FASTEST GAMING GPU EVER THE GEFORCE RTX 3090 Ti TESTED

CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 226

BUILD A GAMING PC 4K

PLAY THE LATEST GAMES IN ULTRA HIGH DEFINITION AT HIGH SETTINGS

- FULL STEP-BY-STEP PHOTO GUIDE
- RAY TRACING ENABLED
- GPU AT NORMAL PRICE

LIQUID COOLING
WE TEST 7 240MM ALL-IN-ONE CPU COOLERS

+

CACHE FOR QUESTIONS
AMD'S RYZEN 7 5800X3D REVIEWED

PC SOUND EXPLAINED
IS INTEGRATED AUDIO GOOD ENOUGH?

JULY 2022 / £5.99

9 771740 744059 07

Raspberry Pi PRESS

HOW TO FIT A STATS DISPLAY TO YOUR PC

AOC
GAMING

UNLEASH

YOUR POTENTIAL

WITH THE

C27G2ZE

27"(68,89CM) | **FHD @ 1920 X 1080 PX** | CURVED **1500R** | **240HZ** | 0,5MS MPRT

FREESYNC PREMIUM | 3-SIDED FRAMELESS | **G-MENU**

@aoc_gaming @aocgaming @aocgaming

AGONBYAOC.COM

AOC

Welcome

Custom PC Issue 226

/ FROM THE EDITOR

Unleash the pixel flood

We've been relentlessly refreshing the Nvidia GeForce Shop webpage over the course of writing this issue, just to make sure this semblance of normality wasn't a temporary blip in the machine. Sure enough, though, the GeForce RTX 3080 Ti Founders Edition has remained in stock, at its MSRP of £1,049 inc VAT, for several weeks.

In fact, the brand-new RTX 3090 Ti Founders Edition is also still in stock at its MSRP at the time of going to press. At the high end, at least, the graphics card crisis that's blighted PC gamers for the past two years appears to have been corrected.

Not only that, but even if the Founders Edition is out of stock by the time you pick up this mag, there are other RTX 3080 Ti cards going for similar prices. KFA2's GeForce RTX 3080 Ti SG 1-Click OC 12GB LHR has been fluctuating between £1,050 and £1,100 over the past month at **overclockers.co.uk**, and there are others hovering around the £1,100 mark all over the place.

In the space of just two months, the price of our Elite-listed 4K gaming PC bundle has dropped by £227, and that's despite us adding a 2TB PCI-E 4 SSD and an awesome 360mm Corsair iCUE H150i Elite LCD CPU cooler to the mix. If you've been holding off building a 4K gaming PC until the prices settled, then you can now turn to our guide on p78 and start planning with confidence.

We're not going to pretend that our £2,512 PC is cheap, of course, but this system will enable you to play the latest games at super-sharp resolutions with loads of eye candy enabled. Not everyone can afford to spend this much money on a PC, but it's worth it if you love amazing visuals in your games.

I was an early adopter of 4K, and it's been a blessing and a curse in recent times. Once you've played at 4K, there's no going back – lower resolutions just look horrible once you've become accustomed to the smoothness of 4K. That's great if you can afford to keep pace with the latest graphics cards, but less fun when prices are so inflated and you're stuck on aging hardware.

I'm very glad to see the back of the GPU scalping crisis. If you've got the money, then I now heartily recommend building yourself an awesome high-end gaming rig. CPC

EDITOR
Ben Hardwidge
ben.hardwidge@raspberrypi.com
@custompcmag

CUSTOM PC

EDITORIAL

EDITOR
Ben Hardwidge
ben.hardwidge@raspberrypi.com

FEATURES EDITOR
Edward Chester
edward.chester@raspberrypi.com

MODDING EDITOR
Antony Leather

GAMES EDITOR
Rick Lane

CONTRIBUTORS
Gareth Halfacree, James Gorbold, Mike Jennings, Phil Hartup, Richard Swinburne, Stuart Andrews, Tracy King

PRODUCTION EDITOR
Julie Birrell

PHOTOGRAPHY
Antony Leather, Brian O'Halloran, Gareth Halfacree

PUBLISHING

PUBLISHING DIRECTOR
Russell Barnes
russell@raspberrypi.com

DESIGN
criticalmedia.co.uk

HEAD OF DESIGN
Lee Allen

DESIGNERS
Ty Logan

COMMERCIAL & ADVERTISING

ADVERTISING
Charlotte Milligan
charlotte.milligan@raspberrypi.com
+44 (0)7725 368887

DISTRIBUTION
Seymour Distribution Ltd
2 East Poultry Ave,
London EC1A 9PT
+44 (0)207 429 4000

SUBSCRIPTIONS
Unit 6 The Enterprise Centre
Kelvin Lane, Manor Royal,
Crawley, West Sussex, RH10 9PE

Phone
01293 312182

Email
custompc@subscriptionhelpline.co.uk

Website
custompc.co.uk/subscribe

ISSUE 226

ISSUE 226
SUBSCRIBERS EDITION

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

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

Contents

Welcome to Issue 226

Highlights

Cover guide

Regulars

Reviewed

38 PRODUCTS REVIEWED

Custom kit

240mm AIO liquid cooler Labs

Wi-Fi 6 mesh router Labs

Games

Hobby tech

Windows 11

CyberPowerPC recommends Windows.
One experience for everything in your life.

Infinity 129 DDR5

Intel® Core™ i9-12900K

NVIDIA® GeForce®
RTX 3080 TI 12GB

FROM
£3299

Infinity X119

Intel® Core™ i9-11900KF

NVIDIA® GeForce®
RTX 3080 TI 12GB

FROM
£2599

Infinity X127

Intel® Core™ i7-12700KF

NVIDIA® GeForce®
RTX 3080 10GB

FROM
£2099

Infinity X125

Intel® Core™ i5-12600KF

NVIDIA® GeForce®
RTX 3060 TI 8GB

FROM
£1499

Infinity X105 Elite

Intel® Core™ i5-10400F

NVIDIA® GeForce®
GTX 1660 SUPER 6GB

FROM
£799

Tracer V Edge I15X 300

Intel® Core™ i7-11800H

NVIDIA® GeForce® RTX 3070

FROM
£1479

CYBERPOWERPC

WWW.CYBERPOWERSYSTEM.CO.UK

5 YEAR
5 Year Warranty

Free UK Delivery

NEXT DAY
Next Day Delivery

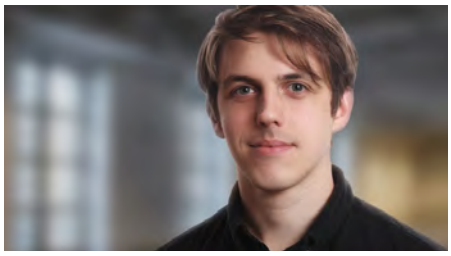
Award Winning PCs

Follow Us! @CYBERPOWERUK @CYBERPOWER_UK | @CYBERPOWER

Order today! sales@cyberpowersystem.co.uk 03333-237776

All information correct at the time of printing. Subject to change.

intel. CORE i7



RICHARD SWINBURNE / VIEW FROM TAIWAN

INTEL'S ARC DESKTOP GPUs ARE TWO YEARS AWAY

After all the hype, Richard Swinburne is mightily disappointed by the real-world availability of Intel's Arc GPUs

Since 2019, Intel has talked about its new Xe era of graphics. After hiring a large chunk of the AMD Radeon team, including its then senior vice president and chief architect, Raja Kadori, several ex-technology journalists and a boatload more, we've been drip-fed a steady stream of news about these magical graphics chips.

Last year Intel introduced the DG1 – the very first Xe GPU fitted onto an actual PCI-E card. Except you couldn't buy it. It was only issued to very select system builders in very limited volumes, and its performance proved little better than what you get inside its CPUs. It wasn't even a sliver of the gaming credibility we were expecting.

Later in the year, it announced that future Xe graphics architectures were now named Arc and would be available in the first quarter of 2022. Then, 48 hours before the end of that quarter, it launched its first Arc graphics chips – the Arc 3 350M, 370M and Arc 5 550M. Except it didn't really.

> We've had three years of marketing hot air already

In the following weeks, only a few Korean users have got an Arc GPU to use in a Samsung Galaxy Book 2. In a tweet following questions on the lack of silicon, Intel revealed that pre-ordered laptops with Arc GPUs were now pushed back into the summer. The number of design wins is (at the time of writing) limited to only Samsung and Acer, which is an indication of Intel's capacity to supply laptop builders.

What's more, the announced Arc GPUs so far are exclusively for laptops. What about desktop PCs? At least a road map would be nice. You know, something more than a fart in the wind. The closest we've seen is a graph that didn't list graphics card names, or even chip names for that matter – it only listed Intel Xe architectures with the broadest of brushstrokes, covering two-year intervals.

Intel had only just sort-of-launched some laptop GPUs in Korea, and it still can't say when we should expect desktop PC graphics cards? But that's not enough – we've had three years of marketing hot air already from Intel. I should have brought balloons.

Intel's graph showed that Arc Alchemist is all we'll see this year, which scales up to the 'performance' category. Then, at some point in 2023-24, we'll get next-gen Arc Battlemage GPUs that reach up to the 'enthusiast' segment, and it won't be until around 2025 that we'll see an ultra-enthusiast (flagship-grade) GPU made on the next-generation Arc Celestial architecture. This puts it out of sync with AMD/Nvidia launch cycles, which are coming this year and in late 2024.

It's not that we didn't expect laptops to be first. Gaming laptop buyers are typically less fussy, so Intel can't get chips made easily – it's the best starting place. Also, because of the unique power and thermal design characteristics in every gaming laptop, the exact performance comparison between any competing GPUs is far harder to determine than for desktop GPUs.

Intel also knows it doesn't have the credibility to win over gamers that easily. It must prove itself first, and it will do that by proving it through laptops, not PC GPUs, unless it decides to work with big partners such as Alienware, Lenovo Legion, Asus ROG and so on with pre-builds, just as it did with the DG1. It's a slow and risk adverse strategy, and it keeps **Custom PC** readers and system builders at arm's length for a few more years yet. CPC

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

OVERCLOCKERS UK

PLAY LIKE A PRO

intel CORE i9

Germanium Z6 - £4799.95

STOCK CODE: FS-IEC-OG

Intel® Core™ i9-12900KS ▪ NVIDIA GeForce RTX™ 3090 Ti
Up to 64GB DDR5 Memory ▪ Configurable storage options ▪ Windows 11

intel CORE i5 | intel CORE i9 | intel CORE i7

overclockers.co.uk/intelpcs ▪ tel: 01782 444455

HAND BUILT & TESTED

CUSTOMISABLE HARDWARE

3 YEARS WARRANTY

TRACY KING / SCEPTICAL ANALYSIS

HELP BACK UP UKRAINE'S DIGITAL HERITAGE

Tracy King looks at the SUCHO project, which is recruiting volunteers to help archive online records of Ukraine's culture and history

There's an old internet meme, a quote from the late American children's TV host Mister Rogers that does the rounds whenever anything bad happens. 'When I was a boy and I would see scary things in the news, my mother would say to me, "Look for the helpers. You will always find people who are helping."'

It's a nice enough quote for children, but I notice lots of adults share it among themselves online and find solace in it. There's nothing wrong with that, but being the original internet curmudgeon that I am, of course I must point out the flaw in doing so. Looking for the people who are helping makes us feel better about the tragedy, but it also consoles those who are doing nothing. I would prefer a line such as 'look for the helpers, and if that makes you feel better, figure out how you can help too.'

I'm of Ukrainian heritage, and last year I started to research that side of my ancestry. My great-grandparents arrived as refugees in Birmingham from Kyiv at the start of the 20th century. I didn't get too far in my research, because huge parts of Ukraine's history and records have been destroyed over the centuries, making it very difficult to find out much without physically going there and searching what paper archives remain. But what I did find out, I got online.

Because of historical threats to the archives of the country, there has been a huge effort to digitise and publish essential records relating to Ukraine's history and culture. This seems reassuring, until there's a new war and suddenly the physical location of servers and backups is at risk. Sebastian Majstorovic, a German academic who works at the Austrian Centre for Digital Humanities and Cultural Heritage, realised the size and weight of the threat to Ukraine's online records, and did something to help.

He started to make a backup. 'Rattled, he got up and started using a suite of tools from the site Webrecorder to archive some cultural heritage sites from Ukraine himself, taking snapshots of a website's content and downloading a full copy for preservation. He worked the entire night,' wrote Jody Serrano in an excellent piece for Gizmodo, in which she interviews Majstorovic.

From there, he asked for others to help, and within days, he and collaborators Anna Kijas and Quinn Dombrowski had set up Saving Ukrainian Cultural Heritage Online, or SUCHO (**sucho.org**). There are now over 1,300 cultural heritage professionals working to preserve Ukraine's online content and data.

> 30TB of irreplaceable data has been backed up by the project

More than 3,500 websites of Ukrainian museums, libraries and archives, comprising 30TB of irreplaceable data including scanned documents and art, have been backed up by the project. The entire archive can be viewed in one place, which is an invaluable resource in its own right, but I also hope it will set a new standard for collaborative digital archiving.

There is already interest from academics and researchers in sharing best practice for future projects. It's a good news story in a bad news situation. SUCHO is collecting funds for fixed costs such as servers, and still needs certain types of volunteers (check the website to see what's what), so if you can help in any way, please do. We can't do anything about the war, but we can look for the helpers, and help them. GPC

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming @tkingdot

PHILIPS

Monitors

get in the moment

innovation you

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

4K Ultra HD

VESA CERTIFIED DisplayHDR™ 400

UltraWideColor

Adaptive Sync

Available at:

amazon ebuyer.com SCAN

Incoming

AMD STEALTH LAUNCHES RX 6400

AMD has sneakily launched a new 'budget' GPU, the Radeon RX 6400. Sporting 768 stream processors and available in low-profile configurations, it's no powerhouse – early benchmarks suggest Nvidia GTX 1650-like performance – but it will offer a modest boost over integrated graphics. The major downside? It still costs over £200. Colour us underwhelmed.

GLORIOUS UNVEILS ERGONOMIC MODEL I

Peripherals specialist Glorious has announced the latest addition to its award-winning gaming mouse line-up, the Model I. Sporting a more sculpted, ergonomic (and right-hand only) shape than its previous mice, the Model I includes nine programmable buttons with four thumb buttons. Two of the latter are modular, so you can customise their shape with magnetically attached alternative top sections, or you can just blank them off.

Despite the extra features, the Model I still weighs just 69g thanks in part to the hexagonal holes that cover the top.

Inside is the excellent Glorious BAMF sensor with a maximum DPI of 19K, a top speed of 400 IPS and 50G acceleration. The Model I can be pre-ordered from **overclockers.co.uk** now for £70 inc VAT.

CORSAIR INTRODUCES HARDLINE WATER-COOLING KITS

Corsair has announced the two complete kits for creating hardline water cooling loops using its Hydro X custom cooling products. The XH305i and XH303i both include a CPU block, 360mm radiator, three fans, a reservoir/pump combo, an iCUE commander and lighting hub, plenty of hardline tubing, coolant, and all the tools you need to cut and bend your piping.

The £560 XH305i includes a larger XD5 pump/reservoir and has QL120 fans, while the £460 XH303i, which is designed for more compact setups, uses a smaller XD3 pump/reservoir combo and SP120 fans.

AMD RAPHAEL TO MAKE 'BIG SPLASH' WITH DDR5 OVERCLOCKING

AMD Memory Enabling Manager, Joseph Tao, has stated that the company's upcoming Raphael Zen 4 platform will make a 'big splash' with DDR5 overclocking support. Speaking at the company's Meet The Experts webinar, he said the platform will offer 'speeds that you maybe thought couldn't be possible'.

STEAM DECK BENCHMARKED WITH RADEON RX 6900XT

YouTuber ETA Prime has experimented with adding an external graphics card to the Steam Deck. With no Nvidia cards working on it, ETA Prime instead opted for a Radeon RX 6900XT and managed to hook it up to the Steam Deck's M.2 slot. Performance was impressive, with the console's 3DMark FireStrike score jumping from 4,856 points to 26,855 points. Meanwhile, 4K gaming was entirely possible, with over 100fps in The Witcher 3 and over 70fps in GTA 5.

AOC AND PORSCHE ANNOUNCE NEW GAMING MONITOR

AOC and Porsche Design have joined forces again to create a new gaming monitor with killer specs. Sporting a 4K resolution, 144Hz refresh rate and support for DisplayHDR 1400, this 32in display should produce stunning HDR. Using the latest mini-LED backlight technology, it can produce a 1,600cd/m^2 maximum brightness while simultaneously producing inky blacks. Available now from **shop.porsche.com**, the PD32M costs £1,750 inc VAT.

THE HERO WE NEED!

new **PURE** POWER 11 FM

Exceptional Quiet, Superior Features

Here to save your system. In times where computers require more power than ever, be quiet! launches new variants of the Pure Power 11 FM series. Enjoy reliable power for your high-performance PC with the Pure Power 11 FM 1000W and 850W. The latest PSUs offer all the features that make the Pure Power series so popular, such as an 80 PLUS® Gold efficiency, the silence-optimised 120mm be quiet! fan and the modular cable management.

- New variants with 850W or 1000W
- 80 PLUS® Gold efficiency (up to 93.3%)
- Modular cables for maximum build flexibility
- Five-year manufacturer's warranty

Available at:
scan.co.uk · overclockers.co.uk · ebuyer.com · novatech.co.uk · aria.co.uk
cclonline.com · amazon.co.uk

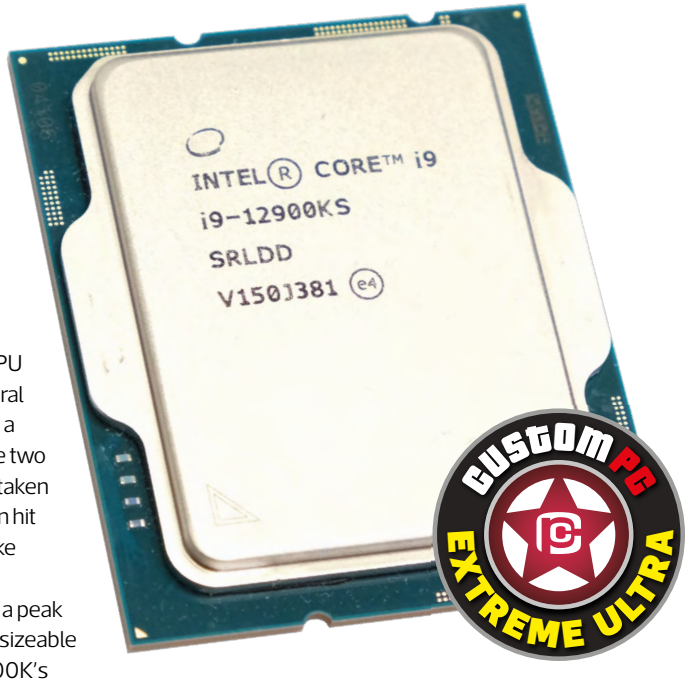
be quiet!®

Reviews

INTEL LGA1700 CPU

INTEL CORE i9-12900KS / £720 inc VAT

SUPPLIER scan.co.uk



How do you offer PC enthusiasts a faster CPU when you don't have any major architectural changes, and you're planning to introduce a new range of CPUs in the near future? Well, we have two very different approaches this month, and Intel has taken the speed-binning approach, creating a CPU that can hit even higher frequencies than the previous Alder Lake flagship, the Core i9-12900K.

The resulting Core i9-12900KS has a peak boost frequency of 5.5GHz, which is a sizeable 300MHz higher than the Core i9-12900K's peak boost clock, and 600MHz higher than the Core i5-12600K's top boost frequency. During testing, we saw the Core i9-12900KS hit 5.4GHz on its P-Cores regularly on a single core, although Intel's specifications reveal that 5.5GHz will only be achieved via its Thermal Velocity Boost feature, which requires the CPU to be operating at a temperature of 50°C.

Seeing as the CPU temperature was quickly topping 85°C in our tests, despite using a custom water-cooling system, it's maybe not surprising that we didn't see it hit its theoretical maximum 5.5GHz boost. Multiple cores were peaking at 5.3GHz simultaneously, though, and its top all-core boost frequency was 5.1GHz in testing, and these clocks are all significantly faster than the equivalents on the Core i9-12900K.

Apart from a slightly higher thermal design power of 150W compared to the Core i9-12900K's 125W, nothing else has changed, as the rest of the 12900KS' specification is identical to that of its predecessor. Both CPUs have a total of 24 threads, derived from eight P-Cores and eight E-Cores, with the former providing the majority of the grunt in games and other workloads. There's a total of 30MB L3 cache and 14MB L2 cache, and both CPUs also sport integrated graphics in the form of Intel's UHS Graphics 770.

Of course, speed-binned CPUs are never cheap, as they're by definition a rarity, and the same goes for the Core i9-12900KS. The cheapest one we could find at the time of writing cost £720 inc VAT, which is over £200 more than the cheapest Core i9-12900K we could find.

By contrast, the other CPU we reviewed this month – AMD's Ryzen 7 5800X3D – takes a very different approach. It showcases AMD's new 3D V-Cache technology, which massively boosts the amount of cache available to its eight cores, but has to have reduced clock speeds because of the cache sitting on top of those cores, which get a little toasty as a result.

However, AMD has kept the price at roughly the same as the Ryzen 7 5800X before it had its recent hefty price cut. You can read James Gorbold's opinion on the pros and cons of Intel and AMD's respective approaches on the back page this month.

SPEC

Base frequency
P-Core 3.4GHz, E-Core 2.5GHz

Max boost frequency
P-Core 5.5GHz, E-Core 4GHz

Core
Alder Lake

Manufacturing process
10nm

Number of cores
8 P-Cores, 8 E-Cores, (24 threads)

Hyper-Threading
Yes

Cache
30MB L3, 14MB L2

Memory controller
Dual-channel DDR4 and DDR5

Packaging
LGA1700

Thermal design power (TDP)
150W

Features
Thermal Velocity Boost, Turbo Boost Max Technology 3.0, Turbo Boost 2.0, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

Performance

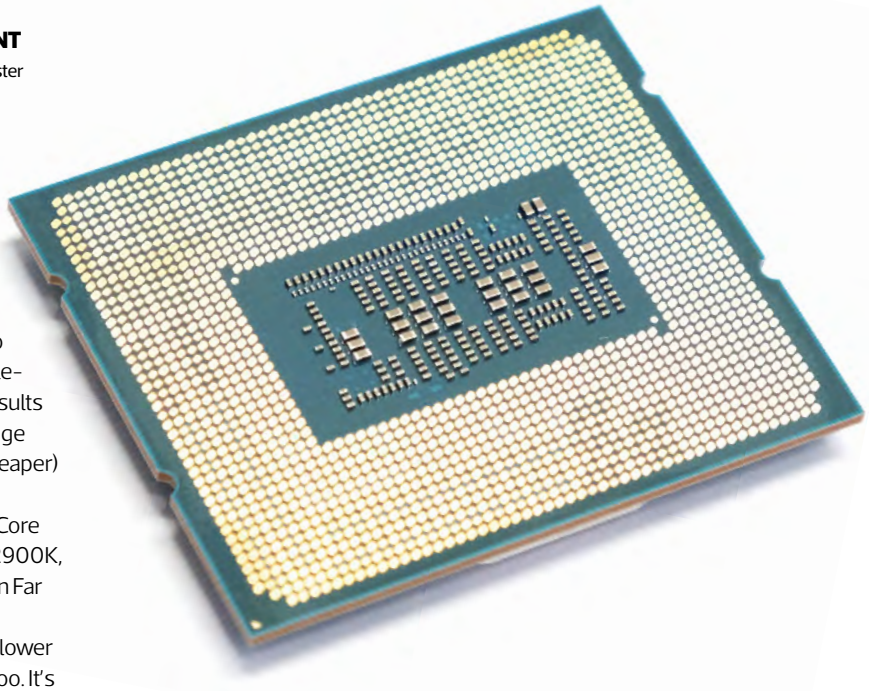
It wasn't a surprise to see the Core i9-12900KS posting record benchmark numbers, with a 2,000-point boost to the image editing score compared with the Core i9-12900K, rising from 81,336 to 83,351 in this test that stresses single-threaded performance. Meanwhile, the result in our heavily multi-threaded Handbrake video encoding test rose from

BULLET TRAIN

- + The fastest desktop CPU for content creation
- + Superb gaming and multi-threaded performance
- + No overclocking needed

RAIL REPLACEMENT

- – Ryzen 7 5800X3D faster in many games
- – Very expensive
- – Hot-running and power-hungry



1,015,501 to 1,125,845, resulting in a system score of 408,849 compared to 373,807.

Cinebench was significantly quicker on the Core i9-12900KS too, with the score rising from 23,079 to 28,645 compared with the older chip, while the single-threaded score rose from 1,981 to 2,069. All these results add to Intel's already commanding lead, and are a huge amount faster than AMD's (admittedly massively cheaper) Ryzen 7 5800X3D too.

Gaming was a very different story, though, as the Core i9-12900KS, while a little quicker than the Core i9-12900K, was bettered by the far cheaper Ryzen 7 5800X3D in Far Cry 6 by a sizeable margin when it came to the 99th percentile result, and the AMD CPU was barely any slower than the 12900KS in Watch Dogs: Legion and Dirt 5 too. It's also clear from other testing we've seen that the AMD chip is usually faster in other games where CPU performance plays a part.

The main issue with the Core i9-12900KS, however, is heat. It might technically have an unlocked multiplier for overclocking, but our sample didn't have any thermal headroom for overclocking, even under our open-air custom water-cooling system. Total system power consumption under load was also up at 384W, compared to around 300W for the Core i9-12900K.

While we didn't have the thermal headroom to overclock the Core i9-12900KS, we were able to squeeze a few more clocks out of the Core i9-12900K. This often resulted in lower single-threaded and lightly threaded performance than at stock speed, as we limited the CPU to lower frequencies than its peak boosts on one or two cores. The overclocked Core i9-12900K wasn't quick enough to eclipse the Core i9-12900KS, which still managed a higher system score and Cinebench results, but it certainly narrowed the gap and consumed less power too.

Conclusion

If you have plenty of cash to splash on a new PC, and you want the very fastest desktop CPU – one that offers excellent gaming performance that's matched with stellar content creation performance, then the Core i9-12900KS is the new king of the hill and we can certainly see it appealing to PC lovers that must have the best. The problem is that you could buy a Core i9-12900K and 32GB of DDR5 memory for the same price as a Core i9-12900KS, which certainly puts the price into perspective if you have a decent budget, but don't want to waste your money.

The fact is, the Core i9-12900K is already fast enough for the vast majority of people, and the gains seen here aren't worth the extra outlay unless you have the cash to burn, or you just want an extremely powerful CPU that you don't need to overclock.

It's a niche product, just like most speed-binned CPUs, but AMD's different approach to boosting CPU performance has produced a chip that's faster in games and is significantly cheaper than the 12900KS, even if it's not such a great choice if you spend a lot of time with heavily multi-threaded content-creation applications.

ANTONY LEATHER

VERDICT

Intel's new speed demon extends its lead over AMD's latest and greatest, but it's extremely expensive, and it's not the fastest gaming CPU either.

PERFORMANCE **49/50**

FEATURES **14/15**

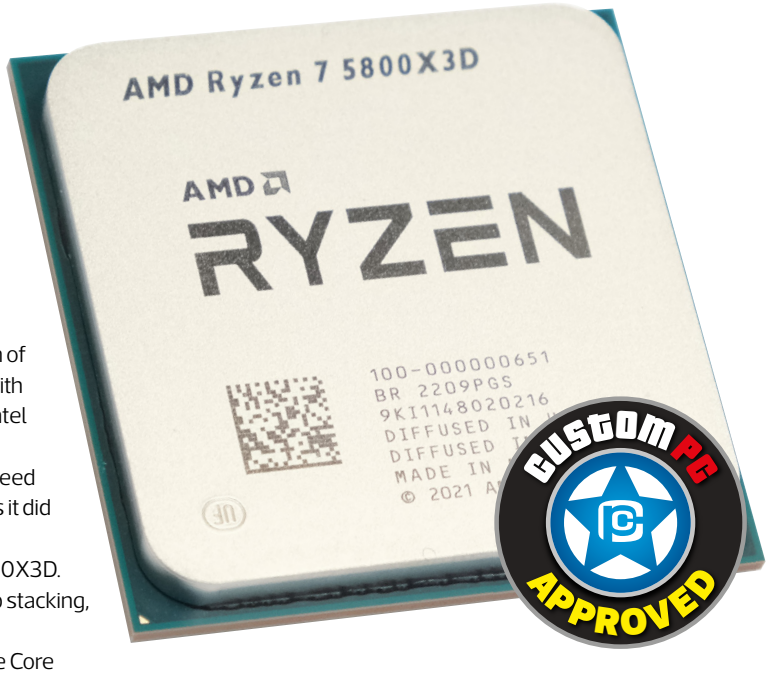
VALUE **17/35**

OVERALL SCORE **80%**

AMD SOCKET AM4 CPU

AMD RYZEN 7 5800X3D / £400 inc VAT

SUPPLIER overclockers.co.uk



We're still some way off the launch of AMD's Zen 4 architecture, and with Zen 3 being 18 months old and Intel having decimated its ranks, a refresh was expected. Rather than simply offering a speed boost or manufacturing process change as it did with Zen+, though, AMD has taken a more interesting approach with the Ryzen 7 5800X3D. It's the first desktop CPU to feature 3D chip stacking, specifically 3D V-Cache.

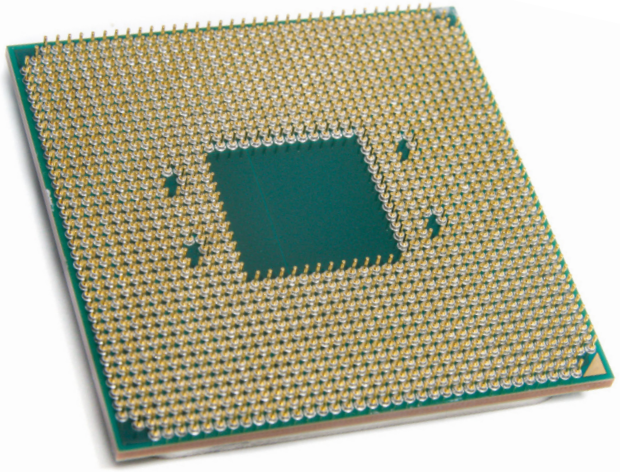
AMD has thinned down the Core Complex Dies (CCD) in its Ryzen CPUs to allow it to stack extra cache directly on top of them. It's had to increase the interconnect density by over 200 times compared with how a standard chipset is constructed, which also has the benefit of reducing the power delivered over each interconnect for greater efficiency. Still built on TSMC's 7nm technology, the added cache works as a 41mm^2 extension sat directly on top of the CCD.

It adds a whopping 64MB L3 cache to each CCD, which already stood at 32MB as standard, giving an 8-core CPU such as the Ryzen 5800X an L3 cache boost from 32MB to 96MB. There are benefits and drawbacks to this arrangement though.

On the plus side, latency is reduced, thanks to less time needed to access system memory when there's such a large cache. With an identical die height to standard Zen 3 chips, despite several layers of wizardry under the heatspreader, the new CPU can also use existing AM4 cooler mounts and motherboards.

The downside is that added cache won't benefit every task. In fact, AMD claims the new CPU will primarily offer significantly improved gaming performance. Of more concern is the fact that AMD has also reduced the boosting frequencies compared with the Ryzen 7 5800X, with the peak boost dropping 200MHz, making it slower than the Ryzen 5 5600X. We saw peak all-core boost frequencies up to 4.2GHz, which is a lot slower than the 4.5GHz the Ryzen 7 5800X can achieve in the same situations.

While lower frequencies enable AMD to quote the same 105W TDP as the 5800X, they also reflect the thermal difficulties of having so much cache on top of a CPU core, as does the lack of overclocking abilities. Even with our custom



SPEC

Base frequency
3.4GHz

Max boost frequency
4.5GHz

Core
Zen 3

Manufacturing process
7nm

Number of cores
8 x physical (16 threads)

Simultaneous Multithreading
Yes

Cache
96MB L3 cache, 4MB L2 cache

Memory controller
Dual-channel DDR4, up to 3200MHz

Packaging
AMD Socket AM4

Thermal design power (TDP)
105W

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

3D V-CACHE

+ Faster than Intel in many games
+ Compatible with current hardware
+ Reasonably priced

3D VIEW-MASTER

- Poor content creation performance
- High internal temperatures
- No overclocking

water-cooling system on top of it, the CPU was regularly hitting 90°C in full-load situations. However, dropping down to less potent forms of cooling didn't see this temperature rise, or the performance fall for that matter.

Performance

The result of the lower frequencies compared with the Ryzen 7 5800X was painfully obvious outside of games, with a drop of nearly 10 per cent in our image editing test, and 5 per cent in our video encoding test, although we saw a slightly higher result in our multi-tasking test. Combine these results with a 4 four per cent drop in Cinebench R23's multi-threaded test and a 9 per cent drop in the single-threaded score, and the Ryzen 7 5800X3D is noticeably slower in content creation and multi-threaded workloads.

It's not touted as a CPU for content creators, though, and it doesn't disappoint in AMD's target of gaming performance, with a massive 103fps 99th percentile frame rate in Far Cry 6 compared to 93fps for the Core i9-12900KS. It was also significantly faster than the Ryzen 7 5800X in Watch Dogs: Legion, albeit a little way behind the Intel CPU, but was again quicker than its AMD sibling in Dirt 5, sitting closer to the Core i9-12900KS here too. Power consumption was up compared with the 5800X, only by 30W under load.

Conclusion

While the Ryzen 7 5800X3D might be slower in most content-creation tasks than the Ryzen 7 5800X, its stunning game performance makes it a fantastic gaming upgrade from an older Ryzen CPU. This is especially true given AMD is planning to open up 300-series chipset motherboards to Ryzen 5000-series CPUs, including the Ryzen 7 5800X3D. If you have a Ryzen 3000-series or older CPU, the Ryzen 5 5800X3D could provide a substantial boost to gaming performance without needing a memory or CPU cooler upgrade.

It's not the best all-rounder available, and Intel's 12th-gen CPUs are still better bets if you dabble in as much content creation as you do games, but the Ryzen 7 5800X3D is a stunning CPU for gamers that beats any other Ryzen CPU and most of Intel's CPUs in a number of games, and for a reasonable price of £400 too.

ANTONY LEATHER

VERDICT

A brilliant CPU for gaming at a reasonable price, although its lack of clock speed hurts it in some tasks.

PERFORMANCE **41/50**

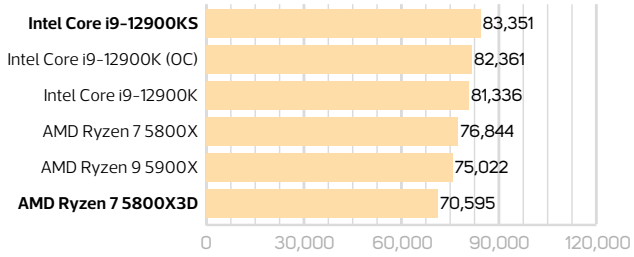
FEATURES **12/15**

VALUE **31/35**

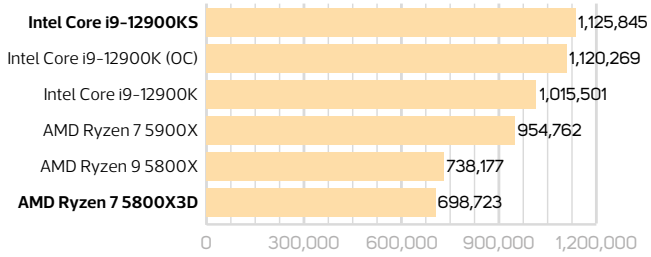
OVERALL SCORE **84%**

CPU BENCHMARK RESULTS

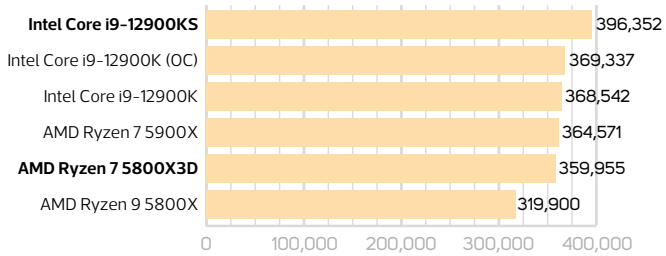
GIMP IMAGE EDITING



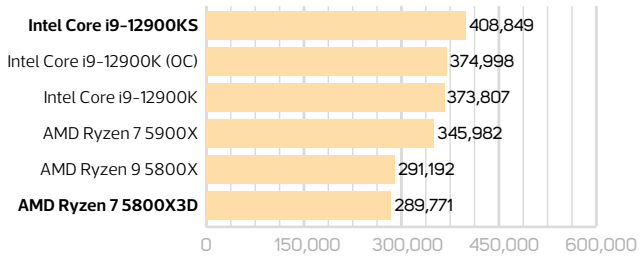
HANDBRAKE H.264 VIDEO ENCODING



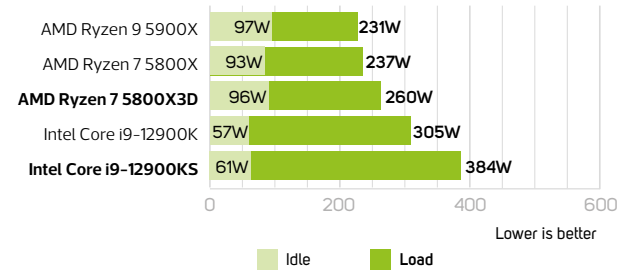
HEAVY MULTI-TASKING



SYSTEM SCORE

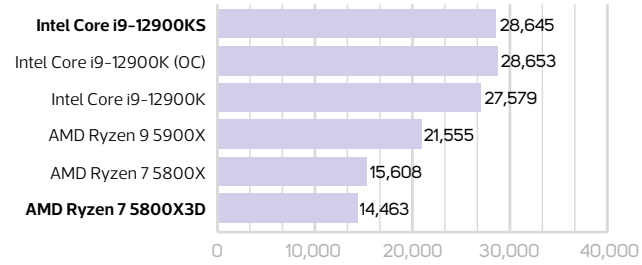


TOTAL SYSTEM POWER CONSUMPTION

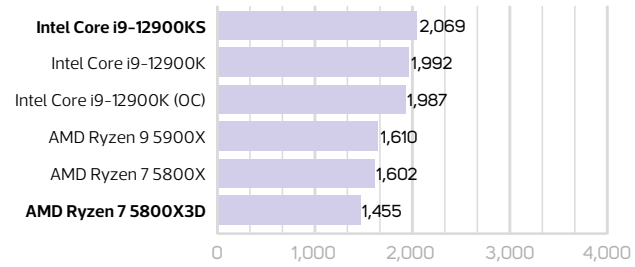


CINEBENCH R23

Multi-threaded

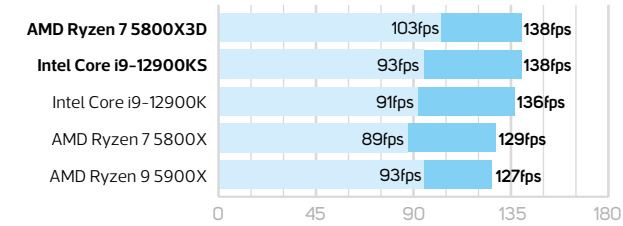


Single-threaded



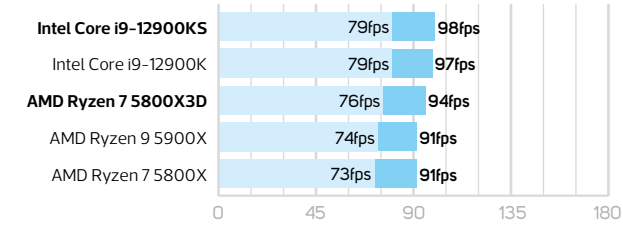
FAR CRY 6

1,920 x 1,080, Ultra settings



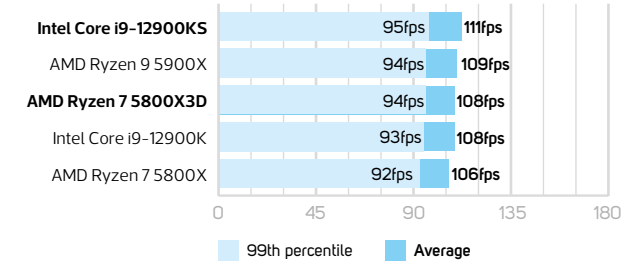
WATCH DOGS: LEGION

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



DIRT 5

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



NVIDIA GEFORCE RTX 3090 Ti / From £1,879 inc VAT

SUPPLIER scan.co.uk

We might have become accustomed to graphics card prices that bear no relation to reality over the past couple of years, but the GeForce RTX 3090 Ti doesn't even need a cryptocurrency mining boom, a relentless army of eBay scalpers or a silicon shortage to get an unashamedly silly price attached it, because Nvidia has actually done it for us this time. Yep, that price up there is the one Nvidia came up with all on its own, and that's just the starting price for the Founders Edition.

What does nearly two grand buy you in terms of GPU horsepower then? The GeForce RTX 3090 Ti represents the all-out last gasp for Nvidia's Ampere architecture before the GeForce 4000 series turns up at the end of the year. It finally brings us a fully enabled GA102 GPU, which is as far as Ampere can possibly go without a brand-new GPU design.

Plenty of Nvidia's existing GPUs are also based on the GA102 GPU, of course, from the RTX 3080 upwards, but they each have several of their streaming multiprocessors (SMs) disabled.

Even the former king of the castle, the RTX 3090, had two SMs disabled. By enabling those last two SMs, the full power of Ampere has finally been unleashed, but that only makes for a miniscule spec difference between the RTX 3090 and 3090 Ti.

Those two extra SMs only get you two extra RT cores for ray tracing, for example, and an additional 256 CUDA cores, plus eight more Tensor cores. That's the same spec difference between the RTX 3070 and 3070 Ti, and there isn't a price difference of anywhere near £500 between the MSRPs of those two GPUs.

