podcasting and interview recording.

Using the EPOS Gaming Suite app that's also compatible with the company's headsets, you can apply virtual surround sound to the headphone output, as well as adjust EQ, add a noise gate, add noise cancellation, and adjust gain and side tone (the amount of microphone input fed through to the headphone output). The software suite isn't particularly comprehensive, but it adds a few extras to make the B20 more than just a basic hardware unit.

Conclusion

The EPOS B20 is a very capable microphone that produces excellent sound quality across a variety of different pickup patterns. It's also more compact than the similarly capable Blue Yeti and uses a more up to date USB Type-C connection.

However, it's also not far off twice the price of the Yeti without delivering any meaningful extra performance, and its stand/mount system needs improvement.

VERDICT

A versatile and great-sounding microphone but it's quite pricey.

DESIGN 14/20	FEATURES 18/20	OVERALL SCORE 76%
SOUND QUALITY 34/40	VALUE 10/20	

Like the Blue Yeti, the EPOS B20 is a considerably more versatile option than most of the other microphones on test. By incorporating three condenser microphone capsules, it can produce four different pickup patterns, making it useful for a variety of recording applications. The patterns on offer are the same selection of cardioid, bidirectional, omnidirectional and stereo as found on the Yeti.

This versatility is rather belied by the design of the B20. It's a markedly more purposefully stylish option than the other microphones on test, with its uniform cylindrical design and

SPEC

Dimensions (mm) 180 x 104 x 275 (W x D x H)

Weight 502g (118g stand, 384g mic)

Sample rate 48kHz

Bit rate 24-bit

Capsules 3 x condenser capsules

Pickup patterns Cardioid, bidirectional, omnidirectional, stereo

Frequency response 50Hz–20kHz

Sensitivity –37dBFS

Max SPL 120dB

Interface USB Type-C

Controls Gain, volume, pickup pattern, mute

Extras Headphone amp with 3.5mm output

RAZER SEIREN MINI / £40 inc VAT

SUPPLIER currys.co.uk

As its super-low price would suggest, the Razer Seiren Mini is by far the most basic microphone on test this month. As such, it won't surprise you to find out that it lacks any physical controls and has a modest spec sheet, but it's still likely to be an adequate streaming option for many gamers' needs.

Its name gives the game away when it comes to the size of Razer's microphone. The whole unit measures just 16cm tall, with an address position of around 14cm. The stand also offers only a modicum of tilt of around ten degrees, so you might struggle to get the microphone facing directly up at your mouth without the aid of a few tomes to bump up the height. You can, however, remove the basic stand and use the 5/8in thread to attach it to a 3rd-party stand.

HONESTY

- + Decent sound quality
- + Stylish, compact design
- + Very low price

DECEPTION

- No built-in controls
- Very basic stand
- Supercardioid pattern has limited use

SPEC

Dimensions (mm) 56 x 89 x 163 (W x D x H)

Weight 272g

Sample rate 48kHz

Bit rate 16-bit

Capsules 1 x 14mm condenser capsule

Pickup patterns Supercardioid

Frequency response 70Hz–20kHz

Sensitivity -17.8dBFS

Max SPL 110dB

Interface USB (tethered cable)

Extras Headphone amp with 3.5mm output, headphone volume and mic mute control

While you miss out on physical controls, there's a light on the front for indicating that the microphone is on, and there's also a micro-USB port on the back for connecting it to your PC. Unlike all the models on test except the Trust GXT 241 Velica, the Razer doesn't include a headphone output, so you don't get live monitoring and you'll have to rely on your computer's existing sound devices to hear what's going on.

As you'd expect for such a compact and low-priced microphone, the Razer also only includes a single condenser capsule, which produces a single pickup pattern. However, in this case, it's a supercardioid pattern rather than regular cardioid. This pattern reduces side noise from being picked up even more than a regular cardioid pattern, but it also introduces more noise from behind the mic.

The assumption is that the only hardware that will be located behind your microphone is your PC's monitor, so it's unlikely to contribute much noise. In our tests the Seiren Mini did indeed have a slightly narrower pickup range, and it also picked up noise to the rear more than the other microphones on test. Ultimately, the pattern that's likely to be more beneficial to you will depend on your setup and usage.

On paper, the Seiren Mini has what might appear to be modest specs, such as its 16-bit/48kHz sample rate, but this spec also matches the Shure MV7, for instance, which shows that these numbers aren't always reliable indicators of performance. In our tests the Razer sounded reasonably clear and full, but it noticeably didn't sound as crisp or spacious as the more expensive microphones on test.

Razer claims there's a built-in shock mount, but this didn't seem to offer the sort of reduction in desk-knocking noises that we'd expect. Only the Trust GTX 241 Velica offers a true anti-vibration mount



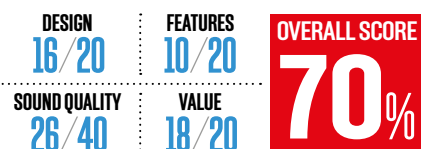
in this test, though, so the Razer is hardly alone in benefiting from a third-party mounting system.

Conclusion

The Razer Seiren Mini is a basic USB mic that lacks the hardware controls that can make controlling a streaming or recording setup so much easier. However, its sound quality is a huge step up from any headset microphone and it does so for a very reasonable price. You'll want to upgrade it with a better stand almost immediately, but it makes for an affordable starting point for your audio setup.

VERDICT

Very basic, but it's priced to match and its sound quality is up to the job of streaming.



ROCCAT TORCH / £90 inc VAT

SUPPLIER roccat.com

The Roccat Torch is easily the most peculiar microphone in this group test – yes, even compared with the gangly-looking Trust GTX 241 Velica. The oddness stems from Roccat's decision to mount all the device's extra features – of which there are many – on its base rather than the microphone itself. As a result, an extra cable is required to run from the microphone to the base, and then a second cable runs from the base to your PC.

This arrangement works perfectly well in and of itself, other than creating a bit of extra cable clutter, but it has one glaring issue – if you want to mount the microphone on any stand other than its default base, you lose all the extra features in the base, because the 3/8in mounting screw for attaching the microphone to another stand is on the underside of the microphone, not the base. You can use the provided longer USB cable to run between them, but it's an awkward workaround.

That's a shame, as the feature set here is great. Around the back of the base there's a headphone jack for PC output and microphone

monitoring, a mode selector for adjusting the sensitivity of the 'no touch' motion-sensing mute button and a brightness control for the RGB lighting. The mute button is an intriguing addition. It works reasonably well, although it takes a while to get used to the slight delay in response and lack of tactile feedback.

Around the front you'll find a dial for switching between three different pickups patterns (created by the Torch's two capsules), adjusting headphone volume, muting the microphone and adjusting gain. Finishing off the features list is a little display at the front for indicating various feature states.

The Torch is also the only model on test to include meaningful RGB lighting, with a backlit Roccat logo in the centre and further lighting hidden behind the edges of the metal grille. Whether you love or loathe RGB lighting, at least it serves a genuinely useful purpose on the Torch, with the side lights indicating the volume of your voice. The lights are also compatible with Roccat's AIMO lighting control software.

The Torch's two capsules provide three pickup patterns, consisting of stereo, cardioid and a proprietary option called Whisper. The latter is just a gain boosting pattern that will be a little better at picking up your quieter musings than a standard pattern.

When it comes to overall sound quality, the Torch didn't quite match up to the more expensive options on test, with just a touch less spaciousness and crispness. However, it's still more than up to the job of game streaming, and the addition of a stereo mode makes it useful for a wide range of applications.

TORCH

- + Packed with features
- + Multiple pickup patterns
- + Decent sound quality
- + Great value

TORCHED

- Strange wiring setup
- Sound quality can't match pricier mics



Conclusion

The Roccat Torch is an impressively versatile microphone for a surprisingly low price. To get multiple pickup patterns, a host of controls, RGB lighting effects and even a whizzy 'no touch' mute button is excellent value for £90, especially as sound quality is decent too.

It can't quite compete with pricier options in terms of sheer clarity, but its quality will be sufficient for most gamers. The only problem is the bizarre wiring arrangement – it works if you're strictly using this mic with this stand, but it's a slightly strange setup.

VERDICT

A great-value, versatile microphone, although it has a bizarre wiring setup.

DESIGN 14/20	FEATURES 18/20	OVERALL SCORE 82%
SOUND QUALITY 30/40	VALUE 20/20	

SPEC

Dimensions (mm) 138 x 95 x 208 (W x D x H)

Weight 510g (215g stand, 295g mic)

Sample rate 48kHz

Bit rate 24-bit

Capsules 2 x condenser capsules

Pickup patterns Cardioid, stereo, Whisper (Roccat proprietary)

Frequency response 20Hz–20kHz

Sensitivity -25dBFS

Max SPL 110dB

Interface USB Type-C

Extras Base with volume, mute, mic gain and pickup pattern controls

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SHURE MV7 PODCAST KIT WITH MINI TRIPOD / £220 inc VAT

SUPPLIER scan.co.uk

Shure is the most recognisable maker of microphones in the world, with its SM57 and SM58 being the two most popular microphones in the whole performance and recording industry. The MV7, then, is the closest the company gets to the more convenience-orientated world of home recording thanks to its included USB connection.

Available in four different configurations, you can get the MV7 on its own with a small tripod, a boom arm or the mini tripod that we're looking at here. The tripod is made by Manfrotto – of photographic tripod fame – and is very well put together. There's nothing more to it than a mounting screw and its foldout feet, but it's very solid and the legs are surprisingly stable. The legs' inherent slight flexibility also means they take the edge off desk vibrations being transmitted to the microphone, compared with big, flat, solid-stand bases.

The microphone itself is a big unit that's quite distinct from most of the others on test. Instead of being addressed from the side, you talk straight at its foam-covered end. As such, despite it sitting high on its stand and high-

quality Y pivot mount, its address position isn't much higher than the likes of the Blue Yeti. With the MV7 at a 45-degree angle, its front sits at a height of 30cm.

The foam sock does an excellent job of reducing plosives and wind noise, immediately elevating the MV7 over all the others on test for close-up, more intimate styles of voice recording. The desktop mounting position of these microphones reduces the need for pop shields and wind protection, but they're essential once mounted on a boom arm and held close to you. You can easily slide off the foam and replace it.

Running around the top half of the centre is the MV7's cluster of touch controls. They work well enough, but physical controls would be preferable here. There's a mute button to the left (with the microphone facing you), and on the right is a button for switching between headphone volume and gain control. In between them is a row of eight lights with a touch-sensitive strip that you use for adjusting the headphone volume and gain.

Meanwhile, at the back of the MV7 is where you really start to see the professional recording pedigree of Shure, with the inclusion of an XLR analogue output alongside the micro-USB PC connection. There's also a headphone jack for monitoring.

Less premium is the inclusion of a single capsule for producing this microphone's single cardioid pickup pattern. However, Shure's software (that annoyingly requires an email sign-up to download) lets you set near and far mic positions to help optimise the pickup. You can also change the tone (dark, natural or bright), adjust the gain and monitor mix, change the EQ and add a compressor. It's a very useful selection of features.

As for sound quality, it comes as no surprise that the MV7 tops our charts for overall clarity and range, making for a much more lifelike,



SURE, GO ON THEN

- + Class-leading sound quality
- + Great overall feature set
- + Integrated foam windshield
- + XLR output makes it versatile

YOU SURE?

- Expensive
- Micro-USB connection
- Single pickup pattern

engaging presentation than the other models. This is despite the MV7 only sporting a modest 16-bit/48kHz sample rate on paper.

Conclusion

If you can afford it, the MV7 is our top choice for pure sound quality. It also has easy-to-use controls and the versatility that comes with an industry standard XLR output. However, it's arguably overkill if you only want to stream games and lacks extra pickup patterns.

VERDICT

Fantastic sound quality and a professional-grade feel, but you have to pay for it.

SPEC

Dimensions (mm) 153 x 90 x 164 (W x D x H)

Weight 753g (198g stand, 555g mic)

Sample rate 48kHz

Bit rate 16-bit

Capsules 1x condenser capsule

Pickup patterns Cardioid

Frequency response 20Hz–20kHz

Sensitivity -55dBFS

Max SPL 132dB

Interface Micro-USB, XLR

Extras Headphone amp with 3.5mm output, windshield

DESIGN 16/20	FEATURES 16/20	OVERALL SCORE 84%
SOUND QUALITY 38/40	VALUE 14/20	

TRUST GXT 241 VELICA / £50 inc VAT

SUPPLIER amazon.co.uk

If you were to envisage an affordable alternative to the other big-brand USB microphones featured in this group test, we bet you'd never imagine the peculiar setup of the GXT 241 Velica by Trust. This little kit comes complete with a pop shield, anti-vibration mount and mini tripod. Meanwhile, the impressively well-built metal mic itself is a front-address unit that's the size of a classic highlighter / marker pen.

If you're familiar with microphones, you might wonder if the microphone is shaped this way because the GTX 241 Velica uses a shotgun pickup pattern (where it only picks up sounds directly in line with it), but it does just use a standard cardioid pattern.

Instead, the overall setup here is one that would certainly lend itself to podcasting on

the move, as the whole setup packs down to a very small package. The tripod legs fold up, the pop shield can be removed and the mic slides out from its shock mount. It's actually a bit of a shame Trust didn't go the whole hog and include a carry case.

The downside to this setup is that the GXT 241 sits fairly low, with an address position of just 17cm when set at 45 degrees.

Many users will be better off unscrewing the tripod and using the 5/8in mounting screw to fix the rest of the setup to a boom arm instead.

The addition of the pop shield and shock mount really can't be overstated though. It immediately makes the Trust GXT 241 Velica the most complete setup on test when it comes to cutting out the worst irritating noises on your stream or recordings. The included setup will also work for quite a few other mics too, as long as they're not much wider than the 19mm diameter of this model, making for a potential upgrade path in the future.

Outside of the mounted features, this microphone is fairly basic. It has just a USB Type-C port, a mute button and an indicator light at the rear – that's your lot. As such, you'll have to adjust gain and manage any monitoring via third-party software. Sadly, Trust doesn't make a custom driver with any adjustable settings outside of standard Windows options.

Not surprisingly for the price, the Trust also has modest sound quality specs, with a single capsule producing its cardioid pickup pattern. It has a 16-bit / 48kHz sample rate, and its top frequency response figure is the only one to drop below 20kHz.

Consequently, sound quality is a step down from the more expensive microphones on test. There's a slightly boxy, compressed



quality that sucks a little of the life from recordings. There's still plenty of frequency range here – far more than any headset microphone, for example – but paying more for a microphone does get you that extra clarity. Notably, the pickup pattern does a better job than most patterns of ignoring noises to the rear of the microphone though.

Conclusion

The Trust GXT 241 Velica is a great option for those seeking a complete microphone setup for very little money. All the others on test will require extra money for pop shields and shock mounts to reach the noise-suppressing prowess provided here. However, its raw sound quality isn't that impressive, lacking clarity compared with the best on test. **GPC**

VERDICT

Great value for a full mic setup that eliminates shock and plosives, but the mic itself is pretty basic.

DESIGN
12/20

SOUND QUALITY
26/40

FEATURES
18/20

VALUE
20/20

OVERALL SCORE
76%

TRUST FUND

- + Great value
- + Useful pop shield and shock mount
- + Very compact

TRUST ISSUES

- Middling sound quality
- Basic features on mic
- No control software

SPEC

Dimensions (mm) 200 x 150 x 250 (W x D x H)

Weight 320g (184g stand, 136g mic)

Sample rate 48kHz

Bit rate 16-bit

Capsules 1x condenser capsule

Pickup patterns Cardioid

Frequency response 30Hz–18kHz

Sensitivity -36dBFS

Max SPL 130dB

Interface USB Type-C

Extras Headphone amp with 3.5mm output, windshield

A low profile

Antony Leather tests five CPU coolers that can squeeze into a tight space

How we test

We're testing a bunch of low-profile air coolers this month, which retail for between £30 and £70. We've tested them on both AMD and Intel CPU sockets, as different mounting mechanisms can affect cooling performance.

As low-profile coolers have limited cooling headroom compared with their tower heatsink counterparts, we've stepped down to 6-core CPUs in this month's Labs test, as several of the smaller heatsinks would never stand a hope of dealing with CPUs such as the toasty Core i9-11900K.

As a result, we've opted for the Core i5-11600K and AMD's Ryzen 5 5600X, which are far easier to cool than their higher-end counterparts in the kind of small systems in which these coolers would be used. We've overclocked the Core i5-11600K to 4.8GHz using a 1.35V vcore, and pushed the Ryzen 5 5600X up to 4.6GHz with a 1.25V vcore, though, so we're still packing a punch when it comes to performance and heat loads. We used an MSI MEG Z590 Ace motherboard for Intel LGA1200 testing and an MSI MEG X570

Unify for AMD AM4 testing, along with 16GB of Corsair Vengeance RGB Pro memory.

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

We use CoreTemp to measure the CPU temperature, before subtracting the ambient air temperature from this to give a delta T result. This method allows 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 reading after ten minutes.

For the Intel system, we take an average reading across all eight cores to iron out any hot spots that might be misleading. AMD CPUs only list a single temperature reading rather than doing so per-core, so we list what's reported in CoreTemp. We finally calculate scores based on cooling performance, noise, features, ease of installation and value, with a weighted calculation providing an overall score.

Contents

- be quiet! Dark Rock TF 2 / p51
- Noctua NH-L12S / p54
- Cryorig C7 / p52
- Rajjintek Pallas 120 RGB / p55
- Jonsbo CR-701 / p53

BE QUIET! DARK ROCK TF 2 / £70 inc VAT

SUPPLIER aquatuning.co.uk

As it's the most expensive cooler on test by a long way, the be quiet! Dark Rock TF 2 has to live up to some serious expectations and the company's usual build quality is certainly evident. The Dark Rock TF 2 is beautifully made and looks like it means business, although it's also rather large. Measuring a full 134mm tall, it's only a little shorter than many full-sized tower heatsinks, but this slightly shorter height still allows it to sit in many cases with limited cooler height restrictions.

It makes the most of the extra heatsink volume as well – not only are there two layers of heatsinks in this cooler, but there are two large 135mm fans too. When combined, these fans shift a substantial amount of air, although they're also a tad loud when they're running at full speed.

The cooling system is fed by six 6mm heatpipes that sit among the black-coated heatsinks, with the fans pointing towards your motherboard for the added benefit of creating more airflow over your VRMs than usual as well. However, it does spread out horizontally – you'll need to make sure your motherboard can accommodate it.

You get a tube of thermal paste included in the box and be quiet! is good enough to include a fan splitter cable as well, allowing you to power both fans from a single fan header on your motherboard. The company is also pretty confident in its cooling abilities here, as it lists the cooler as being compatible with Intel's LGA2066 socket, with a claimed 230W TDP cooling capacity.

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3+

Heatsink size with fans (mm) 163 x 140 x 134 (W x D x H)

Fans 2 x 135mm

Stated noise 27dBA

Installation is rather fiddly, though, with you having to contend with a mound of screws, pins, backplates and yet more pins, so you'll need to pay careful attention to the instructions to make sure you don't miss a step. Don't be tempted to wing it when you're fitting this cooler, and make sure you have a long screwdriver too, in order to reach through the gaps in the heatsink to access the mounting screws.

Installation is a little easier on AMD sockets than Intel ones, thanks to the cooler making use of the stock AMD backplate found on motherboards, but you'll need to build and then fit the included backplate if you're fitting the cooler to an Intel socket.

Thankfully, cooling is superb, with the Dark Rock TF 2 keeping our overclocked Core i5-11600K at a delta T of 54°C – this result was well below every other cooler on test; even the Noctua NH-L12S could only manage 59°C. In our AMD system, it was similarly impressive, again hitting the top spot this month, although this time its result was only 3°C cooler than that of the Noctua cooler, despite the be quiet! having a much higher price tag.

Conclusion

If you have a case with a lower than usual height (below the usual 160mm you'll see with most models), the be quiet! Dark Rock TF 2 is perfect if you need to maximise

BEE QUIET

- + Excellent cooling
- + Reasonably quiet
- + Looks good

THE BIG BAD I SAID NO



- Potential compatibility issues
- Comparatively tall
- Installation involves a lot of parts



cooling and don't want to use an all-in-one liquid cooler. It's a little fiddly to fit, and some mini-ITX motherboards may struggle with its size, but it's the most potent cooler you'll find with room to spare below 140mm and it's reasonably quiet too. It also looks fantastic and will have no trouble dealing with overclocked CPUs that are more powerful than the ones we used here.

VERDICT

Fantastic cooling on both Intel and AMD sockets, but it's on the large side and demands a premium.

LGA1200			
COOLING 39/40	FEATURES 17/20	OVERALL SCORE 89%	
DESIGN 18/20	VALUE 15/20		
		FITTING Medium	
AM4			
COOLING 38/40	FEATURES 17/20	OVERALL SCORE 88%	
DESIGN 18/20	VALUE 15/20		
		FITTING Medium	



CRYORIG C7 / £30 inc VAT

SUPPLIER overclockers.co.uk

to 2,500rpm, so the Cryorig C7 is easily the loudest cooler on test this month, although the fan speed drops back quickly if your CPU isn't under full load.

Sensibly, Cryorig also includes a socket wrench to secure the nuts when you're mounting the C7, which is more than can be said for the Jonsbo CR-701, which comes with a spanner. The Cryorig's fan and Intel mounting pins also come pre-installed, which is handy, but the installation process isn't without its issues.

Securing the nuts from around the back of the motherboard proved troublesome, and they were incredibly hard to slot through the backplate that Cryorig provides for installation on AMD motherboards. It's a tricky mounting process, with you having to support the cooler from one side while trying to secure the nuts from the back.

The instructions also aren't particularly clear either, and while the C7 comes set up for Intel sockets out of the box, switching to AMD mounts requires you to pay careful attention to the manual, and for you to take ten minutes swapping parts around on the cooler. You'll also want to make sure your fingers stay well clear of the fan when it's running, as it's quite exposed.

The big question, of course, is how this short cooler actually performs. Sadly, even with the fan running at full speed and seemingly shifting a reasonable amount of air, the heat load from our overclocked Core i5-11600K was nearly too much for it. Our CPU didn't quite throttle, but with the CPU temperature hitting 100°C (making for a delta T of 73°C), it's right on the line.

That said, if you put it on a Core i5-11600K running at stock speed in less demanding loads than our torturous Prime95 smallest

FFT stress test, the Cryorig would probably be fine. The cheaper and larger Jonsbo CR-701 was better here, knocking 5°C off the temperature. The Cryorig was only just about able to tame our Ryzen 5 5600X too, with a delta T of 64°C, with the Jonsbo CR-701 managing a much lower temperature of 57°C here.

Conclusion

A stock speed 6-core CPU with momentary high-load stress would be within reach of the Cryorig C7, but its tiny size and limited airflow mean it's not able to deal with any CPU setup that's more potent, especially under sustained heavy loads. However, while the C7 didn't fail on either of our sockets, its tricky mounting mechanism and exposed fan mean it's still a questionable recommendation.

VERDICT

Extremely compact and keenly priced, but the C7 only just made it through our stress tests.

If you need an extremely low-profile cooler, perhaps for a build in a slimline desktop case, then you'll likely want a design that ends up looking short even when it's sat next to your memory modules. If that's you, then you may well find yourself drawn to the Cryorig C7.

This cooler's diminutive height of just 47mm means it will fit into spaces that simply aren't accessible to most of the other coolers on test this month. Not only that, but with a price of just £30 inc VAT, it looks like it offers remarkably good value, especially given its chunky, dense design that manages to cram four 6mm heatpipes into the unit.

What's more, it's also designed to sit within the confines of any small motherboard, sporting only a 92mm fan that won't spread across the board and clash with multiple components. This fan spins at up

CRY OF JOY

- + Very low-profile
- + Four 6mm heatpipes
- + No motherboard compatibility issues

CRY OF DESPAIR

- Noisy at full speed
- Tricky mounting mechanism
- Limited cooling potential

SPEC

Intel compatibility LGA115x, LGA1200

AMD compatibility Socket AM4, AM3+

Heatsink size with fans (mm) 97 x 97 x 47 (W x D x H)

Fans 1 x 92mm

Stated noise 30dBA

LGA1200			
COOLING	21/40	FEATURES	15/20
DESIGN	12/20	VALUE	15/20
OVERALL SCORE			
63%			
FITTING Medium			

AM4			
COOLING	22/40	FEATURES	15/20
DESIGN	12/20	VALUE	15/20
OVERALL SCORE			
64%			
FITTING Hard			

JONSBO CR-701 / £27 inc VAT

SUPPLIER overclockers.co.uk

We were a bit irritated that you can't control the RGB lighting on the Jonsbo CR-701 – it's great to see RGB lighting on a sub-£30 cooler, but you'll have to make do with a continuous cycling of colours if you install it in your PC. To be fair, the continuous rainbow effect isn't unpleasant and actually looks quite snazzy.

