REVIEWED NVIDIA GEFORCE RTX 3070 Ti AND 3080 Ti

CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 216

BUILD YOUR DREAM PC

CREATE A DAZZLING SYSTEM WITH YOUR OWN PERSONAL STAMP

- WATER COOLING
- CASE CUTTING
- GLASS ETCHING
- VINYL WRAPPING
- EGO SATISFYING

SPRAY-PAINT YOUR CASE +

FULL HOME NETWORKING GUIDE

CHOOSE THE RIGHT SETUP

WIRED, WI-FI OR POWERLINE?

REVIEWED

6 OF THE LATEST ROUTERS

SEPTEMBER 2021 / £5.99

9 771740 744059 09

Raspberry Pi PRESS

LIQUID COOLING 240MM CPU COOLER GROUP TEST

AGON
ULTIMATE
IMMERSION
with the
AG49UCX
DQHD
5120x1440
120HZ
1MS
HDR 400
Available at:
amazon
OVERCLOCKERS UK
AOC
@aocgaming
@aoc_gaming
@aocgaming
aocgaming.com

Welcome

Custom PC Issue 216

/ FROM THE EDITOR

Pretty in pink

Just look at the gorgeous PC on our cover this month. Our modding editor, Antony Leather, has really outdone himself this time. The neat lines of the water-cooling tubing, the marble-effect paint job, the bright pink lighting – I've never seen another PC exactly like it, and that's what makes building your own dream PC so special.

By 'dream' I mean 'amazing fantasy' not 'nightmarish', of course. No one wants to build a PC when they're naked on a public street, while being watched by a friend they haven't seen for 20 years and an old school teacher taunts them because the PC doesn't have enough gerbils in it. Or do they? We have seen some pretty weird PCs in Readers' drives over the years.

What I particularly love about our dream PC feature on p74, though, is that it's broken up into individual sections with loads of different ideas, so you can just pick and choose what you want to do within your own budget and skill set.

You don't need to have buckets of cash either. You can completely transform your PC into your own unique creation using some cans of spray paint, a bottle of etching cream, some vinyl sheet and a roll of masking tape. If you have a crafty friend with a cutting machine then you'll be able to create even more detailed designs too. Of course, it also helps if you have a Dremel handy.

What's more, unlike some computer hardware, these materials aren't in severe short supply. No one is scooping up all the masking tape as soon as it goes on sale, then flogging it on eBay at an extortionate price.

It may be a while before we can start building PCs at vaguely sensible prices again, with the current demand for GPUs still being insatiable. But what you *can* do is put your own personal stamp on your PC. Remove your hardware, dismantle your case and then transform it into a one-of-a-kind rig that you can be proud to show off – make it glow, make it colourful and make it your own dream PC. CPC

EDITOR
Ben Hardwidge

ben.hardwidge@raspberrypi.com

@custompcmag

CUSTOM PC

EDITORIAL

EDITOR
Ben Hardwidge
ben.hardwidge@raspberrypi.com

FEATURES EDITOR
Edward Chester
edward.chester@raspberrypi.com

MODDING EDITOR
Antony Leather

GAMES EDITOR
Rick Lane

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

PRODUCTION EDITOR
Julie Birrell

PHOTOGRAPHY
Antony Leather, Brian O'Halloran, Gareth Halfacree

PUBLISHING

PUBLISHING DIRECTOR
Russell Barnes
russell@raspberrypi.com

DESIGN
criticalmedia.co.uk

HEAD OF DESIGN
Lee Allen

DESIGNERS
Ty Logan

COMMERCIAL & ADVERTISING

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

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

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

Phone
01293 312182

Email
custompc@subscriptionhelpline.co.uk

Website
custompc.co.uk/subscribe

ISSUE 216

ISSUE 216
SUBSCRIBERS EDITION

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

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

DON'T TRY THIS AT HOME The information in this magazine is given in good faith. Raspberry Pi (Trading) 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.

recycle
When you have finished with this magazine please recycle it.

Raspberry Pi PRESS

Contents

Welcome to Issue 216

Highlights

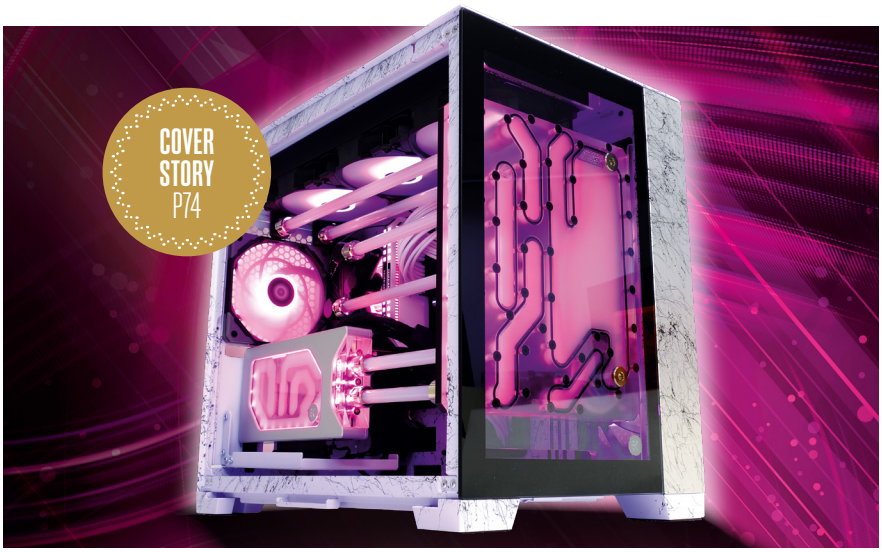
08 Cache rich
Richard Swinburne ponders the impact of AMD's upcoming 3D V-Cache technology.

16 GeForce RTX 3070 Ti and RTX 3080 Ti
You may not be able to buy them anywhere, but the latest updates to Nvidia's graphics card line-up are here and we've put them through their paces.

26 IceGiant ProSiphon Elite
Enormous and expensive, but does this heatpipe-based air cooler for your CPU delivers the goods?

30 Corsair Sabre RGB Pro
Lightweight and ideal for a relaxed palm grip, Corsair's new mouse is a bargain.

42 Radiator therapy
Antony Leather tests six of the latest 240mm all-in-one liquid CPU coolers.



50 Scanning the airwaves
Six mid-range Wi-Fi 6 routers are put to the test by Edward Chester.

68 Resident Evil Village
Infamous for its larger-than-life Lady Dimitrescu character, the latest Resident Evil is finally here. Rick Lane endures its horrors.

71 Totally Accurate Battle Simulator
Accurate or not, this cut-down strategy game is a quirky delight that costs just £15.

74 Build your dream PC
Paint, etch, water-cool and cut your PC to personal perfection with our complete guide to customising the look of your machine.

86 Home networking
What's the best way to get the highest speeds, lowest ping and longest range for your home network? Edward Chester investigates.

94 Arduboy FX
Gareth Halfacree investigates the new and improved version of this Arduino-based handheld games console.

102 How to guides
Antony Leather shows you how to get the perfect finish when spray-painting your PC case.

107 3Dfx Voodoo 3D
Stuart Andrews relives the glory days of the first must-have 3D graphics acceleration card.

Cover guide

Regulars

3 From the editor
8 Richard Swinburne
10 Tracy King
12 Incoming
38 Custom kit
58 How we test
66 Elite products
70 Inverse look
72 Reality check
94 Hobby tech
99 For the win
100 Customised PC
102 How to guides
107 Retro tech
110 Readers' drives
114 James Gorbold

Reviewed

34 PRODUCTS REVIEWED

GRAPHICS CARDS
16 Nvidia GeForce RTX 3070 Ti
18 Nvidia GeForce RTX 3080 Ti

MOTHERBOARDS
22 Gigabyte Z590 Vision G

CPU COOLERS
26 IceGiant ProSiphon Elite

GAMING MICE
28 Roccat Kone Pro
30 Corsair Sabre RGB Pro

GAMING LAPTOPS
32 Asus TUF Dash 15

PC SYSTEMS
34 Wired2Fire Ultimate
36 Chillblast Fusion Testarossa

Custom kit

38 SanDisk iXpand Wireless Charger Sync
38 Klim Bamboo Laptop Cooler
38 ColorCoral Cleaning Gel
39 Nanoleaf Shapes Triangle Starter Kit
39 Mouse Jiggler

240mm AIO cooler Labs

43 Alpenföhn Glacier ARGB
44 Antec Neptune 240
45 be quiet! Silent Loop 2
46 Corsair iCUE H100i Elite Capellix
47 Lian Li Galahad 240mm
48 Phanteks Glacier One 240MPH HALOS

Wi-Fi 6 router Labs

51 Asus RT-AX68U
52 Belkin RT3200-UK
53 Linksys MR9600
54 Netgear Nighthawk RAX40
55 Netgear Nighthawk Pro Gaming XR1000
56 TP-Link Archer AX73

Games

67 Dread XP Collection: The Hunt
68 Resident Evil Village
70 Nier Replicant
71 Totally Accurate Battle Simulator
72 Wraith: The Oblivion: Afterlife

Hobby tech

94 Arduboy FX
96 2600 Magazine Lifetime Subscription
98 Bolt Industries PCB Rulers

Windows 10

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

Infinity X109 GT

- Intel® Core™ i9-10850K
- MSI GeForce® RTX 3080 10GB

FROM **£2549**

Infinity X99 GT

- Intel® Core™ I9-9900KF
- MSI GeForce® RTX 3070 8GB

FROM **£1849**

Infinity X107 Elite

- Intel® Core™ I7-10700KF
- MSI GeForce® RTX 3060 12GB

FROM **£1699**

Infinity X97 Elite

- Intel® Core™ i9-9900KF
- NVIDIA® GeForce® RTX 3060 12GB

FROM **£1599**

Infinity X105 Elite

- Intel® Core™ i5-10400F
- MSI GeForce® GTX 1660 SUPER 6GB

FROM **£999**

Tracer III Evo HDR-600

- Intel® Core™ i7-9750H
- NVIDIA® GeForce® RTX 2060 6GB

FROM **£999**

CYBERPOWERPC

CUSTOM BUILD **GAMING PCs**

WWW.CYBERPOWERSYSTEM.CO.UK

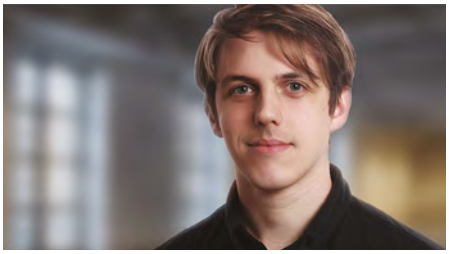
- **5 Year Warranty**
- **Free UK Delivery**
- **Next Day Delivery**
- **Award Winning PCs**

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.

intel CORE i7



RICHARD SWINBURNE / VIEW FROM TAIWAN

AMD SURPRISES WITH ITS 3D V-CACHE

Intel's forthcoming Alder Lake platform has just been given some real competition, says Richard Swinburne

At Computex 2021 on 1 June, AMD surprised those watching online with the revelation that it had developed a Zen 3 design with a stacked L3 cache, strapping an extra 64MB directly on top of the 32MB inside each 8-core chip. AMD called this innovation 3D V-Cache and showed off a Ryzen 5900X featuring it, stating it would give a 12-core or 16-core Ryzen 9 CPU a total L3 cache of 192MB.

What's more, an evaluation BIOS for the company's EPYC server CPUs showed an option that implied four of these caches could be stacked four on top of each other. This means, in theory, that a 64-core CPU could have 2.3GB of L3 cache!

Huge 'last level' caches benefit compute-focused workloads by keeping more data closer to the processing cores. These caches won't ever have the sheer capacity of main memory, but they're much faster and have lower latency, so the CPU doesn't have to wait.

AMD claims a 15 per cent performance increase on the same Zen 3 CPU

AMD is claiming 2TB/sec of throughput and a 15 per cent performance increase on the same Zen 3 CPU, which is equal to an average CPU generational improvement itself. However, there are still many unanswered questions, such as how much power it draws, whether the hot spots get worse and how often we're really going to see that 15 per cent performance uplift. This 3D V-Cache is built using TSMC's direct chip-to-chip stacking with 'through-silicon-via' (TSV) tech. TSV is absolutely leading-edge tech.

Intel's 2019 Lakefield chip had another stacked design, which it branded Feveros. However, Intel's technology uses micro-bumps of solder that, while advanced at the time, can only offer up to 400 connections/mm². In comparison, AMD is claiming a 15x improvement using this chip-to-chip bonding, which equates to around 6,000 connections/mm². AMD is also mating two 7nm chips together, while Intel partnered a 10nm compute die with a much older 22nm I/O die.

To its credit, last year Intel stated it had test chips using similar chip-to-chip packaging technologies working in its labs, but it has yet to announce a product or even show the test chip working. AMD's announcement has caught Intel napping, and it's now under considerable pressure to demonstrate a competitive technology, because the strength of its claims is rapidly evaporating.

In AMD's closing statements during the Computex stream, CEO Lisa Su noted that 3D V-Cache will be coming 'later this year'. It's been 18 months since its Zen 3-based CPUs launched, and Zen 4 won't be ready until late 2022, so it's likely we'll see some refreshed Zen 3-based Ryzen chips with this tech this year, in an attempt to snatch the hype from Intel's new 12th-gen Alder Lake chips.

However, the cost of implementing 3D V-Cache can't be understated. It requires even more silicon than normal at a time when wafers are in exceptionally high demand, and uses a cutting-edge packaging technology that, by TSMC's own admission, won't be ready for mass production until next year. I expect we'll see 3D V-Cache limited to select products only – maybe even just a single flagship processor (at a premium price) to battle for the title of fastest CPU.

This matters, because even if AMD doesn't sell many of these chips, the effect of being the best at the top affects the perception of all its CPUs down the product range, boosting sales. This CPU could be like one of the premium AMD FX CPUs of the early 2000s. Could they be making a comeback? CPC

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

CUTTING OLD TIES

new **PURE** POWER 11 FM

Exceptional Quiet, Superior Features

It was time to cut the old ties – and with that we have made our best-seller even better! Even higher efficiency! Even quieter operation! And thanks to the fully modular cables now with even more freedom! Combine this with the world-renowned be quiet! quality and five years of manufacturer's warranty, and you have an irresistible power package at a very popular price!

- 80 PLUS® Gold efficiency (up to 93.9%)
- Modular cables for maximum build flexibility
- Silence-optimized 120mm be quiet! fan
- Five-year manufacturer's warranty

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

be quiet!®

TRACY KING / SCEPTICAL ANALYSIS

MORE GAME ADDICTION NONSENSE

Following a headline in The Guardian, Tracy King gives us a lesson in how statistics can be distorted for clicks

The pandemic might not be entirely over yet, but I would like to draw a line with a very thick pencil under some of the nonsense from the media about video games during lockdown.

The Guardian has seen fit to publish a scaremongering piece that claims in loud headliney letters that referrals to UK gaming addiction clinics have tripled during lockdown. Oh no, TRIPLED! That must mean a huge number of people are having serious mental health issues because of gaming, right?

These headlines are designed to make small numbers sound big, otherwise it would be a non-story. The implication is that the number of 'gaming addiction' referrals is high in the first place, and therefore a tripling must be very serious indeed, but of course, this isn't the case.

The number of people referred to the NHS specialist clinic in the year before lockdown was ... 17. Tripled, that's a whopping 56. It's an irresponsible clickbait trick, which panics parents and distorts the nature of video game culture and science (I recommend Tom and David Chivers' excellent book How to Read Numbers for more information on misleading numbers in headlines).

> Even without the histrionic headline, the story doesn't stack up

But even without the histrionic headline, the story doesn't stack up. George Osborn, head of comms for the UK's gaming trade body UKIE, did the maths and tweeted that 56 referrals is 0.0000047 per cent of gamers in the age group reported in the Guardian story – 56 out of 12 million young gamers just isn't a problem.

The article goes on to quote The Nightingale Clinic, which also claims to have seen a rise in cases during lockdown. It doesn't say that the clinic charges hundreds of pounds an hour to treat kids who play 'too many' video games, or that despite the World Health Organisation classifying 'gaming disorder', the WHO also endorsed gaming as a healthy hobby at the beginning of the pandemic.

The Guardian article also quotes psychologist Dr Linda Papadopoulos, an ambassador for the parental internet safety organisation Internet Matters, as saying: 'While the data is worrying, there are some key signs parents should look out for to help their children find a healthy balance before gaming turns into a problem. Some children might begin to show a lack of interest in their usual hobbies, spend less time with real-life friends, and their schoolwork might start to suffer. Complaining of headaches and problems with sleep can also be symptoms.'

Well yes, there's been a pandemic. I also have all of those symptoms, but I won't be rushing to pathologise them or pay for private treatment. I'd love to stop writing about gaming disorder, because I truly think that the evidence doesn't support its existence, or at least not to the extent that it needs national newspaper stories.

In June 2021, a new study showed that children who play co-op Fortnite demonstrate greater prosocial tendencies (prosocial is the opposite of antisocial). Did The Guardian report on it, perhaps with a headline screaming 'violent video games make kids kinder and more generous?' Nope.

There's a growing profitable industry in treating gaming disorder, and uncritical news stories that (unwittingly or deliberately) promote private clinics at the expense of good science are part of the problem. Let's just hope that the end of the pandemic is the end of this nonsense. CPC

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

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

Incoming

When's the next issue out?

CUSTOM PC

AUGUST 5

Issue 217
on sale Thursday, 5 August

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**

RAZER UNLEASHES COMPACT AMD LAPTOP

Razer has released a new version of its compact Blade 14 laptop that uses AMD CPUs, being the first Razer laptop to do so. The latest Blade 14 uses AMD's Ryzen 9 5900HX CPU; despite its Ryzen 9 branding, this contains eight cores, rather than the 12 of its desktop counterpart, with a boost clock of up to 4.6GHz.

Meanwhile, GPU power comes from Nvidia's GeForce RTX 3000-series, with options for RTX 3060, 3070 and 3080 chips. All the models come with 16GB of RAM, a 1TB SSD and a 14in 2,560 x 1,440 display with a 165Hz refresh rate. Prices start at £1,800 inc VAT for the RTX 3060 model from **razer.com**

AMD COUNTERS DLSS WITH FSR

AMD has finally released its equivalent of Nvidia's DLSS tech, called FidelityFX Super Resolution (FSR). Like DLSS, it works on the principle of upscaling gaming graphics to higher resolutions to lessen the workload and improve performance. Unlike DLSS, however, it doesn't require AMD-specific hardware, and works on Nvidia's GPUs too.

AMD claims that FSR can improve performance by up to 2.4x at 4K on average in the technology's Performance mode, when compared with running at 4K natively. Four modes are available – Performance, Balanced, Quality and Ultra Quality, with AMD claiming that 'image quality is almost indistinguishable from the target native resolution' in the latter mode'.

According to AMD, FSR's 'spatial upscaling technology utilises an advanced edge reconstruction algorithm to analyse features in the source image and recreate them at a higher target resolution, followed by a sharpening pass to further improve quality by enhancing texture details'.

Seven games support FidelityFX Super Resolution at launch, including Anno 1800, Rift Breaker (pictured) Evil Genius 2 and Godfall, with support for other games, including DOTA 2, Far Cry 6 and Resident Evil Village, expected to be implemented by the end of this year.

Look out for a full analysis of both DLSS and FidelityFX Super Resolution in the next issue of **Custom PC**.

AOC LAUNCHES MINI LED GAMING MONITOR

AOC has unveiled a 27in IPS gaming monitor in China, which has a mini LED backlight with 576 local dimming zones, helping it to meet the VESA DisplayHDR 1000 standard.

The Agon AG274QXM also has a resolution of 2,560 x 1,440, a 170Hz refresh rate and adaptive sync support. According to AOC, the monitor also has a maximum peak brightness of 1,000cd/m^2, going down to 600cd/m^2 in HDR mode and 550cd/m^2 in standard mode.

It's that 576-zone mini LED backlight that will really help with HDR though. Comparatively, most gaming monitors we review don't have many-zone backlights and struggle to display HDR content properly, despite often having high-contrast panels.

The Agon AG274QXM is currently listed on AOC's website in China (**aocmonitor.com.cn**), but there's currently no word on if or when it will launch in the UK.

LIQUID-COOLED RADEON RX 6900 XT

An AMD-branded Radeon RX 6900 XT graphics card with liquid cooling has been detailed on the website of UK system builder PC Specialist, along with a few other sites.

There's been no official word from AMD about it yet, but PC Specialist's page says the 'AMD Radeon RX 6900 XT Liquid Cooled graphics card enables the best of 4K gaming with ultra-high frame rates at max settings, with the noise and temperature benefits of liquid cooling designs'. The card is attached to a single-fan radiator.

Hardware enthusiast website **videocardz.com** has also dug up some details from other retailers and leaks around the world, which suggest the liquid-cooled card will have a 2250MHz game clock, giving it a 185MHz boost over the standard Radeon RX 6900 XT. The maximum boost clock of 2435MHz is also a good 235MHz higher than that of the air-cooled 6900 XT.

Meanwhile, the liquid-cooled card's memory also gets a clock speed bump to 18GHz (effective), compared to 16GHz (effective) for the original card.

The two cards otherwise have the same basic specifications. PC Specialist's website says the card is 'coming soon', so watch this space.

8PACK UNVEILS NEW HYPERCUBE

Overclockers UK's master system builder, 8Pack, has unveiled a new version of his Hypercube PC, which packs a load of shiny bells and whistles into a mid-tower PC case. The PC's centrepiece is the custom water-cooling system, which uses rigid tubing and gear from EKWB, including an 8Pack custom lightbox, and a custom distro plate at the front.

It's all housed in a Lian Li O11D Mid-Tower, and the machine is kitted out with an RGB lighting system worthy of the Las Vegas Strip, featuring RGB strips from Phanteks, TechForge and Mayhems, and all the lighting can be controlled and customised with Asus' Aura system.

Not surprisingly, the PC also has a killer spec, including a Ryzen 9 5900X overclocked with Precision Boost Overdrive 2, a water-cooled and overclocked GeForce RTX 3090 graphics card and a pair of 2TB WD PCI-E 4 SSDs. Brace yourself before we tell you the price though. Are you ready? It's £8,888 inc VAT. See **custompc.co.uk/Hypercube** for more information about the 8Pack Hypercube MK2.

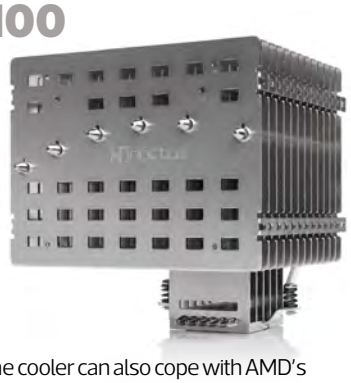
CORSAIR RELEASES 420MM CAPELLIX COOLER

Corsair has added a colossal AIO cooler to its current Capellix line-up, with a 420mm radiator that comes with three 140mm fans. The Corsair H170i RGB Elite Capellix package includes 140mm Corsair ML RGB fans, featuring eight RGB LEDs per fan, while the waterblock/pump unit features 33 bright Capellix RGB LEDs.

Corsair also says that the H170i's pump can dish out a flow rate of 0.82 litres per minute, while generating under 20dBA of noise. With the radiator's large surface area, and three 140mm fans aiding cooling, you should be able to cool an overclocked high-end CPU while the cooler makes minimal noise.

Corsair's iCUE accompanying software also includes a zero RPM fan mode for operation at low temperatures, while the fans can spin between 400 and 2,000rpm while they're running. The Corsair H170i RGB Elite Capellix has a recommended retail price of £200 inc VAT.

NOCTUA LAUNCHES £100 PASSIVE CPU COOLER



Cooling specialist Noctua has brought out a massive block of fins that it says can cool a CPU without the need for a dedicated fan. The NH-P1 measures 158 x 152 x 154mm (W x D x H), and weighs in at 1.18kg. Its cooling fins are all made from aluminium, and are linked to a copper baseplate via copper heatpipes. There's also the option to add a 120mm fan to the arrangement.

Noctua warns that the cooler isn't designed to be used with overclocked CPUs, or processors that dish out a lot of heat. The firm has issued a compatibility list, which includes Intel's Core i5-11400F as a CPU that can be cooler without a fan.

The cooler can also cope with AMD's Ryzen 7 5800X with a quiet fan attached, but while the chip can be cooled passively with the NH-P1, Noctua warns that the base clock may drop under sustained loads. The Noctua NH-P1 is available now from **overclockers.co.uk** for £100 inc VAT.

LIAN LI MAKES ROTATABLE CHASSIS

Lian Li has released a new large tower case that can be rotated in different orientations. The Lian Li Odyssey X has three configurations – Dynamic, Dynamic-R (Rotate) and Performance.

Dynamic is the default setup, while Dynamic-R rotates the motherboard tray to improve airflow to the GPU. Meanwhile, the Performance configuration involves flipping the entire chassis 90 degrees, which the company says will improve airflow even further. There's room to fit a 480mm radiator in the bottom of the case in both the Dynamic-R and Performance configurations.

As with several of Lian Li's recent high-end cases, the Odyssey X was designed with overclocker Der8auer. Lian Li says the case uses premium materials, including anodised aluminium that's been sandblasted to create a fine finish. The tempered glass side panel also has a double tint.

The Lian Li Odyssey X is available to pre-order now from **overclockers.co.uk** for a price of £395 inc VAT.

ASUS MAKES ALL-AMD LAPTOPS

While many laptop makers are adding AMD's cracking new Zen 3 mobile CPUs to their machines, Asus has gone a step further by adding machines with both AMD CPUs and GPUs to its line-up. The new Strix G15 and G17 Advantage Edition machines, with 15in and 17in screens respectively, come with a Ryzen 9 5900HX CPU and AMD's new flagship mobile Radeon RX 6800M GPU.

This GPU has 2,560 stream processors at its disposal, along with 40 Ray Accelerators for real-time ray tracing. It also comes with 12GB of GDDR6 memory attached to a 192-bit memory interface. Clock speeds vary depending on the laptop's design, and Asus says it can boost to up to 2300MHz in the Strix Advantage Edition machines.

The new laptops can also be equipped with up to 32GB of 3200MHz DDR4 memory, as well as a 1TB NVMe SSD. Meanwhile, a number of screen options are available, including 1080p screens that refresh at 300Hz, and 2,560 x 1,440 screens that refresh at 165Hz, all with FreeSync Premium support.

You can pre-order the Asus Strix G15 Advantage Edition with a 2,560 x 1,440 screen and 16GB of memory now from **scan.co.uk** for £1,899 inc VAT, with availability expected in mid-July.

PHILIPS

Monitors

get in the moment

innovation you

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

4K Ultra HD

VESA CERTIFIED DisplayHDR™ 400

UltraWideColor

Adaptive Sync

Available at:

amazon ebuyer.com SCAN

Reviews

NVIDIA GEFORCE RTX 3070 Ti FE / ~£1,100

SUPPLIER ebay.co.uk

SPEC

Graphics processor
Nvidia GeForce RTX 3070 Ti, 1575MHz base clock, 1770MHz

Pipeline
6,144 CUDA cores, 96 ROPS

RT cores
48 (2nd-gen)

Tensor cores
192 (3rd-gen)

Memory
8GB GDDR6X, 1188MHz (19GHz effective)

Memory interface
256-bit

Card interface
16x PCI-E 4

Memory bandwidth
608GB/sec

Number of slots
2

Power connectors
1 x 12-pin (2 x 8-pin PCI-E adaptor supplied)

Card length
267mm

Well, would you look at that? Another new graphics card that you can't actually buy anywhere. Who'd have thought it? Nvidia may have attempted to cut Ethereum miners out of the loop with its Lite Hash Rate system, but the insatiable demand for new graphics cards after a nine-month shortage is clearly so titanic that nothing can stop the scalping bulldozer in its tracks.

At a nominal price of £529 inc VAT, the RTX 3070 Ti would already be asking a lot from mid-range gamers. We're so used to bonkers eBay pricing, we sometimes forget that £500 is more than most people pay for a graphics card even in normal times. At the current eBay price of ~£1,100, it's just out of the question unless you're desperate.

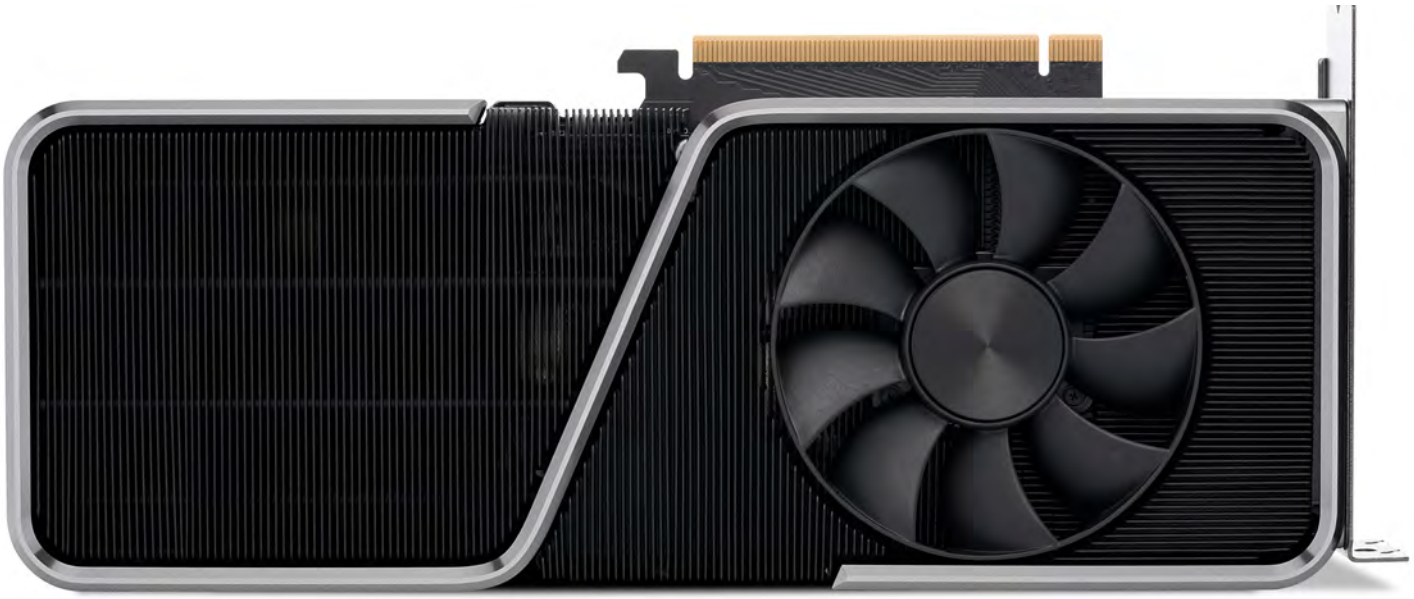
If we look at the Nvidia store pricing, though, the RTX 3070 Ti only costs £60 more than the RTX 3070, which seems about right for its small bump in spec. Unlike the RTX 3080 Ti (see p18), which adds 1,536 CUDA cores to the RTX 3080 spec, the 3070 Ti only adds 256 CUDA cores to the RTX 3070's 5,888, giving you 6,144 of them.

The RTX 3070 Ti basically has a fully enabled GA104 GPU, with all of its 48 streaming multiprocessors (SMs) intact, giving you 48 corresponding RT cores. Comparatively, the vanilla RTX 3070 has two SMs disabled. It's not a huge difference when it comes to core spec. The only other differences are clock speeds, with the 3070 Ti having a 1770MHz boost clock, compared to 1725MHz on the 3070.

The 3070 Ti also has faster memory, with its GDDR6X memory running at 1188MHz (19GHz effective), while the 3070's memory runs at 1750MHz, but because it's only GDDR6, this gives it an effective frequency of 14GHz. The end result is a decent step up in memory bandwidth on the Ti model, topping out at 608GB/sec compared to 448GB/sec on the standard RTX 3070.

Performance

As you would imagine from the spec, the RTX 3070 Ti is a bit quicker than the standard RTX 3070, but not by a huge amount. At this card's target resolution of 2,560 x 1,440,



the 3070 Ti adds 6fps to the 3070's average frame rate in Metro Exodus at Ultra settings, but it's still 15fps off the RTX 3080 with its GA102 GPU. Its 85fps average in this game is a great result, being a good 12fps ahead of AMD's Radeon RX 6700 XT.

The RTX 3070 Ti also confidently beats the Radeon RX 6700 XT by 12fps in Cyberpunk 2077 at this resolution and Ultra settings, with a decent 99th percentile result of 49fps. The 3070 Ti also excelled in Doom Eternal, clocking up a superb average of 300fps at 2,560 x 1,440, with a 192fps 99th percentile result – easily fast enough to run high-speed titles in sync with a 144Hz monitor. The 3070 Ti can also comfortably play this game at 4K, with its 159fps average beating the Radeon RX 6700 XT by 30fps.

Where the AMD GPU fights back is in Assassin's Creed Valhalla, but not by a huge amount – the AMD GPU is generally only around 3fps in front of the Nvidia card, and the latter even beats it at 4K. This game also responds well to enabling Resizable BAR if your motherboard supports it, adding another 5-6fps to the 3070 Ti's frame rates at 2,560 x 1,440.

Where the RTX 3070 Ti really rinses the Radeon RX 6700 XT, however, is when you enable ray tracing. The Radeon can't even play this game at 1,920 x 1,080 with Medium ray tracing at 1,920 x 1,080, dropping right down to 25fps, but the 3070 Ti comfortably averages 57fps with a 49fps 99th percentile result at these settings. If you enable DLSS, it will even average 68fps with a 55fps 99th percentile result at 2,560 x 1,440 – a great result for a £529 card if you could actually buy it at that price.

Enabling High ray tracing on the less demanding Metro Exodus also showed the 3070 Ti in a good light (ho ho!), with its average of 68fps at 2,560 x 1,440 being 21fps ahead of the Radeon RX 6700 XT – add DLSS and this goes up to 76fps with a 44fps 99th percentile.

Conclusion

While the GeForce RTX 3070 Ti isn't much quicker than the standard RTX 3070, it would easily justify its £60 premium at normal retail pricing, and it generally carves out a very comfortable lead over the Radeon RX 6700 XT – it isn't even far behind the AMD chip in Assassin's Creed Valhalla, which is an AMD stronghold.

The problem, of course, is that it isn't available at retail pricing, with cards going for around £1,100 on eBay. That's a bit of a problem when the Radeon RX 6700 XT *is* available at retail, and while it's overpriced compared with normal pricing, you can pick up one for £750 inc VAT from **overclockers.co.uk**

At standard pricing, the RTX 3070 Ti would be the obvious choice, being much quicker than the Radeon for an extra £100. In the current climate, though, you simply can't justify spending an extra £350 for the RTX 3070 Ti. It might be a fair bit faster, but it's not £350 faster. If you want a mid-range GPU at the moment, your best bet is to either wait out the stock problems, or to pick up a Radeon RX 6700 XT. It can't handle ray tracing in Cyberpunk 2077, but it holds up well in our other tests for a much more reasonable price.

BEN HARDWIDGE

RAY OF LIGHT

+ Confidently outperforms Radeon RX 6700 XT
+ Ray tracing at 2,560 x 1,440 with DLSS
+ Resizable BAR support

RAY OF DEATH

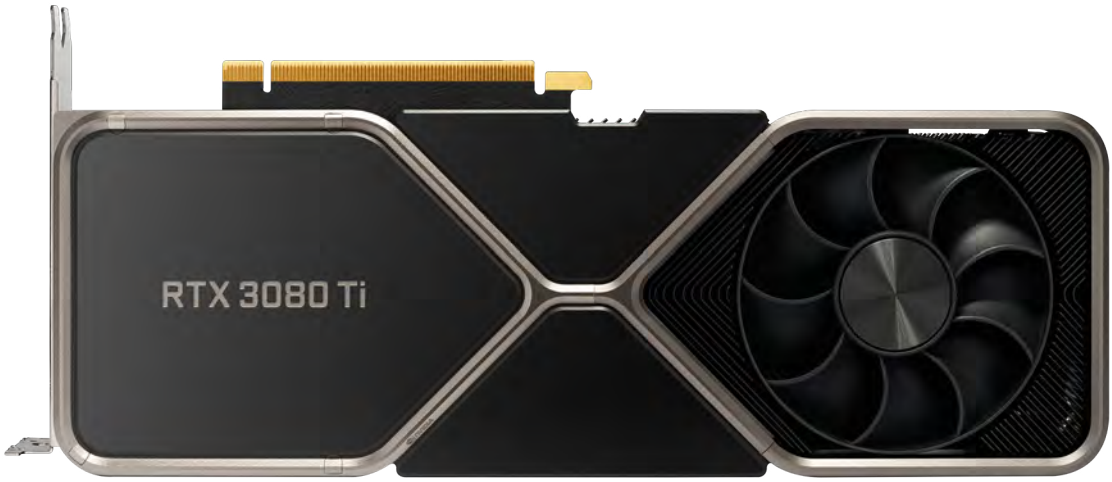
– Not much quicker than RTX 3070
– Only available for inflated prices on eBay

VERDICT

It's not much faster than the RTX 3070, but the 3070 Ti comfortably handles ray tracing at 2,560 x 1,440 and confidently beats the Radeon RX 6700 XT. If only you could buy it for a reasonable price.

NVIDIA GEFORCE RTX 3080 Ti FE / 1 ARM + 1 LEG

SUPPLIER ebay.co.uk



Read the room, Nvidia. We've just endured nine months of catastrophic stock shortages, your GPUs are going for absurd prices on eBay and you messed up your last attempt to limit mining performance with an accidental driver release. Was this the best time to release a new card for over £1,000? Really? We'll give you a hint – no.

Not surprisingly, the GeForce RTX 3080 Ti sold out soon after its launch, and the cards are now going for around £1,700 on eBay. That might be a smaller markup than we saw the last time around, but Nvidia's Lite Hash Rate feature, which limits Ethereum mining performance, clearly isn't enough to quell the current swollen demand.

That's not particularly surprising, given the pent-up demand from gamers unable to buy any GPUs for months, as well as supply problems from the pandemic and silicon manufacturing woes, but it shows the scale of the problem.

In terms of specs, the RTX 3080 Ti has 'only' 12GB of memory, compared to 24GB on the RTX 3090, and it also lacks the flagship's SLI support, but it does have plenty of processing power. The RTX 3080 Ti enables 80 streaming multiprocessors (SMs) on its GA102 GPU, giving you 80 corresponding RT processors, 320 Tensor cores and 10,240 CUDA cores.

Like the RTX 3090, it also has a wide 384-bit memory interface, giving it a total bandwidth of 912GB/sec with its 1188MHz (19GHz effective) of GDDR6 memory. Comparatively, the RTX 3090 has 10,496 CUDA cores, while the RTX 3080 has 8,704 – the RTX 3080 Ti is much closer to the 3090's spec. The RTX 3090's 1695MHz boost clock is also slightly higher than the RTX 3080 Ti's 1665MHz.

SPEC

Graphics processor
Nvidia GeForce RTX 3080 Ti, 1365MHz base clock, 1665MHz boost clock

Pipeline
10,240 CUDA cores, 112 ROPS

RT cores
80 (2nd-gen)

Tensor cores
320 (3rd-gen)

Memory
12GB GDDR6X, 1188MHz (19GHz effective)

Memory interface
384-bit

Card interface
16x PCI-E 4

Memory bandwidth
912GB/sec

Number of slots
2

Power connectors
1 x 12-pin (2 x 8-pin PCI-E adaptor supplied)

Card length
285mm

Performance

As expected, the RTX 3080 Ti gives you a solid step up in performance over the RTX 3080, with a smaller difference (generally under half the size) between the 3080 Ti and the 3090. In Metro Exodus at Ultra settings, the 3080 Ti adds an extra 14fps to the 3080's 99th percentile and average frame rate results at 2,560 x 1,440, and it adds 10fps to the average at 4K. The 3080 Ti also beats AMD's Radeon RX 6900 XT at those two resolutions (although the latter is a bit quicker at 1,920 x 1,080).

Similarly, in Cyberpunk 2077 at Ultra settings, the RTX 3080 Ti beat the Radeon RX 6900 XT, and offered a solid jump in performance from the RTX 3080. Sadly, this isn't enough to make the game properly smoothly playable at 4K, with an average of 42fps and 99th percentile result of 37fps, but even the RTX 3090 only adds 3fps to these results.

Where Nvidia still struggles to compete with AMD's Radeon RX 6900 XT is in Assassin's Creed Valhalla. Here, the RTX 3080 Ti was soundly beaten by both the Radeon RX 6900 XT and 6800 XT at 2,560 x 1,440, and it was behind the 6900 XT at 4K.

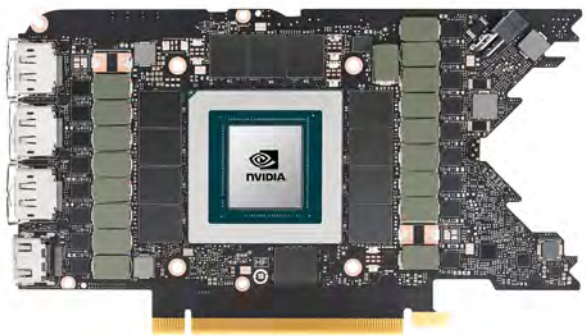
This game also benefits heavily from enabling Resizable BAR if you have a motherboard that supports it. This enabled the RTX 3080 Ti to average 60fps at 4K, although this was still 7fps off the pace of the Radeon RX 6900 XT with Resizable BAR enabled. What's also interesting here is that the RTX 3080 Ti with Resizable BAR enabled is quicker than the RTX 3090 in this game, showing that this feature can make a bigger difference to performance than the number of CUDA cores and clock speed.

