

BUDGET LIQUID COOLING 9 120MM CPU COOLERS REVIEWED

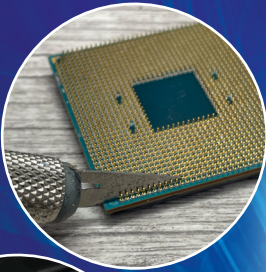


CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 223

50 TIPS TO BUILD A BETTER PC

► FIT HARDWARE ► USE THE RIGHT SLOTS AND CONNECTORS ► SET UP YOUR GEAR
► POSITION FANS ► TIDY CABLES ► MAKE YOUR PC COOL AND QUIET ► AND MORE



SCREEN TEST
+ VA GAMING MONITOR LABS TEST

HOW TO
+ SPRAY-PAINT RIGID TUBING
+ MOUNT YOUR GRAPHICS CARD VERTICALLY

APRIL 2022 / £5.99



RACE AHEAD BUILD THE ULTIMATE DRIVING SIM



AGON

BY AOC



THE NEW GAMING UNIVERSE
CHOOSE YOUR POWER

CU34G3S | AG493UCX2 | AG254FG

AVAILABLE AT

amazon **ebuyer**



AGONBYAOC.COM

[@aoc_gaming](#) [@aocgaming](#) [@aocgaming](#)

Welcome

Custom PC Issue 223

/ FROM THE EDITOR

Tipping point

When you've been mucking about for PCs as long as we have (and in my case that's longer than I really want to think about), you accumulate a veritable bank of tips and tricks that prepare you for the future. You learn from your mistakes, other people pass on their wisdom to you and you get better at PC building as you go.

Sometimes you make a mistake and think 'I really wish I'd known that before I started', or 'why did no one tell me that?!' Here's a confession from a PC veteran who's been fiddling with the insides of computers for years – after being accustomed to Intel's LGA sockets for many years, I made a big slip-up when I moved over to AMD's AM4 socket a few years ago.

I tested my Ryzen 7 2700X with the stock cooler first, then removed the cooler, so I could fit my waterblock and noticed that my new CPU was stuck to the contact plate, with a row of bent pins that I had to straighten out again. It was a rookie mistake borne out of a lack of recent experience with AMD CPUs, and it could have been avoided if I'd had this month's feature to hand (see p70).

If you're upfront and honest with other PC enthusiasts, you'll find people have made all sorts of mistakes. Another common one is leaving the plastic film on your CPU cooler's contact plate, so it doesn't make thermal contact with the CPU. Most of us have done it at some point.


It's easy to take your accumulated knowledge for granted, and you'd be surprised how much you can learn from other people's experience. It might be easy enough to put an SSD in an M.2 slot, and fit a fan to a case, but knowing which slot and fan mount to use, and which way round to mount your fan, isn't always obvious.

That's why we've devoted this month's lead feature to passing on some of the advice that has made life easier for us over the years – tips that aren't always in instruction manuals or build guides, but that you'll be glad you know when it comes to your next build.

We'd also be really interested in hearing some of your tips for PC building. Send them to us at custompc@raspberrypi.com, and we'll print the best ones. **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

Andy Vandervell, Gareth Halfacree,
James Gorbould, Mike Jennings,
Phil Hartup, Richard Swinburne,
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, Olivia Mitchell

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 223



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.

ISSUE 223 SUBSCRIBERS EDITION



DON'T TRY THIS AT HOME The information in this magazine is given in good faith. Raspberry Pi Ltd cannot accept any responsibility for loss, disruption or damage to your data or your computer that may occur as a result of following or attempting to follow advice given in the magazine. If things do go wrong, take a break.



When you have finished with
this magazine please recycle it.



Contents

Welcome to Issue 223

Highlights

08 Broken promises

Richard Swinburne laments the lacklustre announcements regarding AMD's latest and last round of AM4 desktop CPUs.

10 Facebook fears

Tracy King turns a sceptical eye on Facebook's vision of the metaverse.

16 MSI MPG Z690 Carbon EK X

MSI's ludicrously expensive new motherboard includes a custom-built waterblock that cools the CPU, VRMs and an M.2 SSD.

18 Thermaltake Toughair 310

Cheap but effective, Thermaltake's new CPU cooler is ideal for lower and mid-range CPUs.

20 LG Ultragear GP9

LG has entered the PC speaker market with an intriguing and pricey Bluetooth soundbar.

22 HP Omen 16

HP's new all-AMD powered gaming laptop houses an excellent screen and is surprisingly affordable.



34 120mm AIO liquid coolers

Antony Leather puts a whopping count of nine all-in-one liquid coolers to the test.

44 VA gaming monitors

Prized for their high contrast ratio, Edward Chester tries out five of the latest VA gaming monitors.

64 Forza Horizon 5

Rick Lane thinks the latest instalment in the Forza series is perhaps its best yet.

66 Call of Duty: Vanguard

The latest addition to the CoD series sees players return to the WWII setting. Is there anything of meaning left to explore?

70 50 tips to build a better PC

Take your PC building skills up a notch with our tips to speed up, cool down and quieten your machine.

82 Sim racing rig buyer's guide

Find out all the information you need to take your virtual racing to the next level.

88 Mouse modding

Learn how to change switches, shed some of your mouse's weight or just add some style to your mouse with our modding guide.

102 How to

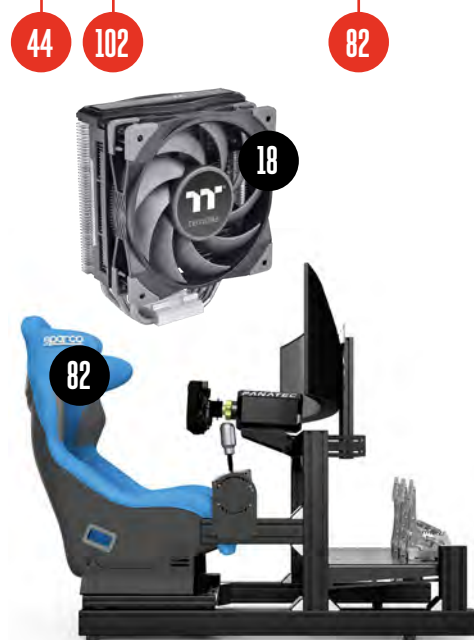
Learn how to spray-paint your rigid water-cooling tubing and mount your graphics card vertically.

110 Readers' drives

Steve Grever's touch-screen-equipped PC features a load of custom 3D-printed parts.



Cover guide



Regulars

- 3 From the editor
- 8 Richard Swinburne
- 10 Tracy King
- 12 Incoming
- 30 Custom kit
- 54 How we test
- 56 Elite products
- 62 Inverse look
- 68 Reality check
- 94 Hobby tech
- 100 Customised PC
- 102 How to guides
- 107 For the win
- 108 Retro tech
- 110 Readers' drives
- 114 James Gorbald



Reviewed



MOTHERBOARDS

- 16 MSI MPG Z690 Carbon EK X

CPU COOLERS

- 18 Thermaltake Toughair 310

PC SPEAKERS

- 20 LG Ultragear GP9

MICROPHONES

- 21 NZXT Capsule

GAMING LAPTOPS

- 22 HP Omen 16

PC SYSTEMS

- 26 PC Specialist Magnus Supreme
- 28 AlphaSync iCUE Gaming PC

Custom kit

- 30 Tile Mate 2022
- 30 Perfect Part Thumbstick Caps
- 30 Nobo Desktop Whiteboard
- 31 Havit Headset and Phone Stand
- 31 Luminoodle Click

120mm AIO CPU cooler Labs

- 35 Aerocool Pulse L120F
- 36 Antec Neptune 120 ARGB
- 37 be quiet! Silent Loop 2 120mm
- 38 Corsair iCUE H60i RGB Pro XT
- 39 Deepcool Gammaxx L120 V2
- 40 EK AIO 120 D-RGB
- 41 GameMax Ice Chill 120 ARGB
- 42 NZXT Kraken 120
- 43 SilverStone PF120 ARGB

VA gaming monitor Labs

- 45 AOC CQ27G3SU
- 46 BenQ Mobiuz EX2710R
- 47 Gigabyte G27FC
- 48 MSI Optix MAG322CQR
- 49 Samsung Odyssey G5 LC27G55TQWRXXU

Games

- 63 Age of Empires 4
- 64 Forza Horizon 5
- 66 Call of Duty: Vanguard
- 67 Exo One
- 68 Warhammer: Age of Sigmar - Tempestfall

Hobby tech

- 94 Bangle.js 2
- 98 Crackers II: The Data Storm

**Infinity 129 DDR5**

Intel® Core™ i9-12900K

NVIDIA® GeForce®
RTX 3080 TI 12GBFROM
£3599**Infinity X119**

Intel® Core™ i9-10900K

NVIDIA® GeForce®
RTX 3080 10GBFROM
£2399**Infinity X127**

Intel® Core™ i7-12700KF

NVIDIA® GeForce®
RTX 3070 TI 12GBFROM
£1999**Infinity X125**

Intel® Core™ i5-12600KF

NVIDIA® GeForce®
RTX 3060 TI 8GBFROM
£1499**Infinity X105 Elite**

Intel® Core™ i5-10400F

NVIDIA® GeForce®
GTX 1660 SUPER 6GBFROM
£949**TRACER V LITE i15L**

Intel® Core™ i7-1165G7



Intel® Iris® Xe Graphics

FROM
£1099

CYBERPOWERPC



WWW.CYBERPOWERSYSTEM.CO.UK



**5 Year
Warranty**



**Free UK
Delivery**



**Next Day
Delivery**



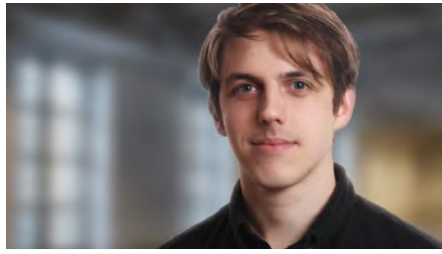
**Award
Winning PCs**

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.





RICHARD SWINBURNE / VIEW FROM TAIWAN

IS THAT IT, AMD?

Richard Swinburne is nonplussed by AMD's announcements at CES, with just one desktop AM4 chip seemingly planned for this year

I got in a real grump at AMD's CES announcements last month. It released 20 new Ryzen 6000-series APUs for laptops, but for desktop users, the promise of new '3D V-Cache' CPUs has been whittled down to a single chip: the Ryzen 7 5800X3D. Arriving sometime in the spring, this 8-core chip is probably the last AM4 CPU we'll see before AMD brings in its new AM5 socket.

AMD even admitted that the claimed 15 per cent performance gains were pretty much exclusive to gaming, and that most other workloads, such as productivity, won't see similar benefits. It also didn't announce the price, and it looks like there's a reason for that.

Over the following days, AMD's chief architect of gaming solutions & marketing, Frank Azor, stated in an interview that 'V-Cache is an expensive technology', implying that the 5800X3D isn't going to be cheap. Unfortunately, that's the reality of this *really* leading-edge packaging technology, which mates silicon directly to silicon. It will undoubtedly have yield issues, and it will demand extra silicon while there's a shortage. In that respect, it's better to have lots of stock of one chip design than hardly any stock of several designs.

However, I still feel sour because that one expensive chip is all us desktop AM4 users are now getting. A year and a half after launching Zen 3, there's still no follow-up to the epic Ryzen 5 3600, and there are no Ryzen 3 options to challenge Intel's new Core i3-12100. AMD has completely abandoned the affordable market whose users helped to keep it going in hard times.

I also raised an eyebrow at AMD's claim that AM5 will be a 'long lived socket', given that boards based on AM4 B350 and X370 chipsets are locked out from using Ryzen 5000-series

CPUs. You can probably assume that Zen 3 Threadripper won't be happening either.

AMD is now clearly focusing on its new AM5 platform, with its launch date seemingly moved forward from late 2022 to only the 'second half' of 2022. In addition, in another follow-up interview, David McAfee, corporate VP and GM of AMD Client Channel Business, stated that AMD's new 'Rembrandt' chip, which forms the backbone of its new Ryzen 6000-series APUs for laptops, will eventually come to desktops later this year in an AM5 package.

The interview also states that the introduction of AMD's AM5 platform is dependent on the supply and price of DDR5 memory, which feels a bit up in the air for such an important launch. It relies on the expectation that the price and supply of DDR5 memory will have smoothed out by the middle of the year. However, the memory market is volatile and the shortage of essential power management chips required by each DDR5 DIMM is still ongoing.

Zen 4 does look exciting, but why would anyone buy an AMD CPU in the next six months? AMD currently only has a few expensive and now-uncompetitive CPUs with a redundant socket. Comparatively, Intel's fast and well-priced Alder Lake CPUs have a motherboard ecosystem that supports both DDR4 and DDR5 memory, and will also support Intel's 13th-gen CPUs.

AMD has had a year and a half to refresh its Ryzen desktop line-up, a feat that it's achieved twice for its laptop CPUs in that period. After years of languishing, AMD's revenue now puts it in the top ten of fabless semiconductor companies, so it should have the resources to focus on both laptop and desktop products at once. **GPC**

There's still no follow-up to the epic Ryzen 5 3600

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 [@Bindibadgi](#)



GET THE ULTIMATE PLAY WITH NVIDIA'S
LATEST RELEASE. THE RTX 3050.



SCAN HERE TO VIEW SYSTEMS

THE ULTIMATE PLAY

GEFORCE RTX™ 3050

AVAILABLE IN STORMFORCE PRE BUILT PC'S,
OR CONFIGURE YOUR OWN!

www.stormforcegaming.co.uk

contact the sales team today

T: 01925 287 008 sales@stormforcegaming.co.uk



Finance
options available



Built in
the UK



Rated 'Excellent'
on Trustpilot



Free UK
delivery



3 year Full Parts &
Labour Warranty



@stormforcegaming



@wearestormforce



@stormforcegaming



TRACY KING / SCEPTICAL ANALYSIS

METaverse AND WORSE

The metaverse is the big buzzword at the moment, but Tracy King is sceptical about Facebook's vision of the future

The metaverse is coming, or is already here, or was here and was called Second Life but isn't here anymore, depending on how you define 'metaverse'. I wish I could be excited, because I'm not afraid of new things and most technology – including Facebook – has improved my life. However, I haven't yet seen anything metaverse-related that gives me hope. It's all a bit Black Mirror adjacent.

The main concern is that the biggest player in whatever the metaverse turns out to be (online connected 3D virtual world, or just a buzzword intended to reassure shareholders) is Facebook. While the other internet behemoth Google at least started out with the motto 'don't be evil', Facebook's origins were a tad more unwholesome, with Zuckerberg's website for rating the 'hotness' (or notness) of people on campus setting the tone.

At its core, Facebook is a set of crude buttons. Hot or not, love or hate, agree or disagree. The degree to which we can be manipulated into pressing those buttons is debatable (the woollier claims, for example that Facebook is bad for mental health, can be countered by research that shows Facebook can also be good for it), but that debate is overshadowed by more provable harms.

Facebook has been accused of tax avoidance, privacy violations, censorship and government surveillance. That doesn't necessarily make Facebook's existence a net negative, but it's what stops me seeing the metaverse as potentially exciting. I just don't trust the company with any more involvement or influence in my life.

But perhaps the point is moot. While everyone and their bottom line is trying to jump on the bandwagon (when announcing the acquisition of Activision Blizzard for \$68.7 billion, Satya Nadella, Microsoft's chair and chief executive,

said gaming 'will play a key role in the development of metaverse platforms'), Zuckerberg's vision of the metaverse relies on a successful marriage of physical tech with digital culture, and that won't happen if the physical tech is a virtual reality headset.

For a start, up to half of the population experiences motion sickness in VR. While the effect is stronger for certain games and motions, it's still a significant enough problem that many people won't be able to participate. Then there's the 'one size fits all' problem, in which tech manufacturers design for a physical average (sometimes, only a male average), which further excludes a significant chunk of the population.

Then there are the logistics of cutting yourself off from the world for a meeting, which won't fit in with the working from home model to which many are now accustomed, particularly where there might be children in the house, so there's no possibility of popping into VR to work.

Then there are people with disabilities that mean they can't use VR – accessibility is still terrible in the 2D online world; I can't imagine it suddenly being a priority for the metaverse. Plus there are many people who just don't like wearables, object on political or privacy grounds, or who feel claustrophobic and simply won't do it.

Disney just patented a type of virtual world simulator called Simultaneous Localization and Mapping that doesn't require a headset or goggles, but it's tied to a large physical environment through which the participant travels (so, a theme park ride) and as far as I can tell, isn't going to result in headset-free domestic 3D, which is what will be needed. When it comes to Facebook's vision of the metaverse, I just don't see it. **GPG**

For a start, up to half of the population experiences motion sickness in VR



EYE- OPENER

new LIGHT WINGS

Impressive Lighting, Superior Cooling

The difference to conventional LED fans will open your eyes. The first be quiet! fans with ARGB lighting set the bar higher. No need to choose between strong performance, impressive illumination, or quietness, when you can have it all. Available in different versions to meet every need.

- ARGB LED ring at the front and rear
- Available in 120mm and 140mm
- Triple Packs with ARGB hub included
- Easy synchronisation via motherboard software

Available at:

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

be quiet![®]

Incoming

When's the next issue out?

CUSTOMPC

Issue 224

on sale Thursday, 3 March



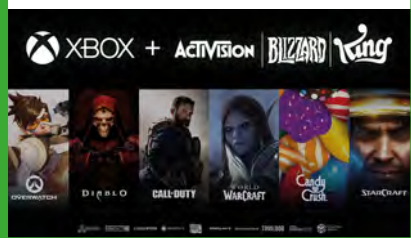
Letters

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

MICROSOFT PLANS TO BUY ACTIVISION BLIZZARD

Microsoft has announced its intention to buy games firm Activision Blizzard in a deal worth \$68.7 billion US (around £50.4 billion). The move follows Microsoft snapping up a number of other high-profile game publishers and developers, from titans such as Bethesda to quirky indie developers such as Double Fine. It's a strategy that's enabled the firm to add many high-profile titles to its Game Pass services, which are available to Windows and Xbox gamers for a subscription fee.

Activision Blizzard publishes a number of high-profile game franchises, including Call of Duty, Overwatch, Warcraft and Diablo, as well as the highly popular Candy Crush. 'We want to make it easier for people to connect and play great games wherever, whenever and however they want,' said Microsoft chairman and CEO Satya Nadella in an email to employees.



AMD OUTLINES NEW DESKTOP CPUS

AMD kicked off 2022 by demonstrating one of its Zen 4 CPUs in action at an online briefing for the Consumer Electronics Show (CES), claiming that all the CPU's cores were running at 5GHz.

AMD says the first Zen 4 chips (pictured) will be launched in the second half of this year, and will be fabricated on a 5nm process. The company also confirmed that its Zen 4 platform will support the PCI-E 5 interface and DDR5 memory, bringing it into line with Intel's Alder Lake chips.

In addition, Zen 4 sees AMD finally moving its consumer desktop CPUs to a land grid array (LGA) socket, rather than having pins on the CPU. Socket AM5 will feature 1,718 pins and will also be compatible with Socket AM4 coolers.

There's also going to be a last outing for the Zen 3 architecture on the desktop, with AMD confirming that its first CPU to feature its 3D v-cache tech will be launched in spring this year. The Ryzen 7 5800X3D will feature eight SMT-enabled cores, a maximum boost clock of 4.5GHz and a whopping 96MB of L3 cache, compared to 32MB on the current Ryzen 7 5800X.



CORSAIR ONE GETS ALDER LAKE UPDATE

Corsair has updated its One series of mini-ITX PCs to feature Intel's latest Alder Lake platform. Based on Corsair's acclaimed 12-litre custom-designed One chassis, the Corsair One i300 can be loaded with up to 64GB of Corsair Vengeance DDR5 memory, and can also come equipped with a top-end Core i9-12900K and GeForce RTX 3080 Ti GPU. It's not cheap, though, with that spec costing £4,400 inc VAT from [corsair.com](https://www.corsair.com)



PHILIPS

Monitors

get in the **moment**

innovation  you



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

4K
Ultra HD

 **VESA CERTIFIED**
DisplayHDR™ 400


UltraWideColor


Adaptive Sync

Available at:

amazon

ebuyer.com

SCAN

NVIDIA ANNOUNCES RTX 3050 AND 3090 Ti

Nvidia has lifted the lid on two new GPUs based on its Ampere architecture, sitting at opposite ends of the price scale. At the cheaper end is the new GeForce RTX 3050 that, like the Radeon RX 6500 XT, only comes with 4GB of GDDR6 memory and only runs at 1750MHz (14GHz effective). However, it's also attached to a 128-bit memory interface, giving it a total memory bandwidth of 224GB/sec.

Unlike the budget Radeon, the GeForce RTX 3050 also uses a full 16x PCI-E 4 interface, so its performance won't be significantly reduced if you use it on a PCI-E 3 setup. Meanwhile, the GPU itself features 18 Streaming Multiprocessors, giving it 2,304 Nvidia CUDA cores and 18 RT cores for ray tracing, along with 72 Tensor cores. The reference boost clock for the GPU is 1740MHz.

At the other end of the scale is the new GeForce RTX 3090 Ti (pictured), which finally enables all 84 of the Streaming Multiprocessors on Nvidia's GA102

Ampere GPU, giving it 10,752 CUDA cores, 84 RT cores and 336 Tensor cores.

It also has 24GB of GDDR6X memory running at 1325MHz (21.2GHz effective) attached to a 384-bit memory interface, giving it a total memory bandwidth that passes the 1TB/sec barrier at 1,018GB/sec. Comparatively, the RTX 3090 has

82 Streaming Multiprocessors, giving it 10,496 CUDA cores, and it has a total memory bandwidth of 936.2GB/sec.

No release date has been announced for the RTX 3090 Ti yet, but the RTX 3050 should be out by the time you read this. We hope to get a sample in for review in our next issue.



ASROCK LAUNCHES RAZER-BRANDED Z690 BOARD

ASRock and Razer have collaborated in order to create a Razer-branded Z690 motherboard. The ASRock Z690 Taichi Razer Edition natively integrates Razer's Chroma RGB lighting system, with lighting emanating from the I/O panel shroud, the chipset heatsink and from under the right-hand edge of the board.

This enables the lighting to be controlled by Razer's highly flexible Synapse software, so you can synchronise it with other Razer devices. The motherboard also features several additional ARGB headers, to which you can connect strips that can be controlled by Synapse too.

Other features include support for up to 6400MHz DDR5 memory, two Thunderbolt 4 USB Type-C ports, Realtek ALC1220 audio, Killer 2.5 Gigabit Ethernet, 802.11ax Wi-Fi and support for two PCI-E 4 M.2 SSDs.

AMD LAUNCHES BUDGET RDNA2 GPU

AMD has just released a new cut-price GPU based on its RDNA2 architecture. That cut-down price also accompanies a seriously cut-down spec though. Based on AMD's 107mm² Navi 24 GPU, the Radeon RX 6500 XT has just 16 compute units, giving it 1,024 stream processors and 16 accompanying Ray Accelerators.

Its memory system is also limited, with just 4GB of 2250MHz (18GHz effective) GDDR6 memory attached to a tight 64-bit memory interface, resulting in a total memory bandwidth of just 144GB/sec. There's 16MB of AMD's Infinity Cache to potentially help performance here, but that's still a limited spec.

Potentially compounding the GPU's performance further, Radeon RX 6500 XT cards also only have a 4x PCI-E 4 interface, which shouldn't be an issue if you have a PCI-E 4 CPU and motherboard, but could

severely hamper performance on PCI-E 3 setups, such as Zen 3 CPUs installed in X470 motherboards, or Intel Comet Lake platforms, as it would only be able to use four PCI-E 3 lanes.

The cards launched on 19 January at prices starting from £179 inc VAT, but the initial round of stock soon sold out, and cards are now already going for around £400 on eBay. AMD wasn't able to get us a sample in time for us to test in this issue, but we hope to get hold of one for testing soon.





Chillblast

CUSTOM BUILT

PCs

Get the Perfect PC for your needs and budget.



Anything you dream of

Choose from our pre-made specifications, use our website or speak to our friendly team to build the perfect computer for your needs. Something quiet and simple? Or something bright and powerful, we cater for all needs.



Complete Support

Our PCs are hand-built in our UK facility, come with Windows 10 pre-installed and are rigorously tested to ensure the utmost reliability. Backed by our industry leading 5-year warranty and lifetime access to our support staff, you're in good hands.



Finance Available



Free UK delivery



5 year warranty



Lifetime-Support



Trustpilot

Rated 'Excellent'

Call our sales team on: 01202 068 333

www.chillblast.com

Reviews

ATX Z690 MOTHERBOARD

MSI MPG Z690 CARBON EK X / £625 inc VAT

SUPPLIER scan.co.uk

We've looked at previous collaborations between MSI and waterblock manufacturer EK before, and while they might seem like they spoil the fun of picking your own components, they can save you money and hassle. The MSI MPG Z690 Carbon EK X is the latest pairing of the two, including an MSI MPG Z690 Gaming Carbon WiFi motherboard that's been stripped of its VRM heatsinks ready for water cooling.

An EK monoblock is included, which has been beefed up compared with previous models to cool the SSD in the top M.2 port, as well as your CPU and VRMs, using a single inlet and outlet. You'll need to fit this block yourself, cutting thermal pads to size, applying thermal paste and securing it using the included mounting kit. This will take an hour or two, but it's fairly straightforward and easier than usual, as the heatsinks have already been removed.

The waterblock isn't available separately yet, but with existing models fetching upwards of £180, the addition of M.2 cooling will probably push the price towards £200 or more. Considering the motherboard on its own retails for around £420, you're saving money compared with buying the bits separately, as long as the board retails for £625 or less.

Also in the box is EK's leak tester, which retails for around £30. This can be connected to a port on your loop, allowing you to use the pump to add pressure, with any leaks revealed by a drop in pressure on the gauge. It's a great way to spot leaks before they happen, either due to faulty components or loose fittings.

The mounting mechanism is fairly basic, especially compared with EK's recent blocks such as the Velocity 2, and you'll need to fit it



outside your case. We found it easiest to put the waterblock face down on a flat surface and place the motherboard onto it, securing it from above. The waterblock itself looks fantastic, with an integrated flow indicator and channels that run around the block cooling the VRMs, CPU and M.2 SSD, with your coolant visible through the clear top.

RGB lighting is also integrated, via a 3-pin digital connector. The lighting is visible whether you use clear or opaque coolant, although pastel-type coolants will tone it down, as they absorb light. The MSI dragon logo and Carbon EK X text on the lower heatsink are also illuminated, but the waterblock hogs most of the limelight.

Despite being a premium Z690 board and using DDR5 memory, this motherboard's water-cooled M.2 port only offers PCI-E 4 support, with the only PCI-E 5 slots being the two 16x PCI-E slots. Still, it's not like PCI-E 5 SSDs are readily available right now anyway. There's no shortage of M.2 ports either, with a further three PCI-E 4 M.2 ports and one of the PCI-E 3 variety under massive heatsinks. The water-cooled slot is where you'll want to put your SSD for the best cooling though – our water-cooling system kept it at a chilly 33°C under load, while the VRMs were equally cool at 38°C.

Meanwhile, audio is provided by the latest Realtek ALC4080 codec, there's a 2.5Gbps Intel network controller and 802.11ax Wi-Fi is included too. The rear I/O panel is

SPEC

Chipset

Intel Z690

CPU socket

Intel LGA1700

Memory support

4 slots: max 128GB DDR5 (up to 6666MHz)

Expansion slots

Two 16x PCI-E 5, one 16x PCI-E 3

Sound

8-channel Supreme FX 7.1 Realtek ALC4080

Networking

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

Form factor(s)

Mini-ITX

Cooling

Eight 4-pin fan headers, CPU, VRM and M.2 waterblock

Ports

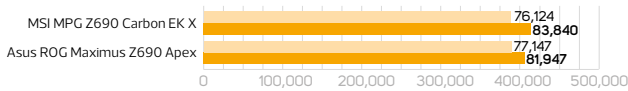
6 x SATA 6Gbps, 4 x M.2 PCI-E 4, 1 x M.2 PCI-E 3, 5 x USB 3.1 Type-A, 4 x USB 2, 1 x USB Type-C, 1 x USB 3.1 Type-C header, 1 x LAN, 3 x surround audio out

Dimensions (mm)

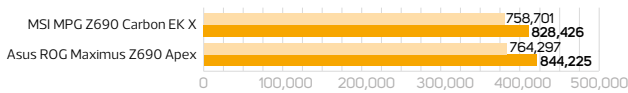
305 x 244

BENCHMARK RESULTS

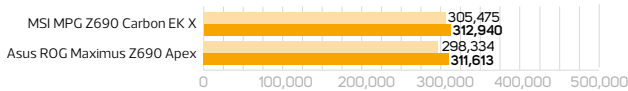
GIMP IMAGE EDITING



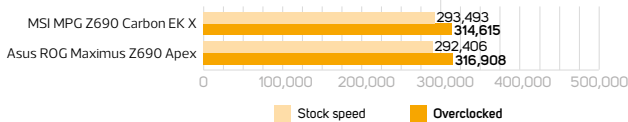
HANDBRAKE H.264 VIDEO ENCODING



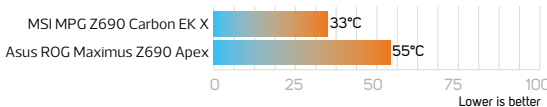
HEAVY MULTI-TASKING



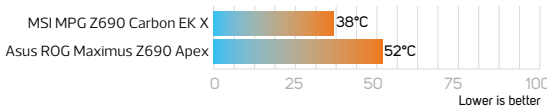
SYSTEM SCORE



LOWEST M.2 TEMPERATURE

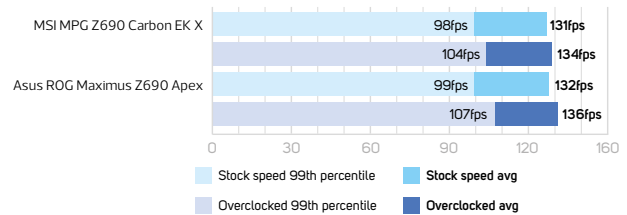


LOWEST VRM TEMPERATURE



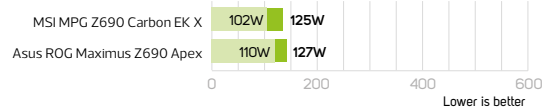
FAR CRY 6

1,920 x 1,080, Ultra settings

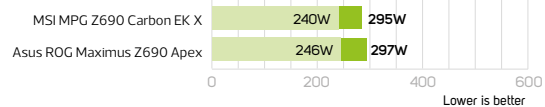


TOTAL SYSTEM POWER CONSUMPTION

Idle



Load



bristling with ports as well, including nine Type-A ports for typical devices, USB Type-C and the full complement of audio outputs. There aren't many overclocking and testing tools, though, with just a USB BIOS FlashBack button and LED POST code display, which is a shame given the cooling potential on offer.

Finally, MSI's EFI's have been top-notch for a while – we love the clear, simple layout and excellent fan control suite. The latter allows you to switch between sources for fan control, and customise each fan header with its own fan response curve. The same can't be said of MSI's software, though, which feels clunky and slow.

Performance

The MSI's audio performance was good, although not exceptional, with a noise level of 108dBA and dynamic range of 107dBA, and a low total harmonic distortion (THD) of 0.0015 per cent, but most will struggle to tell any difference between these numbers and those of the best Z690 boards we've tested, with ALC1220 codecs.

Overclocking was simple, with a vcore of 1.36V needed to hit 5GHz on our Core i5-12600K's P-Cores and 4GHz on

the E-Cores, which was the same as we needed with the MSI MPG Z690 Gaming Carbon WiFi. This saw the system score rise from 293,493 to 314,615 and the multi-threaded Cinebench test from 17,444 to 19,322.

Conclusion

There's no getting away from the fact that spending more than £500 on a motherboard is going to make most people's wallets squeal. However, if you're aiming to water-cool your CPU anyway, this is an excellent way to go about it.

You get a motherboard primed for water cooling, a great-looking waterblock that cools not only your CPU and VRMs, but an M.2 SSD as well, and the whole package costs noticeably less than buying the parts separately. If you want to water-cool your Z690 system, the MSI MPG Z690 Carbon EK X is a great starting point.

ANTONY LEATHER

VERDICT

Nearly everything you need to water-cool your shiny new 12th-gen Intel CPU and plenty more besides.

CARBON FIBRE

- + Cools CPU, VRMs and SSD
- + Superb M.2 and VRM cooling
- + Looks fantastic

CARBON FOOTPRINT

- High price
- DDR5 only
- Not many overclocking and testing features

CPU AIR COOLER

THERMALTAKE
TOUGHAIR 310 / £35 inc VAT

SUPPLIER scan.co.uk

SLOW-COOKED RIB

- + Good cooling for the price
- + Excellent build quality
- + Quiet fan

TOUGH MEAT

- Can't cope with Core i9-12900K
- No way to install a second fan
- Mounting mechanism needs double checking

SPEC

Intel compatibility
LGA1700, LGA115x, LGA1200

AMD compatibility
Socket AM4, AM3/+

Heatsink size with fan (mm)
124 x 97 x 160 (W x D x H)

Fans
1 x 120mm

Stated noise
24dBA

Even the cheapest all-in-one liquid coolers often can't compete with air coolers when it comes to price, and if you only need to cool a low to mid-range CPU, a decent air cooler should do the job fine. With an asking price of £35 inc VAT, Thermaltake's new Toughair 310 isn't the cheapest CPU air cooler we've seen, but this price is typical for a tower-shaped cooler with a 120mm fan.

That price buys you decent build quality as well. The Thermaltake's heatsink is solid, well made and features an elegantly shaped, well-spaced stack of fins, and a plastic shroud sits on the top, rather than exposing the bare metal heatsink. It looks smart and continues to do so once the fan has been installed.

The fan has a unique and simple way of mounting on the heatsink as well – it secures to two plates with standard fan screws, and these plates then clip to the heatsink. It's a more involved process than some air cooler designs we've seen, but once the plates are secured to the fan, installing and removing it takes seconds. That's just as well too, as you'll need to remove the fan to get at the cooler's mounting mechanism. Sadly, though, there's no way to add a second fan in a push-pull configuration.

As the heatsink is so slim, there's plenty of clearance for your memory next to the CPU socket, but its height sits at a fairly typical 160mm, so you won't be able to squeeze this cooler into some height-limited cases. At full speed, the fan is fairly potent, running at 2,000rpm, but the wide-spaced fins on the heatsink won't provide much resistance and lean towards improving performance at lower fan speeds.

Meanwhile, the mounting mechanism is compatible with Intel's new LGA1700 socket out of the box, and the mounting mechanism is simple and hassle-free to use too. Pins

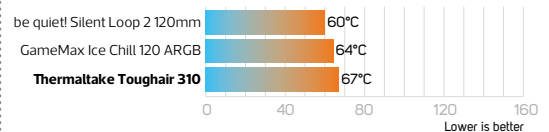


pass through a backplate, which holds them in place, so installing the cooler without removing your motherboard should be possible. Supports sit under a mounting plate on the CPU socket side, with our only complaint being that the thumb nuts that secure the plate to the supports were occasionally tricky to tighten fully.

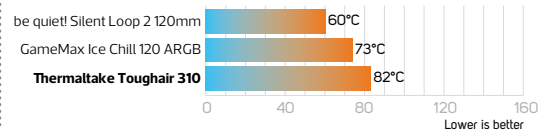
Our AMD system with an overclocked Ryzen 7 5800X sat at a CPU delta T of 67°C with the Thermaltake cooler,

TEMPERATURE RESULTS

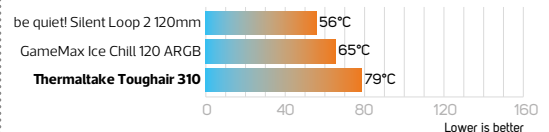
AM4 DELTA T



LGA1700 P-CORE DELTA T



LGA1700 E-CORE DELTA T



which was a few degrees warmer than most of the 120mm AIO liquid coolers we tested this month, but it was noticeably quieter at full speed too. It even managed to beat the Corsair iCUE H60i RGB Pro XT at its quiet fan speed setting.

Our Core i9-12900K proved too much for it, though, with the stock speed CPU hitting 100°C before the end of our stress test and starting to throttle. It was happy outside of a full-load test, but pushing all 16 cores to their limits for extended periods was beyond the limits



of this slim heatsink with its limited number of fins. The Thermalright coped okay with our Core i5-12600K, though, with the P-Cores sitting at an average of 76°C, equating to a delta T of 58°C.

Conclusion

A single 120mm fan and slim heatsink isn't going to cut it against monster CPUs such as the Core i9-12900K, where the Thermalright Toughair 310 got too toasty in our full-load stress test. However, as our additional test proved, it was more than able to cool the Core i5-12600K with room to spare for a modest overclock, plus it boasts excellent build quality and a reasonably quiet fan. As long as you're not cooling a high-end CPU with loads of cores at high clock speeds, this is a decent cooler for a reasonable price.

ANTONY LEATHER

VERDICT

A great air cooler for mid-range CPUs, but it struggles with high-end models.



LGA1700	Socket AM4
COOLING 26/40	COOLING 30/40
FEATURES 16/20	FEATURES 16/20
DESIGN 18/20	DESIGN 18/20
VALUE 15/20	VALUE 20/20
FITTING EASY	FITTING EASY
OVERALL SCORE 75%	OVERALL SCORE 84%

Transform your
Raspberry Pi
into a

**FREE
DIGITAL
SIGNAGE
PLAYER**

Details at
bit.ly/xogo-rpi

XOGO





GAMING SPEAKER

LG ULTRAGEAR GAMING SPEAKER GP9 / £250 inc VAT

SUPPLIER currys.co.uk

ULTRA CLEAR

- + Versatile portable design
- + Easy setup
- + Doubles as a microphone

ULTRA STEER CLEAR

- Cheesy gamer styling
- Severely lacks bass
- Surround modes can't compete with a headset

SPEC

Weight
1.5kg

Dimensions (mm)
376 x 108 x 86 (W x D x H)

Speaker config
2 x 2in woofers,
2 x 20mm tweeters,
2 x bass radiators

Buttons
Power, input, headset,
volume, mute, FPS
mode, RTS mode, EQ

Connections
Mains power, USB
Type-C input, optical
audio input, auxiliary
out, combi headset jack

Stated battery life
Five hours

Extras
RGB lighting

The PC speaker market has been rather neglected in recent years, so we were quite excited when we saw LG has decided to enter the market with a high-end gaming soundbar. Originally priced at a whopping £500, it's currently discounted in several shops to a more palatable £250.