The Jonsbo CR-701 feels well made too. It has five 6mm heatpipes making direct contact with your CPU, which is one more than the Cryorig C7 that retails for £3 more. The Jonsbo also has a 120mm fan compared with the C7's diminutive 92mm fan, but the latter cooler is much shorter, with its height of just 47mm, compared with 125mm for the CR-701.

The Jonsbo is also quite large in the area near the CPU socket, and will need some careful jiggling and adjustment to clear VRM heatsinks and memory modules, if that's even possible on your setup – we recommend taking some measurements first. The CR-701 only just cleared the heatsinks on our MSI MEG Z590 Ace motherboard by the skin of its teeth. It also blocked the first DIMM slot, although standard dual-channel setups with two modules won't be restricted in terms of memory module height.

The Raijintek Pallas RGB is the closest model on test in terms of price and size, sitting around 5mm taller than the CR-701 and also sporting RGB lighting. Neither cooler had a particularly friendly mounting mechanism, and the washers provided by Jonsbo to protect your motherboard from the four nuts on the rear eating into the delicate circuitry in the PCB

are essential. More worryingly, you need to use a spanner to tighten them, which is asking for trouble.

Two sets of mounting brackets are provided in the box, catering for both Intel and AMD sockets. However, due to the mounting pins being secured to the cooler, you'll need to support it yourself while you secure the nuts from the rear of the PCB. Needless to say, you'll likely find it extremely difficult to mount the cooler with your motherboard already fitted in the case.

On the plus side, when it was up and running, the fan was very quiet at full speed and certainly far less noisy than the Cryorig C7's fan, and dishing out slightly lower amounts of noise than the Raijintek Pallas RGB and Noctua NH-L12S. The fan comes pre-attached to the cooler, so there's very little work to do once you've mounted the backplates and Jonsbo even includes a tube of thermal paste in the box, so you'll be good for a couple of applications.

Performance was sadly lacking in both our test systems, though, with the Jonsbo producing a CPU delta T of 68°C when it was pitted against our overclocked Core i5-11600K, which only just kept the CPU away from throttling. It fared slightly better when it was cooling our overclocked Ryzen 5 5600X CPU, but its delta T of 57°C here was still much warmer than the results from the Raijintek Pallas 120 RGB and Noctua NH-L12S. This is expected given the lower noise levels, but it's important to be aware of this cooler's limitations.



Conclusion

With RGB lighting and decent built quality, on paper, the Jonsbo CR-701 seems like a great deal for under £30. However, a tricky and potentially risky installation method, and lacklustre cooling means there are better options at this price, and far better coolers available if you can spend a little more money.

VERDICT

An attractive and well-made cooler, but its installation process is fiddly and its cooling is sub-par for its size.

SPEC

Intel compatibility LGA115x, LGA1200

AMD compatibility Socket AM4, AM3+

Heatsink size with fans (mm) 120 x 120 x 125 (W x D x H)

Fans 1 x 120mm

Stated noise 29dBA

ZIPPY

- + Attractive design
- + RGB lighting
- + Low price

BUNGLE

- RGB lighting can't be controlled
- Tricky installation
- Lacklustre cooling

LGA1200			
COOLING	24/40	FEATURES	19/20
DESIGN	15/20	VALUE	19/20
OVERALL SCORE			
77%			

FITTING		Hard
---------	--	------

AM4			
COOLING	23/40	FEATURES	19/20
DESIGN	15/20	VALUE	19/20
OVERALL SCORE			
76%			

FITTING		Hard
---------	--	------



NOCTUA NH-L12S / £50 inc VAT

SUPPLIER scan.co.uk

The Noctua NH-L12S makes great use of the company's excellent slim 120mm NF-A12x15 PWM fan in order to create a reasonably large cooler that still has a low profile. Interestingly, Noctua has also pre-installed the fan to exhaust air up through the heatsink, with the fan mounted beneath it. This setup should still draw air over your motherboard, creating extra airflow, but it likely won't cool your VRMs as much as the be quiet! Dark Rock TF 2, which has both of its fans pointing downwards.

The Noctua isn't as expensive as the be quiet! cooler either, with a price of £50 inc VAT compared to the latter's lofty £70 price tag, but it still costs a good deal more than the other three low-profile coolers on test. It also lacks the RGB lighting provided by the Raijintek Pallas RGB, which sits at a similar height and undercuts the Noctua by £17.

You can see where some of Noctua's extra budget has been spent, though, with the premium fan and extras included with the NH-L12S making an impression when you open the box. The bundle includes a tube of thermal paste and a fan speed reduction cable, as well as excellent instructions and a cooler with epic build quality.

The fan clips can even attach to standard-height fans if you want to attach a more

powerful model to the top of the heatsink instead of the included slim fan. The heatsink only has four 6mm heatpipes, which is fewer than the be quiet! and Raijintek coolers on test this month, but there's more to a CPU cooler's ability than the number of heatpipes.

Installing the Noctua was relatively simple, but you'll need to make sure you use the correct colour of spacers depending on whether you use the Intel or AMD mounting kits. As you mount a securing bracket first and then the cooler, you should be able to get away with mounting the Noctua with your motherboard already fitted in your case as well.

Despite its much smaller size, the NH-L12S' cooling performance was never far away from that of the massive be quiet! Dark Rock TF 2, managing a CPU delta T of 59°C when dealing with our overclocked Core i5-11600K. This was 5°C off the pace of the be quiet!, but still a great result.

It was only 3°C off the result from the be quiet! cooler when dealing with our overclocked Ryzen 5 5600X, with a CPU delta T of 42°C compared to 39°C.

In both situations, the Raijintek Pallas was never far behind either result, though, and it costs less money. At full speed, the fan proved to be very quiet as well, producing a low-frequency airflow sound.

Conclusion

The Noctua NH-L12S strikes an excellent balance between cooling performance and being truly low-profile at just 70mm tall. It coped well with our overclocked 6-core CPUs and has headroom to spare for dealing with CPUs with more cores too.

You can find more cooling power if you're happy to spend the extra money for the be

SUMMER BREEZE

- + Excellent cooling
- + Easy installation
- + Low noise

HURRICANE

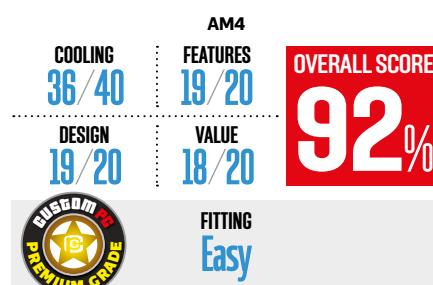
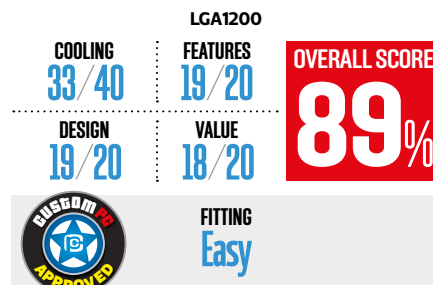
- More cooling on offer elsewhere
- Cheaper coolers perform nearly as well
- No RGB lighting

quiet! Dark Rock TF 2, while the Raijintek Pallas 120 RGB is cheaper, has RGB lighting and nearly performs as well.

However, you can't argue with the quality, accessories and cooling on offer here, even at £50. This is a superb low-profile CPU cooler if you can afford it.

VERDICT

There's no RGB lighting, but this well-built and effective cooler shows Noctua doing what it does best.



SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3+

Heatsink size with fans (mm) 128 x 146 x 70 (W x D x H)

Fans 1x 120mm

Stated noise 30dBA

RAIJINTEK PALLAS 120 RGB

£33 inc VAT

SUPPLIER overclockers.co.uk

While the RGB lighting on the fan of the Jonsbo CR-701 can't be controlled, leaving it stuck in a cycle of rainbow colours, the Raijintek Pallas 120 RGB's slim 120mm fan sensibly comes with standard 4-pin RGB connector, enabling you to tweak its colours to your liking. The lighting is fairly vivid when it's running, but due to the highly angular blades, it doesn't quite manage to produce the same full illumination effect that we've seen other full-sized fans achieve.

The angular blades, which can hit a maximum 1,400rpm, also added to a noticeable airflow noise at full speed, but this was thankfully backed up with decent amounts of air flowing through the heatsink for such a slim fan. Combined with a total of six heatpipes with a 6mm diameter, there's clearly some good cooling potential on offer here. In fact, on paper, it has more clout than the pricier Noctua NH-L12S.

Unlike the latter's setup, the Raijintek's heatsink area sits beneath the fan with air being directed towards your motherboard. Its total height sits 2mm lower than that of the Noctua cooler too, measuring 68mm, and the heatsink is coloured jet black with cut-outs to access the mounting screws.

LIGHTING

- + Good cooling
- + RGB lighting
- + Reasonable price

LIGHTNING

- A tad noisy at full speed
- Overcomplicated mounting mechanism
- Better quality and cooling available for a little more money

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3+

Heatsink size with fans (mm) 147 x 130 x 68 (W x D x H)

Fans 1 x 120mm

Stated noise 28dB(A)

As it sits fairly low, you'll lose the first DIMM slot on most motherboards, but it's otherwise pretty good at clearing motherboard components. We even managed to fit the Raijintek on the otherwise troublesome Asus ROG Strix Z590i Gaming WiFi we reviewed this month (see p16), albeit with low-profile memory.

Installation of the Raijintek is relatively straightforward but you do have to deal with a large number of components. It also uses motherboard standoffs to secure the cooler to the mounting brackets, but moving these to adjacent brackets in order to rotate the cooler resulted in one of them failing to screw into place by hand, getting stuck halfway and requiring pliers to be screwed fully into place.

If you didn't notice that it hadn't screwed all the way into its hole, you could easily end up with the cooler making poor contact with your CPU. The mounting pins struggled to get through foam on the rear of the backplate. However, once the installation process is out the way, the cooler sits solidly on its Meccano-esque throne.

Cooling is very good, although it failed to match the Noctua and be quiet! coolers on test. The former was only a small amount cooler, though, especially on our LGA1200 test rig, where just a single degree separated them. However, the Noctua cooler was a little quieter and much easier to install. The CPU delta T of 71°C in our AMD system cooling an overclocked Ryzen 5 5600X was two degrees warmer than the Noctua cooler, but significantly better than the Jonsbo CR-701 and Cryorig C7. Again, though, the be quiet! Dark Rock TF 2 posted a significantly cooler temperature, which you'd hope given that it costs twice the price.

Conclusion

The Raijintek Pallas 120 RGB offers excellent cooling for its price, as well as controllable RGB

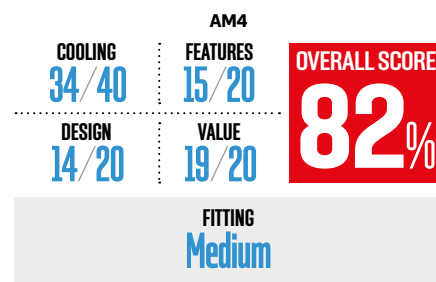
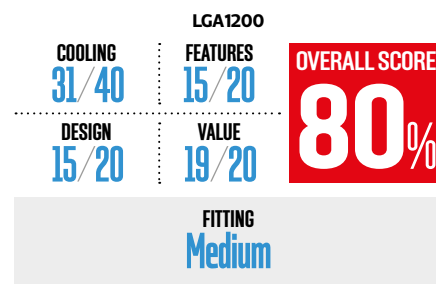


lighting, but it also presents a few issues. It can make a fair bit of noise, and the installation process took a little longer than we expected, largely due to some snug-fitting components needing a little more elbow grease than normal to fit them.

Ultimately, we'd recommend stumping up the extra cash for the Noctua NH-L12S, but if you need a cheaper cooler or really want RGB lighting, the Raijintek has some decent cooling power on tap. **CPC**

VERDICT

Good cooling, RGB lighting and a reasonable price, although it has a few niggles.



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

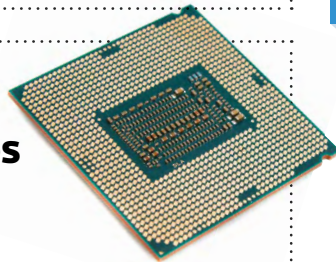
TEST MOTHERBOARDS

- **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, or Core i5-11600K overclocked to 4.8GHz with 1.35V core on low-profile coolers, MSI MEG Z590 Ace motherboard.

AMD AM4

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

INTEL LGA2066

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



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 Issue 218, p76 for an example build guide.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5700G	scan.co.uk	#218 p20	£320
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	£78
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	£43

Total £529

*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	overclockers.co.uk	#218 p16	£450
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	#204 p74	£78
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	£43

Total £906

UPGRADES

SWAP GRAPHICS CARD	AMD Radeon RX 6700 XT (2,560 x 1,440 gaming)	overclockers.co.uk	#213 p19	£700
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£117
SWAP CPU COOLER	SilverStone Hydrogen D120 ARGB	amazon.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 Hydrogon D120 ARGB	amazon.co.uk	#217 p43	£46
GRAPHICS CARD	AMD Radeon RX 6700 XT	overclockers.co.uk	#213 p19	£700
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£101
MOTHERBOARD	MSI MPG B550 Gaming Carbon WiFi	ebuyer.com	#210 p74	£180
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£117

Total £1,404

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£75
SWAP CPU COOLER	Antec Neptune 240	scan.co.uk	#216 p44	£80

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	£370
CPU COOLER	Lian Li Galahad 240mm	overclockers.co.uk	#216 p47	£110
GRAPHICS CARD	Nvidia GeForce RTX 3080	scan.co.uk	#211 p43	£1,055
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£101
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	£117

Total £1,963

UPGRADES

ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	#166 p54	£75
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	£370
CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	#216 p46	£150
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	scan.co.uk	#216 p18	£1,380
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M2Z3600C20)	scan.co.uk	#210 p74	£101
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 £2,456				

UPGRADES

ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	#166 p54	£75
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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	scan.co.uk	#213 p45	£530
CPU COOLER	NZXT Kraken X63 (280mm AIO liquid cooler)	scan.co.uk	#207 p47	£130
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	#218 p16	£450
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 3600MHz (CMW32GX4M2D3600C18)	scan.co.uk	#210 p74	£140
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	#193 p48	£440
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£396
Total £2,026				

UPGRADES

SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	scan.co.uk	#216 p18	£1,380
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	£75

* 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
AMD B550 (AM4 budget)	Asus ROG Strix B550-I Gaming	scan.co.uk	#206 p44	£197

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	#206 p18	£100
TOWER	Ssupd Meshlicious	overclockers.co.uk	#219 p18	£110
PREMIUM	Streacom DA2 V2	quietpc.com	#214 p51	£195

Other components

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
LOW-PROFILE CPU COOLER	Noctua NH-L12S	scan.co.uk	#219 p54	£50
SFX POWER SUPPLY	SilverStone SX750	scan.co.uk	#219 p72	£130

ATX cases



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Phanteks Eclipse P300 Glass	overclockers.co.uk	#176 p28	£55
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	#214 p26	£75
SUB-£100	be quiet! Pure Base 500DX	scan.co.uk	#202 p39	£99
COMPACT	Fractal Design Meshify 2 Compact	scan.co.uk	#215 p20	£100
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

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	£110

Cases

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

Networking



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	#216 p52	£130
ROUTER	Asus RT-AX68U	scan.co.uk	#216 p51	£170
MESH ROUTER	Asus 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	laptopsdirect.co.uk	#200 p22	£160
DUAL-BAY MEDIA NAS BOX	Synology DS218play	laptopsdirect.co.uk	#174 p34	£210
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	#212 p25	£268

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	£150
25IN, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	#209 p57	£375
25IN, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	#212 p20	£590

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 27G2U	overclockers.co.uk	#201 p53	£180
27IN, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	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	£339
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	very.co.uk	#218 p56	£749

Over 28in

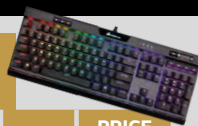
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5IN, 60Hz, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£370
32IN, 165Hz, VA, 2,560 X 1,440, F, G	Dell S3220DGF	amazon.co.uk	#214 p28	£399
34IN, 144Hz, VA, 3,440 X 1,440, W, F, G	Cooler Master GM34-CW	ebuyer.com	#215 p30	£550
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	iiyama G-Master GB3461WQSU	scan.co.uk	#206 p53	£330
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	£300

Peripherals and audio

Gaming keyboards



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
MEMBRANE	Corsair K55 RGB	amazon.co.uk	#201 p45	£50
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	£74
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£60
WIRELESS	Razer Viper Ultimate	box.co.uk	#217 p54	£90
PREMIUM WIRELESS	Razer Deathadder V2 Pro	scan.co.uk	#210 p28	£104
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	#211 p28	£48
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	#217 p52	£119

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	£37
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	£61
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	#204 p50	£149
PREMIUM WIRELESS	Razer BlackShark V2 Pro	overclockers.co.uk	#211 p26	£160

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
BUCKLING SPRING MECHANICAL	Unicomp New Model M	keyboardco.com	#219 p26	£129

PCs and laptops



Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
6-CORE GAMING	CyberPower Infinity X115 GT	Intel Core i5-11400	Nvidia GeForce RTX 3060	cyberpowersystem.co.uk	#217 p32	£1,299
MINI-ITX GAMING	Chillblast Fusion Diablo	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	chillblast.com	#215 p34	£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	£4,724
PREMIUM WATER-COOLED 4K GAMING	Chillblast Fusion Kraken	AMD Ryzen 9 5950X	Nvidia GeForce RTX 3090	chillblast.com	#217 p34	£7,000
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	#145 p58	£14,840

Laptops



CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Lenovo Legion 5 (82JU002YUK)	AMD Ryzen 7 5800H	Nvidia GeForce RTX 3070 Laptop	15.6in, 1,920 x 1,080 IPS 165Hz	box.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
ULTRA PORTABLE GAMING + EGPU DOCK	Asus ROG Flow X13 GV301	AMD Ryzen 9 5980HS	Nvidia GeForce GTX 1650 Max-Q (laptop) / RTX 3080 Laptop (dock)	13.4in, 1,920 x 1,200 IPS 120Hz	overclockers.co.uk	#219 p28	£2,699
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

REFUND REQUEST

Steam's refund policy fails to account for developers of shorter games, argues Rick Lane

Back in 2015, Steam introduced a refund system, which enables players to get their money back for games purchased within the last 14 days, as long as they've been played for under two hours. The new policy was introduced partly to comply with EU regulations, which assert that online purchases must be allowed to be returned within two weeks of purchase 'for any reason and without a justification'.

However, the system also reflects Steam's massive growth and diversification as a marketplace, selling games that range from polished mainstream open worlds and artful indie experiences, to cheaply made anime puzzlers and dodgy Unity asset flips.

EU policy says nothing about the 'two-hour playtime' allowance that Steam stipulates. While this seems like a fair compromise between developers and consumers, letting the latter try the game while protecting the former from baseless refunds, the rule in fact leaves the policy open to exploitation on both sides.

Unscrupulous developers can 'front-load' their games, ensuring the first couple of hours are thrilling and engaging in a way that isn't representative of the final product.

On the flip side, many games take longer than two hours to reveal their best side, which means disgruntled players may refund their purchase before seeing a game's true colours.

The biggest problem, however, is that the system essentially excludes games that are shorter than two hours from protection. Recently, solo developer Emika Games announced it was stepping away from game development 'for an indefinite

time' after one of its games had so many refunds processed that it obliterated the game's profit margin.

That game, *Summer of '58*, has a 'Very Positive' rating on Steam from a total of 674 reviews, with an RRP of £6.19. In a statement, Emika Games said its game 'did not reach two hours of playing time by Steam standards', which had led to 'a huge number of returns of the game'. This has led the developer to remove itself from game development, abandoning its latest project, another horror game called *From Day to Day*.

Earlier this year, indie developer Bela Messex also directly called out a player who openly admitted to refunding its game for no other reason than that the rules allowed them to do so (the player subsequently apologised and repurchased the game). Ultimately, though, the problem stems not from players, but from the rules. The two-hour window is an arbitrary metric that fails to account for the enormous variance in individual gaming experiences.

There are several potential solutions. Valve could reduce the window to, say, 45 minutes, or simply remove it entirely. Alternatively, that window of playtime could be made reflective of game length, so that sub two-hour games get a 30-minute window, while longer games get the full two hours.

But in my opinion, the best solution is simply to put a hand on the tiller. Players that pass the two-hour limit can still make refund requests directly to Valve, which are assessed on a case-by-case basis. This could be the default process for games that don't reach a two-hour running time. When a system has a problem, it's humans, not further systems, that need to solve it. **CPC**

The best solution is simply to put a hand on the tiller

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

Chernobylite

/ **£12.39** inc VAT

DEVELOPER The Farm 51 / PUBLISHER The Farm 51

Superficially, Chernobylite resembles a clone of 2007's *Stalker: Shadow of Chernobyl*, a nascent open-world shooter which saw players exploring the Exclusion Zone surrounding the ill-fated nuclear plant, collecting anomalies and shooting mutants. Chernobylite uses the same ingredients, but combines them in a way that results in a very different dish.

The game puts you behind the gas mask of Igor Khymynyuk, a physicist and former employee of the Chernobyl NPP who was present at the time of the disaster on 26 April, 1986. Thirty years later, Khymynyuk returns to the Zone on a mission to find his wife Tatyana, who disappeared on the night of the disaster, and of whom Igor has heard nothing until he recently began seeing visions of her located somewhere in the plant.

Khymynyuk hires a couple of mercenaries to help him infiltrate the plant, now owned by a private military company known as the NAR, but the plan goes awry and they're forced to retreat. Khymynyuk and the surviving mercs regroup on the border of the Zone, devising a new, more elaborate plan to get into the plant and discover Tatyana's fate.

The game features similar base mechanics to *Stalker*, including robust combat, rudimentary stealth, and a host of survival systems such as resource gathering and crafting. Rather than exploring the Zone seamlessly, however, Chernobylite sees you venture to a different part of the Zone on each in-game day, completing missions, gathering



resources to expand your home base and locating other characters that will join you on your quest.

It's an unusual structure that helps and hinders Chernobylite in equal measure. Each of the five Zones evolves over time. The NAR's soldiers become tougher and more numerous, while radiation storms become more frequent and intense, resulting in the arrival of new, more powerful kinds of mutants. It's a neat system, but it fails to alleviate the repetition generated by the small size of each location and the number of times you need to revisit them.

What rescues Chernobylite from mediocrity is its storytelling and set-piece design. The story is underpinned by a complex network of choices and consequences, affecting your relationship with your NPC companions and how the general story plays out. An early example gives you the choice to blow up the enormous Duga Radar Array, a massive communication structure that sits just outside Chernobyl. Doing so not only looks spectacular, but changes the layout of that area for the rest of the game.

Likewise, the game's cast of interesting sub-characters and occasional ability to create fun emergent play helps to raise Chernobylite above its less enjoyable idiosyncrasies. It isn't the long-awaited successor to *Stalker* that many wanted, but in a lot of ways, it's far more interesting.

RICK LANE

3.6 ROENTGEN

- + Good story
- + Some cool missions
- + Decent combat and stealth

15,000 ROENTGEN

- Repetitive structure



/ VERDICT

Chernobylite blends *Stalker*-like atmosphere and gunplay with robust survival systems and complex player choices, with mostly positive results.

OVERALL SCORE

75%



Wildermyth / £19.49 inc VAT

DEVELOPER Worldwalker Games LLC / PUBLISHER Worldwalker Games LLC

Video games have borrowed liberally from Dungeons & Dragons for decades, but while games have built countless brilliant RPGs on the shoulders of D&D, they've always struggled to recreate the main draw of the pen-and-paper system, namely the ability to create a story that feels like your own.

No matter how deep a game's systems or how meticulous its narrative design, it simply can't beat D&D for creative storytelling. A video game can't conjure new ideas out of nothing like a human Dungeon Master; neither can they represent character development with the same level of depth and nuance.