Meanwhile, Doom Eternal shows how raw shader power can translate into super-fast frame rates in a well-optimised game that scales accordingly. The RTX 3080 Ti's average of 227fps at 4K is a great result, and its massive 391fps average at 2,560 x 1,440, coupled with a 253fps 99th percentile frame rate, shows you can pair this card with a 240Hz monitor and reap the benefits. Again, though, the Radeon RX 6900 XT was a little faster at this resolution, and not far behind the 3080 Ti at 4K.

Ray tracing

Where Nvidia has a big upper hand over AMD is ray tracing, and the RTX 3080 Ti excelled here. Its 55fps 99th percentile and 91fps average in Metro Exodus with High ray tracing at 2,560 x 1,440 are superb results, with the latter being 18fps ahead of the Radeon RX 6900 XT, and 10fps in front of the RTX 3080. Its 35fps 99th percentile result at 4K shows the start of a struggle, but if you enable DLSS, this jumps to 47fps with a 74fps average. If you enable DLSS, you can realistically play games with ray tracing at 4K on this card.

Meanwhile, in Cyberpunk 2077, the RTX 3080 Ti only managed a clunky average of 26fps with Medium ray tracing and no DLSS, although again, even the RTX 3090 only adds 2fps to this result and is equally sluggish. However, its 51fps average and 44fps 99th percentile results at 2,560 x 1,440 are workable, and well in front of the feeble 25fps 99th percentile result from the Radeon RX 6900 XT.



Add DLSS to the equation, though, and you can play this game at the same level of performance with Medium ray tracing at 4K, and an average of 88fps at 2,560 x 1,440. Cyberpunk 2077 with ray tracing is highly demanding, and AMD's GPUs can barely run it at all, but you can comfortably use this card to run it at 2,560 x 1,440 with DLSS enabled.

Impressively, the RTX 3080 Ti's power draw was also well below that of the RTX 3090, with our system drawing 526W from the mains at peak load – that's well behind the 679W with the RTX 3090, and only a little higher than the 494W with the RTX 3080.

One word of warning, though, is that the RTX 3080 Ti Founders Edition comes with the same cooler as the RTX 3080 FE, rather than the colossal cooler included with the RTX 3090 FE, and it became extremely hot to touch during testing. You will want to install this card in a case with plenty of airflow to work with the card's flow-through cooling design. In our test rig, this cooler also made a lot more noise at full load than the cooler on the Radeon RX 6900 XT.

Conclusion

If we hadn't had nine months of stock chaos, we'd happily recommend the RTX 3080 Ti at £1,049 inc VAT – it would be a high-end card that few people could afford, but it would undercut the RTX 3090 while offering close to the same performance. If you want to play games at 4K, this card will do it, and with ray tracing if you enable DLSS.

In the grim reality of the actual situation, though, the RTX 3080 Ti is pointless. There's no stock, and Nvidia could have used these GPUs to make the £649 RTX 3080 cards that people have been desperate to buy. While £1,700 on eBay is cheaper than the silly prices of RTX 3090 cards, it's still enormously overpriced.

BEN HARDWIDGE

VERDICT

A solid step up in performance from the RTX 3080, but you can't buy it at the retail price so the point is moot.

SHOCK ABSORBER

+ Decent step up from RTX 3080
+ Ray tracing at 4K with DLSS
+ Close to RTX 3090 performance for less money

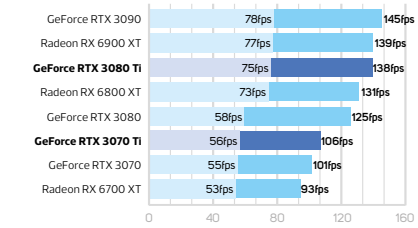
STOCK ABSORBER

– Practically fictional retail price
– Can't beat Radeons in Valhalla
– Cooler gets very hot
– No stock

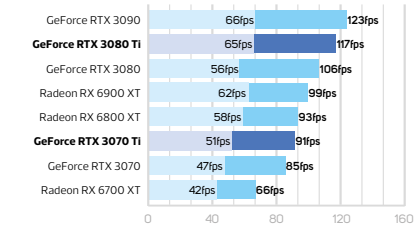
GPU BENCHMARK RESULTS

METRO EXODUS

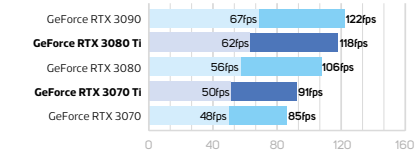
1,920 x 1,080, Ultra settings, HairWorks off, PhysX off



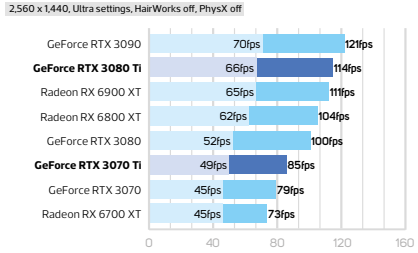
1,920 x 1,080, Ultra settings, High RT, HairWorks off, PhysX off



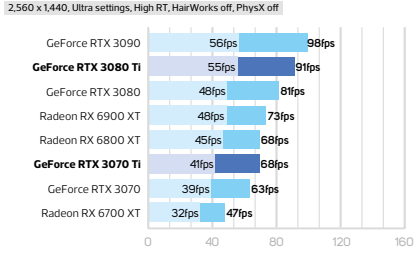
1,920 x 1,080, Ultra settings, High RT, HairWorks off, PhysX off, DLSS



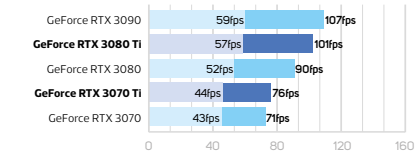
2,560 x 1,440, Ultra settings, HairWorks off, PhysX off



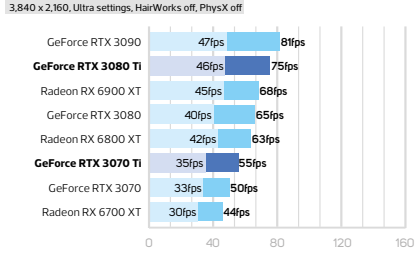
2,560 x 1,440, Ultra settings, High RT, HairWorks off, PhysX off



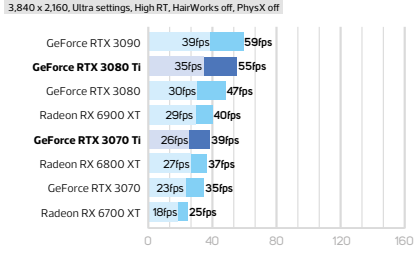
2,560 x 1,440, Ultra settings, High RT, HairWorks off, PhysX off, DLSS



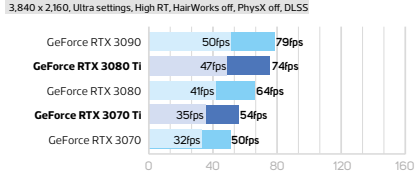
3,840 x 2,160, Ultra settings, HairWorks off, PhysX off



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

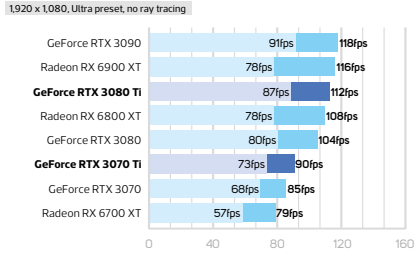


3,840 x 2,160, Ultra settings, High RT, HairWorks off, PhysX off, DLSS

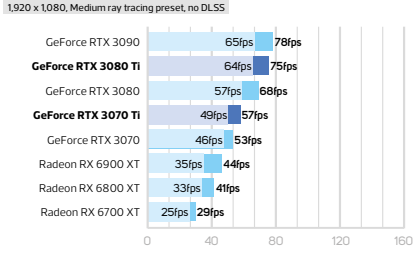


CYBERPUNK 2077

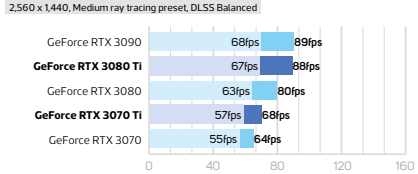
1,920 x 1,080, Ultra preset, no ray tracing



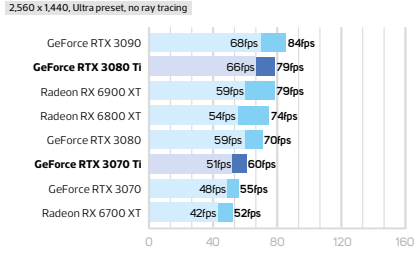
1,920 x 1,080, Medium ray tracing preset, no DLSS



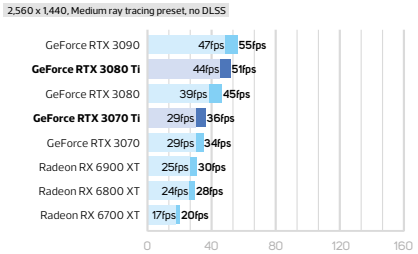
2,560 x 1,440, Medium ray tracing preset, DLSS Balanced



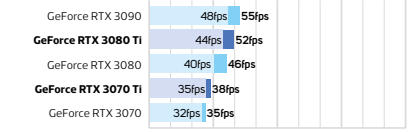
2,560 x 1,440, Ultra preset, no ray tracing



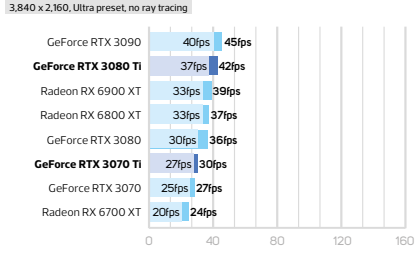
2,560 x 1,440, Medium ray tracing preset, no DLSS



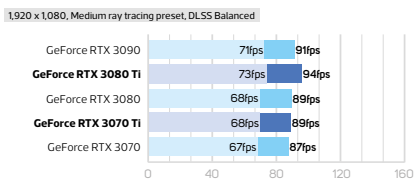
3,840 x 2,160, Medium ray tracing preset, DLSS Balanced



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



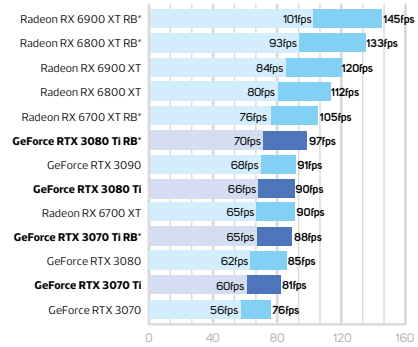
1,920 x 1,080, Medium ray tracing preset, DLSS Balanced



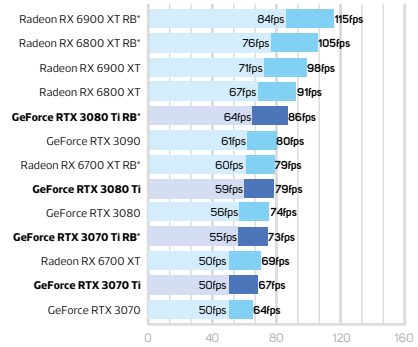
GPU BENCHMARK RESULTS

ASSASSIN'S CREED VALHALLA

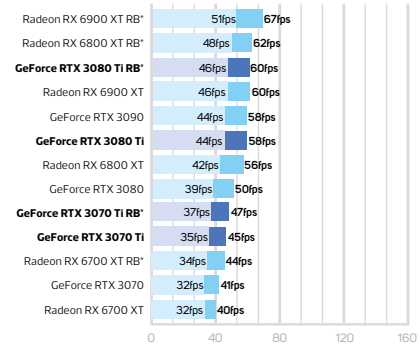
1,920 x 1,080, Ultra high settings, High AA



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

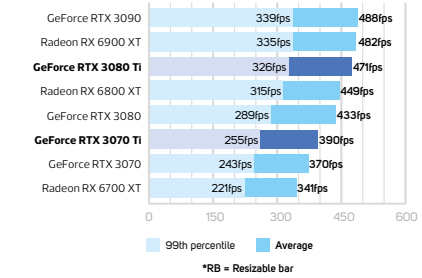


3,840 x 2,160, Ultra high settings, High AA



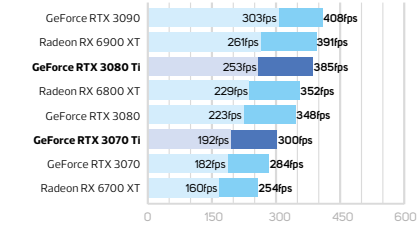
DOOM ETERNAL

1,920 x 1,080, Ultra Nightmare settings

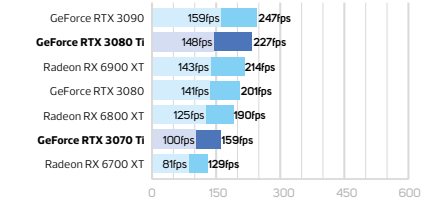


*RB = Resizable bar

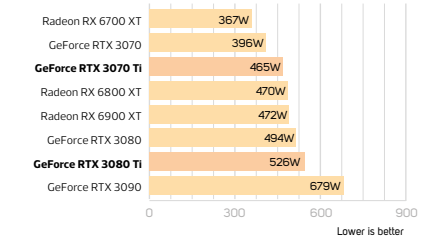
2,560 x 1,440, Ultra Nightmare settings



3,840 x 2,160, Ultra Nightmare settings



LOAD TOTAL SYSTEM POWER CONSUMPTION



ATX Z590 MOTHERBOARD

GIGABYTE Z590 VISION G / £221 inc VAT

SUPPLIER cclonline.com

There aren't many options below £200 at the moment if you want a Z590 motherboard with the cooling and power circuitry needed to properly push Intel's K-series CPUs, while keeping your PCI-E 4 SSD cool. Gigabyte's Z590 Vision G comes close, though, costing just over £220, but sporting some decent credentials and a funky white colour scheme.

The power circuitry offers 12 phases for the CPU, which is two more than its mini-ITX sibling, the Z590i Vision D, and it has a pair of heatsinks linked with a heatpipe. One has fins, while the second is a block of aluminium at the top of the PCB to aid VRM cooling.

This did a reasonable job, with the VRMs staying below 70°C in our stress test despite Intel's Adaptive Boost Technology being enabled on our Core i9-11900K. We've seen cooler results, though, probably because half of the finned heatsink is hidden within the I/O shroud, which isn't the best place to get rid of its heat.

Meanwhile, there's an impressive count of four M.2 ports, each covered with a heatsink, and the top three ports support PCI-E 4. We suggest using the top slot if you have a single SSD, as the two slots below it sit under a single large heatsink, requiring you to remove your graphics card to access them.

In addition, an SSD in the top slot won't be at the mercy of any warm exhaust air your graphics card expels. The top heatsink kept our PCI-E 4 SSD at a steady 66°C under load, which is a tad warm compared with the competition but still well away from throttling.

Like other Gigabyte Vision boards we've seen this year, there's very little RGB lighting apart from a subtle strip on the I/O shroud. However, this board is geared towards clean builds and creators, rather than gamers who want to still see their motherboard when they close their eyes.

That said, if you do want to give your retinas some action, there are four RGB headers catering for 3-pin and 4-pin connectors.

There have been some cuts to the specifications to keep the price reasonable though. The Z590i Vision D costs £50 more, which buys you Wi-Fi and Thunderbolt 4 support, which are sadly lacking on the Z590 Vision G. Apart from Q-Flash Plus, Gigabyte's version of USB BIOS Flashback, there are precious few overclocking and testing tools too, but again, this isn't really the focus of the board.

What you do get are eight Type-A USB ports on the rear I/O panel, plus two Type-C ports and a USB 3.1 Type-C header. There's 2.5 Gigabit LAN and Realtek ALC4080 audio as well, although fan headers sit at a rather average count of six.

Gigabyte's Windows software is also really well designed, with special mention going to the System Information Viewer, which provides highly granular control over fan speeds and even allows you to choose alternative temperature inputs to control them, rather than just the CPU.

SPEC

Chipset
Intel Z590

CPU socket
Intel LGA1200

Memory support
4 slots: max 128GB DDR4 (up to 5333MHz)

Expansion slots
One 16x PCI-E 4, two 16x PCI-E 3

Sound
8-channel Realtek ALC4080

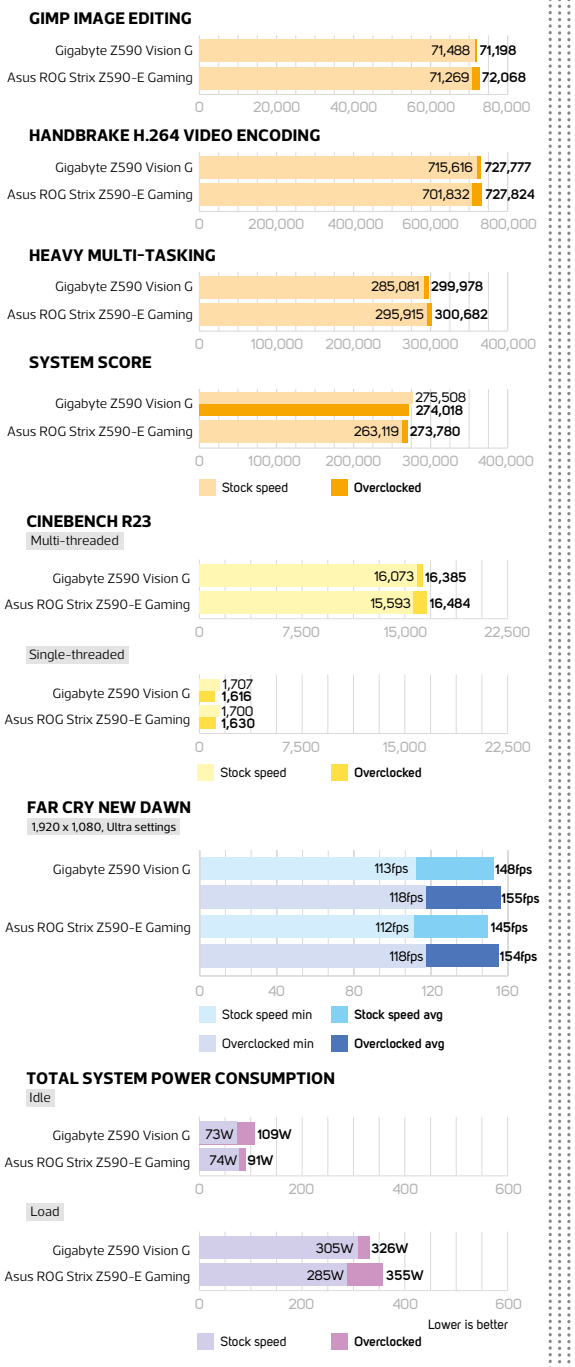
Networking
1 x Intel 2.5 Gigabit LAN

Cooling
Six 4-pin fan headers, VRM heatsinks, M.2 heatsinks

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

Dimensions (mm)
300 x 244

BENCHMARK RESULTS



You can do the same in Gigabyte's pretty new white EFI, which is well laid out with popular overclocking options all in the same tab, which is an improvement over older Gigabyte EFIs. Sadly, while there are various temperature sensors from which to choose for fan control, none of them allows you to strap a thermal probe to them, so you can't use coolant temperature in your water-cooling loop to control radiator fans, for example.

Performance

The Vision G's RealBench performance was on par with other Z590 boards we've tested, although its audio performance in RightMark Audio Analyzer was a bit disappointing, with a noise level of -98dBA and dynamic range of 99dBA. The sound quality will be fine for most people, but if audio quality is a priority you can get better performance elsewhere.

Overclocking was easy, though, with 1.38V needed to get our CPU to an all-core overclock to 5.1GHz. With Adaptive Boost Technology enabled, the Cinebench R23 multi-threaded score was 16,073, which rose to 16,385 with the manual overclock. The manual overclock also resulted in gains in our video encoding and multi-tasking tests, but there were limited gains compared to using Adaptive Boost Technology.

Power consumption was a little higher than that of the Vision G's mini-ITX sibling, but not by much, and the CPU temperature was close to 90°C under sustained load. Its power draw was more restrained once overclocked than the Asus ROG Strix Z590-E Gaming WiFi, although that board was more frugal at stock speed.

Conclusion

There's less to tempt high-end users to the Vision G than the mini-ITX Z590i Vision D with its Thunderbolt 4 support and Wi-Fi. However, the Gigabyte Z590 Vision G is good-looking, it can provide a home to an extensive PCI-E 4 storage array, and it keeps your SSDs and VRMs cool. It provided a solid base for overclocking the Core i9-11900K as well, and the same will go for Intel's Core i5-11600K or Core i7-11700K.

While there are few flies in the ointment, other than lacklustre audio performance, this board does notably lack extra features. Otherwise, though, it offers a solid overclockable motherboard for a reasonable price, especially if you're bored with the visual design of the usual black gaming-focused motherboards.

ANTONY LEATHER

WANDAVISION

- \+ Attractive design
- \+ Four heatsink-equipped M.2 ports
- \+ Solid feature set

DOUBLE VISION

- – Average VRM and M.2 cooling
- – Only six fan headers
- – No Wi-Fi

VERDICT

A solid Z590 board for the money, although it lacks high-end features.

PERFORMANCE 32/35

FEATURES 28/35

VALUE 25/30

OVERALL SCORE 85%

PCSPECIALIST

CUSTOM GAMING

DESKTOPS & LAPTOPS

CUSTOM BUILT TO YOUR SPEC

EASY TO USE CONFIGURATOR

CUSTOM PCS & LAPTOPS

AWARD-WINNING SYSTEMS

SWIFT ELITE
GAMING DESKTOP

- Intel® Core™ i5-11600K
- ASUS® TUF Gaming B560-Plus WiFi
- 16GB CORSAIR VENGEANCE® 3200MHz
- 8GB NVIDIA GeForce RTX™ 3070 Ti
- 512GB PCS PCIe M.2 SSD
- 1TB SEAGATE BarraCuda HDD
- Genuine Windows 10 Home

This spec from
£1,659.99*

RECOIL
SERIES LAPTOP

- 165Hz QHD Panel
- 2560 x 1440, sRGB 100%
- Intel® Core™ or AMD® Ryzen™ CPU
- GeForce RTX™ 3060 / 3070 / 3080
- Genuine Windows 10 Home

This spec from
£1,389.99*

FUSION PRO
GAMING DESKTOP

- AMD Ryzen 7 5800X
- ASUS® TUF X570-Plus Gaming
- 16GB CORSAIR VENGEANCE® 3000MHz
- 16GB AMD Radeon™ RX 6800
- 512GB PCS PCIe M.2 SSD
- Genuine Windows 10 Home

This spec from
£1,799.99*

GET A FURTHER **£15 OFF**
WITH THIS EXCLUSIVE VOUCHER

CPC21

ORDER ONLINE NOW AT
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 @PCSpecialist

CPU AIR COOLER

ICEGIANT PROSIPHON ELITE / £150 inc VAT

SUPPLIER overclockers.co.uk

Large air coolers have plenty going for them. They're much less hassle than a full water-cooling system, but can often handle the heat produced by high-end overclocked CPUs while remaining relatively quiet. You don't have to worry about pumps, coolant or leaks – you can just fit them and then forget about them. Their size can be an issue, though, taking up a huge amount of space around the CPU socket, but that hasn't prevented IceGiant from creating one of the largest aid coolers we've ever seen in the ProSiphon Elite.

Thankfully, it's only 164mm tall, so it's unlikely to run into too many issues with CPU clearance in the vast majority of ATX and micro-ATX cases. It's compatible with all current sockets too, including all generations of AMD's Threadripper sockets. Accordingly, it sports four 120mm fans (really) and a huge heatsink that uses a two-phase dielectric fluid that combined, acts like a bunch of giant heatpipes.

In fact, if you look inside the heatsink from the edge, you can see a large centre pipe and three enormous horizontal channels for the liquid and vapour to move inside, dumping the heat into eight heatsink sections once the vapours cool and condense inside.

The cooler makes use of gravity to transfer the liquid back to the contact place where it's heated and phase-changes into vapour again, moving heat away from the contact plate. The company claims this effect works whether the cooler is mounted on a vertical motherboard or if the motherboard is flat and face up.

The contact plate itself is enormous, which is good seeing as IceGiant makes a song and dance about Threadripper compatibility. It's certainly large enough to cover all but tiny slivers of the edge of a Threadripper headspreader, which is far bigger than any other universal heatsink we've tested.

In stark contrast to many large air coolers, memory clearance is only a slight issue, thanks to a generous gap of 48mm underneath the heatsink, although this does mean the likes of Corsair's Vengeance RGB Pro modules, which are some of the highest models we've used, are just a couple of millimetres too tall.

Nearby I/O shrouds and VRM heatsinks can also potentially be an issue, although we tried several boards where the shroud extended well above the actual I/O bracket, and they all fitted underneath the ProSiphon Elite's massive heatsink.

The fans are mounted on the sides of the heatsink, so have no bearing on memory or motherboard clearance. Two fans are mounted out of the box in pull mode, with a further two included in the box that you can add in push mode. They're reasonably powerful, with peak speeds of 2,300rpm, and use standard screws to fit. As such, if you wanted, you could use your own fans, perhaps to add some RGB lighting to the equation, or to liven up the otherwise bland black exterior a bit.

Installation can be tricky due to the size and weight of the cooler, although the mounting mechanisms are relatively simple. The mount for AMD sockets has a single large top plate that sits over the CPU socket, securing to the mounting threads on Threadripper motherboards and the

SPEC

Intel compatibility
LGA115x, LGA1200, LGA2066, LGA2011

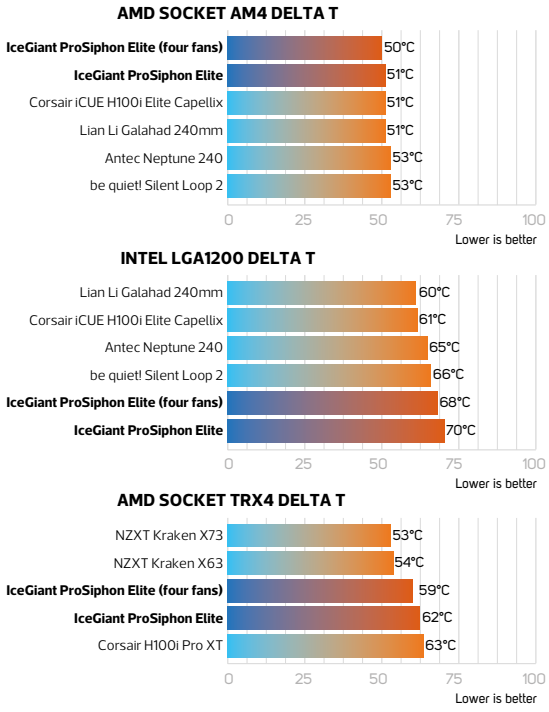
AMD compatibility
Socket AM4, TR4/TR4X

Heatsink size with fans (mm)
251 x 129 x 164 (W x D x H)

Fans
4 x 120mm

Stated noise
32dBA

TEMPERATURE RESULTS



stock backplate on Socket AM4, which is suspended by a quartet of pins.

The mount for Intel sockets uses a similar arrangement, although it took us a few tries to get right with our LGA1200 system. The pins can be tricky to secure fully, and any unevenness is magnified with such a tiny area to cool. The cooler only secures using two screws, and we'd prefer to see a four-point mount for the cooler itself given its weight.

We can't argue with the included tube of Thermal Grizzly Kryonaut thermal paste, though, and the instructions were simple to follow, with the components bagged up according to the socket you're using.

Performance

In our LGA1200 system dealing with a Core i9-11900K, the IceGiant ProSiphon Elite managed a delta T of 70°C with two fans and 68°C with four fans strapped to the already imposing heatsink. It performed similarly to the be quiet! Silent Loop 2, which managed a delta T of 66°C, but with slightly lower noise levels. However, the Corsair iCUE H100i Elite Capellix did a better job of handling this CPU's high heat density, with a CPU delta T of just 61°C, albeit with considerably more noise at full speed.

ICE T

- \+ No leaks or noisy pumps
- \+ Excellent cooling on most sockets
- \+ No need for a radiator mount

VANILLA ICE

- – Expensive
- – No lighting or software control
- – Liquid coolers better in some situations

The performance differences were much closer in our Socket AM4, with the ProSiphon matching the Corsair cooler with two fans and beating it by one degree with four fans installed. However, this result was only a couple of degrees cooler than the far cheaper Antec Neptune 240, while the Corsair cooler also sports RGB lighting and software control.

Finally, as the ProSiphon is kitted out with an enlarged contact plate, we strapped it to our Threadripper 3960X system, where it managed a delta T of 62°C with two fans and 59°C with four fans installed. This was cooler than the Corsair H100i Pro XT we used in our last group test on a Threadripper system, although the NZXT Kraken X63 and X73 were cooler still, thanks to their large radiators.

Conclusion

The IceGiant ProSiphon Elite can compete with the best 240mm liquid coolers out there, and it has plenty of appeal with no liquids or pump noise, and you don't need a radiator mount in your case either. The price is high, though, and with no change from £150, there are much cheaper options, especially if you're dealing with a mainstream CPU and not a high-end Threadripper monster.

Performance on LGA1200 was lacklustre, and even the £80 Antec Neptune 240 bettered the ProSiphon here. For a hassle free, air-cooled way of getting awesome cooling on other sockets, though, especially those with larger heatspreaders, the ProSiphon Elite is an innovative cooler that air-cooling purists with love, as long as your memory fits underneath it of course.

ANTONY LEATHER

VERDICT

An awesome air cooler that can easily tame the most powerful desktop CPUs, although it's very expensive.

LGA1200

COOLING 32/40

FEATURES 13/20

DESIGN 14/20

VALUE 13/20

FITTING Medium

OVERALL SCORE 72%

Socket AM4

COOLING 39/40

FEATURES 13/20

DESIGN 14/20

VALUE 16/20

FITTING Medium

OVERALL SCORE 82%

Socket TRX4

COOLING 36/40

FEATURES 13/20

DESIGN 14/20

VALUE 16/20

FITTING Medium

OVERALL SCORE 79%

GAMING MOUSE

ROCCAT KONE PRO / £70 inc VAT

SUPPLIER box.co.uk

The Roccat Kone Pro is the newest addition to the company's line-up of gaming mice, which also includes our current ultra-lightweight mouse of choice, the Burst Pro. The Kone Pro is in fact even lighter than that model, weighing in at just 66g. However, it eschews the modern trend for symmetrical lightweight mouse shapes and instead has a resolutely right-handed design.

This lopsided shape, with a high left side that slopes down to the right, makes for a more comfortable wrist angle for right-handed users, in the same way as the raised centre portion of ergonomic keyboards.

This design particularly enhances the comfort of this mouse for use with a palm grip, where your whole hand is draped over the mouse.

However, the right edge where your left and ring fingers rest isn't as comfortable as the same area on the Corsair Sabre RGB Pro (see p30) in palm grip. Conversely, the Kone Pro's back end is shorter, so it's better suited to fingertip grip than the Corsair, thanks to the extra clearance under you palm. In this regard, it's more of a hybrid design than the resolutely palm grip-focused Sabre. The Roccat's surface also has a pleasantly smooth, matt finish that provides a good level of grip.

In terms of styling, the rear portion of the mouse is plain, with its black plastic finish and simple painted-on silver logo. Instead, the pizzazz is kept up front, with RGB lighting shining through the translucent left and right buttons, creating a firefly-like effect. It's a design choice that makes a certain sense, as the tip of the mouse is the most visible when in use, but that could also prove distracting.

Meanwhile, the braided cable measures 1.8m and is very flexible, so it doesn't push back annoyingly against your movements. It also arrived with impressively few kinks, making for a tidy setup. Two very large glide pads, plus a small circular pad around the sensor, provide a very smooth, stable gliding experience and you even get a spare set of pads too.

You get the standard five buttons atop the mouse, with a DPI button on the underside, and that's basically it for features – it's a simple mouse. Roccat uses its own Titan optical switches and Owl-Eye optical sensor (based on the PixArt PAW 3370) and both feel very good in action, offering a crisp response and accurate tracking respectively.

Meanwhile, the scroll wheel has an intriguing hollowed-out design, with just a thin, flat outer circle and three spokes to save weight. This makes it feel very precise to use, with minimal inertia as you scroll up and down from one notch to the next, which is ideal if you use the wheel to change weapons in games, for instance.

Finally, Roccat's excellent software is on hand to change all the usual settings, such as DPI levels, lift-off distance and button assignment, and these settings can be saved to the mouse for use on other PCs.

ICE CREAM KONE

+ Excellent all-round performance
+ Comfortable, easy-grip design
+ Impressively light

TRAFFIC KONE

– Not ideal for fingertip grip
– On the expensive side

SPEC

Weight
66g

Dimensions (mm)
72 x 126 x 40 (W x D x H)

Sensor
Roccat Owl-Eye 19K (based on PixArt PAW 3370) sensor, 19,000 DPI, 50g acceleration, 400 IPS

Buttons
5 (left, right, scroll wheel, back, forward)

Cable
1.8m, lightweight braided

Extras
RGB lighting, DPI button on underside

Conclusion

The Roccat Kone Pro is a decent gaming mouse. It's very lightweight and has a great sensor and switches, nailing the basics. The shape is an interesting hybrid that isn't necessarily preferable for any given grip style, but we found it worked well for palm grip and not so well for fingertip grip. The only problem is the £70 inc VAT price tag, which is a little steep for such a simple mouse. With a drop in price, this would be an undeniably solid option.

EDWARD CHESTER

DESIGN 15/20
FEATURES 12/20
PERFORMANCE 27/30
VALUE 22/30

OVERALL SCORE 76%

VERDICT

A solid high-end gaming mouse option for right-handed users, although it's quite pricey for what's on offer.

FREE CHILLBLAST AERO RGB GAMING MOUSE

WITH A 12-MONTH SUBSCRIPTION TO CUSTOM PC

SPEC

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

WORTH £40

Custom PC APPROVED

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

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

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

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

SUBSCRIBE TODAY!

Chillblast

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

01293 312182

custompc.co.uk/chillblast

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

GAMING MOUSE

CORSAIR SABRE RGB PRO / £50 inc VAT

SUPPLIER currys.co.uk

The Sabre RGB Pro is Corsair's new palm grip-focused gaming mouse, which incorporates a large, rounded, curvy design to make for a comfortable, palm-filling shape. It also embraces the modern move towards lighter mice – a significant shift for Corsair, given that its mice have tended to be on the heavy side – and the Sabre RGB Pro weighs just 74g.

The most obvious and long-running comparison to the Sabre is Razer's DeathAdder series, with its similar non-symmetrical design, wide back end, raised left edge and downward-sloping right edge. It's similar also to the Roccat Kone Pro (see p28) but that mouse is a littler shorter and wider at the back.

The upshot of this design is a mouse that fills the underside of your palm, making for a comfortable, relaxed grip. It can also be used with fingertip and claw grip styles, but the sheer size of the back end means there's not much room to manoeuvre the mouse under your palm.

The surface of the mouse is also interesting, as it's a cross between the slightly rough plastic typically used on areas such as monitor surrounds (similar to the SteelSeries Aerox 3's surface), and the fine finish that's almost like a matt paint, which you find on mice such as the Logitech G Pro Superlight.

It feels reasonably grippy – particularly in this summer heat – but not quite as much as the latter types of finish, or as the proper rubber used on the Razer Viper. Regardless, because this mouse is primarily designed for palm grip use, the grippiness of the sides isn't too important, as you don't tend to lift the mouse up and down quite as much.

The Sabre RGB Pro looks smart too, with its illuminated scroll wheel and Corsair logo, the lighting of which can be controlled independently. On the side there's also a trio of white LEDs to indicate the selected DPI level. It's a sensible place to put them, as you can see them even when your hand is on the mouse, although it's debatable just how often you might look down at them in the heat of battle.

You get six buttons on this mouse, with a top-mounted DPI button sitting behind the scroll wheel. They all feel crisp and responsive, and we got on well with their fairly light action. Meanwhile, the cable is of the very loose braided type, with a thin inner core of cable surrounded by an oversized braiding. It's supple and doesn't interfere with your movements, although it was quite kinked out of the box.

This mouse's large footprint is supported by four small glide pads that provide a very stable footing, but the mouse doesn't glide quite as smoothly as the Roccat Kone Pro. As for sensor performance, the PixArt PMW3392 delivers the sort of stellar performance we'd expect of a modern mouse, with smooth, accurate tracking no matter how extreme our movements.

Meanwhile, Corsair's software is on hand to switch up the DPI levels, lighting and more. What's more, thanks to the company's extensive RGB-enabled product range, it's easy to sync up your mouse, case, keyboard, fans and more via the same software.

SABRE RATTLING

+ Comfortable palm grip design
+ Lightweight
+ Good value

BREAD KNIFE BRANDISHING

– Not the grippiest outside surface
– Not ideal for fingertip and claw grip

SPEC

Weight
74g

Dimensions (mm)
70 x 129 x 43 (W x D x H)

Sensor
PixArt PMW3392 sensor, 18,000 DPI, 50g acceleration, 400 IPS

Buttons
6 (left, right, scroll wheel, back, forward, DPI)

Cable
1.8m, lightweight braided

Extras
RGB lighting

Conclusion

The Corsair Sabre RGB Pro is a great mouse for gamers who like to use a palm grip or just generally like a large, contoured mouse shape. It's comfortable to hold and delivers all the performance you'd expect from a modern gaming mouse. With a competitive price and light weight, it's one of Corsair's best mice in years.

EDWARD CHESTER

VERDICT

Comfortable, light and with great performance. There's a lot to like here.

DESIGN 16/20
FEATURES 14/20
PERFORMANCE 28/30
VALUE 26/30

OVERALL SCORE 84%

Wireframe

Join us as we lift the lid on video games

Visit **wfmag.cc** to learn more

GAMING LAPTOP

ASUS TUF DASH F15 / £1,299 inc VAT

SUPPLIER scan.co.uk

Asus' TUF hardware usually tries to balance performance with value, and the Dash F15 is no different – this laptop costs £1,299 inc VAT, but it includes an RTX 3070 and a new Core i7-11370H processor.

This 11th-gen Intel CPU has four Hyper-Threaded cores, alongside base and boost speeds of 3.3GHz and 4.8GHz, and a maximum TDP of 35W – that's 10W lower than the chips usually used in gaming laptops. Intel wants this CPU to find a home inside slimmer, lighter laptops, but Asus has redressed the balance by deploying performance modes that sometimes push the chip back up to 45W with higher clock speeds.

There are power considerations with the RTX 3070 8GB too. In this machine, it runs at 1290MHz with a boost peak of 1390MHz, thanks to its low TDP of 85W. That will restrict performance – the Aorus 15G XC (see Issue 213, p30) is pricier than the Asus, but it deploys the same GPU at 105W for faster clock speeds. The rest of the F15's specification is solid, if unspectacular – it has 16GB of dual-channel 3200MHz DDR4 memory, a 512GB SSD, Gigabit Ethernet and dual-band Wi-Fi 6.

The F15's affordability means there's not much to shout about on the outside. The chassis combines plastic and metal, mostly in black, and it looks underwhelming and feels cheap in some areas. Build quality is good enough to ensure that this machine will survive frequent transport, though, and the weight and thickness of 2kg and 19.9mm are fine.

The left-hand side has a USB Type-C/Thunderbolt 4 port that supports up to 100W of power delivery. Elsewhere, the Asus has three USB 3.2 Gen 1 ports and an HDMI 2 port. Still, the absence of a webcam, card reader, or fingerprint reader mean the Asus is limited compared with many competing laptops.

The keyboard has no numberpad either, and its turquoise backlight can't be changed. It's fast, consistent and comfortable, so it's fine for mainstream gaming, but it lacks crispness. The trackpad buttons are also soft, so you'll want to use a USB mouse if possible. Then there are the speakers: the top-end is tinny, the mid-range is muffled, and the bass is overwhelming and lacks detail – you'll want a headset or external speakers for this machine.

SPEC

CPU
3.3GHz Intel Core i7-11370H

Memory
16GB 3200MHz DDR4

Graphics
Nvidia GeForce RTX 3070

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

Storage
512GB SK Hynix HFM512GD3JX013N M.2 SSD

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

Weight
2kg

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

Dimensions (mm)
360 x 252 x 19.9 (W x D x H)

Operating system
Windows 10 Home 64-bit

Warranty
One year parts and labour return to base

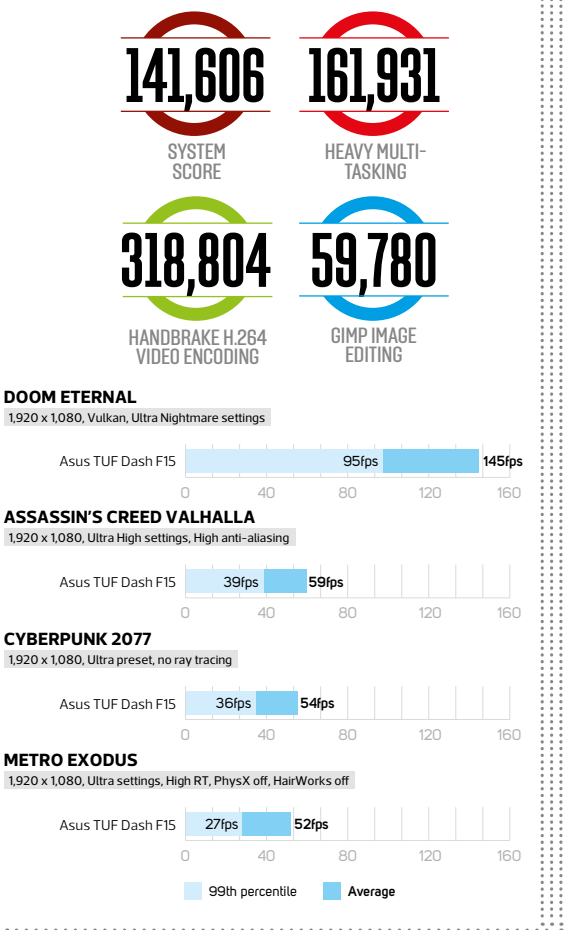
Performance

In Assassin's Creed Valhalla and Cyberpunk 2077, the Asus returned 99th percentile minimums of 39fps and 36fps. Those frame rates are playable, even if you won't always hit a 60fps average. In Doom Eternal, the F15 managed a 99th percentile result of 95fps, so esports games at high frame rates are unlikely to be an issue. However, the Dash F15 also has a Turbo mode option, which ups the GPU boost clock by 100MHz over the standard Performance mode, and resulted in the Assassin's Creed and Cyberpunk 99th percentile results rising to 46fps and 39fps. This is well worth having, although it also resulted in louder fan noise.