Featuring a quad-driver design with two passive woofers on its rear, the GP9 includes a USB Type-C input for your PC and Bluetooth for your phone, laptop or tablet. It also boasts DTS virtual surround sound support, a headset output and a microphone, allowing you to use the speaker for calls and in-game chat. The big news, though, is that it's a portable Bluetooth speaker as well. Its 2600mAh (7.2V) internal battery will provide up to five hours of music playback on the go.

It's quite the feature list and, given its high price, you might expect it to be a hefty unit akin to a TV soundbar. However, it measures just 376 x 86 x 108mm, although it's reassuringly dense and weighs 1.5kg. It's also sturdily built, with thick and stiff plastic used for its frame, and it's finished in a rough texture that adds further to the rugged vibe.

It has that clichéd angular gamer-aesthetic styling, with LG's gaming logo glowing in the centre and RGB lighting shining between the front speaker grilles. The styling isn't to our liking, but you can switch off the lights or change to a muted colour at least.

The setup process is plug-and-play for PC use. However, to change any of the speaker's settings you'll need to connect the free LG XBoom mobile app via Bluetooth. This provides options for adjusting the lighting and EQ, tweaking input and aux out gain, auto power-off management and an option to turn off UAC 2, so the speaker works properly with the Sony PS4 and PS5.

Along the top are buttons for power, input, headset on/off, FPS virtual surround mode,

RTS surround mode and a user EQ setting. In the centre is a large volume knob, with a button that mutes the microphone when connected to a PC, or brings up your virtual assistant when connected via Bluetooth to a phone. Around the back are the ports, all of which except the headset jack are covered by a large dust flap that just hangs open when the speaker is plugged in.

For all its promise, though, sound from this speaker was disappointing. There's plenty of volume for PC listening but there's a distinct lack of bass power, making for a forced and messy delivery once any bass kicks in. More delicate sound is handled with a decent amount of clarity, but it's outclassed by basic sub-£100 PC speakers.

Meanwhile, the virtual surround modes do fill out the soundscape a little, but it's not enough of an upgrade to make much difference for gaming. You'll still want to reach for a headset to get meaningful sound cues in games. It works great for watching movies on your PC though.

Conclusion

We like what LG has attempted with the GP9, creating a crossover device that can boost your PC's audio while also giving you a portable Bluetooth speaker. However, its audio quality isn't a patch on conventional PC speakers for a fraction of its price. The GP9 just about gets away with its current £250 price, thanks to all its extra features, but we'd steer well clear of it at £500 inc VAT.

EDWARD CHESTER

VERDICT

An intriguing, versatile design let down by audio quality that's well below its asking price.

DESIGN
14/20

FEATURES
18/20

SOUND QUALITY
16/30

VALUE
12/30

OVERALL SCORE

60%

USB MICROPHONE

NZXT CAPSULE / £100 inc VAT

SUPPLIER scan.co.uk

THE RED PILL

- + Stylish and well built
- + Excellent sound quality
- + Basic but easy to use features

THE BLUE PILL

- Single pickup pattern
- Lacks XLR output
- A touch expensive

SPEC

Dimensions (mm)

115 x 131 x 253 (W x D x H)

Weight

883g total, 314g without stand

Sample rate

96kHz

Bit rate

24-bit

Capsules

1 x condenser capsule

Pickup patterns

Cardioid

Frequency Response

20Hz-20kHz

Sensitivity

Not stated

Max SPL

120dB

Interface

USB Type-C

Extras

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

The NZXT Capsule's biggest claim to fame is a particularly high sampling rate of up to 96kHz, with a bit-depth of 24-bit. In comparison, most competing USB streaming mics max out at 48kHz, potentially making the Capsule better for those dealing with particularly demanding recording applications.

Unfortunately, there was a problem with the higher sampling rate when the mic launched, with recordings sounded tinny compared with 48kHz recordings. It took a few months, but NZXT has finally sent out a firmware that now resolves this problem, and sure enough this mic does sound very good.

It outclasses the likes of the Elgato Wave 1, Roccat Torch and Razer Seiren Mini, for instance, producing clearer more open-sounding recordings. Any of those mics will do for streaming, but for backup recordings or use in a home studio, the Capsule is a small step up.

That said, we couldn't actually hear the difference between 48kHz and 96kHz in our recordings – the Capsule sounds good because it's a quality microphone in other regards. Likewise, the fantastic-sounding Shure MV7 only uses a 16-bit/48kHz sampling rate, showing that these headline numbers are only a small part of the equation.

So, the Capsule sounds good, but that's not all it has going for it. For a start, it looks and feels fantastic. Available in black or white, its cylindrical shape is clean and smart whichever colour you choose. Its main body is also built from machined aluminium, with a very tough painted finish.

As standard, it comes with an equally smart and solid metal stand that provides a degree of tilt for the mic, but no height adjustment or vibration damping. The address position of the mic sits at just 22cm, so you'll need to angle the mic up towards you, raise the whole stand by putting it on some books or mount the mic on an arm to get it in line with your mouth.

NZXT makes its own boom arm called the *checks notes* Boom Arm. For £85, this provides a cable-tension balanced adjustable arm with three articulated joints, plus a desk clamp in which the arm swivels. Once the tension is adjusted it works okay, but it has a plasticky build and the movement isn't all that smooth, although its internal cable management keeps that side of the equation tidy. If



you don't mind exposed cables, though, the Rode PSA1 is a much more robustly built and cheaper option.

The Capsule uses a single condenser capsule to produce its single cardioid pickup, so it doesn't offer the versatility of the likes of the Blue Yeti or EPOS B20, but for most desktop, home recording and streaming applications, it's the only pattern you'll need. Sadly, there's no XLR output though.

It has a USB Type-C connection on its underside, along with a 3.5mm jack for real-time monitoring and PC audio output. On the front are two controls: one for microphone volume and one for monitoring volume.

They're odd controls, in that they spin continuously as you'd expect from a digital control, but don't offer digital interaction with your PC – turning the volume wheel doesn't adjust Windows' volume controls. They're easy enough to use though.

Conclusion

In general, the NZXT Capsule delivers excellent sound quality, fantastic build quality and an easy-to-use feature set. It isn't cheap compared with the highly versatile Blue Yeti, but its features and performance are competitive with most of its peers.

EDWARD CHESTER

VERDICT

An excellent quality USB microphone, even if its headline 96kHz sampling rate isn't that significant in real-world use.

DESIGN
18/20

FEATURES
14/20

PERFORMANCE
32/40

VALUE
12/20

OVERALL SCORE

76%

GAMING LAPTOP

HP OMEN 16 / £1,139 inc VAT

SUPPLIER currys.co.uk



This affordable HP Omen machine is a rare beast – a laptop that relies on AMD for its processor and graphics. The Radeon RX 6600M laptop GPU boasts the same RDNA 2 architecture used in AMD's mid-range desktop cards. The 6600M deploys 1,792 stream processors alongside a 2416MHz boost clock, and it has 8GB of memory. Meanwhile, AMD's now familiar Ryzen 7 5800H processor has eight SMT-enabled Zen 3 cores (16 threads), alongside base and boost speeds of 3.2GHz and 4.4GHz.

The rest of the machine's specification is respectable for the money too, comprising 16GB of dual-channel DDR4 memory, and a 512GB WD SN730 NVMe SSD, along with support for dual-band Wi-Fi 6, Gigabit Ethernet and Bluetooth 5.2. On the outside, there's one USB 3.2 Gen 2 Type-C port and three slower, full-sized USB 3.2 Gen 1 ports. The Omen also has a futureproof HDMI 2.1 output and SD card slot, but no Thunderbolt, and its 720p webcam doesn't support Windows Hello.

The display is also surprisingly good for this price. It's a 16.1in IPS panel with a 165Hz refresh rate, and its 2,560 x 1,440 resolution goes further than the 1080p screens used in most rivals.

HP has packed this hardware into a discreet, good-looking case, which is made from a mix of aluminium and plastic, and its dimensions impress – the Omen weighs 2.28kg and measures just 23mm thick.

Build quality is middling, though, and be aware that the underside rattles and the screen flexes too much. It's not a disaster, but a protective sleeve would be prudent. The Omen also falters in the ergonomic department. Despite the HP's

width, the keyboard doesn't have a numberpad, and the power button is annoyingly installed above the Backspace key, where it's all too easy to tap accidentally. The keys themselves are fast and comfortable to use, but they're soft and lack travel compared with the keyboards on pricier gaming laptops.

For casual gaming, the keyboard is fine, but no better. The trackpad's plastic surface is rougher than the glass you'll often find elsewhere as well, and its clicking motion never satisfies – it's too stiff and shallow in the top half of the pad and too deep at the bottom. Use a mouse instead.

HP's biggest competition comes from the 15.6in Lenovo Legion 5, which is our favourite budget laptop. It's thicker and heavier than the HP, with similar build quality. It has better USB connection options, but no SD card slot and a 1080p display. If you want the Lenovo with the AMD Ryzen 7 5800H and 16GB of memory, it will cost £1,199 and you can pick between the Radeon RX 6600M and Nvidia's GeForce RTX 3060.

If you want the Omen with the RTX 3060 then you'll have to pay £1,249 for the 15.6in version – it's currently unavailable in its 16.1in guise.

PERFORMANCE

AMD's graphics core delivers solid 1080p rasterisation performance. In Assassin's Creed Valhalla, its 99th percentile of 45fps with a 62fps average is easily playable,

HOPEFUL

- + High-quality, high-resolution screen
- + Superb AMD processor
- + Good-looking design
- + Not hot or loud

OMINOUS

- GPU is a bit weedy
- Mediocre keyboard
- Disappointing trackpad
- Average build quality

SPEC

CPU

3.2GHz AMD Ryzen 7 5800H

Memory

16GB 3200MHz DDR4

Graphics

AMD Radeon RX 6600M 8GB

Screen

16in 2,560 x 1,440 IPS 165Hz

Storage

512GB WD SN730 M.2 SSD

Networking

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

Weight

2.31kg

Ports

3 x USB 3.2 Gen 1, 1 x USB 3.2 Gen 2 Type-C/DisplayPort, 1 x audio, 1 x HDMI, SD card reader

Dimensions (mm)

369 x 248 x 23 (W x D x H)

Operating system

Windows 10 Home 64-bit

Warranty

One year parts and labour return to base

and it wasn't far behind in Cyberpunk 2077. Its Doom Eternal average of 173fps is good, showing that undemanding games will be able to run at high frame rates.

The AMD GPU struggled with our test games at the screen's 2,560 x 1,440 native resolution, however, and couldn't achieve smoothly playable frame rates in any of them except Doom Eternal. It will still be able to handle undemanding esports titles at this resolution, but you'll want to run trickier titles at 1,920 x 1,080.

While the Radeon RX 6600M does the job, though, Nvidia's RTX 3060 is better. In the Lenovo, this Nvidia GPU ran at 125W, and it was consistently quicker – with 7fps and 9fps leads in Assassin's Creed Valhalla and Cyberpunk 2077. The Radeon also struggles with ray tracing, with the 99th percentile dropping down to 28fps in Metro Exodus with High ray tracing at 1080p.

It's a shame because games look superb on the Omen's panel. The size and resolution make games immersive, and the 165Hz refresh rate keeps motion smooth. The delta E of 1.36 and colour temperature of 6,368K are both excellent. Combine that with the panel's 94.6 per cent sRGB coverage level and you have a screen that accurately produces virtually every shade required by games. The contrast level of 1,277:1 is strong, and means this display offers ample punch and depth in all situations, while the brightness level of 345cd/m² is high enough for indoor and outdoor use.

The Ryzen processor is great too. Its Handbrake score of 592,468 is superb, even for this chip, and the HP's overall result of 226,984 is better than any results we've seen from Intel's current mobile CPUs. Meanwhile, the SSD's read and write speeds of 2866MB/sec and 2695MB/sec are fine, if unspectacular – the storage speed won't slow down the machine in everyday use, although you'll fill that 512GB of space quickly with game installs.

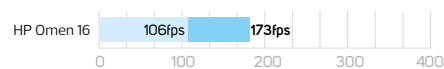
The Omen is never a poor thermal performer either. Its noise levels are moderate and modulated during gameplay, and the output is more consistent during multi-threaded work tasks, and virtually silent in standard Windows use. Warm air is pumped from the rear, and the external panels never became hot or uncomfortable to touch.



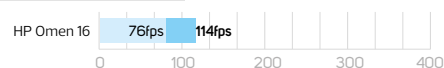
BENCHMARK RESULTS

DOOM ETERNAL

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

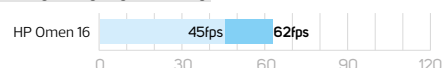


2,560 x 1,440, Vulkan, Ultra Nightmare settings



ASSASSIN'S CREED VALHALLA

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

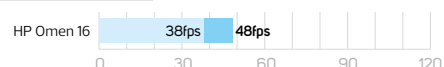


2,560 x 1,440, Ultra High settings, High anti-aliasing

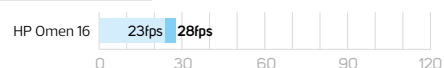


CYBERPUNK 2077

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

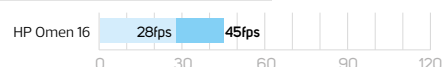


2,560 x 1,440, Ultra preset, no ray tracing



METRO EXODUS

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



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



99th percentile Average

65,514

GIMP IMAGE EDITING

592,468

HANDBRAKE H.264 VIDEO ENCODING

231,260

HEAVY MULTI-TASKING

226,984

SYSTEM SCORE

The Omen's battery life isn't surprising. It lasted for four hours when working and 90 minutes during gaming, with the former a bit worse than the Lenovo and the latter slightly better. Finally, the speakers are loud and clear, so they're usable for gaming, but they lack bass and they also sound a bit tinny.

CONCLUSION

The HP Omen 16 combines solid thermal performance with a high-quality display, first-rate processor and attractive design. However, it does also have some shortcomings. The keyboard and trackpad are mediocre, and the AMD GPU can't compete with the equivalent Nvidia hardware, and it can't handle games at the machine's native resolution either. If screen quality is your top priority, this is a great buy for the money. For most gamers, though, the Lenovo Legion 5 remains the better budget choice.

MIKE JENNINGS

VERDICT

The processor and screen excel, but HP's affordable machine is hindered by its GPU and a few other shortcomings.

PERFORMANCE

21/25

DESIGN

19/25

HARDWARE

20/25

VALUE

22/25

OVERALL SCORE

82%



CUSTOM GAMING

DESKTOPS & LAPTOPS



CUSTOM BUILT
TO YOUR SPEC



EASY TO USE
CONFIGURATOR



CUSTOM PCS
& LAPTOPS



AWARD-WINNING
SYSTEMS

MAGNUS PRO GAMING DESKTOP

- › Intel® Core™ i7-12700K
- › GIGABYTE Z690 Gaming X DDR4
- › 16GB Corsair VENGEANCE RGB Pro 3600MHz
- › 8GB GEFORCE RTX 3070 Ti
- › 1TB PCS PCIe M.2 SSD
- › 2TB SEAGATE BARRACUDA HDD
- › Windows 11 Home

This spec from

£2,010.00*



intel
CORE
i7

GEFORCE
RTX

TOPAZ ELITE GAMING DESKTOP

- › AMD Ryzen 5 5600X
- › ASUS® TUF Gaming B550-PLUS
- › 16GB Corsair VENGEANCE RGB Pro 3600MHz
- › 12GB AMD RADEON™ RX 6700 XT
- › 500GB SEAGATE FIRECUDA 520 NVMe
- › 1TB SEAGATE BARRACUDA HDD
- › Windows 11 Home

This spec from

£1,740.00*



AMD
RYZEN | RADEON

ELIMINA® PRO SERIES LAPTOP

- › 17.3" FHD (1080p) 144hz Screen
- › Intel® Core™ i7 11800H Processor
- › GeForce GTX 1650 / RTX 3050 / 3050 Ti / 3060
- › Single Zone RGB Backlit Keyboard
- › Windows 11 Home

This spec from

£970.00*



intel
CORE
i7

GEFORCE

144HZ

GET AN EXCLUSIVE £15 DISCOUNT WITH CUSTOM PC USING CODE:

CPC22

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

INTEL Z690 GAMING PC

PC SPECIALIST MAGNUS SUPREME / £1,499 inc VAT

SUPPLIER custompc.co.uk/Magnus

This PC costs just £1,499, but amazingly includes an Intel Alder Lake processor and GeForce RTX 3070 Ti graphics card. That's spectacular value – the graphics card alone often goes for around a grand on the market at the moment, and the Gigabyte card used here overclocks the reference clock from 1770MHz to 1830MHz. The Core i5-12600KF CPU is great too – it has

six P-Cores with a 4.9GHz boost frequency, alongside four power-efficient E-Cores that peak at 3.6GHz.

Those core components are partnered with 16GB of Corsair RGB DDR4 memory clocked to a decent 3600MHz, and the Magnus features a 1TB M.2 SSD and a semi-modular Corsair TX650M PSU with an 80 Plus Gold efficiency rating.

It's all plugged into an Asus Prime Z690-P D4 motherboard, which has two spare memory slots and three M.2 connectors that support PCI-E 4. It also has four 16x PCI-E slots, including one with PCI-E 5 support, but the graphics card blocks one and another slot is used for a Wi-Fi card. On the plus side, the board has 2.5Gbps Ethernet, and it has a high-speed USB 3.2 Gen 2x2 Type-C port on the rear.

Otherwise, the board is a little basic and plain-looking. The rear I/O panel has only has five Type-A USB ports, for example, and two of them use the aging USB 2 standard. You only get four SATA ports, and just one of the M.2 sockets has a heatsink.

There are some specification compromises elsewhere too. The Wi-Fi card is a weedy, single-band 802.11n unit, for example, rather than a dual-band 802.11ax card. The own-brand SSD also disappointed, with read and

write speeds of 2,309MB/sec and 675MB/sec. That read speed is perfectly fine for everyday use, but the write speed isn't much faster than a SATA drive.

PC Specialist has built this PC inside its own-brand Prism-X chassis. It's a conventional mid-tower, with a mix of mesh and plastic on the front, and a tempered glass side panel. Three RGB LEDs act as air intakes, and on the inside, you'll find a PSU shroud and a bracket to support the bulky 1.36kg graphics card.

However, it's not too hard to move this system from one place to another, especially as there's no liquid cooling – instead, PC Specialist's own-brand FrostFlow air cooler does the honours. The Prism-X has no big problems, but its build quality isn't awe-inspiring – the side panel, PSU shroud and front panel could be stronger, for example.

But then you have to expect compromises at this price, especially in the current climate, and none of the issues is terminal. That price is also amazing – the last rig we saw at this price, the CCL Horizon 5, used an RTX 3060 Ti, but that machine now costs north of £1,800. None of the other big UK firms supplies this Alder Lake CPU with an RTX 3070 Ti GPU at this price. The Magnus has a reasonable warranty too, with three years of labour coverage and one year for parts.



SPEC

CPU

3.7GHz Intel Core i5-12600KF

Motherboard

Asus Prime Z690-P D4

Memory

16GB Corsair Vengeance RGB Pro 3600MHz DDR4

Graphics

Gigabyte GeForce RTX 3070 Ti 8GB

Storage

1TB PC Specialist M.2 SSD

Networking

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

Case

PC Specialist Prism-X

Cooling

CPU: PC Specialist FrostFlow 150 with 2 x 120mm fans; GPU: 3 x 90mm fans; front: 3 x 120mm fans; rear: 1 x 120mm fan; roof: 1 x 120mm fan

Ports

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

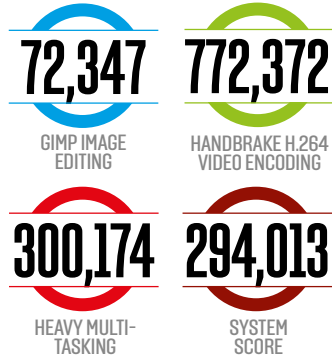
Operating system

Windows 11 Home 64-bit

Warranty

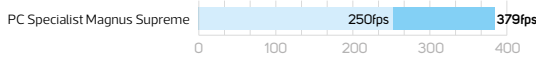
One year parts and labour, plus two years labour only. One month collect and return, then return to base

BENCHMARK RESULTS



DOOM ETERNAL

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



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



ASSASSIN'S CREED VALHALLA

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



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

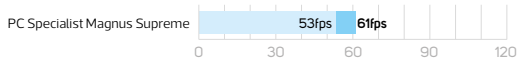


CYBERPUNK 2077

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

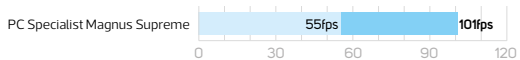


2,560 x 1,440, Ultra preset, no ray tracing

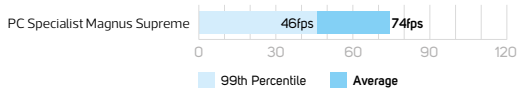


METRO EXODUS

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



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



PERFORMANCE

The RTX 3070 Ti's 99th percentile result at 2,560 x 1,440 snuck beyond 60fps in Assassin's Creed Valhalla and hit a solid 53fps with a 61fps average in Cyberpunk 2077 too. You can even enable Medium ray tracing with DLSS at this resolution. You'll be able to play the latest games with decent settings at 2,560 x 1,440 on this cut-price machine.

Drop down to 1080p and you'll get even faster scores, with averages between 90-110fps in three of our test games, and an amazing average of 379fps in Doom Eternal. You'll have no problem running undemanding games at high refresh rates with this machine.



Meanwhile, the Core i5-12600KF delivered superb scores in all of our benchmarks, being miles ahead of the Ryzen 5 5600X – the other chip you'll see in PCs at this price. Alder Lake remains your best option for games, mainstream content creation and general-purpose workloads.

The PC Specialist delivers sensational performance for £1,499, but our system was extremely loud out of the box. Internal investigation revealed that one of the exhaust fans was attached to the motherboard's all-in-one pump header, which is the only header that doesn't hook up with Asus Q-Fan, meaning it couldn't be PWM-controlled.

Connecting the fan to a PWM-enabled header solved the problem. The system's fan noise reduced to modest levels, even during demanding tasks, and the CPU and GPU delta Ts of 55°C and 43°C were fine. Thankfully, PC Specialist has assured us that the machine definitely wasn't intended to be set up with the fan hooked up to the pump header, and that this has been flagged with the production team, so machines bought by customers won't be set up in this way.

CONCLUSION

The fan noise, sluggish wireless card and underwhelming SSD all mean that the PC Specialist is rough around the edges. It's still worth considering this rig though. The Intel processor delivers the best performance you'll find from any mid-range CPU, and the overclocked RTX 3070 Ti will handle any gaming task at a sub-4K resolution. This PC isn't perfect, but it is the best mid-range gaming rig we've seen for ages.

MIKE JENNINGS

VERDICT

Superb performance for the money. There are some compromises around the edges, but the core spec is fantastic.

ULTRAMAGNUS

- + Superb gaming ability
- + Fast, versatile CPU
- + Impressively affordable
- + Neat and tidy case

MEGATRON

- Disappointing Wi-Fi
- Mediocre SSD
- Entry-level motherboard

PERFORMANCE
22/25

DESIGN
19/25

HARDWARE
19/25

VALUE
25/25

OVERALL SCORE

85%

AMD X570 GAMING PC

ALPHASYNC iCUE GAMING PC / £2,649 inc VAT

SUPPLIER ebuyer.com

A

AlphaSync's iCUE includes an Ryzen 9 processor and GeForce RTX 3080 graphics card for £2,649. That's about as cheap as it gets for a PC with those core components, and elsewhere the AlphaSync impresses, with 32GB of memory and loads of storage.

The RTX 3080 has 8,704 stream processors and 10GB of memory, and the AlphaSync's EVGA FTW3 Ultra card runs its boost clock at 1800MHz rather than the conventional 1710MHz. There's no overclocking in the CPU department, but that's sensible for AMD's Ryzen 9 5900X, which has 12 SMT-enabled Zen 3 cores and a boost speed of 4.8GHz anyway.

It's backed up by 32GB of DDR4 memory running at 3200MHz, and storage comes from a 1TB Seagate FireCuda 512 SSD and a 4TB Seagate Barracuda hard disk – a capacious storage array that offers fast speed for your OS, games and apps, along with loads of space for file storage. It's all powered by a modular Corsair RM1000x PSU with an 80 Plus Gold certification, which is a great inclusion.

It's decent hardware, and the Asus ROG X570-F Gaming motherboard is another reasonable mainstream choice. It has PCI and M.2 sockets that support PCI-E 4 alongside SupremeFX S1220A audio, and at the rear, you'll find three full-sized USB ports and a USB 3.2 Gen 2 (10Gbps) Type-C connector. The Asus has plenty of

extra on-board headers, and it also has loads of RGB LEDs alongside sizeable heatsinks. The board has Gigabit Ethernet too, and AlphaSync has added a discrete dual-band 802.11ax Wi-Fi card.

It's a capable spec for the price. The only problem now, though, is that you could spend this kind of cash on an RTX 3080 system underpinned by a factory-fresh Intel Alder Lake processor instead, and also get a newer Intel Z690 motherboard with PCI-E 5 support, Thunderbolt, better networking and faster USB ports.

On the plus side, the Corsair iCUE 4000X case has excellent build quality and great looks, with tempered glass front and side panels that show off the internal RGB LED lighting. The case has a USB Type-C port on its front panel I/O, and on the inside, you'll find neat cabling. The Corsair iCUE H100i cooler's radiator is mounted in the front of the case, so it doesn't intrude on the rest of the hardware, and around the rear, there's space for 2.5in and 3.5in drives alongside a couple of extra fans on the fan hub.

ALDER CORES

- + Great gaming performance
- + Cheaper than many rivals
- + Neat and quiet build

ALL THE PROBLEMS

- Intel's new CPUs are faster
- Dated motherboard
- Average warranty

SPEC

CPU

3.7GHz AMD Ryzen 9 5900X

Motherboard

Asus ROG Strix X570-F Gaming

Memory

32GB Corsair Vengeance RGB Pro 3200MHz DDR4

Graphics

EVGA GeForce RTX 3080 10GB

Storage

1TB Seagate FireCuda 512 M.2 SSD, 4TB Seagate Barracuda hard disk

Networking

Gigabit Ethernet, dual-band 802.11ax Wi-Fi

Case

Corsair iCUE 4000X

Cooling

CPU: Corsair iCUE H100i Elite Capellix with 2 x 120mm fans; GPU: 3 x 90mm fans; front: x 120mm fan; rear: 1 x 120mm fan; roof: 1 x 120mm fan

Ports

Front: 1 x USB 3.2 Gen 1, 1 x USB 3.2 Gen 1 Type-C, 1 x audio; rear: 3 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 4 x USB 3.2 Gen 1, 1 x optical S/PDIF, 5 x audio

Operating system

Windows 11 Home 64-bit

Warranty

Three years labour with one year parts, collect and return





Finally, the warranty is fine – a three labour deal with a year of parts coverage, complete with collect and return cover. We usually expect more parts cover at this price though – other British builders are often more generous in this respect.

PERFORMANCE

The overclocked RTX 3080 excelled in gaming tests. At 2,560 x 1,440, it ran Assassin's Creed Valhalla and Cyberpunk 2077 with 99th percentile results of 60fps or beyond, and it wasn't far behind in Metro: Exodus.

It didn't balk at 4K gaming either, with a 48fps 99th percentile and 64fps average in Assassin's Creed Valhalla and a cracking average of 216fps in Doom Eternal. It couldn't quite handle Cyberpunk 2077 smoothly at 4K, but enabling DLSS on Metro Exodus enabled it to produce a decent average of 70fps with ray tracing enabled at 4K.

Meanwhile, the 12-core AMD Ryzen 9 5900X proved strong in heavily multi-threaded content-creation tasks, with a solid Handbrake result of 839,966. That's all great, but those scores are at the low end of the scale when it comes to this particular processor, and AMD's chip struggles against Intel's latest silicon. The Core i7-12700K, for instance, hit 78,744 points in our image editing test, and it scored 948,267 in the Handbrake benchmark. While this CPU might be beaten by Intel's latest top-end Alder Lake CPUs, though, it will still handle any task, from gaming and content creation to streaming and multi-tasking.

The SSD is fine too, but its read and write speeds of 3,474MB/sec and 3,024MB/sec aren't particularly impressive these days. More positively, the AlphaSync has no thermal issues. It's virtually silent when running low-intensity tasks, and its moderate noise during gaming and content creation will easily be masked by speakers or a headset. The CPU and GPU attained their stated clock speeds, and their delta Ts of 45°C and 54°C are fine.

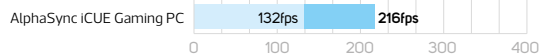
BENCHMARK RESULTS

DOOM ETERNAL

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



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



ASSASSIN'S CREED VALHALLA

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



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

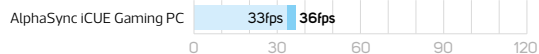


CYBERPUNK 2077

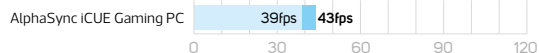
2,560 x 1,440, Ultra preset, no ray tracing



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



3,840 x 2,160, Ultra preset, Medium ray tracing, DLSS Balanced



METRO EXODUS

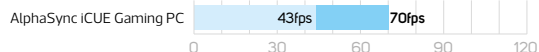
2,560 x 1,440, Ultra, HairWorks off, Advanced PhysX off, High RT



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



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



Legend: 99th Percentile (light blue), Average (dark blue)

59,804
GIMP IMAGE EDITING

839,966
HANDBRAKE H.264 VIDEO ENCODING

342,761
HEAVY MULTI-TASKING

319,407
SYSTEM SCORE

CONCLUSION

AlphaSync's system offers reasonable speed inside a tidy, attractive and quiet build, and it's cheaper than most equivalent AMD rigs. Look beyond the Ryzen bubble, though, and you'll find faster systems with Intel's Alder Lake processors. Even Core i9-based Alder Lake systems usually aren't much more expensive – indeed, AlphaSync sells one for £2,699, albeit with some spec differences compared with this machine. This is a well-built and fast machine for a decent price, but it's worth shopping around for an Intel Alder Lake PC now.

MIKE JENNINGS

VERDICT

A fast, quiet and well-built PC, but at this price you'd be better off buying a system based on Intel's latest Alder Lake platform.

PERFORMANCE
21/25

DESIGN
22/25

HARDWARE
20/25

VALUE
21/25

OVERALL SCORE

84%

Custom kit

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

TILE MATE 2022 / £14.99 inc VAT

SUPPLIER uk.tile.com

The 2022 iteration of the Tile Mate tracking device is a dead ringer for its older siblings, at least from the outside. However, the past few years have been good for the technology at the heart of the Tile Mate, even if they've been pretty rough for everybody else. The new Tile Mate now boasts a solid three-year lifespan, which mitigates the fact that the battery can't be replaced. Also new to this version is a QR code on the back, which can be scanned by a phone to identify the owner of the item to which it's attached, which might help to get a lost item home if it's found by a helpful individual.

An IP67 survivability rating also means it stands a better chance of surviving long enough to be discovered in the wilderness, or 1m of water for up to half an hour, or wherever it ends up. The increase in resilience feels like a fair trade for the loss of a replaceable battery. The Bluetooth range to connect to a phone extends to around 60m in decent conditions; along with the app's ability to tell you where the

tag was last seen on a map, this makes finding the tag surprisingly easy.

The app works on iOS or Android, and there's a premium option that covers an array of extra features, but the basic package is fine unless you're feeling particularly unlucky. As with the earlier models, the button on the front can also make your phone ring to help you find it. Even if the Tile Mate just helps you to find your keys with your phone in its three-year lifespan, that's extremely helpful. The fact that you can also track the tag so unerringly is the icing on the cake.



Check ●●●●● Mate

PERFECT PART THUMBSTICK CAPS / £4.95 inc VAT

SUPPLIER amazon.co.uk

The Thumbstick Caps are made of silicone and, as the name suggests, they cap standard mushroom-shaped gamepad thumbsticks to make them more comfortable and grippy to use. They also make the pad look a mite smidgen cooler, because the caps have little coloured circles on them, which are generally more interesting-looking than regular black sticks.

The caps bring more comfort and grip to your thumbsticks by being slightly squashy and having a raised textured centre – it's not completely transformative, but it's a step up. The caps attach without adhesive, but knocking them off during play would require some very odd moves, although they can be deliberately removed easily enough if necessary. A very cheap and effective way to improve any pad with ordinary-sized thumbsticks.



Death cap ●●●●● Closed cup

NOBO DESKTOP WHITEBOARD / £20.39 inc VAT

SUPPLIER amazon.co.uk

Having a notebook on the desk for any random scribbles you find yourself needing to make is often useful, and the Nobo Desktop Whiteboard approaches this task with impressive confidence, inviting you to replace your desktop notebook with a big glass-fronted whiteboard. The Nobo makes a good case for its existence – it's big, sturdy and tidy, with a groove in the top to store pens, and a drawer in the side to store extra bits and pieces.

Writing on it is also fun – it comes supplied with a black pen but there's space to store several of them. If there's an elephant in the room, it's the comparatively elephant-like size of the Nobo itself, having similar dimensions to a full-sized keyboard. This means it takes up a lot of desk space, especially if you want to keep it handy to use at all times, but its size also means you can write a lot on it. It's ideal as part of a comfy, spacious setup with room and reasons to use it.



Mumbo ●●●●● Jumbo

HAVIT HEADSET AND PHONE STAND / £17.99 inc VAT

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

Havit's combination of a phone stand with a headphone stand seems odd at first, but the pairing makes sense when you realise the two stands aren't supposed to be used at the same time. This is for folks who want to use their phone for watching video, and who have a set of headphones with which to do that.

The phone holder is adjustable up and down, and it can tilt, while the headphone part is just a basic stand - you put the phone in position to watch your show, put on the headphones and off you go. When you're finished, you put the headphones back on the stand and your phone back in your pocket.

There's no charging capability for either device, but this limitation is mitigated by the spartan design, with no unnecessary features or flourishes to get in the way of cables. Aside from situations where this pairing might be useful, though, the Havit stand doesn't thrive in either role and feels rather flimsy.

Trouble ●●○○○ Double



LUMINOODLE CLICK / £38.11 inc VAT

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

Sticking lights to literally any object that can have lights on it is a noble goal, and the Luminoodle Click represents an advance in this field. The device itself is a string of white LEDs (no colour changing here), but instead of relying on an external power source the LEDs are powered by a battery pack at one end. This pack doubles as a switch, or a chunk of the casing does at any rate, and both this pack and the LEDs can be fixed to clean, flat surfaces with double-sided tape.

The net result is that the Click can be installed in places where lights usually can't go - inside cupboards, underneath shelves and (quite handily) under desks, so you can see when you have to go digging around. Cleverly, the switch part of the battery pack is removable, and this is also where the batteries (three AAs) go. As such, when it's time to swap out the batteries, you don't have to detach the whole device - you just slide off the switch, swap the batteries and slot it back into place.



The Luminoodle's tail of LEDs starts at 1m long, but can be trimmed to fit as needed, providing a strong, even light along its length. It works well if you need to bring light to a dark place without hooking up a power connection.

Voluminous poodles ●●●○○ Luminous noodles

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

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.

SUBSCRIBE TO **custompc**



🖱️ custompc.co.uk/subscribe

LABS TEST

Chill out zone

Antony Leather puts nine of the latest 120mm all-in-one liquid coolers to the test

How we test

Not everyone wants or even needs an all-in-one (AIO) liquid cooler with a large radiator for their system. Some micro-ATX and mini-ITX cases simply don't have room for them, and you can save yourself some money by going for a 120mm cooler as well. Not only that, but 120mm AIO coolers can also keep some of the most powerful CPUs out there in check.

We've been pleasantly surprised at how well some 120mm AIO liquid coolers have coped with the likes of Intel's Core i9-12900K, for example, which has a total of 16 cores (eight P-Cores and eight E-Cores). This CPU makes for a tough test, though, so every cooler on test this month will need to deal with this CPU to make the cut.

We'll also be checking each cooler's compatibility with Intel's LGA1700 socket, using adaptor kits where possible or checking performance with the LGA115x/1200 mounting holes on our motherboard on coolers where an LGA1700 adaptor isn't available.

We used an Asus ROG Maximus Z690 Apex in our Intel test system, along with 32GB of Corsair DDR5 Dominator memory, while our AMD test system used an MSI MEG X570 Unify and 16GB of Corsair Vengeance RGB Pro DDR4 memory, along with a Ryzen

75800X overclocked to 4.6GHz with a 1.25V vcore. Alongside these components sit a 256GB Samsung 960 Evo SSD and Corsair CM550 PSU. Both systems are housed in a Fractal Design Meshify C case and use the latest versions of Windows 11, plus the latest BIOS and driver versions.

We use CoreTemp to measure the CPU temperature before subtracting the ambient air temperature from this to give a delta T result to allow us to test in a lab that isn't temperature controlled. We run the Prime95 ([mersenne.org](https://www.mersenne.org)) smallest FFT test with AVX instructions disabled to load the CPU, and we then take the temperature reading after ten minutes.

To iron out any abnormally hot-running cores that might skew the results in our Intel system, we take an average temperature reading across the all-important P-Cores for the performance data, and take note of the E-Core delta T as well. AMD CPUs only list a single temperature reading, so we record what's reported in Core Temp. Finally, we calculate scores based on cooling performance, noise, features, ease of installation and value, with a weighted calculation giving an overall score.

Contents

- Aerocool Pulse L120F /p35
- Antec Neptune 120 ARGB /p36
- be quiet! Silent Loop 2 120mm /p37
- Corsair iCUE H60i RGB Pro XT /p38
- Deepcool Gammaxx L120 V2 /p39
- EK AIO 120 D-RGB /p40
- GameMax Ice Chill 120 ARGB /p41
- NZXT Kraken 120 /p42
- SilverStone PF120 ARGB /p43

AEROCOOL PULSE L120F

£70 inc VAT

SUPPLIER overclockers.co.uk

With its pump located in the radiator, the Aerocool Pulse L120F's radiator unit is a fair bit longer than those of most other AIO liquid coolers, stretching to 176mm. As a result, you'll need to make sure your case has space for it before you consider purchasing it. On the flip side, the waterblock that would normally hold the pump section is comparatively quite small, so you shouldn't have any trouble trying to fit it in your motherboard's CPU socket area.

The whole setup is also very thin, with the radiator and fan together only measuring 52mm thick, which is about as slim as you can get. A single 120mm fan is included in the box, with both the fan and waterblock unit sporting 3-pin digital RGB lighting, with a spinning propeller in the pump that looks snazzy.