In this respect, Wildermyth is no exception, but it gets closer than most games and that's one heck of an achievement. Worldwalker Games' tactical RPG is one of the best storytelling engines around, boasting a dynamic narrative and character development that's unparalleled in the virtual realms.

Wildermyth's five campaigns (six if you include the replayable randomised adventure) start out in traditional fantasy fashion, with a bunch of young inexperienced fighters, hunters, wizards and so on coming together to form a band of heroes. Yet while most fantasy stories focus on a snippet of their characters' lives, a Wildermyth campaign charts your heroes' entire careers.

Each campaign is split into several chapters, and each chapter sees your party exploring a procedurally generated world map seeking to complete a specific objective. The world map is divided into different regions, such as mountains, fields, marshland, towns and so on. Moving into a new region first requires your party to scout it, which will always trigger a random event. These events are presented as short comic strips, and usually involve you making one or several decisions that influence the story's outcome.

There's a truly dazzling number of these mini-stories, and they can influence your characters in a wide variety of ways. A story's effect could be as simple as providing your main fighter with a new weapon, or it could see your hunter possessed by a shadow creature that begins to transform





him into a beast. They can be a bit of fun, such as your party deciding to name a particular location, or they can be melancholy, such as your party getting a chance to view (but not change) an event from their past that might have pushed their lives in a different direction.

These stories gradually layer atop one another, giving each member of your party a distinct personality and their own storied history. It isn't only these stories that define your characters either. Almost every part aspect of Wildermyth does it too. For example, scouting an area will also often trigger a battle, at which point Wildermyth switches to an X-COM-style tactical map, brilliantly presented in pop-up book style. Here, your characters take turns to move, attack and perform special abilities against Wildermyth's colourful array of monsters, until one side is defeated.

Structurally, the combat isn't remarkable, but it has an impressive level of tactical depth, alongside a couple of interesting systems. Party members who fight adjacent to one another, for example, receive a defence bonus, representing your party's camaraderie at a mechanical level and encouraging you to think in formations.

Meanwhile, the game's magic system, known as Interfusion, sees your magical characters mentally bind with objects on the map, such as tree stumps or rocks. They then use these items as foundations for their spells, such as exploding the tree stump in a cloud of splinters, or throwing a chunk of the rock at an enemy's head.

Victory in combat not only furnishes your team with new weapons and armour, but it also gains them experience. When a character levels up, you get to choose one of four skill upgrades, which range from active and passive combat skills, to bonuses on skill checks. On the flip side, if a hero is defeated in combat, you're left with a choice. You can let them die, or you can choose to save them. However, there are consequences for the latter, such as the loss of a limb, or another party member becoming injured while trying to save their friend.

These systems and ideas impress individually, but the real power of Wildermyth reveals itself over time. As the days and months pass, your characters go from

farmhands wielding pitchforks and pickaxes, to seasoned adventurers, to grizzled veterans. When you complete a campaign chapter, several years will pass before the next one, with the timespan depending on the thoroughness of your explorations.

But your adventurers are still active in this time, going off on adventures of their own, or settling down and starting families, or perhaps even retiring from adventuring completely. But don't fret if the latter happens; new adventurers are always appearing, eager to take up the sword. Some of them may even be the grown-up children of previous party members.

A campaign's end doesn't necessarily close the book on a hero's story, and neither does retirement nor even death. Instead, these veteran adventurers become available as 'legacy heroes' who can be recruited for new campaigns, albeit scaled down to the relevant age and skill level. In this way, your favourite heroes become legends of Wildermyth's world, going off on countless different adventures, becoming myths that are remixed with every telling.

There's so much to recommend about Wildermyth – so many clever little ideas we've yet to mention, such as how enemies gain new abilities after every battle, making them stronger and more difficult to fight. It's also a clean and tidy game, although there are a couple of small issues.

While the pop-up book presentation of combat is undeniably stylish, for example, it does take some of the drama out of battles. The way heroes hop around, as if manipulated by some omnipotent toddler, is also a little immersion breaking. On the subject of moving characters around, this process can also be a bit fiddly on the world map, especially if you split up your party into multiple groups.

Beyond these minor gripes, there are precious few complaints. Wildermyth is comfortably one of the best RPGs ever devised, fighting proudly alongside games with much larger budgets, such as the Dragon Age titles and The Witcher 3. It's a storytelling marvel that throws in some excellent tactical combat for good measure – an unmitigated triumph of RPG design.

RICK LANE

WILDERMYTH

- + Remarkable storytelling systems
- + Incredible character development
- + Great tactical combat

BEWILDERED

- Pop-up book presentation undermines impact of battles
- Some minor UI issues

/ VERDICT

Wildermyth is a brilliant RPG that mixes revolutionary storytelling systems with excellent tactical combat.

OVERALL SCORE

90%

Cruelty Squad / £15.49 inc VAT

DEVELOPER Consumer Softproducts / PUBLISHER Consumer Softproducts

Cruelty Squad is a cross between an immersive-sim, a mid-1990s shooter and a nightmare. It sees you play as a depressed assassin hired to perform 'extreme liquidations' for the cruelty squad, the private mercenary arm of a shady corporate conglomerate.

Visually, it's designed to be as repulsive as possible, combining the colour palette of a pre-school children's cartoon with the fleshy hell-world textures of Doom, all sprinkled with 1990s-era Microsoft clip art and warped, unsightly character models. It looks like nothing else you've played, avoiding both modern visual trends and the comfort of nostalgia.

Each mission tasks you with assassinating one or several targets within a large, open-ended level. Your job is to kill these targets in whatever way you see fit, then exfiltrate the area via a predetermined exit point. What will probably happen instead is that you'll die at the hands of one of the game's lethally accurate security guards, and lose more money from having your body restored than you gain from the actual job.



But that's okay! After dying multiple times, the Cruelty Squad recognises your ineptitude and enrolls you in an experimental program that provides free resurrections. That's because Cruelty Squad isn't really about assassinations, but learning how to navigate the ruthlessly capitalist society in which you live in, both literally and figuratively.

For example, Cruelty Squad offers a wide range of character upgrades, from health and armour boosts to the ability to use your own intestines as a grappling hook. There's no way you can afford these on your murder commission, but you can earn extra money by collecting the internal organs of the guards you kill, before selling them on the black market.

Discovering Cruelty Squad's many secrets and idiosyncrasies is where the game is most satisfying. Despite its childish appearance, the game's levels are vast, intricate 3D spaces filled with alternate routes, secret passageways, hidden weapons and plain weird stuff. There are also secret levels within the game, some of which are enormous.

All of this works well, but shooting is extremely basic, while the theoretical ability to sneak is made next to impossible by the game's psychic enemies, who will all be alerted to your presence the moment one of them spots you. Again, this is the point – Cruelty Squad doesn't want you to feel good about assassinating people, because assassinating people shouldn't feel good. This is why there's so much emphasis on exploration, discovering secrets and even an elaborate fishing mini-game.

While Cruelty Squad is fascinating, it's hard to recommend a game where the base interactions are repulsive by design. Cruelty Squad has big, bold ideas, but it's also an acquired taste by its very nature, and there's no guarantee you'll end up enjoying its oblique and wilfully unpleasant world.

RICK LANE

CRUEL INTENTIONS

- + Excellent level design
- + Interesting structure

CRUELLA DEVILLE

- Lacklustre shooting
- Stealth doesn't really work

/ VERDICT

Cruelty Squad's anti-capitalist polemic rejects modern design conventions, with interesting but oblique results.

OVERALL SCORE

60%



Orcs Must Die 3 / £23.79 inc VAT

DEVELOPER Robot Entertainment / PUBLISHER Robot Entertainment

Orcs Must Die 3 is a sequel to Orcs Must Die 2. This might sound asinine, but there isn't much else to say. After Robot Entertainment's abortive experiment with free-to-play gaming in Orcs Must Die: Unchained, Orcs Must Die 3 goes back to its roots, then clings onto them like an agoraphobic mole.

Around 80 per cent of it is familiar fare. Each campaign level plunks you into an arena with several locked doors. At your discretion, orcs pour through those doors, attempting to reach a portal. You must prevent them from vanishing through the portal with tactical placement of ACME-style traps, ranging from floor spikes and poison darts to giant

springboards. Unlike traditional tower-defence games, you also actively participate in combat, able to directly fight orcs that evade your traps with weapons, spells and other gizmos.

There are some obligatory sequel additions, with new traps such as the Acid Geyser, which melts armour off enemies and makes them more vulnerable to other traps. There are also new enemies, such as the Elemental, which divides into smaller variants of itself when killed.

You also play as one of two new characters, both of which are as forgettable as the heroes from previous games. OMD 3 is geared toward cooperative play, and while it can be played by one player, many of the maps are clearly designed to have two players running around them.

There is one more substantial new feature. War Scenarios are steroid-enhanced versions of Orcs Must Die's regular levels, with two or three times the number of orcs and bigger traps. These include a manually fired catapult that launches exploding bombs, and an extra-large springboard trap that can punt the largest enemy over a parapet. It's fun, but it's not that much different from the regular game mode.

We understand why Robot hasn't fiddled with a formula that clearly works, but there's still a missed opportunity to really ramp up the action. In particular, the game could make more of its traps and their effects on the orcs. While a few traps have specific effects on orcs, most of them simply trigger the model's ragdoll. Why not have, say, piston traps that squash orcs flat, or concertina them like in a Looney Tunes cartoon? There's huge potential to make the ultimate slapstick comedy game, but it doesn't push far enough.

Still, playing Orcs Must Die 3 is by no means a bad time. It knows what it needs to do, and achieves it competently with sufficient style. You'll almost certainly enjoy it, even if you probably forget that you played it three weeks later.

RICK LANE

ORC

- + Classic OMD play
- + Fun new enemies and traps
- + War Scenarios are pleasing addition

BORK

- Trap effects on orcs are a bit underwhelming
- Unambitious

/ VERDICT

Orcs Must Die 3 does what a sequel needs to do. No more, no less.

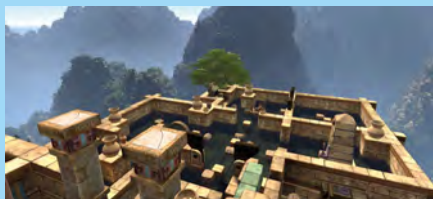
OVERALL SCORE

70%



REALITY CHECK

Rick Lane prepares his bullwhip for some Indiana Jones-style action and picks scorpions out of his sandwiches in his latest VR roundup



NEWS

EYE OF THE TEMPLE

Eye of the Temple is the closest you're likely to get to being Indiana Jones without studying for an archaeology degree and then finding some Nazis to punch. A solo project by Danish indie game developer Rune Skovbo Johansen, it sees you exploring a complex, ancient ziggurat, solving puzzles and dodging traps just like Dr Henry Jones Jr.

Indeed, comparisons with Spielberg's adventure trilogy are apt for reasons beyond the thematic. One of your primary ways of interacting with the game world is through your trusty bullwhip.

It's used for various actions, such as pulling levers from across a chasm, and attacking certain enemies, such as flying beetles. The whip is fully simulated too, meaning you'll need to aim your strikes carefully to ensure it wraps around manipulable objects.

Other puzzling elements include using a torch to light fires, 'balancing' on rolling rocks and even racing through sections of the temple inside a minecart, careening through dark subterranean tunnels and searing magma-filled chambers.

It all looks smartly assembled, with inventive-looking puzzles and clever twists on familiar VR concepts. The only part that isn't clear about the game is its story – your motivation for exploring the temple, and what you expect to find beyond its labyrinth of puzzles and deathtraps.

Eye of the Temple is currently scheduled for release later this year, although we wouldn't be surprised to see it slip into 2022. It will support all major headsets, including the Oculus Rift and the Valve Index. There's also a demo you can download for free right now, letting you get some whipping practice before the full game debuts.

NEWS

UNPLUGGED

Remember the late 2000s when Guitar Hero was in its heyday, and there seemed to be more fake plastic guitars than real ones? Well, Unplugged aims to bring back those late nights pretending to be a rock god, but without embarrassing faux instruments.

Instead, Unplugged transforms your air guitar into a real guitar through the magic of

VR hand-tracking. The game uses a similar rhythm-action interface as Guitar Hero, but simulates the guitar itself in VR, and tracks the movement of your hands across its virtual strings.

You slide your left hand up and down your virtual guitar's neck in time with the notes, using your right hand to strum.

Unplugged started as a small independent project, but has greatly expanded in scope due to a partnership with publisher Vertigo Games. This has enabled the team to bring on board Marcus Henderson, the lead guitarist on the original Guitar Hero, in a producing role, while also signing music from several major bands, including The Offspring.

Unplugged is scheduled for release later this autumn on Oculus Quest. A Steam VR version will also be available, although it will require touch controllers to play.





REVIEW

I EXPECT YOU TO DIE 2 / £18.99 inc VAT

DEVELOPER Schell Games / PUBLISHER Schell Games

You can't fault *I Expect You to Die 2* for style. The sequel to Schell Games' spy-tacular VR puzzler has wonderfully colourful locations, and superb writing and voice acting. It even kicks off with a James Bond-style credit sequence, complete with psychedelic visuals and a suitably camp song. It's an extremely likeable VR game, albeit one that doesn't exactly push boundaries, and sometimes makes you feel less like 007 and more like Wile E. Coyote wearing a tuxedo.

The story sees your plucky agent once again on the trail of the villainous organisation Zoraxis, which appears to have gained

powerful influence over major world leaders through some unknown means. Your mission is to infiltrate Zoraxis, find out what it's doing and thwart its dastardly plans.

Like the first game, *I Expect You To Die 2* is a dedicated seated experience, while each of the six missions is an elaborate puzzle that you need to solve in the right sequence.

For example, the first mission sees you masquerading as a technician in a theatre while protecting the British Prime Minister from a Zoraxis assassination attempt. Stationed up in the rafters, you must first prepare the stage by setting the lighting and using pulleys to assemble the set, then follow directional cues while you attempt to figure out Zoraxis' plan and how to keep the PM alive.

Other missions include flying on a luxurious private jet to meet a Zoraxis agent, where the airline food is laced with poison and deadly lasers are embedded into the seats, and disguising yourself as a butler during a Zoraxis party, serving drinks from the cellar of a French Chateau.

The way the game maintains its spy fiction without requiring you to move around is impressive, while grappling with all the puzzles is enjoyable. Every dial you turn and lever you pull reveals another layer to the conundrum, be it a secret control panel or a booby trap you need to disarm.

Indeed, as the title implies, *I Expect You To Die 2*'s puzzles are filled with deadly pitfalls, from time bombs to scorpions hidden in your sandwiches. The sense that every action you take might be your last is crucial to the game's tension. However, death always catapults you back to the very start of a mission, which becomes frustrating after you've died in the same spot for the fourth or fifth time.

The game also doesn't expand upon its premise that much. Mechanically, it's almost identical to the first game, with few new features or ideas. It's also roughly the same length as the original, at two to four hours depending upon your puzzle-solving skills.

Still, *I Expect You To Die 2* offers an enjoyable enough way to pass an afternoon in virtual reality. It isn't massively innovative, and its trial-and-error puzzling can frustrate, but its entertaining spy pastiche makes up for its shortcomings. **CPC**

CASINO ROYALE

- + Great presentation
- + Entertaining puzzles

DIE ANOTHER DAY

- Short
- Trial-and-error solutions can be frustrating

VERDICT

I Expect You To Die 2 won't shake up VR gaming, but its tongue-in-cheek style and imaginative puzzles stir up some affection.

OVERALL SCORE

70%





MAKE A MINI MARVEL

ANTONY LEATHER GIVES YOU HIS TOP TIPS ON HOW TO DOWNSIZE YOUR DESKTOP AND BUILD THE PERFECT MINI-ITX PC FOR YOUR NEEDS

This month we're taking a look at the growing market for diminutive desktops, so we can provide you with all the knowledge you need to build your own mini PC. If you've been put off going small, we'll be covering common misconceptions around mini-ITX, such as the build process being more difficult and hardware running hot, as well as addressing perceived limitations.

The latter is particularly important, because if you own a PC with a single graphics card and no other PCI-E expansion cards, you'll probably be able to easily build a mini-ITX that suits your needs, save loads of space and avoid compromising on performance too.

We'll be offering our top tips on how to build a small PC, looking at what hardware works best and why, while covering both air

and water-cooled builds as well as covering current issues, such as PCI-E risers, mini-ITX case layouts, SFX power supplies, slim fans and potential compatibility issues.

There's an awful lot of hardware from which to choose when it comes to buying mini-ITX gear, but the end result will be a super-sleek, small and powerful PC that will turn heads wherever you take it.

A BRIEF HISTORY OF MINI-ITX

Until socketed mini-ITX motherboards first became available around 15 years ago, small form factor PCs were very limited in their flexibility. Confined to low-power integrated CPUs, there wasn't much point using mini-ITX boards for any purpose other than a home server, basic computer or an extremely small PC. When you could drop high-end CPUs into them, though, that changed, and the first boards with 16x PCI-E graphics slots followed soon after.

This meant you could finally use the same hardware as an ATX PC, including graphics cards and CPUs. That happened all the way back when the H55 chipset was doing the rounds, and the likes of DFI and Zotac were still regularly churning out motherboards. Gigabyte was quick to join the party and then Asus went all-out with its P8Z77-I Deluxe, becoming the first manufacturer to offer a truly premium mini-ITX motherboard. With its VRM daughterboard, it was more than up for some overclocking too.

Now, most manufacturers have at least one mini-ITX motherboard available for both Intel and AMD sockets, sometimes two, and ASRock has even ventured into high-end desktop territory with X99 and X299 models. The only disadvantages you'll see now are a limited number of memory slots and just having a single PCI-E slot.

However, most of us only really need two memory modules in dual-channel mode and a single graphics card anyway, meaning mini-ITX poses very few compromises. In fact, the shorter PCB traces between the CPU and other components can sometimes even mean overclocking is more effective on mini-ITX motherboards than on their ATX counterparts.



Asus went all-out with its P8Z77-I Deluxe, becoming the first manufacturer to offer a truly premium mini-ITX motherboard

TYPES OF CASES

Your first consideration is that mini-ITX cases vary in shape, size and layout considerably more than their ATX counterparts. Your choice of case is the most important decision by far, as it will dictate what kind of hardware you can fit inside it. Similarly, if you already know what hardware you'll be using, then you'll need to pick a suitable mini-ITX case or risk components not fitting inside it or getting enough airflow.

Cube cases come in a variety of layouts, but the most common is with the graphics card sat at the bottom of the case with its fan pointing downwards and the motherboard in its normal position at the back of the case. Some cases offer vertical GPU mounts here as well, either as an option or as standard, and these cases either come with vented or glass side panels.

The alternative layout for cube cases is called 'sandwich', which means the motherboard tray sits in the middle of the case, splitting the case length-ways into two sections, so the motherboard and graphics card have their own chambers. The two components are connected using a riser cable and face outwards, so you get a better view of your hardware. It can be easier to work with these cases than ones with a standard layout too, since you can remove the motherboard, while leaving your graphics card in place.

While sandwich layouts often allow for better water-cooling support than standard layouts, and can give a better view of your hardware, they do the opposite for air cooling. The fact that the motherboard sits close to the side panel reduces the CPU cooler height limit, while a more standard layout can often allow for large air coolers to be used.



Cooler Master's NR200P uses a standard layout, and is friendly towards both air and water cooling



Sandwich cases, which mount the motherboard in the middle, aren't great for air cooling but they're often good contenders for water cooling

Thankfully, cases such as Cooler Master's NR200P and Streacom's DA2 V2 (used in our example build), while sticking to the standard layout, are still relatively water cooling-friendly.

The sandwich layout is often seen as the most efficient and flexible design for mini-ITX systems. The key is its ability to cater for the graphics card in terms of airflow if a mesh panel is used, while the base or roof are freed up to allow for radiators to be installed. The latter is important, because the sandwich design means the CPU cooler height is very limited, making some sort of liquid cooling essential if you want to use a high-end CPU. You'll have options for glass or vented side panels, so a lot will depend on whether you want to air or water-cool your PC.

Tower cases such as the Phanteks Shift 2 have the benefit of super-small footprints



If you're happy to use integrated graphics, you can go for a super-small case such as InWin's Chopin

Next up are tower cases, such as Ssupd Meshlicious (see p18), NZXT's H1 and Phanteks Shift 2, which have the benefit of super-small footprints. They're worth considering if you want to maximise desk space, and their extra height means they can still house large graphics cards.

The Meshlicious' mesh panels allow it to cater well for water-cooling hardware as well, but custom water-cooling support is non-existent in the other two cases without modding or an extremely tight fit. Support for all-in-one liquid coolers is also very limited in these cases.

Meanwhile, NZXT's H1 has been at the centre of fire-hazard issues, but the company is now shipping the case with nylon riser cable mounting screws, so if it takes your fancy, ensure your sample includes these screws or contact NZXT to make sure.

If you don't need a GPU and want to use integrated graphics, there are plenty of options to go really small. InWin's Chopin and the similar CIT MTX-007B are smaller than a shoebox, and while they won't be able to cope with powerful Intel CPUs such as the Core i9-11900K, mid-range quad-core CPUs such as the Core i3-10300 will be manageable. Sadly, though, their sub-200W PSUs aren't able to handle AMD's new Zen 3 APUs under full load.

SMALL POWER SUPPLIES

Keeping the volume of components in a mini-ITX case to a minimum is important, as unnecessarily large parts can limit space for coolers, radiators and graphics cards. One component that has been shrunk in recent years is the PSU. They're now available in



SFX PSUs are smaller than ATX PSUs in every dimension



SFX and SFX-L form factors – SFX PSUs are smaller than an ATX PSU in every dimension, while SFX-L PSUs are just thinner.

However, even SFX-L PSUs can enable a case manufacturer to shave an inch or so off case's width or height, while an SFX PSU's tiny size means you gain even more space inside a case and can shrink it down further.

What's great about modern SFX PSUs is that they lack little in terms of power, efficiency or customisation. They're available in capacities above 1000W, have high efficiency ratings, enough power connectors for graphics card with three or four 8-pin PCI-E power sockets, and you can even get custom cables for them too.

Even if your case has an ATX PSU mount, you can still save space by mounting an SFX PSU there instead, using adaptor plates that are either included with the PSU or readily available. You'll need to be prepared to invest in an SFX PSU if you're considering downsizing your desktop, as many mini-ITX cases require them now.

AMD VS INTEL

Both of the main CPU manufacturers have pros and cons when it comes to mini-ITX, both in terms of their CPUs and the motherboards available to support them. Intel has wider adoption of Thunderbolt than AMD, which can be handy for reducing cables. There's also a more modern, varied selection of mini-ITX motherboards available with its Z590 chipset than with AMD-based models, with wider

AMD's Ryzen 9 5900X is currently the most powerful CPU you can install in a mini-ITX system

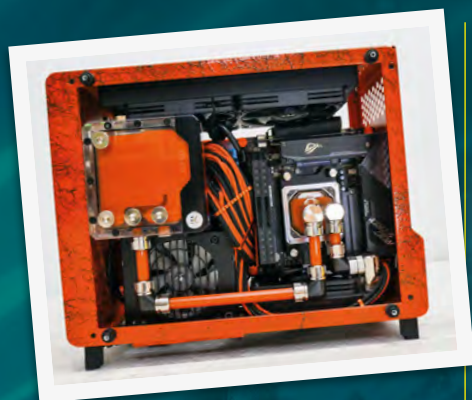
use of USB Type-C headers and the latest networking standards.

Intel's CPUs also offer integrated graphics (as long as they're not 'F' models), so if you don't want to use a discrete graphics card, Intel offers the fastest performance with CPUs such as the Core i9-11900K and Core i9-10900K being faster than AMD's APUs. However, its Core i5-11600K and Core i5-11400F are still excellent choices in their own right, even if you'll be using a graphics card.

If you do want to use a graphics card, though, then AMD has some distinct advantages. An AMD CPU can offer more multi-threaded performance, with the 16-core Ryzen 9 5900X being the most powerful CPU you can use with mini-ITX, seeing as ASRock's X299E-ITX/ac is no longer available. AMD's latest CPUs are generally less power-hungry than Intel's too, which is a big bonus for smaller cases.

CPU COOLING TIPS

Despite their small size, some mini-ITX cases can house the biggest air coolers available, while other can accommodate enough radiators to cool high-end water-cooled PCs. Your choice here will largely depend on the case you use and its internal layout. For example, many tower cases and sandwich cases have very limited CPU cooler headroom, so if you need potent CPU cooling, you'll want to opt for a case that has an option for AIO liquid coolers.