Meanwhile, the processor scored 59,780 in our single-threaded image editing benchmark, and that's superb – better than the Aorus' 52,183, and faster than Core i9 CPUs. That bodes well for games, where you won't find bottlenecks, and the F15 handles web browsing, office apps and photo editing without issues.

With just four cores, the Core i7-11370H is ordinary in our multi-threaded video encoding benchmark though – it falls behind the older Intel Core i7 chip and further behind AMD's Zen 3-based laptop silicon, so it's not the best option for content creation. The SSD is only middling too, with read and write speeds of 1,413MB/sec and 834MB/

BENCHMARK RESULTS



sec – that's faster than a SATA drive, but you can get quicker performance elsewhere.

The thermal results could be better as well. The GPU delta T of 51°C is fine when running high-end games, but hot air is ejected from the right-hand side, so your mouse hand can feel toasty. The laptop's underside is too hot for it to be comfortable on your lap when gaming as well, and the metal above the keyboard was warm. In a tricky work test, the CPU peaked at a high delta T of 77°C and throttled to just under 4GHz, while external temperatures remained high. The fan noise was noticeable and high-pitched here too.

It's not all bad news. In mainstream games and esports titles – and during everyday workloads – the Asus remained far quieter than in our stress tests, and the underside was cooler too.

DASH

- \+ Solid 1080p gaming ability
- \+ Good CPU for everyday tasks
- \+ Reasonably robust, slim and light
- \+ Includes Thunderbolt 4

RUSH

- – Weak version of the RTX 3070
- – Not the best CPU for tough work
- – Mixed thermal performance
- – Weak speakers

Meanwhile, the 15.6in, 1080p IPS display has a 144Hz refresh rate with adaptive sync and a 3ms response time, so it's well suited to gaming – it's smooth, fast and tear-free; only the most demanding competitive gamers will want a quicker screen.

It has decent image quality too. It covered 96.7 per cent of the sRGB gamut with a delta E of 2.58 and a colour temperature of 6,945K. The latter figure is a tad cool, so the colours do lack a little vibrancy, but it's not ruinous. The brightness level of 284cd/m^2 is good enough for indoor use and contributes to a decent, punchy contrast ratio of 1,136:1.

The Dash F15 lasted for just an hour and 20 minutes when gaming on its battery, which is a normal result. Impressively, though, it lasted for eight hours in an everyday work test.

Conclusion

The Asus TUF Dash F15 is one of the more affordable gaming laptops around, and there are positives to find beyond the price. It has the pace to tackle mainstream games and esports titles, its CPU can handle everyday computing and it has a decent screen in a relatively slim, light chassis.

In plenty of areas, though, the F15 is average. It has one of the slowest RTX 3070 laptop implementations we've seen, the CPU isn't great in multi-threaded software and the Asus has inconsistent thermal performance and underwhelming speakers. Ultimately, you get what you pay for. The Asus is a capable everyday laptop, but spending more will buy you better performance and quality.

MIKE JENNINGS

VERDICT

An affordable and capable gaming machine, but the price results in compromises in important areas.

PERFORMANCE **19/25**

DESIGN **18/25**

HARDWARE **19/25**

VALUE **21/25**

OVERALL SCORE **77%**

AMD X570 GAMING PC

WIRED2FIRE ULTIMATE – POWERED BY MSI / £3,250 inc VAT

SUPPLIER wired2fire.co.uk

Wired2Fire's Ultimate is the first rig we've seen with Nvidia's new GeForce RTX 3080 Ti GPU. It's a fearsome piece of pixel-pushing hardware, with 10,240 stream processors and 12GB of memory, and Wired2Fire's PC uses an MSI-made card that ups the original boost speed from 1695MHz to 1770MHz.

The powerful GPU sits alongside AMD's 12-core Ryzen 9 5900X. It's a superb CPU for content creation and other trickier work tasks, and its Zen 3 hardware runs at its conventional base and boost speeds of 3.7GHz and 4.8GHz. It's topped by an MSI MAG CoreLiquid 240R cooler, which has a radiator in the top of the case and an attractive RGB LED waterblock.

The CPU is an excellent content-creation option, and it's appropriately accompanied by 32GB of RGB-equipped Corsair Vengeance RGB Pro 3600MHz DDR4 memory, and storage comes from a 1TB PCI-E 4 Samsung 980 Pro SSD. It's all powered by an MSI MPG A750GF PSU, which impresses with 80 Plus Gold certification and a modular design.

There's a lot of MSI hardware here, and that continues with the X570 Gaming Edge WiFi motherboard, which has decent USB options and Realtek ALC1220 audio. There are limitations though – the second 16x PCI-E slot is restricted to 4x speed, the second M.2 connector uses the slower PCI-E 3 standard and you get dual-band 802.11ac Wi-Fi and Bluetooth 4.2 rather than 802.11ax and Bluetooth 5.

This Wired2Fire system shares its CPU with the pricier Chillblast Fusion Testarossa (see p36), but its lower price means it struggles to compete elsewhere. Chillblast's machine has more storage and a motherboard with better networking and connection options.

Wired2Fire has used an MSI chassis for this build too. The Gungnir 110M looks the part, with a slatted, angled façade, a tempered glass side panel and three RGB LED intake fans. Measuring 450mm tall and 430mm deep, it's far smaller than the Chillblast's Fractal case, so it's easier to slot into compact environments.

The top of the case has a USB 3.2 Gen 2 Type-C port and a button for altering the lights, while the inside has a PSU shroud, rubber grommeted cable holes, and neat cabling. Meanwhile, around the back you'll find a 2.5in mount and two admittedly flimsy 3.5in bays.

It's a solid case, but there are weaker areas. It's a little cramped inside: the bottom of the board is tricky to reach, and the CPU cooler's radiator blocks the memory slots at the top of the case. There's no doubt that the Chillblast's case is better, with a more spacious interior and loads of storage room.

The Wired2Fire matches Chillblast's excellent warranty though. Both systems have five years of labour coverage alongside two years of parts coverage with collect and return transport.

Performance

The Wired2Fire PC may be cheaper than the Chillblast, but the RTX 3080 Ti proved a better gaming option than the Chillblast's Radeon RX 6900 XT. In Cyberpunk 2077, the RTX 3080 Ti returned a 99th percentile minimum of 38fps, 5fps ahead of the 6900 XT. That score improved to 46fps with ray tracing and DLSS activated, the latter not being a luxury afforded to the AMD card. In Doom Eternal, meanwhile, the Wired2Fire machine hit 144fps, which was marginally quicker than the Chillblast.

SPEC

CPU
3.7GHz AMD Ryzen 9 5900X

Motherboard
MSI MPG X570 Gaming Edge WiFi

Memory
32GB Corsair Vengeance RGB Pro 3600MHz DDR4

Graphics
MSI GeForce RTX 3080 Ti 12GB

Storage
1TB Samsung 980 Pro SSD

Networking
Gigabit Ethernet, dual-band 802.11ac Wi-Fi, Bluetooth 4.2

Case
MSI MPG Gungnir 110M

Cooling
CPU: MSI MAG CoreLiquid 240R with 2 x 120mm fans; GPU: 3 x 80mm fans; front: 3 x 120mm; rear: 1 x 120mm fan

PSU
MSI MPG A750GF 750W

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

Operating system
Microsoft Windows 10 Home 64-bit

Warranty
Two years parts and labour collect and return, followed by three years labour only return to base

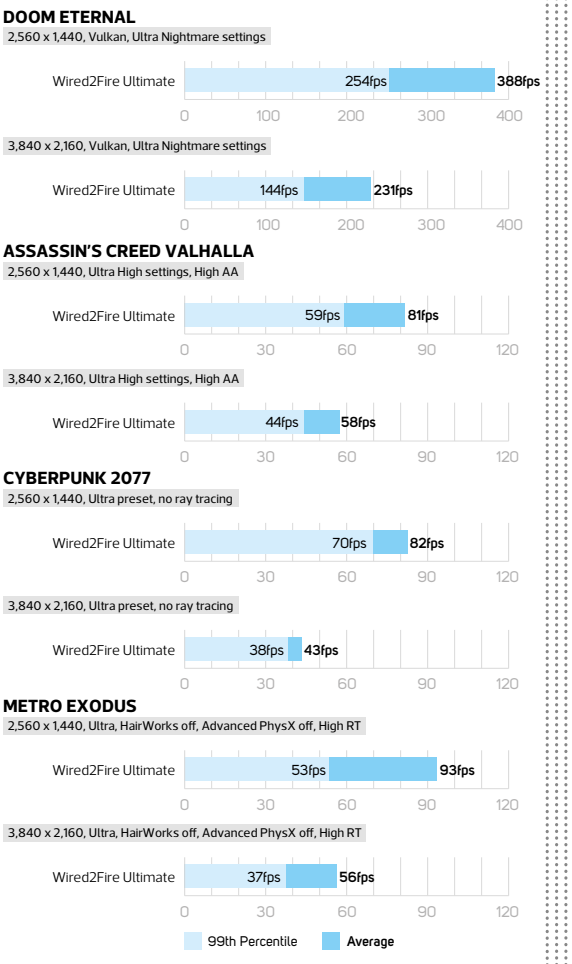
BENCHMARK RESULTS

64,770 GIMP IMAGE EDITING

951,126 HANDBRAKE H.264 VIDEO ENCODING

364,490 HEAVY MULTI-TASKING

355,019 SYSTEM SCORE



The Nvidia GPU also achieved a 99th percentile result of 37fps at 4K in Metro Exodus with ray tracing and 48fps with DLSS. Not surprisingly, that's faster than the AMD GPU. Without ray tracing, the Nvidia's minimum of 47fps was a couple of frames per second behind the AMD GPU, but that's a minor difference. The Wired2Fire machine only fell behind significantly in Assassin's Creed Valhalla, but while the AMD card had a decent lead there, the RTX 3080 Ti still comfortably plays the game at 4K.

The processor is no slouch either. The Wired2Fire system delivered Handbrake and multi-tasking results that crept ahead of the Chillblast, and it was barely slower in the image editing test. The differences are small, though, and both systems offer a huge amount of power from their Ryzen 9 5900X CPUs.

The Samsung 980 Pro SSD is a great inclusion as well – its respective read and write speeds of 7,134MB/sec and 5,195MB/sec in this machine are superb, and while you won't often see those speeds in standard use, it's good to know you have such fast data transfer speeds on tap if you need them.

The Wired2Fire was good in thermal tests as well. It was consistently quiet, with the noise from this machine and the Chillblast both proving easy to overpower with speakers or a headset. The CPU and GPU delta Ts of 53°C and 51°C are solid too. The Wired2Fire's processor was marginally quicker than the Chillblast's during work benchmarks: in an all-core test, it hovered at around 4.15GHz, and single-core testing regularly saw the chip achieving its 4.8GHz Turbo pace.

Conclusion

Wired2Fire's Ultimate system impresses. The RTX 3080 Ti will tackle any gaming task, it has ray tracing and DLSS, and it's usually quicker than the rival Radeon RX 6900 XT. The AMD CPU is great for content creation, and this rig has loads of memory and a great warranty.

It's cheaper than the Chillblast, but this does mean a weaker motherboard, a smaller SSD and a case with limited upgrade potential. These aren't major issues for most people, though, and while this system costs over three grand, it does offer Nvidia's latest GPU without paying the silly prices we see for individual cards on eBay. This rig is fast, reasonably affordable and available, making it a solid gaming choice if you can afford it.

MIKE JENNINGS

WIRED2FIRE

- \+ Excellent gaming performance
- \+ Terrific CPU
- \+ Generous warranty
- \+ Cheaper than competition

WIRED4SOUND

- – Mediocre motherboard
- – Average case
- – Middling storage capacity

VERDICT

Great performance in games and multi-threaded work. It's expensive, but you get a superb spec for that money.

PERFORMANCE **24/25**

DESIGN **21/25**

HARDWARE **20/25**

VALUE **20/25**

OVERALL SCORE **85%**

AMD X570 GAMING PC

CHILLBLAST FUSION TESTAROSSA / £3,799 inc VAT

SUPPLIER chillblast.com

Chillblast's Fusion Testarossa is a fast-paced contender with all the key hardware from the red team, which seems appropriate given its Ferrari-inspired name. The Radeon RX 6900 XT graphics card deploys 16GB of memory and 5,120 stream processors, and this rig's Gigabyte-made card has had its initial boost speed of 2250MHz overclocked to 2365MHz.

The card is physically impressive: it has loads of RGB LEDs, alongside a small LCD that displays GPU information or custom images and GIFs. The 6900 XT does have 80 AMD Ray Accelerators, and can handle ray tracing, but AMD's DLSS equivalent is still absent.

Meanwhile, AMD's Ryzen 9 5900X is one of the best content-creation chips around thanks to its 12-core design, and here, it runs at its stock base and boost speeds of 3.7GHz and 4.8GHz, and it's cooled by a massive Fractal Celsius+ S36 Prisma cooler with a 360mm radiator.

Chillblast has rounded out the specification with 32GB of DDR4 memory clocked to 3600MHz and a 2TB Samsung 980 Pro SSD. This hardware should scythe through content-creation apps and top games, and an impressive Fractal Design PSU powers it, with a fully modular design and 80 Plus Gold certification.

The Asus ROG Strix X570-E Gaming motherboard impresses too. It looks the part, with big heatsinks and plenty of RGB LEDs, and it's packed with features. It provides 2.5Gbps Ethernet, dual-band 802.11ax Wi-Fi and Bluetooth 5, and it has two 16x PCI-E 4 slots and two PCI-E M.2 connectors.

On the board you'll find a generous array of connectors and a POST display, while the rear I/O panel serves up a mighty count of seven full-sized USB 3.2 Gen 2 ports and a Type-C connection. There's a high-end SupremeFX S1220A audio codec, and this board includes eight SATA ports. It's an excellent high-end option.

The case lends itself to storage too. Fractal's Vector RS is a big bruiser that stretches 552mm from front to back. It has room for six 3.5in hard disks and two 2.5in drives around the rear, with the vibration-reducing hard disk bays hidden behind a plate to keep the front neat.

The huge Vector has rock-solid build quality, and the cabling is neat. The components are accessible too, and this system's band of RGB LEDs along the top are synchronised with the internal lighting. There's a USB Type-C connector on the front as well.

The Chillblast shares its AMD processor with this month's Wired2Fire rig, and both machines have superb warranties, with five years of labour coverage joined by two years of parts protection with collect and return transport. The Chillblast beats the Wired2Fire with its larger SSD, better motherboard and more versatile case, but Wired2Fire's machine does have an Nvidia GeForce RTX 3080 Ti and a cheaper price.

Performance

The overclocked Radeon GPU delivered its best performance results in Assassin's Creed Valhalla. At 2,560 x 1,440, the AMD GPU returned a 99th percentile minimum of 75fps, with that score declining to 49fps at 4K. Those aren't just playable

SPEC

CPU
3.7GHz AMD Ryzen 9 5900X

Motherboard
Asus ROG Strix X570-E Gaming

Memory
32GB G.Skill TridentZ RGB 3600MHz DDR4

Graphics
Gigabyte Radeon RX 6900 XT 16GB

Storage
2TB Samsung 980 Pro M.2 SSD

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

Case
Fractal Vector RS

Cooling
CPU: Fractal Celsius+ S36 Prisma cooler with 3 x 120mm fans; GPU: 3 x 80mm fans; front: 2 x 140mm; rear: 1 x 140mm fan

PSU
Fractal Ion Gold 850W

Ports
Front: 2 x USB 3.2 Gen 1, 1 x USB 3.2 Gen 1 Type-C, 1 x audio; rear: 7 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2 Type-C, 1 x optical S/PDIF, 5 x audio

Operating system
Microsoft Windows 10 Home 64-bit

Warranty
Two years parts and labour collect and return, followed by three years labour only return to base

OUTRUN

- + Superb 12-core AMD CPU
- + Versatile, feature-packed motherboard
- + Large and generous enclosure
- + Excellent warranty

OUTCLASSED

- – AMD GPU beaten by RTX 3080 Ti
- – Chassis will be too large for some
- – Pricier than rivals

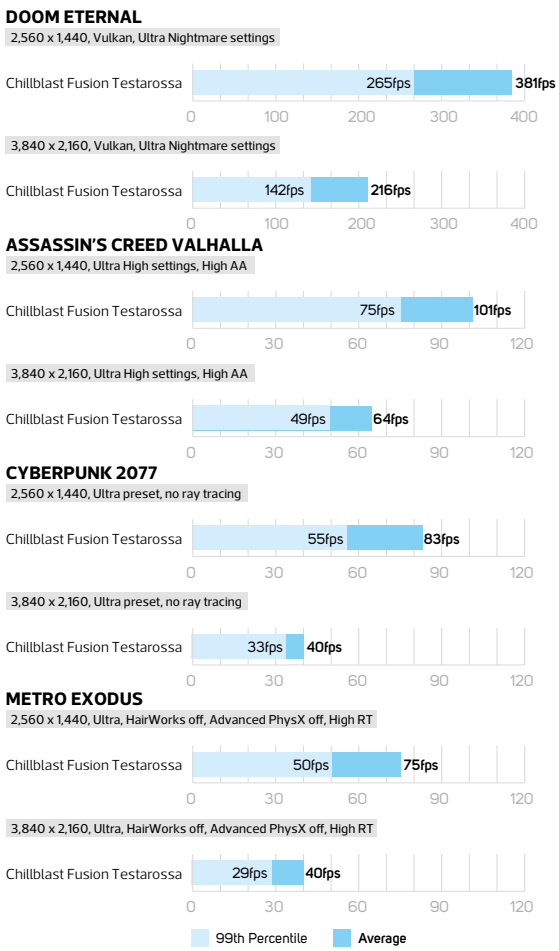
results – they're easily ahead of the Wired2Fire's RTX 3080 Ti too. Elsewhere, though, AMD's card fell behind – a sole victory in Doom Eternal's 2,560 x 1,440 benchmark isn't much to celebrate.

The Radeon RX 6900 XT zipped through Metro Exodus without ray tracing with a 49fps 99th percentile result, and it got beyond 30fps in Cyberpunk 2077 at 4K, but that's pretty much unplayable in this game. Nvidia's card is faster here, and AMD's relative lack of ray-tracing power and the absence of a DLSS equivalent means you can't enjoy those technologies on the 6900 XT. Indeed, it couldn't even play Cyberpunk 2077 with Medium ray tracing at 2,560 x 1,440.

On the plus side, AMD's 12-core processor is superb. Its single-threaded image editing score of 66,973 is solid, and its result of 942,675 in our heavily multithreaded Handbrake test is sensational – far beyond Intel's Core i9-11900XE. That makes the Ryzen 9 5900X a fantastic choice if you need content creation and gaming ability in equal measure. It's a little slower than the Wired2Fire, but the difference is negligible. The SSD is brilliant too – its respective read and write speeds of 7,126MB/sec and 5,202MB/sec are great, and you get 2TB of space as well.

What's more, Chillblast's system is an impressive thermal performer. The fan noise is modest and manageable when gaming, and the GPU ran at boost speeds beyond 2400MHz during games. The machine was barely any louder during a full-system stress test, and in a multi-threaded work benchmark, the Chillblast was consistently quiet, with the CPU running at just over 4.05GHz across all cores. There were no temperature issues – the CPU and GPU delta Ts of 51°C and 56°C are fine.

BENCHMARK RESULTS



66,973
GIMP IMAGE EDITING

942,675
HANDBRAKE H.264 VIDEO ENCODING

360,048
HEAVY MULTI-TASKING

352,183
SYSTEM SCORE

Conclusion

The Testarossa is expensive, but it does go some way to justifying that price with excellent hardware. The processor is a top-tier content-creation option, the motherboard is packed with features, the sizeable SSD is fast, and the case is large, accessible and versatile.

Those attributes bode well for tough workloads, but the Testarossa isn't infallible. The Radeon RX 6900 XT is fast, but the Nvidia GeForce RTX 3080 Ti is generally faster, particularly when you add ray tracing to the mix. Wired2Fire's system is significantly cheaper too, even if both PCs cost well over three grand. The Chillblast Fusion Testarossa is a great machine for content creation, future upgrades and additional storage, but it's not necessarily the best option in this price bracket for gaming.

MIKE JENNINGS

VERDICT

A fast and versatile system with solid hardware choices, but there are better (and cheaper) options for 4K gaming.

PERFORMANCE **22/25**
DESIGN **22/25**
HARDWARE **22/25**
VALUE **17/25**
OVERALL SCORE **83%**

Custom kit

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

SANDISK iXPAND WIRELESS CHARGER SYNC / £99.99 inc VAT for 256GB

SUPPLIER westerndigital.com

The iXpand takes the idea of the simple wireless charger and turns it into a relatively complicated wireless charger and phone backup system. When you put the phone on to charge, it backs up all the data, which you can then access via an app if you want to restore it to your phone, or to a new phone that you've paired with the device.

Power is provided by a micro-USB port or a mains plug, and the iXpand connects to your phone via Bluetooth and then to the same Wi-Fi network as your phone. It uses a 2.4GHz connection only though – it won't work with 5GHz, which can be inconvenient if it means swapping your phone to a lower speed. You can secure the data on the iXpand by creating an account, or using a PIN that it generates on setup, so that you can transfer the backup to a new phone.

The charger is quick and can function reliably through thin phone cases, but it struggles with any barrier over 3mm thick. The minor inconvenience of Wi-Fi speed notwithstanding, this is a very slick device that handles its tasks with cool assurance.

Back down ●●●●○ **Backup**

KLIM BAMBOO LAPTOP COOLER / £24.97 inc VAT

SUPPLIER amazon.co.uk

The propensity for laptop coolers to look like spaceships can be off-putting, and the usual alternative is to go with a sleek or minimalist design. In this case, however, KLIM has taken a completely different approach, creating what's ostensibly a ventilated chopping board upon which to rest a laptop. Surprisingly, it's a very natural fit.

The base is a chunk of bamboo with big vents cut into it for the twin 130mm fans underneath. The illuminated fans, two USB ports and speed control are located in a plastic compartment underneath, which is coloured to match the wood. There are fold-out legs on the back and a removable wooden bracket on the front to prevent the laptop from sliding off. The fans aren't too loud, and while a metal cooler would conduct heat, and wood is an insulator, the airflow is still fine for cooling a laptop.

The use of illuminated fans with a visually rustic device is faintly absurd, but it works.

Wood pun ●●●●○ **Would not**

COLORCORAL CLEANING GEL / £10.99 inc VAT

SUPPLIER amazon.co.uk

The ColorCoral Cleaning Gel is a stinky viscous goop that, unlike most stinky viscous goops, is designed to make devices clean, rather than cover them in stinky viscous goop. The goop is ideal for keyboards, but it works on other computer peripherals too. The stink isn't horrible, by the way – it's a heady mix of citrus with hopefully enough of a cleaning chemical note to it to deter curious children and pets from wanting to taste it.

Once you dig the gel out of the pot, you ball it up and squash it onto whatever you want to clean, roll it around a bit and that's all there is to it. The effect of such a haphazard cleaning method is surprising – the gel removes dust and any other material that isn't firmly stuck to your device very effectively.

Despite the goopiness of the gel, the ColorCoral can't get too deep in between keys or other spaces, so it's a surface-level job at best. If you want to clean an object fairly well, but you're short on time, the ColorCoral gel is ideal.

Bleached coral ●●●●○ **Coloured coral**

NANOLEAF SHAPES TRIANGLE STARTER KIT / **£89.99** inc VAT

SUPPLIER nanoleaf.me

Nanoleaf Shapes offer a sophisticated answer to the question 'how do you put addressable RGB lighting everywhere?' The Triangle Starter Kit starts with a choice of four, nine or 15 triangular panels, as well as a controller and enough linker pieces to hook all the bits in the kit. Each triangle operates as a light capable of displaying over 16 million colours, and also functions as a touch panel. They can then be connected together with the other pieces in the kit, or different-shaped pieces from other kits.

The net result is that you can tile together a panel of lights, which then attaches to whatever surface you want, using either very strong tape or screw-in plates if necessary. You power this mosaic via a mains connection that tucks in behind any of the connection points, so it's easy to keep the arrangement tidy. The control app is available for Apple or Android phones, as well as Windows PCs, offering excruciatingly detailed options for many settings, from the colour scheme and timing, to the functions assigned to pressing different shapes.

The panels connect via 2.4GHz Wi-Fi and software setup is relatively simple. However, make sure you install the software and pair the devices before attaching the plates to any surface from which they can't be easily removed. The panels can also be controlled via Razer's Synapse software, so they can augment your PC's RGB array if you already have Razer gear. The result is an expensive but undeniably awesome RGB lighting setup.

Macro trunk ●●●●● **Nanoleaf**

MOUSE JIGGLER / **£15.97** inc VAT

SUPPLIER amazon.co.uk

The Mouse Jiggler is a weirdly inventive gadget – it's designed to prevent your computer from realising you're away from the keyboard by moving the mouse without your help. The weirdness of this take on the mouse spoofing gadget is that it's based around the repurposed body of a wristwatch.

You start up the watch with a button on the side, place it inside the frame, put your mouse on top and the movement of the second hand ticking around causes a little movement every so often, so the computer thinks you never left your desk. That's the theory anyway – in practice, getting it to work depends on finding a sweet spot where the mouse sensor sees enough of the movement of the hands to react, and this can be tricky and time-consuming.

Also, although the watch is quiet, its operation is still constant and noticeably audible. It doesn't care about whether the device is in use or not, it's just going to keep ticking for around a year. The Mouse Jiggler is a clever idea, but it could be better.

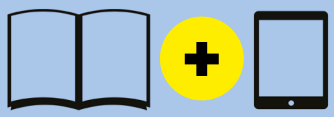
Cross ●●○○○ **Tick**

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 + FREE Chillblast Aero RGB mouse**
  UK only - use code **CPCMOUSE**
- **£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 CUSTOM PC

GET 3 ISSUES FOR £10 +

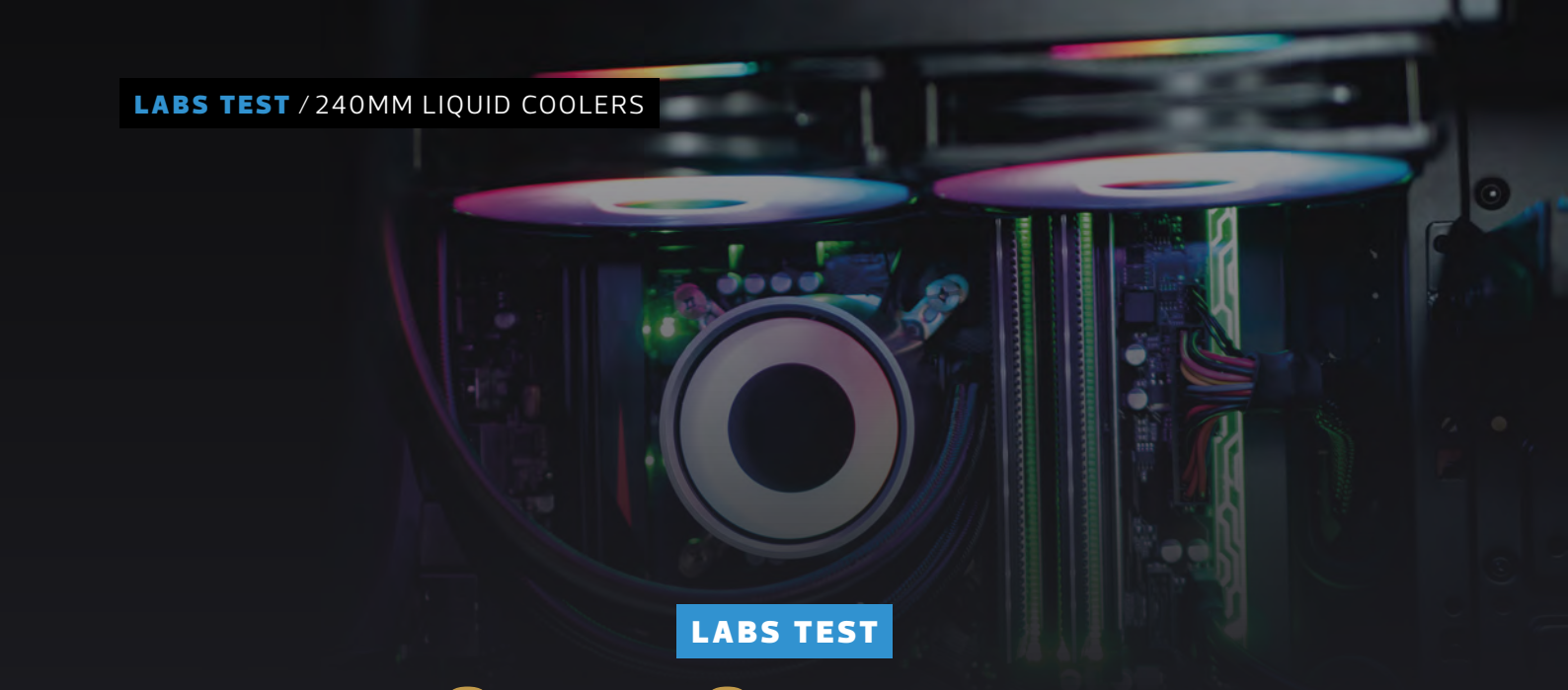
FREE BOOK!

custompc.co.uk/freebook

FREE CHILLBLAST AERO RGB GAMING MOUSE WITH A 12-MONTH SUBSCRIPTION

Subscribe to Custom PC, and get your first three issues for £10, then our great-value rolling subscription afterwards. Includes a voucher for one of five fantastic books. UK only. Free delivery on everything.

We're offering an award-winning **Chillblast Aero RGB mouse** with a 12-month UK subscription for £45 at **custompc.co.uk/chillblast**, using code **CPCMOUSE**. See p29 for more information.



LABS TEST

Liquidated

Antony Leather puts six of the latest 240mm all-in-one liquid CPU coolers to the test

How we test

When testing CPU coolers, it's important to examine performance across different sockets, as the mounting mechanisms vary between them. We've seen differences here in the past and this month's Labs test is no different. This month we're using the latest 8-core CPUs from AMD and Intel – the Core i9-11900K and Ryzen 7 5800X – to see how each of our chosen coolers performs on Socket AM4 and LGA1200 CPUs.

With the Intel CPU, we've left it at stock speed, but enabled Adaptive Boost technology, which can hit 5.1GHz across all cores and also dish out a lot of heat – a great test for any cooler. Meanwhile, our Ryzen 7 5800X was overclocked to 4.6GHz using a vcore of 1.25V.

We used an MSI MEG Z590 Ace motherboard for Intel testing and an MSI MEG X570 Unify for AMD testing, along with 16GB of Corsair Vengeance RGB Pro memory. Alongside these components sit a 256GB Samsung 960 Evo SSD and Corsair CM550 PSU. Both systems are housed in a Fractal Design Meshify C case and use the latest versions of Windows, plus the latest BIOS and driver versions.

We use CoreTemp to measure the CPU temperature, before subtracting the ambient air temperature from this 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 system, we take an average reading across all eight cores in order to compensate for any hot spots that might be misleading. AMD's CPUs only report a single temperature reading, rather than per-core readings, so we list what's reported in CoreTemp. We calculate scores based on cooling ability, noise, features, ease of installation and value, with a weighted calculation giving the final overall score.

Contents

- Alpenföhn Glacier Water 240 ARGB / p43
- Antec Neptune 240 / p44
- be quiet! Silent Loop 2 / p45
- Corsair iCUE H100i Elite Capellix / p46
- Lian Li Galahad 240mm / p47
- Phanteks Glacier One 240MPH HALOS / p48

ALPENFÖHN GLACIER WATER 240 ARGB / £145 inc VAT

SUPPLIER overclockers.co.uk

While Alpenföhn's Glacier Water 240 ARGB appears to be fairly basic for a price that's just shy of £150, when other coolers are more lavishly equipped with software or exquisite aesthetics, it makes up for this by coming equipped with a wireless remote control for its digital RGB lighting. It's the only cooler on test to do so, making it simple to flick through colours and lighting effects without the need for software.

The actual RGB lighting, as you'd expect at this price, extends not just to the pump housing, but to the fans too. That's good, but bear in mind that this feat is also matched by the far cheaper Antec Neptune 240. However, the Alpenföhn Glacier Water 240 ARGB's lighting is far superior to that of the Antec, both in terms of brightness and colour accuracy, with vivid colours on the fan rings and pump.

The top of the pump has interchangeable plates too, enabling you to reveal the full force of the RGB lighting beneath the plate or have it shining through a logo-equipped pattern. The lighting can also be hooked up to standard 3-pin digital RGB headers on a motherboard or controller.

Rather than pre-apply its thermal paste, Alpenföhn has instead equipped this cooler with a generously sized tube of the highly regarded Thermal Grizzly Hydronaut thermal paste. As a result, you'll be good for several installations of this cooler, and you won't have to worry about paste quality either.

We were impressed with the build quality of the fans too, which feel solid and use fluid dynamic bearings, although at 2,200rpm, they're not the fastest we've seen. Sadly, there are no extra screws for mounting an additional row of fans, which are included on Corsair's cooler, but at least it was simple to deal with the mounting mechanism on both of our CPU sockets.

Our Core i9-11900K is a toasty beast when it gets going, but the Alpenföhn Glacier Water 240 ARGB prevented it from throttling, even with Adaptive Boost Technology enabled, resulting in a delta T of 70°C. Its fans were also very quiet despite their speed, but both the fans and the pump, while very quiet, weren't that powerful in terms of cooling. This cooler's Intel delta T was by far the warmest on test – the cheaper, but slightly louder Lian Li Galahad 240mm was more powerful in this regard.

The Alpenföhn fared better with our cooler-running Ryzen 7 5800X, though, keeping pace with the other coolers and being only a few degrees off the top spot. Its delta T of 54°C wasn't too far off the 51°C for the Lian Li Galahad 240mm and Corsair iCUE H100i Elite Capellix.

Conclusion

The Alpenföhn's remote LED lighting control is a great feature, and the lighting itself is vivid, accurate and easy to control, although it doesn't actually extend to the fan blades themselves.

The inclusion of good quality thermal paste also adds points, as do the quiet pump and fans, as well as the reasonable performance in our AMD Ryzen system.

However, it was poor when dealing with the Intel Core i9-11900K, producing the highest CPU delta T on test, which in spite of its features makes it hard to justify the price, given that the Lian Li Galahad 240mm has more swagger and costs £30 less. Ultimately, though, the better-performing Corsair iCUE H100i Elite Capellix would be our choice if you have around £150 to spend on a 240mm liquid cooler.

SPEC

Intel compatibility LGA 2066/2011/V3, LGA1200, LGA115x

AMD compatibility Socket AM4, AM3/+, AM2/+, FM2/+, FM1, TR4/TRX4

Radiator size with fans (mm) 120 x 52 x 282 (W x D x H)

Fans 2 x 120mm

Stated noise 36.8dBA

GLACIER MINT

- \+ Premium thermal paste
- \+ Wireless RGB lighting control
- \+ Quiet

GLACIER MELT

- – Average cooling in our Intel system
- – Lighting not as extensive as competition
- – Expensive

VERDICT

A good-looking cooler, but it's not the best performer at this price.

LGA1200

COOLING	FEATURES	OVERALL SCORE
31/40	13/20	73%
DESIGN	VALUE	
17/20	12/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
35/40	13/20	77%
DESIGN	VALUE	
17/20	12/20	

FITTING: Easy

ANTEC NEPTUNE 240 / £80 inc VAT

SUPPLIER overclockers.co.uk

With its price of just £80 inc VAT for an RGB-equipped cooler, you really can't go wrong with the Antec Neptune 240 – it's been our affordable all-in-one liquid cooler of choice since we first reviewed it. The fact that you get RGB lighting on both the fan and pump, not to mention a fan and lighting hub with a manual RGB controller thrown into the box, is amazing at this price.

However, there's some stiff competition this month, so the key questions for Antec's venerable 240mm AIO liquid cooler are whether it can hold its value, a well as whether it's worth spending a bit more money.

Interestingly, with the Neptune's design, the pump isn't actually located in the usual housing that sits on the CPU, but in the end of the radiator. As a result, the Antec Neptune 240 should be immune to getting air bubbles getting trapped in the pump section, seeing as it's mounted to the system's reservoir in the radiator. This setup does mean the radiator unit is quite long, though, at 287mm, so you'll need to check that your case has clearance to accommodate it.

SEA BREEZE

- \+ Fantastic value
- \+ Good performance
- \+ Fan and lighting hub

SEA SNOT

- − Better-performing coolers available
- − Lighting isn't as vivid or accurate as pricier coolers
- − Few extras

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+, AM2/+, FM2/+, FM1, TR4/TR4X

Radiator size with fans (mm) 121 x 287 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 36dBA

Meanwhile, the RGB lighting is bright and vivid, but it's not quite as punchy or accurate as the lighting on the other RGB-equipped coolers on test, especially the Corsair iCUE H100i Elite Capellix and Lian Li Galahad 240mm.

Aside from the fact that the RGB lighting stretches to the pump and fans, the best feature about the Antec Neptune 240 is its fan and lighting hub.

This offers five 4-pin fan headers, which can be controlled from a single motherboard fan header, as well as some 3-pin RGB lighting connectors, allowing you to stow all these cables neatly behind the motherboard tray and cut cable clutter.

There aren't many other features, though, which is perhaps expected at this price. You only get enough screws for the included fans, and only pre-applied thermal paste is supplied plus there's no software control provided. The fans aren't particularly potent either, being only able to hit 1,600rpm at full speed.

When it comes to mounting, you'll need to use backplates on both AMD and Intel motherboards, and there are even components for mounting this cooler on AMD Threadripper sockets too. The installation process is a tad fiddly, but only because you have to deal with a few more components than with the likes of the Corsair iCUE H100i Elite Capellix.

Cooling in our Intel system was excellent, being only a few degrees off the top spot. The Antec tamed our toasty Core i9-11900K and bettered the Alpenföhn Glacier Water 240 ARGB by 5°C and the be quiet! Silent Loop 2 by 1°C, albeit while making more noise. However, the Corsair iCUE H100i Elite Capellix, Lian Li Galahad 240mm and Phanteks Glacier One 240MPH HALOS were noticeably cooler.

The Antec fared better in our AMD system, again bettering the Alpenföhn Glacier Water 240 ARGB, and matching the be quiet! Silent Loop 2, but sliding a degree or two behind the Corsair, Lian Li and Phanteks' coolers on test this month.

Conclusion

Still offering fabulous value for money, the Antec Neptune 240 is unbeatable for £80. It might not offer the best cooling, but you get full RGB lighting and a decent-performing cooler for just £80 – only the Lian Li Galahad 240mm would tempt us to go above the £100 mark with its better cooling and lighting.

VERDICT

Still fantastic value – you'll need to spend over £100 to get much better.

LGA1200

COOLING	FEATURES	OVERALL SCORE
36/40	11/20	80%
DESIGN	VALUE	
14/20	19/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
36/40	11/20	80%
DESIGN	VALUE	
14/20	19/20	

FITTING: Easy

BE QUIET! SILENT LOOP 2 / £116 inc VAT

SUPPLIER aquatuning.co.uk

We liked a number of features found within the be quiet! Silent Loop 2 when we first took a look at it a couple of issues ago. It has powerful Silent Wings 3 fans that boast a speed rating of 2,200rpm, giving it more scope for high-end cooling than slower fans when it's needed. What's more, these fans proved to be barely any louder than the far slower-spinning fans on the Antec Neptune 240 in action.

The Silent Loop 2's tri-chamber pump is also exceptionally quiet, and uses an enlarged cold plate in order to improve performance on CPUs with large heatspreaders, such as AMD's Threadripper chips.

There are also two interesting inclusions in the form of a fill port and coolant bottle. This is still an all-in-one liquid cooler, but rather than being sealed with maintenance completely off the table for the end user, be quiet! instead allows you to top up the coolant if needed, perhaps if the coolant level drops due to evaporation, which can happen slowly over time through the tubing.

This ability should allow the cooler to stay quiet and prevent it from running dry, which are common issues with old AIO liquid coolers after they've been used for a while.

While the fans lack RGB lighting, the pump does have a bit of lighting in the form of an illuminated RGB logo, which can be controlled using a 3-pin RGB header on your motherboard or with the included controller. However, the box is otherwise empty of accessories, other than a fan splitter cable, which is a little disappointing given that the Antec Neptune 240 includes full RGB lighting and a fan and lighting hub for £30 less. Meanwhile, other coolers include screws for installing additional fans, which are again absent here, although the included fans are admittedly quite powerful.

Installation isn't tricky, but it does involve dealing with far more components than the other coolers on test, with CPU backplate pins, securing tags and thumb screws all needed in order to mount the pump. The end result is also quite plain-looking, especially compared with the Lian Li Galahad 240mm, which costs £6 less.

The be quiet! includes a tube of thermal paste, though, and performed reasonably well when pitted against our Core i9-11900K, with a CPU delta T of 66°C. That's reasonable, but only the Alpenföhn Glacier Water 240 ARGB was warmer at 70°C, with all four of the other coolers on test performing better – the Lian Li Galahad 240mm shaved 6°C off the load delta T at 60°C.

The be quiet! Cooler had fewer issues in our AMD system, where it was within 2°C of the best result achieved by the Corsair iCUE H100i Elite Capellix and Lian Li Galahad 240mm. It had some of the lowest noise levels on test too, and it easily has the quietest pump.