We were initially confused by the RGB lighting's cables, though, so follow the instructions carefully. There are two connectors on the CPU section, and both are for lighting control and power. You can daisy-chain the pump and fan to your motherboard, an external RGB controller or just have them sat in colour cycle mode, although the lighting isn't as vivid as the best-looking coolers on test.

At £70 inc VAT, this bundle is relatively expensive too, especially given its lack of software control and the fact it only comes with a single fan. Aerocool's website is also devoid of LGA1700 compatibility information, but the cooler's long sprung screws and adjustable backplate meant enough pressure was applied

with our Core i9-12900K's heatspreader. The included sachet of thermal paste spread well and the radiator got warm during testing, so we're confident that the cooler can at least get enough heat transferring from the CPU to the coolant.

Meanwhile, installation is easy, if a little involved, with the kit coming with Intel and AMD mounting plates and thumbscrews, although you don't get a spare set of fan mounting screws to use a second fan. The fan and radiator-mounted pump are controlled using separate 4-pin PWM cables, so you can control the speed of each part separately. However, given that the pump proved to be very quiet in testing, we recommend running it at full speed all the time.

Unfortunately, despite the cooler appearing to make good contact with our Core i9-12900K, the delta T of 79°C only just prevented our CPU from throttling and was significantly warmer than all the others with this CPU. It was more competitive on our AMD motherboard cooling an overclocked Ryzen 7 5800X, but even here it had the second warmest result on test of 69°C, and the only warmer result was from the Corsair iCUE H680i RGB Pro XT running at low speed. The Aerocool does have a particularly quiet pump, though, and its fan was no louder than the likes of the be quiet! Silent Loop 2 120mm and Deepcool Gammaxx 120 V2.



Conclusion

With a comparatively high price and lacklustre cooling results, especially when dealing with our Core i9-12900K, we can't recommend the Aerocool Pulse L120F. It even failed to perform well in our AMD system, so while we had our doubts about it fitting Intel's new LGA1700 socket, it's clear that it doesn't perform well in general. That's a shame given its quiet operation and funky design, but you can get better cooling power for less money elsewhere.

VERDICT

Poor cooling all round – it might look good, but you can get better cooling power for less cash elsewhere.

Intel LGA1700

COOLING
20/40

FEATURES
13/20

DESIGN
10/20

VALUE
11/20

OVERALL SCORE
54%

FITTING
Easy

AMD Socket AM4

COOLING
30/40

FEATURES
13/20

DESIGN
9/20

VALUE
12/20

OVERALL SCORE
64%

FITTING
Easy

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3+, TRX/4

Radiator size with fans (mm)

124 x 176 x 52 (W x D x H)

Fans 1 x 120mm

Stated noise 32dBA

PULSE

- + Funky design
- + Full RGB lighting
- + Quiet pump

FLATLINE

- Poor cooling on Intel and AMD sockets
- No LGA1700 compatibility information
- Radiator-mounted pump too big for some fan mounts

ANTEC NEPTUNE 120 ARGB

£60 inc VAT

SUPPLIER techinn.com

We loved the 240mm model in Antec's Neptune ARGB range of AIO liquid coolers, so we had high expectations for the 120mm version. As with the bigger model, you get a fan and lighting hub thrown into the bundle, giving you the ability to control five fans from one PWM input from your motherboard, with a similar arrangement for RGB connectors – that's a really great inclusion for a cooler that costs just £60 inc VAT.

Despite Antec not listing any kind of LGA1700 socket compatibility on its website, we managed to get the Neptune 120 ARGB installed on our Asus ROG Maximus Z690 Apex motherboard using its LGA115x/1200 mounting holes. Bear in mind that not all LGA1700 motherboards have these holes, though, and you'll be out of luck if your motherboard only has the newer LGA1700 holes.

The Antec's RGB lighting is bright and vibrant on the pump, but while the same can also be said of the lighting on the fan, it didn't diffuse much across the semi-transparent blades. Comparatively, EK's effort this month does a better job of fan lighting, getting more kudos if

good looks are a priority for you. Still, the ability to control the pump and fan lighting, as well as several LED strips, with the included hub is very useful, and you can synchronise their colours as well.

Installation is a little fiddly, with the Antec forcing you to deal with more components than other coolers on test, but the process is straightforward. While there's no LGA1700 compatibility listed, the cooler worked well cooling our Core i9-12900K with the aforementioned LGA115x/1200 mounting holes, hitting a delta T of 70°C under full load.

That's a full 9°C cooler than the result from the Aerocool Pulse L120F, and also lower than the SilverStone PF120 ARGB and GameMax Ice Chill 120 ARGB. However, the be quiet! Silent Loop 2 120mm knocked a further 10°C off that temperature, and the Deepcool Gammaxx 120 V2 costs a bit less money than the Antec and offers slightly better cooling too.

On our AMD system, which features an overclocked Ryzen 7 5800X, the Antec achieved a delta T of 62°C. This was much more competitive, beating the Corsair iCUE H60i RGB PRO XT and Deepcool Gammaxx 120 V2, with only the be quiet! Silent Loop 2 120mm and EK AIO 120 D-RGB able to match or better this result. The Antec's fan is also slightly quieter than the fans with most other coolers on test, and the pump is exceptionally quiet too, even at full speed.

Conclusion

With a quiet pump and fan, as well as a lighting hub and decent performance – the Antec Neptune 120 ARGB is still a decent offering for just £60, despite its aging design. It keeps up with other more expensive coolers, it's easy to install and it still represents great value. However, it struggled when dealing with our Core i9-12900K, even if its lack of official LGA1700 support didn't ruin its



thermal performance, unlike the Aerocool Pulse L120F. As a result, we can't really recommend the Antec for an Intel Alder Lake system where the Deepcool Gammaxx 120 V2 is a better buy. However, it remains a great option for AMD Socket AM4 systems – it effectively cooled our overclocked Ryzen 7 5800X, and you have to pay more money to get better AM4 cooling performance.

VERDICT

Great cooling on AMD systems, but there are better options for Intel's 12th-gen Alder Lake CPUs.

GAS GIANT

- + Excellent cooling on AMD systems
- + Fan and lighting hub included
- + Reasonably priced

GAS BILL

- Mediocre LGA1700 cooling
- Fan lighting could be better
- Installation requires lots of parts

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)
120 x 169 x 52 (W x D x H)

Fans 1x 120mm

Stated noise 36dBA

Intel LGA1700

COOLING
33/40

FEATURES
19/20

DESIGN
14/20

VALUE
18/20

OVERALL SCORE

84%

FITTING
Easy

AMD Socket AM4

COOLING
37/40

FEATURES
19/20

DESIGN
12/20

VALUE
18/20

OVERALL SCORE

86%



FITTING
Easy

BE QUIET! SILENT LOOP 2 120MM / £80 inc VAT

SUPPLIER overclockers.co.uk



Adding a second row of fans isn't always worth it with some radiators, but any extra airflow is welcome with the high heatloads our bunch of AIO liquid coolers have to handle this month. Thankfully, the extra fan here doesn't mean the only dual-fan cooler on test costs the earth, with the be quiet! Silent Loop 2 120mm retailing for £80 inc VAT.

According to be quiet!, the Silent Loop 2's all-new pump design, with a six-pole motor, three chambers and high-density cold plate fin stack, all combine to offer better cooling, lower noise and less turbulence. We can confirm that the Silent Loop 2's pump was indeed inaudible unless we put it to our ears, so it gets top marks for low-noise operation, even at full speed.

The fans are a tad louder, hitting 2,200rpm at full speed and being among the loudest spinners on test, although both fans are PWM-controlled, so they can spin down to inaudible levels when needed. At low to medium loads, this cooler will also get away with lower fan speeds, thanks to its increased grunt in the airflow and static pressure departments.

The pump section is the only part of this cooler's arrangement to feature RGB lighting, but it's bright and extremely vivid – it's ideal if you like a touch of class from your lighting without going overboard. A digital RGB

controller is included should you not wish to hook it up to a 3-pin RGB header on your motherboard, and you can also turn off the lighting completely. The fans and pump have their own power cables, with the fans benefitting from a 4-pin PWM splitter cable, so you only need a single header to power them.

The pump only has a 3-pin power connector, so if you want to control its speed, you'll need to switch the control system for that header to voltage or DC mode. However, given that the pump is extremely quiet at full speed, we doubt anyone will feel the need to do that.

Our sample didn't offer LGA1700 compatibility out of the box, but be quiet! can supply an adaptor kit. Installation on all sockets is also straightforward, although you have to deal with quite a lot of components. We'd like to see fewer parts involved in the installation of future be quiet! coolers, although we appreciate the inclusion of a tube of thermal paste, so you can remove this cooler and reinstall it without having to buy new paste.

Having two fans on a 120mm AIO liquid cooler is clearly a good idea, because the Silent Loop 2 120mm posted the best results in both our test systems. Its delta T of 60°C cooling our Core i9-12900K was a degree cooler than the EK AIO 120 D-RGB and 8°C cooler than the Corsair iCUE H60i RGB PRO XT. It recorded

a delta T of 60°C with our Ryzen 5800X too, where it was 5°C cooler than the Corsair iCUE H60i RGB PRO XT and 2°C cooler than the EK AIO 120 D-RGB.

Conclusion

The be quiet! Silent Loop 2 120mm is the best-performing 120mm AIO liquid cooler we've tested, so if you can warrant the outlay and want a powerful, compact cooler with a smattering of RGB lighting and quiet pump, this is the cooler for you. However, the cheaper EK AIO 120 D-RGB looks better and is only slightly off the pace.

VERDICT

Fantastic cooling on both Intel and AMD's latest sockets, although it's a tad expensive.

Intel LGA1700

COOLING 39/40	FEATURES 17/20	OVERALL SCORE 91%
DESIGN 18/20	VALUE 17/20	
FITTING Easy		

AMD Socket AM4

COOLING 39/40	FEATURES 17/20	OVERALL SCORE 87%
DESIGN 16/20	VALUE 15/20	
FITTING Easy		

SPEC

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

AMD compatibility Socket AM4, AM3/+, TRX/4 (with adaptor kit)

Radiator size with fans (mm)
120 x 154 x 77 (W x D x H)

Fans 2 x 120mm

Stated noise 36dBA

SILENT BOB

- + Excellent cooling
- + Quiet pump
- + RGB controller included

SILENT TREATMENT

- Expensive
- Pump is 3-pin rather than 4-pin
- Noisy at full speed

CORSAIR iCUE H60i RGB PRO XT

£80 inc VAT

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

As you'd expect given Corsair's propensity for light-up products, Corsair's iCUE H60i RGB Pro XT includes RGB lighting, but only on the pump housing, which is a bit of a shame given it costs £80 inc VAT. On the plus side, however, this cooler does feature full software control of the pump and lighting, allowing you to customise the cooling and lighting to your own needs.

Only one 120mm fan is included in the box, but the cables have a spare port available to power a second fan, and Corsair includes the necessary screws for another fan in the bundle too, which is handy. Seeing as the be quiet! Silent Loop 2 was the best-performing cooler on test with its two fans, an extra fan could be a good upgrade to this cooler, although you're already paying £80 for just a single fan here, with Corsair instead prioritising software control.

You'll need to buy Corsair's LGA1700 mounting kit if you want to use the iCUE H60i RGB Pro XT with Intel's 12th-gen Alder Lake CPUs; this uses a new backplate and shorter mounting pins to cater for the lower heatspreader found on the latest range of Intel chips. That said, Corsair is already shipping some of its other AIO liquid coolers with LGA1700 mounting equipment, and the H60i RGB Pro XT may follow suit.

Thankfully, installation is painless and you won't even have to remove the standard mounting clips on your motherboard if you



have a standard AMD system, as the cooler clips straight onto them.

Delving into the software revealed a trio of speed presets, as well as a custom mode. The quiet mode aggressively skewed the fan and pump speed in favour of low noise, and saw our Core i9-12900K hit its thermal limit after five minutes under full load. This won't be an issue unless you do a lot of video editing, encoding or rendering or other heavily multi-threaded tasks.

With the pump and fan running at full speed, the Corsair's CPU delta T of 68°C wasn't bad considering it was cooling Intel's current 16-core flagship mainstream CPU, but this result was still 8°C warmer than the result from the be quiet! Silent Loop 2 120mm.

Likewise, in our overclocked AMD Ryzen 7 5800X test rig, the Corsair's result of 65°C at full speed was again several degrees warmer than that of the be quiet! Silent Loop 2 120mm and EK AIO 120 D-RGB, and our CPU also became very hot when the fan and pump speeds were set to quiet mode, hitting a delta T of 79°.

However, the Corsair was also quieter than most other coolers on test at full speed, and the software sensibly monitors the coolant temperature (rather than just the CPU temperature) to slow the fan and pump ramp up times, making the noise easier still on your ears.

Conclusion

Corsair's iCUE H60i RGB Pro XT is better suited to mid-range CPUs such as Intel's Core i5-12600K and AMD's Ryzen 5 5600X, rather than top-end chips.

While it might not offer the best cooling on test, the Corsair's flexible software, quiet operation, RGB lighting, extra fan screws and

CUE UP

- + Software control
- + Reasonable cooling
- + Easy installation

QUEUE UP

- Expensive
- Not the best cooling results
- Currently requires separate adaptor for LGA1700 CPUs

official LGA1700 support mean that it still comes highly recommended to those who want software-controlled RGB lighting and cooling, as well as a quiet liquid cooler – you just need to be aware of its limitations.

VERDICT

Reasonable cooling and excellent software, although it's also expensive and you'll need an LGA1700 adaptor kit for Alder Lake systems.

Intel LGA1700			
COOLING 34/40	FEATURES 19/20	OVERALL SCORE 84%	
DESIGN 16/20	VALUE 15/20		
FITTING Easy			

AMD Socket AM4			
COOLING 34/40	FEATURES 19/20	OVERALL SCORE 84%	
DESIGN 16/20	VALUE 15/20		
FITTING Easy			

SPEC

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

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)

120 x 157 x 52 (W x D x H)

Fans 1x 120mm

Stated noise 37dBA

DEEPCOOL GAMMAXX L120 V2 / £57 inc VAT

SUPPLIER technextday.co.uk

Giving you change from £60, the Deepcool Gammaxx L120 V2 is one of the cheaper AIO liquid coolers in this month's Labs test, yet it still manages to include RGB lighting on its pump and a single 120mm fan. The lighting is fairly simple, though, with no fancy diffusing effect or flow indicators. There are also no extra fan screws included for mounting an additional fan, although you do get a sachet of thermal paste instead of it being pre-applied on the contact plate – handy if you ever need to remove and reinstall it.

Despite having a slightly longer radiator than some other coolers on test, the Gammaxx L120 V2 has its pump located above the contact plate as normal, rather than housing it in the radiator like the Aerocool. The waterblock/pump unit is very compact too, so it should fit in the CPU socket area of any motherboard.

The barbs for the tubing also rotate, allowing you to point the tubes in your chosen direction without putting pressure on them to turn through tight angles. Meanwhile, the pump and fan have separate 4-pin PWM cables, but their RGB cables can be daisy-chained

together to connect to a single RGB header.

Deepcool says the Gammaxx L120 V2 will include an LGA1700 adaptor in the near future (and you can order one for free too). Our older review sample came without one, but we were still able to mount it to the LGA115x/1200 mounting holes on our Asus ROG Maximus Z690 Apex motherboard without any problems.

The installation process was mostly trouble-free, but like several other coolers on test, it involves dealing with an excessive number of components. For example, the pump mounting plates require four tiny screws to install, rather than slotting into place, while the backplate installation procedure could pass as a Meccano set.

On our LGA1700 system dealing with a mighty Core i9-12900K, the CPU delta T of 67°C was better than half the other coolers on test, but still 7°C adrift of the lowest result achieved by the more expensive be quiet! Silent Loop 2 120mm. The EK AIO 120 D-RGB was also much better in this respect. The Deepcool can handle Intel's latest top-end CPUs, but they get hot.

In our AMD system cooling an overclocked Ryzen 7 5800X, the Deepcool's CPU delta T of 64°C was much closer to the competition, with its result bettering those of the Corsair iCUE H60i RGB Pro XT, NZXT Kraken 120 and Aerocool Pulse L120F. The pump proved to be extremely quiet at full speed as well, although the fan was fairly loud (although not disastrously so), with several other coolers on test this month offering lower fan noise levels.

Conclusion

As the cheapest cooler on test to offer reasonable temperatures in our LGA1700 Core i9-12900K test system, the Deepcool Gammaxx 120 V2 offers better value than lots



of the coolers on test for LGA1700 cooling, and its pump is also fairly quiet.

The competition is a little stiffer when it comes to cooling an AMD AM4 system, so even though the Deepcool is cheaper than the other coolers on test, you'll be better off paying a bit more money for a better-performing cooler that's easier to fit. Overall, the Gammaxx L120 V2 is a good cooler – it's well priced and its compact pump eliminates CPU socket compatibility issues, but it requires a lot of parts to fit, and you can get better cooling for a bit more money.

VERDICT

Decent cooling for a reasonable price, although it requires a lot of parts to fit.

MAXIMUS

- + Reasonable cooling
- + Costs less than £60
- + Quiet pump

COMMODUS

- Other coolers offer lower temperatures
- Lots of components for installation

SPEC

Intel compatibility LGA1700, LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)

120 x 159 x 52 (W x D x H)

Fans 1 x 120mm

Stated noise 30dBA

Intel LGA1700

COOLING
35/40

FEATURES
15/20

DESIGN
15/20

VALUE
19/20

OVERALL SCORE
84%

FITTING
Easy

AMD Socket AM4

COOLING
35/40

FEATURES
15/20

DESIGN
13/20

VALUE
17/20

OVERALL SCORE
80%

FITTING
Easy

EK AIO 120 D-RGB

£73 inc VAT

SUPPLIER scan.co.uk

Better known for its huge range of custom water-cooling components, EK has produced numerous top-end all-in-one liquid cooler designs over the years, but it's now turning its focus to surprisingly affordable mainstream cooler designs. The AIO 120 D-RGB we're reviewing here retails for £73 inc VAT, which is cheaper than both the Corsair iCUE H60i RGB PRO XT and the be quiet! Silent Loop 2 120mm.

Both those coolers have advantages though. The be quiet! model has two fans compared to the EK's single fan, and the Corsair cooler has software control, which the AIO 120 D-RGB lacks. The EK cooler has the best-looking RGB lighting on test this month, though, and it has the most premium-feeling build quality in this Labs test as well.

The RGB lighting is controlled by a 3-pin digital connection and the fan emits a beautiful diffused glow. The pump and fan lighting cables can be daisy-chained as well, so you only need to connect one cable to your motherboard.

What's more, the pump is extremely quiet at full speed and was practically inaudible from more than a foot away, while the fan running at full speed was a little quieter than the fans with the Deepcool Gammaxx 120 V2 and be quiet! Silent Loop 2 120mm.

Intel's new LGA1700 for its latest 12th-gen Alder Lake CPUs isn't supported by the EK cooler out of the box, but EK offers an adaptor

kit for under £5 including shipping, which we used for our testing this month. The cooler is easy to fit on all its supported sockets, although the pump section is quite large, which could be an issue on some motherboards that have a cramped CPU area.

You also get a separate tube of thermal paste, rather than having it pre-applied to the contact plate, meaning you can remove and reinstall the cooler without having to buy a new tube of paste – you get enough for at least two mounts on mainstream CPUs. While you only get the one fan with this cooler, the EK box does also include screws to fit a second fan if you want to upgrade it.

Even with the one fan, though, performance was excellent on both our CPUs, with the delta T of 61°C with our Core i9-12900K being the second lowest on test and only a single degree cooler than the be quiet! Silent Loop 2 120mm with its two 120mm fans. The AMD delta T of 62°C was the joint second result on test with the Antec Neptune 120 ARGB, and second only to the be quiet! cooler again.

Conclusion

The EK AIO 120 D-RGB combines fantastic looks with easy installation, an exceptionally quiet pump and a quiet fan at full speed too.

It also costs less money than many other coolers on test this month and it's easy to get hold of EK's LGA1700 adaptor kit for Alder Lake CPUs as well.



While its cooling performance is just pipped by the be quiet! Silent Loop 2 120mm, which managed to knock an extra degree or two off the temperatures thanks to its twin 120mm fans, the EK AIO 120 D-RGB's other advantages make it our top pick this month, plus it gives you the option to add a second fan in the future.

VERDICT

Fantastic cooling on both our test systems, an easy installation process, a quiet pump and great-looking RGB lighting. The EK is our top pick this month.

Intel LGA1700

COOLING
39/40

FEATURES
17/20

OVERALL SCORE

93%

DESIGN
19/20

VALUE
18/20



FITTING
Easy

AMD Socket AM4

COOLING
37/40

FEATURES
17/20

OVERALL SCORE

90%

DESIGN
19/20

VALUE
17/20



FITTING
Easy

SPEC

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

AMD compatibility Socket AM4

Radiator size with fans (mm)

120 x 155 x 52 (W x D x H)

Fans 1 x 120mm

Stated noise 36dBA

EK

- + Excellent cooling
- + Great-looking RGB lighting
- + Quiet pump

EEK

- No extra fan
- No software control
- Pump is quite large

GAMEMAX ICE CHILL 120 ARGB / £50 inc VAT

SUPPLIER cclonline.com

Despite costing just £50 inc VAT, the GameMax Ice Chill 120 ARGB manages to cram RGB lighting for both its fan and pump block into its package. It looks great too, with an infinity mirror effect on the single 120mm fan. The cables for the fan and pump can be linked together as well, allowing you to use a single 3-pin RGB header to power both of them.

There's no mention of official LGA1700 compatibility on GameMax's website, but the GameMax Ice Chill 120 ARGB installed fine on our Asus ROG Maximus Z690 Apex motherboard, with its lengthy sprung mounting screws seemingly offering enough pressure to make solid thermal contact with our CPU. The GameMax's mounting plate and backplate can cater for both LGA1700 and LGA115x/1200 mounting holes as well, so the design will be compatible with any LGA1700 motherboard, even if there's no mention of official support.

Installing the Ice Chill 120 ARGB is incredibly easy, without the silly number of parts we've had to use to install some of the other coolers

ARGB

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

ARGY BARGY

- Expensive
- RGB connectors are proprietary
- Lots of cables

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)
120 x 155 x 52 (W x D x H)

Fans 1 x 120mm

Stated noise 30dBA

on test, such as the be quiet! Silent Loop 2. The GameMax's backplate is pre-assembled and on AMD systems, and the cooler clips to the existing plastic mounts on your AM4 motherboard, so it can be installed in seconds.

While there are no screws in the box for adding an extra fan, GameMax at least includes a tube of thermal paste, so you don't need to worry about damaging a pre-applied layer, or having to buy more paste if you need to change your CPU or motherboard.

In terms of cooling performance, the Ice Chill 120 ARGB hit a delta T of 73°C when cooling our Core i9-12900K, which was the second warmest result on test, but the radiator did get warm, so we can only suspect that the GameMax's pump isn't particularly powerful, or that its fan design isn't as efficient as the others on test. Still, this result was 6°C cooler than the Aerocool Pulse L120F and a match for the SilverStone PF120 ARGB, but 13°C warmer than the more expensive be quiet! Silent Loop 2 120mm.

The GameMax's cooling power was far more competitive when it sat on top of our overclocked Ryzen 7 5800X, resulting in a delta T of 64°C, which is only two degrees warmer than the result from the EK AIO 120 D-RGB. While the GameMax's fan was reasonably loud at full speed, its pump was surprisingly quiet for such an affordable liquid cooler – only the pumps on the pricier be quiet! Silent Loop 2 120mm and EK AIO 120 D-RGB were quieter.

Conclusion

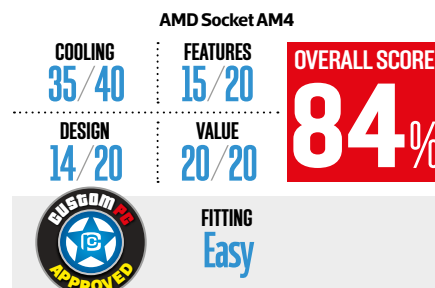
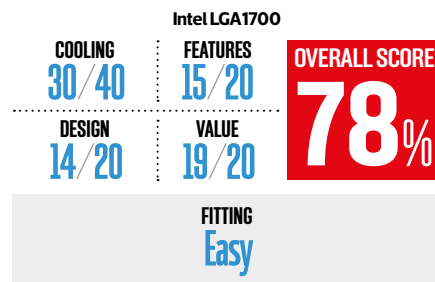
Given that the GameMax's mount seemed to apply enough pressure in our LGA1700 system to cater for the low heatspreader

height on Intel's new 12th-gen CPUs, we suspect its poor performance here is related to the pump or radiator and fan combination, but all the above could have had an impact.

That said, there's no mention of LGA1700 support, so we can't be too harsh here, as it was a shot in the dark. The GameMax was much better at cooling our Ryzen 7 5800X, where it bettered more expensive coolers and often with less noise too. It's a shame we can't recommend it for Intel Alder Lake CPUs, but at just £50 inc VAT, it's a great choice for AMD AM4 systems.

VERDICT

Not great for Intel's 12th-gen CPUs, but it's a bargain for AMD AM4 systems.



NZXT KRAKEN 120

£74 inc VAT

SUPPLIER cclonline.com

While NZXT's more expensive coolers are lavishly endowed with RGB lighting and software control, the Kraken 120 is only equipped with an RGB pump, sporting NZXT's familiar infinity mirror hologram effect. The waterblock section is significantly smaller than the one on NZXT's larger coolers too, which have had compatibility issues with some mini-ITX motherboards, including the Asus ROG Strix Z690-I Gaming WiFi we reviewed recently.

The reason the waterblock section is smaller is because this cooler's pump is actually located within the radiator fins rather than the waterblock, with a separate 3-pin power cable protruding from it, making it the only AIO liquid cooler on test this month to incorporate this type of design. This does mean there's a matchbox-sized area of the radiator that doesn't cool anything, although this area sits behind the fan's rotor, so it shouldn't impact too much on cooling.

Sadly, the Kraken 120's pump is also noticeably louder than that of some other coolers, although the fact that it will likely be placed at the rear of your case should mean the extra noise isn't too noticeable. You get a premium AER P120 fan in the box, and more recent models shipping from NZXT should also have LGA1700 mounting kits included, although these are available to buy separately as well.

Meanwhile, the RGB lighting for the waterblock needs to be powered by a 3-pin

RGB header, but the included 20cm cable means this should be simple to do with your motherboard, or with a separate controller hidden behind the motherboard tray. Installation is simple, especially on AMD Socket AM4 motherboards, as the cooler makes use of AMD's stock mounting clips, using brackets that hook to them on either end, so you can install the cooler in a matter of seconds.

Sadly, there's no extra thermal paste in the box, as the paste is pre-applied to the contact plate, so you'll need to make sure you don't touch it before you mount the waterblock. There are no screws for mounting an additional fan either, and the only notable extra is the ability to control the lighting using NZXT's CAM software, albeit via your motherboard.

The fan proved to be powerful, yet quieter than a lot of others on test, including those included with the be quiet! Silent Loop 2 120mm and GameMax Ice Chill 120 ARGB, but this didn't seem to impact its cooling performance much. Its CPU delta T of 65°C when cooling our Core i9-12900K was second only to the be quiet! Silent Loop 2 120mm and EK AIO 120 D-RGB, while the CPU delta T of 67°C from our Ryzen 7 5800 test rig was a little less competitive, being the second warmest result on test.

Conclusion

If it had a slightly lower price tag, we'd definitely recommend the NZXT Kraken 120 as a compact liquid cooler capable of taming Intel's 12th-gen CPUs, but the problem is that similarly priced coolers such as the be quiet! Silent Loop 2 120mm and EK AIO 120 D-RGB either offer cooler temperatures or more features.

There are plenty of better, cheaper options when it comes to AMD's Socket



KRAKEN

- + Good cooling on LGA1700 CPUs
- + Compact waterblock section
- + Easy to install

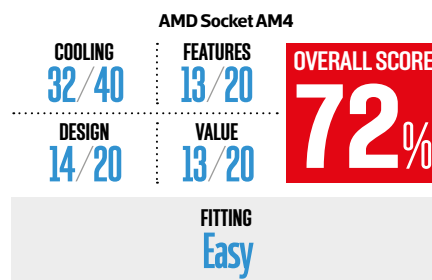
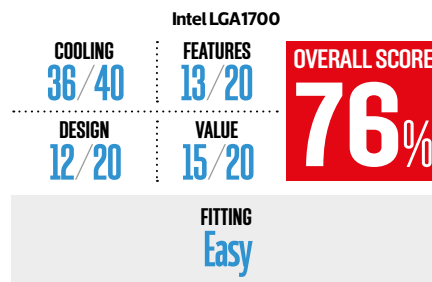
MINNOW

- Sparse feature set
- Other coolers offer better performance
- Pump louder than other coolers

AM4 too, which is a shame given the prowess of NZXT's other coolers. It's a solid effort as far as LGA1700 cooling goes, and we commend NZXT for getting to grips with adaptor kits too, unlike some manufacturers. However, there are better options available for the same or less money.

VERDICT

Good cooling on LGA1700 CPUs, but it's pricey for its limited feature set.



SPEC

Intel compatibility LGA1700, LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)

120 x 152 x 57 (W x D x H)

Fans 1 x 120mm

Stated noise 36dBA

SILVERSTONE PF120 ARGB

/ **£70** inc VAT

SUPPLIER overclockers.co.uk

The web page for the SilverStone PF120 ARGB is packed with impressive details about the cooler, and with its top-end price of £70 inc VAT, we were hoping for a cooler that matched the likes of the EK AIO 120 D-RGB and the quiet! Silent Loop 2 120mm, but for slightly less cash.

It gets off to a good start with the inclusion of addressable RGB lighting on the pump block and fan, and a lighting controller is included as well, if you want to have physical control over the lighting colour and modes rather than using your motherboard's software. The lighting itself is vibrant and accurate, and the semi-translucent fan blades did a good job of diffusing the light as well, so the lighting appears as a solid block of colour rather than separate pinpoints.

Meanwhile, the contact plate uses 0.2mm micro channels for improved heat dissipation, while the waterblock/pump unit uses a multi-chamber design to limit heat from the contact plate warming up the rest of the block, reducing performance. A sine wave generator also controls the pump, which is meant to keep electrical noise and vibration to a minimum.

SILVERSTONE

- + Snazzy RGB lighting
- + RGB lighting controller
- + Easy installation

M25

- Average cooling
- Noisy pump
- Cheaper coolers offer better performance

SPEC

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

AMD compatibility Socket AM4, AM3/+

Radiator size with fans (mm)

120 x 153 x 53 (W x D x H)

Fans 1 x 120mm

Stated noise 36dB(A)



Installing the SilverStone PF120 ARGB was easy in our test systems, with the fitting process just requiring sprung screws and clips for AMD systems, using the stock mounting brackets found on AMD motherboards, while there's a backplate with mounting pins for Intel's mainstream sockets.

We were also pleased to see that the box includes enough fan screws to mount a second fan if you want one, and you get a tube of thermal paste rather than a pre-applied layer as well, so you can remove and reinstall the cooler without needing to buy more paste.

Unfortunately, though, in testing, the SilverStone PF120 ARGB's pump was one of the loudest models on test, producing a medium-pitched whine that was noticeable outside our case when the fan was running at on low speed. This is a shame, as the included fan is powerful and also one of the quietest on test when at full speed.

Sadly, there were no impressive temperatures to be seen from the SilverStone either. The CPU delta T in our LGA1700 system sat at 72°C when cooling our Core i9-12900K, which was 12°C warmer than the result from the be quiet! Silent Loop 2 120mm after our lengthy stress test. Only the cheaper GameMax Ice Chill 120 ARGB and Aerocool Pulse L120F offered worse cooling than the SilverStone on this socket.

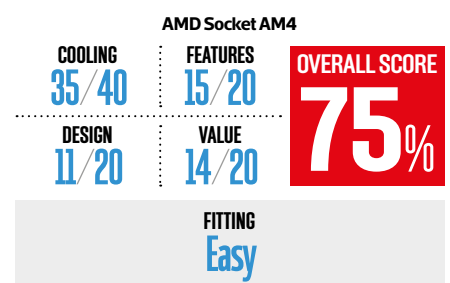
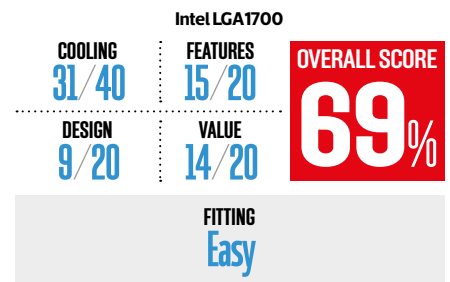
The SilverStone fared much better when we pitched it against our AMD AM4 test system, with the CPU delta T sitting at 64°C when dealing with our overclocked Ryzen 7 5800X. This was only 4°C off the top spot, but even then, three coolers on test this month still performed better than the SilverStone, albeit by only a few degrees.

Conclusion

On paper, the SilverStone PF120 ARGB seems to offer decent credentials for a well-priced AIO liquid cooler. If it had the cooling chops, it could have picked up an award thanks to looking great once illuminated, as well as including an RGB lighting controller, extra fan screws and a tube of thermal paste. Sadly, though, its performance is average at best, and you'll get more features and better cooling from the EK AIO 120 D-RGB, and far better cooling for just an extra tenner if you go for the be quiet! Silent Loop 2 120mm. **CPC**

VERDICT

Despite looking good, the SilverStone struggles to justify its price, with average cooling performance across the board.



LABS TEST

Compare and contrast

Coveted for their high contrast ratios, VA monitors are the top choice for inky blacks and can bring video and games to life. **Edward Chester** puts five of the latest VA screens to the test

How we test

VA displays tend to have at least double the contrast ratio of IPS or TN panels, making them particularly desirable for watching video. This extra visual depth can also add atmosphere to games and is preferred by some people to the slightly more washed-out look of other LCD panel types.

The downside is that their response time is much slower than IPS or TN panels, making for sluggish gaming performance characterised by detail-destroying, ghostly trails behind fast moving objects. For this reason, we generally don't recommend them for competitive, fast-paced gameplay, although they can still hold their own in esports titles if you're just playing casually, and they're fine for single-player gaming.

We start our testing by assessing the fit, finish and features of the monitors, looking at the quality of materials, adjustability of the stand connections on offer and any other extra features. Next, we look at image quality, subjectively assessing the viewing angles and colour reproduction before moving onto testing colour accuracy, contrast, panel uniformity and more with a colorimeter.

We then assess the gaming potential of the screen subjectively by playing games on them. We look at the responsiveness and whether the screen offers any

clarity-improving modes for fast motion, such as backlight strobing blur reduction, adaptive sync (FreeSync and G-Sync) or overdrive options in the on-screen display (OSD) control system. We also assess the response time using the BlurBusters UFO ghosting test, taking pictures of the screen to determine the level of ghosting or smearing.

Most of these displays offer HDR modes but they don't boost native contrast or colour range, instead just employing dynamic adjustments to the overall backlight brightness and colour balance. None are what we would consider worth using at all, so we've not recorded test results for these modes.

VA panels (right) have more noticeable ghosting than IPS panels (centre) and TN panels (left) but better contrast



Contents

- AOC CQ27G3SU / p45
- BenQ Mobiuz EX2710R / p46
- Gigabyte G27FC / p47
- MSI Optix MAG322CQR / p48
- Samsung Odyssey G5 LC27G55TQWRXXU / p50
- Results graphs / p52

AOC CQ27G3SU / £340 inc VAT

SUPPLIER box.co.uk

AOC has a solid track record when it comes to more budget-focused gaming monitors, with them often offering a great balance of performance and features for a great price. Those qualities are highlighted perfectly with this latest model.

Where this display is perhaps less impressive is with its design. There's nothing much wrong with its nearly all-black plastic colour scheme – other than the little red highlights on the lower bezel and back of the panel – and its generally slim look. However, it lacks just that final sense of clean finesse that the MSI and Samsung displays on test this month possess.

Another less than perfect showing is the OSD control system. AOC has improved the controls slightly over some of its other recent lower-cost displays, by making the power button a different size and shape from the other buttons, so it's not so easy to accidentally turn off the display midway through changing a setting. However, the row of buttons on the underside of the bezel is still a clunky choice compared with the mini-joysticks on the other displays tested here.

SPEC

Screen size 27in

Resolution 2,560 x 1,440

Panel technology VA

Maximum refresh rate 165Hz

Stated response time 4ms GTG, 1ms MPRT

Maximum brightness 300cd/m²

Stated contrast ratio 3,000:1

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.2, 2x HDMI 2

Audio 2x 3W speakers, headphone out

Stand adjustment Height, rotation, tilt

Extras 100 x 100mm VESA mount, 4-port USB 3.2 hub

These issues aside, though, the AOC hardly misses a beat. For a start, the stand offers height, rotation and tilt adjustment, which is more than most others on test, leaving only the option to pivot into a portrait orientation (not much use with a curved display anyway) as a move this stand can't perform.

You can, of course, also remove the stand and attach an alternative via the 100 x 100mm VESA mount beneath it.

Connection options are solid too, with a standard selection of one DisplayPort 1.2 and two HDMI 2 video inputs, along with a headphone out joined by a whopping count of four USB ports, one of which is rated to the 3.2 standard.

There are speakers too. They're rated at 3W a piece, which is higher than the typical 2W units, but they're not a significant upgrade to our ears.

As for image quality, this panel is astonishingly good. Other than a slightly high gamma rating, it basically offers perfect image quality right out the box. Just choose your brightness and away you go. All that, and the panel provides by far the highest maximum brightness and contrast on test.

The display uses a wide colour gamut by default (127 per cent sRGB), but you can clamp the gamut to 100 per cent sRGB with an sRGB mode. This fixes the brightness at a rather bright 248 nits, though, so it's not ideal for any setting other than brightly lit rooms.

HIGH FIDELITY

- + Excellent out-of-the-box image quality
- + Lots of features
- + Class-leading gaming performance

BACKGROUND NOISE

- High fixed brightness in sRGB mode
- Fiddly menu controls
- Red details mar its good looks



Gaming performance is also impressive, with the sharpest image in fast motion on test, even without an overdrive setting.

With overdrive cranked up and the backlight-strobing blur reduction mode engaged, it romps home with the win. Fast IPS and TN panels still hold a significant lead in terms of response time, with reduced trailing shadows and improved clarity in fast motion, but the AOC is still impresses for a VA panel in this respect. The blur reduction doesn't work while adaptive sync is enabled, though, which is a shame.

Conclusion

The AOC CQ27G3SU is a fantastic VA gaming monitor, offering capable gaming performance while delivering exceptionally high contrast and colour-accurate, sharp image quality. Add in the simple but smart design and plenty of features and you have a winner.