Nvidia has also tweaked a few other aspects of the spec, taking advantage of the binning process that's given it these fully working and highly clockable GPUs over the past couple of years. For starters, the RTX 3090 Ti has a boost clock of 1860MHz, compared to just 1695MHz on the RTX 3090.

The huge 24GB allocation of GDDR6X memory has also been given a speed bump from 1219MHz (19.5GHz effective) to 1313MHz (21GHz effective). Combine this with the 384-bit wide memory interface, and this is the first desktop GPU to officially surpass the 1TB/sec figure for memory bandwidth.

The downside to all these high frequencies, of course, is power consumption. Nvidia recommends a minimum of an 850W PSU for the RTX 3090 Ti, and we don't recommend skimping here. We tried to get it working with a Corsair HX750 PSU with 80 Plus Platinum specification, to see if a high-end 750W PSU could do it, but it fell over in every game test after a minute or so.

We've changed the PSU in our GPU test rig since the last GPU Labs, so we can't give you comparative figures for other GPUs, but our Ryzen 9 5900X system drew 680W from the mains when the RTX 3090 Ti was running at full pelt. You'll want a decent, high-power PSU if you aim to run this card.

Speaking of which, the RTX 3090 Ti also introduces us to the new PCI-E 5 16-pin power connector (the RTX 3090 Ti still uses the PCI-E 4 interface, however) on the edge. It's a neat and tidy bundle of pins, but unless you have the appropriate cable for a modular PSU for it, you'll need to use the cable adaptor that comes bundled with RTX 3090 Ti cards, which splits a 16-pin plug into three 8-pin standard plugs.

SPEC

Graphics processor
Nvidia GeForce RTX 3090 Ti, 1560Hz base clock, 1860MHz boost clock

Pipeline
10,752 CUDA cores, 112 ROPS

RT cores
84 (2nd-gen)

Tensor cores
336 (3rd-gen)

Memory
24GB GDDR6X, 1313MHz (21GHz effective)

Memory interface
384-bit

Card interface
16x PCI-E 4

Bandwidth
1,008GB/sec

Power connectors
1 x 16-pin / 3 x 8-pin

Performance

We had limited time available with the GeForce RTX 3090 Ti before we went to press, so we decided to focus on testing in games at 4K and 2,560 x 1,440. There are undoubtedly also workstation applications that can benefit from this huge amount of GPU processing power and 24GB of memory, but for this review, we want to see if it can really claim to be the fastest ever gaming GPU.

The answer to that question is, of course, yes, but the difference between this extremely expensive card and cheaper ones is tiny. If you wanted to describe it without words, you could pinch your index finger around 1mm away from your thumb while squinting at someone.

One test where the RTX 3090 Ti excelled was in Assassin's Creed Valhalla. With Resizable BAR enabled and a load of clock speed at its disposal, the RTX 3090 Ti (finally) became the first Nvidia GPU to beat the Radeon RX 6900 XT in this test at 4K. It averages 72fps here, compared to 67fps for the Radeon, which is a cracking result.

You can also safely max out every setting in Doom Eternal, and enable ray tracing, and still play the game at 4K on the RTX 3090 Ti without dropping below 100fps. The difference between the RTX 3090 and the Ti was more muted in games that benefit more from extra shader power than clock speed though. For example, the difference in Metro Exodus was only 1-2fps. There was a similarly minute performance difference in Cyberpunk 2077 at Ultra settings.

Irritatingly for us, CD Projekt Red's latest patch for this game also alters the way the game handles ray-traced shadows, with them now responding to all light sources, rather than just sunlight outdoors. This has a positive impact on image quality, but it also drops performance a bit, and also means our results for the GeForce RTX 3090 Ti aren't comparable with the results from our last GPU Labs test.

As a result, the RTX 3090 Ti didn't quite hit our frame rate target of a 45fps 99th percentile in Cyberpunk 2077 at 4K with Medium ray tracing and DLSS enabled, but a bit of tweaking in the settings should get it there. Of course, other GPUs will now be slower at these settings than before too, but it's hard not to be disappointed that a £1,879 GPU can't handle this game at 4K with Medium ray tracing and DLSS, let alone Ultra ray tracing.

Conclusion

Just six months ago, RTX 3090 cards were going for close to £2,500, which somehow makes the RTX 3090 Ti's £1,879 starting price a bit more palatable, but there's no getting around the fact that this is a ridiculous price for a GPU that's only a smidgen faster than the RTX 3090. More to the point, the RTX 3080 Ti isn't far behind either, and will save you over £800 if you want a still blisteringly fast gaming GPU.

If you really want the absolute fastest desktop GPU available, and you're happy to pay the extreme price for a fully enabled, clocked up speed-binned chip, then the RTX 3090 Ti is indeed that GPU.

It's also good to finally see the full potential of Nvidia's killer Ampere architecture, but there's simply no way you can justify an £1,879 MSRP when the RTX 3090's MSRP is £1,399 (and is nearly as quick for both workstation and gaming tasks), and the GeForce RTX 3080 Ti's gaming performance is so close. If you want a 4K gaming GPU, do your bank account a favour and buy the GeForce RTX 3080 Ti instead.

BEN HARDWIDGE

LUXURIOUS

+ Fastest desktop GPU ever
+ Loads of memory
+ In stock at MSRP

SUPERFLUOUS

- Extremely expensive
- High power draw
- RTX 3080 Ti is almost as quick in games

VERDICT

This fully enabled Ampere chip is the fastest desktop GPU ever, but the benefits are slight and the price is extreme.

PERFORMANCE **49/50**

FEATURES **19/15**

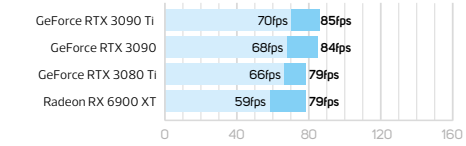
VALUE **2/30**

OVERALL SCORE **70%**

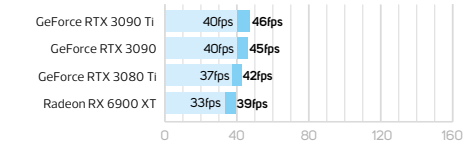
BENCHMARK RESULTS

CYBERPUNK 2077

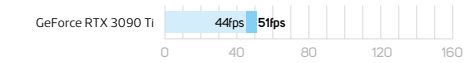
2,560 x 1,440, Ultra preset, no ray tracing



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

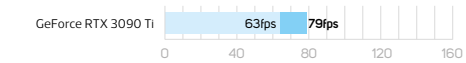


2,560 x 1,440, Medium ray tracing, DLSS disabled*

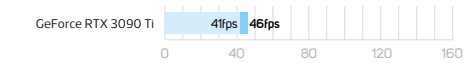


3,840 x 2,160, Medium ray tracing, DLSS disabled*

2,560 x 1,440, Medium ray tracing, DLSS Balanced*



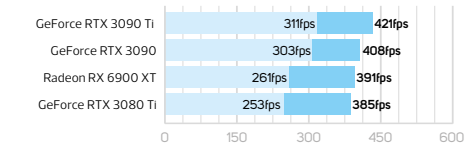
3,840 x 2,160, Medium ray tracing, DLSS Balanced*



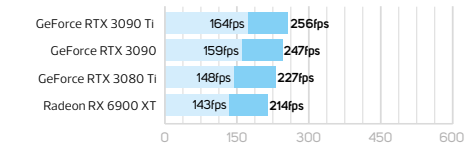
*Note: The latest Cyberpunk 2077 patch causes a substantial drop in performance at this preset, meaning previous results from other GPUs aren't comparable.

DOOM ETERNAL

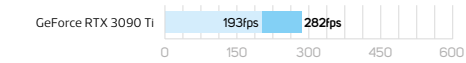
2,560 x 1,440, Ultra Nightmare settings



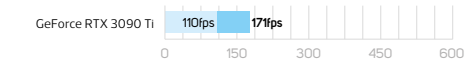
3,840 x 2,160, Ultra Nightmare settings



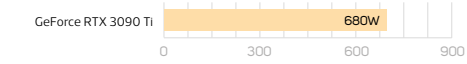
2,560 x 1,440, Ultra Nightmare settings, ray tracing enabled



3,840 x 2,160, Ultra Nightmare settings, ray tracing enabled



LOAD TOTAL SYSTEM POWER CONSUMPTION*

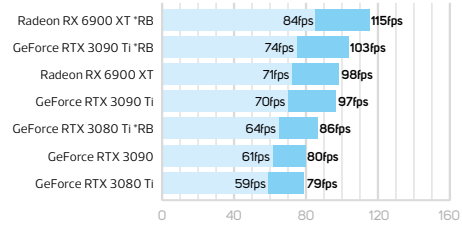


Lower is better

*Note: We had to change our PSU to test the GeForce RTX 3090 Ti, meaning previous power draw results from other GPUs aren't comparable.

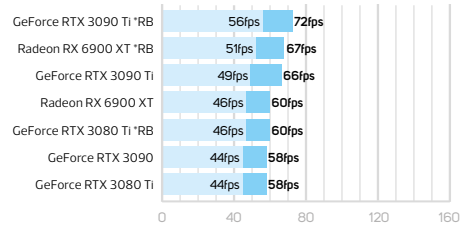
ASSASSIN'S CREED VALHALLA

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



ASSASSIN'S CREED VALHALLA

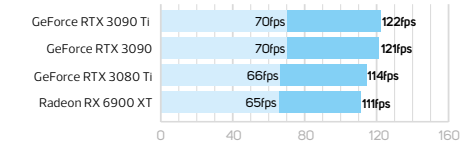
3,840 x 2,160, Ultra high settings, High AA



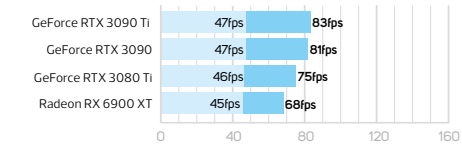
*RB = Resizable BAR

METRO EXODUS

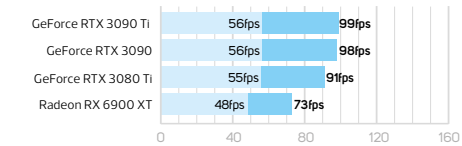
2,560 x 1,440, Ultra settings, HairWorks off, PhysX off



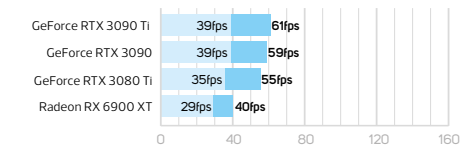
3,840 x 2,160, Ultra settings, HairWorks off, PhysX off



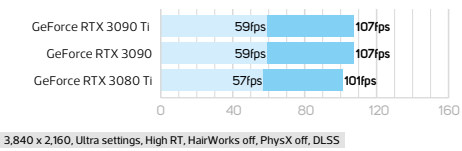
2,560 x 1,440, Ultra settings, High RT, HairWorks off, PhysX off



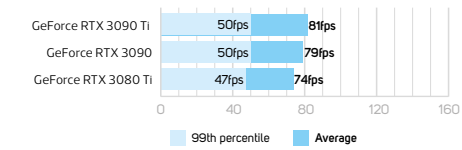
3,840 x 2,160, Ultra settings, High RT, HairWorks off, PhysX off



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



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



ATX CASE

SAHARAGAMING P44M / £80 inc VAT

SUPPLIER amazon.co.uk

If you're looking to kit your PC out with extensive RGB lighting for as little money as possible, then SaharaGaming's P44M potentially offers a good starting point. It's an ATX case that not only costs just £80 inc VAT, but also includes four digital RGB fans, a lighting and fan hub, and even the ability to remotely control the fan speed and lighting too.

Starting with the all-important RGB lighting, you get a 10-port hub included in the box, which uses 6-pin cables that dish out both a PWM signal to control fan speed, as well as lighting control to four included Pirate Eye fans. The fans combine the two inputs into a circuitboard, with contact pads on one side of the fan and pins on the other. This allows fans to be clipped together in series, so they require just a single cable to control the speed and RGB lighting on all of them.

It's a similar design to the fans included with Lian Li's Galahad SL 240 liquid cooler we reviewed in this month's Labs test, and like the fans on that cooler, the actual blade area is noticeably smaller on the Pirate Eye fans than it is on standard 120mm fans. Here, though, the fans don't have quite such a critical mission as cooling your CPU, as they're case fans, although they'll still push less air than your average case fan, assuming all other factors are equal.

We can't deny that the fans are blissfully easy to install, though, and we even got away with using a single fan screw in one corner to mount our row of three fans clipped together and installed in the front of the P44M case, saving time compared with dealing with 12 screws. Further time savings were found when dealing with a single cable to control the speed and lighting for all three fans, compared with six cables if they all had separate ones for both lighting and fan speed.

The instructions aren't particularly clear, and the fans arrived in individual boxes rather than being pre-installed, but if that helps to keep the price down, we're not too opposed to installing them ourselves, especially given the easy installation process.

Meanwhile, the hub has a built-in sensor that detects signals from an RF remote control. From here you can switch between low and high fan speeds, or opt for automatic control using a PWM cable that you can connect from the hub to your motherboard. However, the manual fan control was very limited, with the difference between low and high speed being tiny, so we'd recommend opting for motherboard control instead.

The lighting control is far more detailed, though, and we particularly liked having the ability to freeze the colours in a particular pattern, although each time you reboot your PC, the hub will reset fan speed and lighting to their defaults, and there's no way to save them, which is a shame. You can also control the lighting using a Mode button on the case, with the

SPEC

Dimensions (mm)
205 x 430 x 470 (W x D x H)

Material
Steel, plastic, glass

Available colours
Black

Weight
6.6kg

Front panel
Power, reset, 1 x USB 3, 2 x USB 2, stereo, microphone, LED control

Drive bays
1 x 2.5in/3.5in, 1 x 3.5in, 3 x 2.5in

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

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

CPU cooler clearance
160mm

Maximum graphics card length
400mm

DESERT

- + Good CPU and GPU cooling
- + Snazzy RGB lighting
- + Great value

DESSERT

- – Website inaccuracies
- – Basic design
- – Large frontal opening allows dust ingress

front panel also offering a pair of USB 2 ports and a single USB 3 port, plus power and reset buttons, as well as audio jacks. There's no USB Type-C port though.

The case itself is very compact, but thanks to a generous width and fairly uncluttered interior, there's space for a 360mm radiator in the front and up to a 280mm radiator in the roof. The vents here are also offset away from the motherboard, so even 280mm radiators will clear your motherboard's heatsinks as long as they sit below the I/O panel.

There seem to be some typos on the SaharaGaming website, though, as it first claims there are three 3.5in hard disk mounts, while the manual only lists two. It also only has four 2.5in mounts, rather than the five stated on the website. The website then goes on to state there are five hard disk mounts further down the page, but our counting agreed with the instruction manual – there are just two 3.5in mounts and also four 2.5in mounts.

Meanwhile, the CPU cooler height is fairly limited at 160mm, so you'll need to check the dimensions of any larger air coolers, but there's plenty of room for graphics cards, with 400mm of clearance as well as a spacious vertical GPU mount. The case also supports E-ATX motherboards, although there are no additional standoff mounts, and you may lose the two 2.5in mounts on the motherboard tray, depending on the width of your E-ATX motherboard.

On the downside, cable-tidying options are extremely thin, and while the roof and PSU areas are fitted with dust

filters, the front section's filter is embedded into the panel. As this needs to be removed in order to allow access to the front fan bays, there's a large hole in the base to allow your hand to reach inside the case and pull off the panel, and this hole will allow dust to enter the case.

Performance

The case proved to be extremely quiet, even at full fan speed, and thankfully, while the case itself is basic in a number of areas, cooling was decent. Its CPU delta T fell from 48°C to 47°C between fan speeds, but both matched the best results from recent cases we've tested. The GPU delta T didn't fall at all after adjusting the fan speeds, though, but again was a match for the best cases we've recently tested.

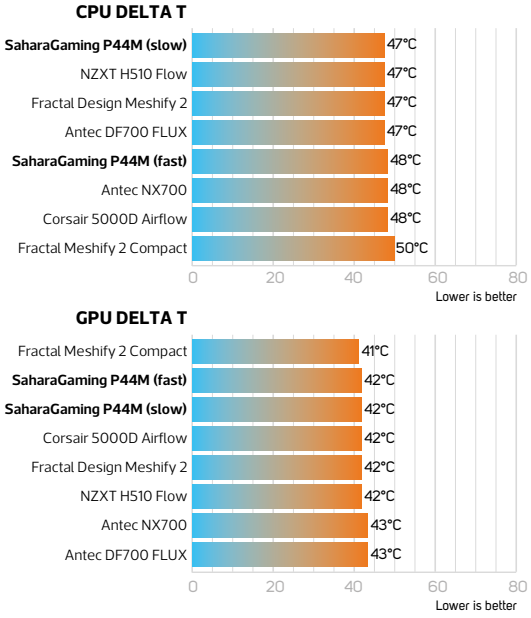
Conclusion

Question marks over inaccuracies on SaharaGaming's website did raise eyebrows, as this isn't what you'd expect from a reputable case manufacturer, but once we got past these issues, the P44M proved to be a reasonable effort, with great cooling and easy-to-use, wonderfully vibrant, modern RGB lighting.

It does lack refinement compared with the Antec NX700, and we worry about dust ingress in the front panel, but ultimately, the SaharaGaming P44M is cheap, but also very cheerful. As long as you're aware of its shortcomings, it can make the basis for a good-looking, well-cooled PC.

ANTONY LEATHER

TEMPERATURE RESULTS



VERDICT

A few too many niggles for an award, but it's cheap enough to be worth considering if you want to kit out an RGB-equipped PC on a tight budget.

COOLING 26/30

FEATURES 14/20

DESIGN 20/30

VALUE 16/20

OVERALL SCORE 76%

MAGNUS ULTRA GAMING DESKTOP

- Intel® Core™ i9-12900KS
- Asus® ROG STRIX Z690-F Gaming WIFI
- 32GB Corsair DOMINATOR PLATINUM 5600MHz DDR5
- 12GB NVIDIA® GeForce® RTX 3080
- 1TB Samsung 980 Pro M.2 PCIe NVMe
- 4TB Seagate Ironwolf Pro HDD
- Windows 11 Home

This spec from
£3,350.00*

TOPAZ PRO GAMING DESKTOP

- AMD Ryzen 7 5800X
- Asus® ROG STRIX B450-F Gaming
- 16GB Corsair VENGEANCE 3200MHz
- 12GB AMD RADEON™ RX 6700 XT
- 1TB Seagate FIRECUDA 520 NVMe
- 1TB Seagate BARRACUDA HDD
- Windows 11 Home

This spec from
£1,730.00*

ELIMINA NOVA GAMING LAPTOP

- 15.6" 144Hz FHD Matte Screen
- Intel® Core™ i7-12700H
- 16GB Corsair 3200MHz
- NVIDIA® GeForce® RTX 3050 Ti
- 1TB Intel® 670p M.2 PCIe NVMe
- Multi-Colour Backlit Keyboard
- Windows 11 Home

This spec from
£1,190.00*

WWW.PCSPECIALIST.CO.UK 0333 011 7000

*Prices are including VAT and are correct at time of printing, but subject to change.
Images are for illustration purposes only, components may differ in aesthetics and brand.

PCSpecialist

DDR5 MEMORY

THERMALTAKE TOUGHRAM RC DDR5 / £350 inc VAT (2 x 16GB, 4800MHz)

SUPPLIER scan.co.uk

BRUSHED ALUMINIUM

+ Very overclockable
+ Clean and smart design
+ Relatively low profile

BRUSHED ASIDE

– RGB fans need to look elsewhere
– No XMP 3 compatibility
– Very expensive

If there's one criticism we can aim at Intel's new Z690 platform for its 12th-gen CPUs, it's the price and availability of DDR5 memory. For the first few weeks after the CPUs launched, DDR5 memory was out of stock everywhere, and when it did turn up, the prices were ridiculous. Thankfully, the situation is now gradually improving, making the more lustworthy Z690 motherboards available a little more accessible, and there are DDR5 modules with even faster speeds inbound too.

Thermaltake's entry into the DDR5 market isn't exactly cheap, though, and with a price of £350 for a dual-channel 32GB (2 x 16GB) 4800MHz kit, the Toughram RC DDR5 is much more expensive than the competition too. The Toughram RC modules also lack RGB lighting, but they look extremely smart, with square-edged, black brushed aluminium heatsinks that sit tightly packed, with zero gap between them if you fill adjacent sockets.

They're compact as well, measuring just 40mm tall, although Kingston's Fury Beast models are a little shorter. This means they're less likely to clash with large CPU coolers than taller modules, and the RC in the name also means the modules are compatible with Thermaltake's Floe RC RGB-clad liquid coolers, which add the memory to an AIO liquid cooler loop that also cools the CPU.

Thermaltake's RC Ultra coolers not only feature an integrated display on the waterblock/pump unit, but also add a second display that spans the memory modules. These coolers demand a hefty price, but if you're happy to ditch the displays and just have RGB lighting (again spanning the memory as well as the CPU block), then a version with a 240mm radiator currently costs under £150.

Sadly, the price of the memory itself is another issue, though, because at £350 inc VAT, a dual-channel Toughram RC 32GB DDR5 kit costs over £100 more than other equivalent kits from the competition. Even a faster 5200MHz 32GB (2 x 16GB) Corsair Dominator kit, with RGB lighting, comes in at under £300 from **scan.co.uk** at the moment.

The Toughram's rated speed of 4800MHz is the lowest speed of DDR5 memory you'll find at the moment, and it gets there with relatively relaxed timings of 40-40-40-77 too. However, our eyebrows were raised when we found we could overclock it to 5600MHz, and it kept going too.

It only fell over when we ran it at 6200MHz, at which point our system refused to enter Windows, but it was happy at 6000MHz, proving stable enough to get to the Windows desktop and run a few benchmarks. That's a seriously impressive overclock, but we did find that our Asus ROG Maximus Z690 Apex didn't allow us to set any kind of XMP profile that matched its specification.

Thermaltake's website states that the 4800MHz kit lacks XMP 3 compatibility, but thankfully, opting for the Asus optimised profile, and then dialling in the 40-40-40-77 latency settings worked fine, and continued to work all the way up to 6000MHz too.

Conclusion

There were still some question marks over the final UK price of the Toughram RC DDR5 when we wrote this review, but with a dollar price of $429 US on Thermaltake's website, a UK price of £350 inc VAT seems pretty accurate. This puts it at a significant disadvantage, especially when plenty of other 32GB kits offer speeds of 5600MHz for under £300.

If you like RGB lighting, then you're out of luck with the Toughram RC too – again, there are cheaper kits that offer it and with higher rated speeds. While it overclocks like a trooper, the Thermaltake Toughram RC DDR5 is simply too expensive to be worth it, even if you factor in the overclocking headroom and compatibility with Thermaltake's Flo RC liquid-cooling components.

ANTONY LEATHER

SPEC

Frequency
4800MHz

Timings
40-40-40-77

Voltage
1.1V

Height (from base)
40mm

Lighting
No

VERDICT

Smart looks and awesome overclocking headroom, but it's just too expensive compared with the competition.

PERFORMANCE 29/30

DESIGN 19/25

VALUE 29/45

OVERALL SCORE 77%

HackSpace

TECHNOLOGY IN YOUR HANDS

THE MAGAZINE FOR THE MODERN MAKER

SUBSCRIBE AND SAVE UP TO 35% on the cover price

ISSUE #54

OUT NOW

hsmag.cc

Available on the App Store

GET IT ON Google Play

27IN GAMING MONITOR

ACER PREDATOR XB273UNV / £405 inc VAT

SUPPLIER ebuyer.com

HIGH DYNAMIC RANGE

+ Excellent image quality
+ Solid gaming performance
+ Decent value

LOW FIDELITY

– Low maximum brightness
– Middling pricing

The Acer XB273UNV is by many measures a middle-of-the-road 27in 2,560 x 1,440, IPS gaming display with an average price to match. However, it has a few features that put it ahead of the pack. The most obvious is its 170Hz refresh rate (5Hz higher than typical 165Hz competitors!), but such a small increase is imperceptible in real-world gaming.

Next up on its hit list is a high colour gamut, covering 94 per cent of the DCI-P3 colour space (according to our tests), which is equivalent to 90 per cent of the Adobe RGB and 131 per cent of the sRGB colour spaces – that's useful for professional image and video editing and HDR.

We generally find that most wide gamut displays lack the high contrast that HDR also demands. However, we found the Acer's HDR reproduction quite compelling. The step up in colour saturation and brightness variation provided by the dynamic backlight control (where brightness is changed from frame to frame to create the perception of better overall contrast), made for a more dazzling experience than with the display's SDR modes.

However, this is largely because the display tops out at a maximum brightness of just 219cd/m^2 in our tests in SDR mode. It's only in HDR mode that it went up to 364cd/m^2 in our tests. The former result is only adequate for relatively dimly lit rooms (we calibrate our displays for use at 150 cd/m^2) and is on the low side for a bright office. In both HDR and SDR, the contrast ratio tops out at between 916:1 and 1,033:1 depending on the exact mode.

The Acer is also surprisingly thick for a modern gaming monitor, with a wide edge and a protruding middle section around the back. Around the edges of this central section is a strip of RGB lighting, which can be set to many colours and patterns but can't be set to match the on-screen image, as with Philips Ambilight systems. Housed in this middle section are the connections, power supply and 2W speakers. The latter sound weedy, but provide a touch more volume and clarity than the worst we've heard.

Meanwhile, the on-screen display (OSD) is controlled by three buttons and a mini joystick on the display's back right edge. They provide many options that make setting up this display a breeze.

A three-pronged stand provides height, rotation, tilt and two-way pivot adjustment, and the latter makes it particularly easy to access the rear connections, regardless of which side of your desk your monitor sits.

Overall image quality is excellent, with crisp text, great viewing angles, dazzling colours and superb out-of-the-box calibration. In both the default high gamut mode and the reduced gamut sRGB mode, it was less than 1 per cent off the ideal colour temperature of 6,500K, while gamma ranged between 2.14 and 2.24 depending on the mode, which is again very good.

When it comes to gaming, the 170Hz refresh rate, support for FreeSync and G-Sync, and even a backlight-strobing mode add up to excellent all-round performance. An average grey-to-grey response time of between 6.5ms and 3.1ms, depending on the overdrive setting, is good for an IPS panel too, so fast-paced gaming is well handled.

Conclusion

While the Acer Predator XB273UNV doesn't do much to stand out from the crowd, aside from its slightly low maximum brightness, it delivers the goods on every front and does so for a reasonable, if not truly bargain price.

EDWARD CHESTER

VERDICT

Decent all-round performance, a smart design and reasonable price make this a solid gaming monitor.

SPEC

Screen size
27in

Resolution
2,560 x 1,440

Panel technology
IPS

Maximum refresh rate
170Hz

Response time
0.5ms

Stated contrast ratio
1,000:1

Active sync
AMD FreeSync and Nvidia G-Sync compatible

Display inputs
1 x DisplayPort, 2 x HDMI

Audio
2 x 2W speakers, headphone out

Stand adjustment
Height, pivot, rotation, tilt

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

HDR standard
VESA DisplayHDR 400

IMAGE QUALITY 25/30

GAMING 23/30

FEATURES 16/20

VALUE 14/20

OVERALL SCORE 78%

32IN GAMING MONITOR

MSI OPTIX MPG321QRF-QD / £499 inc VAT

SUPPLIER overclockers.co.uk

OPTICAL

+ Punchy colours
+ Loads of features
+ Decent mainstream refresh rate
+ Great OSD

ILLUSITORY

− Expensive
− Mediocre colour accuracy
− Tricky to build

MSI is clearly targeting stereotypical gamers with the styling of its Optix MPG321QRF-QD. Its plastic rear mimics brushed metal and carbon fibre, it sits on a dramatically angled base and around the back you'll find RGB LEDs. Happily, the Optix backs up the dramatic design with practical features.

The stand offers 100mm of height adjustment alongside swivel and tilt movement, as well as a cable-routing cut-out. Around the back there are two HDMI 2 ports, a DisplayPort 1.4 input and a USB Type-C connection that also handles DisplayPort. There are also three USB 3.2 Gen 1 ports, two of which are helpfully located on the left-hand bezel.

Meanwhile, a handy joystick navigates an excellent on-screen display – it's fast, well organised and clearly displays key information and the impact to expect when you change different settings. The MSI's final big feature is its most surprising – a KVM switch. These are usually found on business screens, and allow users to control two devices with one set of peripherals – handy for switching between a PC and laptop.

There are good gaming credentials too. The MSI's 32in IPS screen has a 165Hz default refresh rate that overclocks to 175Hz and it supports FreeSync and G-Sync. Its 2,560 x 1,440 resolution is good for mainstream gaming too, but it's not particularly crisp on a 32in screen – you can easily see the pixels if you look closely.

Build quality is middling as well. Its plastic rear feels weak, it's not a tool-free build and the monitor is heavy. LG's rival UltraGear 32GP850 packs a punch against it too – it has the same core specification as the MSI alongside a 180Hz overclocked refresh rate, a sturdier, more mature design and a cheaper £349 price.

The MSI pairs its adaptable design with bold colours though. This screen rendered 99 per cent of the sRGB gamut with a monster 167.4 per cent volume, and the default contrast ratio of 1,127:1 is good. Those figures mean colours are delivered with huge vibrancy and decent depth.

There's no clear ghosting or inverse ghosting when the panel runs at its default 165Hz refresh rate, and there's hardly any halo around objects either. While this screen doesn't have the speed to sate high-end esports players, it's fast enough to tackle mainstream esports and single-player games. Moving to 175Hz only has a tiny impact, and we'd avoid the MPRT Sync option – it creates ghosting and darkens the display.

The MSI is a bit ordinary in some other areas, however. Its delta E of 4.14 is mediocre, and the colour temperature of 6,143K is on the warm side. The peak brightness of 600cd/m^2 and lack of high-end dimming means this screen isn't good enough for HDR gaming too.

The rival LG is sometimes better. Its colours are more accurate than the MSI, and it offers similar gamut performance alongside a reasonable contrast ratio of 900:1. Its output is more realistic, and better if you want to enjoy gritty games or need a panel for creative work.

SPEC

Screen size
32in

Resolution
2,560 x 1,440

Panel technology
IPS

Maximum refresh rate
165Hz (175Hz overclocked)

Stated response time
1ms

Stated contrast ratio
1,000:1

Active sync
AMD FreeSync Premium, Nvidia G-Sync compatible

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

Audio
N/A

Stand adjustment
Height, tilt, swivel

Extras
100 x 100mm VESA mount, 2 x USB-C 3.2 Gen 1, KVM

HDR standard
VESA DisplayHDR 600

Conclusion

The MSI is pricier than the LG, and not everyone will appreciate its bright, bold visual output. There's no denying its vibrancy, though, and it impresses with loads of features and an eye-catching design. The Optix isn't the cheapest or most mature-looking gaming display, but it's bold, absorbing and has loads of features – it's ideal if you want a versatile, striking screen.

MIKE JENNINGS

VERDICT

MSI's panel is big, bold, and packed with features, although its gamer styling lacks maturity and it's a bit pricey too.

IMAGE QUALITY 25/30
GAMING 26/30
FEATURES 18/20
VALUE 15/20

OVERALL SCORE 84%

STEREO SPEAKERS

CREATIVE T60 / £60 inc VAT

SUPPLIER creative.com

CREATIVE SPARK

- + Loads of connection options
- + Really easy to use
- + Plenty of sonic power and warmth
- + Good value

BRAIN FOG

- – Lacks high-end detail
- – Lacks sub bass
- – Audio compromised for convenience

Creative's venerable T20 speakers have been around for many years and remain an excellent option on a budget. However, their design and feature set are showing their age, which is where Creative's new T60 speakers come in, hitting the same affordable price with an updated design, and convenient Bluetooth and USB connections.

The new design sees the T20's bright yellow drivers ditched in favour of smarter-looking, gold-coloured ones, while the speaker grilles have been dropped completely. The result is a cleaner, more modern design, although you need to take care not to scratch the glossy plastic exterior.

A single knob on the right speaker provides a slightly weird-feeling volume control. It feels like it should be an analogue control (it doesn't spin freely or have detents), but it's a digital control that responds with just enough delay that you often overshoot the level for which you're aiming.

Below the volume dial sit three buttons. On the left is the power button that turns the speakers on and off with a long press. Tap this button while the speakers are on and it will cycle through the various inputs, indicating which is selected via the above LED.

A tap of the middle button switches between stereo and a somewhat useful emulated surround sound mode, while a long press will switch between the speakers and any connected headset/headphones. The latter lets you keep a set of headphones connected via the speakers and choose which device to use, rather than automatically muting the speakers when headphones are connected, as on the T20.

The final button turns on the surprisingly effective 'clear dialog' mode, which boosts the upper mid-range frequencies associated with speech. This and the surround mode are only available when in speaker mode, not headset mode.

Around the back of the right speaker is a headphone port, a microphone port (enabling headset pass-through via the USB connection), a USB Type-C port, a 3.5mm jack aux input and the output to the left speaker (the left speaker's cable is tethered rather than removable). You can also connect via Bluetooth, with pairing initiated by the left front button.

The T60s aren't tiny, portable units but they're far from desk-hogging either. Despite their reasonable size, though, they only sport a single 70mm driver per speaker – a downgrade from the two-driver setup of the T20s. A rear bass port also means you shouldn't set these speakers against a wall.

As a result, the T60s aren't quite as sonically accomplished as the T20s. Not surprisingly, neither speaker set provides huge, booming bass, but the T20s have more top-end detail. The T60s can also sound a little overwhelmed when there's a lot happening in the sound mix.

There's still plenty of power and warmth to make for a satisfying listen at your desk or kitchen party volume levels, but sound quality is clearly compromised in order to add the extra digital connections and hit the same price as the T20. You can get a little more detail by connecting via the aux input, but that rather defeats the point of buying these speakers.

SPEC

Audio configuration
1 x 70mm driver per speaker with rear bass port

Nominal power output
30W RMS, 60W peak

Frequency range
50Hz – 20,000kHz

Connections
USB Type-C, 3.5mm stereo input, Bluetooth 5, 3.5mm mic and headphone

Dimensions (mm)
93 x 147 x 199 (W x D x H)

Weight
1.9kg (pair)

Extras
Volume dial, power/source button, surround sound button, clear dialog mode button

Conclusion

The Creative T60s offer USB and Bluetooth connection, a smart design and entirely adequate audio quality for their price. They're a huge step up from any monitor speakers or smaller, cheaper units. However, you're paying for those extra digital connections and similarly priced pure analogue speakers often offer better sonic performance for the same price.

EDWARD CHESTER

VERDICT

A great set of features and solid sound quality, but you're paying for convenience over sound quality.

DESIGN 16/20

FEATURES 18/20

SOUND QUALITY 20/30

VALUE 22/30

OVERALL SCORE 76%

TKL MECHANICAL KEYBOARD

NZXT FUNCTION MINITKL / £100 inc VAT

SUPPLIER scan.co.uk

FORM FROM FUNCTION

+ Smart design
+ Hot-swappable key switches
+ Useful extra features
+ Reasonable price
+ Custom build option

FORM OVER FUNCTION

– Basic default keycaps
– Only linear red switches at retail
– Custom build option expensive

Famed for its cases and coolers, NZXT has recently branched out into PC peripherals with the launch of a mechanical keyboard and gaming mouse (see opposite). The Function keyboard range is available in three main variants: full-size, tenkeyless (TKL) and the MiniTKL we're reviewing here.

All versions sport the same core features, but the TKL models lose the numberpads to make them more compact, while the MiniTKL compresses its layout even more, although it retains the same number of buttons as the TKL. The full-size and TKL versions also come with a wrist rest.

Available in black, grey (only via NZXT's BLD custom build service – **nzxt.com/build/keyboard**) or white colour options, all have a distinct minimalist sleekness, with the MiniTKL adding further to the effect with its compact layout – it looks great. The matching black or grey (again, only via BLD) keycaps and default white backlighting – despite each key having full RGB backlighting capability – further adds to the attractively minimalist feel.

Build quality is solid for the price, with a plastic base topped by a sturdy aluminium plate. There isn't the steel-reinforced solidity and heft of some custom keyboards, but it's a clear step up from some cheaper, flimsy mechanical keyboards.

Meanwhile, the keycap legends look crisp and clear but their ABS plastic construction means they won't last as long as PBT keycaps. The legends are also just painted on rather than using longer-wearing doubleshot or dye-sublimation techniques. However, as they're standard Cherry MX-style caps, it's easy to upgrade them later, or you can upgrade to dye-sublimated PBT caps using the BLD service.

BLD also provides the option to swap the normal black cable for a coloured one and add coloured accent keycaps for the Esc, Enter and cursor keys, plus you can change the key switches. By default, retail versions only come with Gateron Red switches, which provide a linear key movement. However, via BLD, you can also opt for Gateron Brown (tactile), Blue (clicky), Silent Red, and Black (stiffer linear action) switches.

Even if you only buy the retail version, you can still easily customise the switches, as they're hot-swappable. Using the provided switch puller, you can just pull the switches straight out and pop in any other compatible switch. The default switches are quite loud – as is often the case with linear keys – so you may prefer to use a Brown tactile switch for a different typing feel and lower noise.

You get a handful of useful extras. The 2m braided cable is removable, plugging into a USB Type-C socket on the back of the keyboard (a quarter of the way in from the left). Along the left edge, there's also a rubberised volume wheel and three small buttons on the outside edge. These provide control for mute, disabling the Windows key and adjusting the backlight brightness. The keyboard is also fully programmable and there are shortcut secondary functions on the F1-F4 keys for switching the profile on the fly.

SPEC

Dimensions (mm)
339 x 123 x 40 (W x D x H)

Weight
718g with cable

Format
Mini TKL – 89 keys

Connection
USB Type-C socket with 2m cable

Switch type
Hot-swappable Gateron Linear Red

Switch life
50 million key presses

Backlighting
Per-key RGB

Polling rate
1000Hz

Keyboard rollover
N-key

Extras
Hot-swappable switches, volume wheel, keycap and key switch removal tools

Conclusion

NZXT has hit the ground running with its debut mechanical keyboard. Its design is sleek, it isn't priced too high, its removable cable and extra buttons are useful, and its hot-swappable switches make for an easy upgrade path. The only downside is having Red linear switches as the only option at retail. Although you can swap out the switches or opt for others using the BLD service, both options add to the price.

EDWARD CHESTER

VERDICT

Stylish, capable and versatile – a great first keyboard effort from NZXT.

DESIGN 18/20
FEATURES 16/20
PERFORMANCE 24/30
VALUE 25/30

OVERALL SCORE 83%

GAMING MOUSE

NZXT LIFT / £40 inc VAT

SUPPLIER amazon.co.uk

LIFTS YOU UP

+ Versatile, comfortable shape
+ Light weight
+ Great button layout
+ Excellent performance

KNOCKS YOU DOWN

– Fixed cable
– Minimal button selection
– Not truly ambidextrous

With its debut keyboard (opposite) proving such a success, can NZXT's first mouse also make a positive first impression? Well, on paper, there's not much that makes this mouse stand apart from its peers. Its feature set is basic and its shape is fairly unremarkable. However, in use it delivers all you would expect from a modern, simple and performance-orientated gaming mouse.

The most successful aspect of the Lift is its symmetrical shape. It has a gently sloped back that comfortably supports the palm for palm-grip use but stays out the way enough for claw and fingertip grips too. The sides move from an outward slope at the rear to a slightly inward slope at the front, providing an ideal middle section just under the thumb buttons and at the balance point of the mouse, where there's a slight lip under which your fingers and thumb can hook and grip the mouse.

So many mice have sides that slope the wrong way, so your fingers slide up them, or somehow the balance is just a bit off. Here, though, whichever grip style we tried, it just worked. Mileage will vary depending on your hand size and shape, but this is about as universally appealing a shape as you can get.

The impressively low weight helps a great deal with this mouse's overall handleability too. Despite not sporting the many holes and other weight-saving gimmicks of some mice, it weighs just 67g, making it effortless to fling around your mat. On its underside, the Lift has two large Teflon glide pads with a further smaller ring of Teflon round the sensor, providing smooth gliding and excellent stability.

However, the button arrangement is very simple, with sadly no extra side buttons for left-handed users, and just a single extra button on the top that defaults to switching the DPI setting. We found the latter too small to hit with the lower portion of your middle finger, but it's fairly easy to hit accurately with the tip of your index or middle finger. All the buttons feel very snappy and precise, with no mushiness or play. The scroll wheel also has well-defined notches, so it's easy to hit the scroll wheel button without moving the wheel. Its rubber grip also provides plenty of purchase.

As for the sensor, its headline figures aren't record-breaking but it's still excellent and provides indistinguishable performance from the most extreme sensors, provided you have a good mouse mat. Sprouting from the front of the mouse is its fixed braided cable, which has an ample 2m length, and is light and flexible enough to offer almost no spring back, despite it feeling a bit more robust than some of the very lightest cables. It's a shame the cable isn't removable though.

All of this generally excellent performance is backed up by a smart, minimalist design. Available in base colours of black or white (with black buttons for both) you can also configure the mouse to have blue, cyan, purple, red and yellow buttons and front/undersection if you buy it direct from NZXT. Aside from these optional flashes of colour, the only adornments are two strips of RGB lighting that run down the front two thirds of the sides of the mouse, providing an attractive underglow.

SPEC

Weight
67g

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

Sensor
PixArt 3389 optical, 16,000 DPI, 50G acceleration and 400 IPS

Buttons
6 (left, right, top, scroll wheel, pair of side buttons)

Cable
2m, lightweight braided

Extras
RGB lighting, customisable colour options

Conclusion

A fantastic shape, low weight, simple but functional button layout, excellent sensor performance and smart styling add up to making a truly excellent all-round gaming mouse. For its £40 inc VAT asking price, it's an absolute steal.