SPEC

Intel compatibility LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+, AM2/+, FM2/+, FM1, TR4/TR4X

Radiator size with fans (mm) 120 x 274 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise 38.3dBA

SILENT

+ Good noise to cooling ratio
+ Refillable loop
+ RGB lighting

SILENCED

– Performance isn't exceptional
– Bland design
– Competition looks and performs better

Conclusion

With an exceptional noise-to-cooling ratio, but with the ability to ramp up performance when needed, the be quiet! Silent Loop 2 is recommended for those who want minimal aesthetic fuss, low noise and good cooling, although you do pay a premium compared with the likes of the Antec Neptune 40, which costs nearly £40 less. However, the Lian Li Galahad 240mm is our top pick in this price range, costing less money, offering fantastic RGB lighting and performing slightly better too.

VERDICT

A decent low-noise cooler for the cash, but you can get more for your money elsewhere.

LGA1200

COOLING	FEATURES	OVERALL SCORE
34/40	10/20	77%
DESIGN	VALUE	
19/20	14/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
36/40	10/20	79%
DESIGN	VALUE	
19/20	14/20	

FITTING: Easy

CORSAIR iCUE H100I ELITE CAPELLIX / £150 inc VAT

SUPPLIER scan.co.uk

The £150 price bracket used to be considered the extreme premium end of AIO liquid coolers, and rightly so seeing as you can build a cheap custom water-cooling loop for just a bit more. However, while other Corsair coolers have offered software control and RGB lighting, the iCUE H100i Elite Capellix goes a few steps further.

For starters, the lighting comes from Corsair's Capellix RGB LEDs, which are super-bright, vivid and accurate in terms of colour reproduction. You also get replacement pump tops and an iCUE Commander Core hub in the box. The latter has six fan channels, as well as Corsair-specific RGB lighting ports, and gives you the ability to use Corsair's excellent iCUE software to control not just your cooler's lighting and fans, but those of the whole of the rest of your PC too.

The iCUE Commander Core retails for close to £50 on its own, so combined with premium fans and lashings of high-quality RGB lighting, the iCUE H100i Elite Capellix does go a long way already to justifying its price tag. The ML120 fans can hit a mighty 2,400rpm and were certainly loud at that speed, but the software makes it easy to rein them in. They retail for over £20 each, further adding to the price justification. They look fantastic in motion too, with the semi-transparent blades doing a great job of diffusing the RGB lighting into big blocks of colour.

The fans can also switch off if the coolant temperature is low enough, giving you a near-silent cooler. The pump does make a small amount of noise, but it's inaudible from more than a few inches away in the software's quiet mode.

However, this mode does impact on cooling, resulting in the CPU delta T of our AMD system rising from 51°C to 57°C with the fans on quiet mode too, so you'll need to test it with your own system to find the best fan speed profile for you.

However, the delta T of 51°C in our AMD system was the best result on test, matching the Lian Li Galahad 240mm, and being a degree lower than the Phanteks Glacier One 240MPH HALOS, 2°C cooler than the be quiet! Silent Loop 2 and Antec Neptune 240, and 3°C below the result from the Alpenföhn Glacier Water 240 ARGB.

In our Intel system, the iCUE H100i Elite Capellix also managed the second best result, with a delta T of 61°C, but the Lian Li Galahad 240mm managed to knock an extra degree off that temperature with a result of 60°C. The Corsair was one degree cooler than the Phanteks Glacier One 240MPH HALOS, 3°C cooler than the Antec Neptune 240 and 5°C cooler than the be quiet! Silent Loop 2. It even shaved 9°C off the result from the Alpenföhn Glacier Water 240 ARGB.

Conclusion

While the Lian Li Galahad 240mm performed similarly and the much cheaper Antec Neptune 240 isn't too far away in terms of cooling ability, the Corsair iCUE H100i Elite Capellix beats both of them in terms of features. Its RGB lighting is better than that of the Antec cooler, and it performs better. Plus, unlike both the aforementioned coolers, it has excellent, expandable software control for its lights and fans, and even includes extra fan screws. It's pricey, but worth it if you want the best all-round 240mm AIO liquid cooler you can find.

iCUE

- \+ Excellent cooling
- \+ Fantastic RGB lighting
- \+ Expandable software fan and light control

I QUEUE

- – Expensive
- – Cheaper coolers perform similarly
- – Noisy at full speed

SPEC

Intel compatibility LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+, AM2/+, FM2/+, FM1, TR4/TR4X

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

Fans 2 x 120mm

Stated noise 10dBA-37dBA

VERDICT

Still one of the best premium AIO liquid coolers we've tested.

LGA1200

COOLING	FEATURES	OVERALL SCORE
38/40	19/20	84%
DESIGN	VALUE	
14/20	13/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
38/40	19/20	84%
DESIGN	VALUE	
15/20	12/20	

FITTING: Easy

LIAN LI GALAHAD 240MM / £110 inc VAT

SUPPLIER overclockers.co.uk

Better-known for its cases than CPU coolers, the first liquid cooler we've seen from Lian Li impressed us from the outset with some solid-feeling fans equipped with anti-vibration mounts, not to mention a brushed aluminium-encased radiator and pump. It looks fantastic, and unlike most of the radiators included with the other coolers on test, you'd actually want to make the 240mm model here the centrepiece of your PC.

The lighting is high-quality and accurate too, with vivid colours that looked better than the lighting from cheaper coolers such as the Antec Neptune 240, and the semi-transparent fan blades diffused the colours attractively as well. What's more, the pump unit has a large ring of densely packed circles, which allow the light to shine through them. Plus, if you prefer to cover up the Lian Li logo, there's a magnetic aluminium cap you can place on top instead, which still allows the lighting to be visible.

Installation is a little more involved than usual, with more components needed than average, but it's a pain-free process and it's particularly easy on Socket AM4, where the cooler makes use of the existing socket mounting mechanism (although it's not compatible with previous AMD sockets). You also get a separate tube of thermal paste included in the box, so you won't have to buy more if you upgrade your CPU in the future and need to reseat the cooler.

The only issue with the installation process is that you need to deal with a number of cables to hook up all the various bits. There are splitter cables for the fans, but the pump will need a header of its own. The RGB lighting cables do thankfully have a three-way splitter, so you can control both the fans and pump from a single source, although there's still quite a bit of spaghetti to tidy away.

Meanwhile, lighting control can be performed using your motherboard's software and connecting the cooler's 3-pin RGB connector to a header on your motherboard, or by using the basic included RGB controller. The end result is a setup that easily matches the Corsair iCUE H100i Elite Capellix in terms of lighting prowess, but not in the fan control department, thanks to the Corsair cooler's software control system.

In our AMD system, the Galahad 240mm matched the Corsair cooler's performance with a delta T of 51°C when dealing with our overclocked Ryzen 7 5800X. It was also a little cooler than the Phanteks Glacier One 240MPH HALOS and a couple of degrees cooler than the be quiet! Silent Loop 2 and Antec Neptune 240.

The Galahad also achieved the best result when pitted against our toasty Core i9-11900K, with a delta T of 60°C compared to 61°C for the Corsair iCUE H100i Elite Capellix, 63°C for the Phanteks Glacier One 240MPH and 65°C for the Antec Neptune 240. The Galahad's pump was quiet too, with just a very slight whine audible from a foot or so away.

GALAHAD

- \+ Excellent cooling
- \+ Fantastic RGB lighting
- \+ Great-looking pump and radiator

BRAVE SIR ROBIN

- − No software control
- − Lots of cables to deal with
- − More than average number of installation components

SPEC

Intel compatibility LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4

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

Fans 2 x 120mm

Stated noise 32dBA

Conclusion

With a reasonable price tag, excellent cooling and great build quality, the Lian Li Galahad 240mm is our pick if you have around £100 to spend on a CPU cooler, and don't need the extra features offered by coolers such as the Corsair iCUE H100i Elite Capellix. Its lighting is fantastic and it can tame the latest CPUs from Intel and AMD with ease, while including a few extras to make your life a little easier when dealing with its mass of cables.

VERDICT

A good-looking, great-performing cooler for a surprisingly reasonable price.

LGA1200

COOLING	FEATURES	OVERALL SCORE
39/40	18/20	88%
DESIGN	VALUE	
14/20	17/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
38/40	18/20	88%
DESIGN	VALUE	
15/20	17/20	

FITTING: Easy

PHANTEKS GLACIER ONE 240MPH HALOS / £140 inc VAT

SUPPLIER overclockers.co.uk

The Phanteks Glacier One 240MPH HALOS differs from the Glacier One MP we reviewed a few issues ago in one key area, which is the inclusion of Phanteks' HALOS fan rings, which are equipped with RGB lighting. These rings are available to buy separately, and can jazz up any 120mm fan, especially those with transparent or semi-transparent blades, or white models.

Sensibly, Phanteks has included white 120mm fans here, which look fantastic when they're illuminated. Our particular sample also sported white HALOS fan rings, and a white pump and radiator too, so it would look amazing in a white-themed PC.

The pump top is separate to the actual pump section, and simply sits on top of it using magnets. It's there purely for aesthetic reasons, but we can't argue with how good it looks, illuminated at the edges and sporting an infinity mirror effect in the same colour. To control the lighting, you can either use your motherboard's 3-pin RGB headers, or connect it to one of Phanteks' own RGB-equipped cases with its proprietary connectors. An adaptor cable is also included, allowing you to use either option.

Handily, the RGB components can also be daisy-chained, so you don't need to have dozens of cable strands all over the place, although inevitably you have to deal with a few more cables here than for one with a cooler without RGB lighting. To make building a tidy PC a little easier still, tube clips are included with the Phanteks to keep the two braided tubes equal distances apart. This is actually quite effective, and also anchors the tubes together, which can help to prevent them from bending outwards into the cooler or case fans once it's installed too, especially in smaller cases.

The fans are reasonably powerful, with a peak speed of 2,200rpm, but no extra screws are included in the box to add another row of fans on the other side of the radiator, creating a push/pull setup. Rather than pre-apply paste, Phanteks has also included a tube of thermal goo in the box, so you won't need to buy more if you upgrade your CPU.

Sadly, where the Phanteks is slightly less impressive than the competition is when it comes to cooling ability, especially for its £140 inc VAT asking price. Cooling was akin to the current McLaren F1 team – a solid second row performance, but off the pace of Mercedes and Red Bull.

The Corsair iCUE H100i Elite Capellix and Lian Li Galahad 240mm were always a degree or two cooler, but the Glacier One 240MPH HALOS was the next best performer, consistently beating the be quiet! Silent Loop 2, Antec Neptune 240 and Alpenföhn Glacier Water 240 ARGB.

Its delta T of 62°C was just a degree behind the Corsair iCUE H100i Elite Capellix and two degrees off the Lian Li cooler in our Intel system, and the Phanteks was just one degree behind both the aforementioned coolers in our AMD system. Its fans were reasonably loud, but the noise wasn't unpleasant at full speed. However, the Phanteks' pump did generate a noticeable whining noise.

Conclusion

With good cooling and great looks, the Phanteks Glacier One 240MPH HALOS is a decent cooler, especially if you're building an all-white PC. However, the Phanteks needs a more competitive price. The Lian Li Galahad 240mm looks just as good for a cheaper price, while the Corsair iCUE H100i Elite Capellix offers more features for just an extra tenner. CPC

SPEC

Intel compatibility LGA1200, LGA115x, LGA2066, LGA2011

AMD compatibility Socket AM4, TR4/TR4X

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

Fans 2 x 120mm

Stated noise 34dBA

GLACIER

+ Decent cooling
+ Fantastic RGB lighting
+ Tube clips

ICICLE

– Similarly priced coolers have more features
– Cheaper coolers offer better cooling
– Expensive

VERDICT

Top-notch aesthetics, but not particularly great value for the cooling on offer.

LGA1200

COOLING	FEATURES	OVERALL SCORE
37/40	14/20	78%
DESIGN	VALUE	
14/20	13/20	

FITTING: Easy

AM4

COOLING	FEATURES	OVERALL SCORE
37/40	14/20	77%
DESIGN	VALUE	
14/20	12/20	

FITTING: Easy

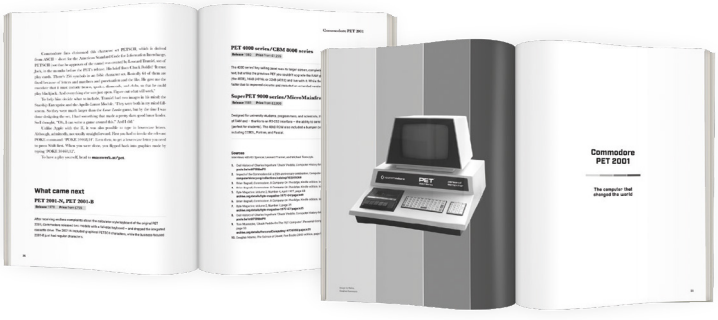
the

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 pining for a future that could have been. It's utterly astonishing!"

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



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

Avilable on amazon

LABS TEST

In the air tonight

Edward Chester puts six of the latest mid-range Wi-Fi 6 routers to the test

How we test

While there's currently a lot of talk about mesh network systems that use multiple Wi-Fi access points to distribute and extend your network, such systems don't come cheap and for many homes, they're overkill. If you live in a little flat, a two-up, two-down terrace or a small three-bedroom home, it's likely that a single, good-quality router will cover the whole house, with a mesh system only needed if you extend into the loft or want to work at the bottom of the garden.

As such, we've grabbed six conventional standalone routers, although most of them are compatible with each company's mesh systems if you want to extend them, to see just what features and performance you can get for £100–£200.

To test the routers, we set them up in the front room of a two-storey, three-bedroom end-of-terrace house, set at a height of 40cm from the floor and in the front corner of the living room. We then tested the Wi-Fi speed from a PC connected to the Ethernet port of the router to a laptop equipped with an AX1500 Wi-Fi card.

You'll achieve considerably faster peak speed results than those shown here if you're using a faster client device (such as the TP-Link TX3000 PC adaptor reviewed in issue 196), but peak speed at close range isn't a significant challenge for any router. Indeed, it's range that counts, and the laptop we used for testing represents by far the most common type of system to connect to such routers.

Test locations were a sofa 2m away from the router in the same room, then a bedroom one floor up and at the back of the house (a 5m total diagonal), and finally halfway down the garden, 7m away from the back wall of the house – about 15m total from the router. We tested using LAN Speed Test, setting up a server on the PC and the client on the laptop. We also used **netmeter.co.uk/ping-test** to test for ping.

Outside of Wi-Fi performance, we also looked at how many features each router offers, such as USB ports, extra buttons and status LEDs. We also assessed the ease of setup and the web interface, as well as the style and build quality of each unit.

Contents

- Asus RT-AX68U / p51
- Belkin RT3200-UK / p52
- Linksys MR9600 / p53
- Netgear Nighthawk RAX40 / p54
- Netgear Nighthawk Pro Gaming XR1000 / p55
- TP-Link Archer AX73 / p56
- Result graphs / p57

ASUS RT-AX68U / £165 inc VAT

SUPPLIER ebuyer.com

The RT-AX68U is Asus' latest mid-range router, having just hit the market early this year. Its pricing may seem surprisingly high given its relatively modest AX2700 rating, compact form and mere count of three antennae, but it's a surprisingly capable unit. It's not short though.

Designed to stand upright, with its trio of non-removable antennae sprouting from its top, it measures a cool 305mm in height. This almost certainly helps with range but it also limits your options for placement – it may be too tall for some shelves and its top-heavy design might be a problem if it's left out on an open surface.

That said, we didn't find the unit to be particularly unstable, despite its tiny 236 x 60mm footprint. It's also a classy-looking router that forgoes the more aggressive angular design of many competitors and instead looks, well, like a handbag. As such, it may be more welcome sat next to your TV than in the corner of the room, for instance. Even the compact power supply that doesn't encroach on neighbouring sockets looks classier than the much bulkier units of some competitors.

In terms of specs, if sports the same four Gigabit Ethernet LAN ports and single Gigabit Ethernet WAN port configuration as the other routers on test – there's no 2.5Gbps Ethernet option in this price range.

SPEC

Weight 630g

Dimensions (mm) 236 x 60 x 155 / 305 (W x D x H) / with antennae

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual band (AX2700), 861+1,802Mb/sec

Antennae 2.4GHz 3x3, 5GHz 3x3

USB ports 1 x USB 3, 1 x USB 2

Processor 1.8GHz dual-core

Memory 256MB flash, 512MB RAM

Extras USB modem support, Asus AiMesh support, Amazon Alexa support

These ports are joined by two USB ports (1 x USB 3 and 1 x USB 2) that can be used for the usual shared USB storage and printer applications, as well as some more esoteric features such as mobile broadband dongle connection and a service for downloading straight to USB storage, rather than via your PC. The Asus was also the only router on test to even recognise a SATA SSD on a USB dongle. All the others were limited to small FAT32-formatted thumb drives, in our tests.

That's it for external features, other than the standard WPS and reset buttons; these are well hidden around the back of the unit, which makes using WPS a bit tricky. The default network settings are also printed on the bottom, which isn't all that convenient.

Internally, a 1.8GHz dual-core processor and 512MB of RAM power the router and there's 256MB of flash for firmware. The Wi-Fi configuration is dual-band, with both the 2.4GHz and 5GHz bands using a 3x3 stream configuration, hence the three antennae. These bands can be combined to appear as a single Wi-Fi SSID, allowing the router to choose the best connection, and further access points can be added to form a mesh network. However, we left them separate.

In our Wi-Fi tests, this router impressively delivered among the most consistent results in all our tests locations. It wasn't always the fastest, but neither did it completely drop the ball at any point. It just delivered a rock-solid connection from both bands that tailed off gradually with distance – we suspect the extra height of those antennae helped out.

This router also packs in loads of features, such as Amazon Alexa support (so you can ask Alexa to turn on the guest network for instance), Trend Micro security integration and a router traffic analyser tool.

TRANSFORMERS

+ Dependable performance
+ Compact footprint
+ Class-leading USB features

GOBOTS

− Hidden WPS button
− May be too tall for some shelves

Conclusion

The Asus RT-AX68U has impressed us with its combination of excellent all-round performance, class-leading USB features and compact form factor. It's not always the fastest, and its interface isn't as slick as some, but it's a dependable unit at a reasonable price.

VERDICT

Rock-solid performance and plenty of features makes the RT-AX68U a great option.

DESIGN	FEATURES	OVERALL SCORE
16/20	16/20	82%
PERFORMANCE	VALUE	
26/30	24/30	

BELKIN RT3200-UK / £80 inc VAT

SUPPLIER currys.co.uk

Currently available for just £80 from Amazon and Currys, Belkin's RT3200-UK is a spectacularly low-cost router considering its headline AX3200 Wi-Fi capabilities. Even at its more widely available price of £130 inc VAT, this router still offers a lot of performance for your money.

At least part of the reason for its low price is obvious when you take this router out of its box. It's the only one on test to not sport external aerials, which in theory could impact its performance. On the plus side, though, it makes for easily the most compact unit overall, with a tiny footprint of 77 x 156mm. It does, of course, still stand quite tall, and it's not designed to be laid on its side, in case you were wondering, but it's still only 220mm tall, which is shorter than the towering Asus.

The white finish may suit some homes better than the black of its competitors too. In particular, the accompanying white power cable and plug are more likely to make for tidier-looking cabling than some routers when set against the white skirting boards and plug sockets of most homes.

On the front of the device there are just two LEDs for power and internet status, while around the back is one big line containing, from top to bottom, the WPS and reset buttons (the former being much easier to reach than most rear-mounted equivalents), followed by four Gigabit LAN ports, a Gigabit WAN port, a single USB 2 port, the power input and power switch.

That single USB 2 port rather sums up the extent of this router's extra capabilities. It does offer printer and storage sharing, but the latter is slow and there's not a huge amount else on offer. You still get standard features, such as guest network and parental controls, but there's just not a lot extra. It's a basic router, but one with the latest high-speed Wi-Fi standards.

Where this relatively modest router really comes to life is in raw performance. Its 4x4 5GHz spatial stream configuration and apparent Wi-Fi witchcraft meant it topped the charts for 5GHz performance in both our close and medium-range tests.

Peak performance in our tests was limited by the AX1500 adaptor in our test laptop, so other higher-spec routers may have more speed on tap when connecting to faster clients. However, in our real-world laptop testing, the Belkin delivered the goods. It wasn't quite so impressive in our longer-range test but it still delivered a stable connection.

However, the 2.4GHz band was less impressive, suggesting a more stripped-back 2x2 spatial stream configuration – as also used on the Netgear Nighthawk RAX40. It still maintained reasonable performance at all ranges, but was some way off the peak performance of more capable units. The 2.4GHz band is certainly still good enough for low-bandwidth operations such as smart home gadgets though.

SPEC

Weight 638g

Dimensions (mm) 77 x 156 x 220 (W x D x H)

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual-band (AX3200)

Spatial streams 2.4GHz 2x2, 5GHz 4x4

USB ports 1 x USB 2

Processor Not stated

Memory Not stated

Extras USB printer and storage sharing

BELISSIMO

+ Incredible value at current price
+ Surprising good performance
+ Compact, tidy design

BELLY FLOP

– High ping at long range
– Basic feature set

Conclusion

It's always a little tricky to assess a product when it's clearly being offered at discount, even if it's a discount being matched across two major shops and that's been active for some time. However, even at £130, the RT3200-UK is still a good buy. The Asus RT-AX68U and Netgear RAX40 offer quite a few more features for not a huge amount more, and have essentially similar performance, but £40 is still a solid saving. Meanwhile, at its current £80 price, this router is a steal.

VERDICT

The Belkin lacks frills, but with solid performance and a rock-bottom current price, this is a bargain of a router.

DESIGN	FEATURES	OVERALL SCORE
14/20	12/20	82%
PERFORMANCE	VALUE	
26/30	30/30	

LINKSYS MR9600 / £200 inc VAT

SUPPLIER amazon.co.uk

The Linksys MR9600 is a mid-sized router in this test. Its footprint of 280 x 170mm is sizeable and it rises to 163mm with its antennae extended, but several other models are quite a bit wider or taller still.

It has four antennae, as befits its 4x4 spatial streams for its 5GHz channel (2x2 for the 2.4GHz channel), which rotate to sit flush with the sides or stand proud. Given their slim profile and the low-slung overall design of the unit, the whole router looks and feels like a home theatre device. You could conceivably find this router a home in a cabinet below a TV, rather than hidden away in a corner or plonked on top of the cabinet, as would be the only option for taller units.

An intriguing aspect of this router's design is its ventilation. Linksys has adorned the whole top of the machine with a brick wall-like pattern of holes that allow you to peer directly at the circuitboard below.

CHAINLINK FENCE

+ Velop mesh compatible
+ Decent feature set
+ Snazzy design

BARBED WIRE

– Underwhelming Wi-Fi performance
– Not overflowing with features

SPEC

Weight 904g

Dimensions (mm) 280 x 170 x 60 / 163 (W x D x H) / with antennae

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual-band (AX600) 1,147 + 4,804Mb/sec

Spatial streams 5GHz 4x4, 2.4GHz 2x2

USB ports 2 x USB 3

Processor 1.8GHz quad-core

Memory 256MB flash, 512MB RAM

Extras Four adjustable antennae, Velop mesh compatibility

Most routers aren't exactly watertight, but the extent to which the components are exposed – the ventilation holes are quite large – is surprising. It will get dusty easily, but then it will also be easier to blow the dust away.

It's the same on the underside, although obviously dust and spillages aren't quite such a concern here. It's reassuring at least to see the numerous chunky heatsinks covering the top of the circuitboard though. Clearly, the hefty 1.8GHz, quad-core processor requires some significant cooling.

Despite the width of the back of this router, you still only get four Gigabit LAN ports, alongside the Gigabit WAN port. You do, however, get two USB 3 ports and Linksys has thought to put the WPS button on the right-hand side of the unit, rather than the back, so it's easy to reach.

Those USB ports support USB storage, although they didn't recognise our USB-attached SATA SSD, but they don't support printers or any other functions. This lack of other function support makes it an odd choice to bother including two ports.

Fire up the MR9600 and log into its setup screen and you'll be immediately prompted to download the Linksys Smart Wi-Fi app, which you can use to set up this router and the company's other networking products. Most notably, the app is useful for setting up its Velop mesh network products, with which this router is also compatible – you can just add Velop nodes later.

However, you can skip the app and jump straight to the browser interface. Once you're there, you're greeted with a smart set of menus that include all the standard features, such as guest access and device prioritisation, but there's nothing particularly outstanding here.

Unfortunately, the same can be said of this router's Wi-Fi performance. In our shortest-range test, its 5GHz band speed was the slowest on test, and it was similarly underwhelming at medium range. At longer range, it didn't fare quite so badly but it still wasn't great either. Meanwhile, the 2.4GHz band was middling at shorter ranges and wasn't stable enough in our longest range to test to allow us to obtain test results.

Conclusion

With its extra LAN ports and USB ports, the MR9600 makes for a good starting point for a Velop-based mesh network, if wired connections and storage sharing are important to you. However, when set against other standalone routers in its price range, the MR9600 underdelivers on Wi-Fi performance.

VERDICT

Generally weaker Wi-Fi performance than the competition and a high price puts this router on the back foot.

DESIGN	FEATURES	OVERALL SCORE
16/20	14/20	68%
PERFORMANCE	VALUE	
18/30	20/30	

NETGEAR NIGHTHAWK RAX40 / £140 inc VAT

SUPPLIER box.co.uk

Netgear's Nighthawk brand has long been associated with high-end routers, but the RAX40 is a relatively modest affair, with a sub-£150 price and AX3000 maximum speed rating, although it still largely impresses. Typically for a Nighthawk router, it's clad in all black with aggressive angles adorning every surface. It's also wide, measuring a whopping 340mm thanks to its twin antennae projecting out from the very tips of the sides.

You get some obvious front-and-centre buttons and status LEDs too, rather than the more hidden features of some more style-focused routers. There are LEDs for power, internet connection, 2.4GHz Wi-Fi, 5GHz Wi-Fi, each individual LAN port and the USB port. You'll generally know when any of those features is working or not by other means, but it's handy to have the quick reference. If you decide you don't like the light show, there's a switch at the back to turn them all off.

Below the lights are buttons for turning the Wi-Fi on or off and triggering the WPS connection feature. It seems an oversight to position the two so close though. A quick fumble in the dark and, instead of seamlessly connecting a new device, you could be waiting for your Wi-Fi to boot back up again.

Around the back you get the same core selection of features as the rest of the routers on test, with four Gigabit LAN ports, one Gigabit WAN port, a reset button, power switch and input, plus a single USB 3 port. Rather surprisingly, the latter can only be used to host storage devices, with even printer sharing not supported. You can at least set up dynamic DNS to access your storage from the Internet.

The Nighthawk router range has long flown in the face of the modern trend for app-based setups and overly swish interfaces, and sure enough, the web interface of this router is easy to use but plain-looking. It's also not overly packed with extra features, although it does support Amazon Alexa and Google Assistant control, and is compatible with Netgear's Nighthawk app, so you can control features from your phone.

When it comes to performance, this router surpassed its modest credentials, delivering solid performance across the board. At 5GHz, its peak close-range speeds weren't chart-topping but still adequate, and at mid-range, it was up there with the faster units. Its long-range impressed too, hitting solid speeds in our longest-range test, with pings that were reasonably stable.

In fact, we initially tested at a longer range and this router coped just fine. It was only when testing subsequent routers that we found most couldn't reach the end of the garden, so we tested at halfway down it instead.

It was a similar story in terms of overall performance with the 2.4GHz band, with the peak speed being slower than that of some of the other routers on test, but the Nighthawk maintained a reasonable speed and stability across the ranges.

Conclusion

The Netgear Nighthawk RAX40 isn't a chart-topping speed demon, nor is it packed with all sorts of fancy bells and whistles. However, it does have several practical extras, such as its front-mounted status LEDs and WPS button, and in our tests it delivered a reliable connection with good speeds. There are better options on test this month, but this is a decent runner-up if you can find it at a good price.

SPEC

Weight 630g

Dimensions (mm) 340 x 206 x 57 / 187 (W x D x H) / with antennae

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual band (AX3000) 600 + 2,400Mb/sec

Streams 2.4GHz 2x2, 5GHz 4x4

USB ports 1 x USB 3

Processor Dual-core

Memory 256MB flash, 512MB RAM

Extras Front-mounted WPS and WiFi buttons, Amazon Alexa and Google Assistant support

FLYING HIGH

+ Solid Wi-Fi performance
+ Useful front LEDs and buttons
+ Good value

CRASHING DOWN

− Not the fastest Wi-Fi
− Very wide design

VERDICT

A simple, practical workhorse of a router with good Wi-Fi range, if not the best peak Wi-Fi speed.

DESIGN	FEATURES	OVERALL SCORE
16/20	16/20	80%
PERFORMANCE	VALUE	
22/30	26/30	

NETGEAR NIGHTHAWK PRO GAMING XR1000 / £300 inc VAT

SUPPLIER ebuyer.com

While we originally planned to look at what the latest mid-range Wi-Fi 6 routers have to offer, we decided the Netgear Nighthawk Pro Gaming XR1000 was interesting – and just about affordable – enough to cover in this group test. However, its higher price makes it less directly comparable to the other units on test.

As well as boasting a speedy AX5400 rating, with peak theoretical 5GHz speeds of up to 4,800Mb/sec, this router's key claim is its gaming credentials. It runs Netgear's DumaOS, which includes features for fine-tuning several aspects of how your system connects to online games.

Specifically, it allows you to geo-filter which game servers with which to connect, so you can ensure the best ping. So, if you're in Europe you can block servers in the USA or the Far East, where the distance results in higher pings. It also includes a ping heatmap so you can visualise which servers for any game provide the best ping to your router and then apply the results to the geo-filter.

It also includes standard features such as QoS and a built-in speed test. However, even these are better presented and more granular than the equivalents on most other routers, making it easy to drill down into the details of managing your home network.

Ultimately, the effectiveness of these features will depend on your home situation and what games you play. If you live alone and play games that either always have a reliable ping, or allow you to specify which server to use anyway, then you won't get much use from these features. However, if you're constantly battling other household users for bandwidth, and have no control over which server your system might use, then you could see gains in connection stability and reduction in typical ping.

Otherwise, this unit is just the beefier cousin to the RAX40. It has the same overall shape but with even sharper lines and metallic red ventilation grilles at the front and back. The top selection of status LEDs and buttons is the same too, but slightly rearranged, with the power light on its own at the back, the LAN ports off to the right and the other LEDs to the left.

We also appreciate the a big removable sticker on the front of the unit with the default Wi-Fi name and password. Plus, Netgear's default password scheme is excellent across all its routers. It uses a combination of two words and three digits that's generally easy to remember but secure, such as rubbishtracker459. It's a better system than the string of eight digits or random selection of characters used by some routers.

The number of antennae has doubled too, and this is the only router on test where they're removable, making them easy to replace if they get damaged, or if you want to attach different antennae.

When it comes to performance, the XR1000 does a reasonable job of justifying its extra cost. At close range, it delivered impressive speeds on both the 5GHz and 2.4GHz bands, and although its 2.4GHz speed dropped off at mid-range, the 5GHz band maintained decent numbers. However, at longer range, it didn't overly impress. It was solid enough but didn't take the win in either band.

SPEC

Weight 600g

Dimensions (mm) 295 x 200 x 64 / 171 (W x D x H) / with antennae

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual band (AX5400) 600 + 4,800Mb/sec

Spatial streams 2.4GHz 2x2, 5GHz 4x4

USB ports 1 x USB 3

Processor 1.5GHz triple-core

Memory 256MB flash, 512MB RAM

Extras Removable antennae, DumaOS

DUMAOS

+ Genuinely useful gaming features
+ Decent performance
+ Removable antennae

DUMASS

– Expensive
– Not all games/gamers will benefit
– No mesh network option

Conclusion

This router's extra gaming features are only going to be of use to some users, but they could be crucial for those users. For others, the high price of this router, along with its good-but-not-stellar Wi-Fi performance and feature set (there's no mesh option, for example), means there are better buys available.

VERDICT

Good for certain online gamers, but pricey for the extra functions it provides.

DESIGN	FEATURES	OVERALL SCORE
16/20	18/20	76%
PERFORMANCE	VALUE	
24/30	18/30	

TP-LINK ARCHER AX73 / £170 inc VAT

SUPPLIER ebuyer.com

Boasting Wi-Fi speeds of up to AX5400 and festooned with six aerials, the TP-Link Archer AX73 certainly looks like it will offer good value for its £170 price tag. Like the Linksys MR9600, this is a shallow, low-slung rectangular unit measuring just 147mm from front to back. This again makes it more suited to potentially being stowed away, although of course, for the best coverage, you'll want to have your router out in the open.

The aesthetic here isn't quite as slick as the Linksys. The six aerials sprouting from the back and sides simply outnumber the four of the Linksys and they lack the same sleek profile. The front of the router doesn't have quite the same home theatre look either, although the diagonal ventilation pattern on the top of the unit, which looks like a Wi-Fi symbol, is a rather neat touch.

SPEC

Weight 734g

Dimensions (mm) 273 x 147 x 49 / 167 (W x D x H) / with antennae

Ethernet 4 x Gigabit LAN, 1 x Gigabit WAN

Wi-Fi Dual-band (AX5400) 574 + 4,804Mb/sec +

Streams 2.4GHz 2x2, 5GHz 4x4

USB ports 1 x USB 3

Processor 1.5GHz triple-core

Memory 256MB flash, 512MB RAM

Extras OneMesh support

A couple of minor points slightly irritated us when setting up this router as well. The first was the tight plastic wrapping used on each antennae, which was a pig to unwrap or tear off. The other was the power supply, the bulk of which extends upwards from the socket, rather than down. All the other units on test had the bulk either extend down or straight out, which tended to interfere less with other plugs when plugged into a multi-plug adaptor.

Along the front of the router, you get seven status LEDs for power, each Wi-Fi band, internet connection, LAN activity, USB and WPS. The actual WPS button is hidden around the back, though, along with buttons for turning off the LEDs and Wi-Fi – good luck hitting the right one without having to peer around the back of the unit.

The rest of the rear is filled with the same four Gigabit LAN ports, WAN port and power input and switch as the other routers on test. A single USB 3 port is situated on the right-hand edge. It only supports USB storage, but does include local and remote access options, media sharing and Time Machine.

When setting up the AX73, we were particularly impressed by the inviting interface. It manages to feel intuitive and easy to follow for novices, without feeling like it's trying to be too clever. It's also immediately obvious early on in the setup process whether you want to use 'Smart Connect' (combining the two Wi-Fi bands into a single SSID) or use separate Wi-Fi bands. Some other router interfaces were a bit less clear on whether they offered this as an option.

Once it's set up, the rest of the interface is again particularly well laid out, and it's also easy to find how to add another OneMesh-compatible device to set up a mesh network.

Sadly, when it came to performance, the AX73 wasn't all that clever. We started by testing the Smart Connect option, as it was the default, but it decided to smartly connect our AX1500-capable laptop over 2.4GHz, giving us 124Mb/sec maximum speeds, so we decided it was better to separate out the Wi-Fi bands.

Once that was done, performance was largely mid-table, which is a little underwhelming given its AX5400 rating and six aerials.

Conclusion

The TP-Link Archer AX73 has a slick interface and is a relatively compact unit considering its AX5400 rating and six antennae. However, its performance isn't quite as impressive as you might hope. It's still competitively priced and perfectly capable, but the Asus RT-AX68U outperforms it and offers more features. CPC

ARCHER

+ Solid Wi-Fi performance
+ Decent feature set
+ Slick web interface

ARCH NEMESIS

– Not as fast as you might expect
– Power plug too tall

VERDICT

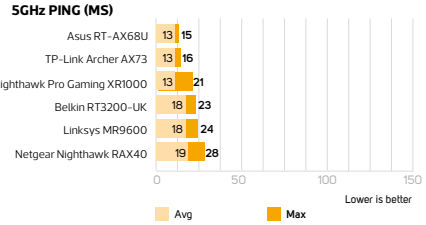
Solid mid-range performance, but there are slightly better options available.

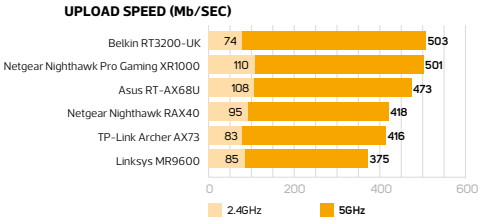
DESIGN	FEATURES	OVERALL SCORE
14/20	14/20	72%
PERFORMANCE	VALUE	
22/30	22/30	

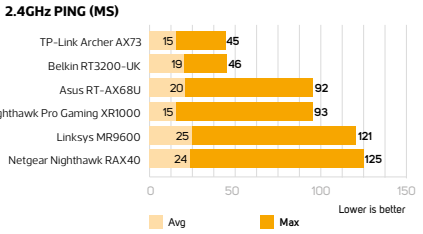
WI-FI 6 ROUTERS BENCHMARK RESULTS

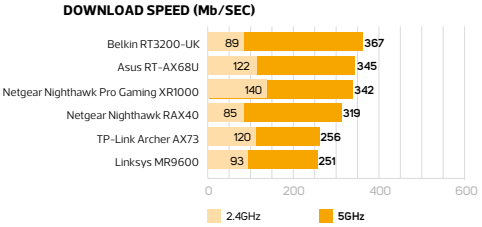
LOCATION 1

SOFA 2M FROM ROUTER IN SAME ROOM



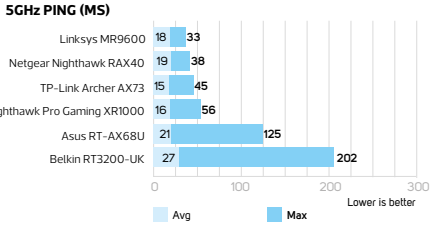


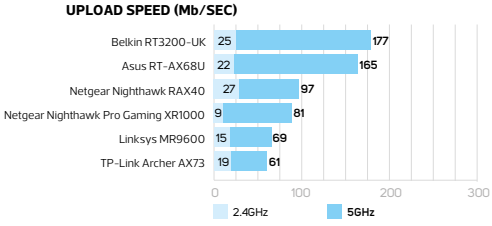


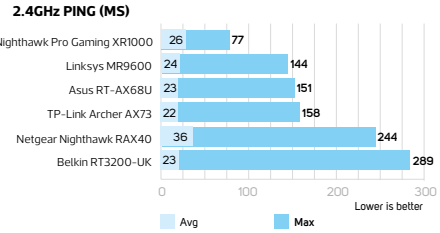


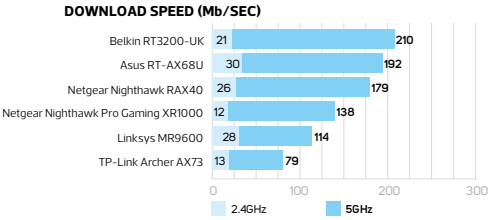
LOCATION 2

UPSTAIRS BEDROOM, 5M DIAGONAL FROM ROUTER



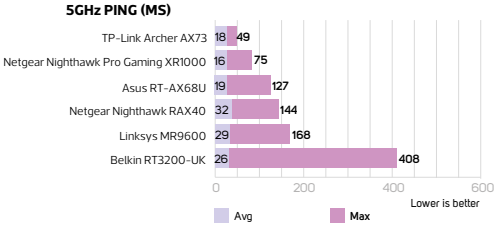


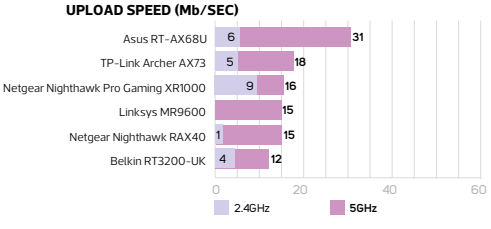


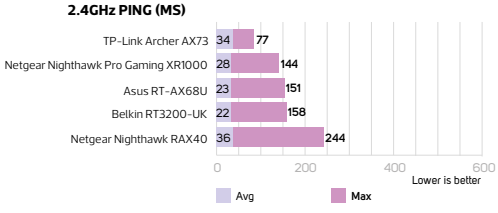


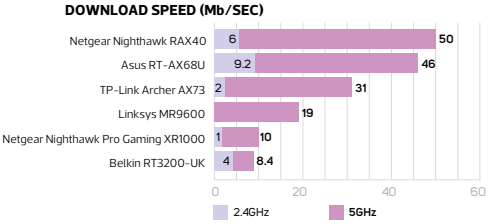
LOCATION 3

OUTSIDE GARDEN, 15M FROM ROUTER









How we test

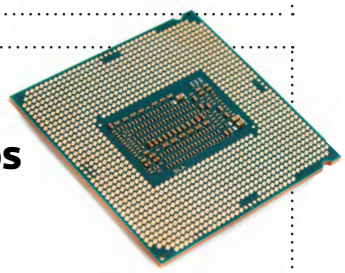
MOTHERBOARDS

TEST PROCESSORS

› **Intel LGA1200** Intel Core i9-11900K
› **AMD AM4** AMD Ryzen 9 5900X, and AMD Ryzen 9 3900X for standalone reviews that require comparisons with older results.

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

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



PROCESSORS

TEST MOTHERBOARDS

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

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

We use the latest version of Windows 10 with security updates, as well as the latest BIOS versions and drivers. We record results at stock speed and overclocked, and our tests include the **CPC** RealBench suite for image editing, video encoding and multi-tasking, Cinebench's single and multi-threaded tests, Far Cry New Dawn and Watch Dogs: Legion.

For our game tests, we record the 99th percentile minimum and average frame rates either using the game's built-in benchmark or Nvidia FrameView. Finally, we measure the idle and load power consumption of the whole system, using Prime95's smallfft test with AVX disabled to stress the CPU.