We squeezed an EK FLT 120 reservoir into this water-cooled mini-ITX build, and used angled fittings to cut down on bends

Cases with a more standard layout will likely have room for a decent-sized air cooler, but there can be issues cooling the graphics card, which is often facing the bottom of the case. You might also prefer to see the graphics card's fans, with it in a vertical mount, but that won't be possible in all cases. We'll talk more about vertical GPU mounts in a minute, but water cooling does have other benefits, aside from making it easier to cool your hardware in a tight space.

EK's FLT 80 reservoir is perfect for squeezing into tight spaces and has plenty of ports for flexibility



The BarrowCH LTPRP-04 combines a pump, reservoir and CPU waterblock in one unit

By placing the radiator in a roof vent or somewhere else it can exhaust warm air, you'll be taking the heat straight from the hot spots and out of the case, which is a great way to keep a cramped system cool. For this reason, it's also a great idea to use motherboard monoblocks, which cool the board's VRMs and chipset as well as the CPU, as it results in a cooler motherboard and more heat being dumped into your water-cooling system, as well as a cooler case temperature.

For this reason, in addition to the fact that mini-ITX cases have a smaller volume of air and fewer fans than your typical ATX case, water-cooling a mini-ITX PC can often be very beneficial in terms of cooling and noise reduction. The downside, of course, is that with fitting custom loops into a small case can often be quite difficult, especially if you're using rigid tubing.

However, it's still possible to build a fantastic PC using all the latest components and have the benefits

Phanteks' Glacier D120 distro plate can be mounted on a flat surface or in a 120mm fan mount

of water-cooling in a small case. You'll need to start by planning your loop very carefully. As usual, there's no strict component order, but you may need to route tubing slightly differently to normal, or use more bends or joins, especially if you're water-cooling multiple components in a dual-chamber sandwich-style case.

To help route the tubing, you may want to consider using angled fittings instead of bending the tubing, as making multiple tube bends in a single length of short tube can be very tricky. You'll also want to limit the hardware that's tightly obstructed by tubing too, such as memory modules and SSDs. If you need to remove them, you'll need to drain your whole loop, which can be very time-consuming.

There aren't many distro plates available for specific mini-ITX cases, but there are universal ones, such as the Phanteks Glacier D120. This can be mounted on a flat surface, or in a 120mm fan mount, and can help you to route tubing around motherboard trays and other components without the need to use too many additional expensive fittings.

Don't use full-sized reservoirs in mini-ITX cases though. There are plenty of smaller

options that will save space and work just as well as their full-sized counterparts. EK's FLT 120 D-RGB is a great choice, and EK has just released an even smaller version – the FLT 80, which is perfect for squeezing into tight spaces and has plenty of ports for flexibility, filling and draining. There are also combined pump, reservoir and waterblock units too, such as the BarrowCH LTPRP-04.

We recommend sticking to 30mm-thick radiators or thinner models in a mini-ITX PC. These slimmer radiators are easier to get working at peak efficiency with fewer fans than thicker radiators. Moving up to 45mm or 60mm-thick models will increase the amount of static pressure needed to get them to perform optimally. With space at a premium, you'll also want to stick to a single row of fans on your radiator.

USE M.2 SSDs

While the latest M.2 SSDs might not give you the huge speed increases we saw when moving from a hard disk to SATA SSDs, they're fantastic for mini-ITX builds for other reasons. Every M.2 SSD you use instead of a SATA drive prevents two cables (power and data) from cluttering the inside of your case. Cable clutter is a real issue in mini-ITX cases, as airflow and cooling are already at a premium.

M.2 SSDs are fantastic for mini-ITX builds, as they mount directly on the motherboard with no cables required. You may even be able to free up more space and improve airflow further by removing the drive bays for SSDs and hard disks.

Most motherboards have at least two M.2 ports, allowing you to use a cheaper high-capacity SSD for mass storage, plus another faster, smaller and pricier one for Windows and game installations.



SLIM FANS AND RADIATORS

Ideally, you want to kit out every fan mount in your mini-ITX case with a fan in order to maximise airflow and ensure heat is being effectively removed. However, sometimes this can be easier said than done. PSUs, coolers, graphics cards and radiators can sometimes obscure fan mounts, meaning there isn't enough headroom for a normal fan.

If you're pushing the boundaries of what's possible in your case, you may find that you're just a few millimetres short of being able to fit fans or radiators in one location, perhaps as the manufacturer hadn't anticipated what you're trying to achieve. Thankfully, there's hardware available that can help you out here. Slim fans are 10mm thinner than typical 25mm-thick fans, shaving a centimetre off the clearance needed to mount them. This might mean the difference between being able to install them or not.

Combining slim fans with slim radiators can mean the difference between water-cooling your mini-ITX PC and not doing so

Similarly, XSPC's TX-series radiators do the same for water-cooling hardware. They're only 20mm thick compared to 25mm or 30mm for other slimline radiators. Combining these slim fans and radiators can mean the difference between water-cooling your mini-ITX PC and not doing so. You might even find you can squeeze a second radiator into the chassis to improve cooling further.

We've used a bunch of slim fans over the last year, and we've cherry-picked our favourites here based on their peak airflow, noise levels and value. If you need decent amounts of airflow and lots of headroom from a fan that can spin up when needed, then we'd



Every M.2 SSD you use instead of a SATA drive saves two cables from cluttering the inside of your case



Noctua's NF-A12x15 offers a great amount of airflow for a slim fan



ARCTIC's P12 Slim doesn't offer the peak airflow of the Noctua, but it can be quieter, especially at lower speeds



recommend Noctua's NF-A12x15. There are slightly quieter fans, but none can beat it in terms of peak airflow and noise, although it is a tad pricey.

If you're looking for a cheaper, quieter fans, ARCTIC's P12 Slim is a great choice. It doesn't offer the peak airflow of the Noctua, but it can be quieter, especially at lower speeds

and it has a slightly more pleasant noise quality too. Finally, Akasa's Slimfan is also worth considering as a sub-£10 option. It has reasonable airflow, but can be a tad noisy at full speed.

UNDERVOLTING

Normally, at **Custom PC** we talk about adding volts to your hardware's settings, but when it comes to getting components running cooler and generating less heat, undervolting them can dramatically lower the temperature of your hardware. This method works especially well and is very easy to implement on your graphics card.

With cards based on the Nvidia GPUs such as the GeForce RTX series, you can lower the voltage to around 900mV quite easily and even further if you reduce the core frequency as well. This obviously has the impact of reducing performance a little, but if you're trying to cram an RTX 3090 into a small case, you'll be glad to have slightly lower temperatures.

Try undervolting your RTX GPU to a maximum of 900mV using MSI Afterburner's curve editor

To give this a whirl, download MSI Afterburner and locate the curve editor. This will open up the voltage curve editor. Click on the required voltage, in this case 900mV, and drag this part of the curve up to where the peak voltage frequency points are. Clicking Apply will limit the voltage to that figure across all remaining frequency points, reducing temperatures and power consumption. Similarly, AMD's GPUs can be tweaked to lower voltages in its driver software.

PCI-E RISERS

Riser cables are very common in mini-ITX cases, and they enable your graphics card to sit in different positions and not be directly attached to the motherboard.

This allows case manufacturers to design sandwich-style cases and some tower cases, such as the Phanteks Shift 2 and Ssupd Meshlicious. PCI-E risers are simple to use and are usually made to fit your specific case,



PCI-E risers enable your graphics card to sit in different positions and not be directly attached to the motherboard

so you won't find too much unsightly slack in the cable.

You need to be aware of a couple of factors here, the most important one being PCI-E 4 compatibility. Until very recently, riser cables didn't support PCI-E 4, and using a PCI-E 4 motherboard and graphics card set to this mode would cause severe system stability issues if you used an older PCI-E 3 riser.

Switching off PCI-E 4 in the motherboard's BIOS fixes this problem, and PCI-E 4 doesn't offer much in the way of speed benefits for most graphics cards anyway. However, it caught out a lot of people pairing the latest AMD X570 and B550 motherboards with PCI-E 4 GPUs. Thankfully, PCI-E 4 riser cables are now available, but it's worth being aware of this issue.

NVIDIA FOUNDERS EDITION GPUS

We generally love Nvidia's Founders Edition graphics cards, with their classy coolers and unique flow-through fans generally doing a good job of cooling the GPUs beneath them. However, the flow-through fans that were present on models, such as the RTX 3070 and RTX 3080, resulted in some difficulties for a lot of mini-ITX case owners.

The trouble came in a variety of forms. The most serious one was that in some cases, especially those that used riser cables to flip the graphics card, the flow-through fan would be sitting right next to the motherboard tray and massively hindering airflow. Cases with sandwich layouts such as the Raijintek Ophion, or tower designs with riser cables such as the NZXT H1, suffered here, seeing far higher GPU temperatures than in other cases.

Cooler Master's NR200P proved to be one of the better options here, as the flow-through fan points at the case's roof fans, and the card can also draw in cool air from the base. If you have a Founders Edition RTX graphics card with a flow-through fan, you'll need to pick your case very carefully and make sure it has adequate clearance, as well as a

Vertically mounted graphics cards look great, but putting them right next to an unvented side panel can cause cooling problems

means to deal with the warm exhaust air from the fan, or alternatively you can water-cool your card.

KEEPING COOL

There are generally fewer fans in mini-ITX cases, and less air, but case fixtures such as storage mounts are the same size as usual, as are cables and other items that can hinder airflow. This can mean that airflow and cooling is lower in mini-ITX cases compared with their ATX counterparts. This can pose a problem for components that rely on case airflow for cooling, such as VRM heatsinks.

You'll want to do a good job with cable tidying to keep airflow paths free of obstructions, reduce cable numbers by using M.2 SSDs and combine cables where possible into single strands, so these areas get the cooling they need. It's also a very good idea to monitor temperatures of your system once you've built it just to check hot spots such as VRMs aren't getting too hot.



The flow-through fans on Nvidia Founders Edition cards are sometimes blocked by mini-ITX case configurations, leading to your GPU overheating



Cooler Master's NR200P is our top mini-ITX recommendation for beginners

VERTICAL GRAPHICS CARDS

Most of us want to see the fancy hardware inside our PCs, and the graphics card is the focal point for many people, especially if you've had to pay over the odds for it over recent months.

The problem with many cases, and not just mini-ITX ones, is that the usual layouts have the graphics card facing down, often with snazzy shrouds, fans and RGB lighting hidden from view as a result.

The way around this is to use a vertically mounted GPU. Many cases include the option to mount them vertically with the aid of a riser cable these days, while some mini-ITX cases use vertical mounts as standard. While this gives you a fantastic view of your graphics card through a side window, though, it can cause problems with cooling.

Your graphics card needs cool air to draw into its cooler, and a glass side panel next to it will be preventing it from being able to access this cool air, dramatically increasing GPU temperatures and even causing throttling. Even having air flowing through the case won't completely solve the problem.

The issue is largely solved by using a vented side panel, but the downside is that you then won't be able to see your graphics card. One way around this is to water-cool it, as you won't need the vent if the heat is removed by a radiator elsewhere.

Another solution to this problem is to dramatically boost airflow in this area, although

that can be difficult without plastering the inside with small fans. An alternative option is to create your own clear side panel with ventilation holes.

You can't do this with tempered glass, as it will shatter if you drill into it, but you can do it with clear acrylic. This way, you can see your hardware and allow it to breathe at the same time – we show you how in our guide on p102.

Overall, you'll need to carefully consider your options here, and whether your chosen case will work

well with a vertically mounted graphics card, even if it's set up for it straight out of the box.

COMPATIBILITY ISSUES

Compatibility issues can be a major factor with mini-ITX hardware, although the spec lists for cases usually specify CPU cooler and GPU clearances. However, it's much trickier to nail down compatibility problems with coolers and motherboards.

For instance, the Asus ROG Strix Z590-I Gaming WiFi we reviewed on p16 was incompatible with three air coolers we tried to fit to it, with the be quiet! Dark Rock TF 2 low-profile cooler fouling the I/O shroud and M.2 heatsink, while even the tiny ARCTIC Freezer i13X's mounting mechanism wouldn't fit between the M.2 heatsink and VRM heatsink.

If you're using hardware than no one else has mentioned online as being compatible then you sometimes run the risk of it not being compatible – if in doubt, always do some Googling on compatibility before you purchase an air cooler for your mini-ITX machine.

OUR TOP CASE PICKS

While many people love the challenge of building a small PC, if you just want a tried and trusted case that won't cook your hardware and doesn't have many limitations, then you still have some solid options.

Our top beginner's case is the Cooler Master NR200P. This fantastic mini-ITX case is well regarded by reviewers, newcomers and long-time small form factor fans alike, thanks to its flexible layout, support for ATX and SFX PSUs and room for water-cooling radiators.

It's well made and has the option of both glass or vented side panels in the box, with Cooler Master sensibly offering both vertical and horizontal GPU mounts as well. It offers excellent value and a great way to start with mini-ITX – it even has 153mm of CPU cooler clearance.

If you want to step up to a case that's a little more distinctive and adventurous, the Ssupd Meshlicious (see p18) is worth considering. This tower-style case has an extremely small footprint, but is shorter than other tower cases such as the Phanteks Shift 2.

It has space for a 280mm radiator, and can be equipped with meshed panels or a combination of mesh and glass side panels, plus it even has space for custom liquid cooling. It's very easy to work with this case, even if it's rather simplistic, and has poor CPU cooler height clearance. Otherwise, though, it's an excellent first case for someone that leans more towards liquid cooling than air cooling.

This month we've chosen Streacom's DA2 V2 case for our feature PC and for a few very good reasons. It looks fantastic and it has all-aluminium construction. What's more, it has customisable elements with the layout, while offering good air and water-cooling support and remaining very compact.

We also loved the Jonsbo A4 in our last mini-ITX case group test, and Phanteks' Shift 2 is also worth a look. The latter is a stunning case, and the new version has improved cooling, although you'll need to carefully choose your hardware, as the Shift 2 can struggle to deal with significant heatloads.



Ssupd's Meshlicious offers room for a 280mm radiator in a small footprint

OUR EXAMPLE MINI-ITX BUILD

We've cherry-picked some of our favourite mini-ITX components for our build this month, so we can show you an example of a cool, small and clean-looking mini-ITX PC.

There are loads of options available, of course, and plenty of combinations from which to choose, but this is our pick of some of our favourite hardware at the moment.

CHOSEN HARDWARE CASE

Streacom DA2 V2

£195 inc VAT

► quietpc.com

The Ssudp Meshlicious might be the case of the moment, and Cooler Master's NR200P is the best for beginners, but Streacom's DA2 V2 is elegant, made from aluminium and highly customisable.

We're using it with the GPU in its standard layout, but you can buy optional kits to mount it vertically and fit a tempered glass side panel, although we don't recommend using the glass panel next to the vertically mounted graphics card unless it's water-cooled.

There's scope for adding liquid-cooling radiators too, although they need to be mounted in the side of the case, which we've not done here for aesthetic reasons, but it is an option.



MOTHERBOARD

Gigabyte Z590I Vision D

£270 inc VAT

► scan.co.uk

With the Asus ROG Strix Z590-I Gaming WiFi proving troublesome when it comes to working nicely with our CPU coolers, we've opted for Gigabyte's Z590I Vision D. Even here, the ARCTIC Freezer i13X we used has mounting components that needed to be shoehorned in among the heatsinks, but it does fit. Uniquely in the mini-ITX world, this motherboard also has a white colour theme, which matches our memory and cooler, plus it has Thunderbolt 4 support.

POWER SUPPLY

SilverStone SX750

£130 inc VAT

► scan.co.uk

As we're using a GeForce RTX 3080 Ti graphics card, we've opted for a fairly powerful SFX PSU in the form of SilverStone's SX750. It's 80 Plus Platinum certified and has more than enough connectors for our hardware. The cables are also all modular, so we can ditch the ones we don't need. We've opted for SFX rather SFX-L, as it gives us more clearance above the graphics card's flow-through fan.

PROCESSOR

Intel Core i5-11600K

£239 inc VAT

► overclockers.co.uk

Intel has some compelling mid-range CPUs at the moment, and as we'd already chosen the gorgeous Gigabyte motherboard as our centrepiece, we've opted for the Core i5-11600K. It's a match for AMD's Ryzen 5 5600X in most gaming tests, but it's much cheaper and it doesn't draw anywhere near as much power as the Core i9-11900K. This makes it a good fit for a mini-ITX build, especially as we'll be using a relatively small cooler.



GRAPHICS CARD

Nvidia GeForce RTX 3080 Ti Founders Edition

£1,095 inc VAT

► scan.co.uk

We've opted for an Nvidia GeForce RTX 3080 Ti graphics card, which is the most powerful card in Nvidia's arsenal below the monstrous RTX 3090, which will be stretching the confines of our case and PSU, plus it's overkill for most scenarios.





Our case is happy dealing with the flow-through fan on the cooler too, as we've added some slim 120mm fans to the roof.

We've even spotted stock of the Founders Edition model on scan.co.uk for the standard £1,095 inc VAT retail price this month. At the moment, buying a graphics card is more a case of getting what you can find or afford than getting what you want, but the RTX 3080 Ti is a cracking GPU and there's nothing to prevent you from putting one in a mini-ITX PC once you've done your homework.

CPU COOLER

ARCTIC Freezer i13X

£22 inc VAT

► overclockers.co.uk

You can jiggle around the layout of our case to mount an all-in-one liquid cooler, but ARCTIC's Freezer i13X sits within the confines of our case's CPU cooler height limit, and our testing showed it was capable of handling Intel's



high-end CPUs, even with an overclock, so our stock speed Core i5-11600K should be perfectly fine. It's also very reasonably priced and relatively quiet.

MEMORY

Corsair Dominator Platinum RGB

£22 inc VAT

► overclockers.co.uk

We've opted for a 16GB (2 x 8GB) kit of white Corsair Dominator Platinum RGB memory to match our cooler and motherboard. However, the height of this memory can be an issue in some situations, so check your CPU cooler's height clearance and the dimensions of any other parts that will be positioned near the memory modules. This memory was certainly pushing the height limit in our system, but we



saw no difference in the temperatures when swapping to shorter memory modules, so we're happy with the choice here, especially as it looks great.

SOLID STATE DRIVE

ADATA XPG GAMMIX S50 Lite

£257 inc VAT

► box.co.uk

We wanted to use a PCI-E 4 M.2 SSD in our mini-ITX build and we've opted for the 2TB version of ADATA's XPG GAMMIX S50 Lite.

It offers fantastic value, and while it doesn't offer the super-fast sequential speeds of the latest high-speed SSDs, it can still offer up to 4,000MB/sec throughput, with 2TB of storage, costing just over £250.

FANS

ARCTIC P12 Slim PWM

£5 inc VAT

► scan.co.uk

Alphacool Eiszyklon Aurora LUX

£7 inc VAT

► aquatuning.co.uk

We've added a pair of ARCTIC P12 Slim PWM fans to the roof of our case to deal with the heat, especially the air directed at them by the flow-through fan on our graphics card. In addition, we've added a single 92mm Alphacool Eiszyklon Aurora LUX RGB fan to the rear of the case, in order to aid the CPU cooler and add a little more RGB pizzazz to our system.







THE BUILD

We've decided to opt for the standard layout in our Streacom DA2 V2, but this optional vertical GPU backplate **1** allows you to mount your graphics card vertically, which can make way for more fans or radiators, albeit at the expense of any kind of view through the side panel. There are quite a few panel options too – you can opt for a tempered glass side panel **2** or stick with the vented side panel for the best cooling **3**. The latter is highly advisable if you opt for the vertical GPU mount.

Our motherboard of choice is Gigabyte's Z590I Vision D, which comes with a large heatsink for M.2 SSDs – ours is already installed under the heatsink here, and our Core i5-11600K is installed in the CPU socket **4**.

Next up is the CPU cooler, which needs to have its fan removed in order to secure it to the mounting bracket **5**. This is also a good opportunity to secure surrounding cables, especially the 8-pin CPU power connector and fan cables. We then installed the CPU cooler's fan and the memory. The memory modules sit a few millimetres over the edge of the CPU cooler's fan, but we didn't notice any impact on cooling **6**.

The PSU secures to a bracket in the roof of the case and is fully adjustable. We moved the PSU to the back of the case as far as it would go **7**, in order to keep the cables away from the graphics card.

The Founders Edition graphics card's flow-through fan needs to be kept clear, so that it can shift air out unobstructed. You can see the PSU cables are well out the way, and no other cables are positioned nearby, with the fan having a clear path to the roof of the case **8**.

Our roof fans sit above the CPU and PSU, and draw air into the case using negative air pressure through the vented side panels **9**. The fan on the right is particularly important, as it deals with air expelled by the GPU's flow-through fan.

Finally, we've installed our rear exhaust fan. The ARCTIC fans come with PWM splitter cables and can connect to each other as well as another fan. However, we found that the three fans would switch off below certain voltage levels when they were all connected in this way, so it's best to hook up this fan to a separate fan header. Our high-powered mini gaming PC is now ready for action **10**. **CPC**

INTEL ARC GRAPHICS

INTEL IS FINALLY READY TO STEP UP ITS GRAPHIC GAME WITH A LINE OF DISCRETE GRAPHICS CARDS. **EDWARD CHESTER** INVESTIGATES WHAT'S IN STORE WHEN THE PRODUCTS ARRIVE EARLY NEXT YEAR

Despite being the by far the largest seller of GPUs in the world, thanks to the integrated graphics in its CPUs, Intel has never managed to successfully break into the discrete graphics card market that's now dominated by AMD and Nvidia. That's not entirely for lack of trying though.

Over the years it has made a number of attempts to enter the fray, such as with the i740 – an AGP-based card built on Real3D technology – that launched in 1998 and was scrapped 18 months later. Then there was the more recent x86-based Larrabee project that launched in 2006 and was again scrapped, this time three years later.

With its latest venture, though, Intel is finally promising that this time its new graphics cards will actually launch and stay the course. They're set to arrive in early Q1 2022, and will be based on a revised version of the company's existing Xe graphics technology – the low-power version of which we saw debut with the Tiger Lake family of processors.

Intel is promising high performance, a full raft of support for the latest graphics technologies and even a cross-platform competitor to Nvidia's DLSS upscaling technology. Many of the finer details are still being very much kept under wraps but there's still plenty to unpack from this initial announcement. Let's dive in.

THE NAME GAME

As is often the case with new launches from processor producers, the naming conventions

for Intel's new discrete graphics venture, and all the layers within it, take a bit of unpacking. At the top of the tree is the new Intel Arc brand. This is the equivalent of AMD's Radeon and Nvidia's GeForce brands – it's the company's overarching graphics brand that you'll see slapped on the side of boxes.

Why Arc? Well, Intel explained that the name doesn't have a concrete link to any one thing, but it does evoke several tangential ideas. You have the idea of an electrical arc that harks back to the foundation of what the company does (never mind that an electrical arc would fry most electronics inside a computer), plus there's the idea of a story arc, so a graphics card can lead to the enjoyment of a game's story.

almost certainly won't be the final name for the product (or feature anywhere in it), but it's equivalent to the company's codenames it uses for CPUs, such as Rocket Lake that came to market as the 11th-gen series of Core processors.

Intel has also confirmed the names of the next three GPUs/SoCs that will follow Alchemist. First up we have Battlemage, which will be based on a 2nd-generation Xe2 architecture, then Celestial (based on Xe3) and then Druid, which will use an 'Xe Next' architecture.

They're all suitably bombastic, gaming-influenced names – it's a far cry from the peaceful evocation of the Lakes and Coves of the company's CPU names – and the

certified geniuses among you will have noticed that they're also alphabetical. It's all logical yet fun, which is a pretty solid option for a gaming brand. Our bets are on Elemental for the fifth generation – any better ideas?

Taking a step further down the naming tree (yes, we're sticking with this analogy) is the name of the underlying microarchitecture that will power the next, and several subsequent Arc GPUs. Here we come across the first existing

branding from previous Intel products, as the overarching microarchitecture brand family is Xe, which we first saw introduced in the integrated graphics of 11th-gen Core CPUs.