EDWARD CHESTER

VERDICT

There's almost nothing not to like about this excellent gaming mouse debut from NZXT.

DESIGN 19/20
FEATURES 13/20
PERFORMANCE 28/30
VALUE 28/30

OVERALL SCORE 88%

14IN GAMING LAPTOP

ALIENWARE x14 / £2,099 inc VAT

SUPPLIER dell.com

Alienware isn't the first company to build a small and light gaming laptop, but the x14's 14.5mm-thick chassis undercuts every rival in this respect. It also looks fantastic, with a machined aluminium design that mimics Alienware's larger machines, and its 1.79kg body is light and robust.

The Alienware impresses in practical areas too. Around the rear you'll find a futureproof HDMI 2.1 port, two Thunderbolt 4 connections and a micro-SD slot. There's also a USB Type-C port that doubles as the power socket, plus one full-sized USB port. Unlike Alienware's larger machines, the rear isn't ringed with RGB LEDs, so the ports are easier to see. All of the ports are at the rear, so you'll have a tidy desk, but you also miss the easy access of side-mounted ports.

The x14 squares up against the Razer Blade 14, which is our current favourite ultra portable gaming laptop. The Alienware is slimmer, and there's little between the two when it comes to weight and build quality. Razer's machine has an extra full-sized USB port, while the Alienware has better Thunderbolt options. The x14's only design misstep is its depth – the large rear hinge means the machine is 263mm deep – while the Razer is a compact 220mm. The x14 may be slim, but the Blade is arguably more compact.

Meanwhile, the x14's keyboard has 1.2mm of travel, an extra column of volume buttons and a pleasing typing action – the buttons are fast and crisp, even if they're shallow. The x14 improves on the Razer with larger cursor keys and those extra buttons, and both have n-key rollover, but the Alienware has single-zone RGB LEDs, while the Blade had per-key lighting.

Don't expect much from the trackpad or wrist rest either – the pad is small, and the wrist rest is so short that it may prove uncomfortable for anyone with large hands. As always, you'll want to use a USB mouse for gaming.

SPEC

CPU
2.3GHz Intel Core i7-12700H

Memory
16GB 5200MHz DDR5

Graphics
Nvidia GeForce RTX 3060 6GB

Screen
14in 1,920 x 1,080 IPS 144Hz

Storage
1TB WD SN810 M.2 SSD

Networking
Dual-band 802.11ax Wi-Fi, Bluetooth 5.2

Weight
1.79kg

Ports
2 x Thunderbolt 4/USB Type-C/DisplayPort, 1 x USB 3.2 Gen 2 Type-C, 1 x USB 3.2 Gen 1, 1 x audio jack, 1 x HDMI 2.1, 1 x micro-SD slot

Dimensions (mm)
322 x 263 x 14.5 (W x D x H)

Operating system
Windows 10 Home 64-bit

Warranty
One year parts and labour return to base

On the inside, this £2,099 model of the x14 pairs Intel's Core i7-12700H CPU with an Nvidia GeForce RTX 3060 Laptop GPU. The processor has six Hyper-Threaded P-Cores with a peak boost speed of 4.7GHz, along with eight E-Cores optimised for efficiency. Meanwhile, the GPU has 6GB of memory, and a TDP that ranges between 60W and 75W.

The spec of the £2,099 model includes 16GB of 5200MHz DDR5 memory, and a 1TB SSD with excellent read and write speeds of 6,876MB/sec and 5,190MB/sec. Meanwhile, wireless connections come from dual-band 802.11ax Wi-Fi and Bluetooth 5.2. That 1080p 14in screen also has a 144Hz refresh rate and Nvidia G-Sync support, plus a 3ms response time. The Alienware's memory and storage beat the Razer, but the Blade's RTX 3060 has a TDP that ranges between 90W and 100W, giving it more power.

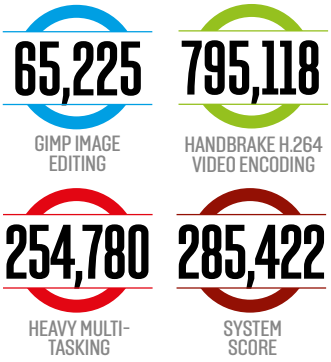
PERFORMANCE

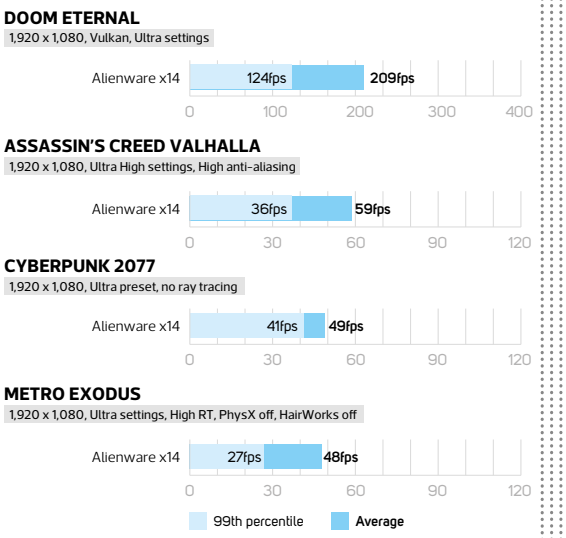
The x14's GPU did an admirable job of keeping up with the Blade in games benchmarks, however. The Alienware's 99th percentile result of 36fps in Assassin's Creed Valhalla is a couple of frames per seconds behind the Blade, but its average is 4fps faster. In Cyberpunk 2077, the Alienware was only a couple of frames per second behind, and the two machines delivered identical scores in Metro Exodus.

Despite the TDP differences, there's not much to choose between the two systems in gaming tests. As such, the Alienware will do a decent job in most situations – it can play single-player games at decent settings at the screen's native resolution – and most titles will only need moderate tweaks to the settings. The x14's Doom Eternal average of 209fps also shows that you can run undemanding games at high frame rates with the 144Hz screen.

Bear in mind, though, that you don't have a huge amount of power for outputting to the 8K/120Hz screens supported by the HDMI 2.1 output. Some games will struggle with advanced graphics settings too – Metro Exodus was barely playable with ray tracing enabled, and Cyberpunk 2077's

BENCHMARK RESULTS



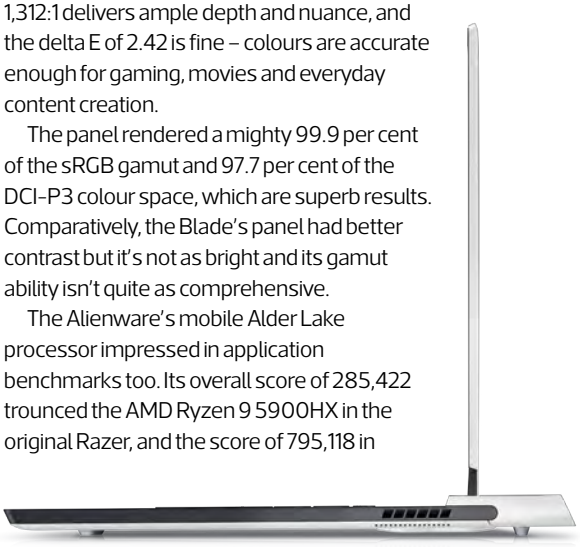


frame rates also declined further at the Medium ray tracing preset, even with DLSS enabled.

Games look brilliant on the 14in display though. The 446cd/m^2 peak brightness is huge, the contrast ratio of 1,312:1 delivers ample depth and nuance, and the delta E of 2.42 is fine – colours are accurate enough for gaming, movies and everyday content creation.

The panel rendered a mighty 99.9 per cent of the sRGB gamut and 97.7 per cent of the DCI-P3 colour space, which are superb results. Comparatively, the Blade's panel had better contrast but it's not as bright and its gamut ability isn't quite as comprehensive.

The Alienware's mobile Alder Lake processor impressed in application benchmarks too. Its overall score of 285,422 trounced the AMD Ryzen 9 5900HX in the original Razer, and the score of 795,118 in



our heavily multi-threaded Handbrake video encoding test shows you'll be able to run tough content-creation workloads with this laptop.

Not surprisingly, the x14 offers mixed thermal performance. The machine's exterior became warm during gameplay, but never hot – it was cooler than the Razer. The CPU and GPU delta Ts of 51°C and 43°C are fine, and the machine is quiet during work tests. It's loud during gameplay, though, so we'd advise using a headset for a comfortable gaming experience.

The battery offers no surprises either. The x14's gaming lifespan of 71 minutes is poorer than the Razer, and it delivered six hours of video playback and five hours of everyday work use. Those middling results help the x14 to prove more useful than most gaming laptops but the Blade made it through a full day in those latter tests. Finally, bear in mind that the speakers sound muddy – you'll want to use a headset for gaming.

EXCELLENT

- + Consistently great performance
- + Superb screen quality
- + Good ports and connection options
- + Slim, sturdy and good-looking design

EXASPERATING

- – Larger than Razer Blade 14
- – Middling battery life
- – Shallow keyboard
- – Noticeable fan noise

CONCLUSION

The x14 is the slimmest gaming laptop we've seen, and it impresses elsewhere: it keeps pace with the GPU in the rival Razer, its processor is excellent, and it has a great screen, a robust design and versatile connection options. As ever, this small laptop does have compromises. Its keyboard is crisp, but shallow, the speakers are muddy and battery life is mediocre.

The Blade remains quieter, longer-lasting and more compact but the X14 is a compelling competitor thanks to its great design, fantastic screen and great CPU performance.

MIKE JENNINGS

VERDICT

Great performance, a bold display and a slim, sturdy design make for a great ultra-portable gaming machine, despite some imperfections.

PERFORMANCE **23/25**

DESIGN **22/25**

HARDWARE **22/25**

VALUE **20/25**

OVERALL SCORE **87%**

INTEL Z690 GAMING PC

SCAN 3XS TORRENT Ti / £4,899 inc VAT

SUPPLIER scan.co.uk

Scan's 3XS Torrent Ti might be pricey, but that's because it features the fastest desktop components you can buy. For starters, it comes with Nvidia's new range-topping GeForce RTX 3090 Ti GPU – a brute with 10,752 stream processors and 24GB of memory. What's more, the EVGA's FTW3 card used by Scan ups the boost clock from 1860MHz to 1920MHz. The monster GPU sits below an Intel Core i9-12900K CPU, which has eight P-Cores with a boost speed of up to 5.2GHz alongside eight 3.9GHz E-Cores.

Scan partners those powerful parts with 64GB of dual-channel 5200MHz DDR5 memory, a 2TB Samsung 980 Pro SSD, and a Corsair RM850x PSU with 80 Plus Gold certification and a modular design. Those components go beyond the specification we'd expect from a gaming PC, which makes sense – Scan is also aiming this rig at content creators, with loads of GPU compute power (and memory) on tap, plus loads of multi-threaded CPU performance.

The warranty is great too, with three years of parts and labour cover, including a year of on-site service.

Not surprisingly, this powerful PC has a muscular motherboard. The Asus ROG Maximus Z690 Hero is a beast – the lightning-fast PCI-E 5 protocol underpins two 16x PCI-E slots and one of the five M.2 sockets. Meanwhile, the ROG SupremeFX ALC4082 audio codec has a high-quality ESS DAC, and at the rear, you'll find two Thunderbolt 4 ports alongside seven USB 3.2 Gen 2 connectors.

The board also has a handy POST code display, plus on-board power and reset buttons. Its heatsinks are huge, and the I/O and VRM cover glows with an array of customisable RGB LEDs. Speaking of VRMs, enthusiasts also benefit from a 20+1 power phase design.

We're big fans of Fractal Design's Torrent enclosures too, and Scan has chosen the Compact model here. It looks elegant, with two intake fans glowing through the slatted front section. Build quality is robust, and Scan's building is impeccable. Around the rear you'll find three 2.5in drive mounts, and on top, there are two full-sized USB ports and a Type-C connection. It's a great case, but the sheer amount of hardware means it's cramped inside – the PSU cables block the 3.5in drive mount, and the huge graphics card and hefty Noctua NH-U12A CPU cooler obstruct most of the motherboard.

SPEC

CPU
3.2GHz Intel Core i9-12900K

Motherboard
Asus ROG Maximus Z690 Hero

Memory
64GB Corsair Dominator Platinum RGB 5200MHz DDR5

Graphics
EVGA GeForce RTX 3090 Ti 24GB

Storage
2TB Samsung 980 Pro M.2 SSD

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-FI, Bluetooth 5.2

Case
Fractal Design Torrent Compact

Cooling
CPU: Noctua NH-U12A Chromax Black with 2 x 120mm fans; GPU: 3 x 90mm fans; front: 2 x 180mm fan; rear: 1 x 120mm fan

Ports
Front: 1 x USB 3.2 Gen 1 Type-C, 2 x USB 3.2 Gen 1, 2 x audio; rear: 2 x USB-C/Thunderbolt 4, 1 x USB 3.2 Gen 2 Type-C, 6 x USB 3.2 Gen 2, 2 x USB 2, 1 x optical S/PDIF, 5 x audio

Operating system
Windows 11 Home 64-bit

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

PERFORMANCE

Not surprisingly, the RTX 3090 Ti is very fast in games. In our 4K Assassin's Creed Valhalla test, the Scan returned a 99th percentile minimum of 49fps, which beat the RTX 3090 by 5fps and the RTX 3080 Ti by a wider margin. The RTX 3090 Ti was a couple of frames per second ahead of the RTX 3090 in Cyberpunk 2077 at 4K, and the card had a 19fps lead in Doom Eternal's 4K test. This GPU can do anything, including 4K gaming at fast frame rates.

That said, the Scan still couldn't quite hit a 45fps 99th percentile frame rate in Cyberpunk 2077 with Medium ray tracing and DLSS enabled, although its 43fps result here is still pretty good – a few tweaks to the settings and it will be smooth. Its Metro Exodus results show it can handle 4K

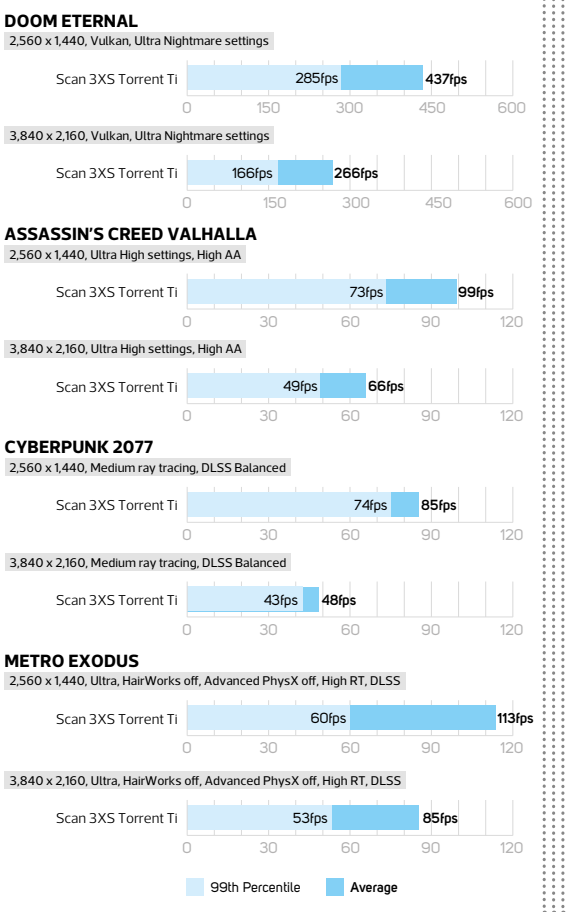
BENCHMARK RESULTS

72,748 GIMP IMAGE EDITING

1,102,547 HANDBRAKE H.264 VIDEO ENCODING

361,913 HEAVY MULTI-TASKING

394,881 SYSTEM SCORE



ray tracing in other games though. With DLSS activated, it hit a 53fps 99th percentile result, beating the RTX 3090 by 3fps. It's not massively quicker than the RTX 3080 Ti and 3090, especially considering the price, but it's without doubt the fastest GPU you can buy at the moment.

Meanwhile, the Core i9-12900K's single-threaded score of 72,748 outpaces rival AMD Ryzen 9 chips, and its multi-threaded Handbrake score of 1,102,547 remains miles ahead of AMD's chips. Likewise, the Cinebench R23 multi-threaded test result of 26,520 is ahead of Ryzen 9 chips and Intel's more affordable i7-12700K. The SSD

is great, too, thanks to pacey read and write speeds of 7,102MB/sec and 5,176MB/sec.

However, while the Noctua's NH-U12A air cooler on top of the CPU does an admirable job of keeping this high-end chip cool, with a delta T of 58°C, the CPU struggles to hit its 5.2GHz boost clock, instead topping out at 4.9-5Ghz, which hurts its performance in our image editing benchmark, which stresses single-threaded performance.

Nevertheless, the Scan's benchmark results remain superb, and you're unlikely to see this difference in normal use. The Scan is a good thermal performer elsewhere too – the GPU's delta T of 50°C is fine, and noise levels are great. The Scan produces modest and manageable fan noise during gameplay, and it's only slightly louder during a multi-threaded CPU test.

CONCLUSION

Scan's 3XS Torrent Ti might not attain record CPU benchmark speeds, but its GPU is still incredibly quick, and its components and chassis are superb. Also, while the Scan may cost £4,899, that's no more than this specification costs from any other UK PC builders.

A stronger CPU cooler could probably extract a little bit more boost pace from the processor, but that's the Scan's only flaw and fixing that would almost certainly involve a larger, noisier build, removing some of the 3XS Torrent Ti's appeal. If you want buckets of CPU and GPU power, for both gaming and content creation, this is a very fast, quiet and compact machine.

MIKE JENNINGS

TORRENT

+ Glorious gaming and processing speeds
+ Great motherboard
+ Excellent memory, storage and case
+ Comprehensive warranty

TORMENT

– Very expensive
– CPU doesn't hit peak boost speed
– Slightly cramped case

PERFORMANCE 24/25

DESIGN 23/25

HARDWARE 24/25

VALUE 19/25

OVERALL SCORE 90%

VERDICT

Huge speed, top-notch components and a great build, although it's expensive and the CPU doesn't hit its peak boost speed.

INTEL B660 GAMING PC

CYBERPOWER INFINITY X125 VR / £1,399 incVAT

SUPPLIER custompc.co.uk/InfinityX125

We're finally starting to see PC and component prices come back down to conventional levels, and the £1,399 CyberPower Infinity balances its relatively affordable price with some reassuringly familiar mid-range components.

The GeForce RTX 3060 may only have 3,584 stream processors, but there's plenty to like elsewhere – it has a mighty 12GB allocation of GDDR6 memory, and its 1777MHz boost clock has been overclocked by board partner MSI to sit at 1837MHz.

The Core i5-12400F is another mid-range part, but it's easily able to cope with everyday workloads thanks to its Alder Lake architecture, six Hyper-Threaded P-Cores and 4.4GHz boost clock. Meanwhile, the 16GB of DDR4 RAM runs at 3600MHz and a rock-solid MSI MPG A850GF provides power with a fully modular design and 80 Plus Gold certification.

Impressively for the budget, the CyberPower also includes two SSDs – the 500GB WD Black SN770 boot drive delivered good read and write speeds of 4,874MB/sec and 3,397MB/sec respectively, while the 1TB WD Blue is a secondary option – and its decent speeds of 3,539MB/sec and 3,073MB/sec easily outpace any hard disk, or SATA SSD for that matter.

Those dual SSDs are the only real surprise about the CyberPower's specification, though, and MSI's Pro B660M-A WIFI micro-ATX motherboard is another middling component. Happily, it has four memory slots, two M.2 connectors that support PCI-E 4 and rapid networking from 2.5Gbps Ethernet and dual-band 802.11ax Wi-Fi.

Beyond this, though, the board is sparse. Its second PCI-E slot only supports PCI-E 3, it has entry-level Realtek ALC897 audio and the reliance on Intel's B660 chipset means you can only overclock the memory, not your CPU (although the 12400F can't be multiplier-overclocked anyway). At the rear, the board has pairs of USB 3.2 Gen 2 and Gen 1 ports, but no Type-C and only three audio jacks.

CyberPower's own-brand NR640 chassis doesn't have any high-end features either, but it's a capable mid-sized tower. It has a tempered glass side panel, a magnetic dust filter on the roof and decent build quality. What's more, its front panel looks fantastic thanks to a trio of RGB LED intake fans that glow through a geometric mesh fascia.

There's a PSU shroud and neat cabling on the inside, and there's loads of room to work – helped by CyberPower's reliance on the modest Intel Laminar RM1 stock CPU cooler. Around the rear you'll find space for pairs of 2.5in and 3.5in drives, and a fan synchronisation board with four free connectors.

CyberPower's machine squares up with the Wired2Fire Phoenix Intel, which is our favourite budget gaming PC. The Wired2Fire includes the same CPU and GPU as the CyberPower for £1,099, but it has a similarly weak motherboard and its SSD and PSU are both underwhelming. CyberPower's PC also beats its rival in the build department – the NR640 case is 80mm deeper than the Wired2Fire's MSI case, giving you more space to

SPEC

CPU
2.5GHz Intel Core i5-12400F

Motherboard
MSI PRO B660M-A WIFI

Memory
16GB Corsair Vengeance LPX 3600MHz DDR4

Graphics
MSI GeForce RTX 3060 12GB

Storage
500GB WD Black SN770 M.2 SSD, 1TB WD Blue SN570 M.2 SSD

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi, Bluetooth 5.2

Case
CyberPower NR640

Cooling
CPU: Intel Laminar RM1 with 1 x 80mm; GPU: 2 x 90mm fans; front: 3 x 120mm fans; rear: 1 x 120mm fan

Ports
Front: 2 x USB 3.2 Gen 1, 2 x audio; rear: 2 x USB 3.2 Gen 2, 2 x USB 3.2 Gen 1, 2 x USB 2, 1 x PS/2, 3 x audio

Operating system
Windows 11 Home 64-bit

Warranty
Two years parts and labour, plus three years labour only. Six months collect and return, then return to base

LIGHTYEAR

- \+ Solid 1080p gaming performance
- \+ Two relatively fast SSDs
- \+ Good-looking, spacious case
- \+ Comprehensive warranty

LIGHTHEADED

- – Rivals are sometimes quicker
- – Underwhelming motherboard
- – Pricier than competitors

expand with a large graphics card, a 280mm radiator and more storage options.

Finally, CyberPower's machine has a five-year labour warranty with two years of parts protection and six months of collect and return service, but Wired2Fire offers the same labour and parts coverage, and two years of collect and return service.

PERFORMANCE

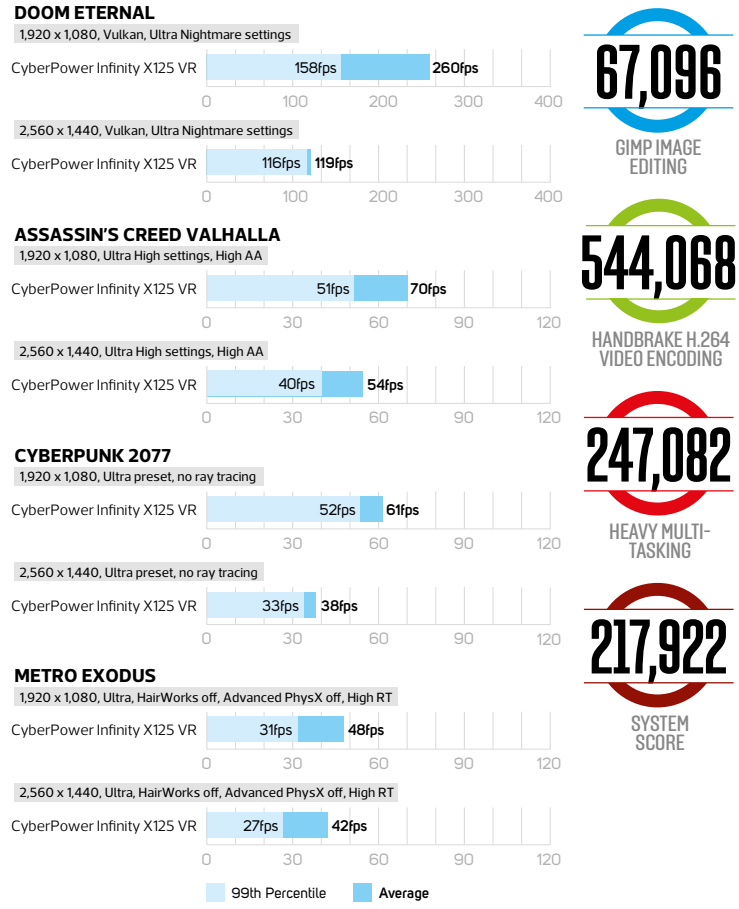
The overclocked RTX 3060 is a decent 1080p gaming card. It played Cyberpunk 2077 with a smooth 99th percentile result of 52fps, and returned similar pace in Assassin's Creed Valhalla – proof that this GPU will play big-name games at 1080p without fuss. Metro Exodus with High ray tracing was the only test where the GPU couldn't attain a 60fps average at 1080p, but activating DLSS took that average from 48fps to 57fps.

The CyberPower's Doom Eternal average of 260fps shows you can run undemanding games in sync with monitors with high refresh rates too. This PC's performance can't quite compare with that of the Wired2Fire rig, though, being consistently a couple of frames per second behind.

CyberPower's system gains ground on the Wired2Fire in application benchmarks, with marginally improved performance in our Handbrake video encoding test and our heavy multi-tasking benchmark. Its overall score of 217,922 is 3 per cent faster than the cheaper Wired2Fire system. That's welcome, but it's not a game-changing result – the Core i5-12400F is fine for gaming, but you'll want a more powerful CPU if you run a lot of heavily multi-threaded content creation software.

The CyberPower performed well in thermal tests too, despite its modest cooling setup. Its CPU and GPU delta Ts of 49°C and 36°C are solid, and there was no throttling. The PC is extremely quiet during gameplay as well, and it's only a bit louder when tackling tough work tasks.

BENCHMARK RESULTS



CONCLUSION

There's plenty to like about this £1,399 PC. CyberPower's Infinity X125 VR has rock-solid 1080p gaming pace and enough CPU power for everyday computing. Elsewhere, its SSD array, modular power supply, warranty and case all impress. Wired2Fire's cheaper rival has marginally more gaming power and remains a great choice if you want affordable mainstream gaming ability, but it's weaker in other areas.

Despite those weaknesses, though, the Wired2Fire's lower price makes it a much more tempting budget gaming rig. CyberPower's machine is a tad too expensive, but the Infinity X125 VR uses its higher budget to deliver a well-rounded specification and a better chassis. It's a solid, affordable 1080p gaming machine with reasonable room for future expansion, but it's a bit too expensive for the core spec.

MIKE JENNINGS

PERFORMANCE 20/25

DESIGN 20/25

HARDWARE 21/25

VALUE 20/25

OVERALL SCORE 81%

VERDICT

More expensive than the competition, but this PC supplies solid mainstream gaming power and a well-rounded design.

MINI-ITX GAMING PC

CHILLBLAST FUSION TORRENT MINI / £2,399 inc VAT

SUPPLIER chillblast.com

Chillblast's latest small form factor system uses the Fractal Design Torrent Mini, and that's a brilliant start – it looks fantastic with its white 180mm intake fan glowing through the front panel's deep slats. The good looks continue elsewhere, thanks to the Torrent's dark glass side panels, and build quality is consistently excellent.

Measuring 374mm tall and 417mm long, the Nano isn't the smallest mini-ITX case, but it's still compact enough to fit into tight spaces, such as a cramped desk setup. On the inside, the 2.5-slot graphics card dominates the bottom of the chassis, while above it, you'll find a Noctua NH-U12S CPU cooler with two 120mm fans.

The interior is cramped, but Chillblast has done a brilliant job of keeping cables tidy, and you can still reach the memory slots and SATA ports, although you'll have to remove the CPU cooler to reach the top M.2 slot.

The wiring remains impeccable around the rear, and there are helpful features around the case, including a soundproofed 3.5in hard disk bay in the roof and two 2.5in mounts behind the motherboard tray.

It's all powered by an excellent Corsair RM850 PSU, which has an 80 Plus Gold efficiency rating, and its fully modular design means Chillblast avoids unnecessary cables. We only have one minor issue with this case, which is that getting those side panels free involves sliding off the roof and releasing the screws, which is a bit tedious.

Still, that's a small price to pay to have a robust, good-looking and tidy mini PC case, and Chillblast has done a great job with the spec too.

The Gigabyte-made RTX 3080 rattles along with an overclocked boost speed of 1800MHz, and the Intel Core i7-12700K is a reliably excellent all-rounder thanks to its eight P-Cores and 5GHz Turbo boost speed.

This rig's 32GB of DDR4 memory runs at a solid 3200MHz, and its 1TB Seagate FireCuda SSD delivered speedy read and write speeds of 7,076MB/sec and 5,853MB/sec. It's all protected by a superb warranty too – Chillblast now offers three years of on-site service covering parts and labour covered, followed by two years of labour support.

The Gigabyte B660I Aorus Pro motherboard's feature set impresses too, with 2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi and Bluetooth 5.2. At the rear, it has single USB 3.2 Gen 2 Type-A and Type-C ports, and six more USB ports of varying speeds. The board looks great too, and its rear I/O panel has a hefty pre-installed shield.

There are limitations to this small board though. It only has two DIMM slots and one M.2 connector, for example, and it's not unusual to find two of the latter on mini-ITX products. The PCI-E slot doesn't support PCI-E 5 either, and you're restricted to DDR4 rather than DDR5.

Meanwhile, the reliance on Intel's B660 chipset means you can overclock the memory, but not the CPU, and the board only has two audio outputs alongside an optical

SPEC

CPU
3.6GHz Intel Core i7-12700K

Motherboard
Gigabyte B660I Aorus Pro DDR4

Memory
32GB Corsair Vengeance RGB Pro SL 3200MHz DDR4

Graphics
Gigabyte GeForce RTX 3080 10GB

Storage
1TB Seagate FireCuda 530 M.2 SSD

Networking
2.5Gbps Ethernet, dual-band 802.11ax Wi-FI, Bluetooth 5.2

Case
Fractal Design Torrent Nano

Cooling
CPU: Noctua NH-U12S with 2 x 120mm fans; GPU: 3 x 90mm fans; front: 1 x 180mm fan; rear: 1 x 120mm fan

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

Operating system
Windows 11 Home 64-bit

Warranty
Three years on-site parts and labour, plus two years labour only return to base

WATERFALL

+ Good-looking, robust build
+ Great gaming and processing power
+ Consistently quiet
+ Excellent warranty

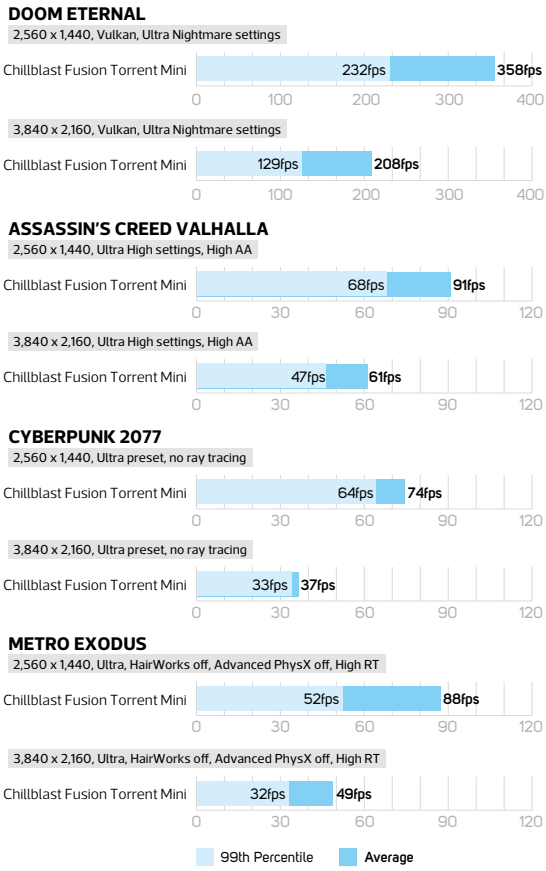
DROUGHT

– Pricier than competitors
– Missing motherboard features

S/PDIF. These restrictions aren't problematic at the moment, given that no PCI-E 5 graphics cards exist yet, and that manually overclocking the Core i7-12700K CPU is arguably pointless for most people anyway, but they're worth bearing in mind.

Despite those minor issues, Chillblast's rig remains a great combination of parts. It's pricey at £2,399, though, and your budget could stretch further if you consider larger ATX PCs. The Gladiator Nocturnal is our favourite quiet PC, for example – its motherboard has PCI-E 5 and USB 3.2 Gen 2x2 support, and it costs £2,176 inc VAT with a Core i7-12700K and RTX 3080.

BENCHMARK RESULTS



PERFORMANCE

The overclocked RTX 3080 delivered a 99th percentile minimum of 47fps in Assassin's Creed Valhalla at 4K, and it hit a 35fps 99th percentile in CyberPunk 2077 with Medium ray tracing and Balanced DLSS. Also, while the Chillblast's 4K 99th percentile result in Metro Exodus with High ray tracing isn't great at 32fps, that figure improves to 45fps with DLSS enabled.

These are tough game tests, though, and if you really want to play at 4K, you're better off paying the extra money for the RTX 3080 Ti. If you're playing at 2,560 x 1,440, though, the Fusion Torrent Mini storms it. This mini PC averaged 358fps in Doom Eternal at this resolution, with a 232fps 99th percentile results – great if you have a monitor with a high refresh rate. Its results in our other test games were also superb at this resolution.

We have no concerns about the Core i7-12700K CPU either. The Chillblast's overall benchmark result of 357,187 outpaces machines based on AMD's Ryzen 9 5900X. For gaming, content creation and multi-tasking, it's an excellent chip for most people's needs.

Impressively, the Chillblast has solid thermal abilities too. The CPU and GPU delta Ts of 59°C and 49°C are great, and the CPU's respective multi-core and single-core peak speeds of 4.7GHz and 5GHz are perfect. During gameplay the noise levels are moderate and consistent, and the Chillblast hardly makes any noise at all during creative workloads.

CONCLUSION

The Chillblast Fusion Torrent Mini is one of the best mini-ITX gaming PCs around today. Its RTX 3080 and i7-12700K handle high-end gameplay and tough creative tasks, the chassis is excellent, and the Fusion Torrent Mini slashes through benchmarks without making much noise. The motherboard has good connections and the warranty is excellent.

As ever, mini-ITX builds have foibles. The motherboard doesn't have futuristic features, and the Chillblast is pricier than similarly specified rivals. However, if you're not fussed about having PCI-E 5 and DDR5 support, and you want a fast, compact, and quiet system, the Chillblast is easily worth the comparatively high price.

MIKE JENNINGS

PERFORMANCE 22/25
DESIGN 23/25
HARDWARE 21/25
VALUE 19/25
OVERALL SCORE 85%

VERDICT

Great performance inside a robust, smart and good-looking case – it's worth the comparatively high price.

Custom kit

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

Rii USB MOUSE JIGGLER / **£10.99** inc VAT

SUPPLIER amazon.co.uk

There are several different approaches to simulate a person using a computer when nobody is really there, from securing a control pad stick with a rubber band (don't do that, it's bad for the pad), weighing down keyboard keys and sitting your mouse on a device that literally jiggles it about. The Rii USB Mouse Jiggler takes a much subtler and sophisticated approach, with a USB device that's smaller than its own plug.

The Rii moves the mouse cursor on its own, so there's no need to move the mouse or have the mouse moved for you when you're absent. What makes this much subtler than traditional methods is that it doesn't use continuous inputs – you get a tiny, almost imperceptible flicker of movement once every two minutes while the device is installed.

More complicated methods of detecting inactivity, if somebody were inclined to employ them, might easily recognise the small regular movement as mechanical, but it's easy enough to flummox a game that might want to kick you out for disappearing for ten minutes. The movement itself is subtle enough you could even get away with having it plugged in while playing, but the nagging concern that your mouse is going to flinch every so often may be unpalatable for some players.

AWOL ●●●●○ **AFK**

MOBVOI EARBUDS ANC / **£49.99** inc VAT

SUPPLIER mobvoi.com

Mobvoi's ANC earbuds are relatively large, and as such, are easy to fit without accidentally pressing buttons or knocking them loose, making them comfortable as a result. Their active noise cancelling itself isn't as aggressive as that of some earbuds – even on its highest setting (called Quiet), there's no problem hearing cars, people, alarms and so on.

This means the earbuds are fine for use out and about, where completely negating your sense of hearing for the sake of your tunes might be risky, but it also means you don't have the option to just drown out all the noise around you. There's also a sound pass-through mode, which allows you to hear every sound around you, almost as clearly as if you didn't have earbuds in your ears at all.

The sound quality is excellent for music and calls, and the earbuds can bring a lot of clarity and volume. There's also a suite of voice commands, and the earbuds can interact with a phone's smart assistant, which is a helpful accompaniment to the button interface, which is both simple and comprehensive. Battery life is around seven hours with 21 more hours stored in the charging case. The Mobvoi Earbuds ANC lack some of the finer attention to design detail you would expect from higher-end earbuds, but the quality is otherwise solid for the money.

Mob rule ●●●●○ **Mobvoi**

CORSAIR iCUE LC100 LIGHTING PANELS

/ **STARTER KIT £99.99 inc VAT; EXPANSION KIT £79.99 inc VAT**

SUPPLIER corsair.com/uk

Science hasn't yet discovered the point at which it can be said a PC has too many lights, although the Corsair iCUE LC100 Lighting Panels look potentially push the limit. The iCUE LC100 system is built around triangular RGB panels, each one containing nine RGB LEDs. You get nine panels in the Starter Kit, one of which is a main panel, which is the point of connection for the power and control wires, then you get eight other panels to attach to it with magnetic connectors.

The magnets enable the panels to easily attach to any steel surface inside your case. In addition to the regular connectors, you also get two slightly larger versions of the connector on each panel, which allow you to hinge a pattern of connected panels over a 90-degree angle. You get the same array of panels in the Expansion Kit, but without the Lighting Node Pro, which is the controller and the means by which the whole system interfaces with the iCUE software.

There's an immediate and comforting easiness to the process of setting up the panels themselves. You easily can tile them into place, with each one having two powered sides for connecting. What's more, because it's all done with magnets, no mistake is permanent.

The trickier part of the setup lies with hooking up the power and control system – the Lighting Node Pro needs to hook up to a USB header on your motherboard for control, and then it draws power from a SATA connector. The main panel also needs a SATA connector for power, and one of the pair of three-pin ports on the Lighting Node, so there's some wiring that you'll need to tuck away in your case somewhere.

The effect of them in use is amazing – there's a muted tone to the panels that diffuses and softens the individual LEDs, allowing for flowing colour transitions and patterns. Used in coordination with other iCUE devices, you can set these patterns to carry across different parts of your system, but even on its own the LC100 is very cool. The iCUE LC100 Lighting Panels are a great way to cram more lumens into a PC – they're entirely unnecessary, but they look lovely.

Should we do it? ●●●●● **Can we do it?**

AUSKANG POWER BANK /**£18.99 inc VAT**

SUPPLIER amazon.co.uk

The Auskang power bank attempts to cram as much battery capacity into the most efficient shape possible. As such, what you get is a flat rectangular device roughly the same width as a smartphone, but slightly shorter and narrower – an ideal size to share a pocket with one in fact. With a capacity of 5,000mAh, the Auskang carries enough charge to refill a Galaxy S21 or Google Pixel 5 with around 20 per cent left over.

One of the ways the Auskang saves space is that, unlike more versatile self-contained power banks, it only has one connector, in this case a USB Type-C port, although different versions with different connections are also available. This is a limiting factor, but it also streamlines the design. There also isn't a built-in connector to charge the bank itself, although a Type-A-to-Type-C cable is supplied for this purpose. Paring back the features to focus on necessities works well for the Auskang – there's very little to it but that's enough.

Features ●●●●○ **Focus**

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

How we test

MOTHERBOARDS

TEST PROCESSORS

- **Intel LGA1700** Intel Core i5-12600K
- **Intel LGA1200** Intel Core i9-11900K
- **AMD AM4** AMD Ryzen 9 5900X

Common test hardware between our CPU test rigs includes a WD Red SN750 SSD, along with a WD Black SN850 SSD to test the speed of M.2 ports, and an Nvidia GeForce RTX 3070. We use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, or 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM.

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 6 on Windows 11. We also test each board's M.2 ports, and record the noise level and dynamic range of integrated audio using RightMark Audio Analyzer.

PROCESSORS

TEST MOTHERBOARDS

- **Intel LGA1700** Asus ROG Strix Z690-I Gaming WiFi
- **Intel LGA1200** MSI MEG Z490 Ace
- **AMD AM4** MSI MPG Gaming B550 Carbon WiFi
- **AMD AM4 APU** MSI MEG X570 Unify

Common gear includes a 2TB Samsung 970 Evo SSD and Nvidia GeForce RTX 3070 FE graphics card. For LGA1700 CPUs, we use 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM and a Thermaltake Toughliquid Ultra 360 CPU cooler. For other systems, we use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz RAM and 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 11 with security updates, plus the latest BIOS versions and drivers. We record results at stock and overclocked speeds, and tests include our RealBench suite, Cinebench, Far Cry 6 and Dirt 5.

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, and for the LGA1700 system, we take an average reading across both the P-Cores and E-Cores. 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 LGA1700

Intel Core i9-12900K at stock speed, Asus ROG Maximus Z690 Apex motherboard.

INTEL LGA1200

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

AMD AM4

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

GRAPHICS CARDS

We mainly evaluate graphics cards on the performance they offer for the price. However, we also consider the efficacy and noise of the cooler, as well as the GPU's support for new gaming features, such as ray tracing. Every graphics card is tested in the same PC, so the results are directly comparable. Each test is run three times, and we report the average of those results. We test at 1,920 x 1,080, 2,560 x 1,440 and 3,840 x 2,160, using an AOC U28G2XU monitor.

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 RM850 PSU, Cooler Master MasterCase H500M case, AOC U28G2XU monitor, 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.