MONITORS

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

CPU COOLERS

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

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

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

INTEL LGA1200
Intel Core i9-11900K at stock speed with Adaptive Boost enabled, MSI MEG Z590 Ace motherboard.

AMD AM4
Ryzen 7 5800X overclocked to 4.6GHz with 1.25V vcore, MSI MEG X570 Unify motherboard, or AMD Ryzen 7 1700 overclocked to 3.9GHz with 1.425V vcore for standalone reviews that require comparisons with older results.

INTEL LGA1151
Intel Core i5-9600K overclocked to 4.8GHz with 1.2V vcore.

INTEL LGA2066
Intel Core i9-9980XE overclocked to 4.2GHz with 1.08V vcore.

GRAPHICS CARDS

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

TEST KIT

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

GAME TESTS

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

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

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

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

POWER CONSUMPTION

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

CUSTOM PC AWARDS

EXTREME ULTRA

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

PREMIUM GRADE

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

PROFESSIONAL

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

APPROVED

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

CUSTOM KIT

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

CUSTOM PC REALBENCH

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

GIMP IMAGE EDITING

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

HANDBRAKE H.264 VIDEO ENCODING

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

LUXMARK OPENCL

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

HEAVY MULTI-TASKING

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

Elite

Our choice of the best hardware available

Core component bundles

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

Budget system with integrated graphics

Quad-core CPU, basic gaming

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 3400G	awd-it.co.uk	**#194** p20	£147
CPU COOLER	AMD Wraith air cooler included with CPU	N/A	**#194** p20	£0
GRAPHICS CARD	AMD Radeon RX Vega 11 integrated into CPU	N/A	**#194** p20	£0
MEMORY	16GB (2 x8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2 Z3200C16)	scan.co.uk	**#204** p74	£91
MOTHERBOARD	Asus TUF B450M-Plus Gaming (micro-ATX)	scan.co.uk	**#204** p74	£83
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£54
	Total £375			

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

Needs a micro-ATX or ATX case.
We recommend a 500W 80 Plus 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	£16
GRAPHICS CARD	Nvidia GeForce RTX 3060	overclockers.co.uk	**#213** p16	£630
MEMORY	16GB (2 x8GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M2Z 3200C16)	scan.co.uk	**#204** p74	£91
MOTHERBOARD	MSI MAG B560 Tomahawk WiFi (ATX)	scan.co.uk	**#215** p18	£170
STORAGE	500GB WD Blue SN550 (M.2 NVMe)	scan.co.uk	**#204** p24	£54
	Total £1,111			
UPGRADES				
SWAP GRAPHICS CARD	AMD Radeon RX 6700 XT (2,560 x 1,440 gaming)	overclockers.co.uk	**#213** p19	£750
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£119

2,560 x 1,440 gaming system

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

Needs an ATX case with room for a 240mm all-in-one liquid cooler. We recommend a 550-600W 80 Plus Bronze power supply.

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 5 5600X	scan.co.uk	**#213** p43	£264
CPU COOLER	Antec Neptune 240	overclockers.co.uk	**#216** p44	£80
GRAPHICS CARD	AMD Radeon RX 6700 XT	overclockers.co.uk	**#213** p19	£750
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	scan.co.uk	**#210** p74	£105
MOTHERBOARD	MSI MPG B550 Gaming Carbon WiFi	cclonline.com	**#210** p74	£165
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£119
	Total £1,483			
UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£80

Mid-range gaming system

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

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	**#213** p44	£380
CPU COOLER	Lian Li Galahad 240mm	overclockers.co.uk	**#216** p47	£110
GRAPHICS CARD	AMD Radeon RX 6800 XT	cclonline.com	**#211** p42	£1,100
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	scan.co.uk	**#210** p74	£105
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	**#193** p44	£290
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	**#215** p43	£119
	Total £2,104			
UPGRADES				
ADD SECONDARY STORAGE	Western Digital Blue 4TB	overclockers.co.uk	**#166** p54	£80
SWAP CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	**#216** p46	£150

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

Core component bundles cont ...

4K gaming system

8-core CPU, 4K gaming

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 7 5800X	scan.co.uk	**#213** p44	£380
CPU COOLER	Corsair iCUE H100i Elite Capellix	scan.co.uk	**#216** p46	£150
GRAPHICS CARD	AMD Radeon RX 6900 XT	overclockers.co.uk	**#212** p44	£1,590
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3600MHz (CMW16GX4M 2Z3600C20)	scan.co.uk	**#210** p74	£105
MOTHERBOARD	Asus ROG Strix X570-E Gaming (ATX)*	overclockers.co.uk	**#193** p44	£290
STORAGE	1TB WD Black SN850	box.co.uk	**#215** p49	£159
	Total £2,674			

UPGRADES

ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	**#166** p54	£80

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

Content creation system

12-core CPU, 2,560 x 1,440 gaming

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	AMD Ryzen 9 5900X	scan.co.uk	**#213** p45	£490
CPU COOLER	NZXT Kraken X63 (280mm AIO liquid cooler)	scan.co.uk	**#207** p47	£130
GRAPHICS CARD	AMD Radeon RX 6700 XT	overclockers.co.uk	**#213** p19	£750
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 3600MHz (CMW32GX4 M2D3600C18)	scan.co.uk	**#210** p74	£259
MOTHERBOARD	MSI Prestige X570 Creation (E-ATX)*	overclockers.co.uk	**#193** p48	£440
STORAGE	2TB WD Black SN850	scan.co.uk	**#215** p49	£370
	Total £2,439			

UPGRADES

SWAP GRAPHICS CARD	AMD Radeon RX 6900 XT (4K gaming)	overclockers.co.uk	**#212** p44	£1,590
SWAP CPU	AMD Ryzen 9 5950X (16 cores - more multi-threaded power)	scan.co.uk	**#213** p46	£700
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	**#166** p54	£80

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

Mini PCs

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

Mini-ITX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	scan.co.uk	**#214** p18	£270
Intel Z490 (LGA1200)	Asus ROG Strix Z490-I Gaming	scan.co.uk	**#206** p40	£275
AMD B550 (AM4 budget)	Asus ROG Strix B550-I Gaming	scan.co.uk	**#206** p44	£197
AMD X570 (AM4 mid-range)	Asus ROG Strix X570-I Gaming	scan.co.uk	**#198** p20	£270

Cases

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

ATX cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Phanteks Eclipse P300 Glass	overclockers.co.uk	**#176** p28	£48
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	**#214** p26	£75
SUB-£100	be quiet! Pure Base 500DX	scan.co.uk	**#202** p39	£99
COMPACT	Fractal Design Meshify 2 Compact	cclonline.com	**#215** p20	£91
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	**#212** p45	£125
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	**#202** p44	£139
SUB-£150	Fractal Design Define 7	overclockers.co.uk	**#204** p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	**#187** p24	£200

Micro-ATX

Motherboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
Budget AMD B450 (AM4)	Asus TUF B450M-Plus Gaming	scan.co.uk	**#204** p74	£83
AMD B550 (AM4)	MSI MAG B550M Mortar	ebuyer.com	**#204** p42	£120

Cases

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET	Fractal Design Focus G Mini	scan.co.uk	**#180** p46	£40
MID-RANGE	Fractal Design Define Mini C	scan.co.uk	**#161** p26	£69

Networking

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	**#216** p52	£80
ROUTER	Asus RT-AX68U	ebuyer.com	**#216** p51	£165
MESH ROUTER	Asus AiMesh AX6100	amazon.co.uk	**#196** p54	£391
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	**#196** p58	£50
DUAL-BAY NAS BOX	Synology DS220j	box.co.uk	**#200** p22	£151
DUAL-BAY MEDIA NAS BOX	Synology DS218play	box.co.uk	**#174** p34	£207
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	**#212** p25	£281

Monitors

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

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	£178
25IN, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	#209 p57	£296
25IN, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	#212 p20	£699

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 27G2U	overclockers.co.uk	#201 p53	£230
27IN, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	scan.co.uk	#209 p60	£349
27IN, 144Hz, IPS, 2,560 X 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	#201 p54	£429
27IN, 240Hz, TN, 2,560 X 1,440, F, G	AOC AG273QZ	overclockers.co.uk	#202 p27	£480
27IN, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	#212 p21	£700

Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.5IN, 60Hz, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	#205 p43	£370
32IN, 165Hz, VA, 2,560 X 1,440, F, G	Dell S3220DGF	amazon.co.uk	#214 p28	£399
34IN, 144Hz, VA, 3,440 X 1,440, W, F, G	Cooler Master GM34-CW	ebuyer.com	#215 p30	£549
34IN, 144Hz, IPS, 3,440 X 1,440, W, F	iiyama G-Master GB3461WQSU	cclonline.com	#206 p53	£399
34IN, 144Hz, IPS, 3,440 X 1,440, W, F, G	LG UltraGear 34GN850	currys.co.uk	#206 p55	£829
38IN, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,499
35IN, 200Hz, VA, 3,440 X 1,440, W, G, HDR	Asus ROG Swift PG35VQ	cclonline.com	#198 p58	£2,751

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
27IN, 75Hz, IPS, 2,560 X 1,440, F	LG 27QN880	ebuyer.com	#210 p26	£395

Peripherals and audio

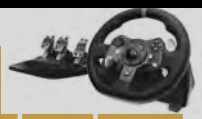
Gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
MEMBRANE	Corsair K55 RGB	amazon.co.uk	#201 p45	£50
BUDGET TKL MECHANICAL	HyperX Alloy FPS Pro	amazon.co.uk	#201 p46	£90
MECHANICAL	Corsair K68 RGB	amazon.co.uk	#181 p53	£126
OPTICAL ESPORTS	Asus ROG Strix Scope RX	overclockers.co.uk	#209 p43	£125
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	#164 p26	£185
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	#193 p56	£150
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	#214 p31	£140
LUXURY MECHANICAL	Ducky Shine 7 RGB	overclockers.co.uk	#212 p53	£175
LUXURY WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	scan.co.uk	#208 p60	£180

Gaming mice

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Corsair M55 RGB Pro	amazon.co.uk	#200 p24	£30
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	box.co.uk	#215 p57	£50
MMO	Razer Naga Trinity	amazon.co.uk	#186 p52	£70
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	#215 p59	£80
WIRELESS	Corsair Dark Core RGB Pro	amazon.co.uk	#202 p25	£95
PREMIUM WIRELESS	Razer Deathadder V2 Pro	scan.co.uk	#210 p28	£126
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	#211 p28	£48
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	#213 p22	£119

Peripherals and audio cont ...



Game controllers

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	**#202** p50	£249
GAMEPAD	Microsoft Xbox One Wireless Controller	currys.co.uk	**#191** p56	£50
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	**#207** p52	£40
FLIGHT STICK	Thrustmaster T.16000M FCS HOTAS	scan.co.uk	**#207** p56	£150

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	£63
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	**#204** p50	£160
PREMIUM WIRELESS	Razer BlackShark V2 Pro	overclockers.co.uk	**#211** p26	£170

Speakers

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

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS MULTI-DEVICE	Logitech K780	currys.co.uk	**#203** p58	£80
WIRELESS TKL MECHANICAL	Keychron K2 Version 2	keyboardco.com	**#208** p57	£84
TKL MECHANICAL	Filco Majestouch Convertible 2 Tenkeyless	keyboardco.com	**#203** p55	£140

PCs and laptops

Pre-built PC systems

CATEGORY	NAME	CPU	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
6-CORE GAMING	PC Specialist Torva Elite R	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	pcspecialist.co.uk	**#214** p36	£1,349
MINI-ITX GAMING	Chillblast Fusion Diablo	AMD Ryzen 5 5600X	AMD Radeon RX 6700 XT	chillblast.com	**#215** p34	£1,949
4K GAMING	Wired2Fire Ultimate – Powered by MSI	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3080 Ti	wired2fire.co.uk	**#216** p34	£3,250
WATER-COOLED 4K GAMING	Scan 3XS Absorbere	AMD Ryzen 9 5900X	Nvidia GeForce RTX 3080 Ti	scan.co.uk	**#209** p46	£5,289
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	**#145** p58	£14,862

Laptops

CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
RTX GAMING	Gigabyte Aorus 15G XC	Intel Core i7-10870H stock speed	Nvidia GeForce RTX 3070	15.6in 1,920 x 1,080 IPS 240Hz	overclockers.co.uk	**#213** p30	£1,899
PREMIUM RTX GAMING	Alienware m17 R4	Intel Core i9-10980HK stock speed	Nvidia GeForce RTX 3080	17.3in 1,920 x 1,080 IPS 360Hz	dell.co.uk	**#215** p32	£3,499

RICK LANE / INVERSE LOOK

LOOT GRATES

Shooters are being ruined by an obsession with loot, argues Rick Lane

Once limited to fantasy RPGs, loot has proliferated into racing games, survival games and even strategy games such as Total War: Warhammer. However, by far the most significant adoption of weapons preceded by words such as 'Rare, Epic and Legendary' is seen in shooters. Games such as Destiny, The Division, Borderlands and Outriders are geared almost entirely around picking up a constant stream of slightly better guns.

Ten years ago, the idea was novel and interesting. Borderlands' promise of a shooter with billions of different guns was an irresistible concept, but now that novelty has worn off, it's clear that looting is antithetical to good shooter design.

One of the most fundamental tenets of making a shooter fun is that every weapon in your arsenal serves a different purpose. Guns should be designed either to respond to a specific situation, or to kill or manipulate enemies in ways that are either useful or fun.

This has been true all the way back to the original Doom, which set the template. The pistol is your default and fallback weapon. The shotgun is your all-purpose death-spitter. The chaingun is for dealing with waves of enemies. The rocket launcher is for clusters of enemies. The plasma gun is for fighting tough enemies, and the BFG is for extracting yourself from particularly sticky situations.

You don't have to use them like this, of course, that's part of the fun, but every weapon is designed as a specific tool for a specific job. That's partly why picking up a new weapon in an FPS is a treasured moment, as you say, 'Ooh, what does this do?'

The idea behind 'looter' shooters is to increase this feeling by a hundredfold, giving you a constant stream of new weapons. However, most weapons you pick up in a looter-shooter are just slightly better versions of weapons you've already seen, offering only incremental stat gains that don't translate to a meaningful difference in play.

This then flattens the core experience. Your only metric for progression in a game such as Destiny is numerical – your power level, or the numbers that fall out of an enemy when you shoot them. Your experience throughout the game is fundamentally the same – you just have cooler-looking armour and do more damage. You might have special powers and spectacular effects, but the core shooting at level 1 is still more or less identical to level 50.

> Your experience is the same – you just have cooler-looking armour and do more damage

Compare this with games such as Bulletstorm or Doom Eternal, where you have maybe eight to ten weapons, each of which is designed to fight a different enemy type or kill enemies in an entirely different way. Here, your metric for progression is your own knowledge about how those weapons work, the combinations between weapons and enemies, the resulting effects and your general ability to cause ten different flavours of mayhem.

Shooters aren't about numbers. A bullet to the head is nearly always fatal, no matter your 'level'. The question is whether you can get the bullet in your enemy's head in the first place. Shooters are about movement and dynamism, and reducing the dynamic joy of an FPS to a weaponised version of Top Trumps is tragic. CPC

Rick Lane is Custom PC's games editor @Rick_Lane

Dread XP Collection: The Hunt / £9.89 incVAT

DEVELOPER Dread XP, David Szymanski et al / **PUBLISHER** Dread XP

Over the past couple of years, horror-focused gaming website Dread XP has collaborated with small and solo indie developers to produce eclectic collections of short horror games. Subtitled The Hunt, this latest collection is directed by David Szymanski, developer of the incredible retro-FPS DUSK. Offering seven short games, The Hunt is a great example of the weirder side of indie game development.

All seven games are horror experiences that involve hunting in some context, but vary wildly. The two best games are Black Relic and The Fruit. In the former, you play as a medieval monk battling hordes of cultists with a crossbow, as the theft of a dangerous relic turns your peaceful monastery into a fiery hellscape. It's a tense and gritty survival horror with vivid and crunchy pixel art.

The Fruit has a similar backwoods horror vibe, but with a completely different visual style. Set in 1884, this thoroughly modern-looking game involves sneaking and fighting through a village where the inhabitants have been corrupted by consuming a black and ichorous fruit. It blends stealth and puzzling with a fantastic hit-and-run combat system. At the forefront of the latter is a musket that must be manually reloaded after each shot, with the player pulling back the hammer and dragging the bullet into the breach with the mouse.

Most of the other games are recommendable. Axis Mundi offers an emotional, time-travelling story about a ghost hunter exorcising the souls of the dead from a Swedish shopping mall, while Uktena 64 sees you play a redneck hunting mutated animals in a twisted facsimile of a Nintendo 64 game (with remarkably accurate visual presentation).

A couple of the games are harder to recommend, particularly Rose of Meat, a surreal horror adventure that involves using a sentient leg to spawn bizarre flesh-monsters. Meanwhile, Seraphixial has a decent premise, with you playing a father searching for his missing daughter. However, it never seems to settle on one idea or theme, and some of the enemy and environment designs appear to have been thrown together in a hurry.

The Hunt's experience doesn't end with these seven games either. The games are packaged within an eighth metagame that involves exploring an abandoned Arctic research base. It's a fully fledged experience in its own right, featuring its own puzzles, story and voice acting. It's an ingenious way to tie the Collection's disparate ideas together, although sadly, the script leans towards ironic wit rather than playing it straight, which lessens the tension.

There are a few rough edges to Dread XP Collection: The Hunt, but that's understandable in a showcase for emerging talent. Even so, the ideas on show are more than worth the price of a takeaway pizza.

RICK LANE

HUNTER

+ Intriguing collection of ideas
+ Clever metagame wrapping
+ Some genuinely great games

HUNTED

− Other games not so great
− Metagame writing is odd

/ VERDICT

It's well worth spending on a tenner on this horror collection from the fringes of indie gaming, even if it's a mixed bag.

OVERALL SCORE

74%

Resident Evil Village / **£64.99** inc VAT

DEVELOPER Capcom / **PUBLISHER** Capcom

VILLAGE

+ Looks and sounds fantastic
+ Huge variety
+ Some individually great moments

HAMLET

– Generally not that scary
– Middling combat

Resident Evil Village is both a sequel to Resident Evil 7 and a spiritual successor to Resident Evil 4. It's also a grab bag of various ideas and influences taken from its own series and further afield. These disparate inspirations are carefully knitted together, then sprinkled with impressive-looking snow and some half-decent first-person combat.

In story, if not in spirit, Village is a direct continuation of 7. Players once again assume control of Ethan Winters – the gaming world's most tepid protagonist – who, after surviving the Baker Mansion in the last game, is now living in Europe with his wife Mia and new-born daughter Rose. Their precise location isn't divulged, but it appears to be towards Europe's eastern fringes, possibly Romania.

Either way, the Winters' peaceful domestic life is shattered when Rose is kidnapped. In his search for her, Ethan winds up lost in a snowbound forest. He makes his way to a local village for help, but instead finds himself hunted by a pack of werewolves known as Lycans, and four powerful monsters who are the 'children' of a local god known as Mother Miranda.

These four children are the main focus of the game. Each resides in their own domain separate from the village, which is unique in environmental style, mechanical features and general tone. Castle Dimitrescu, for example, is the most classically 'Resident Evil' of the four locations. It's a vast, opulent space where elaborate doors are locked with elaborate keys, and where zombie-like creatures lurk in the shadows. It's also the only area where Resident Evil 7's dynamic enemies make a return.

As you explore the castle, you're frequently stalked by the elegant yet vicious Lady Dimitrescu and her three pestilent daughters. Their capacity to hunt you is limited to certain areas, but their hunting of Ethan is convincing in those areas, and is by far the most interesting system in the entire game.

Castle Dimitrescu could easily have been the game's main setting, but it's only a small part of it. Elsewhere, you'll explore a

ramshackle reservoir area dotted with sinking windmills, evoking shades of HP Lovecraft's story The Shadow over Innsmouth. You'll also descend into a vast subterranean factory, filled with dark corridors prowled by fearsome undead cyborgs.

These wild swings between settings mean Village has few slow moments. Each location is a complete refresh, where the rules by which you previously played may no longer apply. Your route through the game isn't directly linear either. Completing each location unlocks more of the central village, letting you access new houses from which to gather more resources.

There aren't many proper puzzles in Village, but there are plenty of secrets to find, such as Treasures. Located in secluded corners of the world, these valuable artefacts let you step off the beaten path and explore Village's nooks and crannies. When retrieved, they can be exchanged with the game's merchant – a giant fat man known as the Duke – for new weapons, equipment and character upgrades.

Village's pace and variety lessens the impact of the game's two major flaws. Firstly, Village isn't especially scary. The bosses can be intimidating, while playing hide and seek with Lady Dimitrescu in her castle is undoubtedly tense, but none of it generates the heart-stopping dread you experience in Alien: Isolation or even the more formidable parts of Resident Evil 7.

The exception to this rule is House Beneviento, which is not only the scariest location in Village, but might be the most frightening sequence in the whole Resident Evil series. Still, one terrifying hour in a game that's approximately 12 hours long isn't much of a hit rate.

A bigger problem than the lack of scares is that Village's combat is middling at best. Feature-wise, it offers some improvements over Resident Evil 7. Ethan is nimbler this time, being able to move faster, hop over certain obstacles and even barricade doors with conveniently placed bookshelves.

He also has access to a much broader arsenal, including pistols, shotguns, sniper rifles, pipe bombs, grenade launchers and more. Yet the result, oddly, is less engaging combat. The primary issue is that common enemies, such as Lycans and zombies, aren't very threatening and they're easy to evade on all but the hardest difficulty setting.

It also has little of the spectacle seen in Resident Evil 4. Aside from popping the occasional Lycan head, your

weapons don't visually affect enemies much, while subsidiary mechanics, such as barricading rooms, only occasionally feature in a meaningful way.

As with the horror, there's only one sequence towards the end where the action kicks up a gear, and you can see the spirit of Resident Evil 4 beneath Village's skin. These issues prevent Village from competing with the best Resident Evil games, but they don't stop it from being an enjoyable adventure.

Part of the appeal is simply exploring the remarkable world Capcom has created, because Village looks incredible. Capcom's RE engine excels at creating realistic-looking environments and characters. The quality of texturing on surfaces such as skin and plastic is phenomenal.

More remarkable still is how Village delivers performance – it's the best-optimised game we've played since Doom Eternal, delivering seamless frame rates at 4K on our GeForce RTX 2080 Super. Yet unlike Eternal, Village also supports ray tracing, in what's probably the smoothest implementation of the technology yet.

The character performances are also outstanding. Village's story is typical Resident Evil shlock, but the adventure is brought to life by the acting. It's enormous fun to be around the four main villains, particularly Lady Dimitrescu and the factory owner Heisenberg. All the performances are great, even that of the genetically milquetoast Ethan Winters.

Ultimately, Village is a pacey and entertaining, if rather familiar, ghost train. It doesn't bring much new to the series and can't compete with its best entries, but its kooky characters and great variety help to compensate for that. Just bear in mind the eye-watering price tag when deciding whether to pay Village a visit.

RICK LANE

/ VERDICT

Resident Evil Village is a decent, if rather inconsistent, addition to the long-running horror series.

OVERALL SCORE

70%

NIER REPLICANT / £49.99 inc VAT

DEVELOPER Square Enix, Toylogic Inc / **PUBLISHER** Square Enix

REPLICANT

- \+ Great story and characters
- \+ Playful encounters and spectacular boss fights
- \+ Remaster improves visuals, sound and combat

REPLICAN'T

- – Side quests still rubbish
- – Main quest still involves too much repetition

Originally released in 2010, Nier was an ambitious but compromised Japanese RPG. It boasted an ambitious storyline, inventive quest design and a fascinating party of characters ranging from foul-mouthed sorceresses to talking books. However, it was let down by terrible performance and an overemphasis on repetition, and this remaster attempts to smooth out some of Nier's kinks.

Set in a future so far-flung it has reverted to medieval fantasy, Nier sees you play as a precocious teenage boy seeking a way to cure his juvenile sister of an illness known as the Scrawl. During his travels, he encounters a powerful, sentient book known as Grimoire Weiss, who may hold the key to ending the Scrawl. Unfortunately, Weiss has lost his memory, and you must help him reclaim it by locating Sealed Verses hidden throughout the game world.

The remaster improves what was already good about Nier. Its distinctive future fantasy is overhauled with crisper, more vibrant textures, while the characters have been remodelled to make them look good on a modern screen. Combat has also been tweaked to make it more impactful and engaging, bringing it closer to the sequel, Nier: Automata. Perhaps most notably, all vocal performances have been re-recorded with the original actors, bringing out the best in Nier's fantastic characters.

These improvements help to make Nier's strongest elements easier to appreciate. The main quest is a splendid adventure filled with thrilling, emotive storytelling and inventive set-pieces. Nier plays with genre, dipping its toes into puzzle-platforming, isometric RPGs and even text adventures at different points. It also features some of the best pre-Dark Souls bosses around, with imaginative designs that require strategy *and* quick reactions.

Unfortunately, the remaster is less good at fixing what was wrong with Nier. It resolves the performance issues, but the more structural problems remain. Nier places a heavy emphasis on repetition and backtracking, forcing you to revisit the same locations over and over. Sometimes these are thinly disguised versions of familiar places, but often you must revisit an existing location to complete the game's tedious side-quests, or to grind specific enemies, so you can upgrade your weapons.

Ironically, the game is better when replayed after initial completion. Not only do multiple playthroughs unlock new endings and new story content, but you progress through it much faster, giving the adventure an urgent pacing that it lacks during that first run. Your initial playthrough may take up to 20 hours, but return visits will see you finish it in half that time.

Nier is a unique specimen, a JRPG that, despite appearances, flaunts many of the genre's conventions. It's definitely worth experiencing, and this remaster is the best way to do that, but £50 is a lot for a better but not quite brilliant version of this flawed, fascinating gem.

RICK LANE

/ VERDICT

It's Nier, but not Nier enough.

OVERALL SCORE

74%

TOTALLY ACCURATE BATTLE SIMULATOR / £14.99 inc VAT

DEVELOPER Landfall / **PUBLISHER** Landfall

Totally Accurate Battle Simulator (TABS) attempts to answer pressing historical hypotheticals, such as 'who would win in a fight between pirates and Vikings, assuming everyone was drunk?' It's a lightweight strategy game where you pitch armies from various eras against each other, then watch them stagger around like a herd of fainting goats trapped on a bouncy castle.

There's a campaign mode and a sandbox mode. Both involve the same simple premise of selecting a bunch of units from a range of different historical armies – represented as googly-eyed mannequins with bodies made of rubber – then pressing Fight, whereupon those armies duke it out through a combination of simple AI and physics-powered attacks. Sandbox mode lets you field both armies how you like; the campaign mode sets you more specific battle challenges, while giving you limited funds to build armies that will overcome them.

TABS' primary objective is simply to make you laugh, and it does it well. The combination of pre-industrial weaponry and fly-by-night physics transforms TABS into a natural slapstick comedy generator. Armies flail pathetically at each other with swords, spears and scythes, often before being blown to smithereens by cannons and catapults.

TABS bolsters the humour with its creative interpretation of military history. Cavemen can field giant mammoths that will split any army in two with a well-timed charge, while the Vikings can call upon Valkyries and Shamans who can send enemies flying with devastating ice spells.

However, there's genuine strategy beneath the silliness. The campaign mode offers multiple campaigns, with the various challenges demonstrating that the outcome of a fight is dependent on the type of army you field. Ninjas with shurikens will easily overwhelm medieval squires, but will be torn to shreds by Viking Berserkers. Similarly, a few strong units will be more vulnerable to artillery than a larger force of weaker units spread across the battlefield.

It's impressive how much TABS gets out of its simple premise. The campaign mode is stuffed with quickfire missions, each of which are just complex enough to provide some challenge without ever being obstructive. Beyond this, there's a fully fledged multiplayer mode, which has a strategic silliness with strong whiffs of Worms Armageddon. TABS also features tonnes of community-created content, ranging from new challenges to whole new army-types.

Totally Accurate Battle Simulator is ideal for when you don't know what to play. It's immediate enough for you to jump in and out without a lingering sense of obligation, but it also has just enough strategic depth to facilitate longer play sessions. Instantly accessible, surprisingly compelling and more fun than a chocolate factory invaded by puppies, Totally Accurate Battle Simulator is a must-have.

RICK LANE

TABS

+ Very funny
+ Surprisingly coherent strategy
+ Good variety in challenges

STAB

– Not much here if you don't like slapstick

/ VERDICT

TABS' ridiculous pick-up-and-play strategy is a breath of fresh air.

OVERALL SCORE

89%

REALITY CHECK

Rick Lane haunts a virtual mansion and considers the HTC Vive Pro 2's chances in his latest VR roundup

REVIEW

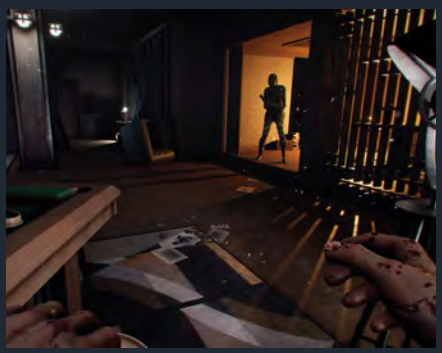
WRAITH: THE OBLIVION: AFTERLIFE / £24.99 inc VAT

DEVELOPER Fast Travel Games / **PUBLISHER** Fast Travel Games

Wraith: The Oblivion: Afterlife is a suitably spooky horror game that struggles to make the most of its VR DNA. It offers a relatively interesting horror story and some tense, evade-the-monster sequences in the vein of Alien: Isolation. However, the experience is undermined by tedious visual design and a paucity of interactive opportunities.

You assume the role of a former photographer named Ed Miller. 'Former' because you were recently killed during a disastrous séance. Trapped inside the sprawling Los Angeles mansion where the séance took place, you must find a way to escape your spiritual prison, while also investigating what exactly happened to you and the other participants.

Like most games in which you play as a ghost, Wraith immediately struggles with this premise. Indeed, you probably wouldn't realise you were a ghost if you weren't explicitly told so, as you can pick up items in your hands and throw them around, while your two main tools for interacting with the environment are 'ghost' versions of your camera and its flash. You also can't walk through walls, although you do eventually learn this ability later in the game.



The meat of Wraith involves exploring the mansion's many rooms and floors, solving simple 'fetch the item' puzzles and avoiding the menagerie of creepy spirits that prowl its corridors. Wraith is certainly tense, although it's more atmospheric than terrifying.

Most of the hunt sequences are fairly well telegraphed, while jump scares are few and far between. Whether this is a positive or a negative will largely come down to your personal tolerance for horror, but for the most part, it felt like the appropriate balance for a game that puts you in the middle of the horror.

Wraith does exhibit some more problematic issues, however. Chief among them is that it looks quite drab. The mansion isn't an especially interesting environment, with an extremely brown interior that's sparsely furnished and struggles to conceal the hardware limitations of the Quest.

The story is interesting from a plot perspective, but told in the worst possible way for VR, with you being forced to stand around and listen to lengthy conversations between spectres.

It's also not the most interactive VR game. This is partly understandable – you're playing a ghost after all. However, Wraith plays fast and loose with this concept elsewhere, and some more elaborate and tangible puzzles wouldn't have gone amiss. One neat mechanic is that you locate new objectives by stretching out your arm and pointing it like a compass, which give you a neat sensation of literally feeling out where you need to go. Unfortunately, playing with your arm stretched out for long periods of time is also quite tiring, so it's less fun in practice.

Wraith is by no means terrible. It's sufficiently spooky and the story is interesting, if rather clumsily told. However, it needs more verve in the environments and to make better use of VR's distinctive toolset. It's not quite a shadow of what it could be, but it does need more life breathing into it.

WRAITH

- \+ Spooky
- \+ Decent story premise
- \+ Couple of interesting ideas

WRATH

- – Drab environments
- – Clumsy story delivery
- – Lacking interactivity

VERDICT

Wraith: The Oblivion Afterlife is a VR ghost story that bounces between tension and tedium.

OVERALL SCORE

67%

NEWS

SNIPER ELITE VR

Rebellion has announced a VR entry into its massively popular Sniper Elite series. Sniper Elite VR sees you play as an Italian anti-fascist resistance fighter attempting to sabotage Nazi U-Boat operations on the island of Sicily.

This isn't a static arcade experience where you shoot waves of Nazis from a belltower or mountaintop. Instead, it's a fully fledged Sniper Elite campaign, offering 18 missions where you'll sneak and blast your way through an array of Nazi-occupied towns and facilities.

You'll be able to freely move around environments, and use an array of weapons such as pistols, STEN guns and grenades alongside sniper rifles. Sniper Elite VR will also include all the mechanics you'd expect from a Sniper Elite game, such as stealth, the grisly X-Ray system and shooting Nazis in the testicles.

The reason I'm particularly intrigued by Sniper Elite VR is that every VR implementation of a sniper rifle I've seen yet has been terrible (especially you, Medal of Honor: Above and Beyond). There's something about trying to hold an invisible scope to an eye covered by a giant plastic box that just doesn't work, like eating soup with a fork.

NEWS

HTC RELEASES VIVE PRO 2

HTC has released its latest commercial headset, the Vive Pro 2. The new headset represents HTC's push to regain its position as the premium headset manufacturer over Valve, with an incredibly high resolution and an equally lofty price.

The Vive Pro 2's whopping 5K resolution offers 2,448 x 2,448 per eye, compared to just 1,440 x 1,600 per eye for the Valve Index. According to HTC, the Vive Pro 2's display virtually eliminates the screen door effect that has plagued VR for years, while also minimising blurring in the periphery of the user's vision.

The Vive Pro 2 also increases the headset's field of view to 120 degrees, and includes several other features, such as a 'quick adjustable sizing dial' and '3D Spatial sound'. It also has a price tag to match, with an RRP of £659 inc VAT for the headset alone, and £1,299 inc VAT for a full kit, which includes base stations and controllers.

Between the affordability of the Oculus Quest and the innovation of the Valve Index, HTC has struggled to establish a unique selling point for its headset. The Vive Pro 2's super-high resolution certainly helps in this regard, although £1,300 is a big ask when you can get an Oculus Quest 2 for £1,000 less. CPC

BUILD YOUR DREAM PC

ANTONY LEATHER SHOWS YOU HOW TO BUILD A DAZZLING PC THAT ATTRACTS ATTENTION

If you're a regular reader of this magazine, there's a good chance you already know the basics of building a PC, especially if you read our Build a Better PC guide in our last issue. You may even know all about the latest hardware and cooling options, and have a list of components that would make it into your perfect rig.

However, if you're anything like us, a dream PC is about more than just owning the latest and greatest hardware. It's much more about making a PC that will stand out from the crowd and have your own personal touch. It's about going beyond the standard black box.

One of the most obvious and popular ways of adding in that extra visual flare is to add a custom water-cooling loop that can twist and turn as you like and be filled with all manner of colours of coolant. What's more, there are umpteen other ways you can make your PC unique.

Spray paint, spray effects, etching and vinyl details are all fantastic options for making your PC a one of a kind. In this guide, we'll be looking at each of these techniques in detail, focusing on how to do them, what tools you'll need and how to get a great finish, as well as showing you the end result.

We don't suggest aiming to do every option we mention in this feature, but instead tailor your choices to your PC. Got a glass-clad case? Consider etching or vinyl details. Got plenty of space for water-cooling components with lots of flat metal or plastic external panels? Why not install an outlandish water-cooling system and spray your case?

We'll be taking a similar approach to our feature PC this month too. We'll be covering all these steps in detail, but only focusing on a few steps to suit our chosen PC case, so you can see what can be achieved with a little knowledge of PC modding and water cooling.

WHAT SIZE OF PC?

Before we start, we need to talk about size. Whether you're spray-painting, cutting, engraving, etching or paying someone to modify your case, it's going to be easier and cheaper to deal with a small case.

You might not have considered a mini-ITX PC until now, but if you just have a graphics card and one or two hard disks with no other PCI-E devices, mini-ITX systems are ideal for modding. You'll need less paint, a smaller work area, fewer water-cooling components as well as less tubing. This is one of the best tips we can give for building a fully customised PC, especially for the first time.

While mini-ITX has many benefits, though, you'll need to weigh up other priorities, such as how many radiators you need and fan noise, as it's not always possible to get low noise and good cooling in a small case.

PICK YOUR HARDWARE CAREFULLY

Building your Dream PC should obviously involve some seriously capable hardware, but you shouldn't pick top-end components for the sake of it. In fact, this might be a really bad idea, as hotter-running components will demand more cooling and space, and could limit your case choice and modding options too.

WATER COOLING

You'll need to tread carefully when you first enter the world of water cooling, as it can go wrong. Thankfully, in many instances leaks won't actually harm your hardware, especially if you're using a low-conductivity coolant.

Of course, if you douse your CPU socket or VRMs in any water-based coolant, you're likely to fry your hardware if it's powered on. However, modern water-cooling components are designed not to leak, with plenty of fail-safes and elaborate ways to identify leaks before they happen too.

There are only a handful of key components in any water-cooling loop, and these include the waterblocks for your CPU and graphics card, as well as the radiators to cool the coolant. You'll also need tubing to connect all the parts together, and fittings to secure the tubing to your components.

Pumps, radiators, reservoirs and waterblocks all have the same-size (G1/4in) threads, and so do the fittings, so you won't find any compatibility issues here. The only differences of which you need to be aware are the different tube sizes and tube materials.

Tube sizes are stated in metric or imperial diameters, which are usually given with a smaller and larger measurement, representing the inner and outer diameters of the tubing. That's important, as the various types of fittings have locking rings, barbs or combinations of both, so you need to match the tube size – whether it's flexible or rigid tubing – to the size of the fittings.

You need to match the fittings to the type of tubing as well. Fittings for rigid tubing don't have barbs, just locking rings with O-rings that clamp down from the outside. Fittings for flexible tubing have barbs that sit inside the tube and usually have a locking ring on the outside too. They can look very similar, so make sure you get the right types of fittings for your chosen tubing.

It's simple to deal with flexible tubing, as it just needs to be cut to length with no need for bending or precise measuring. It's also far cheaper than rigid tubing.

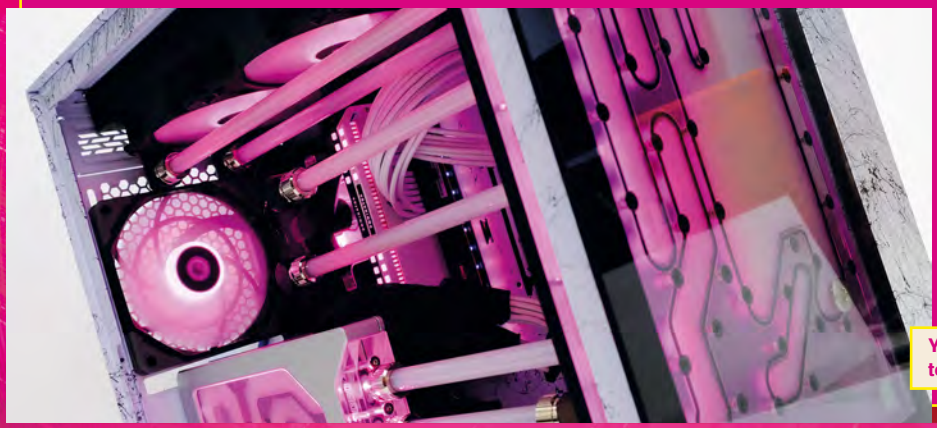
Rigid tubing can't be bent without heating it first, which requires special tools. You also need to be incredibly precise when it comes to bending and cutting to length as, unlike flexible tubing, there's no slack.

There are some tricks to avoid having to bend the tubing, though, such as using angled fittings, so you just need straight runs of tubing between each component. This can actually look neater than bent tubing too, but whether or not you like that appearance is down to your own tastes.

We're using a distro plate in our water-cooling loop, rather than a standard reservoir/pump unit

As much as real customisation can add unique qualities to your PC, water-cooling it with rigid tubing and using coloured coolant is still one of the best ways to make your PC look fantastic. The order of your components doesn't matter, unless you're using a separate pump and reservoir. This is even true when linking waterblocks, as coolant is moving so quickly that it doesn't actually absorb that much heat with each pass.

If you're using a separate pump and reservoir, you'll want to position the reservoir before the pump, in order to aid bleeding the loop of air and preventing your pump from running dry.

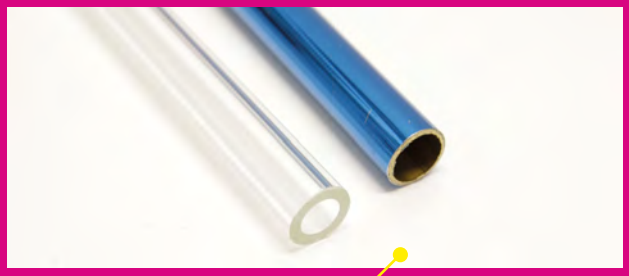


You can use angled fittings to avoid having to bend your rigid tubing at certain angles

TYPES OF TUBING

Flexible tubing comes in a variety of thicknesses and materials, such as black rubber and PVC, leaving you to just decide on the size and colour. Bigger cases look better with thicker tubing, but thinner tubing won't impact on cooling performance. Rigid tubing is even more varied. As well as different sizes of it, you also have a choice of acrylic, PETG, metal and glass tubing.

For your first rigid tubing build, we recommend using acrylic or metal, as it's easier to work with them. We also suggest avoiding PETG tubing unless you plan to install a coolant temperature probe. It's easier to bend and work with PETG than acrylic, but it can deform if the coolant gets too hot, which can cause leaks.



We recommend starting with acrylic or metal tubing for your first rigid water-cooling build

Metal tubing is usually brass with a coating, often in chrome or anodised colours. The surfaces can be quite delicate, so be very wary of handling them too much. You can't bend metal tubing yourself, but you can buy pre-bent lengths that have been coated in specific colours. This means you'll need to use those or invest in angled fittings to point them in the right direction.