The integrated version uses a low-power Xe-LP variant of the Xe architecture, while there have also been several other Xe variants. Xe-HP (high performance) is aimed



The final piece of the puzzle is that Arc is an undeniably neat name – it's short, sharp and impactful. Under the Arc branding, we then have the names of the specific GPUs. Launching next year will be the first of the new Arc GPUs, with the GPU system-on-a-chip (SoC) codenamed Alchemist. As with most new chip launches, this SoC codename



Xe-core

Compute Building Block of Xe HPG-based GPUs

16
Vector Engines

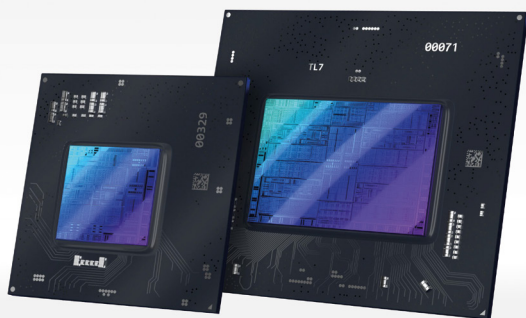
256 bit
per engine

16
Matrix Engines

1024 bit
per engine

intel
ARC[™]

Powered by
Alchemist SoC



Alchemist will be the first gaming GPU to ship under Intel's new Arc graphics brand

at data centre use where many smaller chips will be used in parallel, while Xe-HPC (high performance computing) is a larger standalone computing product akin to Nvidia's Tesla products.

There's also Xe MAX, which is an entry-level standalone GPU used in laptops and marketed as Iris Xe, and this chip was also made into a discrete card that developers could use to start optimising for the upcoming Arc launch. Confusingly, this Xe-Max chip was codenamed DG1 (DG1SDV for the card

version), meaning the first Intel Arc chip (Alchemist) will actually be called the DG2. For Arc, then, Intel is introducing Xe-HPG or Xe high performance gaming, which is going to be our focus for the moment.

XE-HPG

Intel hasn't yet dived deep into the inner workings of the new Xe-HPG architecture – more info will be arriving over the next few months. However, Intel has given us an overview of the key layout and new features, starting with the new building block of the architecture, the Xe-Core.

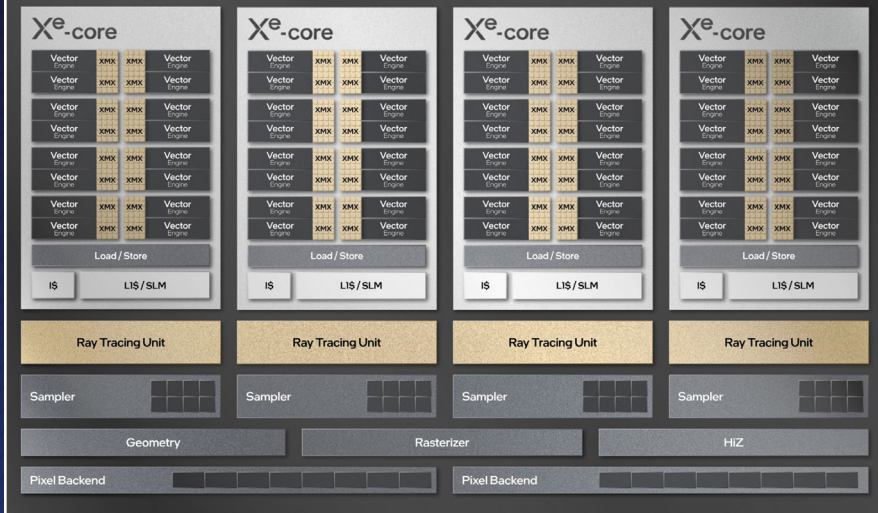
The Xe-Core replaces the EU as the new building block of Intel's GPU architecture and is a much larger structure

The Xe-Core replaces what Intel called an Execution Unit (EUs) in its previous Xe-LP graphics architecture, although part of the reason for the name change is that the two systems are now so different that they're not really all that analogous. To get a sense of the changes, and of what might be inside the Xe-Core, let's start by looking at one of those Xe-LP EUs.

An Xe-LP EU is like an AMD compute unit or Nvidia streaming multiprocessor. It's basically a set of mathematical calculation-performing pipes called arithmetic logic units (ALUs), all arranged together along with some other circuitry for managing the movement of instructions and data to and from the ALUs.

Each block of ALUs receives a single instruction (which can vary but can't be different for each ALU at any given moment) and can perform the same instruction on lots of sets of data at once, determined by the number of ALUs. This is known as a single instruction multiple data (SIMD) structure. Managing the balance of having many ALUs performing more calculations per clock cycle, but the possibility of not having enough data that needs the same instruction performing

Render slice



The Render Slice combines four Xe-Cores with other graphics fixed function units, and adds ray-tracing units

on it in each cycle, is one of the key challenges of GPU architecture design.

Coming back to the Xe-LP EU, then, it houses an 8-wide (eight ALU) SIMD that can perform eight standard integer or floating point vector calculations per clock cycle. It also has a two-wide SIMD for extended maths operations. Surrounding these are the circuits for managing the movement of data and instructions to and from the SIMDs.

With the Xe-Core, then, those SIMD blocks have been called Vector Engines and we now get 16 of them per Xe-Core. Although

we don't officially know the contents of each Vector Engine, we can make an educated guess based on the fact that Intel has said each Vector Engine can process 256 bits per cycle. Breaking that down, this would seem to suggest that each Vector Engine contains eight FP32 (32-bit floating point) ALUs, which would be the same number as the Xe-LP EU.

This apparent similarity in vector calculation capability between the old EU and the new Vector Engine begs the question of why Intel didn't suggest the new Vector Engine is, in fact, the most analogous component to the old EU. The answer would seem to be that the new Xe-Core houses more of the overarching

THE MATRIX ENGINES POTENTIALLY GIVE INTEL AN ADVANTAGE OVER AMD

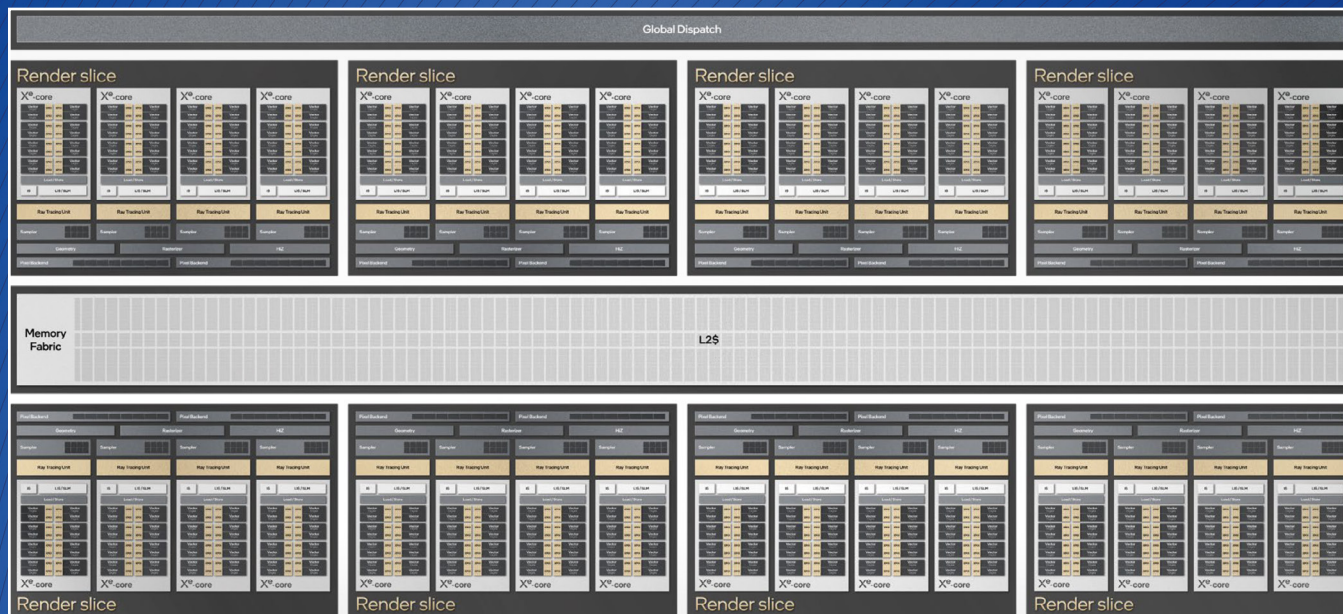
thread management circuitry, and possibly has a separate extended math function area, which was previously housed in the Xe-LP EU.

In other words, while an EU could handle any standard calculation task thrown at it, the Vector Engine can't. You have to move up to the Xe-Core to get that level of feature support, which is why Intel is considering it the new basic building block.

Regardless, what's even more clearly different about the new Xe-Core is the introduction of Matrix Engines. These specialised units are designed to perform the matrix calculations that are so crucial to AI and deep learning techniques. These are analogous to Nvidia's Tensor cores, and they will potentially give Intel a distinct advantage over AMD when Arc arrives, as AMD's RDNA2 architecture doesn't currently have this type of specialised calculation block.

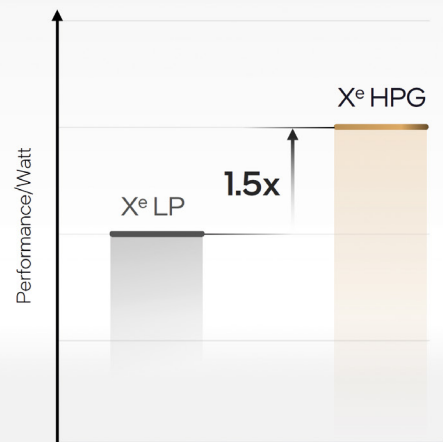
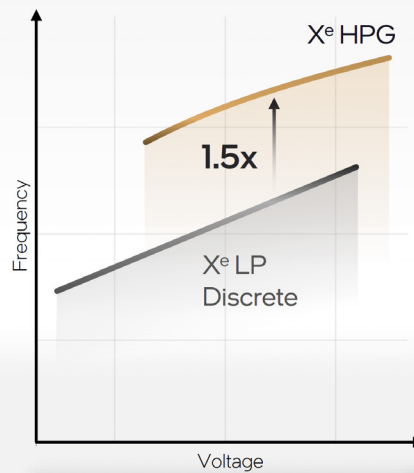
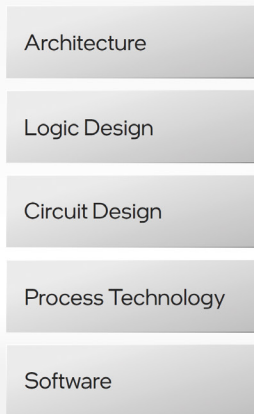
Each Xe-Core will get 16 Matrix Engines, with each engine able to process 1,024 bits per clock, which amounts to 64 FP16 matrix operations per cycle. Multiply that by the 16 matrix engines per Xe-Core and you get 1,024 FP16 matrix operations per cycle.

A full Xe-HPG implementation can support up to eight Render Slices on one chip





Leadership IP Performance/Watt



Intel shows big gains in performance between Xe-LP and Xe-HPG, but it's unclear how much of this is down to the move to a 6nm manufacturing process

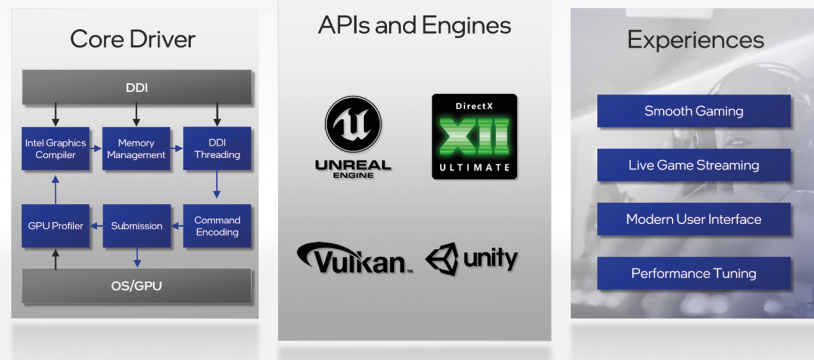
This is actually double the matrix processing power Nvidia has added to each SM block in its Ampere architecture (each SM has the same theoretical vector operation throughput as an Xe-Core), suggesting Intel is betting even bigger on this type of processing in future gaming. This is also apparent with Intel's announcement of its XeSS technology, which we'll discuss shortly. These Matrix Engines will be accessible via Xe Matrix eXtension (XMX) instructions, making them currently exclusive to this new architecture.

SLICE AND DICE

The next stage in putting together an Xe-HPG GPU is combining four Xe-Cores into what's known as a Render slice. Along with the Xe-Cores, the Render Slice introduces the rest of the main graphics pipeline elements, such as texture sampling units, geometry units, a rasteriser and the pixel/render backend. We have no further details on the capabilities of any of these components, but we can see that there are some obvious differences compared with the Slice/Subslice structure used in Xe-LP.

On Xe-LP, you got one geometry engine and rasteriser, plus three pixel backends shared across six subslices (a component analogous to the new Xe-Core that housed 16 execution units) and their 768 vector ALUs. On Xe-HPG, however, you get just

Software First



two pixel backends and the geometry and rasterisation hardware shared across just four Xe-Cores (totalling 512 vector ALUs). Xe-HPG has greater front end power (geometry shading and rasterisation) compared with the rendering and backend elements.

Meanwhile, the elephant in the room is the addition of four ray-tracing units for each Render Slice. Intel has confirmed that these units can accelerate ray traversals, bounding box intersections and triangle intersections, which puts them on par with Nvidia's ray-tracing hardware and ahead of AMD's ray-tracing abilities – RDNA2 lacks ray traversal acceleration.

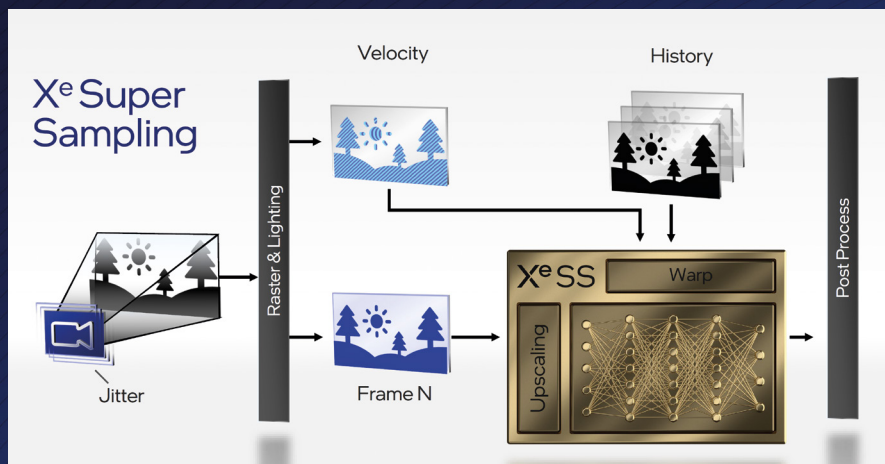
There's no further word on actual performance, though, and as we've seen with the significant improvement from Nvidia's 1st-generation ray-tracing units to its

A new unified driver will bring many new gamer-centric features to the fore

2nd-generation ones, there can be significant differences in performance hidden behind these currently well-guarded technologies.

The final main stage in putting together an Xe-HPG GPU is stacking together the number of Render Slices you want – up to eight can be combined – along with a global dispatch engine that issues work to the Render Slices and a unified L2 cache and memory fabric. Again, there's no performance detail on these features, such as L2 cache sizes or its bandwidth, nor any word on what memory will be used.

However, we can expect this stage of the architecture to be where fixed-function components are added, such as the display controllers, media engine (video encoder /



XeSS uses previous frame and movement data to enhance its upscaling algorithm

when it comes to its graphics products – it's generally been utilitarian and basic. With Arc, though, the company is stepping up to the sort of feature set we'd expect from an enthusiast-level graphics card maker.

For a start, the company is unifying its integrated and discrete graphics drivers, so you'll be able to just download one package to set up any of its GPUs. This will be particularly beneficial for future laptops systems that may include both an integrated graphics module and a discrete GPU. The new Core Driver will also include integrated live streaming, performance tuning and overclocking features, while coming with a host of performance and feature enhancements.

For example, memory management has been improved to provide a boost of up to 18 per cent in memory throughput in CPU bound titles, and a 25 per cent improvement in game load times. Some of the latter comes from enhancements to stage compilation technology, such as eliminating redundant shader compilation and improving task scheduling for compiler threads.

However, we do wonder whether a large part of these enhancements may just be down to implementing DirectStorage and Resizable BAR, which are both technologies that AMD and Nvidia also support.

Intel has also confirmed that Unreal Engine 5 runs on Arc already, and that Vulkan and Unity will be supported too, along with the full raft of DirectX 12 Ultimate features, including hardware-accelerated ray tracing, mesh shading and sampler feedback.

XESS

Saving perhaps the best until last, one of the more exciting features that will arrive with Arc is an alternative to Nvidia's temporal upscaling technology, DLSS. XeSS, or Xe Super Sampling, will use essentially the same principle as DLSS to provide in-game upscaling (and anti-aliasing), which can significantly exceed the image quality of conventional upscaling techniques, but instead of being locked to only one hardware vendor, it will be cross-platform.

DLSS and now XeSS are upscaling techniques that take a lower resolution output from the game engine, then upscale that output to your monitor's native resolution. They use data from previous frames and



The XMX cores of Xe-HPG will allow it to run XeSS faster, but DP4a instruction support will mean it runs on all graphics cards

decoders), PCI-E interface and all the other miscellaneous pieces that make up a modern GPU. Thanks to some Linux driver commitments, it's also believed Xe-HPG will support DisplayPort 2, which would make it the first GPU to do so.

Intel hasn't yet confirmed just what sort of iterations of Xe-HPG we'll see arrive as actual purchasable products either. Will the full eight-Render-Slice version be available at launch, or indeed ever? Will we see an affordable version with just four Render Slices? We'll just have to wait and see.

NEW PROCESS, NEW PERFORMANCE

While we can't yet fully piece together exactly how Alchemist's performance will be created, what we do know is that according to Intel, Xe-HPG should provide a 50 per cent boost in both performance per watt and clock frequency over Xe-LP.

If we take Xe-MAX's 1650MHz clock speed as the representation of the peak frequency of Xe-LP implementations, that would give us a peak speed for Xe-HPG products of around 2475MHz, which would put it well ahead of Nvidia's RTX 3000 series cards and a little ahead of AMD's RX 6000 cards. Whether that proves to be the case, though, is very much an unknown at this point.

What we do know is that Intel will be partnering with TSMC to produce the GPUs, using the latter's latest 6nm (N6) process node technology. This would seem to suggest Intel will be first to market with this new node, giving it a potentially significant advantage over both AMD and Nvidia that are still using the company's 7nm (N7) node. N6 is considered a refinement of N7, rather than a step change in manufacturing technique, so the benefits may not be all that large but any advantage is significant in this game.

CORE DRIVER

Intel has never been well known for having great user-accessible software features



Like DLSS, XeSS can produce incredible detail levels compared with native upscaling

movement information from the game engine (such as how far the view has moved since the last frame) to predict the best possible image quality for the final upscaled image.

Because the upscaling algorithm has visual data from previous frames and movement data from the game, it can vastly outperform conventional (spatial/non-temporal) upscaling algorithms, which can only stretch out the pixels from a single image.

THESE TECHNIQUES CAN BE SO CLEVER THAT THEY CAN SOMETIMES EXCEED THE IMAGE QUALITY OF NATIVE RESOLUTION

AI, or deep learning, is crucial to both these techniques, with DLSS and XeSS taking advantage of the matrix processing units of Intel and Nvidia's latest GPUs (Matrix Engines and Tensor cores) to accelerate the prediction of the final output image.

These techniques can be so clever that they can sometimes (at high resolutions) exceed the image quality of native resolution in some ways, especially if the game can't use conventional anti-aliasing and uses a form of temporal anti-aliasing. This is because the

previous frame data allows the upscaler to more clearly understand the probable colour of any given pixel.

In contrast, when AMD recently introduced FidelityFX Super Resolution (FSR), it completely left out the whole previous frame, movement data and AI prediction elements because its GPU architecture doesn't include matrix processing units. The result was an upscaler that's easy to implement, but one that struggled to maintain the levels of detail managed by DLSS.

There are two major caveats to DLSS, and presumably XeSS, which are that fast motion can throw out prediction (a problem you don't get with FSR), reducing image clarity. It also doesn't work that well on lower resolutions. As such, we don't particularly recommend DLSS for esports-like titles; you're much better off with a 1,920 x 1,080 screen with a fast refresh rate than a 4K screen running at 60Hz with DLSS boosting performance.

It remains to be seen how well XeSS will balance performance and image quality – the

first implementation of DLSS wasn't great. We also don't know what industry support it will get either, but if it's anything like DLSS 2, it will be a major boon to gamers looking to make the most of 4K screens.

Coming back to the cross-platform aspect of XeSS, Intel says performance will be best using the XMX hardware acceleration of its cards, but it will also implement a version that uses DP4a instructions to at least provide the same technique, just with lower performance. This means it will work on both AMD and Nvidia hardware, but the performance improvement you'll get for any given reduction in render resolution will be reduced. In other words, XeSS is what FSR probably should have been.

THE WRAP-UP

There's clearly a lot to get at least a little bit excited about with Arc. There's every chance it won't really compete with Nvidia at the top end of performance, that supply issues will mean Alchemist cards are just as overpriced as other cards, and stability and game support may be flaky at launch. Time will tell on all those fronts. However, the feature set looks strong and, assuming performance is reasonable, it will certainly give AMD and Nvidia something to think about. **GPG**



PROJECT TILIA

THIS TINY, OPEN-FRAMED PC IS A WONDER OF MINIMALIST DESIGN. AXEL LINDMARKER GUIDES US THROUGH THE PROCESS OF DESIGNING AND MAKING IT

My eyes were opened to the world of PC modding, water cooling and custom builds around a decade ago through a specific build by Laine over at [sweclockers.com](https://www.sweclockers.com). He modified a Lian Li V1000 and to me it was to die for. This was the moment when I realised that a computer could be so much more than a tool; it could be a sculpture.

Fast forward to a year ago and I was about to take the opportunity to ruin my wallet and build a once-in-a-lifetime

computer with top-tier components and a custom water-cooling loop.

The last component I needed was a case that could house it all but still have a small footprint, and most importantly, it had to look like a sculpture that highlighted the components.

At that time I found no case designs with which I was happy. There were quite a few candidates but none of them stood out. Being a designer by trade, albeit not for product design, I decided that there was only

one solution that would let me fulfil the life goal I set a decade ago – I was going to learn how to use CAD and design my own case.

Sending out roots

Before I could get started on the design of the case, I knew I had to have some knowledge of the components that were going into the build.

First and foremost, it's designed to handle gaming at high refresh rates and high resolutions for at least a few years. In



The frame was originally made from plain shiny metal before being Cerakoted

addition, it needs to be able to handle my continued use of CAD and 3D modelling for learning, plus the entire Adobe Creative suite for editing both stills and videos.

Since the build had to be a bit futureproof, I wanted to splurge on extra CPU cores, and at the time there was only really one candidate – an AMD Ryzen 9. I'm not sure if the choice of a 5950X was the best one, but I decided it would at least be fun to flex and get one up on a friend whose PC only had 12 cores.

For me, the next most important feature was the graphics card. Here, I was very much debating whether I should get an Nvidia GeForce RTX 3080 or a 3090, but in the end, the price difference proved too much for me to choose a 3090.

Both the CPU and graphics card are slotted into an Asus ROG Crosshair VIII Impact motherboard, which I chose because I wanted two full-speed NVMe slots; to my knowledge, at the time, this was the only board of its type that included them.

The storage system comprises two 1TB Samsung 970 Evo Plus SSDs and one 2TB Samsung 860 Evo SSD, for a total capacity

of 4TB. The memory comes in the form of a pair of 16GB G.Skill Trident Z 3600MHz DDR4 modules and it's all powered by a Corsair SFX750 PSU.

Growing strong

The design started out in 2D, with a simple layout of the components in Illustrator. This gave me an idea of the probable size and how it would look from the front. I decided

THE DESIGN STARTED OUT IN 2D, WITH A SIMPLE LAYOUT OF THE COMPONENTS IN ILLUSTRATOR

from the start to be quite tactical about how I was designing Tilia.