VERDICT

An exceptionally good VA gaming monitor, with great image quality out of the box.

IMAGE QUALITY

28/30

FEATURES
17/20

GAMING

25/30

VALUE
17/20

OVERALL SCORE

87%

BENQ MOBIUZ EX2710R / £400 inc VAT

SUPPLIER ebuyer.com

The BenQ EX2710R walks a different path to the other displays on test this month, as it not only focuses on gaming performance but multimedia too. To this end, BenQ has added uprated 2.1 speakers, a remote control for the OSD and a host of different settings to get the most from the display, depending on whether you're gaming or watching video.

It's not the slimmest or most dainty-looking display on test. Its stand is decidedly chunky and the edges of the panel don't taper to a particularly fine point. The addition of silver and red to the stand, along with a cross of RGB lighting on the back, also means this display lacks the subtle, understated charm of the MSI and Samsung models.

REMOTE CONTROL

- + Reasonably powerful 2.1 speakers
- + Decent image quality
- + Solid gaming performance
- + You get a remote control!

OUT OF CONTROL

- Chunky design
- Very poor default image and sound
- Remote and speakers add to the price

SPEC

Screen size 27in

Resolution 2,560 x 1,440

Panel technology VA

Maximum refresh rate 165Hz

Stated response time 1ms MPRT

Maximum brightness 300cd/m² (SDR), 400cd/m² (HDR)

Stated contrast ratio 3,000:1 (SDR and HDR)

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.4, 2x HDMI 2

Audio 2.1 channel speakers (2 x 2W tweeter, 5W woofer), headphone out

Stand adjustment Height, rotation, tilt

Extras 100 x 100mm VESA mount, 2-port USB 3 hub

This display impresses in terms of features. Its stand offers height, rotation and tilt adjustment, while around the back are one DisplayPort 1.4 and two HDMI 2 video inputs, plus a 2-port USB 3 hub.

Then there's that remote, which has a quality feel, with a directional pad in the middle for menu navigation, along with shortcuts for speaker volume and brightness controls, both of which are handy for multimedia use. It's good the remote is included too, as the OSD control buttons on the underside of the panel aren't the easiest to use, although they're far from terrible.

Disappointingly, the much vaunted 2.1 sound system sounded tinny and hollow when we first fired up the display. Image quality wasn't great either, with a lack of smoothness to colour gradations. That's because the display defaults to its FPS gaming mode, which applies a profile designed to highlight in-game sounds and boost the gamma of the image.

Thankfully, much better performance all round can be engaged by a (slightly hidden) single menu setting. Switch to the Standard input mode rather than Game input mode and the audio switches to the much better Pop mode and a host of image quality settings are changed. With this mode engaged, the audio sounds genuinely impressive. It's still not at the level of even sub-£50 desktop speakers, but you could happily watch a movie with them.

As for image quality, gamma is too high in the default modes but this can be fixed by switching to the gamma 2 setting rather than gamma 3.

Otherwise, colour balance is okay and contrast is impressively high, although panel uniformity is disappointing, resulting in an uneven-looking image. You also get an extended colour gamut of up to 127 per cent



sRGB in FPS mode, which is reduced to 114 per cent in the Standard mode.

In games, the BenQ held up well, with a faster native response time than most of the other panels on test, making for shorter ghosting trails in fast motion. The fastest overdrive mode also didn't introduce too much inverse ghosting, while tightening up the response. Add in the blur reduction mode and you have a viable fast-motion gaming display.

Conclusion

The relatively high price of this display is largely justified by its uprated speakers and included remote control, assuming those features appeal to you. This display also provides solid image quality and excellent gaming performance. If you're not fussed by the extra features, though, other monitors offer better value.

VERDICT

A great movie-watching and gaming display, with genuinely good speakers and a convenient remote control.

IMAGE QUALITY

25/30

FEATURES
18/20

GAMING

26/30

VALUE
15/20

OVERALL SCORE

84%

GIGABYTE G27FC / £240 inc VAT

SUPPLIER scan.co.uk

Dropping to a lower resolution than the other monitors on test, the 1080p Gigabyte G27FC can't compete with its competitors this month in terms of pixel density and general image sharpness. However, its lower price and 27in screen size should make it a decent entry-level gaming monitor if performance holds up.

If sleek looks are a requirement for your budget display, though, the G27FC falls at the first hurdle. The stand for this display has a very wide-footed base that looks decidedly dumpy compared with the slender bases of most other models on test. The sides of the housing are thick too, measuring 11mm thick all the way around – that's forgivable on a high-end panel with a fancy, ultra-uniform backlight, but surprising on a modest panel such as this one.

Thankfully, the stand offers more in the way of practicality, providing height and tilt adjustment. You miss out on little in the way of core features either. For video inputs, you get one DisplayPort 1.2 and two HDMI 1.4 connections, plus there's a 2-port USB 3 hub, a headphone jack and even a pair of 2W speakers. They're decidedly tinny, with none

of the bass that the BenQ can offer up, but they're fine for watching the odd YouTube clip out loud.

A single mini-joystick on the back right of the panel controls the on-screen display. The stick is a little fussy to use, often registering a left or right movement (moving between menu items) rather than an up or down movement (adjusting each setting) but it wasn't too much of a problem. The menus themselves are intuitive enough and include all the settings you'll need.

The big story when it comes to image quality is, of course, the reduced resolution, which does make for a limited experience, particularly for desktop work. However, we actually preferred reading text on this screen than the huge, higher-resolution MSI, as the text stayed sharper while scrolling.

Although image quality out of the box didn't look too bad, our tests showed a consistently low colour temperature and slightly low gamma. These needed tweaking via the OSD, switching to manual colour balance and dropping the red and blue channels to 94/100 and 96/100 respectively, then changing to the gamma 4 option rather than the default 3.

With these changes, the display put in a solid performance. Meanwhile, contrast is consistently high, peaking at 3,270:1, although it did notably drop to 2,540:1 once our tweaks had been made. Panel uniformity wasn't great either, resulting in noticeable variance in the image across the screen's expanse.

In gaming, the most obvious omission is support for a backlight-strobing blur reduction



mode. However, we found the response time of this panel to be natively decent anyway, resulting in a surprisingly snappy-feeling response in gaming. The BenQ and AOC outclass it here, but the Gigabyte does well for its modest price.

Conclusion

If you're after a high-contrast gaming monitor that doesn't break the bank, or ruin your gaming with overly slow, ghosting-riddled image quality, the G27FC is a solid option. Its 1080p resolution is limiting for many applications, but you won't need an expensive graphics card to run games at this resolution, and it's fine for watching HD video. It's just a shame about the rather lumpen design of the housing and stand.

VERDICT

A solid option for those seeking a high-contrast gaming monitor, although its 1080p resolution limits sharpness and it looks a bit dumpy.

SPEC

Screen size 27in

Resolution 1,920 x 1,080

Panel technology VA

Maximum refresh rate 165Hz

Stated response time 1ms MPRT

Maximum brightness 250cd/m²

Stated contrast ratio 3,000:1

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.2, 2x HDMI 1.4

Audio 2x 2W speakers, headphone out

Stand adjustment Height, tilt

Extras 100 x 100mm VESA mount, 2-port USB 3 hub

CRYSTAL CLEAR

- + Decent overall image quality
- + A good smattering of features
- + Solid gaming performance

CLEAR AS MUD

- 1080p resolution can be limiting
- Colour balance and gamma need tweaking
- Dumpy design

IMAGE QUALITY

20/30

FEATURES
15/20

GAMING

22/30

VALUE
17/20

OVERALL SCORE

74%

MSI OPTIX MAG322CQR / £330 inc VAT

SUPPLIER scan.co.uk

Considering the MSI offers you a panel with a diagonal that's fully 5in wider (corner to corner) than the 27in monitors on test, the reasonably low £330 asking price of this 32in display immediately heightens its appeal. What's more, there's plenty else to like about this display.

Despite its large screen size, the MAG322CQR cuts a fine figure thanks to its slim housing. The entire upper half is only 8mm thick, and although the bottom half is much thicker towards its middle, it still has reasonably thin-looking sides. The overall clean, matt black plastic aesthetic is also smart and unobtrusive. Meanwhile, the rather elegant, pointy-footed stand offers height and tilt adjustment but not rotation or pivot.

There aren't many extra features – there aren't even speakers, but there's a smattering of RGB lights on the rear that can be controlled using MSI's MysticLight app. You also get a headphone jack, along with one DisplayPort 1.2, one HDMI 2 and USB Type-C video inputs. The latter will be a major boon for those connecting up a laptop, and there's also a 2-port USB 2 hub.

SPEC

Screen size 32in

Resolution 2,560 x 1,440

Panel technology VA

Maximum refresh rate 165Hz

Stated response time 1ms MPRT

Maximum brightness 300cd/m²

Stated contrast ratio 3,000:1

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.2, 1x HDMI 2, USB Type C

Audio Headphone out

Stand adjustment Tilt

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



On the underside of the monitor is the power button, while around the back is a single mini-joystick for controlling the on-screen display (OSD). The control works well in conjunction with the speedy and intuitive menus.

Out-of-the-box image quality is decent, with near-perfect colour balance, a decent contrast ratio of 2,912:1 and a perfect gamma setting. This display has a wider than usual colour gamut, stretching to 122 per cent of the sRGB colour space, so colours technically look oversaturated, but it's not too obvious. Unlike with some displays, there's no way to reduce this back to 100 per cent coverage though.

We then switched to the manual colour balance setting to calibrate this display, and found we couldn't dial in a better colour balance than the default 'Normal' colour option, so we'd leave it set to that and rely on software calibration for any final tweaking – this monitor is good to go at its default settings.

In terms of gaming performance, this display maxes out at a 165Hz refresh rate and has a 1ms MPRT response time, plus it includes adaptive sync support and a blur reduction mode. However, the blur reduction doesn't work with adaptive sync, as is the case with most of the displays on test.

With or without blur reduction, though, this panel's response time was noticeably worse than that of some of the monitors on test this month. We really struggled in fast-paced games, with a smeared image and loss of detail.

This response time also seemed to affect the overall clarity of the screen for desktop use, with text all but disappearing into a blurry mess when scrolling through a document – we really

BIGGER IS BETTER

- + Dazzling colours and high contrast
- + Great for watching video
- + Elegant design
- + Great value

OVERSIZED

- Sluggish gaming performance
- Poor text quality
- No reduced gamut sRGB mode

wouldn't want to use this display for regular writing duties, for instance.

When watching video, though, this panel comes into its own. The strong high-gamut colours and high contrast give a real punch to the image, while the large panel size gives it real impact and makes it versatile as a display to view while sitting back on the bed or sofa, assuming you've got a decent speaker system.

Conclusion

This large 32in display offers decent value and makes for a great panel for watching video and playing slower paced games. However, its response time is slow even for a VA panel so it struggles with fast motion.

VERDICT

Great for video, but its image smearing makes it less accomplished for games and desktop work.

IMAGE QUALITY

22/30

FEATURES
16/20

GAMING

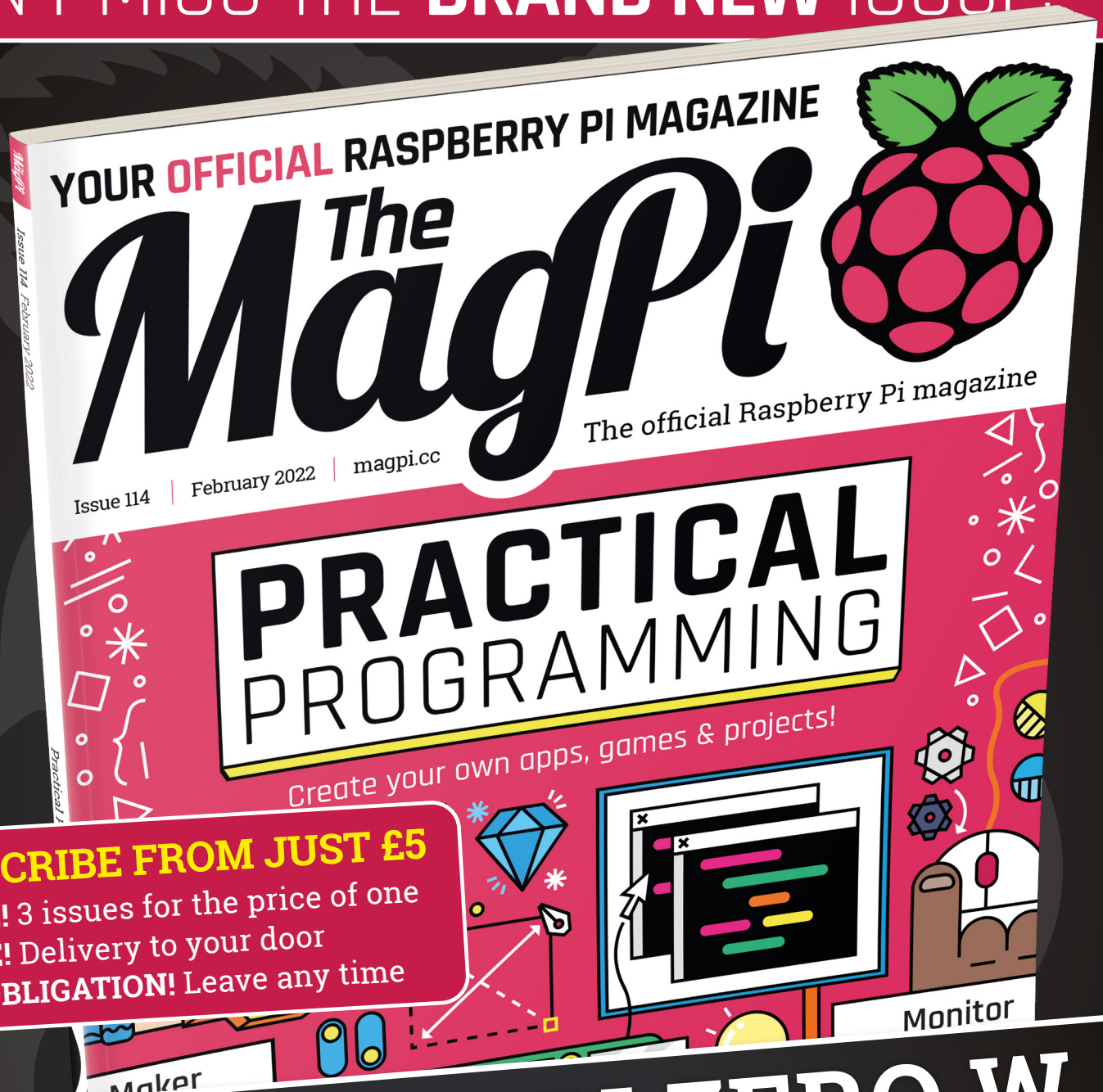
17/30

VALUE
17/20

OVERALL SCORE

72%

DON'T MISS THE **BRAND NEW** ISSUE!



SUBSCRIBE FROM JUST £5

- **FREE!** 3 issues for the price of one
- **FREE!** Delivery to your door
- **NO OBLIGATION!** Leave any time

**FREE PI ZERO W
STARTER KIT***

With your 12-month subscription to the print magazine

magpi.cc/12months

* While stocks last



**WORTH
£20**

Buy online: store.rpipress.cc

SAMSUNG ODYSSEY G5 LC27G55TQWRXXU

/ **£288** inc VAT

SUPPLIER overclockers.co.uk

The Samsung is the most basic of the monitors on test this month in several ways. Its stand offers no adjustment, it has no extended colour range and there's next to nothing in the way of extra features, which is why it's also the cheapest 2,560 x 1,440 display on test.

Open up the notably small box and the lightness of the entirely plastic stand is also striking, as is the complete lack of adjustability – not even tilt is on offer, so you can't angle the display up or down for taller or shorter users. The feet of the stand also stretch nearly the entire width of the monitor, which seems unnecessarily space-hogging considering the lack of adjustability.

ODYSSEUS

- + Smart design
- + Decent overall image quality
- + Solid gaming performance

ODYSSEUS' MEN

- Low maximum brightness
- No speakers or adjustable stand
- Middling contrast for a VA panel

SPEC

Screen size 27in

Resolution 2,560 x 1,440

Panel technology VA

Maximum refresh rate 144Hz

Stated response time 1ms MPRT

Maximum brightness 250cd/m²

Stated contrast ratio 2,500:1

Adaptive sync FreeSync and G-Sync

Display inputs 1x DisplayPort 1.2, 1x HDMI 2

Audio Headphone out

Stand adjustment None

Extras 75 x 75mm VESA mount, 2-port USB 3 hub

While it's basic, though, this is a smart-looking display. It eschews any flashy extras and instead has a muted black plastic finish throughout, with slim bezels around the screen. The panel also has a particularly tight curve, with a radius of 1,000in (as does the AOC), compared to the 1,500in radius of most of the other panels on test.

Curving a display in theory makes for a more consistent viewing angle across its width, and the tight 1,000in curve is even better attuned to a normal desk-sitting position than 1,500in curve, although it's less ideal for viewing elsewhere in a room (such as from a sofa or bed).

Around the back of the panel is a 75 x 75mm VESA mount for attaching alternative stands, along with a single DisplayPort 1.2 input, an HDMI 2 connector, a headphone out jack and the power supply input. You don't get speakers or a USB hub.

On the underside of the monitor's bottom bezel is a mini-joystick controller for controlling the on-screen display (OSD). The controls are fast and intuitive, as is the OSD, which also includes all the options you should need. However, the display strangely defaults to a maximum 60Hz refresh rate in its OSD, so you'll need to change this to 144Hz.

Image quality is generally quite good, with a fairly accurate colour balance and gamma response straight out the box, although dark grey tones can look a bit blocky/stepped (it took a full software calibration to smooth out these gradations).

There's also no extended colour gamut. This means colours lack the extra vividness that can be desirable when watching video or playing certain games, but it also means you don't have to worry about making sure the



display is in the correct higher or lower gamut mode for different uses.

Maximum brightness is low at just 259 nits and, for a VA panel, contrast isn't all that impressive at a peak ratio of 2,451:1. The former is particularly problematic for the blur reduction mode. These reduce peak brightness, and you get just a peak brightness of just 130 nits with this mode engaged.

When it comes to gaming, the blur reduction does work well at sharpening up fast motion but again the brightness is a problem. Otherwise, the display's performance is typical for a VA panel, with rather noticeable ghosting, but we could still play most games on it happily.

Conclusion

The Samsung could make for a decent choice for people seeking a very low-cost panel with high contrast and a 2,560 x 1,440 resolution. It has solid overall image quality and acceptable gaming performance. It's just a shame its maximum brightness is so low. **GPC**

VERDICT

A decent low-cost 2,560 x 1,440 monitor, but you can get quite a few more features by spending just a little more.

IMAGE QUALITY

22/30

FEATURES
11/20

GAMING

22/30

VALUE
16/20

OVERALL SCORE

71%

Wireframe

Join us as we lift the lid
on video games



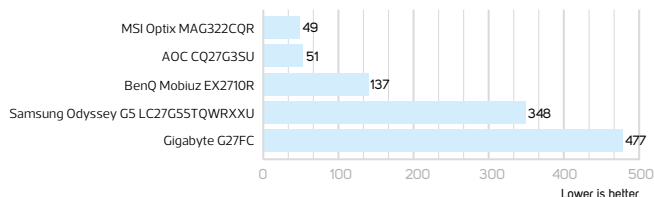
Visit wfmag.cc to learn more

VA GAMING MONITOR LABS RESULTS

DEFAULT / HDR MODE

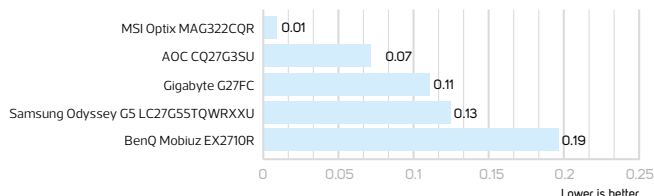
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



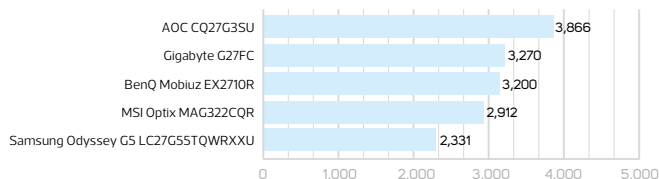
AVERAGE GAMMA

Deviation from ideal result (2.2)



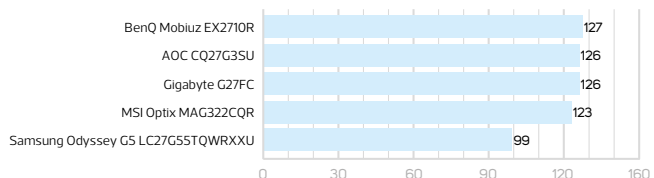
CONTRAST RATIO

Ratio of white-to-black luminance



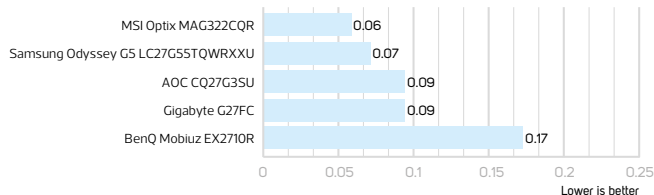
SRGB COLOUR SPACE

Percentage of sRGB colour space covered



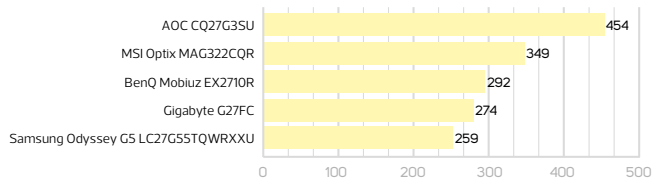
COLOUR ACCURACY

Average delta-E 2000



MAXIMUM BRIGHTNESS

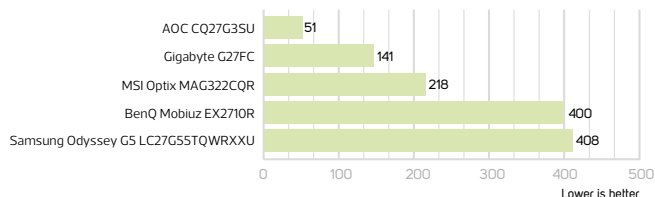
Brightness in cd/m² (nits)



CALIBRATED / SRGB MODE

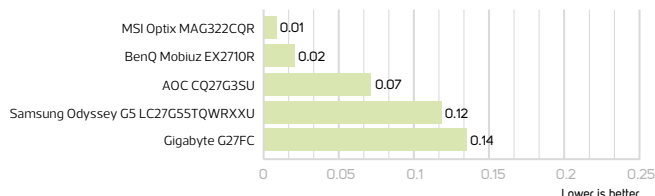
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



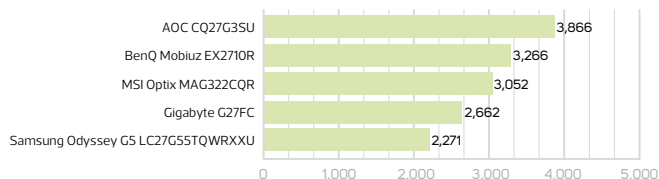
AVERAGE GAMMA

Deviation from ideal result (2.2)



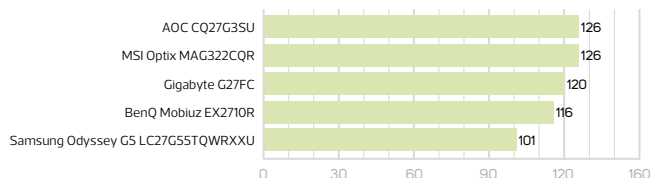
CONTRAST RATIO

Ratio of white-to-black luminance



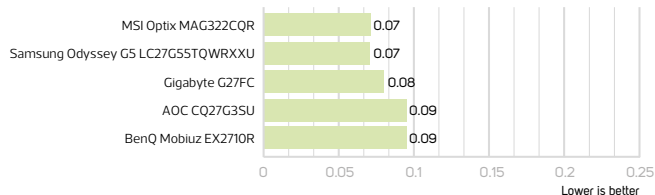
SRGB COLOUR SPACE

Percentage of sRGB colour space covered



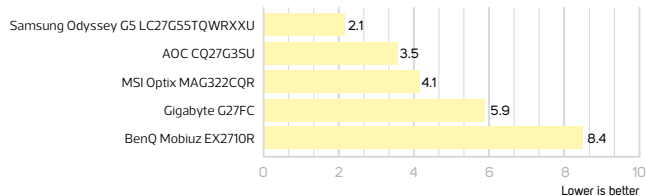
COLOUR ACCURACY

Average delta-E 2000



PANEL UNIFORMITY

Average variance in brightness cd/m² (nits)



HackSpace

TECHNOLOGY IN YOUR HANDS

THE **MAGAZINE**
FOR THE **MODERN MAKER**



SUBSCRIBE AND
SAVE UP TO
35%
on the cover price



ISSUE #51
OUT NOW

hsmag.cc



Available on the
App Store



GET IT ON
Google Play

How we test

MOTHERBOARDS

TEST PROCESSORS

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



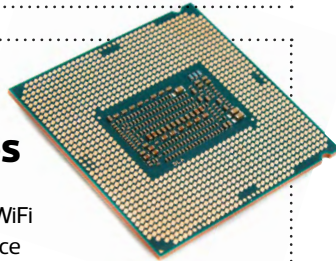
Common test hardware between our CPU test rigs includes a WD Red SN750 SSD, along with a WD Black SN850 SSD to test the speed of M.2 ports, and an Nvidia GeForce RTX 3070. We use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz DDR4 RAM, or 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM.

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 Core Temp.

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.



TEST KIT

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

GAME TESTS

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

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

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

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

POWER CONSUMPTION

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



CUSTOM PC AWARDS



EXTREME ULTRA

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



PREMIUM GRADE

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



PROFESSIONAL

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



APPROVED

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



CUSTOM KIT

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

CUSTOM PC REALBENCH

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

GIMP IMAGE EDITING

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

HANDBRAKE H.264 VIDEO ENCODING

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

LUXMARK OPENCL

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

HEAVY MULTI-TASKING

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

Core component bundles

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

8-core system with integrated graphics

8-core CPU, basic gaming

Needs a micro-ATX or ATX case. We recommend a 450W 80 Plus Bronze power supply. See Issue 218, p76 for an example build guide.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5700G	scan.co.uk	#218 p20	£310
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 (CMK16GX4M2B3200C16)	scan.co.uk	#218 p78	£60
MOTHERBOARD	Asus TUF B450M-PLUS II (micro-ATX)*	awd-it.co.uk	#218 p78	£75
STORAGE	500GB WD Blue SN570 (M.2 NVMe)	scan.co.uk	#222 p20	£50

Total £495

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

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-11400F	scan.co.uk	#215 p16	£150
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	#202 p20	£19
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	#220 p53	£540
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2B3200C16)	scan.co.uk	#204 p74	£60
MOTHERBOARD	MSI MAG B560 Tomahawk WiFi (ATX)	scan.co.uk	#215 p18	£160
STORAGE	1TB WD Blue SN570 (M.2 NVMe)	scan.co.uk	#222 p20	£80

Total £1,009

UPGRADES

SWAP GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	cclonline.com	#220 p55	£699
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£116
SWAP CPU COOLER	SilverStone Hydrogen D120 ARGB	amazon.co.uk	#217 p43	£49

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	£284
CPU COOLER	EK AIO 120 D-RGB (120mm AIO liquid cooler)	scan.co.uk	#223 p40	£73
LGA1700 ADAPTOR	EK-AIO LGA1700 Upgrade Kit	ekwb.com	#223 p40	£4
GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	cclonline.com	#220 p55	£699
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2C3200C16)	scan.co.uk	#221 p76	£70
MOTHERBOARD	Gigabyte Z690 Gaming X DDR4	ebuyer.com	#222 p46	£210
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£116
Total £1,456				

UPGRADES

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

Mid-range gaming system

12-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 i7-12700K	scan.co.uk	#220 p18	£390
CPU COOLER	NZXT Kraken X53 (240mm AIO liquid cooler)	scan.co.uk	#221 p76	£120
LGA1700 ADAPTOR	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	cclonline.com	#220 p43	£949
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2C3200C16)	scan.co.uk	#221 p76	£70
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	cclonline.com	#222 p48	£247
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£116
Total £1,896				

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 240mm all-in-one liquid cooler. We recommend an 850W 80 Plus Gold power supply.



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i7-12700K	scan.co.uk	#220 p18	£390
CPU COOLER	NZXT Kraken X53 (240mm AIO liquid cooler)	scan.co.uk	#221 p76	£120
LGA1700 ADAPTOR	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	ebuyer.com	#221 p48	£1,600
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2 C3200C16)	scan.co.uk	#221 p76	£70
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	cclonline.com	#222 p48	£247
STORAGE	1TB WD Black SN850	box.co.uk	#215 p49	£140

Total £2,571

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	£580
CPU COOLER	NZXT Kraken X73 (360mm AIO liquid cooler)	scan.co.uk	#221 p76	£140
LGA1700 ADAPTOR	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	#220 p53	£540
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 5200MHz DDR5 (CMT32GX5M2 B5200C38W)	corsair.com/uk	#221 p76	£320
MOTHERBOARD	MSI MEG Z690 Unify	scan.co.uk	#222 p50	£520
STORAGE	2TB WD Black SN850	scan.co.uk	#215 p49	£320

Total £2,424

UPGRADES

SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	ebuyer.com	#221 p48	£1,600
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	scan.co.uk	#214 p18	£280
AMD B550 (AM4)	Asus ROG Strix B550-I Gaming	scan.co.uk	#206 p44	£197

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	#206 p18	£100
TOWER	Ssupd Meshlicious	overclockers.co.uk	#219 p18	£92
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	£50
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	£80
SUB-£100 AIRFLOW	Corsair 4000D Airflow	scan.co.uk	#222 p56	£90
COMPACT	Fractal Design Meshify 2 Compact	scan.co.uk	#215 p20	£110
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	#212 p45	£130
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	#202 p44	£140
SUB-£150	Fractal Design Define 7	overclockers.co.uk	#204 p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	#187 p24	£215

Micro-ATX



Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD B450 (AM4)	Asus TUF B450M-PLUS II	awd-it.co.uk	#218 p76	£75
AMD B550 (AM4)	MSI MAG B550M Mortar	ebuyer.com	#204 p42	£120

Cases

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

Networking



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	#216 p52	£130
ROUTER	Asus RT-AX68U	scan.co.uk	#216 p51	£170
MESH ROUTER	Asus AiMesh AX6100	amazon.co.uk	#196 p54	£338
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	#196 p58	£60
DUAL-BAY NAS BOX	Synology DS220j	laptopsdirect.co.uk	#200 p22	£160
DUAL-BAY MEDIA NAS BOX	Synology DS218play	laptopsdirect.co.uk	#174 p34	£205
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	box.co.uk	#214 p28	£180
25IN, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	box.co.uk	#209 p57	£295
25IN, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	#212 p20	£549

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	£230
27IN, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	overclockers.co.uk	#209 p60	£299
27IN, 165Hz, VA, 2,560 X 1,440, F, G	AOC CQ27G3SU	box.co.uk	#223 p45	£340
27IN, 240Hz, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£590
27IN, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£606
28IN, 144Hz, IPS, 3,840 X 2,160, F, G	AOC U28G2XU	amazon.co.uk	#221 p29	£583

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, 165Hz, IPS, 2,560 X 1,440, F, G	LG UltraGear 32GP850	overclockers.co.uk	#220 p38	£450
34IN, 144Hz, IPS, 3,440 X 1,440, W, F	iiyama G-Master GB3461WQSU	scan.co.uk	#206 p53	£460
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	currys.co.uk	#206 p55	£949
38IN, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,199
32IN, 144Hz, IPS, 3,840 X 2,160, F, G, HDR	Asus ROG Swift PG32UQX	scan.co.uk	#218 p54	£3,299

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 75Hz, IPS, 2,560 X 1,440, F	LG 27QN880	box.co.uk	#210 p26	£427

Peripherals and audio

Gaming keyboards



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET TKL	SteelSeries Apex 3 TKL	currys.co.uk	#221 p59	£50
OPTICAL ESPORTS	Asus ROG Strix Scope RX	overclockers.co.uk	#209 p43	£70
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£180
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	#193 p56	£120
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£140
WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	overclockers.co.uk	#208 p60	£180

Gaming mice



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Corsair M55 RGB Pro	box.co.uk	#200 p24	£35
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	overclockers.co.uk	#215 p57	£50
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£58
WIRELESS	Razer Viper Ultimate	amazon.co.uk	#217 p54	£99
PREMIUM WIRELESS	Razer Deathadder V2 Pro	ebuyer.com	#210 p28	£115
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	#211 p28	£48
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	#217 p52	£112

Peripherals and audio cont ...



Game controllers



CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	#202 p50	£299
GAMEPAD	Microsoft Xbox One Wireless Controller	currys.co.uk	#191 p56	£55
PREMIUM GAMEPAD	Razer Wolverine V2 Chroma	razer.com	#221 p30	£149
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	#207 p52	£37
FLIGHT STICK	Thrustmaster T.16000M FCS HOTAS	scan.co.uk	#207 p56	£140

Gaming headsets

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET STEREO	Roccat Elo X Stereo	scan.co.uk	#210 p56	£40
STEREO	Epos Sennheiser GSP 300	amazon.co.uk	#210 p54	£50
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	#204 p50	£155
PREMIUM WIRELESS	Razer BlackShark V2 Pro	scan.co.uk	#211 p26	£180

Speakers

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

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS 84-KEY ELECTRO-CAPACITIVE	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	£722
BUDGET GAMING	PC Specialist Magnus Supreme	Intel Core i5-12600KF	Nvidia GeForce RTX 3070 Ti	custompc.co.uk/Magnus	#223 p26	£1,499
4K GAMING	Scan 3XS Vengeance Ti	Intel Core i9-12900K	Nvidia GeForce RTX 3080 Ti	custompc.co.uk/ScanVengeance	#221 p34	£3,499
WATER-COOLED ALDER LAKE	CyberPower Hyper Liquid Infinity X129	Intel Core i9-12900K	Nvidia GeForce RTX 3080	custompc.co.uk/CPHL	#222 p34	£4,035
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	custompc.co.uk/Barracuda	#145 p58	£14,586

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	£1,499
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
PREMIUM RTX GAMING	Asus ROG Strix Scar G733QSA	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3080 Laptop	17.3in, 1,920 x 1,080 IPS 360Hz	custompc.co.uk/ROGScar	#217 p28	£2,599

Games



RICK LANE / INVERSE LOOK

NO FUN TOKENS

NFTs are a pyramid scheme designed to swindle and entrap investors, argues Rick Lane

Non-fungible tokens, or NFTs, have been one of the defining topics of 2021. They emerged early in the year as a supposed method of authenticating ownership of digital items through the blockchain. Essentially digital receipts kept inside a digital safe, NFTs identify a specific person as the sole owner of a digital image, video or other virtual item.

However, not only do NFTs' reliance on blockchain technology make them incredibly environmentally unfriendly, but they also do nothing to limit the sharing or reproduction of the file with which the NFT is associated.

Buying an NFT is like buying a plot of land on the moon. You may hold the piece of paper claiming ownership of the land, but good luck trying to prevent NASA from treading on it. This makes NFTs catnip for scam artists and charlatans, letting them essentially create their own digital moons and then sell you plots of land on them.

NFTs are especially ripe for exploitation in an industry that's been pulling similar tricks for years. The game industry has a long history of creating and selling digital items, from hats in Team Fortress 2 to licensed avatars in Fortnite. NFTs, so their proponents tell us, will allow players to truly put their stamp on their game, being able to own the only Santa hat in Team Fortress 2, or the only Xenomorph skin in Fortnite.

Several NFT-related projects have already surfaced from studios such as Ubisoft. Perhaps the most notable recent announcement is Peter Molyneux's game Legacy, which has already sold \$52 million US worth of in-game 'land', upon which

players will supposedly build their own virtual businesses and trade in the game's unique Legacy Coin cryptocurrency.

The world that Molyneux and other NFT advocates promise is one where players can 'play to earn', making real money through playing the game, buying in-game items with cryptocurrency and selling it on for a profit. The more likely outcome is a nightmare combination of earn-to-play and pay-to-win, where a minority of players hold all the most valuable and powerful items, while everyone else is left to grind out a meagre living through hours of tedious busywork.

Indeed, in an interview with The Verge, Molyneux openly compared Legacy with the 19th and 20th-century phenomenon

of company towns, decentralised industrial settlements where the workers were paid in local currency known as 'scrip', entrapping them inside that ecosystem while the magnates reaped all the profits.

Of course, Molyneux's recent record of delivering on projects isn't exactly stellar.

His last game, Godus, is still in Early Access, and has a 'mostly negative' rating on Steam. Meanwhile, multiple NFT projects have seen their creators run off with the cash, such as the Evolved Apes fighting game, where the creator disappeared with \$2.7 million US worth of investors' money.

The NFT dream being sold is an objectivist fantasy spun by those who can't see the value in something beyond its potential to produce money. At best, NFT games are a scam designed to swindle foolish speculators out of their investment. At worst, they're an outright attempt to turn players into workers and developers into landlords. Either way, don't fall for it. **GPG**

At best, NFT games are a scam designed to swindle foolish speculators

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



Age of Empires 4 / £49.99 inc VAT

DEVELOPER Relic Entertainment / World's Edge / PUBLISHER Microsoft

Age of Empires 4 is a classy update of a classic strategy game. Embracing the series' age, Relic's strategy revamp offers a familiar blend of historical city building and frenetic RTS combat in a lavish and substantial package.

The game is centred around four single-player campaigns that each see you play through the Norman Conquest of England, the Hundred Years' War, the Mongol conquest of Asia and the founding of the Russian nation. Aside from the Norman campaign, which is essentially an extended tutorial, each campaign focuses on the strengths of that civilisation. The Mongol Campaign, for example, emphasises the Mongols' aggressive cavalry tactics, while the Russian campaign is more orientated around defensive strategies and using post-gunpowder siege equipment.

These campaigns are made with admirable attention to detail. Relic and World's Edge squeeze an impressive amount of variety out of Age of Empires' base mechanics.

Missions range from more narrative-driven scenarios, such as the opening depiction of the Battle of Hastings, to more unusual encounters, such as holding off a

massive French army while awaiting reinforcements by the English King Henry I. Between every mission is a wonderfully produced, BBC-style mini-documentary that contextualises the events leading up to the mission, complete with dramatic flyovers of famous landmarks, from the white cliffs of Dover to the Great Wall of China.