PETG tubing can deform if the coolant gets too hot, which can cause leaks

RADIATORS

Generally speaking, to avoid having the need for your fans to spin up regularly and ensure your dream PC is as quiet as possible, it pays to build in some redundancy and this means adding radiator cooling power.

For every hot component you want to water-cool, you should aim to have at least a 120mm radiator and ideally a 240mm radiator, so really you need at least a 360mm radiator for a high-end GPU and CPU if you want your PC to be seen and not heard. Smaller cases will be more limited here, so you'll need to weigh up your hardware preferences with your need for a quiet-running PC.

If you decide to go down the mini-ITX route, which can make modding your case cheaper and easier, you may be limited to a pair of 240mm radiators, sometimes even less, which does hinder your options. Larger cases, though, allow for much more extensive use of radiators and water-cooling gear in general – just bear in mind that a big case will also increase your modding times and costs.

You need at least a 360mm radiator for a high-end GPU and CPU if you want your PC to be seen and not heard

Metal tube cutters cut into the metal gradually while you twist the tube

HOW TO CUT AND BEND TUBING

Every type of tubing can be cut incorrectly, which can potentially cause leaks, so knowing how to do this basic task is vital. With flexible tubing, use a tube cutter. These act like scissors, but support the tubing on both sides, ensuring you get a straight cut. Don't use a knife or standard scissors for this job, as it can be difficult to get the edges straight.

To cut metal tubing, you need, funnily enough, a metal tube cutter, which is available from most stores that sell plumbing supplies. These cut into the metal gradually while you twist the tube. The benefit here is that it creates minimal mess compared with a saw, but if the tubing is particularly thick, it can be hard on your hands.

Acrylic tubing needs to be cut with a fine saw blade and very gentle pressure, as it's brittle and breaks easily. PETG tubing is much softer and can be cut with a metal tube cutting tool, gradually cutting into it. With all types of rigid tubing, you need to use a tube reamer afterwards. This grinds the inner and out edges, removing any sharp fragments from cutting, and also bevels the edges so they pass more easily through the O-rings in the fittings.

Bending acrylic and PETG tubing is relatively easy, but you'll need a few tools in order to do it. The trick is to line up the bends with your components, while avoiding air bubbles and kinks. Start by cutting the tube to a manageable length, then insert it into a fitting.

With all types of rigid tubing, you need to use a tube reamer afterwards

Use a tube insert to prevent the tubing from kinking when you're bending it

To prevent the tubing from kinking when you're bending it, you'll need to use a tube insert. This should be inserted while coated with lubricant, such as washing up liquid. The reason for this is that, once you've bent the tubing, you'll need to remove it and the friction means it can otherwise see it get stuck. Once you've worked out where to make the first bend, use a heat gun to warm the tubing an inch from either side of the bend point. Move the gun back and forth until the tubing becomes pliable.

You now need to use a tube bender. The insert will take care of the tube's shape, but you need to bend the tube to the correct angle. You can use any smooth rounded object as a tube bender, but beware of bending too tightly, or you might get wrinkles. Try to bend on a flat surface and, if possible, use a dedicated tube bending kit as it will make your life much easier.

A dedicated tube bending kit will make your life much easier when it comes to bending acrylic or PETG tubing

USING A DISTRO PLATE

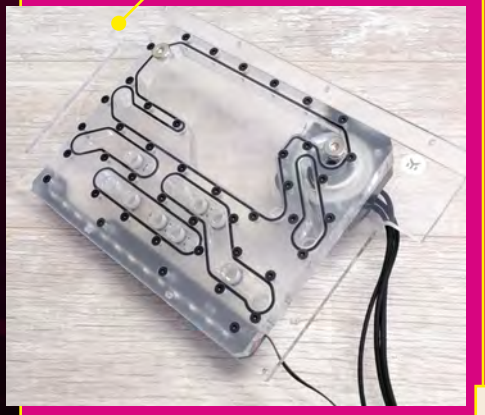
A distro plate can make dealing with rigid tubing much easier, as it can remove a lot of the bends, distributing them from pre-drilled threads to run in straight lines to your components. Most distro plates are designed specifically for a single model of case. This means they can be expensive, but also that the threaded holes are positioned so they line up exactly with your hardware.

This means you just need to run straight lines of rigid tubing to your hardware, with maybe some small tweaks here and there. As well as making your tube-routing exercise easier, a distro plate looks fantastic and really puts your coolant on show.

Even better, a distro plate can work as a reservoir, fill and drain port, as well as a pump mount, so your loop will look very clean. The one from EK we're using is made for the Lian Li O11D Mini case, and has various inlets and outlets that are generally aligned with waterblock and radiator positions in the case.

The coolant passes through channels in the plate to other inlets and outlets. This means you don't need to go through the hassle of connecting components at different angles directly, and it also reduces your bending and cutting time. In fact, you might not need to bend any tubes at all, although you'll need double the number of fittings to cater for the all the inlets and outlets on the distro plate.

On this page you can see the excellent instructions provided by EK that suggest ports to use for connecting your various components to the distro plate. This is important, as there are 16 ports on the inside of the plate, so it's worth starting with the suggested ports first and adjusting if necessary.

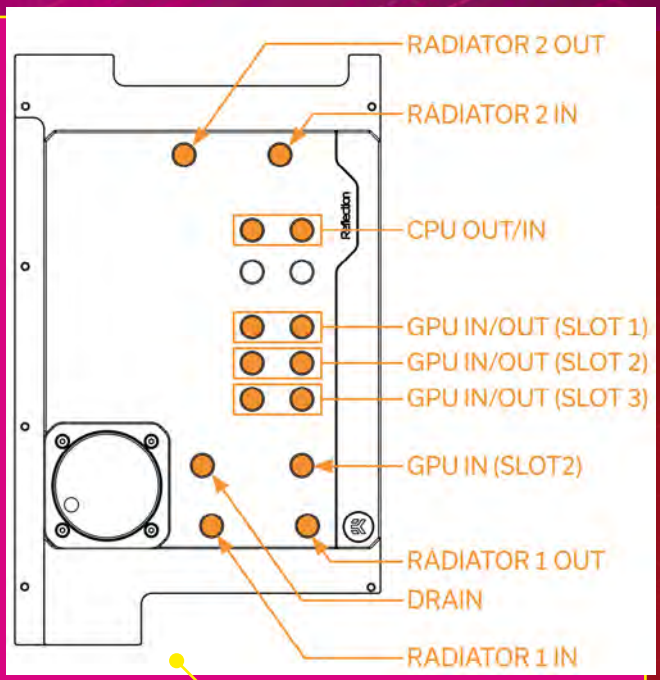


The distro plate we're using is made by EK especially for the Lian Li O11D Mini case

Of course, waterblocks and radiators have slightly different port placements between models, so they might not line up exactly. A great tool for adjusting your tube runs slightly is a rotary adjuster. This is a shallow, straight fitting, which can rotate to move the thread and tube around in a circle, so you can line it up with its opposite end.

This is useful in any circumstances, as it reduces the precision needed to align rigid tubing and can prevent you wasting bent tubes and money. It's also useful with a distro plate, as you'll be dealing with lots of straight runs, and if a tube is slightly out of alignment with a fitting at the other end of the case, bending the tubing to compensate may not be an option if the angle is too small. Thankfully, rotary adjusters are available in a range of colours including those in EK's Torque range we're using here.

The distro plate uses existing case holes to secure itself and is easy to install. Make sure you orientate it so the pump is at the bottom, as the chamber above it acts as a reservoir and should sit above the pump. The distro plate also reduces the clearance for radiators, and is designed to be used with EK's SE 360 radiator, so be sure to use the right components with it.



There are 16 ports on the inside of the plate, so it's worth starting with the suggested ports first and adjusting if necessary

A rotary adjuster is a great tool for adjusting your tube runs slightly

CUSTOM MOUNTS AND SCREW HOLES

The sheer number of off-the-shelf components available these days means it's quite easy to build a unique, or at least nearly unique, water-cooled PC. However, not every component will fit in the place you want it in every PC case, and if you case is quite old, it may not have the right mounts for components such as pumps and reservoirs. Also, while distro plates look great, tailor-made examples are only available for a small selection of cases.

Mounting pumps and reservoirs in cases used to be a pain, and drilling holes in cases used to be routine for this purpose. These days, fan-mounted combined pump and reservoirs are commonplace, so you can make use of a fan, fan mount or radiator as a universal location to secure a pump and reservoir combo unit. Occasionally, though, you might want to make use of a universal distribution plate or tube reservoir that simply can't fit into your case out of the box.

This is where you'll want to use a power drill to discretely create your own mounting holes for components. Start by making absolutely sure of the location where you want to install the reservoir, and that includes pre-planning your tubing routes. You'll also need to remove any of your PC hardware from your case before you start drilling.

After that, mark up where you need the holes to go on your case for the included mounting screws using masking tape and a pencil. In this example, our reservoir has a mounting plate we can use as a template. If the screws aren't long enough to pass through all the materials at your location, eBay and Amazon are great places to find longer ones. The manual for the components should list width of screws needed.

You'll want to use a drill bit that's slightly larger than the screw threads, so they can pass through easily, so use a ruler or digital vernier caliper to measure them. Use a drill on a medium speed setting to create the holes, and then use the included screws to secure your reservoir. Finally, clear away any metal fragments and install your hardware and water-cooling loop.

If you're not keen on drilling into your case, then alternatively you can use 3M mounting tape for components that will carry weight, such as reservoirs. As long as your component has a large enough mounting plate then the tape is more than strong enough to hold it in place. Simply cut it to size and apply it to the rear of your component. Beware, though, as it's extremely strong so if you ever need to remove the component, make sure you can get at the sides to prise it away from your case.

Mark up where you need the holes using masking tape and a pencil

Use the included screws to secure your reservoir to your new custom mounting holes

Use a drill on a medium speed setting to create the holes

As long as your component has a large mounting plate, 3M mounting tape is strong enough to hold it in place

PAINT EFFECTS

We've gone to town on our painting guide in our full guide on p102 this month, as painting is one of the more involved ways to mod your case. Here, though, we're focusing on a slightly more advanced (but still fairly easy) way to make your painted PC even more impressive.

We'll be adding a marble effect to the paint, but there are many more effects you can choose from companies such as Montana and Plastikote. The marble effect spray comes from Montana and is available in a few colours, including black, white and silver.

Start by following our guide on p102 until you get to the part where you need to apply the colour coat, which is where you'll need to make some key decisions if you want to add effects. The marble effects are best applied on top of high-contrast colours. Darker colour coats work best with the lighter marble sprays, such as white and silver. Meanwhile, the black marble effect really stands out on top of colours that are punchy and vivid – bright orange, purple and green for example.

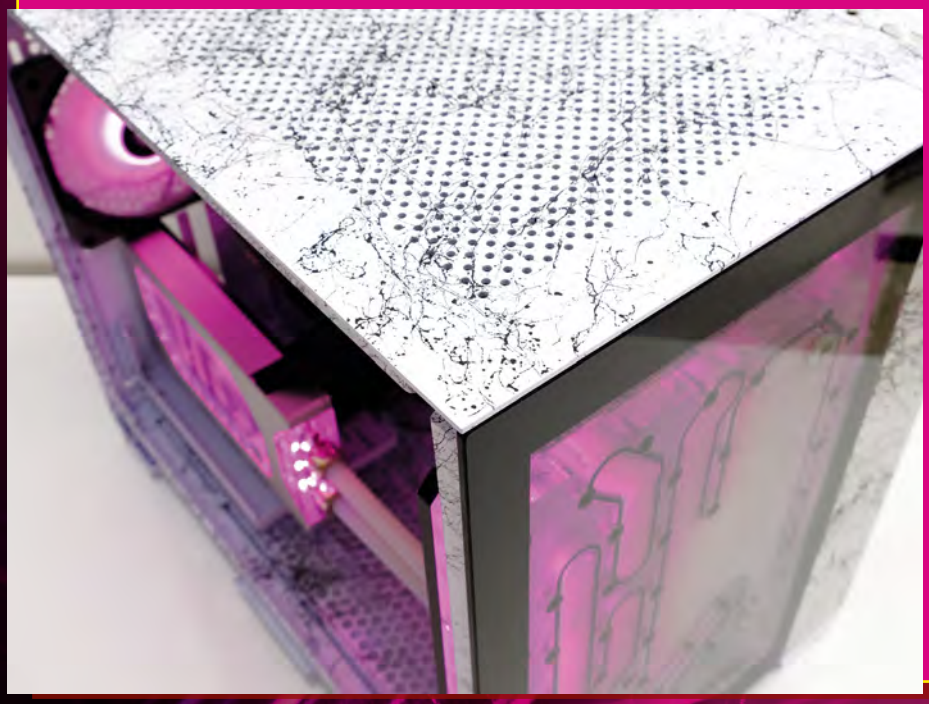
You need to pick the right colour for this to work, even if it affects the rest of your colour scheme. Due to the thickness of the strands, you'll also need a significant amount of clear coat. Instead of two or three layers, you'll need ten to 15 layers or more to cover the marble strands, so consider this before you start.

Apply the colour coat according to our main guide and allow it to dry for an hour before applying the marble coat. After that, crack open your marble effect spray and shake it well. Give this a test on an old piece of cardboard first to gauge how fast you need move the can to get a good marble effect. The effect can change depending on weather conditions, so make good use of your practising on the day.

You won't be able to remove the marble effect once it's on the surface, as it's sticky, so you need to get it right the first time. You'll need to hold the can at least 40cm away from the surface. You're aiming to have a good distance between the strands, and for them not to bunch up or cross over each other too much.

To get a good marble effect, you'll want to concentrate on one direction, then overlay some strands at 90 degrees to that direction. It will likely take only a few seconds to apply all the marble effect you need. Make sure you go over the edges and extend onto your work surface.

This will allow you to fill the whole panel with the marble effect – if you aim to stop at the edges, you're likely to leave large, unnatural-looking gaps. The best tip we can give here is not to apply too much marble effect ,and not to overlay too many strands. Every layer and crossover you add makes the marble effect



Aim to have a good distance between the strands, and for them not to bunch up or cross over each other too much

You'll want to apply many layers of clear coat, in order to cover the marble strands beneath it

2K clear sprays dry faster and harder so you'll be able to get polishing after 24 hours

Polishing is where the magic happens, as the clear surface will become glossy and reflective

higher, which can result in the surface needing a huge amount of clear coat if it's too high.

Don't be tempted to sand down the marble effect to thin it out, as this will dislodge it and ruin the marble pattern. You also won't be able to sand it once a few layers of clear coat have been applied, if you're hoping to need less clear coat, so it's really important to keep the marble effect layers to a minimum.

It's easy to remove the stray excess though – it will just brush away, but avoid pulling the strands, as it's easy to pull them off the paint. The strands will dry very quickly, so once you've removed the excess, it's time to apply the clear coat. This isn't essential, as the marble sticks like paint, but a clear coat will help to protect it and the paint beneath.

The clear coat can be applied in the same way as our guide on p102, but here, you'll want to apply many more layers so they cover the marble strands beneath. As a result, this will probably take a couple of days.

On a flat panel, you can apply the clear coat liberally and at close range in fairly thick layers, but only if you can lay the panel flat.

This will save a lot of time compared with suspending the panel, where you have to be really careful to avoid the spray running before it dries. Gradually build up the layers, allowing each one to dry for 30 minutes before applying the next, but ensure all the marble effect strands are hidden beneath an even layer of clear coat.

It's important to buff and polish the final coat, and you can see how to do this in our guide on p102. Standard clear coat should be left according to the manufacturer's suggested drying time, but you usually need to leave it for at least seven days before it can be polished. Meanwhile, 2K clear sprays dry faster and harder so you'll be able to get polishing after 24 hours. Polishing is where the magic happens, as the clear surface will become glossy and reflective, giving real depth to the marble strands beneath it.

CUSTOM RADIATOR MOUNTS

Ever wanted to put a radiator in a place where your case doesn't have a mount? Do you want to add fan blow holes to boost cooling or expand a water-cooling system? Custom fan mounts are one of the best ways to make an otherwise stock case look unique, and have the benefit of improving cooling and boosting water-cooling potential too.

You might want to perform other cutting tasks too, and the same rules apply here for any case-cutting jobs. As always, don't start cutting with your hardware installed in the case. It needs to be removed first, and your case cleaned before you reinstall it.

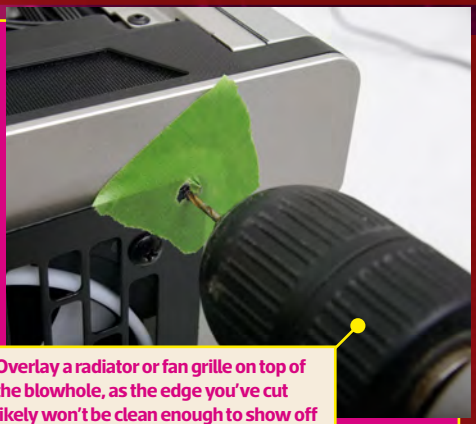
If possible, remove the panel you intend to cut, but if this involves drilling out rivets, it's possible to do most cutting with the sections still in place. Either way, make sure there are no exposed case fittings and ports nearby – remove them or mask them to protect them from metal dust and fragments.

If you're creating a radiator blowhole, then you'll ideally want the radiator to hand so you can test-fit it in the case. This way, you can make sure it won't foul any other parts, and you can also use it as a template to mark your cutting lines onto masking tape, which will also help to protect the panel.

Cutting metal is never an easy task with basic tools and dealing with steel can be especially tough. You'll also generate dust, so be sure to wear a mask and protective goggles. A mini circular saw (such as the Dremel DSM20) is a fantastic tool for this work, and will save a huge amount of time compared with a standard Dremel rotary tool. A jigsaw is another option and, failing that, you can cut some fairly large holes using a Dremel and steel reinforced cutting disc, but it might take you a while.

You can use your radiator as a template to mark your cutting lines onto masking tape on the panel

A mini circular saw, such as the Dremel DSM20, is a fantastic tool for cutting metal



Overlay a radiator or fan grille on top of the blowhole, as the edge you've cut likely won't be clean enough to show off

Our finished custom radiator mount at the front of the case, complete with grille

Once you're done, you'll need to use a metal file to remove any sharp edges and fragments from the edges. With radiator blowholes it's usually best to overlay a radiator or fan grille on top of the blowhole, as the edge you've cut likely won't be clean enough to show off, unless you get it machine-cut by professionals.

To do this, place the grille over the panel and tape it into position, before using a pencil to mark the positions of the mounting holes. Finally, install your fans, radiator and grille into the panel and replace it in your case.

ENLIST THE PROS

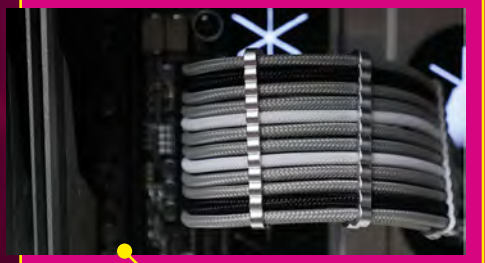
There are some tasks that are best left to the professionals, either because they will simply achieve a better result, or because doing so will save you a huge amount of time.

CUSTOM CABLES

You can create your own PSU cables by hand, picking the colours and lengths to suit your build and crimping them for the connectors, but this can be hugely time-consuming. Thankfully, you have a couple of alternative options at your disposal. Firstly, manufacturers usually offer custom cable kits with their PSUs in a variety of colours, which often include cable combs that space out the cables evenly for a super-neat look.

The next step is to enlist of companies such as CableMod (**cablemod.com**), which offer both pre-made cable kits and the ability to custom-design your own cables, where you can specify the length of the cables and even the colours of individual strands.

Specifying the length can be useful too. A lot of cables come with slack once you've installed them, so you end up spending more time tidying them and tying them down than necessary, and the slack can look unsightly. With mini-ITX cases, you generally need shorter cables too, and many SFX (small) PSUs are equipped with shorter cables for that reason. Also, many small cases have ATX PSU mounts, and these PSUs will come with cables that are far longer than needed.



Cable combs space out your power cables evenly for a super-neat look

CUSTOM CUTS

It's the same for case modifications. A recent PC we built required vents cutting into a case. We estimated that it would have taken several days to at least to cut the pattern by hand, and with unpredictable results. Instead, we turned to a local water jet cutting service to get the job done and it was surprisingly easy too.

We created the design in Microsoft Paint, sent it over to be adjusted, gave the firm the dimensions and locations to be cut and, once we arrived at the cutting place, it was done in 20 minutes. To do this, start by removing all the fittings from the case sections involved. Taking photos will also help the company assess if its team can work with it and provide a quote.

The benefit is that you get access to serious machinery, in this case a water-cutting machine that costs tens of thousands of pounds. Getting the measurements right first time is essential, so pay attention to the details and check exactly what you're getting for your money, as costs can mount.

The end result was spectacular and absolutely worth the couple of hundred pounds it cost, given it would have taken us many days of filing and cutting to do half as good a job. The companies likely won't do any finishing, so you'll need to do this yourself. Use metal finger files to smooth the edges, and sand the top of the sections with 800-grit sand paper if you intend to paint them.

You can get different lengths of cables, as well as different-coloured individual strands

We turned to a local water jet cutting service to get some vents cut into a case

The end result was spectacular and absolutely worth a couple of hundred quid

Scan's 3XS Custom Shop can undertake all-manner of tasks with input from you on designs, colours and materials

ALL-OUT PROFESSIONAL CUSTOM BUILDS

For an all-out customisation service, including 3D printing, cutting and painting, Scan offers its 3XS Custom Shop (**scan.co.uk/3xs/custom-shop**), where professionals can undertake all manner of tasks with input from you on designs, colours and materials. The service includes cutting services as well as part fabrication using 3D printing.

The Scan Custom Shop team has also undertaken personal projects for celebrities and streamers. What's more, Scan has the credentials to back up this service with an enviable history in our own Dream PC Labs tests in the past.

ETCHING

Etching involves using a liquid solution that eats into the surface of glass to create a frosted look, requiring you to protect the parts of the glass you want to remain as they were. This means using masking sheet and, for this reason, a cutting machine is highly recommended if you want to save time or deal with detailed designs. However, you can alternatively use a scalpel and manually cut out your masking for simpler designs.

Start by cleaning your tempered glass panel thoroughly using warm soapy water, then rinse it and wipe it clean. To create your mask using a cutting machine, you'll need to use adhesive masking sheet, which is usually available in A4 sheets or rolls. You can create your image by uploading an image file into the cutting machine's software – we've used the Flight Simulator logo as an example.

Use the software to cut into the masking, enabling you to peel away sections you want to expose to the etching cream. Use a credit card or spatula to firmly press the masking sheet onto the glass when you're done, in order to prevent the cream seeping underneath the sheet.

Finally, apply the etching cream using a brush and leave it on the glass for the specified amount of time, but no more. If you accidentally get some anywhere else, remove it immediately with a damp cloth.

Once the cream has had its allotted time, rinse it off thoroughly using warm water and a sponge, but leave the masking in place.

Now dry off the panel and remove the masking. It might look a little uneven at first, but water can stick in the pattern for a few minutes and will eventually dry.

When your masking sheet has been cut out, firmly press it onto the glass

Apply the etching cream using a brush and leave it on the glass for the specified amount of time

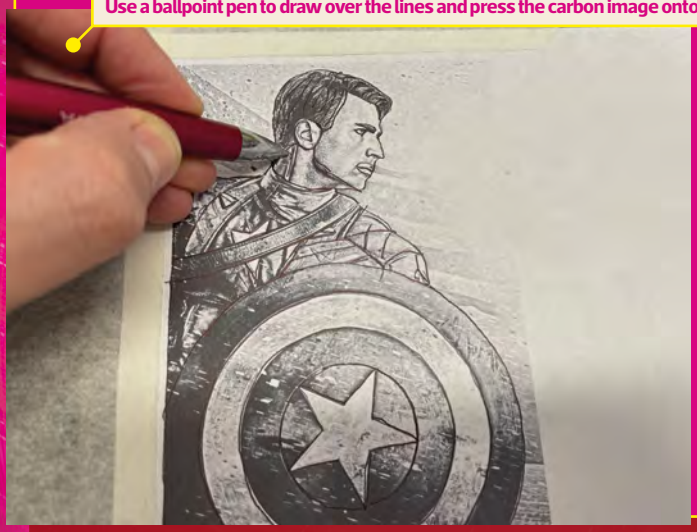
ENGRAVING

Engraving is a fun and easy way to customise your PC, with its only real drawbacks being its requirement for a steady hand, plenty of time, a rotary tool with appropriate attachments and an appropriate work surface. If your case is covered in fragile glass then you'll need to consider etching instead, but acrylic or metal panels are ideal surfaces for engraving.

You can either engrave freehand using grinding tips for a rotary tool, or trace out your design using carbon copy paper overlaid by an image of your choice. A trick here is to head to an image editing program, such as Paint.net, convert it to black and white and then invert the colours. This will show you how your image might look once it's engraved, and also highlight the areas you need trace out into the carbon copy paper.

The engraving tips come in a few different shapes and sizes, but the key ones have small and large ball tips that you can use to trace outlines and fill in large areas respectively. They're readily available for most rotary tools and cheap to buy. Start by tracing the key lines in your image

Use a ballpoint pen to draw over the lines and press the carbon image onto your case



Trace the outlines of the design using a medium speed setting on your rotary tool

onto the carbon copy paper, with it stuck to your case with masking tape. Use a ballpoint pen to draw over the lines as this will press the carbon image onto your case.

Once you're done, remove the papers, but be careful not to smudge the carbon details left behind. It's easier to work with acrylic here, as you can just place your image underneath it and trace the design as you see it.

Now, using a medium speed setting on your rotary tool, trace the outlines of the design, first using sweeping motions and holding the tip at an angle, so it's not pointing straight down. Go over the areas a second time if necessary.

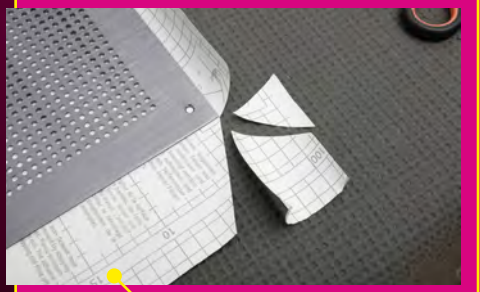
You can then switch to a rounded tip for larger areas, taking care not to press too hard. It's better to go over each area two or three times with lighter pressures, as this will result in a more even surface than pressing too hard at the start. The engraving will create dust, but it should settle locally and it's easy to clean away. Use a damp cloth to clean your engraving area.

It's a good idea to practise first on a hidden area of your case, as all cases have different paint thicknesses and will require different pressure to cut through to the metal. Acrylic can be purchased online in small sections quite cheaply, so if you're dealing with a clear side panel window, practise on some spare acrylic first, and even try engraving your whole design a few times until you're confident.

Use a damp cloth to clean your engraving area

VINYL

An easier way to add a splash of colour or transform the exterior of your case compared to painting is to use adhesive vinyl. You can add smaller details or completely cover your PC, and you only need a pair of scissors or a scalpel to get started. Of course, for real eye-popping details and complicated designs, a vinyl cutter is a fantastic tool, as you can use transfer paper to lift your design out of a machine-cut sheet of vinyl and press it onto your PC case.



Cut vinyl wrap to size with an inch overlap, so you can bend over the corners

Transfer paper sticks to the cut-outs, enabling you to easily lift them off the sheet in one go

Covering the exterior of your PC is fairly simple. Get a sheet of adhesive vinyl (Amazon and eBay are great sources), cut it to size with an inch overlap so you can bend over the corners, and then use a credit card or similar piece of plastic to press it onto the surface in sweeping motions, smoothing out any air bubbles.

With a vinyl cutter, your pattern will be cut out of a sheet of adhesive vinyl with backing paper. The cutting machine has a blade that cuts through the coloured vinyl but not through the vinyl's backing paper, so once it's finished cutting, you can lift the sections it's cut out off the backing paper, leaving the vinyl you don't want behind.

You can then transfer the cut-out pieces to the case by hand, but it's better to use transfer paper, which is tacky on one side. Transfer paper sticks to the cut-outs, enabling you to easily lift them off the sheet in one go, and transfer them all to your case at the same time.

You can place the vinyl on paint or on top of other vinyl, such as this black vinyl on top of a yellow vinyl wrap

It's simple and very effective ,and you can place the vinyl on paint or on top of other vinyl, as you can see below with black text on top of a yellow wrap. Press it firmly onto the surface with a credit card and then lift off he transfer paper off at an acute angle to separate the transfer paper from the vinyl. If any sections of the vinyl stay behind, roll the transfer sheet back over them and use a scalpel if necessary to press them back on, so they stay within the pattern.

You can even cover a whole case with a large enough sheet, which this can be easier than spray painting. Occasionally, the edges can lift over time as the adhesive dries, but it's simple to fix, either by applying glue or recutting an identical piece and reapplying it.

We used a vinyl cutter to create a mask for the etching cream in the earlier section, and this can work for paint masking too. Vinyl masking sheet is a fantastic material for both painting and etching, as you can create neat, complex masks in a fraction of the time it would take to create by hand.

We used a vinyl cutter to create a mask for the etching cream

RGB LIGHTING

Even if you're not a fan of super-bright rainbow lighting effects, illuminating your PC with coloured lighting can add flair while still looking tasteful. If you're going for a specific colour scheme, RGB lighting can complement it, and it's usually easy to combine components into groups so the lighting is easy to manage, even if you're dealing with lighting tech from multiple manufacturers.

Most waterblocks come with RGB lighting, which is often powered using 3-pin digital RGB headers. As such, you'll need to use your motherboard's software or another application that can tie your motherboard's control to its own software, such as Corsair's iCUE.

Manufacturers such as Phanteks offer a huge range of RGB components, and while they use proprietary connectors to hook up to each other and Phanteks' own controllers, the company does ship them with 3-pin and 4-pin adaptors, so you can connect them to other RGB ecosystems. With our PC this month, the fans, waterblocks and other components were so vivid that there wasn't a need to add dedicated lighting strips, so you may not need them either.

Placement of the lighting is important, as you need to decide if you want the LEDs to be visible or if you just want to illuminate your hardware. If they're going to be visible, check if you'll be able to see them when you're actually using your PC. They might look great for a few hours, but they can be annoying if they're in your face all the time.

The rear of the case is a great location for illuminating your hardware with LED strips, although rear fan mounts can interfere with them. If the interior of your case is white, this colour will respond better to the lighting as it's more reflective, while black interiors tend to put more focus on how the lighting illuminates your hardware.

Remember that RGB lighting will add considerably more cables to your case, so you'll need to carefully consider whether the extra spaghetti is worth it, especially if you're using a small case with little cable-tidying space. **CPC**

RGB fans really help to liven up an otherwise dull-looking radiator

The lighting on our fans, waterblocks and other components were so vivid that we didn't need to add dedicated lighting strips

The rear of the case is a great location for illuminating your hardware with LED strips

HOME NETWORKING

EDWARD CHESTER COMPARES THE LATEST HOME NETWORKING OPTIONS TO FIND OUT WHICH ONES WILL BEST SUIT YOUR NEEDS

As Wi-Fi has steadily improved, and especially with the advent of mesh Wi-Fi systems such as the Netgear Orbi or Google Wi-Fi, it's easy to think that all other forms of home networking are pointless relics of a bygone era. It's a wireless world now, so why would you go back? However, in reality, the situation isn't that simple.

For a start, mesh Wi-Fi systems can get expensive pretty quickly, with each node generally setting you back at least £100. If you want to stretch your network all the way to a new home office at the bottom of a garden, you need at least three units to get a reliable, speedy connection, even in a modest two or three-bedroom house.

All forms of Wi-Fi are also prone to interference that can either slow down or interrupt your connection; if you're relying on it for crucial tasks, such as online gaming, this can be a matter of virtual life or death. This tends to be less of a concern up close, but as you move towards the edge of the range of any given Wi-Fi access point, or start daisy-chaining together multiple mesh nodes, there can be a significant reduction in the responsiveness of the whole system.

Obvious alternatives have been around for a while, in the form of running a big long Ethernet connection to your PC or using powerline technology that can run a network connection over your home's existing mains power cables. But how do these systems now compare with the latest mesh networks or standalone routers? That's what we're here to find out.

The test setup

To really dig down into just what sort of performance and ease of use the latest home networking systems offer, we set up a simple test scenario. In a three-bedroom, two-storey brick-built house with a 20m long garden, we decided to see how each technology we used performed at various points throughout the home and out into the garden. There isn't quite a home office at the bottom of the garden yet, but a few sunny days allowed for some al fresco testing.

As with our router Labs (see p50), we chose three key test locations for our network systems. These consisted of a sofa 2m from the home's router in the front, ground-floor room of the house, a rear first-floor bedroom approximately 5m diagonally back from the router, and a spot halfway down the garden, about 15m back from the router.

The host device of each option was plugged into a router next to the Internet connection in the front downstairs room of the house, with a PC attached via a Gigabit Ethernet connection to the router. A laptop was then either connected with a USB/Ethernet dongle to any wired network setups, or its internal AX1500 Wi-Fi card was used to connect to any Wi-Fi signal. We then tested for connection speed using LAN Speed Test and for ping response with **netmeter.co.uk/ping-test**

The former works by running a server app on the PC, which exchanges data with a client app running on the laptop. You can tailor the test to whatever file size and number of test runs you like. For each run of the test, we set the app to send three packets of data varying between 5MB and 50MB, depending on the speed of the test – there was no point in waiting five minutes for a 50MB run to complete on a slow connection when the result is the same as waiting 30 seconds using 5MB files.

The ping test simply pings a reliably quick nearby server, which in our case was registered as being in Manchester – you can also manually pick the server, but we found the Manchester option reliably fast. While this also tested the ping of the Internet connection, which we weren't explicitly testing, there was sufficient variance in the ping due to the local network connection being used that we still obtained clear results.

Ethernet

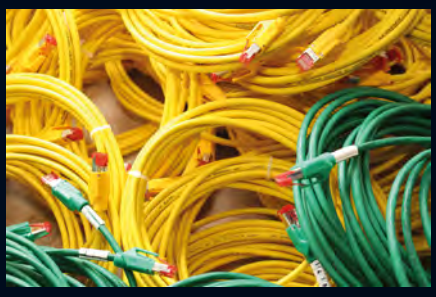
With our test setup established, it was time to start putting our home networking systems to the test, starting with the granddaddy of them all (at least as far as common modern options goes) – Ethernet.

As we've seen from our router Labs test, you can expect to get at least four Ethernet ports on a modern router (although mesh router nodes tend to only have one), all of which will be able to hit speeds of 1Gb/sec. Network switches with many more ports are also readily and cheaply available, making it very easy to provide a dedicated wired connection to as many devices as you need.

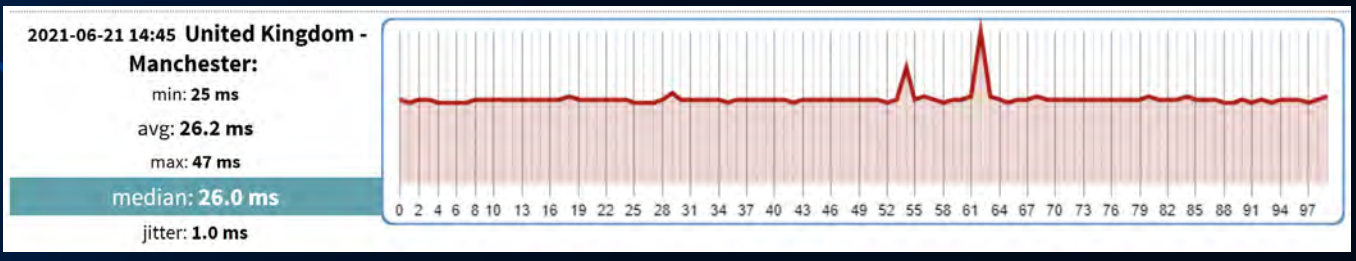
What's more, the maximum rated length (to still achieve full speed) for Ethernet is 100m, so in practical terms, you'll get full Gigabit speeds to your devices wherever they're located in your home.

You can even crank up the connection speed by a notch, as many modern motherboards come with even faster 2.5Gb/sec Ethernet, although as our Labs test has again proven, 2.5Gb/sec Ethernet isn't commonly supported by mainstream routers yet, so you'll need to shop around to find devices that can deliver the extra speed.

You can also stretch to 5Gb/sec or even 10Gb/sec Ethernet. However, these two options require more expensive, higher-quality cabling. Gigabit and 2.5Gb/sec Ethernet will work on Category 5e cabling, so if you already have a Cat 5e cable network



Cat 6a Ethernet cable can hit 10 Gigabit speeds but it's an expensive option



The ping test simply pings a reliably quick nearby server, which in our case was registered as being in Manchester

The Asus RT-A68U is a great example of a powerful modern router, but it still has range limitations

in your home, you can upgrade your Gigabit gear without changing your cabling.

However, 5Gb/sec Ethernet requires Category 6 and 10Gb/sec requires Category 6a, with each type tending to be more expensive than the last.

Any switches or other equipment for distributing the signal are more expensive than standard Gigabit equipment too. An 8-port Gigabit switch can be bought for £30, while an eight-port 10Gb/sec switch will set you back £300. It's for these many reasons that we stuck with Gigabit Ethernet for our testing, as it's the most readily available, affordable and realistic option at the moment.

Whichever standard of Ethernet you choose, the tricky bit comes from the need to have a load of wires strewn around your home. Even now, most new homes aren't built with this most common and universal connection built into the wiring system alongside the mains power, meaning you'll have to either retro-fit the cable, lifting floorboards and chasing cables into walls, or have a load of unsightly cables tacked round your skirting boards and door frames.

The most realistic option for many households will be to have a single Ethernet connection from a front room router through to another section of the house, such as an upstairs office or down the garden to an outside office. A single long run is easier to hide away than a connection for every room, and you can then attach another more convenient networking system at the far end.

It's also common to run a single short section of cable to a switch behind your living room AV setup, so you can then run cables to your TV and games consoles, all neatly hidden behind the TV cabinet.

So just how fast and reliable is Ethernet? Well, in our tests we obtained identical results in all three test locations (margin of error notwithstanding), proving the point that for home use the performance of Ethernet doesn't deteriorate over long distances, which categorically can't be said of most alternatives.

What's more, the Gigabit rating attached to Ethernet actually just about holds up in real-world transfer tests. We measured speeds of 816Mb/sec upload and 907Mb/sec download. That's still a little way off Gigabit, but it's far closer to the claimed speeds than most other alternatives reach.

Our ping test also proved impressive, with an 11ms average and just 15ms maximum. In other words, not only will your ping generally be low in games, but it will be reliably so.

While the Linksys MR9600 has a claimed maximum 9.6Gb/sec speed, a typical laptop is only likely to have a 1.5Gb/sec Wi-Fi card to connect to it

It would take a catastrophic failure of your internet connection, the server or your hardware to lose your connection.

Wi-Fi

Ethernet's performance numbers might be brilliant, but there's no getting around its sheer inconvenience for most homes, which brings us right back to our original option: Wi-Fi. Do the latest technologies largely eliminate the problems we outlined earlier, or is it truly a waste of time for mission-critical connections such as gaming PCs?

Unlike Ethernet, where Gigabit hardware has been around for decades and is now ubiquitous, there's multitude of different Wi-Fi standards – the latest Wi-Fi 6 standard used by the routers in our Labs test has only been around for a couple of years and has been offered in umpteen variants. Indeed, even in our Labs test, no two of the routers sported quite the same Wi-Fi configuration. Meanwhile, if you're still rocking the router provided by your ISP, it probably uses the older Wi-Fi 5 standard at best.

The latest Wi-Fi 6 standard (which used to be known as 802.11ax) can theoretically hit maximum throughput speeds of a massive 9.6Gb/sec, split across its two frequency bands of 2.4GHz and 5GHz. Meanwhile, Wi-Fi 5 maxed out at 3.5Gb/sec. Those numbers are spectacularly far from reality in most situations, though, for several reasons.

The first is that, while the likes of the Linksys MR9600 (see p53) can claim to provide that maximum 9.6Gb/sec, your typical laptop is likely to have a 1.5Gb/sec (AX1500) Wi-Fi card to connect to it, while even a dedicated PC expansion card, such as the TP-Link Archer TX3000 (see Issue 196, p58) maxes out at 3Gb/sec. Generally, the only way you'll get that maximum connection speed is between

Mesh Wi-Fi systems, such as the Asus ZenWiFi XD6, offer a near-effortless and reliable way to extend a Wi-Fi network

two routers, as used in Netgear's top-end Orbi RBK852 mesh system.

Instead, when it comes to client devices, the idea with the latest Wi-Fi standards is that not only can routers deliver these admittedly still impressive speeds to individual devices, but they can also maintain good performance for multiple devices at once. Indeed, one of the key technologies of Wi-Fi 6 is a fundamentally better way of splitting up data packets (called OFDMA), so that certain client devices can't clog up the network, improving the responsiveness for all clients.

However, not only is most client hardware not rated to achieve these theoretical top speeds, but real-world performance also simply doesn't match those numbers. Even with the latest client hardware connected to the fastest Wi-Fi 6 routers available, real-world throughput will struggle to surpass Gigabit speeds.

It's for this reason that we didn't concentrate on maximum throughput speed for our Wi-Fi tests, but instead focused on the performance of standard hardware at realistic locations, as outlined in our test setup.

For comparison, we chose two routers. The first was the Asus RT-68U, which delivered the most consistent overall Wi-Fi performance in our Labs test (despite having among the slowest theoretical Wi-Fi speed rating of just AX2700). The second was a typical example of an ISP-provided router here in the UK, the Plusnet Hub One. It supports up to Wi-Fi 5 (AC), with a 2x2 2.4GHz band and 3x3 5GHz band, for a maximum total throughput of 2,332Mb/sec (600Mb/sec + 1,732Mb/sec).