I knew I wouldn't be able to create a case design as intricate as an NCase M1, for example, but this limitation very much went hand in hand with my idea that this would become a sculptural piece rather than just a nice box. With this in mind, I decided that whatever I designed, it must be able to be folded from one sheet of metal.



The finished frame has a very simple shape, but it's elegant and precisely designed



Tilia was designed using Adobe Illustrator – the bent metal panel was then manufactured to spec

Having designed quite a bit of packaging during my years of learning design, I was quite comfortable thinking about flat shapes and folding them up in my head. The basis for Tilia was basically designed on walks during my lunch breaks, all in my head. When I had a basic idea of the shape I wanted, I set out to make it in CAD.

To my great surprise, working with CAD was much easier than the forays I had made into 3D modelling in Cinema 4D and Blender. The ability to draw an object as a 2D shape that was later extruded made a lot more sense to me, and the ability to finally start visualising the end result was incredible.

The first few rough sketches of Tilia had a lot more sharp edges. It was very much inspired by a rough, cyberpunk-ish industrial sensibility. I was very hyped for Cyberpunk 2077 at the time and was thinking of leaning heavily into its angular, RGB-lit aesthetic. However, after tinkering with that idea

for a bit, I realised this design wouldn't be timeless. Instead, I needed a design that didn't hang on a theme.

Eventually I settled on looking at the works of one of my favourite designers, Dieter Rams. Even if you haven't heard of him, there's a high chance you've seen his work, or work that was influenced by him.

More specifically, I was very much taken by his Phonosuper – SK4 piece, a radiogramophone that combined the organic warmth of wood and the cold machined look of metal. I especially fell for the straight cut-outs for the sound holes, which are also found in some of his other radios.

With this newfound inspiration, I started rounding the corners of Tilia's form. At first, I just made the corners less sharp, but eventually I made them completely round. I also added wooden side panels to give the whole piece a feeling of organic warmth.

As the design became more complete I was faced with two problems. The first one was how to anchor the graphics card and the second was how I to handle cable management.

The final design has attractive symmetry thanks to its mirrored 240mm radiators

The graphics card was the first problem that I ran into. If the entire case were made by folding a single piece of metal, how and where would the graphics card be mounted? I had variants where the holes for the screws were drilled into the side of the bent metal, but this required the thickness of the metal to be increased to 5mm.

I realised this would be hard to manufacture reliably, and in the end I found that the best solution was to make this one

HAVING ALL OF THE PIECES READY AND ASSEMBLING THE CASE FOR THE FIRST TIME WAS AN INCREDIBLE FEELING

little piece separate, and then to manually fasten it to the main body.

After I'd devised that solution, I started fishing for manufacturing help to make the metal body. I didn't have the workspace, tools or expertise to reliably fold thick metal and I needed help. I had to contact several dozen manufacturers in order to find one that would be able to help me out. The journey of finding the right one also proved helpful, as I was able to fish for information

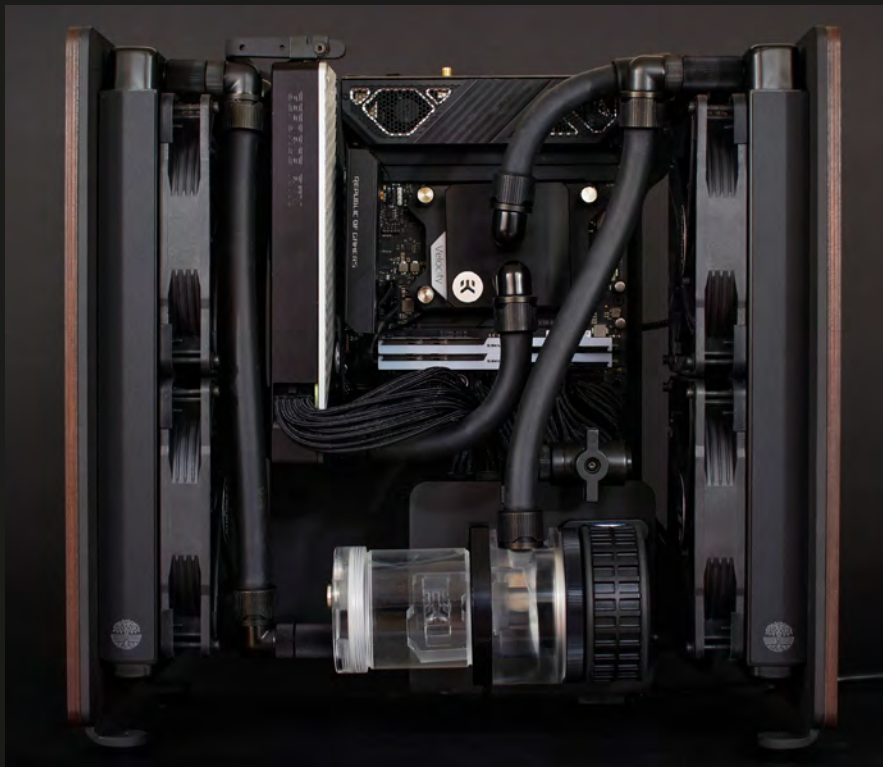
on material choice, tolerances and more, all which helped to improve the overall design.

During this process, I continually updated my CAD model with changes to tolerances, while also attempting to tackle that second problem of cable management. The finished case actually has quite a lot of holes in the back, which were intended for various cable management systems. Unfortunately, one thing I have learned is that 3mm-deep holes don't leave you much space for screw threads, so they're mostly unusable. I did, however, manage to fit mounts for two 2.5in SSDs in the design, as well as a back cover to hide the holey mess.

Eventually, the design reached a stage where I was happy to send it off to the manufacturer, putting my faith in its ability to build the frame to spec. I didn't just hurry up and wait though; I started looking into the two steps that would have to follow. First up was finding a facility to help paint the metal frame. Originally I was planning on painting it myself, but after seeing a Cerakoted Ghost S1 on Reddit, and falling down the Cerakote Reddit rabbit hole, I found that I really wanted the same matt ceramic finish.

Once again I had put myself in a situation where I couldn't make it myself, but fortunately there was a place nearby that specialised in Cerakote painting. When the frame was finished, I shipped it over to the people there, and they painted it black. It

The wooden panels were professionally laser cut, then Axel sanded, stained and varnished them



SYSTEM SPECS

CPU AMD Ryzen 9 5950X with EKWB EK-Velocity Block

Graphics card Nvidia GeForce RTX 3080 Founders Edition with EK-FE waterblock

RAM 32GB G.Skill Trident Z 3600MHz

Motherboard Asus X570 ROG Crosshair VIII Impact

Storage 1TB Samsung 970 Evo Plus, 1TB WD SN750, 2TB Samsung 870 Evo

PSU Corsair SF750 with custom cables

Fans Noctua NF-A14 PWM

Pump EK D5 reservoir combo

Radiators 2 x Alphacool ST30 NexXxos 280mm

Fittings EKWB models of various kinds

took a few tries, because for some reason the paint would flare up in patches and not look uniform, but after a few tries an attractive, uniform finish was achieved.

While the frame was being made, I also decided to deal with the wooden panels. Not having much access to any workspace or tools, I decided to have them made for me, and then spent time sanding them to a smooth finish, staining them and then giving them a coat of varnish for protection.

Finally, having all of the pieces ready and assembling the case for the first time was an incredible feeling. The end result far surpassed anything I had hoped to achieve. Now it was just the final stretch

The professional manufacturing resulted in a superb finish, but made for a less hands-on build process



of assembling a custom loop, which I'd never done before. Since I didn't precisely sketch or model my entire loop, I had some close calls, and had to change the pump top, when assembling it. Next time, I'll model all the fittings to make sure it all will work out before manufacturing.

Full bloom

There were tense moments waiting for the air pressure test to complete after assembly, and the first few attempts didn't pass. It

was only after I went over the entire loop twice, securing all the fittings better, that I gave it a pass. Then it was the moment of truth – filling the loop. After some fiddling, it actually went great, and I left it for 24 hours to further leak-test the loop and remove all the air bubbles.

I'm incredibly proud of the end result, and I think it looks great on my desk. It was an experience that I hated at times, and loved at other times. My main disappointment is that I didn't have access to a proper workshop to do more of the work myself, which I'm looking at rectifying for future projects.

Of course, there are some parts I would like to change with the case itself if I were to make a future revision of it.

The first problem that should be addressed is hiding the I/O cables a bit better. In the short term, I'm just buying some 90-degree adaptors to direct them away, but at some point in the future I may have another frame made that rotates the motherboard in a way that can hide them properly.

More realistically, though, I'm going to move on to other projects. In the short term, I'm more interested in looking at how I can modify an existing case rather than building another one from scratch. **EPG**





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

Airxed IRX Smart Home Hub

Interest is growing in smart home technology, which lets you control devices ranging from TVs and stereos to air conditioning units and lighting with voice assistants or your smartphone. Upgrading a home to a smart home, though, can be expensive if you're looking to rip out standard appliances in favour of their connected equivalents. That's where the Airxed IRX comes in.

Developed using infrared technology licensed from parent company Remotec, the IRX is an unassuming black hockey puck of

a gadget. It has only a single micro-USB port at the rear – just next to a reset button that doubles as a trigger for Wireless Protected Setup (WPS) connection mode.

Taking off the gloss plastic case reveals a not surprisingly circular circuit board, with a 'hedgehog' array of seven LEDs at varying angles. This is key to the device's capabilities: a multi-angle infrared emitter, shining through the IR-transparent black plastic housing, which is designed to let the IRX send signals to any IR-capable device in the room – regardless of where it sits.

The array isn't particularly smart – triggering an IR signal fires up all LEDs at once, with no effort made to target signals in any particular direction. If your room has, say, IR-triggered lighting or ventilation at two sides, you'll find a single signal gets picked



It might look like an oversized hockey puck, but the IRX is a smart little gadget

up by both at the same time. Edge-cases aside, though, it works well. It also does away with the need to carefully position the device in order to control a single target appliance, as with traditional IR blaster accessories, although line of sight to all target devices is still required.

A small piece of foam next to the IR emitter hides a low-cost Espressif ESP8266-based ESP-12S microcontroller module, which forms the brain of the system. It's a low-

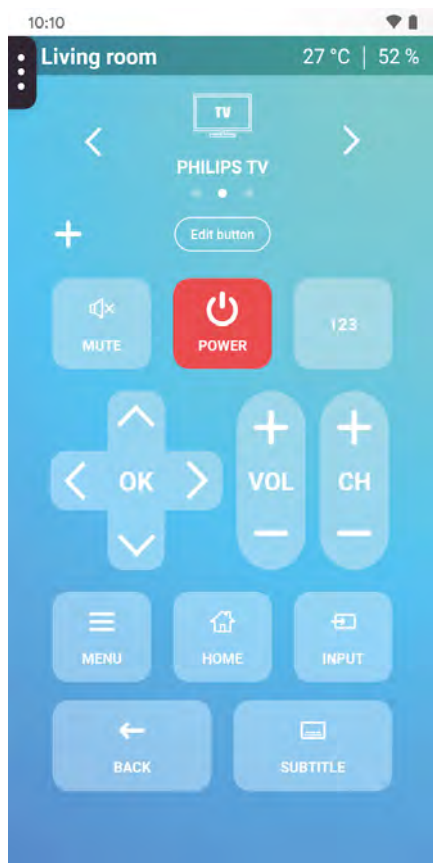


There's only a single micro-USB port on the IRX, plus a button for resetting and WPS connections



The 'hedgehog' array of IR LEDs provides broad coverage for signal transmission

cost but fully functional microcontroller with 2.4GHz 802.11b/g/n Wi-Fi support built into it. However, you only get a PCB antenna, with nowhere to connect a higher-gain external one, so signal strength could be an issue for installation in larger homes.



The app replicates a physical remote control, but is a little light on features

NEWS IN BRIEF

Pine unveils ereader

Pine, best known for its PinePhone smartphone and Pinebook laptop designs, has unveiled a new open-hardware ereader – the PineNote. 'Since the announcement of Rockchip's RK3566 we knew our opportunity to create an open e-ink device had arrived,' Pine's Lukasz Erecinski explained. The Linux-based gadget features a 16-level greyscale electrophoretic display, supports Wacom EMR-standard pen inputs and is powered by a quad-core Arm Cortex-A55 CPU with 4GB of LPDDR4 RAM and 128GB of eMMC flash memory. The company is set to open orders on pine64.org at \$399 US (around £291 ex VAT).



At its heart, the IRX is effectively a smart remote. That's no surprise, given that Airxed's parent company Remotec specialises in exactly those devices, including the Bluetooth-connected Remodo X reviewed in Issue 215.

That's not the full extent of its capabilities, however. The puck also houses a simple temperature and humidity sensor, recording seven days' worth of continuous readings, which can be reviewed through the companion app on Android and iOS devices.

The same sensors can also be used to trigger IR-controlled heating and ventilation systems, including air conditioners. However, you would be hard pushed to find an air conditioning unit that doesn't have its own built-in temperature sensor.

The companion software lets you scroll through a range of appliance manufacturers and try out various control signals to hone in on the protocol required. Airxed claims support for a wide number of devices, including 400 air conditioning brands and 7,000 audiovisual brands.

However, support for older devices is patchy – the IRX failed to control a Yamaha surround sound receiver that was around 15 years old, suggesting it's relying on the same database as Remotec's Remodo X.

The Airxed IRX Smart Home Hub also includes support for voice-activated control via Google Assistant and Amazon Alexa, allowing you to integrate otherwise disconnected appliances into the system. It doesn't, however, support Apple's Homekit standard, although it's possible this may

change in future firmware updates as part of an ongoing development promise.

The software, meanwhile, is straightforward to use. Once an IR device is set up, the app displays a graphical virtual remote with access to most – if not all – of the functions present on the original. TVs can be switched on or off, the volume and channel can be changed, and menus accessed. Meanwhile, air conditioners can have their modes, fan speeds and oscillation settings changed.

It's also possible to set up some very basic logic controls. HVAC devices can be powered on and off according to the temperature sensed by the IRX hub, for instance, while a 'sleep mode' lets you switch to different triggers at night.

The biggest annoyance comes in initial setup. You need to register an account, or sign in with your Google account, before you can actually begin using the IRX. Given the app is entirely useless unless you've given Airxed your money already, this feels entirely unnecessary.

Readings from the temperature and humidity sensor are displayed at the top of the app, with quick access to the seven-day historical readings. The sensor's accuracy seems acceptable, although given its position in a black plastic housing, it's common for the readings to spike if the hub is placed in direct sunlight for any length of time.

The Airxed IRX is available now from airxed.com for HK\$299 (around £28 ex VAT), a very reasonable price for a highly flexible – though imperfect – smart home hub.

REVIEW

Kobol Helios64 long-term testing



The low-cost open-specification Kobol Helios64 five-bay network attached storage (NAS) box impressed us when we reviewed it back in Issue 211, with a few caveats about design flaws and potential software glitches harming stability. Now, having been in active deployment for a number of months, it's time to revisit the device – and the news isn't good.

Based on the surprisingly powerful 6-core Rockchip RK3399, a downgrade from the originally promised and faster RK3399K, the Helios64 packs 4GB of RAM, Gigabit and 2.5Gb Ethernet ports and five 3.5in SATA drive bays with hot-swap sleds into a smart, but awkward to use, compact metal chassis with a clever magnetic cover.

During initial testing, we noted that the Helios64 port of Armbian, a community-driven respin of Debian Linux designed for Arm-based single-board computers, was considered to be in 'testing' with no official support. The good news on that front is that Armbian has now progressed to being 'supported'. The bad news is that 'supported' doesn't seem to mean much in the Armbian world.



Kobol's Helios64 showed promise, but has failed to deliver long-term

Anyone experiencing issues with the Helios64, and there have been more than a few, is encouraged to create a post in the Helios64-specific sub-forum of the broader Armbian forum. Doing so, however, is more likely than not to attract a several-hundred-word rant from Armbian founder Igor Pečovnik, who will tell you in no uncertain terms that you can't expect a jot of support unless you're willing to donate to the project's claimed €2,000-a-day running costs.

Plus, even if you part with an ongoing €50 a month 'angel subscription' fee, there's no guarantee that anyone will look at any issue you report, much less fix it.

It might be possible to overlook such an attitude if Armbian's updates didn't constantly break various features of the supposedly fully supported Helios64. In

Kobol's Helios64 showed promise, but has failed to deliver long-term

the time since the original review, Armbian updates have disabled the 2.5Gbps Ethernet port twice, caused systems to fail to boot, corrupted installations and disabled the cooling fans multiple times.

The latter has the potential to actively damage the hardware, including any drives installed in the chassis, and the root cause is yet to be fixed at the time of writing.

Kobol itself is far from innocent here too. The company has admitted to a variety of design flaws in the Helios64; these include drive sleds that are too tight and a missing link that breaks the 2.5Gb Ethernet port's Gigabit support, which can't be fixed


NEWS IN BRIEF

StarFive and Radxa partner on RISC-V board

Chipmaker StarFive and single-board computer specialist Radxa have confirmed they're working on an open-source, Linux-capable RISC-V development board, which will launch before the end of the year. The partnership comes after **BeagleBoard.org** backed out of mass producing the BeagleV, a board designed around the same StarFive JH7100 system-on-chip as Radxa's planned board.

'At this stage, all related development, debugging, production, and testing work are progressing steadily,' StarFive's Selina Zheng claimed. 'The single board computer will be officially released by the end of Q3 2021.' Neither company has confirmed if the new board will hit the planned \$149 US (around £108 ex VAT) RRP of the BeagleV.





Igor

donator

2299

Posted June 17

On 6/17/2021 at 1:07 PM, snakekick said:

Hi,

a new version armbian-bsp-cli-helios64 (21.05.4) released today but still have the same error. :(

Do you support the project at least this way? <https://forum.armbian.com/subscriptions/> So you don't make additional expenses when asking for support you are far away from.

Software development and support / bug fixing takes time. It is also very expensive since people needs to have a lot of knowledge which is highly paid and very desirable on the market. Here you expect this service for free. Well, then you have to wait with a partially broken system without complaining ... also you can fix it on your own. Or hire some to fix this for all of us. Why this would go on our private expense???

There are "1000 bugs and 1000 people" before this one and this update fixed some other bugs. We made few people happy, but not possible to make all happy.

Attempts to get support through the official Helios64 forum are met with suggestions for donations to the amateur Armbian project

without soldering one in place and voiding the warranty. There's also a USB Type-C connector, which we noted was too deeply recessed for the bundled cable in our original review.

Other issues have since come to light. One of the most serious is a flaw in the cable-based backplane used for the five SATA ports, which rears its head in the form of drive

Frequent drive errors have been traced to the bundled SATA hot-swap harness



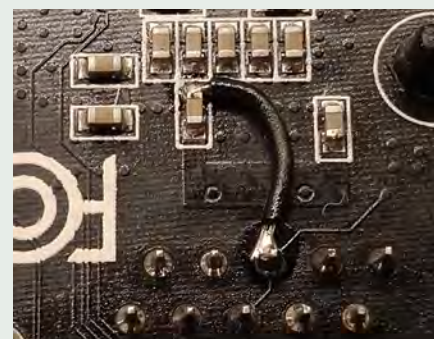
disconnection errors under sustained load – in some cases, bad enough for drives to be kicked out of RAID arrays.

While the company has said it's looking to fix such problems in future hardware revisions, it's doing nothing for those people who have already bought a Helios64 – beyond recommending they replace the bundled backplane loom with a third-party equivalent built to better standards.

Kobol has yet to even deliver on its original promises. The Helios64 was listed as supporting wake-on-LAN. At the time of writing, though, wake-on-LAN was still unavailable – and is likely to remain that way.

All this adds up to unimpressed customers, and while Kobol has previously claimed to be working on design improvements ahead of a second production run, the three-person team is now backing away from the project and closing its doors, blaming a failure to scale the company and personal burnout. 'We have decided to stop the adventure here,' the company wrote in an announcement published just two days before this column's deadline.

'Quite a few reasons made us come up to this difficult decision, but it all comes down to 2 key points. The still ongoing difficulties to manufacture



Kobol has yet to offer a solution to the design flaw in its 2.5Gbps Ethernet port that doesn't invalidate your warranty

electronics, procure parts and mainly to control costs. [And] we made a rookie mistake of stretching ourselves very thin last year with the first delivery of Helios64 while being just a 3 men show. We should have brought [a] few more people on board sooner, but we waited too long until we were a bit burnt out.'

The news means there will be no more Helios64 units built, with or without fixes for the various design flaws, and no more official support channels. However, the team has said it will try to provide 'a bit of support during our free time'. The company promised to upload Helios64 'blue prints' to its website kobol.io in order to assist with troubleshooting in the future, but at the time of writing these had yet to be published.

REVIEW

Quantum Computing

Amit Katwala's *Quantum Computing: How It Works, And Why It Could Change The World* isn't designed to be an exhaustive technical treatise on quantum technology. Instead, it's positioned as a pocket-sized primer for 'people who don't have a background in maths or physics'.

It's almost entirely text-based, bar a single simple illustration of the double-slit experiment on p15, but its wide margins and double spacing give it around half the word count you'd expect from the book's 154 page count.

Katwala's book takes a complex topic and works to boil it down to understandable core concepts. Then it expands on those concepts, pulling down interview content and references to everything from research papers to actual working quantum computers in the labs of Google, IBM and Microsoft, among others.

Of course, quantum computing isn't at the hobbyist level yet. The same would once have been said of personal computing, however, and of computing in general before that. There's nothing preventing interested parties from taking up quantum computing as a hobby either, with universities around the world offering

open access to simple quantum computers and Microsoft having released an open-source Quantum Development Kit for its high-level Q# programming language.

Back to the book, Katwala builds from an initial introduction into the core concepts behind quantum physics in general and quantum computing more specifically, and includes a simplified explanation of quantum bits being held in superposition, immediately followed by the admission that 'the truth is a little more complicated'.

From a basic theoretical grounding, Katwala then proceeds to more real-world examples. These include the construction of real-world quantum computing hardware, including a relatively balanced examination of Google's claims to have proven 'quantum supremacy' with its in-house quantum processors.

Katwala also covers how quantum computing relates to traditional computing, including Moore's Law, as well as the use of quantum computing in science, in particular for simulating nature. There's also a future-gazing look at where quantum computing may be going.

In addition, a chapter dubbed 'Cracking The Code' is dedicated to the threat quantum

computing poses to traditional public-key cryptography, and how the US National Institute of Standards and Technology (NIST) is hoping to release a post-quantum cryptography standard by 2024 to address the issue.

Quantum Computing is broad, but shallow. With its double-spaced pages and compact, pocketable soft-cover format, there's not



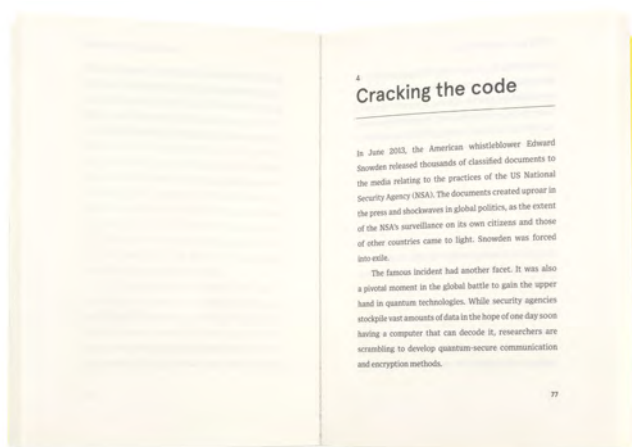
Quantum Computing is a meaty topic to tackle, and Katwala's book offers an accessible introduction

much room for depth. Turning the pages, you'll learn a little bit about a fair number of topics, but to go any deeper, you'll need to turn to the endnotes section and bibliography. Handily, the rear of the book has a full index and a short glossary covering terms including 'decoherence' and 'topological qubit', but there are only 12 entries.

In Katwala's defence, the book isn't designed to be an exhaustive reference tome. Rather, it's the first in a planned series of pocketable books introducing topics of interest to readers of *Wired*, where Katwala serves as senior editor – to be followed by Gian Vilpicelli's *Cryptocurrency* and Matt Reynolds' *The Future of Food*.

For anyone looking to get their head around the basics of quantum computing, and a clue as to the current state-of-the-art in both academia and the commercial world, *Quantum Computing* is an easy recommendation. Just don't be surprised if, once your appetite is whetted, you find your shopping basket filled with more in-depth publications on the same topic.