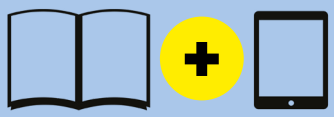
HEAVY MULTI-TASKING

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

ALL PRINT SUBSCRIPTIONS NOW COME WITH A

FREE DIGITAL SUB

PRINT + DIGITAL



- Free delivery of the print magazine to your door
- Exclusive subscriber-only covers
- Save up to 37% on the shop price of print issues
- Access to the digital edition on your iOS or Android device

CHOOSE YOUR SUBSCRIPTION OFFER

- **£5 for 3 issues**
  Renewing at £25 every 6 issues
  UK only
- **£5 Rolling subscription**
  UK only
- **£25 for 6 issues**
  UK only
- **£45 for 12 issues**
  UK only
- **£80 for 12 issues**
  EU
- **£90 for 12 issues**
  Rest of the world

SUBSCRIBE TODAY!

custompc.co.uk/subscribe

01293 312182 **custompc@subscriptionhelpline.co.uk**

Subscriptions, Unit 6 The Enterprise Centre, Kelvin Lane, Manor Royal, Crawley, West Sussex, RH10 9PE

Please allow 28 days for delivery.

LABS TEST

My loops are sealed

Antony Leather puts seven of the latest 240mm AIO liquid coolers to the test

How we test

240mm all-in-one units are de facto standard for sealed-loop liquid cooling these days, and for good reason. Their large radiators offer ample cooling for any mainstream desktop CPU, and usually enough cooling headroom to allow its fans to spin at lower speeds than 140mm or 120mm AIO liquid coolers. As a result, there's a lot of variation in terms of pumps and fans between models, as manufacturers make use of this headroom to offer either better cooling or lower noise levels.

To differentiate products, RGB lighting, software control and snazzy designs are all in the mix, but this month we have a bunch of coolers all vying for your wallet in different ways at a variety of prices. We'll be putting them to the test on both AMD's Socket AM4 as well as Intel's new LGA1700 socket, using adaptor kits where needed or checking performance with the cooler's existing kit where one isn't available.

We used an Asus ROG Maximus Z690 Apex motherboard in our Intel system, along with a stock speed Core i9-12900K, letting its boosting algorithms do their job rather than applying a manual overclock, which can lead to slower performance in some situations. We also used 32GB of Corsair DDR5 Dominator memory.

For our AMD system, we used an MSI MEG X570 Unify motherboard, along with a Ryzen 7 5800X overclocked to 4.6GHz using 1.25V vcore, and 16GB of Corsair Vengeance RGB Pro DDR4 memory. Alongside these components sit a 256GB Samsung 960 Evo 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 updates and driver versions.

We use CoreTemp to measure the CPU temperature, before subtracting the ambient air temperature from this result to give us a delta T, which 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.

To iron out any hot-running cores that might skew the results in our Intel LGA1700 system, we take an average temperature across the all-important P-Cores for the performance data. AMD only lists a single temperature reading, so we list what's reported in CoreTemp. We calculate the final scores based on cooling performance, noise, features, ease of installation and value, with a weighted calculation giving an overall score.

Contents

ARCTIC LIQUID FREEZER II 240 RGB / £80 inc VAT

SUPPLIER scan.co.uk

It's been a while since we've looked at an ARCTIC all-in-one liquid cooler, but we're quite glad the venerable PC cooling manufacturer sent the Liquid Freezer II 240 RGB in for review this month, and for a number of reasons. Firstly, it's the cheapest AIO liquid cooler on test this month, and one of the more affordable 240mm coolers available right now as well.

As with the standard Liquid Freezer II 240 model we reviewed a while ago, we love the fact that the fan PWM cables run through the tubes and down to the pump, giving you just a single cable that powers both pump the pump and the fans, with no cables trailing off the radiator itself. What's more, with the RGB and A-RGB versions of the Liquid Freezer II, the RGB cables from the fans do the same.

In addition, the fans are pre-mounted to the cooler, so installation couldn't be easier or neater. Meanwhile, the attractive braided tubes, chrome tube ends and radiator shroud give the whole setup a cleaner, chunkier look than some other coolers. Our sample's fans have standard RGB lighting, but the A-RGB version can offer more granular lighting control, with both coolers needing your motherboard to control the LEDs, using 3-pin or 4-pin RGB headers respectively.

The Liquid Freezer II 240 RGB is compatible with Intel's new LGA1700 socket for 12th-gen CPUs out of the box, and is fairly easy to install on both this socket and AMD's Socket AM4.

SPEC

Intel compatibility LGA1700, LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4

Radiator size with fans (mm) 120 x 277 x 63 (W x D x H)

Fans 2 x 120mm

Stated noise 0.3 sone

However, the mounting mechanism is quite large, so if you're using a mini-ITX motherboard with a cramped CPU socket area, or indeed any motherboard where there isn't much room around the socket, it's worth checking the dimensions on ARCTIC's website, which provides detailed measurements.

Part of the reason for the large size of the waterblock/pump unit is the inclusion of a fan that pushes air towards your VRMs in order to keep them cool. It's a handy feature, especially if you'll be using a Core i9 CPU. You also get a tube of MX-5 thermal paste in the box, so you won't need to buy any more paste if you reinstall the cooler at a later date, perhaps after a CPU upgrade.

The fans and pump proved to be very quiet in our testing, although the fans only peak at 1,800rpm, so there isn't an enormous amount of cooling power on tap. The ARCTIC's CPU delta T of 56°C in our Socket AM4 system and 55°C in our LGA1700 system were a few degrees off the top spots this month as a result, but the cooler still kept both our overclocked Ryzen 7 5800X and Core i9-12900K below 80°C after our toasty ten-minute stress test.

Conclusion

While the ARCTIC Liquid Freezer II 240 RGB might not top the cooling performance charts this month, with the Corsair iCUE H100i Elite Capellix and EK EK-AIO 240 Basic shaving a few degrees off its temperatures, it was far quieter than the competition.

Combine this with its VRM fan, pre-installed RGB fans and super-tidy cables, and it's an excellent choice, especially for the generous £80 price tag.

We'd like to see some slightly more powerful fans included in future revisions, but it's otherwise it's easily the 240mm AIO liquid cooler we'd pick for a PC unless you really needed software control or more extensive RGB lighting.

ARCTIC COOLING

- \+ Pre-installed fans and cables
- \+ Low noise
- \+ Excellent value

ARCTIC ROLL

- – Fans aren't very powerful
- – Limited RGB lighting
- – Competition offers better cooling

VERDICT

Very quiet operation, decent cooling power, a tidy setup and a surprisingly reasonable price. A great cooler for the money.

INTEL LGA1700

COOLING	FEATURES	OVERALL SCORE
33/40	14/20	85%
DESIGN	VALUE	
19/20	19/20	

CUSTOM PC PREMIUM GRADE

FITTING: Easy

AMD SOCKET AM4

COOLING	FEATURES	OVERALL SCORE
32/40	14/20	84%
DESIGN	VALUE	
19/20	19/20	

CUSTOM PC PREMIUM GRADE

FITTING: Easy

CORSAIR iCUE H100i ELITE CAPELLIX / £110 inc VAT

SUPPLIER ebuyer.com

Corsair is the latest firm to jump on the integrated display bandwagon, with its latest iCUE H100i Elite LCD cooler sporting a screen on the waterblock/pump unit. What's more, you can also buy this feature as an optional upgrade kit (£90 inc VAT from **corsair.com**) for the H100i Elite Capellix we're reviewing here. That gives you room to upgrade at a later date and, what's more, the H100i Elite Capellix has had a recent price drop, with units now going for £110 inc VAT from **ebuyer.com**

Corsair's Capellix RGB LEDs occupy the fans and waterblock/pump unit, making for an exceptionally vivid lighting display, while the pump speed is slightly faster than the pumps on Corsair's previous 240mm models, and the fans are extremely powerful too, peaking at 2,400rpm.

The fans and pump are also controlled according to the coolant temperature (rather than the CPU temperature), ensuring they only spin up after sustained heavy loads. At temperatures below 40°C, they can stop spinning completely, and there are several presets available to fine-tune the pump and fans to your own liking, although all eventually spin up to maximum speed.

Corsair also includes an iCUE Commander Core hub, which offers six individual fan channels and Corsair 4-pin RGB ports, which you can use to control up to six RGB fans directly using a USB header and Corsair's iCUE software. The latter can control most motherboard RGB headers, so while Corsair still mostly uses its own RGB connectors, it's still possible to use standard 3-pin or 4-pin lighting hardware with iCUE using your motherboard.

You have to deal with plenty of cable spaghetti with the H100i Elite Capellix, unlike the ARCTIC Liquid Freezer II 240 RGB, but most of it trails from the fans to the hub, as the pump has a single cable to control speed and lighting. Two pump tops are included too, with one allowing the inner logo plus two outer rings to be illuminated, while the other flips the lighting, and has the logo and rings in black, but allows the lighting to spread over a much larger area.

Installation is simple, especially on Socket AM4 motherboards, where the standard mounting brackets are used, although you'll need to invest in an LGA1700 mounting kit if you want to use an Intel 12th-gen CPU. There's also a second set of fan screws, allowing you to add a second row of fans, but sadly no extra thermal paste with the supplied paste pre-applied to the contact plate.

When dealing with our Core i9-12900K, only the Sapphire Nitro S240 and Phanteks Glacier One 240 T30 were cooler (and noisier), with the H100i Elite Capellix otherwise comfortably bettering the ARCTIC Liquid Freezer II 240 RGB and Lian Li Galahad SL 240, although they were also much quieter.

The Corsair was nearly on par with the Sapphire Nitro S240, Phanteks Glacier One 240 T30 and NZXT Kraken Z53 RGB in our AMD system too, shaving 5°C off the ARCTIC Liquid Freezer II 240's temperature, but was only a degree cooler than the much cheaper EK EK-AIO 240 Basic.

Conclusion

If you want all the bells and whistles, Corsair's H100i Elite Capellix has them, and it's a powerful cooler. It lacks the ARCTIC Liquid Freezer II 240's out-of-the-box readiness, and it's still a bit pricey, but it's a great AIO liquid cooler that also looks the business.

ELITE

- \+ Powerful software
- \+ Detailed fan, light and pump control
- \+ Excellent cooling

LITE

- – Noisy at full speed
- – No extra thermal paste
- – Still a bit pricey

SPEC

Intel compatibility LGA1700 (with optional kit), LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3, TR4/X

Radiator size with fans (mm) 120 x 277 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 37dBA

VERDICT

There are better-value options available, but this is still a seriously powerful, well-equipped and great-looking cooler.

INTEL LGA1700

COOLING	FEATURES	OVERALL SCORE
36/40	19/20	83%
DESIGN	**VALUE**	
12/20	16/20	

FITTING: Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
37/40	19/20	82%
DESIGN	**VALUE**	
10/20	16/20	

FITTING: Easy

EK EK-AIO 240 BASIC / £83 inc VAT

SUPPLIER overclockers.co.uk

Custom water-cooling hardware manufacturer EK has dabbled in the AIO liquid cooler market for a few years, and has now settled on a traditional design with a sealed loop, which comes in either plain black design or with an RGB-enabled pump and fans. It's the former that we're reviewing here in the form of the EK-AIO 240 Basic; if you're not fussed at all by multi-coloured flashing lights, this is the cooler to buy this month.

At a price of £83 inc VAT, it's very reasonably priced too, shaving over £25 off the price of the Corsair iCUE H100i Elite Capellix, although it does lack software control and a fan hub. On the other side of the pricing fence, the ARCTIC Liquid Freezer II 240 RGB is actually slightly cheaper and includes RGB lighting, as well as expertly tidied cables and pre-installed fans. However, the EK's fans are more powerful, which was our one complaint about the ARCTIC cooler. The EK's fans can hit 2,400rpm, which gives the cooler some clout on high-end CPUs.

It's also extremely well made, with braided and highly flexible tubing, along with chrome-plated end caps – it's a premium look that helps to set the EK apart from other coolers. The black brushed cap on the pump will look great with any grey or black-themed motherboards. Just be aware that the large waterblock/pump unit may be an issue on some smaller motherboards when it comes to clearance.

EK also includes a tube of high-performance Thermal Grizzly thermal paste in the box, so unlike the Corsair iCUE H100i Elite Capellix, you get enough paste to cover several remounts or upgrades. Unlike the ARCTIC cooler, though, you'll need to buy an LGA1700 mounting kit for Intel's 12th-gen CPUs separately. On the plus side, it only costs a couple of quid.

With no lighting on offer, you only need to deal with the 4-pin PWM cables for the pump and fans. The latter benefit from a PWM splitter cable, so you need just one fan header on your motherboard to power them. Installation is simple as well, with the EK-AIO 240 Basic having a straightforward mounting mechanism for all sockets, using thumbscrews, springs and a backplate.

In terms of cooling power, the EK cooler's CPU delta T in our Intel system of 49°C beat the Corsair iCUE H100i Elite Capellix and was 6°C lower than the ARCTIC Liquid Freezer II 240 RGB too. What's more, it made a similarly low amount of noise to the latter, and it was far quieter than the former. It wasn't quite as potent in our AMD system, though, only offering a 4°C advantage over the ARCTIC cooler, and it was also bettered by the Corsair cooler in this system, although again the Corsair was much noisier.

Conclusion

While the EK's setup is as basic as liquid coolers come, if you don't want RGB lighting and just want a reasonably priced, good-performing, classy-looking AIO liquid cooler, the EK-AIO 240 Basic gets our vote. It's a shame LGA1700 compatibility doesn't come as standard and the, and the waterblock/pump unit is a bit large, but we can't argue with the cooling, build quality or price.

For most people, we'd still recommend opting for the ARCTIC Liquid Freezer II 240 RGB, which offers a VRM cooling fan, slightly lower noise levels and RGB lighting, as well as out-of-the-box LGA1700 compatibility. However, the EK-AIO 240 Basic remains a great choice if you like its classy minimalist appearance.

SPEC

Intel compatibility LGA1700 (with optional kit), LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4

Radiator size with fans (mm) 120 x 275 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 34dBA

EK	EEK
+ Jet-black design	– Rather basic
+ Reasonable price	– No RGB lighting
+ Great build quality	– LGA1700 kit is optional extra

VERDICT

Great cooling and quiet operation for a reasonable price – ideal if you're not fussed about RGB lighting.

Intel LGA1700

COOLING	FEATURES	OVERALL SCORE
36/40	8/20	80%
DESIGN	VALUE	
18/20	18/20	

FITTING: Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
36/40	8/20	79%
DESIGN	VALUE	
17/20	18/20	

FITTING: Easy

LIAN LI GALAHAD SL 240MM / £140 inc VAT

SUPPLIER overclockers.co.uk

The original Lian Li Galahad AIO liquid cooler was a favourite from our last 240mm cooler group test, thanks to its stunning appearance, decent performance and reasonable price, but a lot has changed with the latest version. The Galahad SL 240mm now costs £30 more than the original Galahad, which puts it at a distinct disadvantage when it's up against the Corsair iCUE H100i Elite Capellix, which has received a sizeable price cut and retails for £30 less.

However, the Galahad SL 240mm sports a number of upgrades this time. Its trump cards are its Uni Fan SL120 fans, which offer stunning RGB lighting, and their slot-together design that means only one PWM and RGB cable is required for both fans. The pump has both power and RGB cables trailing from it, though, so the cable setup isn't quite as slick as that of the ARCTIC Liquid Freezer II 240 RGB, although the Lian Li does at least come with a software-controlled fan and lighting hub.

Using a USB header cable and Lian Li's own software, you can individually control the digital RGB lighting of each fan, as well as the pump, and control the speeds as well. The software is quite basic, and no match for Corsair's powerful iCUE software, but it does the job.

Meanwhile, the cooler's build quality is superb, and the radiator is clad in brushed metal sheets with plenty of shiny bevelled edges, which you'll also find on the fans and waterblock/pump unit. It looks stunning. The pump also sports RGB lighting, with a ring around its base and a dot display in the cap, which is either partially covered by a Lian Li logo or by an aluminium cap that's included in the box.

If you want to use an Intel 12th-gen CPU, then LGA1700 compatibility is all included in the box too, as is a tube of thermal paste to cater for future CPU upgrades or motherboard changes. The fans and pump proved to be reasonably quiet in our testing as well, but the fan blades are significantly shorter than those on usual 120mm fans, in order to make way for the lighting components.

Unfortunately, this arrangement with the fan blades seems to hamper cooling, with the Lian Li's best delta T result of 57°C (on our LGA1700 system) being 2°C warmer than that of the ARCTIC Liquid Freezer II 240 RGB, which is quieter and costs £60 less. Using the low speed setting in the software saw this temperature rise by a further 4°C. It was again not able to better the cheaper ARCTIC cooler in our AMD system either, and the Corsair iCUE H100i Elite Capellix was 6°C cooler in this test as well.

Conclusion

It's hard not to be disappointed by the Lian Li Galahad SL 240mm, especially when its predecessor was one of our favourite 240mm AIO liquid coolers. Here, though, Lian Li has largely sacrificed cooling for aesthetics, and its SL fans appear to be quite compromised – their small fan blades simply don't push air at a rate that's consistent with the noise they churn out.

This, is a real shame, as every other aspect of the cooler is fantastic, but its high price really can't be justified when it has such lacklustre cooling performance. The Corsair iCUE H100i Elite Capellix is cheaper and a much better performer, while the ARCTIC Liquid Freezer II 240 RGB is cheaper and cooler, while still offering RGB lighting.

SPEC

Intel compatibility LGA1700, LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4

Radiator size with fans (mm) 124 x 273 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 32dBA

GALAHAD	SIR ROBIN
+ Fantastic looks	– Poor cooling
+ Innovative fan linking	– Expensive
+ Software control	– Software is a bit clunky

VERDICT

A stunning-looking cooler, but its performance is let down by weak fans.

Intel LGA1700

COOLING	FEATURES	OVERALL SCORE
32/40	14/20	70%
DESIGN	VALUE	
13/20	11/20	

FITTING: Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
31/40	14/20	68%
DESIGN	VALUE	
12/20	11/20	

FITTING: Easy

NZXT KRAKEN Z53 RGB / £230 inc VAT

SUPPLIER scan.co.uk

While Corsair's iCUE H100i Elite Capellix flagship 240mm AIO liquid cooler has seen a hefty price cut, the same can't be said for NZXT's Kraken Z53 RGB White, which is currently the company's priciest 240mm model. As a result, it will set you back over £200 and cost nearly three times as much as the ARCTIC Liquid Freezer II 240 RGB or the EK EK-AIO 240 Basic.

NZXT hasn't just slapped a randomly high price on the box though – it's an extremely good-looking cooler that's packed with the latest tech. Its 120mm AER RGB fans sport amazing lighting arrays and can be software-controlled using NZXT's CAM software, as can the 7th-gen Asetek-derived pump.

We haven't had any issues with the latest version of this software, but we've seen some complaints online about it being a little buggy. The pump and fans can be controlled separately, either using Silent or Performance profiles, a fixed speed or your own custom curve, using CPU, coolant or even GPU temperatures to control them.

Despite the fans sporting daisy-chained RGB cables, you do still have to contend with a frightening amount of cable spaghetti, though, and at this price, we expect more to be done to limit the excessive cabling, especially as ARCTIC did a great job with its cooler for considerably less money. The pump section is extremely large too, being too big to fit some mini-ITX motherboards, including the Asus ROG Strix Z690-I Gaming WiFi.

The highlight of the cooler, of course, is its 2.36in customisable display mounted in the waterblock/pump unit, which can cycle through data inputs, such as GPU, CPU and coolant temperature, as well as clock speed and CPU load. You can also upload GIFs, and customise the display's text, background and detail sections separately.

Corsair's latest displays are even better, but they're not included with the iCUE H100i Elite Capellix and are a £90 optional extra. However, even adding this option would still make the Corsair cooler significantly cheaper than the Kraken Z53 RGB.

Sadly, the included RGB hardware only features proprietary connectors too, so you can't connect it to standard 3-pin or 4-pin controllers on your motherboard.

Meanwhile, the speed profiles on offer vary the fan and pump speeds, but even the Silent profile will eventually ramp up to maximum speed at around 60°C, sitting at lower noise levels below this temperature.

On the plus side, an extra set of fan screws is included if you want to install a second row of fans on the radiator. What's more, Intel's new LGA1700 socket for 12th-gen CPUs are usually supported out of the box too, with all coolers manufactured this year including a new installation kit.

Cooling from the Kraken Z53 RGB was excellent on both our CPU sockets, even matching the mighty Sapphire Nitro S240 in our AMD system with a CPU delta T of 50°C, while making less noise too. However, both the EK EK-AIO 240 Basic and iCUE H100i Elite Capellix were never far away in terms of temperature, and they both cost significantly less money.

Conclusion

If it cost £150 instead of £230, we'd be all over the NZXT Kraken Z53 RGB, but the competition in this market segment is fierce and some coolers have even received price drops too. This makes the Kraken less of a lustworthy item and more of a hideously expensive one. It undoubtedly looks great, but there are numerous coolers that are better buys on test this month.

THE KRAKEN

- \+ Excellent cooling
- \+ Brilliant fan and lighting control
- \+ Great-looking display

BUBO THE OWL

- – Expensive
- – Proprietary RGB connectors
- – Lots of cables

SPEC

Intel compatibility LGA1700, LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3+, TRX/4

Radiator size with fans (mm) 123 x 275 x 55 (W x D x H)

Fans 2 x 120mm

Stated noise 33dBA

VERDICT

Great cooling, lighting and software control, but it's just too expensive.

Intel LGA1700

COOLING	FEATURES	OVERALL SCORE
36/40	19/20	75%
DESIGN	VALUE	
12/20	8/20	

FITTING: Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
38/40	19/20	75%
DESIGN	VALUE	
10/20	8/20	

FITTING: Easy

PHANTEKS GLACIER ONE 240 T30 / £160 inc VAT

SUPPLIER overclockers.co.uk

As its name suggests, the Phanteks Glacier One 240 T30 comes with Phanteks' new T30 120mm fans, which have received rave reviews and we can see why. They're fantastically well made and they shift a huge amount of air, not only for the amount of noise produced, but also in absolute terms. While there's no software control for the pump or fans, each fan has a switch to toggle between Advanced, Performance and Hybrid modes.

The latter cuts the rpm to zero until a 50 per cent PWM signal is applied, before spinning up to a lowly peak of 1,200rpm. Performance mode raises the speed steadily to 2,000rpm and Advanced mode peaks at an unpleasantly noisy 3,000rpm, but this gives you a huge range of speeds with which to play.

The benefit here is that each setting offers a maximum sound level and rpm speed, as well as an easy way to control fan speed ranges. That said, we recommend that anyone who's familiar with their motherboard's EFI should just opt for the 3,000rpm mode and fine-tune their fan speeds in the EFI themselves.

In addition to the high-performance fans, the radiator is also much thicker than the others on test, sitting at 38mm deep, while most others are around 10mm thinner. This allows the radiator to dissipate more heat, thanks to an increased surface area, and make real use of its powerful fans, which can then properly push air through the extra thickness.

SPEC

Intel compatibility LGA1700 (with optional mounting kit), LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4, TR4/X

Radiator size with fans (mm) 120 x 273 x 63 (W x D x H)

Fans 2 x 120mm

Stated noise 40dBA

The rest of the cooler is the same as Phanteks' previous designs, though, with an identical PWM-controlled 7th-generation Asetek pump, and Phanteks hasn't yet added LGA1700 support to its liquid coolers either.

Instead, a mounting kit is available for free by contacting its customer support, or you can buy one for a few quid from retailers or is included (**overclockers.co.uk** will include one if you buy the Glacier One 240 T30 too). Thankfully, installation is straightforward on all sockets, with the familiar Asetek mounting mechanism making use of backplates, pins and thumbscrews.

As expected, the Phanteks' performance was exceptional, although we couldn't help feeling that a more powerful pump could have yielded even better performance. Still, in Advanced mode it was the best-performing cooler on test, with CPU delta Ts of 49°C and 45°C in our AMD and Intel systems respectively, outpacing the Sapphire Nitro S240 and bettering the ARCTIC Liquid Freezer II 240 RGB and Corsair iCUE H100i Elite Capellix by wide margins. However, it was extremely noisy at this setting, which we certainly wouldn't recommend using for everyday computing.

Dropping to Performance mode and cutting 1,000rpm from the fan speeds saw it match the Corsair cooler in our AMD system, with a delta T of 51°C and hit the same 49°C delta T as the EK EK-AIO 240 Basic in our Intel system, with comparable noise levels.

GLACIER

+ Fabulous fans
+ Extreme cooling
+ Snazzy RGB lighting

ICE CUBE

– Poor value
– No LGA1700 compatibility as standard
– Noisy at high speeds

Conclusion

The Phanteks certainly has formidable cooling, and it comes at a cost in terms of price and noise, but even at lower speeds, it's still a match for the best-performing coolers on test this month.

The price for the Phanteks Glacier One 240 T30 is steep, though, especially given that the Corsair iCUE H100i Elite Capellix was never more than a few degrees off the pace and costs significantly less money.

The Phanteks is most at home when it's dealing with significant amounts of heat, so if you want the ability to tap into some extreme cooling, the Phanteks is by far the most powerful 240mm liquid cooler we've tested, but you have to pay for it.

VERDICT

Monstrous cooling power, but it's expensive compared with the competition.

Intel LGA1700

COOLING	FEATURES	OVERALL SCORE
38/40	14/20	77%
DESIGN	**VALUE**	
14/20	11/20	

FITTING Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
38/40	14/20	75%
DESIGN	**VALUE**	
12/20	11/20	

FITTING Easy

Wireframe

Join us as we lift the lid on video games

Visit **wfmag.cc** to learn more

SAPPHIRE NITRO S240 / £130 inc VAT

SUPPLIER overclockers.co.uk

Sapphire is a brand that we normally associate with graphics cards, but the innovative AMD GPU partner is now branching out into the liquid cooler scene, and the Nitro S240 seems like a decent first effort, featuring an attractive RGB-enabled pump and powerful 2,400rpm RGB fans.

The pump is the same 7th-generation Asetek design as we've seen on other coolers this month, such as the Phanteks Glacier One 240 T30, but we're happy to report that, unlike Phanteks, Sapphire includes LGA1700 mounting components in the box.

Sapphire also offers useful measurements for the waterblock/pump section, which is quite hefty, and the company's web page (**sapphiretech.com**) needs to be a first port of call for anyone with a mini-ITX motherboard, so you can make sure it fits, as its 91mm width might foul memory modules in some orientations. You don't have to deal with an overly chunky radiator, though, as it has the standard 27mm thickness.

Both the pump and fans have separate PWM cables for speed control, and you'll need them too, as it's a noisy cooler at full speed. The fans have both speed and RGB lighting signals sent over a single cable to reduce clutter, but with six cables running off the pump, you'll need to spend some time reducing cable tangles around your motherboard's CPU socket.

The cooler is powered by a single SATA connector, while the RGB lighting is controlled using a standard 3-pin connector, so you can link it to your motherboard or use a separate RGB controller. The lighting is very bright and vibrant too, giving Corsair and NZXT a run for their money this month, with beautifully diffusing fan blades. This is where the extras end, though, as there are no additional fan screws, nor a tube of thermal paste for future applications, as the paste is pre-applied.

While the Sapphire Nitro S40 definitely isn't going to be a friend of your ears at full speed, though, the decibels did at least translate into excellent cooling, with thermal performance coming second only to the mighty Phanteks Glacier One 240 T30 – the Sapphire even outpaced the Corsair iCUE H100i Elite Capellix and EK EK-AIO 240 Basic in both our AMD and Intel systems.

Its CPU delta T when cooling our Core i9-12900K was 46°C, which is just 1°C behind the Phanteks cooler and 4°C lower than the result from the iCUE H100i Elite Capellix. In our AMD system cooling, our overclocked Ryzen 7 5800X it managed a CPU delta T of 50°C, again just behind the Phanteks cooler, but only a degree or two behind the Corsair and EK coolers. You can slow down the fan speeds, but at low speeds, the Phanteks was cooler and quieter than the Sapphire.

Conclusion

We can't deny that the Sapphire Nitro S240 looks great, and it's also extremely powerful, but it really isn't the most pleasant cooler to have running in your PC at full speed. It's cheaper than the Phanteks Glacier One 240 T30, but if we wanted the best cooling, we'd opt for the Phanteks, which is even cooler and is also still excellent at its lower fan speeds, where it was quieter than the Nitro S240.

Meanwhile, if you want RGB lighting, the Corsair iCUE H100i Elite Capellix is a better buy, saving you some cash while still offering decent cooling and full software control. However, this is a superb first effort for Sapphire, and only a few niggles and some stiff competition sees it miss out. CPC

SAPPHIRE

- \+ Vibrant RGB lighting
- \+ LGA1700 compatibility out of the box
- \+ Excellent cooling

BLUE GLASS

- – Extremely noisy
- – Lots of pump cables
- – A bit pricey

SPEC

Intel compatibility LGA1700, LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4, TR4/X

Radiator size with fans (mm) 120 x 273 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 36dBA

VERDICT

Good-looking and powerful, but it's also extremely noisy and rather expensive.

Intel LGA1700

COOLING	FEATURES	OVERALL SCORE
38/40	12/20	73%
DESIGN	VALUE	
11/20	12/20	

FITTING: Easy

AMD Socket AM4

COOLING	FEATURES	OVERALL SCORE
37/40	12/20	70%
DESIGN	VALUE	
9/20	12/20	

FITTING: Easy

sinclair

Commodo

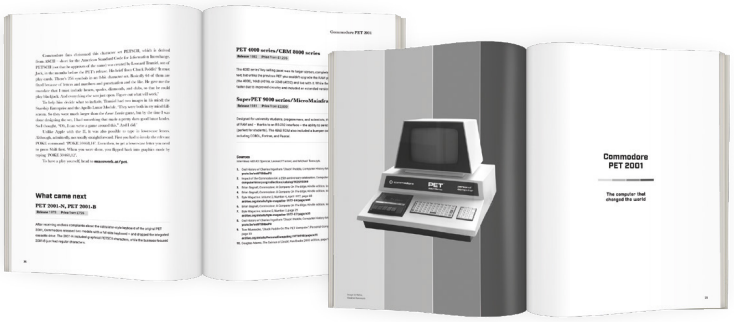
the

COMPUTERS THAT MADE BRITAIN

"The Computers that Made Britain is one of the best things I've read this year. It's an incredible story of eccentrics and oddballs, geniuses and madmen, and one that will have you pining for a future that could have been. It's utterly astonishing!"

- **Stuart Turton**, bestselling author and journalist

.....



Buy online: **wfmag.cc/ctmb**

Avilable on amazon

LABS TEST

Team work

Want Wi-Fi that covers your whole home? **Edward Chester** puts five of the latest mid-range Wi-Fi 6 mesh router systems to the test

How we test

Mesh Wi-Fi routers are the best choice for getting a reliable Wi-Fi signal across a wide area, but the top-end systems can get very expensive, while the budget systems often lack the latest Wi-Fi standards. So, to find out how to get high speeds without breaking the bank, we've grabbed a selection of the latest mid-range offerings that include Wi-Fi 6 (802.11ax) but still all cost under £350 – believe it or not, the top-of-the-range two-node systems cost double that figure.

All the systems on test consist of either two or three units, or nodes, one of which plugs directly into your broadband modem or ISP-provided router, and the other units can then be placed throughout your home, where they can pick up the original Wi-Fi signal and extend it on to the furthest reaches of your home. A typical setup might involve having the first unit in a ground floor front room, putting a second unit on the first floor and using a third unit for even higher floors, or in the garage for wide coverage of your back garden.

To test our systems, we set them up with the base unit in a ground floor front room, one unit in a ground floor back room and the third unit (where applicable) just outside the back door, in an outside shed. Wi-Fi speed tests were then performed in the same room as the router at a distance of 2m, in a first-floor rear bedroom (7m, one floor and one wall away) and half way down the garden (20m and two brick walls away). Tests were performed with one unit, two units then three units, again where applicable.

We tested Wi-Fi throughput using LANSpeedTest, setting up a server attached via Gigabit Ethernet to the router, then connecting to that server over Wi-Fi using a laptop with an AX1650 Wi-Fi card. We also tested for ping (the speed of response from a server) using **netmeter.co.uk/ping-test**. A low ping is essential for gaming and other applications that require a rapid, though not necessarily high-bandwidth, response.

Elsewhere, our assessment comes down to value for money, ease of setup, reliability, features (some units include USB ports for sharing data and printers, while others include extra Ethernet ports for connecting multiple devices) and build quality.

Contents

ASUS ZENWIFI AX HYBRID XP4 / £213 inc VAT (two units)

SUPPLIER amazon.co.uk

The Asus XP4 immediately sets itself apart from the competition with one useful addition – it also supports powerline networking. That's where a networking device uses your home's power cables to transmit data, allowing you to potentially get greater reliability, higher speeds and much greater range than with Wi-Fi.

In this instance, you just plug each of the units into the wall, and they can automatically create and use a powerline connection to pass data between each other (this link between networking nodes is known as the backhaul).

This is particularly useful if you have a garage or summer house that has mains electricity, but is well outside the range of a normal Wi-Fi signal. Some mesh router systems also allow for wired backhaul via their Ethernet connections, which you could then plug into separate powerline adaptors, but Asus' solution to this problem saves the cost and hassle of extra gear.

The big caveat with powerline networks is that they rely on the quality of your mains power cabling. Circuit breakers, extension leads, old wiring and more can result in a break or degradation of the signal. Unfortunately, it's just about impossible to know exactly how well powerline will work for your home setup without trying it.

In our tests, we set up the two units with both a Wi-Fi backhaul and powerline backhaul. For the former, we placed the second unit in the backroom as with our other tests. For the powerline backhaul ,we set up the second unit in the same position, but then also used a 30m extension cord to stretch the powerline signal all the way to the bottom of our garden, well out of reach of the other systems.

With the latter setup, we noted terrible performance in our initial tests until we fully unfurled the spare 3-4m of the cable from the extension reel. With mains cabling being unshielded, the coiled cable was causing massive interference with itself. With the cable fully extended, we got solid speeds of 284Mbps, with very impressive pings of no higher than 28ms. Pings for our other test setups at location three (which is closer than this test) would regularly jump to over 100ms.

As for normal Wi-Fi speeds, the XP4 put in a solid showing. With one unit, it essentially maxed out our laptop's Wi-Fi adaptor, hitting 710Mbps at close range. It also delivered reliable performance in our second test location (359Mbps), although failed to connect at our third location, as did all the single-node setups. With both units, speeds averaged 477Mbps with a Wi-Fi backhaul and 354Mbps with a powerline backhaul at the second test location, while both setups averaged around 250Mbps in the third test location.

Elsewhere, the XP4's feature set impresses, with each unit including a USB 3.2 port that supports a mass of features, such as printer sharing and using USB storage as a media server. Both units also have two LAN ports, so you'll have less need to buy a wired networking switch if you want to wire any of your network.

SPEC

Weight 667g per unit

Dimensions (mm) 143 x 65 x 207 (W x D x H) per unit

Ethernet 1 x Gigabit LAN and 1 x Gigabit WAN per unit

Wi-Fi Wi-Fi 6 AX1800 (802.1ax)

Claimed channel speeds 1 x 5GHz 1,202Mbps channel and 1 x 2.4 GHz 574Mbps channel per unit

USB ports 1 x USB 3.2 port per unit

Processor 64-bit 1.2 GHz quad-core

Extras Powerline backhaul, USB hard drive and printer sharing, USB media server

PEACEFUL

+ Powerline backhaul
+ Solid Wi-Fi speeds
+ Good value

PAINFUL

– Middling peak Wi-Fi speed
– Only dual-band Wi-Fi

Conclusion

The Asus ZenWiFi AX Hybrid XP4 isn't the last word in peak Wi-Fi throughput but it puts in a solid showing and outclasses some other mesh systems rated to the same AX1800 Wi-Fi speed. Its unique feature of built-in powerline networking is also a boon for those needing to stretch their Wi-Fi signal particularly long distances or through thick walls – assuming they have mains cabling to those locations. You also get plenty of features for this competitive price.

VERDICT

Solid all-round performance, plenty of features and potentially handy powerline networking make the Asus a cracking buy.

DESIGN	FEATURES	OVERALL SCORE
8/10	26/30	82%
PERFORMANCE	VALUE	
22/30	26/30	

LINKSYS VELOP MX8400 / £300 inc VAT (two units)

SUPPLIER ebuyer.com

If you want the briefest possible summary of the key performance differences between more basic Wi-Fi 6-capable routers and higher-end units, it's that the top-of-the-range units come with three Wi-Fi bands (2 x 5GHz, 1 x 2.4GHz), with the second 5GHz band peaking at speeds of 2,400Mbps. Meanwhile, cheaper units have just two bands (1 x 5GHz, 1 x 2.4GHz), with the 5GHz band peaking at 1,200Mbps.

For standalone routers, the extra bands are useful for spreading the Wi-Fi load when many devices are simultaneously connecting to the router, which can actually be quite a rare occurrence. However, for mesh systems the extra bands are particularly useful for ensuring you get really fast connections between all the nodes, as well as to your devices. If you only have two bands, mesh systems can get a bit clogged up, as we see with the Netgear Nighthawk Mesh system opposite.

SPEC

Weight 943g per unit

Dimensions (mm) 114 x 114 x 244 (W x D x H) per unit

Ethernet 3 x Gigabit LAN and 1 x gigabit WAN per unit

Wi-Fi Wi-Fi 6 AX4200 (802.1ax)

Claimed channel speeds 1 x 5GHz 2,400Mbps channel, 1 x 5GHz 1,200Mbps channel and 1 x 2.4GHz 600Mbps channel per unit

USB ports 1 x USB 3 per unit

Processor 1.4GHz quad-core

Extras Wired backhaul via Ethernet, hard drive sharing via USB

This Linksys system firmly lands in the high-end, tri-band category. Available in packs with one (£150 inc VAT), two (£300 inc VAT) or three units (£400), the Velop units are each identical, making it easy to buy only as many as you need and then add more units further down the line. They also support wired backhaul via their Ethernet ports, making them even more versatile and further freeing up Wi-Fi bands for client connections rather than backhaul.

Setting up the Velop units has always been expressly only via an app with a Linksys account, which we find a little irritating – it's sometimes easier to just connect a PC to a router to set it up via a browser. However, once you've signed up, it's a slick (if decidedly slow) process as you add each node to the network separately. Some systems are more plug-and-play when it comes to setting them up.

Each unit houses three Gigabit LAN Ethernet ports as well as a WAN Ethernet port, along with a USB 3 port. The latter can be used to connect and share a hard drive on each node but it doesn't support other features such as printer sharing.

In our tests, the MX8400 showed what that extra 2,400Mbps band can do, but only in certain instances. In test location one, the Linksys was limited by our laptop's Wi-Fi adaptor whether using one or two nodes, hitting 770Mbps. In our second test location, though, we saw speeds hit 383Mbps with one node and 535Mbps with two nodes. At the third test location, a single node wasn't enough to reach our laptop, but with two nodes we saw impressive speeds of 331Mbps. Pings were consistently low throughout too.

All told, that's an impressive showing and certainly proves the point that for most homes a decent two-node mesh system is enough to get wide and fast Wi-Fi coverage. However, if you do need more coverage then the Velop MX4200 system (as each unit is called) will sort you out.

MISSING LINK

+ Very fast Wi-Fi
+ Wired backhaul
+ Versatile

WEAKEST LINK

– Quite pricey
– Slow initial setup

Conclusion

Previous Linksys Velop systems have felt a little sparse on features for their price, but this latest system is far more capable and more competitively priced. Its Wi-Fi speeds are excellent and you get wired backhaul too, making it easy to setup complex hybrid wired/wireless network systems. The addition of extra Ethernet ports and a USB port in each node adds extra flexibility too. It's still not a cheap system but its premium price is matched with premium features and performance.

VERDICT

Versatile and with strong Wi-Fi performance, the new Velop system is ideal for those seeking a mesh system with more than just two nodes.

DESIGN	FEATURES	OVERALL SCORE
8/10	24/30	80%
PERFORMANCE	VALUE	
26/30	22/30	

NETGEAR NIGHTHAWK MESH MK63 / £330 inc VAT (three units)

SUPPLIER amazon.co.uk

Netgear's Nighthawk Mesh system is a bit of an oddity, as the company normally reserves its Nighthawk brand for its performance-orientated, gamer-centric products. This system, though, is decidedly basic and includes three units rather than two for its relatively modest asking price.

Each node of this kit features a dual-band Wi-Fi configuration that tops out at 1,200Mbps for the 5GHz band and 600Mbps for the 2.4GHz band. Not only does that mean its peak performance isn't as high as some other routers on test, but also that performance at range will be limited by the lack of an extra Wi-Fi band, especially if you're daisy-chaining all three nodes in a row.

Also, while we say 'nodes', this system doesn't have identical, multipurpose nodes but instead has a dedicated router and two satellites. In theory, this could limit its versatility but in practice, one node will always need to be configured as the primary router, so Netgear is just skipping a few setup steps for you.

There are some other advantages too. Firstly, the company can preconfigure the system to largely work right out the box, with a predetermined network name and password printed on the devices. Secondly, it allows Netgear to add a sync button to the devices that, when pressed, automatically adds a node to the network with no other configuration needed.

Full setup can be done via a web browser or the Netgear app, with the latter also providing a useful network map view that shows how the various nodes are connected and what devices are connected to each one. This makes it easy to know if any particular device is mistakenly trying to connect to a node that's further away than another one, for instance.

Physical features are lacking though. Each tiny unit houses just a single Gigabit Ethernet LAN port (other than the router, which also has a WAN port) and there's no support for USB devices. Thankfully, the Ethernet ports can be used to provide wired backhaul, so you can spread the network further, but if you do, you have no way of connecting any other wired devices to the two nodes at either end.

When it comes to performance, this modest Wi-Fi setup showed its limitations from the off. With one node, it peaked at 662Mbps in location one and only managed 218Mbps in location two, with maximum pings regularly hitting over 50ms at the latter.