The Plusnet router delivered just the sort of modest maximum speeds we'd expect from an older, ISP-provided router in our close range tests. However, its results in the region of 200Mb/sec are still more than ample for several 4K video streams (approximately 50Mb/sec each).

What's more, the ping results were perfectly respectable. You're still looking at nearly double that of Ethernet, but its average ping of 20ms is more than good enough for online gaming.

However, with the maximum pings starting to hit over 50ms, there are signs of the added delay that Wi-Fi can introduce.

Those figures were obtained using the faster 5GHz band, and switching to 2.4GHz, saw the maximum speed drop to just 65Mb/sec and the average ping hit 36ms. This was a trend we saw in our router Labs too, with the slower 2.4GHz band not just offering slower maximum bandwidth but consistently delivering higher pings. If you're looking to get the most from you Wi-Fi connection for any task where ping counts, be sure to connect over a 5GHz channel.

Top-end mesh systems such as the Netgear Orbi RBK852 offer blistering speeds but are very expensive

As we moved to our second test location, the Hub One's speeds plummeted to a level where it wouldn't be able to deliver even a single 4K video stream. Pings also shot up to an average of 45ms on the 5GHz band and 70ms on the 2.4GHz band, with maximums hitting over 500ms. Gaming in this scenario – having a more powerful PC Wi-Fi card notwithstanding – would be a struggle.

When it came to test location 3, the Hub One simply wasn't even visible to our laptop, let alone able to maintain a consistent connection. The picture was considerably rosier for the Asus RT-68U though. At short range on its 5GHz band, it delivered nearly 500Mb/sec and its average ping was just 13ms, with a maximum of 15ms. Its 2.4GHz performance was solid too.

More importantly, it still largely provided adequate performance at medium range. Its maximum throughput at 5GHz was nearly 200Mb/sec, with an average ping of 21ms and a maximum of 125ms (some of the routers in our Labs test hit as maximum ping as low as 33ms in this test). The 2.4GHz band was still usable too, both in terms of ping and throughput.

ETHERNET'S PERFORMANCE NUMBERS MIGHT BE BRILLIANT, BUT THERE'S NO GETTING AROUND ITS SHEER INCONVENIENCE FOR MOST HOMES

At our longest-range test, though, we really see the limitations of a single, albeit powerful, router. The AX68U still delivered usable signals at this range, with the speed maxing out at 46Mb/sec and pings even being just about manageable, at least on the 5GHz band. However, the signal wasn't entirely reliable, with occasional significant pauses and interruptions. We wouldn't consider this

Even our aging Devolo 9225 powerline kit proved fast and reliable at long range

connection viable for gaming or streaming video – occasional emails and web browsing would be your limit.

Mesh Wi-Fi

If one router isn't good enough to cover the furthest reaches of your home, there are currently two main options for solving that problem without resorting to laying extra cable. The first is the classic Wi-Fi extender. These devices will simply connect to the signal from your router and then project their own Wi-Fi signal to which you can connect.

They can do the job at a push but tend to have a couple of key problems. The first is that the more affordable units – under £100 – often just aren't very fast or powerful. You might get one extra room's worth of extended range but at greatly reduced speeds and increased pings.

The second is that basic units don't tend to have a simple setup when it comes to managing the SSIDs (the name of your network as it shows up on devices) and how devices move between your router's signal and the extender's signal.

You'll either have to set up different SSIDs for the extender, so you might end up with a total of four Wi-Fi signals spread around your home (one for each band, for the router and extender), or you can set the router and extender to all use the same SSID. If you do this, however, your client device may struggle to actually connect to the best signal – your laptop might insist on trying to connect to the router's signal when the extender has the stronger signal, or vice versa.

Meanwhile, the more sophisticated extenders, which that can often tap into mesh Wi-Fi networks as outlined below, can be expensive. The Netgear EAX20 that integrates with the company's Orbi mesh system, for example, costs £200 inc VAT.

THE NODES OF A MESH NETWORK ONLY PRESENT A SINGLE SSID TO YOUR CLIENT DEVICES, SO YOU NEVER NEED TO HOP BETWEEN SIGNALS

Instead, the far better solution to this problem, generally, is to opt for a mesh Wi-Fi system. These use the same principle of picking up an existing Wi-Fi signal and extending it, but take a much more proactive, sophisticated approach to managing which signal a client device uses for its connection.

They ensure the fastest route is taken for any given client device or load balance across multiple mesh nodes (routers) if the network is in high demand, all while only presenting a single SSID to your client devices, so you never need to hop between signals. Occasionally, you might end up on a non-ideal signal path, but in our experience they're pretty reliable.

Each of the major router manufacturers now has its own mesh system – Netgear Orbi, Linksy Velop, TP-Link Deco and more – while devices such as Google Wi-Fi, BT Whole Home Wi-Fi and Amazon Eero use the same basic principle. Some systems use dedicated routers, and you can then buy either other routers or just extenders that mesh into the same system (such as Netgear), or some just use the same small nodes for all purposes.

Whichever setup you choose, according to our previous testing, they all tend to deliver reliably on their promise of effortless and speedy range extension. However, there are a few downsides. The first is that they tend not to deliver the utmost in peak performance, depending on the system you use.

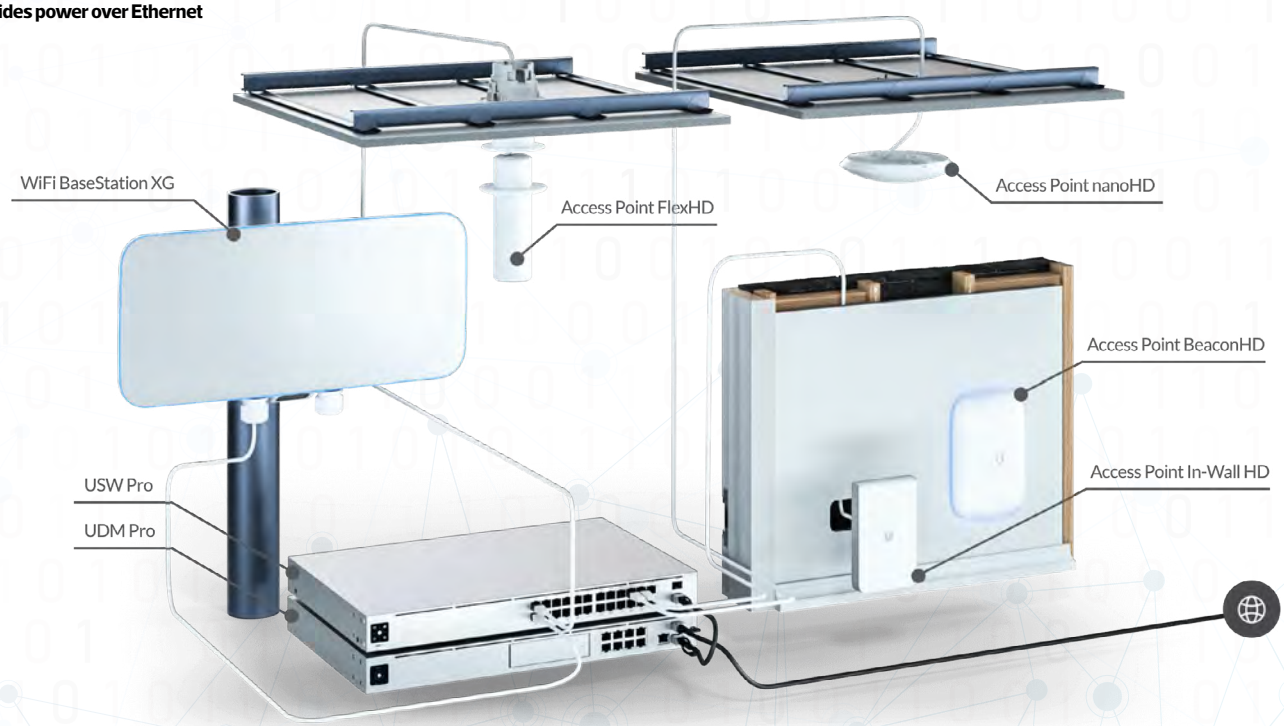
Larger router-like nodes, such as the routers in our Labs test (most of which are compatible with the company's mesh systems), can deliver high peak speeds but the smaller puck-like units, such as Amazon Eero and Google Wi-Fi, tend to lag behind.

The second issue is price. Even those smaller units tend to cost close to £100 each – although the Amazon Eero is currently just £55 – so by the time you've bought the several units you need to span a larger home, the cost can really add up. What's more, if you want the most powerful, speedy system that uses the latest Wi-Fi 6 tech (Eero and Google Wi-Fi are only Wi-Fi 5), you can be looking at £200-£300 per node.

The final potential issue is that by stringing together several Wi-Fi nodes, you're inherently introducing a greater delay to the signal, as the data has to be packaged up for sending over Wi-Fi, decoded then repackaged and resent several times. All of which can result in a higher ping.

The Devolo Magic 2 LAN proved that powerline has its limitations, as it didn't significantly outperform its much older sibling

Ubiquiti's Unify networking system provides a host of ways to connect up Wi-Fi access points and even provides power over Ethernet



To see just what sort of performance a modern mesh system can deliver, we tested the new ZenWiFi XD6 system from Asus. This is a £400 AX5400 system consisting of two nodes, each with a 2x2 spatial stream configuration for each of its 2.4GHz and 5GHz bands. It's not the fastest system out there – for that you'll be looking at the likes of the Netgear Orbi RBK852 that costs £700 – but it's a good example of a mid-range option.

We set up the system with the first node in the front room, as you would with any normal router, then located the second node into the kitchen, one room back from the first node, directly below the second test location and around 6m closer to the garden.

As expected, in our tests, it didn't blow away the competition at close range, but it was still very nippy (418Mb/sec) with pings that were very low (12ms average, 15ms max). It's when we move to our second test location that the system really starts to show its capabilities.

While its peak speeds aren't much better than those from standalone routers (213Mb/sec), our ping measurements were a vast improvement.

Technically, the TP-Link Archer AX73's 15ms average ping beat the 16ms of the ZenWiFi but all the other routers were notably slower. Moreover, when it comes to max pings, the ZenWiFi's 25ms was 8ms quicker than the next best single router, which itself was miles better than the rest.

As we move to our third test location, it's really no contest. While the standalone routers struggled to deliver single-digit Mb/sec figures, with maximum pings hitting 100s of milliseconds, the ZenWiFi hit 130Mb/sec with a maximum ping of 35ms.

We also tested from even further away, right at the bottom of the garden and a further 5m back from location 3 where, although we sporadically could connect to some of the standalone routers, none of them was really reliable enough for testing. The ZenWiFi, though, was still hitting a remarkably strong 130Mb/sec speed and 35ms max ping.

All told, while we do see a step up in ping when our client device is connecting to the second node of the mesh Wi-Fi system – and this would only increase further if three nodes were daisy-chained together – the step up wasn't problematic.

An average ping of around 15ms is still excellent, and we saw no evidence of significant drops in the signal. All told, mesh Wi-Fi has shown in these tests just why we've been so enthusiastic about it before – a good system that's well set up delivers remarkably rapid and reliable Wi-Fi.

Powerline

If you can't afford a mesh Wi-Fi system, but can't possibly risk the occasional dropouts that affect even the best Wi-Fi setups, and must have the best possible ping outside of a dedicated network cable, the most common alternative is a powerline system. These use a home's existing mains power cables to deliver a network signal, saving you having to add in new cabling while overcoming some of the issues of interference and signal drop that can affect Wi-Fi.

The technology has been around for years and speeds have steadily improved, with the latest kits claiming up to 2,400Mb/sec. In reality, though, as with Wi-Fi, the on-packet speeds are generally far higher than any speed you'll actually experience. However, these setups are generally plenty fast enough and, in our experience, as long as the connection works at all, they prove reliable.

The main caveat with the technology is that it totally depends on the nature of your home's mains cabling. If you're looking to stretch a signal to the bottom of the garden and you don't have a mains cable running to the shed, then powerline isn't all that much more useful than running an Ethernet cable. Sometimes the mains cabling within the home doesn't connect up properly either.

Devolo's mesh Wi-Fi kit provides mesh Wi-Fi but with a wired backhaul via powerline networking

As an example, we know of a house where the entire kitchen circuit – that also powers the adjacent room where the telephone cable enters the house – simply doesn't connect to the rest of the house when using powerline. That's despite separate ring mains also being used throughout other areas of the house and powerline working fine across them. The only real way to tell if the technology will work for you is to try it out.

The other major problem can be the quality of your home's power cabling, both in terms of age and degradation, and how much interference and noise is on the circuit due to the appliances that are connected to it.

Certain appliances that put high loads on the circuit – and particularly those that include a motor or some other load that introduces oscillations to the circuit, such as microwaves or washing machines – can introduce enough noise to degrade or totally disrupt the powerline circuit. Some surge protectors can block the signal too, so it often doesn't work over extension cables.

All that said, we've tested the technology over many years and generally found it to be very reliable. Moreover, in our testing, it worked just fine over a 30m mains extension reel with a surge protector, so again, it's worth seeing if you can borrow a kit off a friend if they're going away, giving it a go and seeing if your home's cabling setup will work well with it.

When it came to our testing, we set up one powerline plug in a wall socket next to the router in the front room, then plugged the second adaptor into a socket in the first and second test locations, while using a 30m extension reel to reach the third test location in the garden. We also tested two different powerline products. An older AV600 (600Mb/sec) product and a top-of-the-line 2,400Mb/sec system from Devolo, called the Magic 2 LAN starter kit.

Starting with the older kit, we were actually a little surprised to see a notably higher ping in our first test location than any of the Wi-Fi systems. Seemingly, the interference and error management required by the technology to overcome noise on the line is enough to add a bit of delay when compared with Wi-Fi at close range. However, the average of 17ms and maximum of 21 is still more than acceptable.

As for overall speed, we again see that peak performance is nothing to write home about, with a maximum rate of 157Mb/sec. That's still ample for most uses, but it's still far behind even older Wi-Fi standards.

Instead, it's as we get further away that powerline shows its talents. In both our second and third test locations, the technology delivered essentially identical performance to the close-range test. There was a bit of a speed-drop in location two, suggesting the quality of the cabling between the two locations isn't all that great, but the extension reel didn't miss a beat. Plus, of course, that signal was being carried the full 30m length of the reel, regardless of how much it was extended, so you can expect to get that sort of performance right to its end.

Where the tests became particularly interesting with this technology was when trying the new higher-speed version. We saw peak throughput rise a little at test location one, but it actually performed worse at the other locations. Meanwhile, pings were consistently high in all locations, with averages of around 50ms and maximums of nearly 80ms.

Of course, as we mentioned before, others' mileage may vary here, depending on the cabling in your home. However, there's a possibility that if the technology is relying on a higher-frequency signal to transmit data at a higher rate then it may suffer more from noise on the line.

Either way, it's testament to the limitations and potential pitfalls of the technology. Nonetheless, in our general experience, and as the testing for the AV600 powerline kit showed, as long as the technology works across the circuits in your house then it generally delivers solid (if not record-breaking) performance across different ranges.

MICROWAVES OR WASHING MACHINES CAN INTRODUCE ENOUGH NOISE TO DEGRADE OR TOTALLY DISRUPT THE POWERLINE CIRCUIT

Other alternatives

We've covered the main three or four options open to most homes when it comes to improving the network coverage of your home. However, there are a few more options we didn't test.

For a start, there are technologies that combine the best of both wired and wireless networking by using Ethernet or indeed powerline technology to connect the major backbones of your network, then using wireless access points to actually connect your devices to the network in each location. This general approach is called wired backhauling (the backhaul being the connection between networking products, rather than between client devices and the network).

There are several routes to obtaining this type of network. You can simply add disparate Wi-Fi access points to whatever wired network you've already set up, or there are more integrated systems.

For instance, Linksys' Velop mesh networking nodes support wired backhaul, so you can have two or three nodes connected wirelessly to provide Wi-Fi coverage for your house, then add another one at the end of an Ethernet cable running to the garage or summerhouse, and the whole lot will just appear as one seamless Wi-Fi signal.

Another popular option is a dedicated wired backhaul and Wi-Fi access point system, as used in some professional environments. Companies such as Ubiquiti sell a whole system of scalable network products that allow you to cable up your home and then add compact access points – which can use power over Ethernet, so you only need to plug them into to the network, with no other connections needed – again, the whole Wi-Fi signal will appear as a seamless network.

Alternatively, you can take the powerline route, with the likes of the Devolo Mesh Wi-Fi 2 packing Wi-Fi access points in its powerline adaptors, again creating a seamless network out of the lot.

There are also alternatives to powerline when it comes to using existing cabling, with a popular option being Ethernet over coax. This uses existing TV coax cable to transmit a signal, which due to the nature of coax cable being shielded – unlike mains power – means it can achieve much higher speeds without interference from turning on mains-powered devices.

However, it's much less common to have coax in every room of a house, so its uses are limited.

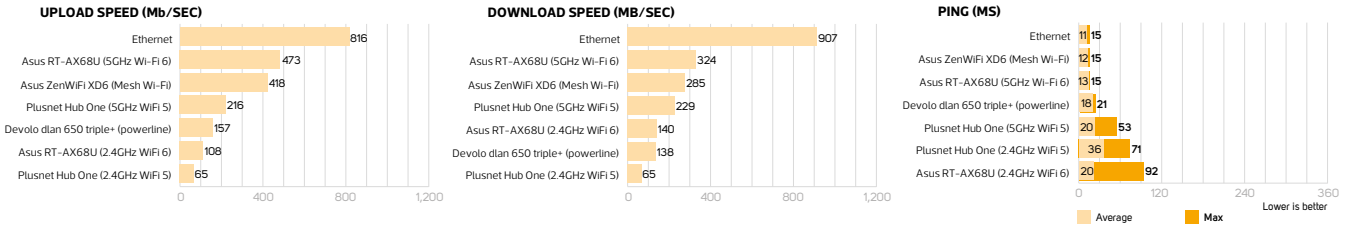
Whichever option you choose, we hope this article has provided you with some insight into what can and can't be achieved with some of the key home networking technologies that are available.

For many homes, a modest mesh Wi-Fi system is likely to be the best option but hard-wired options such as Ethernet and powerline will get you a more reliable connection with lower pings at long ranges. CPC

NETWORK PERFORMANCE RESULTS

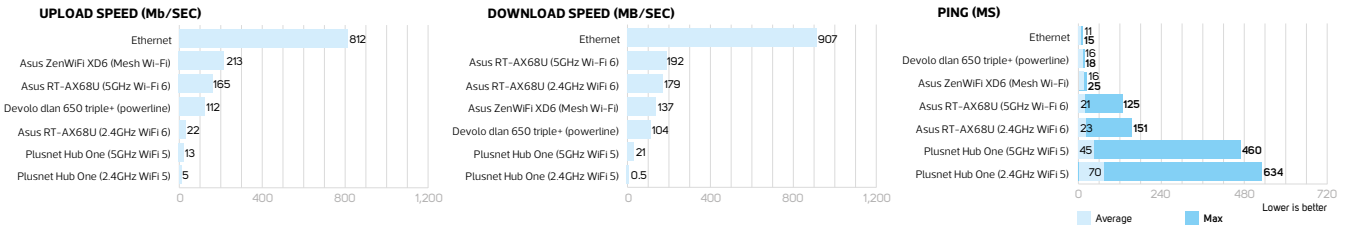
LOCATION 1

SOFA 2M FROM ROUTER IN SAME ROOM



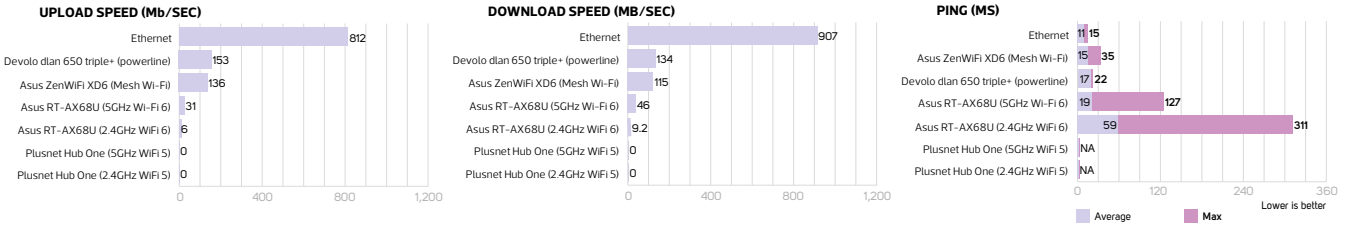
LOCATION 2

UPSTAIRS BEDROOM, 5M DIAGONAL FROM ROUTER



LOCATION 3

OUTSIDE GARDEN, 15M FROM ROUTER



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
Arduboy FX

The credit-card size Arduboy, reviewed back in Issue 162, wasn't the first Arduino-compatible handheld console – even discounting the delays surrounding its crowdfunding campaign, it was soundly beaten to market by the bulkier but more capable Gamebuino (see Issue 134). Its extremely compact dimensions – thin enough to slide into most wallets, although at the risk of scratching the plastic covering the single-colour OLED display – ensured its popularity, though, and now it's back as the improved Arduboy FX.

The box puts the Arduboy FX's main selling point front and centre – 200+ games

There's no massive overhaul of the platform here – the Arduboy FX shares the same physical dimensions and the vast majority of the parts found in its predecessor. Both consoles are driven by a Microchip ATmega32U4 microcontroller with 2.5KB of RAM, a 1KB EEPROM and 32KB of flash memory. They both also offer a constrained environment designed to be accessible to newcomers, but also challenging to experienced developers used to more forgiving specifications.

As before, there are six button inputs – a four-way D-pad and two fire buttons, plus a physical power switch. Outputs are handled by a single user-addressable RGB LED and a four-channel sound system linked to a small piezoelectric buzzer, with the top of the device packing a compact OLED panel with a single-colour 128 x 64 resolution. Finally, there's a micro-USB port for a data connection and to charge the 180mAh battery.

It's not a revolutionary upgrade, as with the move from the Gamebuino to the full-colour Gamebuino Meta (see Issue 178). However, this evolution handily resolves the biggest complaint about the original Arduboy's design – its single-game capacity. The Arduboy FX addresses the problem by simply adding an external flash RAM chip, communicating with the microcontroller via the Serial Peripheral Interface (SPI) and boosting the overall capacity from 32KB to 16MB – enough for 512 games.

The Arduboy FX is near identical to its predecessor, bar a new flash chip

NEWS IN BRIEF

System76 enters keyboard market

Linux-powered laptop and workstation specialist System76 is branching out into peripherals, launching an open-source mechanical keyboard dubbed the Launch. Based on the popular QMK firmware, the keyboard includes a compact tenkeyless 84-key design, with a split spacebar and the choice of Kailh Box Jade or Box Royal switches. The whole design is open, down to the plastic or aluminium chassis, but can also be purchased as a commercial product. The Launch is available from **system76.com** now, starting at $285 US (around £202 ex VAT), including the keyboard, spare key caps, a cap-puller and a magnetic tilt bar.

Surprisingly for such a compact design, the Arduboy FX is easy to open, with just four screws

To prove it, the Arduboy FX comes pre-loaded with around 200 games and tools selected from the development community. A new loader, the first software to boot after you've gone through the out-of-the-box tutorial, lets you select from a range of categories – Action, Adventure, Arcade, Runner, Platform, Strategy, Puzzle, Skill, Tabletop, Racing, RPG, Shooter and Sports, plus sections for Music, Apps and Tools – you then pick the game you'd like to play.

From there, the new loader borrows a trick from the Gamebuino – the game chosen is loaded into memory and booted, replacing the bootloader until the console is switched off. The process is quick – the Arduboy enters the loader instantaneously on power-up, transfers the chosen game in under four seconds, then loads it with only a brief pause to flash the RGB LED and display an animated Arduboy logo.

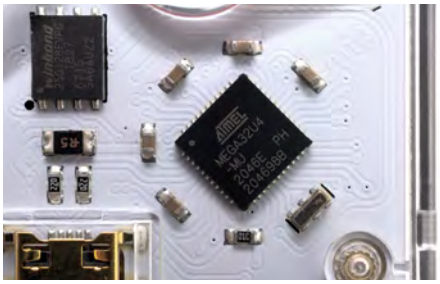
It's a major improvement over the clunky game-switching approach of the original Arduboy, but appears to have been released before it was quite ready. At the time of writing, there's no easy way to load your own games onto the external flash memory beyond a community-provided set of Python scripts – a graphical user interface is in the works, but not yet publicly available.

That doesn't mean you can't still develop your own games for the Arduboy FX though. Flashed through the Arduino IDE or avrdude, the Arduboy FX acts like an original Arduboy and accepts a single game that immediately boots. Turn the Arduboy FX off and back on, and it will bring up the loader, allowing you to select any of the 200 built-in games as before. Tap a fire button without selecting a new game and it will load your own title – but beware, as flashing any of the built-in games will erase your own and require a connection to your PC to re-flash.

The biggest disappointment of the Arduboy FX, meanwhile, is the display. It's the same model as the original Arduboy, and suffers from the same banding issue. While not visible on sparsely populated screens, as soon as a game starts using bright horizontal lines, you'll see the banding clearly, detracting from what's otherwise a bright and clear, if low-resolution, panel.

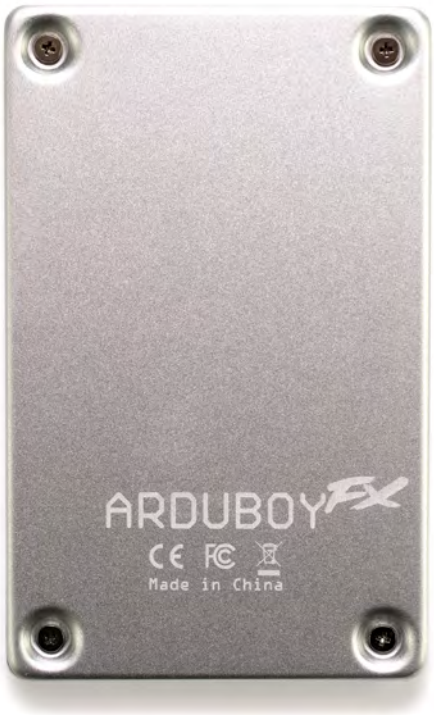
For existing Arduboy owners, the Arduboy FX may not be worth the cost of upgrading, which is why there's an alternative: the FX Mod Chip. Designed for installation in an original Arduboy, the FX Mod Chip adds the external flash and bootloader capabilities, although it requires a little bit of fine-pitch soldering. Oddly, the chip costs more if you want the 200 open-source games pre-loaded. Currently available exclusively from the USA, the chip costs $9 US bare or $15 US with the games (around £6.40 and £10.60 ex VAT respectively).

The Arduboy FX is available to buy from **pimoroni.com** for £48 inc VAT now, while the FX Mod Chip is exclusively available from **arduboy.com** and may attract import charges when entering the UK.



The microcontroller hasn't changed, with the same ATmega328 powering the FX

As with the original Arduboy, power and data connect over a micro-USB port



A physical power switch helps to prevent the battery draining in your pocket

REVIEW

2600 Magazine Lifetime Subscription

The year is 1984, and there's a buzz surrounding telecommunications networks and computing systems. The term 'hacker', originally coined to mean those who use their skills and knowledge to overcome obstacles in computing or otherwise, has begun to take on a darker meaning in the mainstream press. What's more, two college dropouts have been well established as nouveau riche, thanks to the success of a fruit-themed computing company, which was funded in part by the sales of a gadget designed to scam free long-distance calls from the telephone company.

Enter 2600, founded by the pseudonymous Twenty Six Hundred and a hacker group that called itself Phreakers, Hackers And Laundromat Service Employees (PHALSE). The launch issue in January 1984 nearly didn't happen. A high-profile FBI case the year before 'almost derailed the entire thing', the publisher recalls, but the team ploughed ahead anyway with the release of what would later be known as The Hacker Quarterly.

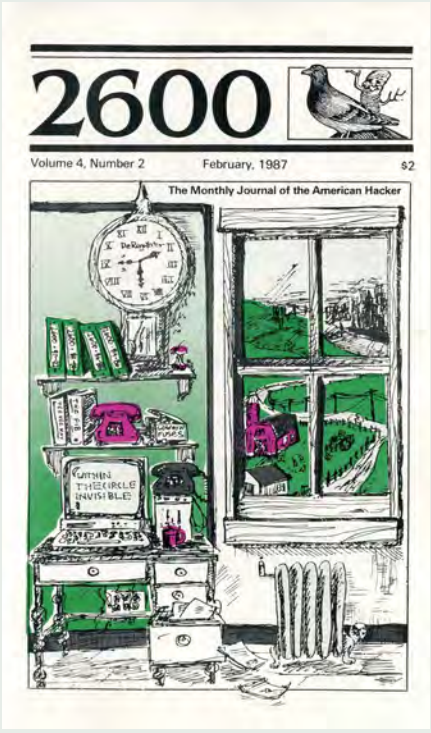
Since then, 2600 has been running continuously, moving from its monthly newsletter format to a quarterly magazine – complete with full cover, in place of the old format's masthead. It covers a range of topics of interest to hackers of the new or old definition alike.

The early issues are dominated by news about telephone networks, including the divestiture of Ma Bell into the Baby Bells, as well as the move from crossbar exchanges to the new digital types. There's also coverage of the infamous Blue Box tone generators that could get you free phone calls, sales of which partially funded the founding of Apple Computers a decade earlier. However, computer systems would prove of increasing interest as time went on.

While first and foremost an anarchic underground publication, 2600 would receive mainstream recognition as its popularity grew. Some of this recognition, such as the seizure of its bulletin board system (BBS), The Private Sector, by 'overzealous New Jersey authorities', was unwelcome. Other attention, including a number of campaigns exposing scams targeting the hacker community, or bringing the public's attention to telephone companies' charging customers for Touch-Tone support, which actually saved them money, were considerably more welcome.

Today, 2600 is less about multi-frequency tones and crossbar switching, and more about topics such as homomorphic encryption, virtual private networks (VPNs), 3D printing, hardware upcycling and even lighter topics, such as the joys of mechanical keyboards.

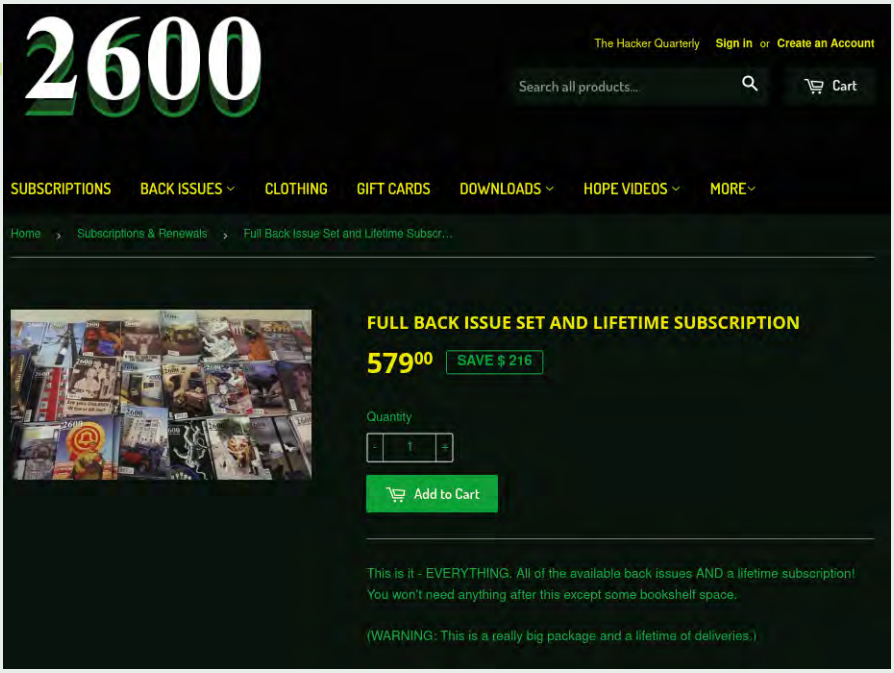
That's not to say it's forgotten its roots. Every issue includes full-colour photographs of interesting or otherwise unusual payphones, sent in by readers throughout the world. One way in which 2600 truly adheres to its founding principles is in its lifetime subscription. In 1988, shortly after the move to a quarterly format, 2600 Enterprises introduced the option to receive every single



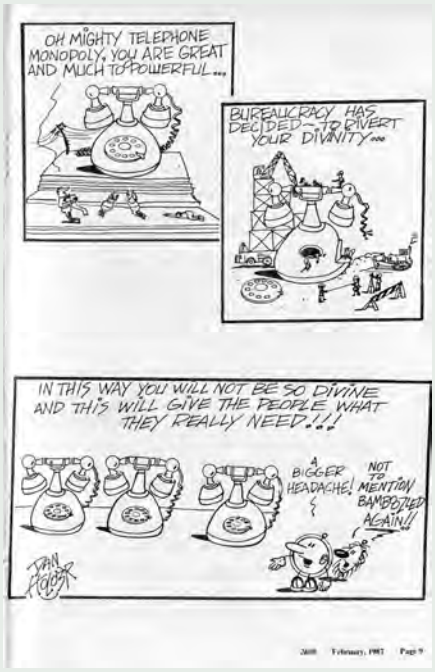
Thanks to a forward-thinking approach to back issues, you too can own every copy of 2600 – going back to its foundation

PDF copies are provided free from DRM, making them compatible with any e-reader, PC, phone or tablet

An archive extracts to nearly 3GB of PDFs, with more to follow every year



For the completist, 2600 offers a box filled with physical back issues – and every future issue to come will land at your door too



The magazine has kept its counter-culture feel over the years

copy of the magazine going forward for a one-time fee of $260 US (around £183, zero-rated for VAT).

Correcting for inflation, that's $587 US (around £414, zero-rated for VAT) in today's money, yet you can still pick up that same lifetime subscription for just $260 US, or $310 (around £219, zero-rated for VAT) for subscribers outside the USA.

Thanks to the march of technology, you also get a choice of how the magazine is delivered. The standard subscription works the same way now as it did back in 1988 – a printed magazine drops through your letterbox once a quarter. For those who aren't tied to physical hard copies, a relatively new digital-only subscription bundles four quarterly publications into a single annual digest as a DRM-free PDF, which lands in your inbox each spring.

There's no cost difference between the physical and digital subscriptions, but digital subscribers get rewarded in a different way, with the subscription including every back issue going all the way to 1984 and the founding of the publication. The moment you subscribe, you'll receive a link to a ZIP archive containing, at the time of writing, 36 annual digests – scans for the early pre-digital issues, and true digital copies for the later issues. Each spring you'll receive another PDF for your growing collection.

Is it worth it? Well, 2600 is an institution, and the more recent issues have a lot to say about tech topics from privacy and security to hobbyism and, yes, criminality. Its current editor-in-chief is the noted hacker Emmanuel Goldstein, who served as a consultant on the classic 1995 film Hackers, and lent his pseudonym to Matthew Lillard's character, Cereal Killer. Contributions come from across the world, although the quality of each article can admittedly vary.

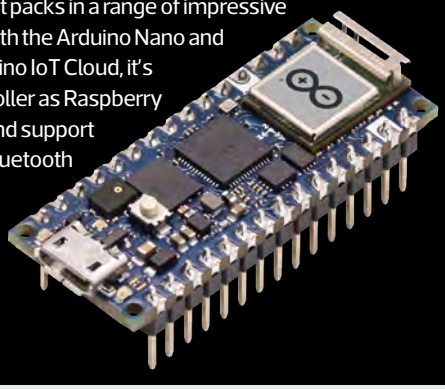
The back issues are a treasure trove of historical content, little of which is directly applicable today – you won't find a Blue Box much use on a modern telephone network, for example. That's not to say these issues aren't without value by any means though. Reading from the beginning to today provides a look at how technology and telecommunications have evolved, and from a perspective rarely considered by mainstream tech publications.

All subscription options are available from **store.2600.com**, along with individual back issues.

NEWS IN BRIEF

Arduino launches Nano RP2040 Connect

Arduino has officially launched its competitor to Raspberry Pi Pico, the Arduino Nano RP2040 Connect. It's more expensive, but it packs in a range of impressive features. Designed to be pin-compatible with the Arduino Nano and fully supported in the Arduino IDE and Arduino IoT Cloud, it's powered by the same RP2040 microcontroller as Raspberry Pi Pico, but boasts 16MB of external flash and support for Wi-Fi 802.11b/g/n, Bluetooth 4.2 and Bluetooth Low Energy (BLE).



It also has an on-board six-degrees-of-freedom inertial measurement unit (IMU) and a microphone. The board is available from **store.arduino.cc** for $24.50 US (around £17.35 ex VAT).

REVIEW

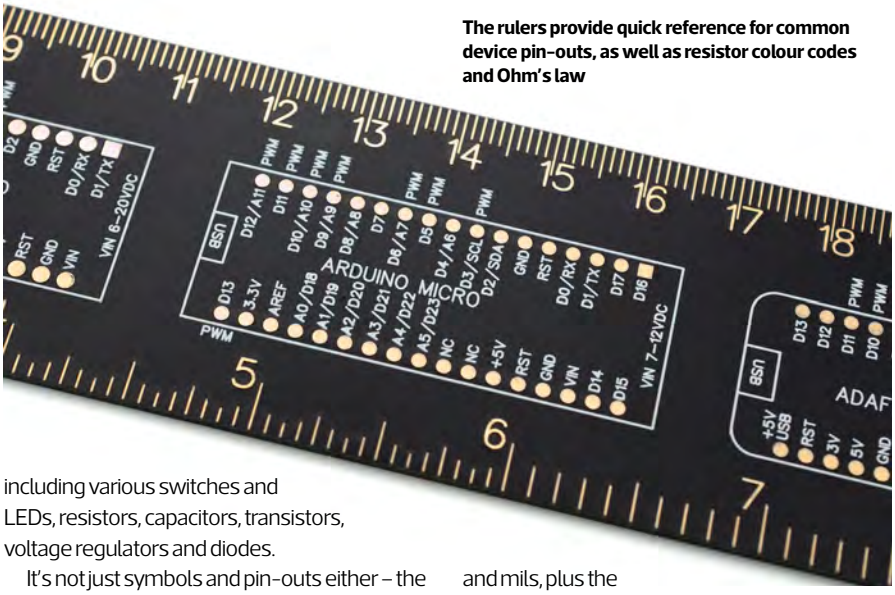
Bolt Industries PCB rulers

What is a ruler? A piece of plastic, wood or metal you can use to measure lengths and draw straight lines. PCB rulers, though, are different – and not just because they're almost completely inflexible, being made out of rigid fibreglass and copper. Sure, you can use them to measure lengths or draw straight lines, but they're designed to act as desk-based reference guides too.

Bolt Industries' Ian Dunn is no stranger to PCB rulers. Now on his third generation of crowdfunded PCB ruler designs, he's been refining his art – and the latest design packs a wealth of information into a surprisingly small space. The front of Dunn's latest ruler design carries, as you might expect, length markings in inches and millimetres. These start, pleasingly, right at the edge, so you can push the smaller edge up against the object you want to measure.

The bulk of the front, though, is taken up by pin-out references for a range of popular microcontrollers: The Arduino Nano, Arduino Micro, Teensy 4.0 and Raspberry Pi Pico (see Issue 212), which replaces the Adafruit Metro Mini reference from earlier designs. There's also a reference for the 40-pin general-purpose input/output (GPIO) header on Raspberry Pi single-board computers.

Each microcontroller is represented as a full footprint, making it easy to figure out which pin is where on the physical device. The references continue on the back, where you'll find guides for common through-hole components, including various switches and LEDs, resistors, capacitors, transistors, voltage regulators and diodes.



The rulers provide quick reference for common device pin-outs, as well as resistor colour codes and Ohm's law

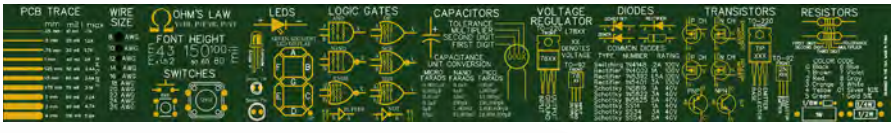
It's not just symbols and pin-outs either – the resistor section includes a guide to decoding the colour bands, and the LED section has a reminder of which leg is the anode and which is the cathode. Likewise, the capacitor section has a three-way conversion table between micro-, nano- and pico-farads, and the transistor sections looks at the inner workings of PNP, NPN, NMOS and PMOS transistors. There's even a copy of Ohm's law, plus a table of common diode types and their ratings.

Dunn isn't done there though. For those looking to design their own PCBs, or reverse-engineer someone else's PCB, there are copper traces to the left of the ruler, which include their measurements in millimetres and mils, plus the maximum current they can carry. Next to these are a number of holes through which you can push wires in order to get their measurements in American Wire Gauge (AWG). There's even a reference guide for font height.

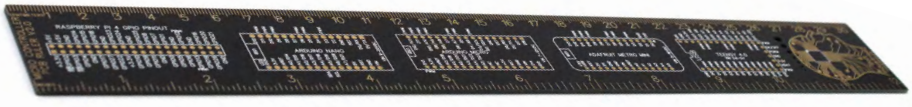
Compared with earlier designs, Dunn's latest ruler focuses a little less on component footprints and more on references. The seven switch footprints of the 2nd-generation rulers have been dropped to just two, making room for a new reference guide to logic gates

Meanwhile, the USB pin-outs have been dropped altogether, and the footprints for capacitors have been replaced with a guide to reading the numerical codes printed on the front of ceramic disc capacitors. While the new design makes it harder to pull a component out of your bits box and quickly figure out its footprint, it's definitely more useful as a general guide to electronics.