Indeed, Age of Empires 4 looks fantastic. The slightly stylised visuals are crisp and colourful, while Relic has imbued many of the game's actions with its trademark physicality. Placed buildings land with a gratifying thump, while city walls and watchtowers spectacularly crumble beneath your siege weapons.

Sadly, that sense of tactility doesn't extend to your soldiers. Actions such as launching a volley of arrows, or smashing into enemy ranks with cavalry, lack any sense of momentum or physicality. Age of Empires 4's presentation of history is also a little too clean and orthodox when it skirts around the less savoury parts of history.

For example, the Mongol campaign conveniently avoids mentioning that army's tendency to terrorise nations by massacring entire cities' worth of people. Meanwhile, the Norman campaign's staunchly monarchical perspective becomes absurd when you assume the role of King John, fighting rebel nobles protesting the King's refusal to acknowledge the Magna Carta.

This isn't to say Age of Empires should be a grisly affair. However, its overview of history is slightly too distanced from the grubbier reality, and it ends up whitewashing some events that should be more starkly presented. Otherwise, though, Age of Empires 4 is a successful attempt to bring the classic strategy game into the 21st century.

RICK LANE

NORMAN CONQUEST

- + Great balance of classic mechanics with modern production
- + Meticulously designed campaigns
- + Stylish mini-docs between missions

NORMAN BATES

- Combat needs more modernising
- Presentation of history is a bit too clean

/ VERDICT

A faithful and meticulous update to the classic formula, although it's a little too conservative in some areas.

OVERALL SCORE

80%





Forza Horizon 5 / £49.99 inc VAT

DEVELOPER Playground Games / PUBLISHER Microsoft



Few games guarantee a good time like Forza Horizon. Playground Games' open-world drive 'em ups currently offer the first and last word in arcade racing, with an alluring combination of amazing locations, a huge range of vehicles to drive, an accessible and flexible driving model, plus a relentlessly upbeat tone.

Not only does Forza Horizon 5 continue this proud tradition, but it's probably the best entry in the series yet. While it's not as innovative as Forza Horizon 4, it does a better job of balancing the features that its predecessor introduced, and the result is a superior experience both in single-player and multiplayer modes.

For its fifth outing, the Forza Horizon Festival sets its sights on Mexico, with Playground Games producing a rugged and diverse map that's a delight to drive around. Its environments range from sandy beaches through verdant jungles to cacti-strewn desert, with a vast rumbling volcano looming over them all at the centre of the map.

It feels both more expansive and more varied than Forza 4's truncated representation of Britain although, unlike FH4, it's overwhelmingly rural. There are a couple of small villages and one largeish town, but it lacks an equivalent of FH4's brilliant depiction of Edinburgh.

Aside from the map, the biggest difference between Forza Horizon 4 and 5 is the latter's more structured single-player campaign. As before, you play as the festival's star driver, having built a reputation for your skills behind the wheel in previous festivals. The introduction is typical of Forza Horizon games, opening with an enormous cargo plane dropping multiple cars around the map.

You get to briefly drive each of these cars, ploughing through a sandstorm in an orange corvette, and startling flamingos out of a river in a Porsche 911, all before racing the plane itself to the festival's main hub. It's a great distillation of the game's joyous spectacle, with the air filled with hot-air balloons and coloured powder bombs as you skid to a halt in the centre of the main racetrack.

Yet whereas FH4's single-player game was pitched as a warm-up for the game's persistent online multiplayer game, the two are more evenly interwoven in FH5. The game's single-player story is framed around expeditions – large-scale events that see you expanding the festival to new outposts.

Examples include racing to the top of a volcano to see its fiery caldera while a news helicopter records your every move, or careening through the jungle while a tropical storm rumbles overhead. Completing these expeditions reveals new racetracks in the game world and unlocks additional story-driven events centring around specific non-player characters.





Adding narrative to a racing game is always a challenge. It's hard to build a coherent, engaging story out of sports car races and drifting challenges. However, FH5 does an admirable job lending context interesting to its stylish and silly events. It helps that the game keeps the tone light-hearted and earnest, avoiding the try-hard edginess that has undermined so many Need for Speed games.

This approach doesn't work 100 per cent of the time. Your driver's inability to question the safety of driving toward an erupting volcano provides an amusingly incongruous moment, and there are some other issues with the tone that we'll discuss shortly. For the most part, though, FH5's unbridled enthusiasm helps to smooth over creases in the logic.

Outside of expeditions, FH5 is the series' familiar, generous self. There's an abundance of different event types, including races both on and off roads, cross-country sprints, drag races, photo opportunities, jump challenges, 'barn-finds' that contain rare and unusual cars, and much more. The points awarded for participating in these events, combined with the skill points handed to you for doing pretty much anything, mean you're constantly unlocking new cars to drive, alongside cosmetic and other rewards.



Multiplayer, meanwhile, sees the return of Forza Horizon 4's weekly 'seasons', in which the map changes each week to reflect one of the four seasons of the year. In Forza Horizon 4 that change was universal, so in winter the whole map would be covered in snow. But FH5's more environmentally diverse map means different areas have different seasons.

As such, summer (or the dry season) will see a greater prevalence of dust storms in desert areas, while autumn will be wetter, with muddier jungle roads and more frequent thunderstorms. During these seasons, you can compete in different event types – such as the head-to-head battle-royale event The Eliminator – to win rare cars and other prizes. The whole game can also be played cooperatively with other players, with you travelling around the game world together and jumping into the same races.

The whole game feels great to control too. It offers slick and responsive arcade handling by default, with more realistic options available to more experienced players. Every vehicle feels noticeably different too – trying to dive a McLaren sports car through the jungle will be far more challenging than doing the same race in a Jeep 4x4. Obviously, it can't match the accuracy or detail of, say, Dirt Rally, but that's not what Horizon is about.

One issue, though, is that Forza Horizon 5's relentless positivity doesn't always serve it so well in its new location. While the game generally avoids the obnoxiousness of many other arcade racers, there are certain events in the game, such as setting up a festival outpost in a pristine patch of rainforest, where its happy-go-lucky attitude can't outrun the egregious display of wealth and hedonism in what's an increasingly vulnerable ecosystem. That's not to say that we expect incisive environmentalist commentary from FH5, but there's a few areas where being more tonally and culturally conscious wouldn't have gone amiss.

This aside, Forza Horizon 5 is another wonderful arcade racer from Playground Games. It's huge, varied, endlessly rewarding and, above all, unmitigated fun. Whether you're a racing fanatic or you've never driven a car in your life, Forza Horizon 5 will almost certainly put a smile on your face.

RICK LANE

RACE LEADER

- + Big new location
- + More storied events
- + Loads of variety and fun

DNF

- Slight tonal issues

/ VERDICT

Forza Horizon 5 puts sees Playground Games lapping the competition as the undisputed champions of arcade racing.

OVERALL SCORE

90%

Call of Duty: Vanguard / £49.99 inc VAT

DEVELOPER Sledgehammer Games / PUBLISHER Activision

Vanguard sees the Call of Duty series returning to the well-trodden battlefields of WWII, with the campaign promising a different kind of WWII adventure. Framed around a fictional special forces team on a clandestine mission in the dying days of the war, the opening mission sees you hijack a train on its way to bombed-out Berlin, before infiltrating a hidden submarine base to retrieve intel on a secret Nazi operation known as Project Phoenix.

It's an exciting and unusual introduction, with shades of Wolfenstein's weirdness. Unfortunately, your team is then immediately captured by the Germans, and spend the whole campaign imprisoned beneath some Berlin administrative building. The remaining missions are all flashbacks to the individual team members' experiences during the war, conveniently covering nearly every theatre.

It's basically a standard Call of Duty campaign dressed up to appear like something new. That doesn't mean it's terrible. There are some excellent individual missions, including a fraught battle through a Pacific jungle with an all-black American regiment, and a harrowing depiction of the Wehrmacht's initial assault on Stalingrad, seen through the eyes of your squad's crack sniper, Polina Petrova. For the most part, though, it's minor variations on the usual WWII tour, and apart from the missions that bookend the game, you never get to see your squad work as a team.

The multiplayer game similarly struggles to innovate. The headline new features are destructible maps and a system called Combat Pacing, which basically adjusts the



intensity of battles through several tiers of player-count limits. The former is a welcome addition, but underwhelming in execution, limited to a few destructible walls and a more cosmetic 'grubbing up' of maps over time. The latter lets you choose whether you want CoD to feel more like Counter-Strike or Battlefield, which lends the game a respectable flexibility, but it's not exactly a reason to rush out and buy it.

The one real highlight here is a new mode called Patrol, a variant upon a capture-and-hold scenario where the capture point moves randomly around the map. The result is a thrilling and frantic take on Domination, which eliminates the problem of camping and point squatting, where both teams must constantly adjust their angles of attack and defence in accordance with the map's layout. It's a fun mode, but again, not a game-defining feature.

Ultimately, Vanguard's dabbling in new concepts can't distract from the fact that Call of Duty is crying out for some proper innovation, a more ambitious campaign or a new take on multiplayer. It isn't a bad game, and if you're a fan of WWII shooters, it does the job well enough. As an FPS in these times, though, Vanguard is stuck in the past both functionally and thematically.

RICK LANE

VANGUARD

- + Neat campaign premise
- + Some great missions
- + Patrol is a multiplayer highlight

RESERVE

- Ultimately derivative
- Tired format
- Lacks innovation



/ VERDICT

Has a few good ideas, but they're undermined by the game's reluctance to change its format.

OVERALL SCORE

60%



Exo One / £14.49 inc VAT

DEVELOPER Exbleative / PUBLISHER Future Friends Games / Exbleative

Exo One straddles the line between game and interactive screensaver, being an incredibly pretty but functionally simplistic sci-fi adventure in which you propel a highly unusual spacecraft across dramatic alien worlds.

Its core systems are based almost entirely around flying your spacecraft, which doesn't move like a conventional earth-built aircraft. Instead, it's a cross between a glider and a gravity-propelled marble. Pressing the left mouse button plummets your spacecraft towards the ground, picking up momentum through the air and on downward terrestrial slopes. Releasing the button will then see it gradually ascend, while holding down the left Shift key transforms the spacecraft from a ball to a disc, helping it to maintain altitude.

The challenge centres around keeping that momentum going, using the terrain to gain speed, then transforming to glide mode at the right moment to keep yourself aloft as long as possible. You can also make limited use of environmental phenomena to help stay in the air. Flying through clouds provides a boost of speed, while occasional geysers and plumes of hot air will push you higher in the sky.



Exo One's biggest success is in how it captures a sense of otherworldliness. Your strange spacecraft is based on accounts of UFO encounters by fighter pilots, and its sudden acceleration and changes in altitude reflect those descriptions well. Moreover, the various planets you visit all feel delightfully alien, from a vast water planet with oceans pummelled by falling meteors, to more surrealist landscapes dominated by geometrically bizarre rock formations.

As a sensory experience, Exo One is a triumph. Soaring across beautiful worlds and through enormous weather systems makes for sublime sci-fi. However, the fun stops when your spacecraft stops, which can be quite often. If you get stuck in a bowl of terrain, regaining momentum can be difficult, while progress is often a frustrating stop-and-start affair. The game would benefit from an ability to kickstart your spacecraft from a stationary position, helping you to quickly get back into the game's hypnotic flow.

More broadly, beyond its interesting movement and spectacular vistas, Exo One doesn't have much else to offer. There's a story of sorts, but it's so vague it's a nonentity. Meanwhile, the differences between planets are largely cosmetic, and the game struggles to tie the changes in environment to new ways to play with its central movement mechanic. It's essentially a marble run where you can fly over most of the obstacles.

Still, if you're after a light and breezy experience that delivers big on visual splendour and doesn't require too much commitment to enjoy, Exo One fits the bill. It doesn't always soar at the heights of which it's capable, but it's a marvel to see when it does.

RICK LANE

EXO ONE

- + Visually stunning
- + Interesting movement mechanic

EXO ZERO

- Relies heavily on flow that's easily broken
- Lacks mechanical variety

/ VERDICT

Pairs a unique movement system with alien worlds that are a joy to see, but its thrills devolve too easily into frustration.

OVERALL SCORE

64%

REALITY CHECK

In his latest VR roundup, **Rick Lane** readies himself for some weird VR adaptations, and tries his hand at some virtual Warhammer battling

REVIEW

WARHAMMER: AGE OF SIGMAR – TEMPESTFALL / £24.20 inc VAT

DEVELOPER Carbon Studio / PUBLISHER Carbon Studio

Warhammer: Age of Sigmar – Tempestfall is the latest game from Carbon Studio, developer of acclaimed VR spellcasting game *The Wizards* and its sequel. The studio's experience with spectacular fantasy nonsense would seemingly make it an ideal fit for an Age of Sigmar game. However, in *Tempestfall*, the spellcasting shenanigans of its previous titles takes a back seat to underwhelming melee combat.

Tempestfall puts you in the role of a Lord-Arcanum leading a group of Stormcast Eternals into the dark lands of Shyish to cleanse it of its undead denizens. You fight these creatures with various melee weapons, each of which can also be used to cast spells. Your sword, for instance, can be swung horizontally to fire bolts of electricity, or raised to the heavens to power it up for a more damaging attack.

Carbon Studio's prior experience in creating spellcasting games is evident in *Age of Sigmar*. Spells feel satisfying upon impact, while the gesture-based system for triggering them is enjoyable to use. Unfortunately, the opportunity to cast spells is diminished by the fact that most enemies fight you from melee range.

This means you need to rely heavily on *Tempestfall*'s melee combat, which is by far the weaker element of the game. Rather than basing its sword fighting on physics, *Tempestfall* uses a gestural system, where parry windows are highlighted by on-screen indicators. Taking advantage of these windows opens up enemies to attack, letting you pummel them into submission.

However, since there's no stamina limit on swings, you can simply dish out loads of sword strikes in quick succession until one of them triggers the parry, making the whole system a bit of a farce.

The problem is compounded by enemies that simply aren't much fun to fight. Most of the foes you encounter in *Tempestfall* are 'Nighthaunt' – wraith-like creatures that float above the ground. It's generally difficult to make floating enemies satisfying to battle, and bashing Nighthaunt with your weapons is like beating your bedsheets on a washing line.

Tempestfall is also a difficult game to comprehend more generally. Structurally, it splits the difference between having a linear and open world, giving you a primary objective to follow, along with several offshoot pathways, which lead to resources

that let you upgrade your weapons. Unfortunately, these paths can be very difficult to navigate, while the game makes the baffling decision to restrict your ability to upgrade weapons to the city's central hub, which results in a lot of tedious backtracking.

Combined with inconsistent presentation, where spectacular scenes such as crumbling buildings are coupled with flat environments and lumpen character designs, there's a sense that *Tempestfall* is a game that needed a few extra months of development.

Warhammer aficionados may find something to like about this Age of Sigmar title, but more general sword and sorcery fans will be better served elsewhere.

AGE OF SIGMAR

- + Good spellcasting
- + Some spectacular moments

RAGE OF SIGMAR

- Bad sword fighting
- Confusing level design
- Inconsistent presentation

VERDICT

Tempestfall's dark Warhammer adventure is undermined by iffy melee combat and tedious enemy design.

OVERALL SCORE

55%





NEWS

AMONG US VR

There's a running theme to this month's VR news, which is 'games that don't seem especially well-fitted to VR, are coming to VR'. First up is Innersloth's hidden-role mega-hit *Among Us*, which is getting a VR version in 2022.

For those unaware, *Among Us* sees up to ten players assume the role of lozenge-shaped spacemen working together to repair their perpetually beleaguered spaceship.

However, at least one player assumes the role of an impostor, whose goal isn't to repair the ship, but to murder all their crewmates. The impostor must eliminate all the crew without them figuring out who they are, while the crew must attempt to deduce the impostor's identity, intermittently taking votes to cast suspected impostors out into space.

Developed by veteran VR developer Schell games, *Among Us* is pretty much a straight conversion of the game into VR. Still, there are some interesting challenges here, not least rendering the game's flat, 2D levels into fully stereoscopic, first-person 3D.

It's an unusual direction for *Among Us*, given that the game's success relies heavily upon its accessible and quickfire nature, being playable on virtually any device with simple visuals and controls. Then again, that accessibility also means there's a huge fanbase who may be eager to invest in a snazzier, VR-enhanced version of the game. We'll find out whether the experiment pays off later this year. **GPC**



NEWS

CITIES: VR

Arguably more baffling than a VR version of *Among Us*, superb city builder *Cities: Skylines* is getting a VR version courtesy of Fast Travel Games, previously responsible for titles such as *Apex Construct* and *Wraith: The Oblivion: Afterlife*.

Cities: VR is a straightforward adaptation, maintaining the perspective and general play of its flatscreen equivalent, while adapting the control scheme to work with touch controls. You'll be able to drag out roads and place buildings with your own virtual hands, and watch your cities apartments and skyscrapers slowly rise up in stereoscopic 3D.

Again, it's an odd choice of game to convert to VR. There can be an appeal to VR

strategy games, especially when they're designed to replicate the tactile joys of tabletop gaming.

However, *Skylines* is a laid-back game designed to be played over weeks and months – it's hard to imagine a scenario where you'd want to play it with a box strapped to your face. That said, if you're a fan of model railways, being able to construct your own virtual city and watch its many cogs turn could be tempting.

If that person is you then look out for *Cities: VR* releasing in spring this year. Bear in mind that it's launching exclusively on Meta Quest 2, and there's currently no information on whether it will come to other VR platforms later.



50 TIPS TO BUILD A BETTER PC

ANTONY LEATHER GIVES YOU HIS TOP TIPS TO HELP YOU GET THE MOST OUT OF THE LATEST PC HARDWARE

Over our many years of experience with building PCs, we've accumulated dozens of tips and discoveries that we don't always get the space to mention in our usual build guides. There are all sorts of ways to make your PC run cooler,

faster, quieter, as well as eliminate dust and build your PC faster and more efficiently.

In this month's feature, we'll be covering pitfalls to avoid and many ways to improve your PC building skills, as well as explaining how to pick the right hardware for you in terms

of monitors, storage, graphics cards and CPUs. We're sure everyone will find tips here they hadn't considered before, and there are 50 of them, so there's plenty to consider for all sorts of machines, from water-cooled ATX rigs to air-cooler mini systems.



1

Enable Resizable BAR

AMD and Nvidia GPUs have recently added the ability for the CPU to access your graphics card's entire frame buffer, instead of smaller chunks, which can boost performance in some situations with compatible hardware and games. It's a simple way to boost frame rates that doesn't have the side effects you might expect with overclocking and often just needs one or two settings enabled in the EFI.

The BAR option is usually located in the PCI subsystem settings of your motherboard's

EFI, which you can access by tapping the Delete key as soon as your system powers up. Its location may differ between manufacturers.

You'll also want to enable Above 4G decoding and then check in your graphics card's driver software. Bear in mind that your Windows install drive will need to have a GUID partition table (GPT), rather than the older master boot record (MBR) partition table, for Resizable BAR to work.



2

Enable XMP

Extreme Memory Profile (XMP) is a feature introduced by Intel, which enables a small amount of information to be stored directly on memory modules that can be read by your motherboard. Enabling an XMP profile in your motherboard's EFI can apply the correct memory settings, such as speed and timings, ensuring your memory is running at its maximum rated speed – by default, it will run at much slower speeds and timings.



4

Use the right fan headers

If you'd rather not enter the EFI, but still want your motherboard to control your case and cooler fans effectively, reducing noise at low loads, you can simply connect the right components to the right ports. The most important is the CPU fan header. This should always be used to connect your CPU heatsink's fan, or your AIO liquid cooler's radiator fans, since it will respond to CPU temperature and ramp up to full speed if needed.

It's also important to connect your AIO liquid cooler's pump to any available pump headers. By default, these will run at full power, which some pumps will require in order to actually start working. If in doubt, ensure the header you use for your pump is set to full speed or connect your pump to your PSU instead.

3

Configure your EFI for Windows 11

You don't often need to visit the EFI on your motherboard in order to install a new operating system, but lots of us had to do just that to get Windows 11 playing nicely. The main issue with the new OS is its requirement for Trusted Platform Module or TPM 2 support. This is disabled by default on many boards, but thankfully, a simple flick from disabled to enabled is enough to solve the issue.

Head into your EFI by tapping the Del key when you power on your PC, then find the TPM setting, called fTPM on some

motherboards. A Google search may help with your brand if you're having trouble, but it's usually in the Advanced section. As with Resizable BAR, your Windows install drive will also need to be based on a GUID partition table, rather than MBR. There are guides to converting MBR to GUID available online, or you can reinstall Windows.

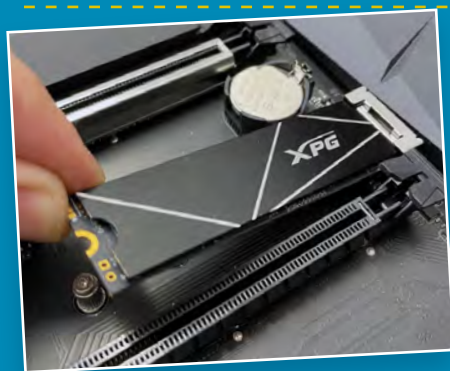
Once you've jumped through these hoops, Windows 11's compatibility checker should give you a clean bill of health and installing the new OS should be problem free.



5

Position your CPU cooler correctly

You can often mount your CPU cooler with its fan pointing in several different directions, but you should orientate your cooler, so it's in line with the rest of your case's airflow. This usually goes from front to back. It's also very important to have the rear fan working with your CPU cooler, so if your case lacks a rear fan and only has a roof fan, consider aligning your CPU cooler's air direction with your top fan, so the hot air exhausts out the roof of your case instead.



6

Use correct M.2 ports

There are numerous different types of M.2 SSDs available, which communicate with your PC in different ways. M.2 is just an interface and M.2 SSDs use a variety of protocols to actually send and receive data. Some use your motherboard's SATA controller, while others use PCI-E 3 or PCI-E 4. Not all M.2 ports support all three standards, so you check your motherboard's manual or website to see which M.2 ports you need to use for your SSDs.



7

Control 3-pin and 4-pin fans properly

Even though 4-pin PWM connectors have been a standard feature on most fans and liquid-cooler pumps for over a decade, some still include 3-pin connectors. These can't be controlled using a PWM signal and will only run at full speed. However, most motherboards include direct voltage control,

which can allow you to adjust the speed of 3-pin devices, so they don't run at full speed all the time. Head to your EFI's fan control section and identify the option to switch between PWM and voltage mode. Do this for each fan header with a 3-pin fan plug connected to it.

8

Avoid negative air pressure

Pressure isn't the same inside your PC case as in the room in which it sits. Your case fans pull air into the case, increasing pressure inside it, while exhaust fans push air out of it, reducing pressure. As a result, pressure inside your case will either be negative, positive or equal.

Positive or equal air pressure is preferable, as negative air pressure will mean air is encouraged to be drawn into your PC case through every available gap, which can potentially lead to dust ingress.

Of course, it's still very important to have exhaust fans in your case in order to push hot air out of your PC, but you just need to aim to at least have the same number of intake fans as exhausts, or ideally more intakes. Air will then be forced out of your PC through all those small gaps.



9

Don't remove displaced case fans

If you install an AIO liquid cooler, you may well have to remove some existing case fans in order to install it. However, don't leave them out of your PC, as every fan will increase airflow and improve cooling. Instead, consider moving them to vacant fan mounts in your PC or, if they offer similar peak RPM speeds to your liquid cooler's fans, mount them on the radiator to have two rows of fans to boost CPU cooling.



10

Use a case with removable roof panels

If you want to make PC building as easy as possible, using a case with removable roof panels is a great idea. Models such as Fractal Design's Define 7 Compact can be dismantled to the extent that they provide a large opening in the top, which makes installing your hardware and tidying the cables a breeze.



11

Position case fans effectively

Even if your case comes with fans out of the box, they might not be positioned in the right places for your hardware. You want the rear fan to be aligned with your CPU cooler and the front fans to be aligned with your CPU cooler and graphics card, giving priority to the latter.

This will feed them with cool air and significantly lower their operating temperatures. Aim to point a fan at your graphics card so that the top of your fan sits level with the lowest point on your graphics card. This way, the fan's airflow will be directed towards the graphics card's cooler intake, rather than the end of your graphics card.



12

Apply thermal paste correctly

While the tried and tested technique of applying a blob of paste the size of a grain of rice on your CPU, then manually spreading it around the heatspreader, usually works okay, it's often best to apply a specific pattern of paste to your CPU's heatspreader and allow the pressure of your

cooler's mounting mechanism to spread the paste naturally. Larger heatspreaders benefit from this approach the most, as large areas could otherwise end up devoid of thermal paste. Above are some effective patterns for modern Intel and AMD CPUs to use as a guide.



13

Update your motherboard's BIOS

Motherboard manufacturers add all sorts of tweaks and updates in new BIOS/EFI releases, and recently these have incorporated some significant performance and security updates.

These include adding support for Resizable BAR on quite a few old motherboards (for example, you can enable it on quite a few Z370 boards with 8th-gen Intel CPUs). You might also need to update your BIOS to get your

board to support newer CPUs. You can grab the latest BIOS file from your motherboard manufacturer's website, making sure you visit your exact motherboard model's support page, place this file onto a USB thumb drive and extract any zip files if necessary.

Head into your motherboard's EFI, locate the BIOS update section, find the BIOS file on your drive and away you go.



14

Consider a smaller system

Most of us don't use more than one PCI-E slot device, and often use just a single SSD and maybe a hard disk. Yet we still opt for large, space-hungry ATX cases that take up valuable floor or desk space. Mini-ITX motherboards and cases often don't cost that much more than their larger counterparts, and can save huge amounts of space, making them ideal if your bedroom, gaming space or office are on the small side. Most smaller cases can house high-end graphics cards and cooling systems too, so you don't even have to sacrifice performance.



15

Always remove pre-applied thermal paste

If you remove and replace your CPU cooler, or upgrade it or your CPU, don't be tempted to simply make do with whatever paste was used originally. Even if you've simply lifted the cooler off the CPU, this will mean the thermal paste layer is disrupted, and you're likely to see higher temperatures if you simply place the cooler back down. Instead, clean off the old thermal paste with TIM cleaner or isopropyl alcohol, plus a lint-free cloth, and reapply a new layer.

16

Don't put M.2 SSDs next to GPUs

When installing your M.2 SSD, avoid placing it directly next to or under your graphics card. Having it sit directly next to it will not only mean you'll need to remove your graphics card to access it, but some graphics cards vent hot air out of side vents too. In some cases, this could heat the SSD, causing it to throttle under sustained loads. It's better to place M.2 SSDs in slots away from other components, as long as the slots themselves fully support your SSD's protocol.

17

Check motherboard standoff

Motherboard standoffs are small threaded pins that raise your motherboard off the motherboard tray in your case. This is vital, as your motherboard has solder ends and components on the rear of its PCB that would otherwise be short-circuited on the metal motherboard tray.

It's essential to check these are installed before you install your motherboard – even in 2021, we found a couple of new cases that didn't have them installed out of the box. Always make sure they're installed when you buy a new PC case and ensure that they match up with all your motherboard's mounting points.



18

Check for case upgrades

If you own a case that's a few years old, you might find it lacks features such as USB Type-C support or vertical graphics card mounting components. However, case manufacturers often release these components as upgrades you can purchase to update you case. They even include optional components such as alternative side panels or parts to optimise water-cooling support, so before you splash out on a new case, check to see if you could revamp your old one first.



19

Use an SFX PSU

Your choice of PSU often dictates what hardware you can power in your PC, but it's also a large, bulky component, especially in a small case. Thankfully, there are smaller alternatives to typical ATX PSUs that can provide enough power for high-end systems. SFX and SFX-L PSUs aren't just for mini-ITX cases – they can be installed in any ATX case too, although larger models may need cable extensions.

In particular, SFX-L PSUs have larger fans than SFX units, and they're just as quiet as the quietest ATX PSUs. Case manufacturers are already making use of their smaller size to reduce case volume, but even standard ATX and micro-ATX cases – especially compact models – can benefit by from using a smaller PSU. Doing so can free up room for cable stowing volume under the PSU cover, and reduce the need to remove components in this area, such as hard disk mounts. Needless to say, they're essential for many mini-ITX cases as well.

20

Use 140mm fans and radiators

Bigger is usually better when it comes to fans and for good reasons. Larger fans generally push more air at the same rotation speed as smaller fans, which in turn means they can push the same amount of air at lower speeds compared to smaller fans. This means that using large fans enables you to achieve similar airflow to smaller fans, but while making less noise, so opting for 140mm fans rather than 120mm ones can cut noise levels.

If you're planning on buying an AIO liquid cooler, or using custom water cooling, 140mm, 280mm and 420mm radiators also offer better cooling potential than their 120mm, 240mm and 360mm counterparts, thanks to their larger surface areas. If your case supports 140mm fans and radiators, definitely opt for them over 120mm equivalents.

21

Speed up Windows installation

If you need to reinstall Windows or install it on a newly built PC, you can speed up the process in a couple of ways. Firstly, use a USB 3 thumb drive to install Windows. You can do this using Microsoft's Media Creation Tool to download Windows 10 or 11 (microsoft.com/en-gb/software-download), load the installation files onto the thumb drive and you can then install Windows in minutes.

This is best achieved by booting your PC directly from the USB thumb drive, and you can do this without entering the EFI. For Asus motherboards, tap F8 when your PC is first powered on, for ASRock and MSI boards press F11 and for Gigabyte boards press F12. Select the USB thumb drive from the menu, select the SSD to which you want to install Windows and continue to the installation.

An additional tip to speed up the installation process is to use ninite.com to download a combined install package for the latest version of popular software. This includes Discord, Skype, Chrome, iTunes, Steam, Dropbox and a host of other programs that will install automatically, saving you from downloading and installing each one separately.



22

Consider dummy RGB memory modules

Illuminated memory looks fantastic, but RGB memory modules look even better when they're sat side by side to create a seamless lighting display. Unfortunately, this often means buying more memory than you need, but some manufacturers have a solution.

Dummy memory modules are available from the likes of Corsair and Gigabyte that look like normal modules, but have no actual memory inside. They're significantly cheaper, but still tap into your memory software's lighting control, filling vacant memory slots for a fraction of the price.



23

Fix graphics card droop

Large, heavy graphics cards can suffer from droop, which means they don't sit level when their back is screwed into your case and one end sags downwards under its own weight. This can look unsightly, but thankfully there's an easy fix. A graphics card support bracket can sit under your card, propping it up. They come in a variety of shapes and sizes, but thankfully they're cheap too – spending around £10 can completely fix the problem, and some brackets are even equipped with RGB lighting too.

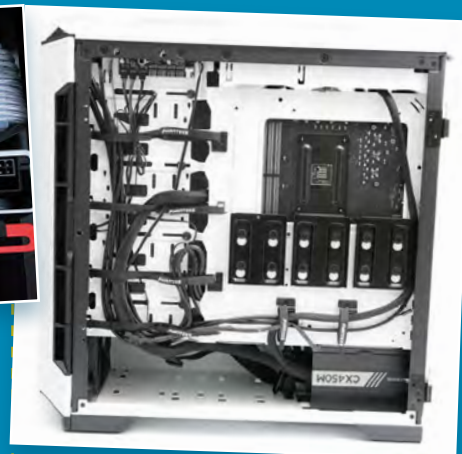


24

Get the best CPU cooler for your PC

If you're using a stock cooler that came with your CPU, or was installed when you bought your PC, we can highly recommend binning it. They're generally noisy and offer poor cooling – even a £30 air cooler can offer significantly better cooling at far lower noise levels. Similarly, you also see better cooling and lower noise levels with larger air coolers and liquid coolers too.

Spending just a few tenners more can have a dramatic impact on your PC's decibels, as well as your CPU's overclocking headroom. In short, get the best CPU cooler you can afford, as long as the price is balanced against the CPU you're trying to cool.



25

Route your cables properly

Cable routing might not sound like a fun activity, but no one wants a messy PC, and tidying up your cables can help to boost airflow too. Your case will probably cater for certain cables running to specific parts of your hardware, and may even include cable channels or heavy-duty cable anchors to handle thicker cables, such as the 24-pin ATX cable or 8-pin CPU connector.

Check your case's manual to see what tools your case offers to help deal with the spaghetti, and make sure to use the right cable-routing holes too, which are usually placed at key locations to make your life easier. For example, an ATX case should have a hole at the top left for the 8-pin CPU12V power connector, and one on the right next to the 24-pin ATX connector. If you have holes in your PSU shroud, these can be handy for routing the PCI-E power cables up to your graphics card, as well as for routing the cables for your case's front panel features.

26

Monitor CPU and GPU temperatures

Just like monitoring fuel efficiency in a car can help you to spot issues, doing the same with your CPU and GPU temperatures can often indicate a problem – perhaps a stray cable has wandered into a fan and prevented it from spinning – or it's a particularly hot day and the fan profile you created isn't quite strong enough to deal with the heat. We recommend installing CoreTemp (alcpu.com) and GPU-Z (techpowerup.com) to keep tabs on temperatures, even if you only check them periodically or on particularly hot days.



27

Solve high CPU temperatures

Once you've built your PC or installed a new CPU cooler, if your CPU temperature is much higher than before, or if it hits 90°C under load, there are a few areas to investigate. Firstly, ensure that the protective plastic on the underside of the heatsink or waterblock has been removed (we've all done it). Next, check that the thermal paste has spread over the surface of the CPU and that no large sections are paste-less. Remounting your CPU cooler can often fix pressure issues too.

If you're using an AIO liquid cooler, ensure the pump is powered and you can hear it

working. Also make sure it's running at full speed by checking settings for that header in the EFI, or using a Molex-to-fan adaptor to connect it directly to your PSU.

Similarly, if you can hear lots of gurgling noises coming from your cooling system, make sure your CPU cooler's radiator is positioned higher than the pump, especially the end without the tubing, as this area often becomes a reservoir for trapped air bubbles.

If there's air instead of coolant sitting inside the pump on top of your CPU, this could also cause high temperatures until it clears.

28

Match your GPU with your monitor

There are four key monitor resolutions right now, and each has different requirements on your graphics card. At 1,920 x 1,080, low-to-medium range graphics cards are usually enough for fast frame rates in current titles, with this being the lowest resolution we'd consider for gaming. A Radeon RX 6600 XT will do the job here. If you have a monitor with a high refresh, you may want to push that envelope to hit very high frame rates, in which case buying a pricier GPU can help out.

Next up is 2,560 x 1,440, where you'll need a mid-range or high-end graphics card to play consistently at above 60fps in the latest demanding titles – a GeForce RTX 3070 Ti is our recommendation for this resolution. Next

is 3,440 x 1,440, otherwise known as ultrawide. This resolution requires far more pixels for your graphics card to process than 2,560 x 1,440, but is less demanding than 4K. Here, a graphics card from the lower part of the top end, such as a GeForce RTX 3080, is recommended for demanding 3D titles.

Finally, there's 4K or 3,840 x 2,160, which is a monstrous resolution and requires the very fastest graphics cards to achieve high frame rates. For this reason, many prefer to opt for 2,560 x 1,440 or ultrawide. We've found that a GeForce RTX 3080 Ti can generally cope with this resolution, but even then you won't be able to run Cyberpunk 2077 with Ultra ray tracing and still get a decent frame rate.



29

Clean your dust filters

Modern cases are nearly always equipped with dust filters to prevent your components from becoming clogged. These will trap dust over time and need to be cleaned. The best way to do this is with an air duster or shower head. Vacuuming should be avoided, as pressing on the mesh can damage the filter and vacuum brush heads can also press clumps of dust into the mesh more tightly, making them hard to remove.

With an air duster or shower head, turn over the filter so the dusty side is facing down. That way, the dust will be forced off the filter instead of pressing up against it. Only once this method has been exhausted should you turn over the filter over and focus on more stubborn areas head on.



30

Add more fans to your CPU cooler

Many air coolers and liquid coolers are equipped out of the box with extra clips or screws to mount a second fan if they only come with one as standard. We give extra points to coolers we review that do this, as an extra fan can boost cooling under load, and aid the first fan in boosting airflow through a heatsink or radiator, meaning both fans can spin at lower speeds to achieve the same cooling. This in turn cuts noise, as well as potentially offering better cooling under heavy loads. Rather than upgrading your cooler, add a second fan first as it might result in a cheaper upgrade.



31

Position RGB LED strips well

Adding RGB lighting to your PC is a simple job these days, thanks to most of the latest motherboards including headers for both 3-pin and 4-pin RGB strips. However, the locations in your case where you place the strips can make all the difference to the end result.

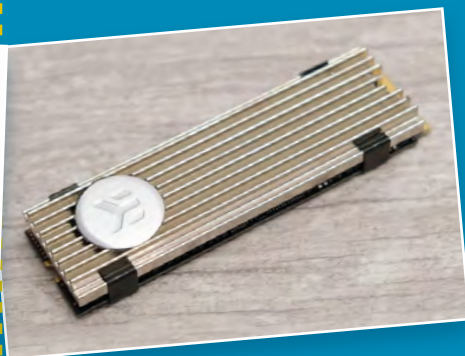
If the inside of your PC is visible from where you sit, perhaps sitting on top of your desk, then you don't really want the full glare of a light strip in your face. Equally, however, you'll also want the strip to illuminate as much of the inside of your PC as possible.

The outer edge of your case's roof is a great place to mount an LED strip, especially if your PC is located on the floor, and this position can

also work well if your PC sits on a desk, as long as the LEDs aren't visible from your normal sitting position.

The rear of your case is also a good spot for mounting an LED strip. Placing it vertically next to your graphics card can work particularly well here, illuminating your PC's interior from the back through a side panel window. However, using this location relies again on finding a position that doesn't end up with lights in your face when you're sat next to your PC.

Mounting a strip at the front of your case against the main side panel is often a good bet for lighting up the interior too, as long as there's space next to your fan mounts.



32

Use an M.2 heatsink

Many motherboards include heatsinks for M.2 SSDs, in order to prevent the peak temperatures getting high enough to cause throttling. However, you can also purchase M.2 heatsinks separately and they're cheap and easy to install. Use the correct thermal pads according to the instructions and then install the heatsink. It should keep load temperatures in check and your SSD will look better too.



33

Avoid damaging CPU socket pins

Bent CPU socket pins are one of the main reasons for motherboard returns, and if you mash a bunch of pins accidentally by dropping an object into the CPU socket, it's usually game over. We can't overstate their delicacy and the ease with which you can make mistakes here, so taking care when building your PC is essential.