With two nodes, performance in location two improved considerably, with peak speeds of 355Mbps and maximum pings of under 35ms. In location three, we also got a consistent 131Mbps, with pings that peaked at 128ms but largely stayed below 35ms.

Adding a third node resulted in some bizarre performance results, which we've seen before with some dual-band systems when daisy-chained together. In location two, we initially saw a big drop in performance until we manually disconnected and reconnected it, at which point performance was about the same as with two nodes. Meanwhile, at location three, performance dropped to just 59Mbps with maximum pings hitting over 500ms. We're sure performance would settle down over time, but it was notable how the other systems on test didn't have such issues finding an optimal signal.

Conclusion

The Netgear MK63 may feature the company's fancy Nighthawk branding but its performance doesn't really live up to the name. It provides solid Wi-Fi coverage but it's outclassed for overall Wi-Fi performance by several cheaper systems. Its lack of USB support and limit of a single Ethernet port per node is disappointing too.

DARK KNIGHT

+ Plug-and-play setup
+ Wired backhaul
+ Good Wi-Fi coverage

THE JOKER

− Modest Wi-Fi speeds
− No USB ports
− Only dual-band Wi-Fi

SPEC

Weight 286g per unit

Dimensions (mm) 122 x 122 x 64 (W x D x H) per unit

Ethernet 1 x Gigabit LAN and 1 x Gigabit WAN (router), 1 x Gigabit LAN (satellite)

Wi-Fi Wi-Fi 6 AX1800 (802.1ax))

Claimed channel speeds 1 x 5GHz 1,200Mbps channel and 1 x 2.4GHz 600Mbps channel per unit

USB ports None

Processor 1.5GHz quad-core per unit

Extras Wired backhaul

VERDICT

A relatively affordable way to get wide Wi-Fi coverage, but there are cheaper, more capable systems available.

DESIGN	FEATURES	OVERALL SCORE
6/10	18/30	66%
PERFORMANCE	VALUE	
18/30	24/30	

NETGEAR ORBI RBK752 / £320 inc VAT (two units)

SUPPLIER amazon.co.uk

Netgear's Orbi systems have long held the performance crown for two-node mesh router systems, with its flagship RBK852 system currently topping our overall test charts. However, with that system costing £700, it's rather out of contention of most buyers. This cheaper RBK752 system, though, sits on the next rung down and still sports impressive specs.

This tri-band system can simultaneously handle one 600Mbps 2.4GHz stream, a 1,200Mbps 5GHz stream and a 2,400Mbps 5GHz stream. Like other Orbi systems, though, one of the 5GHz streams is dedicated to being a wireless backhaul.

Netgear's theory is that this dedicated approach allows for the system to best optimise that single connection (with technologies such as beam-forming), increasing peak performance and reducing the chance of signal drops from having the router constantly trying to dynamically reassign the channels, as with other systems. That's the theory and we've found it's borne out in practice too.

A key factor to note, though, is that this arrangement only really brings a significant performance advantage with a two-unit setup. You can add several more units but because each unit still only has three Wi-Fi channels, one channel can no longer be dedicated to backhaul. What you can do for more complex or long-range arrangements, though, is set up Ethernet backhaul. This will free up a Wi-Fi channel each on the nodes that are connected over Ethernet.

In practice, though, most households will find that two nodes are plenty for getting good coverage. It's only for enormous houses, offices or situations where you either have outhouses or garden space that need coverage that you'll find you need a further-reaching mesh network.

Although the rather large nodes of the RBK752 system look identical, one is actually a dedicated router and the other a satellite. The former includes a Gigabit WAN port for connecting to your modem, along with three Gigabit Ethernet ports. The satellite just has two Gigabit Ethernet ports, while both units lack any form of USB connection.

Thanks to the units' predetermined nature, one of the big advantages of this system is that it's largely plug and play. Other than sometimes needing to reboot your ISP router or modem to get it communicating with the Orbi router, you can just turn on the units and they should automatically connect.

Netgear also uses a fun, yet secure, and often quite easy-to-remember system for naming its Wi-Fi signals too, using a random combination of two words and some numbers, such as orangecandle1234. These are then printed on the two units, so you can easily get away without having to think up a Wi-Fi name and password that you'll inevitably forget.

When it comes to performance, the RBK752 showed what that dedicated backhaul band is all about, with excellent performance across the board. In location one, we were hitting over 700Mbps with one or two nodes, while in location two, the Orbi hit 374Mbps with one node and 560Mbps with two nodes. At location three, we didn't get a signal with one unit but had a consistent and test-topping 358Mbps with two nodes, and with consistently low pings too.

Conclusion

Netgear's latest Orbi system brings its excellent two-node Wi-Fi performance to a more affordable price point, making it an excellent choice for those who need only a small boost in range but want high speeds. A lack of USB support makes this a less versatile system than some, though, and its speed advantage is modest for its price.

SPEC

Weight 862g per unit

Dimensions (mm) 183 x 71 x 231 (W x D x H) per unit

Ethernet 2 x Gigabit LAN and 1 x Gigabit WAN (router), 2 x Gigabit LAN (satellite)

Wi-Fi Wi-Fi 6 AX4200 (802.1ax)

Claimed channel speeds 1 x 5GHz 2,400Mbps channel, 1 x 5GHz 1,200Mbps channel and 1 x 2.4GHz 600Mbps channel per unit

USB ports 1 x USB 3 per unit

Processor 1.4GHz quad-core

Extras Dedicated wireless backhaul

ORBITAL

+ Very fast Wi-Fi
+ Plug-and-play setup
+ Excellent coverage

PERIPHERAL

− No USB ports
− Quite pricey
− Large units

VERDICT

Excellent Wi-Fi speeds for a two-node system, but its feature list is modest and it's quite pricey too.

DESIGN	FEATURES	OVERALL SCORE
8/10	20/30	75%
PERFORMANCE	VALUE	
28/30	19/30	

TP-LINK DECO X50 / £285 inc VAT (three units)

SUPPLIER box.co.uk

The TP-Link Deco X50 has an intriguing Wi-Fi setup that combines a single 2,400Mbps 5GHz band and a 600Mbps 2.4GHz band, rather than the 1,200Mbps 5GHz and 600Mbps 2.4GHz combination we often see on mid-range, dual-band mesh systems. This means you should get high peak performance up close, but performance won't hold up as well as tri-band systems once you get further away with multiple nodes daisy-chained together.

That's the theory, and it was our experience in practice too. Setting up our three-node system initially with just one node, in test location one we saw chart-topping speeds of 775Mbps (although all routers were limited by our test laptop's Wi-Fi adaptor at this range) and average speeds of 331Mbps in location two. Pings were more inconsistent (regularly jumping to over 100ms) than all the other routers on test this month in location two, though, so gaming and applications such as video calls could be affected.

With two nodes, we saw speeds jump to 454Mbps in location two, and the pings then settled down. In test location three, we now had a signal but it was fairly slow at 147Mbps. Pings were quite high too, with an average of 27ms and highs hitting over 125ms.

SPEC

Weight 456g per unit

Dimensions (mm) 110 x 110 x 114 (W x D x H) per unit

Ethernet 3 x Gigabit LAN per unit

Wi-Fi Wi-Fi 6 AX3000 (802.1ax)

Claimed channel speeds 1 x 5GHz 2,402Mbps channel and 1 x 2.4GHz 574Mbps channel per unit

USB ports None

Processor 1GHz dual-core

Extras Wired backhaul

Finally, adding the third node showed the lack of a third Wi-Fi band really affecting long-range performance. In location three, we saw only small gains in throughput (171Mbps) over having just two nodes. However, the signal was stronger, making for more consistent speeds and reliably low pings. Exact performance will also depend on your setup and whether you're daisy-chaining nodes, or if you have them arranged around a central hub node.

That's the performance story of the X50 system, but what else does it have to offer? Well, as its fairly modest price for a triple-node kit suggests, it's not bursting with features. Each very compact and fetching node houses three Ethernet ports, so you have plenty of options for connecting wired devices directly. What's more, the Ethernet ports support wired backhaul. However, you don't get any USB ports, which rules out a great swathe of potentially useful features.

Setup can be performed via a web interface or using the Deco app and it was a simple and quick procedure. The app also lets you see connected devices, change device priority and set up guest networks. The system is compatible with Amazon Alexa as well, so you can get your voice assistant turn on the guest network, for instance.

TP-Link HomeShield is also built in, providing features such as a real-time scanning for Internet of Things (IoT) devices, checking that their security is up to par. There's also a malicious site blocker, parental controls and it can spit out a host of impressively detailed reports to help you track time spent online, sites visited, blocked activity and more.

As well as a triple-node pack, the X50 units are available individually for £130 inc VAT and as a twin-pack for £220, making the triple-pack very clearly the best-value option if you're likely to need that many nodes.

DECOROUS

+ Good Wi-Fi coverage
+ Fast peak Wi-Fi speed
+ Decent value

DISASTROUS

– No USB ports
– Only dual-band Wi-Fi
– Slow long-range Wi-Fi

Conclusion

Thanks to its reliance on a dual-band configuration, the TP-Link Deco X50 doesn't set new records for performance at long range, especially if you're having to daisy-chain three or more nodes together. It's also a shame it lacks any USB ports for sharing connected devices. However, it has high peak performance up close, it's easy to set up, it has reliable long-range coverage and it's versatile thanks to its support for wired backhaul. It offers decent value too, especially in this triple-pack version. CPC

VERDICT

Not a speed demon at range, and not exactly bursting with features, but the Deco X50 is a solid option for getting reliable wide coverage.

DESIGN	FEATURES	OVERALL SCORE
8/10	18/30	74%
PERFORMANCE	VALUE	
22/30	26/30	

Elite

Our choice of the best hardware available

Core component bundles

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

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	£280
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 (CMK16GX4M 2B3200C16)	scan.co.uk	**#218** p78	£63
MOTHERBOARD	Asus TUF B450M-PLUS II (micro-ATX) with BIOS flash	awd-it.co.uk	**#218** p78	£90
STORAGE	500GB WD Blue SN570 (M.2 NVMe)	scan.co.uk	**#222** p20	£43

Total £476

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

Needs an ATX case. We recommend a 500W 80 Plus power supply. See Issue 224, p76 for an example build guide.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-12400F	scan.co.uk	**#224** p14	£169
CPU COOLER	ARCTIC Freezer i13X	scan.co.uk	**#224** p76	£20
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	**#220** p53	£390
MEMORY	16GB (2 x8 GB) Corsair Vengeance LPX DDR4 3200MHz (CMK16GX4M2E 3200C16)	scan.co.uk	**#224** p76	£62
MOTHERBOARD	Gigabyte B660 Gaming X DDR4 (ATX)	box.co.uk	**#224** p50	£138
STORAGE	1TB WD Blue SN570 (M.2 NVMe)	scan.co.uk	**#222** p20	£77

Total £856

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	scan.co.uk	**#220** p55	£480
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£116

2,560 x 1,440 gaming system

10-core CPU, 1080p and 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	Intel Core i5-12600K	scan.co.uk	**#220** p19	£269
CPU COOLER	ARCTIC Liquid Freezer II 240 RGB (240mm AIO liquid cooler)	scan.co.uk	**#226** p49	£80
GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	scan.co.uk	**#220** p55	£480
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX 4M2C3200C16)	scan.co.uk	**#221** p76	£75
MOTHERBOARD	Gigabyte Z690 Gaming X DDR4	scan.co.uk	**#222** p46	£200
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£116
		Total £1,220		
UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£78

Mid-range gaming system

10-core CPU, smooth 2,560 x 1,440 gaming and ray tracing

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-12600K	scan.co.uk	**#220** p19	£269
CPU COOLER	ARCTIC Liquid Freezer II 240 RGB (240mm AIO liquid cooler)	scan.co.uk	**#226** p49	£80
GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	overclockers.co.uk	**#220** p43	£630
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX 4M2C3200C16)	scan.co.uk	**#221** p76	£75
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	ebuyer.com	**#222** p48	£250
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£116
		Total £1,420		
UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£78

Core component bundles cont ...

4K gaming system

12-core CPU, 4K gaming

Needs an ATX case with room for a 360mm all-in-one liquid cooler. We recommend an 850W 80 Plus Gold power supply. See p78 for an example build guide

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i7-12700K	cclonline.com	**#226** p78	£377
CPU COOLER	Corsair iCUE H150i Elite LCD (360mm AIO liquid cooler)	scan.co.uk	**#226** p78	£250
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	nvidia.com	**#226** p78	£1,050
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2 C3200C16)	scan.co.uk	**#226** p78	£75
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	ebuyer.com	**#226** p78	£250
STORAGE	2TB WD Black SN770	box.co.uk	**#226** p78	£178
	Total £2,180			

UPGRADES				
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	**#166** p54	£78

Content creation system

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

Needs an E-ATX case with room for a 360mm all-in-one liquid cooler. We recommend a 750W 80 Plus Gold power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i9-12900K	scan.co.uk	**#220** p16	£550
CPU COOLER	Corsair iCUE H150i Elite LCD (360mm AIO liquid cooler)	scan.co.uk	**#226** p78	£250
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	**#220** p53	£390
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 5200MHz DDR5 (CMT32GX5M2 B5200C40)	scan.co.uk	**#221** p76	£295
MOTHERBOARD	MSI MEG Z690 Unify	scan.co.uk	**#222** p50	£520
STORAGE	2TB WD Black SN850	scan.co.uk	**#215** p49	£220
	Total £2,225			

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	nvidia.com	**#221** p48	£1,050
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	**#166** p54	£78

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 Z690 (LGA1700)	Asus ROG Strix Z690-I Gaming WiFi	scan.co.uk	**#220** p22	£375
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	awd-it.co.uk	**#214** p18	£180
AMD B550 (AM4)	Asus ROG Strix B550-I Gaming	scan.co.uk	**#206** p44	£205

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	**#225** p51	£100
HIGH AIRFLOW	Fractal Design Torrent Nano	scan.co.uk	**#225** p45	£110
PREMIUM	Streacom DA2 V2	quietpc.com	**#214** p51	£203

Other components

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
LOW-PROFILE CPU COOLER	Noctua NH-L12S	scan.co.uk	**#219** p54	£55
SFX POWER SUPPLY	SilverStone SX750	scan.co.uk	**#219** p72	£130

ATX cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	**#214** p26	£75
SUB-£100 AIRFLOW	Corsair 4000D Airflow	scan.co.uk	**#222** p56	£90
COMPACT	Fractal Design Meshify 2 Compact	scan.co.uk	**#215** p20	£100
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	**#212** p45	£136
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	**#202** p44	£140
SUB-£150	Fractal Design Define 7	scan.co.uk	**#204** p18	£147
PREMIUM HIGH AIRFLOW	Fractal Design Torrent RGB TG	scan.co.uk	**#225** p20	£220
LUXURY	Corsair iCUE 5000T RGB	scan.co.uk	**#224** p22	£350

Micro-ATX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD B450 (AM4)	Asus TUF B450M-PLUS II	awd-it.co.uk	**#218** p76	£80
AMD B550 (AM4)	MSI MAG B550M Mortar	scan.co.uk	**#204** p42	£130

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 ZenWiFi AX Hybrid XP4	amazon.co.uk	**#226** p59	£213
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	**#196** p58	£60
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	**#200** p22	£154
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	**#174** p34	£202
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	**#212** p25	£293

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	overclockers.co.uk	#214 p28	£160
25IN, 240HZ, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	box.co.uk	#209 p57	£200
25IN, 360HZ, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	amazon.co.uk	#212 p20	£543

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	ebuyer.com	#209 p60	£299
27IN, 165HZ, VA, 2,560 X 1,440, F, G	AOC CQ27G3SU	box.co.uk	#223 p45	£280
27IN, 240HZ, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£570
27IN, 240HZ, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£699
28IN, 144HZ, IPS, 3,840 X 2,160, F, G	AOC U28G2XU	amazon.co.uk	#221 p29	£586

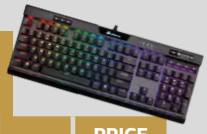
Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5IN, 60HZ, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£385
32IN, 144HZ, VA, 2,560 X 1,440, F, G	iiyama G-Master GB3266QSU	ebuyer.com	#224 p30	£359
32IN, 165HZ, IPS, 2,560 X 1,440, F, G	LG UltraGear 32GP850	overclockers.co.uk	#220 p38	£469
34IN, 144HZ, IPS, 3,440 X 1,440, W, F	iiyama G-Master GB3461WQSU	overclockers.co.uk	#206 p53	£450
34IN, 144HZ, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	overclockers.co.uk	#206 p55	£899
38IN, 144HZ, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	overclockers.co.uk	#208 p30	£1,349
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	£350

Peripherals and audio



Gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET TKL	SteelSeries Apex 3 TKL	currys.co.uk	#221 p59	£48
OPTICAL ESPORTS	Asus ROG Strix Scope RX	amazon.co.uk	#209 p43	£70
MECHANICAL TKL	NZXT Function MiniTKL	scan.co.uk	#226 p32	£100
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£180
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£140
PREMIUM MECHANICAL	Corsair K70 RGB Pro	overclockers.co.uk	#225 p30	£170
LUXURY WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	overclockers.co.uk	#208 p60	£180

Gaming mice

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	NZXT Lift	amazon.co.uk	#226 p32	£40
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	overclockers.co.uk	#215 p57	£45
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£60
MULTI-BUTTON	Roccat Kone XP	roccat.com	#225 p60	£80
WIRELESS	Razer Viper Ultimate	amazon.co.uk	#217 p54	£65
PREMIUM WIRELESS	Razer Deathadder V2 Pro	ebuyer.com	#210 p28	£125
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	£269
PREMIUM GAMEPAD	Razer Wolverine V2 Chroma	currys.co.uk	#221 p30	£139
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	£100

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	£50
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	#204 p50	£155
PREMIUM WIRELESS	Razer BlackShark V2 Pro	scan.co.uk	#211 p26	£149

Speakers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
STEREO	Edifier R1280DB	overclockers.co.uk	#224 p59	£110

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS 84-KEY ELECTRO-CAPACATIVE	Niz Mini 84 Pro	keyboardco.com	#220 p29	£165
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)
AMD APU PC	Wired2Fire Ultima Ryzen Gamestation	AMD Ryzen 5 5600G	Integrated AMD Radeon RX Vega 7	custompc.co.uk/W2F	#222 p36	£692
BUDGET GAMING	Wired2Fire Phoenix Intel – Powered by MSI	Intel Core i5-12400F	Nvidia GeForce RTX 3060	custompc.co.uk/Phoenix	#224 p38	£1,099
QUIET GAMING	Gladiator Nocturnal	Intel Core i5-12600K	Nvidia GeForce RTX 3070	custompc.co.uk/Nocturnal	#225 p36	£1,799
SMALL FORM FACTOR	Chillblast Fusion Torrent Mini	Intel Core i7-12700K	Nvidia GeForce RTX 3080	custompc.co.uk/MiniChillblast	#226 p40	£2,399
4K GAMING	PC Specialist Magnus Pro K500	Intel Core i7-12700K	Nvidia GeForce RTX 3080 Ti	custompc.co.uk/MagnusPro	#225 p34	£2,499
WATER-COOLED ALDER LAKE	CyberPower Hyper Liquid Infinity X129	Intel Core i9-12900K	Nvidia GeForce RTX 3080	custompc.co.uk/CPHL	#222 p34	£3,820
ULTIMATE PERFORMANCE	Scan 3XS Torrent Ti	Intel Core i9-12900K	Nvidia GeForce RTX 3090 Ti	custompc.co.uk/TorrentTi	#226 p36	£4,899

Laptops

CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Lenovo Legion 5 Pro	AMD Ryzen 7 5800H	Nvidia GeForce RTX 3070 Laptop	16in, 2,560 x 1,600 IPS 165Hz G-Sync	custompc.co.uk/Legion5Pro	#222 p32	£1,399
ULTRA PORTABLE GAMING	Razer Blade 14	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3070 Laptop	14in 1,920 x 1,080 IPS 144Hz	custompc.co.uk/Blade14	#220 p40	£2,120
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	custompc.co.uk/ROGFlow	#219 p28	£2,956

RICK LANE / INVERSE LOOK

RING OF CHANGE

Elden Ring may be brilliant, but Rick Lane argues that it would be a mistake to try to mimic its success

When I reviewed Elden Ring last month, I gave it one of the highest scores I've ever doled out in these hallowed pages, and this opinion seems to be a general consensus. Within three weeks of launch, From Software's fantasy magnum opus had sold 12 million copies, making it the biggest new title (not a sequel) since Tom Clancy's The Division in 2015.

What makes this success particularly remarkable is that Elden Ring breaks many of the rules that have come to define mainstream gaming. It's a difficult, obscure adventure that offers minimal hand-holding. Your foes are brutal and ruthless, while the game rarely provides information on how to beat them. Quests aren't marked on the map, so you might never meet some of its most important NPCs. Indeed, it's possible to play through the entire game without ever truly comprehending the story.

Every aspect of Elden Ring is wilfully mysterious and enigmatic. This, alongside its incredible visual design and spectacular combat, has proved popular at a time when open-world games often spoon-feed the experience to players at every turn. Naturally, other major studios will now look at Elden Ring's success and wonder how to get a slice of the pie, but this would be a mistake.

While you can identify elements within Elden Ring that players like, such as challenging boss fights and a story you piece together yourself, trying to break down Elden Ring's success into a repeatable formula is folly. Elden Ring is more than the sum of its parts, a holistic creation by a developer that spent well over a decade cultivating its design ethos. Like Nintendo and Kojima Productions, From Software excels because its team doesn't think like other developers, and you can't replicate creative minds that have dedicated themselves to this style of game design for years.

> From Software can't be beaten by playing it at its own game

We have evidence that you can't outdesign From Software, as developers have already tried. Dark Souls brought about the emergence of the 'Soulslike' genre, inspiring Mortal Shell, the Surge and Nioh, among others.

Some of these games have been commercially successful, but none of them is anywhere near as good as Dark Souls and Bloodborne. They're lesser imitations, highlighting that From Software can't be beaten by playing it at its own game.

There are lessons that developers can take from Elden Ring. Consistent and contiguous world design is one. Although it's massive, Elden Ring focuses on a very specific mood and atmosphere. You don't see it shoving racing minigames into the mix to bulk out the experience.

It's also possible to borrow elements of it and use them to build a different game, as the delightful Tunic (see opposite) shows with its synthesis of Dark Souls and classic Zelda. However, lifting the game's structure wholesale is simply never going to work.

Ultimately, the reason players love From Software's games is because they're made by From Software. They're special events on the calendar, artworks with a distinctive and unmistakable identity. They should remain as such. CPC

Rick Lane is Custom PC's games editor @Rick_Lane

Tunic / £24.99 inc VAT

DEVELOPER Andrew Shouldice / **PUBLISHER** Finji

At first glance, Tunic resembles homage to classic Zelda, from its miniaturised, isometric world, to its cute fox protagonist dressed in a ragged green shirt. But Tunic's divergence from Nintendo's second-best mascot becomes clear when you first meet one of its bullish soldiers, and get the soul literally beaten out of you in three hits.

Tunic might look like Zelda, but it feels like Dark Souls, combining the former's presentation and spatial puzzling with the latter's brutal combat and, er, spatial puzzling. Developer Andrew Shouldice has cleverly latched on to the cross-pollination of ideas between Nintendo and From Software, delivering a captivating adventure pointed at the intersection between the two studios' design philosophies.

The game sees our nameless vulpine hero awaken on the shore of some idyllic-looking land, pursuing a quest for an unspecified objective. There are clues delivered in the form of statues and visions of a maternal-looking vixen, but whether she's a goddess, family member or something else is unclear.

Indeed, much about Tunic is left to your own devising. Even the game's manual, which is collected page by page as you explore, is written in Tunic's custom language and alphabet (which can be deciphered, if you choose). However, exploration slowly reveals the pathways and rules of the game world. When fighting those aforementioned bulls, for example, you'll quickly discover their swords cut through seemingly impassable shrubbery. Hence, when you pick up your own sword, you unlock a bunch of new pathways as well as a better way to fight.

Fighting and unlocking pathways is pretty much the structure of the rest of the game. The latter is where the game excels best. Tunic's world is a brilliantly devised clockwork labyrinth, where you're constantly lowering ropes, bridges and ladders to unlock new areas and create shortcuts to old ones. Each new area is simultaneously beautiful and dangerous, whether it's an underground river prowled by spinning octopuses, or a darkened tomb littered with spike traps and walking skeletons.

Combat is a lighter but no less lethal variant on Dark Souls, where you combine precise sword swings with carefully timed blocks and dodges to avoid enemy attacks. It's a neatly designed system, but Tunic's battles lack the depth and creative potential of the game that inspired it.

You'll unlock a few new abilities as you progress, such as a magic staff and one-off equipment such as sticks of dynamite. However, the combo you learn at the start of the game is the same one you'll use throughout, and there's simply not enough room in Tunic's miniature world for battles to really shine.

Still, Tunic's gloriously presented world and cleverly designed environmental puzzling more than make up for the comparatively basic combat. It clearly understands the appeal of classic Zelda, but mixes up the formula just enough to make it more than a glossy imitation.

RICK LANE

TUNIC

+ Clever synthesis of Zelda and Dark Souls
+ Wonderful visual presentation
+ Fun puzzle-box world

PANTS

– Combat lacks depth

/ VERDICT

Tunic blends a Zelda-like world with Dark Souls-ish combat for an entertaining and challenging adventure.

OVERALL SCORE

82%

Total War: Warhammer III / **£49.99** inc VAT

DEVELOPER Creative Assembly / **PUBLISHER** SEGA

TOTAL WAR

- \+ Fantastic new armies
- \+ Lots of new ideas
- \+ Good prologue campaign

TOTAL CHORE

- – Main campaign forces you into constant firefighting
- – Performance issues on campaign map

Total War: Warhammer III can't be faulted for ambition. This wild and spectacular finale sees Warhammer's armies of Chaos battling across reality to claim the power of a giant bear god. You'll field armies of plague-spreading monsters, watch elemental polar bears battle woolly mammoths, and send out your hellish minions to collect skulls for the skull throne.

It's a game filled with amazing units and silly, enticing concepts. However, within its maelstrom of ideas, the core appeal of both Total War and Warhammer – conquering the world with your army of choice – gets rather lost. It pulls in too many different directions while pushing all its cool ideas at you too hard, too soon. The result is that the most exciting entry in the trilogy is also the hardest to enjoy.

This isn't to say Warhammer III is a disaster though. For starters, it has the best introduction to any Total War game, in the form of a prologue campaign where you play a lost prince searching the frozen Chaos Wastes for the bear-god Ursun, imprisoned by a daemon named Be'lakor.

The prologue campaign meticulously explains the base mechanics of Total War, while also providing an overview of the new Kislev faction, one of two new human factions introduced in Warhammer III. It also provides an intriguing self-contained story that feeds cleverly into the main campaign.

Whether you play the prologue campaign or not, the main campaign sees the race to claim Ursun's power open up to eight playable factions. These include the human factions of Kislev and Grand Cathay. The former is a Slavic-inspired faction that fields ice warriors and bear cavalry, while the latter takes inspiration from Total War: Three Kingdoms, blending dragon magic and gunpowder inspired by the Romance era of Ancient China.

They're both excellent factions, but the true appeal of Warhammer III lies in its daemonic armies. There are four from which to choose. The armies of Khorne are the most straightforward, crimson-skinned daemons that overwhelm their foes with force and rage. The armies of Nurgle, meanwhile, cripple enemy armies with plague and pestilence, using units that range from sentient mould spores to huge, sickness-spitting blobs.

The units of the serpentine Slaanesh, god of temptation, all seem to have arrived on the battlefield via an S&M convention, and can actually lure enemy units to their side with their wily ways. Finally, there are the forces of the God Tzeentch, whose shambling pink and blue horrors double as some of the best ranged units in the game.

Each daemonic faction is so darkly appealing that it can be hard to choose which one to play. Luckily, Warhammer III is one step ahead of you, offering a fifth daemonic faction

named 'Daemons of Chaos'. Led by a newly minted daemon champion, the Daemons of Chaos can recruit units from any of the other daemonic factions by earning favour with them through missions or conquering settlements. They offer a great way to tour the various armies of Chaos, making them an ideal choice for your first campaign.

At least, that's the idea. Although designed to be an introductory faction, in practice the daemons of chaos are one of the more challenging factions to play. Their starting location near a long coastline, combined with the fact they commence the campaign at war with all non-chaos factions, makes them vulnerable to invasion by sea. Within just ten turns you'll be fending off large armies from Imperial and Elven factions, as well as more local enemies designed to be your first major encounters.

This is where the gap between Warhammer III's ideas and their implementation begins to reveal itself. The story campaign isn't won through conquest. Rather, you need to collect the souls of four daemon princes to unlock the path to the Ursun.

This is achieved by taking your main army through Chaos Rifts into separate planes of existence, doing battle with multiple armies there before engaging in a massive 'survival battle', which sees you fighting huge waves of enemy forces. Oh, and you can't do this in your own time. You're racing with other AI factions to acquire these daemon prince souls. If they beat you to them, it's game over.

The idea is clearly to create a campaign that's pacey and intense from the start. However, being accosted by multiple huge armies within a handful of turns is more stressful than entertaining. It means you're constantly fighting fires; strategy games are about balancing reaction and preparation, but in Warhammer III, you're always reacting and never preparing.

More broadly, the structure of the campaign seems designed in direct contradiction to the core appeal of playing as an Army of Chaos, namely rolling over the green and pleasant lands of non-chaos armies in a tsunami of fire and blood. Perhaps Creative Assembly is saving that for the Mortal Empires update, which will stitch together all three TW: Warhammer games and let you take on the entire Warhammer world with the faction of your choice. However, that doesn't change the fact Warhammer III's campaign feels more like a daemonic rat race than a glorious conquest.

The campaign map is also poorly optimised, with frame rates frequently dropping to half that of battle-map performance on the same settings. It's a hugely detailed map, but often that detail makes the map harder to read, which isn't ideal in a strategy game. In addition, there are some smaller changes that are just annoying, such as pre-battle summaries not showing you the relative strength of each army.

You can have a good time with Warhammer III, but it doesn't give all its systems equal room to breathe, and you need to play it the way it wants. You need to be up for making lots of difficult decisions and engaging in almost constant battles. If you're looking for the slow-burn empire building on which Total War made its name, you're better off with Total War: Three Kingdoms, or waiting for the Mortal Empires update.

RICK LANE

/ VERDICT

Total War: Warhammer III truly embraces Chaos, with both positive and negative results.

OVERALL SCORE

70%

SHADOW WARRIOR 3 / £34.99 inc VAT

DEVELOPER Flying Wild Hog / **PUBLISHER** Devolver Digital

SHADOW WARRIOR

+ Colourful environment and enemy designs
+ Some fun weapons

SHADOW OF ITS FORMER SELF

- Rough adoption of Doom Eternal mechanics
- Poor balancing
- Dreadful humour

/ VERDICT

Shadow Warrior's continuing search for an identity leads it to a middling Doom Eternal cosplay and a bunch of bad jokes.

OVERALL SCORE

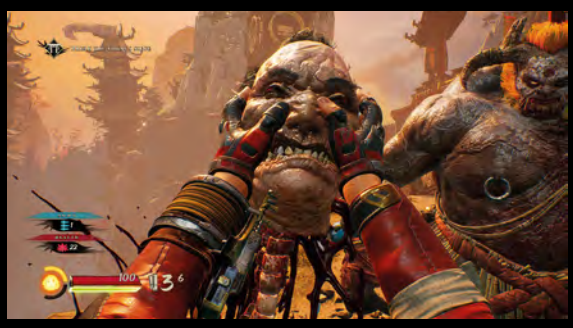
48%

Since the surprisingly decent reboot in 2013, the Shadow Warrior series has opted to parody other shooters, with the latest one picking Doom Eternal as its target for inspiration/mockery. It wholesale borrows the mechanics from id Software's excellent FPS, as protagonist Lo Wang embarks on an adventure to save the world from a giant, planet-eating dragon.

Killing enemies with guns makes them drop health, while killing enemies with your katana makes them drop ammo. It even has a grappling hook because, as Lo Wang put it, 'everybody is doing it these days'.

Flying Wild Hog clearly aims to replicate the brutality and intensity of Doom Eternal's combat, but it's a clumsy imitation. The grappling hook, for example, is locked into specific animations, meaning the game has to awkwardly levitate Lo Wang into the right position before completing the swing. Meanwhile, the game's equivalent of 'glory kills' only have one animation per enemy, and they take too long to complete, quickly becoming tiresome.

Doom Eternal also gave players specific strategies for finishing off enemies quickly; if executed correctly, these made you feel supremely powerful against even the toughest foes. In Shadow Warrior, there are no such strategies. Enemies are made either of titanium or tissue paper, meaning the game alternates between way too easy and way too hard.



Ironically, Shadow Warrior 3 is strongest where it's least like Doom Eternal. Both its world and enemy designs are colourful and creative, while certain levels, such as That Damn Dam, provide impressive views and platforming challenges.

The game's most novel mechanic is that performing a finishing move on special enemies gives you temporary access to a new weapon, such as the arm of a Minotaur-like beast, which Lo Wang uses as a bludgeon. It's a neat idea, but finishing moves can only be performed after killing a certain number of enemies, so often you'll only access these special weapons when the fight is almost over.

The game's main problem, though, is its humour. It isn't simply that it's puerile, although there are endless references to body parts and bodily fluids, it's that the developer seems to have forgotten what makes a joke. Many of Lo Wang's quips involve just reciting the lyrics to a song, or making witless references to other games or general pop culture. It's also relentless. Lo Wang's verbal diarrhoea is so acute that quips are frequently interrupted by another one-liner before the punchline.

The fun that Shadow Warrior 3 offers simply doesn't warrant putting up with its egregious humour and ethically questionable representations of Chinese and Japanese culture. Thanks for the ride, Lo Wang, now please, shut up and get out.

RICK LANE

LOST ARK
/ FREE-TO-PLAY

DEVELOPER Smilegate / **PUBLISHER** Amazon Games

Lost Ark is a sprawling MMO and ARPG hybrid, essentially World of Warcraft meets Diablo. The game sees you pick one of eight classes as you search for seven fabled 'Arks', artefacts of enormous power that could turn the tide in humanity's war against the demonic hordes.

These classes range from warriors and mages to gunslingers and martial arts specialists. However, they're all built to look spectacular and feel powerful, able to blow away crowds of enemies with rays of holy light, devastating meteor showers and massive artillery bombardments.

Using these powers, you carve a path through Lost Ark's fantasy world, which is split into around a dozen different continents, each of which is completely different. One might see you explore the miniature civilisation of a race of pixie-like creatures, before sailing off to a steampunk society with fully functioning railways and airships. Each zone ends in a colourful dungeon, while each continent has at least one spectacular set piece, ranging from awakening gods to battling an army of clowns.

It's filled with wonderful highs, but there's a fair amount of MMO drudgery involved in seeing them. Many of the game's secondary systems, such as the instanced Fortress you can build, or the ship-sailing minigame, sound cool in theory, but are ultimately grindstones designed to keep you playing the game.

Quest design, meanwhile, is utterly insipid. Some quests ask you to move in-game objects a matter of yards, while others are resolved by performing an emote. This isn't too much of a problem in the early game, when you're pushing through zones at lightning pace. However, at around level 50, character progression switches emphasis from XP to the level of your equipment, meaning you must actively seek out small islands filled with these tenuous missions in order to progress.

Lost Ark's biggest flaw is that, for all its locational variety and stunning set pieces, the story is downright inert. Its few consistent characters are all one-dimensional archetypes, from the tedious King Thirain to its pantomime demon lords. Most of the other characters you encounter are little better than quest dispensers, making it all the more ironic that there's an elaborate sub-system called 'rapport' dedicated to getting to know them.

Lost Ark is too wedded to MMO convention to be a truly great game, but as a free-to-play experience, it's worth trying for its propulsive combat and dazzling class design. Moreover, while the story lacks both brains and heart, the game world constantly tempts you to look around the next corner, and there are some truly breathtaking moments that make it worth persevering with the more arduous parts of the journey.

RICK LANE

LOST ARK

+ Excellent combat system
+ Colourful, diverse fantasy world
+ Good dungeons
+ Great set-pieces

CRYSTAL SKULL

- Boring story
- Empty quests
- Too much MMO fluff

/ VERDICT

Lost Ark may not be the smartest MMO around, but it offers some big flashy fun for free, which isn't a bad deal at all.

OVERALL SCORE

70%

REALITY CHECK

Rick Lane checks his time-travelling watch, and has a look at some upcoming VR retro remakes, in this month's VR roundup

NEWS

COLOSSAL CAVE 3D ADVENTURE

In what is surely the most dramatic video game glow-up of all time, foundational game Colossal Cave Adventure is getting a VR remake. Originally released in 1976, Colossal Cave Adventure was one of the first text adventures, inspiring games such as Zork and Rogue among many others.

Created by developer Will Crowther, an enthusiast cave explorer, it saw players delve into an elaborate cave network, seeking treasure and encountering characters such as bears, snakes and trolls.

The remake, named Colossal Cave 3D Adventure, is being designed by Cygnus entertainment, a new studio founded by Sierra On-Line creators Ken and Roberta Williams, themselves pioneers of adventure gaming through the King's Quest series. Speaking to IGN, Ken Williams revealed that the project came about because he was bored during the COVID-19 pandemic. 'While locked down by the pandemic I wrote a book about the old Sierra days. Its success surprised me and brought back many memories of our days making games. This led me to investigating how modern games are made and I just started coding using the Unity game engine for fun,' Williams said in a statement.

Colossal Cave 3D Adventure will stay true to the original game's core premise and story, but will obviously be quite a different experience, featuring a wide array of puzzles in what Williams describes as a 'completely immersive 3D world with almost 150 locations'. The final product is due to release this summer.

NEWS

STAR WARS: DARK FORCES MODS

Although there are several decent Star Wars games on VR now, such as the excellent Star Wars: Squadrons and the (slightly less) excellent Vader Immortal trilogy, this hasn't prevented the VR modding community from adding their contributions to the VR sector of Disney's sci-fi universe. Indeed, two separate projects were recently announced that both focus on remaking games from the Dark Forces series into VR.

First up is Dark Forces VR. Developed by small UK studio Shadow Art Games, it attempts to recreate the 1996 FPS in Unreal Engine 4. Funded via Patreon, there's already a demo that lets players don their headsets and blast stormtroopers in a segment of the original game's first level.

Arguably even more ambitious is Jedi Knight II VR Remaster, which strives to recreate the 2002 hybrid of FPS and third-person melee combat originally developed by Raven Software. This is an enthusiast project by a solo designer, Guido Mariano, and Mariano's footage of his work shows an impressive recreation of JK II's lightsaber combat, right down to the way it scores red-hot gashes into walls and floors.

Both projects look exciting, but whether or not either sees the light of day is debatable. Mariano admits his work is a personal endeavour, offering no guarantee as to how far it will go. Shadow Art seems more committed to seeing its project through, but long-term viability isn't the only factor at play. The spectre of Disney hovers over both projects, and the corporate behemoth could easily step in and attempt to shut down these remakes at any time.

REVIEW

WANDERER / £29.99 inc VAT

DEVELOPER M-Theory, Oddboy / **PUBLISHER** M-Theory, Oddboy

Wanderer is a rare VR title with a premise that goes further than 'experience X, but in VR'. A time-travelling extravaganza, M-Theory's game puts you in the role of a young man named Asher Neumann, who begins the game searching for his grandfather's Boston apartment in the year 2061.

The city is flooded and overrun by hostile gangs after an unspecified disaster in the past. Upon reaching the apartment, Asher discovers what's essentially a talking watch that lets him travel to different time periods, along with a message from his grandfather tasking him with 'fixing' the timeline, so the apocalypse never happens.

It's a slightly convoluted premise, but Wanderer quickly gets you on board with both its fiction and puzzling. You approach your given objective by visiting a bunch of historical locations, such as a Mayan temple and 1940s German bunker. You even get to visit the lunar surface in 1969. These locations are highly detailed and convincingly designed, although the most striking location is arguably the one in which you start, with flooded, overgrown Boston offering some truly impressive VR vistas.

In any case, each location is themed around elaborate, bespoke puzzles, from trying to open a Mayan tomb to assembling the Enigma machine. What makes Wanderer's puzzling interesting, however, is the crossover between timelines. For example, you may need to bring a power tool from Asher's post-apocalyptic present to open a container on the moon, or use an anti-bacterial spray to clean off a Mayan plaque, so it can be translated. It's like a big-budget, VR Day of the Tentacle, only with more elaborate puzzles.

Wanderer can't match Day of the Tentacle for humour, though, despite making a concerted but ill-judged effort. While the broader story is well told, your main companion – the watch itself – has a built-in AI that affects a US 'Southern Gentleman' persona. It's an exaggerated performance that's frankly more irritating than endearing, particularly when you're stuck on a puzzle and your timepiece keeps chiming in with its unfunny 'Ma Gawsh' shtick.

Beyond a slightly annoying sidekick, Wanderer's other notable issue is that interaction can be a little clunky. Your time-travelling watch doubles as your inventory, letting you store objects to carry across time (don't ask how this works, it just does).

To store items, however, you must first tap the watch to bring up the inventory, which means dropping the item you want to store, bringing up the inventory, then picking the item back up before you can finally store it. Also, the game arbitrarily locks storage slots behind an upgrade system, which seems to exist solely so that the game can have an upgrade system.

Still, Wanderer's impressive locations and elaborate, tactile puzzles more than make up for these shortcomings. It doesn't quite reach the heights of Half-Life: Alyx in terms of its significance for VR gaming, but it's nonetheless one of the better premium VR experiences, comfortably justifying its price tag. GPC

WANDERER

+ Great concept
+ Some fantastic locations
+ Complex, entertaining puzzles

BLUNDERER

– Annoying sidekick
– Fiddly inventory system

VERDICT

Wanderer is a delightful time-hopping adventure, even if your travelling companion should have been left in the past.