Following a successful crowdfunding campaign on Kickstarter, Dunn is taking pre-orders for the rulers on **indiegogo.com** at $14 US (around £10 ex VAT). Alternatively, the PCB production files are available to download from **custompc.co.uk/PCBRuler** under an open-source licence. CPC



The latest variant adds a pin-out for the Raspberry Pi Pico, and revises the references on the rear



Ian Dunn is back with another reference ruler design, a follow-up to the pictured 2nd-generation variant

Gareth Halfacree is a keen computer hobbyist, journalist, and author. His work can be found at **freelance.halfacree.co.uk** @ghalfacree

WIN A 27IN BENQ GAMING MONITOR

Fancy giving your gaming setup a visual and performance upgrade? If so, here's your opportunity to do so for free! BenQ has stepped up to the prize-giving plate and is offering a fantastic 27in gaming monitor to one lucky **Custom PC** reader.

The Mobiuz EX2710 sports an IPS LCD panel for exceptional viewing angles and excellent colour reproduction, while its 144Hz refresh rate and 1ms MPRT response time ensure responsive gameplay. It also includes FreeSync Premium technology for eliminating image tearing and stuttering with AMD graphics cards, making for a smoother feel when gaming.

Built-in intelligent HDR modes can also produce HDR-like images from non-HDR sources, while the 2.5W stereo speakers provide a full and immersive sound. All this and you get a smart-looking design with slim bezels on the top and sides, plus a fully adjustable stand.

SPEC

- 27in IPS panel
- FreeSync Premium Pro support
- 1,920 x 1,080 resolution
- 144Hz refresh rate
- 1ms response time (MPRT)
- 1 x DisplayPort 1.2 and 2 x HDMI 2 inputs
- Height, rotation and tilt-adjustable stand
- VESA monitor mount compatibility
- Headphone jack
- 2 x 2.5W speakers

SUBMIT YOUR ENTRY AT **CUSTOMPC.CO.UK/WIN**

Competition closes on Friday 6 Aug, 2021. Prize is offered to participants in the UK aged 13 or over, except employees of the Raspberry Pi Foundation and Trading, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from Custom PC magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. Winners will be contacted by email to arrange delivery. Any winners who have not responded 60 days after the initial email is sent will have their prize revoked.

ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Can't buy a GPU? Have a go at modding

Lian Li's O11D Mini gives you a fun and affordable blank slate for under £100

Every now and then we undertake a Dream PC build of our own (see p74), which means I get to play with some new toys. This time, the highlight for me was a case I'd been itching to get my hands on for a while. Rather than using a case that offers good air cooling out of the box, this time I decided to go for a blank slate and use Lian Li's O11D Mini.

I chose this case for a couple of reasons. Firstly, it is indeed a blank slate, so you can kit out the case with your own fans and other hardware – that's exactly what you want if you're splashing some serious cash and want to cherry-pick all your hardware.

The case also looks great, of course, and has plenty of glass panels to show off the hardware inside. This chassis has also been a favourite among water-cooling hardware manufacturers, and there are huge distro plates available for it that combine pumps and reservoirs and look fantastic. There's plenty of room for other water-cooling hardware too.

It's an incredibly popular case for these reasons, and the interior throws up other surprises too. Despite technically being thought of as a mini-ITX case, there's space and installation mounts inside for ATX motherboards too. If you sticking with mini-ITX, though, you reap the rewards of having a more flexible, spacious interior. Besides, seeing as typical gaming PCs only have a single PCI-E card, two sticks of RAM and a few storage drives, we've decided to go mini too.

There's something for everyone in our feature this month, as we've included water cooling, glass etching and other modding techniques in the mix, with a full guide on how to spray-

paint your PC on p102 as well. With summer fast approaching with warmer temperatures and drier conditions, it's a great time to head into the garden or garage, if you have one, and have a go at some of these techniques yourself.

There's another great reason to have a go at modding as well. Water-cooling components, cases and modding supplies such as paints are all readily available for prices that are no different to before the pandemic. Even a last-gen mid-range graphics card such as a GeForce RTX 2060 will set you back more than water-cooling your PC right now. In fact, you could probably buy the case of your dreams, spray-paint it and kit it out with a water-cooling system for the same price or less.

With that in mind, I'd definitely consider pointing your spare time and cash in a slightly different direction that's still PC-related. Modding your PC is fun and rewarding, and the result is a system that's truly one of a kind. Until the prices of graphics cards fall to more reasonable levels, modding is a great way to fiddle with your existing PC hardware and give it your own personal stamp.

Modding your PC costs no more than it did before the pandemic started

It's time for a motherboard shakeup

Two issues ago we reviewed the NZXT N7 B550 motherboard (see Issue 214, p20), which is good-looking, has a unique design and it isn't outrageously priced either. While it's essentially a rebadged ASRock motherboard, and not actually manufactured by NZXT, its considerably different design compared to other motherboards got me thinking. What do we actually need or even want from modern motherboards, and how can manufacturers stay ahead of the curve? Do they even have too many features now?

One of the more interesting features of the N7 B550 was its ability to tie its fan control into NZXT's CAM software, which can link components such as USB-enabled liquid coolers, RGB lighting and fans together in a single control suite. It's by far the best software I've used within Windows for doing this job, and while it might not have as many options as the likes of Gigabyte's motherboard software, it's far cleaner and easier to use.

Of course, NZXT is also hoping to persuade you to buy into its ecosystem with a Kraken liquid cooler here, but Asus, Gigabyte and MSI all have their own liquid coolers now and none of them manages to offer such a slick interface. I'd go as far as saying that I didn't even mind the N7 not having a fan control suite in the EFI as a result, which surprised me.

Then there's the design. There were certainly a few issues with the large shrouds, specifically the ones that covered the M.2 ports. Replacing them after installing your SSD would see temperatures skyrocket quickly, resulting in throttling under heavy loads. Making these shrouds act as heatsinks would likely fix the issue, but I also appreciate the bold design and extensive details on both the black and white versions of the board.

The inside of the box is markedly different from usual too. It's a decidedly minimalistic affair, with less of the faff and childish additions you'll see with other boards, such as stickers, cup mats and other rubbish you'll likely never use. NZXT even ditched the paper manual and instead gives you a QR code to view it online.

This is a great idea, as I regularly look at the manual of motherboards online, since it's quicker and easier than finding a motherboard's box and sifting through dozens of pages in a paper manual. I'm amazed other motherboard manufacturers haven't done this, as it must cut costs.

NZXT's good-looking N7 B550 has a unique design and isn't outrageously priced

Other motherboard makers all seem obsessed with filling the box with as many pointless accessories as possible, instead of offering genuinely useful gubbins. A few include USB sticks with drivers on them instead of a CD, but this would have been more useful a decade ago.

With AMD and Intel moving to new sockets in the not-too-distant future, I hope that motherboard manufacturers take the opportunity to have a long hard look at their current products and take a leaf out of NZXT and ASRock's book. CPC

Antony Leather is Custom PC's modding editor @antonyleather

How to Spray-paint your case

Antony Leather shows you how to brighten up your PC with a splash of your own chosen colour

TOTAL PROJECT TIME / 7 DAYS

Summer is the best time of year to spray-paint your PC, as you're more likely to get a better finish and the paints will dry much faster than in winter too. It's also easier to get outside into well-ventilated spaces, and you don't have to spend hours outside in freezing temperatures either.

This month we're taking you through the process of spraying your PC case, whether it's screwed or riveted together, and covering all the information you need to make the process as pain-free as possible, while still resulting in a fantastic finish. The products you need are readily available and cost no more than they did two years ago, so unlike some PC components, spray-painting your PC is affordable and a great way to transform your case.

TOOLS YOU'LL NEED

Latex gloves
Most hardware stores

Plastic greenhouse
Most hardware stores

Frog Tape
Most hardware stores

Colour spray paint, primer and clear coat
Most hardware stores

Safety goggles
Most hardware stores

Rivets and rivet gun
Most hardware stores

Respirator mask
Most hardware stores

1 / CHOOSE YOUR COLOURS

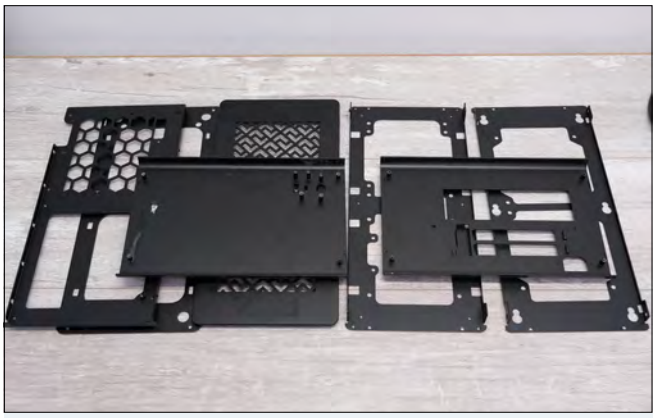
Your first step is to decide on the colour or colours you'll be spraying your case. You'll need to buy enough paint to deal with whole panels of your case in a single session for the best finish.

2 / INTERIOR AND/OR EXTERIOR?

Just spraying the interior or exterior has its benefits. It will mean needing a lot less paint and you'll be done in half the time. However, you'll also need to mask the areas you don't want to paint. An ATX case will need roughly two cans of primer, colour and clear coats for the exterior and the same again for the interior.

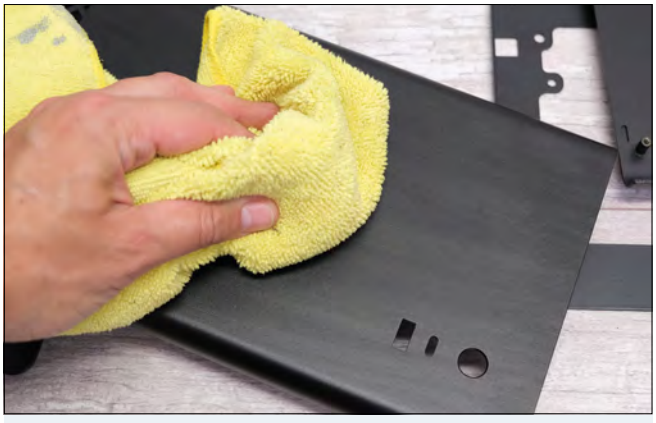
3 / DEALING WITH RIVETS

You need to dismantle your case before you spray it. PC cases are usually held together with screws, rivets or both. It's easy to remove screws, but you'll need to drill out rivets. Start with a 3mm drill bit and increase the bit in size until you drill the rivet out of the case. The holes are usually 3mm, 4mm or 5mm wide.



4 / DISMANTLE CASE

Strip down the case to its individual parts, or just the exterior panels if you're only spraying those. Take photos of the case at each step, so you know which pieces go where.



5 / CLEAN SECTIONS

Cases will have fingerprints, stickers and other grime on them that can affect the paint finish, so you need to clean it first. Use warm water with a dash of washing-up detergent and a sponge, rinsing thoroughly after and allowing it to dry naturally.

6 / REMOVE PORTS, BUTTONS AND FILTERS

It's essential to remove any case buttons, ports and dust filters, as these parts can become clogged with paint and no longer function. They're usually screwed in place and easy to remove.

7 / SAND AND FILL

Deep scratches and dents are unlikely to be solved by filling them with primer, so it's best to fill and sand them first. Use 3M glazing putty, along with a spatula or old flexible plastic card to smooth the putty into the scratches, then use 800-grit sandpaper to finish.

8 / USE PROTECTIVE GLOVES

Protect your skin by wearing long clothes and protective gloves. These are essential not only to prevent skin reactions, but also to prevent you from transferring oils to the paint surfaces from your fingers.

9 / USE GOGGLES

Goggles are essential, as the paint will get everywhere, including your eyes. Make sure the goggles seal around your eyes with no gaps.

10 / USE A FACE MASK

It's highly recommended to get a respirator face mask, so your mouth and nose are sealed away from the fumes. These cost less than £20 and are essential if you're spraying in an enclosed space or dealing with 2K clear coat.

11 / CREATE A SAFE SPRAY AREA

A plastic greenhouse is an ideal place to spray your case, as it contains the spray paint and prevents insects from landing on surfaces, as well as allowing you to paint in the rain or sunshine. However, you'll need to use the full complement of protective gear as mentioned above.

12 / CONSIDER A SPRAY TRIGGER

Spraying a large case can be hard on your trigger finger, and a spray trigger can make this work more comfortable. They're relatively cheap, but don't work with all cans. For example, the Montana Gold cans we used here didn't fit, but most others do.

13 / MASK AREAS

It's a good idea not to spray on areas that make contact with other areas, as this can cause the paint to stick, and for those sections to not sit together properly. Apply Frog tape to these areas, and any other sections you want to remain clear of paint.

14 / WARM THE CANS

If you're spraying in winter, it's a good idea to warm the cans first, so the paint is closer to room temperature. You can leave them indoors for 12 hours, or place them in warm (but not hot) water for 20 minutes.

15 / USE A HEATER

In winter, paint can take a long time to dry and is more at risk of running than in summer. A warm spray area can be hugely beneficial, so it's worth warming the area with a heater between sprays. Never turn on the heater when there are strong fumes – allow the fumes to clear first.

16 / USE THE RIGHT NOZZLES

Cases generally demand wide spray patterns to deal with large areas, but most cans are equipped with relatively narrow spray nozzles. It's best to invest in some alternative nozzles where possible, such as these Montana nozzles, which offer a variety of spray widths – the two widest ones are ideal for cases.

17 / SUSPEND THE PARTS

One simple way to position your components for spraying is to suspend them, which is easy from inside a plastic greenhouse. You can use electrical cable to suspend them, as it's sturdy, durable and easy to tie. Bend it away from the case sections so the spray can reach every part of them.

18 / APPLY PRIMER

Primer creates a smooth undercoat on which the colour coat sits, as well as helping with adhesion. Apply light coats, moving the can about 30cm every second, left to right, from 30cm away. Leave each coat to dry for ten minutes, adding four coats in total or stopping when the base case colour can't be seen.

19 / SAND AS NECESSARY

You want the surface to be as smooth as possible for the colour coat, and sanding with 1,000-grit sandpaper can smooth the primer to a perfect finish. Do this after three or four primer coats, adding more as necessary. Keep pressure to a minimum and use your fingers to feel when the surface is silky-smooth.

20 / APPLY COLOUR COAT

Ensure the colour coat is properly mixed according to the can's instructions, then spray in the same way as the primer, from 30cm away, moving swiftly over the panels. Build up layers with 15 minutes' drying time between each coat. Aim to apply four coats, or more until the primer layer is covered.

21 / REMOVE MASKING

Once you've applied the colour coat, remove the masking – if you do this after applying the clear coat, you can end up with the paint tearing. Pull on the masking tape gently and slowly peel it off.

22 / CONSIDER 2K CLEAR COAT

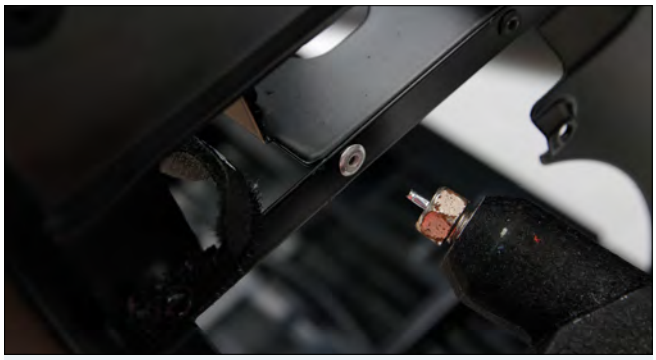
Standard clear coat is easy to apply, but it's quite soft, even once it's fully dried. You can consider using 2K clear coat, which dries harder, but is expensive and more hazardous, needing a proper respirator as well as skin and eye protection. It also needs to be mixed first, so be sure to follow the instructions.

23 / APPLY THE CLEAR COAT

Clear coat needs to be applied more liberally than colour coats, so it binds to the surface. Apply it from 30cm away, moving 20–30cm a second from left to right. It takes longer to dry than colour coat, with most clear coats needing 30–60 minutes between coats, especially on cooler days.

24 / POLISH CLEAR COAT

Leave the clear coat to dry for the specified time, which is usually a few days, or up to a week in some cases. You can now gently use automotive polish such as T-cut to buff the finish to a shine.

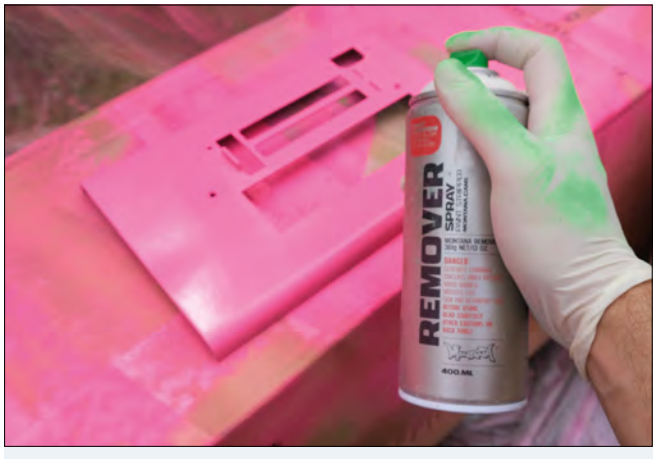


25 / RE-RIVET CASE

If you've drilled out rivets in your case, you'll need to insert new ones. Measure the diameter of the holes and buy the appropriate-sized rivets, along with a rivet gun. Insert the rivets into the gun and squeeze the handles to secure the rivets in place.

26 / REASSEMBLE CASE

Once the panels are dry, polished and up to your standards, reassemble the rest of the case with screws and/or rivets. Take care not to press too hard on the paint finish, especially if you've used standard clear coat.



27 / HELP, I'VE MESSED UP

If you've messed up, or if the paint hasn't taken well to the surface, all is not lost. Use paint remover to dissolve what you've applied, wiping it clean with kitchen towel, then rinsing with washing-up liquid and an abrasive sponge before trying again. CPC

Retro tech

3DFX VOODOO 3D

Reflective surfaces, smooth frame rates and the pure awesomeness of GLQuake. **Stuart Andrews** recalls the truly transformative effect of 3Dfx's Voodoo chipset on PC gaming

It's a classic case of being the right company with the right tech at the right time. 3Dfx launched its revolutionary Voodoo Graphics chipset just as fully polygonal 3D graphics hit the mainstream and PC gamers wanted an easy and accessible way to get them.

In late 1996, Quake and Tomb Raider had just been released, the Nintendo 64 was out in Japan and North America, and the Sony PlayStation and Sega Saturn were still in their first year. Reliant purely on CPU horsepower, and with no dedicated 3D hardware to back it up, the PC was beginning to lose its place as the king of gaming platforms.

Sure, it had a bunch of 2D/3D accelerator cards, but they were too damn slow to make any difference. With the Voodoo Graphics chipset, 3Dfx played a bigger role than any other graphics hardware manufacturer in turning around that situation. In doing so, it made 3D acceleration an absolute, cast-iron must-have feature.

THE BIRTH OF VOODOO

3Dfx was founded in San Jose, California in 1994, by a trio of ex-Silicon Graphics (SGI) employees, Ross Smith, Scott Sellers and Gary Tarolli. At the time, SGI was by far the biggest name in 3D graphics, with its enormously expensive workstations used to create the pioneering CGI effects in Terminator 2 and Jurassic Park.

What's more, SGI was already involved in 3D gaming hardware, developing the core components for what would eventually become the Nintendo 64. At this time, however, some of SGI's engineers were thinking that there were serious opportunities being overlooked in developing 3D hardware for PCs.

One group would eventually leave to found a company called ArtX, which would later get bought by ATI. Meanwhile, Smith, Sellers and Tarolli founded a new startup, Pellucid, in 1992, with the intention of bringing affordable 3D hardware to the PC.

In 1993, Pellucid was bought by Media Vision, a company that had grown rich from selling multimedia kits for PCs during the CD-ROM revolution. Pellucid had proposed the design and manufacture of a PC 3D gaming chip, and Media Vision wanted some of that action.

Unfortunately, Media Vision had its own (mostly legal) issues, and went out of business. However, just when the situation looked bleak, Scott Sellers met Gordon Campbell, founder of the pioneering graphics chip manufacturer, Chips & Technologies. Campbell asked the trio what they wanted to do, and helped them to find the venture capital to do it.

With Smith working as vice president of sales and marketing, Sellers and Tarolli used all the know-how they'd built up at SGI and Pellucid to design a cost-efficient 3D architecture built specifically to handle the polygonal rendering pipeline used in 3D games.

If 3Dfx needed a killer app, GLQuake delivered. You could play id's cutting-edge 3D title at 640 x 480 in 16-bit colour at a smooth 30fps

Tomb Raider was a 3Dfx showcase, smoothing out the blocky textures, improving frame rates and adding transparent water to the mix

With Sellers working on the hardware and Tarolli on the core algorithms, the 3Dfx team came up with the idea of an add-in card that only accelerated 3D, and left 2D graphics and Windows acceleration to a separate graphics card. At first, all they had working was a software simulation built in C and running on a Pentium 90 processor, but this evolved into a card based on two heavily optimised processors.

The first, the Frame Buffer Interface, took polygon scene data from the CPU and applied Z-buffering and Gouraud shading, tracking which polygons were visible, and ensuring that only those were drawn and filled, then applying shading to provide an impression of simulated light and colour.

Each frame of the image would then be converted into scan lines from top to bottom, then sent on to the second chip. The Texture Mapping Unit, or T-Rex as it was known, applied perspective-correct textures, complete with mipmapping (the process of using smaller, less-detailed textures as an object gets further away) and bilinear or trilinear filtering (smoothing out blocky textures when displayed at their largest size close to the viewpoint).

What's more, the T-Rex supported alpha blending, for convincing transparency effects. No other consumer-grade graphics hardware was able to handle this at the time. Each chip worked with its own frame buffer or texture memory – a bank of 2MB of high-bandwidth (for the time) EDO RAM, and the resulting scanlines were fed out to a DAC, which output to a good, old-fashioned analogue VGA output.

By the time Unreal hit the market, 3Dfx was established as the best tech to run it. Check out those shiny surfaces and lavish textures

THE FIRST CARDS

The fact that the Voodoo Graphics chipset was 3D-only helped to keep down the price, but it did make using the card a little strange. While the card itself could talk to the CPU and system RAM through the PCI bus, it worked in tandem with an existing 2D graphics card for 2D DOS and Windows acceleration, only taking over when there were 3D graphics to be rendered.

This happened through a D-Sub pass-through cable running from the output of the 2D card to an input on the Voodoo Graphics card. While some 3Dfx cards handled the switching electronically, others actually had a mechanical switch. On these, you could literally hear when the Voodoo Graphics card kicked into action.

3Dfx never manufactured its own 1st-generation cards. Instead, the designs and chips were sold and licensed to third-party manufacturers, with Diamond and Orchid first out of the gate with the Monster 3D and Righteous 3D in late 1996. These first cards sold for approximately £300, which was a lot but not exorbitant for a PC graphics card at the time.

What's more, these beauties could perform amazing feats with even fairly modest PC configurations. At a time when even Intel's Pentium 133 processors were struggling to deliver consistently good frame rates with the standard software renderer in some demanding games, you could slot a Monster 3D into your Pentium 90 system and see great-looking, silky-smooth visuals.

You could now run Quake at 640 x 480 in glorious 16-bit colour and still hit 30fps

Yet 3Dfx's work went beyond designing the architecture to creating an API that enables game developers to support the card. At the time, there were no 3D engines that supported 3D hardware and no standard APIs for developing 3D games. OpenGL was focused mainly on CAD and workstation graphics, while Intel was unwilling to release its new 3DR rendering library for use on hardware that would run DOS games. Microsoft had yet to develop what became Direct3D.

As a result, 3Dfx developed its own API, GLide. This was based on OpenGL, so it wasn't unfamiliar to experienced 3D developers, but it pared back the calls and instructions to focus on those used in real-time 3D games.

To show off Glide's capabilities, 3Dfx didn't just have its own internal demos, but a range of Atari and Midway arcade games, including the racer, San Francisco Rush, and the beat-'em-up, Mace: The Dark Age. These ably demonstrated what the new hardware could do. All that was needed were some suitably awesome PC games.

The Orchid Righteous 3D was one of the first Voodoo boards to hit the market, along with Diamond's mighty Monster 3D

KILLER APPS

This was 3Dfx's one problem at launch. The technology itself was impressive, and the cards came with some decent demos, including a slick 3D combat demo, Valley of Ra, which featured amazing reflective surfaces and gouraud shaded characters, and a stunning dolphin sim, Grand Bleu. Orchid and Diamond took them around to show to eager PC journalists, and jaws consistently hit the floor, but there still wasn't a killer app.

At this point, the early 2D/3D graphics cards all tended to support the same games, and we'd got used to seeing the likes of Descent 2, Actua Soccer, Terminal Velocity and MechWarrior 2 with only mildly improved, filtered 3D textures running at frame rates that barely climbed above what you could get with a software renderer. The Voodoo 3D ran these games faster at higher resolutions, but nobody was going to pay £300 for that.

Luckily, 3Dfx soon had two absolute bangers. The first was Tomb Raider. Lara Croft's debut was already one of the most stunning-looking games around on the Sega Saturn, Sony PlayStation and PC, but the pixelated, low-resolution graphics meant that you weren't seeing it at its best.

However, just a few months after launch, the publisher, Eidos, released a patch that allowed you to run Tomb Raider under GLide. The effect was amazing, not only smoothing out the blocky textures and adding transparent water, but allowing you to play the game at a 640 x 480 resolution at close to 30fps. You saw it and you wanted Voodoo in your life.

With its high-res models and reflective surfaces, 3Dfx's lead tech demo was a jaw-dropper. Nobody had seen anything like this outside of Sega's Virtua Fighter arcade games

An even more impressive transformation awaited us with id Software's Quake. I first played Quake on a Pentium 133 laptop with 16MB of RAM, and the game was only just playable at a 360 x 240 (or half SVGA). And when I say playable, I mean the right side of 20fps.

Then 3Dfx released MiniGL, a cut-down version of OpenGL designed to handle just the functions used in Quake – id responded with a port of the game, GLQuake, which could take advantage of the MiniGL wrapper. The port had its problems, including gloomy brightness levels, but the bilinear filtered textures went from looking slightly rough to looking awesome, and you could now run the game at 640 x 480 in glorious 16-bit colour and still hit 30fps.

Serious PC gamers saw Quake running unaccelerated and then accelerated, then voted with their wallets. Sure, the new Pentium MMX CPUs released in 1997 could run the game at a decent lick, but did it look as good as Voodoo? Not even close.

GLQuake sold 3Dfx cards, and a growing user base boosted game support. True, 3Dfx had rivals. Videologic's PowerVR tech was affordable and efficient, but it also used an unconventional tile-based rendering pipeline and needed a faster CPU to get the best out of it. Rendition's Verite chipsets looked promising, but were too pricey and struggled with their 2D performance.

3Dfx grew to become a kind of de facto standard just as the next wave of 3D games started taking off. From Need for Speed II SE to Myth: The Fallen Lords, Shogo: Armor Division and Unreal, Voodoo Graphics made the best-looking games of the era look even better and run at what seemed incredible speeds. The PC was back on top as the most technologically advanced gaming platform of the era.

3Dfx continued through a glorious period. Its 1997 Voodoo Rush 2D/3D graphics chipset was admittedly a dud, suffering from a lack of memory bandwidth and sync issues with the on-board 2D graphics chip. However, 1998's Voodoo 2 was a worthy successor, arriving just a few months after another iD showcase, Quake II.

This purple period wasn't to last, as GLide fell out of favour and ATi and Nvidia delivered high-performance all-in-one graphics chips, but we owe 3Dfx a huge amount for bringing 3D power to the PC when it needed it most – and helping to show the world the full potential of hardware-accelerated 3D graphics. CPC

Readers' drives

Die Wasserkammer (The Water Chamber)

Aaron Fredregill transformed his Deepcool Steam Castle case into a dieselpunk stunner, with hand-cut copper piping, a Nixie tube clock and a plasma disk on the front panel

/MEET THY MAKER

Name Aaron Fredregill

Age 39

Occupation Automotive technician

Location Lincoln NE, USA

Main uses for PC 3D modelling/printing, gaming and video editing

Likes Fast cars, espresso, dogs and my wife!

Dislikes Silicon chip shortages

CPC: What was your original goal when you set out to build this system?

Aaron: My inspirations for any given project are kind of hard to nail down. I'm always building or modifying something. I'd gone down the basic gaming PC route a couple of times already, and I finally decided that I wanted to build a unique system. I'm a fan of steampunk, horror and gothic vibes. My original plan was a steampunk theme. However, several people have pointed out to me that what I've built is more in line with dieselpunk, being a bit darker than the more optimistic nature of steampunk. I tend to agree.

CPC: Where did the design process start?

Aaron: I knew the different elements I wanted to bring into the design from the start. It was then just a matter of figuring out how many of those elements I could incorporate into the case without going too far. A lot of the process just involved taking ideas from my head and working on them one at a time, with some careful measuring and cutting. I'm not sure a single idea even went onto paper – there were a lot of Sharpie marks on the case before I painted over it all.

CPC: What case did you base this on and why?

Aaron: The case was one produced by Deepcool called the Steam Castle. It looks more like a retro refrigerator than a PC case, and I knew I could work with it to make a PC fitting of the 'Die Wasserkammer' name.

CPC: How did you create the green electrical storm effect on the front?

Aaron: That effect is actually created by an active plasma disk. I've loved the effect they create ever since I saw one as a kid on Star Trek in the Borg regeneration alcoves. It's surrounded by an open aluminium fan grille from Mnpctech (**mnpctech.com**) and a layer of plastic to which I've applied some automotive tint to

keep the brightness down a little. I've also incorporated a Nixie tube clock above the plasma disk, which is backlit with green LEDs.

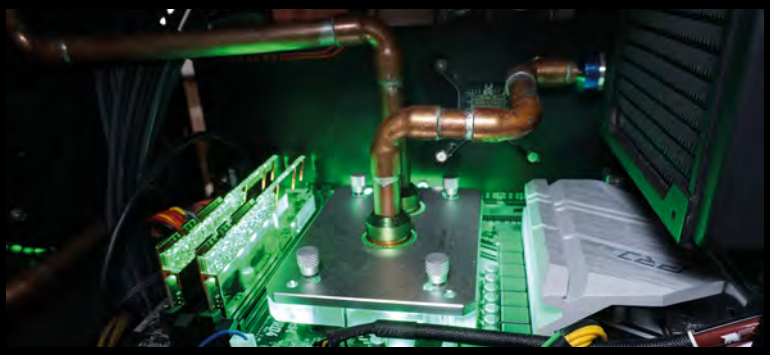
CPC: We love the mottled metal effect on the outside of the case – how did you achieve this??
Aaron: All of the paint work on the case came from spray cans. I wanted it to look like weathered iron. I used a grey 'hammered effect' paint to cover the majority of the case, and the other accents come from a spray paint that comes really close to looking like actual copper. I also used a lot of flat black brushwork to wash over almost every part of the case, which is an easy way to make it look more worn and older than it is.

CPC: What's that on the side panel?
Aaron: I originally had some cogs on the side; along with the open fan grille in the front, these were made from fan covers that I purchased from Mnpctech. However, I felt that area was one of the parts that didn't work for the aesthetics once I'd figured out that what I'd built wasn't really steampunk. The grille that's there now is actually the base of the Revenant statue that came with the collector's edition of Doom (2016). I found a weirdly sized 170mm fan that fits into it and aids cooling.

CPC: How did you create the wood panelling effect on the front?
Aaron: The wood effect is made with a high-quality textured vinyl, and it just about passes for the real thing.

CPC: Take us through the water-cooling system – how did you go about planning the loop, as well as routing and cutting/bending the piping?
Aaron: The water-cooling system came together slowly. The pipe is all copper with soldered copper fittings. I knew that I wanted as much of that piping to be visible on the side as possible. So, with that in mind, I laid out the major components in the available space and figured out the best way to route a single-loop system.

The only connection that isn't copper is the one between the



The grille that's there now is actually the base of the Revenant statue that came with the collector's edition of Doom 2016

reservoir and the pump, as I wanted to control the vibration and for that area to also act as the bottom mount for the reservoir. Most of this work was done slowly, cutting pieces of copper pipe and then experimenting to get the right angles before joining them together.

CPC: What coolant do you use?
Aaron: I originally used some green coolant, which was a nightmare. It looked great in the pictures, but clogged up all of the waterblocks with pearls after a bit. It was a Mayhems coolant called Aurora – I'm not sure Mayhems even makes it any more. Nowadays, I just use distilled water with a couple of stabilisers and maybe a little bit of green dye.

CPC: The copper heatsink fin stacks down the sides look great.
Aaron: They're a stock feature to the case, and one that I knew would look great with a reservoir recessed into the fins. They're all made of plastic with some convincing paint applied to them.

CPC: Is that a wood-effect expansion card?
Aaron: I originally had an EVGA GeForce GTX 980 Ti hybrid card that came water-cooled from the factory. I used the same vinyl overlay method on it that I used to create the wood effect on the front of the case. It also had a 'vertical mount', simply as a product of the micro-ATX board laying flat in the case, but it does do a good job of showing off the card.

I've since gifted that card to my brother, and put some copper piping in a prominent place behind the window, along with the waterblock that's now on my Radeon RX 5700 XT graphics card. The interior modifications don't go much past that area, since so little of it is visible behind the wide panel. The card you can see is an Elgato HD60 Pro capture card, which has had a little paint job because it's fairly visible behind the window now.

CPC: Was all the work done by hand, or did you use any CNC machinery?
Aaron: All the work was done with basic hobby-grade tools, apart from a few of the cuts made to the steel panels – I used an air-powered cut off-tool to make that work a little easier. Most of the mods on this case are bits that I fitted very precisely with quite a lot of Dremel work.

The Nixie clock on the top required a few components to be cut to make clearance, and another panel built behind it to close off the back. The reservoir on the side is one I chose after I measured the available space and figured out what diameter of reservoir I could fit in that space. There are no solid mounts on the

reservoir – it's held in place by the lower hose, as I mentioned before, along with the copper return and fill lines located at the top and side, plus a few strategic zip ties.

CPC: Did you come across any difficulties?
Aaron: A big concern of mine was the plasma disk and having that current flowing freely right by critical electrical components. A lot

of care was taken to ensure that no electrical conductivity was present between the plasma disk and the case. One issue I later discovered was that the open aluminium grille surrounding it, even though there is a gap, has a slight bit of electrical charge to it while the plasma disk is on. It's not a major concern, since the grille is also isolated, but it's something I'm aware of.

Solidly mounting the reservoir with just the tubing connections, as I mentioned before, was another struggle, but I had to do it, as even a basic mount pushed the reservoir our further than I wanted it. Getting the right angles on the fitting took quite a bit of finicky pipe bending (and a few zip ties) to make it all fit well with a solid connection.

CPC: How long did it take you to complete this build, from start to finish?

Aaron: I'd already been using the case for a while without getting into modifying it. When I got started, it probably took a good couple of months to make this system, between tweaking bits of it, waiting for parts and figuring out what finishes I wanted to use.

CPC: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect?

Aaron: I have a hard time 'completing' projects, because there's always something else I feel I could do a little better, but I'm calling this one done. I'm happy with the result, and feel like the project has lived up to the original concept well enough. CPC

SYSTEM SPECS

CPU AMD Ryzen 5 3600

Case Deepcool Steam Castle

GPU AMD Radeon RX 5700 XT

Storage 1TB Intel 660p SSD, 4TB Seagate BarraCuda hard drive

Memory 16GB (2 x 8GB) G.Skill Trident Z Royal 3200MHz

Motherboard ASRock X570M Pro4

PSU OCZ 700W

Cooling 1 x 120mm XSPC radiator, 1 x 240mm XSPC radiator, 3 x Noctua NF-A12 fans on the radiators, XSPC D5 pump with acetal top, Bykski CPU waterblock, Bykski GPU waterblock, 170mm intake fan. All radiator fans are in an exhaust/pull configuration. Hard, soldered copper tube with 90-degree fittings

WIN CORSAIR HYDRO X WATER-COOLING GEAR

CORSAIR

To enter your rig for possible inclusion in Readers' Drives, your build needs to be fully working and, ideally, based in the UK. Simply send us a couple of photos on Twitter (**@CustomPCMag**) or Facebook (**CPCMagazine**), or email low-res ones to **ben.hardwidge@raspberrypi.com**. Fame isn't the only prize; you'll also get your hands on some fabulous prizes, courtesy of Corsair.

Corsair Hydro X Series XD3 RGB Pump/Reservoir C

WORTH £151

The Corsair Hydro X Series XD3 RGB Pump/Reservoir Combo features a high-performance DDC PWM pump, integrated RGB lighting and in-loop temperature sensor to drive even the most compact custom cooling systems. It has a high-performance Xylem DDC PWM pump controlled via PWM to deliver the perfect flow balance for your loop. There are also 16 individually addressable RGB LEDs, which light up the pump head to produce stunning, customisable lighting effects to match your build.

Corsair Hydro X Series XC7 RGB CPU Water Block

WORTH £70

The Corsair Hydro X Series XC7 RGB CPU Water Block combines premium construction, vivid RGB lighting and extreme cooling performance to become the centrepiece of your water-cooling loop. It has a nickel-plated copper cold plate and more than 60 high-efficiency micro-cooling fins, which efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose the AM4/LGA1151 or LGA2066 version.

Corsair Hydro X Series XR5 240mm Radiator

WORTH £55

The Corsair Hydro X Series XR5 240mm Water Cooling Radiator delivers extreme custom cooling performance, with a 30mm radiator thickness and premium copper core. Its dual 120mm fan mounts on each side are ready for your most ambitious custom cooling build, and its 25 micron-thick cooling fins offer a high thermal transfer rate.

JAMES GORBOLD / HARDWARE ACCELERATED

MINING VS GAMING, ROUND TWO

James Gorbold takes a closer look at Nvidia's second attempt to make more GPUs available to gamers

With much of the population in lockdown over the past year and a half, there's been unprecedented worldwide demand for gaming GPUs. On top of that, the huge rise in value of some cryptocurrencies has created additional massive demand for GPUs. In addition to ramping up production, Nvidia's response has been twofold. Firstly, to develop a new range of dedicated mining GPUs, the CMP HX series, although these have yet to seen in the wild, so it's impossible to judge their desirability to miners.

Nvidia's other response is an attempt to reduce the attractiveness of its 30-series GPUs to miners, thereby freeing up stock for gamers. The first GPU to get this treatment was the RTX 3060, with a driver that detected when the Ethereum mining algorithm was being run and halved the hash rate, making it less profitable for mining and in theory less desirable to miners.

This has now been improved with a new mining speed limiter, which uses a secure handshake between the driver, the GPU and the graphics card's BIOS to reduce performance. This technology, known as Lite Hash Rate (LHR), is present in the newly launched RTX 3070 Ti and 3080 Ti, which are reviewed in this issue, plus RTX 3080, 3070 and 3060 Ti cards made from late May onwards.

You can spot these newly made RTX 3080, 3070 and 3060 Ti cards by the addition of 'LHR' in the name of the cards. These LHR cards only reduce the Ethereum mining speed, however, not mining other cryptocurrencies, gaming or rendering performance.

While I'm not a fan of cryptocurrency mining, as it consumes vast amount of electricity and hardware yet barely has any intrinsic value or purpose, I was curious to gauge the effectiveness of this LHR mining speed limiter on these new GPUs.

Comparing one of the new RTX 3070 LHR GPUs with an original 3070 was revealing. Using Phoenix Miner, the Ethereum hash rate dropped from 52MH/sec on the original to 25MH/sec on the LHR card, a drop of 48 per cent. By way of comparison, the RTX 3070 Ti which has LHR baked into the design, mined at 38MH/sec – 29 per cent slower than the original RTX 3070.

This is enough of a performance drop to make Ethereum mining far less attractive and potentially unprofitable on LHR GPUs. What's more, unlike the first implementation of LHR on the RTX 3060, which was controlled solely by the driver and was soon cracked, returning 3060 cards to full mining performance, the second implementation of LHR seems more secure, and hasn't been cracked at the time of writing.

> This performance drop is enough to make Ethereum mining far less attractive

As such, while new GPUs such as the RTX 3070 Ti and 3080 Ti are by no means revolutionary, merely providing stepping stones between existing GPUs, they're more important than the benchmark and price data would suggest. The LHR technology is, if you'll forgive the expression, a game changer, as the new GPUs are no longer so desirable to miners.

That said, LHR alone won't open the floodgates and see a deluge of GPUs suddenly being available to gamers. The sheer demand and backlog of orders for GPUs worldwide, plus ongoing shortages of components, mean it will take months for GPU availability and prices to return to normal. Still, LHR is the first genuinely good step in the right direction I've seen from any GPU manufacturer – AMD and Intel had better be taking note. CPC

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

G-MASTER™
#MONITORS4GAMERS
by iiyama

UNLEASH YOUR FULL GAMING POTENTIAL

Get the competitive edge you need to unleash your full gaming potential with the 24'' and 27'' G-Masters offering 0.8ms MPRT and 165Hz refresh rate. Armed with FreeSync Premium you can make split second decisions and forget about ghosting effects or smearing issues. The ability to adjust brightness and the dark shades with the Black Tuner delivers greater viewing performance in shadowed areas and the IPS panel technology guarantees superb image quality.

165 Hz | FAST IPS | 0.8ms MPRT | BLACK TUNER | HDMI DISPLAY PORT | USB HUB

Fixed stand versions:
24'' G2470HSU-B1 & 27'' G2770HSU-B1

Version with height adjustment:
24'' GB2470HSU-B1 & 27'' GB2770HSU-B1

Find your match at
gmaster.iiyama.com

XS SYSTEMS PRO GAMING

You dream it. We build it.

PCs designed and custom-crafted for a totally individual look in your home

Scan recommends
Windows 10

Contact the Custom Build Team

scan.co.uk/3xs/custom-shop • 01204 47 47 47

SCAN