Firstly, don't open the socket or remove the protective cap until it's wholly necessary. Secondly, avoid lowering the CPU from a height into the socket. Instead, lower it down next to the socket, then move it over. If you lose your grip, the CPU will then probably land next to the socket rather than inside it. The socket cap is designed to be pressed outwards by the CPU when you close the latch, so leave it in place until this point.

34

Use the right PCI-E slots

Most motherboards have at least one 16x PCI-E slot (the big one), and you'll want to use the one at the top, nearest the CPU socket area, for your graphics card, as this slot usually has the most lanes allocated to it. Sound cards or other expansion cards generally only require 4x or 1x PCI-E slots, so it makes sense to use those smaller slots where necessary. However, you can actually use a 16x slot for any PCI-E device. This can be especially useful if one of the other slots is blocking a heatsink or M.2 port on your motherboard, or you if you don't intend to use a discrete graphics card and want to free up bandwidth for other devices.

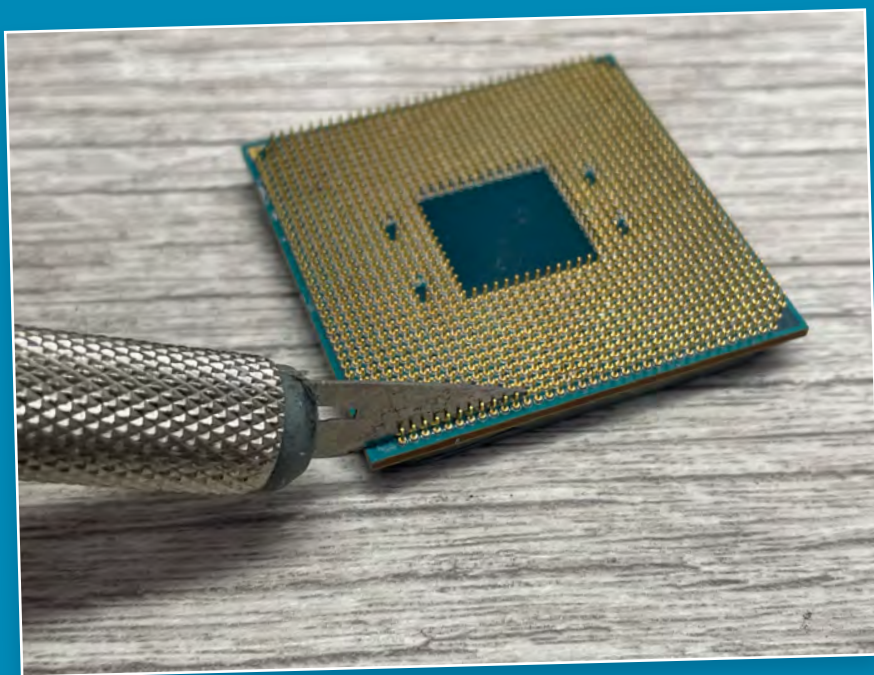


35

Buy the right CPU for your needs

The CPU landscape has changed significantly over the past two years, and gamers and content creators can get significant benefits from CPU upgrades. Aiming for the latest generations, we recommend gamers opt for a minimum of six cores, as tests have shown some games do make real use of more than four cores. Both AMD and Intel have current 6-core CPUs, and the likes of the Core i5-12600K and Ryzen 5 5600X are generally all you need to feed all but the most powerful graphics cards.

Opting for a more lavish CPU with more cores can offer small improvements in very specific games, but it's mainly with content creation that you'll get a benefit from eight or more cores. Here, 3D rendering, video editing and streaming can all dish out plenty of threads to keep the most powerful desktop CPUs busy, so we recommend eight cores or more if these will be regular tasks.



36

Fix bent CPU and socket pins

If the worst happens, and you end up bending a CPU socket pin, or CPU pin on an AMD Ryzen CPU, you might be able to fix it. If you have a delicate hand, and you're very careful, you can use a pin and magnifying glass to identify a bent socket pin and use the pin to bend it back in line with the rest. This method won't always work, but it's worth a try, especially if it's just a couple of pins that are out of line and preventing your PC from booting.

AMD Ryzen CPUs will soon ditch their pins in favour of socket pins, but currently they all have pins on the rear of the CPU itself. These are more durable than socket pins, but can still be bent if dropped or dinged. You can use a small knife or scalpel to manoeuvre bent pins back in line, checking the rows from both sides to make sure they line up. If you're careful, patient and do it right, eventually a CPU that resisted slotting into the socket will drop into it again.

37

Check your graphics card's PCI-E requirements

Usually, you just need to ensure you're using a 16x PCI-E 3 slot to ensure you get the best performance from your graphics card, but recent low-end models have muddled the waters

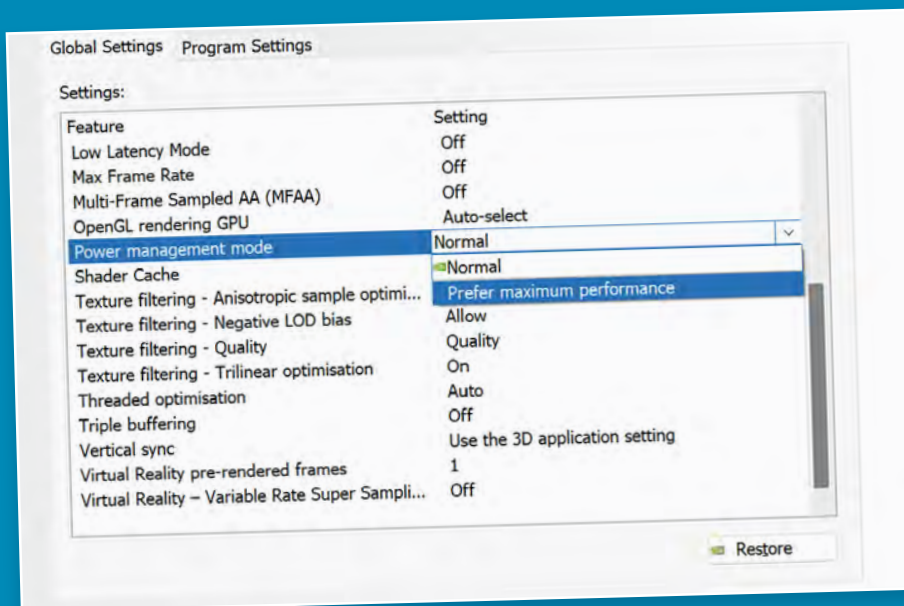
If you own a modern low-end graphics card, such as AMD's Radeon RX 6600 XT with an 8x PCI-E 4 interface, you'll want to use it with a PCI-E 4 CPU and motherboard. If you use it in a system limited to PCI-E 3, either because the CPU, motherboard or both don't support PCI-E 4, then these GPUs will be forced to operate at 8x PCI-E 3 instead, which has far less bandwidth and results in a performance drop of 2-3fps in our tests.

38

Get an efficient PSU

While stability is one reason to opt for an efficient PSU, getting an 80 Plus Gold, Platinum or Titanium-rated PSU can offer other benefits too. For example, an 80 Plus Titanium PSU will mean it's over 10 per cent more efficient than an 80 Plus Bronze PSU at full load and likely even more than an unbranded or standard 80 Plus-rated model.

This might not seem a lot, but if your PC draws 350W in games, it could be drawing a whole light bulb more in power. Over the course of its life, this could mean more efficient PSUs pay for themselves. Also, as they draw less power for the same output than less efficient PSUs, they generate less heat and often run quieter too.



39 Use Nvidia's max performance mode

A lot of hardware is set to run with power efficiency in mind, which can cut performance in some situations. Your graphics card is no exception and there's a small setting you can tweak to get more performance without any overclocking involved. With Nvidia cards, right click on the desktop and go to Nvidia Control Panel. Then, under Manage 3D Settings, find Power Management Mode. This will be set to Normal by default, but setting it to 'Prefer maximum performance' can result in higher frame rates at the cost of a little extra power consumption.

40 Fix a broken graphics card fan

The graphics card is often your pride and joy when it comes to PC components, and it can be devastating to accidentally break one. However, graphics card fans can be repaired if you manage to break a blade, which can happen easily, since most graphics card fans are quite flimsy. Replacement fan assemblies are available for lots of different graphics cards on websites such as Amazon and eBay, and will simply replace fans and cables on your existing graphics card.

If there are no replacement fans for your model, consider removing the shroud and adding a couple of case fans in there instead. These can be mounted using cable ties and will probably offer far better cooling and quieter noise levels than your original fans too.

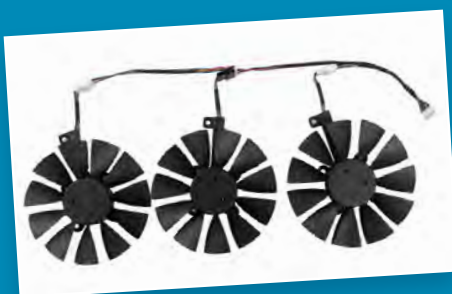


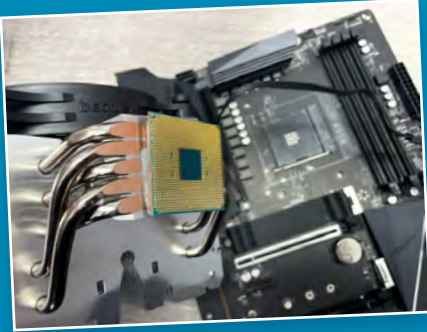
41 Install your PSU correctly

Most of the power supply mounts in PC cases allow you to install your PSU facing up or down, but your case will be designed with one orientation in mind.

It's important to check your case's manual to identify the correct PSU orientation, as the

case will likely have ventilation and dust filters in place to cater for the PSU facing one way. Also, if the case uses an extension cable to run a PSU housed differently to usual, the extension might not reach if the PSU is the wrong way around.





42

Stop your cooler pulling your Ryzen CPU out of the socket

If you've ever owned an AMD CPU, you'll likely have encountered the dreaded problem of the CPU being wrenched out of the socket when you remove your heatsink.

The problem arises from thermal paste acting like glue between the CPU and heatsink – when the latter is removed, it takes the CPU out with it. This can easily lead to bent pins if you don't realise what's happened. To avoid this happening, twist the heatsink on top of the CPU before removing it. This can loosen the thermal paste and prevent the CPU from being pulled out of the socket.



43

Remove unwanted case features

If you've ditched hard disks in favour of SSDs, or otherwise don't need for half dozen hard disk mounts, pump mounts or other case fittings that can be included with some models, don't be afraid to remove them.

They can hinder airflow, make cable routing harder and can also make installing your hardware a trying process. Drive cages, for example, are often held in place with screws, so grab a screwdriver, remove them and place them in your case box or somewhere safe, just in case you want to use them in the future or sell your case.



44

Run memory in dual or quad-channel mode

If you install your memory incorrectly, you can forfeit dual or quad-channel mode. This can have a huge impact on performance in some cases, particularly if you're using an AMD APU with integrated graphics, so it's important to get it right. If your motherboard has four memory slots together, the second and fourth slots away from the CPU should usually be used to enable dual-channel mode.

The same is true with quad-channel mode, with a second set of four slots on the opposite side of the CPU, where the modules should be installed in a mirror image. If in doubt, this will all be documented in your motherboard's manual, and you can check you've got it right with CPU-Z (cpuid.com) – click on the Memory tab and the channel mode will be listed in the top right box.



45

Use a modular PSU

Being able to ditch unused PSU cables when you build your PC gives you a warm fuzzy feeling when building your PC, as it makes cable tidying easier, your build will look cleaner and there will be fewer cables

obstructing better airflow. Modular PSUs are more expensive than ones with captive cables, but they're absolutely worth it, plus you'll have the option of using custom braided cables too.

46

Check your M.2 SSD's performance

Firmware issues, thermal throttling, bandwidth restrictions and varying levels of support across M.2 ports, even on the same motherboard, can all easily result in your M.2 SSD not reaching its claimed performance. Whether you've just finished installing Windows, or if you've owned your SSD for a year, it's worth checking it's performing to expectations.

Grab CrystalDiskMark from **crystalmark.info** and run the test at the top of the box. This is the sequential test and will measure raw throughput. This should be within a few hundred megabytes a second of your SSD's rated speed, or perhaps a touch lower if your SSD is nearly full. However, make sure it's running in the right slot for its PCI-E interface, and that the correct PCI-E standard is selected for that slot in your motherboard's EFI.

47

Check your M.2 SSD's temperature

A simple way to check the load temperature of your M.2 SSD, and ensure it's not throttling under load, is to grab HWMonitor from **cpuid.com**, then use CrystalDiskMark from **crystalmark.info** and click All in the upper left box. This will run all the tests and is a good stress test for an SSD. Check HWMonitor's sensors and find your SSD. If the temperature rises above 70°C, this is quite toasty and could result in throttling if it gets much higher.

48

Buy the best SSD for your needs

The best rule for SSD storage is that bigger is better. We'd sooner have a 2TB PCI-E 3 SSD than a 1TB PCI-E 4 model, as you get diminishing returns in real-world use once you get past PCI-E 3 – you only benefit from PCI-E 4 in large sequential file transfers. We also always recommend an M.2 SSD, even if it's just a SATA model, as it cuts down on cable clutter.

We advise avoiding 128GB and 256GB models, as Windows 10 and Windows 11 can occupy well over 30GB of space once installed and many games top 100GB as well. A 500GB SSD is a must for gamers who want several titles installed, and ideally you want 1TB.

NVIDIA Driver Downloads

Select from the dropdown list below to identify the appropriate driver for your NVIDIA product.

Product Type: GeForce

Product Series: GeForce RTX 30 Series

Product: GeForce RTX 3090

Operating System: GeForce RTX 3090
GeForce RTX 3080 Ti
GeForce RTX 3080
GeForce RTX 3070 Ti
GeForce RTX 3070
GeForce RTX 3060 Ti
GeForce RTX 3060

Download Type: ?

Language:

SEARCH

49

Update your GPU drivers

Not regularly updating your graphics drivers is a really bad idea, as newer versions can not only bring sizeable performance increases in games, but also fix bugs and stability issues. If you right click on the Windows desktop, you should see a menu appear showing either a green Nvidia software link or a red one for AMD. This will

indicate the manufacturer of your graphics GPU. From here, head to **nvidia.com** or **amd.com** and locate the driver download sections.

You can use these companies' automatic driver update options if you don't know your exact graphics card model, or if you know it, simply select your GPU from the dropdown list.



50

Use fan speed reduction cables

If you prefer not to tweak settings in the EFI, and just want to slow down your case fans to more tolerable speeds, you can easily do this using fan speed reduction cables, which simply force fans to operate at lower voltages, either with a resistor in the middle of the cable, or by cutting out the 12V cables.

These cables cut your fans' speeds, but still allow them to speed up and down according to your motherboard's own fan control. It's like putting a smaller engine in your car. They're cheap, very easy to install and maintenance free. Just make sure your thermals don't suffer too much, especially on hot days. **CPG**

DRIVING SIM BUYER'S GUIDE

SIM RACING AFICIONADO **ANDY VANDERVELL** GUIDES YOU THROUGH THE WORLD OF DRIVING SIMS AND ONLINE SIM RACING

What happens when you lock the world's racing drivers indoors for several months? They all go racing online. Sim racing gained huge exposure during the first COVID-19 lockdown, even culminating in an official virtual 24 hours of Le Mans. A team featuring Formula 1 (F1) hot shots Lando Norris and Max Verstappen were robbed of victory when Verstappen's game froze and he crashed. Max enjoyed much greater fortune in his real-life racing exploits.

While the huge explosion in sim racing has since slowed, driving sims continue to grow in

popularity and many pro drivers play online. So, how do you get involved in the fun and what do you need to get started? Whether you want to relax by driving an HGV across the continent, or compete in 12-hour endurance races in the latest racing machinery, we're going to guide you through all the options to take your virtual driving to the next level.

GETTING STARTED

Most driving games are enhanced by playing with even a basic force feedback wheel and pedal set, even those that lack the grandiose 'simulation' moniker. The important phrase here is 'force feedback'. While you can buy wheel and pedal sets for around £100, they won't feature active force feedback, instead opting for 'bungee cord' mechanisms to create a self-centering force. Some budget brands advertise such wheels as having force feedback, but they're just vibration motors. Avoid them.

Thrustmaster and Logitech offer the most affordable entries into real force feedback wheels. Logitech's range is gear-driven – a



More expensive wheels such as the Thrustmaster T248 (pictured) and Logitech G29 include a decent pedal set

series of metal cogs connect a small internal motor to the steering wheel, amplifying the force of the motor and communicating the force feedback of the game to you. Thrustmaster's wheels use a hybrid system that includes gears and belts, but the basic principles are the same.

Broadly speaking, belt-driven wheels produce stronger and smoother force feedback, but there's no conclusive winner



An entry-level racing wheel such as the Thrustmaster T150 can get you into the world of sim racing but its pedals are very basic



Even if you're just starting out, a basic foldaway racing rig such as the Playseat Challenge is a worthy investment

here. Logitech's gear-driven wheels can feel 'notchy' in comparison and their metal cogs are rather noisy (not great for shared spaces), but they're also better at communicating fine details, which belt-driven wheels can dampen.

The cheapest decent option is the Thrustmaster T150/TMX, which is available online for around £180 inc VAT. It's a tried and tested force feedback wheel, but the real compromise here is the twin pedal set, which is plastic and low quality. And, as we'll discuss in more detail soon, good pedals are the real secret to going quicker in sims.

The next step up here is the Thrustmaster T248 (£300 inc VAT) wheel and pedal set and the various options from Logitech, including the G29/G920 (£270/£300 inc VAT) and the newer G923 Trueforce (£300 inc VAT). All three feature three-pedal units that include a clutch, although the Thrustmaster ones have one useful advantage.

Entry-level pedal units all have one aspect in common – they measure distance, not force. Most cheaper pedals use potentiometers with rotating contacts to measure pedal travel, but



the Thrustmaster T248 pedals use Hall effect magnetic sensors instead. Hall effect sensors can be a little smoother and more accurate than potentiometers, but more importantly they're resistant to dust and wear, which degrade potentiometers over time.

This gives Thrustmaster a slight edge, but not a definitive one. Logitech's wheels and pedals win on build quality and feel, while

iRacing has the best organised online multiplayer racing but requires a costly subscription

All these wheels can be desk-mounted without difficulty, but an entry-level wheel stand or rig is worth considering if you have the funds. Two options we'd recommend are the Playseat Challenge (£190 inc VAT) or the Next Level Racing Wheel Stand Lite (£119 inc VAT).

A SERIES OF METAL COGS CONNECT A SMALL INTERNAL MOTOR TO THE STEERING WHEEL, AMPLIFYING THE FORCE OF THE MOTOR

Thrustmaster wins on feedback strength and features. Logitech also offers an affordable manual shifter, the Logitech Driving Force Shifter (£30 inc VAT), whereas Thrustmaster's costs a chunky £150 inc VAT, which may swing your choice.

The Playseat Challenge is basically a folding deckchair with mounting points for a wheel and pedals – a long-time favourite of sim racers. The Wheel Stand Lite is a high-quality alternative if you want to use your own chair.

If this is already looking a tad expensive for you, it's worth exploring the second-hand market. Sim racers are always upgrading their setups to the next big thing, so it's easy to find them selling complete sets of wheels, pedals and wheel stands for cheaper prices.

INTRO TO RACING SIMS

So you've got a wheel and pedals, what next? It's time to decide in which game or 'sim' to cut your teeth. The likes of Forza Horizon 5 are a good, accessible way to get to grips with the basics, but sim titles offer more advanced physics simulation, superior force feedback and greater immersion as a result.

Assetto Corsa Competizione is a fantastic sim to start out on but is limited to GT3 and GT4 racing formats



	PROS	CONS
iRACING	Best organised online racing; large range of cars and tracks; good introduction to racing online	Dated graphics and UI; excessive cost; limited single-player appeal
ASSETTO CORSA COMPETIZIONE	Outstanding graphics and sound; lively online community; decent single-player	Limited to GT3 and GT4 racing; not great for VR; high hardware requirements
AUTOMOBILISTA 2	Good selection of tracks and cars; great for single-player; excellent VR	Small online community; not the most engaging physics
RACEROOM RACING EXPERIENCE	Mix of modern and historic cars; excellent sound; low hardware requirements	Dated graphics; uneven content quality; confusing DLC model
F12021	High production value; excellent single-player campaign; official licence	Limited physics simulation; toxic online community
DIRT RALLY 2.0	Looks and sounds amazing; Wide variety of cars and locations; great in VR	You will crash a lot (at first)
RFACTOR 2	Excellent physics simulation; eclectic selection of cars, including Formula E	Notoriously buggy and tricky to set up; limited single-player appeal
ASSETTO CORSA	Loads of free and paid mods; strong community; decent physics simulation	Looks dated when unmodded

It's tempting to dive straight into the most popular online sim racer, iRacing, but we'd caution against that. Not only is iRacing hugely expensive in the long term, it's a daunting intro when you're just getting to grips with driving with a wheel. Instead, it's best to seek out a good single-player experience.

For that reason, the likes of Automobilista 2 and Assetto Corsa Competizione (ACC) are the best starting points. We recommend trying both, as they offer slightly different experiences. ACC is purely focused on the GT3 and GT4 racing categories – GT3 racing is hugely popular online – while Automobilista 2 is a jack-of-all-trades, spanning everything from Caterhams, formula cars new and old, and everything between.



Direct drive wheels bases such as the Fanatec CSL DD provide the ultimate in feedback power and accuracy

Automobilista 2 is great, as it gives you a chance to try all different kinds of racing classes and learn what you enjoy. It also means you can learn the ropes in slower cars such as Caterhams before graduating to a faster class of car, and it's a great option for those wishing to do their racing in VR.

ACC is the second most popular sim online after iRacing, and is a nice starting place, as it features a clever real-time driving tutorial and rating system that warns you when you're taking a corner too slow or too fast. It's also the best-looking sim out there, although this comes with higher hardware requirements.

A GeForce GTX 1060 6GB and Ryzen 5 2600 minimum is advisable for a smooth 1080p experience at decent settings, although an 8GB card is preferable. It's also a notoriously CPU-limited game in single-player due to the demands of running the AI and the game's advanced physics.

We've included a table summarising the pros and cons of numerous games, but a final word must go to the original Assetto Corsa (AC). It's showing its age in vanilla form, but the booming modding scene means few people play it that way. There's a huge range of graphics and content mods (free and paid) to explore. The Formula Hybrid 'F1' mods from Race Sim Studio are highly regarded, as they're

There's a wide choice of sim racing titles available, with each bringing its own unique appeal

based on FIA-provided data, making them some of the most realistic F1 car simulations around. They've even made a version of an F1 car based on the upcoming 2022 regulations. Fun though it is, the official F12021 game isn't renowned for its driving physics.

DIRECT DRIVE WHEELBASES

While most people start with a basic rig such as a Logitech G29, sim racing addicts inevitably go chasing more immersion after a year or so. Whether you choose to skip the entry-level gear or work your way up, your options get more varied and complicated the higher up you go. It's very easy to spend 'good second-hand car' money on your sim racing setup.

Until recently, upgrading from the likes of the G29 meant moving to higher-end belt-driven wheels from the likes of Fanatec and Thrustmaster's mid-tier offerings such as the T500 or TS-PC.

However, Fanatec changed the game recently with the release of the CSL DD, the first entry-level 'direct drive' wheelbase.

Direct drive is exactly what it sounds like. There are no belts or gears in direct drive wheelbases, as your wheel is connected directly to the force feedback motor. This



Premium wheel sets such as the Fanatec CSL Pedals LC provide robust build quality and more precise braking feel

requires more powerful motors, but the removal of conduits increases the speed and fidelity of the force feedback.

Most direct drive wheelbases cost in excess of £1,000, but the Fanatec CSL DD starts at (£295 inc VAT) for the base alone – at this level, the pedals and wheel rims are (mostly) interchangeable and sold separately. Unless you're prepared to dive into the £1,000+ world of boutique direct drive bases from the likes of Simucube, Fanatec is the only game in town right now.

What's the difference, then, between a £300 direct drive wheelbase and a £1,500 one? Torque. Wheelbases are generally rated by their 'peak torque'. Entry-level wheels such as the Logitech G29 and Thrustmaster T248 are in the 2.5 to 3.5 Nm range.

The CSL DD comes in two flavours – a 5 Nm version for £295 inc VAT and an 8 Nm version at £400 inc VAT, although the 5 Nm can be upgraded to 8 Nm with the £125 inc VAT boost kit. Top-end bases such as the Fanatec DD1 (£950 inc VAT) and Simucube 2 Sport (£1,050 inc VAT) hit around 17 to 20 Nm. The most powerful bases peak in the low 30s.



The likes of the Heusinkveld Sim Pedals Sprint will set you back £580 inc VAT but provide exceptional pedal feel



For our money, the 8 Nm Fanatec CSL DD is the sweet spot for 90 per cent of serious sim racers. While more powerful motors will simulate the feeling of a real racing car more accurately, it's a marginal gains situation – more so when you consider many modern racing cars have power steering anyway. Even those who own top-end direct drive bases don't run them at full power – search for '100 per cent force feedback' on YouTube to understand why.

The bottom line, however, is that direct drive is a step change in quality and immersion compared with belt and gear-driven systems. While Thrustmaster is planning a direct drive competitor, Fanatec has stolen a march

Basic wheel stands such as the Next Level Racing Wheel Stand DD support your wheel and pedals but you'll need a seat too

PEDAL UPGRADES

Choosing your pedals is the next big decision. And, unlike wheelbases and wheel rims, you can mix and match different brands of pedals and wheelbases, as pedals plug directly into your PC via USB.

As noted earlier, entry-level pedals use sensors that measure pedal travel. This is a reasonable approach for throttle pedals and clutches, but real brake systems use hydraulics to convert pedal pressure into braking force. The next level of sim racing pedals uses load cell sensors to do the same.

THERE ARE NO BELTS OR GEARS IN DIRECT DRIVE WHEELBASES, AS YOUR WHEEL IS CONNECTED DIRECTLY TO THE FORCE FEEDBACK MOTOR

on its competition. It also offers a more comprehensive range of wheel rims and pedals, making it a better bet when choosing which ecosystem in which to invest.

For instance, Fanatec's CSL Elite McLaren GT3 V2 wheel (£165 inc VAT) is the best-value formula rim on the market. The company also recently partnered with BMW to produce the real-world steering wheel for its M4 GT3 racing car, which can be used on its wheelbases as well. Yes, you read that correctly, you can use the same wheel as a real-life racing car on your sim rig. It's a casual £1,200 inc VAT for that privilege.

Upgrading to a load cell brake system is a big deal for sim racers. Where conventional systems make it hard to consistently brake with the same force every time, load cell brakes tap into your muscle memory, so you can brake with greater finesse and consistency. Anyone who has moved to a load cell system will tell you it made them a faster, more consistent driver.

Thrustmaster and Fanatec make load cell pedals for around £180 inc VAT (the Fanatec CSL Pedals LC and Thrustmaster T-LCM) and both systems employ Hall effect sensors for the clutch and throttle.

Fanatec offers the £300 inc VAT Clubsport Pedals V3 as a further upgrade path. The improvements over its CSL Pedals are numerous, but are mainly focused on build quality, adjustability and pedal feel. High-end pedals also put a greater emphasis on improving fidelity in the throttle pedal, too, which often feels excessively light and imprecise on cheaper sets.

If you want the best out there, sim racers swear by the £580 inc VAT Heusinkveld Sim Pedals Sprint. Yes, this hobby can get expensive very quickly, and they're not even the most expensive pedals Heusinkveld sells.

WHEEL STANDS AND RACING RIGS

Hard-mounting your wheel and pedals becomes a necessity at this stage of your sim racing journey. While the CSL DD can be mounted to a sturdy desk, load cell pedals generally aren't viable without some kind of permanent fixture.

The choice in the racing rig market is increasingly dizzying, but they generally fall into three categories: robust wheel stands; tubular steel cockpits; and modular aluminium extrusion rigs. The latter are favoured by the sim racing fraternity for their formidable rigidity and adaptability, but there's a solution to suit every need.

While the options are near endless, the main players are Next Level Racing, GT Omega, Trak Racer and Sim-Lab. Next Level Racing's range, for example, encompasses

nearly every variety of cockpit, including an ultra-robust wheel stand that's strong enough for top-end direct drive wheelbases (Wheel Stand DD, £229 inc VAT), mid-tier steel rigs (F-GT, £399 inc VAT), and its new aluminium extrusion rig, the eye-wateringly expensive F-GT Elite (£999 without seat).

Trak Racer and GT Omega offer a similar range of options, including their own takes on aluminium rigs. Sim-Lab, however, is considered the gold standard when it comes to aluminium extrusion rigs. Sim-Lab's GT1 Evo rig starts at £329 inc VAT without a seat – expect to pay between £150 to £300 inc VAT

adds not only to the immersion, but also to your ability to pick your lines and braking points accurately.

Dirt Rally 2.0 – and rallying in general – gains the most from playing in VR. In circuit racing, your eyes normally look in the same direction as your car is pointing, but it's the opposite in rallying. When you're flicking your car through a 50mph right hander, your eyes are searching for the apex of the upcoming left hander, and the point of view (POV) control afforded by VR is totally liberating. Rallying in VR is a totally different experience to a monitor – just remember to close your eyes when you crash.

LOAD CELL BRAKES TAP INTO YOUR MUSCLE MEMORY, SO YOU CAN BRAKE WITH GREATER FINESSE AND CONSISTENCY

for a seat – and its top-end P1-X starts at £629 inc VAT. The beauty of aluminium rigs is that you can mix and match accessories (shifter mounts, keyboard trays, monitor mounts and so on) from all over and they should fit just fine.

We've included some suggested combinations of wheels, pedals and rigs for various budgets at the end of this article, but it pays to do your research on rigs to work out what's best for your specific circumstances.

TO VR OR NOT TO VR

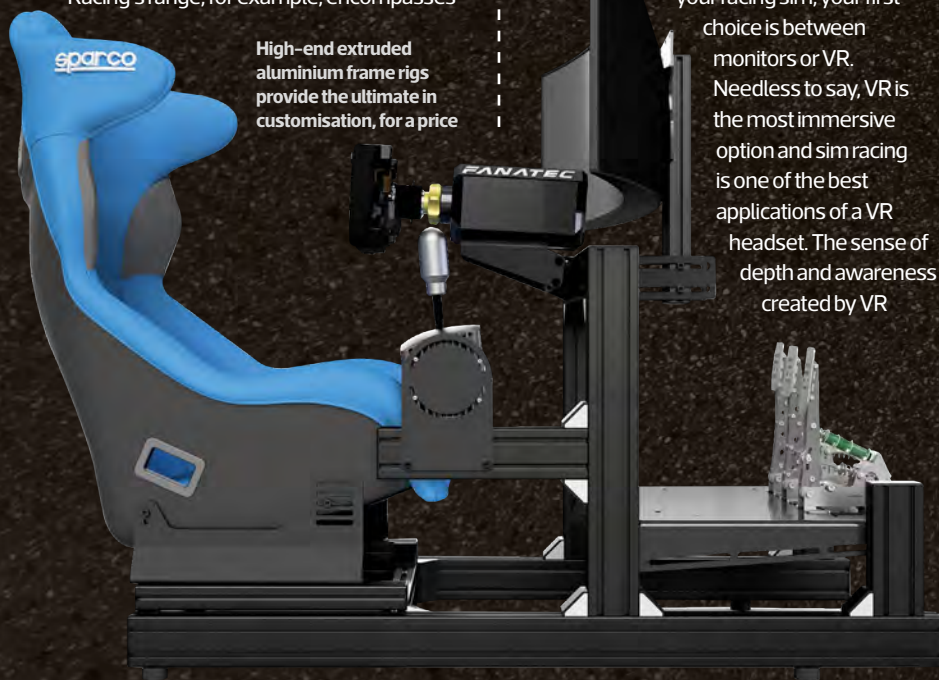
When it comes to viewing your racing sim, your first choice is between monitors or VR. Needless to say, VR is the most immersive option and sim racing is one of the best applications of a VR headset. The sense of depth and awareness created by VR

It's a less conclusive advantage for circuit racing. It's more immersive and does afford some benefits in spatial awareness and depth perception, but you can be equally quick racing on a single monitor as you are in VR. It mostly comes down to what you're most used to and a VR headset is tiring for longer (60 minutes or more) races. Sim racing in VR is great fun, no doubt, but it's not necessary to have a good time. And, if you do choose to use VR, it's a good idea to have the option of not using it when you don't feel like it.

For sim racing, the most important factors for VR headsets are comfort, horizontal field of view (FoV) and resolution/refresh rate. Sadly, FoV is a notoriously complicated issue in VR headsets, as the quoted figures often don't align with reality, so tread carefully when doing your research. The £299 inc VAT Meta Quest 2 is a more than serviceable VR headset for racing, though, so you don't have to spend stupid money. If you don't mind shopping around, the discontinued Samsung HMD Odyssey+ headset is a good-value used option.

MONITORS FOR SIM RACING

The requirements for a monitor aren't too dissimilar to VR – more horizontal FoV is desirable, as is a high refresh rate. But while an ultrawide or triple monitor setup is better than a single 16:9 monitor, you can still have fun and be fast with a regular gaming monitor. Just remember that if you're struggling driving in the cockpit view on a 16:9 monitor, switching to bonnet cam is fine. The sim racing mafia might



High-end extruded aluminium frame rigs provide the ultimate in customisation, for a price



Triple-monitor setups provide the ultimate field of view for sim racing and can look great with a bezel-free kit to hide the gaps

not approve, but that's their problem. No chase cam though. That's just wrong.

Not surprisingly, many regard triple monitors as the ultimate setup for sim racing. Triple monitors afford you a complete view of your cockpit and sufficient periphery vision for both wing mirrors with a turn of your head. It is, however, a huge luxury and requires enough space and a PC powerful enough to drive, at minimum, three 1080p monitors above 60fps at all times. If you go this route, the Asus ROG Bezel-Free Kit (£100 inc VAT) is an essential bit of kit for making your bezels disappear.

Force feedback wheels don't come cheap but a basic model can be had for under £300. For higher-end systems, prices can rise rapidly

Increasingly, though, even triple-monitor fans admit a 21:9 or 32:9 ultrawide monitor is more than enough. While having your mirrors in view is a nice-to-have, most games implement an audible spotter to warn you of cars near you, while the likes of ACC even have an on-screen radar, so you see exactly where they are relative to you. And, if that's not enough, TrackIR (\$149 US approx £110 inc VAT) adds VR-like head tracking and is supported by most sims.

Overall, a good 34in, 1,440p, 21:9 ultrawide is the sweet spot – you'll get a good view of your cockpit and the width of your car. Where possible, it's advisable to position your monitor as close to you as possible (60cm or less) to optimise your FoV, but don't panic if your circumstances prevent this. A super-wide, 32:9 monitor is great if you can afford it, but brings fewer benefits than you'd imagine, as they're

still not wide enough to emulate the visibility of triple monitors.

Adaptive sync technologies (FreeSync and G-Sync) are, as ever, desirable features if you can fit them into your budget. High-end racing sims are more likely to be CPU-limited than mainstream games, which often makes it hard to maintain your display's maximum refresh rate, in turn requiring adaptive sync to smoothly remove screen tearing.

For example, ACC running on a Ryzen 5 3600 system with a GeForce RTX 3080 Ti on max settings at 3,440 x 1,440 typically fluctuates between 80fps and 110fps during online races, but this drops closer to 60fps if playing offline with AI.

WRAPPING UP

To conclude, it's important to remember that getting into driving sims doesn't have to be expensive. Expensive gear might be more immersive or give you a slight edge in performance, but some of the fastest sim racers either did, or still do, use old Logitech G29s.

We've included some suggested setups to give you an idea of how costs scale as you move up the sim racing food chain, but you can mix, match, add or subtract however you please to hit your desired budget or experience. Just like a gaming PC, sim rigs are a modular, evolving platform you can improve whenever you feel the need.

Above all, remember to do what you find fun, not what other sim racers think is right or correct. If that means turning on the assists and racing line, do that. It's your game. **GPC**

ROOKIE

Logitech G29 – £269 inc VAT

Next Level Racing Wheel
Stand Lite – £119 inc VAT

TOTAL: £388 inc VAT

INTERMEDIATE

Fanatec CSL DD 8Nm – £400 inc VAT

Fanatec CSL Pedals LC – £165 inc VAT

Fanatec McLaren GT3 V2 Wheel – £165 inc VAT

Next Level Racing F-GT Cockpit – £399 inc VAT

TOTAL: £1,129 inc VAT

PRO

Fanatec DD1 – £935 inc VAT

Heusinkveld Sim Pedals Sprint – £580 inc VAT

Fanatec BMW GT2 V2 wheel – £250 inc VAT

Sim-Lab GT1 Evo – £329 inc VAT

GT Omega RS6 Sim Seat – £139 inc VAT

TOTAL: £2,233 inc VAT

RODENT RENOVATIONS

MOUSE MODDING HAS TAKEN OFF IN RECENT YEARS, WITH ALTERNATIVE SWITCHES, CABLES AND FEET AVAILABLE FOR MANY MODELS.

EDWARD CHESTER INVESTIGATES THE LATEST TREND



Accessing the switches for the G Pro Wireless involves removing the bottom, then the left/right buttons, before unscrewing a separate small PCB

Modders have long explored ways of repainting and visually modifying their mice, but for most people, the only time they'll ever take apart their mouse is if a cable breaks or if the mouse has become so dirty that a full dismantling and deep clean is warranted. However, in recent years a whole community has built up around the idea of not just fixing and changing the look of mice, but also improving them.

Whether you're looking to trim your mouse's weight, change the feel of its switches, make it glide better or replace its tired, overly stiff or kinked cable, it's now easy to get hold of all manner of replacement parts. We grabbed a handful of the most popular options, along with an old mouse – a much-used and much-loved Logitech G Pro Wireless – to see what upgrades are worth your time and money.

A NEW PAIR OF SHOES

One of the unfortunate design choices of many mice on the market is that the screws used to assemble them are hidden under the feet/pads/skates (there seems to be little consensus on what they're called) that are used to keep your mouse sliding freely.



The original feet of our Logitech G Pro Wireless were already mangled from being previously removed



The addition of new feet transformed the smoothness of our mouse, and the contrasting white looks good too

While the original pads can be stuck back onto the mouse, it's almost impossible to get them to stick as strongly and remain as flat as they were originally – we've already taken our Logitech G Pro Wireless apart once before, so its feet are rather mangled. As such, whatever other mouse modifications you try, buying a set of replacement feet is essential.

Several companies, such as Endgame Gear and Glorious PC Gaming Race, sell their own replacements, which is great to see, but for most other mice you'll have to seek out third-party options.