OVERALL SCORE

85%

BUILD A GAMING PC 4K

RUNNING THE LATEST GAMES IN ULTRA HIGH DEFINITION REQUIRES SOME SERIOUS COMPUTING POWER, AND A CAREFUL SELECTION OF COMPONENTS. ANTONY LEATHER SHOWS YOU HOW IT'S DONE

Picking the right parts to build a 4K gaming PC can be tricky, as you not only need to factor raw gaming performance into the equation, but CPU power and cooling too. This month, we've picked some of the best PC hardware for the job that, until recently, would have been a very tough (and prohibitively expensive) job.

However, now that GPU prices are finally starting to settle, you can pick up Nvidia's GeForce RTX 3080 Ti Founders Edition, which is a great 4K gaming GPU, for just over a grand. Meanwhile, CPU and motherboard prices are reasonable, and cases, PSUs, coolers, memory and SSDs are all readily available.

With Intel's latest Alder Lake CPU architecture, a decent storage system and plenty of cooling power, this month we'll show you how to build a cracking 4K gaming PC with hardware that's actually available and for a decent price. Plus, we've also got an extensive list of alternative parts and detailed discussion to suit lower or higher budgets, so you'll be equipped to build the best PC for you. Finally, we'll show you how to put it all together and what frame rates you can expect in the latest games.

OUR 4K PC SHOPPING LIST

CPU

Intel Core i7-12700K

£377 inc VAT

cclonline.com

Intel's current stack of 12th-generation CPUs are fantastic, but it still pays to do a little digging into the specifications and prices, so you're not wasting hundreds of pounds on a pointlessly powerful processor. For starters, while the Core i9-12900K and more recent Core i9-12900KS are the flagship models, they won't leave you with any change from £500.

There's also the fact that, at our target resolution of 4K, the graphics card will be the bottleneck in terms of gaming performance. It has to deal with a huge amount of pixel pushing power, and it's only really at 1,920 x 1,080 and 2,560 x 1,440 that bottlenecking could result from a poor choice of CPU.

We've opted for the Core i7-12700K ,as even in our tests at 1080p, it was barely any slower than the Core i9-12900K with little to no difference at higher resolutions and it will save nearly £150 over a Core i9-12900K. The two CPUs each have eight performance-optimised P-Cores, which account for the bulk of performance, with the pricier Core i9-12900K benefiting from eight efficiency-optimised E-Cores compared to four for the Core i7-12700K.

In all other areas, the two chips are evenly matched, with slight drops in cache amounts and frequencies, but nothing that will result in noticeable performance sacrifices at high resolutions. Of course, if you'll be doing a fair amount of multi-threaded content creation, then the Core i9-12900K might well be worth the extra money, but for a pure high-end gaming system, the Core i7-12700K covers all your bases, while still offering plenty of multi-threaded power if you ever need it.

Alternatives

Intel's Core i7-12700K strikes a good balance of power and value, offering plenty of change from £400, but you can save even more money by opting for its Core i5-12600K. It costs just £260 inc VAT, shaving over £100 off the price of its bigger sibling. The downside is that while it has the same four E-Cores, it only has six P-Cores compared to eight for the Core i7-12700K. It also has lower peak boost frequencies for both its E-Cores and P-Cores.

However, benefits of the Core i5-12600K are its reasonable overclocking headroom and reduced cooling and power requirements, so you'll likely end up saving more than just £100 for very little performance sacrifice. It's also a better option for gaming than AMD's Ryzen 5 5600X.

CPU COOLER

Corsair iCUE H150i Elite LCD

£250 inc VAT

scan.co.uk

As we've seen in this month's AIO liquid cooler group test (see p48), 240mm liquid coolers can cope with Intel's Core i9-12900K at stock speed. Some can even do it at reasonable noise levels, and if you're on a tight budget, we highly recommend taking a look at the Labs before reaching for your wallet, as they cost less than our chosen cooler here as well.

With 12 cores under the hood, though, your cooler will need to be able to shift quite a lot of heat from the CPU, despite the cores being produced using a 10nm manufacturing process. If you're serious about your gaming, and want your PC to be as quiet as possible, then we'd argue the money saved by opting for the Core i7-12700K over the Core i9-12900K would be best spent on a potent CPU cooler.

We've picked Corsair's iCUE H150i Elite LCD, as it not only looks fantastic, but it's also LGA1700 compatible out of the box, gives you

fantastic control over your PC's lighting and cooling and uses a large 360mm radiator to keep your PC cool. As the radiator and its three 120mm fans can dissipate more heat than a 240mm radiator, it will be able to keep its fans at slower speeds, but cool your CPU to the same level as a smaller cooler with much louder fans.

Alternatives

If you're not too concerned about noise, and you want to save a bit of cash, then using a 240mm liquid cooler can save you over £150. Corsair's own iCUE H100i Elite Capellix costs just over £100, and offers the same level of control as our chosen cooler, except with a less funky pump top out of the box.

ARCTIC's Liquid Freezer II 240 RGB is also an excellent choice and costs just £80. Unless you're pushing the Core i7-12700K to its limits, neither of these coolers is likely to get near their peak fan speeds often anyway.

MOTHERBOARD

MSI MAG Z690 Tomahawk WiFi DDR4

£250 inc VAT

ebuyer.com

Given that a manual all-core overclock on the Core i7-12700K will result in slower gaming performance than leaving the CPU to its own boosting algorithms, there's no need to opt for a very expensive motherboard. The MSI MAG Z690 Tomahawk WiFi DDR4 is a great all-rounder. It costs £250 inc VAT, which is reasonable for a Z690 motherboard, but it doesn't hack and slash its feature set to get there. For starters, you get Realtek ALC4080 audio instead of the basic and dated ALC897 codec provided by many cheaper offerings.

What's more, all its M.2 ports are equipped with heatsinks (and three of them support 4x

PCI-E 4) and there are 16 power phases for the CPU, along with large heatsinks to cool the VRMs. There's a smattering of futureproofing too, with a 16x PCI-E 5 slot and, as its name suggests, there 802.11ax Wi-Fi and 2.5 Gigabit Ethernet. You also get a USB Type-C port on the back panel, as well as a header on the PCB.

Alternatives

Gigabyte's cheaper B660 Gaming X DDR4 might lack the ability to tweak the unlocked multiplier on Intel's K-series CPUs, but it handles them perfectly well at stock speed, plus it has decent cooling for its VRMs and M.2 SSDs, solid power circuitry and a USB Type-C header. However, there's no Wi-Fi or rear USB Type-C port and its audio codec is Realtek's paltry ALC897.

The MSI MAG Z690 Tomahawk WiFi DDR4 isn't particularly lavish either, and if you want to go all-out with a good-looking motherboard that's packed with features, then MSI's MEG Z690 Unify or Asus' ROG Maximus Z690 Apex get our votes, although they cost a lot more money.

GRAPHICS CARD

Nvidia RTX 3080 Ti Founders Edition

£1,050 inc VAT

scan.co.uk

Your choice of graphics card for a high-end gaming system is extremely important, and at the moment ,a pretty complicated one too, so we'll go into some extra detail here. Thankfully, there is some good news as, following 18 months of sky-high graphics card prices, the price of Nvidia's GeForce RTX 3080 Ti has plummeted in price over recent weeks.

Most GPUs have seen small price reductions in both new and used markets, but the RTX 3080 Ti's hard-wired low hash rate makes it unattractive to crypto miners, and the fact it's pretty expensive in the first place limits its appeal to mainstream users too – amazingly, it's now back to its MRSP in several places.

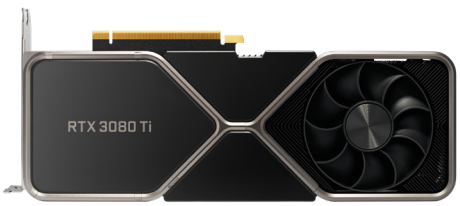
We've picked the Nvidia GeForce RTX 3080 Ti Founders Edition, as it's been in stock on Nvidia's online GPU shop (which links to **scan.co.uk**) for a couple of weeks at the time of writing. It's available for £1,050 inc VAT, which is the MSRP of the Founders Edition card – yes, the mind-bogglingly expensive RTX 3090 Ti is faster, but it costs over £800 more for a pretty minimal boost in performance.

If it's out of stock when you're looking to buy, there are also some other options. At the time of writing, KFA2's RTX 3080 Ti SG 1-Clock OC costs the same £1,050 inc VAT price at **overclockers.co.uk**, and there are plenty of other options from board partners, with more RGB bells and whistles, going for under £1,300 at various etailers. As usual, we suggest checking prices to see what's around, as the situation changes all the time.

Alternatives

Once you get above the RTX 3080 Ti, the situation starts to get tricky and extremely expensive, as the RTX 3090 and RTX 3090 Ti are retailing for silly prices. They have a lot more memory than the RTX 3080 Ti, which can be useful for workstation use, but our tests have shown it doesn't make much difference in games yet. These cards are also a bit faster in games than the RTX 3080 Ti, but not to an extent that's justified the huge difference in price.

AMD's Radeon RX 6900 XT is another option – in some titles, such as Assassin's Creed Valhalla, it beats the RTX 3080 Ti, and in non-ray-traced software it's competitive, but its ray -racing performance is poor. You can also currently pick up a Sapphire Nitro+



Radeon RX 6900 XT from £999 from overclockers.co.uk

Below this level, the GeForce RTX 3080 gets our vote. It's still a capable 4K card, especially if you enable DLSS, but you'll be entirely reliant on partner cards, the current price of which will only save you a couple of hundred pounds at most compared with the RTX 3080 Ti.

MEMORY

16GB (2 x 8GB) 3200MHz DDR4 Corsair Vengeance RGB Pro

£75 inc VAT

scan.co.uk

For our system, we've opted for a 16GB kit of Corsair's Vengeance RGB Pro memory with a speed rating of 3200MHz. Our chosen motherboard supports DDR4, which is still significantly cheaper than DDR5 for the same capacity, and our tests show that going for DDR5 memory currently only gives you a miniscule performance advantage.

16GB is the bare minimum we'd recommend for a high-end system now, though, and with memory prices currently low, it's worth considering buying a 32GB kit instead, especially if you like to have lots of software and browser tabs open at the same time.

CASE

Corsair iCUE 5000X RGB

£147 inc VAT

ebuyer.com

We've opted for Corsair's beautiful iCUE 5000X RGB for this top-end build. It's a great-looking case, and it's equipped with three RGB fans as standard, it has tempered glass all around it, and even has its own fan and lighting control. There's plenty of scope for liquid cooling too, with 360mm radiator mounts in the front, side and rear. It's a great premium case in terms of both looks and features.

Alternatives

There are dozens of fantastic cases available right now, and we're also huge fans of Fractal Design's Define 7 and Meshify 2 cases – it's easier to work with both of them than the Corsair case, they cost around the same price and they both come in compact versions too, which cost significantly less money. We fell in love with Fractal Design's Torrent case last issue too, with its fantastic cooling and eye-catching front grille, making it our most wanted case for around £200.

STORAGE

2TB WD Black SN770

£178 inc VAT

scan.co.uk

Since we reviewed the WD Black SN770 in our last issue, the price of the 1TB model has fallen from around £130 to just £100. However, if you're serious about your games, you'll need larger capacity in order to house half a dozen of the latest gigabyte-munching titles Thankfully, the 2TB model of the SN770 is now one of the cheapest 2TB PCI-E 4 M.2 SSDs available, retailing for just £178 inc VAT, which is over £100 less than the cost at launch.

This is a steal and offers great way to ditch hard disks for any task other than mass storage. With read and write speeds around 5,000MB/sec, it's not the fastest SSD available, but it's plenty quick enough for gaming needs.

Alternatives

There are even cheaper ways to ditch your hard disk ,as Crucial's 2TB 2.5in BX500 costs just £130 inc VAT, giving you a great way to add extra storage space for less frequently used games and programs. Also, in real-world use, you won't notice a huge difference between this drive and the WD Black SN770, at least outside of large file transfers. If you need more space for mass storage, then we can recommend WD's Blue hard disks, with a 4TB drive available for £80.

POWER SUPPLY

Corsair RM850x

£130 inc VAT

scan.co.uk

Nvidia's high-end GPUs are pretty power-hungry, and using the likes of the RTX 3080 Ti will see your PC draw over 500W when it's running games. This means that you need to factor at least another 300W into your PSU budget on top of this figure, in order to ensure your PC isn't pushing your PSU to its limits, which will only result in it making more noise and running less efficiently. We've opted for Corsair's RM850x – it has 850W of power on tap, which is plenty for this system, and it costs around £130. It's quiet and has plenty of after-market custom cable support too.

EXTRAS

Corsair ML120 Pro RGB

£25 inc VAT

scan.co.uk

We've not had to add much to our PC, but as the case lacks a rear exhaust fan, we've added another RGB fan to the mix in the form of a Corsair ML120 Pro RGB fan. It can be controlled by our cooler's fan and lighting hub, and will boost cooling while occupying the otherwise-vacant rear fan mount.

Corsair Vengeance RGB Pro Light Enhancement Kit

£30 inc VAT

scan.co.uk

Filling all your motherboard's memory slots always looks better than just filling two of them, especially when you're using Corsair's Vengeance RGB Pro modules. Thankfully, there's a cheaper way to fill vacant slots than buying extra memory, which is to use Corsair's Light Enhancement Kit. This is simply a pair of dummy modules that fill out your lighting array across all four memory slots. They're completely superfluous to computing requirements, but they look lovely.

TOTAL £2,512 INC VAT

BUILDING THE PC

Start by installing the CPU in the motherboard. Press on the handle next to the CPU socket and lift it up, along with the socket lid. The CPU can only fit in the socket one way around, but be extremely careful with the CPU socket pins as these are easily damaged.

Don't lower the CPU down into the socket from a height. Instead, move it over from the side an inch or so above the socket and gently lower it into place 1. When it's in place, gently place the lid over the top of the CPU and slide down the handle.

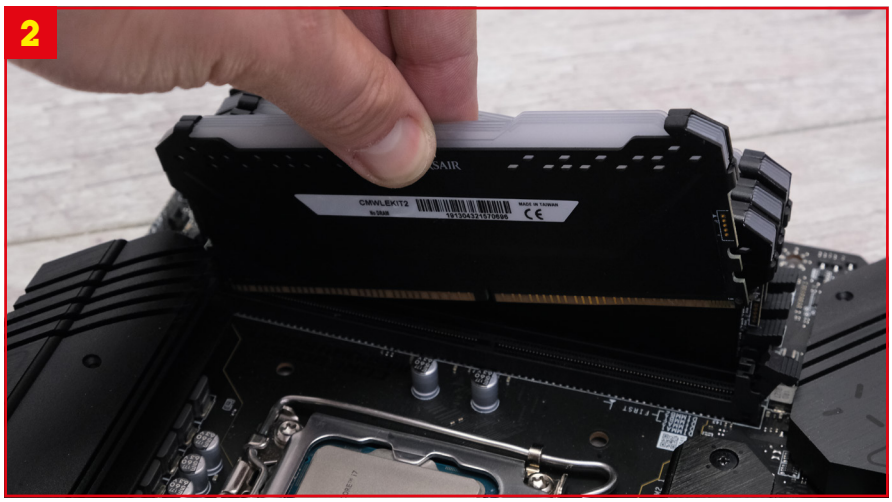
Next, install the memory modules and Light Enhancement modules into the motherboard, placing the actual memory modules into slots two and four away from the CPU socket 2. This will ensure the memory runs in dual-channel mode. Not doing this could result in the memory running in single-channel mode, making your PC slower.

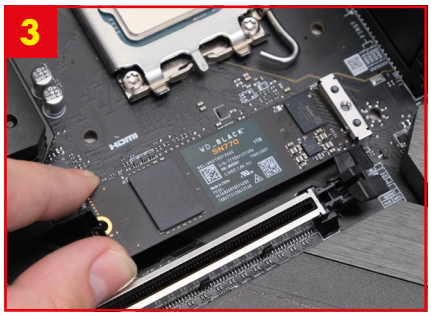
Now install the SSD. We've placed it in the top slot above the graphics card, as it's slightly easier to access once the system is built. The motherboard includes a tool-free clip, so you don't need to use screws 3. Next, remove the protective film on the underside of the heatsink to reveal the thermal pad, then replace the heatsink on top of the SSD.

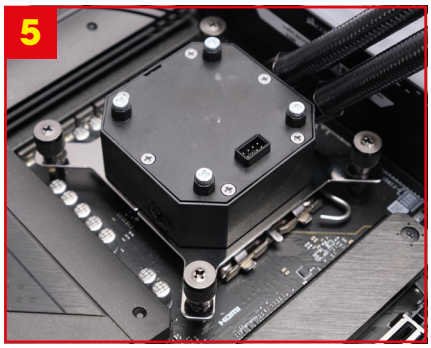
The Corsair H150i Elite LCD CPU cooler includes specific components in the box for Intel's new LGA1700 socket, so be sure to identify these parts and use them – you don't want to end up using the LGA1200 kit by mistake. The new CPUs sit a little lower than their predecessors, and using the wrong fittings can result in higher temperatures. Install the cooler's backplate in the back of your motherboard, then secure it in place by installing the LGA1700 mounting pins 4.

The cooler's waterblock/pump section has a removable top, and it's a good idea to detach this before installing the pump. It's also a bit easier to install the pump with the motherboard out of the case than once all the gear is installed.

However, it's a good idea to hold the radiator up and orientate it into the position in which it will sit in the case. This way you can work out the best orientation for the tubes. Thermal paste is pre-applied to the pump's contact plate, so there's no need to apply any here. Fit the waterblock/pump unit to the LGA1700 mounting pins around the CPU







socket 5, and secure it, following the instructions with the cooler.

Another reason to check which way around the radiator will sit in the case before you install it is to make sure you install the fans with their cables pointing towards the motherboard tray 6. Do this using the long screws provided with the cooler. We'll be installing the radiator in the roof and it's important to point the cables this way, or the wires will end up dangling from the radiator in full view of the side window.

We're using the radiator as an exhaust, as this means the heat from the CPU will be expelled straight out of the case, and the Corsair iCUE 5000X case has three front 120mm fans to balance out the airflow too.

MAKE SURE YOU INSTALL THE FANS WITH THEIR CABLES POINTING TOWARDS THE MOTHERBOARD TRAY

Now screw the motherboard into the standoffs in your case 7, using the provided screws, and place the radiator next to the case, supporting it if necessary, so it doesn't dangle. You can now also install the extra 120mm fan in the rear of the case. This is optional, but it will improve airflow as well as filling the vacant rear mount with some extra snazzy lights.

Now move the radiator and its attached fans into the case. We found the radiator tubes sat best with the tubing end of the radiator positioned towards the front of the roof fan vent. Before you install it, though, thread the fan cables through the routing holes in the case's motherboard tray 8. It will be impossible to do the latter after you've installed the radiator.

To install the radiator in the roof, you'll need to remove the dust filter and top glass panel in order to access the fan mounts – these parts are tool-free and simple to

remove 9. Both will need to be replaced later, with the dust filter protecting the inside of the PC from dust falling into the case.

Use the small screws provided with the cooler to mount the radiator into the roof of the case. The 360mm radiator has 12 screw threads to accommodate three 120mm fans, but you only need to use four screws, with one in each corner of the radiator, in order to mount it 10.

The radiator tubes need to be routed so that they don't straddle the memory modules. We found that one tube can sit where the radiator meets the case, and the other can rest just below (make sure it's not touching) the middle fan, clearing the memory so it's in full view 11.

The case includes its own fan hub and RGB lighting controller, which can be connected to your motherboard and controlled using Corsair's iCUE software. You'll need to ensure the case fans and connected to these parts, including the new 120mm fan we added 12. We've opted to use the Commander Core hub included with our cooler to control its fans and lighting, as neither the case or cooler's hub has enough connectors to power every part.

As both the case and cooler are software-controlled, they both need to be connected to motherboard USB headers. However, there are two headers required for the cooler, powering both the pump and the Commander Core hub.

Thankfully, Corsair has included a USB header splitter cable, so even though you have three header cables to connect, you only need two actual USB headers.

CORSAIR HAS INCLUDED A USB HEADER SPLITTER CABLE, SO YOU ONLY NEED TWO ACTUAL USB HEADERS

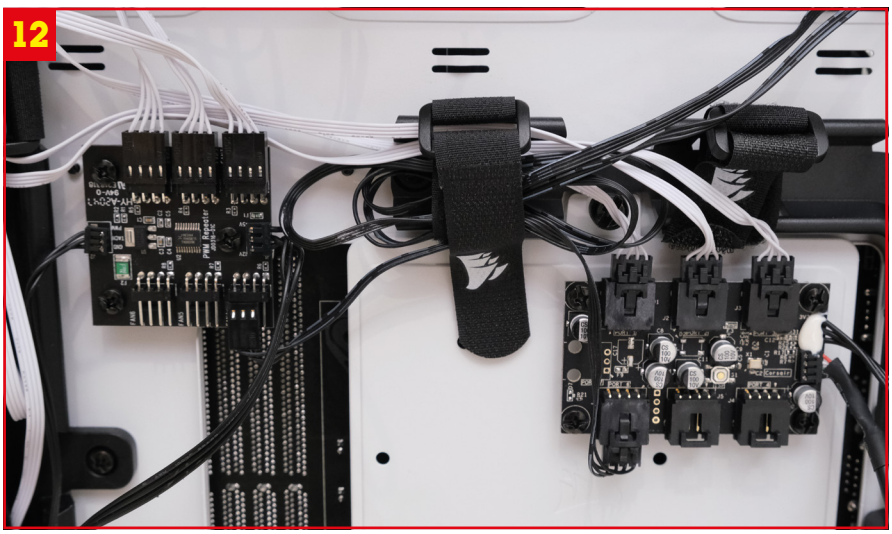
Connect the cooler's two headers to the splitter cable, and then connect this and the case header cable to the USB 2 headers on the motherboard 13.

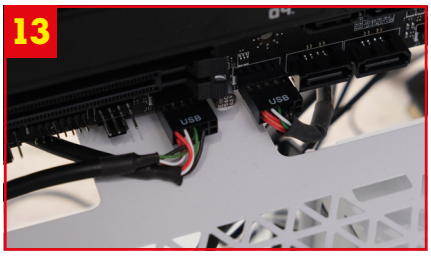
You can now install the graphics card. Our system is well suited to the Founders Edition's flow-through cooling system, with a row of roof fans helping to exhaust the warm air from the case 14.

However, we'd don't recommend using the vertical GPU mount in the case, as it will mean the hot exhaust air from the RTX 3080 Ti will be pointed straight at your motherboard, and there's also very little clearance between the cooler and the side panel of the case.

We've also opted for an extension cable for the graphics card's power cable. This replaces the rather unattractive one provided with the graphics card and simply connects to two 8-pin PCI-E power connectors.

The CPU cooler's Commander Core hub can be installed anywhere with a flat surface, thanks to its included double-sided foam pads – we found the perfect place was behind the motherboard tray beneath the





case's own RGB hub [15]. Don't worry about connecting the RGB cables in order, as you can rearrange them in Corsair's iCUE software later if necessary.

You can now install the power supply in the case's mount [16], being sure to only connect the power cables you'll be using. For this specific build, we didn't need any 4-pin Molex connectors, for example, and we only needed a single pair of 8-pin PCI-E connectors, as well as the usual 8-pin CPU and 24-pin ATX connectors.

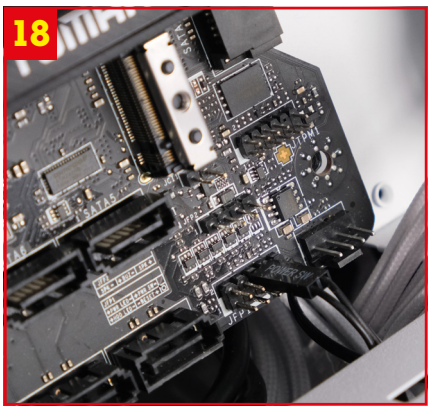
Space is tight in the lower chamber, so if you don't plan to use a hard disk, we also highly recommend removing the hard disk mount that's located here too.

You can now route the power cables from the power supply to the parts where they're needed. The case has a large cover to hide the cable-routing holes, so make sure to thread as many cables as possible through here in order to keep the PC neat and tidy.

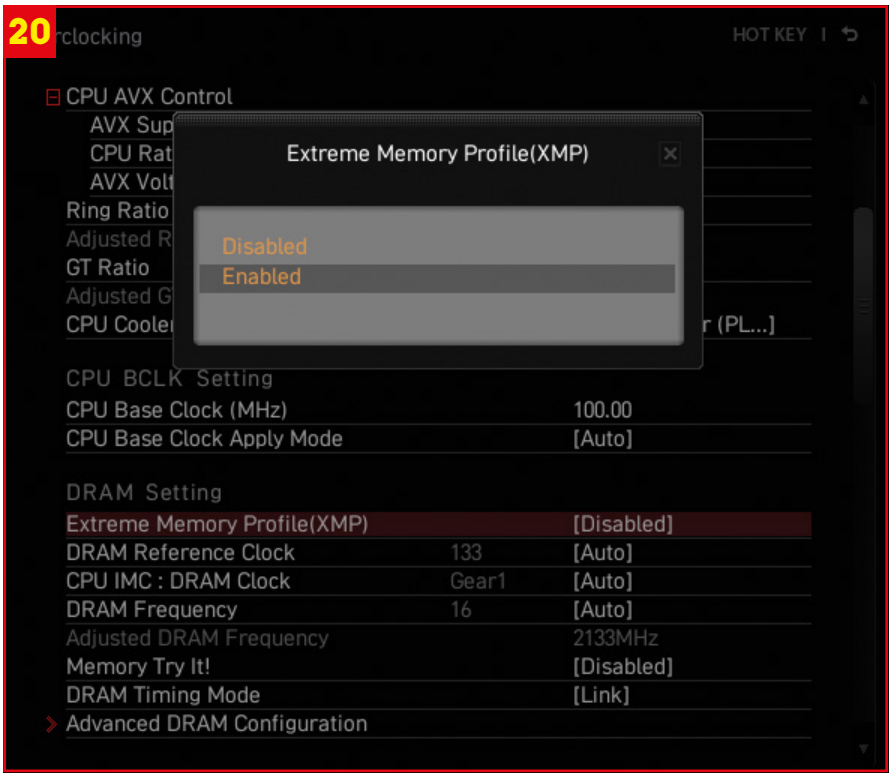
Next, thread the case's USB 3 and USB Type-C cables under the cover and connect them to the motherboard as well [17]. At this point, you also need to hook up the case's front panel connectors for its power and reset buttons, as well as its audio jacks to the headers at the bottom of the motherboard [18]. There's a table next to the headers that shows where the connectors go, but you can also refer to the motherboard manual if you're not sure.

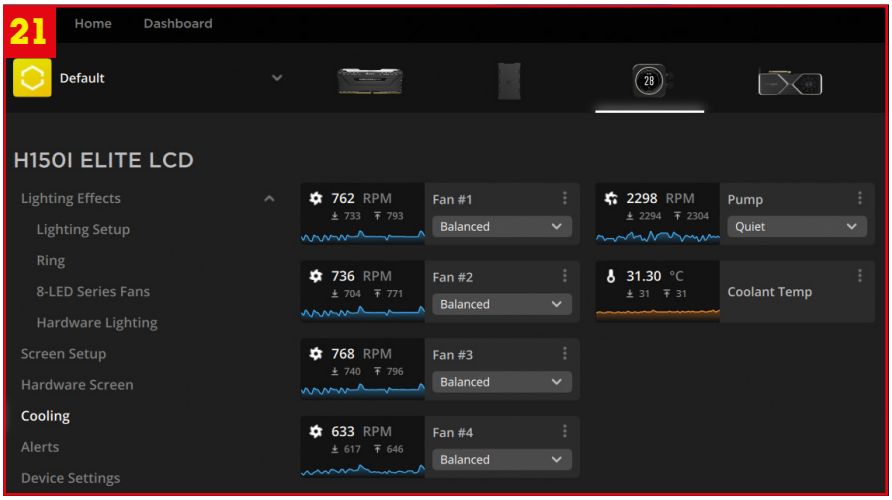
The rear of the case has a large area to stow cables, and hefty Velcro ties to anchor them down too. However, there's no point going too overboard with the cable tidying, as the case includes a large cover than hides them all anyway. However, it won't fit if all the cables are loose, so you'll need to at least tie down the key ones [19]. The basic PC is now built, so you can plug in your monitor,


17


18


19





keyboard, mouse and power supply, and switch it on.

We're leaving our Core i7-12700K at stock speed, as there are limited gains to be had from a manual overclock, especially in games. However, you'll need to enter the EFI in order to make sure the correct memory speed and timings are applied. Press the Del key as soon as you see a display on your screen and you'll enter the EFI. You can then switch to Advanced mode, find the setting for Extreme Memory Profile, and in the Overclocking section and enable it 20.

Once you've installed Windows, as well as the latest Intel chipset driver, the motherboard drivers and the driver for the Nvidia GPU, install Corsair's iCUE software. This is easy to use, but can be a little overwhelming if you're using it for the first time, especially with the hefty amount of fans in our system.

We decided to connect the PWM input for the case's own fan hub to the Commander Core hub on the cooler, as this will allow us to control all four case fans as one in order to save time 21.

Here, we can see the three fans on the cooler's radiator, with the four case fans combined into one setting at the bottom, running at a slightly lower speed. Above these readouts are the icons to control the memory lighting, case fan lighting, cooler and pump display, as well as the lighting on the graphics card.

From the iCUE software, you can select from profile presets or create your own custom fan speed curve based on various temperature inputs. However, we suggest using one of the presets unless

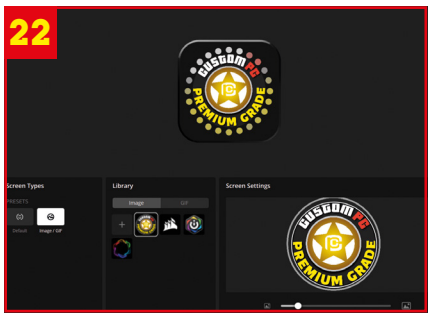
THERE ARE LIMITED GAINS TO BE HAD FROM A MANUAL OVERCLOCK, ESPECIALLY IN GAMES

you know what you're doing. There's plenty of headroom here, so feel free to experiment and fine-tune your own cooler to your surroundings.

Beware of the temperature input that controls the fans though. This should be set to coolant temperature and not CPU temperature, but you also need to bear in mind that CPU and coolant temperatures have different thresholds – 70° might be fine for the CPU, but not for your coolant.

You don't want the coolant to get this hot, so run a load test using Prime95's small FFT test for ten minutes with your custom curve, and see how warm the coolant and CPU become. Loading one of the presets and tinkering with it is a good place to start.

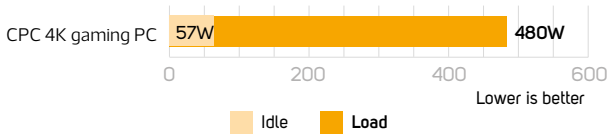
You can also use iCUE to customise the screen on the cooler's waterblock/pump unit, which we've done with a CPC Premium Grade award as an example 22. It looks great when it's all lit up with the rest of the system 23. CPC



BENCHMARK RESULTS

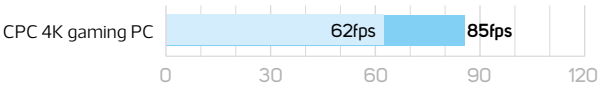
77,667	855,918	316,761	323,329
GIMP IMAGE EDITING	HANDBRAKE H.264 VIDEO ENCODING	HEAVY MULTI-TASKING	SYSTEM SCORE

TOTAL SYSTEM POWER CONSUMPTION

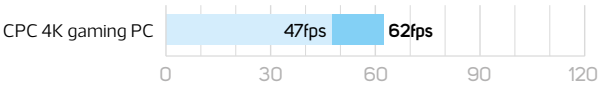


ASSASSIN'S CREED: VALHALLA

2,560 x 1,440, Ultra settings

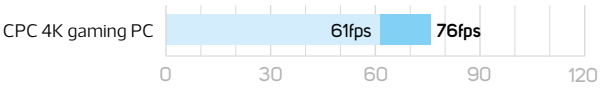


3,840 x 2,160, Ultra settings

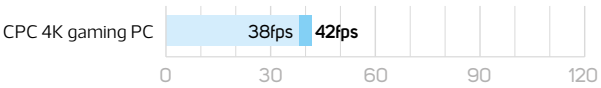


CYBERPUNK 2077

2,560 x 1,440, Medium ray tracing preset, DLSS Balanced

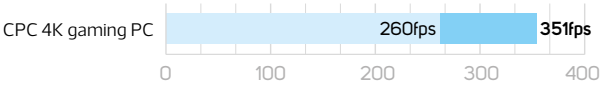


3,840 x 2,160, Medium ray tracing preset, DLSS Balanced

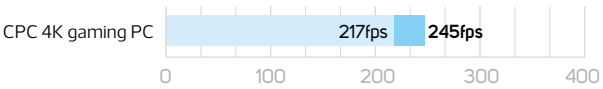


DOOM ETERNAL

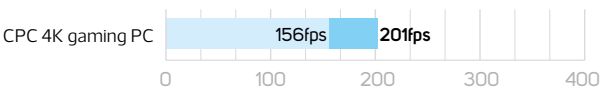
2,560 x 1,440, Ultra Nightmare settings



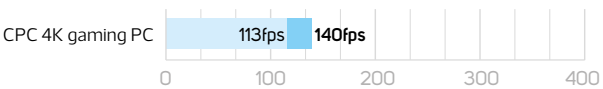
2,560 x 1,440, Ultra Nightmare settings, ray tracing enabled



3,840 x 2,160, Ultra Nightmare settings



3,840 x 2,160, Ultra Nightmare settings, ray tracing enabled



AUDIO FILES

CONFUSED BY CODECS AND FLUMMOXED BY FREQUENCIES? EDWARD CHESTER EXPLAINS ALL YOU NEED TO KNOW TO ABOUT GETTING THE BEST AUDIO EXPERIENCE FOR YOUR PC

The world of PC audio has gone through all manner of shifts in trends when it comes to device capabilities over the years. A decade or two ago, a quality gaming sound card was a must-have, along with a surround sound speaker setup. These days, though, built-in motherboard audio is greatly improved and most 3D effects and other gaming features are handled in software by your CPU, negating the need for fancy gaming features in sound cards.

Meanwhile, headphones with virtual surround sound have well and truly taken over from surround sound speakers, and external headphone amps are all the rage instead of internal sound cards. All of which begs the question of just what is the overall situation with PC audio these days – are you better off with an audiophile-grade headphone amp, a wireless headset, an internal sound card or just sticking with your monitor speakers and integrated audio? That's what we're here to find out.

Digital tech in an analogue world

The most fundamental difficulty that any audio device connected to a computer needs to overcome is that sound is an analogue signal and computers operate digitally. If you're trying to get a sound into your computer, it will need to go through an analogue to digital convertor (ADC), and if you're trying to get sound out of a computer, it will need to go through a digital to analogue convertor (DAC).

At their core, then, the role of any audio interface is to perform either or both the ADC and DAC conversion for the devices connected to it. The simplest audio interfaces do that and nothing more, providing an input for a microphone or output for a set of speakers or headphones, such as with USB headphone DACs.

However, many devices these days come with built-in ADCs and DACs, and use a convenient USB interface to connect directly to your computer, negating the need for any other sound interface devices – even on-board motherboard audio. Many gaming headsets, gaming/streaming-orientated microphones and even many speakers come with a USB connection, while any wireless devices with a USB dongle, such as wireless headsets, will take care of ADC/DAC duties internally.

In many ways, this greatly simplifies your buying decision, as a device with all these features built into it will only ever deliver sound quality of a certain level, so you don't need to worry about whether to buy a fancy sound card or headphone amp to get the best from it. If the whole unit is high-quality then it will produce quality audio, regardless of your other hardware.

ANY WIRELESS DEVICES WITH A USB DONGLE, SUCH AS WIRELESS HEADSETS, WILL TAKE CARE OF ADC/DAC DUTIES INTERNALLY

Crucially, any such dedicated interface is only useful when connecting analogue devices to your computer, such as a set of speakers with a line level input, an analogue headset or a microphone with an analogue output. Buying the best-quality or most feature-rich interfaces/converters will bring benefits to any such analogue devices that are plugged into them.

However, the downside of devices that don't have an analogue input or output is

External audio interfaces, such as the Epos GSX 1000, bring convenient audio controls to your desktop

that, if the internal circuitry isn't very good, it can hold back the potential performance of the analogue parts of the device.

We find this quite often with cheaper speaker sets, such as the Creative T60 (see p30), that offer a USB or other digital connection. Circumvent their cheap circuitry by using an analogue input, and they can often produce better audio quality – you'll still be relying on the cheap amplifiers in the speakers, but they'll at least be fed the best quality signal.

Some wireless and USB headsets can suffer noticeably from this phenomenon too. Their audio quality is seldom terrible with the built-in hardware, but if an analogue input is available, they'll often sound better when hooked up to a quality headphone amp. Analogue inputs in headphones also skip any internal amplifiers, so this method means you're often getting the very best possible signal to the headphones' drivers.

You pay extra for digital convenience too. Again, taking the example of the Creative T60, this set's USB and Bluetooth connections are convenient, but sonically, these speakers aren't as good as the company's identically priced, simpler and all-analogue T20 speakers. However, you will need a decent-quality audio output to get the best from the T20s.

All of which is to say that, if you're eyeing up a wireless headset, USB microphone or Bluetooth speakers, almost all other considerations about PC audio go out the window. If they're high-quality, they'll deliver that quality consistently whichever device they're connected to, and if they're not very high-quality, there won't be much you can do to get around it.

We always recommend seeking out devices that at least give you the option of an analogue input, especially when it comes to any vaguely portable device. Being able to fall back on plugging in a 3.5mm jack plug is always preferable to a device being unusable because its digital input is down.

Utility first

Assuming you're not investing purely in standalone USB or wireless audio devices, at some point you'll need to plug your analogue device into an audio interface, which is where all the other considerations about motherboard audio, sound cards and external interfaces come into play.

However, while many buyers primarily consider sound quality and price, it's also worth thinking about the features and utility of these devices. With motherboard audio, it's just inconvenient to be reaching round the back of your PC to plug in devices, as is also the case with internal PCI-E sound cards. Most such devices offer the option of front panel audio connections to plug into your case, but not all cases have multiple jack sockets on the front. You also can't

Some audio interfaces provide a huge array of extra controls and connections for gaming and streaming

Recording-focused interfaces provide useful functions, such as XLR input and microphone gain controls, as well as top-notch sound quality

adjust any settings, such as microphone gain or headphone volume, except via software.

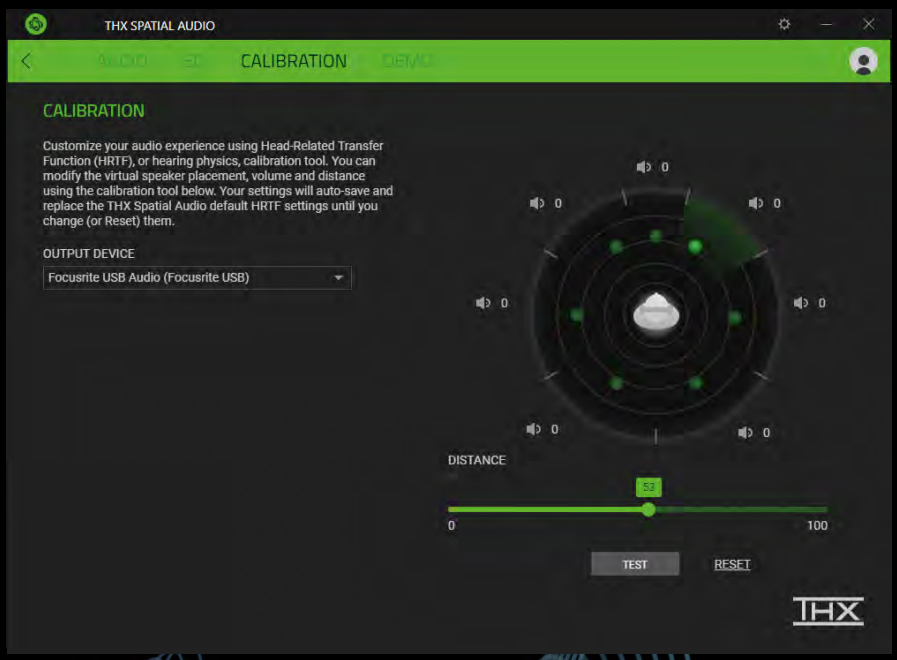
With external interfaces, though, you get easy access to sockets in which you can quickly plug and unplug headphones and microphones (or other devices such as keyboards and guitar amps if you want to record your own music), and you often get convenient gain/volume controls and even extra buttons for quickly muting your audio, turning on effects or playing and pausing music.

For example, devices such as the Epos GSX1000 provide just three jack sockets for an analogue headset (separate headphone and microphone inputs) and a stereo speaker output – so there's no fancy multi-channel audio here – but then you also get a volume wheel and touch-buttons for switching between a host of virtual surround sound modes, different EQ settings and more.

Other gamer-focused examples include the Elgato Wave XLR, which provides a headphone output and an XLR input for attaching a professional-grade microphone for streaming. The desktop interface then allows for volume control, mic muting, and controlling the mix of your own voice and your game.

Taken to extremes, you have the Creative Sound Blaster GC7, which provides a whole mixing desk-like desktop interface, with volume knobs, game/voice faders, dedicated buttons for mic mute and EQ, plus extra programmable buttons. You also get a mass of inputs and outputs that allow it to be used for both PCs and consoles.

For those more interested in home recording than gaming, the options are even vaster. Something of an industry standard entry-level option is the Focusrite Scarlett 2i2, which provides a headphone amp output and two combined XLR and 1/4in jack inputs (with gain controls) for use with microphones and musical instruments such as electric guitars. This style of interface



Razer's spatial audio software makes it particularly easy to fine-tune its virtual surround sound

can also scale all the way up to models with dozens of inputs.