Quantum Computing is available from penguin.co.uk for £8.99 (zero-rated for VAT), or can be ordered at your local bookshop under ISBN 978-1-847-94326-2. **GFC**



With 154 double-spaced pages, the book is broad but sadly shallow

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at freelance.halfacree.co.uk [@ghalfacree](https://twitter.com/ghalfacree)

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pinning for a future that could have been.
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- **Stuart Turton**, bestselling author
and journalist

.....



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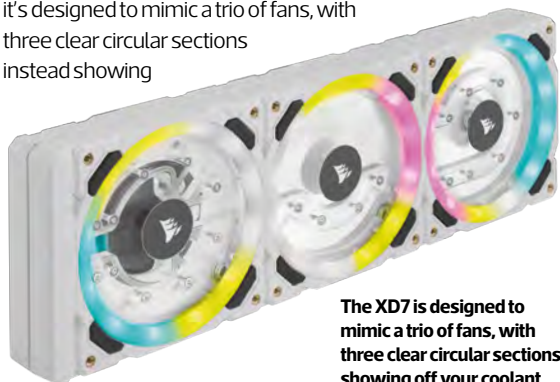
Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Hands on with Corsair's XD7 RGB

Despite being a newcomer to the custom water-cooling scene, Corsair hasn't held back with its product range, offering every single product you need to build a water-cooling loop.

However, one missing option was a distro plate – the funky clear panels designed to route coolant to different points in your case, making it a little easier to add hard tubing runs. Corsair has just fixed this omission now, with the new XD7 RGB.

It's a very unusual distro plate too, as it's designed to mimic a trio of fans, with three clear circular sections instead showing



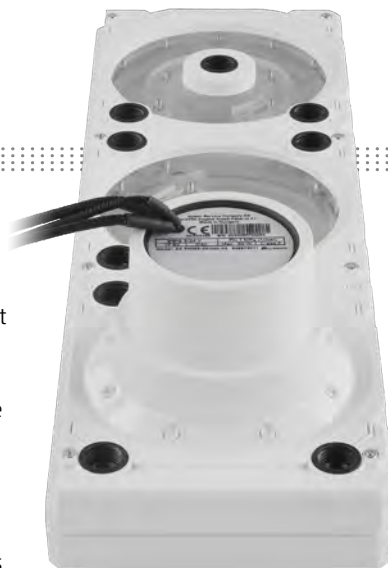
The XD7 is designed to mimic a trio of fans, with three clear circular sections showing off your coolant

off your coolant. They're surrounded by RGB LEDs, of course, but the benefit is that, unlike some distro plates, the XD7 will fit in most locations that also support 360mm radiators.

You'll lose the cooling potential from those fan mounts in the process, but the XD7 does have a couple of other tricks up its sleeve.

It can also act as a reservoir, with nine ports on the rear offering a mix of inlets and outlets, as well as fill and drain ports. Of course, this means it needs to be installed in the front of your case. It might be possible to install it in the side of your case too, if it has fan mounts there, but the second main feature might hinder this, which is an integrated D5 pump. This means you won't need a separate pump or reservoir, while you get a distro plate thrown into the mix too.

Of course, you can argue it's maybe half distro plate, half reservoir, seeing as most other distro plates are clear all the way around. The XD7 looks like some kind of hybrid radiator, especially in black, but our white version helped



As well as acting as a distro plate, the XD7 is also a reservoir with an integrated D5 pump

to bolster its appeal as a distro plate and look less like a brick to which you'd strap some fans. The pump needs a Molex connector for power, but also has a PWM connector to allow your motherboard to control the pump speed to reduce noise.

Meanwhile, the various RGB lights are strung together with a single cable, allowing you to use either a 3-pin RGB header or Corsair's own connector, and iCUE software and controllers to

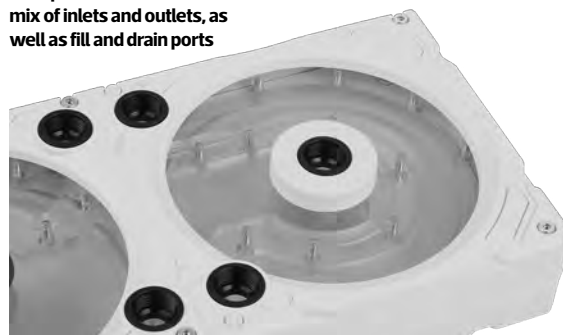
deal with the lighting. The glossy white plastic finish might not be to everyone's taste, but once illuminated and full of coolant, that fades into the background. It actually looks really good and it's easy to install too.

The instructions indicate the ports you should use for various components, and we were impressed to see an anti-vibration mounting system too, with rubber pads helping to dampen any shakes. The price is slightly eye-

watering at £250 inc VAT, but you do get a high-performance PWM-controlled pump and reservoir with RGB lighting included. This is also similar in price to EK's alternatives.

Overall, the HD7 looks great; it's well made and compatible with more cases than some of its competitors. If you're splashing out on a lavish water-cooled PC then the only worry about it is whether its unique design fits in with the rest of your PC.

Nine ports on the rear offer a mix of inlets and outlets, as well as fill and drain ports



Should mini-ITX always be challenging?

I've spent many moments pondering why I'm such a huge fan of small form factor systems and hardware over the past couple of years. Moving into a bigger house has meant having a bigger office and far less of a need to maximise desk or floor space by downsizing my PC. Yet, my two main systems I've used since moving have both been mini-ITX.

I think it's fair to say that it's more than just a space-saving exercise. I hate waste and, for me, if you have a single graphics card and no other PCI-E devices, along with two sticks of RAM, you really don't need a massive ATX case. Unlike a car, there's no situation that might need more space, such as bringing home a bunch of DIY materials or throwing a bike in the back. Our PCs remain fairly static in terms of specifications, and upgrades usually focus on core components such as CPUs and graphics cards that don't generally get larger with each generation.

Graphics cards do, of course, come in all shapes and sizes, but mini-ITX cases are usually able to house even the large models, although triple-slot cards may lop a few cases from that list. Overall, though, you can house a PC in a good mini-ITX case that's just as powerful as one in an ATX case in the vast majority of situations.

Still, it's about more than just size or wasted space for me. Building a mini-ITX PC has been challenging ever since I began using them, back when mini-ITX boards had integrated CPUs. Making sure there's enough cooling is still a primary concern today, along with issues such as graphics card compatibility and water-cooling support. Once you've built dozens of ATX PCs, you can develop a craving for more of a challenge.

When it comes to building a PC in small to medium sized mini-ITX cases,

It's very easy to work with the Ssupd Meshlicious, but some of the fun is lost, as there's less of a challenge



you need to pick each component carefully. Even memory module height can play a part, depending on the cooler you'll be using, and the situation becomes even more complicated when you add water-cooling systems.

This is a challenge I relish, though, and it's probably the main reason I've stuck with mini-ITX PCs for so long. It's fun and hugely rewarding, even if there are a lot of compatibility issues and consequences if you get it wrong. However, I don't think building a mini-ITX PC should necessarily be easy.

Cases such as the Ssupd Meshlicious (see p18) make it incredibly easy to build an air-cooled or water-cooled mini-ITX PC and in a relatively compact case. However, the result in the community so far is a bunch of copycat clone builds with similar cooling arrangements and very little originality. Delve deeper into small form factor Facebook groups, though, and you see much more interesting builds that use other, smaller cases.

I love the fact that small form factor PCs are becoming more popular, but the original appeal – the challenge of building a custom, tiny, powerful PC – feels like it's being diluted by cases such as the Meshlicious. It will undoubtedly bring new people into the niche, though, and that's something I always like to see. **CPC**

How to Make a clear side panel

Antony Leather shows you how to create an acrylic ventilated side panel for your case

TOTAL PROJECT TIME / 4 HOURS

Case side panels have changed a lot over the last few years, and now include features such as hinges, tempered glass and ventilation holes. However, getting the exact combination of these features you want on your chosen case can be tricky. Some manufacturers prefer to have solid metal panels with vent holes, which can improve cooling with vertical graphics card mounts, but don't let you see your hardware.

Similarly, tempered glass will shatter if you try to drill into it, so while those glass panels look pretty and give you a great view of your hardware, they can result in higher GPU temperatures compared with vented panels. The solution is to create your own, which can be surprisingly easy if you have a case that secures side panels with thumbscrews. We'll be creating a clear side panel to provide a clear view of our shiny hardware, while also adding ventilation holes.

TOOLS YOU'LL NEED



100, 800, 2,000 and
3,000-grit sandpaper
Most hardware stores



Fine-blade saw or rotary
tool and sanding wheel
Most hardware stores



Acrylic sheet
plasticsheets.com



Safety goggles
Most hardware stores



Stanley knife
Most hardware stores



Plastic polish
ebay.co.uk



Drill and drill bits
Most hardware stores



1 / INSPECT EXISTING SIDE PANEL

Ideally you want a bare side panel to copy, and not one with lots of fixtures and fittings. It also needs to be flat. You can bend acrylic, but it will make your job a lot harder and we won't be covering the process in this guide.



2 / ONE OR BOTH PANELS?

Mini-ITX cases often have two panels that would benefit from modding and they're usually identical too, potentially making it easy to do both at the same time, boosting airflow or improving the view to your hardware. You can always do one first and see how you fare.



3 / IDENTIFY MOUNTING MECHANISM

Ideally you want the panel mounting mechanisms to be as simple as possible, such as holes with screws and thumbscrews. Mounting hinges or brackets to acrylic can be time-consuming and troublesome.



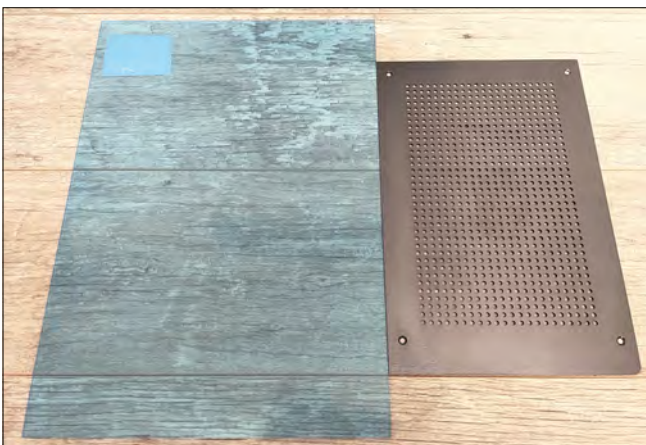
4 / MEASURE THICKNESS

Acrylic sheet is available in a range of thicknesses, so you should be able to match a sheet to the thickness of your side panel. This is important, as screws and mounts may require a specific thickness.



5 / CHECK FOR BEVELLED EDGES

Some side panels may use bevelled or angled edges, which need to sit flush with the rest of the case. These can make it extremely difficult to create a new panel that fits properly. Ideally, you want square edges, as they'll be much easier to replicate.



6 / ORDER CLEAR ACRYLIC SHEET

The cheapest way to obtain the acrylic you need to is to order a size large enough to be cut to size. This is relatively easy to do yourself and will mean the panel itself will cost just a few quid.

7 / ORDER TO SIZE

If you're not confident to cut the panel to size yourself, many sheet acrylic suppliers (such as plasticsheets.com pictured) offer custom cutting services. This will cost extra money, but the benefit is that the firm will cut the panel to the exact size you need, leaving you with minimal extra work.

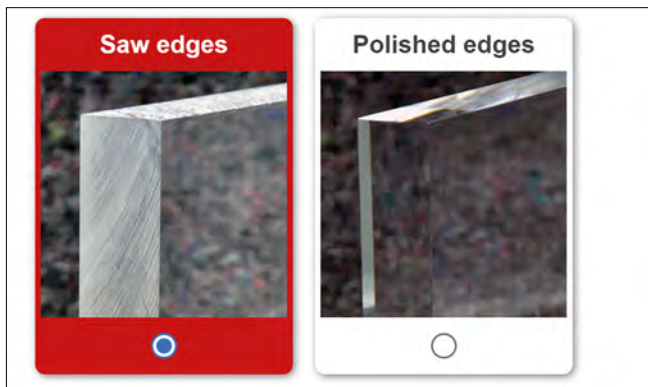
8 / SPECIFY MOUNTING HOLES

Some sheet suppliers (such as plasticsheets.com pictured) can also cut your mounting holes. You'll need to take highly accurate measurements of the locations of the centres of the holes. For this reason, it can be easier and cheaper to drill the holes yourself.



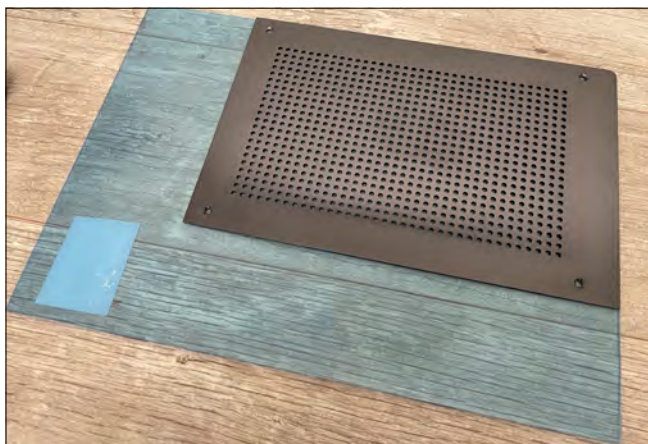
9 / CONSIDER MACHINING

We'll be drilling holes for the vents and, for these vents to be effective, we need to make quite a few of them. If you're short on time, this is one job you might want to get done professionally, but again it can cost many times the price of the panel.



10 / OPTIONAL POLISHED EDGES

If you're cutting the acrylic, the edges will look dull and opaque, but polishing them makes the panel look more professional. Some acrylic suppliers will also offer to do this work on pre-cut sheets, but you can use 2,000-grit followed by 3,000-grit sandpaper, followed by an automotive polish to achieve the same result.



11 / USE ORIGINAL PANEL AS TEMPLATE

Having a basic flat panel is useful, as you can use it as a template for your new panel. Don't remove the protective film on the acrylic until you've finished work on it, though, as it scratches very easily. You can use marker pens to draw your cutting lines onto the film.



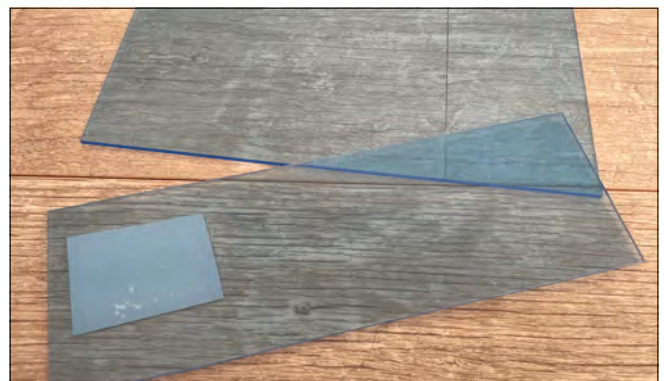
12 / MARK UP SHEET

If you're using a cutting tool such as a table saw, now is the time to draw your cutting lines onto the acrylic. Ensure the film isn't moving and that it's firmly stuck to the acrylic.



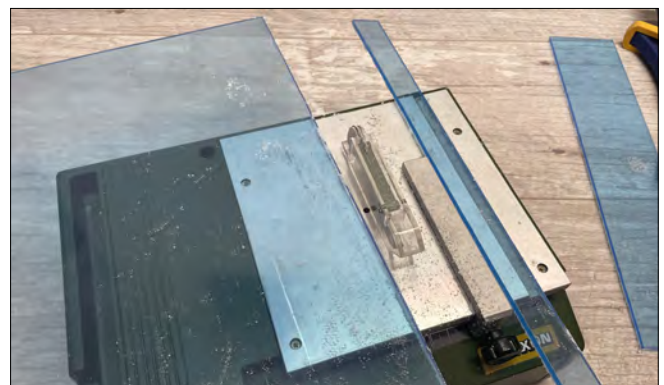
13 / SCORE LINES

If you don't have a machine for cutting, you can score straight edges on small to medium sheets of acrylic with a Stanley knife on both sides, while clamping the shortest side to a flat surface. Use a straight-edged object as a guide, putting medium pressure on the knife. Run over the score line three times to create a groove.



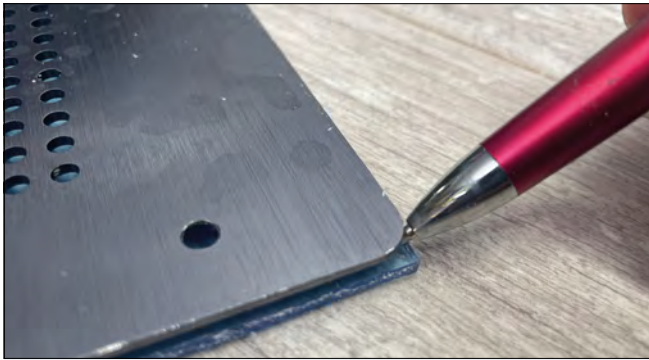
14 / SNAP TO CUT

Leave the shortest edge clamped and apply even pressure to the larger section in order to spread the force as much as possible along the cut. Press down and the acrylic should snap along the cut.



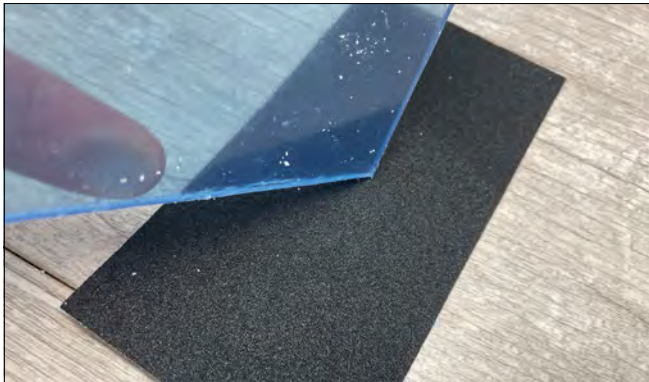
15 / ALTERNATIVE: USE A TABLE SAW

A table saw can result in a quick, clean cut that requires minimal finishing and can deal with large surfaces such as full-tower ATX side panels. Use a plastic-specific cutting blade and run the sheet through it along the cutting mark you made earlier.



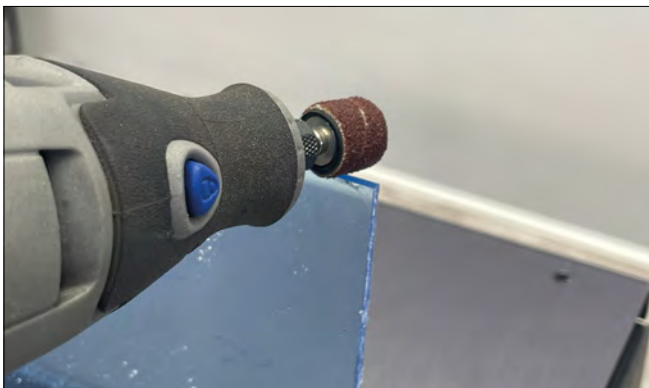
16 / ROUND CORNERS

You may need to round the corners of your panel in order for it to fit in your case, which is an easy job. A rotary tool such as a Dremel with a sanding wheel can eat away at the acrylic up to the lines you marked on it earlier. Alternatively, a coping saw can cut away a larger area first in order to cut down on sanding time.



17 / USE SANDPAPER

You can also use 100 or 120-grit sandpaper to do the same job, again perhaps using a saw with a fine blade to cut away some of the waste acrylic first. Hold the panel firmly, apply medium force, and use a back and forth motion against the sandpaper. This helps to keep the edge flat.



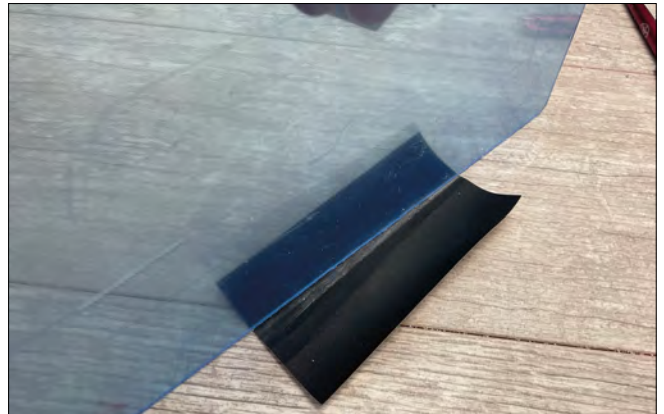
18 / USE A ROTARY TOOL

If you have a Dremel, you can use a sanding wheel to cut away at the corners to remove the unwanted acrylic, working up to the marked lines. This is more delicate than using a saw, but it's still a good idea to remove the final millimetre up to the line with 120-grit sandpaper.



19 / TEST-FIT PANEL

Offer up the side panel to the case – make sure it fits, and that all the corners sit flush and don't foul the rest of the case. Be sure to fit the panel the right way around too.



20 / FINISH THE EDGES

Now it's time to smooth all the edges you've cut by sanding them. Start by using 600 or 800-grit sandpaper paper to smooth over the edges over, then use 2,000-grit sandpaper to finish them off. You can now use a plastic or automotive polish to buff the edges, so they turn clear.



21 / MARK UP HOLES

Our case uses four screws to secure the side panel, and we'll need to drill holes for each of them. Use the original panel as a template and mark the centre of each hole onto the acrylic.



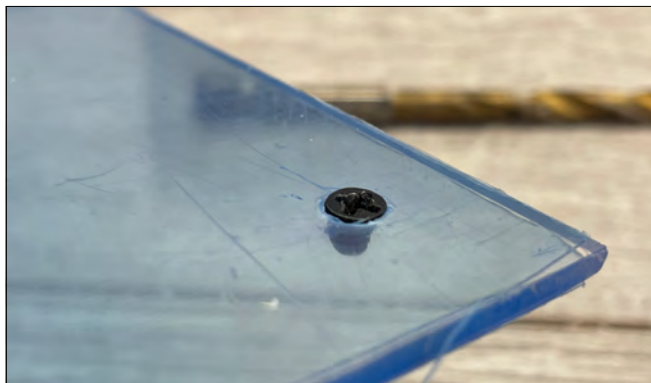
22 / CHECK FOR SCREW TYPE

The screws with our case are countersunk and require shallow recesses in which they can sit. You can, of course, use whatever screws you like with your new panel, but we'll be creating new recesses for the original screws with our one.



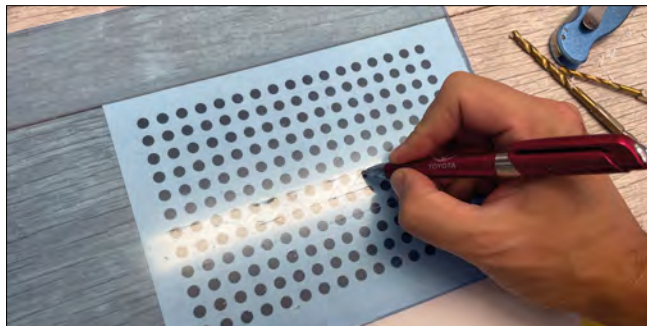
23 / DRILL HOLES

Start by creating holes half a millimetre wider than the screw-thread thickness, in order to allow the screw to thread through the acrylic into the mounting thread on the case. You'll need to measure your screws, as cases use a variety of sizes.



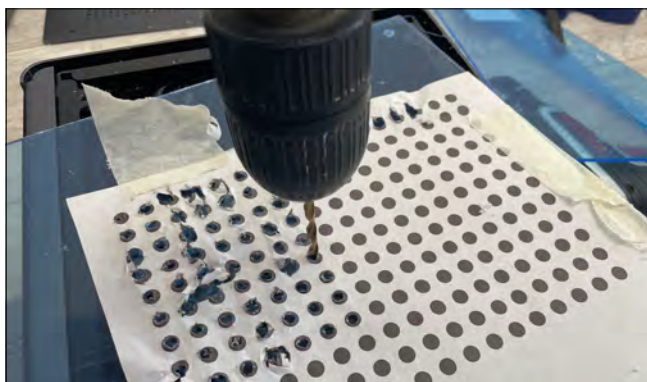
24 / CATERING FOR COUNTERSUNK SCREWS

To create the countersunk holes, use a drill bit that's the same width as the head of the screw. Use this bit to cut a small way into the acrylic, but not all the way through it. Drill a little at a time, placing the screw into the hole after each time, and stop drilling when the screw eventually sits flush.