Among the most popular brands are Corepad and Hyperglide, both of which offer feet for a range of mice from several different companies, including Finalmouse, Logitech, Razer, SteelSeries and Zowie – even the Microsoft Intellimouse is supported.

We grabbed a set of Corepad Skatez Pro 147 (£12 inc VAT for two) feet for our mouse, along with a set from Ghostglides (£9 inc VAT each), to try a couple of different options. They're both made from pure PTFE (Teflon) with a thickness of 0.8mm, which is around 0.1mm thicker than the worn pads on our G Pro Wireless. We didn't find this

in case the wipes aren't enough to get the area clean – cleanliness really is the key to ensuring that the new feet stick firm and flat.

You then just need to line up each pad, ideally using tweezers to carefully lay them it into place. The sticky pads should adhere instantly, but can be pulled off again if the pad and landing zone aren't lining up properly. Just be aware that each time you remove the pad, you increase the likelihood of dirt getting into the hole and distorting the pad.

With our new pads fitted, our mouse glided

smoother than ever before, making even more of a difference than we expected. It's an upgrade we highly recommend.

OUR MOUSE GLIDED SMOOTHER THAN EVER BEFORE, MAKING EVEN MORE OF A DIFFERENCE THAN WE EXPECTED

affected our mouse's performance, but you may need to tweak your lift-off distance if your mouse has this option.

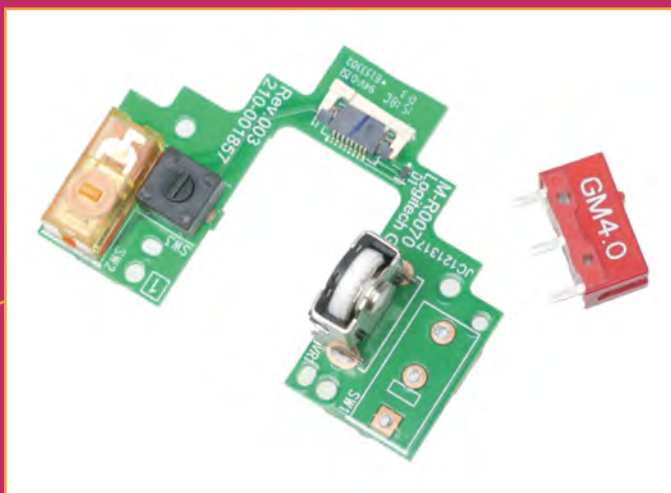
Application of the feet is easy but fiddly. Corepad provides a couple of isopropyl alcohol wipes for cleaning off the glue residue from the original feet, but we advise having a bottle of the stuff on hand

LEFT RIGHT, LEFT RIGHT

Once you've prized off your precious pads, the entire rest of the mouse is at your disposal and the first change many users



The left, right and scroll wheel switches can all be replaced, along with the scroll wheel encoder



Just three pins are required to solder the switches into place, but removal of the old switches can be tricky

will want to make is to the microswitches that sit under each mouse button.

The reasons to upgrade could be a broken or faulty switch, a worn-out switch that doesn't feel like it used to, or you just want a switch that feels slightly different. For instance, the Logitech G Pro Wireless has a notorious problem with its left and right buttons double clicking when they shouldn't.

Thankfully, replacing microswitches is generally easy, as long as you're comfortable with basic

soldering, and there's a vast range of options available from the likes of Kailh, Omron and TTC.

There's a handful of key criteria to consider when choosing a mouse microswitch. The first is the operating or actuation force, which is the measure of how hard the switch needs to be pressed to activate, measured in gram force (gf) – with ratings generally sitting between 45gf and 70gf. Lifespan is another criterion, with premium switches offering gold or silver plating and lifespan ratings varying from as low as ten million clicks up to 80 million clicks.

Along with the mechanical aspects of different switches, they can also make surprisingly different noises. The likes of the Kailh GM 4.0 Red are noticeably louder than many stock switches, for example. Combined with their heavier, snappier feel, this makes them popular for those that like tactile feedback.

In many mice, it will only be the left and right buttons that use the same form factor switches as the ones we're looking at here. For the side, scroll wheel and other extra buttons, they may use an even smaller type of microswitch. These switches can still be replaced – as can the encoder of the scroll wheel, but it's not quite as easy to find the parts and there are fewer established options.

For our mouse, we picked up a set of Kailh GM 4.0 Red (£3.99 inc VAT each from [ebay.co.uk](https://www.ebay.co.uk)), which are rated for a lifetime of 60 million clicks and have a 65gf operating force, and some TTC Gold 30M switches (£3.43 inc VAT for two from [ebay.co.uk](https://www.ebay.co.uk)), which have a lifetime of 30 million clicks and a 45gf operating force. As the switches are so cheap, you can easily try a host of different options without breaking the bank.

Accessing and initially de-soldering our mouse's original Omron D2FC-F-K switches



A mouse bungee is a simple but highly effect mouse cable upgrade



This simple cable mod can raise the front of your mouse cable, reducing cable drag

wasn't too tricky, but actually prising them off their PCB was very difficult, requiring some brute force and slight damage to the copper PCB pads. Thankfully, though, we had no such issues fitting the new switches.

Ultimately, we came down on the side of the TTC Gold 30M switches to use in our mouse in the long term. We preferred the slightly quieter, lighter feel to the Kailh switches.

Crucially, they also fixed the double-clicking problem that had plagued our Logitech mouse originally.

CABLE UPGRADES

For those using a wired mouse, there are umpteen potential cable annoyances. They can get damaged, they can snag on other desk items, they can be overly stiff and they can also be heavy or just plain ugly. Thankfully, there's a handful of ways to alleviate your mouse cable woes.

The first isn't a mod but simply an accessory that really does work: a mouse bungee. These simple devices sit on your desktop and hold your mouse's cable up in the air on a springy arm. They reduce cable drag, stop the cable snagging and generally keep your mouse's cable under control. Even the likes of Currys and Ikea sell them, with prices starting at under £10, and it's well worth getting one.

There's also a nifty trick you can try that gives you some of the same bungee benefits. Take two small cable ties and wrap one around your mouse cable just as it exits the front of the mouse, ensuring the zip tie tail faces up and away from the desk.

CRUCIALLY, THEY FIXED THE DOUBLE-CLICKING PROBLEM THAT HAD PLAGUED OUR LOGITECH MOUSE ORIGINALLY

Then, wrap the second tie around the mouse cable and the tail of the first tie, about an inch further away from the mouse.

Snip off the excess tails from the cable ties and you'll create a mini mouse bungee effect on the front of your mouse. This will add a gram of weight but reduce cable drag and provide some of the same sprung cable effect as a bungee.

Moving onto cable upgrades, you have a number of options. For a start, if your mouse is one of the handful of new models to offer a detachable cable, such as the SteelSeries Aerox 3, then you can simply buy an alternative cable with the right plug on the end.

The likes of Dream Cables in the US (dream-cables.com) or

Replacement custom mouse cables are lightweight and can come in all sorts of styles and sizes

Paracablemods (paracablemods.co.uk) in the UK offer a range of lightweight, paracord-wrapped cables in all sorts of lengths, patterns and colours. They also offer a host of different device connectors on the end, so you can completely customise your cable to your needs.

If your mouse doesn't have the luxury of a detachable cable, you still have plenty of options.

Some companies sell replacement cables for their own mice that plug into the internals of your mouse. You'll need to pull off and replace the feet to access the innards, but there's no soldering required.

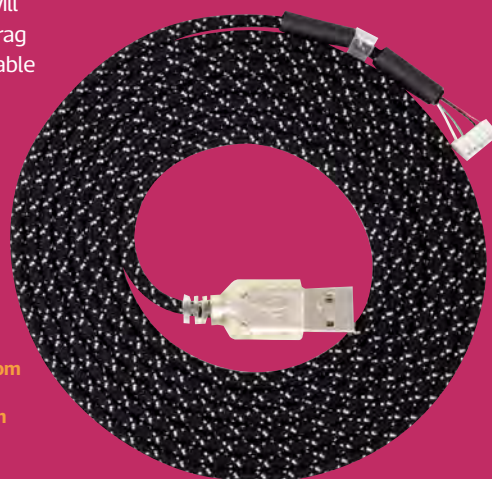
Otherwise, Dream Cables and Paracablemods will again have you covered. You can buy cables from them that terminate in a generic 4-pin plug that will fit most mice internally, or you can specify the exact connection you need – both companies support a wide degree of customisation. Both companies also offer the inclusion of a matching 3D-printed cable stress relief section for where the cable enters the front of your mouse, but mouse support for this feature is very limited. Prices typically

range from £12.95 to £15.90 for a cable from Paracablemods.

The final option is to take one of these new cables, snip off the plug and just solder it to the existing cable inside

your mouse (or directly to the PCB).

This is very tricky to carry out, as the cables are very fine, but it's doable if you're a dab hand with a soldering iron.

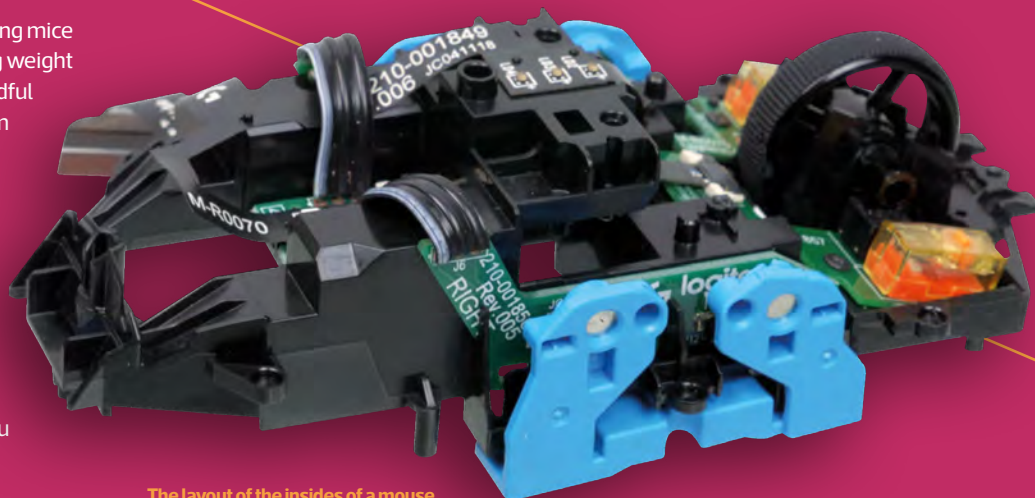


WEIGHT REDUCTION

One of the biggest trends in gaming mice in recent years has been reducing weight as much as possible. In just a handful of years, we've seen mice go from topping the scales at upwards of 150g to now, when any weight over 80g is considered heavy. Simply buying a light mouse in the first place and perhaps swapping out its cable for an ultralight one is as far as most people think you can go for keeping down mouse weight, but there are plenty of tweaks you can do yourself.

Let's take our Logitech G Pro Wireless as an example. It has a slot on the underside of the mouse where you can stow the wireless dongle, and that slot has a magnetically attached cover. Ditch the cover when the mouse is in use and you've saved 2g. Open the mouse and you can also detach the magnets for that cover, which also double as contact points for the mouse's charging dock, saving another 2g – we don't have the dock anyway.

This mouse is also ambidextrous, with side buttons on both sides, and it uses a brilliant system of magnetically attached plastic pieces to either enable or just cover up each of the buttons. However, if you know you're never going to use those extra side buttons, rather than just blank them off, you can remove the covers (0.5g each), and even open the mouse and remove the switch mechanism itself. We removed the blue plastic part that sits between the



The layout of the insides of a mouse can vary wildly, but most mice have parts that may be surplus to your requirements, such as the side buttons on our Logitech mouse

outer buttons and the microswitches, saving us another 2g.

This mouse's battery is a tiny custom lithium cell for which you'd be hard pushed to find a smaller replacement. However,

THE FINAL AND MOST DRASTIC WEIGHT-SAVING STEP IS TO START CUTTING PIECES AWAY FROM YOUR MOUSE

some wireless mice may use a larger generic battery. If your mouse uses an AA battery, you can buy an AAA battery and use a little converter to make it fit – this swap alone could save you over 10g.

The final and most drastic weight-saving step is to start cutting pieces away from your mouse. Again, looking at our G Pro Wireless, an obvious place to start is to just chop out the entire USB dongle slot section, which saves 2–3g.

Meanwhile, in nearly all mice, you'll be able to find sections of plastic that can be snipped out, buttons that can be removed

and RGB LEDs that can be excised. You can even perform your own version of the modern trend of filling your mouse with holes to reduce weight. We've seen this done to G Pro

Wireless models, bringing them down to as little as 57g. We shaved off a mere 8g by ditching those side buttons, the cover plate and the charging points, to get ours down from 80g to 72g.

SURFACE TREATMENTS

If your mouse has lost its soft-touch finish, its buttons have worn to a shine, you need some extra grip or you just want a change of colour, there's a handful of options available for upgrading the exterior of your rodent.

If you're after more grip, the best option is to slap some grip tape on your mouse.



Removing the side buttons and the blue plastic mechanism for them inside trimmed 3g off our mouse



Removing the charging dock points and the cover for the USB dongle slot removed another 4g from our mouse

Lizard Skins (lizardskins.com) has become the go-to option for this purpose. Originally designed for baseball bat grips, the material has been repurposed for use on mice. You can get all manner of colours and patterns and you just need to cut the material to the shape you need and stick it on (£14 inc VAT from overclockers.co.uk).

Other companies such as Glorious PC Gaming Race sell pre-cut grip tape that exactly match their mice (£8 inc VAT from overclockers.co.uk) and even Razer sells generic pre-cut hexagonal grip tape (£10 inc VAT from currys.co.uk). As with applying new glide pads, ensuring the surface of your mouse is squeaky clean by using isopropyl alcohol will ensure your grip tape stays stuck.

The other main external upgrade option is to repaint your mouse. Whether you're after a colourful, glossy look or a rough and grippy rubberised paint, a fresh coat can transform a mouse.

As with any painting project, preparation is the key. Once you've dismantled your mouse into the constituent panels you're going to paint, you'll need to prepare all the surfaces. If your mouse already has a soft-touch finish, you'll have to painstakingly remove it with a combination of isopropyl alcohol and a mild abrasive, such as a Scotch-Brite pad. The same is true for

any old peeling paint, which will need either sanding off completely, or sanding smooth and scuffing up to provide purchase for the new paint. You'll also need to clean the surface with alcohol once it's sanded.

At this point you can apply any finish or combination of finishes you require, as per your paint's instructions.

Generally, you'll need to apply a coat of primer, a couple of coats of top coat then two or three coats of lacquer if you're creating a gloss finish, but rubberised or matt paints will be different.

However, bear in mind that paint finishes will add a bit of weight to your mouse and they will fail eventually – if your fingers can wear a shiny patch into bare plastic, they can do so with paint too, so be prepared to repeat the process again in a few years. **GPB**

Lizard Skins and other mouse grips provide an easy, stick-on way to colourise and add mouse grip



Glorious PC Gaming Race sells pre-cut grip tape that exactly match its mice





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

Bangle.js 2

Engineer Gordon Williams rose to fame in 2013 with a crowdfunding campaign for the Espruino, an effort to meld the worlds of JavaScript and the Internet of Things (IoT). In 2019 he unveiled the JavaScript-powered Bangle.js smartwatch – and now its successor.

The positioning of the Bangle.js range as an open-source, hacker-friendly gadget echoes that of the Arduino-compatible Sqfmi Watchy (see Issue 218). Unlike the Watchy, the Bangle.js 2 isn't open hardware. In fact, the hardware is a commercial off-the-shelf product – the SMA Q3, a low-cost smartwatch available in bulk from China for \$28 US (around £21 ex VAT) per unit.

The Bangle.js ecosystem is definitely open though. The firmware allows the watch to load

The rear of the watch includes a 4-pin connector for charging and debug, plus a pulse sensor



any one of a number of compact applications, from watch faces to calculators and live mapping. Management is handled through a spartan (but functional) web interface, also open-source, where software can be added, removed and upgraded as new releases become available.

This is where you'll find the first flaw in the Bangle.js 2's design: every user-facing activity takes place over Bluetooth using the Web Bluetooth standard. While the watch has a 4-pin connector on the back, designed for use with a bundled magnetic pogo-pin USB cable, it's for power and Serial Wire Debug (SWD) only. That's a problem, as Web Bluetooth still isn't broadly supported, and you may well find yourself

The Bangle.js 2 puts JavaScript on your wrist, running atop a bargain-basement smartwatch

installing Google Chrome just to manage the watch. If you're on a machine without Bluetooth, there's no easy way to manage it at all.

After that, though, the process is relatively smooth. Compared with the Watchy's out-of-the-box experience, the Bangle.js ecosystem is slick – click Connect, find your watch, upgrade the stock apps with one click, then browse through a list of optional extras to see if any take your fancy.

The hardware inside the watch is surprisingly powerful, given the low cost of the hardware. There's a Nordic Semi nRF42840 system-on-chip with a single Arm Cortex-M4 microcontroller, 256KB of RAM, 1MB of on-chip



Pop the included 22mm strap home, charge and you're ready to go

flash and an additional 8MB of external storage. There's also a built-in GNSS receiver with GPS and Glonass support, a heart-rate monitor on the rear, a three-axis accelerometer and three-axis magnetometer, plus a combined pressure and temperature sensor.

NEWS IN BRIEF

Pop!_OS launches for Raspberry Pi

Linux system builder System76 has announced the first version of its in-house Pop!_OS, a custom Linux distribution built atop Canonical's Ubuntu 21.10, for Raspberry Pi single-board computers. 'Pop!_Pi adapts Pop!_OS to the Raspberry Pi, giving you the same powerful software tools at your disposal,' the company explains. 'So whether you're programming a robot or learning Rust, have fun tinkering and experimenting!' The 'tech preview' release is compatible with the Raspberry Pi 4 and Raspberry Pi 400 computers and can be downloaded free of charge from pop.system76.com



The display is the real selling point though. It's an always-on memory LCD, as popularised in the smartwatch world by Pebble, meaning it draws very little power when not actively changing states. The specs claim a 40-day runtime, although the actual figure varies considerably depending on usage.

The panel is protected by a 6H glass layer, and it's fully readable in sun and artificial light, while a poke of the single physical button on the side activates a backlight for use in the dark. It's also a touch-screen, although its small 1.3in diagonal means it can sometimes be a challenge to hit your target option, which is particularly irritating when you're trying to silence an alarm.

It's a colour display, but not exactly full colour – it offers three bits of colour depth, translating to a limited eight-colour palette. Thankfully, the firmware includes a built-in dithering function, meaning it's possible to fake a wider colour gamut – albeit one that gets a little spotty thanks to the low 176 x 176 resolution.

The watch leans on Gadgetbridge to connect with your smartphone. At the time of writing, the support was functional but rudimentary – Android message notifications worked but incoming call notifications didn't, and the interface for media playback control wasn't great.

The same could be said for much of the software, which typically has a version number of zero with a decimal point. Every app in the app store – alongside the app store itself, and the

```
// Two variables to update
var boolean = false;
var number = 50;
// First menu
var mainmenu = {
  "": {
    "title": "-- Main Menu --"
  },
  "Beep": function() { Bangle.beep(); },
  "Buzz": function() { Bangle.buzz(); },
  "Submenu": function() { E.showMenu(submenu); },
  "A Boolean": {
    value: boolean,
    format: v => v?"On":"Off",
    onchange: v => { boolean=v; }
  },
  "A Number": {
    value: number,
    min: 0, max: 100, step: 10,
    onchange: v => { number=v; }
  },
  "Exit": function() { E.showMenu(); },
};
// Submenu
var submenu = {
  "": {
    "title": "-- SubMenu --"
  },
  "One": undefined, // do nothing
  "Two": undefined, // do nothing
  "< Back": function() { E.showMenu(mainmenu); },
};
// Actually display the menu
E.showMenu(mainmenu);
```

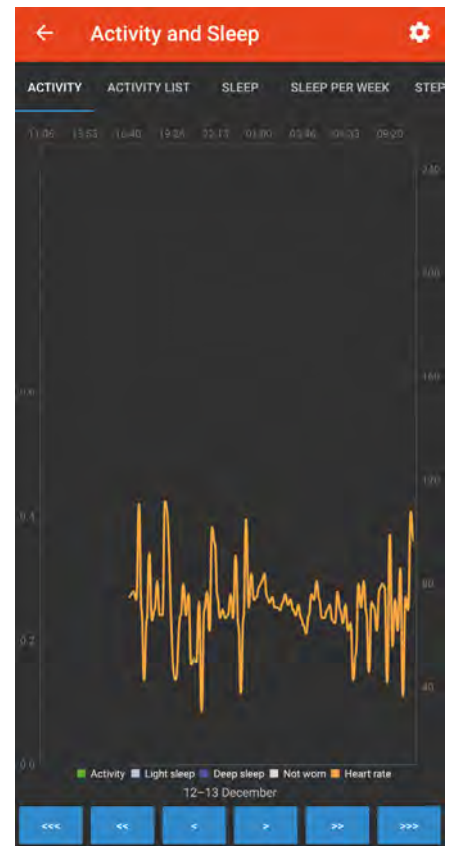
All apps, and the firmware itself, are released as open-source

firmware that sits on the watch – is open-source, though, meaning it's possible to dive into the JavaScript if anything isn't working quite how you'd prefer.

The Bangle.js2 isn't perfect. During testing it crashed a few times, and the magnetic charging cable had a tendency to fall off. It also ignores alarms set in Gadgetbridge, the figures reported by the heart-rate monitor seem wildly inaccurate and there's no sleep monitoring. Notifications are also patchy, and the SWD pins remain energised at all times – potentially leading to skin irritation and contact corrosion over time, unless you cover them with lacquer or a sticker.

It's still an impressive effort, though, and one of the few devices to come close to recreating the classic Pebble look and feel. It's ideal for JavaScript programmers – not only is it functional, but no other smartwatch family lets you flex your programming chops in your favourite language.

Williams is promising to notify those signing up at espruino.com/Bangle.js2 when the next version, which will cover the SWD pins by default, is available. Pricing hasn't been confirmed, but the crowdfunded units sold for £59 inc VAT.



Gadgetbridge links the watch to Android smartphones, but only sends heart rate data, and the accuracy is questionable

ANALYSIS

Dragon 32 archaeology

Vintage computing enthusiasts invariably end up with collections of disks cluttering up their shelves, but what do you do when the computer system that made them is no longer around, but you're curious about what's on them?

Creating an emulator-compatible disk image from a physical Dragon 32 disk is fairly straightforward, if you have the right gear. You can capture a raw image using a KryoFlux (see Issue 131) and turn it into a VDK image using the HcX Floppy Disk Emulator software (see Issue 222).

That's enough to get you some of the way there, but not all. Take, as an example, a disk labelled 'PIC-DISC' and full of files with the extension '.LR'. An emulator will let you list the files, but go no further, unless you happen to have a copy of whatever software was used to create the pictures. You need a way to get at the files themselves, and preferably without poring over the disk image with a hex editor and a copy of the Dragon DOS disk format specification.



A picture nobody has likely seen since the late 1980s, recovered for posterity

Back in 1997, engineer Graham E. Kinns wrote

Dragon DOS Utils, a suite of software tools designed for handling Dragon floppy disks and extracting the files within them. Anyone with a dead Dragon and a pile of floppies could simply pop a disk into their shiny new MS-DOS desktop and extract whatever they needed, no Dragon required.

It's no longer 1997, though, and shiny new MS-DOS desktops are now older than the Dragon 32 was when Kinns originally wrote the tool. Tying into the BIOSes of old PCs, and requiring a physical floppy disk, the software isn't compatible with emulators such as DOSBox or virtual machines, but it is open-source.

When Kinns released the tools in 1997, he also released the source code, copies of which are still available today. Taking this code, Haiku OS developer Adrien Destugues was able to quickly convert the software for use on modern *NIX systems – specifically Linux and Haiku, a free operating system designed as a successor to BeOS.

The new Dragon DOS Utils suite, thanks to Destugues' work, no longer requires a physical floppy drive; instead, the utilities use VDK disk images – the same format most Dragon emulators require.

One tool provides a directory listing, displaying information about the format of the disk, and the name and size of the files upon it. Armed with this information, a second tool is used to extract one or more files from the disk image to the local filesystem – ready to be processed through any digital archaeology

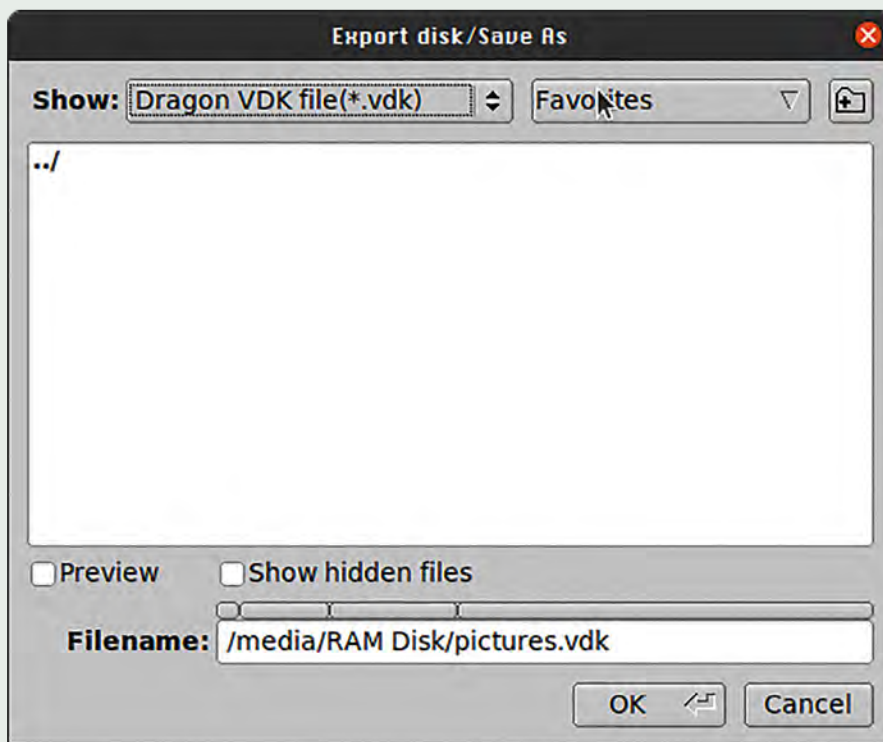
How do you get files off a Dragon 32 floppy without a Dragon 32?

NEWS IN BRIEF

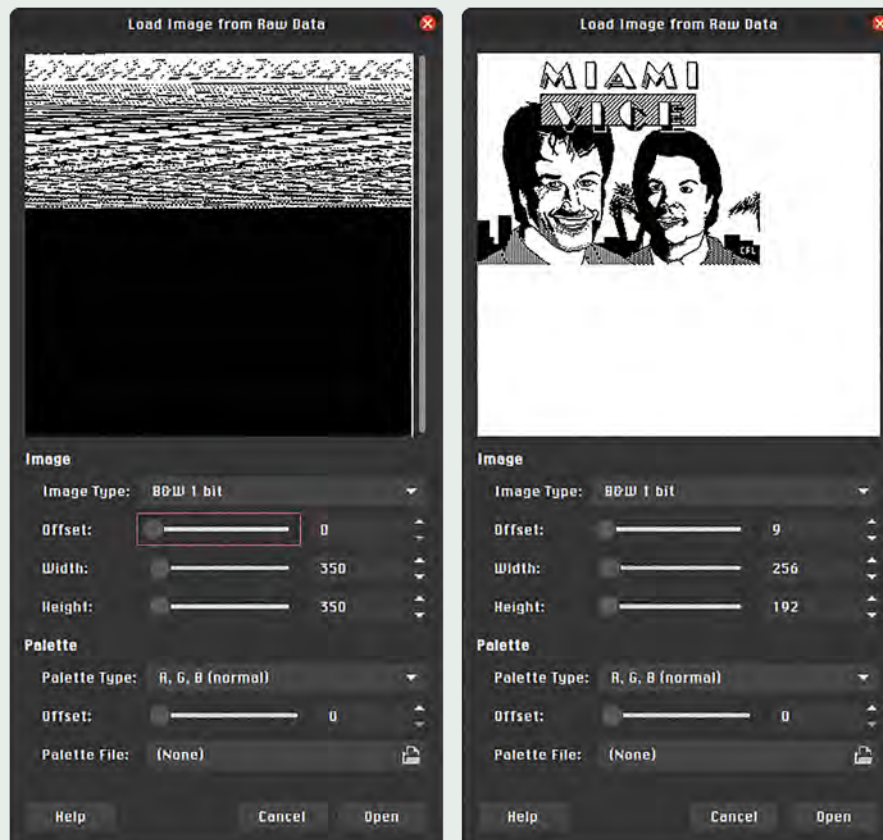
Firmware boosts DevTerm pointing performance

A community-developed firmware update, based on Clockwork Pi's open-source code, has addressed the poor trackball performance of the DevTerm open-hardware portable PC. Using the new firmware, the trackball now accelerates properly, enabling the user to cross the ultra-wide display in a single swipe. Accuracy is also improved, and the middle button can now act as a modifier for scrolling. 'Thanks to this self-organising community,' says Clockwork Pi founder Hal Lui, 'we were planning to start fixing the problem when it was already fixed.' The firmware is available now from custompc.co.uk/Clockwork





A VDK image will load the disk into an emulator, but get you no closer to the underlying files



A little fiddling with settings, and the raw image data can be loaded into The GIMP

tool of the user's choice. Those aren't the only tools included. There are two converters – one for Dragon BASIC .BAS files and another for DosDream .DRM files, which take extracted Dragon files and convert them to plain text. For BASIC listings, this offers a great way to publish the files, and allows them to be viewed without a Dragon emulator using a simple text editor.

There's no converter for graphics, though, so finding out exactly what's on the 'PIC-DISC' disk will take a little more effort. The Dragon 32 was, thankfully, a relatively simple 8-bit home computer, which makes it likely the image files contain little more than raw bitmap data.

Open-source image editing tool The GIMP includes a raw data import function that, handily, offers adjustable settings for interpreting the data. Loading one of the files retrieved from the disk reveals little more than a thin strip of noise, indicating that the default settings are incorrect and that it's time to start adjusting.

The first step is to set The GIMP to expect a 1-bit black-and-white colour palette, on the assumption that the pictures use the Dragon 32's high-resolution display mode.

The thin strip of noise then resolves into something that looks almost recognisable, like an analogue TV signal that's lost its horizontal hold.

The next step is setting the resolution. The Dragon 32's high-res display mode offers a 1-bit 256 x 192 canvas, laughably small by modern standards. Adding these dimensions as the width and height of the imported image has a dramatic effect; the shifted image becomes immediately clearer, revealing – in the case of 'MIAMI.LR' – a drawing by artist 'CFL' of the stars of Miami Vice.

The picture's not quite perfect though – it's shifted horizontally. A quick tweak of the offset setting, adding a nine-column offset, is the final step in taking a picture file nobody's seen in 30 years and making it accessible on a modern computer system.

Once the settings are dialled-in, all the images on the disk can be loaded ready for export to PNG and safe storage for someone else to find in a few decades' time.

Anyone looking to extract files from their own archive of Dragon DOS disks can find the required software online at github.com/pulkomandy/ddosutils, with many thanks to Destugues' efforts.

REVIEW

Crackers II: The Data Storm

Crackers II: The Data Storm continues from where Crackers I: The Gold Rush (see Issue 218) ended. Where the first book focused on the explosive rise of software piracy in the days of high-speed tape dubbing and 'don't copy that floppy', the second moves into an era of digital networking. However, it's firmly positioned in the early 1990s, when 'digital networking' meant bulletin board systems (BBSes) rather than the Internet.

The second book begins, after a Commodore 64-focused introduction by David Almer, at chapter eight of the combined work. 'The scene started to operate faster and faster,' it reads – a direct follow-on from where the first volume's chapter seven ended. In other words, you're not going to want to read this book as a standalone.

A mixture of prose and interview content, as before, Crackers II has an impressive list of contributors. Members of Fairlight, The Bladerunners, Fuzion, Elite, Pompey Pirates, Automation, LSD and The Medway Boys are

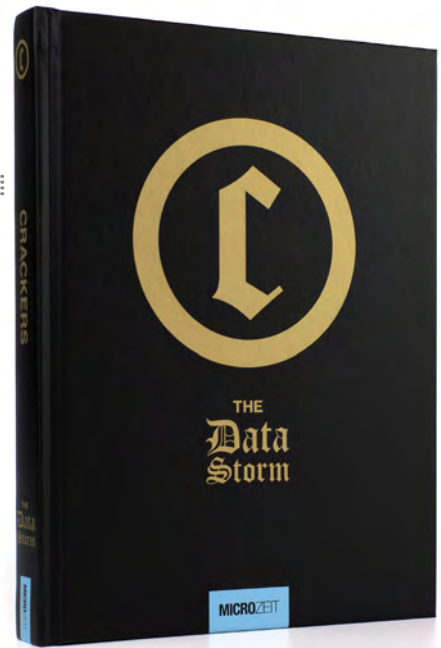
Splitting the content into two books allows the imagery to breathe

included, to name just a few – the majority, as before, contributing under pseudonyms, such as The Alien, Stranger, Pitcher, Cameo, and Angel Face, in order to avoid any possible legal action.

While much of the latter half of the book focuses on the BBS scene – including a look at Little Lulu's, the primary landing site for cracked software coming from Europe to the USA – this isn't its exclusive focus.

There's also a section in the book devoted to the 'Copy Markets' where physical disks traded hands, a piece by Denis Lechavallier walking through the operation of copy protection systems on the Amiga and Atari ST, and even a section on ASCII art by French artist Senser (SNS).

One big difference between the two books is that the second one includes a look at console game piracy. Some crackers became disillusioned with the ease with which you could crack home computer software and turned their attentions to the more challenging physical cartridges of the Sega Mega Drive and Super Nintendo.



Microzeit's latest book is a great follow-up to Crackers I

Along the way, Crackers II covers art battles between cracktro coders, a pair of big cracking and coding parties. It even takes a look at the Chaos Computer Club – Europe's biggest hacker group, founded in 1981 and boasting 7,700 registered members at the last count.

In short, Crackers II is packed. Like its predecessor, it's a must-have for anyone who remembers the era, fondly or otherwise, or who would simply like to learn what piracy was like before the Internet and peer-to-peer sharing software. It's hard to shake the feeling that the two books could have been a single publication though.

With each book containing a pleasingly symmetrical 332 pages, a combined volume in the present layout would have been a hefty 664 pages, but it would have been easy to reduce the page count by reducing the size of the visual content to prioritise the text. That said, splitting the content allows the imagery to breathe, making the books great additions to your shelves or coffee table. Crackers I and II are available from microzeit.com now for €39.90 (around £34 inc local VAT), and you can also pick up slightly damaged B-stock copies for €19.90 (around £17 inc local VAT), while stocks last. **CPC**



Gareth Halfacree is a freelance author, journalist and keen computer hobbyist who likes to tinker with technology. [@ghalfacree](https://twitter.com/ghalfacree)

sinclair



Commodore



the COMPUTERS

THAT MADE

BRITAIN

OUT
NOW

"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
pinning for a future that could have been.
It's utterly astonishing!"

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

.....



Buy online: wfmag.cc/ctmb

Available on
amazon



ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

EK announces Asus ROG Strix X570-I Gaming block

A week before I wrote this column, I was planning to make a YouTube video discussing the lack of monoblocks for mini-ITX motherboards. It's just great being able to dump as much heat as possible from your motherboard into your water-cooling system's coolant, so your radiator can deal with it. This ability is especially important in toasty, space-limited mini-ITX systems. I've always used monoblocks where possible.

As well as cooling your CPU, they help to keep your motherboard's VRMs in check, save on fittings and nightmare plumbing scenarios by having single inlets and outlets, and in some cases, they allow you to ditch chipset fans too. There's been a distinct lack of monoblocks for mini-ITX motherboards recently, though, and I'd created a list of questions to ask the likes of EK why this is so. The company

produced loads of monoblocks for boards with Z87, Z97 and Z170 chipsets, but there's been nothing for Intel and AMD's last few generations in the mini-ITX arena.

Amazingly, a few days after I started planning the video and had sent the email to EK, the company announced a monoblock for the Asus ROG Strix X570-I Gaming.

This news came as a complete surprise, for a number of reasons. Firstly, the motherboard is old. Yes, X570 is still AMD's current premium mainstream chipset; it was launched over two years ago and the motherboard itself is over two years old too.

This begs the question, why now? According to EK, there's been a large and vocal community complaining about the motherboard in question, specifically its noisy chipset fan. I can certainly sympathise, since I'm



EK has finally introduced a monoblock for Asus' mini-ITX X570 board, over two years after it came out

currently using this board in my own system. The chipset fan is often the noisiest component in the PC, as the CPU and GPU are water-cooled, while the speed of the chipset fan ramps up under sustained medium or high loads.

Sadly, unlike more recent boards with chipset fans, there's no way to control this motherboard's chipset fan in the EFI or Asus' AI Suite, so you're left at the mercy of whatever fan profile is applied out of the box. The EK monoblock solves this issue, though, as it cools the hot-running chipset, VRMs and CPU, allowing you to ditch the noisy fan as well. EK should be commended for pleasing the community, even at this late stage, but I'd have loved to see the product available 18 months ago.

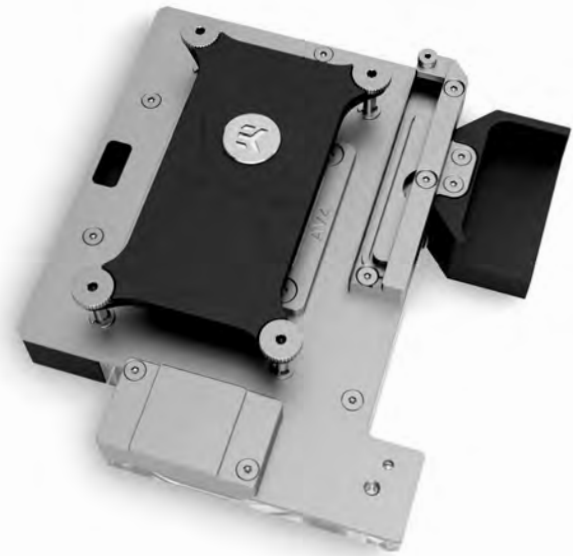
However, EK did give some reasons for the late arrival. For starters, gauging popularity of a particular motherboard is tricky. This is especially true with mini-ITX motherboards, as there are only a handful of boards released for each chipset and it's very easy to identify the best one. In fact, Asus' efforts with Intel's chipsets on mini-ITX boards haven't proved to be very popular, especially with air-cooled PC owners, as their huge heatsinks and M.2 stacks limit cooler compatibility. If a board has one or more of these types of issues, sales can drop drastically.