All these extra features are at the heart of why most people should consider investing in external audio interfaces, although certainly there can be audio quality benefits too, as we'll discuss shortly.

Virtual vs real surround

One of the key shifts we've seen in computer audio over the past decade or two has been away from surround sound speaker systems, and headsets with multiple drivers in each earcup, to virtual surround sound. The latter uses just two drivers in a headset (or set of headphones), or two speakers, and then uses digital manipulation of the signal to emulate the effect of surround sound.

It seems like it should be a gimmick, but it ultimately makes sense given we only have two ears. As long as the sound manipulation is sophisticated enough, it should be possible to recreate as decent a sense of direction as our ears can otherwise provide.

Sure enough, that's been our experience, particularly in recent years as the technology has improved. In fact, when it comes to headphones and headsets, we find good virtual surround is actively better than the old multi-driver surround sound headsets of the past.

In particular, we've been impressed by Razer's spatial audio tuning software, which is based on THX virtual audio and can be bought separately for use with any headset for £20 inc VAT.

The crucial addition is a little graphic that shows a top-down view of a person standing in the sound field, allowing you to move the speakers relative to the person to adjust the surround effect and tune it to how you perceive the sound. This enables you to account for any slight imbalance in your hearing, and ensure the delivered surround effect reflects what you perceive.

The situation is far less clear-cut when it comes to speaker surround sound. Virtual surround through stereo speakers is inherently limited by the speakers being in front of you and not directly next to your ears. As such, any software manipulation has to not only account for how the sound bounces around a virtual world and into your ears, but also how it bounces around your room before reaching your ears.

There are systems used to tune rooms and speaker systems in this way, but they're not readily available for home PC users, and even then, they're generally still designed for optimising physical surround systems, rather than producing virtual surround over stereo speakers.

Our experience of the various stereo 'surround' modes often provided on speakers and hi-fi systems is that they

The Logitech Z906 is one of the last holdouts for an all-in-one surround sound speaker system designed to plug straight into a computer

do at least widen the perceived sound field and can sometimes pull out the dialogue to sound a little clearer. However, equally we've come across systems – we're looking at you, cheap TVs and monitors – where the virtual surround setting sounds downright terrible.

Make sure you play around with these settings to find the one you prefer, as often the default setup will have these features turned on, making your device sound worse than necessary.

As such, if you're in the position to hook up a full surround system with multiple speakers and a subwoofer and not worry about disturbing your neighbours or family, then a true surround speaker setup is still far superior to any sort of virtual surround speaker setup.

Unfortunately, the trickiest aspect when it comes to real surround sound these days is the lack of options for direct connection to a PC. Creative no longer lists any surround systems on its site, while the Z906 is the only system from Logitech.

Even Edifier – one of the last holdouts for making a wide range of quality PC speakers – only lists a single system on its website. For more choice, you'll have to invest in an AV receiver and dip your toes into the vast array of home cinema surround sound systems if you want to take the surround speaker route.

Motherboard audio

When it comes to the specifics of motherboard audio options, there are four main factors to consider. The first is, as highlighted above, whether you have any audio devices that already have their own ADC and DAC hardware.

If you have an external audio interface for your speakers, a USB microphone and a wireless headset (or a similar combination that doesn't use your motherboard's audio sockets), you simply don't need to worry about motherboard audio at all. In fact, you can even go as far as turning off the

Headsets with multiple drivers used to be the only viable surround sound headset option but virtual surround is now as good, if not better

on-board audio in your motherboard's EFI. Doing so makes for one less driver to install and one less audio device from which you have to choose when setting up your programs.

Next will be the number and type of connections you need. If you're hoping to run an analogue surround system (with individual speakers connected to multiple jack plugs), you'll require a sufficient number of outputs from the motherboard to attach all those speakers. Or, if you have a digital surround system, it may require an optical or coaxial digital S/PDIF output.

However, if you're only using stereo speakers and a headset, you'll only need the trio of jack plugs that come with basic on-board audio.

At least that's the theory. In practice, fewer outputs tends to be a sign of lower-quality on-board audio, so you often have to invest in boards with many extra connections just to get good quality audio from one of them.

Also, one specific consideration for on-board audio is whether you'll be using a headset or headphones, and whether your case has audio connections on its front panel. If the answer is yes to both those questions then you'll want to pay attention to the specific capabilities of your motherboard's front panel audio.

The latest and highest-end motherboards specifically provide headphone-friendly features for these outputs, such as a high-quality DAC with a high signal-to-noise ratio (SNR), the use of a capacitor-free connector that reduces the loud pops and crackles when you plug in your headphones, and an amplifier that's optimised for use with high-impedance headphones.

IT COUNTS FOR NOUGHT IF THERE'S LOTS OF NOISE ON THE LINE AND THE AMPLIFIERS AREN'T UP TO SNUFF FOR DRIVING YOUR DEVICES

The next factors to consider are the internal features that the main audio coder decoder (codec) chip provides. Modern codecs support all manner of extras, such as port routing (so you can plug a device into one of several ports and have it perform different functions), echo cancellation on mics and support for alternative audio formats, such as direct stream digital (DSD), along with various EQ and audio effects. We'll discuss these features in more detail shortly, but the key point here is that the codec is only a part of the audio circuit.

The final consideration is the amplifier circuitry and noise isolation between the codec, and the inputs and outputs.

It's all very well having lots of ports and software/digital features, but it counts for nought if there's lots of noise on the line and the amplifiers aren't up to snuff for driving your devices. It's for the latter reason that most motherboards have a gap on the PCB between the audio section and the rest of the board; the extra physical isolation reduces the chance of interference from the rest of the board.

These features are among the trickiest to find when browsing through motherboard feature lists and reviews. Unless manufacturer websites (or reviews of the products) really highlight exactly what high-end features have been added to a board's audio circuit, it can be very tricky to know how the real-world audio quality will sound. Generally, though, the better the codec, the better the hardware matched with it.

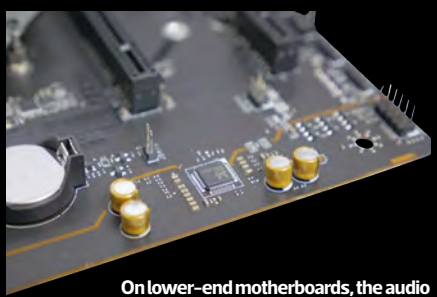
The Creative Sound Blaster Z SE is one of the few dedicated internal sound cards still available

Codec cracking

At the heart of any motherboard audio – and indeed most audio interfaces – is the codec chip. The biggest player on the market is Realtek whose chips are used on just about every motherboard available these days, but the features of its codecs can also be compared with those of other standalone sound cards and audio interfaces.

Among the most popular current-generation high-end Realtek codecs is the ALC1220, which boasts ten 110dBA SNR DAC channels for supporting up to 7.1 channel speaker setups and two other stereo outputs via the front panel headphone output (they can be multi-streamed together). It also provides three 102dBA SNR ADC channels for microphone and line-level input, with the microphone input supporting acoustic echo cancellation, beam forming, noise suppression and far field voice pickup.

Three of the outputs can be driven by internal headphone amplifiers, with the front panel output given a boosted SNR of 120dB compared to 110dB for the other outputs. It also has a 2.1V RMS output voltage that can drive headphones with up to 600Ω impedance, and it has a capacitor-free output that reduces the pops when you plug in your headphones.



On lower-end motherboards, the audio codec tends to be left uncovered

On higher-end motherboards, the audio codec is often shielded from interference by an extra cover

In comparison, the lower-end ALC892 codec, for instance, still has ten DACs but their SNR is only 95dB, so every output is just a little noisier and less clear. Likewise, the ADCs drop to a 90dB SNR, making it less suited for use as a device for high-quality recordings, although it's still ample for most in-game chat and video call input.

Meanwhile, the Creative Sound Blaster Z SE – among the most popular internal sound cards on the market – provides an impressive 116dBA SNR front panel output, while its rear outputs are rated to 102dBA. Its headphone amplifier can also drive headphones with an impedance of up to 600Ω. However, it has less multi-channel output support, providing connections for only a 5.1 speaker system (although it can provide 7.1 virtual surround). All of which puts it a little behind the highest-end Realtek on-board codec.

WHEN IT CAME TO SUBJECTIVE TESTING, WE DID IN FACT PREFER THE SOUND BLASTER Z SE'S SOUND TO THE OTHER DEVICES TESTED

Audio quality compared

To test the audio quality claims of the latest motherboard audio codecs, as well as a range of sound cards and external audio devices, we set up a test using RightMark Audio Analyzer. It feeds a set test signal out through an output of the audio device then records that signal back through one of the inputs of the device (via a cable, not a microphone).

The software then analyses the combined ability of the two connections to produce a clear signal.

It's not a perfect, all-encompassing test, but it gives reliable results for indicating the combined quality of a device's inputs and outputs. We also plugged a set of headphones into one of the outputs to assess the subjective audio quality produced by each device.

In our RightMark tests, we saw a fairly linear relationship between the claimed abilities of any given device's codec and the SNR, dynamic range and total harmonic distortion numbers of our tests. In particular, the ALC1220 codec we tested was an outright winner, showing that on-board audio really has come a long way in recent

RightMark Audio Analyzer results

	Realtek ALC1220	Realtek ALC892	Creative Sound Blaster Z SE	Creative Sound Blaster X4
Frequency response (dB)	+4.97, -3.79	+3.13, -2.93	+0.02, -0.2	+5.18, -3.57
Noise level (dBA)	-106.2	-88.5	-99.5	-91.3
Dynamic range (dBA)	106	88.5	99.5	91.2
Total harmonic distortion (per cent)	0.00606	0.00327	0.00839	0.00308
Intermodulation distortion + noise (per cent)	0.268	0.016	0.00971	0.014
Stereo crosstalk (dB)	-16.8	-82.6	-92.2	-84.4
Intermodulation distortion + noise – swept frequencies (per cent)	0.053	0.015	0.011	0.484
Frequency response – swept sine (dB)	+9.1, -3.9	+3.1, -2.8	+0.0, -0.1	+3.5, -2.6

Codec comparison

	Realtek ALC892	Realtek ALC1220	Creative Sound Blaster Z SE
Channels	7.1	7.1	5.1
Input SNR (dB)	90	110	101
Output SNR (dB)	95	110	102
Front audio SNR (dB)	95	120	116
Stereo ADCs	2	3	2
Front audio port (Port D)	Standard output, 32Ω	Capacitor-free output, 600Ω	Standard output, 600Ω
Headphone impedance detection	No	Yes	No

Different codecs and sound cards provide fundamentally different capabilities that can significantly impact sound quality and usability

years. The older ALC892 chip came dead last, with poor results across the board. Meanwhile, the Creative Sound Blaster Z SE sound card and Sound Blaster X4 USB interface both sat in the middle of the pack, comfortably behind the ALC1220 codec.

However, in some areas, the ALC1220 setup wasn't quite as accomplished, with very high stereo crosstalk in particular. This is testament to how other factors can affect audio quality, such as the PCB design and shielding of the board.

Also, when it came to subjective testing, we did in fact prefer the Sound Blaster Z SE's sound to the other devices tested, with the X4 coming next, then the ALC1220-equipped motherboard and finally the ALC892 setup. The difference between the top three options was very small though. All three had a much fuller bass sound than the ALC892 codec and more articulation in the top-end. There was just a hint more smoothness again in the Z SE.

Our tests showed the latest on-board audio really can outperform discrete audio hardware, but that doesn't tell the whole story

As an aside, our tests were done with lossless FLAC encoded tracks, rather than MP3s or a streaming service. When using Spotify, although the ALC892 board was still noticeably worse, the difference was muddied considerably by the low overall quality of that streaming service.

Even when opting for the best streaming quality, we noticed a massive difference compared with the FLAC tracks. Suffice to say, make sure your audio source is good-quality before spending lots of money on high-end audio hardware.

Nonetheless, what our tests proved sufficiently for us was that motherboard audio really is good enough for most uses these days, assuming you're getting a top-end codec. An external headphone DAC might be more convenient, but you'll have to spend quite a bit of money to get a clear advantage over a good on-board setup.

Of course, discrete devices – whether internal or external – mean you only have to spend the extra once to get the benefit of great audio across multiple motherboards. Plus, any external devices can be plugged into laptops and other devices.

Add in all the extra features such devices can bring to the table and there's still plenty of reasons to opt for one. CPC

GARETH HALFACREE'S

Hobby tech

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

REVIEW
Argon Eon

Argon40 is no stranger to building boxes in which you can nestle a Raspberry Pi computer. Its first design, the Argon One (see Issue 188) launched in late 2018, and was updated for the latest Raspberry Pi 4 in 2019 (see Issue 197). 2021's Argon One M.2 (see Issue 213) added a neat new feature in the form of an M.2 slot connected to a USB-to-SATA adaptor for high-speed storage, but the Argon Eon is a different beast entirely.

The Raspberry Pi 4 mounts upside down, with pillars connecting to the system-on-chip and RAM for cooling

Produced following a highly successful crowdfunding campaign, the Argon Eon is a case that turns any Raspberry Pi 4 model into a four-bay network attached storage (NAS) system. Like its predecessors, it has a near-full-metal construction (the two magnetically attached side panels are made of thin acrylic), with the metal doubling as a heatsink for the Raspberry Pi 4 inside.

It's a lot larger than an Argon One, though, and for good reason. Inside are four SATA 3 ports, connected to a USB-to-SATA bridge chip, supporting up to four hard drives or SSDs. To keep down the size, Argon40 has opted to focus on 2.5in drives – you can install four 2.5in drives with plenty of room for each to breathe, or two 3.5in drives and two 2.5in drives, but the two larger drives will end up being crammed very closely together.

There's an internal USB 3 port too, designed for booting from an SSD without sacrificing a SATA port. Oddly, this also works around a flaw in the design that renders all four SATA ports non-bootable for reasons that didn't make themselves known during the review.

The big sibling to the Argon One, the Eon packs in up to four SATA drives for a home-brew NAS system

The rear of the machine exposes the Gigabit Ethernet, USB 2 and USB 3 ports of the connected Raspberry Pi 4, although one USB 3 port is occupied by a bridge connector to the SATA backplane. There's also an audio-video daughterboard with 3.5mm AV jack socket and two full-sized HDMI ports, an easily accessible

The OLED display is handy, although it fails if you configure a slow fan speed

micro-SD slot, a 12V jack for the bundled 60W power supply and access to the Raspberry Pi 4's 40-pin general-purpose input/output (GPIO) header.

Two round break-out sections are also present, near an unidentified expansion header. Argon40 has yet to reveal its plans for these sections, although an optional high-quality audio board seems a likely guess.

Assembly is reasonably straightforward, although the instructions are lacking – pushing the Raspberry Pi 4 home is near impossible without removing the back I/O shield, a step not shown in the small manual provided. There's not much room to manoeuvre 3.5in hard drives, and until secured with the bundled screws, they bend the SATA ports alarmingly. On the plus side, you can fasten the screws with the high-quality bundled screwdriver.

For best results, use 2.5in drives; you can squeeze two 3.5in drives into the Eon, but they practically end up touching

The rear includes full-sized HDMI ports and two break-outs for an as yet unpopulated expansion header

Firing up the device reveals a bonus feature – a single-colour OLED screen hidden behind the power button on top. Once Argon40's software is installed, this pages through a selection of system stats, including CPU temperature, CPU usage, RAM usage, storage usage, IP address, and date and time. The latter is linked to a real-time clock, which requires an optional CR1220 battery, and is capable of waking the system from standby on a schedule.

As with the Argon One, the metal chassis acts as a passive heatsink, although it's also easily scratched, making installing the rubber feet on the base the first step to take during assembly. A 40mm fan at the top provides active cooling, and it's configured to pull in air through three thin vents and blow it down through the case.

Community-driven testing shows that flipping it over to exhaust hot air instead makes for a better setup, with Argon40 saying it will ship future models in that configuration instead.

With all that metal, it's no surprise to see the Raspberry Pi 4 keeps cool. The same can't be said for the hard drives, however. With two 3.5in 6TB NAS-spec SATA drives installed, the hottest drive idles at 41°C.

Meanwhile, the internal software-controlled fan is almost entirely ineffective. Whether it's working as an exhaust or intake, it makes little difference to drive temperatures and makes a real racket at the same time, plus when it's running at slow speeds, it somehow disables the OLED display.

That's a shame, as a better fan could have made all the difference to cooling – with a whisper-quiet USB-powered, speed-controlled 120mm fan pointing at the rear panel, the hard drive temperatures plummet by over 10°C each in our tests.

Performance is good though. The Raspberry Pi 4 runs exactly as you'd expect, with no thermal throttling, and the SATA bridge benchmarked at 390MB/sec read and 261MB/sec write speeds.

Power draw is a little high – the Eon idles at 5.5W with no drives installed, a notable uplift over the 2.9W sipped by the Raspberry Pi 4 alone. With two 3.5in drives installed, that idle draw jumps to 14W. The Argon Eon is available to order from **argon40.com** now at $150 US (around £115 ex VAT).

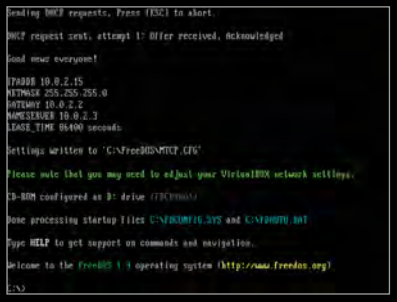
NEWS IN BRIEF

FreeDOS reaches version 1.3

FreeDOS, the open-source alternative to MS-DOS, has hit version 1.3 – a release that brings support for FAT32 storage devices on 8086 hardware, new networking support, updated packages and a floppy disk installer that requires around half as many disks as MS-DOS.

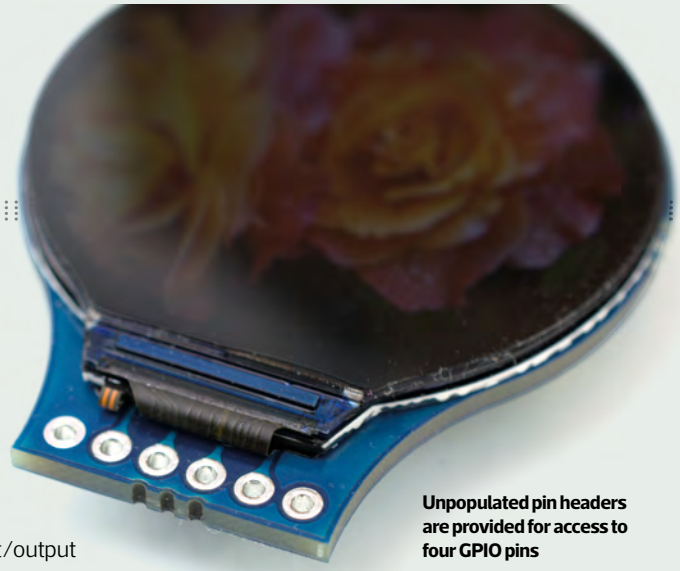
'The new FreeDOS 1.3 reflects all the hard work of everyone who wrote code, translated messages, edited documentation, tested new versions, offered support,' says project maintainer Jim Hall, 'and all the other things that go into a new version.'

FreeDOS is available to download from **freedos.org** now.



REVIEW

RoundyPi and RoundyFi



Unpopulated pin headers are provided for access to four GPIO pins

Designed by self-described 'DIY enthusiast' Om Singh, and produced by SB Components, the Roundy family consists of a pair of development boards with a difference – the fronts feature surprisingly high-resolution colour displays shaped as perfect circles.

The two devices use identical displays, but different microcontrollers. The RoundyPi is based on the Raspberry Pi RP2040 microcontroller, offering a dual-core Arm Cortex-M0+ processor running at 133MHz, with 264KB of static RAM, an eight-state-machine programmable input/output (PIO) block, 1MB of external SPI flash memory and a micro-SD slot for local storage.

The RoundyFi, by contrast, has an Espressif ESP-12E, one of the company's ESP8266 range, running its single Tensilica L106 core at up to 160MHz. It also has 128KB of static RAM, 4MB of flash memory and its key feature, 2.4GHz 802.11b/g/n Wi-Fi.

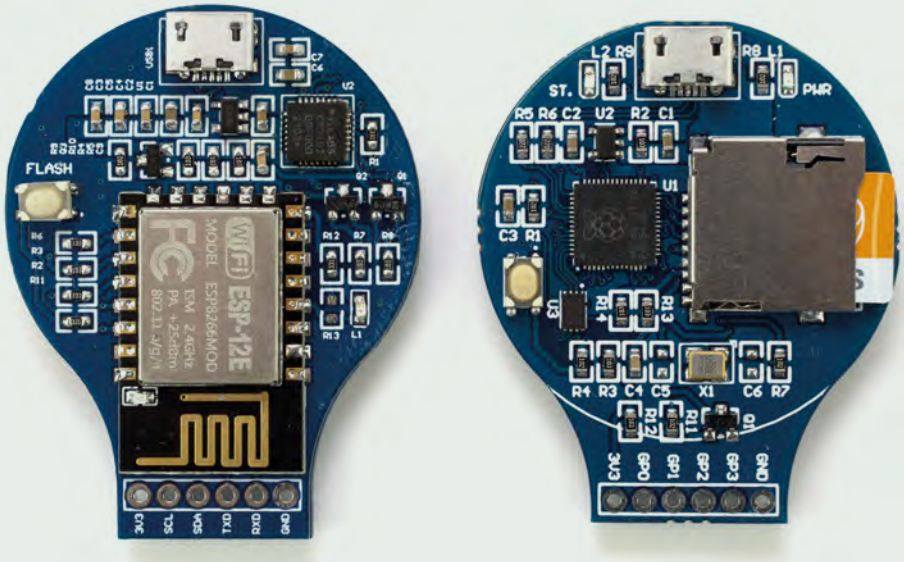
Regardless of whether you're using the RoundyPi or RoundyFi, the boards include a 1.28in 65,000-colour display, with a 240 x 240 resolution, driven by a GC9A01 driver module. There's a micro-USB port at the top of each board for power, data and programming, and an unpopulated 2.54mm header at the bottom for breadboard use or external expansion.

It's here that the Roundy range begins to show its limitations. Only four general-purpose input/output (GPIO) pins are brought out to the 2.54mm header, leaving a lot of the microcontroller features inaccessible.

The next disappointment, which isn't surprising given a little thought into the matter, is the display's resolution.

While SB Components claims the screen has a 240 x 240 resolution, astute readers will note that an image with 240 pixels on each side forms a square – not a circle. In the company's demo code square format, 240 x 240 images are loaded into flash for display, and appear as a cropped circle with a 240-pixel diameter.

A quick calculation reveals a usable display pixel count of around 45,239 – notably lower than the 57,600 available from a square display of the same claimed resolution.



The two variants differ in microcontrollers and features – one has Wi-Fi, the other a micro-SD slot

NEWS IN BRIEF

Monotech offers hope for missing MOS chips

Pseudonymous electronics designer Monotech has designed a carrier board to address the increasing scarcity of MOS Technology chips found in vintage computing hardware, by converting the considerably more common MOS 6502 chip.

Dubbed the MOS CPU Replacer, Monotech's carrier board accepts an original MOS 6502 and adds in the missing logic to convert it to the equivalent of a much rarer MOS 6510/8500, 6510T, 7501/8501 or 8502 chip. Design files for the boards are available at **custompc.co.uk/CPUReplacer**, while assembled boards can be purchased now from **custompc.co.uk/ReplacerBoards**, starting at $15 US (around £11.50 ex VAT).

The display on the Roundy range is eye-catching, colourful and bright, but also glossy

The RoundyPi is programmable as a Raspberry Pi Pico in MicroPython and CircuitPython

If you want a square display, though, there are plenty to be found. If you're picking up a Roundy, it's because you want a circle – and it's certainly eye-catching. The display is bright and clear with good colour reproduction, but the glossy finish to its glass cover makes it ill-suited for use outdoors or in the presence of bright light.

The documentation, sadly, is less clear. SB Components has prepared a small handful of sample projects for both boards, offering Arduino-based code for the RoundyFi and CircuitPython code for the RoundyPi. It's very much a learn-by-doing approach with little hand holding, and the provided brief instructions are sometimes misleading and occasionally entirely wrong.

The projects themselves are basic too. The company's Kickstarter campaign shows a RoundyPi being used as a smartwatch, complete with heart monitoring, step tracking, time, date and weather information, but that's just a mock-up, and these graphical smartwatch features aren't found in the provided source code.

Instead, the RoundyPi has a project to load predetermined images from flash memory, another to read and write text to a micro-SD card, and another to interface with an external air quality sensor and display the readings as flat text on the screen. The RoundyFi has a simple web server example, a weather app that again, uses basic flat text, and a Wi-Fi-connected clock – the latter is the only one of any of the samples that makes use of the boards' circular display.

It's not a deal-killer, by any means. If you don't mind poring over source code and jigsawing things together, there's enough there to build a bigger project – loading images from a micro-SD card instead of the RoundyPi's tiny 1MB flash memory, for example, or having the RoundyFi pull down system stats via Wi-Fi for a system monitor with realistic gauges. However, it's unlikely you'll get close to the company's smartwatch mock-up, particularly given the relatively primitive drawing tools included in the graphics library.

The biggest issue with the Roundy range, however, isn't the accessibility of programming it but its price. The RoundyPi is the cheapest mode in the range, yet costs £35 (inc VAT), while the RoundyFi will cost you an additional £5 at £40 (inc VAT).

The same GC9A01-driven round LCD panel purchased from a Chinese seller in single quantities, meanwhile, will set you back as little as £5.74 (inc VAT) – and a Raspberry Pi Pico to drive it costs just £3.60 (inc VAT), while providing access to all the RP2040's GPIO pins. Add a micro-SD breakout for under a pound and you've built your own RoundyPi.

The all-in-one format of the Roundy range is admittedly attractive – particularly for projects where space is at a premium, with a footprint only marginally above that of the 1.28in display itself. If SB Components can improve the documentation and build some better sample projects, the premium asking price could potentially be justified.

Both Roundy boards are available to buy from **shop.sb-components.co.uk** now.

With a 1.28in display at the front, the Roundy range is pleasingly compact

REVIEW

The Colouring Book of Retro Computers

The Colouring Book of Retro Computers, by Neil Thomas, host of the 'RMC' YouTube channel, is on the surface a similar tome to the Retro Computer Colouring Book (see Issue 214). It's aimed at adults and packed with nostalgia-tinged line-art illustrations of vintage computers. While the Retro Computer Colouring Book had 15 entries, though, Thomas' version of the idea packs a grand total of 31.

Every machine pictured is found in Thomas' collection, housed in an old mill dubbed The Cave, which Thomas is opening to the public as a museum of classic computing – complete with a mock-up shop where users can browse, but not buy, old games and software.

While Thomas took the reference photos, though, the line-art illustrations were created by Stuart 'Stoo' Cambridge, a former Sensible Software staffer best known for his iconic pixel-art work in games including Cannon Fodder and Sensible World of Soccer.

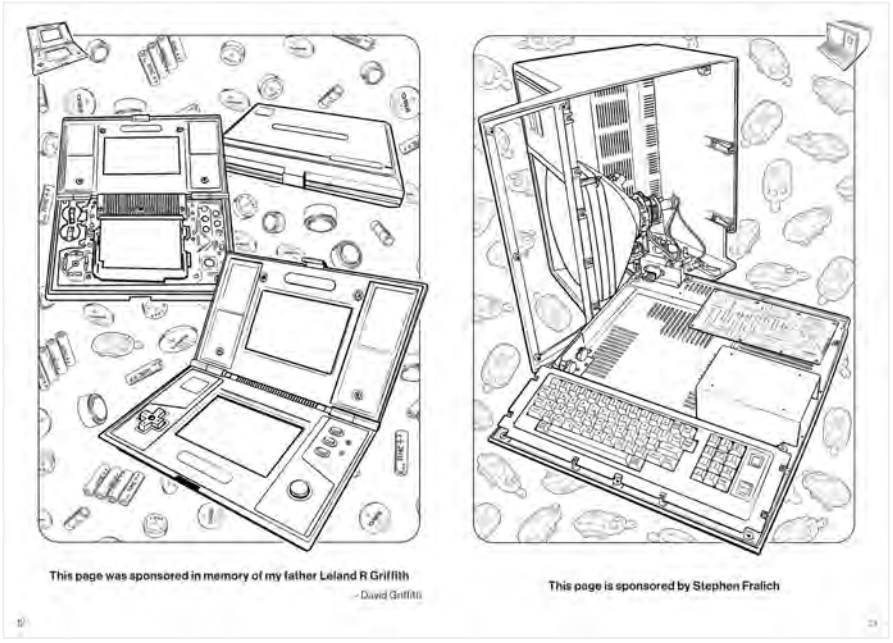
Stoo Cambridge's art is great, although the print version has quality issues and no systems are labelled or even badged

Each reference photo has been turned into a detailed line-art illustration, with casings opened to reveal circuitboards and other components – an opportunity to drop the beige pencil and pick up some greens, blacks and golds.

To keep it interesting, every page also has a background containing joysticks, batteries, floppy disks, tapes, CD-ROMs and more. However, background imagery is shared between pages, and there isn't a great deal of choice when it comes to colouring button-cell batteries.

What isn't found inside the book, sadly, is any labelling. Each page has a caption at the bottom, but it's provided by those who paid for the privilege of leaving a personal message during the book's crowdfunding campaign.

None of the machines is identified, which is a missed opportunity, but also gives the book a second life as a 'guess-the-machine' quiz, albeit one where no answer is provided. It's also made more challenging by Thomas' decision to skirt any potential copyright complaints by replacing company logos and product identifiers with 'RMC' equivalents.



This vintage computing colouring book gives you an excuse to sharpen your beige pencils

A bigger problem is the print quality or, rather, image quality. Many pages are perfectly clear, showing dark line-art against a bright white page with clearly defined boundaries. Others are muddied by the tell-tale block-like artefacts of heavy or repeated JPEG compression. This isn't nearly as visible, oddly, in the digital download variant, suggesting a mistake was made somewhere during the printing process.

It's a minor nitpick, and any quality issues are quickly buried when you whip out the Crayolas for a colouring session. The 31 machines include an arcade cabinet, a Commodore PET, an NEC PC Engine with CD-ROM add-on, a Nintendo Game Boy, an immediately recognisable Vectrex and an equally standout Sinclair ZX Spectrum – there's certainly plenty to keep even the quickest colourist busy.

It does, however, come at a price. While the Retro Computer Colouring Book was priced at just £4.50 (inc VAT), Thomas' take on the concept will set you back £9.60 for the PDF download or £12 in print (both inc VAT). The former is the version to choose – the image quality is higher, and you can print multiples of your favourites to experiment with different colour schemes. The Colouring Book of Retro Computers is available from **rmcretro.store** now. CPC

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at **freelance.halfacree.co.uk** @ghalfacree

WIN

AN NZXT GAMING PERIPHERALS BUNDLE

Fresh off the launch of its new award-winning mechanical keyboard and gaming mouse (see p32-33), NZXT has partnered with **Custom PC** to give away a cracking bundle of peripheral goodies in this month's competition. One winner will bag a Function full-sized mechanical keyboard, Lift gaming mouse, Capsule USB microphone with matching boom arm and an extra-large mousepad.

NZXT FUNCTION

The Function keyboard features hot-swappable Gateron key switches, per-key RGB backlighting and a slick black or white design (winner's choice). With its handy USB Type-C socket, you can also swap out the main cable or easily replace it if it ever gets broken.

NZXT LIFT

The Lift mouse weighs just 67g and sports a comfortable symmetrical design that we found to suit all grip types. Again available in black or white, it features six main buttons and uses the excellent PixArt 3389 optical sensor for faultless tracking. Coming with an extra-large fabric mousepad that will fit under your keyboard and mouse, you'll have no excuses for missing your shots.

NZXT CAPSULE

The Capsule is a stylish and compact USB microphone that houses a single condenser capsule, USB connection and headphone amp to provide superb audio quality for your home recordings, video calls or gaming streams. Coupled with NZXT's matching Boom Arm, you won't even have to worry about how to fit the Capsule on your desk – it can clamp to the side of your desk and swing easily in and out of range.

SUBMIT YOUR ENTRY AT **CUSTOMPC.CO.UK/WIN**

ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Keep an eye on your AIO liquid cooler

NZXT makes some great liquid coolers, but the one in its original H1 case didn't last long at all

Last month I wrote about my experience with NZXT's original H1 case, and its included AIO liquid cooler filling up with gunk. This gunk ended up clogging the copper contact plate and saw my CPU temperatures skyrocket – only extensive flushing ridded the loop of the gunk that kept blocking it. It seems this issue is more widespread than you might suspect too, according to a well-researched article I found after writing last month's column.

I found an article on **igorslab.de** looking at this exact issue, posted after I wrote my article last month, and the issue seems to be related to comparatively cheap AIO liquid coolers that use aluminium radiators. These aren't uncommon, of course, but they skip one or two steps of the manufacturing process. To achieve lower prices, Igorslab claims residues from the solder flux used to create the radiator are left exposed to the coolant.

The anti-corrosion additives then react with the flux to create the gunk that clogs the contact plate, reducing heat transfer and eventually killing flow rates too, which is what I found. The Igorslab investigation went through some serious lengths to identify the chemical reactions and compounds concerned, and it seems that cheaper coolants that use aluminium silicate as a protective layer against corrosion are the prime suspects.

What can we do as PC enthusiasts? Well, not a lot other than monitor CPU temperatures, and if they start to climb for no apparent reason then you have two options. The first is to clean the contact plate and flush the coolant, as we did our last issue on p106. The second is to send back your liquid cooler via RMA. Thankfully, this issue does seem to be relatively rare, and the NZXT H1's AIO liquid cooler is the first time I've come across it.

This is off the back of a decade of using AIO coolers to test CPUs, and models from the likes of Corsair, EK and NZXT have lasted years, so I'm in no doubt that not all liquid coolers not suffer this problem, at least not in under a year. Still, it does bolster the argument for opting for custom liquid cooling, especially if you're considering an AIO liquid cooler that costs upwards of £200. At the very least, a custom loop will certainly last longer than some AIO liquid coolers.

Don't be put off using an AIO liquid cooler though. Good-quality units that match the correct coolant with decent quality control should be fine. However, I'll certainly be keeping a close eye on any models that we use long-term.

Why I'll never give up water cooling

A couple of years ago I remember saying (after several new CPU launches) that boosting algorithms would have a huge impact in the future, and that they could even make overclocking only worthwhile on a select few CPUs. In fact, this situation has changed even more than I predicted. Intel's Alder Lake CPUs don't just rely on boosting to optimise performance in varying workloads, but dynamic clock speed adjustment also has an impact on features such as Intel's thread director, which divvies up work across a CPU's P-Cores and E-Cores.

The result is that most mid-range and high-end CPUs are now hitting frequencies at stock speed that are too difficult, time-consuming or power hungry to better achieve with a manual all-core overclock. As usual, all-core frequencies can usually be bettered with an overclock, making them a tempting overclock for those who want the best multi-threaded performance. The issue is that you usually kill all boosting on the CPU if you do an all-core overclock, potentially reducing single and lightly threaded performance.

I can safely say that my next PC will likely not have any kind of overclock, especially as I'll be upgrading from a Ryzen 3000-series CPU – I'll be getting a huge boost from either the Ryzen 5000-series CPU or Intel 12th-gen chip I buy, whether it's overclocked or not.

However, both those ranges of CPUs, while more efficient than their predecessors, still benefit from high-end cooling setups. Both have options to boost performance above default settings, such as AMD Precision Boost Overdrive, as well as Intel's various boosting add-ons, such as Thermal Velocity Boost and the numerous power limits available for its 12th-gen CPUs.

Of course, cooling a Core i9-12900K or Ryzen 9 5950X is no easy task either. You'll need a large liquid cooler, or one of the biggest air coolers, to cool them under load at low noise levels. In smaller cases with less airflow, you'll need to pay even closer attention to your choice of cooling. For me, the case for water-cooling your PC is as strong as ever, whether you're overclocking your CPU or not.

It's not just CPUs that push the limits of mainstream power and cooling demands – graphics cards do it too. Graphics card coolers have to be enormous these days, in order to cope with the large heatloads produced in gaming workloads, and the memory modules on the rear of some cards get so hot, they can result in the card throttling too.

It's no surprise, then, that waterblock manufacturers such as EK have produced actively cooled backplates for some high-end cards – in particular Nvidia's RTX 3000-series. Even if you don't consider the backplate heat issues, graphics cards are usually the loudest components in PCs when you're gaming as well.

Overclocking might be useful in only limited scenarios, but water-cooling your PC is also relevant with a stock-speed CPU

For most people, there's little point in manually overclocking the latest high-end CPUs, such as the Core i9-12900K

Some of the massive coolers can keep noise in check with good airflow, but another benefit of water-cooling your graphics card is that you don't need to worry as much about airflow. For instance, if you want to mount your graphics card vertically or near a tempered glass panel, perhaps in a way that allows you to fit more cooling hardware in your case, your graphics card will always be cooler if it's water-cooled than air-cooled.

For these reasons, whichever CPU I use in my next PC, I'm pretty sure it won't be manually overclocked, since I mainly need the best single and lightly threaded performance from my CPU, which is best achieved by using its boosting algorithms.

However, it will still be water-cooled, as having some cooling headroom means I can still use a monstrous CPU and graphics card, but keep noise levels low even in games, while allowing the boosting algorithms to hit the highest speeds possible. It might also be useful when it comes to dealing with the next generation of GPUs, which are reportedly very power-hungry. CPC

Antony Leather is Custom PC's modding editor @antonyleather

How to Install a custom display

Antony Leather shows you how to fit a customisable stats screen in various places in your PC

TOTAL PROJECT TIME / 3 HOURS

Available in a variety of sizes, small 5in or 7in displays are ideal for creating a custom screen in your PC to display your own graphics, videos, images or stats from your PC, such as temperature, fan speeds, CPU and GPU load, and a whole host of other pieces if information.

This month we'll be showing you how to solve the tricky task of installing one of these screens in your PC using a variety of methods, while also taking you through the main ways to create a custom PC stats display using software.

TOOLS YOU'LL NEED

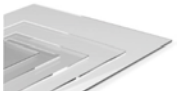
Waveshare 5in TFT LCD 800 x 480 monitor
amazon.co.uk

Dremel and cutting disc
Most hardware stores

Finger files
Most hardware stores

Double-sided mounting tape
Most hardware stores

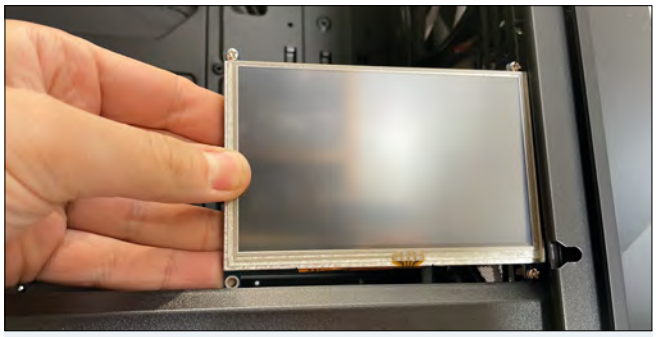
Coloured card
Most hardware stores



2mm sheet acrylic
ebay.co.uk

Drill with 3mm and 7mm bits
Most hardware stores

Angled micro-USB-to-USB header cable
amazon.co.uk

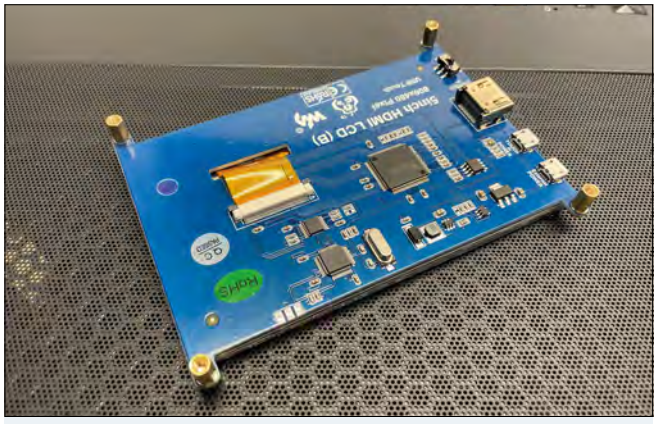


1 / PICK THE RIGHT LOCATION

You can mount a screen almost anywhere in your PC, but on or in your PSU cover if it has a cut-out, or against a glass side panel, are the best options. You need to be able to see it clearly and not have graphics cards or cooling components obscuring its view. You can mount it horizontally or vertically.

2 / BUY THE RIGHT SCREEN

Picking the right resolution for your screen is important, as you need to work with specific sensor panel software designs. You need one that has HDMI and micro-USB ports, so avoid models that mount straight to a Raspberry Pi. We've opted for a 5in screen with a resolution of 800 x 480.



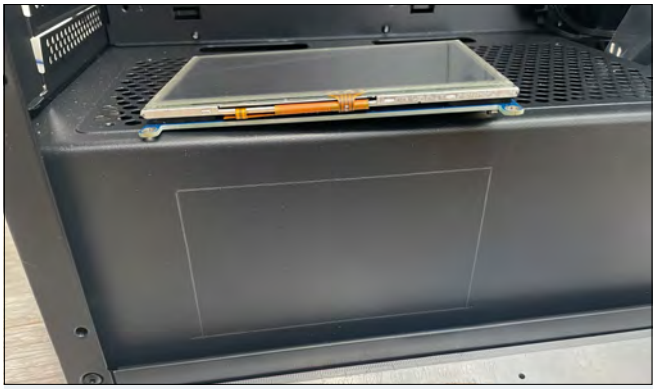
3 / IDENTIFY MOUNTING OPTIONS

Work out how best to fix the screen to your particular case. Our screen has motherboard standoffs, so it can be screwed to flat areas in your case with the aid of a drill or you could create your own mounting surface to secure to the standoffs and use mounting tape.