25 / MARK UP VENTILATION HOLES

You'll need to create ventilation holes in a similar pattern to those in the original side panel if it had them. If not then you don't need to add too many – just a few will be an improvement. Mark the centres of the holes using the original panel as a template, or print out your own design and lay it underneath the acrylic.



26 / DRILL VENTILATION HOLES

Start by using a 2mm drill bit to create a pilot hole for each hole. This will provide an anchor for the larger drill bit, which will help to make the rows as straight as possible. Next use the larger drill bit to enlarge each hole.



27 / INSTALL SIDE PANEL

Now you can remove the protective film from the side panel, wipe it down to remove any dust or acrylic fragments and install it on your case. You should find you get a much better view of the interior, or improved your cooling if there were no vents originally. **CPG**

WIN

A ROCCAT PYRO KEYBOARD AND BURST PRO MOUSE

We're offering a fantastic opportunity to get your hands on some top-notch gaming peripherals this month, courtesy of the fine folks at Roccacat. There are two bundles of gaming peripherals up for grabs, each containing a Roccacat Pyro keyboard and BustPro mouse, with dazzling lighting and great gaming abilities.

ROCCAT PYRO

The Roccacat Pyro mechanical gaming keyboard not only offers RGB lighting, but it also comes with mechanical switches that offer an accurate linear-feeling (red) keystroke response with 2mm actuation. The keyboard also features advanced anti-ghosting technology, so you can enjoy reliable gaming without worrying about a keystroke not registering.

What's more, it's reinforced by a brushed aluminium top plate for robust durability. Switches are also long-lasting, with a lifespan of 50 million keystrokes per switch, so you can enjoy reliable gaming with a solid build quality. The Pyro also features Roccacat's Easy-Shift[+] button duplicator technology and a detachable palm rest for customisable comfort.

WORTH
£90



ROCCAT BURST PRO

The Burst Pro is an extremely lightweight optical gaming mouse, which Roccacat has engineered from scratch with a symmetrical ergonomic shape.

While other manufacturers dot the surface of their mice with holes to cut down weight, that kind of feels like cheating, not to mention being a magnet for dust and dirt.

The Roccacat Burst Pro gaming mouse features a more efficient engineering approach, with a solid yet light honeycomb shell at an extreme light weight of only 68g.

This also provides an impressive showcase for the mouse's AIMO lighting.

Meanwhile, its Titan optical switches still provide the familiar click feeling you know and love, but are engineered with speed-of-light optical actuation for unprecedented quickness and precision. They're faster than any mechanical switches and have twice the durability, offering 100 million clicks. Meanwhile, the Bust Pro's heat-treated glides and PhantomFlex cable provide high-performing, unrestricted gameplay.

WORTH
£50



SUBMIT YOUR ENTRY AT **CUSTOMPC.CO.UK/WIN**

Competition closes on Friday 5 November, 2021. Prize is offered to participants in the UK aged 13 or over, except employees of the Raspberry Pi Foundation and Trading, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from Custom PC magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. Winners will be contacted by email to arrange delivery. Any winners who have not responded 60 days after the initial email is sent will have their prize revoked.

Retro tech

SINCLAIR ZX SPECTRUM

Ben Hardwidge recalls how Sir Clive Sinclair's rubber-keyed 48K computer ignited his love of computers and magazines

On 16 September, I heard the sad news that Sir Clive Sinclair had passed away, aged 81. I can't comment on Sir Clive Sinclair as a person, but I wanted to pay a personal tribute to the invention of his that permanently shaped my life.

One evening I came downstairs to find my dad at the dining room table playing a game he called 'bat and ball' on our old black and white TV (the 'new' colour TV we'd started renting was in the living room), while pushing the buttons on a small black box with grey keys. I was young, probably 5-6 years old, and I'd never seen a computer before.

I didn't know anyone at school with a NES – I wasn't even aware it existed

I don't remember my jaw dropping to the floor, nor it feeling revolutionary – I didn't honestly even really know what a computer was, but I did find it fascinating that you could plug this little box into a TV and make things appear on the screen yourself, rather than just watching a TV programme.

I had a go on the bat and ball game, a Breakout clone called Thro' The Wall – it was the first programme on side two of the Horizons cassette bundled with the computer, and I fell in love with it. Over the next year or so, I must have learned how to connect it all up and get it running, because I distinctly remember dragging the black and white TV to the dining room table, connecting up all the wires and getting the Spectrum all set up. I remember my Mum nervously asking 'are you sure you know what you're doing, Ben?' as I did it, and I nodded as I hooked up the aerial and tuned the dial on the front of the TV to the correct RF channel for the Spectrum.



REVISIONIST HISTORY

I sometimes feel like I was brought up in a parallel universe when pundits discuss video games from the 1980s. People talk about the NES and Super Mario Bros as being revolutionary, but I didn't know anyone at school with a NES – I wasn't even aware it existed. People also talk about heated playground spats between Spectrum and Commodore 64 owners – I don't remember them either.

Most of my friends didn't have a computer at home, and there was such a huge variety of systems available that when you did find someone else at school with a computer, it probably wasn't the same one as yours. One friend had a Commodore 16, another an Acorn Electron, another a ZX81 – I was the only one with a Spectrum, so there was no playground cassette swapping.

Whenever I tell people I had a Spectrum, they generally reel off a list of classic games, including Manic Miner, Jet Set Willy and 3D Ant Attack. We never had any of them, but there wasn't really a culture of must-have games then. One game we did have was The Hobbit, a text adventure with slow-loading graphics, which I loved even if it was brutally hard and I never managed to get past the trolls.

Another was Valhalla, which we got from my uncle when he became the PR manager for Legend Software. Like The Hobbit, it had slow-loading graphics and a text interface, but it also had stick characters based on Norse mythology with

basic character attributes – you could summon dragons, fight gods and write rude words (which resulted in a dwarf called Mary being ‘not amused’ as she came onto the screen and prodded you).

This game dominated a large part of family life in the 1980s. My Dad drew up a full-colour map of all the locations, as we tried to solve it (we never did). Generally, though, if I wanted new games for the Spectrum, I had to hope for a £1.99 Mastertronic cassette in my Christmas stocking, or type them in myself from books and magazines – it was the latter that really kicked off my love of computers.

INPUT

I never completed a single game on the ZX Spectrum, and I think that’s partly because I didn’t actually care about the games as much as marvelling at the computer doing things – watching the computer draw the castles in Valhalla was more interesting to me than actually playing the game.

For me, the Spectrum’s best feature was the BASIC language housed in its 16KB ROM. You had to input text in it to load a game in the first place, but you could also start writing your own program as soon as the computer started.

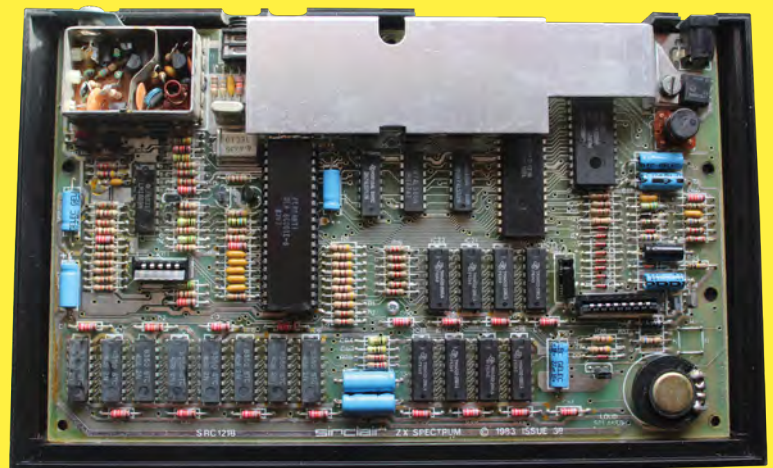
The obvious classic was to 10 PRINT “‘Hilarious statement here’” 20 GOTO 10, and then watch your comedy genius cover the TV screen infinitum. The first program I wrote and saved was basically the same as this, but with some of the Spectrum’s on-board graphical blocks in the first PRINT command so it made a pretty pattern when it scrolled down the screen – I called it ‘Lift’.

After that, I was hooked. Over the next few years I checked various Usborne programming guides out of the library, so I could make the computer do more. My parents kindly started buying me Input magazine, a multi-platform Marshall Cavendish part-works publication that taught you how to write BASIC code.

The first issue showed you how to create an animated jumping frog and shooting tank with machine code routines (made from individual pixels rather than the standard on-board graphic blocks) that you could control with the keys. This then spurred on several experiments with graph



Valhalla – Mary is not amused



Inside a ZX Spectrum 48K – a basic PCB that gave you a full-colour, programmable computer for an affordable price

paper to create my own custom animated characters, while my brain whizzed round with other ideas of things I could make the computer do.

I drank it all in – I even read the code for the other systems, so I could get an idea of how they worked – I was highly envious of the Commodore 64’s sprite system.

A FLAWED SYSTEM FOR A GOOD PRICE

The ZX Spectrum was far from perfect, of course. It regularly froze and needed to be reset (by physically switching it off at the mains) – often when you were right in the middle of something. It took ages to load software from tape, often coming up with an error message after you’d already endured five minutes of the screechy noises it made when it was loading.

The code in the magazines was also frequently flawed – you’d type it all in, and then have to go through debugging it. Sometimes you’d made a mistake, but sometimes that mistake was in the magazine and you wouldn’t know until you received the ‘errata’ page in the next issue.

Let’s face it, the Spectrum wasn’t even that great for the time either – the BBC Micro had a far superior keyboard to the Spectrum’s rubber keys, and the Commodore 64 had a far superior colour graphics system, with none of the garish colour clash problems that plagued Spectrum games.

But then the Commodore 64 cost nearly twice the price of the ZX Spectrum 48K. Clive Sinclair’s genius was to create a programmable, full-colour computer with plenty of memory that was much more affordable than the competition. The 16KB ZX Spectrum cost £125 (around £450 today), compared to £235 (about £850 today) for the BBC Micro Model A.

There were still a lot of families who couldn’t afford a computer at all at this time, of course, but the Spectrum opened up the magic of video games and coding to a much wider audience. Without the ZX Spectrum and early computer magazines, I expect I’d be doing a very different job now, as would a lot of today’s game developers and software engineers in the UK. For that, Sir Clive Sinclair, you have my eternal gratitude. Rest in peace. **GPG**

Readers' drives

Tweaked Meshify S2

Jeroen ter Horst gutted his Meshify S2 and completely changed the layout, with a custom distro and cable management plate, while moving the motherboard to centre stage, flanked by a pair of angled 360mm radiators

SEE THE FULL
PROJECT LOG AT
[custompc.co.uk/
TweakedMeshify](http://custompc.co.uk/TweakedMeshify)



GPC: How did this project start?

Jeroen: It all started in early 2019 when I was still happy with the performance of my previous build, but I wanted my PC to have a fresh look. My goal was to create a fresh and new-looking design that hadn't been seen from a particular case before, while also being able to fit at last two 360mm radiators inside the case for cooling.

GPC: Why did you base this build on the Fractal Meshify S2?

Jeroen: From my earlier experience of modding a Fractal Define S in 2018, I knew that adding an extra front panel on the back side of the Meshify S2 would be quite easy. Add the full mesh panels on the top, and I was

convinced this case would be a great candidate for this mod.

GPC: The airflow system is quite unusual – how does it work?

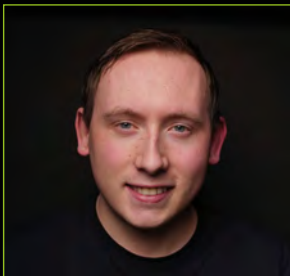
Jeroen: I wanted to highlight the unique radiator layout, and I liked the clean look of just the radiators being on show without fans on top. Thanks to the dual mesh front panels, it was possible to move the six intake fans to the sides of the radiators that face the front panels.

These fans push fresh air from outside the case through the radiators in the main compartment, where the motherboard and GPU are located. Meanwhile, the PSU pulls its own fresh air from the underneath of the case, and there are also vents in the main compartment. With the help

from two exhaust fans in the top, all the hot air gets pulled out of the system.

GPC: We're intrigued by the minimalist look of the water-cooling loop – where does it all hook up inside?

Jeroen: The front side of the loop directly hooks into a custom-designed distro plate that sits behind the motherboard tray and serves as the base for all the cable management. Once the liquid enters the distro plate, it's routed through both radiators and goes into the built-in reservoir until it enters the pump again and goes around. In total, this system has four drain ports, three of which are hidden behind vanity panels in the back.



/MEET THY MAKER

Name Jeroen ter Horst

Age 24

Occupation Electrical engineer student with a part-time job at a company that makes X-ray imaging components

Location Aalten, The Netherlands

Main uses for PC Playing games, designing new builds in CAD and watching Twitch and YouTube

Likes Formula 1

Dislikes Nothing

SYSTEM SPECS

CPU Intel Core i7-6700K running at 4.2GHz on all cores

Case Fractal Design Meshify S2 White TG

GPU Nvidia GeForce GTX 1080 Ti Founders Edition

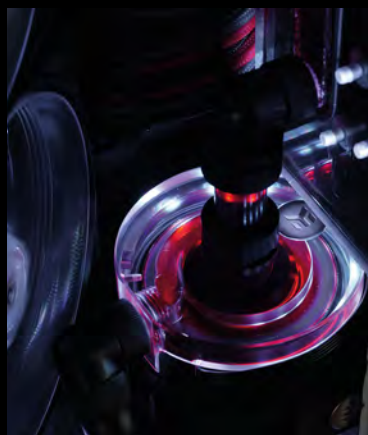
Storage 1TB Samsung 970 Evo

Memory 16GB G.Skill Trident Z 3200MHz CL16

Motherboard Asus ROG Z170 Maximus VIII Gene

PSU Fractal Design Ion+ 760P

Cooling Custom water-cooling loop, featuring the following components: EK-Quantum Velocity RGB Nickel + Plexi CPU waterblock, EK-FC GeForce GTX FE RGB Nickel GPU waterblock, 2 x EK-CoolStream SE 360 radiators, EK Classic Series 90-degree fittings and extenders, EK-Quantum 16mm HDC Quantum Torque fittings, EK-XTOP Revo D5 PWM Plexi pump, 6 x Noiseblocker NB-eLoop X B12-PS ARGB fans



The custom cable management and distro plate is 35mm thick and built up out of three layers of 10mm acrylic

CPC: Moving the motherboard to the middle of the case must have involved a fair amount of work. Tell us about the process.

Jeroen: I started by drawing the internal frame of the Meshify S2 in CAD. In this case, I used SolidWorks, since I was familiar with using it at school. Once that was done, I knew exactly how much space there would be available with which to play, and I could create a design that would fit.

With the help of the online 3D library GrabGAD, I was able to find models of a micro-ATX motherboard, a water-cooled GeForce GTX 1080 Founders Edition, EK 360mm radiators and

the Noiseblocker fans I used. I then compared these with pictures of components from the Internet, and I was able to confirm and modify the 3D models to my needs and start the puzzle to fit all the hardware inside the build.

The first step was finding the optimal angle for both the 360mm radiators, which ended up being 45 degrees. Once those were in place, I started placing the motherboard, GPU and PSU in the model, and designed a new internal frame out of 2mm steel.

This frame needed to be placed into the case via the top, requiring me to only remove one panel in the case, minimising the number of

rivets I needed to drill out. Once the new internal frame was sorted, I went on to design the custom distro system for the build. The final step was the cable management plate that goes on top of the distro system.

I produced the new internal frame with the help of the company where I did my internship. The people there handled the laser cutting and bending of the 2mm steel for me, since I don't have the tools for that work at home.

The custom distro and cable management plate was made with the help of a fellow Dutch case modder known as TheDutchmanModifies ([youtube.com/TheDutchmanModifies](https://www.youtube.com/TheDutchmanModifies)). He used his CNC machine to mill out all the liquid channels, O-ring grooves and mounting holes in the 10mm and 5mm sheets of acrylic that I used.



In total, the custom distro and cable management plate is 35mm thick and built up out of three layers of 10mm acrylic, with one final 5mm acrylic plate that's wrapped in black vinyl to create a clean aesthetic.

GPC: The cable-tidying work is immaculate. How did you go about planning it?

Jeroen: As you can see from the pictures, I do like clean cable management. What's neat about having almost all of the build drawn in CAD is that it gives you a lot of freedom to explore multiple options and ideas before you fully commit to one.

At first I bought some sleeved cable samples, so I could figure out what kind of bending radius could be achieved, and I then combined this knowledge with the available space known from the CAD model to work out the best method for cable routing. I could then design my own cable combs and have them 3D printed by my college.

Some people with a keen eye might have spotted that there's a cable route towards the back end of the case, but the PSU isn't located there – it has its own space directly under the GPU and between the

radiators. This is because I couldn't make a bend tight enough with the sleeved cables, and I also needed a space to create a pocket to put all the splitter cables for the fans and RGB lighting – this is located in the central area behind the motherboard tray.

GPC: The motherboard ports are hidden inside the case. How do you access them?

Jeroen: With the Meshify S2, it's really easy to take out the mesh from the front panels – it's also possible to run the I/O cables into the case through a slotted hole at the bottom of the back front panel. From there onwards, it's just like a regular PC when it comes to plugging cables into the motherboard and graphics card. You just have to make sure you do it when the PC is off, so your hands don't hit any spinning fans.

GPC: How did you go about planning and installing the water-cooling loop?

Jeroen: Like most of this build, the planning for the water-cooling loop was done in CAD. This gave me time to think about how to assemble it all before building it. First, I mounted the custom



distro plate on the back side of the motherboard tray (with the pump already attached). Secondly, the motherboard and graphics card were installed, and connected with 16mm PEGT tubing. I bent these tubes based on the dimensions from the 3D model. The third and final step was mounting the radiators and fans, then connecting the tubes between the distro plate and radiators.

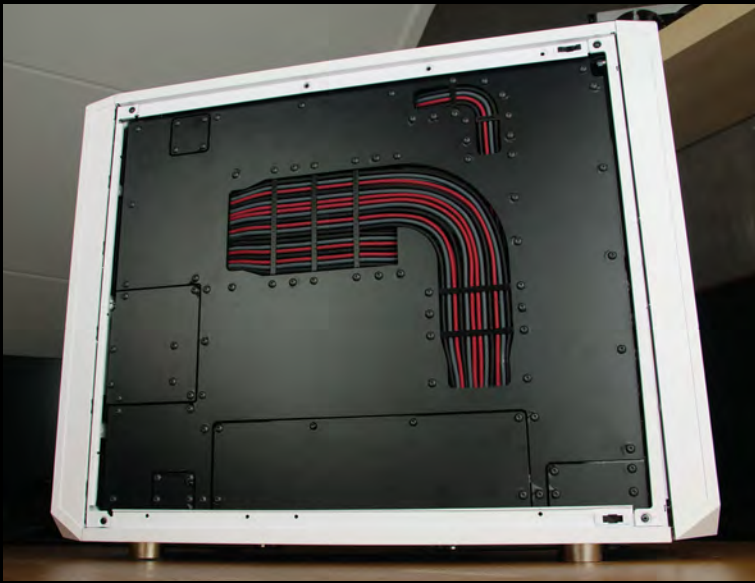
GPC: What type and colour of coolant did you use?

Jeroen: The coolant in the build is EK-CryoFuel Blood Red. I chose this, as I thought it would be a great match with the red accents on the heatsink of the Asus ROG Maximus VIII Gene board. The white lights make the red colour pop inside the blocks, tubes and distro plate as well.

GPC: What sort of peak CPU and GPU temperatures do you get with two 360mm radiators?

Jeroen: Both the CPU and GPU max out at 60°C with a 20°C ambient room temperature. You could say this is on the warm side but I like my systems to be really quiet. The radiator fans are fixed at 550rpm, the top exhaust fans are fixed at





750rpm and the D5 pump runs at 50 per cent (PWM) power.

GPG: What specs did you choose?

Jeroen: I was quite happy with the specs I had at the time – a Core i5-6600K, an ATX Z170 motherboard, 16GB of 2400MHz memory, a 500GB SATA SSD and a Gigabyte GeForce GTX 1080 Ti card. Still, some of these specs needed to change because of what I wanted to achieve with the build.

The Core i5 processor was swapped out for a Core i7-6700K, the ATX motherboard was swapped for a micro-ATX board to save space, the 16GB of 2400MHz memory was updated to 3200MHz, I changed the graphics card to an Nvidia GeForce GTX 1080 Ti Founders Edition and the 500GB SATA SSD was swapped for an M.2 one.

Most of the changes were made to save some well-needed space during the build. I bought the CPU, motherboard, RAM and GPU second-hand to save money, but they all still work great now.

GPG: Did you come across any difficulties?

Jeroen: Generally, the one problem was space. Since all the gear needed to fit inside the shell of the Meshify S2, there was only a set amount of

room. This created some headaches during the design process, but nothing so big that it couldn't be overcome with a good night's sleep and a fresh look the next day.

GPG: How long did it take you to complete this build?

Jeroen: It took one and a half years in total, split into two phases for the build. The first phase was the design process, which ran from April 2019 until January 2020. This was the first time I'd done a full design in CAD first before building, and it was also my first custom loop.

As a result, I didn't set a deadline for when I wanted to have the design finished, but instead decided to take all the time I needed. From January 2020 onwards it was time for building. Unfortunately, the whole world shut down soon after that, as we all know, but the build was finally finished mid-September 2020.

GPG: Are you happy with the result, or do you wish you'd done some of it differently now?

Jeroen: I'd paint the final cover panel on the back instead of using vinyl wrap, so I could create a smoother finish at the mounting points, but that's it. **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 AMD or Intel socket 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

HOW IMPORTANT IS POWER EFFICIENCY?

There's more to PC tweaking than maximising performance, says James Gorbald

As somebody who used to benchmark lots of PC hardware, I've long been aware of how much power specific PC components draw vs one another. However, in a world of rising energy costs and supply fragility, I've found myself thinking about it more.

To this end, I recently had a smart meter installed at home, and it's really opened my eyes to how much power the different PCs in my house consume. For instance, my office PC sips under 25W whereas my gaming PC guzzles over 700W. What's interesting to me is comparing these figures not just with other PCs, but also other appliances.

For instance, my electric oven consumes just over 1kW when it's first warming up, but that quickly drops below that of my gaming PC once it hits the desired temperature. In contrast, my gaming PC is often powered up for hours on end, constantly drawing 700W.

High-power-consumption devices don't just mean higher electricity bills, although of course that's forefront in most people's minds – there are additional considerations too. You don't have to be an environmental activist to be curious about how the electricity that powers your favourite hobby is generated.

In addition, every watt of power consumed by your PC is emitted as heat waste and has to be removed from the case. That means more elaborate cooling systems that themselves cost more to buy and run, plus lots of unwanted noise. All that heat is both a blessing and curse – in the winter my gaming PC does a great job of heating my home office, but in the summer it can make the room unbearable.

What's more, gaming PCs are guilty of power consumption inflation, with power draw ramping up with practically every

new generation. Nvidia now recommends 750W for its GeForce RTX 3080, vs 650W for the RTX 2080 and 500W for the GTX 1080. CPUs are also particularly power-hungry.

On the plus side, SSDs consume less power than hard drives, but that, of course, comes with a trade-off in capacity. That said, if like many PC enthusiasts, you transfer old hard drives to your latest PC every time you upgrade, I'd thoroughly recommend trying to wean yourself off them. The amount of power, space and noise saved is well worth the hassle of backing up.

Scan recently ran a poll on Twitter asking our followers how important they considered PC power consumption. It had received 645 responses at the time of writing, with 52 per

cent stating that power consumption isn't important compared with max performance, 31 per cent stating that power consumption is a consideration while 16 per cent stated that power efficiency is a must. Fortunately, there are a fair few ways PC enthusiasts can reduce power consumption and still enjoy

your favourite hobby. Stop overclocking your CPU for starters, as the handful of extra performance you eke out is nowhere near worth the hundreds of extra watts consumed.

You can even go in the other direction and consider undervolting (detailed in our feature on p72), although just like overclocking, it also comes with risks, so do your research properly first.

Another trick, at least when it comes to Intel CPUs, is to buy a non-K edition, as these CPUs consume nearly half the power and boost to more or less the same speed in games. The upcoming ATX12VO standard, which ditches the 3.3V and 5V rails, should also help, dramatically lowering power consumption when your PC is idle. **GPC**

My office PC sips under 25W whereas my gaming PC guzzles over 700W

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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