Secondly, Asus' mini-ITX boards are undeniably complex, which this increases the complexity of the monoblock design to fit them,

especially if you want to cool more than just the CPU and VRMs. It takes time to design it, and check sales and community support. EK also admitted that the quick succession of chipsets we've seen in recent years means that by the time the company has worked out how to create a monoblock for one board, a new chipset and motherboard range is just around the corner. For me, though, taking this leap and offering support is about more than just sales.

It shows willing for starters, but also takes a leap into a niche, but very passionate area of computing that's sure to result in plenty of PR-boosting eye candy on the modding scene. I'll hopefully be taking a look at the waterblock and how to install it soon.

The block cools the hot-running chipset, enabling you to ditch the board's irritating fixed-speed fan



Hands on with EK's Quantum Velocity 2

Another EK product I've wanted to check out for a while is its Quantum Velocity 2 CPU waterblock. Initially thought it was a new monoblock, given its large square design, but actually it just cools your CPU. It does occupy the entire CPU socket area, though, resulting in a cleaner look than a smaller waterblock or AIO liquid cooler with mounting arms.

My sample was finished in black and nickel and has a strip of RGB lighting

A strip of RGB lighting separates the black and nickel-coloured areas, and hooks up to a 3-pin digital RGB connector

separating the two colours, and hooks up to a 3-pin digital RGB connector. It weighs a tonne, so be wary of lowering it down onto your motherboard – instead, lower your motherboard face down onto it. Its size was also a concern, especially with motherboards that have cooler compatibility issues such as the Asus ROG Strix Z690-I Gaming WiFi, but thankfully, it just fitted on that board, albeit with millimetres to spare between the heatsinks and memory.

The backplate is socket-specific due to its integrated mounting screws being fixed in place, so you'll need to make sure to order the right one for your CPU. The pins on the waterblock are also fixed, so there will be limited compatibility between sockets. However, I love the mounting screws themselves – they secure easily and don't mince your fingers, as you can use an included hex key to secure them. A tube of Thermal Grizzly thermal paste is also included.

The RGB lighting looks fantastic. As it's digital RGB, you can add a rainbow mode to the lighting, moving between



The backplate is socket-specific due to its integrated mounting screws

colours along the strip, or stick to a single colour. If you prefer your RGB lighting to be vibrant but subtle, it will definitely appeal to you.

The downside to all this eye candy, however, is the price. At £150 inc VAT, it's the second most expensive CPU waterblock I've seen, and as it's an LGA1700 block, that's adding a huge amount to a likely already expensive motherboard. However, I absolutely love the design, the build quality is epic and thankfully, despite its size, it can fit on motherboards that have compatibility issues with other cooling hardware. **GPC**



How to Spray-paint rigid tubing

Antony Leather shows you how to add your own choice of colour to hard runs of acrylic tubing

TOTAL PROJECT TIME / 3 HOURS

If you're well versed in the dark arts of water cooling, you've probably given rigid tubing a go, either in the form of acrylic or metal variants. You might even have bent some tubing yourself, which can be a tricky but rewarding experience. However, there's another layer of personalisation you can add to your tubing that can really make coloured coolant pop.

By adding masking to your tubing and spraying over it, you can easily add spirals, lines or ring patterns to the tubing, using a background colour that allows your coolant to show through. All you need is some edging tape, some plastic primer and some colour spray paint to take your rigid tubing loop to the next level.

TOOLS YOU'LL NEED



Edging tape
ebay.co.uk



Colour coat and clear coat
fatbuddhastore.com



Plastic primer
fatbuddhastore.com



Protective gloves
ebay.co.uk



1 / MEASURE UP SPRAY AREAS

With the tubing cut to size, measure and mark up the positions where the locking rings of your fittings end. You don't want the paint touching the internal fitting, but you do need to make sure the area sitting just inside the outer locking ring is painted.



2 / USE GLOVES

To protect the paint surface from further muck, use clean gloves to prevent your fingers from touching the surface again, and to protect your hands from being irritated by the paint.



3 / CLEAN TUBING

The tubing will likely have residue from the manufacturing process on it, as well as your own fingerprints, so use washing-up liquid to clean it, then rinse it thoroughly afterwards.



4 / APPLY MASKING

To obtain clean edges and create curves or spirals, you'll need to use edging tape. This tape is flexible and can be easily manipulated. In our example, we're wrapping it around the tube in a spiral to create a coil-like finish.



5 / SUPPORT THE TUBING

Hold the tubing using a length of material such as a pen or straw. Avoid using metal here, as it can scratch the acrylic.



6 / SPRAY THE TUBING

Standard acrylic spray paint may take to your tubing, but it's best to use a plastic primer in order to create a binding layer for the paint. Spray from 8in away and coat the area once. Allow the primer to dry for five minutes.



7 / ADD COLOUR LAYER

It's important for your chosen paint to contrast with your coolant colour, so black, grey or white colours here are often good. Apply two coats of your chosen colour, allowing each coat to dry for ten minutes.



8 / PEEL OFF MASKING

Peel off the masking before the paint has fully dried, in order to prevent it from cracking. Do this gently and try to pull the masking tape upwards, rather than at an angle. At this stage, you can also add an optional clear coat, but do this after you've removed the masking, so you create an even layer.



9 / INSTALL TUBING

Take care when handling the tubing and try not to touch the painted areas. Pastel coolants with a solid colour look best with painted tubing, but any colour will work well as long as it contrasts well with the spray colour.

How to Mount your GPU vertically

Antony Leather shows you how to show off your graphics card in its full glory behind your side panel

TOTAL PROJECT TIME / 30 MINUTES

Your graphics card is one of the most attractive bits of hardware in your PC, but it's often facing the base of your case as if it's being sat in the naughty corner. This obscures your view of its cooling system, be it elaborate heatsinks and fans or a waterblock, with the latter also hiding away any coolant channels.

Thankfully, you can mount your graphics card vertically, so you can see these features and some cases offer this ability out of the box. However, you'll often need extra components to do it and you'll need to factor in cooling issues too due to the proximity of the side panel hampering cooling. However, even cases that lack vertical GPU mounts can be converted using universal kits and in this month's modding guide, we'll show you how to get your graphics card standing up to attention.

TOOLS YOU'LL NEED



No 2 Phillips screwdriver
Most hardware stores



Tape measure
Most hardware stores



Universal vertical graphics card kit or riser cable
overclockers.co.uk



1 / CHECK FOR REQUIRED COMPONENTS

Every case is different, with some models offering vertical mounts out of the box, while others will need additional components. Your case manufacturer's website may offer vertical GPU kits or replacement panels, but if in doubt, the manual should indicate if it's possible to vertically mount your graphics card.



2 / CONSIDER VENTED SIDE PANEL

Mounting an air-cooled graphics card vertically can mean it sits close to the side panel, which will hinder cooling if it's solid. If you use a big air-cooler card, consider using vented side panels to improve ventilation.



3 / CONSIDER UNIVERSAL MOUNT

Some cases lack vertical mounts, but thankfully there are clever universal kits that can be fitted inside many ATX cases with no modding required. You simply route your graphics card's cables through the rear expansion slot covers. However, if your case has slats between each slot, these may need to be cut out first.



4 / CHECK FOR PCI-E COMPATIBILITY

Check if your GPU and motherboard support PCI-E 4. If so, and you want to run in that mode, you'll need a PCI-E 4 riser cable. If you're using a PCI-E 3 cable, you'll need to disable PCI-E 4 in your motherboard's BIOS to avoid stability issues.



5 / REMOVE EXPANSION SLOT COVERS

To install your graphics card vertically, you'll likely need to remove additional expansion slots in your case to make room. Don't forget to reinstall the horizontal ones, as not doing so can allow dust to enter your case.



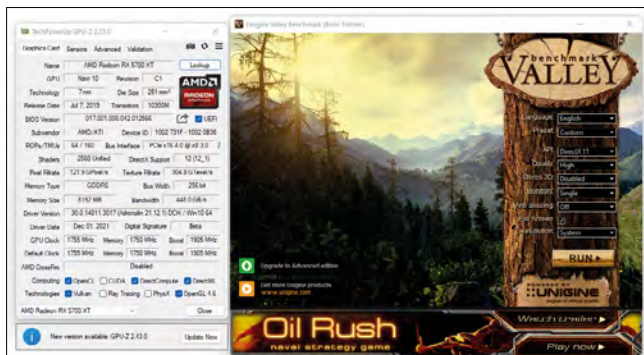
6 / TEST-FIT GRAPHICS CARD

It's a good idea to test-fit your graphics card first. It will be sitting further out of your case than normal, so larger models can occasionally end up fouling case components. This is also a good time to see if your graphics card is sagging, so you can buy a support if necessary.



7 / MEASURE COOLER CLEARANCE

Check the clearance between your graphics card's cooler and the side panel. You need at least 2-3cm of clearance to allow the fans to breathe. It's especially important to check clearance on 2.5-slot or triple-slot graphics cards. If the clearance is less than 2cm, consider a universal mount, as they can offer more clearance.



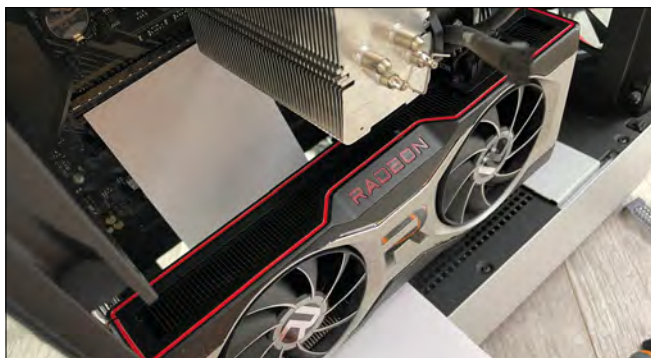
8 / TEST GPU TEMPERATURE

To check your vertical mount won't result in unacceptable temperatures, run Unigine's Valley benchmark on default settings for 15 minutes with your graphics card mounted horizontally (with the side panel on), then test it again vertically. You can use GPU-Z to inspect GPU temperatures and see if the results are acceptable.



9 / CHECK CABLE ROUTING

You might need to alter the cable routing in your case compared with how you had it set up before. For example, it may be better to run the GPU PCI-E power cables through the PSU cover, since the graphics card will then be hiding them.



10 / MEASURE FOR RISER CABLE

If you're purchasing a riser cable separately, you'll need plenty of slack in order to comfortably mount your graphics card vertically. Cut a piece of A4 paper lengthways in half to use as a template. You want it to run from the primary PCI-E slot to the base of your graphics card with an inch or two of slack.



13 / CONNECT RISER TO MOTHERBOARD

Before you install your graphics card, connect the PCI-E riser cable to the motherboard's main PCI-E slot. It's far easier to do this job now rather than after you've installed your graphics card.



11 / INSTALL UNIVERSAL MOUNT

A universal mount sits on top of your existing PCI-E slots, and you fit it to the expansion slot brackets in your case, just like a standard graphics card. Place it into position and secure it with your case's screws.



14 / MOUNT GRAPHICS CARD SLOT

The vertical mount may come with support pads in order to prevent your graphics card from sagging, so use the appropriate ones for your case, so the mount sits level, then attach the PCI-E graphics slot to the mount.



12 / CHECK FOR ADDITIONAL SLOTS

Both integrated and third-party vertical mounts often include numerous slot brackets, enabling you to adjust your graphics card's position relative to the side panel. Place air-cooled cards as far away from the side panel as possible in order to boost airflow.



15 / INSTALL YOUR GRAPHICS CARD

Now go ahead and install your graphics card in the vertical mount. If you're just using a riser cable with no mount, you can now run the cable's female port from the motherboard and connect it to your graphics card. **GPC**

WIN

A 27IN 240Hz AOC GAMING MONITOR



If you want to run games at high frame rates, but find that your current monitor can't keep up, then make sure you enter our competition this month. We have a 27in AOC C27G2ZE gaming monitor up for grabs this month, which couples a super-fast 240Hz refresh rate with a high-contrast, 1500R-curved VA screen.

The 240Hz refresh rate completely unleashes top-end GPUs, bringing unprecedented fluidity to the picture on your screen. With every detail brought sharply into focus and every movement shown with crystal clarity, you can feel your reactions become one with the action and elevate your game. Meanwhile, the pixel response time of 0.5ms means fast-moving action and dramatic transitions will be rendered smoothly without the effects of ghosting.

The screen's curved design also wraps around you, putting you at the centre of the action and providing an immersive gaming experience. What's more, this monitor's support for AMD FreeSync Premium ensures that your GPU's frame rate and monitor's refresh rates are synchronised, providing a fluid, tear-free gaming experience.



SPEC

- 240Hz refresh rate
- 27in VA panel
- 1500R curve
- 3-sided frameless bezel
- FreeSync Premium
- 1,920 x 1,080 resolution
- 0.5ms response time (MPRT)
- 300 nits brightness
- 3,000:1 static contrast ratio



SUBMIT YOUR ENTRY AT **CUSTOMPC.CO.UK/WIN**

Competition closes on Friday, 4 March. Prize is offered to participants in the UK aged 13 or over, except employees of the Raspberry Pi Foundation and Raspberry Pi Ltd, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from Custom PC magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. Winners will be contacted by email to arrange delivery. Any winners who have not responded 60 days after the initial email is sent will have their prize revoked.

Retro tech

NVIDIA GEFORCE

Lights, transform, action! **Ben Hardwidge** recalls the very first 'GPU'

It's testament to Nvidia's late 1990s marketing team that one of its buzzwords has now slipped into common parlance. Not only did Nvidia's 1st-gen GeForce 256 introduce us to its now famous 'GeForce' gaming graphics brand, but it also brought the term 'GPU' with it. An initialism that we now use as shorthand for any graphics chip, or even a whole graphics card, started life as an Nvidia marketing slogan.

To give you an idea of how long ago this was, I was introduced to the term 'GPU' by a paper press release the same week I started my first tech journalism job in September 1999. We didn't get press releases via email then – they were physically posted to us, and the editorial assistant sorted them all into a box for the team to peruse.

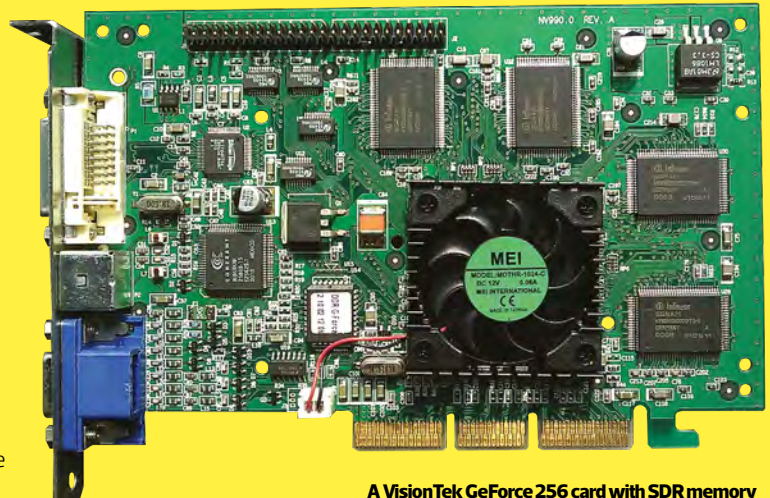
'In an event that ushers in a new era of interactivity for the PC, Nvidia unveiled today the GeForce 256, the world's first graphics processing unit (GPU)', it said. At the time, I thought it seemed pompous – how could this relative newcomer to the 3D graphics scene have the nerve to think it could change the language of graphics? But I now see that it was a piece of marketing genius. Not only did 'GPU' stick for decades to come, but it also meant Nvidia was the only company with a 'GPU' at this point.

TRANSFORM AND LIGHTING

Nvidia's first 'GPU' did indeed handle 3D graphics quite differently from its peers at the time, so it's time for a little history lesson. If we want to understand what made the first GeForce GPU so special, we first have to take a look at 3D pipelines of the time.

It was October 1999, and the first 3D accelerators had only been doing the rounds for a few years. Up until the mid-1990s, 3D games such as Doom and later Quake were rendered entirely in software by the CPU, with the latter being one of the first games to require a floating point unit.

If you want to display a 3D model, it has to go through the graphics pipeline, which at this stage was all handled

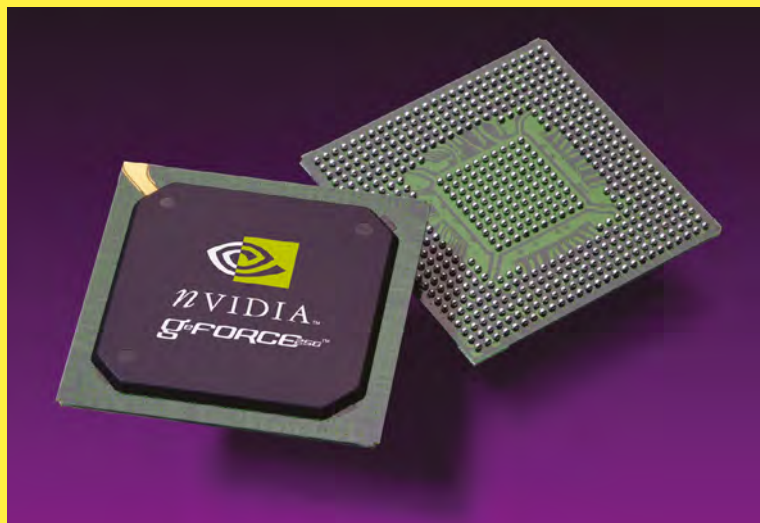


A VisionTek GeForce 256 card with SDR memory

by the CPU. The first stage is the geometry, where the CPU works out the positioning (where polygons and vertices sit in relation to the camera) and lighting (how polygons will look under the lighting in the scene). The former involves mathematical transformations, and is usually referred to as 'transform', with the two processes together called 'transform and lighting' or T&L for short.

Once the geometry is nailed, the next step is to fill in the areas between the vertices, which is called rasterisation, and pixel processing operations, such as depth compare and texture look-up. This is, of course, a massive oversimplification of the 3D graphics pipeline of the time, but it gives you an idea. We started with the CPU handling the whole graphics pipeline from start to finish, which resulted in low-resolution, chunky graphics and poor performance.

We then had the first 3D accelerators, such as the 3dfx Voodoo and VideoLogic PowerVR cards, which handled the last stages of the pipeline (rasterisation and pixel processing), and massively improved the way games looked and performed, while also ushering in the wide use of triangles rather than polygons for 3D rendering. With the CPU no longer having to handle all these operations, and



Nvidia's GeForce 256 was the first consumer graphics chip to handle the whole 3D graphics pipeline, including the transform and lighting stages

dedicated hardware doing the job, you could render 3D games at higher resolutions with more detail and faster frame rates. At this point, the CPU was still doing a fair amount of work though. If you wanted to play 3D games, you still needed a decent CPU.

Nvidia aimed to change this situation with its first 'GPU', which could process the entire 3D graphics pipeline, including the initial geometry stages for transform and lighting, in hardware. The CPU's only job then was to work out what should be rendered and where it goes.

At that point Nvidia had won the performance battle – nothing else could compete

BATTLE OF THE PLANETS

As with any new graphics tech, of course, the industry didn't instantly move towards Nvidia's hardware T&L model. At this point, the only real way to see it in action in DirectX 7 was to run the helicopter test at the start of 3DMark2000, although some games using OpenGL 1.2 also supported it.

The latter included Quake III Arena, but the undemanding nature of this game meant it practically ran just as well with software T&L. DirectX 7 also didn't require

hardware-accelerated T&L to run – you could still run DirectX 7 games using software T&L calculated by the CPU, it just wasn't as quick.

The GeForce was still a formidable graphics chip whether you were using hardware T&L or not though. Unlike the 3dfx Voodoo 3, it could render in 32-bit colour as well as 16-bit (as could Nvidia's Riva TNT2 before it), it had 32MB of memory compared to the more usual 16MB, and it also outperformed its competitors in most game tests by a substantial margin.

ATI's response at the time was a brute-force approach, putting two of its Rage 128 Pro chips onto one PCB to make the Rage Fury Maxx, using alternate frame rendering (each graphics chip handled alternate frames in sequence – note how I'm not using the term 'GPU' here!) to speed up performance. I tested it shortly after the release of the GeForce 256 and it could indeed keep up.

THE GPU WINS

The Rage Fury Maxx's limelight was cut shortly afterwards, though, when Nvidia released the DDR version of the GeForce in December 1999, which swapped the SDRAM used on the original GeForce 256 with high-speed DDR memory. At that point, Nvidia had won the performance battle – nothing else could compete.

It also took a while for everyone else to catch up, and at this point, various people in the industry were still swearing that the ever-increasing speed of CPUs (we'd just passed the 1GHz barrier) meant that software T&L would be fine – we could just carry on with a partially accelerated 3D pipeline.

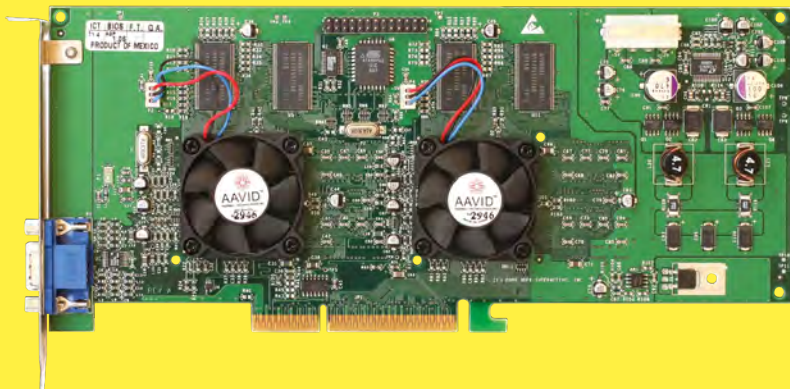
When 3dfx was building up to the launch of the Voodoo 5 in 2000, I remember it having an FAQ on the website. Asked whether the Voodoo 5 would have software T&L support, 3dfx said, 'Voodoo4 and Voodoo5 have software T&L support.' It's not deliberately dishonest, but every 3D graphics card could support software T&L at this time – it was done by the CPU – it looked as though the answer was there to sneakily suggest feature parity with the GeForce 256.

In fact, the only other graphics firm to come up with a decent competitor in reasonable time was ATI, which released the first Radeon half a year later, complete with hardware T&L support. Meanwhile, the 3dfx Voodoo and VideoLogic PowerVR lines never managed to get hardware T&L support on the PC desktop, with the Voodoo 5 and Kyro II chips still running T&L in software.

But 3dfx was still taking a brute-force approach – chaining VSA-100 chips together in SLI configuration on its forthcoming Voodoo 5 range. The Voodoo 5 5500 finally came out in the summer of 2000, with two chips, slow SDRAM memory and no T&L hardware. It could keep up with the original GeForce in some tests, but by that time Nvidia had already refined its DirectX 7 hardware further and released the GeForce 2 GTS.

By the end of the year, and following a series of legal battles, 3dfx went bust and its assets were bought up by Nvidia. GeForce, and the concept of the GPU, had won. **GPU**

With no T&L hardware, 3dfx fought back with a brute-force, multi-chip approach on the Voodoo 5 5500. Photo credit: Konstantin Lanzet



Readers' drives

Thermaltake P3 PC Build

Wanting to get away from the standard black box, Steve Grever built this touch-screen-equipped PC in a red Thermaltake P3 chassis, with several custom 3D-printed parts made with matching red filament

CPG: How did this build start?

Steve: The Thermaltake P3 case caught my eye from the moment

it was released, and I finally pulled the trigger and purchased one last year. I didn't want a basic black case, so I made a bold choice to go with the red version, which will stand out great on my desk and at LAN parties.

I embraced the red colour scheme and 3D-printed some custom parts (some functional, some decorative) to match the overall design. I decided to use matching red and black power supply extension cables and minimal RGB lighting via 140mm Zalman fans and magnetic RGB light strips – I didn't want the case to be too

bright or distracting while gaming or working from home.

I've also been a PC gamer since 2002, and I wanted to share my love of games such as BioShock, Cyberpunk and so on, so I made room at the bottom of the case to swap out different gaming figures I wanted to show off. I created custom graphics for two small LCDs (one on the all-in-one liquid cooler and the 7in touch-screen) to display my favourite game characters and sometimes funny memes (*Ed: We like what you've done with it in the photos!*).

CPG: What made you choose the Thermaltake P3 as the foundation?

Steve: The Thermaltake P3 case was great for me, not only because of its open-air design, but also because of its versatility for customising the orientation of the entire case. In addition, it offers a variety of placement options for different

hardware, such as the graphics card, power supply and water-cooling components. With this case, the sky was the limit in terms of how I wanted the hardware to be displayed – I even had the option to mount the entire case on the wall to save desk space.

CPG: How did you create the custom parts, such as the surround on the cooler's pump unit?

Steve: I designed the custom shroud for the NZXT Kraken Z63 cooler in Autodesk Tinkercad, and I created the STL files using Ultimaker Cura. I also found some shiny silk red filament on Amazon that matched the case really well. The shroud took around four hours to print on my Ender 3 V2 3D printer. I was really happy with how it turned out, so I added the same fire theme to my gamer tag plate, which I attached to the top of the graphics card.



/MEET THY MAKER

Name Steve Grever

Age 44

Occupation Web content Strategist

Location Cibolo, Texas, USA

Main uses for PC Work, gaming, photo/video editing, crypto mining

Likes Gaming, motorcycles and specialty coffee

Dislikes BSODs, Starbucks coffee and burnt popcorn

There are lots of other 3D-printed parts in this build with the same matching red filament, including the 7in touch-screen housing, gamer tag plates, hat and headphone hangers, and tempered glass brackets. I wanted to add a few more tempered glass sections to the front and top of the case. This was partly for safety, but also because I wanted room on the top of the case to add more gaming figures and other stuff.

I found some shiny silk red filament on Amazon that matched the case really well

I was able to find a custom glass fabricator online that helped me to find the right tempered glass to match my case.

Thermaltake also has a great resource website (custompc.co.uk/TTPrint) with 3D printing assets for its P3 cases, which is where I found the brackets to attach the tempered glass to the case. I also found some red and black-sleeved power supply

extension cables to keep the theme consistent between the case, components and cables.

GPC: Tell us about the touch-screen.

Steve: It's a Kuman 7in capacitive touch-screen that has a 1,024 x 600 resolution. I use it to monitor PC temperatures, fan speeds and gaming frame rates. It interfaces with Windows via HDMI and is running AIDA64 Extreme software,

which allows me to customise the entire layout and design of the monitoring panel. I found a panel design that matched the cyberpunk look and modified it to fit my needs.

GPC: What's the story behind the BioShock Big Daddy model in the bottom?

Steve: BioShock was one of the first series of games that got me interested in PC gaming. The Big Daddy character had such a unique style, and the figure I purchased has eyes that can glow red, yellow or green. It can stand on its own, and it's just the right size to place it at the bottom of the case.

GPC: How did you plan the lighting for this build??

Steve: I wanted the RGB lighting to be as minimal as possible, so I only added a 12in magnetic RGB strip in front of the graphics card, and used the lighting on the Zalman SF140 fans that covered the radiator.

I got really lucky finding these particular fans. The Kraken Z63 cooler requires 140mm fans, which can be difficult to find in different styles and designs. However, I came across the Zalman SF140 140mm RGB fans on Newegg, and immediately knew they would fit my design concept. These fans add accent RGB lighting, and also have



SYSTEM SPECS

CPU AMD Ryzen 5 5600X

Case Thermaltake P3

GPU Nvidia GeForce RTX

3060 Ti Founders Edition

Storage 500GB WD Blue

SN550 M.2 NVMe SSD (for Windows), 2TB Mushkin Pilot-E M.2 NVMe SSD (game storage), 2TB Western Digital Enterprise 7,200rpm 3.5in SATA hard drive (secondary storage)

Memory 32GB (4 x 8GB)

G.Skill TridentZ RGB

F4-3200C16-8GTZR

Motherboard Asus ROG Strix

B550F-Gaming WiFi

PSU Corsair RM750x

Cooling NZXT Kraken Z63 all-in-one liquid cooler with 2 x Zalman SF140 140mm RGB fans



two sets of open-air fins per fan, which push more than enough air through the radiator to cool the CPU. The combination of an open-air fan design and X-shaped RGB lighting made the fans pop in my P3 case.

I then used Asus Aura Sync app to create a custom lighting profile for the case. I really liked using an all-red hue across all the RGB components. The setup adds enough ambient light to brighten up the case a bit, but it doesn't overpower the LCD on the CPU cooler or the touch-screen.

GPC: What specs did you choose and why?

Steve: I've always liked AMD processors, and the Ryzen generation of CPUs were getting great reviews for their gaming speeds and overall performance. I also had to consider my budget, which was around \$2,000 US. I focused on getting mid-range to high-end hardware for my processor, CPU cooler, motherboard and graphics card, and then used the rest of my budget on the power supply, system memory and storage.

This was a bit challenging with the PC hardware shortages at the time (and I didn't want to pay scalper prices), but I managed to piece together an AMD Ryzen 5 5600X processor, NZXT Kraken Z63 cooler, Corsair RM750x modular PSU, 32GB of G.Skill TridentZ 3200MHz DDR4 RAM and an Asus ROG Gamers Strix

B550-F Gaming Wi-Fi motherboard. Luckily, I was also able to acquire an Nvidia GeForce RTX 3060 Ti Founders Edition at MSRP from Best Buy using the Stock Drops Discord channel.

All of the hardware I chose is great for daily tasks, such as word processing, internet browsing and photo/video editing, but the PC is also excellent for gaming at 1,920 x 1,080 and 2,560 x 1,440 – I haven't had any issues running games such as Horizon Zero Dawn, Outriders and Battlefield 2142 at High or Ultra settings (depending on the game).

I work from home as a web designer and content creator, so I use my PC daily for Photoshop, Illustrator and Dreamweaver. After work, I spend quite a few hours playing Rocket League, Halo Infinite and Battlefield 2142, to name a few games. I also design 3D parts in Tinkercad and dabble a bit in Blender too. At night, I also let my PC do some basic cryptomining using Nice Hash with my RTX 3060 Ti.

GPC: Did you come across any difficulties?

Steve: The main challenges during the PC build process were cable management and placement of the 7in LCD touch-screen. The case has plenty of room for your main components, but the only area left open for the touch-screen was at

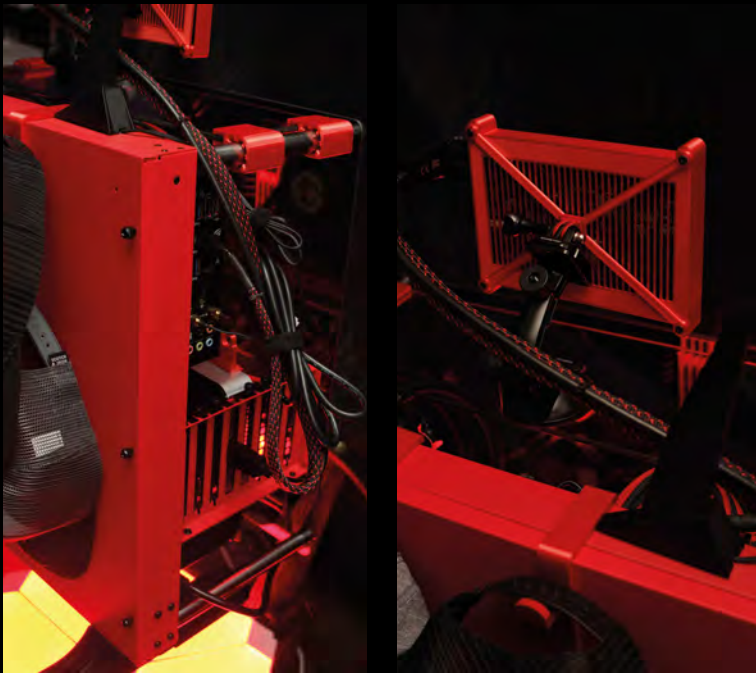
the bottom of the case, or on the top using a suction cup mount that I secured to the glass. I also had difficulty routing the cables from the touch-screen to the back of the case. I overcame the latter by finding right-angled HDMI and USB adaptors, which helped to move the cables towards the back of the case and give my PC a cleaner look.

GPC: How long did it take you to complete this build, from start to finish?

Steve: The initial build took only a few hours, but creating and printing the custom 3D parts took another week or so. I also had to wait almost two weeks for the custom tempered glass parts to be cut and shipped.

Cable management took a bit of time as well, but it was really a treat to do this with the P3 case because all the cables are hidden behind the back panel of the chassis. It was so easy to route cables under the case





I came across the Zalman SF140 140mm RGB fans on Newegg, and immediately knew they would fit my design concept

and over the top of the motherboard to connect the CPU power cables too. I finally completed the PC in a little over three weeks.

The build process was pretty straightforward—the main decisions were the case orientation (wall mounted, horizontal or vertical standing), graphics card and power supply orientation (two options for both) and where I wanted to mount the hard drive and radiator for the AIO cooler. The case has many extra parts, which enable you to change the case's configuration to accommodate different layouts.

One of the final additions I made to the P3 case was creating and printing custom hat rack brackets for the back of the chassis. I own quite a few baseball caps, and the back of the case seemed pretty bare, so the hat racks are very functional.

GPG: Are you completely happy with the end result, or do you wish you'd done some of it differently?

Steve: I'm around 80 per cent happy with the overall design to be honest. I'm thinking about creating some custom graphics that will be etched into the tempered glass panels.

I'd also like to add some extra RGB lighting to light up each glass panel and bring out the etched graphics too.

In addition, I'd like to install a custom water-cooling system, because the closed-loop AIO system I chose is limited in many ways.

I'd like to add hard, clear tubing and change the colour of the liquid to match the case. I've seen some awesome custom reservoirs and waterblocks that could look great in this PC.

I also want to add more custom sleeving to the rest of the power supply cables, fan cables, SATA cables and RGB header cables. Lastly, I'm going to 3D-print a custom PSU cover using the silk red filament to match up all the hardware with the P3 case colour scheme. **GPG**

WIN CORSAIR HYDRO X WATER-COOLING GEAR



To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (@CustomPCMag) or Facebook (CPCMagazine), or email low-res ones to ben.hardwidge@raspberrypi.com. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

The Corsair Hydro X Series XD3 RGB Pump/Reservoir Combo features a high-performance DDC PWM pump, integrated RGB lighting and in-loop temperature sensor to drive even the most compact custom cooling systems. It has a high-performance Xylem DDC PWM pump controlled via PWM to deliver the perfect flow balance for your loop. There are also 16 individually addressable RGB LEDs, which light up the pump head to produce stunning, customisable lighting effects to match your build.



WORTH
£151

Corsair Hydro X Series XC7 RGB CPU Water Block

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overlocks. You can choose a version for Intel or AMD CPU sockets.



WORTH
£70

Corsair Hydro X Series XR5 240mm Radiator

The Corsair Hydro X Series XR5 240mm Water Cooling Radiator delivers extreme custom cooling performance, with a 30mm radiator thickness and premium copper core. Its dual 120mm fan mounts on each side are ready for your most ambitious custom cooling build, and its 25 micron-thick cooling fins offer a high thermal transfer rate.



WORTH
£55



JAMES GORBOLD / HARDWARE ACCELERATED

PLEASE NOT ANOTHER 2020

James Gorbald is looking forward to the new hardware of 2022, but not the availability issues

As is standard practice, the three big PC silicon giants, AMD, Intel and Nvidia, all rolled out senior execs at CES to present their view of the year ahead, or in Nvidia's case, a snapshot of what's coming down the line over the next few months. AMD's presentation was arguably the most detailed one of the show, covering CPUs and GPUs in extensive detail, including a sneak peek at its upcoming Ryzen 7000-series processors.

While the Ryzen 5000 series will get a shot of adrenaline with a helping of 3D V-Cache in the spring, Zen 4 is AMD's true next-generation processor architecture. Its support for PCI-E 5 devices and DDR5 memory is a big deal for AMD.

That's because, for the first time in over two years, Intel is back on top, with its 12th-gen Alder Lake CPUs retaking not only the performance crown from AMD, but also outselling its Ryzen 5000-series CPUs, a trend that's likely to accelerate further as the new H670, B660 and H610 chipsets make building an Alder Lake PC cheaper.

AMD also had a lot to say about next-gen laptop CPUs and GPUs, which is undoubtedly a sensible strategy, as gaming and content creator laptop sales continue to grow at a rapid rate. Intel also revealed a remarkably similar laptop road map for Q1, with mobile Alder Lake CPUs accompanied by laptops featuring the company's first Arc GPUs, and desktop GPUs set to follow a bit later in the year.

Nvidia's presentation, while much more bombastic than the those of the other two companies, only looked ahead a few months, and included just two new GPUs – the already expected RTX 3090 Ti and RTX 3050. Instead of revealing what's further off, Nvidia chose to highlight the benefits of its

current RTX 30-series GPUs in games. Still, with little effective competition (currently) when it comes to ray tracing, the lack of info on future GPUs wasn't wholly surprising.

However, despite some great-sounding tech coming down the line in the second half of the year, including a grand showdown between AMD's Zen 4 and Intel's Raptor Lake CPUs, I suspect that 2022 won't be defined so much by innovative new products, but by the continuing supply shortages and disrupted logistics.

Whether these shortages have been caused directly by the ongoing pandemic, or are merely a knock-on effect of it, is largely immaterial at this point, as the impact is the same – limited availability of many products and significant cost increases, especially on hot-selling products such as graphics cards.

Understandably, none of the presentations at CES touched on these ongoing challenges, choosing instead a far more upbeat tone and focusing on what's to come, rather than how easy it will be to get hold of the hardware. In some ways, that's because supply chains are so complex there's not much that can be done in just a couple of years.

For instance, despite record investment in new manufacturing facilities, most industry forecasts predict the shortage continuing well into 2023, and in some instances as far as 2025. Still, it's not all entirely doom and gloom, as one company, Intel, has succeeded in getting decent numbers of Alder Lake CPUs out the door, with stock freely available at non-inflated prices.

I'd cross my fingers for the same happen to happen with GPUs as the year gets underway, but the outlook is pretty bleak at the moment, even with a third player, Intel, joining the market this year. **GPC**

None of the CES presentations touched on these challenges

James Gorbald has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



G-MASTER™

MONITORS 4 GAMERS

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.



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

3XS SYSTEMS

It's Colder Inside



Scan recommends



Windows 11

Spec up your perfect PC today



scan.co.uk/3xs · 01204 47 47 47

SCAN^s