INSIDE PSU COVER

1 / CHECK PSU COVER

A PSU cover is an ideal location for the screen, as it's close to the side panel and some covers even have openings to see the PSU that could be used to reveal the screen if you mount it inside.

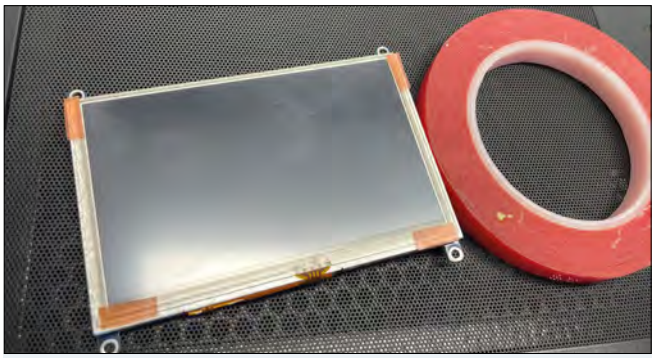


2 / MEASURE OPENING

If the PSU cover has an opening, measure it up and consider whether it's large enough to show the screen. You can consider enlarging it if it's too small, or even cut a new opening if your cover doesn't have one already.

3 / CREATE HOLE AND FILE EDGES

The opening should line up with the edges of the illuminated display area, which is 11 x 6.5cm in our case. Check the display can sit inside the cover, mark up the area you need to cut and use a Dremel with a cutting wheel on medium speed to create or enlarge the hole. Then smooth the edges with a finger file afterwards.



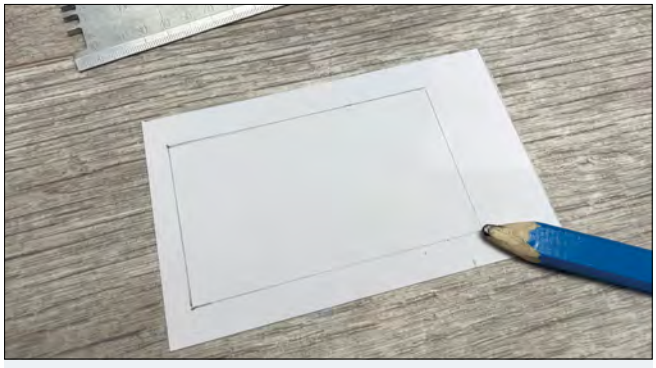
4 / USE MOUNTING TAPE

The screen has a thin bezel on which you can apply mounting tape to secure it to the inside of the PSU cover. Apply the mounting tape in 1cm strips in each corner to this area, but be prepared to use more depending on the strength of the tape you use.

5 / INSTALL SCREEN

Connect the screen's HDMI cable, and micro-USB-to-USB header cables (see Connection and setup, p105), before you insert it in the PSU cover, as it will be tricky to do this afterwards. Line up the screen with the hole and press it firmly into place, so the mounting tape holds it.

INSIDE A FRAME



1 / CREATE YOUR OWN FRAME

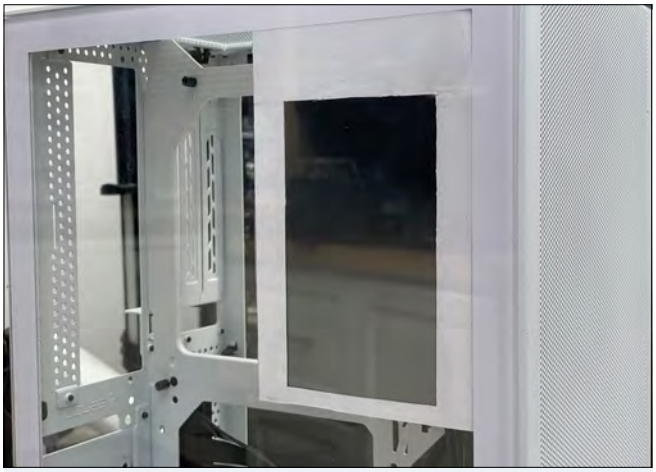
If you want to install the screen so that it's exposed, it's worth covering the unsightly frame around the display itself. To do this, you can use thick paper card in the same colour as your case and stick it to the display to hide the bezel. You can also use a 3D printer, or cut some acrylic or thin metal sheet to size, to create a thin frame.

2 / CUT OUT AND STICK TO SCREEN

If you're using card, simply use a scalpel to cut out the inner section of the frame and trim the rest of it to size with scissors. You may need to add an extension to cover the cables, depending on your cable management setup.

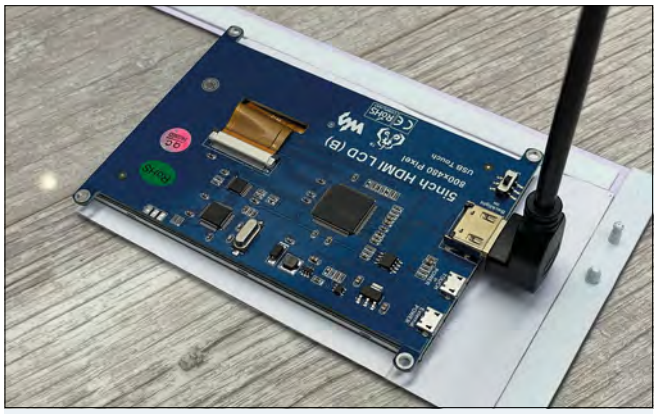
3 / FIND BEST LOCATION

The easiest way to mount your screen in the open is to fix it to your case's glass side panel. Place it on the inside of the panel and investigate where it would look best. Check there's enough clearance behind it and that your USB and HDMI cables are long enough – you may need to buy longer ones.



4 / APPLY MOUNTING TAPE TO FRAME

Apply mounting tape to the card. It's best to place the tape over all of the card, so there's no uneven colour due when the screen is illuminated.



5 / FIX INTO POSITION

Press the screen firmly into place on the side panel, ensuring you stick it to the correct side and that it's level.

OTHER CASE LOCATIONS

1 / INSTALL STANDOFFS

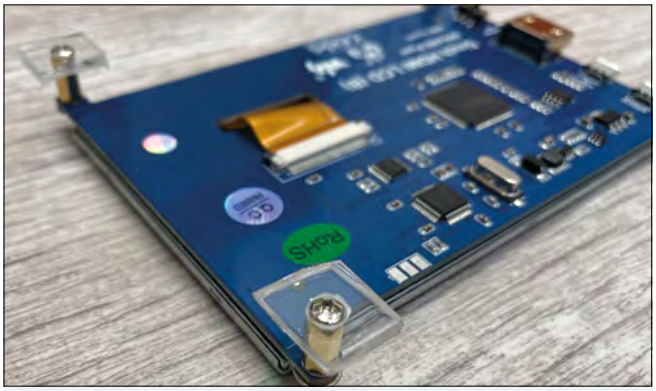
To mount the screen to a flat surface such as your motherboard tray, install the included standoffs to the mounts on the screen's PCB. You can use standard M3 PC screws with the standoffs included with our screen.

2 / CUT ACRYLIC TO SIZE

If you want to fix it to a flat surface without drilling holes into your case, you can create small flat acrylic pads to mount to the standoffs, and then apply mounting tape to these pads. Cut out four 10 x 10mm sections of 2mm acrylic sheet.

3 / DRILL HOLES

Use a 3mm bit to drill holes in the middle of each of the four pads, which will allow M3 screws to pass through them. On one side, use a 7mm drill bit to cut a shallow recess in which the screw head can sit. This way, you can apply mounting tape over the top.



4 / INSTALL MOUNTS

Use standard M3 PC mounting screws to secure the pads to the standoffs. These are the same screws that come with most cases to install 2.5in SSDs, so you should have a few spare, but they're otherwise very cheap.

5 / APPLY MOUNTING TAPE

Once you've screwed each pad to the standoffs, cut the mounting tape into 10 x 10mm strips and apply it to the pads. This tape will be strong enough to hold the screen in place, but it's also easy to remove should you want to place it elsewhere or remove it in future.

6 / FIT INTO POSITION

Press the screen into place firmly, pressing on all four corners to ensure they're all secure. Move the screen from side to side to ensure there's no movement.

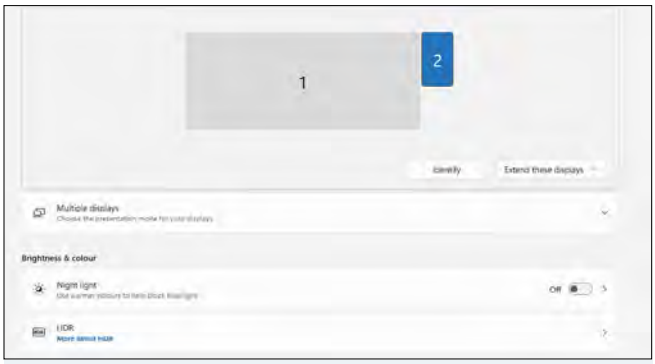
CONNECTION AND SETUP

1 / USE MICRO-USB HEADER CABLE

It's best to use a micro-USB-to-USB header cable, as this will mean the display switches on and off with your PC. Using the included Type-A cable also means you need to route it to your motherboard's I/O panel, which creates unnecessary extra cable mess round the back.

2 / CONNECT HDMI CABLE

The HDMI cable needs to be connected to your graphics card, or if you're using your CPU's integrated graphics, a second display output on your motherboard. To get it there, you can remove a blank expansion slot cover or find an opening in your case that allows you to route the cable to the HDMI port.



3 / SET UP WINDOWS

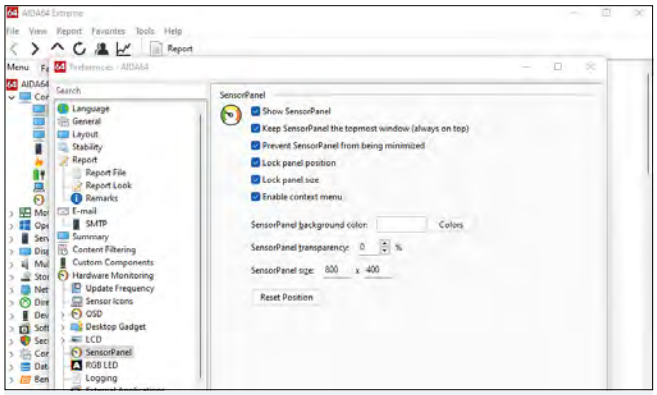
With your screen connected and powered on, you should be able to set it up in Windows' Display settings, accessible by right clicking on the desktop. Here you can set the display orientation, as well as make sure it's set to run at the right resolution.

4 / USE EXISTING MONITORING SOFTWARE

The easiest way to use your screen is to upload an image, play a video or use existing monitoring software such as MSI Afterburner or NZXT CAM. However, these packages can be limited, and some can't be resized either, meaning they sometimes won't fill your screen or are too large, as is the case here.

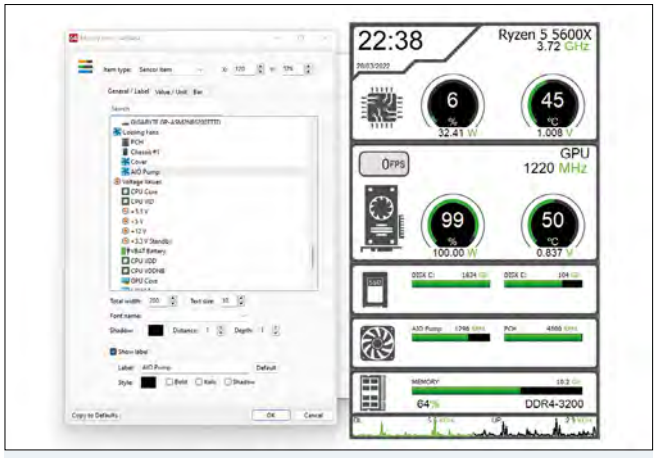
5 / USE CUSTOM SENSOR PANEL

Monitoring programs such as AIDA64 can create custom sensor panels, or you can download ones made by the community. For AIDA64, visit **custompc.co.uk/SensorPanel**, sign up and browse the files. HWiNf064 is another option paired with Rainmeter, with guides available online. We credit Leandroltp67 for the one we used.



6 / IMPORT SENSOR PANEL FILE

In AIDA64, click Preferences and scroll down to SensorPanel. Here you can load the default panel and adjust its parameters. Once you've loaded the default panel, right click on it and click on SensorPanel Manager. Here you can import the panel file you downloaded, which will load the new panel.



7 / ADJUST SENSOR PANEL

As people of all languages create sensor panels, and in various resolutions, sometimes you might need to tweak the design. Right click on the panel and you can move objects in it. Also, if you click Modify, you can adjust the names, colours and sensor inputs.

8 / DRAG SENSOR PANEL TO YOUR DISPLAY

We've chosen a vertical panel, so we've adjusted the Windows Display settings to have the screen in portrait mode. You then just need to drag the sensor panel onto your screen. If it doesn't fit, check that the sensor panel design resolution matches that of your screen. CPC

Retro tech

WINDOWS 3.1

Screensavers, colourful icons and proper fonts. 30 years after its release, **Stuart Andrews** looks back at the version of Windows that finally put it on the map

Windows 3.1 is arguably the most crucial Windows ever – the Windows that defined how PC computing looked just as it was beginning to take off. Before version 3.1, Windows was a successful operating system, but one that looked and felt like a GUI shell perched precariously on DOS.

With the launch of Windows 3.1 in April 1992, Windows finally looked and felt like the real deal. What's more, it was a sales phenomenon, shipping over 3 million copies in its first six weeks on the market and 25 million within the first year. Windows was already big, but 3.1 put Windows in the lead.

How did Windows 3.1 do this? That's not something you can nail down to any one factor. It was partly a question of stability, partly features and partly look and feel. Believe us – Windows 3.1 looks rough by today's slick standards, but not half as rough as what came before.

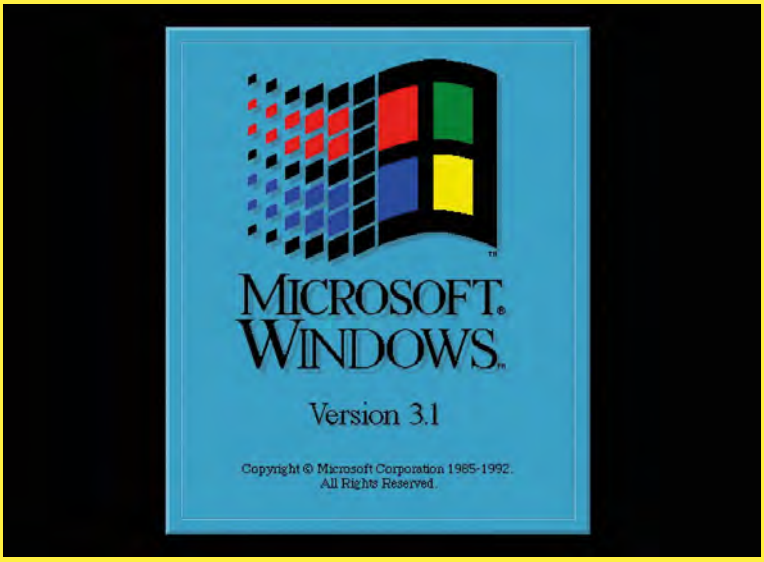
LOOK AND FEEL

Look and feel certainly played an important part in Windows 3.1's success. Windows 3.0 has already done some of the hard work of introducing a proper GUI, replacing the horrible, text-based MS-DOS Executive of Windows 1.x and 2.x with the new Program Manager and File Manager components. Instead of clicking on a program or a file in a list, you could double click on an icon to launch it. Yet Windows 3.1 went further, taking advantage of the VGA and SVGA graphics standards to introduce a revamped UI with more colourful icons.

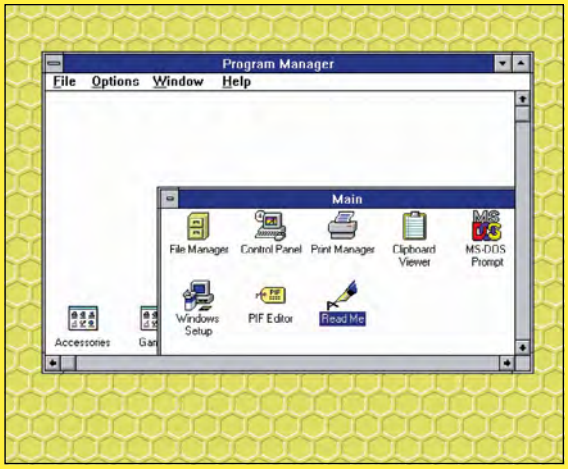
What's more, those icons could now do more than just get clicked on, as Windows 3.1 introduced drag and drop. You could explore your PC's file system visually, copying files from one folder to another by clicking on the file, dragging it over and releasing the mouse button. You could drag a file onto the Print Manager icon to print it out, or onto the application's icon in Program Manager to open it and start work.

Yet perhaps the most vital enhancement over Windows 3.0 was the introduction of TrueType fonts. At this point, Windows still involved a lot of text and, up until Windows 3.1, this text didn't look good. It was pixelated, primitive and ugly, with no real provision to vary horizontal or vertical spacing.

While developing Windows 3.1, Microsoft put a team together to fix this problem, and that team worked with



Cue a sigh of relief when this splash screen showed up. Launching Windows from MS-DOS could be s...l...o...w



The Program Manager was the heart of Windows 3.1. Double clicking icons launched the applications, or you could drag and drop files onto the icons or open windows

TrueType fonts were a revelation to Windows users, making the OS look significantly better and opening up more sophisticated WYSIWYG DTP and design applications

one of the two leading typesetting companies of the era, Monotype, to design a new set of core fonts. Meanwhile, Microsoft worked on the technology to render those fonts on-screen, so they could be scaled upwards and downwards, rotated and respaced, and still look pretty good.

Monotype came up with the Times New Roman, Arial and Courier New fonts that Windows still incorporates today, while Microsoft licensed and adapted Apple's TrueType technology, adapting the font hinting tech that made these fonts clear and legible even on a VGA resolution (640 x 480) screen. This not only made Windows look a whole lot better, but made it a viable platform for desktop publishing and design. Suddenly, the Mac had competition.

This was also the first version of windows to include a built-in screensaver

FUN AND GAMES

Other aspects of Windows 3.1 revealed a more playful side to Microsoft. Windows 1.0 includes one game – Reversi, while Windows 3.0 introduced Solitaire, a patience card game originally developed by a Microsoft intern, Wes Cherry, and responsible for so much lost productivity that Microsoft banned its 'boss key' feature, which switched from the game to a mocked-up Excel spreadsheet, before release.

Windows 3.1 added Minesweeper, the classic game of grid-based bomb discovery so addictive that, legend has it, Bill Gates had it uninstalled from his PC. Not that this stopped him or anyone else playing it. While Gates was known to sneak onto a colleague's computer after hours to play it, the rest of the company joked that Minesweeper was the most carefully tested of all Windows 3.1's new features.

This was also the first version of windows to include a built-in screensaver. As with so many new features, this wasn't all that new – screen burn-in was an issue for CRT-based VGA monitors, and After Dark's fish and flying toasters had already appeared on Windows 3.0 and macOS. However, Windows 3.1 made screensavers a standard component, introducing long-time favourites, such as the classic flying Windows logo, the Star Trek-style Starfield, and the psychedelic Mystify and Swirl. Seriously. After few too many shandies, they blew our primitive, PC-loving minds.

ARCHITECTURAL IMPROVEMENTS

Yet the most important features that Windows 3.1 introduced were those you couldn't see. Windows 3.0 had introduced protected memory – a way of using the protect mode of the 80286 CPU to allow Windows and Windows apps to use up to 16MB of RAM rather than just the first 640KB.

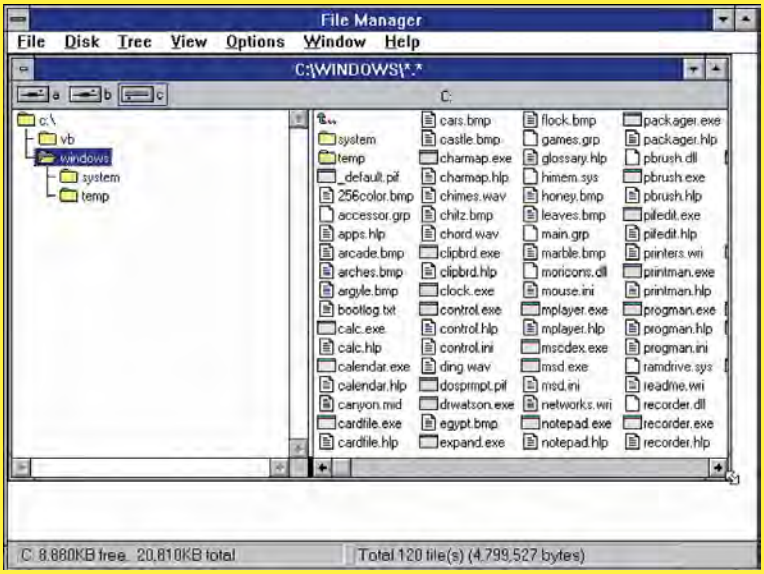
Coded by ex-physicists David Weise and Murray Sargent, this feature had been crucial, making Windows a viable alternative for Microsoft to working with IBM on what would become OS/2. Running in protected mode gave Windows programs more stability, and enabled MS-DOS applications to run under Windows and still access all the available RAM. This in turn meant that Windows spent less time crashing, which made it a lot more attractive to people trying to get some actual work done.

Windows 3.1 built on this foundation by taking the new memory management features built into the newer 386 processors and using them in a 386 Enhanced mode. Where Windows 3.0 was limited to a maximum of 16MB, Windows 3.1 upped that limit to 256MB (or, in theory, up to 4GB) and enabled programs to use virtual memory above and beyond the physical memory installed.

It also enabled most DOS programs to be run inside a Window with mouse support, and multiple DOS programs to be run simultaneously. What's more, all these enhancements meant Windows 3.1 only worked on an Intel 80286 CPU or later. Rocking an old-school 8086? Tough.

These changes improved not just Windows' overall stability, but its multi-tasking capabilities as well. Applications

Windows 3.1 gave us new ways to customise our desktops, although not much of any value with which to customise them



This was as exciting and intuitive as file management got in Windows 3.1. Notice those old-school 8.3 character filenames

mostly got the resources they needed, and a central messaging system alerted them to hand over resources as and when they were needed, although not all Windows programs behaved as well as others. A Task List enabled you to see all the currently running programs and halt any that were gumming up the system, although the more likely outcome was that they would crash Windows first.

What's more, all of this went hand in hand with another major Windows feature. Windows already had the Dynamic Data Exchange (DDE) protocol, which allowed you to take messages and/or data from one Windows program to another. Windows 3.1 went one better with Object Linking and Embedding (OLE), which enabled you to embed an object created by one application into a document created by another, with both apps updating seamlessly when you made any changes.

WinG worked on a technical level, as proven by a WinG port of id Software's Doom

Suddenly, you could create a chart in Microsoft Excel and stick it in your Microsoft Word report, then update the data in Excel and see the changes rolled out in Word. I know. It doesn't sound that thrilling, but at the time, this rocked the computing world.

Last, but not least, Windows 3.1 gave the world the Windows registry. At the time, this central database of settings wasn't all that well known or understood, and we never felt the need to edit it directly as we would in the Windows 95 years. Still, it showed a willingness to gather vital system information and preferences in one place, rather than in a horde of SYS, INF and INI files, as had been the Windows way until this point.

CONFOUNDING ISSUES

Let's not heap too much praise on Windows 3.1; it still had its fair share of issues. One was that Windows still didn't support long filenames, so both files and directories were limited to names eight characters long, followed by a three-character suffix that told the OS what kind of file it was. This meant users became ingenious at truncating filenames, which in turn made looking through a folder full of documents or save games feel like decoding some esoteric text.

What's more, while Windows 3.1 had support for multimedia hardware, which was just about becoming affordable and available, ease of installation wasn't on Microsoft's list of priorities. Restrictive hardware didn't help – these were the days when solving hardware conflicts involved moving jumpers from pin to pin to swap Direct Memory Access channels. However, Windows 3.1 made the whole process of installing drivers for a CD-ROM drive and sound card as challenging as possible – it might take hours to get the whole setup running.

Networking wasn't any better either, because Windows 3.1 didn't have any built-in networking support. Instead, it piggy-backed on networking clients for the underlying MS-DOS operating system. If you hadn't already mastered Novell Netware or Microsoft LAN Manager, you were still going to have to get to grips with them here.

Nor was the Windows shell ideal. Simply finding a program in Program Manager could be daunting, especially if you weren't sure which folder or group held it. With screen space at a premium, you would have to constantly minimise and restore Windows while you looked. Don't even ask about finding files in File Manager.

Most of all, Windows wasn't a great platform for games. Dodgy drivers and the massive overheads involved in just running Windows itself made it much, much easier to run Wolfenstein 3D or The Secret of Monkey Island 2 in DOS, which Windows needed to run anyway and for which all Windows users had to pay. This also meant that getting games running still required tinkering at text editor level with a range of crucial system files, to the point that most PC gamers were on intimate terms with config.sys, himem.sys and autoexec.bat. Windows 3.1 didn't change this one bit.

With time, there was some movement. In 1994, Microsoft released a new API, WinG, which was designed to deliver faster graphics performance under Windows and encourage more developers to port their DOS games. WinG worked on a technical level, as proven by a WinG port of id Software's Doom. Yet it didn't work so well on the commercial level, with developers looking at the work involved and the existing DOS user base, then shrugging their shoulders until Windows 95 and DirectX came along.

Still, for all these faults, Windows 3.1 was a major leap in the right direction, paving the way not just for Windows 95, but for the switch from IBM and OS/2 towards Windows NT. Without that we might never have had the PC boom of the mid-1990s, Windows XP and everything beyond. And where would we all be without that? CPC

Readers' drives

Ikigai

Inspired by Japanese Kumiko woodworking, Nick Falzone made this exquisite wooden scratch-build with a custom hard-tube water-cooling system

SEE THE FULL PROJECT LOG AT custompc.co.uk/Ikigai

/MEET THY MAKER

Name Nicholas Falzone

Age 36

Occupation Bicycle technician

Location Alameda, California, USA

Main uses for PC Gaming, photo editing, 3D modelling and YouTubing

Likes Tools, whiskey and hiking

Dislikes Phone calls

CPC: What inspired you to build Ikigai – what were your design influences and what look were you trying to achieve?

Nick: I wanted to make a compact, scratch-built case with a clean look and a small desk footprint. As for the aesthetics, I really wanted to combine my love of Japanese woodworking and design with my new CNC machine's capabilities. I really wanted to incorporate Japanese Kumiko woodworking into the design and the wood choices were based on that decision.

The wenge wood that I used for the rest of the case has a modern look that helped contrast with the light-coloured Kumiko wood. I also wanted every aspect of the case to have a purpose, which helped to keep the case and wiring as clean as possible.

I chose the name 'Ikigai' firstly because I thought it sounded cool, plus most of my mods have Japanese names and I liked how the kanji (written characters) looked. The main reason, though, was because the term 'ikigai' means to find meaning in one's life and, for the months that I worked on this mod, this is mostly what I thought about and spent my time doing.

CPC: How did you go about planning and designing this build?

Nick: I'm not very good at sketching, but I did a couple of rough sketches before I took it to CAD. The Cooler Master Case Mod contest for which I made this case has size constraints (under 20 litres), so I really had to squeeze it all into a smallish envelope.

It turns out I'm not great at using CAD either, so I made several full-scale models of the case out of cheap wood to see how it would all fit together in real life. The case design changed a lot with these models, as nothing seemed to turn out in real life like it did in CAD. This process also helped me work on the CNC G-code.

CPC: Tell us about the basic chassis. What materials did you use, and how did cut and shape them?

Nick: The case is a full scratch-build. Most of the hardware is centred around a sandwich layout, with most of the wiring in the centre panel of the case. The centre is made out of acrylic and contains most of the guts of the wiring and lighting, plus it had a distribution plate for the water-cooling system built into it. This piece alone took a long time to get right, as there were many different parts of it and I hadn't made a distribution plate before.

I made several test iterations out of wood, which allowed me to check for fitment, check my G-code files and learn the process I would use to make the final product. The CNC mill does a lot of the work, but it still takes a lot of practice to anticipate any issues that might crop up with the manufacturing of the plate, and to optimise the order of operations.

In terms of layout, I have the I/O plate on the bottom. This is because I envisioned making a custom desk for this case, which will have a plate on the desktop to allow cables to be routed under the desk for a clean look. This also gave me the freedom to make the other sides of the case more decorative and in line with the rest of the case design.

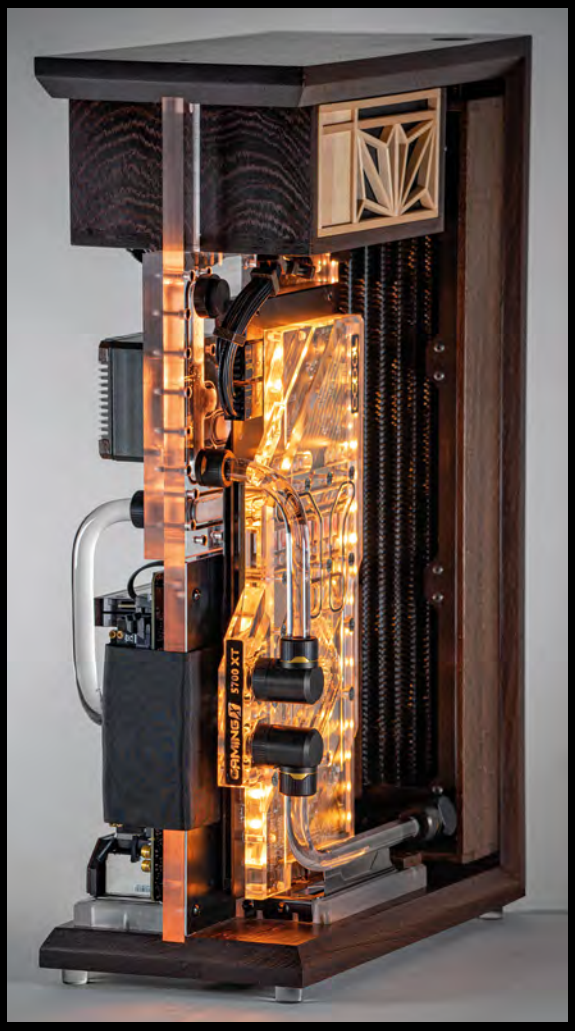
CPC: That's some amazing detail in front of the mesh on the front. How did you design the pattern and cut the wood to shape?

Nick: The pattern itself is a traditional Kumiko design that I'd wanted to make for years and this seemed like a great opportunity to use it. It's based on a grid, so I wanted to play with the scale of the 'flower' portion of the pattern and use two different sizes of the main element. I made the design in CAD to make sure I had the proportions right and, once this was close enough, I milled up the wood to several different thicknesses to make the Kumiko piece.

I used Sitka spruce for the wood and left it unfinished. I started with the main grid and cut each piece by hand using traditional hand tools and techniques. With the main grid done, I turned to the flower portion and made angled blocks, using a hand plane to get consistent angles on each piece. From there, I finished each piece and put them into place, using only a few drops of glue to keep it together.

CPC: There are so many wooden details scattered around the power connectors, heatsinks and so on. Are these also made from wood?

Nick: These are all made from scraps of the wood used for the main case. I wanted every aspect to tie into the case design down to



I remade the rest of the power cables using 16-gauge wire and custom cable combs

SYSTEM SPECS

CPU AMD Ryzen 5 5600X

GPU MSI Radeon RX 5700

Storage 1TB WD Black SN750 SSD

Memory 32GB G.Skill Ripjaws 3600MHz DDR4

Motherboard MSI B550I Gaming Edge WiFi

PSU Cooler Master 650W SFX

Cooling Alphacool GPU waterblock and radiator, Optimus CPU waterblock, EKWB fittings and tubing, Cooler Master SF360R fans

the smallest detail. I made most of the pieces with my CNC machine, usually making a couple of test pieces first. I made models of each piece in CAD, machined a test piece, then made the final piece out of the wenge wood. It was time-consuming but the details help to bring it all together.

CPC: Take us through the water-cooling loop – what parts did you use and how does it all hook up?

Nick: I used the distro plate to keep the loop as neat as possible, and because I didn't have a ton of space with which to work. It all starts at the pump mounted in the distro plate, which also acts as a small reservoir. It then heads to the CPU waterblock, then to the radiator, back around to the GPU block, and then back into the distro plate and pump.

I used an Alphacool GPU block and radiator, EK fittings and an Optimus CPU block. It took a lot of mocking up to get all the parts matched up cleanly with as few bends and fittings as possible. This was also my first loop using hard plastic tubing, so getting the bends right took a lot of practice.

I used EK PETG tubing with a 12mm outer diameter. I used a heat gun and a couple of inexpensive forms to do the bends, and I cut the tubing with a PETG tubing shear and sanded the ends even and smooth. To get the lengths and angles right was mostly a process of trial and error. I probably threw away as much tubing as I eventually used.

CPC: How did you plan the lighting?

Nick: I was going to go no-RGB with this build, since I didn't want to deal with routing all the RGB cables, but since the GPU block was going to have lights, I decided to add more. The fans I used from Cooler Master also have lights and only one cable, so they were easy to route.

There's a RBG hub in the acrylic behind the graphics card, where all the lighting cables connect to go to the motherboard header. I was unsure if lighting the distro plate was doable, but I used a very cool and small strip of RGB lights from Alphacool and put them into a slot in the plate to light it up. The beauty of the RGB lightings is that I can make them whatever colour I want – I just used orange for most of the photos since I liked the warmth it added to the wood.

CPC: The cable tidying is immaculate for an open-air build – how did you hide all the cables and route them so tidily?

Nick: The cable routing was a big deal for me, especially with little room to hide excess cables. I started by using as few cables as possible – there are only two cables for the fans and their RGB lights, and only two other RGB strips. The cables that came with the Cooler Master

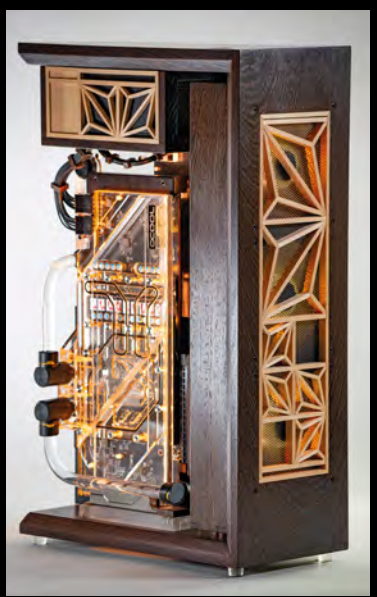
power supply were already great, and didn't have cable sheathing on them, making them thin already.

I used the 24-pin ATX cable as it came out of the box, but I remade the rest of the power cables using 16-gauge wire and custom cable combs. I used some space by the PSU to hide some cable slack, but there isn't much, since I cut the cables to length. I stashed the rest of the cables into the acrylic portion behind the graphics and next to the motherboard's 24-pin socket in the wenge cover plate area. Some of the cables took some creative soldering to get small enough to fit, but it all worked in the end.

CPC: Did you come across any difficulties?

Nick: The hardest aspects of the build process were dealing with the size constraints and the amount of time I had to finish the mod. I worked for around two months, almost every day, including nights after work, to get this case done by the contest deadline.

That would have taken a toll on me had I not been so excited about the project. The size constraint issues were mostly self-inflicted, but an extra centimetre here and there would have made my life a lot easier. I didn't have a lot of specific difficulties – the hardest part was staying the course and working on the same project every day to get the case done in time. The planning in the earlier stages really paid off as far as avoiding stressful situations with the build production itself.



CPC: How long did the build process take from start to finish?

Nick: Going from the first concept to the finished product took me around four months overall, but a lot of this time was spent on planning and design – the actual production time was pretty fast.

CPC: Are you happy with the end result, or do you wish you'd done some of it differently in retrospect?

Nick: I'm very pleased with how this case turned out. With the amount of time I took planning and designing every part down to the smallest detail, I was happy that the bigger picture of the case turned out to be cohesive too. I didn't have a master drawing or render of how the case was going to look – it was mostly just a design in my head, so it was a relief when I made it all work well.

I have made a couple of changes since I took the photos. I've upgraded the Radeon RX 5700 card to a GeForce RTX 3080, which resulted in a new loop being made for the GPU side, and new wiring for that side as well. The new card is a lot smaller than the first one, so fitting it took a lot more reworking than I'd planned. I also upgraded the 650W SX power supply to the 850W version, but luckily they use the same cables. I upgraded the riser cable too, but otherwise, the build is still the way I made it originally.

I wouldn't change much now, other than making more of a reservoir for the water-cooling loop. Getting the loop filled takes quite a while, and it got messy a couple times. Also, the on/off switch was an afterthought and I could have incorporated it better into the design. CPC

WIN CORSAIR HYDRO X WATER-COOLING GEAR

CORSAIR

To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (@**CustomPCMag**) or Facebook (**CPCMagazine**), or email low-res ones to **ben.hardwidge@raspberrypi.com**. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

WORTH £151

The Corsair Hydro X Series XD3 RGB Pump/Reservoir Combo features a high-performance DDC PWM pump, integrated RGB lighting and in-loop temperature sensor to drive even the most compact custom cooling systems. It has a high-performance Xylem DDC PWM pump controlled via PWM to deliver the perfect flow balance for your loop. There are also 16 individually addressable RGB LEDs, which light up the pump head to produce stunning, customisable lighting effects to match your build.

Corsair Hydro X Series XC7 RGB CPU Water Block

WORTH £70

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose a version for Intel or AMD CPU sockets.

Corsair Hydro X Series XR5 240mm Radiator

WORTH £55

The Corsair Hydro X Series XR5 240mm Water Cooling Radiator delivers extreme custom cooling performance, with a 30mm radiator thickness and premium copper core. Its dual 120mm fan mounts on each side are ready for your most ambitious custom cooling build, and its 25 micron-thick cooling fins offer a high thermal transfer rate.

JAMES GORBOLD / HARDWARE ACCELERATED

CACHE VS CLOCK SPEED

James Gorbold takes a look at AMD and Intel's differing approaches to boosting performance

This month marks the release of two new CPUs aimed squarely at the PC enthusiast readership of **Custom PC**. It's great to see AMD and Intel in true competition once again, although the two companies are on very different technology tracks, with little in common between their latest CPUs.

The first CPU out of the gates was Intel's Core i9-12900KS (see p16), a fine-tuned version of the 12900K, with a 200MHz higher base clock and 300MHz higher boost clock, if your motherboard, cooling and power supply are up to the challenge. This makes the 12900KS the fastest CPU on the block, although in a weird way, it actually feels a bit underwhelming, no doubt because the 12900K is such a damn fine CPU already, being the all-round champion in the vast majority of benchmarks. In effect, Intel is competing with itself.

The second CPU released this month is the AMD Ryzen 7 5800X3D (see p14). Like Intel's aforementioned new CPU, it's also based on an existing model, the 5800X. However, rather than chasing clock speed to increase performance, AMD has gone in a different direction to Intel with the 5800X3D, instead opting to massively scale-up the Level 3 cache.

Ryzen 5000-series CPUs such as the original 5800X already had a large 32MB Level 3 cache, but rather than redesigning the CPU from scratch with an enlarged cache, the 5800X3D has an additional 64MB of SRAM made from a separate wafer stacked on top of the CPU die, above where the existing Level 3 cache is located and connected via a bi-directional ringbus.

Given the branding name of 3D V-Cache, it's an ingenious way to add a tonne of extra cache to a CPU without a monolithic die and all the problems that would entail in terms of yields and cost. There is a downside though – the 3D V-Cache SRAM can't run at the high voltages normally used by the 5800X, so the 5800X3D's base and boost clock are respectively 400MHz and 200MHz lower than on the 5800X.

In the extensive testing carried out in Scan's 3XS lab, and from the reviews I've read, it's clear that the whopping 96MB of cache gives the 5800X3D a massive shot in the arm in games. Even at 2,560 x 1,440 or higher, where typically you don't expect to see much performance difference between CPUs, the 5800X3D really shines, with an average lead of 7 per cent over the 5800X and in some notable cases, such as Borderlands 3 and Far Cry 5, as much as 42 per cent.

> It shows that AMD is really onto something with 3D V-Cache

That's frankly a staggering achievement, and it shows that AMD is really onto something with 3D V-Cache. However, one downside is that the lower clock speed means the 5800X3D is on average 6 per cent slower than the 5800X in many non-gaming tasks, such as rendering and encoding, so if these sorts of tasks are important to you, it's not such a good choice.

However, despite its gaming credentials, I'm not sure the 58003XD makes a huge amount of sense. Yes, it delivers incredible gaming performance and, on that metric, puts AMD back into contention. However, when you're spending this much money, why would you not want the best CPU possible – not just the best at one sort of software? As such, the 5800X3D feels more like a proof of concept for 3D V-Cache rather than a well-rounded, really desirable product. However, it does bode extremely well for the future of CPUs, with increased competition leading to more innovation. CPC

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

G-MASTER™
#MONITORS4GAMERS
by iiyama

UNLEASH YOUR FULL GAMING POTENTIAL

Get the competitive edge you need to unleash your full gaming potential with the 24'' and 27'' G-Masters offering 0.8ms MPRT and 165Hz refresh rate. Armed with FreeSync Premium you can make split second decisions and forget about ghosting effects or smearing issues. The ability to adjust brightness and the dark shades with the Black Tuner delivers greater viewing performance in shadowed areas and the IPS panel technology guarantees superb image quality.

165 Hz | FAST IPS | 0.8ms MPRT | BLACK TUNER | HDMI DISPLAY PORT | USB HUB

Fixed stand versions:
24'' G2470HSU-B1 & 27'' G2770HSU-B1

Version with height adjustment:
24'' GB2470HSU-B1 & 27'' GB2770HSU-B1

Find your match at
gmaster.iiyama.com

XS SYSTEMS

4K gaming done right

Spec up your perfect PC today

scan.co.uk/3xs · 01204 47 47 47

SCAN